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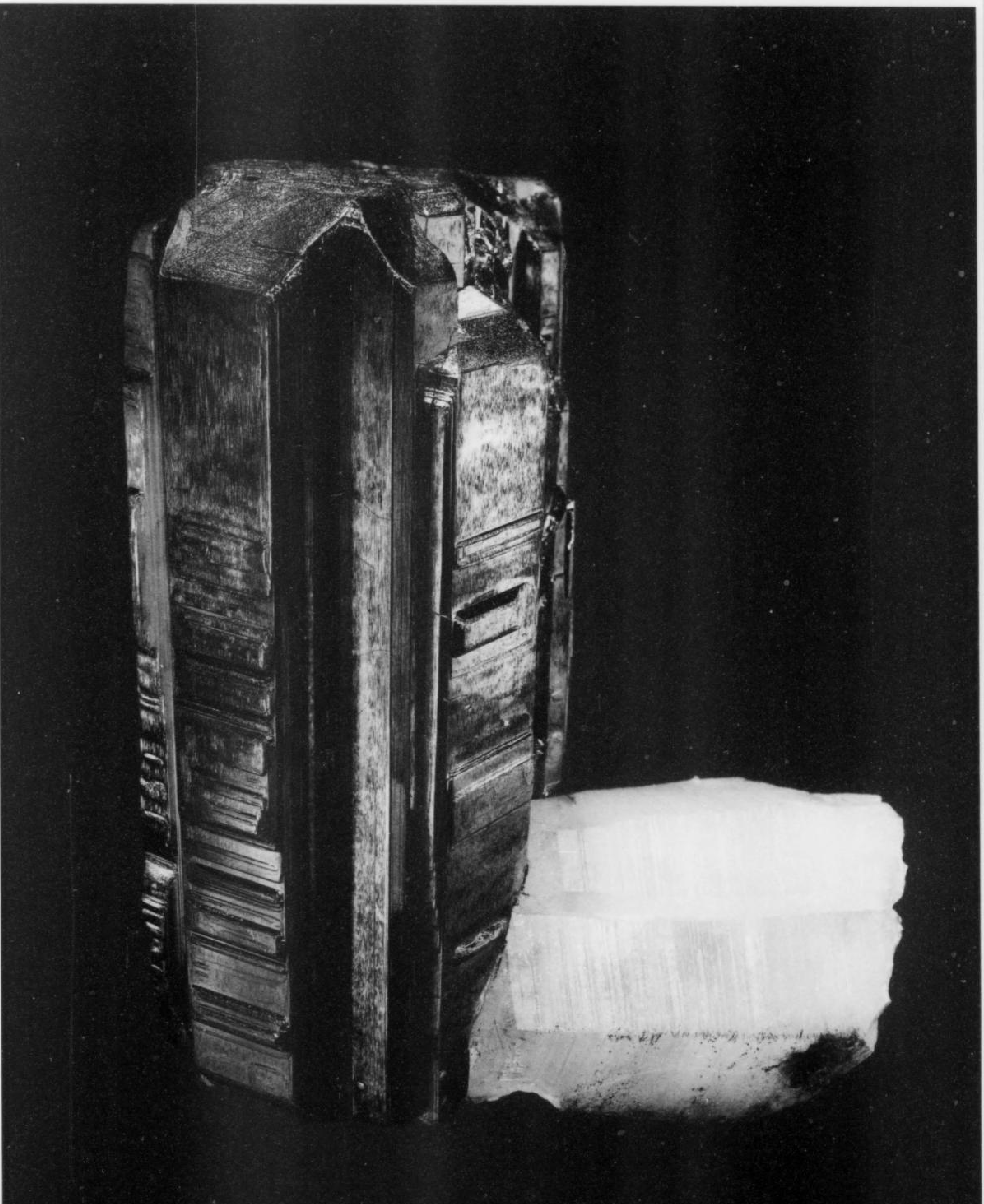

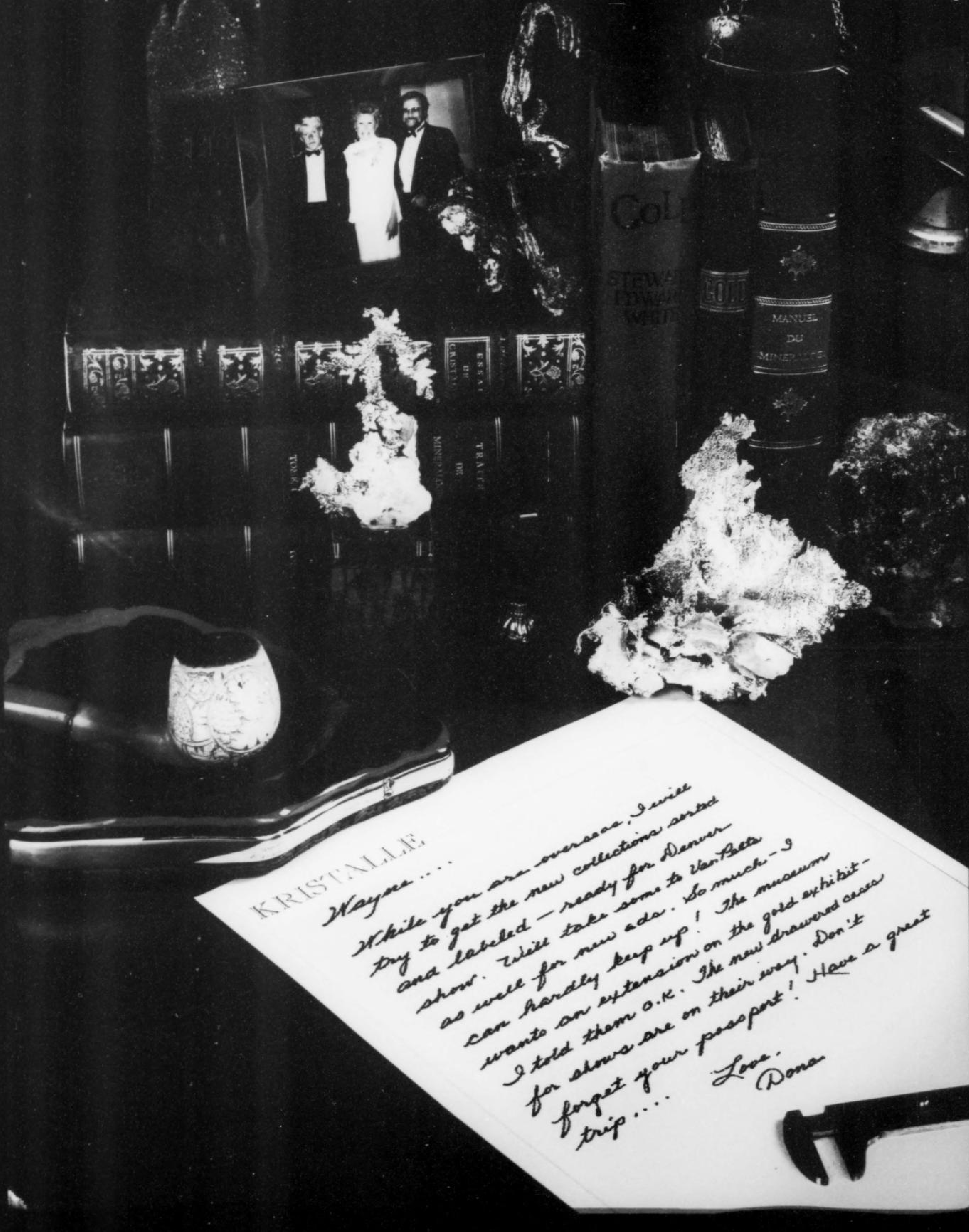
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COVER:
BOURNONITE crystal, 10.5 cm, with quartz, from the Yaogangxian mine, Hunan, China. Private collection; Jeff Scovil photo.

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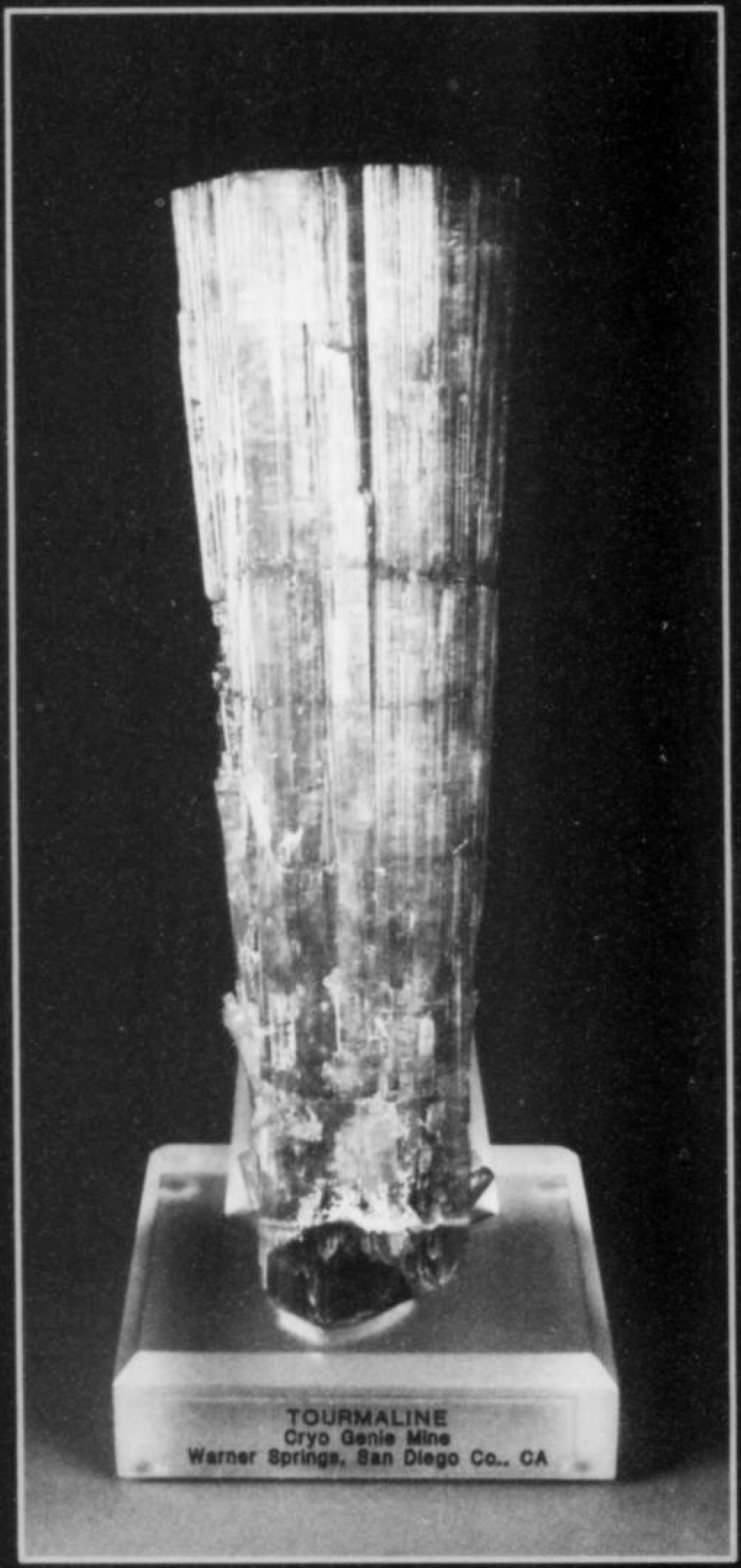

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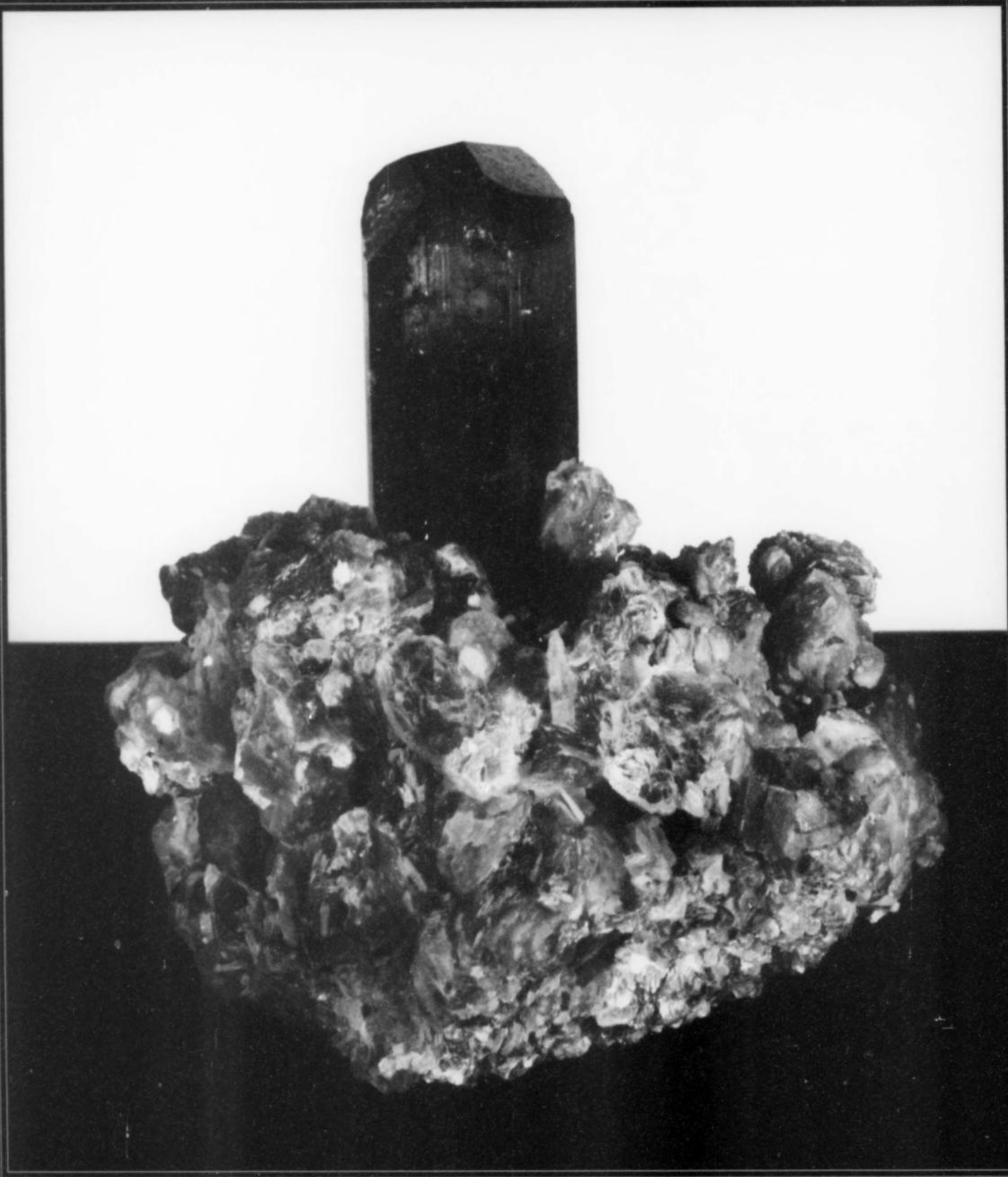

TOURMALINE on Lepidolite, Paprock, Afghanistan, 4 inches. From Stuart Wilensky in May 2002. Trinchillo to Wilensky to Fuss to Wilensky Collection. Earl Lewis calendar; Sunnywood Ad.

Clara and Steve Smale
COLLECTORS

PHOTO BY STEVE SMALE

THE PALITRA PEGMATITE

A NEWLY DISCOVERED HYPERALKALINE PEGMATITE IN THE LOVOZERO MASSIF, KOLA PENINSULA, RUSSIA

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The Palitra pegmatite, recently discovered during underground mining operations at a loparite deposit in the Lovozero massif, is one of the most interesting mineral localities within this famous alkaline complex. It has produced remarkable specimens of many rare minerals, including the world's best specimens of natrosilite and manaksite, and is the type locality for bario-olgite, kapustinite, pautovite and potassicarfvedsonite.

INTRODUCTION

The Palitra pegmatite, located on the northern flank of Kedykverpakhk Mountain in the Lovozero Mountains on the Kola Peninsula, is the largest known "dry" hyperagpaitic pegmatite in the Lovozero massif. Late-stage hydrothermal activity did not develop here (hence the term "dry"), and consequently remarkably fresh anhydrous and water-poor ultra-alkaline minerals rarely found or preserved elsewhere occur in the pegmatite.

Dry hyperagpaitic pegmatites are not rare in the deep levels of the Lovozero intrusion, having been encountered in underground mines at Mt. Karnasurt, Mt. Kedykverpakhk and Mt. Alluaiv. However, they are typically thin veins and lenses, usually not thicker than 5 cm (Khomyakov, 1995; Pekov, 2000). All famous Lovozero pegmatites, including pegmatites found at significant depths from the surface such as the Yubileinaya, the Shkatulka, and the Shomiokitovoye pegmatites, were altered by hydrothermal processes. Late-stage water-bearing minerals which have completely or partially replaced primary minerals are abundant in these pegmatites (Pekov, 2000). Although the existence of larger (up to 1 meter thick), only slightly altered dry pegmatites has been mentioned in earlier studies of the Lovozero massif (Khomyakov *et al.*, 1980), these pegmatite bodies were unstable when exposed to water, were never described in detail, and unfortunately no longer exist for comparison.

Therefore, it is both interesting and important to describe in detail a large, dry, differentiated hyperalkaline pegmatite, especially inasmuch as the Palitra pegmatite differs significantly from smaller pegmatites in its mineralogy. The author was fortunate to have been able to examine the Palitra pegmatite only a few days after its discovery, well before the moisture and dust of an operating mine had had time to exert their destructive influences on the typically unstable hyperalkaline minerals which form almost half of the polymineralic core of the pegmatite. Unique fresh material was collected immediately, permitting preservation of the many uncommon assemblages; subsequently, the minerals were studied intensively in the laboratory using chemical, optical and structural techniques.

In the course of this study we have found 46 mineral species in the Palitra pegmatite, including four new species accepted by the IMA Commission on New Minerals and Mineral Names: ***bario-olgite*** (IMA No. 2003-002), ***kapustinite*** (2003-018), ***potassic-arfvedsonite*** (2003-043), and ***pautovite*** (2004-005) (Pekov *et al.*, 2003b; 2004a,b; 2005). The world's largest masses and finest specimens of natrosilite (semitransparent single-crystal blocks up to 20 × 30 cm) and manaksite (crystals to 8 × 20 cm, some perfectly formed!) have been found in the Palitra pegmatite. Just as noteworthy are the pegmatite's remarkable, well-formed crystals of thorosteenstrupine (the first ever found), kazakovite, chkalovite,

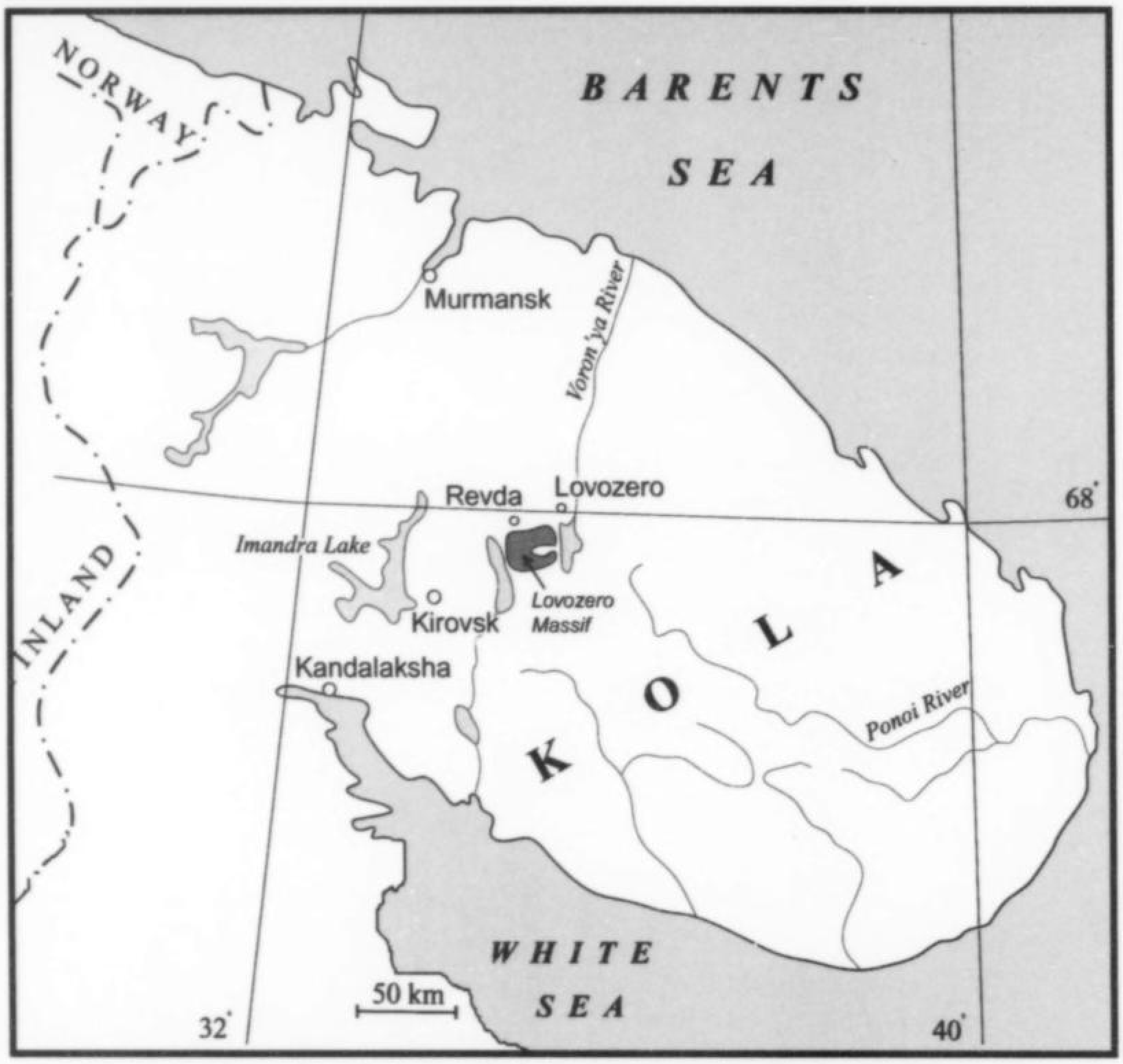

Figure 1. **Location of the Lovozero Massif in the Kola Peninsula, northern Russia.**

Figure 2. **Northeast cliff face of Kedykverpakhk Mountain, facing the slope of Mount Karnasurt, July 1995. N. A. Pekova photo.**

vuonnemite, nalipoite, revdite, minerals of the nordite-(Ce)/ferronordite-(Ce) series, very large segregations of zakharovite, villiaumite, plates of lomonosovite, the rare sulfides bartonite and chlorbartonite, and water-clear, gem-quality nepheline.

HISTORY

The Palitra pegmatite was discovered on August 20, 2002 by Pavel Rayanov, a miner, during construction of an inclined underground shaft in the Kedykverpakhk area of the Karnasurt mine. On the following day, Nickolay Pavlov, chief geologist of the mine, and geologist Ludmila Ksenofontova examined the pegmatite and noted the wonderful diversity of its minerals. For further study, they kindly invited the author and local amateur mineralogist Viktor Grishin to see the amazing assemblages that had been uncovered. Grishin proposed a fitting name for the pegmatite: the *Palitra* (in English, "palette"), in allusion to the large pods of brightly colored minerals (red villiaumite, pearly-white natrosilite, green aegirine, lilac ussingite, lemon-yellow vuonnemite, crimson sodalite, orange eudialyte, salmon-pink serandite, dark-brown lomonosovite and lorenzenite, etc.) that had been exposed.

GEOLOGICAL SETTING, MORPHOLOGY AND STRUCTURE

The Palitra pegmatite is situated within complex, layered urtite-foyaite-lujavrite rocks. Only the upper part and core of the pegmatite has been uncovered, the lower part remaining inaccessible to observation. Overall the Palitra pegmatite is probably lens-shaped, with a length of 7 meters and a thickness of more than 1.5 meters. The upper contact surface is inclined, dipping eastward.

The exposed portion of the Palitra is enclosed by foyaite. A layer of loparite-enriched malignite 10 cm thick lies above the pegmatite. In some areas, the foyaite is enriched by sodalite and villiaumite lenses up to 20 cm thick; these lenses lie between the pegmatite and the malignite layer. All contacts of the pegmatite with surrounding rocks are sharp. The Palitra pegmatite body has clear zoning in its upper part whereas its core is characterized by a "spotted" texture because of the chaotic distribution of areas of differing mineralization.

Immediately below the upper contact line, a nepheline zone 5 to 12 cm thick is developed in the pegmatite. Elongated nepheline crystals pointing downward form brush-like crusts, with eudialyte grains and dark green aegirine aggregates between the nepheline crystals.

Just under the nepheline zone is a eudialyte-aegirine-microcline zone. Its most striking feature is the abundance of fibrous green aegirine spheroids and hemispheres up to 30 cm in diameter. Also, this zone contains large blocks of microcline (up to 15 × 60 cm) and eudialyte (up to 6 × 20 cm) and long prisms of arfvedsonite (up to 5 mm × 15 cm). Aggregates of smaller individual crystals of microcline, aegirine, eudialyte, nepheline, sodalite, lorenzenite, lamprophyllite, etc., fill the interstices. Microcline blocks contain abundant inclusions of bright-red villiaumite. The eudialyte-aegirine-microcline zone is seen to extend into the bottom of the mine workings (i.e. its thickness is more than 1.5 meters), and it constitutes more than two-thirds of the exposed portion of the pegmatite.

Numerous pods of hyperalkaline minerals are found within this zone. The largest pods (more than 70 × 100 cm) occur in the central portion of the pegmatite body and can be considered its core. The major constituents of the pods are sodalite, analcime, ussingite, villiaumite and natrosilite, in variable ratios. Sporadically, lomonosovite, manaksite and natrolite become rock-forming

SOME PETROLOGICAL TERMS

(from JACKSON, J. A., Ed. (1997) *Glossary of Geology,* Fourth Edition. Alexandria, VA: American Geological Institute.)

Agpaite: A group of feldspathoid-bearing igneous rocks, first described from Ilimaussaq, Greenland, by Ussing in 1912, that includes sodalite-bearing nepheline syenite, naujaite, lujavrite, kakortokite, etc., and is distinguished by having (Na + K)>Al on a molecular or atomic basis. **Agpaitic** refers generally to crystallization in the presence of excess alkali elements, especially sodium, so that the amount of aluminum oxide is insufficient for the formation of aluminum silicates. **Hyperagpaite** is an extreme manifestation of this condition.

Alkaline rock: As defined by Shand in 1922, any igneous rock in which the molecular ratio [($Na_2O + K_2O$) : Al_2O_3 : SiO_2] differs from 1:1:6 by deficiency in either Al_2O_3 or SiO_2.

Foyaite: A nepheline syenite containing a predominance of potassium feldspar. Originally described by Blum as synonymous with nepheline syenite, and later applied by Brögger to nepheline syenite with trachytic texture. Its name is derived from Foya, Portugal.

Ijolite: A series of plutonic rocks containing nepheline and 30–60% mafic minerals, generally clinopyroxene, and including titanite, apatite and andradite; also, any rock of that series . . . urtite is a type rich in nepheline. Named by Ramsay in 1891 for Ijola (Iivaara), Finland.

Lujavrite: A coarse-grained trachytic eudialyte-bearing nepheline syenite, containing thin parallel feldspar crystals with interstitial nepheline grains and acicular aegirine crystals. The rock was originally described by Brögger in 1890 from Luijaur (Lujavr), now Lovozero, Kola Peninsula, Russia.

Malignite: A mafic nepheline syenite which has more than 5% nepheline and roughly equal amounts of pyroxene and potassium feldspar. The name, given by Lawson in 1896, is derived from the Maligne River, Ontario, Canada.

Rischorrite: A variety of nepheline syenite in which nepheline is poikilitically enclosed in microcline perthite. ("Poikilitic" refers to a texture in which small crystals of one mineral are irregularly scattered within a larger anhedral crystal of another mineral.) The name, given by Kupletsky in 1932, is for Rischorr in the Khibina complex, Kola Peninsula, Russia.

Urtite: A light-colored member of the ijolite series that is composed chiefly of nepheline and 0–30% mafic minerals, especially aegirine and apatite. The name, given by Ramsay in 1896, is for Lujavr-Urt (now Lovozero), Kola Peninsula, Russia.

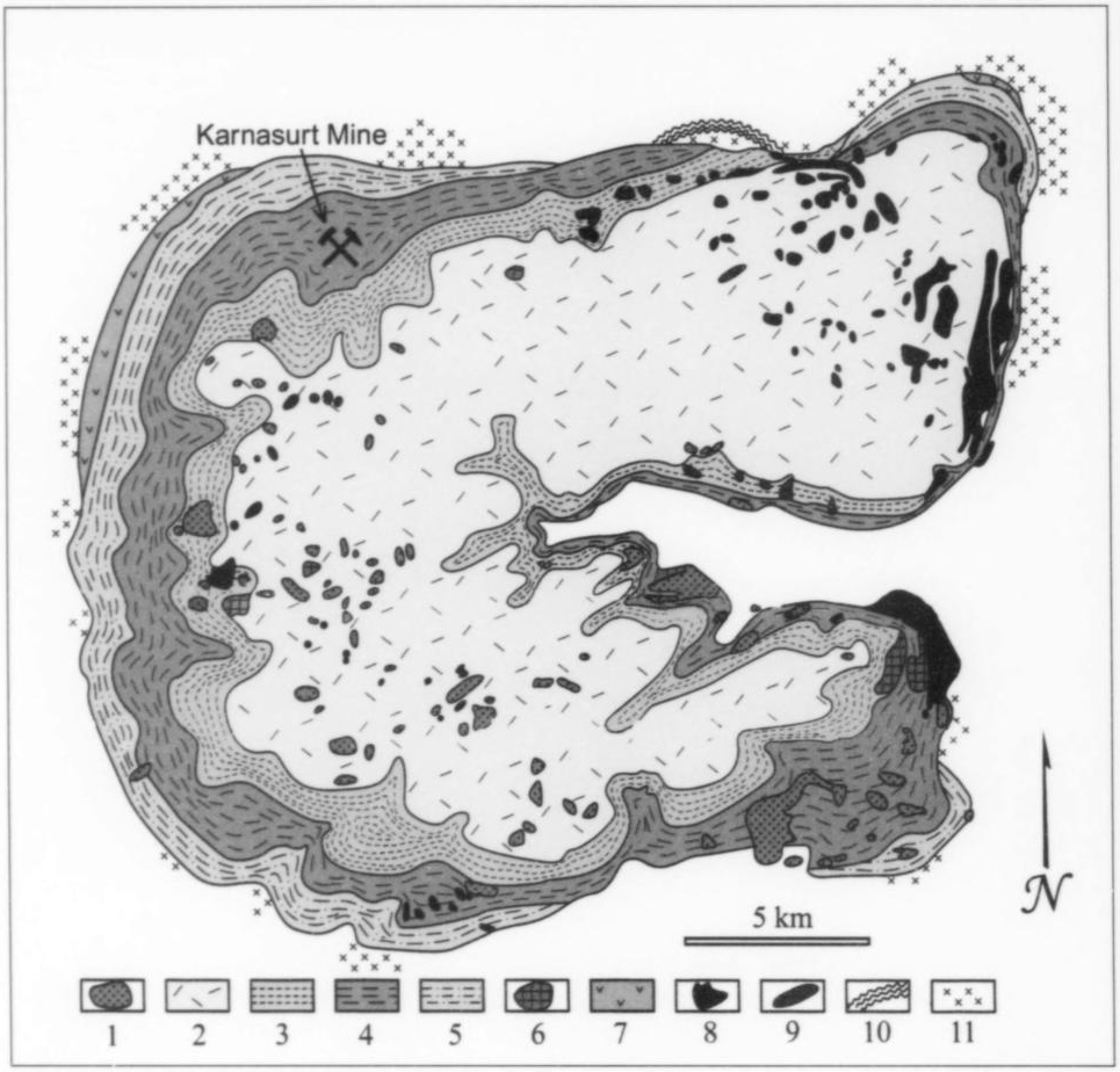

Figure 3. **Geologic map of the Lovozero Massif showing the location of the Karnasurt mine, Kedykverpakhk area. Compiled from the map by I. V. Bussen and A. S. Sakharov (1972) with additions by O. A. Vorob'eva and R. M. Yashina (Shchelochnye *et al.*, 1984). (1) Complex of poikilitic nepheline-sodalite and nosean syenites. (2) Complex of eudialyte lujavrites and porphyritic lujavrites. (3)–(5) Zones of the differentiated complex of lujavrites, foyaites and urtites. (3) Upper zone. (4) Middle zone. (5) Lower zone. (6) Porphyritic and non-porphyritic nepheline syenites. (7) Fine-grained foyaites of the endocontact zone and the near-roof portion of the massif. (8) Effusive formations of the Lovozero suite. (9) Devonian tuffaceous schists, sandstones and aleurolites. (10) Proterozoic quartz-silimanite schists. (11) Archean gneisses and granite gneisses.**

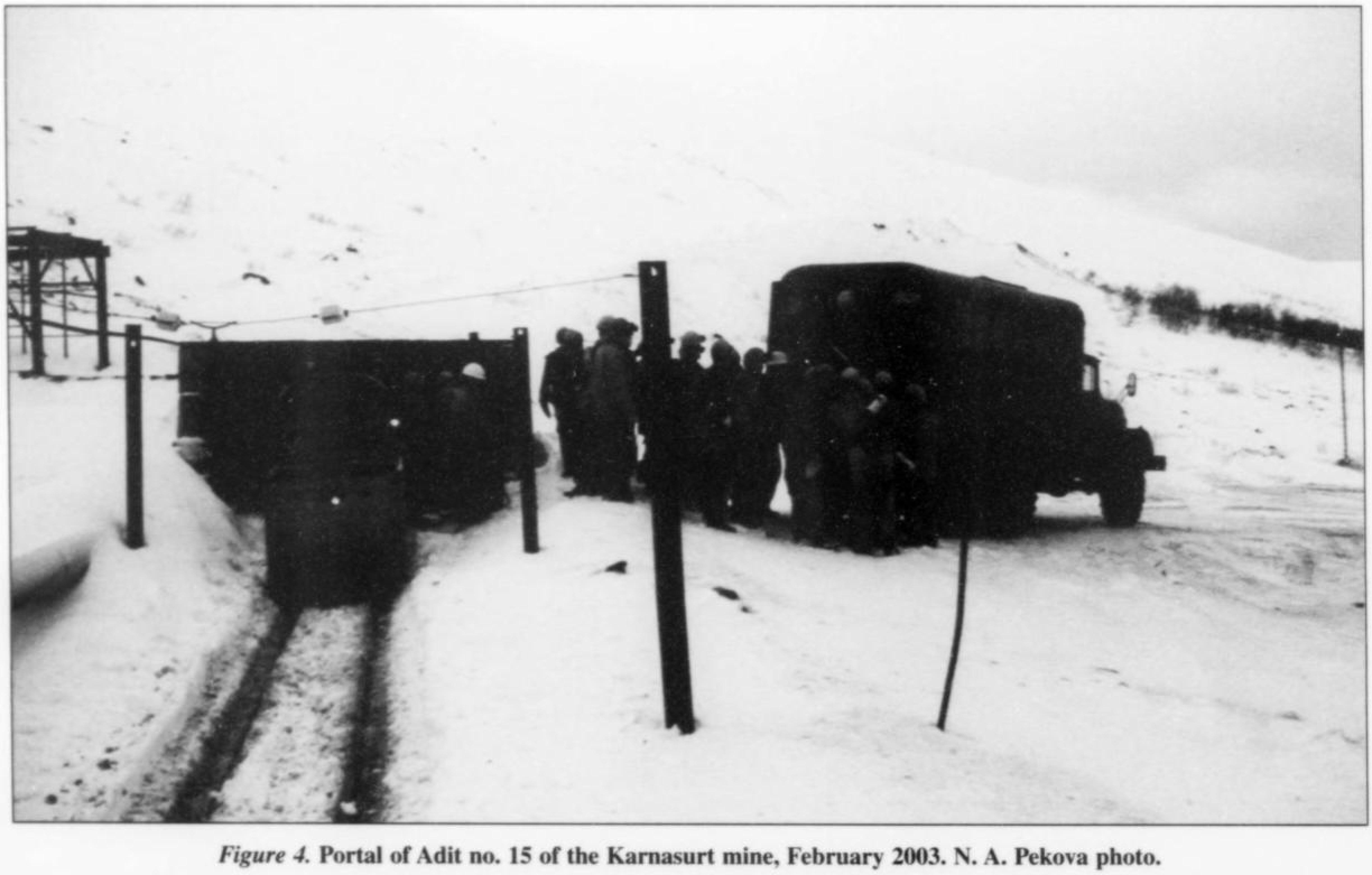

Figure 4. **Portal of Adit no. 15 of the Karnasurt mine, February 2003. N. A. Pekova photo.**

Figure 5. **Underground mine train in the Karnasurt mine. N. A. Pekova photo.**

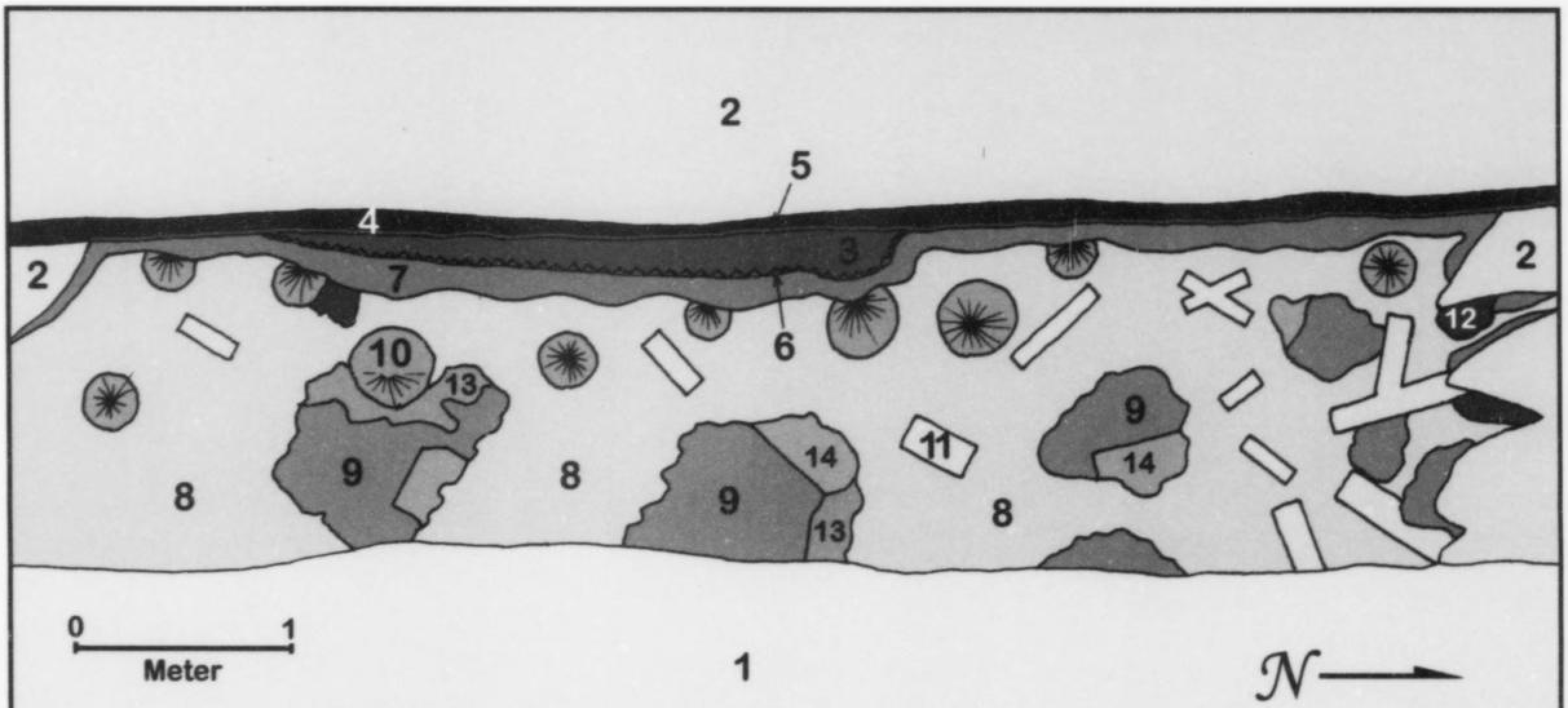

Figure 6. **Schematic cross-section showing the general structure of the Palitra pegmatite. (1) Footwall rock. (2) Foyaite rock. (3) Foyaite rock rich in villiaumite and sodalite. (4) Malignite rock rich in loparite. (5) Eudialyte-sodalite border. (6) Microcline-eudialyte-sodalite border. (7) Nepheline zone. (8) Eudialyte-aegirine-microcline zone. (9) Polymineralic nests consisting mainly of sodalite, ussingite, analcime, natrosilite and villiaumite with various rare species. (10) Aegirine spherules. (11) Microcline crystals. (12) Eudialyte. (13) Villiaumite. (14) Natrosilite.**

Figure 7. **Reddish purple sodalite, yellow manaksite and white natrosilite in situ with other minor minerals in the Palitra pegmatite. N. A. Pekova photo.**

minerals. Black aegirine, vuonnemite, serandite, sphalerite, steenstrupine-(Ce) and kapustinite are present in subordinate quantities, accompanied by accessory amounts of nordite-(Ce), ferronordite-(Ce), vitusite-(Ce), phosinaite-(Ce), kazakovite, barytolamprophyllite, mangan-neptunite, chkalovite, thorosteenstrupine, bario-olgite, nalipoite and löllingite. Rarely, small cavities contain revdite.

MINERALS

Aegirine $NaFeSi_2O_6$

Aegirine, an important rock-forming mineral in the Palitra pegmatite, is widespread in all zones and assemblages. Several aggregate habits differing in morphology and color have been found. Aegirine occurs most abundantly as green acicular crystals and fibers, forming spheres and hemispheres up to 30 cm in diameter, and also chaotic masses of crystalline aggregates. In most cases the aegirine spheres contain lomonosovite, lorenzenite or eudialyte in their centers. The largest aegirine crystals measure 1 mm × 15 cm. Black prismatic aegirine is a typical component of late polymineralic pods. An unusual variety of aegirine has been found as pseudomorphs after manaksite, associated with serandite; here it forms lath-like crystals up to 5 mm long, commonly split and curved. The crystals are color-zoned: orange-red to bright red in the middle sections, pale blue-green on the terminations, and yellow in intermediate parts. Some crystals have yellow-orange cores and olive-green terminations. It has been proposed, but not confirmed, that the red aegirine in the pseudomorphs after manaksite might be Mn-enriched; electron probe microanalyses indicate a common aegirine composition with $MnO \leq 1.7$ weight %. Black late-stage aegirine contains 3 weight % TiO_2.

Analcime $NaAlSi_2O_6 \cdot H_2O$

Analcime is widespread in the polymineralic core of the Palitra pegmatite. Massive, coarse-grained analcime aggregates up to 7 cm and sodalite-ussingite-analcime intergrowths have been observed. Sharp, gray to white, trapezohedral analcime crystals up to 4 cm are included in dark red villiaumite, associated with serandite and vuonnemite. The walls of cavities filled by villiaumite are lined by analcime crystals which may be partially or completely replaced by ussingite.

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

Arfvedsonite is a typical mineral of the eudialyte-aegirine-microcline zone. It occurs as black, poorly terminated, elongated prismatic crystals up to 5 mm × 15 cm, bounded by the faces {110} and {010}. Arfvedsonite "suns" up to 20 cm in diameter are not uncommon. The average chemical composition of arfvedsonite corresponds to the following formula: $(Na_{0.62}K_{0.32})_{\Sigma 0.94}(Na_{1.92}Ca_{0.08})_{\Sigma 2}$-$(Fe^{2+}_{2.13}Mg_{1.55}Fe^{3+}_{0.80}Mn_{0.26}Ti_{0.26})_{\Sigma 5}(Si_{7.66}Al_{0.29}Fe^{3+}_{0.05})_{\Sigma 8}O_{22}(OH)_{1.97}Cl_{0.03}$.

Bario-olgite $Ba(Na,Sr,REE)_2Na[PO_4]_2$

Bario-olgite, the barium analog of olgite, is a new mineral recently described from the Palitra pegmatite (Pekov *et al.*, 2004a). It occurs as equant, flattened grains to 1.5 cm, some showing a hexagonal cross section. Several well-formed prismatic crystals of bario-olgite up to 3 mm long were found by V. G. Grishin in a villiaumite cavity; the crystals show faces {100}, $\{\bar{1}00\}$, {101}, $\{\bar{1}01\}$, $\{10\bar{1}\}$ and $\{\bar{1}0\bar{1}\}$, as well as other faces visually similar to those found on quartz crystals. Unequally developed faces of four different pyramids illustrate the primitive symmetry. Bario-olgite is transparent and pale green, with vitreous luster and imperfect cleavage. It fluoresces strongly pinkish orange in shortwave ultra-

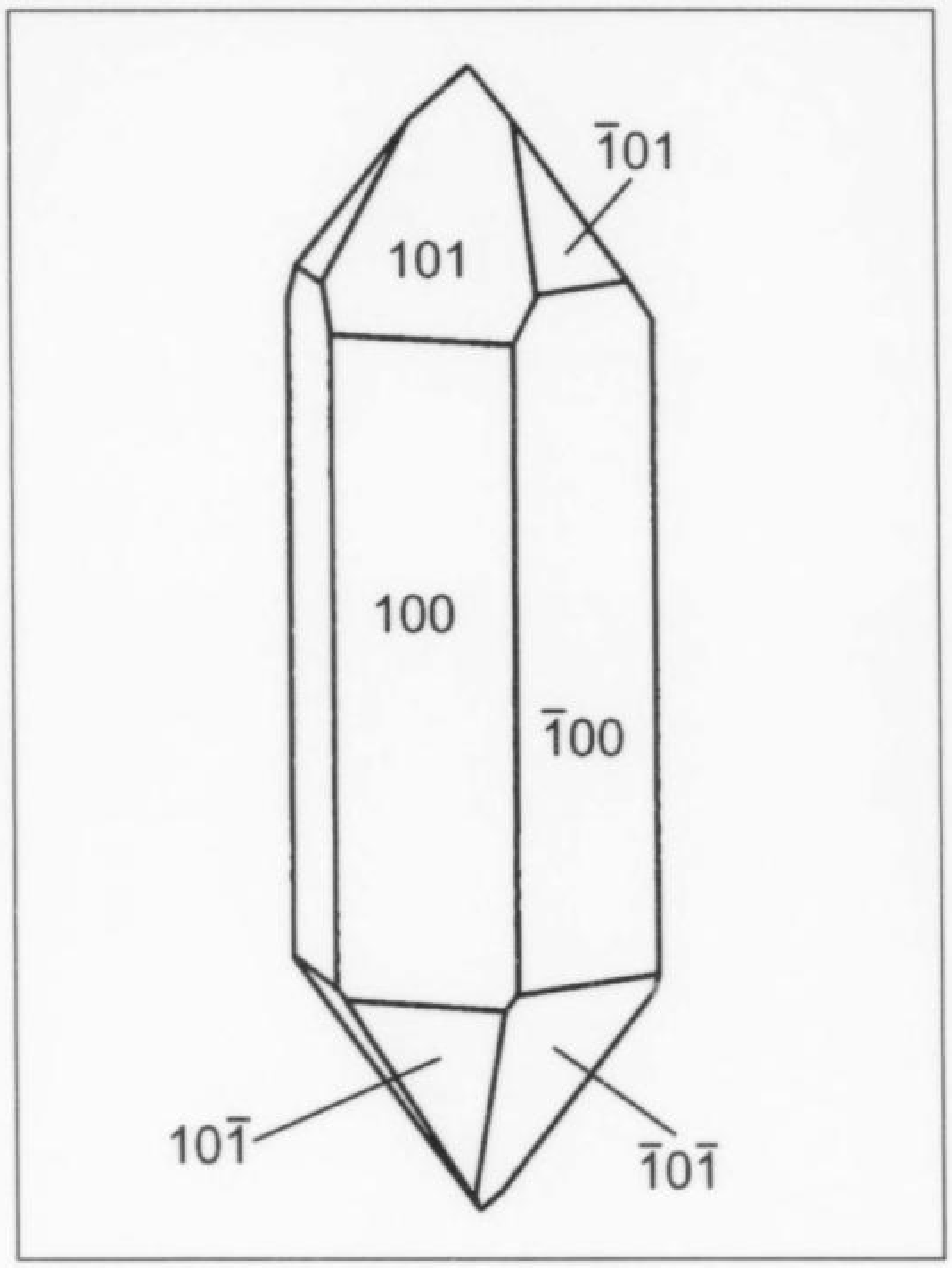

***Figure 8.* Bario-olgite crystal drawing; Palitra pegmatite.**

violet light and very weakly pinkish red in longwave ultraviolet light. Bario-olgite occurs in a manaksite-villiaumite-natrosilite assemblage; it commonly forms inclusions in manaksite and is found between manaksite and natrosilite, villiaumite, aegirine, vuonnemite, or chkalovite (Pekov *et al.*, 2004a).

Bartonite $K_6Fe_{24}S_{27}$

Bartonite has been found in the Palitra pegmatite, and (for the second time in Lovozero) in an ussingite-natrolite vein in the same Mt. Kedykverpakhk deposit (Pekov *et al.*, 2003a). Together with the visually indistinguishable chlorbartonite, it forms dark bronze-brown, granular masses (to 1 cm) with metallic luster. Both species were found in the upper part of the Palitra pegmatite body, associated with nepheline, eudialyte, lorenzenite, arfvedsonite, aegirine and villiaumite.

Barytolamprophyllite $Na_2(Ba,Sr)_2(Ti,Mn,Fe)_3(SiO_4)_4(OH,F)_2$

An Mn-enriched barytolamprophyllite is a rare late-stage mineral in the pegmatite. It forms golden yellow rosettes and spheroids up to 7 mm in diameter, consisting of radiating acicular crystals. It also occurs as golden brown, transparent, elongated lamellae to 4 mm overgrown epitactically on lorenzenite.

Belovite-(Ce) $Sr_3NaCe(PO_4)_3(F,OH)$

Belovite-(Ce) occurs as colorless acicular to hairlike crystals up to 3 mm long with hexagonal cross-sections. The crystals form cotton-like aggregates intergrown in villiaumite and perched on microcline and aegirine.

Bornemanite $Na_4BaTi_2NbSi_4O_{17}(F,OH)\cdot Na_3PO_4$

Bornemanite was found in a late-stage assemblage. It forms pale yellow to lemon-yellow spheroids to 2 mm in diameter, consisting of transparent, elongated lamellar crystals with pearly luster. It commonly forms overgrowths on lomonosovite and in some cases replaces it. Occasionally, bornemanite spheroids and rounded aggregates (to 1 cm) of curved scales are found intergrown in villiaumite and natrosilite.

***Figure 9.* Bornemanite crystals 0.2 mm wide, from the Palitra pegmatite. I. V. Pekov collection and SEM photo.**

***Figure 10.* Bornemanite spherulite 0.9 mm across, from the Palitra pegmatite. I. V. Pekov collection and SEM photo.**

Chkalovite $Na_2BeSi_2O_6$

Chkalovite occurs in the core of the pegmatite, closely associated with manaksite, natrosilite, bario-olgite, sphalerite and late-stage, bladed microcline crystals. Sharp, transparent, colorless, equant chkalovite crystals reach 3 × 5 cm. They are face-rich and complex, and in some cases they combine into clusters up to 8 cm across. Chkalovite crystals also occur commonly within manaksite aggregates.

Chlorbartonite $K_6Fe_{24}S_{26}(Cl,S)$

Chlorbartonite is a recently described new mineral from the Khibiny alkaline massif (Yakovenchuk *et al.*, 2003); it has also been referred to as "Cl-bartonite" in specimens from its occurrence at Coyote Peak, California (Czamanske *et al.*, 1981). The Palitra pegmatite is the first occurrence of the species in the Lovozero massif. Together with bartonite, it forms dark bronze-brown, granular masses to 5 mm × 1 cm. Numerous small (to 0.3 mm) flattened monomineralic chlorbartonite grains in ussingite and serandite were also found. Chlorbartonite was confirmed by its chemical composition and X-ray powder diffraction pattern.

Eudialyte $Na_{15}Ca_6(Fe,Mn)_3Zr_3Si_{25}O_{72}(OH,Cl,F)$

Eudialyte is widespread in peripheral parts of the Palitra pegmatite. It occurs as brownish red and orange-red irregular grains up to 6 × 20 cm and aggregates up to 30 cm. It is closely associated with aegirine, arfvedsonite, lorenzenite, microcline, nepheline, villiaumite, etc.

Figure 11. **Ferronordite-(Ce) crystal group, 5 mm, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

Ferronordite-(Ce) $Na_3SrCeFeSi_6O_{17}$
and **Nordite-(Ce)** $Na_3SrCeZnSi_6O_{17}$

Ferronordite-(Ce) and nordite-(Ce) form a continuous isomorphous series and are visually indistinguishable. Both minerals are typical of the late-stage assemblages. They form transparent, coffee-colored, well-formed tabular (flattened on {100}) crystals up to 5 mm, in most cases split and combining into groups, rosettes and spherules up to 1 cm. They overgrow ussingite, analcime and aegirine linings on the cavity walls. Commonly nordite-(Ce) and ferronordite-(Ce) are included in natrosilite and villiaumite. Samples from the Palitra pegmatite mostly correspond to intermediate members of the nordite-(Ce)/ferronordite-(Ce) series.

Galena PbS

Galena forms isometric grains and sharp cuboctahedral crystals (sometimes skeletal) up to 1 cm associated with sphalerite and löllingite.

Kapustinite $Na_{5.5}Mn_{0.25}ZrSi_6O_{16}(OH)_2$

Kapustinite, a new mineral of the lovozerite group discovered in the Palitra pegmatite (Pekov *et al.*, 2003b), was named for Yury L. Kapustin (1933–2002), an outstanding researcher who made great contributions to our understanding of alkaine complexes and who studied the lovozerite group in detail. Kapustinite forms equant grains from 5 mm to 4 cm and aggregates to 8 cm; some of the grains have rounded rhombohedral and hexagonal cross-sections. The mineral is transparent, with a dark cherry-red color, sometimes with a brownish tint, and a vitreous luster. No cleavage has been observed. The fracture is conchoidal. Kapustinite is an early-stage

Figure 12. **Nordite-(Ce) crystal cluster, 6 mm, on analcime, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

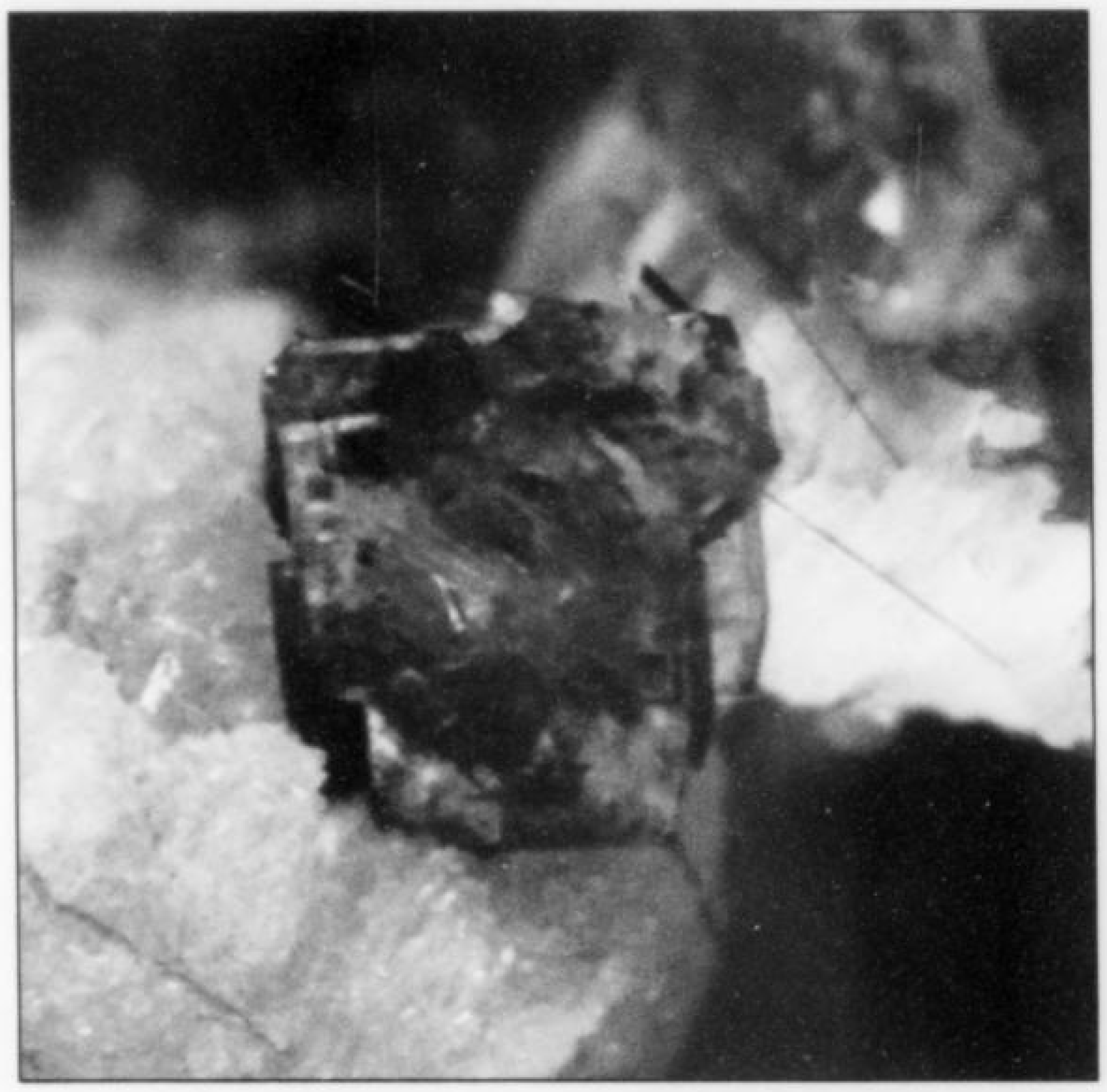

Figure 13. **Nordite-(Ce) crystal cluster, 4 mm, on natrosilite, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

mineral which crystallized simultaneously with blocky microcline and eudialyte. Kapustinite grains in sodalite, ussingite, analcime and natrosilite are often surrounded by kazakovite rims. In some cases the rims are more complex, their inner parts consisting of kazakovite and their outer parts of a mixture of ussingite and mangan-neptunite.

Kazakovite $Na_6MnTiSi_6O_{18}$

Kazakovite is a relatively common mineral in the core of the Palitra pegmatite. Its sharp, yellow-brown crystals to 7 mm show the faces of two rhombohedrons. The crystals are typically included in natrosilite. Equant grains of kazakovite to 1.5 cm occur in ussingite and sodalite. The grains are concentrically zoned: the dark brown cores are enriched by Zr (Ti : Zr = 2.5–3) whereas the honey-yellow peripheral zones are Zr-poor (Ti : Zr = 7–10). Transparent brownish yellow kazakovite rims to 3 mm thick sometimes surround kapustinite grains. Kazakovite in the Palitra pegmatite is very fresh and water-free. The occurrence of this mineral, typically very unstable in the presence of water, is one of the most convincing pieces of evidence that hydrothermal activity in the Palitra pegmatite has been absent, or at least insignificant.

