the Mineralogical Record

Volume Twenty-nine, Number Two
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Porfirio Díaz,

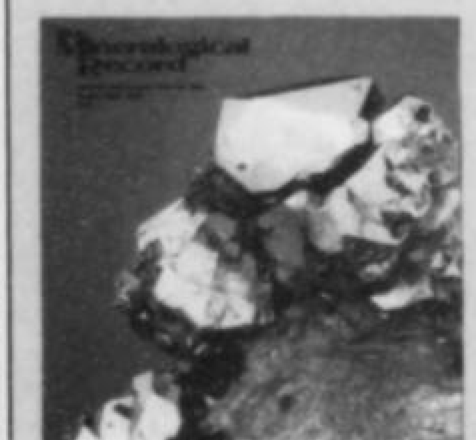
THE MINERALOGICAL RECORD

March–April 1998 Volume Twenty-nine, Number Two

Articles

Columns

What's new in minerals



COVER: SPERRYLITE crystals on chalcopyrite, from Talnakh, Noril'sk, Russia. The large crystal at the top measures 1.5 cm. This is probably the world's finest specimen of the species. Collection of the Rice Northwest Museum of Rocks and Minerals, Hillsboro, Oregon. Photo by Jeffrey A. Scovil.

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notes from the EDITOR

GOLD SPECIMENS STOLEN

Wayne and Dona Leicht of *Kristalle* in Laguna Beach, California, have reported a major theft of gold specimens from their vault. Antique gold-nugget jewelry from the Gold Rush days, a superb small cabinet specimen of wire silver in the shape of a "d" on white matrix, and ten specimens of gold (thumbnail to miniature size) from the Eagle's Nest mine in Placer County, California (half of them with quartz matrix) were taken.

The gold nugget jewelry and the wire silver specimen may be viewed on their website at **www.kristalle.com.** These are beautiful, distinctive pieces which can readily be identified. If you are approached by someone wishing to sell antique California gold nugget jewelry as pictured on their website, or a selection of ten Eagle's Nest crystalline gold specimens 2.5 inches and under in size, please contact:

Eric Lee—Laguna Beach Police
Cast #97-05742
(714) 497-0369

A LARGE REWARD IS OFFERED for information leading to the recovery of these specimens!

Scott J. Williams
1924–1997

NOTICES

Died, Scott John Williams, 73, in Oberlin, Kansas. Scott Williams was well-known to a generation of mineral collectors as one of the leading mineralogist/dealers of his day. He started his first mineral business, called *Minerals Unlimited*, with partner David Grigsby at Berkeley, California, in 1947. They had met as geology students at UCB and took a liking to each other (13-year-old Si Frazier, later a well-known mineral dealer in his own right, was their first part-time employee). Grigsby was eventually hired by Ultra-Violet Products, and his share in the partnership was bought out by Ralph Merrill. Merrill ultimately also bought out Scott Williams, and has continued to operate *Minerals Unlimited* up to the present day.

After a divorce from his first wife, Mimi, Scott married his second wife, Margaret. He received his B.S. degree in Geology, and they moved to Scottsdale, Arizona, in the late 1950's. There he started a new mineral business, called *Scott Williams Mineral Company*, and attended graduate school at Arizona State University. He took on David New as a partner in the business, and New took it over around 1963. Scott received his M.A. degree in Geography from ASU in 1965, and married his third wife, Ann, that same year, following his divorce from Margaret. He had, in the meantime, started up a third mineral business, *Southwest Scientific Company*.

Scott and Ann got out of the mineral business, however, and moved to Lincoln, Nebraska, where he pursued his PhD studies in mineralogy, and led field trips for geology students (with his daughter Julie as his highly knowledgeable assistant). He was then hired by Peru (Nebraska) State College, where he taught classes in mineralogy, geology and geography for the next 25 years, retiring as Professor Emeritus in 1990.

In 1990 Scott renewed his old love of mineral dealing by opening a new business, *Julie's Minerals and Art*, with his daughter Julie (an Art/Geology major in college). In 1991 Scott and Ann moved the business to Oberlin, Kansas, and renamed it the *Scott Williams Mineral Company*. Ann intends to keep the business going under that name (at P.O. Box 48, Oberlin, KS 67749).

Scott was an active field collector for much of his life, and was a superb mineralogist in the old sense. He was reputed to be the very best at sight identification during his years in California, and was skilled in the use of old-fashioned tools of identification such as the blowpipe and the petrographic microscopes. The many catalogs he issued, all collector's items today, are models of thorough description. In fact he was sometimes criticized for his enthusiastic eloquence, making specimens sound more exciting (in the buyer's opinion, at least) than they turned out to be. But Scott's catalogs, heavy on study specimens and rare species, were read eagerly by collectors everywhere; and his academic background in geography made his locality citations particularly reliable and professional. Scott Williams was an important force in species collecting, and will be remembered by many collectors who got their start building a collection through his mail-order catalogs.

Died, Richard L. Rice, 86, in Hillsboro, Oregon. Richard Rice, a lifetime resident of Washington County, Oregon, was a retired logging contractor. With his wife, Helen (see vol. 28, no. 3, p. 164), he began collecting rocks and minerals in 1938, eventually assembling the finest collection in the Pacific Northwest. Among his favorite specimens were: an emerald crystal cluster from Coscuez, Colombia, pictured on the cover of vol. 25, no. 3, a suite of fine Bisbee specimens, the extraordinary "Alma Rose" rhodochrosite specimen from the Sweet Home mine (pictured in vol. 24, no. 3, p. 228, Fig. 24), and the fabulous Russian sperrylite pictured on the cover of this issue. He also owned outstanding petrified woods, palms, ferns and cycads from around the world, many of them self-collected. He was a lifetime member of the Oregon Agate and Mineral Society and the Tualatin Valley Gem Club, and a member of the Pacific Northwest Chapter of the Friends of Mineralogy.

(Continued on page 141)

MINERALOGY OF THE SAINT-AMABLE SILL

VARENNES AND SAINT-AMABLE QUÉBEC

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An extensive nepheline syenite sill, genetically related to Mont Saint-Hilaire and other intrusions in the Monteregian alkaline rock province, is a recently discovered, prolific locality for many rare minerals. More than 100 species have been identified to date, including ancylite-(La), calciohilairite, cordylite-(Ce), franconite, gaidonnayite, hilairite, hochelagaite, kukharenkoite-(Ce), magadiite, sazhinite-(Ce), serandite, shkatulkalite, thornasite, tuperssuatsiaite, yofortierite, zakharovite, and the new species, varennesite. Most of the minerals occur as well-formed microcrystals.

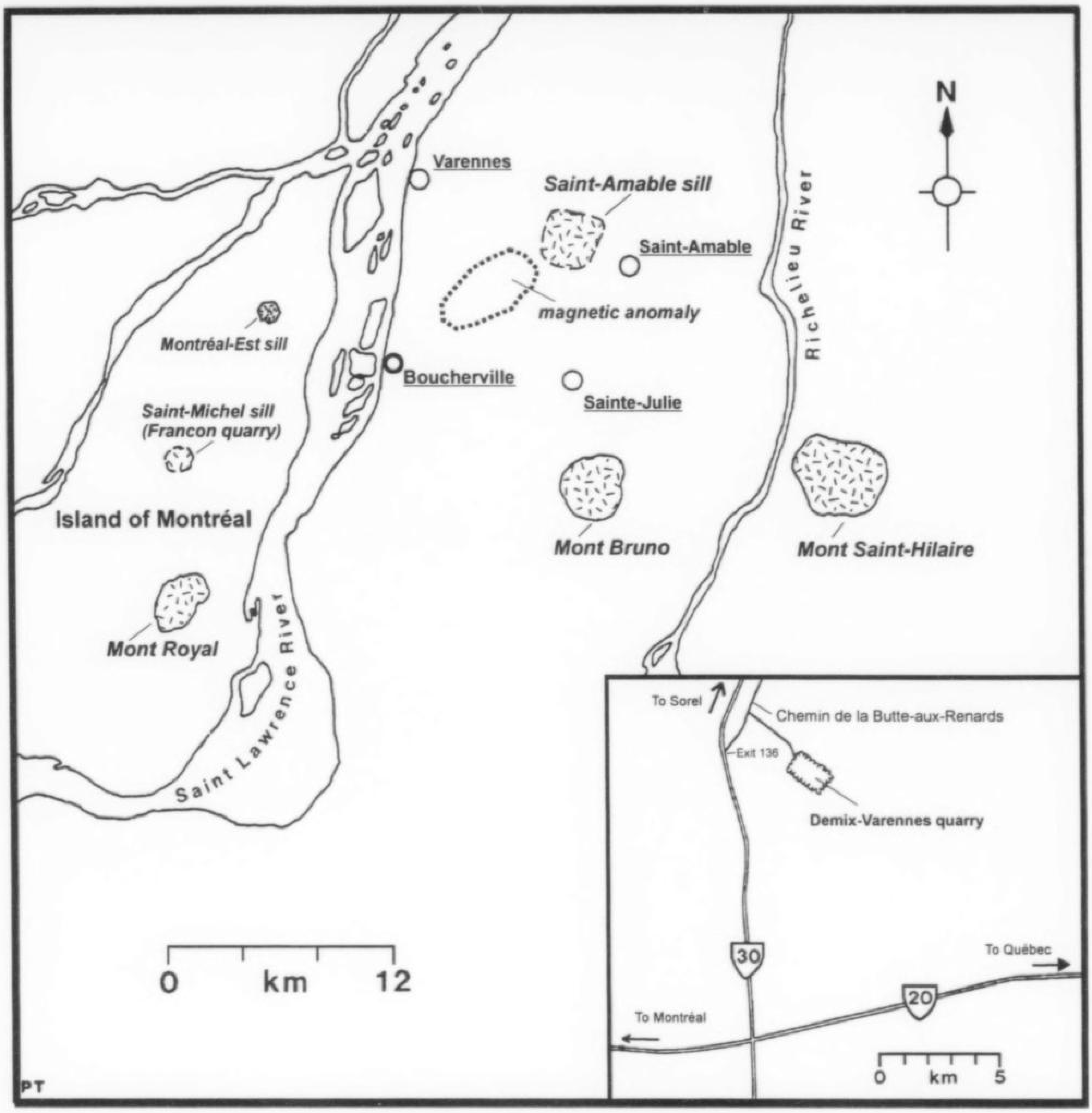


Figure 1. **Locality map showing the Saint-Amable sill and other intrusions of the Monteregian alkaline rock province (stippled areas) in Québec. Inset: Location of the Demix-Varennes quarry in the Saint-Amable sill.**

LOCATION

The Saint-Amable sill is located between the towns of Varennes and Saint-Amable in Verchéres County, Québec, approximately 20 km east-northeast of Montréal and 7 km east of the Saint Lawrence River (latitude: 45°39′ N; longitude: 73°17′ W; Canada National Topographic System, Map 31 H/11, Beloeil). It forms part of an extensive low plateau or butte which rises an average of 25 meters above the surrounding, generally flat countryside. The butte comprises an oblong area of approximately 100 km^2, and is situated within the town boundaries of Varennes, Saint-Amable and Sainte-Julie, with the town of Saint-Amable near its center. Approximately 60% of the butte is covered by woodland, 30% by farmland and 10% by mixed residential and commercial properties.

The Demix-Varennes quarry (the main mineral collecting site) and three small, Bau-Val quarries are located at the northwestern edge of the butte, approximately 3.5 km west-northwest from the center of the town of St-Amable, and 6 km east-southeast from the town of Varennes on the south shore of the Saint Lawrence River. At its current state of development, approximately 60% of the Demix-Varennes quarry lies within the municipal limits of Varennes, and 40% within the municipal limits of Saint-Amable.

Access to the Demix-Varennes and Bau-Val quarries is from Autoroute 30 at Exit 136, approximately 10 km north (in the direction of Sorel) of the Autoroute 20 (Trans-Canada Highway) interchange. Take Exit 136 to Chemin de la Butte-aux-Renards, proceed east on this road for 1.7 km, then turn right (SE) onto a paved road 1.9 km long, which ends at the Demix-Varennes quarry gate; a private, unpaved road to the right leads to the Bau-Val quarries.

HISTORY

The earliest mention of the Saint-Amable sill is in a report of a survey of the regional geology carried out mainly during 1942 (Clark, 1943 and 1955). Clark, who named the sill after the town of Saint-Amable, provided the locations and brief descriptions of the sill outcrops visible at that time. The first known quarry to exploit

Figure 2. **View of the sill. The grey sill rock overlies the dark crumbly shale, and the light colored band is the contact-zone.**

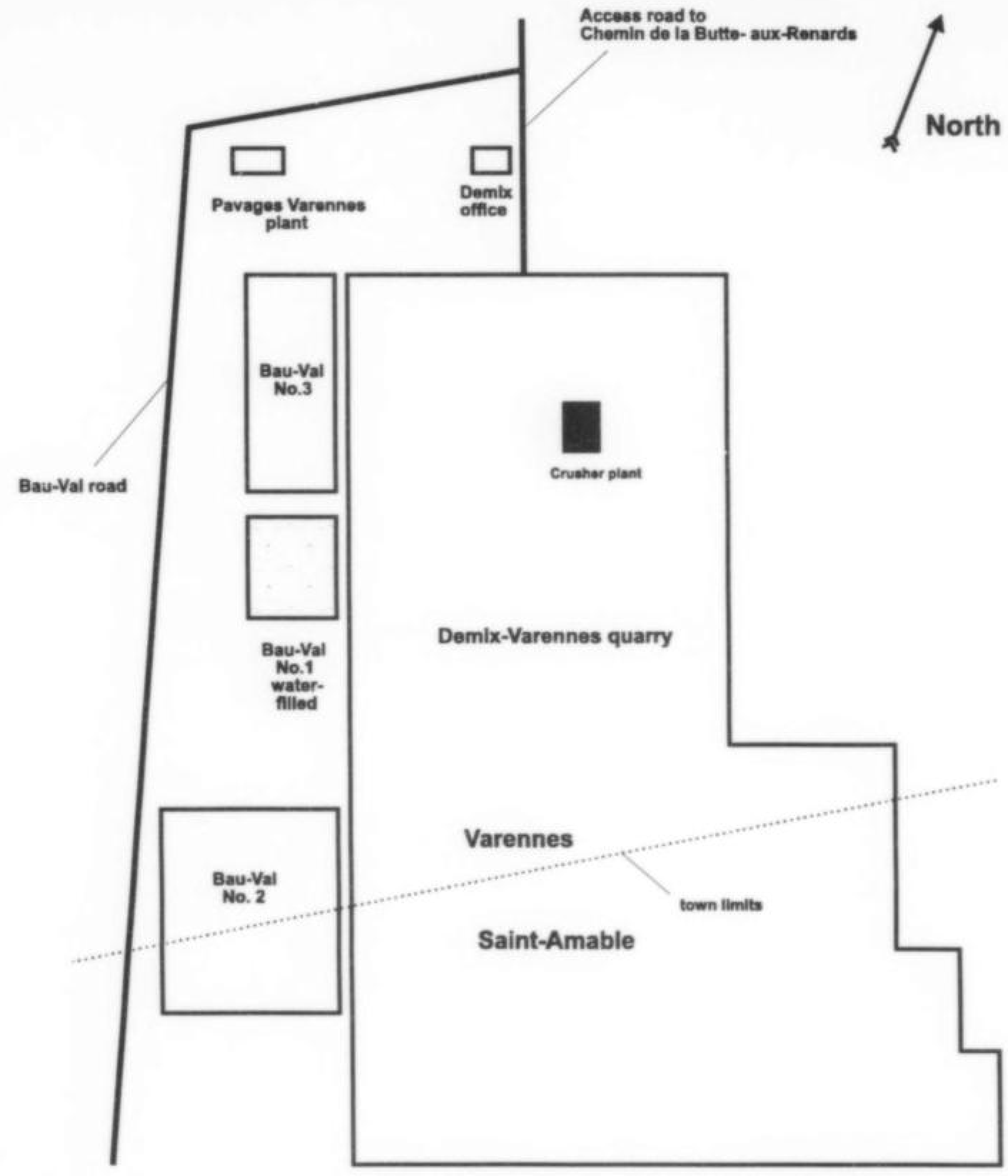
the hard nepheline syenite sill rock was opened in 1959 by Carrières Varennes Ltée. at the northwestern edge of the butte, within the town limits of Varennes. The primary use of the crushed rock was, and still is, as concrete aggregate and road ballast. The quarry ownership changed to Carrières Goyer Ltée. in the period 1969–73, and during this time the quarry was largely inactive. In 1973 the quarry and a large tract of land surrounding it were acquired by Demix Inc. (now Demix Agregats, a division of Ciment Saint-Laurent), and a new crushing plant was installed. The quarry was reactivated and has been in continuous production ever since. This is the same company which operated the now-famous Demix quarry at Mont Saint-Hilaire until 1981 (Horváth and Gault, 1990).

A second company, Les Carrières St-Amable Ltée., commenced operations immediately to the south of the Carrières Varennes quarry in 1964. Two quarry pits, now designated as Bau-Val Nos. 1 and 2, were developed and worked for a few years. By 1972 both of these were inactive and water-filled. The property was acquired by Bau-Val Inc. (now Pavage Varennes, a division of Bau-Val) from Les Carriéres St-Amable Ltée. around 1970. A new pit, Bau-Val No. 3, was started in the 1980's northwest of the two older pits; this and the dewatered Bau-Val No. 2 have been worked intermittently in recent years by Sintra Inc. under a lease from Pavage Varennes. The Bau-Val No. 1 and No. 2 pit designations were used by Globensky (1985); the third pit was arbitrarily designated as Bau-Val No. 3 by the authors. The three Bau-Val pits are separated from the Demix-Varennes quarry by a narrow, blast-fractured wall of rock.

During the last few years the Demix-Varennes quarry has been worked mainly at the Saint-Amable end, with current and planned future expansion continuing toward the southeast and northeast. Quarrying is confined to the sill, as there is no market for the underlying soft shale. This has resulted in a very large (approximately 1.5 x 0.9 km) but shallow (10–15 meters deep) open pit.

Although Clark (1955) observed vesicles in one of the sill outcrops, he made no mention of any minerals. During a visit in 1962 to what is now the Demix-Varennes quarry, one of the authors (PT) noted the presence of mineralized cavities containing unusual minerals. Among the species identified from the material collected there were rhodochrosite, mangan-neptunite, natrolite, aegirine, serandite, eudialyte and astrophyllite. However, there was very little additional collecting activity during the next ten years as local mineral collectors focussed their attention on Mont Saint-Hilaire. In 1972, two of the authors (EP-H and LH) began collecting in the present Demix-Varennes quarry, which was inactive at the time, and have continued to make infrequent visits over the following 19 years during which a number of additional minerals were identified, including the rare species yofortierite, doyleite and catapleiite. A comprehensive study of the mineralogy of the Saint-Amable sill was initiated by the authors in 1991, and entailed the examination of a large volume of material collected over many years up to the present. The list of species quickly grew to the current, rather impressive total of over 100, and includes the new sodium-manganese silicate, varennesite (Grice and Gault, 1995), which is named after the locality, the Demix-Varennes quarry. Several other possible new species are under study, and the potential for the discovery of additional species is very good.

This paper summarizes the results of our investigations as of December 1997.



Not drawn to scale

Figure 3. **Quarries in the Saint-Amable sill. A schematic plan view.**

GEOLOGY

The Saint-Amable sill is genetically related to the Monteregian alkaline rock province of Lower Cretaceous age (Adams, 1903). The province includes ten main plutons known as the Monteregian Hills, which are aligned along an east-west-trending belt, from Mont Megantic about 190 km east of Montréal, to Oka 35 km west of Montréal. Several magnetic anomalies associated with the belt are believed to represent additional, buried plutons (Philpotts, 1970; Telford *et al.*, 1976). There are also numerous minor intrusions in the form of dikes, sills and igneous breccias (Clark, 1972; Currie, 1976; Globensky, 1985). Besides the Saint-Amable sill, a number of other major sills have been exposed in and around the greater Montréal area by quarrying and building excavations. One of these, the Saint-Michel sill (Francon quarry), has become a famous mineral collecting site (Sabina, 1978; Vard and Williams-Jones, 1993) and the type locality for nine mineral species.

The Saint-Amable sill is the most extensive and the thickest known Monteregian sill (Hodgson, 1969). While it has not been age-dated, it is very likely coeval with two of the closest Monteregian intrusives, Mont Saint-Bruno and Mont Saint-Hilaire, dated at 90 and 135 ± 10 million years respectively (Gold, 1979; Eby, 1984). As noted previously, the sill underlies a butte, which probably formed as a result of the resistance of the sill rock to glacial abrasion and other erosion. The sill extends below a thin overburden of glacial till for a distance of at least 3 km from the northwestern margin of the butte, and occupies an area of at least 8 to 9 km^2 based on known surface outcrops, quarrying and related surface stripping and test drilling. It is probable that the sill has a considerably larger total area, but the scarcity of outcrops and dense forest cover has thus far precluded full mapping.

The sill overlies black shale of the Lorraine Group of Upper Ordovician age (425–450 million years), interbedded with thin layers of sandstone and limestone (Clark, 1955; Globensky, 1985). Its upper surface is an erosional surface, and only its lower contact can be seen. In the Demix-Varennes quarry, the sill has an average dip of 3° NE (Globensky, 1985) and becomes generally thicker toward the east. The thickness varies from about 3 meters to a maximum of 24 meters (Globensky, 1985). Since its present upper surface is erosional, it is certain that the sill was thicker at the time of emplacement. This interpretation is supported by the fact that horizontal-trending, cavity-rich mineralized zones in the upper portion of the sill are absent where the sill thickness is reduced. The lower contact of the sill is undulating, probably due to natural stoping of the soft, fissile shale. There is no visible evidence of hornfelsization of the shale at the sill contact. In one unusual occurrence a xenolith of hornfelsized shale was observed *in situ*, in the sill near the contact; the xenolith, about 1 meter across, was brecciated throughout and permeated by a dense network of narrow fissures lined with labuntsovite and pyrrhotite crystals.

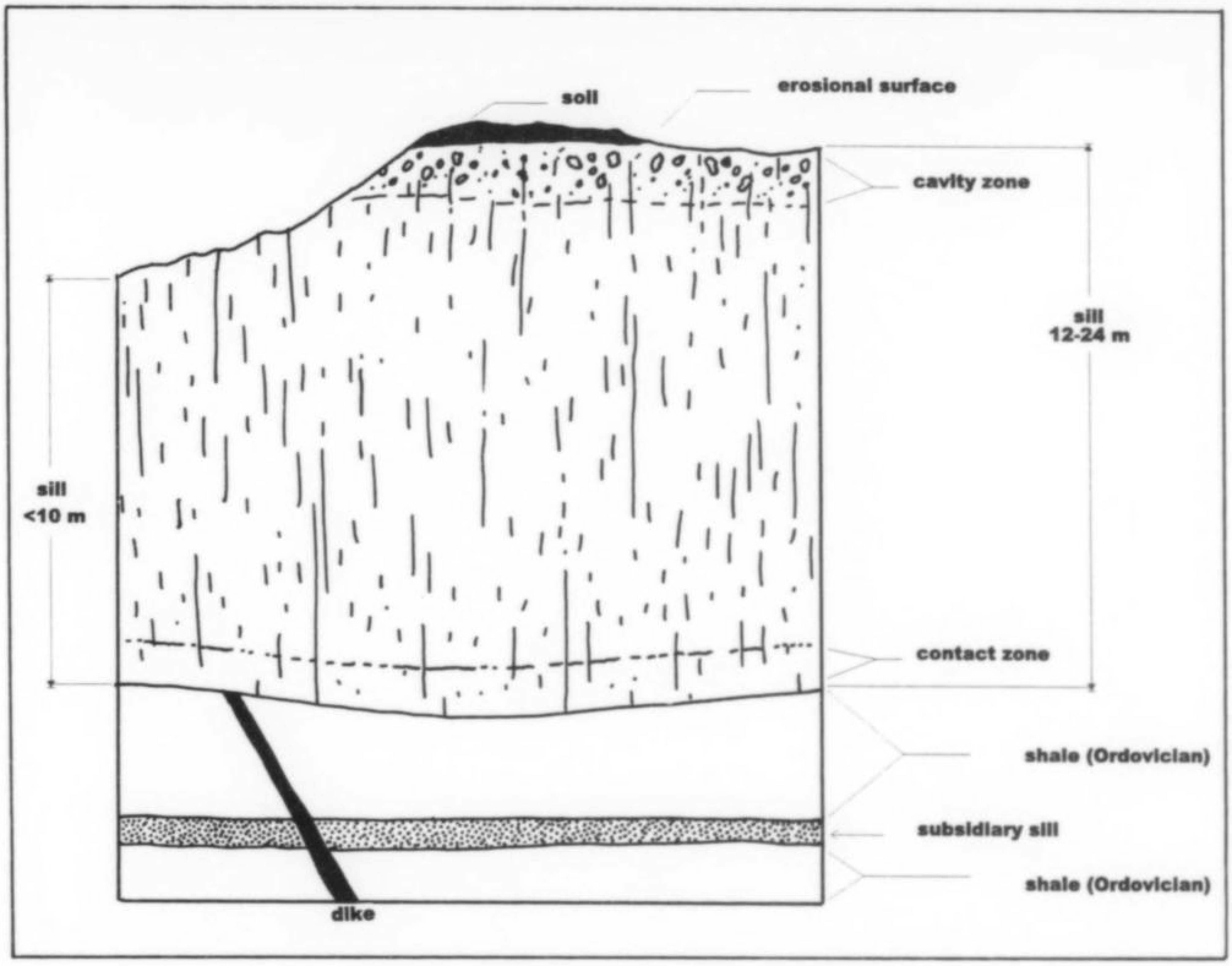


Figure 4. **Schematic cross-section of the Saint-Amable sill showing typical features and relationships.**

A conspicuous feature of the sill is a well-defined contact zone which is much lighter in color than the rest of the sill. The zone follows the undulations of the lower contact and is up to 2.5 meters thick. Rock in this zone has a peculiar mottled appearance and contains numerous randomly oriented, mineralized cavities. A body of very similar rock exposed in the south corner of the Demix-Varennes quarry in 1994–95 appeared to occupy the entire thickness of the sill; the rock was in part shattered and heavily weathered, and its margins were obscured. Its relationship to the rest of the sill is unclear.

Based on an examination of sill outcrops, one of which exposed a 12-meter-thick section, Clark (1955) concluded that the sill was made up of multiple injections, each 0.6 to 1.2 meters thick, and "each with an approach to a chill zone." No detailed study has been made of the internal structure of the sill as exposed in the present quarries. Globensky (1985) cited Clark's conclusions but added no new information regarding the structure or mechanism of sill emplacement. Our examination of the sill has not revealed any evidence of multiple emplacements. The most notable internal features of the sill are horizontal-trending zones of mineralized cavities in the upper portions of the sill, close to the erosional surface, and thin, mainly horizontal mineralized seams containing tiny cavities that often extend to the central portions of the sill. The location of these mineralized zones was probably controlled by converging solidification fronts within a single thick emplacement of magma (Marsh, 1996).

A peculiar feature of the sill is the rare occurrence in the Demix-Varennes quarry of pod-like, cavity-rich areas which appear to have a hydrothermal origin. These are also found in the upper zones of the sill, and have a distinctive mineralogy.

Several smaller (20–50 cm thick) sills and dikes occur below the main sill, and are exposed in the Demix-Varennes and Bau-Val quarries. The dikes truncate at the main sill contact. The rocks forming these subsidiary sills and dikes appear to be considerably different from that of the main sill, and surely represent separate injections.

Regional stresses have resulted in prominent vertical jointing in the sill rock. One set has a strike of N10°W and a spacing of 30 cm or more, and a second set has a strike of N65°W with a spacing of 2 cm or more (Globensky, 1985).

The source of the magma which formed the sill is a matter of conjecture. The nearest Monteregian pluton, Mont Saint-Bruno, is approximately 10 km south of the sill exposures, whereas Mont Saint-Hilaire is approximately 15 km to the southeast. A ridge-like projection of the butte which contains the sill extends to about 1 km from Mont Saint-Bruno. Dresser (1910), in his report on the geology of Mont Saint-Bruno, suggested that this ridge might conceal an "underlying sill or trap" connected to the pluton. Closer to the Saint-Amable sill there is a magnetic anomaly which has been interpreted as a large, deeply buried Monteregian pluton (Telford *et al.*, 1976). It is centered approximately 3 km west of the western edge of the sill, and extends below it at an estimated minimum depth of over 900 meters. It is interesting to speculate whether this may be the actual "feeder stock" for the Saint-Amable sill.

PETROLOGY and GEOCHEMISTRY

The bulk of the sill is a dense, gray to dark gray, fine-grained rock with relatively little textural variation. The average grain-size is 40 µm (Grice and Gault, 1995). The rock has been variously

Table 1. **Bulk chemical compositions of the Saint-Amable sill rocks.**

	A	*B*	*C*	*D*	*E*	*F*	*G*
SiO2	56.20	56.00	55.47	57.05	54.8	55.90	57.60
TiO_2	0.35	0.33	0.34	0.30	0.34		
Al_2O_3	20.70	20.59	21.10	20.52	20.70	20.46	20.80
Fe_2O_3	2.74	2.68	2.86	2.79	2.63	2.06	
FeO	0.68				0.68	0.58	
MnO	0.48	0.39	0.43	0.37	0.43	0.33	
MgO	0.20	0.19	0.22	0.09	0.25	0.19	
CaO	0.70	0.52	0.96	0.78	0.85	0.81	
Na_2O	9.71	8.70	9.83	9.02	9.26	9.72	8.40
K_2O	4.94	4.56	4.96	5.46	5.11	5.33	5.28
P_2O_5	0.02	0.05	0.04	0.03	0.02	0.03	
H_2O	2.45				3.49	3.44	
CO_2	0.18				0.85	0.10	
S						0.008	
F						0.30	
Cl						0.08	
V_2O_5						0.001	
BaO		0.02	0.02	0.02		0.02	
SrO		0.01	0.01	0.01		0.004	
ZnO		0.03	0.02	0.02			
Nb_2O_5		0.03	0.04	0.03		0.06	
ZrO_2		0.12	0.14	0.13		0.12	
Y_2O_3		0.005	0.01	0.01			
Ce_2O_3						0.05	
LOI		6.53	4.03	3.18			
Totals	99.35	100.75	100.48	99.81	99.41	99.59	92.08

A—"lower chilled margin of sill" (Hodgson, 1969)
B—light-colored contact-zone rock (McDonald, 1996)
C—gray (regular) sill rock (McDonald, 1996)
D—dark, dense sill rock (McDonald, 1996)
E—"center of sill" (Hodgson, 1969)
F—sill rock analysis (Québec Dept. of Natural Resources, Z. Katzendorfer analyst 1963)
G—sill rock analysis (Globensky, 1985)

described as tinguaite (Clark, 1955; Hodgson, 1969), trachytic phonolite (Hanes, 1962) and nepheline syenite (Currie, 1976; Globensky, 1985). Compositionally, the rock types covered by these terms are similar. According to current classification schemes (Sørensen, 1974; Le Maitre, 1976) and the available petrographic and chemical analyses, the sill rock is best classified as nepheline syenite.

Only limited studies of the petrography of the sill have been carried out. Hanes (1962) and Hodgson (1969) examined a small number of rock samples taken during the initial period of quarrying. Their modal analyses of thin sections showed the principal rock-forming minerals to be: K-feldspar, 29–40%; natrolite, 27–30%; nepheline, 5–17%; albite 15%; and aegirine, 5–12%. Grice and Gault (1995) reported the analysis of a single thin-section of rock from the central portion of the sill as follows: K-feldspar, 45%; natrolite, 40%; nepheline, 5%; and aegirine 5% by volume.

Thin sections show the rock to consist of phenocrysts of nepheline in a matrix of K-feldspar laths, prismatic crystals of aegirine, and fine-grained, apparently primary, natrolite. A trachytic texture is imparted by the orientation of the feldspar and aegirine. The K-feldspar laths, consisting principally of microcline and sanidine, are rimmed by albite. Nepheline is partly altered to natrolite and contains inclusions of feldspar and radiating acicular aegirine. Accessory minerals include eudialyte (which may constitute up to 3% of the rock in some zones of the sill), analcime, rinkite and astrophyllite. In the contact zone at the lower margin of the sill, the rock is uniformly fine-grained and much lighter in color than the rest of the sill, probably due to a low concentration or absence of mafic minerals. The rock has a peculiar mottled appearance, with pale gray to brownish gray orbicular patches up to 10 or more cm across surrounded by pale beige to almost white, distinct reaction rims and aureoles. The contact-zone rock has not been examined in thin section.

Reported whole-rock chemical analyses (Table 1) are remarkably consistent, and show no significant difference between the lower contact zone and the bulk of the sill. The composition is typical of nepheline syenites.

The rock is marginally agpaitic with a calculated average agpaitic[1] index of 1.03. Its classification as agpaitic is further supported by a second criterion for agpaicity, the presence of alkaline Ti and Zr-rich silicates and rare-earth minerals (Gerasimovsky, 1956 and 1963). The Saint-Amable sill contains eudialyte, rinkite and astrophyllite both as accessory rock-forming minerals and as cavity minerals. The sill is also remarkable for the relative abundance of other minerals characteristic of agpaitic rocks such as catapleiite, låvenite, lorenzenite and mangan-neptunite, and for the presence of villiaumite, vuonnemite and many rare-

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[1] For agpaitic characterization, the agpaitic index or coefficient should be (Na_2O + K_2O) : Al_2O_3 = > 1, and some typical indicator minerals such as eudialyte, rinkite, lorenzenite etc. should be present.

earth-element (REE)-bearing minerals such as ancylite-(Ce), bastnäsite-(Ce), cordylite-(Ce), monazite-(Ce) and synchysite(Ce). Compared to other agpaitic intrusions, the apparent scarcity or absence of beryllium and boron is notable.

MINERALIZATION

As already noted, the Saint-Amable sill contains many mineralized cavities and seams. These are the source of well-formed microcrystals of interest to collectors. The most abundant, species-rich cavities and seams occur in the upper portions of the sill. They are concentrated in horizontal-trending zones, and are absent where the sill thickness has been reduced by erosion to less than 10–12 meters. Within these zones there are several modes of occurrence of the minerals, distinguished by variations in physical characteristics, associations and paragenesis. A distinctly different type of mineralization is found in the lower contact zone of the sill, and in the similar body of rock exposed in the southwest corner of the Demix-Varennes quarry.

Figure 5. **Miarolitic cavities.**

Miarolitic Cavities

The miarolitic cavities are flattened, round to oblong or free-form cavities, commonly 5–10 mm deep and 2–5 cm across. Larger cavities up to 2 cm in depth and 10–20 cm across are rare. Extremely elongated, winding, tubular "worm-hole" cavities, 2–10 mm in diameter and up to 25 cm in length are also found. The miarolitic cavities generally contain clean, sharp, lustrous crystals. They are typically lined with microcline, aegirine and natrolite, which are the earliest minerals in the paragenetic sequence.

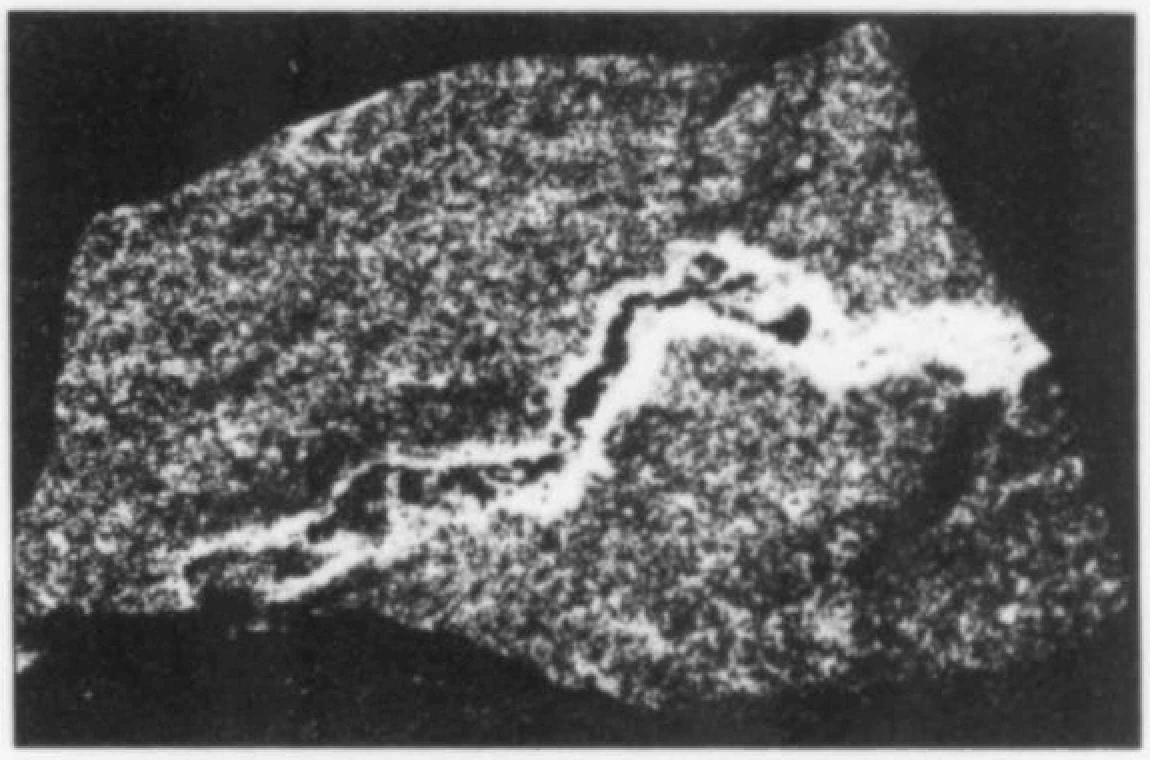


Figure 6. **Miarolitic "worm-hole" cavity. Field of view 15 cm.**

The wall rock around miarolitic cavities often contains numerous small, rounded vesicles 1–3 mm across which provide a substrate for a rich and varied assemblage. The mineral assemblage lining these vesicles, and its paragenesis, are almost identical to those of miarolitic cavities, but are more limited in the number of species.

It is likely that the miarolitic cavities were formed by volatiles exsolving from the magma during the final stages of solidification. As degassing progressed, the cavity minerals were deposited from residual alkaline fluids enriched in zirconium, titanium, niobium, rare-earths and other elements. As suggested previously, the cavities were localized between advancing solidification fronts in what was most likely the original center of the sill.

Altered Miarolitic Cavities

Some miarolitic cavities found generally near the erosional surface contain minerals that have been subjected to oxidation and leaching, probably by meteoric water. Serandite is commonly altered to birnessite; eudialyte and some of the aegirine has a bleached appearance; commonly there is an accumulation of a powdery smectite-group mineral; and opal is deposited as a crust on other minerals.

Mineralized Seams

Very narrow, 1–5 mm wide mineralized seams riddled with tiny cavities occur locally in the sill. They are generally horizontal, and can be traced over distances of several meters. During blasting in the quarry, the rock often fractures along these seams, exposing mineralized surfaces up to 2 square meters in area. These seams probably formed as the mineralizing fluids penetrated fissures in the cooling magma. A characteristic of the mineral assemblage, which is similar to that in miarolitic cavities, is an abundance of closely associated astrophyllite, låvenite, rinkite and lorenzenite.

Natrolite Pipes

Some tubular cavities, 2–10 cm in diameter and sometimes up to 2 meters in length, show signs of alteration, and contain very few mineral species other than natrolite. A microcline lining, typical of miarolitic cavities, is rarely present, and many of the pipes are completely devoid of minerals. Natrolite occurs as solid masses, sometimes completely filling the pipes, and as a lining of well-formed crystals forming spherical aggregates 2–3 cm in diameter. The few pipes that have been observed *in situ* are close to the erosional surface and have a generally vertical orientation. The natrolite pipes may represent post-emplacement, hydrothermal deposition.

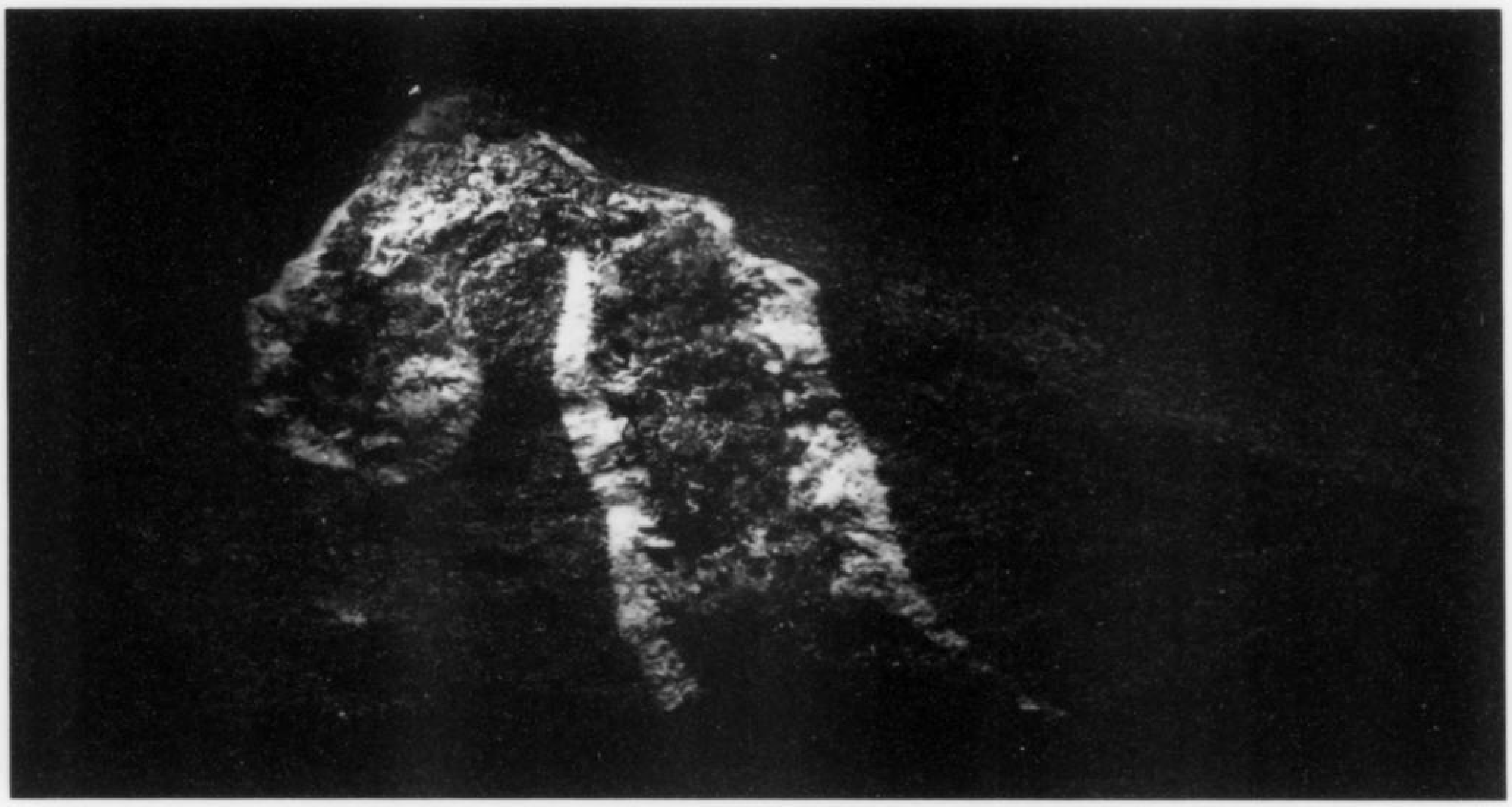


Figure 7. **Part of a "natrolite pipe." Field of view 20 cm wide.**

Hydrothermalite Pods

Very rarely encountered are pod-like structures having characteristics analogous to those of hydrothermalite bodies associated with other agpaitic alkaline rocks, notably those in the Lovozero massif (Khomyakov, 1995). One of their characteristics is an abundance of Na-rich, highly alkaline minerals. Of the few observed to date, the largest, about 2 meters across, was found in the southeast corner of the Demix-Varennes quarry. It consisted of a series of interconnected, largely infilled cavities roughly spherical to oblong in shape and 20–30 cm in diameter. The margins of the cavities show a zonation from very dense, fine-grained nepheline syenite through a narrow (~ 1 cm wide) alteration zone with evidence of brecciation, to a porous, white, medium-grained intergrowth of natrolite, feldspar and magadiite, with scattered radiating aggregates of acicular aegirine. This intergrowth forms an irregular cavity lining several centimeters thick, and grades into the cavity infilling. The infilling is vuggy and has a texture which suggests that the minerals were deposited in several stages. It consists primarily of crystallized natrolite intergrown with smaller masses of magadiite, polylithionite, nodular chalcedony and other minerals. Varennesite is relatively abundant in this assemblage, both as masses and as crystals in vugs. Also notable is the presence of VUK1, VUK9 and especially shkatulkalite. Most of the minerals in the assemblage have an altered appearance. Peripheral to the large infilled cavities are small cavities with mineralization similar to that of miarolitic cavities. Similar but smaller hydrothermalite pods containing a somewhat different and smaller suite of minerals were also found in the southwest and southeast corners of the quarry.

The genesis of the hydrothermalite pods is unclear. They may represent a very late but localized hydrothermal stage of the sill emplacement, or they may have been formed after emplacement by migrating hydrothermal solutions.

Contact-Zone Cavities

The mineral assemblage in the contact zone of the sill and in a similar body of exposed rock in the south corner of the Demix-Varennes quarry is very different from that in other parts of the sill. The rock is riddled with numerous cavities, 5–50 mm in size, and often extending over areas of up to several hundred square centimeters. The cavities form interconnected networks in the pale beige to white aureoles around the darker orbicular patches; the shape of the cavities generally conforms to the pattern of the aureoles. The cavities are invariably lined with flattened, poorly formed analcime crystals commonly associated with natrolite, calcite, dolomite and fluorite. Many of the minerals which are common in the rest of the sill, such as aegirine, eudialyte, låvenite, serandite and lorenzenite, are completely absent.

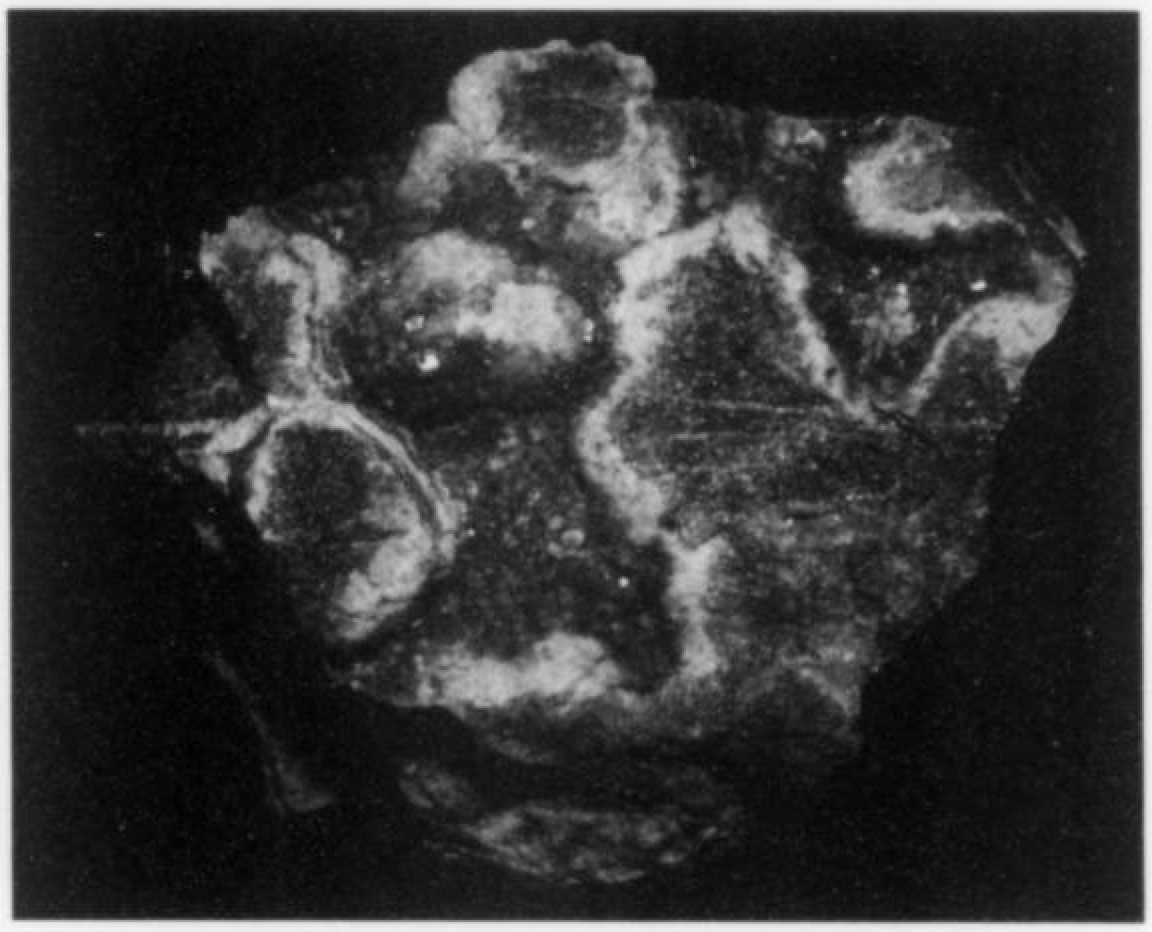


Figure 8. **Close-up of interconnected contact-zone cavities. Field of view 15 cm wide.**

The texture and the mineralogy of the contact zone suggest that while the rock was still hot it was invaded by solutions derived from the underlying shale. The solutions penetrated the rock along a network of fractures, partially dissolving the rock. With further cooling, analcime, natrolite and other minerals crystallized in cavities formed along the fractures. This process would entail little change in overall chemistry since the principal minerals, both in the sill rock and the contact zone cavities, are sodium-aluminum silicates. This would account for the consistency of the chemical analyses of the contact-zone rock and the rest of the sill. The very rare and unusual occurrence of late-stage cryolite, thomsenolite, gibbsite and doyleite in the contact zone is probably analogous to the paragenesis of the hydrothermalite pods.

The observed paragenetic relationships for the three most important assemblages are shown in the accompanying tables.

Table 2. **Minerals of the Saint-Amable sill.**

Sulfides
Arsenopyrite
Erdite
Galena
Löllingite
Marcasite
Pyrite
Pyrrhotite
Sphalerite

Oxides & Hydroxides
Anatase
Birnessite
Doyleite
Franconite
Gibbsite
Goethite
Hematite
Hochelagaite
Lueshite
Todorokite
Woodruffite
VUK3

Halides
Cryolite
Fluorite
Thomsenolite
Villiaumite

Carbonates
Ancylite-(Ce)
Ancylite-(La)
Aragonite
Bastnäsite-(Ce)
Calcite
Cerussite
Cordylite-(Ce)
Dawsonite
Dolomite
Donnayite-(Y)
Kukharenkoite-(Ce)
Rhodochrosite
Siderite
Strontianite
Synchysite-(Ce)
VUK11

Sulfates
Celestine
Gypsum
Halotrichite
Jarosite

Phosphates
Carbonate-fluorapatite
Fluorapatite
Monazite-(Ce)
Rhabdophane-(Ce)

Molybdates
Wulfenite

Silicates
Aegirine
Albite
Amphibole grp.
Analcime
Arfvedsonite
Astrophyllite
Calciohilairite
Catapleiite
Chabazite
Chlorite grp.
Elpidite
Epididymite
Epistolite
Eudialyte
Gaidonnayite
Gmelinite
Hilairite
Kaolinite grp.
Labuntsovite
Låvenite
Lemoynite
Lorenzenite
Magadiite
Makatite
Mangan-neptunite
Microcline
Montmorillonite
Muscovite
Natrolite
Nenadkevichite
Nepheline
Opal
Paranatrolite
Pectolite
Polylithionite
Quartz
Rinkite
Sazhinite-(Ce)
Serandite
Shkatulkalite
Smectite grp. [A and B]
Sodalite
Terskite
Tetranatrolite
Thornasite
Titanite
Tuperssuatsiaite
Varennesite (type loc.)
Vuonnemite
Yofortierite
Zakharovite
Zircon
VUK1
VUK6
VUK7
VUK8
VUK9

MINERALOGY

With the exception of a short abstract (Gault and Horváth, 1993) and the description of the new species varennesite (Grice and Gault, 1995), nothing has been previously published on the mineralogy of the Saint-Amable sill. The following descriptions are based mostly on specimens in the Horváth collection, with supplementary information derived from the collections of Peter Tarassoff and the Canadian Museum of Nature. All species identifications have been confirmed by X-ray diffraction (XRD) methods, supported in many cases by electron microprobe analysis, sometimes on several specimens. It is impractical to include the X-ray data in the present article; however this information is available on request. A number of institutions provided X-ray data and employed the following equipment for routine analyses: Carleton University, Ottawa and the Royal Ontario Museum use 114.6-mm and 57.3-mm-diameter Gandolfi single-crystal diffraction cameras generally with Cu$K\alpha$ radiation; the Canadian Museum of Nature, Ottawa and the Geological Survey of Canada, Ottawa use 114.6-mm Debye-Scherrer powder diffraction cameras generally with Cu$K\alpha$ (Ni-filtered) radiation.

