the Mineralogical Record

JULY/AUGUST 1971
VOLUME 2/NUMBER 4

WHAT'S YOUR BAG

IF IT'S MINERALOGY, GEOPHYSICS, SEISMOLOGY, VOLCANOLOGY, PETROLOGY, PALEONTOLOGY OR ANY OTHER GEOSCIENCE YOU CAN COME UP WITH THEN WE CAN HELP YOU WITH YOUR RESEARCH BECAUSE OUR BAG IS GEOSCIENCE LITERATURE. WE HAVE EXTENSIVE BACKFILES IN ALL THE IMPORTANT JOURNALS AS WELL AS GOVERNMENTAL REPORTS IN SEVERAL LANGUAGES. WE HAVE NOT AS YET ACQUIRED EVERYTHING THAT WAS EVER WRITTEN ABOUT GEOLOGICAL MATTERS BUT WE ARE TRYING. YOUR INQUIRIES ARE SOLICITED.

FRANCIS PAUL

GEOSCIENCE BOOKS AND PERIODICALS
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Luzonite

- copper arsenic sulfide
- Chinkuashih mine, Keelung, Taiwan
- 4x5 $50.00, 2x3 $20.00, 2x2 $10.00, 1x5 $5.00, 1x1 $3.50, 1" $2.50
- lavender-gray, metallic luster, nearly pure

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- from $4.50 to $12.50

Pandaite

- hydrated barium strontium member of the pyrochlore-microlite series
- Panda Hill, Tanzania
- ref: E. Jager *et al*, Min. Mag. *32*, 10-25 (1959)
- single, loose octahedral crystals suitable for micromounts - @ $5.00 ea.

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- Narushima, Nagasaki-ken, Kyushu, Japan
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editorial matter

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

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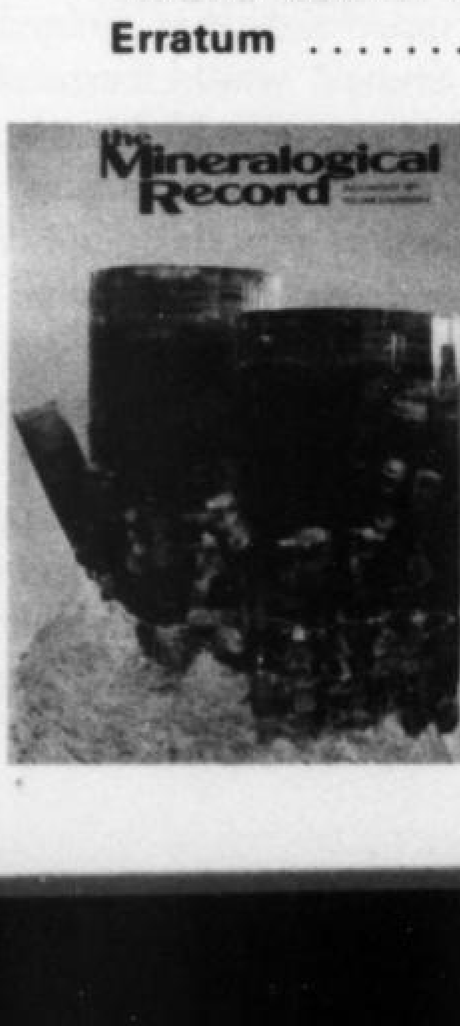

Elbaite, from Pala, San Diego County, California. This fine specimen has long been considered by many collectors the finest mineral specimen in the collections of the Smithsonian Institution. The two largest crystals are nearly 6 inches (15 cm) in length. Photograph by Joel E. Arem.

To the Editor

Dear Sir:

In the year and a half we've had the pleasure of receiving the *Record* it has become a treasure to read and re-read and share with others.

Since we've been aware of the fact that the *Record* has only half enough subscribers to break even we've been wondering if each of us who now subscribe couldn't get one new customer. After all, we should know at least one other amateur mineralogist who *needs* the *Record* too.

Along with other subscribers and Friends of Mineralogy we will be representing the *Record* at shows in Northern California. While this will be going on all over the United States we're inclined to think that it will not replace individual effort to see that the *Record* continues to grow and expand; so our plea is, "EACH ONE SELL ONE."

Harold and Violet Frazier
Pt. Arena, California

A great idea, it should help very much. Ed.

Dear Sir:

The review in the March/April issue of my book by Joel E. Arem, whom I do not know personally, was very kind and generous. It is much appreciated, an encouragement to future work.

Having taken an active part in mineral (rock-gem-lapidary-fossil) clubs since 1934, I am amused by the recent remarks (in several publications) on the quality of meetings and the lack of educational activities. It seems inevitable that these clubs reflect the social and intellectual concerns of a majority of the members, so that more and smaller local clubs, perhaps combining in larger affairs, may be the answer. The Colorado Springs Mineralogical Society, for example, has a separate inner study group, and of course a number of clubs conduct regular courses.

On the negative side, one of the reasons why educational talks are so seldom scheduled is that they are often boring. The famous Harvard entymologist William Morton Wheeler once said: "The truth is that the amateur naturalist radiates interest and enthusiasm as easily and copiously as the professor radiates dry-rot." A few lines later he excluded "dear old, mellow, disinfected professors of the type of Louis Agassiz...who could enter at once into sympathetic rapport with the humblest amateur."

On the positive side, learning is just as real when done by personal contact with other collectors as when acquired in a classroom or library, and often is more effective. The poor abused dealer may transmit much information of value to his customers. Although I stand firmly with these who disapprove of the present rigidity of the rules for judging at shows, the emphasis on systematic labeling (however artificial) may jog favorably the learning process.

A member of one of the clubs I attended recently returned from a most successful collecting trip, but nothing was said about it at the meeting. Instead, twenty minutes were devoted to awarding him the Order of the Purple Thumb because he had banged his hand during the last local field trip. What can be done about this sort of trivia? Patience, more patience, and perhaps other virtues not yet discovered; meanwhile the formula of St. Paul: faith, hope, and charity.

Richard M. Pearl
Professor of Geology
Colorado College
Colorado Springs

COMPETITIVE EXHIBITING

Dear Sir:

The variation on competitive exhibiting you propose is so simple and fair it can hardly be ignored by the Federations.

One specie being judged for "Best in Show" would certainly be an incentive to hundreds who are now not entering competition cases of 25 minerals, especially when the show is hundreds of miles from their home.

I join with those asking no lapidary please, in the *Record.*

All credit to you for thinking of it first!

Mrs. Wallace McGregor
Oceanport, New Jersey

Dear Sir:

It is indeed a pleasure to read an editorial on competitive displaying which dispassionately mentions some of the current difficulty in applying the Uniform Rules. It is equally interesting to note your suggestions regarding a new type of mineral competition; and your conscientious follow-up to define the basis by which this competition might be applied.

I do not know if "Best of Show" competition has any broad-based appeal to mineral collectors; but should your editorial prompt a demand for this (or any other variation regarding competition), the following information will be helpful.

Competitive displaying exists because a significant number of hobbyists have asked for the opportunity. The mineral display classes and the criteria by which they are evaluated (quality, showmanship, rarity, and labeling) exist also because a significant number of mineral collectors have asked for them. Many changes and additions have occurred in relatively few years in response to the wishes of the collector. The process of change has, as you noted, caused much discussion and much compromise as ideas from all parts of our nation come together. A working procedure has evolved to coordinate the requests for change through the regional federations. Each federation has a Uniform Rules chairman. It is his responsibility to represent the wishes of hobbyists within his federation at the annual meeting. Each federation has an equal vote on all proposed changes, and only the federations may vote.

It should now be obvious that if a change, for example the inclusion of "Best of Show" mineral competition is desired, the request must be directed to the federation Uniform Rules chairmen. One of the following people would be pleased to receive any thoughts regarding mineral competition:

CFMS Sharr Choate
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San Jose, California
95125

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EDITORIAL PAGE

Variety Selenite?

At a recent mineral show I was reading the score cards carrying the remarks of the experts who judged the mineral exhibits entered in competition at that show. My attention was drawn to one remark that stunned and upset me. The card read "Gypsum, should be Gypsum variety Selenite, -2 points." One of the judges of this collection was a high official of the American Federation, a long-time advanced mineral collector, a gentleman of the first order, and a good friend of mine who came to the show equipped with impressive credentials for judging and all of the pertinent reference literature. That such a crime upon reason and logic could have been perpetrated by this man was very disturbing. Further, this one example of outrageous unreasonableness casts considerable doubt upon the viability of the entire competitive exhibiting program.

Here was an example of an exhibitor losing points for calling a mineral by its *proper name*! In modern mineralogic literature the term variety is very nearly always applied only to minor variations in the chemistry of a mineral. Thus freibergite, for example, is a silver-bearing tetrahedrite, or a *variety* of tetrahedrite. Silver must be present in substantial amounts, no limits set except that if silver should be present in an amount greater than copper, the mineral should be designated a *new* species. The assignation of varietal names even to these minerals with slightly different chemistry is a practice that has just about been abandoned. Why freibergite when argentian tetrahedrite tells exactly what it is and does not clutter the nomenclature with a new name? Spessartine, pyrope, and grossular, on the other hand, are not varieties of garnet, they are distinct and legitimate species. The same is true of the tourmalines elbaite, schorl, and dravite.

Selenite does not qualify as a variety of gypsum, it is a name inherited from antiquity. Over the years it has been used in reference to any gypsum in crystals that are well-formed and visible without magnification. The other "varieties" of gypsum recognized by the Uniform Rules people are *massive* and *satin spar*. These clearly are not varieties, they are HABITS of gypsum. When I inquired as to why points were not deducted for the omission of "habit" names on other specimens, I was told that their use is required only when such terms have been long established and are widely used. In spite of this I noted that no points were taken for the exhibitor's failure to label his colorless quartz - Quartz variety Rock Crystal. Certainly rock crystal is a well-established and widely used term. There were numerous other examples of how inconsistently this rule was applied and how arbitrary it really is. I suspect the rule was written so that exhibitors could bypass the "duplication of species" ban. Without this exception exhibitors could not place colorless quartz, rose quartz, amethyst, etc. in the same case; with it they can. It seems completely ridiculous to permit an exception for quartz but prohibit it for other species that are found in a variety of colors.

Thus we see here a glaring example of a very bad rule, one which is absolutely arbitrary and works toward diminution of faith in the whole system. Of greater importance, however, is that this rule tends to complicate and confuse the nomenclature. All rules should favor clarification of the nomenclature snarl and help to eliminate the ambiguities. What could be more right and proper than requiring that a mineral be called by its right and proper name? We don't need a label to tell us that a gypsum specimen is beautifully crystallized or that the quartz is rose colored. I urge that all concerned exhibitors write to their rules representatives (see letter from Terry Huizing, this issue) and insist that this regrettable rule be eliminated. Be sure to specify Rule B-1, (a), (1), on page 9, in the "Regional and Local Uniform Rules" book. ■

John S. White, Jr.

The Record Bookshelf

JOEL E. AREM

Crystals and the Polarising Microscope, *by N. H. Hartshorne and A. Stuart,* American Elsevier Pub. Co., New York, 1970, 614 pp., ($29.50)

Seldom has this reviewer encountered a textbook that might justly be called "exhaustive", yet this accolade is well deserved in the case of *Crystals and the Polarising Microscope.*

Excellent books have been written about the theory of optical crystallography, or the identification of inorganic materials by optical microscopy. Yet none of these can offer the comprehensive coverage of polarized light techniques to be found in Hartshorne and Stuart's text. Designed for the student, the book does more than merely outline or mention various tools and techniques recommended for specific problems. Rather, the authors have given a detailed, step-by-step description of methods, as well as a lengthy explanation of nearly every routine chore involved in polarized light microscopical investigations. Not one but several spindle stages are described and figured in detail. Chapter titles include "The crystalline state", "The morphology of crystals", "The optical properties of crystals", "The polarising microscope", "Rotation methods", "Hot and cold stages", "Chemical and industrial applications", "Liquid crystals", and "Polymers and biological materials". The book is, in short, comprehensively thorough in coverage of material, detailed in presentation and instructive in outlook.

I pointedly searched, as I read, for structural explanations of optical effects. After many pages of crystallography, crystal growth mechanisms, crystal optics and morphology, all relevant and well presented, I began to expect disappointment. But from pages 133 to 157 I encountered one of the most lucid explanations of the relationship between optical properties and crystal structure I have found in current literature.

The only adverse comment I can make actually involves the attitude of the reader. One must have a strong desire to learn all about the behavior of crystals in polarized light in order to benefit from this book. It is eminently readable throughout, but must be read in proper sequence for maximum benefit. This means plodding, in some places, through pages of "rote" material that may be review to some readers. The presentation of basic crystallography and morphology is classical in outlook, and relatively uninspired. No matter, however, for the whole justifies the parts.

The book does not tabulate data for identification of materials, since its aim is to train the student in the theory and use of the polarizing microscope. A large nomogram for determination of refractive indices is included, as well as a good index and extensive literature coverage. Though the purchase price may seem high, the book is almost twice as voluminous as most other similar texts currently available. The information contained in *Crystals and the Polarising Microscope* is not likely to go out of date, and its great scope should merit the book serious consideration for purchase by anyone interested in becoming proficient in the use of the polarizing microscope. ■

Crystals and their Structures, *by Arthur P. Cracknell,* Pergamon Press, London, 1969, 231 pp., hardcover ($7.00) and paperback ($5.50)

Many books are currently available that present the basic theories of crystal symmetry, structure, and bonding. Cracknell's book was written for the British high school or first year university student, and presents these subjects in a logically developed manner. The book's chief merits are therefore a discursive, almost conversational style, and rather thorough coverage of material.

The presentation of basic concepts of symmetry, lattices, space groups, indices and other crystallographic topics parallels that in most other texts. Illustrative diagrams are clear and uncluttered, though not necessarily original or innovative. One of the major achievements of the text, however, is a fairly detailed survey of color symmetry and group theory. These are fundamental crystallographic subjects that receive very little attention in most other books for introductory courses or for nontechnical readers.

Certain of the phrases used by Cracknell (such as: "symmetry seems to imply a tidiness in the shape of an object...") may appear typically British to some readers (they did to this writer), adding a subtle freshness to the descriptive passages. Although much of the material covered appears elsewhere in much the same format, Cracknell's book brings it all together in a thoughtfully comprehensive way. The relatively low cost of the paperback edition makes it even more desirable as an addition to one's mineralogical library. ■

Irradiation Colors and Luminescence, *by Karl Przibram,* Pergamon Press, London, 1956, 332 pp., ($10.00) (Transl. from 1953 German ed. by J. E. Caffyn)

The color of a mineral is one of its most striking and most immediately obvious characteristics. Similarly, the cause of an unusual mineral color is almost always of some interest, even to the most casual collector. For these reasons Przibram's book, well known in the German edition and now available in English, is a welcome source of fascinating information.

The book is as much a wealth of references to original work as it is a summary of virtually all important published research on color in solids. The production of color in the laboratory is described by way of introducing natural processes. Much attention is given to the alkali halides, since the theoretical aspects of the causes of coloration in these salts are fairly well understood. All types of coloration processes are discussed, including photo-

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Personality Sketch

William Thomas Pecora

Photo courtesy of U.S. Department of Interior, Geological Survey

In this issue we salute Dr. William Thomas Pecora who has recently been named to the post of Under Secretary of the Department of the Interior. Other publications will be detailing his numerous accomplishments in administrative work; here, appropriately, we should like to tell about his accomplishments in mineralogy and petrology.

The geology majors at Princeton University and Harvard University receive part of their basic training in field work in Montana and this was where Bill began his work on nepheline syenite pegmatites - in the Bearpaw Mountains - which led to his first big publication after joining the U.S. Geological Survey in 1939. This was titled "Nepheline syenite pegmatites, Rocky Boy Stock, Bear Paw Mountains, Montana," and was published in the *American Mineralogist,* vol. 27, p. 397-424, 1942. Soon after the beginning of World War II, however, he was chosen to be one of a Survey team engaged in cooperative work with Brazilian geologists locating scarce mineral commodities, and this gave him an intimate knowledge of Brazilian pegmatites.

In 1945, F. H. Pough and E. P. Henderson discovered a new hydrous sodium aluminum phosphate in the Corrego Frio pegmatite in Minas Gerais, Brazil, which they named brazilianite. Returning to the United States at the end of the war, Pecora continued work on material from the Corrego Frio pegmatite and in 1949, with J. J. Fahey, published descriptions of two additional new minerals. These he named scorzalite, for Dr. Evaristo Pena Scorza, and souzalite, for Dr. Antonio José Alves de Souza, both of the Departmento Nacional da Produção Mineral in Brazil. Both minerals are hydrous Fe Mg Al phosphates. Scorzalite is massive and blue; souzalite is fibrous, green, and a hydrothermal alteration product of scorzalite. Later, in 1949, Bill and his co-author Fahey described the second reported occurrence of scorzalite, found in 1947 in the Victory pegmatite, two miles northeast of Custer, South Dakota. Soon afterwards they published on the lazulite-scorzalite isomorphous series, in which a third occurrence of scorzalite (from White Mountain, California) is listed. These articles have appeared in the *American Mineralogist,* vol. 34, p. 83-93, 1949; vol. 34, p. 685-687, 1949; vol. 35, p. 1-18, 1950.

When the colleagues of Dr. Clarence S. Ross and Dr. Waldemar T. Schaller sponsored a special issue of the *American Mineralogist,* Bill (with Joe H. Kerr as his co-author) contributed an article entitled "Burbankite and calkinsite, two new carbonate minerals from Montana," an outgrowth of his continuing work in the Bearpaw Mountains (*American Mineralogist,* vol. 38, p. 1169-1183, 1953). Burbankite is an anhydrous carbonate, $Q_6(CO_3)_5$ where Q represents Na, Ca, Sr, Ba and rare earths. Calkinsite is a hydrous carbonate $(RE)_2(CO_3)_3 \cdot 4H_2O$. These two minerals are named for USGS colleagues, Wilbur S. Burbank, now retired and living in Exeter, New Hampshire, and Frank C. Calkins, both of whom formerly worked on mineral deposits in the West. Bill was also a co-author (with Marie L. Lindberg and A. L. deM. Barbosa) on another article in the same volume entitled "Moraesite, a new hydrous beryllium phosphate from Minas Gerais, Brazil" (*American Mineralogist,* vol. 38, p. 1126-1133, 1953). Moraesite, named for Dr. Luciano Jacques de Moraes, Brazilian geologist and former Director of the Departmento Nacional da Produção Mineral, was found at the Sapucaia pegmatite mine, the same locality from which frondelite and faheyite were first described by Lindberg in 1949.

(Continued on next page)

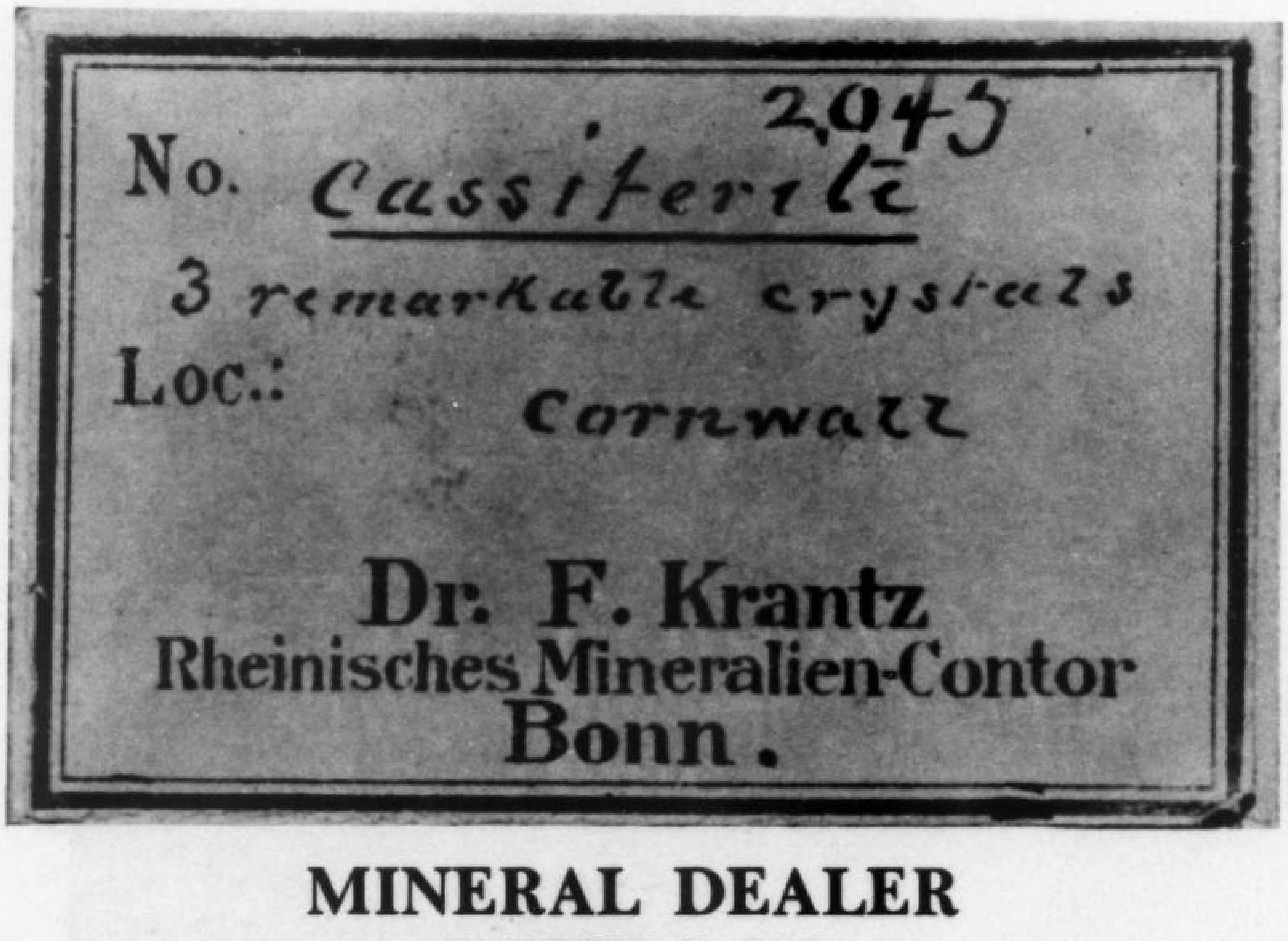
In 1954 Pecora, again with Joe Kerr as co-author, described the first North American occurrence of whewellite, a calcium oxalate monohydrate found as a crystal on calcite crystals in a septarian limestone concretion in the Late Cretaceous Bearpaw shale near Havre, Montana. The following year (1955) Lindberg and Pecora contributed an article to the issue of the *American Mineralogist* dedicated to Edward Henry Kraus on his 80th birthday. Dean Kraus, now 95 years old and in good health, lives in Ann Arbor, Michigan and is the Honorary President of the Mineralogical Society of America. The article described two new phosphate minerals from the Sapucaia pegmatite mine. These were tavorite, named for Dr. Elysairio Tavora, professor of mineralogy at the Universidade do Brazil, and barbosalite, named for Dr. A. L. deM. Barbosa, professor of geology at the Escola de Minas in Belo Horizonte, Brazil. Tavorite is a yellow hydrous lithium ferric phosphate; barbosalite is a hydrous ferrous ferric phosphate, the iron analogue of scorzalite. (*American Mineralogist,* v. 40, p. 952-966, 1940).

Considering Pecora's long-time work in Montana in an area of alkaline igneous rocks and his personal acquaintance with other similar areas in the United States, it was appropriate that he should have been chosen to write a review article on the subject of carbonatites. Published in 1956, it is still the best synthesis of what was known about carbonatites up to that time. (*Geol. Soc. America Bulletin,* v. 67, p. 1537-1555, 1956).

The recognition of undiscovered minerals, the field work, and the published scientific papers portray the geologist and the mineralogist, but what of the person?

Bill Pecora is an extrovert. He likes people and they like him. In talking with him, people find themselves listening and believing, and well they might for what he says is usually true. His sense of humor is always close to the surface and he knows when to use it. A few days after he was appointed Chief of the USGS Branch of Geochemistry and Petrology, on February 1, 1957 (his 44th birthday), he bounced into the annual Branch Chiefs' meeting brandishing a large saber and transformed that usually sedate gathering into something a bit more lively.

Knowledgeable and witty on a wide variety of subjects, and apparently never at a loss for the right words, he is literally "golden-voiced". He can discuss cyclical changes of the stock market as comfortably and probably more convincingly than the man from Merrill Lynch. Many people who recall Bill adlibbing his way around the stage in a Pick and Hammer Show realize that in this man the Interior Department has an intelligent and eloquent spokesman. There's no doubt he would still prefer to be out in the field finding more new minerals, but as he himself says, there is a job to be done and he feels he can do it so he has chosen that trail. We wish him all the luck in the world!



No. 2045 Cassiterite
3 remarkable crystals
Loc.: Cornwall

Dr. F. Krantz
Rheinisches Mineralien-Contor
Bonn.

Joel E. Arem

MINERAL DEALER LABELS ???

This Krantz label is not terribly old or rare, but we find it interesting. If you have a favorite dealer's label that is old, rare, or just interesting, send us a photograph of it (with caption) and we will print it in the **Record.**

The 1971 Pacific Micromount Conference

By Garrette Powell Baker

The seventh annual Pacific Micromount Conference, held in wonderful, foggy Santa Monica, California, was in all respects a great success. The theme of the Conference was "Copper Minerals" and the success of the meeting, hosted by the Southern California (Temblorville) Micro Mineralogists, is largely due to the following events chairmen: Gus Meister, Program; Al Valenti, Facilities; Charles and Juanita Curtis, Publicity; Marion Godshaw, Reservations; and Wayne and Dona Leicht, overall Conference planning.

The activities began unofficially Friday evening with preregistration and cocktails, followed by several excellent, impromptu slide programs and additional cocktail breaks (far better than coffee breaks). Charles Curtis led off with his new slide program on the Gold Hill, Utah mining district. Charles outlined the area's geology and mineralogy in his presentation, which was accompanied by a number of very fine photomicrographs of specimens recently collected in the area.

Dr. Joel Arem then followed with a set of specimen slides photographed with a "new" lighting technique he has developed, a technique so simple and logical that we should all have thought of it years ago. The lighting system uses three distinct light sources, each in precisely the manner in which it was designed to be used. A 2-tube desk fluorescent lamp provides general "fill" illumination. A high intensity (tensor) lamp, provides specimen highlights. The final touch is a high intensity narrow-beam microscope lamp, whose beam is directed at the major crystal on the specimen to be photographed. The beam penetrates the crystal and is disrupted (scattered) by the specimen's internal structure, causing a burst or explosion (to use Joel's term) of light within the specimen. A word of caution this technique is not to be used with light-sensitive (or heat-sensitive) minerals. Joel also recommended using Julius Weber's suggestion to photograph red minerals with Kodachrome and blue-green minerals with Ektachrome. In other words, match the color balance of the film to the subject. Joel uses Kodachrome A in his work, as the color response seems to be well balanced for the illumination used.

After a short break for liquid libation, Lou Perloff presented an excellent collection of copper mineral slides in order of their Dana classification. This writer enjoyed the slides immensely, but was sporadically saddened to note specimens that in some way matched his unidentified ones. Perhaps I'll have better luck next time.

Del Oswald was the anchor man for the evening. He gave a short slide-talk on the Jefferis Collection at the Carnegie Institute in Pittsburgh. There are several parts to this collection, both macro and micro, and Del spoke chiefly about the micro collection dating from the mid 1880s. The specimens are mounted on corks in one-inch boxes—that seems somehow familiar! The unique points of the collection, discounting its similarity to today's techniques, are that it dates from the 1880s and that the corks are equipped with brass rings to protect the specimens. Del is presently reworking and cataloging the collection in his home. This must surely be a real work of love for Del since the collection, when retrieved from storage was, to quote Del, "a real mess." Specimens were not only broken from their mounts, but had had their labels shuffled.

Saturday morning, the first official day of the conference, dawned in typical Santa Monica fashion to the sound of a fog horn!

The conference opened at 8:00 A.M. with registration and got underway at 9:30 with the first scheduled program. Dick Thomssen spoke on the "Paragenesis of Copper Deposits." Dick spent perhaps an excess of time on the ideas of various schools of thought regarding ore genesis, but it was all well presented. The discussion of oxidation-reduction in the formation of copper minerals was limited by time (the sequential order of the equations and the causes and effects of the processes were clarified Sunday by Paul Desautels). The problem of paragenesis is an unbelievably complex one, but the huge number of copper minerals vastly compounds the problem for the mining geologist interested in copper deposits.

Following Dick Thomssen's talk was a workshop session that lasted until lunch time. During this first workshop I got together with Dr. Alan Mitchell of Pacific Grove, California, and we went over the 60-odd specimens collected (and identified) from Gold Hill, Utah over the last Labor Day weekend. We each had about 30 specimens and found only 7 duplicates between us. We vowed to make another trip to Gold Hill.

Dr. Joel Arem, staff Crystallographer at the Smithsonian Institution, was our speaker for the afternoon session. Joel spoke on "The Role of Copper in Silicates," and discussed why there just aren't very many copper silicates, of which only four or five are reasonably common. He did a fantastic job of walking us through the explanation of the properties of the divalent copper ion, describing how its electronic structure makes it nearly impossible for the ion to fit comfortably into a rigid silicate tetrahedral or octahedral cavity. If copper does enter a silicate, it tends to fit into a distorted site, and this may account for the scarcity of copper silicates. Joel also explained that copper silicates seem always to be secondary minerals, and never form in an original silicate melt or in unoxidized ore bodies. Since Joel used the term "never," it is up to one of us to find a primary copper silicate, giving him the exception to his rule and yet another strange "beastie" to bug him.

During the workshop following Joel's talk, I learned from Neal Yedlin, the world's largest micro mounter, that he is, in reality, 14

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NEW MINERALS FROM CALIFORNIA

In the 104 years from 1867 through 1970, 102 minerals have been described as new species from California. Seventy-four remain as recognized species. The other 28 have been shown to be identical to previously described species, varieties, mixtures, or of doubtful composition and validity.

The first new mineral described from the State was partzite, which Arents (1867) described from the Blind Spring Hill silver district near the northern end of the Owens Valley in Mono County. It was no sooner described than it was questioned (Blake, 1867) as probably a mixture. However, more recent work by Mason and Vitaliano (1953) supports the validity of the species - so it stands as number 1.

The large number of new minerals described from California during the following century is due to the diversity of the geologic provinces of the State. Eighty-three of the 102 described came from four well-defined, relatively small districts. Twenty-three came from the lake bed deposits of Death Valley, Searles Lake, and Kramer, all of which fall within a radius of fifty miles in the desert region of the southern part of the State. Twenty were reported from the pegmatites and associated contact rocks in a fifty mile long north-south trending zone in the Peninsular Ranges of southern California. Twenty-eight were from the central 200 miles of the Coast Ranges, an area dominated by the Franciscan formation and associated serpentinites.. Twelve were from the southern, NW-SE trending, section of the gold-bearing area along the western side of the Sierra Nevada Province.

Photography by
Charles H. Baines
Mineral Research Society
of California

The Lake Bed Minerals

Twenty-seven of the 102 new minerals described from the State were from Lake bed deposits. Sixteen of these were borates, eight of which came from the Furnace Creek Wash and the eastern edge of the Black Mountains in Death Valley National Monument. All eight species are currently considered valid. Four of the 16 borates, along with two associated sulphides, gerstleyite and greigite, were described from the massive borate deposit at Kramer. One of these, lesserite, is now considered identical with inderite. Two borates, neocolemanite and veatchite, were found in the Tick Canyon borate deposit of Los Angeles County. Neocolemanite was found to be identical with colemanite. Teepleite was described from Borax Lake in Lake County in the Northern part of the State.

Description of new borates has followed the progressive development of the borax industry in the State. Tincalconite, the pentahydrated alteration of borax, was the first borate described from the State. It was identified by Shepard (1878) only as "from California." The exact type locality might have been Death Valley, Searles Lake, or Borax Lake, each being known before 1878 as source of borax.

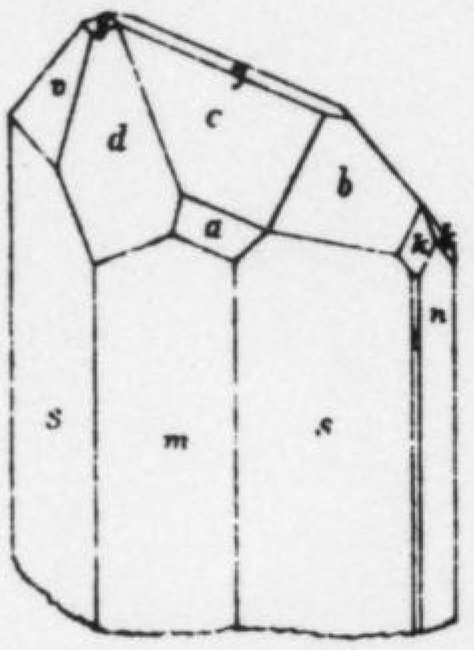
Colemanite, the second new California borate, was described in 1883, only a year after the rich colemanite beds were found in the Furnace Creek district. These deposits were not worked intensively until the early 1900's. Then in 1903 bakerite was described and, in 1914, inyoite and meyerhofferite - all from the Furnace Creek district.[1] In 1927 the rich kernite and borax deposits of Kramer were discovered, followed by the identification of kernite (1927) and probertite (1929). Increased professional development in the industry and detailed investigation of borate resources by the U.S. Geological Survey produced seven new minerals from the Furnace Creek and Kramer deposits between 1956 and 1970.