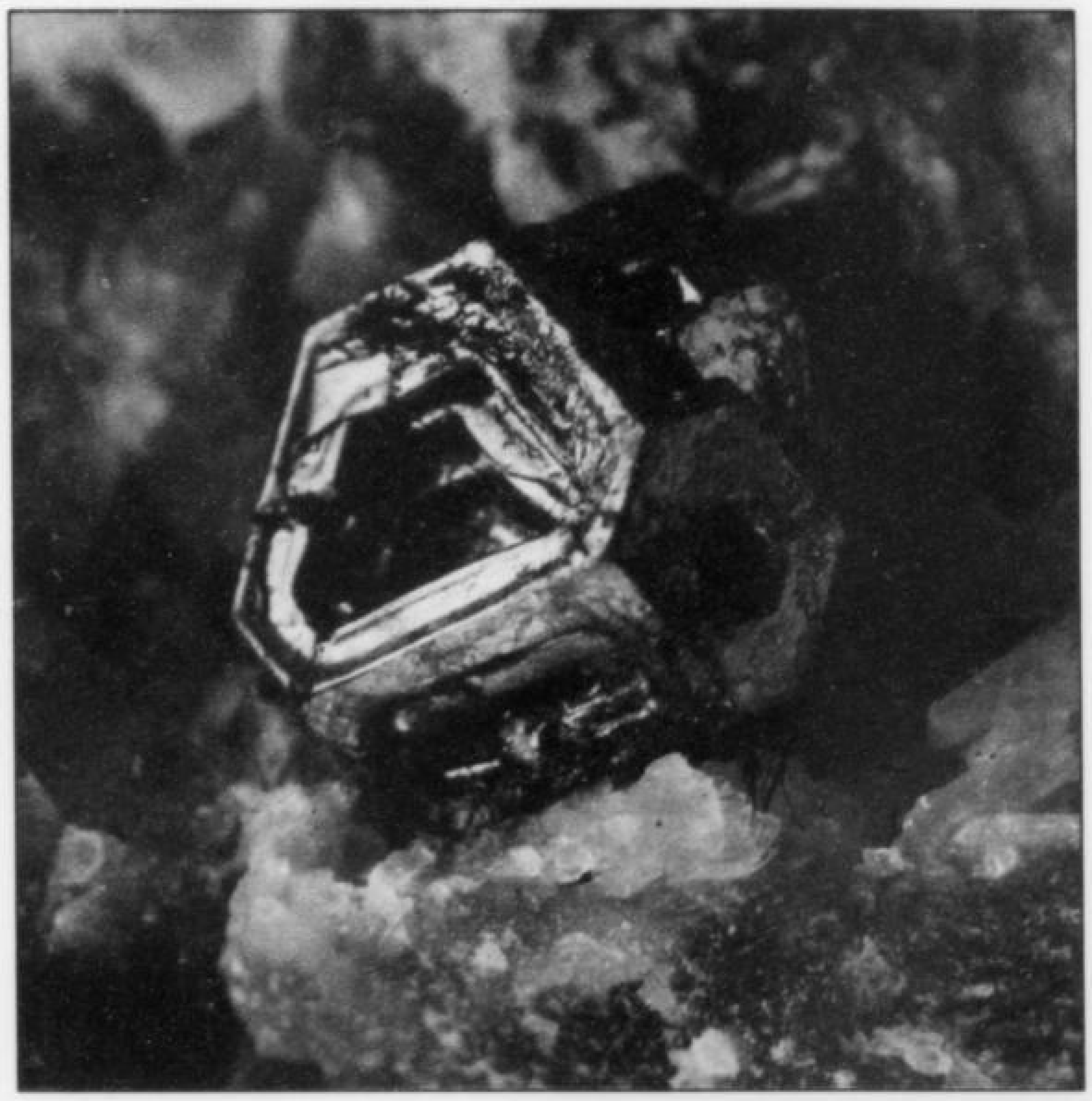

***Figure 14.* Cavernous galena crystal, 7 mm, on ussingite, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

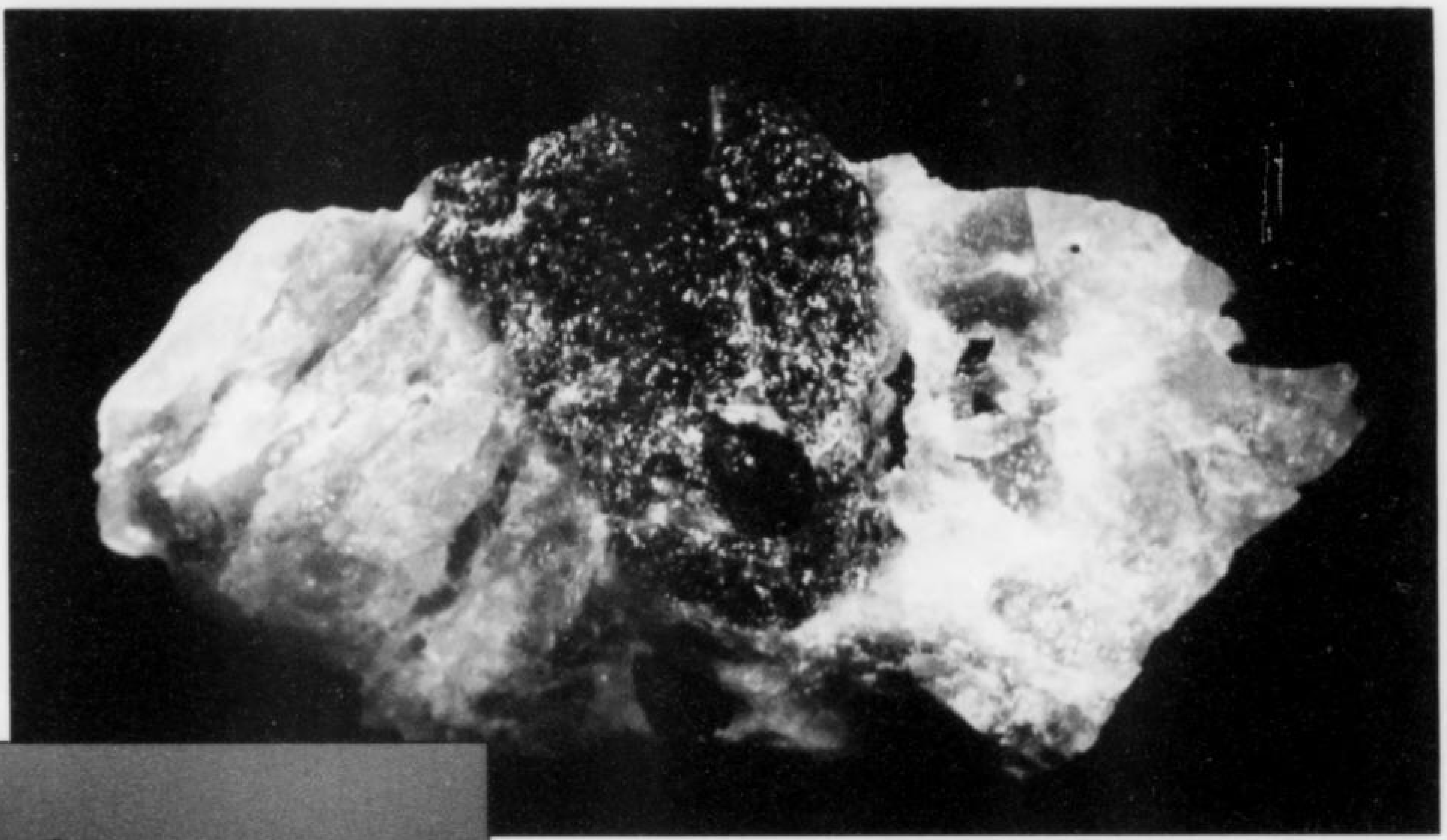

***Figure 15.* Kapustinite mass (2.5 cm) in sodalite, from the Palitra pegmatite. I. V. Pekov collection; N. A. Pekova photo.**

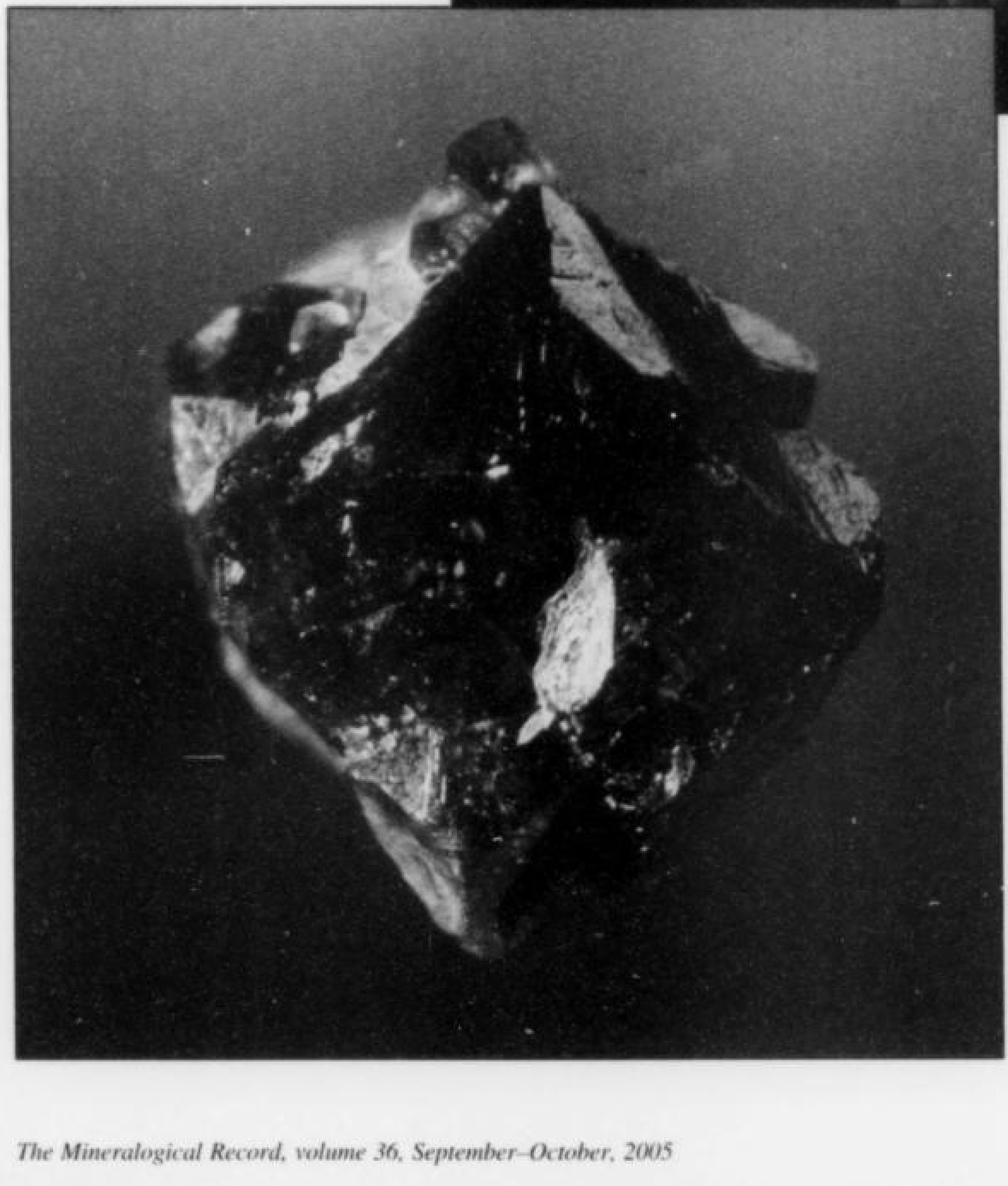

***Figure 16.* Kazakovite crystal, 4 mm, from the Palitra pegmatite. I. V. Pekov collection; N. A. Pekova photo.**

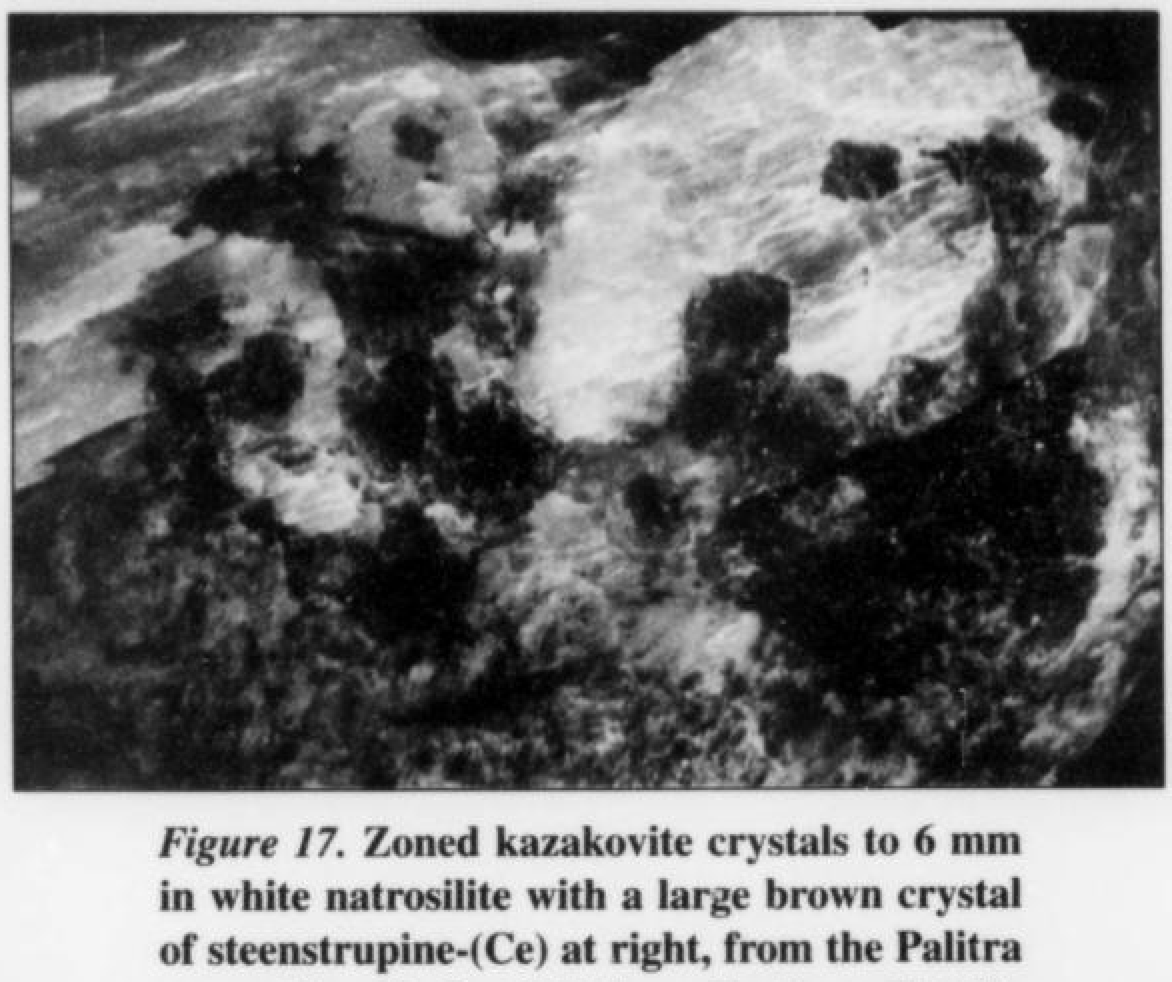

***Figure 17.* Zoned kazakovite crystals to 6 mm in white natrosilite with a large brown crystal of steenstrupine-(Ce) at right, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

Lamprophyllite $Na_2(Sr,Ba)_2(Ti,Fe,Mn)_3(SiO_4)_4(OH,F)_2$

Lamprophyllite is a subordinate mineral of the eudialyte-aegirine-microcline zone. It forms radiating "stars" up to 3 cm in diameter consisting of long-prismatic golden brown crystals, the "stars" most commonly situated among green fibrous aegirine.

Löllingite $FeAs_2$

Löllingite occurs as individual tabular and prismatic crystals up to 7 mm with silvery white color and bright metallic luster. It is commonly associated with galena in aggregates of ussingite, sodalite and aegirine.

Lomonosovite $Na_2Ti_2Si_2O_9 \cdot Na_3PO_4$

Lomonosovite is abundant in the core of the pegmatite. It forms dark brown to almost black lamellar and tabular crystals to 12 cm long and 1.5 cm thick, with bright vitreous luster. Some of the crystals are sharp, with numerous small steps on the {001} face. Complex twins are common. Some crystals are split and combine to form fanlike clusters. Monomineralic lomonosovite aggregates up to 20 cm are not uncommon at the locality. Some lomonosovite occurs in association with structurally related vuonnemite, but oriented parallel intergrowths of these minerals have not been found in the Palitra pegmatite. In the peripheral zones of the pegmatite, lomonosovite occurs as lamellae to 5 cm in the centers of large aegirine spheroids and in aegirine-eudialyte-lorenzenite aggregates. Unlike the majority of other Lovozero pegmatites, the Palitra contains absolutely fresh lomonosovite without replacement by murmanite. Rarely, small bornemanite spherules replace lomonosovite on its contact with natrosilite.

Figure 18. **Large manaksite crystal, 2.6 cm, overgrown by yellow zakharovite on pale purple ussingite, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

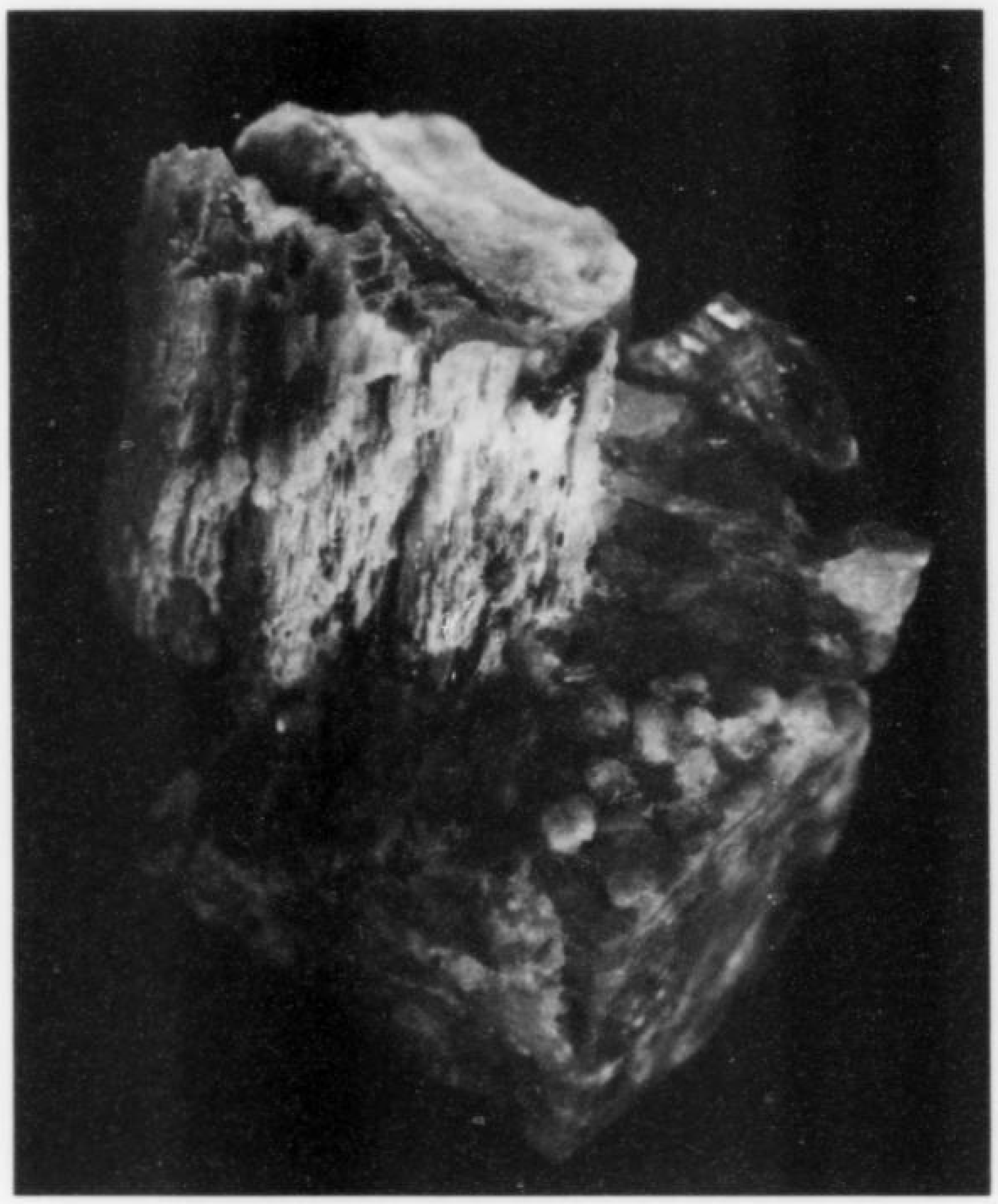

Figure 19. **Corroded yellow manaksite crystal with orange serandite and white analcime crystals on pale purple ussingite, 3.5 cm, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

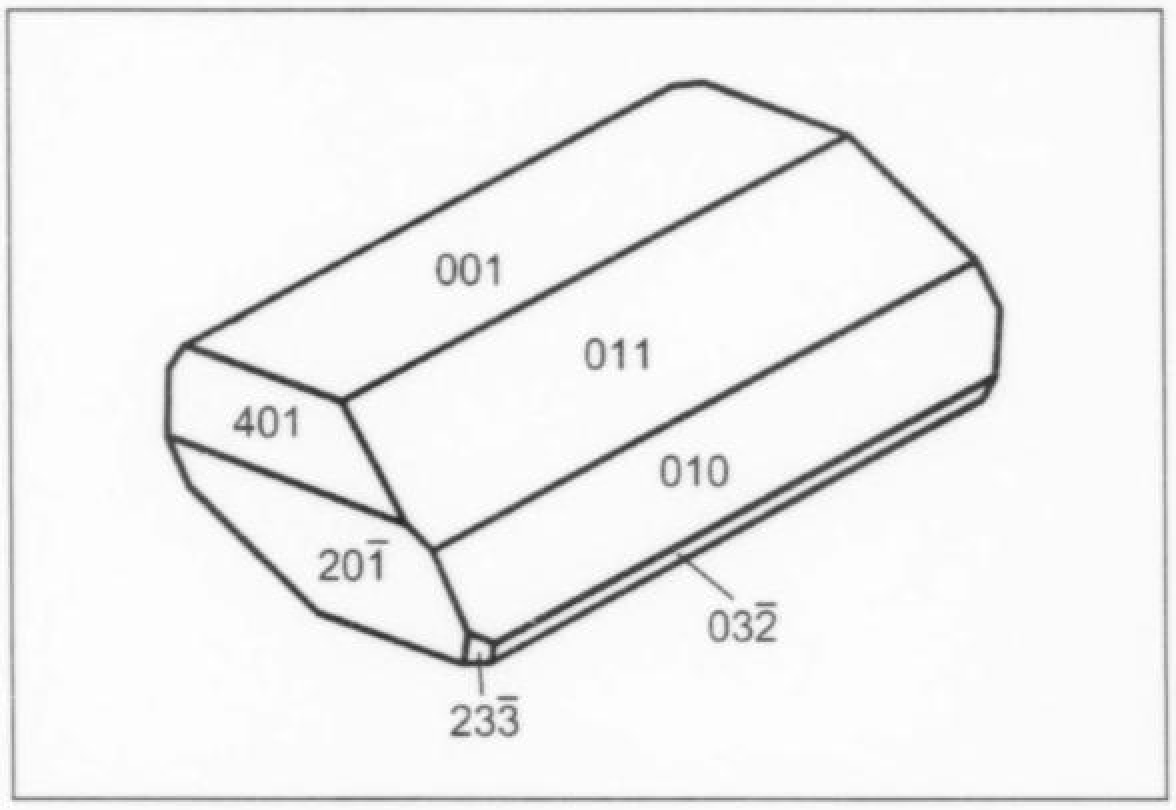

Figure 20. **Manaksite crystal drawing, Palitra pegmatite.**

Lorenzenite $Na_2Ti_2Si_2O_9$

Lorenzenite is a common mineral of the eudialyte-aegirine-microcline zone. It forms dark brown coarse prismatic crystals and irregular grains to 3 × 5 cm.

Manaksite $NaKMnSi_4O_{10}$

Manaksite is one of the most remarkable minerals of the Palitra pegmatite. Before the discovery of this pegmatite, two localities for manaksite were known; in both it occurs as small grains. It was first described in pegmatitic rock at Mt. Alluaiv in the Lovozero massif as grains to 3 mm and aggregates to 5 mm (Khomyakov *et al.*, 1992). Later, it was found as a rare accessory mineral in the rischorrites of the neighboring Khibiny alkaline massif (Ageeva,

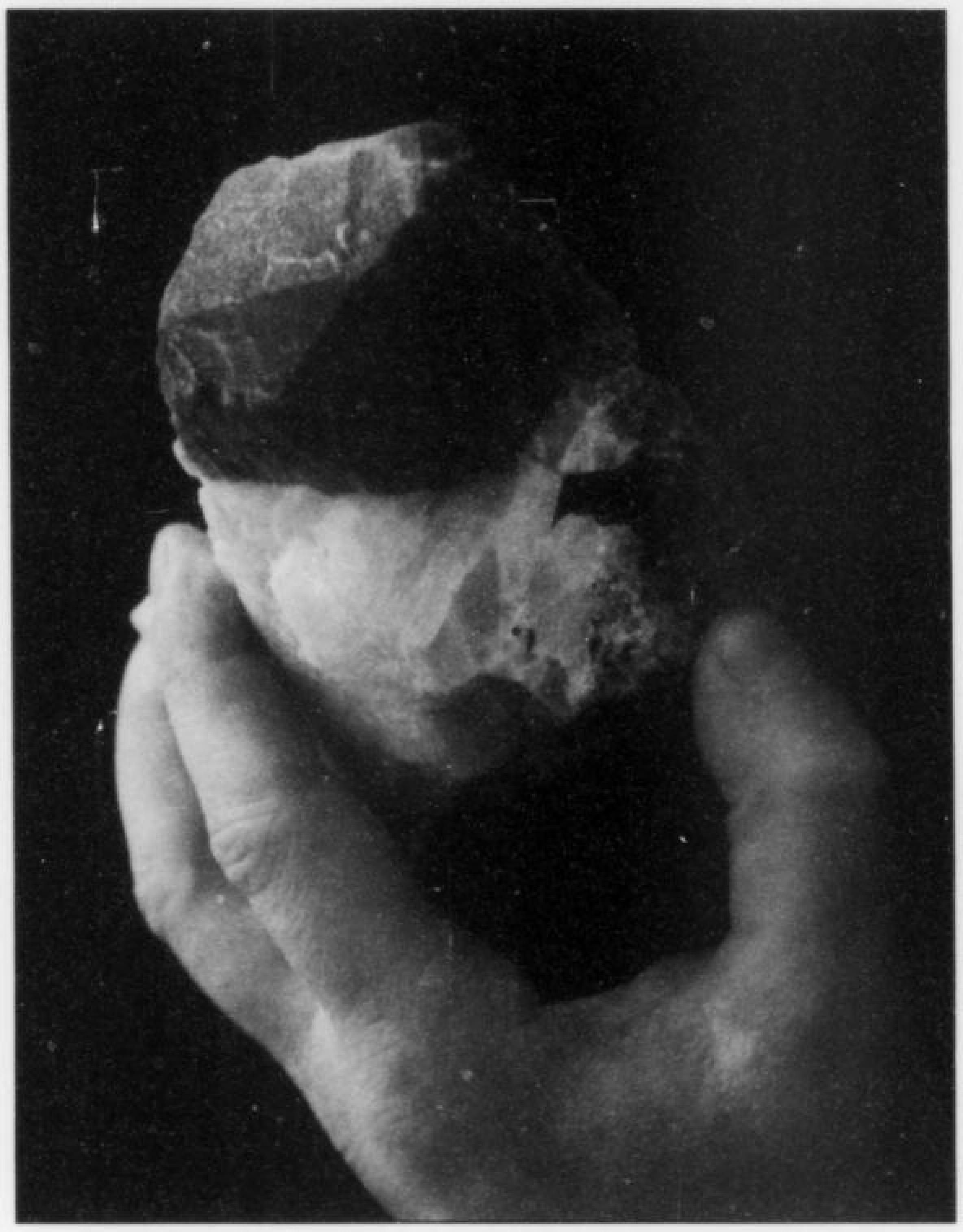

Figure 21. **Large manaksite crystal on white natrosilite and ussingite, 11.5 cm, from the Palitra pegmatite. Natalia Pekova photo.**

2000). In the core of the Palitra pegmatite, manaksite forms beautiful prismatic crystals to 8 × 20 cm and crystal clusters to several kilograms (!). Individual crystals of this astounding size were previously unknown, even for fenaksite, $NaKFeSi_4O_{10}$, the isostructrural Fe-dominant analog of manaksite which constitutes a rock-forming mineral in several rischorritic pegmatites in the Khibiny massif. The sharp crystals of manaksite from the Palitra pegmatite are bounded by faces {001}, {011}, {010}, $\{03\bar{2}\}$, {401}, $\{20\bar{1}\}$ and $\{23\bar{3}\}$. Manaksite is pinkish yellow to grayish pink. Small fragments are almost colorless, and transparent. The mineral is easily identified visually because of its bright pearly luster on a broken surface, two directions of perfect cleavage parallel to the crystal elongation, and very typical splintery fracture. Manaksite can be easy split into thin needles and fluffed up like asbestos. The empirical formula of manaksite from Palitra is: $Na_{1.03}K_{0.99}(Mn_{0.84}Fe_{0.17}Mg_{0.03})_{\Sigma 1.04}Si_{3.975}O_{10}$. This mineral is closely associated with natrosilite, villiaumite, ussingite, analcime, vuonnemite, chkalovite, bario-olgite, steenstrupine-(Ce), and sphalerite. Manaksite is unstable; several minerals commonly replace it in the Palitra pegmatite. Some manaksite crystals are partially or completely replaced by aggregates of pale pink Ca-free serandite and polychromatic aegirine. Prismatic to acicular crystals of these secondary minerals are in most cases oriented parallel to the elongation of the manaksite crystal. Films and crusts of bright yellow zakharovite commonly replace manaksite in cracks in the crystal surfaces.

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

Mangan-neptunite occurs as a minor mineral in ussingite areas in the core. It forms dark red prismatic crystals up to 5 mm, in some cases closely associated with kazakovite. Mangan-neptunite from the Palitra pegmatite is Fe-rich: Mn : Fe = 1.15–1.20.

Microcline $KAlSi_3O_8$

Microcline is one of the major rock-forming minerals of the pegmatite. Its white and pale greenish crystalline blocks reach 15 × 60 cm and are the largest mineral masses in the pegmatite. Ussingite and sodalite commonly replace microcline in cracks in its crystals. A later-stage variety of microcline occurs inside pods of villiaumite, natrosilite and manaksite, where it forms clusters of colorless and pale pink, transparent, blade-like crystals to 3 mm long.

Molybdenite MoS_2

Molybdenite occurs rarely as hexagonal platelets and rosettes to 3 mm in diameter on analcime and ussingite. It is typically found inside natrosilite-filled vugs.

Figure 22. **White nalipoite crystals to 3 mm with dark yellow sphalerite crystals on ussingite, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

Figure 23. **Colorless nalipoite crystal, 4 mm, on white natrosilite with black aegirine, from the Palitra pegmatite. Fersman Mineralogical Museum collection (donated by I. V. Pekov); Natalia Pekova photo.**

Nalipoite $NaLi_2PO_4$

Nalipoite is a very rare mineral, previously described only from the hyperagpaitic derivatives of the Mont Saint-Hilaire alkaline complex, Quebec (Chao and Ercit, 1991). In the Palitra pegmatite, nalipoite occurs as sharp prismatic crystals to 1 × 1 × 7 mm bounded by faces {100}, {010} and {001}. These crystals are commonly split and combine to form sheaf-like clusters which are situated on the walls of cavities later filled by natrosilite and villiaumite. Nalipoite, together with nordite-(Ce), ferronordite-(Ce) and bornemanite, also forms overgrowths on analcime, ussingite and lomonosovite. The mineral is transparent and colorless, and has a vitreous luster. After dissolution of the surrounding natrosilite or villiaumite, nalipoite crystal surfaces become white and slightly corroded. Nalipoite from the Palitra pegmatite contains (by weight) 25.11% Na_2O and 52.72% P_2O_5; Li was not detected. Its X-ray powder diffraction pattern is identical to that for one of the samples from Mont Saint-Hilaire published by G. Y. Chao and T. S. Ercit (1991).

Natrolite $Na_2Al_2Si_3O_{10}\cdot 2H_2O$

Natrolite forms massive granular pods to 5 × 10 cm in the core of the pegmatite. It is colorless and transparent, occurring commonly in ice-like or saccharoidal drusy aggregates.

Natron $Na_2CO_3\cdot 10H_2O$

Natron is a post-mining mineral formed after the Palitra pegmatite was uncovered; it is probably a product of the reactions of unstable hypersodic minerals with CO_2 in the air. It forms white efflorescences on the walls and on loose pieces of pegmatite.

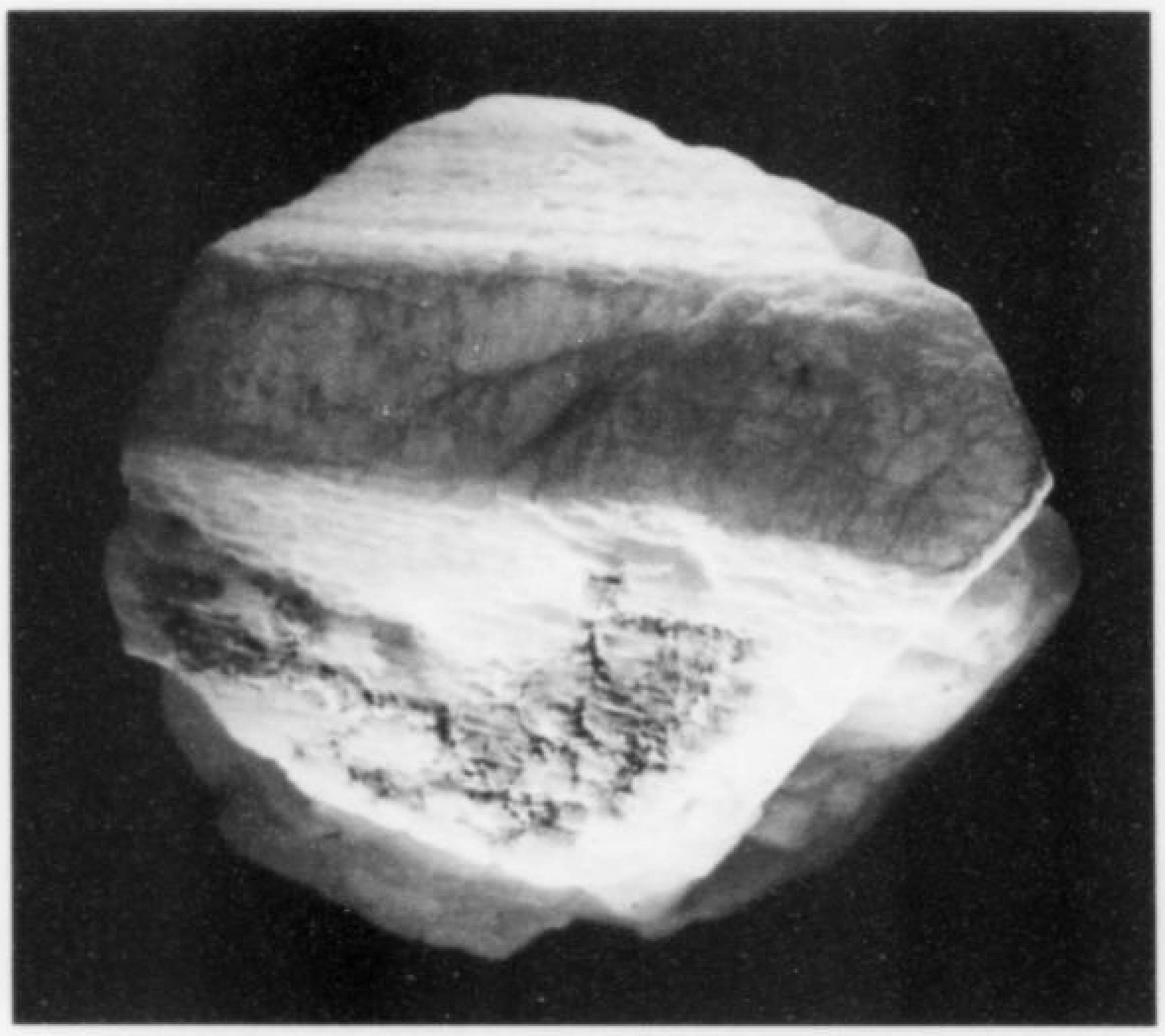

Figure 25. **Coarse natrosilite crystal, 7 cm, from the Palitra pegmatite. I. V. Pekov collection; N. A. Pekova photo.**

Figure 24. **White natrosilite zone, 1 meter across, *in situ* in the Palitra pegmatite. N. A. Pekova photo.**

Natrosilite $Na_2Si_2O_5$

Natrosilite forms very large individual crystals and aggregates in the core of the Palitra pegmatite. Grains up to 6 cm had been known from numerous other pegmatites in the Lovozero massif (Timoshenkov *et al.*, 1975; Pekov, 2000); here, however, natrosilite single-crystal blocks to 20 × 30 × 30 cm and aggregates weighing to several dozen kilograms have been found! It is a rock-forming mineral in the core of the pegmatite, and it encloses sharp crystals of many other minerals; these include manaksite, nordite-(Ce), ferronordite-(Ce), kazakovite, chkalovite, nalipoite, vitusite-(Ce), vuonnemite, lomonosovite and serandite. Natrosilite is a mica-like mineral: it is elastic, with perfect one-directional cleavage and very pronounced pearly to vitreous luster on fresh cleavage surfaces. In most cases its blocks have no crystal faces, but coarse faces have been observed in rare instances. Natrosilite is colorless to pale pinkish yellow; if the natrosilite block is thick, it appears pearly white. Waterclear, gem-quality tablets to 5 mm thick are occasionally observed, but in general natrosilite is semi-transparent because of an abundance of microfractures and gas-liquid inclusions, the gas portion of most of these being carbon monoxide. An interesting property of natrosilite from the Palitra pegmatite is its pronounced triboluminescence: when its lamellae are broken, a bright lilac to violet flash is observed. This phenomenon is probably caused by combustion of CO released from the inclusions.

Natrosilite and dark red villiaumite were the last pegmatitic minerals to form; they precipitated simultaneously into cavities from the last portion of the water-poor melt, by this stage maximally enriched in Na and F. Natrosilite is very unstable in the presence of water. It is replaced by revdite in cavities and cracks. In the moist air of the underground mine, hydrolysis of natrosilite is

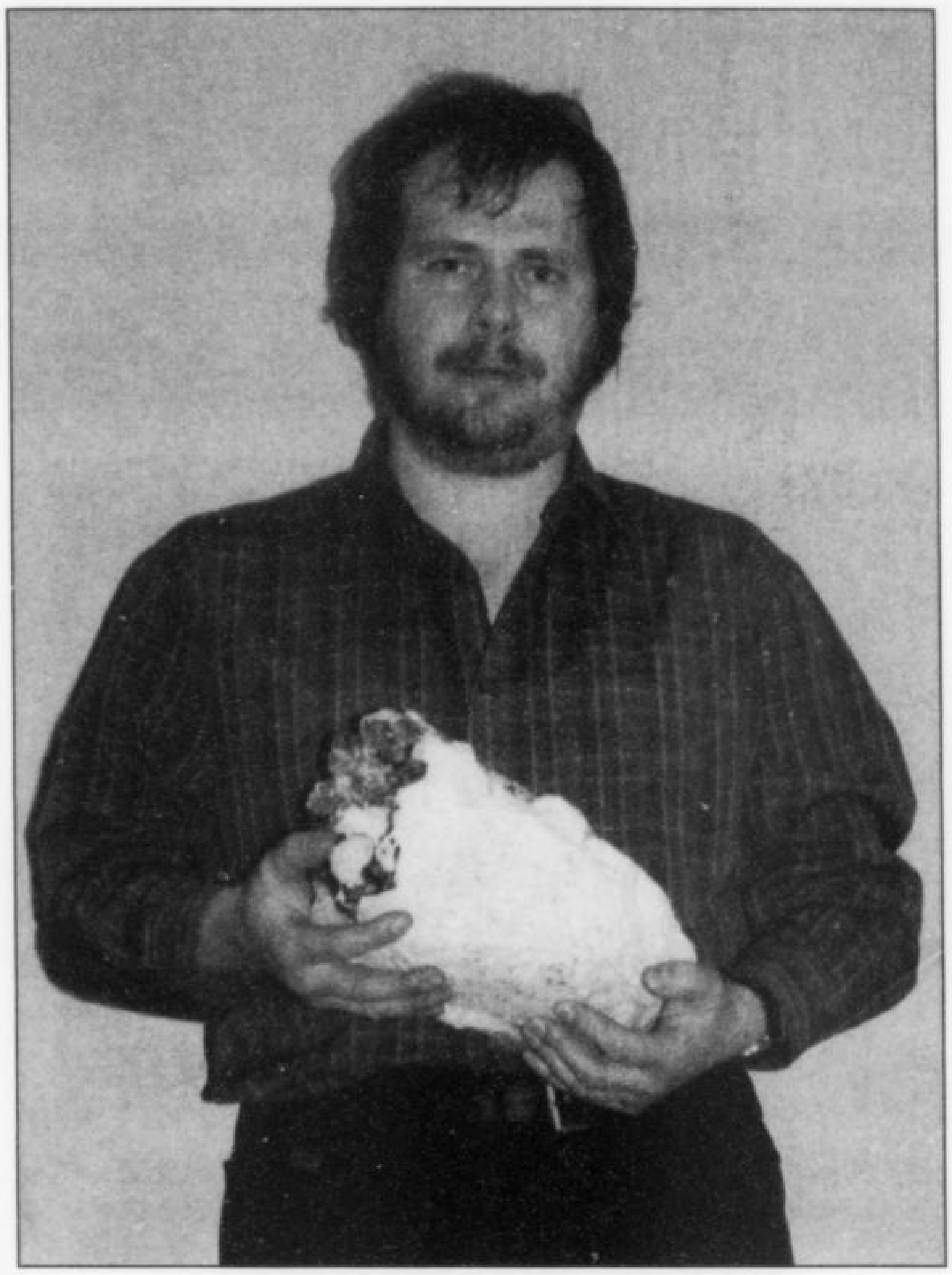

Figure 26. **Igor Pekov holding the world's largest natrosilite specimen, a 9-kg cleavage fragment collected in September of 2002 by Nickolay Pavlov, chief geologist at the Karnasurt mine. N. A. Pekova photo.**

very rapid; the mineral becomes covered by a gelatinous sodium hydrate silicate. In dry air, this "glue" alters to a mixture of opal and semi-amorphous hydrous Na silicates. Blocks of natrosilite up to several centimeters in size can be completely dissolved by flowing water in three to five days, even at room temperature.

Nepheline $(Na,K)AlSiO_4$

Nepheline is concentrated, for the most part, in the thin top zone of the Palitra pegmatite, where it is very common. Its coarse, elongated crystals, to 4 × 12 cm, form brush-like crusts. The crystals are zoned: their peripheral parts are semitransparent green and their cores are yellowish to colorless and water-clear. Gem-quality areas up to 1 cm are not uncommon. Nepheline also occurs as a subordinate mineral in the eudialyte-aegirine-microcline zone.

Nordite-(Ce): see **Ferronordite-(Ce)**

Opal $SiO_2 \cdot nH_2O$

Opal is a post-mining mineral, a final product of natrosilite alteration after its contact with mine water. Crusts of colorless, white, bluish and brownish opal are observed on the walls of the underground workings.

Pautovite $CsFe_2S_3$

Pautovite, a new mineral from the Palitra pegmatite and the cesium analog of rasvumite, was recently approved by the IMA Commission on New Minerals and Mineral Names (No. 2004-005). It is named in honor of Leonid A. Pautov (born 1958), outstanding Russian mineralogist and specialist in physical methods for the study of minerals, for his significant contributions to the mineralogy of alkaline pegmatites and the mineralogy of cesium (Pekov *et al.*, 2005). Pautovite occurs as isolated coarse prismatic to acicular crystals up to 0.12 mm long and up to 0.005 mm (very rarely up to 0.015 mm) thick. Some crystals are slightly curved and split. Pautovite typically forms intergrowths, and in many cases it occurs in parallel growth with earlier-formed needle-shaped to filiform crystals of belovite-(Ce) in cavities. Dark pautovite individuals are visible, in spite of their small size, on the surface of white belovite-(Ce) "cotton." Some pautovite crystals were observed on ussingite and microcline and as inclusions in massive red villiaumite in cavities. The mineral is dark steel-grey with metallic luster, but in moist air it becomes dull black. Pautovite is (after galkhaite) the second known natural sulfide with essential cesium to be described, and it is one of the richest cesium minerals known. Its chemical composition is: K 0.21, Rb 1.31, Cs 36.12, Tl 0.50, Fe 33.80, S 28.85, total 100.79 weight %. It corresponds to the empirical formula: $(Cs_{0.91}Rb_{0.05}K_{0.02}Tl_{0.01})_{\Sigma 0.99}Fe_{2.02}S_{3.00}$.

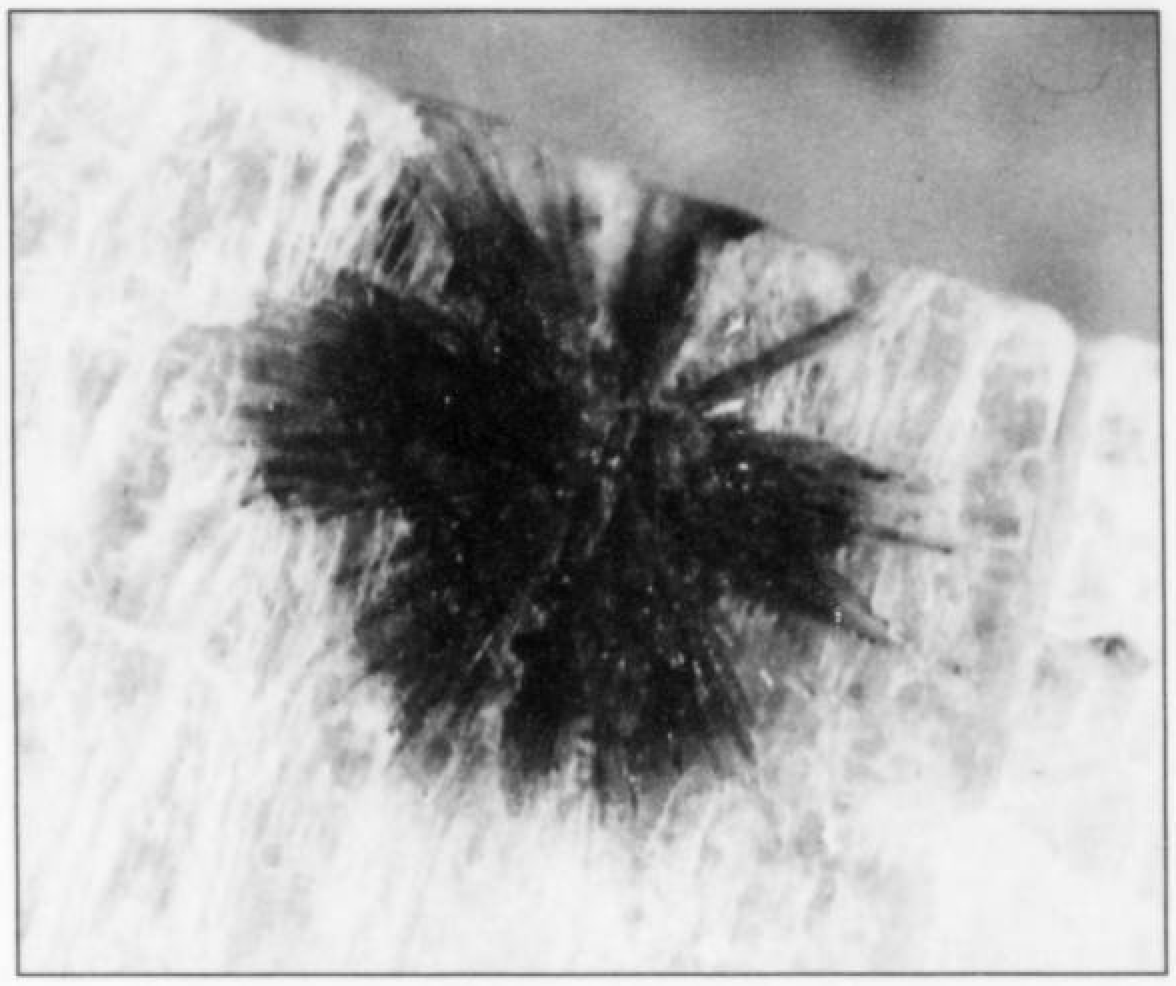

Figure 27. **Phosinaite-(Ce) radiating cluster, 8 mm, with yellow vuonnemite crystal on white natrosilite, from the Palitra pegmatite. I. V. Pekov collection; N. A. Pekova photo.**

Phosinaite-(Ce) $Na_{13}Ca_2Ce[Si_4O_{12}](PO_4)_4$

Phosinaite-(Ce) is a minor mineral of the core of the Palitra pegmatite. Sprays of its coarse columnar, chocolate-brown crystals (to 1 × 15 mm) with resinous luster were found in ussingite. Grayish brown phosinaite-(Ce) "stars" up to 2 cm in diameter are found included in natrosilite. They consist of long prismatic crystals with an almost quadrangular cross-section, commonly forming parallel intergrowths with morphologically similar pale pink serandite crystals. Chemically, phosinaite-(Ce) from the Palitra pegmatite is most common, with the ratios of Nd to La (Ce:La:Nd = 3.6:1:1.7) which are typical for this mineral. Vitusite-(Ce) may replace phosinaite-(Ce) in the Palitra pegmatite, as in other Lovozero pegmatites.

Potassicarfvedsonite $KNa_2Fe^{2+}_4Fe^{3+}Si_8O_{22}(OH)_2$

Potassicarfvedsonite is a new amphibole recently approved by the IMA Commission on New Minerals and Mineral Names (No. 2003-043). It was described simultaneosly from three alkaline massifs: Ilímaussaq in South Greenland (Kangerluarssuk area), Lovozero (the Palitra pegmatite) and Khibiny (Kukisvumchorr Mountain), the latter two on the Kola Peninsula (Pekov *et al.*, 2004b). In the Palitra pegmatite, potassicarfvedsonite forms greenish blue to dark grayish blue acicular crystals to 0.1 × 2 mm, commonly combined in bunches and hedgehog-like clusters to 4 mm. It also occurs as massive nodules to 1.5 cm across, consisting of thin acicular to fibrous individuals. Potassicarfvedsonite aggregates are found in ussingite cavities, and, together with late-stage Ca-free serandite, inside partially altered manaksite crystals. For comparison, large earlier-stage arfvedsonite crystals are widespread in the peripheral zone of the pegmatite.

***Figure 28.* Pale brown clusters of revdite microcrystals in a 1-cm cavity in microcline, from the Palitra pegmatite. I. V. Pekov collection; N. A. Pekova photo.**

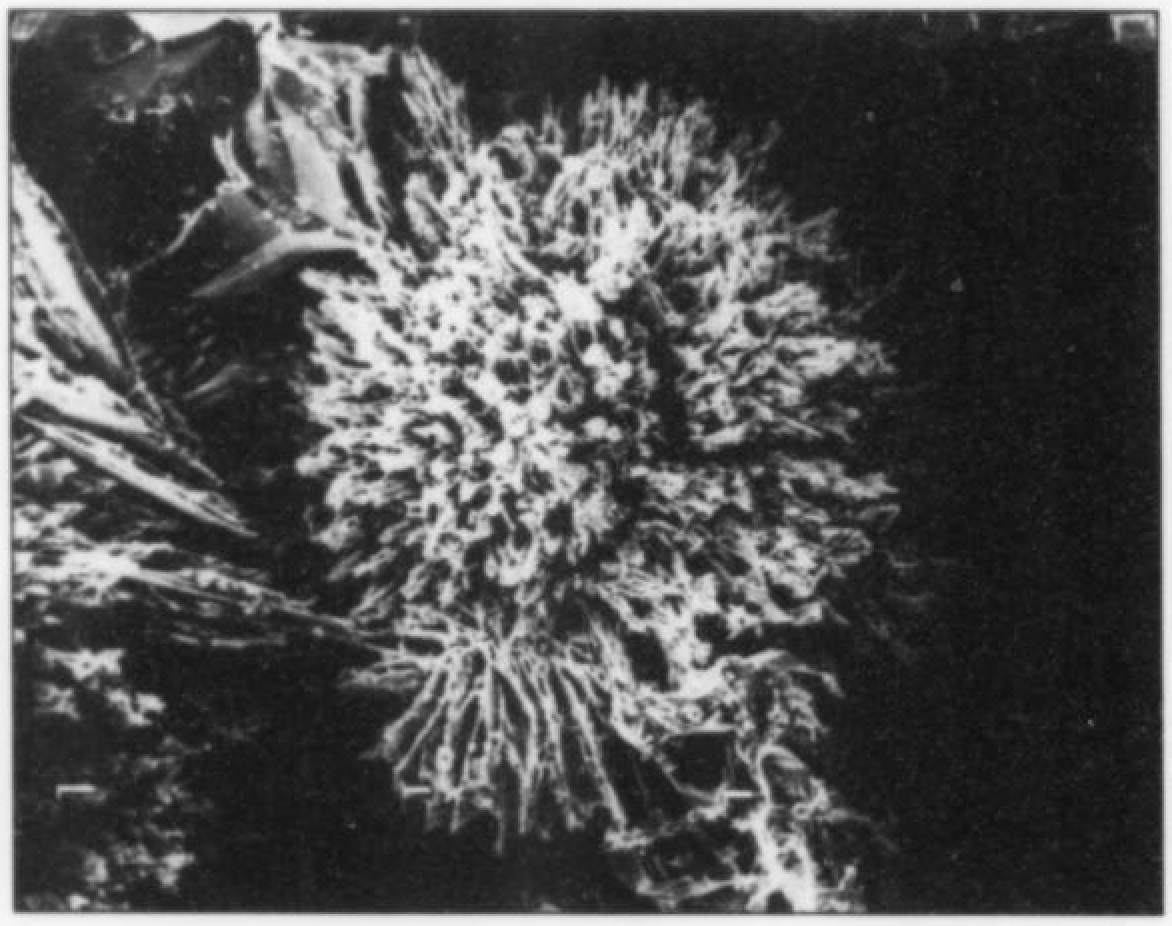

***Figure 29.* Revdite spherical crystal cluster, 0.26 mm across, from the Palitra pegmatite. I. V. Pekov collection and SEM photo.**

***Figure 30.* Revdite crystal, 0.6 mm across, from the Palitra pegmatite. I. V. Pekov collection and SEM photo.**

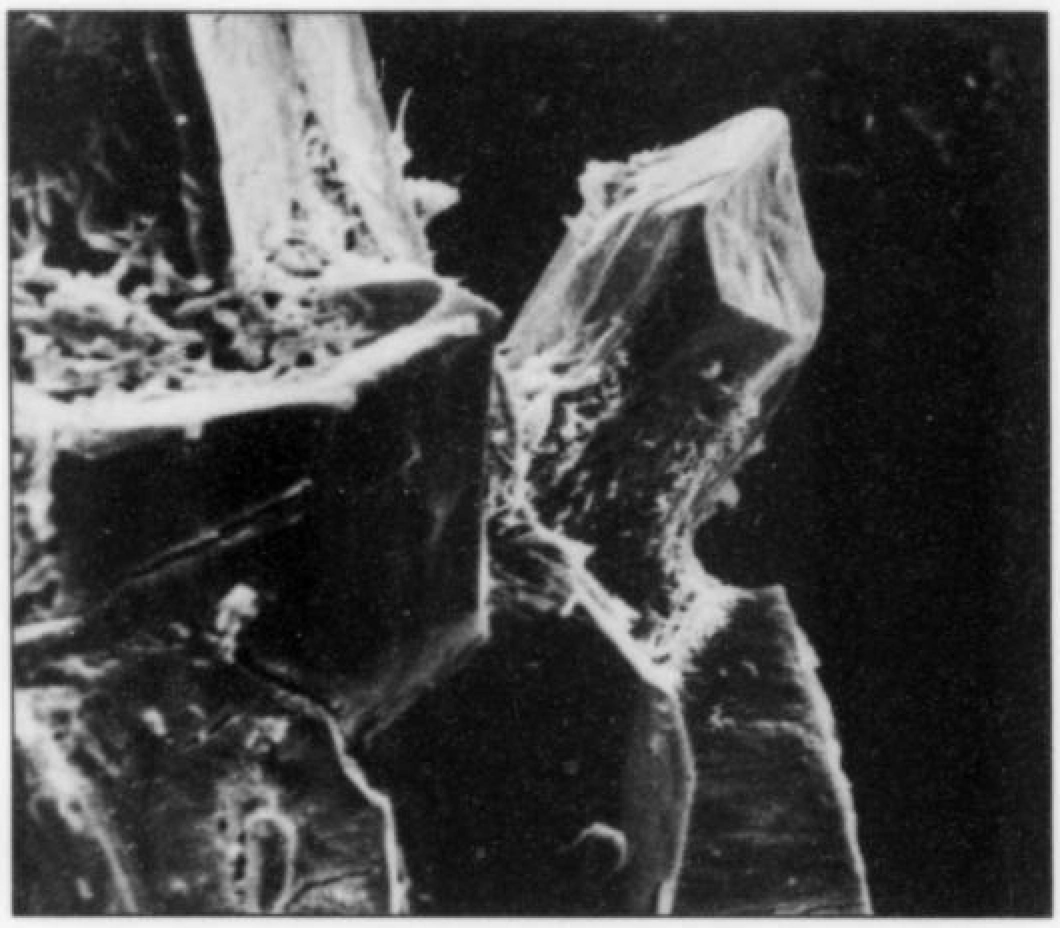

***Figure 31.* Revdite crystal, 0.03 mm across, from the Palitra pegmatite. I. V. Pekov collection and SEM photo.**

Revdite $Na_2Si_2O_5{\cdot}5H_2O$

Revdite, a product of low-temperature hydrothermal activity, is the last endogenetic mineral of the Palitra pegmatite. Revdite was found only in a few small cavities—no larger than 2 mm × 1 cm. Different morphological varieties of revdite have been observed in the Palitra pegmatite. Small (0.1 mm), colorless and transparent, short prismatic crystals with bright vitreous luster form sprays in vugs within ussingite and villiaumite aggregates. Similar but coarser, translucent white to greenish crystals overgrow natrosilite surfaces. Snow-white fibrous revdite replacing natrosilite forms crusts up to 0.1 mm thick. Pale brown and white brushes and spherules consisting of coarse lath-like revdite crystals up to 0.2 mm long have been found in cavities of microcline blocks. Loose aggregates (up to 1 cm) of pale brown, fine-grained revdite fill some cavities in the core of the pegmatite.

Serandite $Na_2HMn_2Si_3O_9$

Serandite is a common mineral in the core of the Palitra pegmatite. Its salmon-pink and pinkish yellow, coarse, lath-like crystals, up to 8 cm long but in most cases curved and split, are associated with ussingite and villiaumite. Well-terminated pinkish yellow and orange serandite crystals up to 4 cm are included in natrosilite. Another morpological variety of serandite is pale pink, transparent crystals to 1 × 1 × 10 mm with quadrangular or

Figure 32. **Serandite crystal, 1.3 cm, in natrosilite, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

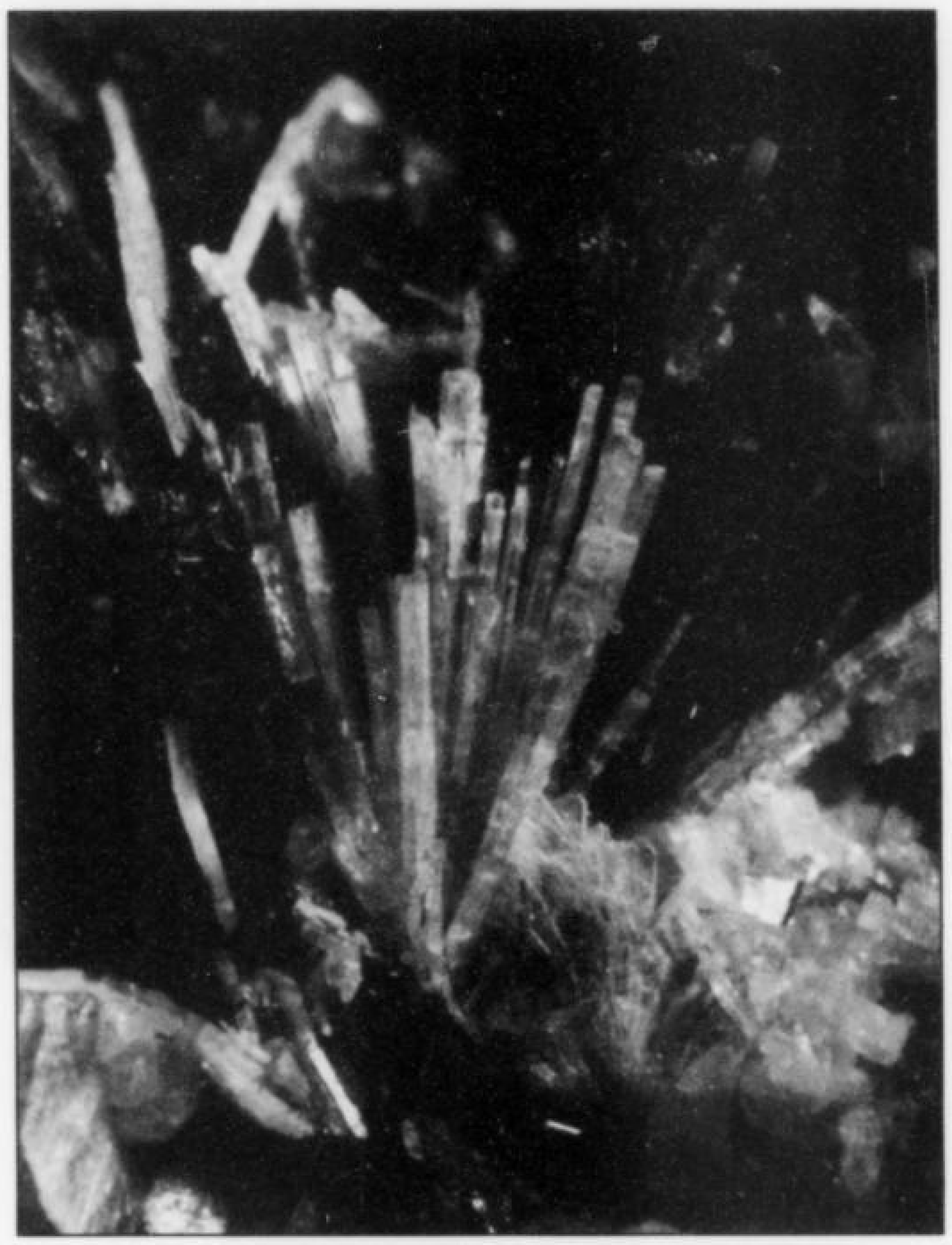

Figure 33. **Serandite crystals to 8 mm, with black aegirine and white ussingite, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

octagonal cross sections. Usually these crystals replace manaksite, and they are rarely observed in natrosilite or villiaumite, closely associated with phosinaite-(Ce). Curved, bright pink serandite platelets up to 5 mm were found in pseudomorphs after manaksite, together with polychromatic aegirine. Serandite replacing manaksite is almost Ca-free, probably because Ca is absent in manaksite. Serandite included in ussingite is Ca-enriched and close to manganoan pectolite in its chemical composition: studied samples are characterized by Mn:Ca = 1.02.