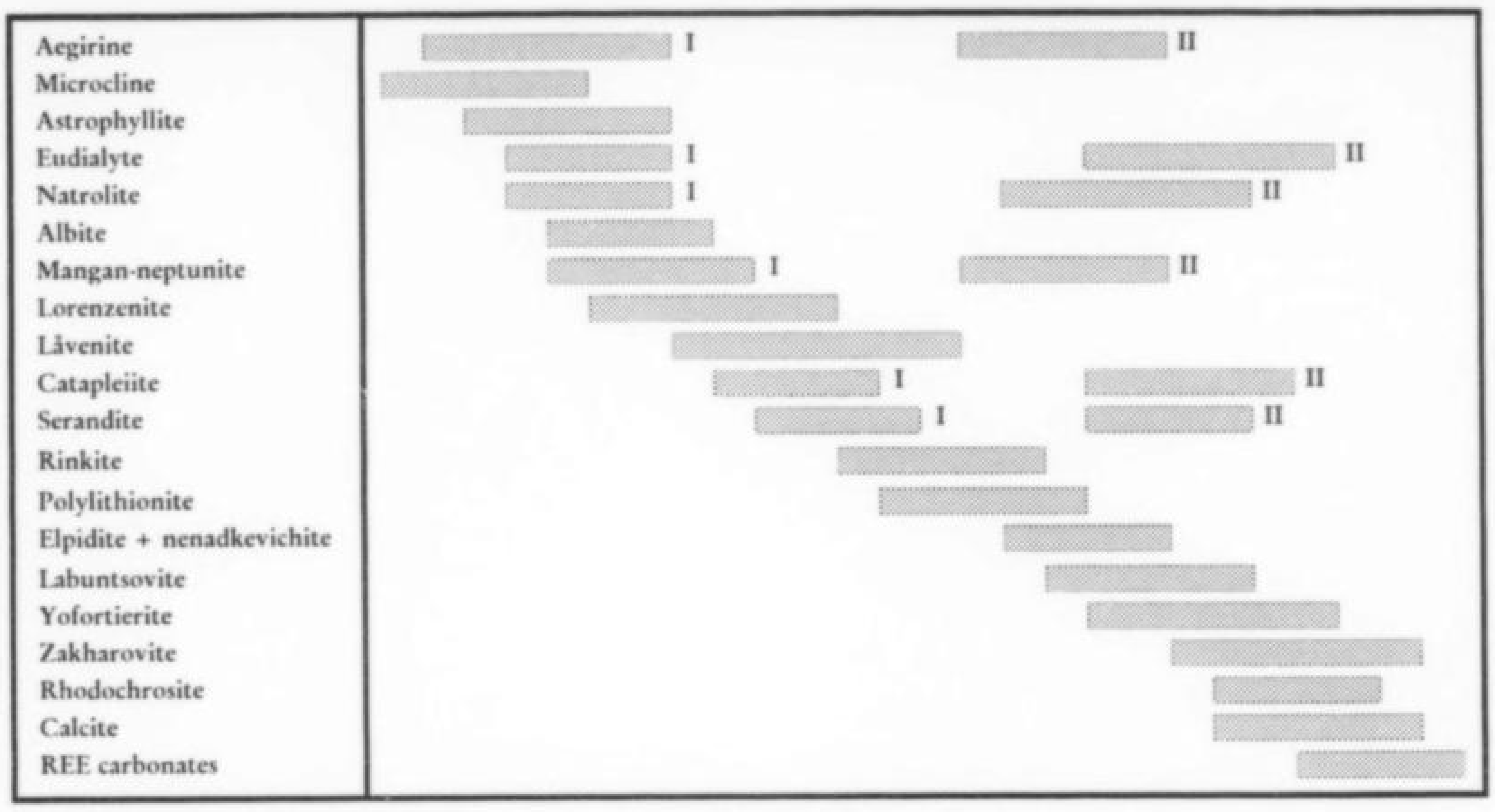
All chemical analyses were performed on a JEOL 733 electron microprobe using Tracor Northern 5500 and 5600 automation, at the Canadian Museum of Nature, Ottawa. For all analyses reported in this paper, the wavelength-dispersion (WDS) mode was used. Data reduction was accomplished with a conventional ZAF routine in the Tracor Northern TASK series of programs. In all analyses the operating voltage was 15 kV and the beam current was 0.20 µA. The beam diameter varied according to the type and size of material analyzed. Commonly a 20–30 µm beam diameter was used. Minerals such as carbonates, zeolites and other H_2O-bearing minerals, and minerals with high Na content, generally require a beam diameter of at least 40–50 µm to prevent sample burn-up or Na migration/volatilization. The energy-dispersion system (EDS) was frequently used to quickly check for major elements on many of the specimens, and 100-second EDS scans were used to confirm that no elements with $Z > 8$ were missed in the WDS analyses. Only those elements which were detected are reported in the analyses. Samples were also checked for chemical homogeneity using the backscatter electron (BSE) detector. Data for all elements in the samples were collected for 25 seconds or 0.50% precision, whichever was attained first. Data for all elements in the standards were collected for 50 seconds or 0.25% precision, whichever was attained first. Standards used varied with the type of material analyzed. All microprobe analyses were carried out by one of the authors (RAG), and information on standards and operating conditions used in the analyses are available on request.

Species whose identity is presently unknown have been assigned VUK (VUK stands for Varennes unknown) code numbers; these are either potential new species, or species for which the available analytical data are insufficient for definite identification; descriptions of these have also been included. All of the mineral species identified to date are shown in the accompanying table, classified by chemical groups.

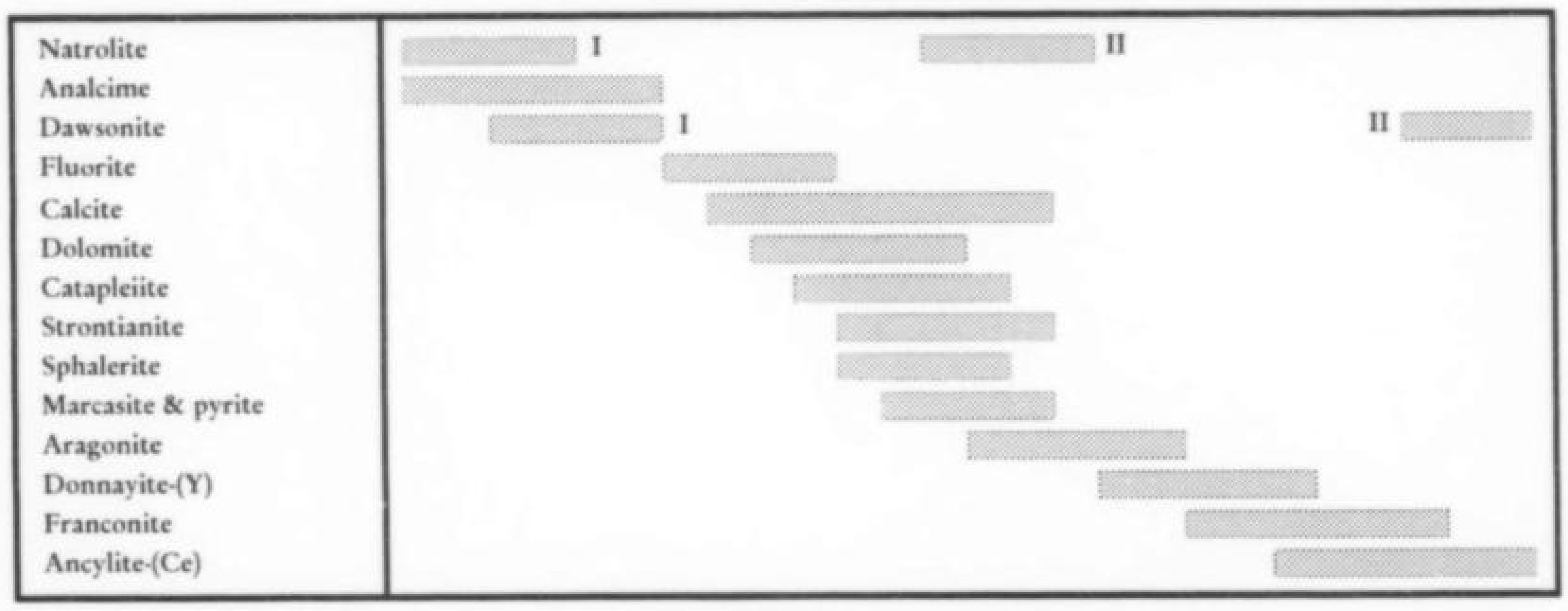
Some of the minerals found in the Saint-Amable sill fluoresce under ultraviolet radiation. Their fluorescence characteristics are tabulated (Table 4) as a diagnostic aid to visual identification.

The illustrated specimens, unless otherwise noted in the captions, are from the Horváth collection, and all specimen and locality photos with the exception of the SEM photomicrographs are by L. Horváth. A series of crystal drawings have been included to show typical morphologies of some of the more interesting species. The crystal drawings were made using SHAPE and CorelDRAW software.

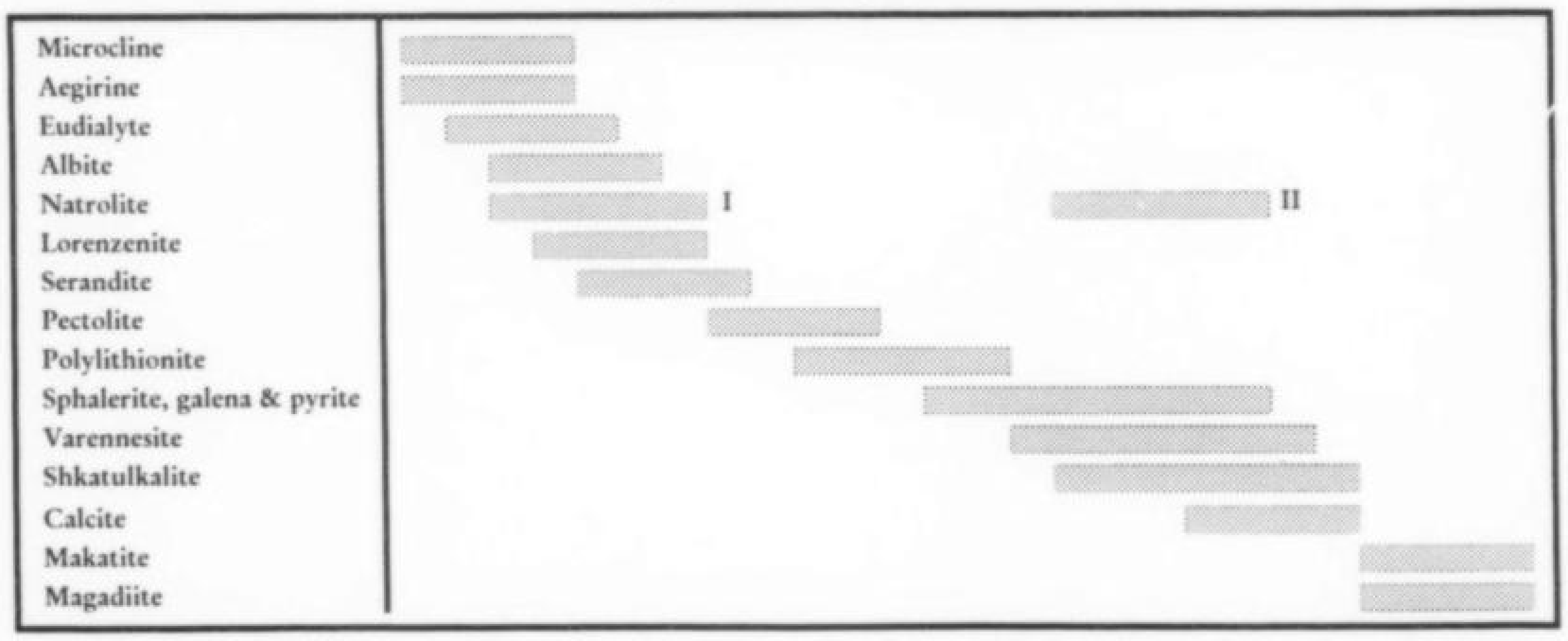
Table 3. **Mineral parageneses of the Saint-Amable sill.**



Contact-zone cavities



Hydrothermalite pods



Aegirine $NaFe^{3+}Si_2O_6$

Aegirine is one of the most common and conspicuous minerals in miarolitic cavities, mineralized seams and hydrothermalites. It is found as free-growing, acicular, somewhat flattened prismatic crystals forming divergent sprays and radiating spherical groups, with individual crystals 1–15 mm long. The predominant color is medium to dark green, grading toward a lighter brownish yellow at the terminations. Golden yellow, reddish brown acicular crystals 1–2 mm long, and black prismatic crystals up to 1 cm long are also common.

Aegirine is one of the earliest primary minerals of the sill rock, while in the miarolitic cavities, it is often present as at least two generations, a very early and a mid-stage mineral. It is notably absent in the contact-zone mineralization.

Albite $NaAlSi_3O_8$

Albite, one of the rock-forming minerals, is relatively uncommon as euhedral crystals. It occurs in miarolitic cavities and mineralized seams as sharp, colorless, tabular to thin bladed crystals, 0.5–1.5 mm long, and as colorless, epitactic overgrowths on microcline crystals.

A single microprobe analysis (WDS) of albite gave SiO_2 68.59, Al_2O_3 18.66, Na_2O 11.66, K_2O 0.18, FeO trace, total 99.09 weight % resulting in the empirical formula $(Na_{1.00}K_{0.01})_{\Sigma 1.01}Al_{0.97}Si_{3.02}O_8$, based on 8 oxygen atoms. Ca was specifically sought but not detected.

Amphibole group

An amphibole-group mineral is found rarely in altered miarolitic

***Table 4.* Fluorescent minerals of the Saint-Amable sill.**

Abbreviations: Int = intensity; S = strong; W = weak; SW = shortwave; LW = longwave

Mineral	*Ultraviolet fluorescence*				*Phosphorescence*			*Remarks*
	Shortwave		*Longwave*					
	Int	*Color*	*Int*	*Color*	*SW*	*LW*	*Color*	
Aragonite	S	bluish white	W	bluish white				
Calcite	S	whitish yellow	S	orange yellow	S		whitish yellow	not all phosphorescent
Catapleiite	W	pale orange-yellow						
Cryolite	S	yellowish white	W	yellowish white	W		white	
Fluorite	W	pale blue						not all fluorescent
Franconite	S-W	yellowish white	W	yellowish white				
Gibbsite	S +	bluish white	S	bluish white	S	S	pale yellow	
Hochelagaite	W	yellowish white	W+	yellowish white				
Lorenzenite	W	pale yellow						
Magadiite	S	yellowish white	W	white				
Makatite	W	bluish white						
Microcline	S	dark red						
Opal	S +	yellowish green	W	pale yellow-green	W		pale yellow	not all phosphorescent
Polylithionite	S	yellow						
Quartz “chalcedony”	S	greenish yellow	W	bluish white	W		pale yellow	
Sodalite	S	reddish orange	S	orange-red	W		yellow	
Strontianite			W	bluish white				
Terskite	W	pale yellow						
Thomsenolite	S	yellowish white	S	yellowish white				
Thornasite	W	pale yellow-white						
Vuonnemite	W	pale yellow-white						
VUK6	W	white						not all fluorescent
VUK8	W	white						

Note: Fluorescence response was observed using Raytech Model No. 183 ultraviolet equipment.

cavities, as fibrous tufts and as dark green to black acicular crystals up to 1.5 mm long. The exact identity of the species has not been determined.

Analcime $NaAlSi_2O_6 \cdot H_2O$

Analcime is the dominant species in cavities in the contact zone, where it lines nearly all the cavity walls in crystals from a few millimeters to 5 cm in diameter. The crystals are opaque, white to tan, poorly formed, flattened, invariably intergrown and rarely show more than a few crystal faces. Analcime is relatively rare in miarolitic cavities, where it occurs as colorless trapezohedra to 1 mm, with many inclusions, and as opaque, white or grayish white, rather poorly formed, partially etched, 1–20 mm crystals. The latter are similar to and easily mistaken for intergrown natrolite crystals found in some cavities.

Analcime is one of the earliest minerals in the paragenetic sequence of the contact-zone assemblage, whereas in the miarolitic cavities it appears to be a mid to late-stage species.

Anatase TiO_2

Anatase is relatively uncommon in miarolitic cavities. It occurs as groups of sharp, equant, transparent, lemon-yellow or pale green, 0.3–0.6 mm dipyramidal crystals bounded by the {111} pyramids and small {001} basal pinacoids. It also forms translucent to opaque, pale gray to greenish blue to dark blue, thin to thick tabular crystals 0.5–1.5 mm in diameter, dominated by {001} pinacoids; druses of tiny steel-blue plates 0.1–0.3 mm across; and opaque, dark green to black, square tabular crystals 1–2 mm across with peculiar rounded corners and etched basal pinacoids.

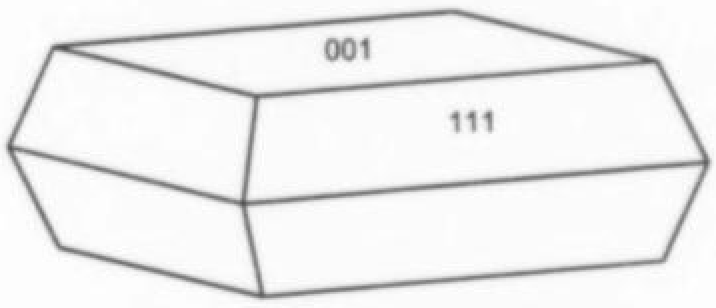


***Figure 9.* Anatase crystal drawing.**

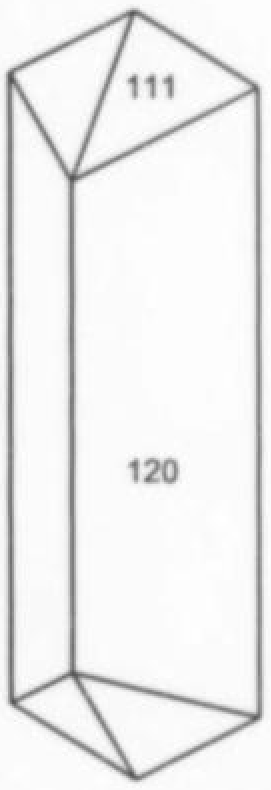


***Figure 10.* Ancylite-(Ce) crystal drawing.**

Ancylite-(Ce) $SrCe(CO_3)_2(OH) \cdot H_2O$

A relatively uncommon late-stage mineral in miarolitic and contact-zone cavities, ancylite-(Ce) occurs as sharp, transparent, colorless to pale yellow and very rarely pale pink, slender, commonly doubly terminated prismatic crystals, 0.6–3.0 mm long, typically forming divergent, fan-shaped groups. In both associations the crystal morphology is identical, consisting of an elongated {120} prism terminated by the {111} rhombic pyramid. The luster varies from vitreous to greasy.

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

Electron microprobe (EDS) and XRD analyses identified the La-dominant analog of ancylite-(ce), ancylite-(La), which has recently been described from Mount Kukisvumchorr Khibiny massif, Kola

Figure 11. **Aegirine crystal, 4 mm.**

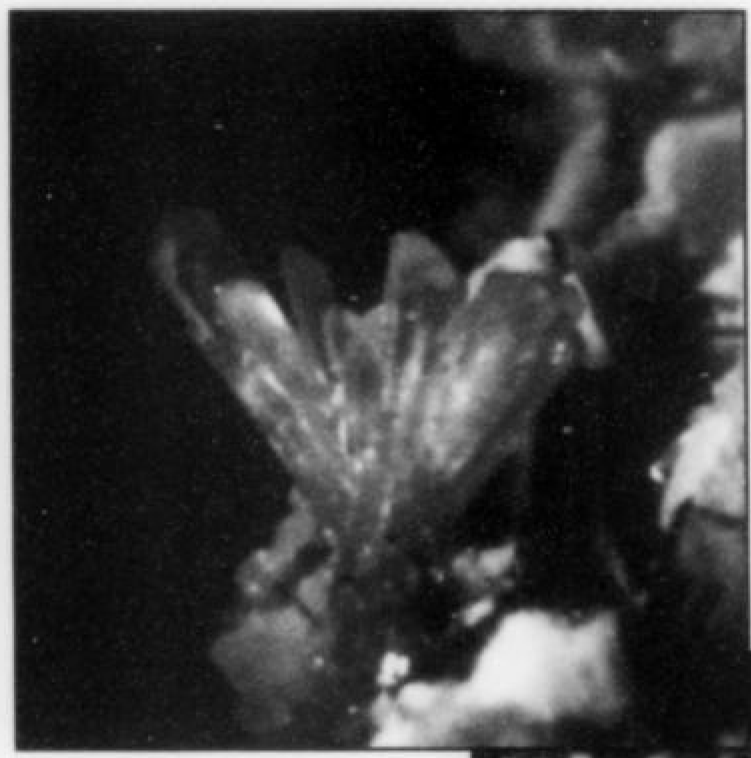


Figure 12. **Ancylite-(Ce) crystal group, 1.5 mm in size.**

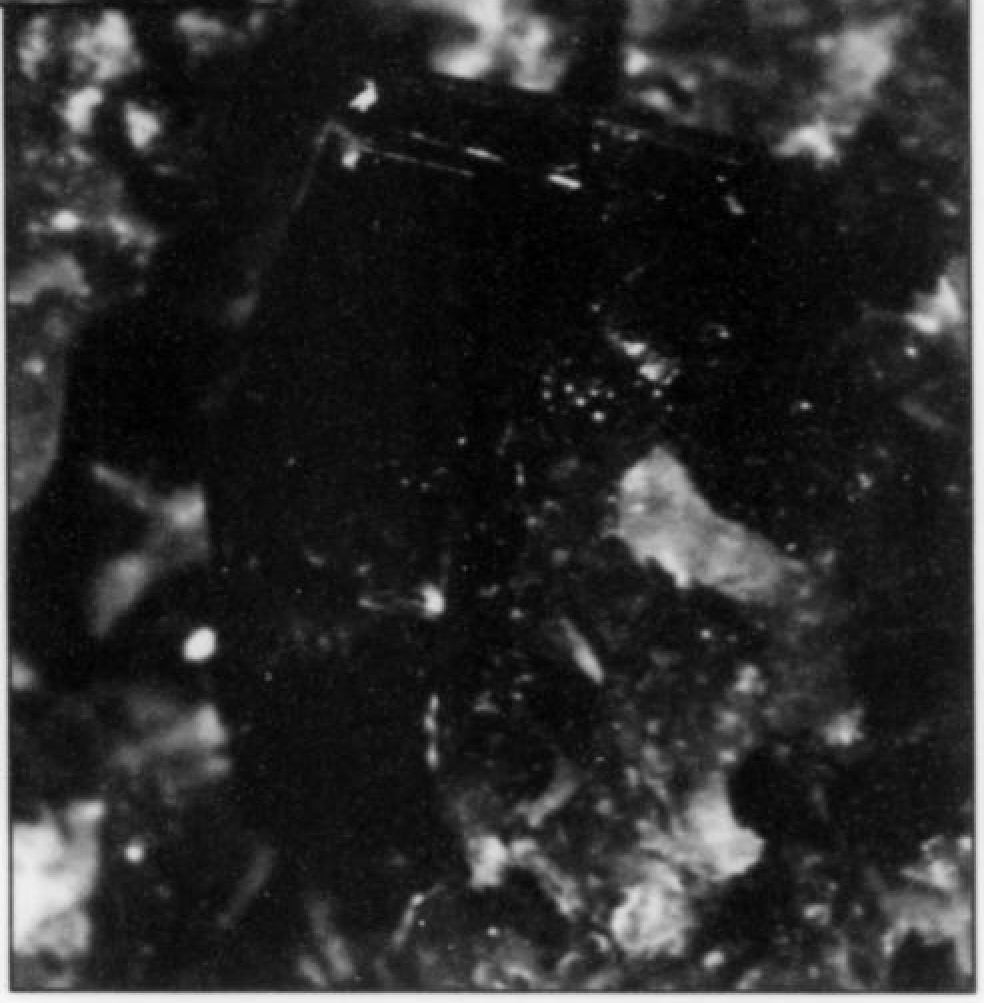


Figure 13. **Astrophyllite, in tabular crystals, 3 mm long.**

Peninsula, Russia (Yakovenchuk *et al.*, 1997). It occurs very rarely in miarolitic cavities as vitreous, sharp, transparent, colorless to pale yellowish gray prismatic crystals 0.5–0.8 mm long, forming fan-like and spherical groups. Crystal morphology is identical to that of ancylite-(Ce). The probe analysis also indicates minor Ca and Th content. These crystals will require further investigation.

Aragonite $CaCO_3$

Aragonite is uncommon in the cavities of the contact zone, occurring as opaque, dull, white, fibrous tufts, and as somewhat crude, acicular crystals forming hollow, spherical aggregates 2–3 mm in diameter. It fluoresces bluish white under both shortwave and longwave ultraviolet radiation.

Arfvedsonite $Na_3(Fe^{2+},Mg)_4Fe^{3+}Si_8O_{22}(OH)_2$

Arfvedsonite is rare, and has been observed in only a few miarolitic cavities that show evidence of alteration. It occurs as very dark green to black, 1–4 mm short prismatic crystals often partially enclosed in natrolite. The luster varies from vitreous on prism faces, to dull on the terminations.

Arsenopyrite FeAsS

An extremely rare mineral in miarolitic cavities, arsenopyrite is found as silvery, metallic, equant, wedge-shaped crystals 0.4–1.0 mm across, forming complex aggregates. (Arsenopyrite is very similar in appearance to, and difficult to distinguish from, löllingite.)

Astrophyllite $(K,Na)_3(Fe^{2+},Mn)_7Ti_2Si_8O_{24}(O,OH)_7$

Astrophyllite is a very common species in the sill, occurring as a rock-forming accessory mineral and also as well-formed crystals in miarolitic cavities and mineralized seams. In miarolitic cavities it is found as superb, transparent to translucent, reddish brown to orange brown, tapering tabular crystals 1–5 mm long. Crystals consist of a dominant {100} pinacoid bounded by somewhat rough, often striated, bevelled edges which are difficult to index. The crystals often form attractive fan-shaped groups and rosettes. The luster is vitreous on the pinacoids, and waxy to dull on all other faces. Astrophyllite is also found as thin rectangular sheets and somewhat fibrous, radiating aggregates with a waxy luster.

Astrophyllite is one of the earliest species in miarolitic cavities and mineralized seams, associated with practically all species found in these assemblages. It is notable that the contact zone of the sill is completely devoid of the mineral.

A single microprobe analysis (WDS) of astrophyllite gave K_2O 5.73, Na_2O 2.81, CaO 1.07, SrO 0.09, FeO 19.23, MnO 15.48, MgO 0.38, TiO_2 10.72, Nb_2O_5 1.27, ZrO_2 0.98, SiO_2 35.49, Al_2O_3 0.32, F 1.05, H_2O 4.36 (calculated by stoichiometry) O = F –0.44, total 98.55 weight %, resulting in the empirical formula: $(K_{1.58}Na_{1.18}Ca_{0.25}Sr_{0.01})_{\Sigma 3.02}(Fe_{3.47}Mn_{2.83}Mg_{0.12})_{\Sigma 6.42}(Ti_{1.74}Nb_{0.12}Zr_{0.10})_{\Sigma 1.96}$-$(Si_{7.66}Al_{0.08})_{\Sigma 7.74}O_{23.96}[(OH)_{6.32}F_{0.72}]_{7.04}$ based on 31 anions.

Bastnäsite-(Ce) $(Ce,La)(CO_3)F$

Bastnäsite-(Ce) occurs as a very rare, late-stage mineral in both miarolitic and contact-zone cavities. In miarolitic cavities it is found as translucent to opaque, silvery gray, micaceous hexagonal plates 2–3 mm in diameter; as beige to white rosettes 0.5–1 mm in diameter, with a pearly luster; and as aggregates of minute, pearly, pale gray to white flakes less than 0.2 mm across. The larger hexagonal crystals show concentric zoning, with a translucent, pale gray zone around the edges, becoming darker and opaque in the center. Associated minerals are microcline, natrolite, catapleiite, astrophyllite, labuntsovite, mangan-neptunite, aegirine, rhodochrosite and pyrrhotite. In the contact-zone cavities it is found as pale gray, somewhat fibrous, acicular crystals forming divergent sprays and spherical aggregates 0.5–1.0 mm in size associated with analcime, siderite, calcite, pyrite and sphalerite.

Birnessite $Na_4Mn_{14}O_{27}\cdot 9H_2O$

Birnessite, a late-stage alteration product, has been found in altered and weathered miarolitic cavities as sharp, well-formed pseudomorphs after serandite, and as thin crusts and small masses. The pseudomorphs form equant to elongated blocky crystals up to 1 cm long, and bladed crystals 2–8 mm long, associated most frequently with microcline, natrolite, aegirine, eudialyte, opal and mangan-neptunite. Crystals are black with a submetallic to dull luster on the faces, and resinous to dull black luster on freshly broken surfaces. Many of the crystals and crusts exhibit irregular, natural cracking. As observed at Mont Saint-Hilaire (Horváth and Gault, 1990), the pseudomorphs very clearly exhibit the morphology and habit of the precursor serandite.

Birnessite is regarded as a solid solution series, having variable composition, unit cell parameters and X-ray diffraction pattern (Kim, 1980). Kim proposed that birnessite should be considered a mineral group, with individual, Ca, Mn^{2+} and Na end-members. Although difficult to analyze, microprobe analyses (EDS) carried out on several specimens clearly indicate that the Saint-Amable birnessite is Ca-dominant with only a trace of Na present. The XRD pattern is identical to that reported from the type locality (Jones and Milne, 1956).

Calciohilairite $CaZrSi_3O_9\cdot 3H_2O$

Calciohilairite was described as a new species from the Golden Horn batholith in the northern Cascade Mountains, Washington (Boggs, 1988). The Saint-Amable sill is the second known occurrence of the mineral. Recently, it was also identified from Mont Saint-Hilaire (G. Y. Chao, personal communication, 1996), and an intermediate composition between hilairite and calciohilairite has been reported from the Strange Lake alkaline complex on the Québec-Labrador border, Canada (Birkett *et al.*, 1992).

Calciohilairite is extremely rare in the Saint-Amable sill, with only two confirmed specimens known from two separate finds, both in miarolitic cavities. In one it occurs as opaque, pale beige, somewhat crudely formed, short trigonal prisms 0.6–0.9 mm long, with rhombohedral terminations and a dull luster. These crystals are similar to the somewhat altered calciohilairite found at the type locality. The crystals are found in small, interconnected, boxwork cavities in a mass of intergrown natrolite crystals associated with nenadkevichite, rhodochrosite, polylithionite, fluorite, aegirine and pyrite.

In the second specimen, from an altered miarolitic cavity, calciohilairite occurs as sharp, white, blocky crystals 0.5–0.8 mm in size, having a pearly luster and forming intergrown aggregates on birnessite pseudomorphs after serandite. Associated minerals are astrophyllite, aegirine, eudialyte, microcline, mangan-neptunite and natrolite. In both assemblages calciohilairite is a late-stage mineral in the paragenetic sequence.

Calciohilairite was confirmed by single-crystal X-ray diffraction and an electron microprobe (WDS) analysis which gave the formula: $(Ca_{0.99}K_{0.01})_{\Sigma 1.00}(Zr_{0.96}Ti_{0.02}Mn_{0.01})_{\Sigma 0.99}(Si_{3.00}Al_{0.01})_{\Sigma 3.01}O_{8.98}\cdot 3H_2O$. Sodium was specifically sought, but not detected in the analysis, confirming the mineral to be pure end-member calciohilairite.

Calcite $CaCO_3$

Calcite is very common, especially in the contact-zone cavities in which it occurs as colorless druses and as well-formed, colorless to pale yellow simple rhombs and complex crystals 1–2 mm in size. It is also a common late-stage mineral in miarolitic cavities as transparent, pale to lemon-yellow scalenohedra up to 5 mm long; as white, acicular crystals; and as translucent to opaque, yellow botryoidal aggregates, often with dull, frosty surfaces. Calcite fluoresces strong whitish yellow under shortwave and strong orange-yellow under longwave ultraviolet radiation, in some specimens retaining a weak whitish yellow phosphorescence for a very short duration.

Carbonate-fluorapatite $Ca_5(PO_4,CO_3)_3F$

A very rare, late-stage mineral in miarolitic cavities, carbonate-fluorapatite occurs as spherical aggregates 0.5–1.0 mm in diameter composed of thin, rounded colorless to very pale yellow plates having a vitreous luster.

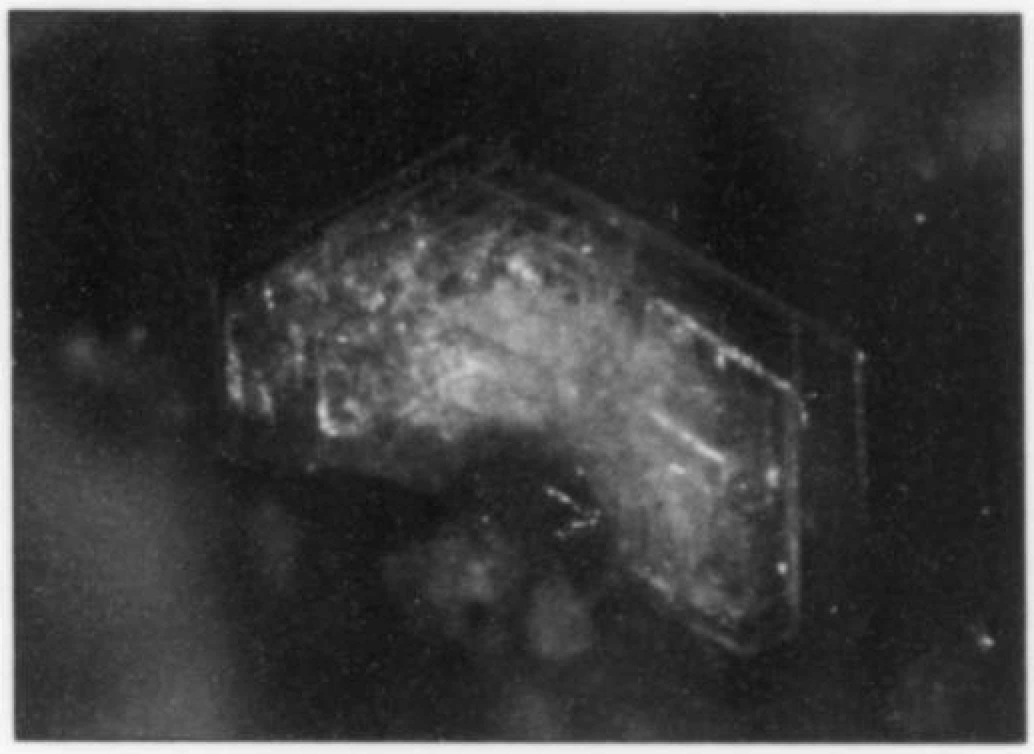


Figure 14. **Catapleiite crystals, 1.5 mm in diameter, from contact-zone cavity.**

Catapleiite $Na_2ZrSi_3O_9\cdot 2H_2O$

Catapleiite is one of the characteristic species found in agpaitic alkaline rocks, either as a primary mineral or as an alteration product of eudialyte. In the Saint-Amable sill, both types are present. Primary catapleiite is very rare in the miarolitic cavities, occurring as sharp, colorless, very thin pseudohexagonal plates 0.5–1.0 mm in diameter, with a vitreous luster. Secondary catapleiite is more common, occurring as irregular, pearly, opaque, silvery gray, micaceous plates 0.2–0.4 mm in diameter which form cellular aggregates and crude pseudomorphs replacing eudialyte. These occasionally enclose relict fragments of eudialyte.

Primary catapleiite is relatively common in cavities in the contact zone as thin, translucent, colorless, pale beige to white pseudohexagonal plates 0.5–2.0 mm in size, forming attractive rosettes and spherical groups up to 4 mm in diameter. The crystals are very sharp and have a vitreous to pearly luster. Some of the catapleiite in this association fluoresces a weak, pale orange-yellow under shortwave ultraviolet radiation.

The primary catapleiite found in the miarolitic and contact-zone cavities appears to be one of the mid-stage minerals in the paragenesis. The secondary catapleiite found in miarolitic cavities is a relatively late-stage species. Associated minerals include practically all the species found in the sill.

Celestine $SrSO_4$

Celestine is rare, occurring in the contact-zone cavities as radiating groups of colorless, prismatic crystals 1–4 mm long, and as opaque, white, somewhat fibrous radiating aggregates forming crude spheres, with the colorless prisms protruding from the spheres. Luster varies from vitreous to dull.

Cerussite $PbCO_3$

An extremely rare secondary mineral in miarolitic cavities, cerussite is found as thin opaque, white to tan crusts on galena crystals.

Chabazite $CaAl_2Si_4O_{12}\cdot 6H_2O$

Chabazite is extremely rare, occurring as colorless, hexagonal plates 0.2–0.5 mm in diameter, forming spherical aggregates in miarolitic cavities.

Chlorite group

Aggregates of minute micaceous plates of a chlorite-group mineral admixed with fibrous fluorapatite and also with foliated masses of monazite-(Ce) were identified from a number of miarolitic cavities.

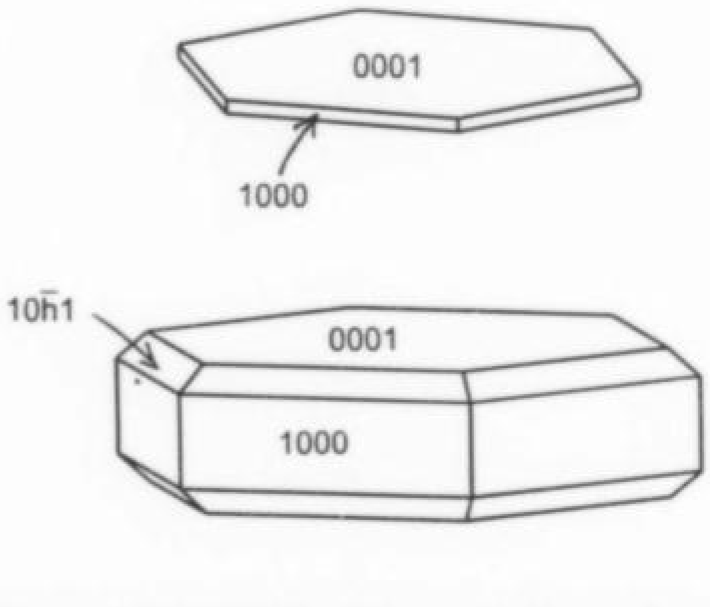


***Figure 15.* Cordylite-(Ce) crystal drawings: (top) very thin habit, (bottom) thick tabular habit with rare pyramid form.**

Cordylite-(Ce) $BaNaCe_2(CO_3)_4$

Cordylite-(Ce) was first described from Narssârssuk in South Greenland (Flink, 1901); it was later reported from Mont Saint-Hilaire (Chen and Chao, 1975), and Bayan-Obo, Inner Mongolia, China (Zhang and Tao, 1985). The chemical data presented in these descriptions did not show the presence of any sodium, which appears to be at variance with more recent work by Shen Jinchuan and Mi Jinxiao (1992a and b), a group of investigators in Europe (J. Zemann, personal communication, 1996) and one of the present authors (RAG). In conjunction with the study of cordylite-(Ce) from the Saint-Amable sill, which is the fourth reported locality for the mineral (Gault and Horváth, 1993), electron microprobe analyses were also performed on cordylite-(Ce) from Narssârssuk and Mont Saint-Hilaire. The results confirm that essential sodium is present in cordylite-(Ce) from all these localities, and the compositions are consistent with those reported for *baiyuneboite-(Ce)* described from Bayan-Obo (Fu and Kong, 1987; Fu and Su, 1988). The species status of *baiyuneboite-(Ce)* is doubtful (Fleischer and Mandarino, 1995), but it has not been discredited. Recently, cordylite-(Ce) has also been reported from the Khibina massif, Kola Peninsula, Russia (Khomyakov, 1995) but no chemical data are given.

A partial microprobe analysis (WDS) of cordylite-(Ce) from the Saint-Amable sill gave Na_2O 3.96, BaO 20.91, SrO 0.74, CaO 0.36, La_2O_3 14.73, Ce_2O_3 23.85, Pr_2O_3 1.46, Nd_2O_3 4.90, Sm_2O_3 0.21, F 2.64, CO_2 24.50 (F and CO_2 calculated by stoichiometry), O = F –1.11, total 97.15 weight %, based on 13 anions resulting in the empirical formula: $Na_{0.92}(Ba_{0.98}Sr_{0.05}Ca_{0.04})_{\Sigma 1.07}(La_{0.65}Ce_{1.05}Pr_{0.06}Nd_{0.21}Sm_{0.01})_{\Sigma 1.98}(CO_3)_4F$.

Cordylite-(Ce) is relatively rare, although surprisingly abundant locally, as a very late-stage species in miarolitic cavities and in mineralized seams. Two distinct crystal habits have been observed: very rare, short hexagonal prisms, and more common, thin to thick, tabular hexagonal crystals. The prismatic crystals are 1–2 mm long, greenish gray, opaque, with a greasy luster, and terminated by {000$\bar{1}$} basal pinacoids. Prism faces are striated parallel to the basal pinacoids, and a good basal cleavage and a layered structure are evident in broken crystals.

Tabular crystals are colorless, transparent to translucent, pale yellow, amber-yellow, opaque gray, greenish gray and white. They are 0.5–1.5 mm across, are dominated by the {0001} basal pinacoid, and often form rosettes and complex, stacked, curved barrel-shaped groups. Other forms observed are the small {1000} prism, and very rarely the {10$\bar{h}$1} pyramid. Luster varies from vitreous on some basal pinacoids to pearly or dull and frosty on all other crystal faces, whereas cleavages or broken surfaces are resinous. Some of the thin tabular crystals exhibit concentric, alternating transparent and opaque zones on the basal pinacoids. Cordylite-(Ce) has also been found as compact, spherical aggregates up to 1 mm in diameter, consisting of silvery, micaceous, very thin hexagonal plates.

In one particular, localized assemblage, an unusually high concentration of very thin, tabular crystals was observed intimately associated with and adjacent to masses of dark gray aggregates of catapleiite with altered, relict fragments of eudialyte, zakharovite, fluorite, elpidite, pyrrhotite, rhodochrosite and labuntsovite. This mineral assemblage appears to be the result of the alteration of eudialyte. It occurred in a zone characterized by a parallel series of very narrow (2–3 mm wide), peculiar sinusoidal seams, spaced 3–5 cm apart and generally oriented parallel to the sill horizon. Other associated minerals are natrolite, aegirine, serandite, mangan-neptunite, microcline, astrophyllite, nenadkevichite, quartz and pyrite.

Cryolite Na_3AlF_6

In a very rare and unusual occurrence, cryolite was found as cavity fillings in the contact zone of the sill exposed in the southeastern part of the Demix quarry in December of 1996. Masses of colorless cryolite up to 10 cm in diameter are enclosed in cellular aggregates consisting of white to pale beige powdery gibbsite, and drusy crusts and aggregates of colorless thomsenolite crystals. The cryolite masses are strongly corroded, with step-like etch-features; crude, partially dissolved crystals are visible on some specimens. The cryolite has a frosty appearance but is quite transparent; the luster varies from vitreous to waxy. It fluoresces intense yellowish white under shortwave ultraviolet radiation, with short-duration pale yellow phosphorescence; under longwave radiation it fluoresces a weak yellowish white.

Cryolite is a late-stage mineral in the paragenetic sequence, and its deposition is probably the result of hydrothermal action. Associated minerals in addition to gibbsite and thomsenolite are doyleite, pyrrhotite, sphalerite, galena, pyrite and a pale yellow unidentified mineral.

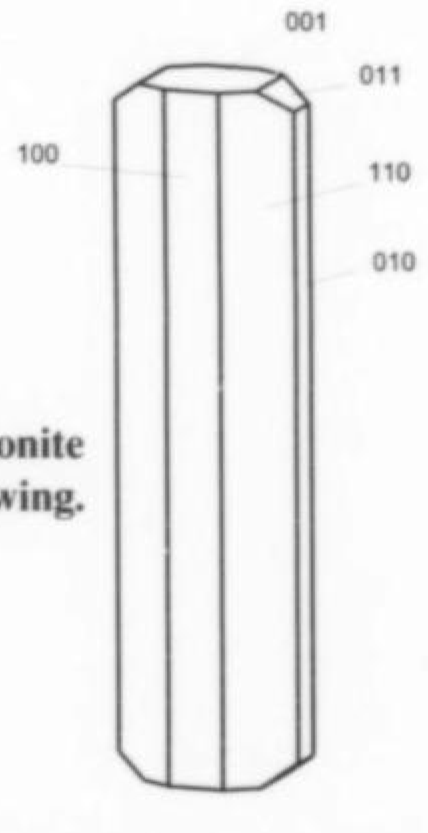


***Figure 16.* Dawsonite crystal drawing.**

Dawsonite $NaAl(CO_3)(OH)_2$

Dawsonite is a relatively common species in the western Monteregian intrusions, and was the first new mineral species described from the alkaline rocks in this area (Harrington, 1875 and 1878; Graham, 1908).

Dawsonite is very rare in the Saint-Amable sill. It is found as crude, colorless, prismatic crystals, forming embedded masses to 5 mm across in the light-colored aureoles around cavities of the contact zone. Individual crystals are 2–3 mm long, longitudinally striated, somewhat fibrous, and lack distinct terminations. Dawsonite has also been found in a hydrothermalite pod as sharp, colorless, terminated prismatic crystals, 1–3 mm long. The crystals are bounded by dominant {110} prisms and {100} pinacoids, with a usually very small {010} pinacoid, and are terminated by the basal pinacoid {001}; some crystals show a small {011} prism. Crystal faces in the prism zone are invariably striated parallel to the *c*-axis, giving the crystals a silky luster. Associated minerals in the contact zone are natrolite, analcime, catapleiite, franconite, hematite, hochelagaite, siderite and calcite, whereas in the hydrothermalite pod they are natrolite, varennesite, makatite, serandite, eudialyte and zakharovite.

Dawsonite is one of the early species in the paragenesis of the contact zone, whereas in the hydrothermalite pod it is one of the late-stage minerals. Exceedingly rarely, it has also been observed as a very late-stage mineral in contact-zone cavities, occurring as silky white, powdery to finely fibrous aggregates and as spherical groups of short, radiating, capillary crystals.

Dolomite $CaMg(CO_3)_2$

Dolomite has been identified from cavities in the contact zone, where it occurs frequently as crude, blocky, pale yellow to grayish green, 0.5–1 mm crystals; as sharp, equant, colorless, complex 1–1.5 mm crystals on analcime; and as pale pink, 3–5 mm, simple rhombic and saddle-shaped crystals. Rarely, dolomite has also been found in miarolitic cavities as white and pale pink spheres and as irregular, pale yellow aggregates.

Donnayite-(Y) $Sr_3NaCaY(CO_3)_6 \cdot 3H_2O$

Donnayite-(Y) was first described from Mont Saint-Hilaire (Chao *et al.*, 1978). It was later reported from Vishnevye Gory, South Urals (Nikandrov, 1989), and from the Khibina massif, Kola Peninsula (Khomyakov, 1990 and 1995), both in Russia. The Saint-Amable sill is the fourth known locality for the species.

Donnayite-(Y) is extremely rare, and is found in cavities in the contact zone as crude, equant, opaque, beige to yellowish white hemimorphic crystals 0.5–1.0 mm in size, having a roughly hexagonal to circular cross-section, and dominated by a {001} basal pinacoid. Some crystals are hollow shells with a powdery white or brown unidentified mineral partially filling some of the shells. Rarely, multiple pagoda-shaped pseudohexagonal crystals grow from a common base in parallel groups. Donnayite-(Y) has also been found in miarolitic cavities as opaque, beige, 0.5–1.5 mm, bell-shaped hemimorphic crystals with a nearly circular cross section, and a {001} basal pinacoid as the only distinct form observed. The prism zone is covered by small donnayite-(Y) crystals in parallel growth. The luster is waxy on the dominant pinacoid and dull on all other surfaces. Donnayite-(Y) was also found as transparent, pale yellow and salmon-pink, tapering prismatic and short hemimorphic crystals 0.5–1.0 mm across having a well-defined, hexagonal cross section. These crystals are vitreous with unusually sharp, step-like features on the prism faces.

In the Khibina massif two polytypes of donnayite-(Y), a trigonal and a triclinic, have been reported (Trinh *et al.*, 1992; Khomyakov, 1990 and 1995). In the Saint-Amable sill, only the triclinic polytype has been identified. It is one of the latest minerals in the paragenesis of both assemblages. Most typical associated minerals are analcime, dolomite, pyrrhotite, siderite, catapleiite and pyrite in the contact-zone cavities, and microcline, aegirine, natrolite and elpidite in the miarolitic cavities.

Doyleite $Al(OH)_3$

Doyleite, a very rare polymorph of gibbsite and bayerite, was described as a new species from Mont Saint-Hilaire, and simultaneously from the Saint-Michel sill (Francon quarry) in Montréal (Chao *et al.*, 1985). The Saint-Amable sill is the third known locality for the mineral. Recently, doyleite was also reported from Grube Clara, Wolfach, Germany (Walenta, 1993).

Doyleite is very rare in the Saint-Amable sill, occurring as a late-stage mineral in miarolitic cavities. It was first identified in 1986 from a specimen collected in 1982, in which it was observed as small, opaque, beige, irregular masses (A. P. Sabina, and A. C. Roberts, personal communications). Doyleite with a minor admixture of fluorite was found in miarolitic cavities as rosette-like aggregates of opaque, waxy, white, tabular crystals 0.3–0.6 mm across. Crystals are rectangular or square in outline and gently taper from a thicker center to thinner outer edges. Associated minerals are microcline, eudialyte, yofortierite, astrophyllite, serandite and aegirine. Recently doyleite was also found in contact-zone cavities as white, powdery aggregates admixed with gibbsite and associated with thomsenolite and cryolite.

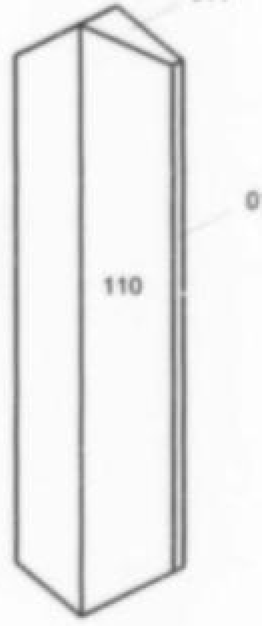


***Figure 17.* Elpidite crystal drawing.**

Elpidite $Na_2ZrSi_6O_{15} \cdot 3H_2O$

Elpidite is relatively common in miarolitic cavities, where it occurs as pale to bright orange, brownish yellow, orange-yellow and beige aggregates of short to elongated 0.5–1.5 mm prisms with chisel-shaped terminations. Most crystals are doubly-terminated and rather simple, consisting of a short {110} prism terminated by a {011} prism. Less commonly, the crystals are modified by the {010} pinacoid. Crystals are opaque with some translucency at thin edges and the terminations; the luster varies from predominantly vitreous to waxy. In this paragenesis, elpidite is a mid to late-stage mineral, and is associated with most of the species found in the miarolitic cavities.

Crystals of elpidite bear a close resemblance to and may be difficult to distinguish from labuntsovite, to which it is structurally related. The two species often occur together, sometimes in an epitactic relationship with labuntsovite growing on or enclosing elpidite. As the predominant color of elpidite is shades of orange rather similar to that of labuntsovite, visual identification based on color is unreliable. However, the opacity of elpidite, and the transparency of labuntsovite combined with the presence of the {001} basal pinacoid on labuntsovite, are reasonably good distinguishing features.

Epididymite $NaBeSi_3O_7(OH)$

Epididymite, the only beryllium-bearing mineral identified to date from the locality, is extremely rare. It is found as colorless, short prismatic crystals 0.2–0.5 mm long, forming complex intergrown clusters in miarolitic cavities. Individual crystals are colorless, but the clusters appear white and opaque, with a vitreous luster. The few identified specimens were collected in 1994 in the

Figure 18. **Donnayite-(Y) in hemimorphic crystals, 1 mm in size.**

Figure 19. **Cordylite-(Ce) crystals forming rosettes, 2 mm in diameter.**

southwest corner of the Demix pit. The crystals are very small and may be easily overlooked or confused with the more abundant clusters of short prismatic nenadkevichite.

Epididymite appears to be one of the late minerals in the paragenesis, and is associated with microcline, natrolite, aegirine, astrophyllite, mangan-neptunite and pyrrhotite.

Epistolite $Na_2(Nb,Ti)_2Si_2O_9 \cdot nH_2O$

Epistolite was originally described from Ilímaussaq, Greenland (Bøggild and Winther, 1901; Karup-Møller, 1986a), and has also been found in the Lovozero massif, Kola Peninsula, Russia (Semenov, 1961), and at Mont Saint-Hilaire, Québec (Mandarino and Anderson, 1989). The Saint-Amable sill is the fourth documented locality for the mineral. It has been identified from a miarolitic cavity, as a single specimen collected in 1994 in the southwest corner of the Demix quarry. It occurs as vitreous, transparent, pale yellow, very thin, elongated, rectangular blades 2–3 mm long. Associations include microcline, natrolite, aegirine and mangan-neptunite. Epistolite is essentially identical in appearance to its precursor mineral, vuonnemite, and to shkatulkalite.

Epistolite is a mineral that is known only as pseudomorphs after vuonnemite, and belongs to an interesting special class of *homoaxial pseudomorphs* (Khomyakov, 1995) in which the secondary mineral retains the chemical and structural properties of the primary species.

Erdite $NaFeS_2 \cdot 2H_2O$

Erdite was originally described from Coyote Peak, California (Czamanske *et al.*, 1980), and later reported from the Lovozero massif (Khomyakov *et al.*, 1982) and Mont Saint-Hilaire (Horváth and Gault, 1990). The Saint-Amable sill is the fourth locality known for the mineral; it was identified from a single miarolitic cavity.

Erdite occurs as sharp, opaque, coppery, prismatic crystals (possibly pseudomorphs) up to 1 mm long, having a submetallic luster and forming parallel, intergrown groups. It was identified by XRD and microprobe analysis (EDS), with the XRD also indicating the presence of minor pyrite. It appears to be a late-stage mineral, associated with aegirine, eudialyte, nenadkevichite and an unidentified red X-ray amorphous mineral.

Eudialyte $Na_{15}Ca_6Mn_3NbZr_3Si_{26}O_{76}F_2$

Eudialyte is one of the most characteristic and ubiquitous minerals in miarolitic cavities and hydrothermalite pods. A very complex mineral chemically, eudialyte is one of the key minerals in the paragenesis of both types of occurrences, and through its alteration contributes significantly to the proliferation of mineral species in these assemblages. It is also an important constituent (estimated 2–3%) of some zones of the sill rock and, as the most abundant Zr and REE mineral, it is an important factor in the geochemistry of the Saint-Amable sill.