Nine of the new lake-bed minerals were from Searles Lake (in the northwest corner of San Bernardino County, twenty miles southwest of Death Valley, and about 45 miles north of Kramer). Of the nine, four are sulphates, four are carbonates, and one is a borosilicate. All are considered valid species.

The salts of Searles Lake were first mined in 1873 when borax was scraped from the mud along the margin of the main salt area. In 1884, hanksite, the first new mineral from the district, was described. In 1887, drilling was started in the lake bed. Intensive study of the cores has resulted in the identification of eight additional new minerals during the ensuing fifty years.

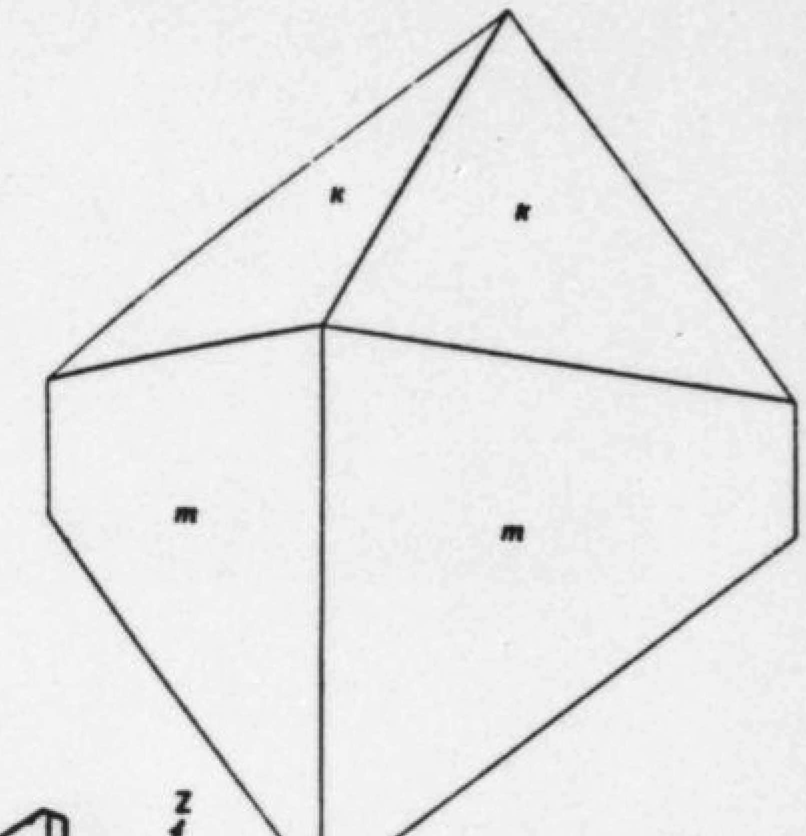
The Central Coast Ranges

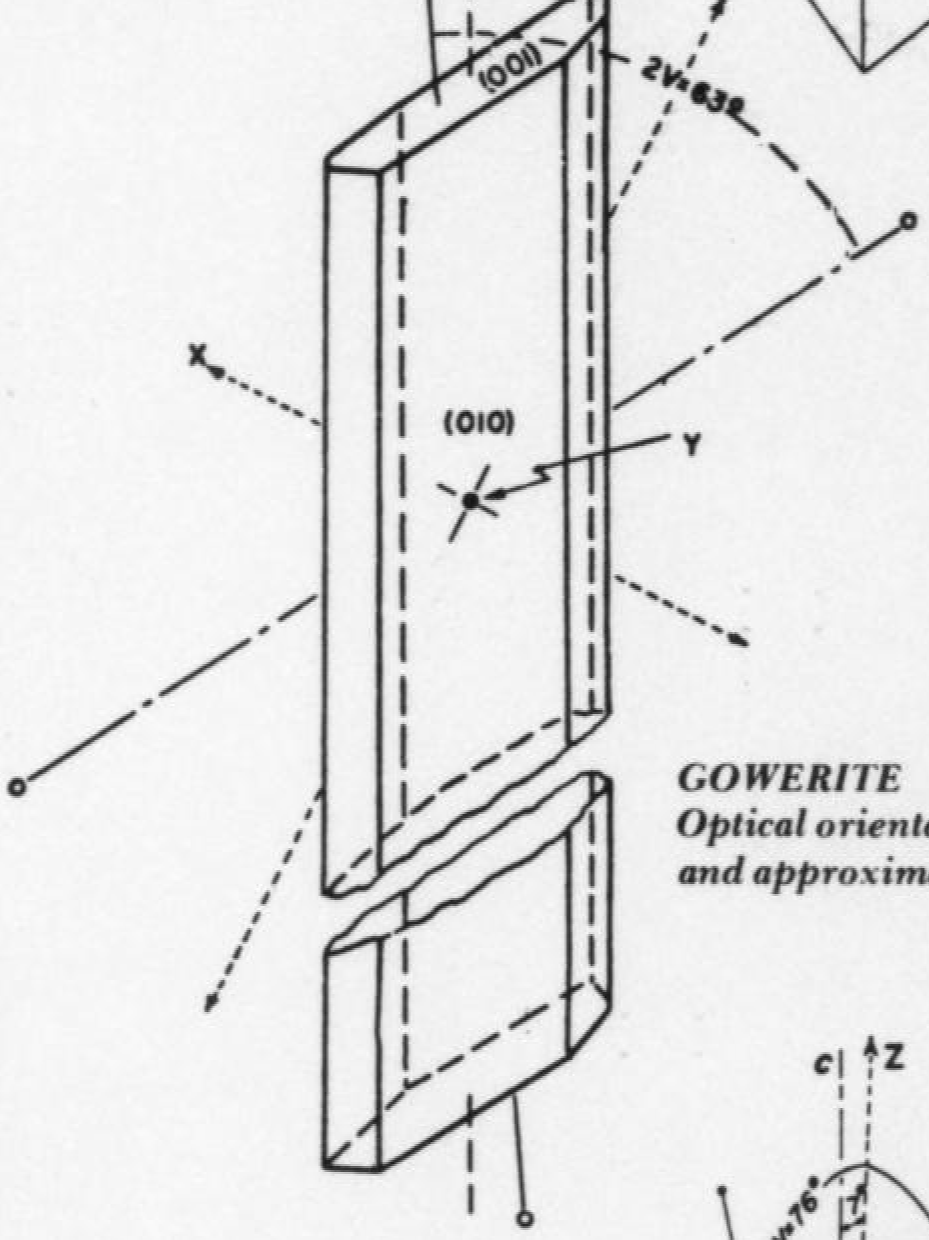
TheCoast Ranges Province extends along the Pacific shore for nearly 600 miles, from the Oregon line to the Transverse Ranges which cut east and west just north of Santa Barbara and Los Angeles. The central 200 miles of the Province are dominated by the Franciscan formation and associated serpentinites.



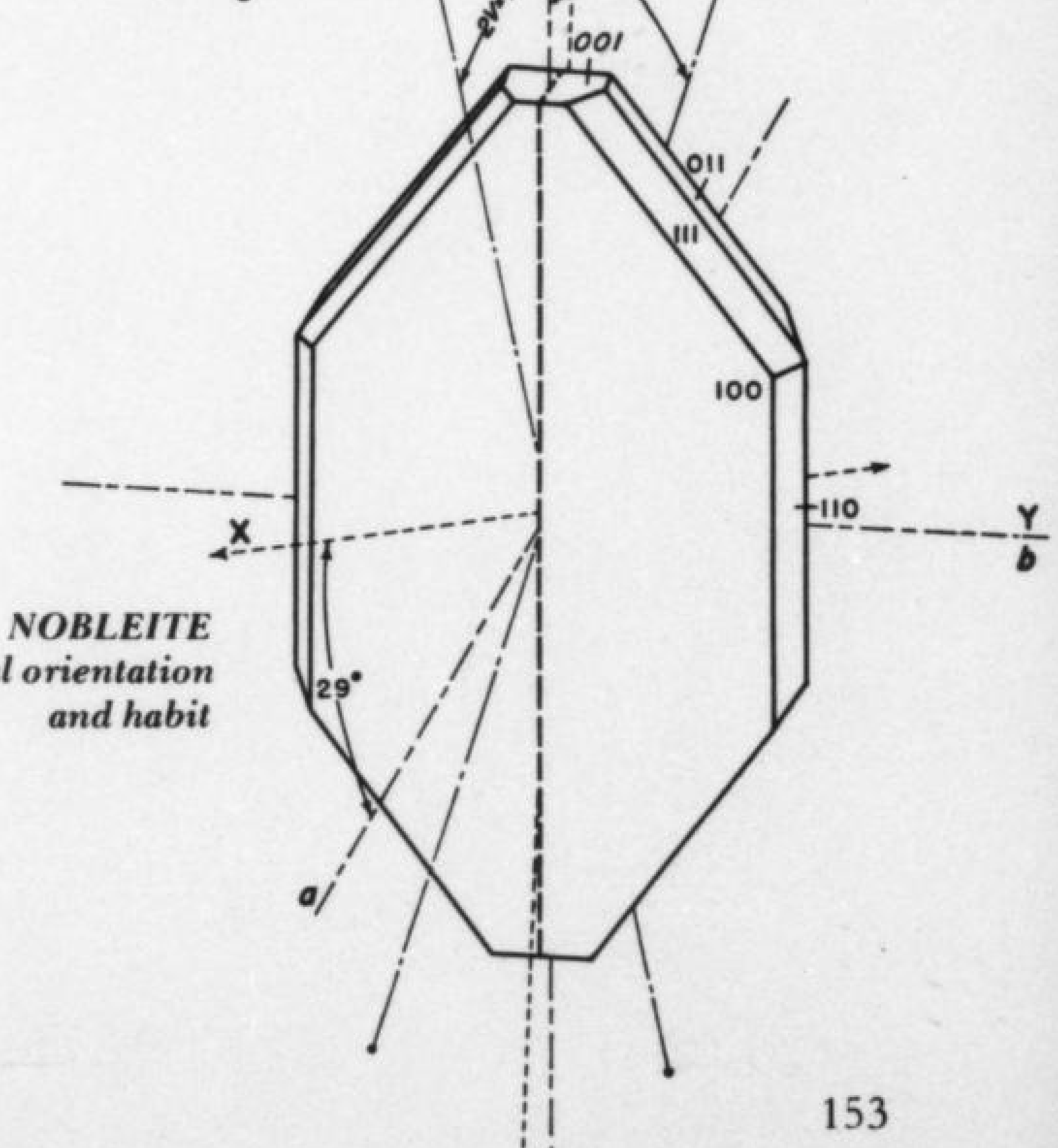
COLEMANITE*
(Jackson, 1885)

NEOCOLEMANITE





GOWERITE
Optical orientation and approximate habit



NOBLEITE
Optical orientation and habit

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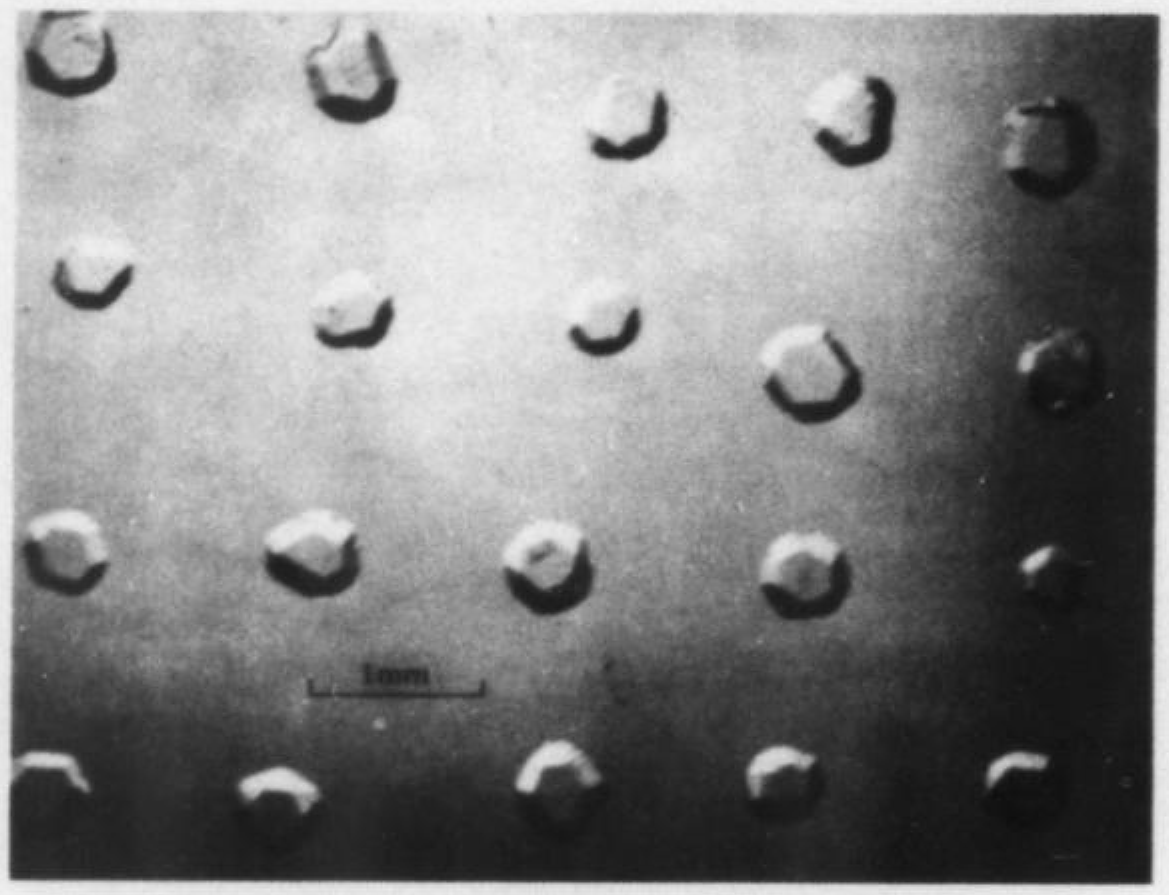
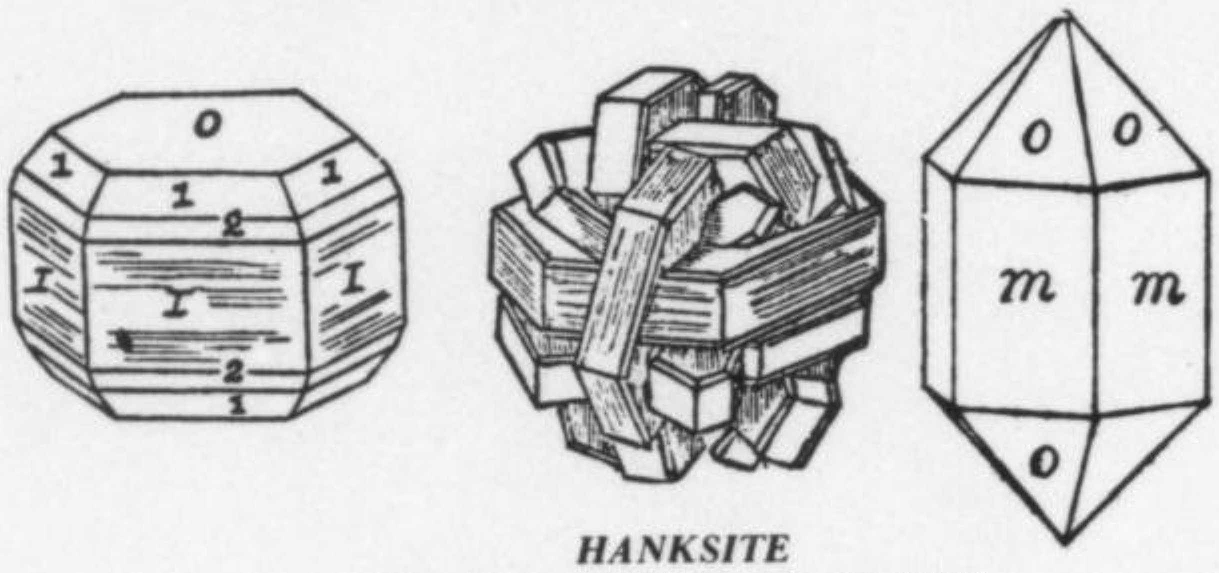
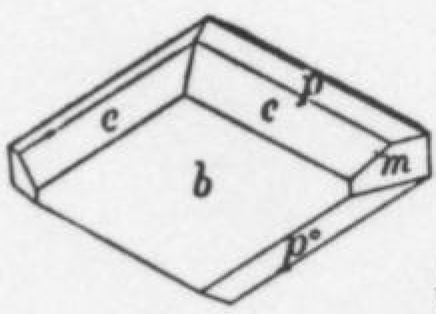
[1] See Pemberton, 1971, for recognition of Death Valley as type locality for bakerite.

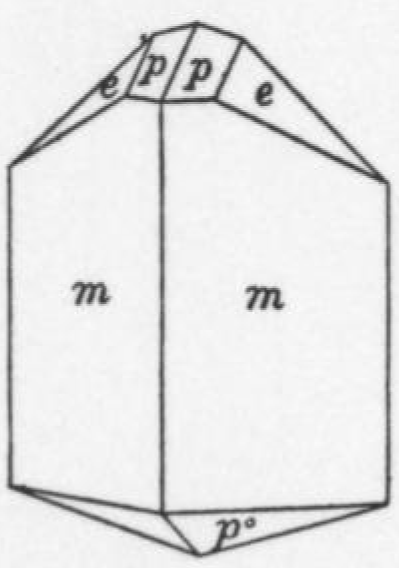


MACALLISTERITE
Synthetic crystals

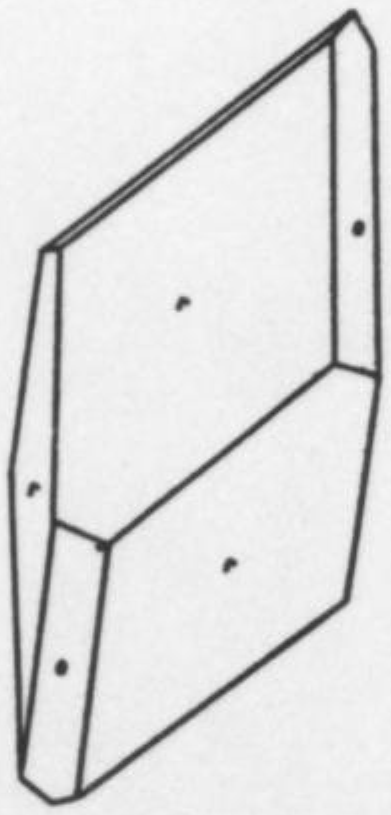


HANKSITE
Drawing on right from Pratt (1886)

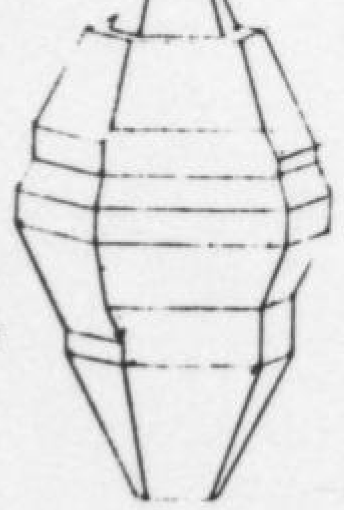




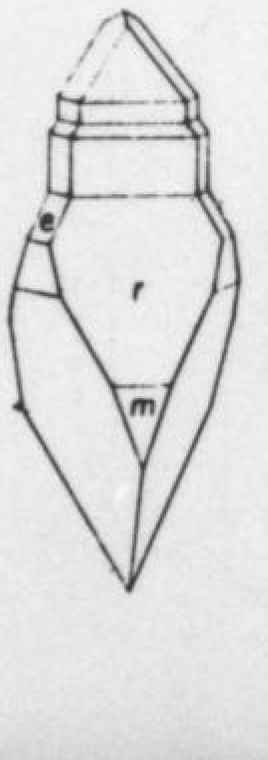
PIRSSONITE
Typical habits



SCHAIRERITE



GALEITE
Barrel habit



SCHAIRERITE-GALEITE POLYCRYSTAL
Forms labelled on schairerite part only

This central section has been the source of 28 of the new mineral descriptions from the State.

Apparently the earliest descriptions were mainly the result of prospecting for and mining of mercury, still an important activity in this part of the Province. Metacinnabar was the first (1870). After this good start the batting average was below par. Aragotite (1873), a hydrocarbon, is of doubtful validity; trautwinite (1873) and stibioferrite (1873) are mixtures; the hydrocarbons, posepnyte (1877) and napalite (1888), are probably mixtures; sonomaite (1877) is identical with pickeringite and knoxvillite (1890) is a magnesian copiapite. Redingtonite (1890) is still recognized as a species but may, on further study, prove to be a Ni-Cr halotrichite in which some Ni substitutes for Fe^{II} and Cr replaces some Al. This uncertain sequence in which nine minerals were described, of which only two remain as recognized species, was ended in 1903 with the description of the valid species, boothite, and of palacheite, which was found to be identical with botryogen.

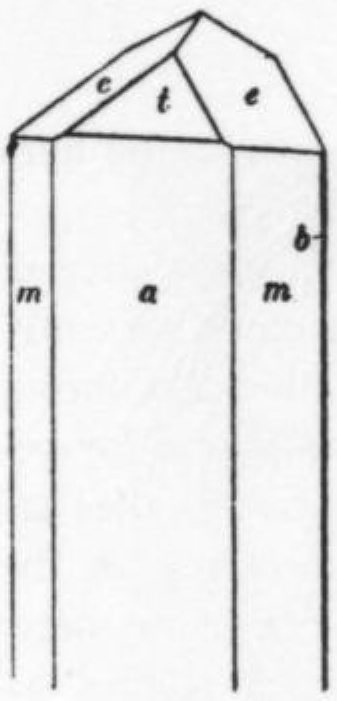
Four other minerals have been described from the mercury districts in more recent years. Two are hydrocarbons: curtisite (1930), which is identical with idrialite, and pendletonite (1967), which was found to be the same as the earlier-named carpathite when the latter mineral was properly described. The other two are the valid species schuetteite (1959) and buddingtonite (1964).

Thirteen additional minerals have been described from the central coastal ranges: three from the benitoite deposit near the headwaters of the San Benito River, two of which remain valid (benitoite, joaquinite), and one (coalingite) from the serpentinite body just east of the Gem mine. Six of the remaining nine are from the schists of the Franciscan formation. Five of these are recognized species, and the sixth, crossite, is an iron-rich glaucophane. The other three are iddingsite, a mixture, and rosenhahnite and kempite, both found in boulders in the Franciscan zone but of uncertain origin.

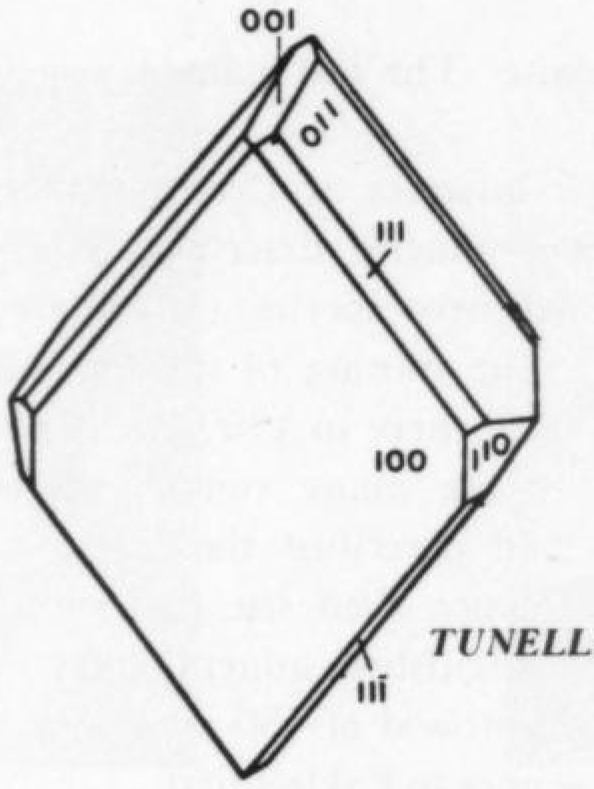
The Pegmatites and Associated Rocks of the Peninsular Ranges

The Peninsular Ranges pegmatites and associated contact zones, from which twenty of the new mineral descriptions have come, lie in a narrow NW-SW trending zone about 50 miles long, in the western part of of Riverside County and the northern border area of San Diego County. Fifteen of these minerals were from Crestmore, four from the Pala pegmatites, and one (nuevite, from a small quarry near Nuevo) which was later found to be identical with samarskite.

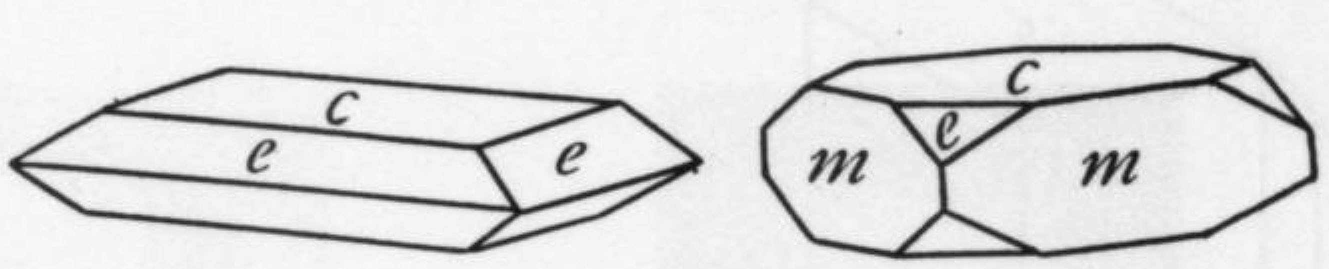
The earliest descriptions from this area were phosphates from the lepidolite and tourmaline mines of the Pala District. Mining started there about 1902 and attracted the attention of W. T. Schaller, who published his first paper on the area in 1903. His studies of the district continued and in 1912 he described four new phosphates from the area: salmonsite, sicklerite, stewartite,



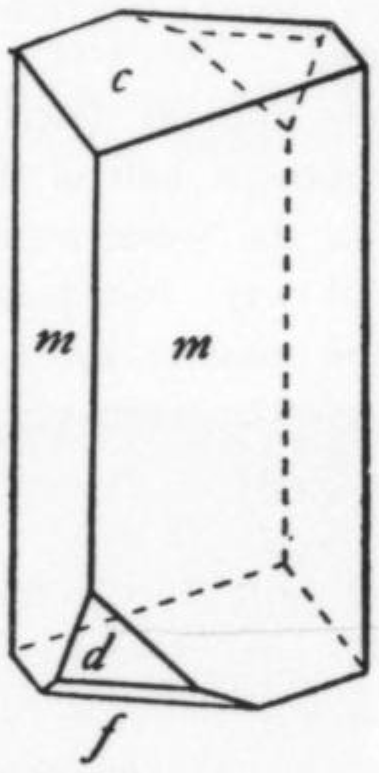
KERNITE



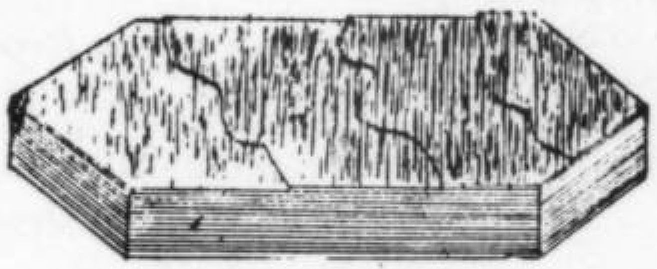
TUNELLITE



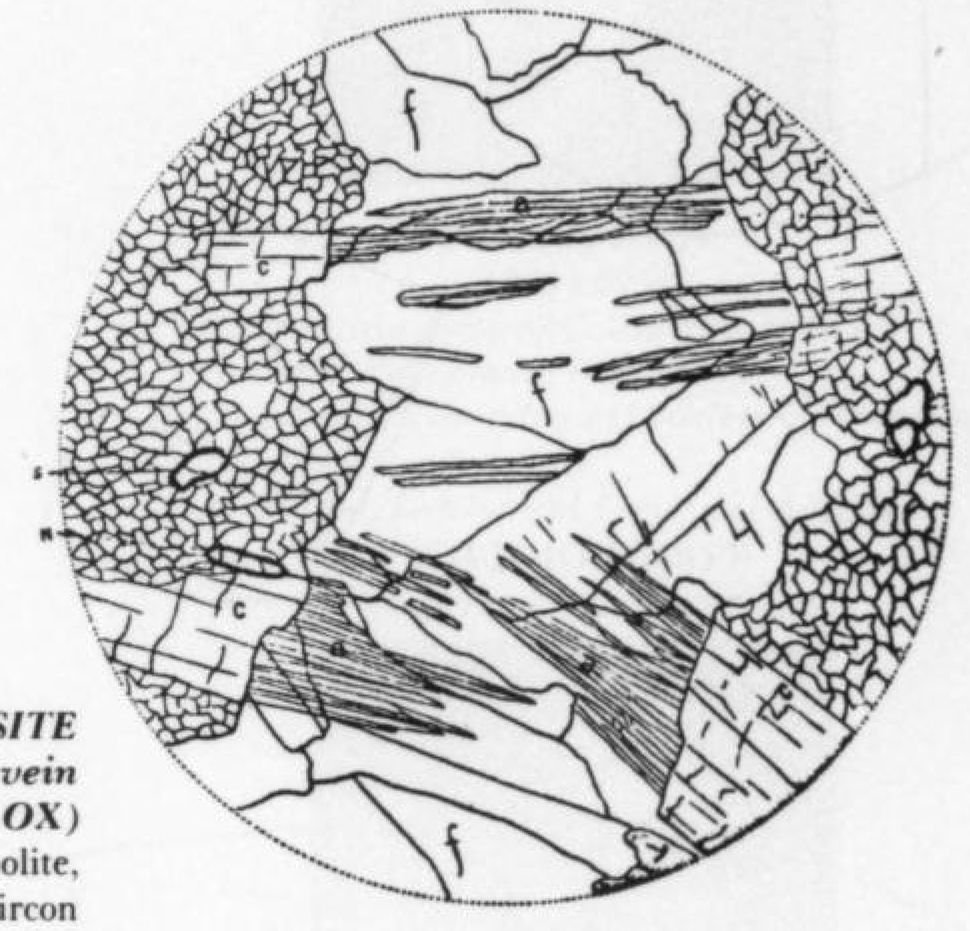
TEEPLEITE
Borax Lake (left), Artificial (right)



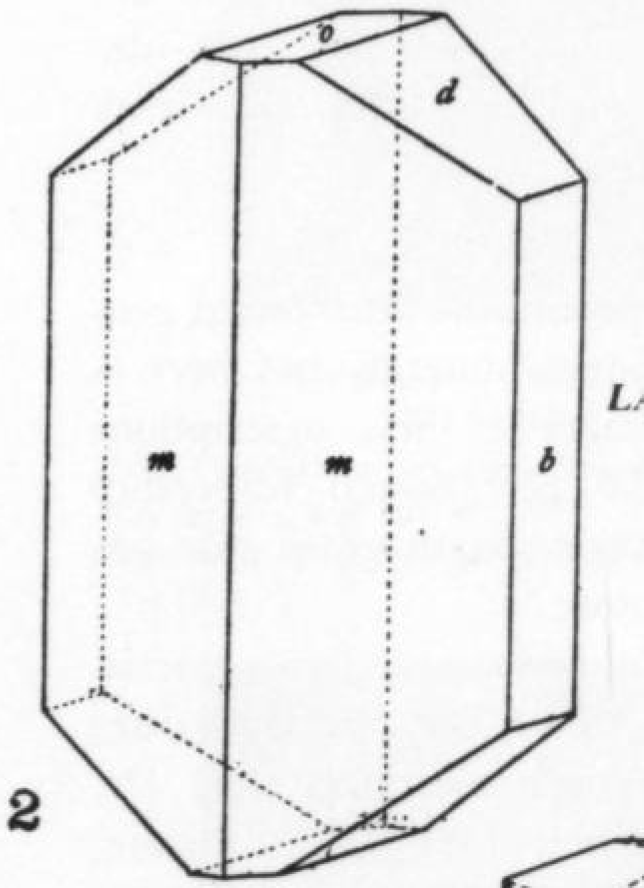
KRAUSITE



IDDINGSITE
Cleavage fragment

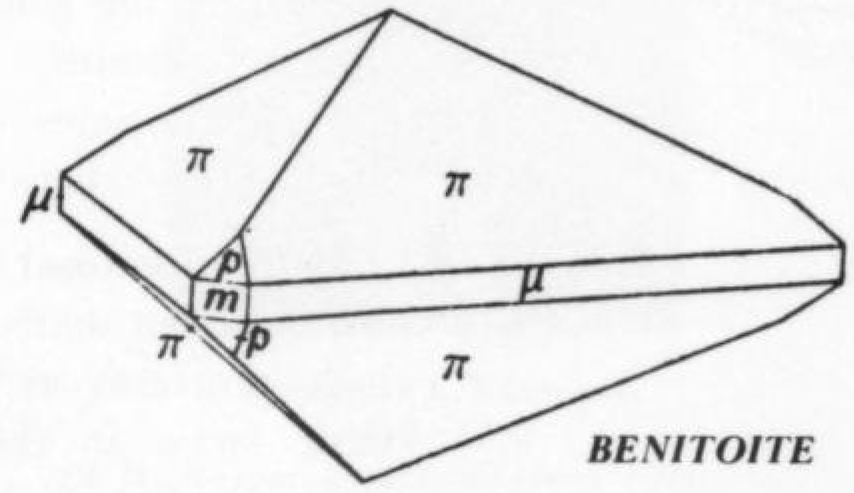


CROSSITE
Cross section of vein traversing the rock (1OX)
f = albite, s = sphene, a = actinolite,
c = crossite, n = zircon

