the Mineralogical Record

Volume Twenty-eight, Number Six
November–December 1997
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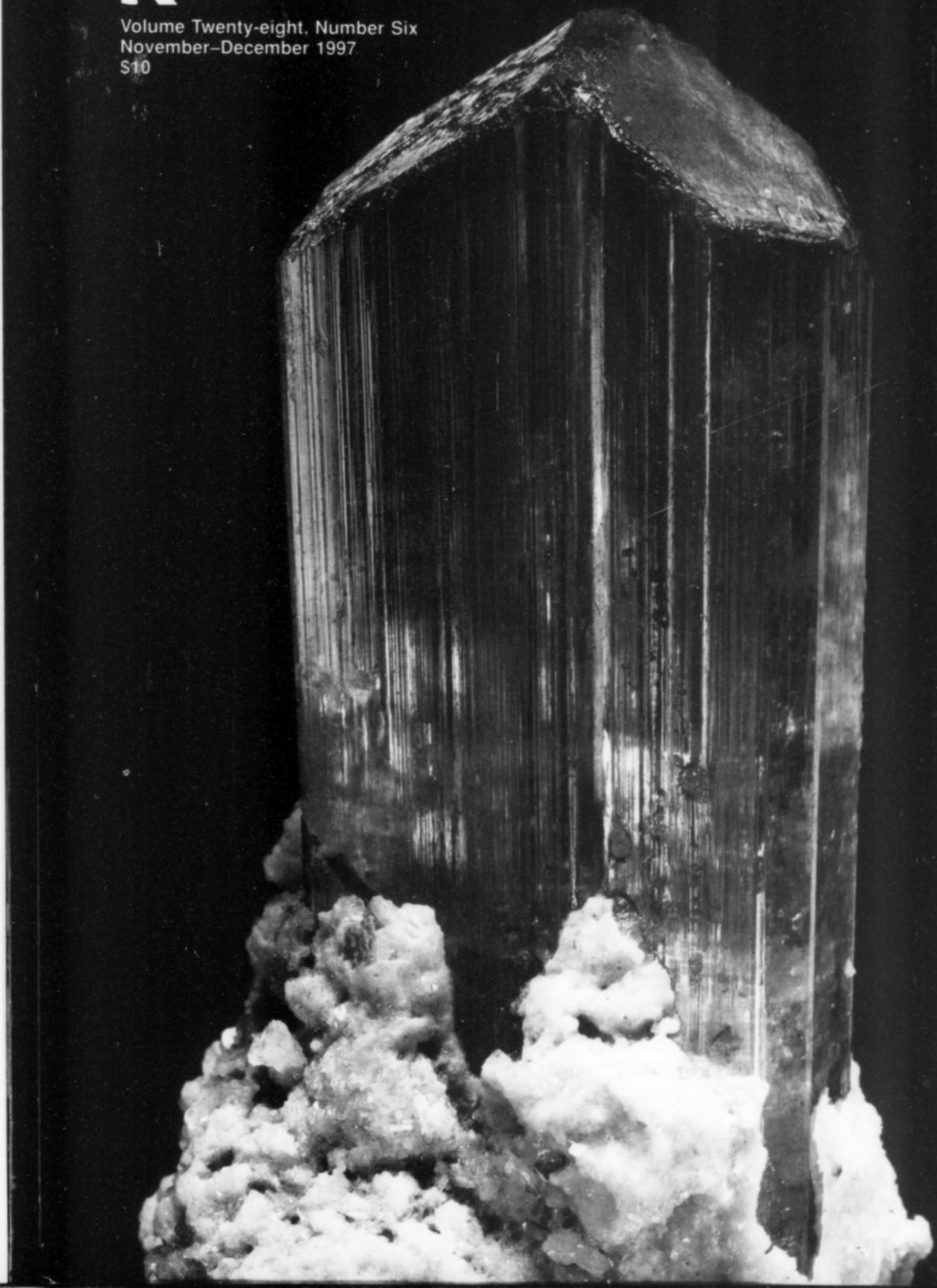

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*Continued on p. 519

THE MINERALOGICAL RECORD

November–December 1997 Volume Twenty-eight, Number Six

Articles

Columns

COVER: SPODUMENE crystal, 11.8 cm, with albite, from Nuristan, Afghanistan. (See the article on the Nuristan Pegmatites by P. Bariand and J. Poullen in vol. 9, no. 5.) William Larson collection; photo by Jeff Scovil.

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notes from the EDITOR

BACK ISSUE SALE

We have never done this before, but here goes: For the months of November and December *only*, i.e. until the end of the year, we will be giving an automatic discount of **20% off on all back issue orders**.

Why? Because we want to encourage people to build their sets of back issues. It helps to preserve the magazine, and it increases the distribution of mineralogical information, in keeping with our mission. Each issue of the *Mineralogical Record* is carefully crafted to be a *permanent* reference work of lasting value. Thus an issue from several years ago can prove to be of as much value to you as the latest one. The Christmas season is a good excuse to stock up, either for yourself or on behalf of another collector. Or buy the issues for donation to a public library and receive a tax deduction (in the U.S., at least). In any case, there is no better time than right now to acquire some of these issues before they sell out.

To help you choose we are publishing in this issue, on pages 475–480, the *complete listing* of all back issues and reprints which are still available. We don't run the whole thing like this very often, so here again it is a good time to review your own holdings and take advantage of this opportunity to fill them out.

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There are still some copies left of the leatherbound edition of our recent special issue on the mines and minerals of Peru. (Our initial ad had the wrong area code for fax and phone orders.)

Leatherbound special issues are a separate kind of collectible publication; we've issued several in the past (Mont Saint-Hilaire, Arizona I–V, Michigan Copper Country, Yukon Phosphates, Mineral Books, The History of Mineral Collecting). Previous editions have *all sold out* within a few months, so if you want one, please order immediately.

The leatherbound special issues are all bound in a reconstituted 100% leather material called *Lexohyde*, which is textured like leather and even smells like leather (but doesn't cost $50 to $100 per book!). It is particularly worth noting that these hardbound copies consist of sewn signatures (nested, folded sheets), rather than cut-and-glued "perfect" binding used for the regular softcover run. This type of sewn binding costs more but is the ultimate in durability.

You can FAX your credit card order, while supply lasts (only 300 copies total were prepared) to the Circulation Manager at 520-544-0815 (Visa and MasterCard only). The price is $49 per copy plus $1 shipping. It makes a nice Christmas gift, too.

WULFEN

Up to now our Antiquarian Reprint Series has reproduced limited hand-made editions of nine rare and beautiful old mineralogical works most sought after by wealthy book collectors. We usually include some English translations and commentary where appropriate; we carefully reproduce the color mineral illustrations, printing the book on 100% cotton paper that will never deteriorate like wood-pulp-based paper, and then we have the copies hand-bound with a genuine calf-skin spine (not reconstituted leather as on our leatherbound special magazine editions). The color plates are reproduced by high-fidelity color xerography *directly* from the original old plates, so we also have to locate copies which we can use to reproduce. Naturally all this handwork is expensive, but very few people could ever do it themselves, at any price, so we feel we are providing a service. We also use the Antiquarian Reprint Series as a fund-raiser, adding on an increment (tax deductible) to support the Record Library, which in turn enriches the magazine and aids research down the road. Bottom line: the money goes for a good cause. And I don't know of anyone who ever resold one of the Antiquarian Reprints for less than he paid.

Now, after two years since the last entry in the series, we are finally ready to issue Antiquarian Reprint no. 10. The subject is one of the most famous and most desired color-plate mineral books of all time: **F. X. Wulfen's original description of wulfenite**. Wulfen illustrated 46 specimens on 21 handcolored, engraved plates; most of the minerals shown are wulfenite, plus a few of the other "lead spars" such as cerussite and pyromorphite, all from the Bleiberg district in Austria.

For this edition we first had to locate two copies to reproduce: one of the 1785 German-language edition (loaned by Herb Obodda) and one of the 1791 Latin edition (already in the Record Library). Both editions have identical plates, but we wanted to reproduce both texts, for the sake of completeness.

Since neither edition is very readable in antique German, difficult in spots even for a native speaker, and Latin (even worse), we decided to have the entire 26-page introduction translated into English. This tough job was ably carried out by Quintin and Willow Wight, with the assistance of Marga Abear, Lt. Col. John C. Bauer (RCAF, retired) and Jeffrey de Fourestier. The result gives a fresh insight into Wulfen's personality and analytical techniques, and his knowledge of mineralogy.

Next, because Wulfen's life has not been recounted in any detail in English publications up to now, we arranged for the preparation of a biographical sketch by bibliographer Curtis Schuh. Curtis was aided by the discovery of an extremely rare contemporary biography of Wulfen published in 1810 (in German, of course). In fact, it is so rare that we decided to append a complete facsimile reprint of it, including a fine portrait of Wulfen, just to save it from oblivion for possible use by future biographers.

In addition to the translated introduction and the biography, there is also an introduction to the new edition in which I review Wulfen's discoveries, techniques, and place in mineralogical history. In all, there is plenty to read that is in English.

Finally, the attractive binding with calf spine is designed to display nicely by itself, on the bookshelf, or perhaps even in a display case with a collection of wulfenite specimens.

This reprint, translation, biography and commentary on Wulfen's *Treatise on Carinthian Lead Spars* (we just call it "Wulfen"), is available in exchange for a donation of $290 to the Record Library (add $10 for airmail shipping outside the U.S.). Copies must be ordered directly from the editor, Mineralogical Record, 4631 Paseo Tubutama, Tucson, AZ 85750. Fax orders will be accepted at 520-299-5702 (Visa and MasterCard only). The edition is limited to 150 numbered copies. Contact me immediately to guarantee getting a copy before they are sold out.

Barite after Paralstonite, A New Pseudomorph from Cave-in-Rock, Illinois

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A new type of pseudomorph occurs as white hexagonal crystals to 2 mm in length associated with brown calcite from a new find on the Bethel level of the Minerva No. 1 mine near Cave-in-Rock, Hardin County, Illinois. They are replacement pseudomorphs of barite after paralstonite which formed late in the mineral paragenesis.

INTRODUCTION

The Southern Illinois fluorite district has been an important domestic source of commercial fluorite for more than a century and is a prolific source of fluorite crystals and cleavages for collectors, schools and museums. Other minerals typical of Mississippi Valley type deposits such as calcite, galena and sphalerite are common throughout the district. The Minerva No. 1 mine near Cave-in-Rock has been the premier specimen producer in recent years. Not only has it yielded beautifully color-zoned fluorites, but also an interesting suite of barium and strontium minerals including alstonite, barite, benstonite, paralstonite, strontianite and witherite. Of these, alstonite and paralstonite are by far the rarest. They occur as small, inconspicuous, colorless hexagonal dipyramids which cannot be visually distinguished from each other.

In May of 1995 one of us (RCL) obtained a batch of calcite specimens from a new pocket in the Minerva mine. Associated with the calcites are 1 to 2-mm white crystals, the morphology of which strongly resembles that of alstonite and paralstonite (Figs. 1 and 2). When an X-ray powder pattern failed to verify this tentative identification an investigation was undertaken which conclusively demonstrated that they are replacement pseudomorphs of strontian barite after paralstonite.

*Deceased

GEOLOGY

The geology of the Southern Illinois fluorite district is well studied. Grogan and Bradbury (1968) give an excellent review. We are unaware of published studies specific to the Minerva No. 1 mine, but Lillie (1988) gives a lucid explanation of the deposits and makes frequent reference to Minerva mine minerals.

The Minerva No. 1 mine, located in the NW ¼ of the SE ½ of Section 24, Township 11 S., Range 9 E., about 5 miles north of Cave-in-Rock, is typical of the mines in the Cave-in-Rock district which exploit fluorite orebodies that have replaced limestone horizons. In contrast, the older mines at Rosiclare exploited fluorite oreshoots in vertical calcite veins. Several Mississippian-age limestone beds were consistently susceptible to replacement throughout the district. These ore horizons are named for the overlying impermeable sandstones, against which the mineralizing waters ponded, allowing them to react with the limestone and form orebodies. The Minerva mine produced ore from the Bethel, Levias, Rosiclare and Sub-Rosiclare levels. During pillar robbing in a previously mined area on the Bethel level, a pocket of calcite crystals was encountered. Cleaning the brown, oil-soaked calcite specimens liberated a small quantity of loose, millimeter-size crystals and crystal groups of an unknown white mineral mixed with fragments of calcite, fluorite, marcasite and black bits of a hydrocarbon, all of which had been loosely attached at the base of

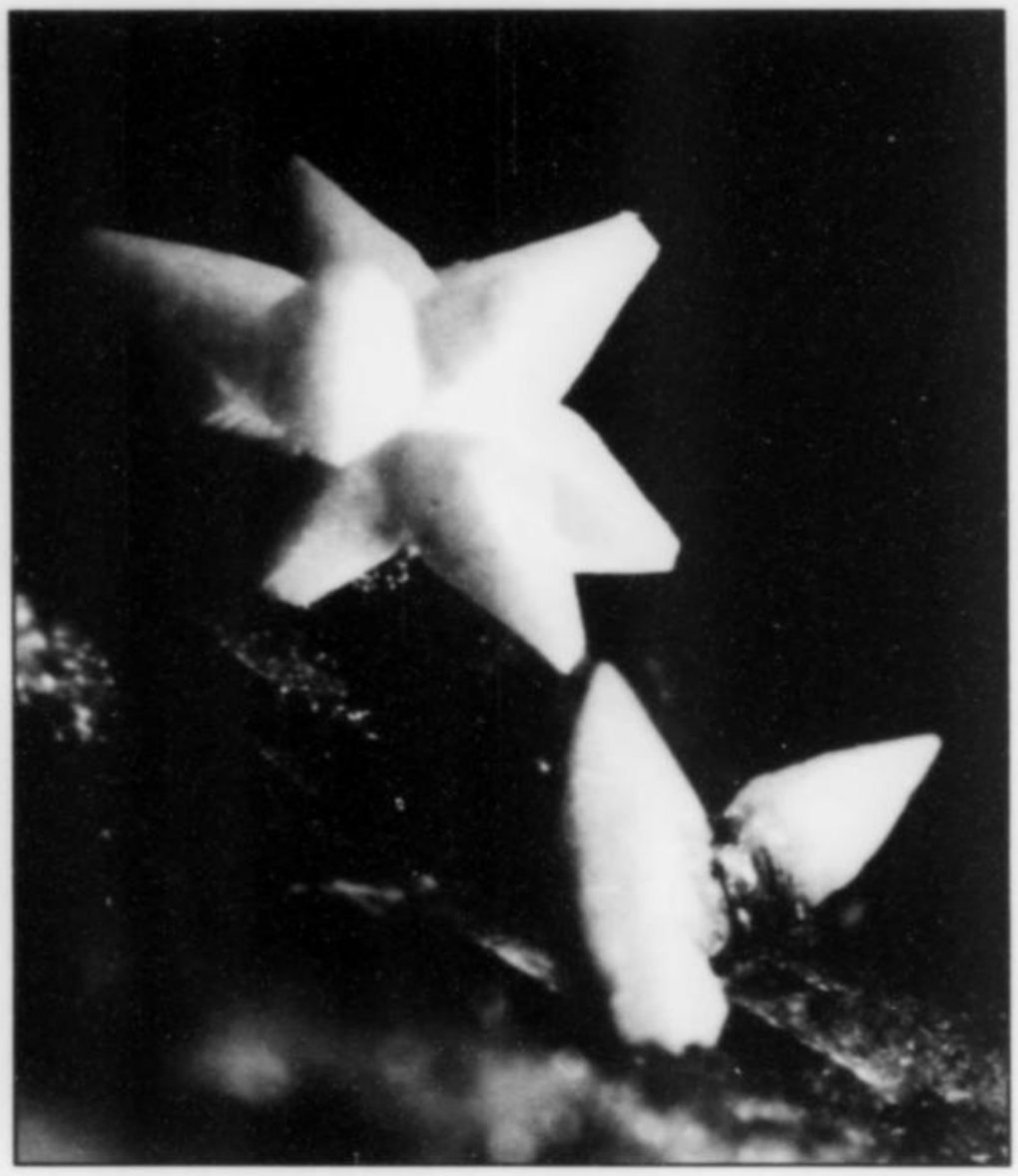

Figure 1. **Barite pseudomorphs after paralstonite on calcite from the Minerva No. 1 mine, Cave-in-Rock district, Hardin Co., Illinois. Individual crystals are about 1 mm in length.**

Figure 2. **Scanning electron microscope image showing the hexagonal dipyramid termination of a pseudomorph. Note the characteristic striations perpendicular to the c-axis on the "prism" faces. These striations can be used to distinguish paralstonite from calcite.**

the calcite crystal groups. The paragenetic sequence is: calcite → etched purple fluorite → white unknown. Doubly terminated single and twinned blades of marcasite are a notable associate because marcasite is quite uncommon in the Southern Illinois fluorite deposits (Lillie, 1988). The marcasite crystals are unattached, so their place in the crystallization sequence cannot be determined. The paragenetic position of the hydrocarbon is also ambiguous. The studied material is preserved in the Harvard mineral collection under catalogue number 134064 and in the R. C. Lillie collection.

Although the original descriptions (Roberts 1978, 1979) do not mention the underground location where type paralstonite was collected, we suspect it was also on the Bethel level. However, we are confident that this is a distinctly different occurrence because benstonite and sphalerite which are associated with type paralstonite are completely lacking in this paragenesis.

ANALYTICAL INVESTIGATION

Mineral identification begins with the direct and seemingly simple question, "What is it?" In the case of pseudomorphs we also ask, "What was it?" Finding answers to these questions involved the methods and instrumentation described in the following paragraphs. The results obtained are discussed in the succeeding section.

An attempt was made to identify the mineral optically by spindle stage methods but this gave poor results and was abandoned. Similarly, an attempt was made to measure the apical angle of the hexagonal dipyramid on a two-circle goniometer but the specimen failed to give usable reflections. X-ray powder diffraction (XRD) data were then collected from smear mounts using a Scintag 2000 automatic powder diffractometer. Data were reduced on-line using Scintag's DMS system of programs.

A specimen was affixed to an aluminum stub and coated with carbon for observations with a JEOL model 840 scanning electron microscope equipped with a Noran Li-drifted silicon detector and controlled with PGT electronics and software for semiquantitative chemical analyses.

To obtain quantitative chemical analyses specimens were embedded in epoxy, ground flat to expose a cross section, polished, and coated with a conductive layer of carbon. Backscattered electron (BSE) images and quantitative wavelength dispersive (WDS) analysis of both barite and paralstonite were made using a Cameca MBX electron microprobe equipped with a Noran TN-5502 energy dispersive system (EDS) and a TN-1310 automation system operating at 15 kV with a 15-nanoampere, 16 x 16-micrometer beam. Dolomite was used for the Mg standard, calcite for Ca, rhodochrosite for Mn, siderite for Fe, celestine for Sr, barite for Ba, and anhydrite for S; CO_2 was calculated by difference. Average analyses for two samples are reported in Table 1; Mg, Fe and Mn were sought but not detected in either mineral.

DISCUSSION

The initial X-ray experiment yielded an excellent pattern with a superficial resemblance to paralstonite. However, a close comparison showed that it did not match the reference pattern for paralstonite or any of the other common species known from the district. A computer search-match routine pointed to the rare mineral avogadrite, KBF_4, which is an improbable species in this geochemical environment, but an interesting identification because avogadrite has the same crystal structure as barite. The unit cell of avogadrite is smaller than barite but larger than celestine which led to the conjecture that the unknown mineral may be an intermediate member of the barite-strontianite solid solution series. The X-ray data were indexed and the unit cell refined using the computer program LCLSQ (Burnham, 1993). The results: a = 7.051(2), b = 8.686(6), c = 5.440(3) Å, V = 333.2(4) Å^3, indicate barite with strontium substituting for about one-third of the barium. The inconsistency of this identification with the hexagonal-dipyramidal

Table 1. **Electron microprobe analyses (in weight %).**

	Paralstonite			*Barite*			
Sample	*1*	*2-1*	*2-2*	*1-1*	*1-2*	*2-1*	*2-2*
# analyses	*3*	*7*	*6*	*2*	*3*	*9*	*6*
CaO	16.65	16.25	16.17	1.70	0.49	1.52	1.55
SrO	6.33	7.01	6.86	10.13	5.72	10.31	10.18
BaO	47.35	47.21	46.70	50.61	58.38	49.52	49.42
SO_3				37.51	34.79	37.00	36.80
CO_2*	29.67	29.53	30.27				
Total	100.00	100.00	100.00	99.95	99.38	98.35	97.95
Mineral formula on the basis of one cation							
Ca	0.445	0.436	0.437	0.066	0.020	0.060	0.062
Sr	0.092	0.102	0.100	0.213	0.124	0.221	0.219
Ba	0.463	0.463	0.462	0.721	0.856	0.718	0.719
S				1.023	0.977	1.028	1.026
C	1.011	1.008	1.044				

*By difference

Figure 3. **Scanning electron microscope image at 2000x of the surface of a pseudomorph which is a druse of tabular barite crystals in fine and coarse sizes.**

morphology of the crystals led to our recognition of these as pseudomorphs. Re-examination of the specimens under the binocular microscope showed that many of the crystals contain colorless, transparent cores. This material was proved to be paralstonite by XRD. Thus the specimens are a new kind of pseudomorph, barite after paralstonite.

The SEM data supported the XRD identification of the white mineral as barite. The photographs clearly illustrate the polycrystalline nature of the sample, which is expected of a pseudomorph.

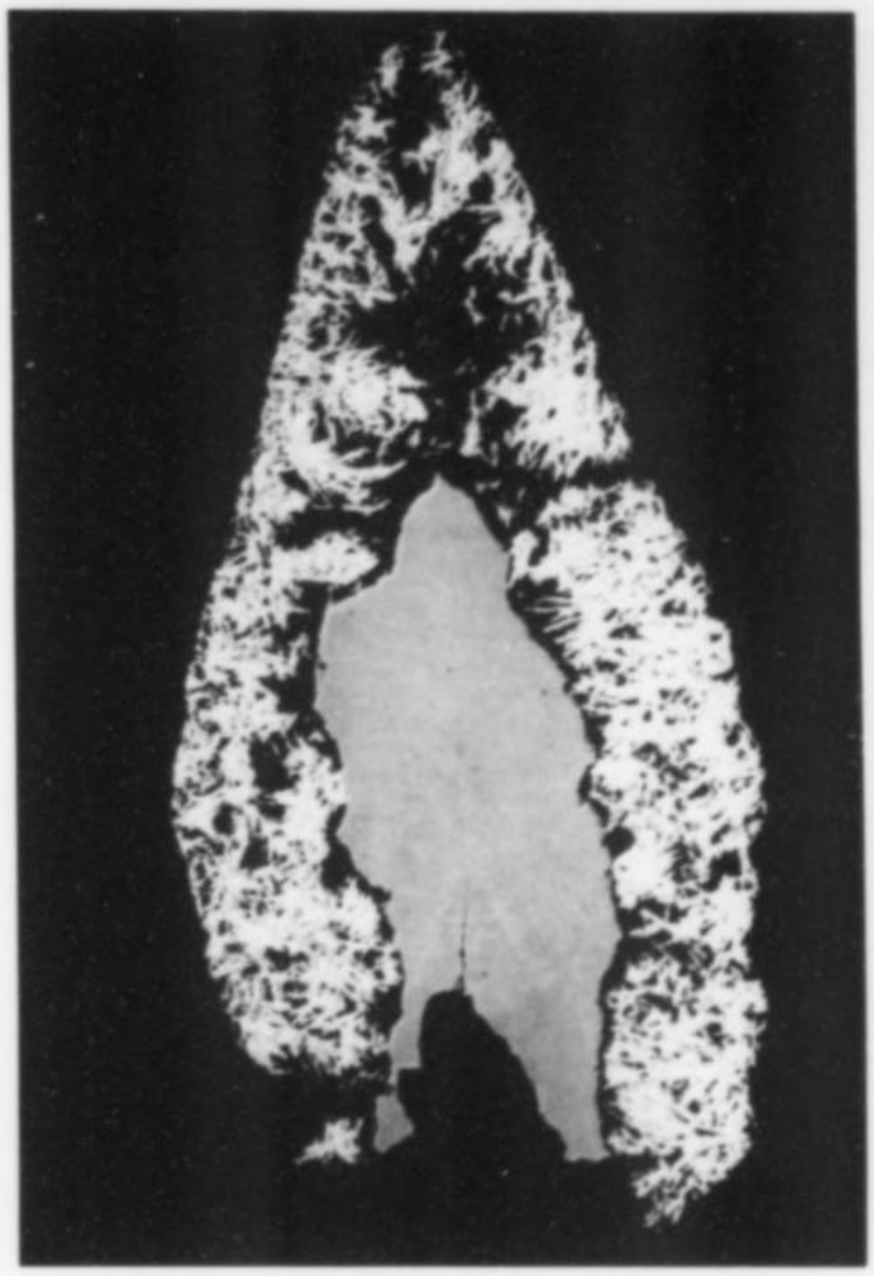

Figure 4. **Backscattered electron image at 100x of a vertical section through a pseudomorph showing a homogeneous core (gray) of paralstonite partially replaced by bright white barite. Specimen is 1.0 mm in length.**

This readily explains why the optical results didn't make sense and why goniometric measurements were impossible. Also the tabular crystal habit (Fig. 3) is typical of barite. The semiquantitative EDS analyses of the barite showed strontium and minor calcium as well as barium and sulfur which is consistent with the composition inferred from the X-ray results.

The BSE image (Fig. 4) shows that the specimens consist of paralstonite which has been replaced by barite. The spectacular texture demonstrates that replacement began at the surfaces of the paralstonite crystals and proceeded inward. In most cases the replacement is not complete and the remnant paralstonite can be easily dissolved in dilute hydrochloric acid yielding a fragile barite epimorph after paralstonite.

The paralstonite analyses (Table 1) are similar to that reported by Roberts (1978, 1979). This occurrence is slightly more strontian, containing ~7 weight % SrO. Both are thus members of a solid solution series with olekminskite, $Sr(Sr,Ca,Ba)(CO_3)_2$, which was described from the Kedrovyj massif, Aldan Shield, Siberia, Russia, by Konev *et al.* (1991). Numerous point analyses on three different crystals show that the paralstonite cores are unzoned.

As inferred from the unit cell refinement and consistent with the EDS analysis, the barite is a strontian variety. In sample 1 (see Table 1), fine (#1-1) and coarse (#1-2) textured varieties were observed in BSE images, and analysis showed them to have significantly different strontium contents. Sample 2 is a fine-textured high-strontium variety. Both varieties are much richer in strontium than the range of compositions reported by Park and Ghosh (1974) for primary bedded, colloform and disseminated barite from the Minerva mine.

Replacement of paralstonite by barite is consistent with barite

being a late (probably the last) mineral to form in the Cave-in-Rock paragenesis (cf. Hall and Friedman, 1963; Richardson and Pinckney, 1985). Furthermore, barite pseudomorphs after witherite are known from the Minerva mine, and barite pseudomorphs after celestine were described by Lillie (1988) from the nearby Annabel Lee mine.

The pseudomorphs may easily be distinguished from the original paralstonite by their opaque white appearance. Paralstonite, in contrast, is colorless and transparent. It is frequently observed as cores in broken pseudomorphs. An acid test is not reliable to distinguish the pseudomorphs from paralstonite because unreplaced remnants of paralstonite, which effervesces vigorously, may still be present. The hexagonal (vs. rhombohedral) morphology and especially the characteristic striations perpendicular to the axis of elongation distinguish both the pseudomorphs and the paralstonite from calcite, but not from one another.

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Edward R. Swoboda

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In each age a handful of mineral collectors go beyond the normal, traveling farther, making more important discoveries, building greater collections, and simply lasting longer at it than their contemporaries. Ed Swoboda is one of those, a collector whose name and exploits and collections are known or heard of by almost every connoisseur of minerals.

INTRODUCTION

Although he virtually never displays at mineral shows, Ed Swoboda built a fabulous personal collection and has worked at many of the most famous mineral localities in the world. He doesn't give slide lectures, either, and is generally rarely seen and hard to find. But sooner or later the serious mineral collector will run into him or hear about him, or will have the opportunity to marvel at some superb specimens that once were his. White-haired, trim and fit at 80, this quiet, dapper, native Californian still manages to leave his field-collecting long enough to attend the Tucson Show each year. He doesn't stay long, though; the busy, crowded halls and aisles of the show are not really his favorite place. He is happiest out in the solitude of remote localities, enjoying the excitement of the hunt for fine mineral specimens.

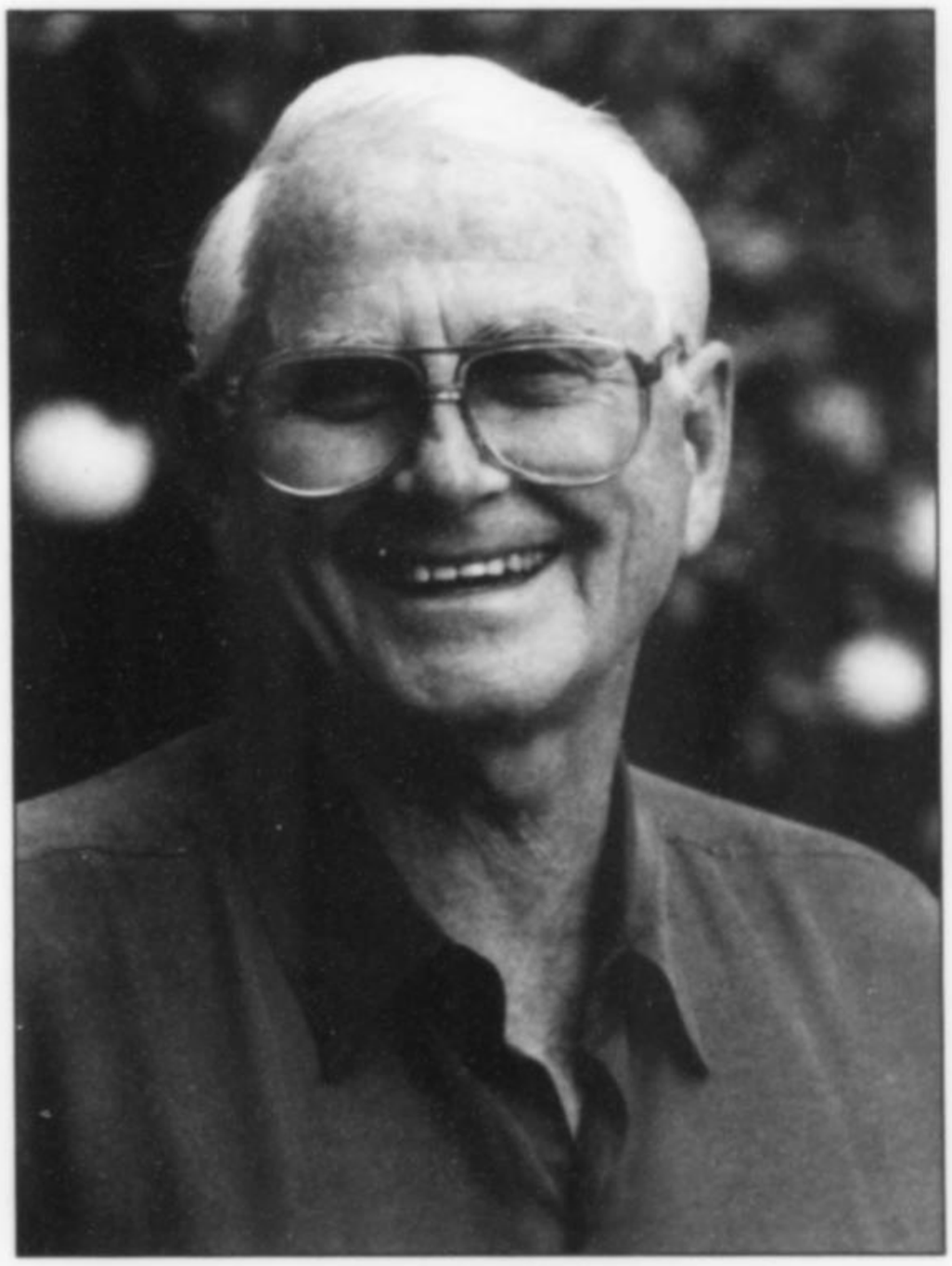


Figure 1. **Ed Swoboda**

EARLY YEARS

Ed Swoboda was born in California in 1917, and by the age of eight was already pestering his father to take him on mineral-collecting field trips. On that first excursion in 1925 he collected bright green olivine fragments from a basalt at Amboy Crater in the Mojave Desert.

Around 1930 Ed met Peter Bancroft, who was about a year older and equally caught up in the fever to collect minerals. (Bancroft later became a prominent author and collector as well.) They teamed up to work several local mineral sites, including the Griffith Park calcite crystal occurrence, the Eagle Rock gypsum deposit, and the now well-known barite crystal occurrence at Palos Verdes.

