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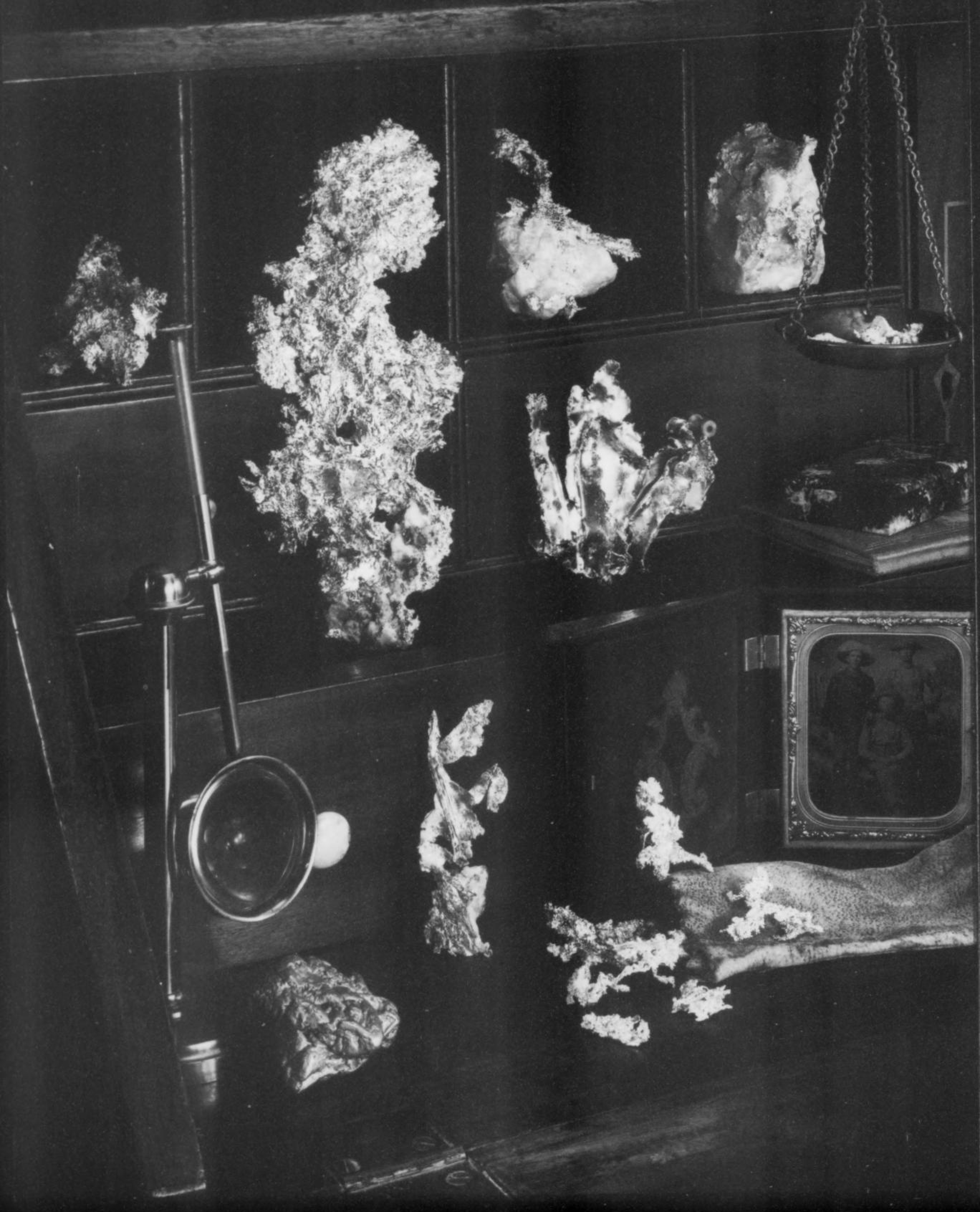

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Articles

Columns

COVER: QUARTZ crystal (a so-called "Herkimer diamond") on matrix, 5.8 cm, from Middleville, Herkimer County, New York. Martin Zinn collection; Jeff Scovil photo.

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notes from the EDITORS

Slipcase Boxes Now Available

Years ago the Highsmith Company produced slipcase boxes designed to hold issues of *The Mineralogical Record*. The boxes proved handy for many people because they were much less expensive than hardcover binding, and they allowed access to and removal of individual issues. Unfortunately the Highsmith Company eventually ceased production of the boxes, and for some years there has been no similar product on the market.

We are pleased to announce that Tom Cannon of TNC Enterprises is now making available custom library-quality slipcase boxes once again. Each box holds two volumes (even for the years in which page totals were the highest) and has a durable, maroon, calf-textured leatherette covering with a gold-stamped black spine label. We have our office set of the *Record* in these boxes and they work great. The boxes cost $15 each, three for $40 or six for $80 (plus $3.50 per box for postage and handling for US orders and $7.50 per box for foreign orders). Discounts may apply for larger orders; contact tom@tncenterprises.net for prices on larger quantities. To order online go to www.tncenterprises.net/mr, or write to TNC Enterprises (Dept. MR), P.O. Box 2475, Warminster, PA 18974. Telephone (215-674-8476) and Fax (215-674-5949) orders also accepted with VISA, MC or AmEx. The boxes come with an unconditional money-back guarantee and orders are shipped within one week.

Died, F. John Barlow, 89

F. John Barlow (1914–2004)

John Barlow, one of America's most prominent private mineral collectors, was born in Milwaukee, Wisconsin on July 12, 1914 and died at his home in Appleton, Wisconsin on June 5, 2004. In 1932 he graduated from Washington High School, where he was the All-City Fullback for the undefeated football team. After attending St. John's Military Academy for a year, he enrolled in the Mechanical Engineering program at the University of Wisconsin-Madison. He received his B.S. in 1937 and was selected as the outstanding engineering student in his class. There he also was a member of the Wisconsin Badger football team and president of Sigma Chi fraternity. While in Madison, John married his high-school sweetheart, Dorothy M. Marx, on Oct. 13, 1935. She preceded him in death in January of 1994.

John worked for Buffalo Forge Company and then A.O. Smith Company until 1944, when he moved to Appleton, Wisconsin with the Western Condensing Company, the only company in the United States providing the means to grow penicillin for the war effort.

In 1949, with $5,000 and a pick-up truck, he founded AZCO Inc. as an industrial piping contractor. He succeeded in developing AZCO into one of the country's major contractors, specializing in industrial and power plant (including nuclear) construction and pipe fabrication. In 1998 he sold AZCO to its employees so he could devote all of his time to his mineral collection and to his philanthropic work.

John was an avid hunter, and in his younger years he traveled the world in pursuit of big game. He hunted in Africa, India, Mexico, British Columbia and even the Arctic. His mineral room contained a polar bear skin rug from one of his hunts. In 1966 he became a member of the exclusive "Grand Slam Club" of the North American Sheep Hunters' Association (for bagging a Coues Deer, a Desert Mule Deer, a Pronghorn Antelope and a Bighorn Sheep). He is only the 46th person to have achieved this distinction. In 1970, John represented Wisconsin, along with Governor Knowles, in the One Shot Antelope Hunt—an event that they won.

In 1964 John received his pilot's license at the age of 50 and bought his first plane, which he flew for both business and pleasure. He took many wonderful flying trips with Dorothy; they enoyed especially their deep sea-fishing trips to Mexico.

Mineral collecting was a passion for John. He assembled one of the best and largest privately held mineral collections in the world, and often exhibited specimens at the Tucson Gem and Mineral Show. He won many awards in the field, including the Ed McDole Memorial Trophy in 1975 and 1978, the Walt Lidstrom Memorial Award in 1993 (for a Russian sperrylite), the Paul Desautels Award in 1993, and the highest honor, the Carnegie Mineralogical Award in 2000. He was also awarded the Smithsonian Gold and Silver medals for a very large donation of rare and valuable Indian jewels and jewelry. One of his proudest accomplishments was self-publishing the impressive book, *The F. John Barlow Mineral Collection* (1996), which describes and pictures the extensive collection he built. Most of his collection has by now been sold to dealers and private collectors or donated to museums.

John Barlow was a creative entrepreneur, starting many projects and small businesses in Appleton. He was a founding member of Air Wisconsin. He was instrumental in bringing cable television to the Appleton area in the early 1980's. He brought the first Mexican food to the area with Tippy's Taco House. During the 1970's and 1980's he was president and owner of Schlafer Supply Company, Inc. He worked with former Mayor Dorothy Johnson in getting the Avenue Mall built in Appleton. He also founded the region's premier jewelry store, Earth Resources, which he sold to his daughter Alice in 1995.

In support of the local community he gave both his time and his means. For example, he provided an educational mineral exhibit to the Appleton Children's Museum. John also gifted a unique Perthshire glass paperweight collection to the Bergstrom-Mahler Museum. He is probably best known for the Barlow Planetarium at the University of Wisconsin-Fox Valley, which is dedicated in honor of his wife Dorothy. Most recently, he donated a large and important collection of minerals to the Weis Earth Science Museum. He supported numerous other community organizations in meaningful ways.

John was a member of numerous organizations including the Mechanical Contractors Association of Wisconsin and the Mechanical Contractors Association of America; he served the latter as president in 1974. During that year President Gerald Ford appointed him to The Summit Conference on Inflation. In 1983 John received the Distinguished Service Award from MCAA. He was a long-time member and two-term president of Butte des Morts Country Club, a past Exalted Ruler of the Appleton Elks Club, director of First National Bank (now Bank One), and a member of the Downtown Appleton Rotary Club and a Paul Harris Fellow. He was a member of All Saints Episcopal Church and served it as Senior Warden.