Sodalite $Na_4(AlSiO_4)_3Cl$

Sodalite is one of the major minerals in the core of the Palitra pegmatite. Massive aggregates of sodalite to 25 cm across are colorless or white; some show pale purple areas. Grains of villiaumite and analcime included in white sodalite are in some cases surrounded by rims of deep red sodalite. Grayish green sodalite occurs as aggregates associated with analcime and ussingite. Under longwave ultraviolet light, colorless sodalite strongly fluoresces orange, while green sodalite shows a weak orange response. Pale purple sodalite shows practically no fluorescence. Sodalite and eudialyte form reaction borders on the contacts of the pegmatite with the bedrock.

Sphalerite ZnS

Sphalerite is the most abundant sulfide mineral in the Palitra pegmatite. It forms aggregates of yellow-brown transparent lamellae to 5 mm, twinned on (111), which are included in natrosilite and villiaumite, and it is closely associated with ussingite and sodalite. Sharp tetrahedral crystals and arborescent skeletal crystals of sphalerite occur inside natrosilite.

Steenstrupine-(Ce)
$Na_{14}(REE,Th)_6(Mn,Fe,Ti)_4(OH)_2(PO_4)_7(Si_6O_{18})_2\cdot nH_2O$

Steenstrupine-(Ce) is common in the core of the Palitra pegmatite. It occurs as translucent, red-brown, rhombohedral crystals and equant grains up to 5 cm associated with microcline, ussingite, sodalite, analcime, and rarely natrosilite. It contains 10–11 weight % ThO_2 and 0.6% UO_2, and is therefore radioactive.

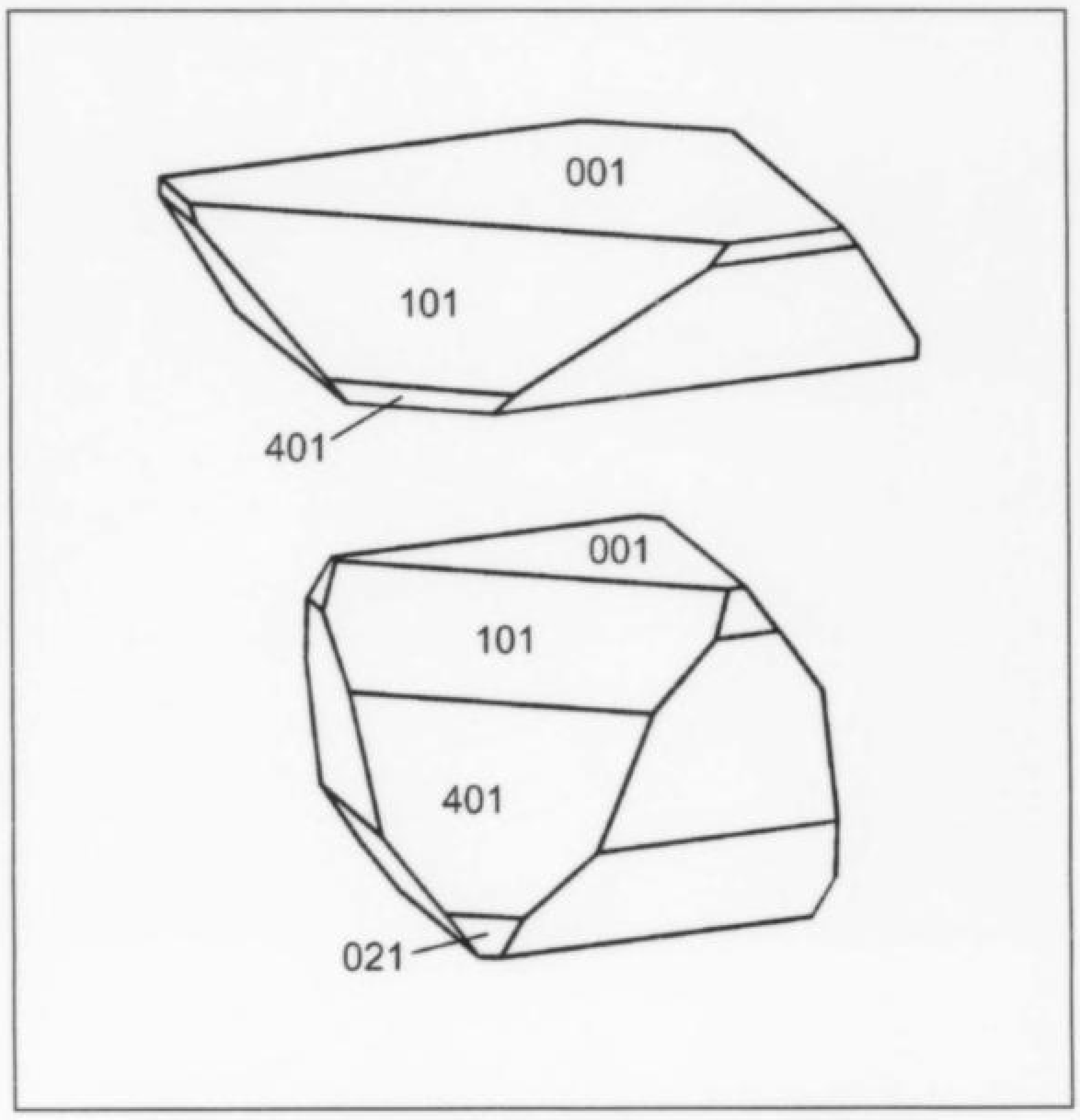

Figure 34. **Thorosteenstrupine crystal drawings, Palitra pegmatite.**

Thorosteenstrupine $Na_{0-5}Ca_{1-3}(Th,REE)_6(Mn,Fe,Al,Ti)_{4-5}$-$[Si_6(O,OH)_{18}]_2[(Si,P)O_4]_6(OH,F,O)_x\cdot nH_2O$

Thorosteenstrupine, the thorian analog of steenstrupine-(Ce) (Pekov *et al.*, 1997), occurs as crystals to 1.5 mm on microcline, ussingite, analcime and sodalite. It was found after enclosing villiaumite was dissolved away by water. Palitra is the first known locality for sharp thorosteenstrupine crystals; many are tabular and rhombohedral-pinacoidal, bounded by faces {001}, {101} and {401}, while equant crystals also show the {021} face (*hkl* indices are assigned by analogy with steenstrupine-(Ce) morphology).

Thorosteenstrupine is dark red-brown and translucent. Unlike the abundant, relatively early-stage steenstrupine-(Ce), thorosteenstrupine is a rare late-stage mineral.

Troilite FeS

Troilite occurs as bronze-colored grains to 1 mm included in aggregates of bartonite and chlorbartonite.

***Figure 35.* Ussingite crystals in parallel growth, 0.4 mm, from the Palitra pegmatite. I. V. Pekov collection and SEM photo.**

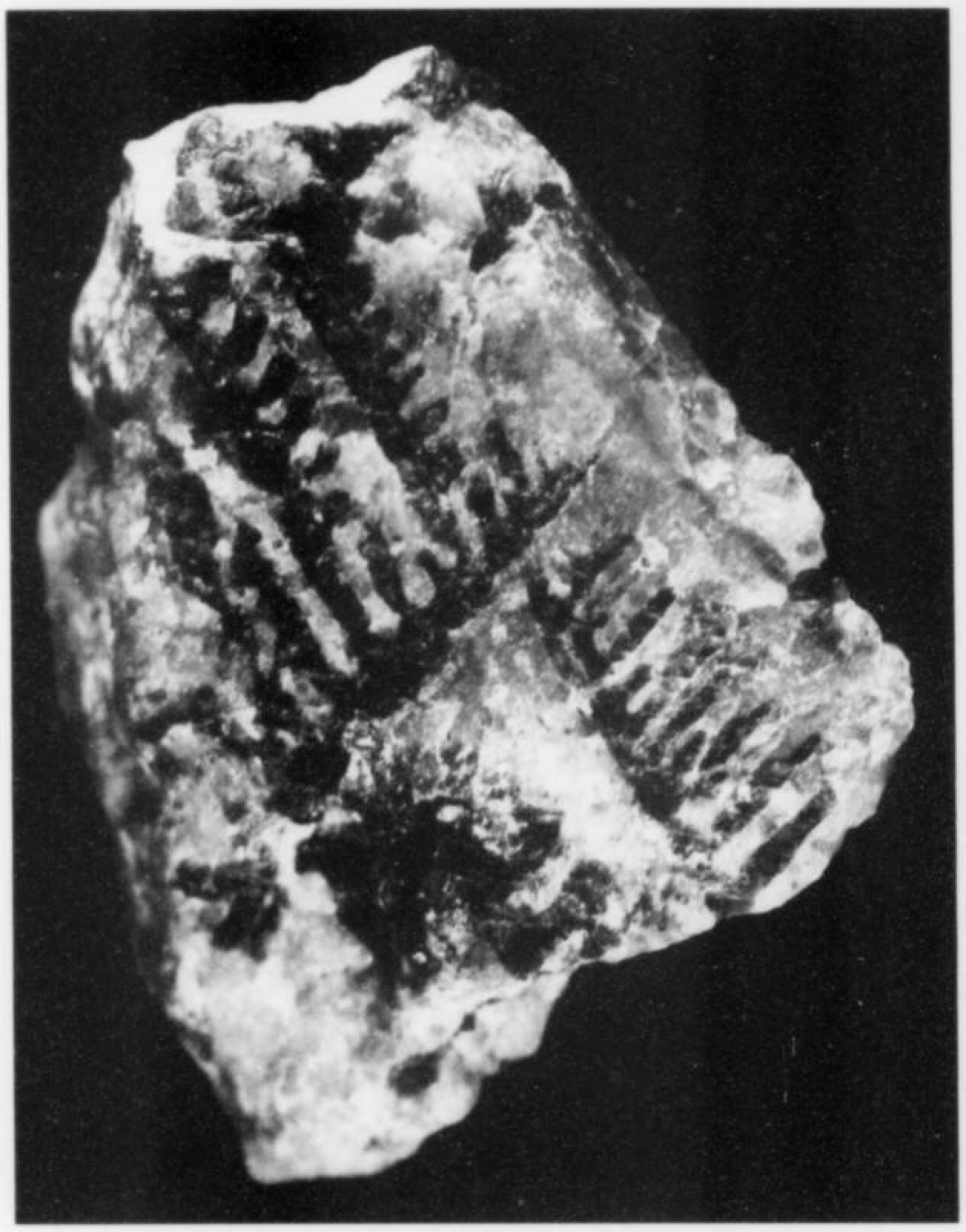

***Figure 36.* Skeletal villiaumite crystals in white microcline, 5 cm, from the Palitra pegmatite. I. V. Pekov collection; N. A. Pekova photo.**

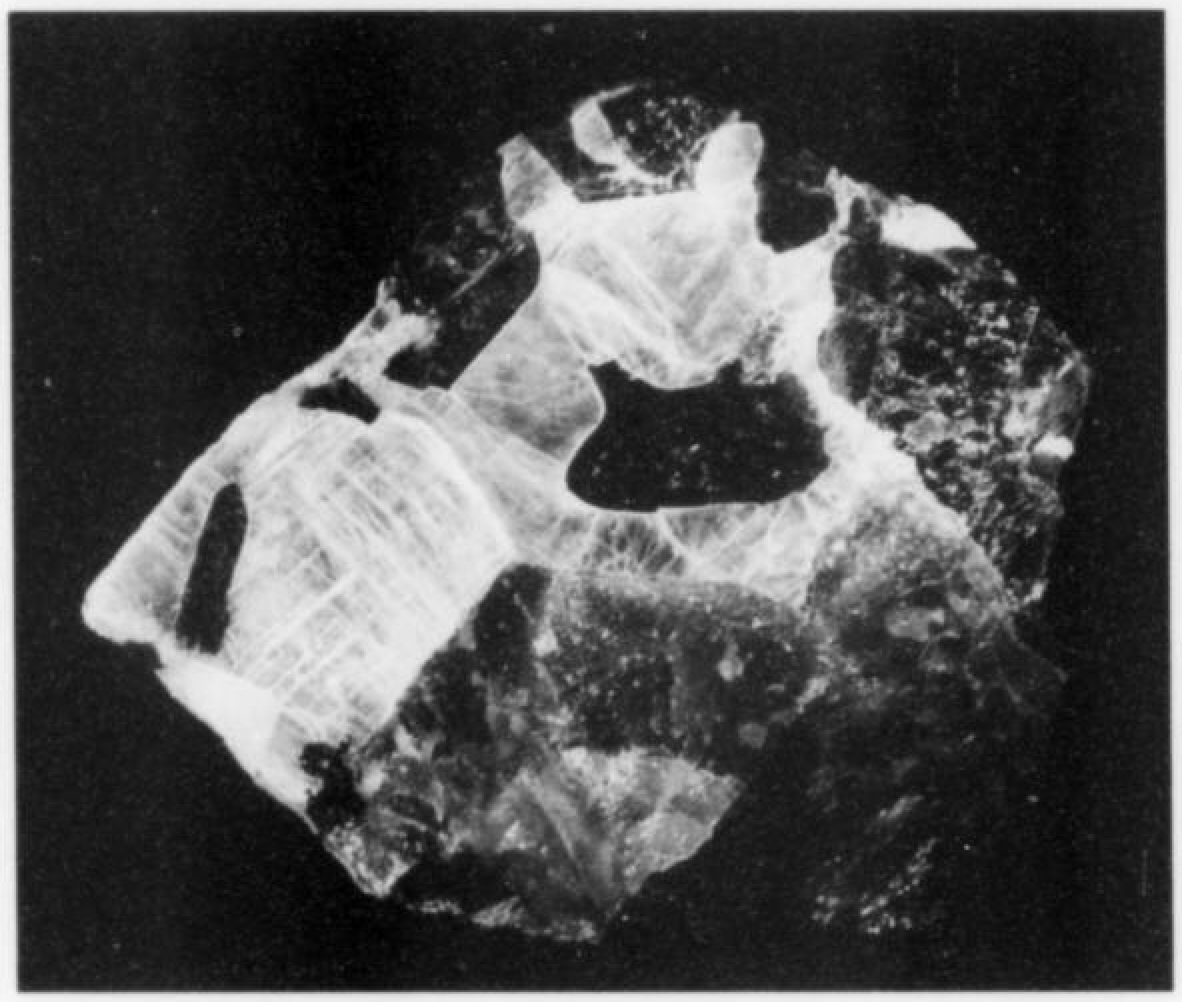

***Figure 37.* Dark red villiaumite blebs in white natrosilite, 8 cm, from the Palitra pegmatite. I. V. Pekov collection; N. A. Pekova photo.**

Ussingite $Na_2AlSi_3O_8(OH)$

Ussingite is a common mineral of the core of the Palitra pegmatite, although not a major constituent as it is in numerous other Lovozero pegmatites. The ussingite content of the polymineralic aggregates of the Palitra core is not more than 20% by volume. It forms massive, pale purple masses to 10 cm and is closely associated with sodalite, steenstrupine-(Ce), lomonosovite, vuonnemite and serandite. Ussingite replaces analcime; partial and complete pseudomorphs of pale purple ussingite after sharp analcime crystals are common. The surface of some of these pseudomorphs is formed by colorless, oblique-angled tabular or prismatic ussingite crystals to 3 mm.

Villiaumite NaF

Villiaumite, of at least three different generations, is widespread in all assemblages in the Palitra pegmatite. Bright red, first-generation villiaumite (designated villiaumite-I) forms abundant arborescent and cuboctahedral inclusions in large crystals of other early minerals including eudialyte, lorenzenite, lomonosovite and especially microcline. Beautiful graphic intergrowths of red villiaumite-I and greenish white microcline are not uncommon. The length of such villiaumite "trees," which are actually skeletal crystals, can reach 10 cm. Ruby-colored and dark red second-stage villiaumite-II forms equant, commonly rounded inclusions up to 3 cm in analcime and sodalite. The third-generation, dark red villiaumite-III, occurs as aggregates to 30 cm in the core of the Palitra pegmatite, filling cavities together with simultaneously crystallized natrosilite. It also occurs as graphic intergrowths within natrosilite and villiaumite. In small cavities, well-formed cuboctahedral villiaumite crystals to 1.5 mm have been observed. Villiaumite-III is one of the main constituents of the pegmatite core. Perfect crystals of earlier-formed analcime, serandite, nordite-(Ce), ferronordite-(Ce), vuonnemite, bario-olgite and other minerals are commonly present inside villiaumite-III aggregates.

Vitusite-(Ce) $Na_3Ce(PO_4)_2$

Vitusite-(Ce) is a common mineral of the late-stage assemblages. It forms transparent, pale brown, tabular crystals to 8 mm with bright vitreous luster on crystal faces and resinous luster on broken surfaces. Radial clusters of such crystals overgrow analcime, sodalite, ussingite and aegirine, and in most cases they are situated inside natrosilite, only rarely in manaksite or villiaumite. Another morphological variety of vitusite-(Ce) occurs as brown spherules up to 1 mm in diameter forming crusts on serandite crystals in cracks and in the peripheral parts of corroded manaksite crystals. That this morphological variety of vitusite-(Ce) replaced phosinaite-(Ce) is supported by rare-earth-element ratios (Ce:La:Nd = 3.3:1:1.5) which are typical for phosinaite-(Ce), whereas the above-mentioned large crystals of vitusite-(Ce) show a REE ratio common for the species in other localities (Ce:La:Nd = 1.4:1:0.2). Partial pseudomorphs of fine-grained vitusite-(Ce) after phosinaite-(Ce) crystals have been observed in ussingite aggregates. Vitusite-(Ce) fluoresces pale violet in shortwave ultraviolet light.

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

Vuonnemite is abundant in the core of the pegmatite. Its transparent, bright lemon-yellow lamellae (to 7 cm wide and 5 mm thick) with bright vitreous luster occur included in villiaumite, natrosilite and ussingite together with serandite and sphalerite. Some of these lamellae are curved. When villiaumite-III is carefully dissolved in water, perfect, tabular vuonnemite crystals to 5 mm are sometimes revealed on aegirine.

Wurtzite ZnS

Wurtzite from the Palitra pegmatite represents the first occurrence of the mineral anywhere in the Lovozero massif. It forms red-brown, translucent crystals to 0.5 mm bounded by faces of hexagonal pyramids and terminated by the pedion {001}. The crystals, forming clusters to 1 mm on ussingite and sodalite, were found after dissolving away enclosing villiaumite. Wurtzite was confirmed by the presence of the $d = 3.29$ Å reflection in its X-ray powder diffraction pattern.

Zakharovite $Na_4Mn_5Si_{10}O_{24}(OH)_6\cdot 6H_2O$

Zakharovite is an alteration product of manaksite in the Palitra pegmatite. It occurs as bright yellow films and crusts to 0.5 mm thick

***Figure 40.* Yellow zakharovite crystals to 2 mm, with pale pink serandite and black aegirine, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

***Figure 38.* Yellow rectangular vuonnemite crystal, 3 mm, in a cavity in yellow manaksite with dark gray aegirine and brown sphalerite, from the Palitra pegmatite. V. G. Grishin collection; Natalia Pekova photo.**

***Figure 39.* Yellow vuonnemite *in situ* with white sodalite and dark brown lomonosovite. N. A. Pekova photo.**

Table 1. **Chemical composition (wt. %) of bartonite (1), chlorbartonite (2), troilite (3), sphalerite (4), wurtzite (5) and löllingite (6) from the Palitra.**

	1	*2*	*3*	*4*	*5*	*6*
Na	0.04	0.02				
K	9.66	9.53				
Tl	0.20	0.20				
Cu	0.18	0.15				
Zn	0.07	0.21		64.56	59.40	
Mn				0.37	0.55	
Fe	53.93	53.69	62.07	2.26	7.64	24.26
Co	0.11	0.08				2.27
Ni	0.14	0.15				
As						72.81
S	35.82	35.01	36.72	32.43	32.90	0.56
Cl	0.02	1.13				
Total	100.26	100.17	98.79	99.62	100.49	99.90

Table 2. **Chemical composition (wt. %) of bario-olgite (1), belovite-(Ce) (2), vitusite-(Ce) (3–4), steenstrupine-(Ce) (5), thorosteenstrupine (6–7), phosinaite-(Ce) (8–9), ferronordite-(Ce) (10) and nordite-(Ce) from the Palitra.**

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Na_2O	14.78	4.32	21.91	24.05	6.26	14.16	15.33	29.80	25.87	12.47	12.12
K_2O	0.87	0.11							0.12		
CaO	0.32		1.20	1.18	2.05	0.50	1.44	6.11	7.33	0.30	0.27
SrO	16.57	41.44	1.67		0.33					12.86	12.66
BaO	31.17	1.32	0.29							0.80	0.87
MgO					0.30	1.20			0.20	0.45	0.46
MnO	0.39			0.92	7.87	6.73	7.30	2.57	2.24	1.93	2.05
FeO					1.55	1.67	1.98		0.06	2.50	2.36
ZnO					0.22				0.19	2.61	2.95
Al_2O_3						0.68				0.06	0.06
La_2O_3	2.41	5.49	14.42	5.04	9.03	1.41	1.50	2.05	2.57	8.35	8.53
Ce_2O_3	1.90	12.41	20.26	16.77	13.38	6.39	6.06	7.35	9.04	11.07	11.23
Pr_2O_3	0.10	1.19	1.30	2.13	1.12	0.14	1.05	1.17	0.73	0.27	0.44
Nd_2O_3	0.16	2.43	2.29	8.01	2.86	3.34	2.13	3.53	3.75	0.68	0.82
Sm_2O_3			0.71	0.74					0.26		
ThO_2			0.17	2.99	10.24	20.13	23.39		0.64		
UO_2					0.64	0.99	3.83				
SiO_2	0.08		0.05	3.23	30.84	35.21	30.13	21.63	21.04	44.82	44.61
P_2O_5	31.77	28.62	34.74	33.90	6.22	5.43	2.54	24.23	23.20		
Total	100.52	98.33*	99.01	98.96	94.46*	98.29*	96.68	98.44	97.24	99.17	99.43

NOTE: vitusite-(Ce): 3—large crystal, 4—spherulite replacing phosinaite-(Ce); phosinaite-(Ce): 8—thick crystal in ussingite, 9—thin needle forming rosette in natrosilite.

* Totals also include: #2—1.50 F, –0.63 $-O=F_2$; #5—1.06 TiO_2, 0.49 ZrO_2; #6—0.31 PbO.

on manaksite surfaces and in cracks in manaksite crystals. Zakharovite crusts up to several square centimeters have been found. They consist of subparallel, spherulitic or scaly aggregates. Larger zakharovite spherules (to 1.5 mm in diameter) consisting of yellow lamellae are rarely observed in natrosilite near its contact with manaksite.

GEOCHEMICAL AND GENETIC FEATURES

Taking into account the Palitra pegmatite's geological setting, morphology, structure and mineral relations, it is possible to propose that the pegmatite was formed within a closed system from a relatively high-temperature, residual water-poor ("dry") melt oversaturated in alkali (especially Na) volatiles and rare elements. Inside this "bubble" situated under the malignite "shield," a strong differentiation of elements gave rise to the diverse mineral assemblage and the zoning observed. The pegmatite's influence on surrounding rocks was insignificant, causing only thin contact-zone reaction rims consisting of sodalite, eudialyte and villiaumite.

The temperatures of mineral formation (except for revdite in cavities) can be determined as approximately 200–450°C.

An unusual feature of the Palitra pegmatite is that, unlike the majority of hyperagpaitic rocks and pegmatites, it contains no endogenetic carbonates or other minerals containing carbonate ions. These minerals (natrite, thermonatrite, trona, shortite, sidorenkite, cancrinite group members, etc.) occur in alkaline pegmatites where CO_2 is a common constituent of gas-liquid inclusions. Abundant gas inclusions were found in natrosilite from the Palitra pegmatite, but N. V. Chukanov, using infrared spectroscopy, determined that the major phase of these inclusions is CO, whereas CO_2 is almost totally absent. This is very rare for alkaline rocks, and it reveals the reducing conditions that must have existed during late stages of the formation of the Palitra pegmatite.

Another interesting feature of the pegmatite is its enrichment in potassium. Such enrichment is abnormal for late-stage assemblages of Lovozero pegmatites, which are usually hypersodic with relatively low K content. The potassium enrichment is reflected in the crystallization of large amounts of manaksite in the Palitra pegmatite. The amounts of the other major and minor elements (Li, Be, Ca, Sr, Ba, Mn, Fe, Zn, Al, REE, Th, Ti, Zr, Nb, P, S, Cl, etc.) are typical for hyperagpaitic derivatives of the Lovozero massif.

The sequence of formation of the mineral assemblages in the Palitra pegmatite is inferred to have been as follows.

Nepheline, which composes the thin top zone of the pegmatite, was the first mineral to form. This corresponds to the normal order of mineral crystallization from an agpaitic melt (Kogarko, 1977). Green fibrous aegirine-I, microcline, eudialyte, arfvedsonite, lorenzenite, lamprophyllite, lomonosovite, kapustinite and villiaumite-I were formed after nepheline.

Table 3. **Chemical composition (wt. %) of aegirine (1–2), serandite (3–5), arfvedsonite (6), potassicarfvedsonite (7), manaksite (8), zakharovite (9) and ussingite (10) from the Palitra.**

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Na_2O	13.31	13.11	9.11	9.54	10.95	8.52	7.65	8.14	10.04	20.25
K_2O			0.02			1.64	3.76	11.90		0.04
CaO	0.81		0.10	0.13	14.04	0.47	0.09		0.13	0.02
MgO	0.84	0.38	0.03		0.02	6.76	4.80	0.27		
MnO	0.76	1.60	34.78	35.31	18.28	1.99	3.26	15.24	23.04	
FeO			1.40	0.88	0.61	16.83**	13.82**	3.10	5.00	
Fe_2O_3	26.82	33.11				7.02**	8.50**			0.05
Al_2O_3	0.80	0.97				1.62	0.51			16.07
SiO_2	51.96	51.24	51.23	51.74	52.71	49.72	52.82	61.20	51.91	59.40
TiO_2	3.13	0.03				2.22	0.77			
Total	99.04*	100.43	96.67	97.60	96.61	96.88*	97.52*	99.85	90.12	95.83

NOTE: aegirine: 1— black thick crystal, 2—red crystal in pseudomorph after manaksite; serandite: 3—pale-pink bar-shaped crystal in pseudomorph after manaksite, 4—bright-pink platy crystal in pseudomorph after manaksite, 5—large salmon-pink crystal in ussingite.
* Totals also include: #1—0.61 ZrO_2; #6—0.11 Cl, –0.02 –O=Cl_2; #7—0.73 Li_2O, 0.11 ZnO, 1.21 F, –0.51 –O=F_2.
** Calculated from Fe_{tot}.

Table 4. **Chemical composition (wt. %) of kapustinite (1), kazakovite (2–4), eudialyte (5), barytolamprophyllite (6–7), bornemanite (8–9) and mangan-neptunite (10) from the Palitra.**

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Na_2O	24.42	26.89	26.27	28.47	12.32	9.35	10.13	25.58	27.06	7.16
K_2O	0.02				0.49	1.08	1.12	0.41	0.83	5.05
CaO	0.18	0.65	0.74	0.46	6.07	0.12	0.16	0.24		
SrO						6.45	5.43			
BaO						15.27	17.75	8.63	8.35	
MgO	0.02		0.06	0.02		0.16	0.22			0.18
MnO	2.36	5.46	5.43	4.56	2.43	3.77	3.95	1.58	1.18	8.52
ZnO	0.05						0.17			
FeO					5.87	0.87	1.38			7.29
Fe_2O_3	0.36	1.87	2.30	2.25				0.65	0.38	
Al_2O_3						0.20	0.20			0.15
SiO_2	52.82	54.27	54.37	54.15	52.82	28.74	27.27	27.38	29.98	52.37
TiO_2	0.54	5.95	5.62	6.52	0.59	27.81	29.28	14.92	14.04	16.39
ZrO_2	16.38	2.42	3.32	1.40	15.04					
Nb_2O_5		0.81	0.66	1.28	1.07	0.72	0.55	10.06	9.70	0.53
P_2O_5								7.27	7.14	
Total	100.84*	98.32	98.77	99.13	97.55*	94.54	98.14	96.72*	98.66	97.64

NOTE: kazakovite: 2—rim around kapustinite, 3–4—zonal crystal (3—dark-brown core, 4—honey-colored rim); barytolamprophyllite: 6—spherulite, 7—crystal epitactically grown on lorenzenite; bornemanite: 8—spherulite on lomonosovite, 9—segregation in villiaumite.
* Totals also include: #1—0.17 Y_2O_3, 0.20 Ce_2O_3, 0.24 Nd_2O_3, 0.28 UO_2, 2.80 H_2O; #5—1.10 Cl, –0.25 –O=Cl_2;
#8—0.91 F, –0.38 –O=F_2.

Polymineralic aggregates mostly consisting of sodian aluminosilicates (sodalite, analcime and ussingite) are judged to have formed later than the aegirine-eudialyte-microcline paragenesis because of the replacement of microcline by ussingite and sodalite. This assemblage also includes black prismatic aegirine-II, villiaumite-II, serandite-I, vuonnemite, kazakovite, steenstrupine, phosinaite, vitusite-I, chkalovite and mangan-neptunite. Minerals observed on the surface of ussingite and analcime after the dissolving of villiaumite and natrosilite are probably products of the next sub-stage: these are natrolite, manaksite, nordite, ferronordite, thorosteenstrupine, bario-olgite, nalipoite, barytolamprophyllite, and sphalerite. Pseudomorphs of various minerals were formed still later: pale pink serandite-II, polychromatic aegirine-III and zakharovite after manaksite, bornemanite after lomonosovite, and vitusite-II after phosinaite. Cavities were filled by natrosilite and villiaumite-III.

The only low-temperature (late hydrothermal) mineral is revdite. The role of low-temperature mineralization in the Palitra pegmatite is insignificant; in this the Palitra differs from all other known large Lovozero pegmatites.

Generally, the parent medium of the Palitra pegmatite minerals (except perhaps the earliest ones) seems to have been a highly reduced, extremely Na-Fe-oversaturated silicate melt that was water-poor and CO_2-free. When rock-forming and early accessory minerals crystallized, rare elements (Be, Ba, REE, Nb, plus Mn and Zn) accumulated, providing for rich mineralization in the core of the pegmatite. The last primary ("dry") minerals to form were natrosilite with abundant inclusions of CO and villiaumite. After the crystallization of minerals of K, Ca, Mn, Fe, Zn, Ti, P, S, Cl and rare elements, the composition of the residual gas-liquid medium was carbonyl-fluoride-silicate-sodic-rich, without significant admixtures of other constituents.

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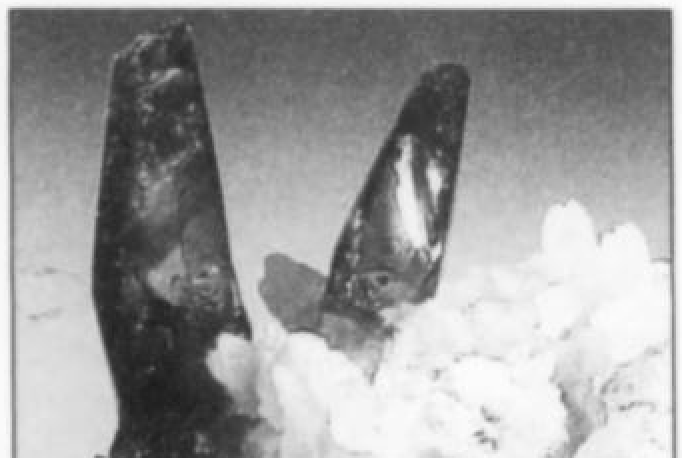

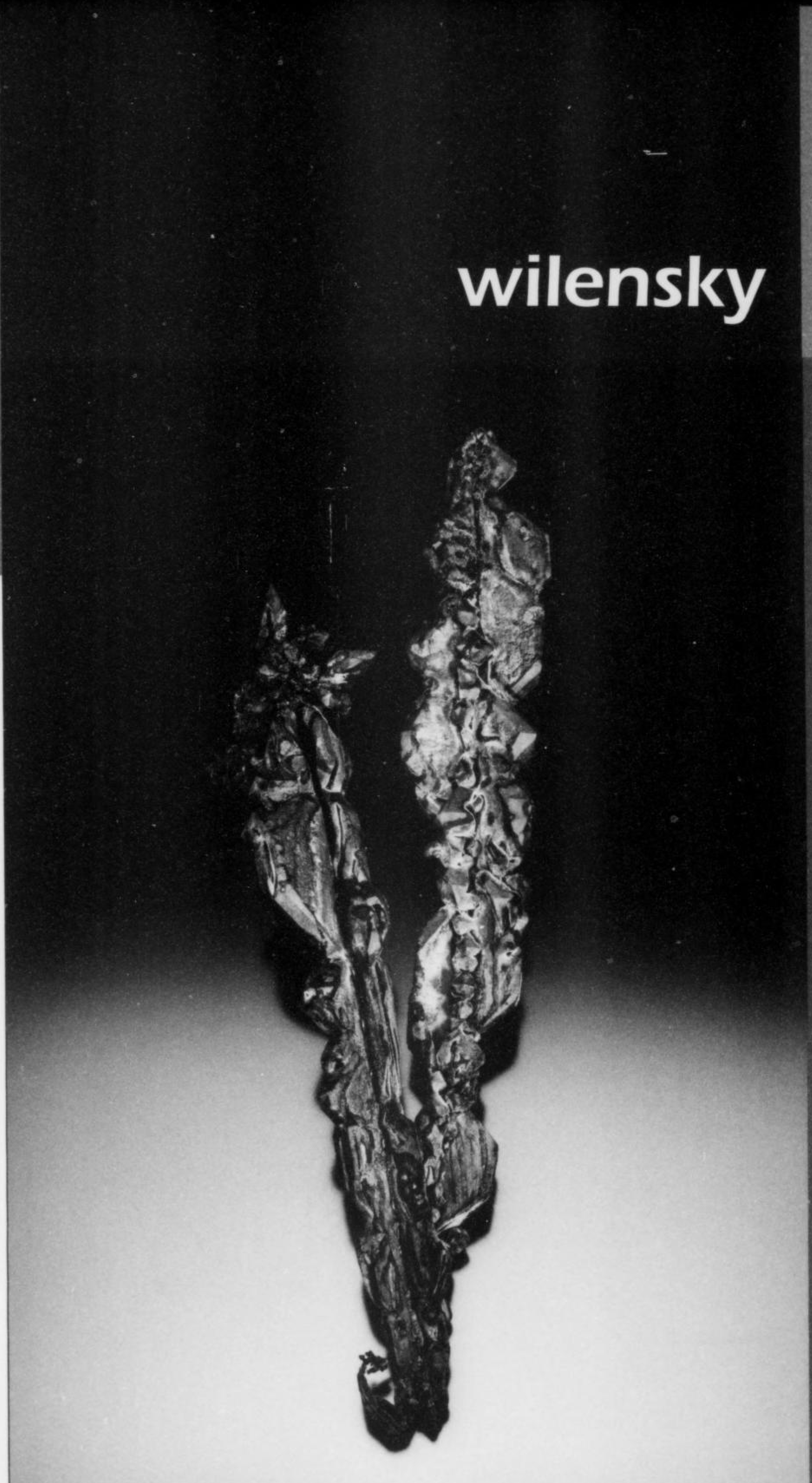

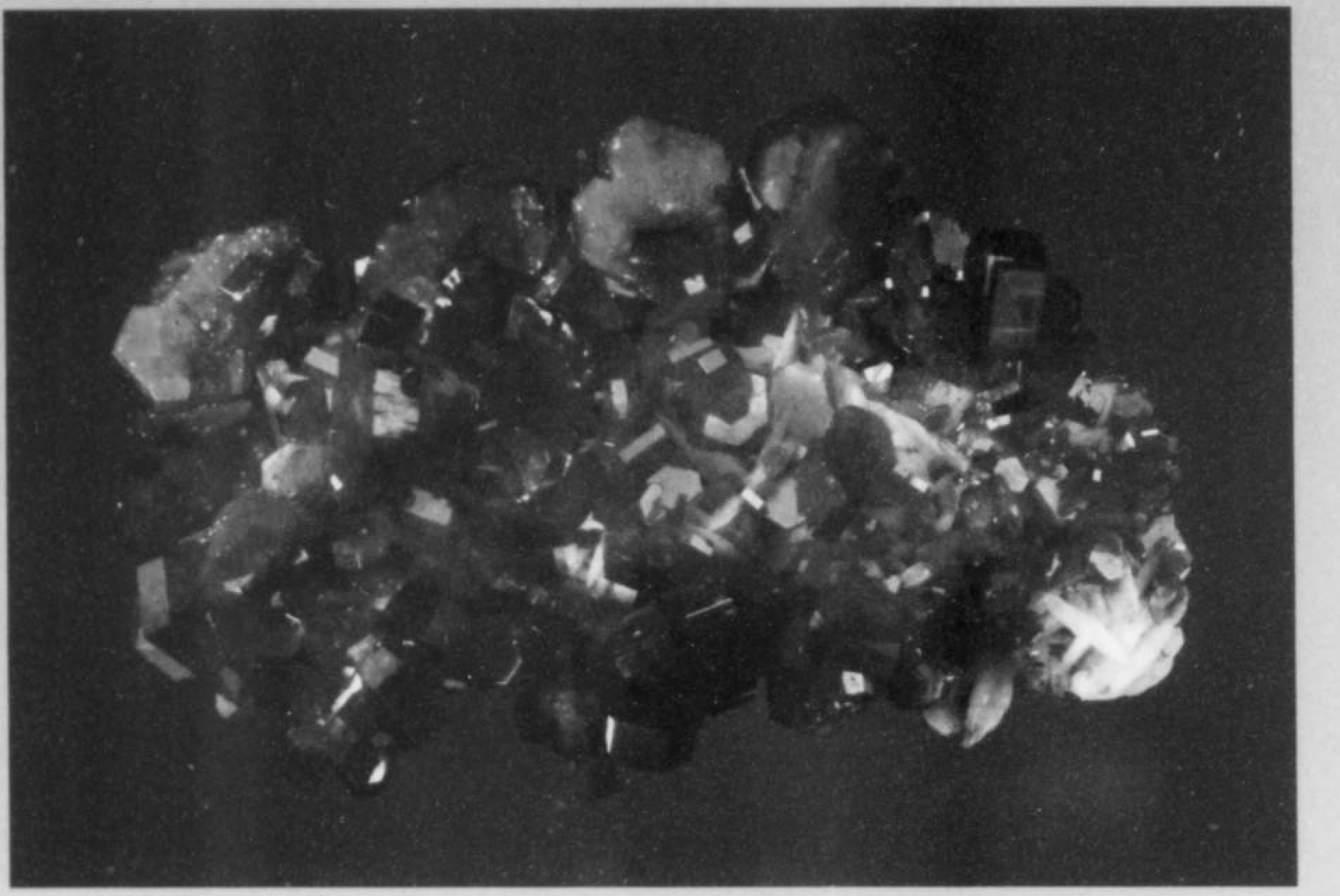

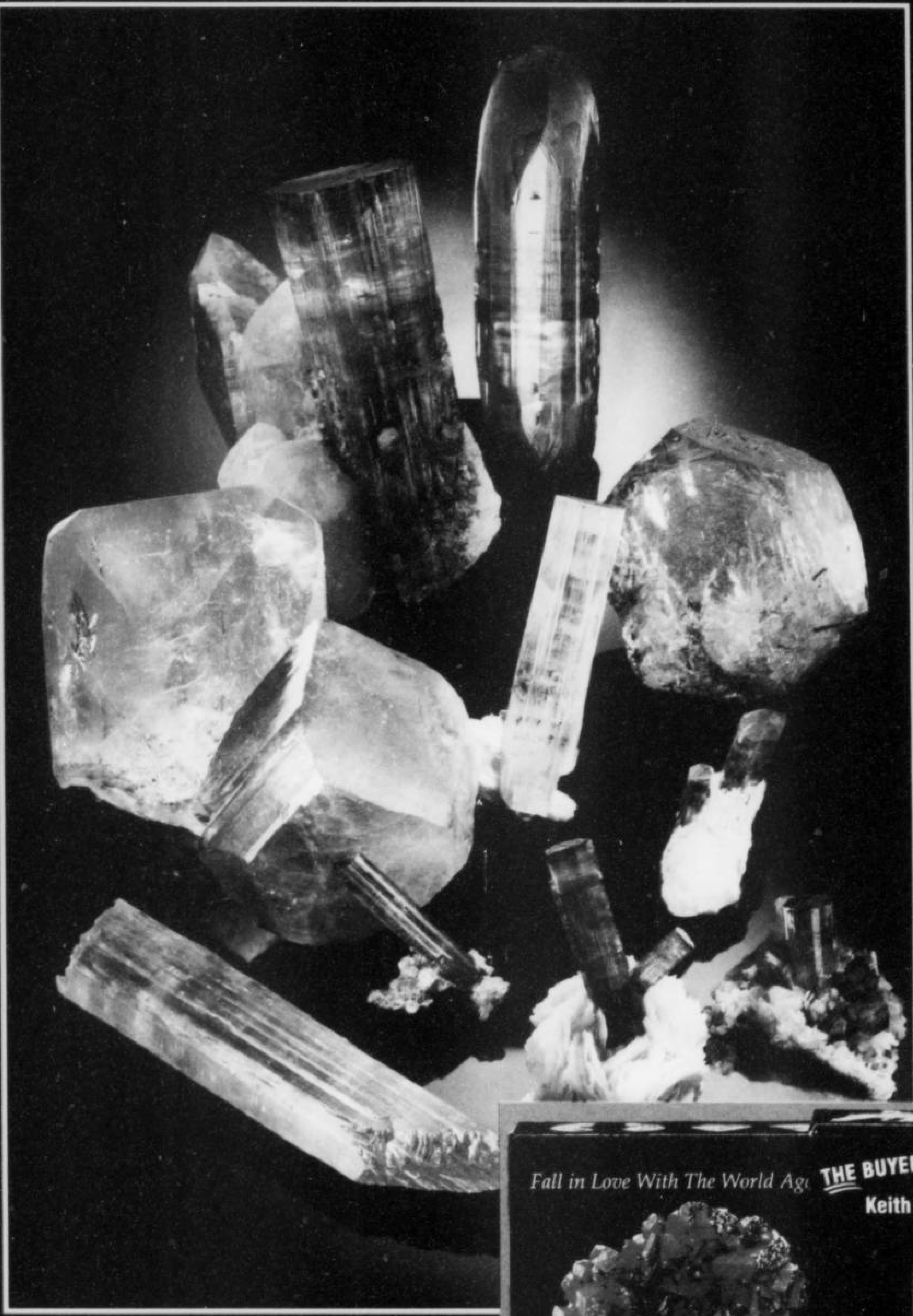

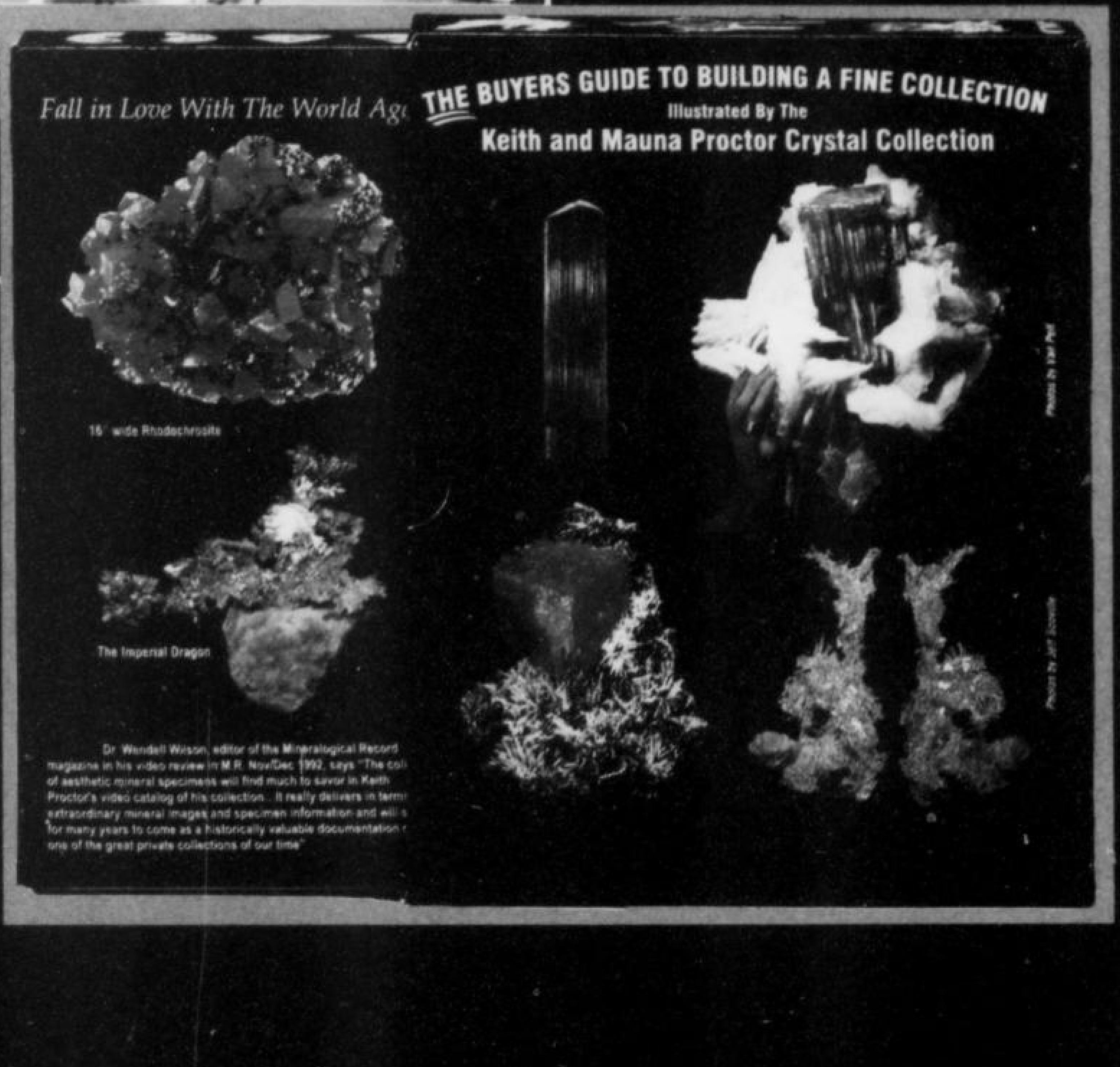
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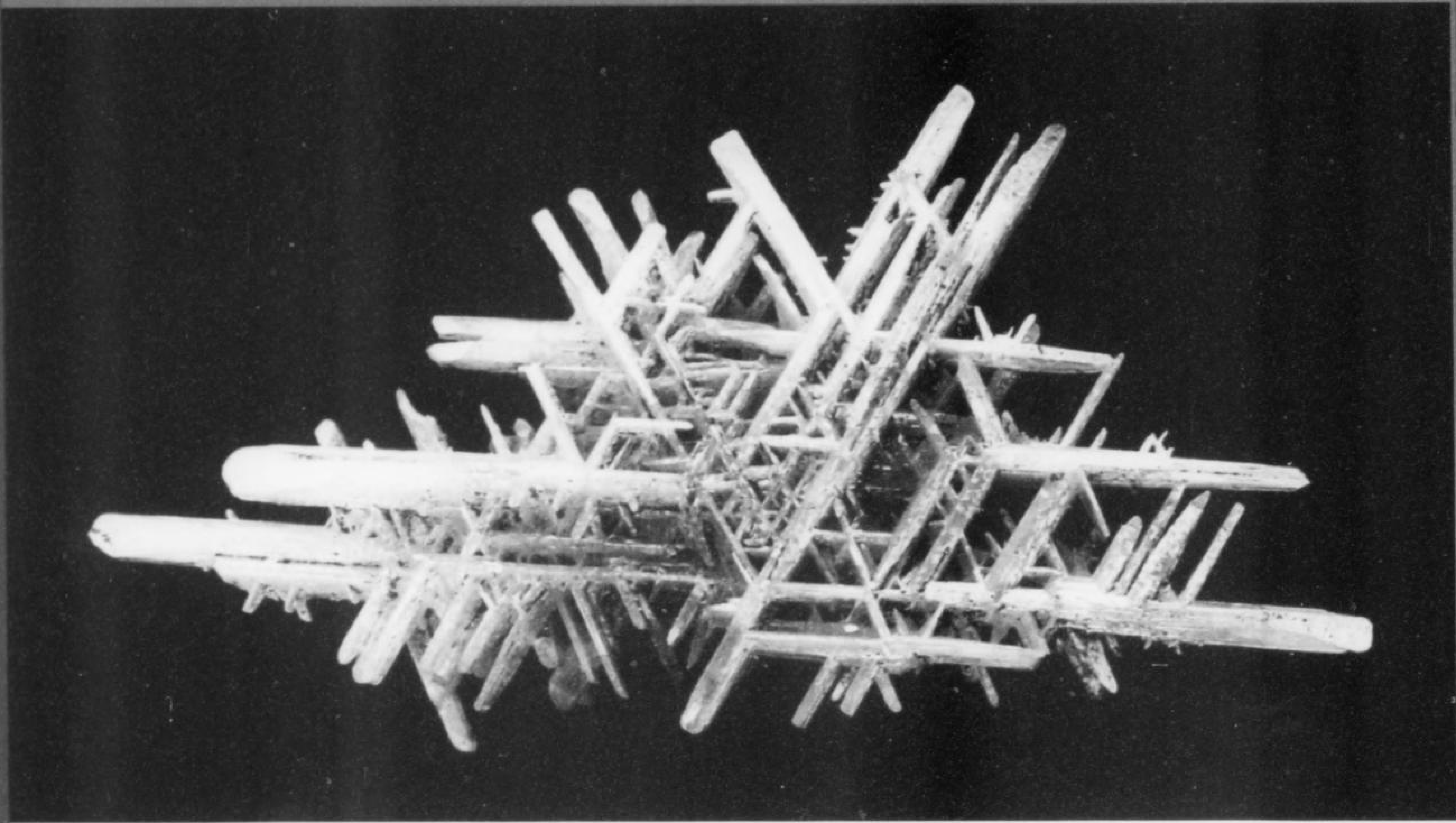

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The Minerals of
WEST-CENTRAL ILLINOIS

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Well-crystallized, varicolored Illinois fluorite and associated minerals from Rosiclare and Cave-in-Rock in the southern part of the state adorn the mineral cabinets of collectors around the world. And excellent specimens of Illinois galena, sphalerite, calcite and iron sulfide minerals have been produced from the famed Upper Mississippi Valley Zinc-Lead District in and around the town of Galena in the north. Less well known, however, are the minerals that have been exposed in limestone quarries in west-central Illinois, including display-quality specimens of twinned calcite and the uncommon minerals violarite and polydymite.

LOCATION

The minerals featured in this report were collected from five operating limestone quarries near the towns of Biggsville and Smithshire in Henderson County, Illinois, and near the towns of Dallas City, Hamilton and Plymouth in Hancock County, Illinois (Fig. 1). Both counties are bordered on the west by the Mississippi River. The cluster of localities will be referred to collectively as west-central Illinois (Fig. 2).

HISTORY

The history of limestone use in west-central Illinois extends back to the time of early European settlement, beginning in the 1830's. At that time, limestone was quarried as "dimension stone" for use in constructing foundations for houses and other buildings. Because the stone was readily obtainable in flat slabs and, owing to its softness, was easily dressed, it was widely used for window sills and lintels, for exterior facings and as ornamental building stone. Surviving examples include the Dallas City High School (Hancock County), which was built about 1890 (Fig. 3), and the Mormon Temple at Nauvoo (Hancock County), construction of which was begun in 1841 and completed in 1846 (Fig. 4). The temple was rebuilt in 2002, using the same site and exterior architectural plans; however, because the old quarry had been flooded by the 1912 Keokuk Dam, the limestone for the building had to be obtained elsewhere.

Another early (and continuing) use of limestone was in the manufacture of "quicklime" (CaO). Quicklime was produced by a process that involved heating the limestone ($CaCO_3$) to a high temperature in kilns in order to drive off the CO_2 and leave calcium oxide. Quicklime was then hydrated to form calcium hydroxide ($Ca(OH)_2$). Calcium hydroxide reacts with water and atmospheric CO_2 to produce a fine-grained calcium carbonate which crystallizes and hardens. Because of this property of hardening upon addition of water, quicklime was used in the manufacture of mortar and plaster, and was also used as a flux in the production of steel, among other uses.

Figure 1. **O'Neill Quarry.**

As the railroads reached western Illinois in the middle and late 19th century, limestone was widely used in building bridge abutments. The masonry for the Burlington Railroad Bridge came from the Burlington Limestone, which was quarried in Hancock County. This single-track bridge, built in 1868, connected the towns of Burlington, Iowa and East Burlington (now Gulfport), Illinois. It was replaced in 1898 by a double-track bridge.

Since the advent of motor vehicles, crushed limestone has been in demand for surfacing gravel roads and as aggregate in concrete for road surfaces, bridges and overpasses. Much of the limestone quarried in western Illinois today is used in road-building. High-strength limestone, however, is used as aggregate in structural concrete, and high-calcium limestone is used in a wide variety of industrial applications, including steel manufacturing, water treatment, agricultural liming and feed supplements, glass making, ore and petroleum refining and paint manufacturing.

GEOLOGY

The rocks hosting the west-central Illinois mineral deposits belong to the Burlington Limestone and Keokuk Limestone formations, of Mississippian (Valmeyeran) age. Both rock units form prominent ledges that can be seen along the Mississippi River (Figs. 5 and 6). The Burlington Limestone is medium-grained to coarse-grained and highly fossiliferous. The upper and middle parts are characterized by the presence of beds and large nodules of chert, and the limestone is locally glauconitic. The basal Burlington "Quincy Lime" is mined for its high-purity limestone (Goodwin and Harvey, 1980).

The Keokuk Limestone includes thick beds of medium-grained to coarse-grained limestone, as well as thinner limestone beds and intercalated layers of argillaceous dolostone and calcareous shale. The shales in the upper part are similar to those in the overlying Warsaw Shale, and they contain scattered quartz-lined geodes similar to those for which the Keokuk Formation is well known

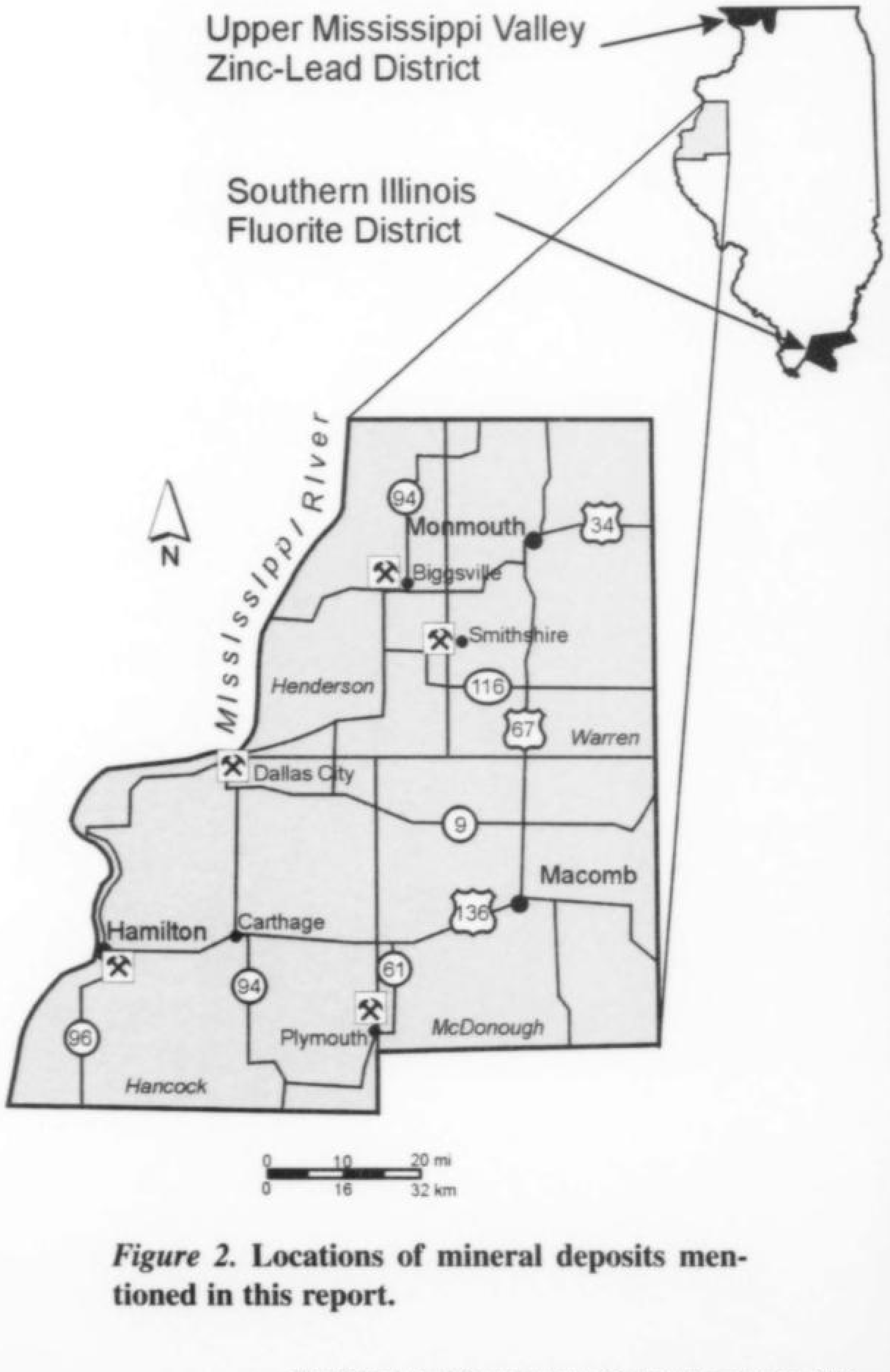


Figure 2. **Locations of mineral deposits mentioned in this report.**

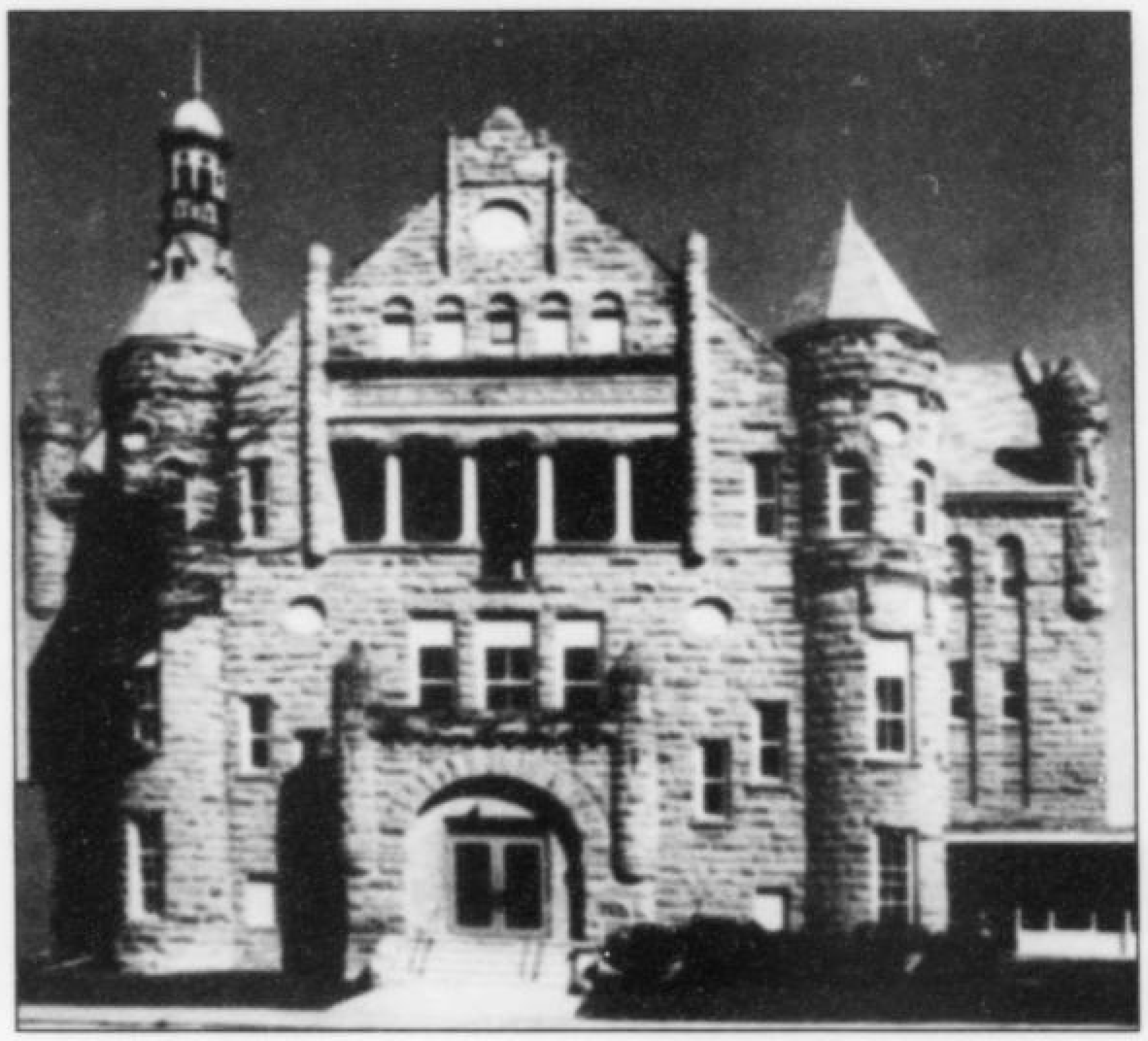


Figure 3. **The Dallas City High School, constructed of Mississippian Sonoran Dolomite; 1890 photo courtesy of the Illinois State Geological Survey.**

Figure 4. **The Mormon Temple at Nauvoo, Illinois, constructed of Mississippian Keokuk Limestone; 1846 photo courtesy of the Church of Jesus Christ of Latter-Day Saints.**

(Goodwin and Harvey, 1980). The Warsaw Shale is present in the uppermost exposed rock at Hamilton.