On other occasions Ed traveled with his family to vacation in a back-country cabin south of the Rincon pegmatite district in San Diego County. Among his discoveries there was a fine pocket of

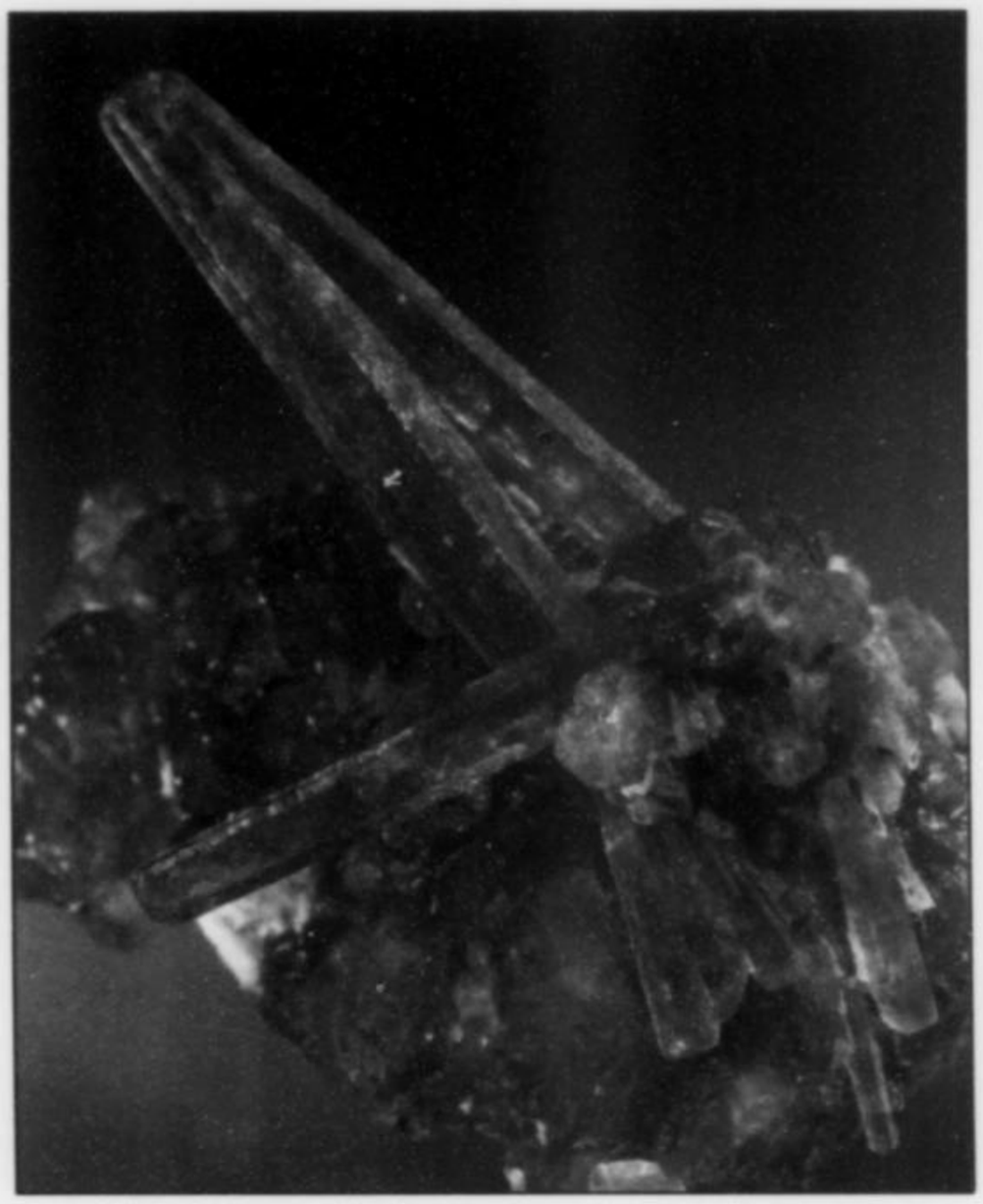


Figure 2. **Jeremejevite crystals to nearly 5 cm from the Cape Cross pegmatite near Swakopmund, Namibia. World's best for the species. Swoboda collection, now in the Houston Museum of Natural Science; Harold and Erica Van Pelt photo.**

Figure 3. **Crocoite crystals, 11 cm, from the Adelaide mine, Tasmania. World's best for the species. Swoboda collection, now in the Houston Museum of Natural Science; Harold and Erica Van Pelt photo.**

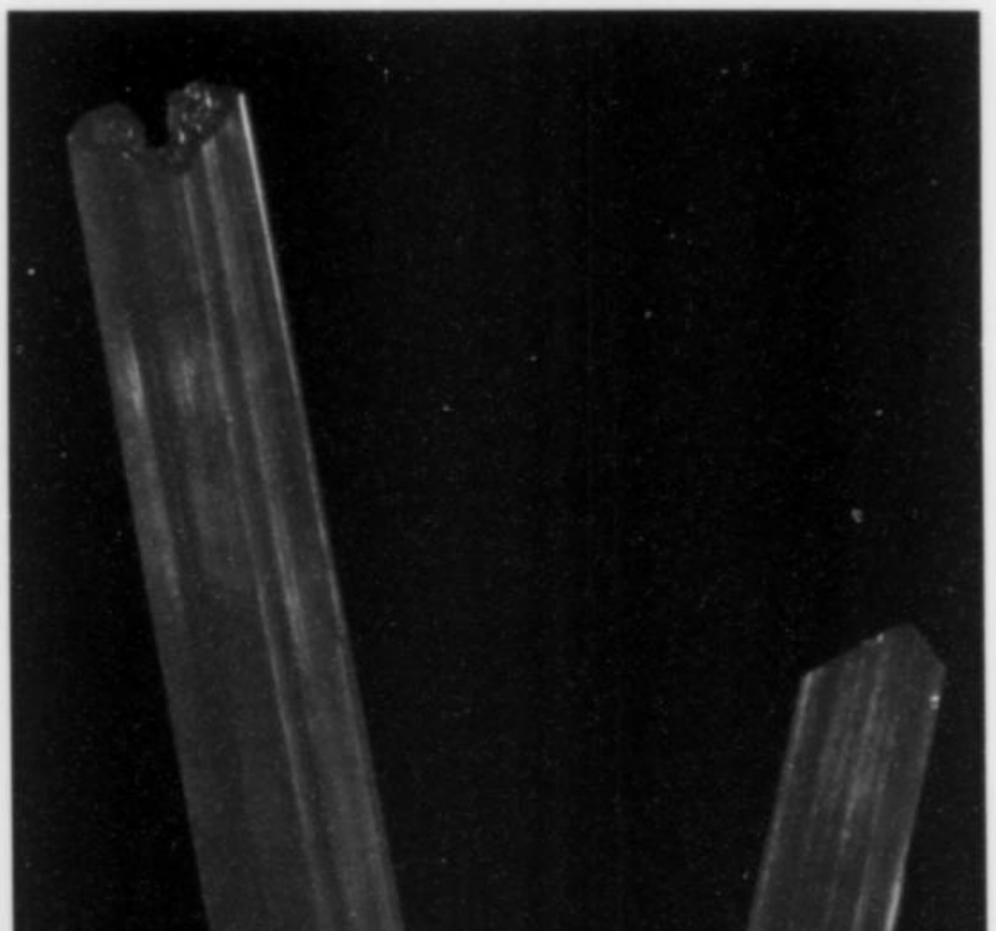


Figure 4. **Topaz crystal, 18 cm, from the Xanda mine, Virgem da Lapa, Brazil. Swoboda collection, now in the Houston Museum of Natural Science; Harold and Erica Van Pelt photo.**

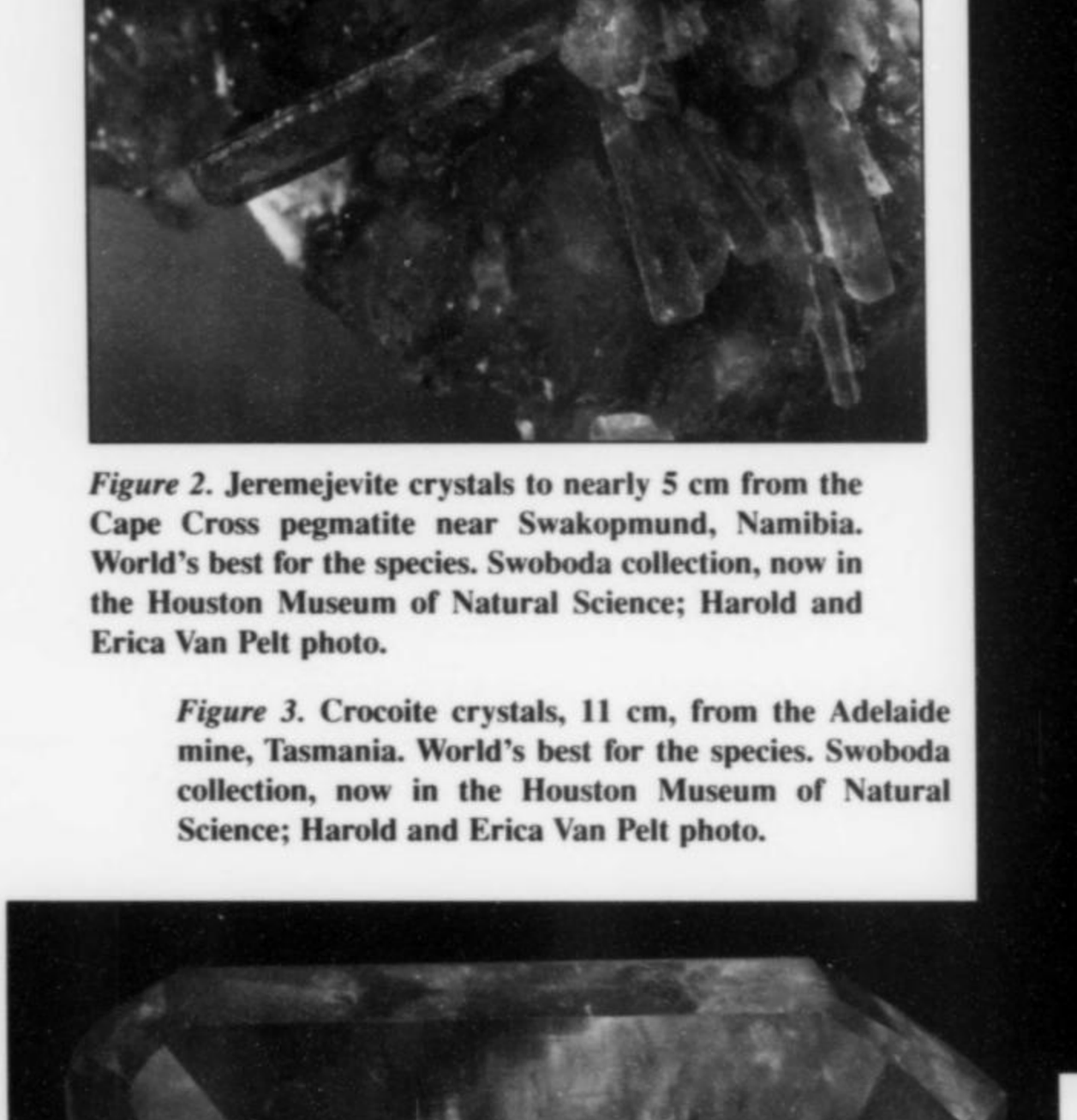


Figure 5. **Turquoise pseudomorph after glauberite crystals, 3.8 cm, from Mina, Nevada. Swoboda collection.**

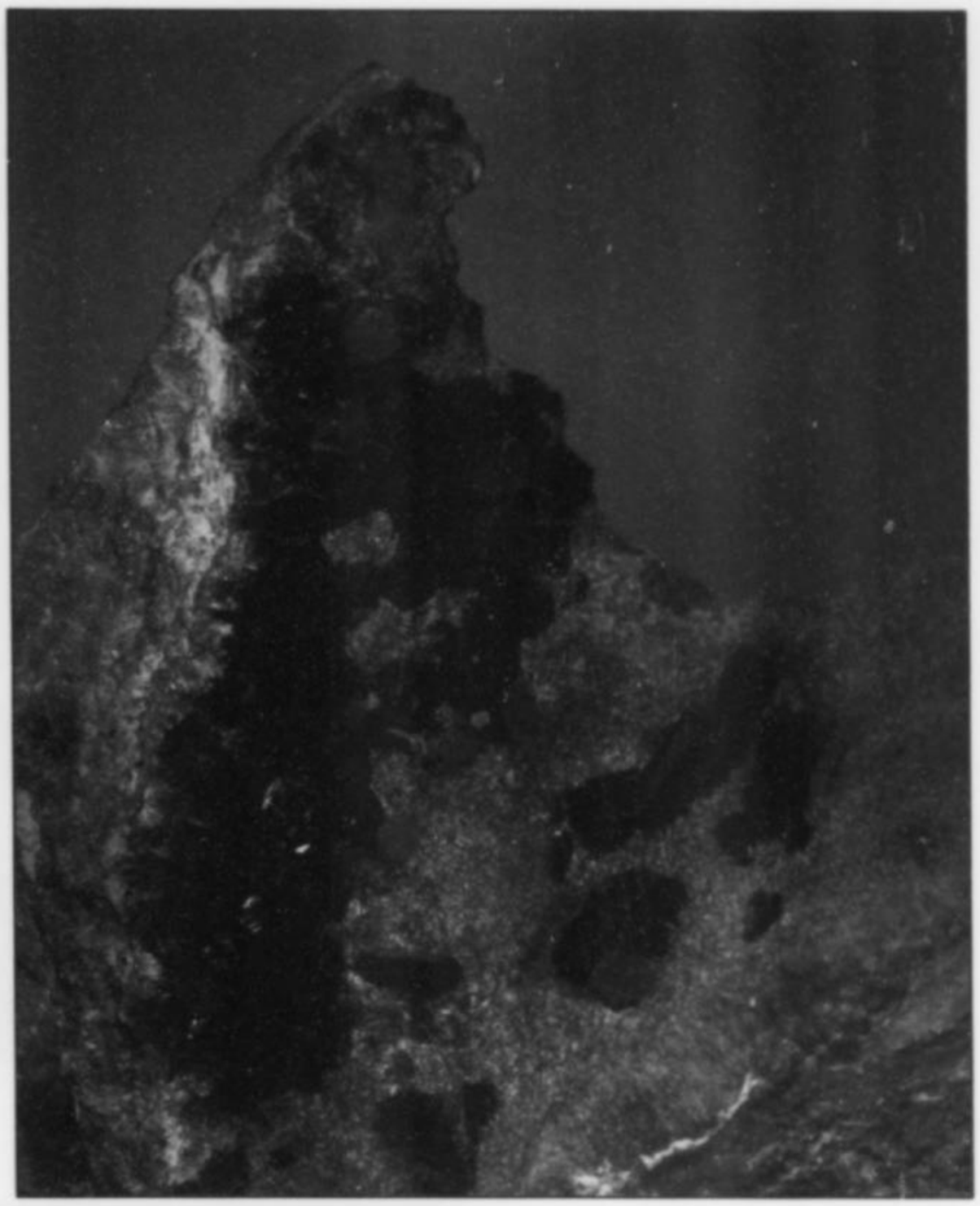


Figure 7. (above) **Spangolite crystals to 1.6 cm on atacamite, from the Copper Queen mine, Bisbee, Arizona. Swoboda collection, now in the Houston Museum of Natural Science; Harold and Erica Van Pelt photo.**

Figure 6. **Cuprian smithsonite pseudomorphs after cerussite, 5 cm, from Tsumeb, Namibia. Swoboda collection.**

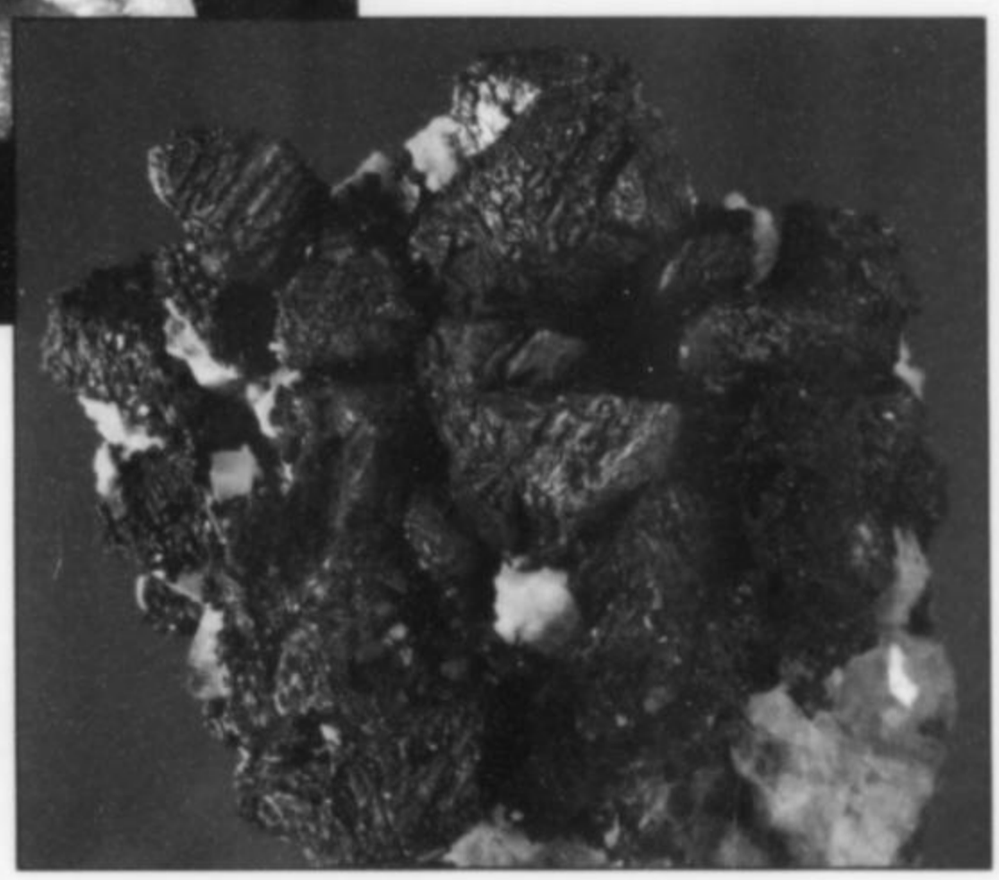


Figure 8. **Native bismuth crystal group, 7 cm, from Schneeberg, Saxony. Swoboda collection, now in the Houston Museum of Natural Science; Harold and Erica Van Pelt photo.**

twinned epidote crystals up to 5 cm each. Soon Pete Bancroft was joining him for 10 to 12-mile hikes through the Rincon pegmatite country prospecting for minerals. Among their most memorable finds was a pocket yielding several hundred pounds of transparent, pale smoky quartz crystals. Some were doubly terminated, and many carried attractive, bright green, prismatic epidote crystals attached to the faces. The biggest quartz crystal in the pocket was a 200-pound giant, but when it broke loose it took off rolling down a steep slope to a dry river bed, arriving in fragments. One of the broken chunks which Ed traded to Grieger Minerals in Pasadena was subsequently cut into a flawless 5-inch sphere.

In 1934 the benitoite deposit in San Benito County was relocated for mining. The renewed activity at the mine encouraged Ed and Pete to spend two weeks of every summer vacation there from 1935 to 1939. After examining the natrolite veins in the open cut, they decided to concentrate their work on the dump. They collected every chunk of serpentine matrix with "bumps" under the natrolite layer; the assumption was that later treatment in acid would reveal the "bumps" as crystals of benitoite and neptunite, an assumption which proved wonderfully true. On most trips they packed out over a hundred pounds each of specimens.

Ed took classes at Long Beach Junior College (now Long Beach State College) for a couple of years, but dropped out in 1937. He was convinced that the war brewing in Europe would eventually involve America, and that was sure to mean being drafted into the military. Before that happened, he wanted to take a long-dreamed-of trip to mineral-rich Brazil, so he went to work in a Long Beach grocery store and saved his money.

BRAZIL AND BEYOND

By 1939 Ed figured he had enough money put away for the big Brazil trip. He drove from California to Louisiana in a Model A Ford, which he sold there for $50, and boarded a passenger freighter for South America. Seventeen days later he debarked in Rio de Janeiro, where he soon met a South African gold/diamond miner who had workings in the interior. Ed signed on with him for a six-week unpaid stint in the jungle. Riding the night train from Rio to Belo Horizonte, they transferred to a narrow-gauge wood-fired train to Diamantina, and from there traveled by car and on horseback to the mining camp a few miles outside the town of Dattas. There he worked as a hoist operator, helping to carefully expose bedrock conglomerate showing fascinating rivulets of bright yellow placer gold and occasional pockets of gem-grade placer diamond crystals. On Sundays, his day "off," he prospected the surrounding hills and found nice pockets of transparent, rutilated quartz crystals.

In 1941 Ed, still in Brazil, was on a year-and-a-half expedition into the Matto Grosso jungle along the Paraguay River and its tributaries. While there he heard many stories, including that of a poor, itinerant miner who described finding heavy, gemmy, dark blue crystals of what was surely sapphire while panning for gold near the headwaters of the Juaru River far upstream. Before that trail could be followed up, however, Ed learned through the BBC radio that America had officially entered the War, and all American men of military age were to report in.

Rather than return to the United States to report for service, Ed reported to the U.S. Embassy in Rio de Janeiro. He was promptly assigned to work with an incoming team of geologists from Washington, DC whose job it was to set up camp in the interior and prospect for strategic minerals. The team, led by William Pecora, worked for six months on the San Jose de Tocantins nickel deposit (garnierite with chrysocolla) in the state of Goiaz. For Ed it was a wonderful opportunity to work under a gifted geologist who was later to head the U.S. Geological Survey and serve as Secretary of the Interior.

Figure 9. **Ed Swoboda in Brazil, 1943, with 117-pound beryl crystal now in the American Museum of Natural History, New York.**

Still in Brazil in 1945, Ed continued visiting important mineral sites, especially pegmatites, and saw a wealth of new specimens mined after the War's end. Tourmaline, spodumene, garnet and beryl seemed to be coming out everywhere, along with rarer and more unusual minerals. In São Paulo he found bright green, sparkling octahedrons of zircon, and pseudomorphic leucite crystals to 12 cm in matrix. During one six-week period he spent all of his time digging and sifting altered schist in the Dom Bosco area, looking for (and finding) a great pile of golden topaz crystals, plus two blue-green euclase crystals and a nice pocket of hematite crystals to 3 cm.

Ed returned again and again to Brazil, making discovery after discovery. Some of the highlights include: 25-cm phantom quartz crystals with multiple chlorite phantoms; extremely fine Japan-law quartz twins to 45 cm (!); *two* separate finds of anatase crystals on matrix, blue and gray-black, and up to 2.5 cm; the famous Lavra Rica discovery of clear quartz crystals with pyrite pyritohedrons floating inside; sceptered tourmaline crystals (pink stem and green termination); single, gemmy axinite crystals to 10 cm; euclase in

gemmy, thick, stubby, bright lemon-yellow crystals to 3 cm; lazulite crystals to 7.5 cm, some yielding 5-carat cut stones; and fabulous brazilianite crystals to 10 cm, which have never been equalled. (When I visited the brazilianite locality near Linopolis in 1972, it was collapsed and overgrown, but the locals still remembered "Señor Edoardo," the American who dug specimens in 1945 and 1946.)

Naturally, to pay his way in Brazil, Ed developed a business focussed on the buying and selling of mineral specimens and cutting rough. He sold mostly to American dealers and to important institutions such as the American Museum of Natural History in New York, the Harvard Mineralogical Museum, the Philadelphia Academy of Science, and the Smithsonian Institution. Well-known dealers such as Ward's, Schortmann's, Hugh Ford and Arthur Montgomery carried his specimens to the collector market. Ed also became half-owner and operator of The Beach Club on Copacabana Beach in Rio, the first American-style restaurant in Brazil, featuring a soda fountain and short order fare.

The years 1948–1949 found Ed in Mexico, mining blue-base fire opal and loose titanite crystals that yielded clean, bright, pale yellow to coffee-brown cut stones up to 1.5 cm, and pink clinozoisite crystals to 2 cm. Moving on, he passed through French Equatorial Africa where he mined dioptase crystal specimens, then Northern Rhodesia to mine for amethyst crystals along the Zambezi River, then onward into Madagascar, where he dug up gemmy, dark green grandidierite crystals to 6 cm in gneissic matrix.

Other countries where Ed has self-collected specimens or purchased materials include Angola (cobaltocalcite, copper minerals), Australia (dyscrasite, opal, copper minerals, johannsenite), Bolivia (apatite, cassiterite, creedite, phosphophyllite, vivianite), Burma (corundum, olivine, danburite, spinel), Chile (proustite, copper minerals), Colombia (emeralds, parisite), Japan (axinite, stibnite, quartz), Kenya (ruby), Mozambique (tourmaline, columbite, herderite, microlite, beryl), Namibia (beryl, milarite, topaz, jeremejevite), Peru (pyrite, rhodochrosite), South Africa (sperrylite), Turkey (diaspore, tourmaline), Uruguay (amethyst, citrine, agate), Venezuela (gold), and Zimbabwe (alexandrite, apatite, beryl and topaz). Of course, this list is not comprehensive.

In a rare digression into archeology (perhaps "treasure hunting" would be more accurate), Ed mounted an expedition to Lake Guatavita in the Colombian Andes to dive for ancient Indian gold objects. During Pre-Columbian times, such treasure had been thrown into the lake for generations as part of religious rituals. In conjunction with the Colombian Department of Anthropology Ed spent several weeks working with a professional diver; they searched the lake bottom for precious metal objects using illuminated underwater metal detectors, and came up with a number of interesting finds.

CALIFORNIA AND MEXICO

Back home in California, Ed purchased the Stewart, Tourmaline Queen and Pala Chief pegmatite mines in 1967, all of them located in the famous Pala district of San Diego County. The Stewart mine at that time was known primarily as a producer of lepidolite; but Ed mined into pockets rich in beautiful pink tourmaline. In 1972 at the Tourmaline Queen mine (mined with partner Bill Larson, under the company name of Pala Properties International) they hit the most famous tourmaline pocket in California history: the fabulous "blue cap" pink elbaites with blue terminations, in crystals to 20 cm, some with beautiful pink beryl crystals attached.

In 1973 it was back to Mexico, on an expedition to revive the Amelia mine at Boleo, in Baja California, as a source for boleite and cumengite. They sunk a 550-foot inclined shaft and hit pay dirt, bringing out hundreds of beautiful crystals and matrix specimens.

Back in California again the following year, Ed reopened the Himalaya mine in San Diego County, an operation which is still yielding fine specimens through Pala International.

Ed's most recent successes have been in Mexico. In 1982 he was involved in mining at the Ojuela mine, Mapimi, which yielded a fabulous pocket of purple adamite crystals to 6 cm, on matrix. These specimens (like many of Ed's other discoveries) remain the standard for the species. One of his longest projects began in 1989 at the San Francisco mine in Sonora. For several years he supervised the sinking of a 1,600-foot inclined shaft positioned so as to intersect the secondary lead orebody right where the best orange wulfenite and mimetite had been found many years earlier. After years of digging they finally cut into the vein, and fabulous wulfenite specimens soon decorated the motel sales room of Ed's partner, Wayne Thompson, at the Tucson Show.

HIS COLLECTIONS

As might be expected, Ed accumulated a fabulous personal mineral collection (actually several collections) as a result of his life of digging and dealing. In the mid-1960's, under financial stress, he sold his first mineral collection to California collector John Jago Trelawney. Much of Trelawney's collection later went to the Smithsonian Institution, where I remember seeing drawers full of California tourmaline come in for cataloging in 1972.

In the early 1970's Ed began to build a second, more sophisticated collection. This time, an entrée into the collection of Arch Oboler (an interesting figure, incidentally, in the history of science fiction) in San Fernando Valley gave him a jump start. After two years of hard negotiations, several of Oboler's finest pieces were acquired and became the nucleus of an extraordinary assemblage of world-class cabinet-size display specimens. By 1982 it numbered 245 carefully chosen "killer" specimens which probably constituted the finest private collection of large display specimens in the country at that time. At the same time, Ed was also building collections of competition-quality "miniatures" (less than 2 inches square), "thumbnails" (under 1 inch square), and "rough-and-cut." The latter consisted of matched pairs of fine natural gem crystals and cut stones of the same species and color.

The value of the cabinet collection grew to alarming proportions over the years, and eventually Ed's limited personal finances could no longer pay for the acquisition of specimens fine enough to fit in with those already owned. Security became another worry, which seemed to be solved for a time when Dr. Richard Jahns at Stanford University graciously constructed some beautiful display cases in the Branner Library to house the collection on loan. However, as luck would have it, one of the glass shelves slipped its fasteners on one end and collapsed, destroying the world's best Washington State realgar and damaging a couple of other important pieces. If such a thing could happen without provocation, what would happen during the next big California earthquake? It was time to sell the collection and stop worrying about it.

And so it was that, at the 1982 Tucson Gem and Mineral Show, a friend pointed out wealthy collector Perkins Sams sitting in the opulent dining salon of the Desert Inn Motel, eating lunch with former Smithsonian curator Paul Desautels. Ed approached Sams, discussed the situation with him, and a short time later the sale was concluded.

Perkins Sams, with the help of Desautels, went on to buy up other important collections in an effort to accumulate quickly the finest collection obtainable. Sams was in the oil business, however, and when that industry ran into trouble a few years later, he sold his entire collection (including the Swoboda collection, its solid core)

Figure 10. (above) **Milarite crystals to 2 cm, on matrix, from Rossing, Namibia. Swoboda collection; Rock Currier photo.**

Figure 11. (above) **Valentinite crystals to 1 cm, from Tatasi, Bolivia. Swoboda collection; Rock Currier photo.**

Figure 12. (right) **Proustite crystal group, 7 cm, from the Dolores mine, Chañarcillo, Chile. Swoboda collection, now in the Houston Museum of Natural Science; Harold and Erica Van Pelt photo.**

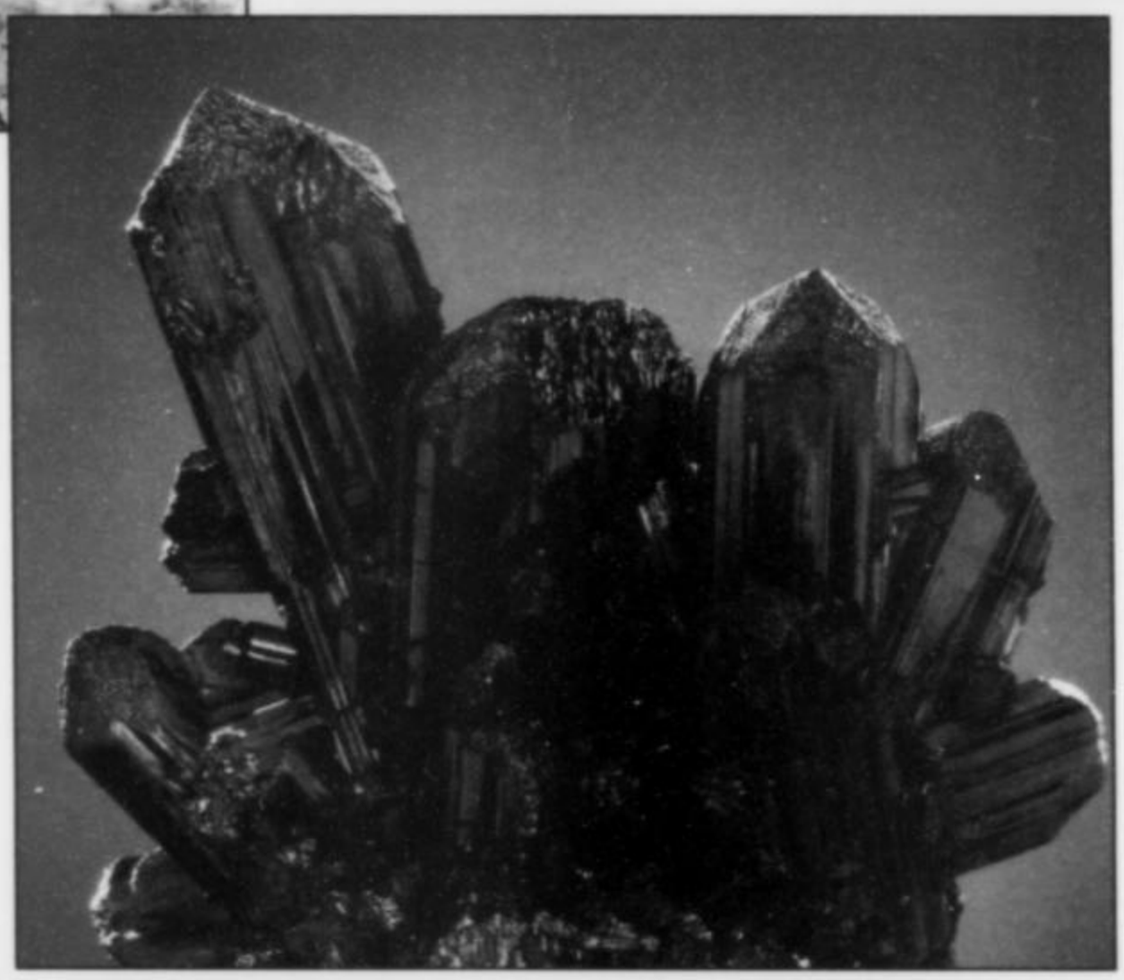
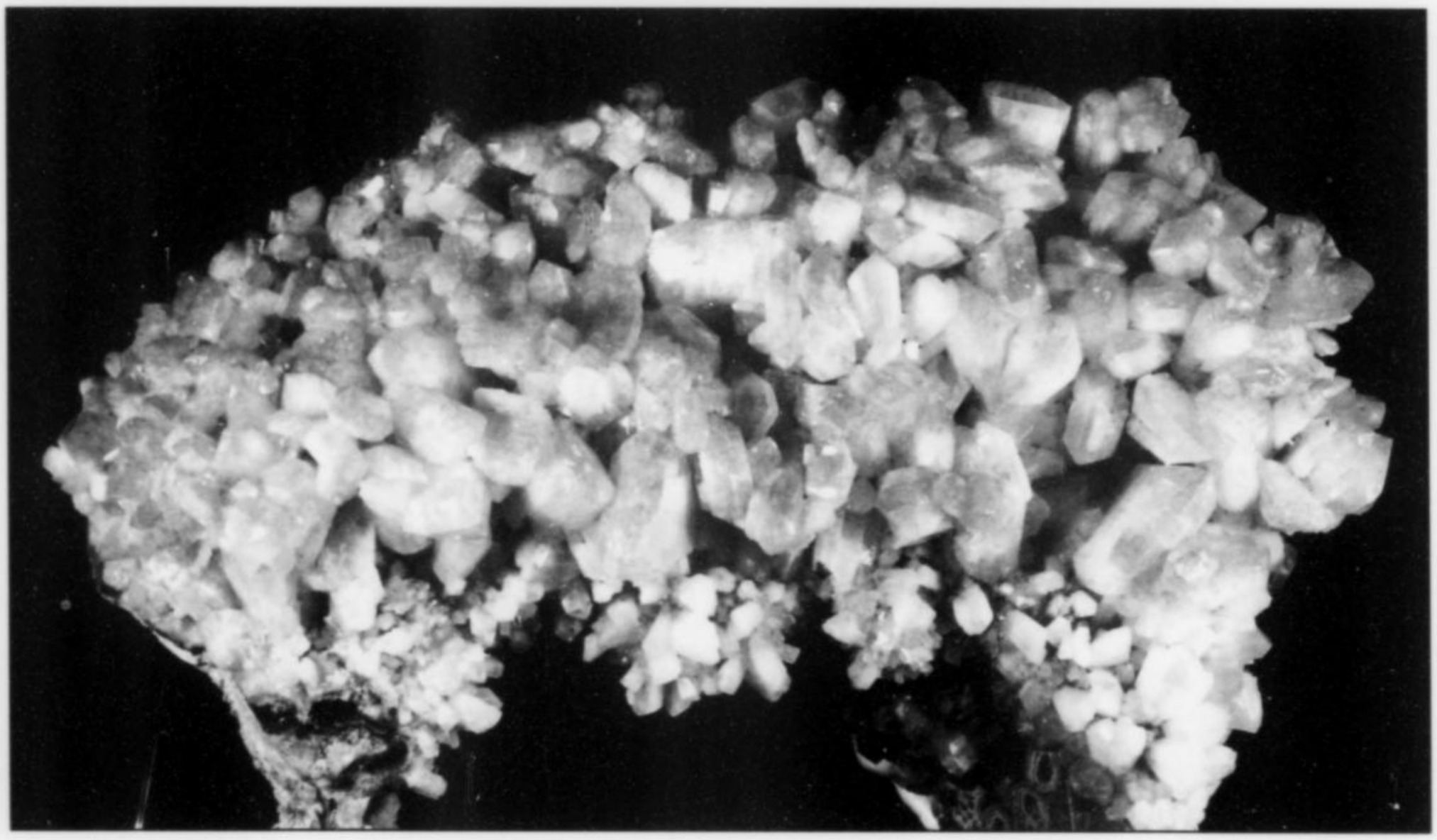


Figure 13. (below) **Hopeite crystal group, 18 cm, from the Broken Hill mine, Zambia. Swoboda collection; Rock Currier photo.**



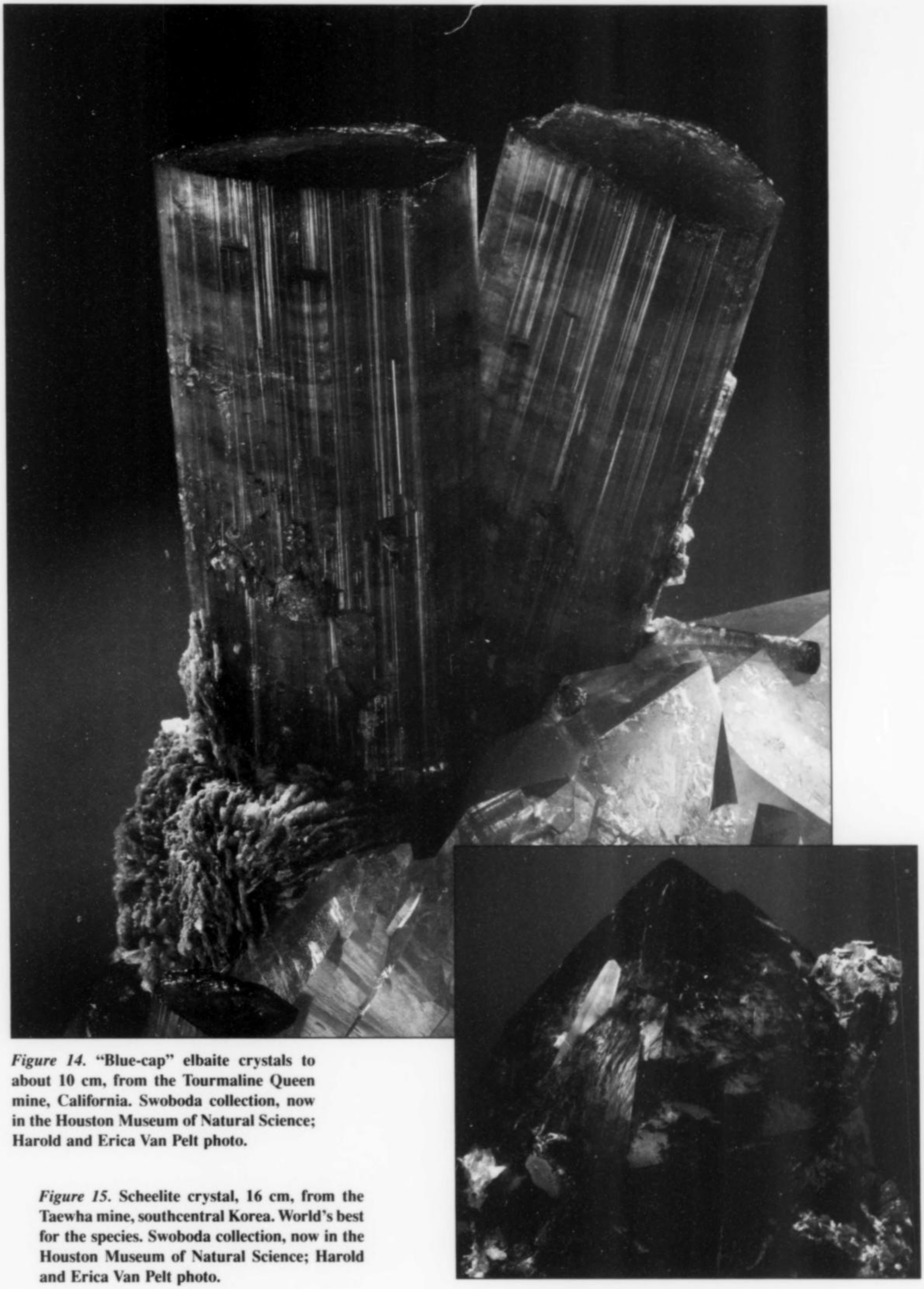


Figure 14. **"Blue-cap" elbaite crystals to about 10 cm, from the Tourmaline Queen mine, California. Swoboda collection, now in the Houston Museum of Natural Science; Harold and Erica Van Pelt photo.**

Figure 15. **Scheelite crystal, 16 cm, from the Taewha mine, southcentral Korea. World's best for the species. Swoboda collection, now in the Houston Museum of Natural Science; Harold and Erica Van Pelt photo.**

to the Houston Museum of Natural Science in 1984, and there it may still be seen (although the Swoboda specimens are not identified specifically).