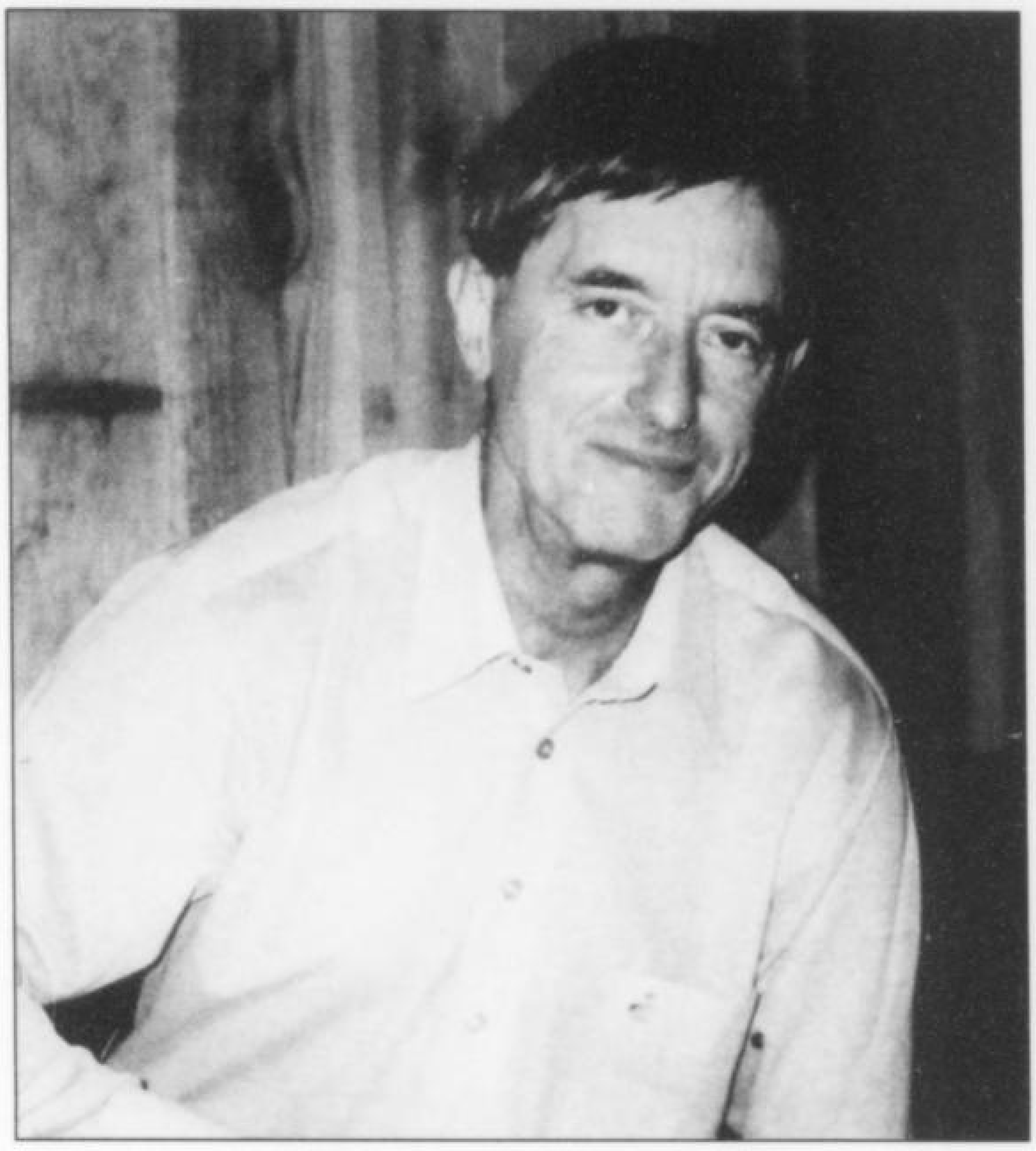
In 1994, Wisconsin Governor Tommy Thompson presented John with an honorary Doctorate of Science from the University of Wisconsin–Oshkosh. For his contributions to education in geology, he also received The Chancellor's Medallion from the University of Wisconsin–Oshkosh.

John is survived by his eight daughters and nine grandchildren.

(Adapted with permission from *The Post-Crescent*)

Died, Jean-Pierre Cand, 66

Mineral dealer Jean-Pierre Cand was a free-spirited person who loved nature and had a passion for minerals. He was born in Geneva, Switzerland on January 14, 1938, and died in San Benito County, California on May 25, 2004, from injuries caused by falling rock while collecting benitoite and neptunite. He lived his life to the fullest and died doing what he loved best.



Jean-Pierre Cand (1938–2004)

Jean-Pierre graduated from High School in Geneva in 1957 and began an apprenticeship program to become an insurance adjuster for the Geneva state government. This became his career for the next 15 years. He had begun his hobby of collecting minerals at a young age, and it was his great passion. He soon built a small personal collection and enjoyed traveling to buy specimens. Wishing to devote more time to minerals, he requested an unpaid three-weak leave of absence from his job in order to take a mineral-buying trip to Morocco. When this request was denied he made the decision to leave his job and become a full-time mineral dealer. He began by selling off his personal collection (so as not to compete with his own customers for good specimens) and never looked back.

His passion for minerals took him to many remote areas around the world in search of the finest specimens. He began traveling in the United States approximately 35 years ago, visiting all the mineral dealers around the country and always trying to find that one special piece that would eventually make one of his customers very happy. He never missed a Tucson show, and was well known for his fine taste in minerals. He was always looking for perfection. Having found a fine specimen, he always took care to see that it was professionally prepared. His extensive knowledge of mineralogy helped him acquire fine specimens, and many of these have found their ways into some of the best private collections around the world. His customers became his friends, and it was through these friendships that he was able to re-visit specimens he had sold.

In December of 1997, Jean-Pierre was granted permanent residency status in the United States, and moved to California in January of 1998. Although he had been born and raised in Switzerland, he loved the freedom and the open space of this country that allowed him to follow his dreams and indulge his love of minerals.

During the last five years of his life, Jean-Pierre dedicated himself to doing a lot of self-collecting. He always felt a sense of gratitude to all of those who shared their "secret prospecting areas" with him. In turn, he was always willing to share his knowledge, and was always happy to invite along on his field trips anyone who shared the same interest.

Damaris Cand

Norman Pellman (1922–2004)

Died, Norman Pellman, 81

Norm Pellman was born on July 5, 1922, in Manhattan and died unexpectedly at his home in Green Valley, Arizona on April 4, 2004. He and his wife Roz (Roslyn, whom he married in 1969) built a beautiful display collection of nearly 500 colorful minerals in all sizes, from thumbnails to large cabinet specimens. The collection is arrayed in two large, well-designed wall-cases with independent lighting above each specimen on each shelf.

Norm graduated from De Witt Clinton High School in Manhattan and studied pre-Law at St. John's University before enlisting in the Army Air Corps in 1943. While in the service he studied at Los Angeles University, then attended cryptography school. As a cryptographer he coded and decoded secret information on guided missiles and submarine reconnaissance. Later, while stationed in Alamogordo, New Mexico, he worked on communications codes for the atomic bomb project.

After the war Norm worked for a chemical company for 18 months, but was eager to be his own boss. Norm was a natural entrepreneur, and enjoyed the process of starting small companies on a shoestring and nurturing them to success. It didn't really matter what the product of a company was; Norm always found a way to make products and sell them at a nice profit. With a capital of just $650 he founded the Coastal Chemical Corporation; after building sales into the millions of dollars he sold the company to a conglomerate in 1973. He continued running Coastal Chemical for another four years before deciding to try a new field. With a minimal investment he started Global World Imports (G.W.I.) Corporation, an emblematic jewelry corporation, and after also making that venture into a multi-million-dollar operation he sold it in 1977.

Norm developed an interest in minerals rather late in life, in 1973. While on business in Pittsburgh he and Roz visited Horn's Dept store, where he bought a decorator amethyst specimen. That inspired the two of them to take a course in mineralogy, and from there they discovered the mineral world and started visiting mineral shows listed in *Lapidary Journal*, finally discovering the Tucson Show. They met Dave Wilber, who arranged for them a three-week round of visiting 18 private mineral collections in California. Norm and Roz then began building their beautiful collection. Norm also enjoyed photography, and began taking large-format photos of their specimens. Many of his photos are framed in a long wall gallery in their house. A number of their specimens have also been pictured in past issues of *The Mineralogical Record*.

In 1999 Norm and Roz had a beautiful custom retirement home built in Green Valley, Arizona, just south of Tucson, and moved there, where they entertained mineral people frequently and enjoyed showing their collection.

Norm was a happy, friendly, intelligent and always interesting character. He and Roz attended the Tucson Show together faithfully for many years, and had an extensive circle of friends in the mineral world. They have one daughter and one grandson.

WEW

Died, Fred DeVito, 66

Fred DeVito was among California's leading micromounters and field collectors, and a long-time member of the Southern California Micro-Mineralogists.

Alfred (Fred) DeVito was born August 14, 1937 in New Jersey and died March 20, 2004 in Oakhurst, California after a long battle with cancer.

Following High School Fred served in the Army as a soils technician at Fort Dix, then majored in chemistry at Seton Hall University. After moving to California in 1961 he attended California State University at Long Beach, graduating with a BS Degree in biology. He also studied mineralogy at UCLA. His favorite hobby was mineral collecting, particularly micromounting, and he identified many microminerals previously unreported from their localities.

Fred began collecting minerals as a boy, visiting the zeolite-rich traprock quarries near his home in New Jersey. This early experience with zeolites inspired his later field work in California, resulting in a number of published articles about the zeolite and calcium silicate minerals of the Santa Monica Mountains. He is best remembered, however, for his work on the minerals of the Crestmore quarry in Riverside County, California.

Fred served as President of the Mineralogical Society of Southern California, and the Friends of Mineralogy of Southern California. He was also President of the Preservation Fund for the California State Mining and Mineral Museum in Mariposa.

He was the author of several publications including "The Occurrence of 17 Minerals found at Crestmore" (1971), and "The Jensen Quarry, Riverside County, California" (with Al Ordway, in the *Mineralogical Record* in 1984), and was considered the leading authority on the mineralogy of Crestmore. He was a frequent contributor of articles to *Microprobe,* the bulletin of the Northwest Microminerals Study Group, and the *Bulletin of the Mineralogical Society of Southern California*, and also wrote the "Microscoop" column for that publication. In addition to his writings, he was a frequent speaker at mineralogical conferences and shows including the Tucson Show.

In the early 1990's he was inducted into the Micromounters' Hall of Fame. He and his wife Joyce established a micromount business, *Micro World,* and a successful family business in Oakhurst, *Pacific Pectin*.

Bill Rader, writing in *Mineral News*, said: "Many of Fred's discoveries reside now in California museums. These mineral specimens will be a lasting legacy of Fred DeVito the mineral collector. However, Fred's legacy as a human being will be even more enduring. Fred DeVito will be remembered as a person who, in a manner completely devoid of ego, generously shared his vast knowledge of minerals—and of life—with anyone who was wise enough to listen."

WEW

Died, Edward Henry Oyler, 89

Ed walked into my U.S. Geological Survey office and into my life in 1961. He had a specimen of a mineral that he hoped I might be able to identify. I took a very tiny bit of the mineral, made an X-ray powder diffraction photo of it, and found that it had no match with any of the thousands of the minerals known at that time. Ed's mineral occurred as beautiful, tiny yellow crystals and Ed suspected that it might be a new mercury mineral. The minerals of mercury were his favorites. His suspicions proved to be correct: the mineral was indeed new to science. I later had the pleasure of naming this mineral *edoylerite* in honor of its discoverer and (by then) my long-time friend.