MINERALOGY

The minerals of west-central Illinois occur primarily as linings in small cavities in the Burlington and Keokuk formations. Some Keokuk mineralization occurs in cryptocrystalline quartz-lined spheroidal cavities (geodes). Locally, geodes are found crushed *in situ* and the associated mineralization occurs as breccia cement. Since the Keokuk Formation, where present, occurs at the top of quarry exposures, the minerals are considerably weathered, and

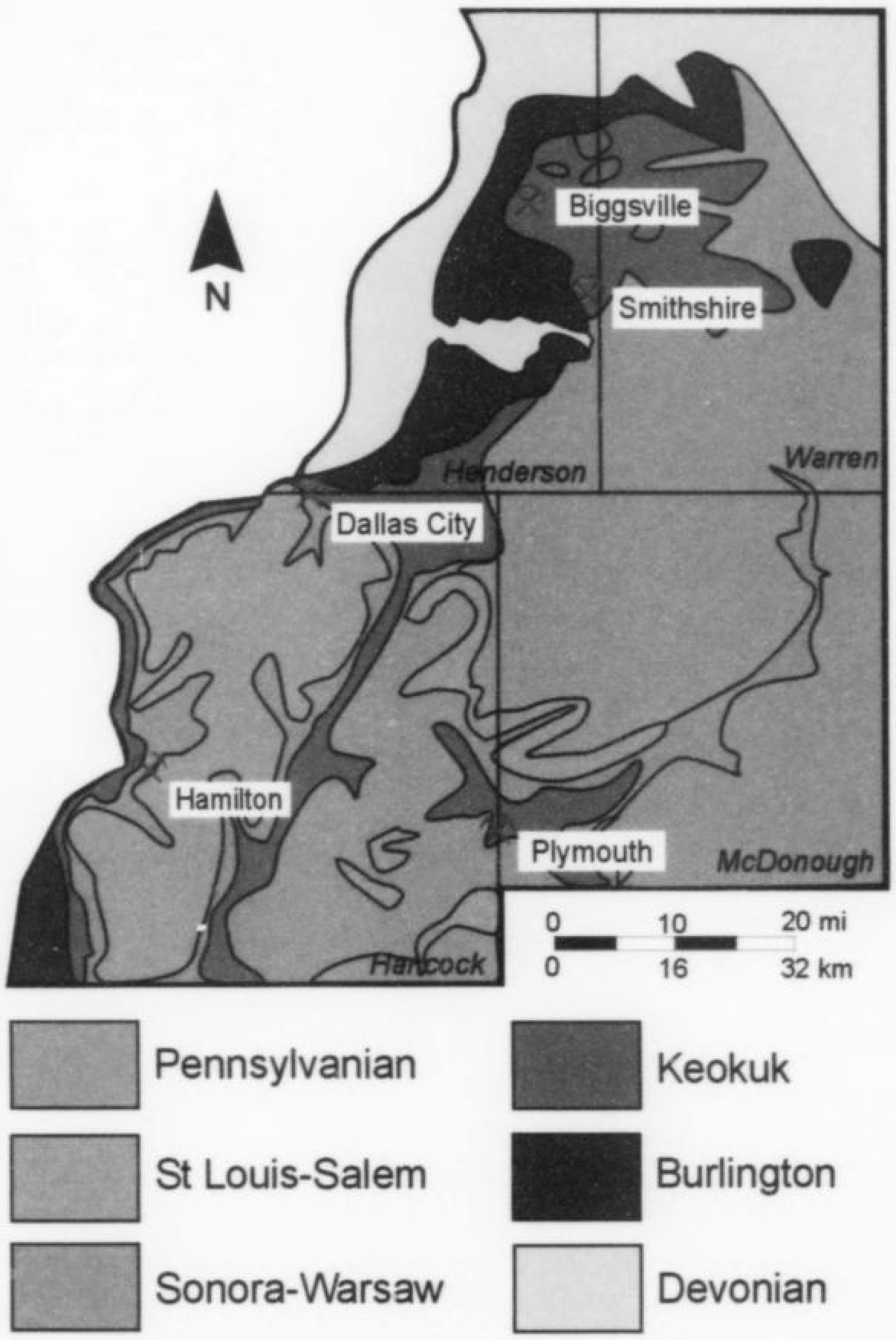


Figure 5. **Geologic map of west-central Illinois. Data from Cloos and Baxter (1981).**

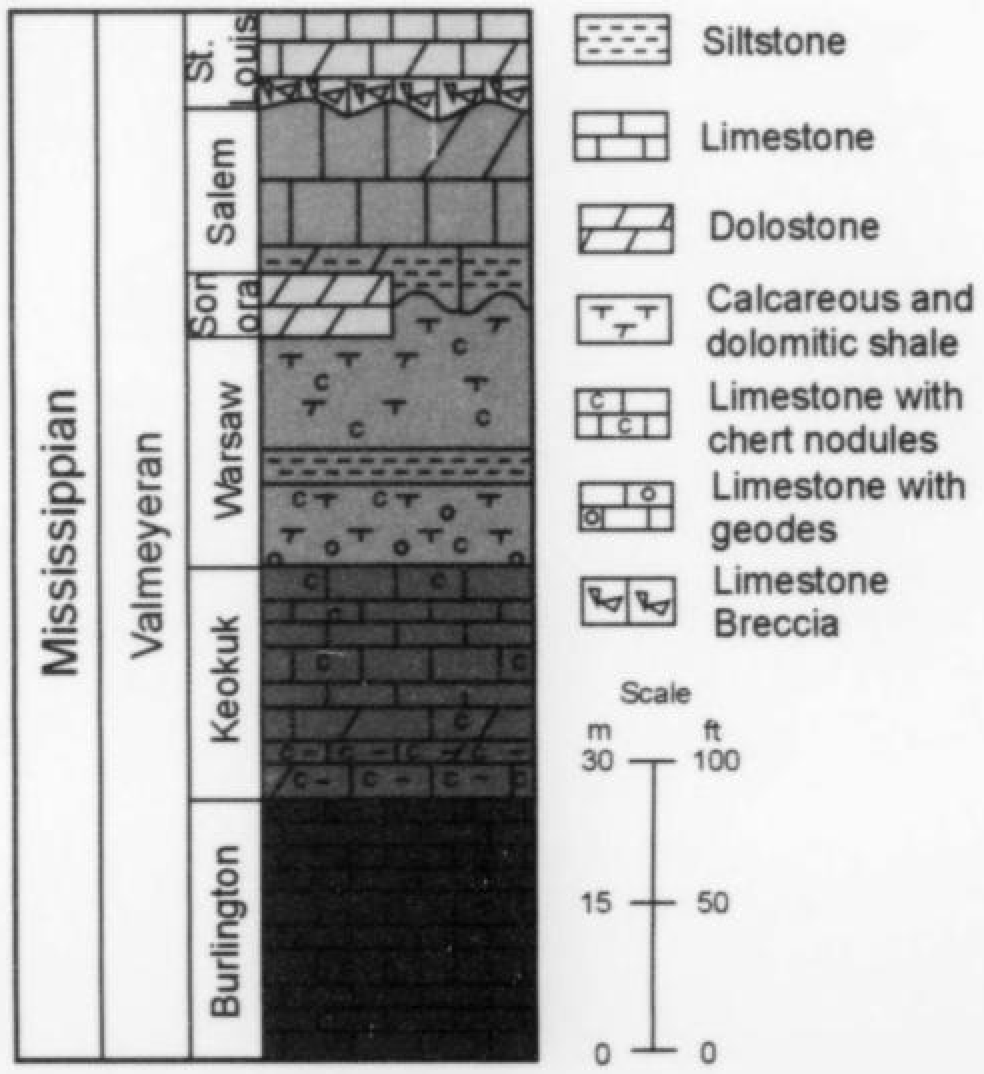


Figure 6. **Generalized stratigraphic section of Mississippian Rocks in west-central Illinois. Data from Goodwin and Harvey (1980).**

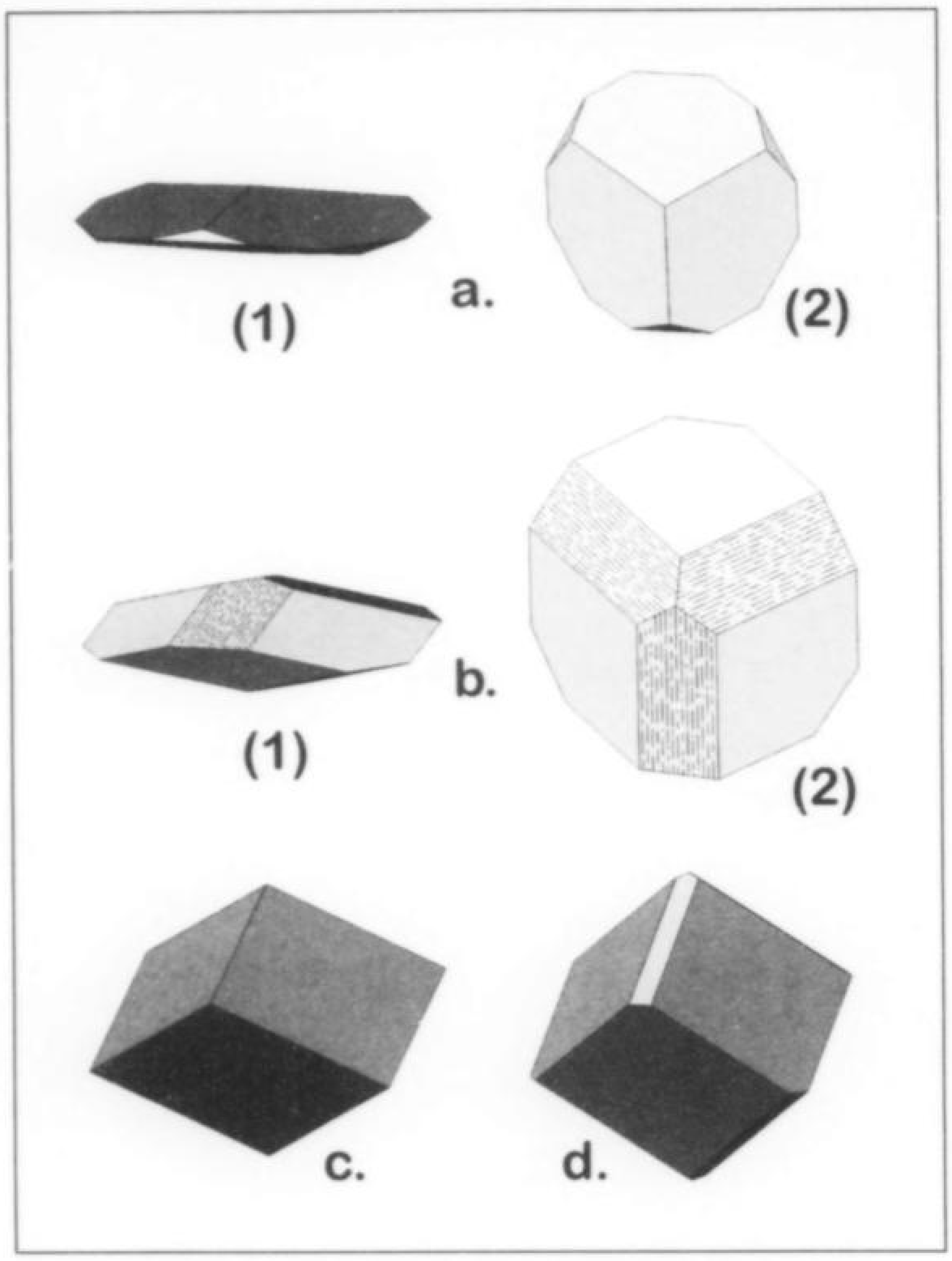


***Figure 7 (a-d).* Idealized drawings of calcite crystals from Biggsville: (a) forms $\{h0\bar{h}l\}$ and $\{0k\bar{k}l\}$. (1) and (2) are different views of the same crystal; (b): forms $\{h0\bar{h}l\}$ and $\{0k\bar{k}l\}$. (1) and (2) are different views of same crystals; (c): form $\{h0\bar{h}l\}$; (d): forms $\{h0\bar{h}l\}$ and $\{0k\bar{k}l\}$.**

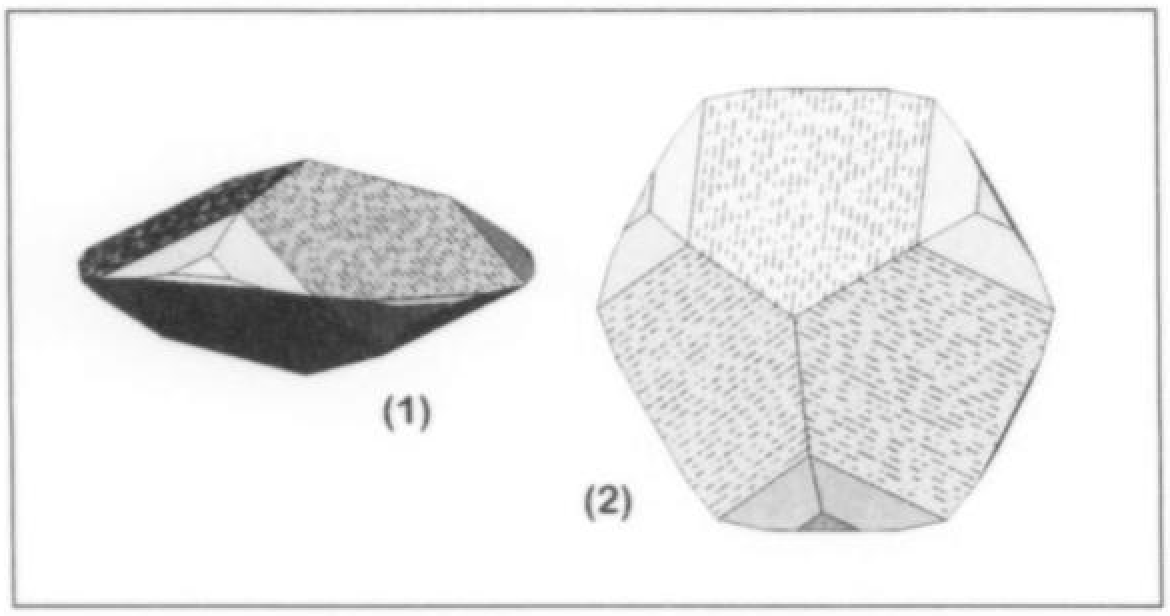


***Figure 9 (a).* Idealized drawings of calcite crystals from Hamilton, IL. (a): forms $\{0k\bar{k}l\}$ and $\{h0\bar{h}l\}$. (1) and (2) are different views of the same crystal.**

commonly show etched and iron-stained surfaces. Most of the highest-quality mineral specimens have been taken from the Burlington and the Warsaw formations.

Aragonite $CaCO_3$

Aragonite is a rare mineral in west-central Illinois, having been observed in a single sample from Biggsville. It consists of a spray of elongated prismatic to acicular crystals up to 1.5 cm long. The pale amber color of the crystals may be due to iron oxide staining.

Barite $BaSO_4$

Barite is rare in west-central Illinois, known only as a single crystal in a specimen from Hamilton. The tabular, pale yellow crystal is perched on drusy quartz.

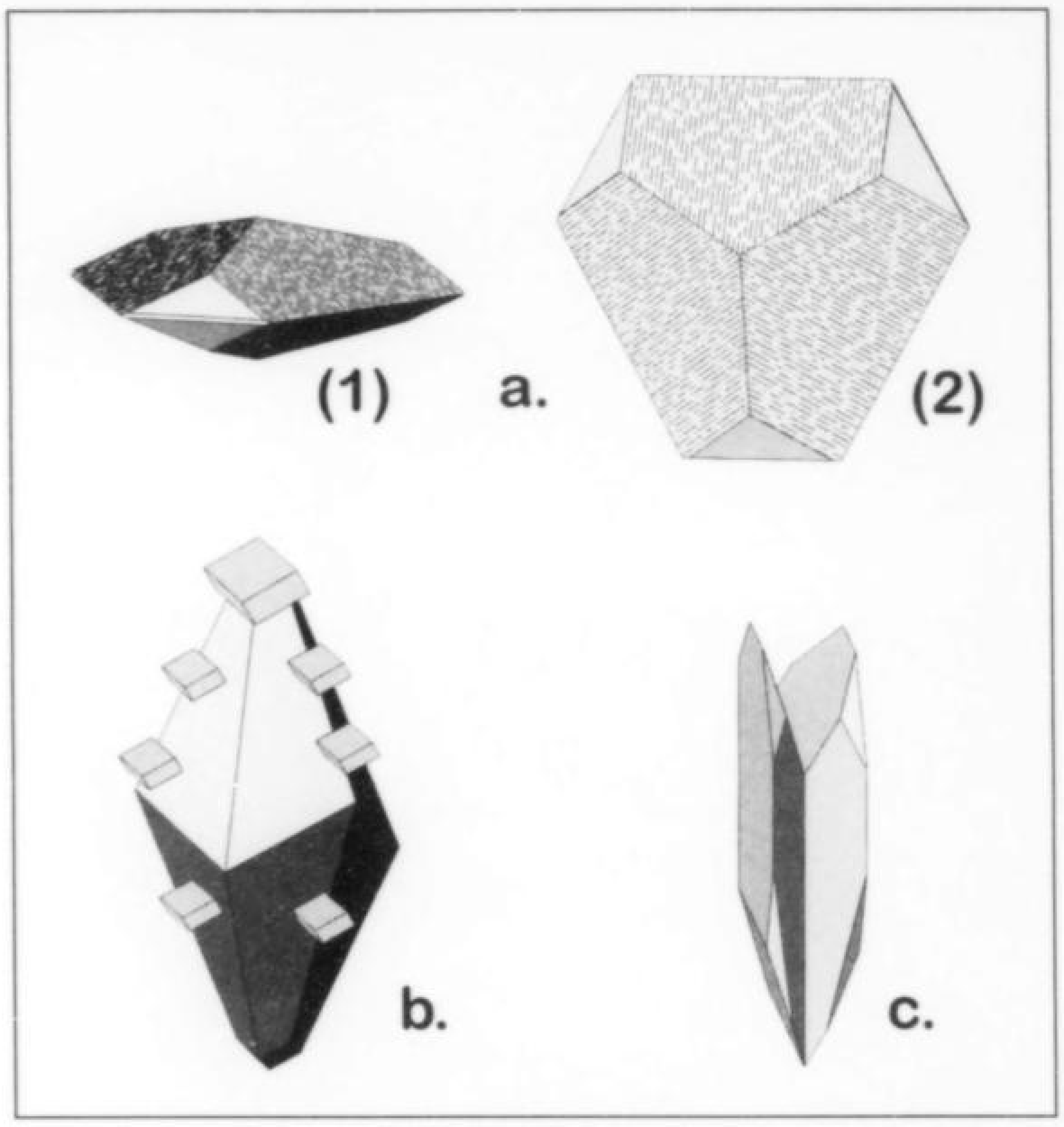


***Figure 8 (a-c).* Idealized drawings of calcite crystals from Dallas, IL. (a): forms $\{0k\bar{k}l\}$ and $\{h0\bar{h}l\}$. (1) and (2) are different views of the same crystal; (b): form $\{hk\bar{i}l\}$ with syntactical overgrowths of calcite, form $\{h0\bar{h}l\}$; (c): twinned rhombohedra, twin plane = $\{0\bar{1}\bar{1}l\}$.**

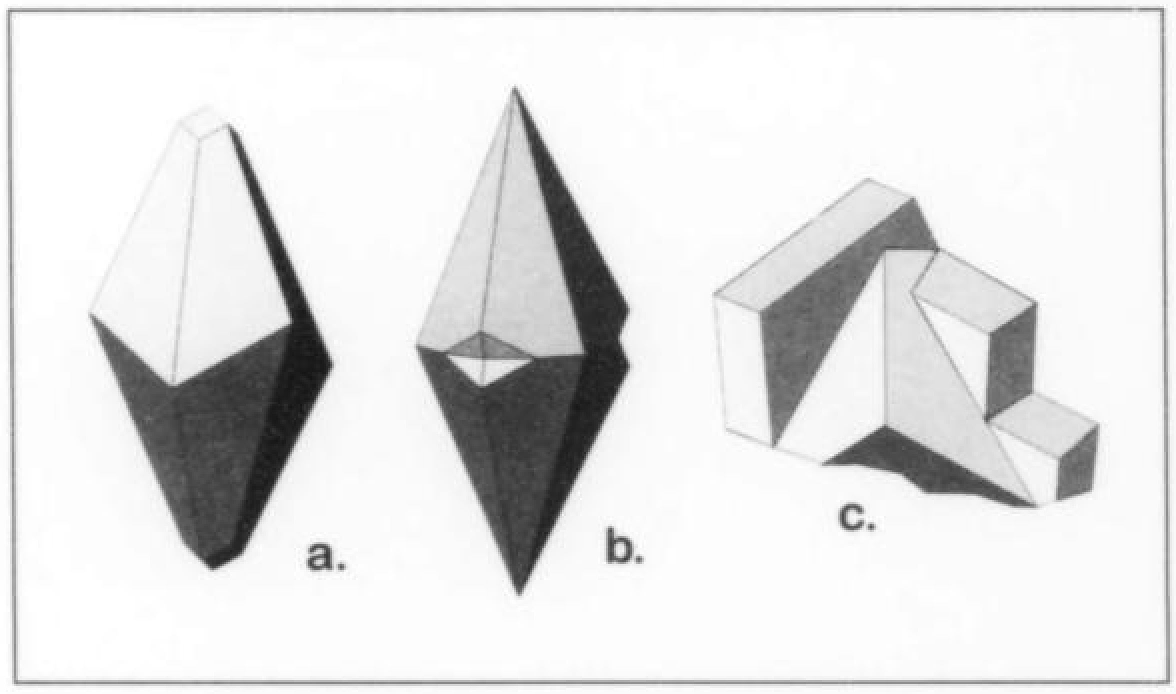


***Figure 10 (a-c).* Idealized drawings of calcite crystals from Plymouth, IL. (a): forms $\{hk\bar{i}l\}$ and $\{h0\bar{h}l\}$; (b): twinned scalenohedra, twin plane = {0001}; (c): twinned rhombohedra, twin plane = {0001}.**

Calcite $CaCO_3$

Calcite is present in all five of the west-central Illinois deposits and in general is the most abundant mineral of the region, with individual crystals ranging in size from microscopic to 8 cm. As is typical of calcites that form in carbonate host rocks in the mid-continental United States, west-central Illinois calcite occurs in several crystal habits (types). Seven distinct types have been observed (Figs. 7–10). Simple and modified obtuse rhombohedral forms (type I) are the most abundant. Type II crystals exhibit marked flattening with respect to the *c*-axis. These appear similar to calcites found in geodes in western Illinois and adjacent Iowa and Missouri. The well-known acute scalenohedral form ("dog-

Figure 11. **Calcite, 6.0 cm, from Gray's quarry, Hamilton, IL. Gene Tribbey collection; Wendell Wilson photo.**

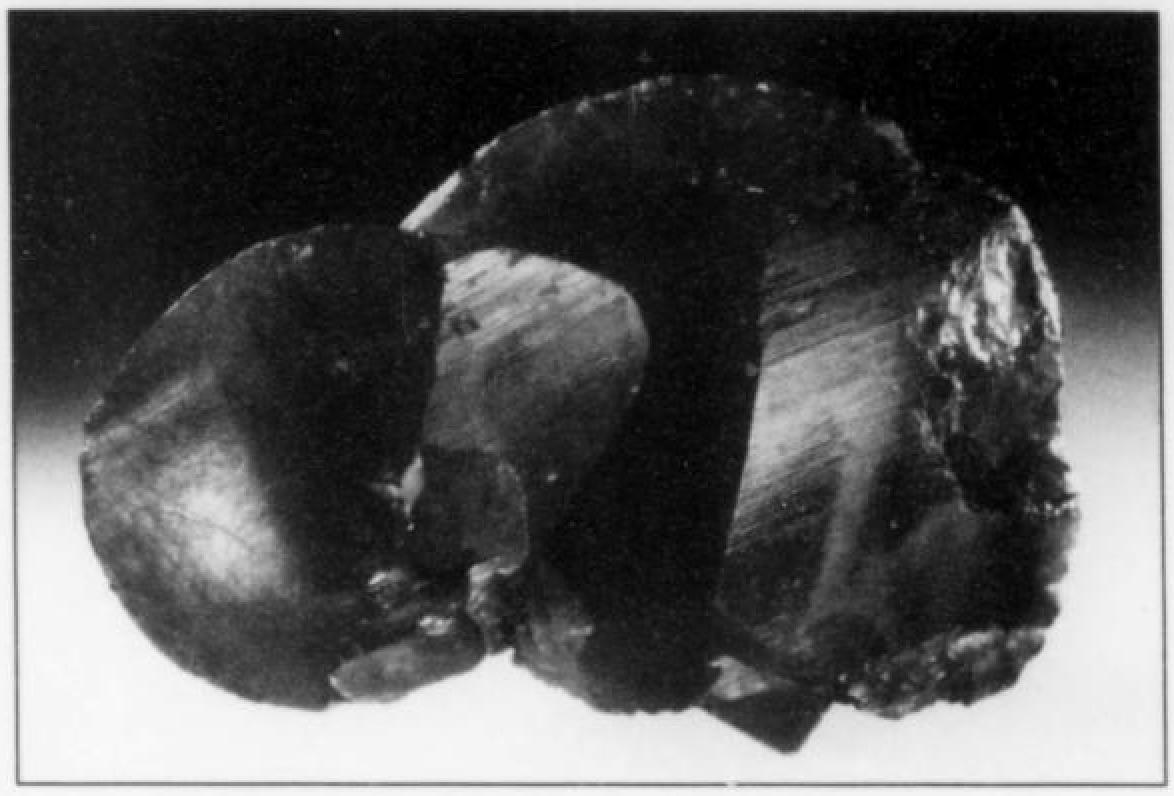


Figure 12. **Calcite, 7.2 cm, dark color due to inclusions of millerite and polydymite, from Gray's quarry, Hamilton, IL. Gene Tribbey collection; Wendell Wilson photo.**

Figure 13. **Calcite, 13.5 cm, from O'Neill quarry, Plymouth, IL. Gene Tribbey collection; Wendell Wilson photo.**

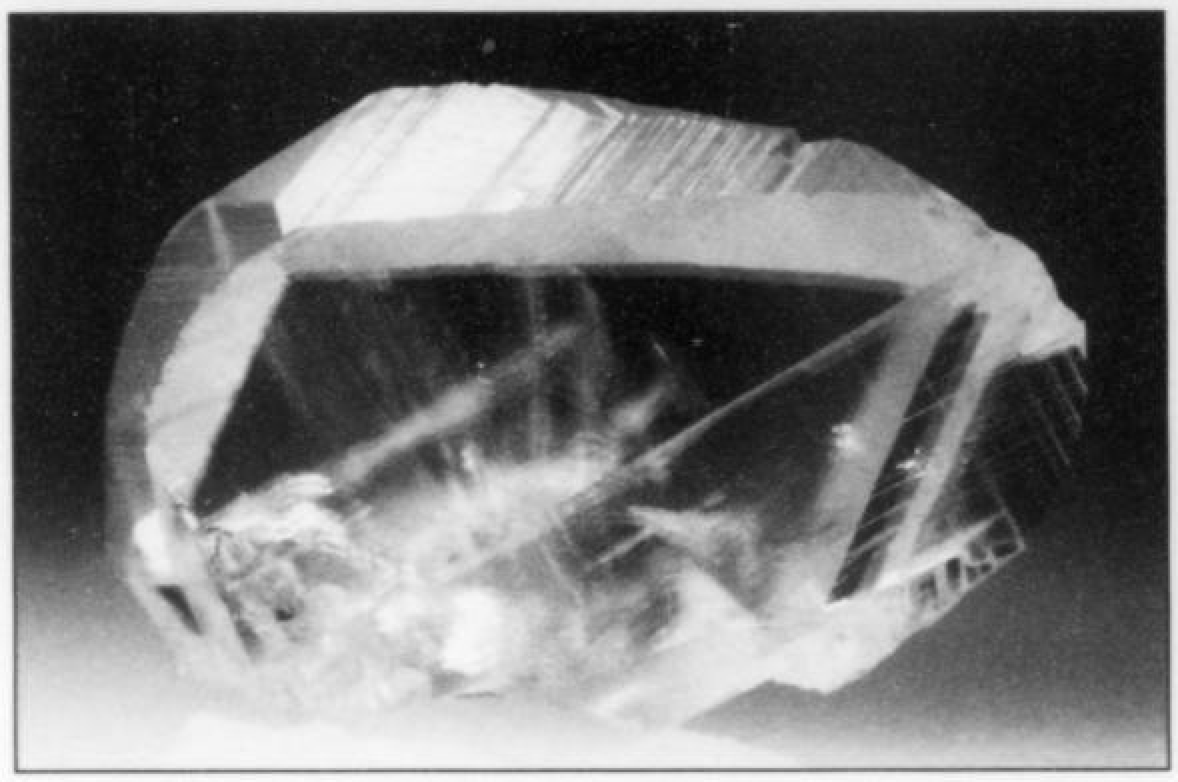


Figure 14. **Calcite twin, 2.9 cm, from Cessford quarry, Dallas City, IL. Gene Tribbey collection; Wendell Wilson photo.**

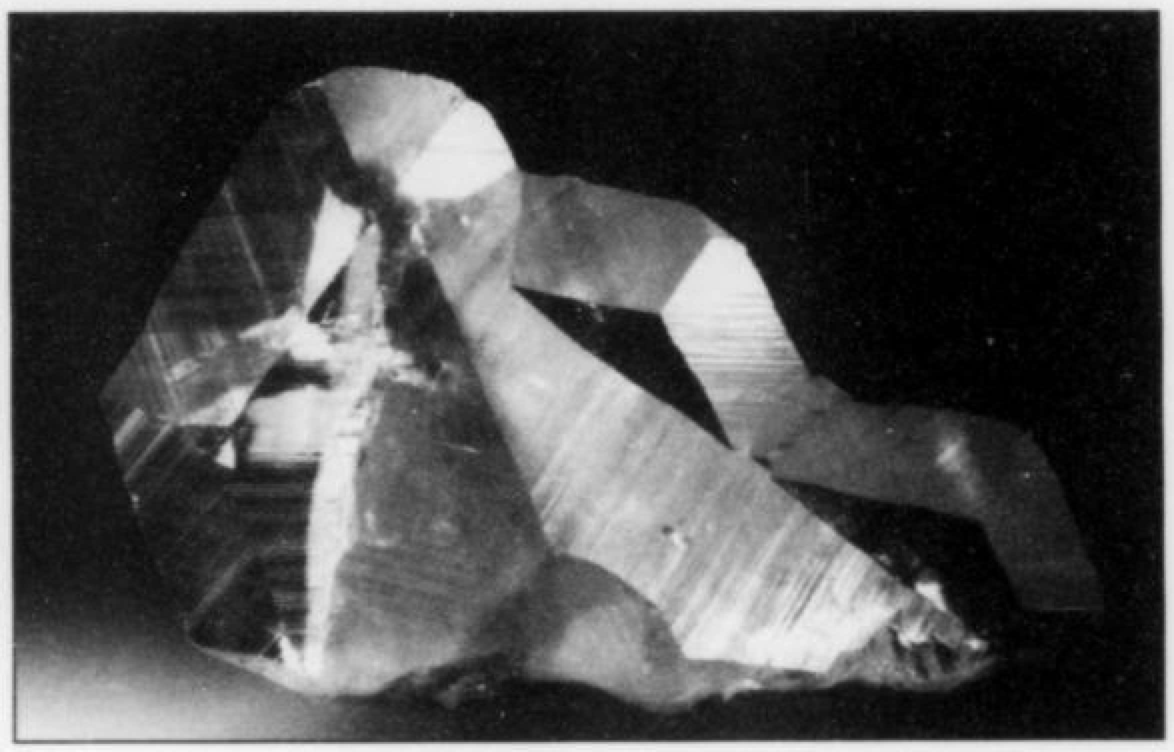


Figure 15. **Calcite twin, 4.3 cm, from O'Neill quarry, Plymouth, IL. Gene Tribbey collection; Wendell Wilson photo.**

tooth spar") is uncommon in the five deposits. Type II crystals are generally striated on crystal faces of one, but not both, of the rhombohedral forms.

Three types of contact twinning have been observed: (1) simple basal twinning on (0001) involving obtuse rhombohedral individuals; (2) simple rhombohedral twinning involving obtuse rhombohedral individuals; (3) simple basal twinning involving acute scalenohedral individuals (Palache *et al.,* 1951) (Figs. 8 and 10). At Biggsville, microcrystalline calcite pseudomorphically has replaced crinoid ossicles, and microcrystals of calcite occur aligned in rows along individual needles of millerite.

Calcite is typically colorless to milky white and is variably etched. Locally, Type III calcite is coated with an iridescent, highly reflective brown material, which is probably iron oxide or manganese oxide. Under long-wave and shortwave ultraviolet light Types I, II and III calcite fluoresce pink, yellow or white. Type IV is nonfluorescent. The brown coating is also nonfluorescent (Figs. 11–15).

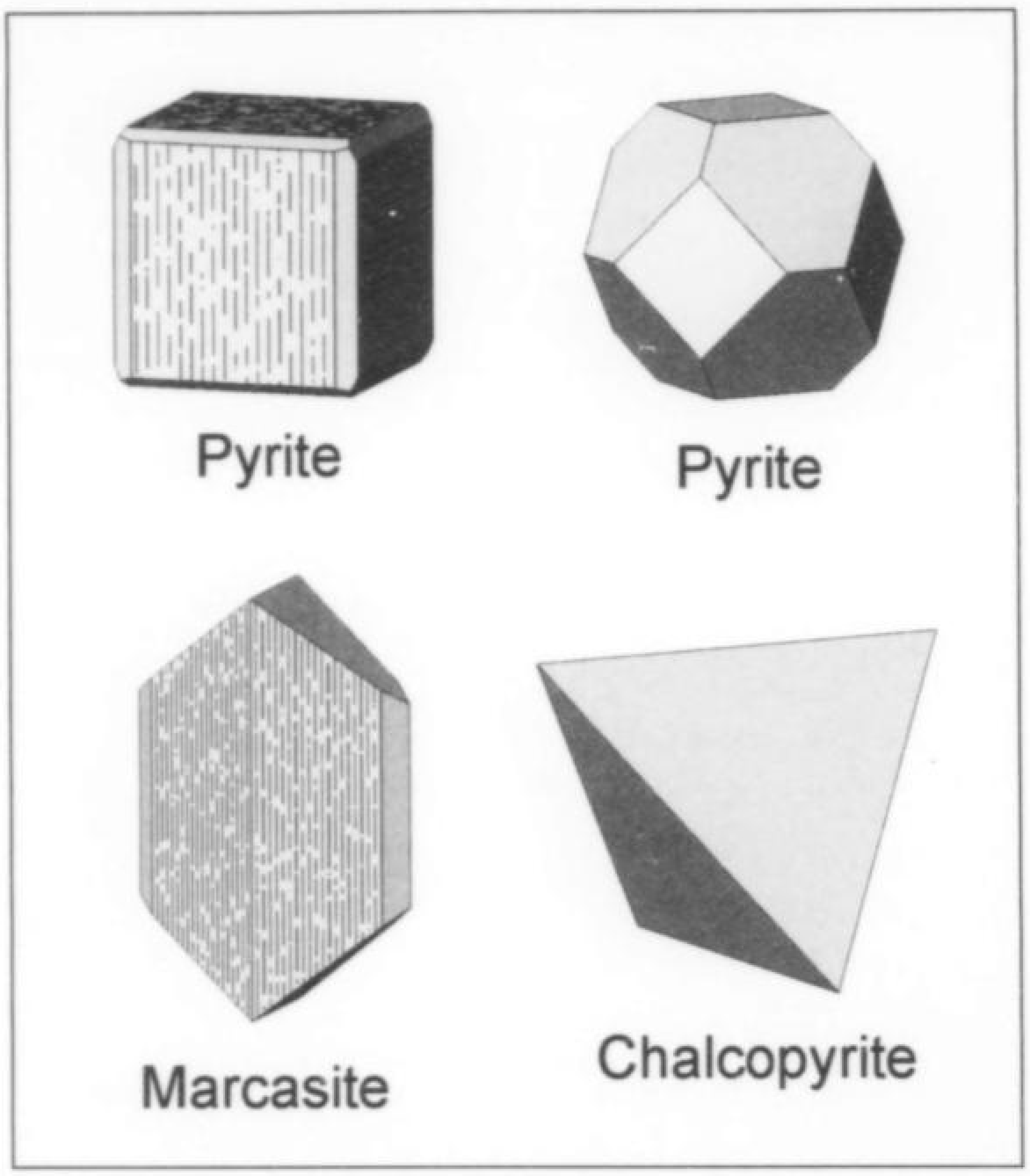


***Figure 16.* Idealized drawings of iron sulfide crystals from west-central Illinois. (a): pyrite, forms {100} and {*hk*0}; (b): pyrite, forms {111} and {100}; (c): marcasite, forms {*hk*0}, {0*kl*} and {*h'k'*0}; (d): chalcopyrite, form {*hhl*}.**

***Figure 18.* Chalcopyrite on sphalerite, 4.5 cm, from Cessford quarry, Biggsville, IL. Gene Tribbey collection; Wendell Wilson photo.**

The calcite types, their crystal forms, their colors (under visible and ultraviolet light) and the quarries where they have been found are shown in Table 1.

Chalcopyrite $CuFeS_2$

Chalcopyrite is present, though not abundant, in all deposits except at Hamilton. It occurs as inclusions in calcite and as microscopic crystals perched on calcite and sphalerite. In the latter case, the chalcopyrite crystals occur in parallel alignment on sphalerite crystal surfaces. The crystal form is the tetragonal disphenoid ("pseudotetrahedron") (Figs. 16 and 17).

Dolomite $CaMg(CO_3)_2$

Dolomite has been identified only at Hamilton and Smithshire. In both localities crystals are approximately 5 mm across and exhibit the typical curved rhombohedral ("saddle") habit. Color ranges from pinkish yellow to yellow-brown.

Galena PbS

Galena is rare in west-central Illinois, occurring only at Biggsville and Plymouth. Small cubes (less than 1 cm) occur in association with Type II calcite.

Marcasite FeS_2

Marcasite is present, though not abundant, at Biggsville, Dallas City and Plymouth. It has not been observed at Hamilton and Smithshire. Individual crystals, ranging in size from microscopic up to a few millimeters long, are typically bladed and wedge-shaped. Marcasite crystals are also found as inclusions in calcite. Striations are parallel to the long axis of the crystal blades. Wedges are polysynthetically twinned; twinning striations observed on this variety have a chevron-like appearance. At Dallas City, blades are locally aggregated in spheroidal clusters and as sheaf-like subparallel intergrowths.

***Figure 17.* Marcasite, 2.0 cm, from Cessford quarry, Biggsville, IL. Gene Tribbey collection; Wendell Wilson photo.**

Marcasite exhibits typical iridescence resulting from thin coatings of iron oxide (Figs. 16 and 18).

Millerite NiS_2

Millerite is present in all of the five west-central Illinois deposits. It occurs as sprays and felted masses of acicular crystals, with individual crystals up to 2 cm long. It can be found on quartz, dolomite, iron sulfide minerals and chalcopyrite. In some small cavities, felted millerite masses lie loose, i.e. they do not appear to be attached to the cavity walls. Millerite is also commonly included in calcite; where needle diameters are very small and needle density high, heavily included calcite appears black.

Millerite is pale brassy yellow, tarnishing to bronze or gray.

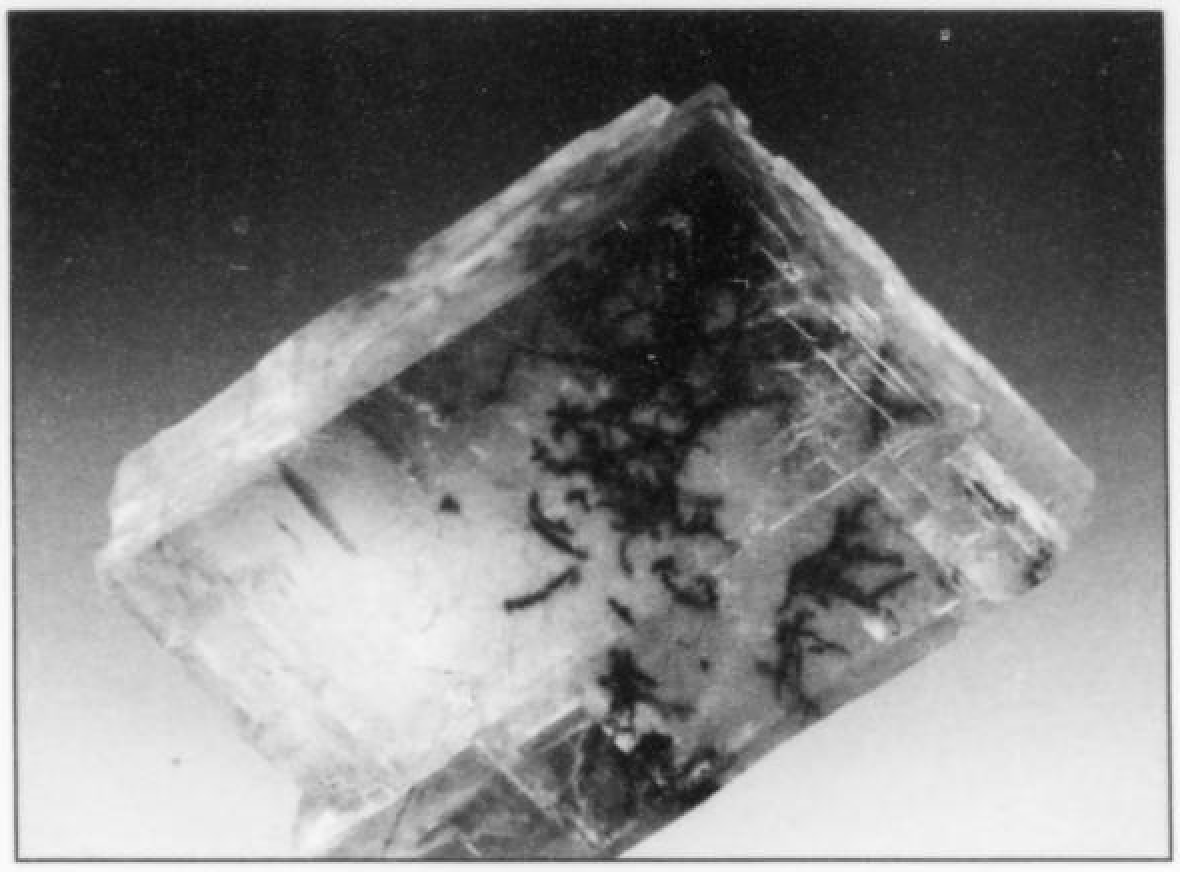
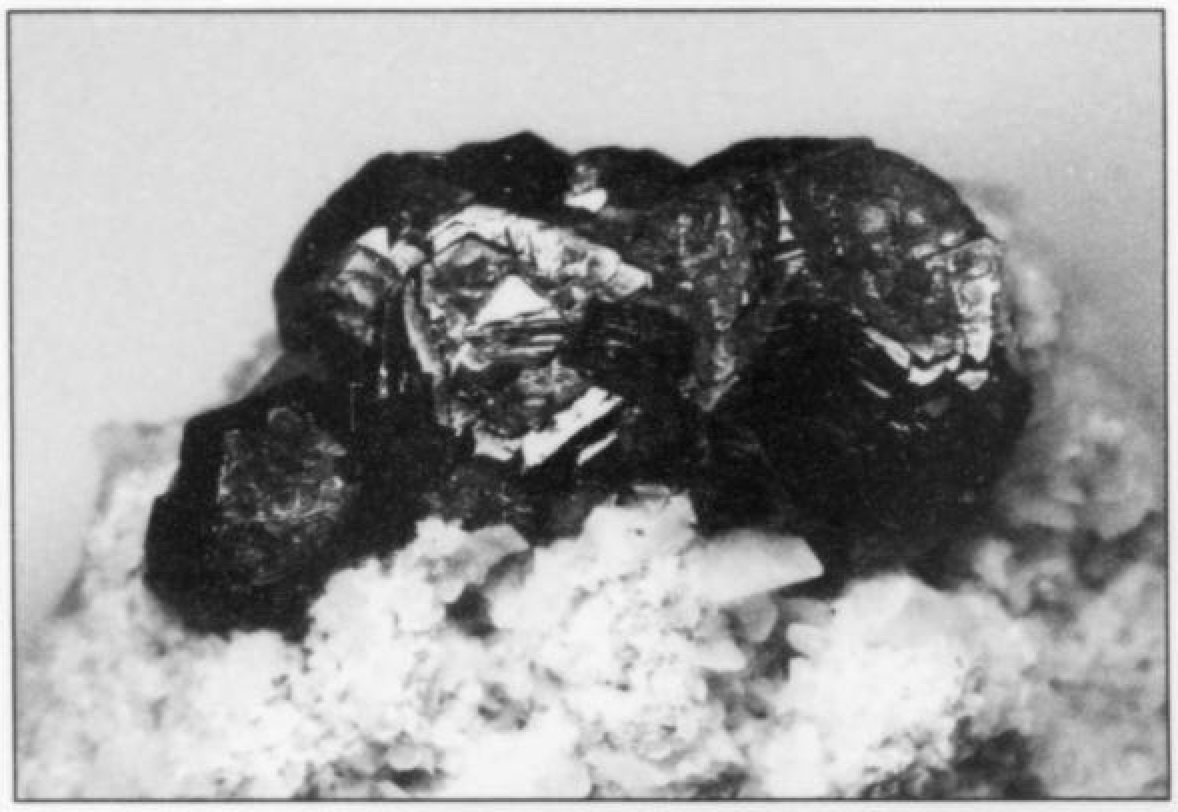


Figure 19. **Polydymite inclusions in calcite, 3.9 cm, from Grays quarry, Hamilton, IL. Gene Tribbey collection; Wendell Wilson photo.**

Polydymite Ni_3S_4

Polydymite, a relatively rare mineral, has been confirmed in specimens from Hamilton by X-ray powder diffraction (White, 1970). The polydymite occurs included in calcite, as curved filaments from which radiate short, densely distributed blue-black needles. Black acicular crystals have also been observed at Plymouth and Dallas City, suggesting the possibility that violarite and/or polydymite may also be present at these localities (Fig. 19).



Pyrite FeS_2

Pyrite has been found in all five of the west-central Illinois deposits. Individual crystals range in size from microscopic up to 5 mm across. Crystal forms are simple cubes, octahedrons and cuboctahedrons. At Plymouth, pyrite cuboctahedrons are stacked in rod-shaped aggregates. In one specimen from Biggsville, pyrite crystals are localized in recesses between quartz crystals; in another, tiny crystals are perched on corners and edges of rhombohedral calcite crystals. Like marcasite, pyrite also occurs as inclusions in calcite and in some cases shows iridescence (Figs. 16 and 20).

Quartz SiO_2

Quartz is present at all five of the west-central Illinois localities, as both cryptocrystalline and macrocrystalline varieties. Botryoidal cryptocrystalline chalcedony was observed at Dallas City and Plymouth.

Macrocrystals of quartz range in size from very small (as components of cavity-lining druses) to 1 cm long. Larger crystals are typically doubly terminated and are loosely aggregated in irregular masses. At Plymouth the aggregates appear somewhat like slabs that are stacked in subparallel alignment. Individual slabs range up to 8 cm across. These aggregates are frequently found loose in the cavities, exhibiting no obvious point(s) of attachment to cavity walls (Fig. 21).

Smithsonite $ZnCO_3$

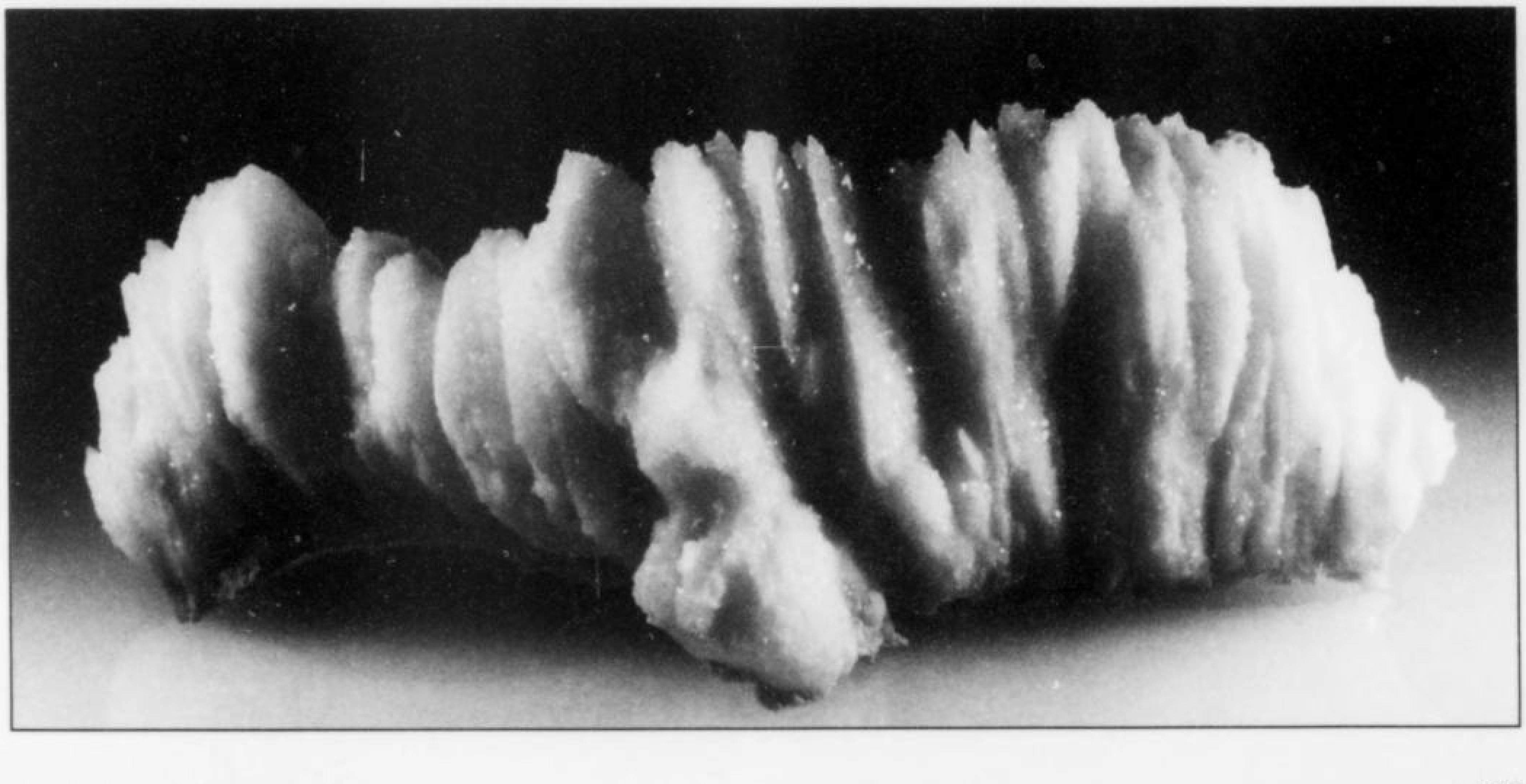
Smithsonite is rare in west-central Illinois, currently known in a single pale amber-colored specimen from Dallas City. It occurs as very small (ca. 1 mm) crystals displaying a short-prismatic habit. The rounded, etched crystals are perched on sphalerite and calcite. The smithsonite was confirmed by X-ray powder diffraction (Kile, 2002).

Sphalerite (Zn,Fe)S

Sphalerite has been found at all five of the west-central Illinois quarries. Individual crystals range from microscopic to more than 8 cm across. Sphalerite most often appears as complex intergrowths

Figure 20. **Pyrite, 2.3 cm, from Cessford quarry, Biggsville, IL. Gene Tribbey collection; Wendell Wilson photo.**

Figure 21. **Quartz, 13 cm, from O'Neill quarry, Plymouth, IL. Gene Tribbey collection; Wendell Wilson photo.**



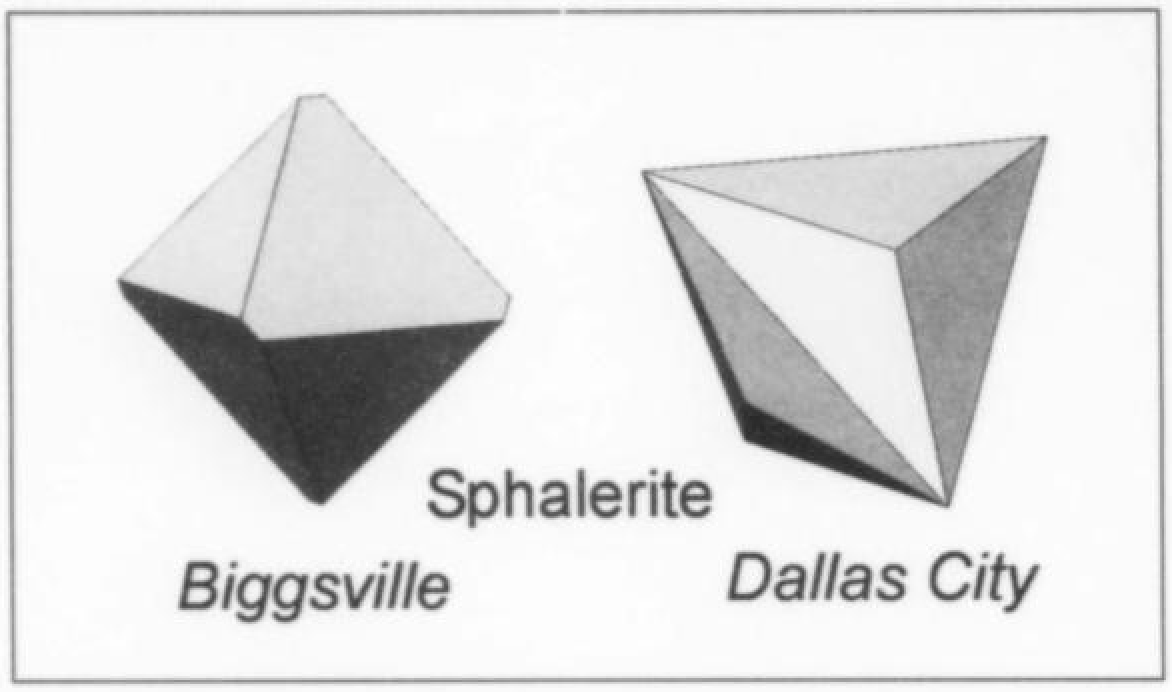


Figure 22. **Idealized drawings of sphalerite crystals from Biggsville and Dallas City. (a): Biggsville, forms {111} and $\{1\bar{1}1\}$; (b): Dallas City, form {*hhl*}.**

Figure 23. **Sphalerite tristetrahedron, 3.0 cm, from Cessford quarry, Dallas City , IL. Gene Tribbey collection; Wendell Wilson photo.**

Figure 24. **Sphalerite, 6.5 cm, from Cessford quarry, Biggsville, IL. Gene Tribbey collection; Wendell Wilson photo.**

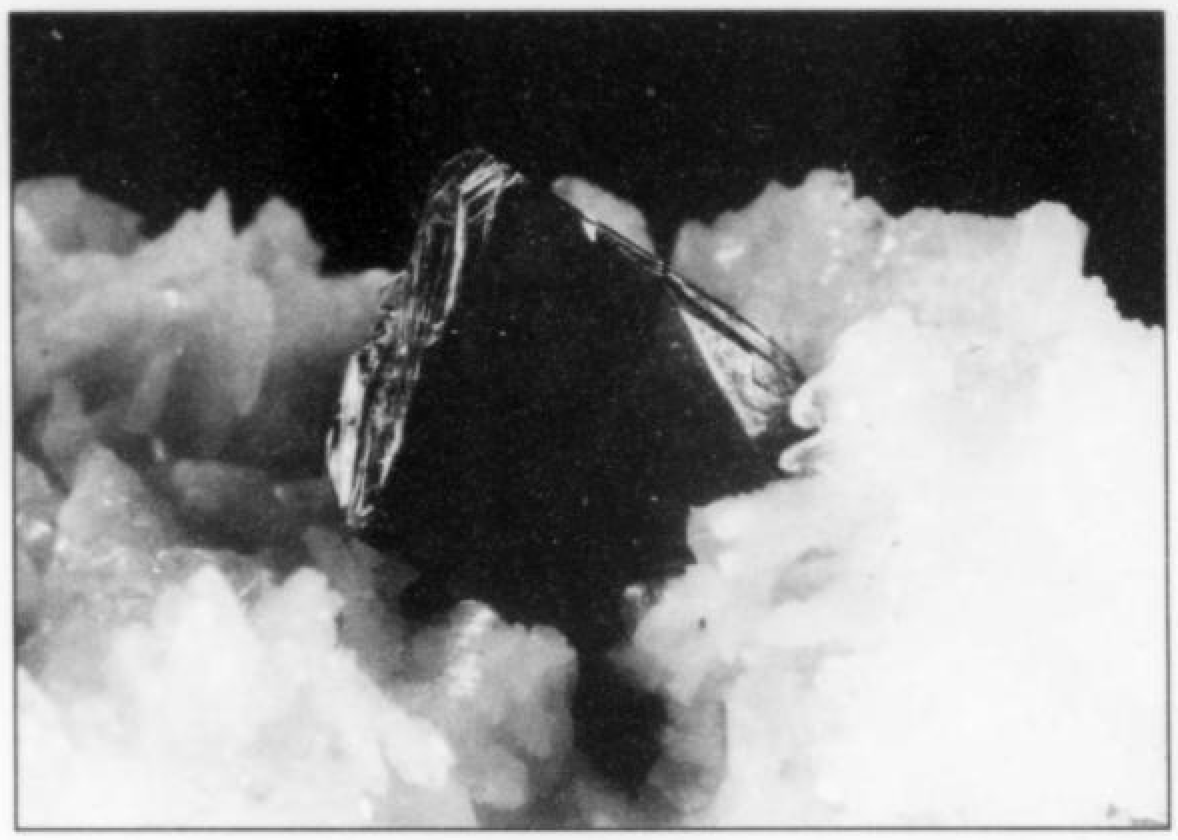


Figure 25. **Sphalerite on quartz, 1.3 cm, from Grays quarry, Hamilton, IL. Gene Tribbey collection; Wendell Wilson photo**

of malformed tetrahedral crystals and as cleavable masses. Polysynthetic twinning is common, especially in the larger masses. At Biggsville and Smithshire, well-formed crystals exhibiting subequally developed positive and negative tetrahedrons ("pseudo-octahedrons") occur. At Biggsville and Dallas City, large tristetrahedrons (up to 3 cm across) have been found. At Biggsville, sphalerite on chert occurs as a druse of nearly black crystals with adamantine luster. Also at Biggsville, tiny crystals of sphalerite are perched along acicular crystals of millerite. All sphalerite is dark brown to black, indicating a relatively high iron content. Crystal surfaces are locally iridescent (Figs. 22–27).

