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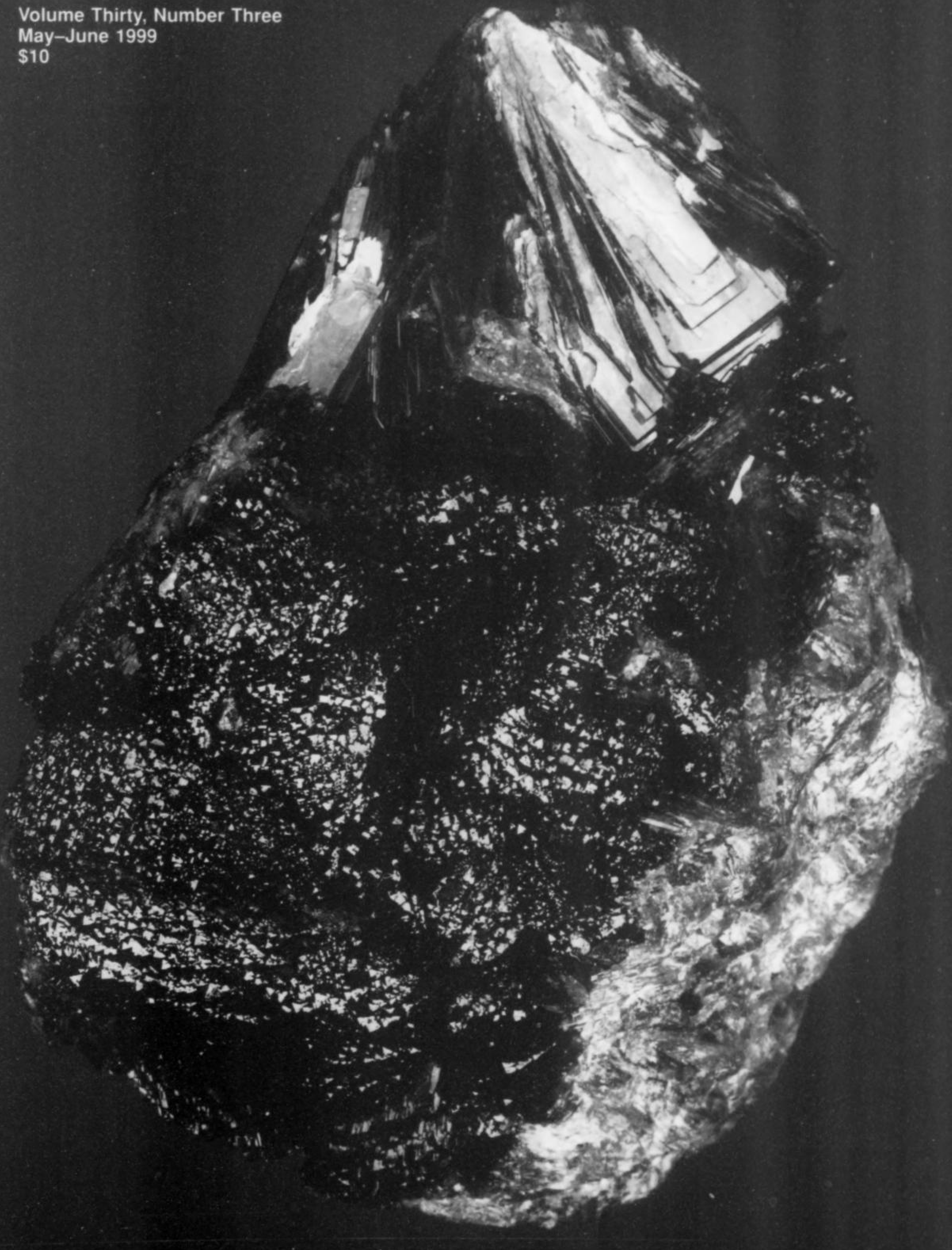

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THE MINERALOGICAL RECORD

May–June 1999 Volume Thirty, Number Three

Articles

Columns

COVER: ANDYROBERTSITE with interlayered calcioandyrobertsite (the only known specimen of both new species; see p. 181) on dark green olivenite and grass-green cuprian adamite, 4.1 cm, from Tsumeb, Namibia. William Pinch specimen; Jeff Scovil photo.

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notes from the EDITOR

CALL FOR PAPERS

A symposium on NYF-type pegmatites is being organized as a tribute to the late Eugene E. Foord, to be held September 11–14, 1999, in Denver, immediately preceding the Denver Gem and Mineral Show (September 14–19). The symposium, sponsored in part by the Denver Museum of Natural History, the Colorado Chapter of the Friends of Mineralogy, and the Harvard Mineralogical Museum, will address recent research and developments in the study of anorogenic pegmatites through a series of oral presentations (and possibly posters), and a field excursion to visit NYF pegmatites in the Pikes Peak Batholith. The talks will be held at the Denver Museum of Natural History, with a banquet on Saturday night, September 11. Extended abstracts of up to two pages are requested by electronic submission to Skip Simmons (E-mail: wsimmons@uno.edu), DEADLINE: JUNE 11. Or mail to Skip Simmons, Dept. of Geology, Univ. of New Orleans, New Orleans, LA 70148.

MINERALS OF BROKEN HILL

Collectors of minerals from the renowned Broken Hill deposit in New South Wales, Australia, will soon be able to purchase the new edition of the 1982 book, *Minerals of Broken Hill*. The original text has been completely revised and new photographs taken of many of the newly recorded species from the deposit. Some of the original photographs which made the book such a collectors' favorite will be retained. The book is presently close to final design and printing. The selling price will be approximately AUS$100 (about US$64) (plus postage and packaging). To be placed on the mailing list to receive an order form, send your name, address and other contact details to:

The Albert Kersten Geocentre
PO Box 448
Broken Hill, NSW 2880
Australia

Fax: 61 8 8087 6538
E-mail: geocentre@pcpro.net.au

NOTICES

Died, L. Russell Haggard, 94, of Edmonds, Washington. Born in South Dakota in 1904, he moved to Lynnwood, Washington, around 1930 and opened his own service station. He earned Bachelor's degrees in Geology from the Universities of North Dakota and Washington, and began working as a mining geologist in 1950. During World War II he had served in the Air Force, and had also became an active and enthusiastic mineral collector, and member of many clubs. For 30 years he judged exhibits at the Northwest mineral shows, and was himself a successful competitor, having won the national trophy for minerals in Salt Lake City. He is survived by his wife of 56 years, Alice.

IMA

The IMA Commission on New Minerals and Mineral Names: Procedures and Guidelines on Mineral Nomenclature 1998

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The Commission on New Minerals and Mineral Names of the International Mineralogical Association was established in 1959 for the purpose of controlling the introduction of new minerals and mineral names, and of rationalizing mineral nomenclature. Since that time, the work of the Commission has gained overwhelming support from the international mineralogical community. Presented here is a summary of the procedures currently employed by the Commission, and the recommended guidelines for mineral nomenclature.

*Vice-chairman, IMA Commission on New Minerals and Mineral Names
**Chairman, IMA Commission on New Minerals and Mineral Names

Introduction

The Commission on New Minerals and Mineral Names (hereinafter referred to as the CNMMN) consists of representatives appointed by national mineralogical bodies, and an executive committee consisting of chairman, vice-chairman and secretary. A list of current members is given in Appendix I.

The activities of the CNMMN, and its various recommendations for mineral nomenclature have been widely published in a substantial number of mineralogical journals over a number of years, and there is a clear need to consolidate these reports to provide an up-to-date report on the procedures currently followed by the CNMMN and to provide updated guidelines on mineral nomenclature. This paper, which represents a consensus of CNMMN members, and which has benefitted from their suggestions, attempts to do that. It incorporates material from previous reports on mineral nomenclature and procedures of the CNMMN, including general papers such as those by Hey *et al.* (1961), Fleischer (1970), Donnay and Fleischer (1970), Dunn and Mandarino (1988), Mandarino *et al.* (1984) and Nickel and Mandarino (1987), as well as papers on more specific topics, which will be referred to in the body of this paper.

It must be understood that the CNMMN does not wish to impose an arbitrary set of rigid rules on the mineralogical community, but rather to provide a set of coherent guidelines that provide a reasonably consistent approach to the introduction of new minerals and the application of mineral nomenclature. The guidelines presented herein probably apply reasonably well to the great majority of cases, but inevitably situations arise that do not conform so readily. As is mentioned several times in the text, each case must be judged on its own merits.

New Minerals

General Considerations

A *mineral substance* is a naturally occurring solid that has been formed by geological processes, either on earth or in extraterrestrial bodies (Nickel, 1995a). A *mineral species* is a mineral substance with well-defined chemical composition and crystallographic properties, and which merits a unique name. General criteria for defining mineral species are given below. In practice, most mineral species conform to these criteria, but exceptions and borderline cases inevitably arise, and ultimately each proposal to introduce a new mineral species or to change mineral nomenclature must be considered on its own merits.

The Concept of a Mineral Species

A mineral species is defined mainly on the basis of its chemical composition and crystallographic properties, and these must therefore be the key factors in determining whether a new mineral species is to be recognized and a new mineral name is justified. If a mineral is found whose composition and/or crystallographic properties are substantially different from those of any existing mineral species, there is a possibility that it may be a new species. A general guideline for compositional criteria is that at least one structural site in the potential new mineral should be predominantly occupied by a different chemical component than that which occurs in the equivalent site in any existing mineral species.

Example 1

Hydroxylapatite and fluorapatite both crystallize in the hexagonal system, with the same space group, and have similar unit-cell parameters. They are considered as separate species because one structural site is predominantly occupied by OH in hydroxylapatite, and by F in fluorapatite.

Example 2

Sphalerite (ZnS) and "marmatite" ([Zn,Fe]S) are both cubic, with the same space group and similar unit-cell parameters, but they are not regarded as separate species because the cationic structural site is predominantly occupied by Zn in both cases. "Marmatite" is regarded as a ferroan variety of sphalerite, and use of the name "marmatite" is discouraged.

Substances Formed by Human Intervention

Anthropogenic substances, i.e., those made directly by Man, are not regarded as minerals. However, there are cases in which human intervention in the creation of a substance is less direct, and the borderline between mineral and non-mineral can be unclear. One such case is the occurrence of "post-mining minerals," new substances that owe their origin, at least in part, to human activities such as mining or quarrying. If such substances are formed purely as a result of the exposure of existing rock or minerals to the atmosphere or to the effects of groundwater, they can generally be accepted as minerals. However, if their occurrence is due, at least in part, to the interaction of existing minerals with substances of non-geologic origin such as blasting powder, corroded human artifacts or industrially contaminated water, then such products are not to be regarded as minerals.

Substances formed by combustion are not generally regarded as minerals. A contentious issue is the occurrence of substances in the combustion products of coal mines, waste dumps or peat bogs. The origin of a particular fire is often difficult to determine, and therefore the possibility of human intervention cannot be entirely eliminated, nor can the possibility of human artifacts contributing to the combustion products. It has therefore been decided that, as a general rule, *combustion products* are not to be considered as minerals in the future.

Another contentious issue is whether substances formed by the action of air or water on anthropogenic substances should be regarded as minerals. A well-known example is that of the Laurium "slag minerals" formed by the reaction of seawater with ancient metallurgical slags. A potential problem with accepting similar products as minerals in the modern age is that a multitude of unusual substances could be created purposely by exposing exotic Man-made materials to the influence of weathering agents, and it would not be appropriate to give such substances the same status as minerals formed entirely by geological processes. It was therefore decided that substances formed from Man-made materials by geological agents should not be accepted as minerals in the future (Nickel, 1995a). However, the exclusion of such substances from the mineral lexicon does not preclude their description as artificial substances.

Substances that would not be accepted as minerals according to the above criteria, but which have been accepted in the past, are *not* to be automatically discredited as a result of the new rulings, as it is not our intention to roll back the clock but rather to establish guidelines for the future.

Biogenic Substances

It is not always possible to draw a sharp distinction between *biogenic substances*, i.e., those produced by biological processes, and minerals, which are normally produced by geological processes. For instance, it is becoming increasingly clear that many of the processes associated with diagenesis are influenced, to some extent, by underground bacterial action, and the biosphere is commonly regarded as an integral part of the geochemical cycle. Nevertheless, it is necessary to make a formal distinction so as to prevent a host of purely biological materials being incorporated into the world of minerals.

Some biogenic substances, such as hydroxylapatite in teeth, whewellite in urinary calculi or aragonite in the shells of molluscs, also exist as minerals formed by geochemical processes, and therefore are regarded as valid minerals. Purely biogenic substances which have no geological equivalents, or whose origin owes essentially nothing to geological processes, are *not* regarded as minerals. However, substances formed by the action of geological processes *on* organic material, such as the chemical compounds crystallized from organic matter in shale or from bat guano, can be accepted as minerals.

Amorphous Substances

Amorphous substances are non-crystalline and therefore do not meet the normal requirements for mineral species. The term "crystalline," as generally used in mineralogy, means atomic ordering on a scale that can produce a regular array of diffraction spots when the substance is traversed by particle waves or radiation of suitable wavelength (X-ray, electrons, neutrons, etc.). However, some geologically derived substances such as gels, glasses and bitumens are non-crystalline. Such substances can be divided into two categories: *amorphous* (substances that have never been crystalline and do not diffract), and *metamict* (those that were crystalline at one time, but whose crystallinity has been destroyed by ionizing radiation). Some mineralogists are reluctant to accept amorphous substances as mineral species because of the difficulty of determining whether the substance is a true chemical compound or a mixture, and the impossibility of characterizing it completely; the term *mineraloid* is sometimes applied to such substances. However, in the past some amorphous substances (e.g., georgeite, calciouranoite) have been accepted as mineral species by the CNMMN.

With modern techniques it is possible to study amorphous phases more effectively than in the past. Spectroscopic methods associated with a complete chemical analysis can often identify an amorphous phase unequivocally. In fact, appropriate spectroscopies (e.g., IR, NMR, Raman, EXAFS, Mössbauer) can reveal the three-dimensional short-range structural environment (chemical bonds) of each atom in the structure. Of course, without the possibility of obtaining a complete crystal structure analysis, which can give the coordinates and the nature of the atoms, the need for a complete chemical analysis is more stringent with amorphous material than with a crystalline phase.

The basis for accepting a naturally occurring amorphous phase as a mineral species could be a series of complete quantitative chemical analysis that are sufficient to reveal the homogeneous chemical composition of a substantial number of grains in the specimen, and physico-chemical data (normally spectroscopic) that prove the uniqueness of the phase.

Metamict substances, if formed by geological processes, are accepted as mineral species if it can be established with reasonable certainty that the original substance (before metamictization) was a crystalline mineral of the same bulk composition. Evidence of this includes the restoration of crystallinity by appropriate heat treatment and the compatibility of the diffraction pattern of the heat-treated product with the external morphology (if any) of the original crystal, e.g., fergusonite-(Y).

The Matter of Size

The main criteria for defining a mineral species are its composition and crystal structure; with the development of modern analytical techniques, it is now possible to perform complete chemical and crystal-structure analyses on nanometric volumes, i.e., on the scale of a few Ångstrom units. Should such submicroscopic domains be accepted as valid mineral species? There is a wide range of opinions on this subject. On the one hand it is argued that if a mineral substance can be characterized in terms of composition and crystallography, then it should be regarded as a valid mineral species. On the other hand, it is contended that the other properties traditionally reported for minerals such as color, hardness, optical properties, etc., cannot be determined on an area of that size, and that the description is therefore incomplete. Furthermore, the size of the described particle should be sufficiently large so that sufficient type material can be retained to enable a later independent examination to confirm the original characterization. Another argument against the acceptance of nanometric specimens as valid mineral species is that such substances cannot be adequately displayed in mineral museums. It has not been possible to reach agreement on a minimum acceptable size for a mineral substance to be regarded as a species, and therefore each case must be decided on its own merits.

Stability under Ambient Conditions

Many minerals were formed under conditions of high temperature and/or pressure and are metastable under ambient conditions; others may tend to hydrate or dehydrate when removed from their place of origin. Such minerals may require special procedures to prevent their decomposition before the investigation is complete. The use of special procedures in the investigation does not preclude the acceptance of a metastable substance as a mineral species if it can be adequately characterized and if it meets the other criteria for a mineral.

Polymorphs

Polymorphic minerals are those that have essentially the same chemical composition, but different crystal structures. The polymorphic forms of a mineral are regarded as different species if their structures are topologically different. However, if the crystal structures of the polymorphs have essentially the same topology, differing only in terms of a structural distortion or in the order-disorder relationship of some of the atoms comprising the structure, such polymorphs are not regarded as separate species; the names of such topologically similar polymorphs can be distinguished by the addition of crystallographic suffixes to the mineral name, as discussed in a later section.

Although the formal definition of polymorphism is restricted to substances with identical chemical compositions, this strict limitation is broadened somewhat to include relatively minor chemical variations that do not significantly affect the topology of the structure.

Example 1

Graphite and diamond are polymorphs of crystalline carbon; both have the same composition, but their structures are topologically different, and therefore minerals such as these are regarded as separate species.

Example 2

Analcime has a number of topologically similar polymorphs (cubic, tetragonal, orthorhombic, monoclinic, triclinic and possibly even trigonal) caused by relatively minor symmetry variations due to different ordering of Si and Al with related different occupancies of the nearest Na structural site. Such polymorphs are not to be regarded as separate species.

Example 3

Orthoclase and microcline have essentially the same composition and topologically similar structures. According to current practice, these minerals would not be regarded as separate species, but their names are retained in the mineral lexicon for historical reasons.

Polytypes and Polytypoids

Polytypes are substances that occur in several different structural modifications, each of which may be regarded as being built up by the stacking of layers of (nearly) identical structure and composition, and with the modifications differing only in their stacking sequence (Guinier *et al.*, 1984). *Polytypoids* are substances that do not fit the strict definition of a polytype, including minerals with the same topology and with somewhat different compositions. Polytypes and polytypoids are not regarded as separate species and, like topologically similar polymorphs, they can be distinguished by the addition of a crystallographic suffix to the mineral name, as indicated in a later section.

Example 1

Högbomite exists in a number of different hexagonal and rhombohedral polytypes due to variations in the stacking of the basic structural layers. These polytypes are not regarded as separate mineral species, and can be distinguished by appropriate suffixes (see later).

Example 2

Pyrrhotite, $Fe_{1-x}S$, where x varies between 0 and 0.12, exists in a number of different crystallographic forms due to variations in the ordering of the Fe vacancies in the S lattice; because of the variable chemistry, the different pyrrhotite types can be regarded as polytypoids and are not regarded as separate species.

Regular Interstratifications

Regular interstratifications of two or more minerals are accepted as separate species if the kinds of layers, their relative proportions, chemical compositions, and regularity of interstratification in three dimensions on a micrometric or nanometric scale have been well documented. Such information can commonly be obtained by transmission electron microscopy (TEM) using lattice imaging techniques. However, if the evidence for regularity of stratification is based on X-ray diffraction data, then the criteria of Bailey (1981) should be applied.

Example

A regular interstratification of talc and trioctahedral smectite qualifies as a separate mineral species, *aliettite*.

Homologous and Polysomatic Series

Homologous structures are those that consist of structural units built on common structural principles and which contain the same chemical elements, although in different proportions, and which differ with respect to the size of the units. A homologous series is a series of structures that can be derived from one type of basic structural unit using one type of recombination principle. Homologous series can be classified into two categories: *accretional* and *variable-fit*; combinations of the two types are also known to occur.

An *accretional homologous series*, also known as a *polysomatic series*, is one in which the types of building blocks (rods, layers, etc.) and the principles that define their mutual relationships remain preserved, but in which the sizes of these blocks vary incrementally (Veblen, 1991). A member of an accretional homologous series can be regarded as a distinct species if it has the following properties: (a) unique size of the fundamental building block; (b) unique crystallographic unit cell; and (c) unique composition or a limited compositional range (Makovicky, 1989).

Example 1

The structures of the sulfosalt minerals lillianite, eskimoite, vikingite, ourayite, gustavite and heyrovskyite can all be interpreted as consisting of alternating galena-like modules twinned on (131) of the galena motif (Makovicky and Karup-Møller, 1977). The sizes of the modules, the unit-cell parameters, and the chemical compositions of these minerals are all different, which justifies their existence as separate species.

Example 2

Composite structures of members of the cylindrite group are formed of two kinds of layers, pseudo-hexagonal (H) and pseudo-tetragonal (Q). Cylindrite and franckeite have the same Q-H-Q-H sequence of stratification, but in franckeite the width of the Q layer is twice that of the Q layer of cylindrite. The two minerals are therefore regarded as separate species.

A *variable-fit homologous series* can also be regarded as *coupled homeotypes* forming a composite structure. Such a series is one in which the structure consists of two kinds of alternating, mutually non-commensurate building blocks. Each kind of building block has its own short-range periodicity, and it takes *m* periods of one block and *n* periods of the other block before they meet in the same configuration as was observed at the preselected origin. The non-commensurability of the building blocks may be one-dimensional or two-dimensional, and is usually connected with geometric and/or compositional long-range modulation of both layer types (Makovicky and Hyde, 1981). The period of the long-range match may vary within certain relatively broad limits because of incremental changes in the value of *m* or *n*. Because of this, the structures are infinitely adaptive, and a great number of possible variants can result. For this reason, individual members of variable-fit homologous series should not be regarded as separate species (see a later section for nomenclature suggestions for this group of minerals).

Example

The cylindrite structure has been interpreted as consisting of incommensurable alternating layers of pseudo-tetragonal and pseudo-hexagonal symmetry. Several different coincident lattices have been reported for this mineral (Makovicky and Hyde, 1981), but these do not qualify for separate species status.

Modulated Structures

Misfits between structural units can also be accommodated by structural perturbations. If these perturbations are of a periodic nature, the resultant structures are termed *modulated structures*, and are generally manifested in diffraction patterns by the appearance of superstructure reflections. Modulated variants of an existing mineral species do not warrant separate species status.

Example

In the antigorite structure, a misfit between the octahedral and tetrahedral layers is resolved by structural adjustments that result in the formation of structural waves with different periodicities. The various modulations are not regarded as separate species.

Solid Solution Series

In a continuous binary *solid-solution series*, only the two end-members are regarded as species, and the compositional range of the species is taken to apply from that of the end member to 50 mol % of the series; this is generally know as the "50% rule." If a binary solid solution is incomplete, and the composition of one of the end-members exceeds 50 mol % by a small amount, then, strictly speaking, that part of the series exceeding the 50% mark could be regarded as a separate species. However, for practical purposes, it may not be desirable to create a new species defining only a very short compositional range, and therefore such cases should be considered on their individual merits.

In multiple solid-solution series, the 50% rule is interpreted to mean *predominant occupancy* of a particular structural site. Thus, if there are two types of atom in a structural site, the species is to be defined by the atom comprising at least 50% of that site. If there are more than two substituting atoms in the site, the species is defined by the predominant atom occupying the site. For the purpose of species definition, site vacancies, commonly shown as "□" in chemical formulae, are to be regarded as atoms.

In minerals with complex structures and a multiplicity of structural sites that can accommodate a variety of different elements, the 50% rule may be difficult to apply, and authors of new-mineral proposals that rely on this rule for a particular structural site should substantiate their designation by a crystal-structure analysis.

The problem of applying the 50% rule to members of a complex group is exemplified by the amphibole minerals. The example given below shows that the 50% rule should not be applied too rigorously, and that a certain degree of latitude must be permitted when dealing with complex minerals.

Example 1

With a generalized amphibole composition expressed by the formula $AB_2C_5^{[6]}T_8^{[4]}O_{22}(OH)_2$, the C "site" actually comprises 5 different sites, and the T "site" actually comprises 8 sites. With the C sites able to accommodate Mg, Fe^{2+}, Mn^{2+}, Li, and a number of less common elements, there is a great opportunity for the proliferation of mineral species if the 50% rule for each structural site were strictly adhered to. Added to this is the difficulty of accurately determining site populations for elements with similar scattering powers. The Amphibole Subcommittee therefore decided to regard the different C sites as one composite site, and to apply the 50% rule to it. The T sites, normally occupied by Si and Al, presented a different problem, as petrologists had long regarded the partial replacement of Si by Al as being of petrological significance. The 8 T sites were therefore not considered as one composite site, and smaller increments in the Si:Al ratio were taken as the effective species boundaries.

Sometimes solid-solution series do not extend to either end member, but instead, the compositions cluster around the 50% mark. For practical reasons it may not be appropriate to denote the compositions on the two sides of the 50% mark as separate species. Such cases should be considered on their own merits.

Example 2

In pentlandite, $(Fe,Ni)_9S_8$, Fe and Ni substitute for each other to a limited extent, with compositions centered around $Fe_{4.5}Ni_{4.5}S_8$. It has not been found necessary to divide pentlandite into two species, an Fe-dominant one and a Ni-dominant one.

Some additional details applying to multiple and partial solid-solution series are given in Nickel (1992).

Requirements for the Approval of New Minerals

Before a new mineral and its name can be accepted into the literature, they must be approved by the CNMMN. To obtain this approval, the senior investigator should submit a proposal to the chairman of the CNMMN (see Appendix I), either directly, or through a national new-minerals committee, if appropriate; at present, national committees perform this function in Russia and China.

It is important that a new-mineral proposal be submitted for approval **before** publication. Such a submission should contain as much information as possible so that the CNMMN can adequately judge the validity of the proposal. Ideally, a new-mineral proposal should contain the following information:

(1.) ***Proposed name*** and reason for its selection.

(2.) ***Description of the occurrence*** (geographic and geologic occurrences, paragenesis, and a list of associated minerals, particularly those in apparent equilibrium with the new mineral).

(3.) ***Chemical composition*** and method of analysis.

(4.) ***Chemical formula***, empirical and simplified.

(5.) ***Crystallography:*** crystal system, crystal class, space group, point group, unit-cell parameters, unit-cell volume, number of formula units per unit cell, and X-ray powder diffraction data.

(6.) ***Crystal structure:*** general description, site populations, structural formula, reliability factor.

(7.) ***General appearance*** and ***physical properties:*** grain or crystal size, morphology, type of aggregate, color, streak, luster, transparency, hardness, tenacity, cleavage, parting, fracture, density (measured and calculated) (Mandarino, 1981a).

(8.) ***Optical properties***

(a) *Non-opaque minerals:* optical character (isotropic or anisotropic; uniaxial or biaxial), optical sign, indices of refraction, 2V, dispersion, orientation, pleochroism and absorption. The compatibility index using the Gladstone-Dale relationship (Gladstone and Dale, 1864) should also be calculated (Mandarino, 1981b; Bloss *et al.*, 1983).

(b) *Opaque minerals:* color in reflected plane-polarized light, internal reflections, reflectance, bireflectance, pleochroism and anisotropy. The reflectance must be measured relative to a reflectance standard approved by the IMA Commission on ore microscopy (IMA-COM), ideally from 400 to 700 nm at intervals of 20 nm. The **minimum** requirement is for reflectance data at the wavelengths 470, 546, 589 and 650 nm. Where data are supplied for measurements in oil, the oil used should conform to the German standard DIN 58.884; this and other recommendations of the IMA-COM are contained in Criddle and Stanley (1993).

(9.) ***Other data:*** Thermal behavior, infrared spectrum, response to chemical tests, etc.

(10.) ***Type material:*** The type material should be designated according to the criteria published by Dunn and Mandarino (1987) and deposited as permanent reference material in at least one major museum or a nationally recognized mineral collection (Dunn, 1988).

(11.) ***Relationship to other species.***

(12.) ***Relevant references.***

(13.) ***Any other data*** that will clarify difficult parts of the description.

It is recognized that it may not always be possible to obtain all of the above data; in such cases the author should give reasons for the omissions. Of particular importance is the calculation of H_2O content when it has not been determined analytically. If H_2O is reported by difference, the method of calculation should be clearly stated and, if possible, evidence for the presence of H_2O should be provided. Also, ample justification should be given for the allocation of hydrogen to H_2O, OH or H_3O.

Because of great differences in the amount and type of information that can be obtained from the study of a particular mineral specimen, it is not practical to specify the irreducible minimum of information required for a mineral to be approved; each proposal must be considered on its own merits.

A general outline of the procedures involved in establishing a new mineral species is given by Dunn (1977). To assist potential authors of new-mineral proposals, a check-list has been drawn up (Mandarino, 1987) and should be submitted as part of the proposal. Copies of an official check-list can be obtained from the chairman of the CNMMN or from one of the national representatives (Appendix I). Guidelines on some aspects of new-mineral proposals are given below.

To assist scientists who do not have all the technical facilities to obtain some important data for the complete definition of a new mineral, the CNMMN (via its chairman or secretary) may ask some of its members, or specialists of some subcommittees, to collaborate with these scientists in order to improve their proposal.

It sometimes happens that non-mineralogical specialists such as crystallographers or chemists publish a crystal-structure description of a new mineral that has not been officially approved by the CNMMN. Such descriptions should not include a name for the mineral.

If the entire mineral specimen has been consumed during the course of the investigation, and consequently nothing of the specimen remains to be deposited in an appropriate collection, approval for the new mineral will not be given; some material must always remain for possible later reexamination.

Treatment of a New-Mineral Proposal

When the chairman of the CNMMN receives a new-mineral proposal from authors, either directly or via the national new-minerals committee in the country of origin, he will acknowledge receipt of the proposal, and may write to the authors asking for more information if he considers this desirable, or he may point out possible objections either to the mineral or to the name. If the authors so desire, the chairman can be required to submit a proposal to the CNMMN whether or not he approves of it. In such cases, the chairman will inform the authors that he will give his reasons as to the unsuitability of the proposal under "Chairman's Remarks." The chairman's abstract of a proposal is sent by air mail to each member of the CNMMN, and approximately 60 days are allowed for receipt of voting papers.

Members of the CNMMN are urged not only to vote, but also to comment in detail. The chairman is authorized to suspend voting on a proposal to enable more information to be obtained, or he may call for a second vote on a proposal if, in his opinion, important comments are made by members which should be seen by all the members. Second votes have the same voting periods (about 60 days) and require the same majorities as those for original proposals (see below). Any member of the CNMMN who objects to a proposal may ask the chairman to suspend voting or to call for a new vote, but the final decision to do so rests with the chairman.

Abstracts of proposals dealing with opaque materials may be sent to some members of the IMA-COM at the discretion of the Chairman. Similarly, the chairman may submit abstracts of any proposals to other specialists for advisory opinions. Such advisors do not vote, but their comments are considered by the chairman. Serious objections raised by advisors are to be treated by the chairman as specified above.

Proposals dealing with minerals belonging to mineral groups for which subcommittees have been organized by the CNMMN may be sent to the appropriate subcommittee chairman for circulation among the subcommittee members if the CNMMN chairman thinks such action is advisable. Subcommittee members are invited to submit opinions, and serious objections raised by them are to be treated as specified above.

If two or more proposals for the same new mineral are received by the chairman, the proposal that arrived first in the chairman's office will have priority. Exceptions can be made if the new-mineral proposal has been submitted via a national new-mineral committee and if the CNMMN chairman has been given prior notification of the receipt of the proposal by the national committee.

A proposed new mineral will be considered approved if more than half ($^1/_2$) of the members of the CNMMN vote on the proposal, and if more than two-thirds ($^2/_3$) of these members have voted "yes." A proposed name will be considered approved if more than one-half ($^1/_2$) of the members who vote on the proposal vote "yes." In assessing the voting results, an abstention is regarded as a negative vote, as it suggests that additional information is required.

After voting on a proposal is completed, the chairman sends the results to the CNMMN members and to the author of the proposal. He includes the comments of the voting members, but the votes of individual members are not disclosed. Reconsideration of adverse votes can be requested by an author at any time if **significant new data or new interpretations** are obtained. If a mineral is approved, but not the name, a new name should be requested by the chairman when he notifies the author of the voting results. In cases of repeat voting, approvals of the mineral and the name require the same majorities as in the original voting.

Authors who have described new minerals without names do not have any priority rights on the subsequent naming of such minerals. However, as a matter of courtesy, it is recommended that a person proposing a name for a previously unnamed mineral communicate with the original authors of the unnamed mineral. Any new names proposed subsequently have to be approved by the CNMMN, as do the minerals for which the names are proposed.

The publication of a non-approved name, or the publication of a name for a non-approved mineral is not acceptable, and journal editors should guard against the introduction of such names.

Mineral Groups

The nomenclature of mineral groups is generally dealt with by subcommittees composed of specialists in the group under consideration, and including at least one member of the CNMMN. The following subcommittees have been established in the past: *Pyrochlore, Amphiboles, Pyroxenes, Sulfosalts, Micas, Zeolites, Platinum-Group Minerals, Nomenclature*, and *Unnamed Minerals*.

The creation of a subcommittee, and the composition of its membership, must be approved by the CNMMN. The subcommittee is expected to formulate recommendations for the nomenclature of minerals in the group under consideration, and these recommendations are submitted to the CNMMN for approval by a voting procedure. The recommendations of a group subcommittee are regarded as being of an advisory nature, with the final decision regarding the adoption of the recommendations resting with the CNMMN.

Proposals for the creation of new subcommittees should be submitted to the chairman of the CNMMN. If the establishment of a new subcommittee is approved, the CNMMN secretary (see Appendix I) is authorized to deal with procedural matters involving the subcommittee.

Changes To Existing Nomenclature

General

Changes to existing mineral nomenclature, including the redefinition or discreditation of existing mineral species, the renaming of minerals, or the revalidation of discredited or obsolete mineral names, must be approved by the CNMMN **before** publication. Toward this end, a suitable proposal should be submitted to the vice-chairman of the CNMMN (see Appendix I).

A list of nomenclature changes approved by the CNMMN since 1987 is given in Appendix II.

Redefinition

Advances in knowledge such as those resulting from structure refinements or new chemical knowledge extending known ranges of solid solution do not, in general, need to be referred to the CNMMN. However, approval of the CNMMN is required if it is proposed to redefine a mineral (a) on structural grounds; (b) by adding or deleting one or more chemical components previously regarded as essential to the definition; or (c) by proposing compositional limits in a solid solution series that are not compatible with the existing definition of the 50% rule (or its equivalent in multicomponent systems). In case of doubt, the authors are invited to consult with the vice-chairman of the CNMMN.

If a mineral is shown to be a mixture and one of the components is still new, the name should usually be transferred to the new phase.

Redefinition of a mineral species requires a review of the literature on the mineral to be redefined, a re-examination of the type specimen (see below), a comparison of the new data with the original published data, and justification for the redefinition.

Discreditation

A mineral or mineral name may be discredited if it can be shown that the mineral is identical to another one that has priority, or if the name is misleading. Requirements for discrediting a mineral species or name are similar to those for redefinition (above), and have been outlined by Dunn (1990).

Revalidation

A mineral that has been discredited or fallen into disuse may be revalidated if a re-examination shows that the mineral meets the normal criteria for a distinct mineral species or that it is a mixture containing a new mineral species. Requirements for revalidating a mineral species are similar to those for redefinition, as given above.

Type Specimens

Whenever possible, the redefinition, discreditation or revalidation of a mineral should be based on a study of type material. If a type specimen exists and if the original description, though faulty, represents a reasonable approximation to material on the specimen, the mineral is to be defined by reference to the type material rather than to the original description. This means that errors in the original description cannot be held to discredit a mineral unless the original description was so grossly inaccurate that, in the words of J. D. Dana (1868), "a recognition of the mineral by means of it is impossible."

If type material cannot be obtained for study, the investigator may propose a *neotype* to the CNMMN, clearly stating the efforts made to seek the original type specimen, and providing satisfactory evidence for the identity of the neotype with the original. Both the acceptance of the neotype and approval of the proposal are within the authority of the CNMMN.

Preparation of a Nomenclature Proposal

A proposal to change mineral nomenclature should include all relevant information, including a summary of the original description of the mineral, a review of subsequent reports, the submission of new data, and recommendations for change.

If one or more of the original authors of the mineral to be discredited or redefined are alive, the author of the discreditation or redefinition proposal should write to the original authors asking them to comment on the proposal, and these comments should accompany the submission to the CNMMN.

A proposal for a change of nomenclature should be sent to the vice-chairman of the CNMMN, who is authorized to write to the author pointing out possible deficiencies in the proposal and making suggestions for its improvement. The proposal, modified if necessary, is then submitted to members of the CNMMN as a draft proposal, inviting them to comment. Such comments, if any, are forwarded to the authors of the draft proposal who are asked to respond to the comments, amend the proposal, or withdraw it, as appropriate. If the proposal is not withdrawn, the amended proposal is submitted to the CNMMN membership for a formal vote, together with the comments on the draft proposal and the authors' responses. The voting procedure is similar to that followed in the case of new-mineral proposals, and at least a two-thirds majority is required to approve such proposals.

General Guidelines for Mineral Nomenclature

Choice of a New Mineral Name

The responsibility for the choice of a name for a new mineral rests primarily with the author(s) of the original description, although the name must ultimately be approved by the CNMMN. A mineral is commonly named for the geographical locality of its occurrence, for the discoverer of the mineral (although not if he/she is the author), for a person or entity prominent in the field of mineralogy, or for a particular property of the mineral.

The naming of the minerals for commercial organizations or interest groups which have made no specific, worthwhile contributions to mineralogy is to be discouraged, in order to prevent inappropriate commercialization of the nomenclature.

If the mineral is to be named after a geographical occurrence, care must be taken to ensure that the spelling conforms to that in use *at the locality*, and should not be taken from translations.

If the mineral is to be named after a living person, that person's permission must be obtained by the author, and this should be done prior to the submission of the proposal to the CNMMN. When deciding to name a mineral after a person, it is well to recall J. D. Dana's (1854) precept:

> It should be remembered that the use of names of persons eminent in other sciences, or of such as are ignorant of all science, is wholly at variance with good usage and propriety; moreover, an attempted flattery of the politically distinguished is degrading to science, and cannot be too strongly discountenanced.

If the mineral is named after a person with a space or a capital letter in the name, the name should be modified to eliminate them, e.g., *mcnearite*, **not** *mcNearite*; *joesmithite*, **not** *joe smithite*. Otherwise, the original spelling of the person's name should be retained.

Although the CNMMN does not have a fixed policy on the use of compounded personal names, some members feel that they should be discouraged, particularly where they become cumbersome or cacophonous, or where they unnecessarily distort the true names of the individual who is being honored.

Mineral names proposed in languages that use other than the Latin alphabet should be transliterated into the Latin alphabet by the author of the name, according to the prevalent system operative in the country of origin. Such transliterated names should be reported, in national journals, for example, when the name of the mineral is written according to other alphabets or phonetic rules. Diacritical marks should be retained wherever possible, but it is recognized that not all printing establishments have the necessary facilities for printing all types of diacritical marks; in such cases diacritical marks may be omitted.

Re-use of a discredited or obsolete name for a new or redefined mineral is to be discouraged, except when the new mineral is a component of a mixture originally described as a single mineral; in such a case, the original name may be transferred to the new phase. Re-use of a discredited name may also be permitted if there is a good reason why the discredited name is particularly appropriate for the mineral in question, and the discredited or obsolete name has not appeared in the active literature (except for the report of its discreditation) for **fifty years**. A proposal to re-use an obsolete name must be accompanied or preceded by a proposal to discredit the obsolete name. If the CNMMN does not approve a proposal to re-use a discredited name, the author of the proposal has no priority for the use of the discredited name, although he is free to propose the name again at a future time.

The re-use of an obsolete or discredited name is not permitted if the name has been used to a significant extent outside the field of mineralogy (e.g., in petrography, metallurgy, paleontology, etc.), or to indicate two or more minerals.

If an artificial substance has been given a name, and a mineral corresponding to that substance is subsequently discovered, the name given to the artificial substance does not necessarily have to be applied to the mineral.

The name must be sufficiently different from existing ones to prevent confusion, both in the author's language and in others. Existing mineral nomenclature already displays a number of examples of unfortunately similar names that are easily confused; names such as *celadonite* and *caledonite*, or *mallardite* and *malladrite* can easily be misspelled; names such as *rhodesite*, *rhodizite* and *rhodusite* are euphonically very similar. Introduction of new names that can create similar problems must be avoided.

If the new mineral is clearly and simply related to an existing one, it is very desirable that this relationship be indicated in the new name, e.g., *clinoenstatite* for the monoclinic dimorph of enstatite, or *magnesiocopiapite* for the Mg analog of copiapite. Such a name should consist of one word only (e.g., *magnesiocopiapite*, **not** *magnesium copiapite*).

Efforts should be made to choose a simple name rather than an excessively complicated one that may be difficult to read or pronounce. The use of excessively long names should be avoided, as these may cause difficulties in pronunciation, tabulations, and computer databases.

Rare-earth Minerals

The name of a mineral with essential rare-earth elements (REE), or the chemically-related elements Y or Sc, must have a suffix indicating the dominant rare-earth element, e.g., *bastnäsite-(Ce)*, and if a new mineral with the same structure and analogous composition, but with a different dominant rare-earth element, is discovered, it should be given a name that is analogous to that of the existing mineral, e.g., *bastnäsite-(Y)*. A suffix of this type is known as a *Levinson modifier*, after the person who introduced this procedure (Levinson, 1966). A subsequent clarification (Bayliss and Levinson, 1988) specifies that more than one chemical symbol may be appended only if the elements occupy different crystal-structure sites. A compilation of rare-earth minerals, appropriately suffixed, was given as an Appendix to Nickel and Mandarino (1987).

An example of a situation that may arise is one in which a mineral has a particular structural site occupied by both Ca and REE, and the sum of REE elements (in mol. props) is greater than that of Ca, but individual REE elements are subordinate to that of Ca. In such a case, the mineral is regarded as a rare-earth mineral, with a Levinson modifier specifying the predominant REE.

Extended Levinson Modifiers

As noted above, Levinson modifiers are used primarily in the nomenclature of rare-earth minerals. In a few cases, however, the procedure has been extended to other mineral groups that can contain different substituting elements in one or more structural sites, e.g., *jahnsites* and *pumpellyites*. In zeolites, such modifiers are used to indicate exchangeable cations. In general, the use of extended Levinson modifiers is acceptable in cases where only one substituting element is suffixed, but suffixes consisting of multiple elements are conditionally acceptable in cases where the structure is complex, and use of such suffixes simplifies the nomenclature.

Adjectival Modifiers

In mineralogical nomenclature, it is important to distinguish the name proper from adjectival modifiers that may precede the name and are not connected to it. An *adjectival modifier* is not considered to be part of the mineral name, and is normally used to indicate a compositional variant, e.g., *ferroan manganotantalite*, where *ferroan* is the adjectival modifier that indicates the presence of some ferrous iron, and *manganotantalite* is the name proper. It is recommended that Latin-derived adjectives should be used whenever possible (Hey and Gottardi, 1980), e.g., *natrian* vs. *sodian*, and *kalian* vs. *potassian*. The adjectival modifiers recommended by Schaller (1930) have found general acceptance, and they have been augmented by additional ones in the more comprehensive list of adjectival modifiers published by Nickel and Mandarino (1987). In constructing an adjectival modifier that is not in the list, the ending *-oan* is to be used for the ion with the lower valency, and *-ian* for the higher. If the valency of an element in a particular mineral is not known, the adjectival modifier derived from the more likely, or more common, valence state of the element should be used.

As adjectival modifiers are not considered to be a part of the mineral name, they should be ignored in the preparation of alphabetical indexes. Occasionally an adjectival modifier is given in the form of a hyphenated chemical prefix, e.g., *Li-tosudite*, rather than *lithian tosudite* or *lithium-bearing tosudite*. Such usage is **incorrect and should be avoided.**

Varietal Names

The existing names of mineral varieties such as *amethyst*, *kunzite*, etc., which are not regarded as species, do not come under the jurisdiction of the CNMMN, and are therefore unregulated. The introduction of new varietal names, however, is to be discouraged, as it tends to create confusion in the mineralogical literature.

Nomenclature of Mineral Groups

As noted above, subcommittees have been established for a number of complex mineral groups. Some of these subcommittees have produced reports that have been approved by the CNMMN, and these reports have been published in a number of different journals. The reports, which include guidelines for the nomenclature of minerals comprising these groups, are too complex to be summarized adequately here, so readers are advised to consult the published reports of these subcommittees, as follows: *pyrochlore*—Hogarth (1977); *pyroxenes*—Morimoto *et al.* (1989); *platinum-group minerals*—Harris and Cabri (1991); *amphiboles*—Leake *et al.* (1997); *zeolites*—Coombs *et al.* (1997), and *micas*—Rieder *et al.* (1998).

