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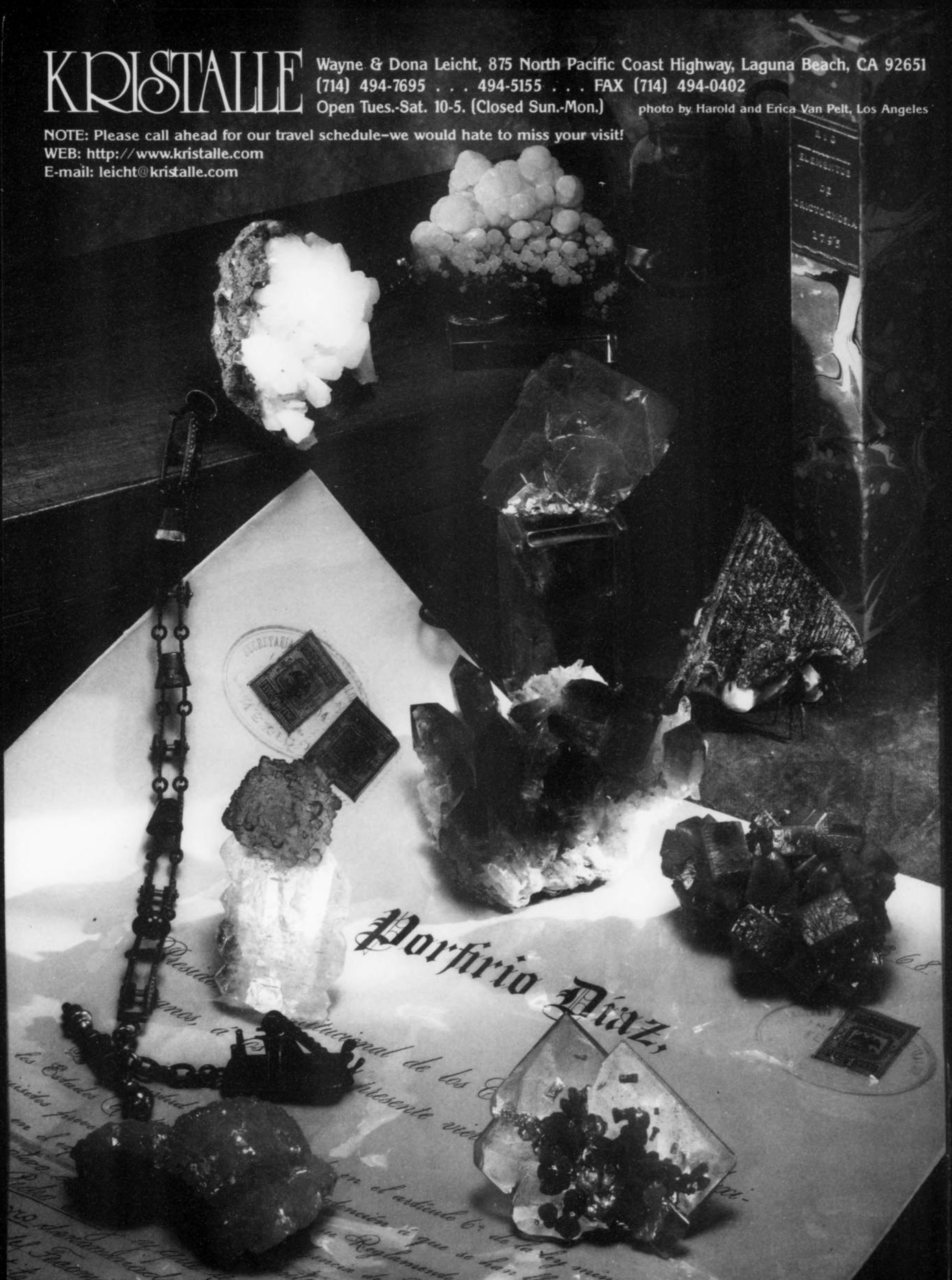
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*Continued on p. 232

THE MINERALOGICAL RECORD

May–June 1998 Volume Twenty-nine, Number Three

Articles

Columns

COVER: CALCITE, 13.9 cm, from Cumbria, England. William Larson collection; photo by Jeffrey A. Scovil.

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notes from the EDITOR

CALL FOR PAPERS

The 20th Mineralogical Symposium sponsored jointly by the Friends of Mineralogy, the Tucson Gem and Mineral Society, and the Mineralogical Society of America will be held in conjunction with the 45th Tucson Gem and Mineral Show, Saturday, February 13, 1999. The topic of the symposium will be **Minerals of Mexico**—the theme of the mineral show. The 1999 symposium is also dedicated to the honor of the late Dr. Miguel Romero for his outstanding efforts in the advancement of studies of Mexican minerals. Papers on descriptive mineralogy, paragenesis, classic and new locations, etc. are invited. An audience of knowledgeable amateurs as well as professional mineralogists and geologists is expected.

If you wish to present a paper, please write or call (**immediately**) James A. McGlasson, Symposium Co-chair (*The Collector's Stope*, 9641 East Hickory Tree Drive, Tucson, Arizona 85749; (520) 760-1501; e-mail: jmcglasson@theriver.com) or Peter K. M. Megaw (President, *IMDEX, Inc.*, P.O. Box 65538, Tucson, Arizona 85728; (520) 529-2231; e-mail: pmegaw@imdex.com), with your topic, a few sentences describing the paper and your address, phone number and e-mail. Presentations will be 15 or 20 minutes in length followed by a period for questions. Upon acceptance of topics all authors will be required to submit a 200 to 300 word abstract by September 15, 1998 (**firm date**). Those abstracts will be published in the January-February issue of the *Mineralogical Record* (subject to approval of the editor), which will be available for sale at the 45th Tucson Gem and Mineral Show.

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NAMIBITE

A SUMMARY OF WORLD OCCURRENCES

Gail E. Dunning
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Namibite, a rare copper-bismuth vanadate, has been identified previously from at least nine world localities. Overlooked for many years because of its resemblance to other dark green copper minerals, namibite has recently become more common than suspected. Three new occurrences are reported here.

INTRODUCTION

Namibite, $Cu(BiO)_2(VO_4)(OH)$,* is a rare mineral generally occurring in granitic pegmatite and polymetallic quartz vein settings. It is commonly associated with other bismuth minerals including native bismuth, bismuthinite, bismutite, bismite, beyerite, eulytite, pucherite, schumacherite and clinobisvanite. Since its first description in 1981 by von Knorring and Sahama from northwestern Namibia, namibite has been identified from a number of diverse worldwide localities. To date, at least nine localities that have been described formally are known to the authors. Three additional occurrences are reported here. This wealth of world localities makes for an interesting compilation of occurrences, associated minerals and deposit types. Diligent examination of polymetallic hydrothermal quartz veins containing copper, bismuth and vanadium and of pegmatite settings will probably reveal additional sources for this mineral.

OCCURRENCES

Iron Monarch open pit, Australia

Namibite has been recorded from the Iron Monarch open pit, South Australia, (Pring *et al.*, 1992) as very dark olive-green, blade-like crystals. Individual crystals reach up to 0.2 mm in length, while compound groups of crystals are up to 1 mm in length and are often associated with bismoclite. The mineral also occurs as radiating clusters of nearly black crystals several millimeters in diameter in vugs within the quartz matrix.

Morass Creek Gorge, Australia

Birch *et al.* (1995) report that namibite occurs associated with schumacherite, eulytite (?), pucherite (?), mrazekite and chrysocolla from a skarn on the western side of a gorge on Morass Creek, north of Benambra, Victoria, Australia. The namibite occurs sparingly as pistachio-green to nearly black hemispheres and coatings which consist of very thin tabular crystals.

Evans-Lou pegmatite, Canada

Namibite associated with native bismuth, bismutite, beyerite and eulytite has been identified from the Evans-Lou pegmatite near Poltimore, Quebec (Grice *et al.*, 1986). Hogarth (1972) gives a detailed description of this unique quarry and its yttrium-niobium-bismuth-vanadium mineral assemblage. The namibite occurs as isolated spheroidal groups of acicular crystals and as delicate "bow-ties" perched in quartz cavities. Its color is very dark green grading into nearly black. When broken, the crystals show the characteristic dark green color.

Elias mine, Czech Republic

Mrázek *et al.* (1994) report an occurrence of namibite from the Elias mine, Jáchymov, Krušné hory, Czech Republic, where it is found in fragments of quartz gangue with eulytite, beyerite, bismutite and pucherite. The namibite here is dark green with an anhedral to subhedral habit. Rough, flattened crystals with no visible terminations occur on the quartz.

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*The composition, formerly considered to be $CuBi_2VO_6$, was redefined by Mrázek *et al.* (1994).

Table 1. **Namibite occurrences, associations and deposit types. (Superscripts refer to references list.)**

Locality	*Associations*	*Deposit Type*
AUSTRALIA		
[9] Iron Monarch Open Pit, South Australia	Bismoclite	Precambrian sedimentary iron ore deposit underlain by granite
[1] Morass Creek gorge, Benambra, Victoria	Mrazekite, schumacherite, eulytite (?) pucherite (?), chrysocolla	Silurian sedimentary rocks overlain by volcanics containing vesuvianite-grossular skarn
CANADA		
[5,6] Evans-Lou pegmatite, Quebec	Native bismuth, bismuthinite, bismutite, beyerite, eulytite	Rare-earth granitic pegmatite dike containing Y, Nb, Bi and V
CZECH REPUBLIC		
[7] Elias mine, Jáchymov	Bismutite, beyerite, pucherite, eulytite	Quartz vein system
ENGLAND		
[8] Buckbarrow Beck, Cumbria	Bismutite, bismutoferrite, eulytite, mixite	Oxidized hypogene assemblage related to granodiorite intrusion
GERMANY		
[2] Am Hechtsberg quarry, Hausach	Chrysocolla, bismutite, beyerite, hechtsbergite, mixite, eulytite	Cavities in gneiss
NAMIBIA		
[10] Khorixas	Native bismuth, bismite, bismutite, clinobisvanite, beyerite	Polymetallic hydrothermal quartz-vein deposit of Cu, Bi, W, Pb, V and Ag
UNITED STATES		
[3] Stewart mine, Pala district, California	Chrysocolla, pseudomalachite	Composite pegmatite-aplite dikes
[4] White Queen mine, Pala district, California	Clinobisvanite, beyerite	Composite pegmatite-aplite dikes
NEW OCCURRENCES		
Pucher shaft, Schneeberg, Germany	Schumacherite, pucherite, U-minerals	Hydrothermal quartz vein
Lodi #4 mine, near Chilcoot, California	Bismite, bismutite, bismutoferrite, bismutostibiconite, clinobisvanite, schumacherite, koechlinite, wittichenite	Quartz dikes in granite related to either hydrothermal phase of magmatic sequence or pneumatolytic origin
Mica Lode–Meyers Ranch quarry, 8-Mile Park, Colorado	Beyerite, schumacherite	Pegmatite

Eskdale intrusion, England

At Buckbarrow Beck, Cumbria, England, namibite occurs in the Eskdale intrusion as very dark green, roughly spherical masses up to 1.5 mm across. In some instances these masses exhibit an internal sheaf-like, platy, crystalline texture and smooth to drusy external surfaces. The mineral occurs in small cavities, both alone and in association with bismutite, bismutoferrite, eulytite and mixite. The locality has been described by Neall *et al.* (1993).

Am Hechtsberg mine, Germany

Blass and Graf (1995) report namibite from the Am Hechtsberg quarry near Hausach in the German Schwarzwald (Black Forest). Further data on the type of deposit and associated species are given by Kraus *et al.*, 1997; minerals occur in cavities in a gneiss which is being quarried for road-building material. Associations include bismutite, beyerite, hechtsbergite, eulytite and mixite.

Khorixas, Namibia

Namibite was first described as a new mineral by von Knorring and Sahama (1981) from a small, polymetallic, hydrothermal quartz vein deposit near Khorixas (formerly Welwitschia) in northwestern Namibia. The monoclinic crystals are platy parallel to (100), with narrow forms {101} and {111}. Penetration twinning is common on (011); polysynthetic twinning is also common, with a good cleavage parallel to (100). Namibite has a distinctive dark green color and good reflectivity. It is found in quartz cavities associated with native bismuth, beyerite, bismite, bismutite, clinobisvanite pseudomorphs after pucherite, and other oxidized Cu minerals. Other minerals present in the deposit include galena, scheelite, cuprotungstite, iodargyite and calciovolbrothite.

Stewart mine, California

Namibite also has been identified from the Stewart mine, Pala district, with associated chrysocolla and pseudomalachite (Foord, 1996). Other bismuth minerals reported from the pegmatites of San Diego County include native bismuth, bismuthinite, bismite, bismutite, eulytite and pucherite (Jahns and Wright, 1951; Shigley *et al.*, 1986; Foord *et al.*, 1989).

White Queen mine, California

Foord *et al.* (1991) and Foord (1996) recently described namibite from the White Queen mine, Pala district, San Diego County, California. At this locality, namibite occurs in small pod-like masses in quartz-rich "pocket-pegmatite" zones as fine-grained, emerald-green masses intergrown with tan clinobisvanite and beyerite.

NEW OCCURRENCES

Wolfgang mine, Germany

A sample from the Pucher shaft, Wolfgang mine, Schneeberg, Germany, containing pucherite and schumacherite was purchased

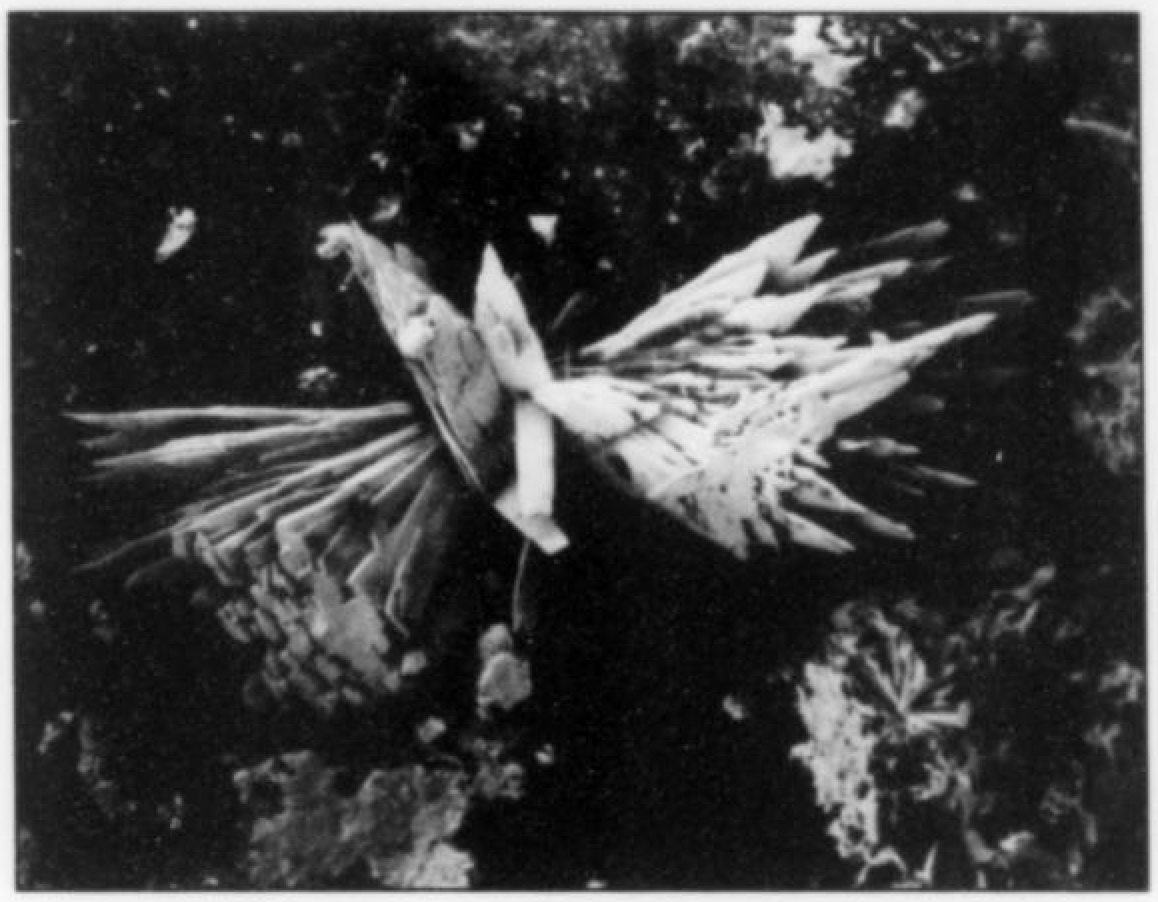

***Figure 1.* Bow-tie crystal group of dark green namibite associated with beyerite, 0.4 mm in length, from the Mica Lode–Meyers Range pegmatite, Fremont County, Colorado. G. Dunning specimen and SEM photo.**

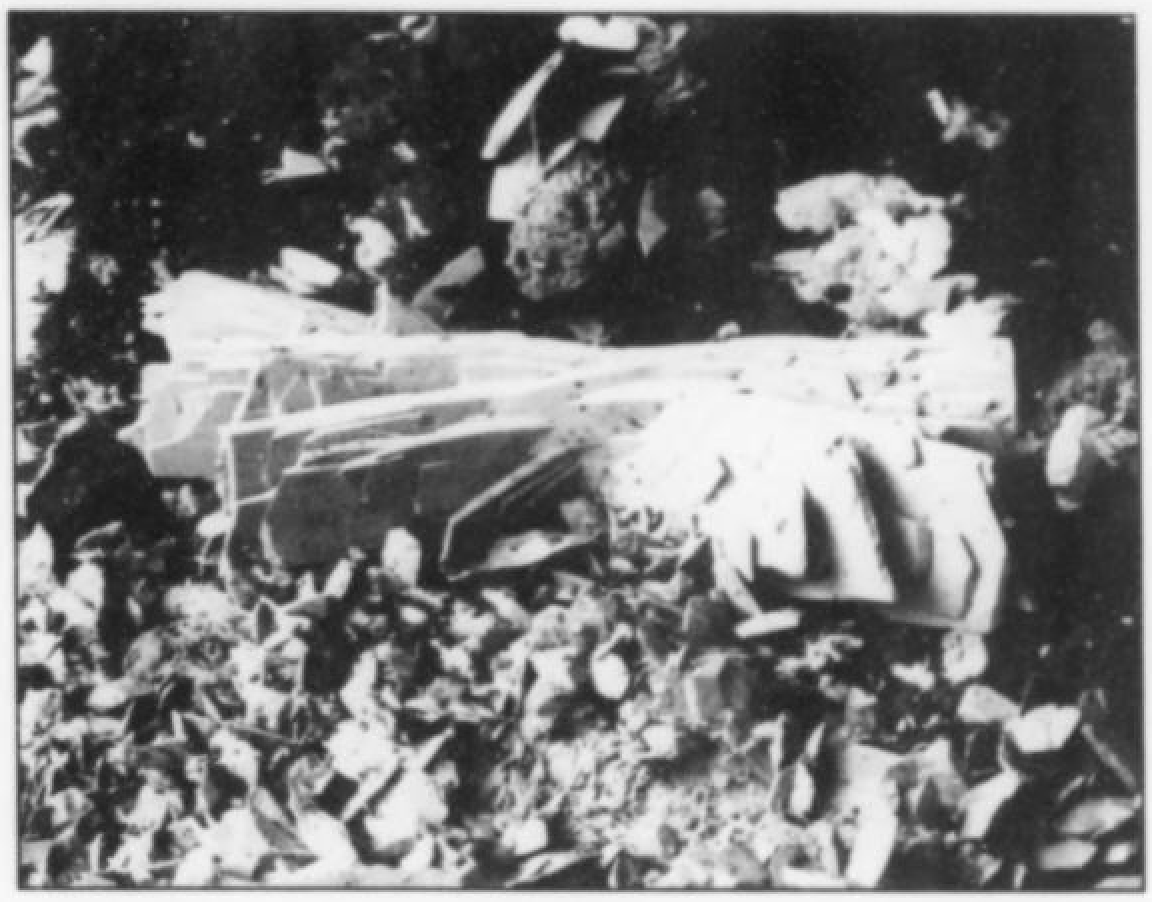

***Figure 2.* Bow-tie crystal group of dark green namibite, 0.6 mm in length, from the Pucher shaft, Schneeberg, Germany. G. Dunning specimen and SEM photo.**

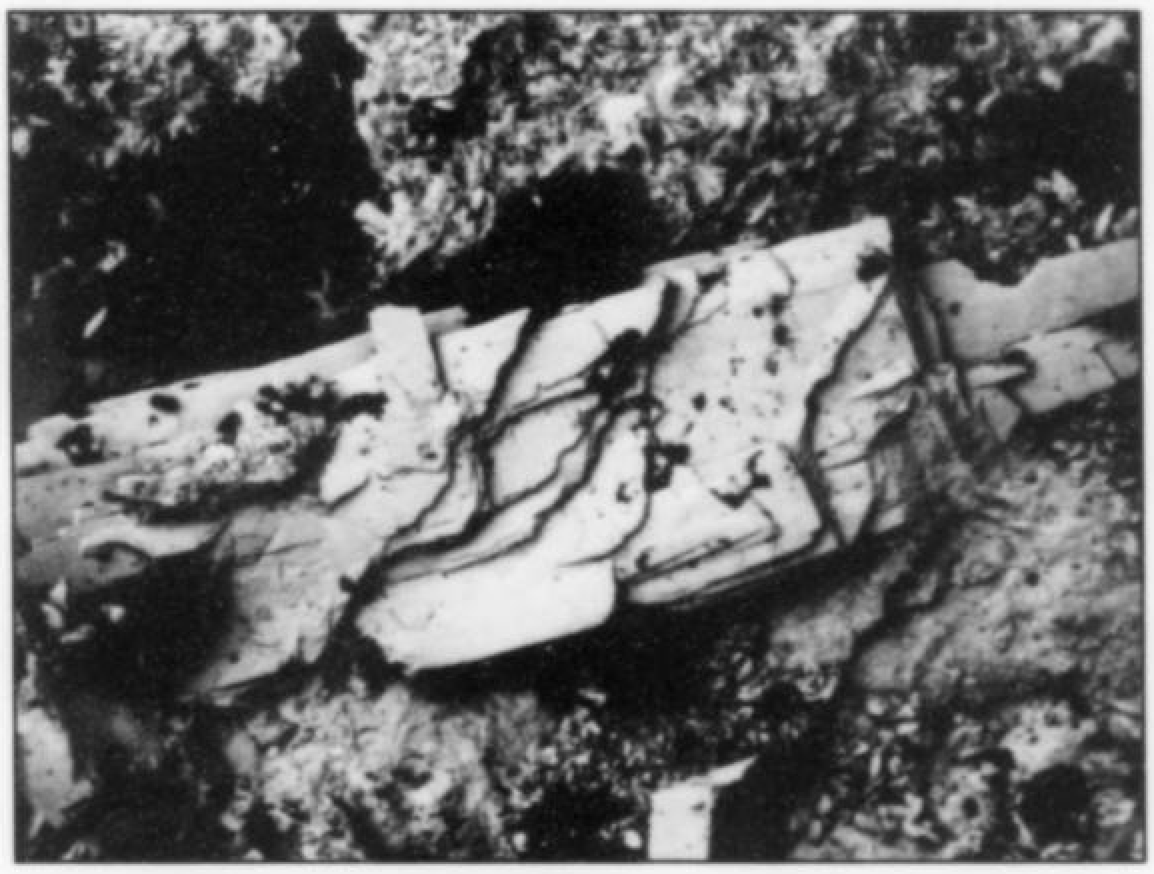

***Figure 3.* Single, elongated namibite crystal showing the perfect {100} cleavage. Pucher shaft, Schneeberg, Germany. G. Dunning specimen and SEM photo.**

***Figure 4.* Spheroidal group of dark green namibite crystals on quartz, 0.05 mm in diameter, from the Lodi #4 mine, Plumas County, California. G. Dunning specimen and SEM photo.**

by one of us (GED) in the 1980's. While the schumacherite and pucherite on the sample were being verified, several dark-green blades and beautiful bow-ties were observed in a depression on the sample. Megascopically, the dark-green mineral resembled namibite, based on our earlier encounters with the mineral. X-ray powder diffraction and EDS confirmed its identity as namibite.

The Schneeberg veins, like many others in Germany, contained a polymetallic assemblage of Co-Ni-Bi-Ag-U minerals (Lieber and Leyerzaph, 1986).

Lodi #4 mine, California

Namibite was identified (by X-ray powder diffraction and EDS) from the Lodi #4 mine, Plumas County, California, during a detailed examination of the Spring Creek copper area in 1970 (Dunning and Cooper, in preparation). The mineral occurs as isolated spheroids up to 2 mm composed of individual, bladed, dark green crystals. The namibite postdates older massive quartz but predates a younger crystallized quartz.

Associated bismuth minerals along the quartz veins include bismite, bismutite, bismutoferrite, bismutostibiconite, schumacherite and koechlinite. The source of the bismuth was traced to altered wittichenite exsolved within the bornite of the copper-rich quartz veins. The vanadium is thought to have been derived from nearby granitic rocks.

Mica Lode–Meyers Ranch pegmatite, Colorado

Namibite has been identified by X-ray powder diffraction and EDS tests on a single quartz sample collected in the 1970's from a pegmatite exposed in the Mica Lode–Meyers quarry, 8-Mile Park district, Fremont County, Colorado. This quartz sample, which

Table 2. **Bismuth species known to occur in association with namibite, $Cu(BiO)_2(VO_4)(OH)$**

Beyerite	$(Ca,Pb)Bi_2(CO_3)_2O_2$
Bismite	Bi_2O_3
Bismoclite	$BiOCl$
Bismuth	Bi
Bismuthinite	Bi_2S_3
Bismutite	$Bi_2(CO_3)O_2$
Bismutoferrite	$BiFe_2(SiO_4)_2(OH)$
Bismutostibiconite	$Bi(Sb,Fe)_2O_7$
Clinobisvanite	$BiVO_4$
Eulytite	$Bi_4(SiO_4)_3$
Hechtsbergite	$Bi_2O(OH)(VO_4)$
Koechlinite	Bi_2MoO_6
Mixite	$BiCu_6(AsO_4)_3(OH)_6\cdot 3H_2O$
Mrazekite	$BiCu_3(PO_4)_2O_2(OH)_2\cdot 2H_2O$
Pucherite	$BiVO_4$
Schumacherite	$Bi[(V,As,P)O_4]_2O(OH)$
Wittichenite	Cu_3BiS_3

measures about 6 x 10 cm, contains abundant, pale green beyerite as thin plates and rough spheres along the fracture surfaces. Embedded in the beyerite are small groups of dark green namibite crystals with a radiating habit, measuring up to 1 mm in diameter. A single group of schumacherite crystals was identified from one of the samples. No primary bismuth minerals have been identified from the quarry.

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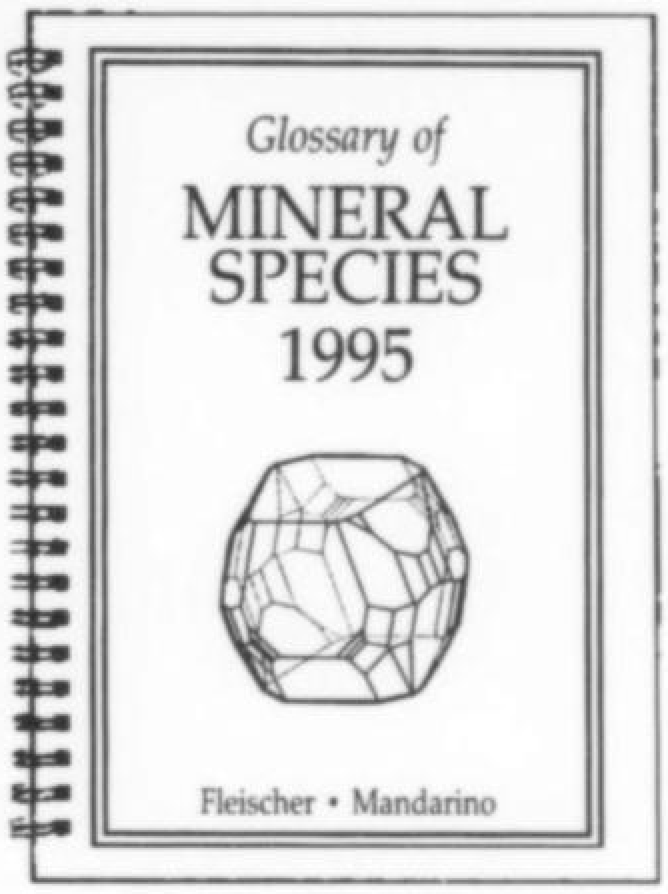

THE SECOND LIST OF ADDITIONS AND CORRECTIONS TO THE GLOSSARY OF MINERAL SPECIES (1995)

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THE AMPHIBOLE GROUP

INTRODUCTION

As stated in the "Note added in proof" to *The First List of Additions and Corrections to the Glossary of Mineral Species 7th Edition (1995)*, a major revision of the classification and nomenclature of the Amphibole Group has been published in several mineralogical journals. I have spent many hours with that report and this article is the result.

I have attempted to summarize the report by Leake *et al.* (1997), but I highly recommend that the original paper be consulted by readers interested in this complex group of minerals. So far, it has appeared in the *Canadian Mineralogist* **35**, 219–246 (1997), *Mineralogical Magazine* **61**, 295–321 (1997), the *European Journal of Mineralogy* **9**, 623–651 (1997), and the *American Mineralogist* **82**, 1019–1037 (1997).

An interesting aspect of the new classification is the probable absence of examples in Nature to fit some of the names and definitions given in the report. As I have said to several people, we now have a wonderfully constructed set of pigeonholes, but we are not sure that there are pigeons in each of these. Quite possibly, there are data in the voluminous literature dealing with amphiboles which represent some of these defined names and I would like to encourage anybody who might recognize any of these to contact me. I then will attempt to get the authors who published the data to: (1) characterize the minerals and submit proposals for their approval to the Commission on New Minerals and Mineral Names of the International Mineralogical Association or (2) provide material to a group here in Toronto which will carry out the necessary work.

I am pleased to acknowledge the assistance of the following people. Prof. Bernard E. Leake, University of Glasgow, gave freely of his time to answer my questions about the new classification of which he is the senior author. Dr. Joel E. Grice, Canadian Museum

of Nature, pointed out that two of the names listed in the report require the prefix "potassic". Mr. Malcolm E. Back, Royal Ontario Museum, offered several suggestions which greatly improved an earlier draft of this article. Dr. John C. Schumacher, Albert-Ludwigs Universität, Freiburg, Germany, kindly provided his expertise regarding the calculation of formulae for the sadanagaite-magnesiosadanagaite series. Dr. Wendell E. Wilson, *Mineralogical Record*, was very encouraging and supportive of this project. Lastly, we all owe a debt of gratitude to the members of the Amphibole Subcommittee of the Commission on New Minerals and Mineral Names, I.M.A. who spent many hours working on the classification; unfortunately, they are too numerous to list here.

AMPHIBOLE GROUP

The classification of the Amphibole Group has been revised by a subcommittee of the Commission on New Minerals and Mineral Names (CNMMN) of the International Mineralogical Association (IMA). The report on the new classification by Leake *et al.* (1997) has been published (or is in press) in many mineralogical journals, including those mentioned above in the introduction. Readers interested in this group of minerals should consult that report.

Seventy-five species names are listed in the report with their *end member* formulae and, according to Prof. Leake (personal communication, 21 May 1997), there are analyses of all of these species which fall into the compositional fields which define them. In other words, all of them are considered to exist in Nature. However, many of the species in the list have not been characterized formally, nor have they been submitted for approval to the CNMMN.

In terms of anions, almost all of the amphibole species are defined with twenty-two oxygen ions and two hydroxyl (OH) groups. Exceptions are kaersutite and ferrokaersutite with twenty-three oxygens and one hydroxyl and ungarettiite with twenty-four oxygens. However, some of the species have fluorine-dominant analogues and the names of such species should have the prefix "fluoro"; for example, richterite and its fluorine-dominant analogue, fluororichterite, are known. On the other hand, although fluorocannilloite exists the hydroxyl-dominant analogue is not yet known; if it is found and approved by the CNMMN, it would receive the name cannilloite. A similar case involves ferroleakeite (hydroxyl-dominant), which has not been found although fluoro-ferroleakeite is known and has been approved by the CNMMN; in contrast, leakeite (hydroxyl-dominant) has been approved by the CNMMN but a fluorine-dominant analogue has not been found. It is interesting to note that analytical data exist in the literature for at least two amphiboles which fall into the hastingsite field and which are chlorine-dominant; one of these is almost completely characterized but the data for the other consists only of chemical analytical data. Once they are characterized and subsequently approved by the CNMMN, their names would be prefixed by "chloro".

Some of the species found in Nature might require the addition of other prefixes such as "potassic"; an example is potassic-fluororichterite. Leake *et al.* (1997) list and define the following prefixes: alumino, chloro, chromio, ferri, fluoro, mangano, permangano, mangani, potassic, sodic, titano, and zinco. Where assigned, *they are an integral part of the species name*.

In an attempt to differentiate between the names of possible amphibole species and those known to exist in Nature, two modified lists are presented here. The lists contain all of the names recognized by Leake *et al.* (1997) and, in addition, prefixed names of species known to occur in Nature which have been properly characterized have been added. The species whose names are given in **bold type** are the equivalents of species that are known to have been formally approved or "grandfathered" by the CNMMN. Most of these were recognized in the *Glossary of Mineral Species 1995*. New species approved since its publication, are also given in **bold type**. Where necessary, the names required by the new classification scheme have been applied. Some species may have been overlooked, but without a thorough examination of all the amphibole analytical data in the literature, this is difficult to overcome. It must be stressed that even if a set of analytical data for an amphibole indicates that a name from the classification scheme applies to that mineral, a formal proposal must be made to the CNMMN for approval of the species.

Some of the names require special discussion: actinolite, fluorocannilloite, fluoro-ferroleakeite, fluororichterite, potassic-fluororichterite, manganocummingtonite, manganogrunerite, sadanagaite, magnesiosadanagaite, and ungarettiite.

Actinolite has been retained by the subcommittee for members of the tremolite–ferro-actinolite series, where the ratio $Mg/(Mg+Fe^{2+})$ is greater than 0.5 and less than 0.9.

The species fluorocannilloite, fluoro-ferroleakeite, and ungarettiite are listed in *The First List of Additions and Corrections to the Glossary of Mineral Species 7th Edition (1995)*, but the spelling of the first two names has been changed by the report.

Fluororichterite and potassic-fluororichterite appeared in the *Glossary of Mineral Species 1995*, with slightly different spellings.

The names manganocummingtonite and manganogrunerite replace the names "tirodite" and "dannemorite", respectively.

The minerals sadanagaite and magnesiosadanagaite present some problems. The formulae given in the new classification for these two minerals are, respectively, $NaCa_2[Fe^{2+}_3(Fe^{3+},Al)_2]Si_5Al_3O_{22}(OH)_2$ and $NaCa_2[Mg_3(Fe^{3+},Al)_2]Si_5Al_3O_{22}(OH)_2$. In both formulae, $Fe^{3+} > Al$, but calculation of the empirical formulae from the original chemical analytical data for the type specimens of these two species shows that $Al > Fe^{3+}$. The formulae listed for these species in this paper have been written with $Al > Fe^{3+}$. There appear to be problems with the original chemical data for magnesiosadanagaite and the calculation of its formula is not completely satisfactory. However, other analyses in the literature confirm the existence of magnesiosadanagaite. In addition, the *type* materials named sadanagaite and magnesiosadanagaite are, strictly speaking, potassicsadanagaite and potassic-magnesiosadanagaite, respectively. The prefix "potassic" is required because $K > 0.50$ in both formulae.

The first list contains all of the amphibole species names arranged alphabetically. The second list gives the amphibole species arranged by subgroup.

The standard amphibole formula is $AB_2^{VI}C_5^{IV}T_8O_{22}X_2$. The components A, B, C, T, and X of the formula correspond to the following crystallographic sites:

A one site per formula unit;
B two *M*4 sites per formula unit;
C a composite of five octahedral sites made up of 2 *M*1, 2 *M*2, and 1 *M*3 sites per formula unit;
T eight tetrahedral sites in two sets of four per formula unit;
X two sites per formula unit.

The ions considered *normally* to occupy these sites are:
☐ (empty site) and K (at *A* only), Na (at *A* or *B*),
Ca (at *B* only), *L*-type ions: Mg, Fe^{2+}, Mn^{2+}, Li, and rarer
ions of similar size such as Zn, Ni, Co (at *C* or *B*),
M-type ions: Al (at *C* or *T*), Fe^{3+}, and, more rarely, Mn^{3+},
Cr^{3+} (at *C* only), High-valency ions: Ti^{4+} (at *C* or *T*),
Zr^{4+} (at *C* only), Si (at *T* only), Anions: OH, F, Cl, O
(at *X*).

ALPHABETICAL LIST OF AMPHIBOLE SPECIES NAMES

Actinolite	☐ $Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$	**C***
Aluminobarroisite	☐ $(CaNa)Mg_3Al_2Si_7AlO_{22}(OH)_2$	**S**
Alumino-ferrobarroisite	☐ $(CaNa)Fe^{2+}_3Al_2Si_7AlO_{22}(OH)_2$	**S**
Alumino-ferrotschermakite	☐ $Ca_2(Fe^{2+}_3Al_2)Si_6Al_2O_{22}(OH)_2$	**C**
Alumino-magnesiotaramite	$Na(CaNa)Mg_3Al_2Si_6Al_2O_{22}(OH)_2$	**S**
Aluminotaramite	$Na(CaNa)Fe^{2+}_3Al_2Si_6Al_2O_{22}(OH)_2$	**S**
Aluminotschermakite	☐ $Ca_2(Mg_3Al_2)Si_6Al_2O_{22}(OH)_2$	**C**
Anthophyllite	☐ $Mg_7Si_8O_{22}(OH)_2$	**M**
Arfvedsonite	$NaNa_2(Fe^{2+}_4Fe^{3+})Si_8O_{22}(OH)_2$	**N**
Barroisite	☐ $(CaNa)Mg_3AlFe^{3+}Si_7AlO_{22}(OH)_2$	**S**
Cannilloite	$CaCa_2(Mg_4Al)Si_5Al_3O_{22}(OH)_2$	**C**
Clinoferroholmquistite	☐ $(Li_2Fe^{2+}_3Al_2)Si_8O_{22}(OH)_2$	**M**
Clinoholmquistite	☐ $(Li_2Mg_3Al_2)Si_8O_{22}(OH)_2$	**M**
Cummingtonite	☐ $Mg_7Si_8O_{22}(OH)_2$	**M**
Eckermannite	$NaNa_2(Mg_4Al)Si_8O_{22}(OH)_2$	**N**
Edenite	$NaCa_2Mg_5Si_7AlO_{22}(OH)_2$	**C**
Ferribarroisite	☐ $(CaNa)Mg_3Fe^{3+}_2Si_7AlO_{22}(OH)_2$	**S**
Ferric-ferronyböite	$NaNa_2(Fe^{2+}_3Fe^{3+}_2)Si_7AlO_{22}(OH)_2$	**N**
Ferri-clinoferroholmquistite	☐ $(Li_2Fe^{2+}_3Fe^{3+}_2)Si_8O_{22}(OH)_2$	**M**
Ferri-clinoholmquistite	☐ $(Li_2Mg_3Fe^{3+}_2)Si_8O_{22}(OH)_2$	**M**
Ferric-nyböite	$NaNa_2(Mg_3Fe^{3+}_2)Si_7AlO_{22}(OH)_2$	**N**
Ferri-ferrobarroisite	☐ $(CaNa)Fe^{2+}_3Fe^{3+}_2Si_7AlO_{22}(OH)_2$	**S**
Ferri-ferrotschermakite	☐ $Ca_2(Fe^{2+}_3Fe^{3+}_2)Si_6Al_2O_{22}(OH)_2$	**C**
Ferri-magnesiotaramite	$Na(CaNa)Mg_3Fe^{3+}_2Si_6Al_2O_{22}(OH)_2$	**S**
Ferritaramite	$Na(CaNa)Fe^{2+}_3Fe^{3+}_2Si_6Al_2O_{22}(OH)_2$	**S**
Ferritschermakite	☐ $Ca_2(Mg_3Fe^{3+}_2)Si_6Al_2O_{22}(OH)_2$	**C**
Ferro-actinolite	☐ $Ca_2Fe^{2+}_5Si_8O_{22}(OH)_2$	**C**
Ferro-anthophyllite	☐ $Fe^{2+}_7Si_8O_{22}(OH)_2$	**M**
Ferrobarroisite	☐ $(CaNa)Fe^{2+}_3AlFe^{3+}Si_7AlO_{22}(OH)_2$	**S**
Ferro-eckermannite	$NaNa_2(Fe^{2+}_4Al)Si_8O_{22}(OH)_2$	**N**
Ferro-edenite	$NaCa_2Fe^{2+}_5Si_7AlO_{22}(OH)_2$	**C**
Ferrogedrite	☐ $Fe^{2+}_5Al_2Si_6Al_2O_{22}(OH)_2$	**M**
Ferroglaucophane	☐ $Na_2(Fe^{2+}_3Al_2)Si_8O_{22}(OH)_2$	**N**
Ferroholmquistite	☐ $(Li_2Fe^{2+}_3Al_2)Si_8O_{22}(OH)_2$	**M**
Ferrohornblende	☐ $Ca_2[Fe^{2+}_4(Al,Fe^{3+})]Si_7AlO_{22}(OH)_2$	**C**
Ferrokaersutite	$NaCa_2(Fe^{2+}_4Ti)Si_6Al_2O_{23}(OH)$	**C**
Ferroleakeite	$NaNa_2(Fe^{2+}_2Fe^{3+}_2Li)Si_8O_{22}(OH)_2$	**N**
Ferronyböite	$NaNa_2(Fe^{2+}_3Al_2)Si_7AlO_{22}(OH)_2$	**N**
Ferropargasite	$NaCa_2(Fe^{2+}_4Al)Si_6Al_2O_{22}(OH)_2$	**C**
Ferrorichterite	$Na(CaNa)Fe^{2+}_5Si_8O_{22}(OH)_2$	**S**
Ferrotschermakite	☐ $Ca_2(Fe^{2+}_3AlFe^{3+})Si_6Al_2O_{22}(OH)_2$	**C**
Ferrowinchite	☐ $(CaNa)Fe^{2+}_4(Al,Fe^{3+})Si_8O_{22}(OH)_2$	**S**
Fluorocannilloite	$CaCa_2(Mg_4Al)Si_5Al_3O_{22}F_2$	**C**
Fluoro-ferroleakeite	$NaNa_2(Fe^{2+}_2Fe^{3+}_2Li)Si_8O_{22}F_2$	**N**
Fluororichterite	$Na(CaNa)Mg_5Si_8O_{22}F_2$	**S**
Gedrite	☐ $Mg_5Al_2Si_6Al_2O_{22}(OH)_2$	**M**
Glaucophane	☐ $Na_2(Mg_3Al_2)Si_8O_{22}(OH)_2$	**N**
Grunerite	☐ $Fe^{2+}_7Si_8O_{22}(OH)_2$	**M**
Hastingsite	$NaCa_2(Fe^{2+}_4Fe^{3+})Si_6Al_2O_{22}(OH)_2$	**C**
Holmquistite	☐ $(Li_2Mg_3Al_2)Si_8O_{22}(OH)_2$	**M**
Kaersutite	$NaCa_2(Mg_4Ti)Si_6Al_2O_{23}(OH)$	**C**
Katophorite	$Na(CaNa)Fe_4^{2+}(Al,Fe^{3+})Si_7AlO_{22}(OH)_2$	**S**
Kornite	$(Na,K)Na_2(Mg_2Mn^{3+}_2Li)Si_8O_{22}(OH)_2$	**N**
Kozulite	$NaNa_2Mn^{2+}_4(Fe^{3+},Al)Si_8O_{22}(OH)_2$	**N**
Leakeite	$NaNa_2(Mg_2Fe^{3+}_2Li)Si_8O_{22}(OH)_2$	**N**
Magnesio-arfvedsonite	$NaNa_2(Mg_4Fe^{3+})Si_8O_{22}(OH)_2$	**N**
Magnesiohastingsite	$NaCa_2(Mg_4Fe^{3+})Si_6Al_2O_{22}(OH)_2$	**C**
Magnesiohornblende	☐ $Ca_2[Mg_4(Al,Fe^{3+})]Si_7AlO_{22}(OH)_2$	**C**
Magnesiokatophorite	$Na(CaNa)Mg_4(Al,Fe^{3+})Si_7AlO_{22}(OH)_2$	**S**
Magnesioriebeckite	☐ $Na_2(Mg_3Fe^{3+}_2)Si_8O_{22}(OH)_2$	**N**
Magnesiosadanagaite	$NaCa_2[Mg_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$	**C**
Magnesiotaramite	$Na(CaNa)Mg_3AlFe^{3+}Si_6Al_2O_{22}(OH)_2$	**S**
Manganocummingtonite	☐ $Mn_2Mg_5Si_8O_{22}(OH)_2$	**M**
Manganogrunerite	☐ $Mn_2Fe^{2+}_5Si_8O_{22}(OH)_2$	**M**
Nyböite	$NaNa_2(Mg_3Al_2)Si_7AlO_{22}(OH)_2$	**N**
Pargasite	$NaCa_2(Mg_4Al)Si_6Al_2O_{22}(OH)_2$	**C**
Permanganogrunerite	☐ $Mn_4Fe^{2+}_3Si_8O_{22}(OH)_2$	**M**
Potassic-fluororichterite	$(K,Na)(CaNa)Mg_5Si_8O_{22}F_2$	**S**
Potassic-magnesio sadanagaite	$(K,Na)Ca_2[Mg_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$	**C**
Potassicsadanagaite	$(K,Na)Ca_2[Fe^{2+}_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$	**C**
Richterite	$Na(CaNa)Mg_5Si_8O_{22}(OH)_2$	**S**
Riebeckite	☐ $Na_2(Fe^{2+}_3Fe_2{}^{3+})Si_8O_{22}(OH)_2$	**N**
Sadanagaite	$NaCa_2[Fe^{2+}_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$	**C**
Sodicanthophyllite	$NaMg_7Si_8O_{22}(OH)_2$	**M**
Sodic-ferro-anthophyllite	$NaFe^{2+}_7Si_8O_{22}(OH)_2$	**M**
Sodic-ferrogedrite	$NaFe^{2+}_6AlSi_6Al_2O_{22}(OH)_2$	**M**
Sodicgedrite	$NaMg_6AlSi_6Al_2O_{22}(OH)_2$	**M**
Taramite	$Na(CaNa)Fe^{2+}_3AlFe^{3+}Si_6Al_2O_{22}(OH)_2$	**S**
Tremolite	☐ $Ca_2Mg_5Si_8O_{22}(OH)_2$	**C**
Tschermakite	☐ $Ca_2(Mg_3AlFe^{3+})Si_6Al_2O_{22}(OH)_2$	**C**
Ungarettiite	$NaNa_2(Mn^{2+}_2Mn^{3+}_3)Si_8O_{22}O_2$	**N**
Winchite	☐ $(CaNa)Mg_4(Al,Fe^{3+})Si_8O_{22}(OH)_2$	**S**

*NOTE: The third column indicates the subgroup to which the species belongs; M = Mg-Fe-Mn-Li, C = calcic, S = sodic-calcic, and N = sodic (Na).

Species names not in bold indicate compositions that have yet to be found in nature.