Violarite Ni_2FeS_4

Violarite is a relatively rare mineral. In west-central Illinois it occurs in intimate association with millerite. In fact, it is very

Figure 26. **Sphalerite, 4.6 cm, from O'Neill quarry, Plymouth, IL. Gene Tribbey collection; Wendell Wilson photo.**

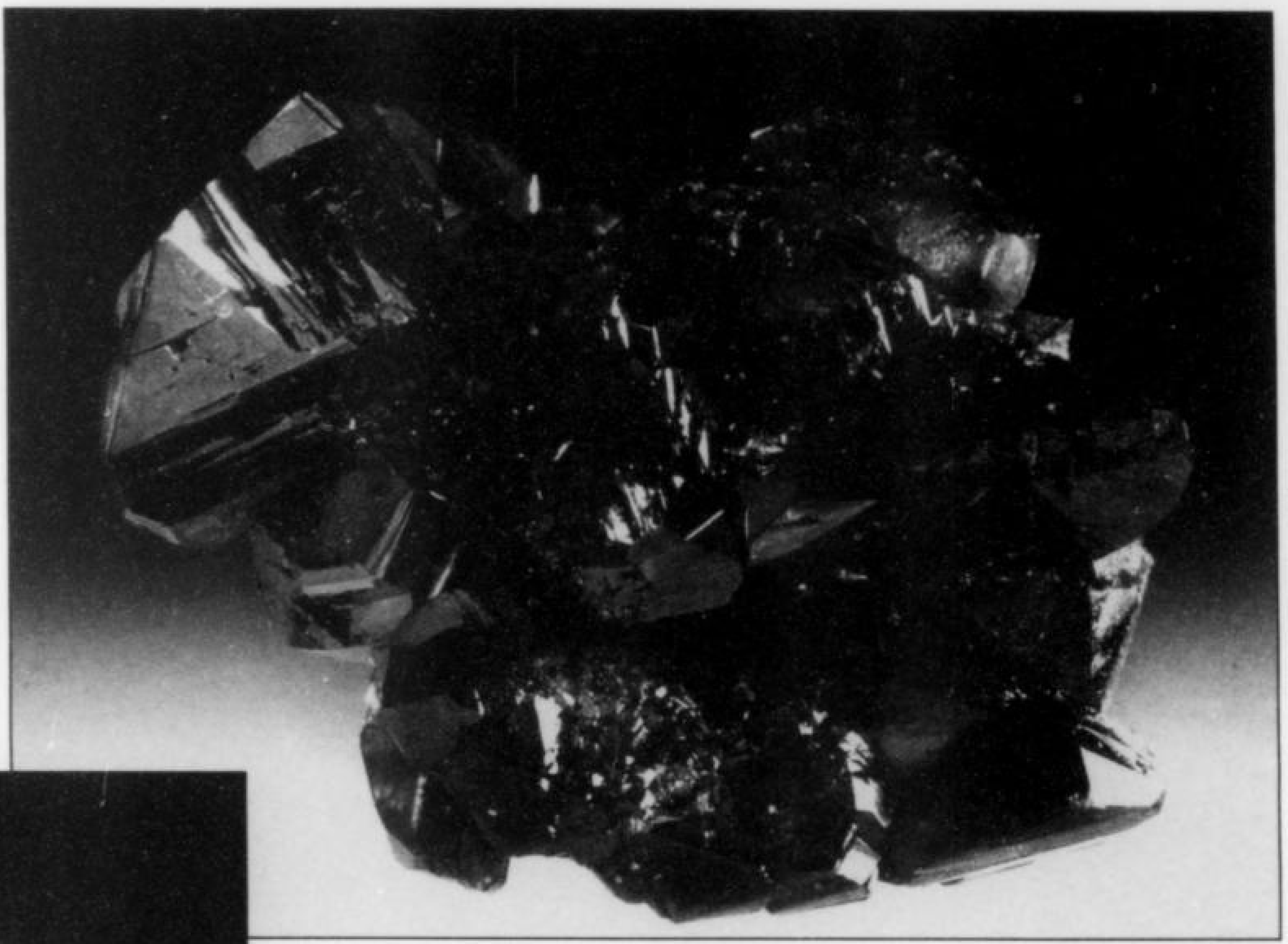
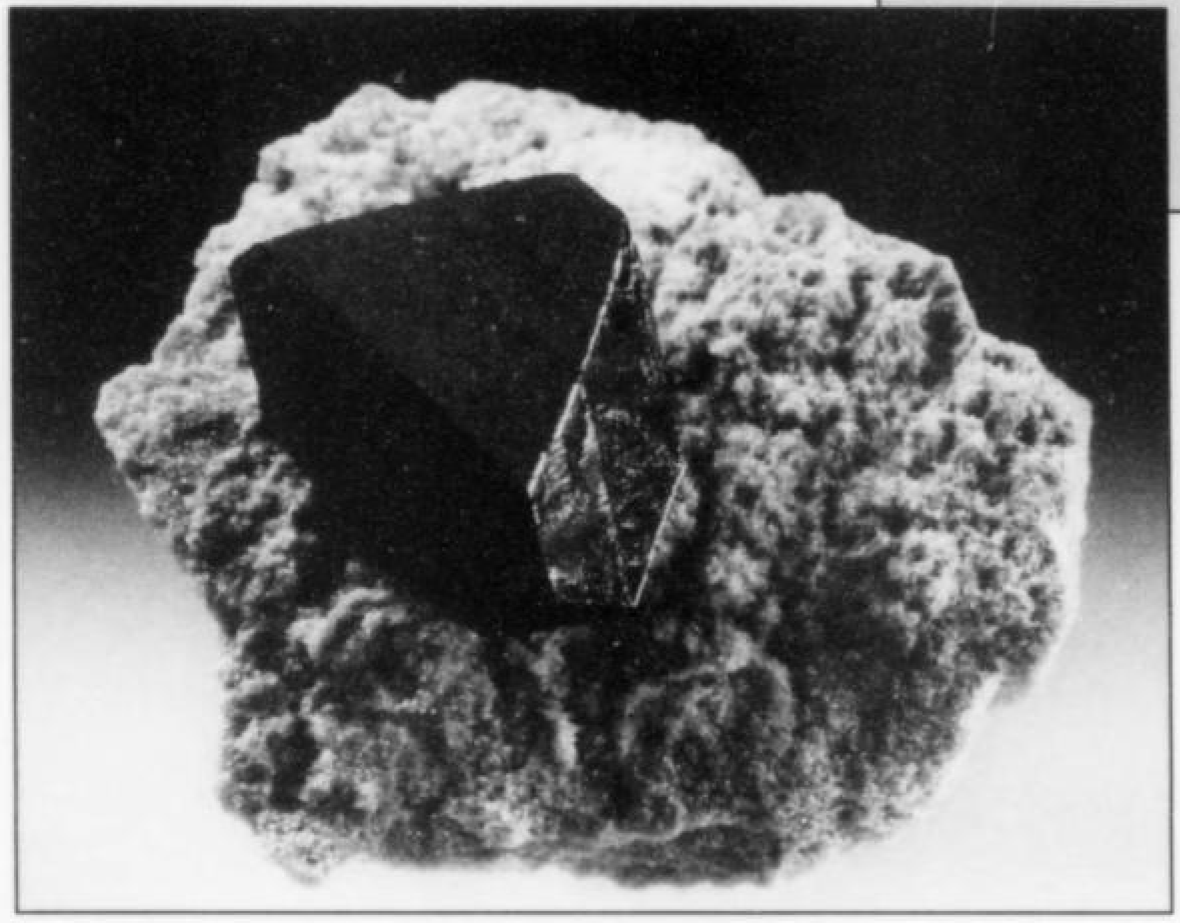


Figure 27. **Sphalerite pseudo-octahedron, 1.3 cm crystal, from Cessford quarry, Biggsville, IL. Gene Tribbey collection; Wendell Wilson photo.**



difficult to visually distinguish the two minerals. Violarite is reported to be black (Palache *et al.,* 1944), and sprays of acicular violarite crystals occurring on calcite at Plymouth do indeed appear black, but under magnification (30X) the needles are seen to be bronze-colored with a black coating. X-ray powder diffraction analysis of a single specimen revealed the presence of both millerite and violarite (Table 2). It is possible that the black coating alone is violarite.

PARAGENESIS

Paragenetic sequences were determined for each of the five mineral deposits. From these a composite sequence for west-central Illinois was derived (Fig. 28). No individual deposit contains all of the minerals found in the general area, but the order of appearance of the minerals at each of the five deposits suggests that the general paragenetic sequence is roughly the same throughout the area.

In general, quartz (including chalcedony) is always the earliest mineral to form and calcite is always late, except at Biggsville, where Type I calcite follows quartz and precedes or overlaps sulfides. It is generally before and during the deposition of calcite that sulfides form. In cases where multiple generations of sulfides occur (e.g. pyrite and sphalerite), the latest generation (always as scattered microcrystals) was deposited after calcite. The positions of the types of calcite relative to each other in the sequence could not be determined with certainty since, with the exception of Types I and II, they do not occur together in the same sample. That each calcite represents a separate depositional event is suggested by differences in fluorescence under ultraviolet light (suggesting differences in trace-element chemistry) and crystal habit (Table 1).

The positions of galena and barite in the paragenetic sequence could not be determined because they are not in contact with other minerals, except calcite.

MINERAL ORIGINS

By studying the compositions, crystal morphologies and parageneses of the minerals in these deposits, and by making comparisons with similar deposits in the upper Mississippi Valley region whose origins are relatively well established, it is possible to reach some general conclusions about the environments of formation of the minerals. More definitive statements await fluid-inclusion and stable-isotope and radiogenic-isotope analyses.

Carbonate-hosted, sulfide-bearing mineral deposits are widespread throughout the mid-continental United States. The ground for them was prepared by the dissolution of carbonate rock along bedding plane fractures and transverse fractures, resulting in openings ranging in size from small vugs to large caves. In west-central Illinois, cavities are relatively small (up to 25 cm) and tend to be elongated parallel to bedding planes in the host rock. Dissolution, which may have been localized by the presence of preexisting fossils or concretions in the rock, was accomplished by aqueous fluids that were undersaturated with respect to calcium carbonate. A controlling variable here was pH. Low-pH fluids may have been derived through leaching of microscopic iron-sulfide minerals contained in carbonate host rocks or in karst-filling muds (Garvin, 1995). Precipitation of all minerals appears to have taken place under phreatic conditions (below the groundwater table). This is suggested by the fact that calcite occurs as euhedral crystals and not as spelaean forms (Jennings, 1985; Ford, 1988), and by the presence of sulfide minerals throughout the paragenetic sequence. Sulfide mineral formation requires an environment with low oxygen activity. It is generally agreed that these conditions occur below the groundwater table.

The occurrence of multiple generations of calcite, a prominent feature in the mineral deposits of west-central Illinois, is also observed elsewhere in the upper Mississippi Valley, e.g. in the Upper Mississippi Valley Zn-Pb District (Heyl *et al.*, 1959), and at the Linwood mine in Scott County, Iowa (Garvin, 1995). Differences in crystal habit and ultraviolet fluorescence among the several calcite types reflect variations in the physicochemical conditions in the growth environment. It has been demonstrated experimentally that the crystal habit of calcite can be modified by varying the magnesium content of the growth fluid (Devery and Ehlmann, 1981). Other variables that are known to influence calcite crystal habit include pH, temperature and growth rate. Ultraviolet fluorescence in calcite is caused by the presence of activator elements in the crystal lattice. The pink color is probably caused by Mn^{2+}; the yellow color may be due to the presence of Fe^{2+}. Both activators are common substituents in the crystal lattice of calcite.

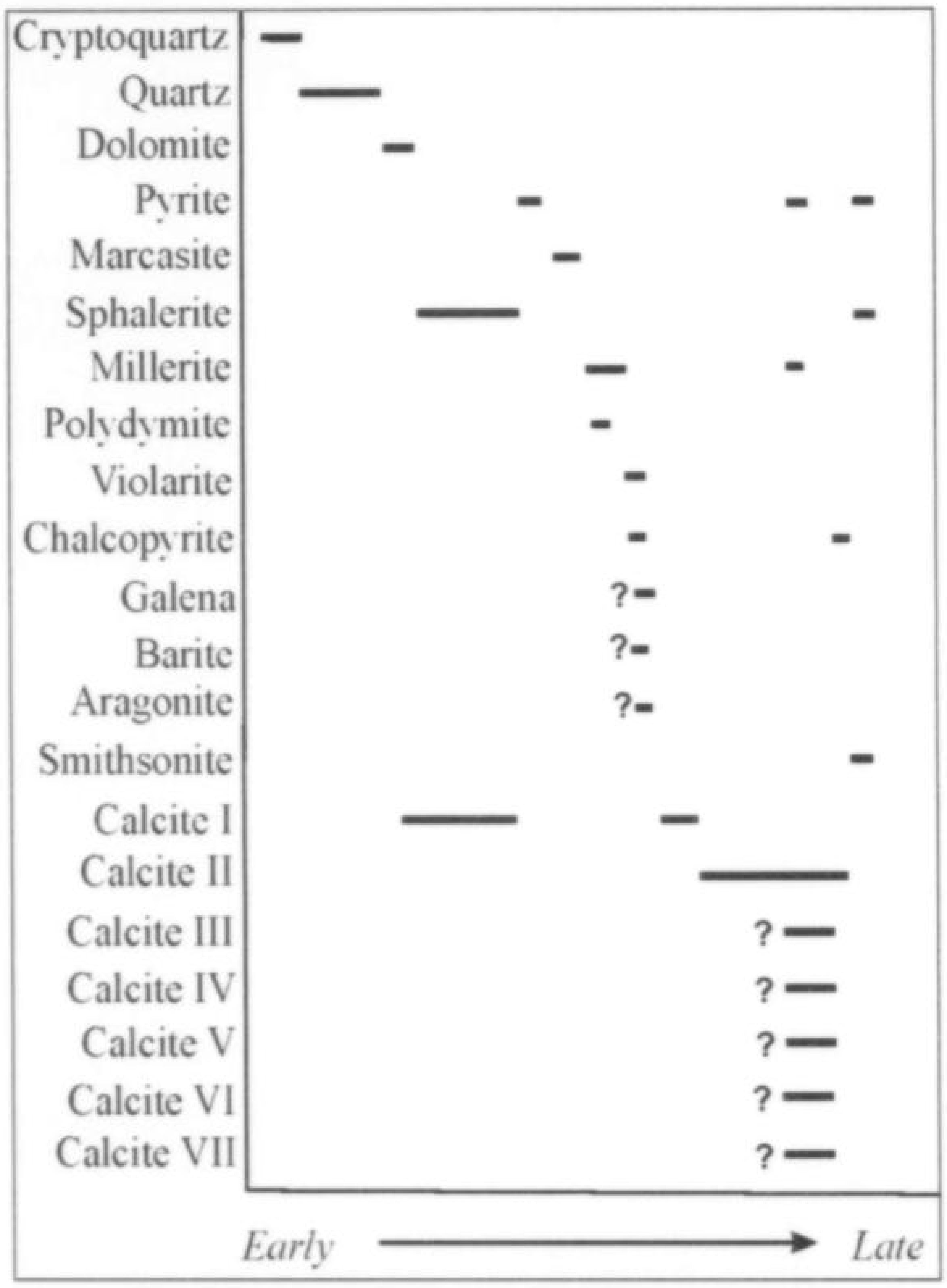


***Figure 28.* Generalized paragenetic diagram for minerals from west central Illinois.**

Examination of specimens from these deposits frequently suggests that an earlier mineral or other material affected the growth of a later one. Epitactic overgrowths of small rhombohedral calcite crystals on single large scalenohedral calcite crystals have been found at Plymouth and Dallas City. Epitactic chalcopyrite on sphalerite occurs at Biggsville and Smithshire. Growth of microcrystals of pyrite on selected faces of calcite has taken place at Biggsville. Millerite needles were sites of nucleation of microscopic pyrite, sphalerite and calcite at Biggsville, the result appearing as strings of beads. Boxwork calcite and pyrite have been observed: the host material here was probably clay that occupied the cavity prior to mineralization; dessication of the clay created fractures along which calcite crystals (at Plymouth) and pyrite crystals (at Biggsville) grew. Following the removal of the clay by subsurface water flow, euhedral calcite crystals grew on the earlier-formed pyrite. The formation of boxwork structures indicates that these cavities were subjected to alternating vadose and phreatic conditions, reflecting climate-driven fluctuations in the groundwater table (Garvin, 1995). The branching and rib-like aggregates of quartz crystals observed at all localities but Smithshire, some showing no obvious points of attachment with cavity walls, might also be a consequence of growth in, and subsequent removal of, some preexisting material.

COMPARISONS

Numerous minor accumulations of sulfides and associated calcite and other minerals fringe the formerly commercial Upper Mississippi Valley Zinc-Lead District in Illinois, Iowa, Wisconsin and Minnesota (see Heyl *et al.*, 1959, Fig. 101). Upper Mississippi Valley Zinc-Lead deposits are carbonate rock-hosted and consist mainly of calcite, dolomite, quartz, marcasite, pyrite, sphalerite and galena (Heyl *et al.*, 1959). Fringing deposits also have carbonate

***Table 1.* Types and distribution of calcite.**

Type	*Crystal Forms*	*Color (Visible)*	*Color (UV)*	*Quarries Where Observed**
I	{h0-hl} obtuse rhombohedron "pseudocubic"	colorless to white	yellow	BG, PL
II	{h0-hl}, {0k-kl} pos. and neg. obtuse rhombohedron - flattened	colorless to white	pink	BG, DA, HM, PL, SM
III	{h0-hl} obtuse rhombohedron "pseudocubic"	colorless to white, locally coated with brown iridescent material	pink	BG, DA, HM, PL
IV	{h0-hl} obtuse rhombohedron	colorless	nonfluor.	BG
V	globular clusters	white	creamy white	BG, DA
VI	{hk-il} acute scalenohedron	colorless to white	creamy white	BG, DA, PL
VII	{hk-il}, {h0-hl} obtuse scalenohedron modified by obtuse rhombohedron	colorless to white	pink	PL

*BG = Biggsville, DA = Dallas City, HM = Hamilton, PL = Plymouth, SM = Smithshire

***Table 2.* X-ray powder diffraction data for nickel sulfide minerals from Plymouth Quarry sample PL-40.**

Plymouth		*JCPDS* Millerite*		*JCPDS* Violarite*	
d-value (A)	*Relative Intensity*	*d-value (A)*	*Relative Intensity*	*d-value (A)*	*Relative Intensity*
				5.47	**20**
4.81	68	4.81	60		
3.34+	**10**			**3.35**	**30**
	2.95	40			
2.86	**23**			**2.85**	**100**
2.78	100	2.78	100		
2.51	7	2.51	65		
2.41	13	2.41	12		
2.37	**10**			**2.36**	**50**
2.23	7	2.23	55		
				1.931	**20**
1.863	18	1.863	95		
1.817	**39**	1.818	45	**1.820**	**60**
1.738	7	1.737	40		
1.676	**9**			**1.674**	**80**
1.634	5	1.634	18		
1.603	**33**	1.604	35	**1.602**	**30**

* data from Joint Committee for Powder Diffraction Standards
+ numbers in bold are for violarite

***Table 3.* Comparison of minerals and mineral characteristics between west-central Illinois (WCI) and Upper Mississippi Valley Zn-Pb (UMV) deposits.**

Mineral/Characteristic	*WCI*	*UMV*
Quartz	Abundant	Abundant
Dolomite	Uncommon	Abundant
Pyrite	Common	Common
Marcasite	Uncommon	Abundant
Sphalerite (euhedral)	Common	Common
Sphalerite (banded)	Not observed	Common
Galena	Rare	Common
Calcite	Abundant	Abundant
Calcite—multiple generations	Yes	Yes
Calcite—iron sulfide inclusions	Common	Common
Barite—euhedral	Rare	Rare
Millerite	Common	Rare

rock hosts, and they generally contain the same minerals as the Upper Mississippi Valley deposits, but individual deposits may be missing galena, dolomite and/or quartz. Table 3 compares minerals and mineral characteristics for west-central Illinois and Upper Mississippi Valley Zinc-Lead deposits. It is clear that these two types of geologic environment are closely similar, as are their paragenetic sequences. In both, quartz and dolomite precede other minerals, sulfides are early and calcite is late. Iron sulfides generally precede sphalerite. These similarities suggest that the two types of deposits are cogenetic, and that both may be products of mineral-forming processes involving hydrothermal fluids (T>50°C) which operated on a region-wide scale. Fluid inclusion and stable isotope studies of west-central Illinois minerals are needed to provide additional bases for comparison of these deposits.

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We express our appreciation to the owners and operators of the Cessford quarries at Biggsville and Dallas City, the O'Neal quarry at Plymouth, the Gray's quarry at Hamilton and the Galbraith quarry at Smithshire for permission to enter their properties for the purposes of studying the geology and collecting mineral specimens. We are grateful to Zak Lasemi and Rod Norby of the Illinois Geological Survey for assistance with field work and for making Survey literature available to us. The specimen photography was supplied by Dr. Wendell Wilson.

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The Minerals of the

HUNTING HILL QUARRY

ROCKVILLE, MARYLAND

Fred J. Parker
2409 Graystone Lane
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Since opening in 1955 the Hunting Hill quarry in suburban Rockville, Maryland has been a popular collecting area. Fine specimens of red grossular, green diopside, lustrous orange botryoidal prehnite, clinochlore and clinozoisite have been found, as well as rare crystals of desautelsite, rare tochilinite crystals over 1 cm, the only known crystals of the magnesium-iron carbonate, coalingite, and at least 52 other species. A range of interesting pseudomorphs has also been found.

INTRODUCTION

Since it was opened in 1955 for aggregate stone for asphalt and road building by the Rockville Crushed Stone Company, Inc., the Hunting Hill quarry has been one of the most popular mineral collecting sites in the Washington, DC metropolitan area. The quarry was sold to London and Northern in 1985, and then to several other companies in succession until it was purchased in 1989 by Bardon Aggregates Industries, who recently sold out to Aggregate Industries-Mid Atlantic. The quarry is still a very active commercial operation despite the encroachment of urbanization, and was 137 meters deep (120 meters below sea level) in August 2002 (John Croney, personal communication).

The site is most commonly called the "Hunting Hill quarry" or, less often, the "Bardon Stone quarry" or the "Rockville Crushed Stone quarry" by collectors. It is located near Hunting Hill on the western city limits of Rockville, Montgomery County, Maryland, off of Shady Grove Road, where it covers more than half a square mile.

The quarried rock is a dense serpentinite with mineralized dikes of rodingite, the latter producing outstanding crystallized specimens of grossular, clinozoisite, diopside and clinochlore. In addition, unusual minerals such as desaultelsite, pokrovskite, mcguinessite and the first occurrence of coalingite in crystals have been documented. To date, 60 mineral species have been verified from the quarry, and the list grows with continued collecting and study. Despite its mineralogical significance, there is no recent publicly available technical work on the mineralogy, geology, and petrology of Hunting Hill. The locality remains largely unfamiliar to collectors outside the Washington DC–Baltimore region.

GEOLOGICAL SETTING

The Piedmont Uplands along the Maryland-Pennsylvania border contain Precambrian-age rocks, including gneisses, quartzites, schists and marbles, which are locally intruded by ultramafic peridotite (dunite) and pyroxenite. These were subsequently partially or wholly altered to serpentinites. Some of the serpentinites were mined locally for high-grade chromite in the 19th century, notably at Bare Hills and Soldiers Delight in Maryland, and the Woods mine deposit of the State Line District in Pennsylvania. The deposits are famous for well-crystallized specimens of brucite, green clinochlore, chromian clinochlore ("kämmererite") and rutile. Land overlain by the serpentines has a unique floral ecology; the region is known as the "serpentine barrens." The decomposition of the serpentine forms thin, magnesia-rich, lime-poor and potash-poor soil horizons which support either desolate grassy fields or thick scrub pine, cedar and greenbriar patches which make for a unique and wild landscape.

Figure 1. **View of the Hunting Hill quarry looking east from the ramp in March, 2003. The floor of the quarry between the automobiles and the far wall contained abundant rodingite dikes with veins of grossular. Photo by the author.**

In Montgomery County, Maryland, serpentinites and serpentinized gabbros form a series of irregular bodies in Rockville (including Hunting Hill), Gaithersburg and Etchison. The Etchison Chrome mine was sunk into a serpentine-talc schist body which yielded magnesiochromite ore, along with chromian tourmaline, margarite, rutile and magnesite.

The Hunting Hill quarry is located within the Ordovician Hunting Hill pluton which is surrounded by a muscovite-chlorite-biotite-quartz schist of the Precambrian-to-Cambrian Wissahickon Formation. The elliptical-shaped ultramafic pluton is about 6.4 kilometers long and 1.6 kilometers wide, and consists primarily of gray to black serpentine containing finely disseminated magnetite, with rodingite dikes which are substantially vertical, and intruded therein. Rodingite is a massive, coarse-grained to medium-grained rock characterized by calcium-rich clinopyroxene and grossular which forms from the metasomatic alteration of mafic to ultramafic protoliths. Rodingites are associated with dunite and serpentinite. The serpentinite is thought to have been originally intruded as a dunite (Brooks 1989). The rodingite is believed to originally have been gabbro dikes which were injected into fractures in the cooling dunite. Subsequent metamorphism and alteration changed the emplaced dunite and gabbro to serpentine and rodingite, respectively. Chloritization and shearing parallel to the rodingite dikes are locally evident at the contacts between the rodingite dikes and serpentine body. The rodingite is strikingly paler in color than the serpentine, and is locally abundant in the northeastern and eastern walls of the quarry. The rodingite bodies range from lens-shaped, on the order of several meters, to parallel or branching, medium-grained to coarse-grained dikes up to about 450 meters in length. Contacts between the serpentine and rodingite frequently show shearing and infilling by silicates and carbonates. These veins show a general trend between N25°W and N45°W. The offsetting of rodingite dikes provides evidence of localized faulting. In hand specimens, the coarse-grained rodingite is seen to consist of subhedral, bright green chromian diopside crystals up to about 10 cm in maximum dimension, with large pods of porcelaneous white to pink to brownish red grossular, along with accessory clinochlore, prehnite, clinozoisite and hydrogrossular. Where openings occur in the rodingite, the walls may be lined with free-growing crystals of grossular, diopside and other minerals which, in turn, are commonly covered by infillings of massive calcite. The rodingite dikes strike N50°E to N60°E whereas the trend of the overall pluton is about N22°E. It appears that Hunting Hill is the only location in the Piedmont Uplands of Maryland and Pennsylvania where rodingite of this type and scale has been observed.

Chromite/magnesiochromite was extensively mined from the serpentines of Maryland and Pennsylvania in the mid to late 19th century (including the Etchison mine about 15 km away), but chromite inexplicably remains an uncommon accessory mineral at Hunting Hill. Bulk analyses (percentages by weight) in Table 2 of Larrabee (1969) show concentrations of 0.15 to 0.7 weight % Cr in the rodingites, which is presumably due to the prevalent green chromian diopside. By contrast, bulk analyses of serpentines showed even smaller chromium concentrations, ranging between 0.05 to 0.2 weight %. Iron (as oxides) was present in amounts ranging from 3.2 to 7.7 weight %. A sample of black serpentine,

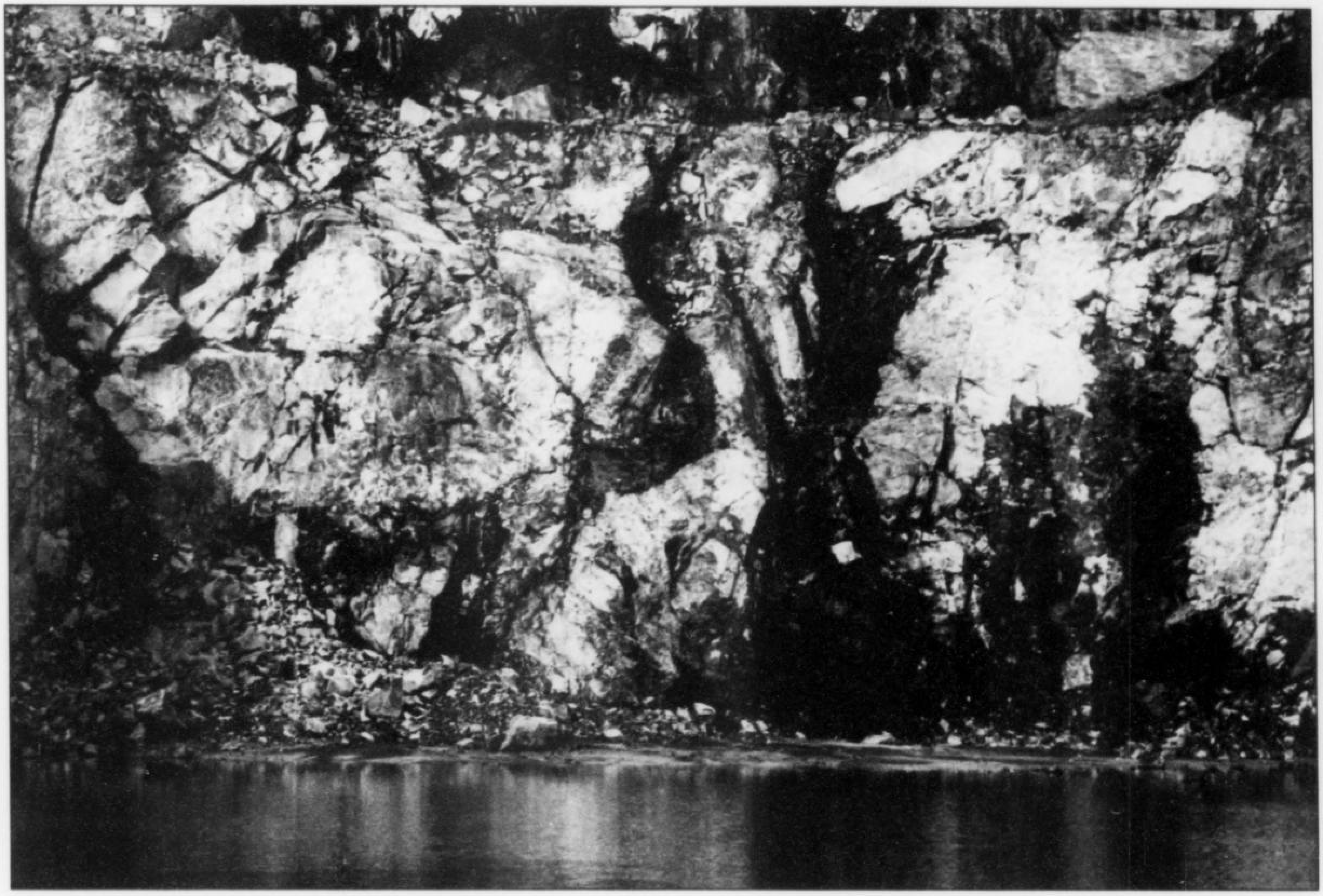

Figure 2. **Closer view of the east wall in March 2003, showing lighter colored, substantially vertical rodingite dikes in serpentine. Photo by the author.**

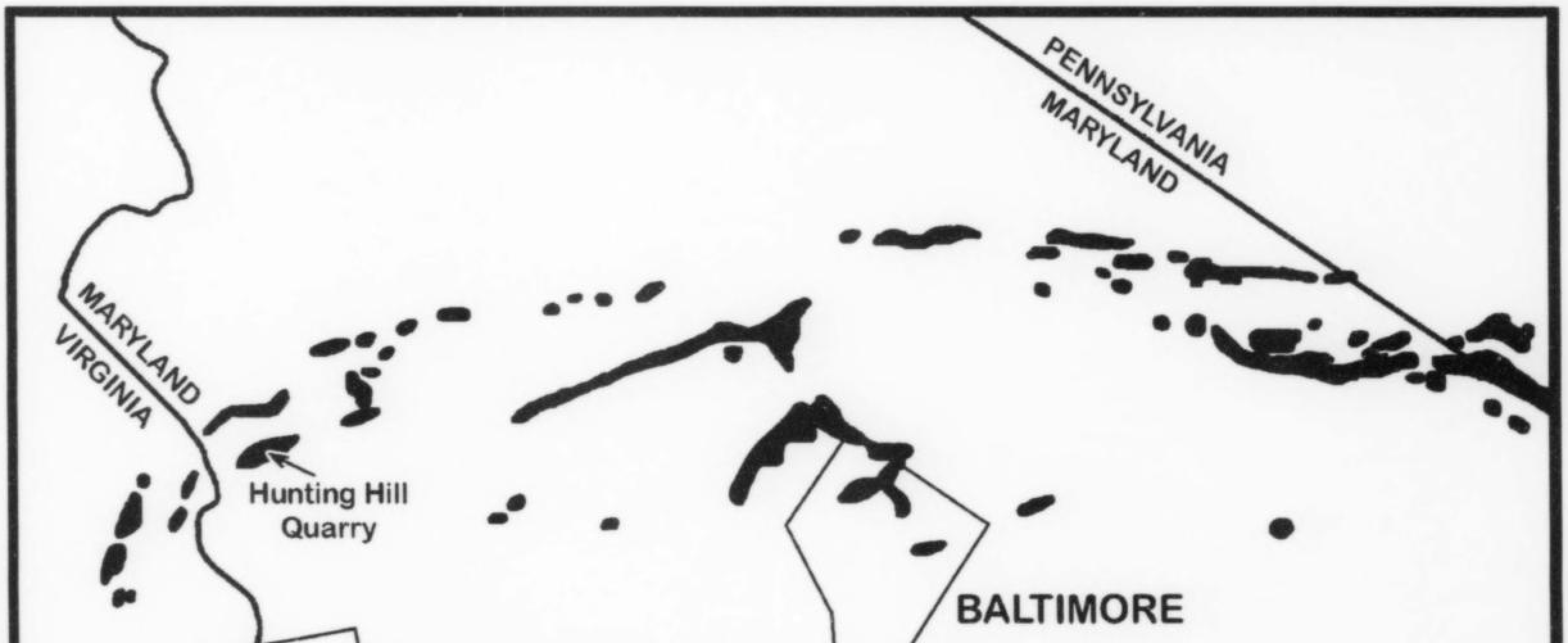

Figure 3. **The distribution of ultramafic rocks in the Baltimore-Washington area (adapted from Larabee, 1969).**

which is common in the quarry, contained 7.7 weight % iron oxides but only 0.11 weight % chromium oxide (Larrabee 1969, Table 1, #3). This analysis supports the notion that minute inclusions of iron oxide (magnetite) rather than chromite are responsible for the black coloration of the majority of the serpentinite body at Hunting Hill.

THE MINERALS

Of the currently verified 60 minerals from Hunting Hill, a large number are rock-forming minerals or microscopic petrologic phases of little or no interest to the collector. While these species are included on the following list, they are not described in detail in this work unless new occurrences of mineralogical interest are being described. The reader is directed to Larrabee (1969) for an excellent, detailed description of these minerals, or to Bernstein (1980) for summary descriptions. By contrast, only 40 verified species were identified by 1971 in the listing by Trapp (1971). The varied and complex mineralogical assemblage at Hunting Hill is a reflection of the unusual ultramafic host which was intruded, followed by episodes of metamorphism, alteration, and faulting.

The following list of verified minerals attempts to cover the species of greatest collector interest and also those species which have been verified at the locality during the past 20 years. A more complete list, in chemical order, is shown in Table 1.

Aragonite $CaCO_3$

Aragonite is commonly found in cavities in massive serpentine as colorless to white, translucent crystals and masses of interlocking blades. The crystals are generally bladed in habit and up to 5 cm in length, in flat radiating sprays and as free-standing chisel-shaped crystals. Aragonite fluoresces white and phosphoresces bluish white under shortwave ultraviolet radiation, and shows a similar longwave response. Although the mineral is abundant, few spectacular specimens are known.

Bornite Cu_5FeS_4

Bornite is uncommon as tarnished, purple-black, iridescent masses and veinlets in rodingite. A few crude dodecahedrons visually identified as bornite were found with grossular crystals, diopside crystals and chalcopyrite in 2000–2001.

Brucite $Mg(OH)_2$

Brucite is locally abundant as colorless to white intergrown platy vein fillings, and rarely as free-growing platy crystals to about 5 mm.

Calcite $CaCO_3$

Calcite is ubiquitous in the rodingites at Hunting Hill and in massive serpentine as colorless and transparent, white, gray or rarely black cleavages filling veins. White to gray calcite crystals are frequently observed in rhombohedral, scalenohedral, and nail-head habits generally not exceeding 1 cm. The majority of calcite crystals at Hunting Hill do not make attractive specimens. The finest calcites were found in open seams adjacent to the ramp on the fifth level. These crystals are colorless and transparent, highly splendent, striated rhombohedrons to 1 cm, on a contrasting pale green serpentine. Larger (to 3 cm) but duller, blocky calcites have been found in pockets of botryoidal prehnite. Calcite is occasionally fluorescent, ranging from pale pink to red under shortwave ultraviolet. A few specimens show a vivid pink response under shortwave and a blue fluorescence under longwave ultraviolet radiation. A vein of "Iceland spar" was found to fluoresce bright creamy white; it is phosphorescent greenish blue under shortwave ultraviolet, and fluorescent/phosphorescent pale blue under longwave.

Figure 4. **Calcite crystals in a vug lined with botryoidal prehnite, overall size 10 × 12 cm, from the Hunting Hill quarry. David Dinsmore collection; Gary Grenier photo.**

Chalcocite Cu_2S

Chalcocite is found as nondescript black metallic masses in rodingite with grossular and diopside.

Chalcopyrite $CuFeS_2$

Chalcopyrite is found as massive blebs and veins, rarely as small tetrahedral crystals.

Clinochlore $(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$

Clinochlore is found as veins of green platy crystals in serpentine, and as very fine quality crystals in cavities to 1 cm in the rodingite. Some pale green crystals are paper-thin and translucent. The best crystals were collected from the third and sixth levels.

Figure 5. **Clinozoisite crystal, 12 cm in length, on calcite, from the Hunting Hill quarry. Author's collection; Gary Grenier photo.**

Clinozoisite $Ca_2Al_3(SiO_4)_3(OH)$

Clinozoisite is abundant in the rodingite as pink (rare) to clove-brown to greenish brown crystalline masses to euhedral prismatic crystals. The mineral is frequently found in calcite-filled veins, and sharp, translucent, terminated crystals are revealed after the calcite has been etched out. Aside from grossular, clinozoisite is the most readily collectable mineral at Hunting Hill. One notable calcite vein exposed in October 1988 yielded large, well-formed, albeit unterminated crystals of clinozoisite up to 12 cm in length and 1.3 cm in diameter (which now reside in the collections of the author and Robert Eberle—see Fig. 5). Gemmy terminated crystals to 1 cm have been found enclosed in black calcite. These clinozoisite crystals are similar in appearence to the vesuvianite crystals from the Jeffrey mine, Asbestos, Quebec, Canada.

Coalingite $Mg_{10}Fe_2(CO_3)(OH)_{24}\cdot 2H_20$

Coalingite is commonly found as golden brown (when fresh) to dark bronzy (oxidized) plates and micaceous flakes on serpentine, with patches to 10 × 10 cm across and several millimeters thick. A single, limited occurrence, found in the 1980's by Fred Schaefermeyer, consisted of vugs in serpentine lined with tiny euhedral crystals that were confirmed to be coalingite by Lance Kearns using X-ray diffraction and EDS. This is the first known occurrence of free-standing coalingite crystals. The crystals are single hexagonal plates and stacks of plates which form prismatic habits resembling those common to the micas (Fig. 6).

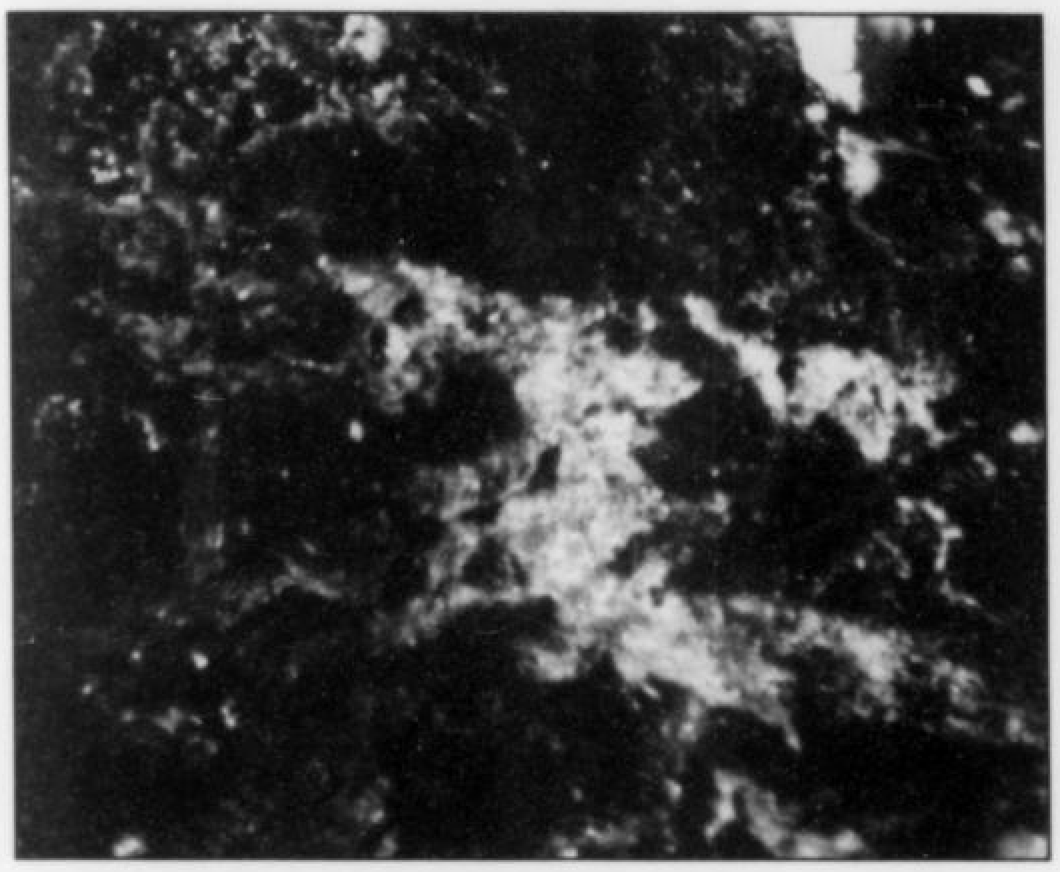

Figure 6. **Coalingite microcrystals to 1 mm on serpentine, from the Hunting Hill quarry. Paul and Jennie Smith collection and photo.**

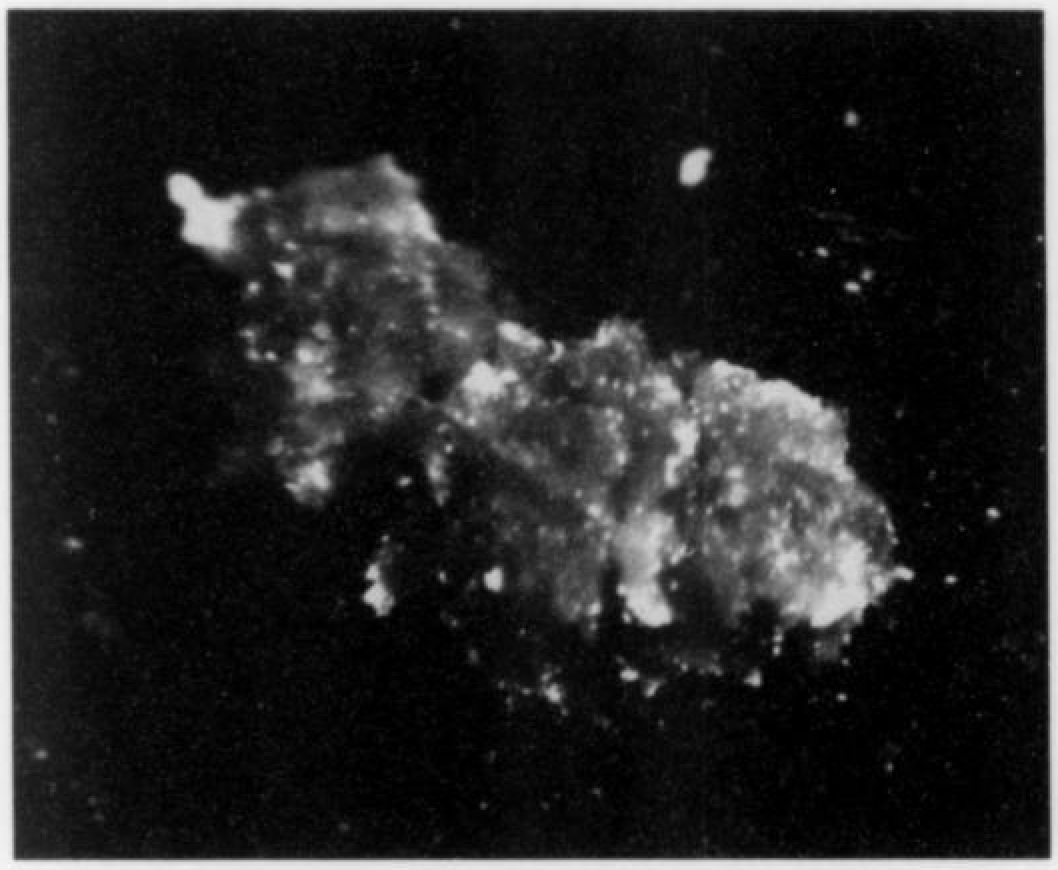

Figure 7. **Desautelsite, a cluster of platy microcrystals from the Hunting Hill quarry. Paul and Jennie Smith collection and photo.**

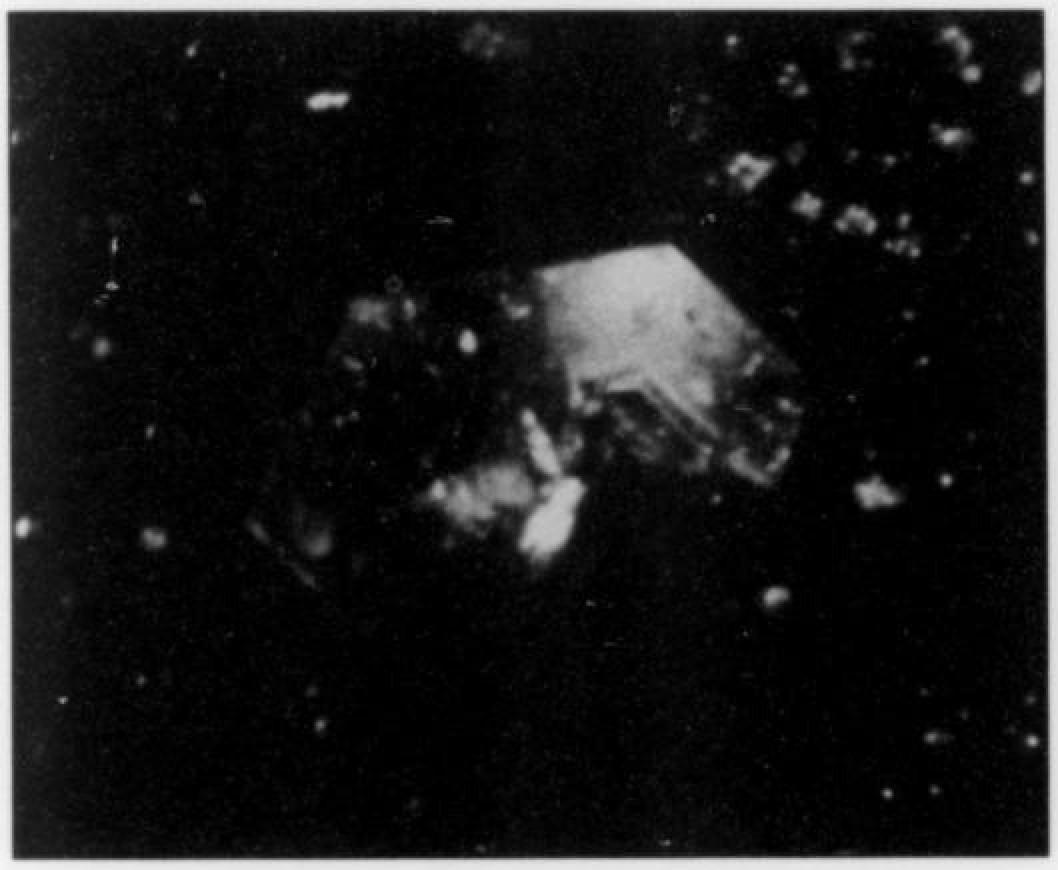

Figure 8. **Desautelsite, a single microcrystal on serpentine from the Hunting Hill quarry. Paul and Jennie Smith collection and photo.**

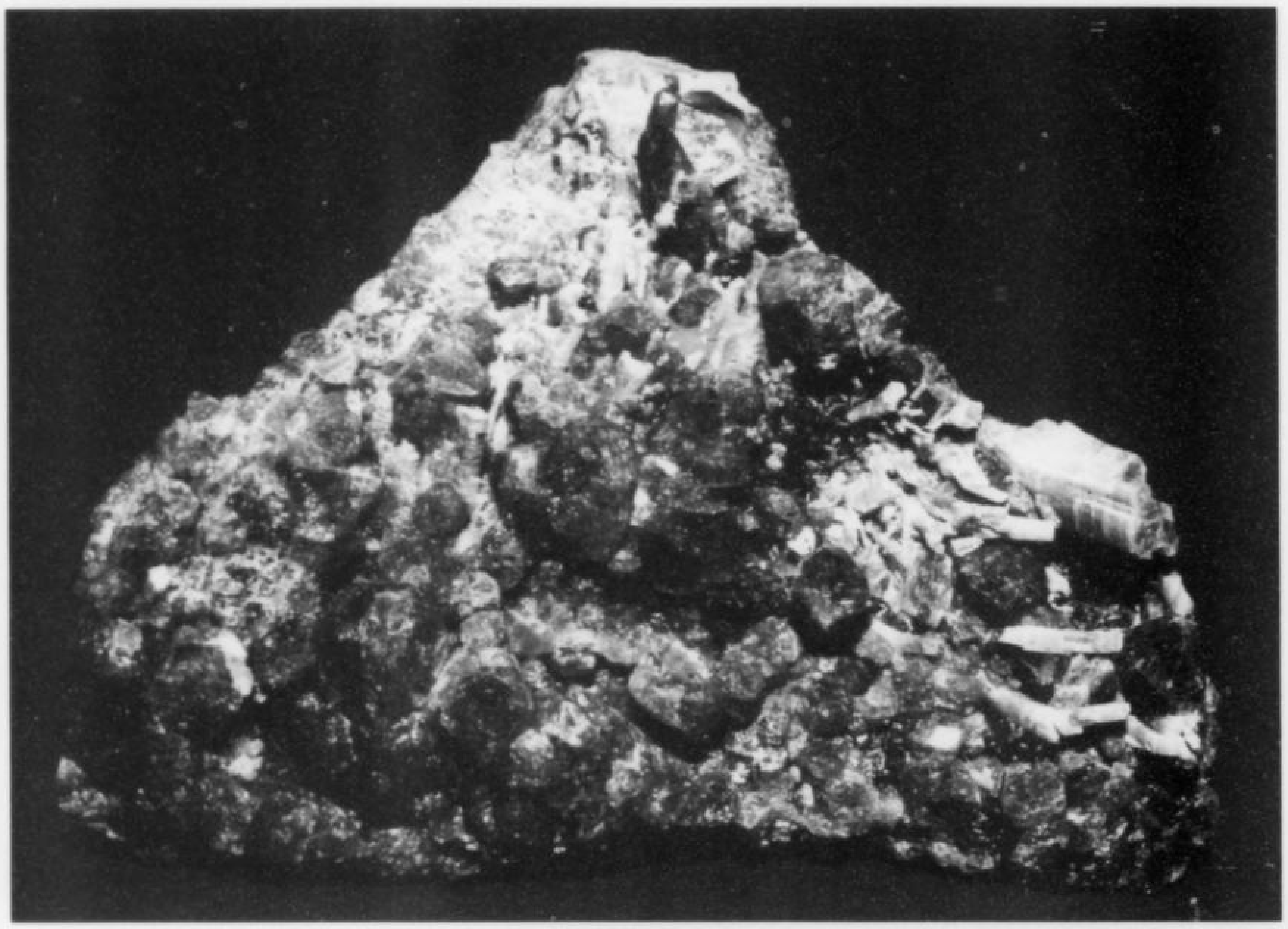

Figure 9. **Grossular, a plate of cinnamon-colored crystals with gray prismatic diopside crystals on serpentine, overall specimen 9 cm in width, from the Hunting Hill quarry. Author's collection; Gary Grenier photo.**

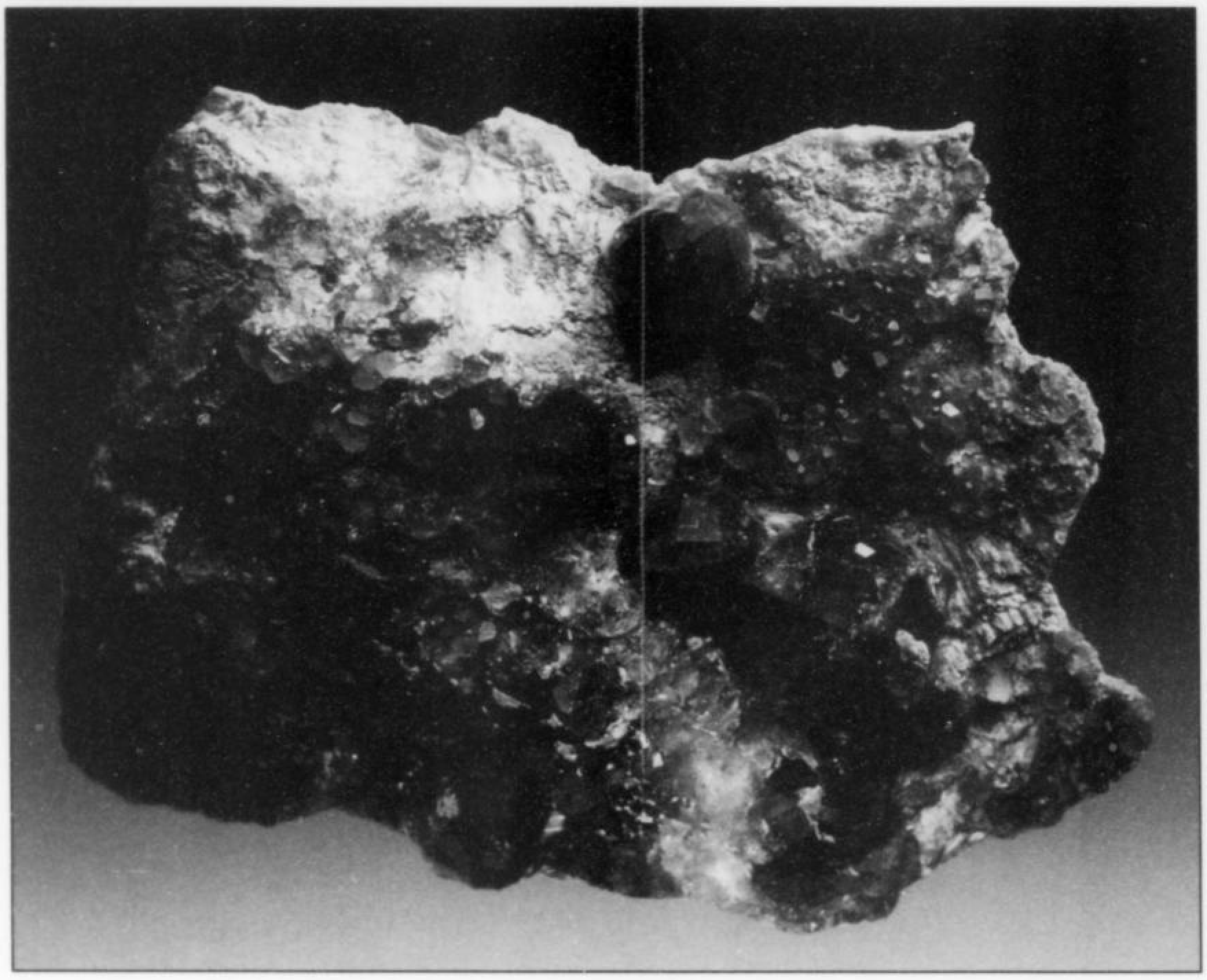

Figure 10. **Grossular in gemmy reddish orange crystals on rodingite, from the Hunting Hill quarry; overall specimen 8 × 8 cm. George Konig collection; Gary Grenier photo.**

Desautelsite $Mg_6Mn_2(CO_3)(OH)_{16}\cdot 4H_2O$

Desautelsite was identified by the staff of the National Museum of Natural History as tiny, orange, hexagonal platy crystals and rosettes (Figs. 7 and 8) on dark serpentine from a now-obliterated portion of the south end of the quarry. The finest specimens now reside in the collection of Jenny and Paul Smith.

Diopside $CaMgSi_2O_6$

Diopside is found as euhedral, transparent, white, gray or green crystals to 1 cm, occasionally with color zoning. They are commonly associated with grossular along the east face of the quarry. The rodingite also contains large cleavage patches of deep green chromian diopside. Rough crystals to 10 cm were found in a calcite vein on the fifth level. A single vug of gemmy grossular crystals, clinochlore crystals and gemmy diopside crystals up to 8 mm maximum dimension, resembling specimens from DeKalb, New York, is in the author's collection.

Dolomite $CaMg(CO_3)_2$

Dolomite is found as small white rhombohedrons and pisolitic masses.

Dravite $NaMg_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$

Dravite is extremely rare at Hunting Hill, but was reported (as "schorl") by Larrabee (1969) as a 6.4-cm vein of bluish black crystals in rodingite from a now obliterated portion of the quarry.

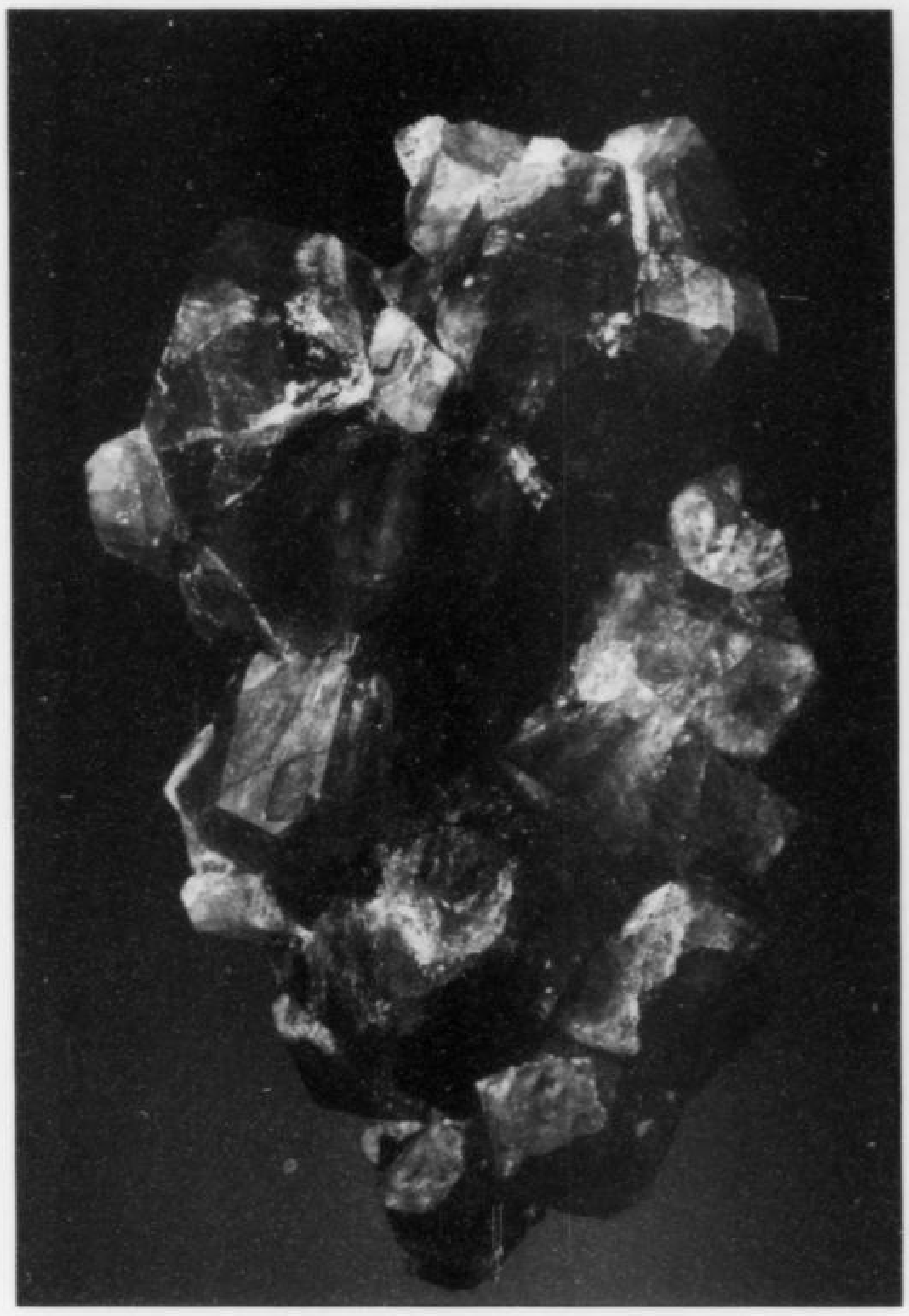

Figure 11. **Grossular in glassy red-brown crystals collected in the late 1970's from the Hunting Hill quarry; overall view 5.4 cm in width. Author's collection; Jeffrey Scovil photo.**

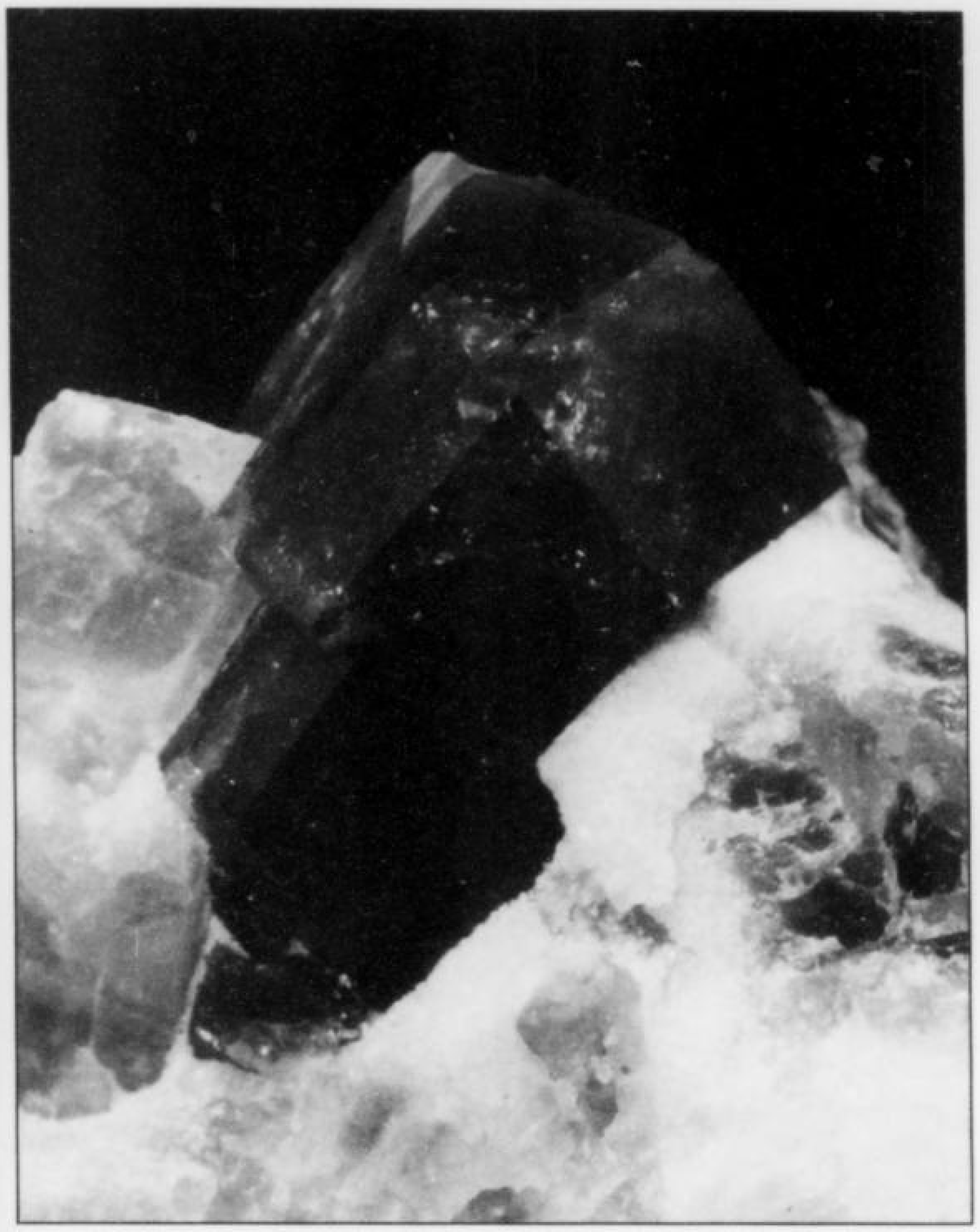

Figure 12. **Grossular crystals to 1 cm on calcite with gray diopside crystals, from the Hunting Hill quarry. Author's collection; Jeffrey Scovil photo.**

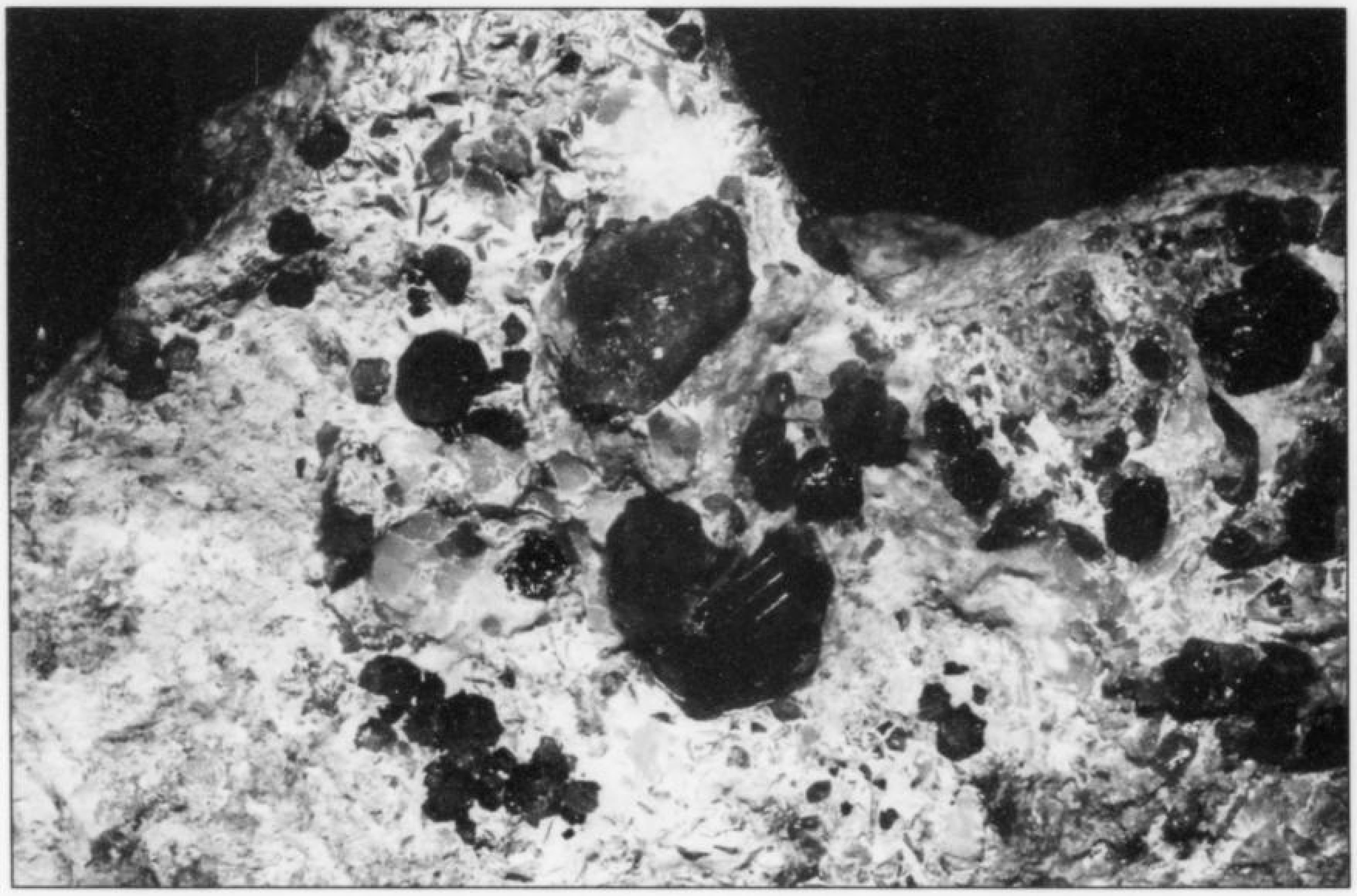

Figure 13. **Grossular crystals to 1 cm in calcite with gray platy molybdenite, from the Hunting Hill quarry. Author's collection; Gary Grenier photo.**

The author collected one specimen of bundles of greenish gray prismatic crystals on rodingite closely matching schorl/dravite in its X-ray diffraction pattern. EDS shows predominantly aluminum and silicon, along with sodium, magnesium, and a trace of iron.