In general, names of less complex mineral groups are well established in the mineralogical literature, and frequently one of the species names of the minerals comprising the group is used for this purpose. The use of such group names is not regulated by the CNMMN, but the creation of a new name must have the approval of the CNMMN.

Nomenclature of Polytypes, Polytypoids and Polymorphs

The approved system for denoting polytypes is the modified Gard notation recommended by the International Mineralogical Association and the International Union of Crystallography (Bailey *et al.*, 1978; Guinier *et al.*, 1984; Nickel, 1993). It consists of the mineral name followed by a hyphenated, italicized suffix comprising an alphabetic character to indicate crystal system, preceded by a numerical symbol to indicate multiplicity of the structural unit, first proposed by Ramsdell (1947). This system can also be used for topologically similar polymorphs and for polytypoids. The alphabetical characters to be used in the suffixes are as follows: cubic—*C*, tetragonal—*Q* (for *Q*uadratic), hexagonal—*H*; trigonal—*T*; rhombohedral—*R*; orthorhombic—*O*; and triclinic—*A* (for *A*northic).

Example 1

Muscovite-1*M* is the monoclinic polytype of muscovite with c = 10Å; muscovite-2M_1 is the monoclinic polytype of muscovite with c = 20Å; and muscovite-3*T* is the trigonal polytype of muscovite with c = 30Å.

Example 2

Analcime has a number of topologically identical polymorphs caused by different degrees of ordering of Al and Si in the tetrahedral structural sites. The different polymorphs are distinguished by the suffixes -1*C*, -1*Q*, -1*M*, etc.

Nomenclature of Nanometric Domains

If a domain of nanometric dimensions in a larger mineral grain has a unique composition or crystal structure but is not sufficiently large to qualify as a mineral species, it should not be given a distinctive mineral name. If it is deemed necessary to refer to such a domain by name, it should retain the name of the host mineral, with the addition of an appropriate suffix to indicate the crystallographic and/or compositional nature of the domain. Such suffixes do not require approval by the CNMMN.

Nomenclature of Variable-Fit Homologous Series

Individual names should not be given to members of variable-fit homologous series (see a previous section). Instead, an optional descriptive modifier may be appended, describing the match between the building blocks. The contents of the appended symbol will vary according to the precision required or the method used, should contain the word "homologue," and should be enclosed by <> brackets. An example is "*cylindrite <homologue (19,13)Q/(30,12)H>*" for a homologue of the cylindrite series with a tetragonal (quadratic) building block of 19 by 13 units which is commensurable with a hexagonal block of 30 by 12 units.

Prefixes in Mineral Names

In applying compositional prefixes to mineral names it is recommended that Latin-derived prefixes should be used instead of other linguistic derivatives (Hey and Gottardi, 1980), e.g., *ferro-* instead of *eisen-*, *natri-* instead of *soda-*, or *stanno-* instead of *olovo-*.

Prefixes are an integral part of the mineral name, and should generally be treated as such in the preparation of alphabetical compilations or indexes. However, an exception can be made in the case of prefixed symbols such as Greek letters or their spelled-out Latin equivalents, which may be positioned after the main name in alphabetical listings, e.g., β-*roselite* may be written as *roselite*-β or *roselite-beta*.

The prefix *para* should be used only for names of dimorphs or polymorphs of known minerals. The prefix *meta* should be used only for names of lower hydrates of known minerals.

Hyphens in Mineral Names

Hyphens are used in mineral names to connect suffixed symbols, such as polytype suffixes and Levinson modifiers. The use of a hyphen to distinguish a prefix from the root name is to be discouraged, but where an unhyphenated name is awkward and a hyphen assists in deciphering the name, it may be used, e.g., *bario-orthojoaquinite*.

Mineral Names for Synthetic Substances

Unmodified mineral names should not, in general, be used for synthetic substances corresponding to existing minerals, chemical analogs of existing minerals, or hypothetical minerals. However, synthetic substances that correspond to existing minerals may be given mineral names if such names are suitably modified to clearly indicate their synthetic origin (Nickel, 1995b), or if the synthetic origin of such substances is clearly stated.

Publication of the Descriptions of Approved Minerals

The published paper describing the new mineral should include sufficient information, comparable to that given in the proposal to the CNMMN. Publication in a brief abstract in which only some of the data are given should be avoided.

Authors of approved proposals should publish descriptions of the minerals covered by these proposals **within two years** of being notified of the approval by the chairman or vice-chairman. If new-mineral descriptions, discreditations, redefinitions or revalidations are not published within that time, the proposals are no longer considered as approved. Any extensions of this deadline must be approved by the chairman or vice-chairman, as appropriate.

Advice to Editors

Journal editors will do a service to the earth science community if they cooperate fully with the CNMMN. All aspects of the nomenclature in submitted manuscripts should be evaluated according to the guidelines given here, and assurance should be sought from authors that they have submitted all matters dealing with mineral nomenclature to the CNMMN, and that their proposals have been approved. Unless they have definite proof of approval, editors should consult with their national representatives on the CNMMN, or with members of the CNMMN executive. Editors should be particularly cautious about the final acceptance of a paper bearing phrases like "has been submitted" or "will be submitted" to the CNMMN. Acceptance of such papers should be delayed until evidence is produced that the nomenclature **has been approved** by the CNMMN.

In the case of new minerals, editors should insist on evidence that a type specimen of the new mineral has been lodged in at least one major museum or a nationally recognized mineral collection. This information should be included in the published paper.

It would be appreciated if all journals that publish mineralogical papers include the following statement in their instructions to authors:

This journal follows the rules of the Commission on New Minerals and Mineral Names of the IMA in all matters concerning mineral names and nomenclature

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Appendix I.
Members of the IMA Commission on New Minerals and Mineral Names as of August, 1998

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Appendix II. Nomenclature Changes 1987–1998*

Discreditations

Andrewsite (= hentschelite)	Dunn: *Am. Min.* **75** (1990), 1197
Anosovite (= armalcolite)	Bowles: *Am. Min.* **73** (1988), 1377
Ashanite (= ixiolite)	Pending
Baumite (= impure serpentine)	Guggenheim and Bailey: *Am. Min.* **75** (1990), 705
Bravoite (= nickeloan pyrite)	Bayliss: *Am. Min.* **74** (1989), 1168
Calciocelsian (= armenite)	Mason: *Min. Mag.* **51** (1987), 317
Calcium Pharmacosiderite (= barium pharmacosiderite)	Pending
Caratiite (= piypite)	Filatov and Vergasova: *ZVMO* **118** (3) (1989), 88
Chavesite (= monetite)	Kampf and Dunn: *Am. Min.* **79** (1994), 385
Coutinhite (= lanthanite-(Nd))	Pending
Coutinite (= lanthanite-(Nd))	Pending
Csiklovaite (= tetradymite)	Bayliss: *Am. Min.* **76** (1991), 257
Cuprocassiterite (= mushistonite)	Dunn and Roberts: *Min. Rec.* **17** (1986), 383
Donathite (= magnetite + chromite)	Burns *et al.*: *N. Jb. Min. Mh.* **1997,** 163
Ferrazite (= gorceixite)	Atencio and Clark: *Min. Mag.* **60** (1996), 841
Ferropseudobrookite (= pseudobrookite)	Bowles: *Am. Min.* **73** (1988), 1377
Herschelite (= chabazite)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Iridosmine (= osmium)	Harris and Cabri: *Can. Min.* **29** (1991), 231

*Additional changes in the nomenclature of pyroxenes, amphiboles, zeolites and micas introduced during this period have been published in reports by the appropriate CNMMN subcommittees (Morimoto *et al.*, 1989; Leake *et al.*, 1997; Coombs *et al.*, 1997; and Rieder *et al.*, in press, respectively).

Kehoite (a mixture)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Kennedyite (= armalcolite)	Bowles: *Am. Min.* **73** (1988), 1377
Laubmannite (= impure dufrenite)	Dunn: *Am. Min.* **75** (1990), 1197
Leonhardtite (= starkeyite)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Lusungite (= goyazite)	Pring *et al.*: *Min. Mag.* **59** (1995), 143
Maufite (= interstratified lizardite/chlorite)	Pending
Neodymite (= lanthanite-(Nd) or lanthanite-(La))	Pending
Niobolоparite (= loparite-(Ce))	Mitchell *et al.*: *Can. Min.* **34** (1996), 991
Osmiridium (= iridium)	Harris and Cabri: *Can. Min.* **29** (1991), 231
Platiniridium (= iridium)	Harris and Cabri: *Can. Min.* **29** (1991), 231
Polymignite (= zirkelite)	Bayliss *et al.*: *Min. Mag.* **53** (1989), 565
Portite (= natrolite)	Franzini and Perchiazzi: *Europ. Jour. Min.* **6** (1994), 351
Protoastrakhanite (= konyaite)	van Doesburg and van der Plas: *Am. Min.* **74** (1989), 1382
Ranite (= gonnardite)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Rezbanyite (= mixture with hammarite)	Zak and Mumme: *N. Jb. Min. Mh.* **(1994),** 314
Ruthenosmiridium (= iridium)	Harris and Cabri: *Can. Min.* **29** (1991), 231
Selen-tellurium (= selenium + tellurium)	Bayliss: *Am. Min.* **76** (1991), 257
Sismondine (= magnesiochloritoid)	Chopin *et al.*: *Europ. Jour. Min.* **4** (1992), 67
Staringite (= cassiterite + ferrotapiolite)	Groat *et al.*: *Min. Mag.* **58** (1994), 271
Sulrhodite (= bowieite)	Bayliss *et al.*: *Min. Mag.* **56** (1992), 125
Svetlozarite (= dachiardite)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Tetranatrolite (= gonnardite)	Pending
Ureyite (= kosmochlore)	Morimoto *et al.*: *Min. Mag.* **52** (1988), 535
Viséite (= disordered crandallite)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Warrenite (= jamesonite)	Pending
Wellsite (= phillipsite and harmotome)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571

Redefinitions

Aguilarite	Pending
Armalcolite	Bowles: *Am. Min.* **73** (1988), 1377
Attakolite	Grice and Dunn: *Am. Min.* **77** (1992), 1285
Berndtite polytypes	Bayliss and Clark: *Min. Mag.* **54** (1990), 137
Gartrellite	Krause *et al.*: *Eur. J. Min.* **10** (1998), 179
Georgeite	Pollard *et al.*: *Min. Mag.* **55** (1991), 163
Kegelite	Dunn *et al.*: *Am. Min.* **75** (1990), 702
Khademite	Cesbron and Bayliss: *Min. Mag.* **52** (1988), 133
Plumbotellurite	Pending
Pseudobrookite	Bowles: *Am. Min.* **73** (1988), 1377
Rutheniridosmine	Harris and Cabri: *Can. Min.* **29** (1991), 231
Tengerite-(Y)	Miyawaki *et al.*: *Am. Min.* **78** (1993), 425
Villamaninite	Bayliss: *Am. Min.* **74** (1989), 1168
Xitieshanite	Li Jiaju *et al.*: *Sci. Geol. Sinica* **(1989),** 106
Zirconolite polymorphs	Bayliss *et al.*: *Min. Mag.* **53** (1989), 565
Zirkelite	Bayliss *et al.*: *Min. Mag.* **53** (1989), 565

Renamings

Acmite (= aegirine)	Morimoto *et al.*: *Min. Mag.* **52** (1988), 535
Actinolitic hornblende (= magnesiohornblende)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Analcite (= analcime)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Crossite (= glaucophane, etc.)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Dannemorite (= manganogrunerite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Edenitic hornblende (= edenite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Fassaite (= diopside or augite)	Morimoto *et al.*: *Min. Mag.* **52** (1988), 535
Ferridravite (= povondraite)	Grice *et al.*: *Am. Min.* **78** (1993), 433
Ferro-actinolitic hornblende (= ferrotschermakite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Ferroan pargasite (= pargasite or ferropargasite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Ferroan pargasitic hornblende (= pargasite or ferropargasite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Ferro-edenitic hornblende (= ferro-edenite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Ferro-pargasitic hornblende (= ferropargasite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Ferro-tschermakitic hornblende (= ferrotschermakite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Fiedlerite polytypes	Merlino *et al.*: *Min. Mag.* **58** (1994), 69
Ginzburgite of Voloshin *et al.* (= roggianite)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Gismondite (= gismondine)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Hastingsitic hornblende (= hastingsite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Herschelite (= chabazite-Na)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Hiortdahlite polymorphs	Merlino and Perchiazzi: *Min. Petrol.* **37** (1987), 25
Hypersthene (= enstatite or ferrosilite)	Morimoto *et al.*: *Min. Mag.* **52** (1988), 535

Leonhardite (= laumontite)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Magnesian hastingsite (= magnesiohastingsite or hastingsite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Magnesian hastingsitic hornblende (= magnesiohastingsite or hastingsite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Magnesio-anthophyllite (= anthophyllite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Magnesio-clinoholmquistite (= clinoholmquistite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Magnesio-cummingtonite (= cummingtonite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Magnesio-gedrite (= gedrite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Magnesio-hastingsitic hornblende (= magnesiohastingsite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Magnesio-holmquistite (= holmquistite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Magnesium orthite (= dollaseite-(Ce))	Peacor and Dunn: *Am. Min.* **73** (1988), 838 [P]
Natroautunite (= meta-natroautunite)	Chernikov and Organova: *Dokl. Akad. Nauk* **338** (1994), 368
Pargasitic hornblende (= pargasite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Penkvilskite polytypes	Merlino *et al.*: *Am. Min.* **79** (1994), 1185
Silicic edenite (= edenite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Silicic ferro-edenite (= ferro-edenite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Sodium-anthophyllite (= sodicanthophyllite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Sodium dachiardite (= dachiardite-Na)	Coombs *et al.*: *Can. Min.* **35** (1997), 1571
Sodium gedrite	Leake *et al.*: *Can. Min.* **35** (1997), 219
Tirodite (= mangano-cummingtonite)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Tremolitic hornblende (= magnesiohornblende)	Leake *et al.*: *Can. Min.* **35** (1997), 219
Tschermakitic hornblende (= tschermakite)	Leake *et al.*: *Can. Min.* **35** (1997), 219

Revalidations

Aerinite	Azambre and Monchoux: *Bull. Min.* **111** (1988), 39
Barium pharmacosiderite	Walenta: *Aufschluss* **45** (1994), 73
Fernandinite	Evans *et al.*: *Can. Min.* **32** (1994), 339
Prismatine	Grew *et al.*: *Min. Mag.* **60** (1996), 483
Pseudorutile	Grey *et al.*: *Min. Mag.* **58** (1994), 597

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Andyrobertsite and Calcioandyrobertsite: Two New Minerals from the Tsumeb Mine, Tsumeb, Namibia

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ABSTRACT

Andyrobertsite, ideally $KCdCu_5(AsO_4)_4[As(OH)_2O_2](H_2O)_2$, and **calcioandyrobertsite**, ideally $KCaCu_5(AsO_4)_4[As(OH)_2O_2](H_2O)_2$, are two new minerals from the Tsumeb mine, Namibia. Both minerals form a lamellar intergrowth that is crystallographically continuous, and hence only average physical properties can be measured. There is only one specimen known, an aggregate of overlapping plates that radiate outward from a common center; the individual plates are up to 0.1 x 5 x 10 mm and the aggregate is pyramidal, approximately 1.4 cm long and 1 cm across the base. The aggregate is perched on cuprian adamite and zincian olivenite with minor tennantite. Andyrobertsite and calcioandyrobertsite have a platy habit with forms {100} (dominant), {210}, {001}, {10$\bar{2}$} and {011}; no twinning was observed. They are electric blue with a pale-blue streak, a vitreous luster, and they do not fluoresce under longwave or shortwave ultraviolet light. The aggregate has a Mohs hardness of 3, is brittle with a conchoidal fracture, and has good cleavage parallel to (100). The strongest five reflections in the X-ray powder diffraction pattern of a bulk sample are [d(Å), I, hkl]: 9.64(100)(100); 3.145(50)(130,122); 4.46(40)(120); 3.048(40)($\bar{2}$22); 2.698(40)(320). The refined cell dimensions for a monoclinic cell with $P2_1/m$ space-group symmetry are a = 9.810(4), b = 10.034(6), c = 9.975(4) Å, β = 101.84(4)°, V = 961.0(6) Å^3, a:b:c = 0.9777:1: 0.9941, Z = 2. The calculated density for an aggregate crystal of andyrobertsite and calcioandyrobertsite in a 50:50 proportion of the end-members is 4.011 g/cm^3. In transmitted light, andyrobertsite [calcioandyrobertsite] is biaxial negative with α = 1.720(3) [1.713(3)], β = 1.749(1) [1.743(1)], γ = 1.757(1) [1.749(1)], 2V(meas.) = 50(5) [50(5)]°, 2V(calc.) = 55 [48]°, with X ^ a = 12° (in β obtuse), Y = b, Z = c; it is non-pleochroic. Electron-microprobe data for andyrobertsite (calcioandyrobertsite) are As_2O_5 = 47.58(49.56), CuO = 31.72(32.86), ZnO = 0.19(0.04), CdO = 6.48(1.26), MnO = 0.64(0.86), CaO = 1.36(3.52), K_2O = 4.00(4.05), H_2O(calc.) = 4.44(4.61), sum = 96.41(96.75) weight %; the corresponding unit formulae (based on 22 anions) are $K_{1.03}(Cd_{0.61},Ca_{0.30}Mn_{0.11})(Cu_{4.85}Zn_{0.03})(AsO_4)_{4.04}[As(OH)_2O_2](H_2O)_2$ and $K_{1.01}(Cd_{0.12}Ca_{0.74}Mn_{0.14})(Cu_{4.85}Zn_{0.01})(AsO_4)_{4.06}[As(OH)_2O_2](H_2O)_2$, where the OH and H_2O groups were assigned from knowledge of the crystal structure; the infrared spectrum indicates the presence of OH and H_2O in the structure. The minerals are named for Andrew C. Roberts (born 1950), mineralogist with the Geological Survey of Canada; he has contributed significantly to the science of mineralogy and has had extensive interactions with the collecting community, providing expertise and scientific support to many collectors around the world.

INTRODUCTION

It was a warm, sunny afternoon in mid-September, 1996. One of us (WWP) stopped to chat with Carol Smith in the parking lot of the Holiday Inn in Denver during the annual Denver Gem and Mineral Show. In the course of the conversation, Carol mentioned a large and spectacular crystal of "keyite" that she had seen for sale in the room of mineral dealer Carter Rich. Immediate investigation

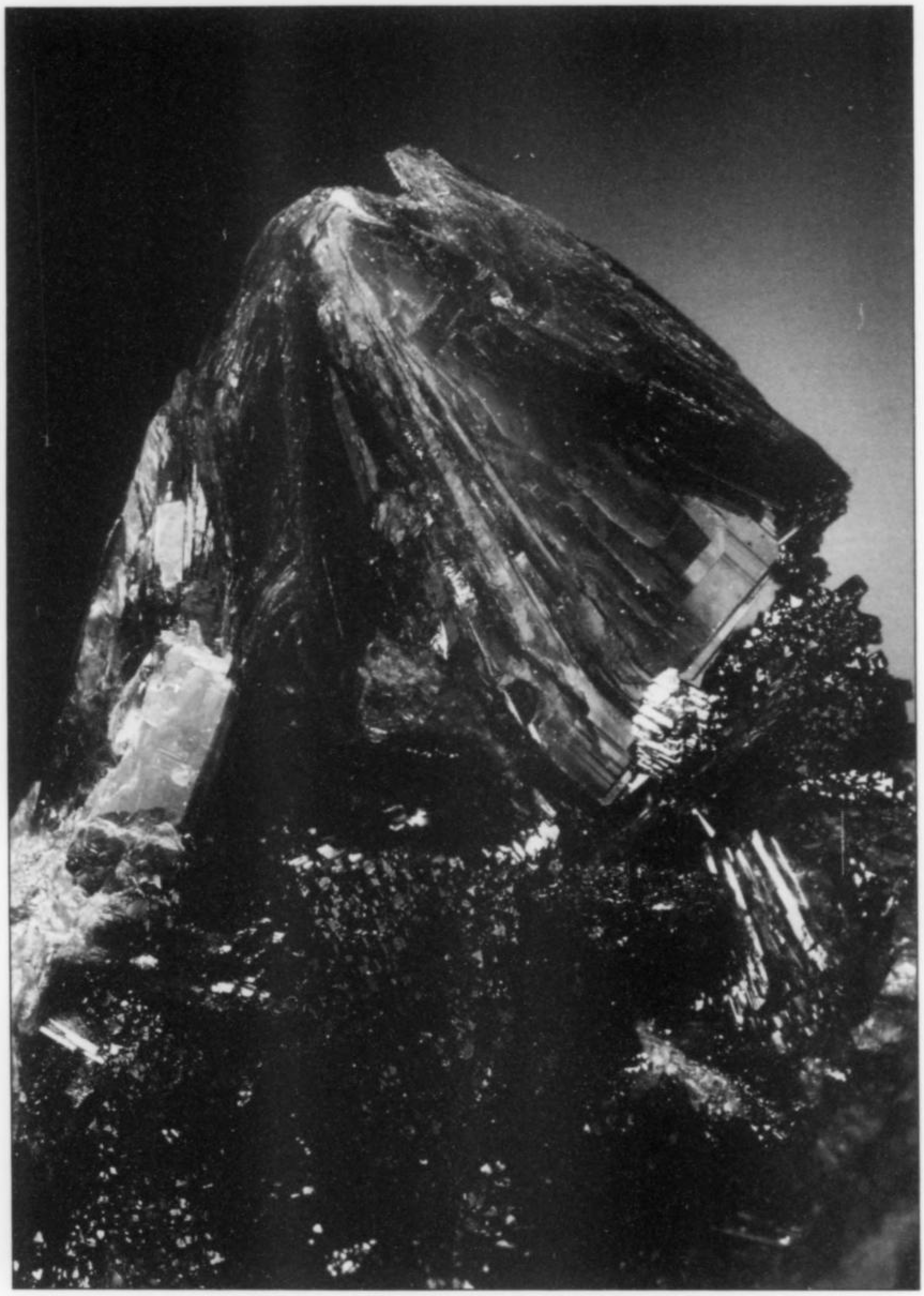

Figure 1. **Andyrobertsite-calcioandyrobertsite (electric blue), 1.5 cm high and 1.8 cm across the base. William Pinch specimen, Jeff Scovil photo.**

revealed a beautiful electric-blue crystal cluster, perhaps the most spectacular rare-mineral specimen any of us had ever seen. The label stated "Keyite crystals, with Zn-deficient analysis provided, from Tsumeb, S.W.A."; but the mineral clearly did not resemble keyite, even though the microprobe analysis contained Cd, Cu and As. The absence of Zn and the presence of K indicated that this must be a new mineral.

HISTORY OF THE SPECIMEN

The specimen first belonged to Richard Baughart, a mining engineer working at Tsumeb; it was reported to have been found in the early 1950's. At a later date, it was acquired by Ben Staskun, a close friend of Baughart. Staskun donated it to a well-known U.S. university. In the early 1990's, the university sold the mineral for a few dollars in a dispersal sale. It was purchased by Steve Kudums who sent a piece of it to Tony Nikisher of *Excalibur Minerals* for analysis by SEM-EDS. Dr. Kudums then exchanged the specimen with Carter Rich for a zincite crystal from Franklin, New Jersey. Carter Rich put the piece up for sale, and it was purchased by one of the authors (WWP) in Denver on September 15, 1996.

The new mineral and mineral name have been approved by the Commission on New Minerals and Mineral Names of the International Mineralogical Association. Type material has been deposited with the Royal Ontario Museum (specimen numbers M47022 and M47110) and the Smithsonian Institution (specimen number NMNH 171487).

PHYSICAL PROPERTIES

The single specimen consists of an aggregate of overlapping plates which radiate outward from a common center; individual plates are up to 0.1 x 5 x 10 mm. The aggregate is pyramidal in shape, approximately 1.4 cm long and 1 cm across the base, and is perched on cuprian adamite and zincian olivenite (see cover photo). The minerals have a platy habit with forms {100} (dominant), {210}, {001}, {10$\bar{2}$} and {011}; no twinning was observed.

Andyrobertsite and calcioandyrobertsite are electric blue (Fig. 1) with a pale-blue streak and a vitreous luster; crystals do not fluoresce under longwave or shortwave ultraviolet light. The minerals are brittle with a conchoidal fracture and a good cleavage parallel to (100); Mohs hardness is 3 and the calculated density is 4.011 g/cm^3 for a 50:50 mixture of the end members.

OPTICAL PROPERTIES

In transmitted light, andyrobertsite and calcioandyrobertsite are greenish blue and non-pleochroic; dispersion is moderate, asymmetric with r < v. The optical orientation is X ^ a = 12° (in β obtuse), Y = b, Z = c; 2V, measured by the Tobi method, is 50(5)°. The refractive indices (Table 1) were measured in monochromatic light (λ = 590 nm); α was measured on a spindle stage, β and γ were measured on a grain mount. Although crystals have pervasive fine-scale chemical zoning and measured optical properties are necessarily an aggregate of different chemical compositions, we could measure optical properties on parts of crystals that are predominantly Cd-rich (andyrobertsite) and Cd-poor (calcioandyrobertsite); the measured optical properties and corresponding chemical compositions are listed in Table 1.

***Table 1.* Optical properties, average chemical compositions and unit formulae for andyrobertsite and calcioandyrobertsite.**

	Andyrobertsite	*Calcioandyrobertsite*
α	1.720(3)	1.713(3)
β	1.749(1)	1.743(1)
γ	1.757(1)	1.749(1)
2*V* (obs)°	50(5)	50(5)
2*V* (calc)°	55	48
As_2O_5	47.58	49.56
CuO	31.72	32.86
ZnO	0.19	0.04
CdO	6.48	1.26
MnO	0.64	0.86
CaO	1.36	3.52
K_2O	4.00	4.05
(H_2O)	4.44	4.61
Sum	96.41	96.75
Unit formulae		
As	5.04	5.06
Cu	4.85	4.85
Zn	0.03	0.01
Σ	4.88	4.86
Cd	0.61	0.12
Mn	0.11	0.14
Ca	0.30	0.74
Σ	1.02	1.00
K	1.03	1.01
OH	2	2
H_2O	2	2

CHEMICAL COMPOSITION

Crystals were analyzed chemically with a Cameca SX-50 electron microprobe operating in wavelength-dispersion mode with an accelerating voltage of 15 kV, a specimen current of 20 nA, a beam size of 20 μm and counting times on peak and background of 30 and 15 seconds, respectively. The following standards were used: Cd: Cd metal; Cu: olivenite; As: cobaltite; K: orthoclase; Ca: diopside; Mn: spessartine; Zn: gahnite. Data were reduced using the ϕρZ method of Pouchou and Pichoir (1985).

Back-scattered-electron (BSE) imaging shows fine lamellar zoning on a scale of microns (Fig. 2). Detailed electron-microprobe analysis shows the zoning to involve variable Cd, Ca and Mn

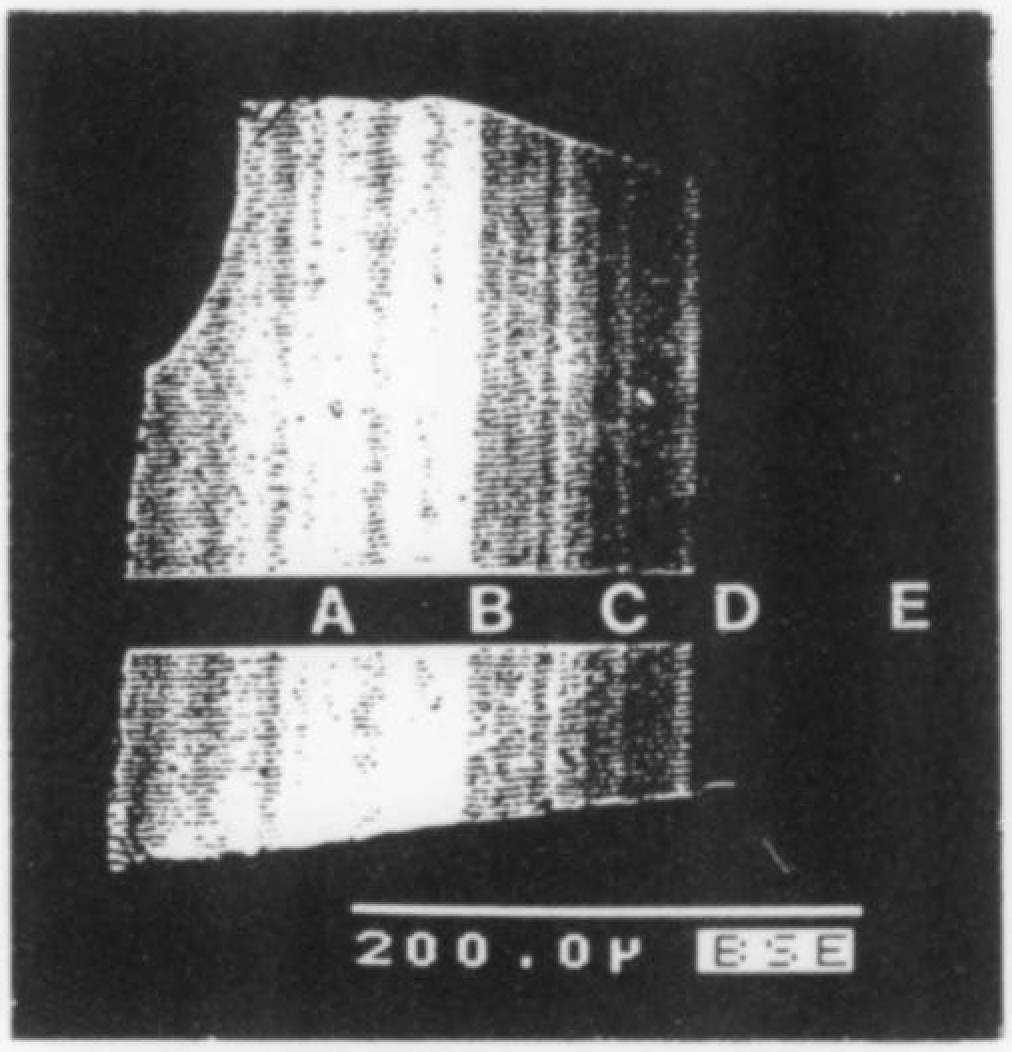

***Figure 2.* Back-scattered-electron image of a crystal of andyrobertsite-calcioandyrobertsite showing lamellar alternation of the two minerals. The edge of the crystal closest to E is the outer growth margin.**

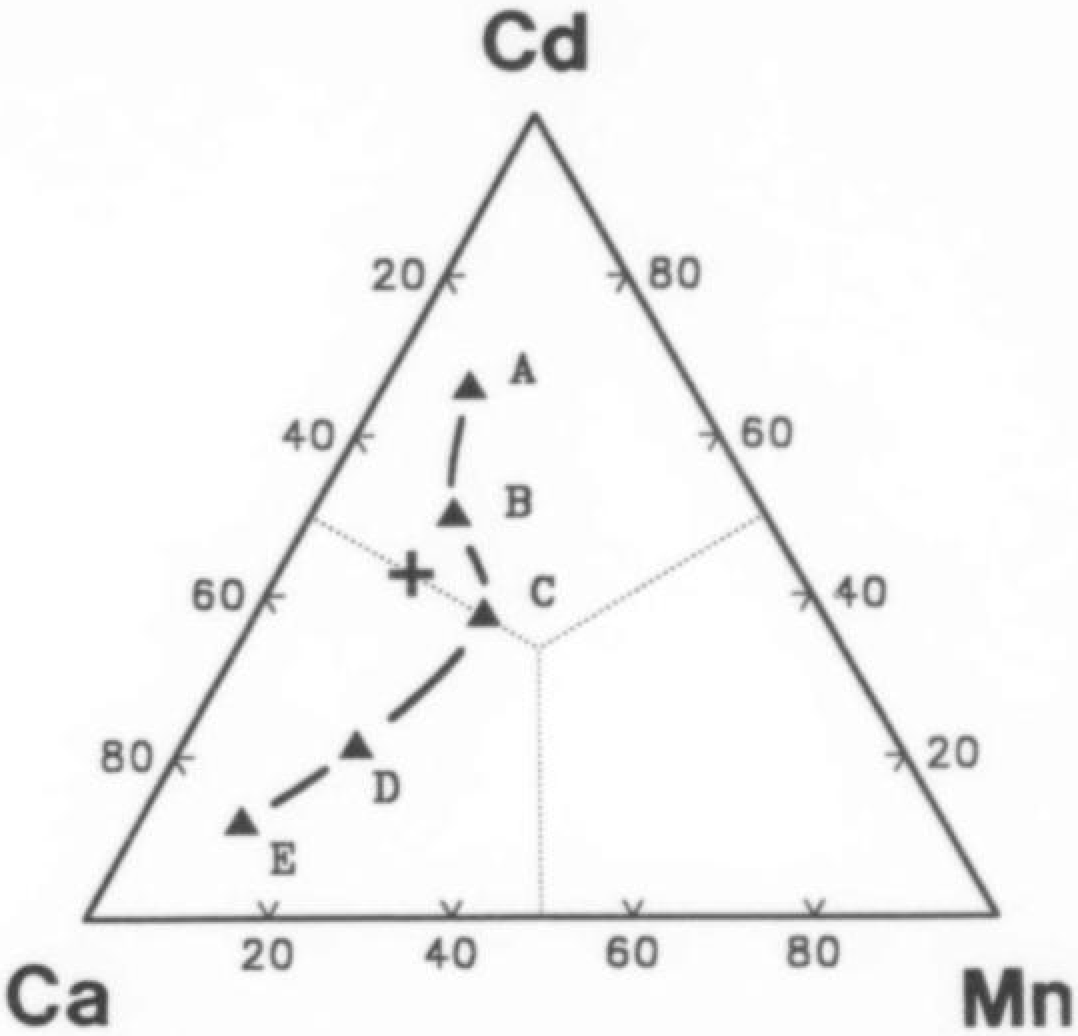

***Figure 3.* The variation in chemical composition of the crystal of andyrobertsite-calcioandyrobertsite shown in Figure 2. The cross marks the bulk composition of the crystal.**

Table 2. **Chemical compositions of andyrobertsite and calcioandyrobertsite from Figure 2.**

	A	*B*	*C*	*D*	*E*	+
As_2O_5	47.19	47.87	48.75	48.97	49.6	48.35
CuO	31.38	32.07	32.39	32.87	32.75	32.17
ZnO	0.08	0.06	0.21	0.10	0.00	0.13
CdO	7.12	5.29	4.09	2.33	1.30	4.60
MnO	0.57	0.92	1.52	1.17	0.69	0.87
CaO	1.15	1.58	1.78	2.86	3.71	2.01
K_2O	4.09	4.03	4.01	4.04	4.07	4.01
(H_2O)	4.41	4.47	4.55	4.57	4.61	4.51
Sum	95.99	96.29	97.30	96.91	96.27	96.63
As	5.04	5.04	5.04	5.03	5.06	5.05
Cu	4.84	4.88	4.84	4.88	4.83	4.85
Zn	0.01	0.01	0.03	0.02	0.00	0.02
Cd	0.68	0.50	0.38	0.21	0.12	0.43
Mn	0.10	0.16	0.26	0.20	0.11	0.15
Ca	0.25	0.34	0.38	0.60	0.78	0.43
K	1.07	1.04	1.01	1.01	1.01	1.02
(H)	6	6	6	6	6	6

+ average composition along the continuous line-traverse A → E.

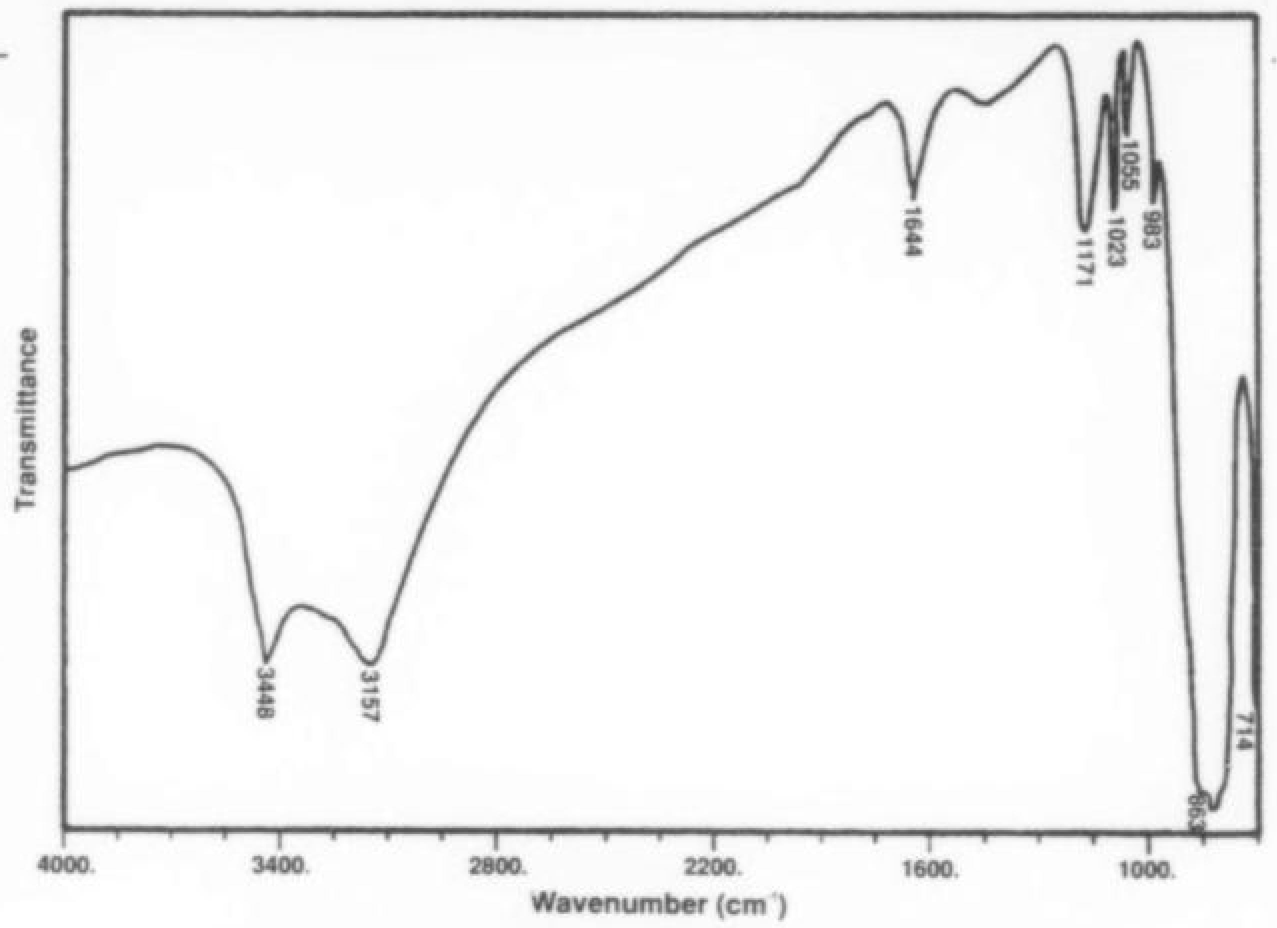

Figure **4. The infrared spectrum of andyrobertsite-calcioandyrobertsite.**

with (approximately) constant K, Cu and As. K_2O values were corrected for overlap of the $KK\alpha$ peak and the Cd *L* peak. Selected analyses from the crystal shown in Figure 2 are listed in Tables 1 and 2. The chemical formulae were calculated on the basis of 22 anions including two OH groups and two H_2O groups, as derived from solution and refinement of the crystal structure (Cooper and Hawthorne, 1999) and are given in Table 1. The crystal in Figure 2 involves a ternary solid-solution of Cd, Ca and Mn, all of which occur at the same site in the structure (Cooper and Hawthorne, 1999); the composition varies from A (andyrobertsite) to E (calcioandyrobertsite), and also shows significant variation in the Mn content (Fig. 3). It is apparent from Figure 3 that there are two distinct mineral species present in the crystal of Figure 2, the Cd-dominant species and the Ca-dominant species. Analysis of several grains showed that the Cd species is more abundant, and hence this was assigned the root name; the Ca-rich species was assigned a name by prefixing the root name with "calcio."

Andyrobertsite is the eleventh mineral containing essential Cd, and is also the first doubly acid arsenate mineral (i.e., contains an $[As(OH)_2O_2]$ group).

X-RAY DIFFRACTION

A single-crystal fragment was mounted on a Siemens P4 four-circle X-ray diffractometer and the unit cell (Table 5) was determined by indexing of 48 automatically aligned reflections in the range $40 < 2\theta < 60°$. The crystal structure was determined in the space group $P2_1/m$ (structural details will be reported elsewhere). The X-ray powder-diffraction pattern is reported in Table 5, together with the experimental conditions and the refined cell dimensions.

INFRARED SPECTROSCOPY

Experimental methods are identical to those reported by Roberts *et al.* (1994). The spectrum (Fig. 4) shows a broad absorption at $\sim$3300 cm^{-1} and a sharp weaker absorption at 1644 cm^{-1}, indicating the presence of H_2O in the structure; the sharp absorption at 3448 cm^{-1} is compatible with the presence of OH in the structure.

Table 3. **Chemical compositions of zincian olivenite and cuprian adamite.**

	Zincian Olivenite	*Cuprian Adamite*
As_2O_5	41.41	41.27
ZnO	4.41	26.43
CuO	51.76	31.63
TOTAL	97.58	99.33
As	1.01	1.00
Zn	0.15	0.90
Cu	1.82	1.10
TOTAL	1.97	2.00

Table 4. **Minerals containing essential cadmium.**

Name	*Formula*	*Reference*
Andyrobertsite*	$KCdCu_5^{2+}(AsO_4)_4[As(OH)_2O_2](H_2O)_2$	(1)
Cadmium	Cd	(2)
Cadmoselite	CdSe	(3)
Černýite	Cu_2CdSnS_4	(4)
Greenockite	CdS	(5),(6)
Hawleyite	CdS	(7)
Keyite	$Cu_3^{2+}(Zn,Cu^{2+})_4Cd_2(AsO_4)_6(H_2O)_2$	(5),(8)
Monteponite	CdO	(9)
Niedermayrite	$Cu_4Cd(SO_4)_2(OH)_6(H_2O)_4$	(10)
Otavite	$CdCO_3$	(5)
Quadratite	$Ag(Cd,Pb)AsS_3$	(11)

References: (1) this study; (2) Oleinikov *et al.* (1979); (3) Bur'yanova *et al.* (1957); (4) Kissin *et al.* (1978); (5) Pinch and Wilson (1977); (6) Hurlburt (1957); (7) Traill and Boyle (1955); (8) Cooper and Hawthorne (1996); (9) Anthony *et al.* (1990); (10) Giester *et al.* (1998); (11) Graeser *et al.* (1998).
* Minerals found at Tsumeb are shown in bold type.

Table 5. X-ray powder-diffraction data for andyrobertsite.

