the Mineralogical Record

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Number Three
May–June 1996
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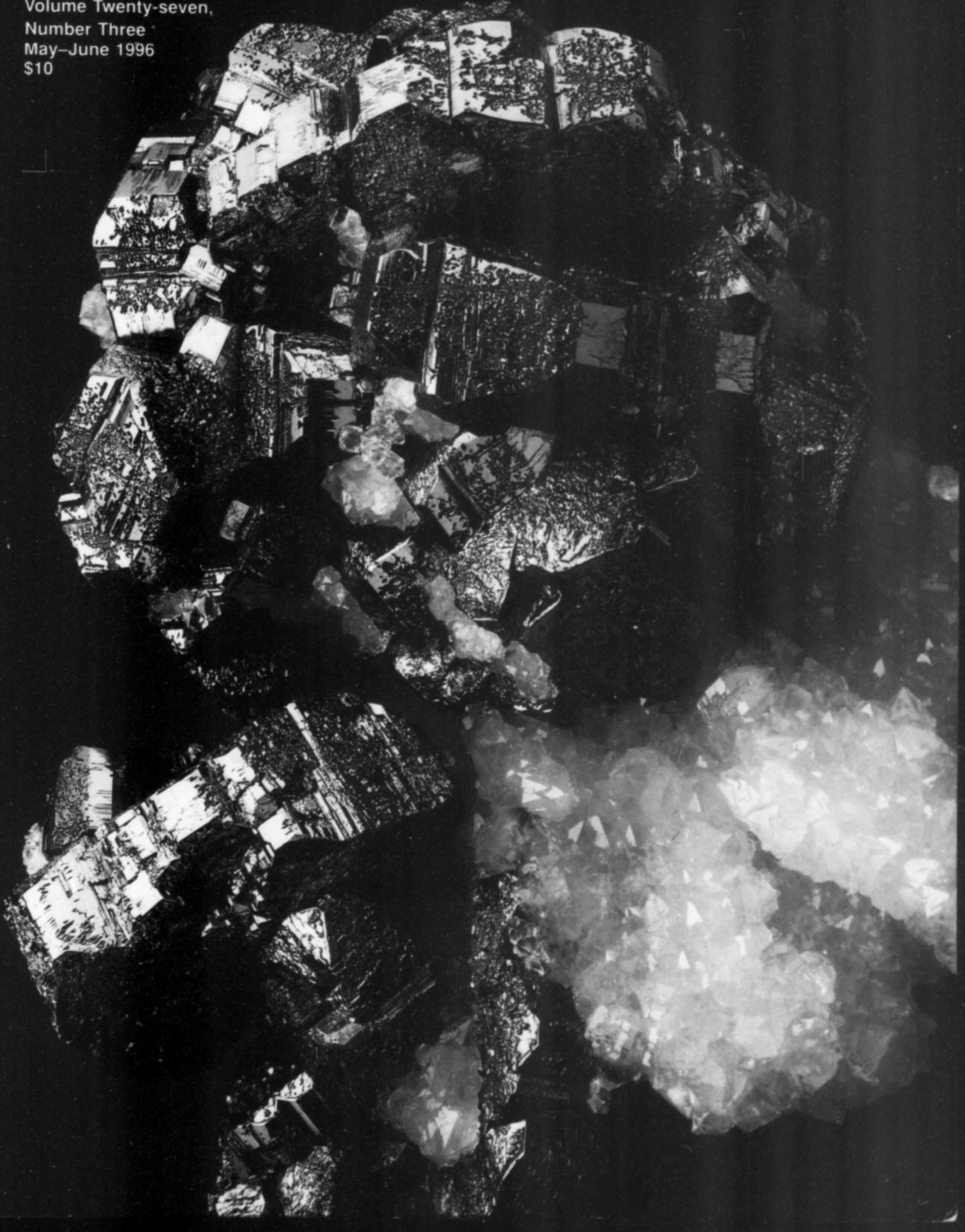


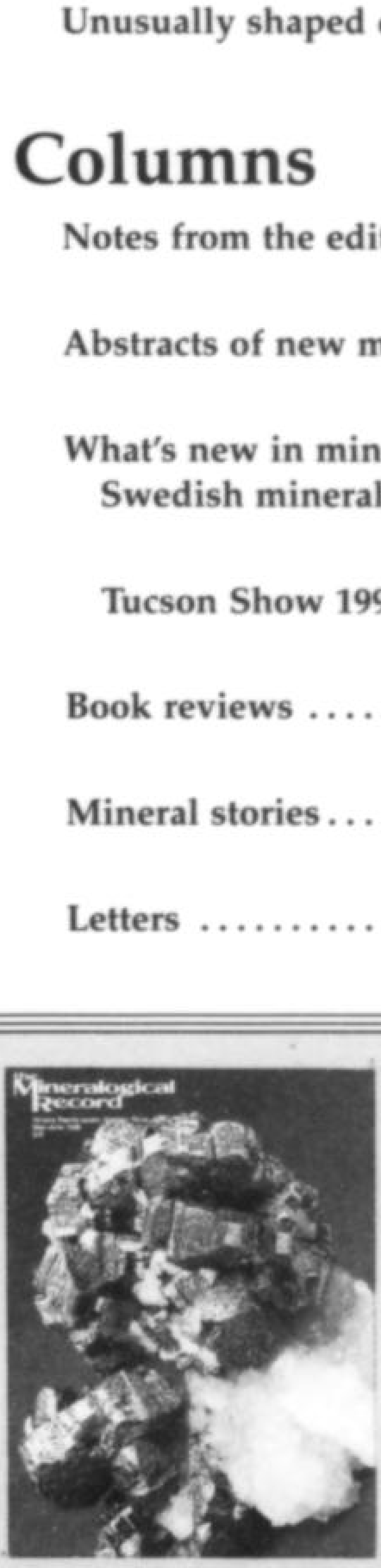
KRISTALLE

THE MINERALOGICAL RECORD

May–June 1996 Volume Twenty-seven, Number Three

Articles

Columns



COVER: BOURNONITE crystals on quartz, 8 cm, from the Herodsfoot mine, Liskeard, Cornwall. Stephen Smale collection and photo.

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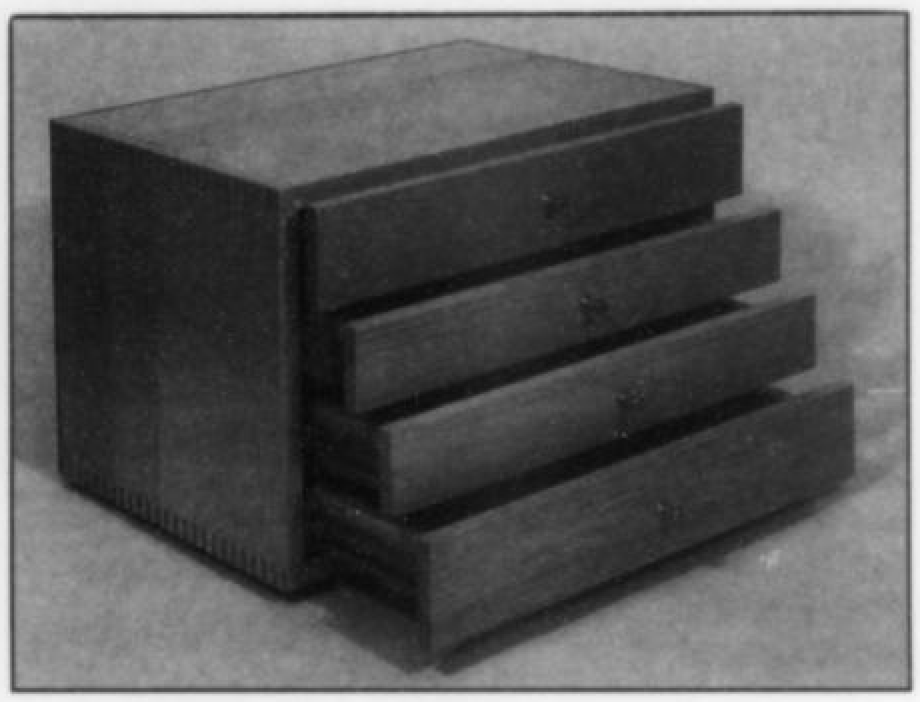
notes from the EDITOR



MINERAL CASES

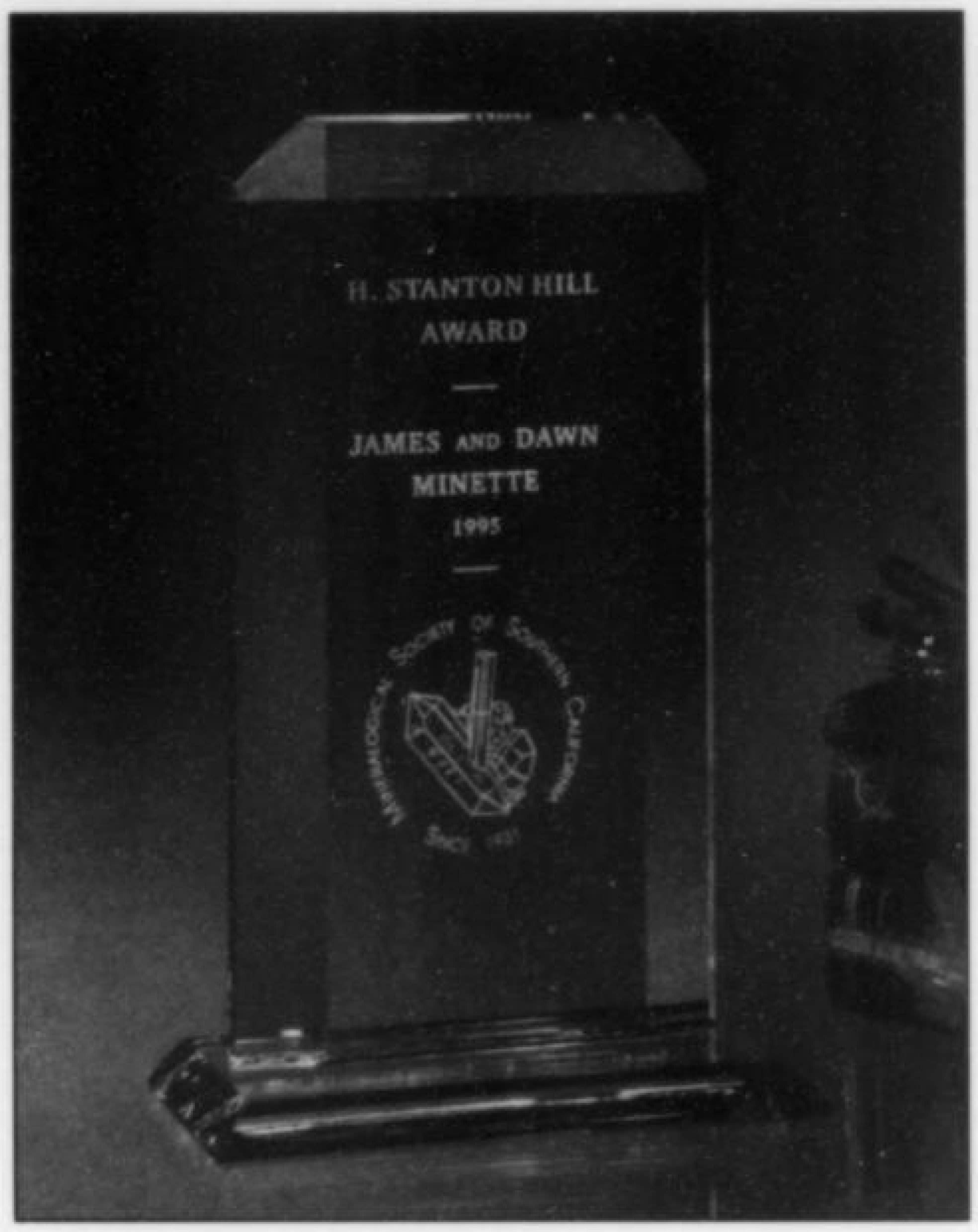
Every collector needs a good place to keep his or her collectibles. Some of us rely on stacks of flats in the closet, while others go so far as to purchase or build display cases and chests of drawers. The real paranoids/realists (take your choice) prefer home security vaults; we reported on some of these in the September-October 1994 issue.

Because proper storage and display is such an important aspect of collecting, we will be featuring here in future issues some of the current manufacturers and suppliers of mineral cabinets and cases. (If you offer such a product, please send us the particulars plus a photo or two.)

To start things off, the featured cabinetmaker for this issue is **Ernie Schlichter** (P.O. Box 193, Sudbury, MA 01776, Tel: 508-443-6141). Ernie is a long-time mineral collector and part-time dealer known to everyone who has made the rounds at major shows. His four-drawer specimen chest measures 13 x 13 x 20 inches, and is sized to hold 72 thumbnail perky boxes in each drawer. Wooden divider strips separate the perky boxes for better viewing and easy removal. Inside dimensions of the drawers are 2 x 12 x 19 inches. The drawers move on nylon rollers out to full extension, and have strong stops. Solid clear pine ($175) or mahogany ($245), finger joint construction, and fully finished surfaces characterize these nice chests. UPS shipping is available.

HANG ONTO YOUR BOOKS ISSUE!

Due to an accidental press underrun combined with the purchase of 200 copies by a philanthropist planning to donate them to libraries, we are already **sold out** of the regular softcover edition of the special *Mineral Books* issue (vol. 26, no. 4) and have less than 100 copies of the hardcover edition left. We haven't sold out an issue so fast since the first *Gold Issue* in 1982 and the rare first *Colorado Issue* in 1976. Considering that it is of interest to bibliophiles as well as mineral people, I think it is safe to accord this one "collector's item" status already. We don't like issues to sell out so fast, but sometimes it happens. And, at 192 pages, it will be far too expensive to ever reprint. So hold onto your copy, and if you happened to be lucky enough to get an extra one, congratulations!



NEW AWARD ESTABLISHED

The Mineralogical Society of Southern California, hosts of the former Pasadena Show which has now been reborn in Pomona, has created an award for the best display case at the show. It will be known as the *H. Stanton Hill Award,* in recognition of Professor Hill's contributions to the M.S.S.C. (he is one of the founders of the Society), to the education and encouragement of earth science students of all ages, and to the advancement of mineralogy throughout his extraordinary career.

Society members and non-members alike are invited to compete (prior application is required). There will be no formal rules; judges will consider any aspects they deem appropriate.

Considering the many superb collections owned and frequently exhibited at the show by Western collectors, this prize will truly represent an accomplishment for the winner.

NEW SERVICE FOR ADVERTISERS

Advertisers who think they may want to tailor the content of their ads to the topics of future special issues can now sign up to be notified in advance. Just let the editor know what your FAX number is, and that you would like to be placed on the *advance notification list*. You will then receive a FAX announcing the topic of each special issue prior to the closing date for changes, with deadlines specified for changes in text, illustrations and size. Normally about two weeks will be allowed for text and illustration changes, but only a couple of days for size changes. This is because layout begins almost immediately after the decision as to which articles or topics will be included in the next issue. (Fax the editor at 520-299-5702.)

ERRATUM

In the January-February issue (p. 64) we pictured a beautiful fluorapatite group from Rio Grande do Norte, Brazil. I remember it clearly because Isaias Casanova of *I. C. Minerals* was kind enough to show it to me in the hallway of the Holiday Inn Denver Show last September. (Laura Johnson is now the proud owner.) So I haven't a clue as to how we could have referred to him in the figure caption as Isaias *Collins*! Anyway, check out his latest mineral video, which contains many other very fine specimens for sale (see his ad for details).

THE BOULBY MINE

CLEVELAND, ENGLAND

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The Boulby potash mine has produced some of the world's finest specimens of blue boracite, ericaite and hilgardite. The locality continues to be actively mined and may yield further specimens in the future.

INTRODUCTION

Boulby mine is situated in the county of Cleveland on the northeast coast of England in the North York Moors National Park (the grid reference for the main shaft is NZ 763 183). It is operated by Cleveland Potash Ltd. and has some of the deepest workings (1200 meters) in Britain. The primary product is potash (KCl minerals), most of which is sold for agricultural use, in fertilizers.

The mine has recently been reported in mineralogical journals as a new locality for well-crystallized boracite and hilgardite (Robinson and King, 1993; Cooper, 1994; Moore, 1994; Weiss, 1994). However, the occurrence of borate minerals in the English Zechstein evaporites has been known for many years (Stewart, 1965), and the presence of nodules of boracite and hilgardite in the sylvinite ore at the Boulby mine has been recognized since mining began in the early 1970's (Milne, 1978). The fine, well-crystallized specimens, particularly of boracite, which are currently available to collectors were discovered during the development of a new area of the workings in late 1991. They represent the only significant discovery of fine-quality collector specimens at the mine to date.

Access for collectors to the workings, which radiate for many kilometers about the shaft bottom, is very restricted. In any case, collecting is difficult since specimens are rare and it is not easy to distinguish good material *in situ*. Temperatures in the headings commonly reach 40° C, and this together with high humidity and a heavily salt-laden atmosphere makes working conditions challenging. The majority of specimens described here were recovered by the mine geologists.

HISTORY

Zechstein salt and potash deposits are the basis of major chemical industries in the United Kingdom, Germany and Poland. Potash was discovered in northeast England in 1939 in a borehole drilled by the D'Arcy Exploration Company to test for oil and gas.

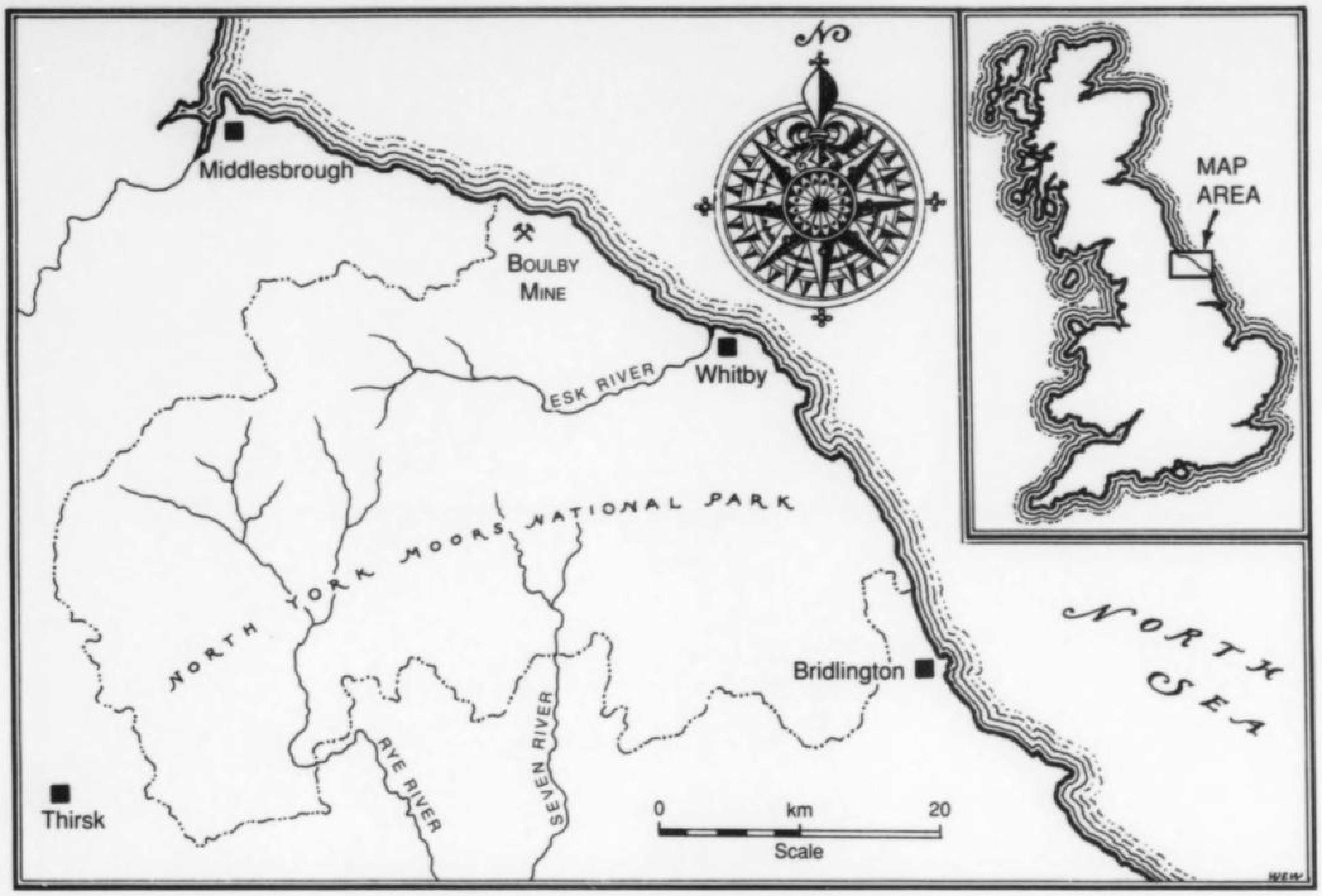


Figure 1. **Map showing the location of the Boulby mine on the east coast of England, in the northeastern corner of the North York Moors National Park.**

Ten further boreholes drilled between 1948 and 1952 (by Imperial Chemical Industries and Fisons) proved the richness of the deposit, but because of its depth, mining was not considered possible (Woods, 1973).

Developments in deep-mining technology in the Canadian potash fields led to a re-evaluation of the Boulby deposit, and further boreholes were drilled between 1962 and 1968. Three separate exploitation plans were submitted as a result, two for conventional mines and one for a solution mine. Planning consents were granted, with the understanding that the developments would blend sympathetically with the environment, since the mines would be within the boundaries of the North York Moors National park.

Only one mine was developed beyond the planning stage. Cleveland Potash Ltd., a company jointly owned by Imperial Chemical Industries (ICI) and Charter Consolidated, began sinking two 5.5-meter-diameter shafts, one for ore and the other for men. This was a considerable engineering task since the shafts were deep, and passed through sandstone aquifers which had to be carefully sealed to stop water flow. A full account of the freezing and grouting technologies developed during the shaft sinking is given by Cleasby *et al.* (1975). ICI relinquished their interest in Cleveland Potash soon after the mine opened in the early 1970's. The company is now wholly owned by Minorco.

The potash deposit is worked using a variation of a mining technique known as room and pillar: this system, which is commonly used principally in coal mining, allows for areas to be extracted (rooms) leaving pillars to support the workings. At the Boulby mine, the voids (rooms) from which the ore is extracted are termed "panels." Potash is extracted from the panels using machines called "continuous miners," similar to those used in coal mining. These machines produce up to 300 tons of ore per hour. The ore is loaded into shuttle cars which work in pairs, loading it into feeder breakers and subsequently onto belt conveyors. It is carried to the shaft system and hoisted out of the mine in 20-ton skips, with an hourly hoisting rate of 600 tph. Current production is more than 3 million metric tons of ore annually, from which about 1 million tons of potash is extracted.

Development work is carried out in a thick, relatively stable halite band some 30 meters below the potash. Ramps are driven upward from the development roadways into the potash, which is less stable structurally. Even the stable salt access roads are under high lithostatic pressure, because of the depth of the workings, and long horizontal slots are cut into the sides of the roadways to relieve stress. An aspect of the high rock pressure in the potash bed which initially made mining difficult was the existence of small, highly compressed pockets of gas (mainly nitrogen and methane). These were breached in the past, occasionally with adverse results. In one case a 60-ton continuous miner was turned on its side. Mine engineers have now developed a system in which the area to be mined is pre-drilled, thus neutralizing the gas pockets and eliminating the possibility of rock bursts.

An interesting feature of the mine, although one that has little to do with either mining or minerals, is the presence of a cold dark-matter detector. Shielded from the effects of cosmic rays by 1000 meters of rock, scientists are performing an experiment which may shed light on the so-called "missing mass" of the universe, a problem which has puzzled cosmologists for decades.

GEOLOGY

The workings at the Boulby mine are developed within a thick sedimentary sequence of late Permian age. In northeast England, the latter part of the Permian was characterized by episodic

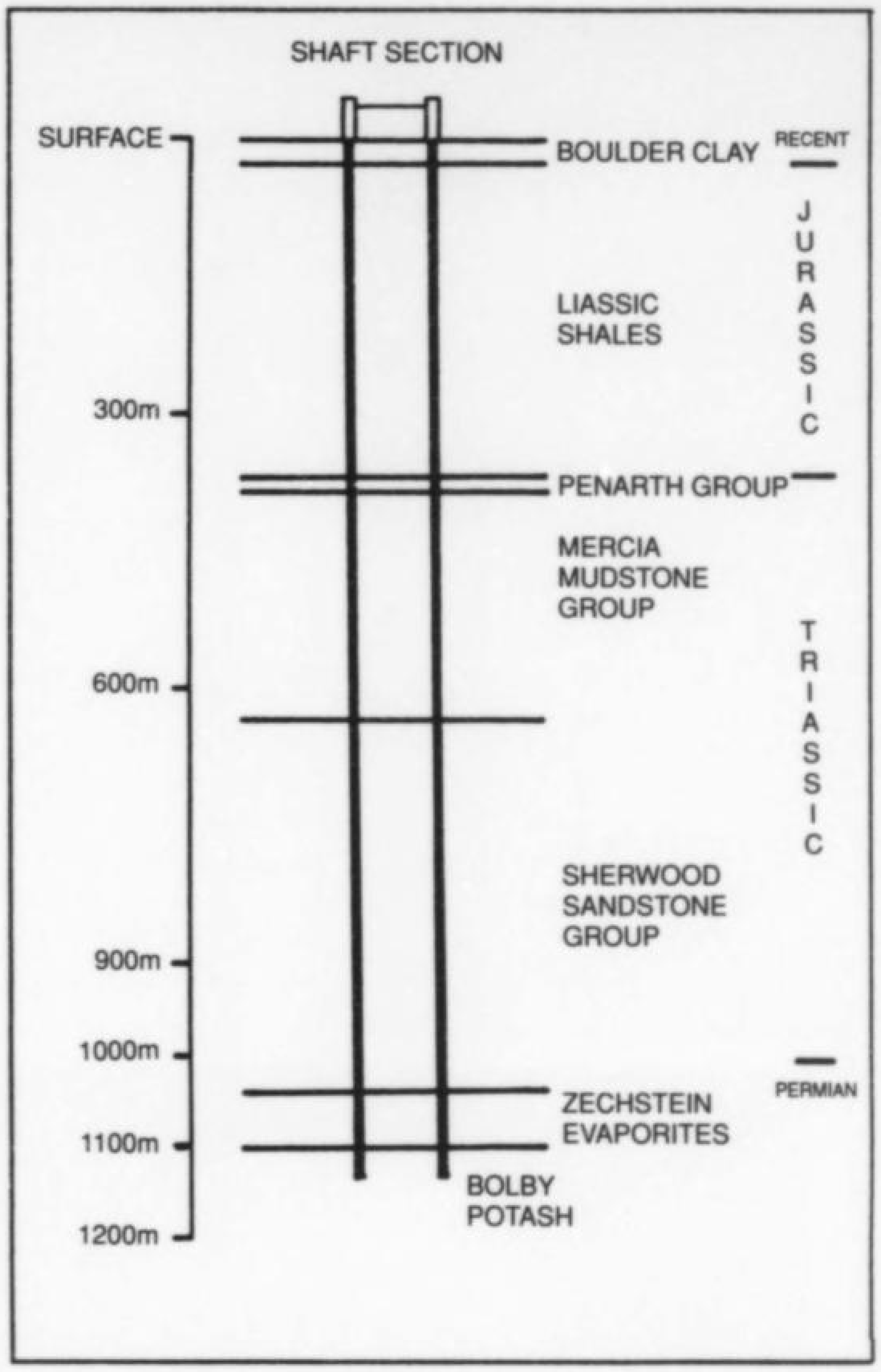
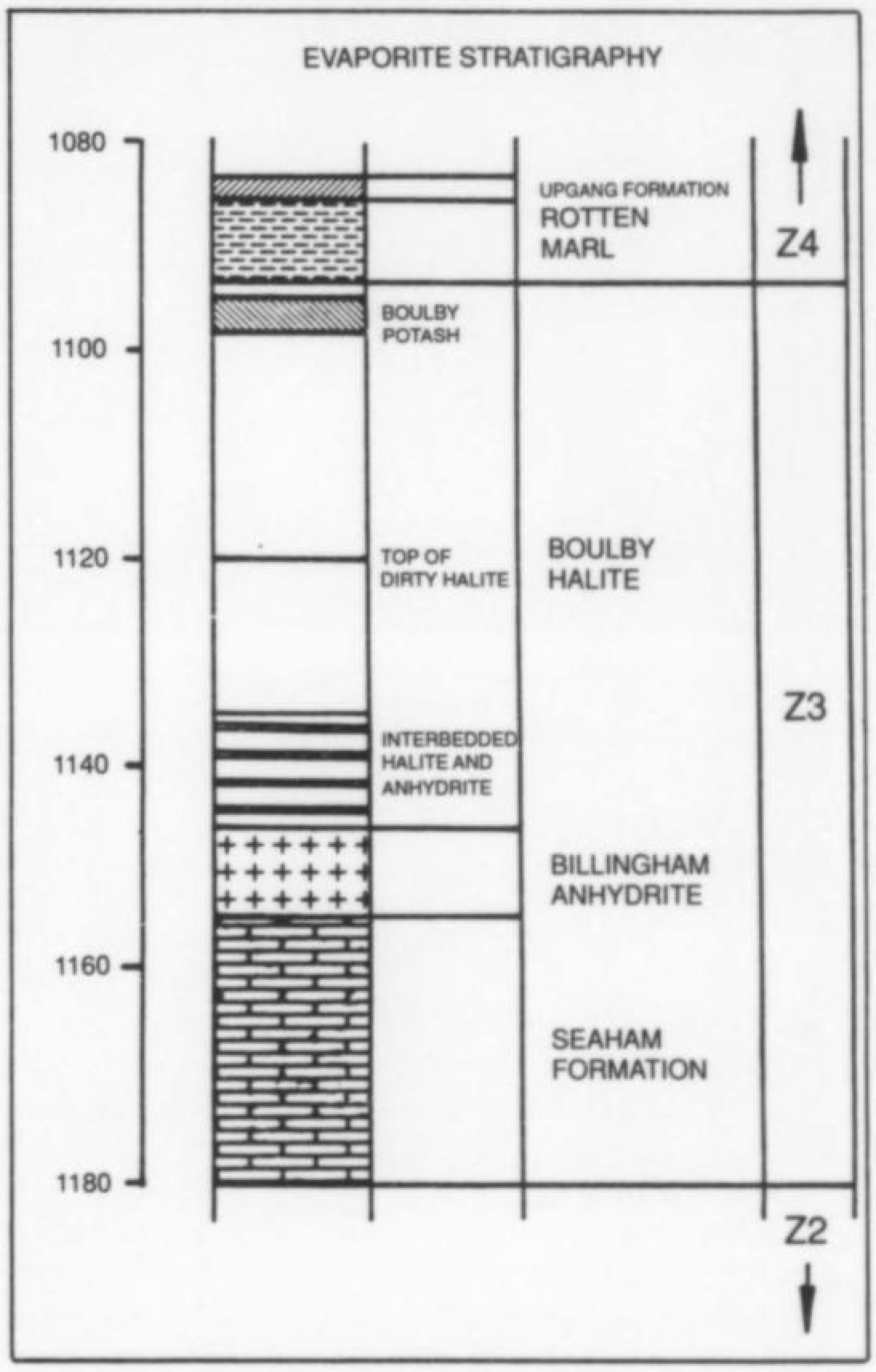


***Figure 2.* A section through the shafts at the Boulby mine showing dominant lithostratigraphic divisions and corresponding ages of the strata. The right-hand diagram presents a more detailed stratigraphy of the third cycle of Zechstein evaporites (the workings of the Boulby mine are developed within the Boulby Potash near the top of this cycle). Both diagrams are modified from Holmes (1991).**



flooding of a large subsiding inland drainage basin, which led to the periodic formation of the shallow Zechstein Sea. The sea was periodically cut off from its oceanic source somewhere to the north, and subsequently evaporated. Successive flooding and evaporation led to the cyclical formation of layers of carbonate, siliclastic and evaporite rocks. Four main cycles of Zechstein Evaporites, termed Z1-4, are recognized in the English part of the Zechstein Sea basin. These are overlain by about 1 km of mostly Jurassic and Triassic sandstones and shales at the Boulby mine.

Sylvinite (a term used to describe sylvite-halite rock) only occurs in economic quantities in the third Zechstein evaporite cycle (Z3). This has the dolomitized limestones of the Seaham Formation at its base, followed by the Billingham Anhydrite. Above the Billingham Anhydrite, the soluble chlorides of the Boulby Halite form the upper part of the cycle. The Boulby Potash is a distinct potassium-rich subdivision of the Boulby Halite. It is separated from the base of the fourth evaporite cycle by a thin, impure halite band.

The Boulby Potash has an average thickness of about 7.5 meters with considerable local variation brought about by flow and remobilization in areas disturbed by faulting. It is made up of an intimate mixture of sylvite, halite, some carnallite and various minor impurities. Insoluble impurities, including anhydrite, magnesite, hematite, borate minerals and clays, can sometimes make up as much as 50% of the rock, but are typically present at a much lower concentration.

Small borate nodules a few centimeters in diameter are common in a distinct band near the base of the Boulby Potash, known locally as the Borate Nodule Bed. It is, however, a series of larger nodules, up to about 1 meter in diameter, which have furnished most of the fine specimens collected recently. These large borate nodules are rare, and appear to be associated with an indistinct carnallite band found at or near the base of the Boulby Potash in the north and west of the mine. They are of no commercial interest, but present a particular hazard to mining due to their exceptional hardness.

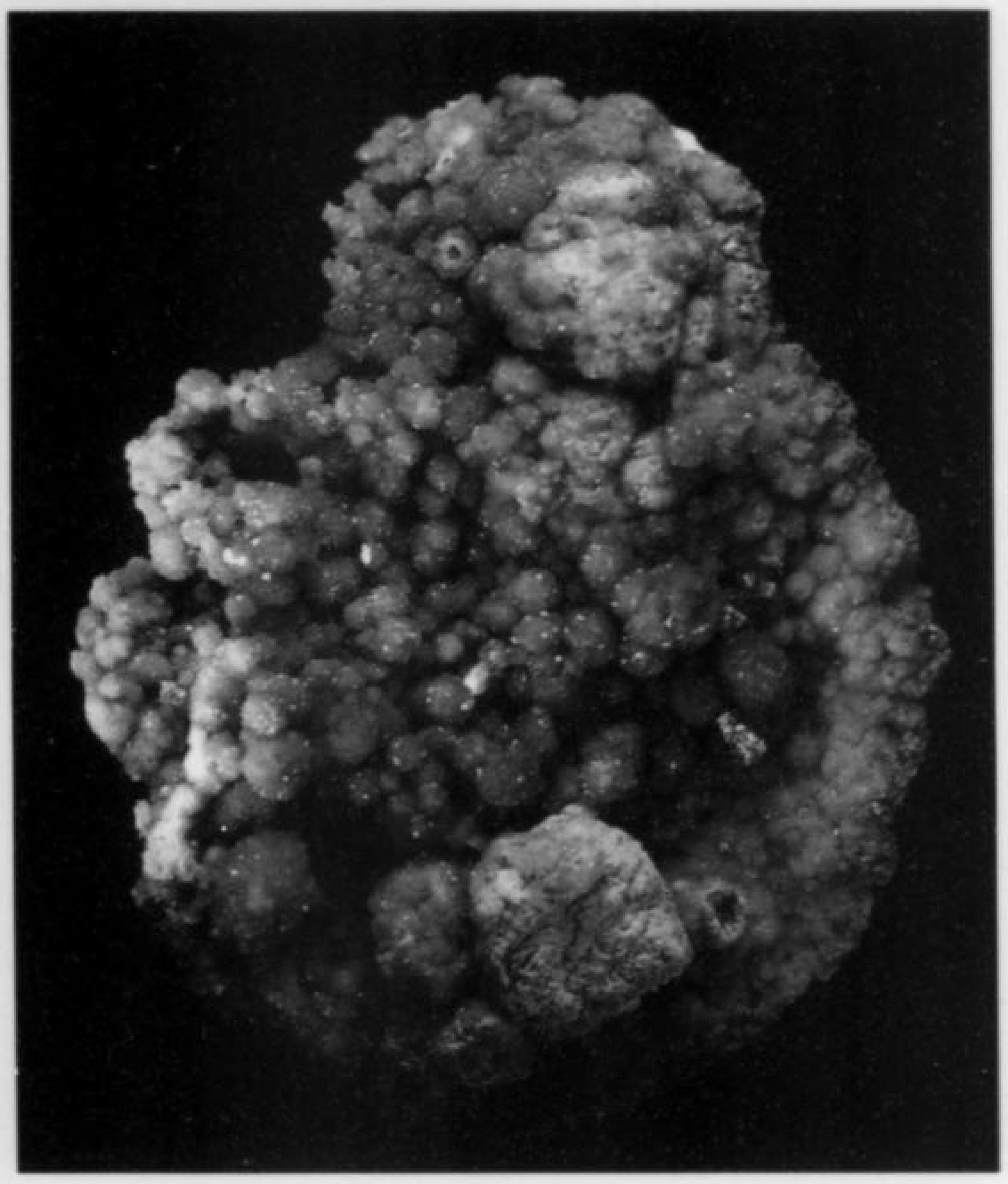
A general review of the Permian paleogeography of the British Isles, describing the conditions in which the Zechstein Evaporites were deposited, is provided by Smith *et al.* (1992). Detailed accounts of the petrology of the evaporites are provided in a classic series of papers by Stewart (1949, 1951a, 1951b, 1956) and also by Armstrong *et al.* (1951). More recent publications which deal principally with the structural geology at Boulby mine are Woods and Powell (1979) and Holmes (1991).

MINERALOGY

A review of the mineralogy of the British Permian evaporites, summarizing the seminal work of F. H. Stewart and others, is provided by Stewart (1965). Descriptions of some of the minerals occurring at the Boulby mine are given by Milne (1978). The following discussion is based on a recent article (Green and Freier,

Figure 3. **Blue pseudo-tetrahedral boracite with white magnesite plates; 2.4 cm. David Green specimen and photo.**

Figure 4. **Blue-green boracite, 7 cm, showing well-developed spherulitic structure. Manchester Museum specimen (MANCH:N12075) donated in 1993 by Michael E. Smith. David Green photo.**



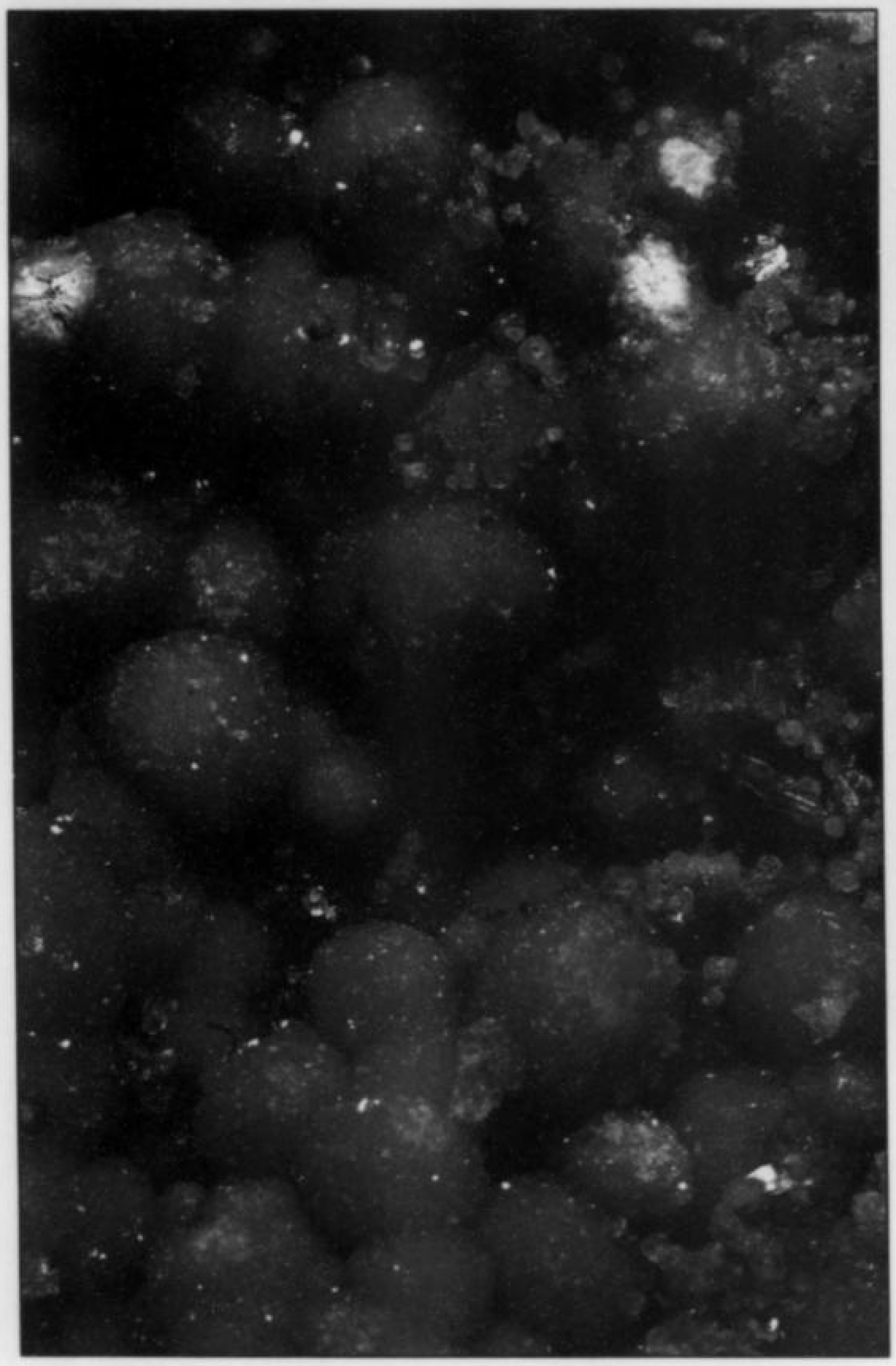


Figure 5. **Blue-green boracite showing well-developed spherulitic structure with interstitial hilgardite. Small area (3.6 cm) of a cabinet-size specimen in the Max Freier collection; David Green photo.**

1994), which described borate minerals from the Boulby mine. It is extended to provide a complete mineral list, with particular emphasis on those species which are of most interest to collectors.

Most of the unusual species described below, including anhydrite, boracite, ericaite, hilgardite, magnesite, rectorite and syngenite were identified by X-ray powder diffraction at Manchester University. In cases where this technique was not sufficient to properly characterize the species, electron probe microanalysis or atomic absorption spectroscopy were used to investigate their chemistry.

Anhydrite $CaSO_4$

Anhydrite is common as a rock-forming mineral at the base of the evaporite cycles, but is much rarer in the more soluble rocks at

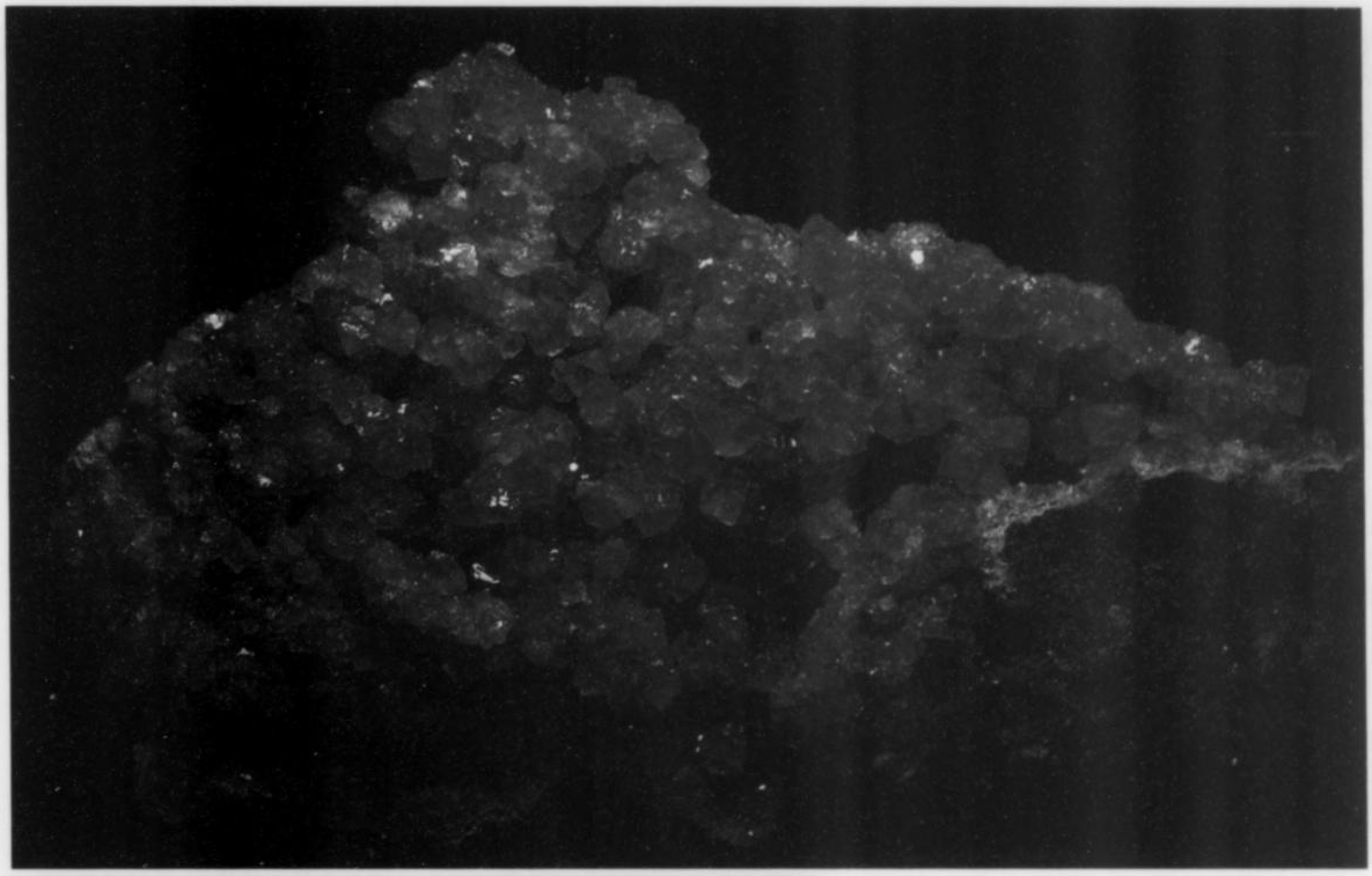


Figure 6. **Euhedral blue boracite crystals to 3 mm on one of the finest recent specimens from the Boulby mine. Max Freier collection; David Green photo.**

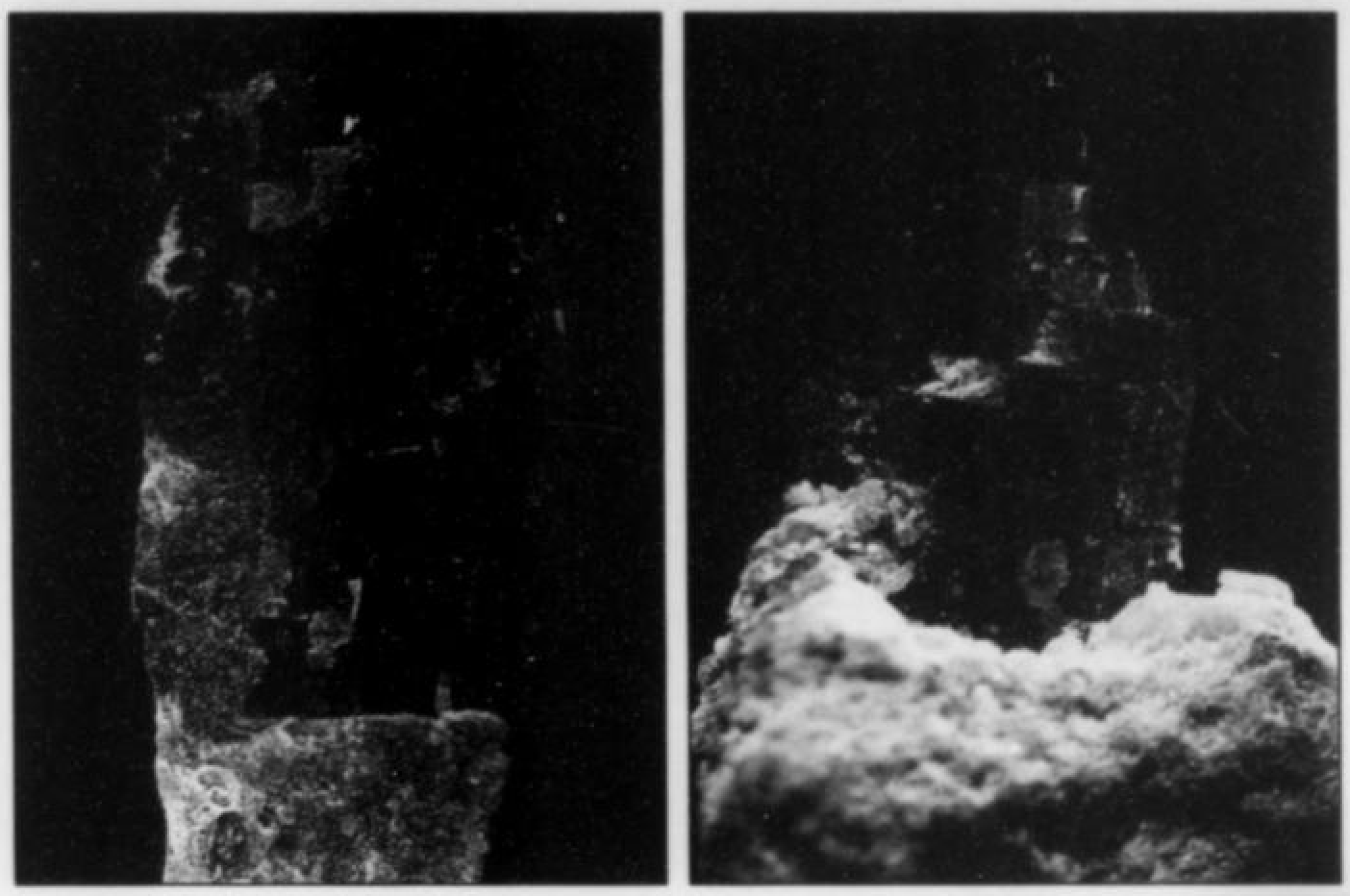
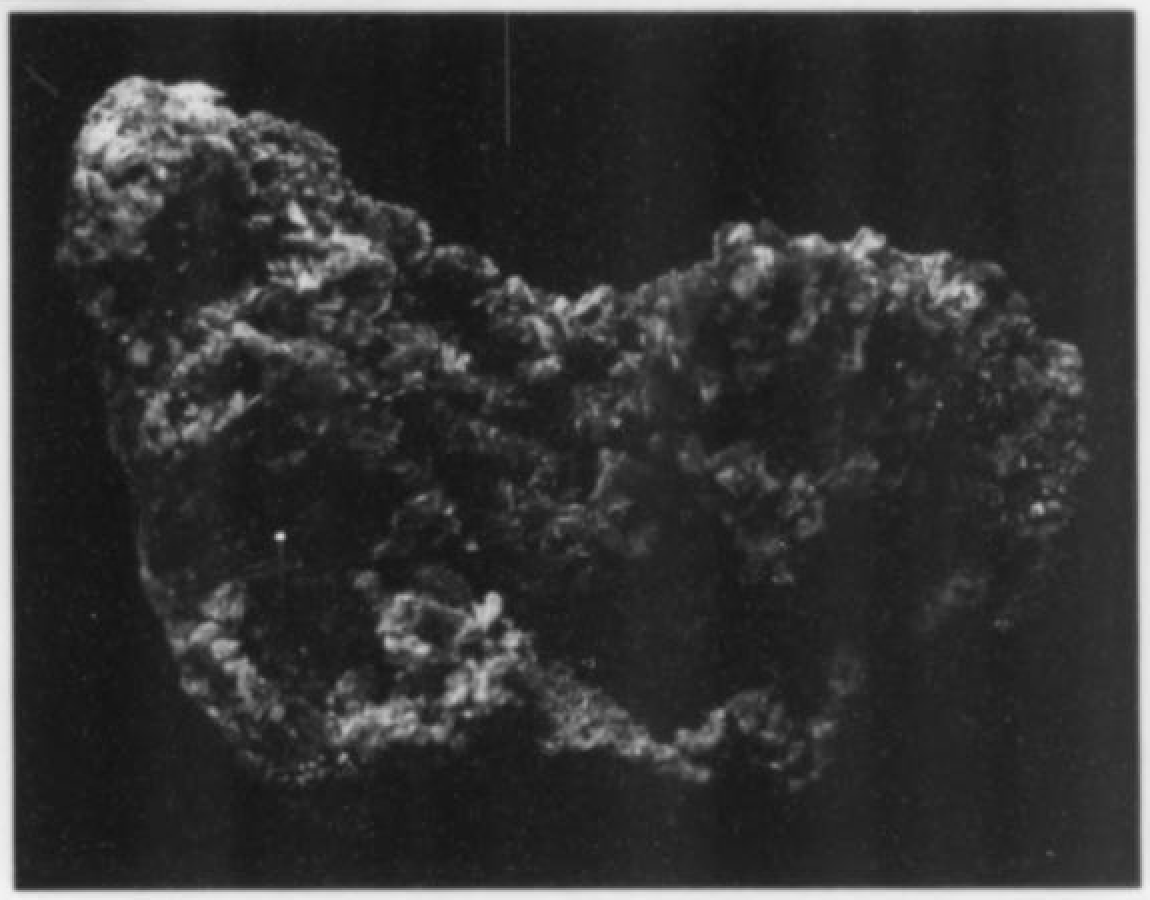


Figure 7. **Dark brown ericaite crystal (far left, 2.2 cm) and crystal group (near left, 8 mm tall on pale sylvinite). David Green collection and photo.**

Figure 8. **Hematite-stained crystals of hilgardite surrounded by minor blue boracite; specimen 5 cm across. David Green collection and photo.**



the top of the cycles. It is a minor constituent of the Boulby Potash (Stewart, 1965). Anhydrite occurs very rarely within boracite nodules as poorly developed, pale lilac, translucent, equant to prismatic crystals.