Epidote $Ca_2(Fe,Al)_3(SiO_4)(OH)$

Epidote is commonly found at Hunting Hill in the rodingite. Darker, pistachio-green microcrystals believed to be epidote are occasionally found in cavities in the serpentine.

Fluorapatite $Ca_5(PO_4)_3$

Fluorapatite has been found as a single, subhedral, yellow glassy crystal approaching 1 cm in a talcose matrix by Jon Ertmann in June 2002; identification was made by Bart Cannon using EDS.

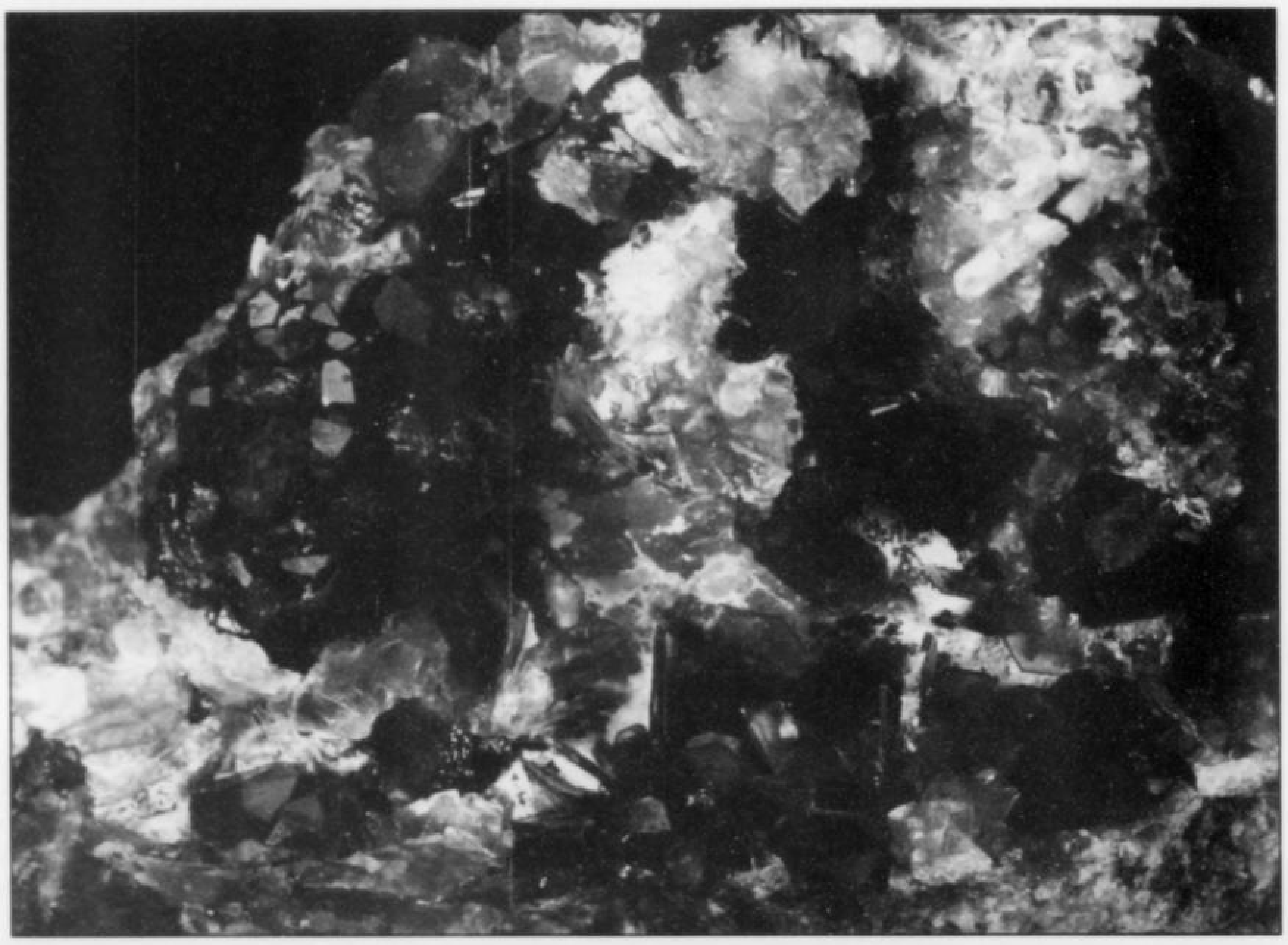

Figure 14. **Grossular in lustrous, gemmy red crystals to 7 mm lining a cavity in rodingite, associated with platy clinochlore crystals, from the Hunting Hill quarry. The cavity had been calcite-filled, and the calcite was removed with acetic acid. Author's collection; Jeffrey Scovil photo.**

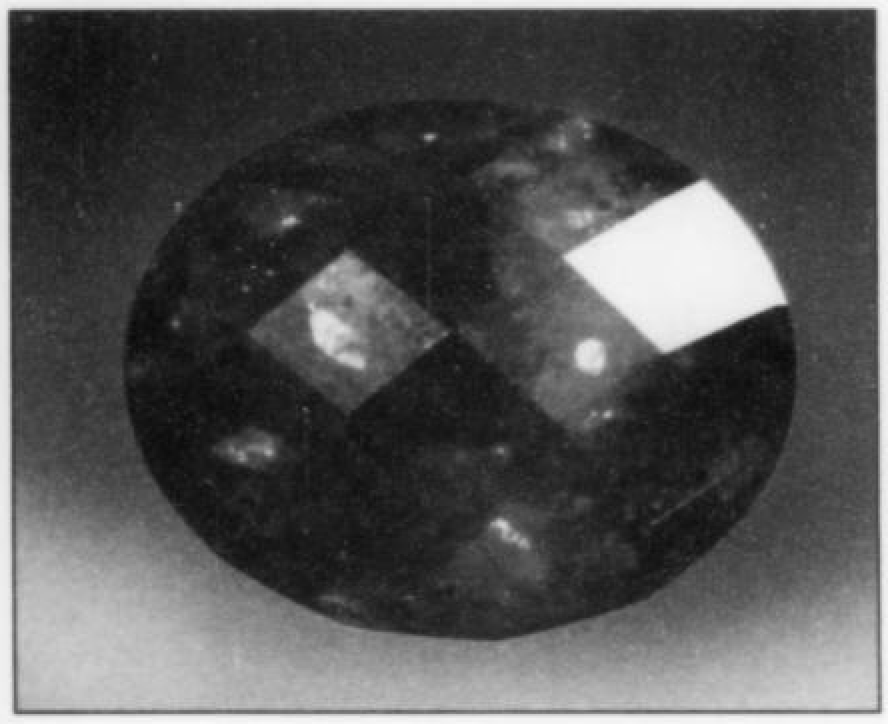

Figure 15. **Faceted grossular, over 8 carats, from rough collected in late 2002 at the Hunting Hill quarry by David Dinsmore. David Dinsmore collection; Gary Grenier photo.**

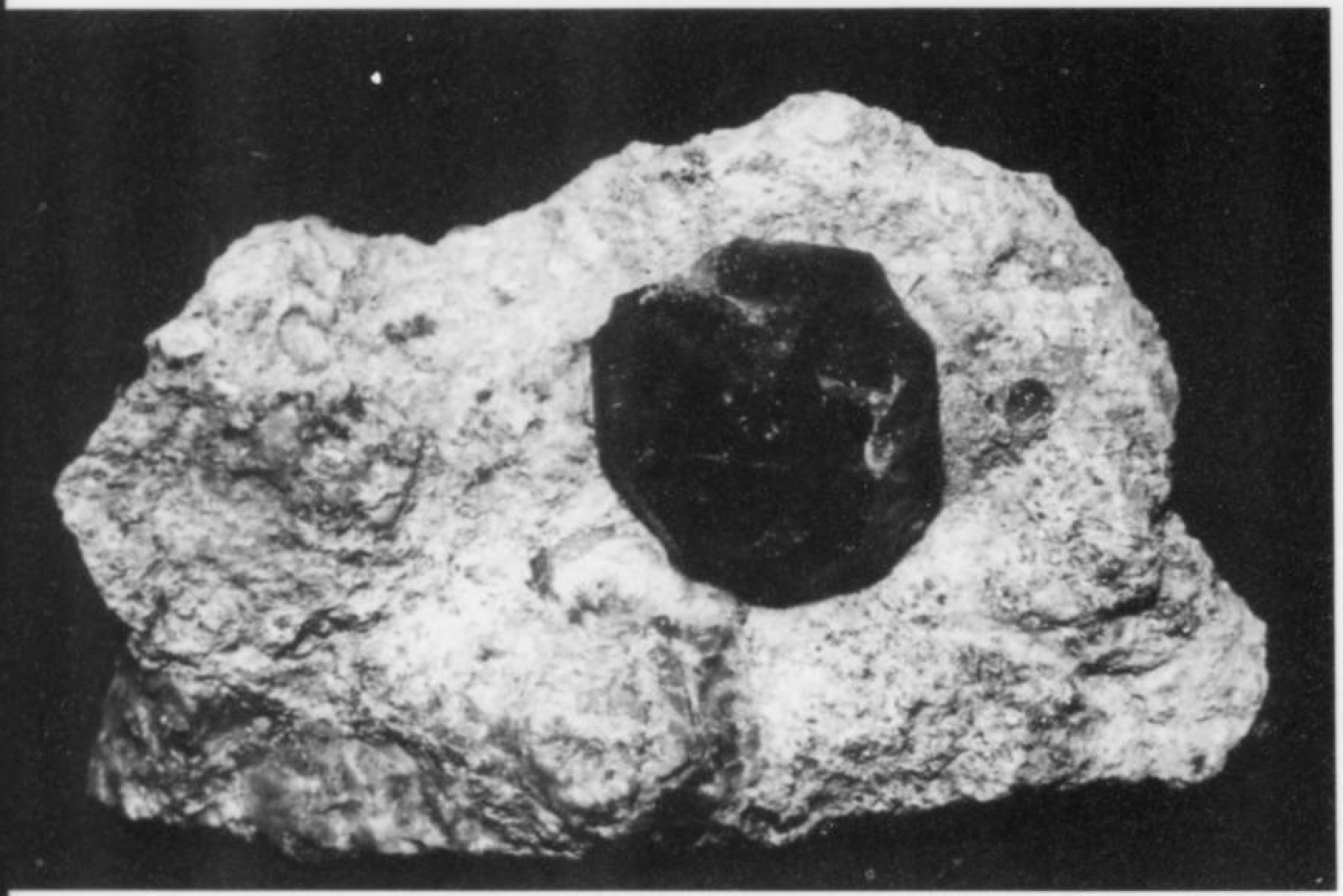

Figure 16. **Grossular crystal, 2.5 cm, on rodingite, from the Hunting Hill quarry. Author's collection; Gary Grenier photo.**

Galena PbS

Galena was observed in a single specimen with clinochlore as a small cuboctahedral crystal collected in 2000 by Jack Nelson.

Goethite $\alpha\text{-Fe}^{3+}\text{O(OH)}$

Goethite was found by Fred Schaefermeyer as tiny radial sprays of golden brown crystals on serpentine.

Grossular $Ca_3Al_2(SiO_4)_3$

Grossular crystals which are highly colored and of faceting grade (one stone exceeding 8 carats, in the collection of David Dinsmore) make Hunting Hill among the best-known collecting sites in the Washington, DC metropolitan area. Grossular ranges in color from massive porcelaneous white (in rodingite) to honey-yellow, chocolate-brown (uncommon), reddish orange and cinnamon-orange (the predominant color). Crystals range from transparent in part and facetable to opaque, may be highly striated, and may occasionally have an iridescent coating. Sizes range from sub-millimeter up to 7.5 cm in maximum dimensions for partial crystals (Edward Goldberg collection). Grossular is abundant in the rodingite dikes, where pockets containing well-formed crystals are locally abundant. Grossular crystals are associated with crystals of colorless, gray or greenish diopside, green clinochlore, calcite, clinozoisite and rarely molybdenite, bornite and chalcopyrite.

Two occurrences of grossular are particularly noteworthy. In the late 1980's, the floor on the east side of the third level yielded a series of large pockets filled with a white sticky mud. When perhaps a half-dozen buckets of the white mud were removed and screened, the mud was found to contain loose gemmy crystals of grossular (including faceting rough) and diopside. The walls of the pocket were lined with beautiful, glassy, reddish orange grossular crystals associated with diopside and clinochlore (Fig. 14). These crystals rank among the finest garnet specimens from the quarry.

Pockets found in adjacent talus tended to be more typical orange to cinnamon-brown, lacking the reddish tinge of the garnet in these wonderful pockets. In 2000, a highly crystallized zone on the fifth level yielded coarse calcite-filled veins which, when carefully broken, revealed large (over 2 cm) but opaque cinnamon-brown grossular crystals (Fig. 12), some of which are striated. Specimen material from this zone was so plentiful and obviously important that Bardon Stone Corporation kindly removed a portion of the occurrence to an area not being actively worked in order to preserve it for subsequent club trips. It is expected that grossular will continue to be found as quarrying operations progress, although color variations appear to change with depth and location in the quarry.

The paragenesis of the crystallized garnet-bearing pockets is fairly consistent: grossular is the first mineral deposited, followed sequentially by diopside, clinozoisite, clinochlore, and lastly calcite. A very few specimens of grossular were observed to contain metallic dodecahedrons believed to be bornite. A few clinochlore-lined pockets have been found containing brown, generally opaque grossular crystals, followed by coarse white diopside crystals, and lastly a second generation of small (1 to 2-mm) gemmy orange grossular crystals. The second generation of grossular is deposited only on the faces of the diopside crystals.

Hematite Fe_2O_3

Hematite occurs as typical red coatings on fracture surfaces.

Hydromagnesite $Mg_5(CO_3)_4(OH)_2 \cdot 4H_2O$

Hydromagnesite is found as water-clear, terminated blades to 1 cm in cavities, and as flattened fans and rosettes on fracture surfaces. Crystals fluoresce pale blue under longwave and shortwave ultraviolet light, with a brief blue-green phosphorescence.

Ilmenite $FeTiO_3$

Ilmenite has been identified in a small number of specimens found in 1997 by George Reimherr. The ilmenite occurs as thick, black, tabular to blocky crystals to about 6 mm in a coarse white calcite vein. Identification was by Lance Kearns at James Madison University.

Magnesite $MgCO_3$

Magnesite occurs as white porcelaneous masses and veins, and as cloudy white rhombohedral crystals. Recent operations (2002) have exposed a zone near the top of the east face of the quarry which yields abundant, dense, white magnesite nodules of lapidary grade, a few of which exceed 20 cm in length.

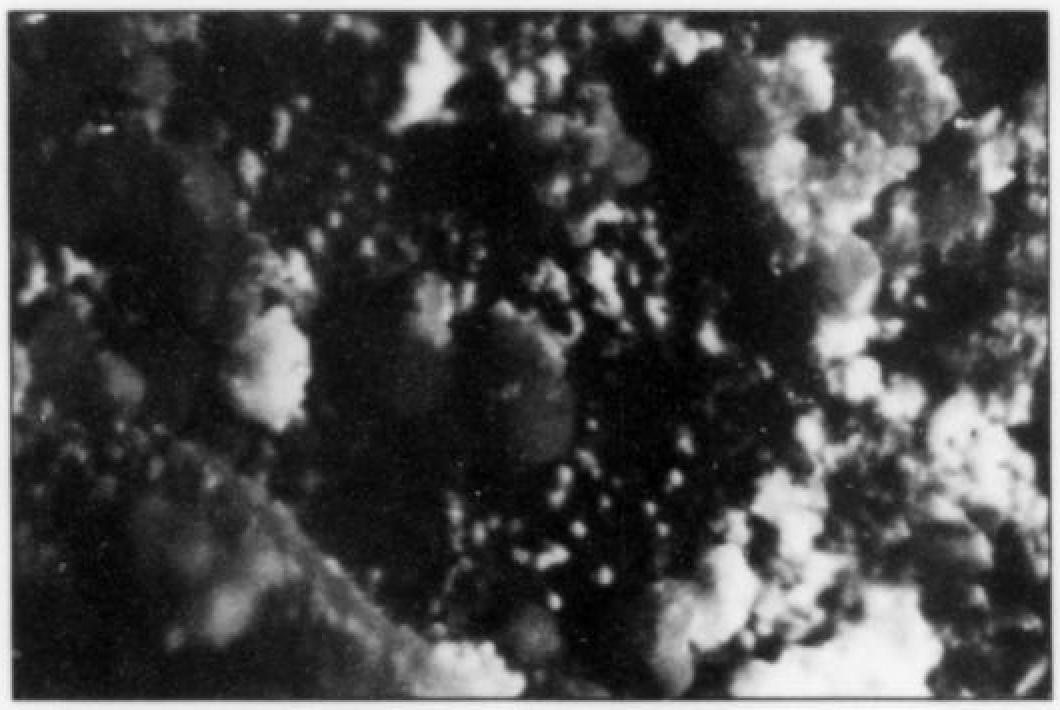

***Figure 17.* McGuinessite in blue sprays and balls on serpentine, from the Hunting Hill quarry. Paul and Jennie Smith collection and photo.**

Magnetite $Fe^{2+}Fe^{3+}_2O_4$

Magnetite occurs as inclusions in serpentine, in veinlets, masses and small crystals to 5 mm. Crystals are generally modified octohedrons on platy magnesite or calcite crystals.

Malachite $Cu_2(CO_3)(OH)_2$

Malachite has been confirmed by Lance Kearns as secondary green stains and masses with an amphibole (see pargasite) from specimens collected by Fred Schaefermeyer in the late 1980's.

McGuinessite $(Mg,Cu)_2(CO_3)(OH)_2$

McGuinnessite is a secondary mineral which was found at the south end of the quarry in the mid-1980's. It occurs as sky-blue stains and mats of acicular crystals less than 0.5 mm (Fig. 17). The specimens were found near a vein of talc associated with massive chalcopyrite. Identification was made by the U.S. National Museum of Natural History (Magnusson, 1986).

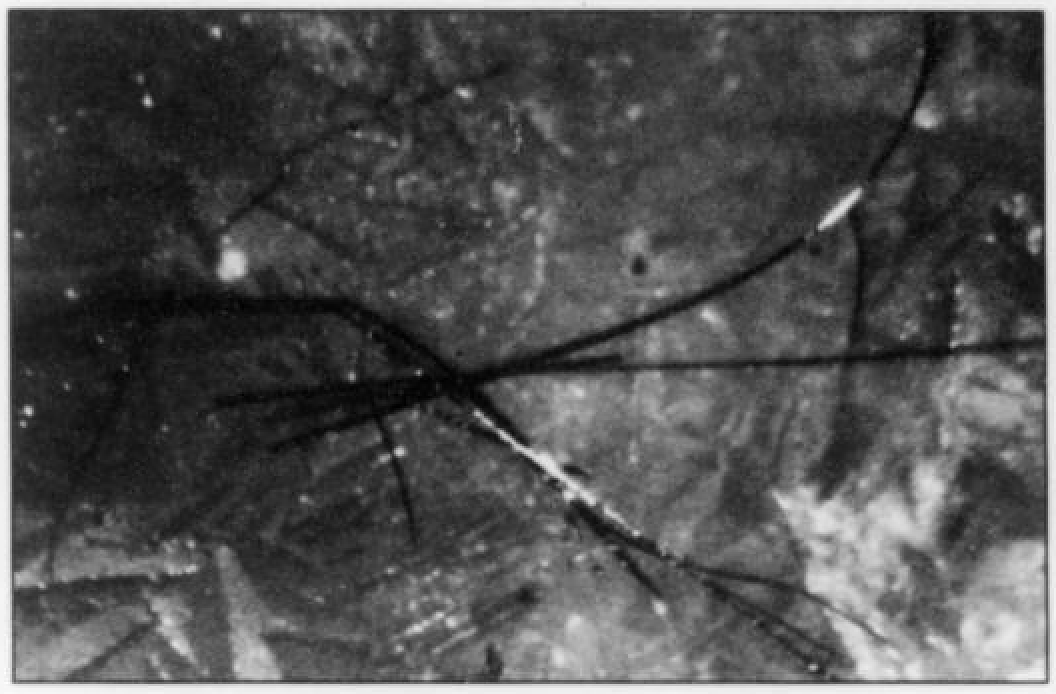

***Figure 18.* Millerite in microcrystals on calcite crystals, from the Hunting Hill quarry. Paul and Jennie Smith collection and photo.**

Millerite NiS

Millerite has been found in two distinct associations. In the first, fine brassy hair-like needles to several millimeters are intergrown with, and included in, rhombic calcite and dolomite crystals (Fig. 18). The second occurrence (discovered by August Dietz in December, 1998) consists of a porous talc-serpentine matrix containing abundant microscopic hairs and intergrown mats of brassy millerite crystals laced throughout the pores, and associated with pyrite cubes to 1 cm. In both occurrences, millerite has been confirmed by various investigators using X-ray diffraction and/or Energy Dispersive X-ray Analysis (EDS).

Molybdenite MoS_2

Molybdenite is found rarely as small gray plates in calcite and serpentine, and very rarely as platy masses up to 3 mm in diameter associated with grossular crystals in rodingite.

Nimite $(Ni,Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$

Nimite has been positively confirmed by Lance Kearns using X-ray diffraction analysis. The single known specimen shows greenish blue fine-grained plates associated with titanite, clinozoisite and black calcite.

Opal $SiO_2 \cdot nH_2O$

Opal has been observed as colorless to waxy, tan to white botryoidal layers on fracture surfaces in serpentine.

Pargasite $NaCa_2(Mg_4Al)Si_6Al_2O_{22}(OH)_2$

Pargasite has been tentatively identified by Lance Kearns using X-ray diffraction. The material consists of tan to brown, intergrown prismatic crystals associated with malachite.

Pentlandite $(Fe,Ni)_9S_8$

Pentlandite was found in Fall 2001 as metallic, bronzy brown, granular veins up to 8 cm in maximum dimension with minor magnetite and coarse platy talc in serpentine from the east face, fourth level. Identification was made by X-ray powder diffraction. The pentlandite was found in proximity to the nimite and millerite finds, strongly suggesting a localized nickel-enriched zone.

Pokrovskite $Mg_2(CO_3)(OH)_2{\cdot}0.5H_2O$

Pokrovskite occurs in the serpentine as three distinct habits: (1) "satin spar"-like fracture fillings with satiny luster and fibrous texture, (2) small white mats and radial tufts of microcrystals, and (3) distinctive cone-like fibrous structures. Although once abundant in the upper levels, pokrovskite has not been collected in many years.

Prehnite $Ca_2Al_2Si_3O_{10}(OH)_2$

Prehnite is locally abundant as white, lustrous, platy crystals lining pockets to several centimeters, with calcite and diopside crystals. Botryoidal white to orange-yellow prehnite is also found. The author excavated one seam over a meter long that was lined with lustrous orange botryoidal prehnite.

Pyrite FeS_2

Pyrite is commonly found as thin coatings, filiform crystals, veinlets and crystals to 1 cm. Crystals generally show cubic or, less commonly, octahedral form. Bright, brassy pyrite cubes are occasionally found in pockets of platy white calcite crystals, making very attractive specimens.

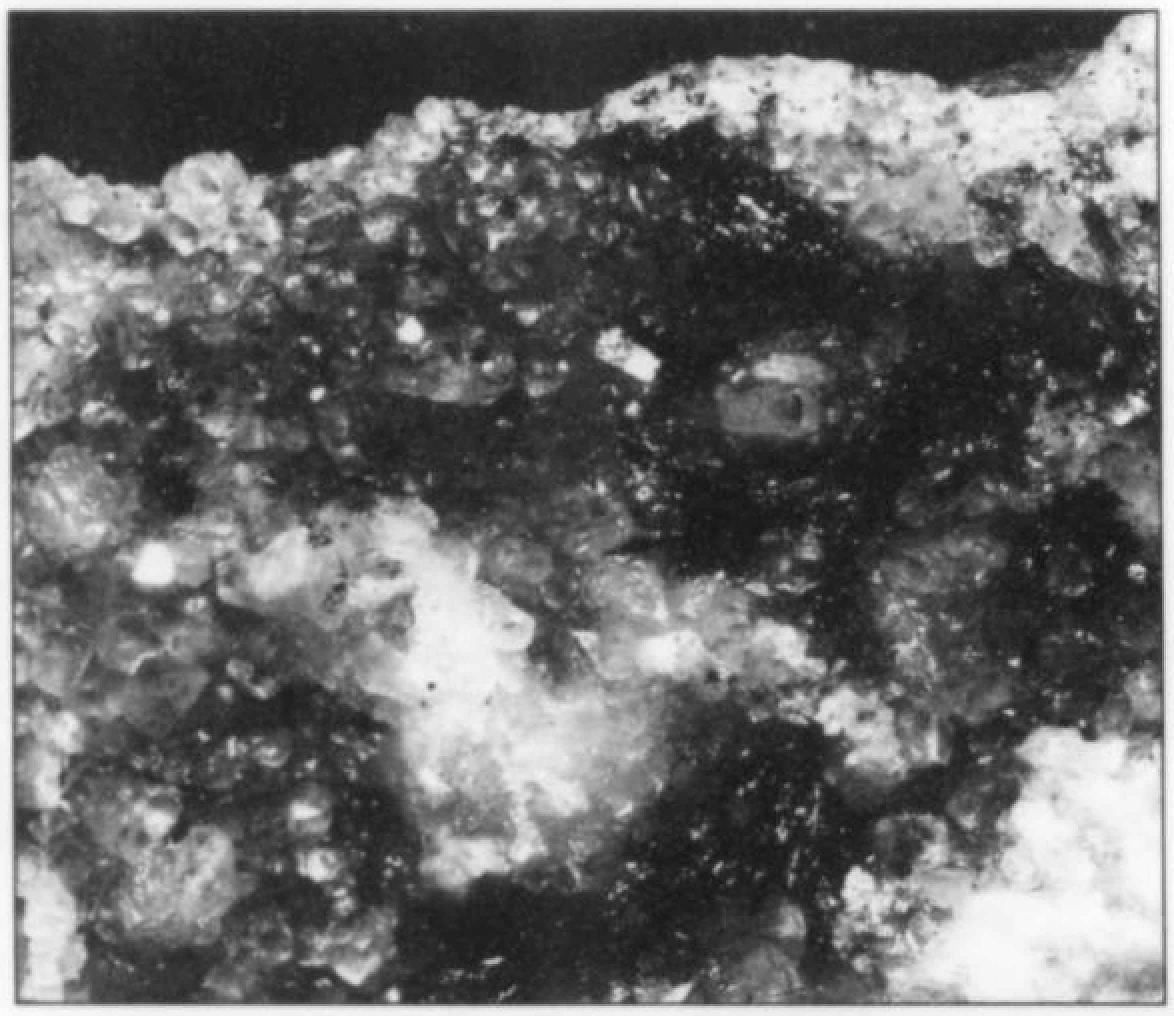

Figure 19. **Tochilinite sprays to 1 cm on calcite crystals, from the Hunting Hill quarry. Author's collection; Gary Grenier photo.**

Quartz SiO_2

Quartz is fairly common as massive white to gray veinlets and drusy crystals (sometime stained red by hematite) on serpentine. A single, unusual pocket found in 1988, on the fourth level, yielded clear, flattened but terminated quartz crystals to 6 cm associated with dolomite rhombs. The quartz uniquely shows an unusual bluish-green fluorescence and phosphorescence under shortwave ultraviolet light and weaker bluish green fluorescence under longwave ultraviolet with no phosphorescence response. Chalcedonic quartz has also been observed as gray to white cryptocrystalline veins.

Rutile TiO_2

Rutile occurs as tiny reddish black grains in calcite with serpentine.

Talc $Mg_3Si_4O_{10}(OH)_2$

Talc is very common as pale to medium green, platy to foliated veins and compact masses, particularly on the east quarry faces.

Titanite $CaTiOSiO_4$

Titanite is rare at Hunting Hill, but has been confirmed from two dissimilar occurrences. Several specimens from an open vein of crystallized epidote-clinozoisite preserved by Fred Schaefermeyer contained green wedge-shaped crystals of titanite to 2 mm. In addition, the author found several large portions of flattened yellow-green plates to 1 cm with clinozoisite and calcite which have been identified as titanite by Lance Kearns using X-ray diffraction.

Tochilinite $6(FeS){\cdot}5[Mg(OH)_2]$

Tochilinite is rarely found as lustrous, black, prismatic crystals or sprays on transparent to milky white calcite crystals. One specimen collected by the author adjacent to the ramp contains a spray of crystals 1.1 cm in length (Fig. 19). The identity was confirmed by X-ray diffraction and EDS.

Vesuvianite $Ca_{10}Mg_2Al_4(SiO_4)_5(Si_2O_7)_2(OH)_4$

A single specimen of dark brown prismatic crystals of vesuvianite with calcite on serpentine was collected by the author (Decem-

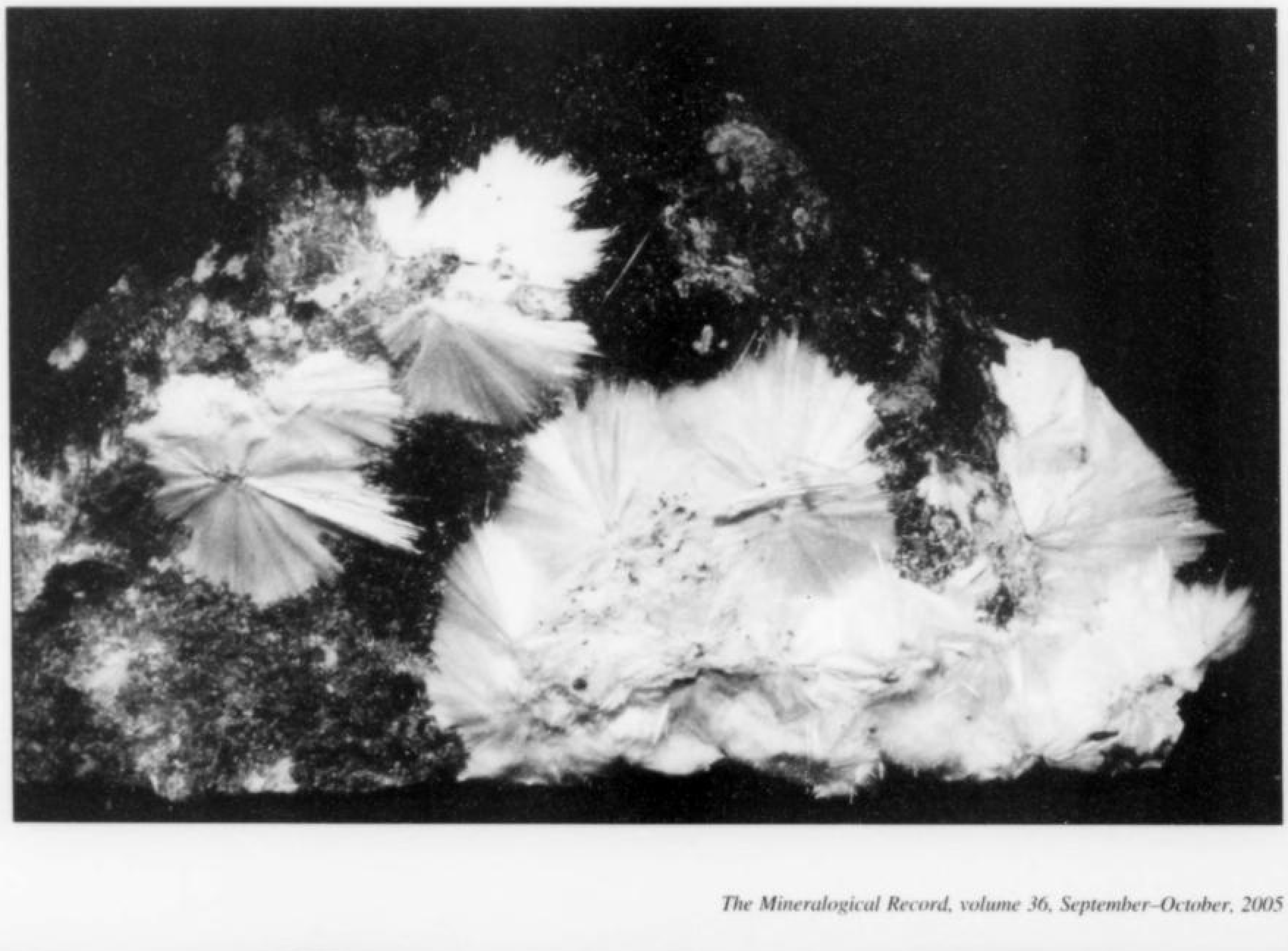

Figure 20. **Xonotlite in white radial growths to 2.6 cm on black serpentine, from the Hunting Hill quarry. Author's collection; Gary Grenier photo.**

Table 1. **Minerals identified from the Hunting Hill quarry, including the rock-forming minerals.**

Native Elements	
Palladium	Pd
Platinum	Pt
Sulfides	
Bornite	$\mathrm{Cu_5\ FeS_4}$
Chalcocite	$\mathrm{Cu_2S}$
Chalcopyrite	$\mathrm{CuFeS_2}$
Galena	PbS
Millerite	NiS
Molybdenite	$\mathrm{MoS_2}$
Pentlandite	$\mathrm{(Fe,Ni)_9S_8}$
Pyrite	$\mathrm{FeS_2}$
Pyrrhotite	$\mathrm{Fe_{1-x}S}$
Oxides and Hydroxides	
Brucite	$\mathrm{Mg(OH)_2}$
Chromite	$\mathrm{FeCr_2O_4}$
Goethite	$\alpha\text{-}\mathrm{Fe^{3+}O(OH)}$
Hematite	$\mathrm{Fe_2O_3}$
Ilmenite	$\mathrm{FeTiO_3}$
Magnetite	$\mathrm{Fe^{2+}Fe_2^{3+}O_4}$
Rutile	$\mathrm{TiO_2}$
Tochilinite	$\mathrm{6(FeS)\cdot 5[Mg(OH)_2]}$
Carbonates	
Aragonite	$\mathrm{CaCO_3}$
Azurite	$\mathrm{Cu_3(CO_3)_2(OH)_2}$
Calcite	$\mathrm{CaCO_3}$
Coalingite	$\mathrm{Mg_{10}Fe_2(CO_3)(OH)_{24}\cdot 2H_20}$
Desautelsite	$\mathrm{Mg_6Mn_2(CO_3)(OH)_{16}\cdot 4H_2O}$
Dolomite	$\mathrm{CaMg(CO_3)_2}$
Huntite	$\mathrm{CaMg_3(CO_3)_4}$
Hydromagnesite	$\mathrm{Mg_5(CO_3)_4(OH)_2\cdot 4H_2O}$
Magnesite	$\mathrm{MgCO_3}$
Malachite	$\mathrm{Cu_2(CO_3)(OH)_2}$
McGuinessite	$\mathrm{Mg,Cu)_2(CO_3)(OH)_2}$
Pokrovskite	$\mathrm{Mg_2(CO_3)(OH)_2\cdot 0.5\ H_2O}$
Sulfates	
Brochantite	$\mathrm{Cu_4(SO_4)(OH)_6}$
Phosphates	
Fluorapatite	$\mathrm{Ca_5(PO_4)_3F}$
Silicates	
Actinolite	$\mathrm{Ca_2(Mg,Fe)_5Si_8O_{22}(OH)}$
Albite	$\mathrm{NaAlSi_3O_8}$
Anthophyllite	$\mathrm{Mg_7Si_8O_{22}(OH)_2}$
Antigorite	$\mathrm{(Mg,Fe)_3Si_2O_5(OH)_4}$
Biotite	$\mathrm{K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)_2}$
Chrysocolla	$\mathrm{Cu,Al)_2H_2Si_2O_5(OH)_4\cdot nH_20}$
Clinochlore	$\mathrm{(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8}$
Clinochrysotile	$\mathrm{Mg_3Si_2O_5(OH)_4}$
Clinozoisite	$\mathrm{Ca_2Al_3(SiO_4)_3(OH)}$
Diopside	$\mathrm{CaMgSi_2O_6}$
Dravite	$\mathrm{NaMg_3Al_6(BO_3)_3Si_6O_{18}(OH)_4}$
Epidote	$\mathrm{Ca_2(Fe,Al)_3(SiO_4)(OH)}$
Forsterite	$\mathrm{Mg_2SiO_4}$
Grossular	$\mathrm{Ca_3Al_2(SiO_4)_3}$
Hydrogrossular	$\mathrm{Ca_3Al_2(SiO_4)_{3-x}(OH)_{4x}}$
Lizardite	$\mathrm{Mg_3Si_2O_5(OH)_4}$
Nimite	$\mathrm{(Ni,Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8}$
Opal	$\mathrm{SiO_2\cdot nH_2O}$
Pargasite	$\mathrm{NaCa_2(Mg_4Al)Si_6Al_2O_{22}(OH)_2}$
Prehnite	$\mathrm{Ca_2Al_2Si_3O_{10}(OH)_2}$
Quartz	$\mathrm{SiO_2}$
Talc	$\mathrm{Mg_3Si_4O_{10}(OH)_2}$
Titanite	$\mathrm{CaTiOSiO_4}$
Tremolite	$\mathrm{Ca_2Mg_5Si_8O_{22}(OH)_2}$
Vesuvianite	$\mathrm{Ca_{10}Mg_2Al_4(SiO_4)_5(Si_2O_7)_2(OH)_4}$
Xonotlite	$\mathrm{Ca_6Si_6O_{17}(OH)_2}$
Zoisite	$\mathrm{Ca_2Al_3(SiO_4)_3(OH)}$

ber 1988). The identification of was confirmed by X-ray diffraction and EDS by Lance Kearns.

Xonotlite $\mathrm{Ca_6Si_6O_{17}(OH)_2}$

Xonotlite was first found in a series of seams in the floor of the fifth level in March 1999, as striking, snow-white, radiating crystal sprays exceeding 3 cm in diameter, on black serpentine (Fig. 20). Smaller tufts of terminated crystals were also found in the seams excavated by Robert Meny, August Dietz, and the author. Identification was made using X-ray powder diffraction by Lance Kearns.

Zoisite $\mathrm{Ca_2Al_3(SiO_4)_3(OH)}$

Zoisite has been found as grayish white, fine-grained to rarely coarse-bladed crystals. In 2001, the author found large calcite-filled veins containing divergent sprays of gray prismatic zoisite crystals up to 10 cm. These occurred in talus boulders on the east face of the quarry. The pink variety of zoisite has also been reported from the rodingite.

PSEUDOMORPHS

A fair number of specimens containing pseudomorphs have been noted in the literature or observed in local collections. The presence of serpentine pseudomorphs after various minerals is not unexpected, and such pseudomorphs are probably overlooked by most collectors. Serpentine pseudomorphous after other minerals is very well known from several localities, most notably the Tilly Foster mine in Brewster, New York (Nightingale, 2001). The following types of pseudomorphs have been noted thus far:

(1) Antigorite after talc (Larrabee 1969, and author's collection)
(2) Chalcedony casts after rhombohedral calcite
(3) Hematite after magnetite (Larrabee 1969)
(4) Serpentine after olivine crystals
(5) Serpentine after platy clinochlore
(6) Serpentine after prehnite crystals (Fred Schaefermeyer specimen)
(7) Serpentine after radial sprays of an unknown mineral (xonotlite?)
(8) Talc after antigorite (Larrabee 1969)
(9) Prehnite after aragonite

DISCREDITED OR QUESTIONABLE SPECIES

"Deweylite" occurs as waxy orange vein fillings which have not been characterized. "Deweylite" is thought to be a mixture of clinochrysotile or lizardite and a "talc-like mineral" (Roberts *et al.*, 1990).

"Pyrolusite" is a term used locally to describe black manganese oxide dendrites at Hunting Hill, but they have never been precisely characterized, and therefore it is unclear if they are pyrolusite or another similar manganese mineral such as romanèchite or todorokite.

DEDICATION AND ACKNOWLEDGMENTS

This paper is dedicated to Fred Schaefermeyer of Arlington, Virginia, whose enthusiasm and knowledge of Hunting Hill inspired the author to write this paper. Fred's sharp eye and astute knowledge of Hunting Hill allowed him to preserve a large number of mineralogically important specimens from Hunting Hill for future study and appreciation which ultimately led to the identification of at least five new minerals for the locality, and the discovery of coalingite crystals.

In addition, the author thanks the following individuals who provided information and/or specimens, or whose specimens were made available for study: Fritz Beckmann, August (Andy) Dietz, David Dinsmore, Robert Eberle, Jonathan Ertmann, Paul and Cathy Gaber, Edward Goldberg, George Konig, George Loud, Wendall Mohr, George Reimherr, Jenny and Paul Smith, Georgia Olmstead and the late Jack Nelson.

Special thanks to Dr. Lance Kearns of James Madison University for X-ray diffraction and EDS analyses; Tony Nikischer of *Excaliber Mineral Company* for EDS analyses of the tochilinite; and to Joseph Orosz of Rockaway, New Jersey for assistance with X-ray diffraction analyses.

The mineral photography of Paul and Jennie Smith, Jeffrey Scovil and the late Gary Grenier are gratefully acknowledged and appreciated.

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Finally, this study would have been entirely impossible without the foresight and cooperation of Aggregate Industries Corporation, the owners of Hunting Hill quarry, and very special thanks to former superintendent John Croney, now deceased, and to current quarry director Jeffry Greene, who both sacrificed many Sunday afternoons to allow our collecting trips. Their cooperation has been appreciated by dozens of local collectors, who, in turn, have shared specimens and knowledge with the local community in the form of talks and donations to local schools and scout groups to promote a better understanding of the natural world around us. The mineralogically important specimens collected on these trips are now preserved for future generations of collectors, mineralogists, and students rather than simply becoming yet another part of a road or building site in the rapidly developing urban areas around Washington, DC.

It is important to note that the policy of the current owners of the quarry provides limited collecting opportunities only to several local groups. Mineral collecting on the property is otherwise not permitted.

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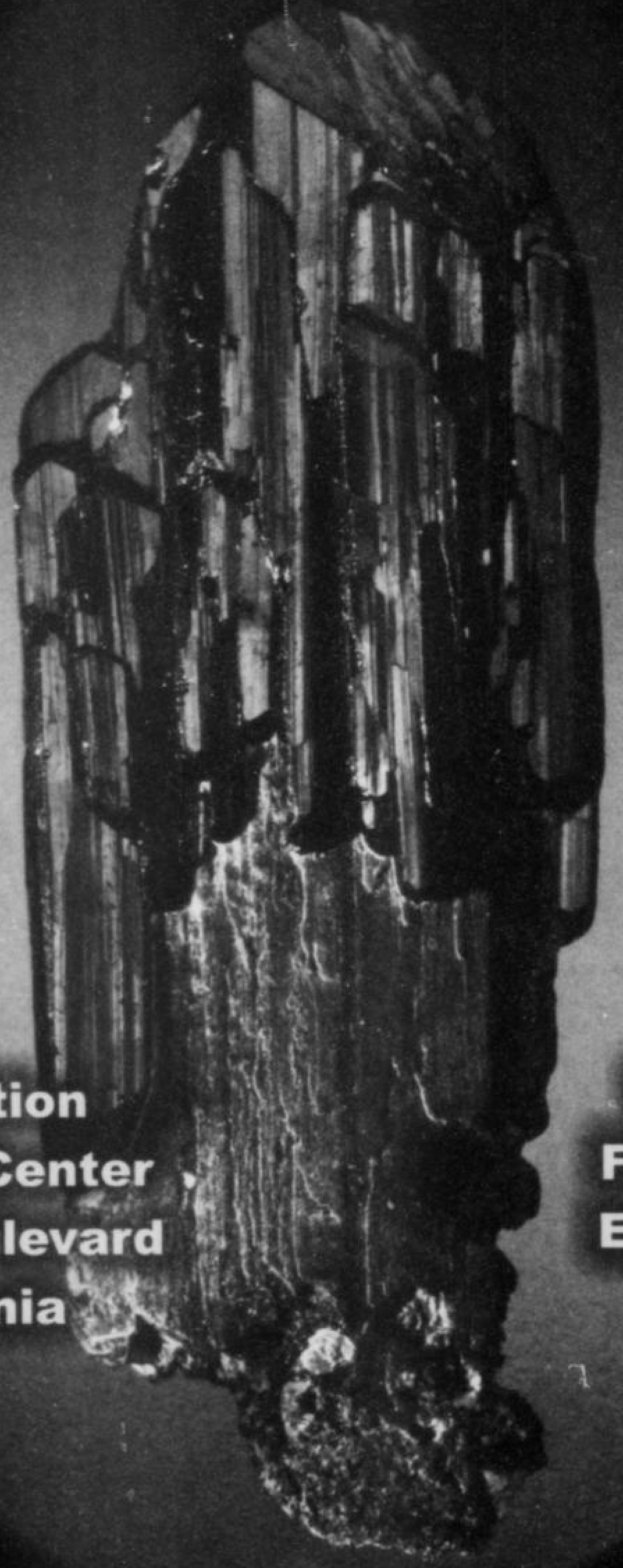

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Azurite on malachite after azurite - Bisbee, Arizona
Natural History Museum of Los Angeles County specimen

Photograph by Harold & Erica Van Pelt
Poster design by Anthony R. Kampf

THE MUSEUM DIRECTORY

New York State Museum
Curator (Geol.): Dr. William Kelly
Tel: 518-474-7559
Collections Mgr. (Geol.):
Michael Hawkins
Tel: 518-486-2011
Fax: 518-486-3696
3140 Cultural Education Ctr.
Albany, NY 12230-0001
Website: www.nysm.nysed.gov
Hours: 10–5 daily (closed Thanksgiving, Christmas, New Years)
Specialty: New York & worldwide minerals
Support Org.: NY State Acad. of Mineralogy (www.nysm.nysed.gov/nysam)

Colburn Gem & Mineral Museum
Curator: Phillip M. Potter
Tel: (828) 254-7162
Fax: (828) 257-4505
Website: www.main.nc.us/colburn
Pack Place Education,
Arts & Science Center
2 South Pack Square
Asheville, NC 28801
Hours: 10–5 Tues.–Sat.
1–5 Sun.
Closed Mondays and holidays
Specialties: North Carolina and worldwide minerals and gems
Accessible to persons with disabilities

Montana Tech Mineral Museum
Curator: Dr. Richard Berg
Tel: 406-496-4172
Fax: 406-496-4451
e-mail:dberg@mtech.edu
Program Director: Ginette Abdo
Tel: 406-496-4414
e-mail:gabdo@mtech.edu
Website: www.mbmg.mtech.edu /museumm.htm
Montana Bureau of Mines & Geology
Montana Tech of UM,
1300 W. Park Street
Butte, Montana 59701
Hours: Mem/Day to Labor Day
9-6 daily; Rest of year M-F 9-4; Open Sat & Sun May, Sept & Oct 1-5 pm
Specialties: Butte and Montana minerals, worldwide classics

Harvard Mineralogical Museum
Curators: Dr. Carl A. Francis
William Metropolis
Tel: (617) 495-4758
24 Oxford Street
Cambridge, Mass. 02138
Hours: 9–4:30 M–Sat.; 1–4:30 Sun.
Specialties: Systematic Mineral Coll'n

Western Museum of Mining & Industry
Curator: Terry A. Girouard
Tel: (719) 495-2182
email: wmmicurator@aol.com
Dir. of Educ.: Scott Wright
Tel: (719) 488-0880
Fax: (719) 488-9261
www.wmmi.org
1025 North Gate Road
Colorado Springs, CO 80921
Hours: 9–4 M-Sat.
Specialties: Colorado minerals & ores, Western mining memorabilia, 14,000-vol. research library

Gillespie Museum of Minerals
Curator: Dr. Bruce Bradford
Tel: (386) 822-7331
e-mail: bbradfor@stetson.edu
Assistant Director: Holli M. Vanater
Tel: (386) 822-7330
e-mail: hvanater@stetson.edu
Fax: (386) 822-7328
Stetson University
234 E. Michigan Avenue
[mailing: 421 N. Woodland Blvd.]
DeLand, FL 32723-3757
Hours: 10 to 4 Tues-Fri; closed during univ. hoidays, breaks, summer
Specialties: Worldwide minerals and rocks; Florida; large historic fluorescence collectionGeology Museum

Colorado School of Mines
Curator: Paul J. Bartos
Tel: (303) 273-3823
e-mail:pbartos@mines.edu
Website: www.mines.edu/academic/ geology/museum
Golden, Colorado 80401
Hours: 9–4 M–Sat., 1–4 Sun. (closed on school holidays & Sundays in the summer)
Specialties: Worldwide minerals; Colorado mining & minerals

A. E. Seaman Mineral Museum
Website: www.museum.mtu.edu
Curator & Professor of Mineralogy:
Dr. George W. Robinson
e-mail: robinson@mtu.edu
Tel: 906-487-2572; Fax: 906-487-3027
Electrical Energy Resources Center
Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295
Summer Hrs (July-Sept.): M–F: 9–4:30, S–S: 12–5
Winter Hrs (Oct–June): M–F: 9–4:30
*Closed Mondays: Nov–Mar.
Specialty: Michigan minerals, Lake Superior region & Midwest U.S. minerals

Houston Museum of Natural Science
Curator (mineralogy): Joel Bartsch
Tel: (713) 639-4673
Fax: (713) 523-4125
1 Herman Circle Drive
Houston, Texas 77030
Hours: 9–6 M–Sat., 12–6 Sun.
Specialty: Finest or near-finest known specimens

Natural History Museum of Los Angeles County
Fax: (213) 749-4107
Website: http://nhm.org/minsci
Curator (Mineral Sciences):
Dr. Anthony R. Kampf
Tel: (213) 763-3328
e-mail: akampf@nhm.org
Collections Manager:
Dorothy L. Ettensohn
Tel: (213) 763-3327
e-mail: dettenso@nhm.org
900 Exposition Blvd.
Los Angeles, CA 90007
Hours: 9:30–5:00 Daily
Specialties: Calif. & worldwide minerals, gold, gem crystals, colored gemstones
Support organization:
The Gem and Mineral Council

Additional listings welcome!
Send vital information, as shown, to the editor. There is a modest annual fee (lower than our regular advertising rates).

Museums listed alphabetically by city

THE MUSEUM DIRECTORY

W. M. Keck Earth Science & Engineering Museum

Administrator: Rachel A. Dolbier
Tel: 775-784-4528, Fax: 775-784-1766
E-mail: rdolbier@unr.edu
Website: http://mines.unr/edu/museum
Mackay School of Earth Science & Engineering
University of Nevada, **Reno** 89557
Hours: 9–4 Mon.–Fri. (closed university holidays) and by appointment
Specialty: Comstock ores, worldwide minerals, mining artifacts, Mackay silver

Arizona Mining & Mineral Museum

Department Director: Doug Sawyer
Curator: Sue Celestian
Tel: (602) 255-3795
1502 W. Washington Avenue
Phoenix, AZ 85007
Hours: 8–5 M–F, 11–4 Sat., closed Sun. & holidays
Specialty: Arizona minerals

Matilda and Karl Pfeiffer Foundation Museum

Executive Director: Anne Winchester
Tel: (870) 598-3228
E-Mail: execdir@ pfeifferfoundation.org
P.O. Box 66
1071 Heritage Park Drive
Piggott, AR 72454
Hours: 9–4 Thurs.–Sat., 9–5 Thurs.–Sat. (Daylight Savings Time)
Specialties: Fine collection of geodes from Keokuk, Iowa, area; worldwide collection of minerals

Carnegie Museum of Natural History

Collection Manager: Marc L. Wilson
Tel: (412) 622-3391
4400 Forbes Avenue
Pittsburgh, PA 15213
Hours: 10–5 Tues.–Sat., 10–9 F, 1–5 Sun., closed Mon. & holidays
Specialty: Worldwide minerals & gems

New Mexico Bureau of Mines & Mineral Resources—Mineral Museum

Director: Dr. Virgil W. Lueth
Tel: (505) 835-5140
E-Mail: vwlueth@nmt.edu
Fax: (505) 835-6333
Associate Curator: Robert Eveleth
Tel: (505) 835-5325
E-mail: beveleth@gis.nmt.edu
New Mexico Tech,
801 Leroy Place
Socorro, NM 87801
Hours: 8–5 M–F, 10–3 Sat., Sun
Specialties: New Mexico minerals, mining artifacts, worldwide minerals

Arizona-Sonora Desert Museum

Fax: (520) 883-2500
Website: http://www.desertmuseum.org
Curator, Mineralogy: Anna M. Domitrovic
Tel: (520) 883-3033
E-mail: adomitrovic@desertmuseum.org
2021 N. Kinney Road
Tucson, AZ 85743-8918
Hours: 8:30-5 Daily (Oct.-Feb.)
7:30-5 Daily (Mar.-Sept.)
Specialty: Arizona minerals

Pacific Museum of the Earth

Curator: Kirsten Parker
Tel: (604) 822-6992
E-mail: kparker@ubc.ca
Dept. of Earth and Ocean Sciences
Univ. of British Columbia
6339 Stores Rd.
Vancouver, BC, Canada V6T 1Z4
Hours: 9–4, M–F
Specialties: BC–Yukon–Pacific NW, Worldwide Gold & Silver

U.S. National Museum of Natural History (Smithsonian Institution)

Curator: Dr. Jeffrey E. Post
e-mail: minerals@nmnh.si.edu
Collection Managers: Paul Pohwat and Russell Feather
(Dept. of Mineral Sciences)
Washington, DC 20560-0119
Hours: 10 am–5:30 pm daily
Specialties: Worldwide minerals, gems, research specimens

William Weinman Mineral Museum

Website: www.weinmanmuseum.org
Director and Curator: Jose Santamaria
Tel: (770) 386-0576 x 401
Fax: (770) 386-0600
51 Mineral Museum Dr.
White, GA 30184
Mailing Address:
P.O. Box 3663
White, GA 30184
Hours: 10–4:30 Tues.–Sat., 2–4:30 Sun.
Specialty: Georgia & worldwide minerals & fossils

University of Delaware Mineralogical Museum

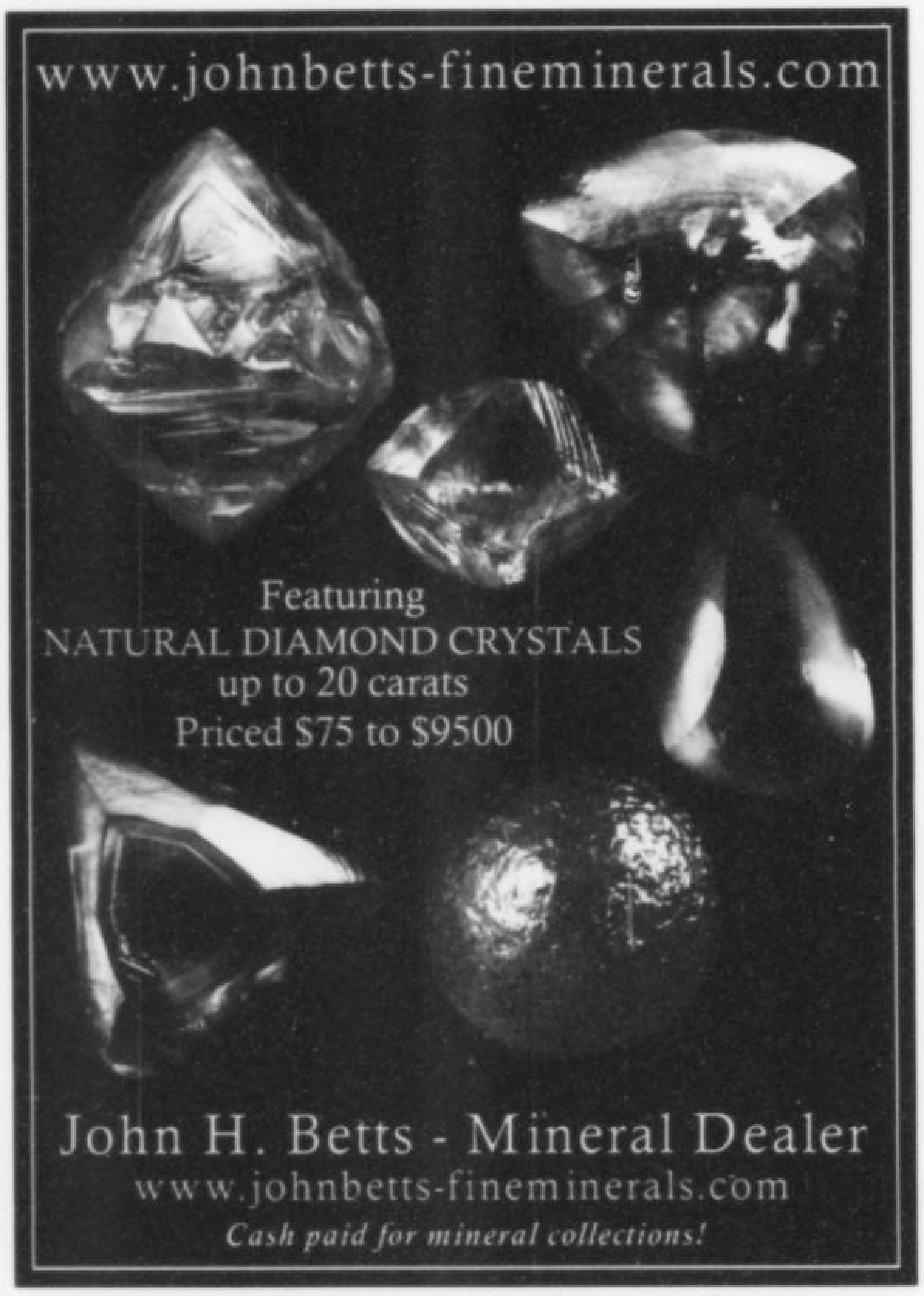
Penny Hall,
Newark, DE 19716
University of Delaware
For directions, hours, contacts and a virtual tour see
www.museums.udel.edu/mineral
Specialty: Worldwide Classic & New Minerals

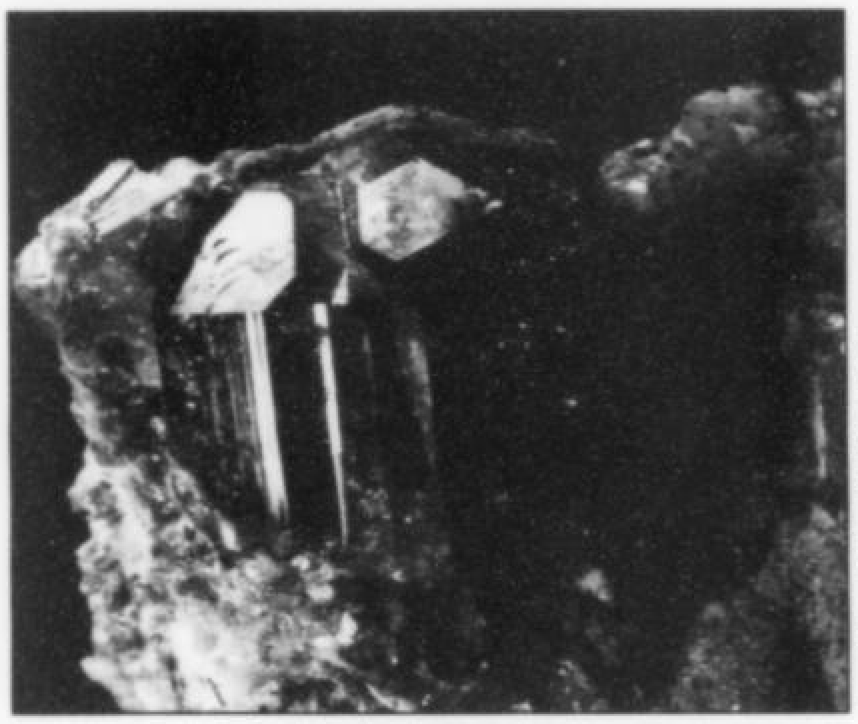
Museo Civico di Storia Naturale

Curator: Dr. Federico Pezzotta
Tel: +39 02 8846 3326
Fax: +39 02 8846 3281
E-Mail: fpezzotta@yahoo.com
Associate Curator: Alessandro Guastoni
Department of Mineralogy and Petrography
Corso Venezia, 55
I-20121 **Milano,** Italy
Hours: 9 am–6 pm daily
Specialties: Italian minerals, pegmatite minerals

Gargoti Mineral Museum

Director: K. C. Pandey
Tel: ++91 2551 230528
Fax: ++91 2551 230866
D-59 MIDC, Malegaon, **Sinnar**, Nashik 422 103 India
Specialty: Minerals of India





Apatite—King Lithia mine

Epidote - Knappenwand © Fabre Minerals

THE MINERALOGICAL RECORD LABEL ARCHIVE

Wendell E. Wilson
Mineralogical Record
4631 Paseo Tubutama
Tucson, Arizona 85750
minrec@comcast.net

The Mineralogical Record Label Archive is a collection of original, primarily pre-printed, mineral specimen labels representing mineral collections and dealerships worldwide during the last two centuries. With the possible exception of holdings in some of the great museums, it is the largest such collection in the world, with over 6,000 examples cataloged.