AMPHIBOLES CLASSIFIED BY SUBGROUPS

Mg-Fe-Mn-Li Amphibole Subgroup

Orthorhombic		Monoclinic
Anthophyllite series		*Cummingtonite-Grunerite series*
Anthophyllite	☐ $Mg_7Si_8O_{22}(OH)_2$	**Cummingtonite**
Ferro-anthophyllite	☐ $Fe^{2+}_7Si_8O_{22}(OH)_2$	**Grunerite**
Sodicanthophyllite	$NaMg_7Si_8O_{22}(OH)_2$	
Sodic-ferro-anthophyllite	$NaFe^{2+}_7Si_8O_{22}(OH)_2$	
	☐ $Mn_2Mg_5Si_8O_{22}(OH)_2$	**Mangano cummingtonite**
	☐ $Mn_4Fe^{2+}_3Si_8O_{22}(OH)_2$	Permangano grunerite
	☐ $Mn_2Fe^{2+}_5Si_8O_{22}(OH)_2$	**Mangano grunerite**
Gedrite series		
Gedrite	☐ $Mg_5Al_2Si_6Al_2O_{22}(OH)_2$	
Ferrogedrite	☐ $Fe^{2+}_5Al_2Si_6Al_2O_{22}(OH)_2$	

Orthorhombic		Monoclinic
Sodicgedrite	$NaMg_6AlSi_6Al_2O_{22}(OH)_2$	
Sodic-ferrogedrite	$NaFe^{2+}_6AlSi_6Al_2O_{22}(OH)_2$	
Holmquistite series		*Clinoholmquistite series*
Holmquistite	□ $(Li_2Mg_3Al_2)Si_8O_{22}(OH)_2$	**Clino holmquistite**
Ferroholmquistite	□ $(Li_2Fe^{2+}_3Al_2)Si_8O_{22}(OH)_2$	**Clinoferro holmquistite**
	□ $(Li_2Mg_3Fe^{3+}_2)Si_8O_{22}(OH)_2$	Ferri-clino holmquistite
	□ $(Li_2Fe^{2+}_3Fe^{3+}_2)Si_8O_{22}(OH)_2$	Ferri-clinoferro holmquistite

Calcic Amphibole Subgroup

(all monoclinic)

Tremolite	□ $Ca_2Mg_5Si_8O_{22}(OH)_2$
Actinolite	□ $Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$
Ferro-actinolite	□ $Ca_2Fe^{2+}_5Si_8O_{22}(OH)_2$
Edenite	$NaCa_2Mg_5Si_7AlO_{22}(OH)_2$
Ferro-edenite	$NaCa_2Fe^{2+}_5Si_7AlO_{22}(OH)_2$
Pargasite	$NaCa_2(Mg_4Al)Si_6Al_2O_{22}(OH)_2$
Ferropargasite	$NaCa_2(Fe^{2+}_4Al)Si_6Al_2O_{22}(OH)_2$
Magnesiohastingsite	$NaCa_2(Mg_4Fe^{3+})Si_6Al_2O_{22}(OH)_2$
Hastingsite	$NaCa_2(Fe^{2+}_4Fe^{3+})Si_6Al_2O_{22}(OH)_2$
Tschermakite	□ $Ca_2(Mg_3AlFe^{3+})Si_6Al_2O_{22}(OH)_2$
Ferrotschermakite	□ $Ca_2(Fe^{2+}_3AlFe^{3+})Si_6Al_2O_{22}(OH)_2$
Aluminotschermakite	□ $Ca_2(Mg_3Al_2)Si_6Al_2O_{22}(OH)_2$
Alumino-ferrotschermakite	□ $Ca_2(Fe^{2+}_3Al_2)Si_6Al_2O_{22}(OH)_2$
Ferritschermakite	□ $Ca_2(Mg_3Fe^{3+}_2)Si_6Al_2O_{22}(OH)_2$
Ferri-ferrotschermakite	□ $Ca_2(Fe^{2+}_3Fe^{3+}_2)Si_6Al_2O_{22}(OH)_2$
Magnesiosadanagaite	$NaCa_2[Mg_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$
Potassic-magnesio sadanagaite	$(K,Na)Ca_2[Mg_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$
Sadanagaite	$NaCa_2[Fe^{2+}_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$
Potassicsadanagaite	$(K,Na)Ca_2[Fe_3{}^{2+}(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$
Magnesiohornblende	□ $Ca_2[Mg_4(Al,Fe^{3+})]Si_7AlO_{22}(OH)_2$
Ferrohornblende	□ $Ca_2[Fe^{2+}_4(Al,Fe^{3+})]Si_7AlO_{22}(OH)_2$
Kaersutite	$NaCa_2(Mg_4Ti)Si_6Al_2O_{23}(OH)$
Ferrokaersutite	$NaCa_2(Fe^{2+}_4Ti)Si_6Al_2O_{23}(OH)$
Cannilloite	$CaCa_2(Mg_4Al)Si_5Al_3O_{22}(OH)_2$
Fluorocannilloite	$CaCa_2(Mg_4Al)Si_5Al_3O_{22}F_2$

Note: Actinolite is used for that part of the tremolite field where $Mg/(Mg+Fe^{2+})$ is greater than 0.5 and less than 0.9

Sodic-Calcic Amphibole Subgroup

(all monoclinic)

Richterite	$Na(CaNa)Mg_5Si_8O_{22}(OH)_2$
Fluororichterite	$Na(CaNa)Mg_5Si_8O_{22}F_2$
Potassic-fluororichterite	$(K,Na)(CaNa)Mg_5Si_8O_{22}F_2$
Ferrorichterite	$Na(CaNa)Fe^{2+}_5Si_8O_{22}(OH)_2$
Winchite	□ $(CaNa)Mg_4(Al,Fe^{3+})Si_8O_{22}(OH)_2$
Ferrowinchite	□ $(CaNa)Fe^{2+}_4(Al,Fe^{3+})Si_8O_{22}(OH)_2$
Barroisite	□ $(CaNa)Mg_3AlFe^{3+}Si_7AlO_{22}(OH)_2$
Ferrobarroisite	□ $(CaNa)Fe^{2+}_3AlFe^{3+}Si_7AlO_{22}(OH)_2$
Aluminobarroisite	□ $(CaNa)Mg_3Al_2Si_7AlO_{22}(OH)_2$
Alumino-ferrobarroisite	□ $(CaNa)Fe^{2+}_3Al_2Si_7AlO_{22}(OH)_2$
Ferribarroisite	□ $(CaNa)Mg_3Fe^{3+}_2Si_7AlO_{22}(OH)_2$
Ferri-ferrobarroisite	□ $(CaNa)Fe^{2+}_3Fe^{3+}_2Si_7AlO_{22}(OH)_2$
Magnesiokatophorite	$Na(CaNa)Mg_4(Al,Fe^{3+})Si_7AlO_{22}(OH)_2$
Katophorite	$Na(CaNa)Fe^{2+}_4(Al,Fe^{3+})Si_7AlO_{22}(OH)_2$
Magnesiotaramite	$Na(CaNa)Mg_3AlFe^{3+}Si_6Al_2O_{22}(OH)_2$
Taramite	$Na(CaNa)Fe^{2+}_3AlFe^{3+}Si_6Al_2O_{22}(OH)_2$
Alumino-magnesiotaramite	$Na(CaNa)Mg_3Al_2Si_6Al_2O_{22}(OH)_2$
Aluminotaramite	$Na(CaNa)Fe^{2+}_3Al_2Si_6Al_2O_{22}(OH)_2$
Ferri-magnesiotaramite	$Na(CaNa)Mg_3Fe^{3+}_2Si_6Al_2O_{22}(OH)_2$
Ferritaramite	$Na(CaNa)Fe^{2+}_3Fe^{3+}_2Si_6Al_2O_{22}(OH)_2$

Sodic Amphibole Subgroup

(all monoclinic)

Glaucophane	□ $Na_2(Mg_3Al_2)Si_8O_{22}(OH)_2$
Ferroglaucophane	□ $Na_2(Fe^{2+}_3Al_2)Si_8O_{22}(OH)_2$
Magnesioriebeckite	□ $Na_2(Mg_3Fe^{3+}_2)Si_8O_{22}(OH)_2$
Riebeckite	□ $Na_2(Fe^{2+}_3Fe^{3+}_2)Si_8O_{22}(OH)_2$
Eckermannite	$NaNa_2(Mg_4Al)Si_8O_{22}(OH)_2$
Ferro-eckermannite	$NaNa_2(Fe^{2+}_4Al)Si_8O_{22}(OH)_2$
Magnesio-arfvedsonite	$NaNa_2(Mg_4Fe^{3+})Si_8O_{22}(OH)_2$
Arfvedsonite	$NaNa_2(Fe^{2+}_4Fe^{3+})Si_8O_{22}(OH)_2$
Kozulite	$NaNa_2Mn^{2+}_4(Fe^{3+},Al)Si_8O_{22}(OH)_2$
Nyböite	$NaNa_2(Mg_3Al_2)Si_7AlO_{22}(OH)_2$
Ferronyböite	$NaNa_2(Fe^{2+}_3Al_2)Si_7AlO_{22}(OH)_2$
Ferric-nyböite	$NaNa_2(Mg_3Fe^{3+}_2)Si_7AlO_{22}(OH)_2$
Ferric-ferronyböite	$NaNa_2(Fe^{2+}_3Fe^{3+}_2)Si_7AlO_{22}(OH)_2$
Leakeite	$NaNa_2(Mg_2Fe^{3+}_2Li)Si_8O_{22}(OH)_2$
Ferroleakeite	$NaNa_2(Fe^{2+}_2Fe^{3+}_2Li)Si_8O_{22}(OH)_2$
Fluoro-ferroleakeite	$NaNa_2(Fe^{2+}_2Fe^{3+}_2Li)Si_8O_{22}F_2$
Kornite	$(Na,K)Na_2(Mg_2Mn^{3+}_2Li)Si_8O_{22}(OH)_2$
Ungarettiite	$NaNa_2(Mn^{2+}_2Mn^{3+}_3)Si_8O_{22}O_2$

Amphibole entries to be changed in the *Glossary of Mineral Species 1995*

Note: Only the species in **BOLD type** in the foregoing lists appear as separate entries in the Glossary.

Page

1 **Actinolite**: change the entry to:
□ **Actinolite**, □$Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$, mon., $Mg/(Mg + Fe^{2+}) = 0.5–0.9$, forms a series with **Tremolite** and **Ferro-actinolite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

5 **Aluminokatophorite**: delete the entry

8 **Anthophyllite**: change the entry to:
□ **Anthophyllite**, □$Mg_7Si_8O_{22}(OH)_2$, orth., dimorph. with **Cummingtonite**, forms a series with **Ferro-anthophyllite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

10 **Arfvedsonite**: change the entry to:
□ **Arfvedsonite**, $NaNa_2(Fe^{2+}_4Fe^{3+})Si_8O_{22}(OH)_2$, mon., forms a series with **Magnesio-arfvedsonite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

17 **Barroisite**: change the entry to:
□ **Barroisite**, □$(CaNa)Mg_3AlFe^{3+}Si_7AlO_{22}(OH)_2$, mon., forms a series with **Ferrobarroisite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

42 After **Clinoenstatite**: add the following entry:
□ **Clinoferroholmquistite**, □$(Li_2Fe^{2+}_3Al_2)Si_8O_{22}(OH)_2$, mon., dimorph. with **Ferroholmquistite**, forms a series with **Clinoholmquistite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

42 **Clinoholmquistite**: change the entry to:
□ **Clinoholmquistite**, □$(Li_2Mg_3Al_2)Si_8O_{22}(OH)_2$, mon.,

dimorph. with **Holmquistite**, forms a series with **Clinoferroholmquistite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

47 **Crossite**: remove the box and change the entry to:
Crossite = **Glaucophane**, **Ferroglaucophane**, **Magnesioriebeckite**, or **Riebeckite**

47 **Cummingtonite**: change the entry to:
☐ **Cummingtonite**, $\square Mg_7Si_8O_{22}(OH)_2$, mon., dimorph. with **Anthophyllite**, forms a series with **Grunerite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

50 **Dannemorite**: remove the box and change the entry to:
Dannemorite = **Manganogrunerite**

57 **Eckermannite**: change the entry to:
☐ **Eckermannite**, $NaNa_2(Mg_4Al)Si_8O_{22}(OH)_2$, mon., forms a series with **Ferro-eckermannite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

57 **Edenite:** change the entry to:
☐ **Edenite**, $NaCa_2Mg_5Si_7AlO_{22}(OH)_2$, mon., forms a series with **Ferro-edenite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

64 **Ferrikatophorite**: delete the entry

65 **Ferri-winchite**: delete the entry

65 **Ferro-actinolite**: change the entry to:
☐ **Ferro-actinolite**, $\square Ca_2Fe^{2+}_5Si_8O_{22}(OH)_2$, mon., forms a series with **Tremolite** and **Actinolite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

65 **Ferro-anthophyllite**: change the entry to:
☐ **Ferro-anthophyllite**, $\square Fe^{2+}_7Si_8O_{22}(OH)_2$, orth., dimorph. with **Grunerite**, forms a series with **Anthophyllite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

65 **Ferrobarroisite**: change the entry to:
☐ **Ferrobarroisite**, $\square(CaNa)Fe^{2+}_3AlFe^{3+}Si_7AlO_{22}(OH)_2$, mon., forms a series with **Barroisite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

66 **Ferroclinoholmquistite**: delete the entry

66 **Ferro-eckermannite**: change the entry to:
☐ **Ferro-eckermannite**, $NaNa_2(Fe^{2+}_4Al)Si_8O_{22}(OH)_2$, mon., forms a series with **Eckermannite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

66 **Ferro-edenite**, change the entry to:
☐ **Ferro-edenite**, $NaCa_2Fe^{2+}_5Si_7AlO_{22}(OH)_2$, mon., forms a series with **Edenite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

66 **Ferro-ferri-tschermakite**: delete the entry

66 **Ferrogedrite**: change the entry to:
☐ **Ferrogedrite**, $\square Fe^{2+}_5Al_2Si_6Al_2O_{22}(OH)_2$, orth., forms a series with **Gedrite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

66 **Ferroglaucophane**: change the entry to:
☐ **Ferroglaucophane**, $\square Na_2(Fe^{2+}_3Al_2)Si_8O_{22}(OH)_2$, mon., forms a series with **Glaucophane**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

66 **Ferroholmquistite**: change the entry to:
☐ **Ferroholmquistite**, $\square(Li_2Fe^{2+}_3Al_2)Si_8O_{22}(OH)_2$, orth., dimorph. with **Clinoferroholmquistite**, forms a series with **Holmquistite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

66 **Ferrohornblende**: change the entry to:
☐ **Ferrohornblende**, $\square Ca_2[Fe^{2+}_4(Al,Fe^{3+})]Si_7AlO_{22}(OH)_2$, mon., forms a series with **Magnesiohornblende**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

66 **Ferrokaersutite**: change the entry to:
☐ **Ferrokaersutite**, $NaCa_2(Fe^{2+}_4Ti)Si_6Al_2O_{23}(OH)$, mon., forms a series with **Kaersutite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

67 **Ferropargasite**: change the entry to:
☐ **Ferropargasite**, $NaCa_2(Fe^{2+}_4Al)Si_6Al_2O_{22}(OH)_2$, mon., forms a series with **Pargasite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

67 **Ferrorichterite**: change the entry to:
☐ **Ferrorichterite**, $Na(CaNa)Fe^{2+}_5Si_8O_{22}(OH)_2$, mon., forms a series with **Richterite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

67 **Ferrotschermakite**: change the entry to:
☐ **Ferrotschermakite**, $\square Ca_2(Fe^{2+}_3AlFe^{3+})Si_6Al_2O_{22}(OH)_2$, mon., forms a series with **Tschermakite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

68 **Ferrowinchite**: change the entry to:
☐ **Ferrowinchite**, $\square(CaNa)Fe^{2+}_4(Al,Fe^{3+})Si_8O_{22}(OH)_2$, mon., forms a series with **Winchite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

69 **Fluor-cannilloite**: change the entry to:
☐ **Fluorocannilloite**, $CaCa_2(Mg_4Al)Si_5Al_3O_{22}F_2$, mon., grey-green, *Amphibole* group, *Mineral. Rec.* **28**, 142, *Can. Min.* **35**, 219–246 (1997)

69 **Fluor-ferro-leakeite**: change the entry to:
☐ **Fluoro-ferroleakeite**, $NaNa_2(Fe^{2+}_2Fe^{3+}_2Li)Si_8O_{22}F_2$, mon., bluish-black to black, *Amphibole* group, *Mineral. Rec.* **27**, 393–394 (1996), *Can. Min.* **35**, 219–246 (1997)

70 **Fluorrichterite**: change the entry to:
☐ **Fluororichterite**, $Na(CaNa)Mg_5Si_8O_{22}F_2$mon., light green to blue green, *Amphibole* group, *New Mins.* (1997), *Can. Min.* **35**, 219–246 (1997)

75 **Gedrite**: change the entry to:
☐ **Gedrite**, $\square Mg_5Al_2Si_6Al_2O_{22}(OH)_2$, orth., forms a series with **Ferrogedrite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

78 **Glaucophane**: change the entry to:
☐ **Glaucophane**, $\square Na_2(Mg_3Al_2)Si_8O_{22}(OH)_2$, mon., blue, forms a series with **Ferroglaucophane**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

81 **Grunerite**: change the entry to:
☐ **Grunerite**, $\square Fe^{2+}_7Si_8O_{22}(OH)_2$, mon., dimorph. with **Ferro-anthophyllite**, forms a series with **Cummingtonite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

84 **Hastingsite**: change the entry to:
☐ **Hastingsite**, $NaCa_2(Fe^{2+}_4Fe^{3+})Si_6Al_2O_{22}(OH)_2$, mon., forms a series with **Magnesiohastingsite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

89 **Holmquistite**: change the entry to:
☐ **Holmquistite**, $\square(Li_2Mg_3Al_2)Si_8O_{22}(OH)_2$, orth., dimorph. with **Clinoholmquistite**, forms a series with **Ferroholmquistite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

101 **Joesmithite**: replace "*Amphibole* group" with "structurally related to the *Amphibole* group"

103 **Kaersutite**: change the entry to:
☐ **Kaersutite**, $NaCa_2(Mg_4Ti)Si_6Al_2O_{23}(OH)$, mon., forms a series with **Ferrokaersutite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

105 Katophorite: change the entry to:
☐ **Katophorite**, $Na(CaNa)Fe^{2+}_4(Al,Fe^{3+})Si_7AlO_{22}(OH)_2$, mon., forms a series with **Magnesiokatophorite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

110 **Kornite**: change the entry to:
☐ **Kornite**, $(Na,K)Na_2(Mg_2Mn^{3+}_2Li)Si_8O_{22}(OH)_2$, mon., dark red to brownish lilac, *Amphibole* group, *New Mins.*

(1997), *Can. Min.* **35**, 219–246 (1997)

111 **Kozulite**: change the entry to:
☐ **Kozulite**, $NaNa_2Mn^{2+}_4(Fe^{3+},Al)Si_8O_{22}(OH)_2$, mon., *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

117 **Leakeite**: change the entry to:
☐ **Leakeite**, $NaNa_2(Mg_2Fe^{3+}_2Li)Si_8O_{22}(OH)_2$, mon., deep red, *Amphibole* group, *New Mins.* (1997), *Can. Min.* **35**, 219–246 (1997)

124 **Magnesio-aluminokatophorite**: delete the entry

125 **Magnesio-anthophyllite**: delete the entry

125 **Magnesio-arfvedsonite**: change the entry to:
☐ **Magnesio-arfvedsonite**, $NaNa_2(Mg_4Fe^{3+})Si_8O_{22}(OH)_2$, mon., forms a series with **Arfvedsonite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

125 **Magnesioclinoholmquistite**: delete the entry

125 **Magnesiocummingtonite**: delete the entry

125 **Magnesioferrikatophorite**: delete the entry

126 **Magnesiogedrite**: delete the entry

126 **Magnesiohastingsite**: change the entry to:
☐ **Magnesiohastingsite**, $NaCa_2(Mg_4Fe^{3+})Si_6Al_2O_{22}(OH)_2$, mon., forms a series with **Hastingsite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

126 **Magnesioholmquistite**: delete the entry

126 **Magnesiohornblende**: change the entry to:
☐ **Magnesiohornblende**, $\square Ca_2[Mg_4(Al,Fe^{3+})]Si_7AlO_{22}(OH)_2$, mon, forms a series with **Ferrohornblende**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

126 Magnesiokatophorite: change the entry to:
☐ **Magnesiokatophorite**, $Na(CaNa)Mg_4(Al,Fe^{3+})Si_7AlO_{22}(OH)_2$, mon., forms a series with **Katophorite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

126 **Magnesioriebeckite**: change the entry to:
☐ **Magnesioriebeckite**, $\square Na_2(Mg_3Fe^{3+}_2)Si_8O_{22}(OH)_2$, mon., forms a series with **Riebeckite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

126 **Magnesiosadanagaite**: change the entry to:
☐ **Magnesiosadanagaite**, $NaCa_2[Mg_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$, mon., forms a series with **Potassic-magnesiosadanagaite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

126 **Magnesiotaramite**: change the entry to:
☐ **Magnesiotaramite**, $Na(CaNa)Mg_3AlFe^{3+}Si_6Al_2O_{22}(OH)_2$, mon, forms a series with **Taramite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

129 After **Manganocolumbite**: add the following entry:
☐ **Manganogrunerite**, $\square Mn_2Fe^{2+}_5Si_8O_{22}(OH)_2$, mon., *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

132 Mboziite: delete the entry

152 **Nyboite:** change the entry to:
☐ **Nyböite**, $NaNa_2(Mg_3Al_2)Si_7AlO_{22}(OH)_2$, mon., *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

160 **Pargasite**: change the entry to:
☐ **Pargasite**, $NaCa_2(Mg_4Al)Si_6Al_2O_{22}(OH)_2$, mon., forms a series with **Ferropargasite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

169 **Potassium-fluor-richterite**; change the entry to:
☐ **Potassic-fluororichterite**, $(K,Na)(CaNa)Mg_5Si_8O_{22}F_2$, mon., light grey, *Amphibole* group, *New Mins.* (1997), *Can. Min.* **35**, 219–246 (1997)

169 After **Potassic-fluororichterite**: add the following entry:
☐ **Potassic-magnesiosadanagaite**, $(K,Na)Ca_2[Mg_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$, mon., dark brown to black, forms a series with **Potassicsadanagaite** and with **Magnesiosadanagaite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

169 After **Potassic-magnesiosadanagaite**: add the following entry:
☐ **Potassicsadanagaite**, $(K,Na)Ca_2[Fe^{2+}_3(Al,Fe^{3+})_2]Si_5Al_3O_{22}(OH)_2$, mon., dark brown to black, forms a series with **Potassic–magnesiosadanagaite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

179 **Richterite**: change the entry to:
☐ **Richterite**, $Na(CaNa)Mg_5Si_8O_{22}(OH)_2$, mon., forms a series with **Ferrorichterite**, compare **Fluororichterite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

179 **Riebeckite**: change the entry to:
☐ **Riebeckite**, $\square Na_2(Fe^{2+}_3Fe^{3+}_2)Si_8O_{22}(OH)_2$, mon., forms a series with **Magnesioriebeckite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

184 **Sadanagaite**: delete the entry

195 After **Soddyite**: add:
☐ **Sodicanthophyllite**, $NaMg_7Si_8O_{22}(OH)_2$, orth., forms a series with **Sodic-ferro-anthophyllite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

195 After **Sodicanthophyllite**, add:
☐ **Sodic-ferro-anthophyllite**, $NaFe^{2+}_7Si_8O_{22}(OH)_2$, orth., forms a series with **Sodicanthophyllite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

195 After **Sodic-ferro-anthophyllite**, add
☐ **Sodicgedrite**, $NaMg_6AlSi_6Al_2O_{22}(OH)_2$, orth., forms a series with **Sodic-ferrogedrite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

195 **Sodium anthophyllite**: delete the entry

196 **Sodium gedrite**: delete the entry

207 **Taramite**: change the entry to:
☐ **Taramite**, $Na(CaNa)Fe^{2+}_3AlFe^{3+}Si_6Al_2O_{22}(OH)_2$, mon., forms a series with **Magnesiotaramite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

212 **Tirodite**: change the entry to:
Tirodite = **Manganocummingtonite**

214 **Tremolite**: change the entry to:
☐ **Tremolite**, $\square Ca_2Mg_5Si_8O_{22}(OH)_2$, mon., forms a series with **Actinolite** and **Ferro-actinolite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

216 **Tschermakite**: change the entry to:
☐ **Tschermakite**, $\square Ca_2(Mg_3AlFe^{3+})Si_6Al_2O_{22}(OH)_2$, mon., forms a series with **Ferrotschermakite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

219 **Ungarettiite**: change the entry to:
☐ **Ungarettiite**, $NaNa_2(Mn^{2+}_2Mn^{3+}_3)Si_8O_{22}O_2$, mon., red, *Amphibole* group, *Mineral. Rec.* **27**, 394 (1996), *Can. Min.* **35**, 219–246 (1997)

231 **Winchite**: change the entry to:
☐ **Winchite**, $\square(CaNa)Mg_4(Al,Fe^{3+})Si_8O_{22}(OH)_2$, mon., forms a series with **Ferrowinchite**, *Amphibole* group, *Can. Min.* **35**, 219–246 (1997)

Note added in proof:

While this paper was being written, the book *Encyclopedia of Mineral Names* by William H. Blackburn and William H. Dennen (1997) was published by the Mineralogical Association of Canada as Special Publication 1 of the *Canadian Mineralogist*. It should be noted that not all the amphibole names listed in that publication conform with those listed here.


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Famous Mineral Localities

THE ANNABERG DISTRICT

LOWER AUSTRIA

Christian Auer
Johann Straussgasse 42
A-2620 Neunkirchen, Austria

The old mines in the Annaberg area, Austria (not to be confused with Annaberg in Saxony) were once famous for an abundance of silver. Because of their close proximity to Vienna, capital of the old Austro-Hungarian Empire, the mines attracted the attention of notable 18th-century mineralogists. It was from this area that Ignaz von Born first described a new mineral that was later to be named wulfenite. The exact ***type locality for wulfenite*** *has now been identified as the Sankt Joannis von Nepomuceni mine.*

INTRODUCTION

The old mine workings near Annaberg in Lower Austria are situated within a mountainous woodland spreading out around Hocheck Peak (1343 meters) about 2.5 km from the town. From the village of Schmelz at the site of an old smelter, visitors can hike to the mines in about an hour. Three different mine groups are known: (1) silver workings including the Sankt Anna and Sankt Joachim mines, (2) lead-zinc workings including the Sankt Joannis von Nepomuceni mine, the Galmeikogel shaft and adjacent small prospects, and (3) iron-ore workings closer to the town of Annaberg and the so-called Lilienfelder Schurf (= pit).

Most of the underground workings have collapsed over the centuries and are not currently accessible. However, the massive dumps which remain from these operations indicate that the silver workings must have been extensive. The only other evidences of mining in the area are a small gypsum prospect, an old hard-coal mine adjacent to the town, a small pyrite prospect and a small fluorite prospect.

HISTORY

The oldest of the mine workings in the Annaberg area is undoubtedly the iron mine, mentioned in a document written by the Abbot Gregor IV of Lilienfeld in 1499. In 1710 Abbot Sigismund offered cannonballs made of Annaberg iron to the Imperial War Department, but they proved to be of poor quality. The iron mine finally closed in 1835 and, aside from a short period of exploration in the Lilienfelder pit during World War II, never reopened.

In 1751 a Jesuit who was "an expert in the field of mineralogy" visited Annaberg and filed reports with the government in Vienna. They caught the interest of a scientist and Royal Imperial Hofrat named Johann Heinrich Gottlob Justi (1720–1771), who that same year went to Annaberg to investigate for himself. Justi was a student of alchemy and wanted to find some bismuth ores to use in his experiments. In Annaberg he made the acquaintance of a local postal clerk and innkeeper named Johann Burger, who showed him a number of specimens including an "alkaline silver ore." Silver

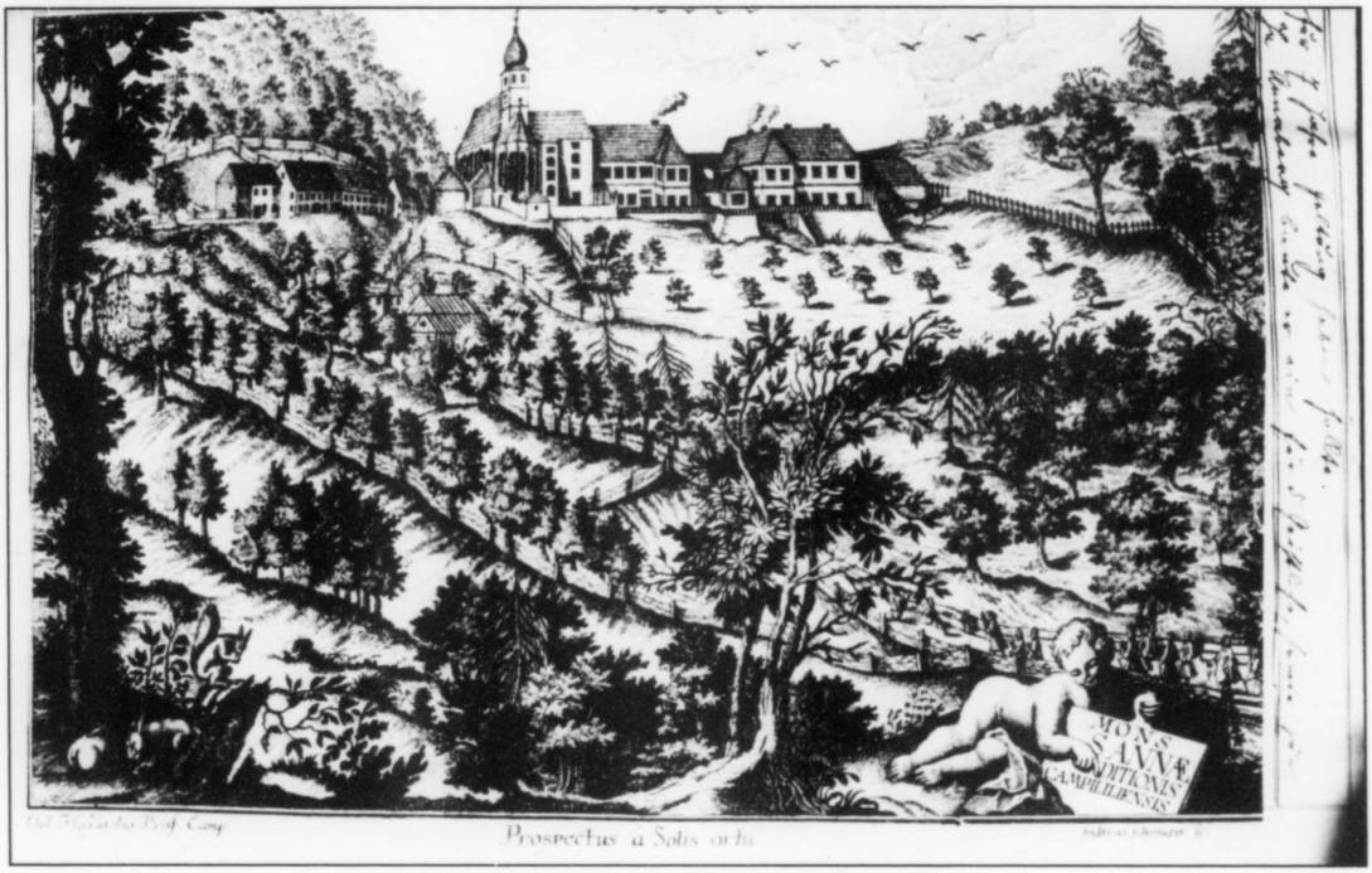

Figure 1. **Copper engraving of Annaberg, 1720.
Courtesy of the Lilienfeld Abbey archives.**

ore of that type, he said, had been collected clandestinely by the locals for 40 or 50 years, but because of its special character they had not succeeded in extracting pure silver from it.

Justi returned to Vienna with the specimens, confirmed that they were rich silver ore, and ultimately made the information public. He wrote:

> After I had discovered the new mine in Annaberg and its richness had become known to everyone, people from Vienna and all over Austria began to look for minerals. Since kind-hearted Mother Nature provided the whole country with numerous minerals, a large number of specimens—from good to worthless—have been brought to the Royal Imperial Mint Office and also to me for examination and analysis. It has not been unusual for large blocks of wallrock to be sent in because people had heard that Annaberg ore looked like plain limestone. Consequently everyone began thinking that all rocks were gold or silver ores.

Naturally, after the discovery of these plain-looking ores, alchemy enjoyed renewed popularity among scientists who saw it as new evidence of the transmutation of "inferior" minerals into valuable gold and silver.

On April 25, 1752, the new silver mine was inaugurated by the Abbott of Lilienfeld. The new mining company created to oversee its exploitation was divided into 128 shares held by notables such as the Empress Maria Theresia, the Archbishop of Vienna, Professor Justi, Johann Burger, and other clerical and secular leaders. Only miners from Steinfeld in Carinthia were hired, none from Saxony or Hungary, so that "access to this holy location should never be granted to a non-catholic."

The innkeeper Burger sold his shares to the Empress Maria Theresa in 1753 for the princely sum of 12,000 gold florins. Unfortunately he died shortly thereafter. Professor Justi served as Mine Director at Annaberg until 1753 (he was described as being "exceedingly proud, uneasy, and insensitive"). He later died as a prisoner of the Prussians in Küstrin fortress in 1771.

An extensive amount of documentation dealing with the mine was generated, since the mine management had been required to transmit monthly reports to Vienna. Their reports included many details of mining and smelting activities, and also of payments issued by the *Bruderlade*, an early social security fund established for miners. Several thousand files and historical maps of the mines are still preserved today in the Royal Imperial *Hofkammerarchiv* in Vienna.

Because the profitability of the mines fluctuated drastically, the shares changed hands often. The enterprise had begun promisingly; already by October of 1752 a total of 5,684 marks (1,590 kg) of refined silver had been delivered to the mint in Vienna. When another silver lode was discovered nearby in 1758, several hundred

Figure 2. **Old silver-smelting or assaying cupels from the Annaberg district, ca. 1782. Collection and photo: Peter Huber.**

Figure 3. **The town of Annaberg today. Photo by Peter Huber.**

Figure 4. **The Annaberg *Ausbeutetaler* ("Profit Dollar") minted in 1765. Collection and photo: Peter Huber.**

Figure 5. **Early map showing the first mine levels in the Annaberg area, 1757. Courtesy of the Royal Imperial Hofkammerarchiv in Vienna.**

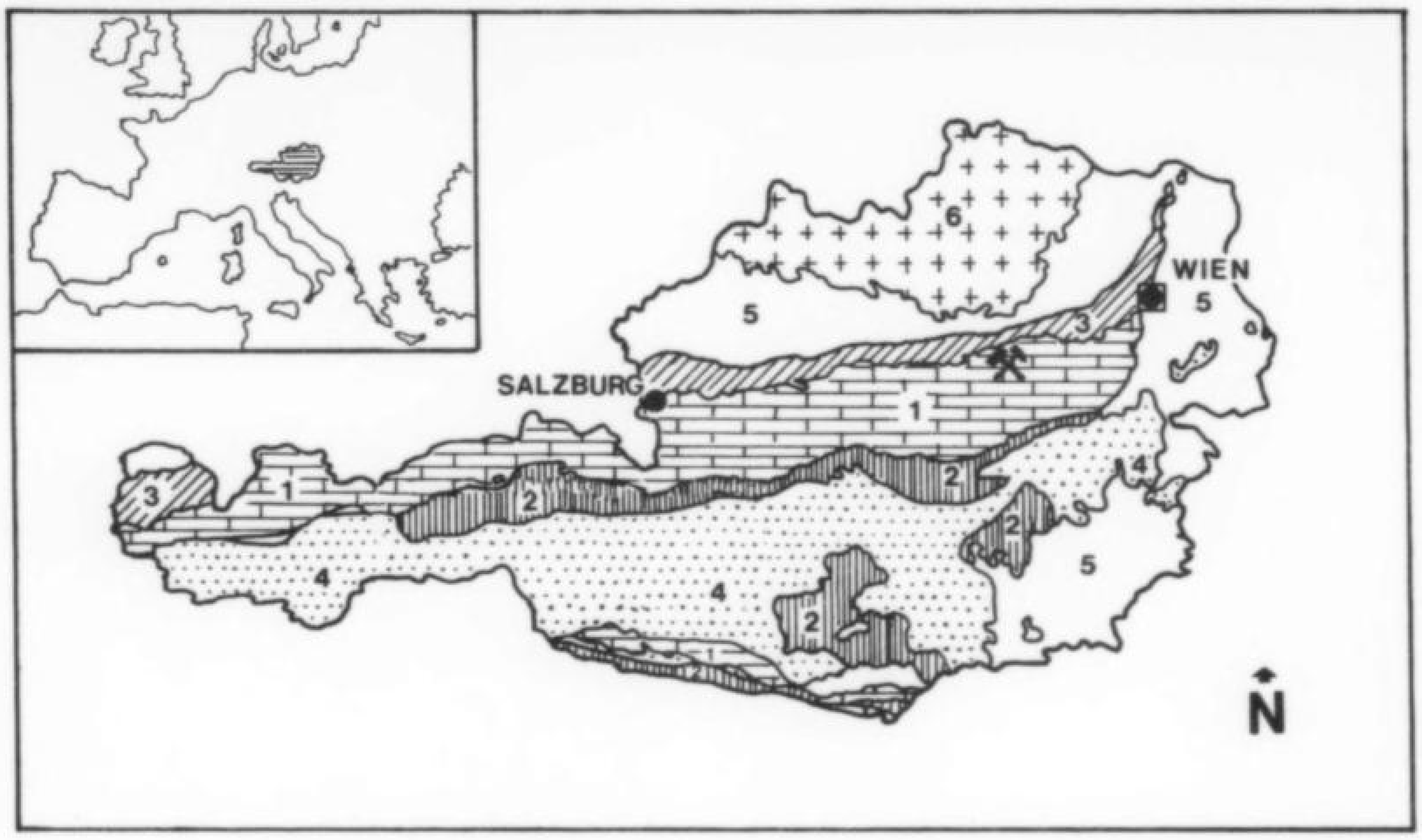

Figure 6. General geologyof Austria.

1. Northern and southern Mesozoic limestone. (Annaberg district indicated ⚒)
2. Early Paleozoic metamorphic series (gray-wackes, limestone, phyllites).
3. Tertiary elveticum and flysch (limestone, sandstones, conglomerates).
4. Metamorphic rocks of the Central Alpine body (schists, amphibolites, gneiss).
5. Neogene sedimentary rocks.
6. The Early Paleozoic-Proterozoic Bohemian Massif (granites, gneisses, schists, amphibolites, granulites).

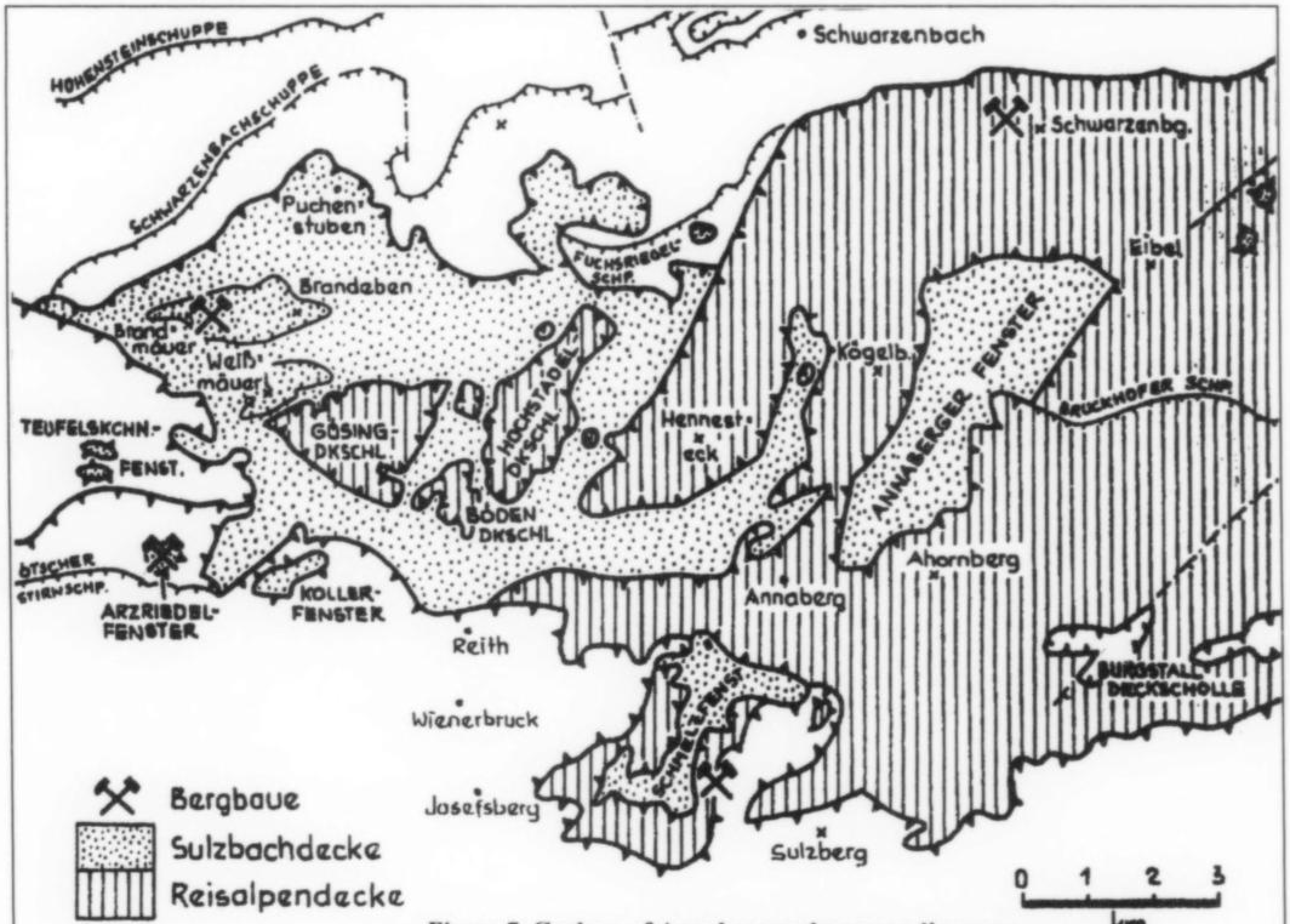

Figure 7. Geology of Annaberg and surrounding area.

specially minted *Ausbeutetaler* ("profit dollars") were coined, and another was issued in 1765. About 20 years ago a modern commemorative edition of this coin was minted of pure silver (the originals were high in sulfur and copper).

In 1756 the Royal Imperial Administrator of Mines, Matthias Zipser, was dispatched to Annaberg to study the mines, since the end of their productive life was in sight. They were finally declared exhausted in 1767, after having yielded over 5,600 kg (12,000 pounds) of silver. A staff of 20 miners continued gleaning operations until 1780.

In order to smelt the Annaberg ores locally, a smelter had been constructed in 1760 at the bottom of the valley. Up to that time, ore had been shipped to Zarnovice (then in Hungary) for processing. A steeply increasing zinc content in the ore resulted in the construction of a brass foundry in 1765. (The copper necessary to make brass was brought in mainly from Hungary.)

Because lead was required for the refining of silver, and had to be brought in from Carinthia at a high price, Johann Burger's widow opened a small lead mining operation on an occurrence near the Galmeikogel shaft; she named it the Sankt Joannis von Nepomuceni mine.*

The output of silver and lead from the Annaberg district was remarkable, considering that most of the mines were in operation

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*Editor's Note: St. John of Nepomuc (ca. 1350–1393), canon of the cathedral of Prague and vicar of the archdiocese, was tortured and drowned in the Moldau River for opposing the tyranny of King Wenceslaus IV. He was canonized in 1729.

for only 15 years. Most noteworthy mineralogically, however, was the discovery in the lead workings of a yellow mineral that would ultimately be given the name wulfenite.

GEOLOGY

Roughly 70% of Austria is within the Alps, and 30% is forelands and extra-Alpine Basement (Bohemian Massif). Many hundreds of metallic and non-metallic mineral deposits have been mined in Austria; as of 1986, 65 mines (including coal) were still in operation, of which six were exploiting metalliferous orebodies. Most of the country's mineral production has come from the Eastern Alps, including Lower Austria (Niederösterreich).

The Eastern Alps extend for about 500 km east-west, forming an elongated zone of mountain ranges. They are built of allochthonous sheets, many extending for hundreds of kilometers but typically being only a few kilometers thick. The mountain-building Alpine Orogeny peaked in Cretaceous-Tertiary time, but frontal movement of the Calcareous Alps continued into the Miocene, resulting in a complex tectonic structure. The Eastern Alps are divided into a Northern Zone and a Central Zone, the former being the location of the Annaberg district. The Central Zone consists primarily of an igneous/metamorphic basement overlain by Paleozoic, Triassic, Jurassic and Lower Cretaceous strata. The Northern Zone contains mainly sedimentary rocks of Permo-Triassic to Eocene age with Paleozoic metasediments and volcanics.

The Northern Zone is further subdivided into (1) the Flysch and Helvetic Zones, (2) the northern Calcareous Alps, and (3) the Grauwacken Zone. Annaberg is situated in the middle of the Northern Calcareous Alps; about 60 lead-zinc occurrences are known in the Northern Calcareous Alps, and many small mines exist, though none is still in operation. Most are concentrated in the far western section of the belt, but Annaberg is situated in the east, along with several other lead-zinc deposits (including Schwarzenberg near Türnitz, Brandmäuer near Puchenstuben, and Kohlanger near Frein). The Annaberg mines and the small Arzriedel mine near Trübenbach/Ötscher lie within Anisian (lower Middle Triassic) carbonates whereas the other occurrences are in the Ladinian (upper Middle Triassic) Wetterstein Limestone-Dolomite.

The following pre-Alpine units are found in the Annaberg area: At the bottom of the sequence is the Sulzbach unit, which has been uplifted by an anticline so as to be exposed in a tectonic structure called the Schmelz Window. Above this is the Reisalpen unit, forming the northern and northeastern boundary of the Schmelz Window. Highest in the local sequence is the Unterberg unit, which has been thrust over the others from the south, forming the rest of the border of the Schmelz Window.

The mines around Hocheck Peak (Sankt Anna mine, Sankt Joachims mine) are situated in the Anisic Annaberger and Gutensteiner limestones, passing into the Wetterstein dolomite of the Sulzbach unit. The deposits in the vicinity of the Galmeikogel shaft (including the Sankt Joannis von Nepomuceni mine) lie within the Gutensteiner Limestone of the Unterberg unit, and to a very small extent within the Wetterstein dolomite of the Reisalpen unit.

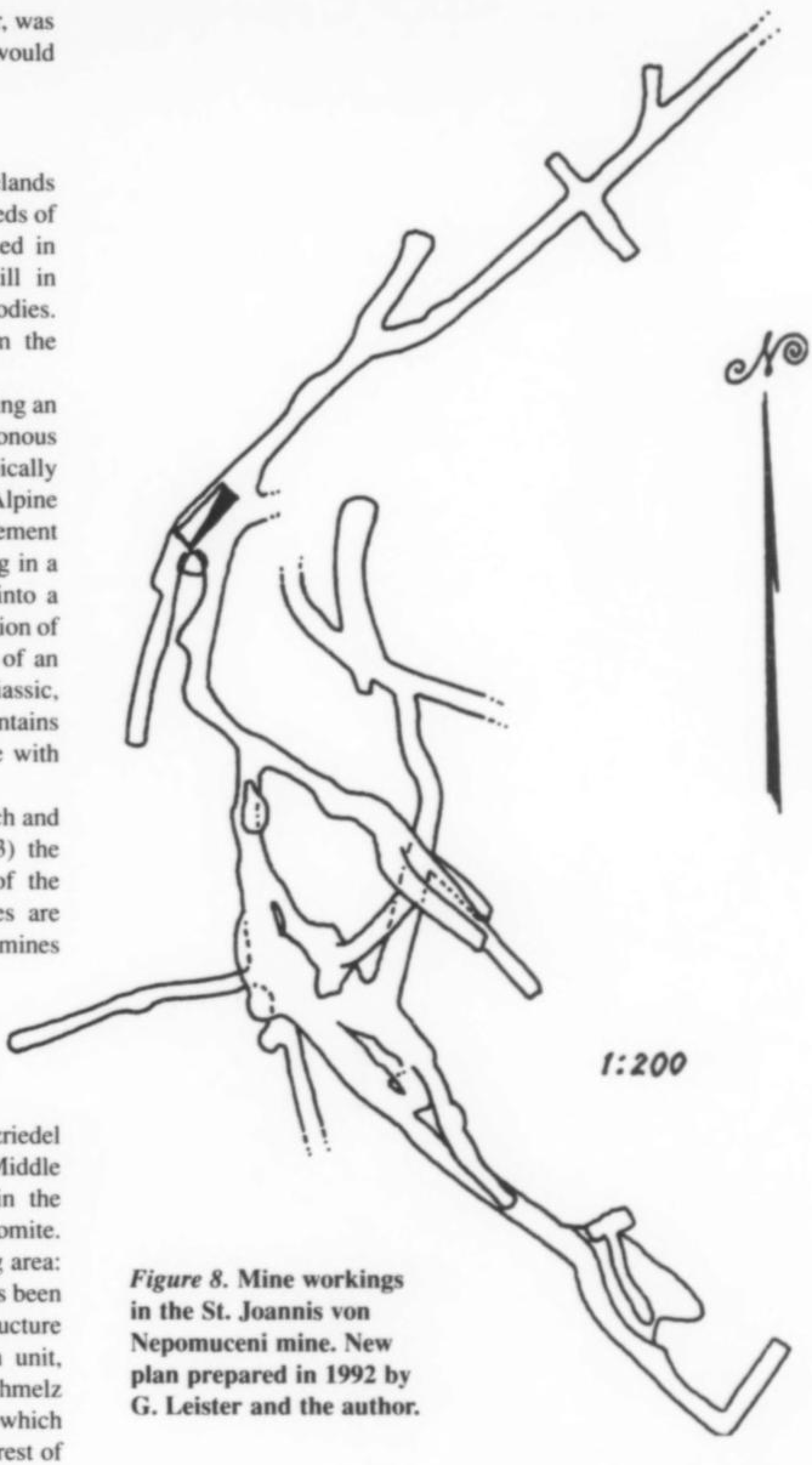

***Figure 8.* Mine workings in the St. Joannis von Nepomuceni mine. New plan prepared in 1992 by G. Leister and the author.**

MINES

The three mineralogically most interesting mines in the Annaberg area are the Sankt Anna, Sankt Joachim, and Sankt Joannis von Nepomuceni. Economically the most important was the Sankt Anna, which began production in 1752. The upper level was named the Theresienstollen ("Theresia Tunnel"); there were also four lower levels and mine entrances, all connected by shafts. The vertical extension of the mine totalled about 95 meters (309 feet). It was well known because of repeated discoveries of very rich silver-bearing pockets. Unfortunately, all but the Theresienstollen is inaccessible today due to the collapse of tunnels, entrances and stopes. Stütz (1807), however, gives the following description of the workings:

> We descended into the mine through the third level and went to a depth of about 40 meters. After we had examined the wooden roof-supports, the boreholes, the extraction of ore, the haulage facilities, the wooden ore cars, the disposal of the waste rock, and the poverty of the stope, we ascended through the second level, about 80 meters above the third level. We met only four miners in the workings, who were barely earning a living. What you find is gray limestone with a very few inclusions of silver ore, a brown ocherous rock type that contains some lead ore, and a liver-brown, soft, clayey schist which is very unlikely to be silver-bearing. Some ore could be found on the dump, especially by looking for blue and green spotted rocks; but it is very poor.

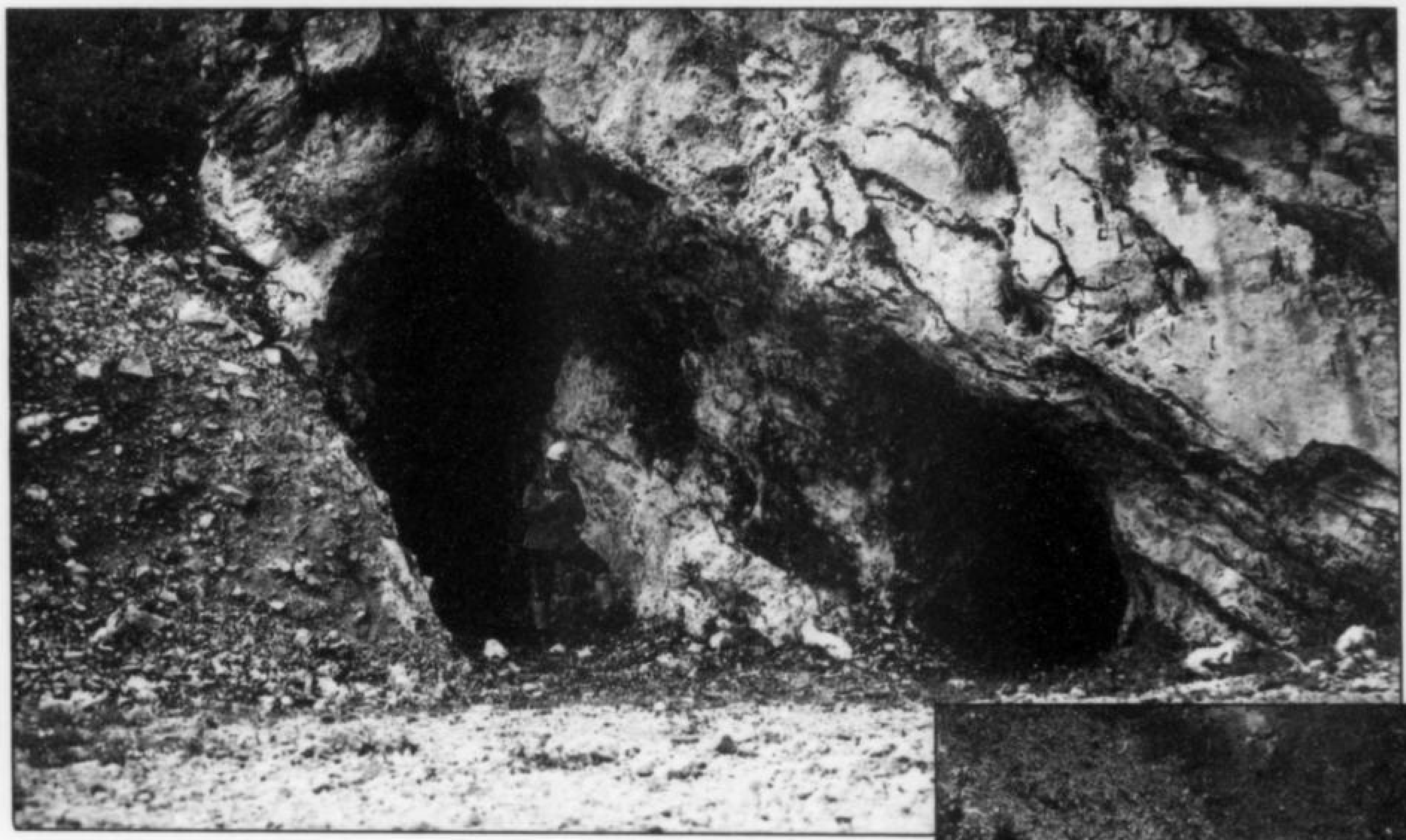

Figure 9. **Dumps of the Sankt Anna mine on Hocheck Peak. Photo by Gerald Knobloch.**

Figure 10. **First-level entrances to the Sankt Anna mine, Hocheck Peak. Photo by Gerald Knobloch.**

Figure 11. **Current entrance to the workings of the Sankt Joannis von Nepomuceni mine, type locality for wulfenite. Photo by Gerald Knobloch.**

On the hillside opposite Hocheck Peak is the Sankt Joachims mine, opened in 1753, which produced some silver and lead-zinc ore. The workings are still accessible through one entrance. However, further descent into the old workings is highly inadvisable because of extremely dangerous conditions, especially around the old ore chutes.