Boracite $Mg_3B_7O_{13}Cl$

Boracite is well-known from the Permian evaporite deposits which formed across northern Europe as a result of the drying of the Zechstein Sea. It is commonly represented in museum collections by small, isolated, pseudo-tetrahedral, pseudo-cubic or pseudo-dodecahedral crystals from German localities. The first British record is from a borehole in Permian salt and anhydrite near Aislaby in North Yorkshire (Guppy, 1944). A mineral described as "iron-boracite," was reported from the Boulby mine by Milne *et al.* (1977). This is not a distinct mineral species; analyses show its composition to be borderline between boracite and ericaite.

At the Boulby mine, boracite occurs within massive sylvinite ore in a variety of forms ranging from isolated single crystals to large nodules. It is commonly white, but may be pale to aquamarine blue or green. The most sought-after specimens are those displaying transparent, euhedral, aquamarine-blue, pseudo-cubic to pseudo-tetrahedral crystals. Exceptional matrix specimens to 20 cm covered with crystals to 5 mm were discovered in late 1991 in an area of the mine around panel 281; this find furnished almost all of the material subsequently offered by mineral dealers.

Examination of the boracite nodules suggests that some are formed by aggregation of spherules a few millimeters in diameter. These spherules usually have a characteristic structure, displaying two concentric boracite shells surrounding a core of impure sylvite. The inner shell is typically compact to powdery, with no readily discernible structure. It is surrounded by a macroscopically crystalline shell, the outermost surface of which is composed of small interlocking crystals.

The spherules are found in varying stages of aggregation in different nodules. They occur within the rock as isolated groups of a few individuals, and as large spherulitic latticeworks; their presence can also be inferred in massive compact boracite which commonly has remnant spherulitic structure. Examination suggests that in the process of nodule formation the crystalline outer surfaces of the spherules have merged and the central cores of white, compact boracite have gradually diminished to produce a tough homogeneous mass. Those rare specimens which display groups of euhedral blue crystals appear to represent a further stage of nodule formation. The massive boracite on which the crystals are disposed shows traces of spherulitic structure, and the well-crystallized specimen surfaces seem to have formed by recrystallization at the boracite-sylvinite interface.

Boracite occurs in an intriguing variety of habits. In addition to the nodules, single crystals are common and make superb micromounts. Crystals commonly appear cubic (although they are in fact orthorhombic polysynthetic twins, since boracite only has full isometric symmetry at high temperatures). Small triangular tetrahedron faces are sometimes seen modifying alternate vertices of cubic crystals producing unusual assymetric habits. Occasionally, the rarer pseudo-tetrahedral habit is well developed. Unusual composite crystals made up of many pseudo-tetrahedral crystals, each slightly offset, have sometimes been found.

The blue specimens are a ferroan variety of boracite. Quantitative analyses of specimens by atomic absorption spectroscopy (at Manchester University) and by electron probe microanalysis (on behalf of Cleveland Potash Ltd.) have shown Fe^{2+} to be substituting for Mg at levels up to about 30 mol%. Very pale or colorless boracite contains very little iron, but above about 5 mol% there seems to be no discernible relationship between color intensity and iron content. Manganese is the only other significant substituent in the lattice, typically at levels of a few mol%.

Boracite specimens are stable in storage, once the soluble halides have been removed. It is perhaps worth noting, however, that the aquamarine-blue color appears pale in daylight but much more intense under tungsten light; such variations in color are sometimes indicative of long term instability and it is suggested that the blue specimens be treated as light-sensitive until proven otherwise.

Carnallite $KMgCl_3 \cdot 6H_2O$

The occurrence and petrological significance of carnallite within the evaporite sequences is discussed in detail by Stewart (1956). Massive carnallite crops out sporadically as a thin bed at or near the base of the Boulby Potash in the north and west of the mine; large boracite nodules are commonly associated with this bed (Peter Edey, personal communication).

Cuprite Cu_2O

Cuprite is very rare, occurring as anhedral grains to about 0.25 mm in massive boracite. (Identification is by X-ray diffraction on specimens in the Hunterian Museum, Glasgow; John Faithful, personal communication.)

Dolomite $CaMg(CO_3)_2$

Dolomite was noted by Stewart (1965) as a scarce minor constituent of the Boulby Potash. It has not been found at Boulby as collector-quality specimens.

Ericaite $(Fe^{2+},Mg,Mn)_3B_7O_{13}Cl$

Ericaite, ideally $Fe_3^{2+}B_7O_{13}Cl$, is the iron analog of boracite. It occurs as isolated, euhedral, brown, subtranslucent, blocky crystals, exceptionally to 2 cm in pinkish sylvinite matrix. The few specimens known were collected in the 1980's by mine geologists in a now-abandoned area of the workings about panel 14. They represent the finest known examples of this rare species.

X-ray diffraction studies are not sufficient to characterize specimens with compositions lying between boracite and ericaite. Quantitative analysis, by atomic absorption spectroscopy, of a fragment of a typical brown pseudocubic crystal gave a formula $(Fe_{2.18}Mg_{0.71}Mn_{0.11})B_7O_{13}Cl$, showing iron to be the dominant cation.

Gypsum $CaSO_4 \cdot 2H_2O$

Gypsum is an uncommon post-mining mineral resulting from the dissolution of anhydrite. It occurs as translucent, prismatic crystals, exceptionally to 3 cm.

Halite NaCl

Halite together with sylvite makes up the bulk of the Boulby Potash. It is not known as well-crystallized specimens within the primary rock, although unusual specimens showing gneissic textures are sometimes found. Typical white cubic crystals, sometimes with hopper faces, are formed by the evaporation of temporary pools of brine.

Hematite Fe_2O_3

Hematite is widespread as a minor constituent of the Boulby Potash (Stewart, 1965). It is common in the borate nodules, which are often stained red by earthy hematite. The iron present in the blue boracite may have been derived from interstitial hematite during diagenesis.

Hilgardite $Ca_2B_5O_9Cl \cdot H_2O$

Hilgardite was recorded in the Boulby Potash by Milne (1978) as a form of "parahilgardite" (using a provisional and now obsolete nomenclature). A year previously, Hodenburg and Kuhn (1977) had identified the Boulby material as a new polymorph which they named Cl-tyretskite. This was shown to be identical to the "triclinic" hilgardite of Rumanova *et al.* (1977) from an undisclosed locality in the Soviet Union. In revising the hilgardite group, Ghose (1985) renamed this triclinic hilgardite [= Cl-tyretskite] as hilgardite-1*Tc*. Recent recommendations on polytype nomenclature have resulted in a further name change, and the currently accepted polytype name is hilgardite-1*O* (Nickel, 1993). (Ed. Note: The International Mineralogical Association does not recognize polytypes as separate mineral species; the correct species name is simply hilgardite.)

Hilgardite is relatively common at the Boulby mine. It is found as well-developed, transparent, colorless to pinkish crystals in boracite nodules and more rarely as nodules in which it is the main insoluble component. It occurs interstitially within spherulitic boracite latticeworks as colorless paper-thin crystals. Thicker but less perfect crystals are sometimes revealed when the central core of sylvite present in some of the hilgardite nodules is dissolved. The brick-red coloration of much of the hilgardite is due to finely divided hematite. Hilgardite is very rare on a worldwide basis, and the recent specimens from Boulby, which include crystalline nodules to more than 25 cm in diameter, with crystals to 1 cm, may possibly represent the finest development of the species.

Magnesite $MgCO_3$

Magnesite is a common minor constituent of the Boulby Potash (Stewart, 1965). It occurs within the borate nodules as colorless, euhedral, transparent to translucent tabular crystals, exceptionally to 1 cm. When dissolved from the enclosing chlorides, magnesite crystals are particularly fragile and should be handled with care.

Pyrite FeS_2

A minor constituent of the Boulby Potash (Stewart, 1965; Woods and Powell, 1979), pyrite occurs uncommonly as small anhedral grains within the borate nodules.

Quartz SiO_2

Noted by Stewart (1965) and by Woods and Powell (1979), quartz is a widespread but minor constituent of the Boulby Potash. It occurs rarely within boracite nodules as drusy crusts of pyramidal crystals to 0.5 mm which commonly contain red hematite inclusions.

Rectorite Interstratified mica/smectite clay

Rectorite is rare at Boulby, occurring interstitially between boracite crystals as white triangular crystals to about 0.5 mm with a perfect cleavage and pearly luster, and as subspherical crystal groups to about 2 mm. Identification is by X-ray diffraction supported by electron probe microanalysis.

Rinneite $K_3NaFe^{2+}Cl_6$

Rinneite was noted by Stewart (1965) as a minor constituent of the Boulby Potash.

Sylvite KCl

Sylvite, a major constituent of the Boulby Potash, sometimes forms pure white bands several meters thick, but is more usually stained red by hematite and intimately mixed with halite. It has occasionally been found as a post-mining crystallization formed by the evaporation of temporary pools of brine. Pure white sylvite commonly forms the core of borate nodules.

Syngenite $K_2Ca(SO_4)_2 \cdot H_2O$

Syngenite occurs as radiating aggregates of white acicular crystals to 1 mm. In common with other similar occurrences (Palache *et al.*, 1951), it is probably of post-mining origin.

CONCLUSION

Evaporite rocks at the Boulby mine have provided a suite of minerals, including some of the finest known examples of the borate minerals ericaite, boracite and hilgardite. The latter two of these species occur as nodules in which they are intimately mixed with soluble chlorides. These chlorides are removed from specimens in order to reveal the insoluble borates by soaking in water. Besides boracite and hilgardite, a number of other insoluble minerals occur within the nodules, including hematite, which commonly stains hilgardite, tabular colorless magnesite, and more rarely anhydrite, cuprite, pyrite and rectorite. Post-mining solution of the evaporite rock has produced gypsum, halite and sylvite in well-crystallized specimens, and is probably also responsible for the formation of syngenite.

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OCCURRENCE OF BARIAN CELESTINE AT THE ELMWOOD ZINC DEPOSIT, SMITH COUNTY, TENNESSEE

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Rare specimens of a fibrous white mineral from the Elmwood zinc orebodies previously believed to be anglesite have been shown both by X-ray diffraction and atomic absorption analysis to be barian celestine. Physical evidence strongly suggests that the occurrence of this species results from partial alteration of strontian barite, a mineral which occurs in relative abundance throughout the deposit.

INTRODUCTION

Since opening in 1974, the Elmwood mine in the central Tennessee zinc district has been studied by a number of workers (Kyle, 1976; Kearns and Campbell, 1978; Gaylord and Briskey, 1983). Various aspects of both the geology and mineralogy have been examined; however, concise data on the mineralogical occurrences has remained relatively brief.

The most commonly observed and recognized minerals continue to be barite (strontian), calcite, dolomite, fluorite, quartz and sphalerite. Rarer species include "anglesite," celestine, chalcopyrite,* enargite,* galena, glauconite,* marcasite* and pyrite. The occurrence of anglesite would be of particular interest, as it would be the only secondary species in the deposit. Recent analyses of several specimens previously believed to be anglesite indicate that the mineral in question is actually a barian celestine.

GEOLOGIC SETTING AND OCCURRENCE

The Elmwood zinc deposit was discovered at a depth of approximately 400 meters in 1967 by a random walk/search drilling program (Callahan, 1977), and was brought into production in late 1974. Additional orebodies have subsequently been discovered on the property, and a total of three mines (Elmwood, Gordonsville, and Cumberland) are currently in production. Zinc mineralization, as iron-deficient sphalerite, occurs predominantly in stratabound breccia bodies hosted by interbedded limestones and dolomites of the lower Ordovician Mascot Formation. The barian celestine specimens examined for this study have been

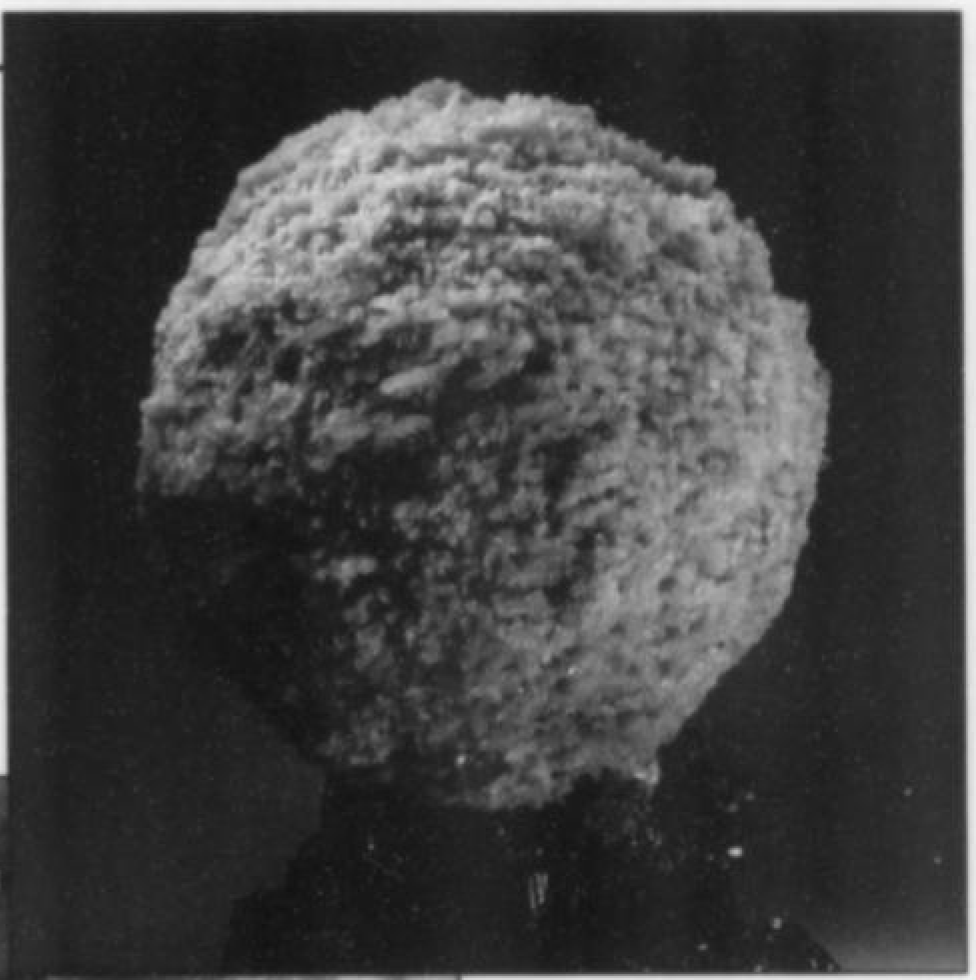

Figure 1. **Strontian barite hemisphere, 8.3 cm in diameter, on sphalerite from the Elmwood mine. R. Scott Werschky collection.**

Figure 2. **Strontian barite crystal aggregates in the hemisphere shown above.**

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*Reported here for the first time.

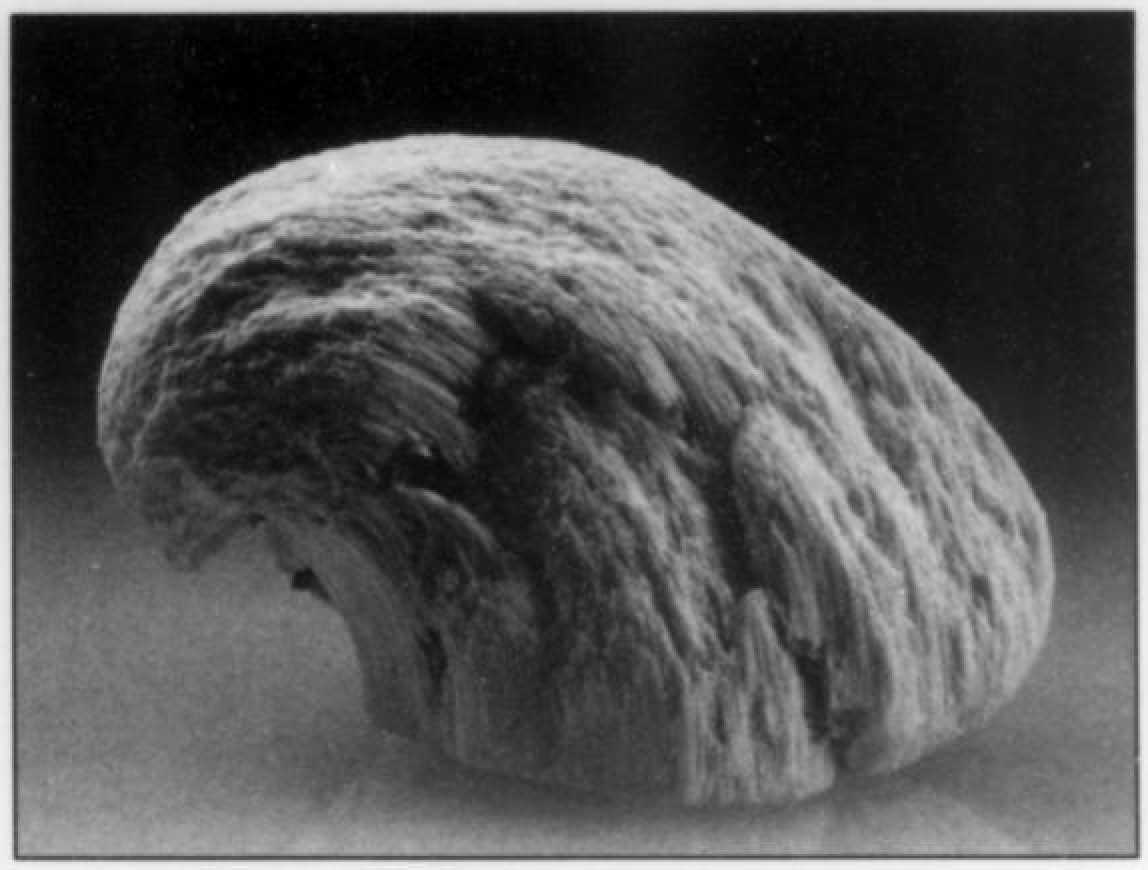

***Figure 3.* "Ram's horn" aggregate of barian celestine, 2.8 cm tall, from the Elmwood mine. Author's collection.**

recovered from each of the three mines, specifically from open cavities within the ore zones. The presence or absence of barian celestine, and its absolute size, appears to be independent of the physical dimensions of the vugs. Distribution of the mineral is widespread and erratic, such that it is observed only rarely.

MINERALOGY AND CHEMISTRY

Barian celestine occurs ubiquitously as aggregates of opaque, cream-white, thin to thick, fibrous crystals somewhat resembling jackstraw cerussite. The most typical specimens exhibit mats to 2 cm of randomly oriented fibrous crystals; however, larger examples reach sizes of up to 10 cm and display a classic ram's-horn morphology. Unfortunately, most specimens are exceptionally soft and brittle and crumble easily upon removal from the mine. Paragenetically, barian celestine is later than barite, galena and sphalerite, but has been noted as inclusions within orange, scalenohedral, twinned calcite crystals (third generation of Kyle, 1978).

Previous analytical data on this fibrous material was apparently obtained using only X-ray diffraction (XRD), and may have been generally characteristic of an anhydrous sulfate, but was misinterpreted by anglesite by Kearns and Campbell (1978). Recent studies of my own on similar material yielded variable results, and so I decided to either prove or disprove the existence of anglesite at the deposit. Fractions of all known specimens previously labeled as anglesite were acquired, including fragments from the type specimen (Smithsonian specimen number 142547). Initial analyses were conducted utilizing a JEOL 840A scanning electron microscope with a Kevex Delta-class energy-dispersive (EDS) chemical micro-analyzer. Qualitative data from this analysis disclosed the presence of major strontium and sulfur, with lesser barium. No lead whatsoever was detected in any of the samples.

X-ray diffraction analysis was then performed, but did not serve well to identify the material in question. Utilizing a Philips automated powder diffractometer (APD), samples of the barian celestine were scanned and the resultant data were compared graphically with JCPDS files for barite (24-1035), celestine (5-593) and anglesite (36-1461). Scans were conducted using CuKα radiation, a 2θ scan rate of 1° per minute, and operating parameters of 40kV and 25mA. The ten most intense diffraction lines for the Elmwood barian celestine are shown in Table 1, and are compared to barite, celestine and anglesite. In general, the *d*-values and intensities for barian celestine present a much simpler data set than those observed for the other three anhydrous sulfates. This feature arises primarily because of orientation effects associated with the fibrous morphology of the material. The two principle lines for the barian celestine (at 3.46 and 3.19) probably correspond to the two major peaks for pure barite and celestine, although they exhibit a minor shift to greater *d*-spacing. Two important lines (at 2.07 and 2.03) for pure celestine are in very close agreement with the same peaks of the barian celestine.

***Table 1.* X-ray diffraction data for Tennessee barian celestine, compared to standard spectra of celestine, barite and anglesite.**

Barian celestine, Tennessee		*Celestine, JCPDS 5-593*		*Barite, JCPDS 24-1035*		*Anglesite, JCPDS 36-1461*	
d(Å)	I/I_o	*d*(Å)	I/I_o	*d*(Å)	I/I_o	*d*(Å)	I/I_o
3.46	100	3.77	35	4.33	30	4.26	50
3.19	73	3.43	30	3.89	50	4.23	51
3.00	12	3.29	98	3.57	30	3.81	40
2.76	16	3.17	59	3.44	100	3.33	67
2.25	11	2.97	100	3.31	70	3.22	53
2.07	28	2.73	63	3.10	95	3.00	88
2.03	12	2.67	49	2.83	50	2.70	43
1.73	10	2.04	55	2.72	45	2.06	100
1.70	12	2.00	40	2.12	80	2.03	58
1.69	13	1.99	48	2.10	75	2.02	54
plus 21 lines		plus 39 lines		plus 69 lines		plus 57 lines	

CuKα radiation (λ = 1.5418Å)

In addition to examining the barian celestine, a sample of typical barite from the deposit was also analyzed. Elmwood barite, which does not form euhedral crystals, occurs as spherical, cream-white mounds consisting of numerous crude, intergrown, minute crystals. It has been known to contain substantial percentages of strontium, but (to my knowledge) has not previously been quantitatively checked. A total of three samples were analyzed, two of barian celestine and one of strontian barite. Each sample was pulverized, weighed to exactly 100 mg, and then fused with 1 gm of Na_2CO_3 at 850° C. The resultant cakes were then leached with hot, de-ionized water and filtered to remove soluble sulfates. The Ba and Sr carbonates remaining on the filter paper were dissolved with 6N HCl and collected in 100 ml volumetric flasks. To each flask was added 100 mg CsCl to suppress ionization interferences during atomic absorption analysis. Concentrations of Ba and Sr were then quantified using a nitrous oxide/acetylene flame and by comparison of the unknown solutions to matrix-matched synthetic standards containing various amounts of Ba and Sr.

***Table 2.* Results from atomic absorption spectroscopy analyses of barian celestine and strontian barite samples from the Elmwood mine, Tennessee (weight % oxides), and comparison with similar occurrences from Palache *et al.* (1951).**

Sample	*SrO*	*BaO*
Barian celestine 1, Tennessee	34.85	24.56
Barian celestine 2, Tennessee	37.40	19.01
Strontian barite, Tennessee	14.68	47.77
Celestine, pure	56.42	0
Barite, pure	0	65.70
Barian celestine, Lansdowne, Ontario	32.83	26.18
Strontian barite, Greiner, Tirol	28.27	32.14

Results of the analyses are presented in Table 2 and are compared to pure celestine and barite, as well as other intermediate-member compounds from other localities. The minor observed variation between the two celestine samples is not entirely attributable to analytical error and may actually reflect slight variation in the composition of the species of the deposit. Similar minor variation undoubtedly exists in the strontian barite samples as well.

DISCUSSION AND CONCLUSION

Such variation or solid solution of Ba and Sr in celestine and barite, respectively, is not an uncommon phenomenon, having been previously documented from a number of other localities. Palache *et al.* (1951) published analytical data on celestine from Lansdowne, Ontario, containing 26.18% BaO; similarly, analyses of barite from Greiner, Tirol, show concentrations of SrO as high as 28.27%. Undoubtedly, a similar situation exists at the central Tennessee zinc deposits, in which pure end-members of either species appear to be particularly rare. Only one example of an essentially pure end-member-species has to date been verified from the mine. This specimen, examined qualitatively by SEM, consists of colorless, thin-bladed, prismatic crystals to 2 cm of essentially pure celestine. Although this material was recovered from the haulage-level drift below the main mining horizon, it may still be related to the ore deposit proper.

Speculation regarding the origin of barian celestine from the central Tennessee zinc district must clearly take into account several factors. For the purposes of this paper, only physical observations are considered. The fact that barian celestine has been observed upon strontian barite hemispheres, and is thus paragenetically later, suggests that it may have been derived from late-stage alteration of the barite. The most dramatic and genetically informative samples which display this feature have been recovered from the Cumberland mine. Here, barite samples exhibit pits and regions to several centimeters distributed randomly over the surfaces of the hemispheres. Corrosion has progressed preferentially down to only a certain depth or layer, perhaps where the strontian barite changes slightly in composition. These corrosion patches have subsequently been overgrown or filled with abundant fibrous white barian celestine. An interesting occurrence on selected Cumberland specimens for barian celestine is that in which sharp-edged cubic impressions to 3.5 cm are present on the bottom of barite hemispheres. These impressions or voids are regions where fluorite crystals were once present, but have since been completely dissolved. Within these cubic voids, mats of fibrous barian celestine have also been found.

Barian celestine is a rare mineral at the deposit simply because corrosion of barite was only a localized phenomena. Geochemical conditions were favorable for corrosion of barite only in certain vugs. Thus, only in places where there was corrosion of barite will barian celestine be found nearby.

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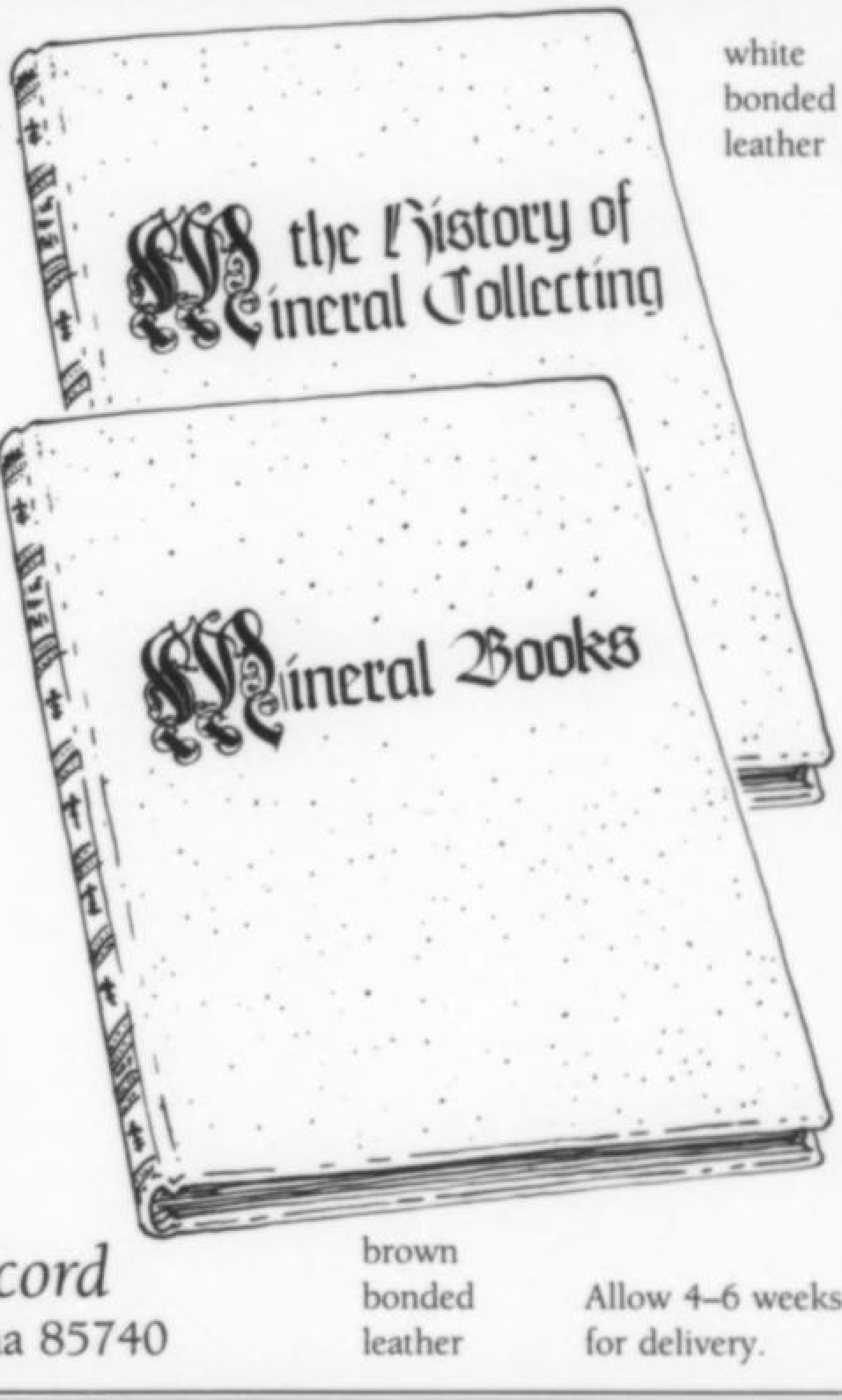

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THE
PICOS DE EUROPA
LEAD-ZINC DEPOSITS, SPAIN

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Since the 1860's superb specimens of sphalerite, perhaps the finest in the world, have been found in the lead-zinc deposits of the Picos de Europa Mountains, especially at the Aliva mines. Unfortunately the closing of the last mines in 1990 and the dismantling of the installations make the future supply of specimens uncertain.

INTRODUCTION

The zinc-bearing deposits of the Picos de Europa, Spain, which have been exploited since 1860, have become justifiably famous throughout the world for the excellent specimens of sphalerite they have produced. Although the most commonly known specimens, and those that have appeared on the market during the last few decades, have come from the Aliva mines, there are other less significant operations which have produced sphalerite and a wide range of associated minerals. The operations, which are all within the Picos de Europa Mountains, have similar geology, and for this reason have been treated as one in this article.

The Picos de Europa mountain range is part of the Cantábrica chain but is distinguished from the rest of the chain by sharp escarpments. These cliffs were formed by the action of water and ice on deep beds of limestone, creating one of the most spectacular and beautiful landscapes in Europe. It has traditionally been divided into the western, central and eastern ranges, which are separated (from west to east) by the Cares, Duje and Deva rivers. The main zinc-bearing deposits are found in the central and western ranges, although some small deposits have been found to the east of the Deva, all within the province of Santander.

At present all of the mines are abandoned. The Aliva mines, the largest operation in the Picos de Europa, ceased production in the spring in 1980. The dismantling of the installations and the blockage of access to the main adits mean that the future supply of sphalerite specimens on the mineral market is uncertain.

HISTORY

It is almost certain that the Romans worked the smithsonite of the Cantabria region for zinc (Sanchez Alonso, 1990) as evidenced

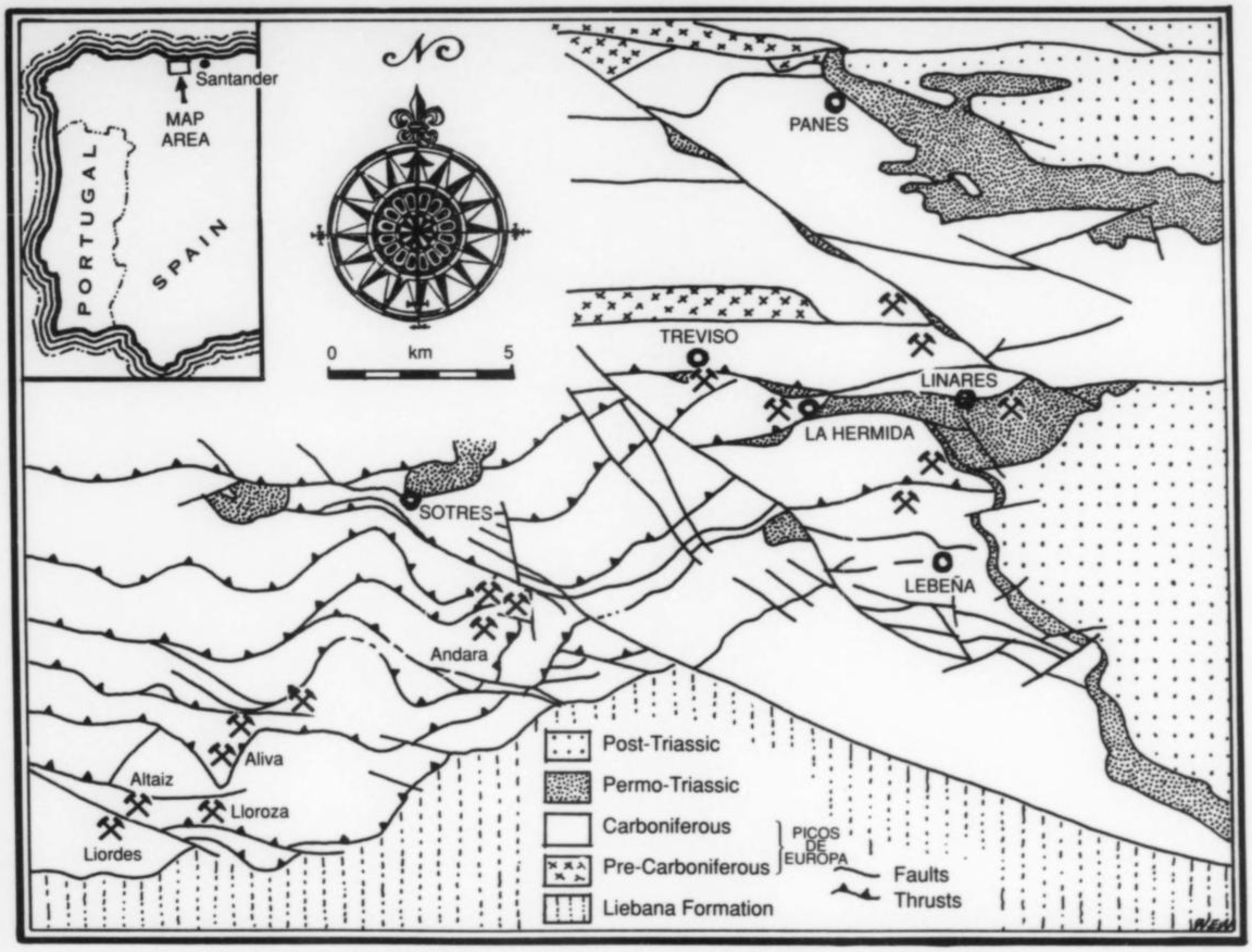


Figure 1. **Regional geology of the Picos de Europa range showing mine locations.**

by the ancient mine workings found in the Reocín, Comillas and Udías regions. However the first modern investigation of the zinc and lead deposits of Cantabria took place in the middle of the 19th century, with the first mining operations beginning between 1849 and 1852 in the Mercadal, Comillas and Udías regions (Sanchez Alonso, 1990). The excellent results these early operations produced caused them to be extended towards the Picos de Europa between 1852 and 1857, culminating in the discovery of the Andara and Aliva deposits around 1859. After the construction of the basic infrastructure needed to transport the ore, the La Providencia Company began working the orebodies in 1860. According to Bouza (1859), the company had to expend a significant amount of capital on the construction of the access roads which rise from La Hermida to the mines of Andara, where it was necessary to ascend 2000 meters in only 19 km. From La Hermida the ore was transported in barges down the Deva River to the Tina Mayor estuary.

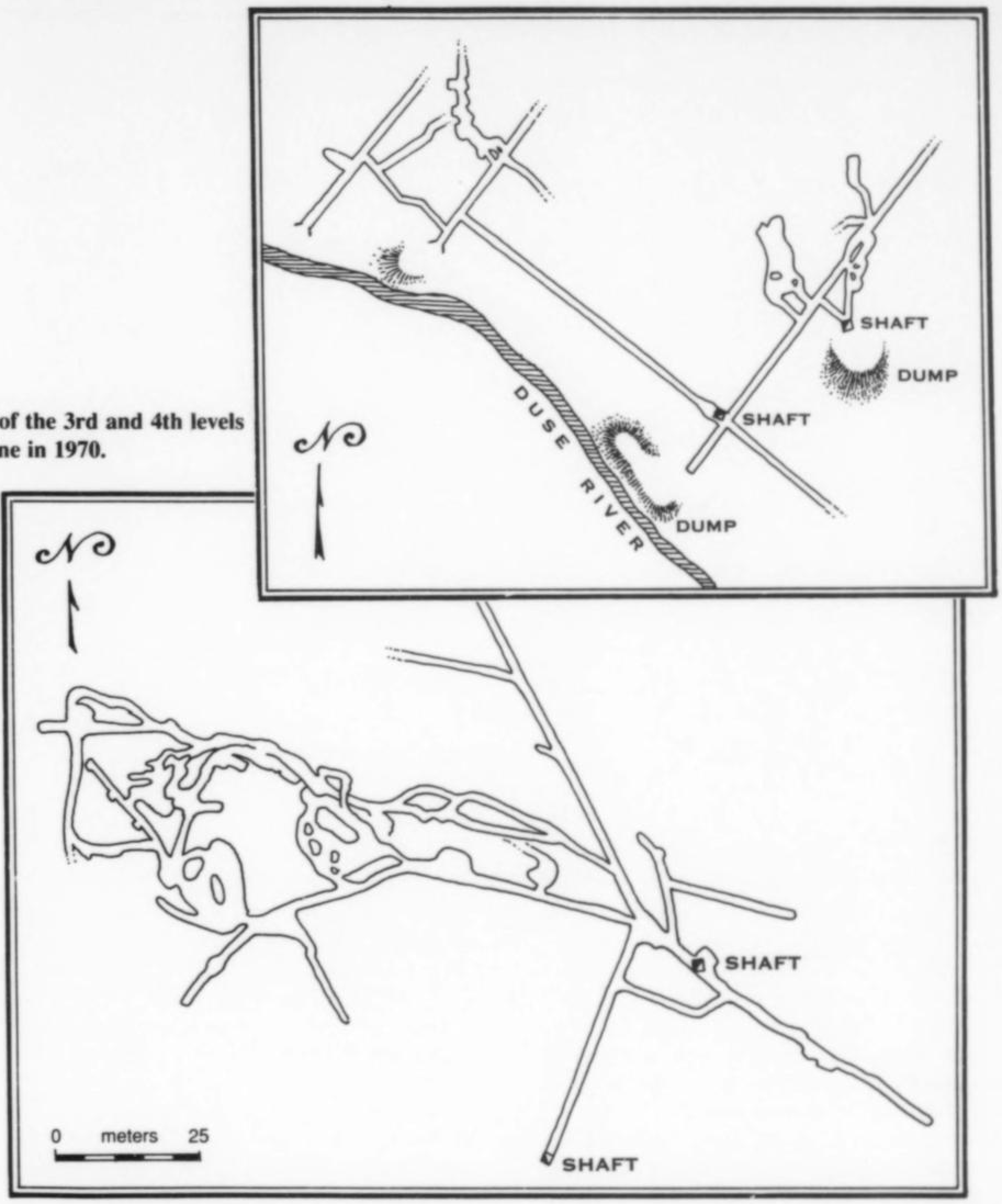
The main companies working the Picos de Europa during this period were the Sociedad Providencia (Andara and Aliva), the Real Compañía Asturiana de Minas (Aliva, Lloroza-Liordes, Andara, and the Peñarrubia-Cabanzón groups), and Herederos de Mazarrasa (Andara). Various private owners operated small prospects, but they were ultimately taken over in 1885 by the Real Compañía Asturiana de Minas (now called Asturiana de Zinc). This resulted in Santander becoming, throughout this period, the main center for zinc ore production in Europe (Sanchez Alonso, 1990). The ore was shipped to Belgium where the Real Compañía Asturiana de Minas (who also worked the nearby Reocín mines) was based. Between 1856 and 1889 the total production of zinc ore from the Picos de Europa region was 160,000 metric tons.

All of the operations were underground, with stopping on a number of levels to take advantage of the steep slope of the terrain and to closely follow the mineral deposits (Mazarrasa, 1930). The drainage, ventilation and supports were all natural. Because of the altitude of the deposits and the harsh local winters, the mines could only be operated from June to October. Production rarely surpassed 4000 metric tons per year and gradually fell as the shallower deposits became exhausted. All work ceased when the Spanish Civil War began in the 1930's. It has been calculated that up to this period the total production was 250,000 to 280,000 tons of ore from the Andara group, and about 100,000 to 120,000 tons from the Aliva and Lloroza groups. Only the Aliva mine continued in production, generally operated by the Real Compañía Asturiana de Minas. During the 1970's ownership passed to the Sociedad Minera Picos de Europa S.A., and then passed back to the R.C.A. De Minas up until its sale in 1985. This was the period of greatest splendor for the Aliva mines, with ore production exceeding 45 tons per day. Perhaps it was the lack of investment in exploration by the last owners which brought about the exhaustion of the known reserves and the final closure of the mine in the spring of 1990. In any case, the Aliva mine is now abandoned and access to the workings is no longer possible.

GEOLOGY

The zinc-bearing deposits of the Picos de Europa are located in

Figure 2. **Plan of the 3rd and 4th levels of the Aliva mine in 1970.**



the Cantábrica zone, as defined by Julivert *et al.* (1972). This zone, which is bounded on the west by the Asturo-Occidental-Leonesa (West Asturias Leon) zone and on the east by the Santander Mesozoic cap, is characterized by a combination of Paleozoic pre-Carboniferous-series rocks with shallow-water platform sediments consisting of detrital and carbonate formations, and a well-developed synorogenic and post-orogenic Carboniferous horizon (Julivert, 1983). From a structural point of view the Cantábrica zone is characterized by its shallow tectonics, consisting of features such as nappes and overthrusts, folds and faults.

The Cantábrica zone is, in turn, divided into five subunits (Julivert, 1967), and it is in one of these, the Picos de Europa region, that the zinc deposits occur. This region is characterized by a major extension of the Carboniferous limestone with little evidence of non-carbonate facies. The most recent studies carried out in this region were made by Julivert (1967), Maas (1974), Marquinez (1978) and Martínez García y Rodríguez Fernández (1984). The following summary of the geology of the Picos de Europa has been compiled from the studies of Martínez García y Rodríguez Fernández (1984) and Julivert (1967).

Structurally the Picos de Europa region is characterized by a series of successive folds and overthrusts primarily in east-west and east-southwest directions, with the remains of the overthrusts almost rectilinear and parallel to the major folds. In the center of some of these folds, surface outcrops of the Cambrian-Ordovonian series show a major stratigraphic gap spanning parts of the Ordovonian, Silurian and Devonian periods.

The Carboniferous carbonate deposits begin in the Lower Visean with a very pronounced layer of red limestone ("griotte limestone"). This carbonate deposit continues until the Stephanian period, with deposits of the deep layers of gray limestone (Caliza de Montaña or "Mountain limestone") during and after the lower Namurian-Westphalian, another thick layer of limestone was deposited, the Westphalian unit, which reaches a maximum thickness of 800 meters (Picos de Europa Formation). These correspond to the bedded deposits which formed under reducing conditions, generally dominating the shallow facies. During the Stephanian period the first discordant deposits appeared, beginning with the Hercynian Orogeny in the Picos de Europa. Beginning in the Permian another long period of sedimentary deposition occurred which lasted until the Cenomanian. After the Lower Oligocene the Alpine deformation occurred, with the formation of folds and overthrusts in an east-west direction, and the displacement of the earlier structure. All of these activities played a significant role in

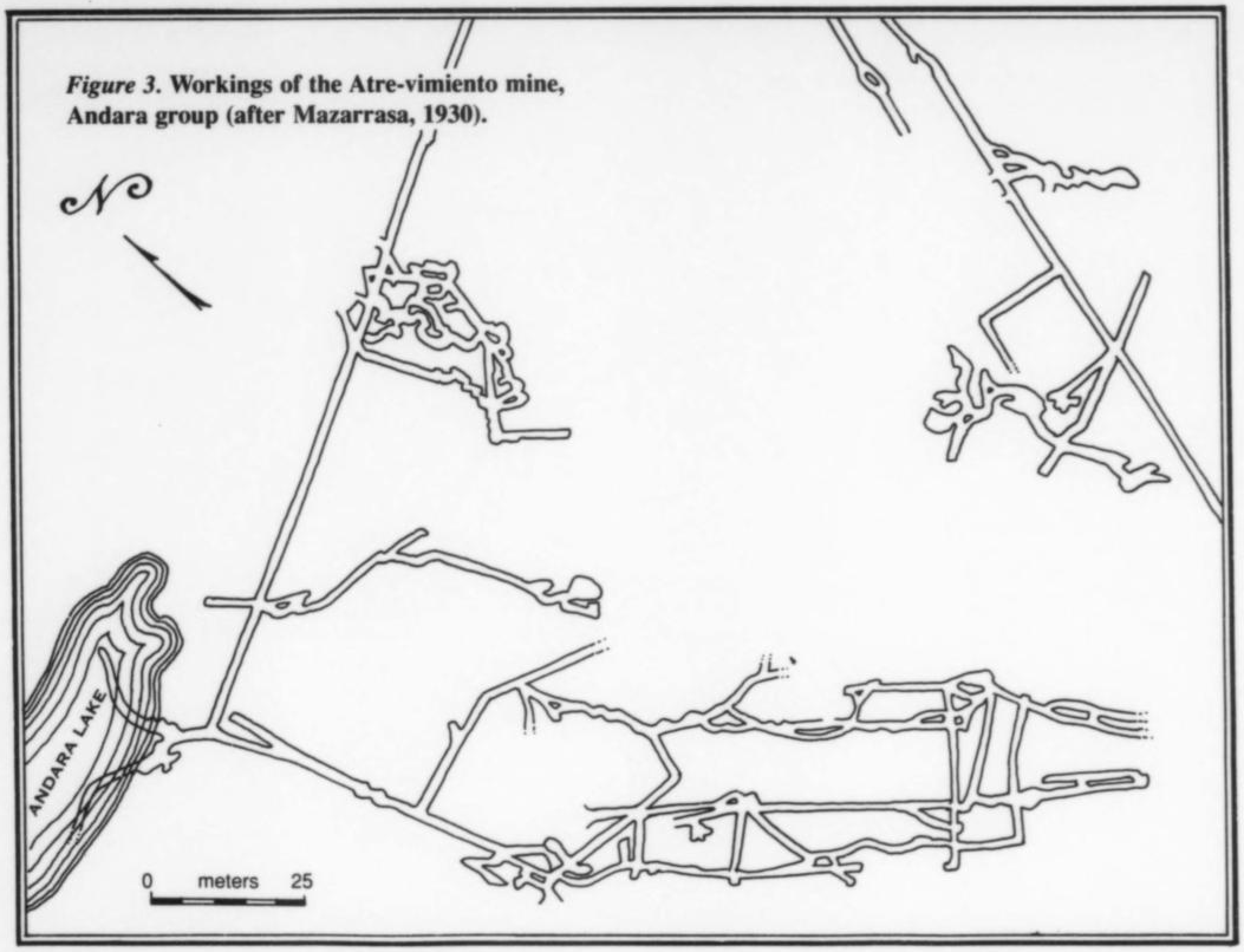


Figure 3. **Workings of the Atre-vimiento mine, Andara group (after Mazarrasa, 1930).**

the creation of fracture systems through which the hydrothermal mineralizing fluids later flowed.

The origin of the zinc deposits of the Picos de Europa has been widely discussed by various authors and attributed to several causes. A common feature of all the deposits is that they are found in Carboniferous limestones, especially in the Caliza de Montaña, and in the Picos de Europa Formation. They also tend to be found near the zones of major faults and, in some cases, near the Permo-Triassic formations (La Hermida-Lebeña zone). The deposits, mainly composed of smithsonite along with some hydrozincite, hemimorphite and sulfides (sphalerite and galena) in a carbonate gangue (dolomite and calcite), have diverse forms (Vazquez Guzmán, 1980). These include (1) veins, as fill in cracks and cavities; (2) massive pockets, through replacement of carbonate rocks; (3) horizontal veins, in the contact zone of the limestones and shales; (4) nodules and large crystals of sphalerite found in a clay matrix which fills tectonic cavities in the form of chimneys. Vazquez Guzmán believes that the deposits formed through deposition and replacement by hydrothermal solutions, circulation of which would have been facilitated by tectonic movements in the limestone beds. He considers the metals in the Caliza de Montaña to have been deposited during the Lower Carboniferous. A similar origin for the deposits of the La Hermida zone is suggested by Burkhart (1976). Alternatively, Sanchez Alonso (1990) suggests that the mineralization is of a syngenetic origin and formed during the Namurian when large basins were formed by subsidence, in which large reef bodies associated with the mineralization grew. He suggests that the sulfur originated from the reduction of sulfates in the closed basins, and the origin of the metals is attributed to the erosion of the existing rocks. But he also admits that hydrothermal activity did indeed occur in the Picos de Europa region.

Finally, Martínez García *et al.* (1991) believe that all the deposits of the Picos de Europa are of Permian age, associated with the sediments of this age. These authors base this conclusion on the fact that the Triassic formations intersect the mineralized veins (for example in the Hozarco mine). According to them, the circulation of ground water caused the leaching of metals contained in the Permian sediments, and these were then deposited in the cavities and fractures of the Carboniferous limestones.

MINES

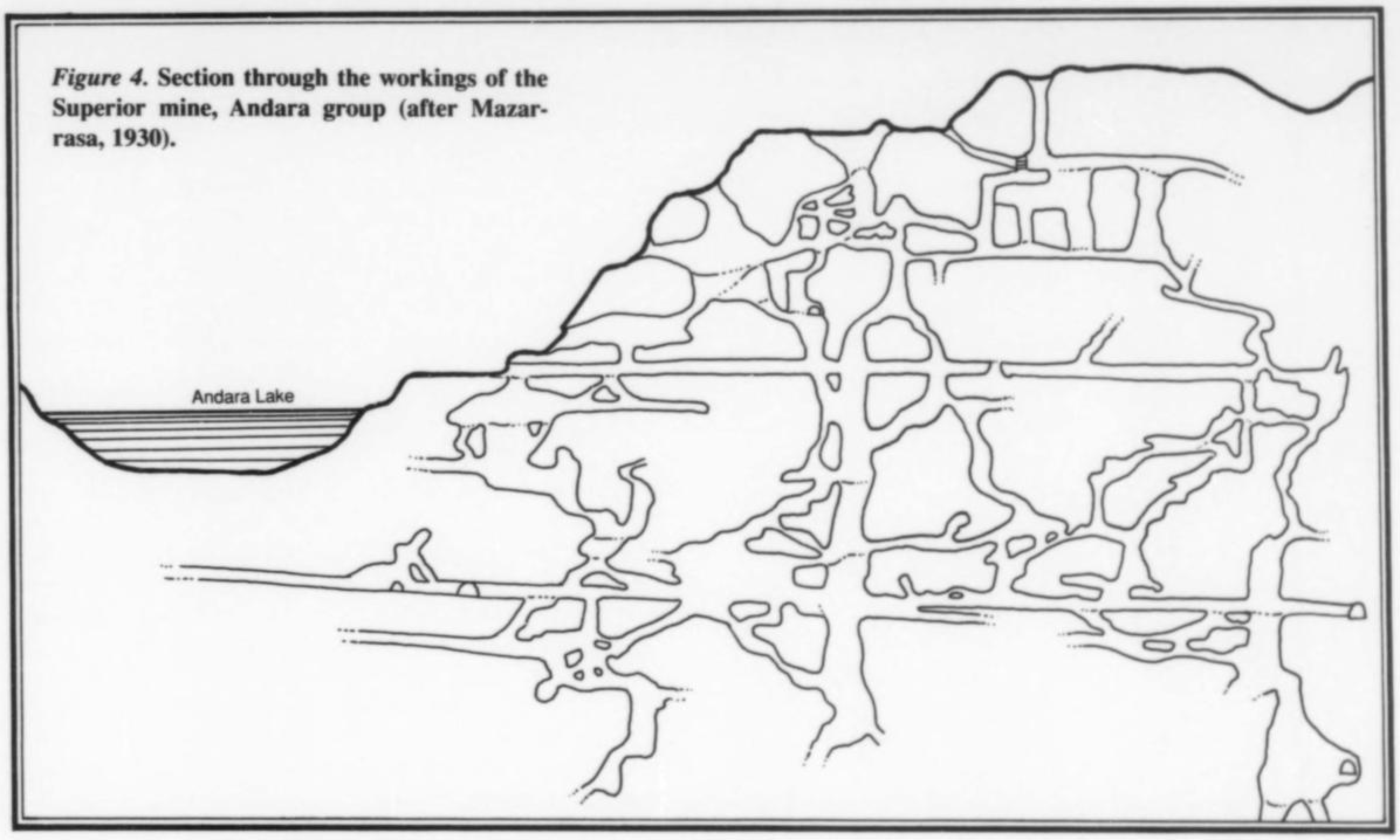
Based in part on the work of Mazarrasa (1930), we have divided the zinc deposits of the Picos de Europa into four basic groups: (1) the Lloroza-Liordes group, (2) the Aliva group, (3) the Andara group, and (4) the La Hermida-Lebeña group.

Lloroza-Liordes Group

Located in the central range of the Picos de Europa, the Lloroza-Liordes group of mines is the most westerly of the lead-zinc deposits. Mining activity in the region began at the end of the 19th century, at almost the same time as the Aliva mines opened, but rapidly died out because of the low yield of the deposits and the high altitude at which they are found (in some cases above 2000 meters). As a result, by 1930 only the Gramas and Altaiz mines, in the Lloroza region, were still active, operated by the Real Compañía Asturiana de Minas (Mazarrasa, 1930).

The main ore mineral was smithsonite, augmented by rarer galena and sphalerite. In general the veins strike in a N60°W direction, and dip 40 to 45° to the northeast, narrowing at depth. Of a similar form are the deposits of Liordes and Fuente Dé further to the south, exploiting small veins of sphalerite and smithsonite. From the Fuente Dé cable car one can still see the old mine shafts (the Precaución, Caina and Elvira concessions), where they drove two tunnels in a northeasterly direction for a distance of 230 and 400 meters, cutting through the sparse mineralization. The ore

Figure 4. **Section through the workings of the Superior mine, Andara group (after Mazarrasa, 1930).**



extracted from this group of mines was taken to Aliva for washing and beneficiation, and was then shipped to Espinama.