While contemplating the sale of his display collection, Ed became interested in a more affordable specialty: pseudomorphs. Normally one thinks of pseudomorphs as being rather dull curiosities, but Ed decided to pursue them in the fashion of a connoisseur, acquiring the very best, most displayable examples in the most attractive colors and habits, carefully trimmed and expertly mounted. His count is now over 300 such specimens, and with these he surely possesses the world's premier collection of pseudomorphs. His favorite pieces include an 8-cm cluster of fire opal after glauberite (Australia), bright green cuprian smithsonite after 2-cm cerussite crystals (Tsumeb), a 19-cm silver after dyscrasite (Bohemia), and many examples of chrysocolla, azurite and malachite replacing each other, just to mention a few. He has examples of pseudomorphism by chemical substitution, chemical subtraction, chemical addition, paramorphism, encrustation, infiltration, and even by replacement by the same species, a subsequent generation unoriented to the original external shape.

STILL DIGGING TODAY

Ed Swoboda is still just as active in minerals, at the age of 80, as he always was. The constant activity must be health-giving, because he could easily pass for a man 10 or 20 years younger. You can never be sure where to find him, but it will probably be in some remote third-world mineral locality, mining and wheeling and dealing for specimens in the daytime and sleeping in a simple tent or primitive local hotel at night. He has a fine home in the Los Angeles area, watched over by his lovely wife Kumja during his absences. His discoveries these days often reach the market via his friend and sometimes partner Wayne Thompson. But Ed is most often following the call of that next big strike, somewhere. Judging by past experience, I would be willing to bet money that he will make that strike.

NOTE:

Readers interested in reading more about the detailed exploits of Ed Swoboda will be pleased to know that this biographical sketch is but the introduction to a series of Swoboda memoirs about his life in pursuit of fine minerals. Watch future issues for installments.

KINGSBRIDGE

AN EARLY QUARRYING DISTRICT ON MANHATTAN ISLAND

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Cambrian/Ordovician marble beds comprise much of the northern end of Manhattan Island. Surface exposures of this rock were exploited by the earliest settlers there in the second half of the 17th century, and commercial quarries were in operation by the late 18th century. The area yielded mineral specimens before the year 1809 and was recorded in print as an American mineral locality in 1812. Quarrying ceased in the 1840's, but in its day the Kingsbridge area was familiar to mineralogists and collectors as a source of well-crystallized diopside, pyrite, pyrrhotite, rutile, titanite, tourmaline and other minerals.

INTRODUCTION

I collected mineral specimens at Kingsbridge as a boy in the 1940's. My interest in that locality was revived in 1994 during a visit, to *The Old Print Shop* in New York City, where I purchased a quaint little drawing entitled *Marble Quarry, "Kingsbridge." N.Y. in 1819* (Fig. 2). Collecting these old glimpses of New York City the way it once was is one of my special interests; another is the history of early American mineral collecting. The drawing was done with brush and ink and is of the school of Archibald Robertson (1765–1835). Robertson opened the *Columbia Academy of Painting* on Liberty Street in New York City in 1792, and this picture is likely the work of a student at the Academy. *The Old Print Shop* had other examples done in the same style, some by other hands, showing various views in the city. The acquisition of the drawing spurred me to explore the printed record to find out what could be learned about marble and mineral specimen production at Kingsbridge, and especially about the quarry and the house depicted in the sketch.

HISTORY

Whereas a few locations in early New York City are recorded as quarrying sites for building stone or road metal in the Manhattan

Figure 1. **Map of the New York City area showing the Kingsbridge quarrying district at the extreme northern end of Manhattan Island, near the Harlem Ship Canal.**

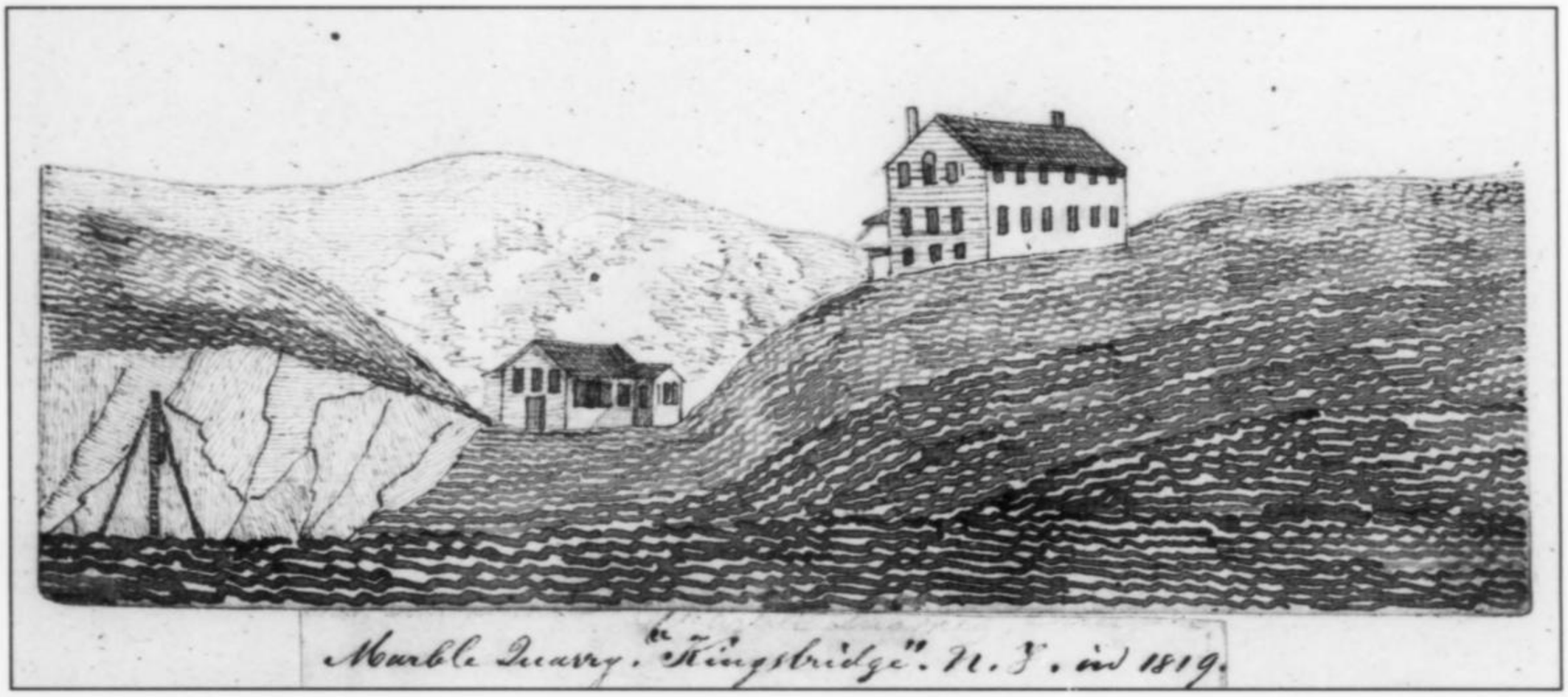

Figure 2. **"Marble Quarry, Kingsbridge, N.Y. in 1819." A contemporary brush-and-ink rendering. The house, built around 1810, was owned in 1819 by the Bolton family and their quarry shown at the left foreground was then in full operation. The view is from the northeast. Collection of the author.**

schist[1] (which, in earlier times, was called *granite*), no area was as extensively exploited for quarried stone as were the marble ridges near Kingsbridge, at Manhattan Island's northern tip. At least one large mansion was constructed entirely of this rock around the year

[1] "Blackwell's island [in the East River, known for many years as Welfare Island and called today Roosevelt Island] near Hurlgate, is a mass of rock, similar to that part of [New] York island opposite. A considerable part of the building stone used in the city is brought from the quarries in the granite of this [167-acre] island." (Akerly, 1814, but written before 1808.) A former stable, now the headquarters of the Colonial Dames of America, constructed entirely of this rock in the year 1799, is a unique survival on Manhattan or "York island" near the East River at 61st Street. It is reasonable to assume that the building material for this structure was transported from the Blackwell's Island quarries directly across the river.

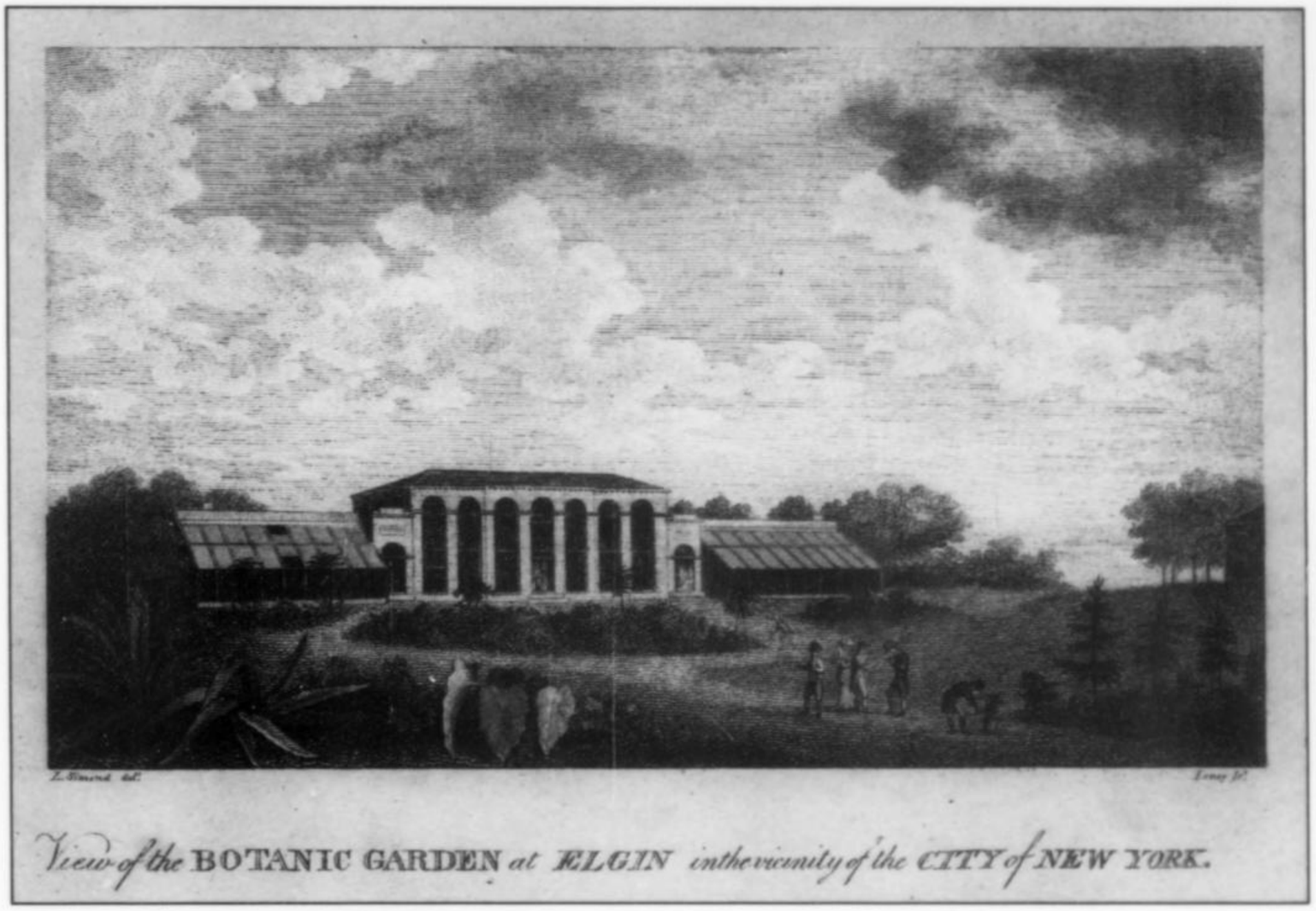

Figure 3. **"Elgin Gardens." In 1812, David Hosack had a large collection of minerals, including many from the Kingsbridge area, on public exhibit here. The site is presently occupied by Rockefeller Center. Collection of the author.**

1845, and there may well have been others. Also produced were numerous tombstones, many still visible in several places on the island, funereal monuments, burial vaults and so on. Lime for mortar cement and plaster, always an important commodity, was produced by several kilns in the district.

This area was the first place recorded in the literature as a distinct Manhattan Island mineral specimen locality. Indeed, Kingsbridge is listed as one of only two specific Manhattan localities in James Dwight Dana's (1850) *Catalogue of American Localities of Minerals*. The Kingsbridge location was published as a source of specimens in the year 1812 and was a mineral collecting site before 1809.

The marble industry was, apparently, well established in Kingsbridge by the end of the 18th century and it can safely be assumed that mineral specimen collecting there was not far behind or, perhaps, even preceded the formal quarrying.

Significant private mineral collections were being assembled in the city at this time, by purchase and by field-collecting. Around 1786, Samuel L. Mitchill, M.D. (1764–1831) brought to New York City, from Edinburgh, one of the earliest mineral collections to come to America. David Hosack, M.D. (1769–1835) owned a large collection of minerals which he opened to public viewing at his famous "Elgin Garden," established around 1804, at what is now Rockefeller Center near Fifth Avenue and 50th Street. However, the most important local devotee of minerals during this period was Manhattan-born, Archibald Bruce, M.D. (1777–1818). His publication *The American Mineralogical Journal* (New York, 1810–1814), had a strong, positive influence on the science of mineral-

Figure 4. **Archibald Bruce, M.D. (1777–1818). Acrylic painting by Susan Robinson, after an engraving in the *American Mineralogical Journal*. Collection of the author.**

Figure 5. **"Jews' Burying Ground," near Chatham Square in New York City, established around 1652. Many of the headstones are of Inwood marble.**

ogy and mineral collecting. Bruce built a very large collection during his short life-span.

Jacobus Dyckman's ancestors settled in New Harlaem (an ancient village that existed for a time on northern Manhattan) around 1660. He added to his already large holdings of land there by purchasing, in the 1790's (according to H. D. Romer and H. B. Hartman in *Jan Dyckman and his Descendants*, New York, 1981), "certain acreage to the north, including Marble Hill—a profitable marble quarry." The name "Marble Hill," however, is modern and was invented by a real-estate developer in the year 1891; but, on a map drawn for The American Scenic and Historical Preservation Society by Reginald Pelham Bolton in 1906, that appears in *Riverdale, Kingsbridge, Spuyten Duyvil, New York* by William A. Tieck (1968), Bolton indicates a fairly large former marble quarry on Marble Hill. According to the mapmaker it existed on land that was once owned by Jacobus Dyckman.

Incidentally, a founding member and one-time president of The American Scenic and Historical Preservation Society was George Frederick Kunz (1856–1932). Kunz was a gemologist and mineralogist with Tiffany & Co., and the pink variety of the mineral spodumene was named *kunzite* in his honor. As the founder and longtime president of The New York Mineralogical Club, Kunz organized and led many Club outings to the Kingsbridge area in order to collect mineral specimens from the marble there.

Proof that marble from this area was being produced during the first quarter of the 18th century survives as a headstone in Trinity churchyard, on lower Broadway at Wall Street, with the date 1723 still visible upon it. Other Kingsbridge area marble headstones in the same churchyard are dated 1777, 1795 and 1796, and there are many others perhaps older, judging by their weathered appearance, whose dates and inscriptions have been entirely obliterated by time and the elements. By contrast, nearby headstones of the same period, made of sandstone (called *brownstone*) quarried in the Connecticut River valley, are holding up much better.

Remains of even earlier Kingsbridge marble gravestones can be seen today in the Jews' Burying Ground in lower Manhattan near present-day Chatham Square. This is the earliest cemetery established on the island, and it is likely that it originated in the year 1652 with a grant of land by Peter Stuyvesant's Council. Some of the gravestones almost certainly date from the 17th century but their inscriptions are long gone. In fact, some stones are so severely weathered that they have shrunk to less than half their original size and look much like melting ice cream pops. Considering their date it is likely that these stones were obtained from surface excavations, but early quarrying cannot be ruled out.

By the year 1808, production of marble had become quite extensive, as shown by a statement made by John Randel, Jr. in his narrative, *City of New York, north of Canal Street in 1808 to 1821* (Randel, 1864). "From 213th to 217th street the road [called at the time the Kingsbridge road and now known as Broadway] passed along the foot of the eastern slope of marble quarries." This places additional marble quarries in Kingsbridge, in the year 1808, on the lands of the Dyckman family and elsewhere. The Dyckmans at one time owned the largest single tract of land in the history of Manhattan and were honored by the naming of present-day Dyckman Street, an important east-west thoroughfare that traverses their former lands. Jacobus Dyckman lends his name to today's Jacobus Place on Marble Hill.

John Randel, Jr. (ca. 1780–1865), a surveyor, was responsible for the field work that resulted in the historic "Commissioners Map." This map, published in 1811 and almost 8 feet in length, laid out the current grid pattern of Manhattan's streets. The commis-

Figure 6. **"Residence of Isaac Dyckman. Kingsbridge, N.Y. 1861" from Valentine, (1861). The house from Figure 2 is shown here 42 years later and from the south-west. Collection of the author.**

sioners, three gentlemen of the City, had been charged by the New York State Legislature "to lay out streets, roads and public squares" in rural Manhattan (mostly north of 14th Street) and this they did, virtually ignoring the natural topography of the island. Their map is generally considered to be the most influential in the history of the development of the city.

Randel, who wrote his narrative in 1864, was but one year from his death at the time, and recollections of observations he made almost 60 years previous must, therefore, be read with some caution. It should be remembered that the streets he mentioned did not yet exist in the year 1808 and he may well have also seen, but did not record, the quarry on Marble Hill claimed by Romer and Hartman (1981) and also by Bolton in Tieck (1968).

The identification of the house in the sketch (Fig. 2) allows the exact site of the depicted quarry to be determined. It was built around 1810 and was pleasantly situated on the southern slope of Marble Hill, 350 feet west of present-day Broadway, approximately 200 feet from, and looking down on, two small tidal creeks. It was probably built by members of the Tison or Post families who were heirs of Jan Nagel, a settler there in the year 1677. According to Reginald Pelham Bolton, in his *Washington Heights, Manhattan, Its Eventful Past* (1924), the house was purchased in 1816 by his ancestors Curtis and John Bolton,[2] who were "the pioneers in the marble industry, and alongside the High [Albany Post] Road, opposite [350 feet southeast of] their dwelling, they opened a marble quarry . . ."

It is likely that the quarry already existed in 1816 and that the Boltons expanded the operation by, among other things, exploiting the creeks that ran between the house and the quarry as a source of power for sawing the blocks of stone. For many years this waterway was known as the Bolton Canal and then, later, the Dyckman Canal until its obliteration by the Harlem Ship Canal in the 1890's. Tieck (1968) states that although the Boltons left in 1824, marble production continued in the area for some time under the auspices of the Lambert family.

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[2] The land records, which are still preserved, show that the Posts sold the property to George W. Hall and John C. Bolton in 1816 and that two years later George Washington Hall transferred his interest in the property to his partner John Curtis Bolton. It is therefore probable that "Curtis and John Bolton" were unwittingly created out of John Curtis Bolton.

Figure 7. **"Kingsbridge Ship Canal thru Limestone N.Y. City." From an old glass lantern-slide taken by Gilman S. Stanton circa 1893. An historic photograph taken during the excavation for the canal. The old house is barely visible at top-center. What may be the remains of one end of the former quarry, now filled with water, can be seen at the far right. Courtesy of Richard Hauck and the Richard Hauck Archives.**

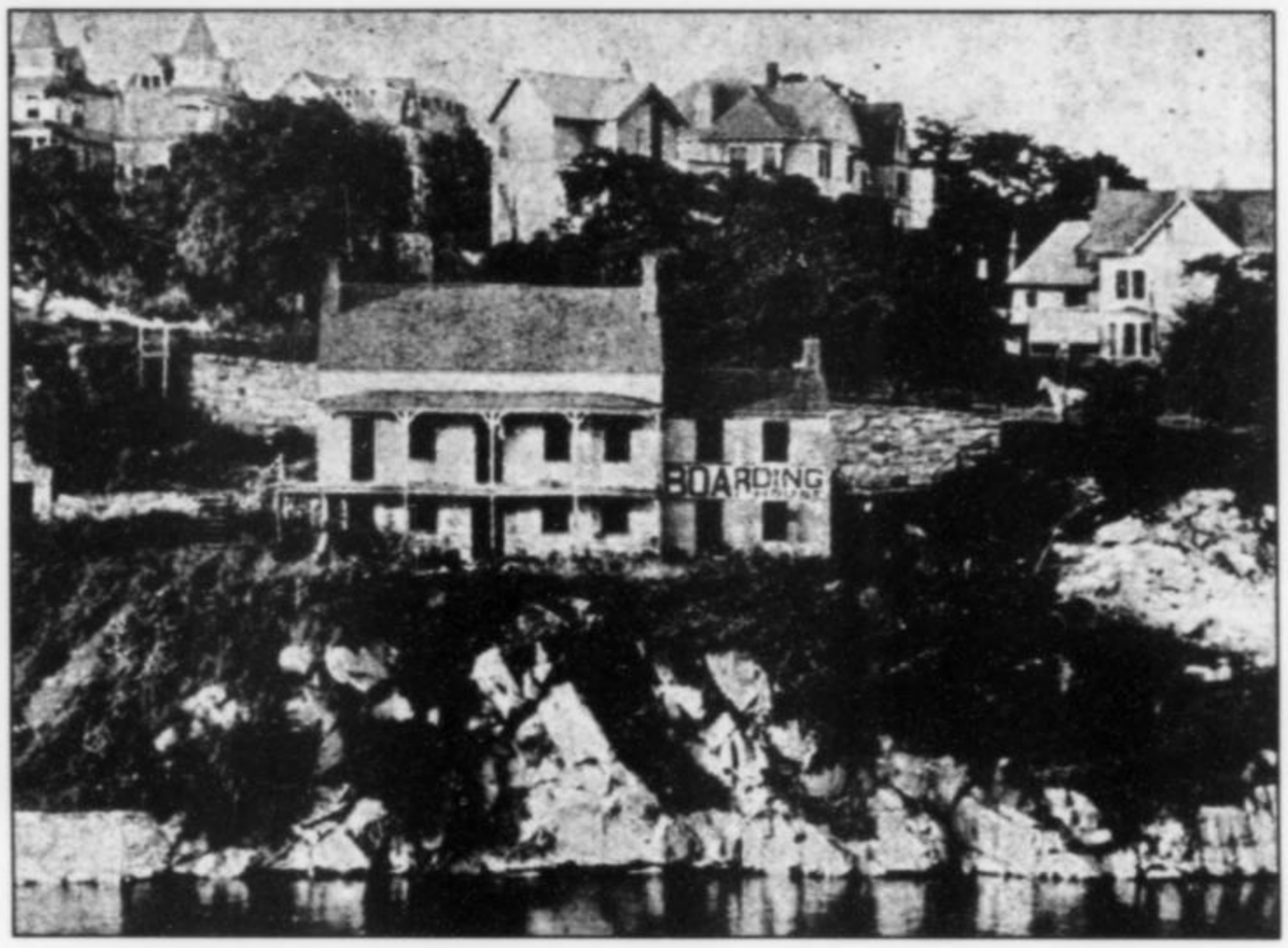

Figure 8. **A still later depiction of the old house called, by this time, "The Old Homestead Boarding House," viewed from the south. The former quarry site lies in the bed of the present Harlem River. Photograph from *New York Herald*, around 1905. Collection of the author.**

Dyckmans purchased this "old yellow house" and moved into it in 1850, but by that time the quarrying of marble had ceased. The house was, according to a description in Tieck (1968), of central-hall type, of good size, 40 x 25 feet, with the hall measuring about 10 feet in width.

Figure 6 shows the Tison/Post-Bolton-Dyckman house, and surroundings, as it appeared in 1861 when it was owned by Isaac Dyckman. (Incidentally, this view from Valentine (1861) is reproduced by Kouvenhoven (1953) but is incorrectly identified.) Whatever remained of the quarry by 1861 does not show in this view but outcroppings of marble are prominently depicted in the foreground. The Dyckmans moved out of the house by the end of the 1860's.

A view of the quarry site from Figure 2 (or what remained of it by the year 1893) was photographed during the building of the Harlem Ship Canal (Fig. 7). What may be at least part of the quarry, reduced by this time to a water-filled hole, can be seen at the extreme right in the photograph. The canal, in this vicinity, followed the path of the old tidal creeks that had been exploited by the Boltons almost a century earlier, and probably even earlier by their predecessors.

When the United States Ship Canal[3] (now designated the Harlem River) was completed in 1895 the remains of the old quarry were

[3] The Harlem Ship Canal is the largest excavation into the marble beds of Manhattan. When it was opened to shipping in 1895, 550,000 tons of marble had been removed and an additional 5,000 cubic yards of the rock were used in the construction of retaining walls. Many buildings on Marble Hill contain some of this rock and a good deal of it was exported to Bayonne, New Jersey for use in a breakwater there. In the early stages of the excavation, in 1891, a mastodon tusk was uncovered, the only such find on the island. It is preserved at the American Museum of Natural History.

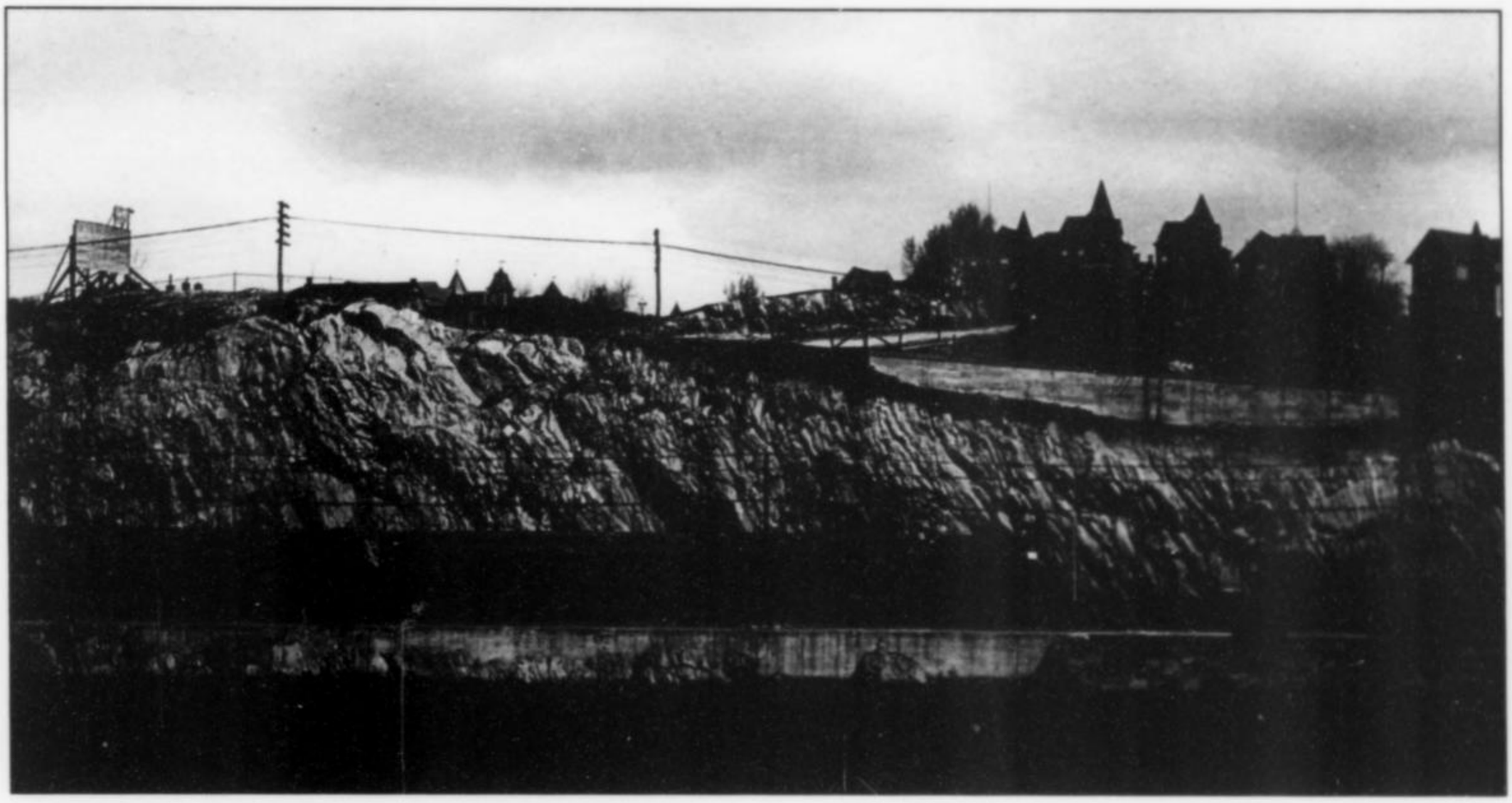

Figure 9. **The same scene, approximately, as shown in Figure 8 as it appeared on April 6, 1913 after the old house had been demolished. From a hand-tinted, glass lantern-slide taken by James G. Manchester. Courtesy of Richard Hauck and the Richard Hauck Archives.**

obliterated by the water. The house, quite run-down by this time and fit only for use as a boarding-house, was left very close to the water's edge (Fig. 8). Ten years later the rerouting of the Hudson Railroad, along the bank of the canal, resulted in the destruction of the house but increased the exposure of the marble (Fig. 9).

The construction of the Harlem Ship Canal cut off from Manhattan island a piece of land approximately 52 acres in size. That detached land, which includes some of the former acreage of the Tison/Post/Bolton/Dyckman families and the remains of other quarries on present-day Marble Hill, is still, politically, part of Manhattan although it is now physically attached only to the Borough of The Bronx. The original upper boundary of Manhattan island was an east-west creek that ran somewhat to the north of the northern slope of present-day Marble Hill and is now entirely filled in.

In a quaint work entitled *Springs and Wells of Manhattan and the Bronx New York City at the End of the Nineteenth Century* (1938), the author, James Reuel Smith, recorded his travels around upper Manhattan during the years 1898 to 1901, and documented, with photographs, the few surviving natural sources of fresh water. Smith was almost certainly describing an abandoned quarry in the marble, which by 1898 had become an ice pond, when he wrote:

> The [Isaac Michael, *not* the previously mentioned Isaac, but his nephew] Dyckman ice pond is about one hundred and fifty feet north of the Seaman-Drake estate . . . [it] is about three hundred feet long by seventy-five feet wide and for the most part is *cut out of the solid natural rock*. [Italics added.] Heavy trees and foliage and vines surround it, and I came within a foot or two of walking into it over a bluff twenty-five feet high!

As final proof, Smith's photograph of the pond (Fig. 10) looks very much like many an abandoned, water-filled quarry that I have seen over the years. If this was, indeed, a quarry, it yielded, according to Smith's measurements, a lot of marble—more than 20,000 cubic yards! It was situated on land that is now occupied by Columbia University's Baker Field.

Archibald Bruce wrote, in his *The American Mineralogical Journal* (1814a), a "Description of Some of the Combinations of Titanium Occurring within the United States." In it he described four specimens of Kingsbridge rutile which he owned and almost certainly collected personally in the field. He depicted one in an engraved plate (Fig. 23) and wrote:

> The above specimens . . . are from the island of New-York. They were found in the limestone ridge which crosses the island at its northern extremity, near Kingsbridge. The lime-stone, which is primitive, has running through it in different directions, veins from one to three or four inches thick, composed of quartz, felspar, mica, and granular lime-stone: through which the oxide of Titanium is sparingly disseminated. The quartz is of the fœtid kind, giving out an unpleasant odour on being fractured.