$I_{est.}$	$I_{calc.}$	$d\text{Å}_{meas.}$	$d\text{Å}_{calc.}$	*hkl*
100	100	9.64	9.601	100
5	4	7.61	7.678	$10\bar{1}$
30	23	7.00	6.997	011
3	1	5.00	5.017	020
30	12	4.81	4.801	200
	10		4.764	$\bar{1}02$
40	38	4.46	4.447	120
5	5	4.31	4.304	$\bar{1}12$
*25	20	4.027	4.030	102
*5	6	3.842	3.839	$\bar{2}02$
5	4	3.723	3.712	211
*15	11	3.493	3.499	022
*10	10	3.243	3.245	$\bar{3}01$
50	33	3.145	3.158	130
	49		3.142	122
*40	49	3.048	3.049	$\bar{2}22$
30	12	2.979	2.994	$\bar{2}03$
	21		2.971	$\bar{3}02$
*5	11	2.908	2.906	103
3	7	2.878	2.872	301
	4		2.759	032
	4		2.754	$23\bar{1}$
30	9	2.747	2.744	230
	7		2.737	$32\bar{1}$
	5		2.730	023
*40	40	2.698	2.698	320
*15	15	2.648	2.648	222
*30	19	2.565	2.571	$\bar{2}23$
		8	2.522	$\bar{2}32$
30	13	2.515	2.515	123
	12		2.509	040
*5	12	2.491	2.491	$\bar{1}04$
3	5	2.452	2.455	302
	2		2.441	004
5	2	2.398	2.400	400
5	4	2.381	2.385	312
	2		2.380	$\bar{4}11$
3	2	2.322	2.318	$\bar{2}14$
*15	11	2.283	2.281	232
10	2	2.227	2.231	$\bar{1}24$
	5		2.221	$\bar{3}32$
*5	4	2.203	2.202	$\bar{4}21$
3	4	2.152	2.152	$\bar{2}24$
3	5	2.125	2.130	142
*5	3	2.102	2.100	$\bar{2}42$
3	3	2.061	2.059	124
*10	5	2.036	2.036	421
3	3	1.989	1.985	$\bar{3}41$

$I_{est.}$	$I_{calc.}$	$d\text{Å}_{meas.}$	$d\text{Å}_{calc.}$	*hkl*
	3		1.966	051
	2		1.964	150
10b	2	1.953	1.962	$\bar{5}01$
	2		1.954	$\bar{2}05$
	3		1.953	005
	3		1.927	$\bar{5}02$
5	1	1.921	1.917	015
	2		1.917	$\bar{3}42$
	5		1.889	341
10	3	1.885	1.886	510
	4		1.870	224
3	2	1.849	1.849	$\bar{1}52$
	3		1.827	$\bar{5}21$
5	3	1.821	1.826	$\bar{5}03$
	2		1.821	$\bar{2}25$
	2		1.820	025
	6		1.796	152
10	4	1.793	1.793	520
	3		1.793	$\bar{4}24$
	2		1.792	$\bar{3}43$
*15	18	1.766	1.767	$\bar{1}44$
3	7	1.746	1.749	044
	2		1.734	440
3	1	1.728	1.730	$\bar{3}25$
	2		1.728	125
3		1.716	1.716	$\bar{5}23$
	1		1.714	$\bar{1}53$
	4		1.700	350
5	5	1.692	1.694	$\bar{4}05$
	2		1.692	205
*5	4	1.672	1.672	060
3	4	1.656	1.661	$\bar{1}06$
3	3	1.611	1.614	$\bar{3}35$
*5	8	1.588	1.588	522
	3		1.565	$26\bar{2}$
3	2	1.561	1.563	442
	3		1.557	253
	2		1.554	352
	9		1.544	$\bar{6}22$
	10		1.540	450
25b	3	1.540	1.536	$\bar{5}05$
	3		1.533	$\bar{2}62$
	4		1.533	305
3	3	1.526	1.527	$\bar{4}52$
*5	3	1.509	1.509	235
3b	1	1.485	1.483	126
	1		1.482	360
15	5	1.466	1.468	$\bar{5}25$
	4		1.466	325
3	1	1.442	1.444	443
	1		1.444	630
*10	6	1.415	1.415	$55\bar{1}$

114.6 mm Debye-Scherrer powder camera; Cu radiation, Ni-filter ($\lambda CuK\alpha$ = 1.54178Å)
Intensities estimated visually; b = broad line
* = lines used for unit-cell refinement
Calculated intensities derived from crystal structure
Not corrected for shrinkage and no internal standard
Indexed on a = 9.810(4), b = 10.034(3), c = 9.975(4) Å, β = 101.84(4)°, V = 961.0(6) Å^3

ASSOCIATED MINERALS

The andyrobertsite-calcioandyrobertsite crystal cluster is perched on dark olive-green zincian olivenite and grass-green cuprian adamite with minor tennantite. The olivenite and adamite were analyzed by electron microprobe; the results are given in Table 3.

Early crystals of cuprian adamite at the base of the sample are overgrown by later zincian olivenite, forming the matrix on which andyrobertsite-calcioandyrobertsite crystallized. The andyrobertsite-calcioandyrobertsite crystals show complex oscillatory zoning (Cd, Ca, Mn) on a scale of a few microns; however, there is a broader zonation over several tens of microns, corresponding mainly to Ca → Cd substitution (A → E, Figs. 2, 3). These compositional variations in all four minerals suggest a fluid becoming relatively depleted in Zn, relative to Cu, prior to the crystallization of andyrobertsite-calcioandyrobertsite, followed by an evolving reversal in the relative activities in solution of Cd and Ca, from Cd > Ca to Ca > Cd during crystallization of andyrobertsite-calcioandyrobertsite.

The discovery of andyrobertsite and calcioandyrobertsite brings the number of minerals with essential Cd to eleven; these are listed in Table 4. Greenockite and hawleyite are reported to occur together by Anthony *et al.* (1990), but no locality is given. With the exception of this possible association and Tsumeb, the other minerals in Table 4 are each the only mineral containing essential Cd at the localities in which they occur. Except for the recently discovered niedermayrite, all known oxide and oxysalt minerals containing essential Cd occur at Tsumeb (Pinch and Wilson, 1977), another unique feature of this amazing mineral deposit.

ACKNOWLEDGMENTS

We thank Andy Roberts for measuring the X-ray powder-diffraction pattern of these minerals and refining the cell dimensions, and J. A. Mandarino and A. Rosenzweig for their comments on this paper. This work was supported by the Natural Sciences and Engineering Research Council of Canada (grants to FCH).

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THE MEIKLE MINE
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Enormous vugs containing some of the finest barite crystals in the world have recently been exposed in a new, underground, high-grade gold mine in northeastern Nevada. This is very likely the first world-class mineral locality for Nevada; selected specimens from this deposit easily rank with classic examples from other historically important occurrences.

INTRODUCTION

In a paper on the mineralogy of the Gold Quarry mine, Eureka County, Nevada (Jensen *et al.*, 1995), one of the authors (MCJ), noted, "It is the authors' opinion that this specific region of Nevada probably contains the most complex and noteworthy mineralogical occurrences in the entire state." With the official opening of the Meikle (pronounced Meekull) mine little more than one year later, this statement has proven to be true in a remarkable way. Underground development and mining at this new operation have exposed a number of huge vugs containing outstanding crystals of yellow-orange barite that are in a class with the best barite specimens found anywhere in the world. Museum-size clusters of lustrous crystals to more than 15 cm have been collected, and unexplored portions of some vugs may yield even larger examples in the future. Barrick Goldstrike Mines, Inc. (BGMI), the owner/operator of the property, conducts mining on a two-shifts-per-day, seven-days-a-week schedule for high-grade gold ore, and the mineralized vugs, at least up through the middle of 1997, have been encountered on a fairly regular basis.

The site of this new occurrence is situated on the famous Carlin Trend gold belt in northeast Nevada. The "Trend" is a northwest-southeast oriented zone about 55 km long consisting of several low-grade, large-tonnage disseminated gold deposits, all of which are, at present, being actively mined. The two major operating companies are Barrick Goldstrike Mines and Newmont Gold Company. All of the deposits, including the Post/Betze, Blue Star, Genesis, Old Carlin, Gold Quarry, and Rain (from north to south) have been mined primarily by open-pit methods to date. Deep drilling from the surface, however, has discovered localized zones of high-grade gold mineralization, necessitating the development of underground mines. In fact, so large has been the push recently toward underground mining that experienced miners have been hired from all over the United States in order to build the necessary staff.

The fourth of these new underground operations to be placed into full-scale production (after Rain, Carlin East and Deepstar) was the BGMI Meikle mine. Named after a retired senior vice

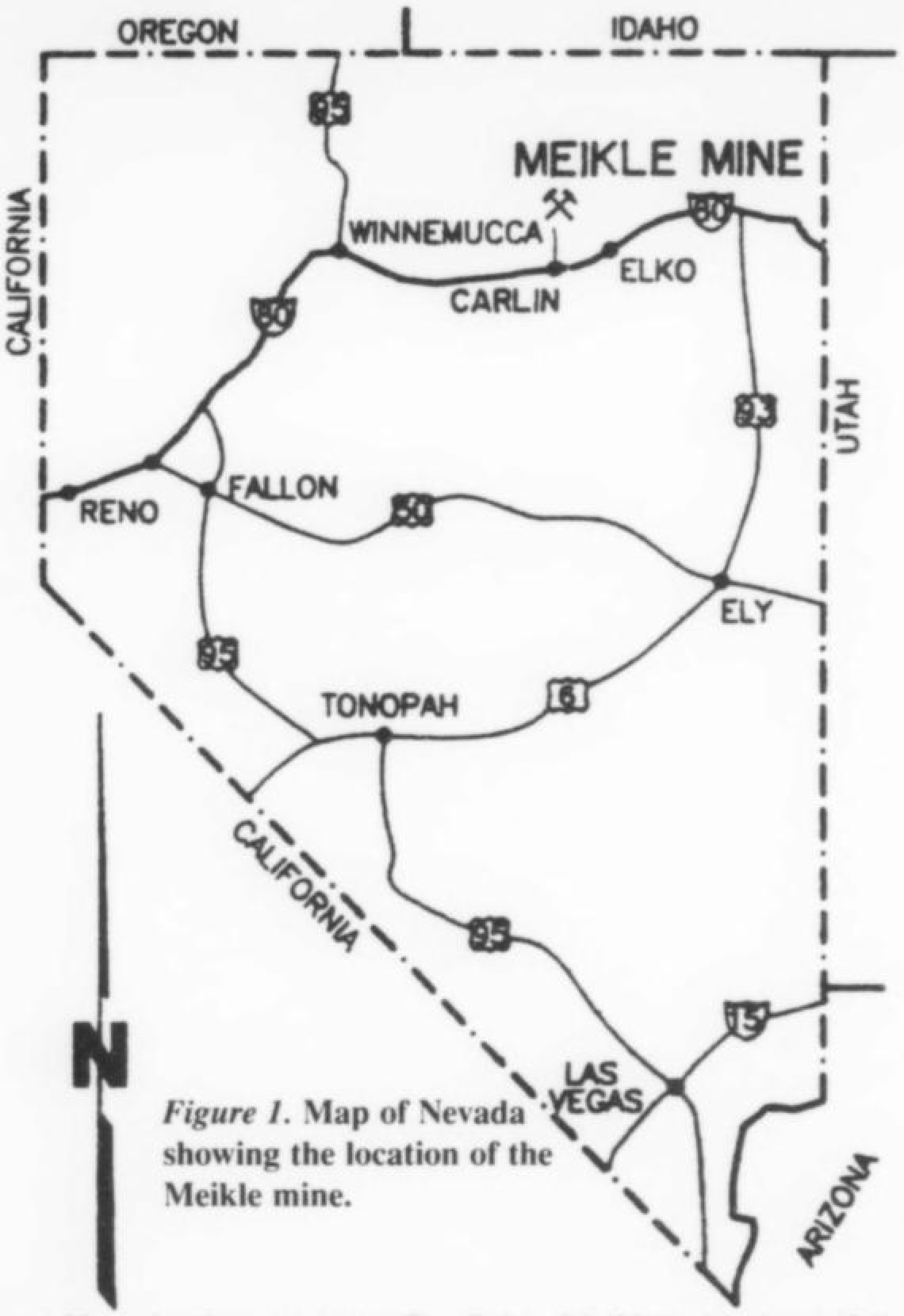

Figure 1. **Map of Nevada showing the location of the Meikle mine.**

president in the company (Dr. Brian Meikle), this beautifully modern and efficient example of state-of-the-art shaft and underground mining technology is situated at the northern extremity of the Carlin Trend. From the nearest town, Carlin, on Interstate 80, a paved county road (Route 776) leads northward to the mines. The Meikle complex is located about 46 km from Carlin. The operation was officially opened on 21 September 1996 with a visit and underground tour by former United States President George Bush, who is a member of the BGMI advisory board.

GEOLOGY and DEVELOPMENT

The Meikle (formerly Purple Vein) gold deposit was discovered in 1989 (*Elko Daily Free Press*, 21 Sept. 1996) by conventional drilling techniques from the surface. The orebody lies approximately 2 km north of the large Post/Betze open-pit gold mine along the northward extension of the Post Fault system. According to Volk *et al.* (1995), the deposit is hosted by a complex series of collapse, tectonic, and hydrothermal breccias which are confined to the Devonian Popovich and Silurian-Devonian Roberts Mountains Formations. These lower-plate carbonate rocks are widespread in this region of Nevada, and consist for the most part of calcareous mudstones to dolomitic limestones. The breccia bodies range in thickness from about 120 to 250 meters and host approximately 85% of the ore reserves at Post/Betze and Meikle (Volk *et al.*, 1995). Highly altered Jurassic monzonite and lamprophyre dikes of varying thickness locally intrude the sediments.

Economic gold mineralization, extending from 250 meters (800 feet) to 580 meters (1900 feet) below the surface at the Meikle mine, is localized for the most part along north-northwest-striking fault systems and at structural intersections (Volk *et al.*, 1995). These high-angle structures also focused the pre-mineral acidic fluids which initiated formation of large-scale collapse breccias (Volk *et al.*, 1995), subsequently providing immense open spaces for the growth of late-stage crystallized barite and calcite. In fact, so large were some of these open spaces that Quaternary surface alluvium has been intersected as far down as the 373-meter level, having slumped or filled voids which could not support themselves and which had collapsed up to the surface. Gold ore zones are commonly characterized by decarbonization, silicification, and the presence of fine-grained sulfides, chiefly pyrite and marcasite. Gold is microscopic, as is typical of all Carlin Trend deposits. The orebody is composed of three zones: the Main Zone, the East Zone, and the South Meikle Zone (J. Volk, pers. comm., 1999). The age of mineralization is controversial; some say about 8.5 to 9.5 million years (Arehart *et al.*, 1993), but Mid-Tertiary is now considered more likely.

Two circular vertical shafts (one production and one service/ventilation) provide access to the deposit. Shaft stations have been developed at 282 meters (925 feet), 328 meters (1075 feet), 373 meters (1225 feet), 396 meters (1300 feet), and 442 meters (1450 feet). Mining levels, connected via spiral ramps from the shaft stations, are situated 15 meters (50 feet) apart, beginning at 259 meters (850 feet) and continuing on down to 488 meters (1600 feet). Mining, utilizing rubber-tired equipment, produces at a rate of more than 2000 tons of ore per day (Volk *et al.*, 1995).

The water table has been pumped down to facilitate access to the ore and the mine workings. Very hot and humid conditions are present locally. Hot, moisture-laden air commonly issues from small fracture zones as well as from the mineralized vugs. Rock temperatures in excess of 71° C (160° F) have been recorded, and selected small fracture zones continually issue forth minute scorching plumes of steam. All of the crystal-bearing vugs, when first encountered, are excessively hot, humid, and often gassy, with ambient temperatures of about 40° C (105° F). Factoring in the "heat index" due to the 100% humidity, the pockets *feel* as if they are actually about 60° C (140° F). For safety reasons, BGMI has implemented stringent policies regarding access to these caverns. The largest mine refrigeration system in North America, with a cooling plant capacity of 10 megawatts (Barrick Goldstrike, Annual Report to Stockholders, 1996), has been installed to provide adequate ventilation throughout the workings.

VUGS and MINERALS

During early development of haulage drifts and ramps, vugs were encountered essentially from the top of the orebody on down. The first few such vugs were opened on the 297-meter level and were small (for the mine), being about 3 to 4 meters in diameter and lined only with thick (20-cm) crusts of pale green, drusy, crystalline calcite. During subsequent work on the 328-meter level, a huge vug (more accurately, a crystal-lined cavern) was discovered. This unsupported natural opening, although somewhat irregular in shape, has maximum dimensions of at least 49 meters (160 feet) horizontally by 49 meters in vertical extent and 27 meters (90 feet) in width. A plywood viewing platform has been erected at the entrance to the vug, and lights (always on) have been installed throughout to illuminate this amazing geological feature. The pocket has been informally named the George Bush Vug, since the former President visited it on his underground tour at the time of the official mine opening. The floor, walls, and ceiling of this "crystal cave" are entirely covered with thick, semi-smooth crusts of bladed, pale green, crystallized calcite. On some surfaces of the calcite, multitudes of sparkling tabular barite crystals averaging 1.5 cm have formed. At the end opposite the platform, the vug pinches down and plunges into a near-vertical structure (a "natural shaft"). In this area, possibly due to increased fluid flow during formation (R. Pye, personal communication, 1996), the barite crystals dramatically increase in size and abundance, covering most of the

Figure 2. **Oblique aerial view to the southeast showing the Meikle mine complex (foreground), the Rodeo shaft headframe (middle right), and the large Post/Betze open pit and Goldstrike mill complex in the background.**

walls and ceiling. It is difficult to comprehend and to describe the magnitude of the crystallization in this area; on virtually every surface visible in the light of the miner's lamp, large, deep orange-yellow, lustrous, undamaged barite crystals stand out from the matrix of pale green calcite. The opportunity to personally examine such an occurrence surely ranks as one of the most magnificent and memorable experiences in the life of a student of mineralogy.

As if this were not enough, the vug twists slightly and continues downward (containing local superb barite clusters) and then drops off sharply for about 10 meters, opening once again into another large chamber. At the limit of the miner's lamp light, statuesque knobs and bulbous masses of bladed calcite decorated with clusters of crystallized barite can barely be seen on the walls and floor of the room. To date, no one has entered or examined this area. Somewhere a connection with drifts on the 373-meter level below has been made, as attested to by the air flow coming up through the vug, but exactly where the connection is remains a mystery.

Barite crystals from these large, calcite-coated vugs (Fig. 10) exhibit a unique and distinctive morphology, tapering slightly along the *b* axis toward the termination, which is in itself stepped like the top of a castle (castellated). The deep, caramel orange-yellow color is nearly identical to that of historic barite specimens from the former Sherman Tunnel locality in Colorado. The combination of unique morphology and distinctive color will serve, in the

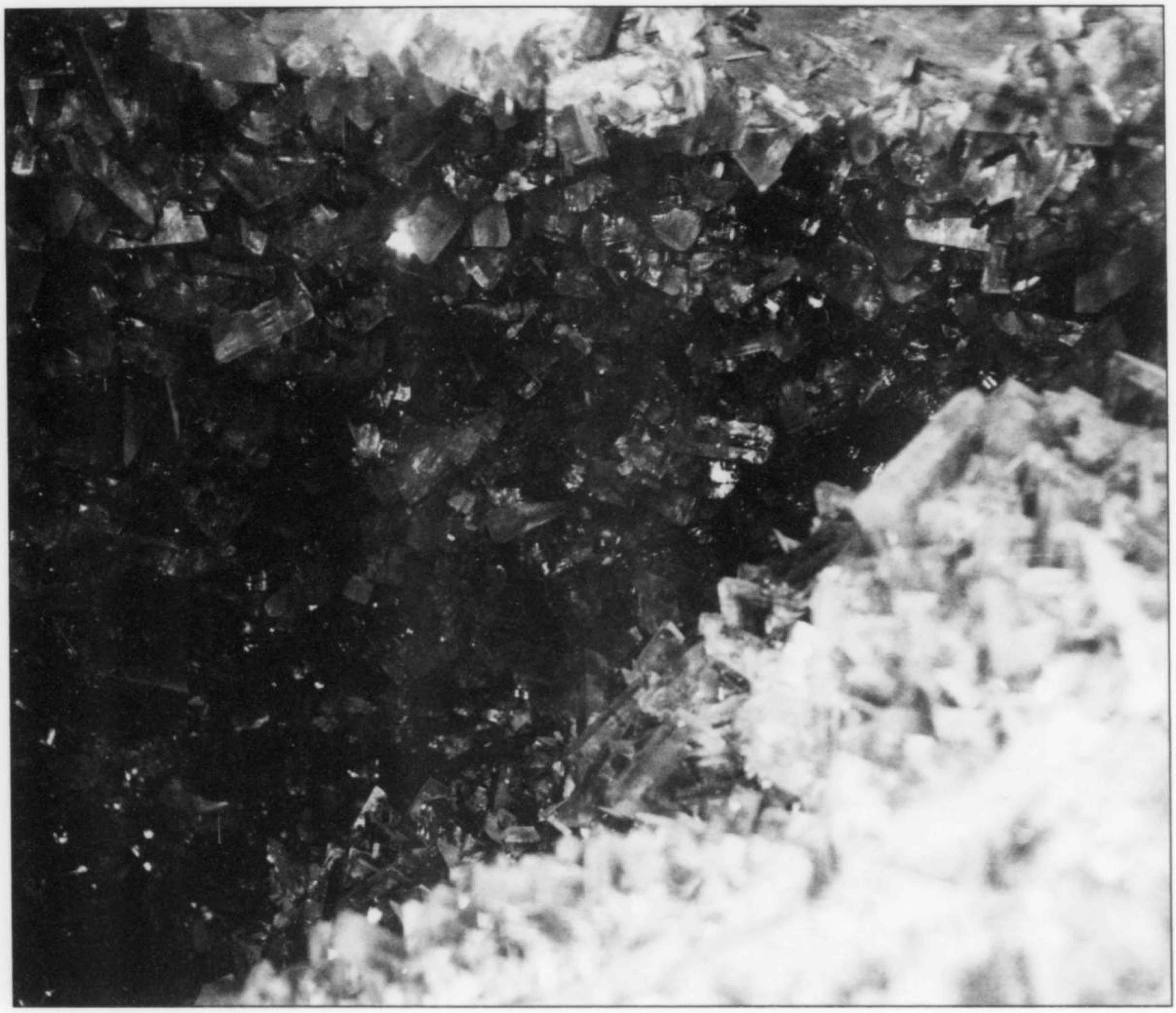

Figure 3. **Magnificent view, about 65 cm across, in a vug of dazzling, deep orange-yellow barite crystals averaging about 5 cm each (328-meter level, 3475 drift).**

future, to instantly characterize this style of barite as being from the Meikle mine.

Another tremendous vug similar to the above was encountered along the rib of the 373-meter level, South Meikle access drift. Though this pocket is similar in dimensions and in the size, quality and abundance of barite, there are also noticeable differences. In addition to wall coatings and bulbous knobs of calcite/barite combinations, well-developed stalactitic and sheet-like structures were also locally present. These protuberances are exceptionally aesthetic and make beautiful specimens (Figs. 7 and 15). When continued pumping lowered the water level in the main open chamber of this vug, it became possible to examine even deeper clefts and chambers. All proved to be lined with lavish crystals. Undulating sheets of crystallized pale green calcite dangling from the ceiling were coated with lustrous orange-yellow barite coalescing into areas several meters square of hummocky, undamaged crystal clusters.

Far down in the widening chamber a truly unbelievable barite occurrence could be seen. Hanging from the ceiling was a perfect mushroom-shaped knob about 1 meter across and 1 meter long, totally overgrown with radiating barite crystals. This eerie "orb" probably weighed on the order of 225 kg and would have required scaffolding and a major effort to collect and preserve. Shortly after its discovery, however, this exceptional pocket had to be backfilled with waste rock when the Griffin ramp access drift was driven over its roof.

Along a fault-controlled zone bordering ore on the 328-meter level, another style of spectacular vug occurs. These vugs are characterized by a general lack of calcite, a simple, tabular morphology of the barite, and abundant, loose, pocket contents. Frustratingly hot geothermal air rising forcefully out of the openings, however, prohibits examination for longer than about five to ten minutes, since longer exposures become dangerous. Although not as large as the calcite-lined caverns, these vugs are nonetheless

Figure 4. **A pocket of lustrous, deep orange-yellow barite crystals to 8 cm, which are in large part overgrown by white scalenohedral calcite crystals; the view is about 80 cm across.**

similarly breathtaking. The largest of these pockets yet discovered is an opening about 3 meters wide by 15 meters tall and 20 meters deep with parallel, near-vertical walls totally covered with drusy crystallized barite. Cubic meters of crystal-bearing breccia fragments ranging in size up to slabs weighing several tons loosely plug the lower half of the vug. Individual barite crystals are mirror-lustrous, razor sharp, glass-clear, lemon-yellow crystals to about 6 cm (!). Absolutely magnificent specimens have been collected from these vugs (Figs. 5, 8 and 14).

From the 328-meter level on down, large vugs are still relatively abundant, but the majority contains only the thick, drusy, pale green calcite. Although the calcite is crystallized and lustrous, the large size (about 10 cm) of individual crystals and the thickness of drusy wall coatings all but preclude the collection of true specimens, since a typical knob or plate with any aesthetic appeal would easily weigh in excess of 200 kg.

Calcite crystals are also widespread throughout the mine in smaller vugs (1 to 2 meters across) apparently paragenetically unrelated to the larger "caves." A wide variation in morphology has been noted for calcite from these pockets, and some truly superb clusters have been seen. Two rather distinct types of crystals occur. Most common are druses of equant, glassy, colorless crystals to 1.5 cm forming plates and knobs on thin selvages of limestone and jasperoid. Far rarer are pockets lined with brilliant, smoky gray to pale yellow to colorless, elongated scalenohedrons ranging up to 24 cm in length. Close inspection of these latter vugs has revealed the presence of stubby contact twins (on (0001)) to 2 cm, elongated "football" contact twins to 5 cm, and very uncommon fishtail twins (on $(01\bar{1}2)$) to 5 mm. Calcite crystals from these vugs easily furnish the finest examples of the species from Nevada, and possibly anywhere else in the United States with the exception of Mississippi Valley-Type deposits.

A relatively small number of other mineral species has been verified and reported from the Meikle mine. In general, however, these occur either as thin coatings, inclusions, or microcrystals. Following is a brief list of these additional minerals.

Clays

The common alteration clay minerals of kaolinite, illite and fraipontite occur throughout the deposit.

Dolomite $CaMg(CO_3)_2$

Dolomitization, developed around zones of extensive collapse brecciation (Volk *et al.*, 1995), has produced "zebra dolomite" (rhythmically banded) textures containing local pearly-white, euhedral, rhombic crystals to 2 mm.

Figure 5. **Golden barite crystal cluster, 17 cm, from the 282-meter level. Steve Smale collection; Jeff Scovil photo.**

Figure 6. **Golden barite crystals, 10 cm, with calcite and pyrite, from the 343-meter level. Private collection; Wendell Wilson photo.**

Figure 7. **Golden barite crystal, 5.2 cm, on pyrite, from the 343-meter level. Martin Jensen collection; Wendell Wilson photo.**

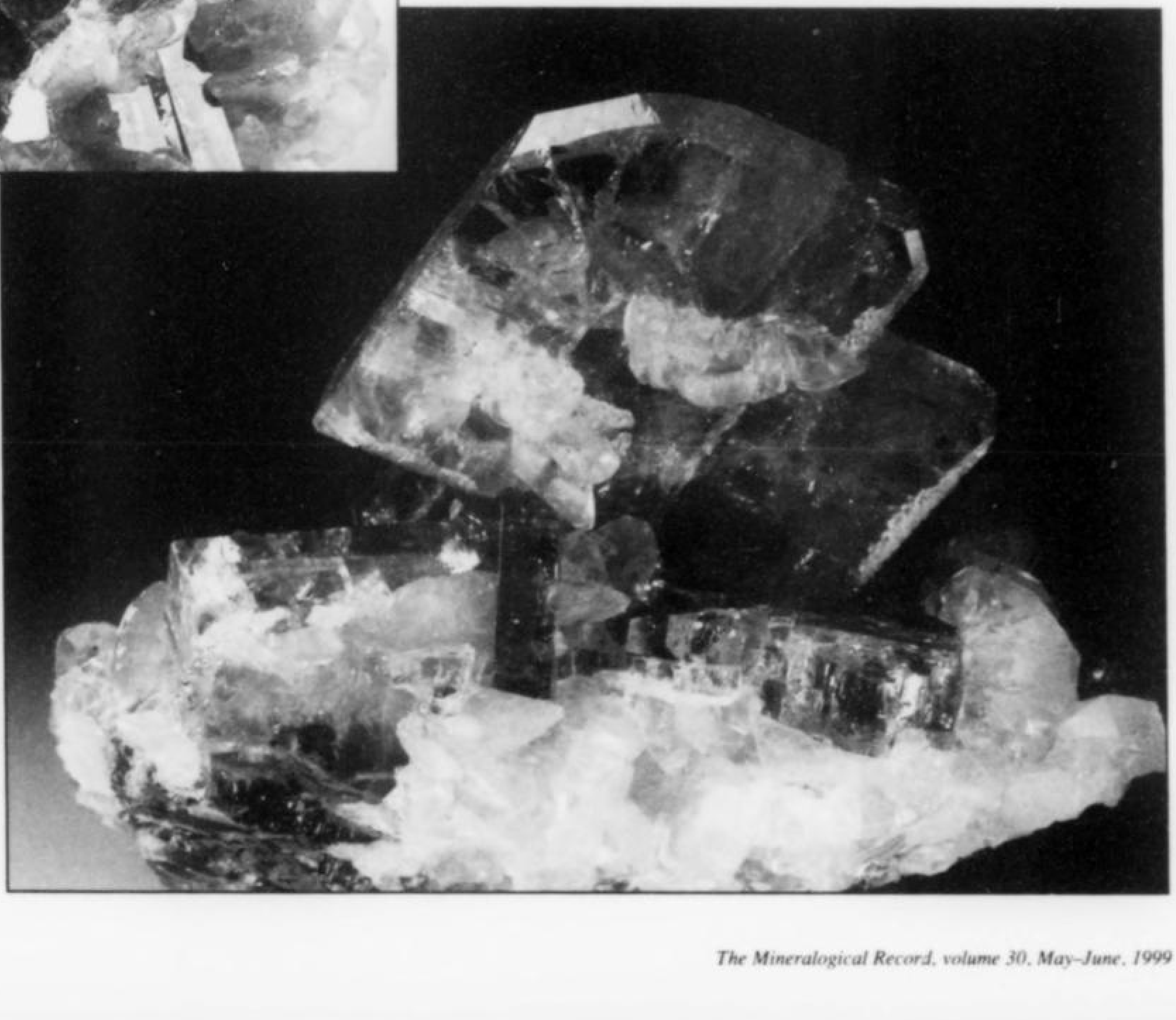

Figure 8. Superb, 12-cm cluster of golden barite crystals from the 328-meter level. Martin Jensen collection; Wendell Wilson photo.

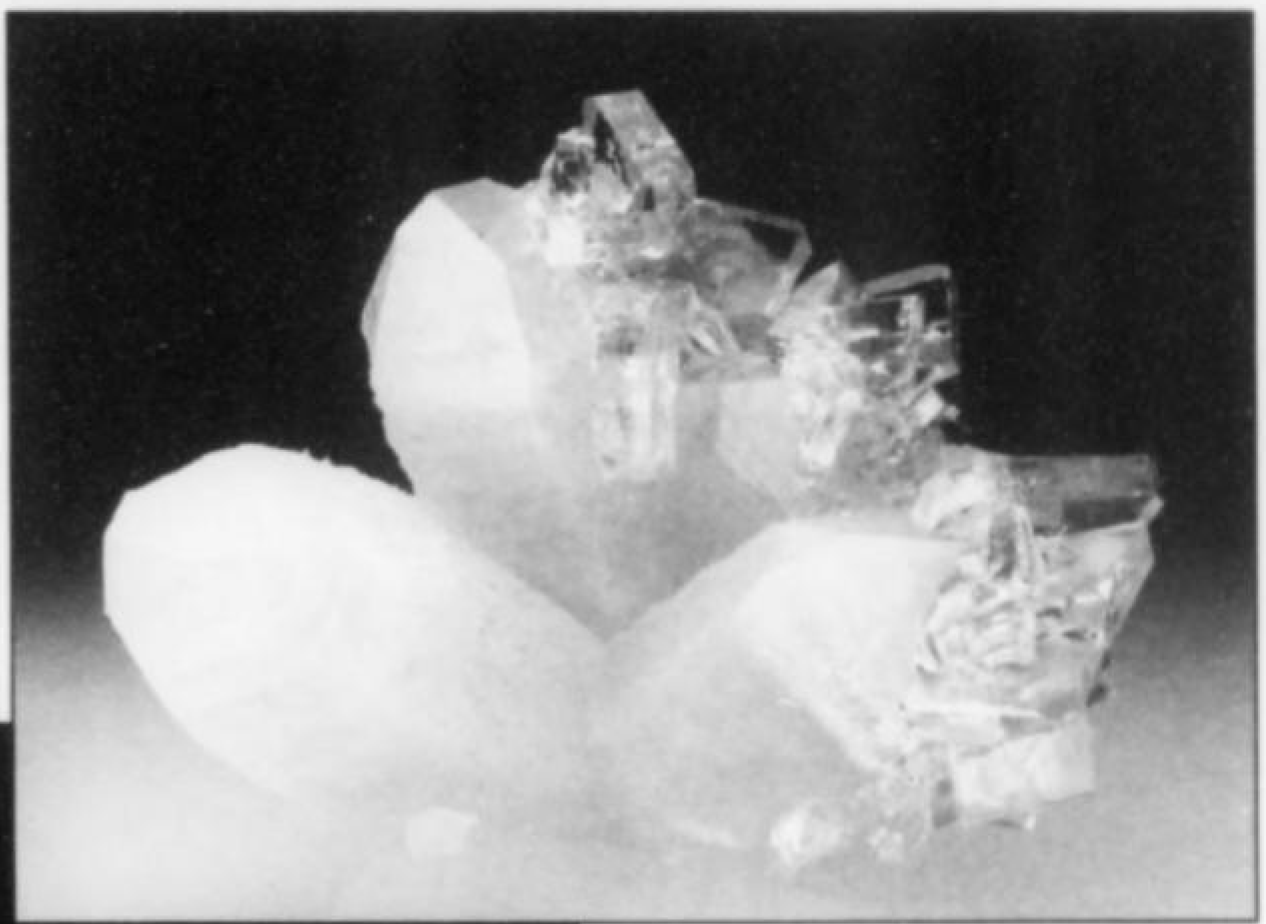

Figure 9. Yellow barite crystals on a cluster of milky quartz crystals, 5 cm, from the 282-meter level. Private collection; Wendell Wilson photo.

Figure 10. Cluster of golden barite crystals, 13.4 cm (reminiscent of barite from the Magma mine in Arizona), from the 328-meter level. Private collection; Wendell Wilson photo.

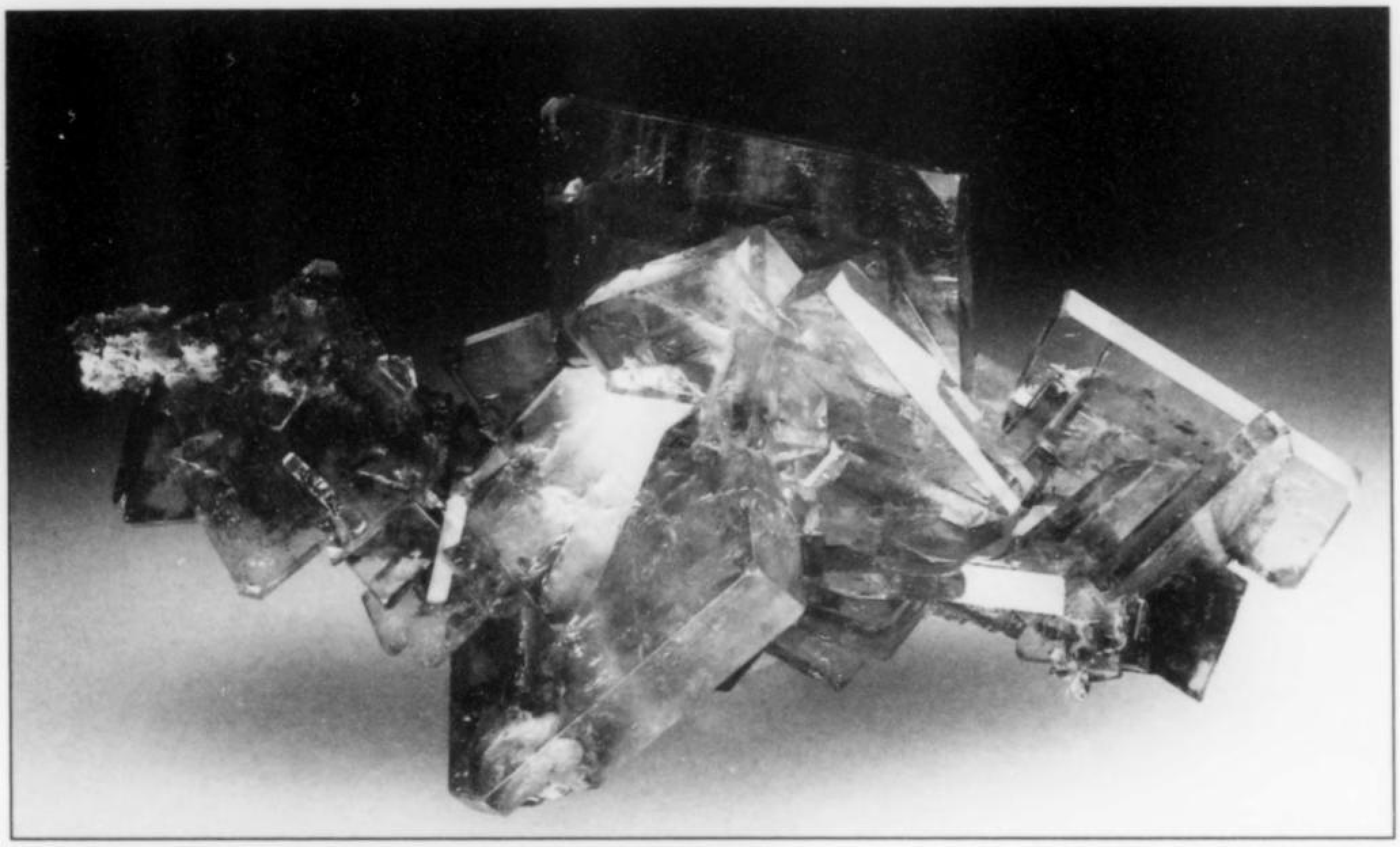

Figure 11. **Gemmy cluster of golden barite crystals, 10.2 cm, from the 328-meter level. Martin Jensen collection; Wendell Wilson photo.**

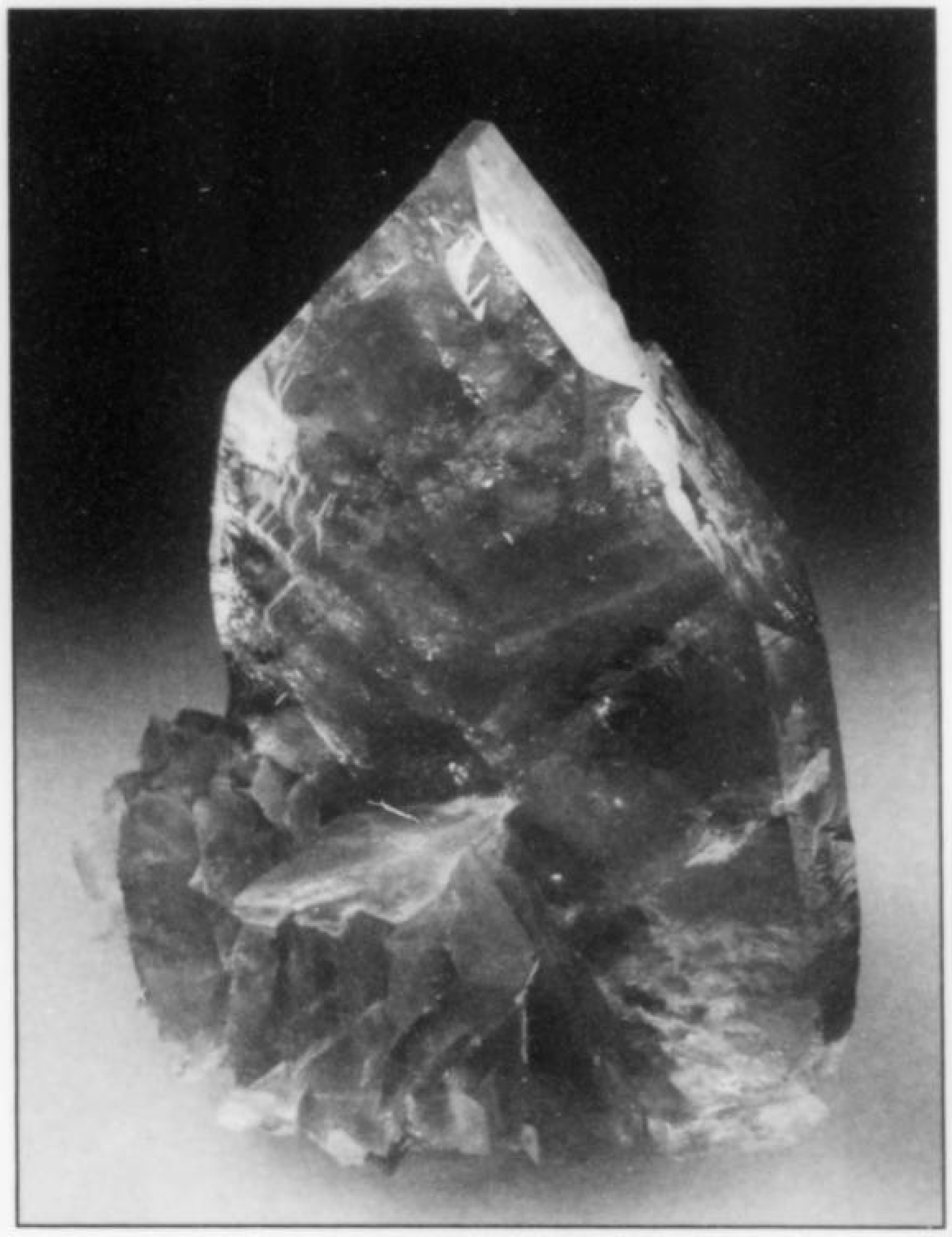

Figure 12. **Large yellow barite crystal, 9 cm, from the 328-meter level. Private collection; Wendell Wilson photo.**

Goethite FeO(OH)

Goethite, as an extensive oxidation product of altered pyrite, occurs predominantly above the 373-meter level.

Other Sulfides

Predominant among other sulfide minerals is **sphalerite**, in fine-grained, brownish red masses and cleavable grains to 2 mm. **Galena** has been found on the 328-meter level as silvery grains to 2 mm in crystallized seams of calcite. **Tetrahedrite**, as lustrous crystals no larger than 0.5 mm, occurs with massive pyrite in samples from the 328-meter level. Massive **stibnite** fans to 5 cm enclosed in siliceous rock and cementing altered monzonite occur with rarer, red coatings of **metastibinite** in stopes on the 282-meter

Figure 13. **Golden barite crystal, 5.9 cm, on white calcite, from the 373-meter level. Private collection; Wendell Wilson photo.**

Figure 14. Golden barite crystal with calcite, 10.2 cm, from the 343-meter level. Private collection; Wendell Wilson photo.

Figure 15. Golden barite crystals to 7.8 cm on calcite, from the 373-meter level. Private collection; Wendell Wilson photo.

Figure 16. Scalenohedral calcite crystals twinned on (0001), 9.8 cm, from the 373-meter level. Private collection; Wendell Wilson photo.

level. Very uncommon drusy quartz casts (epimorphs) after euhedral single stibnite crystals to 5 cm were also discovered in this area. The most common silver-bearing species, a selenian **miargyrite**, has been verified by both electron microprobe and X-ray diffraction techniques on samples from the 282-meter level. **Pyrargyrite**, in small (1 mm) crystals similar to the selenian miargyrite, has also been found at this location. **Chalcopyrite** and **boulangerite** have also been verified (P. Emsbo, pers. comm., 1998).

Tellurobismuthite (Volk *et al.*, 1995), has been reported, but has not been verified (following rather extensive inquiry) by this author.

Phosphates

Microcrystalline phosphate minerals, including **carbonate-fluorapatite** and **englishite**, occur very rarely as late-stage products grown upon barite crystals from the 282-meter level.

Post-Mining Minerals

Mineralogical reaction products where mine wall-rock has been exposed to humidity and air include **gypsum**, **halotrichite**, **ilsemannite**, **jarosite**, and **szmolnokite**.