Aliva Group

The Aliva group of mines is located in the central zone of the Picos de Europa, at the foot of Peña Vieja Peak (2613 meters). It is the largest group in the Picos, and the only one that remained in operation until recent times. It is these mines that have produced the best specimens of sphalerite, and those which have normally been seen on the Spanish and international specimen markets.

The operation of these deposits by the Sociedad La Providencia began in 1860. Around 1930 the same company was operating the La Torpeza, Punta del Clavo, Almanzora, Teresita, se Repite, Aumento a Torpeza, Espectativa, Si Se Encontrará Mineral ("If They Find Mineral!") and Esperanza concessions while the Real Compañía Asturiana de Minas operated the Lenengoa, Zortigarrena, José Mari and Seigarrena concessions; D. Manuel Palacios privately operated the Disputada, Paz, Enriqueta and Juana concessions (Mazarrasa, 1930).

The mineralization is primarily sphalerite, accompanied by small amounts of galena, pyrite, chalcopyrite and smithsonite in a gangue of dolomite, calcite and scarce fluorite. Mazarrasa identified two systems or groups of deposits. The first is made up of the veins striking N60–70°W, and the second consists of those striking N20–30°W. These veins have a typical width of 0.5 to 1.5 meters, and dips ranging from 30° to 40° southwest in the Lenengoa mine to almost horizontal in the Seigarrena.

Over the years the R.C.A. De Minas became the only company operating mines in the Aliva area. They installed a washing plant for the sphalerite, which enabled them to increase their recovery. Mining was by the room and pillar method. Latter on in the 1970's the mines passed, for a short period, into the ownership of the Sociedad Minera Picos de Europa, and then were returned once again to the Real Compañía. It was during this period that winter working started, based on new installations that the company built next to the main mine, which was normally cut off for most of the winter.

The Aliva mine has six levels interconnected by an enormous number of stopes and sub-levels following the richest zones, pockets and broadenings of the ore veins. It has a vertical shaft extending from the first to the sixth level, and a second shaft which connects the first to the third level, but this was abandoned as the mine was deepened. The ore was raised in 1-ton wagons and passed to the crushers and the flotation system, with the final concentrate being transported by truck to Espinama.

The most important ore minerals were sphalerite and galena in a 12:1 ratio. The sphalerite from the first level was caramelized but, because of its proximity to the surface, was not of the highest specimen quality. The highest-quality sphalerite was extracted from the second, third and fourth levels. Some exceptionally pure and transparent crystals and plates to over 10 cm in size were produced. It is probable that these were the levels which produced the best sphalerite in the world. On the fifth and sixth levels the specimen quality was once again poor (altered, fractured, opaque and of a cloudy yellow color). The second level also produced excellent crystals of galena on white dolomite with associated green sphalerite twins. Large crystals of scalenohedral calcite, some of them twinned, were found on the third level along with brilliant gem-quality sphalerite. Finally, on the fourth level magnificent, brilliant, caramel-brown, crystallized sphalerite has been found in pockets which were worked intensively by the miners for collector specimens.

Andara Group

The deposits of the Andara group were worked from 1860 until roughly the end of the 1930's. In general they strike in a northwest-southeast direction for a distance of 2 to 3 km. Mazarrasa (1930) identified two groups: the first and most important (which has a length of 1900–2000 meters) included the Superior, Atrevimiento, Ultima de Andara, Abundantísima, Nosotros, Enclavada, San Carlos

Figure 5. **Old mine in the Aliva district, looking north (1990). Photo by Gonzalo Garcia.**

and Santa Rosa concessions; the second included the Evangelista (or Santiago), Inagotable and Montañesa mines. The first was made up of three parallel mineral veins separated by 30 to 50 meters and averaging 1 to 2 meters in width but narrowing with depth. The deposits of the second group were shorter and less rich.

The mineralization is in the form of veins and large irregular pockets. These held a mixture of sphalerite and smithsonite with lesser amounts of galena, hydrozincite and hemimorphite in an gangue of calcite. Arce (1880) described over 200 distinct habits or varieties of smithsonite. These had been stained various colors by iron oxides, cinnabar, malachite and azurite. The best specimens were found in the early days of operation in the upper levels. These mines also produced caramel-brown sphalerite, sometimes in exceptionally large crystals.

The main companies which worked these deposits were the Sociedad la Providencia, La Real Compañía Asturiana de Minas and the Herederos de Mazarrasa. The workings were always underground, following the mineralization, which either ended in benches or in ascending *testeros* (an old underground method for mining vertical deposits). The ore extracted was classified as either sphalerite or "calamine" (smithsonite). The sphalerite was transported directly to the coastal shipping port of Unquera, and was exported. The "calamine" was taken to Dobrillo where it was roasted; then it was transported to La Hermida and from there to Unquera. It is estimated that at the height of production the mines produced 3,000 to 4,000 metric tons of concentrate per year.

La Hermida-Lebeña Group

To the east of the Andara group, at the edge of the eastern highlands of the Picos de Europa, lies a group of small prospects of little economic interest, but with characteristics similar to those of the mines discussed above. They are all small deposits of sphalerite and galena (some also have associated copper, mercury, barium and silver minerals) within the Carboniferous limestone, but very close to the Permo-triassic outcrops. Between the areas of Tresviso and La Hermida are two of these prospects, which date from the beginning of this century. They produced lead and some caramel-brown sphalerite which was generally translucent to opaque and of a breccia-like nature. The copper and mercury present were not worked.

To the west of La Hermida are the deposits of Peñarrubia (the Argayón and Cotos Rubios mines), just a few kilometers to the north of Linares, where smithsonite is predominant with some sphalerite, galena and barite. A small distance to the south, between the areas of Linares and Lebeña, small deposits of galena and sphalerite were worked (Hozarco and Aurora mines), accompanied by some cinnabar and copper minerals.

The operation of these mines, worked on a part-time basis by local families, ceased in the 1930's and never attracted the attention of the large mining companies who thereafter worked only the largest zinc deposits.

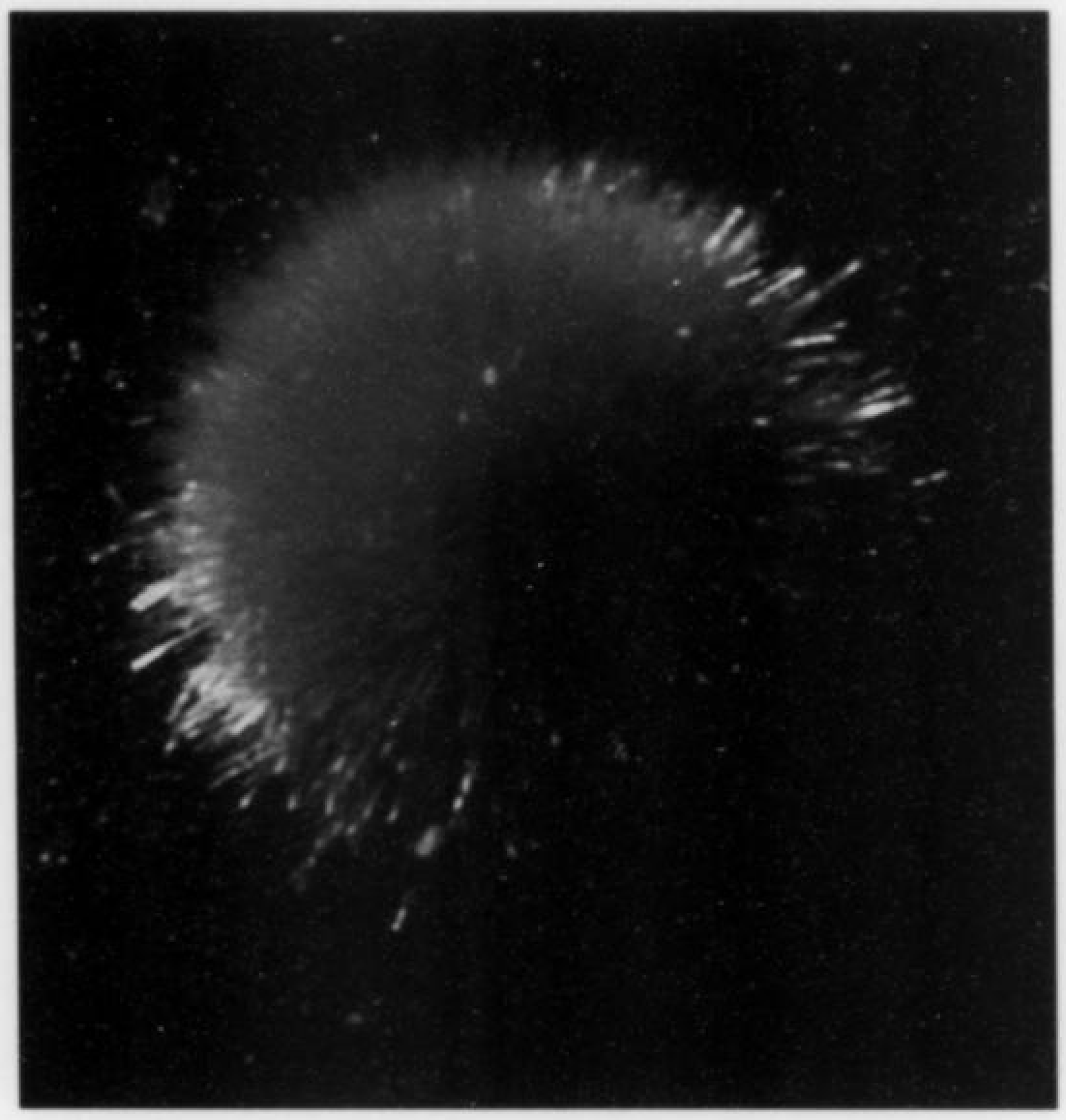


Figure 6. **Aurichalcite, 3 mm, from the Hozarco mine. Francisco Piña specimen and photo.**

MINERALS

Aurichalcite $(Zn,Cu^{+2})_5(CO_3)_2(OH)_6$

According to Calderón (1910), a fibrous calcian variety of aurichalcite (which was named *buratite* by Delesse) has been found in the Picos de Europa.

The best specimens of aurichalcite we have seen have come from the Hozarco mine, near the village of Piñeres, where it is present in the form of attractive groups of needles on iron-stained quartz along with rosasite, hemimorphite, hydrozincite and malachite.

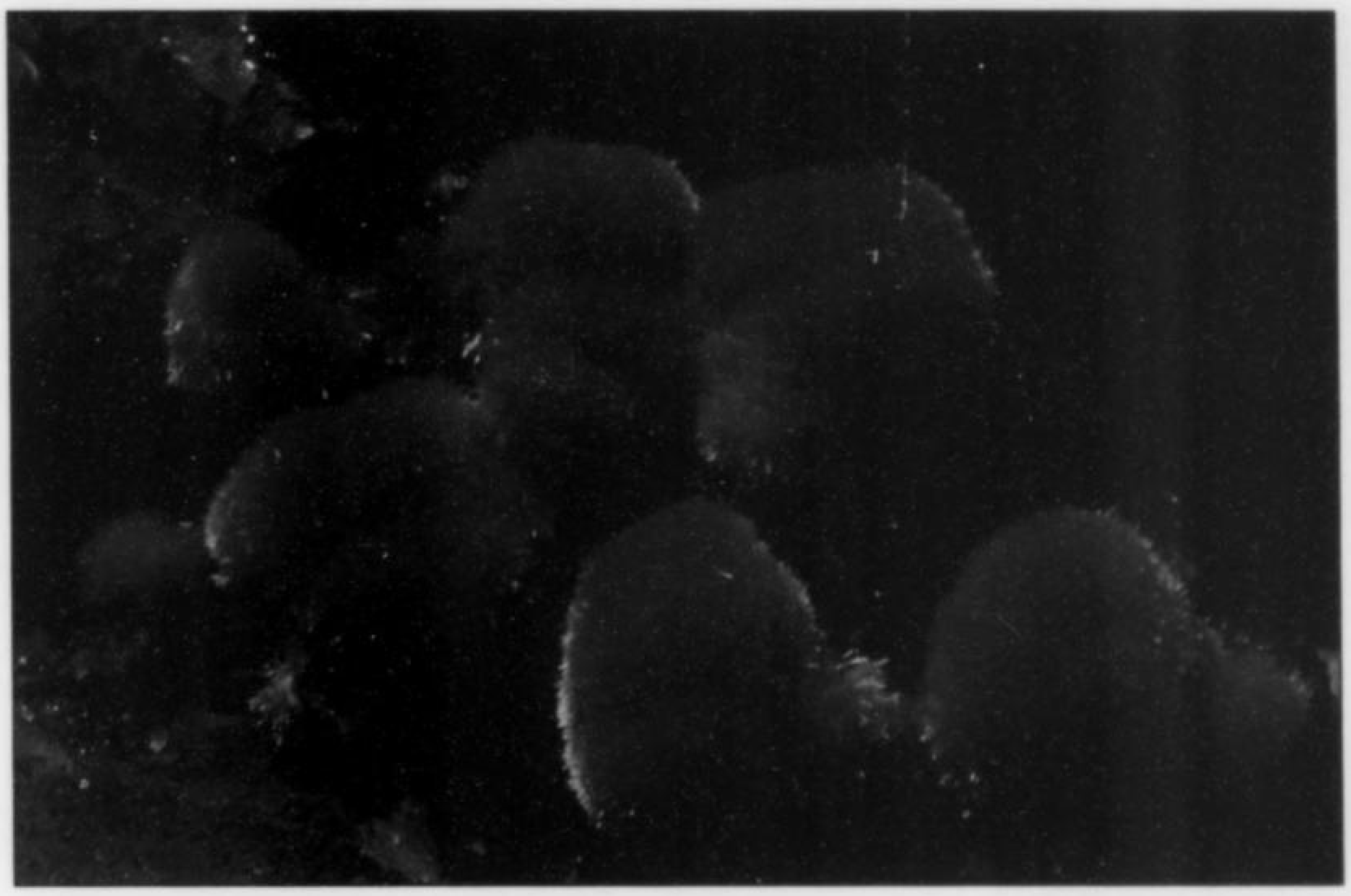


Figure 7. **Rosasite on quartz, 5 x 3 mm, from the Hozarco mine. Photo by Francisco Piña; Carolina Daneyko specimen.**

Figure 8. **Calcite, 8 cm, from the Aliva mines. Photo by Francisco Piña. J. M. Gordillo specimen.**

Figure 9. **Calcite on sphalerite (size of the calcite crystal is 6.6 cm), from the Aliva mines. Photo by Carles Curto; Jordi Fabre specimen.**

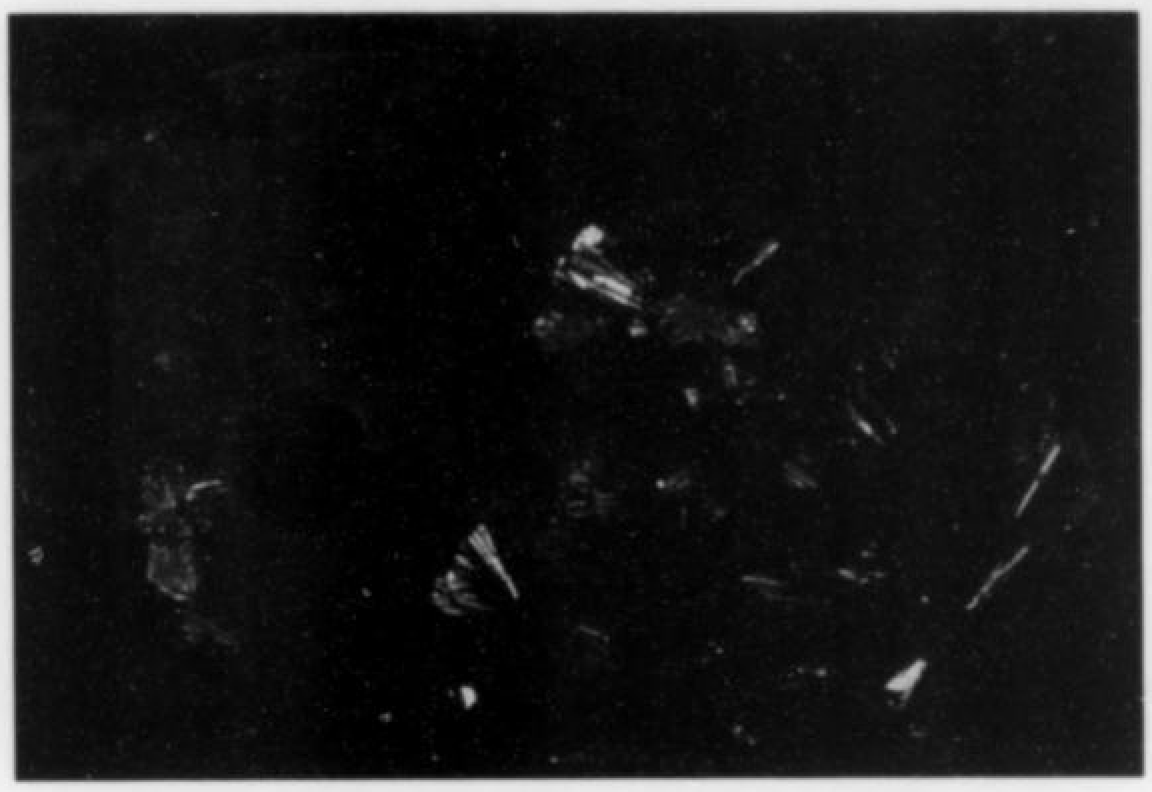


Figure 10. **Rosasite and hemimorphite (3 x 2 mm) on limonitic quartz. Photo by Francisco Piña; Gonzalo García specimen.**

Figure 11. **View of the Aliva mines in July, 1991. Photo by Borja Sainz de Baranda.**

Barite $BaSO_4$

Calderón (1910) states that barite has been found as an accessory mineral in the zinc ores of the Picos de Europa, although he does not quote a specific locality. It has been found in the smithsonite workings in the Peñarrubia area (Argayón and Cotos Rubios mines).

Calcite $CaCO_3$

Calcite is the typical gangue mineral accompanying zinc mineralization in the Picos de Europa, sometimes appearing as prismatic crystals to several centimeters. According to Calderón (1910), excellent scalenohedral crystals covered by zinc carbonates were found in the La Providencia mine (it is almost certain that he was referring to a mine of the Aliva or Andara groups which the La Providencia company operated). Very good crystals have been found in the Aliva mine, especially on the third level, where scalenohedrons and small butterfly twins have been recovered.

Cerussite $PbCO_3$

Sanchez Alonso (1990) notes the occurrence of cerussite at an unspecified locality in the Picos de Europa. We have found it in the Cabañes lead mine, as twinned crystals (on galena) of up to 1 cm.

Chalcopyrite $CuFeS_2$

Chalcopyrite has been reported as occurring at Andara. It has also been found in the Hozarco mine, although highly altered, along with chalcocite and covellite.

Cinnabar HgS

Earthy cinnabar is found in the mines of Andara, associated with smithsonite, the red color of the latter being due to inclusions of cinnabar. In the San Carlos mine, also in Andara, cinnabar occurs as small veins of up to 2 cm in thickness (Calderón, 1910). It has been found in abundance in the Hozarco mine, in two habits (Martínez García *et al.*, 1991): (1) small millimeter-sized crystals dispersed in limestone and associated with sphalerite, chalcopyrite and galena, and (2) as a dust formed during the alteration of mercurian sphalerite to smithsonite.

Dolomite $CaMg(CO_3)_2$

Dolomite is present in all of the orebodies of the Picos de Europa, and along with calcite is the most abundant gangue material. It normally occurs in the typical curved saddle-shaped habit, white to pink in color, and serves as the matrix for splendid crystals of sphalerite, galena and calcite.

Fluorite CaF_2

Fluorite has been found as massive, colorless to blue-violet material, accompanying sphalerite and galena at Aliva.

Figure 12. **Galena crystal, 1.5 cm, on dolomite, from the Aliva mine, second level. Photo by Francisco Piña; Gonzalo García specimen.**

Galena PbS

Galena usually accompanies sphalerite in the main deposits of the Picos de Europa, although its production was not considered to be of importance. Apparently the galena from the La Providencia mine contained some silver. The best crystals came, without doubt, from the Aliva mines, and reach up to 2 cm in size. The crystals consist of a combination of the cube and octahedron, and sometimes display dark, curved faces with indications of corrosion. They are found on crystals of dolomite, and are often accompanied by small crystals of caramel-brown second-generation sphalerite. Very good crystals have been found in the second level of the Aliva mine.

Greenockite CdS

According to Calderón (1910), the smithsonite of Andara is sometimes colored yellow by the presence of the small quantities of included greenockite.

Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$

In general, hemimorphite appears in all of the mines of the Picos de Europa, but is especially abundant in the La Esperanza mine where it occurs as compact masses and stalactites similar in appearance to chalcedony (Calderón, 1910). Small, isolated crystals have been found recently in the Hozarco mine.

Hydrozincite $Zn_5(CO_3)_2(OH)_6$

Hydrozincite occurs as white crusts, stalactites and nodules in all the mines of the Picos de Europa, but is most abundant at Andara and Aliva.

Minium $Pb_2^{+2}Pb^{+4}O_4$

Minium has been found in some of the mines of the Picos de Europa. According to Calderón (1910), Groth mentioned the presence of this mineral in the form of a delicate infill, of pseudomorphic origin, between crystals of galena from this region.

Pyrite FeS_2

Pyrite occurs in small quantities with sphalerite and galena in the Aliva mines, and generally in all of the mines of the Picos de Europa. The crystals are typically small, with pyritohedral faces having small cubic and octahedral modifications.

Rosasite $(Cu^{+2},Zn)_2(CO)_3(OH)_2$

In the Hozarco mine rosasite is found as small, compact groups having a beautiful blue-green color. They are found in association with aurichalcite.

Smithsonite $ZnCO_3$

Along with sphalerite, smithsonite was the main ore mineral in the mines of the Picos de Europa, especially in the Liordes-Lloroza and Andara mines. It is normally found associated with sphalerite, from which it is formed by weathering, with nodules of unaltered sphalerite sometimes found in the cores of earthy masses of smithsonite. It is found in numerous habits: massive, earthy, compact, nodular, botryoidal, stratified and concretionary. (All of these varieties, along with a lesser or greater proportion of hydrozincite and hemimorphite, are given the name "calamine" by the miners.) Smithsonite occurs here in a large number of colors, caused by the inclusion of small particles of copper carbonates, cinnabar, greenockite, iron oxides, etc. Arce (1880) distinguished more than 200 varieties based on the color and texture of the "calamine" found in the Picos de Europa.

Sphalerite $(Zn,Fe)S$

Sphalerite is, along with smithsonite, the main ore mineral exploited in the Picos de Europa, and is famous worldwide for the purity, transparency, size and beauty of its crystals. Because of its special qualities it was studied by many of the major mineralogists of the 19th century (Calderón, Ramsey, Mallard, Freidl, Quiroga, Brauns and Caldwell) in order to determine its optical, chemical and physical properties. Calderón (1910) states that Urbain, Del Campo and Clair Scal (1909) detected the presence of germanium in the red sphalerite of the Picos de Europa, along with gallium and indium. According to Olavarria (1889), the sphalerite of the Picos de Europa contains up to 50 g of gallium per 100 kg. The most recent analyses (Sapalski and Gomez, 1992) contradict this, but confirm the presence of germanium, cadmium and significant amounts of mercury. The yellow and green varieties do not contain germanium. The studies of Llord y Gamboa (1909) revealed thermoluminescence which is present to a high degree in the sphalerite of the Picos de Europa; the authors ascribed the effect to the presence of organic material. According to Calderón (1910), the crystallographic studies which Groth and Sadebeck carried out on the mineral are also of interest.

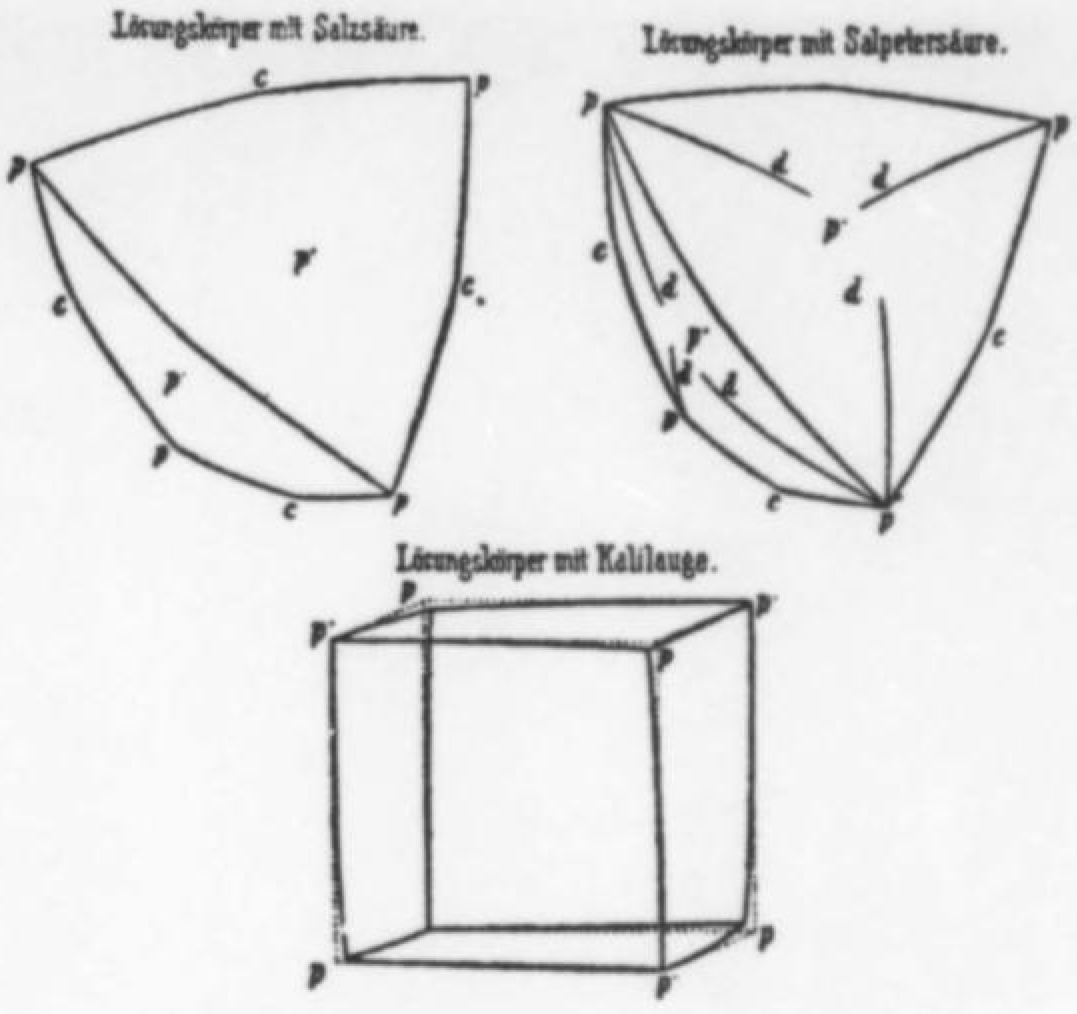


Figure 13. **Dissolution experiments conducted by Hochschild (1908, *Jahrbuch der Mineralogie*) on Picos de Europa sphalerite yielded these crystal shapes when crystals were partially dissolved in hydrochloric acid (left), nitric acid (right) and potassium hydroxide (bottom).**

Barbanson *et al.* (1985) and Martínez García *et al.* (1991) describe a variety of sphalerite which is rich in a solid solution of mercury, with up to 7% substitution of zinc by mercury. This variety has been found in the mines of Argayón, Cotos, Rubios, Tresviso and Hozarco. It also appears that HgS is the cause of certain red tones in these sphalerites.

The best recent, gem-quality, sphalerite crystals have been found in the Aliva mine, especially on the second, third and fourth levels. These crystals, which vary in size from 1 mm to several centimeters, occur in a variety of colors, from yellow, brown and red to green and orange. Zoning in the crystals is common, sometimes with several colors appearing in the same crystal. The degree of transparency also often varies within a particular crystal, especially in the large masses. The most beautiful crystals are those that occur on sheets of white dolomite crystals and (more rarely) on calcite, forming specimens of exceptional beauty. The crystals are often found in twinned groups with curved faces, sometimes with evidence of hydrothermal corrosion. More rarely the sphalerite occurs in the form of single tetrahedral crystals, with small octahedron and cubic faces.

Stibnite Sb_2S_3

According to Calderón (1910), a vein of "antimony" was worked in the mines of Mazarrasa (Andara), although no information on the level of production is given.

Figure 14. (above) **Sphalerite on dolomite, 7.5 cm (largest crystal is 2.5 cm), from the Aliva mines. Photo by Carles Curto; Jordi Fabre specimen.**

Figure 16. **Sphalerite on dolomite, 4.9 cm (largest crystal is 1.5 cm), from the Aliva mines. Photo by Carles Curto; Jordi Fabre specimen.**

Figure 15. (below) **Sphalerite crystal (6.0 cm) from the Aliva mines. Photo by J. M. Sanchis; Museo de Geología de Barcelona specimen (MGB.10159).**

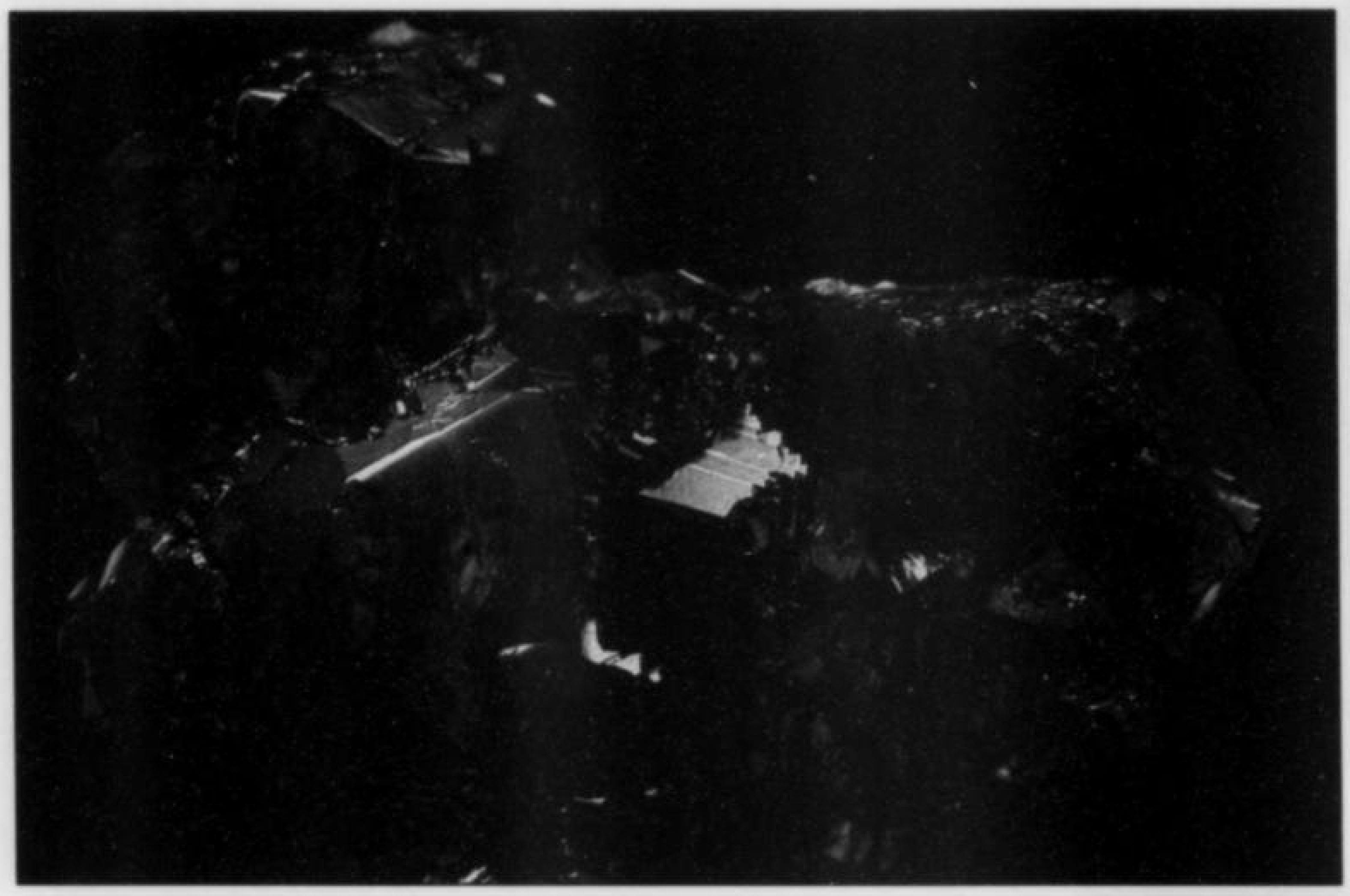


Figure 17. **Picos de Europa sphalerite specimen depicted on a 1994 Spanish postage stamp.**

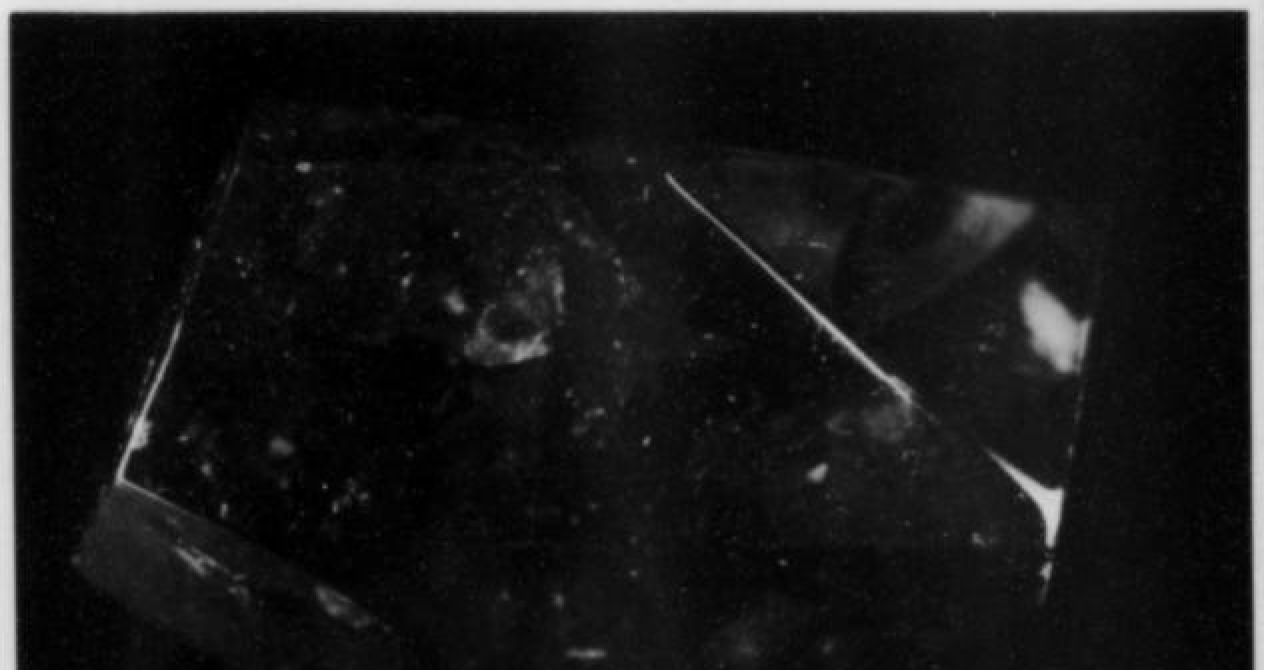


Figure 18. **Sphalerite cut stone, 6.26 cm (835.1 carats), from the Aliva mines. Photo by Carles Curto; Museo de Geología de Barcelona specimen (MGB.12068).**

Figure 19. **Sphalerite group, 2 x 3 cm, on dolomite, from the Aliva mine, second level. Photo by Francisco Piña; Felix Marcos specimen.**

Figure 20. **Sphalerite crystal (6 cm) on dolomite, from the Aliva mines. Museo del Instituto Tecnológico y Geominero de España specimen; photo by Borja Sainz de Baranda.**

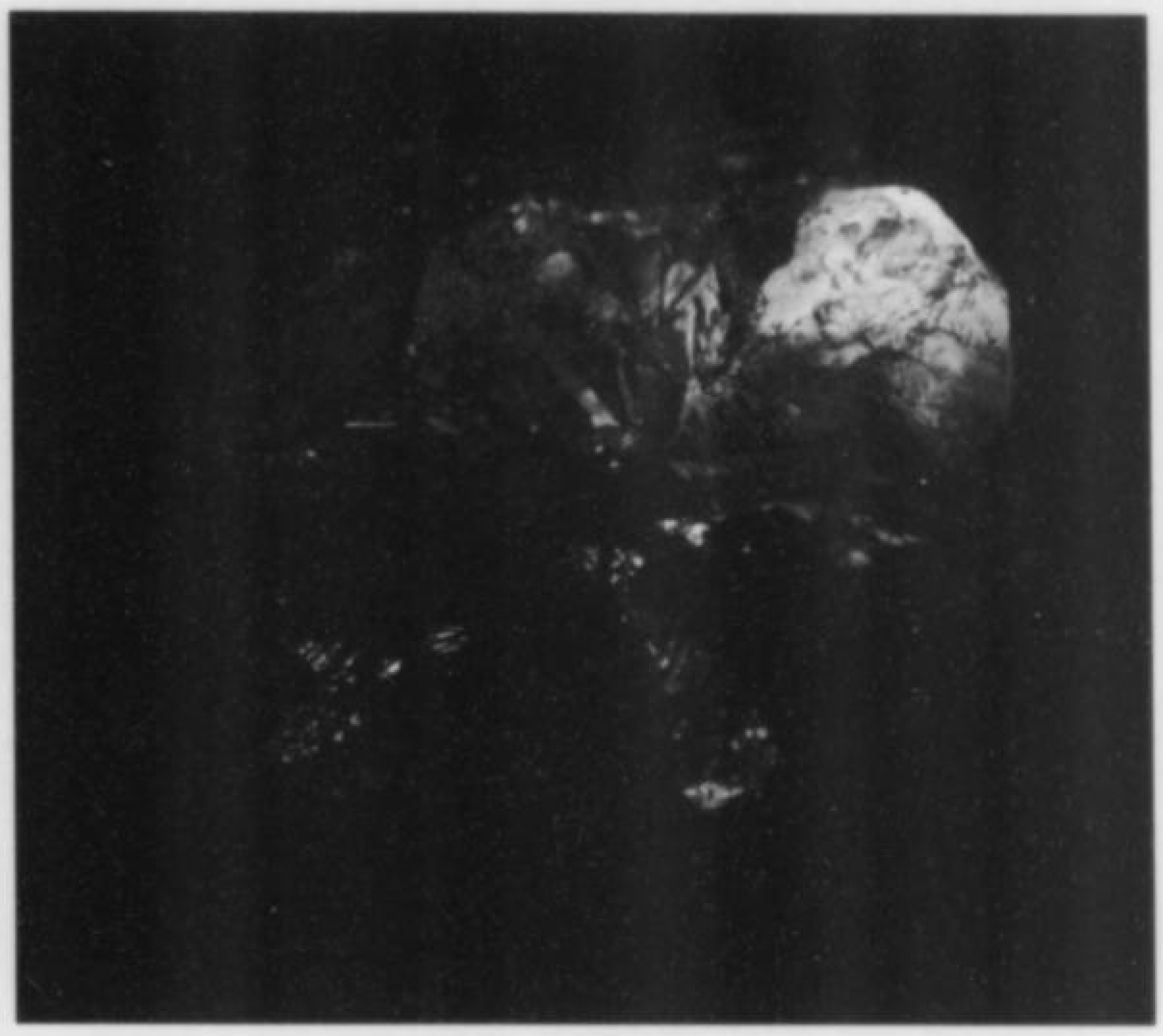


Figure 21. **Sphalerite crystal group, 9 cm, from the Aliva mines. Museo del Instituto Tecnológico y Geominero de España specimen; photo by Borja Sainz de Baranda.**

Figure 22. **Sphalerite crystal (8 cm) with minor dolomite, from the Aliva mines. Museo del Instituto Tecnológico y Geominero de España specimen; photo by Borja Sainz de Baranda.**

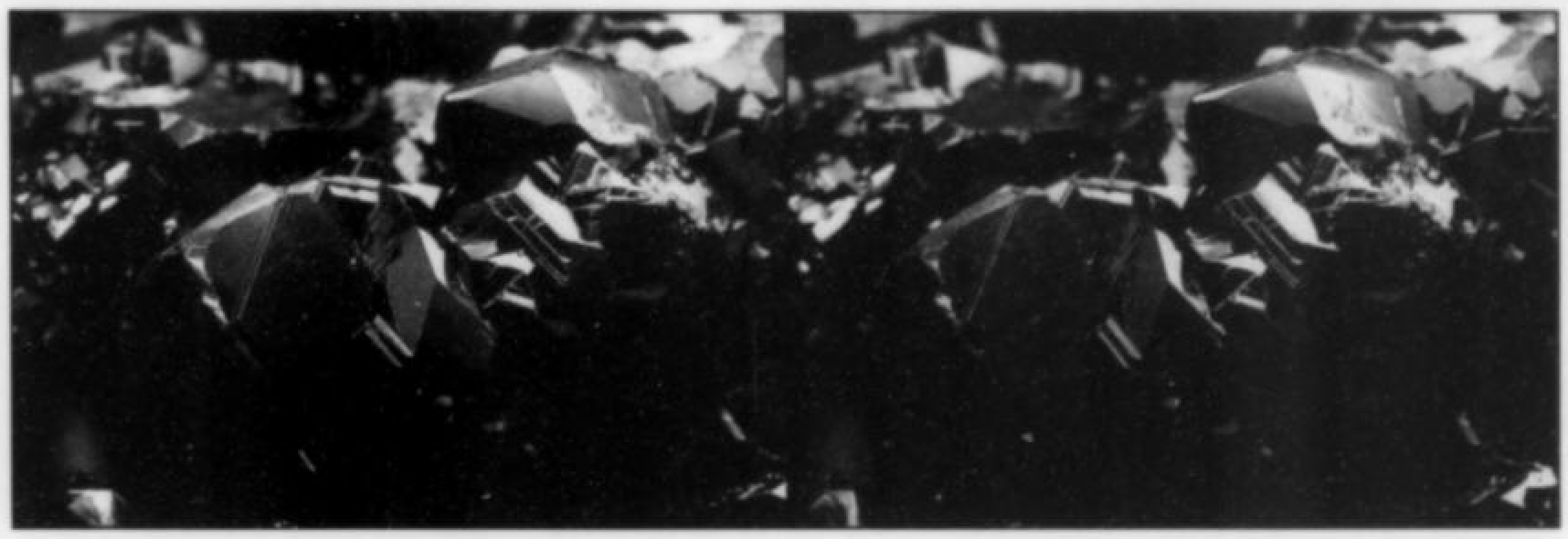


Figure 23. **Sphalerite crystals to 1 cm from the Aliva mine (stereopair). Photo by Francisco Piña. J. M. Gordillo specimen.**

Other Minerals

Other minerals which have been mentioned in the literature as occurring in the Picos de Europa, and which we have in some cases observed, are: native mercury (Andara), malachite (La Hermida, Hozarco), willemite (Andara), pyrolusite (Linares), quartz (Linares, Hozarco), gypsum (Aliva, Hozarco), chalcocite and covellite (Hozarco), azurite (Hozarco), and an unverified report of native silver in the La Hermida gorge.

ACKNOWLEDGMENTS

We are grateful to Carles Curto, Francisco Piña and J. M. Sanchis for photographic work. We thank J. M. Gordillo and J. Fabre for providing additional mineral specimens for photography. James Catmur graciously translated the manuscript into English for the *Mineralogical Record*. Michael P. Cooper, Richard C. Erd and Wendell E. Wilson provided helpful suggestions on the manuscript.

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ORTHOSERPIERITE

FROM THE COPPER CREEK DISTRICT, PINAL COUNTY, ARIZONA

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The El Niño phenomenon and the Philippine volcano Pinatubo have affected weather patterns worldwide, and are the direct cause of at least one unusual mineral occurrence: orthoserpierite crystallizing from vadose water surfacing on the usually dry Arizona desert.

INTRODUCTION

During January and February of 1993, Arizona experienced one of its wettest periods of weather ever; 8.56 inches of rain fell during this period. The normal expected rainfall is 1.23 inches. This excessive rainfall caused extensive flooding throughout the state, and also saturated the ground to a significant degree.

Numerous copper deposits are found throughout the Copper Creek district northeast of Tucson, Pinal County, Arizona. Among some of the larger producing mines in the area are the Old Reliable mine, the Bluebird mine, and the Childs-Aldwinkle mine. The Childs-Aldwinkle is located at the base of a 200-meter-high hill that has been extensively transected by tunnels and stopes. This hill is located in high desert, 3,800 feet elevation above sea level in the rugged Galiuro Mountains.

On one side of this hill about 50 meters from the adit of the Childs-Aldwinkle mine, I observed a bright blue streak measuring one meter wide by ten meters in length. Rainfall had leached through the hill, percolated through to the base, and then found an exit. Such leaching occurrences are frequently encountered in old mine workings; ground water percolating through sulfide-rich ores becomes acidic due to oxidization of the sulfides. This creates sulfuric acid (H_2SO_4) which readily dissolves any available copper, iron and base-metal-bearing minerals in the vicinity. Typical minerals formed under these conditions are water-soluble sulfates such as chalcanthite, melanterite and halotrichite, along with other more insoluble minerals such as malachite and chrysocolla. These minerals precipitated out to form a blue-green amorphous-looking slime.

This is what I presumed the blue streak was composed of on the hillside above the Childs-Aldwinkle adit, but, upon closer examination, this material had an unusual blue-green color and was well crystallized. Subsequent X-ray powder diffraction identification has determined that the predominant mineral is orthoserpierite (Sarp, 1985), a species new to Arizona.

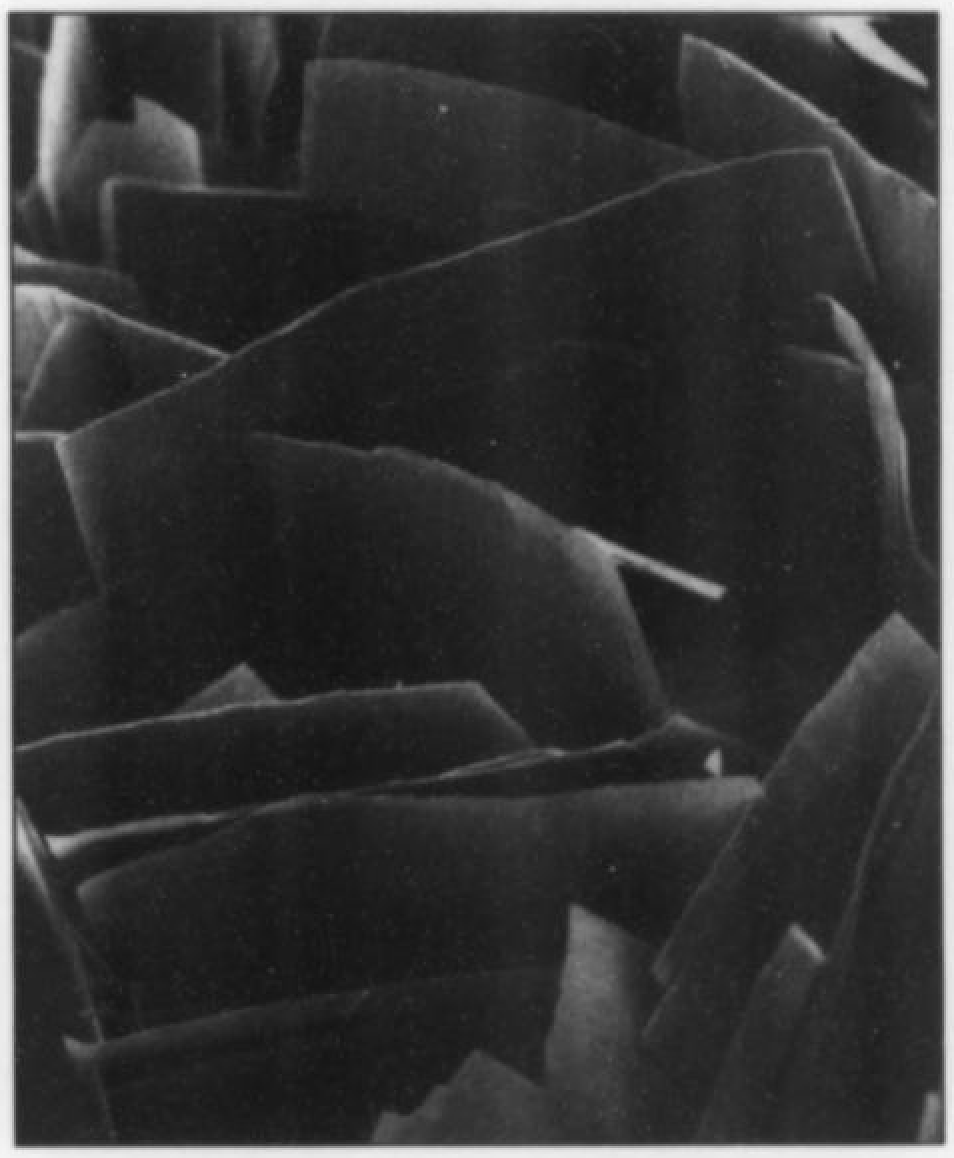

Figure 1. **Scanning electron micrograph showing orthoserpierite crystals to about 40 μm.**

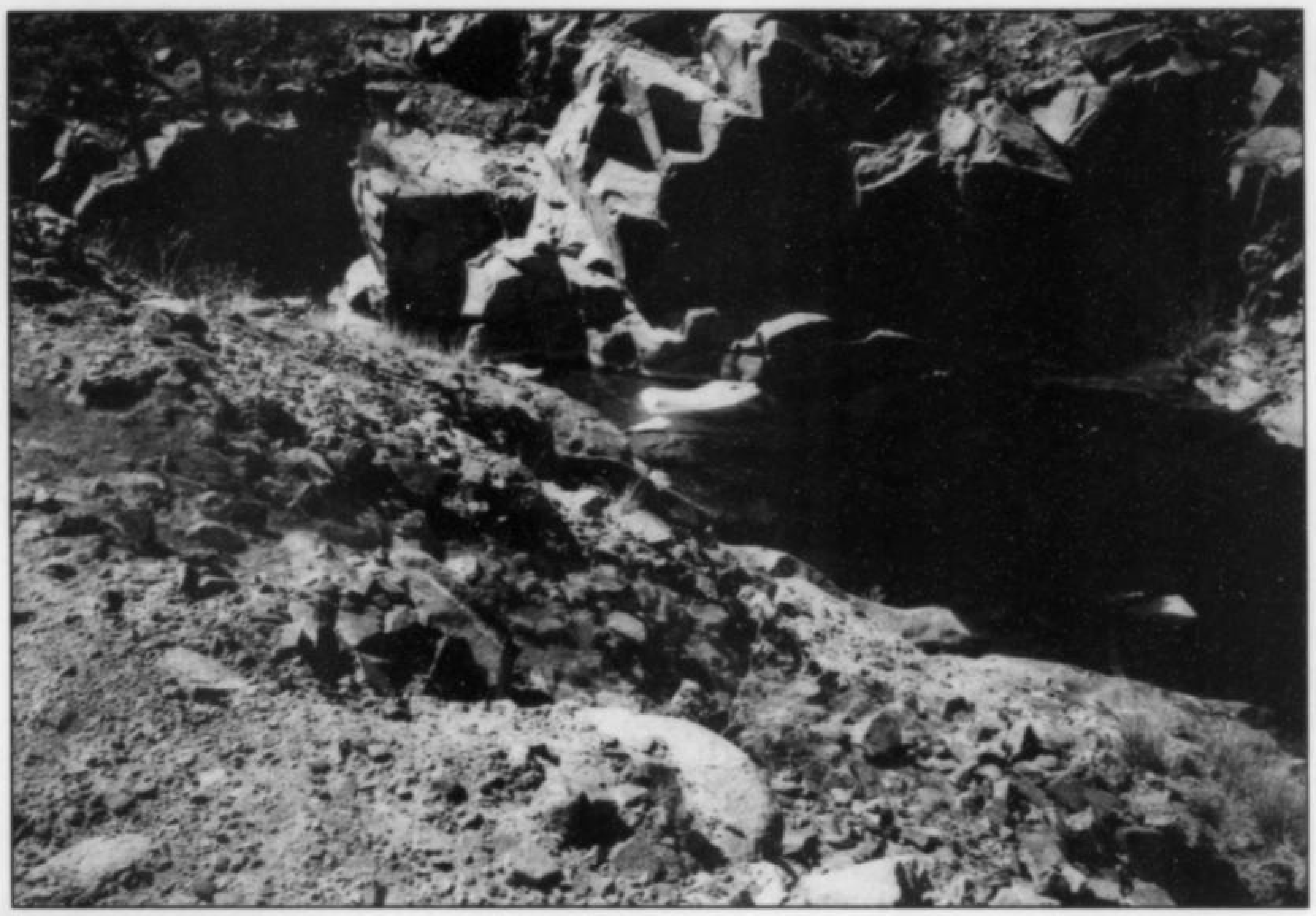

***Figure 2.* Emergence of vadose water near the Childs-Aldwinkle mine is made apparent by the deposition of blue-green orthoserpierite and other secondary copper minerals on the surface. David Shannon photo.**

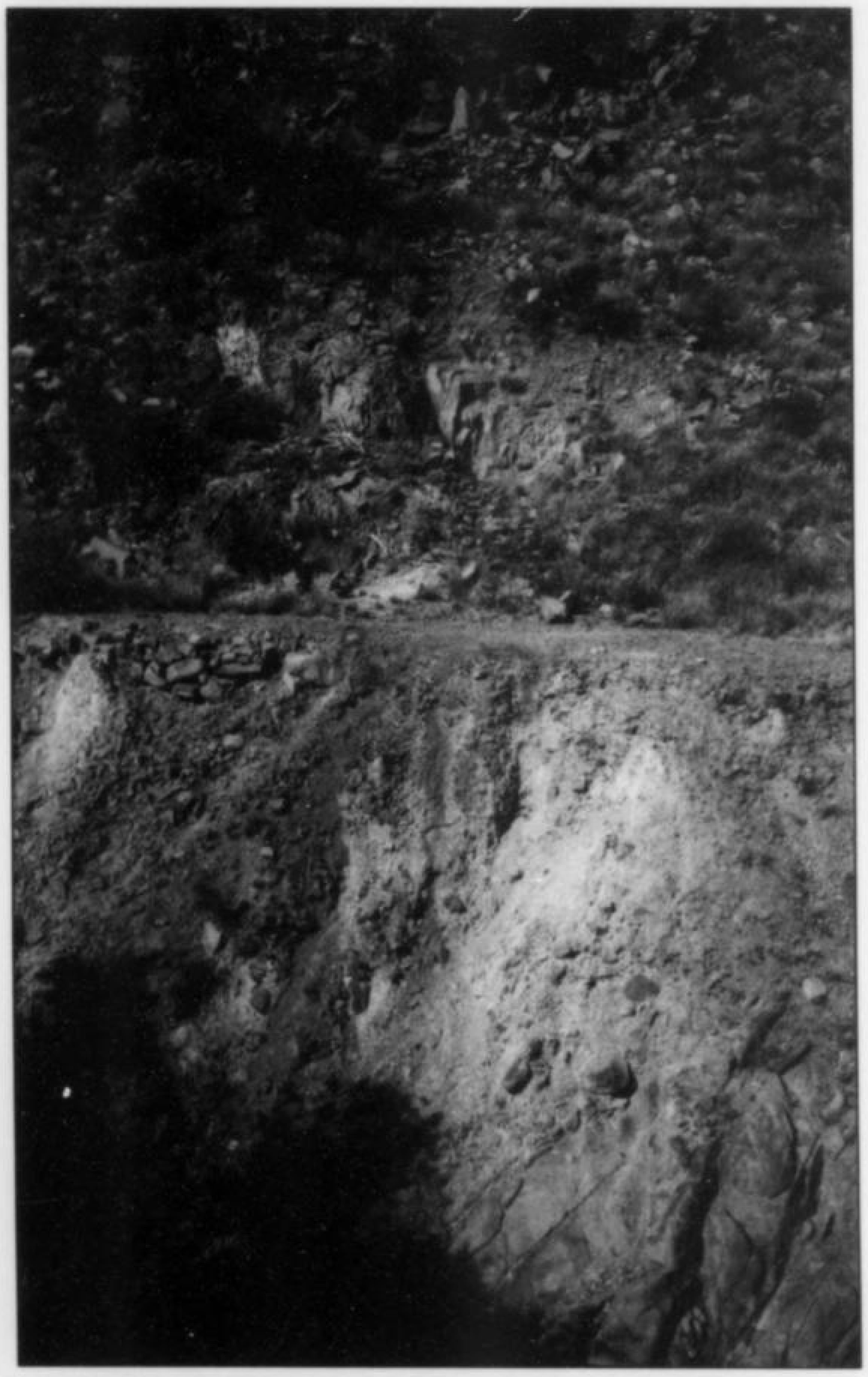

***Figure 3.* Path of mineralizing water down the hillside, culminating near a pool of green water.**

This occurrence was, unfortunately, short-lived; by late April the wet blue streak had completely dried up. With Arizona's long, hot, dry summers, the orthoserpierite has been completely sun-dried, and has been blown away by the wind.