In the same article Bruce wrote also of "Silico-Calcareous Oxide of Titanium" (titanite) and mentioned:

> Small brilliant crystals . . . of a light dove[4] colour, imbedded in primitive carbonate of lime, from the marble quarry at Kingsbridge, Island of New-York.

"The marble quarry" mentioned by Bruce as the source of his specimens could have been the Bolton quarry pictured in Figure 2, although there were others in the Kingsbridge area producing marble at the time. The Bolton quarry was, apparently, the most important. These sites were probably often visited by mineral

[4] The Editor has suggested that "dove" may have been a typographical error for "clove," since titanites are not usually dove colored and a handwritten "cl" could be misread as a "d." The careful proofreading which is evident in Bruce's *Journal* makes this conclusion, in my opinion, unlikely.

Figure 10. **The Isaac Michael Dyckman ice pond (formerly a marble quarry) as it appeared on June 29, 1898. Photograph by James Reuel Smith. From Smith (1938). Collection of The New York Historical Society.**

collectors desirous of obtaining specimens to add to their cabinets. Unfortunately, no specimens known to be from the early quarries can be positively identified today.

Kingsbridge was a favorite with other early physician/mineralogists, too. In his *Chymical Exercises* (1819), William James MacNeven, M.D. (1763–1841) wrote extensively about the area:

> The limestone district adjacent to Kingsbridge is shown, by the character of its minerals and the position of its strata, to be chiefly primitive. The marble extends two or three miles into the county of New-York [Manhattan], and is the termination of a range of primitive granular limestone [that at Kingsbridge] is stratified, presenting an inclination to the south-east of from sixty to seventy degrees.

He remarked that it was the only locality in the United States at which could be found crystals of "white augite [diopside] in nearly rectangular prisms." He also noted that "the limestone of Kingsbridge embraces pyroxene, tremolite, mica, fetid quartz, oxide of titanium, adularia, tourmaline and sulphuret of iron." Samuel Robinson, M.D., in his *A Catalogue of American Minerals With Their Localities* (1825), devoted a full page to Kingsbridge minerals, and in 1842, Lewis Caleb Beck, M.D. (1798–1853) summarized what he knew of Kingsbridge minerals in his *Mineralogy of New York* (1842).

By the year 1888, Benjamin B. Chamberlin was referring to Kingsbridge in the past tense (Chamberlin, 1888). He wrote: "Nearly fifty years ago the Kingsbridge quarries were much resorted to by collectors." By the time that James G. Manchester wrote, in 1931, *The Mineralogy of New York City and Its Environs*, the city was encroaching seriously on the few remaining collecting sites, and there are no further references known to me, thereafter in the literature, to mineral collecting at Kingsbridge.

GEOLOGY and PETROLOGY

What is evidently the earliest printed reference to the Kingsbridge area marble was composed by the year 1808. Dr. Samuel Akerly (1785–1845) wrote "On the Geology and Mineralogy of the Island of New-York," and it was published, six years later in 1814, in *The American Mineralogical Journal*, volume 1, number 4, pages 191–198 (Akerly, 1814). It noted ". . . the primitive limestone which is on the north end of the island." Unfortunately, Akerly wrote nothing at all about the rock's constituent minerals. Earlier, Samuel Latham Mitchill, M.D., in his report "A sketch of the mineralogical history of the State of New-York" (Mitchill, 1798) certainly had the opportunity to describe the marble beds, but did not mention them.

The marble of the Kingsbridge quarries was described by Robinson (1825) as a "granular limestone, sometimes traversed by narrow veins of granite, mica slate, and quartz" with occasional "yellow mica," diopside, tourmaline, kyanite, feldspar, tremolite, pyrite, rutile, dolomite and titanite. He states further that the limestone unit "passes through West Chester [sic.] County [NY], in strata dipping to the S.E. at about 65°," and is "connected with that extensive deposit of granular limestone which accompanies primitive rocks from Canada through the eastern parts of New England, crosses the Hudson near Stony Point into Rockland Co. [New York], and again appears in New Jersey, Pennsylvania, Maryland and Virginia."

Leo M. Hall, writing in *Studies of Appalachian Geology: Northern and Maritime* (1968), subdivided those vast Cambrian-Ordovician marble beds, as they are observed in the Greater New York area, into five units which he labeled *Inwood A, B, C, D and E*, and described them.

Inwood A (the Kingsbridge area): Well-bedded white, gray or blue-gray dolomite marble.

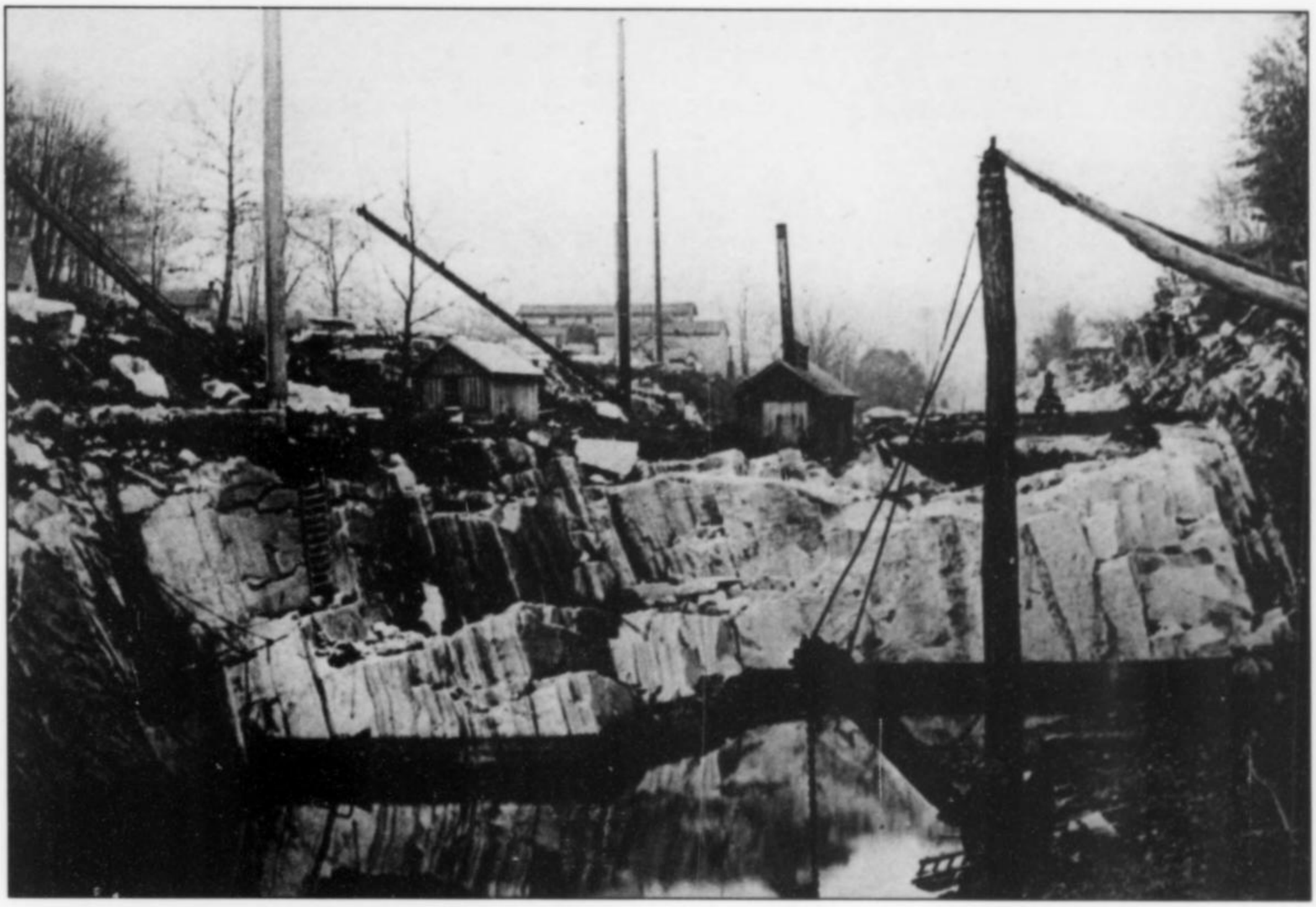

Figure 11. **The Inwood B marble quarry at Tuckahoe, Westchester County, New York, in 1888. Collection of the author.**

Inwood B (Tuckahoe and White Plains, New York, area): Interbedded white, gray, buff or pinkish dolomite-marble, tan and reddish brown calc-schist, purplish brown or tan siliceous calc-schist and granulites, tan quartzite, and calcite-dolomite marble; bedding is typically one half inch to four feet thick. He estimated them to be 2000 feet thick in some places!

Inwood C (Ossining, New York, area): White or blue-gray, clean, dolomite marble.

Inwood D (Farther North): Interbedded dolomite marble, calcite marble and some calc-schist.

Inwood E (Still farther North): Gray or white calcite marble, commonly tan weathering.

The marble deposits of northern Manhattan had long before Leo Hall's time been called Inwood. That name has been in general use in the area since about 1870, but Hall expanded its use to include the entire region.

Unfortunately, it was observed that even in the days of relatively low-level atmospheric pollution, much, *but not all*, of the Inwood A marble of Kingsbridge tended to weather rapidly and so the quarrying of it for building stone was eventually abandoned. John A. Dix (1836), reporting as the Secretary of the State of New York noted that

> The marble at Kingsbridge is mixed with iron pyrites, which on exposure to the weather stains and hastens the decomposition of the stone. [Actually, the pyrite is relatively scarce in the marble and contributed very little to the weathering problem. I have personally observed no pyrite in the surviving pieces. The pyritiferous marble was obviously avoided, whenever possible, by the stonemasons.] Unless it is found in a purer state on further examination, it cannot be advantageously used for architectural purposes.

Beck (1842) believed that the quarries ceased operating by 1842, and said:

> The quarries at Kingsbridge have furnished a considerable amount of marble. It is granular, and belongs to the dolomitic variety. By exposure to the weather, some of the specimens fall to pieces, and form a kind of calcareous sand. It is now, I believe, [and had been for almost two hundred years previous to this time] chiefly used for burning into lime. [Beck did not believe the included pyrite was the main weathering problem.]

Indeed, one has only to look at the gravestones, previously mentioned, in the early Jews' Burying Ground, for examples of the weathering described by Beck, although these stones have not fallen to pieces and do not appear to bear any pyrite. The early dated headstones that survive in Trinity churchyard seem to be exceptions.

Issachar Cozzens, Jr. (1780–1865), writing in *A Geological History Of Manhattan Or New York Island* (1843), called the Inwood A formation a "primitive limestone" (it is one of the oldest of the New York City rocks) and said:

> [It] is well known; it is a Dolomite. This Dolomite I examined some 16 years ago, and found it to contain about 28 per cent of Carbonate of Magnesia, from which I manufactured good Epsom Salts (Sulphate of Magnesia) and [it] has all the varieties of white, gray and light blue, granular, coarse marble; it begins at the south end of Mr. Dyckman's farm and

runs through the middle of the Island to Spuytenduyvel creek; the same rock runs through Westchester County, and is seen on the other side of Kingsbridge, and thence along the river toward Yonkers . . . [where it is known as the Tuckahoe/Inwood B marble] . . . A quarry was opened at Kingsbridge, some years ago, which proved unprofitable.

Figure 12. **The United States Assay Office (originally the Bank of the United States building), constructed of Inwood B marble from Tuckahoe in 1822. The handsome façade has been preserved and is now on display at the Metropolitan Museum of Art in New York. Immediately to the left is the Custom House, partially built of Inwood A/B marble and still standing at Broad and Wall Streets.**

In New York City, in 1822, The Bank of the United States building was erected on Wall Street, just east of Broad Street, and in 1853 it became the United States Assay Office. It was constructed of Inwood B marble from the Tuckahoe beds, in Westchester County, some 18 miles from the city. Tuckahoe produced a finer-grained Inwood marble than that of the Kingsbridge quarries, but it is mostly devoid of mineral specimens. In 1827 The Merchants' Exchange building, which boasted one-piece columns at least 24 feet high, was also built of this rock. The Merchants' Exchange was totally consumed by the Great Fire of 1835, but the handsome facade of the Assay Office, complete with pediment, was preserved when the building was taken down in 1915 and is on display at the American Wing of the Metropolitan Museum of Art.

There were once several Inwood marble quarries located along the ridge paralleling the Bronx River in the town of Eastchester, between Crestwood and Tuckahoe. Operations there started around 1820 and continued until 1930.

Before marble quarrying began in Vermont around 1850, the Tuckahoe beds of the Inwood B were the single most important source of white marble in America. Shipments of this building stone were made from Boston to New Orleans and many places in between. Other notable buildings constructed of this marble include Lyndhurst in Tarrytown, New York (the Jay Gould mansion), The Borough Hall of Brooklyn, New York, and The United States Naval Observatory in Washington, D.C.

The site of the Ossining Correctional Facility (Sing Sing Prison) was chosen because of the availability of Inwood marble. At this location convicts quarried the rock from which the prison was built. Nice crystals of diopside and specimens of rutile on dolomite were reported from here. The Kingsbridge quarrying area was once considered as a possible site for a penitentiary for the same reasons that Ossining was chosen.

Huge quarried blocks of Inwood A/B marble can be seen today in lower Manhattan serving as the foundation of the old Custom House (later known as the Sub-Treasury building) erected in 1842 and still standing on the corner of Broad and Wall Streets (Fig. 12). This rock came from a site around 138th Street near where the present-day Third Avenue Bridge enters the borough of the Bronx. This quarrying site was, at that time, part of Westchester County.

The Snowflake quarry at Thornwood, Westchester County, New York, survived until 1973, supplying, in its last days, Inwood B marble that was crushed for use in terrazzo and stucco, and fine marble powder that was used in paint and soap.

The commercial exploitation of the various Inwood marble beds lasted for a period of more than three centuries.

Smith (1938) mentions the Inwood A marble deposits several times. He states that the area at Hawthorne Street (West 204th Street) near Broadway was "built up some twenty feet above the natural level of the land with many pieces of white marble from the quarry" and shows an excellent photograph of the location. Unfortunately there is no way to ascertain if "the quarry" was re-worked for this project or if, as seems most likely, existing material, perhaps rubble from the Harlem Ship Canal excavation, was used.

Smith continues and describes the "magnificent" Seaman-Drake estate, of 26 acres in 1898, that stood just west of present Broadway at 216th Street until it was demolished in 1939 and says that:

Figure 13. **Arched gateway of Inwood A marble, in its original (and present) location at Broadway and 216th Street as it appeared in the early twentieth century when it graced the entrance to the Seaman-Drake estate. The automobile is a 1910 Matheson. Collection of The New-York Historical Society.**

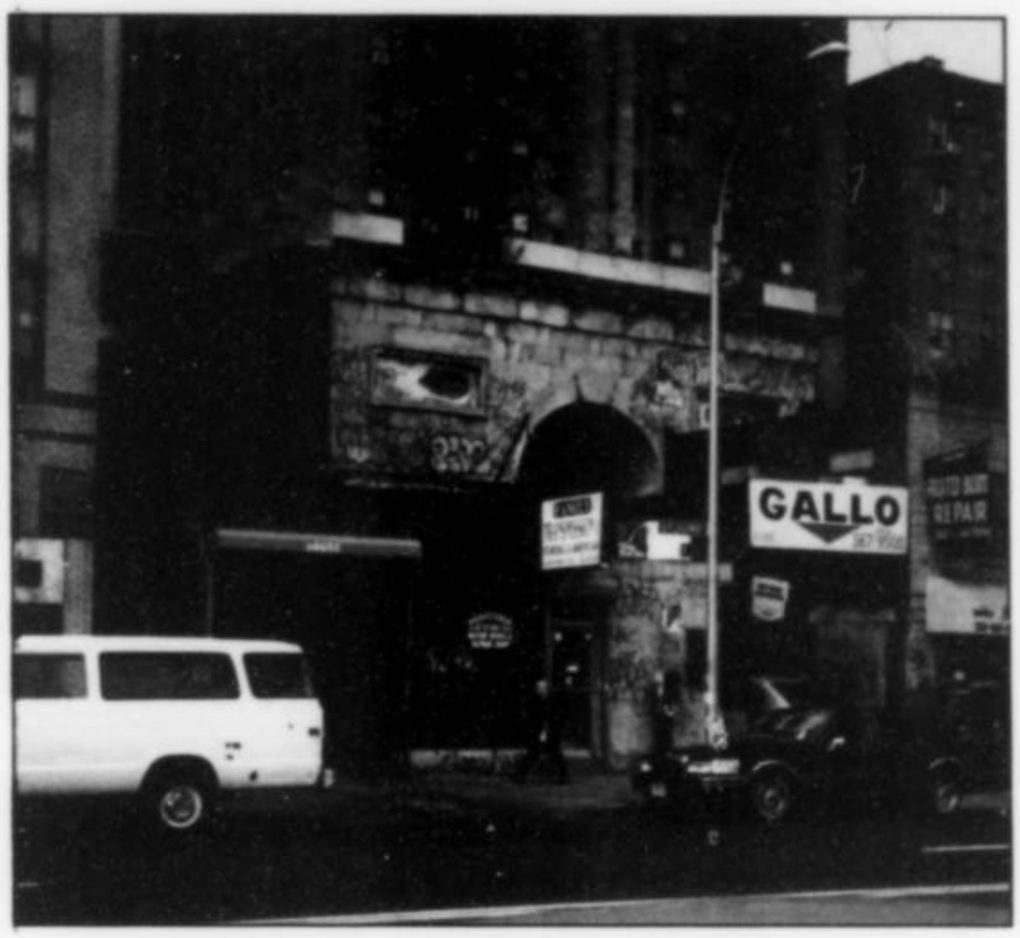

Figure 14. **The arched gateway from Figure 13 as it appears today. Photograph by Robyn Green.**

The dwelling [erected for Valentine Seaman around 1845 at a cost of $150,000] itself is of [Inwood A] marble [which was quarried on the property and came, almost certainly, from the excavation that produced the Dyckman ice pond shown in Figure 10!]. Its large white marble entrance arch (said to have cost $30,000) . . . has for half a century challenged the admiring observation of every traveler entering or leaving New York City by the Hudson River Railroad.

That arch, actually an arched gateway, is today the largest surviving object made of Inwood A marble. Although no longer the visual landmark it was when described by Smith (Fig. 13), it survives, *in situ* as it were, almost swallowed up by modern Broadway. It stands today, patched with modern bricks and vandalized by graffiti, rather under-utilized as part of the entrance to an auto body repair shop. It is partly hidden from sight because it is set back from the current building line at 216th Street (Fig. 14). One suspects that it survived the modernization of Broadway simply because the cost of its demolition and removal was (and probably still is) prohibitive. Today it is still quite impressive and, with its architectonic massiveness (sight measurements—30 by 20 by 12 feet), is reminiscent of the well-known granite arch of New York City at Washington Square but, of course, on a much reduced scale. It seems to be holding up quite well to the weather and air pollution, and is not, as Beck (1842) noted, constructed of "the specimens [that] fall to pieces" and it contains little or no noticeable pyrite inclusions.

James G. Manchester in his *The Mineralogy of New York City and Its Environs* (1931) writing almost a century after Beck, Cozzens *et al.*, discussed the area in some detail:

> The crystalline limestone [technically, it is a metamorphosed limestone, or marble] extending from Vermont to North Carolina, is a part of the rock foundation of New York City and comes to the surface at a number of points, principally in the northerly section of the city. The navigable channels around the island are submerged valleys which came into existence through the ease with which this limestone is eroded, its hardness being about 3 on the scale. [Actually it is more about solubility than hardness although the two are related. There is, surviving to this day at the northern-most end of Manhattan island, a large area substantially *un*-eroded and called, appropriately, Marble Hill.] In the section known as Inwood Valley the prevailing rock is limestone [now called Inwood marble A] and in it many fine minerals have been found, particularly near the zones of contact with the mica schist [and its pegmatite intrusions]. The vacant land in this region, however, is rapidly being improved with buildings and it will not be many years before the opportunity to collect minerals will be somewhat limited. Among the more important minerals reported are pyrrhotite, chalcopyrite, pyrite, marcasite, rock crystal, smoky quartz, rutile, calcite, aragonite [the author pictured a specimen of "Aragonite var. Flos Ferri, Broadway and 215th Street, Manhattan Island, N.Y." as his plate No. 36. This location is but one city-block south of the great marble gateway], malacolite [diopside], tremolite, asbestos, brown tourmaline [uvite], muscovite, foliated talc and gypsum. During the construction of the Harlem Ship Canal [more than a half-million] tons of limestone [including what remained of the former Bolton complex] were removed and the waste pile [on the site that became present-day Baker Field] was the lure of collectors for many years. [Figure 16].

MINERALOGY

The finest collection of Kingsbridge area mineral specimens surviving today belongs to the New York Mineralogical Club and has been permanently deposited by the Club at the American Museum of Natural History in New York City. All of the species described below are represented there in at least a few examples, in some cases many.

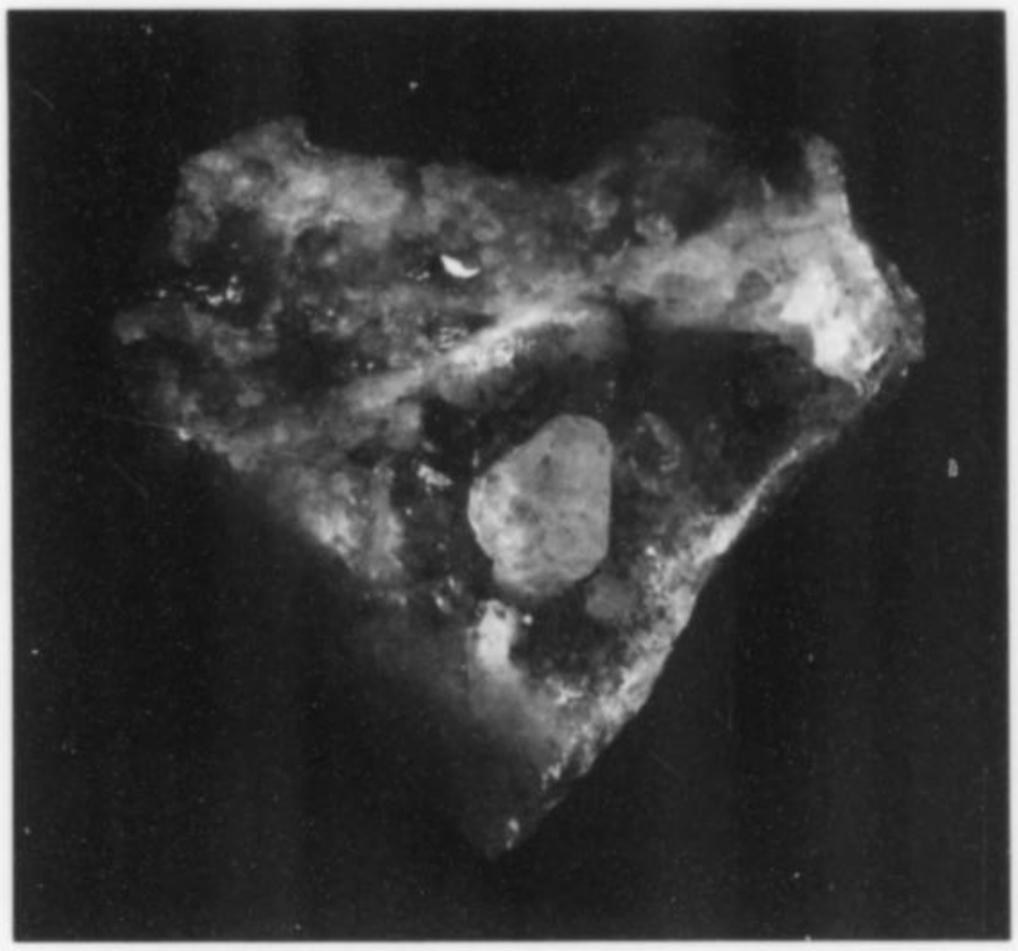

Figure 15. **Calcite scalenohedron 1 cm across on quartz crystals. 207th Street and Broadway. New York Mineralogical Club collection at American Museum of Natural History #1170. AMNH photograph by Jackie Beckett.**

Calcite $CaCO_3$

Calcite in crystals, rare from Kingsbridge, forms scalenohedrons up to 1 cm across and has been collected on quartz crystals as in Figure 15.

Diopside $CaMgSi_2O_6$

Archibald Bruce was the first mineralogist to encounter diopside from Kingsbridge, but without, apparently, knowing what it was—

Figure 16. **The New York Mineralogical Club members collecting at the marble waste-pile excavated from the Harlem Ship Canal, 1887. Photograph by J. Rosch. Collection of the author.**

A mineral presenting some characters which rendered its nature doubtful, [probable clarification: 'I did not have a clue to its identity'] we some time ago transmitted to Paris, for the examination of our venerable friend M. Haüy, [René Just Haüy (1743–1822)] who, after duly considering its structure agreeably to the laws of crystallization, has pronounced it to be *Pyroxene*. [The name pyroxene was created by Haüy in 1796 for a new mineral species; that name is now used for a group of minerals.] This substance is white, and occurs crystallized in eight-sided prisms, of which two opposite sides are often much larger than the other six, so as to present a tabulated form. The prism is variously terminated, sometimes resembling the Pyroxene of Vesuvius, while in other instances the termination is more complex, giving rise to a new variety which M. Haüy has named *épiméride*.–Specific gravity 3.1. Crystals of various sizes, from minute to several inches in length are found imbedded in the primitive limestone which crosses the island of New-York at its northern extremity. (Bruce, 1814b)

Bruce's phrase "some time ago" used in referring to his sending the specimens to Paris, probably meant 1811 or even earlier, since Haüy published his comments on the mineral in 1812. Haüy's article included a plate of crystal drawings, one of which (Haüy's Fig. 4.) was the new mineral épiméride[5] (Fig. 17). This drawing was later reproduced in Victor M. Goldschmidt's *Atlas der Krystallformen* (1922) as his Figure 9 of plate 7 in volume VII. Haüy was very optimistic in his report and added:

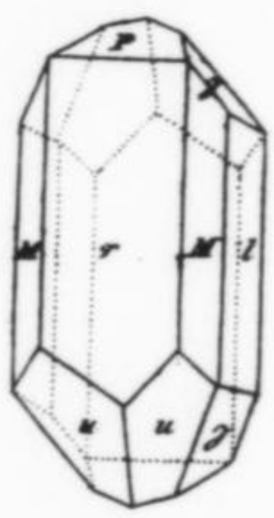

Figure 17. **A crystal drawing of "épiméride" from Haüy (1812).**

The soil of the United States of America has, in the last few years, become the subject of investigations which show the progress and development of mineralogy. In these investigations several highly distinguished scientists . . . Messieurs [Archibald] Bruce, [Benjamin S.] Barton, [Charles W.] Peale, [Silvain] Godon de St.-Memin, [William] Maclure and [Samuel

[5] Haüy stated (not too clearly) that he used this new name because it means "overgrowth" or "over-extended." These were, apparently, the first examples of crystals he had seen that decreased "one unit in size on their sides as against a greater decrease on their angles."

> L.] Mitchill . . . have participated, most of them Americans; and the progress which has already been made gives the right to expect, in the future, the harvest of that which they have begun with so much zeal and success. (Haüy, 1812)

Cleaveland (1816) cited the notice published by Bruce and mentioned the "new and more complex variety of form," épiméride.

In 1819 MacNeven described "white augite [diopside] in nearly rectangular prisms" from the Kingsbridge quarry and noted that "[this] was, for a long time, the only locality for this mineral in the United States, but Mr. Pierce has lately met with it at Singsing, higher up the Hudson," also from Inwood marble deposits. MacNeven also made note of associated pyroxene, tremolite, mica, fetid quartz, rutile, adularia, tourmaline and pyrite. Robinson (1825) described the crystals as having "4 sided tables [terminations]" and "8 sided prisms." Dana (1837) merely noted the occurrence. Beck (1842), in his review of New York State's mineralogy, remarked that the "abandoned quarries at Kingsbridge, about 208th Street, also afford very good [diopside] specimens." Beck depicted a crystal drawing of "épiméride." By the time of the publishing of the sixth edition of *Dana's System of Mineralogy* (Dana, 1892), the occurrence was listed under augite—"In N. York, in N.Y. Co[unty, i.e. Manhattan], white cryst. 2–3 in. long in dolomite."

Forty years later Manchester (1931) considered diopside (calling it "malacolite," a now discredited name) a common mineral of the marble, often found in crystals standing out in relief on the more soluble weathered matrix, and illustrated such a specimen in his plate 42. In fact, he stated that loose single crystals had been collected years earlier in the nearby plowed fields.

I personally collected these diopside crystals as a boy in the 1940's when they were still known locally as malacolite. I remember vividly banging them out of their marble matrix with my hammer and chisel while seated on the ground and then being threatened with arrest by a gruff Irish policeman. As far as the officer could see, I was vandalizing a New York City marble sidewalk.

Dolomite $CaMg(CO_3)_2$

Robinson (1825) reported dolomite as a component of the marble at Kingsbridge, and Beck (1842) elaborated that the dolomite is "large grained . . . with indications of a foliated structure." Dana (1892) stated that augite crystals were found at Kingsbridge in dolomite, but I have never seen, nor heard of, such a specimen. Dana may have been referring to the dolomite-rich marble.

Feldspar

The early references to feldspar at Kingsbridge are rudimentary. Robinson (1825) reported "fetid feldspar . . . bluish white" in color. Bruce (1814a) and MacNeven (1819) had also reported feldspar, but without further description, except that MacNeven mentions the presence of adularia. Beck (1842) described a fetid feldspar as coming from a white limestone at "Thompson's quarry, near 196th Street." This excavation, probably a later one, was almost a mile and one-half from the Bolton quarry and about a mile from the area described by John Randel, Jr. but was located on the same Inwood A marble unit, probably near its southern and western limits. Chamberlin (1888) described the mineral assemblage at Thompson's quarry as including rutile, diopside, kyanite, phlogopite, brown tourmaline, fetid feldspar, tremolite and titanite. The quarry may have belonged to Samuel Thompson who Bolton (1924) called "one of the earliest of those well-to-do residents who settled on the Inwood hillside overlooking the Hudson River." George C. Wissig, Jr., in *Bedrock Geology of the Ossining Quadrangle, New York* (1979), found potassium-feldspar in the Inwood beds by microprobe analysis.

Kyanite Al_2SiO_5

Robinson (1825) reported "rhaetizite" (an early synonym for white kyanite) as occurring at Kingsbridge in "yellowish white, crystalline masses, laminated, translucent or transparent." This description appears to have been taken essentially verbatim from Cleaveland (1822), who cites his source as the "Rev. F. C. Schaeffer," apparently a personal communication from a local collector. Kyanite is unlikely in a marble, and may be a misidentification.

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

The designation of the "mica" as muscovite is merely a guess but a fairly safe one. Robinson (1825) reported "yellow mica." Bruce (1814a) and MacNeven (1819) both reported "mica" without further description. Beck (1842), however, described tourmaline as occurring with a "reddish brown mica" that may perhaps have been phlogopite. Chamberlin (1888) actually does call it phlogopite, having a "handsome light brown" color. The Kingsbridge mica in general, he says, exhibits a variety of colors and occurs in plates seldom of large size but sometimes having a perfect tabular-hexagonal crystal habit.

Pyrite FeS_2

"Sulphuret of iron" was reported by Robinson (1825) as "small dodecahedrons with pentagonal faces," and earlier by MacNeven (1819) without giving a description. Manchester (1931) noted pyrite as well as pyrrhotite, marcasite and chalcopyrite, all of which may have fallen under Robinson's "sulphuret of iron." The pyrite crystals, he said, were "quite common" in the limestone, "where they have been found in such a variety of form and brilliancy of luster as to make them a welcome addition to any cabinet." Illustrated here (Fig. 18) is an example of the type of pyrite crystal ("dodecahedrons with pentagonal faces") to which Robinson referred. Manchester collected it and Whitlock illustrated it in the *American Mineralogist* in 1919. Manchester also illustrated it in his 1931 book. It is the best example that I know of, and is a fine specimen by any standard of judgment. The American Museum of Natural History acquired it from me in 1962, along with a few other New York City specimens that had been illustrated in *The Mineralogy of New York City and Its Environs*. Manchester had also collected other specimens of pyrite in marble which he treated with acid to free the individual pyrite crystals. Ten of these were then measured goniometrically by Whitlock (1919), and one was figured as a crystal drawing. Whitlock described their habit as uniformly rather flattened, and showing combinations of 11 different crystal forms.

Pyrrhotite $Fe_{1-x}S$

Manchester (1931) described "small, hexagonal crystals of thin, tabular habit, iridescent blue in color." These may not have come from Kingsbridge quarries per se, but from masses of rubble thrown up during the digging of the Harlem Ship Canal. Smith (1938) noted that in 1898 for "three acres of ground, made of the white stone taken from the Canal . . . the United States are paying Mr. [Isaac Michael] Dyckman $2000 a year rent" (Fig. 16). Those three acres are included in the present Baker Field location. Specimens of massive pyrrhotite in veins up to 2.5 cm running through the marble were also reported.

Quartz SiO_2

"Fetid quartz" that gave off an odor when broken was described by Bruce (1814a) and MacNeven (1819). It is a common constituent of the veins penetrating the marble. Small, clear, well-formed quartz crystals are seen occasionally.