Ed Oyler was born February 4, 1915, and died March 9, 2004 in San Martin, California. He must certainly have been exposed to minerals at an early age, considering that his father was a prospector and gold miner who had his own gold mine. But it was a friend of Ed's (Jack Parnau, an electrician and mineral collector) who was largely responsible for leading Ed into the world of minerals and assisting him to become a dedicated collector.

Ed worked for the advertising agency of Foster and Khaiser until his retirement, following which he was more fully able to devote himself to his hobbies of duck hunting (he helped build duck habitats), fishing, gardening and mineral collecting. Ed developed a remarkable knowledge of minerals. He had no formal training and yet he was one of the greatest collectors and experts on minerals that I have ever known. I was a professional mineralogist, had an office loaded with microscopes, X-ray diffraction equipment, chemical and other tools for my use. Ed had only his hand lens with a magnification of 10X to use in identifying anything interesting that he found on his collecting trips, but he amazed me with his ability to visually identify rare minerals.

Ed was interested in minerals from many localities—some famous, such as the big Crestmore marble body in southern California, and many that were known only to Ed. He visited almost all of the mercury deposits of California, and was especially interested in the mines of the New Idria mercury field in San Benito County. He also specialized in the rare minerals of the nearby Gem mine where the state mineral, benitoite, was first found. Ed's discoveries at the Gem mine led professional mineralogists (such as Prof. Joseph Murdoch) to write scientific papers describing the minerals found there. One of the mines in the New Idria district received special attention from Ed. This was the Clear Creek mercury mine. This mine holds the world record for the number of new mercury mineral species found at one locality, and the person who found most of these was Ed Oyler!

Ed was keenly interested in Nature and had talents and abilities that are given to very few people. He would have been equally remarkable if his passion had been collecting butterflies. He was many things, but above all he was a kind, generous, humorous, warm, gentle man who gave much more to life than he took from it.

He was preceded in death by his sons Steven and Edward, but is survived by his wife of 57 years, Elaine, six grandchildren and one great grandson.

Richard C. Erd

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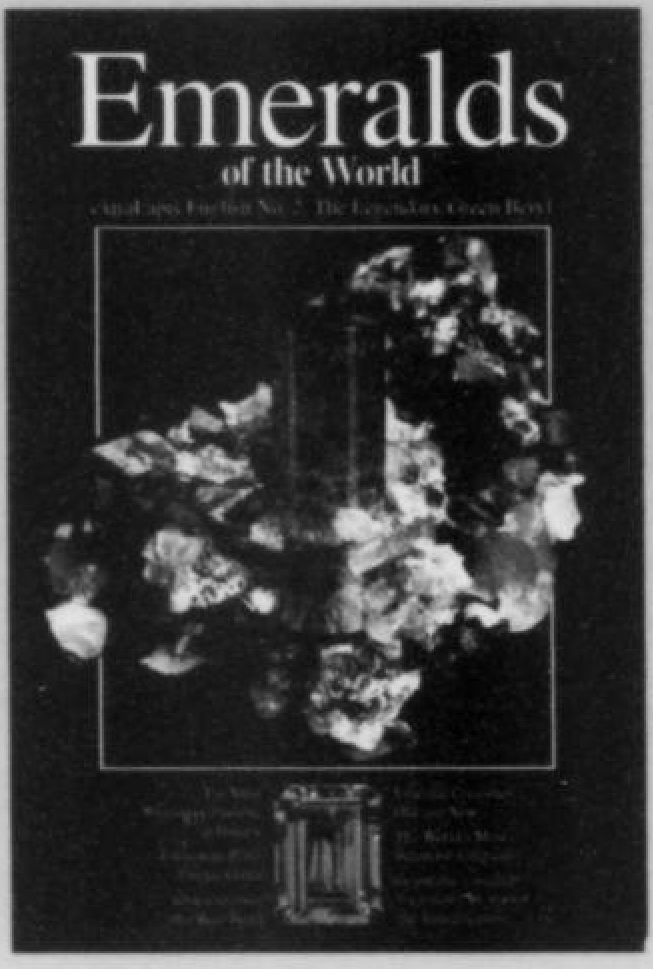

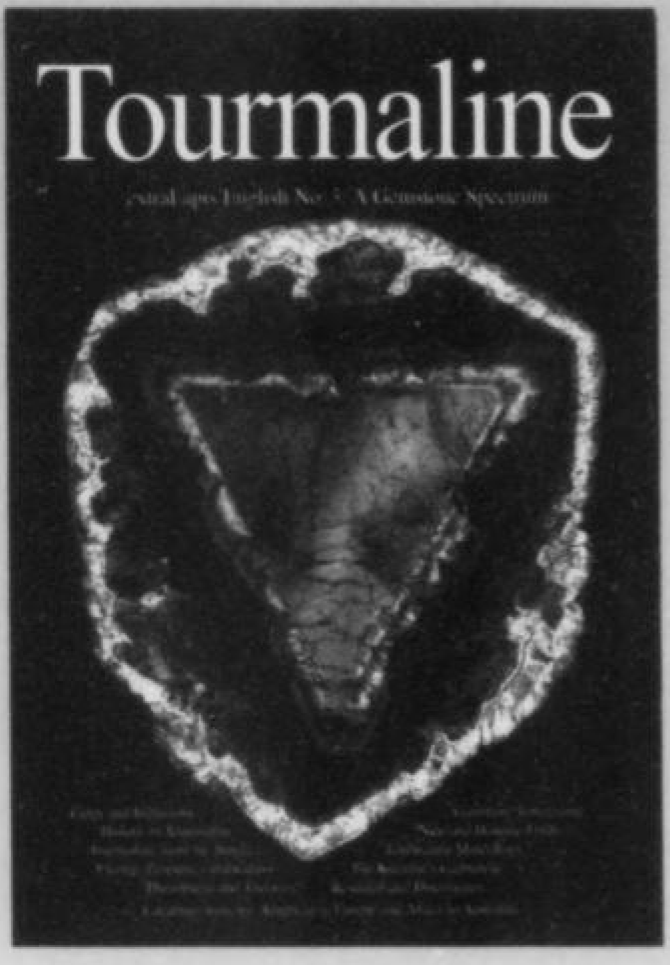

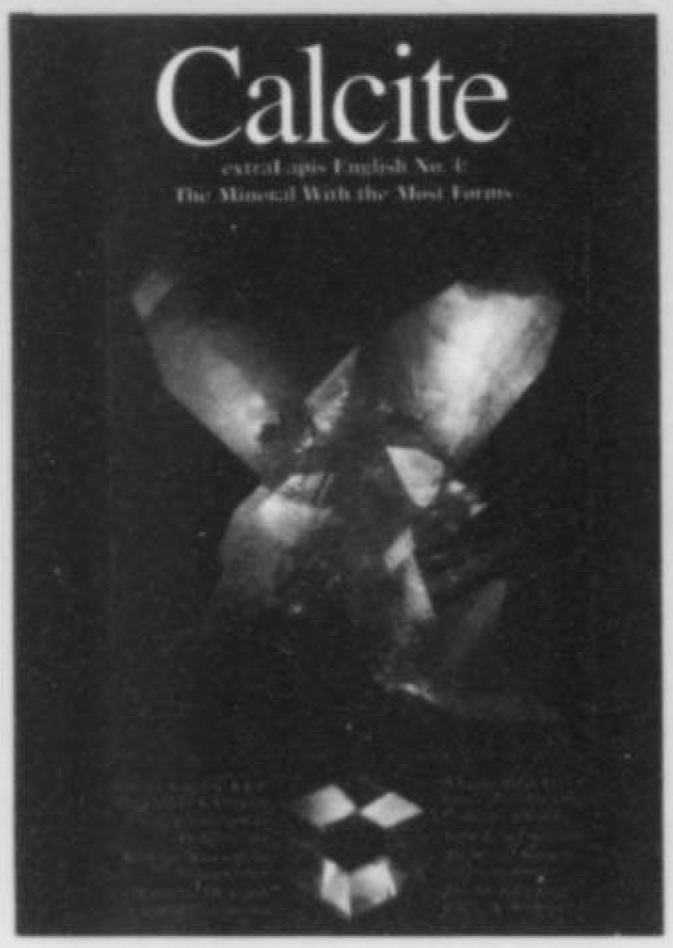

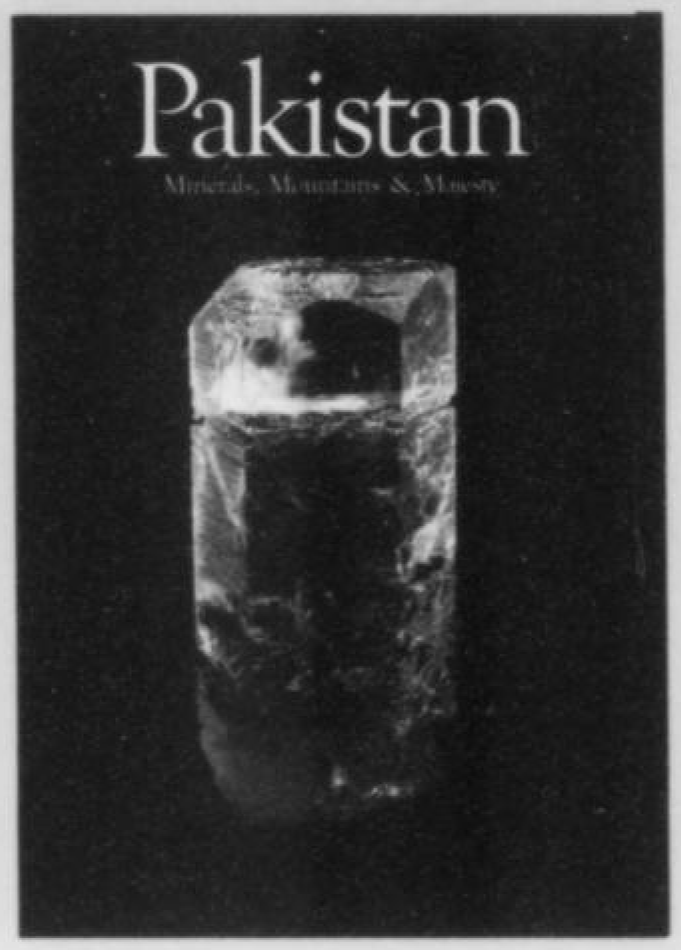

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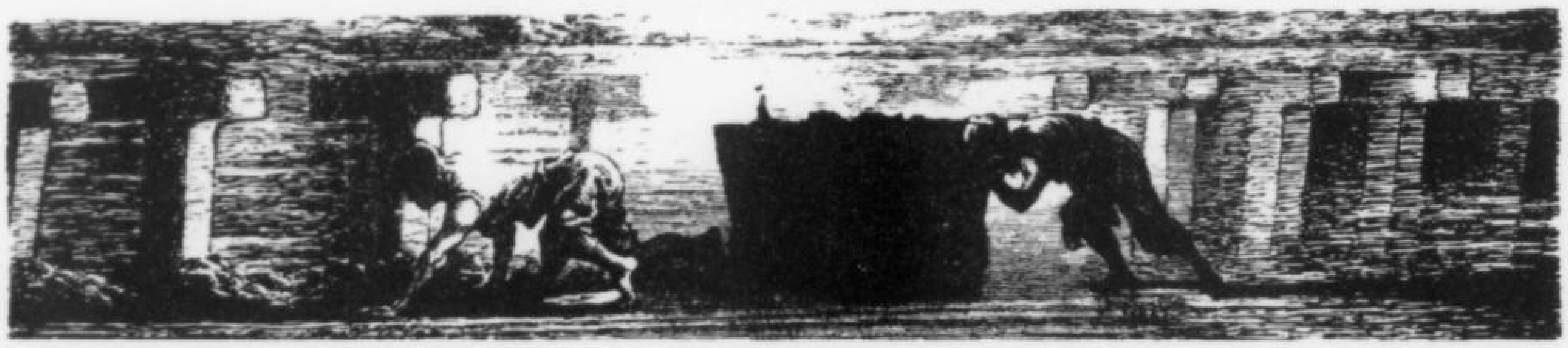