The question of how long a particular mineral took to form comes up for discussion from time to time. This is one of those rare occasions where the actual time involved is clearly established and shows that it is in some cases quite short. All mineral occurrences do not need long periods of geologic time to manifest themselves.

DESCRIPTION

The orthoserpierite consists of thin, 0.03-mm, pale blue-green, transparent plates which, in turn, form 0.1-mm rosettes. There is also minor deep blue chrysocolla and green malachite present.

The orthoserpierite crystals are not water-soluble, but they dissolve rapidly in 0.1N hydrochloric acid. The specific gravity, determined by heavy liquids, is 2.95–3.05.

ACKNOWLEDGMENTS

I thank Andrew C. Roberts (Geological Survey of Canada) for X-ray powder diffraction identifications and for his review of this paper.

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JOHANN GEORG LENZ AND HIS *MUSTERTAFELN*

(1794)

Wendell E. Wilson
The Mineralogical Record
4631 Paseo Tubutama
Tucson, Arizona 85750

Lenz's Mustertafeln, *published in 1794 for an exclusive list of 26 patrons, contained 344 miniature specimen illustrations. Each one was painted from scratch in every copy of the book, without the aid of engraved outlines. Extremely rare today, the book stands as the first general illustrated field guide to minerals and an invaluable documentation of an early Ducal mineral collection.*

INTRODUCTION

Johann Georg Lenz (1748–1832) was a German mineralogist, mineral collector, co-founder of the Mineralogical Society of Jena, curator of the Mineral Museum at the University of Jena, and author of numerous basic mineralogical works. After earning his doctorate in theology and philosophy at the University of Jena in 1770, Lenz joined the faculty there as a lecturer. For a time he busied himself primarily with theological studies, until a sudden attraction to natural history awakened in him, especially to the study of mineralogy.

In 1797 Lenz joined with 18 other founding members to create the "Societät für die gesammte Mineralogie zu Jena," the first scientific society in history to be devoted exclusively to mineralogy. Lenz also served as publisher for the society's annals and journal from 1802 until 1825.

Lenz was a prolific advocate of mineralogy and mineral collecting. His publications were all designed to aid the mineral enthusiast, especially the amateur, in identifying and understanding minerals, based on Werner's emphasis on external characteristics which could be discerned easily in hand specimens: habit, color, cleavage, luster, transparency and hardness. His principal works (see accompanying table) included various tables for rock and mineral identification (1780, 1781, 1800, 1806), several editions of a *Handbook of Mineralogy* (1791, 1798, 1819), an *Outline of Mineralogy* (1793), an *Introduction to Mineralogy* (1794), a *Pocket-book of Mineralogy* for beginners (1798, 1799), a *System of Mineralogy*

J. G. Lenz
(Courtesy Stiftung Weimarer Klassic, Weimar)

(1800, 1809), a systematic six-language glossary relating to the external characteristics of minerals (1800, 1801), guides and handbooks dealing with *Comparative Mineralogy* (1813, 1920, 1822), and his famously rare *Mustertafeln* (1794), a collection of color plates illustrating mineral specimens, which might be considered as the first illustrated field guide for mineral collectors.

THE *MUSTERTAFELN*

The *Mustertafeln* is unique among published colorplate mineralogies in that the plates are *not* merely hand-colored engravings, but pure originals each painted from scratch without benefit of engraved outlines or guidelines. An English translation of Lenz's Preface is given below in the sidebar.

The 344 individual illustrations were all drawn from specimens in the collection established by Karl August (1757–1828), Duke of Saxe-Weimar from the year after his birth until 1815, and Grand Duke from 1815 until his death. Karl's father, Ernst August Constantine, had died in 1758, at which time Karl's mother, Anna Amalia (1739–1807) took over as Regent for him until he came of age in 1775. Anna Amalia was a patroness of literature and art, and surely also a patroness of Lenz in the production of his *Mustertafeln*. Lenz dedicates the work to her, and states in the preface that its publication was made possible by a "distinguished patron."

Karl August's court was a friendly place to scholars. He made the acquaintance of Goethe in 1774, and remained his lifelong friend. Goethe had learned his mineralogy from Johann Voigt (1752–1821) who, like Lenz, was a proponent of Werner. Goethe, Voigt, Baron Friedrich von Trebra (1740–1819) and Lenz all became frequent collecting partners. At the urging of Goethe, Karl August had founded a mineral collection at the University of Jena in 1779. This collection consisted primarily of the cabinet of the late Professor Johann Ernst Immanuel Walch (1725–1778), a scholar and author of books on minerals and fossils. It is likely that Walch, a fellow member of the Jena faculty, had influenced Lenz's turn toward the study of mineralogy. In any case, Lenz was appointed "Ducal Inspector," that is, official curator, of the new collection. From that time on Lenz worked primarily in mineralogy, ultimately gaining the position of first Professor of Mineralogy at the University. His long list of mineralogical publications began the year after his appointment as curator.

In order to help finance the expensive production of the *Mustertafeln*, Lenz's friends and supporters ordered and paid in advance for 26 copies. The prepublication announcement had stated that the *Mustertafeln* would be sold only by prepaid order, at a price of 8 Saxon Reichsthaler. Only enough copies to fill the prepublication orders would be produced. Lenz gives a list of these people. The Duchess Anna Amalia, of course, took one for herself and one for Karl August (though he is not mentioned by name), Goethe took one, and Von Trebra took another. Other subscribers included the Duke of Gotha, the Bishop of Dahlberg, the Prince of Anhalt-Dessau, Louis X (1753–1830), Landgrave of Hessen-Darmstadt, Prince Reuss Heinrich XV, the Count of Castell, Baron Joseph Friedrich von Racknitz (1744–1818), Baron Borck, Baron Poser, Archdeacon Löber, Ambassadorial Privy Councillor Friedrich Bertuch (1747–1822), Major Karl von Knebel (1744–1834), Professor Unger in Passau, Consistorial Assessor Dr. Stephani, Georg Sieveking (1751–1799) in Hamburg, a Göttingen University pharmacist named Sander, the Würzburg University Library and a distinguished Leipzig newspaperman who is not named.

Were these 26 the only copies produced? No one knows, but if there were additional copies they surely were few, as the book is exceedingly rare today. The copy in the Herbert Obodda Library, from which the illustrations shown here were reproduced, bears the stamp of the library of the Grand Duke of Mecklenberg-Strelitz in Neustrelitz, Germany. There is one copy in the Library of the University of Illinois at Urbana, one copy in the library of the Natural History Museum, London, and one copy in a private library in New York. I know of no other copies than those four. Only the

LENZ'S PREFACE, 1794

Through the support of a distinguished patron, I am now in a position to deliver into the hands of the friends of mineralogy my *Mustertafeln* [specimen plates] of all the currently known simple mineral species.

In my prepublication announcement to the mineralogical community I promised 268 drawings; here follow 344. I trust that this will be regarded as sufficient fulfillment.

The minerals, which have been rendered with great care and fidelity by a skilled artist, are arranged according to the eight primary colors and their various shades and tints, so that anyone, whether a beginner or someone with my experience, can conveniently find and identify rocks and minerals, utilizing both the illustrations and the accompanying descriptive text (sometimes more expressive than the paintbrush).

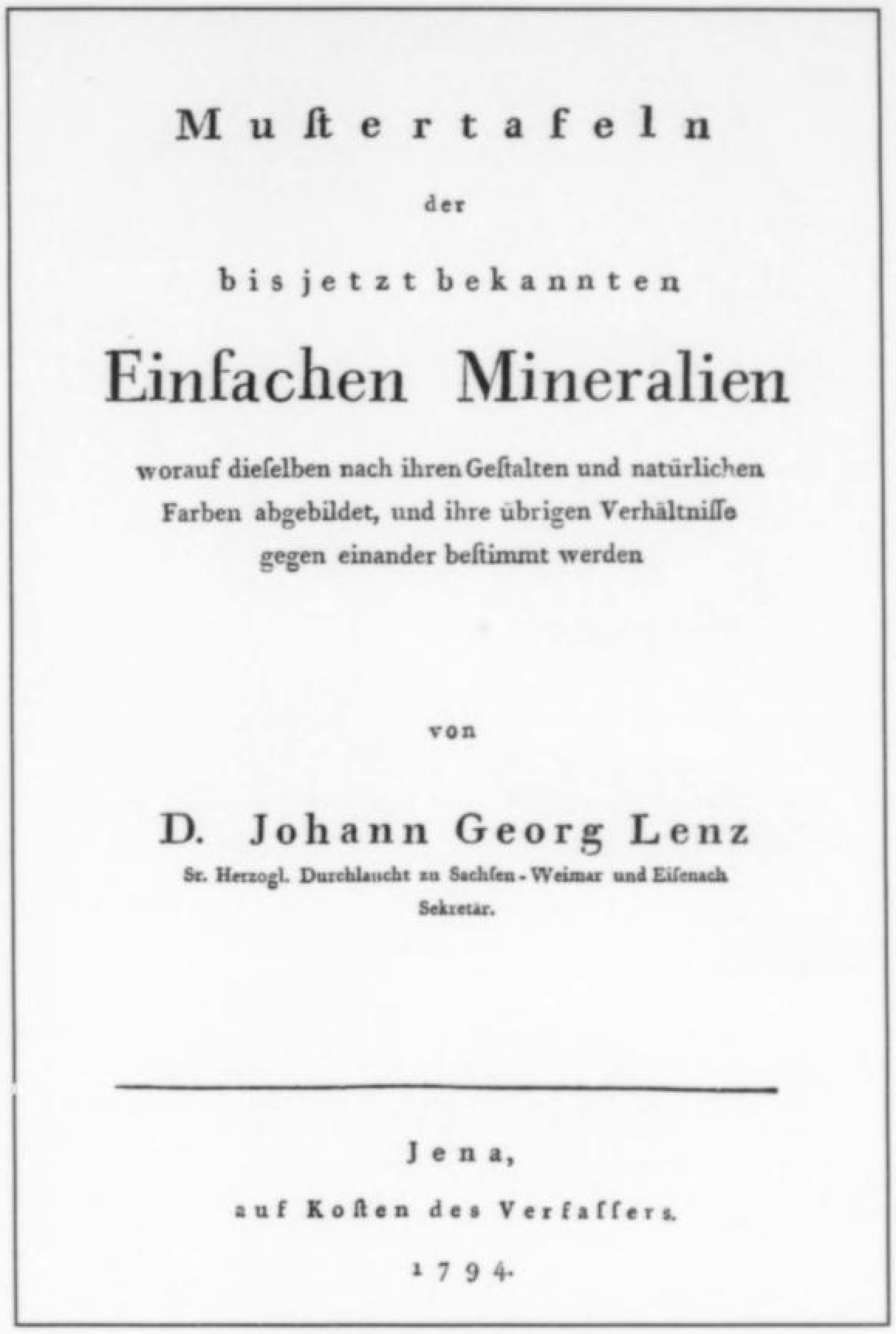
In the instances where no illustration is provided, but only a verbal description of the salient characteristics of a species, the adjacent illustration applies but with the understanding that the information in the text will indicate how to distinguish between the two minerals. The terminology which has been devised for the description of external characteristics can be found not only in Werner's *Von den äusserlichen Kennzeichen der Fossilien* (Leipzig, 1774), but also (alphabetically arranged) in my *Mineralogisches Handbuch* (Hildburghausen, 1791), my *Grundriss der Mineralogie* (Hildburghausen, 1793) and my *Vollständigen Handbuche der Mineralogie nach den neuesten Grundsätzen*, which is scheduled to come out this Easter in two volumes. It will be generally advantageous for the owner of my *Mustertafeln* to purchase this two-volume work because I have referred in it to the numbered illustrations in order to give the reader a completely clear understanding of the concepts.

Zircon, diamond and corundum are not included among the illustrations because the specimens available to me are not sufficiently instructive. Furthermore, these three species are well-known simple minerals. A given mineral can be presented by Nature in three or more versions, each variety differing from the others only in color.

I will not lack for unwarranted critics. But if they were to dare venturing upon the same endeavor which I have undertaken with the greatest effort, and faced the impenetrable difficulties involved in dealing with the myriad variations in the colors and external forms of minerals, they would surely give me my due.

In conclusion, I consider it my duty to my respective subscribers to publicly express here my warmest thanks for their solid support. I offer my heartfelt gratitude in the wish that my *Mustertafeln* will satisfy their expectations.

— Written in Jena in the month of February 1794.



Muſtertafeln

der

bis jetzt bekannten

Einfachen Mineralien

worauf dieſelben nach ihren Geſtalten und natürlichen
Farben abgebildet, und ihre übrigen Verhältniſſe
gegen einander beſtimmt werden

von

D. Johann Georg Lenz

Sr. Herzogl. Durchlaucht zu Sachſen-Weimar und Eiſenach
Sekretär.

Jena,
auf Koſten des Verfaſſers.
1794.

The Title Page above reads:

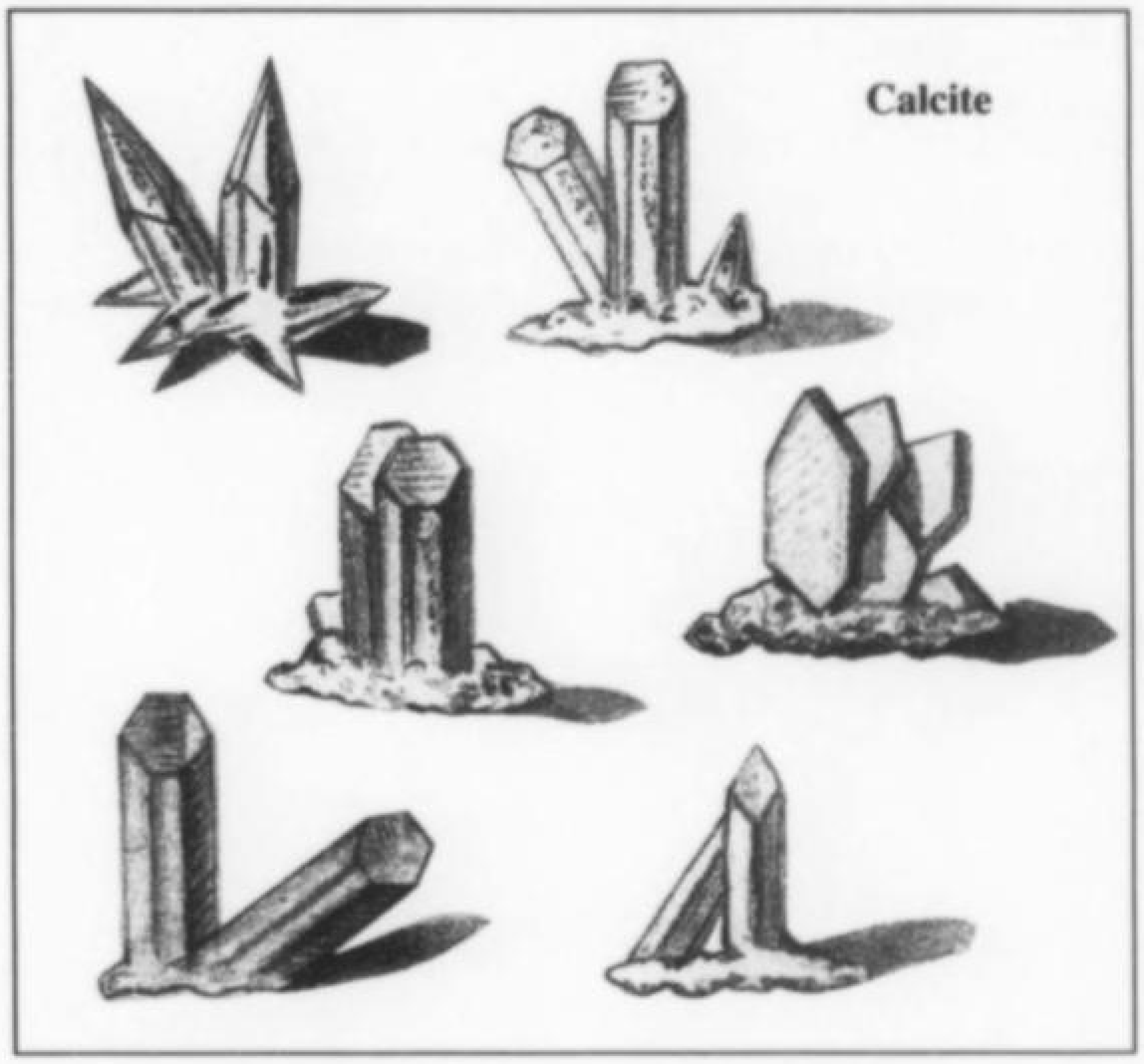
Specimen Plates
of the
currently known
Simple Minerals
illustrating their shapes and natural colors,
and other comparative characteristics which
serve to distinguish them from each other
by
Dr. Johann Georg Lenz
Secretary to His Serene Highness the Duke of
Saxony-Weimar-Eisenach.
Jena,
Published at the Expense of the Author
1794.

Urbana copy is listed in the National Union Catalog; no copies are recorded in the On-line Computer Library Center (OCLC); no copy in the British Library; no copy in the Bibliotheque Nationale, Paris; no copy in the Naturhistorisches Museum library in Vienna; no copy in the Hoover Library at Claremont, California; no copy in the F. D. Adams Library at McGill University, Montreal; no copy in the Sinkankas Library at the Gemological Institute of America; and no copy over quite a stretch of years in the various volumes and indexes of Book Auction Records at the University of Arizona Library. Johann Poggendorff, the well-known biographer, listed Lenz in his multi-volume handbook of scientific biography and cited many of his works but did not know of the *Mustertafeln*. Gümbel, Lenz's biographer in the *Allgemeine Deutsche Biographie*, also listed nearly all of his works but was unaware of the existence of the *Mustertafeln*. Clearly this is an extremely rare book, much rarer than James Sowerby's *Exotic Mineralogy*, for example.

The *Mustertafeln* describes 400 "simple" (*"einfachen"*) minerals. This term was used to make the distinction between pure mineral crystals and polymineralic aggregates ("mixed minerals"). Small paintings are provided for 344 of the numbered entries, one illustration sometimes serving for two or three different numbered species of more or less identical appearance, the practical points of distinction being detailed in the accompanying text. The minerals are presented in a sequence based on color, so that specimens to be identified by comparison can be looked up initially on the basis of their color alone.

Six columns of descriptive information accompany each numbered species. The first column to the right of the illustrations is headed *Aeussere Gestalten* ("External Shape"). The next is *Bruch* ("Fracture/Cleavage"), followed by *Bruchstücke* ("Cleavage fragment shape"), *Durchsichtigkeit und Glanz* ("Transparency and Luster"), *Härte* ("Hardness"), and finally *Namen der Mineralien* ("Names of the Minerals"). Many of the mineral names are familiar to us today, and others are the products of their times.

The specimen illustrations in Lenz's *Mustertafeln* are neither large nor extremely detailed, but they represent by far the most extensive 18th-century colorplate documentation of a mineral



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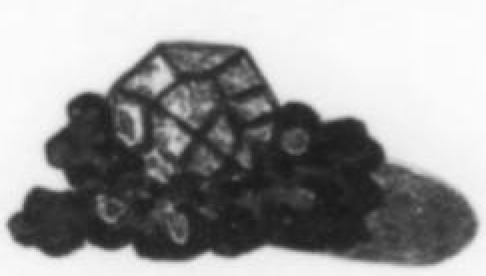

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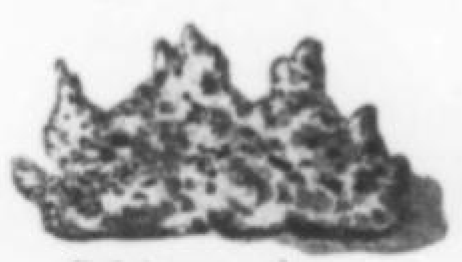
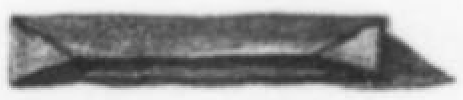


Sal Ammoniac
(Vesuvius)



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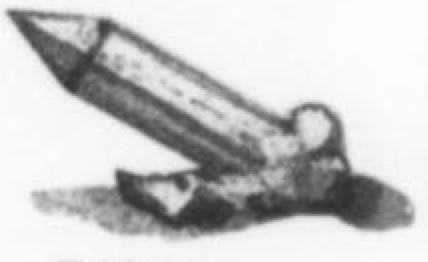
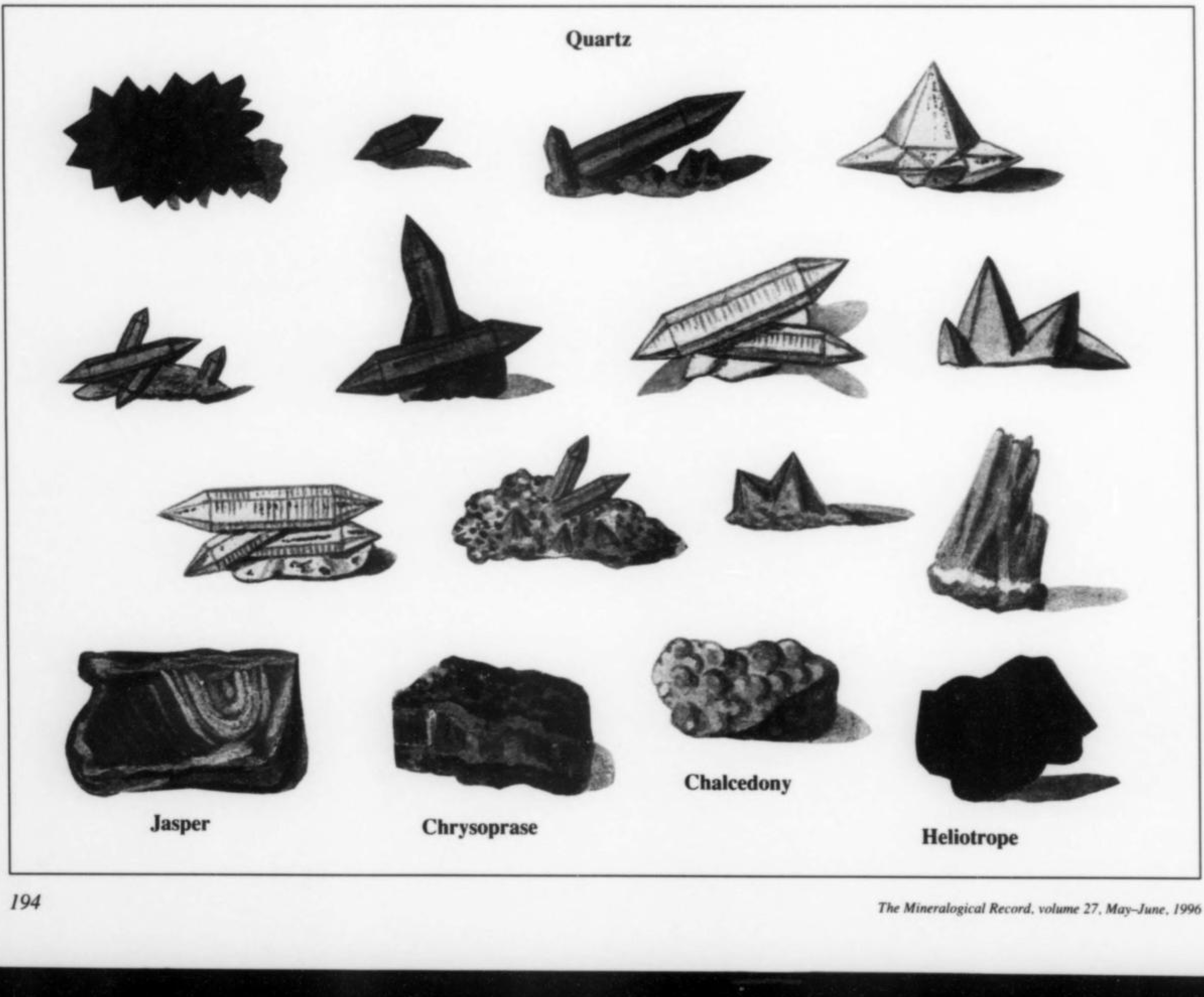


Feldspar

Some mineral illustrations from the *Mustertafeln* in the library of Herbert Obodda (enlarged 40%); specimens from the collection of Duke Karl August (1757–1828).



BIBLIOGRAPHY OF J. G. LENZ

(1780) *Tabellen über die Versteinerungen zum ersten Unterricht*. 4to, Jena.

(1781) *Tabellen über das gesamte Steinreich entworfen*. 4to, Jena.

(1788) *Dissertatione mineralogica de venarum metalliferarum orgine*. Jena.

(1789) *Kurze Abhandlungen vom Basalte, vorzuglich dessen Ursprung betreffend*. Jena.

(1791) *Mineralogisches Handbuch, durch weitere Ausführung des Wernerschen Systems*. 8vo, Hildburghausen.

(1793) *Grundriss der Mineralogie, nach dem neuesten Wernerschen System*. 8vo, Hildburghausen.

(1794) *Mustertafeln der bis jetzt bekannten einfachen Mineralien*. 8vo, Jena.

(1794) *Versuch einer vollständigen Anleitung zur Kenntniss der Mineralien*. 8vo, 2 vols., Leipzig.

(1796) *Mineralogisches Handbuch, durch weitere Ausführung des Wernerschen Systems*. 2nd edition, improved and enlarged, 8vo, Hildburghausen.

(1798) *Mineralogisches Taschenbuch für Anfänger und Liebhaber.* 16mo, 2 vols., Erfurt.

(1800) *System der Mineralkörper mit Benutzung der neusten Entdeckungen*. 8vo, Bamburg and Würzberg.

(1800) *System der äussern Kennzeichen der Mineralien, in deutscher, lateinischer, italienischer, französischer, dänischer und ungarischer Sprache*. 8vo, Bamberg and Würzberg.

(1800?) *Tabellarische Uebersicht der mineralogisch-einfachen Mineralien*. Bamberg and Würzberg. [Obodda Library]

(1801) *System der äussern Kennzeichen der Mineralien in deutscher, lateinischer, italienischer, französischer, dänischer und ungarischer Sprache*. 2nd edition, 8vo, Bamberg and Würzberg.

(1806) *Tabellen über das gesammte Mineralreich, mit Rücksicht auf die neuesten Entdeckungen und mit einigen erläuteruden Anmerkungen*. Folio, Jena.

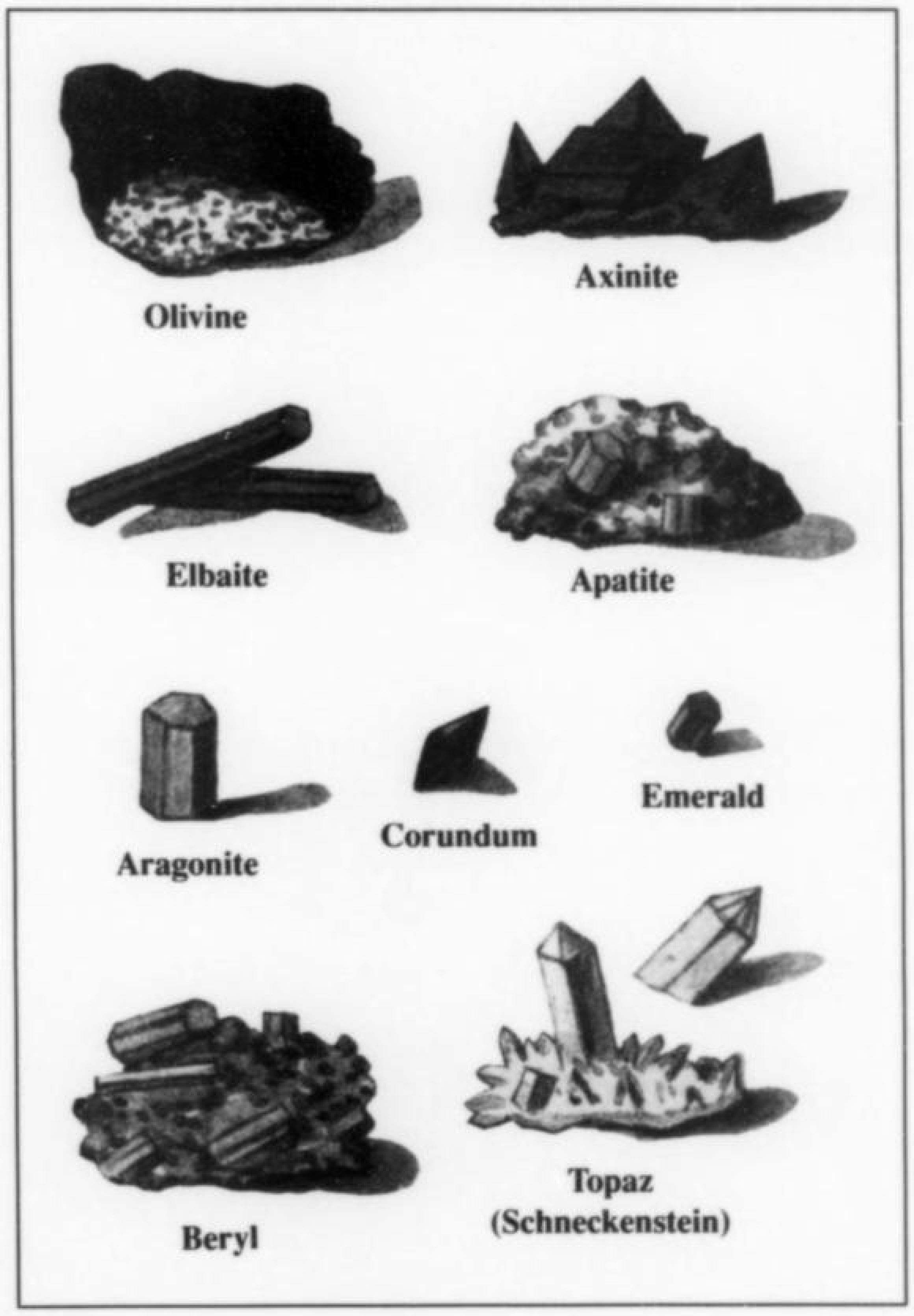
(1809) *System der Mineralkörper mit Benutzung der neusten Entdeckungen*. 2nd edition, 8vo, Bamberg and Würzberg.

(1813) *Erkenntnisslehre der anorganischen Naturkörper . . . für den Selbstunterricht bearbeitet nebst einem Versuche zu einer vergleichenden Mineralogie*. 8vo, 2 vols., Giessen.

(1819–1820) *Handbuch der Mineralogie:*. 8vo, 4 parts in 6 vols., Giessen.

(1820) *Versuch einer vergleichenden Mineralogie für Anfänger und Freunde des Studiums der anorganischen Natur.* Giessen.

(1822) *Handbuch der vergleichenden Mineralogie, ein tabellarisches Hülfsbuch*. 4to, Giessen.



collection. Because their purpose was to depict a *systematic* series of mineral species without regard to either (1) ore value or (2) crystal perfection and beauty, they provide us with the clearest contemporary image of what an 18th-century systematic mineral collection actually looked like (metallic minerals, however, are entirely absent, suggesting that perhaps a second volume had been planned). The works of James Sowerby just a few years later totally eclipsed it in terms of specimen quality and artistic quality, but Sowerby's books drew from many different collections, not just a single one as did Lenz's book. The *Mustertafeln* still stands as a rare and interesting milestone in the history of colorplate mineralogies.

In 1995 the Mineralogical Record issued a limited edition, full-color reprint of the *Mustertafeln* as the ninth in its series of Antiquarian Reprints. Only 70 copies were produced.

ACKNOWLEDGMENTS

My sincere thanks to Herb Obodda for loaning his copy of the *Mustertafeln* for study and reproduction, and to Curtis Schuh for help in locating the portrait of Lenz reproduced here.

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WILSON, W. E. (1994) *The History of Mineral Collecting, 1530–1799*. Mineralogical Record, Tucson, 256 p.

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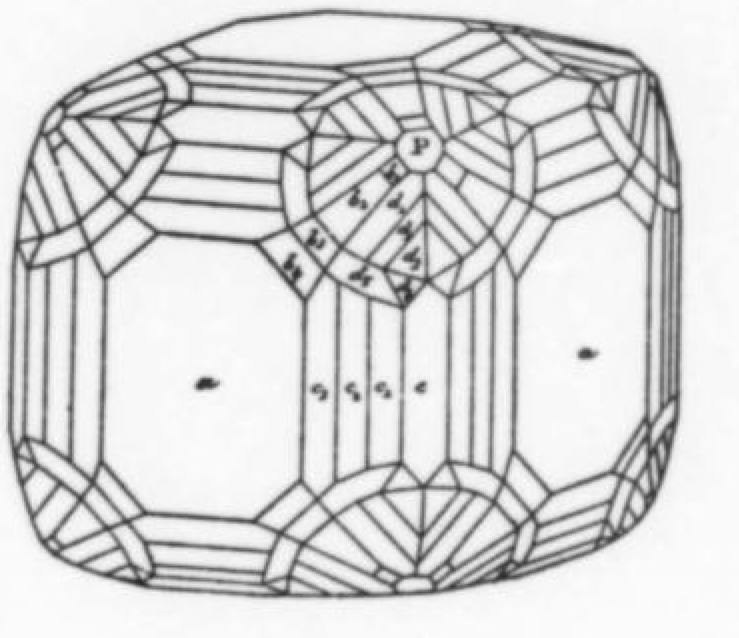
ABSTRACTS OF NEW MINERAL DESCRIPTIONS



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Alarsite — Hexagonal (trigonal)

$AlAsO_4$

Locality: The Tolbachik Main Fracture eruption, Kamchatka, Russia.

Occurrence: A product of fumarolic exhalations; sampling temperature was 400–500°C. Associated minerals are: fedotovite, klyuchevskite, alumoklyuchevskite, lammerite, hematite, tenorite, atlasovite, nabokoite and langbeinite.

General appearance: Fine-grained to glassy crusts and as equant grains (up to 0.3 mm in diameter).

Physical properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless, white or cream. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* VHN_{20} 440 kg/mm². *Tenacity:* brittle. *Cleavage:* absent. *Fracture:* conchoidal. *Density:* 3.32 g/cm³ (meas.), 3.35 g/cm³ (calc.). ***Crystallography:*** Hexagonal (trigonal), $P3_121$ or $P3_221$, a 5.031, c 11.226 Å, V 246.1 Å³, Z 3, c:a = 2.2314. Morphology: no forms observed. Twinning: none observed. ***X-ray powder diffraction data:*** 4.36 (20), 4.06 (31), 3.442 (100), 2.514 (8), 2.359 (15), 2.178 (7), 1.873 (16), 1.7207 (8), 1.4202 (11). ***Optical data:*** Uniaxial (+), ω 1.596, ε 1.608, nonpleochroic. ***Chemical analytical data:*** Means of 20 sets of electron microprobe data: CuO 0.54, Al_2O_3 31.98, Fe_2O_3 0.60, As_2O_5 66.71, Total 99.83 wt. %. Empirical formula: $Al_{1.04}Fe_{0.01}Cu_{0.01}As_{0.96}O_{4.00}$. ***Relationship to other species:*** It is isostructural with berlinite and quartz and is the natural analog of synthetic $AlAsO_4$. ***Name:*** For the composition. ***Comments:*** IMA No. 93-003. Some of the data given in this abstract were taken from the original IMA proposal.

SEMENOVA, T. F., VERGASOVA, L. P., FILATOV, S. K., and ANANIEV, V. V. (1994): Alarsite $AlAsO_4$—a new mineral from volcanic exhalations. *Doklady Akademia Nauk* **338(4)**, 501–505.

Brizziite — Hexagonal (trigonal)

$NaSbO_3$

Locality: The Cetine mine, approximately 20 km southwest of Sienna, Tuscany, Italy.

Occurrence: The result of deep weathering of stibnite. It is associated mainly with stibiconite and mopungite. Other minerals found at the locality are: onoratoite, cetineite, coquandite and rosenbergite.

General appearance: Encrustations of microscopic platy crystals (up to 0.2 mm).

Physical properties: *Luster:* pearly. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* VHN_{15} 57 kg/mm². *Tenacity:* flexible. *Cleavage:* {001} perfect. *Fracture:* not stated. *Density:* 4.8 g/cm³ (meas.), 4.95 g/cm³ (calc.). ***Crystallography:*** Hexagonal (trigonal), $R\bar{3}$, a 5.301, c 15.932 Å, V 387.7 Å³, Z 6, c:a = 3.0055. Morphology: forms, {001}. Twinning: polysynthetic with (001) as twin plane. ***X-ray powder diffraction data:*** 5.30 (53), 4.39 (41), 3.00 (50), 2.650 (67), 2.365 (69), 1.874 (100), 1.471 (69), 1.185 (47). ***Optical data:*** Uniaxial (-), ω 1.840, ε 1.631, non-pleochroic. ***Chemical analytical data:*** Means of forty sets of electron microprobe data: Na_2O 15.98, Sb_2O_5 83.28, Total 99.26 wt. %. Empirical formula: $Na_{1.00}Sb_{1.00}O_{3.00}$. ***Relationship to other species:*** It is isostructural with ilmenite. ***Name:*** For Dr. Giancarlo Brizzi (1936–1992) who discovered the mineral. ***Comments:*** IMA No. 93-044.

OLMI, F. and SABELLI, C. (1994) Brizziite, $NaSbO_3$, a new mineral from the Cetine mine (Tuscany, Italy): description and crystal structure. *European Journal of Mineralogy* **6**, 667–672.

Carlosruizite — Hexagonal (trigonal)

$K_6(Na,K)_4Na_6Mg_{10}(Se^{6+}O_4)_{12}(IO_3)_{12}\cdot 12H_2O$

Locality: Probably in the vicinity of Zapiga, Chile.

Occurrence: In samples of iquiqueite leached from *caliche amarillo* (yellow nitrate ore). Associated minerals are: mainly nitratine, halite and darapskite. Residues of this material leached in cold water contain: dietzeite, brüggenite, tarapacaite, lopezite, ulexite, probertite and gypsum.

General appearance: Platy crystals with hexagonal outline (modified by rhombohedral faces) generally < 200 μm in diameter and 20 μm thick.

Physical properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless to pale yellow. *Streak:* not given, but probably white. *Luminescence:* not given. *Hardness:* could not be measured, but is judged to be 2 to 3. *Tenacity:* brittle. *Cleavage:* {110}, perfection not stated. *Fracture:* not given. *Density:* could not be measured, 3.42 g/cm³ (calc.). ***Crystallography:*** Hexagonal (trigonal), $P\bar{3}c1$, a 9.5901, c 27.56 Å, V 2195 Å³, Z 1, c:a = 2.877. Morphology: forms: {001}, {102}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 13.75 (30), 7.10 (20), 3.561 (100), 3.082 (32), 3.058 (39), 2.717 (39). ***Optical data:*** Uniaxial (-), ω 1.655, ε 1.642. ***Chemical analytical data:*** Means of 10 sets of electron microprobe data: Na_2O 4.7, K_2O 6.7, MgO 9.2, SO_3 7.9, SeO_3 19.0, CrO_3 2.5, I_2O_5 45.6, Total 95.6 wt. %. H_2O could not be measured, but was determined by the crystal structure analysis. The empirical formula is $K_6(Na_{2.6}K_{1.4})_{\Sigma 4.0}Na_6Mg_{10}[(Se^{6+}O_4)_{6.48}(SO_4)_{4.32}(CrO_4)_{1.20}]_{\Sigma 12.00}(IO_3)_{12}\cdot 12H_2O$, which requires: Na_2O 5.89, K_2O 7.70, MgO 8.90, SO_3 7.64, SeO_3 18.18, CrO_3 2.65, I_2O_5 44.26, H_2O 4.78, Total 100.00 wt. %. ***Relationship to other species:*** The selenate analog of fuenzalidaite, $K_6(Na,K)_4Na_6Mg_{10}(SO_4)_{12}(IO_3)_{12}\cdot 12H_2O$. ***Name:*** For Carlos Ruiz F. (1916–), who planned and directed the first national geological institution of Chile (inaugurated in 1957). ***Comments:*** IMA No. 93-020. Some of the data calculated here are slightly different from those given in the description.

KONNERT, J. A., EVANS, H. T. JR., McGEE, J. J., and ERICKSEN, G. E. (1994): Mineralogical studies of the nitrate deposits of Chile: VII. Two new saline minerals with the composition $K_6(Na,K)_4Na_6Mg_{10}(XO_4)_{12}(IO_3)_{12}\cdot 12H_2O$: Fuenzalidaite (X = S) and carlosruizite (X = Se). *American Mineralogist* **79**, 1003–1008.

Chengdeite Cubic

Ir_3Fe

Locality: At the branch of the Luan river (about 200 km NNE of Beijing) in Chengde County, People's Republic of China.

Occurrence: In placer concentrations and chromite ores in ultrabasic rocks. Associated minerals are: chromite, gold, magnetite, galena, ferrian platinum, iridium, laurite, inaglyite and isoferroplatinum.

General appearance: As grains (up to 0.5 mm).

Physical properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* steel-black. *Streak:* black. *Hardness:* VHN_{50} 452 kg/mm², Mohs 5. *Tenacity:* malleable. *Magnetism:* strong. *Cleavage:* not observed. *Fracture:* not observed. *Density:* could not be measured, 19.30 g/cm³ (calc.). ***Crystallography:*** Cubic, Pm3m, a 3.792 Å, V 54.53 Å³, Z 1. Morphology: no forms observed. Twinning: none observed. ***X-ray powder diffraction data:*** 2.18 (80), 1.89 (60), 1.34 (70), 1.26 (20), 1.200 (15), 1.142 (100), 1.094 (80). ***Optical data:*** In reflected light: bright white with a yellowish tint, no anisotropism, bireflectance or pleochroism. R: (66.2 %) 470nm, (69.3 %) 546nm, (71.1 %) 589nm, (72.5 %) 650nm. ***Chemical analytical data:*** Means of thirteen sets of electron microprobe data: Cu 0.83, Pb 0.00, Co 0.03, Ni 0.03, Fe 7.9, As 0.02, Rh 0.19, Pd 0.00, Os 0.06, Ir 88.5, Pt 2.2, S 0.00, Total 99.76 wt. %. Empirical formula: $(Ir_{2.92}Pt_{0.07}Rh_{0.01})_{\Sigma 3.00}(Fe_{0.90}Cu_{0.08})_{\Sigma 0.98}$. ***Relationship to other species:*** The Ir-dominant analog of isoferroplatinum. ***Name:*** For the locality, Chengde County. ***Comments:*** IMA No. 94-023. The calculated density given in the paper is 19.19 g/cm³.

YU, ZUXIANG (1995) Chengdeite—ordered natural iron-iridium alloy. *Acta Geologica Sinica* **69(3)**, 215–220.

Crawfordite Monoclinic

$Na_3Sr(PO_4)(CO_3)$

Locality: Mount Koashva, Khibina alkaline massif, Kola Peninsula, Russia.

Occurrence: In hyperagpaitic pegmatites. Associated minerals are: potassium feldspar, nepheline, sodalite, aegirine, riebeckite, ershovite, shcherbakovite, vuonnemite, barytolamprophyllite, pectolite, magnesium astrophyllite, kazakovite, natrite, chkalovite, villiaumite and rasvumite.

General appearance: Irregular grains (0.5 to 1.0 mm).

Physical properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* colorless. *Streak:* white. *Luminescence:* bright greenish-yellow in the 200–400 nm range. *Hardness:* 3. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* conchoidal. *Density:* 3.05 g/cm³ (meas.), 3.08 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1$, a 9.187, b 6.707, c 5.279 Å, β 89.98°, V 325.3 Å³, Z 2, a:b:c = 1.3698:1:0.7871. Morphology: no forms observed. Twinning: none observed. ***X-ray powder diffraction data:*** 3.35 (50), 2.708 (100), 2.648 (90), 2.172 (100), 2.080 (50), 1.891 (80), 1.676 (50), 1.415 (70), 1.129 (60), 1.106 (60). ***Optical data:*** Biaxial (-), α 1.520, β 1.564, γ 1.565, 2V(meas.) 20°, 2V(calc.) 17°, dispersion not discernible, nonpleochroic; X ≈ b, Y ≈ c, Z ≈ a. ***Chemical analytical data:*** Means of two sets of electron microprobe data: Na_2O 31.83, K_2O 0.22, CaO 1.45, SrO 27.42, P_2O_5 23.64, CO_2 (14.47), Total 99.03 wt. %. CO_2 was calculated from the crystal structure. Empirical formula: $Na_{3.03}(Sr_{0.81}Na_{0.10}Ca_{0.08}K_{0.01})_{\Sigma 1.00}P_{1.02}C_{1.00}O_{7.00}$. ***Relationship to other species:*** It is the strontium-dominant analog of bradleyite, bonshtedite and sidorenkite. ***Name:*** For the Scottish doctor and chemist, Dr. A. Crawford (1748– 1795), who discovered strontium salts. ***Comments:*** IMA No. 93-030. Some of the data given in this abstract were taken from the original IMA proposal.

KHOMYAKOV, A. P., POLEZHAEVA, L. I., and SOKOLOVA, E. V. (1994) Crawfordite $Na_3Sr(PO_4)(CO_3)$—a new mineral from the bradleyite family. *Zapiski Vsesoyuznyi Mineralogicheskoe Obshchestva* **123(3)**, 107–111.

Ershovite Triclinic

$Na_4K_3(Fe^{2+},Mn^{2+},Ti)_2Si_8O_{20}(OH)_4\cdot 4H_2O$

Locality: Mt. Koashva, southeast part of the Khibina alkaline massif, Kola Peninsula, Russia.

Occurrence: In hyperagpaitic pegmatites. Associated minerals are: potassium feldspar, nepheline, sodalite, aegirine, riebeckite, magnesium astrophyllite, shcherbakovite, kazakovite, koashvite, vuonnemite, phosinaite, villiaumite, natrite and rasvumite.

General appearance: Anhedral grains (up to 5 x 10 mm) and fibrous aggregates (up to 3 cm).

Physical properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* olive-green with brownish or yellowish shades. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 2 to 3. *Tenacity:* sectile. *Cleavage:* {100} and {010} perfect. *Fracture:* fibrous. *Density:* 2.75 g/cm³ (meas.), 2.69 g/cm³ (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, a 10.244, b 11.924, c 5.276 Å, α 103.491°, β 96.960°, γ 91.945°, V 620.8 Å³, Z 1, a:b:c = 0.8591:1:0.4425. Morphology: no forms observed. Twinning: none observed. ***X-ray powder diffraction data:*** 11.57 (100), 7.40 (16), 5.18 (16), 3.386 (19), 3.006 (21), 2.992 (28), 2.766 (15), 2.716 (22), 2.598 (26). ***Optical data:*** Biaxial (+), α 1.569, β 1.574, γ 1.590, 2V(meas.) 58°, 2V(calc.) 59°, dispersion r > v, medium, pleochroism strong, X and Y = light green or yellowish green, Z = dark olive green; fibers have positive elongation, angles between the fiber length and X, Y, and Z are 86°, 73°, 17°, respectively. ***Chemical analytical data:*** Means of three sets of electron microprobe data: Na_2O 12.4, K_2O 13.6, MgO 0.5, CaO 0.1, MnO 4.7, FeO 6.1, SiO_2 47.1, TiO_2 3.0, H_2O (12.5), Total (100.0) wt. %. H_2O was calculated by difference from 100.0 wt. %. Empirical formula: $Na_{4.08}K_{2.95}(Fe^{2+}_{0.87}Mn^{2+}_{0.68}Ti_{0.38}Mg_{0.13}Ca_{0.02})_{\Sigma 2.08}Si_{8.00}O_{19.96}(OH)_{4.04}\cdot 5.06H_2O$. This is based on the crystal structure analysis which shows 8 Si atoms and 4 (OH) groups. However, the structure has only $4H_2O$, so the idealized formula is given as: $Na_4K_3(Fe^{2+},Mn^{2+},Ti)_2Si_8O_{20}(OH)_4\cdot 4H_2O$. ***Relationship to other species:*** none given. ***Name:*** For Prof. Vadim Viktorovich Ershov (1939–1989) of the Moscow Mining Institute. ***Comments:*** IMA No. 91-014. Some of the data given in this abstract were taken from the original IMA proposal. Also, the density calculated here is different from that given in the paper.

KHOMYAKOV, A. P., MENSHIKOV, YU. P., RASTSVATAEVA, R. K., and NECHELYUSTOV, G. N. (1993) Ershovite $Na_4K_3(Fe^{2+},Mn^{2+},Ti)_2Si_8O_{20}(OH)_4\cdot 4H_2O$—a new mineral. *Zapiski Vsesoyuznyi Mineralogicheskoe Obshchestva* **122(1)**, 116–120.

Fuenzalidaite Hexagonal (trigonal)

$K_6(Na,K)_4Na_6Mg_{10}(SO_4)_{12}(IO_3)_{12}\cdot 12H_2O$

Locality: A former nitrate mine about 1 km south of the former plant site of Oficina Santa Luisa, Chile.

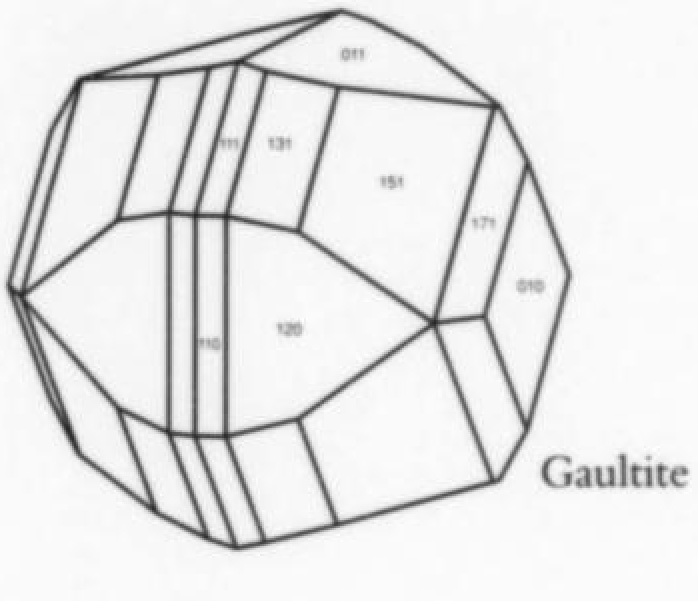
Occurrence: In veins and veinlets of white nitrate ore called *caliche blanco*. Associated minerals are: nitratine, halite, probertite and darapskite.

General appearance: Platy crystals with hexagonal outline (modified by rhombohedral faces) generally < 200 μm in diameter and 20 μm thick.