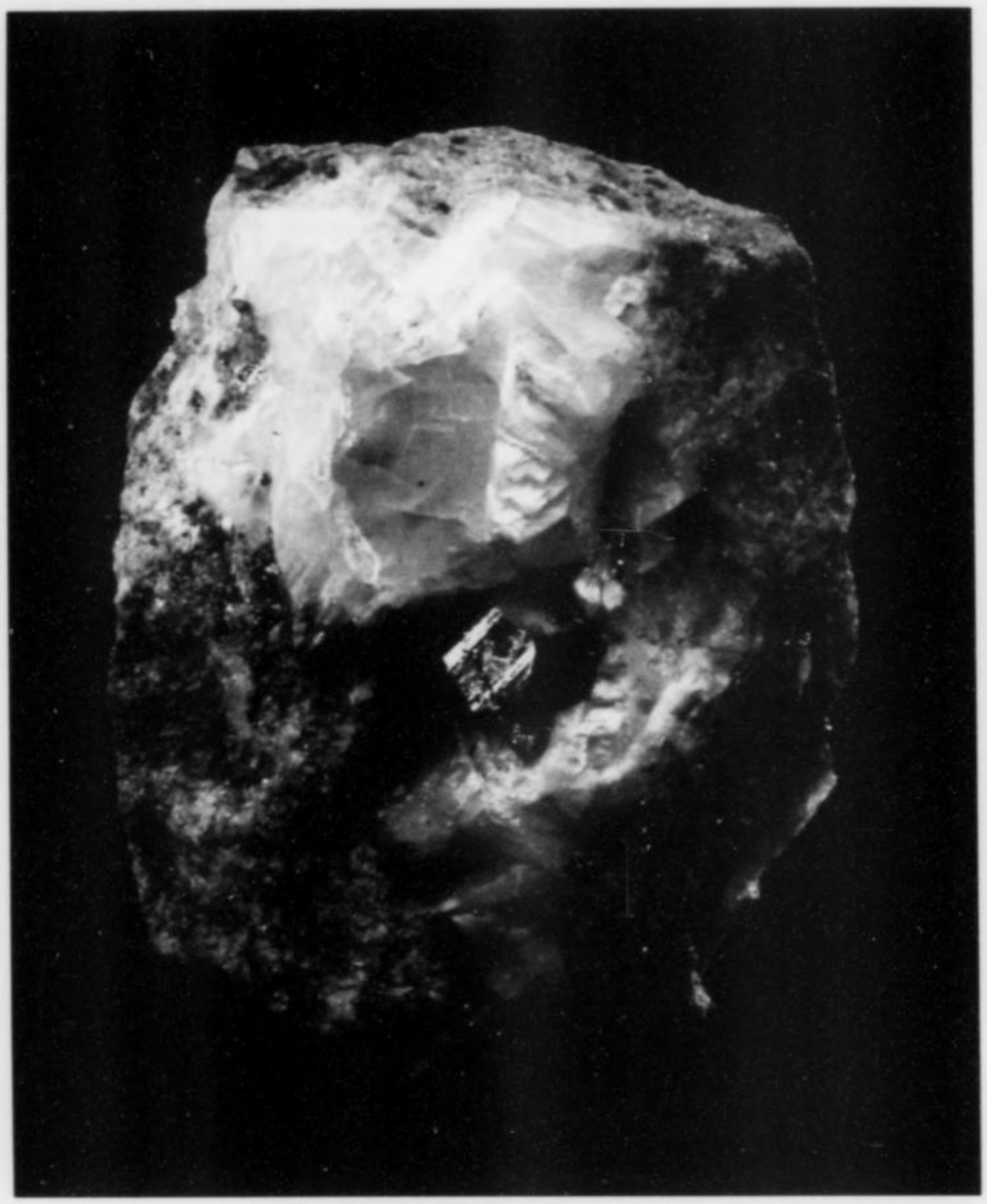

Figure 18. **Pyrite crystal 8 mm across in crystalline calcite. 207th Street and Broadway. American Museum of Natural History specimen #35106, gift of Lawrence H. Conklin. Illustrated by Whitlock (1919) and Manchester (1931). AMNH photograph by Jackie Beckett.**

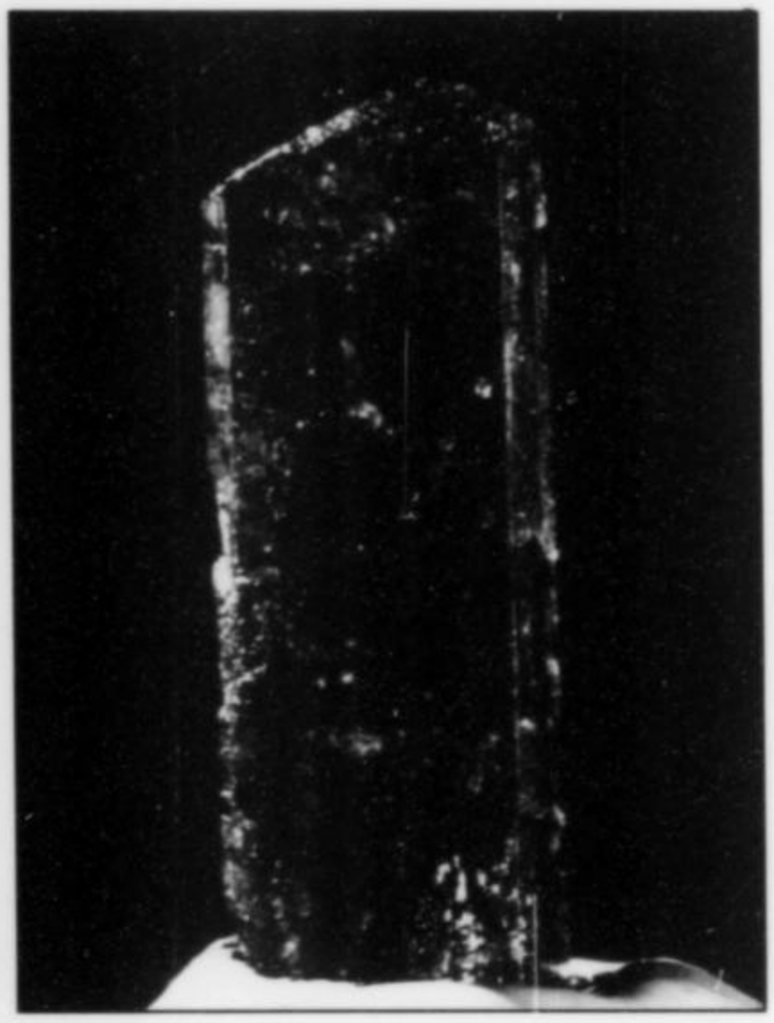

Figure 19. **Uvite (brown tourmaline) crystal, 1 cm high. 225th Street, west of Broadway. New York Mineralogical Club collection at American Museum of Natural History #1182. AMNH photograph by Denis Finnen.**

Figure 20. **Uvite (brown tourmaline) crystals, largest 2.5 cm, in marble. 225th Street, west of Broadway. New York Mineralogical Club collection at American Museum of Natural History #1220. AMNH photograph by Jackie Beckett.**

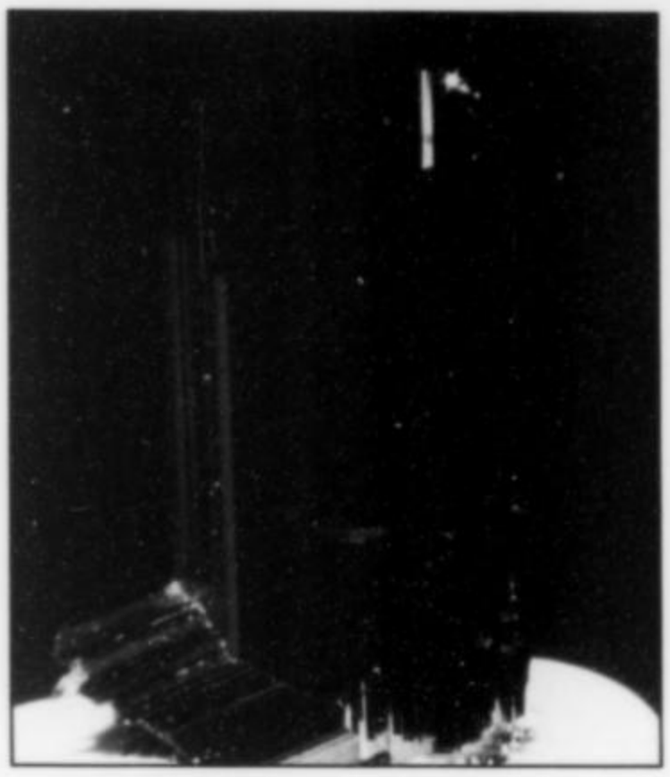

Figure 21. **Rutile crystal, 8 mm high, from 207th Street and Broadway. New York Mineralogical Club collection at American Museum of Natural History #1180. AMNH photograph by Denis Finnen.**

Figure 22. **Diopside ("malacolite") crystals, 7 cm, in marble; this is the largest known Kingsbridge diopside crystal; from Broadway and 218th Street. Formerly in the collection of Morrell G. Birnbaum, Philadelphia; now in the author's collection. Photograph by Wendell E. Wilson.**

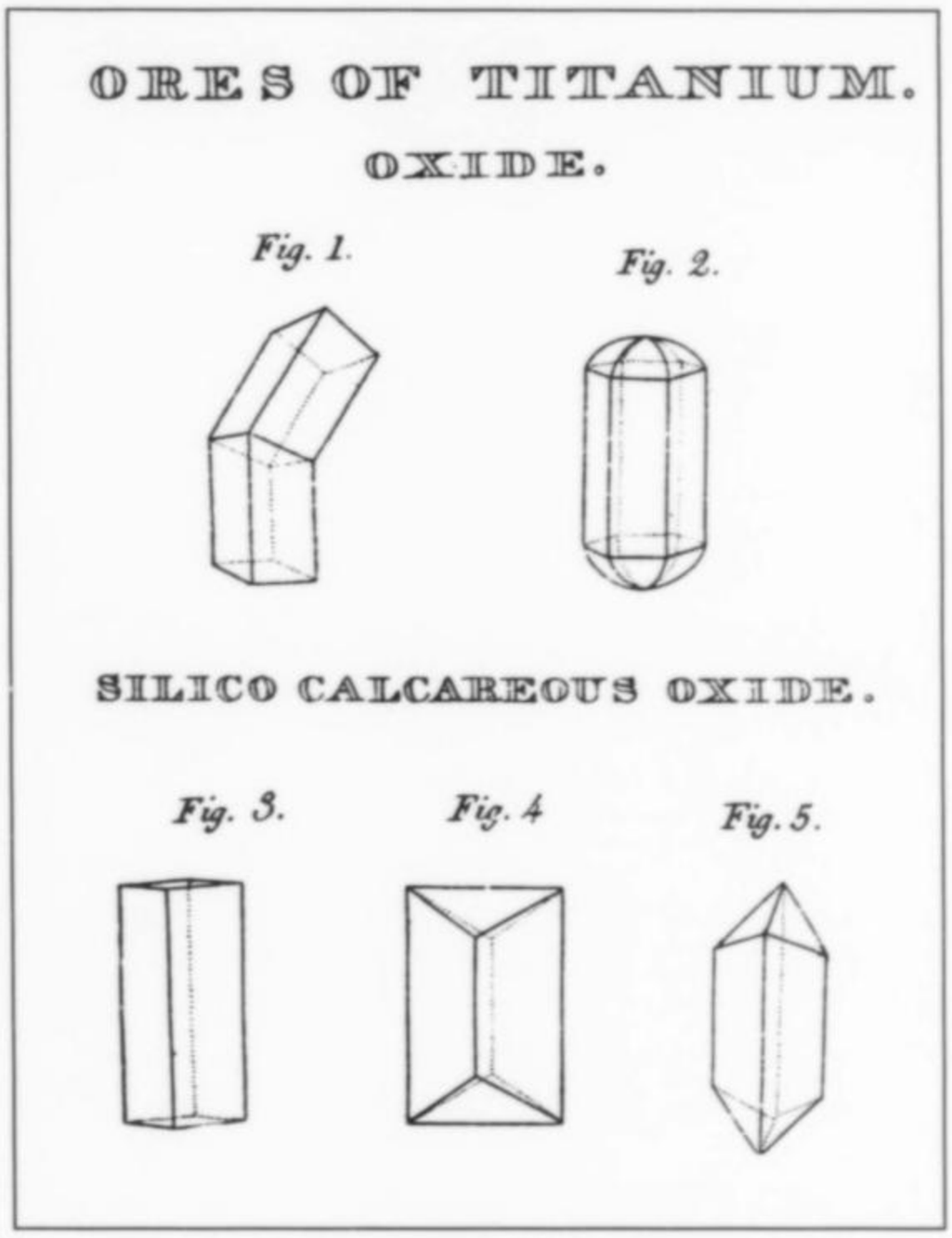

Figure 23. **Rutile crystal from Kingsbridge as illustrated in Bruce (1814a), Plate II, figure 1.**

Rutile TiO_2

Rutile was first reported and figured from Kingsbridge by Bruce (1814a) (Fig. 14), who found it "sparingly disseminated" in veins 2.5 to 7.5 cm wide cutting granular limestone. Associated minerals were said to include fetid quartz, feldspar and mica. The specimens in his collection included: (1) "small quadrangular prismatic, nearly acicular semi-transparent crystals . . . of a dark red color, variously recumbent on a granitic aggregate . . ."; (2) a "small, dark red, semi-transparent double [twinned] crystal . . . four-sided prisms . . . the surface highly resplendent . . ."; (3) a "large amorphous blood-red" mass on white feldspar; and (4) "light red acicular embedded in bluish quartz." MacNeven (1819) noted its presence as well, but without giving a description. Manchester (1931) described "finely terminated crystals . . . semi-transparent, ranging from blood-red to wine color, [and] capillary crystals to one inch or more in length extending across a vug or cavity lined with calcite crystals" (Fig. 21).

Titanite $CaTiSiO_5$

Titanite, like rutile, was first reported and figured from Kingsbridge by Bruce (1814a). He described "small, brilliant crystals . . . of a light dove [or clove?] colour embedded in granular primitive carbonate of lime."

Tourmaline

MacNeven (1819) reported tourmaline from Kingsbridge, but without giving further description. Robinson (1825) referred to "schorl" and "red tourmaline" embedded in dolomitic limestone, as crystals in various shades of red and brown, and cited an 1820 article in Silliman's Journal as his source, which was actually the abstract of an 1819 lecture presented at the "Lyceum of Natural History, New-York" by Mr. N. Pauling. The lecturer described a red tourmaline found at Kingsbridge by Mr. I. Pierce, which was supposed at first to be rubellite but was really just a schorl. He gives a surprisingly detailed morphological description:

> The fundamental form appears to be an equilateral three-sided prism, acuminated by three planes, which at one extremity are

set on the lateral planes. This form is variously modified by truncation and bevelments. Most of the crystals are bevelled on the lateral edges, forming nine-sided prisms. Sometimes the lateral planes are nearly destitute of striae, though the faces of the acumination are always smooth and splendent. [He then gives a series of interfacial angles, and notes that they] agree almost precisely with the tourmaline isogone of Hauy.

Cleaveland (1822) also cited red tourmaline.

Robinson (1825) reported schorl (separately from "tourmaline") as occurring at Kingsbridge in "brown or reddish brown, translucent, usually 9-sided prisms, terminated at each end by 3 faces. Also in brownish yellow, 6-sided prisms well-terminated by 3 planes." Beck (1842) describes "tourmaline" crystals in brown, yellowish brown and reddish brown colors, in 6-sided prisms with three terminal faces, associated with a reddish brown mica.

Manchester (1931) adds a bit more information, describing "finely terminated brown tourmaline, some of gem quality, and small green tourmalines embedded in cream-colored calcite" at the "northerly end of Broadway where at times this mineral is to be found in many of the rock excavations of the neighborhood." He depicted, in his frontispiece plate, two small, brown-colored, faceted stones of this material. These stones, probably uvite, passed through my hands more than thirty years ago and, although they were small, it is my recollection that they were of fine quality.

I have never seen nor heard of *any* tourmaline from this location that was not almost certainly uvite or schorl.

Tremolite $Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$

Robinson (1825) mentioned tremolite at Kingsbridge, "both [presumably coarsely] crystallized and in fibrous masses" in the marble. MacNeven (1819) had noted it too, but without giving a description. Beck (1842) noted "a beautiful white and bluish white tremolite," sometimes in "broad laminated masses," with folia sometimes "six to nine inches in length."

Wissig (1979), writing of the overall Inwood marble deposit, added to the traditional list of species those minerals he observed by microprobe analysis. They are phlogopite, scapolite, apatite, zircon, sericite, sillimanite, biotite, olivine, serpentine and chlorite.

CONCLUSION

The Kingsbridge quarries, like virtually every other early mineral collecting site on Manhattan island, are now long gone and covered over with concrete, steel, asphalt and water. There are no workable outcroppings of the marble anywhere on the island that might offer the modern collector a glimpse of what all the fuss was about nearly two centuries ago. Even the surviving mineral specimens have dwindled to a rare few as attrition has taken its toll on the early collections, leaving present-day mineralogists and collectors almost no clues at all to the former prominence of this interesting and historic quarrying district and its unique mineral assemblage.

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EPILOGUE

As this article was going to press, John Betts informed me of an Inwood Marble collecting site on northern Manhattan Island that was recently rediscovered by Ted Zirnite. The three most significant Kingsbridge species, diopside, dravite and pyrite, can still be collected in good crystals at this location, which is roughly on a line with West 218th Street in Inwood Hill Park. The rock here seems to be rubble from the Harlem Ship Canal excavation as in Figure 16.

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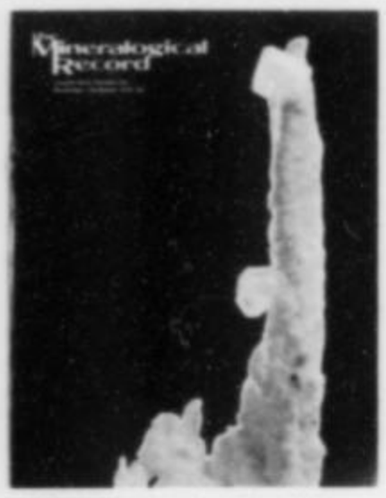

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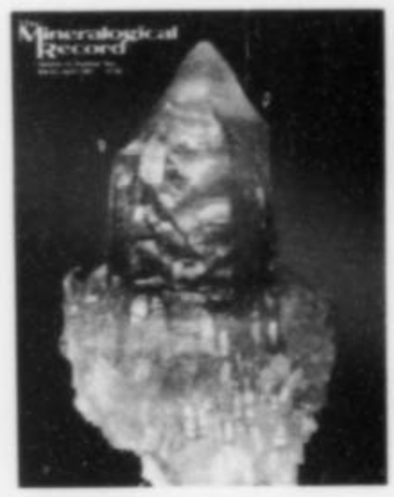

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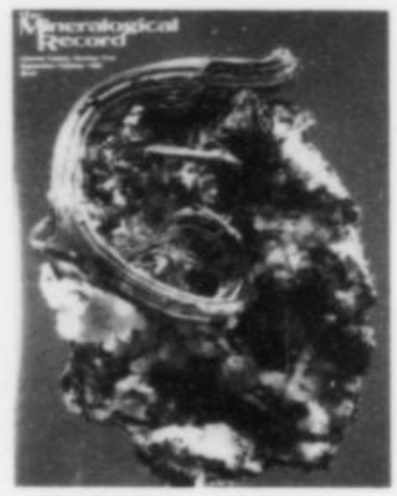

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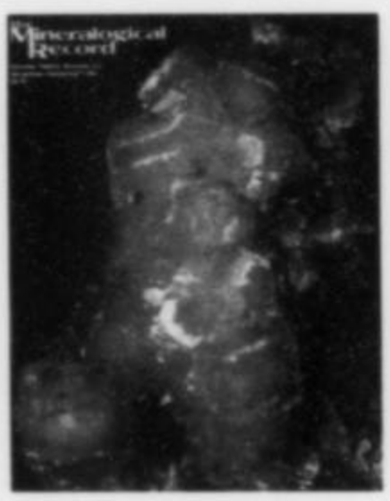

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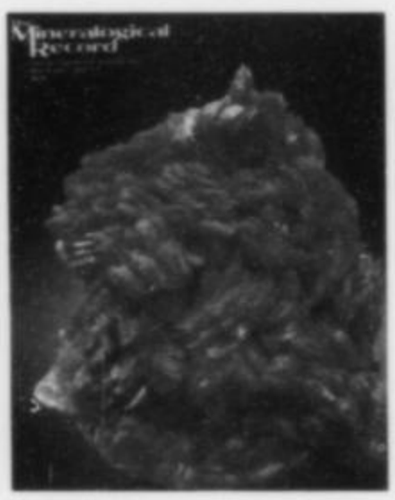

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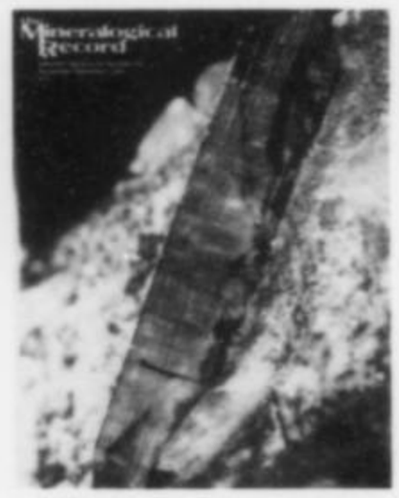

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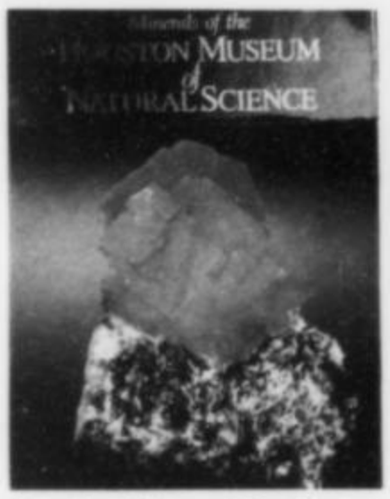

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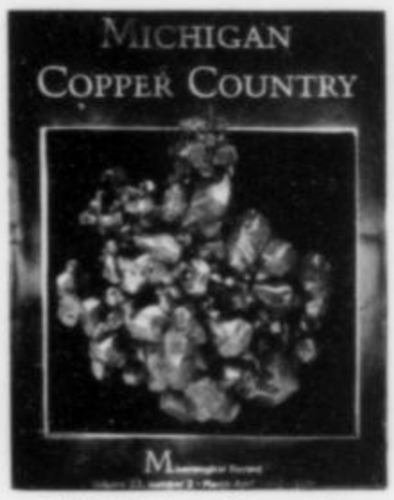

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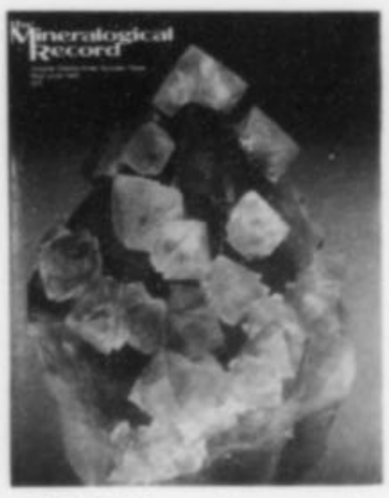

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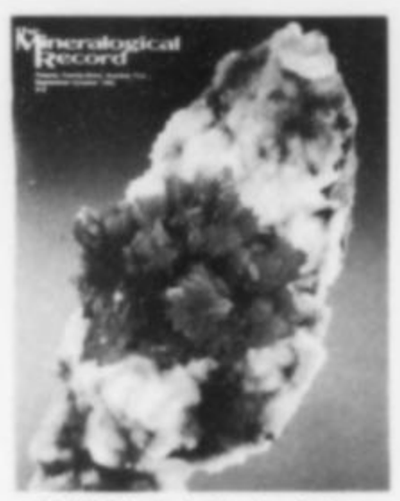

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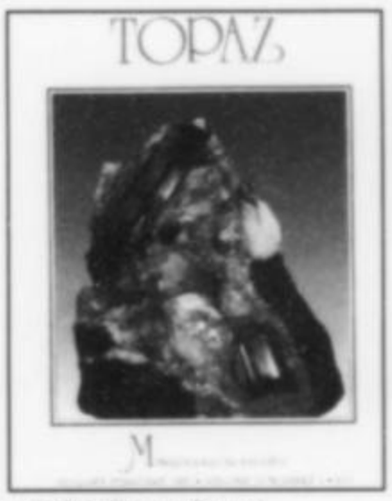

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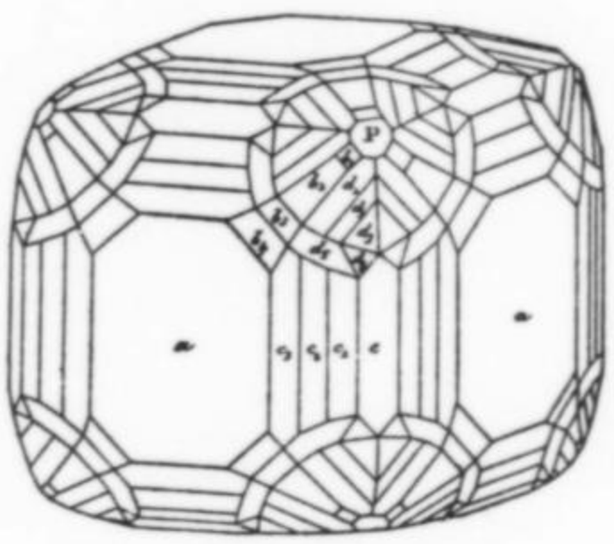

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Androsite-(La)

Monoclinic

$(Mn,Ca)(La,Ce,Ca,Nd)AlMn^{3+}Mn^{2+}(SiO_4)(Si_2O_7)O(OH)$

Locality: A former test pit for manganese ores, at an altitude of 950 meters on the peak plateau of Petalon Mountain, Andros Island, Cyclades, Greece.

Occurrence: In a manganese-rich silicate-carbonate rock. Associated minerals are: rhodochrosite, rhodonite, braunite, spessartine, and quartz.

General appearance: Subhedral to euhedral crystals with a maximum diameter of 20–60 μm.

Physical, chemical and crystallographic properties: *Luster:* vitreous, but the calculated index of refraction indicates adamantine. *Diaphaneity:* transparent. *Color:* brown-red. *Streak:* brownish-pink. *Luminescence:* non-fluorescent. *Hardness:* could not be determined. *Tenacity:* brittle. *Cleavage:* {001} perfect. *Fracture:* not given. *Density:* greater than 4.03 g/cm^3 (sinks in Clerici solution), 4.21 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, $P2_1/m$, a 8.896, b 5.706, c 10.083 Å, β 113.88°, V 468.0 Å^3, Z 2, a:b:c = 1.5591:1:1.7671. Morphology: no forms given. Twinning: none observed. ***X-ray powder diffraction data:*** 3.504 (40), 2.897 (100), 2.857 (45), 2.707 (60), 2.615 (60), 2.178 (60), 2.145 (60), 1.623 (40). ***Optical data:*** Complete optical data could not be determined. Mean index of refraction calculated from the Gladstone-Dale relationship is 1.877; pleochroism very strong X = pale orange-brown, Z = deep brown-red. ***Chemical analytical data:*** Means of four sets of electron microprobe data: CaO 5.810, MnO 28.288, SrO 0.663, CuO 0.155, Al_2O_3 8.542, Fe_2O_3 1.175, SiO_2 30.413, TiO_2 0.027, La_2O_3 7.225, Ce_2O_3 6.673, Pr_2O_3 1.342, Nd_2O_3 4.722, Sm_2O_3 0.313, Gd_2O_3 0.027, H_2O not determined, F 0.100, sum 95.475, less O = F 0.042, Total 95.433 wt.%. Mn was partitioned as Mn^{2+} and Mn^{3+} on the basis of the crystal structure determination and OH was assigned by analogy with other members of the epidote group. Empirical formula: $(Mn^{2+}_{0.60}Ca_{0.40})_{\Sigma 1.00}[(La_{0.26}Ce_{0.24}Nd_{0.16}Pr_{0.05}Sm_{0.01})_{\Sigma 0.72}Ca_{0.24}Sr_{0.04})]_{\Sigma 1.00}(Mn^{3+}_{0.91}Fe^{3+}_{0.05}Al_{0.04})_{\Sigma 1.00}(Al_{0.96}Mn^{3+}_{0.04})_{\Sigma 1.00}(Mn^{2+}_{0.67}Mn^{3+}_{0.27}Fe^{2+}_{0.04}Fe^{3+}_{0.01}Cu_{0.01})_{\Sigma 1.00}Si_{3.00}O_{11.00}(O_{0.97}F_{0.03})_{\Sigma 1.00}(OH)$. ***Relationship to other species:*** A member of the epidote group.

Name: For the locality. ***Comments:*** IMA No. 94-048.

BONAZZI, P., MENCHETTI, S., and REINECKE, T. (1996) Solid solution between piemontite and androsite-(La), a new mineral of the epidote group from Andros Island, Greece. *American Mineralogist* **81**, 735–742.

Baksanite

Hexagonal (trigonal)

$Bi_6(Te_2S_3)$

Locality: The Tyrnyauz deposit, Baksan River valley, Northern Caucasus, Kabardino-Balkaria Republic, Russia.

Occurrence: In small chlorite-calcite nests and veins in garnet-magnetite skarn. Associated minerals are: calcite, "chlorite," magnetite, andradite, bismuthinite, and gold; sometimes ingodite and joseite-A.

General appearance: Spherical aggregates (up to 13 mm).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* bright steel-grey. *Streak:* black. *Hardness:* VHN_5 62 kg/mm^2, Mohs 1½ to 2. *Tenacity:* flexible, but not elastic. *Cleavage:* {001} perfect. *Fracture:* not given. *Density:* 8.1 g/cm^3, 7.98 g/cm^3 (calc.). ***Crystallography:*** Hexagonal (trigonal), $P\bar{3}m1$, a 4.249, c 62.82 Å, V 982 Å^3, Z 3, c:a = 14.7847. Morphology: forms, only {001} was observed. Twinning: none observed. ***X-ray powder diffraction data:*** 5.65 (14), 4.50 (46), 3.58 (22), 3.53 (15), 3.30 (20), 3.09 (100), 2.255 (38), 2.126 (25). ***Optical data:*** In reflected light: bright white, distinct anisotropism from pale yellow to grey, very faint bireflectance, faint pleochroism from white to pale grey. $R_{min.}$ & $R_{max.}$: (48.2, 52.1 %) 470nm, (48.4, 52.5 %) 546nm, (48.8, 51.9 %) 589nm, (49.2, 51.0 %) 650nm. ***Chemical analytical data:*** Means of twenty sets of electron microprobe data: Bi 76.40, Pb 2.15, Sb 0.12, Te 14.33, Se 0.00, S 6.64, Total 99.64 wt.%. Empirical formula: $(Bi_{5.77}Pb_{0.16}Sb_{0.02})_{\Sigma 5.95}(Te_{1.77}S_{3.27})_{\Sigma 5.04}$. ***Relationship to other species:*** It is similar in appearance and some properties to other bismuth sulfotellurides.

Name: For the locality, the Baksan River. ***Comments:*** IMA No. 92-042.

PEKOV, I. V., ZAVYALOV, E. N., FEDYUSHCHENKO, S. V., SHCHERBACHEV, D. K., BORODAEV, YU. S., and DOROKHOVA, G. I. (1996) Baksanite $Bi_6(Te_2S_3)$—a new mineral from Tyrnyauz (Northern Caucasus). *Doklady Akademia Nauk* **347(6)**, 787–791.

Chrombismite — Tetragonal

$Bi_{16}CrO_{27}$

Locality: The Jialu gold mine, Luonan County, Shaanxi Province, Peoples's Republic of China (Lat. 34°22′22″–34°23′48″ N, Long. 110°07′35″–110°11′18″ E).

Occurrence: In quartz veins. Associated minerals are: quartz, pyrite, chalcopyrite, and gold.

General appearance: Isolated columnar or acicular crystals (from 2 x 5 µm to 25 x 50 µm) and as fine-grained spherical or irregular aggregates (from 10 to 500 µm across, also up to 1.5 mm).

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* translucent. *Color:* orange to yellowish brown. *Streak:* brownish yellow. *Luminescence:* not mentioned. *Hardness:* VHN_{100} 113.3 kg/mm^2, Mohs > 3. *Tenacity:* brittle. *Cleavage:* no distinct cleavages noted. *Fracture:* not given. *Density:* 9.80 g/cm^3 (meas.), 9.86 g/cm^3 (calc.). ***Crystallography:*** Tetragonal, I4, I$\bar{4}$, or I4/m, a 8.649, c 17.24 Å, V 1289.6 Å^3, Z 2, c:a = 1.9933. Morphology: no forms mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.19 (100), 2.730 (40), 1.980 (40), 1.715 (30), 1.655 (55), 1.124 (25), 1.054 (25). ***Optical data:*** Uniaxial (+), ω 2.55, ε 2.50, pleochroism very weak. ***Chemical analytical data:*** Means of 15 sets of electron microprobe data: Bi_2O_3 97.25, CrO_3 2.60, Total 99.85 wt.%. The original data are given as weight percentages of Bi, Cr, and O; they have been recalculated as Bi_2O_3 and CrO_3 here. Empirical formula: $Bi_{16.01}Cr_{1.00}O_{27.00}$. ***Relationship to other species:*** None apparent.

Name: For the chemical composition. ***Comments:*** IMA No. 95-044.

ZHOU XINCHUN, YAN JINCAI, WANG GUANXIN, WANG SHIZHONG, LIU LIANG, and SHU GUIMING (1997) Chrombismite, $Bi_{16}CrO_{27}$, a new mineral species from the Jialu gold mine, Shaanxi Province, China. *Canadian Mineralogist* **35**, 35–38.

Feinglosite — Monoclinic

$Pb_2(Zn,Fe)[(As,S)O_4]_2 \cdot H_2O$

Locality: The Tsumeb mine, Tsumeb, Namibia.

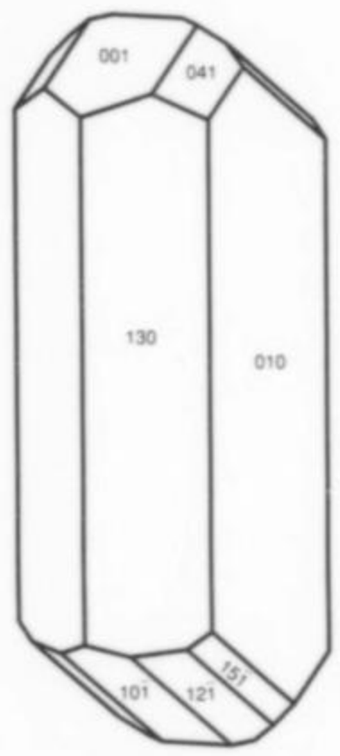
Occurrence: Associated minerals are: chalcocite and goethite.

General appearance: Radiating globular masses with individual clusters about 0.5 mm in diameter consisting of very small crystallites (about 5 to 10 µm).

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* transparent. *Color:* pale olive-green. *Streak:* white. *Luminescence:* not mentioned. *Hardness:* VHN_{100} 263 kg/mm^2, Mohs 4 to 5. *Tenacity:* sectile. *Cleavage:* not mentioned. *Fracture:* not mentioned. *Density:* could not be determined, 6.56 g/cm^3 (calc.) (given as 6.52 g/cm^3 in the paper). ***Crystallography:*** Monoclinic, $P2_1$ or $P2_1/m$, a 8.973, b 5.955, c 7.766 Å, β 112.20°, V 384.2 Å^3, Z 2, a:b:c = 1.5068:1:1.3041. Morphology: no forms mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.85 (50), 3.659 (30), 3.246 (100), 2.988 (60), 2.769 (60), 2.293 (30), 2.107 (50), 1.889 (30). ***Optical data:*** In reflected light: very pale brownish grey, no notable anisotropism, weak bireflectance, nonpleochroic. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (11.2, 11.5; 1.98, 2.11 %) 470nm, (10.8, 10.9; 1.84, 2.00 %) 546nm, (10.7, 10.8; 1.82, 1.97 %) 589nm, (10.7, 10.8; 1.82, 1.96 %) 650nm. ***Chemical analytical data:*** Means of seven sets of electron microprobe data: PbO 61.4, FeO 1.8, ZnO 7.3, As_2O_5 22.1, SO_3 5.3, H_2O (2.1), Total (100.0) wt.%. H_2O was calculated by difference. Empirical formula: $Pb_{2.09}(Zn_{0.68}Fe_{0.19})_{\Sigma 0.87}[(As_{0.73},S_{0.25})_{\Sigma 0.98}O_{4.06}]_{2.00} \cdot 0.88H_2O$. ***Relationship to other species:*** The zinc-dominant analogue of arsenbrackebuschite.