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PEZZOTTAITE

$Cs(Be_2Li)Al_2Si_6O_{18}$

A SPECTACULAR NEW BERYL-GROUP MINERAL FROM THE SAKAVALANA PEGMATITE, FIANARANTSOA PROVINCE, MADAGASCAR

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ABSTRACT

Pezzottaite is a new mineral from the Sakavalana pegmatite, located 25 km south of the village of Mandosonoro, southwest of the town of Antsirabe, 140 km southwest of Ambatofinandrahana, in Fianarantsoa province, central Madagascar. It usually occurs as isolated crystals that can have three distinct habits: (1) irregularly shaped flat masses that fill cavities between "cleavelandite", quartz and tourmaline; (2) subhedral-to-euhedral hexagonal tabular crystals up to 10 cm in diameter; and (3) small flat to equant to elongated crystals attached to faces of large tourmaline crystals. The form {001} is dominant, with minor {100} and {101}; no twinning was observed. Pezzottaite is moderate red (Munsell #15) to pink, with moderate dichroism in polarized light in hand specimen: ω = pink-orange and ε = purplish pink to pinkish purple. The streak is colorless to white, crystals are transparent to translucent with a vitreous luster and no observable fluorescence in long- and short-wave ultraviolet light. Crystals are brittle with both conchoidal and irregular fracture, have an imperfect cleavage parallel to {001}, and no observable parting. Mohs hardness is 8, the observed density is 2.97–3.14 g/cm^3 and the calculated density is 3.06 g/cm^3. Pezzottaite is uniaxial negative with $\varepsilon = 1.601–1.611$ and $\omega = 1.612–1.620$, depending on Cs content. In transmitted plane-polarized light, it is strongly pleochroic, orange-red $\|\varepsilon$ and purple-violet $\|\omega$.

Pezzottaite is rhombohedral, space group *R3c*, with the following unit-cell parameters refined from X-ray powder-diffraction data: *a* 15.946(4), *c* 27.803(8) Å, *V* 6122(2) Å^3, Z = 18. The ten strongest lines in the X-ray powder-diffraction pattern are as follows: *d* (Å), *I*, (*hkl*): 3.271, 100, (036); 2.871, 52, ($\bar{1}53$); 3.027, 41, ($\bar{1}46$); 3.09, 29, ($\bar{1}50$); 2.215, 14, ($\bar{2}70$); 1.636, 14, (0.6.12); 2.229, 12, ($\bar{1}2.12$); 1.749, 12, ($\bar{3}6.12$); 1.743, 12, ($\bar{3}90$); 1.518, 11, ($\bar{3}99$). Chemical analysis by electron microprobe and ICP (Li) gave SiO_2 55.55, Al_2O_3 16.00, Sc_2O_3 0.03, MnO 0.04, Na_2O 0.19, K_2O 0.04, Rb_2O 0.64, Cs_2O 16.12, Li_2O 2.16, BeO_{calc} 7.95, H_2O 0.28, sum 99.00 wt.%, where the amount of H_2O was determined by crystal-structure analysis. The resulting empirical formula, calculated on the basis of 18 structural O atoms, is $(Cs_{0.74}Rb_{0.04}K_{0.01}Na_{0.04})_{\Sigma 0.83}(Be_{2.06}Li_{0.94})Al_{2.04}Si_{6.00}O_{18}\text{-}(H_2O)_{0.10}$. Chemical analysis by LA-ICP-MS gave SiO_2 54.58, TiO_2 0.01, Al_2O_3 16.88, FeO 0.02, MnO 0.02, CaO 0.22, Na_2O 0.46, K_2O 0.14, Rb_2O 0.44, Cs_2O 18.23, Li_2O 2.12, BeO 8.14 sum 101.26 wt.%. The resulting empirical formula, calculated on the basis of 18 structural O atoms, is $(Cs_{0.84}Rb_{0.03}K_{0.02}Na_{0.10})_{\Sigma 0.98}(Be_{2.10}Li_{0.92})_{\Sigma 3.02}Al_{2.00}(Si_{5.86}Al_{0.14})O_{18}$. The end-member formula of pezzottaite is $Cs(Be_2Li)Al_2Si_6O_{18}$. The mineral is named for Dr. Federico Pezzotta of the Museo Civico, Milano, Italy, for his major role in characterizing the granitic pegmatites of Madagascar. The new mineral and mineral name have been approved by the Commission of New Minerals and Mineral Names of the International Mineralogical Association (2003-022). Pezzottaite is related to the minerals of the beryl group, but differs in having essential Cs and a superstructure that arises from ordering of Be and Li in tetrahedral coordination.

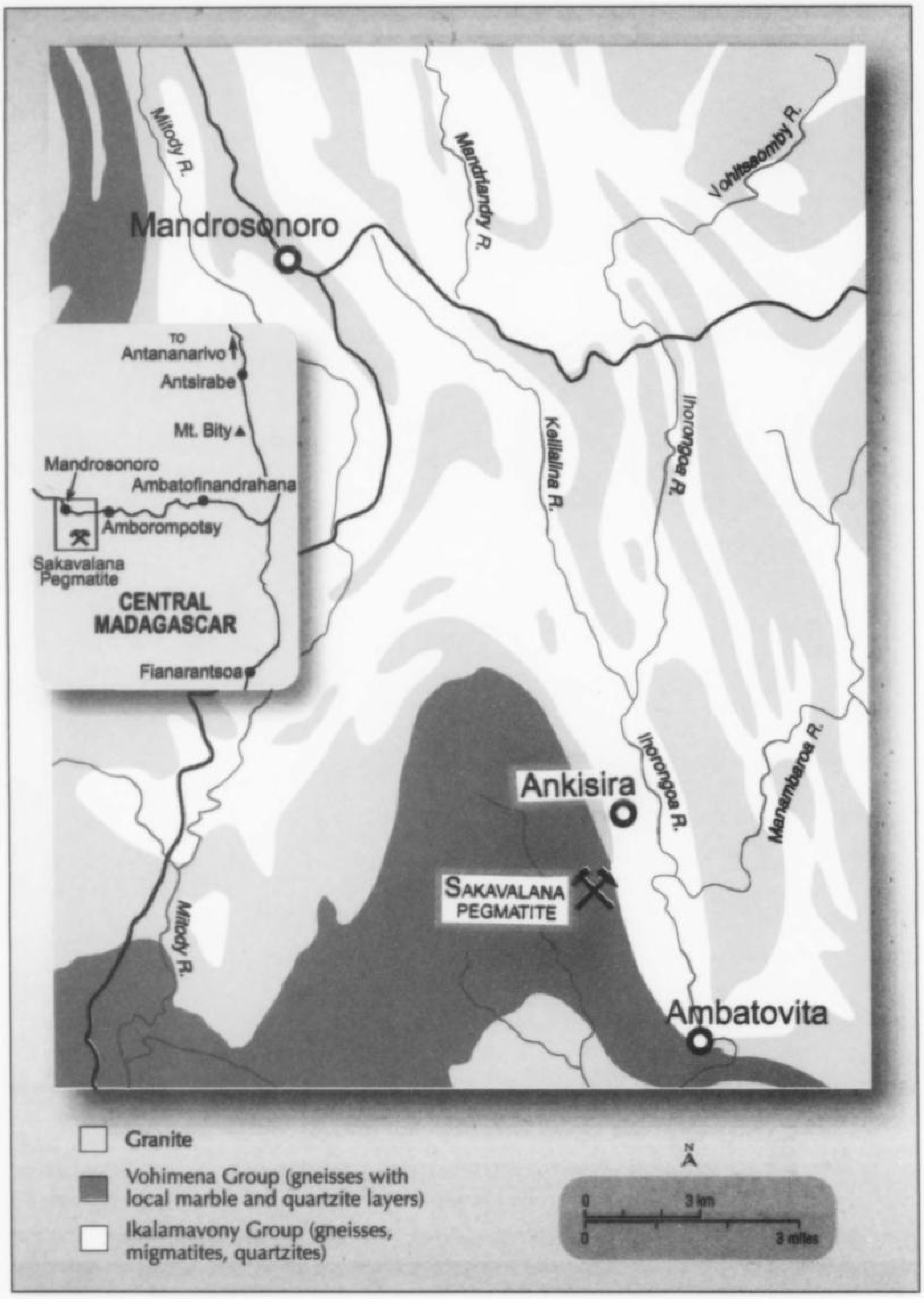

***Figure 1.* Central Madagascar, showing the location of the towns of Antsirabe, Ambatofinandrahana and Mandrosonoro in relation to the pezzottaite type locality.**

INTRODUCTION

One of the most exciting mineral discoveries offered at the 2003 Tucson Gem and Mineral Show was the "red beryl," "raspberyl" or "hot pink-red beryl" displayed by many dealers. Rumors circulated as to the chemical composition of these very attractive crystals and whether or not they represented a new mineral species. The tabular habit, pink color and high refractive index suggested that this material is enriched in Cs, and this was confirmed by recent publications (Simmons *et al.*, 2003; Laurs *et al.*, 2003; Hänni and Krzemnicki, 2003; Abduriyim and Kitawaki, 2003; Warin and Jacques, 2003). Subsequent chemical and crystallographic examination showed that it is indeed a new mineral, and the formal description is presented here. The new mineral and mineral name, *pezzottaite* (pronounced "pets-aw′-tuh-ite"), have been approved by the Commission on New Minerals and Mineral Names, International Mineralogical Association. Type material is deposited in the Smithsonian Institution, Washington, DC, in the Canadian Museum of Nature, Ottawa, Ontario, Canada, and in the Natural History Museum of Bern (NMBE-36990), Switzerland. Sample NMBE-36990 was used for ICPMS analysis and single-crystal structure refinement.