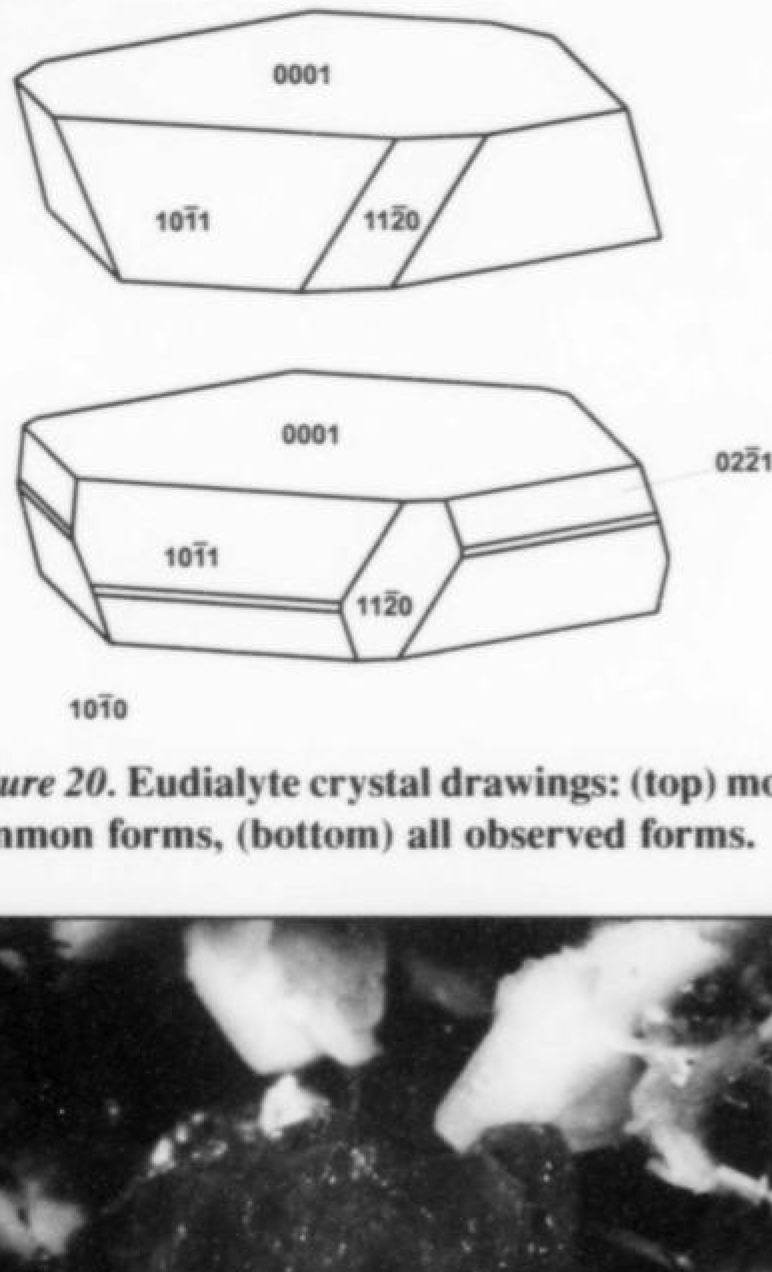


Figure 20. **Eudialyte crystal drawings: (top) most common forms, (bottom) all observed forms.**

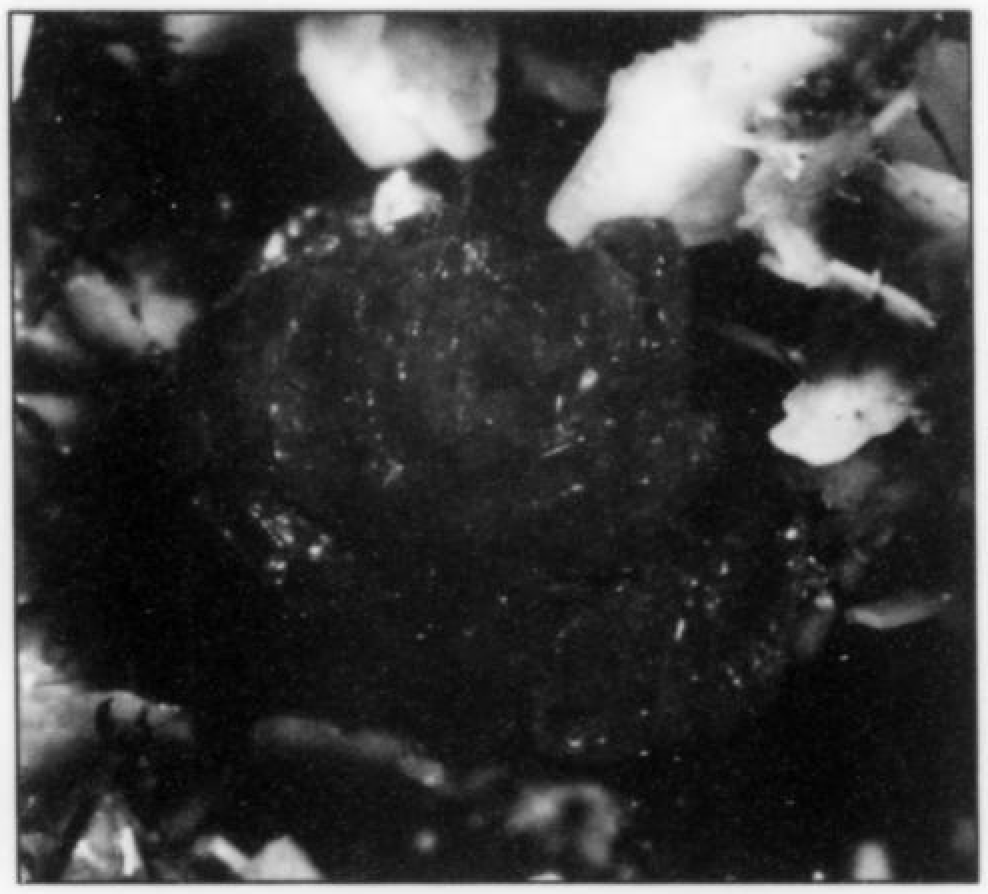


Figure 21. **Eudialyte rosette, 4 mm in diameter.**

Eudialyte alters readily, mainly as a result of rising alkalinity (Khomyakov, 1990 and 1995), to species such as catapleiite and terskite which are found in many miarolitic cavities; it most likely also contributes to the late-stage formation of species like labuntsovite, nenadkevichite, cordylite-(Ce), zakharovite and possibly varennesite.

Eudialyte occurs as excellent, sharp, thin to thick tabular crystals 2–5 mm across, most commonly forming parallel stacked or rosette-like aggregates. Most crystals have a relatively simple morphology, with dominant {0001} basal pinacoid combined with the $\{10\bar{1}1\}$ positive rhombohedron and the $\{11\bar{2}0\}$ prism. Rarely, the $\{02\bar{2}1\}$ negative rhombohedron and $\{10\bar{1}0\}$ prism are also present. It is interesting to note that only the thin tabular habit has been observed to date. Crystals are mostly transparent, with occasional opaque central cores and dull, opaque surface zones, possibly indicating some degree of surface alteration. The color of unaltered crystals varies from pale to dark pink, pale orange-red, carmine-red and reddish brown, whereas altered crystals exhibit gray, tan, yellowish and white surface coloration. The luster varies from vitreous on fresh crystals, to dull and waxy on altered crystals. Inclusions and internal fractures are present in most crystals.

Eudialyte also occurs as embedded crystals and irregular grains in the sill rock, from the highest concentration around miarolitic cavities to total absence in the contact zone. It is present as one of the early minerals in the miarolitic cavities, but the majority of the crystals are late-stage in the paragenesis.

During a current, collaborative study of eudialyte carried out by the Geologisk Museum, University of Copenhagen, and the Canadian Museum of Nature, one of the authors (RAG) performed microprobe analyses on specimens from worldwide localities, including the Saint-Amable sill. The results indicated a wide variation in composition (Johnsen and Gault, 1997). As a general rule, the Saint-Amable eudialyte is low in Nb, Ca and Fe, and high in Na, Mn and Si compared to eudialytes from elsewhere. The problem of calculating eudialyte formulae is complex and is discussed in Johnsen and Gault (1997). They suggest that without a structure refinement, the best procedure for calculating the formula is to base it on 78 anions. This procedure minimizes the potential errors in calculations which can be introduced by other methods. The following is an average of five analyses: SiO_2 48.18, ZrO_2 9.88, Na_2O 16.94, CaO 4.29, FeO 2.63, MnO 6.43, K_2O 0.46, La_2O_3 1.69, Ce_2O_3 2.70, Nd_2O_3 0.53, Y_2O_3 0.71, Nb_2O_5 1.34, Al_2O_3 0.15, SrO 0.17, TiO_2 0.85, HfO_2 0.13, Cl 0.37, F 0.49, H_2O 0.82 (calculated by stoichiometry), O = Cl –0.08, O = F –0.21, total 98.47 weight %. Based on 78 anions the resultant empirical formula is: $(Na_{16.63}K_{0.32}Y_{0.21}Sr_{0.05})_{\Sigma 17.21}(Ca_{2.50}Mn_{1.27}Na_{1.25}REE_{0.98})_{\Sigma 6.00}$-$(Mn_{1.70}Fe_{1.20}Al_{0.10})_{\Sigma 3.00}Nb_{0.33}Si_{2.23}(Zr_{2.62}Ti_{0.35}Hf_{0.02})_{\Sigma 2.99}(Si_3O_9)_2(Si_9O_{27})_2$-$O_{4.02}(F_{0.84}OH_{0.82}Cl_{0.34})_{\Sigma 2.00}$. A single microprobe analysis on an altered crystal shows a large increase in Ca and Ti contents, and a large decrease in Mn relative to the analysis on unaltered material. Faint concentric, chemical zoning, particularly with regard to the elements Ca, Fe, Mn, Nb and REE, is evident in all crystals examined with the BSE detector.

Fluorapatite $Ca_5(PO_4)_3F$

Fluorapatite is very rare and inconspicuous in miarolitic cavities, occurring as colorless to white, fine acicular and fibrous tufts 0.5–1.0 mm long; as opaque, white, crude blocky crystals up to 1 mm in size, and as opaque, gray, hollow spheres 1–3 mm in diameter.

Fluorite CaF_2

Fluorite is relatively common in miarolitic and contact-zone cavities. In cavities of the contact zone it is found as opaque, crude, pure white, blocky pseudomorphs after an unknown mineral, up to 1 mm across; as sharp, transparent, color-zoned cubes up to 1 mm across, with pale purple cores and dark purple outer zones; as extremely rare translucent, pale blue, 0.5–0.8 mm cubes; and as crude, translucent, pale purple, 1–2 mm cubes with peculiarly rounded and etched surfaces.

Figure 22. **Fluorite aggregates, 2–4 mm in diameter, on dark gray natrolite from an altered miarolitic cavity.**

In miarolitic cavities, fluorite occurs as colorless, transparent, pale yellow, pale green and purple cubes and cuboctahedra to 1 mm in diameter; as white, silky, bent and twisted fibrous tufts and masses indistinguishable from other white fibrous minerals; as thin, colorless, white and pale purple coatings, crusts and hollow spherical shells; and as white stalagmitic and curved "ram's horn" aggregates. It has also been found in an altered miarolitic cavity as unusual spherical aggregates of acicular to fibrous crystals, possibly pseudomorphs after strontianite. The spherical aggregates are 2–4 mm in diameter and vivid purple with dull to greasy luster. Some of the fluorite fluoresces a weak pale blue under shortwave ultraviolet radiation.

Fluorite is a late-stage mineral in all assemblages, and is associated with essentially all the species found in the sill.

Franconite $Na_2Nb_4O_{11}\cdot 9H_2O$

Franconite was described as a new species from the Saint-Michel sill (Francon quarry) in Montréal by Jambor *et al.* (1984). It has also been found at Mont Saint-Hilaire (Chao and Baker, 1979 [UK43]; Mandarino and Anderson, 1989), and Vishnevye Gory, South Urals, Russia (Nikandrov, 1989). The Saint-Amable sill is the fourth known locality for the mineral (Gault and Horváth, 1993).

Franconite is found very rarely in cavities in the contact zone and also in miarolitic cavities, as silky, pure white, extremely thin capillary fibers forming radiating spherical aggregates up to 1 mm in diameter. It is identical in appearance to, and visually indistinguishable from the much rarer hochelagaite also found in the sill. It fluoresces yellowish white under both shortwave and longwave ultraviolet radiation.

Franconite is one of the late-stage minerals in the paragenesis, associated with analcime, natrolite, catapleiite, dolomite, fluorite and dawsonite in the contact-zone cavities, and with natrolite, aegirine, eudialyte, serandite, astrophyllite and yofortierite in miarolitic cavities.

Figure 23. **Gaidonnayite crystals, 30 µm. Horváth collection, SEM photo by B. Down.**

Gaidonnayite $Na_2ZrSi_3O_9 \cdot 2H_2O$

Gaidonnayite was described as a new species from Mont Saint-Hilaire (Chao and Watkinson, 1974; Chao, 1985). Many occurrences have been reported since then in other alkaline intrusions, including Narssârssuk, Greenland; the Khibina and Lovozero massifs in Russia; the Langesundfjord area in Norway; the Poços de Caldas complex, in Brazil; in an igneous sill in Montréal-Est, and in the Kipawa complex, both in Québec, Canada.

Gaidonnayite is extremely rare in the Saint-Amable sill, and known only from a single specimen from a slightly altered miarolitic cavity. It occurs as druses and clusters of small, equant, colorless, intergrown crystals measuring 0.2–0.5 mm across and having a vitreous luster. No fluorescence was observed under ultraviolet radiation. Gaidonnayite may be locally more common than the single identified specimen suggests, but may be easily overlooked due to the small size of the crystals, its inconspicuous appearance, and the lack of fluorescence.

Gaidonnayite is a relatively late-stage mineral, associated with natrolite, bastnäsite-(Ce), aegirine, astrophyllite and altered eudialyte.

Galena PbS

Galena occurs frequently in the miarolitic cavities as sharp, 1–1.5 mm cubes rarely modified by small octahedral faces. In addition to the cubic crystals, two unusual habits have been observed: elongated crystals resembling tetragonal prisms, and very thin, sometimes bent, rectangular to irregular foil-like plates which are similar in appearance to molybdenite. Along with sphalerite, galena is one of the late minerals in the paragenetic sequence.

Gibbsite $Al(OH)_3$

In a very rare and unusual mineral assemblage, gibbsite was found as cavity fillings in the contact zone in close association with cryolite, thomsenolite and doyleite. It occurs as dull, opaque, white to pale beige, powdery to compact globular aggregates and porcelaneous crusts in solution cavities in cellular masses consisting mostly of thomsenolite. Gibbsite and the intimately associated doyleite and thomsenolite are late-stage alteration products of cryolite. Other associated minerals are pyrrhotite, pyrite, siderite and galena. Gibbsite fluoresces intense bluish white under both shortwave and longwave ultraviolet radiation, with a strong pale yellow phosphorescence after both shortwave and longwave irradiation. The physical appearance of Saint-Amable gibbsite, its close association with cryolite and its fluorescence are very similar to those of the fluorine-bearing gibbsite described from the Saint-Michel sill (Francon quarry) by Jambor *et al.* (1990).

Gmelinite $(Na_2,Ca)Al_2Si_4O_{12} \cdot 6H_2O$

Gmelinite is extremely rare in the miarolitic cavities as attractive "bow-tie" clusters of 0.8–1 mm long, colorless to white, slightly tapering hexagonal {1010} prisms terminated by the {0001} basal pinacoid. The crystals are colorless at the terminations, grading to translucent white at the base. The luster is vitreous on the prism faces and dull on the basal pinacoid. Gmelinite is one of the late-stage minerals in the paragenetic sequence.

Goethite α-$Fe^{3+}O(OH)$

An uncommon mineral in altered miarolitic and weathered contact-zone cavities, goethite is found as granular, reddish brown masses and crusts, and rarely as rhombic pseudomorphs, most likely after siderite.

Gypsum $CaSO_4 \cdot 2H_2O$

Gypsum occurs very rarely as sharp, colorless, 0.5–1 mm bladed crystals forming divergent, radiating clusters and spherical aggregates in miarolitic cavities.

Halotrichite $Fe^{2+}Al_2(SO_4)_4 \cdot 22H_2O$

An extremely rare secondary mineral, halotrichite has been found in a sulfide-rich cavity in the contact zone as curly, opaque, white fibrous tufts 1–2 mm long on pyrite.

Hematite α-Fe_2O_3

Very rare in contact-zone cavities, hematite occurs as sharp, complex, tabular hexagonal crystals up to 1 mm across, and very thin black plates to 2 mm in diameter. Hematite is also found as crude, tabular, 0.5–1 mm crystals embedded in analcime around these cavities. The color is black, and deep red in thin fragments.

Hilairite $Na_2ZrSi_3O_9 \cdot 3H_2O$

Hilairite, a rare silicate, was described as a new species from Mont Saint-Hilaire (Chao *et al.*, 1974). It has also been reported from the Langesundfjord area of Norway (Raade *et al.*, 1980), the Lovozero massif in Russia (Khomyakov and Chernitsova, 1980), the Strange Lake complex in Canada (Birkett *et al.*, 1992), and the Poços de Caldas complex, in Brazil (G. Y. Chao, personal communication, 1993).

Hilairite is very rare in the Saint-Amable sill, known from a small number of specimens from miarolitic cavities. It occurs as crude, opaque, pale pink, blocky crystals to 0.6–1.0 mm across, and as sharp, translucent to opaque, white, hexagonal 0.3–0.5-mm $\{11\bar{2}0\}$ prisms terminated by the $\{01\bar{1}2\}$ rhombohedra forming complex intergrown groups.

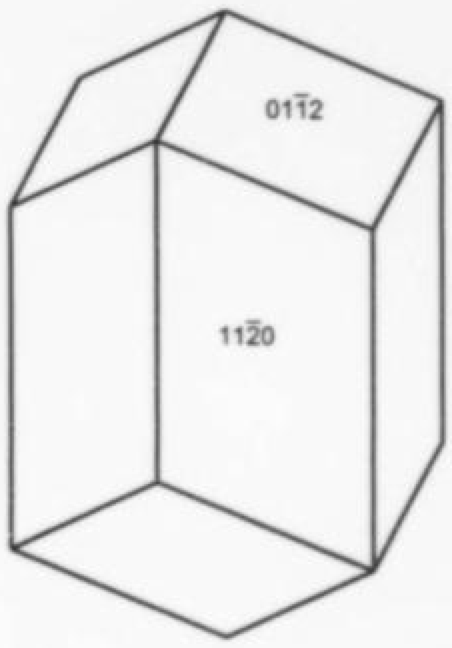


Figure 24. **Hilairite crystal drawing.**

Figure 25. **Kukharenkoite-(Ce), characteristic reticulated crystal group. Field of view 1 mm wide. Horváth collection, SEM photo by B. Down.**

Hilairite is a mid to late-stage mineral in the paragenesis of the miarolitic cavities, and is associated with aegirine, natrolite, serandite, sphalerite, cordylite-(Ce) and zakharovite.

Hochelagaite $(Ca,Na)Nb_4O_{11}\cdot 8H_2O$

Hochelagaite, the Ca-analog of franconite, was simultaneously described from the Saint-Michel sill (Francon quarry) in Montréal (type locality), and from Mont Saint-Hilaire (Jambor *et al*., 1986). The Saint-Amable sill is the third known locality for the mineral (Gault and Horváth, 1993). Recently, hochelagaite was also found at Vardeåsen in the Langesundfjord area, Norway (Anderson *et al*., 1996).

Hochelagaite is exceedingly rare in the Saint-Amable sill, presently known from only a single specimen from a cavity in the contact zone. An electron microprobe (WDS) analysis gave the empirical formula: $(Ca_{0.87}Na_{0.13})_{\Sigma 1.00}(Nb_{3.81}Ti_{0.19}Mg_{0.05})_{\Sigma 4.05}O_{10.89}\cdot 8H_2O$. Hochelagaite occurs as silky, pure white, extremely thin fibers, forming radiating spherical aggregates to 1 mm in diameter. It is visually indistinguishable from franconite, and gives a weak yellowish white fluorescence under both shortwave and longwave ultraviolet radiation. Hochelagaite is a late-stage mineral in the paragenesis, associated with analcime, natrolite, catapleiite, aegirine, fluorite and dawsonite.

Jarosite $K_2Fe^{3+}_6(SO_4)_4(OH)_{12}$

This secondary mineral is found very rarely as clusters of crude beige crystals less than 0.5 mm in diameter, on pyrrhotite crystals in cavities in the contact zone.

Kaolinite group

A kaolinite-group mineral similar to nacrite was tentatively identified by XRD. It occurs as powdery to fine micaceous opaque white aggregates in cavities in the contact zone.

Kukharenkoite-(Ce) $Ba_2Ce(CO_3)_3F$

Kukharenkoite-(Ce) is a new mineral simultaneously described from the Khibina massif (type locality) and the Vuorijärvi Complex, Kola Peninsula, Russia, Mont Saint-Hilaire and the Saint-Amable sill (Zaitsev *et al*., 1996). The mineral appears to be identical to *zhonghuacerite-(Ce)* which was described as a new species from the Bayan Obo rare-earth deposit in Inner Mongolia, China (Zhang and Tao, 1981). Although the name *zhonghuacerite-(Ce)* has been well-established in the mineralogical literature (Fleischer, 1983; Fleischer and Mandarino, 1995), it appears that it has not been submitted to, nor approved by the IMA's Commission on New Minerals and Mineral Names.

The Mont Saint-Hilaire material was first found in 1986 and designated as UK65 (Chao *et al*., 1990); the Khibina material was at first identified as *zhonghuacerite-(Ce)* in 1995 (Khomyakov, 1995). The Saint-Amable material was first collected by the authors (LH and EP-H) in 1976 in the Demix quarry, but remained unidentified until 1993, when it was confirmed to be identical to MSH UK65. A microprobe (WDS) analysis of kukharenkoite-(Ce) from the Saint-Amable sill gave: BaO 50.07, CaO 0.06, SrO trace, La_2O_3 10.27, Ce_2O_3 14.32, Pr_2O_3 0.37, Nd_2O_3 1.47, F 3.14, CO_2 21.54, O = F –1.32, total 99.91 weight %, resulting in the empirical formula: $Ba_{2.01}(Ce_{0.54}La_{0.39}Nd_{0.05}Pr_{0.01}Ca_{0.01})_{\Sigma 1.00}(CO_3)_3F_{1.01}$, based on $1(La^{3+} + Ce^{3+} + Pr^{3+} + Nd^{3+} + Ca^{2+})$.

The mineral is extremely rare in the Saint-Amable sill, and to date only a few specimens have been positively identified. It occurs in small, 1–3 cm miarolitic cavities as colorless to very pale pinkish gray, 0.3–1 mm bladed or prismatic crystals with chisel-shaped terminations, forming oriented, most likely twinned, reticulated aggregates to 3 mm across. The reticulated and oriented crystal groups, reminiscent of reticulated cerussite, are easy to recognize and are characteristic of the mineral. Crystals are transparent grading to translucent with a vitreous to greasy luster. Some crystal groups are sprinkled with very small flakes of a white unidentified carbonate mineral.

Kukharenkoite-(Ce) is a late-stage mineral in the paragenetic sequence, associated with microcline, natrolite, eudialyte, manganneptunite, aegirine, rinkite, pyrite, zakharovite, yofortierite, låvenite, astrophyllite and calcite.

Labuntsovite $(K,Ba,Na)(Ti,Nb)(Si,Al)_2(O,OH)\cdot H_2O$

Labuntsovite, the Ti end-member of the labuntsovite-nenadkevichite series (Labuntsov, 1926; Semenov and Burova, 1955; Semenov, 1959 and 1972; Golovastikov, 1974), is a relatively rare species occurring in alkaline rocks at many localities. In the Saint-Amable sill, labuntsovite is relatively common (Gault and Horváth, 1993), with small local concentrations occurring in miarolitic cavities and mineralized seams. In the fall of 1996, a large concentration of labuntsovite was found in a very unusual hornfelsized shale xenolith in the sill. The xenolith, found *in situ* near the sill contact, was an isolated block approximately 1 meter across, thoroughly brecciated and permeated by a dense network of narrow fractures which are lined by numerous superb, deep orange-red prismatic crystals.

Labuntsovite forms excellent, sharp, transparent, pale yellow to orange to orange-red, short to elongated prismatic crystals 0.5–3.0 mm long, having a vitreous to adamantine luster. The pale yellow

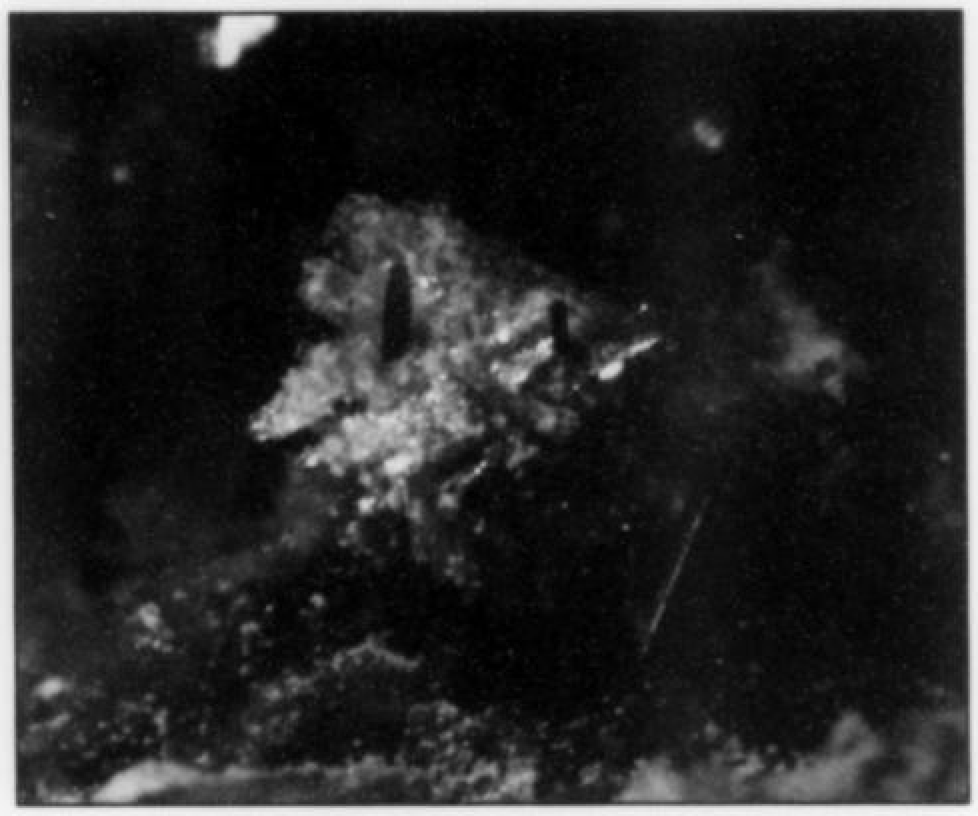


Figure 26. **Kukharenkoite-(Ce) crystals in a 2 mm reticulated group from a miarolitic cavity.**

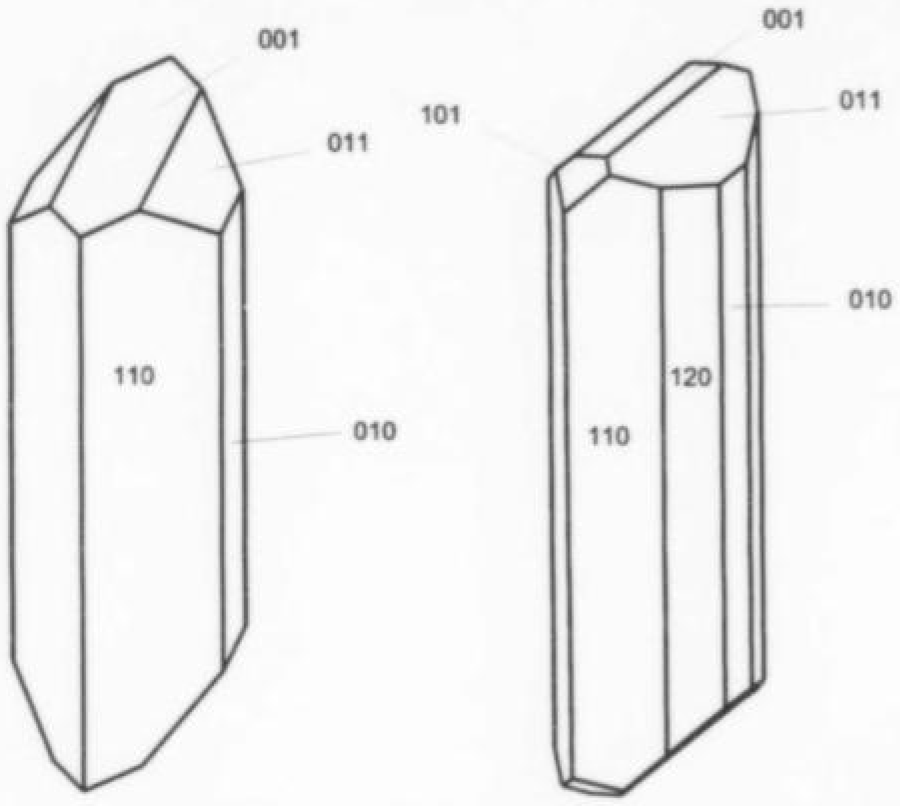


Figure 27. **Labuntsovite crystal drawings: (left) most common forms, (right) all observed forms.**

crystals are generally more slender and smaller (0.5–1 mm long) than the orange and orange-red varieties. Most crystals are bounded by dominant {110} prisms and small {010} pinacoids, and are terminated by the {011} prism and a {001} basal pinacoid. Rarely, the {120} and {101} prisms have also been observed. The color of labuntsovite from most other localities is rather consistently vivid orange-red to orange-yellow, whereas in the Saint-Amable sill it varies from very pale yellow to orange to orange-red. The reason for the color variation has not been determined. The best specimens found to date are the superb deep orange-red prismatic crystals lining fissures in the xenolith mentioned above.

The difficulty of visually distinguishing elpidite from labuntsovite has already been mentioned; it is also difficult to distinguish the nearly colorless to pale yellow labuntsovite from nenadkevichite. In some cavities, all three species occur together. A reasonably good diagnostic feature is the presence of a terminating {011} prism, which tends to be well developed in labuntsovite but has not been observed in nenadkevichite. Epitactic growths of labuntsovite on elpidite have already been mentioned; the most interesting of these are short labuntsovite prisms forming epitactic caps on both ends of doubly terminated elpidite crystals.

Labuntsovite is a late-stage mineral, and in the mineralized seams it appears to be one of the products of eudialyte decomposition. The most common associated minerals are catapleiite, elpidite, cordylite-(Ce), fluorite, zakharovite, pyrrhotite, eudialyte, nenadkevichite, natrolite, microcline and aegirine.

Figure 28. **Labuntsovite crystals from a xenolith. Field of view 8 mm wide.**

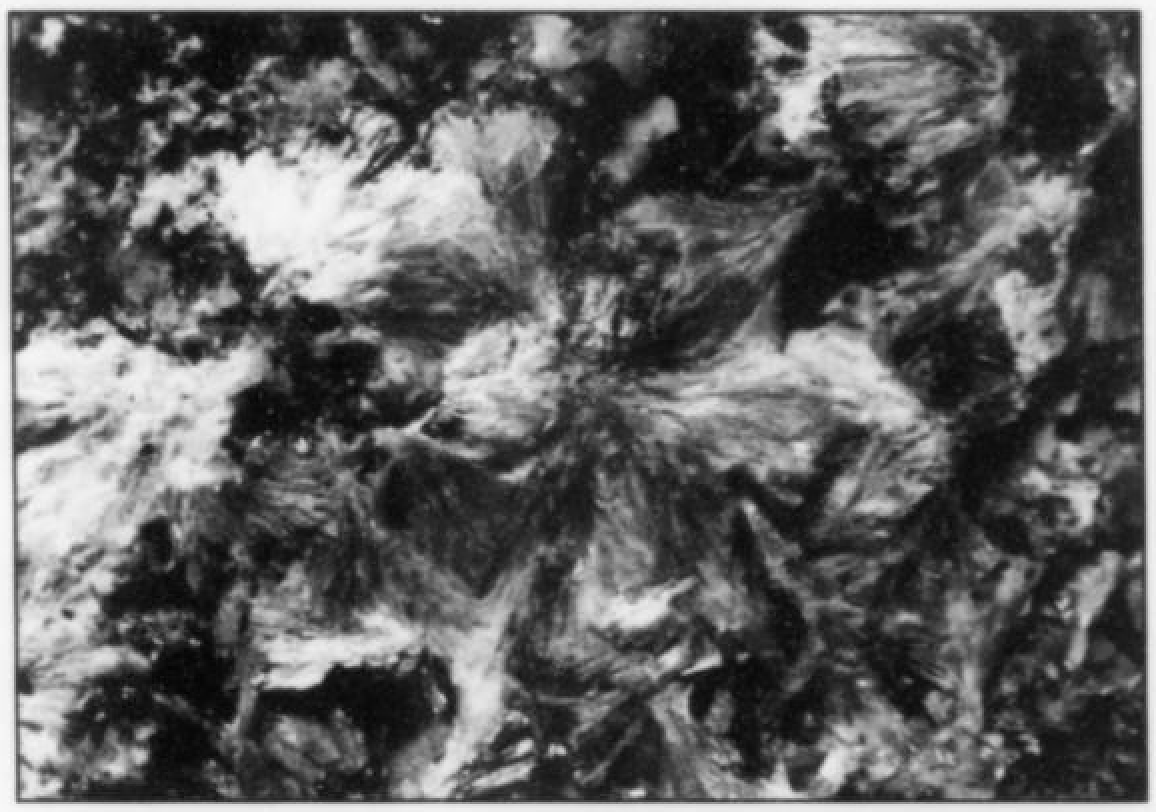


Figure 29. **Låvenite in stellate aggregates to 1 cm.**

Figure 30. **Låvenite aggregate, 1.5 mm in diameter.**

Låvenite $(Na,Ca)_2(Mn^{2+},Fe^{2+})(Zr,Ti)Si_2O_7(O,OH,F)_2$

Låvenite is relatively common in the tiny cavities that typically surround miarolitic cavities and in mineralized seams; it is uncommon in miarolitic cavities. It occurs as translucent to opaque, beige to yellow and orange-yellow, radiating or divergent fibrous sprays and coralloidal aggregates with a greasy luster; as vitreous, transparent to translucent, thin bladed acicular crystals 1–5 mm long; and as silky, matted, yellow to brown fibrous masses 1–2 mm across, typically associated with rinkite, astrophyllite, lorenzenite, aegirine and albite. It is also found as stellate aggregates to 1 cm in diameter, densely-scattered over large surfaces (to several hundred cm^2) in very narrow mineralized seams, especially in the southeast and southwest corners of the Demix quarry, commonly intergrown with astrophyllite and sometimes with lorenzenite. In all occurrences låvenite is one of the mid-stage minerals in the paragenesis.

Microprobe analysis (WDS) of låvenite gave the following result: Na_2O 9.89, CaO 10.44, K_2O trace, MnO 9.09, FeO 2.12, MgO 0.10, Y_2O_3 0.46, Ce_2O_3 0.38, ZrO_2 18.28, TiO_2 6.79, Nb_2O_5 5.03, SiO_2 31.45, F 5.79, H_2O 2.04 (calculated by stoichiometry) O = F –2.44, total 99.42 weight %, resulting in the empirical formula:$(Na_{1.21}Ca_{0.33})_{\Sigma 1.54}(Mn_{0.48}Ca_{0.37}Fe_{0.11}Y_{0.02}Ce_{0.01}Mg_{0.01})_{\Sigma 1.00}$-$(Zr_{0.56}Ti_{0.32}Nb_{0.14})_{\Sigma 1.02}Si_{1.97}O_7[F_{1.15}(OH)_{0.85}]_{2.00}$, based on 9 anions. The Na values are low due to Na migration under the electron beam.

Lemoynite $(Na,K)_2CaZr_2Si_{10}O_{26}\cdot 5\text{–}6H_2O$

Lemoynite was originally described from Mont Saint-Hilaire, Québec (Perrault *et al.*, 1969); the Saint-Amable sill is the second known locality for the mineral. Its occurrence is very rare, in small miarolytic cavities as sharp, vitreous, colorless, prismatic crystals forming compact, spherical aggregates 0.8–1.5 mm in diameter. Associated minerals include albite, natrolite, zakharovite, aegirine, eudialyte and polylithionite.

Löllingite $FeAs_2$

Very rare in miarolitic cavities, löllingite occurs as complex groups of silvery metallic, striated, intergrown, twinned tabular crystals up to 1 mm long, associated with aegirine, manganneptunite, natrolite and sphalerite. The crystals are similar to and are visually difficult to distinguish from arsenopyrite.

***Figure 31.* Lorenzenite aggregate of radiating crystals, 4 mm in diameter.**

Lorenzenite $Na_2Ti_2Si_2O_9$

Lorenzenite is a relatively common species, found mostly as embedded aggregates and in narrow, mineralized seams around miarolitic cavities. Rarely it is also found as free-standing crystals in miarolitic cavities, mineralized seams and "natrolite pipes." It occurs as beige-brown to pale pinkish, thin bladed acicular crystals with pointed terminations and as aggregates of fine, fibrous crystals 0.5–3 mm long which invariably form radiating clusters and spherical aggregates 1–6 mm in diameter. The luster varies from subvitreous on the bladed crystals to silky on the fibrous crystals. Some lorenzenite fluoresces very pale yellowish white under shortwave ultraviolet radiation.

Generally, lorenzenite is one of the early minerals in the paragenesis, most frequently associated with microcline, astrophyllite, mangan-neptunite, eudialyte, aegirine, låvenite and rinkite. Lorenzenite was also found in an altered "natrolite pipe" as a very unusual, late-stage overgrowth on natrolite.

Lueshite $NaNbO_3$

Lueshite, a rare perovskite-group mineral (Safiannikoff, 1959), is extremely rare and is known from only a single specimen from a miarolitic cavity. After Mont Saint-Hilaire and Lovozero, the Saint-Amable sill is the third known occurrence of the mineral in an igneous environment. Lueshite is orthorhombic but typically exhibits pseudocubic symmetry. It occurs as vitreous, translucent, brown, pseudocuboctahedra less than 0.5 mm in size which are very similar in appearance to pyrochlore. Associated minerals are eudialyte, serandite, aegirine, microcline and natrolite.

Magadiite $NaSi_7O_{13}(OH)_3\cdot 4H_2O$

Magadiite was first described from evaporite lake sediments at Lake Magadi, Kenya (Eugster, 1967), and is generally associated with alkaline brine precipitates in Oregon, California and Africa. It is rather surprising that the mineral has also been found at Mont Saint-Hilaire (Horváth and Gault, 1990), and in the Saint-Amable sill (Gault and Horváth, 1993). To our knowledge these are the only two reported localities where the mineral is associated with igneous rocks.

Magadiite is a rare, very late-stage mineral in miarolitic cavities and in hydrothermalite pods. In miarolitic cavities it occurs as compact, opaque, grayish white spheres less than 0.5 mm in diameter, with a dull, frosty, almost opalescent appearance; as silky, pale beige to white, spherical aggregates with a compact, radiating, fibrous to micaceous structure in individual spheres 0.3–0.5 mm in diameter; and very rarely as aggregates of sharp, colorless, equant, bipyramidal crystals 0.1–0.2 mm in diameter. Magadiite was also found in some quantity in hydrothermalite pods exposed in 1995, as opaque, white, compact powdery to fibrous masses up to 2 cm across and as silky, white, spherical aggregates and thin crusts commonly lining small cavities. Associated minerals in the hydrothermalites are: varennesite, natrolite, eudialyte, shkatulkalite, makatite, pectolite, sphalerite, monazite-(Ce), serandite, zakharovite, lorenzenite, aegirine and tuperssuatsiaite. Magadiite fluoresces yellowish white under shortwave, and a very weak white under longwave ultraviolet radiation.

XRD and microprobe analyses (EDS) also disclosed a Ca-rich variety, which may be a new Ca-analog of magadiite (Gault and Horváth, 1993), but no further investigation has been carried out.

Makatite $Na_2Si_4O_8(OH)_2\cdot 4H_2O$

Along with magadiite, makatite was also described as a new species from evaporites at Lake Magadi, Kenya (Sheppard *et al.*, 1970). In recent years the mineral has been reported from a number of alkaline intrusives, including the Lovozero massif (Khomyakov *et al.*, 1981), the Aris phonolite, Namibia (Von Knorring and Franke, 1987), Mont Saint-Hilaire (Horváth and Gault, 1990), and the Khibina massif (Khomyakov *et al.*, 1981).

In the Saint-Amable sill makatite is relatively rare in miarolitic cavities and hydrothermalites, found mostly at the southern end of the Demix quarry. It occurs as silky, pure white to very pale green, fibrous radiating sprays to 1 cm long; as random intergrown masses up to 2 cm across; and as colorless, prismatic crystals to 1 cm long, embedded in fibrous makatite, with at least one excellent cleavage parallel to the longitudinal axis. A weak bluish white fluorescence under shortwave ultraviolet radiation has been noted. It is a late-stage mineral in the paragenesis of both modes of occurrence, typically associated with varennesite, eudialyte, zakharovite, shkatulkalite, magadiite and VUK1. It is sometimes intergrown with white, fibrous VUK1, from which it is visually indistinguishable.

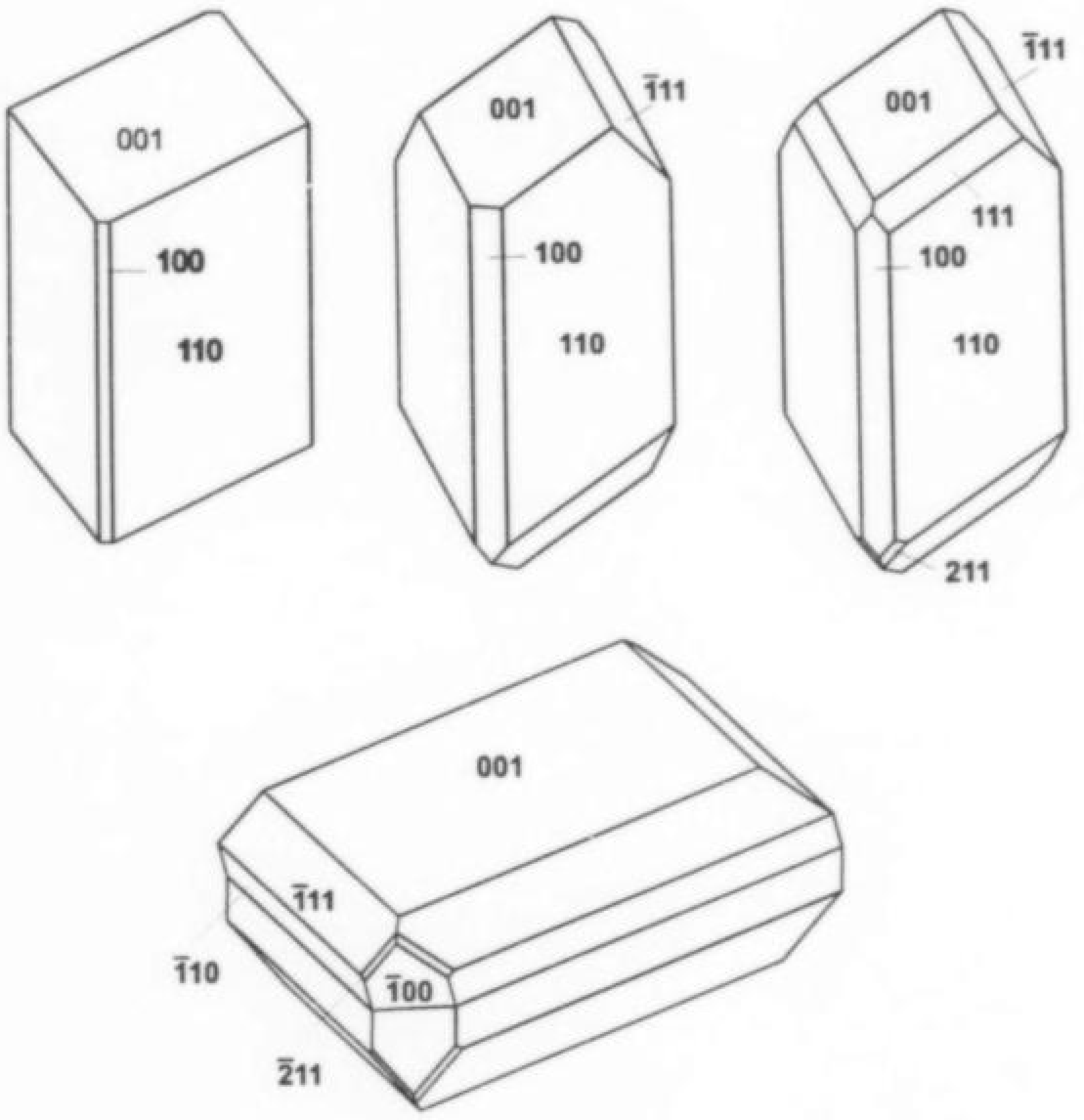


Figure 32. **Mangan-neptunite crystal drawings: (top) prismatic crystals of increasing complexity, (bottom) tabular twin on (001).**

Mangan-neptunite $KNa_2Li(Mn^{2+},Fe^{2+})_2Ti_2Si_8O_{24}$

Mangan-neptunite is one of the most common species in the sill. It is most abundant in miarolitic cavities, but also common in mineralized seams, hydrothermalites and "natrolite pipes" as free-growing crystals, or embedded in the rock at the margins of cavities. It is found as superb, transparent to translucent, deep-red, opaque (almost black) tabular and prismatic crystals 1–8 mm in size. The prismatic crystals vary from the very simple, bounded by the dominant {110} prism and {001} pinacoid, with a small {100} pinacoid, to increasingly more complex crystals with additional, common and well-developed {111} positive and $\{\bar{1}11\}$ negative prisms, and rare {210} prism. The tabular crystals exhibit all the forms noted on prismatic crystals, but are dominated by the {001} basal pinacoid. They are typically twinned, most commonly as contact twins on (001). The luster is vitreous on crystal faces and resinous on broken surfaces. Some crystals are partially hollow and show evidence of etching.

Mangan-neptunite occurs in at least two generations: as one of the early species embedded in the rock or in cavity linings overgrown by other species, and as a late-stage mineral perched on natrolite and other minerals. Although it is totally absent from cavities in the contact zone, it is associated with practically all the species found in the sill.

Marcasite FeS_2

Marcasite is very rare in contact-zone cavities. It is found as brassy, metallic, bladed, 1–2 mm crystals with pointed terminations.

Microcline $KAlSi_3O_8$

Microcline is ubiquitous; it typically occurs as a drusy lining in miarolitic cavities and mineralized seams, and less commonly in hydrothermalites. It forms sharp, translucent to opaque, white to grayish, tabular to blocky crystals 1–10 mm across, often twinned. It is the earliest primary mineral in the paragenesis, associated with practically all other minerals found in the sill.

Microcline fluoresces dark red under shortwave ultraviolet radiation. A single microprobe analysis (WDS) of microcline gave: SiO_2 64.58, Al_2O_3 17.54, K_2O 16.29, Na_2O 0.28, SrO trace, total 98.69 weight %, resulting in the empirical formula: $(K_{0.97}Na_{0.03})_{\Sigma 1.00}Al_{0.97}Si_{3.02}O_8$, based on 8 oxygens.

Monazite-(Ce) $(Ce,La,Nd,Th)PO_4$

Monazite-(Ce) is an uncommon late-stage mineral in miarolitic cavities and hydrothermalites. It is more common in miarolitic cavities, occurring as white to beige, pale brown and pale gray, parallel, lamellar aggregates forming hollow, tabular 3–8 mm crystals and relict skeletal structures with rectangular cross sections. It also forms soft, very pale bluish green, scaly, foliated aggregates; radiating groups of opaque, white, acicular crystals up to 1 mm long; and opaque, beige, thin tabular crystals forming fan-shaped groups 5–6 mm across. The tabular crystals are somewhat crude with a dull luster and appear to be pseudomorphs after an unknown mineral. They are frequently covered by a white, chalky or powdery carbonate resembling bastnäsite-(Ce).

In hydrothermalites monazite-(Ce) has been found as crude, dull, opaque, gray, blocky crystals to 2 mm across. They are soft and somewhat crumbly with a grainy texture and greasy luster, and appear to be either pseudomorphs or heavily corroded crystals.

Montmorillonite $(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$

Powdery aggregates of montmorillonite were identified from an unspecified occurrence in the sill by A. P. Sabina (personal communication, 1993).

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

Relatively rare in miarolitic cavities, muscovite occurs as colorless, tabular pseudohexagonal crystals up to 1 mm in diameter, and as aggregates and micaceous masses to several mm across.

Natrolite $Na_2Al_2Si_3O_{10} \cdot 2H_2O$

Natrolite is one the most abundant minerals in the sill in all modes of occurrence, and is associated with all the other species. It is also one of the main rock-forming minerals.

In the contact-zone cavities natrolite is found as colorless, elongated, 2–15 mm prismatic crystals bounded by the {110} prism, {100} and {010} pinacoids, and terminated by {111} pyramids. Rarely, some of these crystals have a thin layer of epitactic paranatrolite on the surface, which alters to tetranatrolite on extended exposure to air.

In miarolitic cavities, natrolite is found in the following habits: colorless to white, simple prismatic crystals, 2–20 mm long; superb, colorless, short prismatic crystals of great complexity 2–6 mm long; translucent to opaque, gray, complex, somewhat crude etched crystals lining cavities, with only the crystal terminations visible; colorless crystals of a very unusual, dipyramidal habit with extremely small {110} prism, {100} and {010} pinacoids; intergrown crystalline masses filling some of the cavities; chalky to finely fibrous white masses; and as pseudomorphs most likely after nepheline and sodalite.

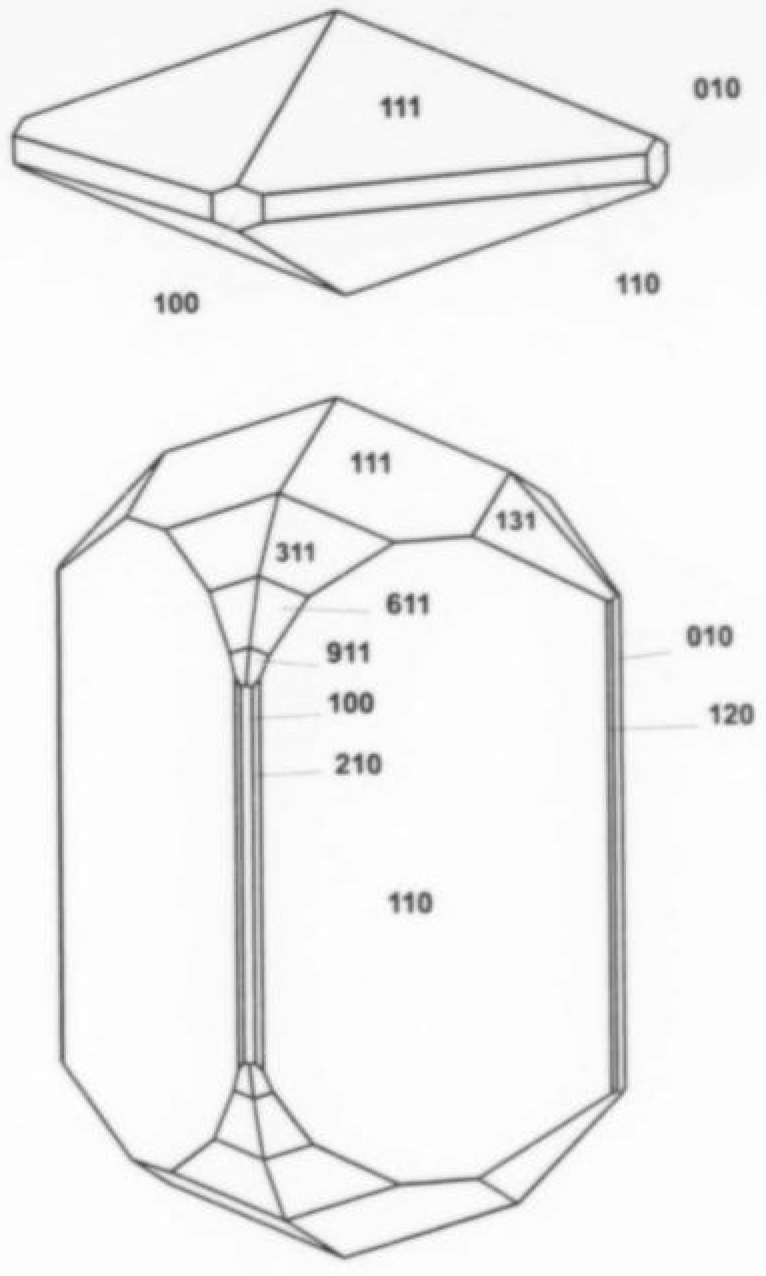


Figure 33. **Natrolite crystal drawings.**

Intergrown, cellular masses of colorless to white prismatic crystals of natrolite also form the bulk of the infilling of the hydrothermalite pods.

The largest crystals occur in the tubular "natrolite-pipes." Colorless to translucent gray, short prismatic crystals up to 2 cm in length have been found lining the walls, commonly forming attractive, intergrown, hemispherical aggregates.

Paragenetically, natrolite is present in at least two generations: an early and a late-stage phase, in the main modes of occurrence.

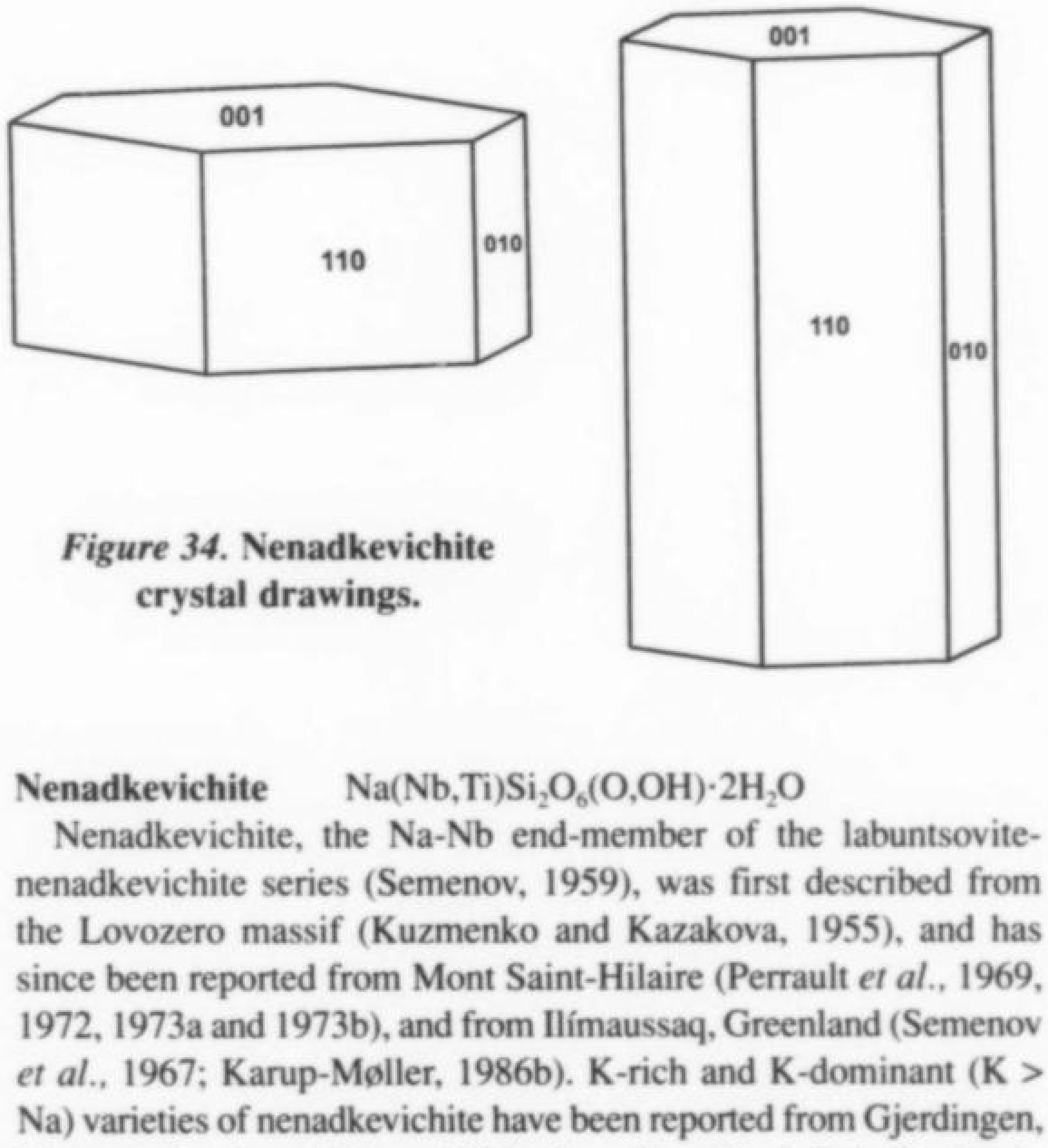


Figure 34. **Nenadkevichite crystal drawings.**

Nenadkevichite $Na(Nb,Ti)Si_2O_6(O,OH) \cdot 2H_2O$

Nenadkevichite, the Na-Nb end-member of the labuntsovite-nenadkevichite series (Semenov, 1959), was first described from the Lovozero massif (Kuzmenko and Kazakova, 1955), and has since been reported from Mont Saint-Hilaire (Perrault *et al.*, 1969, 1972, 1973a and 1973b), and from Ilímaussaq, Greenland (Semenov *et al.*, 1967; Karup-Møller, 1986b). K-rich and K-dominant (K > Na) varieties of nenadkevichite have been reported from Gjerdingen, Norway (Raade and Haug, 1982), from Vuorijärvi, Kola Peninsula (Rastsvetaeva *et al.*, 1994) and from Narssârssuk, Greenland (Petersen *et al.*, 1996). The Saint-Amable sill is the second North American locality for the mineral (Gault and Horváth, 1993).