Pyrite and Marcasite FeS_2

Two of the polymorphs of iron sulfide, pyrite and marcasite, are also relatively common, occurring for the most part as fine-grained veinlets and masses in ore zones. Interesting examples of golden, drusy, crystallized pyrite perfectly coating tabular barite crystals to 2 cm have been seen on the 442-meter level.

Quartz SiO_2

Quartz is the most widespread of the other species, and is present as a massive replacement (silica flooding) of limestone, as (jasperoid) stockwork veinlets, and as euhedral hexagonal crystals up to 6 cm in length (locally overgrown with lustrous, yellow, tabular barite crystals as on the 282-meter level).

CONCLUSION

These are, indeed, good days for mining in Nevada. They are the times of economic boom in the rural towns of the northeast part of the state, the days of the big red and white Al Park Petroleum tankers crossing Interstate 80 carrying diesel fuel to the mines, and the momentary windows of exceptional mineralogical opportunities. The Meikle mine crystallized barite occurrence will be remembered as one of the most significant events during these times.

I have collected in and toured a large number of rich, specimen-producing mines around the world, from localities including Elmwood to Cave-in-Rock to the Viburnum Trend to Panasqueira to Touissit to Dalnegorsk, and it is my opinion that the Meikle mine possesses the greatest concentration of vugs I have ever seen. Throughout the mine workings, large, open holes locally abound. As Watson (1904) said in reference to his examination of the fluorite occurrences in Weardale, England: "The student cannot fail to observe, in the mine as on the surface, how largely the idea of beauty enters into the plan of Creation."

As mining has progressed from September, 1996 to the present, the upper, flat-lying zone is becoming depleted and the deeper, steep zone containing the bulk of the ore is rapidly being developed. Concomitant with this progress has been a dramatic decrease in the number and size of vugs, together with a lack of barite. It appears that the upper portions of the deposit were more favorable to the formation of large vugs and superb barite crystals, because the deeper workings are now encountering only crystallized calcite. The old adage that "the best crystals come out first" may very well apply to the Meikle mine. Then again, who knows what further mining will reveal?

Barrick Goldstrike Mines has recognized the high value that the public places on the preservation of important crystallized specimens. For this reason, in 1997 BGMI entered into a specimen-recovery agreement with Geoprime Minerals Company (Casey and Jane Jones). The purpose of this contract has been to preserve crystallized barite and calcite specimens and to make them available to educators, museums, collectors and researchers.

[Note: Regretfully, the author has no specimens available for sale or trade.]

ACKNOWLEDGMENTS

I deeply appreciate and respect the perspectives, discussions, and insights I have gained from interaction with numerous BGMI personnel. Selected staff of Connors Drilling, including K. Brown, Iceman, J. D., J. R., Lash, Uncle Tom, and especially The Captain, showed me some of the most grueling, intense, and wholeheartedly fun work I have ever known. To them all, I owe a salute. I cannot overemphasize my sincere gratitude to A. Soregaroli and Dr. W. E. Wilson for their excellent editorial assistance, skills, support and friendship. Analytical work was conducted by the author, with supplemental confirmation being kindly provided by D. Brosnahan (formerly Barrick Goldstrike, Nevada) and A. C. Roberts (Geological Survey of Canada, Ottawa). H. Gordon, Reno, Nevada, generously made his selection of specimens available for examination and also shared details of his knowledge of the deposit. T. Cordova of Reno, Nevada, and Beavis (M.D.) Leising are thanked for their enthusiasm and interest in this project, and for providing helpful suggestions. Joanne Newton performed the typing of the numerous revisions of the manuscript. And, to all those individuals who took the time to save a specimen out of the hundreds of tons of crystals exposed during mining, a similar note of thanks is due.

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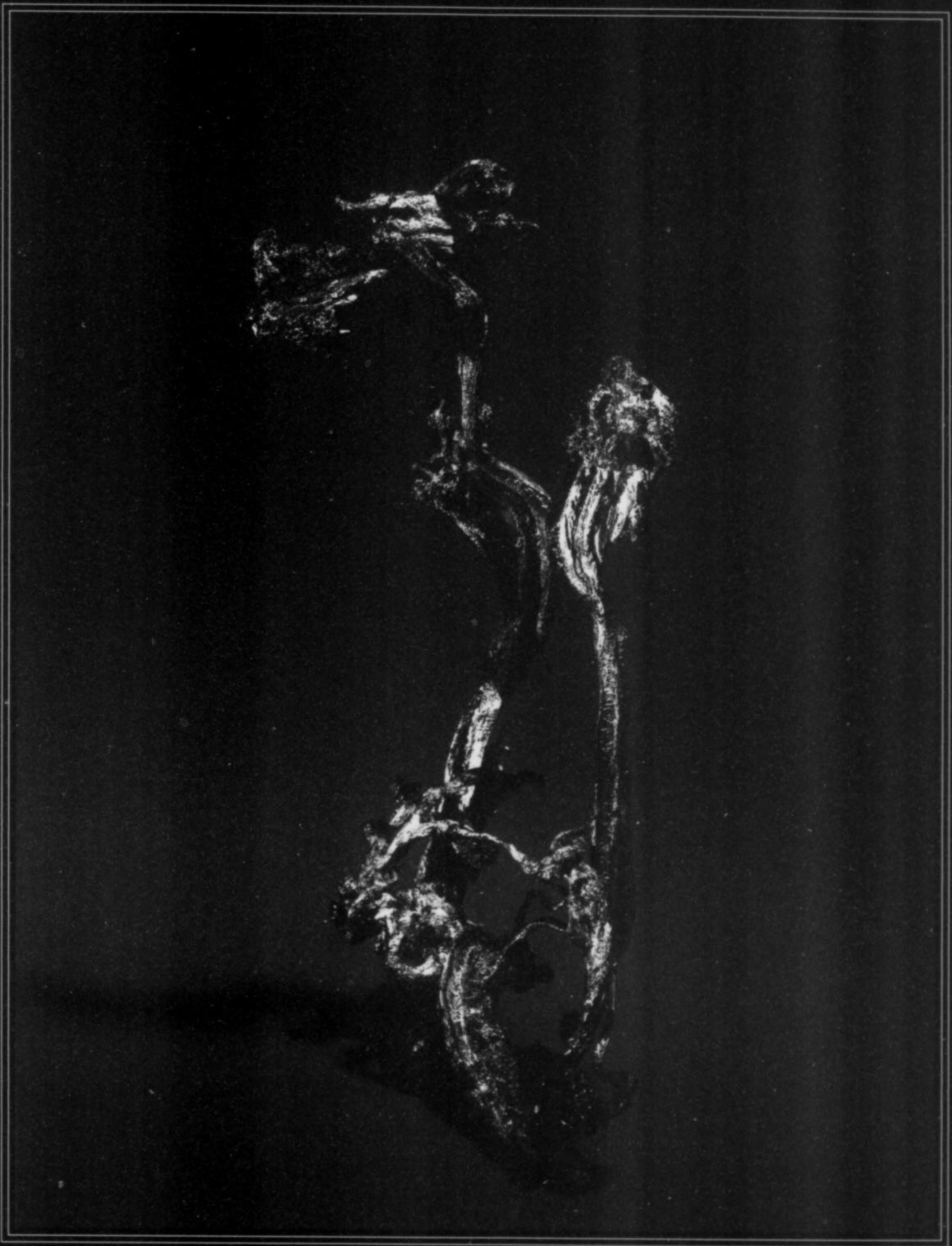

SILVER, 4.5 inches, Kongsberg, Norway; from Si & Ann Frazier (Oct. 73) ex Jack Parnau Collection; photo in Forbes magazine April 12, 1993.

The Ross Hannibal Mine

Lawrence County South Dakota

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A mineral identified as "torbernite" from the Ross Hannibal mine in the late 1800's has recently been shown to be the mineral sincosite. Minyulite and hessite occur in association on hundreds of recently recovered specimens.

INTRODUCTION

The Black Hills of South Dakota have produced over 45 million ounces of gold and 14 million ounces of silver since 1875. Many of the most historic mines are located in the northern Black Hills, including the famous Homestake mine which has been in operation for over 120 years and has produced over 38 million ounces of gold. Unlike the Homestake, which is an underground operation within Precambrian formations, four other nearby deposits are surface mines within the Cambrian Deadwood Formation. Two of the mines are not producing at this time; one of them is the Golden Reward mine where the Ross Hannibal workings are located. The Golden Reward mine is currently in a production hiatus while permits to mine additional areas are pending. The Richmond Hill mine, owned by Lac Minerals, is being closed after several years of production. The two producing mines are the Wharf Resources' Foley Ridge mine and the Brohm Mining Company's Anchor Hill mine.

Mineralogically, the northern Black Hills are very exciting. Styles of mineralization range from vein and replacement deposits to pegmatites. The historic mining camps not only produced gold and silver but also tungsten, lead, iron and tin. Associated with these ores were minerals such as vanadinite, wulfenite, hübnerite, galena, and many sulfosalts and tellurides. This article will focus on the most recent find at the Ross Hannibal deposit.

At this locality in the spring of 1996, sincosite, a rare vanadium phosphate, was found associated with minyulite and hessite in gold-bearing siltstone of the lower Cambrian Deadwood Formation. Although not an original find (sincosite was first discovered here in the underground mine workings during the late 1800's) it was an important mineralogical find in the Black Hills. The sincosite occurs as beautiful tabular microcrystals, possibly the best ever found worldwide; and the associated mineral, minyulite, is new to South Dakota. A rare silver-telluride, hessite, was also found, making this the second known locality in South Dakota for that species.

LOCATION

The Ross Hannibal mine is located on the property of the Golden Reward Mining Company approximately 4 km southwest of Lead

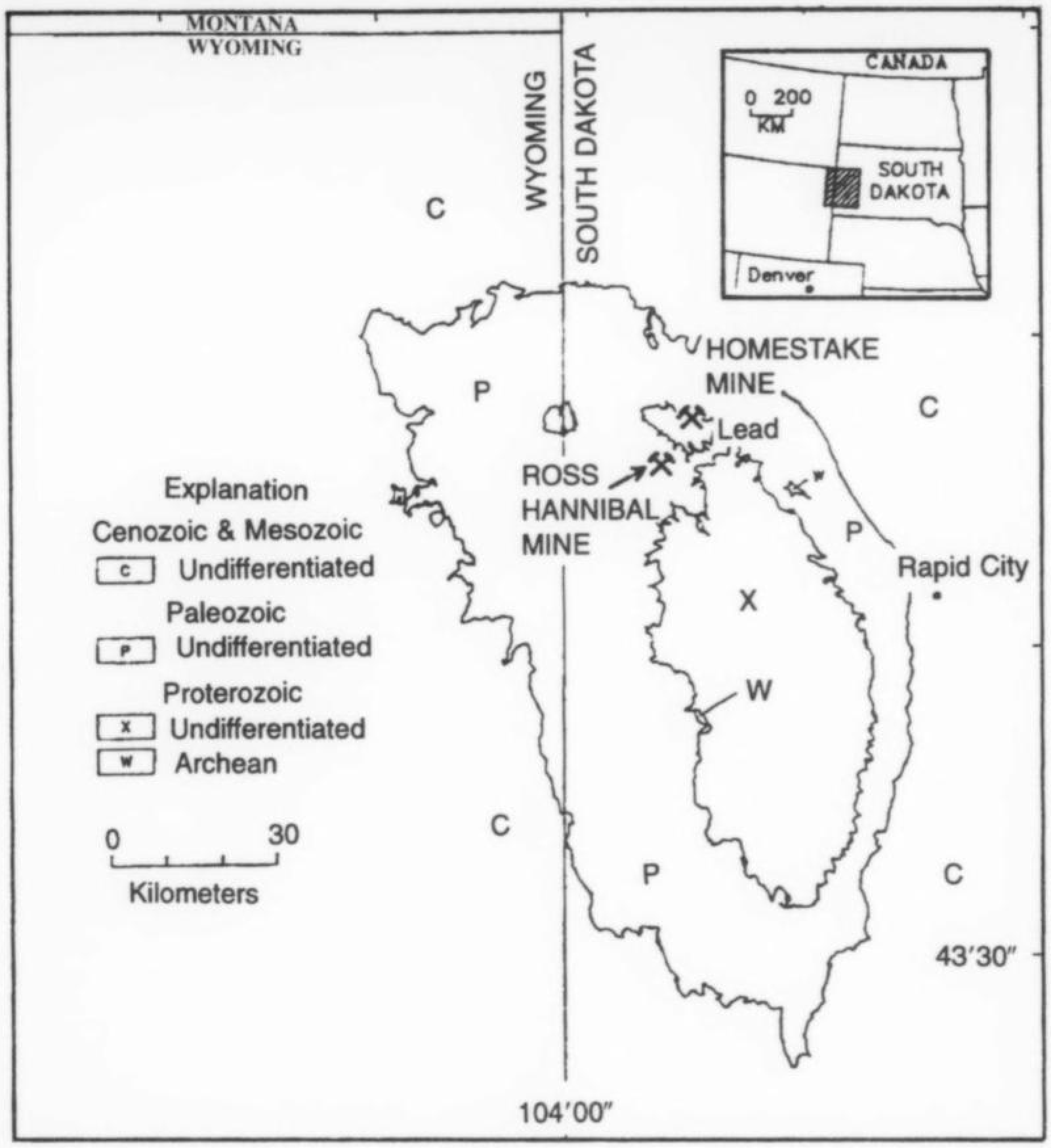

Figure 1. **Generalized geology of the Black Hills Uplift, showing the locations of the famous Homestake mine area and the Ross Hannibal mine (modified from DeWitt *et al.*, 1986).**

Figure 2. **Map showing some of the claims and underground workings in the neighborhood of the Ross Hannibal mine. Crossed hammers mark the sincosite/minyulite occurrence. (From Waterland, 1988.)**

in the northern Black Hills region of South Dakota. Specifically, the mine is located in the center of Section 7 of T4N, R3E on the U.S.G.S. 7½-minute *Lead Quadrangle* topographic sheet. On a Black Hills National Forest map the mine can be located between Fantail and Whitetail creeks in the above-mentioned section. Historically, the mine is located in the Ruby Basin mining district, part of the larger Bald Mountain mining district. Geographically, the Bald Mountain district "drapes" around the western to eastern flanks of the north side of Terry Peak and roughly occupies the saddle area between Terry Peak and Bald Mountain. The Ruby Basin district sits at the base of Terry Peak on the eastern side. Terry Peak today is a ski hill with the Wharf gold mine and the Golden Reward mine flanking both sides. Terry Peak reaches an elevation of 2,153 meters and is the highest point in the northern Black Hills.

HISTORY

The first documented occurrence of gold in the Black Hills was in 1875. A government-commissioned expedition led by a Professor Jennings was sent into the Black Hills of the "Dakota Territory" to confirm what the Custer expedition had previously found in 1874. At that point in time the Black Hills fell within the reservation land owned by the Sioux nation, and prospecting was forbidden by law. Shortly after confirmation of gold in the Black Hills by the Jennings expedition, the U. S. government negotiated a deal with the Sioux nation and paid 4.5 million dollars for the purchase of the Black Hills. Of course that transaction presented problems. The gold rush started (or had already begun) soon after the purchase, and the Sioux were incensed by the scale of the

***Figure 3.* The Golden Reward cyanide mill, Deadwood, South Dakota, in the 1890's. Photo courtesy of the Fielder Collection, Archives, Devereaux Library, South Dakota School of Mines.**

intrusion. Consequently, despite the sale agreement, the Sioux nation refused to give up the Black Hills without a fight. This incident was described by Cleophas C. O'Harra (1902) in *The Mineral Wealth of the Black Hills*, an excellent document on this subject.

A great deal of historical information can be found in Waterland (1988), from which the following information was extracted. Claims were first staked in the Bald Mountain mining district in 1877, on Green Mountain near the present ghost town of Trojan. The North Star group of claims, which included the Ross Hannibal, was also located in 1877 after reports of "ruby silver" and native silver being found there. In 1886, the Ross Hannibal went public as a corporation, with the sale of 10,000 shares. The Fremont, Elkhorn and Missouri Valley Railroad came north out of Rapid City and serviced the northern Black Hills, giving the area an economic boost. Gold production in South Dakota rose to new heights as the miners now had a viable and economic method of transporting the ore to the treatment plants in and around Deadwood, Lead, and Rapid City. The railroad also generated a large influx of capital in the Ruby Basin mining district. By 1887, the nearby Golden Reward Mining Company was formed, which consolidated a number of claims in the area. This later changed to the Golden Reward Consolidated Mining and Milling Company in 1893, spreading over 442 claims. The Ross Hannibal was soon bought out by the Deadwood and Delaware Smelting Company in 1893, but in 1899 this company reverted back to the Golden Reward Consolidated Mining and Milling Company.

In the later years of underground mining in the Ruby Basin district, reserves of high-grade oxidized ore began to run out. By 1918, decreasing grades and rising costs forced the closure of the mines. A total of 48 km of underground workings and 11 shafts were in place at the time of closure. In 1940 the Anaconda Mining Company purchased the holdings of the Golden Reward Consolidated Mining and Milling Company and held them until 1985. At that time the current operator, the new Golden Reward Mining Company, acquired the property. Bulk-minable, heap-leach surface mining of low-grade (1.8 gpt average) oxidized gold ore began in 1989 and ceased in 1996 after all the permitted reserves were depleted. Today the Golden Reward mine is partially closed until additional permits to mine are granted.

RECENT COLLECTING

I worked at the Black Hills open pit gold mines for several years as the Mine Geologist at the Annie Creek mine and Senior

Engineer at Golden Reward, where the Ross Hannibal is located. As a mineral collector, I was very familiar with the mineralogy of the area. Knowing that sincosite occurred at the Ross Hannibal, my grade control engineer, Bob Fox, and I made it a point (which was our job!) to look over each blasted shot. As we examined the broken rock in a particular area, we found gypsum crystals, drusy quartz, and what we called "juiced-up" siliceous blue-ore. We kept an eye on this area, because we knew that sincosite had been found to occur in the blue-ore. The South Dakota School of Mines museum has an example of sincosite in blue-ore from around the turn of the century.

The day finally came when we found a small crystal of sincosite in an isolated area 6 meters below the area we had noted earlier that month. I walked another 43 meters and found myself in the middle of sincosite heaven. I looked to the left and right, picked-up a rock, saw it to be sincosite and started shouting for Bob. (He later described me as doing "the Sincosite Dance"—whatever that was.)

We made three or four weekend collecting trips and recovered about 100 flats full of specimens. This was by far the most fun I had ever had collecting anywhere. Bob and I would stand on a desk-size boulder, and because of the bedding, we were able to fracture the boulder easily with a sledge hammer. Then we would carefully pry open the rock and discover beautiful clusters of sincosite and sprays of minyulite lining the tight vugs in the rock.

We made the find in March of 1996. By mid-April the small pit in the Ross Hannibal mine was flooded by snow melt and the sincosite was completely submerged. I took another job in Mexico in May. To the best of my knowledge the Ross Hannibal mine was back-filled that summer for lack of economic ore.

GEOLOGY

Black Hills geology has been described by Darton and Paige (1925), who wrote the first detailed and comprehensive account. Other historical publications in general terms include O'Harra (1902), and Newton and Jenny (1880). A wealth of publications concerning the northern Black Hills mineral deposits exists. These include: the classic works by Irving (1904), Connolly (1927), Shapiro and Gries (1970) and more recently DeWitt *et al.* (1986) and Paterson *et al.* (1990). Except where noted, most of the following discussion has been taken from Redden and Lisenbee (1990), and also DeWitt *et al.* (1986).

The Black Hills geological record began sometime prior to 2.5 billion years ago with the deposition and subsequent metamorphism of silty, iron-rich sediments. About 1.7 billion years ago the post-tectonic Harney Peak Granite intruded the country rock creating a major domal structure. This batholitic-scale intrusion is the youngest of the local Precambrian rocks and consists of a highly complex group of sills and dikes of granite and pegmatite. Extensive metamorphism and erosion of the country rocks persisted up to about 550 million years ago. That period of time is not represented by deposition in the Black Hills.

During the Paleozoic era the Black Hills region was located along the western part of the North American craton. Regional flexing in the Williston Basin to the north, the Trans-continental arch to the south, and the Cordilleran miogeocline to the west caused epeirogenic movements in the Black Hills area. The result was about 300 million years of shallow, marine deposition of sandstone and limestone. To various extents and with numerous local disconformities, all Paleozoic periods, except Silurian, are represented in the Black Hills. Continental and marine deposition during Triassic and Jurassic time was again the product of epeirogenic activity on the eastern margin of the Cordilleran seaway. During Cretaceous time, the North American craton flexed downward and as a result up to 1,900 meters of marine sandstone and shale were deposited. The Cordilleran seaway retreated during Late Cretaceous time and broad upwarping from the Laramide Orogeny (60–65 million years ago) caused the displacement of crustal-scale blocks. The blocks were the Powder River Basin to the west and the Black Hills uplift to the east. The latter is considered to be the easternmost chain of the Rocky Mountains.

In the northern Black Hills, alkalic plutons were emplaced during Tertiary time about 60 to 50 million years ago. This activity may have been responsible for the base and precious metal mineralization associated with some of these intrusions and the overlying Cambrian Deadwood Formation. Exemplifying this are the numerous gold deposits of the Bald Mountain and Ruby Basin mining districts.

Today, an aerial view of the Black Hills reveals an elliptically-shaped half dome which extends approximately 200 km from southeastern Montana to the South Dakota-Nebraska border and reaches a maximum width of about 120 km. The region is characterized by rolling pine-covered hills with rounded granite pinnacles and spires forming the "needles" around the centrally located Harney Peak. Harney Peak is the highest point in the Black Hills at 2,207 meters. The Precambrian rocks into which the Harney Peak Granite intruded are generally slates, schists and quartzites, and are exposed roughly from the town of Deadwood in the northern Black Hills to Pringle in the southern Black Hills. These Precambrian rocks are blanketed by the Cambrian Deadwood Formation, along with the remaining Paleozoic stratigraphic sequence. All of these formations are exposed in outwardly dipping strata that form kidney-shaped rings around the core complex of the Precambrian metamorphics and the Harney Peak Granite. The outer margins of the Black Hills eventually give way to the surrounding valleys and prairies, where the Permian Minnekata Limestone meets the Tertiary red-beds of the Spearfish Formation through which Interstate 90 is routed. Finally, the "hogback," an outer ridge of Jurassic and lower Cretaceous sandstones, forms the last partial ring around the Black Hills before meeting the high plateaus of the Cretaceous shales to the east and the Powder River Basin to the west.

The gold deposits of the Bald Mountain and Ruby Basin mining districts, where the Ross Hannibal mine is located, are classified as Tertiary epithermal, and are sediment and intrusion hosted (Paterson, 1990). Several small intrusive centers emplaced during Tertiary time are known in the immediate vicinity, including Bald Mountain, Terry Peak, Sugarloaf Mountain, and Deer Mountain. The intrusions form laccoliths (or stocks—a debatable Black Hills subject), sills, and locally dikes composed of rhyolite, porhyritic monzonite, quartz monzonite, phonolite, and trachytes of quartz, biotite, and hornblende.

Emanuel *et al.* (1990) stated that the late-stage trachyte porphyries are the most consistently mineralized igneous rocks in the Golden Reward mine area. The principal ore host is the Cambrian Deadwood Formation into which the igneous rocks intruded. The Deadwood Formation is composed of shallow marine clastic and carbonate sediments. In the mine area it is gently dipping and has been deposited over steeply inclined, isoclinally folded Precambrian metasediments. The mine area is characterized by normal faulting which has produced a structural sag. Tilting, folding and intense fracturing of both the Deadwood Formation and intrusions has occurred in proximity to the major faults (Emanuel *et al.*, 1990). As is typical of the mining area, mineralization occurs along sub-vertical fractures where hydrothermal solutions were channeled. Sandy dolomitic and other carbonate horizons of the Deadwood Formation were most receptive to the solutions and were most intensely mineralized.

Within the Ross Hannibal deposit, the Deadwood Formation is the only sedimentary unit present and only the lower portion is exposed there. The historic underground workings and the most recent surface mining have centered on highly silicified calcareous or dolomitic siltstones and quartzites. The mineralized zone was confined between the phonolitic Sugar Loaf sill below and a shale unit of the Deadwood Formation above. The shale unit probably acted as a barrier to mineralization. The gold ore averaged 1 to 3 meters thick, up to 30 meters wide and about 610 meters in the strike length (Shapiro and Gries, 1970). Historically, two types of gold ore have been mined in the district, including the Ross Hannibal mine. These are termed simply "red ore" and "blue ore." Red ore has been oxidized, a process which probably liberated gold from sulfides or tellurides. Metallurgically, the red ore is leachable by cyanide treatment even though it may be highly altered by silicification. The blue ore contains minute pyrite crystals giving it a bluish color. The blue ore tends to be refractory, meaning that regular cyanide treatment is usually ineffective. Blue ore by local definition is highly siliceous, pyritic, and refractory.

Table 1. **Minerals recorded from the Ross Hanibal mine.**

Elements	
Gold	Au
Silver	Ag
Tellurides	
Hessite	Ag_2Te
Fluorides	
Fluorite	CaF_2
Carbonates	
Azurite	$Cu_3^{2+}(CO_3)_2(OH)_2$
Calcite	$CaCO_3$
Malachite	$Cu_2^{2+}(CO_3)(OH)_2$
Phosphates	
Minyulite	$KAl_2(PO_4)_2(OH,F)\cdot 4H_2O$
Sincosite	$CaV_2^{4+}(PO_4)_2(OH)_4\cdot 3H_2O$
Sulfates	
Barite	$BaSO_4$
Gypsum	$CaSO_4\cdot 2H_2O$

MINERALOGY

Gold and silver mineralization at the Golden Reward and Ross Hannibal deposits occurs within intensely silicified siltstones of both varieties of ore mentioned above. Emanuel *et al.* (1990) stated that an early stage of silicification with gold, silver, and arsenic-bearing sulfides was overprinted by a second episode of gold and silver-bearing pyrite. The heavily pyritized matrix of the "blue ore" supports this, inasmuch as the recent ore samples from the Ross Hannibal assay up to 2 ounces per ton of gold. Shapiro and Gries (1970) also reported ore samples from the Ross Hannibal assaying up to 255 ounces silver per ton. The most common accessory minerals in the mine area, as reported by Emanuel *et al.* (1990), are quartz, fluorite, illite-smectite clays, calcite, dolomite (?), and barite. Traces of azurite/malachite and beautiful sprays of gypsum were also found during recent mining. The minerals of collector interest are described below.

Hessite Ag_2Te

Hessite occurs as crystals less than 1 mm in size displaying a melted-looking, arborescent habit with no observable crystal shape. Hessite is associated with sincosite, and is also found within voids in deteriorated and altered areas of the pyrite in the siltstone matrix. A soft alteration product typically coats the hessite, making the mineral difficult to identify. Other crystals of hessite are associated intimately with sincosite. These examples were readily noticed as peculiar, silvery masses. A black unidentified mineral, which is commonly found at the center of sincosite rosettes, may be hessite. Telluride minerals were also reported from the mine area by Emanuel *et al.* (1990). MacLeod and Barron (1990) reported microscopic hessite at the Gilt Edge gold deposit; however, to my knowledge the Ross Hannibal is the first reported occurrence of interest to the collector. Hessite was identified by Anthony Kampf, Los Angeles County Museum, using X-ray powder diffraction. EDAX/SEM work was performed by Excalibur Mineral Company.

Minyulite $KAl_2(PO_4)_2(OH,F)\cdot 4H_2O$

Minyulite commonly occurs with sincosite as beautiful white, acicular, radiating sprays averaging 3 mm but rarely up to 1.5 cm. Usually flattened along bedding planes, minyulite sprays can also occur as delicate radiating balls attached to sincosite. Sprays are commonly color-zoned from pale green at the center to white at the edges. Minyulite was identified using EDAX/SEM by Eric Fritzsch at the South Dakota School of Mines, and also by Excalibur Mineral Company. This locality is the first for South Dakota and the second North American occurrence.

Table 2. **Chemical analyses, in weight %, of sincosite from the Ross Hannibal mine and from the type locality at Sincos, Peru.**

Oxide	*Ross Hannibal*[1]	*Sincos, Peru*[2]	*Ideal*
P_2O_5	31.37	31.1	31.26
V_2O_4	36.44	37.8	36.54
CaO	12.51	13.3	12.35
H_2O	19.68	17.1	19.85
Insoluble	—	0.7	—
Total	100.00	100.00	100.00

[1]Zolensky (1985); water estimated by difference.
[2]Schaller (1924); water estimated by difference.

Sincosite $CaV_2(PO_4)_2(OH)_4\cdot 3H_2O$

Sincosite occurs as square, tabular, micaceous to thinly laminated crystals up to 1 cm across the *c* face and less than 1 mm on edge. Crystals typically average 2 mm, and commonly occur as pairs, triplets and multiple clusters but seldom as singles. On edge, the crystals display striations of thin lamellae and striations are also visible on the *c* face. Zolensky (1985) described sincosite with perfect (001), and good (110) cleavage. Multiple clusters commonly form rosettes composed of tabular crystals and seem to have formed from smaller, less-than-1-mm sincosite spherules; many gradations of this habit have been observed. An almost botryoidal habit also forms from the single spherules to aggregates. Aggregates such as these are pale dull green to blue-green and do not display the vitreous, tabular crystal habit.

The tabular sincosite crystals are typically grass-green or meta-torbernite-green but, through different stages of alteration, can be a pale to dark green, blue-green near the center of some crystals, brown-green, brown to brassy, or olive-green. It is interesting to note that Schaller (1924) described sincosite from Sincos, Peru, with many of these same color ranges. Color zoning is best seen on edge, from dark green to pale green. Luster can vary dramatically depending upon the color but is usually vitreous in the green crystals to sub-metallic in the brown and brassy crystals to dull-lustered in the botryoidal habit. An unidentified black mineral, as

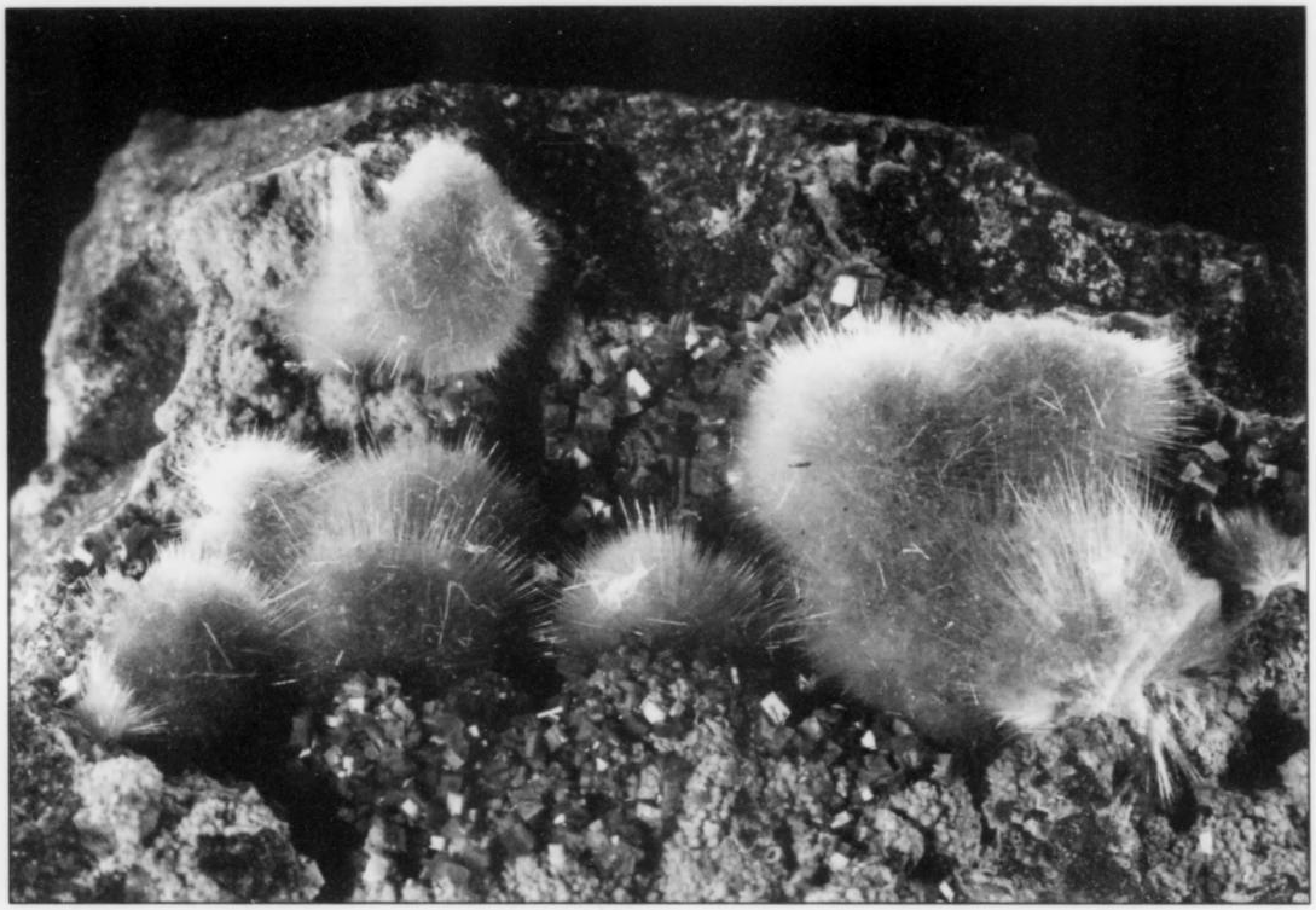

Figure 4. Minyulite in pale green tufts to 3 mm with tiny crystals of sincosite, from the Ross Hannibal mine. Tom Loomis collection; Wendell Wilson photo.

Figure 5. Sincosite crystals to 1 mm in a dense cluster, from the Ross Hannibal mine. Tom Loomis collection; Wendell Wilson photo.

Figure 6. Sincosite crystals to 2 mm, from the Ross Hannibal mine. Tom Loomis collection; Wendell Wilson photo.

Figure 7. **White minyulite spray, 4 mm, with green sincosite from the Ross Hannibal mine. Tom Loomis collection; Wendell Wilson photo.**

Figure 8. **Sincosite crystals to 2 mm, with white minyulite sprays, from the Ross Hannibal mine. Tom Loomis collection; Wendell Wilson photo.**

mentioned above, was occasionally found at the cores of many rosettes.

Sincosite occurs in quartz vugs along bedding and fracture planes in the highly siliceous and sometimes pyritized siltstone. The extent of the occurrence is very localized, within an area of about 10 by 10 meters. Fluorite occurs in an area adjacent to the sincosite area, but is not directly associated with sincosite. Likewise the sincosite area is devoid of fluorite.

A "greenish uranium mica" thought to be torbernite from the Ross Hannibal mine was described by Irving (1904), Smith (1896) and Ziegler (1914), all of whom were cited by Roberts and Rapp in their *Mineralogy of the Black Hills* (1965); the latter authors described it as "bright grass-green torbernite." This "torbernite" must have been correctly identified as sincosite by the early 1970's, since sincosite is listed in the first *Encyclopedia of Minerals* by Robert, Rapp and Weber (1974). Later, Zolensky (1985), using microprobe analysis, re-identified a specimen at Bryn Mawr College as sincosite, which had originally been identified as meta-torbernite from the Black Hills. Unfortunately (for South Dakota), sincosite was not formally described as a new mineral until 1922 when Schaller documented the occurrence at Sincos, Peru, the type locality.

Nevertheless, the occurrence of sincosite at the Ross Hannibal mine marked the first in North America. Other published localities which followed include: Potash Sulphur Springs, Arkansas, found in 1982 by Howard and Owens (personal communication, 1997) and published by Howard and Owens (1995); Bloomington, Idaho (Ream, 1989); and the Gold Quarry mine in Nevada (Jensen *et al.*, 1995). Sincosite is also mentioned as being associated with phosphovanadylite, a new mineral species occurring in phosphatic shale at the Enoch Valley Phosphate mine, Soda Springs, Idaho (Medrano *et al.*, 1998). Sincosite from the recent find at the Ross Hannibal mine was confirmed by EDAX/SEM analysis by Eric Fritzsch at the South Dakota School of Mines and also by Excalibur Mineral Company.

CONCLUSION

As concluded by Zolensky (1985), some minerals labeled "meta-autunites" (and "meta-torbernites") from vanadium-rich deposits should be re-examined because sincosite is easily confused (visually) with these minerals.

The Golden Reward Mining Company prohibits collecting within the mine area. Because of the very limited extent of the mineralization, recent surface mining proved to be sub-economic and was discontinued. The open-pit workings at the Ross Hannibal deposit have now been back-filled and reclaimed.

ACKNOWLEDGMENTS

Special thanks to Eric Fritzsch at the South Dakota School of Mines in Rapid City for his analytical assistance and review of this report. Also thanks to Dr. Anthony Kampf for his analytical assistance in identifying the mineral hessite. The help with editing and reviewing by my wife and best friend, Vicki, and my old collecting friend and colleague, Chris Korpi, is deeply appreciated And, finally, thanks to the Golden Reward and Wharf Resources mining companies for the pleasure of having worked with such a fine group of people.

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What's New

in Minerals

Tucson Show 1999 — by Tom Moore

[February 1–14]

Let me say flatly, without my usual preliminary ramblings, that this was a very, *very* good Tucson Show, even as Tucson shows go. Perhaps it was even a *great* one, perhaps the equal (in general quality, variety and interest of its mineral showings) of Tucson 1993. While poorer than '93 in the appearances of spectacular mineral firsts, '99 featured a great many thrilling offerings representing quantum leaps upward for previously known mineral occurrences. Particularly at the Main Show, I was pleased at how generally good the dealers' stocks were. Some specimen prices continue to climb erratically, while others remain reasonable; there's some evidence that significant numbers of visitors have been scared away by this phenomenon, although—who knows?—maybe many of them were just down in bed in their hotel rooms with the wildfire flu that harried Tucson this year. In any case, I repeat, the market is strong, and the complex processes by which wonderful new minerals are pipelined from out of the earth and into our collection cabinets have never been more robust.

The weather was fine all week, and energy levels (except for the flu-bitten) seemed unusually high. I felt downright exhilarated on the hot day when I took my annual trek down to the kingdom of hotel gem/lapidary shows and the "Four Corners" empire of tents and outdoor tables for motley earth-materials merchants. Among the crowds of those folks who are into things like African spears and spheres, man-high geodes, dinosaur thighbones, mystical-crystal nose-rings, etc., I felt, as a serious mineral man, ambivalently elitist, a spy from an alien, thinner-aired world. But this feeling didn't prevent me from buying a quartz crystal group of a lab-induced shocking yellow, and a pewter Amazon warrior soldered onto an iridescent lump of bornite.

Meanwhile, back in cyberspace, the "Virtual Show" I've mentioned before (www.thevirtualshow.com) hummed busily and successfully along, bidding fair to lure back any regular showgoers who might have wandered away. And there, on a local TV station's evening news broadcast on opening day of the Main Show, was a feature story about that show, with the happy reporter shoving a mike in the face of a "tourist" who turned out to be the *Mineralogical Record*'s past-president Tom Gressman, who enthused, for his allotted few seconds, about how this show was "fantastic . . . greatest in the world . . . I've been coming here for 20 years . . ." Given another few seconds on camera, he would probably have been showing off his new Norwegian anatase thumbnail to a waiting world.

I was shocked and amazed to hear one dealer's report of how a customer had complained that this show was "flat," with "nothing new" (or was it "nothing interesting"?) in it. No, it was a *strong* show; all you needed were mineral-sense receptors that didn't require flaming walls of crocoite, wulfenite, or the like to switch them on. Exactly because of the general strength of the show, this report promises to break all length records, so I had better get started on the world-circumnavigating survey. Most of the photos are Jeff Scovil's, including a few things he saw that I didn't.

The *Arizona Minerals* team of Dick Morris and Mark Hay has spent several months expertly coaxing some fine green octahedral **fluorite** specimens out of the abandoned Hardy mine, Oatman mining district, Mohave County, Arizona. Twenty-four flats of specimens, thumbnail to cabinet size, were collected, and a healthy percentage of these were in the Arizona guys' Executive Inn room, with stray specimens in other dealers' rooms too. Arizona is not especially noted for fluorite, but these pieces are quite respectable, even for this generous species. Crystals to 3 cm on edge form frosty floater groups (found suspended in clay), and individual crystals and clusters on massive white vein quartz matrixes; the color in the best pieces is a lovely, lush, translucent prehnite-green with a hint of blue. Some faces are preferentially coated with chalky white silica, and there are sometimes black specks within the crystals which an old reference work calls "sulfides of silver"; testing is under way.

Jordi Fabre of Barcelona and *Steve Perry* (P.O. Box 136, Davis, CA 95617) share honors for their extensive spreads of specimens of recently collected **andradite** garnet from the Yellow Cat mine, New Idria District, San Benito County, California. A November 1998 strike produced an abundance of pretty specimens, with sharp, gemmy, honey-brown simple dodecahedrons, to 1.5 cm, sitting singly or bunched on seam linings of deep green drusy clinochlore on greenish, schistose ripidolite rock matrixes. About 300 specimens were found, and there's no reason, both dealers say, not to expect more and better in the future.

The big California collecting story, though, was the one being told (with the aid of a videotape that played continuously in his Executive Inn room) by Scott Kleine of *Great Basin Minerals* (3895 Lisa Ct., Apt. C, Reno, NV 89503-1125). Last year, at his prospect at the Junnila property, Clear Creek district, San Benito County, Scott took out about 500 specimens featuring the no-contest world's-best crystals of the rare barium titanium silicate **fresnoite**, known previously only in microcrystals. These are butterscotch-yellow to salmon-pink, sometimes glassily lustrous, flattened tetragonal pyramids resembling wulfenite and reaching to 2.1 cm. Some of the biggest crystals are very sharp. In pieces of all sizes, the fresnoite crystals rest on crystalline analcime, natrolite and stilbite matrix. Although Scott has a lease on the prospect, he says he has no hard plans to do more of the (difficult) collecting required to extract more such material.