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Figure 2. **These rolling hills are typical of those seen in central Madagascar en route to the pezzottaite mine. Photograph by Brendan M. Laurs, GIA.**

LOCATION AND ACCESS

The Sakavalana pegmatite is located about 140 air-kilometers southwest of Antsirabe, in Fianarantsoa province, central Madagascar. In July 2003, one of the authors (BML) accompanied Dr. Federico Pezzotta (Museo Civico di Storia Naturale, Milan, Italy) on a reconnaissance visit to the mine. We were the first foreigners to visit since French mineral dealer Laurent Thomas went there in January 2003, shortly after the mineral was first discovered. The route follows paved roads from Antsirabe to Ambatofinandrahana (Fig. 1), a distance of approximately 160 km that required about 6 hours of driving time. From there, a rough dirt track runs approximately 140 km to the town of Mandrosonoro (Fig. 3), and then another 25 km to the mine. The four-wheel-drive track passes through grasslands (Fig. 2), rolling hills and mountainous terrain, and crosses two rivers. This drive ideally takes about 14 hours, but considerable delays can be expected due to breakdowns caused by the rough terrain. Note that the road is typically hazardous to impassible during the rainy season from December to April.

GEOLOGY

The Sakavalana granitic pegmatite is located in the northern part of the Ampandramaika-Malakialina pegmatite district (Pezzotta, 2001). This pegmatite is a sub-vertical dike about 4–6 m thick and over 200 m long, and is enriched in Li–Cs–Ta minerals and characterized by the typical "mixed" feature (LCT and NYF, Černý, 1991) of some Malagasy pegmatites (Pezzotta, 2001). The pegmatite is hosted in impure marbles of the Vohimena Formation belonging to a metasedimentary sequence of marbles and quartzitic gneiss of medium metamorphic grade. The pegmatite is very rich in K-feldspar and contains large elongated blades of black mica in the border zones. Adjacent to the core zone, blades of white mica and pink to purple lithian muscovite appear, together with locally abundant smoky quartz, platy "cleavelandite" albite, green "amazonite" microcline, and tourmaline. In addition to the minerals mentioned above, danburite occurs in cavities, accompanied by zircon, spessartine and Nb-Ta oxides.

OCCURRENCE

The Sakavalana pegmatite is situated on a low hill at 920 m above sea level, coordinates 20°44.8′ S and 46°04.5′ E. It is located a few kilometers northwest of the village of Ambatovita, and southwest of Ankisira (Fig. 1), both of which lie along the Manambaroa River. The mine consists of pits, shafts and open cuts that explore at least one steeply south-dipping pegmatite dike. Mining at this location began in the 1940's, in search of polychrome tourmaline for specimens, carving and gem use. However, pezzottaite was not found there until mid-November of 2002. At the time of the mine visit in July 2003, mining for pezzottaite (and tourmaline) was continuing, but at a slower pace than in earlier months.

The main discovery of pezzottaite occurred about 6 m below the surface, in a subvertical pegmatite that is about 4–6 m thick and more than 200 m long. Many fine crystals of pezzottaite were recovered from a single pocket containing mostly smoky quartz,

Figure 3. The town of Mandrosonoro, located about 25 km north of the mine. Photograph by Brendan M. Laurs, GIA.

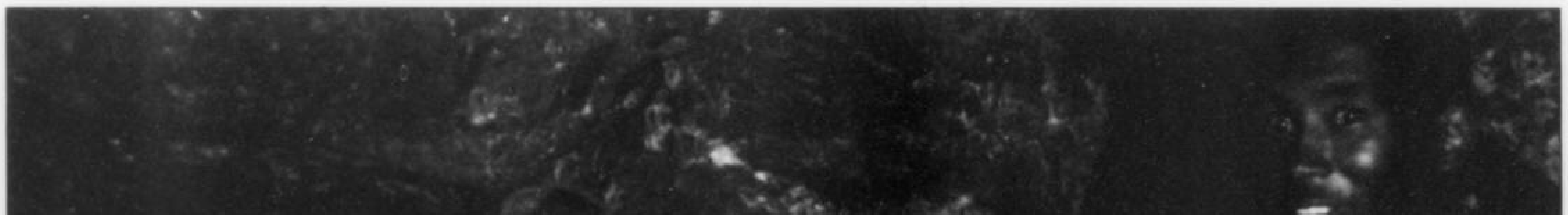

Figure 4. Mining for pezzottaite is done by candlelight using simple hand tools; this zone contained numerous vugs. Photograph by Brendan M. Laurs, GIA.

Figure 5. **Translucent crystal (right, 3 cm) and crystal aggregate (left) of pezzottaite. Stuart Wilensky specimens; Jeff Scovil photo.**

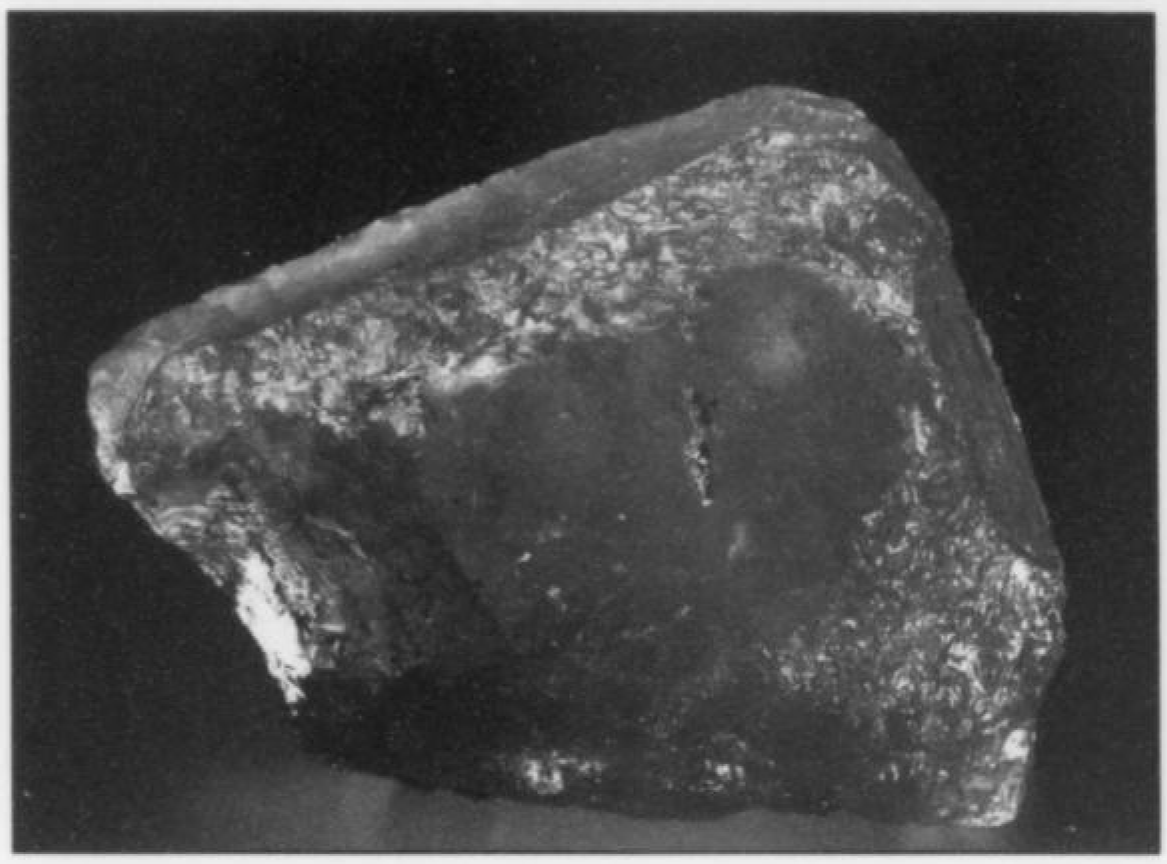

Figure 6. **Pezzottaite crystal, 6.2 cm across, displaying a prominent {001} pinacoid and smaller prism faces. Dudley Blauwett specimen; Jeff Scovil photo.**

Figure 7. **Tabular crystal of pezzottaite, 4.3 cm. Stuart Wilensky specimen; Jeff Scovil photo.**

amazonite and cleavelandite. In addition, multicolored tourmaline, pink-yellow-green spodumene, lithian muscovite and danburite occurred in this pocket which reportedly measured at least 1.2 x 3 x 3 m. Below this pocket was a zone containing numerous vugs with smaller crystals of pezzottaite. The pocket zone occurs within the core zone of the pegmatite, which consists of amazonite, smoky quartz, black tourmaline, lithian muscovite and cleavelandite.

Information provided by the miners, together with our observations of the surface and underground workings, indicate that all the pezzottaite produced up to that time came from a limited area within a single granitic pegmatite body. The majority of the gem-bearing zone has been mined out, and the remaining areas are difficult to work with the hand tools available (Fig 4). The total production of the pocket was about 700 kg of smoky-citrine quartz in crystals up to 50 kg, 280 kg of polychrome tourmaline crystals covered by a skin of black tourmaline (the three largest crystals were 15, 25, and 50 kg), 25 kg of gemmy spodumene (as well as some tens of kg of deeply corroded low quality spongy-crystals), and 40 kg of pezzottaite as crystals, fragments and masses (normally of a few grams, but in a few cases up to 100 g), plus many tens of kg of low-quality fragments and deeply corroded crystals (Federico Pezzotta, personal communication). Small amounts of pezzottaite were available at the mine, as well as elsewhere in Madagascar, but the material available there was of low quality.

PHYSICAL AND OPTICAL PROPERTIES

Pezzottaite occurs in three distinct habits: (1) irregularly shaped flat masses (up to 8 cm in diameter) that fill cavities between cleavelandite, quartz and tourmaline; (2) subhedral-to-euhedral hexagonal tabular crystals up to 10 cm across; (3) small (a few mm) flat to equant to elongated crystals attached to faces of large tourmaline crystals. The surface of the crystals varies from brilliant and adamantine (rare) to matte and slightly corroded (common). Type-2 crystals have occasionally been observed on matrix with quartz, amazonite, lithian muscovite, cleavelandite, and small prisms of black tourmaline (with a polychrome core). In some cases, crystals of type-3 are unusually elongated due to stacking of small tabular crystals. In well-developed crystals, the form {001} is dominant with minor {100} and {101}; no twinning was observed.