The third important lead-zinc mine in the Annaberg area is the Sankt Joannis von Nepomuceni mine (hereinafter referred to simply as the Nepomuceni mine), located near the Galmeikogel shaft, several hundred meters from Hocheck Peak. It was opened in 1765.

A few years ago I succeeded in entering this mine and descended into the old workings. A close examination and survey was made (see mine map), and a number of wulfenite crystals were found.

Several other small prospects exist in the Galmeikogel area, but they are of negligible importance.

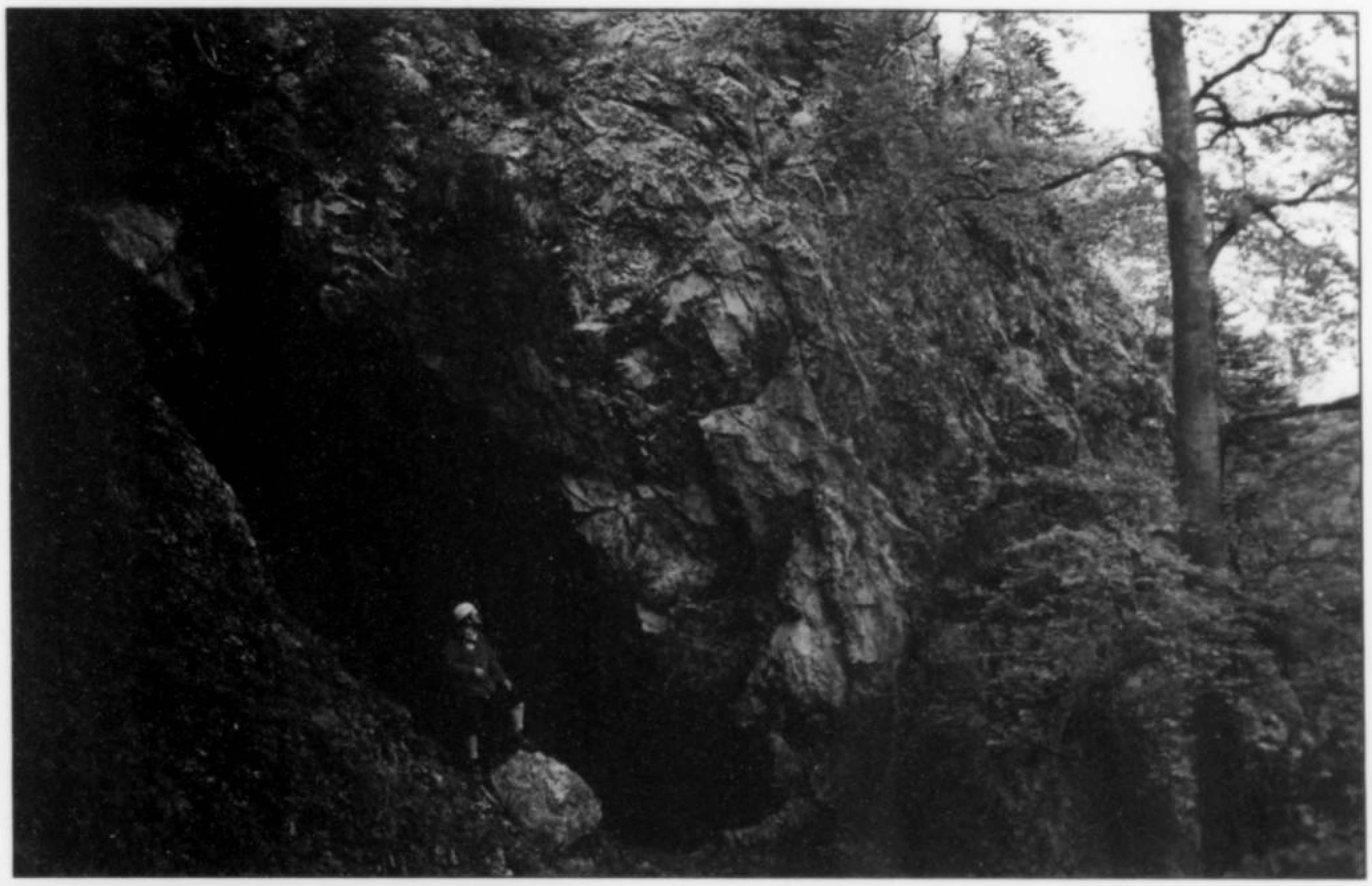

Figure 12. The so-called "St. Caroli" shaft of the Sankt Anna mine, Hocheck Peak. Photo by Gerald Knobloch.

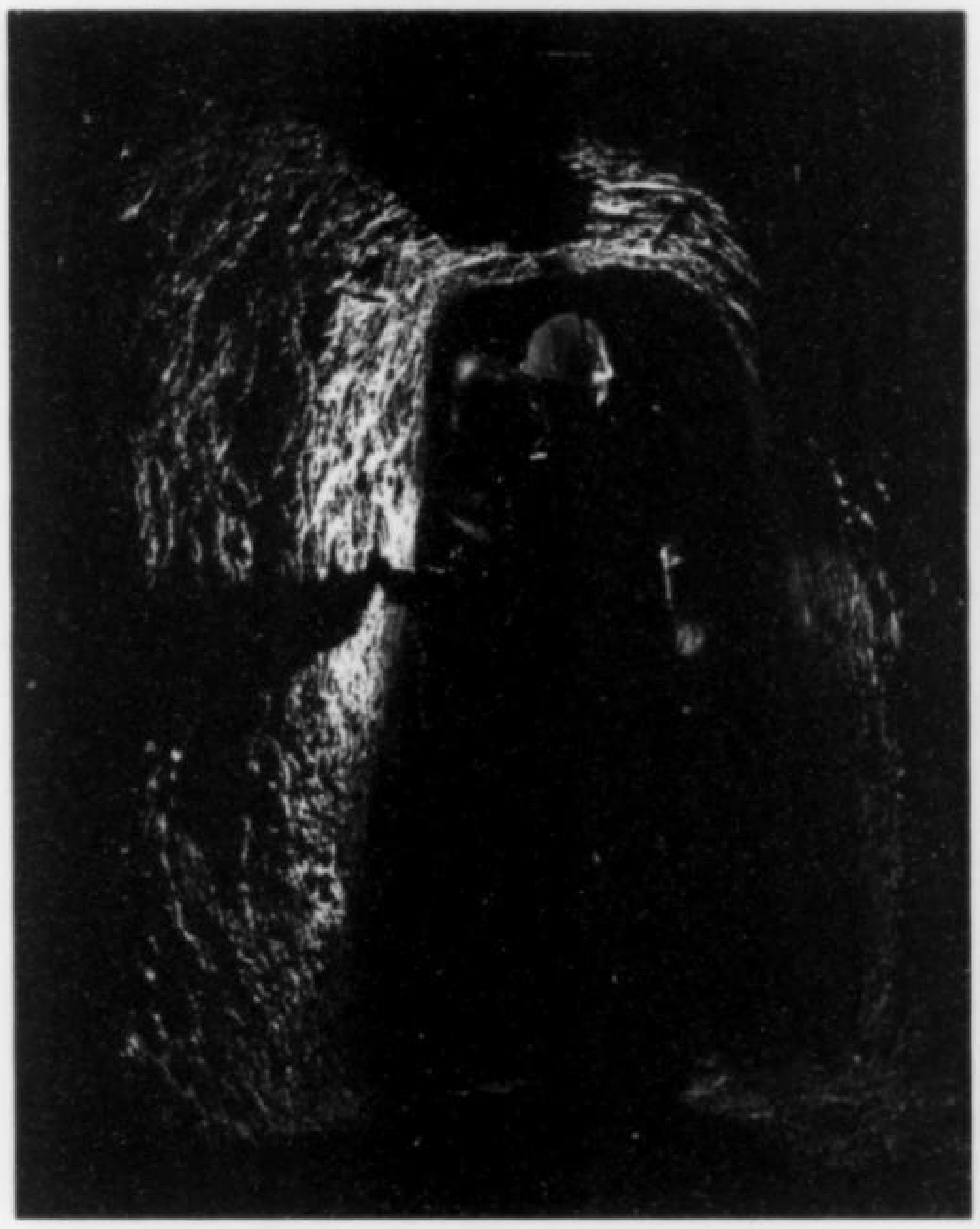

Figure 13. Descloizite occurrence along a drift in the Sankt Joannis von Nepomuceni mine. Photo by Gerald Knobloch.

Figure 14. Stope in the Sankt Joannis von Nepomuceni mine where wulfenite has recently been found. Photo by Gerald Knobloch.

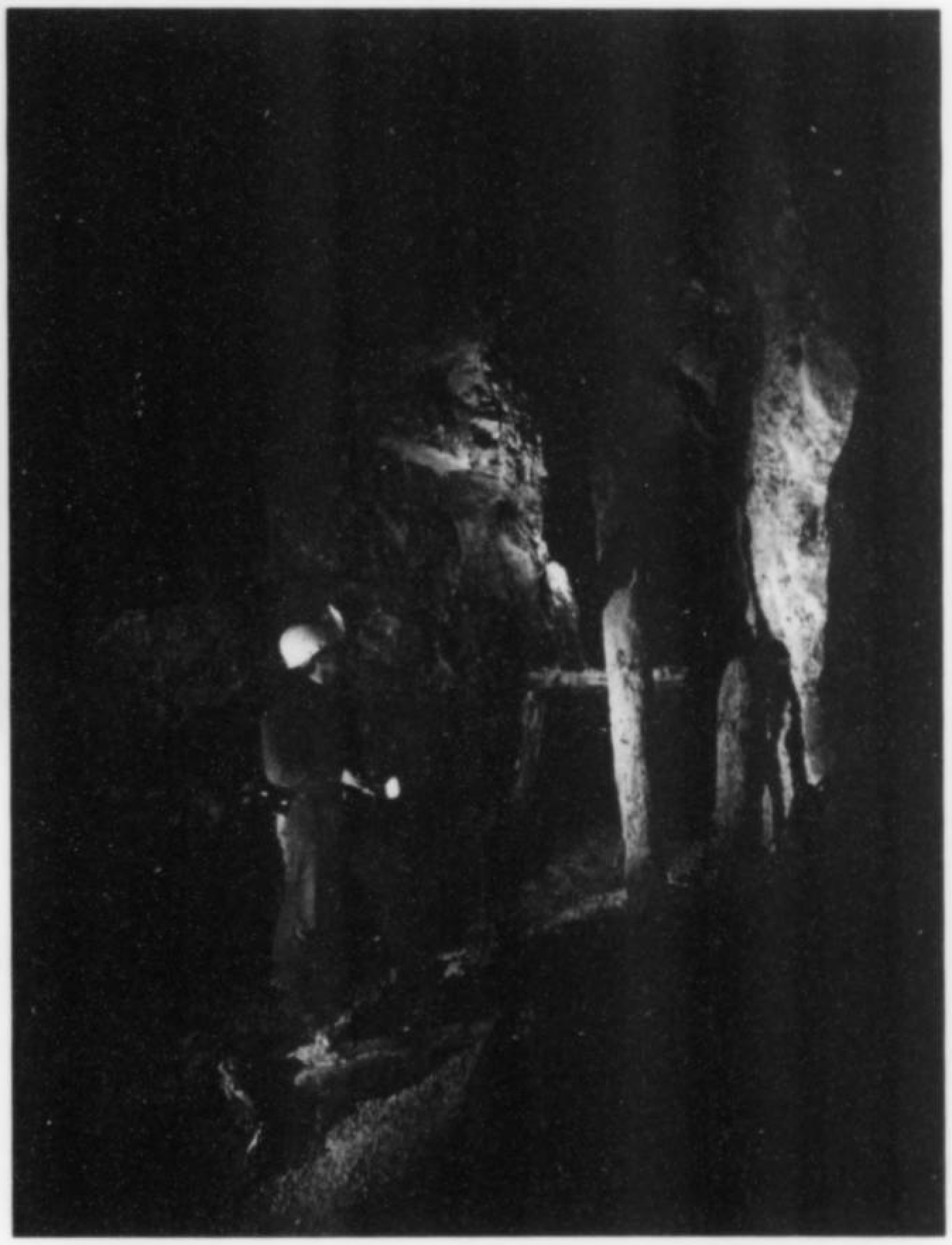

Table 1. **Minerals identified from the Annaberg district.**

Mineral	*Composition*	*Rarity*
Elements		
Silver	Ag	very rare
Copper	Cu	very rare
Sulfides		
Acanthite	Ag_2S	uncommon
Proustite	Ag_3AsS_3	very rare
Galena	PbS	common
Sphalerite	(Zn,Fe)S	uncommon
Pyrite	FeS_2	uncommon
Pearceite	$Ag_{16}As_2S_{11}$	rare
"Fahlerz"		rare
Halides		
Chlorargyrite	AgCl	very rare
Fluorite	CaF_2	uncommon
Oxides		
Cuprite	Cu_2O	very rare
Zincite (artif.)	(Zn,Mn)O	common
Limonite	FeO(OH)	common
Carbonates		
Calcite	$CaCO_3$	common
Cerussite	$PbCO_3$	common
Smithsonite	$ZnCO_3$	uncommon
Dolomite	$CaMg(CO_3)_2$	common
Hydrozincite	$Zn_5(CO_3)_2(OH)_6$	common
Malachite	$Cu_2(CO_3)(OH)_2$	common
Azurite	$Cu_3(CO_3)_2(OH)_2$	uncommon
Aurichalcite	$(Zn,Cu)_5(CO_3)_2(OH)_6$	uncommon
Strontianite	$SrCO_3$	uncommon
Sulfates		
Gypsum	$CaSO_4 \cdot 2H_2O$	common
Wulfenite	$PbMoO_4$	rare
Phosphates		
Adamite	$Zn_2(AsO_4)(OH)$	very rare
Heyite-like min.	$Pb_5Fe_2(VO_4)2O_4$	rare
Vanadinite	$Pb_5(VO_4)_3Cl$	common
Descloizite	$PbZn(CO_4)(OH)$	common
Mimetite	$Pb_5(AsO_4)_3Cl$	rare
Silicates		
Hemimorphite	$Zn_4Si_2O_7(OH)_2 \cdot H_2O$	very rare

MINERALS

Silver Assemblage

Rich ore samples from the Annaberg mines have been preserved in various historical collections, including those at the Lilienfeld Abbey, the Seitenstetten Abbey, the Joanneum in Graz, and the Museum of Natural History in Vienna. They carry the old mineral names, such as *Glaserz, Rothgültigerz, Sprödglaserz, Silberschwärze,* and *Silberhornerz.* Most specimens appear to consist primarily of acanthite and native silver with small specks of proustite. The complex assemblage, currently under study at the Joanneum, includes pearceite, tiny green spherules of chlorargyrite, and tetrahedrite-tennantite.

Adamite $Zn_2(AsO_4)(OH)$

A few specimens containing tiny, citrine-yellow crystals to 0.5 mm were found on the dump of the Sankt Joachim mine at Hocheck Peak. Analysis showed the crystals to be adamite.

Aurichalcite $(Zn,Cu)_5(CO_3)_2(OH)_6$

Greenish to pale blue lumps consisting of a mixture of aurichalcite, malachite and minor azurite were found in a small Cu-Zn zone at the top of the Galmeikogel shaft. Nice, brush-like aurichalcite tufts are rare. Some aurichalcite has also been found in the silver workings.

Cerussite $PbCO_3$

The lead ore consists partially of *Schwarzblei,* a black mixture of galena and cerussite. Sharp crystals of cerussite to 1 cm were found in the Nepomuceni mine.

Descloizite $PbZn(VO_4)(OH)$

Very attractive microcrystals of descloizite have been found in the Nepomuceni mine. The pale brown to deep black crystals always occur singly on a carbonate matrix, and never as crustiform aggregates, as at Carinthia and elsewhere.

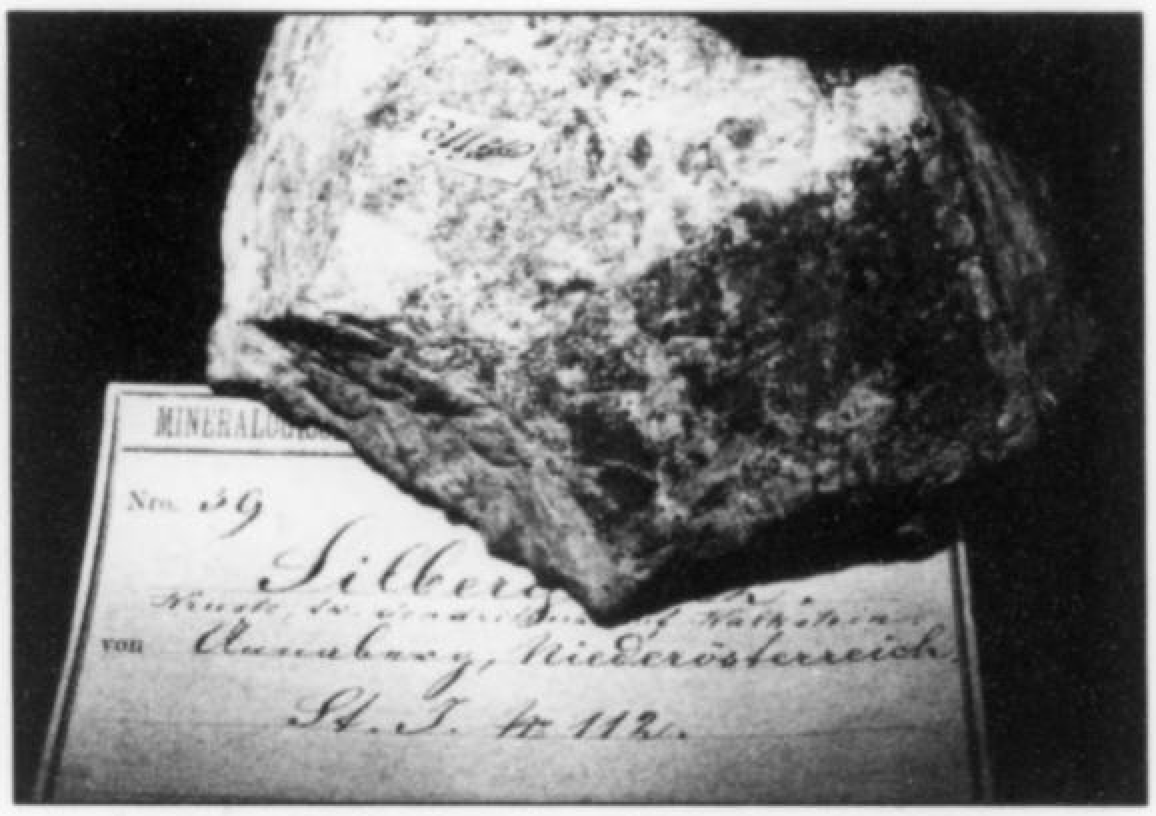

Figure 15. **Old specimen of Annaberg acanthite, 10.7 cm, with old label, from the collection of the Joanneum in Graz. Photo by Peter Huber.**

Heyite $Pb_5Fe_2(VO_4)_2O_4$

A heyite-like mineral at the Nepomuceni mine has been identified by the Styrian Research Institute at the Joanneum in Graz. Analysis shows approximately the same composition but a completely different habit. It occurs as yellow coatings on and replacing wulfenite and vanadinite.

Mimetite $Pb_5(AsO_4)_3Cl$

The construction of a bridge near the village of Schmelz uncovered a highly oxidized zone of mineralization containing the finest crystals of mimetite ever found in Austria. The yellow-green acicular crystals are highly lustrous. Associations include minor cerussite and smithsonite in a carbonate matrix. Specimens of modest quality have also been found in the old silver mines.

Vanadinite $Pb_5(VO_4)_3Cl$

Until a few years ago, only a single specimen of vanadinite from

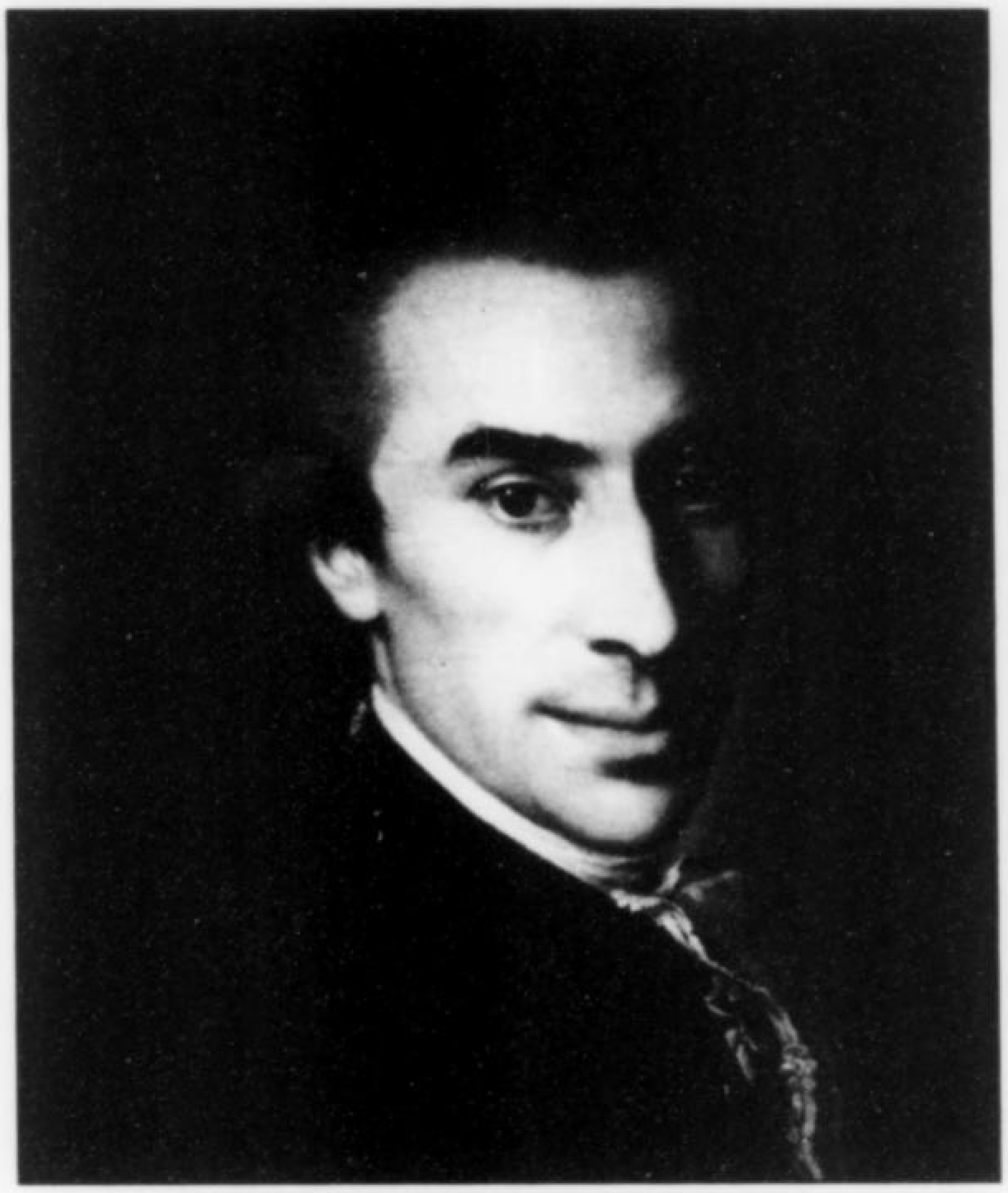

Figure 16. **Portrait of Ignaz von Born (1742–1791), the Hungarian mineralogist who first published a written description of wulfenite.**

90 METALLA PERFECTA.

PLUMBUM.

OCHRA PLUMBI, *Cronſt.* §. 185. alba, efferveſcens, *e Rautenkranz ad Johanngeorgenſtadt Sax.*
- - flaveſcens, efferveſcens, *ex Latgill Dale in Derbyſhire Angliæ.*
- - flava efferveſcens, *ibid.*
- - vireſcens nec efferveſcens, *ibid.*
- - cæruleſcens, *e Leadhill Scotiæ.*
- - fuſca, *ad Saska Bannat Temeſ.*

PLUMBUM SPATOSUM calciforme induratum opacum album, amorphum, *e Przibram Boh.*
- - hyalinum, *e Windiſchleiten ad Schemniz Hung. inf.*
- - - *e Villach Carinthiæ.*
- - - *ad Zellerfeld Hercyniæ.*
- - - *e territorio Sulzbach. Palatinat. ſuper.*
- - - *e Platomine ad Winſter in Derbyſhire Angliæ.*
- - vireſcens opacum, *e Lorenz Gegentrum ad Freyberg Sax.*
- - vireſcens ſtillatitium, *ad Freyburg Auſt. anter.*
- - - *ad Przibram Boh.*
- - cæruleſcens opacum, *e Platomine ad Winſter in Derbyſhire Angliæ.*
- - cæruleſcens hyalinum, *e Windiſchleiten ad Schemniz Hung. inf.*
- - cæruleum opacum, *ibid.*
- - flaveſcens efferveſcens, *Carinthiæ.*
- - flavo rubrum pellucidum, *ex Annaberg Auſt.*
- - cinereſcens, *e fodina Trinitatis ad Tſchopau Sax.*
- - nigreſcens, *ibid.*
- - nigrum, *e Windiſchleiten ad Schemniz Hung. inf.*

Plumbum

Figure 17. **The page from Ignaz von Born's published collection catalog of 1772 (*Lithophylacium Bornianum*) in which he lists his "lead spar" minerals, including wulfenite (PLUMBUM SPATOSUM flavo rubrum pellucidum *ex Annaberg Aust.*).**

Table 2. **"Lead spar" minerals as noted in Ignaz von Born's 1772 catalog, in Latin, with modern English translations.**

LATIN	*ENGLISH*
PLUMBUM SPATOSUM calciforme induratum opacum album, amorphum, *e Przibram Boh.*	LEAD-SPAR limestonelike hardened opaque white amorphous, from Pribram, Bohemia.
—hyalinum, *e Windischleiten ad Schemniz Hung. inf.*	—transparent, from Windischleiten near Schemnitz, Lower Hungary.
——*e Villach Carinthiae.*	——from Villach, Carinthia.
——*ad Zellerfeld Hercyniae.*	——from Zellerfeld, Harz.
——*e territorio Sulzbach. Palatinat. Super.*	——from the territory of the former manor of Sulzbach.
——*e Platomine ad Winster in Derbyshire Angliae.*	——from the Platomine near Winster in Derbyshire, England.
—virescens opacum, *e Lorenz Gegentrum ad Freyberg Sax.*	—greenish, opaque from Lorenz Gegentrum near Freiberg, Saxony.
—virescens stillatitium, *ad Freyburg Aust. anter. ad Przibram Boh.*	—greenish, drop-shaped, from Freiberg, Upper Austria, from Pribram, Bohemia.
—caerulescens opacum, *e Platomine ad Winster in Derbyshire Angliae.*	—bluish, opaque, from the Platomine near Winster in Derbyshire, England.
—caerulescens hyalinum, *e Windischleiten ad Schemniz Hung. inf.*	—bluish transparent, from Windischleiten near Schemnitz, Lower Hungary.
—caeruleum opacum, *ibid.*	—blue opaque, same location.
—flavescens effervescens, *Carinthiae.*	—yellowish effervescent, from Carinthia.
—flavo rubrum pellucidum, *ex Annaberg Aust.*	—yellow red transparent, from Annaberg, Austria.
—cinerescens, *e fodina Trinitatis ad Tschopau Sax.*	—ash-colored, from the Trinitatis-mine near Tschopau, Saxony.
—nigrescens, *ibid.*	—blackish, same location.
—nigrum, *e Windischleiten ad Schemniz Hung. inf.*	—black, from Windischleiten near Schemnitz, Lower Hungary.

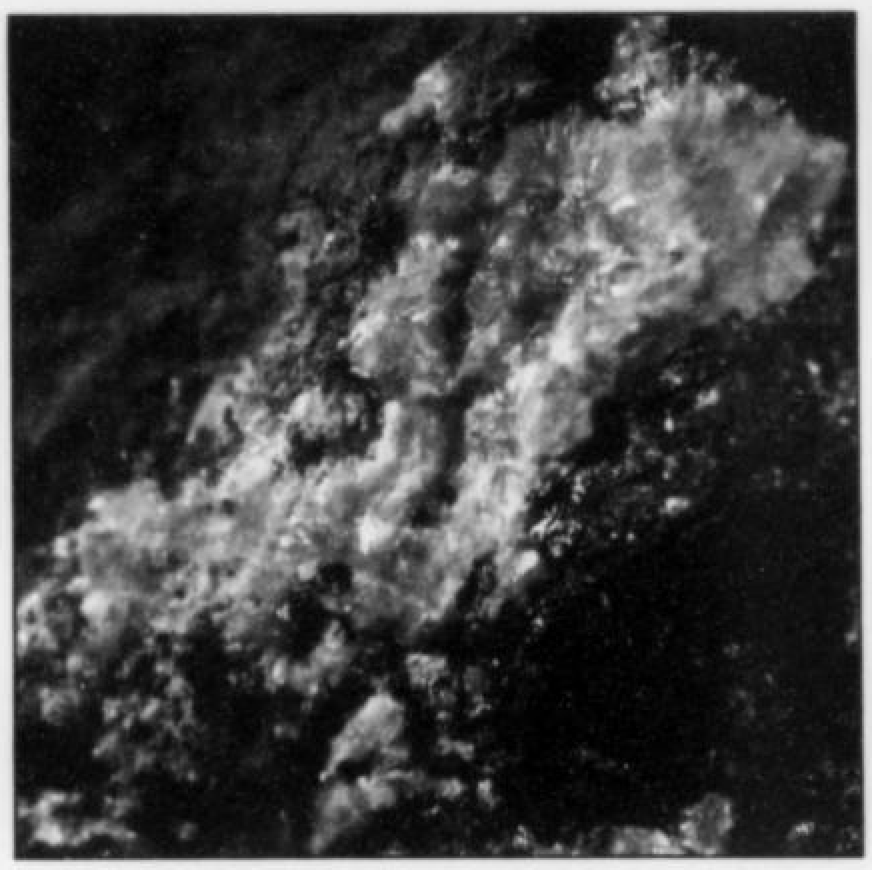

Figure 18. **Aurichalcite, about 1.5 cm across, from the Galmeikogel Zn-Cu prospect. Collection and photo: Gerald Knobloch.**

Figure 19. **Cerussite crystal, 2 mm, from the Sankt Joannis von Nepomuceni mine. Collection and photo: Gerald Knobloch.**

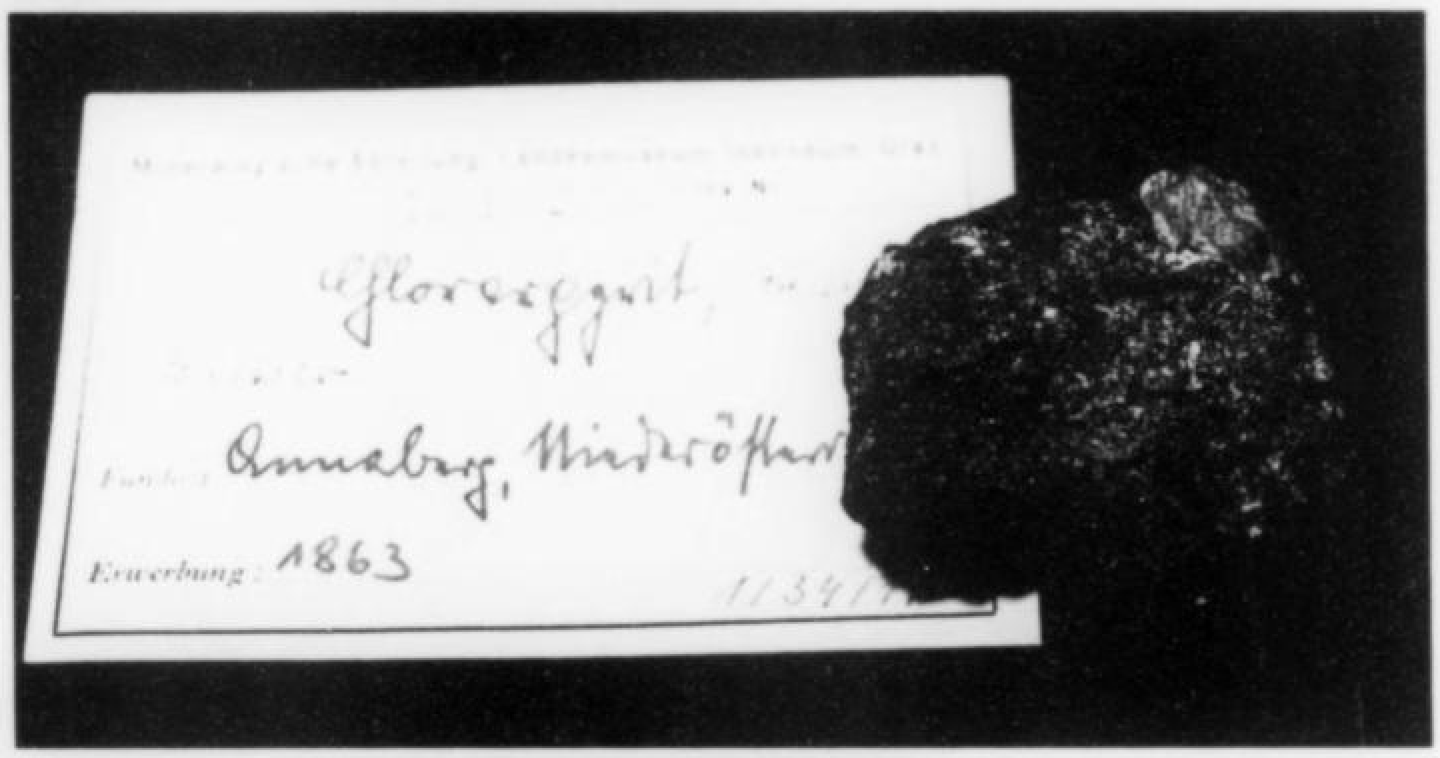

Figure 20. **Old chlorargyrite specimen, 5 cm, from Annaberg, acquired by the Joanneum in 1863. Photo by Peter Huber.**

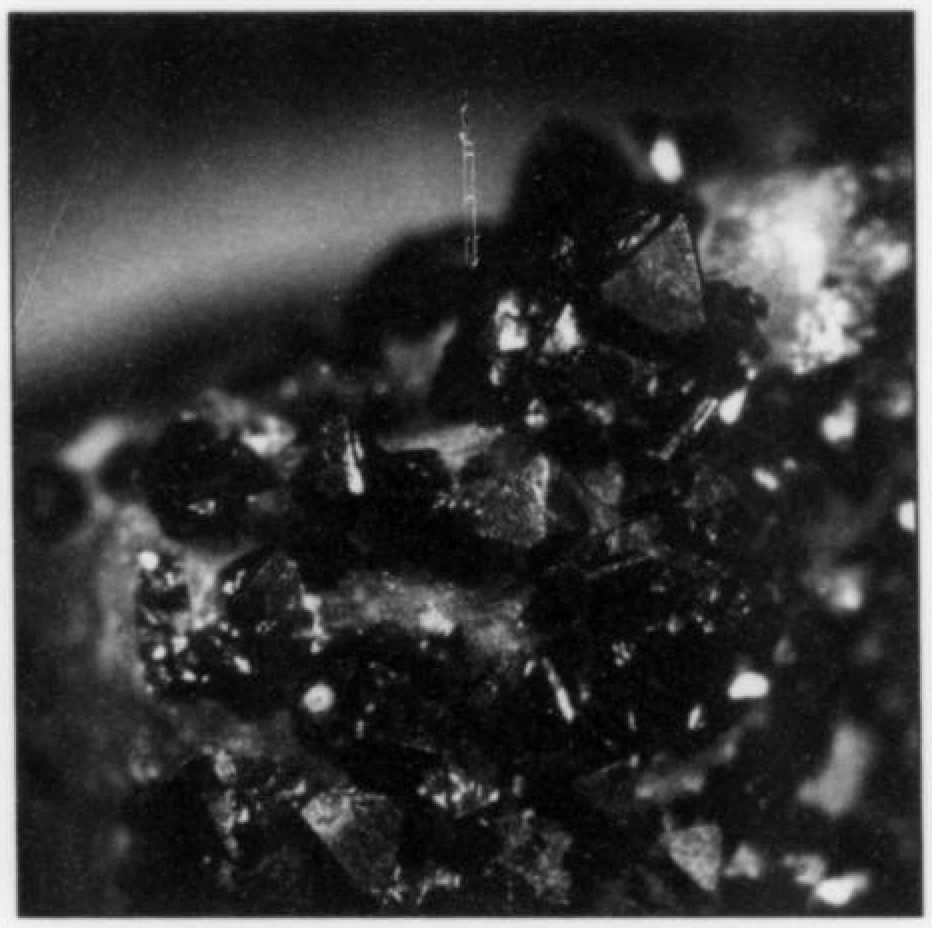

Figure 21. **Descloizite crystals to 1 mm from the Sankt Joannis von Nepomuceni mine; collected recently. Collection of Christian Auer; photo by Gerald Knobloch.**

Figure 22. **Heyite-like mineral druse, about 5 mm across, on matrix and on vanadinite crystals, from the Sankt Joannis von Nepomuceni mine. Collection of Christian Auer; photo by Gerald Knobloch.**

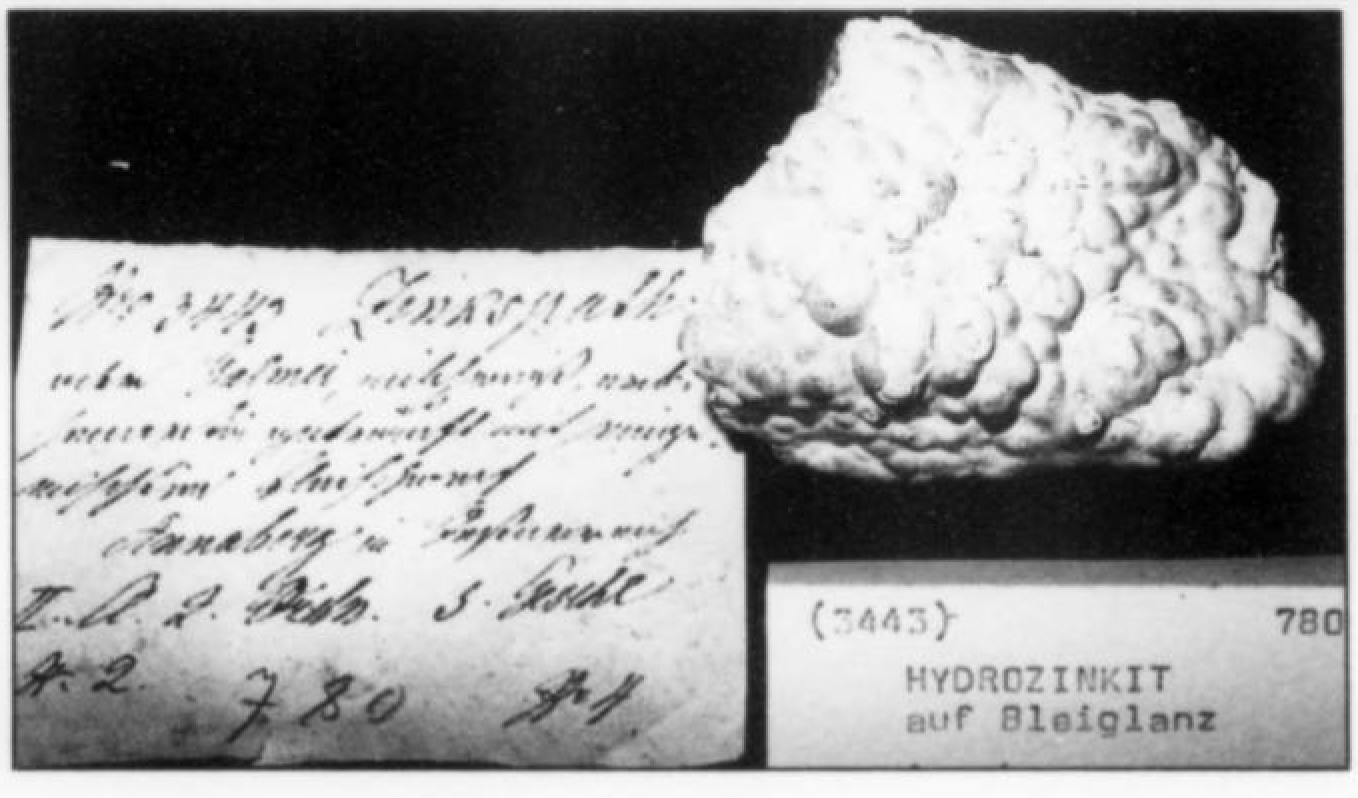

Figure 23. **Old specimen of botryoidal hydrozincite, 8 cm, from Annaberg. Collection of the Lilienfeld Abbey; photo by Peter Huber.**

Figure 24. **Vanadinite crystals to 3 mm from the Sankt Joannis von Nepomuceni mine. Collection and photo: Gerald Knobloch.**

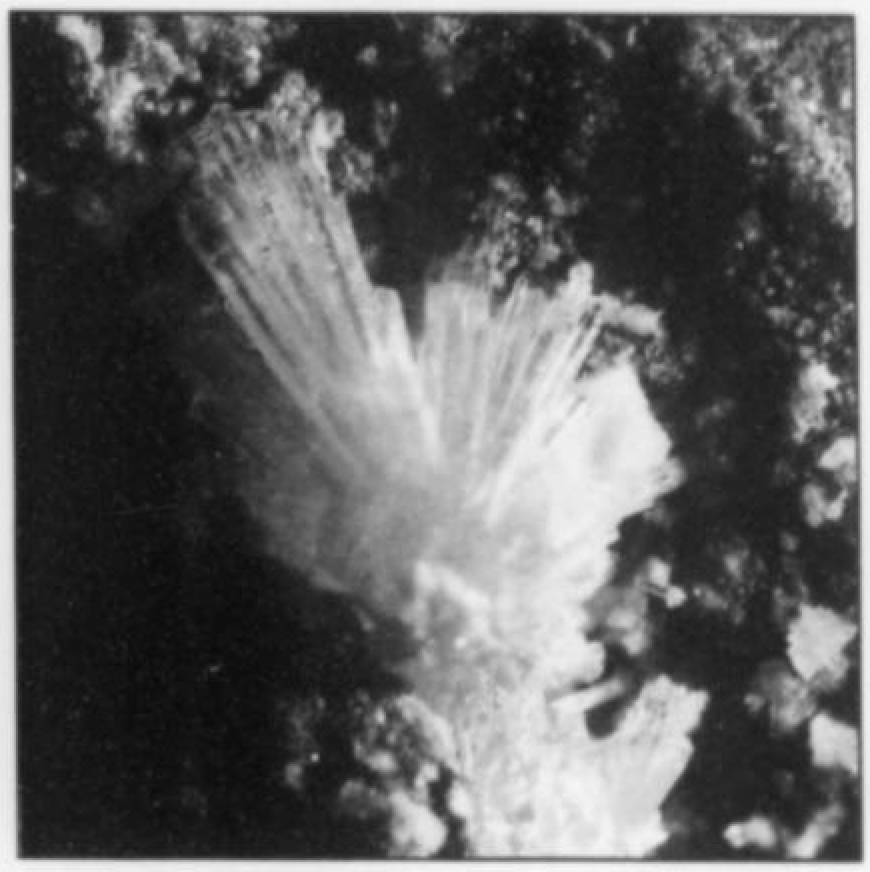

Figure 25. **Mimetite crystal cluster, with crystals to 3 mm, from the Schmelz area. Collection and photo: Gerald Knobloch.**

K.K.Mineralien-Kabinett.

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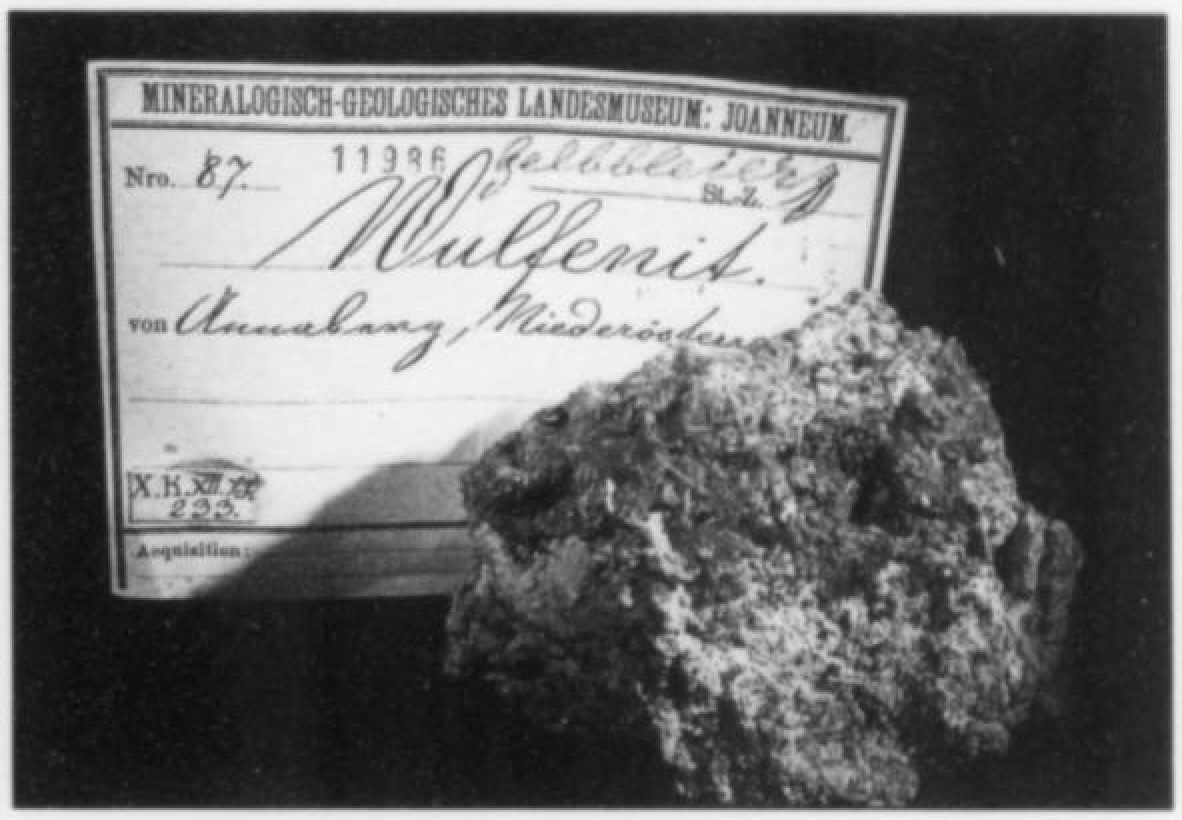
Figure 26. **Old wulfenite specimens, to about 1 cm, from Annaberg, now in the Natural History Museum, Vienna. Photo by Peter Huber.**



MINERALOGISCH-GEOLOGISCHES LANDESMUSEUM: JOANNEUM.

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Wulfenit.

von Annaberg, Niederösterr

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Figure 27. **Old wulfenite specimen, 8 cm, from Annaberg, now in the collection of the Joanneum, Graz. Photo by Peter Huber.**

Figure 28. **Wulfenite crystal, 7 mm, collected recently at the Sankt Joannis von Nepomuceni mine. Christian Auer collection; photo by Gerald Knobloch.**

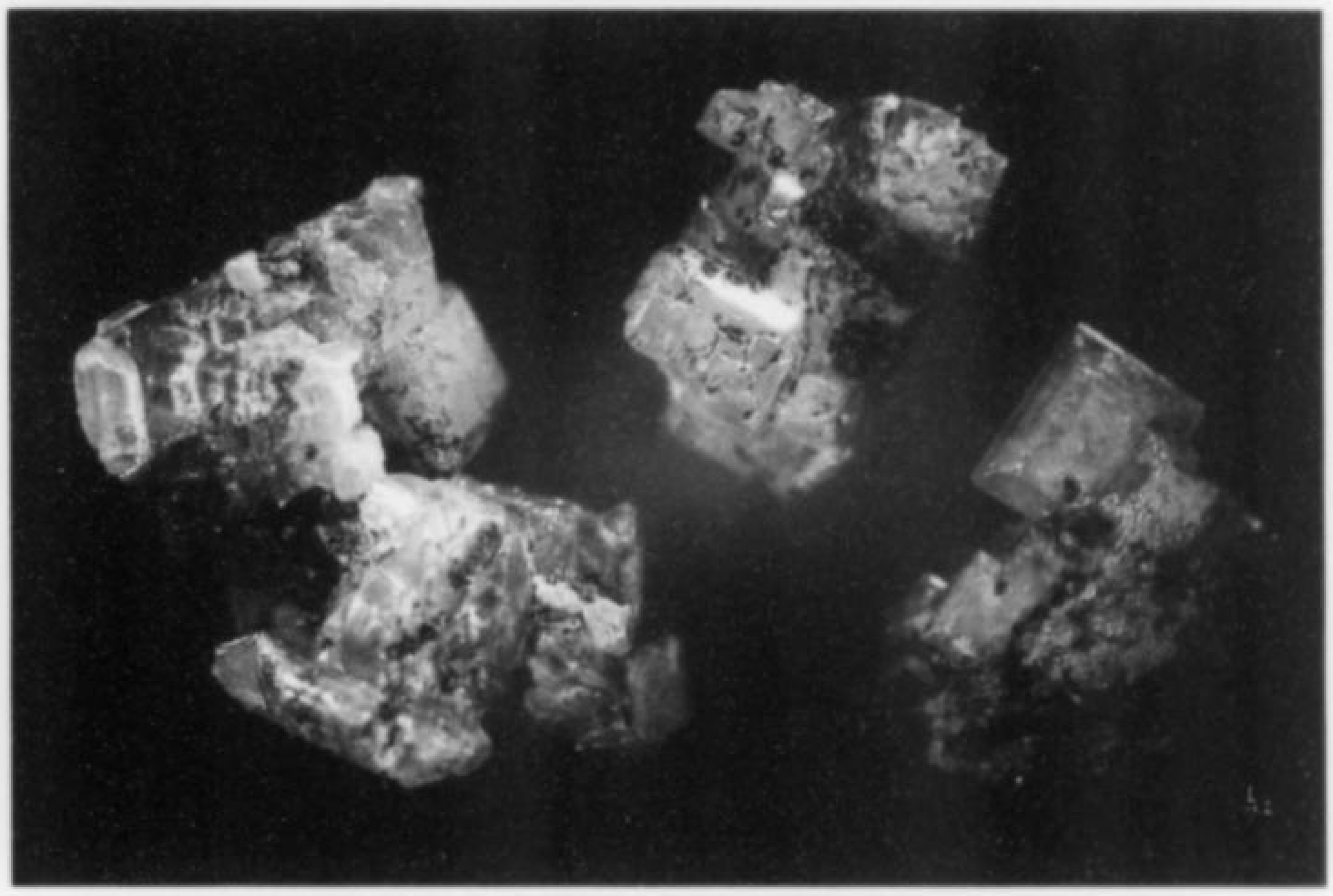

Figure 29. **Wulfenite crystal clusters, to about 1 cm, collected recently at the Sankt Joannis von Nepomuceni mine. Collection of Christian Auer; photo by Gerald Knobloch.**

Lower Austria was known to exist. It was described by Sigmund (1904):

> Vanadinite, of which a nice specimen was found 12 years ago on the eastern slope of the Gsenger by Mr. Haberfelner of Lunz . . . whose collection still contains the sample of this rare mineral species, has only this once ever been reported to occur in Lower Austria. I have seen the specimen and offer a short description: It occurs as brown, hexagonal, columnar crystals up to 2 mm in length, covering an area of about 30 square centimeters on dolomite.