Nenadkevichite is relatively common in the miarolitic cavities, occurring as well-formed crystals, in tabular and prismatic habits. The less common of the two habits are colorless to transparent, very pale pink, tabular pseudohexagonal crystals, 0.5–1 mm in diameter, bounded by a dominant {001} basal pinacoid, {110} prism and {010} pinacoid. Short to elongated prisms are more common, occurring as colorless to transparent, pale yellow crystals 0.5–2.0 mm long, dominated by a {110} prism and {010} pinacoid and terminated by the {001} basal pinacoid. The luster in both habits is vitreous.

Nenadkevichite is one of the late-stage species in the paragenetic sequence, and it is associated with practically all other minerals found in the miarolitic cavities. As noted earlier, elongated prismatic crystals of nenadkevichite bear a close similarity to pale yellow labuntsovite, making it difficult to visually distinguish between the two.

The nenadkevichite-labuntsovite series (Rastsvetaeva *et al.*, 1994; Organova *et al.*, 1976 and 1981) exhibits marked chemical and structural variations, and according to these authors includes three chemically distinct members: an orthorhombic member represented by the Na-Nb nenadkevichite from Mont Saint-Hilaire (Perrault *et al.*, 1969, 1972, 1973a and 1973b); a monoclinic Ti-rich member (Organova *et al.*, 1976); and a monoclinic, K-rich nenadkevichite from Vuorijärvi (Rastsvetaeva *et al.*, 1994). The K-dominant nenadkevichite from Narssârssuk is reported to be orthorhombic (Petersen *et al.*, 1996).

The Saint-Amable nenadkevichite is close in composition to that reported by Perrault *et al.* (1969) from Mont Saint-Hilaire and is one of the closest to end-member nenadkevichite reported. Microprobe analysis (WDS) of nenadkevichite gave: Na_2O 6.85, K_2O 0.81, CaO trace, FeO 0.49, MnO 0.11, Nb_2O_5 26.50, TiO_2 9.63, SiO_2 39.59, H_2O 14.84 (calculated by stoichiometry), total 98.82 weight %, resulting in the empirical formula: $(Na_{0.66}K_{0.05}Fe_{0.02}Mn_{0.01})_{\Sigma 0.74}(Nb_{0.59}Ti_{0.36})_{\Sigma 0.95}Si_{1.96}O_6(OH) \cdot 2H_2O$, based on 9 anions. The Na value may be low due to Na migration under the electron beam. This effect in nenadkevichite is described by Petersen *et al.* (1996).

Nepheline $(Na,K)AlSiO_4$

To date, nepheline is known only as one of the significant rock-forming minerals in the sill. Rarely, pseudomorphs of natrolite, most likely after nepheline, have been found in miarolitic cavities. They are greenish gray, short hexagonal prisms, 2–3 mm long, with basal pinacoid terminations and a greasy luster.

Opal $SiO_2 \cdot nH_2O$

Opal is found as a very late-stage, post-emplacement deposition in some near-surface miarolitic cavities that show signs of alteration and weathering. It occurs as mostly colorless, but very rarely pale yellow and pale blue spheres, 1–2 mm in diameter; as botryoidal aggregates; and as a thin, colorless to white, glaze-like crusts on other minerals. The luster is vitreous. It fluoresces an intense yellow-green under shortwave, and pale yellow-green under longwave ultraviolet radiation. A very weak, pale yellow phosphorescence is observed on some specimens.

Paranatrolite $Na_2Al_2Si_3O_{10} \cdot 3H_2O$

Paranatrolite, a member of the zeolite group, was described as a new species from Mont Saint-Hilaire (Chao, 1980), where it occurs as epitactic overgrowths on natrolite. In the Saint-Amable sill it is quite rare, observed only in contact-zone cavities as a thin, colorless, visually indistinguishable epitactic layer on natrolite

Figure 35. **Mangan-neptunite in twinned tabular crystals on microcline, 2 mm in size.**

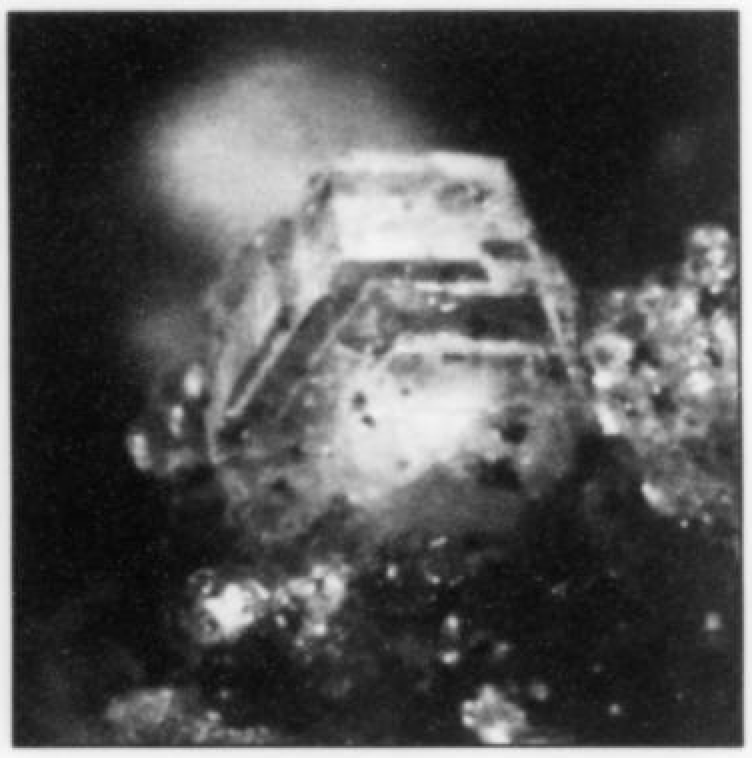


Figure 36. **Nenadkevichite crystal, 1 mm in diameter.**

crystals. When exposed to air, it dehydrates to a white flaky or powdery, sometimes exfoliating layer of tetranatrolite. Fresh specimens may be preserved in water.

Pectolite $NaCa_2Si_3O_8(OH)$

Pectolite is found very rarely in miarolitic cavities, as translucent to opaque, white, blocky crystals, 0.5–1 mm long, with a vitreous luster, and in a hydrothermalite pod as dull, white, divergent, fibrous sprays.

Polylithionite $KLi_2AlSi_4O_{10}(F,OH)_2$

Polylithionite is relatively common in miarolitic cavities and hydrothermalite pods, associated with most of the species found in these. It occurs most frequently as pearly, white to pale greenish gray, foliated spherical aggregates 1–3 mm in diameter, and compact masses up to 2 cm across consisting of very fine, almost powdery, irregular flakes, 0.1–0.3 mm across. These masses often fill cavities and enclose some of the associated minerals. Rarely, it also occurs as thin, well-formed, colorless, tan to silvery gray and pale green pseudohexagonal plates up to 2 mm across, forming rosette-like aggregates. Polylithionite fluoresces a strong yellow under shortwave ultraviolet radiation, which is a reliable method of distinguishing it from other micas.

XRD and electron microprobe analysis has established that most of the mica in the sill is polylithionite. Both polylithionite-1*M* and polylithionite-3*T* polytypes have been identified from the sill, with the 1*M* polytype being predominant. An average of five microprobe analysis gave K_2O 12.01, Na_2O 0.10, Li_2O 7.41, FeO 0.47, MgO 0.09, MnO 0.13, Al_2O_3 12.03, SiO_2 61.30, F 8.37, H_2O 0.56 (Li_2O and H_2O calculated by stoichiometry), O = F –3.52, total 98.95 weight %, resulting in the empirical formula: $(K_{1.02}Na_{0.01})_{\Sigma 1.03}$-$(Li_{1.97}Fe_{0.03}Mg_{0.01}Mn_{0.01})_{\Sigma 2.02}Al_{0.94}Si_{4.06}O_{10.08}[F_{1.75}(OH)_{0.25})_{\Sigma 2.00}$, based on $5(Al^{3+} + Si^{4+})$.

Pyrite FeS_2

Pyrite is relatively common in contact-zone cavities, but is observed only infrequently in miarolitic cavities, and as a drusy, monomineralic fracture-filling in the sill rock and in the shale underlying the sill. It occurs as bright, metallic, simple cubic crystals, rarely modified by {111} octahedra measuring 0.5–2.0 mm across, and very rarely as elongated "bars" and thin, filiform crystals.

Pyrrhotite $Fe_{1-x}S$

Pyrrhotite is a relatively common sulfide in miarolitic and contact-zone cavities. It occurs as bronze to brassy, metallic, thin tabular hexagonal crystals, 1–4 mm across, and as rosette-like groups often with a bluish green iridescence. Thick tabular pyrrhotite crystals associated with labuntsovite were found in a hornfelsized xenolith. Pyrrhotite has also been found in mineralized seams as foil-like plates, sometimes encrusted with reddish brown goethite.

Quartz SiO_2

Quartz is a relatively rare, late-stage mineral in miarolitic cavities, found as colorless, prismatic crystals 0.5–3 mm long. In a rare occurrence it has been observed as randomly intergrown, colorless, doubly terminated crystals 1–3 mm long, forming aggregates up to 5 cm across.

In hydrothermalites, white to pale gray chalcedony nodules having a porcelaineous luster and measuring up to 5 cm in diameter have been found embedded in natrolite and magadiite. The nodules fluoresce weak bluish white under longwave and strong greenish yellow under shortwave ultraviolet radiation, retaining weak pale yellow phosphorescence for short periods following shortwave irradiation.

Rhabdophane-(Ce) $(Ce,La)PO_4 \cdot H_2O$

Rhabdophane-(Ce) is an extremely rare, late-stage mineral in miarolitic and contact-zone cavities, known only from a few specimens. In contact-zone cavities it occurs as crude, dull, beige rosette-like aggregates 1.5 mm across with a somewhat powdery interior. It is similar in appearance to aggregates of donnayite-(Y) found in the same environment. Associated minerals are analcime and natrolite. In miarolitic cavities, rhabdophane-(Ce) has been found as crude, pearly, opaque, beige rectangular plates 1–2 mm across, probably pseudomorphs, associated with eudialyte, yofortierite and natrolite.

Rhodochrosite $Mn^{2+}CO_3$

Rhodochrosite is relatively common in miarolitic cavities, occurring as white, pale pink, orange-red, dark red and brown simple rhombs 1–8 mm across; as beige to pale pink, compact spheres, botryoidal masses and crusts; and as aggregates of pale pink, curved, "saddle-shaped" crystals up to 2 mm across encrusting cores of larger rhombs of rhodochrosite. It is also found as grains or subhedral crystals embedded in the sill rock. Rhodochrosite is associated with practically all the minerals occurring in miarolitic cavities.

Rinkite $(Ca,Ce)_4Na(Na,Ca)_2Ti(Si_2O_7)_2F_2(O,F)_2$

Rinkite is relatively common, found most frequently in mineralized seams, in tiny isolated vugs, and rarely in miarolitic cavities. It occurs as very thin, transparent to translucent, colorless to white, pale yellow and beige micaceous rectangular plates and lamellae 1–4 mm long, forming radiating, fan-like aggregates and foliated masses. In many of the tiny vugs, rinkite is the only visible mineral, frequently filling the cavities completely. Låvenite and astrophyllite are commonly associated with rinkite in the mineralized seam and small vugs.

Rinkite is a mid to late-stage species in the paragenesis of the mineralized seams and miarolitic cavities, and is associated with most species found in these.

There has been some uncertainty regarding the species status of some members of the rinkite-mosandrite series (Petersen *et al.*, 1989). The current view (Fleischer and Mandarino, 1995) is that rinkite is a valid species, and mosandrite is an altered variety of rinkite.

Sazhinite-(Ce) analog $Na_2(La,Ce)Si_6O_{14}(OH)\cdot nH_2O$

Sazhinite-(Ce) was originally described from Mount Karnasurt, Lovozero massif, Kola Peninsula, Russia (Eskova *et al.*, 1974; Shumyatskaya *et al.*, 1980). The mineral has also been found at Mont Saint-Hilaire as excellent tabular crystals (Horváth and Gault, 1990). The Saint-Amable sill is the third reported locality for sazhinite (Gault and Horváth, 1993).

Sazhinite is exceedingly rare, and known from only one confirmed specimen from a small miarolitic cavity. It occurs as pearly to dull, opaque, white to pale purplish gray, rectangular, tabular crystals up to 2 mm long. On broken surfaces the mineral appears waxy and lamellar, zoned with alternating colorless and translucent to opaque, milky white zones.

Sazhinite is one of the mid-stage species in the paragenesis, and is associated with microcline, eudialyte, aegirine, serandite, yofortierite (pink), galena, natrolite and zakharovite.

A microprobe analysis (WDS) indicates that Saint-Amable sazhinite is an La-dominant analog with the following empirical formula: $(Na_{1.69}K_{0.18}Ca_{0.16})_{\Sigma 2.02}(La_{0.44}Ce_{0.37}Th_{0.08}Nd_{0.05}Y_{0.03}Pr_{0.02}U_{0.01})_{\Sigma 1.00}Si_{5.93}O_{14}(OH)\cdot 6H_2O$, based on 21 anions and with H_2O calculated by stoichiometry. Lanthanum-dominant sazhinite was also reported from Mont Saint-Hilaire (Horváth and Gault, 1990) as zones in sazhinite-(Ce) crystals. The material from both localities shows patchy zoning, numerous holes and many inclusions. The currently available material is unsuitable for a full description as a new species.

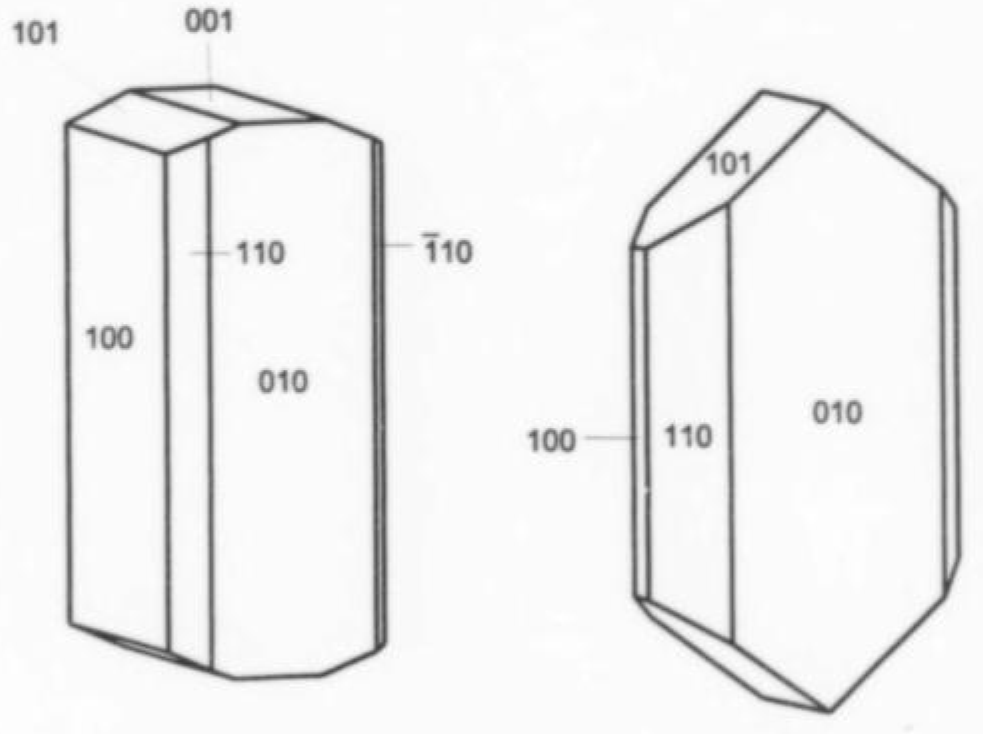


Figure 37. **Serandite crystal drawings.**

Serandite $Na(Mn^{2+},Ca)_2Si_3O_8(OH)$

In the Saint-Amable sill, serandite is a relatively common species in miarolitic cavities, hydrothermalites and "natrolite pipes," occurring as excellent sharp crystals with a blocky to bladed habit. The blocky crystals range from opaque white to transparent or translucent, pale to intense pink and orange-pink. They are typically elongated with an approximately square to rectangular cross-section, often showing contact twinning. The largest crystals attain a length of 2.5 cm, but most are in the 2–6 mm range. The luster varies from vitreous to waxy.

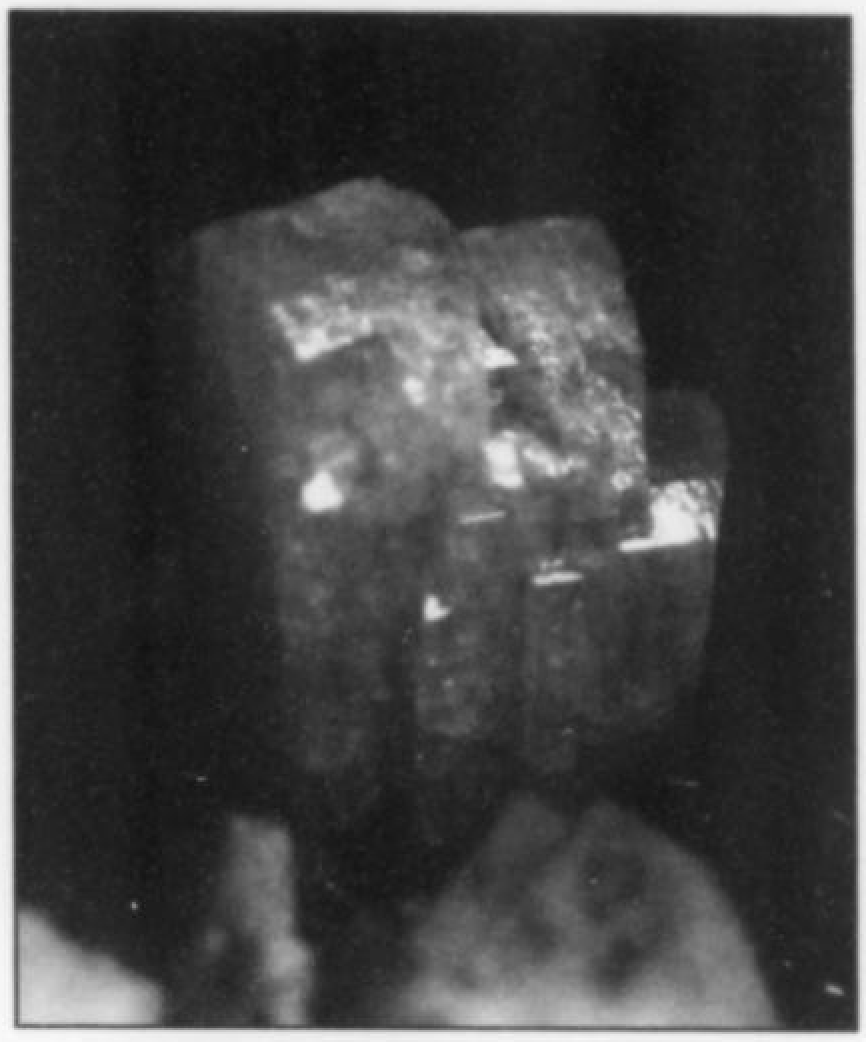


Figure 38. **Serandite crystals, 5 mm.**

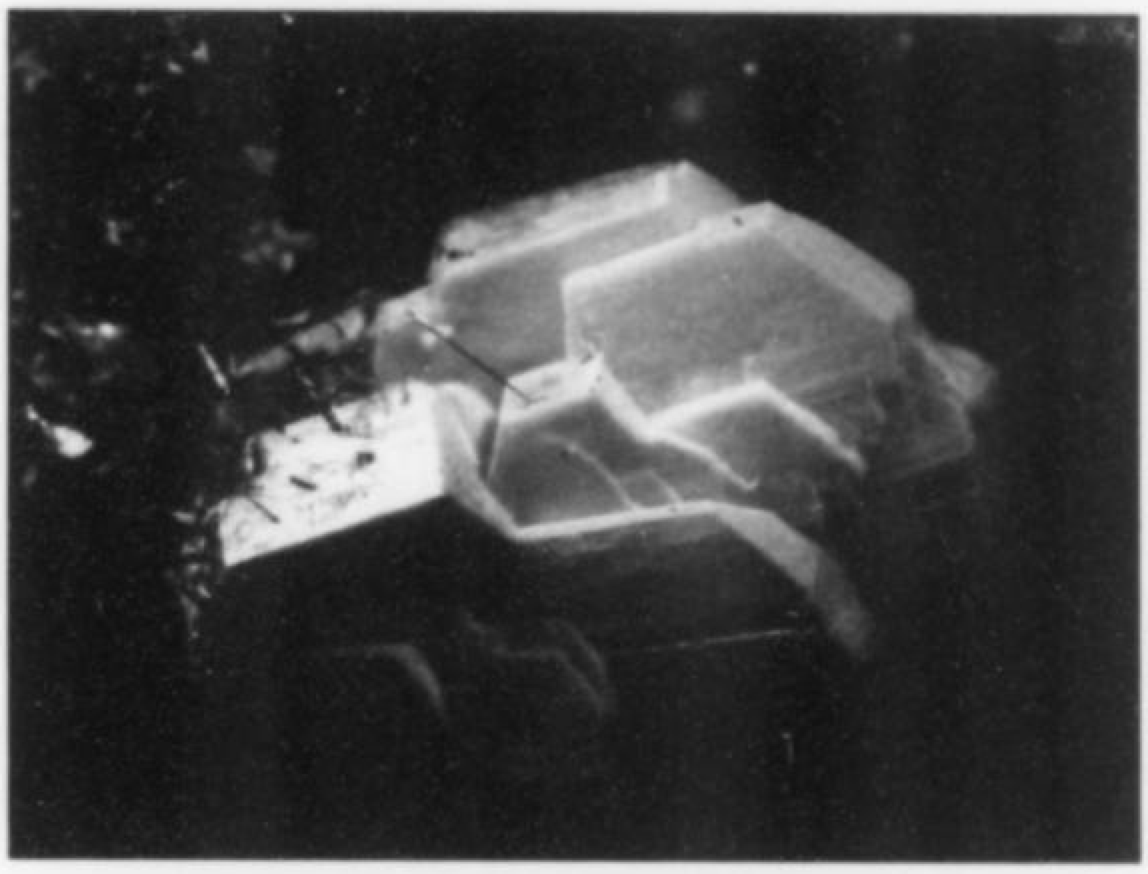


Figure 39. **Serandite crystal group, 6 mm.**

Figure 40. **Serandite group, 8 mm in size, from a "natrolite pipe."**

The bladed habit occurs as colorless, transparent to translucent, pale pink to beige and opaque white, short to elongated crystals, with the luster varying from sub-vitreous to pearly to dull. The bladed crystals are generally smaller, 1–4 mm long, very rarely attaining 1 cm in length, and often occur in radiating, fan-like clusters.

Serandite is a mid-stage mineral in the paragenetic sequence of miarolitic cavities and hydrothermalites, with a late-stage second generation often found in miarolitic cavities. In altered miarolitic cavities it is the precursor of the birnessite pseudomorphs.

Microprobe analysis (WDS) of a colorless crystal gave: Na_2O 8.95, MnO 23.75, CaO 10.83, FeO 1.11, TiO_2 0.15, SiO_2 52.67, Al_2O_3 trace, H_2O 2.59 (calculated by stoichiometry), total 100.09 weight %, resulting in the empirical formula: $Na_{1.00}(Mn_{1.16}Ca_{0.67}Fe_{0.05}Ti_{0.01})_{\Sigma 1.89}Si_{3.05}O_8(OH)$, based on 9 anions.

Shkatulkalite $Na_{10}MnTi_3Nb_3(Si_2O_7)_6(OH)_2F\cdot 12H_2O$

Shkatulkalite was described from the Shkatulka vein at Mount Alluaiv, Lovozero massif, Russia (Menshikov *et al.*, 1996), where it is found as colorless, silver-white and pale pink rectangular plates and aggregates. At Saint-Amable, the only other locality for the mineral, it was found by the authors in 1995, in a very unusual hydrothermalite pod in the southeast corner of the Demix quarry, and more recently in miarolitic cavities in other parts of the quarry. In both associations it is very rare.

Shkatulkalite occurs as transparent, pale yellow to orange yellow, thin, flexible, rectangular tabular crystals and irregular plates 2–5 mm long, showing a vitreous to waxy luster and occurring in radiating aggregates 5–8 mm across. Some of the tabular crystals are well-formed and sharp, but most are characterized by rough, ragged edges, and all have numerous internal cracks. In the hydrothermalite pods most crystals are found embedded in compact masses of intergrown magadiite, natrolite and makatite, and many are bent and twisted. Shkatulkalite is visually indistinguishable from vuonnemite and epistolite.

Shkatulkalite is a mid to late-stage mineral in the paragenesis of both, miarolitic cavities and hydrothermalites. Associated minerals in the hydrothermalite are varennesite (pale and dark brown or gray and dark green), natrolite, altered eudialyte, aegirine, chalcedony nodules, sphalerite, galena, magadiite, pectolite, monazite-(Ce), lorenzenite, serandite (white sprays), calcite, pyrite, albite, opal, ancylite-(Ce), polylithionite, tuperssuatsiaite, VUK1 and VUK8. In miarolitic cavities it is associated with natrolite, analcime, eudialyte, terskite, calcite, mangan-neptunite, varennesite and zakharovite.

Siderite $Fe^{2+}CO_3$

Siderite is rare in miarolitic cavities and uncommon in contact-zone cavities. The crystals are simple rhombs, 0.3–1.5 mm in size, with color varying from beige to brown, and luster from vitreous to dull.

Smectite group

Two distinct minerals belonging to the smectite group have been identified by repeated X-ray diffraction analysis, but the exact species have not been determined.

Mineral A consists of compact to loose masses up to 3 cm across, of a soft, pale brown to pale orange-yellow, powdery to fine-grained mineral with a somewhat greasy luster partially filling some miarolitic cavities and "natrolite pipes." It appears to be a ubiquitous alteration product after some as yet undetermined mineral, and is almost always associated with zakharovite, from which it can be difficult to distinguish. Other closely associated species include varennesite, yofortierite, eudialyte, sphalerite and mangan-neptunite. It has also been found in very pale grayish green, bladed prismatic crystals, probably pseudomorphs, and as pale yellow-orange, very finely fibrous, sponge-like masses associated with yofortierite.

Mineral B is very rare in miarolitic cavities; it consists of thin, dark green, micaceous aggregates forming spherical masses 1–2 mm in diameter, associated with natrolite, aegirine and quartz.

Sodalite $Na_8Al_6Si_6O_{24}Cl_2$

While characteristically abundant in agpaitic alkaline intrusions, sodalite appears to be relatively uncommon and inconspicuous in the Saint-Amable sill. It occurs as embedded colorless grains and subhedral crystals 1–4 mm in diameter disseminated in the sill rock. It fluoresces intense orange to orange-red under shortwave and less intense orange-red under longwave ultraviolet radiation, with a yellowish phosphorescence of short duration. Sodalite-enriched zones of rock in the southern end of the Demix-Varennes quarry exposed during 1994–96 contained a number of species not previously encountered in the quarry, including villiaumite, varennesite, vuonnemite, epistolite, gaidonnayite and calciohilairite.

To date, no euhedral crystals of sodalite have been found in the cavities. However, natrolite crystals with a dodecahedral morphology, which appear to be pseudomorphs after sodalite, have been observed in miarolitic cavities.

Sphalerite (Zn,Fe)S

Sphalerite is one of the most common sulfide minerals in miarolitic cavities and hydrothermalites. Rarely, it is also found in the contact-zone cavities. It occurs as excellent, sharp, lemon-yellow to orange, amber yellow, brown and black, complex, modified tetrahedra, often twinned and measuring 1–3 mm in size, and also as peculiar, elongated crystals up to 6 mm in length. The black crystals are opaque, whereas all others are transparent to translucent with vitreous to frosty or dull luster.

Strontianite $SrCO_3$

Strontianite is relatively common in the contact-zone cavities, occurring as colorless, and dull white acicular crystals forming spherical aggregates up to 1 cm in diameter; as colorless capillary crystals and felted aggregates; as dull white, radiating fibrous sprays up to 5 mm long; and as colorless, elongated, pseudo-hexagonal prismatic crystals 1–4 mm long. It is rare in miarolitic cavities, as sharp, colorless, square to elongated tabular crystals 1–2 mm across, forming oriented and reticulated clusters and aggregates. Weak bluish white fluorescence under longwave ultraviolet radiation has been noted.

Synchysite-(Ce) $Ca(Ce,La)(CO_3)_2F$

Synchysite-(Ce) is extremely rare, known from only a single, slightly altered miarolitic cavity. It occurs as sharp, opaque, beige and pale yellow to brownish yellow, tabular pseudohexagonal crystals 1–1.5 mm in diameter, forming attractive rosettes. The brownish yellow color of some crystals may be caused by iron-oxide discoloration. The luster is greasy on crystal faces and dull on broken surfaces. The crystals and crystal aggregates are very similar in appearance to, and visually indistinguishable from, those of the more common cordylite-(Ce). It is a late-stage mineral in the paragenesis, associated with microcline, astrophyllite, natrolite, eudialyte, aegirine, birnessite and opal.

Terskite $Na_4ZrSi_6O_{15}(OH)\cdot 2H_2O$

Terskite was described as a new species from Mount Alluaiv, Lovozero massif, Kola Peninsula, Russia (Khomyakov *et al.*, 1983), where it occurs as alteration rims on, and pseudomorphs after eudialyte. It has also been found at Mont Saint-Hilaire (Horváth and Gault, 1990) as pseudomorphs, most likely after lovozerite. The Saint-Amable sill is the third known occurrence for the species (Gault and Horváth, 1993).

Terskite is rare, found only in miarolitic cavities as dull, crude, equant, white to beige crystals resembling dodecahedra 0.6–1.0 mm in diameter. Crystal faces have a rather sugary surface texture, and some crystals are partially hollow; they are almost certainly pseudomorphs after an unknown precursor. The morphology of the crystals, and their association with fresh crystals of eudialyte almost certainly preclude eudialyte as a possible precursor. Terskite fluoresces a very weak pale yellow under shortwave ultraviolet radiation.

Terskite is clearly a late-stage mineral in the paragenesis, and is associated with eudialyte, microcline, zakharovite, aegirine, nenadkevichite, mangan-neptunite, shkatulkalite and a smectite-group mineral.

Tetranatrolite $Na_2Al_2Si_3O_{10}\cdot 2H_2O$

Tetranatrolite was described as a new species from Mont Saint-Hilaire (Chen and Chao, 1980); the mineral has since been reported from numerous other localities.

Tetranatrolite is a relatively rare species in the sill, found only in some cavities in the contact-zone as powdery white layers and crusts replacing epitactic paranatrolite zones on natrolite crystals. As at Mont Saint-Hilaire, it forms as a result of dehydration of paranatrolite on exposure to air.

In recent years there has been some question as to whether gonnardite and tetranatrolite are separate species. Recent work on the natrolite group of minerals (Alberti *et al.*, 1995) has shown that they are distinct phases, and has confirmed tetranatrolite from three localities, all in agpaitic alkaline intrusions: Mont Saint-Hilaire, Ilímaussaq and Lovozero. The tetranatrolite found at Saint-Amable has an XRD pattern identical to tetranatrolite from Mont Saint-Hilaire, but has not been evaluated by the criteria used by Alberti *et al.*

Thomsenolite $NaCaAlF_6\cdot H_2O$

Thomsenolite is a relatively rare mineral, known most notably from Ivigtut, Greenland (type locality) and also from lesser-known occurrences in Colorado, Utah, Norway, Ukraine, Russia and Nigeria. At all these localities thomsenolite is associated with cryolite, as it invariably evolves as an alteration product of cryolite (Bailey, 1980). In the Saint-Amable sill thomsenolite occurs as a late-stage alteration product of cryolite, intimately associated with leached masses of cryolite and other probable cryolite decomposition products such as gibbsite and doyleite. It is very rare and to date has been found in only small quantities in the southeastern part of the Demix quarry, exposed in December 1996. Although thomsenolite has been reported from alkaline rocks, mainly alkali granites (Bailey, 1980), the Saint-Amable sill appears to be the first occurrence in agpaitic nepheline syenites. It is also the first occurrence of the mineral in Canada.

Thomsenolite was found in a very unusual mineral assemblage in the contact zone of the sill, consisting of leached cryolite and cellular masses of thomsenolite, gibbsite and doyleite. Thomsenolite forms the walls and wall linings of a dense network of small solution cavities 2–15 mm in diameter. The cavities are lined by drusy layers of thomsenolite crystals; clusters of numerous, sharp, vitreous, colorless, square tabular crystals 0.2–0.5 mm in size, project into the cavities. Crystals are bounded by the dominant {001} basal pinacoid and small {110} prisms; minor modifying faces are also present. The tabular morphology is markedly different from the well-known columnar crystals with steep pyramidal faces found at Ivigtut, but is similar to the tabular crystals reported from Miask, Ilmen Mountains, Russia (Bøggild, 1913) and Gjerdingen, Oslo Region, Norway (Raade and Haug, 1980). The drusy crusts and crystal groups display the parallel crystal orientation characteristic for the mineral. An unusual feature of the Saint-Amable thomsenolite is that it fluoresces strong yellowish white under both shortwave and longwave ultraviolet radiation. Associated minerals other than those already mentioned are pyrrhotite, pyrite, galena and siderite.

Thornasite $(Na,K)ThSi_{11}(O,F,OH)_{25}\cdot 8H_2O$

Thornasite was first described from Mont Saint-Hilaire (Ansell, 1985; Ansell and Chao, 1987), where it occurs as anhedral crystals and irregular grains in an altered pegmatite. The Saint-Amable sill is the second known locality for the mineral, and the first occurrence of euhedral crystals.

Thornasite is extremely rare, having been identified from a single specimen collected in 1991 from a cavity in a large boulder quarried many years ago. The elongated cavity was approximately 10 x 10 x 50 cm in size, unusually large for the locality, and had some resemblance to a hydrothermalite. It was filled with a mass consisting almost entirely of small, intergrown, colorless natrolite crystals. In the natrolite mass are numerous interconnected cavities 2–20 mm across which are lined with superb, small, water-clear, very complex natrolite crystals. The thornasite occurred in a small cavity as a group of parallel, elongated prismatic crystals 1.5 mm long. The crystals are opaque and beige with brownish patches, with a greasy to pearly luster and smooth, well-defined faces. Broken surfaces have a chalky appearance, a patchy white to beige color, and a greasy to dull luster, and reveal unidentified black inclusions. The crystals have a hexagonal cross section and rhombohedral terminations, and may possibly be pseudomorphs. They fluoresce bluish white under shortwave ultraviolet radiation.

Thornasite is clearly a late-stage mineral in the paragenetic sequence, and closely associated only with natrolite, nenadkevichite, yofortierite, monazite-(Ce), altered eudialyte and rhodochrosite.

Titanite $CaTiSiO_5$

Titanite is extremely rare, identified from only a single specimen as an embedded pale brown, short prismatic crystal.

Todorokite $(Mn^{2+},Ca,Mg)Mn^{4+}_3O_7\cdot H_2O$

Todorokite is rarely found in altered miarolitic cavities as thin, opaque, dark brown to black dendritic deposits and crusts.

Tuperssuatsiaite $Na_2Fe^{3+}_3Si_8O_{20}(OH)_2\cdot 4H_2O$

Tuperssuatsiaite was originally described from the Ilímaussaq alkaline intrusion in South Greenland (Karup-Møller and Petersen, 1984). It has also been reported from the Aris phonolite in Namibia (Von Knorring *et al.*, 1992), from Mont Saint-Hilaire (Wight and Chao, 1995) and the Poços de Caldas complex in Brazil (G. Y. Chao, personal communication, 1995). The Saint-Amable sill is the fifth known locality for the mineral.

Tuperssuatsiaite is very rare, identified from only two specimens from a miarolitic cavity and a hydrothermalite pod. In the miarolitic cavity it occurs as short, fibrous, orange-yellow aggregates. In the hydrothermalite, it is found in small cavities in intergrown masses of natrolite, makatite and magadiite, as silky, pale brown, "paintbrush-like," finely fibrous bundles and tufts 1–2 mm long. Other associated minerals include varennesite, eudialyte, pectolite, shkatulkalite, aegirine, VUK1 and VUK9.

Tuperssuatsiaite is practically identical in appearance to and visually indistinguishable from the more common yofortierite. The X-ray powder diffraction patterns of the two species are nearly identical and generally poor and diffuse. As discussed in the section on yofortierite, the mineral from Saint-Amable sill is extremely variable in composition, however the following electron microprobe analysis (WDS) gave a formula in reasonable agreement with that of tuperssuatsiaite: Na_2O 2.43, CaO 0.94, K_2O 0.56, Fe_2O_3 19.67, MnO 4.83, Al_2O_3 1.22, MgO 0.16, TiO_2 0.38, SiO_2 55.97, H_2O 10.35 (calculated by stoichiometry) total 96.51 weight % resulting in the empirical formula: $Na_{0.68}Ca_{0.15}K_{0.10})_{\Sigma 0.93}(Fe^{3+}_{2.15}Mn^{2+}_{0.58}Al_{0.21}Mg_{0.04}Ti_{0.04})_{\Sigma 3.02}Si_{8.11}O_{20}(OH)_2\cdot 4H_2O$, based 26 anions. Tuperssuatsiaite may be more common than the two identified

Figure 41. Shkatulkalite crystal aggregate from a hydrothermalite pod. Field of view 1.5 cm wide.

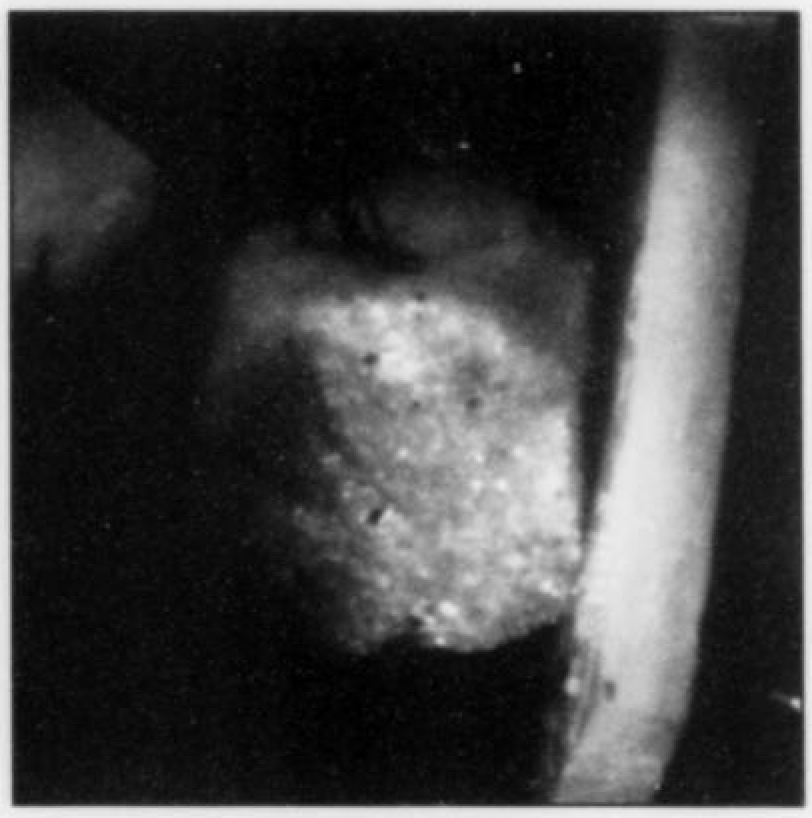


Figure 42. Terskite crystal, 1 mm.

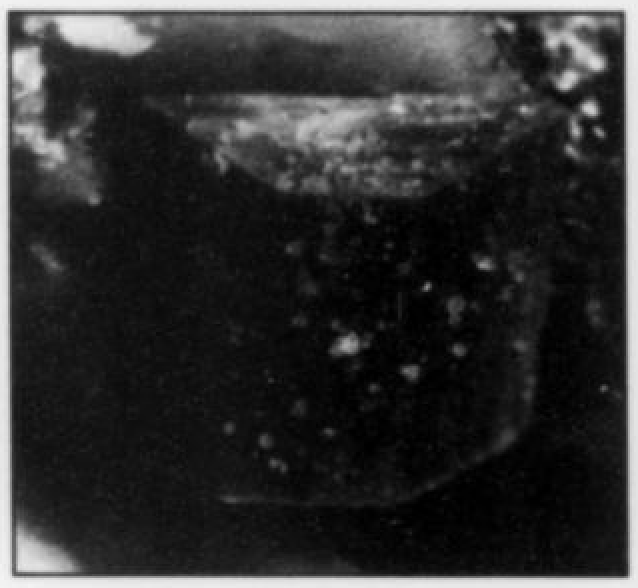


Figure 43. Varennesite crystal, 5 mm in size, from a hydrothermalite pod. The tiny white spheres on the varennesite crystal are magadiite.

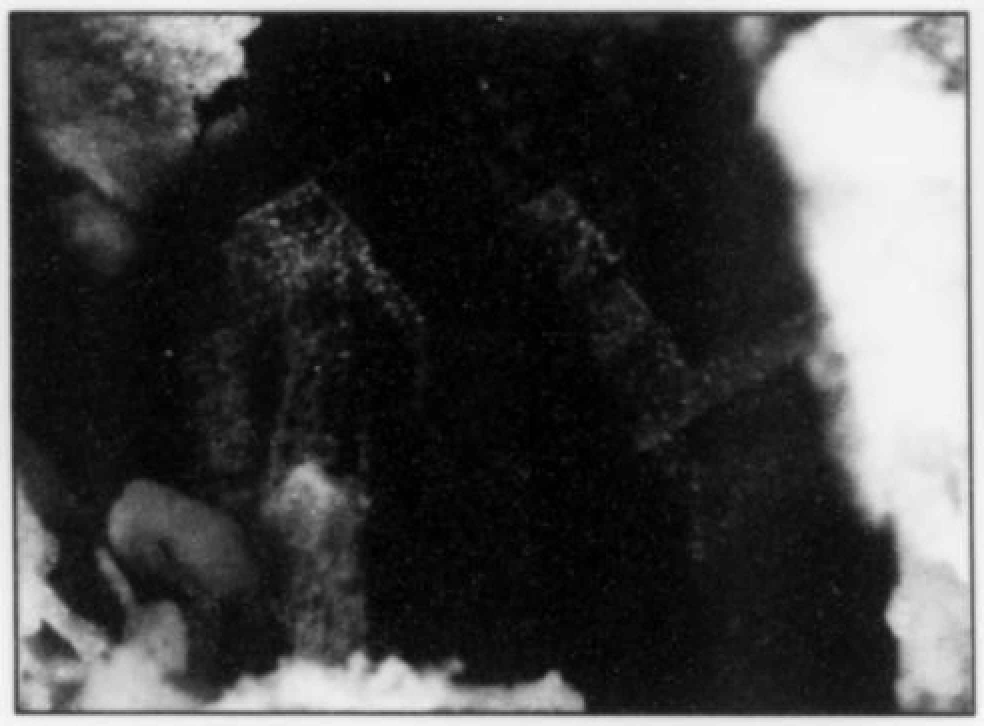


Figure 44. Varennesite crystals, to 1 cm, from a hydrothermalite pod.

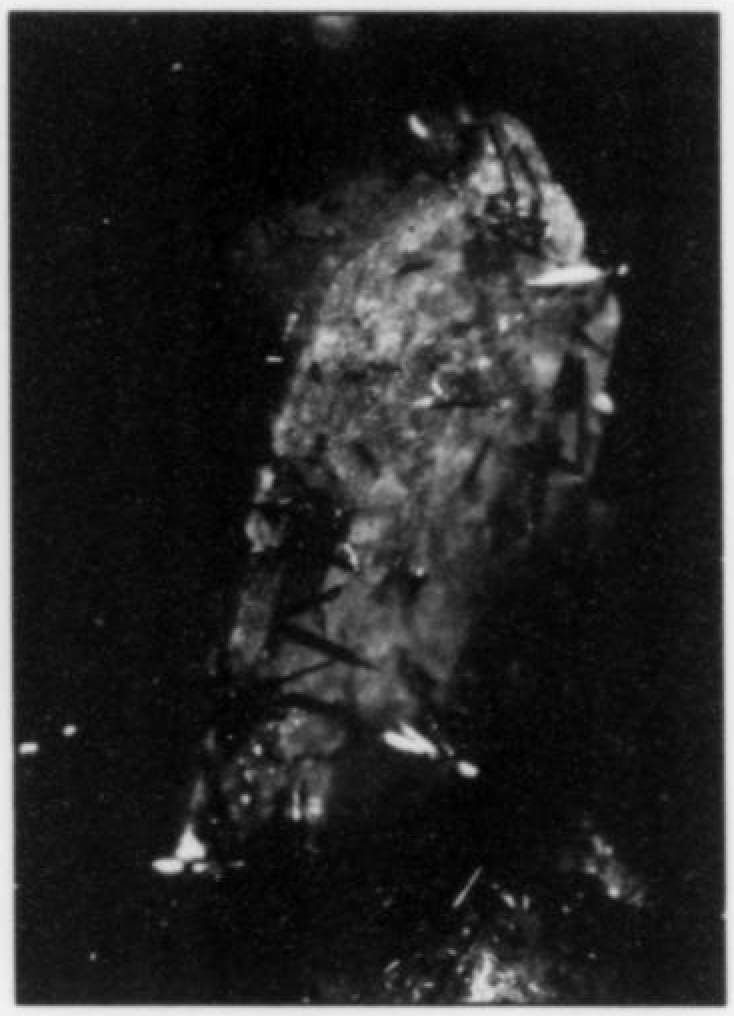


Figure 45. Varennesite crystal, 3 mm long, from a miarolitic cavity. The inclusions are acicular aegirine crystals. Photo is of the cotype specimen in the P. Tarassoff collection.

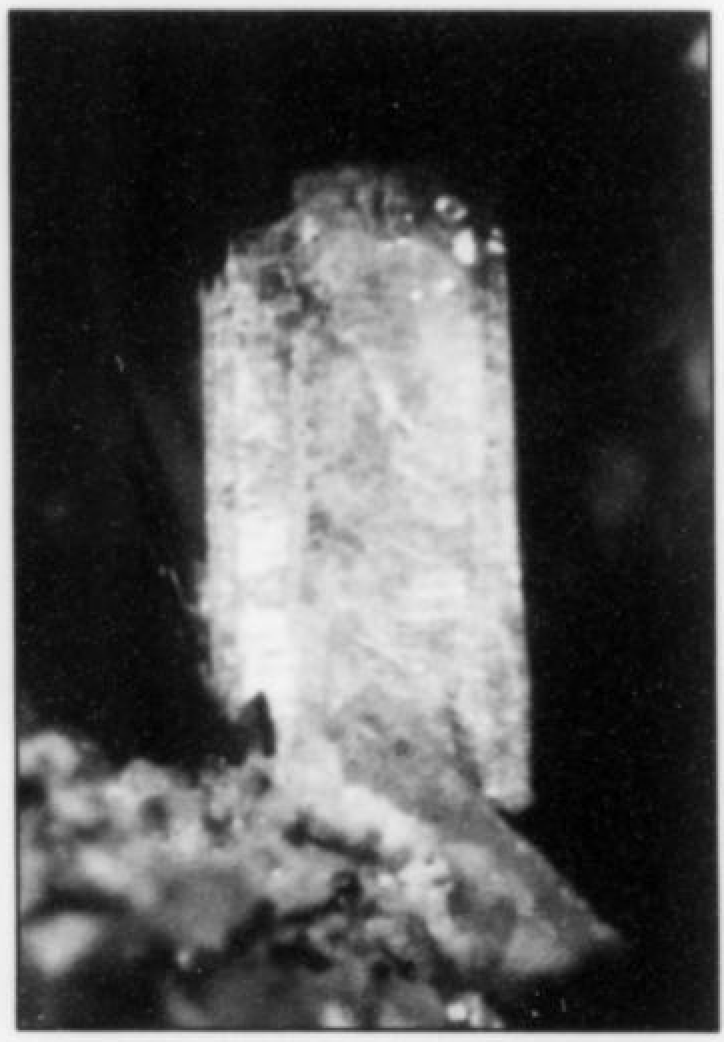


Figure 46. Vuonnemite crystal, 2 mm.

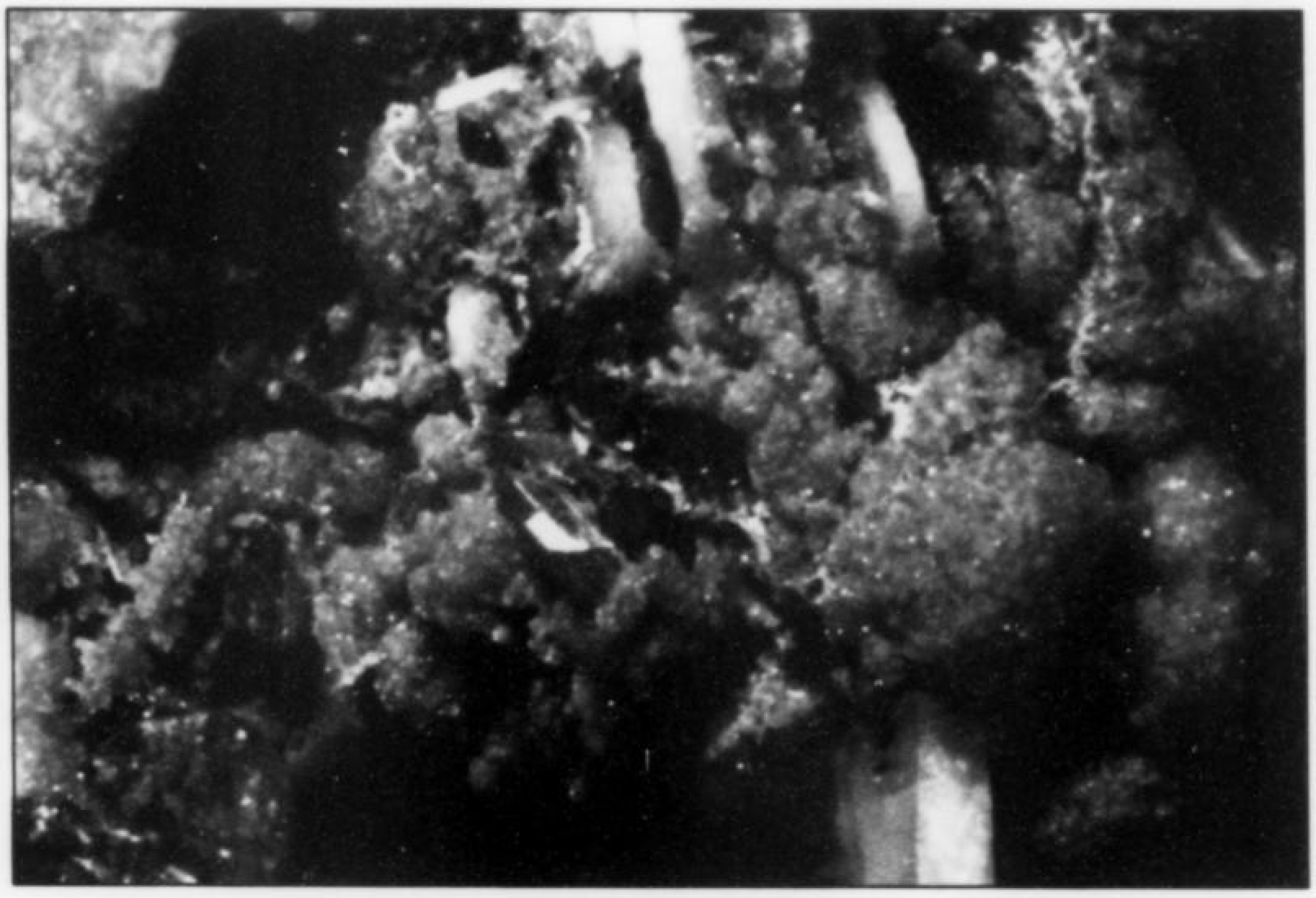


Figure 47. Zakharovite crystal aggregates, 1.2 cm wide.