Larger crystals of pezzottaite tend to be hexagonal in outline and tabular on {001} (Fig. 7); the largest crystals of this type (Fig. 6) are up to approximately 10 cm in width. Crystals range from fairly opaque to translucent (Fig. 5), and sub-parallel aggregates of crystals are common. In translucent crystals, tubular channels containing water extend parallel to the *c*-axis, and impart chatoyancy to some crystals (Fig. 9) such that cat's-eye cabochons (Laurs

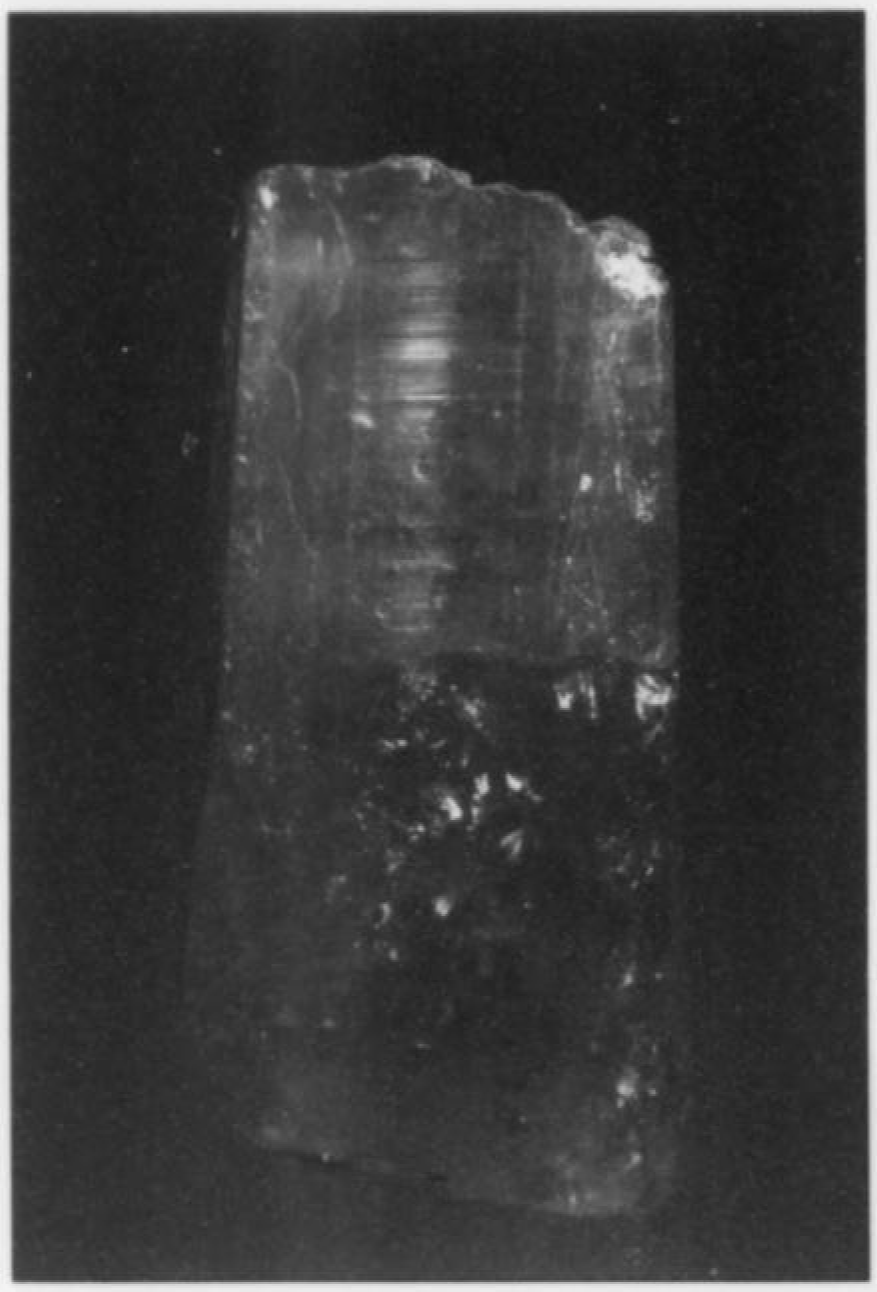

Figure 9. **Tabular crystal of pezzottaite, 6 cm across, viewed edge-on, showing chatoyancy associated with tubular fluid inclusions parallel to the *c*-axis. Dudley Blauwett specimen; Jeff Scovil photo.**

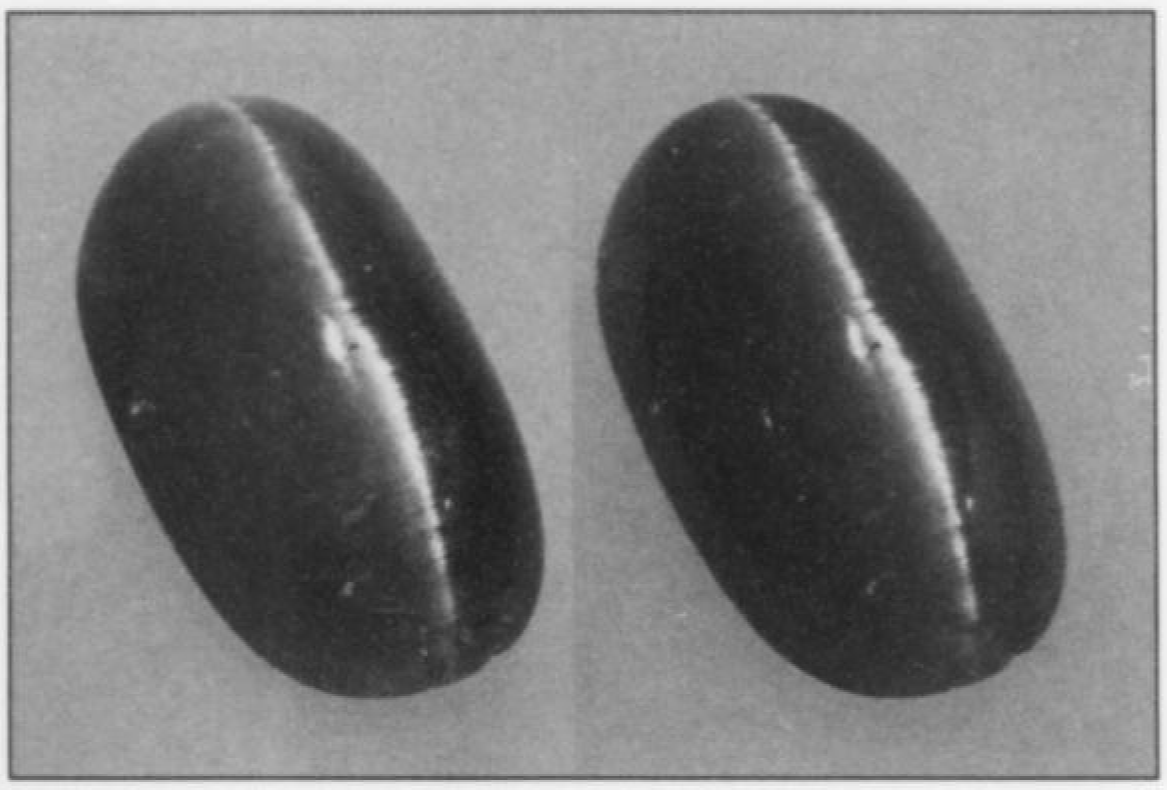

Figure 8. **Cat'e-eye cabachon of pezzottaite (8.78 ct.). The two views photographed through a polarizer (in orthogonal orientation) and show distinct dichroism. Bill Pinch collection; Maha Tannous photos.**

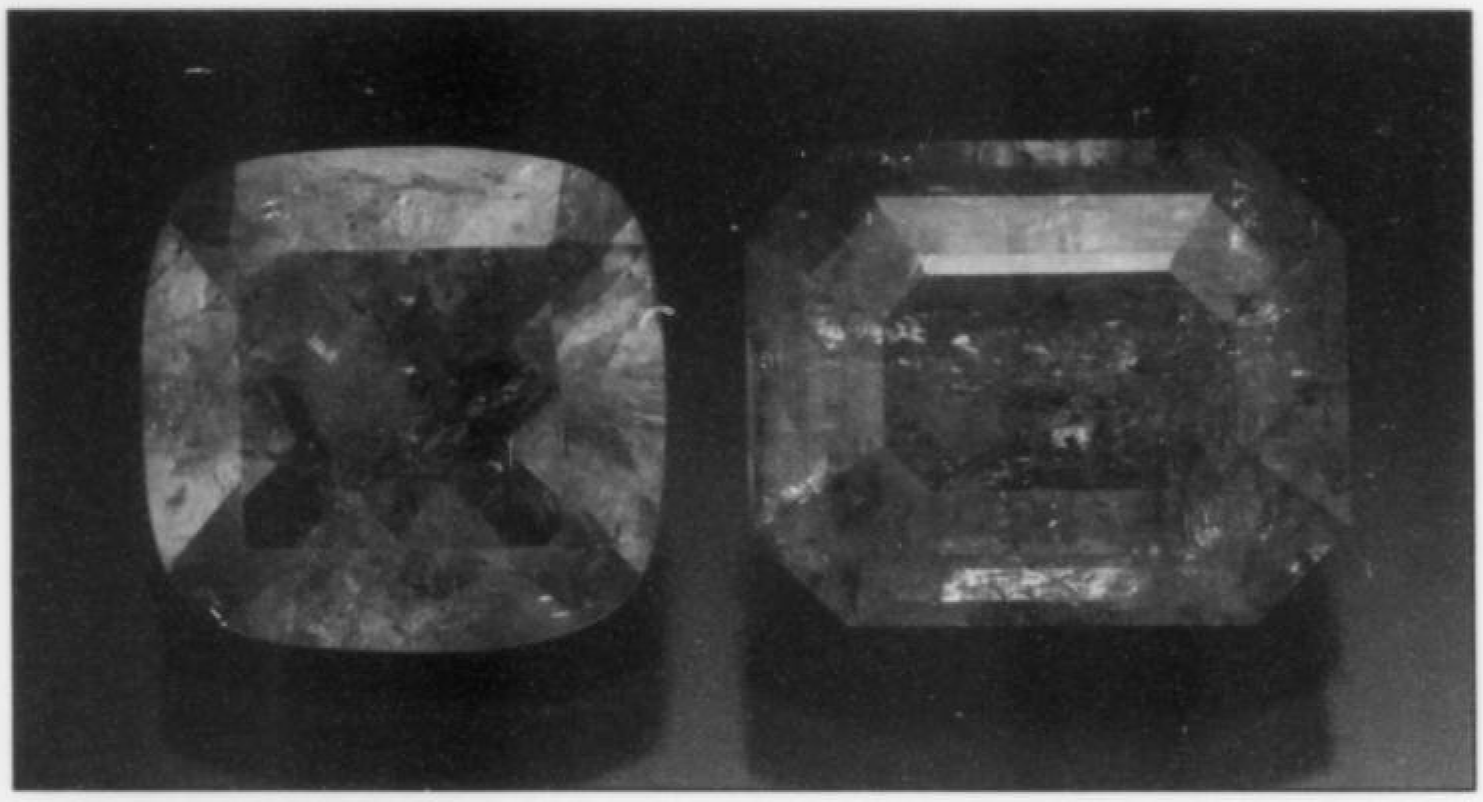

Figure 10. **Two faceted stones of pezzottaite. Photograph by Jeff Scovil; private collection.**