Name: For Dr. Mark N. Feinglos (1948–), of Duke Medical Center, Durham, North Carolina, who first noticed the mineral. ***Comments:*** IMA No. 95-013. Although the ideal formula is given correctly in the text of the paper, it is given as $Pb_2(Zn,Fe)[(As,S)O_4] \cdot H_2O$ in the abstract.

CLARKE, A. M., CRIDDLE, A. J., ROBERTS, A. C., BONARDI, M., and MOFFATT, E. A. (1997) Feinglosite, a new mineral related to brackebuschite, from Tsumeb, Namibia. *Mineralogical Magazine* **61**, 285–289.



Jentschite

Jentschite — Monoclinic

$TlPbAs_2SbS_6$

Locality: The Lengenbach quarry, Binntal, Canton Wallis, Switzerland.

Occurrence: In cavities in dolomite. Associated minerals are: hutchinsonite, wallisite, hatchite, edenharterite, bernardite, realgar, and orpiment.

General appearance: Long prismatic, platy to acicular crystals (up to 2 mm).

Physical, chemical and crystallographic properties: *Luster:* metallic to submetallic. *Diaphaneity:* opaque, but translucent in thin fragments. *Color:* brilliant black (dark red in thin fragments). *Streak:* dark red. *Hardness:* VHN_{10} 38 to 51 kg/mm^2, Mohs 2 to 2½. *Tenacity:* extremely brittle. *Cleavage:* {$\bar{1}$01} perfect. *Fracture:* uneven to conchoidal. *Density:* could not be determined, 5.24 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, $P2_1/n$, a 8.121, b 23.969, c 5.847 Å, β 107.68°, V 1084 Å^3, Z 4, a:b:c = 0.3388:1:0.2439. Morphology: forms, {010}, {001}, {130}, {041}, {$\bar{1}$01}, {$\bar{1}$21}, {$\bar{1}$51}. Twinning: usually on (010), also on (100); the first twins are similar to albite twins and the second twins resemble gypsum twins. ***X-ray powder diffraction data:*** 5.346 (32), 3.998 (74), 3.816 (54), 3.587 (86), 2.823 (100), 2.778 (84), 2.670 (58). ***Optical data:*** In reflected light: greyish white, clearly visible anisotropism, visible bireflectance, nonpleochroic. $R_{min.}$ & $R_{max.}$: (29.7, 35.4 %) 470nm, (28.8, 33.1 %) 543nm, (26.7, 30.3 %) 587nm, (26.6, 29.9 %) 657nm. ***Chemical analytical data:*** Means of fifteen sets of electron microprobe data: Tl 23.92, Pb 21.44, Sb 12.53, As 19.16, S 22.42, Total 99.47 wt.%. Empirical formula: $Tl_{1.01}Pb_{0.89}As_{2.20}Sb_{0.89}S_{6.02}$. ***Relationship to other species:*** It is an ordered

Sb-bearing analogue of edenharterite, $TlPbAs_3S_6$, in which the Sb occupies a site different from the As.

Name: For Franz Jentsch (1868–1908), a "Strahler" who found many of the new minerals from Lengenbach. In 1904, the name "jentschite" was given to a supposedly new sulphosalt from Binn. Shortly afterwards, this mineral was shown to be identical to lengenbachite. As the name "jentschite" was discarded in 1905, permission was given by the Commission on New Minerals and Mineral Names of the International Mineralogical Association to use the name for this mineral. ***Comments:*** IMA No. 93-025. The crystal drawing in the paper is not in the standard orientation, but has been rotated 16° about [001] for better comparison with the drawing of edenharterite which also appears in the paper. The drawing given here is in the standard orientation. Note that the crystal structures of jentschite and edenharterite have been solved.

GRAESER, S. and EDENHARTER, A. (1997) Jentschite ($TlPbAs_2SbS_6$)—a new sulphosalt mineral from Lengenbach, Binntal (Switzerland). *Mineralogical Magazine* **61**, 131–137. BERLEPSCH, P. (1996) Crystal structure and crystal chemistry of the homeotypes edenharterite ($TlPbAs_3S_6$) and jentschite ($TlPbAs_2SbS_6$) from Lengenbach, Binntal (Switzerland). *Schweizerische mineralogische und petrographische Mitteilungen* **76**, 147–157.

Jørgensenite

Monoclinic

$Na_2(Sr,Ba)_{14}Na_2Al_{12}F_{64}(OH,F)_4$

Locality: The cryolite deposit at Ivigtut, Greenland.

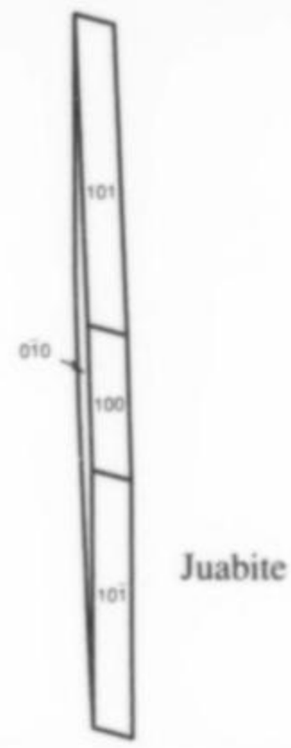
Occurrence: In fissure fillings within the main cryolite mass and in crystal-lined cavities. Associated minerals are: jarlite, stenonite, strontian barite, bøgvadite, fluorite, pyrite, topaz, and muscovite.

General appearance: Fan-shaped aggregates (up to 2 mm across) and as grains up to 10 mm across overgrown by jarlite.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* white. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 3½ to 4. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* uneven. *Density:* 3.89 g/cm^3 (meas.), 3.92 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, C2/m, a 16.046, b 10.971, c 7.281 Å, β 101.734°, V 1254.9 Å^3, Z 1, a:b:c = 1.4626:1:0.6637. Morphology: no forms were identified, grains elongated parallel to [010]. Twinning: none observed. ***X-ray powder diffraction data:*** 7.844 (8), 3.643 (9), 3.453 (10), 3.193 (10), 3.112 (9), 2.989 (9), 2.220 (8), 2.173 (9), 2.001 (8). ***Optical data:*** Biaxial (-), α 1.436, β 1.442, γ 1.442, 2V(meas.) 0 to 5°, 2V(calc.) 0°; dispersion not observed; nonpleochroic; Y = b. ***Chemical analytical data:*** Means of eleven sets of electron microprobe data: Na 3.25, K 0.30, Mg 0.38, Ca 0.28, Sr 32.76, Ba 8.63, Al 10.97, F 42.50, H_2O 1.22, Total 100.29 wt.%. H_2O was calculated to give OH + F = 68.00 atoms per formula unit. Empirical formula: $(Na_{1.54}Mg_{0.46})_{\Sigma 2.00}(Sr_{11.09}Ba_{1.85}Na_{0.63}K_{0.23}Ca_{0.21})_{\Sigma 13.95}Na_{2.00}Al_{12.00}F_{64.00}[(OH)_{2.00}F_{2.00}]_{\Sigma 4.00}$. ***Relationship to other species:*** It is the Na-dominant analogue of jarlite, which was defined as $Na_2(Sr,Na,\square)_{14}(Mg,\square)_2Al_{12}F_{64}(OH,H_2O)_4$ by Hawthorne (1983).

Name: For Vilhelm Jørgensen (1844–1925) founder of the cryolite factory (with G. A. Hagemann) in 1870, and father of C. F. Jarl. ***Comments:*** IMA No. 95-046. The crystal structure has been solved and the results are in press in the *Canadian Mineralogist*. The a:b:c ratio given in the paper is slightly different from the correct ratio given here.

PAULY, H., HAWTHORNE, F. C., BURNS, P. C., and DELLA VENTURA, G. (1997) Jørgensenite, $Na_2(Sr,Ba)_{14}Na_2Al_{12}F_{64}(OH,F)_4$, a new aluminofluoride mineral from Ivigtut, Greenland. *Canadian Mineralogist* **35**, 95-046. HAWTHORNE, F. C. (1983) The crystal structure of jarlite. *Canadian Mineralogist* **21**, 553–560.



Juabite

Juabite

Triclinic

$Cu_5(Te^{6+}O_4)_2(As^{5+}O_4)_2\cdot 3H_2O$

Locality: The dumps of the Centennial Eureka mine, Tintic District, Juab County, Utah, U.S.A. (Lat. 39°56′38″ N, Long. 112°07′18″ W).

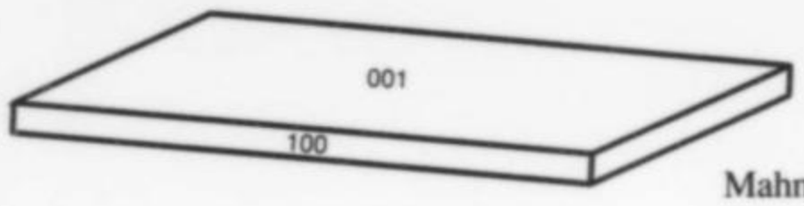
Occurrence: In drusy quartz-lined cavities. Associated minerals are: enargite, beudantite, and an ill-defined mineral which may be a lead-analogue of arsenobismite.

General appearance: Crystalline subhedral platy masses (up to 0.2 to 0.3 mm long) and relatively scarce euhedral crystals 125 x 100 x 1 to 2 μm.

Physical, chemical and crystallographic properties: *Luster:* vitreous to adamantine. *Diaphaneity:* translucent (masses) to transparent (thin plates). *Color:* emerald-green (masses) to lighter green (crystals). *Streak:* pale green. *Luminescence:* non-fluorescent. *Hardness:* 3 to 4 (estimated). *Tenacity:* brittle. *Cleavage:* {010} perfect. *Fracture:* uneven, almost subconchoidal. *Density:* could not be determined, 4.60 g/cm^3 (calc.). ***Crystallography:*** Triclinic, P1 or $P\bar{1}$, a 8.984, b 10.079, c 8.975 Å, α 102.68°, β 92.45°, γ 70.45°, V 746.8 Å^3, Z 2, a:b:c = 0.8914:1:0.8905. Morphology: forms, {010}, {100}, {$\bar{1}$01}, {101}. Twinning: none observed. ***X-ray powder diffraction data:*** 9.28 (70), 4.65 (70), 3.097 (100), 3.018 (60), 2.658 (50), 2.468 (50), 1.740 (50). ***Optical data:*** The indices of refraction could not be measured in liquids and the reflectance data are considered too unreliable for calculation of the indices. ***Chemical analytical data:*** Means of three sets of electron microprobe data: CuO 38.25, PbO 0.57, As_2O_5 22.81, TeO_3 32.58, H_2O (5.19), Total (99.40) wt.%. Water calculated to give $3H_2O$. Empirical formula: $(Cu_{5.01}Pb_{0.03})_{\Sigma 5.04}(Te^{6+}O_4)_{1.93}(AsO_4)_{2.07}\cdot 3.00H_2O$. ***Relationship to other species:*** None apparent.

Name: For the county in which it was found. ***Comments:*** IMA No. 96-001. A single specimen is known. Mr. Roberts has informed me that the crystal structure of juabite has been solved by Dr. Peter Burns and the tellurium has a 4+ valence rather than 6+. Also, another element (probably iron) is present. A paper redefining the mineral will be published. The crystal drawing for this abstract was produced from the data and the SEM image given in the paper and was approved by Mr. Roberts.

ROBERTS, A. C., GAULT, R. A., JENSEN, M. C., CRIDDLE, A. J., and MOFFATT, E. A. (1997) Juabite, $Cu_5(Te^{6+}O_4)_2(As^{5+}O_4)_2\cdot 3H_2O$, a new mineral species from the Centennial Eureka mine, Juab County, Utah. *Mineralogical Magazine* **61**, 139–144.



Mahnertite

Mahnertite

Tetragonal

$(Na,Ca)Cu_3(AsO_4)_2Cl\cdot 5H_2O$

Locality: The Cap Garonne mine, near Le Pradet, Var, France.

Occurrence: Associated minerals are: tennantite, covellite, geminite, pushcharovskite, and quartz.

General appearance: Aggregates or spherules (0.2 mm in diameter) of thin square plates (0.1 mm on edge).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* intense blue to emerald green. *Streak:* pale blue. *Luminescence:* non-fluorescent. *Hardness:* 2 to 3. *Tenacity:* fragile. *Cleavage:* {001} perfect. *Fracture:* irregular. *Density:* 3.33 g/cm^3 (meas.), 3.37 g/cm^3 (calc.). ***Crystallography:*** Tetragonal, $P4_22_12$, a 10.085, c 23.836 Å, V 2424.1 Å^3, Z 8, c:a = 2.3635. Morphology: forms, {001} and {100}. Twinning: none observed. ***X-ray powder diffraction data:*** 11.90 (100), 9.29 (60), 7.132 (50), 5.043 (60), 4.641 (40), 3.098 (80), 3.061 (70). ***Optical data:*** Uniaxial (-), ω 1.686, ε 1.635, pleochroism O = blue to intense green blue, E = clear blue to clear green. ***Chemical analytical data:*** Means of nine sets of electron microprobe data: Na_2O 4.58, K_2O 0.40, CaO 2.14, CuO 36.37, As_2O_5 39.07, H_2O 14.5, Cl 4.67, sum 101.73, less O = Cl 1.06, Total 100.67 wt.%. H_2O was determined by weight loss. Empirical formula: $(Na_{0.90}Ca_{0.23}K_{0.05})_{\Sigma 1.18}Cu_{2.79}(AsO_4)_{2.07}Cl_{0.80}\cdot 4.91H_2O$. ***Relationship to other species:*** None apparent.

Name: For Dr. Volker Mahnert (1943–), Director of the Natural History Museum of Geneva. ***Comments:*** IMA No. 94-035. The description of pushcharovskite (an associated mineral) has not been published yet. The crystal drawing given here was produced from the photograph and data in the paper.

SARP, H. (1996) La mahnertite, $(Na,Ca)Cu_3(AsO_4)_2Cl\cdot 5H_2O$, un nouveau minéral de la mine de Cap Garonne, Var, France. *Archives de Science Genève* **49 (2)**, 119–124.

Malanite

Cubic

$Cu(Pt,Ir)_2S_4$

Locality: (1) The Malan valley, near the town of Zunhua, 150 km east of Beijing, Peoples's Republic of China; (2) Near the village of Shuangfeng, about 200 km NNE of Beijing, Peoples's Republic of China.

Occurrence: (1) In olivine pyroxenite dikes; associated minerals are: pyrrhotite, pentlandite, chalcopyrite, bornite, moncheite, cooperite, and sperrylite. (2) In placer concentrates; associated minerals are "iridisite," "iridosmine," and platinum.

General appearance: As octahedral or dodecahedral crystals (0.1 to 0.2 mm in diameter) and as veinlets (5 to 10 mμ wide by 100–200 mμ long).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* steel-grey. *Streak:* black. *Hardness:* VHN_{20} 417 kg/mm^2, Mohs 5. *Tenacity:* brittle. *Cleavage:* {111} sometimes observed. *Fracture:* "none." *Density:* could not be determined, (1) 7.35 g/cm^3 (calc.) and (2) 7.58 g/cm^3 (calc.). ***Crystallography:*** Cubic, Fd3m; (1) a 9.910 Å, V 973.2 Å^3, (2) a 9.940 Å, V 982.1 Å^3; Z 8 (erroneously given as 4). Morphology: forms {111} and {110}. Twinning: none mentioned. ***X-ray powder diffraction data:*** For locality (1): 5.70 (5), 2.98 (6), 2.48 (8), 1.90 (8), 1.75 (10), 1.011 (7), 0.783 (8); a similar set of data are given for locality (2). ***Optical data:*** In reflected light: white with a greenish tint, isotropic. R: (37.3 %) 470nm, (37.7 %) 550nm, (38.1 %) 590nm, (38.6 %) 650nm. ***Chemical analytical data:*** Locality (1): means of six sets of electron microprobe data: Fe 0.6, Co 2.2, Ni 0.3, Cu 10.9, Rh 0.7, Pd 0.5, Ir 23.2, Pt 37.0, S 23.8, Total 99.2 wt.%; empirical formula: $(Cu_{0.93}Fe_{0.06})_{\Sigma 0.99}(Pt_{1.03}Ir_{0.66}Co_{0.20}Rh_{0.04}Ni_{0.03}Pd_{0.03})_{\Sigma 1.99}S_{4.03}$. Locality (2): means of five sets of electron microprobe data: Fe 0.7, Co 1.1, Cu 10.7, Rh 1.5, Ir 15.4, Pt 47.4, S 22.6, Total 99.4 wt.%; empirical formula: $(Cu_{0.95}Fe_{0.07})_{\Sigma 1.02}(Pt_{1.37}Ir_{0.45}Co_{0.11}Rh_{0.08})_{\Sigma 2.01}S_{3.97}$. ***Relationship to other species:*** None apparent.

Name: For the Malan valley which appears to be the type locality. ***Comments:*** IMA No. 95-003. A description of this mineral was published in 1974 without approval of the CNMMN of IMA. The associated minerals "iridisite" and "iridosmine" are not valid species. The latter should be called osmium. Dr. George Y. Chao kindly assisted with this abstract.

YU, ZUXIANG (1996) Malanite—a new cupric platinum (Pt^{3+}) and iridium (Ir^{3+}) sulfide. *Acta Geologica Sinica* **70 (4)**, 309–314.

Sheldrickite

Hexagonal (trigonal)

$NaCa_3(CO_3)_2F_3\cdot H_2O$

Locality: The Poudrette quarry, Mont Saint-Hilaire. Rouville County, Quebec, Canada.

Occurrence: In a marble xenolith in nepheline syenite. Associated minerals are: shortite, pectolite, microcline, polylithionite, arfvedsonite, aegirine, calcite, fluorite, molybdenite, leucosphenite, thenardite, thermonatrite, sphalerite, galena, schairerite, and kogarkoite.

General appearance: A 1 x 1 x 2 mm aggregate of blocky twinned crystals with individuals up to 0.1 x 0.1 x 0.2 mm and, more commonly, as radiating thin flakes to fibrous masses up to 2 mm wide.

Physical, chemical and crystallographic properties: *Luster:* vitreous to silky. *Diaphaneity:* transparent to translucent. *Color:* colorless to white. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 3. *Tenacity:* brittle. *Cleavage:* good {001} parting. *Fracture:* uneven. *Density:* 2.86 g/cm^3 (meas.), 2.86 g/cm^3 (calc.). ***Crystallography:*** Hexagonal (trigonal), $P3_2$, a 6.718, c 15.050 Å, V 588.3 Å^3, Z 3, c:a = 2.2403. Morphology: no forms were observed. Twinning: by reflection on (001). ***X-ray powder diffraction data:*** 5.809 (30), 5.010 (30), 3.358 (30), 2.791 (50), 2.508 (40), 2.010 (100), 1.939 (40). ***Optical data:*** Uniaxial (+), ω 1.538, ε 1.563, nonpleochroic. ***Chemical analytical data:*** Means of three sets of electron microprobe data: Na_2O 9.16, CaO 48.84, SrO 0.36, CO_2 25.81, H_2O 5.61, F 16.17, sum 105.95, less O = F 6.81, Total 99.14 wt.%. CO_2 was calculated from the crystal structure and H_2O was determined by TGA. Empirical formula: $Na_{1.01}(Ca_{2.97}Sr_{0.01})_{\Sigma 2.98}(CO_3)_{2.00}[F_{2.90}(OH)_{0.12}]_{\Sigma 3.02}\cdot 1.00H_2O$. ***Relationship to other species:*** None apparent.

Name: For Prof. George M. Sheldrick (1942–), Institute for Organic Chemistry, University of Göttingen. ***Comments:*** IMA No. 96–019. The paper contains details of the crystal structure. About 60 mg of the mineral are known to exist.

GRICE, J. D., GAULT, R. A., and VAN VELTHUIZEN, J. (1997) Sheldrickite, a new sodium-calcium-fluorocarbonate mineral species from Mont Saint-Hilaire, Quebec. *Canadian Mineralogist* **35**, 181–187.

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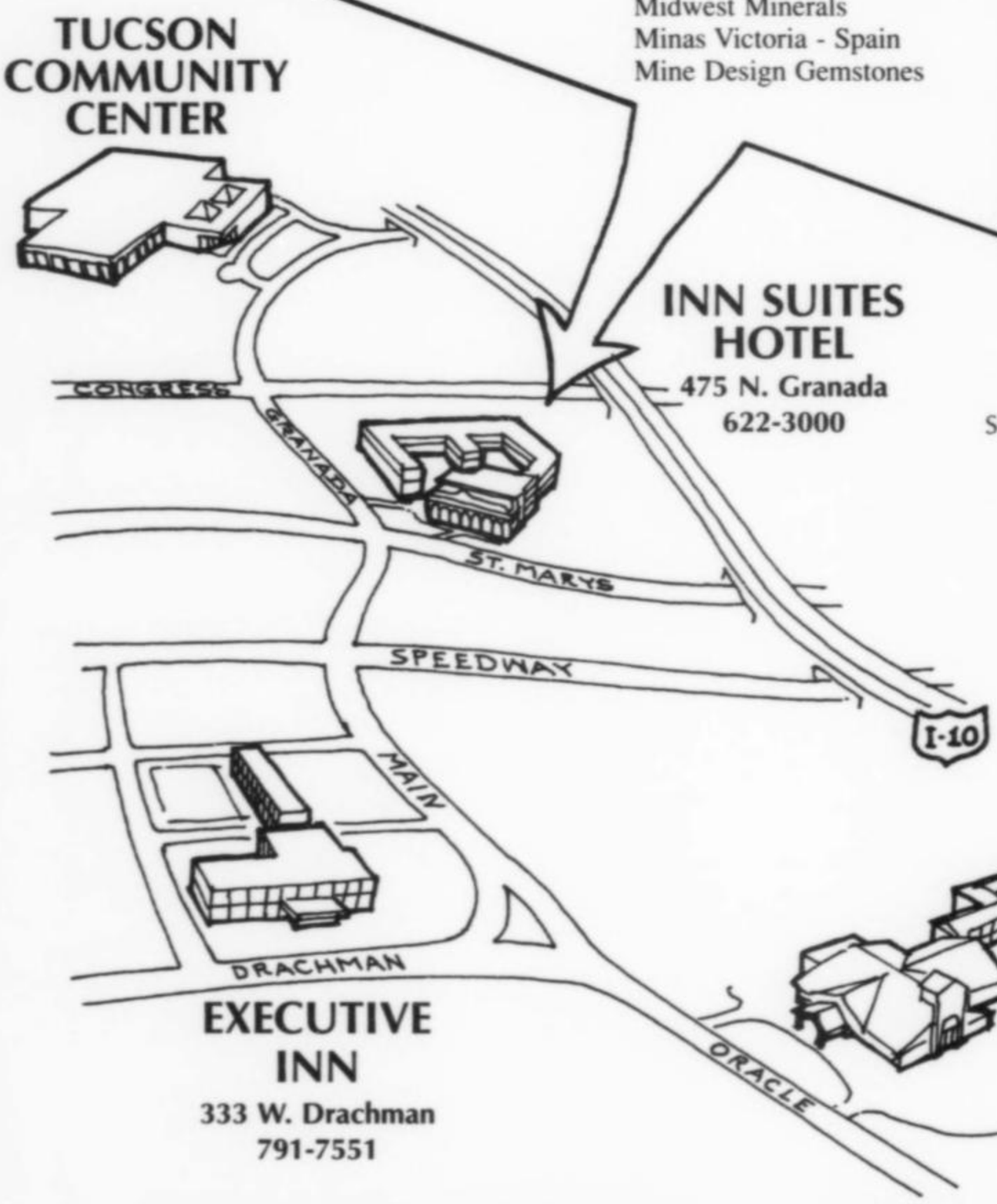

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Ernstite and Eosphorite from Minas Gerais, Brazil

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Rusty brown eosphorite-shaped crystals from a pegmatite near Linopolis have been sold on the American mineral market as ernstite, an alteration product of eosphorite. Detailed analysis has revealed that they are predominantly eosphorite.

INTRODUCTION

The mineral-rich region surrounding the small village of Linópolis is situated in the Município (= County) of Divino das Laranjeiras, in the State of Minas Gerais, Brazil. Pegmatites in this area have been famous since the 1940's for spectacular phosphate minerals, especially brazilianite and eosphorite (see Pough and Henderson, 1945; Cassedanne, 1983). The best of these specimens today are a part of major public museum and private collections worldwide.

Wilson (1990) first reported the appearance of rusty-brown apparent pseudomorphs of a mineral identified as "ernstite" after eosphorite from near Linópolis. These had been introduced onto the American mineral market at the 1990 Tucson Gem and Mineral Show by Brazilian mineral dealer Carlos Barbosa; "crystals" up to 12 cm in length were described.

In 1994 Mrs. Fátima Neri of *Phantom Crystal*, a mineral dealership in Belo Horizonte, purchased some specimens of these same rusty-brown apparent pseudomorphs plus some translucent to transparent, yellowish to pinkish brown eosphorite from the same locality. A North American dealer, perhaps recalling the Barbosa specimens, suggested that the rusty crystals could be ernstite. Subsequent X-ray diffraction analysis, however, suggested a mixture of childrenite, eosphorite and ernstite. We enquired of Mr. Barbosa recently as to the analytical technique on which his own identification was based, and he responded that X-ray diffraction had been used. We were encouraged by Mr. Barbosa and Mrs. Neri to undertake new and more definitive analyses of the Linopolis material, not only the purported ernstite but also the unaltered childrenite/eosphorite.

CHILDRENITE/EOSPHORITE

Childrenite and eosphorite have both been commonly reported from Minas Gerais pegmatites, not only from near Linópolis but from Mendes Pimentel, Lavra da Ilha near Araçuaí, and elsewhere. Childrenite, the Fe end-member of the series, was first discovered in Devon, England, in 1823 (see Braithwaite and Cooper, 1982); eosphorite, the Mn analog, was first described from Connecticut by Brush and Dana in 1878 (see Hurlbut, 1950). Both species are generally accepted to be the products of hydrothermal alteration of primary pegmatite phosphates (Moore, 1973). Barnes and Shore (1951) remarked about the series that "a real anomaly exists between the optical and X-ray diffraction data." The crystallography has been described as orthorhombic, pseudo-orthorhombic, monoclinic and even triclinic (Barnes, 1949; Hurlbut, 1950; Winchell, 1958; Guiseppetti and Tadini, 1984; Bermanec *et al.*, 1995; and others).

Phosphates from the Linópolis area have been well described by Cassedanne (1983). The specimens analyzed in the current study came from the Roberto Caldeira mine (formerly and more familiarly known as the João Modesto mine; mine names tend to change with the ownership). Some of the crystals measure up to 5 cm in length, and are commonly perfectly doubly terminated. The color is the typical pinkish to yellowish brown, and the crystals are translucent to transparent and gemmy. Many contain visible inclusions of pyrite-like yellow to gold-colored flakes.

Optical and Physical Properties

Portions of striated, translucent, yellowish to pinkish brown,

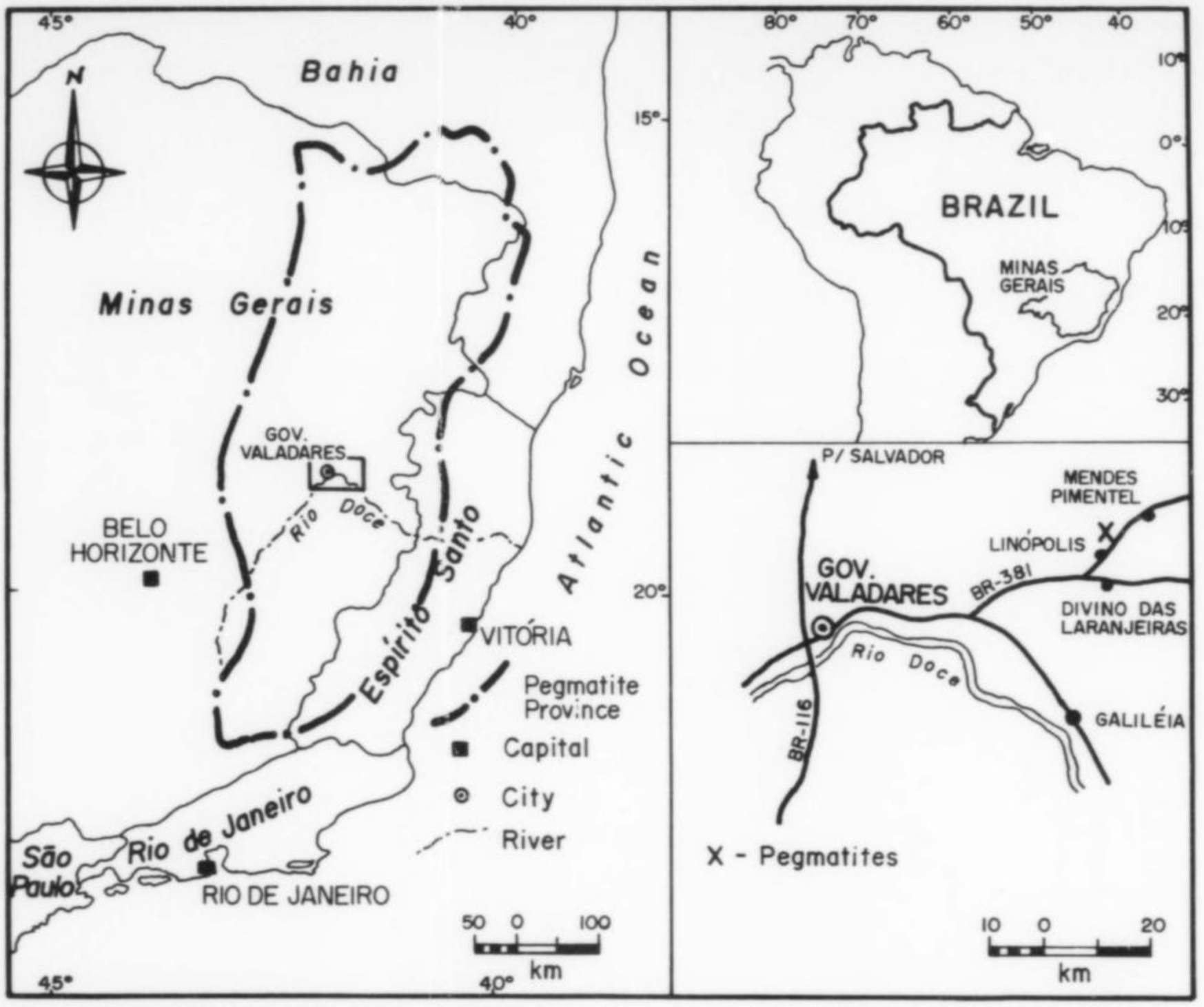

Figure 1. **Location map showing Linópolis in the pegmatite province of east-central Brazil.**

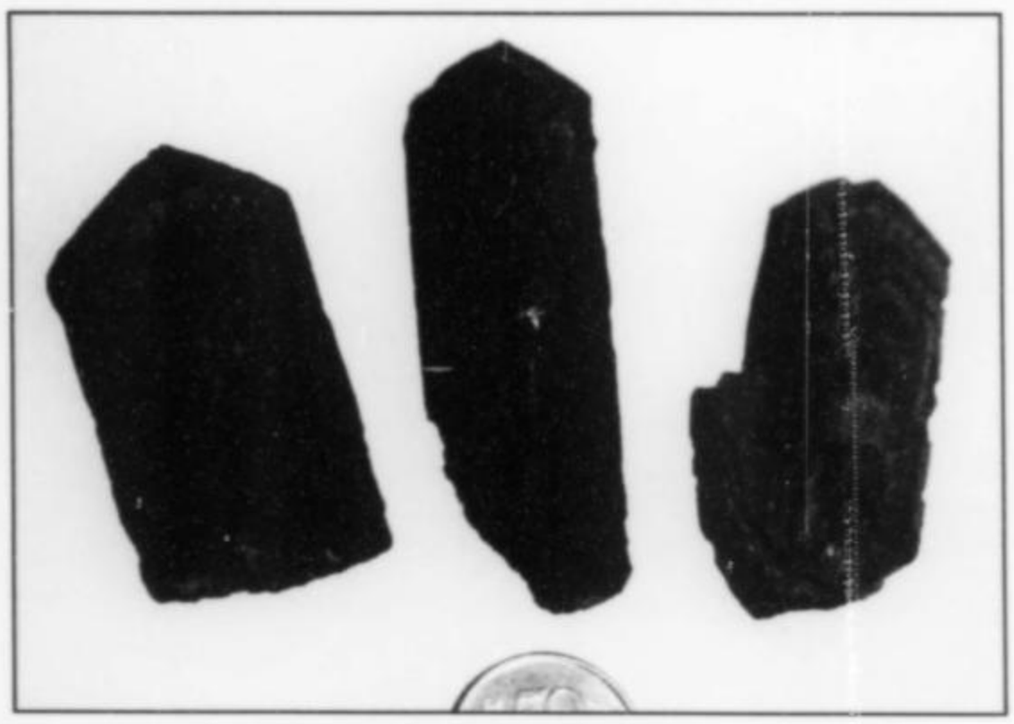

Figure 2. **"Rusty" altered eosphorite from the Roberto Caldeira mine (coin = 3 cm).**

1-cm crystals (considered by the local miners to be childrenite) were analyzed optically and yielded the following results:

$n\alpha = 1.643(1)$
$n\beta = 1.668(1)$
$n\gamma = 1.669(1)$
$\Delta n = 0.026$
Dispersion of $2Vx = r < v$
$2Vx(5893nm) = 22.8(4)°$

These values resemble those of eosphorite from the Palermo mine, North Groton, New Hampshire, containing 12.15 weight % FeO (Hurlbut, 1950). No deviation from straight extinction parallel to the striation was observed.

From the same mine as the above analyzed specimens, 12 transparent to translucent, 2 to 3-cm crystals were cut and analyzed using an Eickhorst gemological refractometer (monochromatic source at 5893Å). The results confirm the initial analysis:

$n\alpha = 1.645$ (MP160.001)
$n\gamma = 1.671$ (MP160.001)
$\Delta n = 0.026$ (MP160.002)
Density: 3.107 to 3.121 g/cm^3
Hardness: 4.5 to 5.0 (mohs)

X-Ray Analysis

Part of a crystal utilized in the optical and physical analyses was powdered and analyzed by X-ray diffraction, yielding the following results (left column), compared with values for Hagendorf eosphorite (JCPDF card 36-402, right column):

Space group: Bba2 or Bbam

a = 10.436(1)Å	[a = 10.436(1)Å]
b = 13.466(2)Å	[b = 13.495(2)Å]
c = 6.929(l)Å	[C= 6.923(1)Å]

No deviation from orthorhombic symmetry was observed.

Infrared Absorption Spectroscopy

The infrared spectrum of the Brazilian "childrenite" is similar to that reported by Braithwaite and Cooper (1982) for childrenite specimens from South Wheal Crebor, Devon, and from Taquaral, Minas Gerais (the detailed data are available on request).