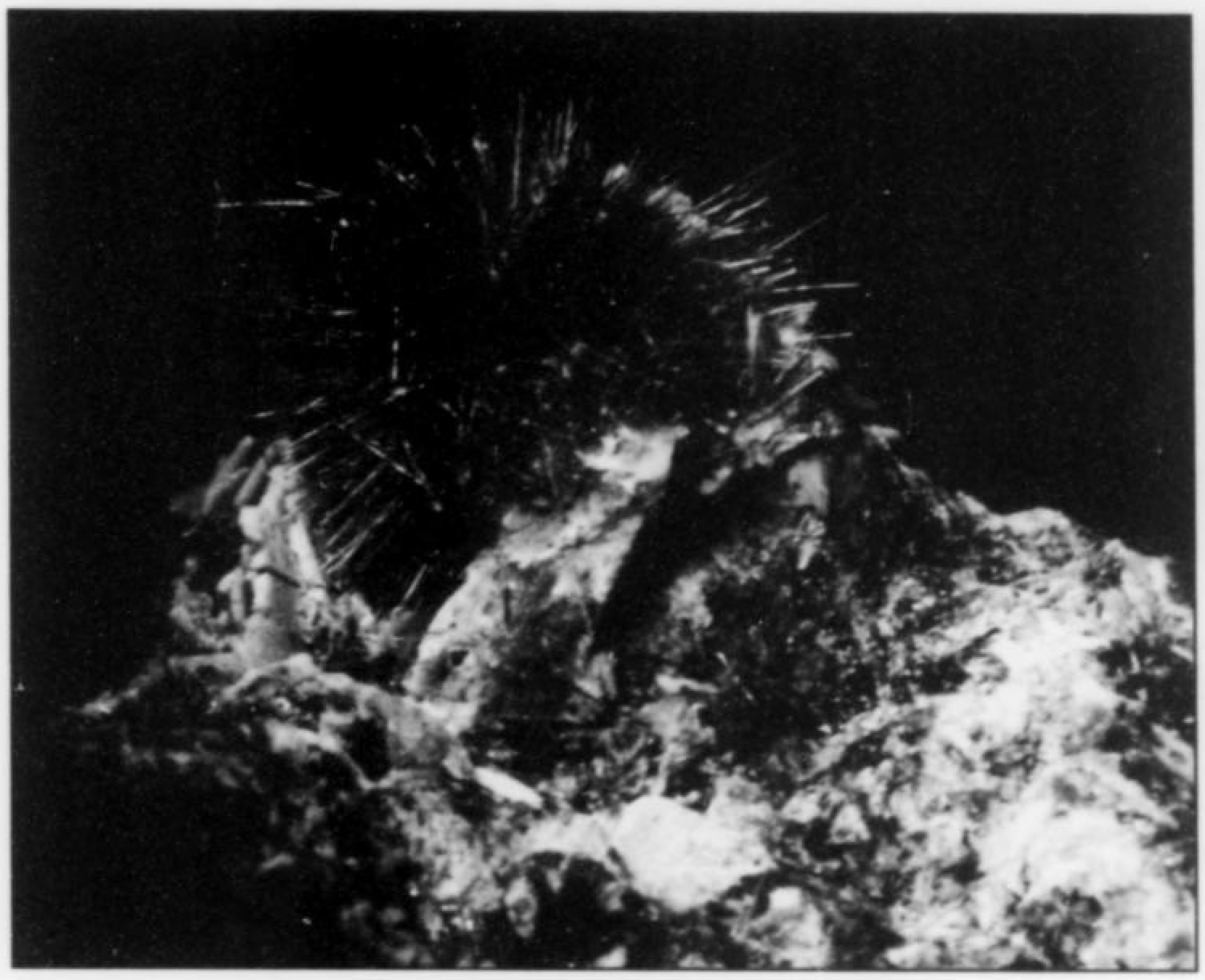


Figure 48. **Yofortierite aggregate, 1 cm in diameter. P. Tarassoff collection.**

Figure 49. **Yofortierite tufts on eudialyte, 3 mm.**

specimens would indicate, as few attempts to analyze the yofortierite-like fibrous aggregates have been made.

Varennesite $Na_8Mn_2Si_{10}O_{25}(OH,Cl)_2 \cdot 12H_2O$

Varennesite [pronounced *varenn-ite* with a silent *s*] a hydrated Na-Mn silicate, is the first new mineral species described from the Saint-Amable sill (specifically from the Demix-Varennes quarry; Grice and Gault, 1995). Although it is very rare in miarolitic cavities, high local concentrations have been encountered in a small number of peculiar, hydrothermalite pods. The type specimen was found in 1993 by one of the authors (PT) in a miarolitic cavity. Additional specimens were collected in 1994 and 1995 in hydrothermalites in the southwest and southeast corners of the Demix quarry. More recently it has been found in altered "natrolite pipes." The occurrences within the quarry may be small in number but are widespread and are separated spatially by hundreds of meters.

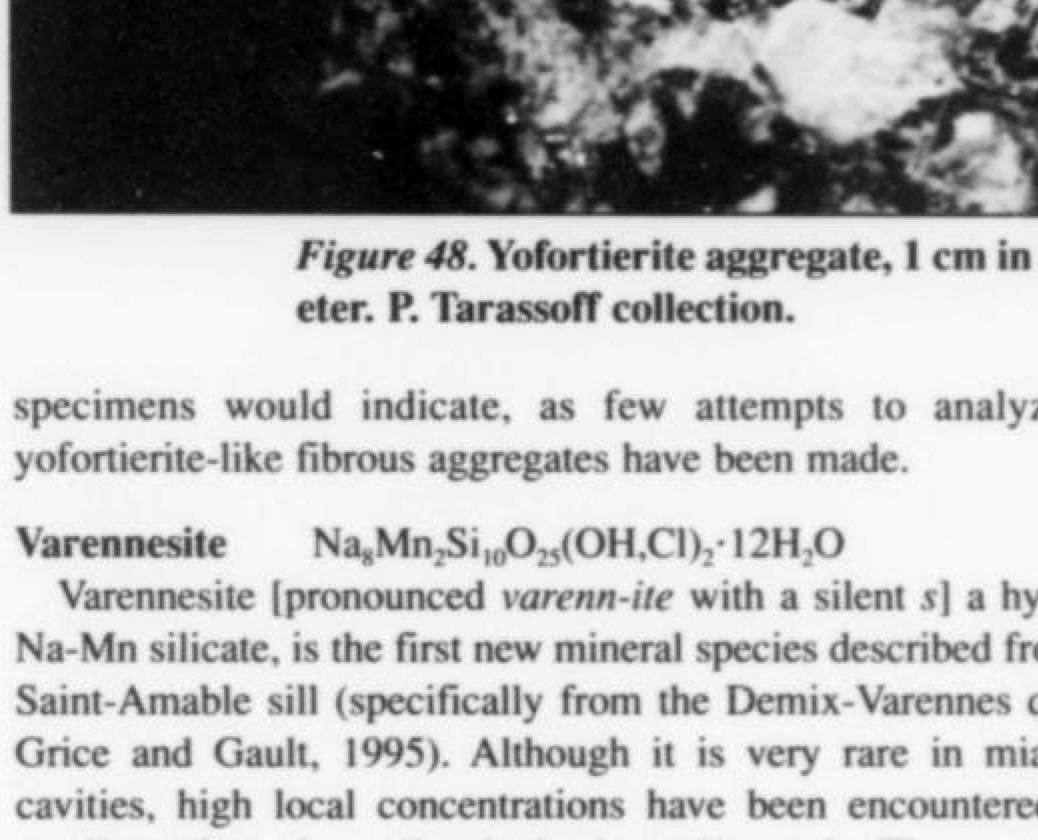


Figure 50. **Varennesite crystal drawings: (left) the more common prismatic habit, (right) the less common tabular habit showing the rare {001} basal pinacoid.**

Varennesite is found as excellent, sharp, tabular to blocky crystals with crystals of both habits bounded by {100} and {010} pinacoids, and terminated by {101} prisms. Rarely, a small {001} basal pinacoid has also been observed on the tabular crystals. The crystals are partially translucent to opaque and the color ranges from cream-yellow to orange-yellow, deep orange, beige, pale brown, dark brown, dark green and black. Luster varies from vitreous to waxy to dull on crystal faces, and waxy to satiny to dull on cleavages and broken surfaces. The blocky crystal habit is more common, with crystals forming tightly packed, parallel aggregates 2–30 mm across. Individual crystals are 0.5–10 mm long, opaque, rarely with translucent edges and corners, and are typically doubly terminated. Crystals are usually zoned with variously altered, etched and fresh zones and some contain inclusions, such as acicular aegirine crystals. Some crystals have a fresh, vitreous outer shell and a crumbly, powdery core. Color-zoning is also common, often but not always conforming to the textural zoning, with a range of colors alternating most frequently in a concentric, and rarely in an "hourglass" pattern. Varennesite is relatively brittle, with one good cleavage along {010}, and a conchoidal fracture. Often crystals exhibit a peculiar natural cracking, sometimes exposing a dull, woody texture. Varennesite is also found as beige to pale yellow, irregular, compact, powdery to chalky masses, and as lamellar masses to several cm across. The luster is dull, except on cleavage surfaces in the lamellar masses, which have a characteristic satiny luster.

Varennesite is a very strongly alkaline late-stage mineral in miarolitic cavities, and a mid to late-stage mineral in the paragenesis of hydrothermalites. In miarolitic cavities it is associated with eudialyte, microcline, aegirine, zakharovite, mangan-neptunite, makatite, natrolite, smectite group mineral A, VUK1, VUK7, VUK8 and villiaumite. In hydrothermalites, it is associated with natrolite, magadiite, serandite, chalcedony, makatite, polylithionite, shkatulkalite, eudialyte, pectolite, lorenzenite, monazite-(Ce), VUK1, VUK9, galena, sphalerite, fluorite, dawsonite and tuperssuatsiaite.

Villiaumite NaF

Villiaumite is rare, occurring as fillings or partial fillings in small vugs, thin vein-like cavities, miarolitic cavities, in some zones of the sill characterized by dense, fine-grained, dark-colored rock particularly in the south and southeast corners exposed during 1994–96 in the Demix-Varennes quarry. The small vugs are 1–5 mm in diameter, and are typically lined by microcline with the villiaumite completely filling the cavities. In the larger miarolitic cavities, villiaumite is found exceedingly rarely as anhedral grains, infillings, and partially dissolved, crude crystals 1–2 mm across showing some crystal faces. Villiaumite is transparent and pale pink to dark carmine-red with perfect cleavage in three directions. White, sugary zones indicating partial leaching are evident in some specimens.

Paragenetically, villiaumite is a late-stage mineral found associated with microcline, lorenzenite, astrophyllite, aegirine, natrolite, eudialyte, sodalite, serandite, zakharovite, vuonnemite, makatite, varennesite and VUK1.

Vuonnemite $Na_5Nb_3Ti(Si_2O_7)_3O_2F_2 \cdot 2Na_3PO_4$

Vuonnemite was first described from the Vuonnemi River valley, Khibina massif, Kola Peninsula, Russia as a new mineral species (Bussen *et al*., 1975). It has also been found in the Lovozero massif (Khomyakov *et al*., 1975), the Ilímaussaq complex in Greenland (Rønsbo *et al*., 1983) and in Mont Saint-Hilaire, Québec (Mandarino and Anderson, 1989).

In the Saint-Amable sill, vuonnemite is very rare; it was found in miarolitic cavities in the southeast corner of the Demix pit in 1994, associated with varennesite, eudialyte, zakharovite, makatite, villiaumite and VUK1. It occurs as very thin, colorless to transparent pale yellow and opaque white, rectangular tabular crystals 1–2 mm long, dominated by the {001} pinacoid. No other forms could be indexed on the available crystals. Some of the white crystals are etched, with ragged edges and irregular perforations through the crystals. Luster varies from vitreous to greasy. The mineral fluoresces pale yellow-white under shortwave ultraviolet radiation. Vuonnemite is similar to, and may be visually indistinguishable from epistolite and shkatulkalite.

Woodruffite $(Zn,Mn^{2+})Mn^{4+}_3O_7 \cdot 1\text{–}2H_2O$

Woodruffite was identified from a weathered miarolitic cavity collected in the Bau-Val No. 3 pit. It is very rare, occurring as black spheres up to 1 mm in diameter having a submetallic luster. Woodruffite is a late-stage mineral associated with microcline, eudialyte, mangan-neptunite, aegirine and birnessite.

Wulfenite $PbMoO_4$

An extremely rare secondary mineral in miarolitic cavities, wulfenite occurs as thin, vitreous, opaque, tan to white tapering acicular crystals 0.5–0.8 mm long on galena cubes.

Yofortierite $(Mn^{2+},Mg)_5Si_8O_{20}(OH)_2 \cdot 8\text{–}9H_2O$

Yofortierite, the Mn-analog of palygorskite and tuperssuatsiaite, was described as a new species from Mont Saint-Hilaire (Perrault *et al*., 1975). The Saint-Amable sill is the second known locality for the mineral; excellent specimens have been collected in the Demix-Varennes quarry since 1976 (Gault and Horváth, 1993). More recently, yofortierite has also been reported from Mount Karnasurt, Lovozero massif, Kola Peninsula, Russia (Khomyakov, 1995).

One of the more common species in miarolitic cavities and hydrothermalites, yofortierite occurs as opaque, reddish to orange brown, dark brown, bronze-colored, pink, purple and beige capillary fibers forming tufts, divergent sprays, tightly-packed bundles, random masses and radiating spherical aggregates 5–15 mm in diameter. Individual fibers are 3–15 mm long, very thin and flexible, with a silky luster. It is visually indistinguishable from tuperssuatsiaite. For the collector, yofortierite is one of the most attractive minerals found at Saint-Amable, and the locality has yielded some of the best specimens known for the species.

Yofortierite is a mid to late-stage mineral in miarolitic cavities and hydrothermalites, and is associated with practically all the other species occurring in the sill.

Several electron microprobe analyses (WDS) indicate that some of the brownish yofortierite is an Fe-dominant (Fe > Mn) member, and may be a new species. The following analysis with resultant empirical formula is presented here, based on the formula given by Fleischer and Mandarino (1995): FeO 19.73, MgO 4.86, MnO 3.86, Al_2O_3 2.39, CaO 1.61, TiO_2 0.51, K_2O 0.06, SiO_2 49.77, H_2O 16.98 (calculated by stoichiometry), total 99.77 weight % resulting in the empirical formula: $(Fe^{2+}_{2.60}Mg_{1.14}Mn^{2+}_{0.52}Al_{0.44}Ca_{0.27}Ti_{0.06}K_{0.02})_{\Sigma 5.04}Si_{7.84}O_{20}(OH)_2 \cdot 8H_2O$. This analysis was performed under the same operating conditions and set of standards as the analysis reported for tuperssuatsiaite. Na was sought but not detected in this analysis. Further studies are required on the chemical variations in yofortierite and tuperssuatsiaite. Ideally, structure analysis would be useful in assigning cations to various sites, however to date no suitable crystals have been found.

Figure 51. **Zakharovite, pseudohexagonal crystals 20–40 µm in diameter. Horváth collection, SEM photo by B. Down.**

Zakharovite $Na_4Mn^{2+}_5Si_{10}O_{24}(OH)_6 \cdot 6H_2O$

Zakharovite was described simultaneously as a new mineral from Mount Karnasurt, Lovozero massif, and from Yukspor and Mount Koashva, Khibina massif, Kola Peninsula, Russia (Khomyakov *et al*., 1983). It had also been found in 1974 at Mont Saint-Hilaire and designated as UK38 (Chao and Baker, 1979). In the Saint-Amable sill, which is the fifth known (Gault and Horváth, 1993) and probably the richest locality for the mineral, it was first collected prior to 1976, but remained unidentified until 1991.

Zakharovite is a common and relatively abundant species in the miarolitic cavities, but relatively rare in hydrothermalites. It occurs as compact masses of bright yellow to orange to greenish yellow micaceous aggregates and scaly masses to 1 cm across. Occasionally, it is found as subhedral aggregates and crude pseudomorphs (often embedded in natrolite and replacing some unknown mineral) consisting of randomly intergrown tabular pseudohexagonal crystals less than 0.2 mm in diameter, having a layered, micaceous structure and perfect basal cleavage. Crystals are translucent to opaque with a vitreous to waxy luster.

At the type localities zakharovite is reported as a primary mineral, but in the Saint-Amable sill it is a late-stage species, and appears to be a secondary mineral associated with the alteration of eudialyte and possibly varennesite. Further studies are needed to determine the process and to pinpoint the origin of zakharovite. In miarolitic cavities the closest and most characteristic associations for the mineral are eudialyte, varennesite, catapleiite, smectite group mineral A, and labuntsovite, but practically all the other minerals occurring in these cavities, as well as in the hydrothermalites may be included as associated species.

As noted previously, zakharovite may be difficult to distinguish visually from the smectite group mineral A. A distinct scaly, rather than powdery appearance under high magnification is usually indicative of zakharovite.

Zircon $ZrSiO_4$

Zircon occurs very rarely, as beige to brown, 0.5–1 mm dipyramidal crystals embedded in the light colored rock of the contact zone.

Undetermined species

In addition to descriptions of the currently undetermined (VUK) minerals, identified species with past VUK designations are also included here for reference and continuity. All the undetermined VUK minerals were first identified from specimens in the Horváth collection, and additional reference material is deposited in that collection and the collection of the Canadian Museum of Nature. X-ray data on these minerals are available on request.

VUK1

Very rare in miarolitic cavities and hydrothermalite pods, VUK1 occurs as opaque, beige and white, powdery or fibrous aggregates up to 1 cm across, most commonly associated with varennesite, zakharovite, eudialyte, makatite (sometimes intimately intergrown), shkatulkalite and mangan-neptunite. Electron microprobe (EDS) analysis shows major Si and Ti peaks, and minor Na, Ca, Th and Ce peaks.

VUK2 = Varennesite

VUK3

VUK3 is identical to the undetermined species UK51 from Mont Saint-Hilaire (Chao *et al.*, 1990). In the Saint-Amable sill, it is found very rarely in miarolitic cavities as opaque, white, powdery aggregates 1–1.5 mm in diameter, and as crude, compact, beige spheres, less than 0.5 mm in diameter. Associated minerals are microcline, albite, aegirine and mangan-neptunite. The X-ray diffraction pattern and the chemical composition are similar to those of nordstrandite.

VUK4 = Cordylite-(Ce)

VUK5 = Calciohilairite

VUK6

Very rare, this mineral is found as sharp, pearly, opaque, white, bladed crystals and masses of irregular plates several mm across, associated with albite, microcline, mangan-neptunite, astrophyllite, zakharovite and an undetermined white powdery mineral. The X-ray powder diffraction pattern is similar to that of phillipsite. The bladed crystals are well-formed, and appear to have monoclinic or triclinic symmetry. Some of the bladed crystals fluoresce a very weak white under shortwave ultraviolet radiation.

VUK7

This mineral occurs as tan, beige and pale yellow, compact, powdery or fine micaceous masses filling interstices in miarolitic cavities. Associated minerals include eudialyte, natrolite, K-feldspar, albite, zakharovite, varennesite, mangan-neptunite and makatite. It is very similar in physical appearance to the smectite group mineral A, and to fine-grained aggregates of zakharovite. The mineral has also been identified from Mont Saint-Hilaire, where it occurs as reddish, fibrous masses, and is designated as Vogg#7 (G. Y. Chao, personal communication, 1995).

VUK8

VUK8 occurs very rarely in miarolitic cavities as random masses up to 3 mm across of silky, opaque, white fibers closely associated with makatite and varennesite. Other associated minerals are eudialyte, zakharovite, natrolite and aegirine. It is visually indistinguishable from makatite and fibrous VUK1, but exhibits weak white fluorescence under shortwave ultraviolet radiation. The XRD pattern does not match that of any known species (A. C. Roberts, personal communication, 1995).

VUK9

Very rare in miarolitic cavities and hydrothermalite pods, this mineral occurs as silky, very pale green to brownish green, somewhat matted, fibrous masses and sprays of very fine, flexible capillary crystals 2–3 mm long. It is very similar in appearance to yofortierite and tuperssuatsiaite except for the color. Associated minerals are zakharovite, eudialyte, microcline, varennesite, sphalerite, serandite and natrolite. No match has been found for the XRD powder pattern.

VUK10 = Shkatulkalite

VUK11

VUK11 was found in 1995 in the southeast corner of the Demix quarry in small miarolitic cavities associated with natrolite, aegirine, albite, mangan-neptunite, rhodochrosite, sphalerite, astrophyllite and a beige to brown unidentified mineral. It occurs as thin, pearly, silvery white, flexible, rounded to irregular micaceous plates 0.3–0.5 mm in diameter forming spherical and rosette-like aggregates.

The XRD pattern and physical appearance are nearly identical to those of the undetermined Mont Saint-Hilaire mineral designated as UK60, a carbonate of Sr, Ba, Ca and REE (Chao *et al.*, 1990). Microprobe analysis (EDS) of VUK11 indicates major Ca but no Ba or Sr. Based on the available data, it appears to be the Ca analog of UK60, and a possible new species.

VUK12 = Kukharenkoite-(Ce)

ACCESS

In recent years the owner of the Demix-Varennes quarry, Demix Agregats, has granted mineral clubs permission for weekend field trips if they are covered by suitable liability insurance. A fee is charged to cover the additional cost of security. Arrangements must be made through the company's head office in Longeuil, Québec.

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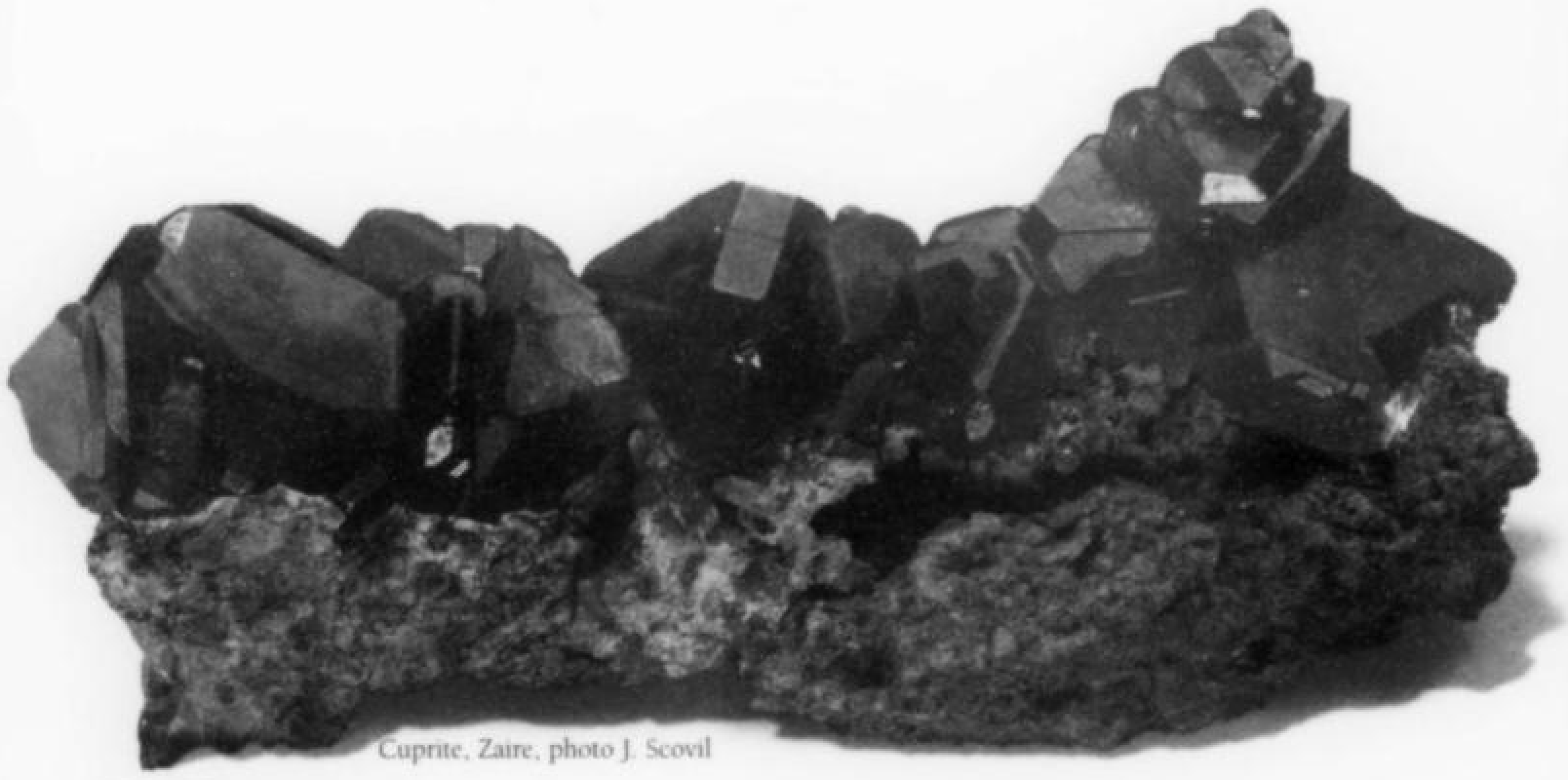

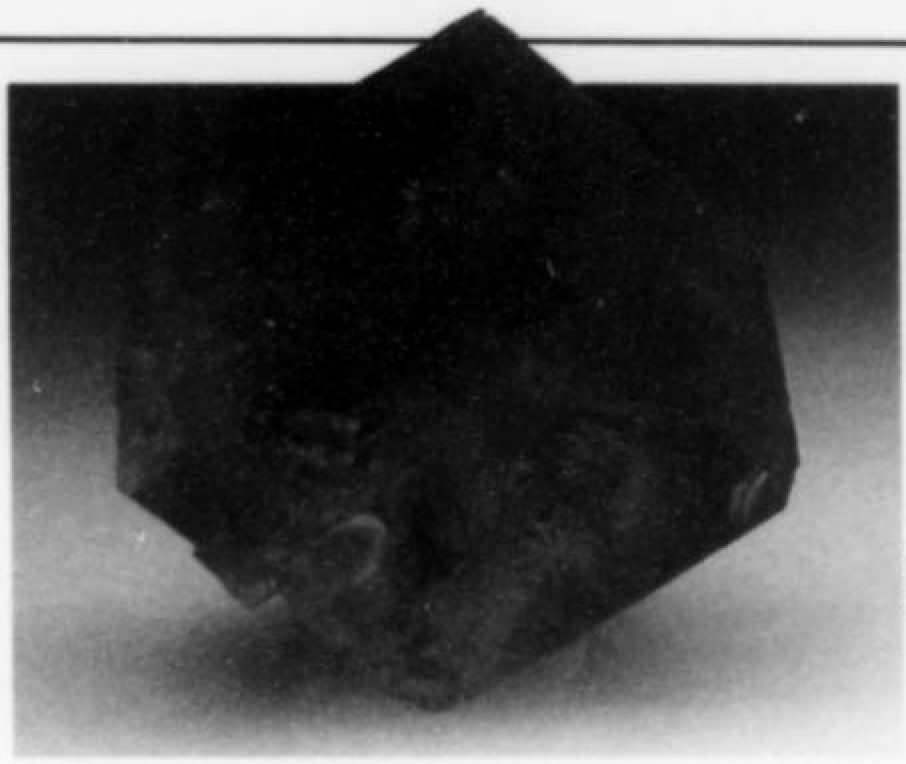

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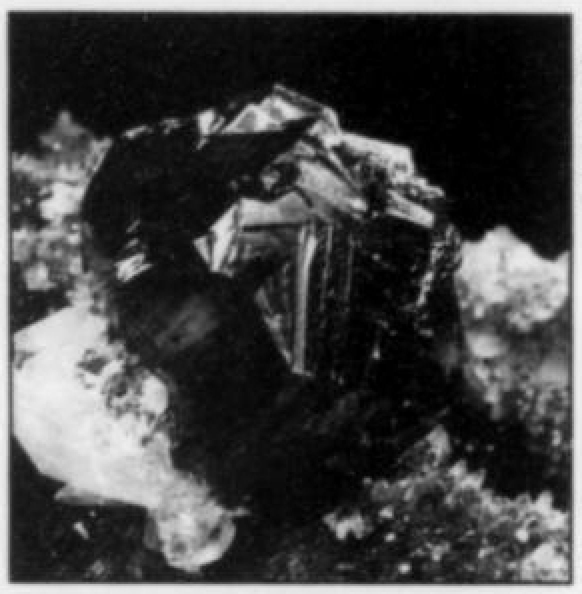

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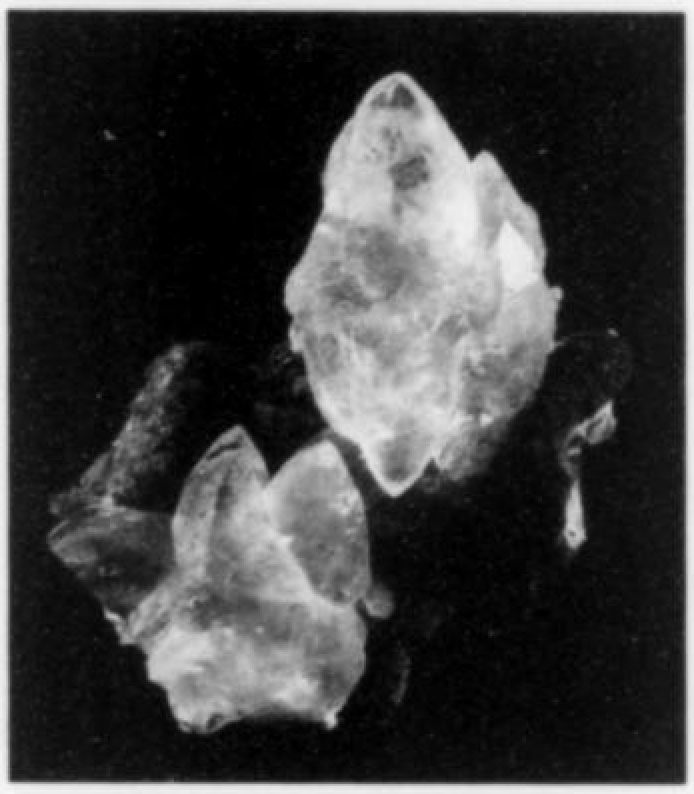

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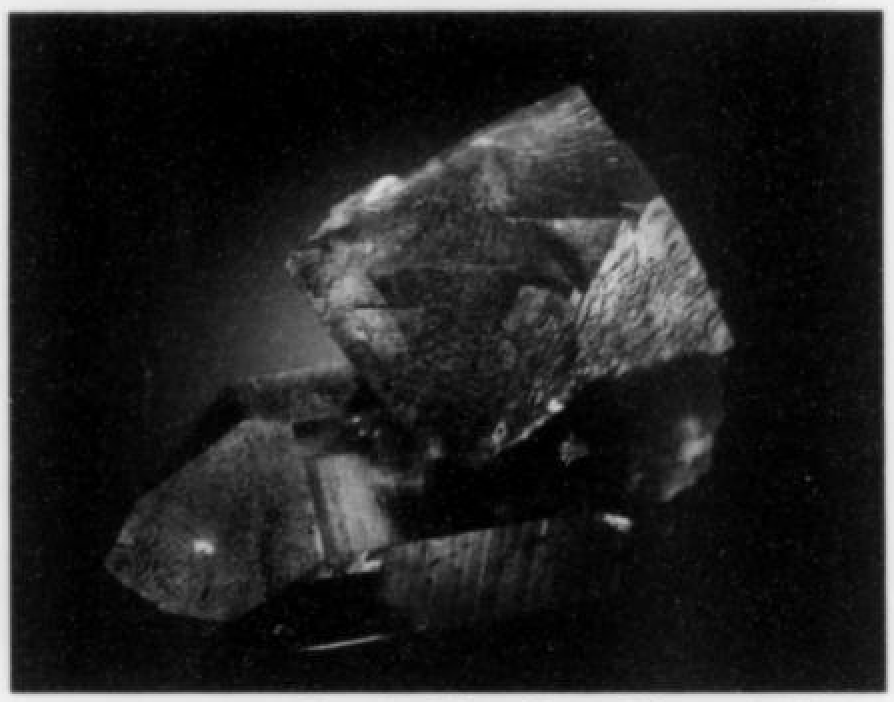

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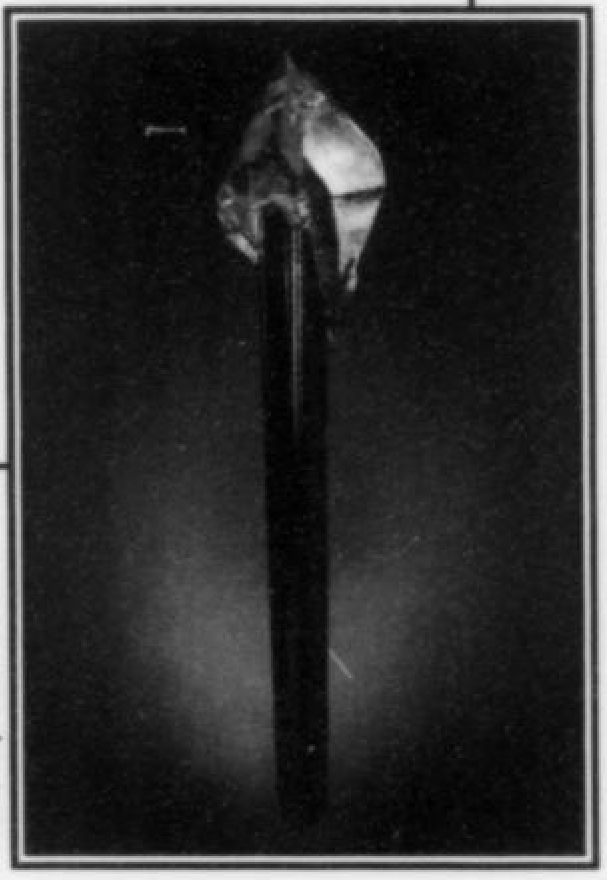

Photo by Jeff Scovil

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Vol 1, No 1, Mineralogical Record, Spring 1970
The *Friends of Mineralogy* was founded in Tucson, Arizona, on February 13, 1970. Its objectives were to promote better mineral appreciation, education and preservation. The chief aims and activities of *FM* include:

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

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

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What's New

in Minerals

Denver Show 1997

by Tom Moore

[September 10–14]

You might say that Marty Zinn's hotel show and the Main Show at Denver both came up gold this year. The usual sense of the cliché is nothing unusual for the former show, as hotel-room shoppers and gawkers found plenty, as usual, to bring them glows of contentment. But the theme of the Main Show this year actually was *gold* itself, and much that glittered in the long row of display cases really *was* gold (see later). It seemed that a special excitement informed everyone in the dense crowds—everyone, indeed, from the bussed-in schoolchildren (normally high-octane in any case), to the numerous pistol-packing security guards of professionally paranoid aspect, to the local news people who showed up on opening day, armed with cameras, notebooks, and the self-consciousness of local fame, to bring all that gold to still wider circles of attention. One very early morning in the hotel's downstairs breakfast area, as the mountain dawn came up all in gold, I saw the result of this media reconnaissance on the local TV news program: a chirpy few moments of pride in the richness of things to which the home mountains have given birth—the Colorado gold, of course, and very particularly the great Sweet Home mine rhodochrosite specimen in Bryan Lees' "That's Colorado" case (again, see later). There was, in summary, a general feeling that the Denver Show (meaning *both* shows) had labored mightily this year to outdo itself, and had succeeded.

To monitor these great international shows is, of course, not only to see what's proudly debuting here and now, but also to track which recent occurrences seem on the rise, and look promising for the future, and which seem dormant or past their primes. Here, then, is much of what this mineral newshound could glean in Denver, about a satisfying number of *truly* new things in mineraldom, and about where some other items of interest, one or two shows old now, seem to be in the market pipeline.

Unquestionably the most dramatic of the Main Show's commercial features was the extraordinary array of newly collected **smoky quartz** and **microcline** ("amazonite") specimens from Bryan Lees' workings at the Two Point mine (the same place as was called the "Two Point claim" last year), in Teller County, Colorado. This was a case of what's new/what's familiar duality, for these beautiful specimens have long been known, in a general way, from Colorado occurrences; revered in memory, for example, are the Clarence Coil/Richard Kosnar find of the 1970's, and the still earlier strike as preserved in the reconstructed pocket at the Denver Museum of Natural History. The new Two Point mine specimens are predictable combinations of fat, tapered, transparent smoky quartz crystals of dull to medium luster with blue-green blocky (untwinned) microcline crystals in lightly attached groups. But what makes these new pieces special is their size: perhaps a dozen specimens in the *Collector's Edge* booth had microcline crystals to 10 cm across and quartz prisms to 12 cm high, the whole groups, in a couple of instances, reaching to 25 cm. Another remarkable fact is the sheer intensity of the microcline color, which leaps out at you with an energy comparable to that of Bryan's best Sweet Home rhodochrosite reds. This color goes to the core of each microcline crystal (no wimpy whiteness in the interior regions that show on the side of plates), and mineral-aesthetic experts have not thus far come up with the single ideally pithy word for it; "classic blue-green" seems still the only available, if clumsy, term. The color is thought to be caused by trace-element lead, whose geochemical source in these simple pegmatites is somewhat of a mystery.

The pieces are skimpy in associated species, with only some small rosettes of glistening white albite (variety cleavelandite) here and there, although Bryan says that a 2-cm **columbite** crystal popped off one group during mining. (Bryan also had an incredible 6-cm columbite from the Cruziero mine in Brazil.) No white-surfaced microcline crystals were found in the pocket, although, given the richness of that blue-green color, you'd have to be truly weird to miss absent "whitecaps." The *Collector's Edge* booth held, in all, about a hundred outstanding groups, small to large cabinet size (this is no occurrence for thumbnail collectors), the very best of them priced in the low five figures, but they surely set quality records for this general material.

Much typically hard, slow, careful preliminary work by *Collector's Edge* lay behind the big payoff. Bryan Lees first noted the area, where no prospecting had yet been done, as far back as 1983 when he was a student at the Colorado School of Mines. He secured a lease in 1995, at which time the area was *still* untouched, and began an extensive geological survey and study to discover prime target zones for mining. The first heavy work filled six weeks in 1996, and yielded suggestive results that I briefly reported from last year's Denver Show. Within hours of beginning the first day's work of the new season this past June, the crew breached the 4 x 6-foot, 8-inch-high pocket from which all these new pieces came; it was named (and the labels all say so) the "Tree Root Pocket," as the roots of a big tree had penetrated it, gnawing down through the already collapsed ceiling of the pegmatite dome. Bringing out the big groups with minimal damage was fairly easy, but cleaning and preparing them was not: Rob Lorda and Bill Hawes, back in the *Collector's Edge* lab, took most of the specimens through seven separate acid treatments, then further scrubbed, trimmed and generally crafted them to their present glory. The crew will now begin probing beyond the now cleaned-out Tree Root Pocket, drilling and blasting through hard pegmatite. If their skill and luck remain as high as they've been, we might well see more outstanding groups like those in the photos here.

Meanwhile, three good new **rhodochrosite** pockets were hit at the Sweet Home mine this year, and the "classic" rose pinks with white quartz made a dynamite color-combo with the "classic" microcline greens and black quartz in that Main Show booth. A decision whether to mine yet another year at the Sweet Home is

Figure 1. **Bulldozing into the "Tree Root pocket" zone at the Two Point mine, Teller County, Colorado.**

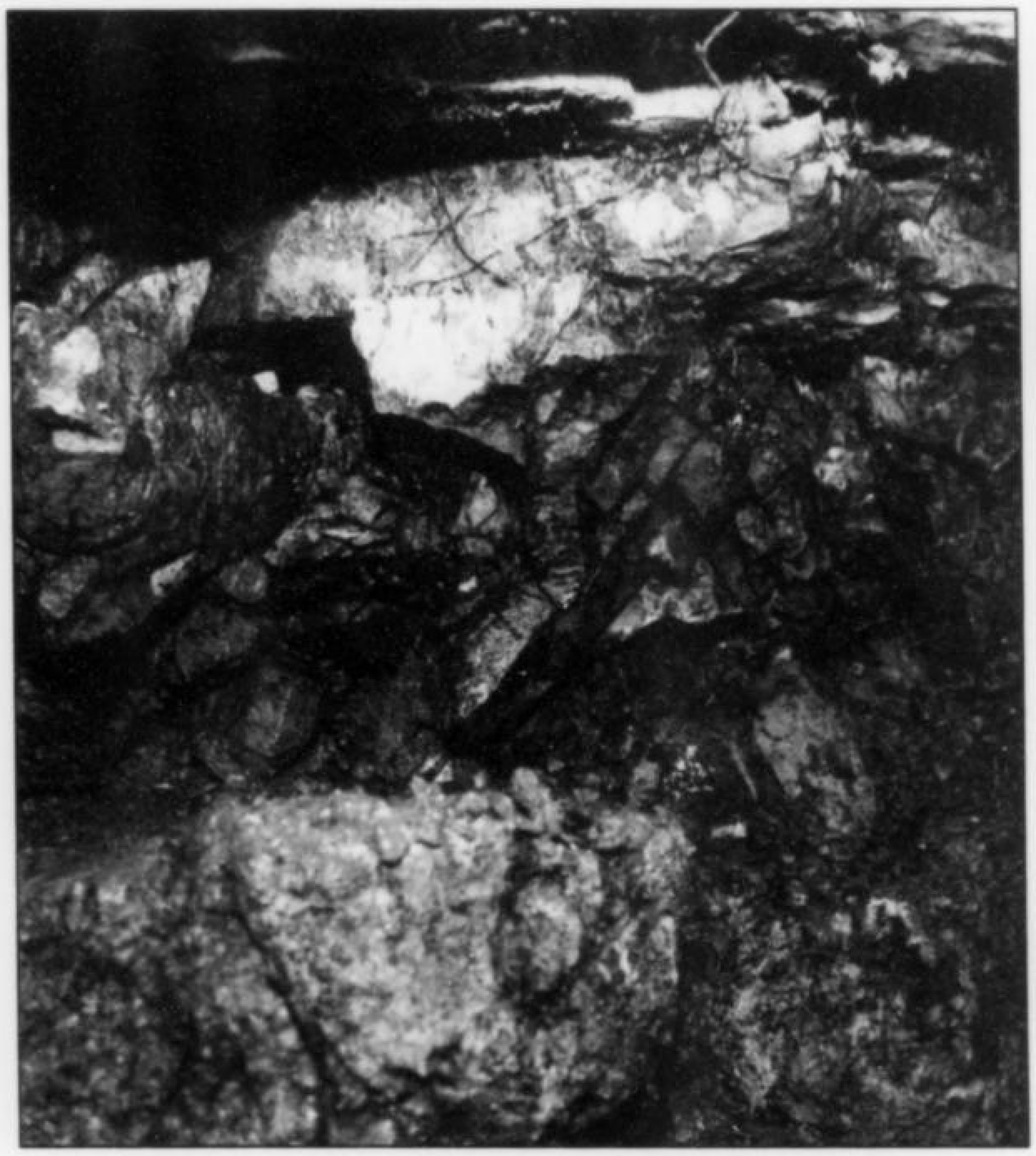


Figure 2. **Muddy "Tree Root pocket" of amazonite and smoky quartz *in situ* at the Two Point mine.**

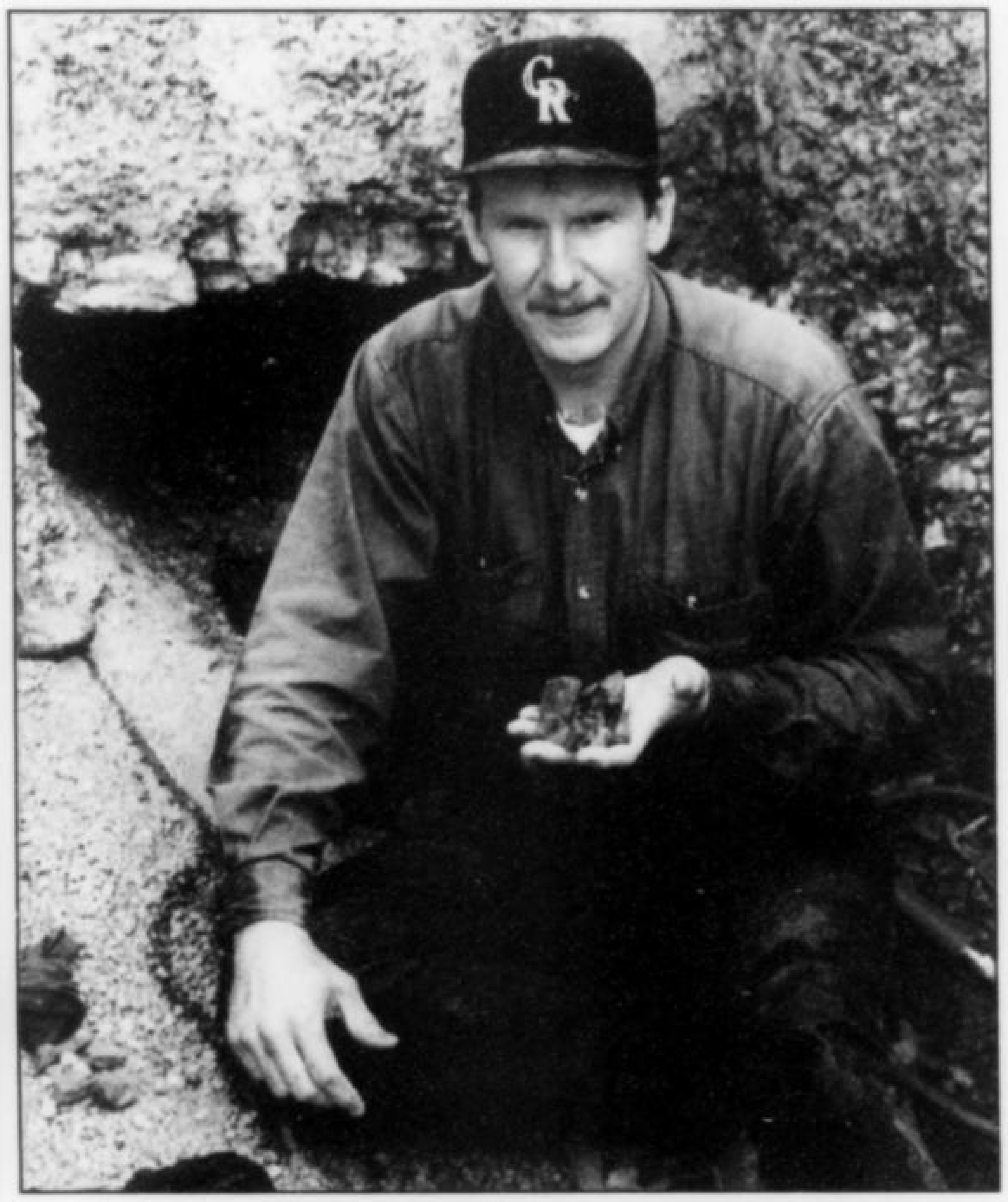


Figure 3. **Bryan Lees holding what will clean up to become a superb amazonite and smoky quartz specimen just extracted from the "Tree Root pocket" behind him at the Two Point mine.**

All photos by Jeff Scovil, except as noted.

Figure 4. **Amazonite and smoky quartz crystal group, 15.4 cm, from the Two Point mine, Tree Root pocket.**

Figure 5. **Amazonite and smoky quartz crystal group, 9.7 cm, from the Two Point mine, Tree Root pocket. Bryan Lees specimen.**

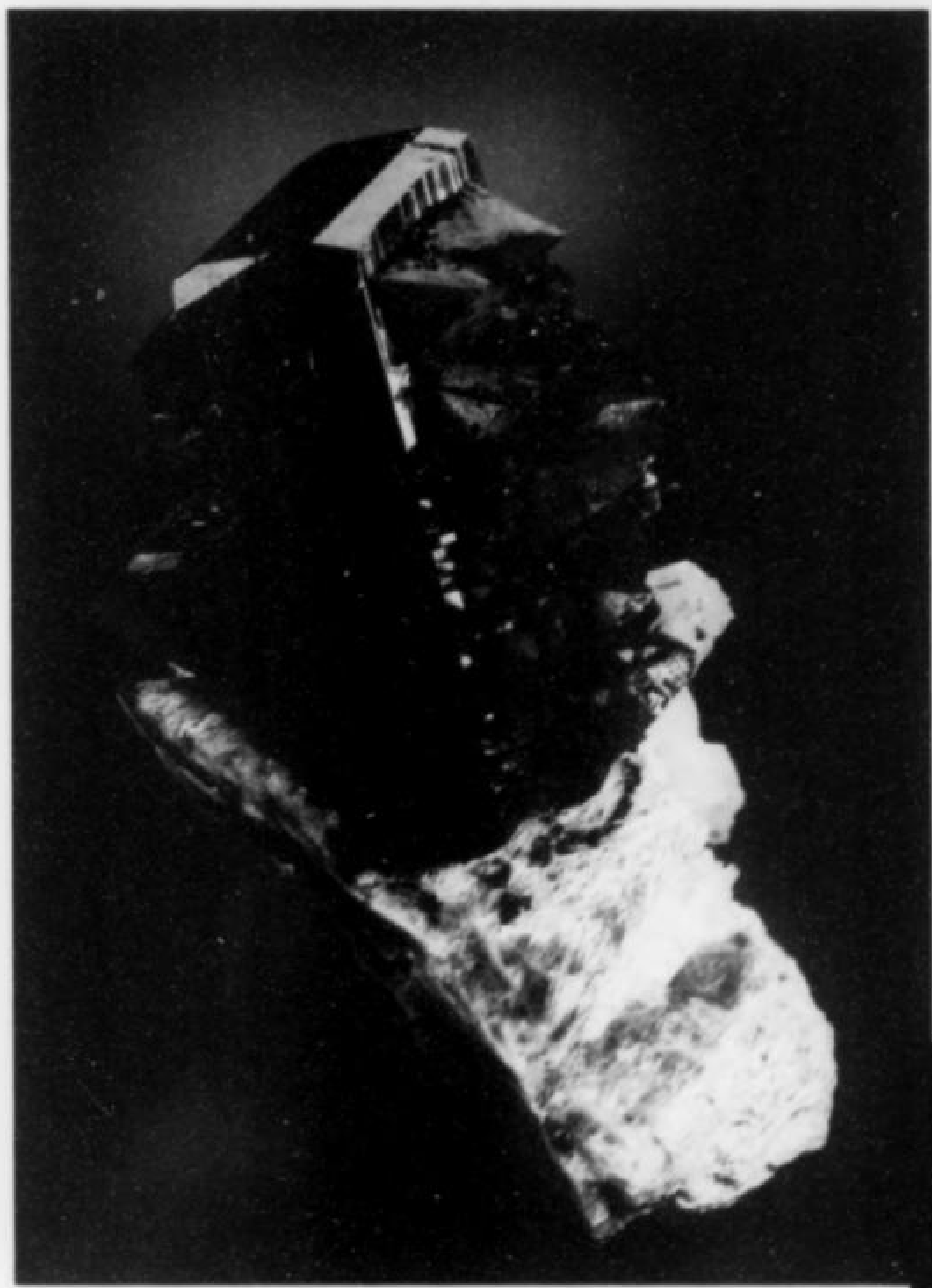


Figure 6. **Columbite crystal with cassiterite crystals growing from the surface, 6 cm, from the Cruzeiro mine, Minas Gerais, Brazil Bryan Lees specimen; Bernie Kowalski photo.**

Figure 7. **Barite crystal group, 6.5 cm, from the Barrick Meikle mine, Carlin, Nevada. Bill Dameron specimen.**

now pending, and won't be finally made until December. Some factors in the deliberation will be easier to handle than before, as Bryan Lees has now *bought* the Sweet Home mine from its previous owners.

Another large hole in the western American ground with exciting prospects is the Barrick Meikle mine near Carlin, Elko County, Nevada—a gold mine in the Carlin Trend, that has been brought into full operation within this past year. Casey and Jane Jones of *Geoprime Earth Materials Co.* (132 S. Encinitas Ave., Monrovia, CA 91016) made a recent fact-finding and specimen-scouting visit there, going underground and collecting about 25 fine **barite** specimens within 15 minutes before being asked to leave by the busy mine crews. These specimens are, at their best, truly beautiful and major barites, with sharp, slightly edge-modified tabular crystals to 4 cm. The crystals are highly lustrous, bright orange to yellow, transparent and gemmy with cleavage planes showing clearly; they form jumbled groups on a brown limonitic gossan material, and on white beds of subhedral calcite. A more attractive yellow barite would be difficult to find, and the specimens even when underground seem to cry out "newness": the miners report that the pockets were still filled with hydrothermal fluids when the drills breached them.

A thousand-odd miles away, at Elk Creek, South Dakota, the honey-brown, tapered, gemmy **barite** crystals which sit on yellow drusy calcite lining openings in gray chert concretions are, of course, *not* new . . . but that's only to say that Ken Roberts of *Roberts Minerals* knew just what he was looking for when he went collecting at this site in July of this year. The results he was offering at the Main Show are first-rate even for Elk Creek: cabinet-sized matrix pieces with prismatic 15-cm barite crystals with perfect chisel terminations, of richest color, standing up vertically and alone or else reclining in lazy subparallel piles on that yellow calcite. The specimens are almost entirely free of damage, and expertly prepared.

Now it's back again to the *Geoprime* room of Casey and Jane Jones, where we've just lately visited the Nevada barites, to see something sadder: the last of the now-famous Flambeau mine, Ladysmith, Wisconsin **chalcocite** crystal groups that we can ever plausibly call "new." These past three years of the Wisconsin chalcocite sensation have seemed short, and are now at an absolute end, for the Joneses report that the Flambeau mine not only has ceased operations but is about to be entirely backfilled. Mindful, then, that the 12 or so flats of thumbnail chalcocite specimens in the *Geoprime* room held soon-to-be "old," no longer "new," classics, I went all-out at the job of picking my thumbnail at last, and you should pick yours, too, if you get a chance. About two-thirds of the remaining crystal groups are golden colored and a third are of the iridescent blue kind, with the blue ones pricier, especially as the luster gets higher.

Rod and Helen Tyson of *Tyson's Minerals* had a couple of new, or new/old, Canadian items at the Main Show. For one, about 30 cabinet specimens of **hematoid amethyst** from the Diamond Willow mine, Thunder Bay, Ontario, represented the pick of the lot from collecting last summer, and they are the best of these darkly beautiful, utterly distinctive quartz specimens I have seen in some time. Flat plate sections of massive amethyst are blanketed with spiky beds of solidly intergrown crystal points, the points reaching 3 cm at the bases where they meet the plates, and all are deep rusty red, with very bright luster.

Also the Tysons had just two thumbnails of a lovely, bicolored **grossular** from the Jeffrey quarry, Quebec; they are from a single 6-inch pocket which, when collected in 1983, yielded a small handful of such thumbnails. Absolutely transparent grossular dodecahedrons to 5 mm are pinkish orange in their outer zones, but bright green in their cores; a "dreamy" effect comes from seeing the green through the orange in each crystal, a shimmering company of delicate green spots all over, but deep within, the lustrous little orange groups. Each matrixless group is about 1.5 x 1.5 x 2 cm, and both got instantly "spoken for" as I stood describing them in my notes—so it's not as if you can easily have one right now; it is just that you should know of this prettiest and probably rarest of all moods of Jeffrey mine grossular, should any more ever come to light.