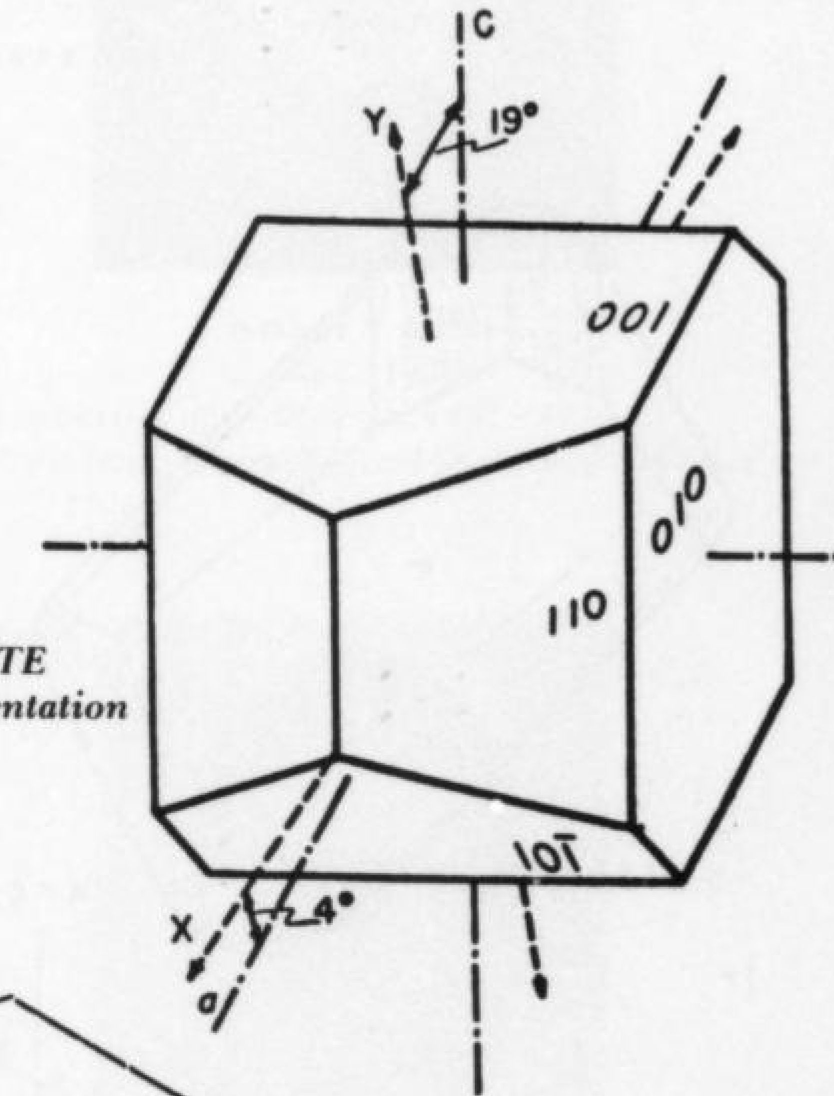


LAWSONITE

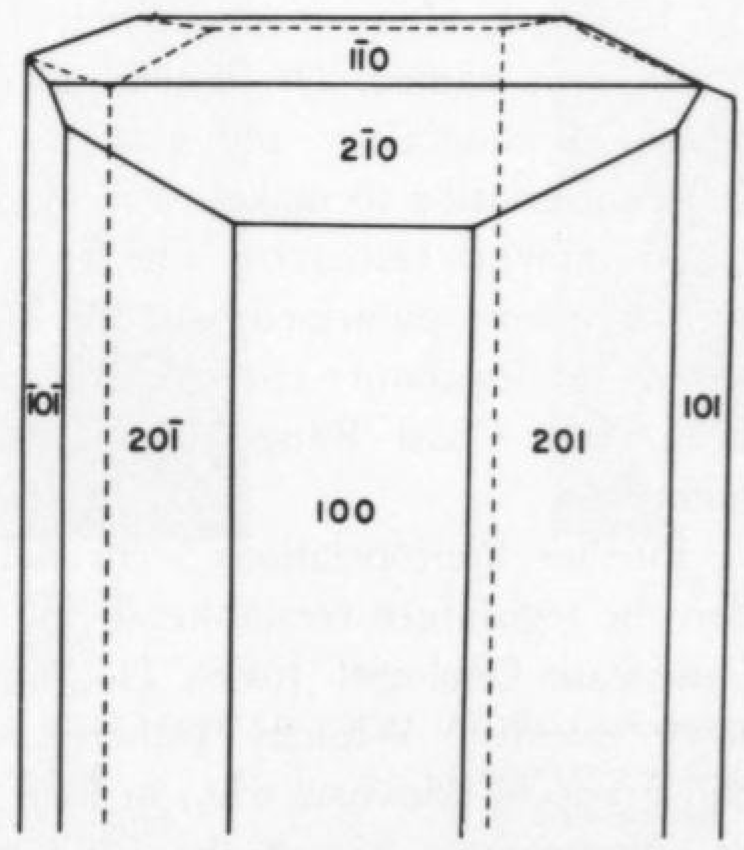
2



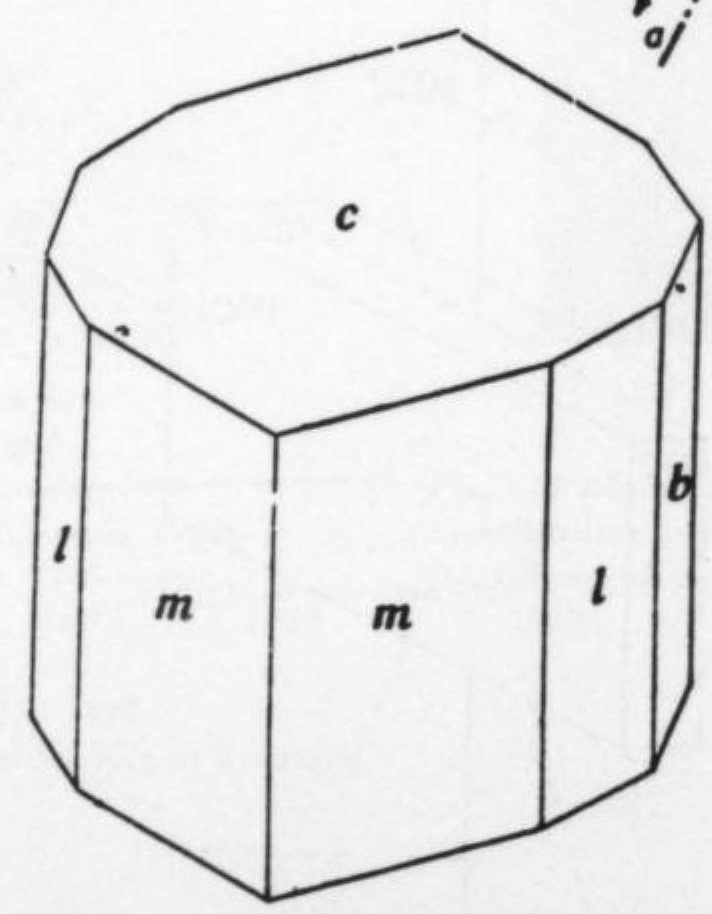
BENITOITE



BUDDINGTONITE
Typical habit and orientation



PENDLETONITE



PALACHEITE

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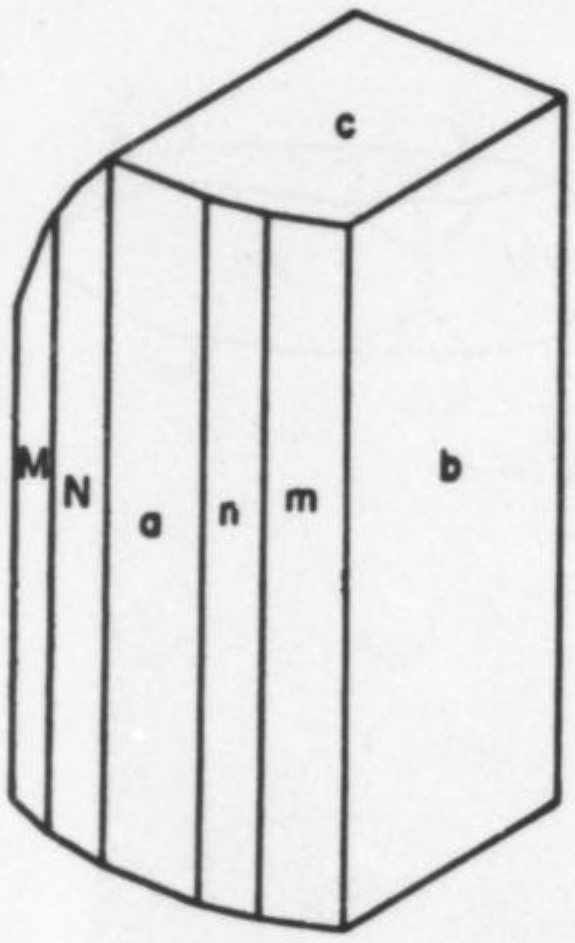
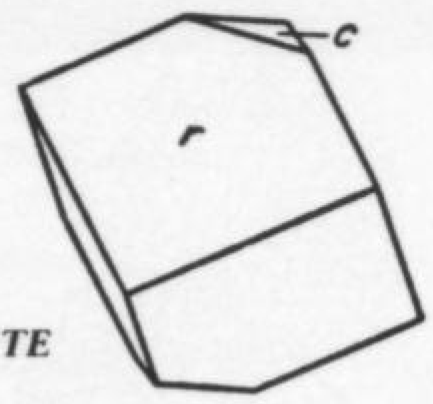
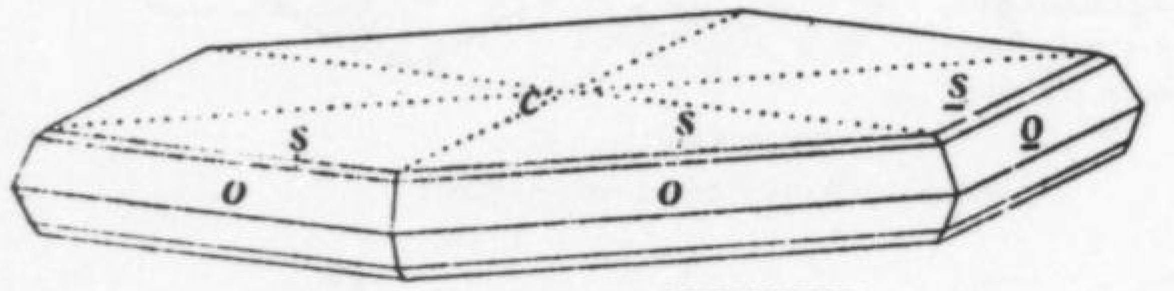
*crystal drawings are from the original description of the mineral except as otherwise referenced.



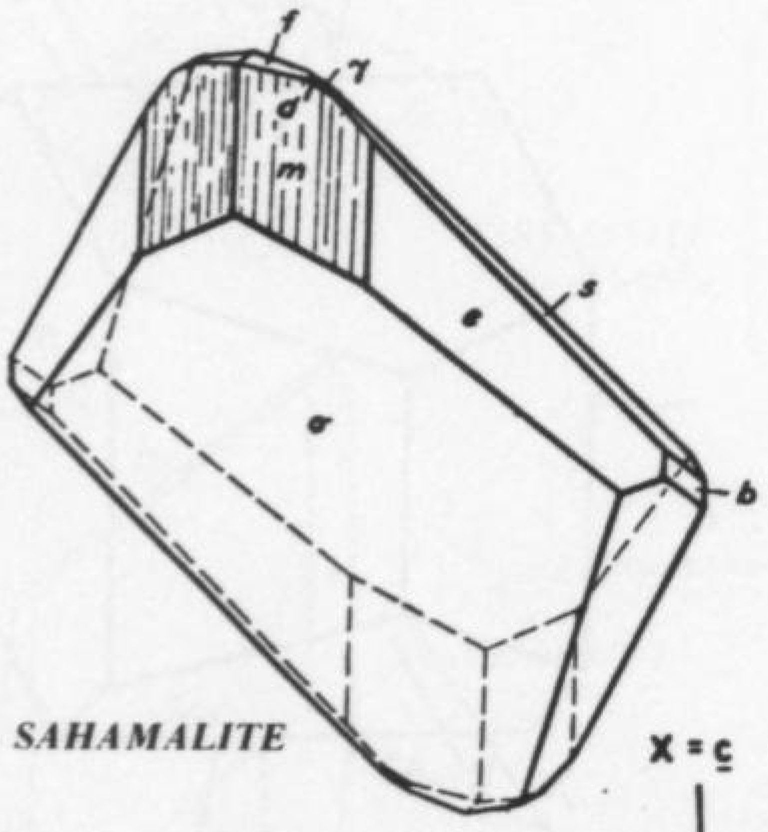
ROSENHAHNITE



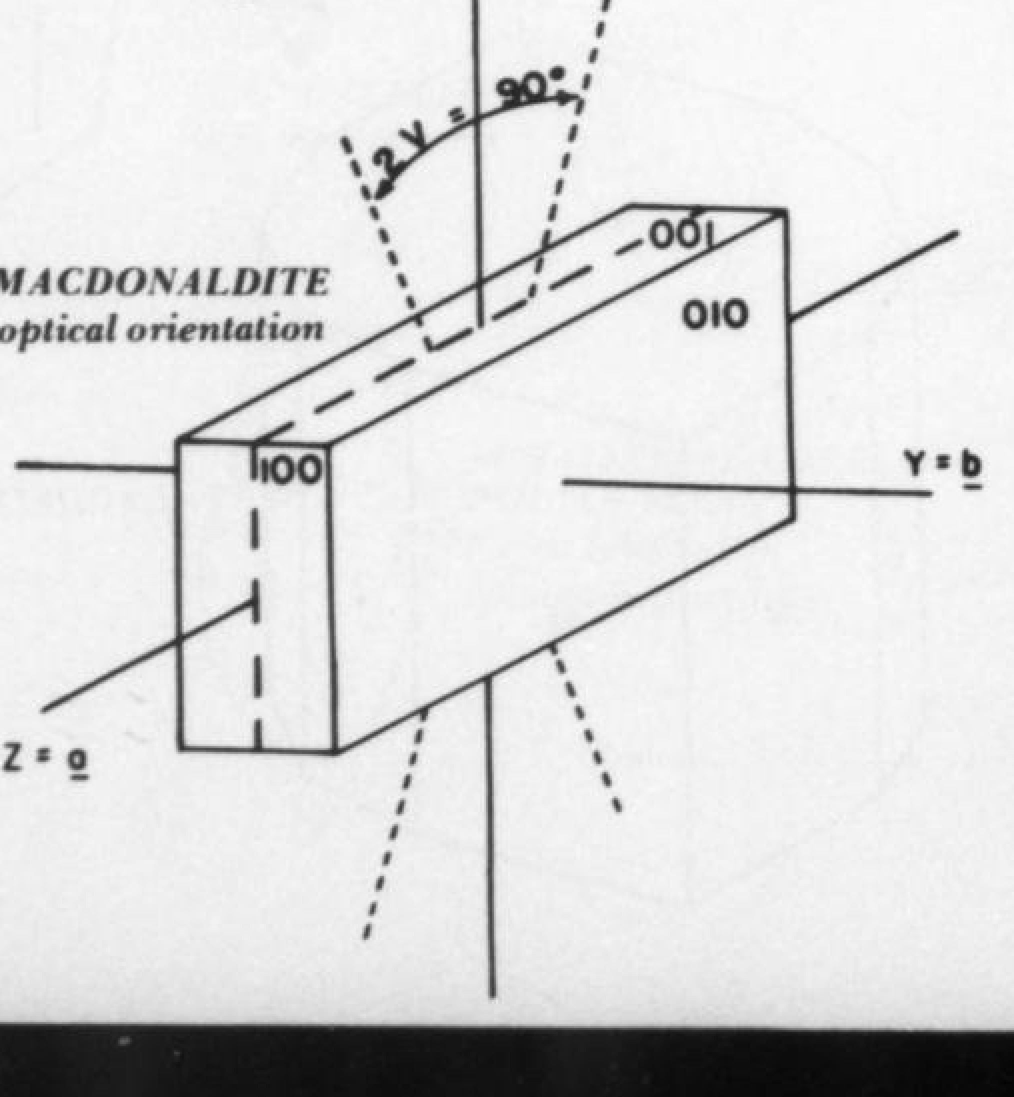
WOODHOUSEITE



ARCANITE



SAHAMALITE



MACDONALDITE
Typical habit and optical orientation

and palaite. The last named was found later to be hureaulite.

The quarries at Crestmore have been the source of more new mineral descriptions (15) and more currently recognized new species (10) than any other California locality. The mining of the crystalline limestone for cement started there in 1909. In 1914 A. S. Eakle called attention to the many contact minerals occurring in the deposit and described the first new species from there, wilkeite. Since then the quarries have been studied by many distinguished mineralogists who have identified in the neighborhood of 150 species in the deposit and added nine new ones to Eakle's first.

The Sierra Nevada Province

Twelve of the 102 new mineral descriptions from California were from the southern half of the 250 mile long gold-bearing district on the western slopes of the Sierra Nevada Province. All were found in the metamorphic formations near the massive intrusive granites which form the backbone of the Sierra. Eleven of the twelve are considered valid species. The twelfth is mariposite, a chromian variety of muscovite.

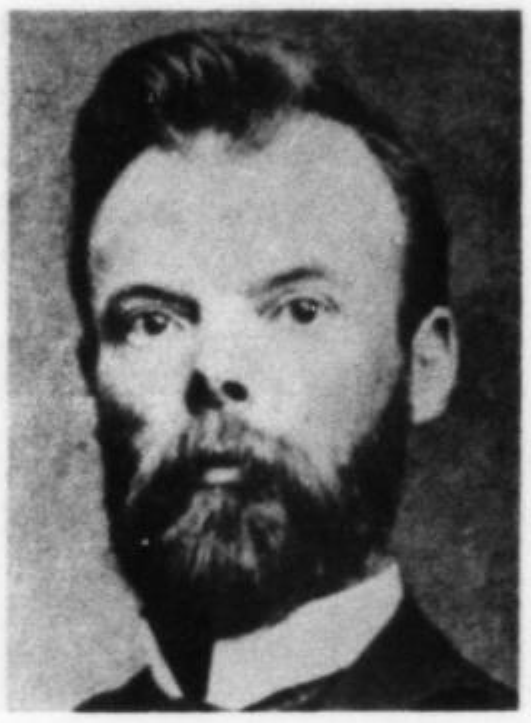
Four of the twelve were found in the gold veins: the tellurides, melonite and calaverite, from the rich Carson Hill lode; and the micas, mariposite and roscoelite, associates of the gold-bearing quartz. The other eight are barium silicates: sanbornite and seven recently described associates of that mineral from the Big Creek District in northern Fresno County.

The Professional Leadership

Without doubt, the wide potential of the varied geologic provinces as sources of new minerals has been a basic factor in the large number of new descriptions from California. However, the professional leadership capacity within the State to take advantage of this potential has been a companion factor.

Professional interest in California's minerals started the first year of its statehood, 1850. The first legislature created the post of State Geologist and appointed Dr. John B. Trask, after whom the new, rare barium silicate, traskite, was named. Dr. Trask, a physician deeply interested in mineralogy and geology, was given a three year appropriation to make a survey of the State's geology and mineral resources. The results of Trask's one-man study were published between 1853 and 1856 as reports to the legislature covering the geology of the Sierra Nevada, the Coast Ranges and northern and southern California.

Further appropriations were not made until 1860 when the legislature reestablished the office and appointed as State Geologist Josiah D. Whitney, a nationally known scientist. Whitney gathered around him "...a small group of scientists who, in their ability and dedication, immediately placed the California Survey in the front rank, if not perhaps in the top spot, among all State Surveys of that time...such men as Clarence King



Andrew C. Lawson
1861 - 1952
University of California, 1892 - 1952*
President, Geological Society of America, 1925

George D. Louderback
1874 - 1957
Ph.D., University of California, 1899
University of Nevada, 1900 - 1906
University of California, 1906 - 1944

Charles Palache
1869 - 1954
Ph.D., University of California, 1894
Harvard University, 1896 - 1941
President, Mineralogical Society of America, 1921
President, Geological Society of America, 1937

Waldemar T. Schaller
1882 - 1967
B.A., University of California, 1903
U.S. Geological Survey, 1903 - 1905
President, Mineralogical Society of America, 1926

Frederick L. Ransome
1868 - 1935
Ph.D., University of California, 1896
U.S. Geological Survey, 1897 - 1924
University of Arizona, 1924 - 1927
California Institute of Technology, 1927 - 1935

Arthur S. Eakle
1862 - 1931
University of California, 1901 - 1930
President, Mineralogical Society of America, 1925

Adolph Knoph
1882 - 1966
Ph.D., University of California, 1909
U.S. Geological Survey, 1905 - 1920
Yale University, 1920 - 1951
Stanford University, 1951 - 1966
President, Geological Society of America, 1944

Esper S. Larsen
1878 - 1961
B.S., University of California, 1906
Ph.D., University of California, 1918
University of California, 1907 - 1908
U.S. Geological Survey, 1909 - 1923, 1949 - 1958
Harvard University, 1923 - 1949
President, Mineralogical Society of America, 1928

William F. Foshag
1894 - 1956
Ph.D., University of California, 1923
Smithsonian Institution, 1919 - 1956
President, Mineralogical Society of America, 1940

Alfred O. Woodford
1890 -
Ph.D., University of California, 1923
Pomona College, 1923 - Emeritus

Adolf Pabst
1899 -
Ph.D., University of California, 1928
University of California, 1927 - Emeritus
President, Mineralogical Society of America, 1951

Austin F. Rogers
1877-1957
Stanford University, 1902 - 1942
President, Mineralogical Society of America, 1927

Joseph Murdoch
1900 -
University of California at Los Angeles, 1928 - Emeritus
President, Mineralogical Society of America, 1959

George F. Becker
1847 - 1919
University of California, 1871 - 1878
U.S. Geological Survey, 1879 - 1919
President, Geological Society of America, 1914

Waldemar Lindgren
1860 - 1939
U.S. Geological Survey, 1884 - 1912
Massachusetts Institute of Technology, 1912 - 1933
President, Geological Society of America, 1924

(later to become the first Director of the U.S. Geological Survey), Arnold Hoffman (later to become Chief Topographer of the USGS), W. H. Brewer (later to become a professor at Yale and to be recognized as the 'father of soil science'), and W. H. Dall (later to become one of the country's foremost paleontologists and Director of the Philadelphia Academy of Sciences)" (Campbell, 1966, p. 14). With this staff Whitney produced a series of mineralogical and geological reports through the early 1870's.

The first systematic report on California minerals was a review published in 1866 by William P. Blake, professor of mineralogy, geology and mining at the College of California, parent to the University of California at Berkeley. Blake first came to the State in 1853 as geologist for a railroad survey party and, between then and the end of the century, published many reports and papers on the mineralogy of the State.

In 1892 a new era began in California mineralogy. In that year Andrew C. Lawson was appointed as professor of geology at the University of California, Berkeley. With George D. Louderback, who was one of his earliest students, he built the department to an outstanding position. Their students and associates included Waldemar T. Schaller, Fredrick A. Ransome, Charles Palache, Arthur S. Eakle, William F. Foshag, Adolph Knopf, Esper S. Larsen, Alfred O. Woodford, and Adolph Pabst. This leadership from the Berkeley Department was joined in 1902 by professor Austin F. Rogers at Stanford University, and 1928 by Joseph Murdoch at the University of California, Los Angeles.

These thirteen distinguished mineralogists, all born during the latter decades of the 19th century, have been author or coauthor of 50 of the 82 new mineral descriptions from the State since 1890. They have authored or coauthored over 300 publications on California min-

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***Except as otherwise noted University of California refers to the Berkeley campus**

erals. Eight have served as President of the Mineralogical Society of America, and three as President of the Geological Society of America, with Charles Palache serving in both roles.

During all of these years of strong California-based professional study of California minerals, there has been constant interest and help from the U.S. Geological Survey staff. The first annual report of the Survey (1880) included an article on the San Francisco, Eureka, and Bodie districts by George F. Becker. Becker began his career as a professor of mining and metallurgy at the University of California, Berkeley, and in 1879 joined the USGS where he remained for 40 years. In 1914 he served as President of the Geological Society of America. His studies of the mercury deposits of the State are classic.

Waldemar Lindgren joined the staff of the Survey in 1884 and published his first paper on California minerals in 1887. His associate at the Survey was another noted geologist, Henry W. Turner, and these two men became leading authorities on the gold districts of the State. Their combined publications about California minerals came to 52. Lindgren served as President of the Geological Society of America in 1924.

In more recent years Survey studies of minerals resources in the State have produced particularly significant studies of the chromium and manganese deposits (in cooperation with the California Division of Mines and Geology), the borate deposits of Death Valley and Kramer, and the salts of Searles Lake.

A final significant factor in the study of California minerals has been the development of the State Division of Mines and Geology since the founding of the parent organization in 1850. The growth of the department has been sometimes hesitant but since the 1920's has been sure and strong. The Division currently publishes several professional series on the geology and mineralogy of California: Bulletins - the most recent No. 195, Geology of the San Andreas 15 minute quadrangle, Calaveras County; Special Reports - the most recent No. 101, Geology of the Elysian Park - Repetto Hills Area, Los Angeles County; County Reports, detailing the mines and mineral resources of each county; Geologic Maps with accompanying text, usually covering mineral deposits; and the monthly, *California Geology*.

California has been truly blessed with professional leadership in mineralogy and geology.

Acknowledgments

The author is indebted to Dr. Michael Fleischer of the United States Geological Survey for reviewing the tabulated list of minerals and checking the present status of each, and to Richard Bideaux for his careful review of the manuscript.

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New Mineral Descriptions from California

No.	Mineral	Author and Year	Locality	Present Status
1	Aragotite	F.E. Durand, 1873	New Almaden	A mixture
2	*Arcanite*†	A.S. Eakle, 1908	Trabuco Canyon	
3	*Bakerite*	W.B. Giles, 1903	Death Valley	
4	*Benitoite*	G.D. Louderback and W.C. Blasdale, 1907	Headwaters of San Benito River	
5	*Boothite*	W.T. Schaller, 1903	Leona Heights	
6	*Buddingtonite*	R.C. Erd, D.E. White, J.J. Fahey, D.E. Lee, 1964	Sulphur Bank	
7	*Burkeite*†	W.F. Foshag, 1935	Searles Lake	
8	*Calaverite*	F.A. Genth, 1868	Carson Hill	
9	Carlosite	G.D. Louderback and W.C. Blasdale, 1907	Headwaters of San Benito River	= Neptunite
10	Chromrutile	S.G. Gordon and E.V. Shannon, 1928	Washington	Redefined as redledgeite
11	*Coalingite*	F.A. Mumpton, H.W. Jaffe, C.S. Thompson, 1965	Idria	
12	*Colemanite*	R. Neuschwander, 1883	Death Valley	
13	Crestmoreite	A.S. Eakle, 1917	Crestmore	= tobermorite
18	Crossite	C. Palache, 1894	Berkeley	Iron-rich glaucophane
15	Curtisite	F.E. Wright, E.T. Allen, 1926	Skaggs Springs	= Idrialite
16	*Deerite*	S.O. Agrell, M.G. Brown and D. McKie, 1965	Laytonville	
17	Eakleite	E.S. Larsen, 1917	Santa Inez, 1917	= xonotlite
18	*Ellestadite*	D. McConnell, 1937	Crestmore	
19	*Foshagite*	A.S. Eakle, 1925	Crestmore	
20	*Fresnoite*	J.T. Alfors, M.C. Stinson, R.A. Matthews and A. Pabst, 1965	Big Creek	
21	*Galeite*	A. Pabst, D.L. Lewis and G.S. Switzer, 1955	Big Creek	
22	*Gerstleyite*	C. Frondel and V. Morgan, 1956	Kramer	
23	*Gowerite*	R.C. Erd, J.F. McAllister, H. Almond, 1959	Death Valley	
24	*Greigite*	B.J. Skinner, R.C. Erd and F.S. Grimaldi, 1964	Kramer	
25	Griffithite	E.S. Larsen and G. Steiger, 1917	Cahuenga Pass	Ferroan saponite
26	*Haiweeite*	T.C. McBurney and J. Murdoch, 1959	Haiwee Reservoir	
27	*Hanksite*	W.E. Hidden, 1885	Searles Lake	
28	*Hectorite*	W.F. Foshag and A.O. Woodford, 1936*	Hector	
29	*Howieite*	S.O. Agrell, M.G. Brown and D. McKie, 1965	Laytonville	
30	Iddingsite	A.C. Lawson, 1893	Carmelo Bay	A mixture
31	*Inyoite*	W.T. Schaller, 1914	Death Valley	
32	Ionite of Allen	V.T. Allen, 1927	Ione	= Kaolinite
33	Ionite of Purnell	S. Purnell, 1878	Ione	A mixture
34	*Jennite*	A.B. Carpenter, J.A. Gard, K. Speakman and H.F.W. Taylor, 1966	Crestmore	
35	*Joaquinite*	G.D. Louderback and W.C. Blasdale, 1909	Headwaters of San Benito River	
36	Jurupaite	A.S. Eakle, 1921	Crestmore	= Xonotlite
37	*Kempite*	A.F. Rogers, 1924	San Jose	
38	*Kernite*	W.T. Schaller, 1927	Kramer	
39	Knoxvillite	G.F. Becker, 1888	Knoxville	Magnesian copiapite
40	*Krausite*	W.F. Foshag, 1931	Calico Mts.	
41	*Krauskopfite*	M.C. Stinson and J.T. Alfors, 1964	Big Creek	
42	*Lawsonite*	F. Ransome, 1895	Tiburon	
43	Lesserite	C. Frondel, V. Morgan and J.L.T. Waugh, 1956	Kramer	= Inderite
44	*Macallisterite*	W.T. Schaller, A.C. Vlisidis and M.E. Mrose, 1965	Death Valley	
45	*Macdonaldite*	M.C. Stinson and J.T. Alfors, 1964	Big Creek	
46	*Maghemite*	R.B. Sosman and Posnjak, 1927**	Iron Mountain	
47	Mariposite	B. Silliman, 1868	Sierra gold belt	Chromian muscovite
48	*Melonite*	F.A. Genth, 1867	Carson Hill	

†—First occurrence in nature

***Described but not named. Later recognized as a species and named by Strese and Hofmann, 1941**

****Described but not named, Later named by Wagner (1927).**

No.	Mineral	Author and Year	Locality	Present Status
49	*Merwinite*	E.S. Larsen and W.F. Foshag, 1921	Crestmore	
50	*Metacinnabar*	G.E. Moore, 1870	Knoxville	
51	*Metahaiweeite*	T.C. McBurney and J. Murdoch, 1959	Haiwee Reservoir	
52	*Meyerhofferite*	W.T. Schaller, 1914	Death Valley	
53	*Muirite*	J.T. Alfors, M.C. Stinson, R.A. Matthews and A. Pabst, 1965	Big Creek	
54	Napalite	G.F. Becker, 1888	Pope Valley	A mixture
55	*Nekoite*	J.A. Gard and H.F.W. Taylor, 1956	Crestmore	
56	Neocolemanite	A.S. Eakle, 1911	Tick Canyon	= Colemanite
57	*Nissonite*	M.E. Mrose, R. Meyrowitz, J.T. Alfors and C.W. Chesterman, 1966	Panoche Valley	
58	*Nobleite*	R.C. Erd, J.F. McAllister and A.C. Vlisidis, 1961	Death Valley	
59	*Northupite*	W.M. Foote, 1895	Searles Lake	
60	Nuevite	J. Murdoch, 1946	Nuevo	= Samarskite
61	Palacheite	A.S. Eakle, 1903	Knoxville	= Botryogen
62	Palaite	W.T. Schaller, 1912	Pala	= Hureaulite
63	*Partzite*	A. Arents, 1867	Blind Spring	
64	Pendletonite	J. Murdoch and A.T. Geissman, 1967	Idria	= Carpathite
65	*Pirssonite*	J.H. Pratt, 1896	Searles Lake	
66	Plazolite	W.F. Foshag, 1920	Crestmore	= Hibschite
67	Posepnyte	J.V. Schrockinger, 1887	Sulphur Bank	A mixture
68	*Probertite*	A.S. Eakle, 1929	Kramer	
69	*Redingtonite*	G. Becker, 1888	Knoxville	
70	*Redledgeite*	H. Strunz, 1961	Washington	
71	*Riversideite*	A.S. Eakle, 1917	Crestmore	
72	*Roscoelite*	J. Blake, 1875	Coloma	
73	*Rosenhahnite*	A. Pabst and E.B. Gross, 1967	Cloverdale	
74	*Sahamalite*	H.W. Jaffe, R. Meyrowitz and H.T. Evans, 1953	Mountain Pass	
75	*Salmonsite*	W.T. Schaller, 1912	Pala	
76	*Sanbornite*	A.F. Rogers, 1932	Incline	
77	*Schairerite*	W.F. Foshag, 1931	Searles Lake	
78	*Schuetteite*	E.H. Bailey, F.A. Hildebrand, C.L. Christ and J.J. Fahey, 1959	Sulphur Bank	
79	*Searlesite*	E.S. Larsen and W.B. Hicks, 1914	Searles Lake	
80	*Sicklerite*	W.T. Schaller, 1912	Pala	
81	Sonomaite	E. Goldsmith, 1877	The Geysers	= pickeringite
82	*Stewartite*	W.T. Schaller, 1912	Pala	
83	Stibioferrite	E. Goldsmith, 1873	Santa Clara Co.	A mixture
84	*Sulphohalite*	W.E. Hidden and J.B. Mackintosh, 1888	Searles Lake	
85	*Teepleite*	W.A. Gale and M. Vonsen, 1938	Borax Lake	
85	*Tilleyite*	E.S. Larsen and K.C. Dunham, 1933	Crestmore	
87	*Tincalconite*	C.U. Shepard, 1878	California	
88	*Traskite*	J.T. Alfors, M.C. Stinson, R.A. Matthews and A. Pabst, 1965	Big Creek	
89	Trautwinite	E. Goldsmith, 1873	Monterey Co.	A mixture
90	Treanorite	A.O. Woodford, J.D. Laudermilk and E.H. Bailey, 1940	Crestmore	= Allanite
91	*Tunellite*	R.C. Erd, V. Morgan and J.R. Clark, 1961	Kramer	
92	*Tychite*	S.L. Penfield and G.S. Jamieson, 1905	Searles Lake	
93	*Veatchite*	G.S. Switzer, 1938	Tick Canyon	
94	*Verplanckite*	J.T. Alfors, M.C. Stinson, R.A. Matthews and A. Pabst, 1965	Big Creek	
95	*Vonsenite*	A.S. Eakle, 1920	Crestmore	
96	*Walstromite*	M.C. Stinson and J.T. Alfors, 1964	Big Creek	
97	*Wardsmithite*	R.C. Erd, J.F. McAllister and A.C. Vlisidis, 1970	Death Valley	
98	*Wightmanite*	J. Murdoch, 1962	Crestmore	
99	*Wilkeite*	A.S. Eakle and A.F. Rogers, 1914	Crestmore	
100	Woodfordite	J. Murdoch and R. A. Chalmers, 1958	Crestmore	= Ettringite
101	*Woodhouseite*	D.M. Lemmon, 1937	White Mts.	
102	*Zussmanite*	S.O. Agrell, M.G. Brown and D. McKie, 1965	Laytonville	

A Wavellite and Strengite Occurrence in Tennessee

by **William G. Lehnert**

Good crystals of strengite and wavellite have recently been found at the Wood mine, Cocke County, Tennessee. The Wood mine is located in the Del Rio district of Cocke County, on the southwestern slope of Meadow Creek Mountain near Burnett Gap. Worked for manganese in 1906 by J. N. Adams of Charlestown, Tennessee, little if any ore was shipped due to its high phosphorus content. The mine consisted of a pit 15 feet in diameter and 8 feet deep. Its approach was a 50 foot trench cut N60E into the hill. Evidence of the original opening is visible, but deteriorated, and only a few tons of ore are scattered in the immediate vicinity of the mine, much of which is covered by dirt. The ore is a hard nodular, or lump type, of massive cryptomelane with very little of a stalactitic or botryoidal form. It occurs in the residual clay and slopewash overlying the Hesse quartzite of the Erwin formation.