Physical properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless to pale yellow. *Streak:* not given, but probably white. *Luminescence:* not given. *Hardness:* could not be measured, but is judged to be 2 to 3. *Tenacity:* brittle. *Cleavage:* {110}, perfection not stated. *Fracture:* not given. *Density:* could not be measured, 3.31 g/cm³ (calc.). ***Crystallography:*** Hexagonal (trigonal), $P\bar{3}c1$, a 9.4643, c 27.336 Å, V 2120 Å³, Z 1, c:a = 2.888. Morphology: forms, {001}, {102}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 13.67 (50), 7.05 (40), 3.927 (100), 3.515 (24), 3.023 (41), 2.681 (33), 2.3273 (21). ***Optical data:*** Uniaxial (-), ω 1.622, ε 1.615. ***Chemical analytical data:*** Means of 10 sets of electron microprobe data: Na_2O 5.2, K_2O 5.9, MgO 10.0, SO_3 20.9, SeO_3 0.1, CrO_3 0.2, I_2O_5 49.3, Total 91.6 wt. %. H_2O could not be measured, but was determined by the crystal structure analysis. The empirical formula derived from the crystal structure analysis is $K_6(Na_{2.8}K_{1.2})_{\Sigma 4.0}Na_6Mg_{10}[(SO_4)_{11.40}(Se^{6+}O_4)_{0.60}]_{\Sigma 12.00}$-$(IO_3)_{12}\cdot 12H_2O$, which requires: Na_2O 6.46, K_2O 8.03, MgO 9.54, SO_3 21.61, SeO_3 1.80, I_2O_5 47.44, H_2O 5.12, Total 100.00 wt. %. ***Relationship to other species:*** The sulfate analog of carlosruizite, $K_6(Na,K)_4Na_6Mg_{10}(Se^{6+}O_4)_{12}$-$(IO_3)_{12}\cdot 12H_2O$. ***Name:*** For Humberto Fuenzalida P. (1904–1966), who planned and directed the first school of geology in Chile (inaugurated in 1958) at the

University of Chile. ***Comments:*** IMA No. 93-021. Some of the data calculated here are slightly different from those given in the description.

KONNERT, J. A., EVANS, H. T. JR., McGEE, J. J., and ERICKSEN, G. E. (1994): Mineralogical studies of the nitrate deposits of Chile: VII. Two new saline minerals with the composition $K_6(Na,K)_4Na_6Mg_{10}(XO_4)_{12}(IO_3)_{12}\cdot 12H_2O$: Fuenzalidaite (X = S) and carlosruizite (X = Se). *American Mineralogist* **79**, 1003–1008.



Gaultite

Gaultite

Orthorhombic

$Na_4Zn_2Si_7O_{18}\cdot 5H_2O$

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

Occurrence: In a cavity in a sodalite syenite xenolith, approximately 5 m from a contact of hornfels and nepheline-sodalite syenite. Associated minerals are: aegirine, analcime, cancrinite, catapleiite, chabazite, eudialyte, galena, graphite, lovozerite-group minerals, makatite, microcline, nepheline, natrolite, phillipsite, polylithionite, pyrite, serandite, sodalite, steenstrupine, ussingite, villiaumite, vitusite, vuonnemite and two unidentified species.

General appearance: As euhedral, equant crystals up to 0.5 mm in diameter (average diameter is 0.25 mm).

Physical properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless to pale mauve. *Streak:* white. *Luminescence:* bright green in short-wave ultraviolet radiation and strong pale green under an electron beam. *Hardness:* about 6. *Tenacity:* brittle. *Cleavage:* {101} and {010}, perfect; {021}, poor. *Fracture:* conchoidal. *Density:* 2.52 g/cm³ (meas.), 2.52 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, F2dd, a 10.211, b 39.88, c 10.304 Å, V 4196 Å³, Z 8, a:b:c = 0.2560:1:0.2584. Morphology: forms, {010}, {110}, $\{\bar{1}10\}$, {120}, $\{\bar{1}20\}$, {151}, $\{\bar{1}51\}$, {111}, $\{\bar{1}11\}$, {131}, $\{\bar{1}31\}$, {171}, $\{\bar{1}71\}$ and {011}. Twinning: not mentioned. ***X-ray powder diffraction data:*** 6.35 (10), 4.96 (3), 3.240 (6), 3.167 (4), 3.140 (4), 2.821 (3). ***Optical data:*** Biaxial (+), α 1.520, β 1.521, γ 1.524, 2V(meas.) 61.3°, 2V(calc.) 60°, dispersion r > v (weak to moderate). X = a, Y = c, Z = b. Nonpleochroic. ***Chemical analytical data:*** Means of two sets of electron microprobe data: Na_2O 16.6, ZnO 19.2, SiO_2 52.6, Total 88.4 wt. %. H_2O could not be determined quantitatively, but is present according to an IR study. The crystal structure data indicate an empirical formula of $Na_{4.29}Zn_{1.88}Si_{6.99}O_{18.00}\cdot 5H_2O$. This requires: Na_2O 16.67, ZnO 19.23, SiO_2 52.78, H_2O 11.32, Total 100.00 wt. %. The ideal formula requires: Na_2O 15.55, ZnO 20.41, SiO_2 52.74, H_2O 11.30, Total 100.00 wt. %. ***Relationship to other species:*** It is a zeolite-like mineral. ***Name:*** For Robert Allan Gault (1943–) of the Canadian Museum of Nature, Ottawa, Ontario, Canada. ***Comments:*** IMA No. 92-040. The associated "steenstrupine" presumably is steenstrupine-(Ce). There are errors in the forms given in the paper: $\{\bar{1}51\}$ is given as {151}, {021} does not occur and {120} and $\{\bar{1}20\}$ were omitted; the correct list is given in this abstract. It should be noted that the faces belonging to the forms $\{\bar{1}10\}$, $\{\bar{1}20\}$, $\{\bar{1}51\}$, $\{\bar{1}11\}$, $\{\bar{1}31\}$, and $\{\bar{1}71\}$ appear on the back of the crystal.

ERCIT, T. S. and VAN VELTHUIZEN, J. (1994): Gaultite, a new zeolite-like mineral species from Mont Saint-Hilaire, Quebec, and its crystal structure. *Canadian Mineralogist* **32**, 855–863.

Mikasaite

Hexagonal (trigonal)

$Fe_2^{3+}(SO_4)_3$

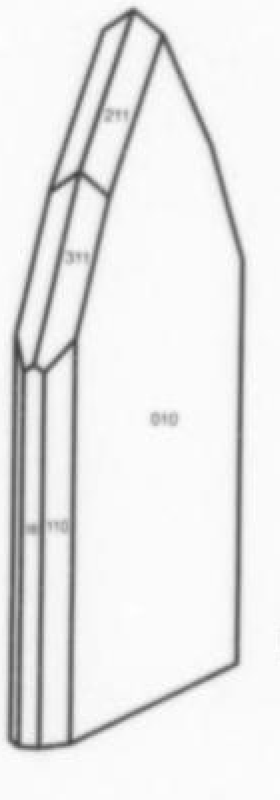
Locality: Ikushunbetsu, Mikasa city, Hokkaido, Japan (Lat. 43°16′ N, Long. 141°58′ E).

Occurrence: As a sublimation product around a coal-gas escape fracture in a coal-bearing formation. The temperature of the gas was 307° C.

General appearance: Aggregates (up to 10 cm) of fine porous hollow spherical crystals which have an average diameter of 100 µm and a thickness of 1-5 µm.

Physical properties: *Luster:* dull. *Diaphaneity:* transparent. *Color:* white to light brown. *Streak:* white to light brown. *Luminescence:* non-fluorescent. *Hardness:* 2. *Tenacity:* not given. *Cleavage:* difficult. *Fracture:* earthy. *Density:* could not be measured, 3.06 g/cm³ (calc.). ***Crystallography:*** Hexagonal (trigonal), $R\bar{3}$, a 8.14, c 21.99 Å, V 1262 Å³, Z 6, c:a = 2.7015. Morphology: no forms given. Twinning: not mentioned. ***X-ray powder diffraction data:*** 5.99 (28), 4.35 (23), 3.56 (100), 2.97 (20), 2.72 (20), 2.64 (11), 2.35 (7), 2.24 (6), 1.78 (6). ***Optical data:*** Uniaxial (+), ω 1.504, ε 1.518. ***Chemical analytical data:*** Means of 7 sets of electron microprobe data: Al_2O_3 4.3, Fe_2O_3 24.3, Mn_2O_3 0.5, SO_3 46.8, H_2O^- 23.0, Total 98.9 wt. %. Ignoring the H_2O, which is adsorbed from the atmosphere and is not a true constituent of the mineral, the empirical formula is: $(Fe^{3+}_{1.56}Al_{0.43}Mn^{3+}_{0.03})_{\Sigma 2.02}S_{2.99}O_{12.00}$. The ideal formula, with Fe:Al:Mn=1.54:0.43:0.03 requires: Al_2O_3 5.66, Fe_2O_3 31.74, Mn_2O_3 0.61, SO_3 61.99, Total 100.00 wt. %. ***Relationship to other species:*** It is the ferric-dominant analog of millosevichite, $(Al,Fe^{3+})_2(SO_4)_3$. ***Name:*** For the locality. ***Comments:*** IMA No. 92-015. Many of the usual properties are not given in the description. However, most of these were given in the original IMA proposal and the authors have given me permission to include these data here.

MIURA, H., NIIDA, K., and HIRAMA, T. (1994): Mikasaite, $(Fe^{3+},Al)_2(SO_4)_3$, a new ferric sulphate mineral from Mikasa city, Hokkaido, Japan. *Mineralogical Magazine* **58**, 649–653.



Nchwaningite

Nchwaningite

Orthorhombic

$Mn_2^{2+}SiO_3(OH)_2\cdot H_2O$

Locality: The N'chwaning II Mine, Kalahari Manganese Field, Northern Cape Province, Republic of South Africa.

Occurrence: In a vug in manganese ore. Associated minerals are: calcite, bultfonteinite, and chlorite.

General appearance: Small ball-like aggregates (up to 5 mm in diameter) of radiating acicular crystals (average size: 1.0 x 0.1 x 0.05 mm).

Physical properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* light brown. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* could not be determined because of the small fibre size. *Tenacity:* brittle. *Cleavage:* {100} and {010}, perfect. *Fracture:* not observed. *Density:* could not be measured, 3.19 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, $Pca2_1$, a 12.672, b 7.217, c 5.341 Å, V 488.3 Å³, Z 4, a:b:c = 1.7559:1:0.7401. Morphology: forms, {010}, {110}, {201}, {301} and probably {100}, {311} and {211} (see comments below); elongated parallel to [001] and platy parallel to {010}. Twinning: none observed. ***X-ray powder diffraction data:*** 7.220 (60), 4.083 (60), 3.011 (100), 2.547 (80), 2.503 (60), 2.456 (80), 2.440 (80), 2.154 (60), 2.116 (60), 1.804 (60), 1.713 (60), 1.600 (60), 1.585 (60), 1.552 (80), 1.466 (60). ***Optical data:*** Biaxial (-), α 1.681, β 1.688, γ 1.690, 2V(meas.) 54.4°, 2V(calc.) 56°, nonpleochroic, X = b, Y = a, Z = c. ***Chemical analytical data:*** Means of five sets of electron microprobe data: MgO 1.93, CaO 0.19, MnO 60.02, FeO 0.27, Al_2O_3 0.27, SiO_2 28.02, Total 90.70 wt. %. H_2O could not be determined due to the small amount of material available, but the crystal structure determination gave four H atoms. Empirical formula: $(Mn_{1.84}Mg_{0.10}Fe_{0.01}Ca_{0.01})_{\Sigma 1.96}(Si_{1.01}Al_{0.01})_{\Sigma 1.02}O_{3.00}(OH)_{2.00}$, which requires: MgO 1.87, CaO 0.26, MnO 60.70, FeO 0.33, Al_2O_3 0.24, SiO_2 28.22, H_2O 8.38, Total 100.00 wt. %. ***Relationship to other species:*** It is structurally related to the pyroxene group. ***Name:*** For the mine. ***Comments:*** IMA No. 94-002. Some of the data given in this abstract were taken from the original IMA proposal. The calculated density and empirical formula given here are slightly different from those given in the paper. No crystal drawing appeared in the paper, but the drawing given here approximates the crystals shown in the SEM photograph in the paper. Examination of the photograph indicated the presence of some additional forms: {100} and two {hkl} forms. The latter probably are {311} and {211} or {321} and {221}. Sample drawings were sent to the authors and the senior author confirmed that the crystal drawing given in this abstract is most characteristic for the actual crystals.

NYFELER, D., ARMBRUSTER, T., DIXON, R., and BERMANEC, V. (1995) Nchwaningite, $Mn_2^{2+}SiO_3(OH)_2\cdot H_2O$, a new pyroxene-related chain silicate from the N'chwaning mine, Kalahari manganese field, South Africa. *American Mineralogist* **80**, 377–386.

Sazykinaite-(Y) Hexagonal (trigonal)

$Na_5YZrSi_6O_{18}\cdot 6H_2O$

Locality: Mt. Koashva, southeast part of the Khibina alkaline massif, Kola Peninsula, Russia.

Occurrence: In hyperagpaitic pegmatites. Associated minerals are: sodalite, potassium feldspar, natrolite, aegirine, a sodium amphibole, pectolite, astrophyllite, shcherbakovite, kazakovite, koashvite, vuonnemite, phosinaite, villiaumite, natrite and rasvumite.

General appearance: As rhombohedral crystals (up to 2 mm across).

Physical properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* light green to yellow. *Streak:* white. *Luminescence:* bright green in ultraviolet light (200–400 nm). *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* {012} imperfect. *Fracture:* step-like to subconchoidal. *Density:* 2.67 g/cm³ (meas.), 2.71 g/cm³ (calc.). ***Crystallography:*** Hexagonal (trigonal), R32, a 10.825, c 15.809 Å, V 1604 Å³, Z 3, c:a = 1.4604. Morphology: forms, {012}. Twinning: none observed. ***X-ray powder diffraction data:*** 6.03 (32), 5.40 (63), 3.236 (84), 3.127 (88), 3.030 (100), 2.708 (19), 2.018 (18), 1.805 (21). ***Optical data:*** Uniaxial (-), ω 1.585, ε 1.578, nonpleochroic. ***Chemical analytical data:*** Means of five sets of electron microprobe data: Na_2O 15.18, K_2O 3.05, Y_2O_3 8.74, Ce_2O_3 0.17, Nd_2O_3 0.25, Sm_2O_3 0.38, Eu_2O_3 0.24, Gd_2O_3 1.03, Tb_2O_3 0.21, Dy_2O_3 1.26, Er_2O_3 0.79, Tm_2O_3 0.16, Yb_2O_3 0.60, ThO_2 0.74, ZrO_2 10.24, TiO_2 1.36, SiO_2 40.51, Nb_2O_5 1.30, H_2O 12.6, Total 98.81 wt. %. Empirical formula: $(Na_{4.33}K_{0.57})_{\Sigma 4.90}(Y_{0.68}Dy_{0.06}Gd_{0.05}Er_{0.04}Yb_{0.03}$-$Th_{0.02}Sm_{0.02}Nd_{0.01}Eu_{0.01}Tb_{0.01}Ce_{0.01}Tm_{0.01})_{\Sigma 0.95}(Zr_{0.74}Ti_{0.15}Nb_{0.09})_{\Sigma 0.98}Si_{5.96}O_{17.80}\cdot 6.19H_2O$. ***Relationship to other species:*** It is the yttrium-dominant analog of hilairite and calciohilairite. ***Name:*** For Ludmila B. Sazykina (1934–) a Kola artist. ***Comments:*** IMA No. 92-031. Some of the data given in this abstract were taken from the original IMA proposal. The calculated density and the subscripts in the empirical formula derived here are different from those given in the paper.

KHOMYAKOV, A. P., NECHELYUSTOV, G. N., and RASTSVATAEVA, R. K. (1993) Sazykinaite-(Y) $Na_5YZrSi_6O_{18}\cdot 6H_2O$—a new mineral. *Zapiski Vsesoyuznyi Mineralogicheskoe Obshchestva* **122(5)**, 76–82.

Wycheproofite Triclinic

$NaAlZr(PO_4)_2(OH)_2\cdot H_2O$

Locality: A granite quarry near Wycheproof, northwestern Victoria, Australia (Lat. 36°05′ S, Long. 143°14′ E).

Occurrence: In pegmatite cavities. The pegmatite consists mainly of quartz, orthoclase, albite, muscovite and schorl. Associated minerals in the cavities are: wardite, eosphorite, cyrilovite, a kidwellite-like mineral, rockbridgeite, leucophosphite and saleeite. Other zirconium-bearing species at the locality are: selwynite and kosnarite. In the description of selwynite from this occurrence, montmorillonite is noted as an associated mineral. Presumably, it should be listed here, also.

General appearance: Compact aggregates of finely fibrous crystals (5 to 10 μm thick and up to several mm long).

Physical properties: *Luster:* vitreous to pearly. *Diaphaneity:* transparent. *Color:* pale pinkish orange to pale brownish orange. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* between 4 and 5. *Tenacity:* not given. *Cleavage:* none observed. *Fracture:* rough. *Density:* 2.81 g/cm³ (meas.), 2.82 g/cm³ (calc.). ***Crystallography:*** Triclinic, P1 or $P\bar{1}$, a 10.926, b 10.986, c 12.479 Å, α 71.37°, β 77.39°, γ 87.54°, V 1375.9 Å³, Z 6, a:b:c = 0.9945:1:1.1359. Morphology: no forms observed. Twinning: not mentioned.. ***X-ray powder diffraction data:*** 8.865 (40), 4.128 (80), 3.711 (65), 3.465 (60), 3.243 (35), 2.875 (30), 2.603 (100), 1.524 (30). ***Optical data:*** Because of the finely fibrous nature, complete data could not be obtained. Indices of refraction range from 1.62 normal to the fibers to 1.64 parallel to the fibers, which show parallel extinction and are length slow. Nonpleochroic. ***Chemical analytical data:*** Means of 5 sets of electron microprobe data: Na_2O 6.36, K_2O 0.44, Cs_2O 0.03, CaO 0.66, MnO 0.21, Al_2O_3 12.03, ZrO_2 32.43, HfO_2 1.24, SiO_2 0.23, P_2O_5 35.85, H_2O 9.0, F 0.34, sum 99.18, less O = F 0.14, Total 99.04 wt. %. Empirical formula: $(Na_{0.81}Ca_{0.05}K_{0.04})_{\Sigma 0.90}(Al_{0.93}Fe_{0.02}Mn_{0.01})_{\Sigma 0.96}(Zr_{1.03}Hf_{0.02})_{\Sigma 1.05}(P_{1.99}Si_{0.02})_{\Sigma 2.01}O_{8.00}[(OH)_{1.93}F_{0.07}]_{\Sigma 2.00}\cdot H_2O$. ***Relationship to other species:*** No apparent relationship to the other four known alkali zirconium phosphates: gainesite, mccrillisite, selwynite and kosnarite. ***Name:*** For the locality. ***Comments:*** IMA No. 93-024. The density and empirical formula calculated here are very slightly different from those given in the description.

BIRCH, W. D., PRING, A., BEVAN, D. J. M., and KHARISUN (1994): Wycheproofite: a new hydrated sodium aluminium zirconium phosphate from Wycheproof, Victoria, Australia, and a new occurrence of kosnarite. *Mineralogical Magazine* **58**, 635–639.

Yuanfuliite Orthorhombic

$Mg(Fe^{3+},Fe^{2+},Al,Ti,Mg)(BO_3)O$

Locality: Zhuanmiao boron deposit, Kuandian County, Liaoning Province, People's Republic of China.

Occurrence: Disseminated in and between suanite crystal grains in crystalline magnesian marble. Associated minerals are: suanite, anhydrite and "apatite."

General appearance: Prismatic crystals about 0.1 x 0.2 x 1 mm.

Physical properties: *Luster:* adamantine to submetallic. *Diaphaneity:* nearly opaque. *Color:* black. *Streak:* brownish black. *Hardness:* VHN_{50} 843 kg/mm², Mohs 5 to 6. *Tenacity:* brittle. *Cleavage:* {100} perfect. *Fracture:* not mentioned. *Density:* could not be measured, 4.02 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, Pnam, a 9.258, b 9.351, c 3.081 Å, V 266.8 Å³, Z 4, a:b:c = 0.9901:1:0.3295. Morphology: prisms observed but not identified. Twinning: none observed. ***X-ray powder diffraction data:*** 6.563 (23), 4.176 (38), 2.957 (30), 2.570 (100), 2.088 (20), 1.591 (18), 1.550 (19). ***Optical data:*** In reflected light: light grey, weak anisotropism, indistinct bireflectance, pleochroism dark red to dark brown. $R_{max.}$: (9.99 %) 470nm, (9.50 %) 546nm, (9.29 %) 589nm, (8.79 %) 650nm. ***Chemical analytical data:*** Means of 4 sets of electron microprobe data: Na_2O 0.70, K_2O 0.03, MgO 27.71, CaO 0.04, FeO 36.87, CoO 0.04, B_2O_3 20.44, Al_2O_3 6.02, Cr_2O_3 0.04, SiO_2 0.07, TiO_2 5.76, P_2O_5 0.15, MnO_2 0.23, Total 98.10 wt. %. Empirical formula: $(Mg_{0.91}Fe^{2+}_{0.09})_{\Sigma 1.00}(Fe^{3+}_{0.56}Al_{0.19}Mg_{0.22}Ti_{0.12}Fe^{2+}_{0.10})_{\Sigma 1.19}(B_{0.97}O_{3.00})O$. ***Relationship to other species:*** It is the Fe^{3+}-dominant analog of warwickite. ***Name:*** For Prof. Yuan Fuli (1893–1987. ***Comments:*** IMA No. 94-001. The calculated density and some of the subscripts in the empirical formula given here are different from those given in the paper. Some of the data given in this abstract were taken from the original IMA proposal.

HUANG, Z., and WANG, P. (1994) Yuanfuliite—A New Borate Mineral. *Acta Petrologica et Mineralogica* **13(4)**, 328–334.

UNUSUALLY SHAPED QUARTZ AGGREGATES FROM TIRNIAUZ, RUSSIA

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INTRODUCTION

The Russian city of Tirniauz (about 40,000 inhabitants) is situated in the central Caucasus Mountains, in the Baksan River Valley, at an altitude of approximately 1,600 meters, about 40 km northeast of Elbrus Mountain (Fig. 1). A well-known molybdenum-tungsten deposit, in which Cu, Bi, and Au mineralizations also occur, lies only a few km northwest of the city. It is exploited by underground as well as open-cast mining. The so-called "upper open mine" is probably the highest active open-mine (altitude of about 3,000 meters) in Europe.

GEOLOGY

The structurally complex Tirniauz deposit is a skarn. In the Tertiary, Paleozoic limestones (Devonian to Carboniferous) were altered by endogenous metamorphism caused by the influence of intruded granitoids, and transformed into marbles. In this process, differently mineralized skarns originated at the contact of hornfelses surrounding the granitoids with the marbles. The skarns usually show layered or stratiform structures. They are often about a hundred meters long, but reach a thickness of only a few meters.

The metamorphism and the formation of younger hydrothermal minerals connected with this process took place in several stages. Many signs of repeated alteration, decomposition, and recrystallization of minerals can be observed. The results of age determination measurements on these minerals vary from 20 to less than 2 million years.

The specimens described here were found in the region of the middle skarn of the "third anomaly." The latter term goes back to the geophysical exploration of the deposit; several magnetic anomalies were found here which were used to name parts of the deposit. The place of discovery lies on the left slope of the valley of the Tirniauzsu River, on the Gitche-Tirniauz mountain ridge.

At an altitude of about 2,800 meters an approximately 20-meter-wide, brecciated skarn-like rock is exposed by a road cut. This breccia adjoins a volcanic-sedimentary conglomerate to the north and a black marble to the south. In this brecciated zone the complex structure of the rock has originated from tectonic torsional movements.

After the marmorization of the limestone, a pyroxene-magnetite-garnet skarn was formed, in which minerals such as epidote, calcite, gold and bismuth tellurides were later deposited by predominantly hydrothermal fluids. This skarn was then fractured by tectonic stresses. The rock fragments were altered metamorphically and cemented into a breccia by newly formed hedenbergite. In the course of this process, cavities were generated, in which actinolite, stilpnomelane, quartz, ilvaite and other minerals crystallized. In subsequent stages arsenopyrite, quartz, a clinochlore-like chlorite, ankerite, dolomite and other rarer minerals were formed. The crystallization of sulfides such as sphalerite and galena, and of manganese-bearing carbonates (manganiferous dolomite and calcite) took place during subsequent hydrothermal stages.

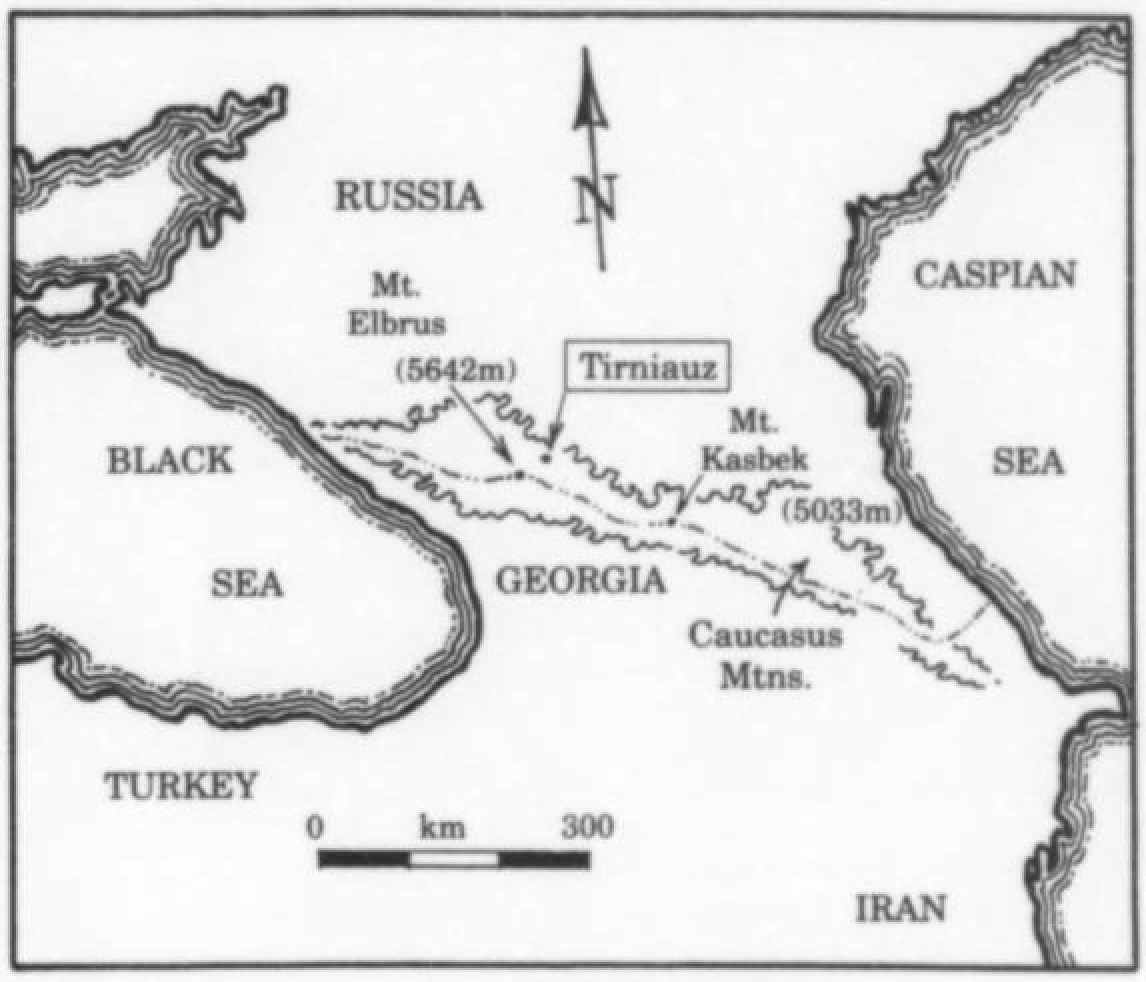


Figure 1. **Location map.**

QUARTZ

During a geoscientific excursion organized by the Faculty of Geosciences of Moscow State University in June of 1989, a 1-meter pocket was discovered in the metasomatic skarn-breccia. In association with brownish to grayish yellow rhombohedral, calcite,

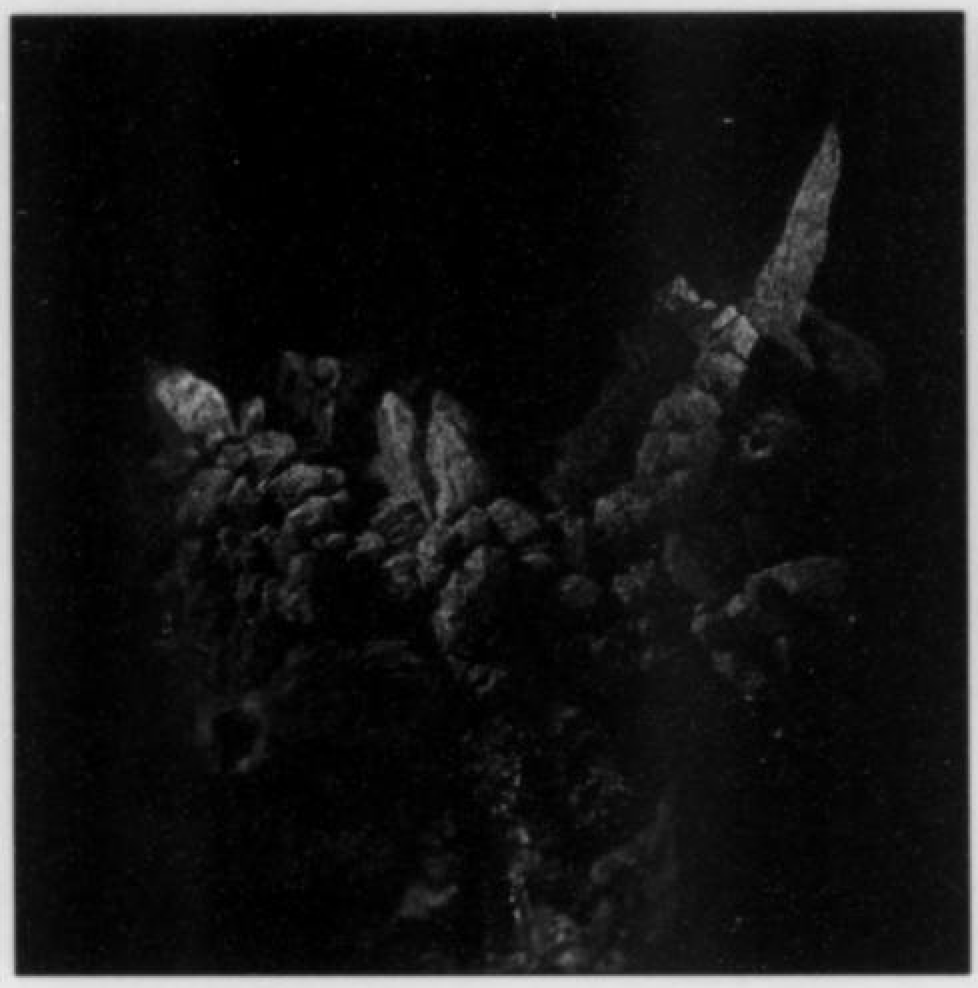


Figure 2. **Quartz specimen from Tirniauz, colored brownish by limonite; 4.3 cm in height.**

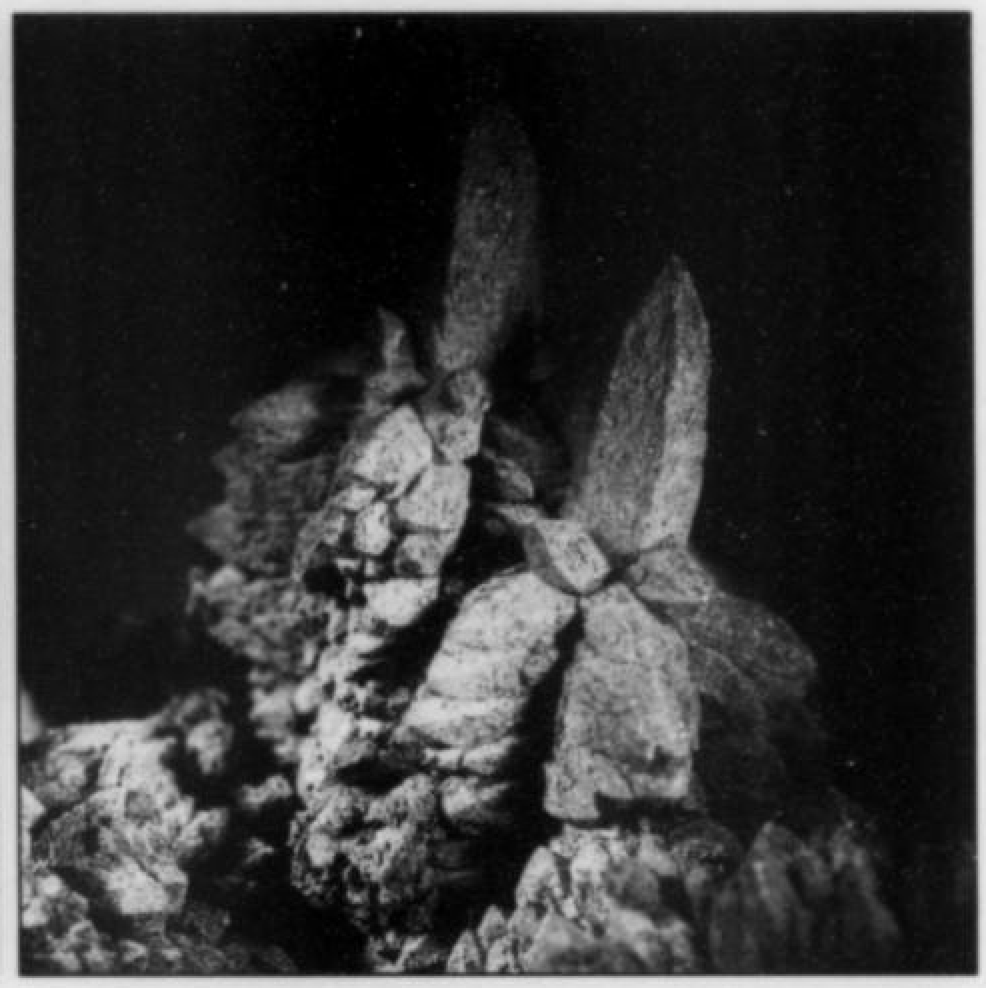


Figure 3. **Quartz crystal aggregates with the radial "pine-tree" habit. Width of photo 2.8 cm.**

Figure 4. **Single quartz aggregate on calcite, showing the regularity of the radial individuals. Width of photo 1.3 cm.**

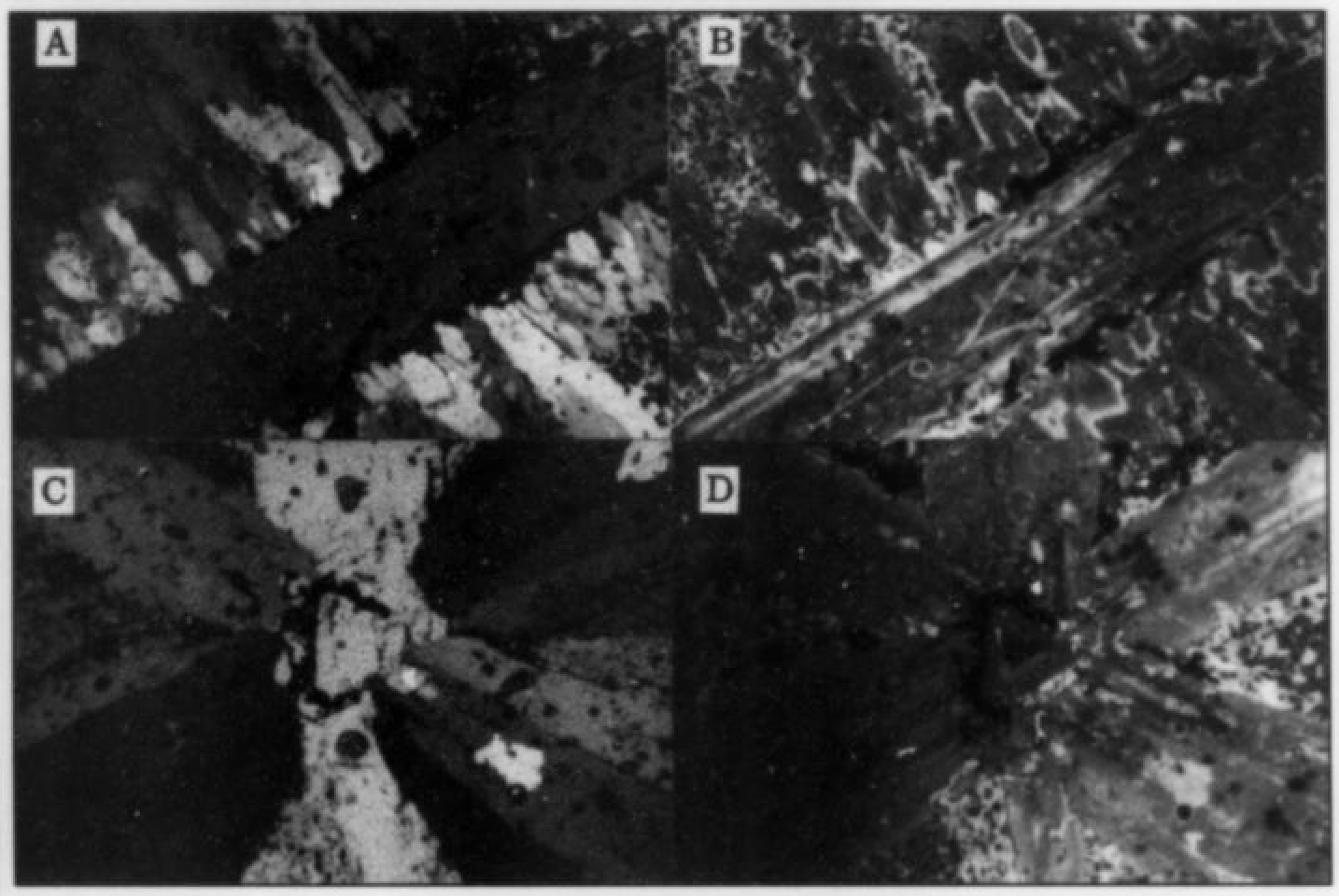


Figure 5. **Microsection micrographs of quartz aggregates, sputter-coated by gold (fields 2.4 x 1.8 mm). (A) View perpendicular to the *c* axis, crossed polars. (B) Cathodoluminescence photograph of the same sample. (C) View parallel to the *c* axis. (D) Cathodoluminescence photograph of the same sample. The cathodoluminescence photographs were taken by an HC 1—LM/SG cathodoluminescence microscope. The operating potential was 14 kV, the beam current 0.8 mA. Due to the required long exposure of about 15 minutes, the short-lived bluish cathodoluminescence color seems already destroyed and has changed to brownish violet to orange.**

quartz crystal aggregates up to 4 cm in size were found. Both minerals are overgrown by poorly crystallized secondary minerals, particularly by earthy "limonite" and dark brown manganese oxides and hydroxides which have not yet been identified.

The individual quartz crystals are invariably intergrown in an unusual hexagonal "pine tree" habit (Figs. 2 and 3). Even in publications which specifically deal with the morphology of quartz in great detail we could not find any reference to such completely symmetrical quartz aggregates (see e.g., Hintze, 1915; Rykart, 1989). Starting from the six edges of a hexagonal quartz prism, other quartz crystals are arranged in a six-rayed pattern, their *c* axes almost perpendicular to the *c* axis of the host individual in the center (Figs. 4 and 5c–d).

The regularity of intergrowth in these aggregates first suggested that they might have been formed by repeated twinning: the approximate right angle between main and radial individuals is reminiscent of Japan-law twins (compare Fig. 100 in "Multiple Japanese twins" in Rykart, 1989). However, microsection investigations show that the aggregates have not formed by twinning. Firstly, the main and radial crystals of the quartz aggregates are not identically related, as would be expected for twins. Main and radial individuals represent two different quartz generations, and also the boundaries between them show shapes which are not typical of twins but *are* typical of overgrowths. Secondly, the angle between main and radial individuals (experimentally determined by extinction between crossed Nicols) is 90° ± 1.5° and, consequently, differs greatly from the 84½° angle between the two crystals of a $(11\bar{2}2)$ contact twin.

(continued on p. 223)

What's New

in Minerals

Swedish Minerals and Mineral Shows 1995

by M. P. Cooper

Stockholm is a beautiful place. Flying in from Manchester takes you over the broad southern tip of Sweden and, as you get lower and the landscape details come into focus, the view slowly dissociates into three elements: rock, forest and water. There are lakes large and small everywhere, the land around swathed in trees and the whole pushed aside by rounded masses of pegmatite-striped bedrock bulging purposefully from the earth. In the city (the "Venice of the North")—basically a group of islands and peninsulas joined by bridges—the rock and the water is again everywhere, but the forest is replaced by some splendid architecture, surmounted everywhere by green copper-clad roofs, symbol of the one-time dominant power of Swedish sources of the metal.

I went to Stockholm to photograph minerals, and was met at the airport by Curator of Minerals, Jörgen Langhof, who drove me straight to the *Naturhistoriska Riksmuseet* (the Swedish Museum of Natural History) in his beloved Volvo "Amazon." He provided a crash course, so to speak, in other classic Swedish cars en route. We lived and breathed minerals and mining for a good 12 to 18 hours a day for the rest of the week. On our one brief break we took a tourist trip into the city to visit the *Vasa*, a sixteenth century state-of-the-art warship that sank on its maiden voyage (like England's equivalent the *Mary Rose*, the art wasn't quite up to it). The good ship *Vasa*, raised from the sea bed after 400 years, is housed in a custom-built museum that is quite stunning. With its remarkable range of interpretation of the ship, the sea, of maritime lore, superstition and battle, this is one of the finest museums I have ever visited. The memory of the sea-blackened ship looming up from its dry dock will stay with me forever.

Back at the SMNH I was allocated a small basement room packed with bizarre minerals from Långban, one of the world's most remarkable mineral deposits. Quirks of geochemical history had deposited an unusual assemblage of elements at Långban—iron, manganese, arsenic, antimony, beryllium, lead, etc.—and mixed and matched them with complete disregard for "normal" mineralogy. For a few decades around the turn of the century Långban produced unknown after unknown, many of them noted by keen-eyed Swedish dealers and collectors like Gustav Flink and Karl Finneman, the latter an ore-picker at the mine. But despite the remarkable mineralogy, Långban specimens are relatively unknown in the international collector community. This may owe as much to history as rarity since Långban bloomed during one of the dark ages of mineral collecting. Be that as it may, the SMNH has a huge store of these remarkable specimens, the largest single-site collection in the world and an incredible research resource. The SMNH mineralogy department is producing an English-language book on the minerals of Långban, which will be the first complete treatise on these fascinating minerals in any language. I worked my way through scores of exotic specimens which up till then were only names in mineralogy texts to me: perite, allactite, akrochordite, paulmooreite, molybdophyllite, and eveite (the manganese analog of adamite, whose naming once elicited much criticism for its flippancy). Locked in some of these intriguing, and often surprisingly attractive, minerals is some fascinating chemistry: swedenborgite is sodium beryllium antimonate, bromellite is straight beryllium oxide, Långbanite itself is an appropriate manganese antimony silicate, and there are lead silicates and almost every combination of lead, chlorine and arsenic that you can think of. I'm sure that many readers of their new book will be agreeably surprised to find that not only are these minerals chemically interesting, they are often very beautiful as well: raspberry-red sarkinite globules, deep purple allactite, bright yellow trigonite in simple triangular plates, and some of the prettiest nadorite crystals you ever saw, adamantine yellow on their black matrix.

Among other treasures in the museum is the remarkable collection of Hjalmar Sjögren (1856–1922). Sjögren was a dedicated and meticulous collector. His taste was wide-ranging but refined, and his attention to detail awe-inspiring. In its own way the Sjögren collection is as stunning as the specimens and documentation of the collection of Frederick Ashcroft in the British Museum (Natural History) in London. Sjögren built his collection in the closing years of the nineteenth century, housing it in custom-made beechwood cabinets each elaborately inlaid with his initials and the date of manufacture. On top of each is a showcase glazed with beveled plate glass and fitted with stepped shelves, each bearing rows of fine specimens on custom-made polished wood pedestals. His labels are written out in a wonderfully neat calligraphic hand, and the drawers in the lower parts of the two-door cabinets are filled with black-velvet-lined trays. When Sjögren became curator of minerals in 1901 he donated his collection to the museum. The donation documents themselves are works of calligraphic art, with illuminated capital letters and elaborate script. He continued to work on the collection for the rest of his life. Every major museum should have a collection like this, to amaze and inspire collectors in the realization that collecting is not just about accumulating specimens, it's about storage, preservation and documentation, too.

Tom Moore visited the *Riksmuseet* in 1990 and wrote up his trip in the *Mineralogical Record* (vol. 22, p. 45–46). He was disappointed with the mineral displays and would be even more so today, now that the main mineral gallery has been closed and only a small temporary exhibit of minerals is open to the public. Nevertheless, this display contains some marvelous pieces, and the informed visitor will be suitably impressed by such Swedish specialties as the world's best pyrosmalite, edingtonite and cobaltite. The ten cabinets of the Sjögren collection are also on display, replete with fine Russian pegmatite minerals, Långban and Franklin oddities. British calcite and barite, and old American wulfenites in their cabinet-top showcases.

Stockholm Show 1995

The day after I arrived in Sweden the Stockholm Mineral Show opened. This weekend-long show is in its infancy (this was its second year), and is mostly devoted to lapidary and *schmuckstein*. There were a few serious dealers in minerals, although some expected foreign dealers did not come, perhaps as a result of a badly timed strike by the Swedish national airline, SAS. The show had two small special displays, one from local collectors and another from the *Riksmuseet*. The latter was devoted to pegmatite minerals and contained a few of their specialties described in Burchard and Bode's *Mineral Museums of Europe*, notably a large and fine elbaite from Elba sprouting bi-colored prisms from a large granitic matrix, and a few lovely single crystals on delicate wood-mounted brass clips from the collection of Axel Hamberg (including a superb deep blue euclase).

The main body of the show was disappointing for the serious collector, but the entrance hallway contained a few Swedish and Russian collector-dealers with some particularly interesting specimens. I am indebted to Jörgen and to mineralogist and collector Erik Johanssen for the following invaluable notes on these occurrences. Among the more interesting and spectacular recent finds in Sweden are **babingtonite** crystals of international importance. The first specimens found several years ago were sold and traded as augite crystals, but suspicions about the true nature of the material led to analysis at the SMNH, which showed it to be babingtonite. The crystals are sharp, jet-black and prismatic, often very lustrous, and occur in a nice contrasting combination with small quartz crystals and, rarely, grass-green epidote crystals. The locality, a couple of small old limestone quarries named Gronsjöberg, is situated between Borlänge and Falun, the famous old copper mine in south-central Sweden. The limestones in the neighborhood are contaminated with many different skarn minerals such as garnet, epidote, wollastonite and vesuvianite which were formed by regional or contact metamorphism or both. The babingtonite-bearing zones were probably formed by late hydrothermal activity. The first babingtonite finds at Gronsjöberg were restricted to occasional dump material found by local collectors searching for garnet crystals. But in September 1993 a big *in situ* find was made in an outcrop, between two of the small quarries, consisting of large quantities of naturally leached-out pockets. Deeper down were pockets filled with calcite, which after its removal were shown to contain some of the best and most lustrous babingtonite crystals. They are often packed tightly together making very rich specimens, but much of the material from the roofs of the elongated pockets shows superb single crystals scattered on small colorless quartz crystals to form the most aesthetic and valuable specimens.

Another interesting find, which actually was a rediscovery of an earlier known small locality, was made a couple of years ago but is still on everybody's lips. **Garnets**, probably with a large grossular component, were found in a small old prospect near the little mining village Herräng, north of Stockholm. The occurrence is a garnet skarn rock with associated scapolite minerals among others. In narrow calcite-filled pockets and fractures red to reddish brown garnet crystals in sharp and occasionally very perfect single dodecahedrons occur in sizes up to 3 cm. The calcite is easily removed, and many lustrous specimens have reached Swedish collectors.

The Chibougamou (Quebec) cubanites are known worldwide and are of unbeatable sizes; a very few such specimens have made it to Sweden, but now the Swedes have some consolation. Early this spring what seems to be the first free-grown **cubanite** crystals in Scandinavia (perhaps in Europe?) were found in a newly blasted railway-cut at Kalkugnstorp, some 70 km west of Stockholm. The small cut was accessible for a few months, and consisted of an ordinary gneiss with a narrow zone of a pyrrhotite-pyrite mineralization, which, probably through percolating surface water, has been partly decomposed. The result is a greenish clay-rich rock with open cavities in between large subhedral pyrite crystals. In these cavities cubanite occurs sparsely as long prismatic or complex flat multiple twins. The prisms reach 1 cm. Rarely the crystals show a beautiful bluish purple tarnish. Associated minerals include crystals of pyrrhotite, pyrite, galena and adularian orthoclase.

During the last five years a range of new and interesting pegmatite minerals has been encountered in Sweden. In the mine dumps of the famous Utö area (a pretty island in the Skerries archipelago of Stockholm) lithium pegmatites have been an interesting objective for keen-eyed collectors and mineralogists. The first notable find was **pollucite**, actually the second Swedish locality. Though Utö is the type locality for the LCT-type pegmatites (Lithium-Caesium-Tantalum)—and being also the locality for the original find of the element lithium and the minerals petalite, manganotantalite and holmquisite is well picked-over—many other minerals have recently been found there. Among the more exciting finds are boron-bearing **chiavennite** in sprays up to 1 cm (the third world occurrence), zoned **genthelvite-helvite** crystals, **stokesite** and **wickmanite**. Nice micromounts of **milarite**, **bavenite** and **manganite** have also turned up. These associations have been investigated at the SMNH and an article is under preparation.

Another **milarite** locality was discovered in 1993 at Högsbo in the southern part of Gothenburg in western Sweden. In an abandoned pegmatite quarry drusy quartz-bearing material was found to contain gray-white to greenish yellow milarite crystals up to 5 mm. Further collecting has resulted in larger crystals, actually in competition with the famous Jaguaraçu milarites of Brazil. One crystal 1.6-cm long and 1 cm wide, now in the SMNH collection, was found in a big boulder. Even larger crystals (up to 2.5 cm), though bent and crude, have been found by private collectors—the second largest pegmatite milarites in the world? The paragenesis includes bavenite and fluorite, the typical accessory minerals in milarite-bearing environments.

Further north in the middle of Sweden a pegmatite quarry at Sels Vitberget near Kramfors was worked in the 1960's for beryl and quartz. It has recently been shown to contain many hydrothermally decomposed beryl crystals. The first find was noted in 188, but during the last five years *in situ* finds have been made, including beryl crystal sections up to 20 cm in diameter completely replaced by **bertrandite** and **euclase**, together with quartz. Parts of the former beryl are very drusy and contain euclase in colorless semi-transparent crystals up to 1.5 cm long and red-stained bertrandite crystals up to 5 mm; small **phenakite** crystals have also been noted.

During the 1980's, bright yellow to pale yellow-brown and rarely greenish gray, transparent to opaque **barite** crystals were found in the Silurian limestone of Götland Island in the middle of the southern Baltic Sea. Recently, very attractive specimens were collected, in which bright yellow tabular barite crystals together with colorless **calcite** crystals occur in a fossil-bearing limestone horizon. The crystals may reach several cm in size. Among the older finds an impressive 4-cm yellow barite floater, from a clay-filled pocket, must be mentioned. It is probably the best Swedish barite ever found.

Swedish rarities

Turning to the more exotic mineral names we must start with the Långban oddities. Much could be said about this remarkable spot on the earth's crust, but one thing is for sure, many of the minerals are unique and very difficult for the average collector to recognize.

Though much of the nice specimen material disappeared into collections around the world, especially the SMNH, in the early 20th century, interesting finds and new associations are still uncovered every year. Much of this work of discovery is contributed by the members of the *Långban Society,* founded in 1984, but other collecting visitors may reap Långban specialities after observant and patient collecting. During recent years rare things like welinite, bromelite, trimerite, pyrobelonite, wickmanite and tetrawickmanite have been found in dump material, though most of them had to be identified by means of x-ray diffraction analysis. Rare minerals have also been yielded by some of the smaller, neighboring Långban-type deposits, perhaps the most interesting being Jakobsberg, an old iron-manganese mine south of Nordmark, the site for the newly described mineral **lindqvistite**, a lead-manganese-magnesium-iron oxide resembling plumboferrite from which it is hard to distinguish. Other newly-made dump finds include **hancockite**—the second world occurrence—**sahlinite**, **katoptrite** and **ericssonite**.

The other small-scale manganese-iron occurrence in the Filipstad area is the Harstigen mine, famous for its classic rhodonite crystals and as the type locality of the rare beryllium minerals trimerite and harstigite, and the manganese arsenates brandtite and flinkite. The first natural lead crystals were found and described from this small mine too. Much of the dump material has been searched thoroughly, but specimens of interest still show up. During the last two years good **trimerite** and two beryllium minerals new for the locality, **bromellite** and **helvite**, have been found, the former as a 3.5-mm crystal aggregate in a calcite-filled skarn fissure, and the latter as crude flat crystals several centimeters across in narrow fissures in an iron ore skarn association.

At Nordmark, an iron ore field consisting of several mines with some small manganese orebodies has yielded specimens as well; dump and *in situ* finds of several interesting minerals have been made, including rare manganese arsenates such as **synadelphite**, **hematolite** and **allactite** in small but attractive micromounts; also **filipstadtite**, **manganostibite**, **katoptrite** and **alabandite**. In different limestone-dolomite associations the boron-rich minerals **harkerite**, **ludwigite** and **fluoborite** have been identified, though not together. The harkerite forms crystals to 5 mm with vesuvianite and other species. Among the classic skarn-fissure minerals **pyrosmalite** and **hedenbergite** have been found, the latter as druses of lustrous green-black crystals to 1 cm in one of the mine walls.

The phosphate minerals of the pegmatites at Norro, a peninsula of Rånö Island just south of Utö Island, are Swedish classics. Triphylite and other phosphates were described from here in the early 1940's. More recent notable finds include the beryllium phosphates **herderite**, **väyrynenite**, **beryllonite** and **hurlbutite**, all as late-stage products more or less replacing beryl. Some 20 km to the west (we're now on the mainland south of Stockholm), is a large abandoned limestone quarry with interesting pegmatite minerals. The quarry is named Stora Vika, and has been the home collecting area for Stockholm-based collectors for the last 25 years. In recent times interest has been more and more focused on the pegmatites transecting the limestone quarry. Notable finds include **helvite** (zincian), **bityite**, an **unknown Ca-REE-Be-silicate** and **milarite** (yttrian). At the moment the collecting activity has declined, but there is still potential for interesting finds.