I have confirmed this historical description through recent discoveries of more vanadinite in the stopes of the Nepomuceni mine. The new specimens feature pale orange to dark red crystals, mainly hexagonal prisms, measuring 1 to 3 mm in size.

Wulfenite

The mineral later named wulfenite was known during the productive period of the Nepomuceni mine, and was referred to by mineralogists of the time. The first published description appeared in 1772, in the collection catalog of Ignaz von Born. He listed all of the "lead ochres" and "lead spars" known at the time, which were represented by specimens in his collection. The entry, in Latin, which modern mineralogists ascribe to wulfenite identified the mineral as *"plumbum spatosum flavo rubrum pellucidum, ex Annaberg Aust."* ("lead spar, yellowish red, transparent, from Annaberg, Austria").

Another line in the catalog lists *"plumbum spatosum flavescens effervescens, Carinthiae"* ("lead spar, yellowish, effervescent [in acid], from Carinthia").* Some mineralogists have concluded that this, too, refers to wulfenite, but wulfenite does not effervesce in acid. Most likely it was a yellowish cerussite. The locality designation of "Carinthia" might well have referred to the famous wulfenite occurrence at Bleiberg, but might just as well have applied to other lead mines in the province (e.g. the Hochobir mines, the Mezica mines, or the workings at Jauken or Schwarzenbach among others). Consequently this entry is not sufficiently precise to establish precedence, and probable does not refer to wulfenite anyway.

Ignaz von Born's collection was sold to the British collector Charles Greville, and was subsequently obtained by the British Museum of Natural History (in 1810), where it is still preserved intact along with Born's handwritten catalog. The catalog specifies the locality of the yellowish effervescent lead spar as the town of Villach in Carinthia. Unfortunately, such old specimens have lost their pedigree in the British Museum collection, and the wulfenite cannot now be specifically identified as having been Born's.

The next probable reference to wulfenite from Annaberg is a report by Stütz (1777); writing on the mineral history of Austria, he states:

> The occurrence of the yellow lead spar can be described as follows: It is not mined. Therefore I could not obtain any samples. A few broken lead[spar] crystals were available from Mr. Siegel [the mine surveyor], but I wanted to obtain some crystals on matrix. However, these are very rare even when being mined, because only in care cases does the brittle matrix rock stand the work of the miners without falling apart.

During the following 200 years, wulfenite from Annaberg was described by many other writers, including J. F. Gmelin (1778). In 1845 Wilhelm von Haidinger named the yellow lead spar after the Jesuit naturalist Franz Xavier von Wulfen, in honor of Wulfen's magnificent work describing the lead spars of Carinthia (*Abhandlung vom Kärnthnerischen Bleyspate,* published in Vienna in 1785). Wulfen's wulfenite, however, was from Bleiberg, not Annaberg.

A few years ago, collectors succeeded in recovering some wulfenite specimens from old workings in the Nepomuceni mine. The loose yellow to orange crystals are identical to 18th-century specimens from Annaberg that have been preserved in the collections of the Natural History Museum in Vienna and the Joanneum in Graz.

CONCLUSIONS

The 1772 entry in Born's published catalog (predating Wulfen's 1785 work) is brief, but it specifies correctly (1) the major element—lead, (2) some degree of transparency, (3) color, (4) its spar-like nature, and (5) its specific locality. Aside from a morphological description, there is not much more that could be said in 1772 (molybdenum had not yet been discovered as an element). Furthermore, the specimen on which this description was based probably survives somewhere in the British Museum collection, with the rest of Born's collection. Consequently it must be concluded that Born's 1772 description qualifies as the first scientific description of wulfenite, and that "Annaberg" is the type locality. Field work has further confirmed that the Nepomuceni mine is the actual source of Annaberg wulfenite, and is therefore the correct type locality, rather than Bleiberg.

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*There is some disagreement over the correct translation of *flavescens,* which might instead be read as "begins to become yellowish" while effervescing. Of course, there may simply have been a thin carbonate coating on the sample which could effervesce momentarily. In any case, the word *effervescens* is enough to preclude this mineral from being unambiguously identified as wulfenite.

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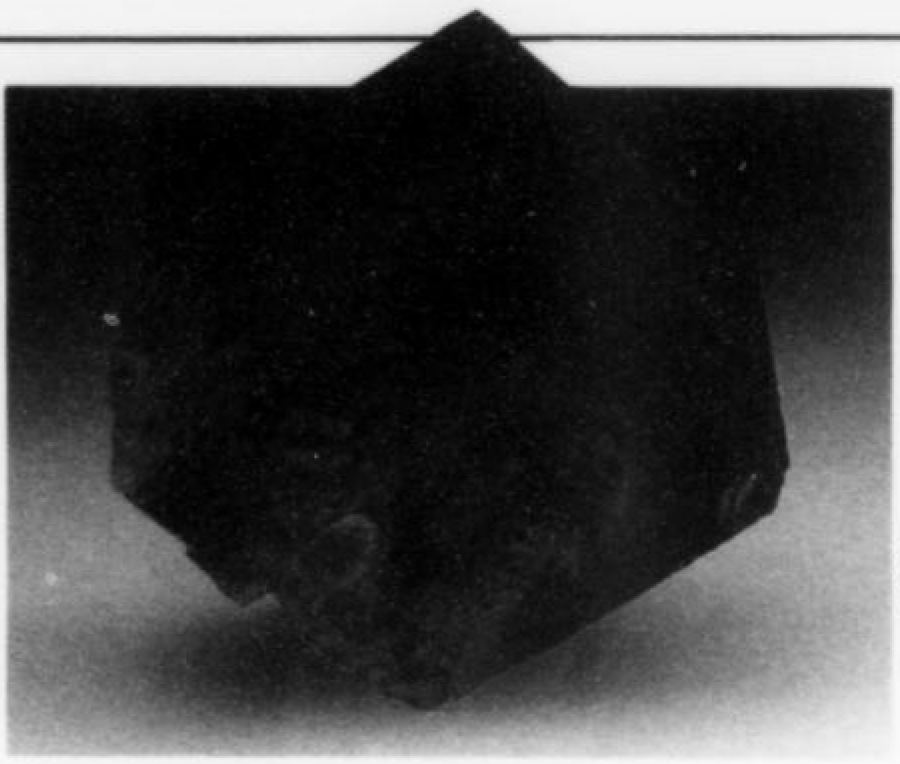
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AZURITE/MALACHITE, BISBEE, 5 INCHES
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Sphalerite–China
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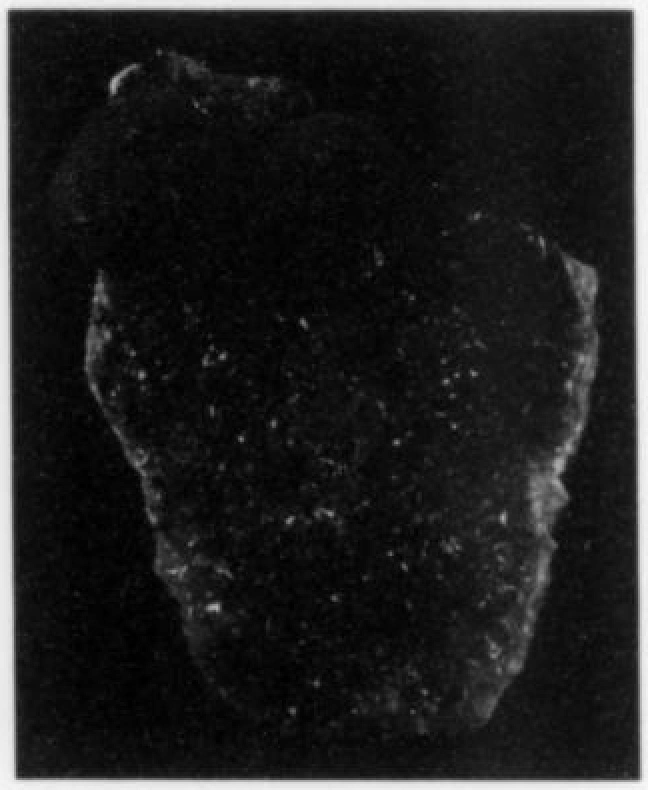

Tanzanite
(zoisite)
Arusha, Tanzania
7.3 cm

photo by Jeff Scovil

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MINERALOGY OF THE BOQUEIRÃOZINHO PEGMATITE

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BRAZIL

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The Boqueirãozinho pegmatite has been a source of collector-quality triploidite and fluorapatite crystals, and represents the first reported occurrence of hessite in a granitic pegmatite.

INTRODUCTION

The occurrence described here was first found by one of us (RRW) in February of 1988 and noted by Robinson and King (1990). The unusually high quality of the triploidite from this locality makes it of special interest to collectors, and the occurrence of hessite in pods of digenite is of scientific interest, since these minerals normally occur in hydrothermal deposits.

The Boqueirãozinho[†] pegmatite (also known as the Capoeira pegmatite) lies approximately 3 km east of the village of Parelhas, in the state of Rio Grande do Norte, and was last operated for feldspar by the Companhia de Desenvolvimento de Recursos Minerais—CDM. The more famous Boqueirãozinho pegmatite (Johnson, 1945; Murdoch, 1958), known as the type locality for "chavesite" (shown to be monetite by Kampf and Dunn, 1994) lies approximately 1 km to the south. Access is by road via Equador and Parelhas, from National Road 230, 101 km west of Campina Grande. From Parelhas, the deposit is reached by taking a dirt road leading north then east from the village. The pegmatite is conspicuously exposed on the north side of a hill south of the road, approximately 3 km east of Parelhas.

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[*] Formerly at Canadian Museum of Nature, Ottawa, Ontario.

[†] Pronounced "Bo-care-ahn-zeen-yo."

Figure 1. **The Boqueirãozinho pegmatite as seen looking southeast from the access road. R. Wegner photo.**

GEOLOGY

The Boqueirãozinho pegmatite forms an elongated, lenticular body that intrudes metaconglomerate. The contacts are sharp, and the metaconglomerate is frequently epidotized, especially along shear planes. The pegmatite strikes east-west and is exposed for a distance of about 200 meters. It attains a maximum width of about 25 meters. There are three symmetrically disposed sets of bands progressing inward from the contacts for about a half meter; each set consists of fine-grained microcline and quartz with garnet plus-or-minus minor black tourmaline. Beyond this point, the pegmatite becomes very coarse-grained, with crystals of perthitic white microcline up to several meters across in its central-most part. Some of the microcline crystals contain small pockets (up to half a meter) hosting crystals of milky quartz, muscovite and bright blue crystals of fluorapatite (Robinson and King, 1990). In addition to microcline, the central portion of the pegmatite also contains abundant aggregates of muscovite-quartz-microcline up to several meters across, though the individual crystals within these aggregates average only 2–5 cm. No massive quartz core has yet been encountered in the pegmatite, but isolated, discontinuous concentrations of quartz up to several meters do occur in its central portion.

Numerous other minerals also have been observed in the central part of the pegmatite. These include isolated, somewhat brecciated pods of phosphate minerals up to a meter across composed predominantly of lithiophilite and albite with lesser amounts of triploidite, triplite and triphylite. Additional minerals present include zircon, gahnite, minor spessartine, hectorite and coronadite, and secondary phosphates fluorapatite, eosphorite and crandallite. One specimen examined contains a pale green, vitreous mineral that may be a member of the alluaudite group, but this is exceedingly rare. To date, the phosphate pods appear to be concentrated in the western end of the pegmatite.

An additional feature of particular interest is the occurrence of isolated masses of digenite in some of the central microcline. These masses vary in size from a few centimeters up to nearly a meter across, and are conspicuously stained green by malachite and chrysocolla which occur abundantly as alteration products. The segregations occur throughout the unaltered central microcline, suggesting they were formed simultaneously, and therefore are part of the late, but main pegmatite paragenesis. Other minerals observed scattered throughout the central part of the pegmatite, but in small amounts, are listed in Table 2.

MINERALOGY

Only those mineral species of collector-quality or scientific interest will be described. The identity of all species has been confirmed by X-ray and/or electron microprobe analyses. Table 1 gives microprobe analyses for the lithiophilite, triploidite, triplite and fluorapatite. These analyses were carried out on a Jeol Superprobe 733 using an accelerating voltage of 15 KV and a beam current of 25 nanoamperes. The electron beam was defocussed to

Table 1. **Microprobe analyses of selected phosphate minerals from the Boqueirãozinho pegmatite.**

	Fluorapatite	*Lithiophilite*	*Triplite*	*Triploidite*
MgO	0.14	1.05	8.62	1.11
MnO	6.08	33.74	42.91	50.52
FeO	0.47	9.16	7.14	11.01
CaO	48.99	0.05	0.84	0.03
Li_2O	nd	9.65*	nd	nd
TiO_2	nd	nd	0.82	nd
P_2O_5	42.05	46.29	34.37	32.80
H_2O	nd	nd	0.92*	4.07*
F	5.35	0.00	7.20	0.00
O = F	−2.25		−3.03	
Sum	100.83	99.94	99.79	99.54

nd = not determined

*calculated by stoichiometry

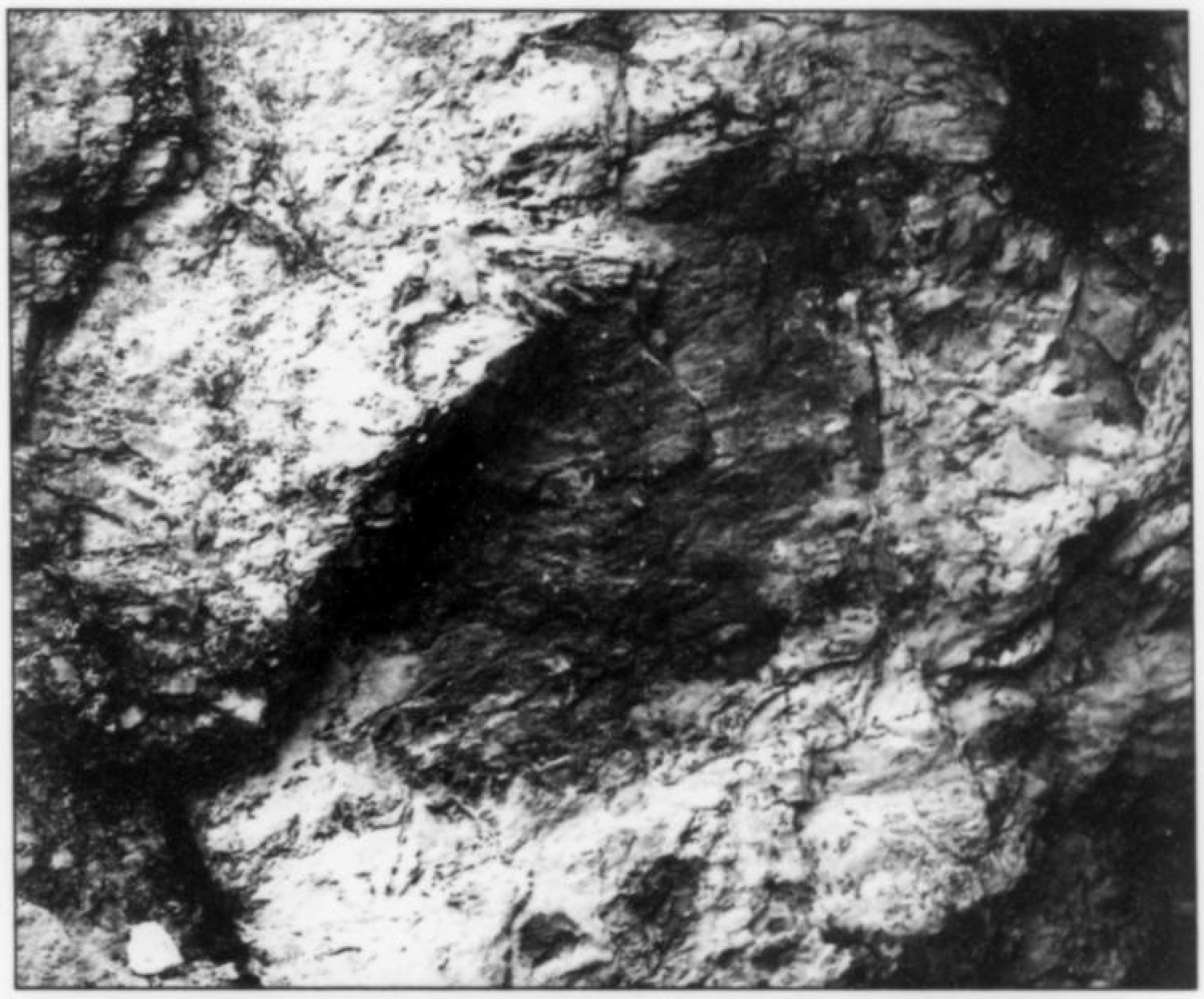

Figure 2. **A typical half-meter phosphate pod *in situ*. R. Wegner photo.**

Figure 3. **A typical 20-cm mass of digenite *in situ*. R. Wegner photo.**

Figure 4. **Triploidite crystals in lithiophilite, 13 x 18 cm. Canadian Museum of Nature specimen, no. 59275; G. Robinson photo.**

Figure 5. **Fluorapatite crystal, 1 cm, on quartz from a pocket in the central microcline zone. Canadian Museum of Nature specimen, no. 81526; G. Robinson photo.**

20 microns to minimize sample decomposition. Standards used were almandine (Mg and Fe), apatite (Ca and P), tephroite (Mn), titanite (Ti) and fluorian riebeckite (F). Total iron is reported as FeO; Li_2O and H_2O are calculated stoichiometrically.

Digenite Cu_9S_5

Digenite occurs in masses approaching a meter across in the central perthitic microcline. Microscopic examination of polished sections shows the digenite is commonly replaced by covellite at its outer margins, which helps explain the blue appearance of some hand specimens.

Fluorapatite $Ca_5(PO_4)_3F$

Lustrous, blue, often tabular crystals of fluorapatite associated with quartz and muscovite occur in pockets in the central perthitic microcline and are certainly the best known specimens from the locality (Robinson and King, 1990). In addition, fluorapatite also forms pale green to white, fine grained, earthy coatings on lithiophilite, which are probably secondary in origin. From the analysis in Table 1, the formula for the pale green fluorapatite, based on 8 cations is $(Ca_{4.48}Mn_{.44}Fe_{.03}Mg_{.02})(P_{1.01}O_{3.94})_3F_{1.44}$.

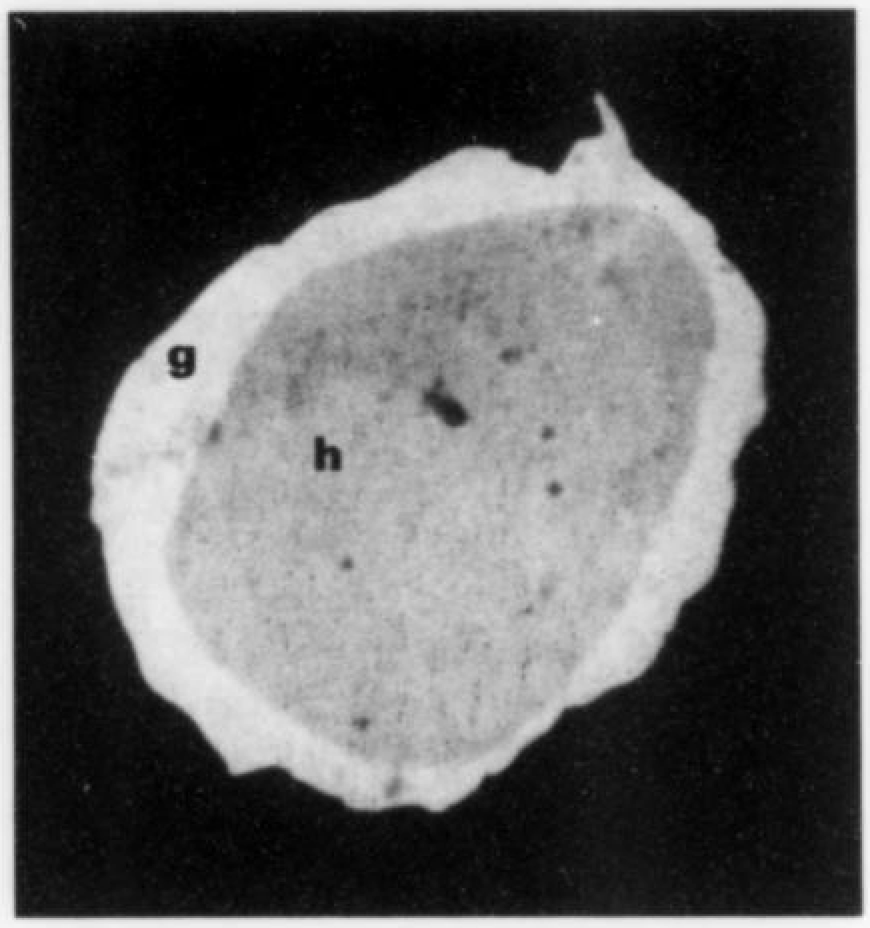

Figure 6. **Back-scattered electron photomicrograph of hessite (h) rimmed by galena (g) in digenite (d). Scale bar is 10 microns. G. Robinson photo.**

Hessite Ag_2Te

Hessite is a relatively uncommon mineral, found principally with other tellurides in metalliferous hydrothermal veins and sulfide bodies (Ramdohr, 1980; Palache *et al.*, 1994). To our knowledge, the occurrence of hessite outside such environments has not previously been reported. At the Boqueirãozinho pegmatite hessite forms drop-like inclusions up to 80 microns in diameter within some of the digenite pods. Back-scattered electron images reveal the hessite to be rimmed by galena, as shown in Figure 6. Microprobe analyses indicate both the hessite and galena are essentially pure, though a Bi-S mineral (bismuthinite?) is occasionally present in minute amounts along microfractures in some specimens.

The drop-like form of the inclusions suggests the presence of an initially complex Cu-Ag-Te-Pb-Bi-sulfide liquid which segregated from the silicate melt during crystallization. Upon cooling, the liquid further separated into at least three apparently immiscible sulfide liquids which formed the observed minerals.

Lithiophilite $LiMnPO_4$

Lithiophilite is the major constituent of the phosphate pods. It occurs both as massive aggregates and isolated crystals up to 20 cm embedded in albite. The cores of both the masses and crystals are unaltered and pale salmon-pink in color. The outer surfaces of the lithiophilite show varying degrees of alteration, and appear pale to dark brown due to minute films of coronadite and/or hectorite. Microprobe examination of the lithiophilite shows it is generally homogeneous with an average composition of $Li(Mn_{.74}Fe_{.20}Mg_{.04})P_{1.01}O_4$, based on 4 oxygen atoms and assuming 1 Li. Triphylite, with Fe:Fe + Mn + Mg > 1.0, has also been observed, but is uncommon.

Triplite $(Mn,Fe^{+2},Mg,Ca)_2(PO_4)(F,OH)$

Triplite occurs sparingly as dark brown, waxy grains and patches associated with lithiophilite and triploidite in some of the pods. It is relatively homogeneous in composition, with an average empirical formula $(Mn_{1.26}Mg_{.45}Fe_{.21}Ca_{.03}Ti_{.02})P_{1.01}O_{4.00}(F_{.79}(OH)_{.21})$, based on $(O + F + OH) = 5$.

Triploidite $(Mn,Fe^{+2})_2(PO_4)(OH)$

Triploidite, while not a rare mineral, is certainly an uncommon one, especially in euhedral crystals. It is found primarily in phosphate pods in granitic pegmatites, though at least two hydrothermal occurrences are known (Clark and Couper, 1979; Adam and Gagny, 1986). At the Boqueirãozinho pegmatite triploidite occurs as elongated, subparallel, prismatic, pinkish red crystals up to 8 cm in length within some of the lithiophilite. The crystals have a brilliant luster and the smaller ones are nearly transparent. While individual, terminated crystals have not yet been found, the size and quality of the Boqueirãozinho specimens make them some of the finest known. Regrettably, only a few of the phosphate pods encountered have contained triploidite, and the area from which they came is now under water. Microprobe analyses of the triploidite show it is relatively homogeneous, with an average composition of $(Mn_{1.58}Fe_{.34}Mg_{.06})(P_{1.02}O_{4.03})(OH)$, based on 3 cations and assuming 1 (OH).

Unknown No. 1

One specimen composed chiefly of lithiophilite and triploidite contains rare, minute grains of a vitreous, green, unidentified mineral. The X-ray powder diffraction pattern of this mineral is somewhat similar to those of the alluaudite group minerals. The strongest lines are (d in Å, I/I_0) 3.16 (10), 6.15 (7), 2.74 (4), 5.51 (3), 2.69 (3), 3.51 (2), 2.55 (2) and 2.51 (2). Unfortunately, the amount of sample currently available precludes further characterization.

Unknown No. 2

An unidentified, powdery, yellow-green, bismuth-bearing mineral occupies tiny fractures in some of the digenite. Based on its variable composition and overall heterogeneous appearance, it is most likely a mixture of secondary copper and bismuth carbonates or oxides probably originating by oxidation of a primary bismuth sulfide mineral.

Table 2. **List of minerals identified from the Boqueirãozinho pegmatite.**

Central Pegmatite	*Sulfide Pods*	*Phosphate Pods*
Primary Minerals	*Primary Minerals*	*Primary Minerals*
Albite	Bismuthinite (?)	Albite
Beryl	Covellite	Gahnite
Fluorapatite	Digenite	Lithiophilite
Gahnite	Galena	Spessartine
Manganocolumbite	Hessite	Triplite
Microcline		Triploidite
Muscovite	*Secondary Minerals*	Triphylite
Pyrochlore		UK-1
Quartz	Chrysocolla	Zircon
Rutile (niobian)	Malachite	
Schorl	UK-2	*Secondary Phosphates*
Spessartine		Crandallite
Spodumene		Eosphorite
Uranmicrolite		Fluorapatite
Uranpyrochlore		
Zircon		*Secondary Minerals*
		Coronadite
		Hectorite

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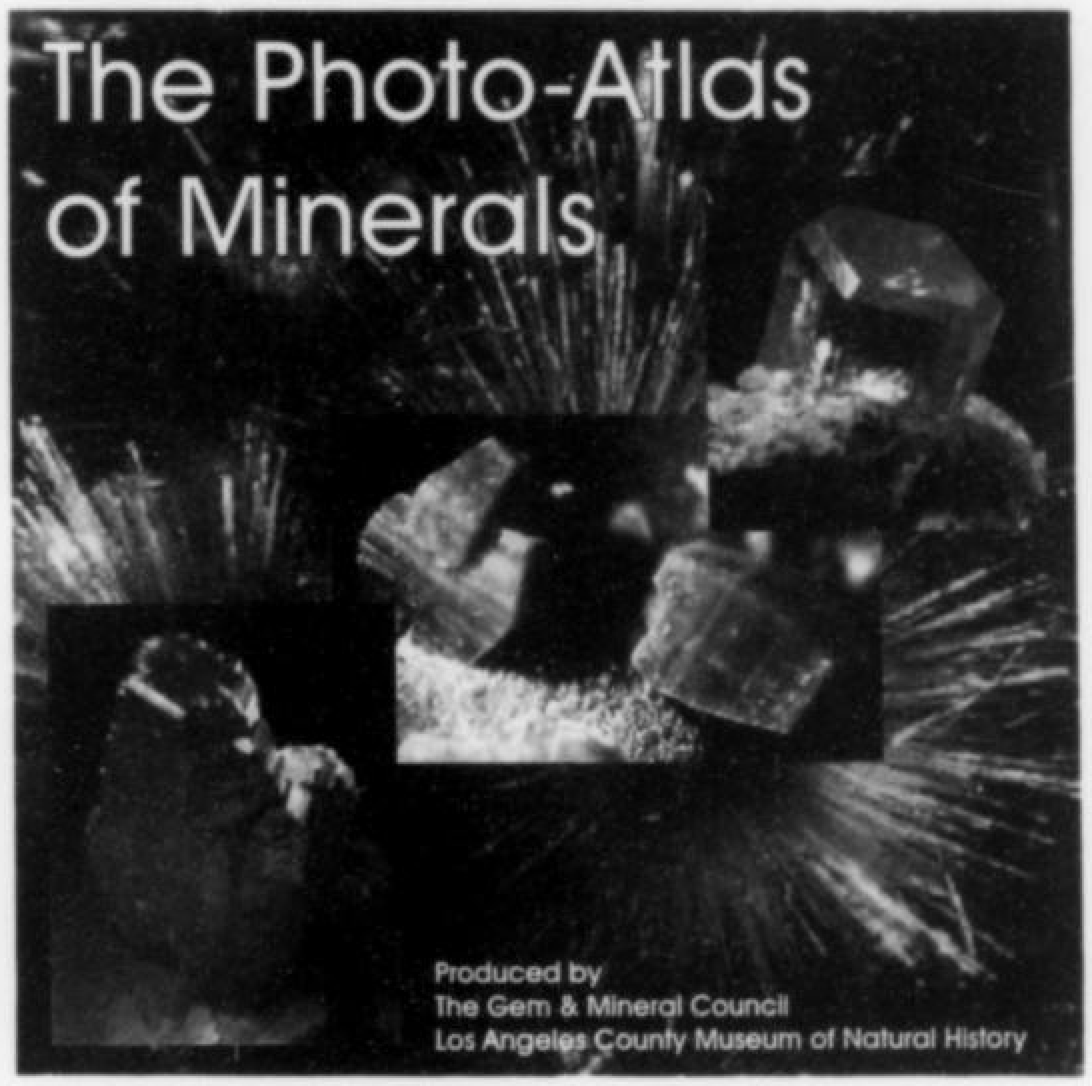
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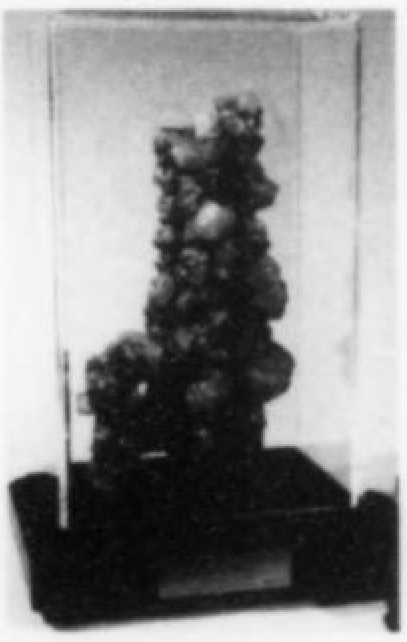

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PHILOLITHITE

A NEW MINERAL FROM LÅNGBAN, VÄRMLAND, SWEDEN

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ABSTRACT

Philolithite, $Pb_{12}O_6Mn(Mg,Mn)_2(Mn,Mg)_4(SO_4)(CO_3)_4Cl_4(OH)_{12}$, is a new mineral from the Långban mines, Bergslagen ore district, Vårmland, Sweden. The name is from the Greek *philos* (= loving) and *lithos* (= stone) in honor of the Friends of Mineralogy. Philolithite occurs principally as crust-like overgrowths and simple tetragonal tablets on subhedral lead, and on lead wires in a calcite-rich Mn oxide ore matrix, dominated by braunite with lesser amounts of hausmannite, pyrochroite and manganoan phlogopite. Philolithite also occurs as thin cleavable, pale apple-green fissure filling in Mn-silicate-rich carbonate rock. Philolithite is mineralogically and genetically related to the lead oxychloride "family."

Philolithite is pale to medium apple-green with a white streak and adamantine luster. It is brittle, exhibits conchoidal fracture, and has no obvious cleavage. The Mohs hardness is 3–4. The calculated density based on the structural formula is 5.91 g/cm^3. Philolithite crystals are typically simple tetragonal tablets dominated by the forms {001} and {111}; {110} and {112} are observable on some crystals by SEM. Crystals exhibit anomalous biaxial (+) optics ($2V \approx 60°$) and sector twinning about the *c*-axis. Indices of refraction are greater than 1.92, but could not be measured because crystals decompose immediately in higher index liquids. Philolithite is tetragonal, space group $P4_2/nnm$, $a = 12.627(9)$, $c = 12.595(9)$ Å, $V = 2008(2)$ Å^3, $Z = 2$. EDS and EMP analyses coupled with atomic structure analysis provided PbO 74.91, MnO 9.13, MgO 2.71, SO_3 2.24, Cl 3.97, CO_2 4.92, H_2O 3.02, O = Cl –0.89, TOTAL 100.00. The seven strongest powder diffraction lines are [d(Å)(I)(hkl)] 2.975 (100) (330,303), 3.99 (30) (301), 2.752 (30) (421,412), 8.95 (20) (110), 7.30 (20) (111), 2.473 (20) (413), 1.716 (20) (633,336).

The atomic structure consists of edge-sharing Mn-Mg-octahedral chains linked through MnO_4 and SO_4 tetrahedra into an elegant trellis-like framework. CO_3 groups also connect to octahedra within chains, and Pb and Cl atoms occupy the open spaces between the trellis members.

INTRODUCTION

In 1965–66 while conducting postdoctoral research at the Swedish Museum of Natural History, one of the authors (PBM) noticed the apple-green crystals described herein as the new mineral philolithite. They were recorded as unknown number 263 in the Flink Collection. Crystals identical in appearance were noted on a second specimen (mislabeled #319 apparently by Flink), and a fragment of this specimen was obtained for further study. Powder and single-crystal X-ray diffraction and EDS chemical analyses on crystals from this specimen confirmed the species to be new. This specimen is now in the collection of the Los Angeles County Museum of Natural History (LACMNH #41794).

A third specimen, provided by William W. Pinch and now in the collection of the Canadian Museum of Nature (CMN #58623), yielded a crystal for structure determination. Unfortunately, the low quality of this crystal coupled with absorption effects allowed only an approximate solution of the structure. Subsequently, the new species was identified by another of the authors (EJJ) on other specimens in the collection of the Swedish Museum of Natural

History, including Flink unknown numbers 128 (SMNH #255116), 264, 316, 434, 435 and U:89, and also on a few others purchased in 1937 by that museum from Långban miner *cum* dealer Erik Gustaf Warg. The latter are some of the richest and best specimens of philolithite encountered thus far. Utilizing a crystal from one of these specimens (SMNH #37389), the complete solution and refinement of the crystal structure was achieved. The characterization of the material as a new mineral is reported herein; complete details of the structure determination will be reported in a subsequent paper.

THE NAME

The name of the new mineral, *philolithite* (pronounced fĭ-lō lĭ-thīt), was suggested by Kay Robertson of Los Angeles, California. It is derived from the Greek *philos* (= loving, friendly toward) and *lithos* (= stone), in honor of the Friends of Mineralogy, Inc. and in recognition of the friends and lovers of minerals everywhere who enthusiastically and with great zeal offer (and give) their help to the mineralogical community.

It seems particularly appropriate to apply this name to a mineral first noted as an unknown by Gustaf Flink, one of the most dedicated and productive friends that the field of mineralogy has evern known. Gustaf Flink (1849–1931) studied mineralogy at the Stockholm Högskola (now Stockholm University) under O. Pettersson and W. C. Brøgger in the 1880's. While subsequently employed as a school teacher, he maintained his deep interest in minerals. This led to his appointment as Assistant Keeper of the cabinet at the Swedish Natural History Museum, where he contributed tremendously toward the preservation and study of Långban minerals. After retiring and while active as a dealer, Flink continued his dedicated efforts in deciphering the complex mineralogy of the Långban deposits. He assembled over 10,000 Långban specimens with the assistance of local mines, and singled out hundreds of unknowns for further study.

The mineral and name were approved by the Commission on New Minerals and Mineral Names, IMA. Specimens LACMNH #41794, CMN #58623, SMNH #37389 and SMNH #225116 mentioned above are designed as cotypes.

OCCURRENCE

All known specimens of philolithite have been found in collection and are noted as being from the Långban mines (59.86°N, 14.27°E), Bergslagen ore district in the province of Vårmland, south central Sweden. Flink's numbers 263, 264 and 316 are recorded as coming from the Amerika workings. The specific provenance of all other philolithite specimens except #128 is unknown; however, these specimens resemble the Amerika material in most aspects.

The textural relations between philolithite and native lead suggest that native lead generally formed prior to philolithite. On some specimens philolithite occurs as crust-like overgrowths on subhedral lead, as well as in the form of euhedral crystals perched on lead wires (Fig. 6). Native lead further occurs regularly as subhedral to (mainly) anhedral blebs enclosed in massive and crystallized philolithite, as well as by itself in larger (up to several cm^2) platy, mainly anhedral, associated fissure fillings. Sporadically native copper may also occur associated in small amounts.

The matrix of the philolithite-bearing fissures is a calcite-rich Mn oxide ore, dominated by braunite with lesser amounts of hausmannite. Other Mn-bearing silicates, mainly pyrochroite and a reddish brown manganoan phlogopite, are ubiquitous in smaller amounts. Very small amounts of a fine-grained red litharge-like phase have also been noted on one specimen (not analyzed).

Figure 1. **Philolithite crystals, about 0.2 mm on edge, associated with small remnants of native lead in a small pocket in a pyrochroite-native lead-bearing fissure in braunite ore. (SMNH #37389; cotype specimen)**

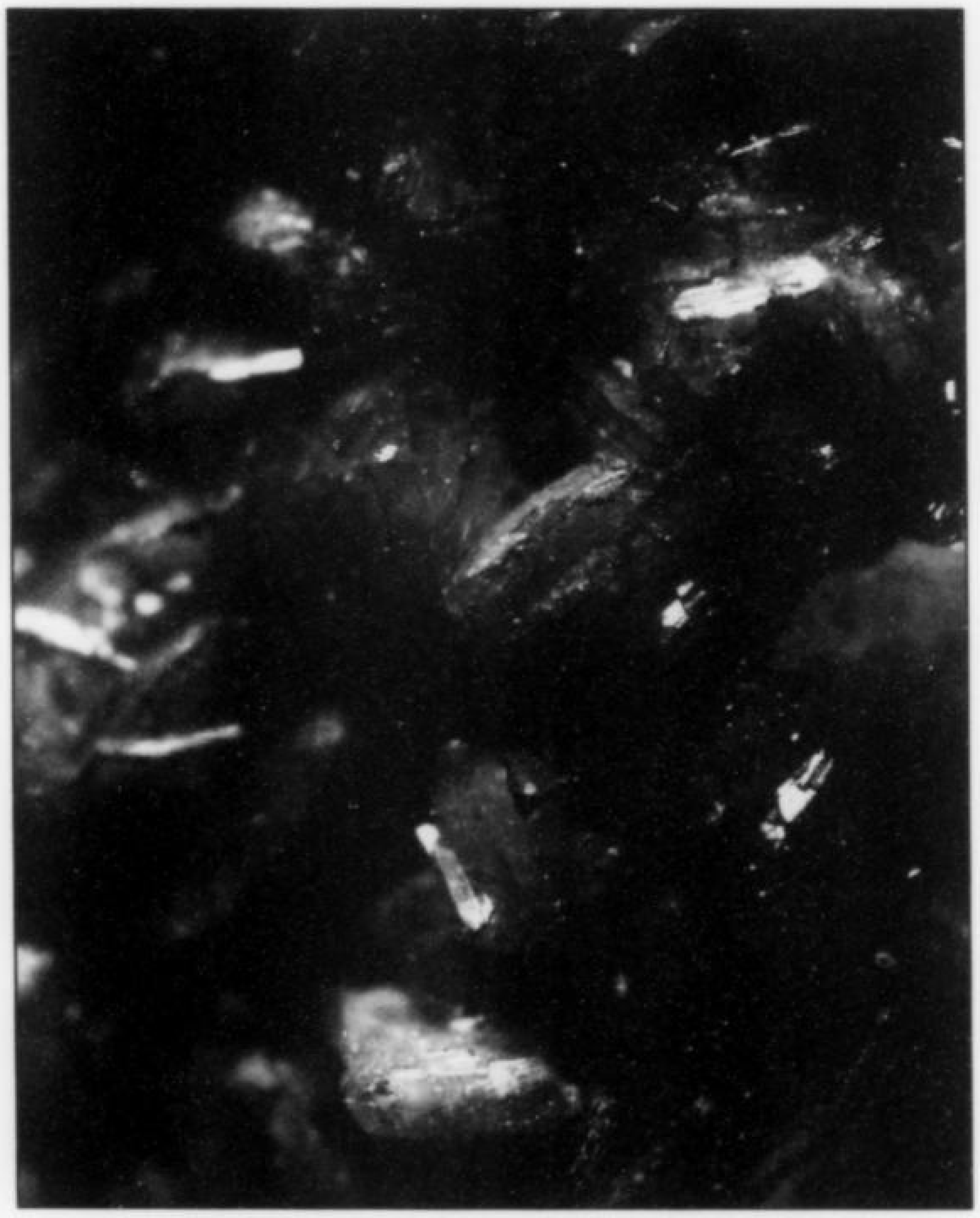

Figure 2. **Apple-green philolithite crystals (typically rather turbid), around 0.2 to 0.3 mm on edge, on an open fissure in braunite ore. (SMNH #25885)**

Figure 3. **Apple-green philolithite crystals (typically rather turbid) about 0.3 mm on edge with calcite crystals, on an open fissure in braunite ore. (SMNH #25885)**

Considering the general frequency of litharge as a low-temperature alteration product of native lead in Långban material, it is highly likely that this red phase is litharge. Hydrocerussite and rare allactite have also been noted in this assemblage.

Flink unknown #128, recorded as coming from the Rämsorten drift, contains a second type of philolithite. On this and one other specimen the new mineral occurs as a thin (<1 mm), cleavable, dull, olive-green fissure filling in a Mn-silicate-rich carbonate rock, which on one specimen grades into a jacobsite-bearing Mn-oxide-impregnated carbonate rock. The fissure fillings of philolithite contain anhedral grains of native lead and euhedral to anhedral grains of native copper. In one instance, platy, highly lustrous white mendipite crystals occur intergrown with the philolithite, as well as native copper and lead. In thin-section this philolithite is very turbid, with a pale oily green color, and is practically optically isotropic. Backscattered electron images exhibit a mottled sieve-like texture at near the upper limit of electron-microscope magnification. This philolithite is apparently undergoing alteration. The foregoing description is based upon the well-crystallized philolithite mentioned earlier.

PHYSICAL and OPTICAL PROPERTIES

Philolithite is pale to medium apple-green and has a white streak. Its luster is adamantine. No fluorescence was observed in either longwave or shortwave ultraviolet radiation. It is brittle, exhibits conchoidal fracture, and has no obvious cleavage. The Mohs hardness is 3–4. The mineral sinks in Clerici solution, but insufficient material was available for density determination by other methods. The calculated density based on the structural formula is 5.91 g/cm^3.

Philolithite crystals are typically simple tetragonal tablets dominated by the forms {001} and {111}. Faces corresponding to the apparent forms {110} and {112} are observable on some crystals by SEM, but they could not be measured optically. A drawing of a single crystal of philolithite is provided as Figure 7 and a diagram showing the optical orientation and sector twinning in philolithite is provided in Figure 8.

Crystals exhibit anomalous biaxial (+) optics ($2V \approx 60°$) and sector twinning about the *c*-axis. The optical orientation is $X \wedge a = 45°$; $Z = c$. Very weak pale green to pale yellow-green pleochroism was noted. Indices of refraction are greater than 1.92, but could not be measured because crystals decompose immediately in higher-index liquids, with the evolution of bubbles. The Gladstone-Dale relationship predicts a mean index of refraction of 1.95.

CHEMICAL COMPOSITION

Chemical analyses of philolithite were performed by energy-dispersive X-ray spectrometry and electron microprobe. The analyses and corresponding atomic proportions are reported in Table 1. Variability in the relative amounts of Mn and Mg suggests at least partial solid solution. This is supported by the results of the structure determination in which two sites were found to contain both Mn and Mg. The compositions of these sites were refined, providing the structural formula $Pb_{12}O_6Mn(Mg_{1.07},Mn_{0.93})_{\Sigma 2}(Mn_{2.71},Mg_{1.29})_{\Sigma 4}(SO_4)(CO_3)_4Cl_4(OH)_{12}$. Partial chemical analyses on other crystals provided (Mn,Mg) contents normalized to 7, ranging from $(Mn_{6.09}Mg_{0.91})$ to $(Mn_{4.46}Mg_{2.54})$. The simplified formula can be written as $Pb_{12}O_6Mn(Mg,Mn)_2(Mn,Mg)_4(SO_4)(CO_3)_4Cl_4(OH)_{12}$.

Raman-laser microspectrometric investigations (Dilor Microdil-28 with diode-array detector and 514.5 nm Ar-laser operated at 20 mW) showed Raman active modes corresponding to sulfate (≈ 420, 1011, 1111, and 1122 cm^{-1}), carbonate (≈ 1073^{-1}), and OH/H_2O (cluster around 3400 cm^{-1}). Infrared spectroscopy applied to a transparent single crystal (Biorad FTIR spectrometer equipped with a SbIn detector, CaF_2 window) confirmed the aforementioned

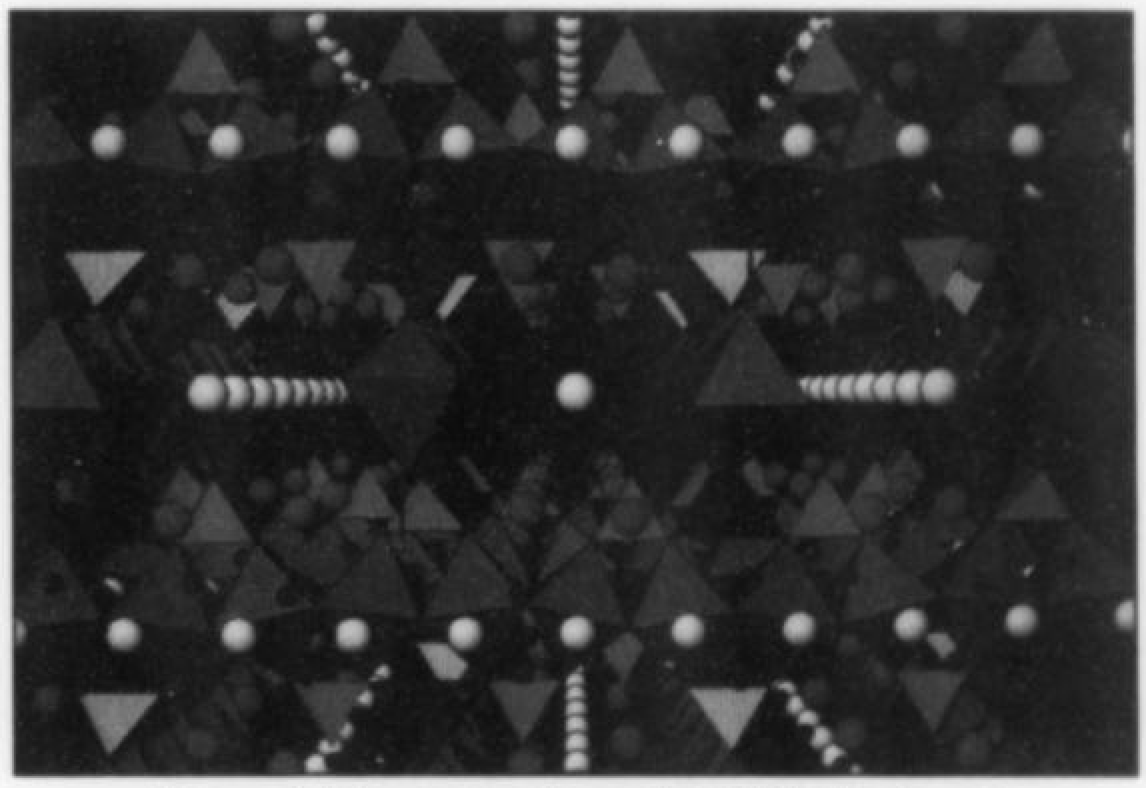

Figure 4. **Atomic structure of philolithite viewed in perspective down [$\bar{1}$10]. Pink = Mn,Mg-O octahedra, red = Mn-O tetrahedra, yellow = S-O tetrahedra, light blue = C-O triangles, dark blue spheres = Pb; green spheres = Cl; white spheres = O.**

Table 1. **Compositional data for philolithite.**

	Structural Formula	*LACMNH #41794**	*SMNH #37389***	*Flink #128*†
	Oxide wt. %			
PbO	74.91	73.7	75.4	75.9
MnO	9.13	10.3	8.0	8.7
MgO	2.71	1.8	2.6	2.1
SO_3	2.24	1.7	1.2	2.2‡
Cl	3.97	3.4	4.4	4.4
CO_2	4.92	4.9‡	4.9‡	4.9‡
H_2O	3.02	3.0‡	3.0‡	3.0‡
O = Cl	–0.89	–0.8	–1.0	–1.0
TOTAL	100.00	98.0	98.5	100.2
	Formula assuming O + Cl = 38			
Pb	12.00	12.29	12.69	12.32
Mn	4.64	5.41	4.24	4.45
Mg	2.36	1.66	2.42	1.89
S	1.00	0.79	0.56	1.00
Cl	4.00	3.57	4.66	4.50
C	4.00	4.14	4.18	4.04
H	12.00	12.40	12.51	12.07
O	34.00	34.43	34.43	33.50

* = Energy dispersive analyses; average of 4 points; standards; synthetic Pb silicate for Pb, magnesian manganoan fayalite for Mn, diopside glass for Mg, barite for S, and apatite for Cl.

** = Electron microprobe analyses; average of 25 points; standards; vanadinite for Pb and Cl, pyrophanite for Mn, synthetic MgO for Mg, sphalerite for S.

† = Electron microprobe analyses; average of 5 points; standards as above.

‡ = Not measured; deduced from the structure analysis.

results and showed no bands corresponding to H_2O bending (≈ 1630 cm^{-1}) and H_2O bending and stretching (≈ 5200 cm^{-1}); H_2O is therefore indicated as being present only as OH.

In 1:1 HC1 at room temperature, philolithite gradually dissolves and decomposes with slow production of bubbles, leaving a white curd.

X-RAY DIFFRACTION STUDY

Single-crystal X-ray precession and four-circle diffractometer studies showed philolithite to be tetragonal, space group, $P4_2/nnm$, a = 12.627(9), c = 12.595(9) Å, V = 2008(2) Å^3, Z = 2. The cell parameters were obtained by least-squares refinement from the setting angles of 25 reflections between 18° and 28° 2θ automatically centered by the diffractometer. In Table 2 the X-ray powder diffraction pattern is seen to be in good agreement with the pattern calculated from the crystal stucture.

The atomic structure of philolithite (R = 0.053) is a remarkable trellis-like framework (Fig. 4). The principal trellis members are edge-sharing Mn-Mg-octahedral chains oriented in two directions, parallel to [110] and [$1\bar{1}0$]. Octahedra within each chain are further linked by sharing free corners with MnO_4 and SO_4 tetrahedra and CO_3 triangles. MnO_4 and SO_4 tetrahedra also form bridging struts between the octahedral chains, connecting them in the [001] direction. Pb, Cl and non-trellis O atoms occupy spaces between the trellis members. Details of the structure analysis will be reported in a subsequent paper.