Wavellite is the dominant phosphate mineral and is plentiful in almost all the ore. It is distributed throughout the ore forming irregular stringers, veinlets, and radiating groups of micro to cabinet size specimens. Colorless or white, translucent to transparent crystals up to 13 mm are reported, but generally they average 2 to 5 mm. In the radiating aggregates, each individual crystal is terminated with the tips being transparent. The wavellite is truly beautiful and snow-white clusters on the black matrix present a striking contrast worthy of any specimen.

Strengite occurs as micro and semi-micro crystals forming small veinlets and filling fractures and cavities. Its color is "raspberry" red and is quite attractive, particularly when in association with wavellite. Not reported in prior descriptions of the locality (Harder, 1910, Stose and Schrader, 1923), strengite is contained in a very small percent of the dump material. Since the quantity is limited one or two specimens is not uncommon for a day's effort.

Permission for collecting is rather uncertain since the mine is located within the Cherokee National Forest in the midst of a reforestation project. However, for those interested in visiting the locality, take Tenn. 70 south from Greenville approximately 8 miles to Tenn. 107 (Del Rio turnoff). Turn west and proceed 7 to 8 miles to Burnett Gap. Turn right on the Meadow Creek Mountain Auto Trail and go 200 yards. The mine is located 200 yards north on the first fire-break road to the left.

The author is indebted to David Brantley of Knoxville, Tennessee, who relocated the mine in 1970 and informed other collectors.

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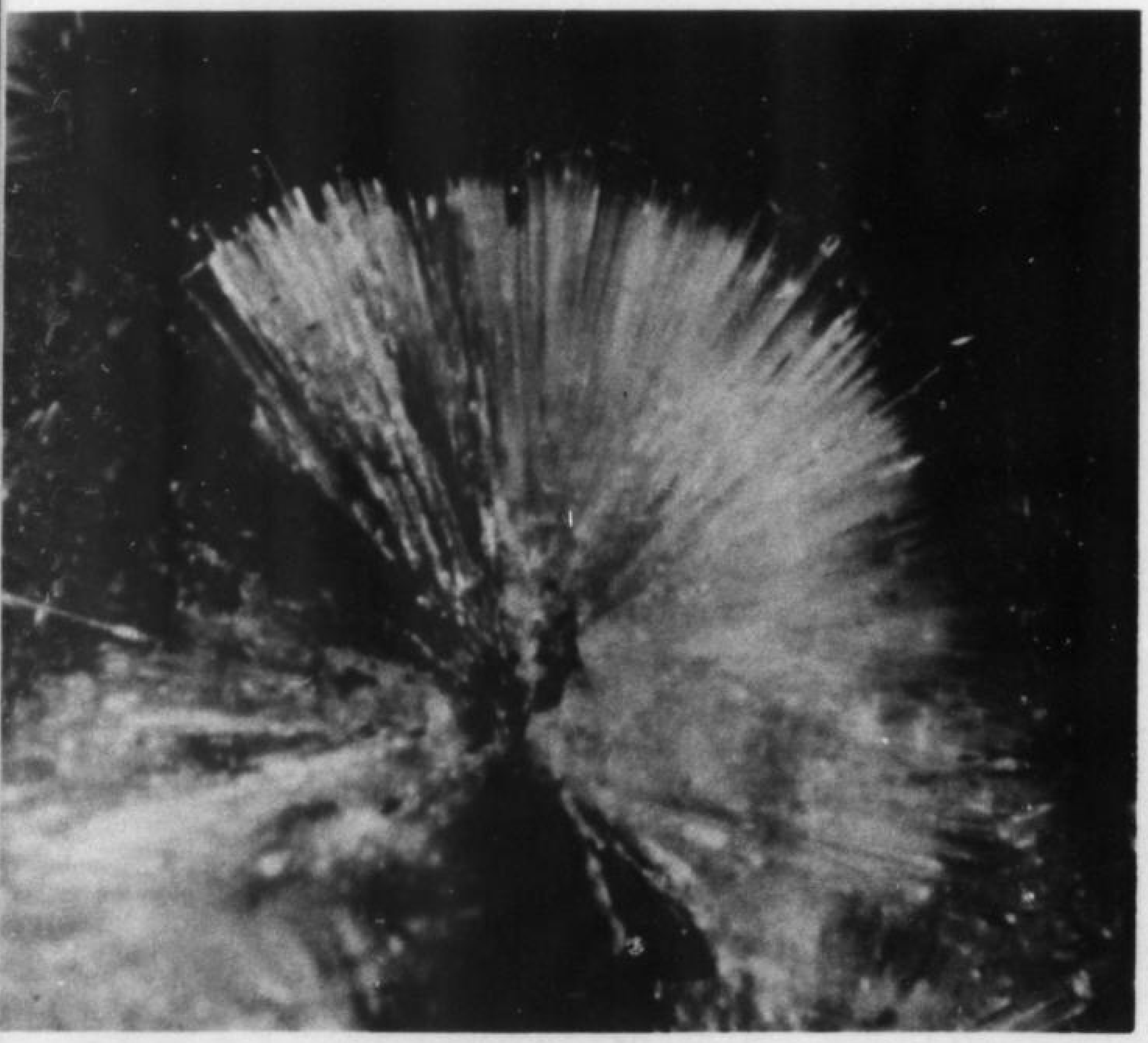
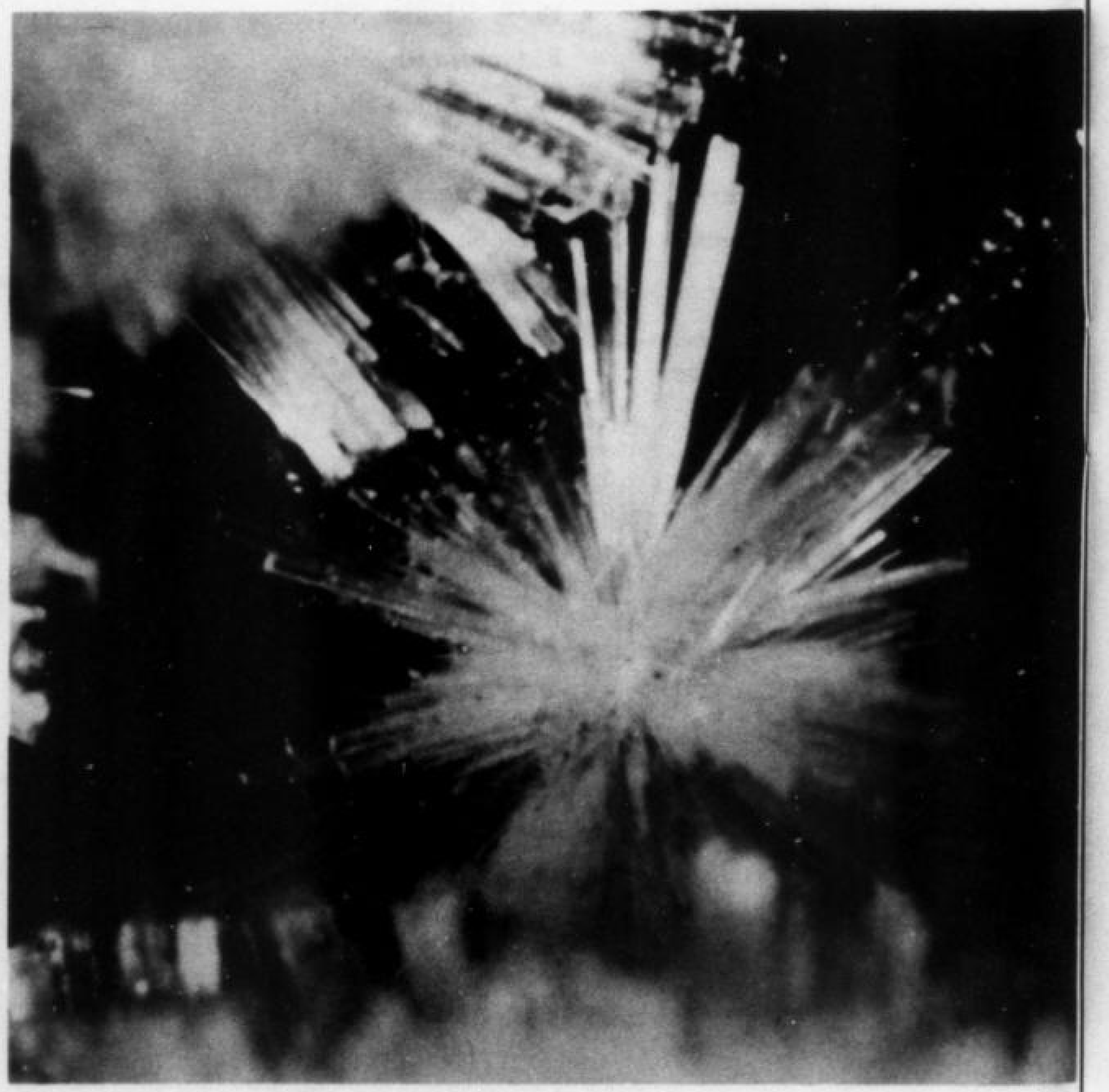
Specimen belongs to Lee Wood, Kingsport.



Photograph by Ben Kinkead, Kingsport, Tenn.



FRIENDS OF MINERALOGY

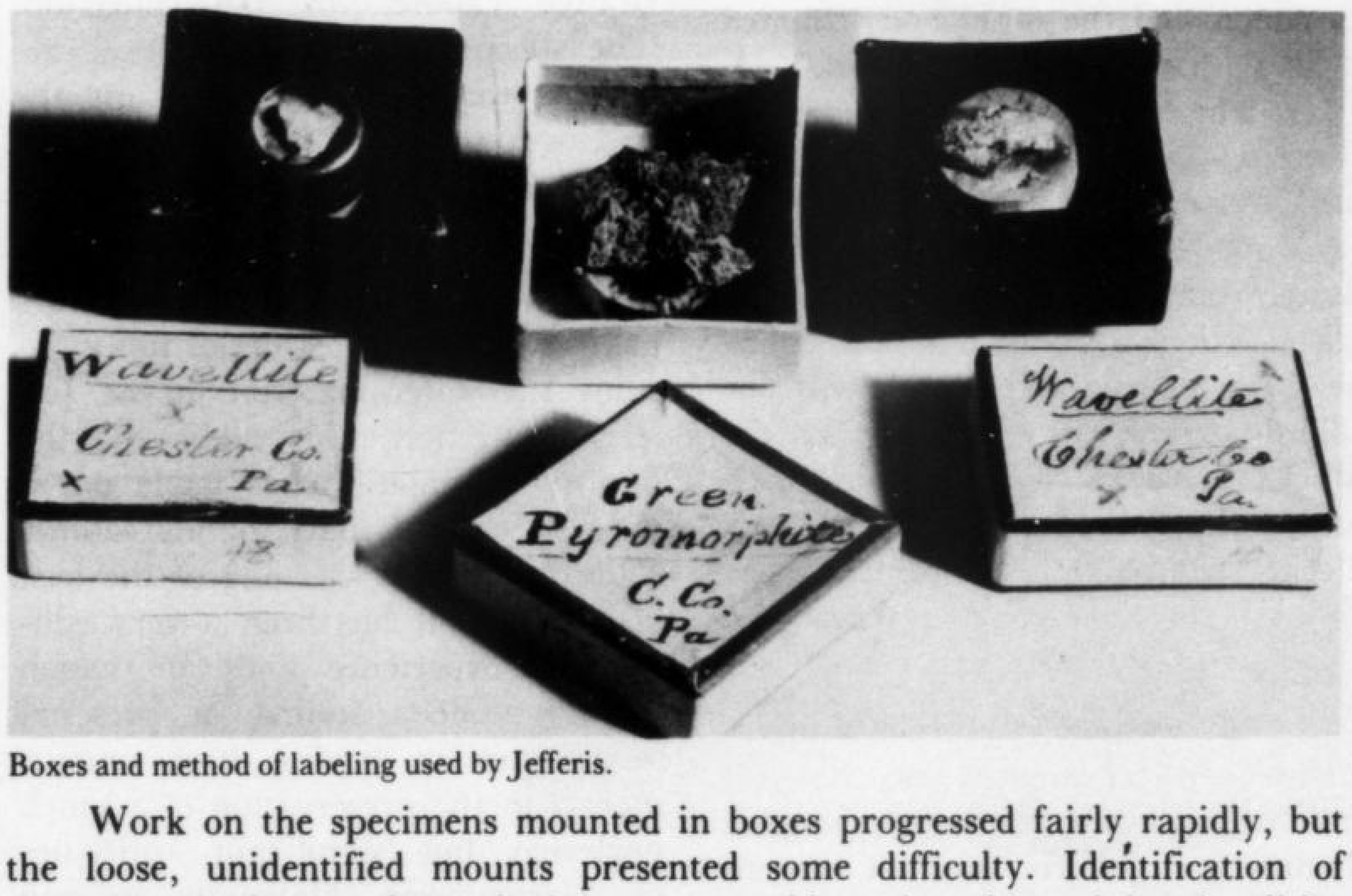
The Jefferis Micromounts at Carnegie Museum

D. L. Oswald

The chief aims of the Friends of Mineralogy refer often to informal and altruistic effort on behalf of minerals (stressing the conservation and preservation of mineral specimens) and to the compiling and publication of information on important mineral collections. Oddly enough the fulfillment of these aims can be set in motion by curiosity aroused by a chance remark or question asked.

While visiting the mineral section of the Smithsonian Institution in the Spring of 1967, this writer was asked if he had visited the Carnegie Museum to view the micromounts in the Jefferis mineral collection. It was inevitable that an inveterate micromount collector, who had not even been aware of the existence of the Jefferis minerals, would at least inquire at Carnegie about the possibility of viewing this old collection. A meeting was arranged with E. R. Eller, now curator emeritus of geology and invertebrate fossils, to examine the collection.

The micromount collection was found to consist of some 577 specimens including 217 mounted in cardboard boxes with the balance contained in round pill boxes. The latter group were mounted on cork pedestals, each inserted into a short length of brass tubing for protection. Only the specimens in the cardboard boxes were identified as to mineral and locality where found. All were coated with the lint and dust of many years of neglect. Quite a few of the specimens had fallen from their pedestals and several had disintegrated to sand in their boxes. Even so it was clearly evident that here was a group of exceedingly fine micro-mineral specimens that needed to be cleaned, remounted as necessary and properly catalogued. The museum Director, M. Graham Netting, and Dr. Eller very kindly accepted the writer's offer to undertake this task of a voluntary basis and, happily, the work is now essentially completed.

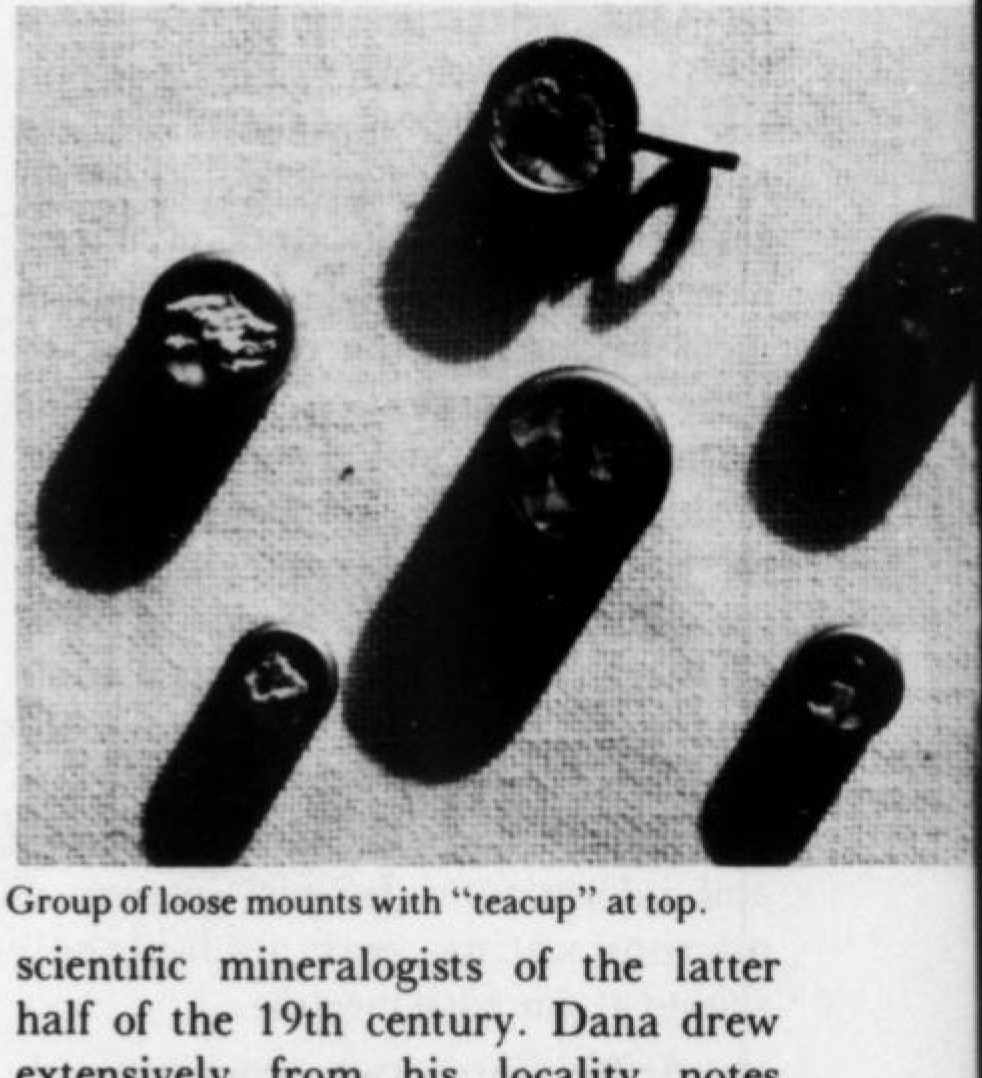


Boxes and method of labeling used by Jefferis.

Work on the specimens mounted in boxes progressed fairly rapidly, but the loose, unidentified mounts presented some difficulty. Identification of the minerals (except for a few) was no problem, but determining localities was, and in some instances still is, a 'sticky' situation. However, assuming Jefferis derived the majority of his micro material from the cabinet specimens in his own collection, then as a 'rule-of-thumb' one should be able to fall back on the 'camp habit' of minerals, etc. to determine from which of the major specimens the micro-minerals were taken. In pursuing this course it was deemed advantageous to learn as much as possible about Jefferis and his system and habits in acquiring and processing his mineral specimens.

William W. Jefferis was born January 12, 1830, son of Horatio T. Jefferis, cashier of the Bank of Chester County at Chester, Pennsylvania. He graduated from the West Chester Academy and entered the service of the bank as second teller in December, 1843, advancing to cashier fourteen years later, which position he held until his resignation in June, 1883. He was interested in mineralogy as a youth and started accumulating his mineral collection in 1837. His activities in the mineral field continued for more than sixty years until shortly before his death in February, 1906.

He was made emeritus professor of mineralogy of the State Normal School of West Chester in 1878. In 1883 he moved to Philadelphia and became curator of the William S. Vaux mineral collection to which he devoted all his spare time for fifteen years. Jefferis was the friend and constant correspondent of George J. Brush, James D. Dana, Charles Upham Shepherd, Isaac Lea, William S. Vaux and many others of the leading collectors and scientific mineralogists of the latter half of the 19th century. Dana drew extensively from his locality notes for minerals along the Eastern seaboard and used specimens from his collection for drawings of crystal forms while developing his System of



Group of loose mounts with "teacup" at top.

Mineralogy. Dr. F. A. Genth acknowledged his indebtedness to Jefferis in the preface of his Mineralogy of Pennsylvania, published in 1875. Jefferis was very active in the affairs of the Mineralogical and Geological Section of the Academy of Natural Sciences, organized in Philadelphia in 1880. He is credited with collecting many mineral specimens in Pennsylvania and New York which were first reports of the minerals for those areas, and the mineral jefferisite (a variety of vermiculite) was named in his honor.

The Jefferis cabinet collection contained in excess of 12,000 specimens, most of museum display quality, when purchased by Andrew Carnegie in December, 1904, and presented to Carnegie Museum in January, 1905. When packed for shipment to Pittsburgh, it filled two large railroad cars. The collection is especially notable for fine specimens of Pennsylvania minerals from localities long ago mined out and exhausted. It is also notable for its remarkable catalogue documentation which has been of tremendous help in cataloguing the micromount collection.

There is no definite indication when Jefferis began his collection of micro-mineral specimens but it must have been about 1880 or shortly thereafter. A letter from Isaac Lea in 1864 refers to mica specimens with beautiful apatite of microscopic size apparently "injected" into the mica. The first definite record of the collection and classification of micro-material and the mounting of specimens began with the activities of the Reverend George G. Rakestraw in Cornwall, Pa., and George W. Fiss during the latter part of 1878. Soon thereafter, others became interested, including a Dr. J. C. Green of West Chester, Pa. Small groups would gather at the home of one of the members to view each other's micromounts and exchange material and information. Jefferis' interest in micromounting was undoubtedly roused at one such meeting.

Jefferis used two types of cardboard boxes for his collection, the rectangular Rakestraw box and a somewhat shallower box one inch square. The mineral name and locality were printed on the box lid and a name plate was glued to the bottom of the box. Corks of various sizes were used as pedestals for mounting all but a few of the specimens. Larger pieces were not mounted at all, but were wedged tightly into a box with pieces of cork cut to fit snugly around the specimen to hold it in place. Cementing media in most general use were fish glue and a red lead paste. A surprisingly large number of the mounts had cement covering some of the crystal tips or one whole side of the specimen. These were easily cleaned, the fish glue being readily soluble in water and the paste yielding to soaking in alcohol. The larger specimens were generally loose in their boxes; they were cleaned, excess material trimmed away, and the specimen remounted in the box on a balsa wood pedestal. In all remounting, care was exercised so that the face to be viewed and its general attitude in the box were essentially as Jefferis had originally arranged it.

The brass tubing used by Jefferis to protect most of the mounts is indicative of his love and appreciation for all minerals and his concern for seeing them properly preserved. One end of the tube was rolled over to eliminate sharp edges and form a sort of frame for the specimen and the other end trimmed flush with the base of the cork pedestal. The diameter of the tube was selected so the specimen, when mounted on its cork pedestal, could be slipped into the tube with the cork fitting tightly to hold it securely in place. When assembled in this manner, the specimen is level with or slightly below the rolled lip of the tube and makes a very pleasing picture. One of these mounts has a handle riveted to the side of the tube giving it the appearance of a tea cup.

Only 64 mineral species and varieties are represented in the collection, with copper minerals predominating. Jefferis was not content with just one good specimen of a species but gathered every crystal form and habit of a mineral he could obtain from each occurrence. There are many duplicates of several of the species such as wavellite (41), azurite (33), and cuprite (29). There are two loose mounts that one could only label 'pot-pourri', Jefferis having covered the surface of a cork pedestal with red paste and then poured a variety of single crystals and loose fragments of several species over it. Another specimen consists of a group of acicular crystals 0.1 to 0.5 mm in width and up to 5.0 mm long, reticulated at an angle of 60 degrees and occupying interstitial openings in a coarsely granular matrix. It is labeled simply "Frame Houses - Canada". There are several very fine mounts of cinnabar with the locality given only as California. They are the typical prismatic, hexagonal crystals, some with associated quartz crystals, that occur in the coastal ranges north of San Francisco Bay. Eastern Pennsylvania is particularly well represented with suites of the Cornwall minerals, the Wheatley mine at Phoenixville, General Trimble's mine and many of the old quarries in the Philadelphia area. Lead and copper minerals from Arizona, Scotland and England are also well represented. Carnegie Museum has selected a 1 x 1 x 3/4 inches plastic box with a maroon base and a clear hinged lid to house the loose mounts and an antique wooden Cardex file was made available for use as a storage cabinet for the collection. The specimens are now indexed according to the Dana system and the catalogue will eventually include a listing of the specimens by locality.

Pursuit of this volunteer effort has given me the opportunity to study the micro-material in the Jefferis collection; in addition, the locality information has made possible a review of much of his cabinet collection which was one of the best of his time. It has been a very educational experience and one which affords a deep feeling of personal satisfaction in having been instrumental in the preservation of a much neglected but significant collection of micromounts. Hopefully it may some day become the nucleus of a major reference collection of micro-minerals.

Pacific Micromount Conference

(Continued from page 151)

inches too short. For those who know Neal, a real privilege in itself, this statement is self explanatory. For those unfortunate not to know him, Neal's statement will be understood once the acquaintance is made.

After the Saturday night Banquet (a delightful buffet), we were entertained by Dr. Julius Weber of New York, who took us on a tour of his "mine." In my opinion, this "mine" is the best privately-owned photomicrograph laboratory in existence. Dr. Weber then presented slides he has taken of specimens owned by Paul Seel, Neal Yedlin and Lou Perloff. As to Dr. Weber's photography, all I can say is "WOW"! In no other color photomicrographs have I seen better composition, clarity and depth of field.

Paul Seel completed the Saturday evening session with a slide program entitled "The Field Trip." This is a fast-moving and hilarious description of an (most hopefully) untypical field trip, replete with all-those-things-that-can-go-wrong.

Paul Desautels led off Sunday's activities with a talk on "Copper Localities Around the World." At the beginning he promised, as usual, not to speak on the proported subject and noted that the Pacific Micromount Conference was usually fueled by smog-free alcohol. Paul not only covered the major copper deposits of the world, but went into an in-depth discussion of the paragenesis of each. He showed that all of the deposits had basically the same paragenesis, but modified by local conditions such as rainfall, age, etc.

Sunday morning's workshop turned out to be a delight. I learned (with the help of Dr. Royal Marshall of Pasadena and Del Oswald) that my personal "question marks" were in turn, dioptase, brochantite and pseudomalachite. That's one of the fringe benefits of workshops attended by experts—you solve a lot of problems all at once. This revelation, of course, makes another trip to the western face of the Panamint Range in order since the presence of pseudomalachite adds phosphates to the mineralogical "pot" of the area and further confuses my identification problems.

In the afternoon Richard Bideaux, a recipient of the American Federation of Mineralogical Societies Scholarship for Earth Sciences, gave a highly informative illustrated talk on a specialty of his—the minerals of Tiger, Arizona.

After Dick's talk the conference wound its way to a close with the participants heading home, or east to the Tucson Show. Once again I didn't make Tucson. Instead, I collected the flu—well, maybe next year...

Churchite and Florencite (Nd) from Sausalito, California

by Daniel J. Milton and Harry Bastron
U.S. Geological Survey, Menlo Park, California

Rare earth phosphate minerals occur in association with manganese oxides slightly over half a mile south of Sausalito, Marin County, California, at the base of a roadcut on the north side of the lateral to Highway 101. Churchite (weinschenkite)[1] was first found here by Leo Rosenhahn of San Anselmo and identified by E. B. Gross, then of the California Division of Mines.

The minerals are found in the weathering zone on fracture surfaces in a chert unit of the Jurassic and Cretaceous Franciscan formation that consists of alternating beds of radiolarian chert, 5 to 10 cm thick, and shale, 1 or 2 cm thick. A basalt unit of the Franciscan crops out about a hundred meters away. The minerals occur near a fault (Fig. 1), which probably favored downward percolation of ground water. Before excavation the occurrence was probably 5 or 10 meters below ground level on a steep hillside. Clay minerals, hematite, and lithiophorite are the most abundant minerals on the fracture surfaces; todorokite and the two rare earth minerals churchite and florencite are moderately abundant.

Lithiophorite occurs as dark-brown or black botryoidal crusts up to several millimeters thick, composed of very thin shells. The X-ray diffraction pattern is almost identical with pattern 3 of Fleischer and Faust (1963). A spectrographic analysis is given in table 1. Despite the name and the accepted formula $(Al,Li)MnO_2(OH)_2$ of lithiophorite (Wadsley, 1952), the low content of lithium is not unusual. Lithiophorite from some occurrences contains only trace amounts of lithium. Copper, barium and other elements perhaps fill the role, assigned by Wadsley to lithium, of expanding the bond lengths in the $(Al)(OH)_6$ octahedra some 3 percent over normal Al-OH bond lengths, allowing a match to the $Mn(OH)_6$ octa-

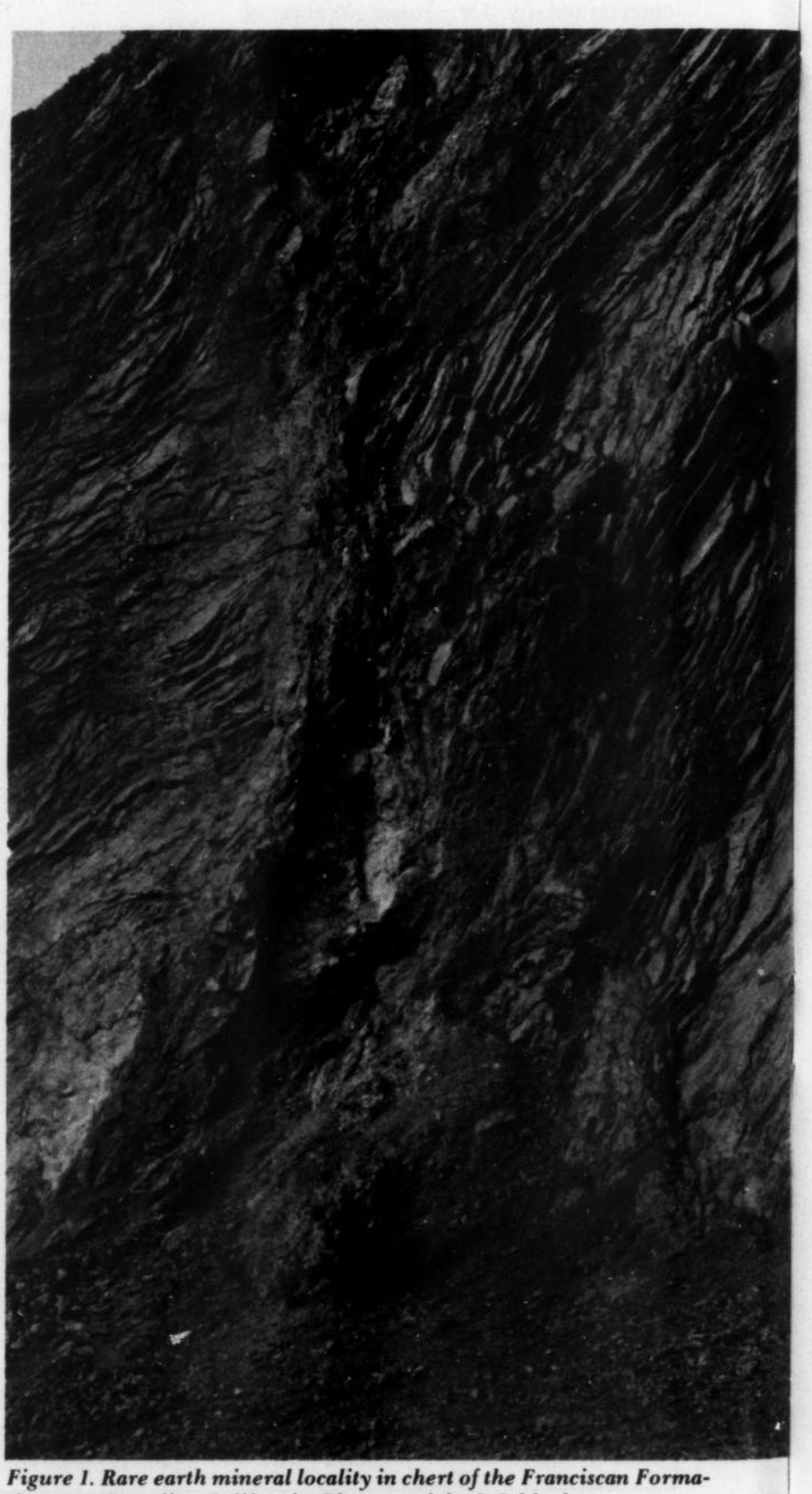


Figure 1. Rare earth mineral locality in chert of the Franciscan Formation near Sausalito, California. Photograph by J. Schlocker.