Chemistry

Crystals from Linópolis similar to those used for the infrared spectroscopic analysis were also analyzed by wet chemical methods to determine the iron and manganese contents:

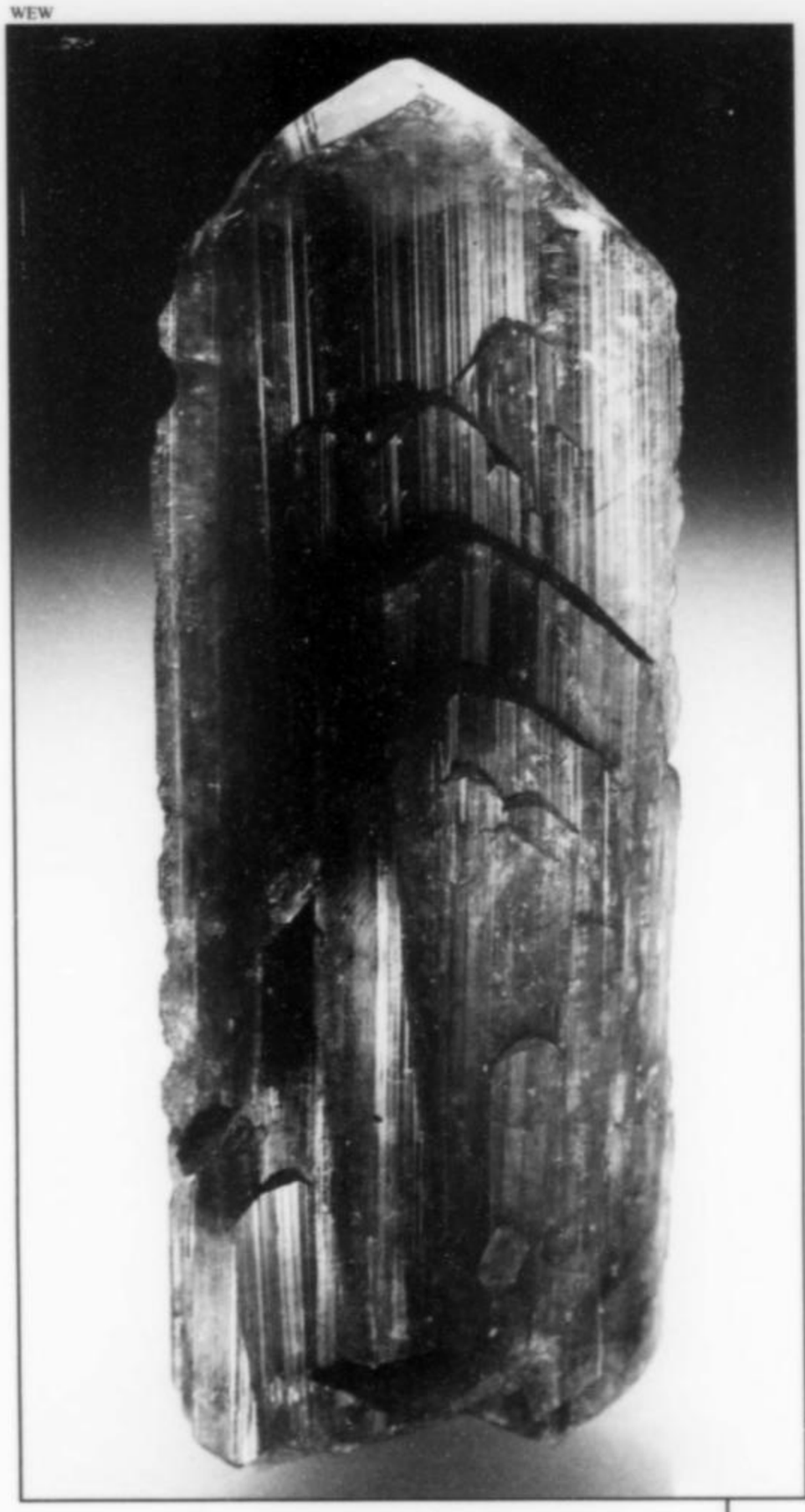

Figure 5. **Translucent to transparent eosphorite crystals from the Roberto Caldeira (formerly João Modesto) mine near Linópolis.**

FeO = 13.07 weight % [Hagendorf = 14.86 weight %]
MnO = 16.89 weight % [Hagendorf = 15.17 weight %]

These values resemble those of eosphorite from Hagendorf (Strunz and Fischer, 1957) and North Groton (Hurlbut, 1950).

Figure 3. **"Ernstite" crystal group, 2.5 cm, from near Linopolis, sold at the 1990 Tucson Show. These specimens are actually about 90% eosphorite and 10% or less ernstite. Carlos Barbosa specimen (from Wilson, 1990).**

Figure 4. **Large eosphorite crystal, 9.3 cm, from the Roberto Caldeira mine. Smithsonian specimen 148431.**

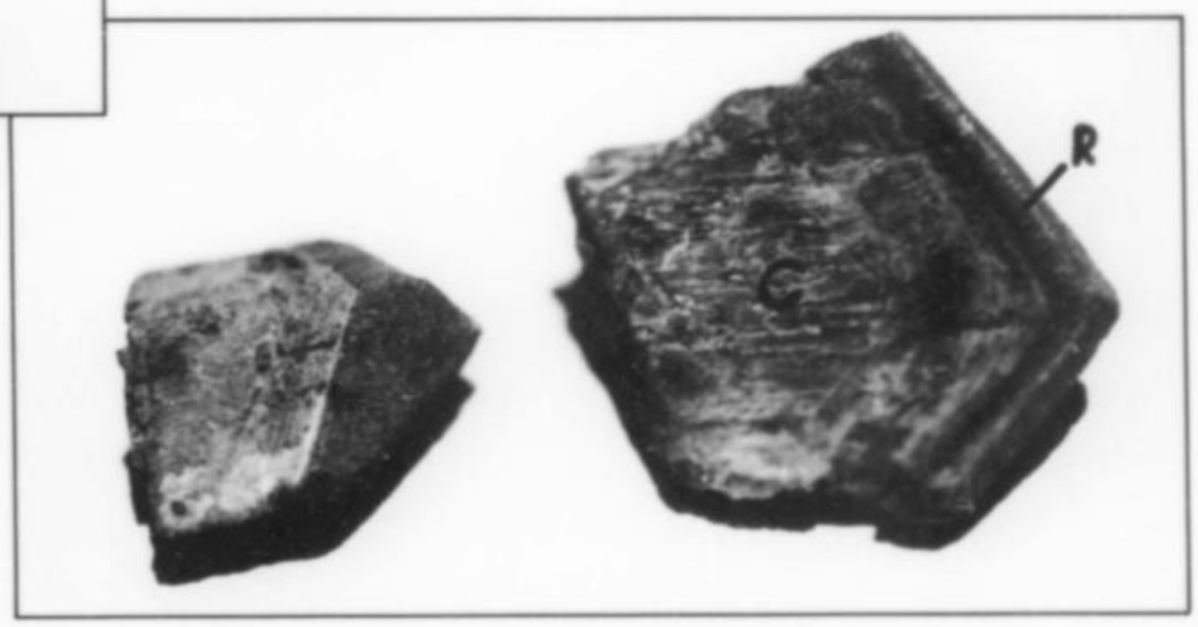

Figure 6. **Two eosphorite crystals (to 6 cm) from the Roberto Caldeira mine. The unaltered core (C) is surrounded by a "rusty" opaque rim (R) comprised of radial aggregates.**

The large, translucent crystal shown in Figure 5 was cut parallel to the *c* plane (001) and the *a* plane (100). The core (labeled "C") appears fresh and unaltered; it consists of yellowish to pinkish brown, translucent eosphorite showing optical growth-zoning. The brown, opaque, "rusty"-looking rim (R) shows radiating microcrystal aggregates 0.4 mm long which are remarkably similar to the African ernstite of Seeliger and Mücke (1970, Figs. 1 to 4, p. 292). Electron probe microanalyses were carried out using an ARL-SEMQ electron microprobe set at 15 Kv and 15 nA; 12 points on

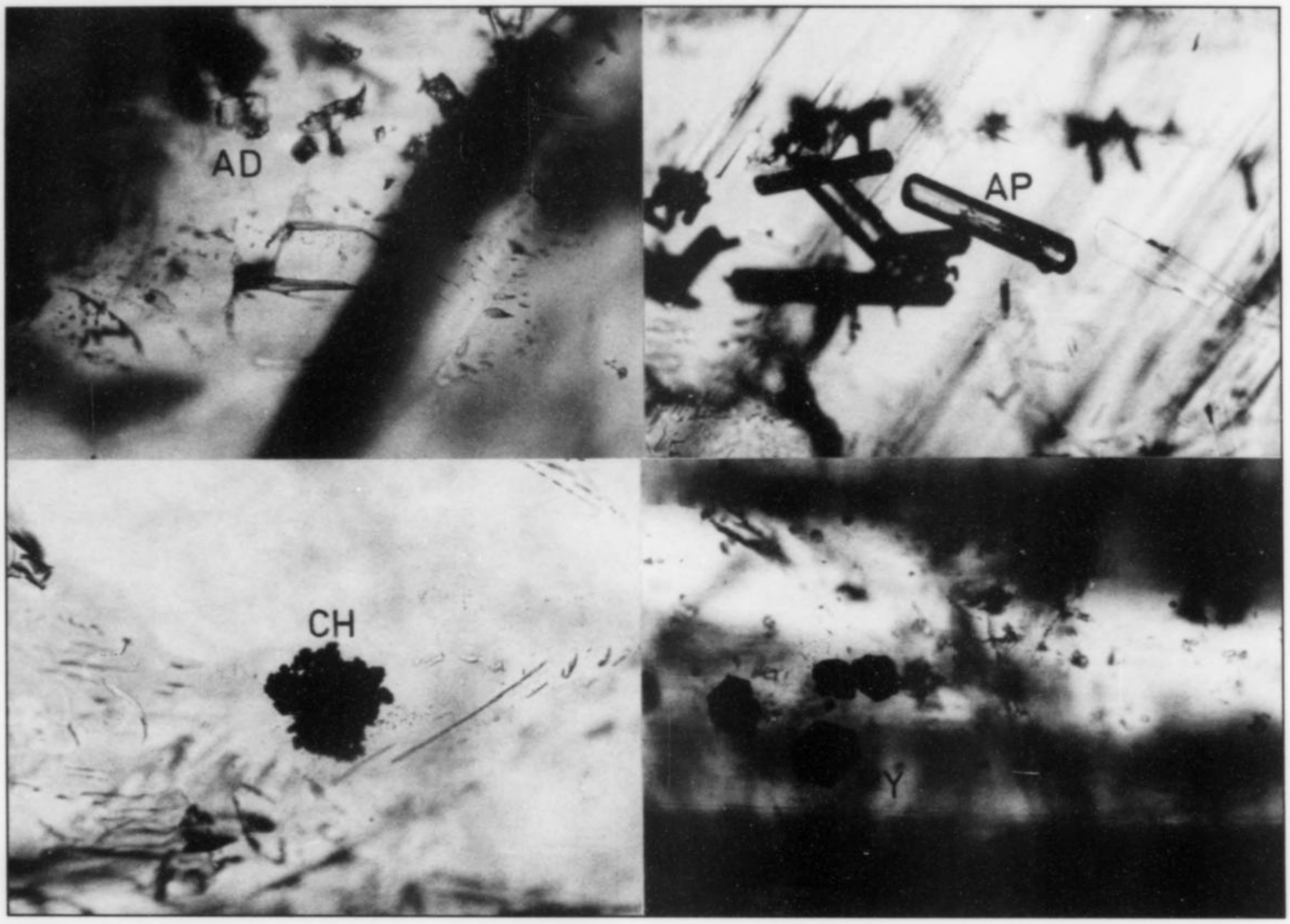

Figure 7. **Inclusions in eosphorite: chlorapatite (Ap), orthoclase (Ad), pyrrhotite (Py) and chalcopyrite (Ch).**

Figure 8. **Fingerprint-like inclusion layers resulting from fracture healing in eosphorite (30X).**

the sample were analyzed, from core to rim, yielding the following results (in weight %):

P_2O_5 = 30.40
CaO = 0.13
MgO = 0.08
Al_2O_3 = 22.90
MnO = 29.40
FeO = 3.90
H_2O = n.d.
Total = 86.81

A small decrease in manganese and an increase in iron were found from core to rim:

Core: $Eo_{91}Ch_9$
Rim: $Eo_{87}Ch_{13}$
Ave.: $Eo_{88}Ch_{12}$

Inclusions

The following species were identified as inclusions in the eosphorite crystals using electron probe microanalysis:

Chlorapatite	$Ca_5(PO_4)_3(Cl,F,OH,CO_3)$
Albite	$NaAlSi_3O_8$
Orthoclase	$KAlSi_3O_8$
Pyrrhotite	$Fe_{1-x}S$
Chalcopyrite	$CuFeS_2$

The megascopic preliminary observation of "pyrite-like" inclusions proved to be chalcopyrite and pyrrhotite.

These inclusions occur only in the outer crystal zones, and show no preferred orientation; only the two-phase colorless "fingerprint" inclusions typically resulting from the healing of cracks occur in the cores.

ERNSTITE

Ernstite was first described by Seeliger and Mücke (1970) from a granitic pegmatite near Karibib, Namibia, and was regarded by them as an oxidation or alteration product of eosphorite (relict cores of which remain intact). The formula for ernstite is given as:

$$(Mn^{2+}_{1-x},Fe^{3+}_{x})Al[(OH)_{2-x}O_xPO_4]$$

This composition appears to be the result of complete oxidation of Fe^{2+} to Fe^{3+}, and the complete loss of crystallographic water with the substitution of O for (OH). The climatic conditions prevailing in the Namib Desert were reportedly responsible for the oxidation and dehydration which took place without disrupting the crystal lattice.

Several mines in the Linópolis area produce not only eosphorite ("childrenite") but also rusty-brown crystals up to 12 cm in length which are called *monte fumaça* ("smoky mountain") by the local miners. As mentioned above, these crystals have been sold on the American mineral market as "ernstite."

Material taken from the altered rim of the large crystal analyzed by electron microprobe was subjected to X-ray diffraction analysis. The resulting diagram was overlayed for comparison on the diagrams of African ernstite and standards for ernstite, eosphorite and childrenite. The comparison shows almost perfect concordance with eosphorite, fairly good agreement with childrenite, and differences in comparison to four of the ernstite peaks (although the other ernstite peaks are all concordant). Our conclusion is that the rim material actually consists of a mixture of eosphorite/childrenite and subordinate ernstite.

A second purported ernstite crystal, this one "rusty" throughout from rim to core, was analyzed by the same method and yielded the same results: eosphorite component overwhelmingly in excess of childrenite, together with minor ernstite. The weak peak observed at 2.881Å on the diagram is diagnostic for ernstite, so its presence is definitely established, but it probably comprises less than 10% of the altered crystals sold as ernstite.

CONCLUSIONS

Our analyses indicate that the translucent to transparent crystals are predominantly eosphorite, and that the altered rims and the completely altered rusty-opaque crystals still consist primarily of eosphorite but with up to 10% ernstite present as well. The pinkish crystals are higher in the eosphorite/childrenite ratio ($Eo_{0.88}$) whereas the more yellowish crystals contained closer to 1:1 ratio, with Mn slightly exceeding Fe.

Incidentally, Ginzburg and Voronkowa (1950) described a "new mineral" (not currently accepted) from Kazakhstan which appears to be the oxidation product of childrenite, with an X-ray pattern similar to that of childrenite but differing in details.

The climatic conditions in east-central Brazil are quite different today from those prevailing in the Namib Desert (or Kazakhstan), to which Seeliger and Mücke (1970) attributed the oxidation of eosphorite to ernstite. However, research in east-central Brazil centering on paleoclimates indicates that during the late Pleistocene (17,000 to 11,000 years B.P.) the climate was indeed arid, with a nearly complete absence of vegetation. In contrast, the Holocene (10,000 years B.P. to the present) has been marked by humid climatic conditions with heavy rainfall and erosion. Without a careful comparison of the climatic conditions prevailing at each of the localities discussed it is difficult to make meaningful comparisons of the possible geneses of alteration products. Under other conditions different oxidation species may result from eosphorite/childrenite.

The so-called ernstite from the Linopolis area should, in any case, be labeled "eosphorite with minor ernstite."

ACKNOWLEDGMENTS

We wish to thank Dr. George W. Robinson (A. E. Seaman Mineral Museum) and R. Wegner (UFPb, Brazil) for many helpful comments regarding the manuscript. Analyses were graciously carried out by V. Hammer (Vienna) and Walter Brito (CDTN, Belo Horizonte).

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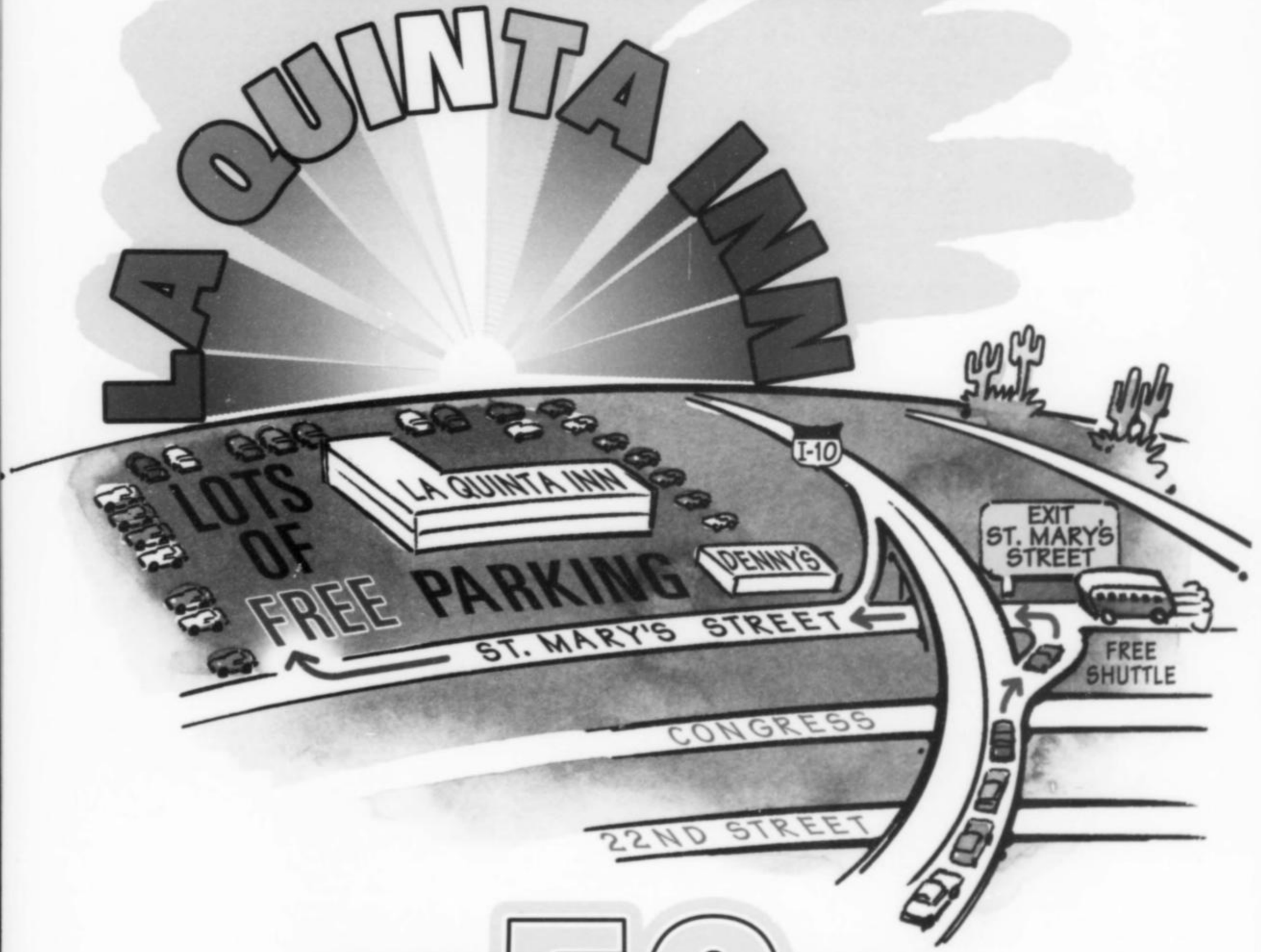

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Emerald and Associated Minerals from A Franqueira, Pontevedra, Spain

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Tecnologia de los Alimentos
Facultad de Veterinaria
Miguel Servet 177
50013 Zaragoza, Spain

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Well-crystallized emerald specimens have been found, embedded in phlogopite schist, in a roadcut in northwestern Spain. Associated minerals include phenakite crystals and chrysoberyl crystals and twins, some showing the alexandrite effect.

HISTORY

The first report of a discovery of emeralds in Spain was circulated by Jacomo de Trezzo, a famous Italian silversmith who worked in the court of Spanish King Philip II in the 16th century. He spread the (false) rumor that emeralds were to be found in Abroñigal Creek, at that time a marshy and unhealthy belt near Madrid (Calderón, 1910), resulting in a small gem rush to that area. Following this spurious report, nothing was recorded about beryl in Spain for many years.

Christian Herrgen (1799), in a work that is considered the first Spanish national mineralogy, wrote that beryl (not emerald, then considered to be a similar but different species) was not found in Spain. Many years later, Naranjo (1862) listed Pontevedra Province as the only known Spanish source for beryl, but did not give the specific locality. According to his description, the beryl was found there as opaque, greenish yellow hexagonal prisms.

As it later turned out, beryl is a relatively common mineral in northwestern Spain, where it occurs in a number of pegmatite deposits (Calderón, 1910; García Guinea and Galán Huertos, 1992). Most of the localities had escaped notice until the beryl was identified in deposits being exploited for feldspar and kaolinite used in the ceramics industry.

Emeralds were discovered at A Franqueira by Eloy Sanmartino, a schoolteacher, during construction of the road between A Franqueira and Cebreiro in 1968–1969. News of the find spread very slowly among mineral collectors until around 1986, when emerald specimens began to turn up at mineral shows. In 1989 the first photograph of an emerald crystal from Pontevedra Province was published in a gemology book by M. Baquero, but the precise locality was not given. Three years later the exact location of the outcrop was finally published (Calvo, 1992; Martín-Izard *et al.*, 1992).

In 1990 one of us (JRG) found a different species in the beryl-containing phlogopite of the outcrop. The morphology, paragenesis and (especially) a change in color depending upon illumination source suggested chrysoberyl, an identification confirmed by X-ray diffraction analysis at Oviedo University. The locality thereby became even more interesting to Spanish mineral collectors, who worked the outcrop for more specimens.

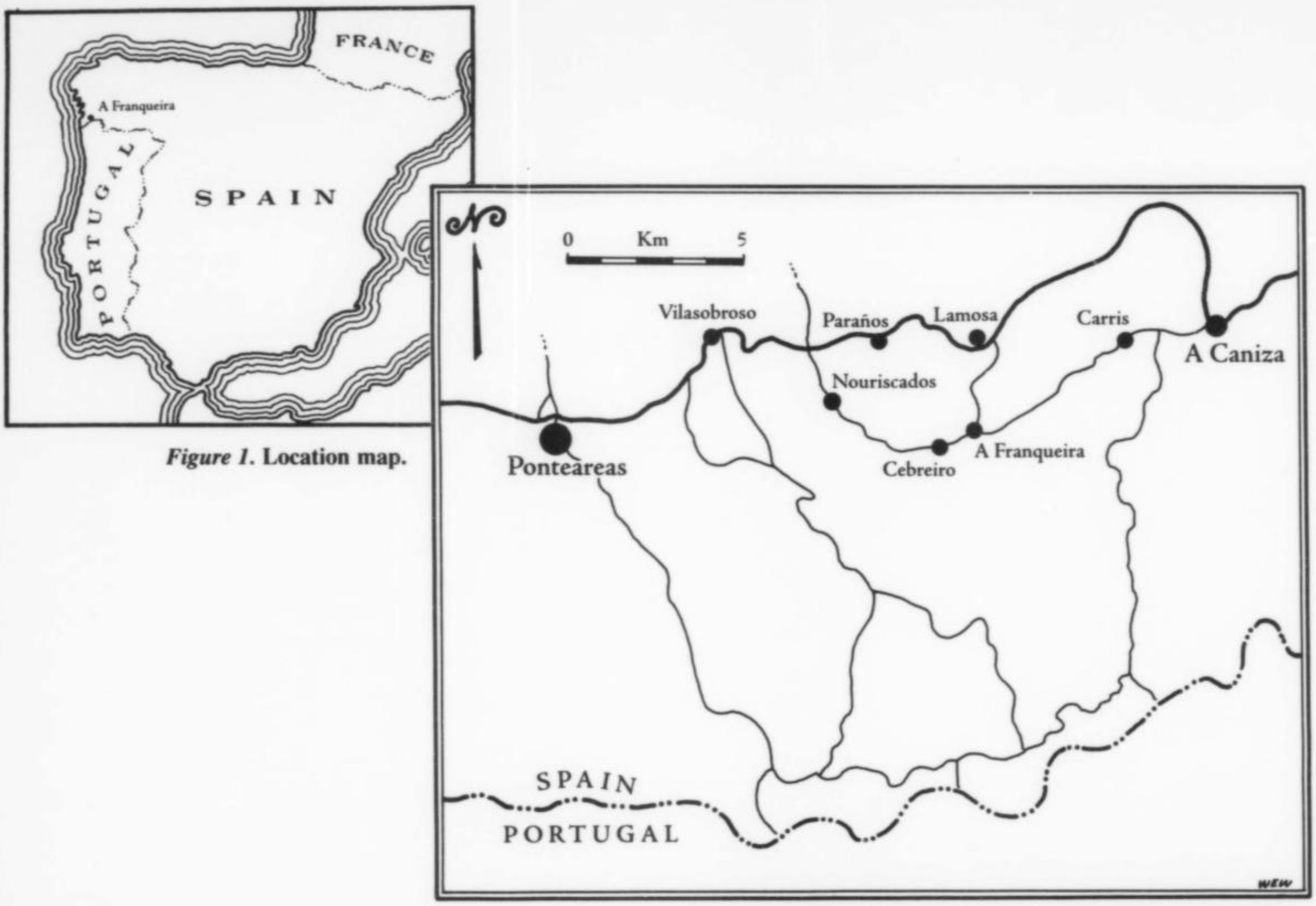

Figure 1. **Location map.**

LOCATION

The small village of A Franqueira, in the municipio of A Caniza in Pontevedra Province, is located about 15 km east of Ponteareas, 10 km north of the Spain-Portugal border and about 40 km east of the Atlantic coast. Despite its small size, A Franqueira is known for its interesting 14th-century Romanesque church. The largest town in the surrounding area is Ponteareas, incorrectly cited as the emerald locality by some mineral dealers.

The emerald-bearing outcrop first discovered is now a small prospect pit, measuring about 1 x 2 x 3 meters, in the roadcut about 1 km from A Franqueira toward Cebreiro. The phlogopite rock has been excavated wherever accessible, except where it passes under the roadway. Unless and until the road is someday diverted, the locality will have to be considered as exhausted. Heavy vegetation and rough terrane have thus far prevented any thorough search for additional pegmatite outcrops in the surrounding area.

GEOLOGY

The geology of the A Franqueira beryl deposit has been studied and described in detail by Martín-Izard *et al.* (1992, 1995). Emerald beryl and associated minerals occur in narrow phlogopite lenses which originated through the reaction of Hercynian pegmatites with dunite host rock. The pegmatite intrusions caused some metasomatic alteration of the dunite, resulting in near-contact zones consisting predominantly of phlogopite. Farther away tremolite also appears. In zones nearest the contact, chrysoberyl, phenakite and beryl formed. Chromium from the dunite served as the chromophore in the beryl and chrysoberyl; the Cr content of the phlogopite decreases toward the contact (Martín Izard *et al.*, 1992).

The genetic process which resulted in emerald and associated

Figure 2. **Ornately carved tympanum and surrounding arches above a doorway in the 14th-century Romanesque church at A Franqueira.**

species at A Franqueira is very similar to that which operated at other well-known schist-hosted emerald occurrences such as Takovaya in Russia (Sinkankas, 1989), Gebel Zabara and Wadi Sikait in Egypt (Grundmann and Morteani, 1993), and Habachtal in Austria (Niedermayr, 1988). Schist-type deposits are the source

Figure 3. The A Franqueira outcrop in August of 1993.

Figure 4. (below) Emerald crystal group, 7 cm, on schist matrix. Manuel Mesa collection and photo.

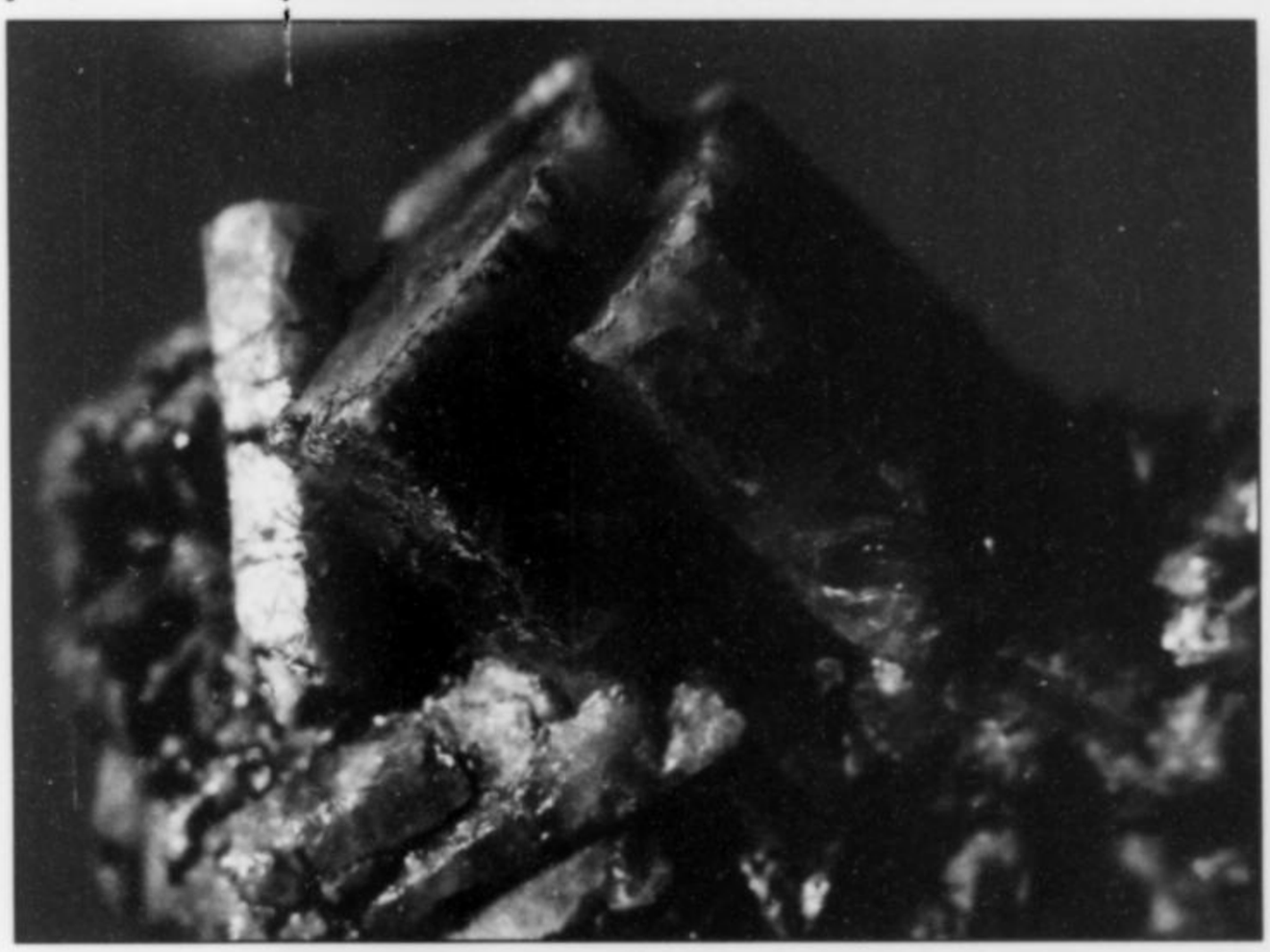

Figure 6. Parallel cluster of emerald crystals, 2 cm across, in schist. Calvo collection; J. M. Sanchis photo.

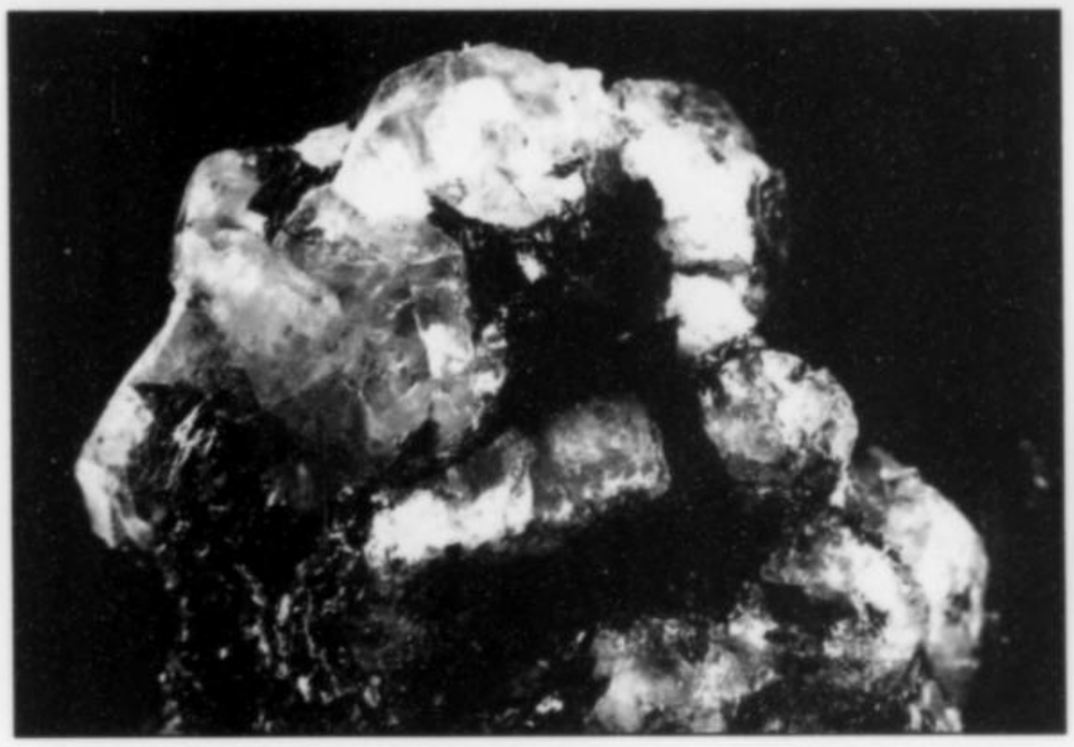

Figure 5. Cluster of crude phenakite crystals, 2 cm, in schist. Calvo collection; J. M. Sanchis photo.