PARAGENESIS

Långban, an Fe-Mn oxide deposit, is geologically situated within a sequence of regionally metamorphosed Proterozoic (ca. 1.9 Ga; Björk 1986) volcano-sedimentary rocks dominated by felsic, alkali-rich metavolcanics, metabasites, argillitic schists and marbles of greenschist to amphibolite facies grade (e.g. Björk 1986). The iron- and manganese oxide ores, presently held to be of a syngenetic, submarine volcanic-exhalative origin (Boström *et al.* 1979), are spatially well-separated and contained within lenses of

Table 2. **X-ray powder diffraction data for philolithite.**

I_{obs}	d_{obd}	d_{calc}	I_{calc}	*hkl*
20	8.95	8.929	18	110
20	7.30	7.284	18	111
10	6.29	6.298	10	002
10	5.15	5.153	6	211
		5.146	3	112
10	4.20	4.204	12	212
30	3.99	3.992	31	301
5	3.81	3.799	6	113
10	3.364	3.369	12	213
5	3.149	3.149	6	004
100	2.975	2.976	37	330
		2.972	63	303
10	2.819	2.823	10	420
30	2.752	2.755	7	421
		2.754	22	412
20	2.473	2.474	17	413
5	2.422	2.424	4	115
10	2.160	2.163	14	334
10	2.103	2.105	7	600
		2.102	5	424
5	2.042	2.043	3	116
5	1.862	1.862	6	631
5	1.784	1.786	6	710
5	1.768	1.768	5	711
5	1.749	1.750	6	604
20	1.716	1.718	15	633
		1.715	6	336
5	1.653	1.654	8	307
5	1.603	1.603	5	723
5	1.552	1.553	2	714
		1.551	2	417
5	1.519	1.520	3	742
10	1.487	1.488	4	660
		1.486	4	606
5	1.467	1.467	3	743
10	1.330	1.331	2	930
		1.331	2	903
		1.330	2	754
5	1.301	1.301	4	637

Note: 114.6-mm Gandolfi camera, Cu$K\alpha$ (Ni filtered) radiation, observed intensities visually estimated, calculated intensities obtained from structure data.

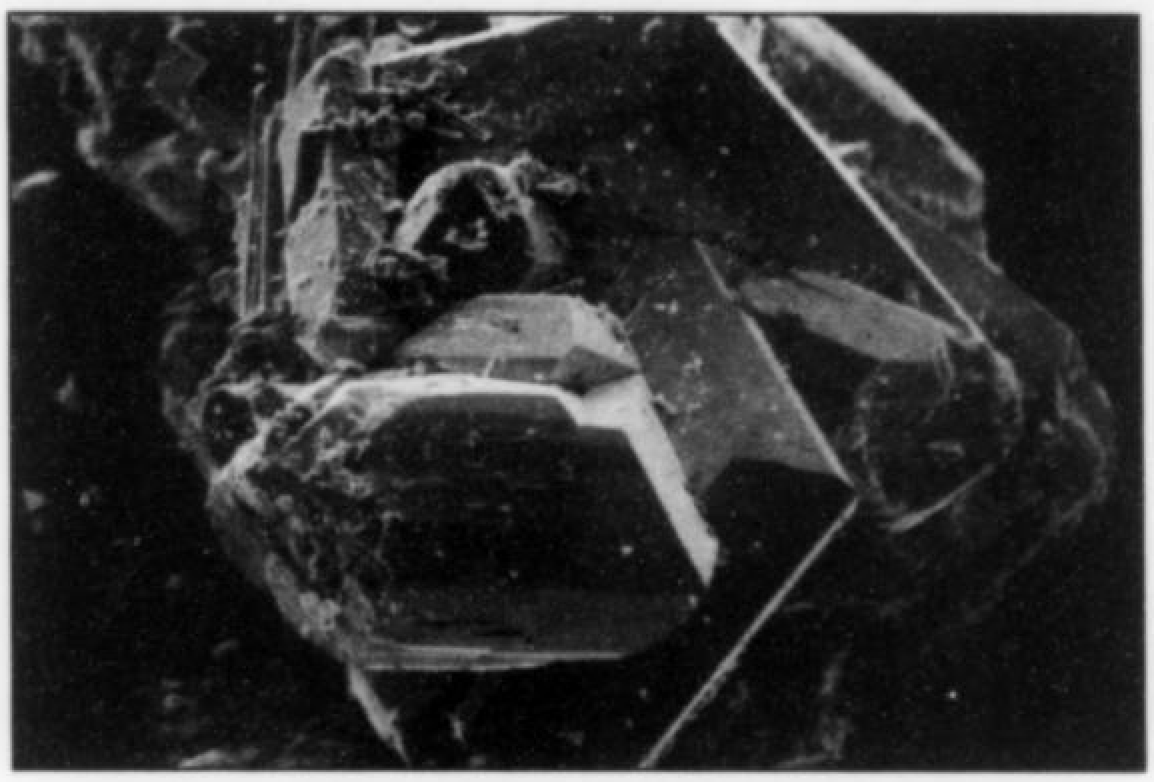

Figure 5. **SEM photo of a cluster of philolithite crystals. Field of view is about 0.55 mm. (SMNH #25885)**

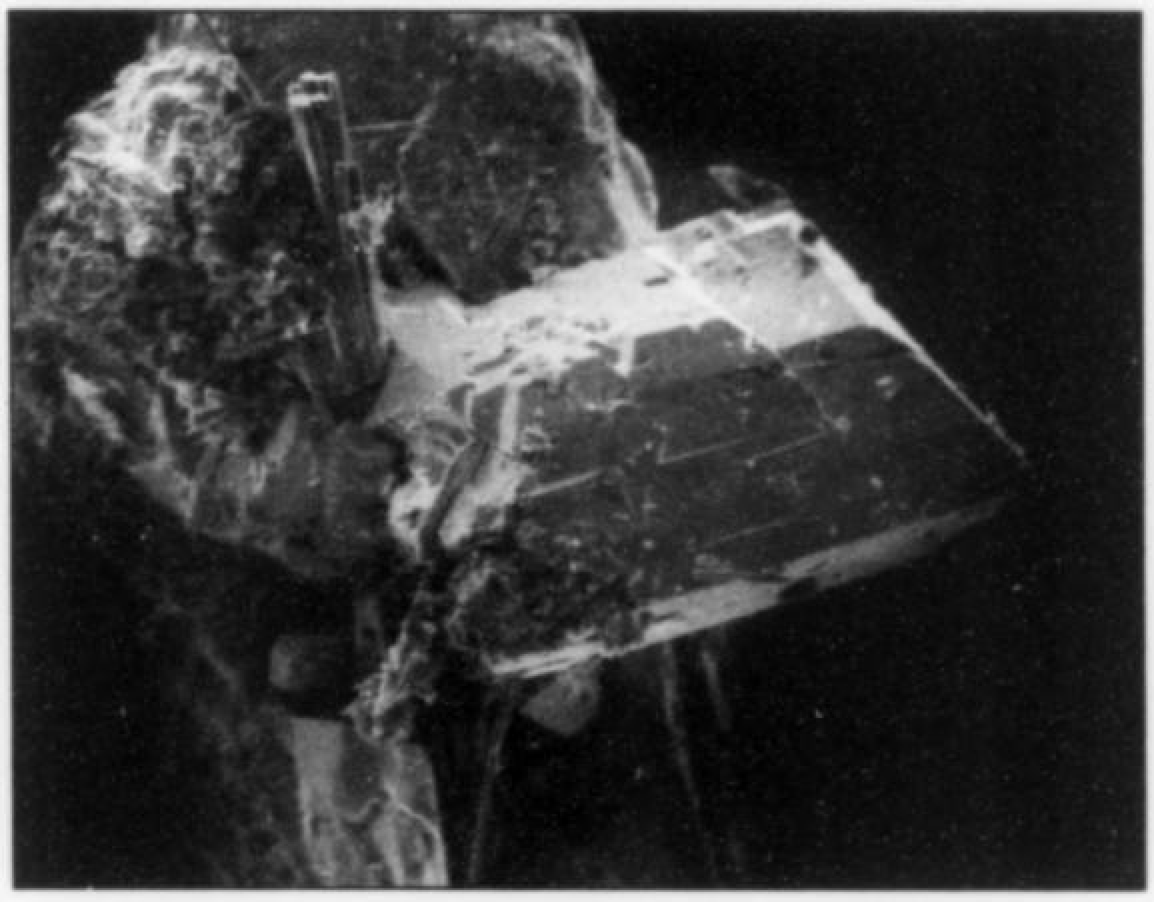

Figure 6. **SEM photo of a stout philolithite crystal implanted on a wire of native lead, associated with acicular (brown) crystals of an unidentified Mn-Mg-mineral. Field of view is about 0.65 mm. (SMNH #25885)**

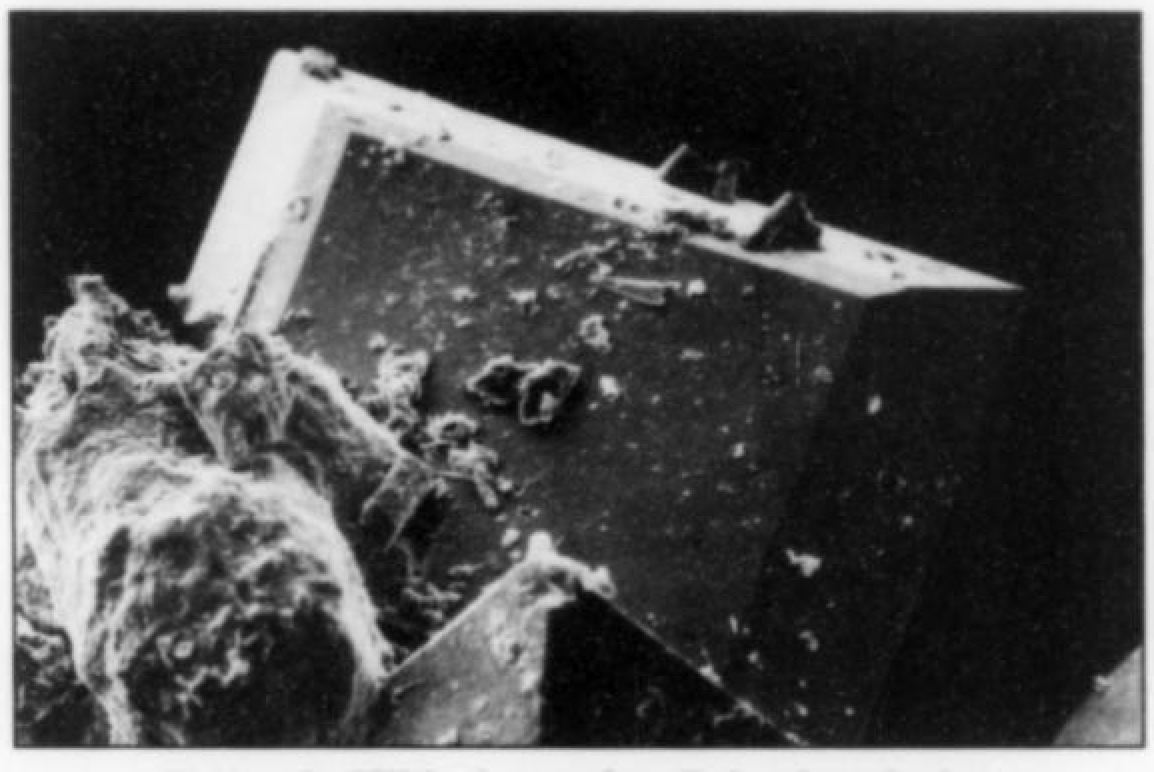

Figure 7. **SEM photo of well-developed platy philolithite crystal. Field of view is about 0.3 mm. (SMNH #25885)**

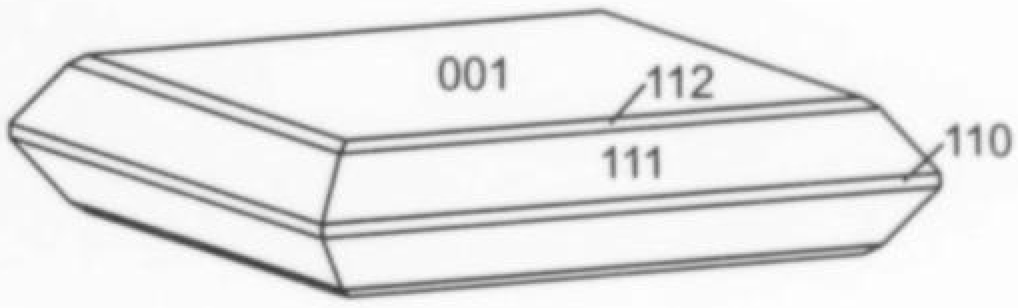

Figure 8. **Clinographic projection of a philolithite crystal.**

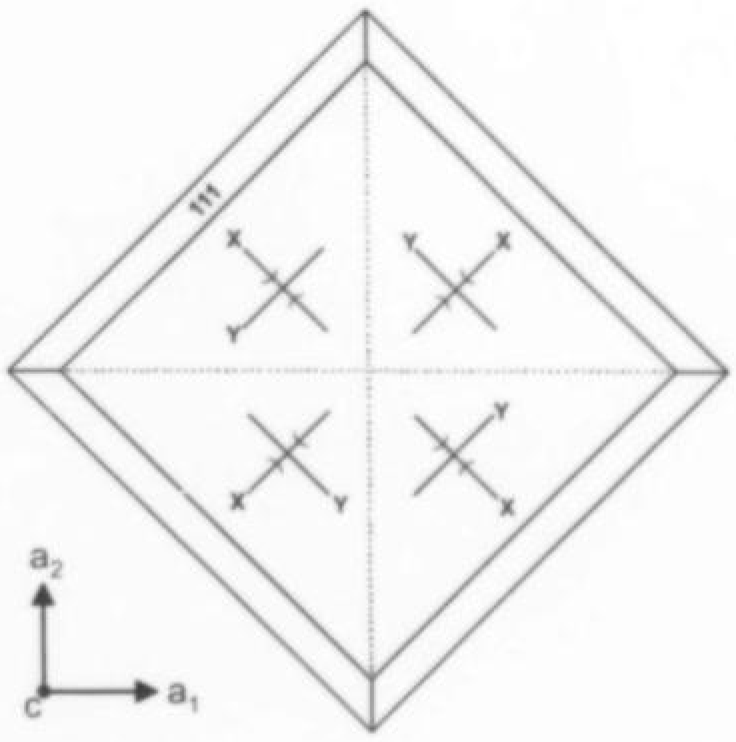

Figure 9. **Diagram showing the optical orientation and sector zoning in philolithite.**

mainly dolomitic marble. Fe and Mn skarn bodies enveloping the oxide-dominated carbonate-rich ores have formed during Svecocarelian regional metamorphism and presumably also associated magmatism.

Philolithite is mineralogically and genetically related to the lead oxychloride "family," which at Långban presently comprises blixite, ekdemite, freedite, heliophyllite, mendipite, nadorite, perite, sahlinite, and sundiusite. These minerals occur as late-stage crack or fissure phases, in earlier-formed schlieren-like veins or druses in substrates dominated by Fe and Mn oxide ores and oxide and silicate-rich carbonate rocks, and more rarely in open druses in Fe-Mn skarn. They are also found intergrown as single crystals or podiform aggregates in dolomitic carbonate rocks.

The age relations of these minerals within the Långban deposit correspond to phases C and D of Magnusson's (1930) rather crude four-stage paragenetical sequence (A–D). In this, the first period, A, corresponds to formation of the primary minerals including the earliest of skarn formation. Period B corresponds to mineral formation during peak metamorphic conditions; period C to formation of vein assemblages and schlieren assemblages at decreased temperatures, and finally period D corresponds to low-temperature mineral formation, mainly in fissures. The major amounts of the oxychloride species are intimately coupled to the late fissure mineralizations. Paragenetically, the lead oxychlorides mainly occur associated with native elements (As, Pb, Cu), hydrocerussite, minor arsenates and arsenites, with calcite and barite as ubiquitous companions.

The occurrence in the Långban deposit of minerals of lithophile elements such as B, Be, Mo and Sn, which may be appointed as a main indicator of metasomatic fluids introduced by local graintoid magmatism, is very limited in the late fissures. They seem to be concentrated in period C of Magnusson's (1930) sequence terminology.

For more details on the mineralogy and chemistry of Långban-type deposits see the review by Moore (1970).

ACKNOWLEDGMENTS

William W. Pinch provided the specimen used in the initial structure study and Dr. George W. Robinson provided the same specimen later from the collection of the Canadian Museum of Nature for subsequent examination.

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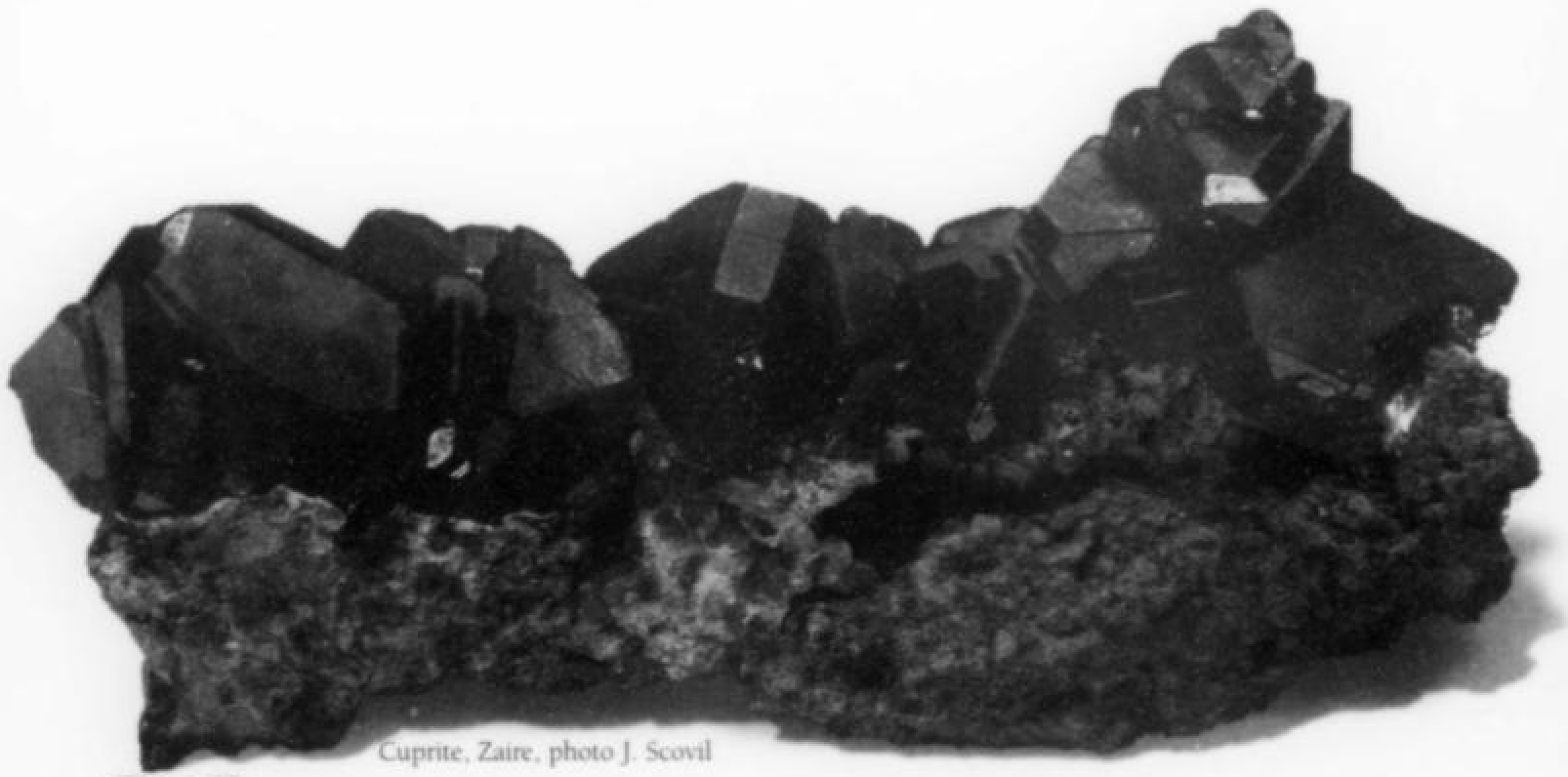

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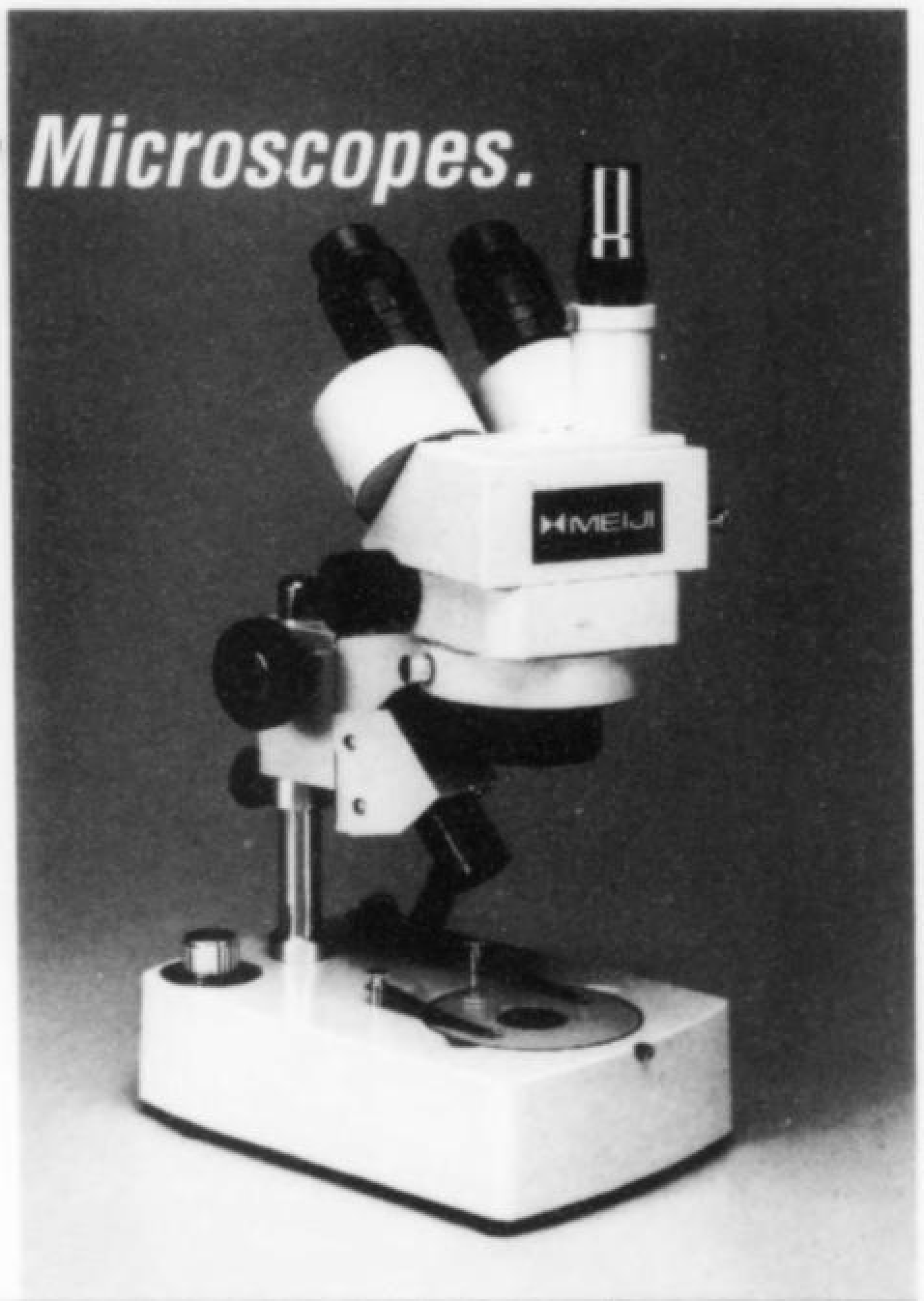

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What's New

in Minerals

Tucson Show 1998

by Tom Moore

[Feb. 1–15]

In the taxonomy of temperament there are order-lovers and order-loathers: routine-seekers and routine-avoiders. My own taste in life-texture has always favored spontaneity (disorder, if you want to put it that way), and childlike openness to sweet treats of Surprise. But this, my seventh Tucson Show, reminds me that even routine can be thrilling, since paradoxically it can enable surprises to come the more sweetly. Specifically, I mean that at any time during Tucson week one may spot by surprise the great mineral specimen, great trade or purchase opening, old friend, new insight as regards crystals or character—but in a kind of mystical retrospect, then, one thinks that the treat came somehow *because* of its place in the showtime routine. Each regular visitor will evolve, without thinking much about it, a sense of the weave of his or her personal Showtime. My own Showtime by now has defined itself clearly, and (to sketch it as an exemplary case) it goes like this: Arrive on ***Saturday*** afternoon, greet predictable people, look quickly and randomly around the hotel show, eat, collapse into bed; scurry, ***Sunday*** and ***Monday***, about the Executive Inn and (now) InnSuites, scooping up notes and information and personal acquisitions in great loads; an eye-of-the-hurricane lull on ***Tuesday***, and a good time to cruise the west side of town, with its funky regions of gem tents, minor hotel shows, and mystics' encampments along the freeway; ***Wednesday***, visit the set-up day at the Main Show to take a few notes, and begin to draft this report; ***Thursday-Friday*** at the Main Show itself, renewed frenziedness, panicky plannings around the budget, and much more writing; ***Saturday***, making a clean copy of the report, doing laundry, and looking in on the Friends of Mineralogy awards ceremony; ***Sunday***, the ride to the airport, and home. Over this solid matrix of routine, twinkling, winking their little eyefaces, treats of surprise are apt to come everywhere and anywhere . . . and boy! did I get a lot of good stuff *this* time!

Last year I mentioned the general discontent with the many shows having been unusually stretched out in time, and not well synchronized. This year there was better synchronization, and, among the strictly-mineral people at least, the grumbling faded away. Besides, the colonization of a new hotel, the InnSuites, by Marty Zinn's show seemed a thorough success: the InnSuites dealer rooms, all ground-floor, are smallish but open onto a courtyard enfolded in palms and kissed with orange trees, with a kindly green lawn, genteel flag-stoned paths, and a swing-and-slide area for the kids. Almost all of the dealers I talked to here loved their new venue, and the logistics were running smoothly, they said, except for a slight bit of bother about the room phones. At the two mineral hotels generally the shuttles were timely, staffs helpful, and mineral-socialization busy and strong as ever. Marty's show at the Ramada (former Quality Inn) was this year exclusively fossil-oriented. The only early-week killjoy, nobody's fault (even Marty Zinn couldn't stop it) was the El Niño Effect blowing in from the West, with cold, dampness and storms, including a blast of monsoony rain one night that woke me up at two in the morning and blew down one of the big Gem Show tents near the freeway.

Mineralogically it was a pretty strong show, with surprises, on all scales of value, around every corner. The new Venezuelan gold specimens (see below) were, naturally, the vibrant heart of the show-buzz, but then how *about* that new mimetite from improbable Thailand, or the new-style vanadinite from Morocco, or that charismatic Spanish pyromorphite, or . . . ?

Well, let's embark:

Arizona weighs in modestly this year with a small lot of newly dug, Herkimer-like **quartz** crystals from Diamond Point, near Payson, being offered by Les and Paula Presmyk at the Main Show. A surface exposure of limestone where the little glittering things have been casually picked up for years by hunters and boy scouts is now the target of some real specimen-prospecting work, so that a dozen or so pieces (so far) have become available. The crystals are very faintly amethystine, bright, sharp and transparent; they can reach 4 or 5 cm, and on the matrix specimens they sit up well on their tough, buff, hard limestone.

Before I could get to Mike Bergmann at the Main Show he had already sold all but a few of the 250 cabinet specimens he'd had of **azurite** from the Hanover #2 mine, Fierro, Grant County, New Mexico—but the few remaining ones were still more than noteworthy. Dug six or eight months ago, the specimens consist of a hardened, slightly cracked, whitish brown clay matrix (looks like fault gouge) on which sit azurite rosettes to 3 cm, but averaging 1.5 cm, very bright blue and showing sparse malachite spots. Some rosettes approach Bisbee standards for sharpness of form.

Recent work at the famous Gem mine in San Benito County, California, has yielded a large number of nice **neptunite** specimens, with good crystals to over 8 cm, plus a substantial amount of **benitoite** faceting rough and one huge fabulous, 43-cm plate of benitoite crystals (photo on following page). Bryan Lees sold the big one and Bill Forrest and Buzz Gray sold the rest in their Executive Inn room.

In the Executive Inn room just next door to mine I found Scott Kleine of *Great Basin Minerals* (3895 Lisa Ct., Apt C, Reno, NV 89503-1125) with some very nice thumbnails of **chalcophyllite** which he collected two months ago in the Copper Stope of the Majuba Hill mine, Antelope district, Pershing County, Nevada. The jackpot pocket was in an altered sulfide pod, and was lined with dark brown goethite and medium-green chrysocolla, and this handsome matrix hosts little bunches of micaceous 3-mm chalcophyllite crystals in generous coverages of a brilliant blue-green color (though not especially lustrous). About two feet away from this vug another was hit, with microcrystals of blue **scorodite** in sparkling rounded druses on sulfides. Likable thumbnails of both the scorodite and the chalcophyllite could be had for no more than $25.

Figure 1. **Benitoite with neptunite and natrolite, 43 cm, from the Gem mine, San Benito County, California. Bryan Lees specimen;**

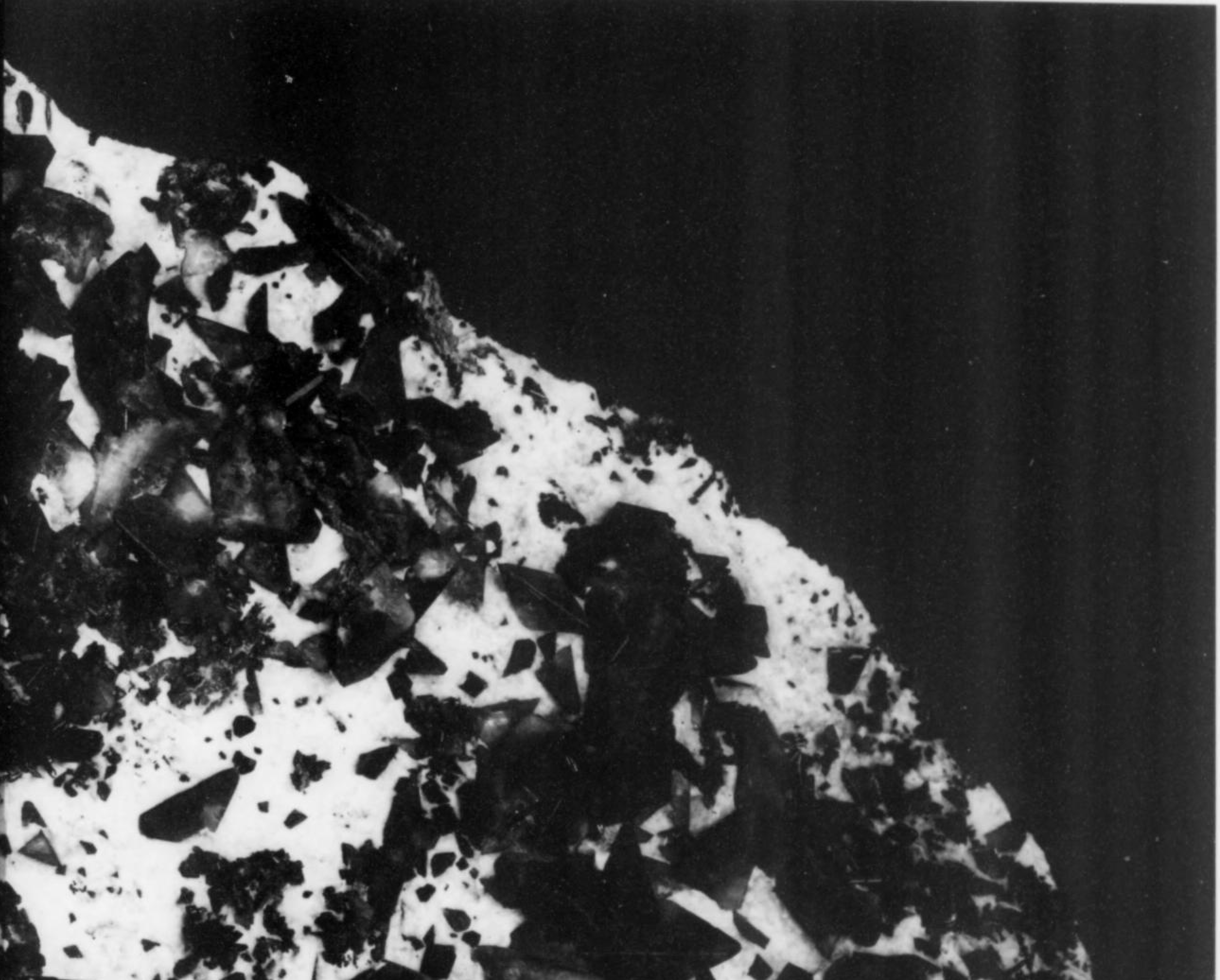


photo by Jeffrey Wheeler. (Shown about 85% of actual size.)

The major Nevada story, though, must be conceded to be the beautiful gemmy yellow **barite** now being dug at the Barrick Meikle mine, near Carlin, Elko County. In my last Denver report I mentioned some specimens in the room of Casey and Jane Jones; the Joneses continue to have such, as also did about ten other dealers in Tucson. The barite crystals at their very best are richly yellow, lustrous, gemmy, and tabular, and up to 2 cm or so in size; other, less pretty ones are thicker, more orange, and merely translucent. Matrix specimens have grayish white discoids or transparent colorless scalenohedrons of calcite to 2 cm scattered over a dark rock, the barite spreading itself liberally over the calcite. Harvey Gordon of *Harvey Gordon Minerals* (500 Ballentyne Way, Reno, NV 89502) seemed to have the biggest stash: about 50 specimens, of all sizes and qualities, at the Main Show.

From California, first a teaser, and then it's on to some serious gold. Do not skip the teaser, though, as the material is attractive: **ferroactinolite** and **tschermakite** in specimens mined last September in the Minarets mining district, Madera County, and now in the keeping of *Tom Wolfe Minerals* (P.O. Box 9791, Fountain Valley, CA 92728-9791). There are about 75 pieces, in all sizes from thumbnails up to 20 x 20-cm groups, with or without backing by dense skarn (garnet/epidote/pyroxene) matrix. Dull of luster, pale to dark green, and splintery, the prisms reach 4 cm long, and look just like "uralite" (amphibole pseudomorphous after pyroxene). The loose groups feature well-individualized, fragile crystals in jackstraw intergrowths.

California **gold** was being offered by Bryan Lees at his rhodochrosite-bedecked *Collector's Edge* stand at the Main Show. It is from the Mockingbird mine, Mariposa County—a claim adjacent to, and along the strike of the quartz vein from, the legendary Colorado Quartz mine. Bryan says that the Mockingbird claim has been dormant for decades, but now is producing sporadic small pockets from surface diggings; these pockets tend to be only 8 or 10 cm across, and only about a dozen top gold specimens have been found so far. The 8 miniature-sized examples which were on view here are all loose crystal groups, except that two have some minor massive white quartz adhering. The gold crystallizes mainly as octahedrons, and on a couple of pieces there are sharp, hoppered crystals to 5 or 6 mm on edge; some smaller euhedral crystals, though, are 2 or 3-mm dodecahedrons, perched on subhedral gold. On still other specimens, the arborescent growth habit rules, in delicate, high-rise, ferny clusters. The color on all pieces is a medium gold-yellow, and the luster is extremely high; this is top-drawer specimen gold, as the Colorado Quartz Gold Corporation, which does the prospecting, is well aware. With luck we will see more abundant supplies in the future.

Nor is this all: the Colorado Quartz mine itself has recently yielded a single 2 x 2.5-cm specimen which Bryan opines is the best thumbnail gold in the world (however, see later under Venezuela; these judgments are somewhat a matter of individual taste). Bryan's piece is brilliantly lustrous, electric with reflected light, and is a giant octahedron so deeply hoppered that one's first impression is of a stack of discrete 7-mm octahedrons, each of *these* hoppered. Between this single specimen, the Mockingbird pieces, and the Venezuelan golds (later, later), I must say I've seen enough unearthly-fine gold at this show to keep me dazzled for a while.

An InnSuites room with the interesting company name *PyroManiacs* over its door turned out to be a full of some terrific new **pyromorphite,** hit 18 months ago along an extension of the Jersey Vein at the famous Bunker Hill mine, Kellogg, Idaho. These pyromorphites vary widely in color (deep orange through bright yellow and lime-green) and in habit (large hoppered barrels to bundles of thin prisms to mammillary grape-bunches). The pieces themselves come in all sizes, with special authorial excitement directed here to the great profusion of first-rate thumbnails priced under $100. A few specimens have yellow mammillary clusters in which calcium replaces lead up to about 5%. I know, I know, Bunker Hill pyromorphite is hardly "new," but with these very bright, very beautiful, plentiful new specimens the place excels itself once again.

Dave Lare of *Jeffrey Mining Company, Inc.* (115 Booth Loop Rd., Henderson, TN 38340) showed me something newly emerged from the Lexington quarry, on the outskirts of Lexington, Jessamine County, Kentucky. Here, in 1994–1995, in pockets in the Highbridge Group limestone, the mine superintendent discovered big crystals of transparent **gypsum** which have since been collected to the tune of about 200 big pieces. The crystals are sharp and colorless to slightly grayish, and are sometimes measured in feet; in Dave's room, though, the biggest singles were a mere 10 to 15 cm high. From the same quarry comes **fluorite** in somewhat rough-surfaced 2 to 3-cm cubes in medium-cabinet-size clusters; the color is a translucent pale yellowish purple, with (strong) butter-yellow fluorescence. Some smaller specimens of this fluorite have clinging nests of acicular pale bluish white **celestine** crystals to 2 cm. The celestine exists alone in a few delicate, miniature-sized clusters.

In this same room I found Calvin Sigmon, one of a five-man collecting consortium calling itself *Beeline,* out of Lincolnton, North Carolina. Calvin is justly proud of his eight large, beautiful groups of **amethyst** crystals, these dug ten months ago at the Old Reel mine, Lincoln County, North Carolina. Sharp, clean, medium-purple transparent points to 2 cm at their bases join to make lustrous groups to 25 cm—some of the best amethyst I have ever seen from the United States.

I always look forward to wandering a while among little pale pastel eccentric things in the Executive Inn room of Mont Saint-Hilaire collector Gilles Haineault (*Collection Haineault,* 224 2ieme Ruisseau, St-Mathieu de Beloeil, Quebec, Canada J3G 2C9)—but this time, alas, there wasn't much new from that famous locality. There *were* a few thumbnail specimens, collected by Gilles last October, of what is probably the best **elpidite** found to date here or anywhere: loose 2-cm bundles of densely packed subparallel acicular crystals, flaring to rounded, glassy tops which, looked down into, are a lovely translucent grayish green. The silky to dull luster on the sides of the bundles is what we're used to seeing in this rare species, but the growth as sheaves, and the solid green glassiness on the tops of these sheaves, is quite new. Gilles brought about 20 good specimens to Tucson, in addition to the usual **serandites** and a superb little **donnayite-(Y)**.

Out of Mexico, more specifically out of Level 5 of the San Luis mine, Fresnillo, Zacatecas, Dan Belsher has recently brought some fine thumbnail **stephanite** crystals. These are brilliant, metallic black, flattened prisms with handsomely compound side faces; one loose 1.5 x 2.5-cm crystal is doubly terminated. This, with about ten thumbnail groups, was available from Stefan Stolte of *Mineralien & Fossilien Galerie* (Fahrgasse 88, 60598 Frankfurt, Germany).

I first found George Witters' gorgeous new pink **smithsonite** when I saw George wandering about in the courtyard of the InnSuites, ogling the glowing chatoyant pink stuff in the sunlight, where it shows best. But he had the main hoard for sale at the Main Show—about 100 specimens. The locality is the Santa Anita mine, Choix, Sinaloa, Mexico, where last summer the claim owners began actively mining for the first time, taking out five *tons* of smithsonite, almost all of it gray or lavender or blue-green; *George Witters Minerals* (2210 Park Lake Dr., Boulder, CO 80301) ended up with the very few elite pink pieces. Thick mammillary smithsonite crusts line open seams in a mottled gray weathered rhyolite;

the sizes of specimens offered at Tucson cluster closely around 7 x 7 cm.

Americans Roger LaRochelle and Jack Carlson lived for about 25 years in the Gran Sabana alluvial gold mining region of southeastern Venezuela; these gentlemen have decided finally to retire and to sell off an accumulation of Venezuelan **gold** specimens which, they say, have been collected over the past 30 years. Under the company name *Rarities,* Jack and Roger were in the InnSuites, in a small room perpetually filled with large crowds, offering up the gold hoard for sale. The material ranges from the tiniest grains and flakes of gold in vials, to 1 or 2-mm loose crystals, small-thumbnail octahedral crystals, a single 2-cm ram's horn, some interesting jewelry (necklaces of subhedral crystals of gold; rings with 1-cm hoppered crystals mounted on 18-karat gold bands; pins with emeralds and diamonds accompanying large bright nuggets) . . . and on up to three truly most amazing gold specimens. Number Three is an exquisite group of deeply hoppered octahedrons, with three sharp trapezohedral crystals sitting lightly on one side; it is 1.8 x 3.1 x 3.4 cm, extremely bright, and hardly at all rounded. They say Paul Desautels once pronounced it the most beautiful gold in the world. That's the number *three* piece? Well, yes: Number Two is a single 2-cm trapezohedron with all 24 faces showing, bright and extremely sharp (think of a nice floater garnet, then turn it to gold). The Number One piece they had "out" on the first day I visited, and I held it in my hand; when I went back the next day they'd come to their senses and stored it in a bank vault. It is a single, hoppered octahedron 2 x 4.2 x 4.4 cm, 217 grams weight, very deeply grooved but also of excellent freshness of form and color, and high luster. (The asking price was equally staggering.)

The Gran Sabana mining area, with the village of Santa Elena as its headquarters, is a swath about ten miles wide and 80 miles long; some account of it is given in vol. 18, p. 89 (the second Gold Issue). Whew. Roger LaRochelle says he got stabbed, almost fatally, in some connection with gold, whilst living down there, and that this is one of the reasons he now wants to leave. Time now for some nice, non-threatening Peruvian smoky quartz.

That **quartz** was in the *Great Basin Minerals* room (see also under chalcophyllite), and again Scott Kleine briefed me. At the Cantera Raurita mine, Ancash Department, Peru, just a month ago, about 400 smoky quartz pieces were taken out, and they are at present, Scott says, "the buzz of Lima." Transparent, medium-smoky, well-terminated crystals reaching 12 cm long and averaging 2 cm fat occur alone or in groups of two to five; smaller, brighter crystals are found sitting on drusy, pale green chlorite linings on granitic matrix to 15 cm across. Look closely, and see quartz at play: besides being smoky, some crystals are nicely phantomed, some have large flaky inclusions of black hübnerite (?), and some do Dauphiné twinning or are even intergrown as crude gwindels. The luster is not high on the larger crystals, but all are at least very nice.

Dr. Jaroslav Hyrsl (Heverova 222, CZ-280 00 Kolin 4, Czech Republic) had a single fine specimen from a new find of **wurtzite** at "Huanzala," Peru. Brightly metallic black, tightly intergrown platy wurtzite crystals, all about 1 cm, cover a 12-cm matrix of massive wurtzite/pyrite, and there is white barite in a few 1-cm bunches of thin crystals over the wurtzite. Only four of these were extracted, Jaroslav says, from a single pocket last September.

For species collectors and micromounters Terry Szenics had something new, and even pretty: the world's best specimens of **villyaellenite,** a hydrous manganese arsenate/arsenite whose only two known localities heretofore were Ste.-Marie-aux-Mines, France, and the Ojuela mine, Durango, Mexico. These are famous places, but now hopelessly eclipsed villyaellenite-wise by the Veta Negra mine, Pampa Larga district, Tierra Amarilla, Chile (source also of Terry's schneiderhöhnite of recent note). The pieces Terry collected here in the first week of November 1997 show beautiful sparkling pink seam coatings, on dark limonite, of 1-mm sheaves of villyaellenite microcrystals, with associated tiny spherules of dark red rhodochrosite. This serious specimen-mining operation turned up 275 specimens from a single pocket along a fault gouge; Terry was marketing them at the Main Show stand of *Aurora Mineral Corporation* (679 S. Ocean Ave., Freeport, NY 11520).

John Attard of *Attard's Minerals* (P.O. Box 17263, San Diego, CA 92177) had a few very nice, small thumbnails—to 1.5 cm high—of gemmy, medium blue-green, twinned **phosphophyllite** from Cerro de Potosi, Bolivia. More remarkably, he had a *matrix* miniature of phosphophyllite, with flat-lying gemmy crystals to 7 mm all over the top of a 3.5-cm plate of reniform black cassiterite.

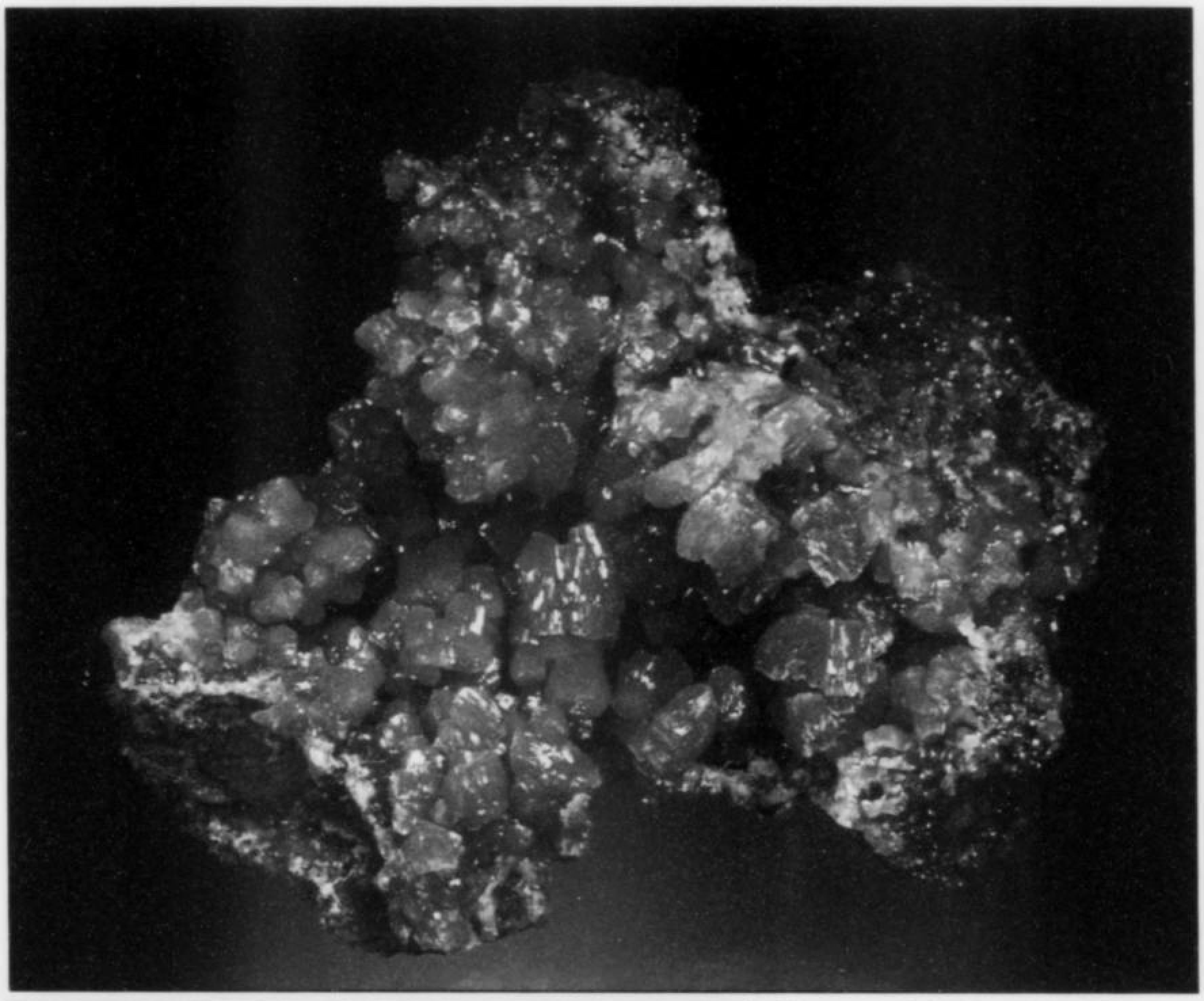
Here and there around the show, one saw some interesting specimens of Japan-law twinned **quartz** crystals in solid coatings over a gray-green amphibolite, from the Kami mine, Cochabamba Department, Bolivia. The one I liked best is a flat 17-cm plate with individual crystals to 1.5 cm, offered by Jaroslav Hyrsl. What's remarkable is that this ordinary-looking (at first glance) plate of quartz is seen to consist *entirely* of Japan-law twins, hundreds of them, all over the matrix expanse. Jaroslav also had a few other such pieces, in sizes down to 3 x 4 cm. Reportedly, fine ferberite crystals have also been found at this tungsten mine.

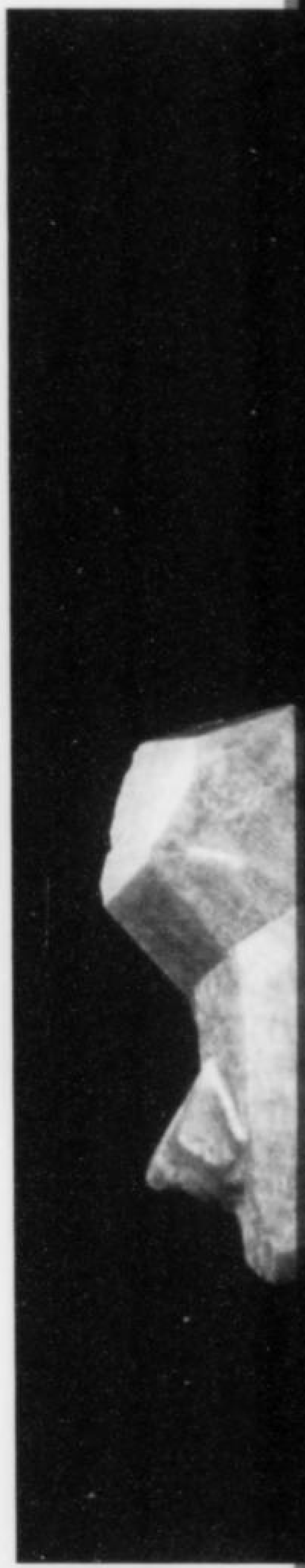
Like the lovely yellow Nevada barites, the **azurite/malachite** specimens from Seabra, Bahia, Brazil made a tentative foray last September to Denver, and with some puzzlement I mentioned them: in the case of the azurite I had only a single specimen then to describe. Well, Tucson this year saw an upwelling of Brazilian azurites, many dealers having nice ones, most notably *Roberts Minerals*, Benny and Elva Fenn (*Fenn's Gems & Minerals*, P.O. Box 16285, Las Cruces, NM 88004), and Riccardo Prato (see later under Thai mimetite). Whether as thumbnails or as Riccardo's 35-cm mammoth, these specimens feature a deep blue azurite in tiny blades grouped in tight spheres 5 mm to 2 cm across. Alteration to malachite is irregular, with some spheres totally gone to a rich deep green, some merely dusted with green spots, some split blue/green down the middle. The loosely packed, velvety, colorful agglomerations of spheres make mighty attractive pieces, though nobody still seems to know anything about the occurrence.