HISTORY

What is today the Mineralogical Record Label Archive was informally begun by Peter Zodac (1894–1967), founder of *Rocks & Minerals* magazine. Lawrence Conklin had purchased the contents of Zodac's three-story house in Peekskill, New York in 1967, and found that Zodac had saved thousands of old specimen labels in boxes, many probably dating from the 1920's to the 1950's. It might be a stretch to call these a "collection," totally unorganized as they were, but Zodac may well have been the first person to consciously recognize the historical interest value inherent in these little slips of paper—the Father of Mineral Label Collecting, as it were.

The first label collection to be formally initiated and pursued for its own sake was probably that of the well-known mineral collector and micromounter Neal Yedlin (1908–1977) in the 1960's. Yedlin's label collection was inherited upon his death by fellow historian Ronald E. Bentley (1948–1995), who some years before had been inspired to start his own collection as well. Bentley merged Yedlin's labels with his own extensive holdings, and wrote a number of installments of his "Historical Record" column specifically on label collecting in order to make the general mineral-collecting community more aware of the importance and significance of old labels. His efforts no doubt prevented many interesting labels from being thrown away. Ron Bentley died of AIDS at the young age of 47, and bequeathed his and Yedlin's label collections (over 2,600 examples, not counting duplicates) to the Mineralogical Record Library in 1995.

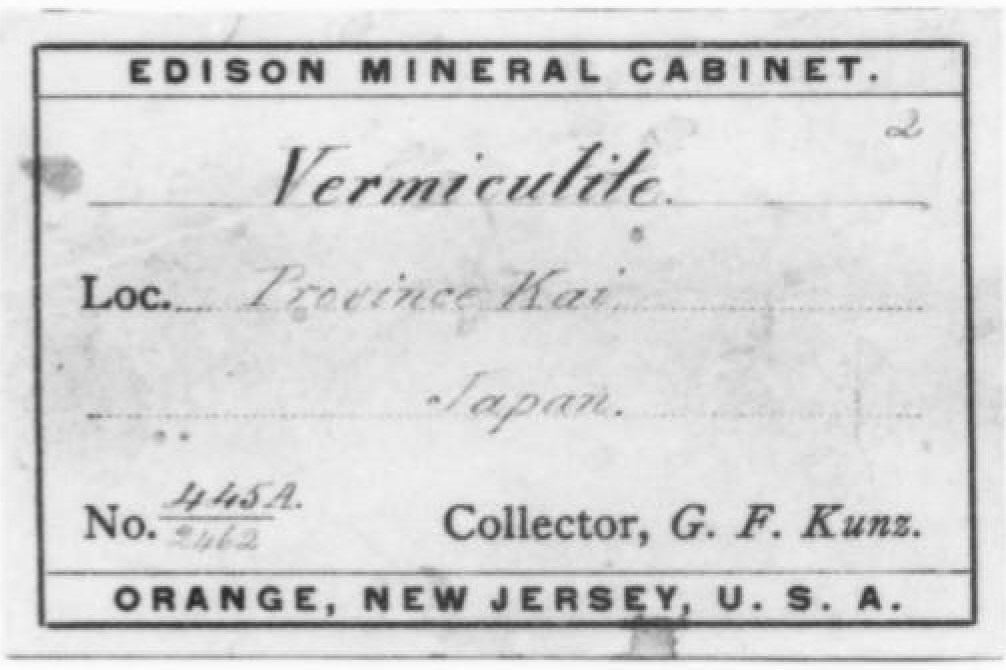
Yet another major private label collection was assembled by mineralogist, mineral collector and part-time mineral dealer Richard A. Bideaux (1935–2004), bit by bit over the years. Upon comparing their collections, Bideaux and Conklin realized that there was very little overlap or duplication. Conklin declared that the Zodac labels and Bideaux's label collection really should be combined, and offered to decide the issue by an all-or-nothing flip of the coin! According to Conklin, Bideaux blanched at the idea and didn't want to gamble with a collection he had so laboriously assembled. But over the next few years Bideaux traded minerals to Conklin for labels and eventually acquired the entire Conklin/Zodac label collection. Dick Bideaux passed away recently and, like Ron Bentley, graciously bequeathed this entire combined collection of over 3,500 labels to the Mineralogical Record Library. Dick believed the M.R. Library to be the only sensible choice as the ultimate repository for such a historically significant collection—especially since the Bentley/Yedlin collection was already here.

Other collectors, dealers and curators have also graciously donated labels or whole collections of labels (though none as large) to the Mineralogical Record Library, to become part of the Archive. These include **William Borden**, **Diederik Visser**, **Thomas M. Gressman**, **Martin Zinn III**, **Andy Seibel**, **Jordi Fabre**, **Gerhard Niedermayr** of the Vienna Natural History Museum, **Marc Wilson** of the Carnegie Mineralogical Museum, and **Carl Francis** of the Harvard Mineralogical Museum.

No 15

Argent natif en filon avec face de glissement sur une roche altérée "Mine Charcas Mexique"

Comptoir Géologique & Minéralogique
ALEXANDRE STUER
PARIS

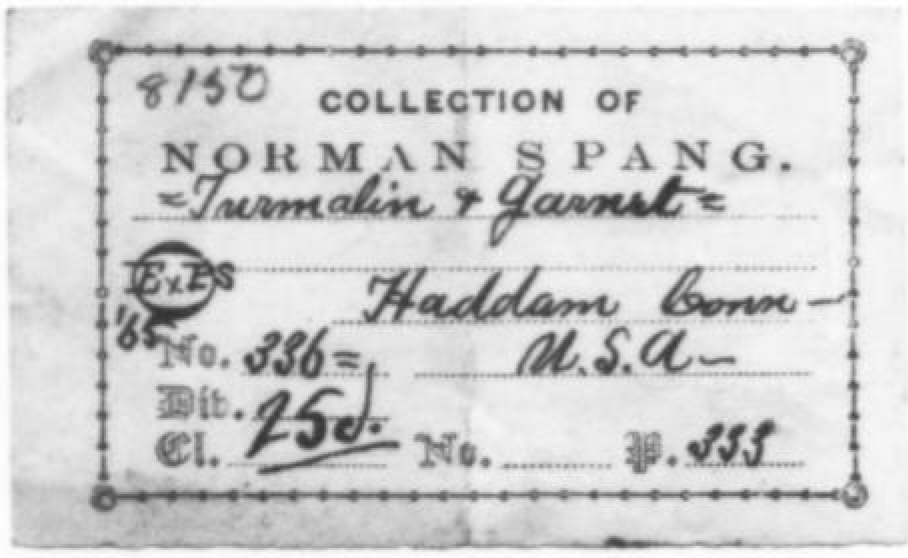


EDISON MINERAL CABINET.
2
Vermiculite
Loc. Province Kai
Japan.
No. 445A. 2462 Collector, G. F. Kunz.
ORANGE, NEW JERSEY, U. S. A.

Figure 2. **A label from the mineral collection of American inventor Thomas Alva Edison (1847–1931), assembled for him by George F. Kunz (1856–1932). It was kept for many years at his research facility in Orange, New Jersey.**

Figure 1. **Perhaps the most artistic of all mineral labels is the one shown here, produced by the prominent Parisian mineral dealer Alexandre Stuer. This particular label is for a specimen of native silver from Charcas, Mexico—unfortunately now lost.**

E. B. BENJAMIN,
Importer of Fine Chemicals,
Spinel & Chondrodite
Loc. Amity N.Y.
No. 10 BARCLAY STREET,
15 NEW YORK.



8150 COLLECTION OF
NORMAN SPANG.
=Turmalin & Garnet=
ExES '65
Haddam Conn–
No. 336= U.S.A–
Dit.
Cl. 25d. No. P. 333

Figure 3. **A label from the mineral collection of Norman Spang (born 1842) of Etna, Allegheny County, Pennsylvania. The mineral *spangolite* was named in his honor, since he supplied the first specimens. In 1877 he sold his large collection to Clarence Bement for $22,000.**

Figure 4. **A label from the chemical supply house of Edmund Burke Benjamin (1828–1894) in New York; his stock included mineral specimens and fossils , according to his 266-page catalog of 1872.**

MINERALIEN- SAMMLUNG
S. kais. kön. Hoheit des
ERZHERZOGS STEPHAN.
№ 425 3 Amalgam
Fundort Moschellandsberg

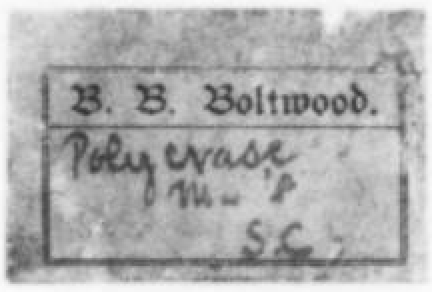
Figure 5. **Surely the most elegant of all mineral labels is that of Austrian Archduke Stephan Franz Viktor von Hapsburg-Lothringen (1817–1867), who assembled a collection of over 20,000 specimens, most of which are now in the collection of Humboldt University in Berlin.**

Some examples from the archive are reproduced here, all of them shown actual size. The selection is somewhat heavy on the "B" collectors (Bement, Benjamin, Blake, Bernstein, etc.) simply because that's the portion of the alphabetized holdings that we're researching at present.

THE ONLINE LABEL ARCHIVE PROJECT

The history of mineral collecting, especially by private individuals, is fragmented and scattered. The M.R. Label Archive constitutes a unique historical documentation of mineral collecting and dealing over the last two centuries; in fact, some labels are the only surviving evidence that a particular person was a mineral collector or dealer. Preserving these unique and fragile items is of utmost importance, of course, but we would also like to see the archive actively serve the collecting community as a resource, rather than being buried away in the deep, dark, subterranean vaults of the Mineralogical Record Library.

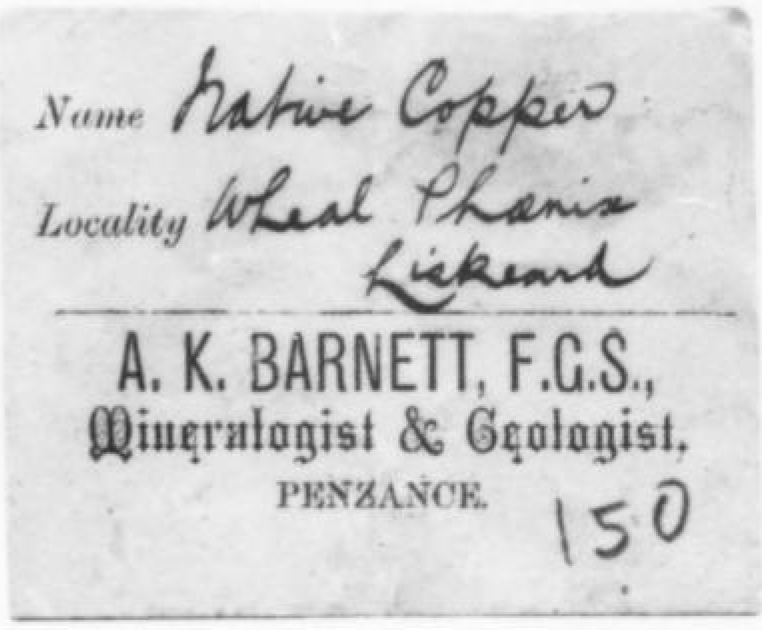
Therefore, in order to begin making the contents of the Archive more widely available, we have undertaken the tedious task of scanning all of the labels and posting the label images on our website, www.MineralogicalRecord.com, as an interesting databank



B. B. Boltwood.

Polycrase
M-'P
S.C.

Figure 6. **Perhaps the only surviving label from the mineral collection of Bertram Borden Boltwood (1870–1927), after whom *boltwoodite* was named. He was a radiochemist at Yale University and the inventor of the U/Th isotopic age dating method.**



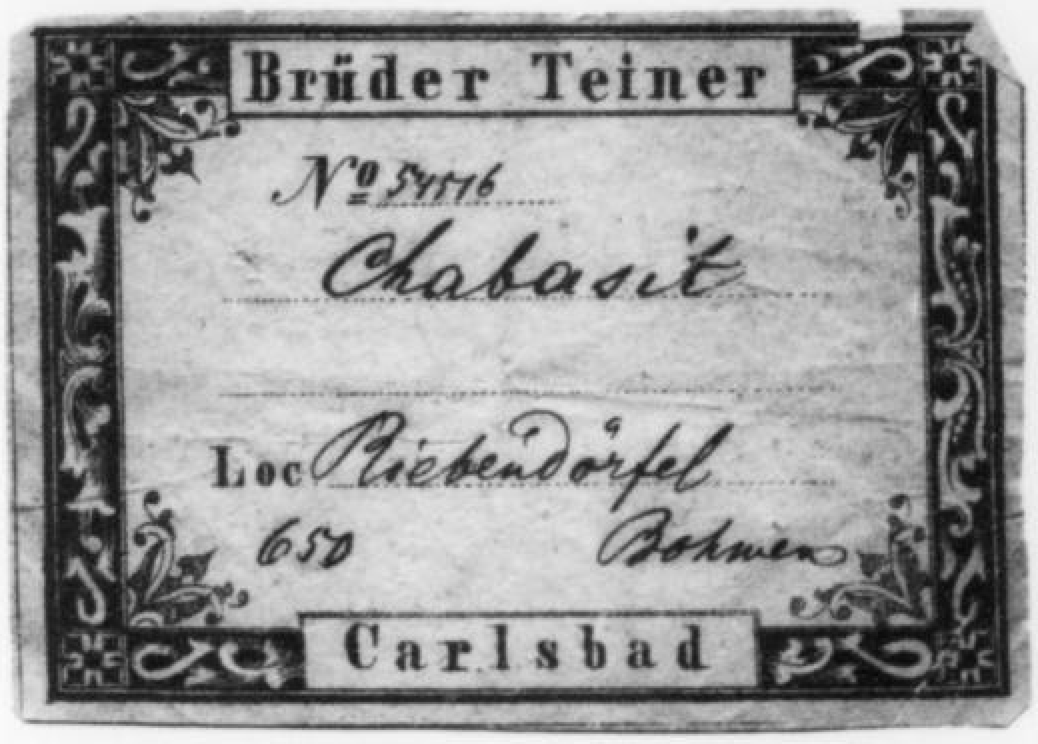
Name Native Copper

Locality Wheal Phoenix
Liskeard

A. K. BARNETT, F.G.S.,
Mineralogist & Geologist,
PENZANCE.

150

Figure 7. **A label from the Cornish mineral dealer Andrew Ketcham Barnett (1852–1914). He was Principal of the Mining and Science School of Penzance, Cornwall, and Mayor of the town of Penzance; he was active as a dealer in Cornish mineral specimens at least from 1876 to 1887.**



Brüder Teiner

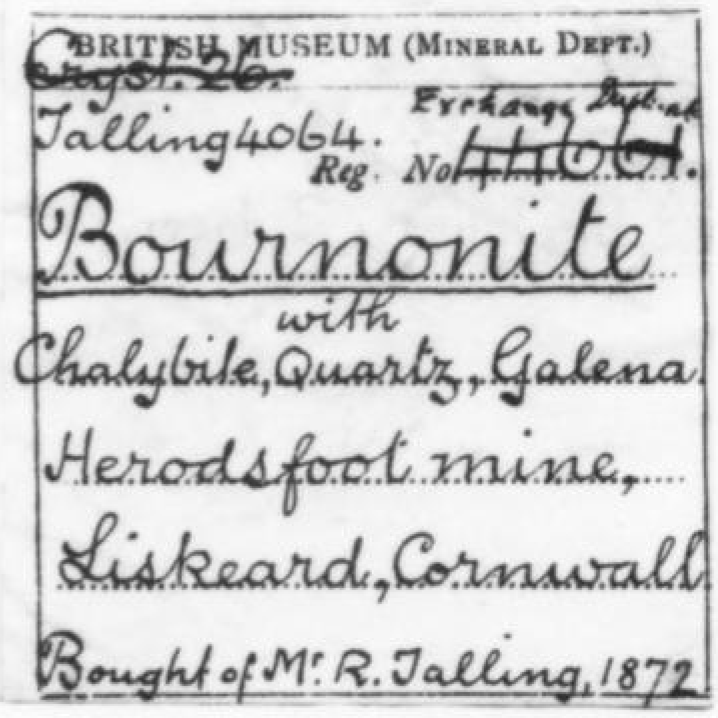
No 54516

Chabasit

Loc Riebendörfel
650 Böhmen

Carlsbad

Figure 8. **An ornate, 19th-century label of Brüder (="Brother") Teiner from Carlsbad, Germany. Nothing more is known about him.**



~~Augst. 26.~~ BRITISH MUSEUM (MINERAL DEPT.)

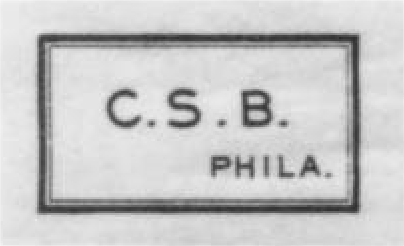
Exchange Dept. at

Talling 4064. Reg. No [illegible]

Bournonite
with
Chalybite, Quartz, Galena
Herodsfoot mine,
Liskeard, Cornwall

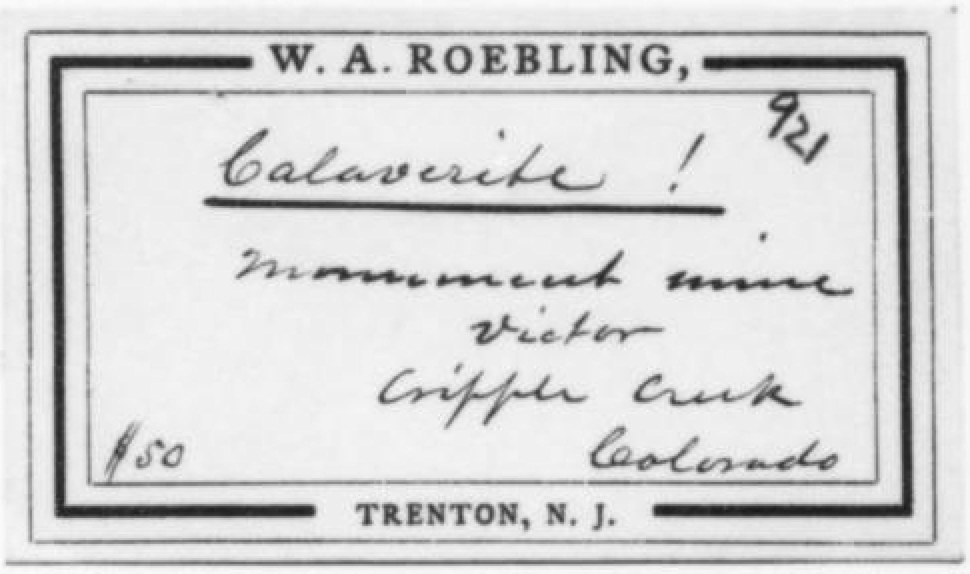
Bought of Mr. R. Talling, 1872

Figure 9. **An old British Museum label for a bournonite specimen from the Herodsfoot mine, Liskeard, Cornwall, indicating that it was purchased in 1872 from the greatest Cornish mineral dealer of all time, Richard Talling (1820–1883). He started in business in or around 1844, and was the chief source of the now-classic Cornish bournonite specimens.**



C.S.B.
PHILA.

Figure 10. **A mini-label (gummed, perhaps meant to be affixed to dealer labels for specimens he purchased) from the collection of Clarence Sweet Bement (1843–1923), perhaps the single greatest mineral collector in American history. His collection of over 12,000 specimens was remarkable for uniformly high quality; it was purchased for the American Museum of Natural History by financier J. P. Morgan in 1900.**



W. A. ROEBLING,

Calaverite ! 921

monument mine
Victor
Cripple Creek
$50 Colorado

TRENTON, N. J.

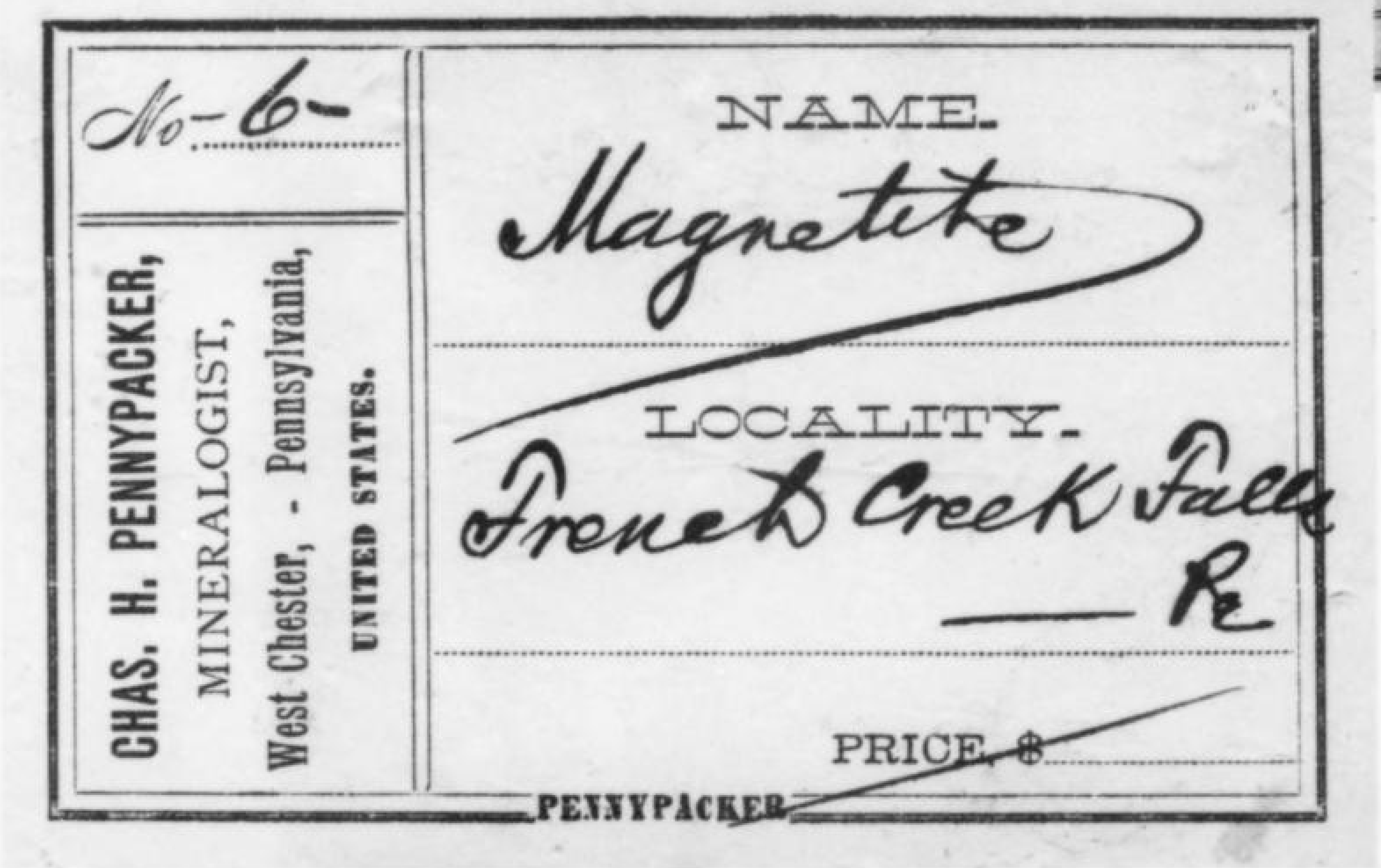
Figure 11. **A label from the collection of Washington Augustus Roebling (1837–1926), famous as the architect of the Brooklyn Bridge and one of the greatest mineral collectors in American history. His collection of 16,000 specimens is now in the Smithsonian Institution.**

Berliner Mineralien-Comtoir
von
3750 C. F. PECH 30
$ 450
Name Klinochlor 9

Fundort Achmatowsk
2996

BERLIN, W.
Charlotten-Strasse 36.

Figure 12. **A label from the prominent Berlin mineral dealer C[hristian?]. F[riederich?]. Pech, who supplied fine specimens to Clarence Bement in the 1870's. Pech's labels show a succession of three different addresses in Berlin over the years, but the sequence and dates are unknown.**



No -6-

CHAS. H. PENNYPACKER,
MINERALOGIST,
West Chester, - Pennsylvania,
UNITED STATES.

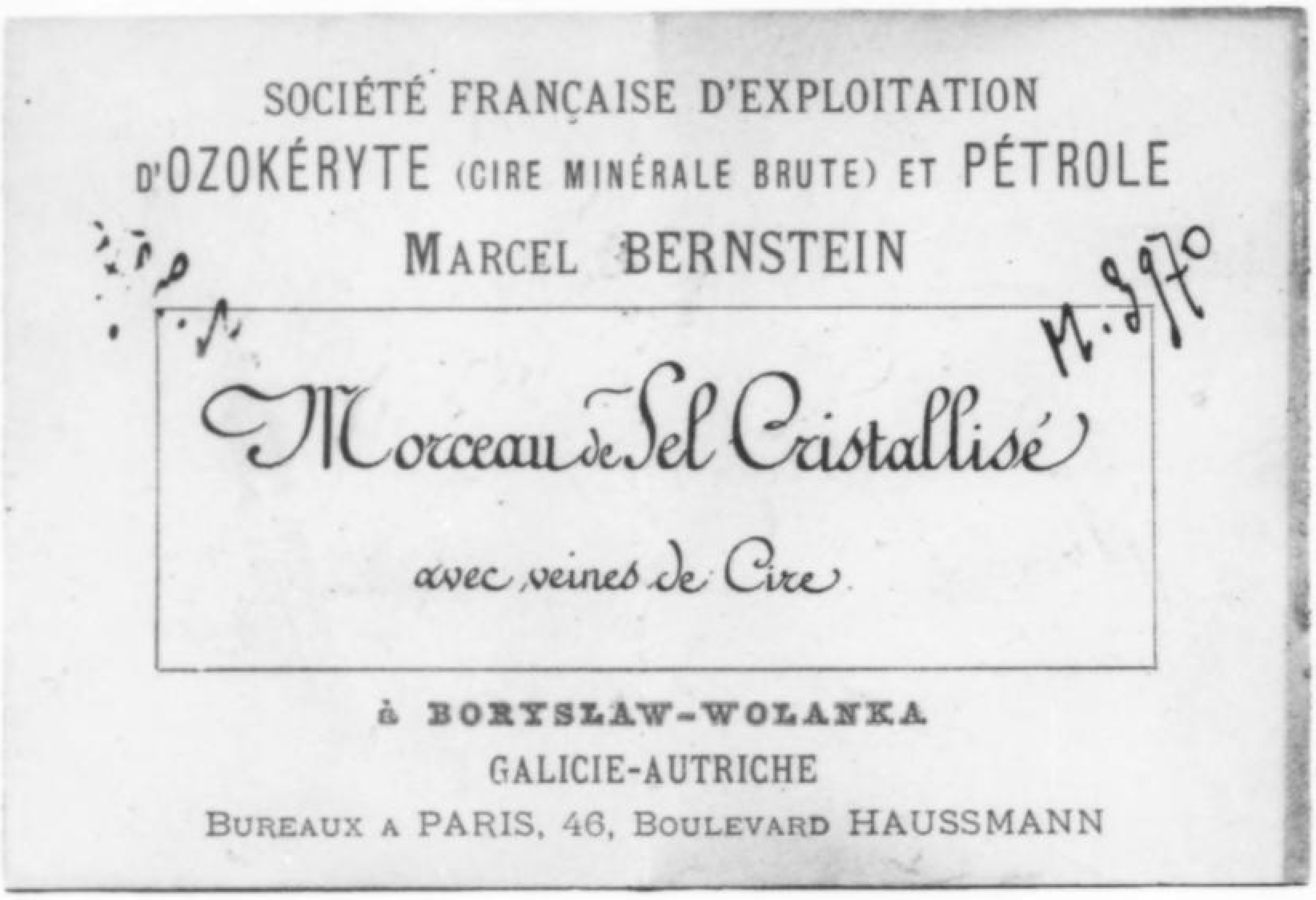
NAME.
Magnetite

LOCALITY.
French Creek Falls
— Pa

~~PRICE, $~~

PENNYPACKER

Figure 13. **A large label from the collection of Pennsylvania mineral collector and part-time dealer Charles H. Pennypacker (1845–1911). A lawyer by profession, he dealt in minerals for fun, and published numerous ads and articles in *The Mineral Collector.* He sold his collection to Henry Garrett, who had died by 1923 and dispersed his collection through a dealer.**



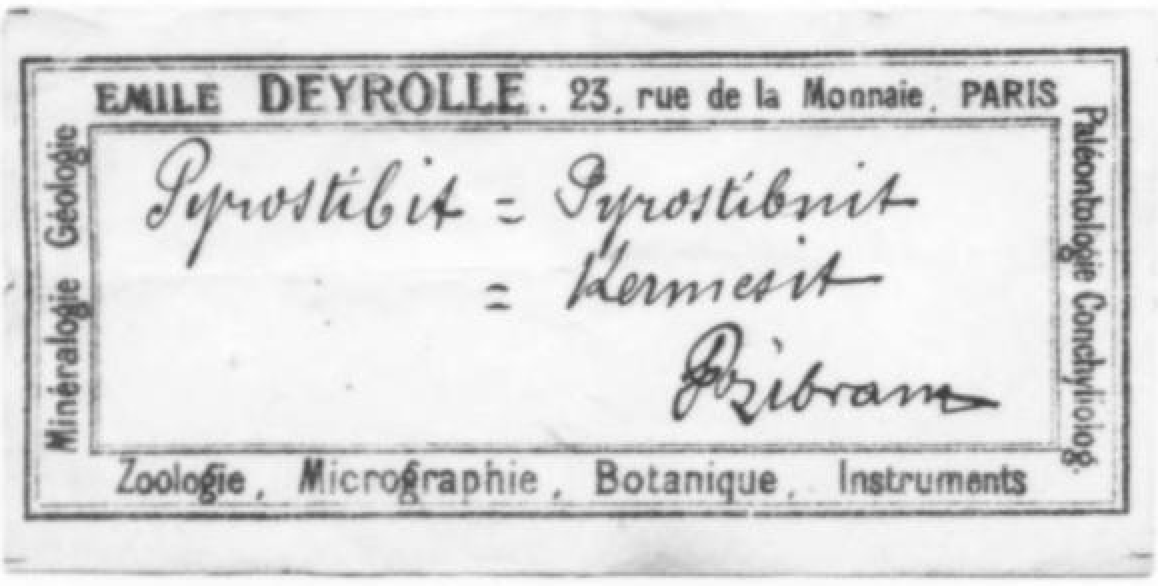
SOCIÉTÉ FRANÇAISE D'EXPLOITATION
D'OZOKÉRYTE (CIRE MINÉRALE BRUTE) ET PÉTROLE
MARCEL BERNSTEIN

N. 8970

Morceau de Sel Cristallisé
avec veines de Cire.

à BORYSLAW-WOLANKA
GALICIE-AUTRICHE
BUREAUX A PARIS, 46, BOULEVARD HAUSSMANN

Figure 14. **A large and complex label for a "specimen of crystallized salt [halite]." The collector is Marcel Bernstein of the French Society for the Exploitation of Hydrocarbons and Petroleum, headquartered in Boryslaw-Wolanka, Galicia, Austria, but with an office in Paris where Bernstein worked. Bernstein was a prominent art collector as well, a friend of the artist Édouard Manet, and father of French playwright Henry Bernstein (1876–1953).**



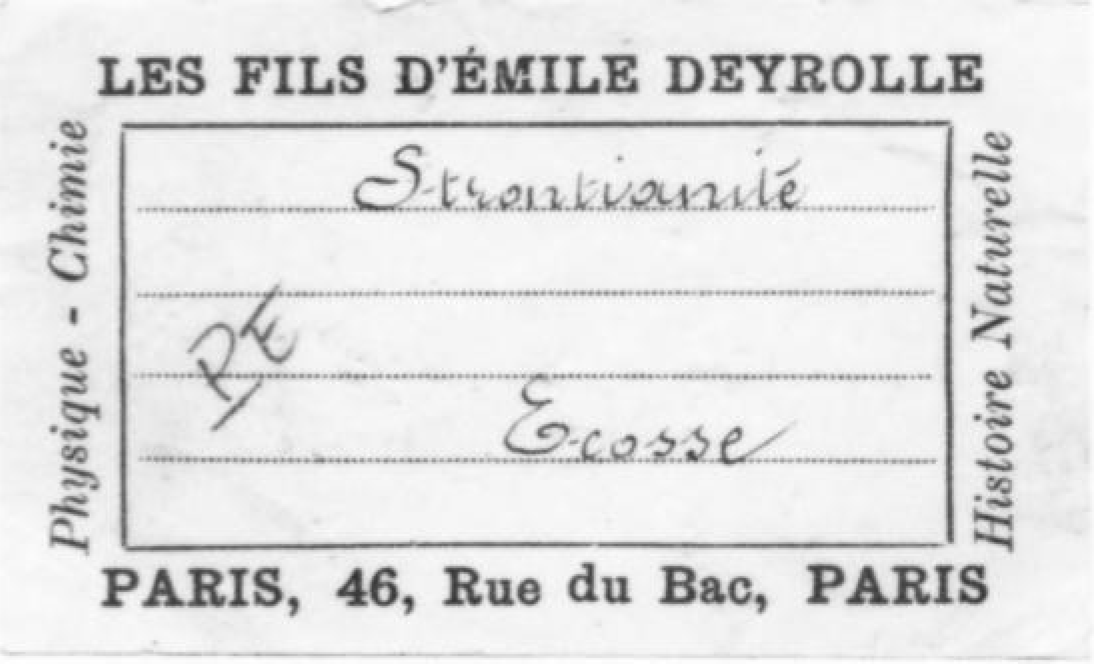
EMILE DEYROLLE. 23, rue de la Monnaie, PARIS

Minéralogie Géologie

Paléontologie Conchyliolog.

Pyrostibit = Pyrostibnit
= Kermesit
Přibram

Zoologie, Micrographie, Botanique, Instruments



LES FILS D'ÉMILE DEYROLLE

Physique - Chimie

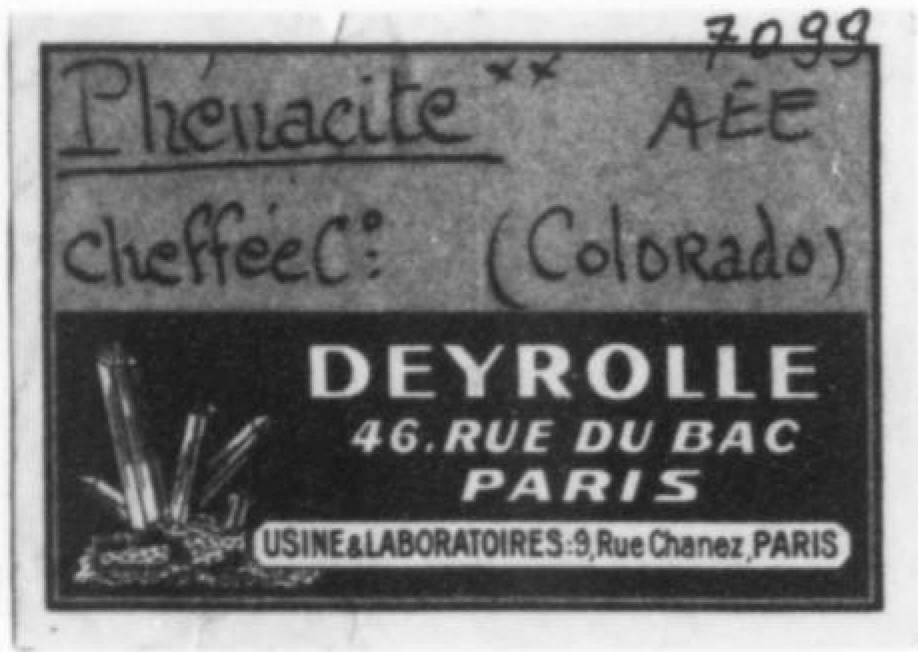
Histoire Naturelle

Strontianite

RE

Ecosse

PARIS, 46, Rue du Bac, PARIS



7099

Phénacite ** AÉE
Cheffee C° (Colorado)

DEYROLLE
46, RUE DU BAC
PARIS
USINE & LABORATOIRES: 9, Rue Chanez, PARIS

Figure 15. **Three labels including an attractive two-color label from the 19th-century Paris dealer Émile Deyrolle. His rarest labels show the original address where he first opened for business in 1831: 23, rue de la Monnaie; all the rest show 46, rue du Bac, where the company has done business since 1881 and still operates today. He specialized in natural history publications and specimens (minerals, rocks, fossils, botanicals, shells), taxidermy, microscopic specimens and instruments. His sons ("Les Fils d'Émile Deyrolle") inherited the business.**

for collectors to browse through, and as an aid to those conducting historical research on mineral specimens, mineral collections, the histories of institutional collections, or the biographies of mineral collectors and dealers.

What makes this project even more monumental (as if the job of scanning and posting over 6,000 labels wasn't big enough!) is that in addition to the label images, we are also researching and providing biographical notes and background on every collector, dealer and institutional collection represented. This is a huge and truly encyclopedic undertaking, and it will take years to finish. But, rather than make everyone wait until it is fully completed, we are going to go online with it now in its partially completed state, and will be adding to it as time permits. We're starting at the beginning of the alphabet (with a few exceptions), and will be completing each letter before moving on to the next.

Also posted on the site is an interesting, previously unpublished introduction to mineral label collecting written by Dick Bideaux and Ron Bentley in 1981.

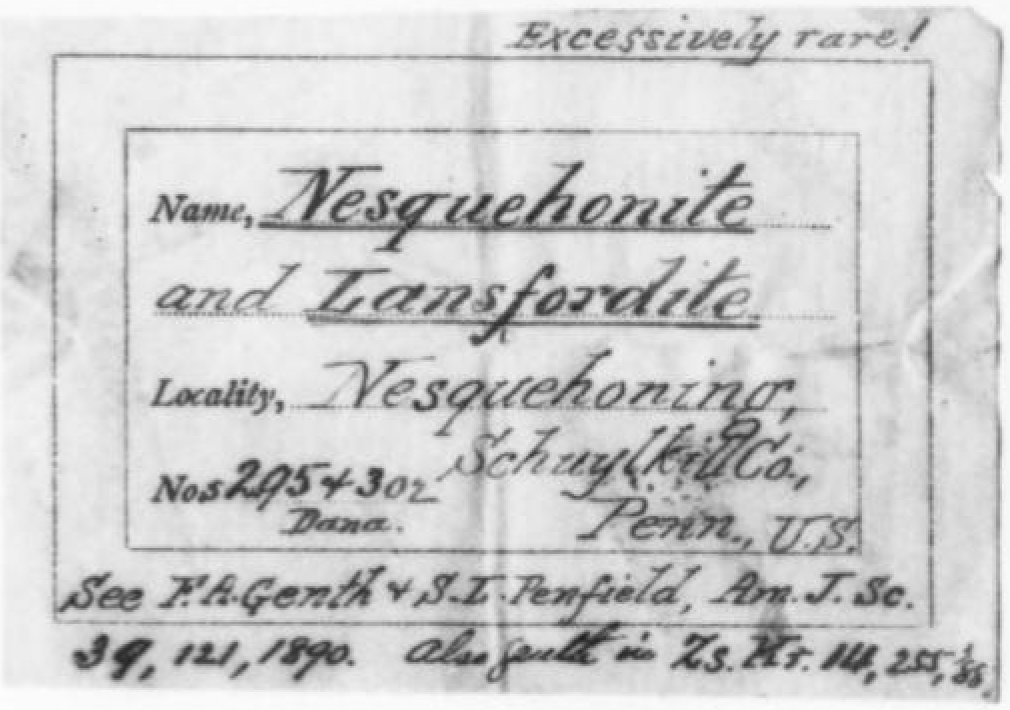
Readers Can Help Provide Information

The information we have on many of the collectors and dealers, and even some of the more obscure institutions, is scant, and we invite readers to contribute additional data they might possess from their own experience, or to point out published biographical sources we could draw on. Some biographical data have already been kindly contributed by Curtis Schuh and Mick Cooper from their extensive historical files. In fact, it might be kind of fun for readers, especially the more senior members of our fraternity, to read through the various names and biographical notes, such as they are, and reminisce about the old days. The deficiencies in our data will be obvious, and you can simply click on the e-mail link and send us a quick note about any of the people or companies that you remember. This project can, in a way, be everybody's project.

GROWING THE ARCHIVE

By Bequests and Donations

We hope that in the future the Label Archive will continue to grow. First of all, we ask that today's active label collectors consider


Excessively rare!

Name, Nesquehonite and Lansfordite.

Locality, Nesquehoning, Schuylkill Co., Penn., U.S.

Nos 295 + 302 Dana.

See F. A. Genth & S. L. Penfield, Am. J. Sc. 39, 121, 1890. also Genth in Zs. Kr. 14, 255, '88

Figure 16. **An original handwritten label from the collection of the American mineralogist and Professor of Mineralogy at Yale, George Jarvis Brush (1831–1912). Brush donated his collection of over 15,000 specimens to Yale. The mineral *brushite* was named in his honor.**

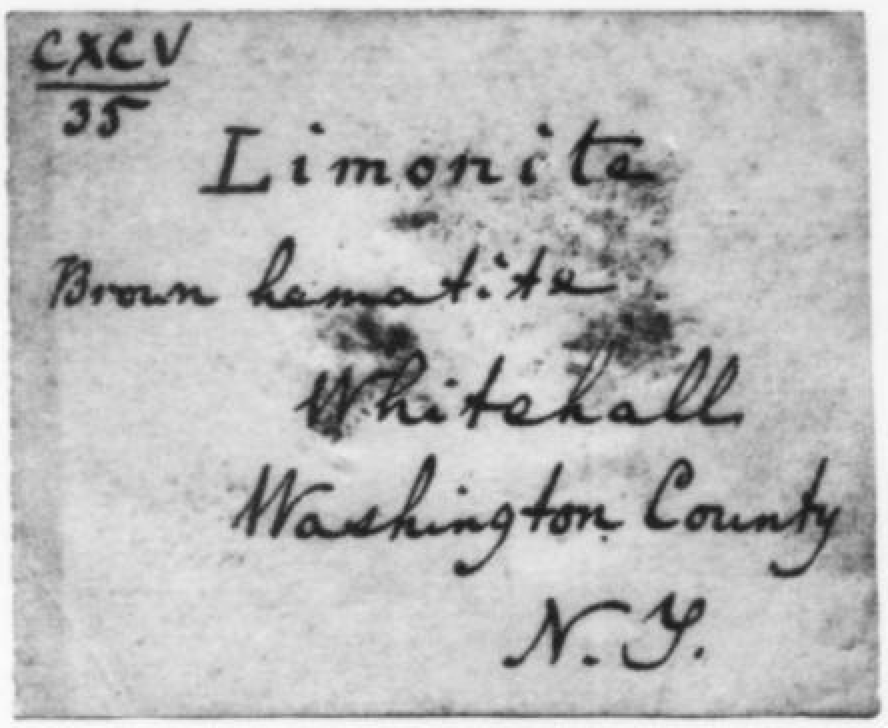

CXCV
35
Limonite
Brown hematite
Whitehall
Washington County
N.Y.

Figure 17. **An original handwritten label from the collection of Lewis C. Beck (1798–1853), an early New York State Geologist and author of *Mineralogy of New York* (1842); his collection later went to his alma mater, Rutgers College.**

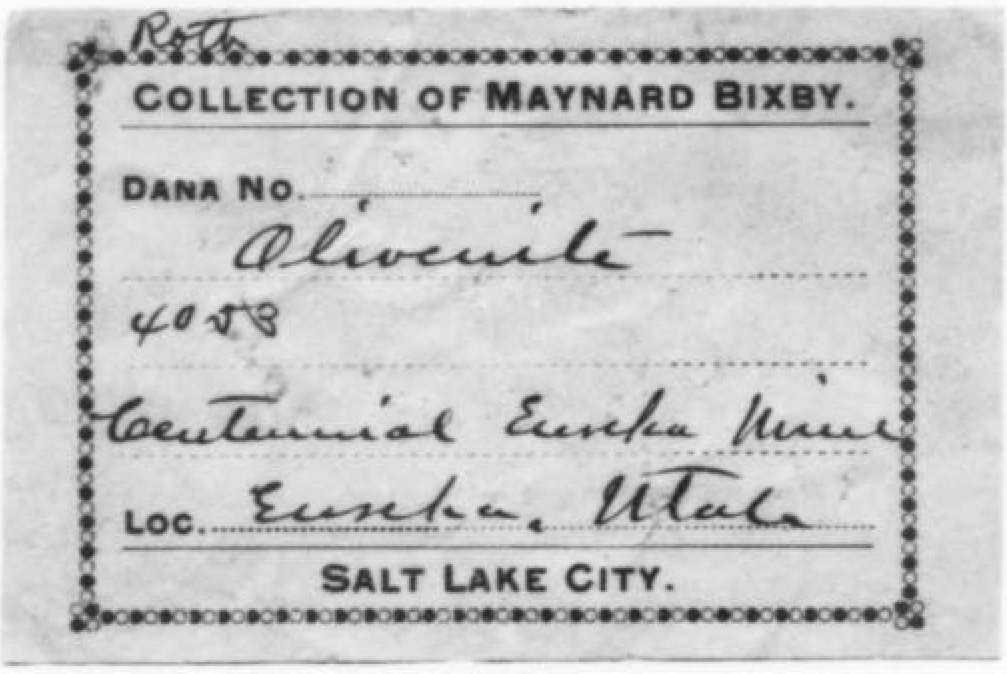

Rott
COLLECTION OF MAYNARD BIXBY.
DANA NO.
Olivenite
4058
Centennial Eureka Mine
LOC. Eureka, Utah
SALT LAKE CITY.

Figure 18. **A label from American mineral dealer, prospector and professional rockhound Maynard Bixby (1853–1935). He was born in Pennsylvania and maintained a rock shop in Salt Lake City from the 1890's through the 1920's. The mineral *bixbyite* is named in his honor.**

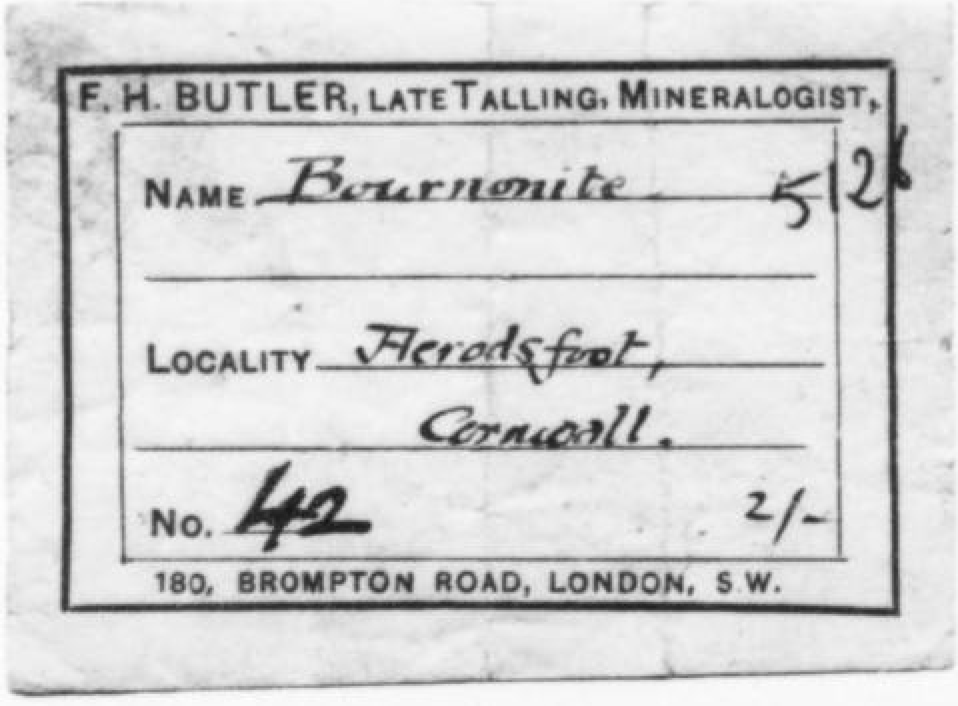

F. H. BUTLER, LATE TALLING, MINERALOGIST,
NAME Bournonite 5|26
LOCALITY Herodsfoot,
Cornwall.
NO. 42 2/-
180, BROMPTON ROAD, LONDON, S.W.

Figure 19. **A label from the London mineral dealer Dr. Francis Henry Butler (1849–1935), whose business was absorbed upon his death by the London firm of Gregory, Bottley & Company (today Gregory, Bottley & Lloyd).**


ÉMILE BERTRAND
Anatase transformée en rutile
(les cristaux brisés montrent
des petits prismes de rutile)
Décrit par Mr Damour.
Dans les sables diamantifères de
Pozzo alto près la rivière
de Parahuna Brésil
PARIS

Figure 20. **A label from the collection of the Parisian mineralogist and mining engineer, Émile Bertrand, after whom *bertrandite* was named.**

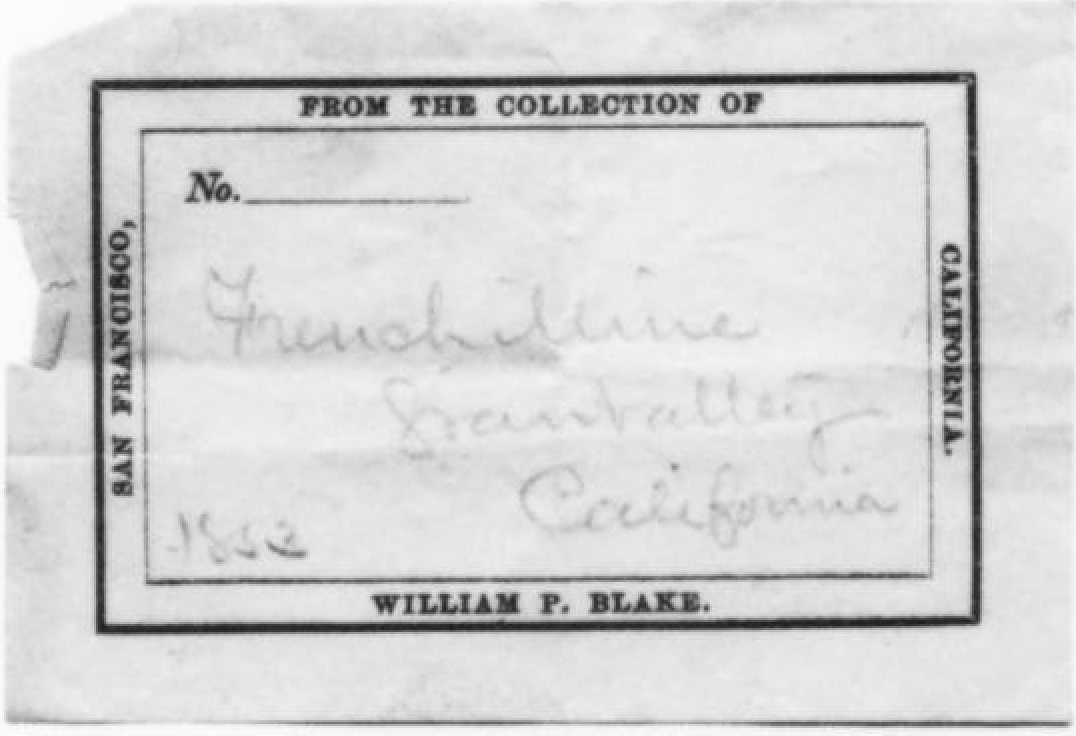
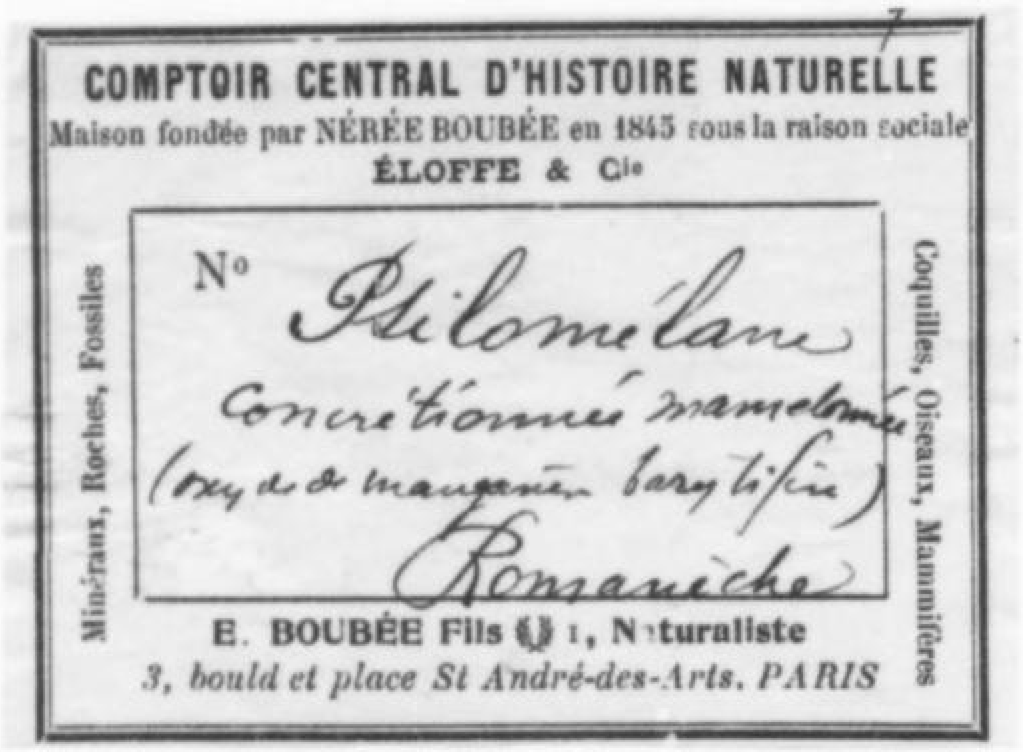

FROM THE COLLECTION OF
No.
French Mine
Grass Valley
California
1852
SAN FRANCISCO, CALIFORNIA.
WILLIAM P. BLAKE.

Figure 21. **A label, probably for a gold specimen, from the collection of William Phipps Blake (1825–1910), a prominent American geologist and mining engineer. He eventually became Arizona's first and only official Territorial Geologist.**

following the lead of Ron Bentley and Dick Bideaux, and arrange to donate their label collections to the Mineralogical Record, to be added to the Label Archive. What better place is there for your collection to go? And where else would it be shared with the mineral community, as it will be with the Online Label Archive Project? Each label posted will carry an indication of who donated it.