In the two active mines of Garpenberg new and sensational finds have been made during the last two years. Specially notable are microcrystals of **samsonite**, **pyrostilpnite** and **pyrargyrite**, large masses of **alabandite**, crude pinkish gray crystals of **wenkite** up to 1 cm and **apophyllite** in colorless to white crystals up to 2 cm, rarely associated with white **harmotome** crystals of the same size.

In a small old dump in the orefield of southern Haborshyttefaltet, just south of the famous pyrosmalite locality at Nordmark, poor crystals up to 5 mm of greenish brown **ferropyrosmalite** have been found. They occur in thin fissures unfortunately often coated with a thin sulfide layer. The Leveaniemi deposit in northern Sweden, renowned for violet strengite, has produced some other rare phosphates during the last few years. Among them **paravauxite**, **montgomeryite-kingsmountite** and **tinticite** should be mentioned.

Going a couple of hundred of kilometers to the south into the Skellefte orefield, where the famous and now-closed Boliden mine is situated, we find the largest active gold mine in Europe, the Bjorkdal mine. This huge open cut yields some 2,000 kilograms of gold every year. The gold-bearing quartz veins also host the rare bismuth telluride **tsumoite** as gray masses and brittle plates. Another interesting gold mine is the Akerberg mine, some 30 km north of the Bjorkdal mine, where a lithium-bearing pegmatite was encountered during preparatory blasting. One or more pods or local units in a schorl-bearing pegmatite proved to contain, among other things, lumps of **pollucite**, also **elbaite**, **petalite** and **amblygonite**, and as rare accessory minerals a few lumps of **allemontite** with native **arsenic**.

From the type locality of the copper selenide **berzelianite**, Skrikerum in southeastern Sweden, several selenium-bearing minerals have been newly identified: **athabascaite**, **bukovite**, **umangite** and **chalcomenite** are the additional phases. The last pegmatite mineral discovery I'll mention originates from middle Sweden, where prospecting for tin in pegmatites has revealed the rare tin sulfide **herzenbergite** as gray metallic replacement rims in and around cassiterite. The locality is known as Jarkvissle and is situated some 55 km northwest of Sundsvall. And, finally, in a newly abandoned quartzite quarry at Stakholmen, about 50 km southwest of Sundsvall, huge, elongated, divergent masses of gray **kornerupine** have been discovered. Aggregates up to 30 cm long are said to have been found.

Kopparberg Show 1995

The weekend I left Sweden coincided with the best Swedish mineral show, that in Kopparberg. Tom Moore wrote a good account of this northern answer to Ste-Marie-aux-Mines in the *Mineralogical Record* a few years ago (vol. 22, p. 46–48). I would've loved to have gone this year, but I was due in Ste-Marie itself in a week and in between I needed to do some work. Reluctantly, therefore, I said my farewells and left Jörgen and Erik to take the trip without me. I am indebted to them for this report on the show:

Extremely bad weather (i.e. heavy rain and wind) threatened to thwart Kopparberg this year, which by tradition is an outdoor event. In the end, though, the show went on, albeit with some reduction in the numbers of visitors, but the main effect was just unusually damp mineral collectors. As in recent years, the presence of eastern European dealers and collectors was quite strong and the highlight of this year was perhaps a suite of minerals from the already classic Yubileynaya ("Jubilee") pegmatite of the Kola Peninsula, including good crystals of **rarite**, **mountainite**, **laplandite** and **leucosphenite**. Other interesting minerals from Kola included **sazhinite-(Ce)**, **nordite**, **leucophanite** and **meliphanite**. The occurrence of **herderite** at Chukotka, Russia, was represented by a few specimens of pale wine-yellow crystals in small, loose groups. Also among the minerals from alkaline rocks, Richard Schøler of Denmark again had an array of material from the Illimaussaq intrusion of southern Greenland. Particularly interesting were **tundrite-(Ce)** in bronze-colored to yellow, hair-like crystals in open cavities, rich pieces of **cuprostibite**, and unusually large specimens of the beryllium silicate **chkalovite** in pods up to 5–7 cm.

Figure 1. **Babingtonite from Grönsjöberg, Borlänge, Dalarma, Sweden. Lustrous black crystals to 6 mm with quartz. Andreas Forsberg specimen; M. P. Cooper photo.**

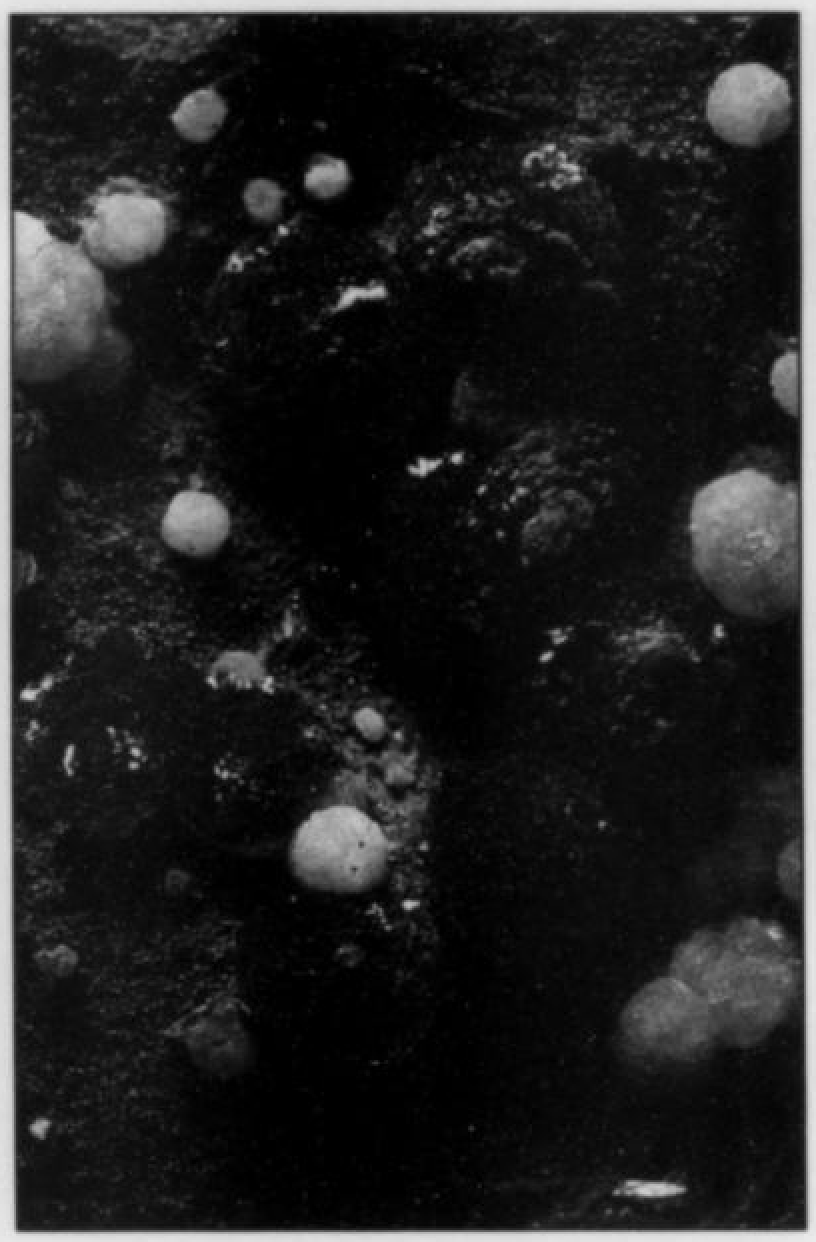
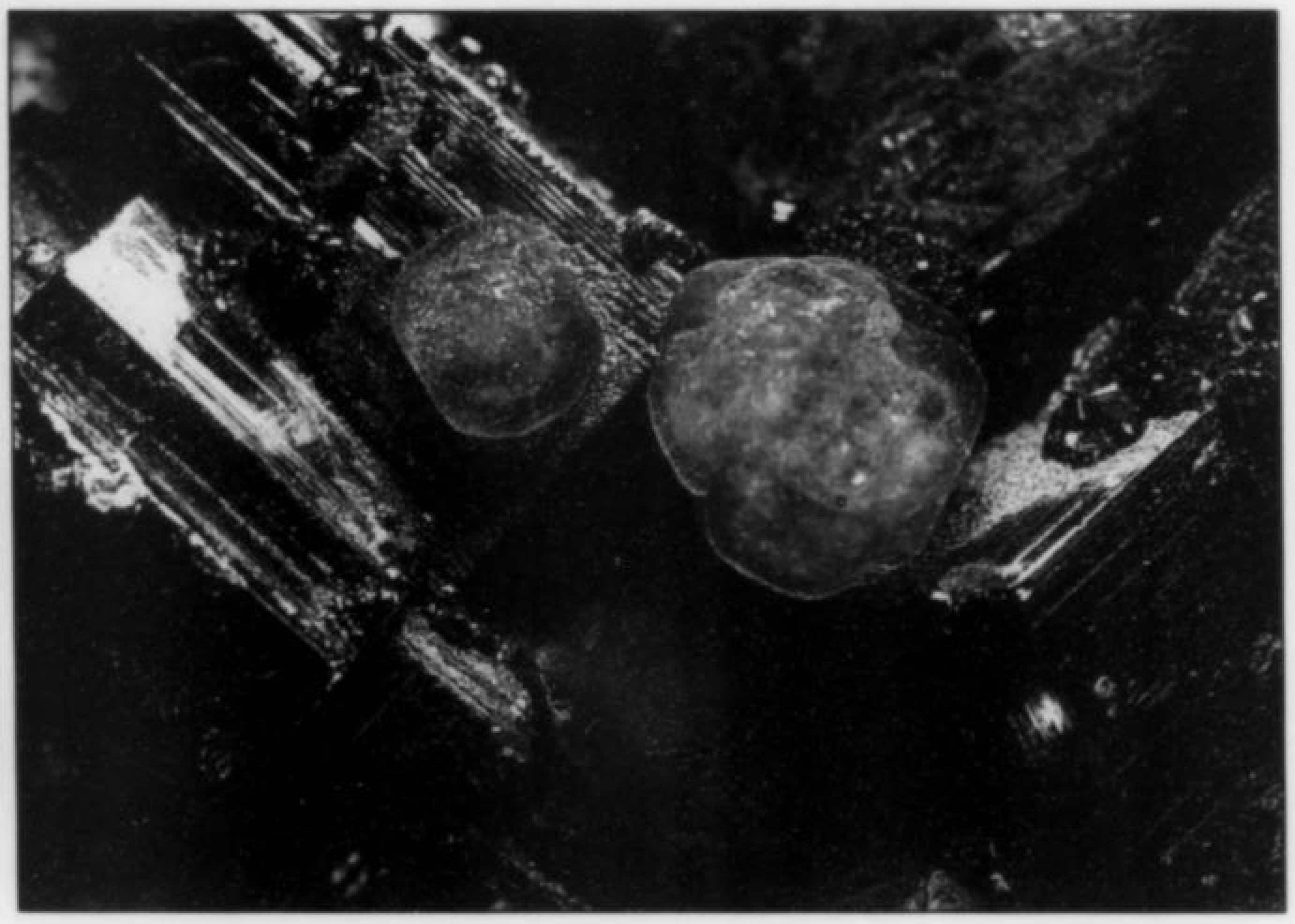


Figure 2. **Sarkinite, brandtite and allactite from Långban, Filipstad, Värmland, Sweden. Drusy spherules of raspberry-red sarkinite (to 2 mm) with white brandtite spherules and blades of yellowish allactite. From a specimen acquired from Gustav Flink by the Stockholm Technical High School, and now in the SMNH, specimen number 532388-90 (Flink 357-359). M. P. Cooper photo.**

Figure 3. **Milarite from Högsbo (Södra brotet), Göteborg, Bohuslän, Sweden. Translucent hexagonal prisms to 1.9 mm scattered on matrix, from a (relatively) recent find. SMNH Collection Ref. 930071; M. P. Cooper photo.**

Figure 4. **Calcite from Storugns, Gotland, Sweden. A complex crystal 1.3 cm long, on an earlier generation of golden, iridescent calcite on limestone matrix. Some faces of the large crystal are frosted and others are highly lustrous, especially noticeable in the narrow faces between the larger planes. A new find made in 1995. Andreas Forsberg specimen; M. P. Cooper photo.**

Figure 5. (below) **Fluorite on pyrite from the Huaron mine, Cerro de Pasco, Peru, in globular masses to 8 mm scattered on cubes of pyrite to 2 cm with small black sphalerite crystals. Photographed at the Ste-Marie-aux-Mines Show, June 1995, by M. P. Cooper; Gilles and Françoise Barras-Gauthier specimen.**



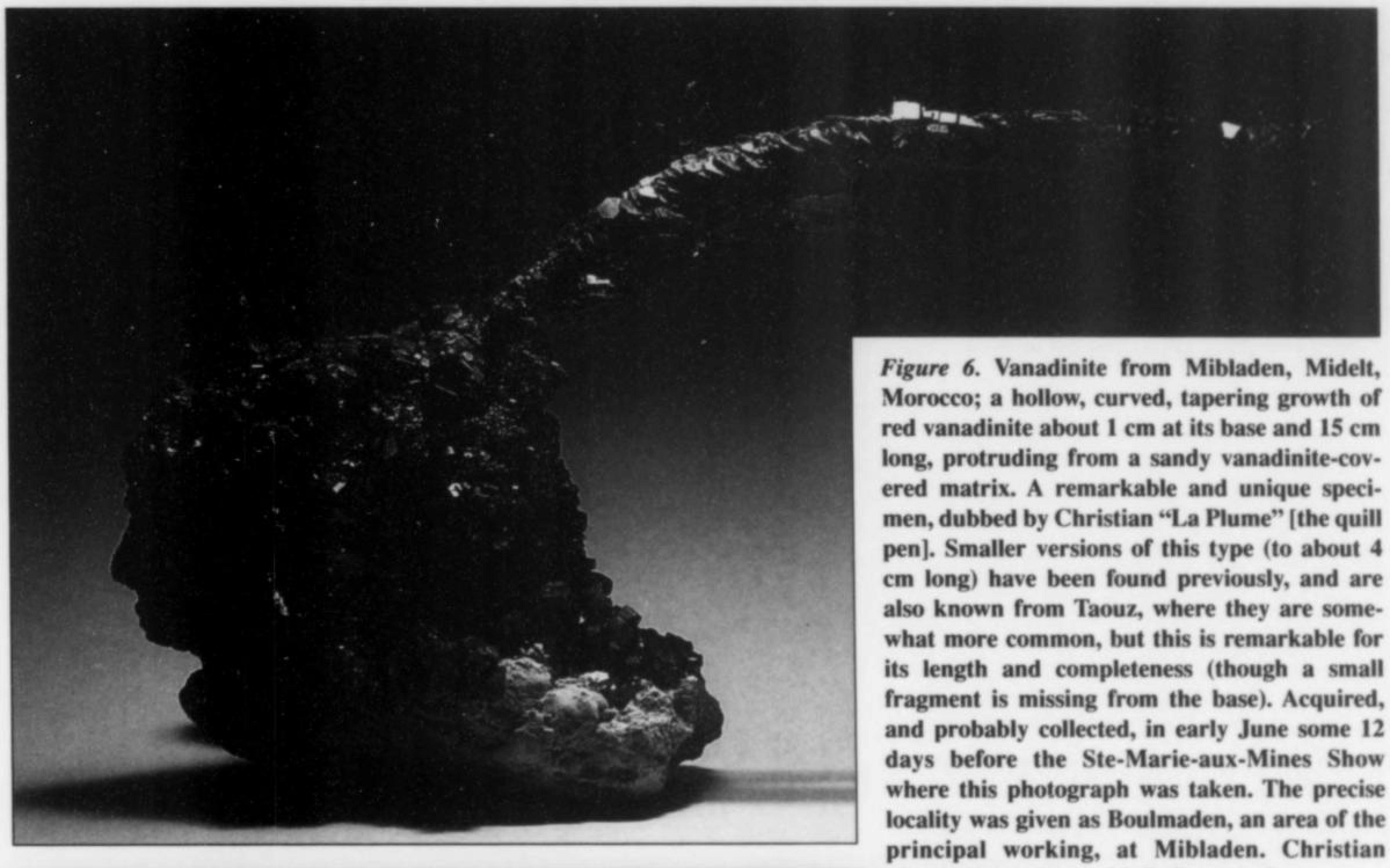


Figure 6. **Vanadinite from Mibladen, Midelt, Morocco; a hollow, curved, tapering growth of red vanadinite about 1 cm at its base and 15 cm long, protruding from a sandy vanadinite-covered matrix. A remarkable and unique specimen, dubbed by Christian "La Plume" [the quill pen]. Smaller versions of this type (to about 4 cm long) have been found previously, and are also known from Taouz, where they are somewhat more common, but this is remarkable for its length and completeness (though a small fragment is missing from the base). Acquired, and probably collected, in early June some 12 days before the Ste-Marie-aux-Mines Show where this photograph was taken. The precise locality was given as Boulmaden, an area of the principal working, at Mibladen. Christian Mondeilh specimen; M. P. Cooper photo.**

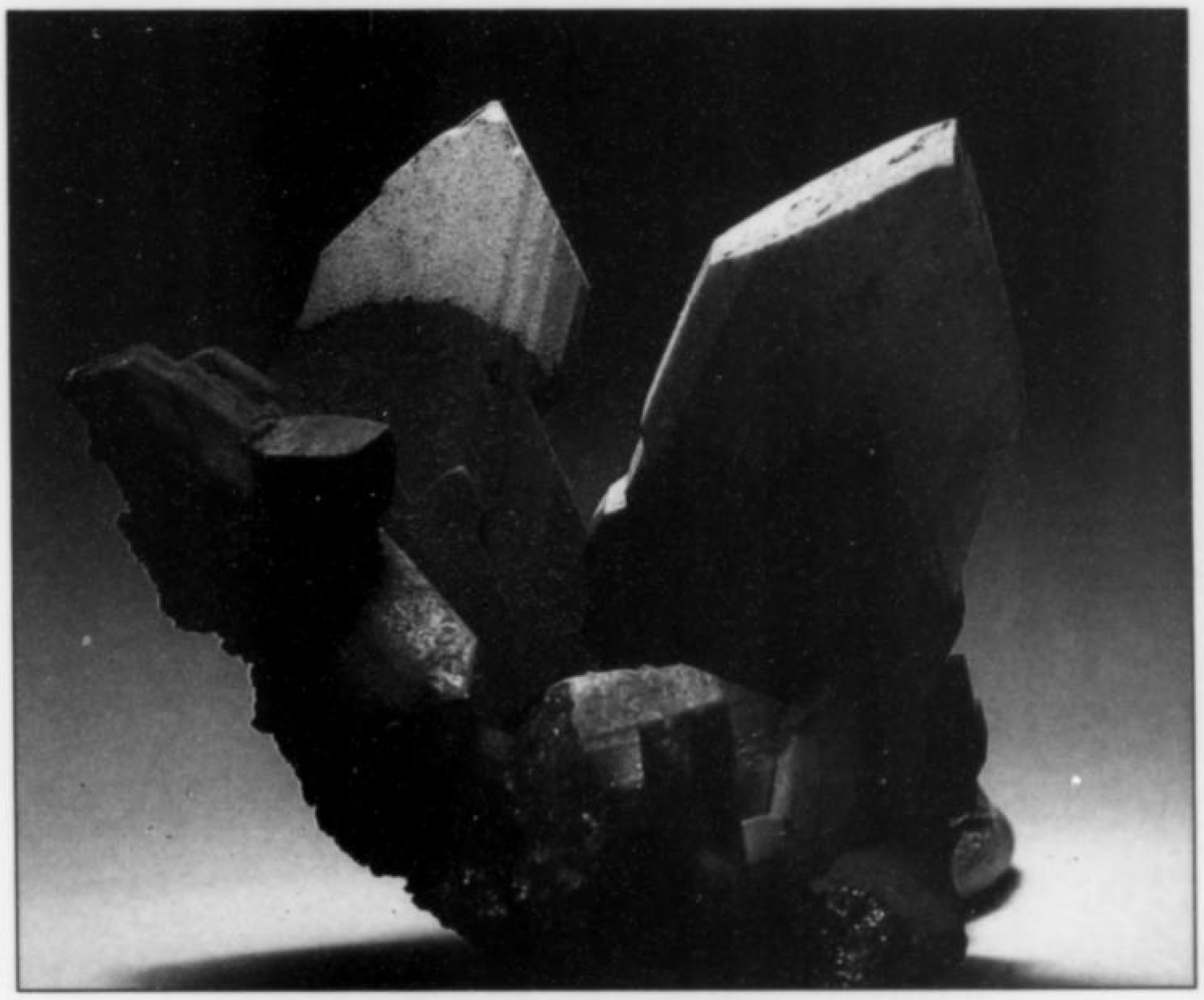


Figure 7. **Anglesite from Touissit, Oujda, Morocco. Two blades of anglesite (to about 5 cm), with several smaller crystals, thinly coated with a fine-grained creamy mineral (superficial alteration to cerussite?), the lower parts of the crystals subsequently stained green (a thin alteration to malachite?). An aesthetic group from the new find in Shaft 99 at Touissit. Photographed at the Ste-Marie-aux-Mines Show, June 1995, by M. P. Cooper; Jean-Francois Astier specimen now in the collection of Frédéric Escaut.**

Figure 8. **Anglesite and cerussite from Touissit, Oujda, Morocco. A pale brown, transparent V-twin of cerussite, 1 cm long, clinging to the side of a transparent, bright yellow blade of anglesite 6 cm long. From a recent find in the No. 99 Shaft at Touissit, Morocco. Photographed at the Ste-Marie-aux-Mines Show, June 1995, by M. P. Cooper; Gilles and Françoise Barras-Gauthier specimen.**

Commanding serious attention was a lot of very good material from the Poona area, brought by an Indian dealer. This of course included much of the new **cavansite**, but definitely more interesting were the different types of **heulandite**: as reddish or salmon-colored aggregates associated with white zeolites and apophyllite, and as almost opaque, green (through numerous inclusions of chlorite), complex floater aggregates to more than 5 cm. The prices were initially a bit on the steep side, but as the increasing rain soaked through the poor dealer's business suit (totally un-Kopparberg attire), his prices sank rapidly.

A definite one-of-a-kind was a magnificent **zircon** specimen from the well-known occurrence at Seiland in northern Norway. Contrary to what has been previously available for these dark reddish brown giants, these zircons were not intergrown but occurred in an open cavity, later filled with a fine-grained barite-like substance. Meticulous preparation work had stripped the latter away and exposed several tens of well-formed, 2 to 3-cm crystals grouped together in the cavity. This must without question be among the finest matrix zircons ever to have come out of this locality. According to some sources, zircon mining activity has been low on Seiland in the last years. Should more material of this type be around there, we must hope for a reactivation!

Ste-Marie-aux-Mines Show 1995

by M. P. Cooper

I didn't go to Ste-Marie-aux-Mines in 1994, but this past year I did, in a frenzied month of mineralizing which began with my week in Stockholm. Feeling very much the international mineralogist, I jetted in to England for a few days' work at the museum before getting into my hired car—a good deal more powerful and comfortable than I'm used to—and cruising down France's luxurious motorways to Alsace. (If any French reader thinks that "luxurious" is an odd word to describe a motorway, try driving down England's overcrowded M1 where "Road Rage" is a way of life.) It was a hot day to travel, but the weather soon changed and Ste-Marie was unseasonably chilly during the show. Despite the cold and drizzle it was an enjoyable and much expanded event and, despite a general lack of novelties, business was reported as good. Much of what was new was just old occurrences revisited; no bad thing if you'd missed out the first time around. For instance, Touissit, Morocco, had again produced a flood of fine **anglesite**, **cerussite** and **azurite**, perhaps not up to the *highest* standards set by this now-classic locality but nonetheless very acceptable. My favorites were a blade of yellow anglesite with a minute but perfect heart-shaped pale smoke-brown cerussite twin clinging to one side, belonging to dealers Gilles and Françoise Barras-Gauthier, and a superb radiating spray of dark honey-yellow to black lustrous blades to 8 cm from the collection of Christian Mondeilh. A further interesting piece (on the stand of Jean-François Astier, of Grenoble) is a pale yellowish cerussite pseudomorph after anglesite, the base of the crystals stained green, probably by superficial alteration to malachite, as if it had been dipped half-way into a cupreous solution. The finest cerussites of the new lot are a delicate smoky brown, in highly lustrous heart-shaped or arrowhead twins, on and off matrix. The fire in some of these 1 to 5-cm crystals is superb. The azurite crystals from the new batch reach a good 10 cm long and many are loose, doubly terminated examples. The color of these thick crystals is almost black. Also from Morocco, from Boulmaden, part of the famous Mibladen deposit, was an incredible **vanadinite**, again produced for my delight from the private collection of Christian Mondeilh. He had named it "La Plume" (The Quill) with good reason: it is a terrifyingly fragile hollow skeletal growth of blood red vanadinite about 1 cm across at its widest point curling to a fine point an amazing 15 cm from the matrix. Smaller specimens had been known from the area for a while, and also from Taouz, but this piece has to be unique, if only because it has survived at all! Everyone who saw it during its brief sojourn in my makeshift studio was suitably impressed, including veteran Moroccan-minerals dealer Victor Yount.

From Europe the best plentiful material is still from Romania. There's still a lot of very good **stibnite**, **fizelyite**, etc. at extremely reasonable prices. Peter Barth (Höhenweg 34, D-83253 Rimsting, Germany) had the best at the show. In Portugal the Panasqueira mine, despite recent rumors of imminent permanent closure, is again at work and producing the usual array of fine specimens. **Siderite** and **arsenopyrite** are abundant in fine specimens but **apatite** is rare and the classic purple crystals are currently not being found. Jordi Fabre had a nice suite. A couple of old localities for **pyromorphite** are again producing specimens after a long hiatus: from St. Salvie, Tarn, France, there are some pretty grass-green sprays on gossany matrix, gorgeous under low magnification, the product of much hard work by French collectors; and from the Cerro Canalesa, Santa Eufenia in Cordoba, Spain, an old mine has recently been persuaded to part with some pale, milky, olive-green crystals encrusting matrix pieces to 10 cm or so. The latter had been collected a few weeks before the show by Juan Rivera (Alfareria 4, 41010 Sevilla, Spain) and Luis Burillo (Escosura 22, Pral. Centrum, 50005 Zaragoza, Spain) who shared a stand just inside the main show.

There were some unusual **fluorites** on show. One dealer on the street had some attractive green to purple botryoidal specimens from the Nancy Hanks claim, Mesa County, Colorado, and in the theater Gilles and Françoise Barras-Gauthier had a couple of specimens showing deep purple globular masses on bright pyrite crystals from the Huaron mine in Peru. But for the best display of fluorite in 1995 you had to go to Munich, where a remarkable array of specimens was assembled for a special exhibit, and the dealers geared up to offer plenty of good material to the expected crowd of fluoritophiles.

Collectors of **prehnite** have had a good time of it recently: specimens from three exceptional finds in Africa were available at Ste-Marie. The earliest African find (made a couple of years ago at Brandberg, Namibia) has already been reported. The latest is a one-of-a-kind find made in a road cut at Kudicop, Namibia. The whole find was bought by French dealers Pierre and Martine Clavel; it consists of definitively botryoidal masses of grape-green well-defined globular masses—classics for devotees of mineralogical etymology—encrusting matrix to over 15 cm across, the delicate colors and interesting shapes forming some very attractive pieces. Although most of the finer pieces had already been sold, Pierre and Martine still had some good material at Ste-Marie. There was also a lot of material from Morocco, carried by many dealers at the show; the new find of prehnite from an Alpine-cleft-type deposit at Bouarfa, between Erachidia and Oujda, in the Anti-Atlas Mountains, was obviously a considerable one. Although the majority of pieces are not exactly show stoppers, the best are well-worth having, if only for the exceptional coarseness of their crystallizations, showing thick, pale green prehnite crystals in fans to 5 or 6 cm across, sometimes in criss-cross intergrown groups forming almost globular masses. Associated species include quartz, epidote and hematite.

One find that I unfortunately didn't get the opportunity to discuss properly with the owner was a group of beautiful **elbaite** prisms on the stand of François Lietard. From Pederneira, Cruzeiro, Minas Gerais, these gorgeous, partly gemmy, elongated crystals (to 2 x 20 cm or so) are a characteristic blue-green with rose-pink tips, the latter color sometimes extending into the body of the prism. At Ste-Marie they were available as singles and intergrown groups of two or three individuals, although at their earlier debut at the 1995 Tucson Show some matrix pieces were to be had (and were picked up, very quickly) with elbaite implanted on large, pale yellow quartz crystals. Many of the specimens were found to be broken in the pegmatite pocket that yielded them, and had been carefully restored; it was good to see that the repaired pieces were thoughtfully labeled as such. Repair is par for the course for tourmaline crystals of this delicate habit, so the damage hardly detracted from their immediate ascension to a high place in the hierarchy of fine tourmalines.

Most of the recently plentiful Russian minerals are still to be had, if you can afford them, but one new rarity has apparently disappeared. The remarkable deposit of **rhenium sulfide** found in fumarolic deposits at the Kudriavy Volcano, Iturup Island (between Kamchatka and Japan), which caused much excitement as the first rhenium-dominant mineral known, is reported to have been vaporized following a rise in temperature of the site! Visiting scientists hoping to acquire more of this novel mineral were disappointed by this recent turn of events, but searches will doubtless continue. One small growth area in Russian minerals is a much-talked-of trade in "chernobylite." The rumor is that persons unknown are trying to sell as mineral specimens colorful efflorescences and encrustations from the decomposing reactor chamber at Chernobyl. Official warnings are reported to have been given regarding this material by the radiological protection authorities, so there might be some truth in this horrifying scenario. However, if this stuff is as viciously radioactive as the stories have it, the vendors are likely soon to be in no fit state to hawk it about any further.

Chinese minerals are becoming more common. Terminated **stibnite** crystals a meter long, and lustrous, perfect, jet-black bipyramidal **cassiterite** crystals weighing several kilograms can be had.

My trip to Ste-Marie was a hasty one this year, but despite the rush there was one thing that had to be done before we left: *Les Hauts Konigsbourg*, a conical red-sandstone mountain with a fortress on the top just down the valley from Ste-Marie. You can see it for miles from the east of the Vosges Mountains. I had been told so often of this place that I felt this year I had to go. I went. It's incredible. A ruin for centuries, the site was lavishly restored around 1900. In the 1600's, during the Thirty Years War, the site was ransacked by the Swedes. Though, frankly, after trudging across Europe laden with arms and armor and arriving battle-worn at the foot of this monstrous and forbidding place, I think I would've just done a little mineral collecting and gone home.

Tucson Show 1996

by Thomas Moore

[ca. Feb. 1–11]

This being my fifth consecutive year of coming out to Tucson from Connecticut, I should declare the escaping-the-weather-back-home motif a cliché by now, and retire it. But let's just say, one more time, that this year's refugees from eight inches of new snow back east, ice storms down south and minus-triple-digit windchills in the upper Midwest never lacked for entry-level smalltalk in Tucson. Meanwhile, the balmy ambiance of the Executive Inn's courtyard enfolded a Sunday night party that Marty Zinn organized to observe Dr. Fred Pough's ninetieth birthday, and all, including the guest of honor himself, had a most mariachi good time.

The downsides this year were the closing of the Desert Inn (in mid-show) and the inescapable fact that Russia, Brazil, Mexico and much of the U.S. all seemed to be having down years for new specimen production—by earlier Tucson standards at least. But the familiar kinds of excitement ran high anyway, and it seemed to me that the general buzz of backchannel specimen-gathering intrigue was up as well. Maybe it's just that I'm coming to know more people and hear more insider talk each year. But I was especially struck this time by the frequent whispers of good-natured secrets, promises pending, Amazing Stuff sneaking in soon from Peru or Colorado or Kazakhstan, tradings and sellings, and mysterious deals said to be in the offing. The innocent paranoia is (paradoxically) part of the fun.

One sunny morning, with collectors Ralph Clark and Steve Neely, I set out to cruise some outlying hotel shows (there were 21 such shows going on all together!), specifically *La Quinta* and the *Pueblo* (the *Desert Inn*, as I've said, being out of action). These shows are always important to check out, because a few serious mineral dealers always seem to nest there, among the lapidarists and fossilists. Yet the real fun of going to this hotel-strip part of town is in visiting the circus-like jewelry/beadwork/cutting rough/machinery/mystic accessories/native crafts tents, and strolling along sidewalks and through parking lots full of more and more and more of the same, to absorb the sheer funky motliness of the scene. Steve, a doctor, was briefly tempted to buy a lifesized chromium femur from one young man at an outside table; but the sale kind of withered when the fellow looked up and proved to have almost as much chrome stuck into his face as was in that bone: little metallic beads on forehead and cheeks and chin and nose, aesthetically placed with regard to the tattoos. My point is that even the most single-mindedly mineral-obsessed collectors owe it to their own humanity not to miss *this* sideshow, with tens of thousands of casual shoppers, critter diggers, bead freaks, Greyhound excursionists, cowboy-hat-and-bola-tie-wearers, mystics, headtrippers, and Ph.D. mineralogists all striving for pelvis room around the tables all over this side of town.

My intention in this report, as usual, is to combine the offerings of the Executive/Ramada Inn shows, the "Main" show and the sideshows into one grand geographical tour, with a word or two at the end about the displays at the great Tucson Gem and Mineral [Main] Show. Jeff Scovil and Wendell Wilson scoured the shows, too, looking for good things to photograph. Their work accompanies this report as usual, including a few subjects which I never got to see or write up. So, ready at the gate:

Arizona has been uncharacteristically dormant all this past year except for one promising development: Wayne Thompson's project, beginning in December 1995, to work the famous Red Cloud mine for more of that red-orange **wulfenite** which is among the state's proudest classics. Wayne found that before starting serious collecting he had to remove a 15-foot-deep rubble pile that covered the hanging-wall side of the vein before being able to trench along it. Later this year he plans to dig further down along this 45° plane. But some 15 to 20 fine wulfenite specimens have already been hit, in a single pocket discovered during the rubble-clearing. The best of these pieces were a couple of small miniatures with very bright red-orange (though not as red as the reddest of old), beveled, tabular crystals to 2.5 cm perched on their edges on matrix. A few specimens reach 10 cm matrix sizes, with good 1.5-cm wulfenite crystals scattered or bunched, like handfuls of leaves. Since all these good things were found during only about a month's work, there is good reason for optimism about what comes next: keep an eye on Wayne (1723 E. Winter Drive, Phoenix, AZ 85020).

Carter Rich (P.O. Box 69, Aldie, VA 22001) in the Executive Inn had a couple of flats of old historic micromounts in antique-looking little boxes from such famous early collectors as George Rakestraw, George Washington Fiss, William Jefferis, George

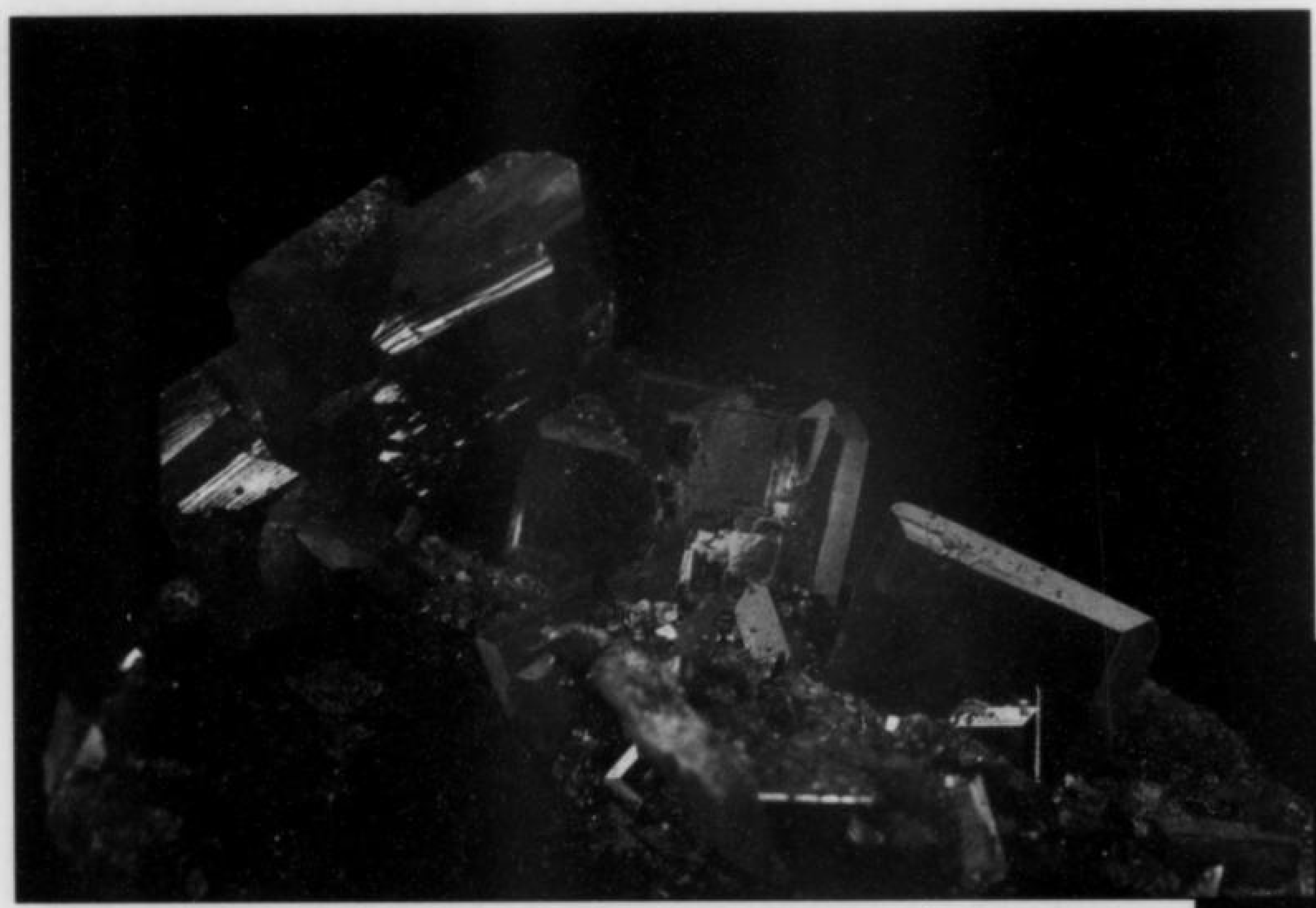
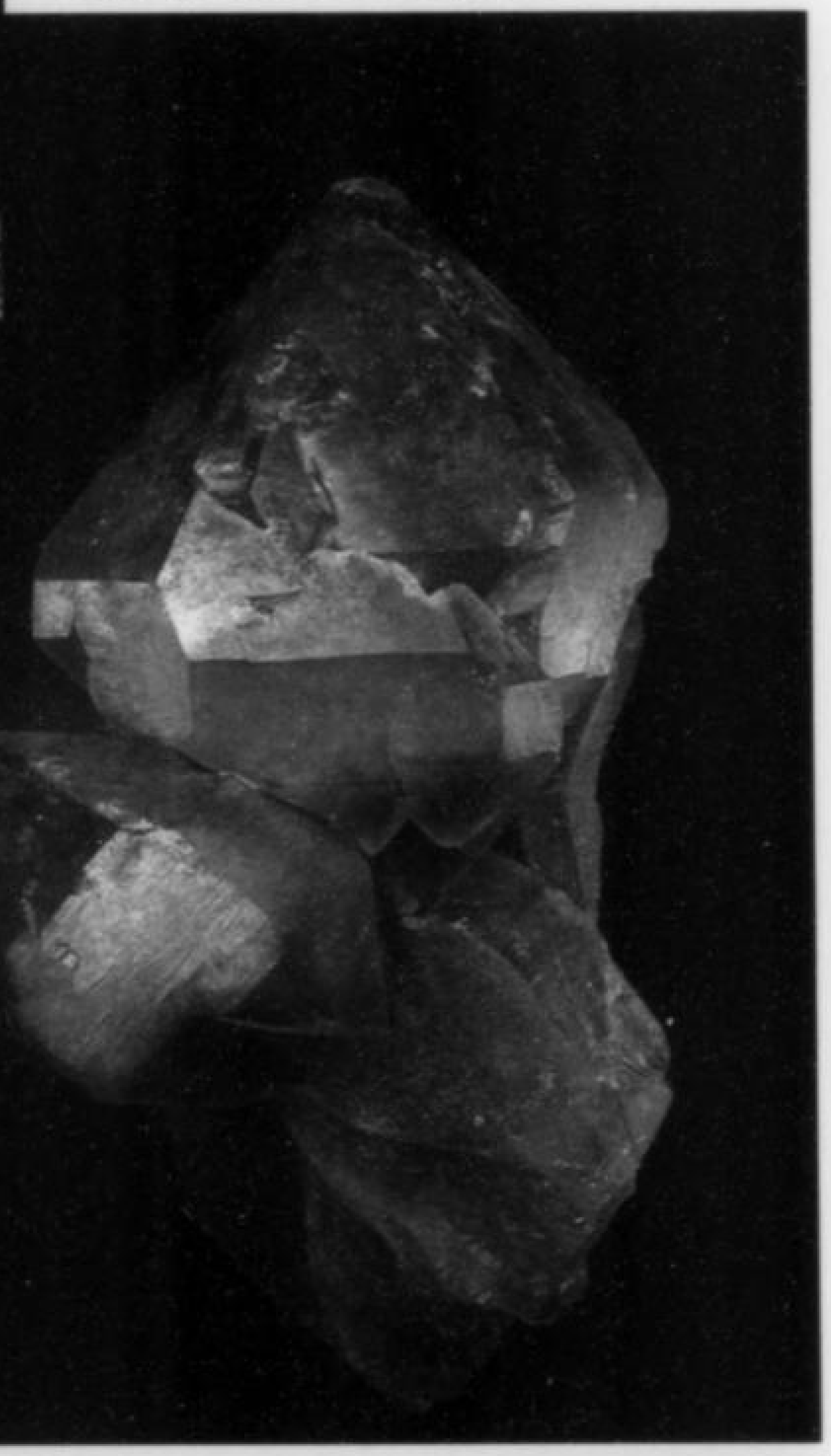


Figure 9. **Wulfenite crystals to 2.3 cm, from the Red Cloud mine, La Paz County, Arizona. Wayne Thompson specimen; Jeff Scovil photo.**

Figure 10. **Amethyst scepter, 11.1 cm, from Duquesne, Arizona. Les Presmyk collection; Jeff Scovil photo.**



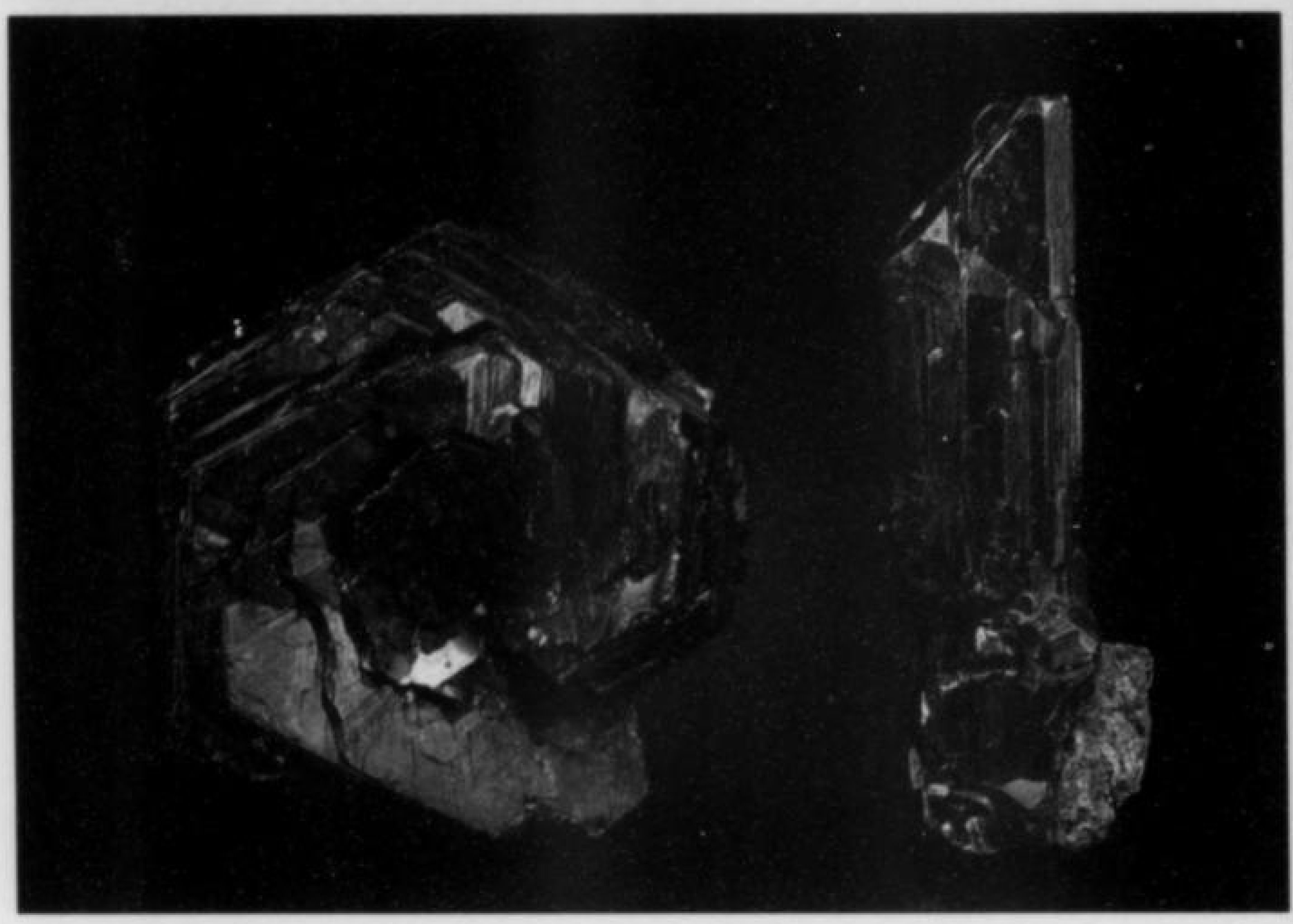


Figure 11. **Polybasite (left, 1.6 cm) and stephanite (2 cm) from the Husky mine, Elsa, Yukon, Canada. Ralph Clark collection; Jeff Scovil photo.**

Figure 12. **Azurite with malachite, 4.1 cm, from Morenci, Arizona. Dick Morris collection; Jeff Scovil photo.**

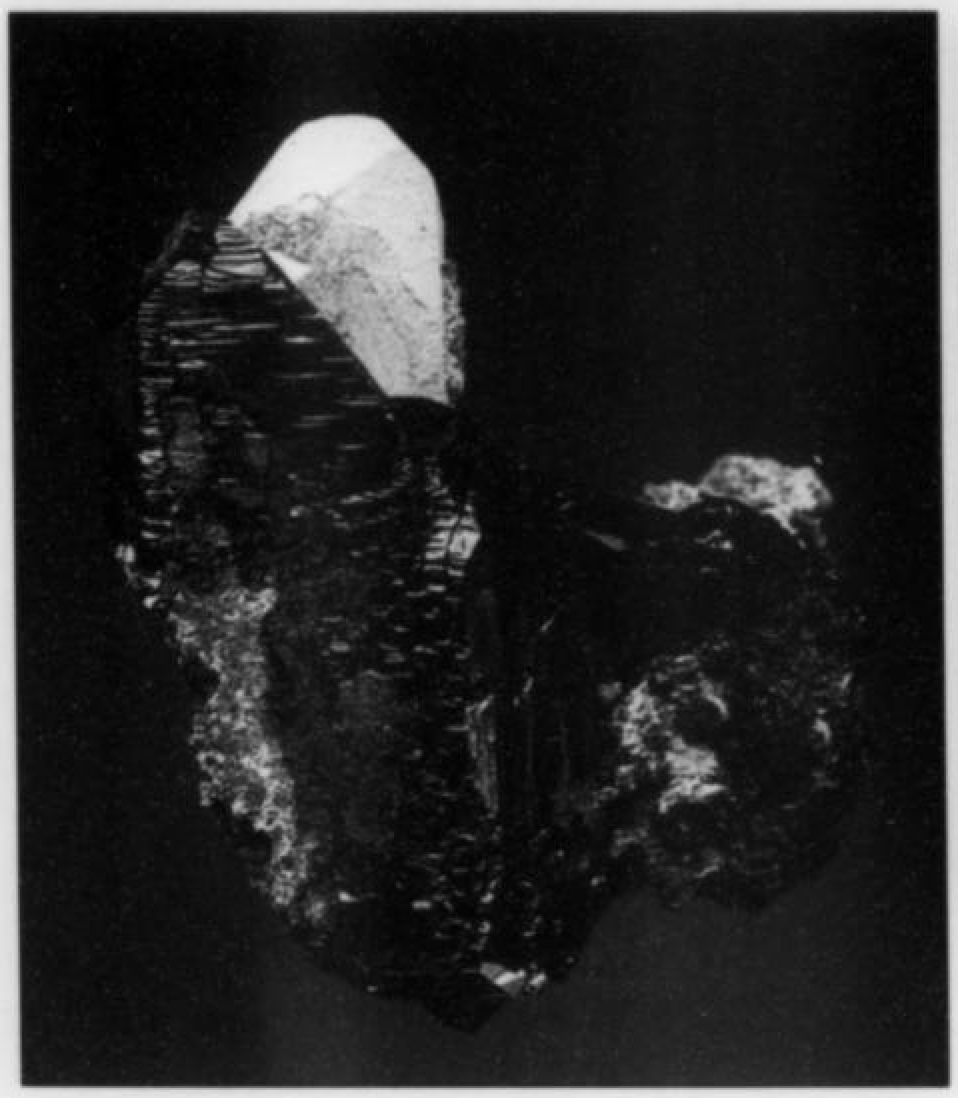


Figure 13. **Calcite crystal group, 7 cm, from Kjorholt, Langesundsfjord, Telemark, Norway. Peter Lyckberg specimen; Jeff Scovil photo.**

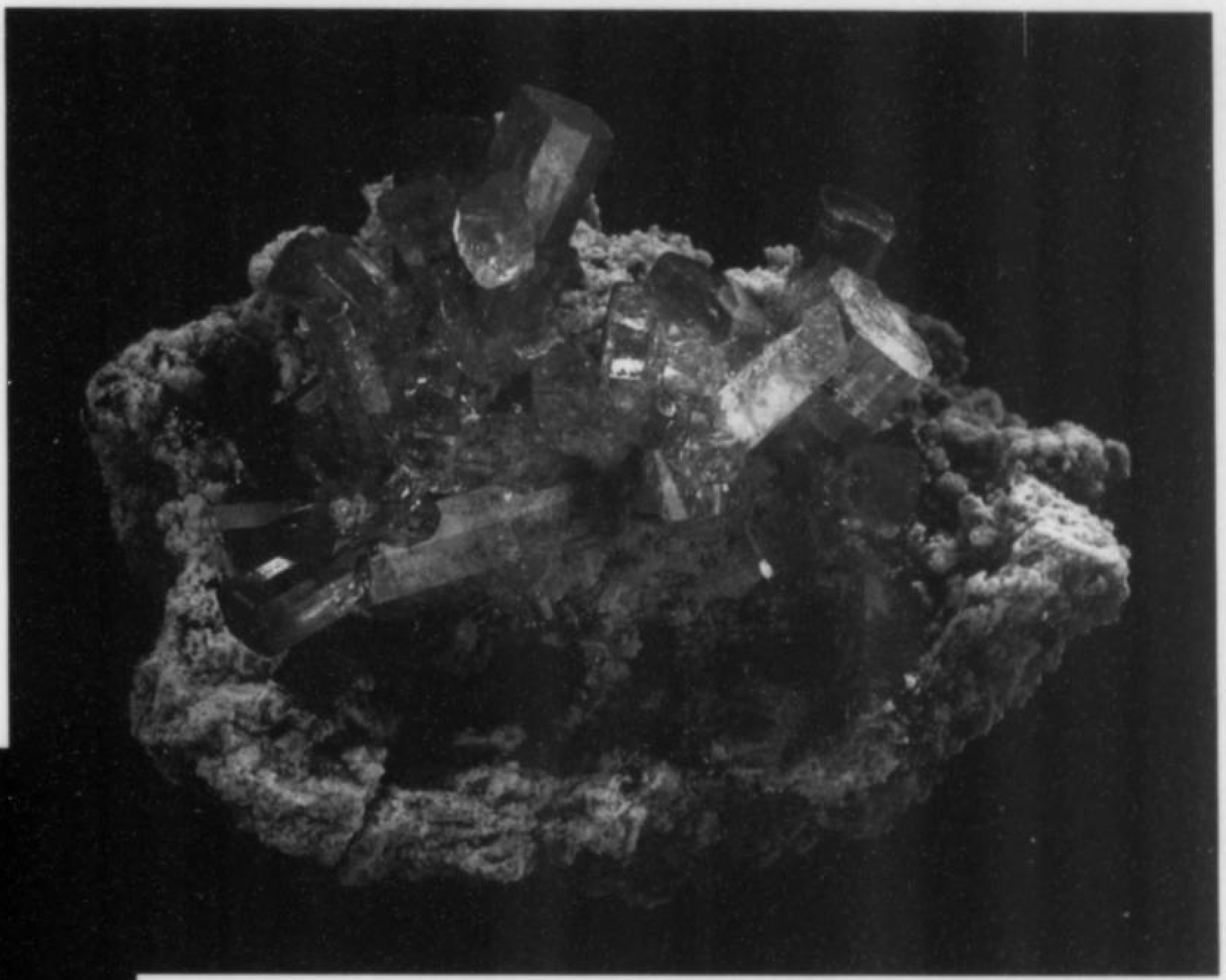


Figure 14. **Topaz on matrix, 5 cm, from Zacatecas, Mexico. De Natura specimen; Jeff Scovil photo.**

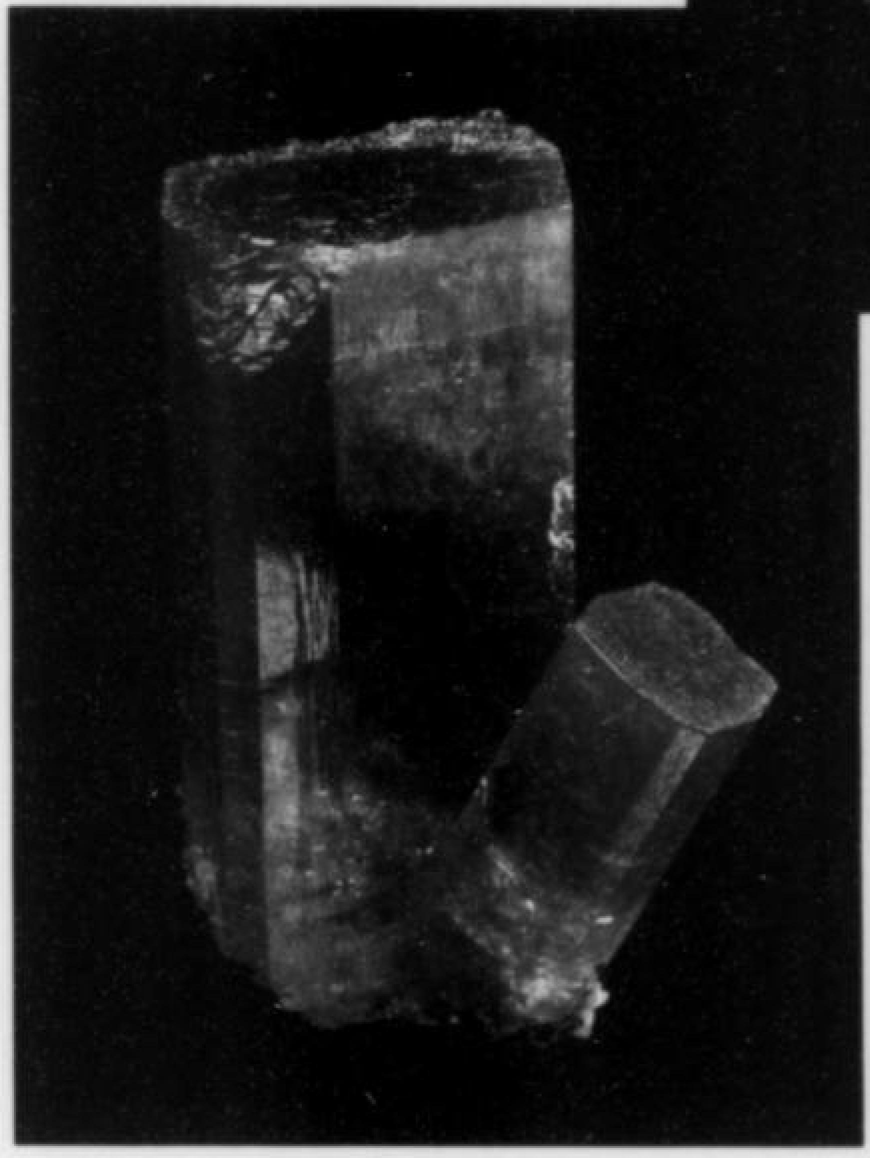


Figure 13. **Topaz, 2.9 cm, from Zacatecas, Mexico. De Natura specimen; Jeff Scovil photo.**

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Figure 16. **Brazilianite crystals to 2.4 cm, from Linopolis, Minas Gerais, Brazil. Hawthroneden specimens.**

Figure 17. **Poldervaartite crystal group, 2 cm, from the Wessels mine, Kuruman, South Africa. Ralph Clark collection; Jeff Scovil photo.**

English, John Grenzig, O. Ivan Lee, J. B. Brinton and Neal Yedlin. Priced at $10 to $75 each, some proved to contain quite attractive little specimens in addition to being bonafide pieces of collecting history.