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[1] Churchite was discovered in Cornwall in 1865. Only qualitative tests for the rare earth elements were made, and the mineral was assumed to be a cerium mineral. Weinschenkite was described from Bavaria in 1922, where it was found in such abundance that miners used it for Christmas tree "snow." In 1952 analysis of type material showed churchite to be an yttrium mineral identical with weinschenkite. Both names have continued in use, reflecting a difference of opinion as to whether or not the deficiencies in the original characterization of churchite justify setting aside priority. In connection with this report a decision was requested from the Commission on New Minerals and Mineral Names of the International Mineralogical Association, and it has ruled by a majority vote in favor of churchite.

Table 1. Semiquantitative spectrographic analysis of lithiophorite[1]

Mn	major	Li 700 ppm (Li_2O 0.32%)
Al	5%	Be 15
Cu	>2	Sc 50
Si	2	Ti 200
Fe	2	Cr 5
Ba	2	Co 70
Ni	0.5	Sr 30
Zn	0.5	Nb 10
Ca	0.2	Mo 30
Na	0.15	La 100
Mg	0.15	Nd 300
V	0.15	Gd 150
Y	0.1	Dy 200
		Ho 30
		Yb 70

Chris Heropoulos, analyst. Li_2O by atomic absorption spectrophotometry, H. N. Elsheimer, analyst.

[1] Values in left column all percent, those in right column parts per million.

hedra in the adjacent layers. The cobalt content of the Sausalito lithiophorite is surprisingly low; other analyses show one or two percent cobalt, on the same order of abundance as nickel.

Todorokite $(Na,Ca,K,Mn^{+2})(Mn^{+4},Mg)_6O_{12}\cdot 3H_2O$ occurs as soft dark-brown nodular aggregates with a bronzy luster, composed of platy crystals too small for satisfactory optical measurements. X-ray diffraction yielded four lines at the spacings of the stronger lines of todorokite, together with strong quartz lines, perhaps resulting from a fine skeletal intergrowth of the two minerals, as at some other occurrences. Nodules of todorokite are closely associated with the rare earth minerals; some are perched on churchite crusts.

Churchite ($YPO_4\cdot 2H_2O$), a structural isotype of gypsum ($CaSO_4\cdot 2H_2O$), occurs as snowy white crusts and tufts composed of radiating needles just resolvable with the hand lens. Florencite [$RE\ Al_3(PO_4)_2(OH)_6$] occurs as moderate-brown pulverulent earthy material in which individual crystals cannot be distinguished with the microscope. The two minerals are usually but not invariably associated; a crust of churchite commonly rests on a base of florencite. The X-ray diffraction pattern of the churchite matches existing standards; the pattern obtained from the florencite is indeterminate within the plumbogummite group.

Churchite is now known from over a dozen localities. All are in the weathering zone; at least half are in association with manganese and iron oxides. Florencite is generally a primary mineral found in pegmatites, carbonatites, or metamorphic rocks, but it occurs along with churchite in the weathering zone of the Burley pegmatite, Virginia (Mitchell and Geitgey, 1968). A third hydrous rare earth phosphate, rhabdophane, occurs at the Burley pegmatite and in an iron-manganese oxide deposit at Salisbury, Connecticut (Hildebrand, Carron, and Rose, 1957), but has not been found at Sausalito.

At three or four churchite occurrences there is an obvious source of rare earths, for example at Krasnoyarsk, Siberia (Noneshnikova, 1960) where churchite replaced xenotime, or the Burley pegmatite, which contains large masses of perrierite. At most of the occurrences, however, the primary source seems to be the trace amounts dispersed in ordinary rock or soil. At Sausalito the rare earths are presumably derived mostly from the shale, which has a normal low total content of rare earths and a normal Ce/Nd+La ratio (table 3). The mineral association at Sausalito and other localities suggests that absorption of rare earths on colloidal manganese oxides was an important step in the formative process, as proposed for a churchite occurrence at Kelly Bank, Virginia, by Milton, Murata, and Knechtel (1944) and supported by the experiments of Belousov and Kolobov (1965). Crystallization of the churchite and florencite was presumably a later event, probably coincident with recrystallization of the manganese oxides.

For the Kelly Bank occurrence, Milton, Murata, and Knechtel (1944) postulated that the primary concentration of rare earths, before adsorption on the manganese oxides, was a biogeochemical extraction, particularly by chestnut and hickory trees. Robinson, Bastron, and Murata (1958) found that hickory leaves can contain four or five times as much rare earths as the soil on which the tree grows. At the Sausalito locality it is undetermined whether concentration involved a biogeochemical stage. There are at present no broad-leaved trees; the flora consists of grass, low brush, and annuals.

Table 3. Semiquantitative spectrographic analyses of rocks from Sausalito lateral.

	Chert	Shale	Basalt
Y	n.d.	.007%	.003 %
La	n.d.	.010	n.d.
Ce	n.d.	.020	n.d.
Nd	n.d.	.015	n.d.
Yb	n.d.	.0007	.0003

n.d. - not detected; Helen Worthing, analyst.

Spectrographic analyses (table 2 and Fig. 2) show the usual predominance of rare earth elements of even atomic number. Yttrium and the heavier rare earths are concentrated in the churchite and the lighter rare earths in florencite. This can be attributed to the effect of the smaller ionic radii of the heavier rare earth elements and

Table 2. Semiquantitative spectrographic analyses of churchite and florencite.

	Churchite (percent)	Florencite (percent)
Y	>20	1.5
La	(<0.03)	2
Ce	0.2	0.5
Pr	(<0.1)	0.7
Nd	(<0.07)	3.
Sm	1.5	1.
Eu	1.	0.7
Gd	1.	1.5
Tb	1.5	(<0.1)
Dy	7	0.7
Ho	1.5	0.1
Er	5.	0.2
Tm	1.	0.01
Yb	5.	0.05
Lu	0.5	(<0.015)
P	>10	10
Ba	0.2	7
Sr	0.02	0.7
Ca	1.5	1.
Fe	0.3	10.
Mn	1.5	7.
Mg	1.5	0.3
Ti	--	0.7
Cu	0.5	0.5

Rare earths were not found at detection limits given in parentheses. Si, Al, K not looked for. Harry Bastron, analyst.

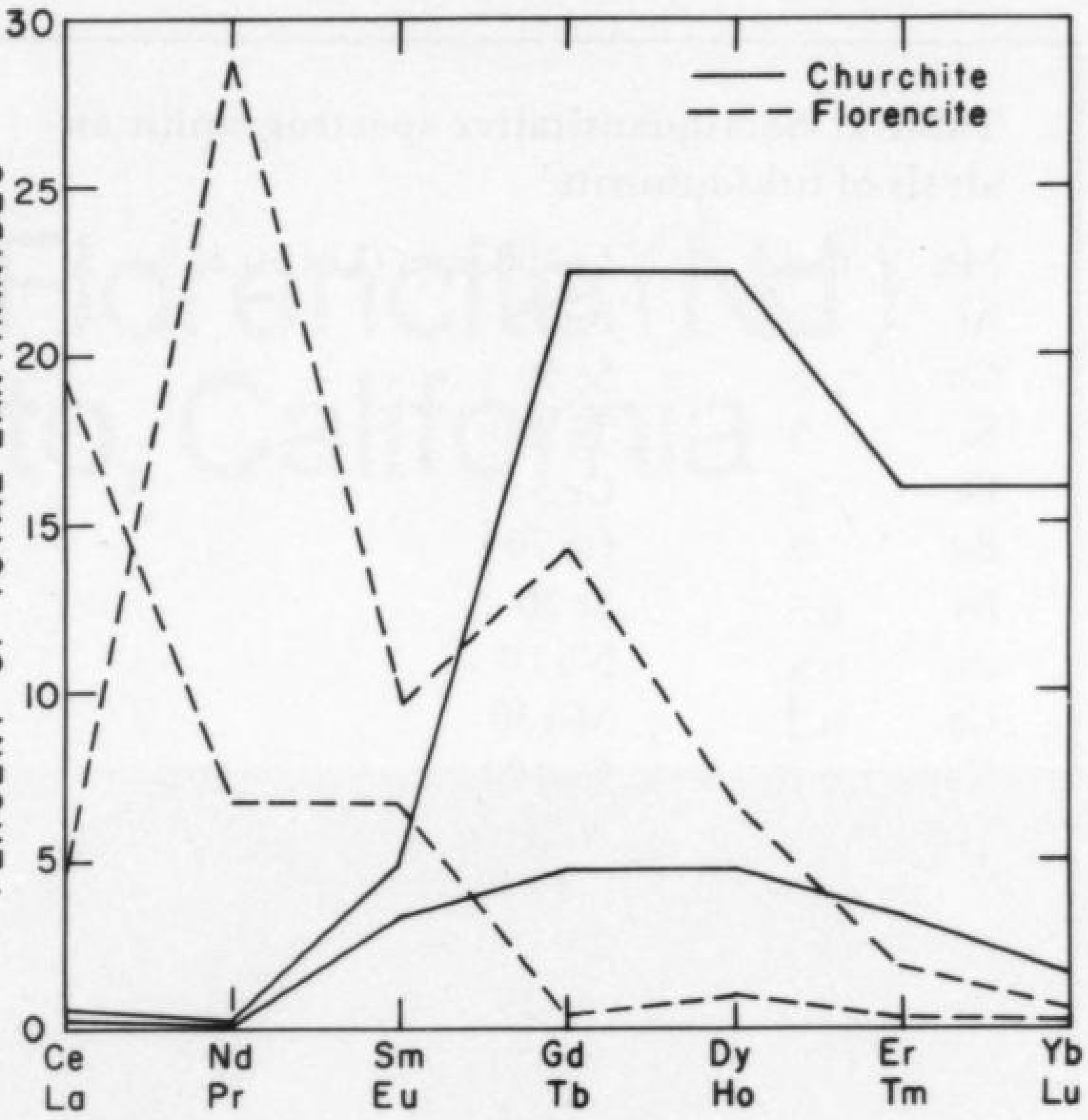

Figure 2. Distribution of rare earth elements in churchite and florencite. Upper and lower curves are for elements of even and odd atomic number, respectively.

yttrium. Structural sites occupied by these elements in churchite have an eight-fold coordination, whereas those in florencite are slightly larger, with a nine-fold coordination (Strunz, 1966). A sample of Kelly Bank, Virginia, churchite was analyzed at the same time and showed a composition almost identical with the Sausalito mineral.

All florencites that have been analyzed heretofore are the species florencite-(Ce), following Levinson's (1966) system of nomenclature in terms of the dominant rare earth element, and have ratios of Ce/Nd+La of about 1:1, normal for most cerium group minerals. The Sausalito mineral is a barian variety of the species florencite-(Nd). The unusual Ce/Nd+La ratio of 1:10 is comparable to the 1:100 ratio in the rhabdophane-(Nd) from Salisbury (Hildebrand, Carron, and Rose, 1957). The anomalously low content of cerium in the florencite indicates that during at least one stage of the process cerium failed to follow its sister elements. Cerium alone among the rare earths can be oxidized in nature to the quadrivalent state and, as Robinson, Bastron, and Murata (1958) pointed out, the transition takes place within the range of Eh and pH found in soils. Quadrivalent cerium is in general less soluble and will not be transported with other rare earths. It is significant that the florencite from the Burley pegmatite, which formed by oxidation in place, shows little if any loss of cerium relative to its predecessor perrierite, even though a small amount of secondary cerianite (CeO_2) also formed.

Churchite is undoubtedly a much commoner mineral than realized. Any powdery white mineral associated with supergene manganese oxides should be suspected as churchite and if confirmed, the much less noticeable florencite and rhabdophane should be looked for.

We acknowledge helpful suggestions by our colleague, K. J. Murata. Publication authorized by the Director, U.S. Geological Survey.

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MEETINGS & SHOWS

WHO & WHAT	WHEN	WHERE	CONTACT
Rocky Mountain Federation Show	**Oct. 1-3**	Topeka, Kansas	**R. C. Roderick,** 2106 East 6th Topeka, Kansas 66607
Baltimore Mineral Society, 15th annual micromount symposium	**Oct. 2-3**	Stemmers Run Junior High School Baltimore, Md.	**H. V. Corbett,** 3220 Berkshire Rd. Baltimore, Maryland 21214
Mineralogical Society of Lombardy, 6th Exchange-day of Minerals	**Oct. 23-24**	"Sala della Balla" Sforzesco Castle Milan, Italy	**Daniele Ravagnani** Via Procaccini, 54 20154 Milano (Italy)
Waterford Gem & Mineral Club, annual show "The Wonder of Rocks"	**Oct. 23-24**	Gold Room Oakland University Rochester, Mich.	**Vic Wendler,** 45 W. Drahner St. Oxford, Mich. 48051
Geological Soc. of America and Mineralogical Soc. of America, annual meeting	**Nov. 1-3**	Washington, D.C.	**GSA Headquarters,** Box 1719 Boulder, Colorado 80302
Michigan Mineralogical Society Greater Detroit Gem & Mineral Show	**Nov. 5-7**	Detroit Light Guard Armory, Detroit Michigan	**Mrs. Charles Towle** 22114 Allen-A-Dale Birmingham, Michigan 48010
The Mineralogical Society of Southern California, Annual Mineral Show	**Nov. 6-7**	Pasadena City College, Pasadena California	**Bob Pederson,** 645 Maryanna Lane Monrovia, California 91016
The Gem and Mineral Club of Scarborough - annual show	**Nov. 13**	Scarborough Junction United Church Scarborough, Ontario	**Barry Murphy,** 1059 Don Mills Road, Apt 403, Don Mills, Ontario, Canada
1972			
Tucson Gem & Mineral Society, 18th Annual Show	**Feb. 11-13**	Tucson Community Center Tucson, Arizona	**Joe D. Kreps,** 1402 W. Ajo Way #271, Tucson, Arizona
Geological Society of America, *Northeast Section,* ann. mtg.	**Mar. 9-11**	Buffalo, New York	**E. J. Buehler,** Dept. of Geol. Sci., State University of New York Buffalo, N.Y. 14207
Geological Society of America, *South Eastern Section,* annual meeting	**Apr. 15-17**	Tuscaloosa, Alabama	**T. A. Simpson,** Geological Survey of Alabama, Drawer O University, Ala. 35486
South Central Fed. of Mineral Societies Convention and Show	**May 5-7**	New Convention Center Waco, Texas	**Otto Schlemeyer** 1913 Mountainview Drive Waco, Texas 76710
The Rochester Gem & Mineral Show	**May 6-7**	Nazareth College, Rochester, New York	**Miss Dorothy Lind,** 190 Weldon Street, Rochester, New York 14611
Mineralogical Society of Arizona (& Rocky Mountain Federation), 1st annual show "Gems of the Desert"	**Jun. 23-25**	Veterans Memorial Coliseum, Arizona State Fairgrounds Phoenix, Ariz.	**Perry Stufflebeam,** 3139 W. Holly Phoenix, Arizona 85009
Amer. Fed. of Min. Societies & Calif. Fed. of Min. Societies, Annual show "Fantasy of Gems"	**June 29-July 2**	Anaheim Convention Center Anaheim, California	**Don J. Blood,** P.O. Box 3055 Orange, California 92665
Geological Soc. of America and Mineralogical Soc. of America, annual meeting	**Nov. 13-15**	Minneapolis, Minn.	**GSA Headquarters,** Box 1719 Boulder, Colorado 80302
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Amer. Fed. of Min. Societies & Eastern Fed. of Min. Societies show	**June 28-July 1**	Charlotte Merchandise Mart, Charlotte North Carolina	**Al Lewis,** P.O. Box 712 Charlotte, N.C. 28201

NEWS RELEASE

Mineralogical Research Company Now Full Time Operation

Sharon Cisneros reports that the Mineralogical Research Company has just gone from a part time to a full time business. More time will be devoted to expanding stock, putting out lists more frequently, assisting mineral collectors with their special needs, and attending mineral shows.

They also report a new find of vivianite crystals from the Dana locality at Wannon River, Victoria, Australia. These are said to be the finest emerald green, transparent to translucent, and range up to 4 inches in length. The crystal habit varies from terminated feather-like singles to aggregates or groups of flat top terminated crystals. For further information, write to Mineralogical Research Co., 14770 Whipple Court, San Jose, Calif. 95127.

To the Editor

(Continued from page 146)

EFMLS	John Hanahan, Jr. Dept. of Geology Belmont Abbey College Belmont, North Carolina 28102
MWFMS	Betty J. Crawford 1119 Seminole Ave. Mansfield, Ohio 44906
NFMS	Norman W. Steele, Jr. 607 North 62nd. St. Seattle, Washington 98103
RMFMS	David H. Garske 1604 38th. St. Rapid City, South Dakota 57701
SCFMS	Jane Magrum 1313 Yorkshire Drive Austin, Texas 78723
	Terry E. Huizing MWFMS Uniform Rules Committee Cincinnati, Ohio

Record Book Shelf

(Continued from page 148)

electric effects and luminescent excitation. More than half the book, nonetheless, is devoted to a discussion of color in minerals, treated in groups of similar composition (halides, carbonates, silicates and so on). Some attention is also given to pleochroic haloes and radiation damage in crystals.

Some technical terms (such as Reststrahlen and eigen absorption) are used without definition or explanation, and will transcend the comprehension of those not versed in crystal physics. Nonetheless, the bulk of the text is entirely nonmathematical and eminently readable, so even the nontechnical reader can hope to extract much useful information. In light of the remarkable dearth of review literature on color in solids, and especially minerals, Przibram's book is a bright spot indeed, and should occupy a place in any library of books on minerals and their characteristics.

Antarcticite from California

Gerhard G. H. Muehle

Antarcticite, $CaCl_2 \cdot 6H_2O$, is a rare mineral occurring at only two known localities in the world. The type locality is Don Juan Pond, Victoria Land, Australia. This occurrence was described by Dunning and Cooper (*American Mineralogist, 54,* pp. 1018-1025, 1969). The second known occurrence is Bristol Dry Lake, San Bernardino County, California.

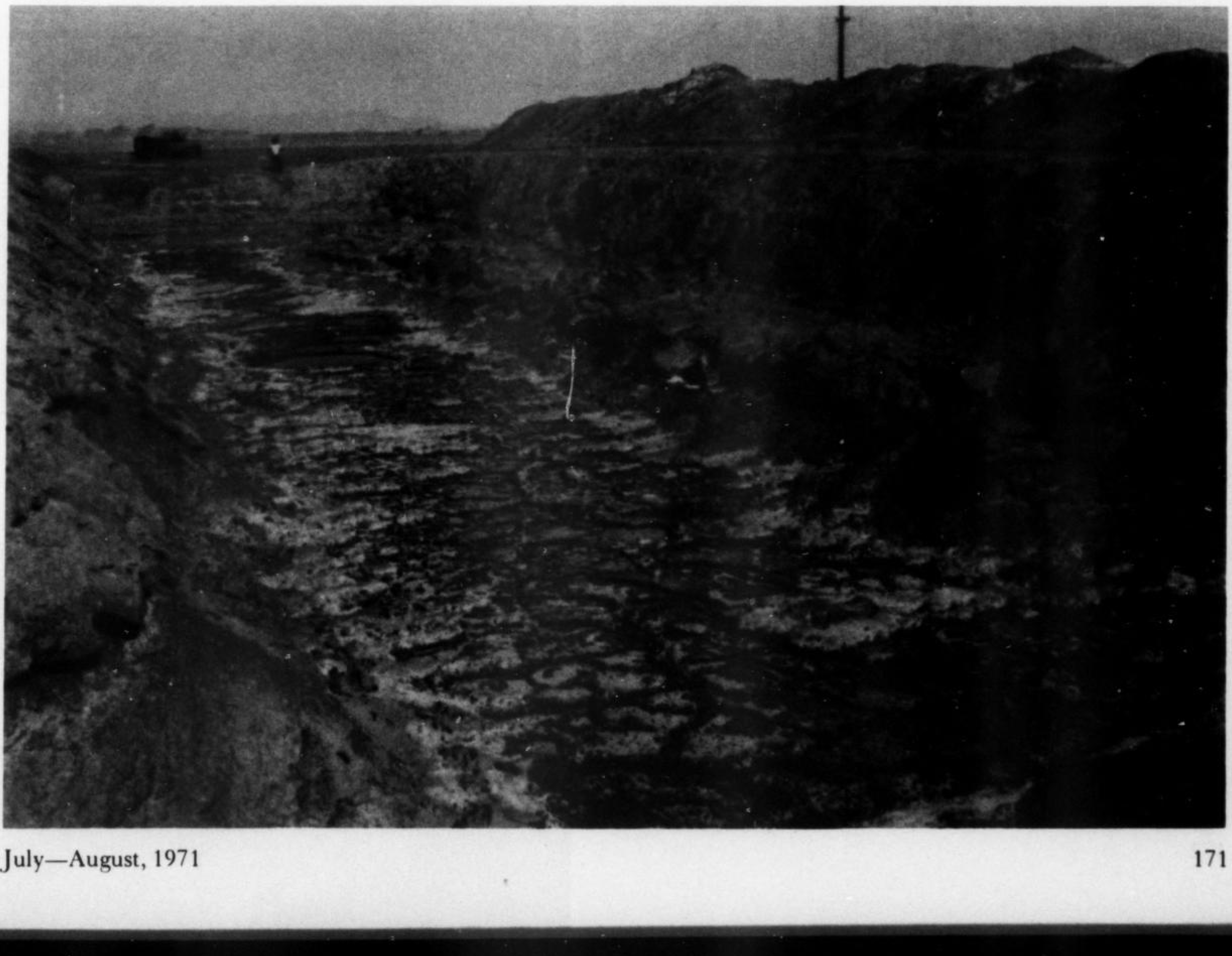
It is with the Bristol Dry Lake deposit that we shall be concerned. Antarcticite from this locality occurs in a pit which is one of a series of excavations in the area made to explore the subsurface salt and brine deposits. The pit, located in the SE 1/4 sec. 32, T. 5N., R. 12E., S.B., B.M., is just a few yards from the county road from Amboy to Twentynine Palms.

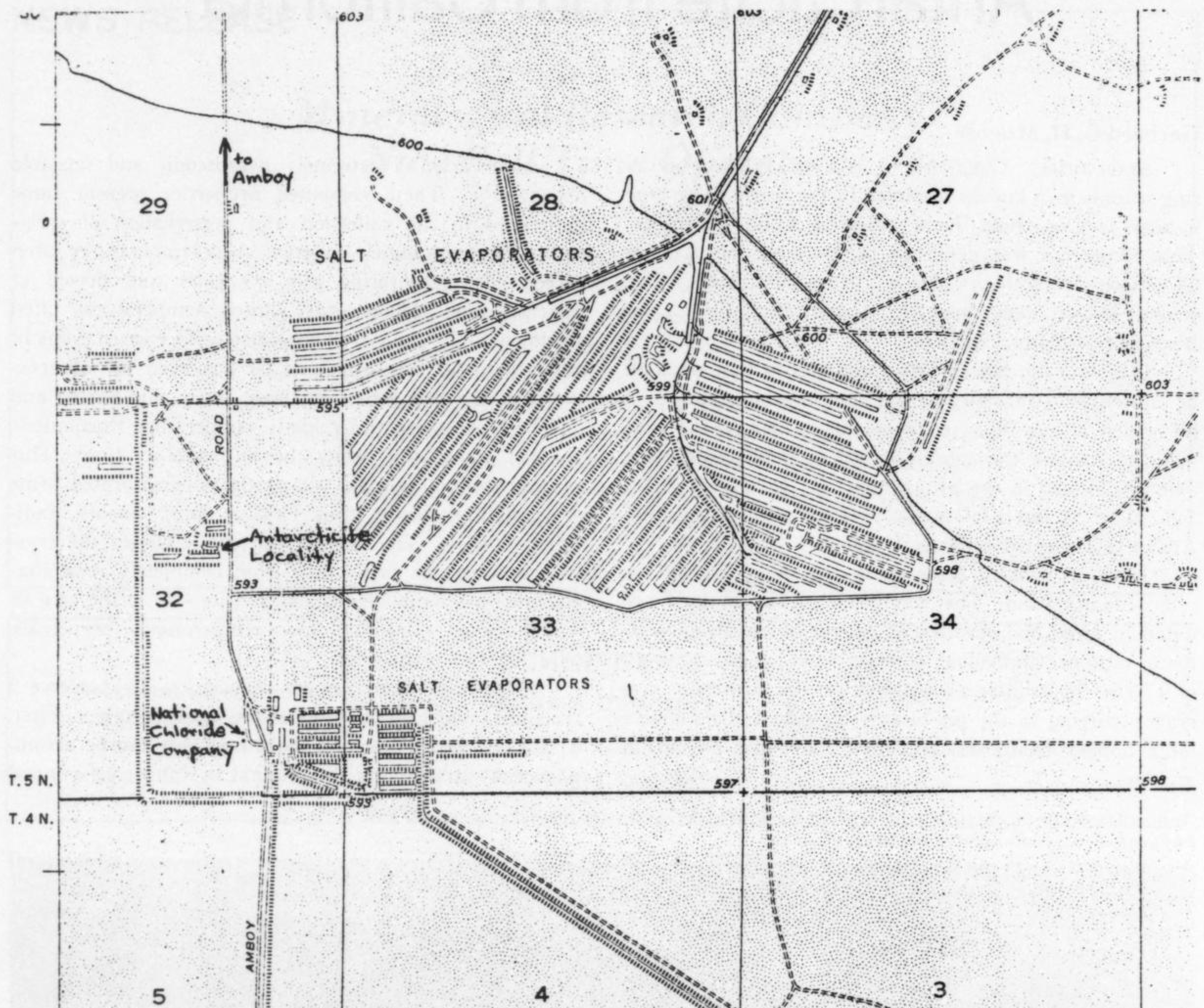
Here, in isolated brine pools, the mineral forms by solar concentration. The specimens to be obtained are found in large and spectacular groups of radiating, prismatic crystals. Individual crystals may exceed a length of 17 cm. In addition to antarcticite, the evaporite minerals occurring in the pit include gypsum and extremely large hopper halite crystals, some exceeding 35 cm on an edge.

Antarcticite is extremely hygroscopic and unstable above 86°F. These combined properties present some difficulties in the collection and preservation of specimens. During summer months when temperatures often exceed 120°, the brine pits are clear and devoid of mineralization. During the winter, temperatures often go down to 15° and at these times solid encrustations of antarcticite fill the brine pits. It has been my observation that the best collecting times are in mid-Spring and mid-Fall. At these times, daily temperature fluctuations go well above and below the 86° stability limit. This gradual cooling at night allows the supersaturated brine to crystallize slowly, thus forming long, smooth, individual crystals. The heat of the day dissolves the crystals, keeping the brine pool from completely crystallizing into massive bodies of antarcticite - as is the case in winter when continual low temperatures perpetuate crystallization of the brine.

Collecting, then, has its drawbacks. To preserve a specimen, two general precautions must be taken. First, it must be sealed from all moisture. This can be accomplished by submerging the mineral in anhydrous mineral

Antarcticite occurs in the clear brine pools at the head of the excavation pit. Selenite crystals and hopper halite crystals occur in the banks of the pit.

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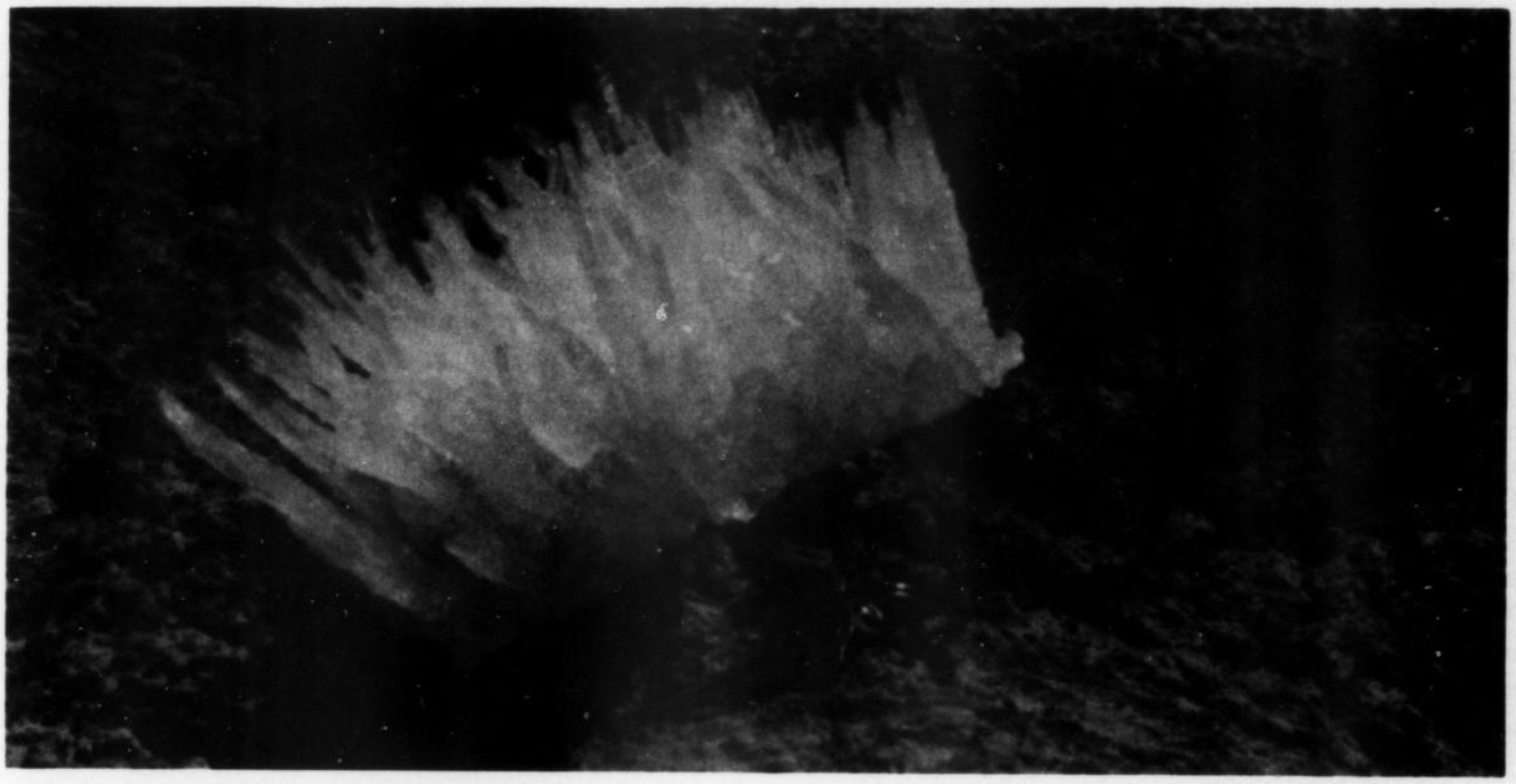
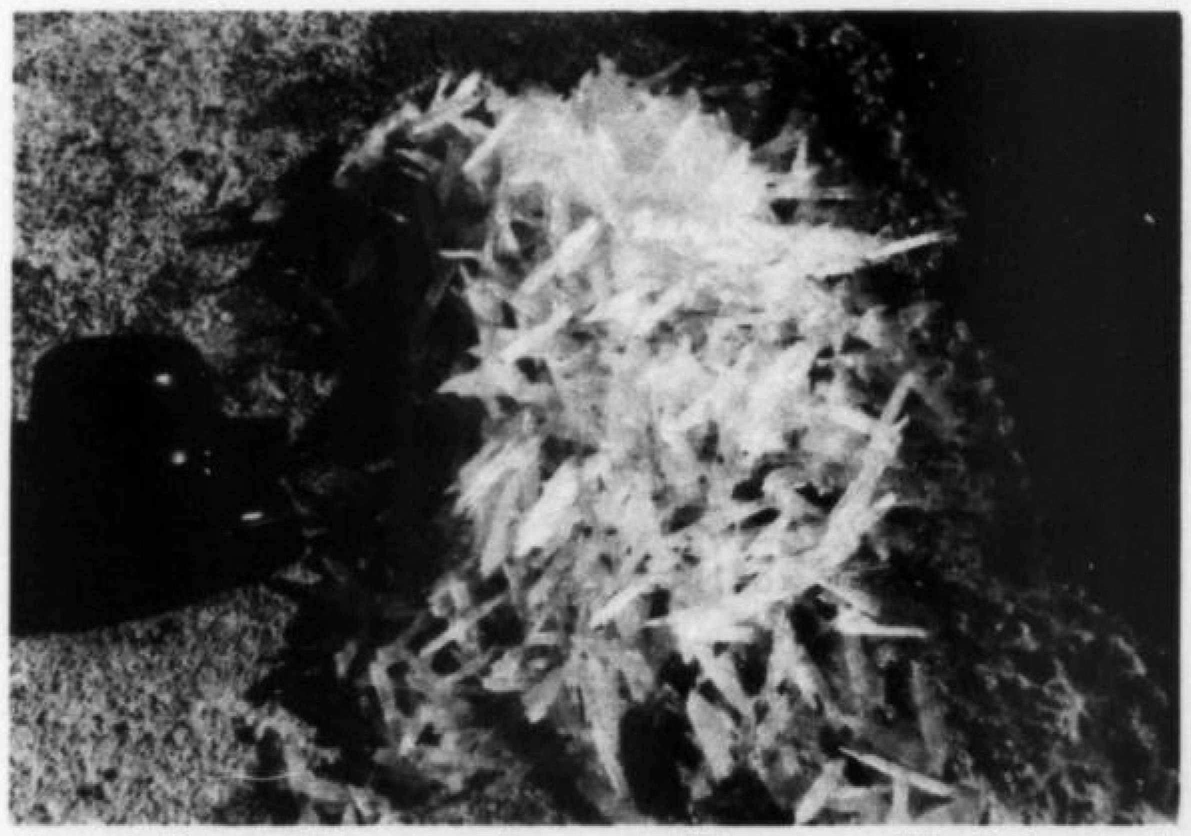
oil, or by sealing it in a container partially filled with silica gel. Second, the specimen needs to be kept below a temperature of 86°F. This last precaution is not much of a problem, since most homes do not normally exceed that temperature.