On now to Mexico. First, Chris Wright of *Wright's Rock Shop* had a Holiday Inn room sporting about 25 large sword-cluster **gypsum** ("selenite") groups from an unspecified mine in Naica, Chihuahua. They start at generous cabinet sizes and reach up to 2 *feet* across, and were mined only weeks before the show. What really makes them noteworthy is that they are tinted smoky green, exactly like Alpine chlorite-included quartz, though the tinting substance in this case is unknown. These make dramatic "museum"-sized mineralogical spectacles. Also from Mexico were some excellent yellow-green **mimetite** groups from Santa Eulalia, offered by *Blue Sky Mining*.

As at Springfield, Chris also had some nice specimens of the bright pink **grossular** garnet crystals in mica-flecked quartz matrix which have suddenly gotten radically better than previously; many other dealers around the show had these too. From the man who mines them, Benny Fenn of *Fenn's Gems & Minerals* (P.O. Box 16285, Las Cruces, NM 88004), I got some clarification about the occurrence. The western slope of a mountain overlooking Lake Jaco is the "Lake Jaco" source that has long been worked for green, brown and white grossular crystals, as well as for tannish brown floater vesuvianite crystals; but the *other*, eastern, slope of the same mountain in the Sierra de Cruces range has, near its base, the prospect that Benny has only lately begun to work for the raspberry-pinks. Because the border between Chihuahua and Coahuila states runs along the ridgetop, the older garnets have always been labelled "Lake Jaco, Chihuahua," while these new ones are usually said to come from "Sierra de Cruces (no town or other handy feature being near the prospect), Coahuila." Benny reports that the country rock is a complex contact-metamorphic quartz/phlogopite/garnet/vesuvianite/calcite chowder, the calcite occurring in irregular veins and pods in the tougher material, so that when the grossular crystals occur frozen in the calcite, they may be brought to light by acid etching, reducing chances of damage. Even so, they tend to be already fractured *in situ*, so the hard fact is that even now, while we're seeing the products of the calcite veins, a top-class, damage-free crystal is extremely hard to find. I saw only a couple in Denver, among the thousands of matrix pieces of all sizes, at dozens of dealerships. Still, even with all the damage, these are very impressive crystals for their color, sharpness of form and aesthetic manner or perching on the white matrix. Let's hope that those calcite pods hold out for a while as Benny continues to work the prospect.

Rob Lavinsky of *The Arkenstone* (9244-A Regents Rd., La Jolla, CA 92037) was carrying around a couple of flats of miniature and small cabinet specimens of brilliant black **schorl** on microcrystallized feldspar from the Chacoya mine, Castrovirreyna Province, Huancavelica Department, Peru—these were most of the 80 pieces which, he said, were dug a couple of months ago. Most of the 1 or 2-cm schorl crystals are blocky and rhombohedral with prism faces, interestingly intergrown in radial aggregates, although a minority of the schorls are slender terminated prisms instead. The luster is high, and the deep jet-blackness contrasts well with the creamy white matrix covered with millimetric feldspar crystals. These are handsome specimens from an entirely new schorl provenance; more, Rob says, will be with him at the Pomona Show.

Likewise from Peru, a small lot of very good, newly mined **axinite** specimens from Espinal, Ica Department, were trying hard not to be upstaged by the microclines and rhodochrosites at the *Collector's Edge* booth at the Main Show. The axinite crystals are sharp, smoky brown, translucent to transparent blades to 5 cm, in aesthetic clusters without matrix. The luster is fairly bright in the best pieces, only medium-bright otherwise, and the general resemblance, I'd say, is more to the old axinite from the Obira mine, Japan, than to that from the French and Russian occurrences. There were about 20 miniatures to small cabinet-sized specimens available. Finally, there was Art Soregaroli's superb **sellaite** from the Huanzala mine, Huanuco province, Peru: a sharp, gemmy, colorless crystal measuring 2.1 cm.

Stashed away under Mike Bergmann's bed in his Holiday Inn room were about 20 superlative new **vivianite** specimens from the Huanuni mine, Oruro, Bolivia. On these cabinet-sized pieces, vivianite crystals to 12 cm long sit, mostly singly, on brown matrix of pyrite and phosphates which is further adorned with sharp, bright, glassy green **ludlamite** crystals to 1 cm. The vivianite has a lush submarine-green transparency better than which it is hard to imagine, and all major crystals are sharp and almost entirely free of damage. As a sideshow there's a small selection of miniatures consisting of loose sprays of radiating acicular vivianite crystals.

Mike Bergmann (Galena Rock Shop, 312 South Main St., Galena, IL 61036) also took pride in showing me what was left—three specimens—of an original small handful from a new Brazilian find of **brazilianite**, namely São Geraldo do Baixio, Minas Gerais. A small pocket dug in April yielded these sharp, lustrous, part-gemmy floater crystals, which can reach 10 cm long and are pleasingly fat, the equals of all but the best of the early brazilianite gem crystals from Corrego Frio. Tiny crystals of quartz, elbaite and hydroxlherderite adhere to one of the three brazilianite floaters.

Of the two or three Brazilian stories and rumors going around the show, the most intense concerned Wayne Thompson's **aquamarine** crystal that *he* had stashed under *his* bed. It is an incredible 20 cm long and 5 cm wide and thick, with lustrous side faces showing complex growth (or solution) hillocks, pyramidal modifications near the top, and a flat basal face. And it is completely gemmy and deeply colored, more green than aqua—a zillion carats' worth of prime gem stock. The locality, an unnamed prospect in Minas Gerais which never produced gems before, is being called the Medina prospect, after Medina, the nearest town. About two months ago a water-filled void several meters wide was unexpectedly breached, with this crystal and about 15 others (one or two, Wayne says, even *better* than this one) lying loose on the pocket floor.

Brazilian buzz #2 concerned a single beautiful **azurite/malachite** specimen from the Seabra copper mine, in Bahia. All I've been able to learn about this place is that it has turned out, only just recently, a few very good specimens of copper minerals, the best being the one I saw in the room of *Ikon Mining* (P.O. Box 2620, Fallbrook, CA 92088). The specimen is a 2 x 5 x 12.5-cm cluster of bright blue balls of azurite crystals, the 2-cm balls not too tightly packed, the luster uniformly bright. Near the bottom there is a very sharp line below which the balls, as if on a sudden whim, turn deep malachite-green; on the back are suggestions of gossany limonite matrix. You would certainly think that this piece is from Bisbee, or conceivably Chessy—but *Brazil*?

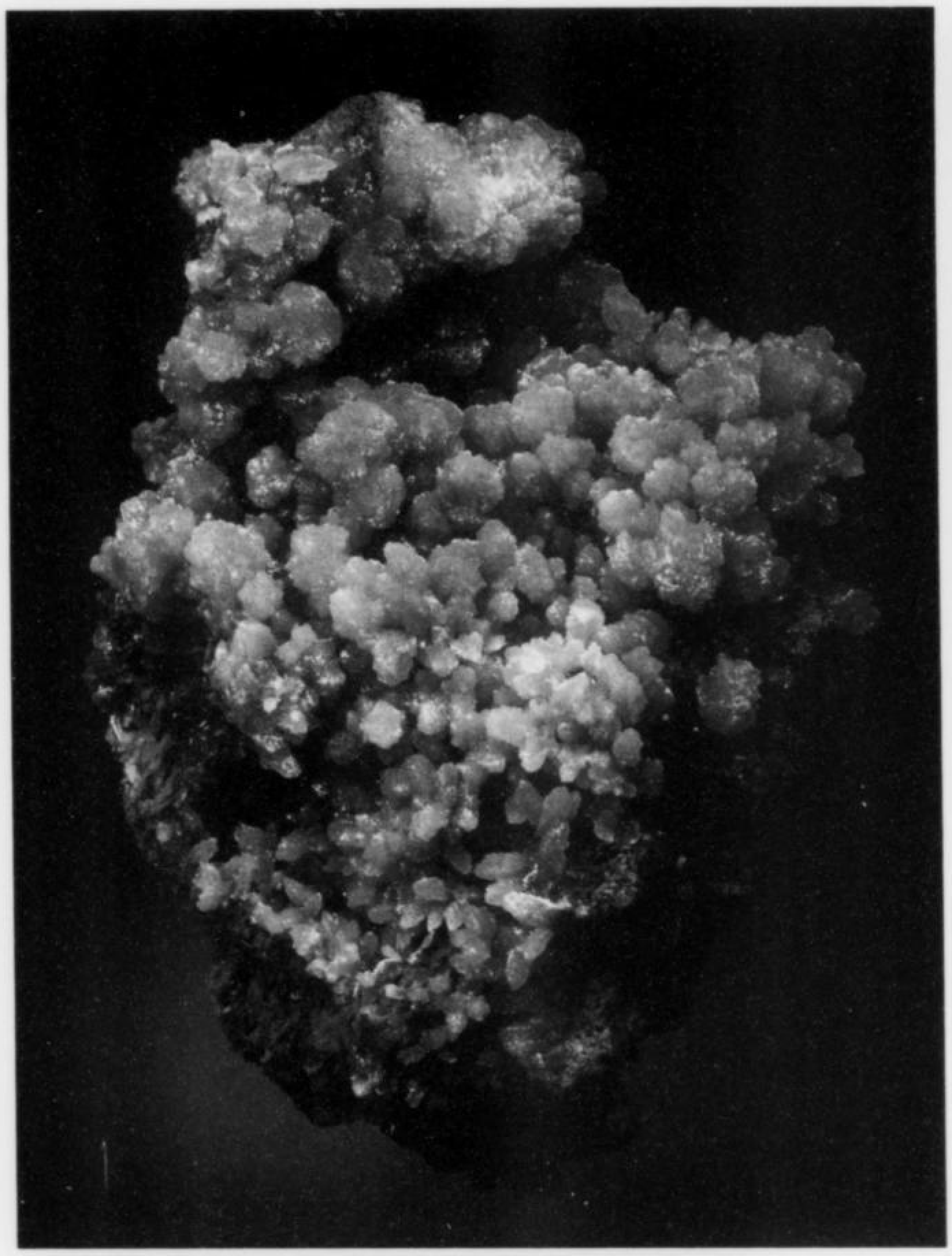
A much more prolific new Brazilian occurrence is a large strike of loose, twinned, often large, sometimes semi-gemmy, pale yellow **amblygonite** crystals from near Linopolis, Minas Gerais. Hundreds of these were to be seen all over the show, in sizes from small miniature on up, and the best single piece was hiding out with the giant aquamarine under Wayne Thompson's bed: a wedge-shaped 17-cm floater. In general the amblygonite crystals are sharp and lustrous, with interesting forms and prominent twinning planes and notches. But rarely do any interior areas attain gemminess, the color is wan, and there is usually chipping along the sharp edges. Let's hope the locality can do better in future days, but anyway this is the first good Brazilian amblygonite to show up on the market since the smaller and gemmier specimens of about 20 years ago (those, too, from "Linopolis"). Besides Wayne, the dealers in Denver who had the best and/or the most were probably Luiz Menezes and The Rocksmiths.

Back in Wayne Thompson's room *again*, we were wishing that we lived in France, because then we'd be closer to where the world-class **pink fluorite** and the superb **torbernite** specimens brought in this year came from. The fluorite specimens are recognizably from Chamonix, deep pink octahedrons over granite or smoky quartz crystals. They were found on August 7, 1997 (the morning of the Chamonix show), at Tour Noir, Argentiere, Haute-Savoie. A single pocket produced about 25 top pieces, mostly matrix specimens already partly carved out by natural ice action. Although lacking the lustrous sparkle of the best of the Swiss pink fluorites, these are a very beautiful, deep rose-pink, and sometimes show slightly scalloped faces. The simple octahedrons reach 2.5 cm on edge, and occur in loose groups, on white granite, and as regal crowns on groups of gemmy **smoky quartz** prisms to 6 cm long. Eric Asselborn showed me THE thumbnail, and as I heard its price I heard also the gods' mocking laughter at me. It is a single, perfect, roseate, transparent, scalloped, 2.5-cm octahedron sitting up on a smoky quartz broken off at the base. Mon Dieu!

Eric Asselborn also brought out a box with about 10 thumbnails of truly the best-imaginable French **torbernite**, from a classic locality with a modern story: the Margabal mine, Entraygues, Aveyron Department. Each thumbnail group consists of deep green, lightly interlocked sheaves of micaceous torbernite crystals, the sheaves razor-sharp and even faintly lustrous. These are simply the classiest thumbnails of this material you could ever hope to see. Most people preferred them, in fact, to the several giant groups—to 20 cm across—consisting solely of thousands of smaller, duller-lustered torbernite sheaves all grown together. Eric says that just before the closure of the Margabal mine in 1959, almost 1.5 tons of torbernite ore were extracted from it, and there matters rested until a few months ago, when some adventurers found these new specimens, large and small, floating in the mud somewhere in the old mine. Wayne Thompson was offering six of the giants.

In the "International Dealers" alcove at the Main Show, László Pálinkás of *Stoneland Ltd.* (Arany Janos str 16, H-1051 Budapest, Hungary) was showing off a nice little hoard of a kind of **quartz** which in Europe, I learned, is commonly called "diamonds of Maramures." Hailing from the renowned Herja mine, Maramures district, Rumania, the 2-cm quartz crystals occur as simple floaters and as lightly attached clusters, and do indeed suggest "Herkimer diamonds" except that they're milky-translucent and tinted slightly gray by inclusions of the same sulfosalts that turn calcite from the Herja mine nearly black. Inexpensive singles and miniature groups seemed irresistible fun-buys . . . so I made one, to help out my Herja mine suite, with its semseyite, berthierite and black calcite pieces. (Ah, how we like to glorify our random pickings of things by lining up our few diversely acquired pieces from the same place and calling it our "suite").

Ernesto Ossola of *Ossola-Mineraux* (8 rue du Luxembourg, 30140 Anduze, France) is "Mister Morocco" these days, and he had two new Moroccan items. One, still more in the promise than in the accomplishment stage, is the **native silver** in massive **proustite**, of which Ernesto had a couple of (very heavy) hand specimens. The silver comes as bright, subhedral, 1-cm crystals



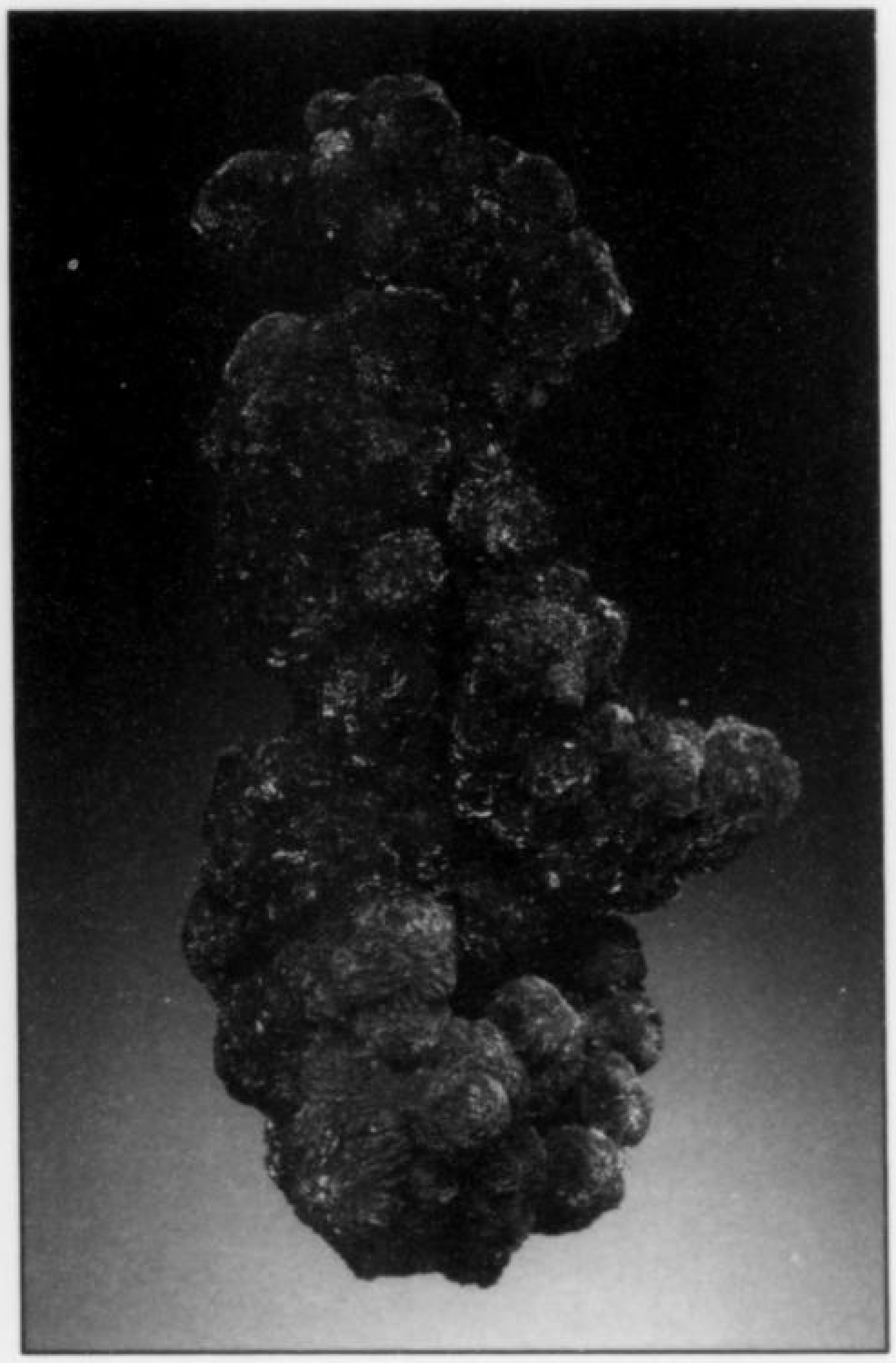
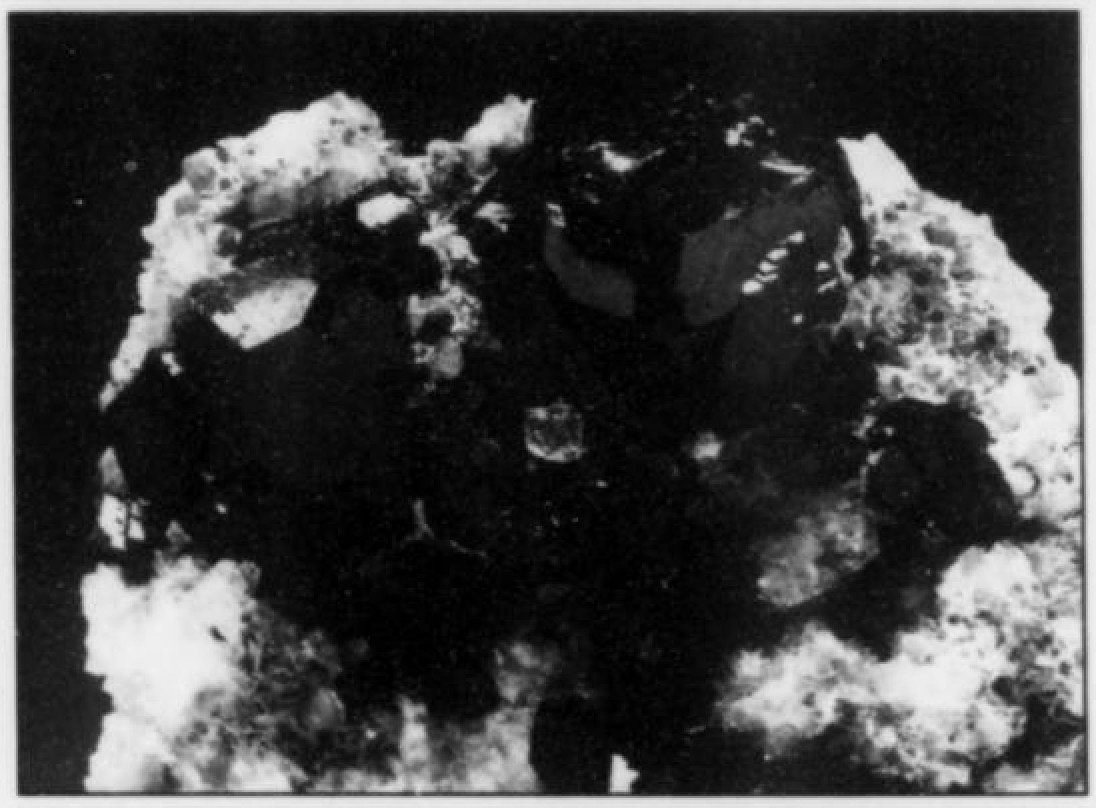


Figure 8. Azurite with malachite, 14.2 cm, from Seabra, Bahia, Brazil. IKON Minerals specimen.

Figure 9. Mimetite crystals on matrix, 5.5 cm, from Santa Eulalia, Chihuahua, Mexico. *Blue Sky Mining* specimen.

Figure 10. Schorl crystals to 1.5 cm on matrix, from the Chacoya mine, Castrovirreyña, Huancavelica province, Peru. Rob Levinsky specimen.



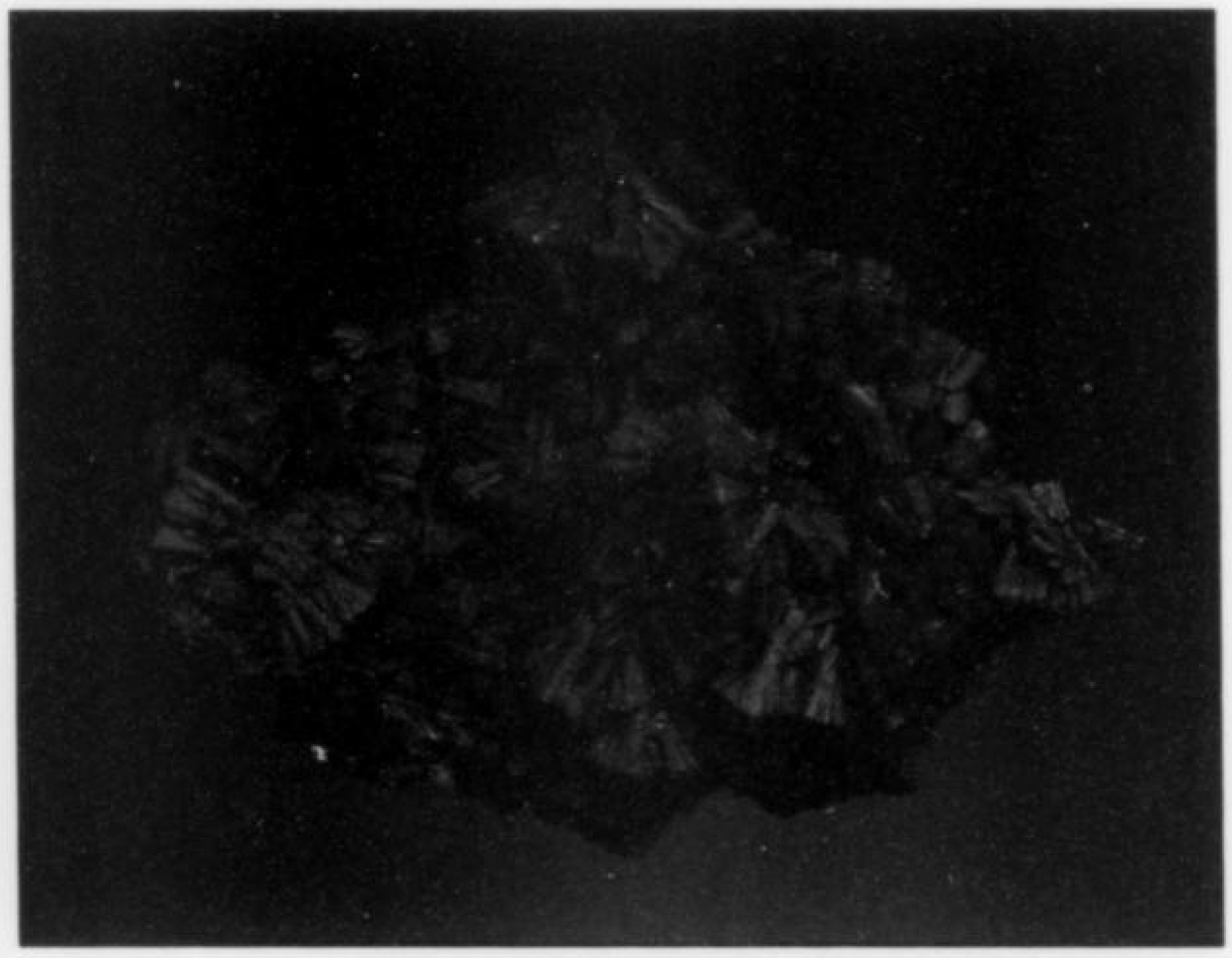


Figure 11. Metatorbernite crystal group, 9 cm, from Margabal, Aveyron, France. Steven Nealy collection.

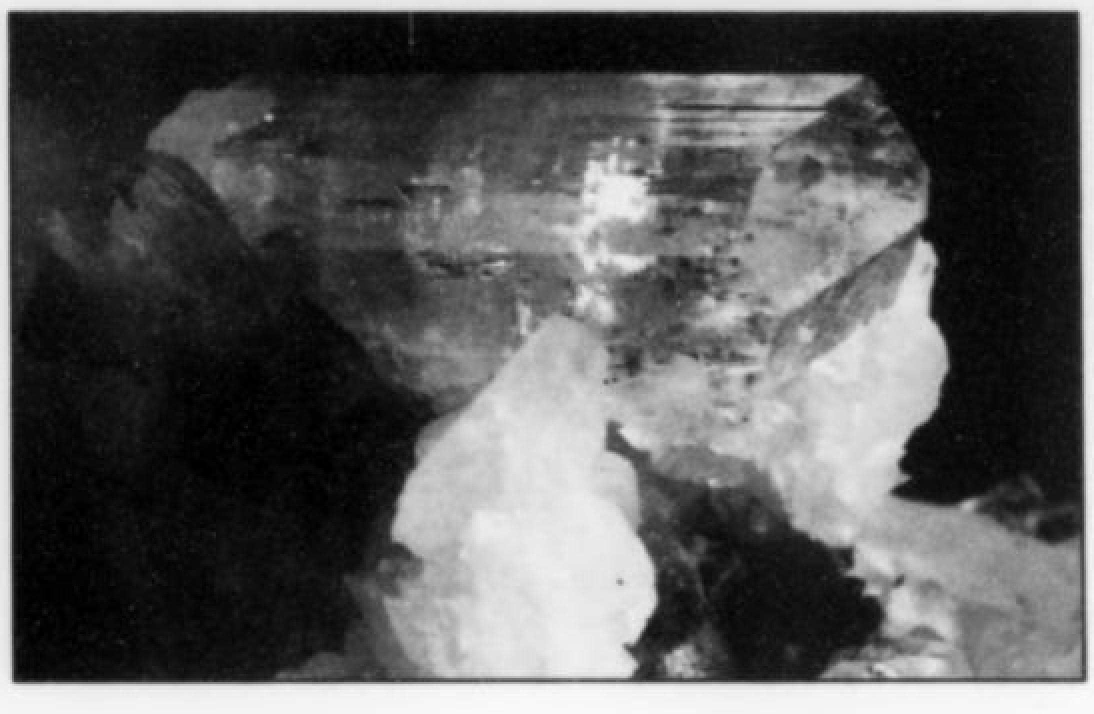


Figure 12. Sellaite crystal, 2.1 cm, from the Huanzala mine, Huanuco province, Peru. Art Soregaroli collection.

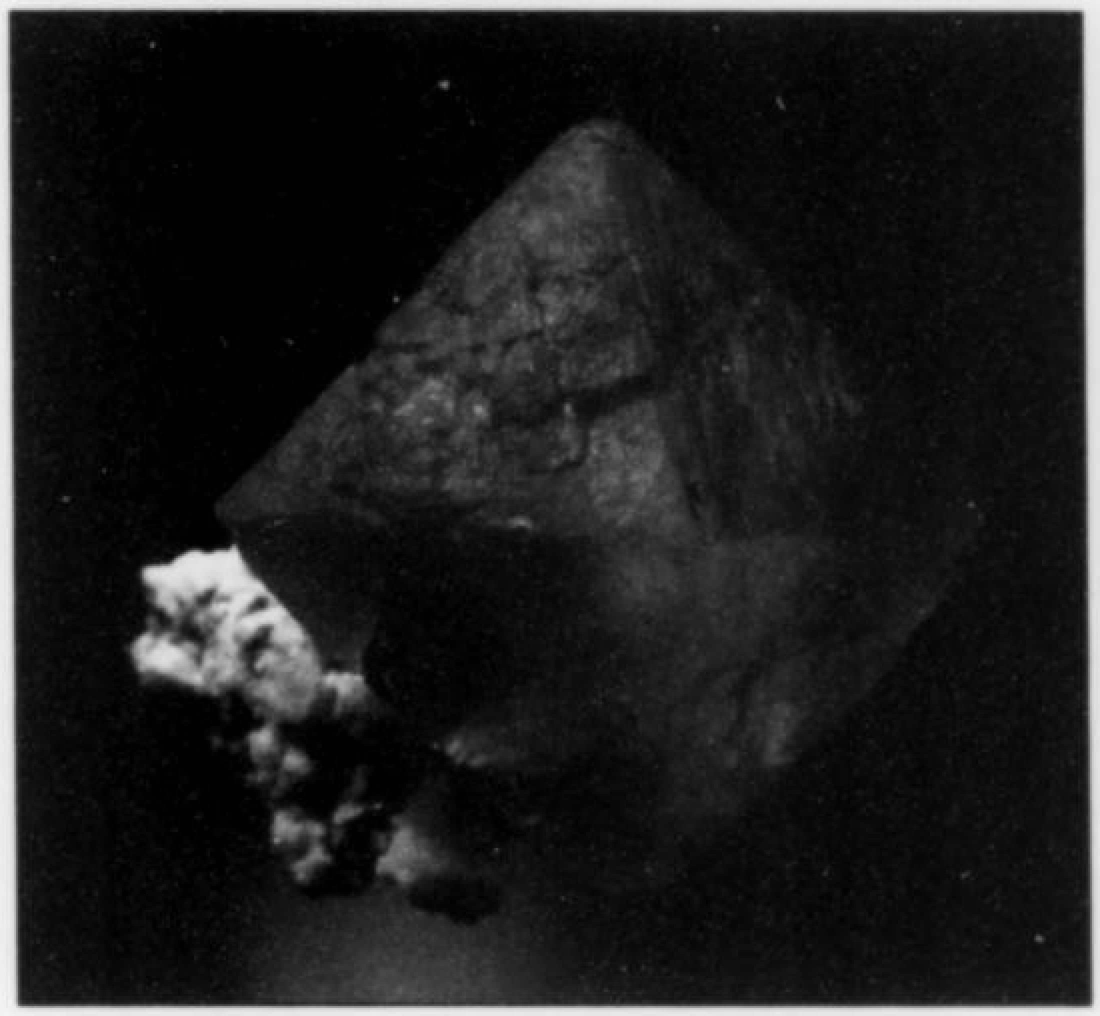
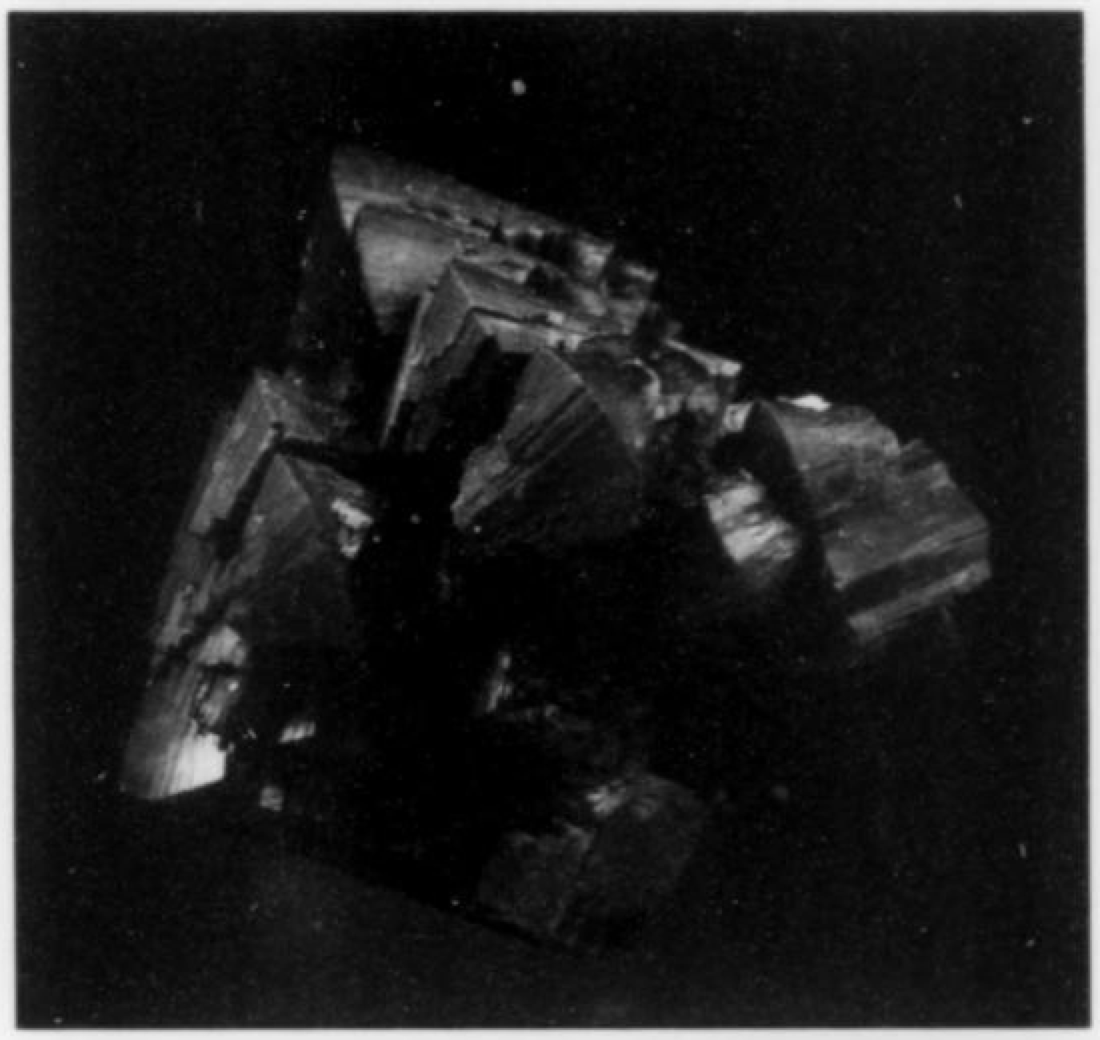
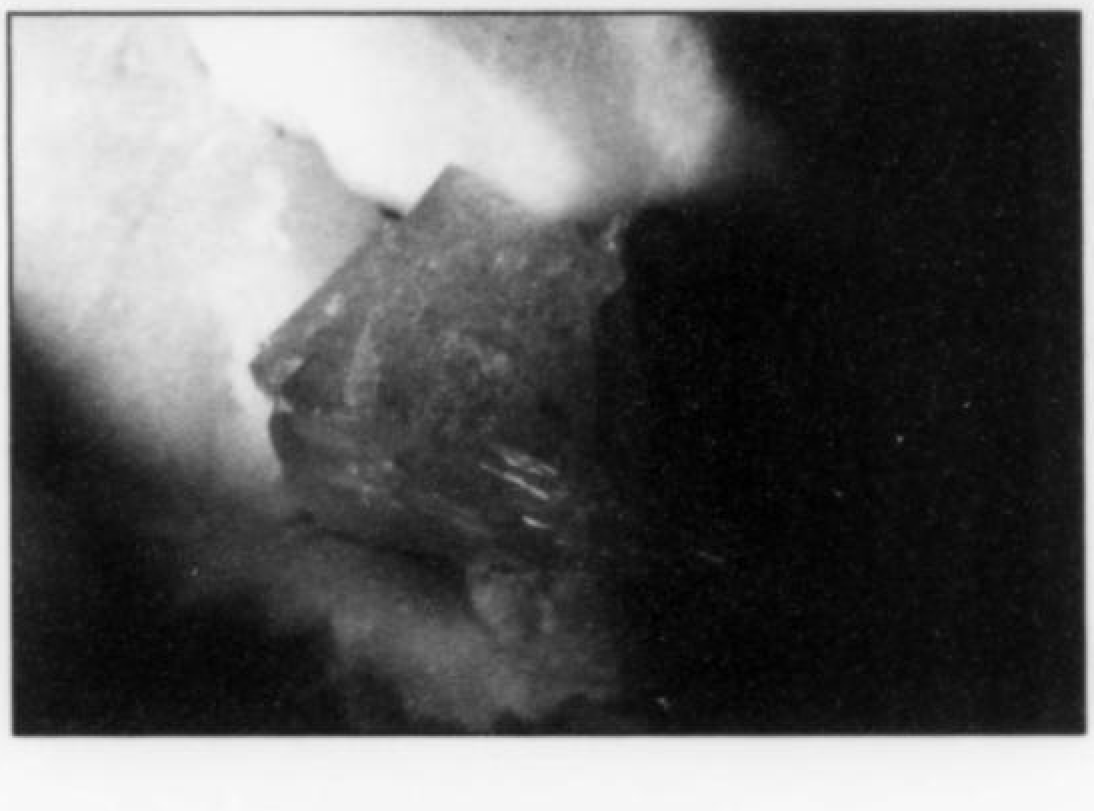


Figure 13. **Fluorite crystal, 2.3 cm, with matrix, from Chamonix, France. Wayne Thompson specimen; Ralph Clark collection.**

Figure 14. **Fluorite crystals on quartz, 6.5 cm, from Chamonix, France. Wayne Thompson specimen.**

Figure 15. **Metatorbernite, 2.2 cm, from Margabal, Aveyron, France. Ralph Clark collection.**





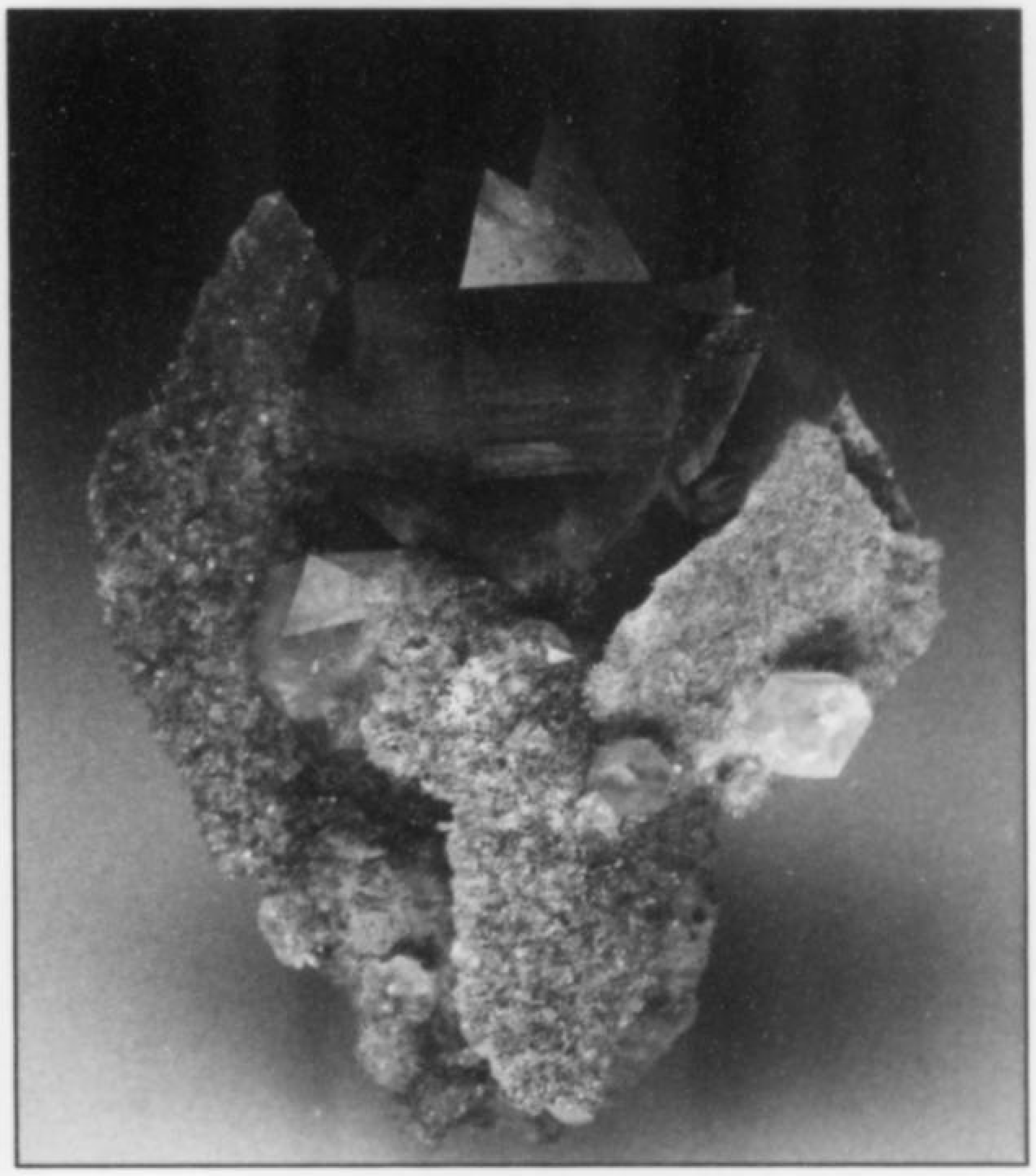


Figure 16. **Quartz (amethyst) on matrix, 3.3 cm, from Preozersk, Lake Balkhash, Dzhezkazgan, Kazakhstan. Jeff Scovill collection.**

Figure 17. **Fresnoite crystal, 8 mm, on natrolite from the Junilla mine area, Clear Creek, San Benito County, California. John Seibel specimen.**

and as twisted leaves pervading the faintly reddish metallic-black ore, in which proustite microcrystals may occasionally be made out. The locality is the Imiter mine (type locality for imiterite), central Shargo region, Morocco. It is an active silver mine from which we may hope to hear more someday. The other item, entirely different, is **nepheline** in very sharp, opaque, gray-white prismatic crystals to 2 cm long, with flat basal terminations, all jumbled together in jackstraw groups with dull-lustered, subhedral black **schorlomite**. The species-identity has been confirmed, Ernesto vouches, by several workers in Europe, and the sharpness of crystallization is exceptional for nepheline. Here there were about 15 acid-cleaned specimens, all in the small miniature size range. The locality is Jebel Aouli, a quarry in a highly weathered volcanic pipe ("Jebel" means "mountain") rising out of the desolate desert.

Getting seriously into Africa now, we are not surprised to meet Gilbert Gauthier, emerging cheerfully out of the darkness, and again this year offering **carrollite** in exceptional small specimens from the "established" locality of Kamoto-Fond, Shaba, Zaire. "Fond" denotes an underground rather than open pit mine. These carrollite crystals, collected about 7 years ago, are occasionally simple cubes but usually are cuboctahedrons; they were found frozen in calcite veins in dolomite. Most available crystals are loose singles of small-thumbnail size; I saw only three matrix pieces out of a total of 20 or so specimens Gilbert had. The metallic luster is extremely bright, the forms sharp, and individual crystals can get to 1.5 cm across. Gilbert had the serious carrollites at the Main Show, although, surprisingly, somebody in a "jewel tunnel" tent outside the Holiday Inn had a handful of loose, incomplete, dinged crystals selling for quite a bit less than Gilbert's $100–$400 per specimen (this is still a pretty good deal for brilliant sharp crystals of this rare Cu/Co sulfide).

From Springfield this year I reported on my first learning experience with yet another good **golden barite** locality: the Rosh Pinah mine in southern Namibia, this an active zinc mine where the good barites have only been found during this past year. They are yellow-orange to deep orange, lustrous, and occur in solid coverages of tabular or prismatic crystals over a dark matrix. I heard, as well, about their "ghostly yellowy green" fluorescence from South African part-time dealer Ronnie McKenzie (P.O. Box 95403, Pretoria 0001, South Africa), who had about 50 thumbnails and small miniatures of this material in the International Dealers section.

Rocko Rosenblatt of *Rocko Minerals and Jewelry* (Box 3A Route 3, Margaretville, NY 12455) works with Clive Queit to market much good southern African stuff, and in his Holiday Inn room he had a flat of something quite new, and very recently mined, from the complex rare-earth pegmatite at Mt. Malosa, Zomba District, Malawi. It is the rare amphibole species **arfvedsonite**, in glistening black crystals to 2 cm, sometimes prismatic (resembling the well-known aegirine from the same place) and sometimes blocky. The blocky crystals are finely grooved, with a sort of chatoyant incipient fibrousness, and they are implanted on very sharp, chalky white microcline crystals to 4 cm, in stately groups: nice-looking white/black pieces. The flat held about 25 specimens, from thumbnail-sized up to about 6 x 8 cm.

Now to keep a promise. In last year's Denver report I told you about the small lot of nice specimens of **almandine** in pegmatite matrix from somewhere in Madagascar; I couldn't get more locality data, but promised to do so in due course. Well, this year Fabrice Danet and Denis Gravier of *Le Mineral Brut* (Hauterive, 01640 Saint-Jean-le-Vieux, France) can say that the garnet diggings are in a pegmatite at a place 6 km southeast of Manandona and 30 km southeast of Antsirabe. The garnet species, they add, has been found to be an intermediate almandine-spessartine. These sharp, deep red trapezohedrons to 3 cm are as impressive as ever, perched smartly as they generally are on white matrix in all sizes, and this year there were at least a hundred such specimens for sale. The Bruts also had a nice relict hoard of last year's gem **zoisite** (tanzanite), in loose thumbnail single crystals and parallel groups of two or three, the gemmiest specimens approaching $1000 in price, but a bright, sharp one with too much internal crazing for gem use ran only $129.

From Russia there is not much new this time around, though a one-of-a-kind specimen that Brad van Scriver showed me in the *Heliodor* dealership's room certainly rates a brief, drooly word. It is a **brookite** matrix specimen from the Dodo mine, Polar Urals, the lone crystal a gigantic 2 x 5-cm, paper-thin, doubly terminated plate, complete everywhere except where lightly attached; it is undamaged, and a beautiful transparent rootbeer brown. The matrix is a 15 x 15-cm dull greenish chloritized lump on which the brookite crystal lies flat, but with edges and both terminations elevated enough to show off that gorgeous color and transparency. Could this be the world's best brookite? Why not?

The pretty **amethyst** crystals from Lake Balkhash, Kazakhstan, which the *Heliodor* folks had in Tucson (see my 1997 report) were here again and getting better. More of them, this time, are clearer and more deeply purple in the "good" zones, and they still sit up pertly on their flat shaly matrix. Thumbnails predominate, and your pocket change could buy a good one.

Mine 57 at Dzhezkazgan, Kazakhstan has lately produced some excellent specimens of bright metallic black **djurleite**: thin bladed crystals in edge-lying parallel bundles to 4 cm, streaked across surfaces of massive black djurleite (or chalcocite?). The *Heliodor* people had only four of these, large miniature to small cabinet size.

For a bit of *entirely* different Kazakhstaniana, the Czech dealership of *KARP* had some nice, small **natrolite** specimens from the Sokolovskoye quarry near Rudniy—the source of the orange **stellerite** balls and blocky yellow **calcite** crystals of recent years. In a dozen or so winsome thumbnails and small miniatures, the natrolite makes brightly sparkling radial tufts of tiny acicular crystals, the tufts to 2 cm across, implanted singly or in little grape-bunches on a weathered gray rock, with sharp, tan, 2-mm **chabazite** and/or **gmelinite** rhombohedrons for garnish. A thumbnail of this material would only run you $10 to $20 (being, you see, for your evolving Sokolovskoye *suite*).

Dave Bunk had a new style of **orthoclase** collected last summer at Nieosla, Basha Valley, Baltistan, Pakistan—and Andreas Weerth and Herb Obodda said that they had some too, though Dave's were the only specimens I got to see. The (very unusual) color is a pale whitish green, and specimens consist of loose, blocky Carlsbad or Baveno twins, a few with sharp biotite books, in all sizes. Generally the crystals are milky to translucent, although Dave does have one 2-cm faceted greenish gem. This is very nice, very unorthodox orthoclase. Dave also had some fine clusters of yellow-brown **titanite** with epidote crystals from Alchuri, Baltistan, Pakistan.

Who nowadays can think of Pakistan minerals without thinking of the intrepid Dudley Blauwet of *Mountain Minerals International*, and his way of coming up with something new nearly every time? This time it was a couple of dozen thumbnails and small miniatures showing excellent **herderite** crystals sitting on white weathered granite matrixes, from Bulochi, Gilgit-Skardu Road, Northern Areas, Pakistan. These are translucent grayish white blocky single crystals and twins to 2 cm, shiny and sharp, altogether first-rate for the species except perhaps for the paleness of color; the winningest thumbnail went for $200.

Although I generally don't like "reporting" on things I have not actually seen, I feel it my duty to pass on the well-attested fact that two specimens of **hureaulite** recently unearthed at Shengus, Pakistan are among the world's best examples of the species: a significant claim, considering how good the ones from Brazil can get. Beautiful pink prismatic crystals of hureaulite reaching 3 cm long are said to form aesthetic clusters . . . let's hold on until more appear.

Before leaving the Himalayas we should also mention Jack Lowell's superb **petalite** crystals to *23 cm*, from Paprok, Afghanistan. The well-formed but somewhat corroded crystals are colorless and suprisingly gemmy.

One of those "evolving" what's-news caused much talk at the show, as specimens of it, sparse in Tucson, were abundant here. I refer to the beautiful butterfly-twinned, **hematoid calcite** crystals sitting on beds of likewise hematoid needle calcite . . . locality designations vary, but Debbie Meng of *Debbie Meng's Minerals* (P.O. Box 117, Marina, CA 93933) ought to be trusted, I'd guess, when she puts "Chenzhou, Hunan Province, China" on her own labels. At their very best these are smashing calcite specimens, the butterfly twins razor-sharp, precise and petite, and to 5 cm, as they rise from their needly beds, the transparency pure and clean where it can be seen under preferentially hematite-dusted faces. Qualities varied around the show, from the little bashed thumbnail-sized shards I saw in one of the outside tents, through the great pristine beasts of cabinet specimens offered by Debbie, by Danny Trinchillo of *DeTrin Minerals*, and by others. It must be said that prices varied rather crazily from here to there among dealers.

Let the likewise satisfying abundance, around Denver, of the new red **sphalerite** specimens (on which I and others have written before) from Hengyang, Hunan, China close out the survey. These, you'll recall, consist of drusy, coxcomby quartz surmounted by brilliant, complex, rounded clusters of dark red-brown transparent sphalerite crystals to 3 cm, and they are beautiful.

As I have said, the Denver theme-species this year was **gold**, and the fact that so many cases were filled with gold must surely account for the goggle-eyed look of spectators (not just the layman ones, either) that seemed a bit extra and special. My own eyes goggled most at the case of gold specimens from the John Barlow collection (while John himself was seated a few feet away, selling copies of his recent fine book). Indeed, for *my* money (I wish . . .), the two most impressive gold specimens on the whole show floor were two Barlow thumbnails of Santa Elena, Venezuela gold (both pictured in the book): a 2.75-cm, deeply hoppered floater octahedron, and an elbowy 2.5-cm group of sharp crystals of many intricate forms. [Editor's note: But then, the author is a thumbnail collector, and you know how they are.]

I will stipulate that there were many great gold specimens, in ten or so other cases devoted to gold, which ranged through a gamut of sizes—all the way up to "The Whopper," a hackly mass with minor quartz about a foot and a half long. Gold-case contributors included the California State Mining and Mineral Museum; the Denver Gem and Mineral Guild; the Colorado School of Mines; Wayne and Dona Leicht; the Arizona-Sonora Desert Museum; the American Museum of Natural History; the Virginia Polytechnic Institute (surprisingly, "Gold in Virginia"); and Collector's Edge (fine Colorado gold specimens donated by several local collectors).

Other terrific cases on other themes, of course, abounded. The Houston Museum of Natural Science showed 12 fabulous native silver specimens from worldwide localities; the Natural History Museum of London showed English classics from the Sir Arthur Russell Collection. Bill Pinch put in an informative case describing, with abundant text, charts, photos and other visual aids, the characterization of the new Tsumeb species **andyrobertsite**, centering everything on the type and only known specimen, where the andyrobertsite is a beautiful deep blue 1.5-cm spray lying over deep green zincian olivenite. Oh yes, and Marty Zinn and Rock Currier had a flamboyant case of *stalactites*—thin, straight-up, super mineral specimens of, among many others, pyrite, malachite, prehnite, smithsonite, galena, apophyllite . . . a forest of little leafless mineral trees of every thinkable style and hue.

The Rice Northwest Museum of Rocks and Minerals displayed about ten amazing (and, to most show veterans, unfamiliar) specimens of gold, silver and platinum minerals. The centerpiece of the case (see cover photo) could be the best Siberian **sperrylite** specimen extant. It is a 5-cm lump of bright yellow etched chalcopyrite (and other sulfides) girdled by a belt of brilliant sperrylite crystals, most of which are near in size to the crowning 2-cm one on the top. Nor can I forbear to mention the flaring, brilliant red 10 x 12-cm Chanarcillo, Chile, **proustite** in this extraordinary case.

Finally, the "That's Colorado" case to which I alluded before held just four Colorado specimens, but it drew, I'd say, the heaviest crowds of all, since one of these specimens was the Sweet Home mine rhodochrosite that Bryan Lees calls "the ribbon": one of the top five or six Sweet Home pieces ever mined, and kept back by Bryan until its debut here. On it, about ten 3-cm, transparent, deep red rhodochrosite rhombs come together in a linked, wavy, indeed ribbonlike row which drapes itself over a small quartz/tetrahedrite matrix. The rhodochrosite crystals' sharpness, brilliance of luster, and gemminess attest (to those who follow Sweet Home arcana) that this piece is from the Good Luck Pocket strike that occurred right after the Denver Show of 1992.

This report is appearing an issue later usual, having been "bumped" by the Boleo Issue. By the time you receive it I will be putting the finishing touches on my 1998 Tucson Show Report for the next issue, having seen (I hope) even more glories. These are great times indeed to be a mineral collector! See you then.

Franklin Show 1997

by Joe Polityka

[September 26-28]

The temperature was 48 degrees Fahrenheit when we arrived in Franklin, New Jersey, at 7:30 on Saturday morning. The cloudless blue sky glowed like the finest Persian turquoise. The leaves were starting to change and I could see scattered blotches of red, orange and yellow as I scanned the distant ridges and valleys. Ripe pumpkins ringed the parking lots of roadside stands and handwritten signs announced that "apple cider" was for sale. This was definitely a morning for hot cider. There was no doubt that autumn had arrived in the New Jersey Highlands!