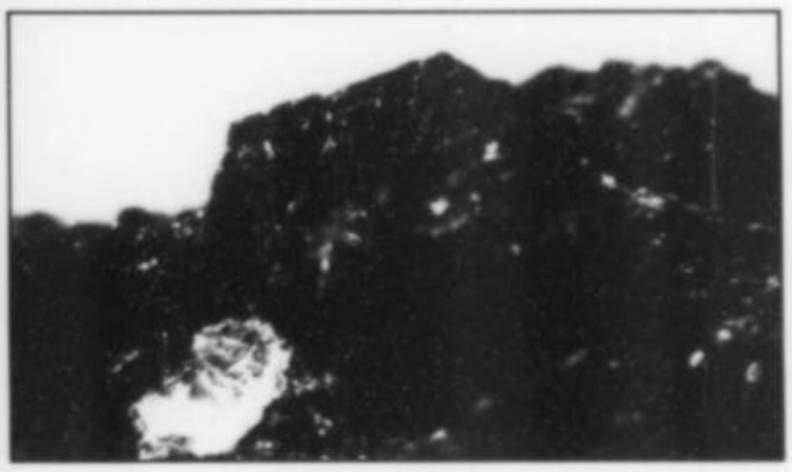

Figure 7. Chrysoberyl twin, 1 cm, in schist. Manuel Mesa collection and photo.

of most of the world's emeralds, the Colombian deposits being a notable exception (Sinkankas, 1989). Unfortunately the transparency, and therefore the gem value, of schist-type emeralds tends to be low.

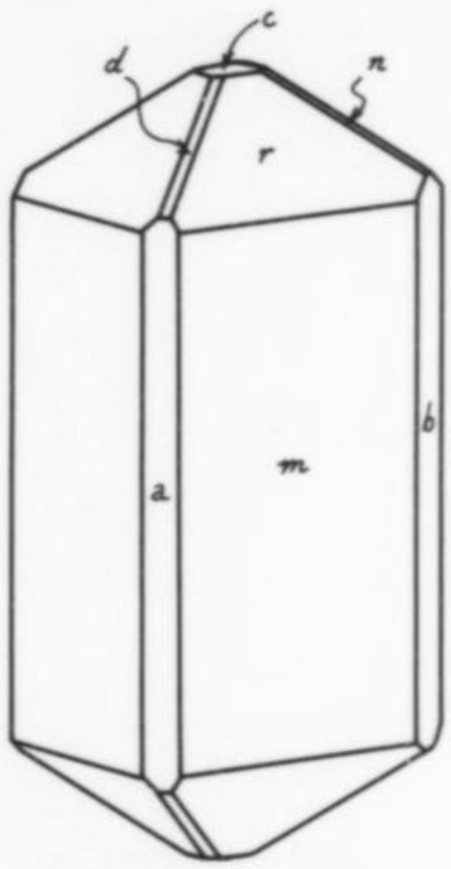

Figure 8. **Crystal drawing of A Franqueira chrysoberyl by Fernando Gascón, based on a specimen in the Miguel Calvo collection; forms are *a*{100}, *b*{010}, *c*{001}, *m*{hk0}, *d*{h0l}, *n*{0kl}, *r*{hkl}.**

MINERALS

Beryl $Be_3Al_2Si_6O_{18}$

Beryl crystals at A Franquiera have very simple morphology, consisting only of the first-order hexagonal prism {10$\bar{1}$0} and the basal pinacoids {0001}. Most crystals are rather elongated and doubly terminated. Some of the largest crystals have cavernous to irregular terminations, reflecting their actual structure as subparallel growths combining many individual crystals. Because the beryl crystals nucleated and grew in massive phlogopite, their crystal faces are rough and carry the imprints of myriad phlogopite scales. Many crystals are also heavily included by phlogopite, primarily in the near-surface zone of the crystals.

Beryl from A Franqueira ranges in color from yellow-green to grass-green due to the presence of up to 0.2% Cr, averaging 0.15% (Martín-Izard *et al.*, 1995). This is comparable to the Cr content of schist-type emeralds from other deposits worldwide, and also to Muzo emeralds (Sinkankas and Read, 1986). A Franqueira emerald contains an average of 0.71% Fe, which also serves as a chromophor (Martín-Izard *et al.*, 1995). Vanadium content has not been measured.

Crystals range from opaque to translucent, the lack of good transparency being attributable to phlogopite inclusions and internal fracturing. Some crystals are so heavily included as to appear gray-black in color. Many crystals show fracturing and rehealing roughly perpendicular to the *c*-axis, and some have become bent in the process. No significant amount of etching has been observed. Maximum crystal size is around 15 cm, but most crystals are 5 cm or less. The best crystals for color and translucency rarely exceed 2 cm. The few crystals that have been faceted resemble poor-quality Brazilian emerald.

Stream-rounded crystals of aquamarine beryl have been found near the roadcut, but these have no doubt originated from an as-yet undiscovered pegmatite body nearby.

Chrysoberyl $BeAl_2O_4$

Chrysoberyl is probably the earliest beryllium mineral in the assemblage (Martín-Izard *et al.*, 1995), and most crystals show heavy etching. Chrysoberyl occurs as irregular grains to 5 mm grouped in skeletal aggregates, as individual crystals to 1 cm, and as cyclic twins to 2 cm. Crystals and twins are most commonly around 5 mm in size or less, often associated in confused aggregates.

Morphologically the individual chrysoberyl crystals consist of the rhombic prism and rhombic bipyramid, modified by small pinacoid and second-order prism and pyramid faces. Irregular crystal surfaces preclude precise goniometry.

The more common (130) twins display a different habit consisting of a dominant pinacoid which results in flat hexagonal plates modified by small bipyramid faces; most twins measure under 3 mm, but larger examples show more development of the dipyramid at the expense of the pinacoid.

Many A Franqueira chrysoberyl specimens appear purplish red in incandescent light and green in daylight. This color change is prized in the gem variety known as alexandrite, but specimens found at A Franqueira tend to be highly fractured and unsuitable for cutting.

Phenakite Be_2SiO_4

Over the years, many phenakite specimens found at the locality have been discarded as poor quartz—the name "phenakite" is derived from the Greek word meaning "to deceive," in reference to its close similarity to quartz. A Franqueira is, at present, the only known locality for phenakite in Spain.

The phenakite occurs as irregular, rounded masses up to 5 cm, and more commonly as crudely formed crystals to 3 cm (usually 1 cm or less) in irregular groups. Most are heavily fractured. Isolated crystals of rhombohedral habit are also known, with rough surfaces showing the imprint of phlogopite scales.

Phlogopite $KMg_3Si_3AlO_{10}(F,OH)_2$

Phlogopite schist is the principal alteration product of dunite near the contact with pegmatite intrusions (Martín-Izard *et al.*, 1995), and it is within this schist that the crystals of beryl, chrysoberyl and phenakite are found suspended. The grain size is around 5 mm, with a preferred orientation resulting in the schistosity.

Tremolite $Ca_2(Mg,Fe^{2+})_5Si_8O(OH)_2$

The tremolite alteration zone, at some distance from the pegmatite contact, contains masses of rod-like crystals to 3 cm which are heavily fractured and intergrown. Tremolite content exceeds that of phlogopite in the zone. Beryl crystals near and inside the tremolite zone are more deeply colored, probably as a result of the increase in overall Cr away from the pegmatite contact.

CURRENT STATUS

The area surrounding A Franqueira is currently under claim (the "Beatriz" claim) by one of us (JRG), and is under study. Exploration to develop sources for industrial beryl, gem material and collector specimens is pending.

ACKNOWLEDGMENTS

We are pleased to acknowledge the valuable assistance provided by Fernando Gascón of Zaragoza and Manuel Mesa of Oviedo.

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What's New in Minerals

Springfield Show 1997

by Tom Moore

Early each August, we major-show-deprived easterners look forward avidly to Marty Zinn's *East Coast Gem, Mineral and Fossil Show* at the big Eastern States Exposition Building, in an outlying precinct of West Springfield, Massachusetts. This is not, of course, a hotel show like Marty's yearly productions at Denver and Tucson, and, except for Canadians, there are very few international elements to it. But there are 150 or so dealers, half of them mineral dealers, to keep a visitor buzzing, and many mineral offerings prove to be early blips on the What's New screen as we zoom in towards Denver.

Besides, this show usually has—and had again this year—numerous helpings of tangential, generous-hearted side features. Once again this year there was, for example, the "Gem and Fossil Mine" for the very young: six dollars admission fee at the spooky dark entrance, plastic hardhats with lamps provided; keep all you can find in there, kids. Then there was the "Kids' Store," with beginners' specimens, plastic dinosaurs, a mineral coloring book, and more, all proceeds to be donated to the Springfield Science Museum. There was a gold-panning station; also a mineral identification service; a large wholesale section; erudite lectures; Jeff Scovil taking pictures; and the ever-friendly Charlie and Marcelle Weber selling *Mineralogical Record* subscriptions. And stationed near the snack bar there was a perpetually cheerful man passing out free red balloons to whomever passed by—whether he was one of Marty's helpers, or had other affiliations, or had any at all, I never found out.

As **topaz** was the theme species for Denver in '96 and Tucson in '95, so it was for Springfield this year. Thus among the display cases was one by the American Museum of Natural History (New York) with five great and wonderful topaz specimens, including a huge blue Bement Collection specimen from Mursinka, Urals, Russia. Among other topaz-flashers were Bill Shelton, Ernie and Vera Schlichter, and Harvard—from whence Carl Francis lugged down a 225-pound crystal from Fazenda do Funiel, Minas Gerais, Brazil. The Peabody Museum, Yale University, had a thoughtful case on greisen mineralization, including, of course, topaz specimens, one of which was an 18th-century piece from the Gigot d'Orsy collection, with wine-yellow crystals all over a 15-cm matrix, from Schneckenstein, Obersachsen, Germany (see the 1781 illustration on p. 29, vol. 26, no. 1).

A partial list of other excellent cases: "Minerals of New England," with a gorgeous, gemmy, pink 3-cm elbaite crystal from the Strickland quarry, Connecticut (Boston Mineral Club); self-collected Bay of Fundy zeolite group, calcite and quartz specimens (David Redfield and Tom Minnich); self-collected Connecticut minerals (Joel Sweet); Tsumeb pseudomorphs (George Feist); a case of huge and dramatic barite and rhodochrosite specimens (Marv Rausch); English specimens from the W. W. Jefferis Collection (Carnegie Museum, Pittsburgh); European classics, including some fantastic miniatures of ultra-sexy things like German stephanite, German proustite and Rumanian gold (Phil and Cheryl Scalisi). Finally, the Mineralogical Society of Brattleboro, Vermont, put in three cases, one of which was devoted to miscellaneous mineral specimens from places with preposterous names: here the stars of the show were not the minerals but the labels, which, with neatly printed straight faces, showed locality designations like Childs Aldwinkle, Pinal County, Arizona; the Suckthumb quarry, Dorset, England; Slaughter Yard Face, Tasmania; and the Old Painful mine, Booger Bottom, Georgia. I wanted to go and get one of those red balloons and fasten it here just to help this case.

But on to market. Regrettably, there wasn't a lot of new material . . . although, yes, there *was* some beautiful orange **creedite** from Mina Navidad Rodeo, Durango, Mexico, in the keeping of Chris Wright of *Wright's Rock Shop*. This is not to be confused with *purple* Mexican creedite, which is from the Potosi mine in Chihuahua; I have seen the orange "Rodeo" kind only once before, and reported on it from the 1988 Nürnberg show (see vol. 20, no. 2, p. 147). These new specimens were found last September, and numbered, reportedly, fewer than 20 in all, in miniature to small cabinet sizes. They are spheres of divergent, well individualized spiky prisms, with individuals to 2.5 cm long; the crystals are actually colorless and transparent, but stained in most areas a bright reddish orange or occasionally pale brown. The luster is high and the overall aspect of these bristling, glittering specimens is extremely attractive.

Chris Wright also had about ten miniatures with 2-cm "raspberry" **grossular** garnet dodecahedrons on white weathered skarn matrix from Coahuila—*much* better specimens than the general run we are used to seeing, as the crystals have sharp form, deep color and very little damage. Still again, Chris had large (to 12 cm long) Guerrero **amethyst** crystals on matrix coated by orange-brown **calcite** crystals—a new association for this material.

Frank and Wendy Melanson's dealership *Hawthorneden* is a busy hive towards which I always make an early beeline in Springfield, as there are usually many odd things here available from few (or no) other dealers, and usually lots of thumbnails too. This time, the Melansons had about 25 fine thumbnails of **stokesite** from Corrego do Urucum, Galileia, Minas Gerais, Brazil (see locality article in vol. 17, no. 5). Each specimen is an elegant, sparkling 1.5 or 2-cm sphere, its whole surface ridged and ruffled by the canted edges of grayish pink, flattened, 1-mm stokesite crystals: not bad-looking specimens, and certainly best-from-anywhere for this very rare Ca/Sn silicate. Industrious digging last year in the Urucum dumps yielded, Frank says, maybe 200 such stokesite balls, none larger than 4 cm in diameter.

Still speaking of rarities—Isaias Casanova of *I.C. Minerals* has latched onto some excellent new specimens of **boltwoodite**, a K/U silicate reported from the Arandis mine, Namibia (still the only

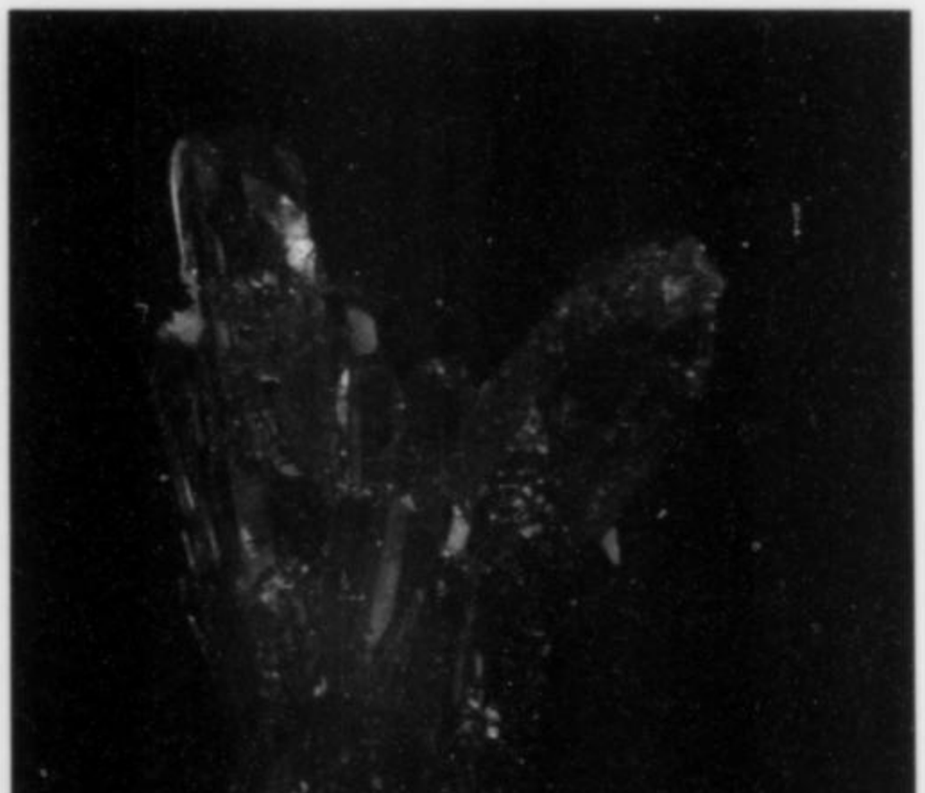

Figure 1. **Barite crystal group, 3.3 cm, from the Rosh Pinah mine, Namibia. *I.C. Minerals* specimen; Jeff Scovil photo.**

Figure 2. **Boltwoodite sprays on matrix, 3.5 cm as shown, from the Rossing mine, Arandis, Namibia. *I.C. Minerals* specimen; Jeff Scovil photo.**

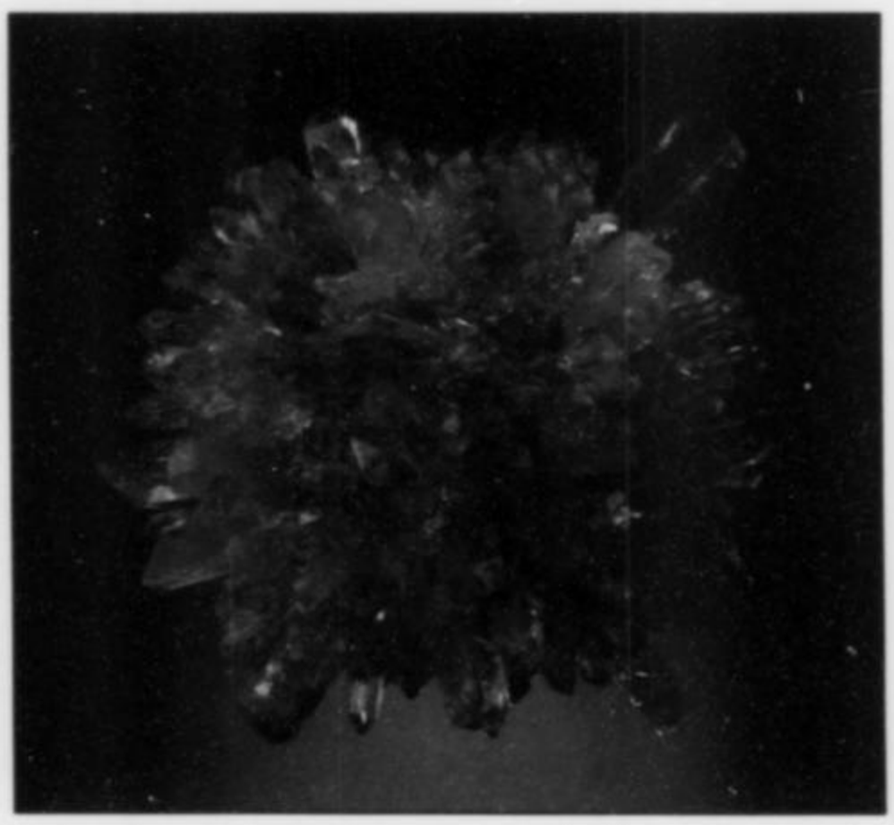

Figure 3. **Creedite crystal cluster, 5 cm, from Rodeo, Durango, Mexico. *M. Phantom Minerals* specimen, now in the collection of Joe Polityka; Jeff Scovil photo.**

Figure 4. **Sturmanite crystal to 3.5 cm, from the N'Chwaning mine, near Kuruman, South Africa. *I.C. Minerals* specimen; Jeff Scovil photo.**

(Continued on page 508)

Wayne A. Thompson

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What's New *(continued from page 506)*

good specimen source) in 1975 (see What's new in minerals? vol. 6, no. 5). Arandis mine boltwoodite comes as bright yellow-orange sprays of acicular crystals, the sprays to 1 cm, flat-lying or upstanding on dark drusy calcite vug linings in weathered brownish limestone (?). Isaias had about a dozen miniature and small cabinet pieces ($200–$300), with small sprays scattered about fairly generously on each: handsome hand specimens of a rare species, and with good micromount potential as well.

Additionally, the *I.C. Minerals* stand featured some beautiful **barite** from the Rosh Pinah mine, southern Namibia: a couple of 8-cm chunks of gray vuggy rock covered everywhere by lustrous, pale orange, transparent 1-cm barite blades. Jeff Scovil took a photo of one unbelievable **sturmanite** specimen Isaias had: a simply monstrous, *gemmy* yellow prism on matrix, from the N'Chwaning mine, South Africa. But from the N'Chwaning II mine, a few new specimens showed sturmanite microcrystal coatings over black manganese ore, the sturmanite being a yellow-*green* color quite new (I believe, and Isaias believes) for the species; think of the color of green-leaning Bunker Hill mine, Idaho pyromorphite.

The *Fersman Mineralogical Museum* (Leninski Prospect 18-2, 117071 Moscow, Russia) showed up at Springfield with some **magnetite** specimens from Dashkesan, Azarbaijan, which represent a quantum jump in quality for this material. In perhaps 20 miniature and small cabinet-sized matrix specimens, the half-embedded magnetite crystals, usually sitting alone, may be octahedrons, dodecahedrons, or any combination of these; they are generally very sharp, have a medium-high submetallic luster, and reach 4 cm across. The matrix is a massive epidote/garnet/quartz/calcite skarn rock, occasionally with bright blackish green brushworks of epidote prisms in dense parallel growth. Also from Dashkesan, there is good **quartz** in milky to transparent prisms to 12 cm long, some with girdles of smaller prisms down around the bases. I saw none of the fat, sharp, milky white hexagonal crystals of apatite which sometimes appear from this place, but surely Dashkesan is a locality worth close watching.

Dudley Blauwet of *Mountain Minerals International* always makes the Springfield scene, and nearly always has something new and gemmy and/or exotic from the Himalayas. One standout this time was pale brown, transparent **axinite** in typical French or Russian-style axe-blade crystals to 3 cm, sometimes lightly chloritized (and then opaque with a greenish surface schiller), and implanted singly or in decorative small clusters of two or three on quartz matrixes to 10 cm across. The locality is a new one for axinite: Khapalu, Ghanche District, Baltistan, Pakistan. There's also a new and pretty **diopside**, in loose sprays of deep smoky green, lustrous, translucent to transparent bladed crystals, from Markhi Khel near Spinghar, Nangarhar Province, Afghanistan: about 20 thumbnails and miniatures of these. Finally, check out Dudley's beautiful, doubly terminated, simple hexagonal prisms of bicolored **beryl** from Baha, S.W. Buspat Peak, Baltistan, Pakistan. These utterly transparent 2-cm crystals are zoned palest green and palest pink, and are extremely sharp, and so subtly laid over their white microcrystallized feldspar matrix that you have to look twice to see that they're there—you see the matrix *through* them, à la "icecube" fluorite from Dalnegorsk.

The major New England news is of a long-known locality which seems to be in an upbeat mood nowadays. I refer to the Wise mine, Westmoreland, New Hampshire, a hypothermal deposit long famous for beautiful sea-green **fluorite**; you may have noticed the recent plenitude of this material largely as cleavage octahedrons and cutting stock but also as lovely large crystal groups. The Wise mine began in 1890 as a commercial operation for fluorite as flux material, but from its closure in 1919, almost all the way to the present day, it was merely a haunt for casual rockhounds. Serious specimen mining commenced in 1994, when a lease was secured by James Tovey and Bob Borofsky of *Jolynne Associates* (363 Scoby Rd., Francestown, NH). I talked to them in Springfield, where they were showing an enormous spread of green fluorite and sceptered **milky quartz** specimens of every quality but almost all of one size: very large. Some fluorite crystal groups indeed are 45 cm across, and individual octahedrons reach 9 cm on edge. Scepter quartz prisms reach 5 cm, and a few are slightly smoky; these occur in pleasing cabinet-sized groups by themselves, or else nicely complement the big green fluorite crystals on other groups. All specimens are in good shape, as the Jolynne folks keep their blasting to an absolute minimum, often working crystallized pockets by flushing them out with water.

A final tip of the Springfield topper must go to Wayne and Dona Leicht of *Kristalle*. The Leichts recently have been having fun buying up old collections in New Jersey and in Europe, and for this show they assembled two very nice suites of things to sell: oldtimers from (1) Cornwall, England, and (2) the Paterson/Prospect Park, New Jersey, zeolite-bearing basalt traprocks. There were outstanding classics in both categories, but the specimen I dwelled on longest was a 2 x 3-cm cluster of sharp, medium-lustrous black **chalcocite** crystals, a handsome piece, with individuals to 1 cm. And *I'll* bet *you* thought I was going to say it belonged to the Cornwall suite; but no, the locality is the Chimney Rock quarry, Bound Brook, New Jersey (the article on this locality in vol. 9, no. 1, mentions only vague "sulfides of copper" occurring sparingly there). When I checked back again at the Leichts' stand near the end of the day I was quite surprised to note that no northeastern collector had yet snapped up this amazing "locality" specimen. Where is it now (a serious question: would someone care to share a photo?)?

Well yes, it's a short report this time . . . but I'll try to make it up to you, and soon, from DENVER.

The Friends of Mineralogy

Who We Are:

Vol 1, No 1, Mineralogical Record, Spring 1970

The *Friends of Mineralogy* was founded in Tucson, Arizona, on February 13, 1970. Its objectives were to promote better mineral appreciation, education and preservation. The chief aims and activities of *FM* include:

* Compiling and publishing information on mineral localities, and important mineral collections.
* Encouraging improved educational use of mineral specimens, collections, and localities.
* Support a semi-professional journal of high excellence and interest designed to appeal to mineral amateurs and professionals, through which *FM* activities may be circulated.
* Operating informally in behalf of minerals, mineral collecting, and descriptive mineralogy, with voluntary support by members.

The Mineralogical Record has agreed to an affiliation with the Friends of Mineralogy whereby it will publish its written material and news of its activities. The *Friends of Mineralogy* will support the *Mineralogical Record*, since the aims of both are similarly educational and directed toward better coordination of the interest and efforts of amateurs and professionals.

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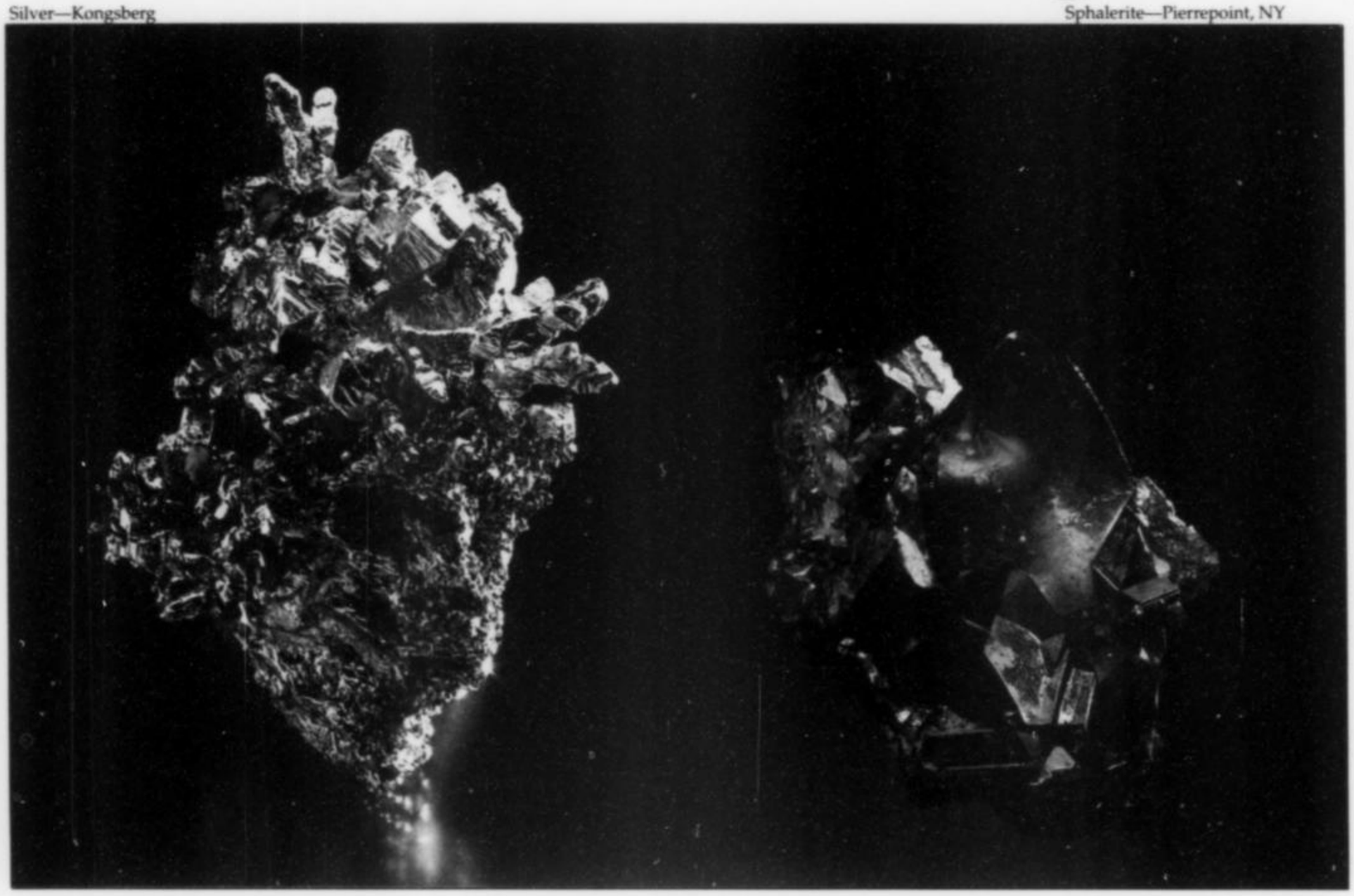

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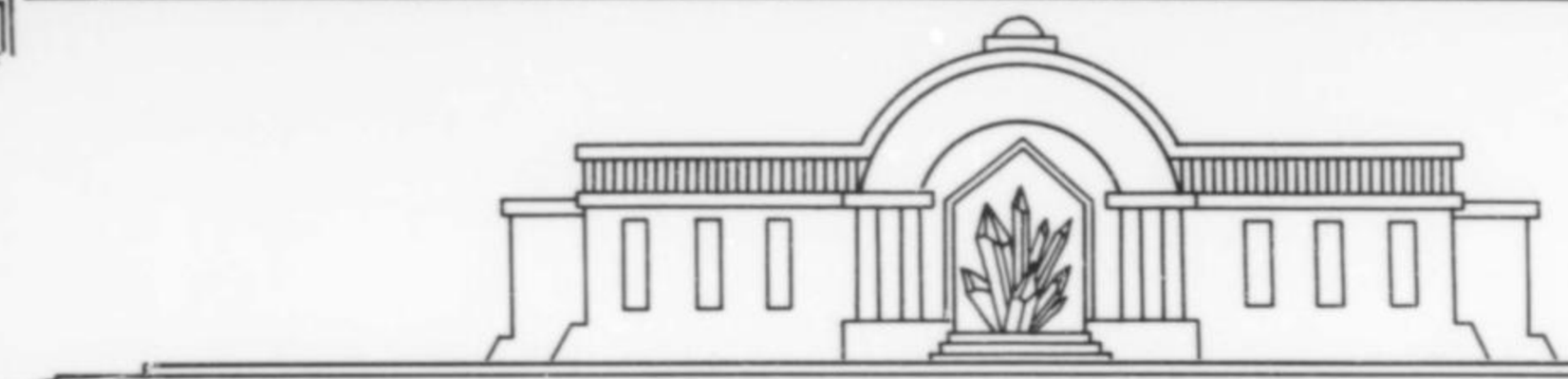

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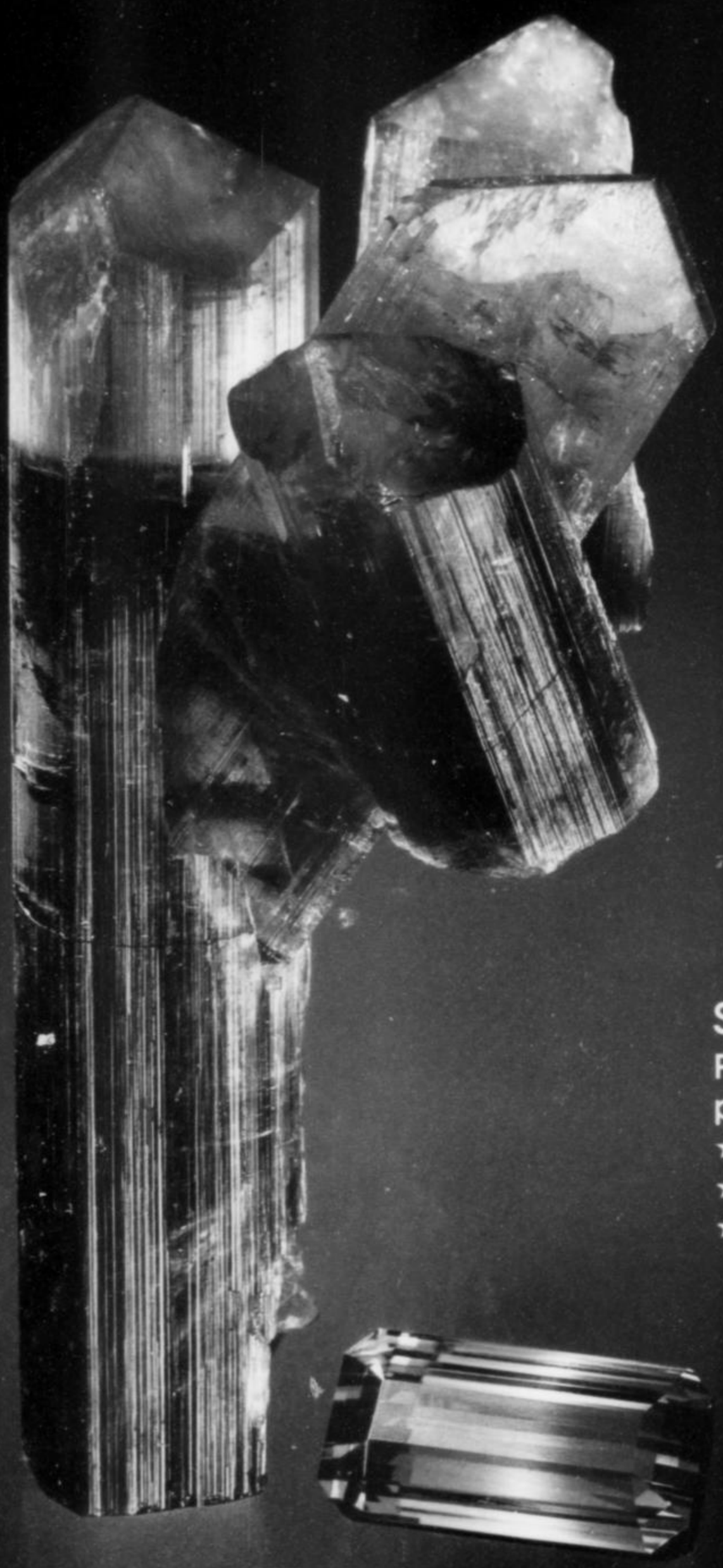

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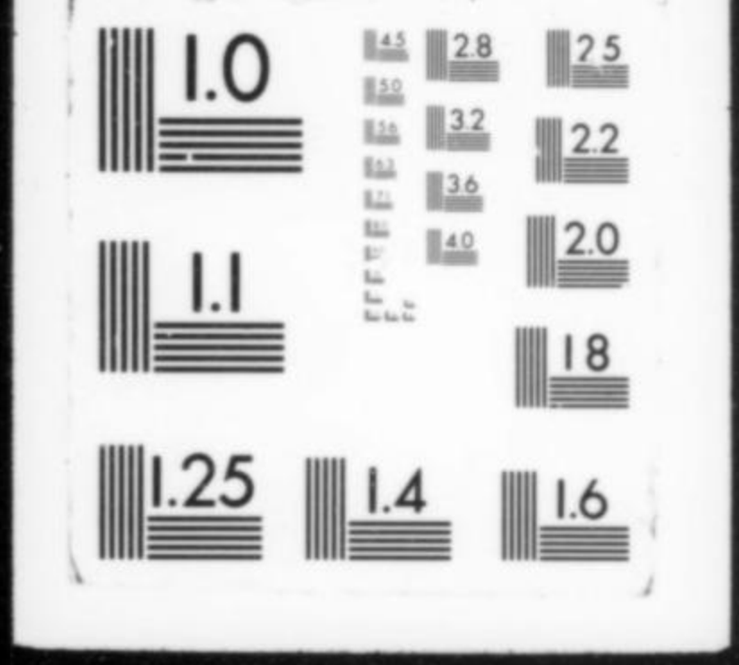
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