Dave Bunk of *Dave Bunk Minerals* (1441 W. 46th Ave., Unit #8, Denver, CO 80211) had about 30 miniature-size to large cabinet-size specimens of **azurite** from the Henry Clay mine, Lordsburg, Hidalgo County, New Mexico—a batch collected in the 1950's, and quite exceptional, Dave says, for the Lordsburg District. Over matrixes of hard, splotchy, copper-mineralized gray rock, little bladed azurite crystals in rosettes to 5 mm form solid, bright, medium-blue coatings. One very handsome foot-wide block is lavish with deep vugs, all filled with the brilliant blue druses ($400).

A *very* new What's-New involves the work being done in Nevada by Harvey Gordon of *Harvey Gordon Minerals* (500 Ballentyne Way, Reno, NV 89502). He has been digging near the contact between two phases of pegmatite which intrude an Upper Triassic limestone in the Gillis Range near Hawthorne, Mineral County. Some smoky quartz and/or green **microcline** ("**amazonite**") specimens have been found which are quite distinctive. Sharp, translucent to transparent, dark to pale smoky quartz prisms can get to be a foot long, and (as in Colorado) are frequently intimate with blue-green microcline crystals which themselves can be fist-sized. The microcline is of a strong bluish cast, and is almost transparent! In this way and other, more intangible ways which are hard to describe (see photo) the crystals differ distinctly from what we are used to seeing from Pikes Peak. Best of all, there are also colorless to pale blue, gemmy **topaz** crystals here; one 7-cm partial crystal I saw would cut several substantial gems, but other fine examples were around 3 cm. The prospect is being called the Zapot mine; it has been actively worked by Harvey for about six years now, with the good stuff beginning to come out about four years ago. I hardly need say "future work is planned," but I *will* say that a full article is in preparation.

Now for a couple of bulletins from Vermont. The famous old quarry at Eden Mills was worked hard by five expert collectors last year, ending in September: they had to rappel on ropes to prospect for pockets in the steep walls of marly diopside/epidote/clinozoisite rock. The jackpot was a sizable pocket of, yes, **grossular** in about 50 mid-range specimen sizes, of which about ten pieces may be called "top." The grossular crystals are brilliantly shiny, gemmy, sharp, simple dodecahedrons, and of a color much darker than the standard cinnamon-orange: more of a dark orange-brown. Individuals reach 2 cm across, and the crystals are tightly clustered on greenish matrix, with subhedral prismatic **clinozoisite** and/or **diopside** crystals. Apparently there are further plans to go back in quest of vesuvianite—but meanwhile these are surely some of the best grossulars that this old place has produced in many years.

The above information came courtesy of Mike Haritos of *S.T.D. Mineral Company* (22 Spring Hill Rd., Hyde Park, MA 02136-4013), as does also the second Vermont bulletin. In August of 1995, in Rutland County, Richard Ransom and Langis Anctil found some **quartz** crystals which could pass anywhere for New York "Herkimer diamonds"—pristine clarity, sharpness and beauty included. They range from tiny ones up to 3 cm long, and were mostly found loose in vugs (detached by frost action or by the blasting) in a tough, pale gray dolomite. Some crystals also show pale smoky transparent overgrowths on an earlier generation of clear prisms, so that smoky scepters result. My favorites, though, were the single, loose, simple pseudo-Herkimers, of which there were about ten, from 1 to 2.5 cm in size. Rutile, as brownish black, thin, striated prismatic crystals to 1 cm, with complex terminations, is infrequently to be seen on and included in the quartz. The precise location of this deposit is being kept secret for now, at least until the collectors have gotten most of the "easy" exposed surface specimens.

Now, *Notes from Canada,* meaning, this time, from the Executive Inn room of Rod and Helen Tyson of *Tyson's Fine Minerals* (10549-133 St., Edmonton, Alberta, Canada T5N 2A4). The first grabbers of my attention here (even though not a What's-New) were a few top-class **cubanite** specimens from the Henderson #2 mine, Chibougamau, Quebec. One is a flat 7 x 7-cm matrix with sharp, 1.5-cm, brassy brown cyclic twins all over it; another, the finest small cubanite specimen I have ever seen, is a loose 3 x 3-cm cyclic twin, lustrous, undamaged, and nearly complete. Some very good thumbnail cubanites were more generally available around the show, especially the Main Show. This may be the last, necessarily fast-closing window of opportunity to get The Big One from this now extinct occurrence.

Radically less hi-value but more really new, and quite attractive in their blocky way, were some 4 x 5 x 6-cm crystals of pale pink, earthy **sanidine**, some as Karlsbad twins and some as loners, from Beaverdell, British Columbia (still at Tyson's). Loose crystals are nice enough, but the ones that sit lightly on fine-grained granitic matrixes make unbeatable large-cabinet-sized "feldspar" specimens.

Finally, and least expectedly, Tyson's had just two small specimens of silver minerals—one **stephanite**, one **polybasite**—collected in the late 1970's from the 2-1-264 stope of the Husky mine, near Mayo, Yukon Territory. Production of ore and hence of specimens at this high-grade silver mine is now reportedly finished. But these two small pieces are very fine, and another two thumbnails (acquired elsewhere by Ralph Clark, and again a stephanite and a polybasite) are very fine also. Both stephanites feature a single, sharp, spiky 2-cm crystal surrounded by smaller ones, and with a slight iridescent tarnish. But the iridescence on the midnight-black polybasite at Tyson's is jazzier still; this piece is a 2 x 3.5-cm group of sharp plates. Ralph's polybasite is an exquisite little loose rosette, untarnished, looking very much like a superlative Swiss "eisenrose" hematite. I'd heard that a few more Husky mine sulfosalts might have been lurking somewhere about at the Main Show, but I never succeeded in sniffing them out.

Standing up for Mexico this time around, Mike Bergmann of *Galena Rock Shop* (312 South Main St., Galena, IL 61036) had specimens from the new **wulfenite** strike made in January at La Aurora mine, Chihuahua. Chinese-orpiment-orange although duller-lustered, the crystals are 7 mm wide and thick, with square terminations, and reach 3 cm long. They rest lightly on limonite gossan matrixes of all sizes; Mike had five flats of specimens, although he brought only one miniature and one cabinet specimen to Tucson, the latter a striking 10-cm piece. Also, the San Martin mine, Sombrerete, Zacatecas, has lately turned out some excellent twinned, translucent, white **calcite** crystals, highly lustrous scalenohedrons with prominent twinning re-entrant angles around the waists; crystals are up to 4.5 cm, and Mike had a fine glistening matrix specimen (6 cm) for $25.

Jordi Fabre of *Fabre Minerals* (Arc de Sant Marti 79 Local, 08032 Barcelona, Spain) has a line on an occurrence of octahedral *crystals* of **chromite** from the great chromium mine at Moa, Oriente Province, Cuba. Face it, they're not beautiful; the best on hand at Jordi's was a 7-mm crystal with fairly smooth faces and high luster, bright black, but embedded in a dense pyrite/pyrrhotite/massive chromite ore lump. Nevertheless, any visible crystals of chromite are quite extraordinary, and Jordi might well look further into specimen possibilities here.

Enargite from Peru is familiar enough, but around the turn of the year the Julcani mine, Huancavelica, produced some impressive large crystal clusters with "different" aesthetics: flattish matrix plates of massive enargite from which rise solid pocket linings of very sharp crystals to 2 cm long and 1 cm across. And instead of showing a simple metallic black aspect on the prism faces, most of these crystals are partially coated with a bronze-colored film (possibly chalcopyrite). Except for the radically different morphology, these suggest the old chalcopyrite-coated tetrahedrites from Cornwall. Mike Bergmann (again) had about 20 specimens, average size about 10 x 10 cm.

The beautiful and frustratingly rare **phosphophyllite** from Potosi, Bolivia, has for a long time been a What's-Old classic, but at Tucson this year collectors did have some chance to acquire at least a respectable small thumbnail. It seems that Peter Bancroft has released a couple of dozen loose crystals that he acquired in the 1950's in Bolivia (see relevant chapter in his *Gem and Crystal Treasures*), and these, via Bill Larson, made it into a few Executive Inn rooms, most notably that of Wayne Thompson, who had about a dozen. The phosphophyllite crystals are loose, very pale bluish green, transparent and lustrous, and uniformly around 1 to 1.5 cm. Most are twinned and most, unfortunately, have significant contact deformities. Only one specimen at Wayne's (@ $1100) was a "full" thumbnail, a pretty 1.5 x 2 x 2.5 cm pale sea-green cluster.

Wayne Thompson would also like to tell you about his 20 or so loose (basally cleaved) **topaz** crystals from the Ouro Preto area, Minas Gerais, Brazil. They are gemmy, and resemble the orange "imperial" topazes from the same region except that their color is *purple*, actually a sort of medium-magenta. Ouro Preto topaz of this color was not unknown before but is certainly a rarity (see p. 33 of the recent Topaz Issue, January–February 1995).

As I've mentioned, Brazil seems to have stayed relatively quite during this year just past. But there is some new **bertrandite** from the Golconda mine, Governador Valadares, Minas Gerais—source of the great multi-centimeter white-stilbite-like crystals of the 1993 Tucson Show. What is now being produced is nothing like that, but is simply pretty: druses of glistening white to colorless transparent crystals on matrix in mostly miniature sizes. The druses sometimes make thin casts after now-gone crystals of something, or make little boxwork formations; black spots of manganese oxides decorate them. Carlos Barbosa (Rua Coronel Roberto Soares Ferreira, 586 Cep. 35030-590, Governador Valadares, Brazil) offered several pieces, one of them a 15 x 20-cm plate.

We are not finished with the Golconda mine; at the Main Show, Frank and Wendy Melanson of *Hawthorneden* (L'Amable, Ontario, Canada K0L 2L0) offered a couple of flats' worth of thumbnail specimens of a snazzy bicolored **apatite** from this same place. The colors range from a dark bluish green to a rich "royal" purple (royal enough to raise eyebrows in Maine). The crystals are simple hexagonal tablets to 5 mm; the habit is as stacks and flaring clusters of lustrous, partly gemmy, brilliant crystals, sometimes with a bit of quartz. The most appealing thumbnails are the ones in which half the crystals are blue-green and half are purple. At only around $75 for a very vivid little specimen, these apatites were among the best buys of the show. Then *further* the Melansons had, *also* from the Golconda mine but from a find about 9 years back, **apatites** which couldn't be less like the new bicolors: very pale pink, long and thin, striated prisms devoid of associations but sometimes in columnar or subparallel groups of two or three. It's pretty peculiar to see two such utterly dissimilar-looking occurrences of the same species in the same mine—but there they were. To top off their fine array of Brazilian specimens they had *three* huge blue-stripe **euclase** crystals from Equador, Rio Grande do Norte, in blocky sizes up to about 3.5 cm.

Before leaving the Melansons and Brazil, one had to admire also the new **brazilianite**, represented by specimens also all thumbnail-size, from a strike last fall in a prospect near Linópolis, Minas Gerais. The crystals are fairly long prisms with wedge-shaped terminations (often on both ends), part-gemmy, and pale to medium yellow. Paler and longer than the old brazilianites, they nevertheless share the familiar, very aesthetic associations of muscovite books and occasional quartz. These too were bargains: a top one of the 75 or so pieces available ran you around $40.

A foreign dealer who shone with material from his native region was Peter Lyckberg (Box 25147, S-40031 Göteborg, Sweden). First, Peter had the best batch I've yet seen—best in both quantity and quality—of the distinctive **calcites** which have been trickling out of Kjörholt, Langesundsfjord, Norway, these past few years. The transparent, smoky, greenish gray prisms with wide, low-angle trigonal terminations show an earlier generation of growth as phantoms inside, and these are of a scalenohedral habit different from the end-product crystal. Looking into a side face, one sees a phantom outline which tapers to a point just under the terminal faces; and in the clearest crystals a smaller, innermost scalenohedron phantom lies inside the larger one. Sometimes these phantoms are dusted with tiny, oriented pyrite crystals that sparkle and flash as the crystal is turned. Most specimens are thumbnail crystals cleaved at the bases, but there are also some lovely parallel clusters to 3 cm on matrixes to 8 cm.

Think (further) of Norway and you'll probably think of those very sharp, steely blue-black bipyramidal **anatase** crystals from Hardangervidda, on and in quartz crystals. Well, there were a few excellent thumbnails of this material for sale in Peter's room, but the real scoop was a loose, incomplete (and repaired) anatase bipyramid that Peter kept in a bedside drawer. What's so special about it is that it's 5.6 cm long . . . many years ago Bob Sullivan, in his "Letter From Europe," mused in a couple of columns about what the world's record-size anatase may be, and now we have a winner.

Finally, from a new locality at Kalliosalo, Seinäjoki, Österbotteus Län, Finland, some interesting native **antimony** has recently been dug from a hydrothermal vein in a hard porphyry, with quartz and micro-sized **aurostibite** crystals. The element comes as very lustrous tin-white, solid masses; sadly, there are no crystals, but there are frequent very smooth cleavage planes (think of the old native bismuth masses from Ontario and Australia). Specimens here were available in most sizes, the biggest one being a platy mass about 15 cm across.

Britishers Lindsay and Patricia Greenbank of *Secured Minerals* (no wonder I didn't recognize the name; this is the first time the dealership has appeared in Tucson . . . Fax 539-734761) brought something new from someplace old in England. A crosscut between the High Raise and Treloar veins of the Nentsberry Haggs mine, Northumberland, was first worked in the 1930's by Sir Arthur Russell, who took out several fine specimens of **witherite** and **calcite** pseudomorphs after same. Following Russell's work the pocket zone remained untouched until three years ago, when these new specimens were taken out. Simple, squat, slightly convex 2 to 2.5-cm hexagonal prisms, sharp and opaque chalky white, sit aesthetically in greenish white matrix or form groups of two or three lightly intergrown individuals. Lindsay had only a handful of these, in thumbnail and miniature sizes, but says that about 40 specimens were dug in all. They appear never to be pure witherite, but their weight attests that the pseudomorphism to calcite is never complete, either. A good thumbnail could be had for around $65. And the occurrence is reportedly *really* finished this time. Oh yes, and in 1992 Mike Wood had a good day at the old Brownley Hill mine, Nenthead, Cumbria, collecting glassy, pale pink sprays to 5 mm of the rare species **alstonite**; these sprays lie flat in open seams in sandstone; six thumbnails and one miniature were available in the *Secured Minerals* room.

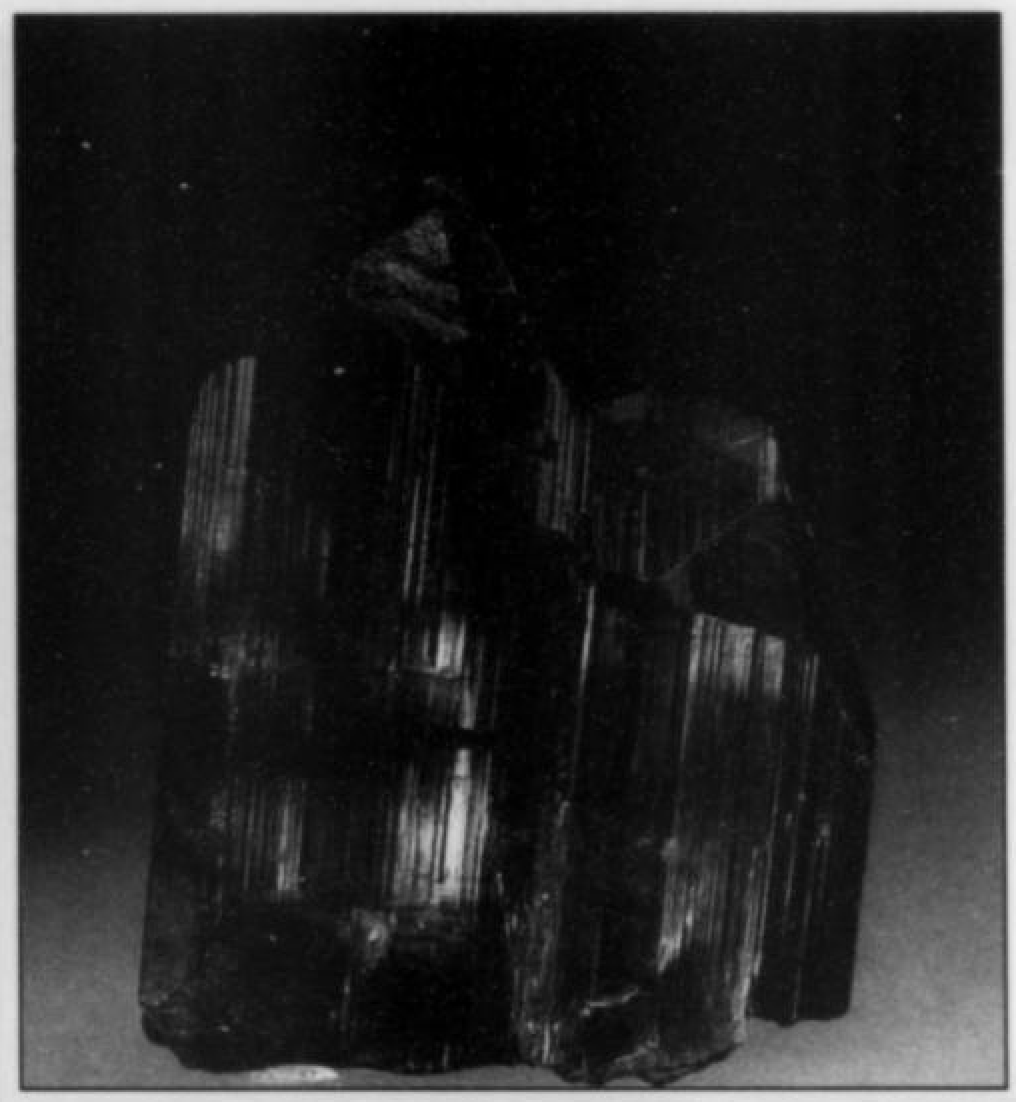

Figure 20. Zoisite ("tanzanite") crystal, 2.1 cm, from the Merelani Hills near Arusha, Tanzania. Cal Graeber specimen.

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Figure 18. Diopside crystal, 4.5 cm, from the Merelani Hills near Arusha, Tanzania. Cal Graeber specimen now in the Gene Meieran collection; Jeff Scovil photo.

Figure 19. Hematite crystals to 2.8 cm, from Arzaneh Island, United Arab Emirates. Keith Williams specimen; Jeff Scovil photo.

Figure 21. Corundum ("sapphire") crystals, 3.2 cm and 2.5 cm, from Galbkka, near Vallivaya, Uva Province, Sri Lanka. Gem-Fare and Mountain Minerals International specimens, respectively.

Figure 22. Kovdorskite crystal, 2 cm, from the Zheleznyi mine, Kovdor, Kola Peninsula, Russia. Rene Trieble (*Top Minerals*) specimen.

Figure 23. Cinnabar twin crystal group, 1.4 cm, from the No. 2 Bis mine, 450-meter level, Nikitova district, Donetsk oblast', Russia. *Heliodor* specimen.

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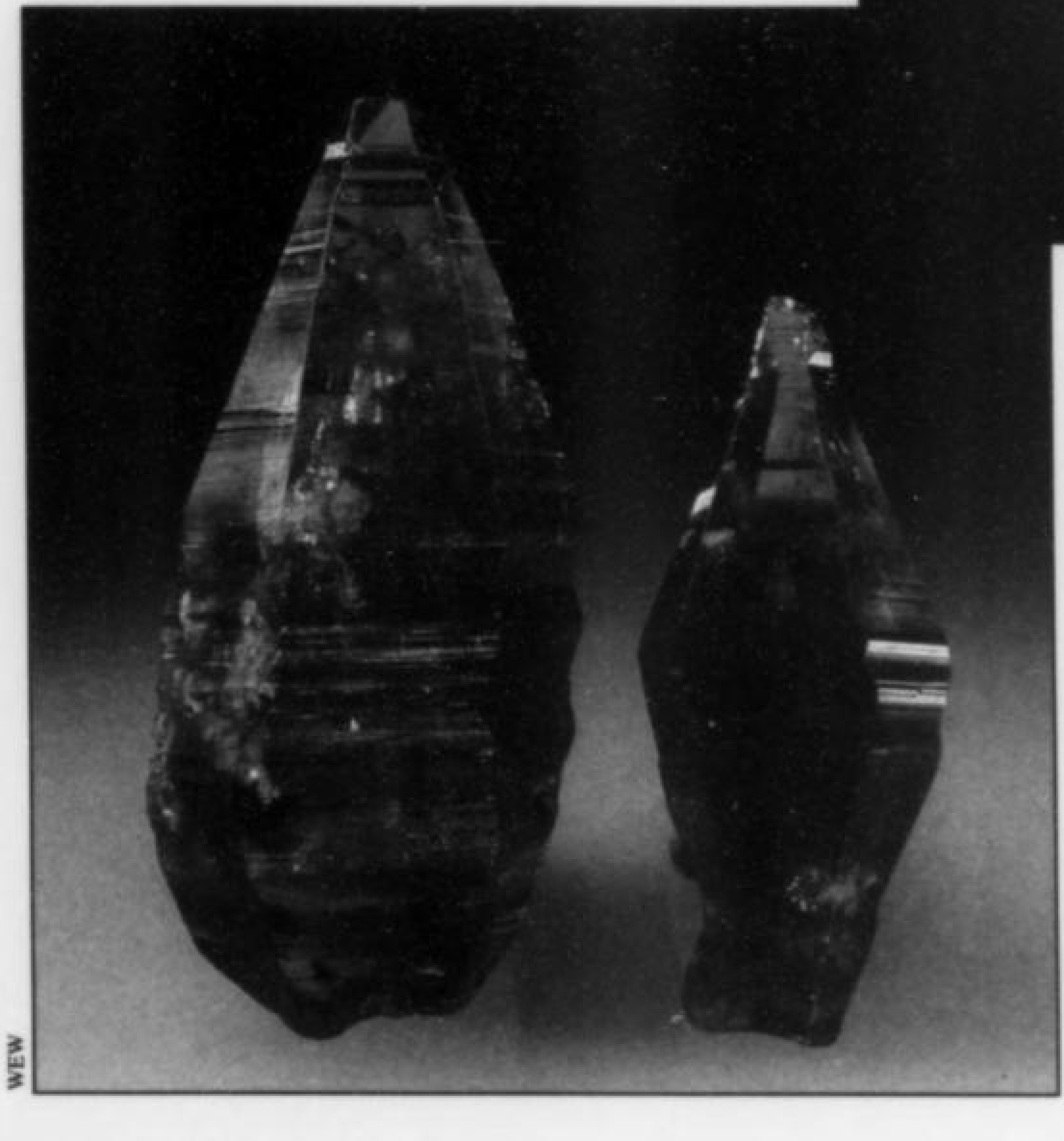

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Figure 24. **Beryl ("aquamarine") crystal (2.7 cm), with a feldspar Baveno twin, on matrix, from the Huya mine, Sichuan province, China. East-West Development Inc. specimen.**

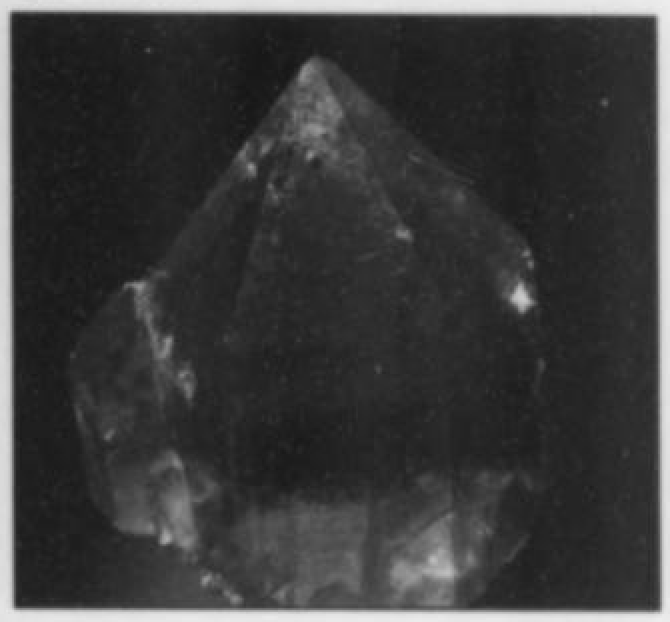

Figure 25. **Quartz crystal, 3.2 cm, from China. Wydar Company specimen; Jeff Scovil photo.**

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Figure 26. **Gene and Roz Meieran's display, winner of the Desautels Award at the Tucson Gem and Mineral Show.**

Figure 27. **The extraordinary case of quartz specimens assembled by Jim Bleess, from specimens taken on loan from many prominent private collections and museums.**

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In Munich last fall a Spanish dealer had a tablefull of **pyromorphite** from a new Spanish source, the Resuperferolitica mine 522, Santa Eufehia, Cordoba. The best few pieces came to Tucson with *George Witters Minerals* (Cincinnati, OH: tel. 513-272-0631). The color is a sort of soft greenish tan, with a silky/vitreous luster such that these do not really suggest any standard pyromorphites I can think of. Crystals are highly cavernous and reach 1.5 cm; they occur in intergrown branching groups of matrixless specimens. Although future supplies are impossible to prognosticate, the 5 and 10-cm pieces I saw at the Main Show are fine indeed.

Occasionally in this space I have mentioned seeing nice orange **calcite** specimens from Hainault Province, Belgium; I now know that the occurrence is in a big limestone quarry, active for years and still so, where the odd isolated pocket is hit. It seems that Gilbert Gauthier (7 avenue Alexandre III, 78600 Maisons-Laffitte, France) just bought up a collection built over many years, which provided him with some 30 top specimens to bring to the Main Show this year. They are thumbnails and miniatures, mostly single, complete or almost complete crystals, most of them perched smartly on small bits of brown matrix. Of different combinations of scalenohedron and rhomb, they are transparent, gemmy, of a gorgeous medium-orange color, and very bright—*major* calcite specimens for their size, and probably the ultimate from (specific locality coming up) Pont a Nole, Mont-sur-Marchien, Hainault, Belgium.

One of the dealers in the Executive Inn to whom I always make an early beeline is Michel Jouty (231 Route des Nants, 74400 Chamonix, France), who seldom disappoints. This time he had about a dozen good-to-fine thumbnails of the rare mineral **cafarsite**, for which the locality (depending on which side of the mountain one collects from) is either Cherbadung, Valais, Switzerland or Cervandone (same mountain), Val d'Ossola, Italy. Virgin cafarsite crystals are simple brown cubes or cuboctahedrons to 1 cm; some, though, are stained a pale earthy green by agardite. The matrix is a sparkly salt-and-pepper fine-grained gneiss. I have seen this material before, especially in Europe, but these specimens of Michel's were taken out just last summer.

Tourists who visit Paris should not miss the beautiful 18th-century house frontages and fragrant food shops of the Ile St-Louis, and *mineral* people must not pass by the shop there of *Alain Carion* (92, Rue St-Louis en l'Ile, Paris, France). Of all mineral shops, his is perhaps the one in the classiest neighborhood. Alain surprised me at the Main Show this year with four flats of crisply dark brown, very handsome pseudomorph clusters of **hematite after marcasite**, collected by himself recently in a limestone outcrop in the White Desert, Egypt. Mindful of the similarly mahogany-colored Pelican Point, Utah, goethite pseudomorphs after pyrite, as well as of the White Desert things that are always labeled "goethite after pyrite," also dark brown, I questioned the identity of the replacing species. But Alain affirms that indeed it has tested out as hematite. Be that as it may, these are roughly spherical or football-shaped floater groups to 12 cm across, with individual, typically stepped-wedge or coxcomb-shaped marcasite forms to 2 cm. These are hard, solid, smoothly subvitreous, very good pseudomorph specimens for around $150 for the best.

And now, as they say, for something entirely different: some nice Namibian material from the dealership of *Johnston and Johnston* (142 Rustic Hills Trail, Royal, AR 71968), whose room I came across in the Pueblo Inn. First, from West Brandberg, Namibia, excellent phantom **amethyst and smoky quartz** comes in shiny prisms to 8 cm, some loose, some in a hard gray-green matrix. Some phantom crystals are also the caps on scepters, and some non-phantom examples are wispily zoned in smoky and amethyst shades. There were about 50 specimens in all sizes. Also from West Brandberg the Johnstons had a surprising few specimens of fair but promising, opaque, glassy, greenish brown **vesuvianite** in square prisms to 4 cm and in jumbled masses of parallel groups, with white quartz, up to large cabinet sizes. These were first found 90 days prior to the show.

But the nicest surprise in this room was a couple of flats' worth of thumbnails and miniatures of the prettiest globular **prehnite** I have yet seen from Namibia. The locality is a near-surface outcrop on the side of a hill called Kudikop in south-central Namibia, with the closest town (at a distance about like, say, New York to Boston) being Keetmanshoop. This place is now being very actively worked for specimens, and no wonder: the prehnite is a clean, pale green, translucent enough to make for a sort of soft opalescence in some specimens, and can come in perfect little fungoidal spheres to about 2 cm. Unlike the prehnite spheres from Virginia and from France, these lack any encircling equatorial ridges of associated species, like chlorite. They are as simply as pristinely spherical as anything can be. In the miniatures, the spheres are intergrown to make reniform groups, which are no less beautiful for all that. A wonderfully weird little thumbnail could be had here for about $15.

I must mention here a one-of-a-kinder of terrific gem interest, from Merelani, Tanzania—the tanzanite place. *Cal Graeber* (P.O. Box 2347, Fallbrook, CA 92088) had an astonishingly sharp and glassy-lustered 4.5-cm **diopside** crystal which is not only a lovely lime-green, but is entirely transparent and gemmy throughout. This crystal puts all gem-grade diopside from China and from DeKalb, New York, in several umbras of shade. Just before the show opened it was sold to Gene Meieran, who already owned a somewhat larger but merely translucent crystal from the same locality. Having a showcase label already made up, Gene made the last-minute switch in his exhibit so that everyone could have a look.

As if this weren't enough in the way of shocking gem crystals, Cal also had a mind-boggling sapphire **corundum** crystal 5 or 6 cm long from Ceylon. Held up to the light it shows a wild, complex pattern of gemmy red, white and blue!

Jose Vincente Rodriguez Rosa of the dealership *Geofil* (Alto da Bela Vista 2-A, 2750 Cascais, Portugal) had an interesting little suite of rare-earth oxide minerals collected 30 years ago from the rare-earth pegmatites of the province of Zambezia in northern Mozambique. At the Muiane mine, rough, grayish green dodecahedrons of **microlite** to 3.5 cm occur as loose crystals, some with small bits of muscovite and/or pinkish massive elbaite; they are not pretty but are giant crystals for this species. Other, browner microlites (some grading from medium-brown to yellow-orange) come from the Munhamola mine in the same province, and Jose had about ten loose, subhedral thumbnail crystals of these. Very good, sharp, blocky **manganotantalite** crystals, dark brown with a rutile-red surface glaze, came from Naijia and Murrua, Alto Ligonha, Zambezia, and Mozambique. There was a further small swarm of thumbnails and miniatures of these, and one amazing, blocky 14-cm loose crystal (*still* sharp). From Maridge, Alto Ligonha, comes **stibiotantalite** in small (averaging 1.5-cm) crystals, but very sharp, of a yellow-brown color with some gemmy areas. And then there are the five good loose prisms of deep pink, part-gemmy **elbaite** given as simply from Alto Ligonha—quite clean, with trigonal terminations and some adhering bits of white clay, from 4 to 12 cm long. Some large gemmy masses of medium-pink morganite **beryl** were also available from Alto Ligonha. This is a once-famous pegmatite region not heard from too often anymore (these are old specimens). But at least they demonstrate what we may hope for should someone with a sledge visit this part of Mozambique again.

South African *Clive Queit* (P.O. Box 1014, Fourways 2055, Sandton near Johannesburg, South Africa) presides each year at his stand in the downstairs ballroom off the bar/restaurant in the

Executive Inn. There was no new main-line-species stuff here from Tsumeb, N'Chwaning or Wessels this time. But beautiful and exotic were Clive's 15 thumbnails and two miniatures of the species **poldervaartite**, a hydrous Ca-Mn-silicate described in 1993. A single, attractive pocket of this material was found at the Wessels mine, Kalahari manganese field, in 1995 (see p. 231 of the new book *Minerals of South Africa,* by Bruce Cairncross and Roger Dixon; in fact, see the book in any case—it is a good one). Poldervaartite from this pocket comes as glassy, pale orange-pink, 1-cm crystal sprays. Occasionally there are individual crystals which can be seen to be pinched in the middle and thus resemble stilbite bowties. The mineral fluoresces deep red under shortwave ultraviolet light, and is quite pretty (especially for a new species) under any light.

At the Main Show, Keith and Brenda Williams of *Williams Minerals* (RR1 Box 77, Rio, WV 26755) had an odd story to tell involving a mineral discovery in, believe it or not, the United Arab Emirates, along the south coast of the Persian Gulf. Well, actually it was Arzaneh Island *in* the Gulf, politically part of the UAE, where, in 1978/79 an American engineer reportedly collected about 1000 specimens of **hematite**, probably from a volcanic rock; there are no matrix specimens, the crystals having been found as float. They are all single loose hematite crystals, from less than 1 cm up to 3 cm, black, of medium luster, and slightly rough. What's interesting are the forms: some are rounded, barrelly hexagonal prisms with prominent basal faces (think of corundum), while some are simply elongated rhombohedrons, and a few, most remarkably, are perfect little calcite-like scalenohedrons. The Williams folks had perhaps 25 loose thumbnails plus some 15 "macros." No further collecting has taken place on Arzaneh Island since the late 1970's, as travel there by westerners is difficult both physically and politically, but Keith and Brenda are presently working on ways to get in again.

The general story from Russia this year is rather bleak. One can't know whether the paucity of new Russian material is just a blip, or the start of a downward trend, but anyway it was a fact at Tucson, despite the many now "old" things, e.g. Puiyva mine **ferroaxinite**, Dal'negorsk **calcite and sulfides**, and Slyudyanka blue **apatite**, which continued to be abundant. Even the Van Scrivers' dealership *Heliodor* (P.O. Box 10, 199 00 Praha 9, Czech Republic) seems to be on a break in the What's-New department. Give Brad and Star and their Eastern colleagues a kudo, though, for the *further* improvement in size and quality of their **smoky quartz** specimens, including **gwindels**, from the Puiyva and Dodo mines, for some likewise fine, much darker **smoky quartz** crystals to 35 cm high from Akchatau, Dzezkazgan Oblast, Kazakhstan, and much good **dioptase** from Altyn Tyube, Kazakhstan.

Heliodor also had a large selection of small cinnabar crystal groups from the #2 Bis mine, 450 meter level, Nikitova district, Donetsk Oblast', in eastern Ukraine. These are in that awkward size range which is a bit too small for a thumbnail but rather large for a micromount. Nevertheless, the little groups of sharp, brilliant penetration twins reach well over 1 cm, with individual twins to 6 or 7 mm, generally without matrix. Except for size, these crystals are just as interesting and well-formed as their Chinese brethren.

Heliodor also had the largest selection to date of platinum crystals from Konder, near Nel'kan, Russia. Well over 30 nice specimens were available, all of them in the 8 to 12 mm range but some showing cubic penetration twins and others consisting simply of singles. A few show partial coatings of native gold. Most are just a little waterworn along the edges, but a small number show good sharpness. They are a bit pricey for the average thumbnail collector, but they are mineralogically unique in that decent macro crystals of the species were virtually unknown prior to this find. I also like them because they are so remarkably un-fragile. You could probably throw one on the floor and step on it without causing noticeable damage; in fact, your house could burn down around it and it would probably be the only specimen from your collection to survive (melting point 1,769° C). It will not oxidize in air, at any temperature, and is insoluble in everything except *aqua regia*. If only wulfenite were as tough!

The Czech dealership which goes by its initials, K.A.R.P., is usually known simply as "the guys from KARP," who specialize in Russian minerals. Actually the letters stand for Kladenska Asociace Rozbíječů Pelosideritů ("Kladno Association for the Breaking Open of Septarian Nodules"). (I had to ask.) Anyway, they had a room at the Executive Inn this year, and also sold out of Rob Sielecki's *Ausrox* booth at the main show. Among their wares were a few more **sperrylites** from the Talnakh orefield, Noril'sk, Siberia, in crystals to 1 cm partially imbedded in chalcopyrite/bornite ore. According to Bryan Lees, the deposit hosting the sperrylite is 80% to 90% worked out, so the supply of the crystals, which are rare even now, may soon come to a complete end.

Jaroslav Hyrsl (Heverova 222, 280 00 Kolin 4, Czech Republic) did show me a new development from the Sarany, Urals, locality for **uvarovite** on chromite (these microcrystalline specimens also continue abundant, by the way). The new examples show shallow open seams in massive black chromite with good, sharp, dark green **clinochlore** crystals to 1 cm in solid coatings. Moreover, there is an alexandrite effect in these clinochlores: deep green in sunlight to translucent purple under a pocket flashlight. **Chromian clinochlore** trying hard to be kämmererite also is found here in tiny columnar crystals in solid vein fillings (we think of the similar efforts of the same species at the old Wood's mine in Pennsylvania). Jaroslav had a handful of miniature to cabinet-sized black matrixes with these green and/or purplish clinochlore seams.

Rene Triebl of *Top Minerals International* (c/o Rudolf Hawel, Gasse 21, A-2700 Wiener Neustadt, Austria) had the last of only four large (2 to 2.5 cm), blue **kovdorskite** crystals found in the Zheleznyi mine, Kovdor, western Kola Peninsula two years ago. One of the four is now in the Keith Hammond collection (pictured in vol. 26, p. 144), one is in the Alexander Schauss collection (exhibited at the Tucson Show this year), and one (pictured here) was sold during the show to a Tucson collector. The locality has yielded other kovdorskite specimens, some on matrix, but they all tend to be yellowish pink or white to extremely pale blue, and are usually in sheaf-like bunches instead of sharp individuals. The habit of the best blue crystals is lustrous and chisel-like, but they lack matrix.

From the ex-Soviet "near abroad" country of Tajikistan, specifically from Zelatoya Voda, near Rangkul, east of Murgab, fine gemmy crystals of heliodor **beryl** continue to come—see my last Springfield report. Rob Lavinsky of *The Arkenstone* (6163 Lakewood St., San Diego, CA 92121) had a glass casefull of loose thumbnail crystals and some large, white pegmatite matrix specimens on which the heliodor crystals stood out and up nicely. The best crystals, on or off matrix, are wholly gemmy, pale to medium yellow, simple hexagonal prisms to 3 cm; some have included elbaite, clear topaz, and possibly apatite.

The high Himalayas of the Afghanistan/Pakistan border region were quite prolific at Tucson this time. For one thing, the quality of the vivid red **ruby corundum** crystals from Jegdalek, Kabul Province, Afghanistan, has taken something of a quantum leap upwards: the town of Jegdalek has been destroyed by guerrilla fighting involving the Mujahedin, but this didn't stop some dealers (notably Dudley Blauwet of *Mountain Minerals International*, Louisville, CO 80027-0302) from having some very well formed, brilliant red ruby crystals, at least part-gemmy, to 2 cm on white marble matrix, these standouts apparently found in October/November 1995.

And then there is François Lietard of *Minerive* (Au Bourg, 42800 Tartaras, France), who had a stunning number and quality-level of **olivine** ("peridot") crystals from Suppat, Kohistan, Pakistan. His stock ranged from a whole flat of nice, only slightly frosted and slightly rounded loose thumbnail crystals for $25 each, to a great 5 x 7 x 8-cm group of three huge, glowing green, wedgy forms. Indeed, although François still leads in the peridot derby, there is now a quite amazing abundance of these crystals; probably 30 dealers I saw had specimens that five years ago you'd have picked up bug-eyed. By the way, Andreas Weerth (see momentarily) was the only peridot-bearing dealer to have matrix peridot specimens showing also good sharp black **magnetite** dodecahedrons to 2.5 cm across (with the chalky white altered-serpentine substance that sometimes enfolds the peridot bases).

From Pech, Kunar Valley, Afghanistan (we are back at François Lietard's stand again) comes another new association: **aquamarine beryl** crystals with pale gray-purple, lustrous hexagonal prisms of **apatite** to 3 cm long. The apatites are tightly intergrown and too flawed internally to be gemmy, but they look good with the aquamarines on the silvery muscovite books on the white pegmatite matrix chunks to 15 cm. Further, François had some dark brown-black pieces of **samarskite** from Kohistan, Afghanistan, about 20 of them, with perhaps half the surfaces on a typical specimen broken (and showing a conchoidal fracture to confess to metamictism), the other half showing sharp crystal faces, including terminations, to 2 or 3 cm wide. These heavy, blocky specimens, some of which have adhering white feldspar, range in size from 3 to 7 cm.

Andreas Weerth (Hochfeldstr. 37, D-83684 Tegernsee, Germany) specialized, at his stand at the Main Show, in one-of-a-kinders from the Himalayas. The most surprising to me of these was a very well crystallized **rose quartz** specimen from the Shigar Valley, Pakistan: a 3.5-cm circular flower-like cluster of good medium-pink, medium-luster rose quartz crystals to 1.5 cm individually, sitting up on a 3.5 x 6-cm matrix of pegmatite with a coating of muscovite books. This would be a very nice piece from Brazil, but is as far as I know (or Andreas knows) a first for *this* pegmatite region. Finally, and also from the Shigar Valley, Andreas had some flattish miniature-sized feldspar matrixes coated with drusy quartz, with very sharp, glassy, translucent white **hambergite** crystals to 1 cm strewn about on them.

Mike Bergmann (see under Mexico and Peru) was extremely proud, not only of his fine selection of the new, brilliant, increasingly damage-free **stibnite** crystals from the Lushi mine, Hunan Province, China, but also, even more so, of the **barite** which now seems to come occasionally, Romanian-style, with the stibnite. The lustrous, translucent crystals are colorless to smoky gray, thick and blocky and up to 6 cm wide; about 50 pieces with varying amounts of stibnite shot through the barite were available here. Observe, too, the **emeralds** in mica schist from Wenshan, Yunnan Province, which Mike and a few other dealers, including some Chinese dealers, had. They are non-gemmy but fairly sharp, long and thin, in groups lying flat on and in matrix, with individual emerald crystals to 15 cm long.

At last, to conclude . . . Martin Rosser of *Willyama Earth History Supplies* (6 Banksia Cres., Wagga Wagga 2650 NSW, Australia) offered samplings from a fine new pocket of **crocoite** which was hit just this January at the Adelaide mine, Dundas, Tasmania, by crocoite king Frank Mihajlowits. About 500 pieces in all were recovered, and here were a couple of flats' worth, plus five superlative miniatures. They have not been acid-etched out of enclosing gibbsite for the very good reason that they were not so enclosed. Slender, hoppered and hollow crocoite prisms to 4 cm form the usual delicate groups, and the red-orange color is extremely bright and fresh.

The display cases at the Main Show were particularly wonderful this year, especially if you like calcite and fluorescent minerals. In the "general" calcite cases there were specimens of (it seemed) every thinkable calcite color and form, and keeping every company of associations, and hailing from every significant locality. Among the presenters were the Sorbonne, the French National Museum, the Smithsonian, Terry Huizing, Bill and Carol Smith, Gene and Roz Meieran, and Mary Miller. The exhibitor whom I'd call the champion in this category was Victor Yount, with 55 tremendous pieces.

The cases devoted to calcites from single mines, mining districts, or states were likewise very instructive. These included (the bare list will have to do in place of the thousands of images that I wish I could transfer somehow) Pennsylvania calcites (Bryon Brookmyer); the Brushy Creek mine, Reynolds County, Missouri (New Mexico Museum of Natural History and Science); the Elmwood mine, Tennessee (Gaylord's Tennessee Minerals); Malmberget, Sweden (Peter Lyckberg); St. Andreasberg, Harz, Germany (Kay Robertson); and, we have a vote for a "winner" again, a huge case called "Copper Country Calcites," with some beautiful copper-enclosing crystals to 25 cm long on some specimens (the Seaman Museum of Michigan Technological University). Also, the cases devoted to overviews of the minerals of Guanajuato, Mexico (Chris and Elvia Tredwell) and Dal'negorsk, Russia (the Carnegie Museum) featured, inevitably, magnificent calcites from these places.

In the long, long row of exhibit cases there was also plenty of life after calcite. Jim Bleess did an inspired job of co-ordinating a quartz case, packed with monumental specimens of all sizes (yes, thumbnails too can be "monumental," e.g. the hematite-dusted Cumbria, England, quartz in this case), these loaned by about thirty private collectors and institutions. No, I can't pause to rhapsodize also over the giant, richest purple Sweden, Maine, amethyst in the same case, but must move on to salute the cases of quartz from the Fat Jack mine, Crown King, Arizona (Gary and Nancy Spraggins); thumbnails from Australia (Sharon Cisneros); German classics, with Eberhard Equit paintings (Peter Langsdorf and Dr. B. Schumacher); The Tourmaline Group (Jesse Fisher and Joan Kureczka); and superb tanzanite crystals in a range of colors (Bill Larson).

A very helpful idea materialized in the "Hidden Treasures" case of the American Museum of Natural History: here were about 20 great specimens *not* on public display in New York, or at least not widely seen since having been "circulated" back into storage some years ago. These included some incredible oldies from the Bement collection, such as a lustrous 8-cm spessartine in matrix from Springfield, Pennsylvania; a "killer" Cornwall bornite miniature; and the towering Japanese stibnite pictured in the *Record* article on the Bement collection (vol. 21, p. 52).

In a corner of the show hall was the dark, narrow entrance to the fluorescent minerals display mounted by the Tucson Gem and Mineral Society; children's voices twittered with excitement around this entrance and from inside, but I somehow expected only a perfunctory case or two along a single short corridor. How unfairly cynical I was! The display turned out to be a full-fledged *museum* of fluorescence, a labyrinth of corridor after corridor, case after case, of wildly fluorescing minerals (only about half of them from Franklin, New Jersey) with clear, fluorescing labels. The hundreds and hundreds of specimens were of all sizes and fluorescent colors, and some of them looked as if they'd even be impressive in natural light; but I didn't care that I couldn't see them that way, so glorious were the glowing colors and so impressive was the sheer size of the whole presentation. This must surely have been *the* finest fluorescent display ever mounted anywhere.

That's probably enough about displays. But, hey, how *about* that natural-sized gatling gun carved in lapis and rock crystal by Wilfried Friedrich, which took that defensive position all alone in its case?

At the Saturday night awards ceremonies, Terry Wallace gave a (deliberately) preposterous slide presentation called "The Mineral Year in Review," and then things got down to serious awarding. The competitive-calcite-specimen winners in thumbnail, miniature, small cabinet and large cabinet sizes respectably were Carolyn Manchester, Terry Huizing, Terry Huizing, and Peter Lyckberg. The Friends of Mineralogy award for best article in the *Mineralogical Record* during the preceding year went to Michael Menzies for his "The Mineralogy of Topaz," in the special Topaz Issue. The Lidstrom Trophy for best competitor-entered specimen went to Gene Meieran, and the Desautels Trophy for best case went to Gene and Roz Meieran. Finally, the Carnegie Mineralogical Award for outstanding contributions to mineralogy went to Marie Huizing, Managing Editor of *Rocks and Minerals* magazine, who charmed all with her ingratiating acceptance speech. It was a big night, in short, for Marie and Terry Huizing, whose four children and two children-in-law were present for the occasion, and got to see Mom cry in front of about two hundred people.

"Well," as a radio disk jockey called Charlie Tuna used to say, "that's going to have to can it for now." And we know what "for now" means here, don't we? It means . . . until Denver.

Tirniauz Quartz *(continued from p. 206)*

In the light of experimental evidence the following genetic explanation can be offered. First a thin, slender prismatic crystal grew which now is the main individual. The edges of the prism were starting points for the crystallization of numerous other quartz individuals. Most of these secondary crystals show a preferential orientation the reason for which is not yet clear. The secondary crystals are oriented in such a way that the directions of their *c* axes are roughly parallel to one of the *a* axes of the central host individual and that one of their *a* axes is nearly parallel to the *c* axis of the central individual (Fig. 2). Therefore, in microsections perpendicular to the *c* axis of the main crystal it can often be observed that the secondary crystal growth started at an edge of the host individual in three main directions (see e.g. central part of Fig. 5d). However, the growth of most of these crystals was restrained in favor of the growth of a few crystals (Fig. 5a) which now are the centers of the radial quartz individuals.

According to cathodoluminescence investigations (Figs. 5b and 5d), crystallization of the framework of the aggregates (i.e., the first two steps of their formation) may have occurred from an undersaturated hydrothermal solution in a relatively slow, steady process. After a superficial decomposition of these first quartz generations (which was sometimes connected with a slight overcrusting by iron oxides), the aggregates continued to grow, in which the crystallographic orientation of every individual was preserved. Cathodoluminescence photographs of this newly formed quartz suggested that it originated from an oversaturated, gel or briny solution, at relatively low temperatures. During further crystallization of quartz, this solution must have been diluted and passed into an undersaturated state. In addition to the central host crystal, the outermost tops of the radial individuals occasionally show a short-lived greenish blue cathodoluminescence color which is characteristic of quartz formed from an undersaturated hydrothermal solution (compare e.g., Ramseyer, *et al.*, 1988; Ramseyer and Mullis, 1990).

The aggregation of quartz by growth of a second generation of crystals starting at the edges of an earlier central crystal suggests that the external forms of some cubic minerals (such as sal ammoniac or gold), which are very similar to that of quartz, need not necessarily be interpreted as crystallographically continuous skeletal growth. Possibly some of them are likewise formed by crystallization and growth beginning at the edges or corners of a central crystal. However, in the case of an isotropic mineral it is certainly more difficult to check experimentally whether the single individuals in those aggregates are crystallographically uniform or not, as compared to the aggregates described here. Perhaps the use of different luminescence methods will help to solve this problem.