When I pulled into the swap-self area adjacent to the school house, I was not surprised to see at least 50 tailgaters set up. In my "glory days" I would have beaten most of this crowd out of sheer stubbornness. However, over the years common sense and the aging process have taken control of my body. Besides, there were plenty of minerals and memorabilia to see and, as you know, when it comes to minerals and collecting in general, "one man's meat is another man's poison."

At the main show 20 mineral and jewelry dealers were set up. *The Rocksmiths* had a selection of the now-ubiquitous **fluorite** from China. New, to the East Coast, at least, were the **amblygonite** crystals from Laranjeiras, Minas Gerais, Brazil. The crystals I saw are sharp, pale yellow singles up to 3 cm in length.

Detrin Minerals has consistently had the best **green fluorite** from Xiang Hua Ling, Hunan, China. Many specimens are associated with small **calcite** crystals, creating a pleasing contrast. I finally picked up the crystal of my dreams, a green 5-cm crystal with a nice phantom. Danny also had some beautiful contact twins of **calcite** to 3 cm, in a scalenohedral calcite matrix from Xiang Hua Ling. The calcite, being sold at crystallized gold prices, is definitely out of my price league. The reddish brown crystals,

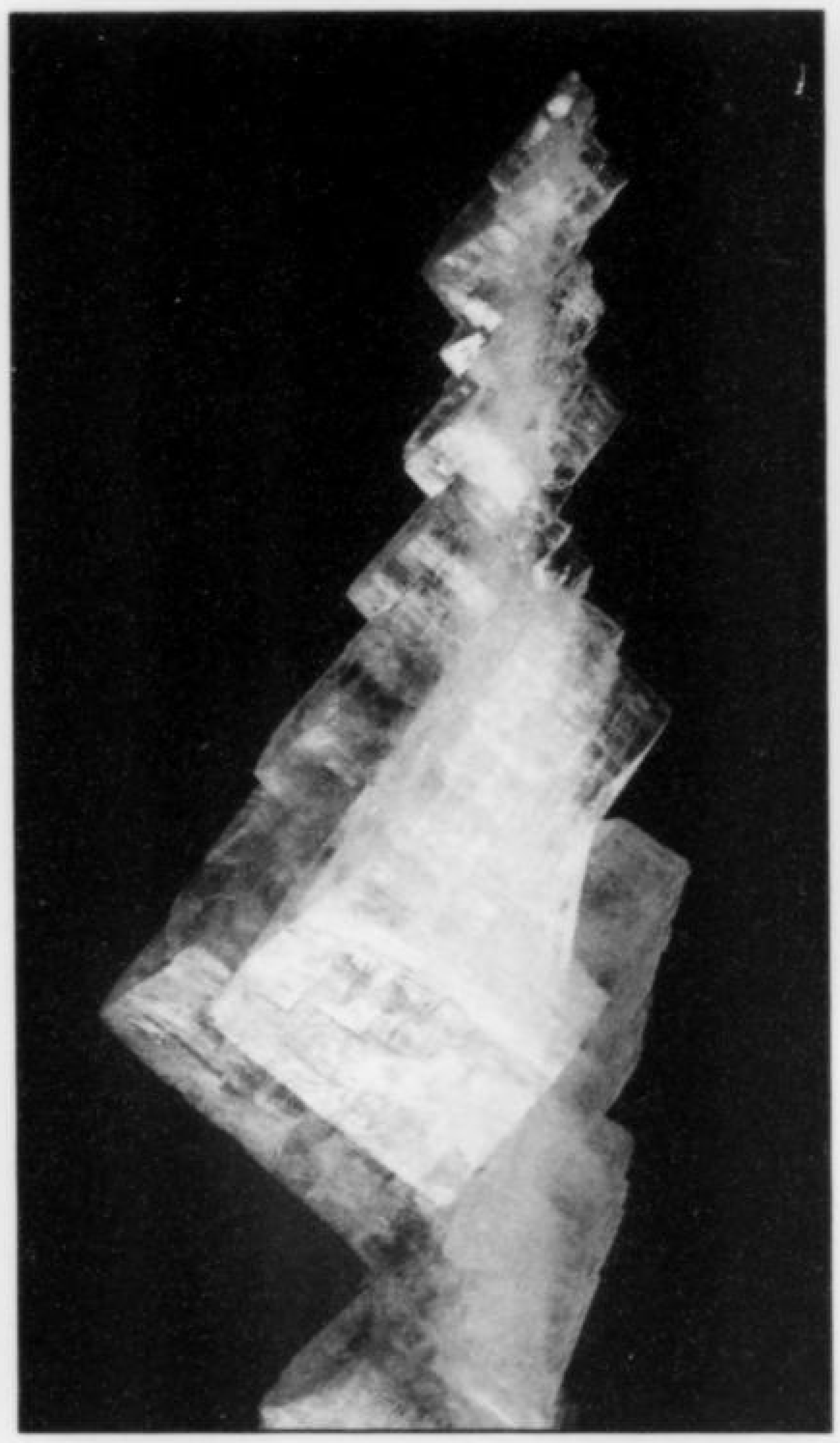
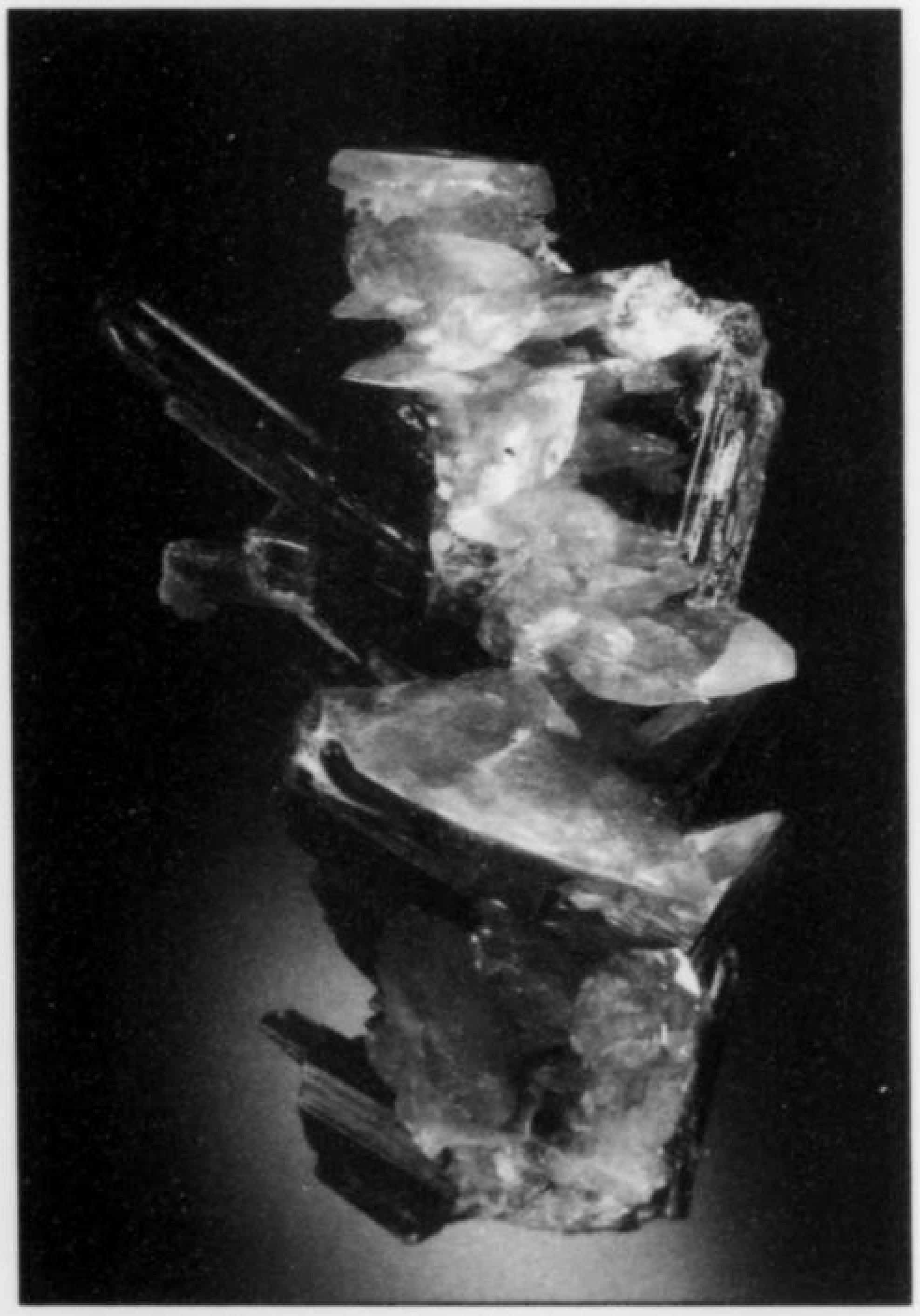


Figure 19. **Orthoclase crystal group, 6 cm, from Nieosla, Basha Valley, Baltistan, Pakistan. Dave Bunk specimen.**

Figure 20. **Titanite crystals with epidote, 5.2 cm, from Alchuri, Baltistan, Pakistan. Dave Bunk specimen.**

Figure 18. **(*left*) Orthoclase crystal, 3.5 cm wide, from Alchuri, Baltistan, Pakistan. Dave Bunk specimen.**



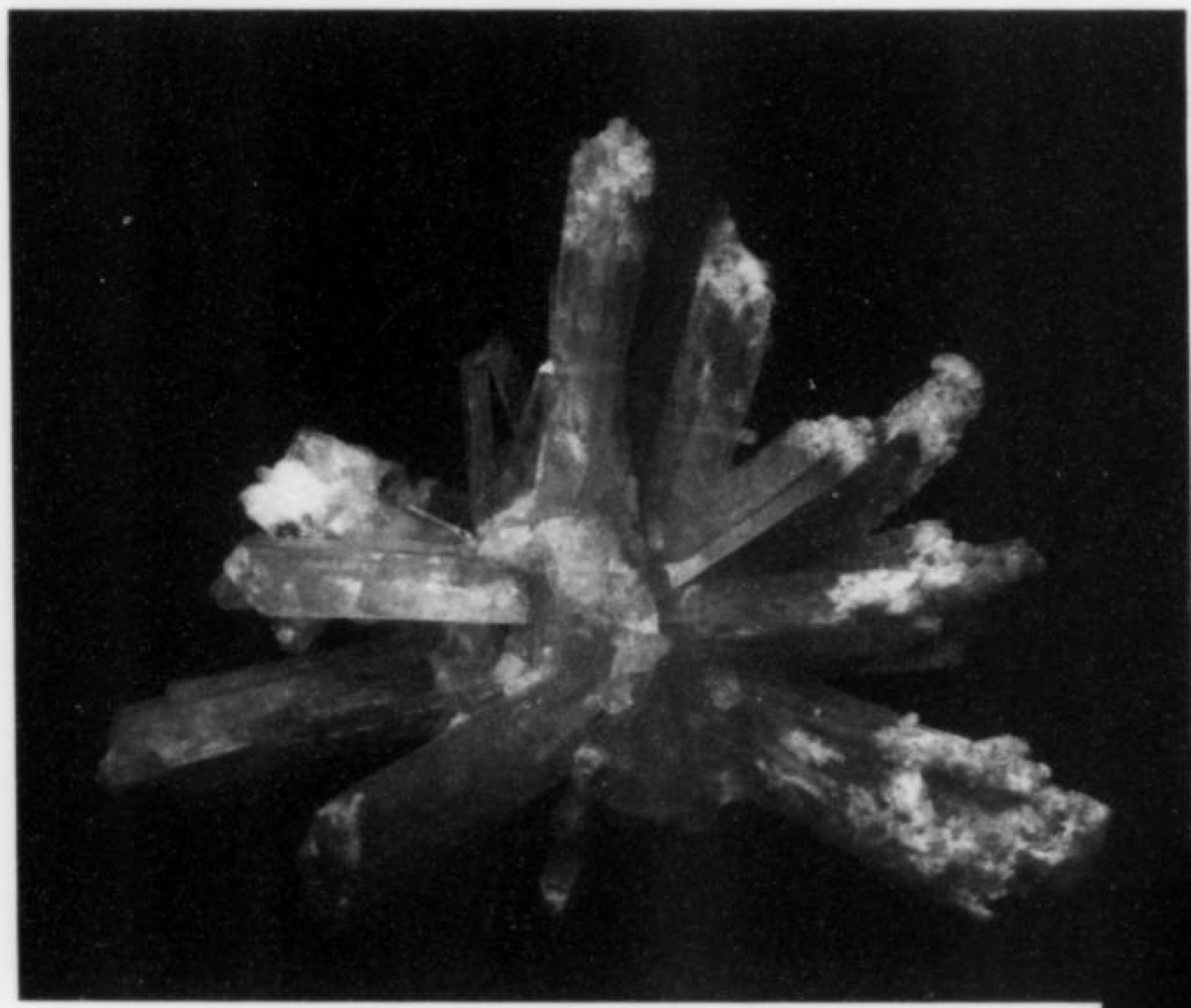
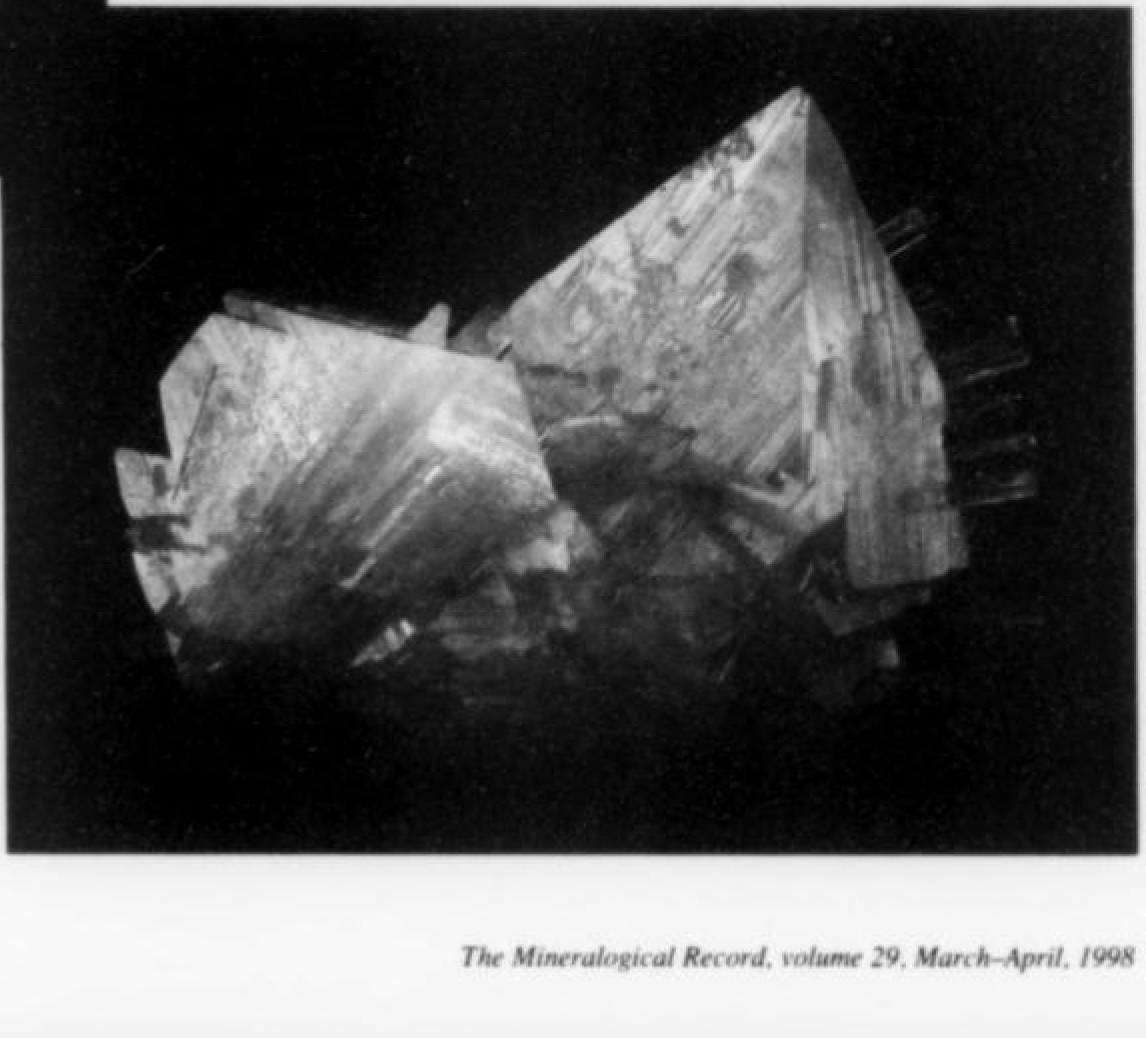


Figure 21. **Hureaulite crystal cluster, 5.3 cm, from Shengus, Gilgit division, Pakistan. Bill and Carol Smith collection.**

Figure 22. **Powellite crystal group, 9 cm, with minor natrolite or scolecite, from Nasik, India. Patrick Allier specimen.**



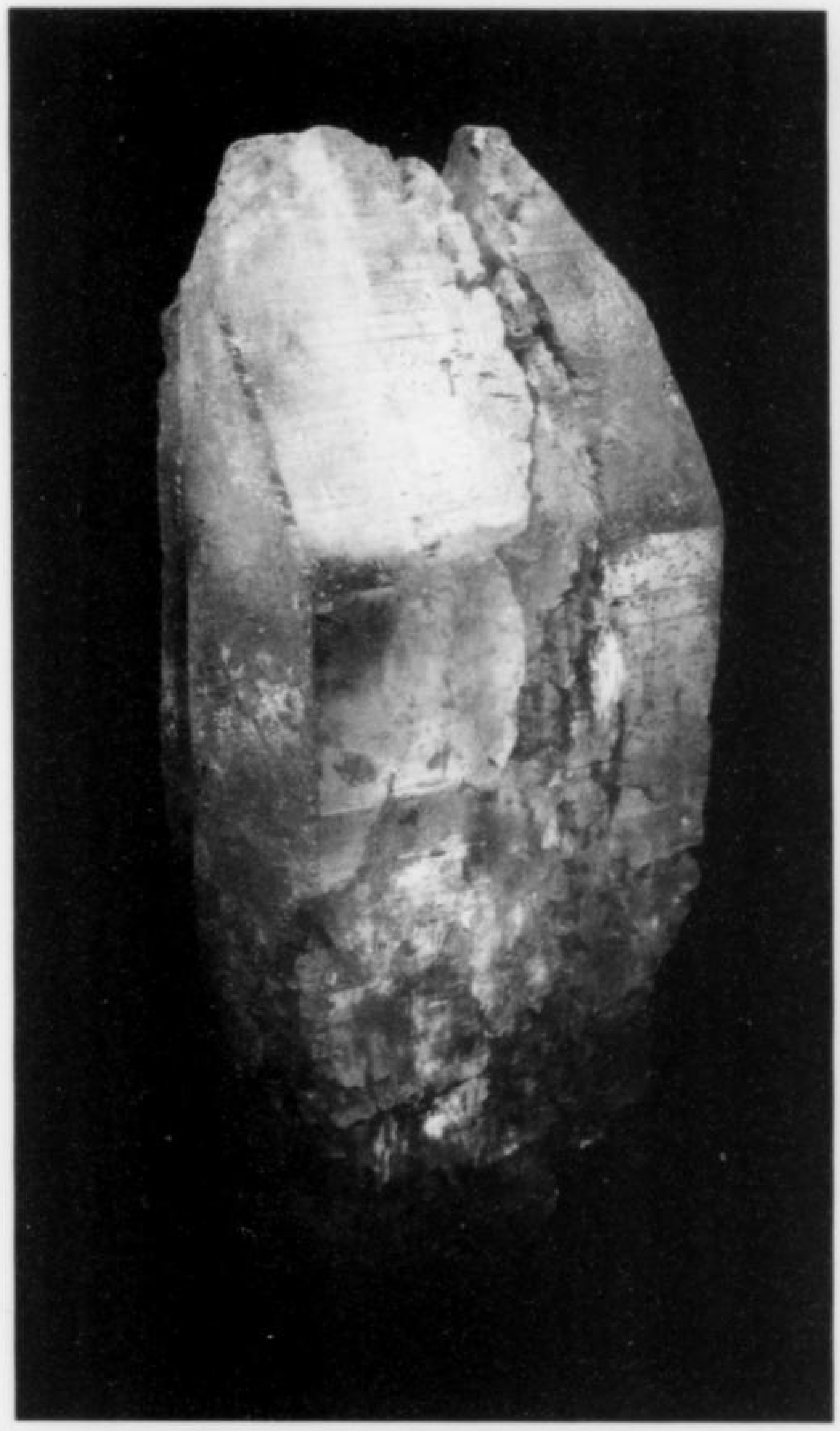


Figure 23. **Petalite crystals, 11.5 cm, from Paprok, Afghanistan. Jack Lowell specimen.**

Figure 24. **Petalite crystals, 23 cm, from Paprok, Afghanistan. Jack Lowell specimen.**

Figure 25. **Actinolite (pseudomorphous?) crystal group, 8.4 cm, from Owens Valley, California. *Fossils Plus* specimen.**

Figure 26. **Scheelite crystal on matrix, 6.1 cm, from Chengzhou, Hunan, China. Debbie Meng specimen.**

however, are beauties and got a lot of attention at the show. Hopefully, for my sake, there are more to come at cheaper prices.

The Mineral Cabinet had some heart-shaped contact twins of **calcite** from Dashkesan, Caucasus Mountains, Azerbaijan. The crystals range from 3 to 5 cm in size and are a pinkish color with pale brown shading. Bill also had his usual selection of New Jersey **zeolites** and related minerals.

More **sphalerite** crystals from the Dolomite Products quarry, Walworth, New York, were available at the booth of *Mohawk Minerals*. The crystals are up to 2 cm in size and are an attractive reddish brown color. Val Collins and his son Jeff also had pale blue **fluorite** crystals to 2.5 cm and transparent **gypsum** crystals from the same quarry.

At the booth of *Mountain Minerals International* I found **aquamarine** on **muscovite** from Chumar Bakhoor, Nagar, Northern Areas, Pakistan. In addition, Dudley had his usual selection of **spessartine-almandine** from the Rondu district, Gilgit-Skardu Road, Northern Areas, Pakistan, and more **olivine** (forsterite) crystals to 2.5 cm from Sapat, Kohistan, Pakistan.

Howard's Minerals had a flat of old-time **wulfenite** specimens from Los Lamentos, Chihuahua, Mexico. The tabular butterscotch-colored crystals reach an average of 1.5 cm and are scattered on typical gossan matrix.

Excalibur-Cureton Minerals had white **barite** crystals to 3 cm from the Hecla Rosebud mine, Pershing County, Nevada.

Willis Earth Treasures had a new supply of Tsumeb minerals provided to them courtesy of Demetrius Pohl, who currently lives in South Africa. A wide selection of **cerussite, smithsonite, calcite** and **dioptase** was available.

In the swap-sell area a lot of guys and gals were selling a lot of rocks. *Jeff Fast* had a large selection of Dalnegorsk **calcite, fluorite, sphalerite** and **pyrrhotite.** They had several large sea-green fluorite cubes with emerald-green phantoms from Dalnegorsk. The crystals reached 6 cm in size and are quite gemmy. Jeff also had a flat of opaque, pale green fluorite from Dalnegorsk with crystals to 3 cm on a gray matrix. What makes these specimens interesting is the dusting of small, white **laumontite** crystals to 2 mm on the fluorite.

Rocko (Margaretville, NY) had **quartz** crystals from Oppenheim, New York, a new location near St. Johnsville. The Herkimer-type crystals reach 2 cm in size and sit on a brown drusy quartz matrix. Most specimens have multiple single crystals which profusely cover the matrix. One specimen I saw has over 20 crystals on a 10 x 10-cm matrix. These specimens are very attractive and quite unusual.

Doug Hall (Palmyra, VA) had **amethyst** crystals, in clusters and singles to 3 cm, from the Reel mine, Lincoln County, North Carolina. The crystals have good color and are quite sharp, with the smoky tints typical of this location. These are from the find of April 1995.

Several collectors set up in the parking area were selling their personal collections. I saw Bisbee **azurite**, Hotazel **rhodochrosite** and English **calcite,** to name a few. The Bolivian college student (the one who used to bring the vivianite) did not show up this year. She had discovered Tucson and Denver since last year's show and had no financial need to attend. I did hear several guys asking for "the Bolivian girl" as they wandered aimlessly around the swap area, a year too late.

John Cianciulli (of *The Franklin Mineral Museum*) was selling off the museum's excess stock of Franklin minerals and Paterson and Millington zeolites, etc. by the piece and by the flat. Prices are quite reasonable and would be of interest to someone who wants to acquire an "instant reference collection" of New Jersey minerals. When you visit Franklin, stop by the mineral museum to see the outstanding collection of minerals and Native American artifacts. You will see utensils and arrowheads from tribes such as the Hackensack who lived in the New Jersey Meadowlands on land presently occupied by the Giants' football stadium. This collection is the life's work of Wilfred Welsh and his wife Mary.

The show exhibits were exclusively devoted to Franklin area minerals and were exceptional. At this show no minerals are allowed from sources outside the Franklin-Ogdensburg, New Jersey area. In fact, zeolites and other minerals from New Jersey are considered to be from "foreign" sources, as far as exhibits are concerned.

Bryn Mawr College "Open House," 1997

by Joe Polityka

[November 16]

If you are a connoisseur of historic mineralogy and antique minerals I suggest you pay a visit to the Earth Science Department of Bryn Mawr College in Bryn Mawr, Pennsylvania. I had heard much about the collection; so, with wide-eyed anticipation, I summoned up the energy and drove solo into my home state of Pennsylvania.

Bryn Mawr lies in Montgomery County about 8 miles northwest of the Philadelphia city line in the piedmont region. The area is picturesque, heavily wooded (with huge deciduous trees) and historic (some towns date back to the early 1700's). After driving through the same intersection four times, I finally surrendered my ego and asked a clergyman at a local church for directions. He kindly led the way to the science building (which was less than a quarter mile from the church) and directed me into the parking lot. Safe at last.

I was graciously greeted by Juliet Reed, assistant curator of the collection, who gave me a guided tour of the facility. Ms. Reed told me that interested individuals can view the collection by setting up an appointment during the academic school year (call (610) 526-5115). Viewing is not permitted during school breaks and summer vacation.

The collection is housed in 28 cases on the first and second floors of the Geology Department; there are additional exhibits in the Mineralogy classroom and Geology lab. There are well over 2000 specimens in the collection. As I studied the minerals in the cases I realized I was on an historic geology and mineralogy tour. Bryn Mawr acquired its college collection in 1895. The collection has mineral labels dating back to 1867 and is rich in specimens from classic domestic and foreign locations. Many specimens are from the George and Henry Vaux collections. The Theodore D. Rand collection was willed to the college in 1903.

So, you ask, what are my favorites? Well, how about 1-cm, pale green **leadhillite** crystals on a cabinet-size matrix from the Beer Cellar mine, Granby, Missouri, or a 10-cm white **calcite** twin from Joplin, Missouri? These are just two of the outstanding pieces in the Missouri case. In contrast to most museums, in which minerals are arranged by species, most of the displays at Bryn Mawr are arranged by mine or region.

In the European cases a pale yellow 2-cm crystal aggregate (on matrix) of **matlockite** from Cromford, Derbyshire, England, caught my eye. Several small cabinet specimens of **silver** from Kongsberg, Norway, with twisted wires to 5 cm, certainly deserve mention. Classic **calcites** from England are also well represented, as is **fluorite** in 3-cm golden cubic crystals from Wolsendorf, Germany. How about **sphalerite** and **jordanite** from Lengenbach, Switzerland, on the same specimen?

For you quartz aficionados out there, how about a 12-cm clear **quartz gwindel** from Switzerland or **Japan-law twins** to 4 cm from Japan? A 12-cm crystal aggregate, with clay inclusions, from

Lincoln County, North Carolina, rivals the best from Brazil, and a 20-cm cluster of **smoky quartz** from the Philadelphia area certainly fooled me.

From the United States, classic locations such as Bisbee, Arizona, and Phoenixville and French Creek, Pennsylvania, are well represented. **Wulfenite** from the Stevenson-Bennett mine, New Mexico, stands out in several large cabinet specimens with yellow crystals to 2 cm. One cabinet specimen from Box Elder County, Utah, looks a lot like the recent specimens that came out of the Red Cloud mine.

I also saw Russian **topaz, aquamarine** and **heliodor.** German **manganite** and a 30-cm-plus cluster of terminated **stibnite** crystals from Japan. Need I say more? And finally for you tool collectors I suggest taking a look at Edward S. Dana's mineral hammer and related memorabilia. Beyond a doubt Bryn Mawr is worth the trip. One note: before you dig out a flat of your best duplicates, the museum does not trade. However, they will accept donations!

Smithsonian Mineral Hall

by Joe Polityka

One fact I learned during my Navy days was this: if you want to avoid crowds in Washington, D.C., pay a visit over a holiday weekend. Well, this Thanksgiving weekend I discovered that this is still true (if you wanted to hang out in the local bars). However, if you wanted to visit the Smithsonian Museums crowds were the order of the day. It was heartening (and disheartening) to see so many parents with young children oohing and aahing and, literally, drooling over the brand-new gem and mineral hall at the Smithsonian Museum of Natural History. I was heartened by the number of people I observed stopping to explain the exhibits to their kids and was disheartened by the fact that I (out of greed) did not have this marvelous exhibit all to myself.

As you enter The Janet Annenberg Hooker Hall of Geology, Gems and Minerals you are shuttled into a fairy-tale land of Earth Science in the computer age. Each thematic area is chock full of interactive computer displays that allow you to push computer buttons until your fingers ache and to watch movies until your eyes bulge (like those of a micromounter).

Upon entering the exhibit area you are introduced to the world of extra-terrestrial objects (meteorites). The latest theories are presented via film, computer graphics and charts with emphasis on the mass extinction theory. This area is crowded with, literally, tons of all types of meteorites and makes me wonder how much steel and concrete was used to reinforce the floor.

The next areas are devoted to plate tectonics, vulcanology, earthquakes and geology. I especially enjoyed the interactive computer display that allows you to create your own earthquake: you are instructed to touch, strike or shake a stone block that is connected to a seismograph which, because of its sensitivity, records the slightest movement.

Upon entering the mineral display area, you suddenly find yourself underground in a series of four mine replicas representing a Tri-state lead mine; Bisbee, Arizona, copper mine; Ogdensburg, New Jersey, zinc mine; and the Morehead mine in Amelia, Virginia. There are displays of minerals dedicated to each of these mines.

The main mineral hall has display cases along the walls dedicated to various categories of minerals and their varieties such as **beryl, tourmaline** and **corundum**. It should go without saying that there are some incredibly fine specimens in these cases. There is a series of cases dedicated to "study specimens," covering the entire mineral spectrum, which are good enough to be the focal points of most other museums. I especially enjoyed seeing the antique East Coast specimens and bowed humbly before the Roebling **purple apatite** from Maine and the Antwerp, New York, **millerite**. In my opinion, if there are better specimens of these species they are still in the ground.

If you get a chance, set aside at least a day and make a special effort to visit the Smithsonian. If you are anything like me, you will be going in three directions at once, will soon show symptoms of mineral overload and will succumb, that evening, to sweet dreams laced with every color in the rainbow. I suggest you reserve a hotel room for several nights; you will want to go back for more!

Pomona Show 1997

by Jeffrey A. Scovil

[November 14-16]

The California Mineral, Fossil, Gem, Jewelry and Lapidary Arts Show is better known as the "Pomona Show." I managed to sandwich this enjoyable show into a busy November schedule that included shows the preceding and following weekends.

New material was at a minimum, but luckily shows do not exist solely on brand new material. There were lots of oldies but goodies, and more and better recently found specimens. Concerning the latter, *Roberts Minerals* had two flats of the new Brazilian **azurite** and **malachite** specimens I first saw at the Denver Show in September. The 26 or so pieces that Ken had range from miniature to cabinet size and consist of botryoidal clusters of azurite. The spheres at one end of a piece are typically pristine, whereas at the other end they may be altered to malachite. Ken continued to work the Elk Creek, South Dakota **barite** locality last summer with excellent results. The specimens are some of the best seen in years.

Fresnoite is a mineral fairly close in composition to benitoite, but substantially more rare. A few yellow crystals perched on analcime and rarely associated with distorted benitoites have been collected within the last couple of years. The locality is near Clear Creek, San Benito County, California and is often referred to (inaccurately) as the "Junilla mine." *Seibel's minerals* was offering a few of the crystals for sale.

An interesting new find for 1997 is clusters of Ferroan **actinolite** from Owens Valley, California. The prismatic crystals can reach nearly 1 cm thick and 4 to 5 cm long. They actually look like they may be pseudomorphous after some other mineral, like the famous actinolite pseudomorphs after amphibole from Salida, Colorado. The Owens Valley material occurs with clove-brown **grossular** crystals in massive grossular and was being sold by *Fossils Plus* (Todd Schowalter, P.O. Box 50186, Irvine, CA 92619-0186).

Debbie Meng frequently comes up with new material from China, and she did not disappoint me. From Chengzhou, Hunan, China she had a very nice, pale brown **scheelite** over 3 cm across on pale green **fluorite** cubes. Minor associations with this and other specimens from the locality are small white quartz crystals and occasional small, white calcite rhombs.

Somewhat of a newcomer on the block is Kathy McCloskey of *Mineral Logistics* (P.O. Box 922, North Hollywood, California 91603). Her contribution to new minerals at Pomona consisted of plates of drusy white **quartz** sprinkled with very attractive doubly terminated **amethyst**. Plates are up to 16 cm, with amethysts to 2 cm in length. What makes these pieces most interesting is the locality: Lam Dong Province, Vietnam.

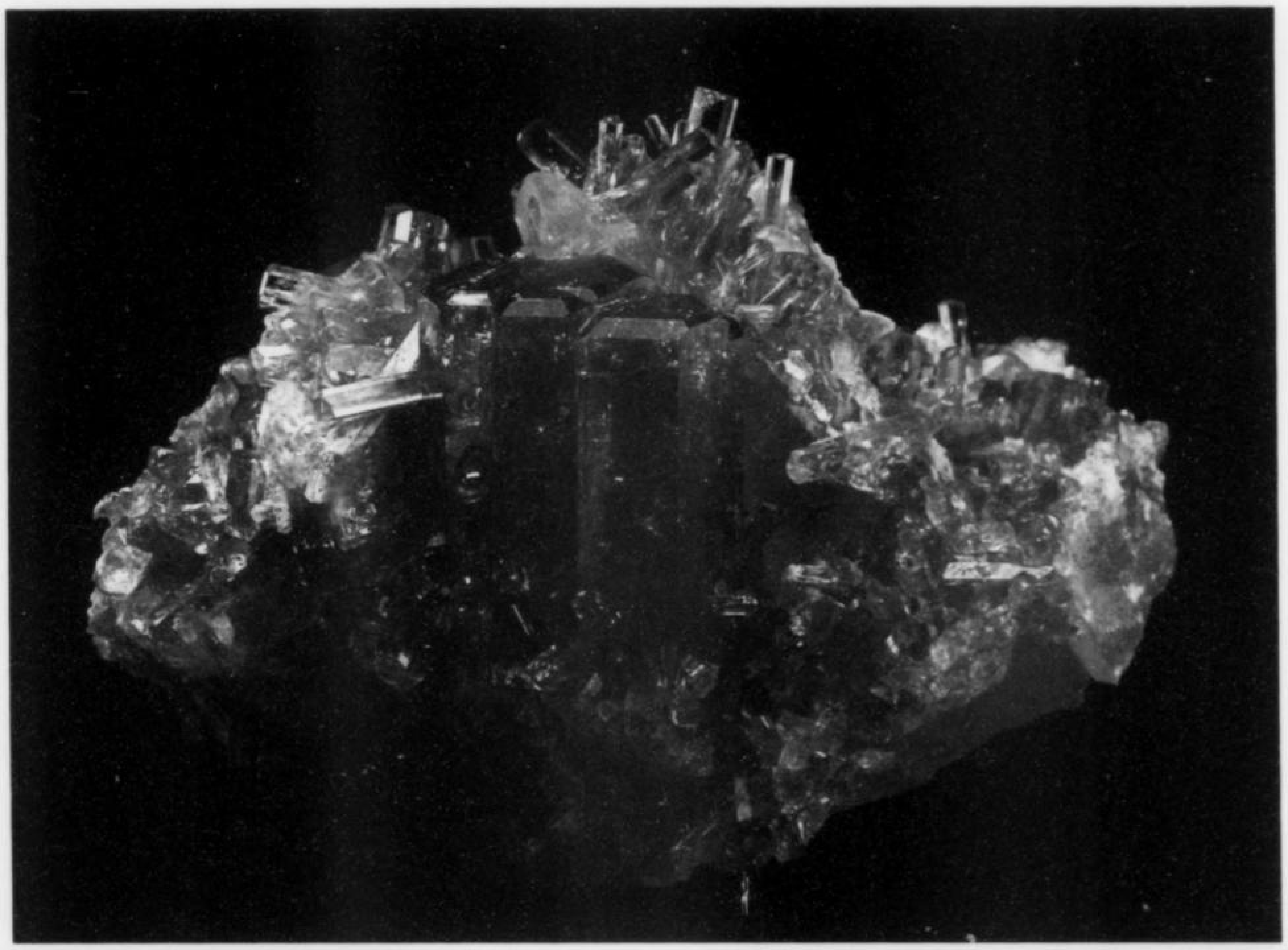
That does it for the Pomona Show; next stop—Munich.

Munich Show 1997

by Jeffrey A. Scovil

[November 21-23]

The famous Munich Show was held one month later than usual in 1997 because of preparations to move out to the old airport in 1998. Although the weather was a bit chillier than showgoers are used to, it did not seem to dampen anyone's spirits nor reduce the crowds.



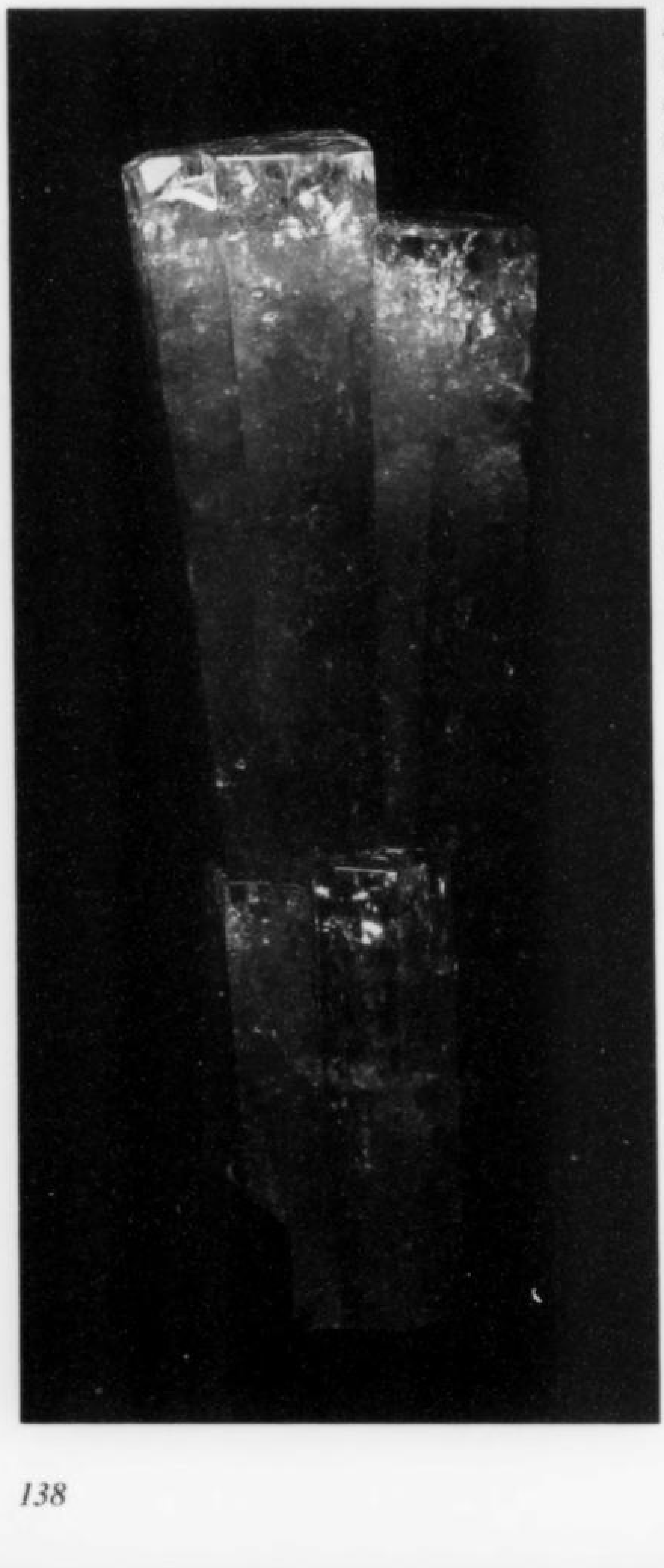


Figure 27. (*above*) **Beryl (emerald) crystal group, 7.5 cm, from the Brumado mine, Bahia, Brazil. Gilles Emringer specimen.**

Figure 28. (*left*) **Beryl (emerald) crystal group, 7.7 cm, from the Brumado mine, Bahia, Brazil. Giles Emringer specimen.**

Figure 29. (*right*) **Beryl crystal, 11 cm, from the Medina mine, Minas Gerais, Brazil. Steven Nealy collection.**

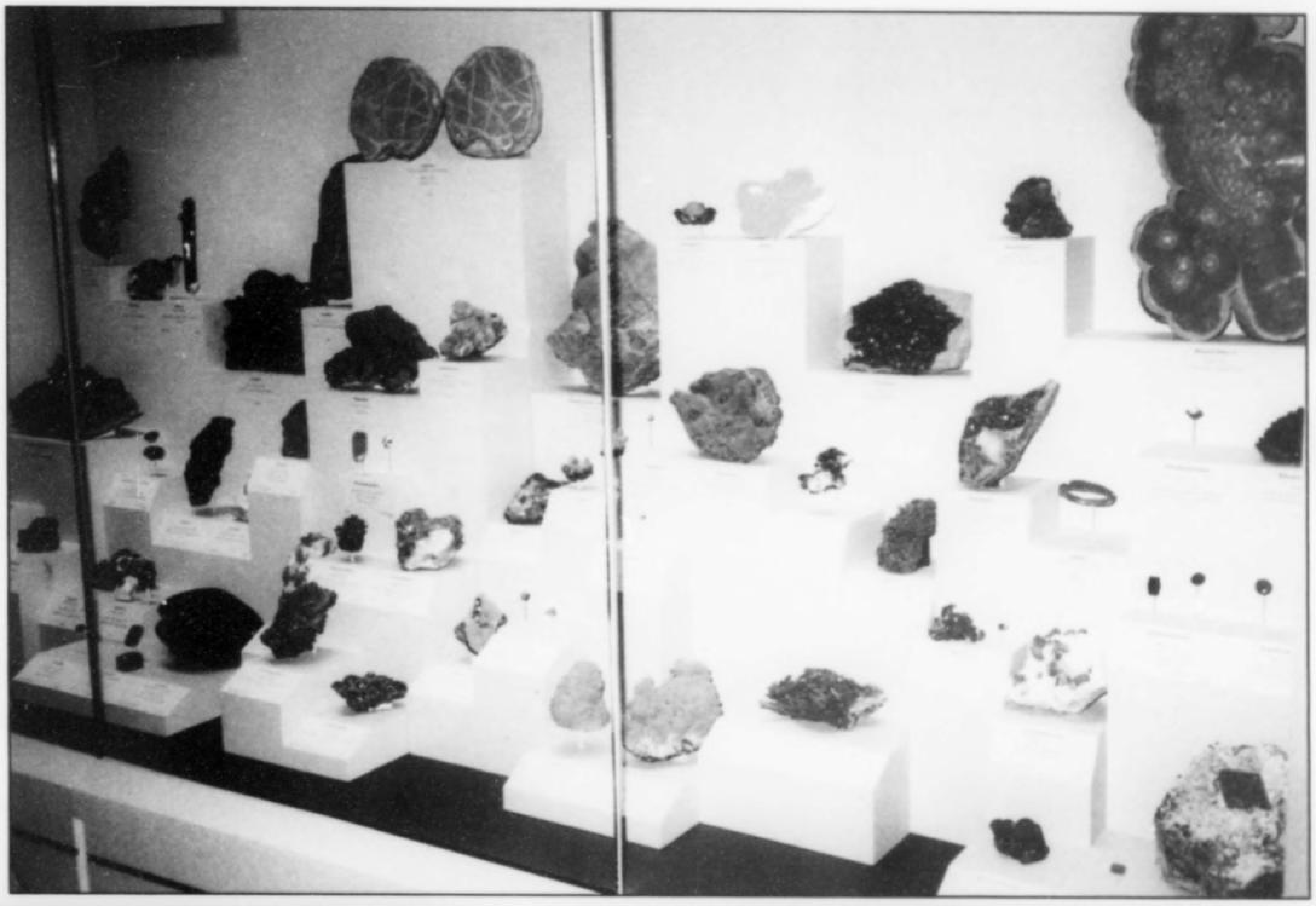


Figure 31. **Beryl specimen (10-cm crystal) on exhibit in the Smithsonian's new mineral hall. Joe Polityka photo.**

Figure 30. **Part of the new mineral hall at the Smithsonian, showing a rainbow of colored minerals. Photo by Joe Polityka.**

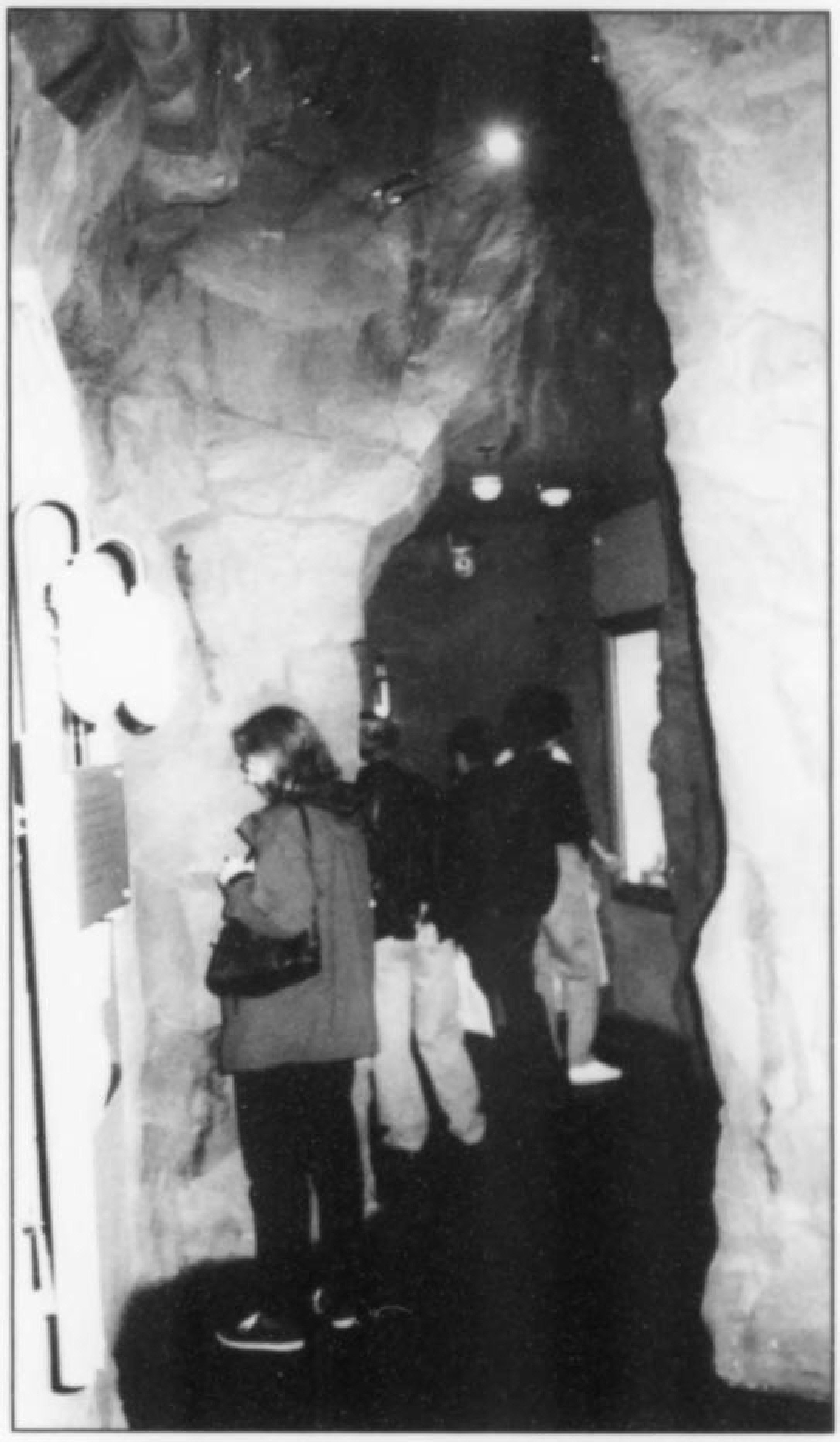


Figure 32. **(*right*) Part of the mine replica in the Smithsonian's new mineral hall. Joe Polityka photo.**

The theme was *copper and related minerals*, and Johannes Keilmann and friends put on quite a show. From the United States there were displays of Bisbee minerals from the collection of Dick and Monica Graeme, Michigan copper of the Upper Peninsula from the A.E. Seaman Museum, and a small but superb selection from the Houston Museum of Natural Science. Of course all of the major European museums were represented, as well as many private collections. There was even a scaled-down version of the famous "Malachite Room" from the Hermitage Museum in St. Petersburg, Russia. As usual, the exhibit area in Hall One was a wonder to behold.

There were a few things worth noting for What's New. Gilles Emringer (1, rue Santiago Soulas, 95270 Baillon, France) almost had the market cornered on interesting **beryls**. He had two fine specimens of the aquamarine that came out of the Medina mine, Minas Gerais, Brazil last summer. I understand that only about a dozen of these superb crystals were found. Gilles also had two very fine **emerald** specimens from the Brumado mine, Bahia, Brazil. Although the color is a bit light, and the larger ones are not facet grade (lucky us), they are incredibly lustrous, sharp pocket crystals.

There is always something interesting coming out of Afghanistan, and François Lietard had some of them. The new material is **elbaite** of a very dark black/green color, with zoned caps going from green to pale blue to an intense blue. Some of the crystals are up to 9 cm in diameter, but are relatively short, and there were not too many to be had.

Patrick Allier of *Cristaux and Co.* (33 allée des tilleuls, 38130 Echirolles, France) had a fine presentation of Indian **zeolites**. Among the usual goodies was a magnificent group of **powellites** from Nasik, shot through with scolecite or mesolite. This breathtaking specimen is 9 cm across. If that was not enough of a thrill, there was a larger and better specimen from the same field in the booth of *Superb Minerals*. This second one may be the finest for the species. It is now in an American collection and I should be photographing it in the near future.

By now we have all seen the fascinating gray **calcite** spheres from the Herja mine, Maramures, Romania. Several were available at the booth of Jordi Fabre, including a few that show a core of contrasting, more finely crystallized tan calcite.

There was quite a flurry of activity around the booth of Marcus Budil both during and before the show. Marcus had quite a nice selection of the fine **fluorites** from Ziang Hua Lin, Hunan, China. I have noted before that a number of the pale green cubes from there contain octahedral phantoms. For the first time, I saw one Marcus sold that consists of a large white octahedron with oriented cubic overgrowths. These fluorites were available in all sizes and prices and were selling fast.

From an as-yet undisclosed locality in Hunan, China Marcus had some rather large, attractive groups of **calcite**. What makes them a bit different is what appears to be dark brown hematite inclusions on only some of the crystal faces. These specimens disappeared very quickly and had to be tracked down for photography.

Last but not least were the new **demantoid** crystals in the booth of Gebruder Henn. The yellowish green gem crystals to over 1 cm in diameter are from the Namgar mine, Usakos, Namibia. A number of matrix groups were available but were quite expensive because of their gem value. Some very nice stones have already been cut from the material.

Although I heard the usual complaints from dealers about there not being enough that was new, it was an exciting and enjoyable show. After show hours there were plenty of fine Bavarian restaurants to visit on the Karlsplatz, and good conversations with old friends. Next year the show should be back in its old time slot, but out at the new fairgrounds located on the old airport. I can never go home immediately after the Munich Show, so I spent a week enjoying the wonderful sights and mineral collections of Prague—but that is another story.

Richard and Helen Rice

Over the years Richard and Helen opened their collection and display to many clubs, countless busloads of children, numerous youth and senior groups, and many mineral study groups and mineralogy classes. What began as a private collection was formally rededicated in 1996 as the Rice Northwest Museum of Rocks and Minerals, a non-profit organization.

The Museum will continue to operate and expand under the direction of their daughter, Sharleen K. Harvey. Visitors are welcome (26385 NW Groveland Drive, Hillsboro, Oregon 97124, Tel: 503-647-2418).

Died, Donald Gordon Wyman, 58, of complications from diabetes, in Winchester, Massachusetts. Don Wyman, known for many years as one of *The Boston Miners*, began collecting minerals as a young man and joined the North Shore Rock & Mineral Club around 1967. There he met Leo Vaught (they both served as field trip chairmen), and they became lifelong friends, collecting partners and business partners.