Figure 11. **Type-3 crystals of pezzottaite approximately 6 mm across, on amazonite. Federico Pezzotta collection; Roberto Appiani photo.**

et al., 2003) can be produced (Fig. 8). Transparent crystals can be faceted to produce very attractive cut stones (Fig. 10). Type-3 crystals (Fig. 11) exhibit a different habit from earlier-generation crystals. The {001} form is still present but far less dominant, and both pyramid {101} and prism {100} faces are of equal importance. Earlier-generation pezzottaite [type-1 and type-2] frequently shows corrosion by later hydrothermal fluids. For first-generation and second-generation crystals, this process is summarized in Figure 12. The characteristic pink-red (Munsell #15) color of pezzottaite is confined to the terminations of the crystal, and the remaining parts of the crystal are milky white or very pale pink. Corrosion selectively alters the white and pale-pink parts of the crystal, either leaving a spongy material on which microcrystals of albite form, or completely removing the central part of the crystal and leaving two separate pink gemmy terminations (Fig. 12A). One side of the termination consists of the morphology of the original crystal, and the other side consists of a series of steps and striations resulting from the corrosion process (Fig. 12A). Later-generation crystals [type-3, Fig. 12B] can also be corroded. The process involved (Fig. 12B) is similar to that depicted in Figure 12A, with the residual fragments of pezzottaite reflecting the habit of the original crystal (Fig. 13).

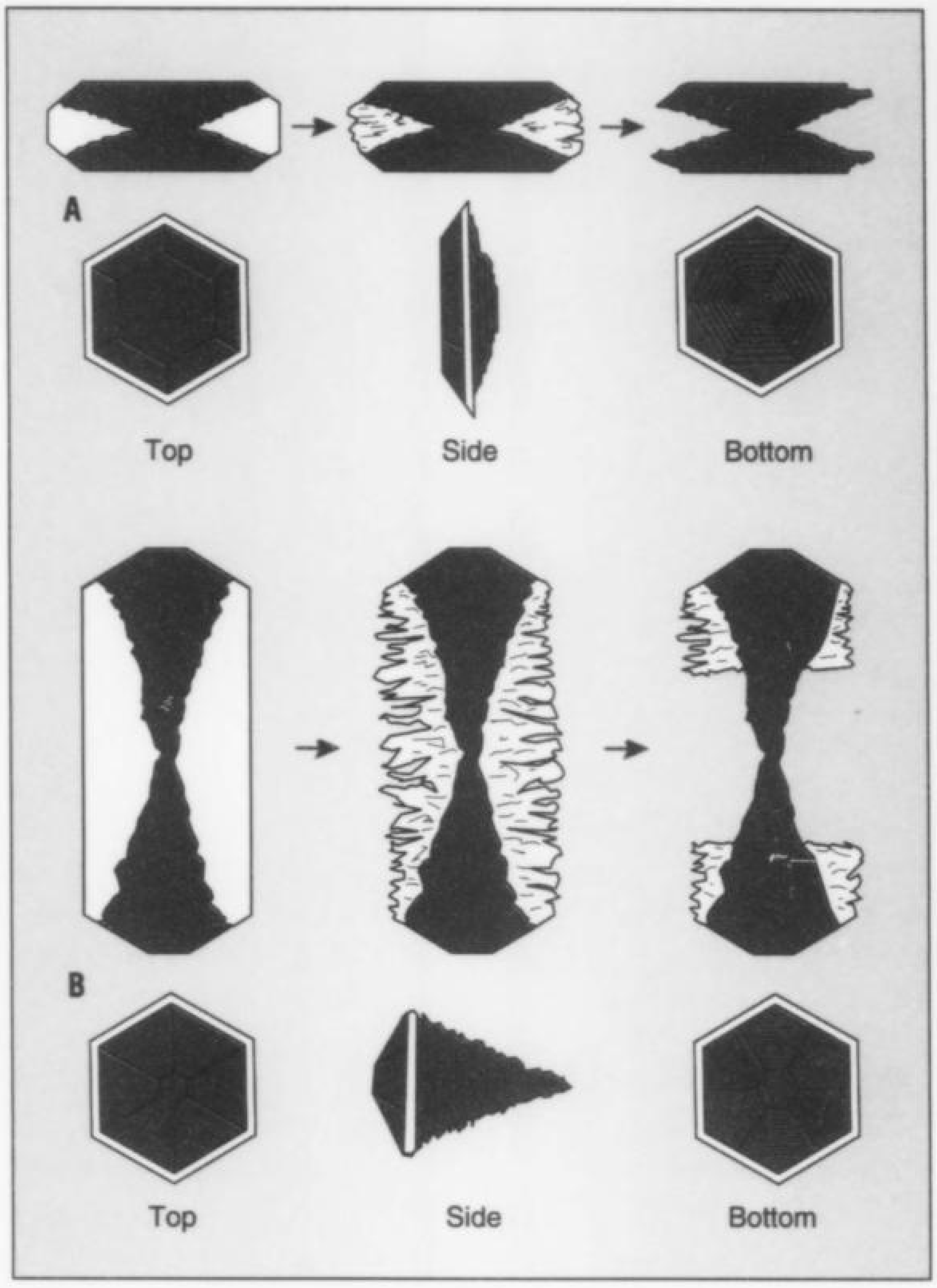

Figure 12. **Sketches of the color zoning and corrosion process of a typical type-1 pezzottaite crystal. (A) The bright pink-red color is confined to two zones at the terminations of the crystal. These terminations are gemmy whereas the other zones of the crystal are milky white or very pale pink. The corrosion process selectively alters the milky white zones of the crystal. Partial corrosion leaves a spongy material on which white microcrystals of albite can form. More commonly, the corrosion process completely dissolves the milky white parts of the crystal, leaving two separated colored zones. (B) The lower part of the figure represents the shape of the separate color zones: on one side, the crystal is terminated by the faces of the original crystal, whereas on the other side are steps and striations resulting from the corrosion process. Modified from information supplied by Federico Pezzotta.**

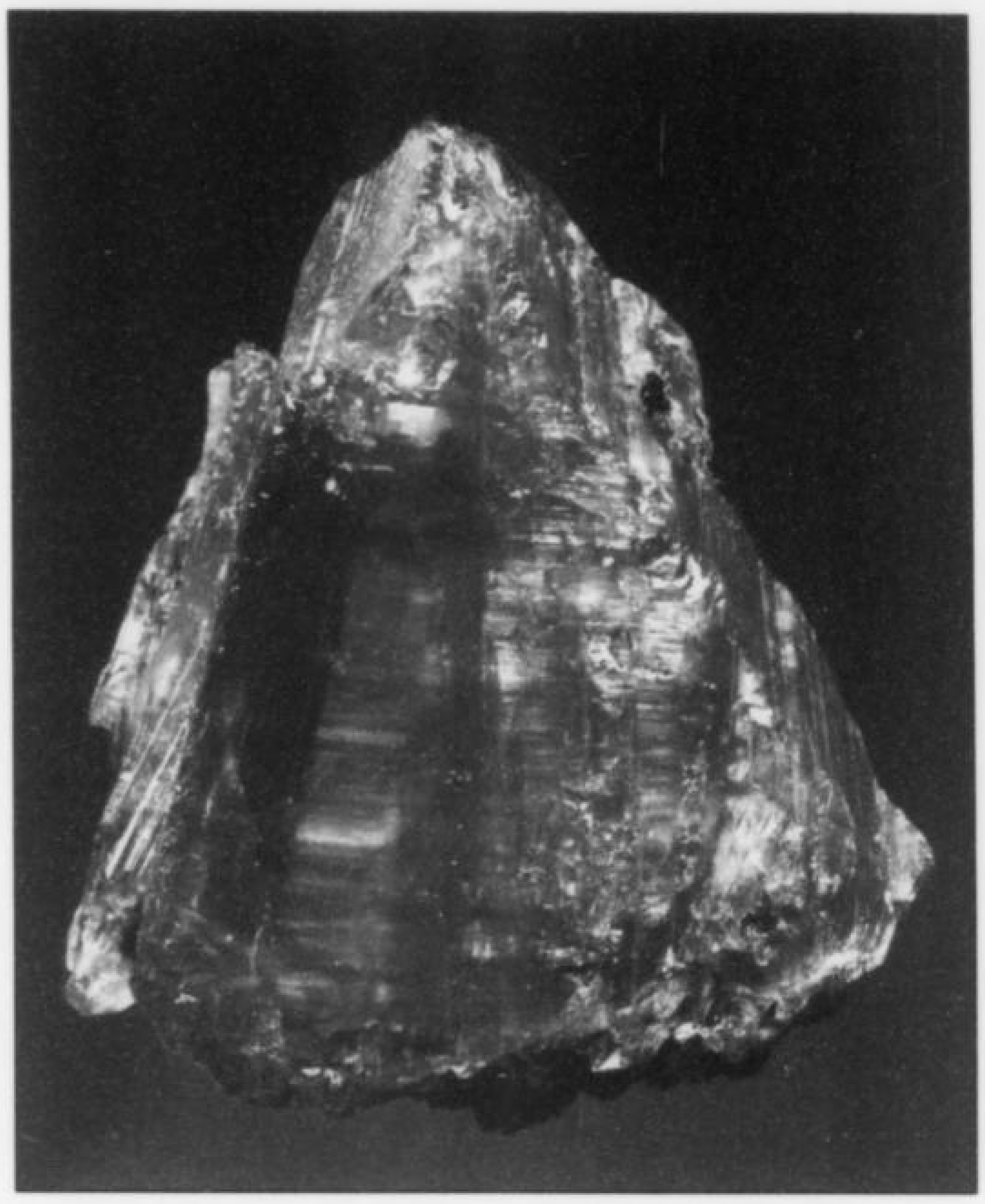

Figure 13. **A cone-shaped corroded crystal that represents the final product of the corrosion process for type-3 crystals (Fig. 12B). Loose crystals of this type are abundant in clay-filled cavities. Stuart Wilensky specimen; Jeff Scovil photo.**