If you plan a trip to the area, some tips are in order. By following the map (see cut), one should have no problem in finding the locality. Permission to collect should, of course, be obtained from the National Chloride Company (shown on map). All specimens that are not to be preserved should be returned to the pools and not left lying around the pit. This is important in order to maintain the unique environmental conditions needed for continued crystallization.

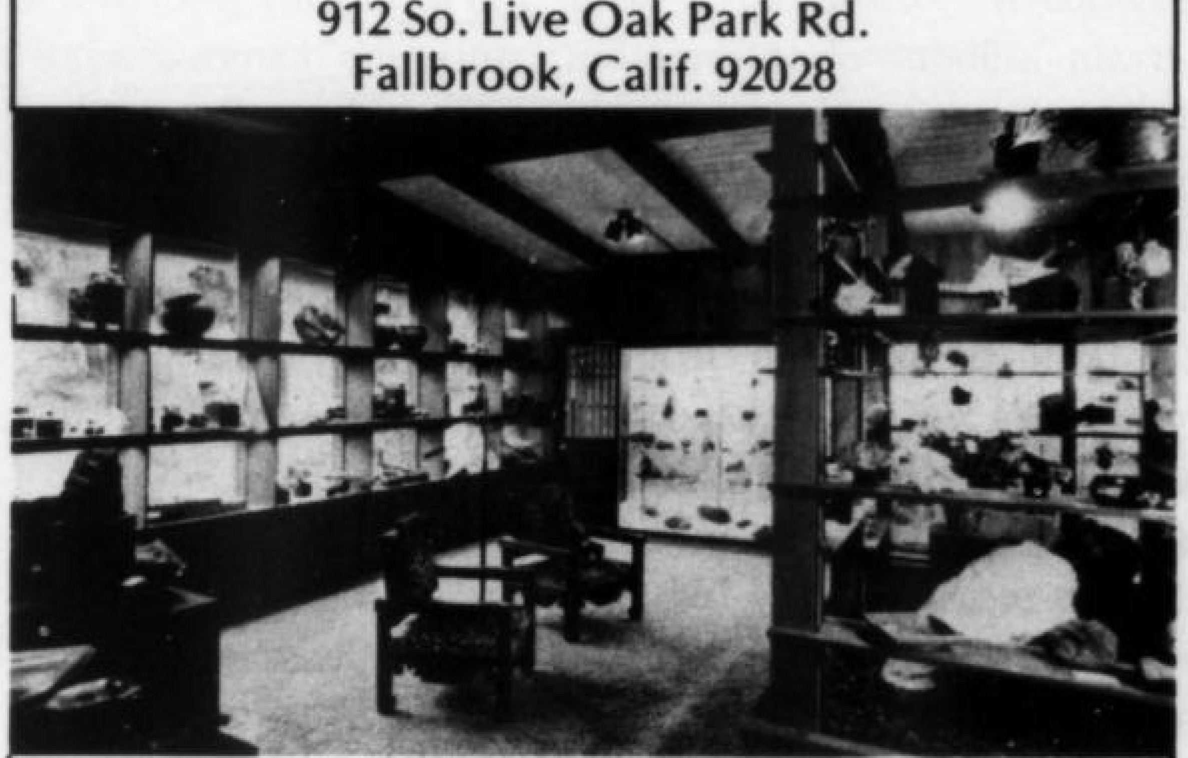


A superb group of radiating, prismatic crystals.



A mass of antarcticite crystals removed from one of the brine pools.

At times large groups of antarcticite crystals may be removed from the brine.



The State of the Art–Part III
The Powder Method

JOEL E. AREM

Max von Laue's discovery in 1912 that crystals could act as three-dimensional diffraction gratings for X-rays was a truly momentous one in the history of physics. Many laboratories throughout the world soon began experimenting with X-rays and their interaction with crystals. This work was disrupted by the outbreak of World War I, when various parts of the world-wide scientific community became isolated from each other. In 1917, Debye and Scherrer (in Germany) and Hull (in the U.S.) discovered, almost simultaneously, that powered crystalline materials produce characteristic X-ray effects. The technique of using ground-up samples in diffraction analysis became known as the powder method, or sometimes as the Debye-Scherrer method, after its discoverers.

The basic theory of powder diffraction does not differ substantially from that of single crystal diffraction, (see *Min. Record,* v. 2, p. 57-68, 111-122 and 144) as might be expected. A powdered crystalline substance is merely a collection of tiny single crystals (crystalline fragments). Powdering a large single crystal destroys a certain amount of information, since the external symmetry characteristics of the crystal are lost. But a distinct advantage is gained: powder techniques offer a convenient, rapid and easy method of identification. In addition, a large amount of crystallographic information can still be obtained from powder data, and powder techniques do not depend for their utility on the availability of a good single crystal.

THEORY

As seen in Part II (*Min. Record,* v. 2, p. 115) X-rays are diffracted from a crystal only when the relative positions of the crystal and incident X-ray beam satisfy the Bragg equation ($n\lambda = 2d \sin \theta$) for the wavelength of radiation used. In the case of a single crystal, discrete diffracted beams are obtained as the crystal is rotated in an X-ray beam. The diffracted rays flash out and are recorded either by a Geiger or scintillation counter or on film. Each diffracted beam falls at a particular point in space; the resulting pattern (easily seen on single-crystal X-ray photographs) is characteristic of the crystal's lattice size and type. The intensities of the diffracted beams are determined by the kind and relative positions of the atoms within the structure of the crystal (that is, by the atomic motifs). It is important to remember that the *positions* of the diffracted beams are governed only by the size and type of the *lattice.* The various lattice spacings are known as *d*-values.

A powered crystalline substance is, in essence, a collection of small single crystals, and each of these will diffract an X-ray beam. The crystallites in a powder sample are randomly oriented, and this might suggest that the diffracted beams they produce will be randomly arranged also. This beam distribution is, however, not at all random, since diffraction angles are predicted by the Bragg equation and have specific values. The Bragg equation relates the following factors: wavelength of the X-rays (constant in a given experiment), the incident and diffracting angles, and the interplanar spacings (d) of the crystal. All the grains in a powder sample that are oriented with a particular set of atomic planes (having a characteristic *d*-value) in correct diffracting position will diffract X-rays at a specific angle. These diffracted beams form a cone, with a fixed angular opening, about the sample (Fig. 1). Each lattice spacing, d, produces a cone with a unique angular opening; some of these "nested cones" are shown in Fig. 2. If one could measure the angular openings of all the cones produced by a sample, one could use the Bragg equation to calculate the *d*-values for the crystal. This set of *d*-values carries complete information about the lattice size and type of the crystal under investigation.

To make sure that all possible sets of crystal planes (each with its particular spacing, or *d*-value) get a chance to diffract, the sample is usually rotated in the X-ray beam. Fine grinding of the sample insures that many particles are present, and in many orientations. Several hundred diffraction cones (including many that open back in the direction of the incident beam) might be generated in the case of a complex, low-symmetry material.

Various options exist for detecting and measuring powder-diffracted beams. One simple method uses a strip of film wrapped about the sample at a fixed (radial) distance. The intersection of the diffraction cones with such a strip is a series of arcs (Fig. 3) that characterizes the familiar *powder photograph.* An alternate arrangement is to rotate the sample slowly in an incident X-ray beam and couple the sample movement to that of a detector, such as the Geiger counter. Each diffracted beam is recorded as it arises in the sample (when the Bragg

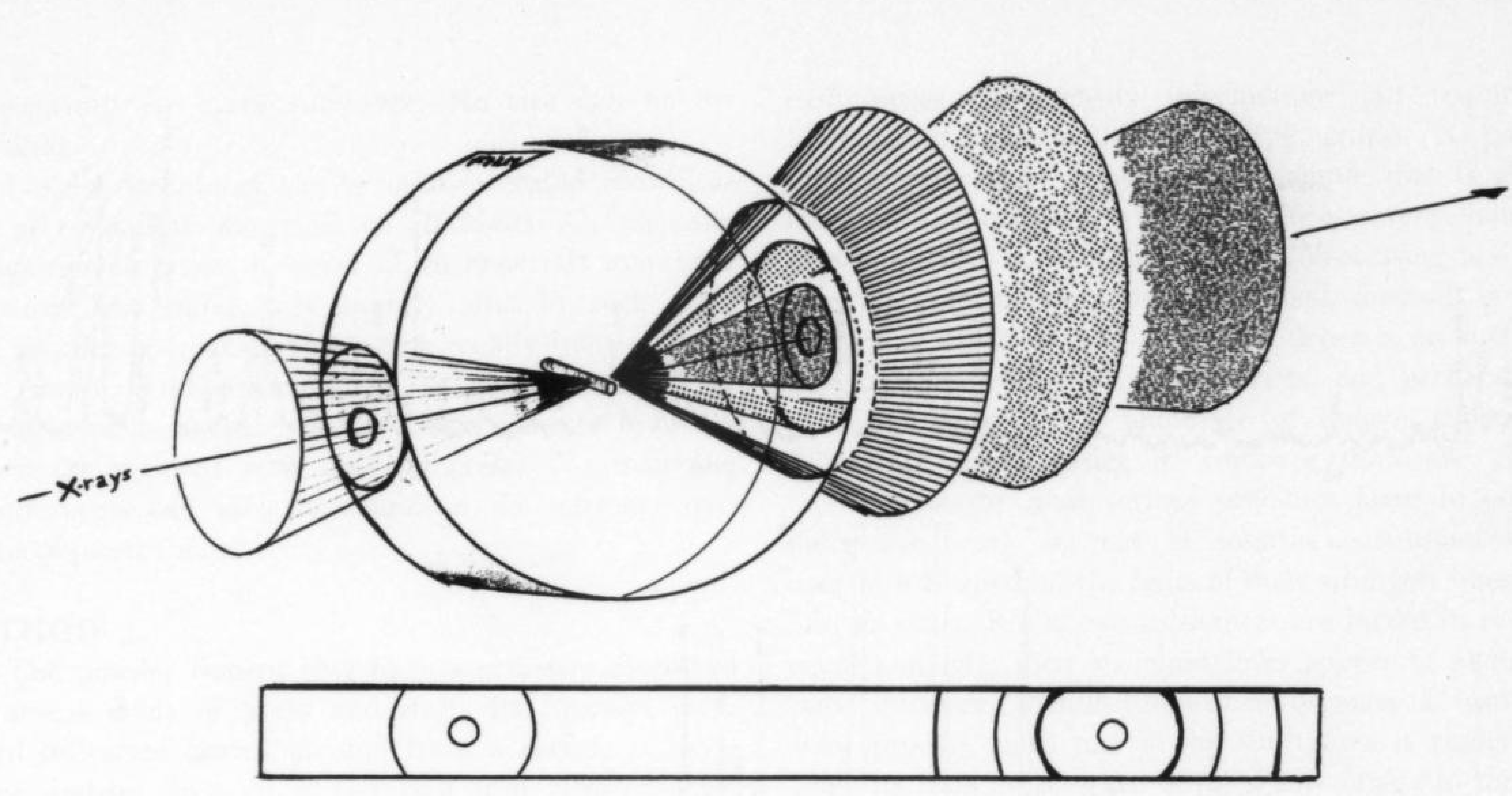


FIG. 1▲

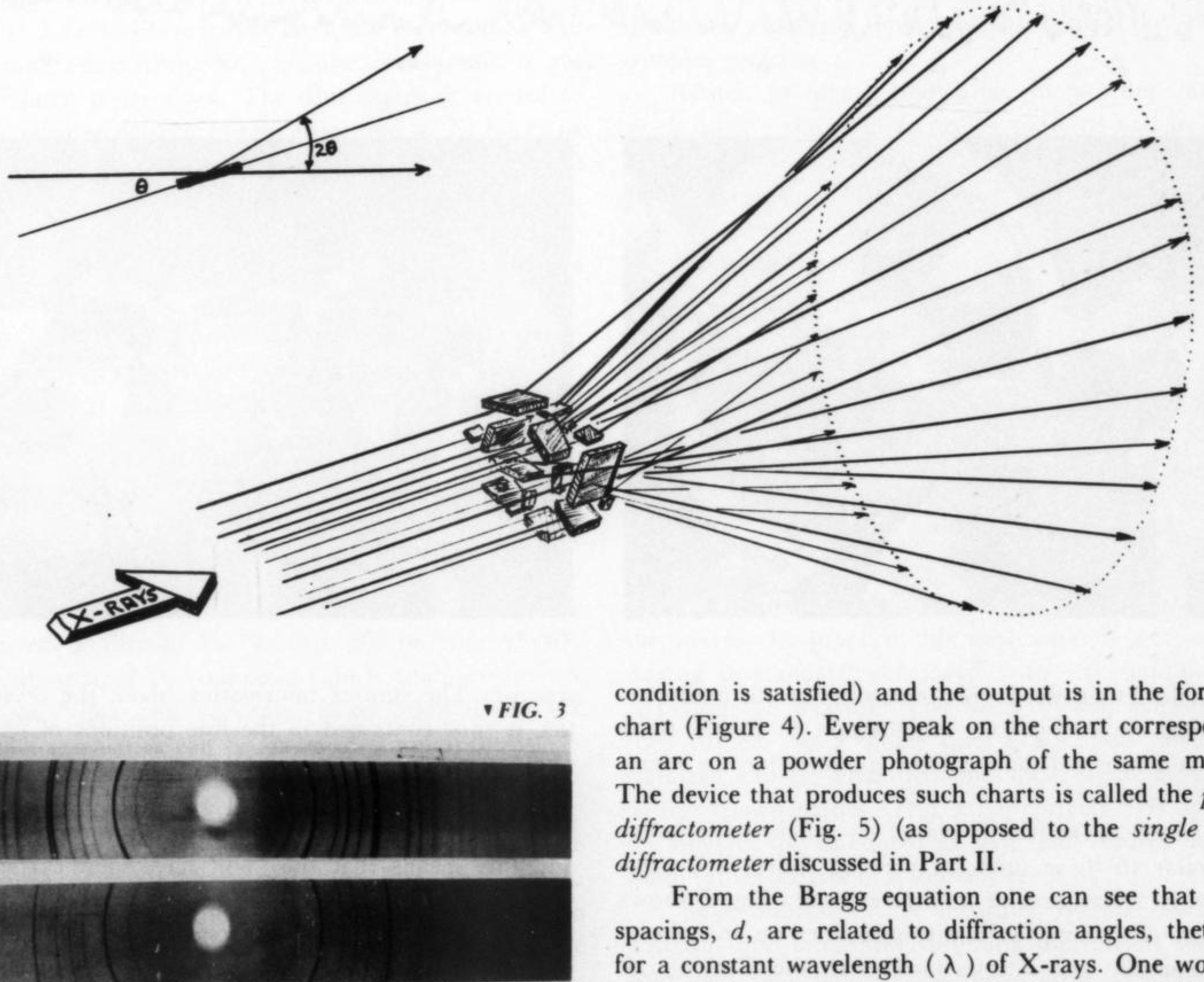
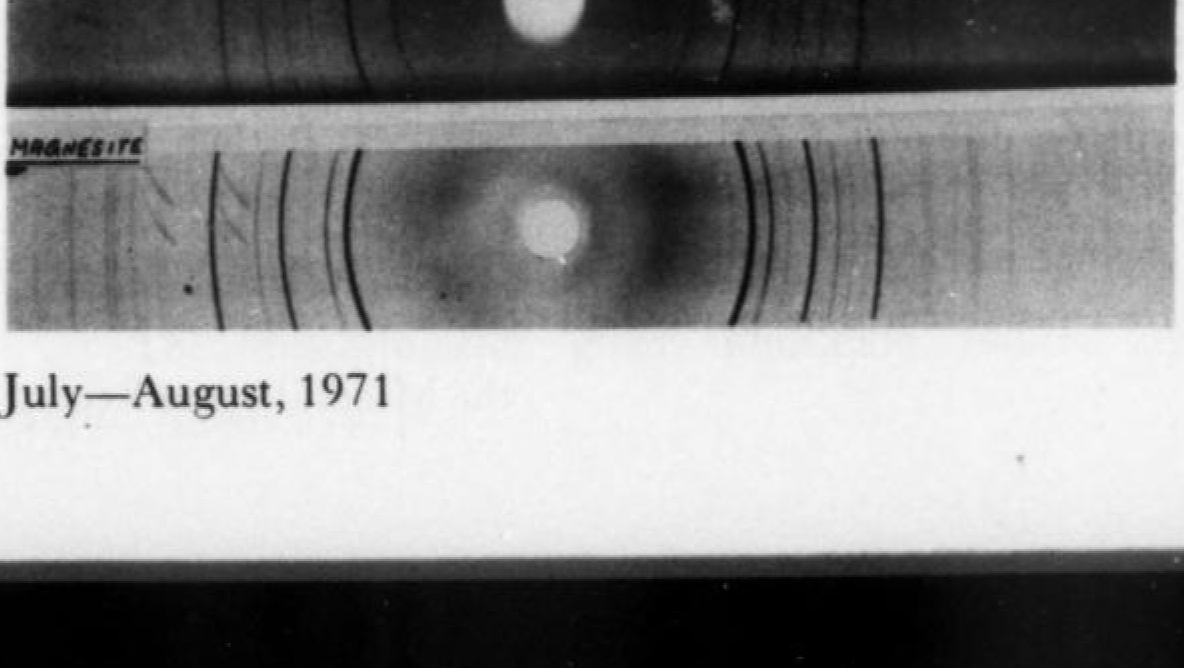


FIG. 2▲

▼*FIG. 3*



condition is satisfied) and the output is in the form of a chart (Figure 4). Every peak on the chart corresponds to an arc on a powder photograph of the same material. The device that produces such charts is called the *powder diffractometer* (Fig. 5) (as opposed to the *single crystal diffractometer* discussed in Part II.

From the Bragg equation one can see that crystal spacings, d, are related to diffraction angles, theta (θ) for a constant wavelength (λ) of X-rays. One would (in the case of the powder photograph) therefore like to know the angular openings of the diffraction cones, because these angles are related to values of theta. The measurement of the cone angles is simplified by carefully designing the camera in which the sample and film are placed. The radius of the camera is specifically set so that arc lengths (in millimeters) on its circumference (where the film is located) are directly related to

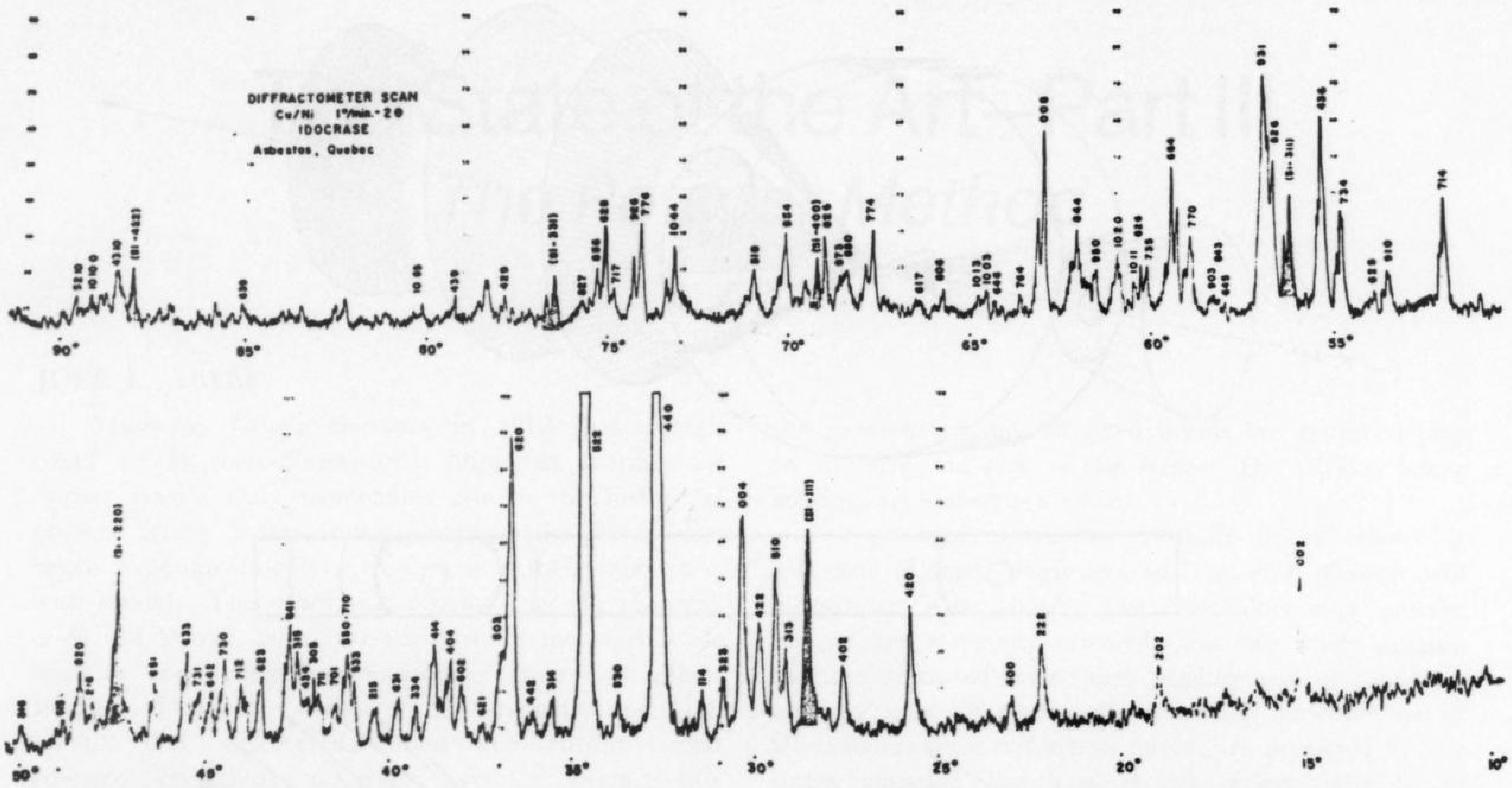


FIG. 4▲

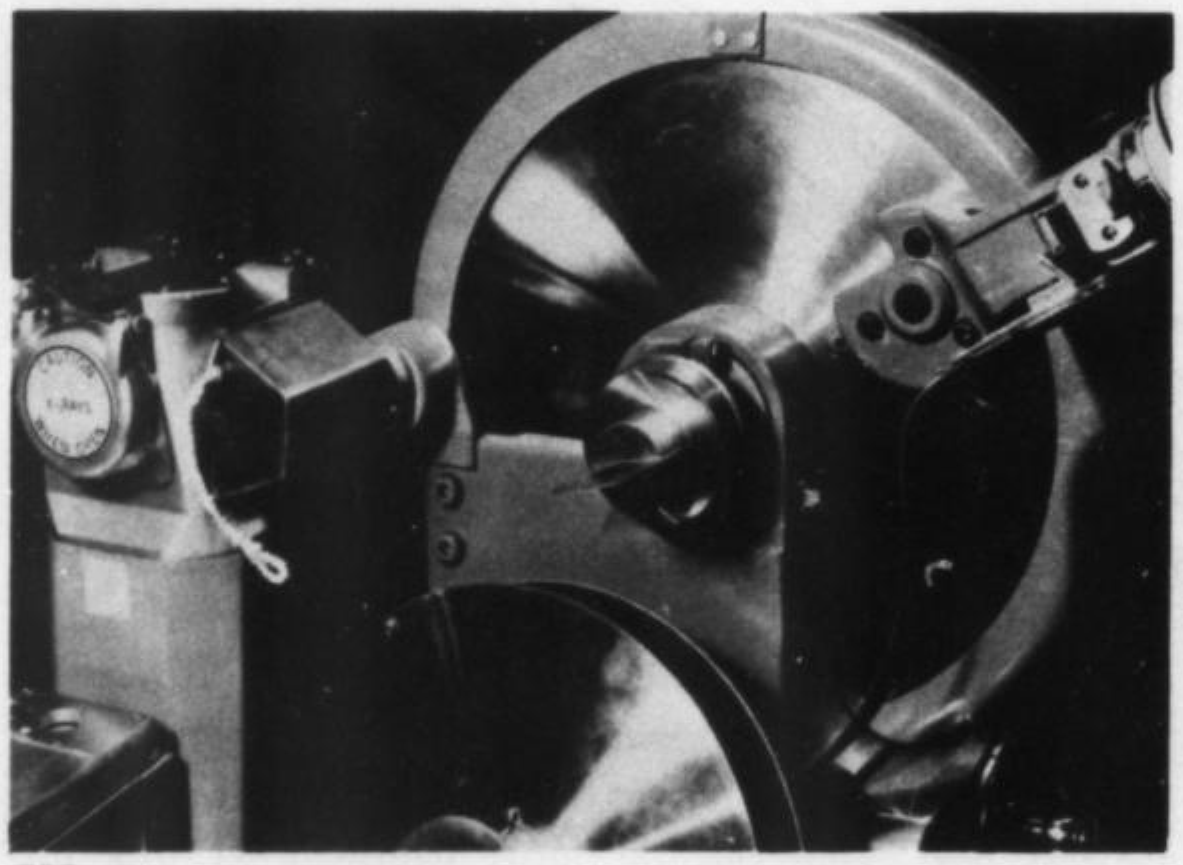


FIG. 5▲

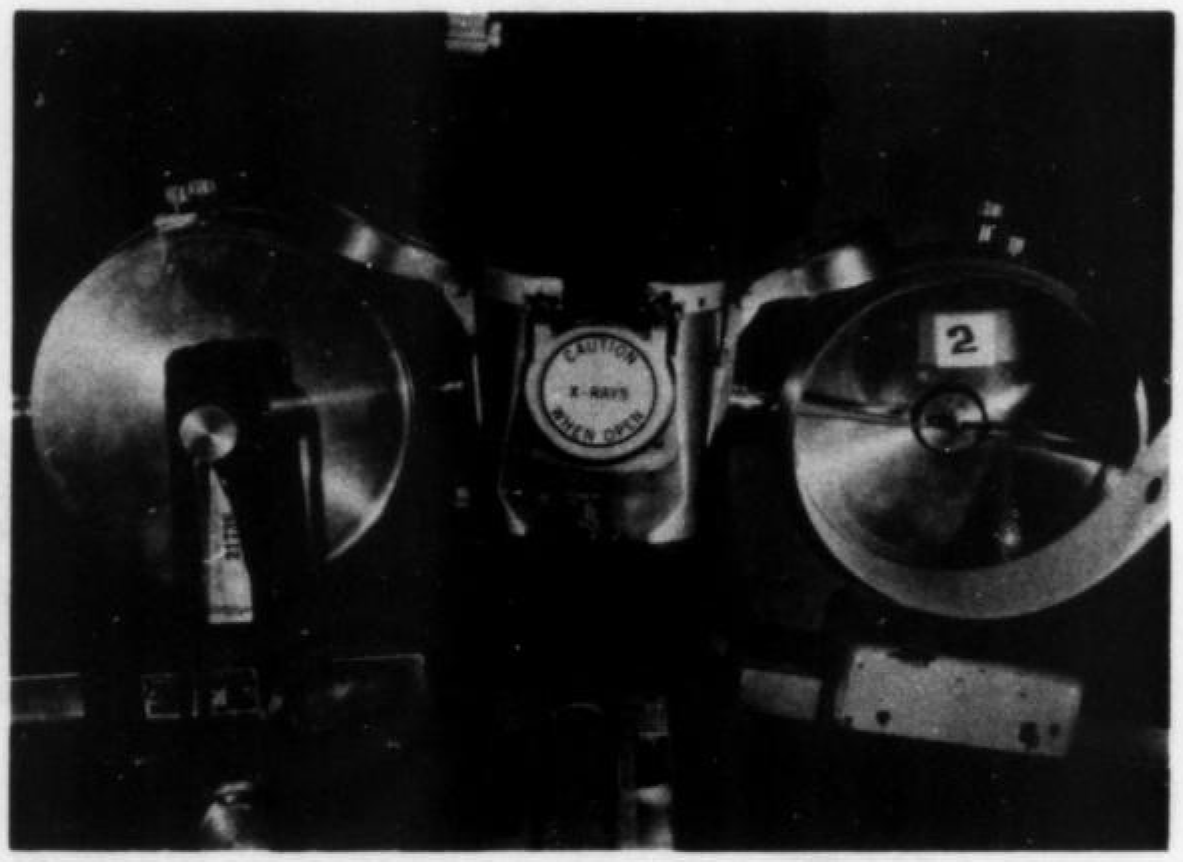


Fig. 6.▲

theta angles. One need only measure the distances between lines on the powder photograph to obtain theta angles, and thus calculate all the *d*-values for the material.

In practice, the film is placed on a light table (a device similar to those used for viewing slides) and measured with a very precise millimeter scale. Fig. 2 shows that pairs of symmetrically-disposed lines on the photograph represent the intersections (with the film) of opposite sides of diffraction cones. The distance in millimeters (on the film) between these symmetrical arcs is thus a measure of the opening of the cone. The wavelength of the radiation used in taking the photograph is known. One can thus use the Bragg equation: $n\lambda = 2d \sin \Theta$ to calculate *d* for that cone. Every pair of arcs on the film represents diffraction from a particular set of crystal planes, characterized by a specific interplanar spacing. The sum of information about the crystal's lattice is thus contained in the line positions of its powder photograph.

No two substances have exactly the same structures. Two substances may have identical *lattices,* however, and this means that they will have identical sets of *d*-values. The locations of diffracted beams arising from these two substances will therefore be the same, line for line. But the atomic constitution and arrangement for the two substances will not be the same, and these two factors govern the intensities of the diffracted beams. Therefore, while the positions of the lines will be identical, the intensities on a film (or peak heights on a chart) will be different for the two substances. It then follows that every crystalline substance must have a unique powder pattern - when both line positions *and* intensities are considered. The powder pattern is therefore a kind of "fingerprint" for every substance. No two can be exactly alike.

Powder techniques can be used for rapid identification of crystalline materials of all kinds. Occasionally ambiguities do occur, however. Two materials may have structures that differ only slightly, and in such cases their powder photographs may be virtually indistinguishable. Another problem may arise, of course, in the event that the examined material has never hitherto been described (as happens with new minerals). No matching measurements can then be found in the various compendia of powder data.

METHOD

The powder camera (Fig 6) is a precisely machined instrument made of brass and steel. Its function is to record diffracted beams, arising from a sample of crystalline powder, in such a way that film measurements will allow calculation of *d* values for the material. This is achieved by making the diameter of the camera cyllinder exactly 57.3 or 114.6 mm; the circumference is then 180 or 360 mm, respectively, and angular measurements are simply related to *d*-values. The film exposure needed to record a powder pattern ranges from one to 20 hours or more, depending on the wavelength of X-rays used and the amount of sample available. The powder diffractometer records patterns in "real time" (i.e., the pattern evolves while you wait), and a complete chart takes about 2 hours.

In routine work it is usually not necessary to carefully measure films or charts. For films, special transparent overlay scales are available that are calibrated for various radiations. Such a scale is placed over a film on a light table, and the *d* for each line can be read directly. Even more convenient and simpler to use is a file of photographs of known materials. Of course, such a file requires much time and effort to accumulate, but if available it can save hours of work.If the identity of a sample is suspected, a film of the known can be simply compared with that of the unknown. Such comparisons are usually very fast and accurate, since many lines and their exact intensities can be matched simultaneously. In such cases the "fingerprint" aspect of powder diffraction work becomes most apparent.

Samples for the powder diffractometer require much more material than those for film and camera work. The sample is either pressed flat in an aluminum holder, or simply spread out on a glass microscope slide with a small amount of acetone and perhaps some binding material. The sample and detector motions are coupled in such a way that any diffracted beams arising in the sample are picked up and measured. Of course, since the diffracted beams arise at specific angles (due to the restrictions embodied in the Bragg equation) the counter detects these radiations as peaks (rather than a continuum) whose intensities can be measured.