One of those dramatic quality/quantity quantum jumps I mentioned earlier was to be seen in *Harvey Gordon's* large, incredibly beautiful array of specimens of yellow **barite** from the Barrick Meikle mine, near Carlin, Nevada. Yes, I've enthused about these before—and why not? This is arguably one of the world's all-time

Figure 1. **Fluorite cluster, 5 cm, from the Hardy mine near Oatman, Arizona. Dick Morris collection; Wendell Wilson photo.**

Figure 3. **Calcite twin, 6.7 cm, from the Meikle mine, Carlin, Nevada. Geoprime specimen; Jeff Scovil photo.**

Figure 2. **Calcite crystal, 13.1 cm, on matrix, from Reynolds County, Missouri. Brass Rooster specimen; Jeff Scovil photo.**

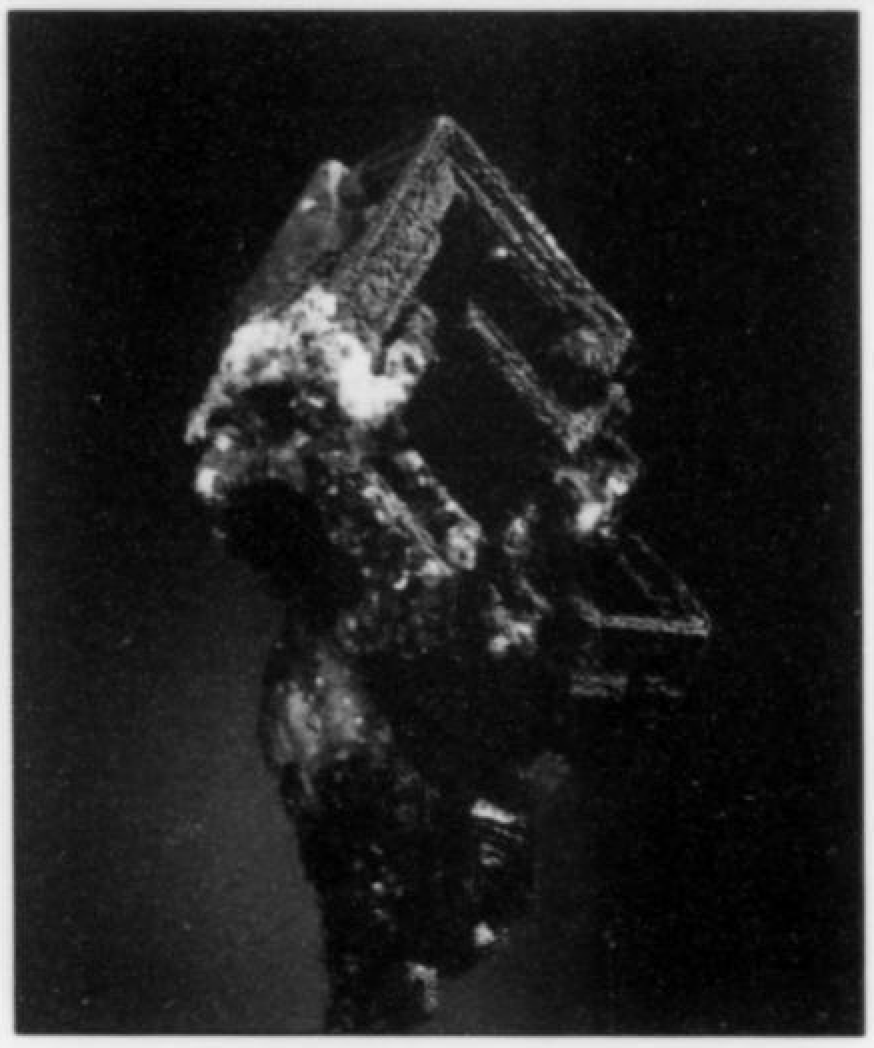


Figure 4. **Aguilarite, 2 cm, from the Sirena mine, Guanajuato, Mexico. Ron Pellar collection; Jeff Scovil photo.**

great barite occurrences. [Ed. Note: See the article in this issue.] But it is hard to imagine anyone's ever topping the showing here of perhaps 150 pieces, *all* of highest quality, in Harvey's big wallcase and a crammed counter case at the Main Show. The matrix plates, with barite crystals up to 10 cm long lavished all over them, reach 25 cm across; specimen sizes ranged down to 3 x 3-cm clusters of handsome, flashing crystals without matrix. The color is (as we know by now) a vibrant lemon-yellow in the thinner crystals to an equally vibrant yellowish orange in the thicker ones; the luster is very high, the gemmy transparency in most cases is total. Some of the large specimens are adorned with milky white tabular calcite crystals. And not the least of the good news is about the prices: an absolutely first-rate, dazzlingly beautiful small miniature could be had for $50 to $150, or so at least it was at Harvey Gordon Minerals (500 Ballentyne Way, Reno, NV 89502). Casey and Jane Jones of *Geoprime*, who also had some specimens at their room in the InnSuites, currently hold the specimen recovery contract at the mine.

As a sort of sideshow, Harvey Gordon had another really *new* mode of Nevada **barite** in a few toenail-sized specimens at the Main Show. A few months ago, the currently active Rosebud gold

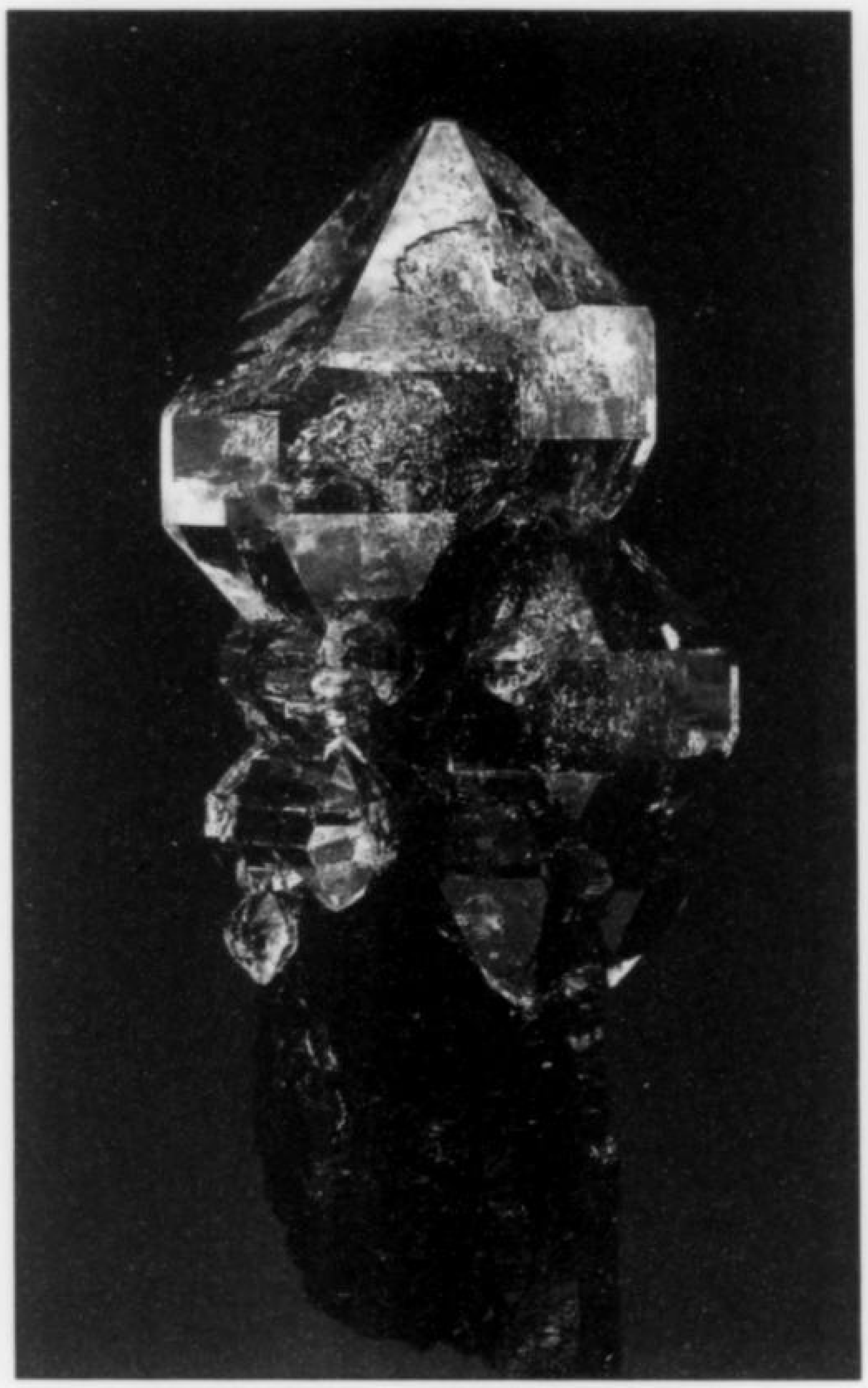


Figure 5. **Quartz, 7.3 cm, from Treasure Mountain Diamond mine, Little Falls, New York. JoLynn Associates specimen; Jeff Scovil photo.**

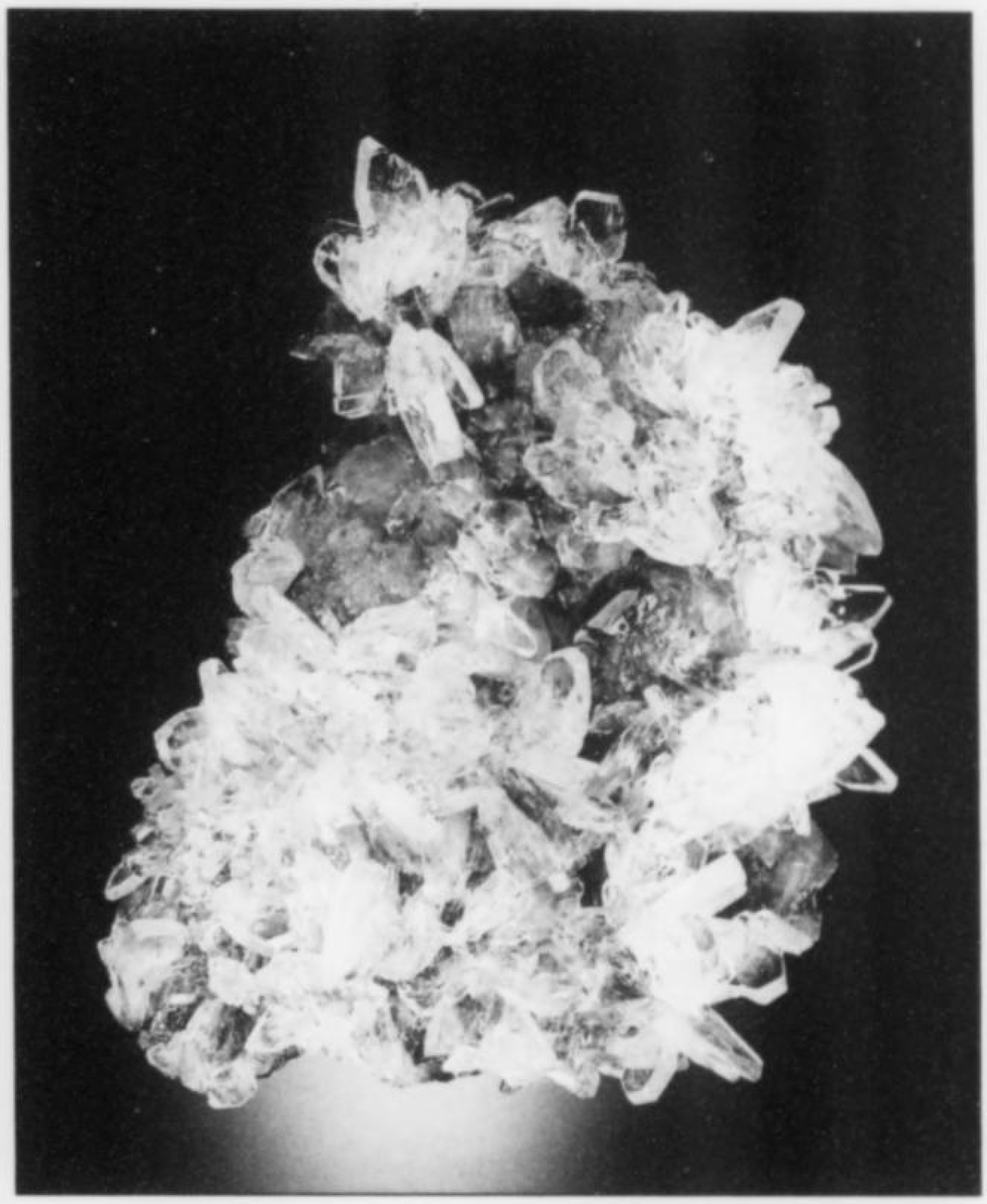


Figure 6. (above right) **Hemimorphite with adamite, 6.8 cm, from Level 13, Minerales shaft, Franco Portillo mine, Santa Eulalia, Chihuahua, Mexico. Blue Sky Mining specimen; Jeff Scovil photo.**

mine, between Lovelock and Winnemucca, Pershing County, Nevada, produced these odd-looking, translucent grayish white, satiny-lustered, blocky barite crystals (so blocky, sometimes, that they look like distorted cubes). Specimens tend to be single loose crystals to 3 cm on edge, a few with bits of white matrix. Although not on a par with the Barrick Meikle barites for beauty, these specimens nevertheless are attractive, and surely there will be more: Harvey says he already has about 30 flats'-worth stashed at home.

Nor are we through with Nevada yet. Scott Kleine (*Great Basin Minerals*, again) acquired from Greg Ferdock, and was selling here, six miniature and two cabinet-sized specimens of extraordinarily fine **realgar** taken out two years ago from the venerable Getchell mine, Humboldt County. The realgar crystals are fully as vividly, transparently red and lustrous as the Chinese specimens which they resemble, but these thick, sharp, complexly modified prisms to 3 cm long differ from the Chinese crystals in that their associated calcite comes in smoky gray, translucent, flattened rhombohedrons to 3 cm (instead of the yellow scalenohedrons of the Shimen, China, source). Also from the Getchell mine, the extremely rare thallium-bearing sulfosalt **galkhaite** was available here in what are, for galkhaite, giant crystals: blood-red to metallic

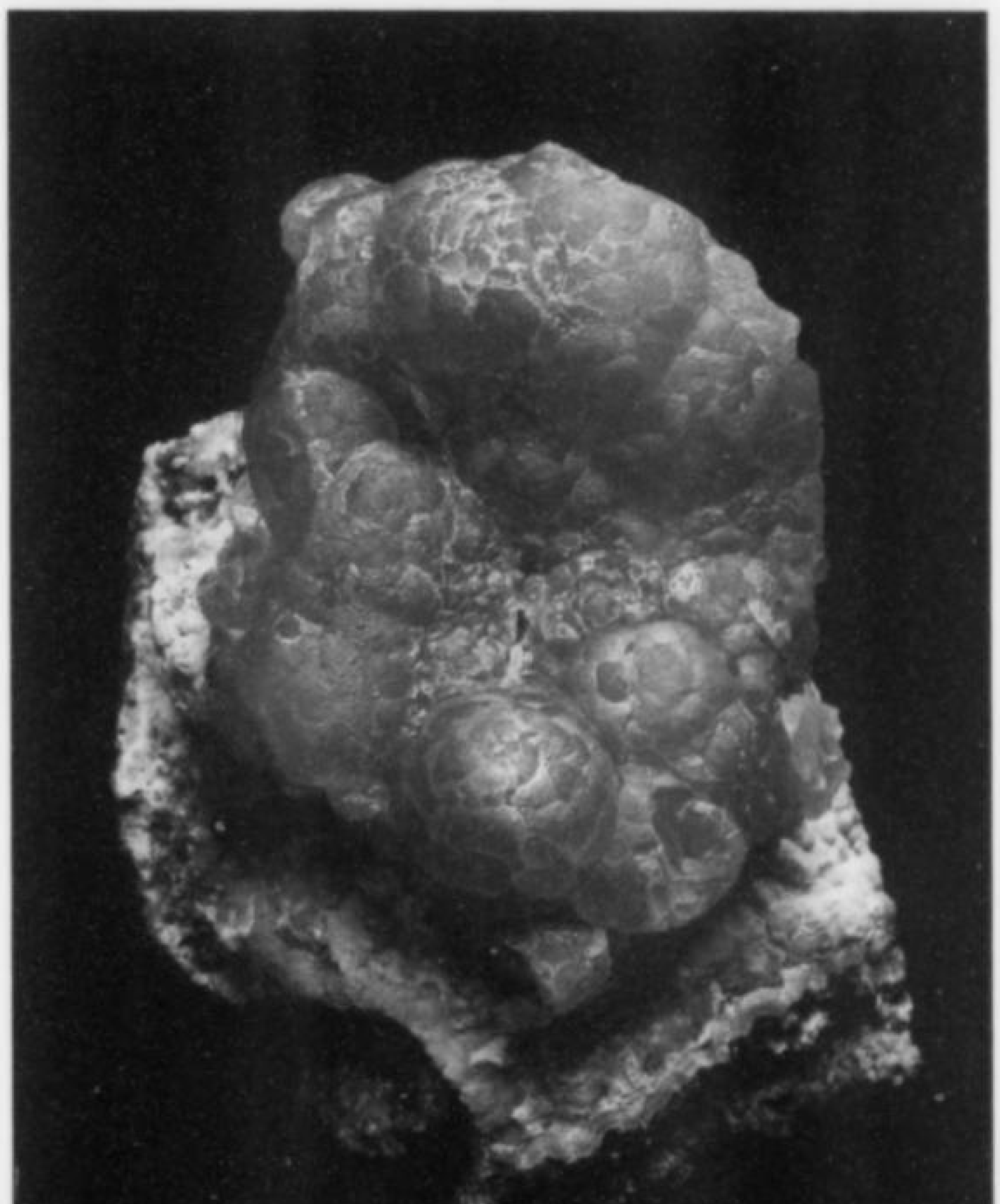


Figure 7. **Smithsonite, 5.3 cm, from the La Mezequite mine, Sahuaripa, Sonora, Mexico. Blue Sky Mining specimen; Jeff Scovil photo.**

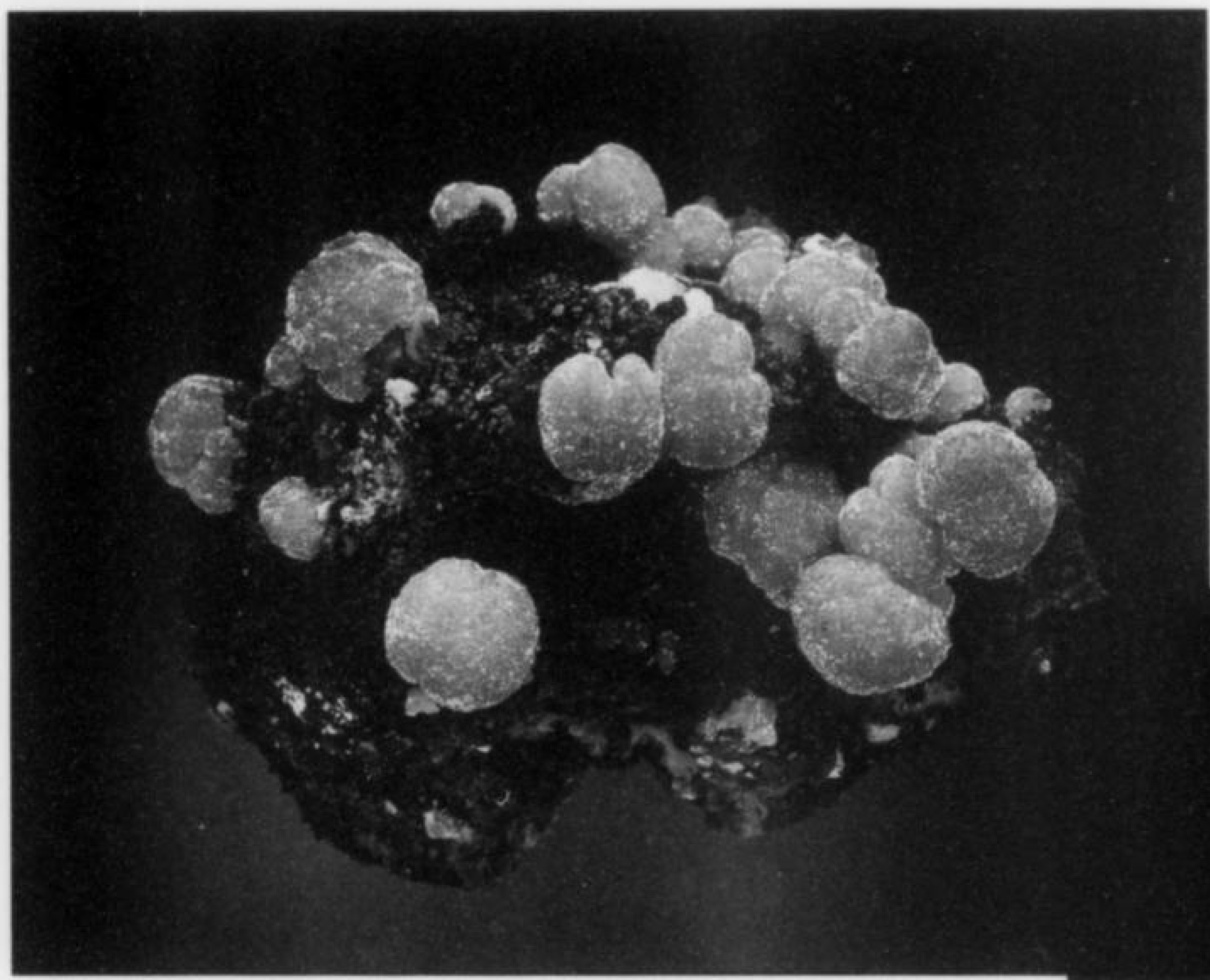


Figure 8. **Mimetite, 5.5 cm, from Level 8, Minerales shaft, Franco Portillo mine, Santa Eulalia, Chihuahua, Mexico. Dan Belsher collection; Jeff Scovil photo.**

Figure 9. **Cannizzarite ($Pb_4Bi_5S_{11}$?) microcrystals on matrix, 10.3 cm, from Vulcano Island, Sicily, Italy. Crystal Classics specimen; Jeff Scovil photo.**

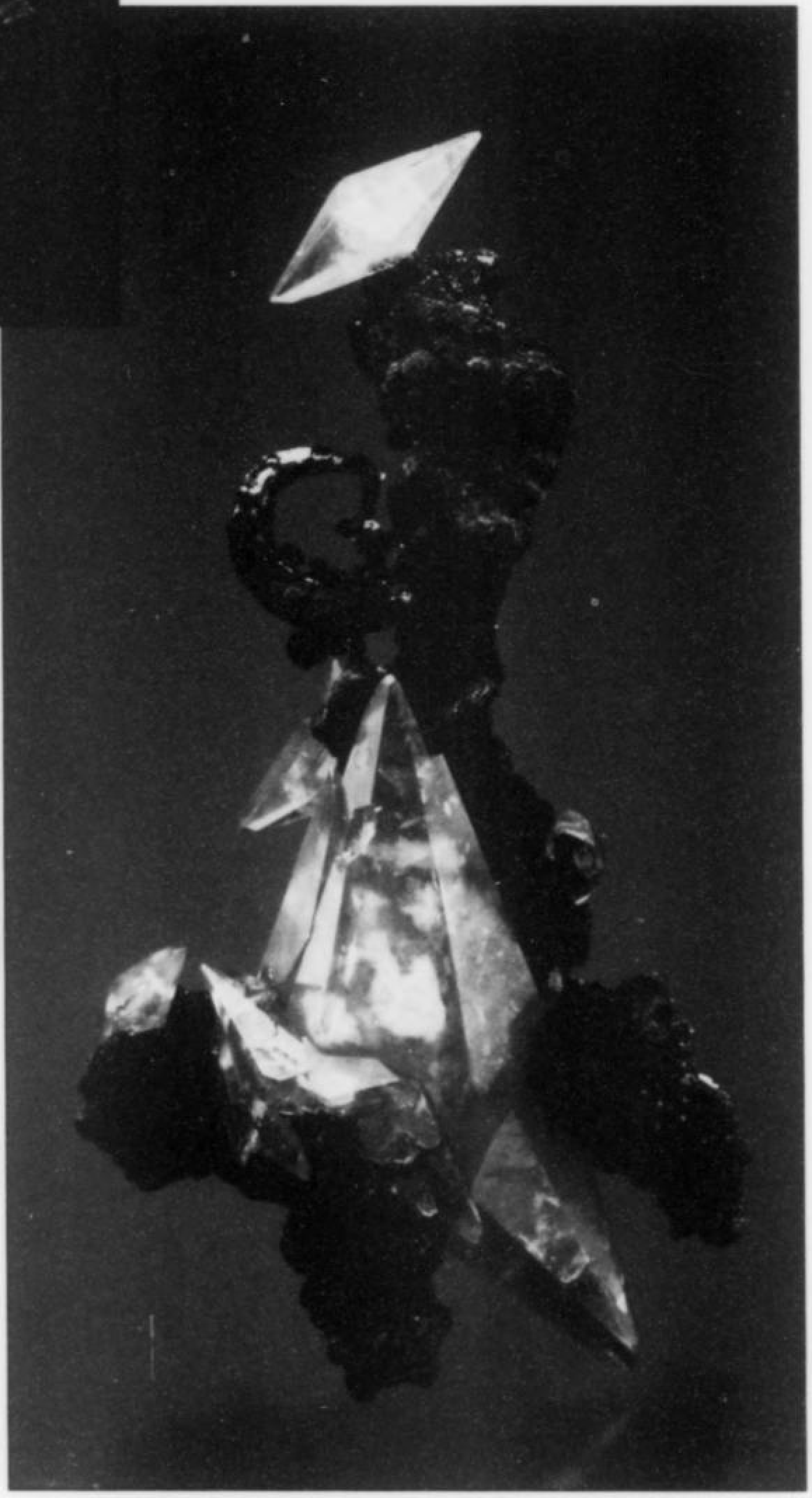


Figure 10. **Rhodochrosite with silver, 3.8 cm, from Uchucchacua, Peru. DeTrin Minerals specimen; Jeff Scovil photo.**

black simple cubes around 3 mm, on seams in a gray silicified limestone. There are six miniatures with the gray rock enlivened by these glistening little cubes.

Finally from Nevada: at the Main Show, *Dave Bunk* had just two very fine **stibnite** specimens (with optimism for more to come), newly dug at the Murray mine, Elko county. One, I'm told, is a huge, loose, brilliant stibnite prism, Chinese-style; the other is a 10 x 10-cm matrix piece with bright metallic-black thin prisms to 6 cm long, most of them terminated, rising abundantly from a base of sharp 2.5-cm barite crystals whose color is hard to see, as they're coated with drusy quartz.

Mike Jaworski and Glen Atwood of *The Pyromaniacs* (tel. 208-772-1610) were back again in their room at the InnSuites, with more excellent **pyromorphite** from the Bunker Hill mine, Kellogg, Idaho. New this year in the room—or at least I failed to spot their likes last year—were some winning thumbnails of **cerussite** from the Bunker Hill mine. This locality's cerussite at its best competes well with cerussite from just about anywhere else, although it has always been radically less plentiful on the market than the pyromorphite. A few lots appeared some years ago, but prices generally were one decimal place to the right of those now being asked by the Pyromaniac people for these sharp, pert, white to colorless, milky to transparent, brightly shining, delicate thumbnail groups. Some

Figure 11. **Pyromorphite group, 4 cm, from the Sedeftche mine, Momtchilgrad, Bulgaria. Keith Williams specimen; Jeff Scovil photo.**

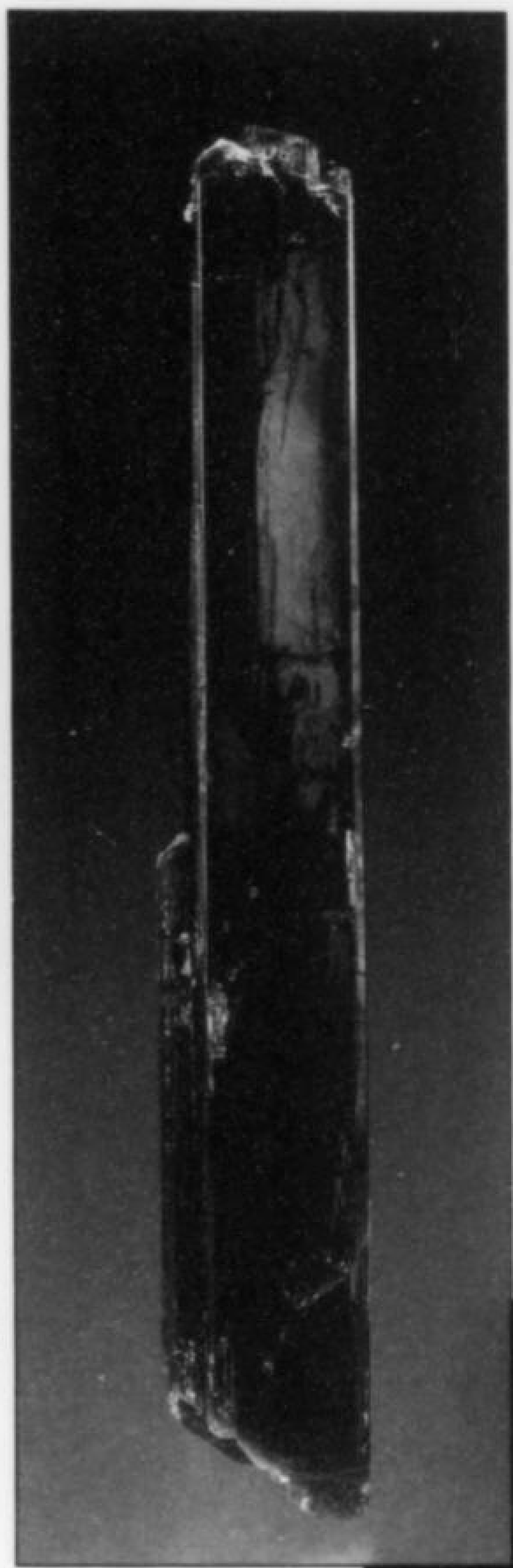
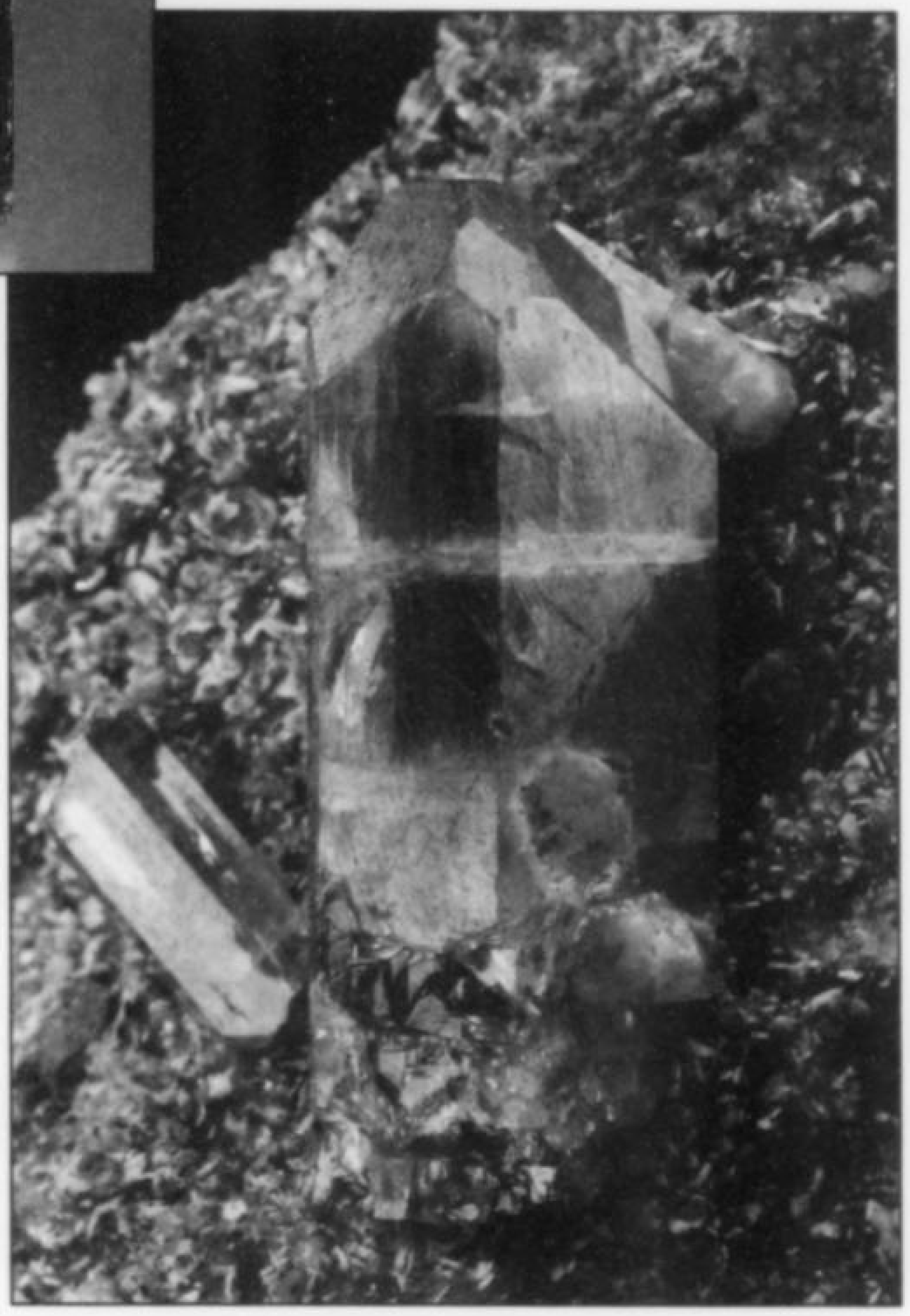


Figure 12. **Diopside crystal, 9.1 cm, from Chamachu, Baltistan, Pakistan. François Lietard specimen; Jeff Scovil photo.**

Figure 13. **Anatase crystal, 2.5 cm, from the Valdres Region, Norway. Budil and Grisse collection; Jeff Scovil photo.**

Figure 14. (below) **Fluorapatite crystal, 3.2 cm, from Vohemar, Madagascar. Peter Korbel specimen; Jeff Scovil photo.**



are classic V-twins, some are cyclic twins with flaring wings all around 360°; one is a cyclic twin of the flattened habit, with individual terminations rising up and around from wide, flat front and back faces. Nice things—although there's one thumbnail that you can forget about getting, because it's now *mine*.

In August and September of last year, Joe Hartsel of *Brass Rooster* (P.O. Box 1770, Rolla, MO 65402) was digging calcite at the Fletcher mine, Reynolds County, Missouri, when what should he break into but the "Red Phantom Pocket," lined with what would trim out to become about 300 **calcite** specimens, including 10 superb pieces, with red hematite phantoms. The matrix is a gray dolomite, and to it are attached (lightly) 10-cm doubly terminated scalenohedrons of yellow calcite with slightly rough, frosted faces; and *in* these are vivid orange-red phantoms which usually come up to a centimeter or two of the crystal surface. These specimens were all taken from one horizon in the mineralized rock, with pockets above and below yielding only the more mundane, simple yellow calcites. We are talking true *cabinet*-size specimens here: the largest I saw is a matrix fully a foot across, with a 13-cm calcite crystal (with that red blush inside) perched horizontally on top.

New Hampshire man *Bob Borofsky*, a partner in the JoLynne operation which works the famous Wise fluorite mine, has recently branched out to the extent of buying (with Rocko Rosenblatt) a farm at Little Falls, New York, with the idea of digging there for Herkimer- diamond quartz. Good idea: last November, after much preliminary work, several hundred scepter **quartz** specimens were found, and the three top pieces are amazingly beautiful things indeed. The quartz crystal shafts are rendered darkly smoky by inclusions of what's locally called 'anthraxolite" (probably a fossil organic residue); a later generation of quartz growth left scepter crystals of the brilliant, waterclear type. Other late-generation crystals are also attached to the prism shafts, though not so thickly as to obscure them entirely. The largest specimen is a 12-cm-long, single dark shaft with a topping scepter 3 cm wide. Another is a more complex affair, with a 4-cm smoky "stem" and an off-branching stem, all points crowned by 1.5-cm clear scepters.

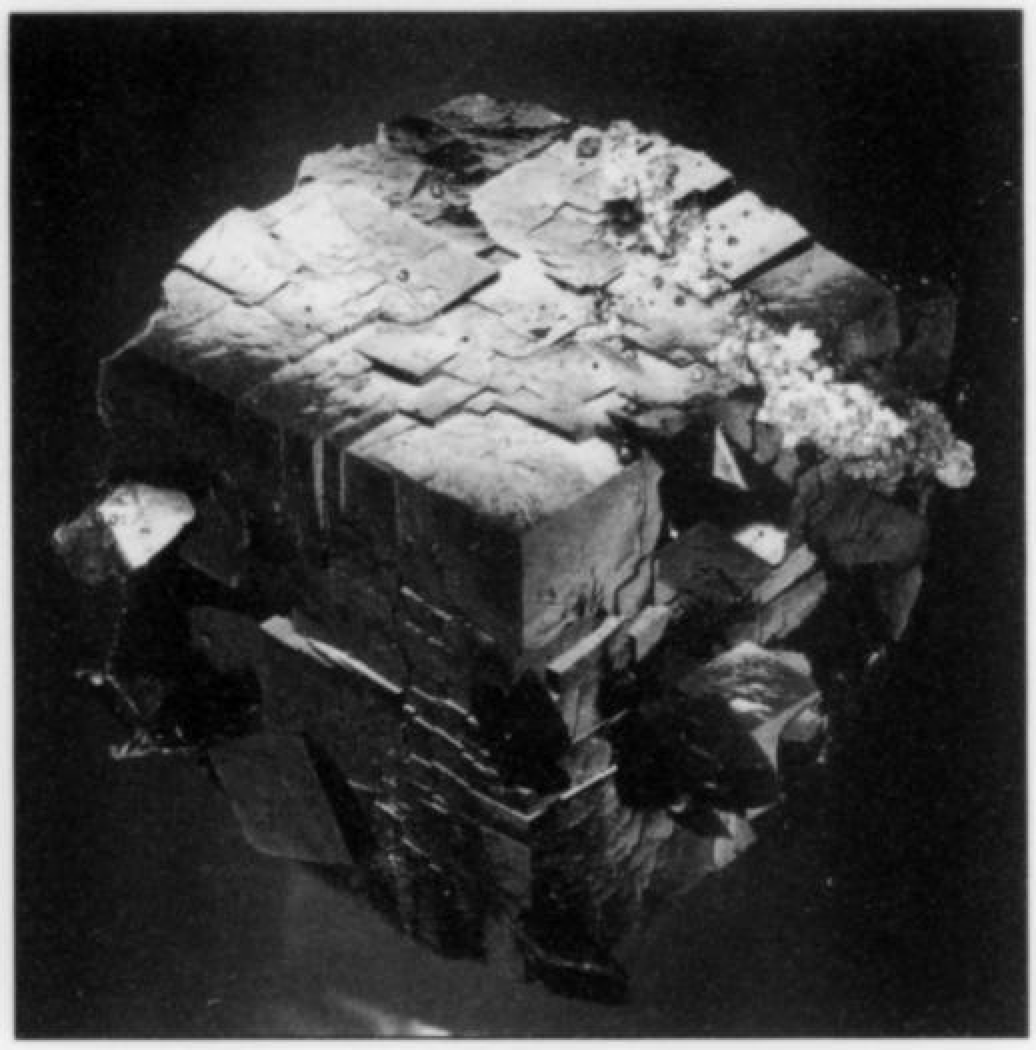


***Figure 15.* Calcite crystal colored black by boulangerite inclusions, 3 cm, from the Herja mine, Baia Mare, Romania. Kent England collection; Jeff Scovil photo.**

Contact Bob (P.O. Box 95, Spofford, NH 03462) if you want to monitor what's new at his "Treasure Mountain Diamond Mine."

The same foot-slogging day at the InnSuites which yielded the previous two items brought me—perhaps in need of a little curative radioactive heat—to the **uraninite** crystals in the room of *Larry Venezia* (115 Coleridge St., East Boston, MA 02128). The locality is the long-known Swamp #1 mine at Topsham, Maine; a small digging there is called "the Trebilcock location" because it has long been and is *still* being collected by Cliff Trebilcock, who lives nearby. Larry Venezia came to Tucson with an impressive 125 or so fair-to-excellent loose uraninite cubes and cuboctahedrons, in small thumbnail to "full" thumbnail size. The faces and edges are sharp, and the luster is high (at least for uraninite). There are no complete floaters; all backsides of crystals are flattened contacts with the muscovite or biotite sheets on which the crystals seem to have grown, and the edges of the mica sheets can sometimes be seen imprinted on these flat backsides. Certainly I have never seen so many good, sharp uraninite crystals together in one place (see also later, under Congo).

As usual, Gilles Haineault of *Collection Haineault* (224, 2ieme Ruisseau, St-Mathieu de Beloeil, Quebec, Canada J3G 2C9) had an Executive Inn roomful of newly collected Ste.-Hilaire, Quebec, material which well repaid close attention. Gilles had a very good year for quantity at Ste.-Hilaire, though, he said, not a particularly good year for quality. But I don't know about that, for among his finds were a dozen thumbnail-sized specimens showing what are surely the world's biggest **cryolite** crystals to date, found, Gilles said, in a large pegmatite. The euhedral to subhedral crystals are equant pseudo-octahedrons with some secondary faces, ranging in size from about 1 cm to an astonishing 2.5 cm, in coherent clusters and as loose singles with bits of adhering (mysterious) Ste.-Hilaire white stuff on them. Granted, they are not pretty—low-lustered, and a sort of pale grayish yellow, translucent to transparent where one can see through the opaque white surface films of analcime and chabazite—but they are larger than Greenland's largest cryolite crystals, and, unlike the latter, which run in parallel rows across big hunks of siderite, *these* cryolite crystals compose themselves as ideal thumbnails.

Further, Gilles had some new **analcime** specimens of a lovely, bluish white color, in lustrous trapezohedrons to 1 cm in groups up to 10 cm; in some miniatures, these "blue" analcimes come with clusters of bright yellow-brown curved siderite rhombohedrons averaging 5 mm. Intriguingly, some of the analcime crystals are hollow, presumably redissolved in part from within, so that you can shake them and hear loose shards rattling around inside. Oh yes, Gilles also showed me a few thumbnails of opaque white, rough-surfaced calcite pseudomorphs after blocky crystals of the (very rare) Ste.-Hilaire species **shortite**, as well as a few loose, 5-cm prismatic sprays of **synchisite** pseudomorphs after the new mineral **petersenite**, in an opaque, mottled white/gray-brown color.

In another familiar "Canadian" room, that of *Tyson's Minerals*, Rod Tyson was proud to show off some specimens of **welagonite** he'd collected back in the 1970's, and was now selling; and fine pieces they were too, with typical pale yellow-green stacked-plate crystal groups to 2.5 cm high, some with chalky white encrustations. There was one fine thumbnail, and one 10 x 15-cm matrix piece with an open 5 x 6-cm cavity with very sharp welagonites projecting into the cavity. The locality, of course, is the Francon quarry, near Montreal. Then, just one shelf away, there was the Tysons' really *new* offering this time: seven thumbnails and small miniatures of surprisingly good **gold** from an as-yet undisclosed locality in Newfoundland. This is a 1998 field season find, and prospects exist for more such specimens of the first good crystallized gold from Newfoundland ever to hit the show scene. The matrix is massive milky quartz and albite with green spots of chlorite; the thin, very bright gold leaves lie flat on the fracture surfaces, and bright microcrystals glitter in tiny vugs. In one toenail there are even pale, delicately curved dendrites of gold wispily crossing a cavity.

The theme of the Main Show this year was ***Mexican minerals,*** so it is appropriate that Mexico was the country which starred on

***Figure 16.* Elbaite crystal, 3.8 cm, with faceted stones (right, 26.5 cts.), from Kaffi, Nigeria. Barker & Company specimen; Jeff Scovil photo.**

***Figure 17.* Steve and Clara Smale exhibit case. Jeff Scovil photo.**

the what's-new-in-minerals stage as well. We begin on Level 13 of the Minerales shaft of the famous El Potosi mine, Santa Eulalia, Chihuahua. Here there has recently been dug some terrific new **hemimorphite** and manganoan **adamite**, both in stock at many dealerships at this show, although the best stayed with Peter Megaw (who brought them out) of *IMDEX, Inc.* (P.O. Box 65538, Tucson, AZ 85728), and with Dan Belsher of *Blue Sky Mining Co.* (8890 North Federal Blvd., #52-D, Denver, CO 80221). The hemimorphite comes as white, translucent to transparent, brilliant prismatic crystals to 1.5 cm, standing up in spikes from red hematite matrix, some of the crystals sprinkled with tiny adamites or with red hematoid calcite microcrystals. Also, from Level 16 of the mine have come larger, stouter crystals of hemimorphite. The adamite presents itself as bright, glassy, blocky crystals to 1 cm or so in attractive groups nesting on and in the same matrix. The interior color is familiar adamite-yellow, but most crystals have deep brownish purple hourglass-shaped zones inside, or a shining brown/purple surface color. Also from this occurrence comes deep pinkish orange **rhodochrosite** in toothy bundles of crystals, in specimens mostly toenail size. Megaw and Belsher between them had a couple of hundred specimens in all sizes. In case you are wondering, the Potosi mine is inactive commercially, but is being busily worked by ex-miners.

In October of last year a small lot of fine **arsenopyrite** specimens came from Level 11 of the San Antonio El Grande mine, San Antonio, Chihuahua, and about 20 specimens could be seen in the *Blue Sky Mining* room at the Executive Inn. Highly lustrous, typically wedge-shaped, striated arsenopyrite crystals to 2 cm sit nicely individualized amid milky needle-quartz beds on solid sulfide matrix; there are numerous fine miniatures and some cabinet-sized plates, one of these 25 cm across.