From Private Mineral Collectors

We also hope that collectors who have had personalized labels printed for their own mineral collections will send us examples. And, if you have a deceased collector friend whom you would like to see remembered, and you have one or more of his personal labels, be sure to send them to us so that we can include them. If



7

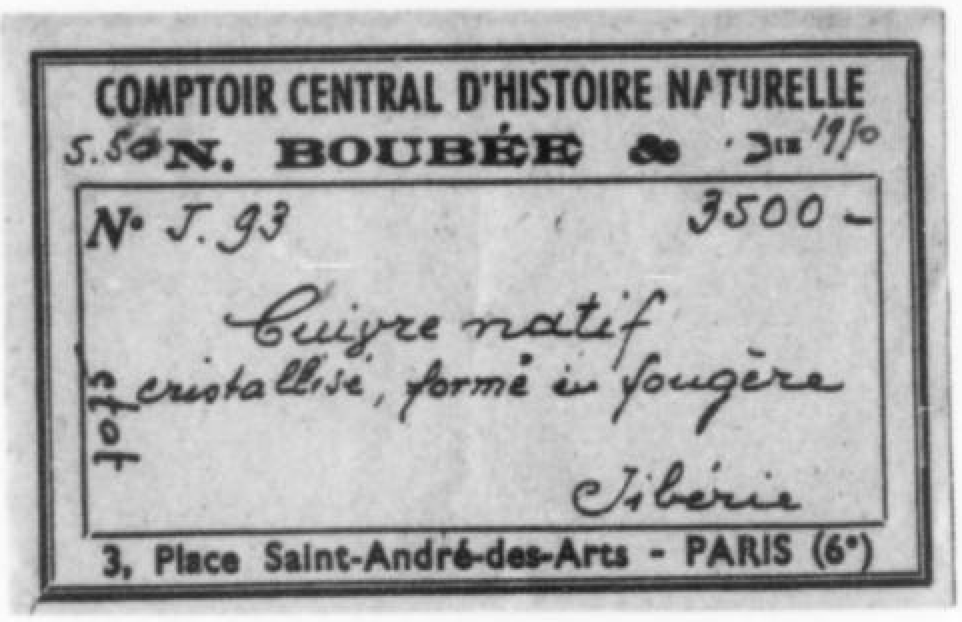
COMPTOIR CENTRAL D'HISTOIRE NATURELLE
Maison fondée par NÉRÉE BOUBÉE en 1845 sous la raison sociale
ÉLOFFE & Cie

Minéraux, Roches, Fossiles

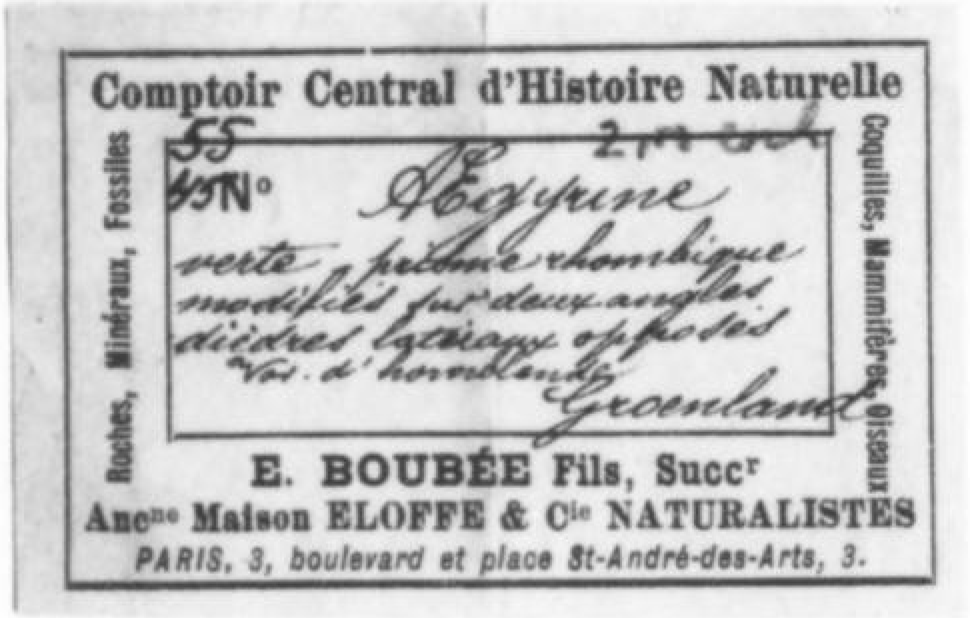
No Psilomélane
Concrétionnée mamelonnée
(oxyde de manganèse barytifère)
Romanèche

Coquilles, Oiseaux, Mammifères

E. BOUBÉE Fils [illegible], Naturaliste
3, bould et place St André-des-Arts, PARIS



COMPTOIR CENTRAL D'HISTOIRE NATURELLE
5.50 N. BOUBÉE & [illegible] 19/10
N° J. 93 3500 –
Cuivre natif
cristallisé, formé en fougère
Sibérie
3, Place Saint-André-des-Arts - PARIS (6e)



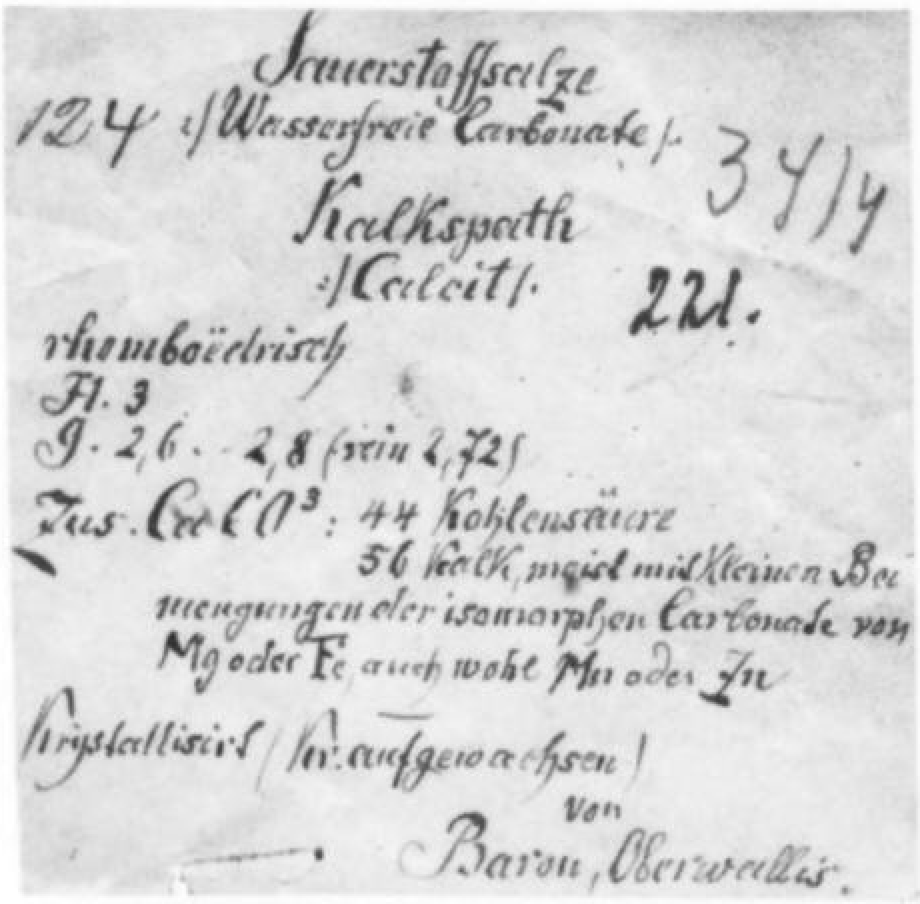
Comptoir Central d'Histoire Naturelle
~~55~~ ~~2 fr 50~~
45 No Aegyrine
verte – prisme rhombique
modifiés sur deux angles
dièdres latéraux opposés
Var. d'hornblende
Groenland

Roches, Minéraux, Fossiles

Coquilles, Mammifères, Oiseaux

E. BOUBÉE Fils, Succr
Ancne Maison ELOFFE & Cie NATURALISTES
PARIS, 3, boulevard et place St-André-des-Arts, 3.

Figure 22. **Labels from Boubée firms in Paris. The founder, Prof. Nérée Boubée (1806–1863), was a naturalist, geologist, author and teacher in Paris. He established the firm of Éloffe & Company in 1845, which later became the Comptoir Central d'Histoire Naturelle under his son, E. Boubée, also a naturalist. This firm was inherited by Nérée Boubée II, who expanded the science publishing portion of the business and died in the early 1960's.**



Sauerstoffsalze
124 (Wasserfreie Carbonate). 34/4
Kalkspath
(Calcit). 221.
rhomboëdrisch
H. 3
G. 2,6 .. 2,8 (rein 2,72)
Zus. $CaCO^3$: 44 Kohlensäure
56 Kalk, meist mit kleinen Bei-
mengungen der isomorphen Carbonate von
Mg oder Fe auch wohl Mn oder Zn
Krystallisirt (Kr. aufgewachsen)
von
Baron, Oberwallis.

Figure 23. **A handwritten label for a specimen of crystallized calcite from the collection of Baron von Oberwallis, now at Harvard.**

you wouldn't mind, please also include some brief biographical data such as birth year (and, if it's for a deceased friend, year of death), city, collecting history and details of your collection. In short, provide whatever information about yourself or your friend that you wouldn't mind having recorded in the annals of mineral collecting. Future historians will thank you.

From Label Collectors

Every collection can be improved by exchanging duplicates with others. And yes, we have many good duplicates available for exchange. The Yedlin/Bentley collection contained about 2,600 cataloged examples *plus* another *2,500 duplicates*, so we have plenty of material to trade. Label collectors interested in exchanging are invited to e-mail us at minrec@comcast.net with a list of their duplicates.

From Dealers

Are you now, or have you ever been, a dealer in mineral specimens? Why not obtain some free advertising of a sort and send us some of your labels? Yes, we do want labels from currently active dealers. Be sure to include at least a little biographical information, such as your birth year, the year you started in business, the year you retired, what city you operated from, and so on. It might be especially useful if you can provide a way to attach approximate dates or time periods to different styles of your labels, thus helping collectors of the future to date their specimens. If you are currently active we can list your mailing address, e-mail or website if you wish. People who own specimens (with labels) obtained from you will enjoy having a little background.

There is one more important area in which dealers can be of special assistance. Mineral dealers often acquire entire collections to resell, sometimes (but not always) after the death of the collector who originally built the collection. This may be the last chance that collector has to be recorded in the history of mineral collecting. Dealers will commonly have special labels made up that note in some way the name of the collector; this is an excellent idea. Even if that collector never had personalized labels of his own, a dealer label carrying the extra inscription "John Doe Collection" is a document attesting to the provenance of the specimens and the erstwhile existence of that collection. Unfortunately, little else is usually recorded, so we may later be unable to determine anything about the John Doe who built that collection. Therefore I would like to encourage dealers to send us examples of their labels that carry a special collection designation and provide us with at least a little background, such as the year the collector died and where he lived. This is most easily done while the collection is still in the process of being sold. Doing so not only commemorates the late collector, but also enriches the recorded history of the dealer.

From Curators

Needless to say, we hope that museum curators will also keep the Label Archive in mind, should they come across caches in storage of old labels no longer identifiable with particular specimens. The curators of a generation ago were often not cognizant of the historical value of retaining original labels on file and keyed to the specimens. Sometimes they would clear them out of the collection drawers in favor of fresh new museum labels, and pack the old ones away carelessly in a drawer or box. This practice already accounts for many of the labels now preserved in the Label Archive, rescued by Yedlin, Bentley and Bideaux.

By Purchase

Yedlin, Bentley, Bideaux and the other early label collectors made a point of not allowing dollar values to be set for old labels. They wanted to keep the hobby enjoyable and inexpensive. Nevertheless, especially interesting old labels have occasionally been sold on the open market and, if absolutely necessary, we may be interested in purchasing special labels or collections of labels when they become available.

CONCLUSIONS

The bottom line is that the Mineralogical Record is the *only* institution in the world that is specializing specifically in preserving the history of mineral collecting. We invite all readers to help us in this important task. Take a look at the posted archive now, and periodically in the future, to see how the project is progressing. Read through the names and the biographical notes and send us additional information or references that we can include. This can and should be a community-wide history-preservation project, to help assure that the mineral collecting, curating and dealing activities and accomplishments of our friends and predecessors are not forgotten.

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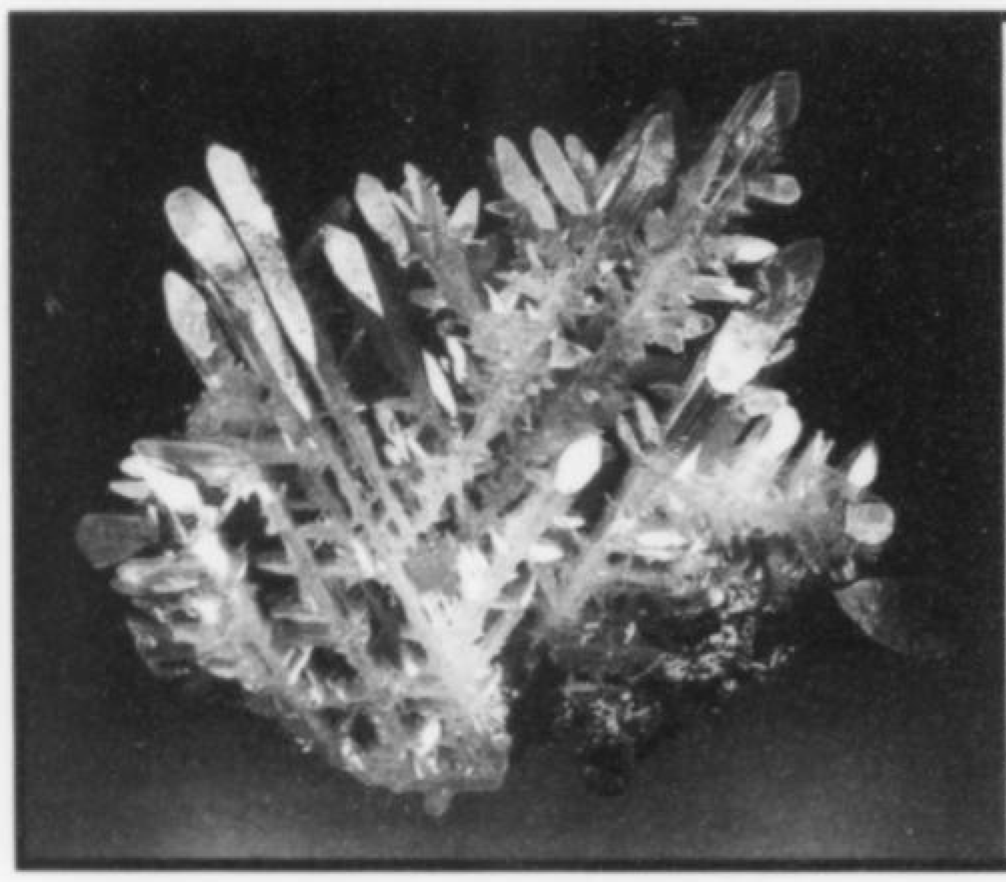
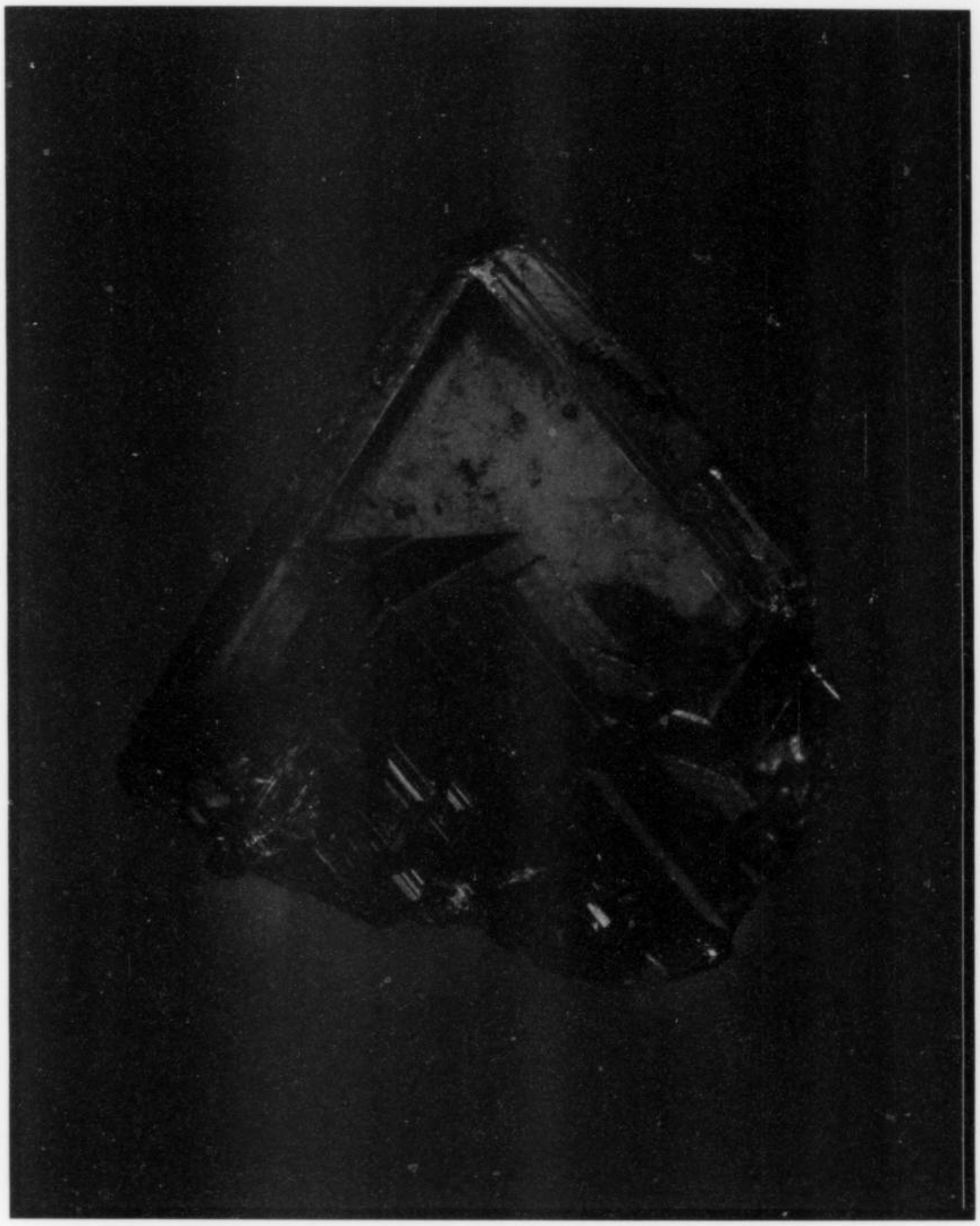
Lapis


Lapis


CERUSSITE, TSUMEB. JOHN SCHNEIDER PHOTO, EX SUSSMAN COLLECTION

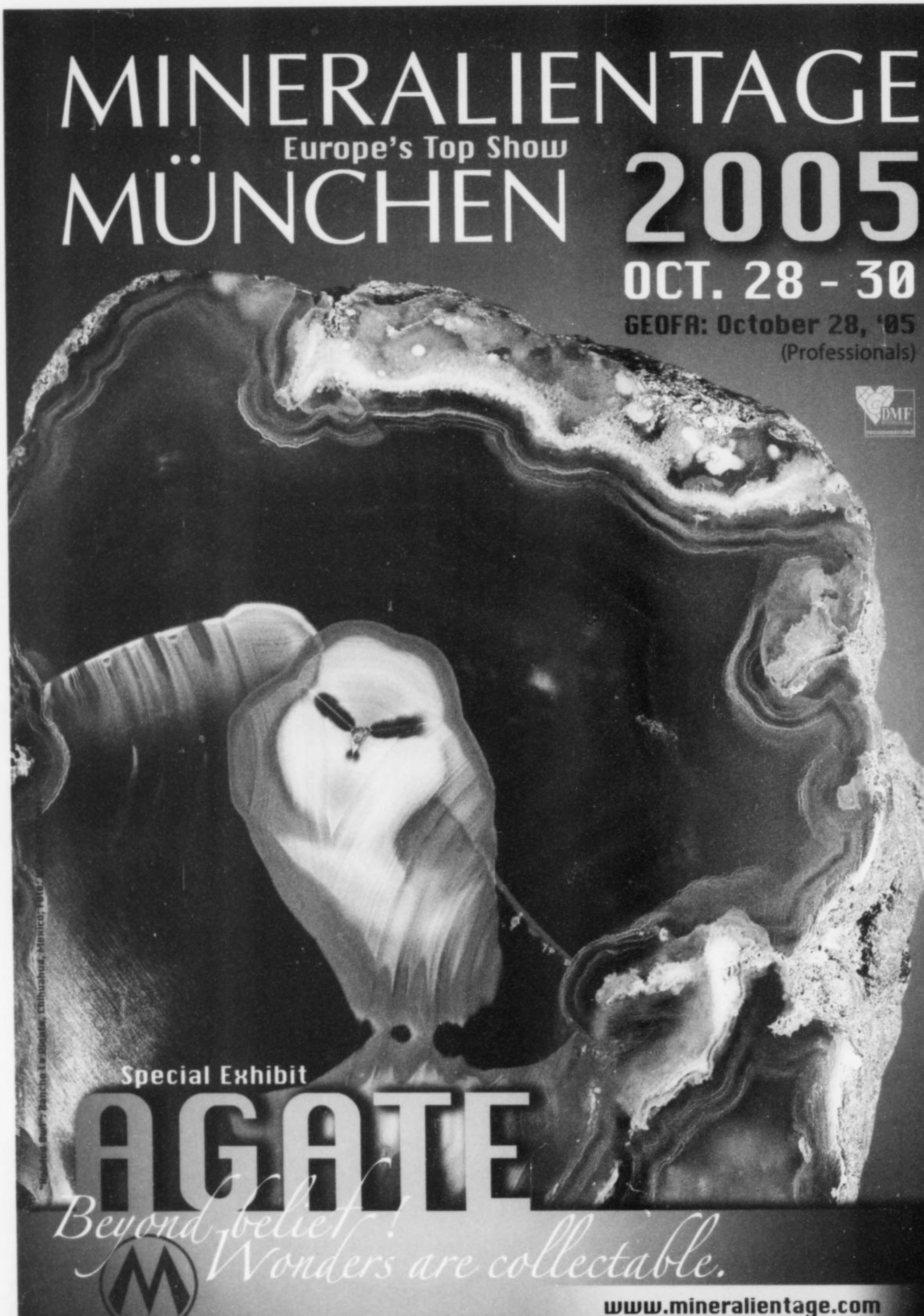


Spessartine, Minas Gerais, Brazil, 3 cm

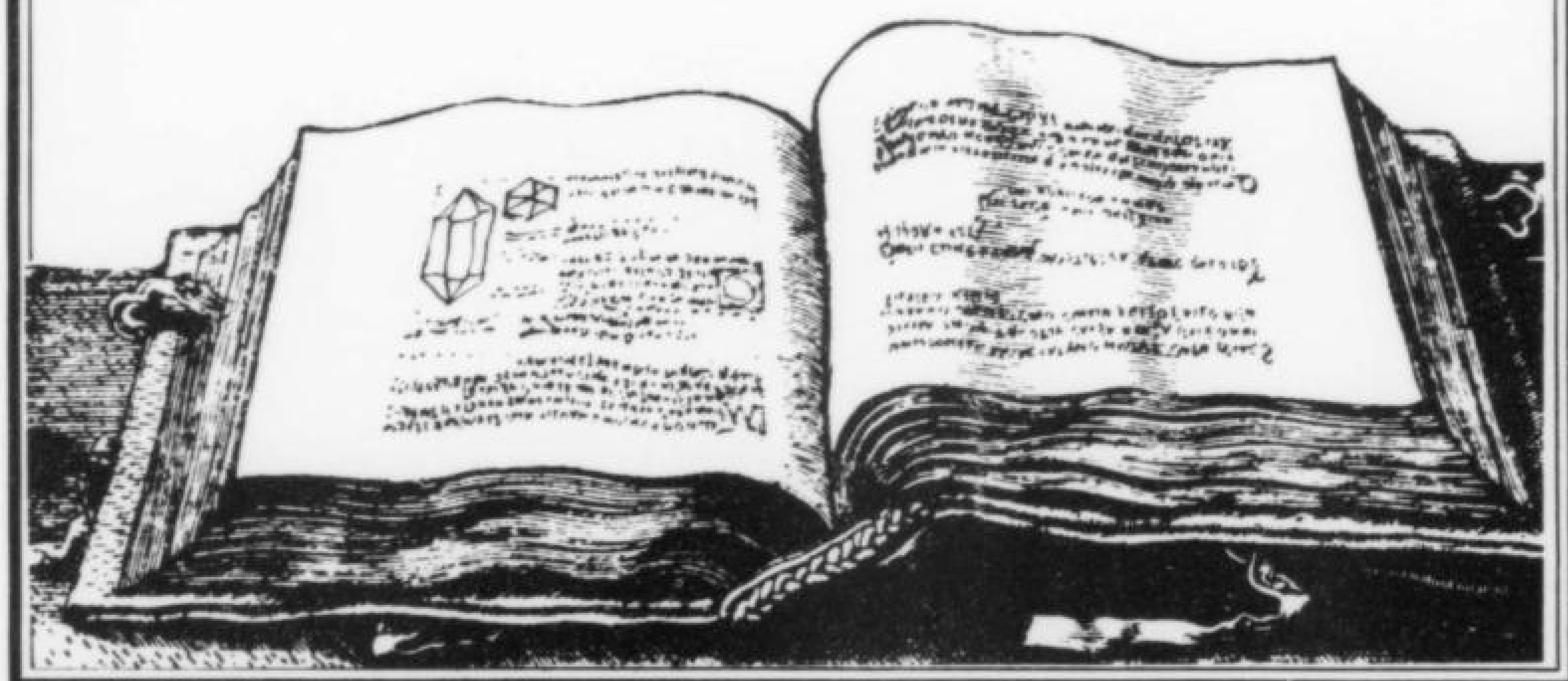
Andy Seibel

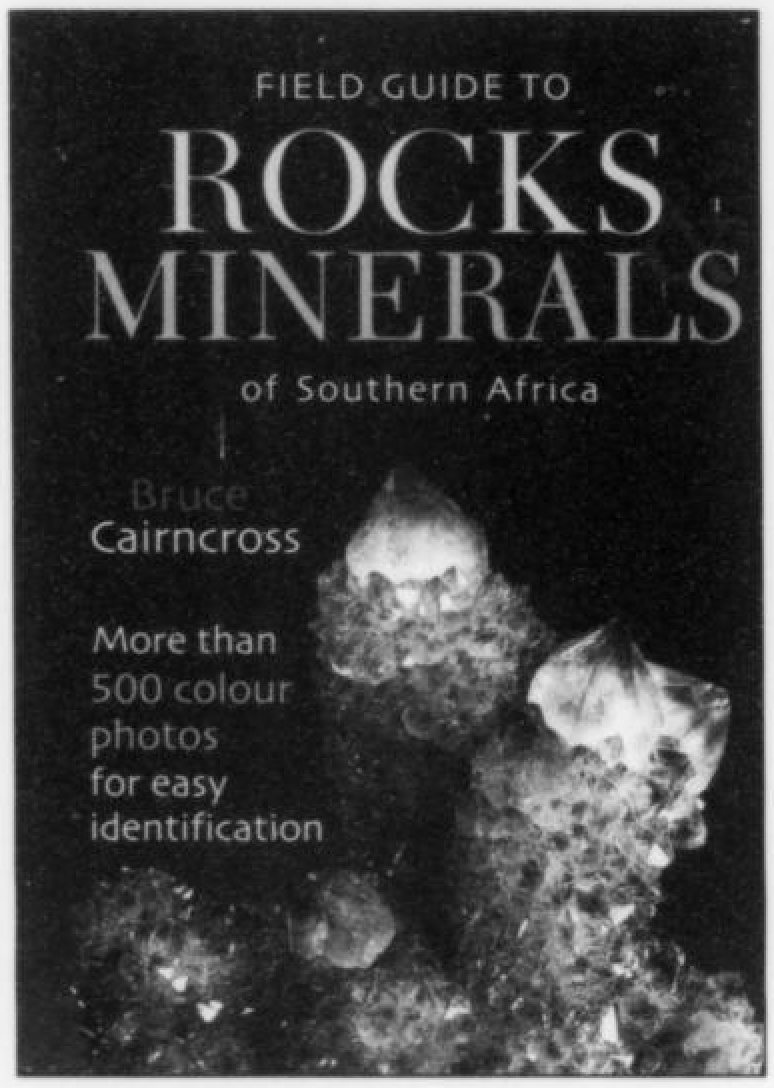
Tel: 661-823-8091 • Website: andyseibel.com

Photo by Jeff Scovil



Book Reviews





Field Guide to Rocks & Minerals of Southern Africa

by Bruce Cairncross. Published (2004) by Struik Publishers, Cornelis Struik House, 80 McKenzie Street, Cape Town, South Africa 8001. Stiff softcover, 5.75 × 8.25 inches, 292 pages. Price 179.95 Rand. ISBN: 1-86872-985-0.

Bruce Cairncross, who has written numerous articles on southern African mineral localities for the *Mineralogical Record*, is also the author of *The Desmond Sacco Collection* (2000) and a co-author of *The Manganese Adventure: the South African Manganese Fields* (1997). He is chairman of the Geology Department at the University of Johannesburg, and an avid mineral collector. Who better, then, to write an attractive, seductive, hobbyist-oriented survey of southern African rocks, minerals and gemstone materials? The famous South African collector Desmond Sacco writes in a Foreward that "a full-color field guide to the rocks and minerals of southern Africa is long overdue." And Cairncross himself, in his Preface, names five readerships—target audiences—it aims to serve, namely (1) mineral collectors, (2) earth science students, (3) gemologists, (4), lapidarists, and (5) outdoorspeople and "naturalists."

Take note that the book's purview is "southern Africa," not "South Africa." While much space is devoted, of course, to the incomparable riches of the Republic of South Africa, all of its neighboring countries are also surveyed: Namibia, Botswana, Zimbabwe, the southern half of Mozambique, and tiny Lesotho and Swaziland (geopolitical "inclusions" in South Africa). A little sketch map of the region appears in each entry for a major mineral species, with each occurrence of the species marked by a red dot—and these dots often come in thick swarms. The device helps to orient non-African readers and to show them how very rich southern Africa is—in minerals for the collector as well as in commercial ore deposits.

The "Minerals" section is rich in specimen photography, with the quality of the specimens shown ranging from mundane to extraordinary. The photos themselves, all in color and nearly all by Cairncross, are quite good enough to reinforce the impression of an embarrassment of riches in the southern African subcontinent.

As a "field guide" aimed at multiple non-technical audiences, the book has some beginner-level material to impart in the 15-page opening section. After a one-page introduction, a series of questions is asked by headings, and crisp replies follow: What is a mineral? What is a gemstone? What is a rock? More innovatively, there is a similar catechistic exchange regarding mineral *collecting*, giving advice on topics like judging mineral aesthetics, specialization, the commercial mineral market, minerals as investments, and curation. Then comes a few more pages on mineralogical basics (the crystal systems, crystal habits, the Mohs scale, etc.).

And then the alphabetized list, Amphibole Group to Zircon, takes off. This central stretch of the book, about 200 pages long, surveys all the species found in southern Africa, with entries heavy on economic data—though sometimes frustratingly short on locality information. Imagine, for instance, lustrous green brucite crystals to 4 cm from the Ethel mine, Zimbabwe; super-sharp, lustrous black cassiterite crystals to 3 cm from the Kamativi mine, Zimbabwe; wonderful 10-cm clusters of radiating natrolite crystals from the Chrome mine, Limpopo, South Africa—it's like visiting exotic animals in a zoo.

We also get to look in on familiar occurrences, often with photos of familiar specimens: Tsumeb, Spitzkoppe, Kuruman, Phalaborwa, Mwami, etc. At the end of the "Minerals" section are some interesting tables on world reserves and the production of various metals, showing the rankings of countries. It is hardly news that South Africa does very well in these competitions, and leads the world by preposterous margins in the production of manganese, chromium, gold and platinum-group metals.

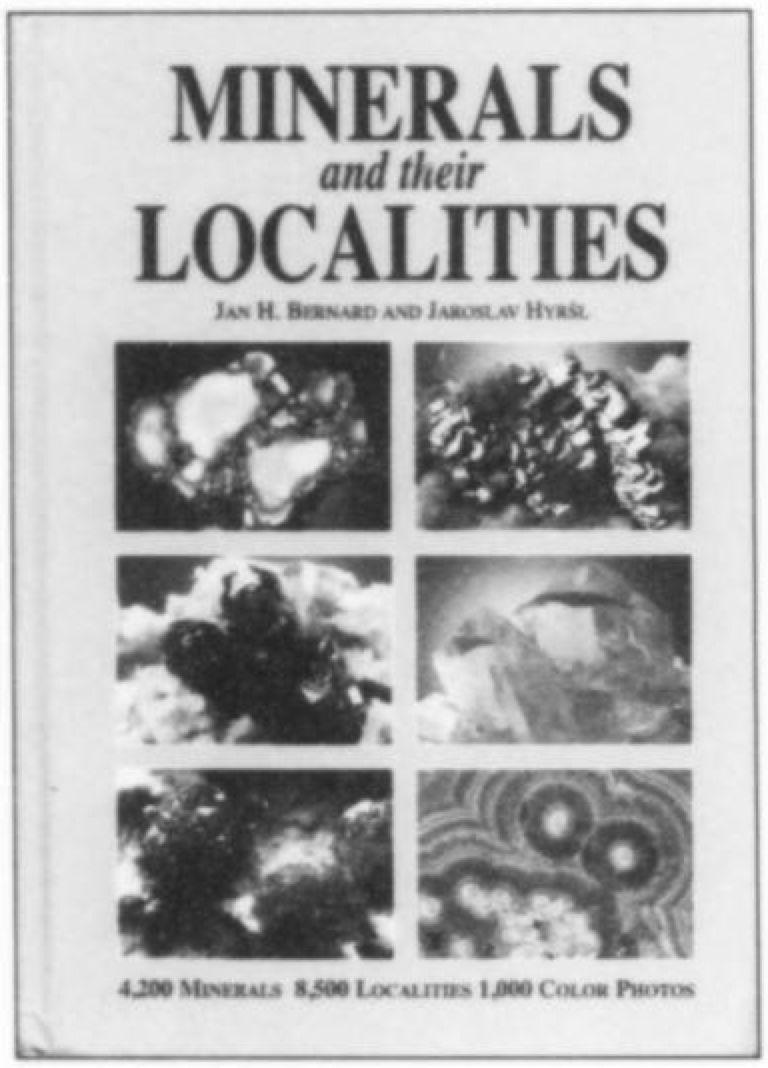
Gemstones are attended to perfunctorily as part of the "Minerals" section, and the mineral collector's interest will naturally fall off when he comes to the (much shorter) section on rocks, formatted similarly and including attention to "decorative" and lapidary rock materials. A two-page glossary of terms, a bibliography sorted by countries (there are 107 titles for South Africa), and a reasonably full index complete the work.

The stiff-softcover book, with its lush-looking front cover showing a purple cluster of "cactus" amethyst stalks against a black background, is physically attractive, and has a size and weight that is satisfying to heft in the hand. It is ideal for ushering interested beginners effectively into the world of the earth sciences, as Cairncross intends.

I might point out that in the entry for wulfenite he states that the species is named after Ernst Anton Wülfing, whereas its actual eponym, as is fairly well known, is

Franz Xavier von Wulfen. But this is a trivial quibble; I can recommend this book highly. As an attractive introduction to mineralogy and as a good medium-light reference work on southern African minerals, it's a pleasure to add to one's library.

Thomas P. Moore



Minerals and Their Localities

by Jan H. Bernard and Jaroslav Hyršl. Published (2004) by Granit, Prague, Czech Republic, and available from the Mineralogical Record Bookstore (online at www.MineralogicalRecord.com), P.O. Box 35565, Tucson, AZ 85740. Hardcover, 6.75 × 9.5 inches, 807 pages. Price $145.00. ISBN 80-7296-039-3.

A best-seller at the 2005 Tucson Gem & Mineral Show, *Minerals and Their Localities* is an 807-page encyclopedic survey of all known mineral species, densely printed, with paragraph-size discussions for each species, emphasizing formation conditions and major worldwide localities. Printed on thick, glossy paper, it is a *heavy* reference work in more ways than one, and despite the steep price it is bound to feel like a well-chosen investment to any mineralogist and/or advanced mineral collector who springs for a copy, then heaves it into place on a shelf alongside copies of "competing" reference works such as *Encyclopedia of Minerals* (Roberts *et al.*, 1990), *Dana's New Mineralogy* (Gaines *et al.*, 1997) and the five volumes of the *Handbook of Mineralogy* (by Anthony *et al.*, 1990–2003).

This new book avoids the risk of fatal redundancy with the works named above in at least two important respects. First, as the work of two Czech authors it is remarkably strong on central European localities (and authoritative on how to spell them, diacritical marks included); although the book aspires to a global purview, its mild Eurocentrism feels, to the present reviewer at least, more like a virtue and an endearing eccentricity, than like a flaw. Secondly, and much more importantly, *Minerals and Their Localities* is valuable for its very strong emphasis on *localities*. Not only does each species entry offer a long list of places where that species has been found, but at the end of the book there is an intriguing table called "The Richest Type Localities of the World," detailing exactly how many species have been discovered at Tsumeb, Långban, Franklin/Sterling Hill, Lovozero, Laurium, Freiberg, Crestmore, Bisbee, Vesuvius, Mont St.-Hilaire, etc., etc., and to what geological and geochemical type each famous deposit belongs. This table is keyed to generic descriptions of principal types of deposits.

The book's virtuoso finish consists of an alphabetical list of worldwide mineral localities, 118 pages long and showing important species which come from each locality. This list will prove useful to serious collectors in a thousand ways.

Color photographs of specimens by the hundreds enliven the book's encyclopedia-style, alphabetical presentation. These pictures add vital visual interest to what would otherwise be a featureless sea of data and print, and, what's more, both the specimens and the quality of the photography are reasonably good, considering that many of the illustrated species are not normally considered photogenic.

The English of the text is frequently unidiomatic and is generally wobbly—it could have used a more thorough editing. However, this does not seem a major problem for a work which aspires, for the most part, simply to organize and present data.

The book is worth the high price for any advanced-generalist or "species" collector who wants to know just where, in every sense of the word, his specimens have come from.

Thomas P. Moore

I Minerali del Somma-Vesuvio
("The Minerals of Somma-Vesuvius")

By Massimo Russo and Imma Punzo (2004). Published by AMI–Associazione Micromineralogica Italiana, Cremona. Hardcover, 21 × 30 cm, 317 pages. Price: €42.00 plus mailing costs. For information and orders contact Ugo Ostan, ostan@dinet.it

The mineralogical importance of the Somma-Vesuvius area (Vesuvius is one volcano within the larger Somma volcanic complex) can hardly be understated. Italy holds the fourth position in terms of type localities for species recognized by the International Mineralogical Association, with about 240 mineral species. Out of these, 62 species were first found in the Vesuvius volcanic complex, one of the most prolific mineral localities in the world. Until now, however, this wealth of mineral species has not been matched by comprehensive, up-to-date literature.

To put this new book into perspective, it is interesting to summarize the history of the main works dealing with Vesuvius. The first books published by the Italian mineralogists of the 19th century and before (in particular Giuseppe Gioeni, Scipione Breislak, Teodoro Monticelli, Nicola Covelli, Arcangelo Scacchi, and Giuseppe Cesaro) and several foreign authors like William Thomson, Gerardus vom Rath, and Alfred Lacroix, were followed in 1910 by a thorough review: *Mineralogia Vesuviana* by Ferruccio Zambonini. This large, 368-pages folio-size volume includes the description of 276 minerals (167 species and many uncertain or poorly defined phases). In 1912 Zambonini updated this book with a brief Appendix and, in the following years, he worked on a comprehensive revision of the entire work. At the time of his death in 1932, his revision was still unfinished, and the task of completing it fell to his former coworker, Emanuele Quercigh.

Quercigh collected and reordered the notes that Zambonini had compiled during the preceding 20 years, and the second edition of *Mineralogia Vesuviana* (a much enlarged folio-size volume of 468 pages) was finally published in 1935. This work remained the standard—and only—general work on the mineralogy of Vesuvius for nearly 70 years.

The only possible exception is a small

book by Mariano Carati, *Guida alla Mineralogia Vesuviana*, issued in 1982 by publisher Calderini of Bologna. This is a very concise, 121-page guidebook for collectors, with relatively little new information beyond what is found in the 1935 edition of *Mineralogia Vesuviana*. However, it filled a gap, as it was available to a large number of collectors who had no easy access to a copy of Zambonini's larger and more scholarly work.

In the 1970's and 1980's field-collecting activity at Vesuvius was lively, supported by the fact that many quarries were active in the Vesuvius area, and during their operation many metamorphosed ejecta rich in crystallized minerals were recovered. A number of local collectors established a mineral club, *Gruppo Mineralogico Geologico Napoletano*, and this group has acted as a useful connection between amateurs and professionals interested in systematic mineralogy.

Authors Massimo Russo and Imma Punzo are, respectively, President and Secretary of this group. The new book that finally collects and updates all the information presently available on the mineralogy of the Somma-Vesuvius complex is due to their efforts and to the continuing support of the Associazione Micro-mineralogica Italiana, the recently founded association of Italian micromineral enthusiasts.

The book begins with a thorough overview of the history of Vesuvius mineralogy, and reviews the most important localities in the Somma volcanic complex. Today, unfortunately, this area has been designated a national park and therefore is virtually closed to collecting; no quarrying is allowed, and consequently fresh ejecta are no longer being uncovered. Another chapter deals with the various collections specializing in Vesuvius minerals, and two chapters cover respectively the volcanic phenomena in the region and the classification of the Somma-Vesuvius volcanic products.

The main part of the book, obviously, is dedicated to systematic mineralogy: the 253 species reported thus far are described briefly but in sufficient detail. Over 200 color photographs and SEM images of large size (mostly 8 × 12 cm) add interest and visual appeal to the book.

A series of appendices help to make the book useful to anybody interested in the fascinating mineralogy of Somma-Vesuvio. Of particular interest is an extensive collection of crystal drawings extracted from the available literature and arranged in tabular form (à la Goldschmidt's *Atlas der Krystallformen*). A very comprehensive bib-liography follows each chapter, providing convenient access to the various original works.

It must be said that this commendable work cannot answer all the questions that a collector may have when he tries to identify the species in his Vesuvius specimens. This is not due to any shortcoming on the part of the authors, but to the difficulty of the problem itself. For example, many species cannot be identified by visual examination alone (for example davyne vs. microsommite, quadridavyne etc.); other species, especially the fumarole minerals, were found only occasionally and there are few recent studies. Many group names are cited, such as "garnet," "mica," "amphibole," "pyroxene," "apatite" etc., where no analysis has been carried out to more precisely determine the species present.

Other open questions, to quote the authors, are about the "guarinites", the zeolites, and the cancrinite group minerals. Much work remains to be done. It will be interesting to revisit with the tools of modern mineralogy many of the minerals that were described in the past, or were not studied at all. The scarcity of fresh material should not be a problem, as quantities of Vesuvius specimens are preserved in public and private collections. Some new and interesting data will certainly be added to our knowledge of Vesuvius in the future.

This book is an important contribution to the mineralogy of the region, and can easily supply information even to people who cannot read Italian.

Renato Pagano

Granito di Baveno; Minerali, scultura, architettura

("The Baveno Granite; Minerals, Sculpture and Architecture")

Edited by Graziella Buccellati; Scientific editor: Carlo Maria Gramaccioli; Text by A. Boriani, C. M. Gramaccioli, A. Guastoni, F. Pezzotta and O. Selvafolta. Hardcover, 24 × 31 cm, 366 pages, in Italian. Published (2003) by the University of Milan, Italy. A few copies may be later available to the general public. Please email adrianapagano@virgilio.it for information on availability and price.

Baveno is a well-known town on the western shore of beautiful Lake Maggiore, about 100 km northwest of Milan. The area has ancient cultural and historical ties to Milan, mainly through the noble families from that area, such as the Borromeos.

Quarrying and working of the local granite was promoted by Cardinal Carlo Borromeo (later to be Saint Carlo), who, at the time of the Counter-Reformation, promoted the construction of new churches, schools and other buildings utilizing that valuable material.

Roughly two centuries later, the orthoclase crystals from the Baveno quarries were described by Ermenegildo Pini, and soon came to the notice of the leading mineral scientists of those days, like Romé de l'Isle, Haüy and others. Baveno orthoclase thus became one of the best known species and an interesting target for collectors, who have often been willing to pay high prices for fine Baveno specimens.

This book, one of a successful series published by the University of Milan, very clearly describes the scientific, architectural and artistic innovations that took place at Baveno, mainly promoted by the illuminist governments of the 18th and early 19th centuries. The book is divided into several monographic sections, which can each be read separately. After a general historical introduction, the Baveno granite is described in the context of the geology of the Alpine region, with many illustrations and maps of the famous quarries. The Baveno minerals are, of course, well represented in the Milan Museum of Natural History, and a section by A. Guastoni and F. Pezzotta describes the best specimens there (not only orthoclase, but also quartz, fluorite, datolite, babingtonite etc.). Also the collection of the Earth Science Dept. of the University of Milan includes fine Baveno specimens, a selection of which is pictured in the book.

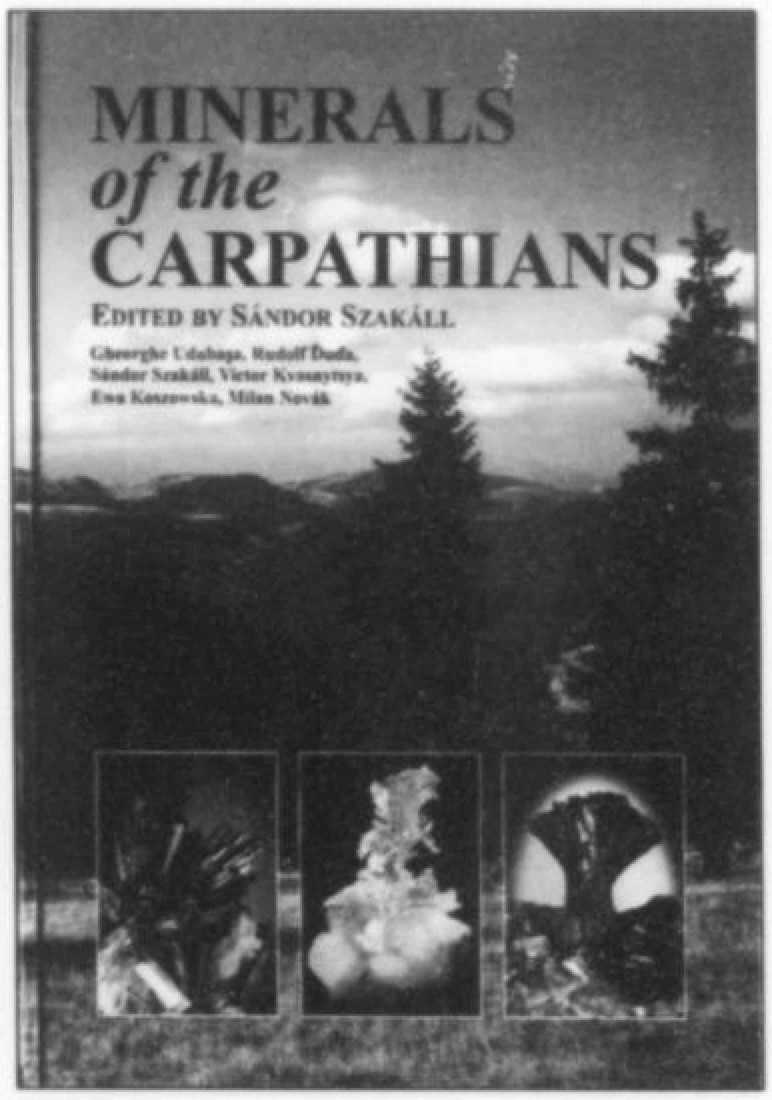
Of special interest to the geo-literati and the more advanced collectors is an excellent review of the early literature on Baveno, from the seminal work by Ermenegildo Pini, *Memoire sur des nouvelles crystallizations de feldspath* (1779), to Romé de l'Isle *Cristallographie* (1783), Gauthier D'Agoty's *Histoire Naturelle* (1781) and *Haüy's Minéralogie* (1801), and continuing with Quintino Sella, Giovanni Strüver, Ettore Artini (who discovered two new species from Baveno: bazzite and bavenite) and a few more recent authors. Several of the famous plates and title pages of relevant antiquarian books are nicely reproduced.

A section on the "Baveno classics" deals first with the famous orthoclase crystals, and includes also very interesting chapters on fluorite, on gadolinite and on the scandium minerals (Baveno is the type locality of bazzite, cascandite, jervisite and scandiobabingtonite; also, thorveitite has been found there: thus five of the nine known scandium minerals occur at Baveno). There follows a chapter on the miarolitic cavities that host the Baveno minerals, and a section describing all of the species reported from Baveno thus far, complete with ten SEM photos and 24 color photomicrographs that will make any micromount collector dream!

The non-mineralogical part of the book deals with the architectural and artistic uses of the Baveno granite,

In conclusion, this book is attractive and very informative, although the treatment of the macromineral photographs is not up to the standard of the excellent text. In any case, all collectors and scientists who can understand at least a little Italian will enjoy it.

Renato Pagano



Minerals of the Carpathians

Edited by Sándor Szakáll. Published (2002) by Granit, s.r.o., Drtinova 10, 150 00 Prague 5, Czech Republic. Hardcover, 7 × 9.75 inches, 479 pages; ISBN 80-7296-014-8. Price: €59; airmail shipping: €20. Payment accepted by bank transfer, credit card or check. Order online from info@granit-publishing.cz.

The Carpathian Mountains are a 1,500-kilometer-long, scythe-shaped range of hills sweeping grandly through parts of six countries: the Czech Republic, Slovakia, Poland, Hungary, Ukraine and Romania. Readers of standard mineralogy texts, formal or informal, are likely to be accustomed to seeing localities specified in mine-town-province-country terms, and thus may not be aware of how many of the great classic localities of eastern Europe lie within these quite lavishly mineralized (as well as beautiful) wooded hills: an extremely abbreviated listing includes Banská Štiavnica (Schemnitz), Kremnica (Kremnitz), Ľubietová (Libethen), Špania Dolina (Herrengrund), Machów, Wieliczka, Ocna de Fier (Vaskö), Săcărâmb (Nagyág), Baia Sprie (Felsöbánya), Cavnik (Kapnikbánya), and Roşia Montană (Verespatak). To make my way through the underbrush of all those Slavic and Romanian diacritical marks I consulted the book's "Locality Index," which is perhaps its most useful appendix, especially inasmuch as it also notes the modern countries in which the hallowed old mining places now find themselves.

Still, English readers may find the book's organization a little confusing, since the mineral occurrences are not listed anywhere *by* mine-town-province-country; instead, they are mentioned opportunistically within the six parts of the large chapter called "Mineralogical Regions." The educational upside, though, is that the discussion of each region offers an overview, with sketch maps, of the geographical and geological relations among localities: the reader's grand tour of the Carpathian arc is a thorough and erudite one, with a specialist author for each country. These authors' names and short biographies are printed on the back cover: each is an academic and/or museum professional with anywhere from 25 to 200 scientific publications to his or her credit.

The whole of the book's first half—an Introduction followed by large sections called "The Carpathians—a Structural & Metallogenic Outlook" and "Mineralogical Regions"—flows smoothly, and is decorated with color photos of rolling green landscapes, ancient towns, mine excavations and rock specimens. On page 126 "Descriptions of Mineral Species" takes over and runs for 269 pages. Here the species are arranged according to the standard Dana rubric (native elements, sulfides, halides, etc.) and there are a final 20 pages of crystal drawings. In the text, each species receives its due—anywhere from a few lines to several print columns—of detailed locality information, subdivided by country. Thankfully, no space is wasted listing general properties of each species, as this information may be found readily in general mineralogy texts. The color photos of specimens are, for the most part, of good quality, as are the specimens themselves (special and super-salivary honors are hereby awarded to the 8-cm hessite from Boteş, Romania on p. 157 and the rhodochrosite from Cavnik on p. 245). The photos are the work of no less than 15 photographers, and the specimens come from 28 museums and an uncounted number of private collections; nearly all of the museums described in Peter Bancroft's "Mineral Museums of Eastern Europe" (vol. 19, no. 1 of the *Mineralogical Record*) are represented, but at least 90% of the specimens pictured have not been illustrated before (at least they were new to me), in Bancroft or anywhere else. It is too bad that a pyromorphite specimen pictured on p. 296 is also shown on p. 290, differently oriented and labeled as hörnesite, but on the whole the book does a fine, nearly glitch-free job of marshalling the immense volume of information into a sleek-paged, sunlit, no-nonsense presentation reminiscent of Bernard and Hyršl's recently published *Minerals and Their Localities*, also a product of the Granit publishing company in Prague.

From pages 396 to 427 the book recapitulates and elaborates Bancroft by describing "Mineral Museums of the Carpathians," showing photos of the major historical builders of those mineral collections, describing displays and emphases, and tempting would-be tourists with up-to-date data on contact numbers and visiting hours. Concluding the book there is a 25-page bibliography (divided, naturally, by country into six subject parts), a mineral species index, and the invaluable Locality Index already mentioned. All in all, this unconventional "regional mineralogy" is a fine, highly polished product, attractive and collector-friendly while serving as an authoritative reference work. It is highly recommended, particularly for those enamored of classic European localities.

Thomas P. Moore

The Pegmatite Mines Known as Palermo

by Robert W. Whitmore and Robert C. Lawrence Jr., mineral illustrations by Frederick C. Wilda. Published (2004) by Palermo Mines Ltd., 934 Stark Highway, Weare, NH 03281. Hardcover, 8.5 × 11.25 inches, 213 pages. Price: $150.

In his "Foreward" to this book about the famous Palermo phosphate pegmatite at North Groton, New Hampshire, senior author Robert Whitmore makes plain that for him the book fulfills a longtime dream of memorializing a place he has always loved. Along the way of offering the mining and cultural history and comprehensive mineralogical survey that we expect from a "locality" volume, this book offers also a real celebration of a place that has been much loved by many besides Whitmore, down through about eight generations of the New Hampshire folk whose faces look warily back at us from the past, in the volume's generous profusion of old photographs.

In fact, the photos in the 63-page chapter called "History of Palermo" delve into rural New England history as industriously as the Palermo workers once dug the mica and beryl: here are white clapboard houses seeming depthless against bleached skies; mud-chowdery village streets; loaded buckboards ready to go; roads curving on into austere pine forests; steam locomotives; and of course miners posing, alone and in groups, in the stiff but soldiering-on way that people used to pose for cameras in the late 19th and early 20th centuries.

Abundant photographs of the Palermo mine excavations themselves are here too, with creatively selected scenes of, for example, rock shooting out of a tunnel during a blast, the arching quartz core of the pegmatite, three-foot crystals of beryl *in situ*, and even two full-page color photos of ice stalagmites. The text is clear and thorough enough, but it is the visuals which fascinate—to say nothing of the mineral specimen paintings (see later). This book is expensive because its makers have sought to make it both lavish and just a little eccentric, with deluxe packaging—thus the crinkly parchment-like dust jacket, the landscapes in spidery brown pen strokes inside the hard covers, and the luxuriantly thick paper throughout.

After "History" comes the book's most "romantic" chapter of all, a short one called "Secrets of Palermo" containing only photographs and their captions, and here, besides those ice stalagmites, are photos of spacious underground mine rooms lit in ways almost mystical (one of these rooms is known locally as The Room With The View). However, between the short "Secrets" and the necessarily long "Palermo Minerals" chapter which follows, the book gets businesslike with a helpful two-page spread offering a "Palermo No. 1 Timeline" to show the various periods of mining in their historical contexts.

The commercial life of the Palermo No. 1 mine began perhaps as early as the Civil War and lasted until 1968, with just two short intervals of dormancy (ca. 1898–1913 and 1928–1942). Throughout this time the mine produced muscovite mica, the many uses of which, past and present, are described by the authors at the beginning of "History." And after 1913 it produced feldspar for use in the glass, ceramics and enamel industries. World War II inspired production of an exotic, classified, "strategic" metal: beryllium, taken from the mine's great reserves of beryl. In the early 1960's, quartz mined from the pegmatite's core was mixed with cement to add sparkle to new buildings rising in East Coast cities.

After the late 1960's, however, industrial mining gave way to disciplined explorations by mineralogists and collectors—for the Palermo pegmatite is one of the world's sacred places to those interested in the rich suite of secondary phosphates which have formed from the alteration of pegmatitic apatite and triphylite. From 1968 to 1974, expert New Hampshire mineral prospector Peter Samuelson leased the mine and sought mineral specimens in it, and since 1974 the mine has been owned by Robert Whitmore and worked by him and his associates for mineral specimens. To date, almost 150 species have been identified from the pegmatite, almost all of the really interesting ones being rare phosphates which occur, superbly well-crystallized, as micromount and thumbnail-size specimens, a few of the species being unique to Palermo. If you can lay hands on a copy of vol. 4, no. 3 (1973) of the *Mineralogical Record*, see "Phosphate pegmatites: descriptive mineralogy and crystal chemistry," written by Paul B. Moore, one of the Palermo mine's most famous and faithful adepts (he is represented by 15 of the 93 titles in the bibliography of this new work).

The chapter title "Palermo Minerals" sets up the book's second half by introducing a 20-page section composed of (1) lists and tables detailed enough to get down to things like which species occur in which individual triphylite pods; (2) a color cross-section of the mine with plastic overlays showing collecting sites, and (3) what is perhaps the book's most surprising feature to come on unawares, an Index to Minerals with page numbers and species names keyed to little paintings of crystal specimens.

This turns out to be a foreshadowing. The chapter "Palermo Phosphate Minerals," we find, contains short, straightforward discussions of each species accompanied and dominated by much larger paintings in the same impressionistic style—beautiful, dreamy, minutely detailed colored flights of mineral fantasy by the obviously highly gifted Frederick C. Wilda. These images are presented, it seems quite frankly, not as formal "scientific illustrations" representing what the minerals actually look like but, rather, as what the finest micromount specimen just past the limits of your imagination *might* look like. Colorings, crystal morphologies, associations, etc. are correct enough, but only in a Platonic sort of way. I think that the artist, by being so frankly impressionistic, succeeds in (if you prefer, "gets away with") his approach, and should not be carped at from "scientific" perspectives. If a caption says that the painting depicts a 0.5-mm specimen of dickinsonite, and the painting is a phantasma of gleaming gray-blue wedges, a *Star Wars* cityscape, thrusting at all angles over a third of a page, well, just enjoy it; this is not dickinsonite but a Dream of Dickinsonite. I am trying to say that the paintings are not only beautiful, they are also playful and fun, and they seem to me to relieve the sometimes excessive solemnity of the book's earlier parts. [Editor's note: If you'd like to see some examples, check out Frederick Wilda's gallery in the Art Museum section of the Mineralogical Record's website (www.MineralogicalRecord.com), where 31 of Fred's mineral paintings are on exhibit, including several showing Palermo minerals.] The text here is, once again, workmanlike and efficient in any case: when you finally unhitch your eyes from the painting, you read plainly what the species in question is all about, what its associations are in the mine, and where (and often when) its best specimens have been found.

After "Phosphates," a short chapter covers "Palermo Quartz and Other Minerals." After that, an even shorter chapter called "Palermo Gems and Carvings" presents photographs of some splendid faceted gems, mostly aquamarine and heliodor beryl, from the Palermo mine, and a couple of carvings. The book concludes with that 93-title bibliography, a rather minimal index, and some final line drawings. You close the book feeling grateful for what has been not only a solid educational read, but an excursion through some substantial and out-of-the-way New England history, and an interesting experiment in mineral-book aesthetics. The only possible drawback is the price, but for a labor of love like this, where someone has pulled all the stops out trying to do the very best possible job documenting a great mineral locality, we should probably just be thankful and give him his money.

Thomas P. Moore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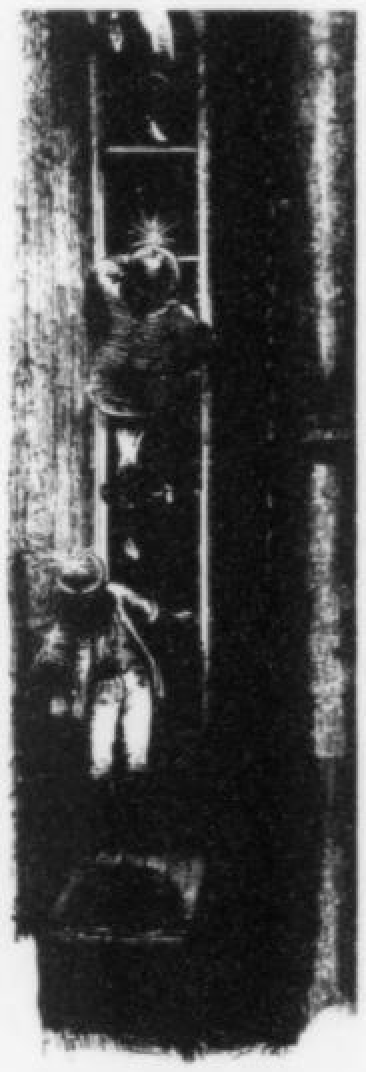

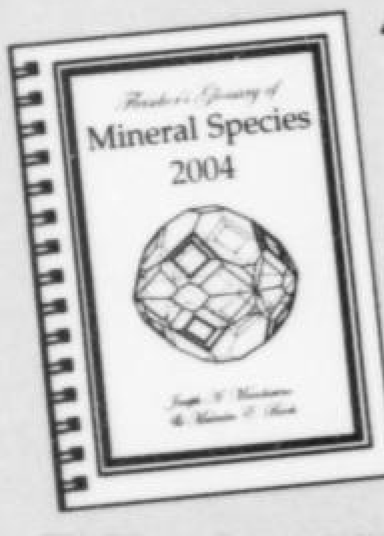
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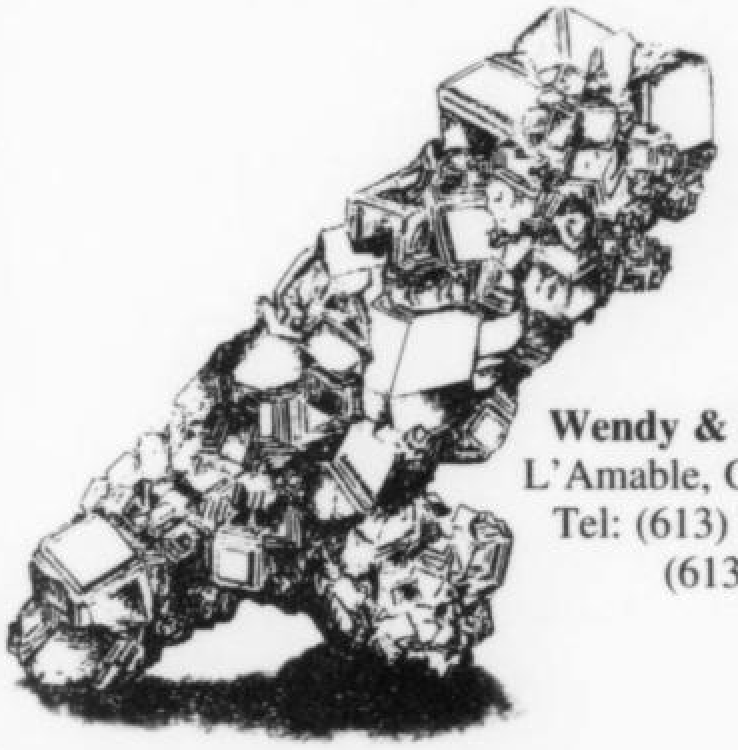

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