The diffractometer gives immediate results and easily-measured intensity information, but requires a large sample (normally about 1/2 gram). A powder photograph can be taken with a sample that is almost invisible to the naked eye, but requires several hours of exposure, plus normal photographic processing and drying. The information produced by both methods is identical, and which technique is used depends on such factors as time, availability of materials, and perhaps even the accessability of a photo-file of known substances. Films are much easier to compare than are charts.

One of the most serious problems faced in powder diffraction work is that of mixtures. Substances are usually identified on the basis of their strongest lines on a film or chart. But if two substances are mixed in roughly equal amounts, their strongest lines appear at about the same intensity. Identification then becomes a trial-and-error process, until one of the substances is recognized. Then its lines are marked off, and any others in the pattern must belong to other substances. Identification of mixtures is a problem ideally suited for computers, and computer programs now exist for sorting out extremely complex patterns.

Other problems that arise in powder diffraction work involve errors in recording patterns and in measuring them. Systematic error is bothersome in any scientific experiment, but can be largely eliminated by making use of standards. Some crystalline materials with simple powder patterns (such as alumina, quartz, silicon, tungsten and halite) have been very carefully studied by numerous laboratories, and the cell dimensions of these substances are known with great accuracy. If systematic error (such as camera eccentricity or shrinkage of film during processing) is present in an experiment, it will affect in an identical fashion all results obtained. In the case of a substance of known characteristics, the deviation of the experimental results from the correct values can be easily ascertained and an overall correction then made for the experimental conditions themselves. In practice this evaluation is performed by mixing a standard substance with the unknown, and X-raying the mixture. The lines of both substances are then present on a single photograph, but those of the standard can be identified and their positions corrected to the known values. This same correction is applied to the lines of the unknown as well, and insures that measured values are free of systematic error.

Since substances are identified on the basis of line positions and intensities, anything that affects these variables may be a potential source of error. Standardization usually corrects line positions adequately, but intensities are altered by a great many factors. One of the most severe problems affecting intensities is *preferred orientation*. Ideally, the grains of a powder should be randomly distributed in the sample, so that all possible sets of crystal planes have a chance to diffract. Many materials, however, are platy (such as the micas) or acicular because they possess excellent cleavage. Fragments of such materials tend to lie in specific orientations, thus biasing the X-ray pattern by intensifying some reflections and weakening others. Elaborate and ingenious methods have been employed to reduce the effects of preferred orientation. Among them are grinding with glass, mixing with finely powdered soap flakes, or even embedding a powdered sample in molten glass and regrinding the cooled aggregate. As stated earlier, two or more substances may have identical lattices, and thus produce identical arrangements of lines on a powder photograph. The only means of distinguishing such materials is by careful comparison of line intensities. Thus, elimination of orientation effects is of paramount importance, and justifies the time and effort spent on the problem.

Sample preparation techniques for powder diffraction are among the most exotic, original and inventive in laboratory science. Imagination is useful in virtually every aspect of the work.

Samples for powder photography normally consist of spindles - small rods that can be rotated in the X-ray beam. Various types of spindles are used: glass fibers coated with vaseline and rolled in the powdered sample, fiberglass eraser bristles, capillary tubes, even slivers of old X-ray film. One can roll a mixture of sample and an adhesive (such as Duco cement or collodion) between glass microscope slides until it forms a small cyllinder or ball. All of these methods seem to work fairly well.

Diffractometer mounts can be made by mixing glass (or even wet filter paper) with the sample and spreading it on a slide, or by smearing on a slide (hence the name "smear mount") a mixture of the sample and acetone or some other liquid. Sometimes, to avoid preferred orientation, the sample is sprayed with an atomizer onto a roughened surface, with or without glue.

Grinding of samples is a problem where the sample might be structurally deformed by the pressure involved, or might oxidize if ground while exposed to the air. Grinding in acetone, toluene, or even liquid nitrogen (to make the sample more brittle) is commonplace. Metals are malleable, and must be filed to obtain a powder. In some exotic cases, such as grinding of micas, people have even employed magnetic stirrers equipped with pieces of razor blades!

HAZARDS

X-rays are an insidious hazard, in that they are invisible and their effects are not immediately felt. The human body can tolerate a small daily dose of X-rays without harmful effects, but larger amounts are damaging. Skin exposed to X-radiation usually reddens a condition known as erythema. Surprisingly, the body can recover even from an erythemal dose, but exposure to much lower radiation levels over a long period of time can be very harmful. X-rays damage tissues by a process of ionization. When a cell absorbs an X-ray quantum, a portion of some molecule in the cell might be split off, causing chemical changes and resulting in the ultimate death of the cell. It is this type of damage that alters genes in reproductive cells, and causes the disfigurements normally associated with atomic radiation birth defects.

X-rays thus have to be *absorbed* by tissues to damage them, and this turns out to be easier for longer wavelengths than for the more penetrating, short wavelengths. Thus copper and iron, with wavelengths of about 1.54 and 1.93 Å, respectively, are more potentially lethal radiations than molybdenum (wavelength 0.71 Å) radiation. But this is not meant to imply that molybdenum X-rays are especially safe. A radiation laboratory is no place for carelessness.

Diffraction work requires X-rays at voltages of 30-50 Kilovolts (30-50,000 volts). Medical X-rays, on the other hand, commonly are generated at potentials in excess of 100 kilovolts, and the wavelengths used are also shorter than those used in diffraction. For this reason, exposure to a medical X-ray machine is therapeutic, while equivalent exposure to iron or copper radiation at lower voltages could easily be fatal.

USES OF POWDER DIFFRACTION

For mineralogists, the most important applications of powder diffraction involve routine identification and characterization of minerals. The inclusion of powder data in a report on a new mineral is of prime importance, in allowing other researchers to recognize the mineral in their own specimens. But the information contained in a powder photograph is useful in many additional ways.

Each line on a powder photograph can be *indexed* - that is, identified as the result of diffraction from atomic planes with a particular spacing in the crystal. Three of these spacings correspond to the unit, or axial dimensions of the crystal (expressed in Ångstroms) and thus identification of powder lines allows determination of the unit cell size. Systematic absence of lines of specific indices provides information about the lattice type of the crystal being studied.

As noted earlier, each line on a powder photograph consists of a myriad of small dots, each of which marks the passage of a diffracted beam arising from a tiny crystallite in the powdered sample. The smaller the grains, the smaller the dots on the film. But a lower limit is reached where the grains may become so small that individual particles contain too little diffracting material to diffract properly. This results in a diffuse blur, and the lines on the powder photograph become hazy, ill-defined smears. Conversely, grains that are too large produce "gritty" powder photographs, where powder lines actually appear as strings of large spots. Refinement of the theory and techniques of powder diffraction work has thus led to a virtually independent discipline: grain size determination.

The physical properties of crystals, such as strain, dislocation and defect content, and elastic behavior are all amenable to study by powder diffraction. A substance that is well crystallized gives powder photographs with sharp, clear lines. A poorly crystallized material (the extreme case of this would be an amorphous substance) gives powder photographs with broad, diffuse lines. A glance at a powder photograph can thus provide information about sample crystallinity that would be difficult to obtain by other means.

Special cameras have been devised that are capable of heating or cooling a sample while the X-ray photo is being taken. Changes in cell dimensions thus observed give excellent measurements of coefficients of thermal expansion. Heating and cooling experiments also allow determination of inversion temperatures. Inversion is the transformation from one structural arrangement to another, at a constant chemical composition, usually in response to a change in temperature. The transformation from low to high quartz at 573° C. is an example.

Powder diffractometry also yields information about preferred orientation in metals and organic materials. Cold working (such as rolling) of metals introduces a linearity in grain orientation, and many organic substances are fibrous. These features can be detected and actually mapped.

Powder diffraction can be used for chemical analysis. Relative heights of peaks arising from components in a complex mixture can be related to the amounts of the various components that are present.

Powder techniques find extensive application in the fields of atomic energy, ceramics, metallurgy and organic chemistry, as well as inorganic chemistry and mineralogy. There is virtually no branch of science that has not been touched by advances in powder diffraction analysis.

SUMMARY

Human beings can directly perceive pitifully little of the universe as it actually exists. Our eyes are sensitive to a microscopic portion of the vast flood of electromagnetic radiation that fills all space. The wavelength of the radiation we call visible light allows us to see only objects above a certain minimum size. But we can use shorter wavelengths to "see", via instruments, very much smaller things. The magic of modern technology has successfully resolved images of the very atoms of which our universe is made.

X-rays constitute a portion of the electromagnetic spectrum whose waves are about the same length as the distances between atoms in crystals. For this reason, X-rays can be used to obtain images of patterns in crystalline solids - patterns caused by the regular repetition of atoms in periodic arrays. This repetition is no accident. It is the result of strict laws of atomic bonding and geometry, as modified by crystal growth processes and chemical variation. But it is the regularity of atomic pattern that makes crystalline solids a distinct class of matter. Symmetry and repetition are characteristics only of solids, such as snowflakes (ice crystals), metals, and the lovely flowers of the mineral kingdom.

External symmetry in crystals is a manifestation of a much more profound regularity that involves groups of atoms. Such atomic groups, called *motifs,* pack together in three dimensions in crystals. The repetition of such motifs conforms to geometrical restrictions, and thus the number of repeat patterns is limited. Likewise, the types of arrangements within the motifs are limited by geometry and chemical bonding requirements. The total number of possible three-dimensional patterns in crystals is a mere 230, although the number of *structures* that can exist is limitless (due to variation in the atomic constitution of the patterns).

X-rays interact with atoms in such a way that an incident X-ray beam is *scattered.* When the wavelength of the scattered radiation is the same as that of the incident radiation the scattering is said to be *coherent.* Coherently scattered X-rays are *diffracted* - that is, they emerge in a pattern that depends on the spacings and arrangement of the atoms causing the scattering. This pattern reflects the crystalline regularity of solids, and reveals the elaborate architecture of crystals.

X-ray photography, in all its guises, is merely a means of recording the patterns of X-ray beams diffracted by crystals. One can use a single crystal or a crystalline powder, but the information carried by the diffracted beams is basically the same. This information pertains to both the type and arrangement of atoms forming the crystal under investigation, but the message is garbled by the physical conditions of diffraction. Crystal structure analysis is therefore done by inference: the devising and testing of models. In spite of all our efforts, no one has ever seen an atom directly, and all our knowledge of structures is a mass of guesswork that seems to fit the data obtained from real crystals. Yet the key to correctness is the successful ability to predict the properties of new materials. Thus has been born the age of transistors and lasers.

Technology holds the reins in the future course of mankind. There is little doubt that in the near future we will witness the creation of principles and techniques as yet unimagined. Crystallography is the backbone of materials science, and through new materials will we reshape our civilization. X-ray diffraction has played a vital part in the development of modern solid-state theory. It will, almost assuredly, perform a similar role in the science of years to come. ■

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Q/A column

Q. What is a "Dana Collector"? I've heard the term time and time again, but have yet to receive a good answer.

William Lehnert
Kingsport, Tennessee

A. A "Dana Collector" is simply a species collector using *Dana's System* as his chief or only reference book. A species collector is one who attempts to obtain a sample of every different mineral known, no matter how unattractive or microscopic the mineral might be.

Q. We have seen the brookite from Ellenville, New York, only as loose crystals. How did it occur?

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

A. Ellenville brookite formed in the same way as the chalcopyrite from that locality which is perhaps better known. The crystals are attached to quartz crystals along flat joint surfaces. Associated minerals are galena and sphalerite.

Q. I recently obtained a specimen of eosphorite from Taquaral, Minas Gerais, Brazil similar to the one which was pictured recently in Mineralogical Record. On the quartz are some pale green crystals with flat terminations about one to two mm in length. Some were coated with a druse of pyrite. Can you give me some idea of what these might be?

Bradley Small
New York, N.Y.

A. The crystals you describe are probably roscherite, a rare phosphate which is sometimes associated with eosphorite from this locality. It has also been found as dark green balls and pale, dull, yellow-brown crusts partially coating eosphorite and tourmaline. Other associated minerals include herderite (in strange vermicular growths) and a mica, probably lepidolite. While the roscherite has been confirmed by x-ray it has been reported to me that optics measurements on other material indicate the green mineral is anapaite. The supposed anapaite needs to be x-rayed as the pattern of anapaite is very different from that of roscherite.

Q. Are there any special problems in carrying minerals from country to country? Is there any limitation on quantity? What about uranium minerals?

Alvaro Lucio
Belo Horizonte, Brazil

A. There are no restrictions on bringing mineral specimens into the United States, just so long as they are not cut and/or polished gems. Other countries may or may not have special restrictions. Most of these relate to exporting rather than importing the minerals.

PLEASE SEND IN YOUR QUESTIONS, WE WILL DO OUR BEST TO ANSWER THEM.

Yedlin on Micromounting

We think you should be saved a major plumbing bill. We use hydrochloric acid continually for cleaning some silicates and sulphides, for releasing crystals from embedded calcite, for removing iron stains, and for other reasons. For a long time we used to pour the used "gunk" into the sink, with a good flush of cold water to help the diluted acid on its way. Fine, until a few year's of this ate some of our copper pipes away, and they had to be replaced.

So we fought our better half for possession of a 6 gallon pickling crock and cover (A half gallon glass jar will do nicely for you who work small.), put a large chunk of limestone in it, covered the rock with water and now pour acid dregs into this receptacle. ($2 HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$) The gas escapes, the salt is harmless, and the water is water. Periodically we pour the liquid off and put in a fresh piece of limestone. We do this with oxalic acid too. Once we let the jar contents evaporate and you should have seen the etched surface of the limestone! Beautiful white flat crystals. Calcium oxalate—maybe whewellite...!! But our pipes hold up fine.

About the last thing we bought at the Lake Placid show, the Eastern Federation convention, was a 1" x 1 1/2" piece of pyrargyrite ore, loaded with fine crystals of argentopyrite. Well, Dana reads (7th ed., vol. I, p. 248) "...in six sided twin crystals...composition consistent with $AgFe_2S_4$. From Joachimstal, Bohemia...probably orthorhombic, and pseudohexagonal by twinning." Hey considers it a valid species, lists it in boldface type, numbers it 3 .2 .17, and gives the formula as 4 ($AgFe_2S_3$). Strunz, too, considers argentopyrite a valid species and repeats Dana's formula for the mineral. Recently Czamanske and Larson, *Amer. Min., 54,* 1198-1201, 1969, showed through microprobe analyses that sternbergite and argentopyrite have the same formula—$AgFe_2S_3$. The mineral is easily recognizable, for its association, the striated prismatic crystal habit, satiny lustre and dull brass color are quite distinct. We have specimens from St. Andreasberg, Harz; and now from Niederschlema, Saxony. Figure 1 shows what it looks like—exaggerated to show twinning. Figures 2, 3, 4 we sketched from one of our mounts.

Boxes for m/ms are getting larger. Today's standard is the 7/8" x 7/8" x 3/4" unit, of plastic, with a clear cover, not hinged, but many prefer the hinged lid container, the smallest of which runs about 1 1/8" square. Fine. There are no hard and fast rules, except that if you enter a club competition you must abide by the regulations set out by the host group.

We've just looked over the uniform rules of the American Federation. Among other things—"Micromount specimens shall be of a size no larger than will fit into a 1 x 1 1/2 x 1 inch box." On the same page—"Thumbnail ...is defined as any mineral specimen displayed so that it will fit into a one inch cube."

Of course the definition of a micro includes the proviso that the individual crystals be so small as to require magnification. Nothing is said about the thumbnail, and since it may rest in a box smaller than a micro... well!

What we're saying is that if you're a m/m collector you need not be bound by box size, mineral size, extent of magnification, etc. Our (arbitrary) definition—a natural mineral, in crystals, permanently mounted, properly identified, requiring magnification for proper observation. Mount 'em in shoe boxes or thimbles; in plastic, paper, wood or metal. The group may weigh a gram or a kilo; just so there is an area that requires optical aid in viewing the specimen.

Buy and use a good mineral book. Some 24 years ago we first used this phrase, and we've been pounding away at it ever since. In sports it's "You can't tell the players without a scorecard." In law, decisions are based on precedents, duly recorded and constantly referred to. In mineralogy, you can't identify a mineral or tell what it's all about unless you use a good reference work. There are many—Dana, Strunz, Hey, Goldschmidt, Pough, Sinkankas and Hurlbut are but a few that come to mind. You have a new specimen from Asbestos, Quebec, with rather clear prismatic crystals. You don't know whether it's the new find of prehnite or odd shaped diopside. Books will tell you one is orthorhombic and the other is monoclinic. So there's the first clue.

The Mineralogy of Greenland, discussed in Vol. I, No. 4 of the *Mineralogical Record* is available at Francis Paul. This you are truly obligated to obtain if you're really a mineral collector. Details of the Ivigtut cryolite area, the Narsarsuk silicate region and many others. Ask for the English translation.

We were browsing through an old copy of the *American Mineralogist* and in one article the name of an old friend jumped out at us, Dorothy Hays, an ardent micromount collector and all-around amateur mineralogist. The article—"The Crystal Structure of a Hexagonal Al-serpentine", by Jahanbagloo and Zoltai, (Vol. 53, p. 14) is 11 pages long, and the opening lines of the introduction state: "A few years ago Mrs. Dorothy Hays brought to the

Here are a few things available from the Superintendant of Documents, U.S. Government Printing Office, Washington, D.C. 20402. These you MUST have. ➔

Name	Code	Price
Glossary of Uranium and Thorium Minerals (Frondel, J., Fleischer and Jones)	USGS Bull. 1250	.30
Systematic Mineralogy of Uranium and Thorium (Frondel, C.)	USGS Bull. 1064	1.50
Identification and Occurrence of Uranium and Vanadium Minerals from Colorado Plateau (Weeks and Thompson)	USGS Bull. 1009 B	.25
Minerals of Colorado—a 100 year record (Eckel)	USGS Bull. 1114	about 2.50
Geology and Quicksilver Deposits of Terlingua, Texas (Yates and Thompson)	USGS Prof. Paper 312	about 2.00
Pegmatite Investigations in New England (Cameron *et al*)	USGS Prof. Paper 255	about 2.50
Minerals of Franklin and Sterling Hill, New Jersey (Palache)	USGS Prof. Paper 180	2.00

There are many others. Ask around.

* * *

authors a pebble collected on the north shore beaches of Lake Superior in Minnesota." That's all. Under acknowledgements the authors thank two mineralogists for "repeated criticism and advice", and the National Science Foundation for money. Well and good. But something was too casual, too taken-for-granted. So we wrote to Mrs. Hays, asking about the details.

Bear in mind that no research can go on without material, and that new minerals are being found all the time by the amateur mineral collector—he is forever collecting, studying, probing, questioning and supplying. Here, then, somewhat edited, is Dorothy's letter:

> "Dear Neal: In July 1962 I spent a week at Grand Marais on the north shore of Lake Superior, one of our favorite collecting areas. Dr. Tibor Zoltai and his family joined our group, and became interested in the fact that I was looking for micro crystals. He suggested that if I found anything unusual he'd like to see it, and he asked me to visit him at the University of Minnesota. After our week collecting I spent another week going over the material. (At this time I was running the X-ray equipment for the Geology Department at Iowa State University, so there was some mutual interest other than just collecting.)
>
> During the time I examined my material I found the first Al-serpentine crystals and couldn't identify them. Over the years I had collected hundreds of pounds of rhyolite material and had not encountered anything like these white, hexagonal crystals. I did visit Dr. Zoltai at the University of Minnesota, and showed him the new-found material. We both thought they might be kaolin, and he asked if he might work on them. I gave them to him.
>
> Preliminary examination showed them to be single crystals and more material was needed, so I found them and sent them off. The results were sent to me in a report in 1966. Dr. Cyrus Jahanbagloo, I believe, was the one responsible for the big job, and the paper was first read at the International Union of Crystallography in Moscow in 1966, and later at the San Francisco meeting, and was accepted for publication in the *American Mineralogist* (Jan.-Feb. 1968).
>
> More turned up in September, 1966, when I collected in the Mass, Michigan area. This time they were associated with the epidote and calcite. I again sent the material for checking, and they turned out to be identical with the first ones.
>
> It was very interesting to learn the amount of work it took to positively identify a 9-layer mineral such as serpentine. I have a deep respect for people capable of doing this. My part was going over thousands of tiny pieces of rock, and finding but one or two crystals of the Al-serpentine in a day's work."

So there it is. We still feel that Mrs. Hays' contribution was more than merely turning over a beach pebble to researchers.

Buy and Use a Good Mineral Book.

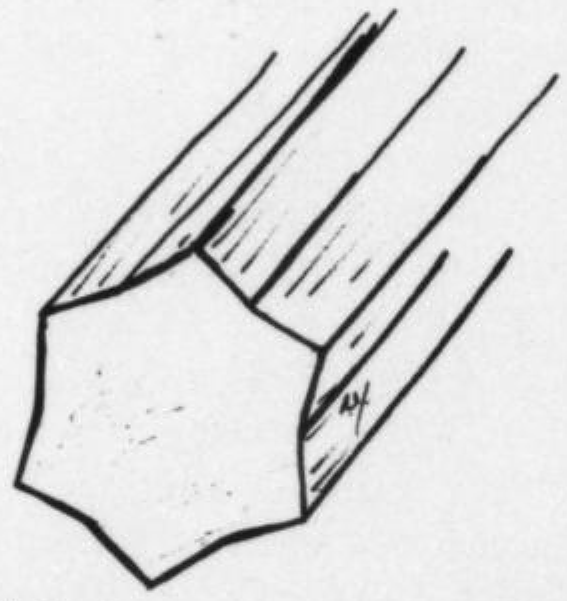
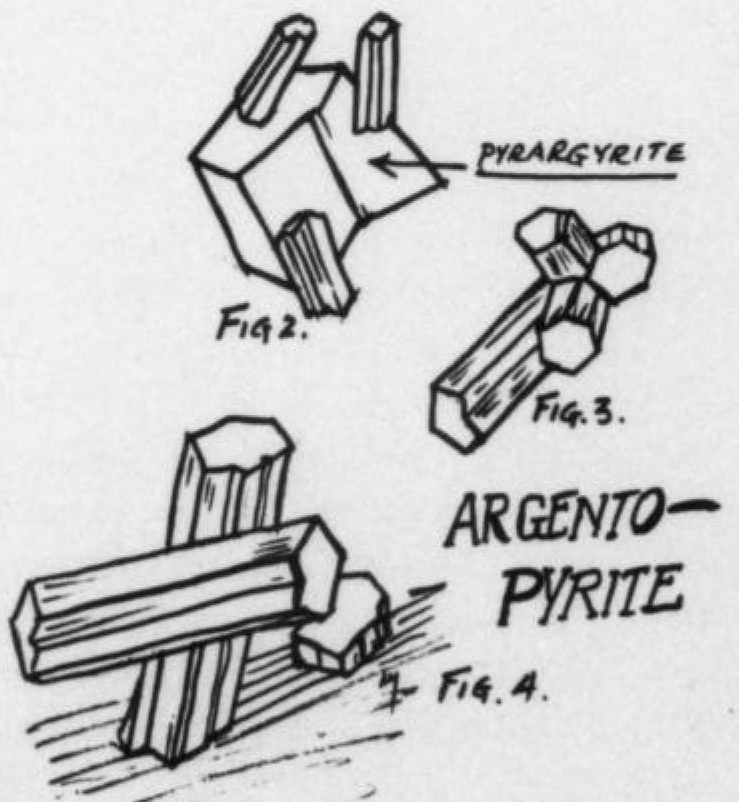
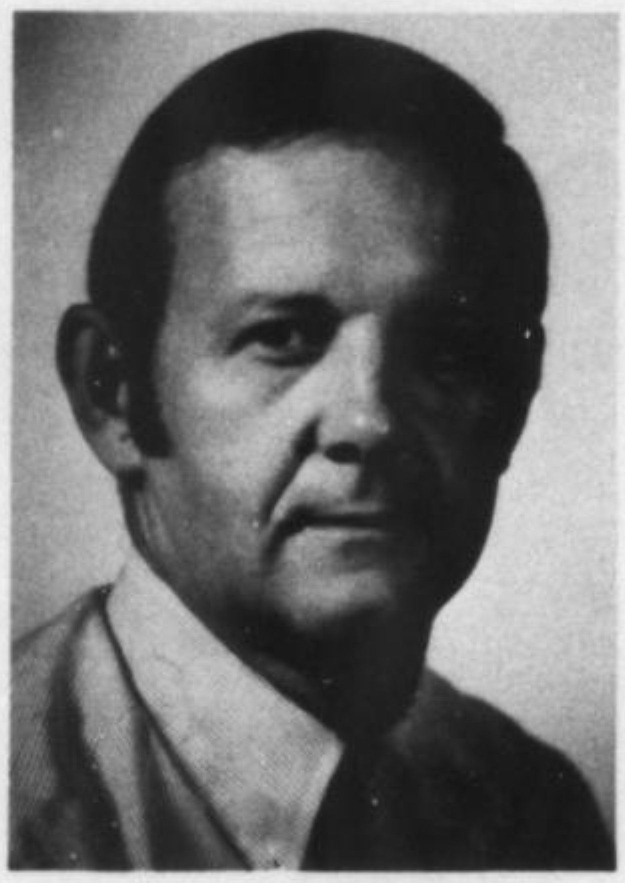


FIG. 1—ARGENTOPYRITE



ARGENTO-PYRITE



The Museum Record

By Paul E. Desautels

A fair portion of the thinking time of an active mineral curator is spent on philosophical cogitation. How did his collection become what it is, what's happening to it and what it will be in the future. Much of this is dead end thinking having to do mostly with museum "geopolitics" and little with mineral specimens. It is such a pleasant change, then, to think about and work with the specimens themselves. And what is there to think about the specimens?

A half hour spent in conversation with a random selection of a half dozen curators would reveal six different attitudes toward specimens and collections. Perhaps that is as it should be. Diversity in museums, to my mind, is a virtue. Watching one curator after another trying to emulate and slavishly follow the lead of the larger museums is a depressing sight. I've even seen some curators (and collectors) pressed into buying specimens on the advice of a dealer that "this specimen was traded out of the British Museum" or "the Smithsonian wanted this specimen but didn't have the money". My feeling has always been that, given moderate freedom of action, the kinds of specimens a curator accumulates are a reflection of his own personal ideas of the functions of the collection. His background training with specimens and his understanding of them will be the determining factors in his success—or lack of it—in expressing himself through the collection.

This grand idea of mine, you will notice, has a strong qualification in it—"given moderate freedom of action". The sad thing is that most mineral curators seem to have precious little freedom when it comes to acquiring specimens or in determining what is to be done with them. We don't have to search far to see how these restrictions arise. For example, any respectable museum administrator these days seems more or less thoroughly convinced that a museum exhibit gallery should be instructional and topical with its contents related to other disciplines as much as possible. In other words, the specimens are displayed for structured or organized educational purposes. This seems to be a very rational and appealing package. However, if I am to judge from my reams of correspondence, contacts with thousands of collectors, professionals, school classes, earth science clubs, etc. something seems wrong. Most people involved in the earth sciences from the professional level to the pebble collector would rather just see quantities of fine specimens from numerous occurrences—the more the merrier. The curator who feels the necessity of yielding all the way to either camp is automatically saddled with restrictions to his freedom. Of course, there are other subtle types of restrictions and any number of obvious ones. There isn't any money or, if there is, the curator may not have the authority to spend it on specimens as he pleases. Exchanges of specimens are not permitted or, if they are, some higher authority must review the transaction. Sales of surplus specimens are not permitted or, if they are, some additional cumbersome appraisal system is required to supplement the curator's value judgement. And so it goes! But let's assume that the millenium has arrived and the curator is suddenly granted "moderate freedom of action". What specimens will he acquire?

The mineral collecting hobby has arrived at a set of criteria for spotlighting a "desirable" specimen. The criteria are expressed in various ways. Formally, they appear as the "Uniform Rules" for show competition. Informally, they are passed along by word of mouth and miscellaneous publications as pronouncements by the "knowledgeable" or "in group" collectors—the establishment if you please. The "in" curator, then, may be tempted to adopt these for his own criteria and to become engaged in an expensive specimen snagging rat race in competition with hordes of moneyed collectors. It is an exhilarating but fatiguing pastime with great psythic rewards after each successful acquisition of one of these "desirables". Very few museums can afford a steady diet of this kind of acquisition even if they can manage to hire someone able to carry it out.

Feeling the pull of the scientific aspects of mineralogy, there are many collectors who assemble their specimens because of the knowledge they embody and facts of mineralogy they can be used to illustrate. The species collectors are among these. Also, many collectors and museums justify their collections as valuable tools for research and reference. I'm often inclined to ask, "what kind of research or reference and by whom"—but I never do. At any rate, since such collecting requires more knowledge about minerals and far less money, the action is far less competitive. Although intellectually satisfying, this kind of collection makes poor exhibits because it is divorced from esthetics.

There is, of course, a third breed of curator whose orientation is neither science nor esthetics. He is the educator who sees mineral specimens as a set of tools for teaching some basic ideas of earth science or for teaching anything else that can be managed and is worth knowing. If it can't be taught with a mineral specimen then a good photograph, diagram or even a botanical specimen etc. can be used. This kind of mineral collecting is also relatively inexpensive. The curator needs know little about mineral specimens but does need a good background in natural history as well as in educational methodology.

Undoubtedly, we can all add to my list of collecting types. For example, how about the curator who feels that certain specimens should be preserved in a museum because they are unique, the largest of their kind, found in peculiar association with certain other species or once were in the mineral collections of Seligmann or Ruskin or Leidy or some other ancient notable. These worthy objects must be preserved for posterity because they will never pass this way again.

And so it goes, with all sorts of possible variations on the mineral collecting theme. It does seem a bit ridiculous then to expect that with all these possibilities every curator will or should come up with the same kind of collection. With a "moderate amount of freedom of action" his collection will unavoidably be a reflection of his own tastes, background, education and understanding of minerals. ■

The COLLECTOR is a new column and will appear in each issue. Anyone having materials appropriate for this column should send them directly to:

RICHARD A. BIDEAUX
1241 West Pelaar
Tucson, Arizona 85705

THE COLLECTOR

Richard A. Bideaux

My note on "A Multiple Japan Law Quartz Twin" appeared on p. 33 of vol. 1, no. 1 in this magazine. Since that time some other instances of this rare multiple twin relationship have been called to my attention.

At the 1970 show of the Mineralogical Society of Southern California several examples were on display. Bill Larson, of Pala Properties International, operating the Stewart Mine at Pala, had a fine display of personally collected minerals. This display included a number of small multiple Japan Law quartz twins, from the San Pedro mine, New Placers district, Santa Fe County, New Mexico. This locality has produced many Japan Law quartz twins in the past; I have seen a number of specimens made up of dozens of 1/2 inch simple twins, while Northrup's *Minerals of New Mexico* cites examples up to 1 1/2 inches.

Since seeing these on display, I have obtained one for my own collection by exchange with Bill. This is a loose group of three individuals, with the central doubly-terminated individual 15 mm long. Two flattened satellites, each about 7 mm long, are attached in twinned relationship. This group differs from that pictured in my article in that the satellites on that Arizona group have *c*-axes 60 degrees apart, while the *c*-axes of the New Mexico group's satellites are at an angle of 120 degrees.

More than two satellites can theoretically occur. In fact, up to six could appear about one termination of the central individual, all 60 degrees apart, in a grouping with the appearance of a paddlewheel. Bill stated that a collecting friend of his has examples from this occurrence with three, four and even five satellites.

Since early in this century, the Holland mine, nearby Washington Camp, Santa Cruz County, Arizona, has produced large and striking quartz groups. About fifteen years ago, as the mine was closing after a period of operation, a remarkable quartz crystal-filled cavity was broken into. The pocket was choked with opaque to translucent milky-white prisms, many over a foot long. Among the quartz crystals were numerous simple rhombic calcite crystals from one to two inches. The entire mass was cemented by drusy quartz and a final coating of a brown carbonate.

Extensive damage was unavoidably done when these crystals were collected - but some beautiful things appeared as the crystal groups were soaked apart in hydrochloric acid. The calcites were found to be a delicate pink color on exposure. Many loose, complete quartz crystals were found between those attached to matrix. Most of the crystals from this pocket were flattened on an a-axis, and many were twinned on the Japan Law. These ranged from a few inches across up to over a foot, tip to tip. These are probably the finest Japan Law twins found in the United States in any quantity.

At this same Pasadena show, Earl and Katherine Burch, from Fullerton, California, displayed one such group of quartz crystals and twins from this pocket. This football-sized mass contains over twenty twins. Buried in the center is a multiple twin with satellites at sixty degrees. The terminations unfortunately have been broken from all the individuals, but the remaining crystal portions are three to four inches (!) in length.

John Patrick, down for the show from Richmond, California, additionally mentioned that several small examples from Japan were preserved in the National Museum in Tokyo, Japan.