But even these Mexican desiderata are—to my taste, anyway—only warm-ups for the extraordinary show of silver-mineral specimens from Guanajuato and Zacatecas, all on a single crowded shelf of a wall case (I nominate it for mineraldom's "the most fine specimens on a single shelf" honors) at the Main Show stand of *Dave Bunk*. All collected within this past year, these dazzling thumbnails, toenails and miniatures include, first, **polybasite** from the 590 Level of the Sirena mine, Guanajuato, in flashing metallic black, supersharp thin hexagonal plates in parallel growth and as flaring clusters; a few have small, metallic yellow fuzzy spheres of what is said to be chalcopyrite-coated acanthite adhering to polybasite plate surfaces. Also, from the Rayas (not "Reyes") mine, Guanajuato, there is **acanthite** in thumbnail groups of oriented, stacked cubes in overall octahedral aspect—yes, a familiar acanthite specimen style, but never in so many pieces so sharp and brilliant as these. And there was equally brilliant metallic black **stephanite** from Fresnillo, Zacatecas; and beautiful **pyrargyrite** from the same place; and odd, dull-black, fuzzy-looking sticklike crystals in jackstraw groups of what are probably polybasite or acanthite pseudomorphs after pyrargyrite. Okay, these are expensive items (a top polybasite or stephanite thumbnail could run you up to $750), but justly so considering the quality. Dave Bunk and Dennis Beals deserve our applause for having brought out so much good stuff.

Jack Crowley was the one who brought out the new specimens of **atacamite** on and in transparent gypsum from a new locality, the Lilly (or Lily) mine, Pisco province, Ica department, Peru—these being marketed in the Executive Inn by Rob Lavinsky of *The Arkenstone* (P.O. Box 948627, La Jolla, CA 92037) and at the Main Show by Isaias Casanova of *IC Minerals* (P.O. Box 1376, Goldenrod, FL 32733-1376). Rob's specimens are mostly sharp, waterclear gypsum crystals to 6 cm in clusters, liberally shot through with bright green needles of atacamite (verified: *not* brochantite), for a beautiful effect. Isaias had five flats of thumbnails and miniatures of more complex aspect: delicate jackstraw clusters of deepest green atacamite needles, sometimes all alone, sometimes in or with the clear gypsum, sometimes whiskering up from a matrix of pale blue chrysocolla, drusy quartz and limonite. This apparently is a small working copper mine which might very well soon be yielding more examples of this very colorful material.

Wayne and Dona Leicht of *Kristalle*, atypically for gold-selling

Figure 18. **Gene and Rosalind Meieran exhibit case (the 15.3-cm Colombian euclase crystal that caused such a stir is on top-center shelf, second from right). Jeff Scovil photo.**

specialists, were offering some *very* large clusters of **amethyst** from a new source: Arrahi, near Puerto Suarez, Bolivia. In an Executive Inn room, Wayne's brother Dennis toured me around a wide table with five crystal clusters starring a 45-cm group with about eight monstrous, thick, well-terminated crystals; a few *somewhat* smaller clusters reposed on a shelf nearby. Considerable volumes of SiO_2 under the steep rhombohedral terminal faces are gemmy, in beautiful medium to deep purple color. The prism faces of all the crystals have nice, intricate, parallel-growth features, and are milky gray-white and translucent. Normally I don't go in for specimens which weigh as much as I do, but I have to say that this looks like a major amethyst find.

Brazil seemed to be lying low this year. *Carlos Barbosa*, though, did have bigger supplies of bigger, better loose prisms of rich yellow-green **milarite** from Jaguaraçu, Minas Gerais, than previously, as well as some small miniatures with pale green glittery rounded aggregates of tiny crystals of the rare **zanazzaiite**, with muscovite. At the Main Show, Frank Melanson of *Hawthorneden* showed me some fairly impressive specimens—including one single 15-cm crystal—of a new find of morganite **beryl** at the Paineiras mine, Virgem de Lapa, Minas Gerais. The pocket was hit in June; the crystals' color is an odd salmon-pink, and they are all gemmy and sharp, with lots of secondary faces.

Last stop in the Western Hemisphere is the Mina Rumi Tucu, Papachacra, Catamarca Province, Argentina, which, as reported by Jeff Scovil from Ste.-Marie-aux-Mines (see vol. 30, no. 1), has recently turned out some excellent large specimens of **microcline**. Larry Venezia (see earlier under uraninite) had about 20 of these specimens in Tucson: large-cabinet-size pieces, with crisp, clearly Baveno-twinned, flesh-colored microcline crystals to 5 cm lined up in soldierly rows in groups without matrix (although some have smoky quartz crystals adhering). Larry, being a New England man, was taken by their resemblance to microcline specimens from Moat Mountain, New Hampshire.

Easily the most dramatic case of an upgrade of an earlier-known occurrence was the newly dug **anatase** specimens from the "Valdres Region," Norway. For now this vague locality designation will just have to do, not only because of the usual fear of claim jumpers, but also because the collecting area is near the border of a national park, and the Norwegian government is touchy, as governments tend to be about such matters. This information comes to me from the German collector, Marcus Budil, who took out the new batch of giant anatase crystals; he also says that the reason why such crystals surfaced briefly about eight years ago, then disappeared, and now are resurfacing, is that a snowfield which normally covers the collecting area melted during the unusually warm Norwegian summer of 1998. So nature and man, in their different vagaries, may or may not allow us to see more such amazing specimens in future years. At any rate, Valdres anatase is not to be confused with the earlier "Hardangervidda" specimens, which look different anyway, with smaller crystals perched on and partly embedded in clear quartz prisms (see the article in vol. 8, pp. 266–271). Now about the new specimens. The anatase crystals are lustrous, very sharp, horizontally striated, fat blue-black bipyramids with small basal pinacoid faces; they reach an astonishing 3 cm long, and it is not uncommon to see crystals in the 2-cm range. They perch or lie

Figure 19. **Exhibitors (from left to right) Gene Meieran, Wayne Thompson, Jeannie and Bill Larson, Steve Smale and Clara Smale. Jeff Scovil photo.**

Figure 20. **Bill Larson exhibit case of rough-and-cut pairs. Jeff Scovil photo.**

flat, but lightly so, on matrix covered with drusy orthoclase occasionally bedecked with tiny brassy crystals of chalcopyrite. Marcus collected perhaps 30 top pieces among a couple of hundred in all. With their gigantic, sharp, textbook-perfect crystals, and their general aesthetic effectiveness, they certainly must be ranked among the best anatase specimens from anywhere—and prices reflect that judgment. There were a great many specimens around the show, but honors for the very best were shared by *Collector's Edge* and *Heliodor.*

France said a modest *bonjour* at the Main Show stand of *Alain Carion* (92, Rue St-Louis en l'Ile, 75004 Paris, France), with some eccentrically handsome-looking new **sand calcite** specimens from Cabreret, in the Dordogne. Found twelve years ago "when a cave collapsed," these are not to be confused with the much older sand calcites of Fontainbleu, as the latter are grayish white while these newer ones are tan, their surfaces looking like medium-coarse sandpaper. Alain's 15 pieces were, he said, the best collected: one 15-cm cluster, the rest miniatures and toenails. The calcite crystals are sharp, simple rhombohedrons to 3 cm, intergrown in well-sculpted groups without matrix.

The hotel shows this year welcomed a new dealer, the Swiss strahler (and native Slovak) *Vladimir Pusec*, who, with his partners

(continued overleaf)

The 1998 Carnegie Mineralogical Award goes to . . .

Robert W. Jones

The Carnegie Mineralogical Award honors outstanding contributions in mineralogical preservation, conservation and education that match ideals advanced in Carnegie Museum of Natural History's Hillman Hall of Minerals & Gems. Established in 1987 through the generosity of The Hillman Foundation, Inc., the award consists of a bronze medallion, a certificate of recognition and a $2500 cash prize. It is presented each February during the Tucson Gem and Mineral Show.

Nominations are now being accepted for the 1999 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:
Marc L. Wilson
Section of Minerals
Carnegie Museum of Natural History
4400 Forbes Avenue
Pittsburgh, PA 15213-4080
TEL: (412) 622-3391
FAX: (412) 622-8837

CARNEGIE MUSEUM OF NATURAL HISTORY

Photo by Harold and Erica Van Pelt

in *Zür Kristall-Höhle* (Schipfe 31, CH-8001, Zürich, Switzerland), filled their room thickly with both old and recently self-collected Swiss specimens. They put out an intriguing, in fact downright addictive, spread of thousands of little specimens. From the clefts of Mt. Cherbadung (on its south slope, but called Monte Cervandonne, in Italy), the strahler Andre Gorsatt, who was also on hand in the room, has collected about a dozen **cafarsite** specimens, mostly as loose brown cubes, cuboctahedrons, and combinations, to about 2 cm. Other Mt. Cherbadung rarities in this part of the room, and in microcrystals, included **asbecasite**, **chernovite-(Y)**, **cervandonite-(Ce)**, and **fetiasite** with **anatase**; and then there were a few thumbnails of white microcrystallized **armenite** from Wasenborn, Simplon area. Further, there was a new find of **albite** from Piz Beverin, Graubünden, in glistening, translucent to transparent, colorless single crystals and twins to 4 cm on clear quartz groups to 12 x 12 cm. There were multitudes of classic **orthoclase** twins, translucent-white, transparent-colorless, or chlorite-dusted, to 5 cm, and one *40-cm* group. Let's see, then there were some outstanding thumbnail **hematite** "Eisenrosen" which Vladimir dug a year ago at Pizzo Lucendro, St. Gotthard Pass, Ticino; there were some fine cabinet-sized **smoky quartz gwindels**, there was **pink fluorite** from the Göschener Alp, and there were **titanite** and **milarite** in brilliant little 1-cm loose crystals. Finally there was something I hadn't known existed: Japan-law **twinned quartz** in transparent colorless 1-cm wings, nestled amid the usual clear needle quartz from Val Bedretto (one super thumbnail of this cost $200: the only thing in the room I thought overpriced). No, in this room there were no great show-stoppers, but for its variety and good taste in Swiss minerals I found it the most interesting and fun room in the whole hotel show.

Yet another news item of the quantum-leap-upward type is the small scattering around the show of new specimens of **boulangerite**-included calcite from the Herja mine, Maramures, Romania. We have grown used to seeing this material as tight, ridgy spheres of brownish black, small, flattened calcite crystals, sometimes as individual spheres to maybe a centimeter or two across, sometimes as grapelike clusters of spheres—fairly presentable but not beautiful, mostly just "odd." But these new specimens, of which about 200 are said to have recently come out of the Herja mine, are truly beautiful (if still odd): curved, satiny-lustrous, flattened calcite rhombs forming spheres to 4 cm across, in grape-bunches to 10 cm across; a few of these, offered at the *Hawthorneden* stand at the Main Show, rest on matrix of massive quartz and galena. Kent England was showing around the ultimate specimen: a single saddle-shaped crystal, clean and bright and undamaged, 5 cm high.

The now familiar Bulgarian-minerals people in *Intergeoresource Ltd.* (P.O. Box 66, 1404 Sofia, Bulgaria), led by Alexander Dikov, came up this year with yet *another* new Bulgarian occurrence of **pyromorphite**. This time it's the Sedeftche mine, near the town of Momtschilgrad, in the Rhodope Mountains—a closed lead/zinc mine where the new specimens were collected last October. The pyromorphite occurs as richly brown, medium-lustered hexagonal prisms, some hoppered, to 3 cm long and 1.5 cm across the tops, in jumbled groups, either loose or on yellow-brown microcrystallized plumbojarosite matrix. The dealership had about 50 pieces in all sizes. The specimens could use cleaning, but are, at their best, fairly serious pyromorphites.

Also out of Bulgaria—brought out, in fact, by Sam Koster of Houston—are a couple of foot-wide flat plates of solid manganoan **calcite**, in tightly intergrown 5-cm scalenohedrons with rhomb terminations. They are from the Erma Reka mine, Zlatograd; their color is a winsome pale pink. They were brought to Tucson by Doug Wallace of *Mineral Search Inc.* (11882 Greenville Ave., Suite 123, Dallas, TX 75243).

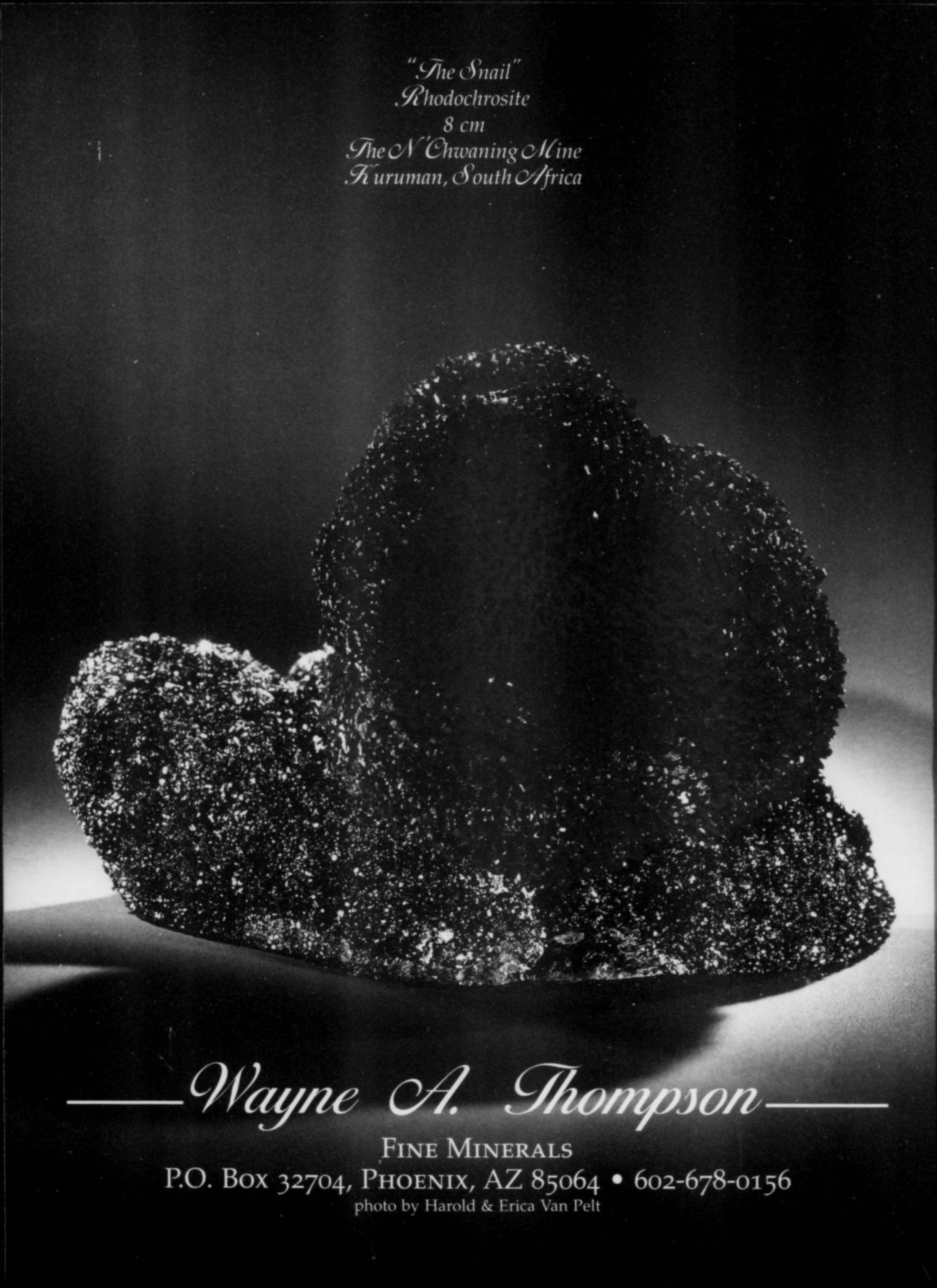
There is an important stop to be made in Morocco this time, as Ernesto Ossola, who self-collects most of his minerals in these desert wastes (and loves it!), has scored some **gersdorffite** from the Ait Hamane mine which surely is among the best yet for this rare nickel arsenide sulfide. Ernesto had about ten outstanding cabinet specimens, with brilliantly lustrous metallic white (think of skutterudite at its best) 5-mm octahedrons of gersdorffite in tight spherical groups, partly etched out of white vein calcite so that the gersdorffite balls sit up well on massive gray ore (with green stains of annabergite). A 7-cm specimen with crystal clusters shining all over the top is the best ($2000). Ernesto had also some of his best-yet miniatures of feathery, sparkling metallic gray aggregates of **nickeline**, also from Ait Hamane, and even a couple of miniatures with open pockets showing linings of 3-mm deep magenta crystals of **wendwilsonite**, from Bou Azzer. From a granite pegmatite at Bou Agra, Morocco, Ernesto took out about eight miniature-sized clusters of sharp black **pargasite** crystals, with individuals to 4 cm, on white feldspar.

Bill Dameron, former U.S. ambassador to Mali, sent me a letter a few weeks ago in which he clarifies the locality information for the large, sharp, green or brown **grossular** (and/or andradite) garnets that have lately been flooding the shows. Noting my mystification last year about the "Kayes," which is all some dealers provided on labels, Bill explains that Kayes is a large region of Mali—about like saying "Siberia" or "Minas Gerais." The name of the town nearest the site where most of the garnets from is Diakon, and the name of its arrondissement (loosely, "state") also is Diakon; and in this same state, farther from the collecting site, lies the larger town of Sandare (also sometimes seen on labels), where all of the specimen-dealing goes on. Further, the very black garnets come from a different site, designated as Trantimou, while reddish brown grossulars come from a place called Bindougou. But the **vesuvianite** and **epidote** specimens come from the primary garnet-producing areas near Diakon. Labels for all but the latter two types of garnet might responsibly read "near Diakon, Diakon Arrondissement, Kayes Region, Mali." Any questions? If so, write to Bill: 1609 N.W. 79th Circle, Vancouver, WA 98665.

Gilbert Gauthier, at the Main Show, had the best lot of malachite-included **barite** from the Shangulowe mine, Congo (formerly Zaire) that I have seen to date—an extremely impressive gathering of about 20 large miniatures to cabinet-sized crystal clusters. The transparent, smoky-gray to colorless barite crystals, reaching 5 cm long, occur in jumbled groups, subparallel fans, and picket-fence formations, with or without earthy green malachite matrix. They are lustrous and sharp, and lightly clouded by gray-green inclusions of finely divided malachite. The prices for the best ones at Gilbert's stand were $200 to $400. Much less predictably, Gilbert also had ten loose, surprisingly sharp, dull black **uraninite** crystals from the Shinkolobwe mine, Katanga: these he took out himself, before the mine closed in 1958. The simple cubes are from 1 to 2 cm on edge; they are not as lustrous, but, being more nearly complete, are fully as nice as their cousins from Maine. Really good crystals of uraninite from this place are true rarities, be it said.

Dr. Dikov and his partners in the Bulgarian concern of Intergeoresource (see under pyromorphite) now have concessions to mine elbaite, rose quartz, morganite beryl, etc., from five mines in Alto Ligonha, Zambezia, Mozambique, and this is interesting, as nothing much has been happening at this famous locality for quite a long time: any minerals from there that we may see on dealers' shelves are almost certainly old-timers. As an appetizer for bigger courses to come (he hopes), Dr. Dikov showed me some nice 4-cm terminated loose prisms of green, pink and blue-purple **elbaite**

(continued on p. 224)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What's New *(continued from p. 221)*

which he's already acquired; a few are zoned, blue in their interiors along the *c* axis, pink in their outside shells. Dikov's **lepidolite**, **beryl**, and pink **spodumene** specimens from Alto Ligonha are unremarkable—but don't forget to add "so far."

There has been a new strike of fine, gemmy yellow **rhodizite** crystals from a working prospect at Antsogombato, near Antsirabe, Madagascar, and a handful of dealers had specimens around the show; the two most notable whose stock I saw were Jordi Fabre and the partnership of *Riccardo Prato* and *Lacagnina Gaetano* of Milan (who had the Thai mimetites last year). The rhodizite crystals are fairly lustrous, often gemmy, although moderately crazed inside; in color they are a bright yellow to "brazilianite" yellow-green. Their matrix is pegmatitic: most crystals are frozen in white albite, though some seem to be pocket occurrences. In the pieces I saw—not the best of the best, I suspect—crystal sizes reach 2 cm, and matrix is of miniature to small-cabinet size.

Orpiment from the Elbussiky mine in the Russian Caucasus is the only new Russian item making the news this time. A couple of Russian dealers had flats of negligible small specimens, all heavily damaged, and no wonder: you'd just have to touch the surfaces of the crystal druses to leave an unsightly yellow bruise on what was originally a glistening velvety carpet of tiny orpiment crystals which fairly glows with a crazy-hot red/orange color and brilliant luster. The only more or less "clean" specimens I saw were about ten miniature and small-cabinet-sized pieces in the InnSuites room of Chris Wright of *Wright's Rock Shop*, where for $100 to $500 you could pick up (carefully!) a flat plate of grayish white calcite or limestone with a centimeter-thick blanket of this incandescent stuff.

Not for the first time, the minerals of Kazakhstan were prominently represented at Tucson. The dealership *KARP* (P.O. Box 54, 272 80 Kladno, Czech Republic) brought in a mighty sophisticated new lot of things from the copper mines of Dzhezkazgan, including the familiar **bornite**, **chalcocite** and **stromeyerite** specimens in good overall quality, and even a few small miniatures of **dolomite** in small pink saddle crystals with quartz: nothing great for dolomite, but at last a non-metallic (gangue?) mineral from this place. Most interesting among the Dzhezkazgan items are about a dozen variously sized specimens of **betekhtinite** from the Twin Pocket, Mine #31, collected in May 1998. Long bundles of tightly parallel crystals, like little gray-black sheaves of hay, lie gently over each other at irregular angles, either as thumbnail specimens without matrix or over a gray rock with quartz crystals. On the large matrix pieces the betekhtinite bales can get to 5 cm long. KARP's Peter Braticak told me that this material has been found to be, internally, at least 70% betekhtinite, the remaining 30% being chalcocite pseudomorphs after betekhtinite.

Jordi Fabre had the best Dzhezkazgan **chalcocite** specimens I have yet seen: one is an 8 x 10-cm flat plate of gray mafic rock lightly sprinkled with chalcocite as matte-lustered, black, pseudo-hexagonal twins averaging 1 cm across. Another, smaller specimen of this type features also the familiar rough, iridescent **bornite** crystals. And Jordi flashed at me three very fine Dzhezkazgan **djurleite** specimens: lustrous jet-black metallic crystals in thick, rounded parallel-grown knobs on drusy quartz with calcite, from the Anna mine. What's unusual here is the height and solidity of the crystal knobs, because djurleite usually appears as thin, flat-lying cuneiform-patterned crystals on matrix surfaces.

Mike Bergmann's room at the InnSuites was nicely greened up with three or four hundred newly acquired (and well cleaned) **dioptase** specimens from the classic locality of Altyn-Tube, Kazakhstan. The dioptase crystals, to maybe 1 cm, are clustered or sprinkled on brownish white limestone, and their color is excellent. It is probably time to get one of these if you haven't yet, as a few years ago they were very abundant on the market, but now much less common.

The distance from dioptase to **davidite** is, on the beauty-meter, at least as great as the distance from your home to Kazakhstan, but I'm duty-bound to mention that a few dealers had record-size crystals of this rare, rare-earths/uranium oxide species, from a new digging at Bek-tau Alta, Kazakhstan. The davidite crystals are tabular, subhedral, iron-stained, dull black, and unspeakably ugly, but they do reach a remarkable 4 cm across.

Pollucite, a rare zeolite in a series with analcime, and crystallizing likewise in trapezohedrons, has popped up in soccer-ball-sized Pakistani crystals at shows before, strictly in a one-of-a-kind way. But this year François Lietard of *Minerive* had a couple of flats of nice thumbnails, the best of the specimens being complete, or nearly so, transparent colorless crystals with frosted faces and no matrix, from Shengus, Gilgit, Pakistan. Prices were proportional to the degree of crystal completeness, but ran around $100 to $300 at the Minerive stand at the Main Show. Meanwhile, back at the Executive Inn, Rob Lavinsky of *The Arkenstone* had some lower-end, i.e., only about half complete at best, loose pollucite crystals, too.

François Lietard, who is always good for a new Himalayan goodie or two, had also some strikingly pretty, deep gemmy green prismatic crystals of **diopside** from Chamachu, Baltistan, Pakistan. These crystals are sharp and lustrous, with good simple or compound monoclinic terminal faces, and can reach 8 cm long. Of the

(continued on p. 238)

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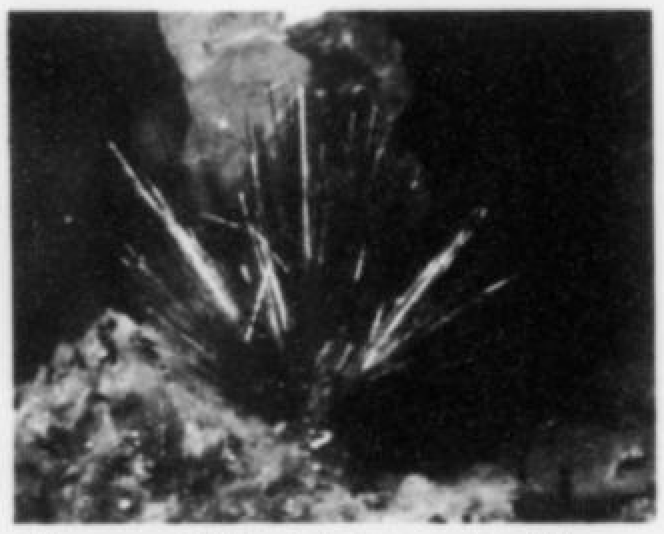

Tuperssuatsiaite- Aris Quarry, Namibia

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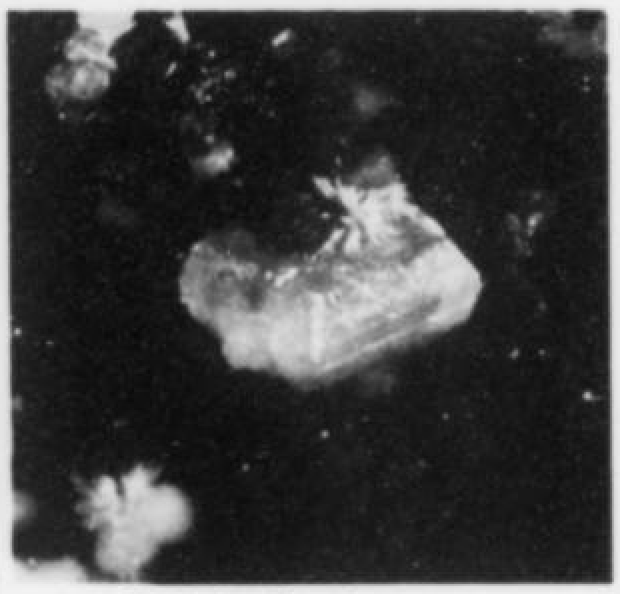

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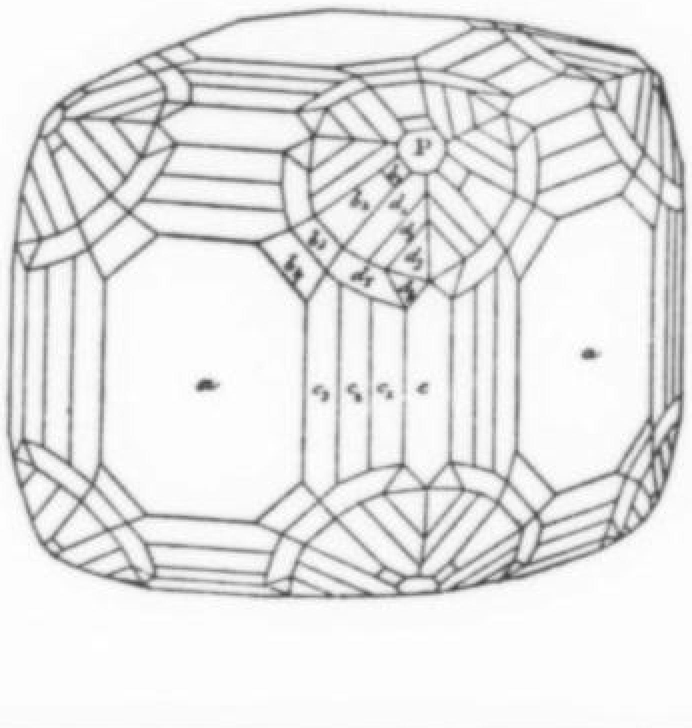
Abstracts of New Mineral Descriptions



J. A. Mandarino
Chairman Emeritus of the Commission on
New Minerals and Mineral Names
of the International Mineralogical Association
and
Curator Emeritus
Department of Mineralogy
Royal Ontario Museum
100 Queen's Park
Toronto, Ontario, Canada M5S 2C6

Averievite — Trigonal

$Cu_5(VO_4)_2O_2 \cdot CuCl_2$

Locality: The Second North Fracture cone of the Main Tolbachik Fracture Eruption, Kamchatka, Russia.

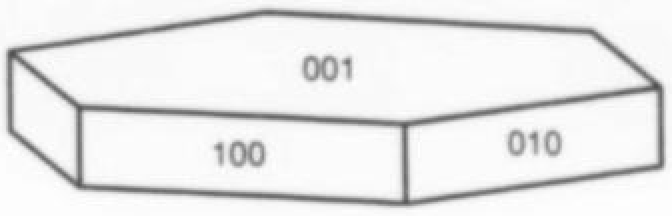
Occurrence: In fumarole deposits. Associated minerals are: alumoklyuchevskite, langbeinite, piypite, and copper arsenates, vanadates, and tellurates.

General appearance: Psudohexagonal prisms (up to 0.3 mm in diameter and 0.05 mm thick).

Physical, chemical and crystallographic properties: *Luster:* resinous to metallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* black. *Hardness:* VHN_{20} 258 kg/mm^2, Mohs 4. *Tenacity:* brittle. *Cleavage:* {100} good. *Fracture:* not mentioned. *Density:* 3.54 g/cm^3 (meas.), 3.97 g/cm^3 (calc.); see Comments. ***Crystallography:*** Trigonal, *P*3, *a* 6.375, *c* 8.399 Å, *V* 295.6 Å^3, Z 1, *c:a* = 1.3175. Morphology: forms, {001}, {00$\bar{1}$}, {100}, {010}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.43 (7), 2.810 (4), 2.315 (10), 2.131 (3), 1.598 (4). ***Optical data:*** Reflectance measurements could not be made because of the fine-grained nature of the mineral. ***Chemical analytical data:*** Means of seventeen sets of electron microprobe data: K_2O 0.98, Rb_2O 0.82, Cs_2O 3.35, CuO 62.01, Fe_2O_3 0.62, V_2O_5 23.84, MoO_3 1.51, Cl 7.56, sum 100.69, less O = Cl 1.71, Total 98.98 wt.%. Empirical formula: $Cu_{5.00}[(V_{1.87}Mo_{0.07}Fe_{0.06})_{\Sigma 2.00}O_{7.78}]O_{2.19} \cdot (Cu_{0.56}Cl_{1.12}) \cdot (Cs_{0.17}K_{0.15}Rb_{0.06})_{\Sigma 0.38}Cl_{0.40}$. ***Relationship to other species:*** Related to stoiberite.

Name: For V. V. Averiev (1929–1968), Russian volcanologist. ***Comments:*** IMA No. 95-027. The measured density is low because of small bubbles adhering to the grains during immersion. This is another example of the crystal structure being published before the description of the mineral. The drawing for this abstract was produced from the data given in the paper.

VERGASOVA, L. P., STAROVA, G. L., FILATOV, S. K., and ANANIEV, V. V. (1998) Averievite $Cu_5(VO_4)_2O_2 \cdot n$MX—a new mineral of volcanic exhalations. *Doklady Akademia Nauk* **359(6)**, 804–807. STAROVA, G. L., KRIVOVICHEV, S. V., FUNDAMENSKY, V. S., and FILATOV, S. K. (1997) The crystal structure of averievite, $Cu_5O_2(VO_4)_2 \cdot nMX$: comparison with related compounds. *Mineralogical Magazine* **61**, 441–446.



Averievite

Blatonite — Hexagonal or Trigonal

$UO_2CO_3 \cdot H_2O$

Locality: The Jomac uranium mine, Brown's Rim, San Juan County, Utah, U.S.A.

Occurrence: In seams of gypsum along bedding planes of a siltstone within the Shinarump conglomerate. Associated minerals are: gypsum, boltwoodite, coconinoite, metazeunerite, rutherfordine, azurite, brochantite, carbonate-cyanotrichite, malachite, manganoan smithsonite, patches of sulfides, and unknown material.

General appearance: Very thin asbestiform aggregates consisting of bundles of needle-shaped subparallel fibers (up to 0.1 x 1 mm). Some crystals are fan-like and terminated.

Physical, chemical and crystallographic properties: *Luster:* silky. *Diaphaneity:* translucent. *Color:* canary yellow. *Streak:* white. *Luminescence:* strong greenish-yellow at 360 nm. *Hardness:* Mohs 2 to 3. *Tenacity:* flexible. *Cleavage:* parting along the fibers. *Fracture:* uneven. *Density:* 4.05 g/cm^3 (meas.), 3.99 g/cm^3 (calc.). ***Crystallography:*** Hexagonal or trigonal, space group unknown, *a* 15.79, *c* 23.93 Å, *V* 5167 Å^3, Z 36, *c:a* = 1.5155. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.86 (47), 6.91 (55), 6.56 (77), 4.76 (40), 4.34 (36), 3.39 (33), 3.056 (100). ***Optical data:*** Uniaxial (+), ω 1.588, ε 1.612, nonpleochroic. ***Chemical analytical data:*** Means of fourteen sets of electron microprobe data: UO_3 81.98, CO_2 12.82, H_2O 5.38, Total 100.18 wt.%. CO_2 and H_2O were determined by TGA. Empirical formula: $(UO_2)_{0.99}(CO_3)_{1.00} \cdot 1.03H_2O$. ***Relationship to other species:*** It is chemically related to rutherfordine, UO_2CO_3, and joliotite, $UO_2CO_3 \cdot 2H_2O$.

Name: For Dr. Norbert Blaton (1945–), crystallographer at the University of Leuven, Belgium, a specialist on the crystal structure of uranium minerals. ***Comments:*** IMA No. 97-025.

The calculated density given here is slightly different from that given in the paper. The mineral was found by Patrick Haynes, American geologist and mineral collector.

VOCHTEN, R. and DELIENS, M. (1998) Blatonite, $UO_2CO_3 \cdot H_2O$, a new uranyl carbonate monohydrate from San Juan County, Utah. *Canadian Mineralogist* **36**, 1077–1081.

Chlorartinite — Trigonal

$Mg_2(CO_3)Cl(OH) \cdot 3H_2O$

Locality: The third cone of the Northern Breakthrough of the Main Tolbachik fracture eruption (1975–1976), Kamchatka, Russia.

Occurrence: From volcanic exhalations. Associated minerals are: halite, aragonite, gypsum, and nesquehonite.

General appearance: Fine-grained mass with grains up to 0.01 mm.

Physical, chemical and crystallographic properties: *Luster:* not given. *Diaphaneity:* not given. *Color:* white. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* could not be determined. *Tenacity:* could not be determined. *Cleavage:* could not be determined. *Fracture:* could not be determined. *Density:* could not be determined, 1.87 g/cm^3 (calc.). ***Crystallography:*** Trigonal, $R3c$ or $R\bar{3}c$, a 23.163, c 7.221 Å, V 3355 Å^3, Z 18, $c{:}a$ = 0.3117. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** 11.66 (100), 3.396 (17), 3.356 (17), 3.264 (21), 3.218 (21), 3.000 (41), 2.657 (22). ***Optical data:*** Uniaxial, ω 1.510, ε 1.510, nonpleochroic. ***Chemical analytical data:*** A wet chemical analysis gave the following data: Na_2O 1.33, K_2O 0.52, MgO 26.26, CaO 3.70, CO_2 15.35, SO_3 0.25, H_2O^+ 19.52, H_2O^- 8.39, Cl 13.65, insoluble residue 14.40 sum 103.37, less O = Cl 3.08, Total 100.29 wt.%. After deduction of 3.3 wt.% halite and 0.4 wt.% gypsum, the empirical formula is: $(Mg_{1.67}Ca_{0.16})_{\Sigma 1.83}(CO_3)_{0.89}Cl_{0.85}(OH)_{1.03} \cdot 3.44H_2O$. ***Relationship to other species:*** It has the same formula as artinite, $Mg_2(CO_3)(OH)_2 \cdot 3H_2O$, with one Cl in place of one OH; note that artinite is monoclinic.

Name: For the chemical relationship to artinite. ***Comments:*** IMA No. 96-005. The calculated density given here (1.87 g/cm^3) is slightly different from the value given in the paper (1.84 g/cm^3).

VERGASOVA, L. P., FILATOV, S. K., SERAFIMOVA, E. K., and SERGEEVA, S. V. (1998) Chlorartinite $Mg_2(CO_3)ClOH \cdot 3H_2O$—the new mineral from exhalations of the Great Fissure Tolbachik eruption. *Zapiski Vserossiyskogo mineralogicheskogo obshchestva* **127(2)**, 55–59.

Ferronordite-(Ce) — Orthorhombic

$Na_3SrCeFe^{2+}Si_6O_{17}$

Locality: (1) Chinglusuai River, Lovozero alkaline massif, Kola Peninsula, Russia; and (2) the Karnasurt Mine, Mount Karnasurt, Lovozero alkaline massif, Kola Peninsula, Russia.

Occurrence: (1) In areas of ultra-alkaline mineralization in small cavities in pegmatoid sodalite syenites. Associated minerals are: aegirine, ussingite, lomonosovite (partly altered to murmanite), eudialyte, and hisingerite. (2) In ussingite veinlets. Associated minerals are: ussingite, sodalite, aegirine, vuonnemite, sérandite, natisite, steenstrupine-(Ce), thorosteenstrupine, kazakovite, and löllingite.

General appearance: Rosette-like aggregates of tabular crystals (up to 8 x 5 x 1 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless or light coffee-color. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* VHN$_{15}$ 749 kg/mm^2, Mohs 5 to 5½. *Tenacity:* brittle. *Cleavage:* {100} perfect. *Fracture:* uneven. *Density:* 3.46 g/cm^3 (meas.), 3.54 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, $Pcca$, a 14.460, b 5.187, c 19.848 Å, V 1489 Å^3, Z 4, $a{:}b{:}c$ = 2.7877:1:3.8265. Morphology: forms, {100} dominant, also {001} and {h0l}. Twinning: none observed. ***X-ray powder diffraction data:*** 7.22 (41), 4.216 (100), 3.325 (67), 2.964 (73), 2.879 (62), 2.595 (46). ***Optical data:*** Biaxial (-), α 1.623, β 1.636, γ 1.642, 2V(meas.) 60°, 2V(calc.) 68°; dispersion r > v, weak; nonpleochroic; orientation, X = a, Y = c, Z = b. ***Chemical analytical data:*** Means of seventeen sets of electron microprobe data: Na_2O 11.34, MgO 0.51, CaO 0.73, MnO 2.22, FeO 3.71, ZnO 2.28, SrO 12.64, BaO 0.31, Al_2O_3 0.09, Y_2O_3 0.00, La_2O_3 8.79, Ce_2O_3 10.64, Pr_2O_3 0.56, Nd_2O_3 0.90, Sm_2O_3 0.06, SiO_2 44.92, Total 99.70 wt.%. Empirical formula: $(Na_{2.92}Ca_{0.10})_{\Sigma 3.02}(Sr_{0.97}Ba_{0.02})_{\Sigma 0.99}(Ce_{0.52}La_{0.43}Nd_{0.04}Pr_{0.03})_{\Sigma 1.02}(Fe_{0.41}Mn_{0.25}Zn_{0.22}Mg_{0.10})_{\Sigma 0.98}(Si_{5.96}Al_{0.01})_{\Sigma 5.97}$. ***Relationship to other species:*** The Fe^{2+}-dominant analogue of manganonordite-(Ce) and nordite-(Ce) and the Fe^{2+}- and Ce-dominant analogue of nordite-(La).

Name: To show the relationship to other members of the nordite group. ***Comments:*** IMA No. 97-008. Ce is omitted from the formulae given in the title of the paper. The ideal chemical formula for nordite-(Ce) is $Na_3SrCeZnSi_6O_{17}$ and for nordite-(La) it is $Na_3SrLaZnSi_6O_{17}$.

PEKOV, I. V., CHUKANOV, N. V., KONONKOVA, N. N., BELAKOVSKIY, D. I., PUSHCHAROVSKY, D. Yu., and VINOGRADOVA, S. A. (1998) Ferronordite-(Ce) $Na_3SrFe^{2+}Si_6O_{17}$ (sic) and manganonordite-(Ce) $Na_3SrMn^{2+}Si_6O_{17}$ (sic) new minerals from the Lovozero massif, Kola Peninsula. *Zapiski Vserossiyskogo mineralogicheskogo obshchestva* **127(1)**, 32–41.

Gerenite-(Y) — Triclinic

$(Ca,Na)_2(Y,REE)_3Si_6O_{18}) \cdot 2H_2O$

Locality: The Strange Lake peralkaline complex on the Quebec-Labrador border, Canada; (Lat. 56°20′ N, Long. 64°10′ W), about 250 km northeast of Schefferville, Quebec.

Occurrence: In an aplite-pegmatite lens. Associated minerals are: quartz, albite, K-feldspar, aegirine, riebeckite, gittinsite, zircon, and kainosite-(Y). Lesser amounts of pyrochlore, thorite, a gadolinite-group mineral, titanite, fluorite, REE-bearing epidote, hematite, monazite-(Ce), sphalerite and trace amounts of other minerals also occur in the deposit.

General appearance: Heterogeneous masses pseudomorphous after a roughly equant, presumably hexagonal mineral (typically 1 to 2 cm across, but up to 3 cm). The gerenite-(Y) crystals are very small and occur as bundles about 100 μm long by about 20 μm wide in a eutectoid-like intergrowth with quartz.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* white to creamy. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* {101} indistinct. *Fracture:* uneven. *Density:* 3.52 g/cm^3 (meas.), 3.30 g/cm^3 (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, a 9.245, b 9.684, c 5.510 Å, α 97.44°, β 100.40°, γ 116.70°, V 420.8 Å^3, Z 1, $a{:}b{:}c$ = 0.9547:1:0.5690. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 8.44 (80), 8.01 (50), 4.51 (50), 3.76 (70), 3.36 (40), 2.973 (100), 2.930 (60), 2.203 (40). ***Optical data:*** Biaxial (-), α 1.602, β 1.607, γ 1.611, 2V(meas.) 73°, 2V(calc.) 83°; no dispersion; nonpleochroic; X ∧ b = 7°. ***Chemical analytical data:*** Several sets of electron microprobe data are given. The means of three sets gave: Na_2O 1.7, CaO

7.6, MnO 0.6, Y_2O_3 28.2, Ce_2O_3 0.1, Nd_2O_3 0.2, Sm_2O_3 0.3, Gd_2O_3 1.1, Tb_2O_3 0.34, Dy_2O_3 4.0, Ho_2O_3 1.05, Er_2O_3 3.6, Tm_2O_3 0.51, Yb_2O_3 2.9, Lu_2O_3 0.41, SiO_2 40.5, H_2O (6.89), Total (100.0) wt.%. H_2O by difference. Empirical formula: $(Ca_{1.13}Na_{0.46}Mn_{0.07})_{\Sigma 1.66}(Y_{2.09}REE_{0.72})_{\Sigma 2.81}Si_{5.64}O_{16.80}\cdot 3.20H_2O$. ***Relationship to other species:*** A cyclosilicate with structural similarities to kainosite-(Y) and leifite.

Name: For Richard Geren (1917–), former executive vice-president of the Iron Ore Company of Canada. Mr. Geren initiated and supported the exploration program of the Strange Lake deposit. ***Comments:*** IMA No. 93-034. The density calculated here (3.30 g/cm³) differs from that given in the paper (3.46 g/cm³).