From Denver I also wrote that loose fishtail twins of pale yellow, gemmy **amblygonite** from "Linopolis" seemed suddenly to be all over the place, and every last one was seriously chipped on the thin edges. In Tucson these were still plentiful in all sizes, and still badly chipped in almost all cases; I had decided against a repeat write-up *until* I saw the marvelous monsters that Frank and Wendy Melanson of *Hawthorneden* had stashed in a flat at the Main Show. The Melansons got a chance to highgrade at just the right time, and came out with about 15 relatively undamaged pieces, the largest of which is 5 x 7 x 8 cm, pale yellow and largely gemmy, with a deep twinning notch, and altogether exceptional. A slightly smaller specimen is the only one showing any associated species: a doubly terminated 3-cm smoky quartz crystal half-embedded on top. Further, the Melansons had what they say is a reliable locality designation: the Joan Firmino mine, Pomarolli (near the village of Linopolis), Minas Gerais. Carlos Barbosa, by the way, seems sure that the species is really **montebrasite,** but no definitive work seems to have been done yet.

Blue-black bipyramidal **anatase** from the Alpine fissure occurrence at Hardangervidda, Norway has been around for at least 20 years, but Cal Graeber at his Main Show stand had the most impressive small lot of these I've seen for a long time. The crystals are fat, lustrous, largely undamaged, of a color like that of dark

Figure 2. Pyromorphite, 9.1 cm, from the San Andres mine, Vilaviçiosa de Córdoba, Córdoba, Spain. Dave Bunk specimen; Jeff Scovil photo.





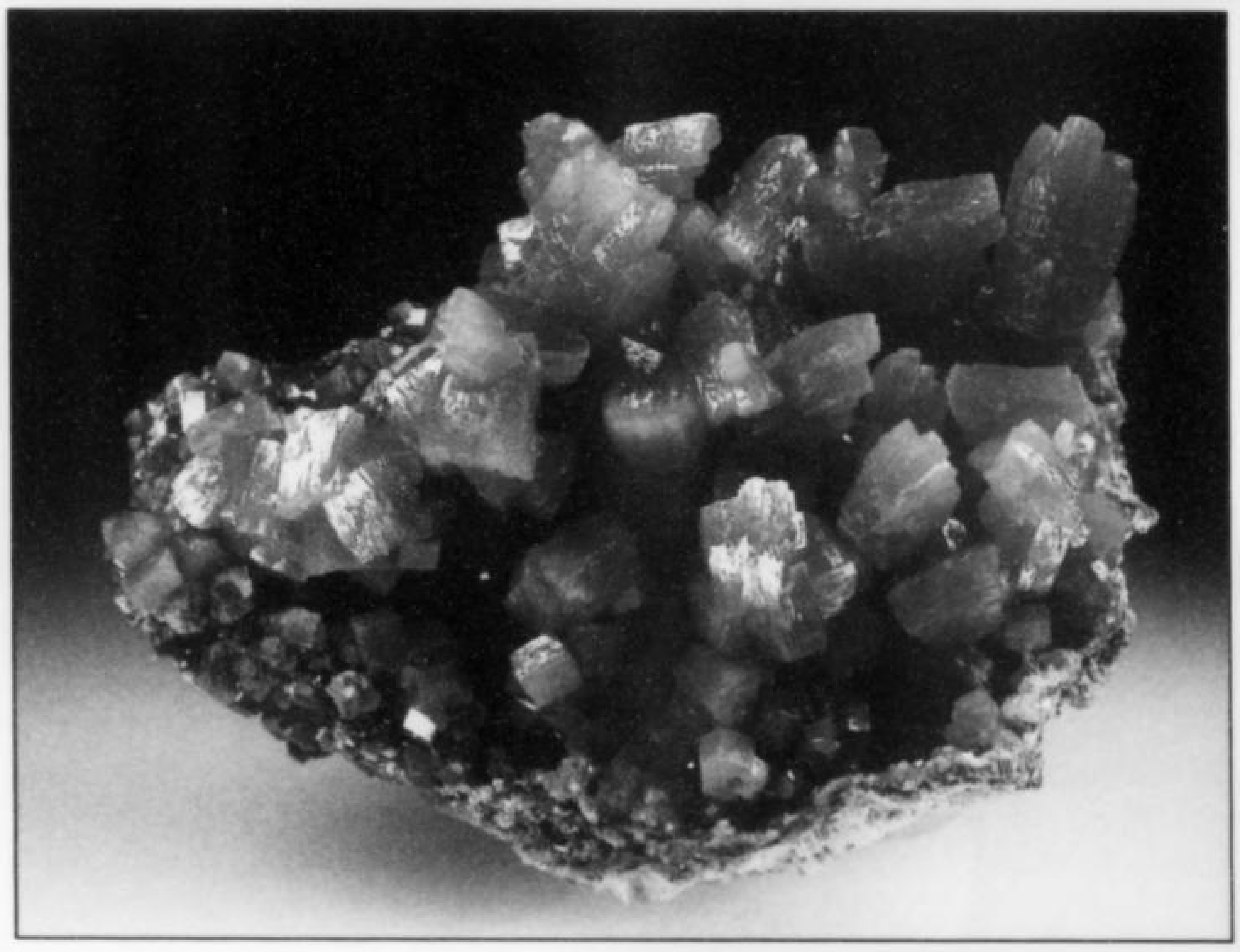


Figure 3. (left) Pyromorphite, 6.4 cm, from the San Andres mine, Vilaviçiosa de Córdoba, Córdoba, Spain. Dave Bunk specimen; Wendell Wilson photo.

Figure 5. Gold, 2.4 cm, from the Mockingbird mine, Mariposa County, California. Bryan Lees specimen; Jeff Scovil photo.

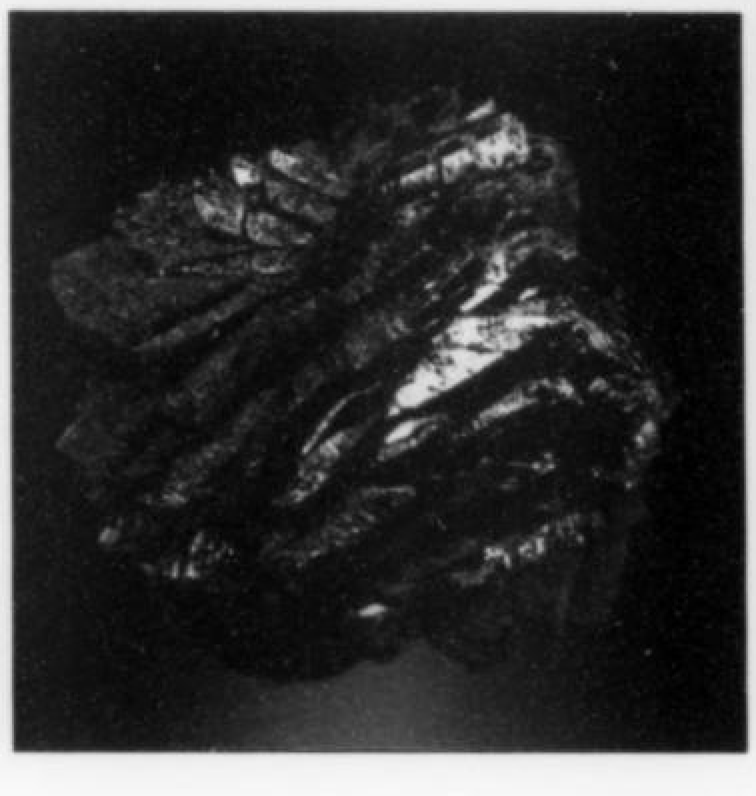


Figure 4. Azurite, 3.5 cm, from Morenci, Arizona. Laura Thompson collection; Jeff Scovil photo.

Figure 6. **Microcline and smoky quartz, 31.5 cm, from the Tree Root pocket, Two Point claim, Teller County, Colorado. Bryan Lees specimen, displayed at the Tucson Show; Jeff Scovil photo.**

Figure 7. **Smithsonite, 17.8 cm, from the Santa Anita mine, Choix, Sinaloa, Mexico. George Witters specimen; Jeff Scovil photo.**

boleite, and are 1.5 to 2.5 cm long and 1.5 cm thick. Most are doubly terminated by small pinacoid faces. In about ten wonderful thumbnails ($500 to $700), these anatase crystals lie comfortably across small matrixes of white albite on grayish micaceous rock. Cal's indeed were almost as superfine as those in the exhibit case put in by the Norwegian Mining Museum.

A much older Scandinavian classic is **cobaltite** in lustrous, slightly rough pyritohedrons from Tunaberg, Sweden. In the Executive Inn, Peter Lyckberg (Box 25147, S-40031 Göteborg, Sweden) had about 20 such loose, sharp cobaltite crystals, mined in the 19th century, in a classy little swarm on his shelf. All but two are 5 to 6 mm across, but one tight cluster of two or three pyritohedrons is 1.5 cm, and the prima donna is a sumptuous, 2.5-cm metallic pinkish gray floater group (for $1100).

Jordi Fabre (in his "fishbowl" booth in the main lobby of the Executive Inn—his flyer shows a swimming fish with Jordi's face on it grinning out from a bowl) kept busy mostly by selling Spanish pyromorphite (next paragraph); but I found interesting, too, the 20 or so miniatures of newly mined **pseudomalachite** from Vilaviçosa, Estremoz, Portugal. These are sparkling, intense bluish green crusts of microcrystals lining seams in tough quartz/limonite matrix, some also harboring microcrystals of the extremely rare trimorph **ludjibaite.**

But it was Jordi's **pyromorphite,** flashing a vibrant yellow-green, that compelled about ten top collectors to line up in the lobby before his opening Saturday morning. The locality is the Realces Stope, San Andres mine, Villaviciosa de Cordoba, Spain, where this new pocket lode was found last October. Jordi says that this is an old barite mine which ceased operations about 12 years ago; this is interesting, because about 10 years ago, at the Ste.-Marie-aux-Mines Show, I scored a nice pyromorphite from a small lot labeled merely "Villaviciosa de Cordoba." It is similar but not identical to the new ones: smaller crystals with darker color. And now my "old," enigmatic specimen has been joined by a "new" one, from this new pocket apparently further along the vein of bladed barite last worked long ago. Anyway, Jordi had about 200 specimens altogether, thumbnail to cabinet-sized, loose groups or matrix pieces with, in the latter, the pyromorphite crystals lightly attached to white barite and/or earthy medium-brown limonite. The crystals are mostly simple hexagonal prisms (a few are lightly hoppered), reaching 2 cm across the pinacoids; they are extremely lustrous, and their color a spectacular yellow-green.

Marshall Kovall of *Silver Scepter Minerals* (P.O. Box 3025, Kirkland, WA 98083) was pleased to be offering 10 specimens of "Eisenrose" **hematite** from the classic locality of Cavradischlucht, Graubünden, Switzerland—these found last summer by a well-known Swiss strahler, Theodosi Venzin. The hematite forms very lustrous, very black platy crystals (much-flattened rhombohedrons) to 4 cm across, lightly striated, and with tiny red epitaxial rutile crystals, as is typical. Thumbnails are simply loose groups of such plates, larger specimens feature an adularia matrix, but the best pieces, I'd say, are a couple of miniature floater groups, the senior one 6 cm across.

Cavnik (or Kapnik), Transylvania, Romania has long produced profusions of **barite** in many habits but I must still commend the 30 or so very large, old specimens that Chris Wright of *Wright's Rock Shop* bought recently in Europe. The color is a medium smoky blue, transparent on crystal edges, grading to paler or whitish, translucent to opaque blue below; the luster is brilliantly glassy. These are very thin blades in rosettes and coxcomb groups rising to points individually as they flare from the lightly intergrown masses of pure barite, like leaping blue flames; there is no matrix. The specimens range from 3 x 8 to 15 x 15 cm. This is a gorgeous variation on the often-played theme of Romanian barite.

The best place to go for Bulgarian minerals these days seems to be the hotel room of Alexander Dikov of *Intergeoresource Ltd.* (P.O. Box 66, 14040 Sofia, Bulgaria), where you'll find lustrous, stately galena groups flashing at you from every surface and corner. What's new this time is excellent **chalcopyrite** from the Mogila mine, Madan district, in very bright crystals to 1 cm, only slightly rough, standing up all over the matrix of lustrous, drusy black sphalerite. The chalcopyrite crystals were found in December of last year, and Dr. Dikov had about 50 thumbnails and small miniatures, plus one dramatic 17 x 17-cm plate, with sprays of needle quartz garnishing the sphalerite. Also, from the Stefanov mine near the city of Zlatograd, there have recently come specimens of **sphalerite** of an entirely different kind: groups to 15 cm across of rounded, 4-cm, brownish black crystals with a resinous luster, their interiors gemmy yellow-brown. I saw only 5 specimens of this material (which would be dynamite as gem stock, if you like weird gemstones). A final Bulgarian note: the Zvezdel mine, for which folks had high hopes after the fine brown **pyromorphites** began to come out of it, is past its pyromorphite zone, and may be closing soon. Odds are that the 50 or so specimens seen at Dikov's this time will be the last: the best of these are a couple of 10 x 10-cm quartz plates with 1-cm Bad Ems-like brown pyromorphite barrels perched precariously all over.

Morocco this time out did not come up with anything really *new,* but it did re-express itself lavishly through two old standby species—azurite and vanadinite. Magnificent, good-as-it-gets **azurite** specimens from the Touissit mine were all over the show, in all sizes, and one hesitates to single out individual dealerships, although I *have* to mention Horst Burkard's stunning miniature-sized clusters of flaring bladed crystals, and, at Evan Jones's new dealership (*Evan Jones Minerals,* 3520 N. Rose Circle Dr., Scottsdale, AZ 85251), some incredibly sharp, lustrous, clean thumbnails, so darkly colored as to appear jet-black.

Then there were Evan's couple of hundred specimens of **vanadinite,** dug just weeks before the show, from the ACF mine, Mibladen, Morocco. The clean, unhoppered, hexagonal prisms reach 3 cm high, and are vividly lustrous and ideally sharp, but what's distinctive about them is their color, or colors: bright red-orange on the basal faces, but a sort of satiny, mottled, smoked-looking, brownish red on the prisms. Also unusual, for Moroccan vanadinite, is an elongated (rather than squashed) *c* axis, such that most crystals tend to be as much prismatic as tabular. Matrix, where present, is either the classic white bladed barite or a buff-colored calcareous sandstone. Specimens range from large thumbnails and toenails, to loose, 3-cm crystals groups and on up to 11-cm matrix pieces with 3-cm single crystals all over.

Now you may say that large **grossular** garnets from the desertlands of the Republic of Mali are neither new nor particularly exciting, but this show saw a general flood of Mali garnets of a new color—pale to deep green—and with a new locality designation: simply "Kayes, Mali." Is this a new occurrence, or a new strike at the old one? Occasional associations of dark dull-lustered epidote and rough vesuvianite crystals would suggest the latter case, though who knows? Not anyone here whom I asked. Anyway, the best specimens are loose dodecahedral singles or tight clusters of two or three crystals, with individuals reaching 5 cm. They can be fairly lustrous, although their surfaces are always pitted at least a little; in their transparent to translucent near-surface zones they are a pleasant apple-green, grading to a Siberian-style oily green. Here and there I saw a few thumbnail single crystals of a much brighter and prettier grass-green, reputedly also from "Kayes." By far the largest hoard of these garnets—hundreds and hundreds—was to be found in the Executive Inn room of *Minerama* (49 Rue de la Republique, 42800 Rive-de-Gier, France).

Gilbert Gauthier at the Main Show and Michel Jouty in the Executive Inn were offering small lots of small specimens of malachite-included **barite** from the Shangulowe mine, near Likasi, Shaba, Zaire. I've mentioned this material before, but at both dealerships this time it set new standards of quality/beauty. The transparent, colorless barite crystals are up to 4 cm long, and are sharp and lustrous; inside them are cirrusy clouds of malachite which tint them green. Crystals make jumbled groups or subparallel clusters on massive, pale green malachite and/or dark brown gossan; Michel had about 50 pieces, mostly miniatures. The biggest one is 12 cm across.

Christian Gornick (*Fine Minerals Worldwide*, Reutergartenweg 20, D-31319 Sehnde (Höver), Germany) is a good-natured enough *Kerl* both to let me try to speak German with him and to ply me with coffee when I visit his Executive Inn room. This time he brought to Tucson about a hundred loose crystals, and two or three matrix specimens of a newly found **demantoid** (i.e., andradite) garnet from the Namgar mine, near Usakos, Namibia. These were brought to Europe in January 1997 by the Henn Brothers firm of Idar-Oberstein, though the first handler, it's said, was a shepherd who brought specimens to a man in Usakos about two years ago. These crystals are prime gem stock (having no "horsetail" inclusions like those found typically in demantoids from Val Malenco, Italy and from Russia), and so most of those found have already been butchered, I mean cut and faceted. The crystals show combinations of isometric forms, reach 2.5 cm across, and are wholly gemmy, in colors between grass-green and peridot-green. In the rare matrix specimens, garnet crystals of this description sit nicely on and in white calcite and weathered limestone.

Before leaving Africa, I must celebrate a one-of-a-kind specimen brought by Bryan Lees, owned now by a lucky private collector who bought it from him. It is from the N'Chwaning mine, South Africa, and must be absolutely the world's finest specimen of **hausmannite.** We're used to seeing this material as large, bristly, dull or medium-lustered compound black octahedral crystals on massive garnet matrix, and these are remarkable enough for the species. This new piece, though, consists of a 10-cm matrix of massive black hausmannite, with, sitting alertly perched on one side, a 4.2-cm hausmannite crystal of razor-sharp form, brilliant metallic black color, high luster, and mirror-smooth faces. It is a star-shaped compound octahedron: try to imagine a hematite pseudomorph after a giant cumengite crystal and you will get the picture.

The ex-Soviet Union pickings were rather slim this time, for a worrisome third or fourth major show in a row. However, Andras Lelkes (Hercegprimas u. 11, H-1051 Budapest, Hungary) did have some excellent specimens of **anatase** from the Lapcha mine (100 km from the better-known Dodo mine) in the Polar Urals. They are very sharp, of the same deep blue color and bipyramidal form as the Norwegian crystals, and smaller but more highly lustrous. The Russian crystals average 8 mm, though one fine crystal sitting canted up on a prism face of a gemmy smoky quartz crystal measures 1.5 cm. The anatase crystals usually sit singly on or partly embedded in quartz crystal faces or in massive, translucent dark quartz. Some specimens show generous sprinklings of maybe 15 bipyramids over a single face. The Lapcha quartz mine stopped working commercially about 8 years ago, but is now picked at by specimen-freelancers off and on; the present pieces were dug last summer.

From a skarn deposit in an iron mine at Korshunovskoye, Irkutia, Siberia, **andradite** garnet has very recently come out in simple, sharp dodecahedrons to 4 cm across. They are greenish brown and fairly lustrous though slightly pitted; some are dotted with tiny second-generation crystals. These were available as floater singles or in clusters of two or three from Petr Korbel (*Eastern Minerals*, Vysokoskolska 488/8, 165 00 Praha 6 - Suchdol, Czech Republic), who also can show you some nice **hematite** from the same place, with lustrous black platy crystals to 3 cm in groups on massive hematite.

The great and super-prolific locality of Dalnegorsk, Primorskiy Kraj, Russia has produced some remarkable "red" **quartz** of late. Only three pieces were brought to Tucson by *Jeff and Gloria's Minerals* (19 Oak Knoll Road, East Hampton, CT 06424), but what glorious/oddball things they are: thin, translucent, pinkish orange quartz prisms to 5 cm in parallel-growth bundles, the bundles sometimes pinched at the middle to make bowties. The biggest and best specimen is 8.3 cm long. Also from Dalnegorsk were many very fine green **fluorite** specimens scattered among several dealerships.

In an Executive Inn room I spoke at length with Pavel Sobotka of *Intergems* (Lekarska 36/2, 150 00 Praha 5, Czech Republic) about some strikingly unusual **celestine** specimens, a dozen or so of which he had brought to Tucson. They are unusual in that this species doesn't generally make thin-prismatic, point-terminated, spiky crystals, but these lustrous, transparent pale blue beauties are as spiky as you could wish, reach 3 cm long, and occur in jumbled groups in cavities in a light brown, reddish stained limestone. The best I saw is a very attractive 7 cm piece for $75. The other odd thing is the locality: near Shurab (village), Firgana Valley, eastern Uzbekistan. It seems that the celestine crystals were first found by a group of mineralogy students visiting from Moscow in 1972. The site since then has remained popular among field collectors, and pieces have been taken out each summer; this was their debut on the Western market. Selling them in Tucson was a joint venture by Pavel and by Andrey Belyakov, publisher of *World of Stones*, and let's hope that the venture succeeds, as we could easily stand to see more of this pretty material at future shows.

François Lietard's big stand at the Main Show is always spectacular, as it was again this time: a fantasy of brilliant splotches of every bright color shot all through the 3-D architecture of the stacked glass shelving. Amidst all the flash, though, only two Himalayan items seemed noteworthily new this time. The first was a revisitation of the transparent, grayish green **zoisite** crystals from Ashudi, Pakistan which first appeared a few years ago. François had some nice loose thumbnail-sized clusters, with prisms to 2 cm, lightly striated and with good terminations on many; further, he had a couple of *matrix* specimens, one of these a giant 17-cm lump of pegmatite showing 6-cm *albite* (cleavelandite) blades and isolated semi-gemmy zoisite crystals to 5 cm lying flat along the top. François' second, humbler, new arrival was a lot of some 20 thumbnails and miniatures of colorless or very pale gray, transparent **calcite** scalenohedrons to 3 cm, with low rhombohedral terminations, rising from salt-and-pepper matrix of what looks like a weathered gneiss. These cute calcite pieces are from "near the airport" at Skardu, Pakistan. Thirdly should be mentioned what appears to be a new pocket of gemmy red **spessartine** this year from Gilgit, Pakistan. We've seen thousands of Gilgit spessartines on white feldspar in recent years, but the new ones are exceptionally lustrous, sharp and gemmy, in sizes up to at least a couple of centimeters. Andreas Weerth had some of the nicest examples, but several other dealers had good specimens as well.

On the China front, the gigantic green **fluorites** and poker-chip **calcites** are already, in this reviewer's opinion, beginning to seem over-abundant on the market; cassiterite, scheelite, and aquamarine of exceptional quality also are nothing new. But who can help being wowed by the sometimes unbelievably beautiful hematoid **calcite** twins from (according to most labels) the Shan Hua Pu mine, Hunan Province—even though these have been seen in

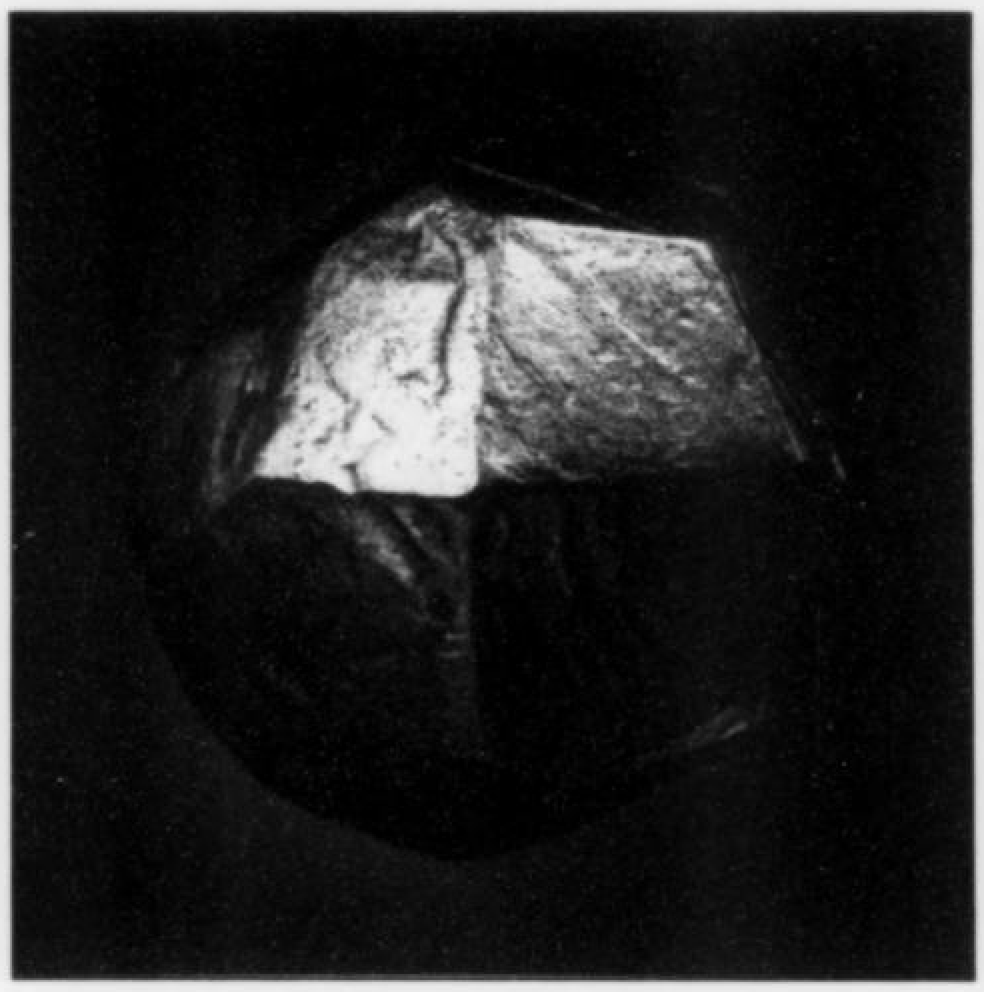


Figure 8. Gold, 2.1 cm, from the Gran Sabana district, Santa Elena, Venezuela. Roger LaRochelle and Jack Carlson specimen; Jeff Scovil photo.

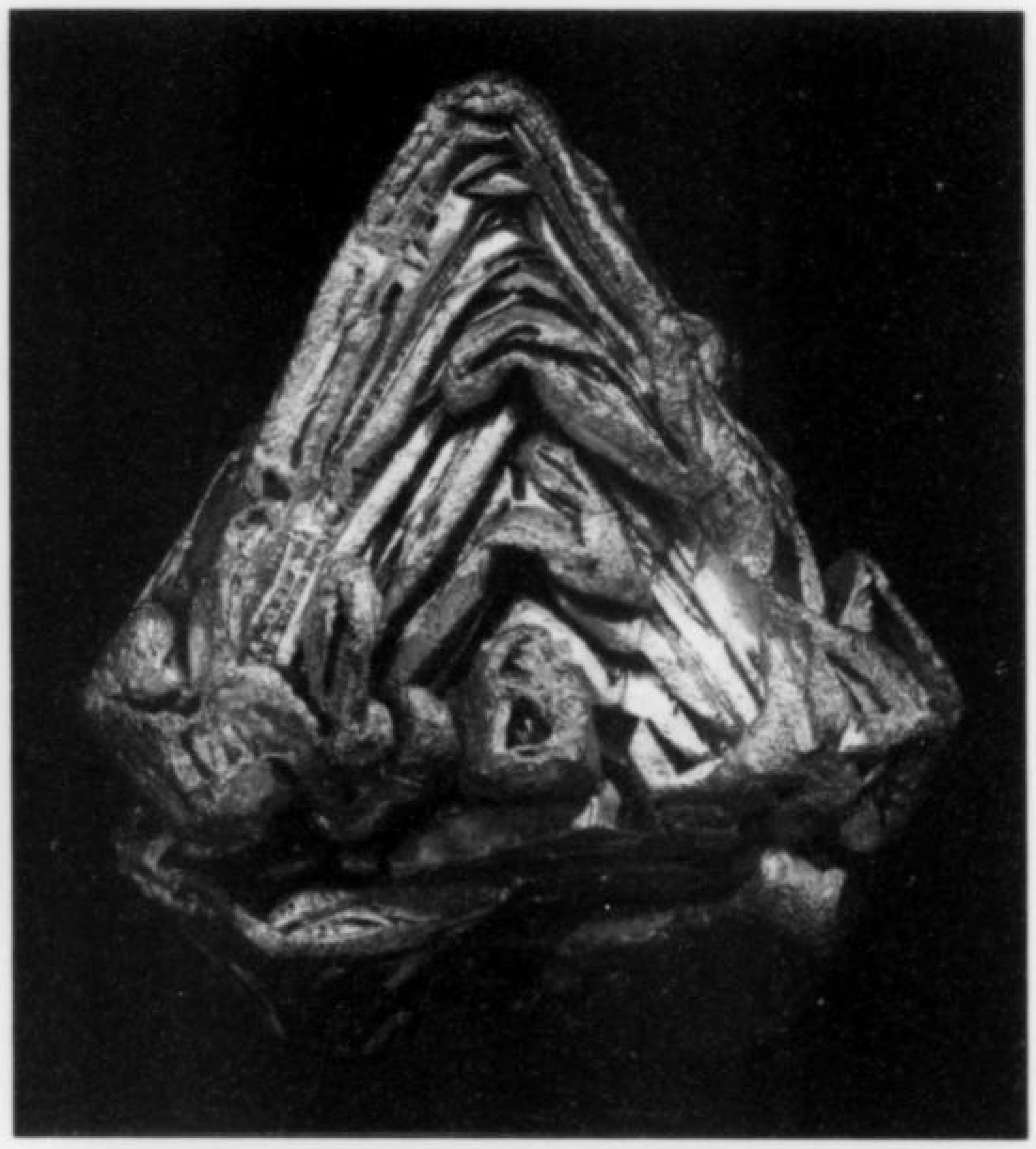
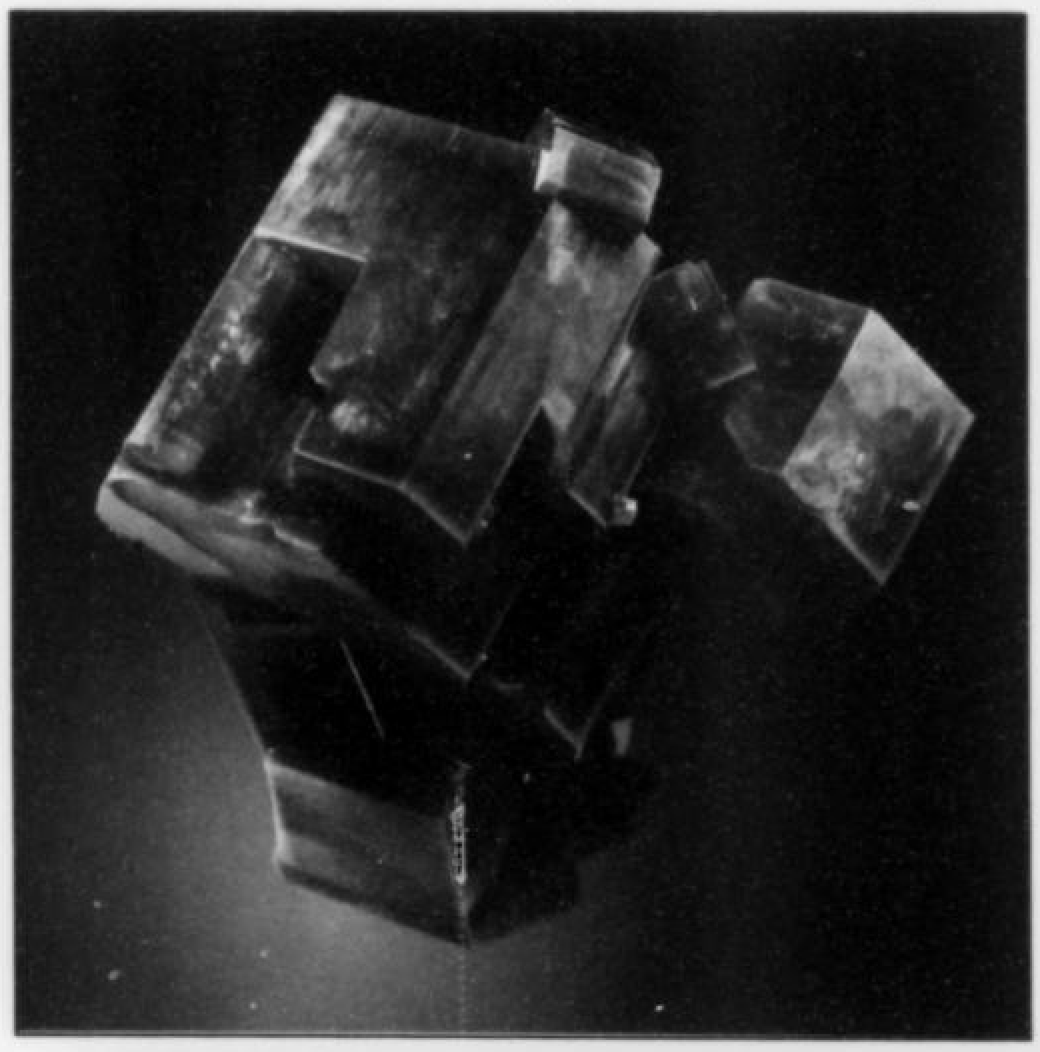


Figure 9. Gold, 5 cm, from the Gran Sabana district, Santa Elena, Venezuela. Roger LaRochelle and Jack Carlson specimen; Jeff Scovil photo.

Figure 10. Vanadinite, 3.6 cm, from the ACF mine, Mibladen, Morocco. Evan Jones specimen; Jeff Scovil photo.



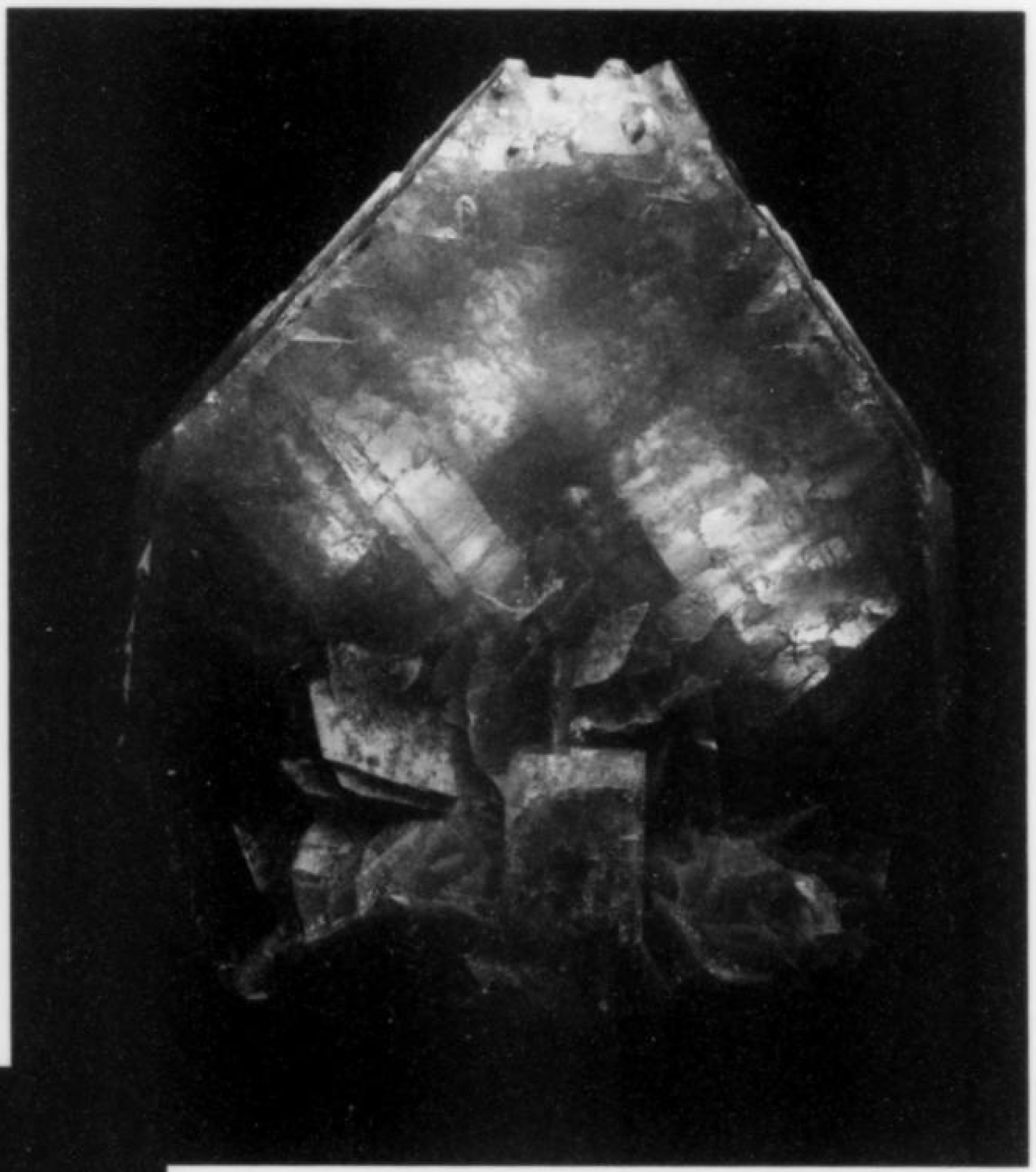


Figure 11. Barite, 15 cm, from the Barrick Meikle mine, Elko County, Nevada. Geoprime Minerals specimen; Jeff Scovil photo.

Figure 12. Calcite twins up to 6.2 cm across, on matrix, from Guiyang, Hunan, China. Bryan Lees specimen; Jeff Scovil photo.

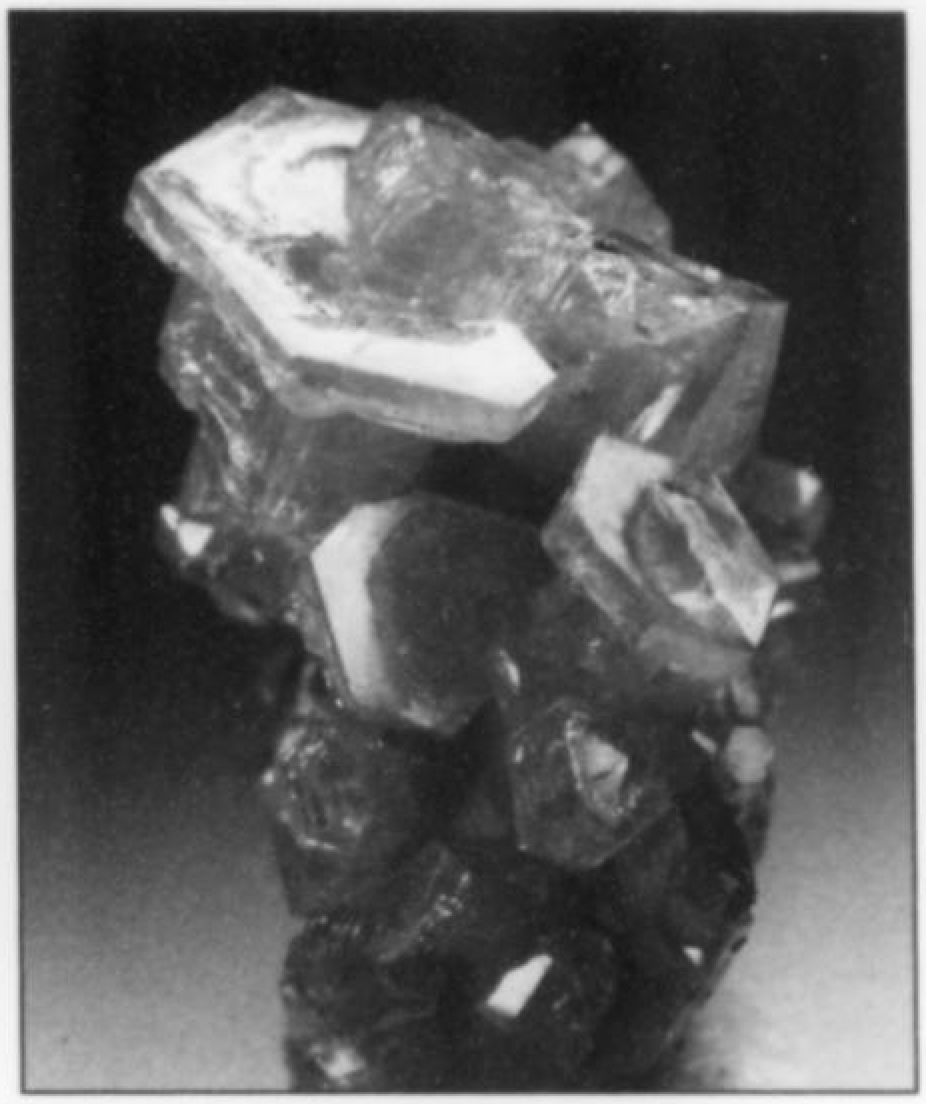


Figure 13. (above) Mimetite, 2.5 cm, from Hat Yai province, Thailand. Riccardo Prato specimen; Wendell Wilson photo.

Figure 14. Mimetite, 2.2 cm, from Hat Yai province, Thailand. Riccardo Prato specimen; Wendell Wilson photo.

Figure 15. Amblygonite, 8.3 cm, from the Joan Fermino mine, Pamarolli, Minas Gerais, Brazil. Hawthorneden specimen; Jeff Scovil photo.

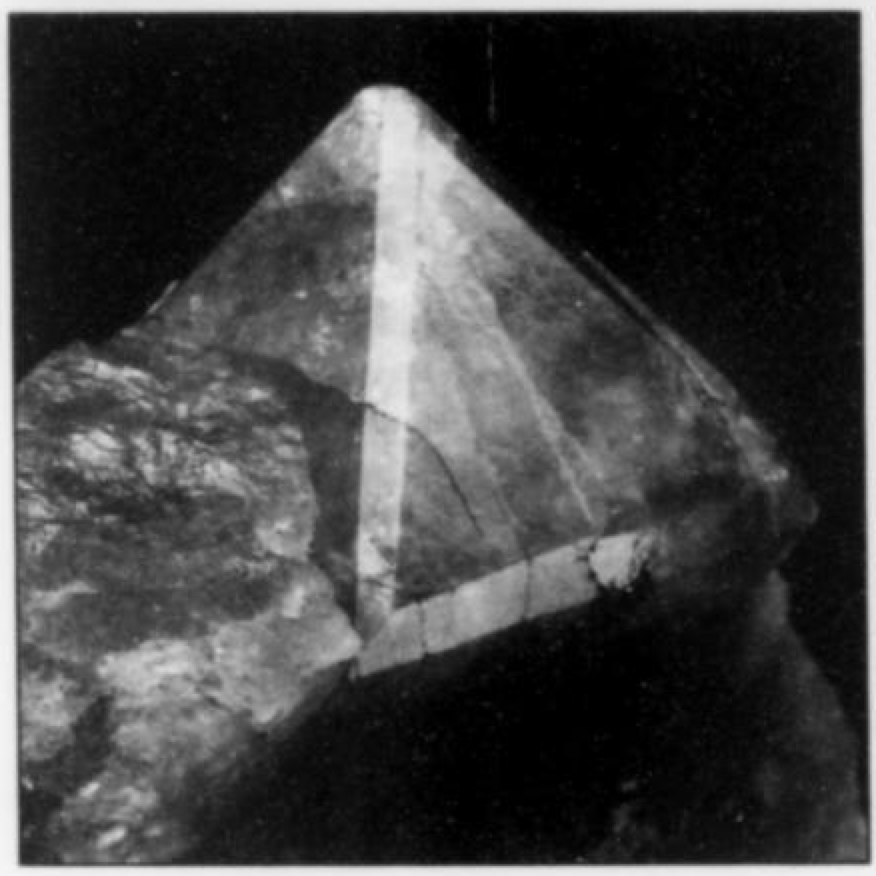


Figure 16. Rhodizite crystal, 2.3 cm, from Ampanivana, Sahatany Valley, Antsirabe, Madagascar. Jordi Fabre specimen; Jeff Scovil photo.

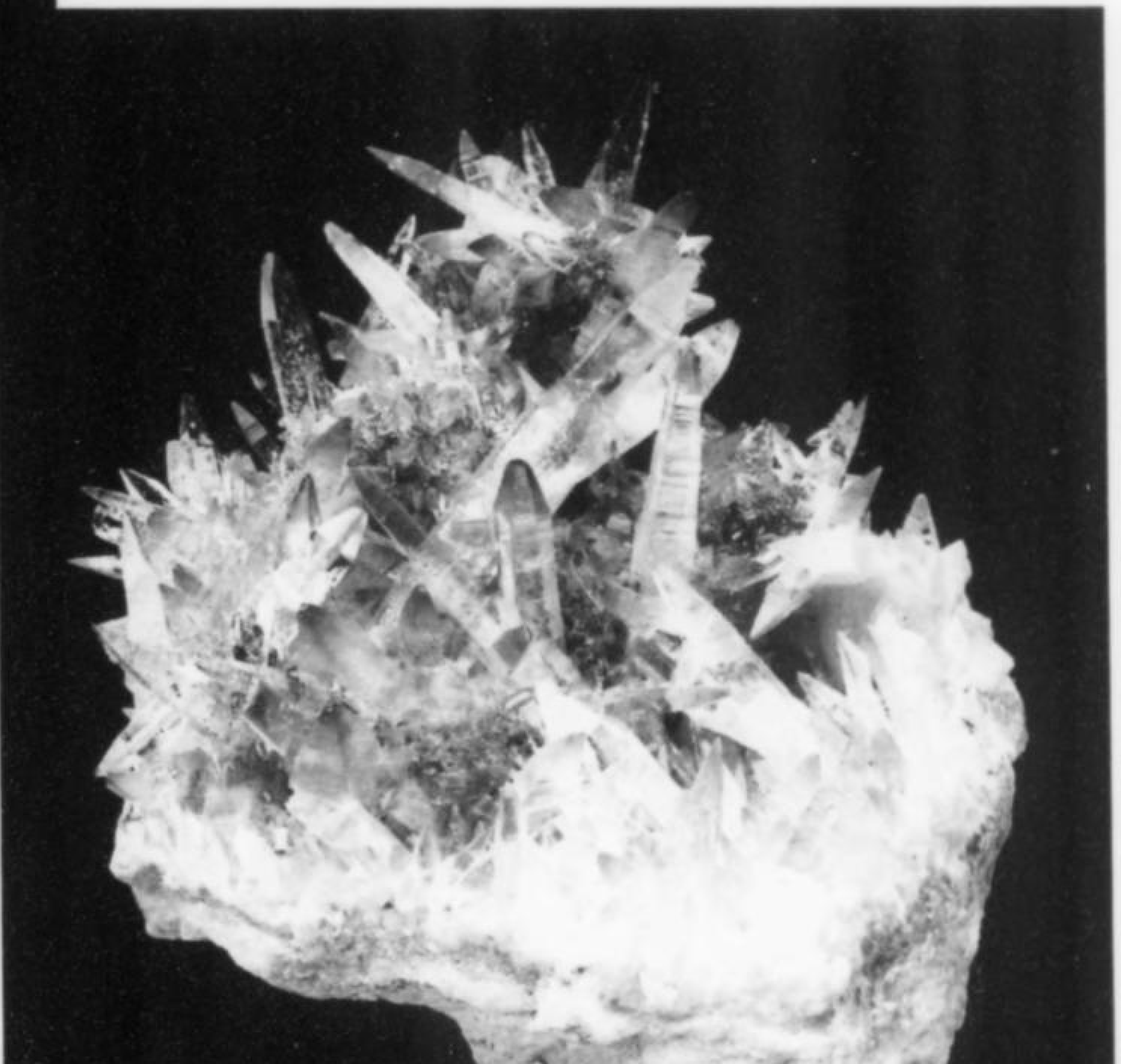


Figure 17. Celestine, 9 cm, from Shurab, Uzbekistan. Jürgen Tron collection; Jeff Scovil photo.

quantity at two or three shows now? There seem to be two styles: clear, thick, lustrous calcite prisms *not* heavily dusted with hematite, in twins with very discrete flaring wings, and the much more heavily reddened, more mashed-looking twins with shallow re-entrant angles. But both types occur on a matrix of spiky hematoid calcite scalenohedrons in dense drusy beds over red massive hematite. As far as I could learn, the best of these Chinese twin calcites in Tucson this year were some enormous pieces sold (before they could be set out on the shelves) by Dan and Jill Weinrich (16216 Copperwood Lane, Grover, MO 63040).

As I hinted at the start, a major what's-new at this show was the **mimetite** from Thailand which only two dealers had; the best available locality designation is Hat Yai Province, near the Malaysian border. I have seen photographs professing to show the site: a hole in a hillside in a green jungly place. Word is that the mimetite crystals were found sometime during this past year, in this old abandoned tin mine, or is it a lead prospect (the latter seems more likely, since we are talking about mimetite), and presently two Italian engineers (or are they geologists?) are digging for specimens. Indeed, the larger of the two lots in Tucson (with Jordi Fabre having the smaller) was in the Executive Inn room of Italian dealer Riccardo Prato, of *Gemmologi Gia* (Via dei Piatti 2, 20123 Milano, Italy): Riccardo had perhaps 10 cabinet specimens, a few miniatures, a few nice thumbnails and several flats of mediocre pieces. The matrix is a porous, gossany limonite; the mimetite crystals, lustrous and brilliant yellow, are hexagonal prisms, some hoppered and some not, the "clean" ones showing small pyramid and pinacoid faces, to about 5 mm. These crystals densely cover the matrix, flashing away at the viewer. Most of the specimens show some damage, but the potential is excellent for more and better in the future.

To end on a comparatively light note from Down Under, Chris Payne of *Gondwana Gems & Minerals* (6 Parkview Drive, Blakeview, South Australia) was able to cover several square feet of a table in his room in the InnSuites with a new find of **glauberite** crystal specimens, taken out of Like Gillies, Lochiel, South Australia, between 1988 and 1991. Collecting, he says, involves slogging horribly through the black mud of a salt flat, and rumor has it that the company which owns the land will forbid collecting within the next six months. Anyway, there were about 100 crystal groups, in all sizes up to 10 x 10 cm (fine thumbnails run $2 or $3), with very sharp, transparent to translucent gray-white glauberite blades to 3 cm. Some of the blades have thin, chalky white incipient-alteration coatings or spots of hydrated glauberite, probably because the specimens have already been out of the ground for awhile, so a cautious optimism that they'll stay as they now are seems warranted.

As to the **exhibits** at the Main Show . . . every time I do this, I wonder how it is possible, and how presumptuous it's going to feel, to "cover" all these exhibits in just a few tight paragraphs at the fatigue-end of this report and of my show experience. Let's see . . .

One of the show's two themes was Alpine minerals—not necessarily from the Alps, understand: these cases taken together offered solid mineralogy lessons in Alpine-fissure environments in low-grade metaphorphic rocks. To my taste, it was two great institutions which did the best jobs with this theme: the American Museum of Natural History (New York) and the Smithsonian. In the American Museum's case, old classic specimens, mostly from the Bement collection, taught the visitor to respect Alpine-cleft (and, as it happens, Alpine) rarities like scheelite, perovskite, milarite, and brookite; and here were four of the world's best brown anatase crystals, all from Alp Lercheltini, Valais, Switzerland. The Smithsonian put in two sprawling cases designed by Paul Powhat, with enlarged photographs of Swiss vistas to help the ample texts to explicate the specimen wonders. In one of the cases, these wonders were all of quartz, with ultimacies of Swiss gwindels and La Gardette mine, France clear crystal clusters; in the other case there were fabulous specimens of epidote, axinite, titanite, hematite roses, and even some sharp, iridescent, 3-cm chalcopyrite crystals on quartz clusters from La Gardette. Oh yes, and a third major museum, that of Los Angeles County, had a starkly simple but extremely handsome case with just three specimens in it: enormous epidote best-of-the-best pieces from Untersulzbachtal, Austria; Rehoboth, Namibia; and Tormiq, Pakistan.