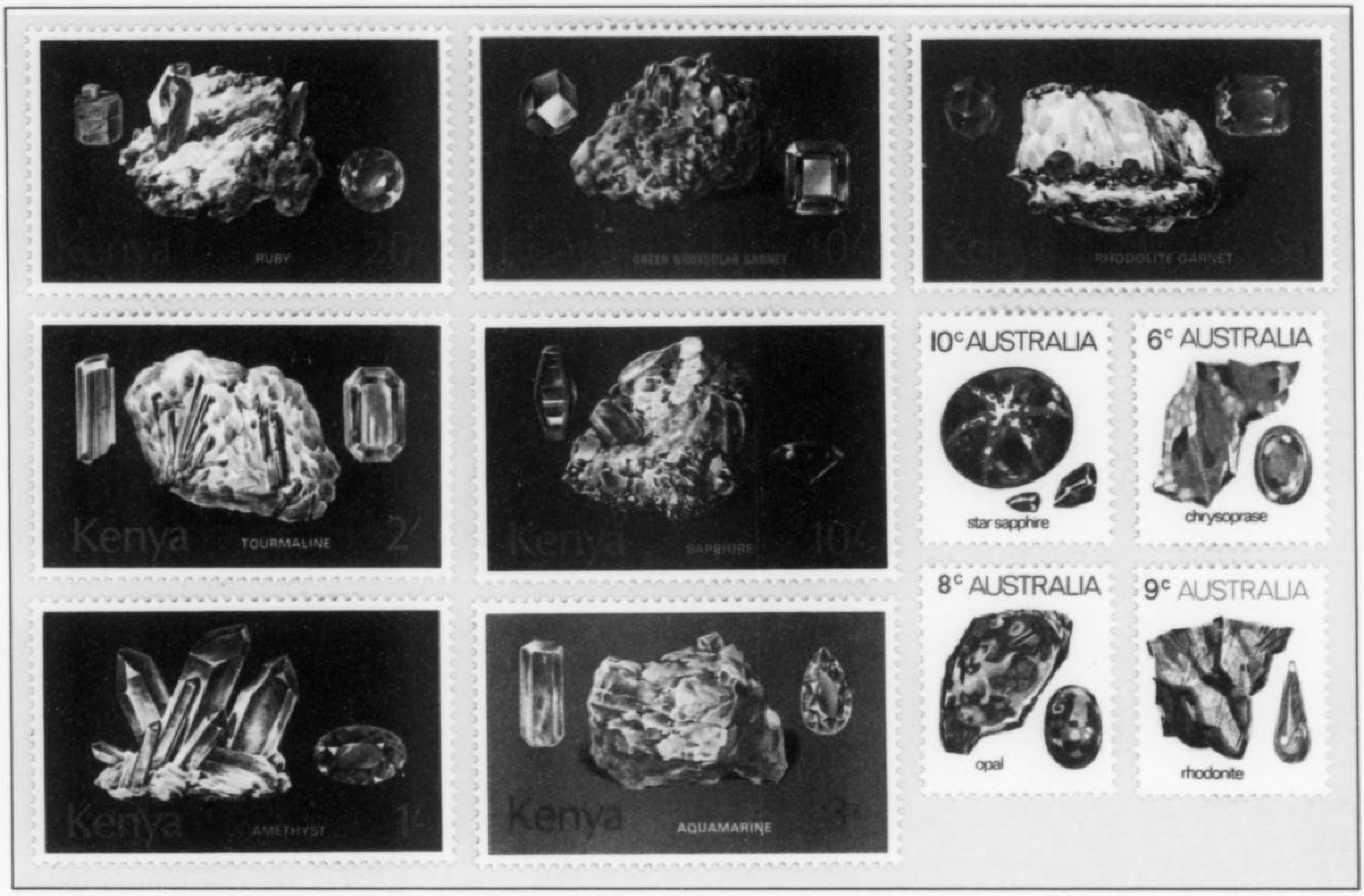
Don studied geology briefly at Tufts College, but left to become manager of a metal specialties company in Arlington, Mass. In the meantime, he and Leo Vaught took many field trips together (including three separate trips to the Wrangell, Alaska, garnet locality) and started their own wholesale mineral business. The business, Leo says, was named by other collectors, who would always say, "Here come those Boston miners," when Don and Leo showed up at a locality.

In 1970 Don left his job at the metal company, and went into full-time business with Leo. They collected all across Canada, the eastern U.S., and even down into South America. As *The Boston Miners* they did many mineral shows, including Tucson (for 27 straight years), Springfield, Franklin, Baltimore, Topsfield, and a great many others.

They got into large-scale specimen mining in the late 1980's, forming (with three other collectors) a group they called the "Resurrection Miners," whose mission it was to resurrect old mineral localities and make them produce anew. Their main project was the Wise mine in New Hampshire, a classic locality for green fluorite. They took in heavy equipment and brought out a significant quantity of beautiful green fluorite, including facet-grade material, for several years.

Leo Vaught, Don's partner, is disabled and will be selling the business. He can be reached at 72 Bowdoin St., Malden, MA 02148.

Though not as well known to the rank and file collectors, because of being exclusively wholesalers, *The Boston Miners* handled a huge quantity of specimens during nearly three decades of operation. Many collectors today have specimens of theirs without knowing it. And many dealers from around the world will miss them as good sources of minerals and as good friends. ▨



Letters

GIVING FALSE DATA

I am fully able to understand and sympathize with the Szenics's desire to initially guard the identity of the type locality for what was ultimately named *szenicsite* (abstract in vol. 25, no. 1; correct locality given later in vol. 28, no. 5). However, I and probably many others do not appreciate intentional deception. Locations would be better left unspecified until such time as they may be safely divulged. Deception could cause serious embarrassment for bona fide dealers to whom they supplied material for resale with the false locality on the label.

Jim Knight
Manchester, England

KINGSBRIDGE

Thanks to Lawrence Conklin's finely researched article on Kingsbridge, readers now share a much greater appreciation of the collecting potential beneath the streets of Manhattan.

Mr. Conklin's meticulous documentation and attention to detail are fully noted. However, Figure 16 is erroneously captioned as being marble waste excavated from the Harlem Ship Canal. The photo actually shows a collecting party at the diabase outcrop at Laurel Hill (also know as Snake Hill) in Secaucus, New Jersey. The photo shown and the one Mr. Conklin apparently intended to use both appear in James Manchester's *The Minerals of New York City and Its Environs* (1931).

Ralph Dames
New York

SINKANKAS COLLECTION

Over the years many mineral specimens have been sold from my collection. However, I find that a large number of 3 x 5-inch catalog cards that are supposed to have accompanied the specimens are still here. If you do not have such a card, please tell me the label information on the specimen itself, which will appear as a 1-cm label marked in india ink, beginning with "JS" and a bar, then the letters and numbers assigned to the specific piece. I'll be happy to send you the original card, if I still have it.

John Sinkankas
5372 Van Nuys Court
San Diego, CA 92109

CLINOCLASE STOLEN

During the period mid-June 1996 to the end of September 1996 a specimen of clinoclase went missing from the Curatorial Area of the museum. The specimen measures 9 x 7 x 5 cm, and consists of an aggregation of dark blue spheres on a brown matrix, and is clearly marked "C107." The specimen is of considerable importance, and any assistance given towards its return would be most appreciated. Its return would be under amnesty. Please contact the Curator of Cornwall Geological Museum, Alverton, Penzance, Cornwall, TR18 2QR, or telephone the museum on 01736 332400.

Colin Sparrow
Museum Trustees Group

PERUVIAN MINERALS

Just got the latest *Mineralogical Record* special on Peru—very nice! I've long had a fondness for Peruvian minerals, so it's very useful for me. I liked the occasional diary extracts as well; they brought it all to life. I recall a story told to me years ago by a visitor to the Peruvian mines. After a protracted negotiation over a box full of specimens a deal was finally struck to everyone's satisfaction and the dealer made to repack the pieces into the cardboard box. This triggered a lot of handwaving and remonstration: further negotiation and money was required to acquire the tatty box, a rare commodity in this remote mining camp and almost worth more to the miner than the contents!

I can confirm the production of fine **malachite** specimens from Yauricocha. Back in the 1960's as a young impoverished student I was in the habit of writing to mining companies asking for specimens and was lucky enough to acquire an interesting box of minerals from various Peruvian mines then operated by the Cerro de Pasco Corporation. Included in these was a 8 x 8-cm cavernous gossany mass of "limonite" lined with azurite microcrystals associated with a delicate belt of acicular malachite. I still have it. It's the only piece like it I've ever seen.

An omission from the descriptions of Peruvian **galena** is the occurrence of fine and unusual tabular spinel-law twins at Castrovirreyna and Quiruvilca. I came across the first of these among a few specimens in the mineral store of Gregory, Bottley and Co., London, in 1979. Only 2 out of 3 such galenas were left, one having already gone to the British Museum (Natural History). They all consist of masses of thin (ca. 3 mm thick), tarnished, twinned plates to 4 cm with slightly "melted" triangular growth marks on the broad faces, and are associated with small, rough **bournonite** crystals. The piece I have is 8 x 5 cm and consists almost entirely of galena plates with a little massive sphalerite, pyrite and galena on the underside. They came from Castrovirreyna. In 1985 I got another, this time from Quiruvilca. In this 7 x 5-cm piece the platy twins reach 1.5 cm and are brilliantly lustrous and sharp. They're partly overgrown with small, white, low-rhombohedral calcite crystals. A very attractive and unusual piece and, again, the only one I've seen. The Huaron mine also produced some excellent galena. A mining engineer friend of mine acquired a small suite of these when he was working out there in the 1970's. The piece I acquired from him in 1980 is a 7 x 6-cm matrix of fine-grained ivory-colored rock covered with small acicular colorless quartz crystals with mirror-bright and somewhat cavernous galena cubes to 1 cm or so scattered or intergrown among them.

Michael P. Cooper
Nottingham, England

My compliments to you and the three authors of the recent Peru Issue. My only comments are that I would like to have seen some discussion of the epidote occurrence in Ica province, and that I can suggest an additional reference not mentioned:

RAIMONDI, A. (1873) *El Departamento de Ancachs y sus Riquezas Minerales.* Published by Enrique Meiggs in Lima, "Imprenta de *El Nacional* por Pedro Lira," large octavo, 651 pages.

It covers Geography (p. 2–267), Geology (268–304), Mineralogy (305–594) and Meteoritics (595–633).

Bob Tichelman
Heemstede, Netherlands

Your *Mineralogical Record* issue dedicated to Peruvian minerals was one of the best in the history of the magazine—informative and a delight to read and view. As journals like the *American Mineralogist* go over more to mineral physics than mineral occurrence, this type of *Mineralogical Record* issue does a real service to the scientific community. Just thought you should know the views of the egg-heads like me.

David London
Univ. of Oklahoma, Norman

Kudos on the recent Peru Issue! I've only had the issue for two weeks now and haven't put it down once. Honest. For content it ranks among the *Mineralogical Record*'s best. It covered all of the important specimen-producing areas, gave exact location information, and the list of species each locality is famous for. The personal insights into the features that distinguish each mineral from different localities are what make the issue so great. It obviously was not written by "armchair" mineralogists. I've spent the last week or so re-doing my labels and catalog cards accordingly. This was not so much a connoisseur's issue but rather a practical collector's issue. Well done, folks!

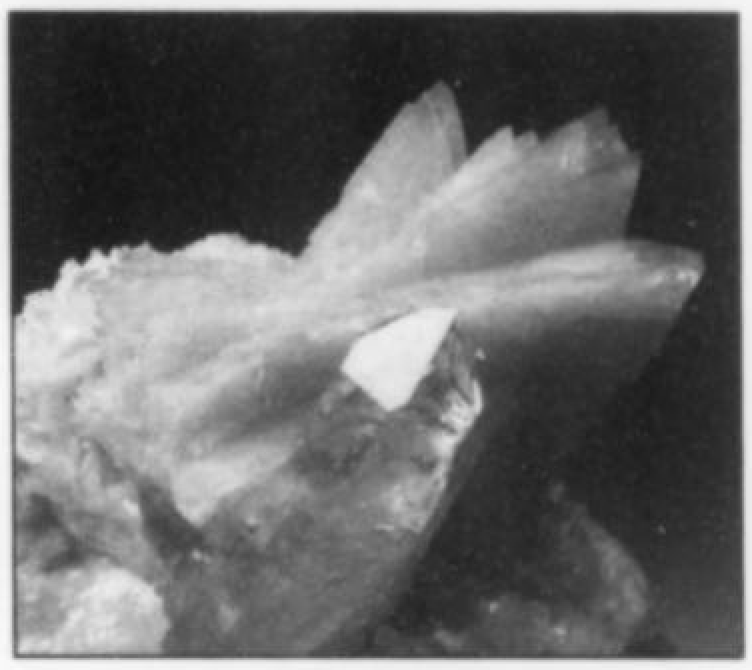
One question: I have several specimens from "La Oyra." Should I relabel them as from Quiruvilca, or as "purported from" La Oyra?

Roger Mitchell
Media, PA

"La Oyra" is a smelter complex located a short distance east of the Ticlio Pass, which lies east and above Casapalca. Back in 1985 a number of bournonite with pyrite specimens came out carrying the locality name "La Oyra." Terry Szenics visited the area to check this out and found that there are no mines at or near La Oyra. The piriteros, it turns out, had lied about the locality to conceal their actual source, which was Quiruvilca. Since then, other species have occasionally come out labeled "La Oyra," but they are probably from Casapalca (35 km away), Morococha (23 km away) or San Cristobal (15 km away). *J. Crowley*

The Pasto Bueno rhodochrosite illustrated on page 35 of the Peru Issue was acquired by the Smithsonian many years ago. Chip Clark's photo of it was used on the cover of my book, *The Smithsonian Treasury, Minerals and Gems* (1991).

John S. White
Stewartstown, PA



Helvite, 1.5 cm, from Galerie Elisabeth, Cavnic, Maramures, Romania. Ralph Clark collection.

Helvite crystal, 5 mm, on manganoan calcite, from the Pachapaqui mine, Ancash Department, Peru. Peter Faust collection.

WRONG HELVITE

Due to a photo mix-up in the editorial office, the wrong helvite was pictured in the Peru Issue, *page 45, Fig. 47. The specimen shown is actually from Cavnic, Romania. The correct, Peruvian helvite is shown above. We regret the error.* *Ed.*

A FRANQUEIRA

I mentioned to Miguel Calvo, author of the recent article on emerald crystals from "A Franqueira," Spain, that this locality spelling looks strange. Here is his response. Ed.

As you pointed out, "A Franqeira" looks very strange. This is because this word ("A") does not belong to the *Spanish* language, but to *Galician* language, a peculiar language from this area. Galicia includes La Coruña, Lugo, Orense and Pontevedra Provinces. During the period of the Franco dictatorship (1936–1937), the only official language in Spain was Spanish, and all geographical names were changed. The legal name of "A Franqueira" became "Franqueira" (without A, but also without La), the name of A Caniza was La Cañize (with La, and ñ), Ponteareas was Puenteareas and so on.

With the recovering of the democracy, local languages (Galician, Basque and Catalan) became official in their areas once again, and local names were recovered. Large towns now have two official names, in Spanish and in the local language (Bilbao is Bilbo in Basque). For large towns, the "international name" is the Spanish name (Bilbao). Some middling and small localities also have two names: Errigoiti is the Basque name of Rigoitia, a locality producing fine datolite crystals. Arrasate is the Basque name of Mondragón, with some interesting smithsonite mines. Both names can be used, and the preference depends on the specific locality. Small and very small localities (as A Franqueira) have only one name, their local name. The "Spanish" name is in most cases only a deformation that disappeared when the political deformation disappeared.

So then, in my opinion, the correct names for these towns are A Franqueira and A Caniza.

Miguel Calvo
Zaragoza, Spain

RAMSBECK MINERALS

In Tom Moore's last Tucson Show report (1997) he mentions some superb **pyromorphites** from Ramsbeck. These were found in 1996 by collectors working underground. Crystals of that quality were never recovered during the main period of commercial mining at Ramsbeck.

Other minerals of world-class quality have also been found at Ramsbeck, including: **imiterite** (best known crystals, up to 1 cm), **ullmannite** (best known crystals, up to 2 cm), **bottinoite** (richest specimens known for the species), **gerhardite** (richest specimens known for the species), **millerite** (in single, free-standing crystals up to 7 cm) and **galena** in superb spinel-law twins.

Georg Gebhard
Waldbröl, Germany

STANDARDS OF AESTHETICS

Considering that only subjective standards seem to be used for aesthetic criteria in judging and evaluating mineral specimens, I would be interested to know specifically what standards are used in giving awards at [American] mineral shows. I would like to know if the same standards are in use throughout the whole of the United States, or whether they are only used by the clubs which sponsor shows.

François Bussat
Geneva, Switzerland

Your best reference to the question of aesthetics, and the broader subject of connoisseurship, is the essay Connoisseurship in Minerals *in vol. 21, no. 1. Judges at shows are usually selected for their own level of connoisseurship, a factor which then determines the quality of the judging. They are not given detailed aesthetics standards to use. Most connoisseurs at the highest levels are in* general *agreement about standards, though there may be subtle differences in emphasis from Eastern to Central to Western states, from America to Europe, and among the regions of Europe. Questions such as "how much matrix is ideal?" have never been codified anywhere, but most factors are generally agreed upon without debate. Ed.*

FAITHFUL READER

My husband, Herbert C. March, M.D., died on November 23, 1996. Your *Mineralogical Record* was a source of great pleasure to him. When, because of his illness, he was no longer able to go to the mineral shows, he would read the *Record* from cover to cover. He was greatly interested in minerals, and had a beautiful collection which was his pride and joy.

Doreen March
Elkins Park, PA

OUTOKUMPU

Recently I had occasion to correspond with the Outokumpu Copper Company in Finland, regarding a publication, and I took that opportunity to enquire about the current production of their famous uvarovite specimens. Their response (below) is worth nothing. Ed.

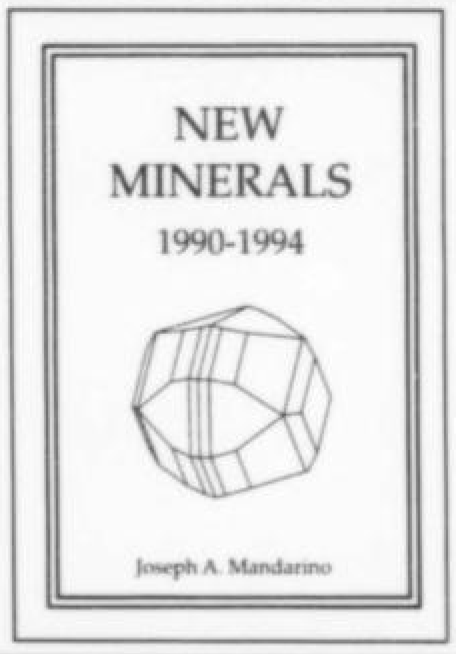
You asked about uvarovite crystals. I phoned the Outokumpu Mining Office and learned that these crystals are no longer available. The Keretti mine in the town of Outokumpu was closed down in 1989, and the last time that uvarovite specimens were recovered there was some time in the 1980's.

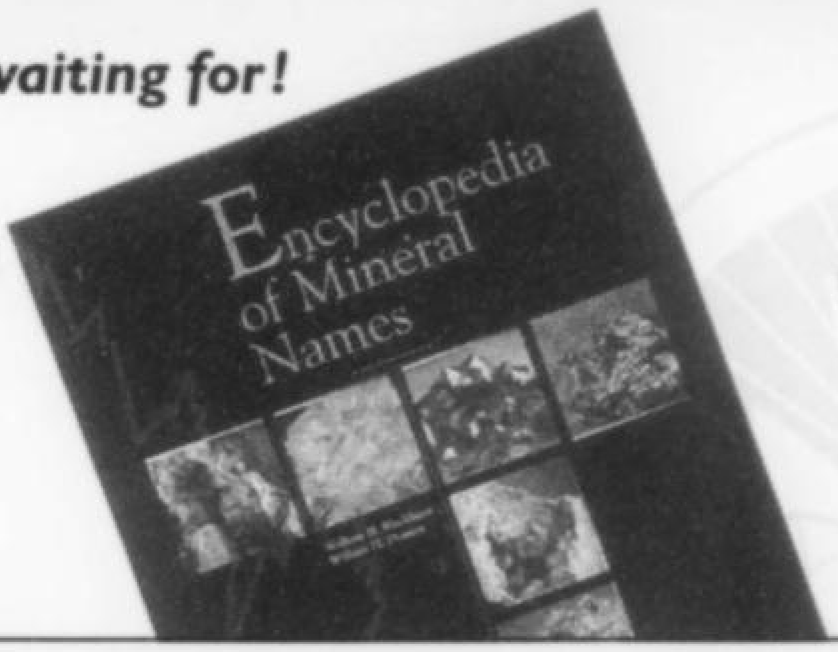
Pirkko Koivula
Outokumpu Copper Products Oy

CALL FOR POSTERS

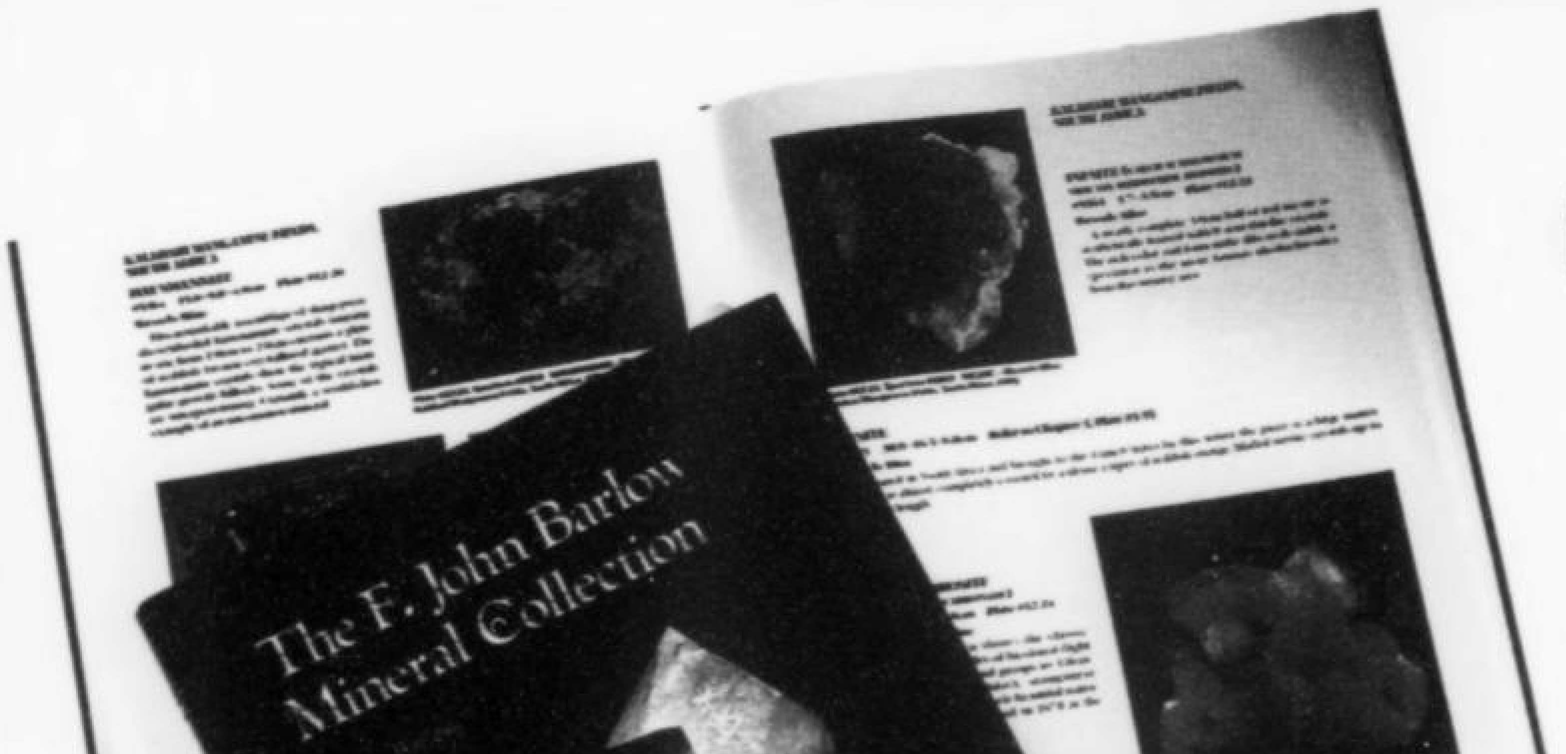
The Gemological Institute of America will host the 1999 International Gemological Symposium in San Diego, California, on June 21–24. More than 2,000 people are expected to attend this pivotal event. The symposium program—with the theme "Meeting the Millennium"—will feature technical sessions and panel discussions on a variety of topics of vital interest to all members of the gem and jewelry industry. In addition, there will be an open Poster Session featuring original presentations on such topics as new gem materials, synthetic gem materials, treatments, gem identification and grading instrumentation and techniques, gem localities, gem exploration, jewelry manufacturing, and jewelry design.

Contributions are being solicited for this Poster Session. To be considered for this important event (space is limited), please submit a preliminary abstract (no more than 250 words) to one of the Poster Session organizers by October 1, 1998. For further information on the Poster Session, contact Dr. James Shigley at 760-603-4019 (Fax: 760-603-4021, e-mail: jshigley@gia.edu) or Ms. Dona Dirlam at 760-603-4154 (Fax: 760-603-4256 or e-mail: ddirlam@gia.edu). For information on the Symposium, contact Carol Moffatt at 760-603-4406 (cmoffatt@gia.edu).

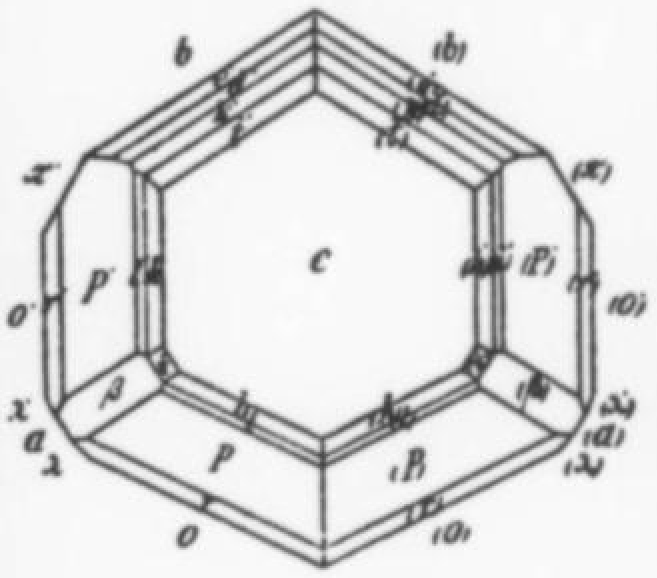




Encyclopedia of Mineral Names



The F. John Barlow Mineral Collection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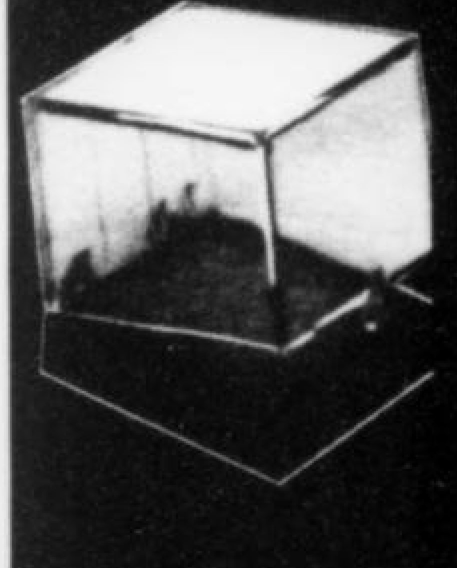

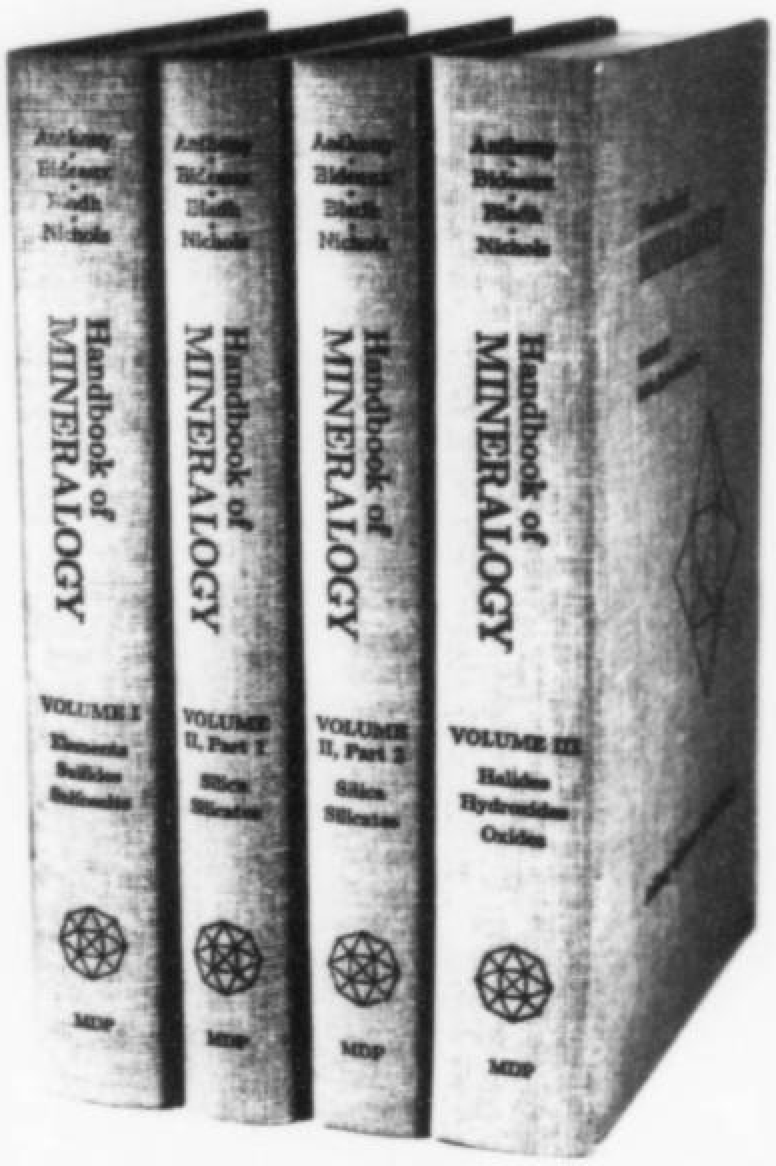
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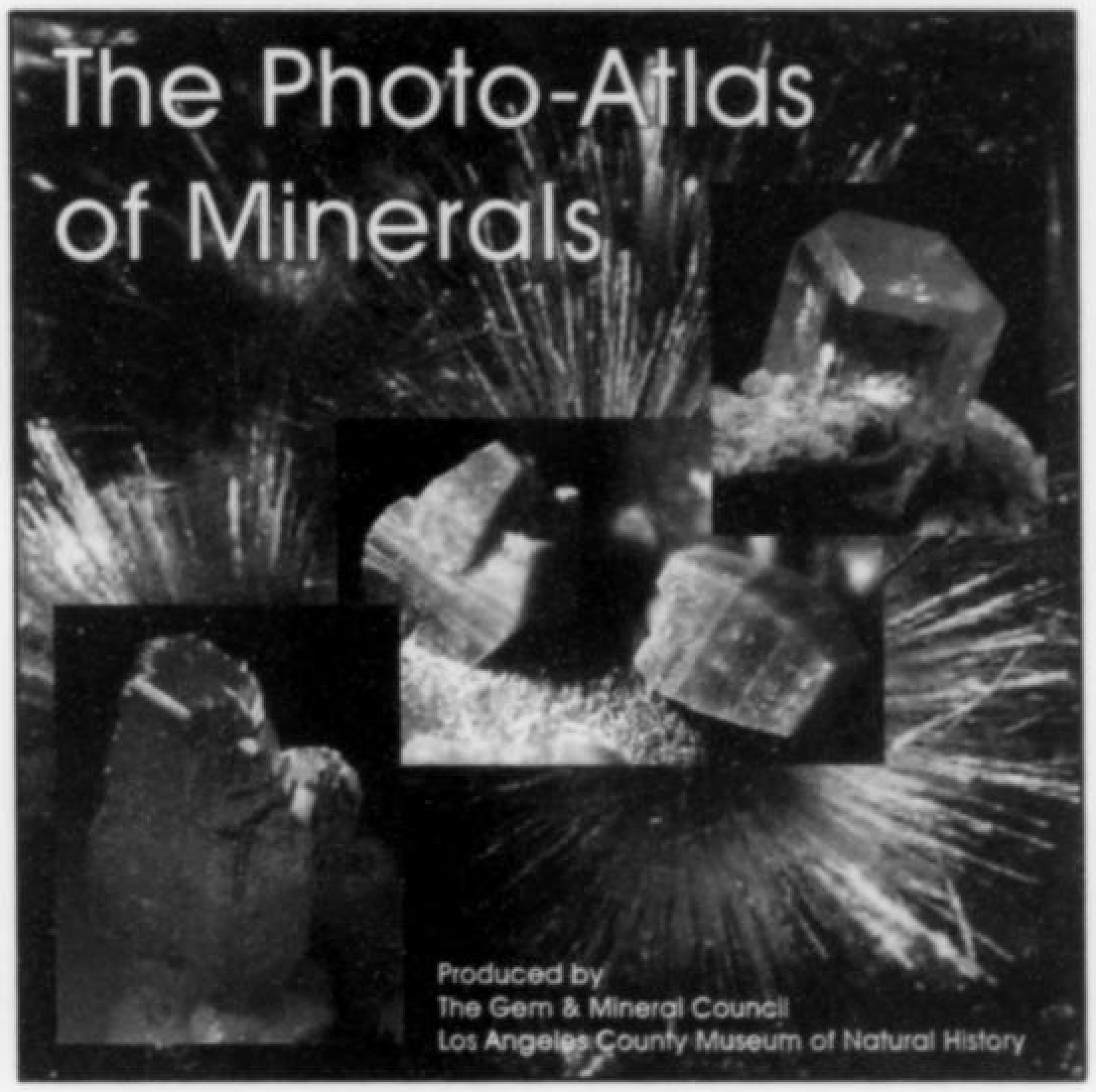

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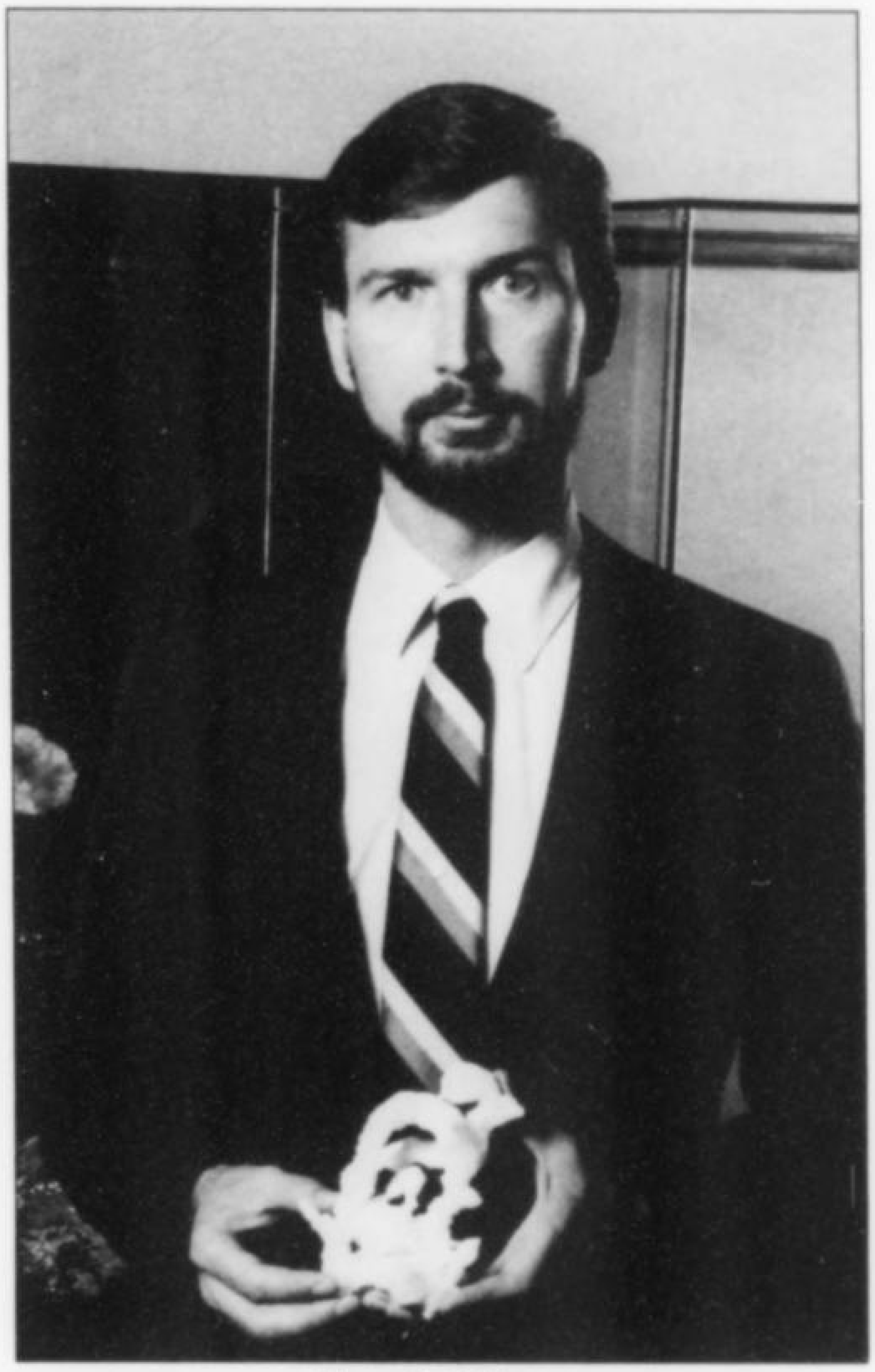
BEST ARTICLES AND THEIR AUTHORS

Saturday night at the Tucson Gem and Mineral Club show is devoted, in part, to the presentation of prizes and awards, including the FM announcement of the best article in the previous year's *Mineralogical Record.* A panel of five judges appointed by the vice president selects the article which, in 1992, was "The Michigan Copper Country" by Marc L. Wilson, New Mexico Bureau of Mines and Mineral Resources, and Stanley J. Dyl, II, Seaman Mineral Museum, Michigan Technological University. Wendell E. Wilson, in his introductory remarks to that issue, opens by writing that the first European to own a specimen of Keweenaw copper was probably Samuel de Champlain (1557–1635), French explorer and founder of the city of Quebec (1608), and closes with:

> It seems like an almost impossible task simply to read everything about the Keweenaw. But the farther one gets into the literature, the more tantalizing it becomes, and the more appreciation one feels as a collector for Copper Country minerals, books and collectible mining artifacts. The Copper Country indeed has a culture all its own, which is as deep and as old as the magnificent, cold blue lake that surrounds it.

There is also a brief commentary on "The Seaman Mineral Museum" of the Michigan Technological University, Houghton, by Wendell Wilson and Stan Dyl. The other 66 pages describe the history, geology, occurrences, copper and silver, and mineralogy of the mining and the minerals, with a selected bibliography. The article is well illustrated with excellent color photographs and numerous crystal drawings.

Imagine a scenario with two baby boys born in the same year, in the same month about four weeks apart, in different states. The career of each is influenced by an early interest in dinosaurs; one, five years old, by a toy; the other, in fifth grade, by reading about them in a Golden Book. These boys go on to become the co-authors of a prize-winning article:



Marc L. Wilson

1992—"The Michigan Copper Country"

(vol. 23, no. 2)

Marc L. Wilson was born in Ann Arbor, Michigan, on February 1, 1953, and grew up "in the Downriver area of greater Detroit." Most of his youth was spent in Grosse Ile, which he considers to be his hometown. His parents told him that before the age of five, he stumbled out of a field next to their Southgate, Michigan, home, clutching a little plastic dinosaur, determined to be a geologist. The only deviation from this goal occurred in junior high school, when his interests moved from paleontology to mineralogy. He was supported and encouraged by his parents.

While Marc was in high school, he attended a short introductory course in geology at Michigan Technological University conducted by Jean Kemp, then curator of the A. E. Seamon Mineralogical Museum. Later, as a student, he worked for Jean at the museum, learning many curatorial skills. Also while in high school, he met Louis Lafayette, a native of Grosse Ile but a high school teacher in Southgate, and one of the foremost mineral experts in Michigan. Through his association with Louis Lafayette, Marc learned much about mineral identification, associations and locations not readily available through formal academic studies. Although professional mineralogists Albert Routsala of Michigan Tech and Bill Roberts of the South Dakota School of Mines influenced Marc considerably, it was Louis Lafayette who was his "guiding light."

Marc's infatuation with native copper dates back to his interest in minerals per se and led him to Michigan Tech in the Copper Country. His study of the copper deposits began in 1971. By 1980, friends including Stan Dyl urged him to publish his observations. He and Stan have been friends since the mid-1970's when they were graduate students together, fenced at the same club on campus, attended the same church and shared the same love for the

Copper Country. It was only natural that they co-author this undertaking.

Marc received his B.S. degree in geology from Michigan Technological University, Houghton, Michigan, in August 1975 and his M.S. degree in geology in August, 1979. As a professional geologist, Marc Wilson has worked for Riomex; St. Joe American Corporation, as head of geological interpretation for GeoSpectra Corporation; as mineralogist for the New Mexico Bureau of Mines and Mineral Resources; and, currently, is Collections Manager and Head, Section of Minerals, the Carnegie Museum of Natural History. He is a member of the Mineralogy Society of America, Michigan Mineralogical Society, United States Naval Institute, and Society of Mineral Museum Professionals (SMMP).

Other activities include competitive fencing, cross-country skiing, mineral collecting and photography.

Stanley Joseph Dyl II was born in Buffalo, N.Y. on February 28, 1953. He attended the Adlai E. Stevenson High School in Livonia, Michigan, before enrolling at Eastern Michigan University, Ypsilanti, Michigan, from which he received a B.S. degree in geology in June 1974. He was granted an M.S. degree in geology by Michigan Technological University, Houghton, in November of 1979. He has also said that his interest in geology started when he was a boy and dinosaurs caught his attention.

Stan has wide experience and extensive knowledge with museum management and curatorial practices. He served as Museum Aide at the A. E. Seaman Mineralogical Museum beginning September 1, 1976, as Research Assistant in 1979, as Senior Museum Assistant, 1981–1986, as Curator (1986–1996), and is currently Director.

Stan Dyl was the recipient of a number of awards announced in the early months of 1993. Not only was he the co-author of Friends of Mineralogy's best article award, but he was named to the Hall of Fame, Mineral Division, sponsored by *Lapidary Journal* and the Pioneer Museum; was named scholarship awardee by the American Federation of Mineralogical Societies, both based on his service in promoting interest and education in the earth sciences. He was also chosen by Blue Key National Honor Fraternity to receive the Clair M. Donovan Award presented annually to a member of the MTU faculty, staff or student body who contributed the most outstanding service to the university during the preceding year in a non-academic area.

Internationally recognized for expertise in the fields of minerals and mining. Stan frequently lectures at mineral shows, conventions and club meetings in the United States and Europe.

Stanley J. Dyl, II

He is a past president of the Copper Country Heritage Council and was a major force in creating the Keweenaw National Historic Park, is a member of the Copper Country Rock and Mineral Club and is a member of the Society of Mineral Museum Professionals. He organizes the Red Metal Retreat hosted by MTU each summer.

Stan's hobbies include calligraphy, historic home restoration, antiques, Copper Country mining history and following MTU hockey.

ACKNOWLEDGMENTS

Heart-felt thanks are due Marc L. Wilson, who answered the call for biographical information and a picture, and John Jaszczak, Michigan Technological University, who gathered together information on and pictures of Stanley Dyl and reviewed the manuscript.

OTHER BEST ARTICLES

The Best Article named for 1993 was "The Minerals of Greenland" by Ole V. Petersen and Karsten Secher, vol. 24, March/April; in 1994, "The history and apparatus of blowpipe analysis" by Ulrich Burchard, vol. 25, July/August; and in 1995, "The mineralogy, geology and occurrence of topaz" by Michael A. Menzies, vol. 26, January/February. These authors will be profiled in future installments of this column.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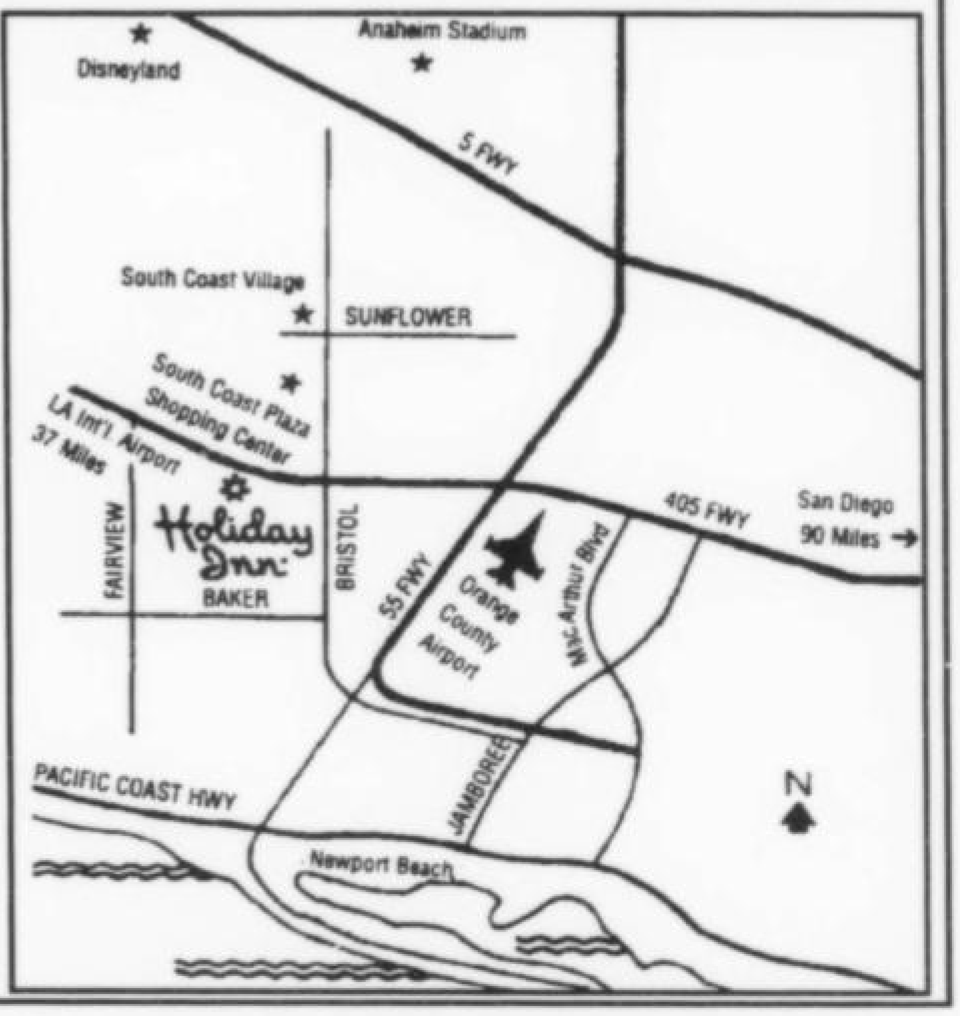
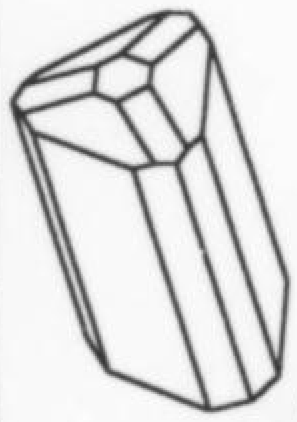
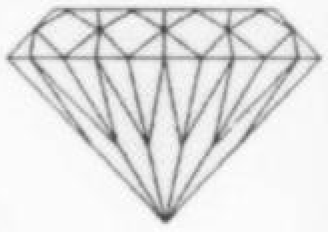


THIRD ANNUAL

The Spring Show in the Rockies





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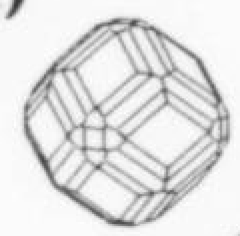

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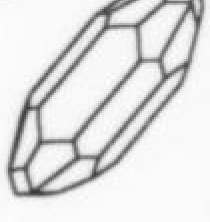

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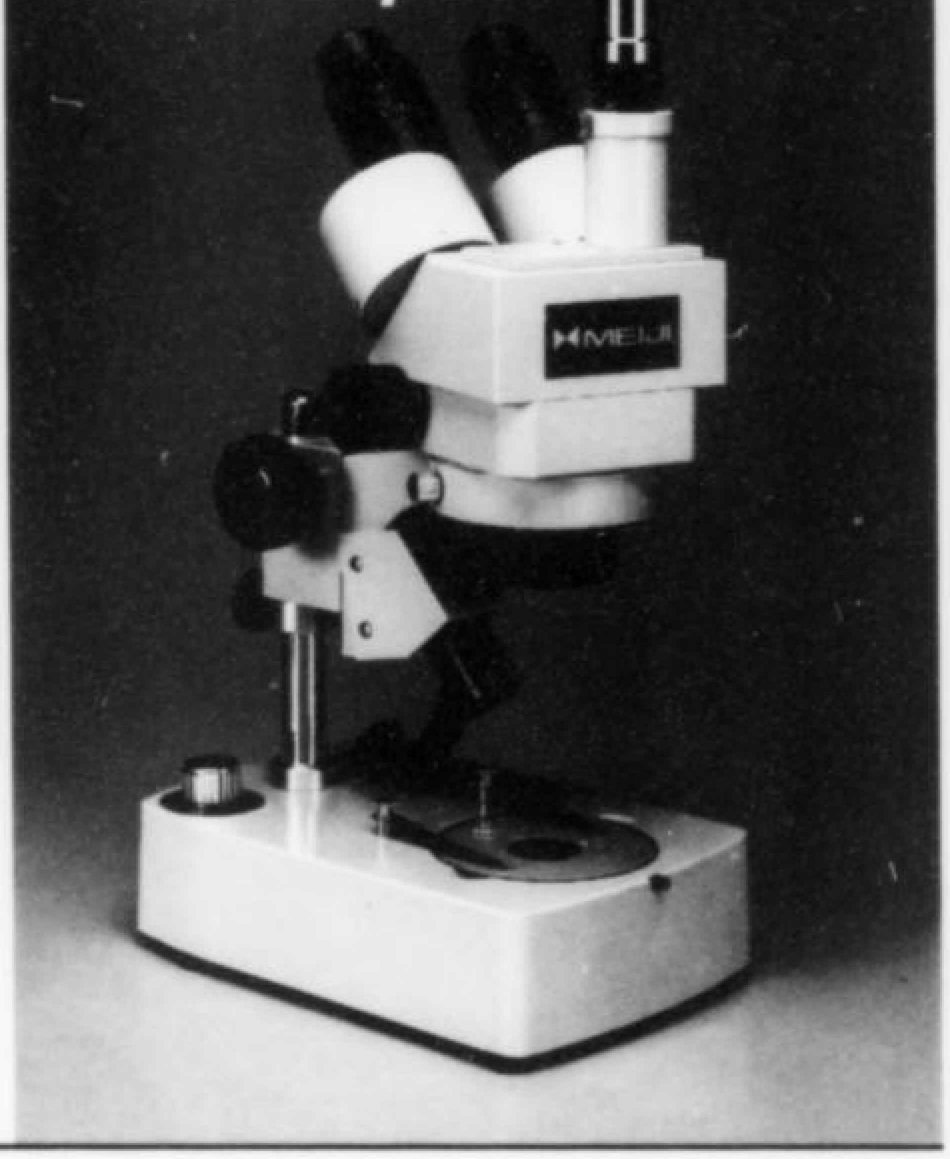

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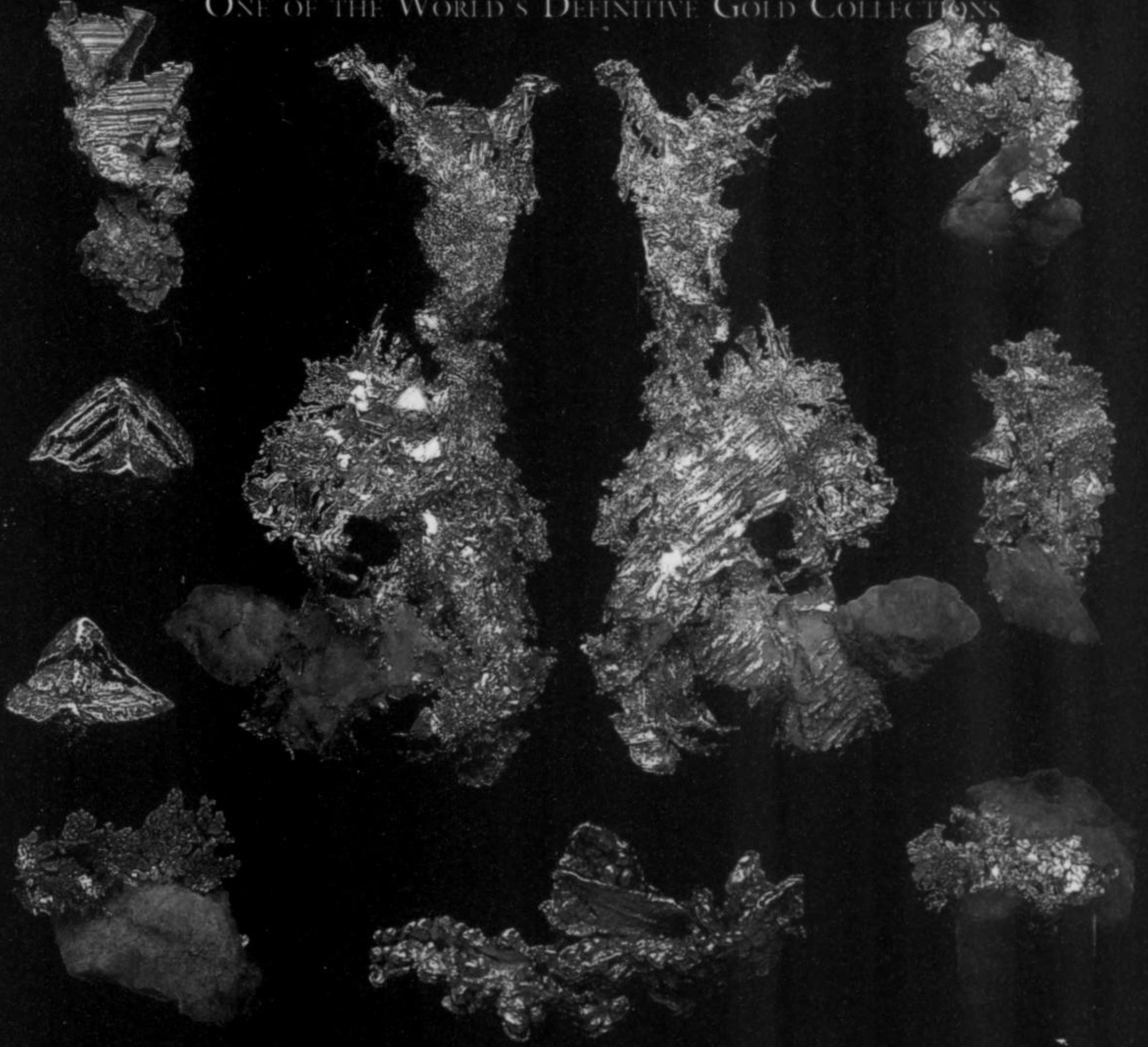

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