JAMBOR, J. L., ROBERTS, A. C., GRICE, J. D., BIRKETT, T. C., GROAT, L. A., and ZAJAC, S. (1998) Gerenite-(Y), $(Ca,Na)_2(Y,REE)_3Si_6O_{18})\cdot 2H_2O$, a new mineral species, and an associated Y-bearing gadolinite-group mineral, from the Strange Lake peralkaline complex, Quebec-Labrador. *Canadian Mineralogist* **36**, 793–800. GROAT, L. A. (1998) The crystal structure of gerenite-(Y), $(Ca,Na)_2(Y,REE)_3Si_6O_{18})\cdot 2H_2O$, a cyclosilicate mineral. *Canadian Mineralogist* **36**, 801–808.

Graeserite — Monoclinic

$Fe^{3+}_4Ti_3As^{3+}O_{13}(OH)$

Locality: Lärcheltini, in the Monte Leone Nappe, Binntal region, western Alps, Switzerland.

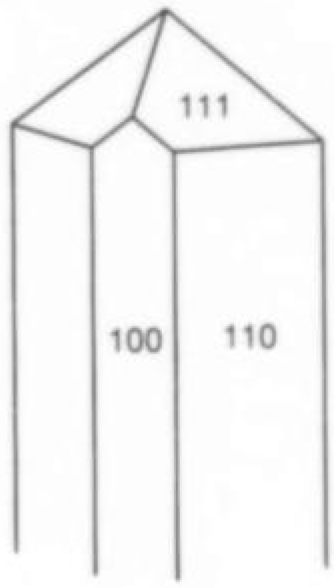
Occurrence: In hydrothermal veins in a two-mica paragneiss. Associated minerals are: anatase, arsenopyrite, asbecasite, bournonite, cafarsite, cervandonite-(Ce), chernovite, fetiasite, gold (traces), hematite, magnetite, monazite-(Ce), rutile, and tennantite.

General appearance: Needle-like crystals elongated parallel to [001] (up to 5 mm long and <10 µm thick); occasionally as radial aggregates.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* black. *Hardness:* VHN_{25} 521 kg/mm², Mohs about 5½. *Tenacity:* ductile. *Cleavage:* {100} moderate. *Fracture:* conchoidal. *Density:* could not be determined, 4.62 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *A2/m*, *a* 7.184, *b* 14.289, *c* 5.006 Å, β 105.17°, *V* 495.9 Å³, Z 2, *a:b:c* = 0.5028:1:0.3503. Morphology: no forms were mentioned. Twinning: extensive. ***X-ray powder diffraction data:*** 3.117 (30), 2.846 (80), 2.681 (100), 2.029 (30), 1.5825 (50). ***Optical data:*** In reflected light: color not given, anisotropism not given, bireflectance and pleochroism not observed. R_1 & R_2: (19.6, 20.3 %) 480nm, (18.7, 19.3 %) 540nm, (18.2, 18.9 %) 580nm, (17.5, 18.1 %) 660nm. ***Chemical analytical data:*** Means of thirty-nine sets of electron microprobe data: MnO 0.06, FeO 3.94, PbO 5.00, Fe_2O_3 33.64, As_2O_3 13.51, Sb_2O_3 1.43, SiO_2 0.02, TiO_2 40.89, H_2O (1.30), Total (99.79) wt.%. Water was calculated to give 1.00 OH. Empirical formula: $(Fe^{3+}_{2.91}Ti_{0.54}Fe^{2+}_{0.38}Pb_{0.15}Mn_{0.01})_{\Sigma 3.99}Ti_{3.00}(As^{3+}_{0.94}Sb^{3+}_{0.07})_{\Sigma 1.01}O_{13.00}(OH)_{1.00}$. ***Relationship to other species:*** It is the Fe^{3+}-dominant analogue of tomichite and the As^{3+}-dominant analogue of derbylite.

Name: For Prof. Dr. Stefan Graeser (1935–), of the Mineralogical-Petrographical Institute of Basel and the Natural History Museum of Basel, in recognition of his extensive research on the oxides and sulfosalts of arsenic in the Binntal region of Switzerland. ***Comments:*** IMA No. 96-010. The calculated density given here is slightly different from that given in the paper.

KRZEMNICKI, M. S. and REUSSER, E. (1998) Graeserite, $Fe^{3+}_4Ti_3As^{3+}O_{13}(OH)$, a new mineral species of the derbylite group from the Monte Leone Nappe, Binntal region, western Alps, Switzerland. *Canadian Mineralogist* **36**, 1083–1088. BERLEPSCH, P. and ARMBRUSTER, T. (1998) The crystal structure of Pb^{2+}-bearing graeserite, $Pb_{0.14}(Fe,Ti)_7AsO_{12+x}(OH)_{2-x}$, a mineral of the derbylite group. *Schweizerische mineralogische und petrographische Mitteilungen* **78**, 1–9.



Gwihabaite

Gwihabaite — Orthorhombic

$(NH_4,K)(NO_3)$

Locality: Gcwihaba Cave (also known as Drotsky's Cave), northwestern Botswana, 280 km west of Maun.

Occurrence: As efflorescences on the walls, boulders, bat guano, and earthy floor of the cave and as saline crusts coating boulders. Associated minerals are: gypsum, syngenite, boussingaultite, and dittmarite.

General appearance: Slender needles and "cave flowers" (up to 5 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* none mentioned. *Hardness:* close to 5. *Tenacity:* not mentioned. *Cleavage:* none. *Fracture:* not mentioned. Very soluble in water and deliquescent in humid air. *Density:* 1.77 g/cm³ (meas.), 1.80 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, *Pbnm*, *a* 7.075, *b* 7.647, *c* 5.779 Å, *V* 312.7 Å³, Z 4, *a:b:c* = 0.9252:1:0.7557. Morphology: forms, {110}, {100}, and {111}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.863 (75), 3.364 (85), 3.212 (95), 3.194 (100), 2.595 (90), 2.400 (50). ***Optical data:*** Biaxial (-), α 1.458, β 1.527, γ 1.599, 2V(meas.) 90°, 2V(calc.) 87°; no detectable dispersion; nonpleochroic; orientation, X = *b*, Y = *a*, Z = *c*. ***Chemical analytical data:*** Analysis of N and H by gas chromatography and of K by X-ray fluorescence gave: $(NH_4)_2O$ 25.09, K_2O 10.40, N_2O_5 61.41, Total 96.90 wt.% (given as 98.90 wt.%. Empirical formula: $[(NH_4)_{0.83}K_{0.19}]_{\Sigma 1.02}(NO_3)_{1.00}$. ***Relationship to other species:*** None apparent.

Name: For the locality. ***Comments:*** IMA No. 94-011. The crystal drawing in the paper is in a nonstandard orientation and has been redrawn here in the standard orientation.

MARTINI, J. E. J. (1996) Gwihabaite—$(NH_4,K)(NO_3)$, orthorhombic a new mineral from Gcwihaba Cave, Botswana. *Bulletin of the South African Speleological Association* **36**, 19–21.

Kalifersite — Triclinic

$(K,Na)_5Fe^{3+}_7Si_{20}O_{50}(OH)_6\cdot 12H_2O$

Locality: Mt. Kukisvumchorr, Khibina massif, Kola Peninsula, Russia.

Occurrence: In a hydrothermally altered pegmatite. Associated minerals are: aegirine, fenaksite, pectolite, and an unidentified light-green mineral. Less closely associated minerals are: "potassium feldspar," sodalite, nepheline, aenigmatite, lomonosovite, lamprophyllite, shcherbakovite, loparite, natisite, paranatisite, and sphalerite.

General appearance: Fibrous bundles elongated parallel to [001] (up to 5 mm long) and aggregates (up 1 cm).

Physical, chemical and crystallographic properties: *Luster:* silky to earthy. *Diaphaneity:* translucent. *Color:* pink-brownish. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 2. *Tenacity:* brittle. *Cleavage:* {100} and {010} good. *Fracture:* fibrous. *Density:* 2.37 g/cm^3 (meas.), 2.28 g/cm^3 (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 14.86, *b* 20.54, *c* 5.29 Å, α 95.6°, β 92.3°, γ 94.4°, *V* 1600.3 Å^3, Z 1, *a:b:c* = 0.7235:1:0.2575. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 12.36 (100), 11.60 (40), 10.21 (14), 4.397 (9) (also aegirine), 3.411 (37brd) (also pectolite), 3.281 (15brd) (also pectolite), 2.896 (12) (also aegirine, fenaksite, and pectolite). ***Optical data:*** Biaxial (+), α 1.523, β 1.525, γ 1.550, 2V(meas.) 30°, 2V(calc.) 32°; dispersion not discernible; pleochroism moderate with X and Y = slightly pink, Z = yellow; X = *a*, Y = *b*, Z = *c*. ***Chemical analytical data:*** Means of ten sets of electron microprobe data: Na_2O 1.98, K_2O 7.71, MgO 1.21, CaO 0.35, MnO 2.38, Fe_2O_3 17.96, SiO_2 55.39, H_2O 13.42, Total 100.40 wt.%. Empirical formula: $(K_{3.58}Na_{1.40})_{\Sigma4.98}(Fe^{3+}_{4.92}Mn_{0.73}Mg_{0.66}Ca_{0.14})_{\Sigma6.45}Si_{20.16}$-$O_{50.00}(OH)_{3.44}\cdot14.56H_2O$. ***Relationship to other species:*** It is part of a polysomatic series with palygorskite and sepiolite.

Name: For the chemical composition: *kali*um (potassium), *fer*rum (iron), *si*licium (silicon). ***Comments:*** IMA No. 96-007.

FERRARIS, G., KHOMYAKOV, A. P., BELLUSO, E., and SOBOLEVA, S. V. (1998) Kalifersite, a new alkaline silicate from Kola Peninsula (Russia) based on a palygorskite-sepiolite polysomatic series. *European Journal of Mineralogy* **10**, 865–874.

Kenhsuite — Orthorhombic

$Hg_3S_2Cl_2$

Locality: The McDermitt open pit mercury mine, about 10 km southwest of the town of McDermitt, Humboldt County, Nevada, U.S.A., near the Oregon State line.

Occurrence: In hydrothermally altered rhyolitic, tuffaceous rocks. Associated minerals are: corderoite and cinnabar.

General appearance: Fine thread-like fibres (1 x 10 µm) and elongate prismatic tablets and blades (1 x 7 x 25 µm).

Physical, chemical and crystallographic properties: *Luster:* given as vitreous, but the index of refraction indicates adamantine. *Diaphaneity:* transparent. *Color:* canary yellow; the mineral is photosensitive and blackens within a few minutes on exposure to direct sunlight. *Streak:* canary yellow. *Luminescence:* fluoresces red to red-orange in 366 nm ultraviolet light. *Hardness:* 2 to 3. *Tenacity:* brittle. *Cleavage:* {100} excellent. *Fracture:* hackly and conchoidal. *Density:* could not be determined, 6.76 g/cm^3 (calc.) (see comments). ***Crystallography:*** Orthorhombic, *Ammm*, *A2mm*, *Am2m*, *Amm2*, or *A222*, *a* 9.332, *b* 16.82, *c* 9.108 Å, *V* 1429.63 Å^3, Z 8, *a:b:c* = 0.5548:1:0.5415. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.65 (90), 3.11 (51), 2.83 (36), 2.60 (49), 2.58 (100), 2.33 (41), 2.11 (31). ***Optical data:*** Biaxial (+), maximum index of refraction 2.25, 2V(meas.) > 70°; dispersion r >> v; pleochroism weak, pale yellow to greenish yellow in thick sections; orientation, length fast, parallel extinction. ***Chemical analytical data:*** Means of twelve sets of electron microprobe data: Hg 81.2, S 9.4, Cl 9.4, Total 100.0 wt.%. Empirical formula: $Hg_{2.94}S_{2.13}Cl_{1.93}$. ***Relationship to other species:*** A polymorph of corderoite.

Name: For Dr. Kenneth Jinghwa Hsu (1929–), Professor Emeritus, Swiss Federal Institute of Technology (E.T.H.), Zurich, in recognition of his numerous contributions to the earth sciences. ***Comments:*** IMA No. 96-026. The calculated density given in the paper is 6.87 g/cm^3 using the ideal formula. The name is pronounced "ken" as in kennel, "hsu" as in shoe, and "ite" as in white. Some of the physical properties were determined from synthetic material.

McCORMACK, J. K. and DICKSON, F. W. (1998) Kenhsuite, γ-$Hg_3S_2Cl_2$, a new mineral species from the McDermitt mercury deposit, Humboldt County, Nevada. *Canadian Mineralogist* **36**, 201–206.

Kentbrooksite — Trigonal

$(Na,REE)_{15}(Ca,REE)_6Mn^{2+}_3Zr_3NbSi_{25}O_{74}F_2\cdot2H_2O$

Locality: Amdrup Fjord, Kangerdlugssuaq intrusion, East Greenland.

Occurrence: In alkaline pegmatite bodies cutting pulaskite rocks. Associated minerals are: kupletskite, låvenite, catapleiite, hiortdahlite, and eudialyte.

General appearance: Anhedral to subhedral aggregates (up to 2 cm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* yellow brown. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 5 to 6. *Tenacity:* brittle. *Cleavage:* no distinct cleavage. *Fracture:* uneven. *Density:* 3.10 g/cm^3 (meas.), 3.07 g/cm^3 (calc.). ***Crystallography:*** Trigonal, *R3m*, *a* 14.1686, *c* 30.0847 Å, *V* 5230.3 Å^3, Z 3, *c:a* = 2.1233. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** 11.385 (43), 7.088 (41), 5.682 (30), 4.295 (34), 3.380 (37), 2.961 (91), 2.839 (100). ***Optical data:*** Uniaxial (-), ω 1.628, ε 1.623, some grains are weakly biaxial, nonpleochroic. ***Chemical analytical data:*** Means of three sets of electron microprobe data: Na_2O 14.51, K_2O 0.43, MgO 0.06, CaO 5.62, MnO 8.01, FeO 1.58, SrO 0.49, Al_2O_3 0.21, La_2O_3 2.23, Ce_2O_3 2.44, Nd_2O_3 0.69, Y_2O_3 1.46, SiO_2 45.34, TiO_2 0.56, ZrO_2 11.08, HfO_2 0.36, Nb_2O_5 2.26, H_2O 1.28, F 0.88, Cl 0.29, sum 99.78, less O = F + Cl 0.44, Total 99.34 wt.%. Water was determined by CHN analyzer. Empirical formula: the authors express this as: $(Na_{14.93}$-$REE_{0.44}Y_{0.42}K_{0.30}Sr_{0.15})_{\Sigma16.24}(Ca_{3.27}Mn_{1.78}REE_{0.62}Na_{0.33})_{\Sigma6.00}(Mn_{1.90}Fe_{0.72}$-$Al_{0.13}Mg_{0.05})_{\Sigma2.80}(Nb_{0.55}Zr_{0.12}Ti_{0.10})_{\Sigma0.77}Si_{0.60}(Zr_{2.81}Hf_{0.06}Ti_{0.13})_{\Sigma3.00}[(Si_3O_9)_2$-$(Si_9O_{27})_2O_2]$-$[(F_{1.51}Cl_{0.27}(OH)_{0.22}]_{\Sigma2.00}\cdot2.3H_2O$. ***Relationship to other species:*** It is the Mn- and F-dominant analogue of eudialyte.

Name: For Dr. C. Kent Brooks (1943–), leader of fourteen geological expeditions to the Kangerdlugssuaq area of east Greenland. ***Comments:*** IMA No. 96-023. Readers interested in the chemical composition of eudialyte are referred to the second paper noted here.

JOHNSEN, O., GRICE, J. D., and GAULT, R. A. (1998) Kentbrooksite from the Kangerdlugssuaq intrusion, East Greenland, a new Mn-REE-Nb-F end-member in a series within the eudialyte group: Description and crystal structure. *European Journal of Mineralogy* **10**, 207–219. JOHNSEN, O. and GAULT, R. A. (1997): Chemical variation in eudialyte. *Neues Jahrbuch für Mineralogie, Abhandlungen* **171**, 215–237.

Manganonordite-(Ce) Orthorhombic

$Na_3SrCeMn^{2+}Si_6O_{17}$

Locality: (1) The second eastern stream, Mount Karnasurt, Lovozero alkaline massif, Kola Peninsula, Russia; and (2) the Karnasurt Mine, Mount Karnasurt and Mount Kedykverpakhk, Lovozero alkaline massif, Kola Peninsula, Russia.

Occurrence: In the central (ussingite) zone of hyperagpaitic pegmatite in sodalite nepheline syenites and in ussingite veinlets. Associated minerals are: ussingite, microcline, aegirine, chkalovite, steenstrupine-(Ce), umbozerite, murmanite, epistolite, gerasimovskite, sphalerite, pectolite-sérandite series, löllingite, eudialyte, lovozerite, lorenzenite, arfvedsonite, and tetranatrolite.

General appearance: Rosette-like aggregates (diameter up to 2.5 cm) made up of tabular crystals (up to 1 x 1 x 0.2 cm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless or pale brownish; altered crystals are brown. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* VHN_{15} 777 kg/mm², Mohs 5 to 5½. *Tenacity:* brittle. *Cleavage:* {100} perfect. *Fracture:* uneven. *Density:* 3.43 g/cm³ (meas.), 3.56 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, *Pcca*, *a* 14.449, *b* 5.187, *c* 19.849 Å, *V* 1488 Å³, Z 4, *a:b:c* = 2.7856:1:3.8267. Morphology: forms, {100} main, also {h0l}. Twinning: none observed. ***X-ray powder diffraction data:*** 7.22 (38), 4.215 (100), 3.326 (67), 2.965 (83), 2.875 (55), 2.597 (54), 2.443 (35). ***Optical data:*** Biaxial (-), α 1.623, β 1.636, γ 1.642, 2V(meas.) 60°, 2V(calc.) 68°; dispersion r > v, weak; nonpleochroic; orientation, X = *a*, Y = *c*, Z = *b*. ***Chemical analytical data:*** Means of nineteen sets of electron microprobe data: Na_2O 11.48, MgO 0.52, CaO 0.33, MnO 3.70, FeO 2.09, ZnO 2.45, SrO 13.24, BaO 0.38, Al_2O_3 0.01, Y_2O_3 0.00, La_2O_3 8.64, Ce_2O_3 10.56, Pr_2O_3 0.43, Nd_2O_3 1.06, Sm_2O_3 0.00, SiO_2 44.57, Total 99.46 wt.%. Empirical formula: $(Na_{2.97}Ca_{0.05})_{\Sigma 3.02}(Sr_{1.03}Ba_{0.02})_{\Sigma 1.05}(Ce_{0.52}La_{0.43}Nd_{0.05}Pr_{0.02})_{\Sigma 1.02}(Mn_{0.42}Zn_{0.24}Fe_{0.23}Mg_{0.10})_{\Sigma 0.99}Si_{5.95}$. ***Relationship to other species:*** The Mn^{2+}-dominant analogue of ferronordite-(Ce) and nordite-(Ce) and the Mn^{2+}- and Ce-dominant analogue of nordite-(La).

Name: For the relationship to other members of the nordite group. ***Comments:*** IMA No. 97-007. Ce is omitted from the formulae given in the title of the paper. The ideal chemical formula for nordite-(Ce) is $Na_3SrCeZnSi_6O_{17}$ and for nordite-(La) it is $Na_3SrLaZnSi_6O_{17}$.

PEKOV, I. V., CHUKANOV, N. V., KONONKOVA, N. N., BELAKOVSKIY, D. I., PUSHCHAROVSKY, D. Yu., and VINOGRADOVA, S. A. (1998) Ferronordite-(Ce) $Na_3SrFe^{2+}Si_6O_{17}$ (sic) and manganonordite-(Ce) $Na_3SrMn^{2+}Si_6O_{17}$ (sic) new minerals from the Lovozero massif, Kola Peninsula. *Zapiski Vserossiyskogo mineralogicheskogo obshchestva* **127(1)**, 32–41.

Mereheadite Monoclinic

$Pb_2O(OH)Cl$

Locality: Merehead Quarry, Cranmore, Somerset, England, U.K. (Lat. 51°12′ N, Long. 2°26′ W)

Occurrence: In lenses and cavities in veins of manganese and iron minerals which cut dolomitic limestones. Associated minerals are: "wad" or pyrolusite, mendipite, blixite, cerussite, hydrocerussite and calcite. Other minerals in the veins are: chloroxiphite, paralaurionite, parkinsonite, and datolite.

General appearance: Grains rarely exceed 2 mm and usually are clustered in compact polycrystalline masses up to 10 x 30 mm (the abstract of the paper gives the size as 10–30 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous or resinous. *Diaphaneity:* transparent to translucent. *Color:* pale yellow to reddish orange. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* VHN_{100} 171 kg/mm², Mohs 3½. *Tenacity:* not given. *Cleavage:* {001} perfect. *Fracture:* uneven, conchoidal to hackly. *Density:* 7.12 g/cm³ (meas.), 7.69 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/c*, *a* 5.680, *b* 5.565, *c* 13.143 Å, β 90.64°, *V* 415.4 Å³, Z 4, *a:b:c* = 1.0207:1:2.3617. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.581 (37), 3.785 (48), 3.267 (35), 2.930 (100), 2.825 (43), 2.780 (36), 2.182 (37). ***Optical data:*** In reflected light: grey, anisotropism masked by internal reflections, weak bireflectance, nonpleochroic. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (15.20, 16.30; 4.07, 4.67 %) 470nm, (14.20, 15.30; 3.59, 4.17 %) 546nm, (13.90, 15.00; 3.44, 4.02 %) 589nm, (13.70, 14.70; 3.37, 3.91 %) 650nm. ***Chemical analytical data:*** Means of seventeen sets of electron microprobe data: PbO 90.0, Cl 7.4, H_2O (1.82), sum 99.22, less O = Cl 1.67, Total (97.55) wt.%. H_2O calculated by the abstractor to give one OH. Empirical formula: $Pb_{1.99}O_{0.97}(OH)Cl_{1.03}$. ***Relationship to other species:*** Related to litharge.

Name: For the locality. ***Comments:*** IMA No. 96-045. Although monoclinic, the mineral is pseudo-orthorhombic and pseudotetragonal. The ideal chemical composition is given incorrectly in the paper as: PbO 90.95, Cl 7.22, H_2O 1.83, sum 100.00, less O = Cl 1.63, Total 98.37 wt.%. It should be: PbO 92.45, Cl 7.34, H_2O 1.87, sum 101.66, less O = Cl 1.66, Total 100.00 wt.%. The calculated density given in the paper is 7.31 g/cm³, which is quite different from the value of 7.69 g/cm³ given in this abstract.

WELCH, M. D., CRIDDLE, A. J., and SYMES, R. F. (1998) Mereheadite, $Pb_2O(OH)Cl$: a new litharge-related oxychloride from Merehead Quarry, Cranmore, Somerset. *Mineralogical Magazine* **62**, 387–393.

Mitryaevaite Triclinic

$Al_{10}[(PO_4)_{8.7}(SO_3OH)_{1.3}]_{\Sigma 10}AlF_3 \cdot 30H_2O$

Locality: Northwestern Karatau Range and Zhabagly Mountains, southern Kazakhstan.

Occurrence: In vanadium-bearing black shales. Associated minerals are: minyulite, crandallite, gorceixite, wavellite, variscite, evansite, aluminite, meta-aluminite, kaolinite, gypsum, and hewettite.

General appearance: Very fine powdery coatings and fine subparallel and complex dendritic veins; rarely in nodules (0.3 to 0.4 mm across) and occasionally as sharply defined globular nodules (0.5 to 0.8 cm across). Microcrystals are 0.01 to 0.04 mm in diameter.

Physical, chemical and crystallographic properties: *Luster:* dull to vitreous. *Diaphaneity:* crystals are transparent. *Color:* white to colorless. *Streak:* white. *Luminescence:* not mentioned. *Hardness:* could not be determined. *Tenacity:* could not be determined. *Cleavage:* {001} perfect, {010} and {100} good. *Fracture:* not mentioned. *Density:* 2.02 g/cm³ (meas.), 2.03 g/cm³ (calc.). ***Crystallography:*** Triclinic, *P*1 or *P*$\bar{1}$, *a* 6.92, *b* 10.09, *c* 22.46 Å, α 92.42°, β 96.43°, γ 104.3°, *V* 1507 Å³, Z 1, *a:b:c* = 0.6858:1:2.2260. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 9.75 (10), 9.24 (2), 6.35 (3), 3.333 (2), 3.222 (2), 2.923 (2). ***Optical data:*** Biaxial (sign unknown), α 1.504, β unknown, γ 1.515, 2V unknown; dispersion unknown; presumably nonpleochroic; Z ∧ *b* = 14°. ***Chemical analytical data:*** Results of a wet chemical analysis are: CaO 0.90, Al_2O_3 30.00, Fe_2O_3 0.30, SO_3 5.50, P_2O_5 32.40, H_2O 29.70, F 3.00, sum 101.80, less O = F 1.26, Total 100.54 wt.%. Empirical formula: $Ca_{0.29}(Al_{9.93}Fe_{0.07})_{\Sigma 10.00}(PO_4)_{8.38}(SO_3OH)_{1.26}Al_{0.80}[F_{2.90}(OH)_{0.03})_{\Sigma 2.93}\cdot 29.60H_2O$. ***Relationship to other species:*** None apparent.

Name: For Dr. Nonna Mikhailovna Mitryaeva (1920–) in recognition of her contributions to the mineralogy of Kazakhstan. ***Comments:*** IMA No. 91-035. The ideal formula has a charge of 2.6+ and the empirical formula has a charge of 3.65+. It appears that the SO_3 reported in the analytical data should be considered as SO_2; i.e., the valence of sulfur should be 4+ rather than 6+.

ANKINOVICH, E. A., BEKANOVA, G. K., SHABANOVA, T. A., ZAZUBINA, I. S., and SANDOMIRSKAYA, S. M. (1997) Mitryaevaite, $Al_{10}[(PO_4)_{8.7}(SO_3OH)_{1.3}]_{\Sigma 10}AlF_3\cdot 30H_2O$, a new mineral species from a Cambrian carbonaceous chert formation, Karatau Range and Zhabagly Mountains, southern Kazakhstan. *Canadian Mineralogist* **35**, 1415–1419.

Nepskoeite — Orthorhombic

$Mg_4Cl(OH)_7\cdot 6H_2O$

Locality: The Asia Nepskoe salt deposit, Nepa river basin in the northern part of Lower Tunguska, Eastern Siberia, Russia (Lat. 59° N, Long. 108° E).

Occurrence: In anhydrite-halite rock in a salt deposit. Associated minerals are: halite, anhydrite, pyrrhotite, and fluoborite.

General appearance: Spherical aggregates (diameter 0.5 to 1.5 mm) made up of fibrous crystals (diameter 0.1 to 5 μm) elongated parallel to [010].

Physical, chemical and crystallographic properties: *Luster:* vitreous or pearly. *Diaphaneity:* translucent. *Color:* yellowish white. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 1½ to 2. *Tenacity:* plastic. *Cleavage:* none mentioned. *Fracture:* splintery. *Density:* 1.76 g/cm³ (meas.), 1.78 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, *Pcmm*, $Pcm2_1$, or *Pc2m*, *a* 11.215, *b* 3.124, *c* 19.21 Å, *V* 673 Å³, Z 2, *a:b:c* = 3.5899:1:6.1492. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 11.41 (29), 10.64 (18), 9.78 (46), 9.60 (38), 4.25 (20), 3.498 (100), 2.448 (18). ***Optical data:*** Biaxial (-), α 1.532, β and γ 1.562, 2V(meas.) 5°, 2V(calc.) 0°; dispersion r < v, weak; nonpleochroic; orientation, X = *b* (direction of elongation). ***Chemical analytical data:*** Means of seven sets of electron microprobe data: MgO 45.71, H_2O 47.49, Cl 10.04, sum 103.24, less O = Cl 2.27, Total 100.97 wt.%. Empirical formula: $Mg_{4.06}Cl_{1.01}(OH)_{7.11}\cdot 5.88H_2O$. ***Relationship to other species:*** It is chemically similar to korshunovskite.

Name: For the locality. ***Comments:*** IMA No. 96-016.

APOLLONOV, V. N. (199) Nepskoeite $Mg_4Cl(OH)_7\cdot 6H_2O$ a new mineral from the Nepskoye potash salt deposit. *Zapiski Vserossiyskogo mineralogicheskogo obshchestva* **127(1)**, 32–41.

Niedermayrite — Monoclinic

$Cu_4Cd(SO_4)_2(OH)_6\cdot 4H_2O$

Locality: An abandoned adit in the Km3-area, Lavrion mining district, Attica peninsula, Greece.

Occurrence: In brecciated marble. Associated minerals are: sphalerite, chalcopyrite, galena, greenockite, hawleyite, pyrite, gypsum, malachite, chalcanthite, brochantite, hemimorphite, hydrozincite, aurichalcite, a cadmium sulfate, monteponite, and otavite.

General appearance: Euhedral crystals (up to 50 mm) forming crusts up to several square cm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* bluish-green. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* could not be determined. *Tenacity:* brittle. *Cleavage:* {010} perfect. *Fracture:* not mentioned. *Density:* could not be determined, 3.36 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/m$, *a* 5.535, *b* 21.947, *c* 6.085 Å, β 91.98°, *V* 738.7 Å³, Z 2, *a:b:c* = 0.2522:1:0.2773. Morphology: forms, {010}, {100}, {001}, and unindexed prisms. Twinning: none observed. ***X-ray powder diffraction data:*** 11.02 (90), 5.496 (100), 5.322 (25), 4.079 (50), 3.437 (30), 3.243 (40), 2.470 (30). ***Optical data:*** Biaxial (-), α 1.619 (calc.), β 1.642, γ 1.661, 2V(meas.) 84° and α 1.599 (calc.), β 1.642, γ 1.661, 2V(meas.) 66°; dispersion r > v, strong; nonpleochroic; X = *b*. ***Chemical analytical data:*** Means of seven sets of electron microprobe data: CdO 16.5, CuO 45.7, ZnO < 0.1, MnO <0.1, SO3 21.6, H_2O (16.2), Total (100.0) wt.%. Water was calculated to give a total of 100.0 wt.%. Empirical formula: $Cu_{4.29}Cd_{0.96}(SO_4)_{2.01}(OH)_{6.48}\cdot 3.47H_2O$. ***Relationship to other species:*** Structurally related to campigliaite and christelite.

Name: For Dr. Gerhard Niedermayr (1941–), Natural History Museum, Vienna. ***Comments:*** IMA No. 97-024. The calculated density given by the authors (3.292 g/cm³) is slightly different from the value calculated here (3.36 g/cm³).

GIESTER, G., RIECK, B., and BRANDSTÄTTER, F. (1998) Niedermayrite, $Cu_4Cd(SO_4)_2(OH)_6\cdot 4H_2O$, a new mineral from the Lavrion Mining District, Greece. *Mineralogy and Petrology* **63**, 19–34.

Oenite — Orthorhombic

CoSbAs

Locality: On dumps from an abandoned mine in the Tunaberg deposit, in the southeastern part of Bergslagen, about 100 km southwest of Stockholm, Sweden (Lat. 58°39′ N, Long. 16°55′ E).

Occurrence: In skarns. Associated minerals are: acanthite, antimony, arsenopyrite, chalcopyrite, cobalt pentlandite, cobaltite, cubanite, allargentum, bismuth, bornite, breithauptite, dyscrasite, gudmundite, kieftite, löllingite, mackinawite, nisbite, paracostibite, pyrrhotite, stannoidite, tetrahedrite, and uraninite.

General appearance: Anhedral, polycrystalline aggregates (up to 300 μm across) in chalcopyrite.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* silver-white. *Streak:* grey. *Hardness:* VHN_{100} 599 kg/mm². *Tenacity:* brittle. *Cleavage:* none. *Fracture:* uneven. *Density:* could not be determined, 7.92 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, space group unknown, *a* 3.304, *b* 6.092, *c* 10.258 Å, *V* 206.5 Å³, Z 4, *a:b:c* = 0.5424:1:1.6838. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** 2.63 (10), 2.53 (8), 1.942 (10), 1.730 (4), 1.640 (4), 1.3963 (4), 1.1182 (8). ***Optical data:*** In reflected light: silver white in air and white with a faint yellowish or creamy tint in oil, distinct anisotropism, no bireflectance in air (weak in oil), no pleochroism (weak in oil). R_2 & R_1 in air: (58.2, 55.5%) 470nm, (56.8, 55.6%) 546nm, (55.8, 55.5%) 589nm, (55.0, 55.5%) 650nm. ***Chemical analytical data:*** Means of 21 sets of electron microprobe data: Co 15.4, Fe 5.6, Ni 2.7, Cu 0.1, Sb 47.4, As 26.9, S 2.0, Total 100.1 wt.%. Empirical formula: $(Co_{0.64}Fe_{0.25}Ni_{0.11})_{\Sigma 1.00}(Sb_{0.96}As_{0.04})_{\Sigma 1.00}(As_{0.84}S_{0.16})_{\Sigma 1.00}$. ***Relationship to other species:*** May be a member of the löllingite group and the arsenic-dominant analogue of costibite, CoSbS.

Name: For Prof. Dr. Ing Soen Oen (1928–1996), Professor of Petrology, Mineralogy and Ore Geology at the University of Amsterdam and the Vrije Universiteit at Amsterdam. ***Comments:*** IMA No. 95-007. The name is pronounced *oonite*.

DOBBE, R. T. M. and ZAKRZEWSKI, M. A. (1998) Oenite, CoSbAs, a new mineral species from the Tunaberg Cu-Co-sulfide skarns, Bergslagen, Sweden. *Canadian Mineralogist* **36**, 855–860.

Okayamalite — Tetragonal

$Ca_2B_2SiO_7$

Locality: The Fuka mine, Bicchu-cho, Okayama Prefecture, Japan.

Occurrence: In a skarn. Associated minerals are: wollastonite, calcite, datolite, undetermined borates, vesuvianite, and johnbaumite.

General appearance: Equigranular aggregates (up to 30 µm).

Physical, chemical and crystallographic properties: *Luster:* earthy. *Diaphaneity:* transparent. *Color:* creamy white. *Streak:* white. *Luminescence:* not mentioned. *Hardness:* about 5½. *Tenacity:* not mentioned. *Cleavage:* none observed. *Fracture:* not mentioned. *Density:* could not be determined, 3.30 g/cm³ (calc.). ***Crystallography:*** Tetragonal, $P\bar{4}2_1m$, *a* 7.116, *c* 4.815 Å, *V* 243.8 Å³, Z 2, *c:a* = 0.6766. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.479 (40), 2.862 (55), 2.654 (100), 2.129 (20), 1.920 (35), 1.644 (20). ***Optical data:*** Uniaxial (-), ω 1.700, ε 1.696, nonpleochroic. ***Chemical analytical data:*** Means of 3 sets of electron microprobe data: CaO 46.28, B_2O_3 28.50, Al_2O_3 0.36, SiO_2 24.24, Total 99.38 wt.%. Empirical formula: $Ca_{2.01}B_{2.00}Si_{0.98}Al_{0.02}O_{7.00}$. ***Relationship to other species:*** the boron analogue of gehlenite, $Ca_2Al_2SiO_7$.

Name: For the prefecture. ***Comments:*** IMA No. 97-002.

MATSUBARA, S., MIYAWAKI, R., KATO, A., YOKOYAMA, K., and OKAMOTO, A. (1998) Okayamalite, $Ca_2B_2SiO_7$, a new mineral, boron analogue of gehlenite. *Mineralogical Magazine* **62**, 703–706.

Parasibirskite — Monoclinic

$Ca_2B_2O_5 \cdot H_2O$

Locality: Fuka, Okayama Prefecture, Japan.

Occurrence: In a vein between gehlenite-spurrite skarns and crystalline limestone. Associated minerals are: takedaite, nifontovite, olshanskyite, frolovite, sibirskite, and calcite.

General appearance: Aggregates of tabular crystals (up to 40 x 20 x 3 µm).

Physical, chemical and crystallographic properties: *Luster:* pearly. *Diaphaneity:* not given but presumably transparent. *Color:* white. *Streak:* not given but probably white. *Luminescence:* not given. *Hardness:* VHN_{25} 121 kg/mm². *Tenacity:* not given. *Cleavage:* {100} perfect. *Fracture:* not given. *Density:* 2.50 g/cm³ (meas.), 2.54 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/m$, *a* 6.722, *b* 5.437, *c* 3.555 Å, β 93.00°, *V* 129.8 Å³, Z 1, *a:b:c* = 1.2363:1:0.6539. Morphology: no forms are mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.73 (70), 3.354 (30), 2.975 (60), 2.855 (20), 2.237 (100), 1.776 (20). ***Optical data:*** Biaxial (+), α 1.556, β 1.593, γ 1.663, 2V could not be measured, 2V(calc.) 74.8°; dispersion not given; nonpleochroic; orientation not given. ***Chemical analytical data:*** Chemical analysis gave: CaO 56.06 (by electron microprobe), B_2O_3 34.10 (by ICP), H_2O 9.97 (by TGA), Total 100.13 wt.%. Empirical formula: $Ca_{1.98}B_{1.94}O_{4.89} \cdot 1.11H_2O$. ***Relationship to other species:*** A polymorph of sibirskite.

Name: For the relationship to sibirskite. ***Comments:*** IMA No. 96-051.

KUSACHI, I., TAKECHI, Y., HENMI, C., and KOBAYASHI, S. (1998) Parasibirskite, a new mineral from Fuka, Okayama Prefecture, Japan. *Mineralogical Magazine* **62**, 521–525.

Polkanovite — Hexagonal

$Rh_{12}As_7$

Locality: A small unnamed placer deposit in the upper Miass River, South Urals, Russia (Lat. 54°44′ N, Long. 59°47′ E).

Occurrence: Associated minerals are: isoferroplatinum, tulameenite, ruthenium, cherepanovite, rhodian irarsite, and unnamed RhNiAs, Rh_2As and $(Pd,Rh)_2As$.

General appearance: Irregular inclusions (up to 45 x 140 µm) in ruthenium.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* megascopic color could not be observed. *Streak:* not given. *Hardness:* VHN_{40} 410 kg/mm². *Tenacity:* not given. *Cleavage:* not observed. *Fracture:* not observed. *Density:* could not be determined, 10.22 g/cm³ (calc.). ***Crystallography:*** Hexagonal, $P6_3/m$, *a* 9.31, *c* 3.64 Å, *V* 273 Å³, Z 1, *c:a* = 0.3910. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** 2.33 (4), 2.03 (2), 1.852 (9), 1.818 (2), 1.767 (6), 1.755 (10), 1.549 (8), 1.446 (2), 1.166 (2). ***Optical data:*** In reflected light: brownish grey, weak anisotropism from grey to brownish grey, weak bireflectance, nonpleochroic. R_{max} & R_{min}: (47.5, 43.9 %) 460nm, (48.3, 44.7 %) 540nm, (49.2, 46.4 %) 580nm, (51.3, 48.6 %) 660nm. ***Chemical analytical data:*** Means of nine sets of electron microprobe data: Ru 2.9, Rh 54.3, Pd 2.0, Os 0.7, Ir 0.7, Pt 0.4, Ni 7.0, As 31.7, Total 99.7 wt.%. Empirical formula: $(Rh_{8.90}Ni_{2.01}Ru_{0.48}Pd_{0.32}Os_{0.06}Ir_{0.06}Pt_{0.03})_{\Sigma 11.86}As_{7.13}$. ***Relationship to other species:*** None apparent.

Name: For Academician Yu. A. Polkanov (1938–), Institute of Mineral Resources, Academy of Technical Sciences of Ukraine. ***Comments:*** IMA No. 97-030.

BRITVIN, S. N., RUDASHEVSKY, N. S., BOGDANOVA, A. N., and SHCHERBACHOV, D. K. (1998) Polkanovite $Rh_{12}As_7$—a new mineral from a placer at the Miass River (The South Urals). *Zapiski Vserossiyskogo mineralogicheskogo obshchestva* **127(2)**, 60–62.

Pushcharovskite — Triclinic

$Cu(AsO_3OH) \cdot H_2O$

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

Occurrence: Associated minerals are: quartz, tennantite, covellite, geminite, lindackerite, yvonite, and mahnertite.

General appearance: Acicular crystals (0.5 x 0.04 mm) and radiated aggregates (up to 1 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* very light green to colorless. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* could not be determined. *Tenacity:* fragile. *Cleavage:* {010} perfect and {001} good. *Fracture:* fibrous. *Density:* 3.35 g/cm³ (meas.), 3.35 g/cm³ (calc.). ***Crystallography:*** Triclinic, *P*1 or $P\bar{1}$, *a* 6.435, *b* 11.257, *c* 18.662 Å, α 79.40°, β 86.48°, γ 83.59°, *V* 1319.3 Å³, Z 12, *a:b:c* = 0.5716:1:1.6578. Morphology: the only form observed is {010}. Twinning: polysynthetic on (010).

X-ray powder diffraction data: 18.3 (25), 11.00 (100), 3.171 (30), 2.952 (50), 2.920 (60), 2.816 (50), 2.492 (25). ***Optical data:*** Biaxial (+), α 1.602, β 1.642, γ 1.725, 2V(meas.) 70°, 2V(calc.) 72°; dispersion r > v, medium; nonpleochroic; $Z \wedge a$ = 18.4° on (010). ***Chemical analytical data:*** Means of seven sets of electron microprobe data: CuO 35.70, As_2O_5 52.31, H_2O 12.0, Total 100.01 wt.%. Water by loss on heating. Empirical formula: $Cu_{1.00}(AsO_3OH)_{1.01} \cdot 0.98H_2O$. ***Relationship to other species:*** A polymorph of geminite, which also is triclinic.

Name: For Prof. Dmitriy Pushcharovsky (1944–). ***Comments:*** IMA No. 95-048.

SARP, H. and SANZ-GYSLER, J. (1997) La pushcharovskite, $Cu(As_3OH) \cdot H_2O$, un nouveau minéral de la mine de Cap Garonne, Var (France). *Archives de Science Genève* **50(3)**, 177–186.

What's New *(continued from p. 224)*

20 or so specimens he had, most are just loose single prisms looking like deep green pencils, but a few are jackstraw groups on miniature-size matrix of massive gray-green diopside.

Although the gemmy **forsterite** crystals from Sappat, Pakistan, are now practically a drug on the market, so plentiful have they been, I can't resist tipping the what's-new hat to a handful of *groups* of sharp gemmy green crystals offered at the Main Show by *Andreas Weerth* (Hochfeldstr. 37, D-83684 Tegernsee, Germany). The olivine crystals are tightly intergrown, but there are still lots of prism faces and all terminal faces on view; the prettiest such group is a premier 3 x 4 x 6-cm piece ($1700).

Together with François, Patrick de Koenigswarter of *Miner K* ("En Barou," F.31540 St. Julia de Gras Capou, France) has brought out of Burma hundreds of loose crystals and matrix specimens of **red spinel** from Pain Pyit, East Mogok. These are crisp, slightly rounded to razor-sharp, translucent to gemmy, deep pink to rich red simple octahedrons (and a couple of flattened spinel twins); the matrix, where present, is a dense, grayish white massive calcite or marble. Sometimes crude gray-green **chondrodite** crystals to 2 cm may be seen in the matrix pieces. Patrick says that the miners take the appearance of chondrodite as a sign that spinel—maybe gem quality!—may be near. Naturally, very few of these spinel crystals are top "ruby" gem stock, but the crystals are still very pretty, and a sharp, loose, deep pink octahedron 1 cm on edge could be had for about $30. Further, Miner K (and Lietard) had some decent pink to deep red **ruby corundum** crystals as individuals and as agglomerated bunches in calcite with stringers of pyrite and green mica, the locality for these specimens being Luc Yen, Yen Bai Province (north of Hanoi), Vietnam. There was a handful of cabinet-sized specimens, some with hexagonal prisms 2.7 cm high, though I saw no really good gemmy areas in any of the embedded crystals.