Pursuing the Alpine theme from further distinctive angles, Harvard showed some amazingly good albite, titanite, fluorapatite and epidote from the Old Bluestone quarry, Acushnet, Massachusetts. The Norwegian Mining Museum of Kongsberg showed "Alpine Minerals from Norway," including a 3.5-cm anatase crystal on adularia matrix from Hardangervidda, and a couple of wonderful thumbnails of seldom-seen brookite from the same place; the Museum of Natural History, Milan had two cases with, among other things, a 30-cm plate of amphibolite covered with gemmy lustrous demantoid crystals to 3 cm, from Sferlum, Malenco Valley, Italy.

The other—somewhat overlapping—theme was fluorite. "General" fluorite cases full of fine specimens were contributed by the Colorado School of Mines, Harvey Gordon, Henry and Patsy Schmidt, the Houston Museum of Natural Science, and several others. Cases on fluorite subthemes included Crystal Forms in Fluorite (Ed Huskinson Jr.), Illinois Fluorite (Paul Harter; also the Cleveland Museum of Natural History), German Fluorite (Kay Robertson), Worldwide Fluorite Thumbnails (Sharon Cisneros), Elmwood Mine Fluorite (Gaylord's Minerals), Canadian Fluorite (Wendy and Frank Melanson), Fluorite from the Former Soviet Union (the Carnegie Institute), English Fluorite (Cincinnati Museum of Natural History), Faceted Fluorites (Art Grant), and finally a whomping case of Pink Fluorites, with several huge specimens, including "Georges," an 18-cm-wide composite pink octahedron collected above Chamonix in 1975.

There was also, of course, the usual bedazzlement of miscellaneous cases on miscellaneous themes—including, I can't help noting, what seemed an *unusually* large number of superlative cases of thumbnails, competitive and not. To skim quickly (though they deserve better) over some of these assorted exhibits, there were Calcite Twins (Gene and Doris Wright), Mexican Minerals (Evan Jones), Transylvanian Minerals (Camelia Hightower), Arizona Minerals (the Arizona-Sonora Desert Museum), and the following three, demanding a bit of verbosity after all. *Collector's Edge* offered a repeat performance of the "That's Colorado" case seen at Denver, except that this time one of the four mega-specimens was the best of the microcline/smoky quartz pieces from the recent work at the Two Point mine, Teller County: a majestic 45-cm cluster of intensely blue-green blocky microcline crystals to 5 cm, with two 8-cm smoky quartz prisms in its midsection. There was a super case on the Himalaya mine, Pala, California, marking the 100th anniversary of the beginnings of work there, with pieces contributed by many people and institutions. It contained great elbaite specimens, naturally, but how many people noticed that terrific, shining, sharp brown thumbnail of stibiotantalite? Giuseppe Agozzino of Genoa had a wonderful case of mostly self-collected pieces from the Italian Alps: brilliant grossular ("hessonite") in lush deep orange, diopside, vesuvianite, etc. from famous places like Bellecombe, the Ala and Susa Valleys, and Beigua Mountain, this last the source of an amazing gemmy red/brown/orange hessonite garnet fully 3 cm wide, sitting alone on matrix.

Finally, our editor and publisher, Wendell Wilson, deserves his own paragraph for having put in his first show exhibit in many years: almost the entirety of his collection of 82 miniatures and thumbnails which he has been carefully building since I first began coming here, i.e. only since 1992. Wendell has, to put it mildly, a good aesthetic eye, and thus the viewer's own eye lingers long on practically every piece, and the longer the lingering, the better seems the specimen in question: for instance, his Mexican ludlamite, Russian sperrylite, Afghanistan lazurite, Yukon lazulite, Russian pyrochlore, Sweet Home mine rhodochrosite . . . I'd better stop now, for more or less obvious reasons (but no, he's not *making* me write this part).

Awards

The **Lindstrom award** for best individual specimen in the show went to Phoenix collector Bob Johnson for his Freiberg silver. Bob *also* won the **Desautels Trophy** for best case of minerals; I spent a long time studying each superb specimen in his collection, and have to agree the award is well-deserved. The newly established **Romero Award** (in memory of the late Miguel Romero, Mexico's pre-eminent collector) honors the best Mexican specimen exhibited at the show. The choice was easy this year, since Sorbonne curator Pierre Bariand had brought the Great Boléo Cumengites from Paris to exhibit in a wonderful case of Boléo memorabilia and minerals. And finally, the exalted **Carnegie Mineralogical Award** was presented to none other than Bryan Lees of *Collector's Edge*, in recognition of his mind-boggling accomplishments in specimen recovery and preservation. Bravo Bryan!

Then it was time finally to conclude the annual experience of total-immersion mineralogy. At exactly 5:00 pm on Sunday an announcer over the Convention Center's public-address system pronounced the 44th Annual Tucson Gem & Mineral Show to be officially over, and was greeted by rousing applause for a successful event all around. The dealers packed up their remaining stocks for shipment home, most of them with smiles reflecting pretty good sales. Housekeeping staffs went to work on vacated motel rooms; collectors, curators and dealers packed up their display-case specimens; dealer booths came down and their parts were packed away for next year; a vast fleet of rental cars were returned; plane tickets sprouted in countless hands; and Tucson returned to its usual casual pace for another 11 months. But by our return next February, it will seem like we've hardly been gone at all. See you then!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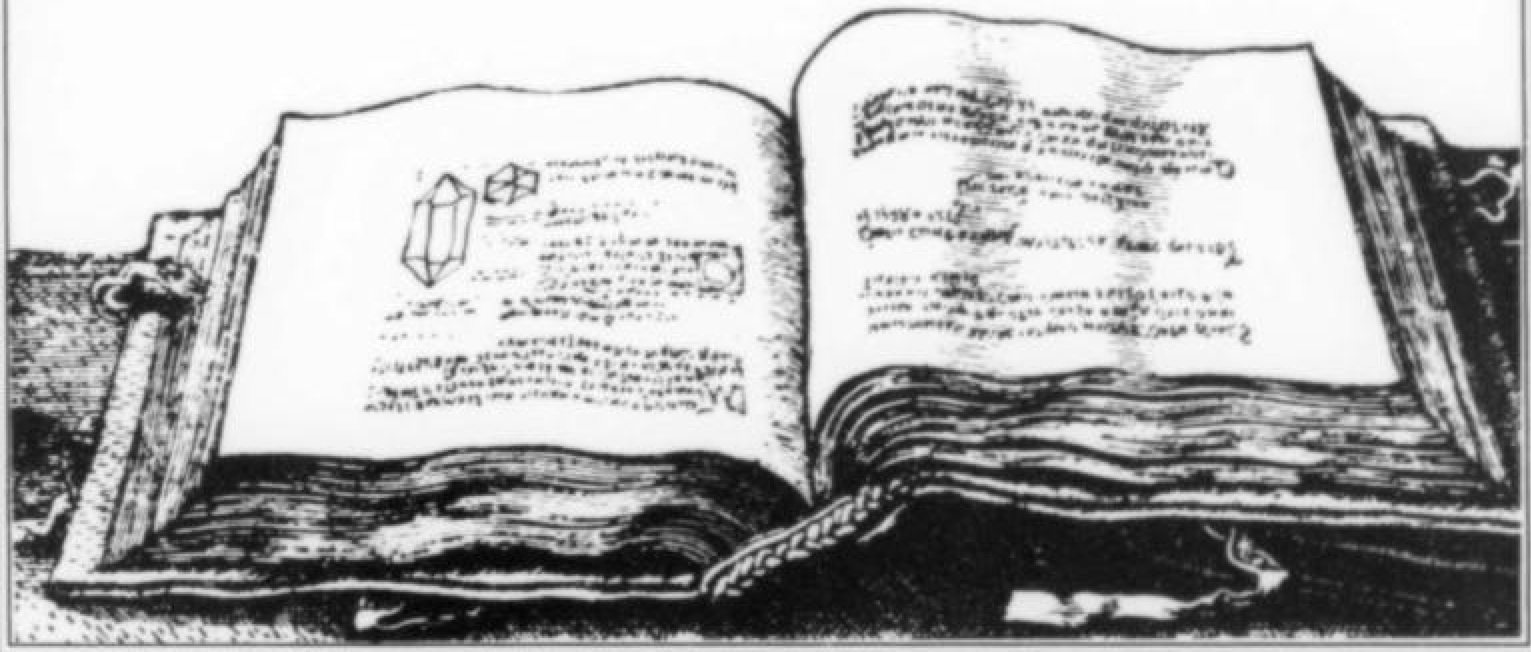
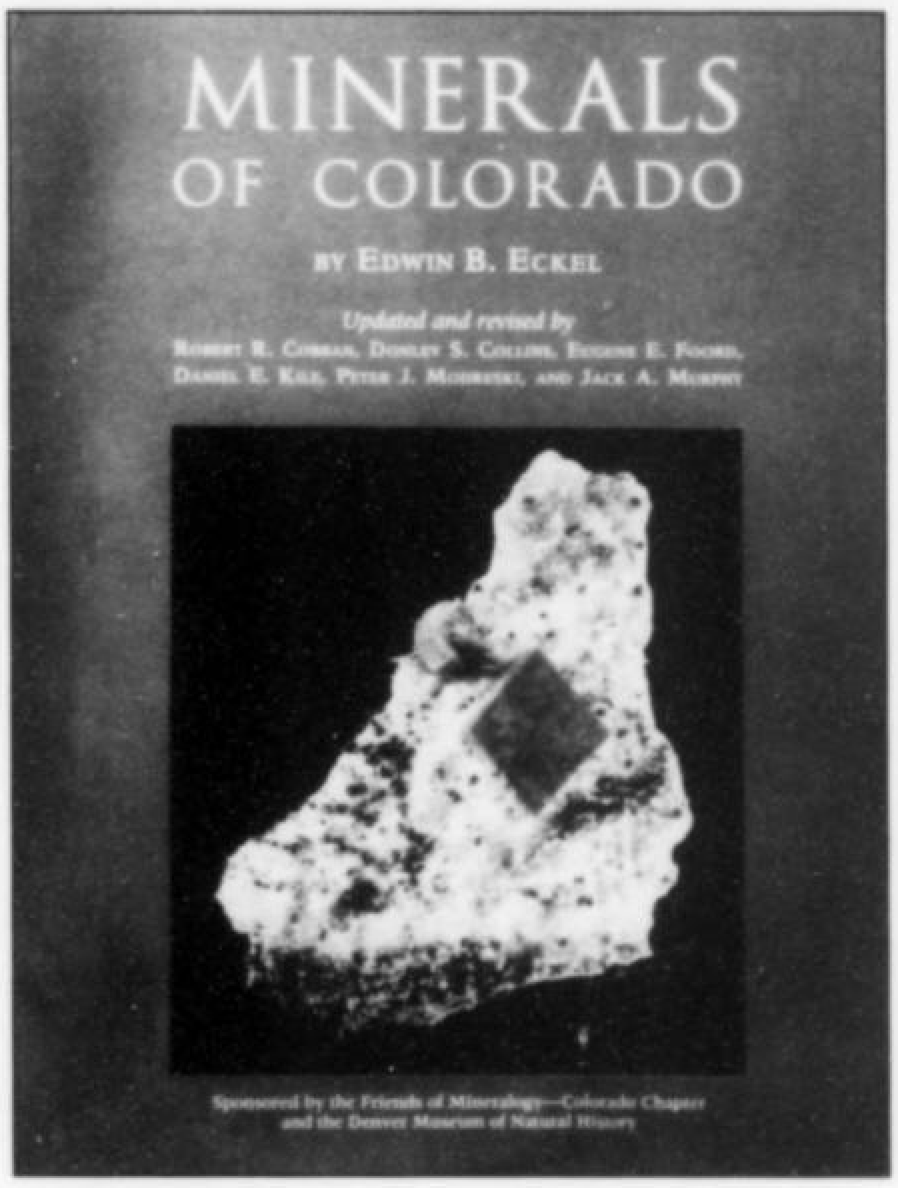
Book Reviews





Minerals of Colorado

by Edwin B. Eckel, updated and revised by Robert R. Cobban, Donley S. Collins, Eugene E. Foord, Daniel E. Kile, Peter J. Modreski and Jack A. Murphy; photography coordinated by Raymond E. Berry and Daniel E. Kile; Cartography coordinated by William Chirnside; Edited by Shirley K. Mosburg. Published (1997) by Fulcrum Publishing, 350 Indiana Street, Suite 350, Golden, Colorado 80401; sponsored by the Friends of Mineralogy—Colorado Chapter, and the Denver Museum of Natural History. Hardcover, 8.5 x 11 inches, 665 pages, plus 145 photos on an additional 40 pages, ISBN 1-55591-365-2, $150 plus $4 shipping in the U.S.

Edwin B. Eckel (1906–1989) spent 30 years compiling information on the minerals of Colorado, covering the period 1858–1958. The result was a competent, convenient-to-use, well-referenced guide published in 1961 as [U.S.] Geological Survey Bulletin 1114, *Minerals of Colorado, a 100-Year Record.* Eckel described the occurrences of 445 species at 93 localities, backing this up with approximately 800 references.

What a pleasure it is to finally see a major update of that important work, meticulously compiled and referenced, in the original format, listing species alphabetically and discussing the occurrences in geographic order (by county). The new work is substantially larger due to the intensive mineralogical and geological work done in the state and published since 1958. Total species have risen to 774 (a 74% increase), and there are now over three times as many references (2,500+). In terms of content, the work has more than doubled in size, from something over 200,000 words to about 500,000 words . . . that is a lot of science and a lot of data considering the concise format of the writing!

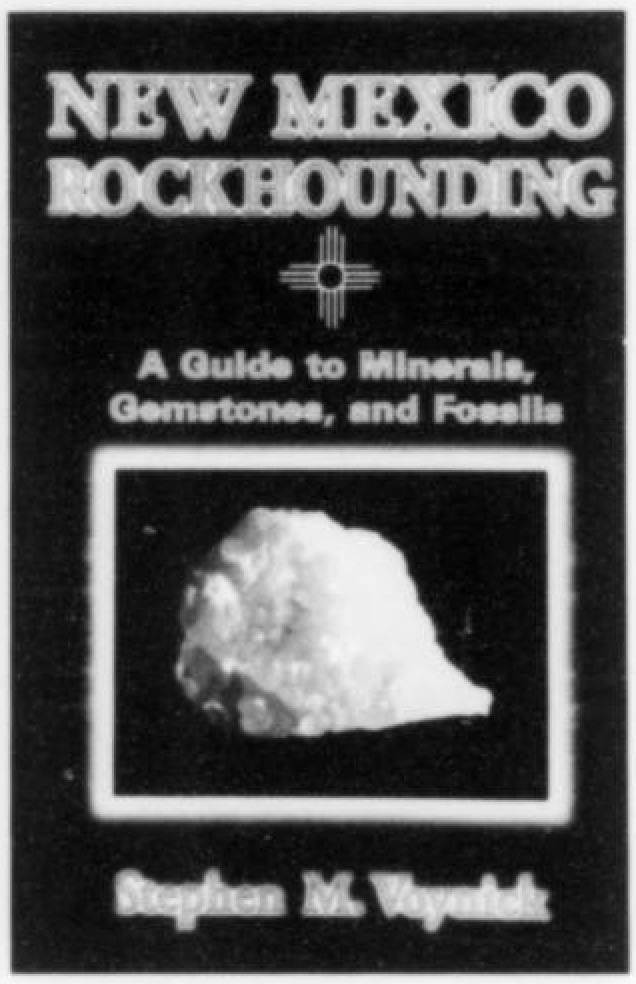
The 131 most important localities (up from 93) are discussed county by county, as in the previous edition, and detailed maps are provided which pinpoint the localities. These occurrences, along with many others, are referred to in the species descriptions, which take up the bulk of the book. The species descriptions give name, formula, crystal system and sometimes mineral group; other standard data (hardness, streak, density, etc.) are wisely left to other reference works, as this book is too big and heavy to be considered a "field guide." Individual descriptions give localities, references, and in some cases a physical description of the crystal size, habit and color as well as associated species, and geological notes pertinent to or characteristic of that particular occurrence. In a few cases there are even notes on the current disposition of important specimens. Varietal names are properly cross-indexed to a discussion under the correct species name.

One hundred, nineteen color specimen photos of good to excellent quality are included to showcase the beauty of the state's minerals, along with 26 scanning electron micrographs of very small crystals. The photos and the specimens are well chosen, although the potential for showing fine Colorado minerals is far from exhausted by this 40-page spread.

In addition to being well-researched and well-illustrated, the book is also well-published. The dust jacket is attractive, the hardcover binding is a nice, dark red buckram with tastefully designed gold lettering, and the binding is in sewn signatures (so that the pages won't fall out with use). The paper is of a high quality, with good thickness, strength, opacity, feel and "tooth" (meaning that it takes ink well and shows the color photos well), with an almost glossy but still soft luster. This is a book which, at over 6 pounds, will put quite a dent in your chest if you try to read it in bed.

Minerals of Colorado is one of those basic topographical mineralogies that should be present in the library of every serious mineral collector.

Wendell E. Wilson



New Mexico Rockhounding

by Stephen M. Voynick. Published (1997) by Mountain Press Publishing Company, P.O. Box 2399, Missoula, MT 59806. Softcover, 6 x 9 inches, 312 pages, ISBN 0-87842-360-5, $23 postpaid.

New Mexico is one of the few states left where field collectors may roam relatively unimpeded over thousands of square miles of mostly government land rich in mineral occurrences. Consequently, a new guide to some of those widely scattered localities is always welcome. In *New Mexico Rockhounding*, author Stephen Voynick gives details on more than 150 localities for minerals, rocks, lapidary rough and fossils.

A brief summary of the geology and mining history of the state is followed by useful notes on collecting legality, safety and responsibility. Then comes the real meat of the book, a county-by-county listing of localities, campgrounds, ghost towns, mining districts and mineral museums, accompanied by good sketch maps. Most of the important localities are covered: the Pine Canyon fluorite deposit, the Kelly mine, the Smokey Bear smoky quartz claim, the Stephenson-Bennett mine, Point of Rocks mesa, the Tyrone pit, Mina Tiro Estrella, the Hillsboro district, the Hansonburg district, the Harding pegmatite and others. Some are noted only briefly, and others are given up to several pages of discussion.

It should be remembered that this is basically a "rockhound's" guide rather than a manual for the really serious mineral collector. Dozens of localities are described which yield little other than agates, poor fossils, interesting rocks, cutting material, and other flotsam of no interest to most mineral collectors. Underground collecting is never seriously discussed, attention being given instead to the mine dumps on the surface. However, each locality is indexed to a list of 106 references, so the serious reader can find easy access to books and articles which go into greater depth on important mineral occurrences of interest. Twenty-four pages give mineralogical data (hardness, color, luster, morphology, etc.) on common species that may be encountered, and 5 pages are devoted to a glossary of basic terminology. The book concludes with an 8-page index.

Many illustrations are included showing collecting sites, a few museum displays, and specimens of various kinds. The specimen illustrations are the major shortcoming of the book. The color and black-and-white photos depict dozens and dozens of specimens of such uniformly poor quality that most collectors (and perhaps even most rockhounds) would classify them as "leaverites," junk better left on the dump. This is sad because a photo spread of *good* New Mexico minerals would have been dazzling and educational, and would have cost no more to publish.

New Mexico Rockhounding contains some good information for the field collector, and cites references needed for further research prior to collecting trips. Ignore the specimen photos, though, or you may well decide to stay home.

Wendell E. Wilson

Minerali dell'isola d'Elba

I minerali dei giacimenti metalliferi dell'Elba orientale e delle pegmatiti del Monte Capanne ["Minerals of the Isle of Elba. The minerals of the metalliferous deposits of Eastern Elba and of the Monte Capanne pegmatites"] *by Paolo Orlandi and Federico Pezzotta, published (1996) by Edizioni Novecento Grafico, Bergamo, Italy; hardcover, 25 x 18 cm, 245 pages. Price: $54 including surface mail postage. Available from Adriana Pagano, P.O. Box 37, I-20092 Cinisello, Milano, Italy (fax ++39-2-612 1229).*

Through two centuries and more, the Isle of Elba has been the subject of many publications on its history, mineralogy and mineral deposits. This remarkable work draws in part from the existing literature, which is carefully listed in the extensive bibliographies at the end of each chapter, but is amply based on recent and original field and laboratory research; thus it can really be considered a milestone in the knowledge of this famous island.

The first chapter reviews the history of Elba, well known for its mines from the time of Aristotle, Virgil, Strabo, Diodorus and others. A fascinating section deals with the many people who, through the years, fell in love with the mineral beauties of this Mediterranean island, and contributed to preserve specimens and to accumulate knowledge. Some of them were men of science, such as Ermenegildo Pini (1739–1825), Ottaviano Targioni Tozzetti (1755–1826), Federico Millosevich (1875–1942), Antonio D'Achiardi (1839–1902) and Giovanni D'Achiardi (1872–1944). Others were collectors, such as Giovanni Ammannati, Raffaello Foresi, Luigi Celleri, Giorgio Roster and Giovanni Pisani.

A second chapter covers the geology of this island which in its small area (about 220 square km) includes a very complex assemblage of igneous, sedimentary and metamorphic rocks.

The rest of the book is dedicated to the descriptive mineralogy of Elba, the type locality of seven species (elbaite, ilvaite, pollucite, dachiardite, bonattite, minguzzite and the recently described uranopolycrase).

A chapter deals with the famous iron deposits and the surrounding skarns in the eastern part of the island: Rio Marina, Capo Calamita and several others, which have produced the classic hematites, pyrites, ilvaites and a number of less common species and secondary minerals.

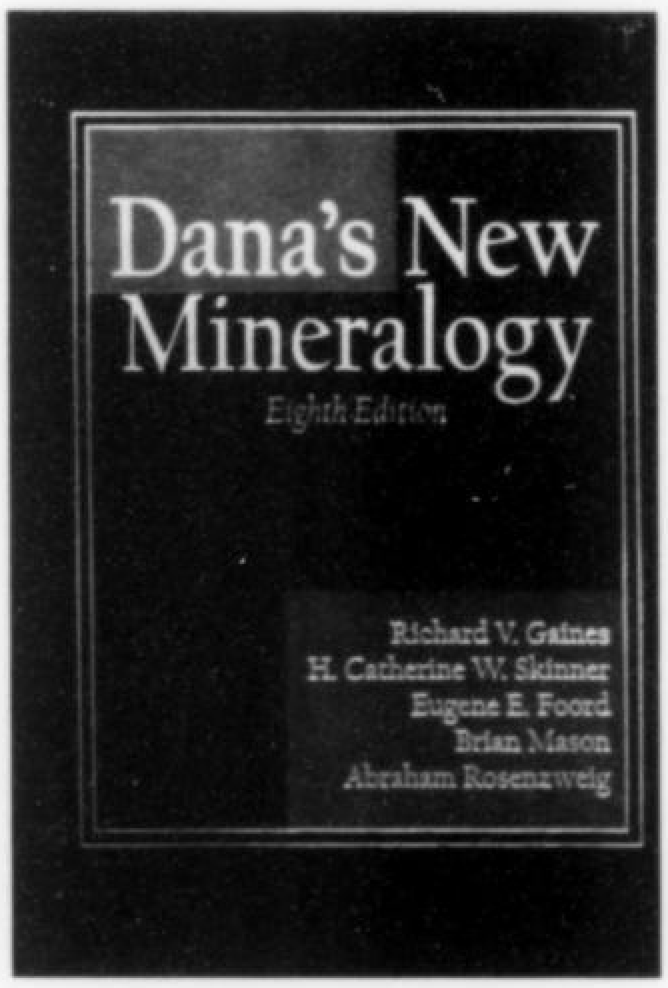
Another chapter deals with the minerals found in the pegmatitic veins of the Monte Capanne area in the western part of the island. Most of these are well known, such as elbaite, beryl, dachiardite, orthoclase, petalite, pollucite and spessartite. Other species, new for Elba, have been discovered recently, with the help of modern analytical tools, and some are reported here for the first time.

A short chapter covers minerals found in other Elba localities. An alphabetical index and several tables complete the work.

The authors, Professor Paolo Orlandi of the University of Pisa and Dr. Federico Pezzotta of the University of Milano, have examined and photographed hundreds of specimens, partly the famous old classics from the museums of the Universities of Florence and of Pisa, but in large measure from more recent finds and private collections. The result is an astonishing photographic documentation of the world-class specimens for which Elba is known, with an adequate coverage of the rare and new species. A total of 160 figures includes over 100 original color photographs, along with 17 SEM photographs and many black and white sketches and diagrams.

All of the Elba mines are now closed, and field collecting in the pegmatite area is mostly prohibited. Still, specimens can be seen in most museums and many collections all over the world, and some material occasionally becomes available from old collections or dealers' stock. Even for readers with little or no knowledge of foreign languages, and of Italian in particular, this book will be an easily accessible source of information on this famous locality and, in any case, will provide a good deal of visual enjoyment.

Renato Pagano



Dana's New Mineralogy

by Richard V. Gaines, H. Catherine W. Skinner, Eugene E. Foord, Brian Mason, and Abraham Rosenzweig. With sections by Vandall T. King and illustrations by Eric Dowty. Eighth Edition, published (1997) by John Wiley & Sons, Inc.; Hard cover, 6 x 9$^{1}/_{4}$ inches, 1819 pages, priced at $250 US.

The long-awaited "New Dana" has arrived! When I was asked to review this book, one of the first things that came to mind was: "I know all of the authors well enough to call them friends. If I say anything negative, will they still be my friends? I hope so." Before going any further with this review, let me say that no book is without errors. I speak from experience on this matter because those books which carry my name as author or coauthor contain their share. So with such an ambitious project as the "New Dana," one must expect errors and they are there. Many of these probably could have been corrected by careful proofreading prior to publication, so these must be marked against the publisher.

The "New Dana" is an important book, especially for collectors. Consequently the following review is more detailed than usual. I start this review with a list of the various section headings given in bold type in each of the paragraphs. After the list, I will comment on most of the sections.

Preface (1 page).

Historical Perspective (2 pages).

Acknowledgments (3 pages).

Introduction: Criteria for Inclusion and Definition of a Mineral (about 2$^{1}/_{3}$ pages).

Descriptions of Mineral Species: Format of Presentation (19 pages). This section includes the following topics: (1) Dana Classification Number; (2) Name; (3) Chemical Formula; (4) Name Derivation; (5) Groups, Dimorphs and Polymorphs, Synonyms and Varieties, and Polytypes; (6) Crystallography; (7) Physical Properties; (8) Composition and Phase Relationships; (9) Occurrence; (10) Localities; and (11) Authorship.

References (9 pages).

The next 1720 pages cover the descriptions of the 3650 species (Yes, I counted them, although only 3546 are listed in the index). The various Dana classes are treated under the following headings which are the broad chemical classes into which they fall. For each heading, I have inserted the following information: the Dana class numbers, the number of pages, the number of descriptions, and the average number of descriptions per page.

Native Elements and Alloys: Class 1, 36 pages, 87 descriptions, 2.42 per page

Sulfides, Including Selenides and Tellurides: Class 2, 113 pages, 341 descriptions, 3.02 per page

Sulfosalts: Class 3, 54 pages, 191 descriptions, 3.54 per page

Oxides: Classes 4–8, 169 pages, 392 descriptions, 2.32 per page

Halogenides: Classes 9–12, 49 pages, 148 descriptions, 3.02 per page

Carbonates: Classes 13–17, 104 pages, 202 descriptions, 1.94 per page

Nitrates: Classes 18–20, 5 pages, 12 descriptions, 2.40 per page

Iodates: Classes 21–23, 3 pages, 9 descriptions, 3.00 per page

Borates: Classes 24–27, 34 pages, 124 descriptions, 3.65 per page

Sulfates: Classes 28–32, 104 pages, 271 descriptions, 2.61 per page

Selenates and Tellurates; Selenites and Tellurites: Classes 33–34, 20 pages, 67 descriptions, 3.35 per page

Chromates: Classes 35–36, 5 pages, 13 descriptions, 2.60 per page

Phosphates, Arsenates, and Vanadates: Classes 37–43, 274 pages, 661 descriptions, 2.41 per page

Antimonates, Antimonites, and Arsenites: Classes 44–46, 14 pages, 55 descriptions, 3.93 per page

Vanadium Oxysalts: Class 47, 8 pages, 33 descriptions, 4.12 per page (most per page)

Molybdates and Tungstates: Classes 48–49, 18 pages, 39 descriptions, 2.17 per page

Organic Compounds: Class 50, 9 pages, 32 descriptions, 3.56 per page

Nesosilicates: Insular SiO_4: Classes 51–54, 113 pages, 147 descriptions, 1.30 per page

Sorosilicates: Isolated tetrahedral Noncyclic Groups N>1: Classes 55–58, 87 pages, 126 descriptions, 1.45 per page

Cyclosilicates: Classes 59–64, 68 pages, 90 descriptions, 1.32 per page

Inosilicates: Two-Dimensionally Infinite Silicate Units: Classes 65–70, 117 pages, 151 descriptions, 1.29 per page

Phyllosilicates: Classes 71–74, 163 pages, 180 descriptions, 1.10 per page (fewest per page)

Tektosilicates: Classes 75–78, 153 pages, 175 descriptions, 1.14 per page

Appendix (2 pages).

Index of Mineral Names in Numerical Order (30 pages).

Index of Mineral Names in Alphabetical Order (30 pages).

General Index (37 pages).

That's the "menu," so let's look at the various sections. Little need be said about the **Preface** and the **Historical Perspective**. The names of about eighty individuals or institutions who assisted the authors are listed in the **Acknowledgments**. The names are listed in alphabetical order and no indication of the extent of the assistance is indicated. I, as one of the people listed, know how I assisted and cannot help but be curious about the contributions of others. I personally know that the names of two people who contributed to this project are missing. Hopefully, those are the only omissions.

The **Introduction: Criteria for Inclusion and Definition of a Mineral** begins with the sentence "Just as the first edition of Dana's *A System of Mineralogy*, this eighth edition also attempts to describe, catalog, and classify all known and recognized minerals reported in the literature up to December 31, 1995." There are two things wrong with this sentence: 1) The first edition of Dana's *A System of Mineralogy* obviously didn't try to compile information on the minerals in the literature up to December 31, 1995; 2) This book really isn't the eighth edition of Dana's *A System of Mineralogy*, it's the first edition of *Dana's New Mineralogy*. The **Criteria for Inclusion** notes that "For minerals discovered after 1959, *recognized* means that the name of the species is approved by the Commission on New Minerals and Mineral Names (CNMMN) of the International Mineralogical Association." This is not quite correct; the *mineral* and name must be approved, but this is clarified later in the section. Minor errors include a statement that at least 50% of the members of the CNMMN must vote on a proposal. The actual number required is 16 which just happens to be about 50%, but when the rule was instituted, there were only about 28 members. The International Mineralogical Association is said to sponsor some 14 commissions; there are nine Commissions and five Working Groups. Purists will have some problems with the **Definition of a Mineral** section. The authors state that strictly biogenic substances produced entirely in the biological sphere are included because they also form under strictly geological conditions. The first half of that has no bearing on the second half. Reference is made to the numerous (about 700) minerals which, because of their small size, cannot be fully characterized. It is stated that some of these are mentioned in the "annual summary of compounds and new minerals in the Canadian Minerologist (sic)." I know of no such annual summary in the *Canadian Mineralogist*.

The **Format of Presentation** section consists of eleven parts and each of these is covered in the following paragraphs.

1. DANA Classification Number. The use of DANA numbers is debated whenever two or more systematic mineralogists get together. Personally, I have had such conversations with myself when I've been alone and have vacillated between pro and con. I have now placed myself firmly in the pro camp. DANA numbers serve several very useful purposes. In large collections such as those of museums, the DANA number can point quickly to the section of the collection where a particular mineral species is stored. In computerized collection records, DANA numbers allow printouts of a given part of the collection in the DANA order. For example, if we wanted a printout of all the carbonate minerals, we could simply punch in the class numbers for that chemical class; in this case, 13, 14, 15, 16, and 17. There is a major flaw in the numbering system espoused in the "New Dana," however. To illustrate the problem, let's look at a small portion of the carbonate chemical class, the Compound Carbonates which is referred to as Class 17. Here are the DANA numbers in their usual order for that class: 17.1.1.1, 17.1.1.2, 17.1.1.3, 17.1.2.1, 17.1.3.1, 17.1.4.1, 17.1.5.1, 17.1.6.1, 17.1.7.1, 17.1.8.1, 17.1.9.1, 17.1.10.1, 17.1.11.1, 17.1.11.2, 17.1.12.1, 17.1.13.1, 17.1.14.1, 17.1.15. If these are sorted by most computer programs, the order will be: 17.1.1.1, 17.1.1.2, 17.1.1.3, 17.1.10.1, 17.1.11.1, 17.1.11.2, 17.1.12.1, 17.1.13.1, 17.1.14.1, 17.1.15, 17.1.2.1, 17.1.3.1, 17.1.4.1, 17.1.5.1, 17.1.6.1, 17.1.7.1, 17.1.8.1, 17.1.9.1. To the computer, 10 follows 1. One way around this is to change "1" to "01," "2" to "02," and so forth. The sorted order for this list would be: 17.1.01.1, 17.1.01.2, 17.1.01.3, 17.1.02.1, 17.1.03.1, 17.1.04.1, 17.1.05.1, 17.1.06.1, 17.1.07.1, 17.1.08.1, 17.1.09.1, 17.1.10.1, 17.1.11.1, 17.1.11.2, 17.1.12.1, 17.1.13.1, 17.1.14.1, 17.1.15, which is in the same order as the first list. Another way of illustrating this is with the following numbers: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 20. Most computer programs will sort these as: 1, 10, 11, 2, 20, 3, 4, 5, 6, 7, 8, 9. The correct sorting sequence is obtained if all the numbers are made double digits: 01, 02, 03, 04, . . . 10, 11, etc., or if a particular part of a DANA number is approaching 100, triple digits might be better.

2. Name. The name, complete with any diacritical marks, follows the DANA number and is followed by the chemical formula. I have not checked every name, but there appear to be some names which are missing diacritical marks. In some cases, where the diacritical marks are present in the descriptive part of the book, they are missing in the indexes. Also, a bothersome aspect of the alphabetical index is the fact that all names with diacritical marks or special characters, appear at the ends of the alphabetical listings. One mineral serves as an example for each of these: černýite appears that way in its description but in the index it is given as cernýite and appears at the *end* of the list of minerals beginning with the letter "c." A quick search found the following other names at the ends of their respective alphabetical lists: bütschliite and bøgvadite after byströmite; fülöppite after furutobeite; görgeyite and götzenite after gysinite-(Nd); häggite, högbomite (three listings for eight polytypes), hörnesite, hübnerite, hügelite, and høgtuvaite after hypercinnabar; löllingite, löweite, lünebergite, långbanite, and låvenite after lyonsite; mäkinenite and mückeite after muskoxite (muthmanite does not appear); örebroite after oyelite; pääkkönenite after pyrrhotite; römerite, röntgenite, and rösslerite after rynersonite; sénarmontite and söhngeite after szymanskiite (the latter name should be spelled szymańskiite); törnebohmite-(Ce) and törnebohmite-(La) after tyuyamunite; väyrynenite after vyuntspakhkite-(Y); wöhlerite, wölsendorfite, wülfingite, and wüstite after wyllieite. For some unknown reason, åkermanite and örebroite (a second entry) appear after zykaite. At the other "end of the spectrum" the first entries in the **Index of Mineral Names in Alphabetical Order** are β-Fergusonite-(Ce), β-Fergusonite-(Nd), β-Fergusonite-(Y), and β-Roselite. Hyphenated names appear out of alphabetical order, although some of these have been kept in order by the elimination of hyphens; for example, ferriannite for ferri-annite. These disorders obviously are the result of computer generation of the indexes, but careful "old-fashioned" proofreading could have eliminated these problems. I realize that there are rules governing where certain letters from languages other than English should fit into alphabetical order, but most lists published in English treat all such characters as if they were written without diacritical marks. Thus ä, å, á, and à would be placed as if they were the letter a; ö and ø as the letter o, and so forth.

3. Chemical Formula. The authors state that they generally follow the formulae given by Fleischer and Mandarino (1995). Two subheadings in this section follow. **3A. Isostructural Substitution** is shown by the use of commas to separate chemical symbols within parentheses. The most dominant element has its symbol given first and the least dominant last. Although the authors do not state this, I emphasize it because some people seem unaware of this. **3B. Vacancies** are indicated by ☐ symbols.

4. Name Derivation. In addition to the origin of the name, it is stated that ". . . sometimes the author to whom the name is attributable . . ." is given. However, many of the descriptions I scanned randomly did not have this information.

5. Groups, Dimorphs and Polymorphs, Synonyms and Varieties, and Polytypes. Each of these terms is defined and I have serious problems only with *Polytypes*. The definition does not conform rigidly with the definition given by the CNMMN and quoted by Fleischer and Mandarino (1995): "Polytypes have been defined as substances that occur in several different structural modifications, each of which may be regarded as built up by the stacking of layers of (nearly) identical structure and composition, and with the modifications differing only in their stacking sequence." Each polytype of a species is denoted by adding a suffix to the species name. However, the form of the suffix is not stated. Quoting again from Fleischer and Mandarino (1995): "The complete name for a given polytype consists of the species name joined by a hyphen to a suffix; the suffix consists of a number and an *italicized* capital letter. The number designates the layering periodicity and the letter represents the crystal system. The following letters are used: *C*, cubic; *H*, hexagonal; *R*, rhombohedral; *T*, trigonal; *Q* (for quadratic), tetragonal; *O*, orthorhombic; *M*, monoclinic; and *A* (for anorthic), triclinic." This system of designating polytypes is not followed in the book. For example, instead of biotite-1*M*, we find biotite-1M. More importantly, however, is the fact that many polytypes are given species status. For example, högbomite-4*H*, högbomite-5*H*, högbomite-6*H*, and högbomite-15*H* are assigned the DANA Number 7.11.7.1; högbomite-8*H* is Dana Number 7.11.7.2; högbomite-15*R*, högbomite-18*R*, and högbomite-24*R* are listed under Dana Number 7.11.7.3. The practice of treating polytypes as species is contrary to the rules of the CNMMN.

6. Crystallography. No detailed definitions of various terms are given, but the reader is referred to nine books. The abbreviation for one of these is erroneously given as **KC**; it should be **KH** for Klein and Hurlbut (1993). **6A. Crystallographic Principles** covers the following: (1) Crystal Systems; (2) Crystal Classes, Point Group Symmetry, and Symmetry Notations; [There is no section 3)]; (4) Miller Indices and Zone Symbols; (5) Crystal Forms; (6) Space Groups; (7) Choice of Settings; and (8) Twinning and Epitaxy. **6B. Order of Presentation of Crystallographic Data**. The following order is followed in the descriptions: (1) Crystal System, (2) Space Group and Point Group, (3) Lattice Constants, (4) Cell Contents and Calculated Density, (5) Powder Diffraction Pattern, (6) Structure, (7) Habit and Twinning. My only comment on these paragraphs relates to semantics. In (5), Powder Diffraction Pattern, "Pattern" should be replaced by "Data"; a pattern is not displayed, only the values of the eight strongest lines are given.

7. Physical Properties. This section explains the treatment of the following properties: **7A. Morphology and Habit**; **7B. Twinning**; **7C. Color**; **7D. Streak**; **7E. Luster**; **7F. Cleavage and Parting**; **7G. Fracture**; **7H. Tenacity**; **7I. Hardness**; **7J. Density/Specific Gravity**; **7K. Infrared, Raman, and Mössbauer Spectroscopic Data, and Differential Thermal Analysis**; **7L. Fluorescence/Phosphorescence**, and **7M. Optical Properties**. It seems strange to me that the first two topics, **7A. Morphology and Habit** and **7B. Twinning**, which were listed under **6. Crystallography**, are now listed under **7. Physical Properties**. A quick look at all of the morphological crystal drawings failed to confirm the statement that all faces are identified by letters on the drawings and these letters are identified in the legend for the figure; that's true for many, but not for all. As to **7E. Luster**, my definitions are somewhat different from those presented in this section. However, this is a minor point. Under **7F. Cleavage and Parting**, the statement referring to a cleavage plane is somewhat ambiguous. The authors state that a cleavage plane represents a plane of weaker bonding within the crystal structure. It would be clearer to say that the bonds *between* parallel cleavage planes are weaker than the bonds *within* those planes. Under **7G. Fracture**, Conchoidal is spelled "Chonchoidal." **7M. Optical Properties** covers both opaque and non-opaque minerals. Although some references are given to books dealing with the optical properties of minerals, no mention is made of the optical tables published by Fleischer, Wilcox, and Matzko (1984). The fourth line of Table 4 in this section is erroneous; "n_ε or n_e" should be n_ε or n_e. Four other errors occur on page xxxii. (1) In the sixth line "$2V_2$" should be $2V_X$ or $2V_Z$. (2) The following statement about dispersion is given: "Dispersion follows in the format $r > v$ or $r < v$ in accordance with whether the indices are greater for red or violet light, but the notation may also refer to dispersion of the optic axis or orientation of the indicatrix." This is wrong; a statement such as "dispersion $r > v$, strong" refers only to the dispersion of the optic axes *not* the indices of refraction. In fact, the dispersion of the indices of refraction is such that the value for red light is *always* less than for violet light. (3) In the statement discussing the optical orientation of monoclinic crystals the example shown, $Z \wedge c = 11°$, should specify if Z is in the acute or obtuse angle β. (4) The definition of the optical orientation of triclinic crystals is incomplete. Readers of this section are advised to refer to some of the optical mineralogy books listed by the authors.

8. Composition and Phase Relationships. The statement "Full chemical analyses of the species are generally not provided" will be discussed later in this review.

9. Occurrence. This consists of a brief summary of the geologic occurrences of minerals.

10. Localities. The number of localities listed for each species is considered to be proportional to the importance of the mineral. For minerals of special interest to collectors, such as calcite and quartz, the number of localities has been expanded. The geologic occurrence is included for most of the minerals. Type localities are italicized, and localities which represent economically important deposits or which are the source of unusual quality specimens are followed by an asterisk (*); localities for truly exceptional specimens are followed by an exclamation mark (!). A table lists abbreviations of states (for the U.S.A., Australia, Mexico, and Brazil) and provinces and territories (for Canada). I noted several places where the abbreviations used in the descriptions departed from those given in the table. One spelling error was noted: "Aguascaientes" instead of Aguascalientes for the Mexican state.

11. Authorship. A set of initials (in small capital letters) appears after most descriptions indicating the author who is primarily responsible for the description, and these are followed by abbreviations for references.

References. Nine pages list the references and their abbreviations used in the descriptions.

Earlier, I referred to the Table of Contents as a "Menu." Continuing my metaphor of treating this book as a meal, we can now say that we have sampled the appetizers, so let's tackle the main dishes, the descriptions. These are set out like a huge buffet and there is no way that I could try a bit of each of the 3650 dishes! How do I overcome this problem? I decided to taste (i.e., review) two dishes (i.e., species) prepared by each of the "chefs" (RG, HCWS, EF, BM, and AR); I added one other description prepared by two people (VK, EF). The following paragraphs are my reviews of the species randomly selected from various DANA classes. The initials of the author who wrote the description of the species appears after the species name. This is followed by a comparison of the space devoted to its description in four books: ND = *Dana's New Mineralogy*; HM = *Handbook of Mineralogy*; D7 = *Dana's System of Mineralogy, 7th Ed.*; and EM = *Encyclopedia of Minerals, 2nd Ed.*. Because all of these books have different page sizes, the extent of the description is given in square inches; the font sizes are approximately the same. Where the abbreviation n/a appears, it indicates that the description is not available in that particular book.

Spiroffite (RG) (ND 10.7, HM n/a, D7 n/a, EM 13.9).

The statement that Kiril Spiroff was a Bulgarian-American economic geologist is not correct. Bulgarian-American, yes; economic geologist, no. He was one of my mentors, professors, colleagues, and close friends from 1947 until his death in 1981. He was a mineralogist, taught mineralogy, and never served as an economic geologist. Also, I prefer to think of the luster as adamantine, not subadamantine.

Ferrinatrite (RG) (ND 9.1, HM n/a, D7 64.7, EM 18.6).

The description conforms well with the data given in D7, which contains a crystal drawing and also lists six localities; only four of these are given in the "New Dana."

Manasseite (HCWS) (ND 12.2, HM n/a, D7 52.9, EM 23.0).

The type locality is incorrectly given as Kongsberg, Norway; it is Snarum, Norway. The "New Dana" lists more localities than D7, but omits one given by EM.

Wardite (HCWS) (ND, 15.2, HM n/a, D7 49.5, EM 42.2).

The second sentence says: "See Cyrilovite 42.7.8.1 the other Fe^{3+} end member." The word "other" should be deleted. The crystals are referred to as pyramidal {102} or {114}, but according to the space group given these forms are bipyramids; they would be pyramids according to the space groups given in D7. Numerous localities are given in the "New Dana."

Merrihueite (EF) (ND 12.2, HM 42.9, D7 n/a, EM 14.1).

The "New Dana" gives a second locality which is not listed in HM or EM.

Topaz (EF) (ND 125.53, HM 48.5, D7 n/a, EM 19.4).

The description, including a structural drawing, covers about 3 pages of which about one page is devoted to localities.

Cubanite (BM) (ND 11.9, HM 46.8, D7 59.6, EM 20.3).

The abbreviation for Quebec is given as PQ not QUE as given in the list of abbreviations. The description in D7 contains three morphological drawings.

Ottemannite (BM) (ND 5.3, HM 39.7, D7 n/a, EM 13.0).

This mineral does not appear in D7 because it was described after 1944. No optical data are given in the "New Dana."

Sodalite (AR) (ND 45.7, HM 48.1, D7 n/a, EM 23.2).

The space given above for sodalite does not include space occupied by a morphological drawing labelled "scapolite" which should have appeared several pages later in the book. The description, almost 1½ pages long, lists many localities.

Steacyite (AR) (ND 18.0, HM 48.1, D7 n/a, EM 14.4).

The mineral iraqite-La is referred to in the description and follows the description on the same page; it should be iraqite-(La) in both places.

Montmorillonite (VK, EF) (ND 64.6, HM 49.9, D7 n/a, EM 19.4).

The description fills about 1¾ pages, which seems overly long for such a mineral. The "selected" occurrences take up more than half a page.

A quick scan of the last eleven paragraphs shows that seven of the species are not treated in D7. Spiroffite and ottemannite are not there because they were described after those volumes were published. Merrihueite, topaz, sodalite, steacyite, and montmorillonite are silicates which explains their absences. All eleven species are covered in EM, but it should be obvious that many species listed in the "New Dana" do not appear in EM. Four minerals (spiroffite, ferrinatrite, manasseite, and wardite) are not in HM because the volumes which would contain these species have not been published yet.

It also becomes apparent that *for the minerals covered*, D7 provides the greatest coverage (average 56.7 sq.in.), followed by HM (average 46.3 sq.in.), followed by ND (average 30.0 sq.in.), and EM (average 20.1 sq.in.). Now before we etch these numbers in stone, we should note that the format of the "New Dana" is such that there is no extra space within the descriptions. In other words, the properties and other information is in a compressed format. By contrast, the formats of the other three books are more tabular in nature with headings. Granted the latter format takes more space, but it is easier to find specific items of interest.

Some General Comments on Descriptions. The following paragraphs indicate some general impressions of the descriptions. The number of pages, descriptions, and descriptions per page for each of the chemical classes are listed above.

The lengths of most of the descriptions are disappointingly short. For example, the *Native Elements and Alloys*, consisting of 87 species, are treated in 36 pages. Palache, *et al.* (1944) (*Dana's System of Mineralogy*, 7th Ed., Vol. I) cover 39 "species" (not all of which are considered valid now) in 67 pages. That means each page in the "New Dana" contains about 2.4 descriptions and each page in the 7th Edition contains about 0.6 descriptions; in other words, the average description in the Native Elements and Alloys section in the 7th Edition is about 4 times longer than similar descriptions in the "New Dana." Granted, there are significantly more species covered in the "New Dana" and if you want information on those which have been published since the 7th Ed. was published, where do you go? One place is HM, but there are several species from the Native Elements and Alloys which are not in the HM.

Quartz is covered in 13½ pages (with no figures) in the "New Dana" compared to the treatment in Dana 7th, Vol. III which devotes 242 pages and about 60 morphological drawings to the mineral. Another example of a common mineral is calcite. The "New Dana" devotes about seven pages including two structural drawings and a figure which consists of eight morphological drawings with the legend "THE MANY CRYSTALLINE FORMS OF CALCITE." Compare this with the 20 pages including 26 morphological drawings given by Palache, Berman, and Frondel (1951) in Vol. II of the 7th Edition of *Dana's System of Mineralogy.*

Drawings, particularly morphological drawings, are extremely valuable to collectors. Structural drawings are of interest, also, but less so to collectors. Referring, once again, to the *Native Elements and Alloys* section, in the present volume there are 11 structural drawings and no morphological drawings. Compare that with 42 morphological drawings and sketches and structural drawings in the 7th Edition. There are 281 drawings among the 3650 species covered in the book. Structure drawings (172) predominate over morphological drawings (109). Three of the crystal drawings included here under "Morphological" are sketches: one shows multiple sections of an andalusite crystal (var. "chiastolite"), one shows the "Scotch-plaid" twinning of microcline as seen in thin section, and the other shows striations on {001} due to polysynthetic twinning on the albite law for the plagioclase series. I would not consider these three sketches necessary for a book of this kind.

The lack of chemical analytical data is very disappointing. If a description contains such information as unit cell parameters, optical data, density, X-ray powder diffraction data, etc., these data should be keyed to the chemical analytical data of the specimen from which they were measured. Without such comparisons, the data are almost meaningless.

The **Appendix**, which lists the names and formulae of 44 minerals whose descriptions were published in 1996 (and which could not be included in the book), contains some errors. Five names are misspelled: "bechereite" should be bechererite, "benavite" should be benauite, "hyttsjoite" should be hyttsjöite, "malinite" should be malanite, "noelbensonite" should be noélbensonite, and "vianeite" should be viaeneite. Also, the name leisingite is out of alphabetical order in the list. The formulae of five of the minerals (dusmatovite, frankamenite, gottardiite, penobsquisite, and shkatulkalite) show minor variations compared to those given in *The First List of Additions and Corrections to the Glossary of Mineral Species 7th Edition* (1995). More importantly, the formulae of two minerals are wrong: hanawaltite should be $Hg_6^{1+}Hg^{2+}$-$[Cl,(OH)]_2O_3$ instead of $Hg^{1+}Hg^{2+}[Cl,$-$(OH)]_2O_3$; viaeneite should be $(Fe,Pb)_4S_8O$ instead of $(Fe,Pb)_4O_8O$. Another mineral published in 1996 is missing; its name is intersilite and the formula is $Na_6Mn^{2+}Ti$-$[Si_{10}O_{24}(OH)](OH)_3 \cdot 4H_2O$. One aspect of this list is a bit jarring in that superscripts do not appear directly above subscripts where they should be. For example, instead of Mn_2^{2+} we see $Mn^{2+}{}_2$. Fortunately, this does not occur in the descriptive part of the book. The formula, $(Zn,Cu)_6Zn_2(OH)_{13}$-$[(S,Si)(O,OH)_4]_2$, given for bechererite was changed recently to $Zn_7Cu(OH)_{13}[SiO$-$(OH)_3SO_4]$.