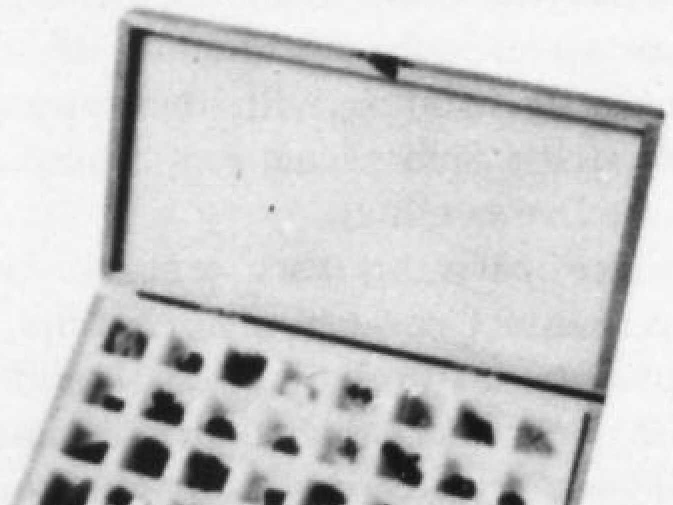
"Mineral Rings and Cylinders" was published here in vol. 1, no. 3, for Fall, 1970, p. 105-112. *Earth Science,* vol. 23, no. 6,. for Nov.-Dec., 1970 appeared at about this same time. Ben Chromy's column, "The Wee Crystals," in that issue was devoted mostly to boulangerite rings from the Roger's mine, Madoc, Ontario, Canada, and twisted millerite from the Mt. Diablo cinnabar mine, Contra Costa County, California. Several scanning electron micrographs, taken by Dr. Eugene Meieran, are with this article. Fig. 2, showing twisted millerite at 900 magnification, is an especially good addition to the literature.

Peter Embrey writes to call attention to two additional references. Dr. L. J. Spencer wrote a note on "Curvature in Crystals" for the *Mineralogical Magazine,* vol. 19, p. 263-274, in 1921. While no rings as such are described, he discusses the twisted phosgenites, $Pb_2Cl_2(CO_3)$, from Cromford, Derbyshire, England. Only a few magnificent phosgenites were found well over 100 years ago, some with crystals between three and four inches long. Several of these have a distinct twist about the tetragonal *c*-axis, although they are in association with untwisted individuals. This is one of the few examples of twisting or curvature in a mineral not a sulfide or sulfosalt.

Spencer also mentions twisted stibnite, Sb_2S_3, from Ichinokawa, Iyo Province, Japan, and an extreme example is figured in a photograph. These twisted stibnites are also noted in T. Wada's *Minerals of Japan,* 1904. Here a photographed example has about a 90 degree twist about the *c*-axis of elongation. In both Spencer's and Wada's examples there is a different amount of twisting per unit length along the crystal, as well as some additional bending about a direction different from the *c*-axis. Wada's crystal has all of the twisting concentrated in the lower half; he states that "the terminal faces do not suffer any perceptible change in the angular values." Other species I have mentioned showing twisting seem to be perfectly regular in the amount per unit length, but with different amounts in different crystals. The twisting in stibnite may well have a different underlying cause.

Embrey's second reference, in *Economic Geology,* vol. 27, 1932, p. 586-590, carries a note by P. J. Shennon on tungsten rings. These were found in the heavy mineral concentrates from the Llano de Oro mine at Waldo, Oregon. While they had previously been identified as platinum (the mine was a platinum placer), careful spectroscopic work by the U.S.G.S. established their identity as tungsten. It seems that the placering area could only be worked part of the year, and it was valuable enough ground to go on a 24-hour basis. Thus the area was floodlit by tungsten lamps; some of these were occasionally broken; and the tungsten filament residue, tightly coiled, stayed with the platinum concentrate to cause later puzzlement!

This column will be devoted primarily to the mineral collecting art - miscellanea concerned with the assembling, caring for, and appreciation of the specimens in a collection. I will be happy to hear from readers, and may use some material in the column directly, or as guidelines for columns. Due to the time pressure however, very few letters can be acknowledged. ■



what's new in minerals

Cafarsite

One of the most exciting aspects of working through old mineral collections is examining specimens that the collector recognized as containing unusual minerals, minerals perhaps undescribed at the time. The real satisfaction comes in recognizing among them a mineral that has since been described. The Smithsonian Institution acquired the Carl Bosch collection (some 30,000 specimens) in 1966. This collection was assembled in Germany during the late 1800's and early 1900's and is, therefore, especially rich in older European material. Unlike most collections where a small number of specimens of a given species usually satisfy the collector, Bosch duplicated endlessly while the material was available. For example, his catalog shows more than 75 different specimens of pyromorphite from Ems, Germany, more than 35 of which are from the Merkur mine. The collection is particularly rich in specimens from the Tavetsch and Binnatal regions of Switzerland. The catalog shows more than 210 specimens of anatase, for example, from these two regions.

It is in the Binnatal material that I made an exciting discovery. Bosch was an astute observer and noted many minerals unidentifiable in his time because they hadn't yet been described. Among these were approximately ten bearing the notation "pseudomorphose?" These were labeled either Binnenthal (now Binnatal) or Alp Lercheltini, Binnenthal. The locality "Alp Lercheltini" was an important one for Bosch and at least 1,000 of his labels carry the name. In spite of this I have not been able to find it in any Atlas and it is not even mentioned in Weibel's *A Guide to the Minerals of Switzerland.*

X-ray patterns of the unknown "pseudomorphose" showed the mineral to be CAFARSITE, a mineral described in 1966 by Stefan Graeser (*Schweiz. Mineral. Petrog. Mitt., 46,* 367-375). Cafarsite is named for its composition—essentially a calcium, iron, arsenic mineral ($Ca_{5.6}Fe_{3.3}Ti_{2.5}(AsO_4)_{12}.4H_2O$). The type locality is given as Cherbadung Mountain, Valais, Switzerland. The crystals in the Bosch collection are typically cubo-octahedra perched upon cleft surfaces on gneiss. Common associated minerals include tabular hematite, quartz and adularia. The mineral is actually dark brown, nearly black, but is always coated with a waxy, tan-colored crust about 1 mm thick. It is this surface alteration that led Bosch to believe these were pseudomorphs.

One particularly fine specimen consists of a 1 cm cafarsite crystal attached to the side of a perfect loose crystal of quartz 3 cm in length. Another specimen carried a Dr. F. Krantz label which read "Hämatit mit Magnetit, Rinn, Schweiz." The "hematite" is really an unusual rutile twin. The magnetite is in brilliant black Octahedra about 1 cm in diameter. In among these crystals (as though they weren't exciting enough) are many small cafarsite crystals (up to 4 mm) and one 1 mm asbecasite crystal. Asbecasite was described concurrently with cafarsite in the paper by Graeser. It too was named for its composition (arsenic, beryllium, calcium, silicon mineral). It occurs as lustrous lemon-yellow, transparent, rhombohedral crystals up to 5 mm.

Because of the abundance of cafarsite in the Bosch collection it is suggested that anyone having Binnatal specimens examine them carefully for this interesting mineral. It is perhaps not terribly rare on old specimens.

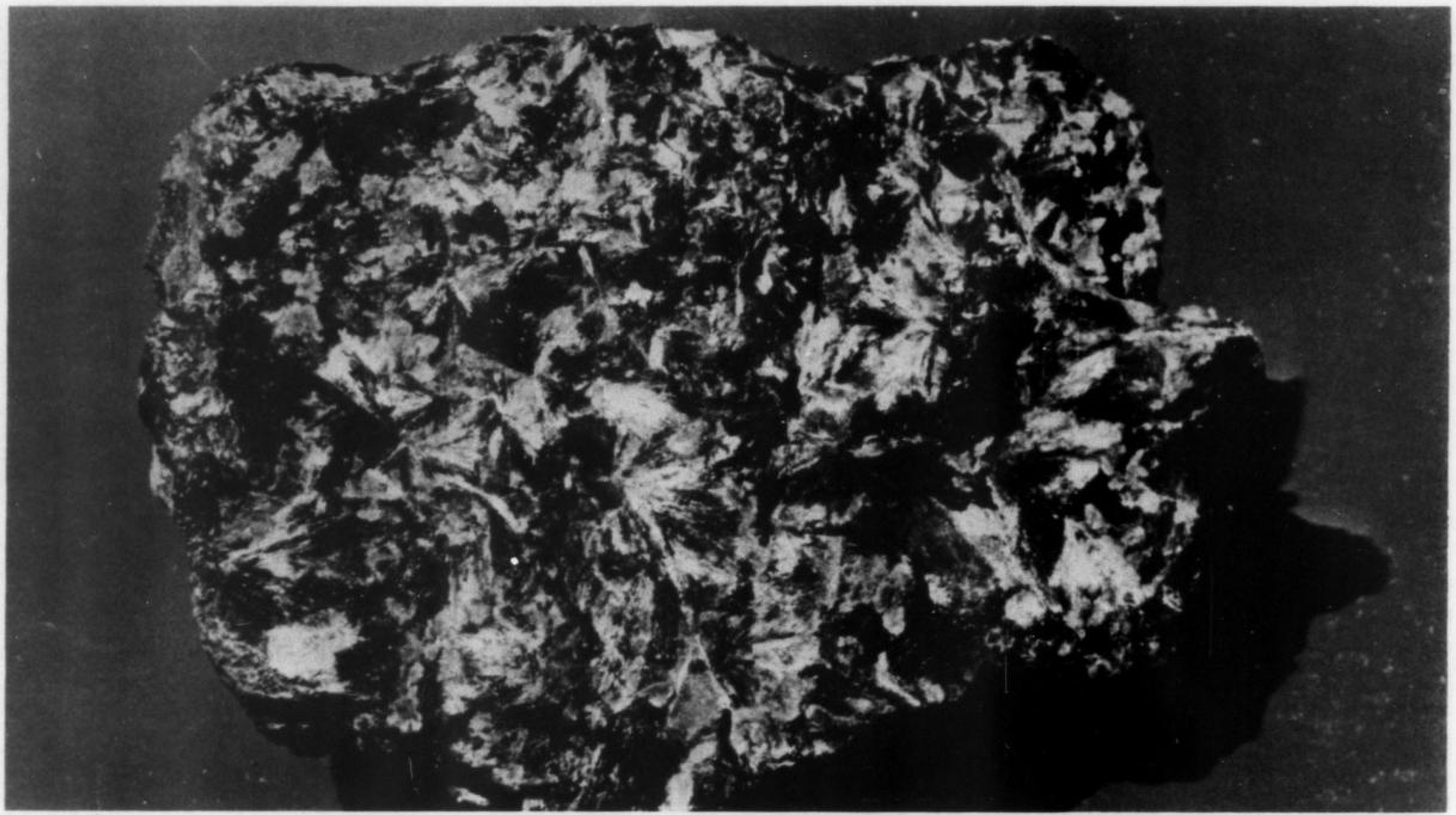
Joel E. Arem

Joel E. Arem

Cafarsite

Jamesonite

Just a few years ago most dealers carried a large supply of "jamesonite" from Noche Buena, Zacatecas, Mexico. It has since become scarce. Bill Pinch, of Rochester, New York, recently told me that he has been checking this material by x-ray methods and discovered that it is not jamesonite, but rather is boulangerite. So I x-rayed two Noche Buena specimens in the collections of the Smithsonian Institution and found that one of them is indeed boulangerite. This one is typical of most of the specimens heretofore labelled jameso-

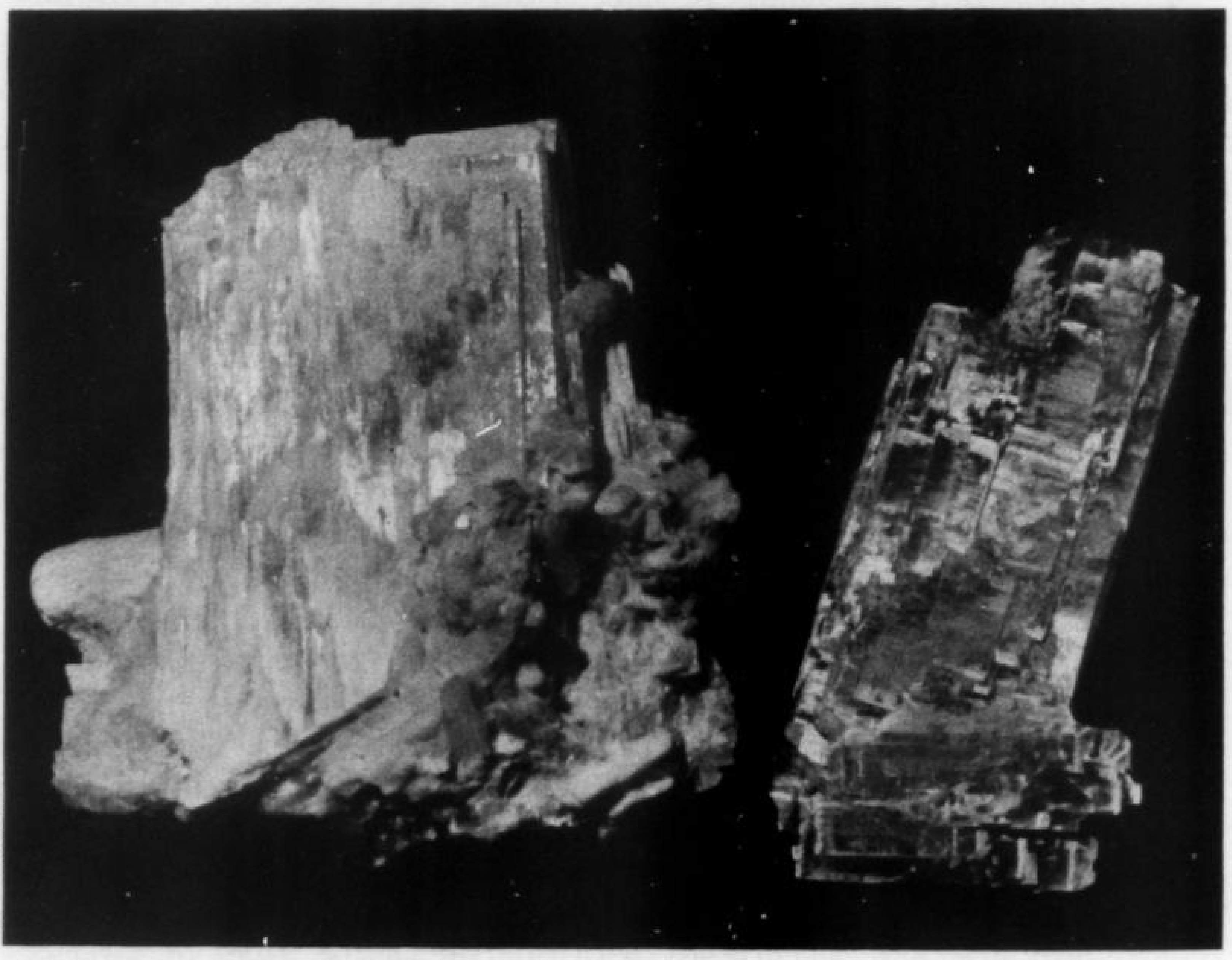


Joel E. Arem

Jamesonite

nite. It consists of free-standing, very delicate, steel-gray crystals nested among quartz crystals and associated with pyrite. Most of the Noche Buena arsenopyrite carries boulangerite of this description. The other specimen, however, turned out to be jamesonite as labelled. This material is very different in appearance (*see photo*), consisting of compact masses of divergent crystals having a stibnite color and bright luster. Based upon these results and Bill Pinch's observations, it is probably safe to conclude that most, if not all, of the "jamesonite" specimens fitting the former description are actually boulangerite.

Pectolite



Joel E. Arem

Pectolite

The Jeffrey mine of the Johns-Manville Company at Asbestos, Quebec has been known for superb transparent, sherry-colored grossular crystals. These are among the very finest garnet specimens known. For this reason it is quite surprising to learn that the mine has also been producing another mineral in specimens that rival the world's best. Recently collected, but formerly unknown to me, were excellent clusters of pectolite crystals. One does not usually think in terms of pectolite crystals in attractive crystal groupings. The Jeffrey mine crystals reach a maximum length of about 3 inches. They are pale green-gray, transparent to translucent. Groups of such crystals are truly spectacular. These are found in altered feldspar and are commonly associated with lovely pink grossular crystals in druses of micro and larger size.

The Jeffrey mine is in the largest asbestos deposit in the Western Hemisphere.

JSW, JR.

WOULD YOU LIKE TO SEE A MINERAL HERITAGE COMMEMORATIVE U.S. POSTAGE STAMP?

It is hoped that such a stamp, or set of stamps, can be issued on May 5, 1972 to coincide with the celebration of the 25th Anniversary of the American Federation of Mineralogical Societies, to be held in Washington, D.C.

Many other nations have issued entire series of stamps carrying pictures of mineral specimens. Don't you feel it is time that the United States produced some as well?

YOU CAN HELP!

Add your support today and urge all of your friends and neighbors to do the same . . .

Write to: **The Postmaster General**
ATTENTION:
Mrs. Mary M. Jamieson,
Coordinator
Citizen's Stamp Advisory
Committee
U.S. Postal Service
Room 3353
Washington, D.C. 20260

If the Post Office receives a flood of letters requesting a Mineral Heritage Commemorative Postage Stamp (or Stamps), the chances of getting it will be greatly enhanced. Mrs. Milton Turner, AFMS commemorative stamp committee chairman, has been working long and energetically on this project and feels that prospects are better than ever before, but a deluge of mail is needed to make it a certainty.

Emerald Rush

Excitement is rampant in Alexander County, North Carolina. On August 24 Tom Adams found 200 "emerald" crystals on his property which is about ¼ mile from the famous old Hiddenite mine. The Hiddenite mine was the source of emeralds and green gem spodumene, "hiddenite" (named for its discoverer W. E. Hidden), in the late 1800's. More recently (this summer) renewed digging at the mine itself produced some outstanding emerald specimens.

Following immediate television coverage of the new discovery on the Adams' property, crowds numbering up to 700 descended on the place. It is reported that in an area about 250 yards long and 100 yards wide there were so many holes dug that miners couldn't find room to throw their dirt. A large number of "emeralds" have been found along with considerable rutilated quartz and gemmy hiddenite.

The term emerald is loosely used for any green beryl by those digging the crystals. A relatively small percent is actually emerald-colored and, of these, an even smaller amount is potential gem material. Nevertheless, as specimens, the crystals and crystal groups are exciting. One specimen was described as a single crystal 4 ½ inches long and 1 ½ inches across, bright transparent green. A terminated, gem-quality hiddenite 3 inches long and ½ inch wide has also been found since the rush began.

Many of these specimens will probably begin to appear at mineral shows very soon. In fact, some half-dozen from the nearby American Gem mines were seen at the Spruce Pine show on August 5-8. These tend to be less transparent than the better "emeralds" now being found on the Adams property.

The digging isn't free as a small fee is charged by the owner of the property but the lure of the emerald is packing them in.

PALA PROPERTIES INTERNATIONAL HAS BEAUTIFUL NEW SHOWROOM

Pala Properties International, Inc. has recently opened a retail outlet appropriately called *"The Collector."* It is owned and operated by Ed Swoboda and Bill Larson; both well known advanced collectors in the Southern California area.

The shop, better called a mineral gallery, features a selection of fine mineral specimens from world-wide localities. Recent acquisitions include a collection purchased in Africa of fine old Tsumeb, Hotazel, and Transvaal pieces; a newly mined selection of tourmaline from the Cruzeiro mine in Brazil; a new find of rutile and woodhouseite from the Champion mine in California; tourmaline from the Stewart Lithia and Tourmaline Queen mines in Pala, California . . . and the list goes on. . . .

"The Collector" is a welcomed addition to the mineral trade, an unexpected plush showroom along one of the most beautiful drives in Southern California.

Visit *"The Collector"* at 912 So. Live Oak Park Road in Fallbrook, Cal. The business hours are 11:30 a.m. to 5 p.m. on Wednesday thru Sunday, but the shop may also be visited by appointment.

See advertisement in this issue.

A new mineral from the Gem Mine, San Benito, California

A Progress Report

Francis T. Jones

In 1957 while examining the debris from benitoite specimens I noticed a few loose clusters of colorless blades and a few broken-off blades, illustrated in Figs. 1 and 2. The size range is one or two millimeters or less. Figure 1 shows an edge view of half a broken cluster. The general tendency is to fan out into sheaf-like aggregates which are usually loose but sometimes compact. A few spherical clusters have been found. The clusters are sometimes stained greenish gray with inclusions of matrix material, possibly crossite, or aegirine. One cluster was found on neptunite.

I determined the optical properties in sodium light on a few fragments like Fig. 2 and found the lengthwise direction = $\gamma = 1.680$, the crosswise directions = $\beta = 1.658$, edgewise = $\alpha = 1.640$. The optical character is (+) 2V = 79.5° by direct measurement of a crystal mounted on a goniometer stage. Dispersion is slight (r <v). Some crystals show zoning, so small variations in composition and optical properties should be expected. I have observed $\beta = 1.656$ on a few fragments. These properties do not agree with any values in tabulations although leucosphenite is close and might be expected in association with minerals like natrolite and benitoite.

In order to be sure that the mineral was new I took it to Dr. A. Pabst at U. of California in Berkeley. His X-ray patterns gave the orthorhombic unit cell dimensions: $a = 13.77$, $b = 25.95$, $c = 10.62$ Å, space group $B22_12$. There is a marked pseudo cell with a and c each halved. The density determined by flotation is 3.27 ± 0.03. These results indicated that the mineral was new but no information on the composition was known. I took some fragments to Bernard Evans who analyzed them in his new microprobe. His two sets of values are:

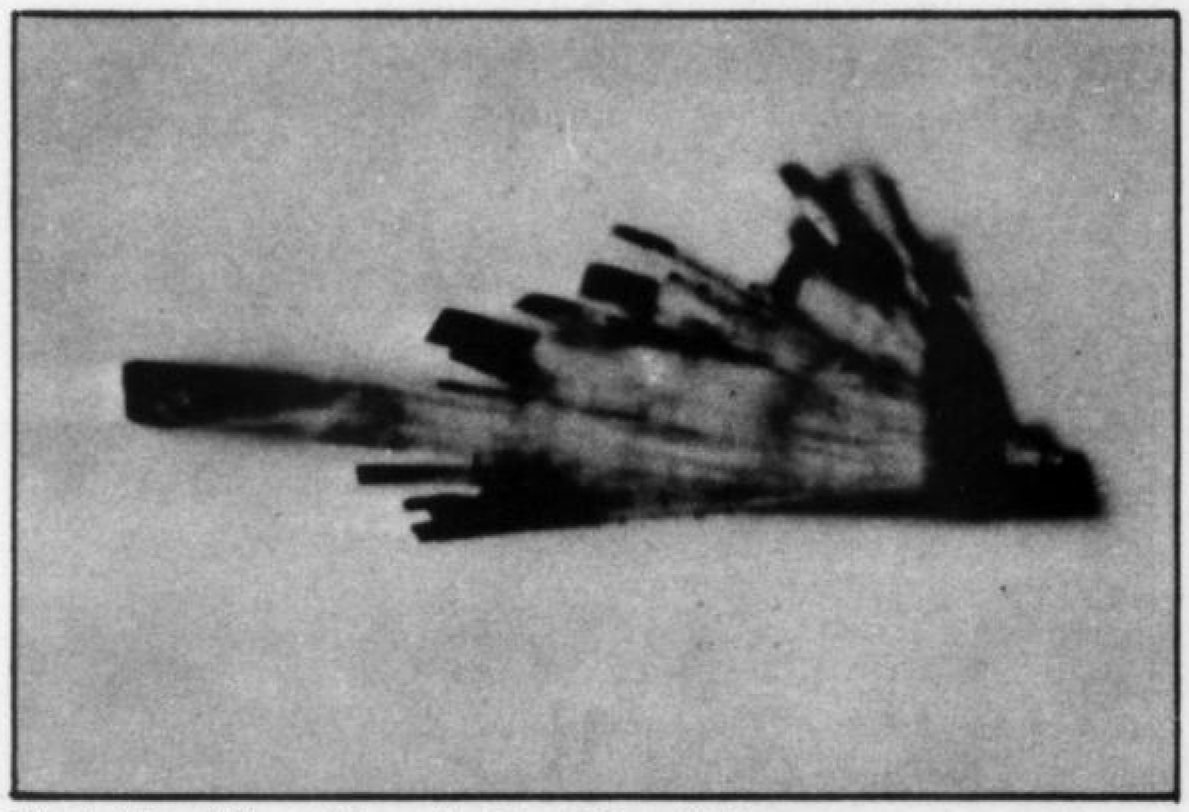


Fig. 1 New Mineral from the Gem Mine 50X

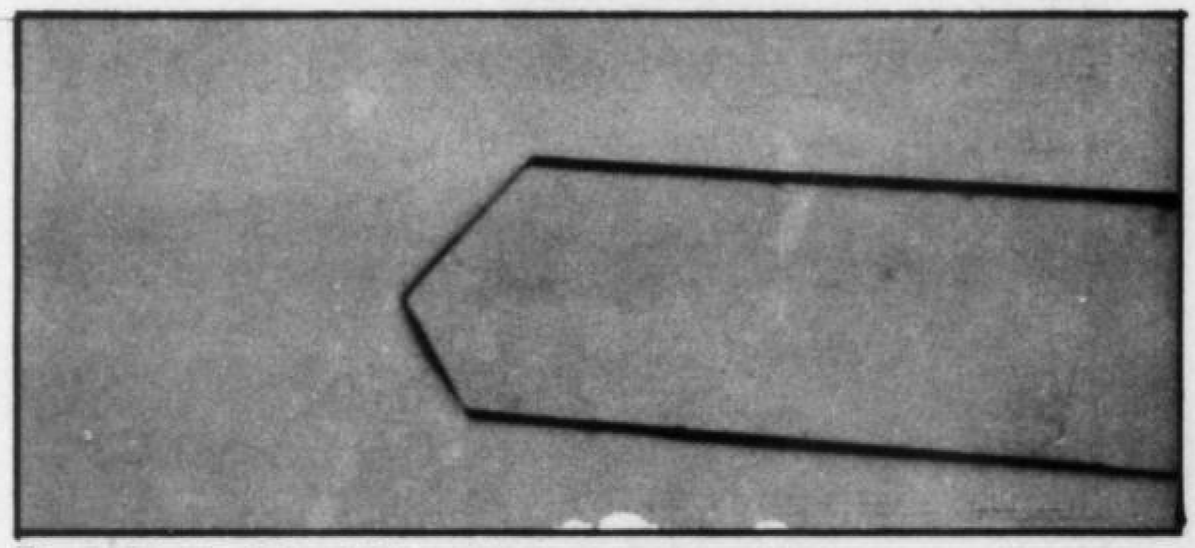


Fig. 2 Blade of New Mineral from Gem Mine 50X

	I	II
SiO_2	35.5 %	35.5 %
TiO_2	18.1	18.1
Al_2O_3	6.0	6.0
K_2O	3.9	1.5
Na_2O	0.2	0.2
BaO	35.0	36.0
Fe_2O_3	0.16	0.16

Dr. Evans attempted to synthesize the mineral but obtained many tiny crystals of benitoite instead.

It was not possible to calculate a formula that could be reconciled with the unit cell volume, the density, and mean refractive index so I tried to get information about possible OH content that the microprobe could not measure. A few blades of the unknown were placed on a salt plate with silicone grease to hold them over the slit of an infrared spectrophotometer. My fellow worker, Glen Bailey, examined the absorption spectrum and pointed out absorptions in wavelength ranges that indicated OH in the sample.

Although we could not quantitate the OH content Dr. Pabst assumed several possible formulae, such as $KBa_4TiAl_2Si_{10}O_{32}(OH)_7$, and calculated the density, mean refractive index, volume per oxygen, etc., assuming $Z = 4$. None of the formulae came close enough to the measured values to be acceptable.

Clarence Cole, who operated the Gem mine at the time, gave me many batches of the silica gel that he removed from his benitoite specimens, plus washings and brushings that might contain the new mineral. By washing out the acid and salts from the silica gel I could dissolve it in NaOH. The residue was washed, dried, sieved, and the smaller sieve sizes were separated by means of heavy liquids into fractions likely to contain the new mineral. These fractions (mostly matrix fragments) were picked through with a needle while being observed through a stereoscopic microscope. Many hours of work resulted in the accumulation of a few milligrams of material but still not enough for a conventional chemical analysis.

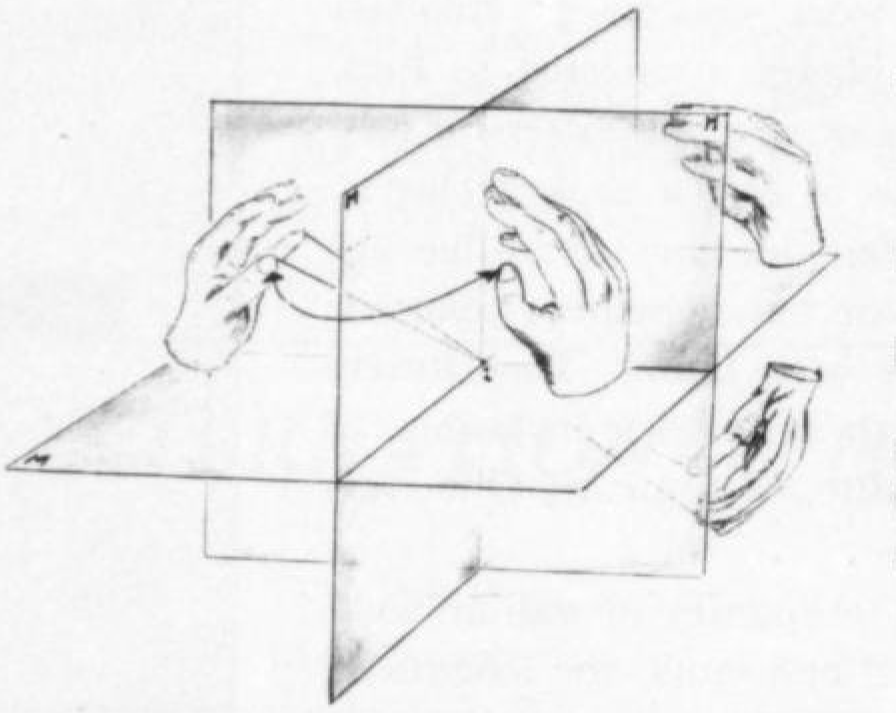
The staff of the California Division of Mines and Geology, especially Charles Chesterman, and John Alfors, have been on the alert to recognize this new mineral among the many barium minerals they have found, but with no luck so far. A fellow mineral society member, Roy Wood, found a few crystals in a specimen he etched out, and gave me some recently. Another mineral society friend, Gerald Jungles, suggested that I send a specimen to P. G. Embrey of the British Museum who agreed to analyze the mineral. This was done a year ago (May 1970) but so far no report has come from him.

This is the status of progress on the identification of a new mineral from the Gem Mine as of May 1, 1971.

ERRATUM

Volume II, no. 2, p. 63 . . .

Confusion may arise regarding Fig. 10, which is incorrectly labeled. Horizontal line is marked M (mirror plane), and should read 2 (2-fold rotation axis). This points out the problem of depicting three-dimensional relationships on a plane surface. As drawn, the hands above the horizontal line M are in front of the plane of the page, while the hand below the line M is *behind* the page (*i.e.* the upper left and lower right hands lie on opposite ends of a *cube diagonal*). The diagram is shown in three dimensions to help clarify this point.



Volume II, no. 3,
p. 141, line 17 . . .

The formula for ancylite should be $SrCe(CC_3)_2(OH)\cdot H_2O$.

p. 142, Table I . . .

Lessingite = britholite. Also, $Sr(PO_4)_3(OH)$ is stronti*um* apatite. Stronti*an* apatite refers to a mineral with $Ca > Sr$.

Greater Detroit Gem & Mineral Show

NOVEMBER 5,6,7 - 1971

Detroit Light Guard Armory—4400 East 8 Mile Road, Detroit
Friday 6 to 10 P.M., Saturday—*'CANADA DAY'*—10 A.M. to 10 P.M.,
Sunday 10 A.M. to 6 P.M.

Host—*Michigan Mineralogical Society* in cooperation with
Family Lapidary Club, Great Lakes Rock Club, Michigan Lapidary Society,
Mt. Clemens Gem & Mineral Club and Rock Exchange Club

Principal Events

Friday 8 P.M.—*Mines & Minerals of the Keweenaw*
Jean Peterman Kemp—Asst. Curator, Seaman Mineral Museum
and Bob Seasor—Resident Geologist, White Pine Copper Co.

Saturday 1:30 P.M. *2nd Annual MMS Mineral Symposium*
'The Role of the Amateur in Professional Mineralogy'
Dr. Mandarino, Moderator—Panel Members—Dr. Robert I. Gait,
Prof. D. H. Gorman, Prof. Guy Perrault, John S. White, Jr.

Saturday 8:00 P.M. Canada Day Feature
'Mineral Occurrences and Collecting in Ontario'
Dr. J. A. Mandarino, Curator of Mineralogy, Royal Ontario Museum

Sunday 1:30 P.M.—*'Rare Gems of the Midwest'*
June Culp Zeitner, Contributing Editor, The Lapidary Journal

Sunday 3:30 P.M.—*'6,000 Miles in Mexico'*
Paul Seel, President, American Federation of Mineralogical Societies

* *

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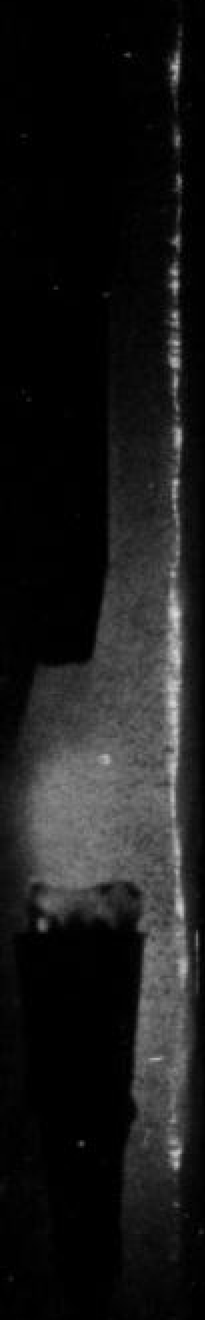

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