Speaking (again!) of old-familiars outdoing themselves, Dr. Jay Zaveri of *Zeolites India* (1970 W. Valencia #219, Tucson, AZ 85746) has decided to sell off his hoard of specimens of classic green **apophyllite** which came from the Pashan #2 quarry, near Poona, India, between 1984 and 1986. Consequently, his stand at the Main Show glowed with the largest and prettiest showing of green "Poona" apophyllite that we've seen for quite a while—a whole wall-full of specimens to more than a foot across, with towering clusters and looping belts of intergrown, rich green transparent crystals to 2.5 cm individually, on matrix of drusy quartz and/or stilbite crystals over gray basalt.

Throughout this show I was looking, hoping, for further developments in the Thailand **mimetite** story begun last year with a small number of specimens offered by just two dealers (see my Tucson report in vol. 29, no. 3, and the mimetite photo therein). No dam has broken as yet; the same two Italians who had some of these "Hat Yai Province, Thailand" mimetites last year had just four unremarkable specimens this year, and they say that, as far as they know, there has been no further work at the prospect. However, I mention the matter because two small miniature specimens which Brad Van Scriver of *Heliodor* said were recently mined prove the great potential of this mysterious locality: highly lustrous, sharp, deep yellow gemmy hexagonal prisms of mimetite to 1 cm rise from gossan matrix on both of these pieces, and I don't think I've seen *gemmy* mimetite like these from anywhere else save Tsumeb. Maybe next year . . .

We end in China—actually, at an undisclosed place in Yunnan Province which promises to become a major locality for beautiful **spessartine** garnet. Simple trapezohedrons to 1.5 cm, exceptionally sharp and brilliant and gemmy red-brown, coat faces of quartz crystals and altered granite, and also sit up individually, as alertly as any Pakistan spessartines. Yes, and they shine and glitter like mad. Several dealers had these specimens, but the best were with *Debbie Meng* (P.O. Box 8393, Monterey, CA 93943): about ten miniature and small-cabinet-sized pieces.

Finally, warp-speeding it back from China to a great big downstairs room at the InnSuites, I'll mention the showtime sale that went on, in that room, of what is left of the very significant mineral collection of Earl Calvert (1904–1964), a California chemist, founding member of the Mineralogical Society of Southern California, and longtime mineral collector. The sale was being run by Rock Currier, "Chief Factotum and Hatchet Man" (his card says) of *Jewel Tunnel Imports* (13100 Spring St., Baldwin Park, CA 91706-2283). Mr. Calvert built his collection for many years chiefly by field collecting in Mexico, then trading specimens worldwide. Since one of his main trading partners was Albert Chapman of Australia, it isn't surprising that Mexican and Australian minerals figure largely even in these collection remains. I say "remains" because the collection has already been "high-graded" by earlier buyers, but even so it was great fun to poke about among the flats (and one glass wall case) and spot good-to-excellent specimens of classics like Phoenixville pyromorphite, Cornwall chalcocite, Cumbria blue barite, Mammoth mine cerussite . . . clearly Earl Calvert knew what he was doing, and once upon a time he must indeed have had, as the flyer says, "one of the finest [mineral collections] in the western states."

Coming to the display cases at the Main Show, I face the familiar dilemma that any recited list of them will, cruelly, make them sound well-nigh infinitely less impressive than they truly were. But the show theme, as I've said, was **Mexican minerals** . . . your imagination ought to be good enough to do the rest. There were three standout Mexican cases, all in a row, by private collectors, and any viewer standing before all three had to be careful not to get too sucked in by each terrific specimen—by almost *any* of them he laid eyes on. Almost randomly I'll select for individual raves Kerith Graeber's red grossular from Coahuila, her 4-cm kottingite spray from the Ojuela mine, and her matrix boleite with three 1.5-cm cubes; Peter Megaw's thumbnail of aguilarite with stacked skeletal crystals, and his Guanajuato wire silver; Evan Jones' 6-cm Fresnillo pyrargyrite, his huge and brilliant and stibnite-mimicking Zacatecas jamesonite, and his unearthly-beautiful San Francisco mine wulfenite. As if that weren't enough, there was slipped in beside these Mexican cases a "general" one by Bill Severance, with great specimens centered on his renowned 6-cm Tsumeb azurite on its pale green smithsonite bed.

Mexican-wise, there was also a good educational case on geology and mine locations in the Guanajuato mining district (with fine specimens too); an American Museum case of Guanajuato calcites from the Bement Collection; a Smithsonian case with their two extraordinary Zacatecas scorodites; and a case with the two great and famous Ojuela mine legrandite specimens, the ones they call "The Aztec Club" and "The Aztec Sun." Other Mexican cases were put in by—to name a few—the Mineralogical Association of Dallas, Harvard (*oh* yes, with that 3.5-cm Chihuahua gold), the Carnegie Museum, the Los Angeles County Museum, the Arizona Mineral and Mining Museum, the Arizona-Sonora Desert Museum, Bob and Vera Turner, Sharon Cisneros (Mexican thumbnails!), Slim and Charles S. Thompson, Harold Urish, Ed Huskinson Jr., and H. J. Kirby Siber. And there was a "mystery case" of superb Mexican stephanite, acanthite, pyrargyrite and polybasite from the collections of anonymous connoisseurs going by the name "Los Amigos de Del Rio"; to maintain their incognito they had Wendell Wilson set up and take down their case, and he wasn't talking.

Then there were the other cases to instruct and dazzle gawkers. Bryan Lees showed "The Dragon," a Colorado quartz mine gold, and the "Snow Cone" Sweet Home mine rhodochrosite specimens, with the two magazine covers they've graced: respectively, *Rock and Gem* and, of course, the Sweet Home Issue of the *Mineralogical Record*. The Urals Geological Museum showed some incredible axinite, apatite, and gwindel quartz specimens from the Dodo mine; the Natural History Museum of Milano showed six also incredible phosgenites from Monte Poni, Sardinia; a fascinating case by the National Museums of Scotland concerned the mines and minerals of Leadhills; and two big cases put in by the Greek Association of Mineral and Fossil Collectors, Athens, showed huge specimens from Laurium and Seriphos, and expounded on how minerals were used to make pigments all over the ancient Mediterranean world. Add to this the cases on Kalahari Manganese Field minerals (Pieter de Bruyn); giant quartz crystals self-collected by Benjy and Liz Kuehling at Ouray, Colorado; minerals of the Andes (Bill and Carol Smith); calcite geodes from Idar-Oberstein (Rainer Hoffmann-Rothe); minerals of Morocco (Ernesto and Jeannine Ossola); the Tucson Gem and Mineral Society's dramatic large case of amethyst specimens from everywhere; and, finally, a case by a brand-new museum, the Pacific Mineral Museum of Vancouver, which *already* has things as good as that 6-cm blue Namibian jeremejevite, that 5-cm bornite crystal from Zimbabwe (!), and those two stunning thumbnails, polybasite and stephanite, from the Husky mine, Yukon.

Four show-stopping cases (excuse the cliche: I'm exhausted) come last. Wide and roomy and side-by-side cases were put in by Steve and Clara Smale and by Eugene and Rosaline Meieran respectively. Behind was a big case of wonderful "rough-and-cut" pairs owned by Bill Larson. And to one side was a small case of exquisite gem minerals put in by Research Charitable Trust. All of these were devoted to loose gem crystals, in some cases very *large* loose gem crystals. Well . . . picture clean glass cases with white velvet shelving and clear plastic pedestals (with holes) to hold up the crystals, picture clean, good light coming down from above, and picture these icy volumes of space entirely riddled with small and exquisite to great stand-up towering gem crystals in rainbow colors. Clearly I can't describe each crystal, but picture, say, the Smales' elbaites of every possible color and zoning habit; the Smales' two doorstop-sized gem spodumenes, one a hiddenite from Pakistan, the other a pristine Brazilian kunzite a foot long or so; and picture the Meierans' V-pair specimen of deepest blue tanzanite, measuring about 5 x 7 cm; their richest-red Burmese spinel octahedron 4 cm on edge; their totally gemmy 2 x 2 x 3-cm Colombian emerald; and their hallucinatorily transparent, flawless Pakistani aquamarine 2 x 4 cm. The star of the show—in fact, many said, of this whole Tucson show—was the Meierans' *12-cm*, deep turquoise-blue euclase crystal from Colombia, lustrous, gemmy throughout. It is missing a slab on its lower-right edge because of the perfect side cleavage, but it is otherwise perfect and so off-the-scale as to size and color that it must redefine all euclase specimen standards forever and everywhere. The crowds knew it too: you could hardly see that great euclase, to bow to it as you passed by, for all the throngs gathered around and mostly discussing *that* crystal, above even all the others. Seeing me scribbling in my notebook, a lady whispered, "you can write that I nearly fainted just now when I saw that thing." As with the debut of Bryan Lees' "Alma King" rhodochrosite a few years ago, even the most knowledgeable and experienced curators, dealers and collectors were stunned by the sight of it.

Saturday evening brought the usual program and awards ceremony. Ubiquitous Arizona author, collector, teacher, photographer and all-around good guy Bob Jones received the coveted Carnegie Mineralogical Award, and gave a touching acceptance speech which he suspended momentarily in order to ask his sweetheart, Carol Sues, to marry him (she said yes!). Kerith Graeber corralled *both* the Lidstrom and Desautels Awards for her wonderful Mexican minerals. [Ed. Note: In order to preserve Tom Moore's modesty I must interject here that the Friends of Mineralogy's annual award for Best Article of the Year in the *Mineralogical Record* for 1998 went to the entire Sweet Home

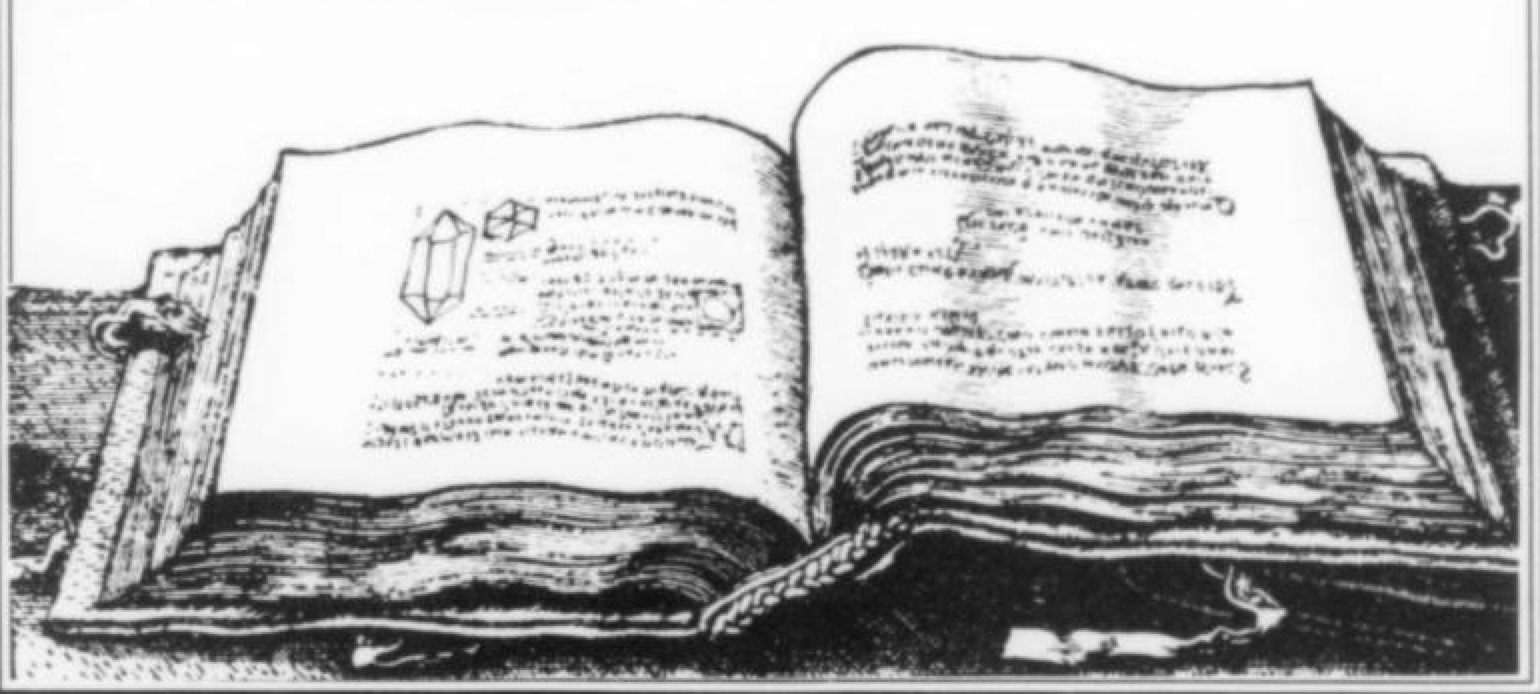

Jesse Fisher

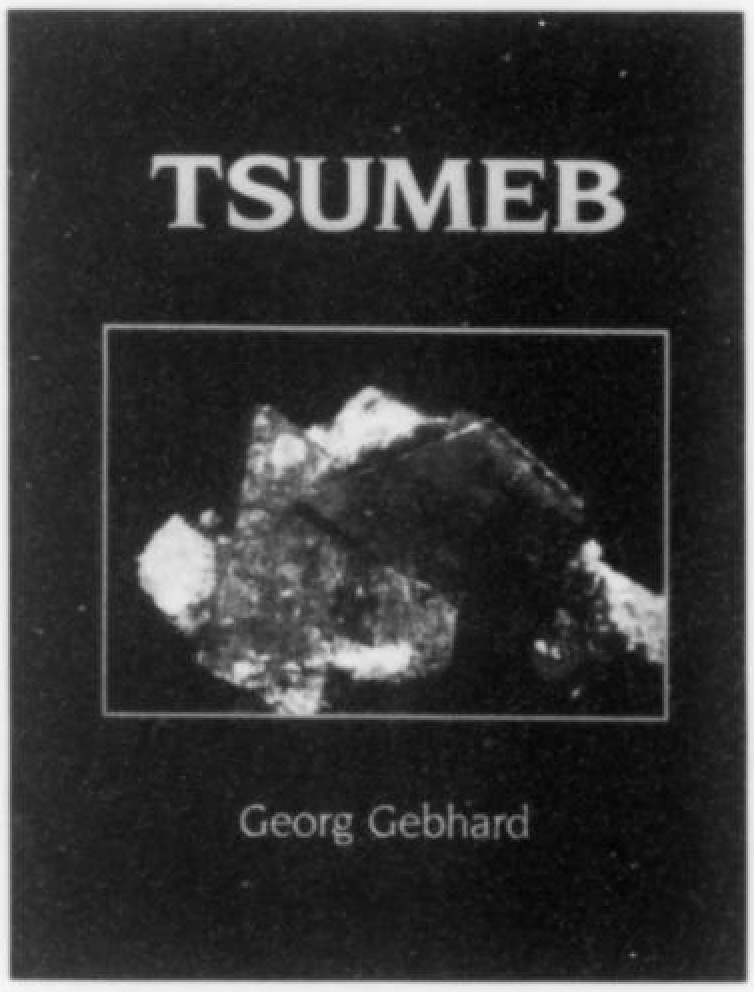
Figure 21. **Kerith Graeber, moderately pleased with her Lidstrom and Desautels awards.**

Mine Issue, of which Tom himself was senior author, along with Bryan Lees, Karen Wenrich, Steve Voynick, Jack Murphy, James Hurlbut, T. James Reynolds, Regina Modreski, Dean Misantoni and Miles Silberman.] The evening was capped off with a guessing-game slide show of childhood photos of prominent mineral people.

So, farewell again, after just one more thing. The well-known imperialist Marty Zinn is again expanding his *Arizona Mineral and Fossil Show* (the "hotel show") into a new colony. Next year, a plot of now vacant ground between the Executive and Ramada Inns will be occupied by a big tent wherein several show dealers will set up business. And there will be paving of the site, food vendors, free parking, security, a shuttle bus service stop, and other amenities for the showgoers' convenience and pleasure. For information, call Martin Zinn Expositions, 303-674-2713. Until then, start rounding up your best "Brazilian Minerals," as that will be the no-doubt spectacular theme of the 2000 show!

Book Reviews





Tsumeb: A Unique Mineral Locality

by Georg Gebhard. Published (1999) by GC Publishing, Grossenseifen, D-51545 Waldbröl, Germany. Hardcover, 22 x 48 cm. $159 postpaid. ISBN 3-925322-02-7.

There is little disagreement that the Tsumeb, Namibia, copper mine is what the *Mineralogical Record* Special Issue of 1976 (vol. 8, no. 3) called it: "the world's greatest mineral locality." By Georg Gebhard's authoritative count, Tsumeb has produced 242 known species, plus some 38 still-unknowns; 52 minerals were discovered here, and 40 still have no other known occurrences; Tsumeb dominates for world-class specimens of some dozen major species. Such a huge, complex and prolific deposit requires a literature for collectors, and to date there have been two comprehensive works: the *Mineralogical Record* issue of 1976, and Georg Gebhard's 1991 *Tsumeb: eine deutsch-afrikanische Geschichte* [a German-African History]. The good news is that Gebhard has created this new English-language work out of the earlier German volume, as the final and *most* comprehensive story on Tsumeb, where all mining ceased in 1996.

The English *Tsumeb* naturally contains much of the same material as Gebhard's earlier work, but the contents have been somewhat re-arranged, the sections on the mine's history and culture somewhat enlarged, and much of the specimen and other photography changed (the author must have an amazing archive of photo documentation on Tsumeb, so considerable is the number of "new" photos here!). Readers who can afford it could make a persuasive case for owning *both* books for the sake of the illustrations alone.

After a brief, predictable paean to Tsumeb, the book has a 45-page section narrating the history of the mine, followed by concise, clearly presented sections on mining methods and on the geology and geochemistry of the ore deposit. Then a lush, 30-page section called "Life in Tsumeb" unfolds, featuring descriptions of the northern Namibian landscape, climate and fauna, and of the cultures and lifestyles of the indigenous peoples; here there are also empathetically detailed accounts of the arrival of German miners from the Siegerland, beginning in 1909, and evocations of daily life in the mining town for miners and their families over the decades. Next comes a mineralculture-friendly section called "Collecting and Dealing," concerning the history of Tsumeb specimen acquisition and marketing, all the way from the underground stopes to the charged ether of the international mineral market, over the whole span of Tsumeb's 90+ active years. Next, "Discovery of Minerals" chronicles the characterization of Tsumeb species, from otavite in 1906 through the intensive work in the 1990's on the minerals of the third oxidation zone (did you *know* that there was a third?) between the mine's 41st and 48th levels. The nearly 100-page section called "The World-Famous Minerals" offers enthusiastic, informal discussion of the finds of great specimens of the main-line Tsumeb species; "The Rarities" offers the same on the *other* couple of hundred species. Three short sections include treatments of such subtopics as Tsumeb ore mineralogy, the still-unknowns, pseudomorphs, and aesthetic "curiosities" among specimens. Finally, there are exhaustive tables, the fullest of which alphabetically lists all Tsumeb minerals with their formulas, cross-referencing each species to earlier textual discussion and photographs, and tipping off the reader on things like crystal sizes, the quality of the best specimens, and the rarity of each species in the mine (where bayldonite is common, fluorite extremely rare). Other tables list varietal names, pseudomorphs, outstanding pocket finds, and minerals first discovered at Tsumeb. A 221-title bibliography concludes the work.

The biggest change from the German to the English-language *Tsumeb* is in the photographs and other pictorials. As I've said, there is not as much overlap as we'd expect, and the selection of the non-specimen pictures is generous and creative (underground ore-walls in color, Gothic-looking mine crews, old coins and documents, a robbery in the streets of early Tsumeb, a pride of lions harrowing a giraffe in the bush).

The mineral specimen photographs in the German book mostly show pieces belonging to a variety of (mostly German) private collectors and institutions, but in the English-language book, all but a small handful of specimens shown belong to the author. Thus, although Gebhard's Tsumeb collection certainly is a fine one, there is some inevitable fall-off in the average quality of pictured specimens. But let us add that the great advantage of showing privately owned specimens (in both books) is that almost all of them will be new sights for the average reader. We've seen the Van Pelt photographs of the four great Tsumeb specimens in the Houston Museum (azurite, cerussite, dioptase, leadhillite) shown again here; but in seeing Gebhard's pieces the feeling will be, not of cliché, but of surprise and instruction. It is always better, as I said earlier, to see new specimens rather than a repeat of old ones.

The bulk of the German-edition photos was taken by Olaf Medenbach, a true master of mineral photography, whereas the principal photographer for the English edition was the relatively uncredentialed Bruce Cairncross. Cairncross chose to set most of these colorful pieces against uniform flat-back backgrounds, instead of Medenbach's shaded, colored, more artistically cross-lit backgrounds. Some readers will disapprove of the aesthetics, as well as of the reduction in sharpness indicative of 35-mm photography rather than large-format.

The sections on Tsumeb's history and the surrounding culture(s) make particularly good reading. Gebhard's sense of history is not Eurocentric: he begins with a fantasy of Bushmen "at the beginning of the 18th century" sending smoke signals from their secret "Green Hill"—the original outcrop of the orebody—to nearby Ovambos, inviting them to come for a trading session involving "heaps of green and blue rock." Since the Ovambos monopolized the copper-smelting technology while the Bushmen jealously guarded the outcrop itself, a capitalistic arrangement developed that was sometimes friendly, sometimes hostile: Gebhard implies a parallel with later arrangements between the Germans who owned the Südwest Afrika colony until the end of the First World War, and the English whose London company worked the mine (down even to the fact that the Bushmen and Ovambos also spoke different languages). After 1851, the whites began penetrating the region, these including a couple of American wildcatters whom the Ovambos ran off in 1876; German control commenced in the 1880's. There follows a rich account of the early mining and building of infrastructure by Africans, Germans, English, Italians, Boers, etc., with strikes, uprisings, economic crises, and growing general realizations of the mine's richness. This account, full of hard facts, proper names, and amusing or scary anecdotes, all amply supported by the early photographs, will fascinate anyone who, like me, loves classic mineral localities as much for their cultural stories as for their specimens or their science.

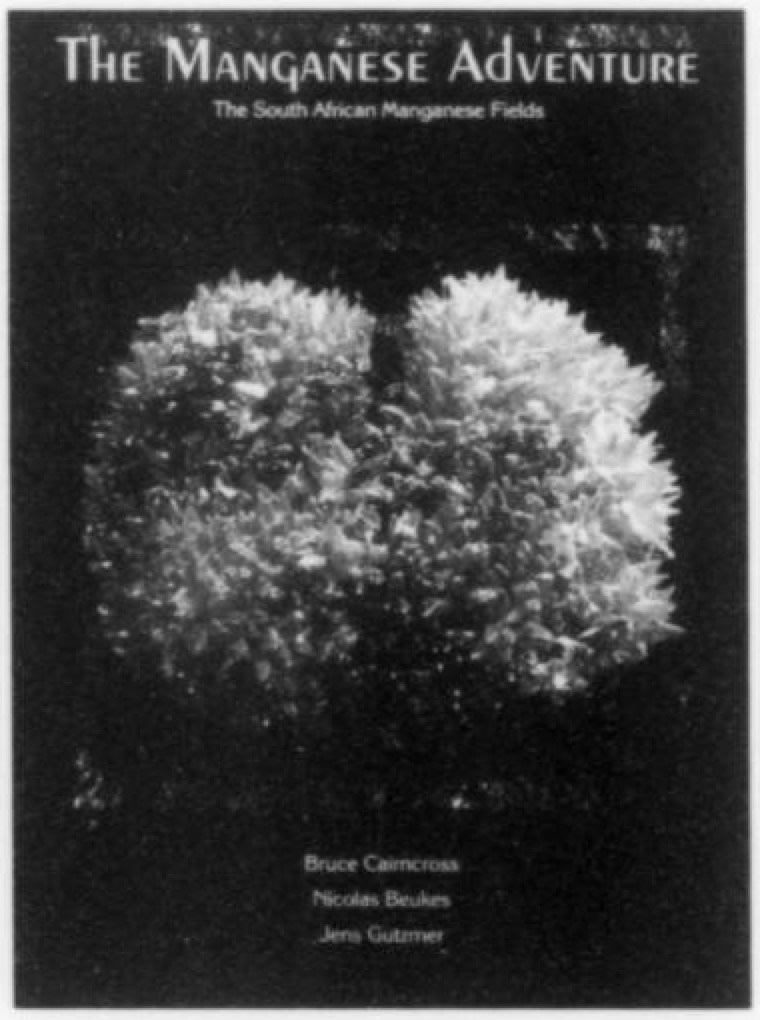
The section on the history of collecting at Tsumeb is equally energetic and informative. We see photos of the first known specimens to be taken from Tsumeb to Europe (cuprite/copper masses, which reached Berlin in the 1860's); we reread the story, told also in the 1976 Special Issue, of Sam Gordon's clash with mine manager Wilhelm Kegel in 1929, over the products of a fantastic azurite pocket Gordon had hit whilst prowling around underground; we find that in Germany in the 1920's and 1930's the dealers Maucher and Krantz had asked immensely high prices for Tsumeb specimens, to the dismay of all . . . you may find out here all about "the most expensive Tsumeb specimen known." While Gebhard is respectful of all who have saved, handled and cherished Tsumeb specimens, this section's subtext is its wicked delight in close-up descriptions of all manner of byzantine, avaricious finaglings, machinations and scams—I especially like (?) a dealer's remark, as quoted here, upon the discovery of leiteite, that, as the mineral has a perfect cleavage, rendering crystals eminently splittable, it's "a specimen-producing mineral, perfect for business."

The sections on Tsumeb mineral species and some of the great pocket finds (The Lead Pocket, The Easter Pocket, The Zinc Pocket) are of course valuable, especially with the extensive tables at the back of the book to complement them. Further, simply by being published in 1999, this book supplies some tantalizing updates on the 1976 Special Issue, and even on the 1991 German *Tsumeb*. For example, the earlier texts only briefly mention Tsumeb phosgenite, as it was earlier known only in a few negligible specimens; but here we read of a 1993 pocket, in the third oxidation zone, which produced the world's finest phosgenite crystals, and to prove the claim there is a full-page photo of a gemmy brown, perfectly formed 9-cm single crystal. The world's best stolzite crystals, we now know, are orange 3-cm bypyramids (which look just like wulfenite) from a 1993 Tsumeb pocket. The chalcocite crystals from the third oxidation zone rival, as the photos show, the best from Connecticut, Cornwall, or Wisconsin, while looking quite different from any of these. All such "greatest specimen" data must now be considered final, as the Tsumeb mine closed in 1996 (having yielded 90 million tons of ore, with 4 million tons of pure metal, half of it copper).

The English of the text is lively, and fully imbued with the author's love for his subject matter. A good-tempered reader may even find it all the more likeable for its, shall we say, German accent: "shooting" as "schooting"; one photo caption speaking of a "pocket after been exhaustet"; a prominent heading on the jacket flap asking "what means Tsumeb." Much less tolerable are the frequent slips in copyediting: a "49" in the Table of Contents should be 249, two photo captions say "lipidocrocite" and "schöngeite" even though the correct spellings appear nearby in the text; there is even a reference to "the Smithsonian Institute, New York."

Nevertheless, this reviewer could find no significant reason *not* to recommend this beautiful book in the strongest way to anyone interested in mineralogy, mineral-culture, Tsumeb, and beautiful mineral specimens. Dr. Gebhard is a fully credentialed professional mineralogist who has discovered eight new species, but here it's his love of specimen mineralogy and of his favorite specimen locality—including a love of its country, peoples, history and lore—which shines through. Your 1976 *Mineralogical Record* Special Issue, and even, if you own it, your 1991 German *Tsumeb*, will not feel comfortably at home unless this new book joints their little family on your shelf.

Thomas Moore



The Manganese Adventure: The South African Manganese Fields

by Bruce Cairncross, Nicolas Beukes and Jens Gutzmer. Published (1997) by the Associated Ore and Metal Corporation Ltd.; available through Bruce Cairncross, Dept. of Geology, Rand Afrikaans University, P.O. Box 524, Auckland Park 2006, Johannesburg, South Africa (Fax: 011-27-11-489-2309). Only bank checks or credit card orders accepted. Hardcover, 8.5 x 11.8 inches, 250 pages printed on high-quality paper, over 250 color photos and 62 color maps, price: $90 plus $15 seamail postage.

To any experienced mineral collector, names like Hotazel and N'Chwaning conjure up images of fabulous rhodochrosite specimens like . . . well, like the one on the cover of this spectacular book on the Northern Cape manganese deposits of South Africa. The largest land-based manganese deposits on earth occur here, in the Kalahari Manganese Field and the Postmasburg region. *The Manganese Adventure* documents the fascinating history, geology and mineralogy in a publication so beautiful that there is little doubt it was heavily subsidized by mining interests. Like the book on Broken Hill, New South Wales, published some years ago under an industry subsidy, this book spares no expense in detailing technical aspects using abundant color graphics, and illustrating over 200 superb specimens in color.

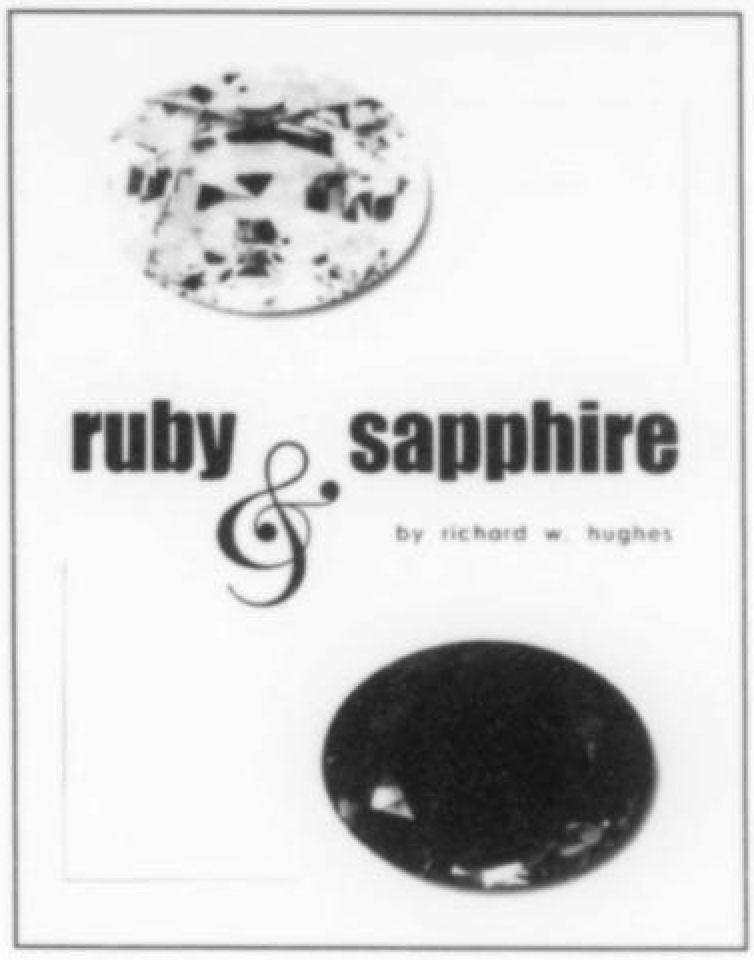
Here we see, as expected, many superb rhodochrosite specimens, yellow sturmanite and ettringite crystals, beautiful black octahedral hausmanite, brilliantly lustrous blocky hematites, hot-pink inesite clusters, magenta-purple sugilite crystals, deep red andradite, black hausmanite prisms and water-clear thaumasite crystals. There are also some surprises: blue celestine crystal clusters, pink datolite looking like Brazilian rose quartz, wine-red tephroite crystals (the rare manganese olivine), golden hexagonal roses of shigaite, fine pink to gemmy-brown microcrystals and clusters or poldervaartite, and a superb doubly terminated crystal of azurite-blue vonbezingite, among others.

The authors' emphasis on geology and paragenesis over hard-core mineralogy is evident in the early chapters, and in the collector-oriented species descriptions, which contain little actual mineralogical or morphological data and no analyses or crystal drawings. But the references are given for those who wish to dig deeper technically; and the more ephemeral collecting history is well preserved. The specimens illustrated are mostly from the excellent collections of Desmond Sacco, Bruce Cairncross and Paul Botha. This book is a fine addition to the shelf of the connoisseur and the geologist alike, even if a bit light on actual mineralogy. Considering the high production quality, the price is very reasonable.

Wendell E. Wilson

Ruby & Sapphire

by Richard W. Hughes. Published (1997) by RWH Publishing, 4946 Clubhouse Circle, Boulder, CO 80301. Hardcover, 8.5 x 11 inches, 512 pages; price: $98.



I like to imagine that if the *Mineralogical Record* decided to do a special issue on gem corundum, had pretty much unlimited financial backing, spent years in research and photo-gathering, and ultimately published a book-size issue that had to sell for a hundred dollars a copy, it would be something like this fascinating book by Richard Hughes. (As editor, however, I get exhausted just thinking about it.) This is a monumental effort, lavishly and beautifully illustrated throughout, and packed with information.

The initial chapters cover history, mineralogy, gemology, synthetics, and an interesting section on "Judging quality: a connoisseur's guide." Then comes the meat of the book, for mineral collectors, at least: a thorough review of localities worldwide, including occurrences in Afghanistan, Burma, Colombia, India, Madagascar, Pakistan, Russia, Ceylon, Tanzania, Thailand, Vietnam, and 35 other countries.

Every chapter is accompanied by an extensive reference list, and almost every page is in color. The paper is glossy text stock which feels essentially identical to the paper on which this magazine is printed. And, like the *Mineralogical Record*, there are color ads throughout, which are a surprise in such a book but not an unpleasant one; they contribute in their own way.

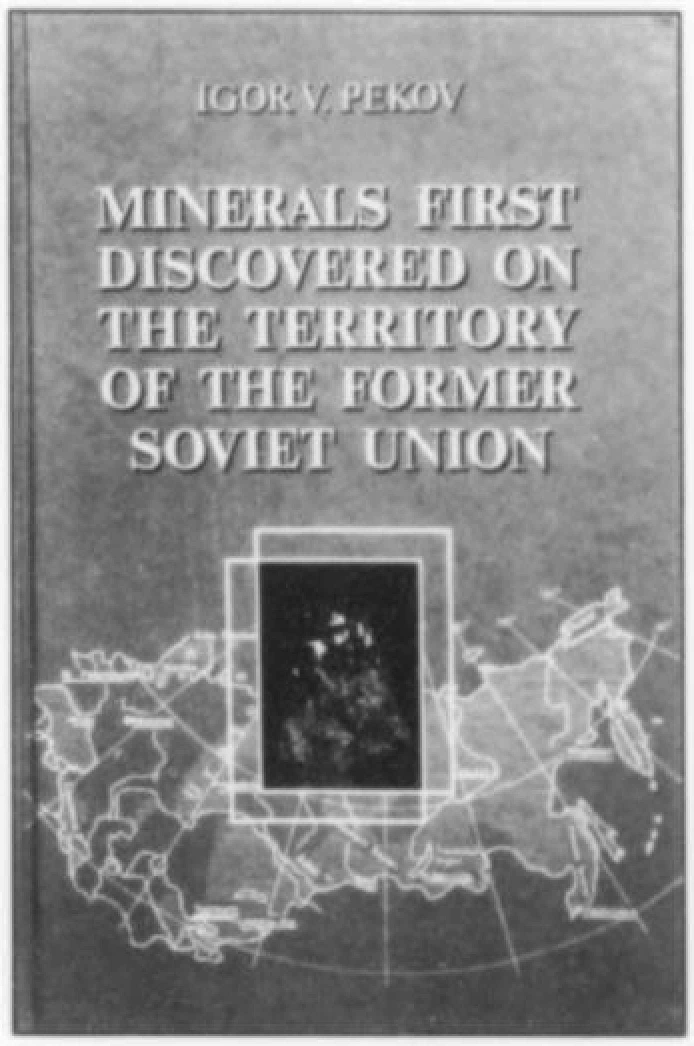
The text style is highly readable, and it is clear that the author has devoted much of his life to his subject. This work has personality, and is a fine reference besides. If you have Sinkankas's *Emerald and Other Beryls*, you should have this one too.

Wendell E. Wilson

Minerals First Discovered on the Territory of the Former Soviet Union

by Igor V. Pekov. Published (1998) by Ocean Pictures, Moscow; available from Carol Finnie, 448 E. Mulberry St., Lebanon, OH 45036. Hardcover, 5.5 x 8.5 inches, 369 pages; price: $53.

During the Cold War period, Soviet government policy was to conceal or distort information on the minerals and mineral occurrences found within Soviet territory, apparently under the assumption that such data might conceivably have strategic significance. With that unhappy time behind us, a book has now been published to clarify the record on no less than 582 mineral species first discovered in Soviet territory. Accurate information, much of it unavailable from any other source, is given on the localities, local geography (with maps), mining regions, nomenclature, appearance, composition and associated minerals.



Species dating back before the October Revolution are also included, such as dioptase. Over 180 color photos are shown, including 38 photos of famous Soviet localities such as Norilsk, Adun-Chilon, and sites in the Kola Peninsula, the southern Urals, Uzbekistan, Kyrgyzstan, Tadjikistan and Kamchatka. Many crystal drawings and scanning electron micrographs illustrate the descriptions, and there is even a section which includes photographs of many of the mineralogists who described the minerals. A good index and 761 references round out the book. The English translation is virtually perfect and reads easily. This is an important reference and an excellent contribution to the literature of mineralogy.

Wendell E. Wilson

Letters

WILL THOSE IN FAVOR OF THE GONIOMETER ISSUE SIGNIFY BY SAYING "AYE" . . .

Thank you for your excellent issues of the *Mineralogical Record*. The Goniometer Issue (November–December) is very interesting and instructive. Please send me a copy of the German translation of the text.

Motofumi Kuze
Tochigi Pref., Japan

I think the issue on the History of the Development of the Crystallographic Goniometer is superb. It is well done, thoroughly researched and nicely composed and published. Most mineral collectors compare their crystals with classic drawings at one time or another, and this article will enrich their experience. Reading this article brought back memories of many long nights of measuring crystals and drawing them. This issue is another crystal in the crown of the *Mineralogical Record*.

Pete J. Dunn
Smithsonian Institution

When I first heard during the summer that the November–December 1998 issue of the *Mineralogical Record* would be a special issue and that none of my abstracts of new mineral descriptions would appear in it, I felt—like any author—slightly upset that anything could be considered more important than my own work. Then the issue, all about goniometers, arrived and I uttered words of forgiveness to you.

This is a magnificent piece of work! I congratulate Uli Burchard for the fine job he has done in recording the history of goniometers both in words and in photographs and other illustrations. I also congratulate you for having the foresight to recognize the value of publishing this important and unique contribution to our science, and for your courage in publishing it; I'm sure that you will receive "brickbats" from some people in the collecting community, but you certainly deserve "bouquets" instead.

As a mineralogist fortunate enough to have been introduced to goniometers early in my undergraduate years, leafing through the pages of the issue brought back memories of many wonderful hours of angular measurements leading up to the production of complex crystal drawings. As a young professor I taught a course in two-circle goniometry and enjoyed that as much as if I were taking the course. Such courses are seldom taught in North America any more, just as very little mineralogy is being taught. Goniometers have become objets d'art rather than scientific instruments. Last year I was at a committee meeting at a local university. The chairman of the department showed us a two-circle goniometer which he had just had refurbished prior to installing it in a display case. The brass sparkled and the instrument looked great. One of the mineralogists asked what it was, so I told him and, after briefly explaining its use, closed with a statement that he had missed a very wonderful part of his education.

A few words to your readers who might object to the goniometer issue. All serious collectors of minerals should be interested in every aspect of the science of mineralogy. Minerals are not just beautiful objects, they are intricately constructed solids which obey precise and strict laws. To know how our knowledge of these minerals has evolved over the centuries can do much to increase our interest in them. I have spoken to many amateur mineralogists over the years and have tried to impress upon them the need to know more about our science. I firmly believe that the future of hand-specimen mineralogy lies in the hands of the amateur community. Very few university mineralogists can identify minerals without recourse to sopishticated equipment. I know one professor of mineralogy who proudly proclaimed that he cannot tell calcite from quartz in hand specimens! Someday, when his instruments are down for maintenance, he may have to turn to a local amateur for identifications.

Neal Yedlin used to say "Buy and read a good book." The November–December 1998 issue of the *Mineralogical Record* is a "must." Bravo, Uli and Wendell!

Joe Mandarino
Toronto, Ontario

What a fantastic issue [on goniometers]! Ulrich Burchard did a splendid job—I could not put the issue down until I finished it. Why isn't there a hardbound edition? Anyway, congratulations to you, the *Mineralogical Record*, and Mr. Burchard.

Suggestion: How about an article on the dichroscope, polariscope, petrographic microscope, etc.? In combination with Burchard's blowpipe article and the goniometer issue, it would complete the coverage of the major instruments of "classical" mineralogy.

John Delly
Lake Forest, IL

. . . AND THOSE OPPOSED BY SAYING "NAY"

I have just received the November–December issue [on goniometers]. It took me only about ten minutes to read your illustrious periodical. I really enjoyed the advertisements very much. Other than the ads, this issue is to me a gaffe of monumental proportions. I am a collector of minerals for about 50 years, and I feel sorry that a novice in this hobby might come across this issue in their tentative exploration of the hobby.

I am sure this copy will appeal to those select few who wield a gargantuan "silver pick" and have wielded it to their satiety in the mineral field. They will be able to stroke their egos and titillate their friends with these arcane instruments. I am sure a leatherbound edition would go over as well.

William R. Kent
Phoenix, AZ

I have enclosed my copy of the goniometer issue with this letter; I thought perhaps you could use it as an extra office copy or resell it. Its only value to me is the advertising.

The *Mineralogical Record* is my favorite magazine. The arrival of each new issue is always an exciting event. Thus it was all the more disappointing to see an issue without a single article about minerals! The goniometer issue and the books issue are aimed more at historians and antique collectors than mineral lovers. The mineral books described in that issue are all obsolete, and the goniometers are certainly obsolescent.

I remember reading a letter to the editor once complaining about the presence of a woman's hand [for scale] on your cover with an extraordinary large tourmaline. You have gone farther astray with these special issues. I hope that in the future you will stick a little closer to minerals.

Jim Means
Alpine, CA

Since I purchase your magazine for *minerals, minerals, minerals,* I am immensely disappointed that there are *none* in the November–December issue.

Veronica Matthews
Westbrook, CT

I enjoy very much the *Mineralogical Record,* but the Goniometer Issue is a bit overdone. [A variety of] pictures and articles should appear in every issue; otherwise you appeal to only one select group, and the rest (the majority) are bored, as by this goniometer business.

C. H. de Groot
Ranua, Finland

The Goniometer Issue is a technical *tour de force* that will delight some of your readers. Alas, however, I know that I will never read it. I don't have the time, knowledge or motivation to laboriously work through such a minutely detailed presentation. Please go back to what you do so very well—excellent articles and photographs on minerals, mines and shows.

Ganny Kolodinsky
Victoria, BC

CALCITE COLLECTOR'S DIRECTORY

The Spar Box, the quarterly newsletter of the International Calcite Collector's Association (ICCA), is proposing to compile an *International Directory of Calcite Collectors.* A listing in the directory is free and should contain the following information: name, exact address, phone and fax numbers, e-mail address, size of specimens collected (e.g., thumbnail, miniature, etc.), number of calcite and total specimen collection, specialties (e.g., pseudos, twins, associations, locality(s), etc.), and if there is any interest in trading or selling. The information should be sent to Dr. Morton L. Metersky, 725 Cheryl Drive, Warminster, PA 18974; e-mail: metersky@aol.com; phone: 215-672-4598 (fax same but must call first). Publication date will depend on the response to this notice. Price will depend on size of directory and postage. Those who indicate that they want a copy of the directory will be notified as to cost. Since the directory will not be fancy, the cost should be moderate.

For those of you who would like more information on the International Calcite Collector's Association, please visit our web page at <http://www.rockhounds.com/icca>. It contains a copy of a *Spar Box* and a membership form. Of course, you can write or call. *The Spar Box* is entering its ninth year of publication.

(Dr.) Morton L. Metersky
Editor & Publisher, *The Spar Box*

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