Some Further Comments.

(1) The formula given for radtkeite on page 397 is Hg_3S_2II rather than Hg_3S_2ClI.

(2) The DANA number 38.4.9.1 is given for Ximengite and for Xenotime-(Y) in the **Index of Mineral Names in Numerical Order** and on pages 727 and 729, respectively. The number for Xenotime-(Y) should be 38.4.11.1 in the index and on page 729.

(3) There is no entry for stibnite in the **Index of Mineral Names in Alphabetical Order** or in the **Index of Mineral Names in Numerical Order** although it does appear in the **General Index**.

(4) There are three polymorphs of HgS: cinnabar, metacinnabar, and hypercinnabar. The description of cinnabar mentions the relationship with metacinnabar and hypercinnabar; the description of hypercinnabar mentions the relationship with cinnabar and metacinnabar; but the description of metacinnabar mentions only the relationship with cinnabar.

(5) Under sulfur, Sicily is given country status.

(6) There are no entries for hydroxyapophyllite in the **Index of Mineral Names in Alphabetical Order** or in the **Index of Mineral Names in Numerical Order**; it is listed in the **General Index**, however.

(7) In the long (33 pages) section dealing with the Amphibole Group, some of the species names are strangely written. For example, (Alumino)tschermakite appears, but no explanation is given for the presence of the parentheses; I searched for reasons, but was unsuccessful. Nine such names appear in tables, but twelve appear in the text of the descriptions. The latter twelve include the nine from the tables plus three others which contain no parentheses in the tables.

(8) Dana Class 78, Unclassified Silicates, is not given a separate heading in the Table of Contents, but is included under Tektosilicates.

(9) Have orientations of cleavages, optical orientation, morphological information, etc., been changed if the unit cell has been re-oriented? See Mandarino (1993): Changes in properties of minerals caused by publication. *Rocks & Minerals*, **68**, 220–225.

(10) Publication as two volumes would have been better; one volume for nonsilicates and the other for silicates. This would have allowed better paper to be used and the smaller volumes of almost equal size would have been easier to handle.

(11) The book is not as "user-Friendly" as it could have been made. It is not easy to find specific sets of information within a description.

(12) The paper is very thin (so-called "Bible paper") which results in some "bleeding through" from adjacent pages, but I did not find this a great problem; possibly because my eyes are not as strong as they used to be. The thin paper is somewhat like thin ice; walk carefully through these pages. Because flipping back and forth between the thin pages of this book may pose problems for some people, I suggest that photocopies of the indexes be produced.

(13) The headings given in the Table of Contents for some of the classes or groups of classes may be rather confusing to some readers. For example: The heading "Halogenides" appears only in the Table of Contents; elsewhere, the term "Halides" is used, but there is no general heading to cover all four halide classes. Similar deviations occur with other chemical classes and the worst examples are among the silicates.

In summary, although a massive amount of labor has obviously been invested in it, this book is nevertheless difficult to heartily recommend. It is filled with little errors, from niggling to serious; most of the species are covered better in other standard works (and even in the previous edition of Dana); the work of the various authors is not consistent; many of the references are not up to date; the lack of chemical analyses is a tremendous shortcoming; the illustrations are scanty and not well chosen; the paper is dangerously thin for everyday use; the mineral name indices have numerous sorting errors, and the DANA numbers will not sort by computer as written. On the plus side, it is currently the most up-to-date compilation of species available; the mineral name indices will prove extremely useful; the DANA numbers can also be useful once adjusted; and the entire work has been compressed into a single volume.

The bottom line for the person who contemplates buying *any* mineralogy book comes down to the question "What can this book offer me for my money?" At various places in the foregoing paragraphs, I have compared the "New Dana" with other references. But this is rather superficial. A person contemplating the purchase of this book should spend some time with it before making a decision.

Although I have finished my feast, I shall be reaching for my copy of the "New Dana" to sample some more of its offerings from time to time.

Joseph ("Joe") A. Mandarino

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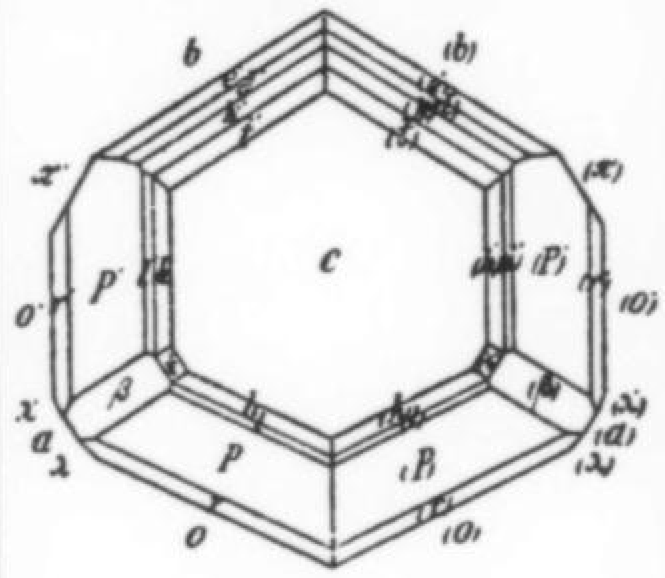

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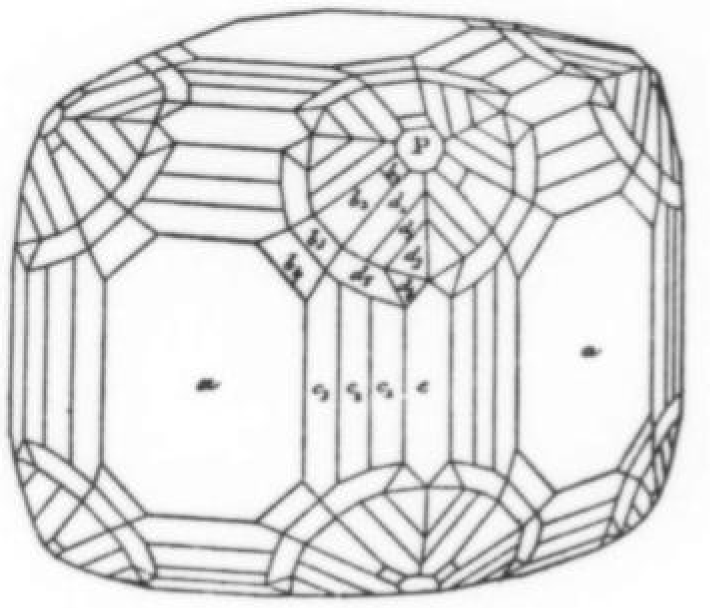

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Ancylite-(La)

Orthorhombic

$Sr(La,Ce)(CO_3)_2(OH)\cdot H_2O$

Locality: Marchenko Peak, Mount Kukisvumchorr, Khibina massif, Kola Peninsula, Russia.

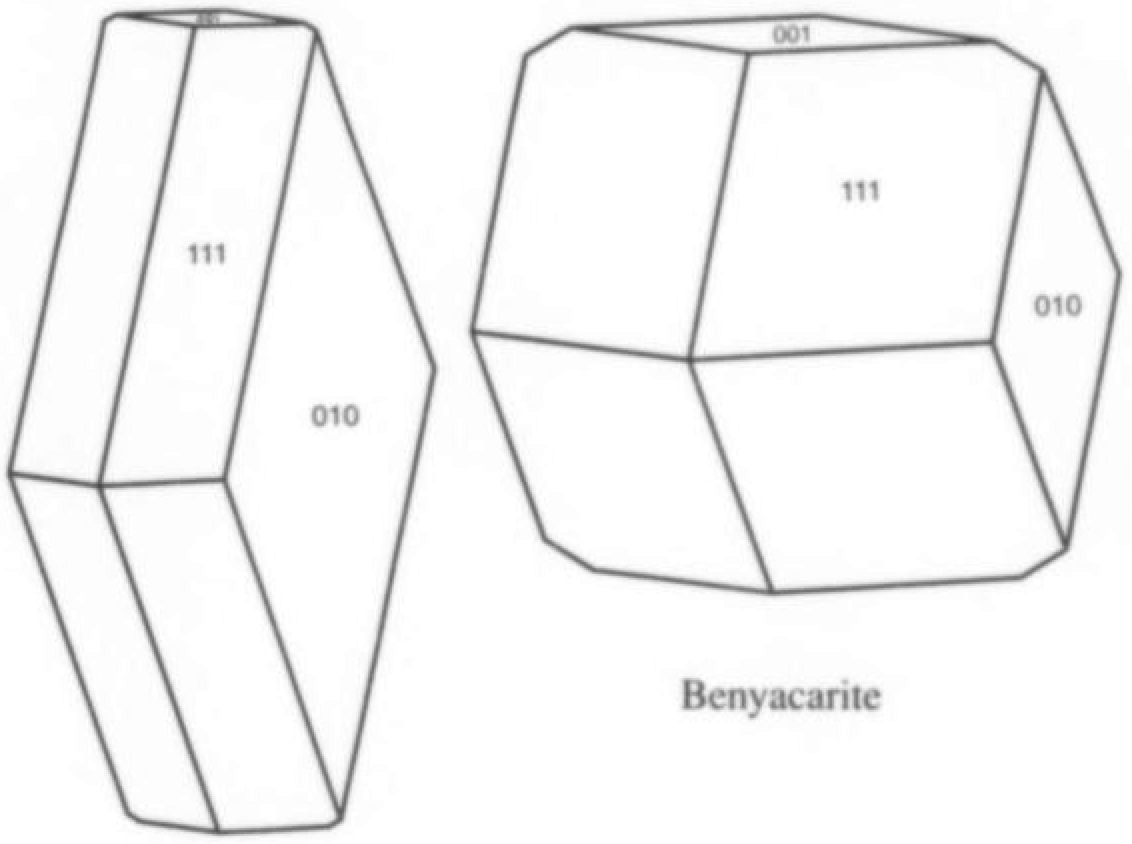
Occurrence: In hydrothermal veins in nepheline syenites. Associated minerals are: aegirine, astrophyllite, loparite-(Ce), lepidomelane, catapleiite, and fluorapatite.

General appearance: Bipyramidal crystals 0.01 to 2.0 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* yellow to yellowish-brown. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 4 to 4½. *Tenacity:* brittle. *Cleavage:* none observed. *Fracture:* conchoidal. *Density:* 3.88 g/cm³ (meas.), 3.97 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, Pmcn, a 5.072, b 8.589, c 7.276 Å, V 317.0 Å³, Z 2, a:b:c = 0.5905:1:0.8471. Morphology: forms, {120} and {111}. Twinning: none observed. ***X-ray powder diffraction data:*** 4.36 (92), 3.738 (88), 3.705 (90), 2.955 (100), 2.664 (89), 2.358 (87), 2.092 (80). ***Optical data:*** Biaxial (+), α 1.640, β 1.668 (calc.), γ 1.731, 2V(meas.) 70°; dispersion r<v, moderate; nonpleochroic; orientation, not given. ***Chemical analytical data:*** Means of seven sets of electron microprobe data: CaO 1.69, SrO 24.22, BaO 0.64, La_2O_3 25.75, Ce_2O_3 16.23, Pr_2O_3 0.13, Nd_2O_3 0.70, CO_2 22.59, H_2O 7.37, Total 99.32 wt.%. Empirical formula: $(Sr_{0.89}Ca_{0.11}Ba_{0.02})_{\Sigma 1.02}(La_{0.60}Ce_{0.38}Nd_{0.02})_{\Sigma 1.00}(CO_3)_{1.96}(OH)_{1.12}\cdot H_2O$. ***Relationship to other species:*** The La-dominant analogue of ancylite-(Ce).

Name: For the relationship to ancylite-(Ce). ***Comments:*** IMA No. 95-053. The calculated value of the β index of refraction is incorrectly given in the paper as 1.717; the correct value is given in this abstract.

YAKOVENCHUK, V. N., MENSHIKOV, Yu. P., PAKHOMOVSKY, Ya. A., and IVANYUK, G. Yu. (1997) Ancylite-(La) $Sr(La,Ce)(CO_3)_2(OH)\cdot H_2O$—a new carbonate from hydrothermal vein at Kukisvumchorr Mountain (Khibiny massif) and its comparison with ancylite-(Ce). *Zapiski Vserossuskogo mineralogicheskogo obshchestva* **126(1)**, 96–108.



Benyacarite

Benyacarite

Orthorhombic

$(H_2O,K)_2Ti(Mn^{2+},Fe^{2+})_2\ (Fe^{3+},Ti)_2(PO_4)_4(O,F)_2\cdot 14H_2O$

Locality: The El Criollo mine, Cerro Blanco mining district in the Sierra Grande, near Tanti (on Route N. 20), 45 km west of Córdoba, Córdoba Province, Argentina.

Occurrence: In a granitic pegmatite. Associated minerals are: "feldspar," quartz, beryl, columbite-tantalite, triplite, phosphosiderite, strengite, rockbridgeite, lipscombite, dufrénite, libethenite, bermanite, hentschelite, fluellite, pachnolite, "apatite," and torbernite.

General appearance: Euhedral crystals (ranging from 0.2 to 0.3 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* greenish yellow to light brown. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 2½ to 3. *Tenacity:* very brittle. *Cleavage:* {010} perfect. *Fracture:* uneven. *Density:* could not be determined, 2.40 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, Pbca, a 10.561, b 20.585, c 12.516 Å, V 2721 Å³, Z 4, a:b:c = 0.5130:1:0.6080. Morphology: forms, {010}, {111}, and {001}; {100} is less common. Twinning: none mentioned. ***X-ray powder diffraction data:*** 10.29 (90), 7.51 (80), 6.26 (100), 5.16 (40), 3.96 (40), 3.76 (50), 3.13 (100), 2.88 (40). ***Optical data:*** Biaxial (+), α 1.612, β 1.621, γ 1.649, 2V(meas.) 60°, 2V(calc.) 60°; dispersion not mentioned; nonpleochroic; orientation, X = b, Y = c, Z = a. ***Chemical analytical data:*** Electron microprobe data (number of analyses not stated):

Na_2O 0.2, K_2O 1.6, MgO 0.3, CaO 0.1, MnO 11.2, FeO 2.8, Al_2O_3 0.7, Fe_2O_3 11.0, TiO_2 12.3, P_2O_5 28.1, H_2O (28.9), F 1.5, sum (98.7), less O = F 0.6, Total (98.1) wt.%. The water content was calculated. Empirical formula: $[(H_2O)_{2.06}K_{0.34}Na_{0.06}]_{\Sigma 2.40}Ti_{1.00}(Mn^{2+}_{1.58}Fe^{2+}_{0.39}Mg_{0.07})_{\Sigma 2.04}(Fe^{3+}_{1.38}Ti_{0.54}Al_{0.14})_{\Sigma 2.06}(PO_4)_{3.97}(O_{1.27}F_{0.79})_{\Sigma 2.06}\cdot 14.00H_2O$. ***Relationship to other species:*** Related to paulkerrite and mantienneite.

Name: For Maria Angelica R. de Benyacar (1928–), Comision Nacional de Energia Atomica, Buenos Aires, Argentina, for her contribution to mineralogical studies. ***Comments:*** IMA No. 95-002. The calculated density and empirical formula given here differ somewhat from those given by the authors. The authors include V in their empirical formula but no analytical data support this. The crystal drawing showing the almost equant habit was produced here using the data and SEM image given in the paper.

DEMARTIN, F., GAY, H. D., GRAMACCIOLI, C. M., and PILATI, T. (1997) Benyacarite, a new titanium-bearing phosphate mineral species from Cerro Blanco, Argentina. *Canadian Mineralogist* **35**, 707–712. DEMARTIN, F., PILATI, T., GAY, H. D., and GRAMACCIOLI, C. M. (1993) The crystal structure of a mineral related to paulkerrite. *Zeitschrift für Kristallographie* **208**, 57–71.

Brianroulstonite Monoclinic

$Ca_3[B_5O_6(OH)_6](OH)Cl_2\cdot 8H_2O$

Locality: The Potash Corporation of Saskatchewan mine (New Brunswick Division), formerly the Potash Corporation of America mine, 5 km east of Penobsquis, Cardwell Parish, Kings County, New Brunswick, Canada.

Occurrence: In the lower third of the Upper Halite member of the Windsor Group evaporites. Associated minerals are: halite, hilgardite, pringleite, trembathite, sellaite, fluorite, hematite, penobsquisite, and a clay-group mineral.

General appearance: Cleavage masses (up to 2 x 1 x 1 mm) with individual micaceous crystals up to 0.5 x 0.25 x 0.1 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* colorless to white. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* approximately 5. *Tenacity:* flexible. *Cleavage:* {010} perfect. *Fracture:* not mentioned. *Density:* 1.97 g/cm³ (meas.), 1.93 g/cm³ (calc.). ***Crystallography:*** Monoclinic, Pa, a 17.42, b 8.077, c 8.665 Å, β 121.48°, V 1040 Å³, Z 2, a:b:c = 2.1567:1:1.0728. Morphology: forms, only {010} was observed. Twinning: merohedral twinning with [102] as twin axis and (010) as composition plane is ubiquitous but not observable visually. ***X-ray powder diffraction data:*** 8.10 (10), 4.04 (4), 3.56 (2), 2.834 (2), 2.535 (2), 2.276 (2); the intensities of the lines at 3.56 and 2.834 are enhanced due to included halite. ***Optical data:*** Biaxial (-), α 1.506, β 1.527, γ 1.532, 2V(meas.) 56°, 2V(calc.) 51°; dispersion, none; nonpleochroic; X ∧ c = 30° (in obtuse angle β), Y = a, Z = b. ***Chemical analytical data:*** Means of four sets of electron microprobe data: K_2O 0.05, CaO 32.85, B_2O_3 33.92, Cl 13.79, H_2O 40.44, sum 121.05, less O = Cl 3.12, Total 117.93 wt.%. The H_2O and B_2O_3 contents were calculated from the crystal structure results. Empirical formula: $(Ca_{3.00}K_{0.01})_{\Sigma 3.01}B_{5.00}O_{6.00}(OH)_{7.01}Cl_{1.99}\cdot 8.00H_2O$. ***Relationship to other species:*** None apparent.

Name: For Brian V. Roulston (1948–), in recognition of his work on the geology of evaporite deposits. He was the first geologist to suggest and use borate minerals as stratigraphic markers in the New Brunswick evaporite deposits. ***Comments:*** IMA No. 96-009. About 10 mg are known. The paper contains details of the crystal structure determination.

GRICE, J. D., GAULT, R. A., and VAN VELTHUIZEN, J. (1997) Brianroulstonite: a new borate mineral with a sheet structure. *Canadian Mineralogist* **35**, 751–758.

Caoxite Triclinic

$Ca(C_2O_4)\cdot 3H_2O$

Locality: The Cerchiara mine, near Faggiona, Val di Vara, La Spezia, eastern Liguria, Italy.

Occurrence: In thin open fractures (up to 0.5 mm wide) cutting manganese- and barium-rich mineralized metacherts. Associated minerals are: quartz, barite, and an unidentified manganese oxide.

General appearance: Isolated elongated, stocky crystals tabular on {010} (up to 0.5 mm) and as spherulitic aggregates (up to 0.05 mm in diameter) of crystals up to 0.01 mm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* could not be measured. *Tenacity:* brittle. *Cleavage:* {010} good. *Fracture:* uneven. *Density:* could not be determined, 1.85 g/cm³ (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, a 6.076, b 7.174, c 8.467 Å, α 76.65°, β 70.85°, γ 70.91°, V 326.3 Å³, Z 2, a:b:c = 0.8469:1:1.1802. Morphology: {010} is the only form identified. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.92 (M), 5.52 (VS), 5.26 (M), 4.99 (M), 3.643 (M), 2.834 (S), 2.758 (M), 2.732 (M). ***Optical data:*** Biaxial (–), α′ 1.483, β 1.516(calc.), γ′ 1.533, 2V(meas.) 70°; dispersion not given; nonpleochroic; orientation not given. ***Chemical analytical data:*** Mean of five sets of electron microprobe data: CaO 30.03, C_2O_3 (39.54), H_2O (29.67), Total (99.24) wt.%. The values for C_2O_3 and H_2O are taken from the ideal formula for calcium oxalate trihydrate. Empirical formula: $Ca_{0.98}C_{2.01}H_{6.02}O_{7.00}$. ***Relationship to other species:*** It is the third calcium oxalate hydrate mineral.

Name: For the acronym of "*C*entennial *A*nniversary *O*f *X*-rays" and also for *ca*lcium *ox*alate. ***Comments:*** IMA No. 96-012. Details of the crystal structure are given and compared with those of the other two calcium oxalate hydrate minerals, whewellite and weddellite.

BASSO, R., LUCCHETTI, G., ZEFIRO, L., and PALENZONA, A. (1997) Caoxite, $Ca(H_2O)_3(C_2O_4)$, a new mineral from the Cerchiara mine, northern Apennines, Italy. *Neues Jahrbuch für Mineralogie, Monatshefte* **1997 (2)**, 84–96.

Dessauite Hexagonal (trigonal)

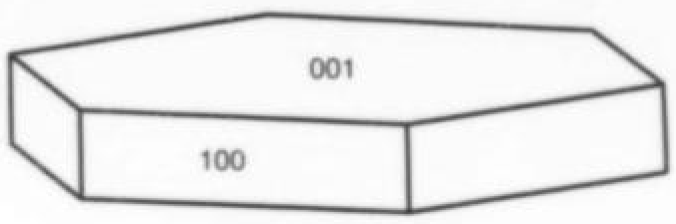
$(Sr,Pb)(Y,U)(Ti,Fe^{3+})_{20}O_{38}$

Locality: The Buca della Vena mine, Apuan Alps, near the town of Stazzema (LU), northern Tuscany, Italy.

Occurrence: In calcite veins within dolomite. Associated minerals are: calcite, rutile, hematite, siderite, and derbylite. Several other rare minerals have been identified previously from this locality: apuanite, versiliaite, stibivanite-2*O*, karelianite, robinsonite, tintinaite, and andorite.

General appearance: Crystals (up to 1 mm in diameter and 0.2 mm thick) flattened on {001}.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* black. *Hardness:* VHN_{100} 1105 to 1782 kg/mm². *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* conchoidal. *Density:* could not be



Dessauite

determined, 4.68 g/cm^3 (calc.). ***Crystallography:*** Hexagonal (trigonal), R$\bar{3}$, a 10.385, c 20.921 Å, V 1954 Å^3, Z 3, c:a = 2.0145. Morphology: forms, only {001} was identified (see comments, below). Twinning: none observed. ***X-ray powder diffraction data:*** 3.412 (m), 2.902 (m), 2.846 (mw), 2.499 (mw), 1.916 (mw), 1.805 (mw), 1.603 (m), 1.441 (m). ***Optical data:*** In reflected light: ash-grey with pale bluish tones, weak anisotropism, low bireflectance, very weak pleochroism. R_1, R_2; $^{imm}R_1$, $^{imm}R_2$: (17.3, 17.7; 5.6, 6.0 %) 470nm, (16.6, 17.1; 5.0, 5.5 %) 546nm, (16.1, 16.6; 4.8, 5.3 %) 589nm, (16.0, 16.5; 4.6, 5.1 %) 650nm. ***Chemical analytical data:*** Means of seventeen sets of electron microprobe data: MgO 0.03, CaO 0.12, MnO 0.56, ZnO 0.42, SrO 2.34, BaO 0.83, PbO 3.18, Al_2O_3 0.08, Cr_2O_3 0.21, Fe_2O_3 27.24, La_2O_3 1.14, Ce_2O_3 0.68, Y_2O_3 2.02, TiO_2 55.71, V_2O_5 0.89, ThO_2 0.11, UO_2 4.52, Total 100.08 wt.%. Empirical formula: $(Sr_{0.41}Pb_{0.26}Ba_{0.10}Ca_{0.04}Th_{0.01})_{\Sigma 0.82}(Y_{0.33}U_{0.31}Mn_{0.14}La_{0.13}Ce_{0.08})_{\Sigma 0.99}Ti_{12.78}Fe^{3+}_{6.25}V_{0.18}Zn_{0.09}Cr_{0.05}Al_{0.03}Mg_{0.01})_{\Sigma 19.39}O_{38.00}$. ***Relationship to other species:*** A member of the crichtonite group.

Name: For Gabor Dessau (1907–1983), professor of ore mineralogy at the University of Pisa. ***Comments:*** IMA No. 94-057. Details of the crystal structure determination are given in the paper. The rhombohedral unit cell has a 9.197, α 68.75°, V 651.3, Z 1. The authors state that the mineral occurs as "flattened rhombohedral crystals, tabular {001} with hexagonal outline," but the SEM image shows no rhombohedra. They probably mean that the symmetry is rhombohedral. The drawing produced for this abstract is based on the data and SEM image in the paper. I have chosen the hexagonal prism as {100}, but it could be {110}.

ORLANDI, P., PASERO, M., DUCHI, G., and OLMI, F. (1997) Dessauite, (Sr,Pb)(Y,U)(Ti,Fe^{3+})$_{20}$O$_{38}$, a new mineral of the crichtonite group from Buca della Vena mine, Tuscany, Italy. *American Mineralogist* **82**, 807–811.

Galileiite

Hexagonal (trigonal) (?)

NaFe$_4^{2+}$(PO$_4$)$_3$

Locality: The type material is from the meteorite Grant IIIB, which was found in the Zuni Mountains, about 50 km NNW of Grants, New Mexico, U.S.A.. The mineral also occurs in the following meteorites: El Sampal IIIA (found in Argentina), Mount Edith IIIB (found about 129 km SE of Onslow, Ashburton District, Western Australia, Australia), Chupaderos IIIB (found near Jimenez, Chihuahua, Mexico), and Bella Roca IIIB (found on Bella Roca Peak, near Santiago Papasquiaro, Durango, Mexico).

Occurrence: In troilite nodules. Other associated minerals are: graftonite or sarcopside, chromite, and schreibersite. Johnsomervilleite occurs in other troilite nodules within the same meteorite, but does not occur in the galileiite-bearing nodules.

General appearance: Usually as crystals ~ 10 µm in longest dimension, but occasionally up to 30 µm.

Physical, chemical and crystallographic properties: *Luster:* waxy. *Diaphaneity:* transparent. *Color:* very pale amber. *Streak:* white. *Luminescence:* not mentioned. *Hardness:* possibly ≤ 4. *Tenacity:* sectile. *Cleavage:* none observed. *Fracture:* none observed. *Density:* could not be measured, 3.91 g/cm^3 (calc.). ***Crystallography:*** Hexagonal (trigonal) (?), R$\bar{3}$, a 14.98, c 41.66 Å, V 8085.2 Å^3, Z 36, c:a = 2.7810. Morphology: no forms are mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.13 (80), 3.47 (50), 3.21 (50), 3.01 (90), 2.93 (50), 2.85 (50), 2.71 (100), 2.57 (50). ***Optical data:*** Uniaxial (+), ω 1.72, ε 1.75, nonpleochroic. ***Chemical analytical data:*** Means of three sets of electron microprobe data: Na_2O 5.87, K_2O 0.04, MnO 3.98, FeO 49.0, Cr_2O_3 0.07, P_2O_5 40.2, Total 99.16 wt.%. Empirical formula: $Na_{1.01}(Fe_{3.64}Mn_{0.30})_{\Sigma 3.94}(PO_4)_{3.02}$. ***Relationship to other species:*** May be related to johnsomervilleite, fillowite, and chladniite.

Name: For Galileo Galilei (1564–1642), Italian astronomer and physicist. ***Comments:*** IMA No. 96-028. Single-crystal studies could not be carried out, so the proposed space group was assigned by analogy with johnsomervilleite. Dr. Olsen kindly supplied the information on the geographical localities for the meteorites.

OLSEN, E. J. and STEELE, I. M. (1997) Galileiite: A new meteoritic phosphate mineral. *Meteoritics and Planetary Science* **32**, A155–A156.

Gordaite

Hexagonal (trigonal)

NaZn$_4$(SO$_4$)(OH)$_6$Cl·6H$_2$O

Locality: The San Francisco mine (Lat. 22°52.8′ S, Long. 69°20.4′ W), 2 km northeast of the Sierra Gorda railway station, in the Sierra Gorda, northeast of Antofagasta, 2nd region, northern Chile.

Occurrence: In the oxidation zone of a hydrothermal vein deposit hosted by andesitic rocks. Associated minerals are: zincian paratacamite, anglesite, hemimorphite, quartz, and christelite.

General appearance: Small flaky crystals (up to 20 mm in longest dimension) and masses of platy interlocked crystals.

Physical, chemical and crystallographic properties: *Luster:* vitreous to pearly. *Diaphaneity:* transparent to translucent. *Color:* colorless to white. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* about 2½. *Tenacity:* flexible, but not elastic. *Cleavage:* {001} perfect. *Fracture:* not given. *Density:* 2.627 g/cm^3 (meas.), 2.64 g/cm^3 (calc.). ***Crystallography:*** Hexagonal (trigonal), P$\bar{3}$, a 8.363, c 13.018 Å, V 788.5 Å^3, Z 2, c:a = 1.5566. Morphology: no forms are mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 12.950 (100), 6.501 (23), 4.339 (15), 3.258 (14), 2.967 (10), 2.523 (6). ***Optical data:*** Uniaxial (-), ω 1.5607, ε 1.5382, presumably nonpleochroic. ***Chemical analytical data:*** Means of four sets of electron microprobe data: Na_2O 9.15, ZnO 52.85, SO_3 15.33, H_2O 12.33, Cl 6.46, sum 96.12, less O = Cl 1.46, Total 94.66 wt.%. H_2O by CHN analyzer, but the value is low due to loss of water during grinding for sample preparation. Because of overlapping peaks for NaK α and ZnL β, the value given for Na_2O is considered too high. A semiquantitative AAS analysis indicated the same amount of ZnO but only about 5.5 wt.% of Na_2O. The composition required by the ideal formula, $NaZn_4(SO_4)(OH)_6Cl \cdot 6H_2O$, is: Na_2O 4.95, ZnO 51.98, SO_3 12.79, H_2O 25.90, Cl 5.66, sum 101.28, less O = Cl 1.28, Total 100.00 wt.%. ***Relationship to other species:*** None apparent.

Name: For the locality. ***Comments:*** IMA No. 96-006. The crystal structure has been solved and a paper is in preparation.

SCHLÜTER, J., KLASKA, K.-H., FRIESE, K., ADIWIDJAJA, G., and GEBHARD, G. (1997) Gordaite, $NaZn_4(SO_4)(OH)_6Cl \cdot 6H_2O$, a new mineral from the San Francisco Mine, Antofagasta, Chile. *Neues Jahrbuch für Mineralogie, Monatshefte* **1997 (4)**, 155–162.

Horváthite-(Y) Orthorhombic

$NaY(CO_3)F_2$

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

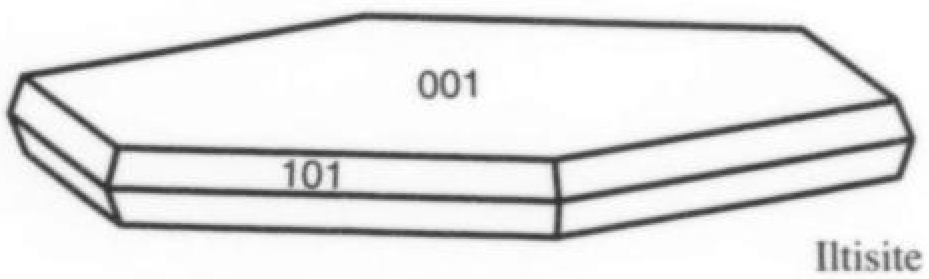
Occurrence: In a large pegmatite dike approximately 1.5 to 2.0 m wide. Associated minerals are: microcline, aegirine, dawsonite, rhodochrosite, sodalite, natrolite, albite, sérandite, siderite, taeniolite, catapleiite, astrophyllite, genthelvite, and a franconite-group mineral. In another part of the same pegmatite, horváthite-(Y) is associated with UK96, an alteration product of UK96, sphalerite, rhodochrosite, and microcline.

General appearance: Tabular crystals (up to 1 x 1 x 0.25 mm) stacked in fan-like groups and as blocky aggregates (1 to 5 mm across) of radiating crystals (up to 1 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent to transparent. *Color:* colorless to pale beige. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 4. *Tenacity:* brittle. *Cleavage:* {100} very good and {010} good. *Fracture:* uneven. *Density:* sinks in methylene iodide (i.e., > 3.3 g/cm³ (meas.), 3.58 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, Pmcn, a 6.964, b 9.173, c 6.302 Å, V 402.6 Å³, Z 4, a:b:c = 0.7592:1:0.6870. Morphology: forms, {100}, {001}, {010}, {110}, {011}, and {101}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.19 (90), 3.477 (100), 2.800 (50), 2.087 (50), 2.057 (50), 1.966 (50), 1.849 (50), 1.763 (50). ***Optical data:*** Biaxial (–), α 1.457, β 1.543, γ 1.622, 2V(meas.) 82°, 2V(calc.) 83°; dispersion, none; pleochroism weak, X = colorless, Y ≈ Z = pale brown; orientation, X = b, Y = a, Z = c. ***Chemical analytical data:*** Means of two sets of electron microprobe data: Na_2O 12.62, CaO 1.86, Y_2O_3 45.07, Gd_2O_3 0.45, Tb_2O_3 0.12, Dy_2O_3 2.49, Ho_2O_3 0.81, Er_2O_3 3.02, Yb_2O_3 1.64, CO_2 19.83, F 17.22, sum 105.13, less O = F 7.25, Total 97.88 wt.%. The CO_2 content was calculated from the crystal structure results. Empirical formula: $(Na_{0.90}Ca_{0.07})_{\Sigma 0.97}$-$(Y_{0.88}Er_{0.03}Dy_{0.03}Yb_{0.02}Ho_{0.01})_{\Sigma 0.97}(CO_3)F_{2.01}$. ***Relationship to other species:*** None apparent.

Name: For Elsa Horváth (1947–) and László Horváth (1937–), husband-and-wife team dedicated to the collection, study, and documentation of the minerals from Mont Saint-Hilaire. ***Comments:*** IMA No. 96-032. Only a few mg are known to exist. The calculated density and some of the subscripts in the empirical formula given in the paper are slightly different from those given here.

GRICE, J. D. and CHAO, G. Y. (1997) Horváthite-(Y), rare-earth fluorocarbonate, a new mineral species from Mont Saint-Hilaire, Quebec. *Canadian Mineralogist* **35**, 743–749.



Iltisite

Iltisite Hexagonal

HgSAg(Cl,Br)

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

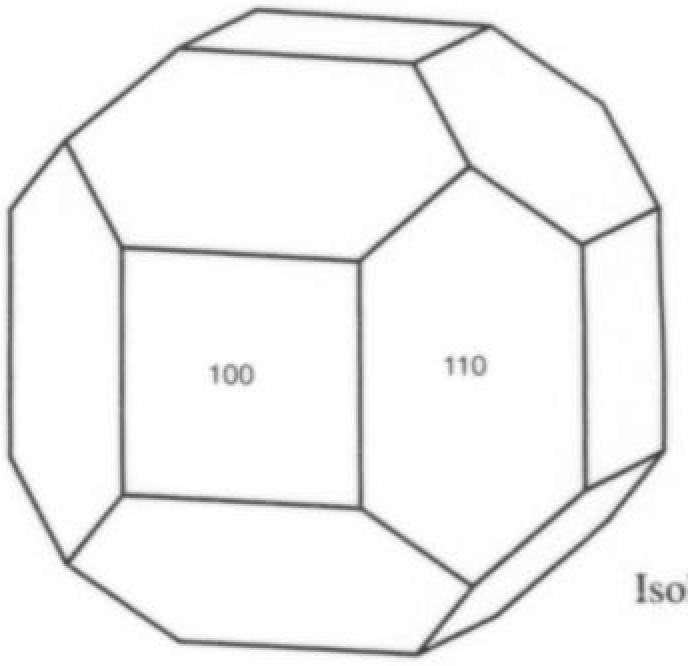
Occurrence: In small cavities in quartzitic conglomerates. Associated minerals are: olivenite, perroudite, capgaronnite, brochantite, parnauite, tennantite, and quartz.

General appearance: Isolated, flat hexagonal crystals (0.09 mm in diameter and 0.02 mm thick).

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* translucent. *Color:* red to brownish red. *Streak:* red. *Luminescence:* non-fluorescent. *Hardness:* could not be determined. *Tenacity:* fragile. *Cleavage:* {001} perfect. *Fracture:* irregular. *Density:* could not be determined, 6.59 g/cm³ (calc.). ***Crystallography:*** Hexagonal, $P6_2$, $P6_4$, $P6_222$ or $P6_422$, a 8.234, c 19.38 Å, V 1138 Å³, Z 12, c:a = 2.3537. Morphology: forms, {001} and {101}. Twinning: none observed. ***X-ray powder diffraction data:*** 6.47 (20), 4.124 (30), 3.357 (60), 3.237 (30), 3.127 (50), 2.879 (100), 2.009 (50). ***Optical data:*** Indices of refraction were calculated from reflectance measurements; probably uniaxial (–), ω ≈ 2.3, ε ≈ 2.1, marked pleochroism O = red, E = brownish red. ***Chemical analytical data:*** Means of six sets of electron microprobe data: Hg 52.40, Ag 25.90, S 8.41, Cl 8.47, Br 4.88, Total 100.06 wt.%. Empirical formula: $Hg_{0.98}Ag_{0.90}S_{0.99}(Cl_{0.90}Br_{0.23})_{\Sigma 1.13}$. ***Relationship to other species:*** An hexagonal polymorph of capgaronnite.

Name: For Antoine Iltis (1942–), who found the mineral. ***Comments:*** IMA No. 94-031. The crystal drawing which accompanies this abstract was produced from the data and SEM image given in the paper. Crystal class 622 was chosen rather than class 6.

SARP, H., SANZ-GYSLER, J., and PERROUD, P. (1997) L'iltisite, HgSAg(Cl,Br), un nouveau minéral de la mine de Cap Garonne, Var (France), polymorphe de la capgaronnite. *Archives de Science Genève* **50(1)**, 1–5.



Isolueshite

Isolueshite Cubic

(Na,La,Ca)(Nb,Ti)O_3

Locality: The Kukisvumchorr apatite deposit, southern part of the Khibina alkaline massif, Kola peninsula, Russia.

Occurrence: In a hydrothermally altered pegmatite vein cutting ijolite-urtite. Associated minerals are: microcline, sodalite, and a Th-rich titanium-niobium oxide, probably pyrochlore.

General appearance: Euhedral crystals (up to 0.3 mm).

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* opaque. *Color:* brownish-black. *Streak:* pale yellow. *Hardness:* VHN_{70} 580 kg/mm², Mohs 5½. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* uneven. *Density:* 4.72 g/cm³ (meas.), 4.64 g/cm³ (calc.). ***Crystallography:*** Cubic, probably Pm3m, a 3.911 Å, V 59.8 Å³, Z 1. Morphology: forms, {100}, {110}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.915 (35), 2.765 (100), 1.953 (53), 1.594 (30), 1.380 (22). ***Optical data:*** Isotropic, n 2.20. In reflected light: bluish with reddish-brown internal reflections, isotropic. R: (16.05 %) 460nm, (15.00 %) 540nm, (14.70 %) 580nm, (14.40 %) 640nm. ***Chemical analytical data:*** Means of four sets of electron microprobe data: Na_2O 12.70, K_2O 0.07, CaO 2.18, SrO 1.78, FeO 0.02, La_2O_3 6.97, Ce_2O_3 5.18, Pr_2O_3 0.25, Nd_2O_3 0.45, Sm_2O_3 0.01, ThO_2 2.86, TiO_2 20.84, Nb_2O_5 45.03, Ta_2O_5 0.60, Total 98.94 wt.%. Empirical formula: $(Na_{0.69}La_{0.07}Ca_{0.07}Ce_{0.05}Sr_{0.03}Th_{0.02})_{\Sigma 0.93}(Nb_{0.57}Ti_{0.44})_{\Sigma 1.01}O_{3.00}$. ***Relationship to other species:*** A cubic polymorph of lueshite.

Name: For the relationship to lueshite. ***Comments:*** IMA No. 95-024. The calculated density given by the authors (4.69 g/cm^3) is slightly different from that given here (4.64 g/cm^3). The authors consider this to be a new member of the perovskite group, but the species of this group are generally considered to be orthorhombic or monoclinic. The crystal drawing given here is based on the SEM image in the paper.

CHAKHMOURADIAN, A., YAKOVENCHUK, V., MITCHELL, R. G., and BOGDANOVA, A. (1997) Isolueshite: a new mineral of the perovskite group from the Khibina alkaline complex. *European Journal of Mineralogy* **9**, 483–490.

Staněkite

Monoclinic

$Fe^{3+}(Mn^{2+},Fe^{2+},Mg)(PO_4)O$

Locality: The Clementine II pegmatite, Okatjimukuju farm, Karibib, Namibia. Also, in a pegmatite at Albères at the eastern end of the Pyrénées, France. Other occurrences are in pegmatites at: Cameroon, Usakos, Namibia; Helikon, Karibib, Namibia; and Cap de Creus, Spain.

Occurrence: Associated minerals are: quartz, kryzhanovskite, eosphorite, arrojadite, ferrisicklerite, heterosite, triphylite and alluaudite (Clementine II) and ferrisicklerite, heterosite, graftonite, wyllieite, and rosemaryite (Albères).

General appearance: Small (0.2 to 5 mm) anhedral grains (up to 2 cm long) (Clementine II) and small aggregates up to 1 mm in diameter (Albères).

Physical, chemical and crystallographic properties: *Luster:* weak submetallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* dark brown. *Luminescence:* non-fluorescent. *Hardness:* 4 to 5. *Tenacity:* brittle. *Cleavage:* none, but parting perpendicular to the c-axis is occasionally developed. *Fracture:* splintery. *Density:* 3.80 g/cm^3 (meas.), 4.04 g/cm^3 (calc.); the lower measured value is due to admixed kryzhanovskite. ***Crystallography:*** Monoclinic, $P2_1/a$, a 11.844, b 12.662, c 9.989 Å, β 105.93°, V 1440 Å^3, Z 16, a:b:c = 0.9354:1:0.7889. Morphology: forms, only {120} was observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.54 (37), 3.621 (35), 3.412 (38), 3.259 (50), 2.971 (100), 2.857 (58), 2.810 (85), 2.548 (30). ***Optical data:*** Indices of refraction were calculated from reflectance measurements; at 587 nm they are: $n_{min.}$ 2.01 and $n_{max.}$ 2.11. ***Chemical analytical data:*** Means of "numerous" sets of electron microprobe data: Na_2O 0.13, K_2O 0.05, MgO 0.50, CaO 0.13, MnO 23.12, FeO 1.56, ZnO 0.22, Al_2O_3 0.01, Fe_2O_3 41.56, TiO_2 0.02, P_2O_5 31.16, Total 98.46 (given as 98.42) wt.%. The iron was partitioned on the basis of Mössbauer spectroscopy. Empirical formula: $(Fe^{3+}_{1.16}Mn^{2+}_{0.73}Fe^{2+}_{0.05}Mg_{0.03}Na_{0.01})_{\Sigma 1.98}(PO_4)_{0.98}O_{1.08}$. ***Relationship to other species:*** It is related to triploidite and wolfeite.

Name: For Prof. Josef Staněk (1928–), Masarykov University, Brno, Czech Republic. ***Comments:*** IMA No. 94-045. The calculated density given here (4.04 g/cm^3) is slightly different from that given by the authors (4.09 g/cm^3).

KELLER, P., FONTAN, F., VELASCO ROLDAN, F., and MELGAREJO i DRAPER, J. C. (1997) Staněkite, $Fe^{3+}(Mn^{2+},Fe^{2+},Mg)(PO_4)O$: a new phosphate mineral in pegmatites at Karibib (Namibia) and French Pyrénées (France). *European Journal of Mineralogy* **9**, 475–482.

Ternovite

Monoclinic

$(Mg,Ca)Nb_4O_{11}\cdot nH_2O$, where n ~ 10

Locality: The central part of the Vuoriyarvi massif on the north shore of Vuoriyarvi Lake, North Karelia, Kola Peninsula, Russia.

Occurrence: In hydrothermal alteration zones of carbonatites as encrustations with other later minerals on primary minerals. The primary minerals are: calcite, magnetite, phlogopite, richterite, "apatite," chalcopyrite, zircon, and pyrochlore. The other later minerals are: franconite, hochelagaite, dolomite, magnesite, "serpentine," barite, pyrite, ancylite-(Ce), and belkovite.

General appearance: Radiated spherulites (up to 0.5 mm in diameter) which consist of elongated lamellar crystals of 0.1 x 0.003 x 0.005 mm average dimensions. These form acicular aggregates up to 0.02 mm in section.

Physical, chemical and crystallographic properties: *Luster:* given as silky, but the indices of refraction indicate adamantine. *Diaphaneity:* translucent. *Color:* white. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* VHN_{20} 80 to 115 kg/mm^2, Mohs near 3. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* uneven. *Density:* 2.95 g/cm^3 (meas.), 2.96 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, P2/m, P2 or Pm, a 20.656, b 13.062, c 6.338 Å, β 91.90°, V 1709.1 Å^3, Z 4, a:b:c = 1.5814:1:0.4852. Morphology: forms, none identified. Twinning: none mentioned. ***X-ray powder diffraction data:*** 10.33 (100), 5.16 (7), 5.04 (6), 4.75 (6), 4.56 (8), 3.15 (17), 3.12 (15), 3.06 (7). ***Optical data:*** Biaxial (–), α 1.725, β 1.830, γ 1.845, 2V could not be measured, 2V(calc.) 39.5°; dispersion not observed; nonpleochroic; Z = crystal elongation. ***Chemical analytical data:*** Means of three sets of electron microprobe data: Na_2O 0.00, MgO 3.82, CaO 1.54, SrO 0.20, BaO 1.25, Fe_2O_3 0.18, TiO_2 0.14, Nb_2O_5 69.20, Ta_2O_5 0.00, H_2O (23.67), Total (100.00) wt.%. H_2O was calculated by difference. Empirical formula: $(Mg_{0.72}Ca_{0.21}Ba_{0.06}Sr_{0.01})_{\Sigma 1.00}(Nb_{3.97}Fe_{0.02}Ti_{0.01})_{\Sigma 4.00}O_{11.00}\cdot 10.02H_2O$. ***Relationship to other species:*** It is the magnesium-dominant analogue of franconite and hochelagaite.

Name: For V. I. Ternovoi (1928–1980), Russian geologist who explored the Kola Peninsula and was a pioneer of the Kovdor phlogopite deposit. ***Comments:*** IMA No. 92-044. The same description has been published (in Russian) by the same authors in *Zapiski Vserossuskogo mineralogicheskogo obshchestva* **127(3)**, 87–97 (1997). Publication of a mineral description in two different journals is not a good practice and it is hoped that editors will prevent this in the future.

SUBBOTIN, V. V., VOLOSHIN, A. V., PAKHOMOVSKII, YA. A., MEN'SHIKOV, YU. P., and SUBBOTINA, G. F. (1997) Ternovite, $(Mg,Ca)Nb_4O_{11}\cdot nH_2O$, a new mineral and other hydrous tetraniobates from carbonatites of the Vuoriyarvi massif, Kola Peninsula, Russia. *Neues Jahrbuch für Mineralogie, Monatshefte* **1997 (2)**, 49–60.

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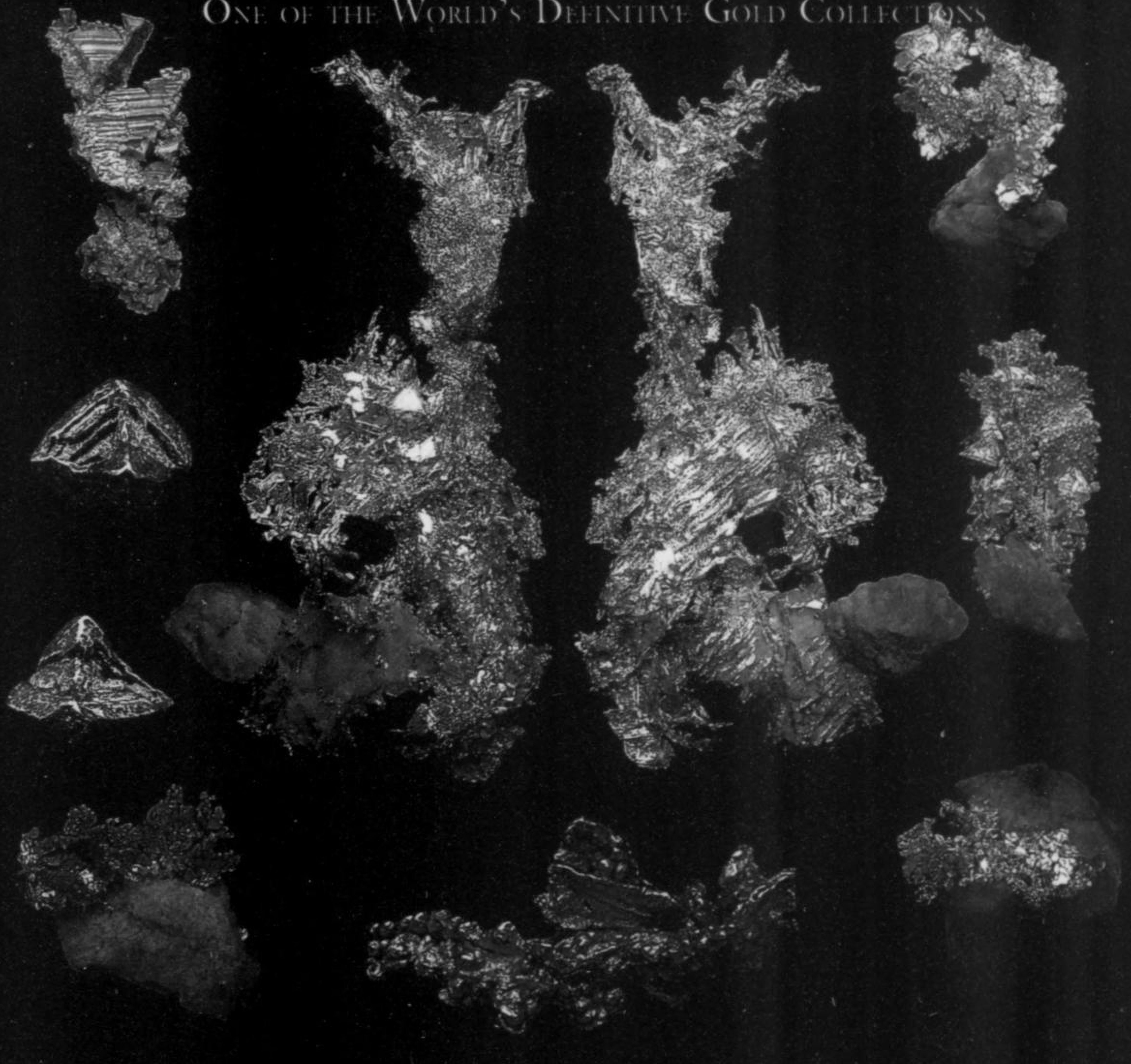

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"The video offers an opportunity to see and study Proctor's exquisite specimens at leisure. Many are pictured on slowly revolving turntables, allowing all sides of the specimens to be seen, and their three-dimensional shapes to be fully realized, as reflections play across crystal faces and gemmy interiors . . . this really is one of the best private collections ever assembled." Video Review: Nov/Dec '92

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