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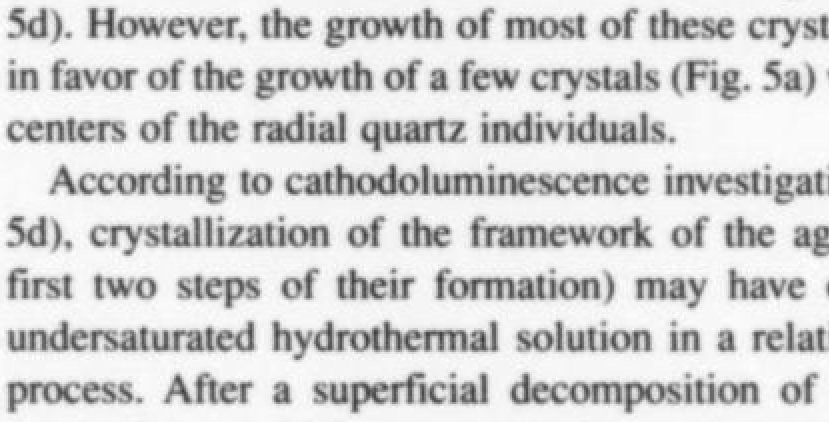

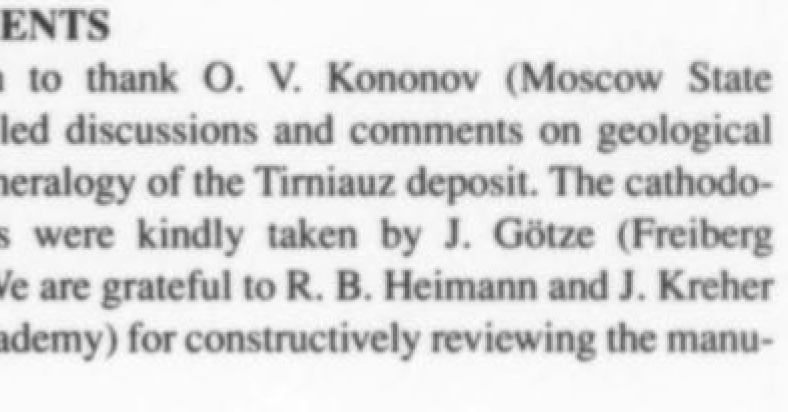

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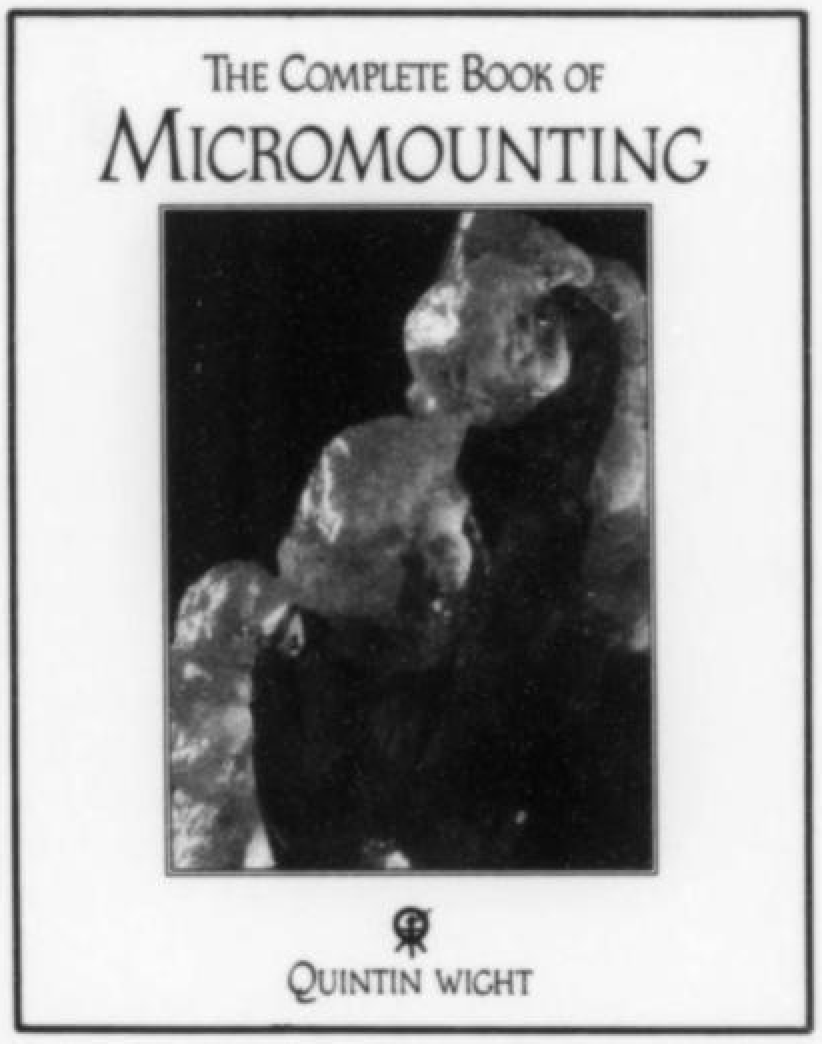

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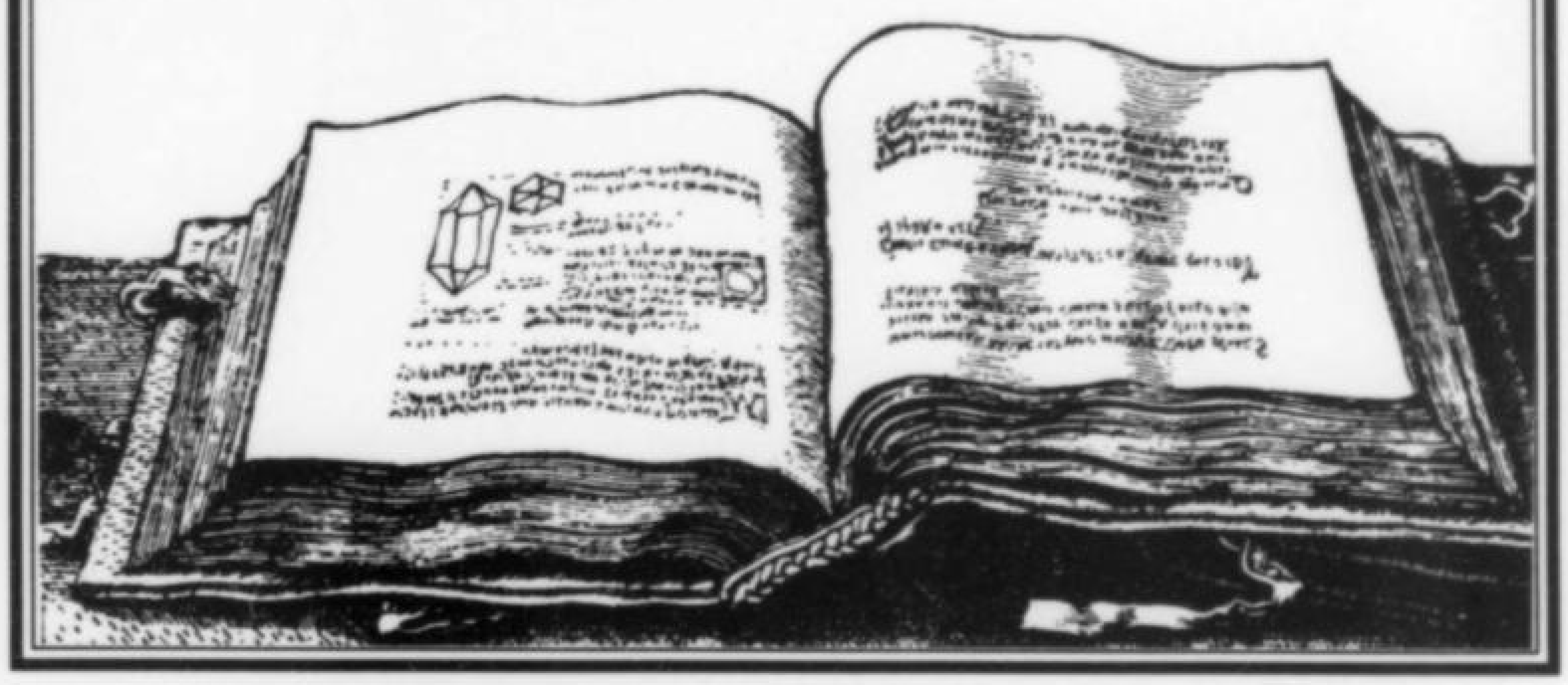
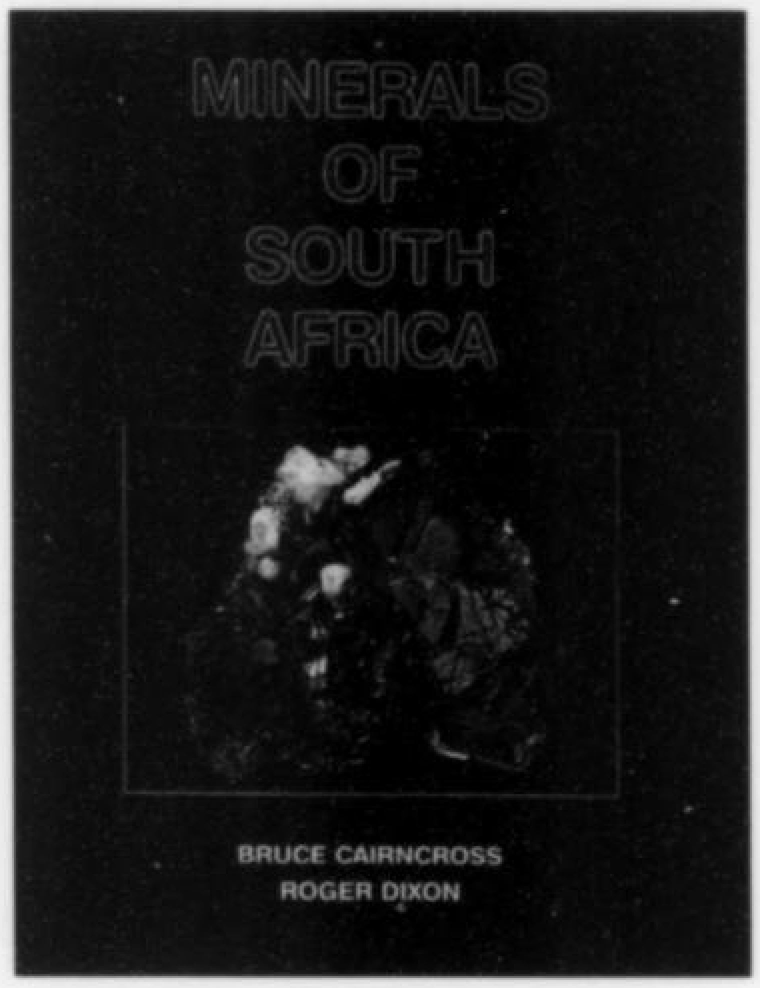




Minerals of South Africa

by Bruce Cairncross and Roger Dixon. Published (1995) by the Geological Society of South Africa, P.O. Box 44283, Linden 2104, Republic of South Africa. Hardcover, with dustjacket, 23 x 30 cm, 296 pages, US $115 plus shipping. Standard edition: ISBN 0-620-19324-7; Collector's edition (enquire about price and availability) ISBN 0-620-19325-5. Tel: 011-27-11-888-2288; Fax: 011-27-11-888-1632.

This monumental book (long-delayed due to production difficulties in Singapore), has been eagerly anticipated, especially by *Mineralogical Record* readers who placed orders in response to the publisher's ad back in the January-February 1995 issue. Furthermore, the special leatherbound edition was priced incorrectly in that ad at $200 due to a garbled fax transmission from South Africa; it should have said $300.

These annoyances can now be forgotten, because the book is finally here, and what a superb volume it is! The oversize page format (about 9 x 12 inches), combined with the use of color photography and colored maps and diagrams on almost every page, give the book an extravagant look. In fact, the retail price would surely have been far higher had it not been for the generosity of eleven corporate donors from the South African mining community. This is, in effect, a partially subsidized book, giving the buyer more than he pays for. (The most notable previous example of this was *The Minerals of Broken Hill*, 1982.)

Unlike most regional mineralogies, the main body of the book (178 pages) is arranged geologically so as to allow discussion of deposits in detail. The maps, site photos and text take pains to describe the geologic context of occurrences, and the role that rocks have played in the formation and distribution of mineral deposits. Consequently the reader receives quite a thorough indoctrination into the geology of South Africa, and a sound understanding of the genesis of minerals there. Economic geologists will find this approach particularly satisfying, but even the average nonprofessional should be intrigued and interested to see such background presented. A substantial amount of history is also provided for many of the occurrences, an aspect always interesting to the collector.

The second main section of the book (75 pages) discusses all minerals in traditional alphabetical order, referring back to individual deposits described in the first section. Additional data on crystal size, morphology, habit, composition, associations, etc., are given, in many cases accompanied by a color specimen photograph. Private and public collections throughout South Africa were drawn on for specimens to illustrate. In addition to the many color locality photos, the first section contains color illustrations of 177 mineral specimens, and another 164 are pictured with the alphabetical species listing, for a total of 341. This is a remarkable number for any regional mineralogy.

The authors have necessarily scoured and distilled an enormous mass of published literature and first-person field accounts. The bibliography, 18 pages, is well chosen, and is arranged in sections according to geologic age of deposits, mirroring the arrangement of chapters. There is a two-page listing of mineral museums and institutional mineral collections in South Africa, a four-page glossary of geological terms used, and a thorough 12-page index in which page references to specimen photos are given in bold.

It is difficult to find any fault with this book. (Okay, I didn't see a good photo of a Tweefontein sperrylite, one of my favorite South African minerals.) The authors have put in a truly heroic amount of work which will enrich the collector community for many decades to come. Connoisseurs of mineralogy worldwide will find this book to be an indispensable addition to their library.

W.E.W.

Mineralogy of Maine

Volume 1: Descriptive Mineralogy, *by Vandall T. King and Eugene E. Foord. Published (1994) by the Maine Geological Survey, State House Station 22, Augusta, ME 04333; 418 p. + 88 pages of color and black-and-white specimen photographs; softcover $40, Hardcover $50.*

Regional mineralogies are among the mineral collector's principal tools in accurately identifying and understanding specimens and their localities. So it is always a joyful occasion when a new one is published, particularly if it gives in-depth information on a famous, mineral-rich area. King and Foord's *Mineralogy of Maine* is just such a book, the mere sight of which (with a gorgeous purple apatite on the cover) will raise a collector's pulse-rate.

The introductory material, including a dedication to Franklin collector Richard Hauck and an essay for beginners on evaluating and caring for good specimens, is brief but interesting. The minerals themselves, however, are the main focus; the book consists almost entirely (373 pages) of an alphabetically arranged catalog of species giving detailed specimen descriptions, locality notes, literature quotes and references (critical to any really scholarly regional mineralogy), crystal drawings, and occasional discussions of nomenclature problems.

The depth of detail given is substantial, especially for the more important species; fluorapatite, for example, occupies 6½ pages of small type illustrated by 11 crystal drawings. Clearly this work represents a labor of love, the result of many years of painstaking literature research and specimen study.

The 88-page section of specimen photography is efficiently layed out so as to include the maximum number of photos. Specimens to illustrate were selected from 48 public and private collections, and represent the work of 24 photographers. About 100 color photos are presented, 63 of these devoted just to tourmaline and fluorapatite; 538 black and white photos follow, and these are actually quite good. The technology for converting color slides to black and white is much better today than it used to be, resulting in good sharpness and detail. All of the photos are printed on glossy paper stock for best reproduction.

The reference list at the end is thorough, with close to 1,100 entries, and is a treasure by itself for those investigating particular localities and species. A township map and a general subject index are also included.

All that is lacking, of course, is mining history and related geology; the data assembled by the authors for these subjects are so massive that they will be given their own volume, due out shortly. Brief biographies of the authors (lacking in volume 1) will presumably appear there as well.

The book is well produced, and designed, with good paper, a sewn binding, and well-structured typography that is both compact and easy on the eye. The hardcover is plastic-coated for easy cleaning, and carries a color photograph, eliminating any need for an annoying dust jacket.

The price ($40 softcover, $50 hardcover) is amazingly low because the book is a state publication. Published through normal channels it would surely have been priced at over $100. Consequently it is not only a highly recommended and well-illustrated reference, it is also a bargain.

Checking the introduction, one finds that statement by the authors which is typical of only the most compendious and valuable works: If we had known how much work would be involved, we would probably never have begun this project. *Mineralogy of Maine* is especially valuable because it is not merely an update of an earlier comprehensive edition, but rather it is truly the first scholarly survey of all the minerals and localities in this remarkable state. As such, it merits a warm and appreciative welcome into the libraries of all mineral collectors.

W.E.W.

Franklin and Sterling Hill, New Jersey; The World's Most Magnificent Mineral Deposits

by Pete J. Dunn. Published by the author (1995); available from the Franklin-Ogdensburg Mineralogical Society, P.O. Box 146, Franklin, NJ 07416. Softcover, in five parts, 8.5 x 11 inches, 755 p., $150 plus $15 shipping.

Franklin and Sterling Hill, the type localities for no less than 69 mineral species, rank unquestionably among the world's most extraordinary and fascinating mineralized areas. Collectors and mineralogists have long relied upon Charles Palache's 1935 monograph, *The Minerals of Franklin and Sterling Hill,* as the definitive overview. But a tremendous amount of research has taken place since 1935, not only in the description of new species but in the refinement of knowledge about the minerals known in Palache's time. Consequently a new review of the deposits and their mineralogy has long been overdue. Considering that Pete Dunn has been personally responsible for describing and naming over a *third* of the 69 type species, and is the leading expert on the localities, no one else was about to attempt the huge task.

Happily, after 22 years of work on the project, the great day is finally here! Dunn has published a massive two-volume compendium which (at 755 pages) dwarf's Palache's 135-page monograph.

The first two parts cover primarily the geology and history of iron and zinc mining in the area, abundantly illustrated by maps, diagrams, drawings and historical photos. Details on beneficiation techniques and local culture (i.e. mineral collecting) are dealt with, plus a general review of geochemical aspects, the famous fluorescence of many of the species, and the nature of typical assemblages. Also included is a thorough bibliography containing over 1,300 entries, nearly five times as many as listed by Palache.

The other three parts deal primarily with the descriptive mineralogy of the 348 Franklin and Sterling Hill species, illustrated by 300 crystal drawings and 420 black-and-white photos. The history of each species is reviewed, followed by a careful physical description and a detailed review of the composition (often complex, problematical, or unique to the district). Then the occurrence and paragenesis are discussed, including the various assemblages and how they differ. With the eye of a collector as well as a mineralogist, the author meticulously describes the quality of specimens of each species from different zones and occurrences, and shows many photographs rich in detail; some of the scanning electron micrographs, in particular, are quite stunning in terms of crystal architecture.

The author has chosen to discuss the species not in alphabetical order but in Dana order. Because of the fascinating chemical and structural relationships of the minerals, this arrangement is instructive by juxtaposition. But it does mean that readers will need to consult the index constantly in order to locate particular species.

The work concludes with appendices on obsolete nomenclatural terms, local mining terminology, a reprint of a Sterling Mine supplement from 1966, a subject index, a mineral index, and front matter for rebinding the five parts as two volumes.

The two major deficiencies of this work are (1) the lack of any color specimen photography, especially considering the diagnostic value of fluorescence at these deposits, and (2) the binding, which is clearly intended to be temporary until such time as the purchaser can have the volumes hardbound at his own expense. The paper quality is good, but the pages are "perfect bound" (glued along the spine rather than sewn in folded "signatures"). These shortcomings are the result of financial constraints on the author, who produced the books via "desk-top publishing." The binding deficiency is at least in part correctable by the buyer. But we can only lament the omission of color work in an otherwise superb and complete monograph, a sentiment no doubt shared by the author himself.

Franklin and Sterling Hill is a masterwork which surely ranks among the finest topographical mineralogies ever published. It merits a place of honor in every mineralogical library, and in a good custom binding for permanent preservation. The author has earned the gratitude and appreciation of the entire mineralogical community for his decades of research on Franklin and Sterling Hill, and for making this work available to the public.

W.E.W.

MINERAL STORIES

The Lepidolite Boulder

by Rolf Luetcke

About 25 years ago I was involved in the production of boxed mineral specimen sets, and in order to keep costs down I collected many of the minerals myself. Since superb specimens were not required, old mine dumps usually yielded everything necessary.

I have collected at many old mine dumps throughout the western states. But when I visited the Pala, California, area, most of the mines proved to be under private ownership and were not open to collecting. However, one of the larger mines, bordering an Indian reservation, could be entered for $3.

Parking near the bottom of the long, steep mine dump, I worked the tailings for useable material. Lepidolite shot through with small rubellite crystals was of primary interest, and was abundant.

The views were spectacular, and after a while I climbed up to the top of the dump for a short rest. Just below the top rim of the dump was a big boulder of fine material, fairly round and weighing close to 300 pounds. I pondered how to get this nice piece down to my truck a couple of hundred yards below.

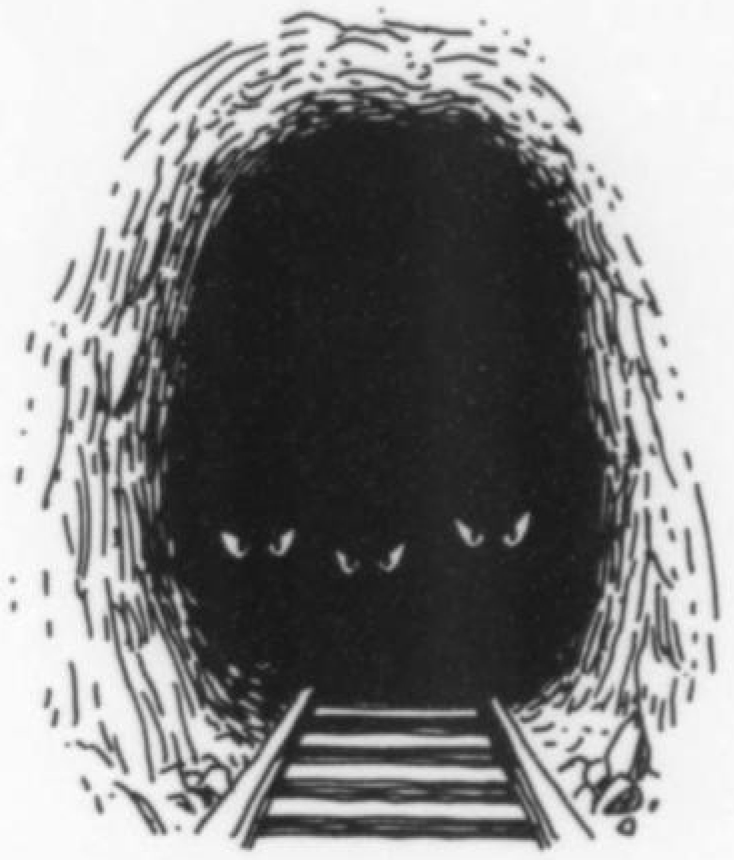
Of course, the easiest option was just to roll it down the slope. The truck was parked off to the side and up a little hill, so I didn't worry about it getting hit. There were hundreds of bushes and other large boulders down the dump slope which would also prevent the rock from reaching as far as my truck.

So, I pushed the big boulder loose and launched it down the slope. As my heart rate increased, the boulder miraculously missed every bush and major obstacle as it picked up speed and took aim directly at my truck! I started tabulating repair bills as it closed in on the vehicle, its course remaining true. It sped along directly toward a manzanita bush about 15 feet in front of my truck.

I've had a new respect for the toughness of the manzanita bush since that day. The boulder, by now traveling at highway speed, was stopped dead by the bush, and rolled harmlessly off to the side by my truck. After my knees stopped wobbling, I went down and examined the bush, which showed remarkably little damage. I then rolled the boulder the final 15 feet and into my truck.

Since that time most of the boulder has been chopped down and is now in sample collections throughout the world. But I still have a few chunks to remind me of the close call. And I've never parked near the base of a mine dump since.

[Editor's Note: I can't help thinking that there must be many more rock-rolling stories out there among our readership. Has anyone ever actually hit their own vehicle? Or something else? Enquiring minds want to know. Drop us a note.]



Wildlife in the Mines

by Rolf Luetcke

Near Portal, Arizona, I once came across an old mine adit driven into a hillside. I searched over the dump for minerals and possible indications of what might still be waiting to be found underground. I had worked my way up to the adit entrance where I sensed something odd.

Although it was a cold winter morning, there was a flow of warm, moist air issuing from the old mine. Standing at the entrance I estimated the temperature difference to be about 30 degrees.

I walked a short distance into the mine. The air had a peculiar musky odor, and the floor was pockmarked with animal tracks which I recognized as those of the javelina.* It would be a dangerous place to run into a herd of javelina, so I left.

A close friend of mine was at that time Director of the Southwest Research Station, and I stopped for a visit. When I mentioned the adit, his wife told me of an experience she and a friend had had in the same mine.

They were studying not minerals but bats, and were attempting to learn how many hibernated in abandoned mines during the winter. So they went in looking for bats, paying little attention to all the animal tracks on the muddy floor.

They were several hundred feet in when they noticed many little red lights glowing back at them from deeper in the tunnel. Now they realized why there had been so many tracks—the javelina liked the warmth of the mine, and had been spending their days there before going out at night to forage.

The intruders froze in their boots, not knowing what to do, but it was too late. The red eyes started bobbing up and down frantically;

---

*For the benefit of readers unfamiliar with Southwestern fauna, the *javelina* ("j" pronounced like an "h") is similar to a small wild boar, complete with tusks, though biologists say it is more closely related to the rhinoceros.

they were stampeding for the entrance, and the humans were right in the way!

Javelina are fast, and attempting to outrun them in the narrow, dark tunnel would have been futile. So the women flattened themselves against the sides of the tunnel and hoped for the best. When my friend put her hand against the wall it fell on something cool and smooth and familiar-feeling. She jerked her hand away, but had nowhere else to move as the panicking javelina grunted and snorted by. Although she was fearful of getting gored in the legs by their little tusks, they passed without touching either of the ladies.

With the javelinas gone she jumped away from the wall and shined her light on a coiled rattlesnake sleeping on a narrow ledge. It never even woke up. Needless to say, though, they cut their bat search short.

I was glad that I hadn't gone in after minerals. But, even though it was a dangerous situation, it demonstrated that most animals are not out to harm us, even when they feel cornered.

My friend, by the way, still goes into mines looking for bats. But she's a little more cautious now.

The Artistic Eye

by Lawrence H. Conklin

I recently acquired a very fine native copper specimen. In addition to showing some large tetrahexahedral crystals, it is quite sculptural, as some native coppers tend to be.

As soon as I saw it I knew that it had to be fitted with a custom-made wooden display base, as I had been doing lately with my best specimens. Although doing so is quite expensive, I feel it is worthwhile (plastic peg stands no longer satisfy my aesthetic sensibilities).

My base-maker, a professional at providing this service, came to see the copper, made notes as to my mounting instructions, and took it back to his shop along with three other specimens.

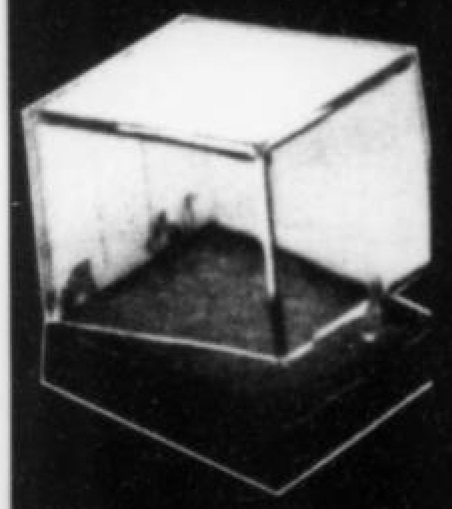
The next day I got a call from the base-maker. He reminded me that, in addition to himself, there were four other artisans on his staff (I knew that). Then he rather sheepishly told me that they had all spent some time looking at the copper, and had unanimously concluded that I was mounting the piece *up-side-down!*

Well, you can imagine my amusement at this opinion. Even though they were all expert base-makers, who on occasion had mounted pieces of sculpture worth over a million dollars, I assured them (I am certain I was quite patronizing) that *I* was the mineralogical expert here, and that they should proceed as I had originally instructed. And they did.

One important factor which had made me decide upon the orientation was that the specimen would indeed stand on its own in that position, albeit rather precariously. In mineral collector's parlance, "it sits," and my base-makers knew nothing of that significant aspect.

The now expertly mounted specimen was delivered back to me in due course. And, guess what? They were right after all. It's going to stay mounted as it is, but I can now see that it *would* have looked much better up-side-down.

Everyone has a good story to tell. How about sharing yours with us? Editing and polishing for publication are cheerfully provided. Send your story to ***Lawrence H. Conklin****, 2 West 46th Street, New York, NY 10036, or c/o* ***Wendell E. Wilson****, the Mineralogical Record, 4631 Paseo Tubutama, Tucson, AZ 85750. You can FAX your story to the editorial office by calling 520-299-5702.*



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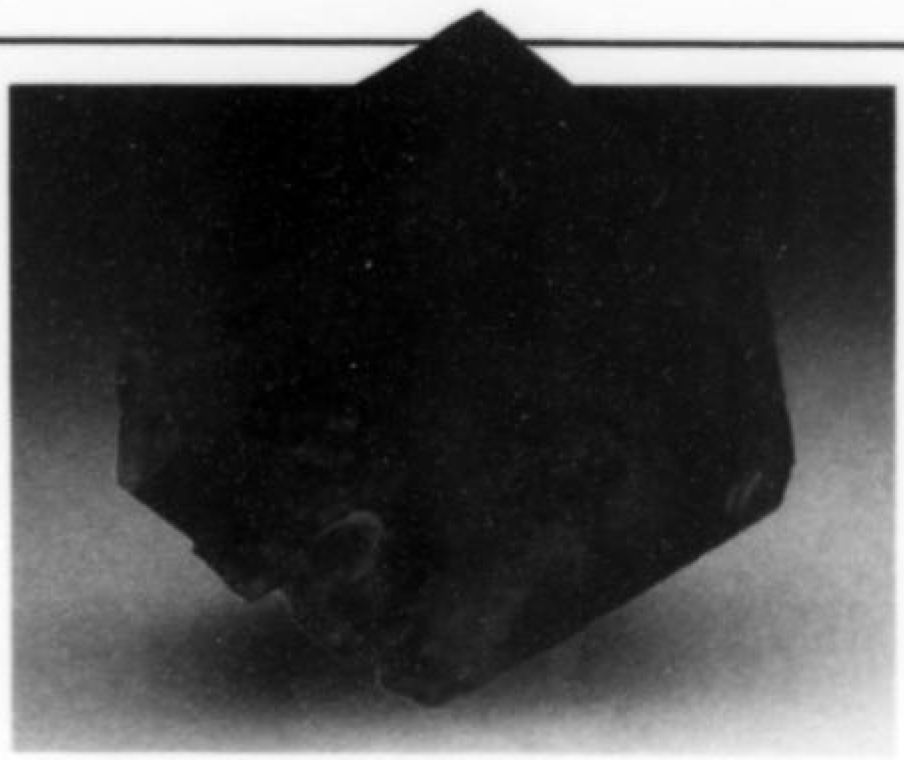

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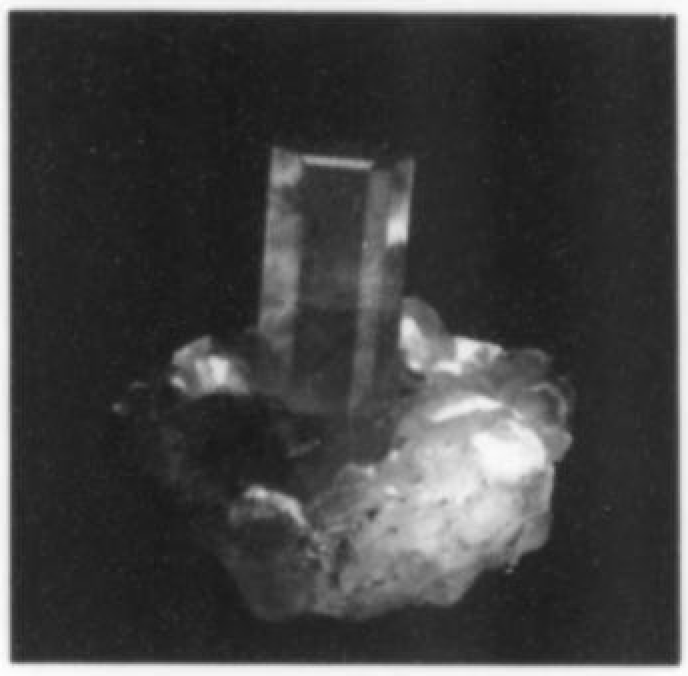

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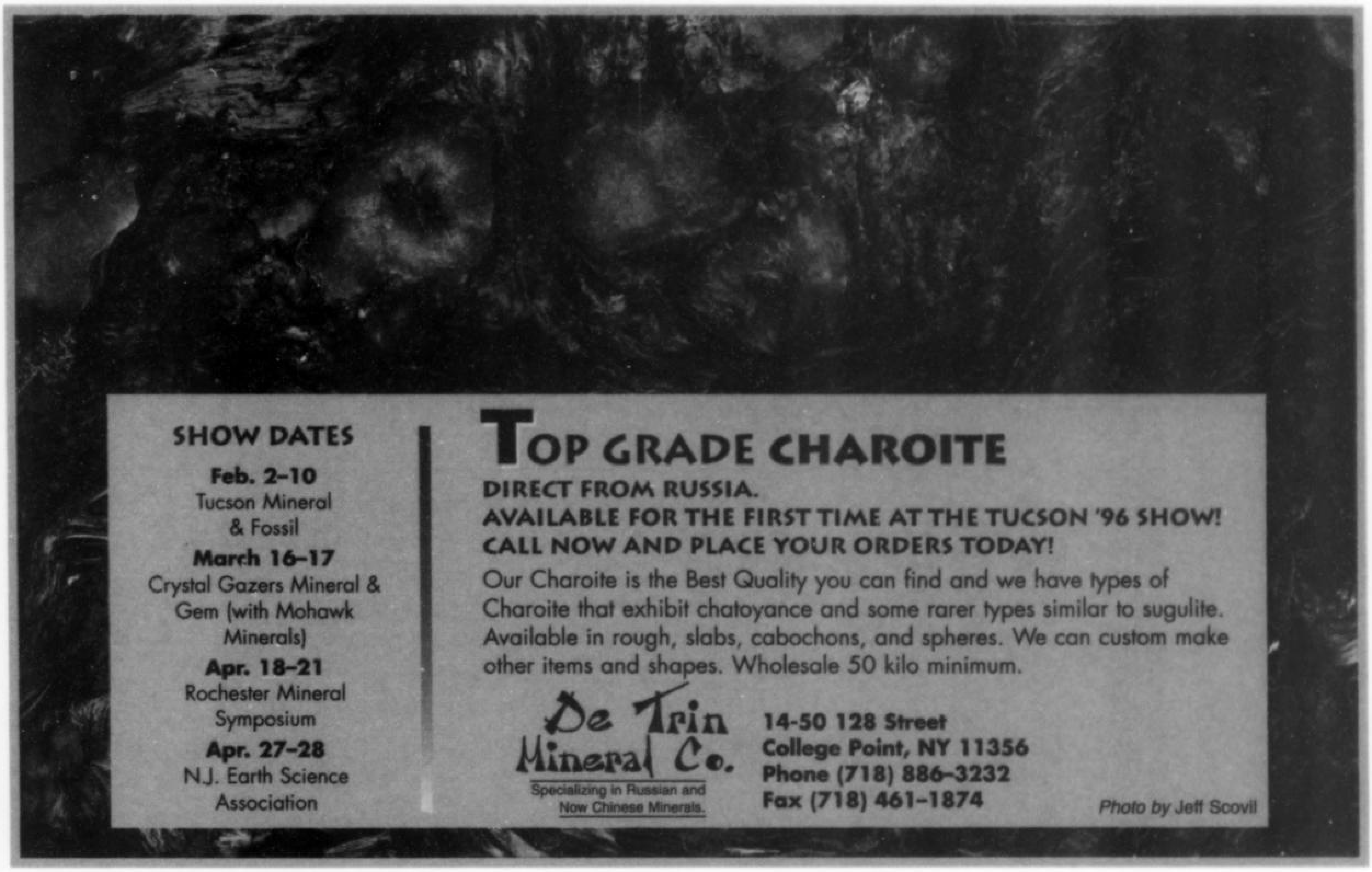

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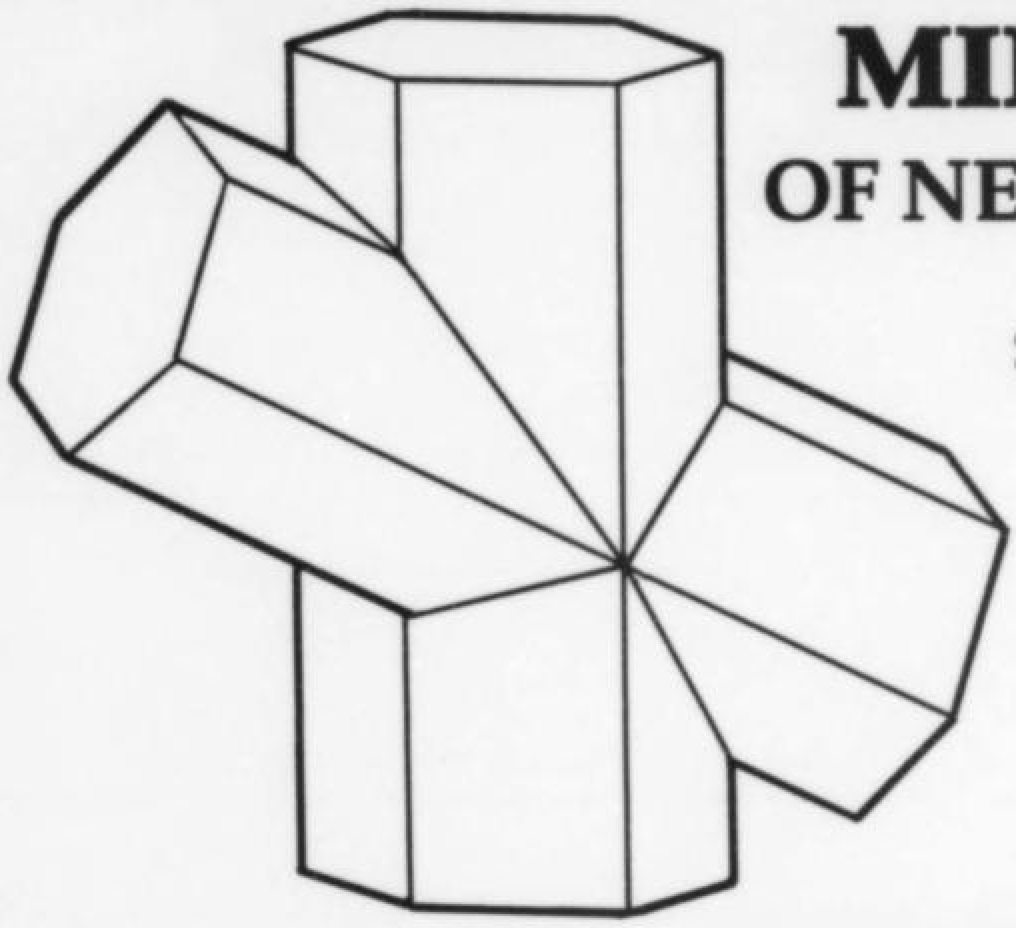

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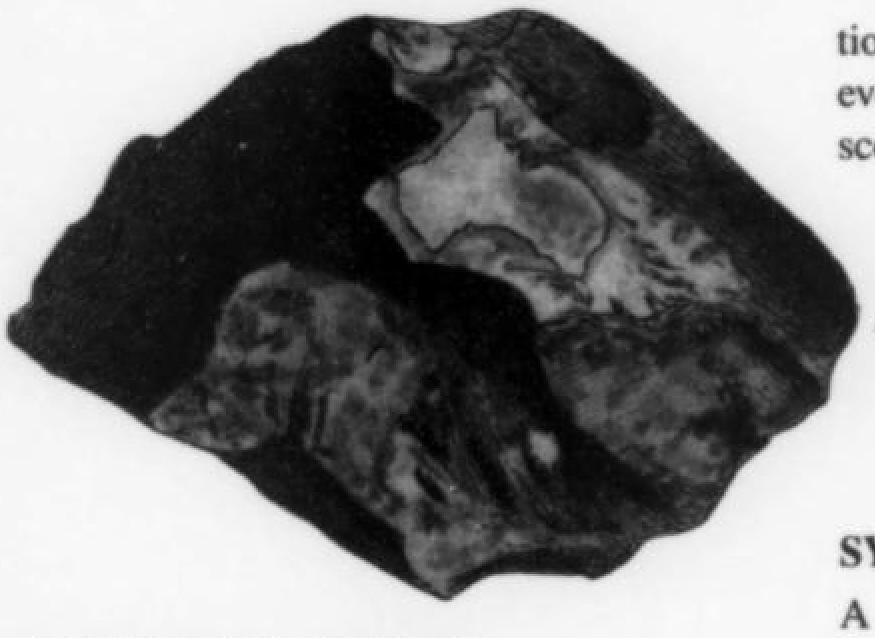

Sowerby Plate 547

SOWERBY SPECIMEN

I recently acquired a copy of your special issue on "The History of Mineral Collecting, 1530–1799," and have found it totally fascinating. My sincere compliments on this splendid production.

You may be interested to learn that one of James Sowerby's specimens is in my own collection. I purchased it in 1975 for about $6, not so much because of its quality but because of the label which reads:

> Ferrum Arsenium, B. M. 547, Oxyde of Iron and Oxyde of Arsenic. Parish of Perran Ar Worthal in Cornwall. Sept. 1808. Revd. W. Gregor.

It was not until 1992 that I grained access to a copy of Sowerby's *British Mineralogy* and found my piece illustrated as plate no. 547! I had always thought the "B. M. 547" on the label referred somehow to the British Museum.

Perhaps my specimen is one of the five you mentioned which were purchased by the Museum in 1934, for $2.25 each (in which case it has appreciated!). Or could it be a different piece which got into circulation by other routes? I don't think I shall ever know, but I do treasure my massive scorodite with traces of orpiment.

Peter Golley
Okehampton, England

SYNTHETIC "EULYTITE"

A note to anyone who purchased synthetic "eulytite" crystals (bismuth silicate) from the Fersman Mineralogical Museum at the Executive Inn during the Tucson Show: The material lacks the cubic symmetry one would expect from eulytite, so I had Bart Cannon of *Cannon Microprobe* in Seattle conduct an analysis. The material turns out to be bismuth germanate, a common scintillator compound used in positron emission tomography machines.

Jack Zektzer
Seattle, WA

REGIONAL MINERALOGIES

I enjoyed the *Mineral Books* issue, but found something missing in Art Smith's chapter on "Regional Mineralogies":

CARLSON, ERNEST H. (1991) *Minerals of Ohio.* Published as Bulletin 69 by the Ohio Geological Survey, Columbus, 60 p.

It contains chapters on Ohio geology, mineral identification, suggested field trips, many illustrations, four pages of color photographs of Ohio minerals, and an index map to the topographical maps of Ohio.

Leonard Piszkiewicz
Santa Clara, California

May I contribute the following additional references to your important and interesting article (vol. 26, no. 4, p. 113) on regional mineralogies of the world?

Under SLOVAKIA:

KODERA, M. (1986, 1990) *Topograficka Mineralogia Slovenska.* Vol. 1 (1980) A-K, Vol. 2 (1990) K-S, Vol. 3 (1990) S-Z. Editor Veda, Bratislava. The three volumes total 1590 pages. ISBN 80-224-010-1-3 and 80-224-010: 02-1.

Under BOSNIA-HERCEGOVINA:

TRUBELJA, F., and BARIC, L. (1979, 1984) *Mineraki Bosne i Hercegovine.* Vol. 1, Silicates (1979), Zemalski Musei BiH, Sarajevo, 452 p. Vol. 2, Non-silicates (1984), Edit. Svjetlost Sarajevo, 571 p.

Because Czechoslovakia no longer exists as a country, the book by Hercko (1984) would today refer to Slovakia. Similarly, since Yugoslavia no longer exists, the book by Voss (1895) today refers primarily to Slovenia.

Otto Fritz
Vienna, Austria

I found the July–August issue ("Mineral Books") to be particularly fine, because I love mineral books as much as the minerals themselves. However, I would like to offer some additions and corrections to the Spanish section of the chapter on "Regional Mineralogies":

Regarding the subheadings, Albacete, la Roda, Alcaraz and Almansa are part of *Albacete Province,* Seville is a part of *Andalusia,* and Teruel is a part of *Aragon.* More importantly, though, I can add many recent works to the listing which may be of use to readers:

CALVO, B., GONZALEZ del TANAGO, J., and GONZALEZ del TANAGO, J. (1991) *Los Minerales y la Mineria de la Sierra Albarrana y su Entorno.* Fundacion ENRESA, Madrid, 204 p.

CALVO, M., BESTEIRO, J., SEVILLANO, E., and POCOVI, A. (1988) *Minerales de Aragon.* Mira Editores, Zaragoza, 142 p.

CALVO, M., GASCON F., and CAVIA, J. M. (1993) *Minerales de las Comunidades Autonomas del Pais Vasco y Navarra.* Museo de Ciencias Naturales de Alava, Vitoria, 156 p.

DEL VALLE, A., and GONZALEZ, V. (1988–1993) *Guia de Minerales de España.* Departmento de Cristalografia y Mineralogia, Universidad de Valladolid, 4 vols.

DEL VALLE, A., GONZALEZ, V. DEL VALLE, L. A., RULL, F., NIÑO, M. P.,

(continued on p. 238)

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Marie Huizing

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Nominations are now being accepted for the 1996 award. Mineral enthusiasts and collectors, educators, curators, mineral clubs and societies, museums, universities and publications are eligible. The deadline is December 31.

For a nomination form, contact:
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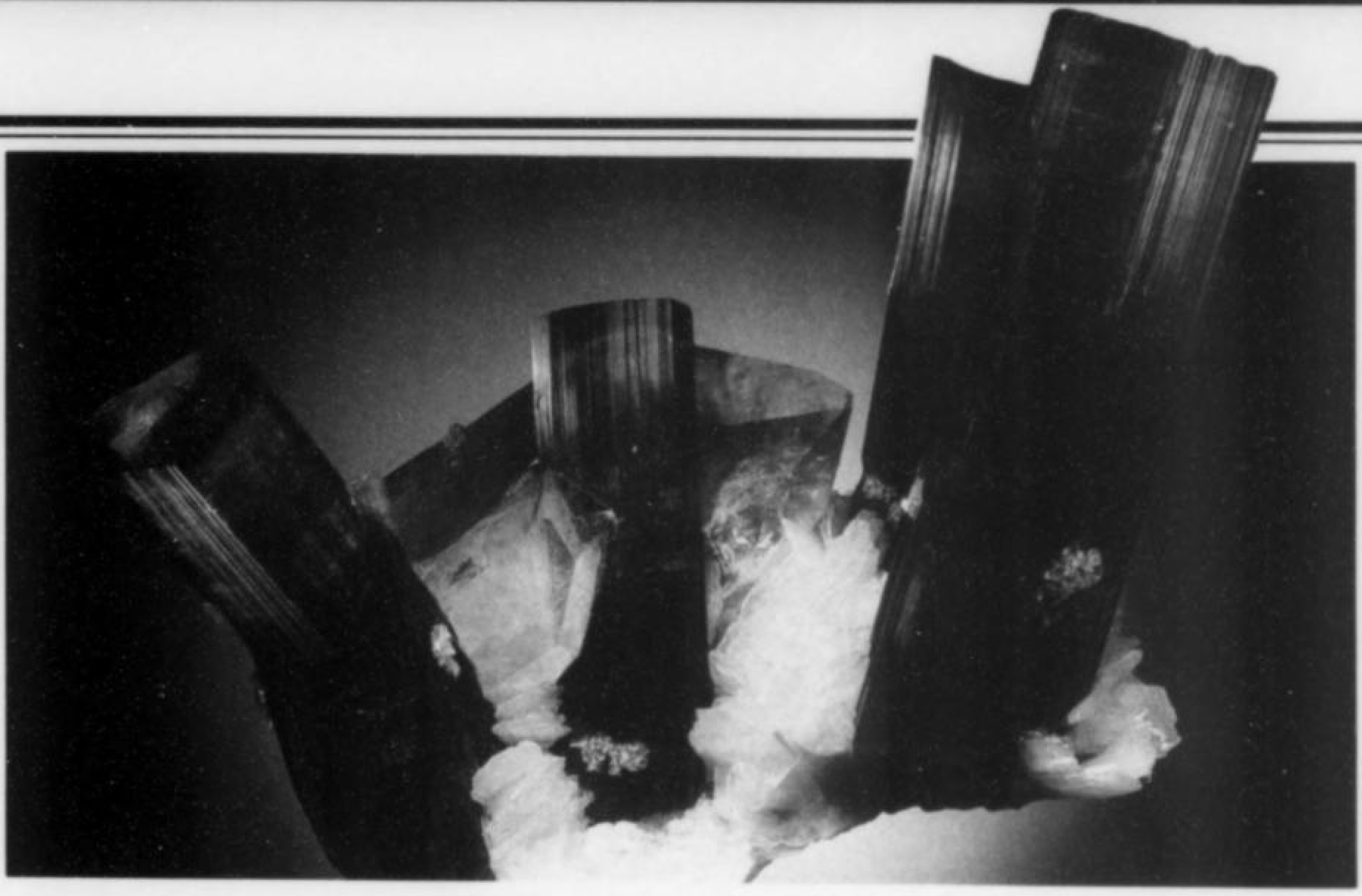

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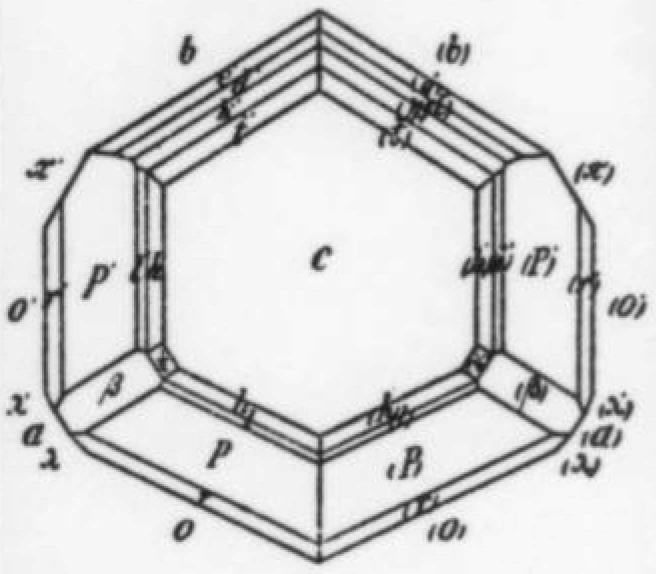

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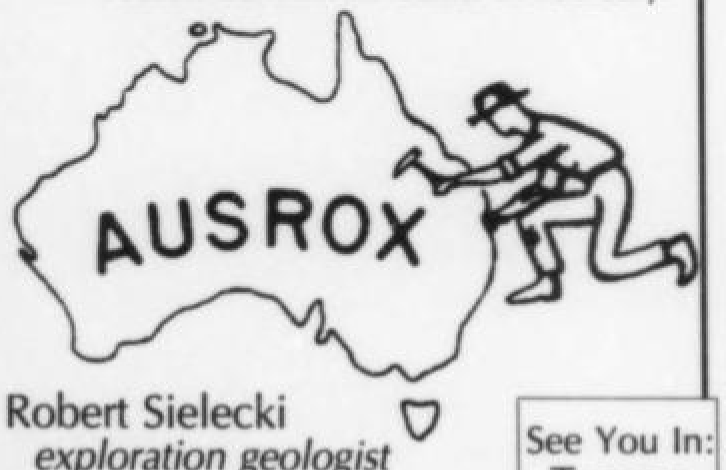

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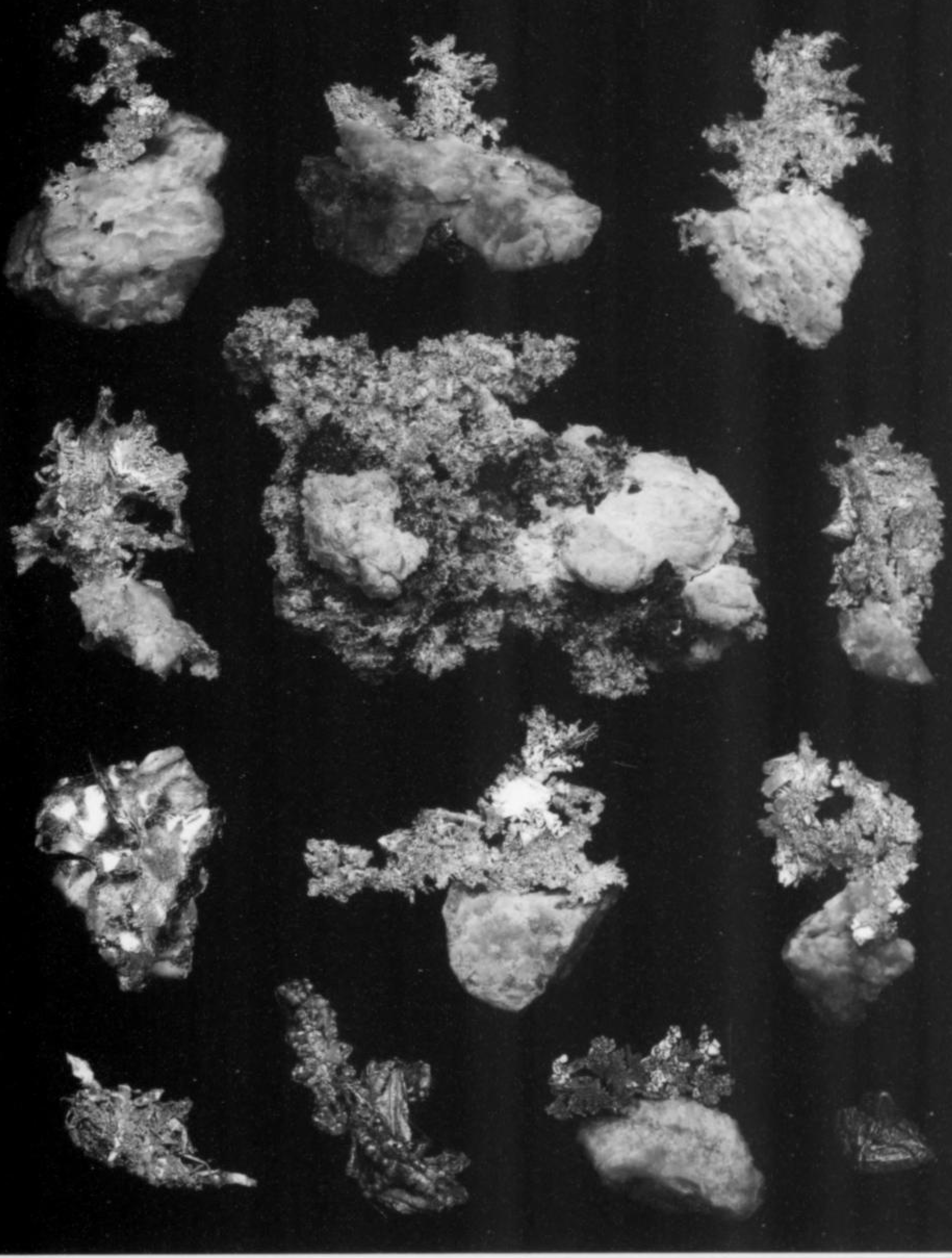

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