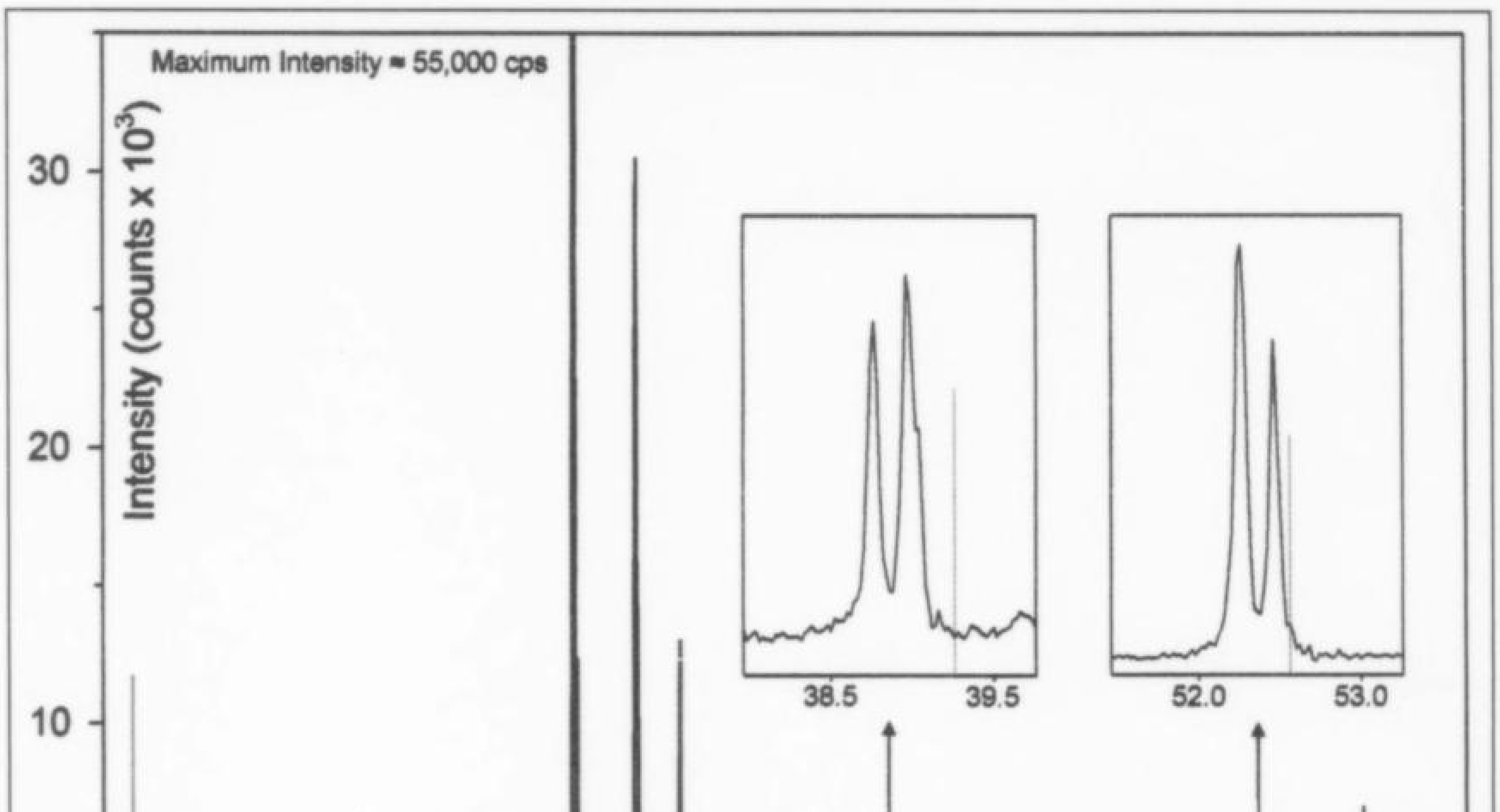

Figure 14. **Selected parts of the X-ray diffraction pattern of pezzottaite compared with the pattern (shown as red lines) of beryl. There are significant differences in the relative intensities of the peaks, particularly with regard to the *h*00 reflections that are strongly affected by the presence of Cs in the channels through the structure. Structurally equivalent peaks in pezzottaite and beryl lie at lower 2θ values in pezzottaite due to expansion of the structure caused by inclusion of Cs and substitution of Li for Be. Moreover, many of the peaks in pezzottaite occur as doublets relative to the analogous single lines in beryl (see insets in figure).**

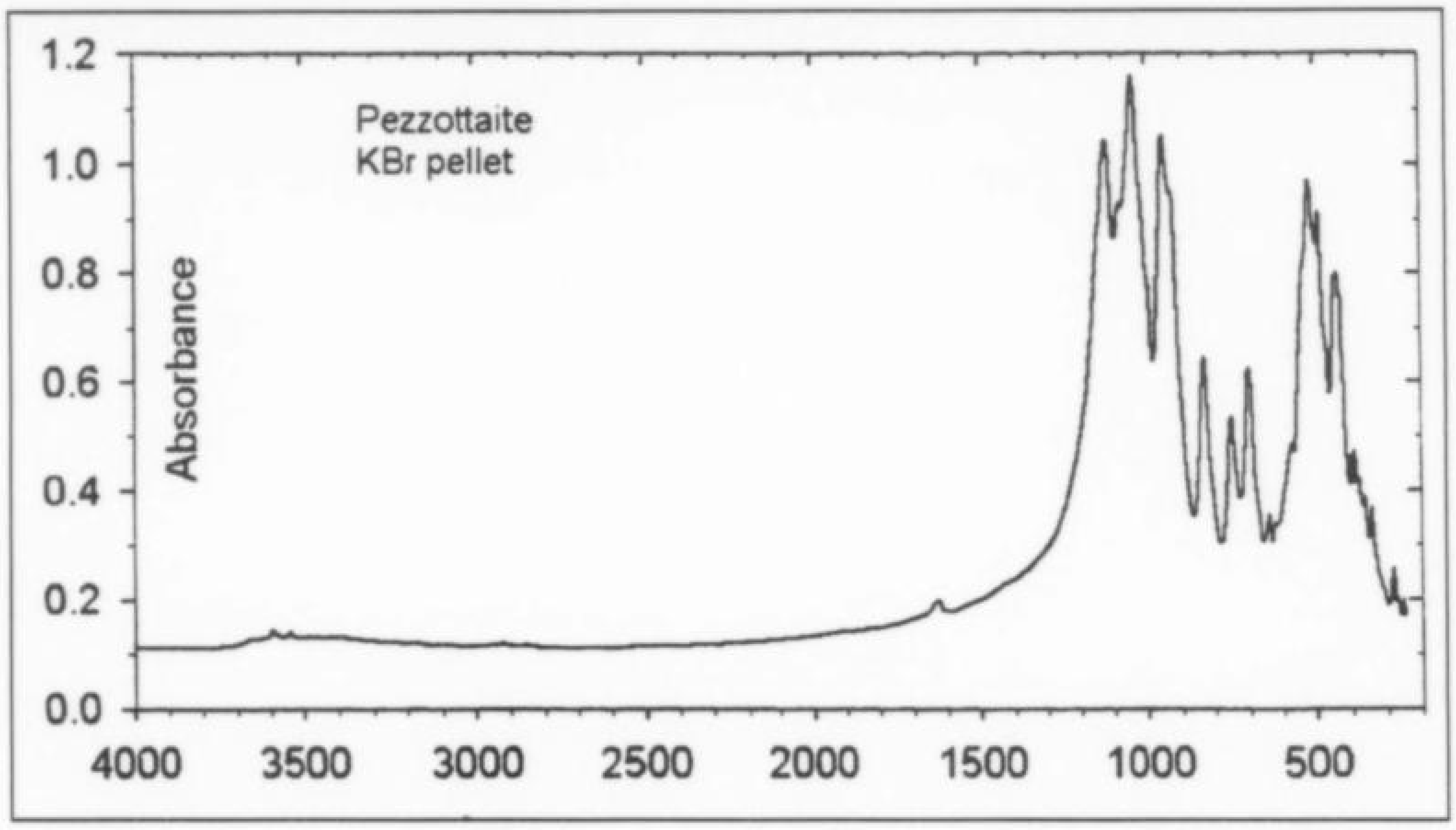

Figure 15. **The infrared spectrum of pezzottaite powder in a KBr pellet.**

Table 1. **Chemical composition (wt.%)* and formulae for pezzottaite.**

	low Cs	*high Cs*	*LA-ICP-MS*
SiO_2	57.59	55.55	54.58
Al_2O_3	16.22	16.00	16.88
FeO	0.00	0.00	0.02
MnO	0.09	0.04	0.02
CaO	0.00	0.00	0.22
Na_2O	0.32	0.19	0.46
K_2O	0.09	0.04	0.14
Rb_2O	0.85	0.64	0.44
Cs_2O	11.12	16.12	18.23
Li_2O	2.16	2.16	2.12
BeO	8.25 **	7.95 **	8.14
Σ	96.69	98.69	101.25
Si	6.06	6.00	5.86
Al	—	—	0.14
Al	2.01	2.04	2.00
Be	2.09	2.06	2.10
Li	0.91	0.94	0.92
Σ	3.00	3.00	3.02
Cs	0.50	0.74	0.83
Rb	0.06	0.04	0.03
Na	0.07	0.04	0.10
K	0.01	0.01	0.02
Ca	0.00	0.00	0.02
Σ	0.64	0.83	1.00

* Below detection limit: Mg, Ti, Fe, Ca, Cr, Bi, V, Pb, Zn, Ba, Cl, F.

** Taken from Simmons *et al.* (2003).

Pezzottaite is raspberry-red to pink, with moderate dichroism in hand specimen (Fig. 8): ω = pink-orange and ε = purplish pink to pinkish purple. The streak is colorless to white, crystals are transparent to translucent with a vitreous luster and no observable fluorescence in longwave and shortwave ultraviolet light. Crystals are brittle, with both conchoidal and irregular fractures, have an imperfect cleavage parallel to {001}, and no observable parting. Mohs hardness is 8, the observed density is 2.97 g/cm³ and the calculated density is 3.06 g/cm³. Pezzottaite is uniaxial negative with $\varepsilon = 1.601–1.611$ and $\omega = 1.612–1.620$ depending on Cs content; these values are high for the beryl-type structure, but are in accord with the trends documented by Černý and Hawthorne (1976). Pezzottaite is strongly pleochroic in transmitted plane-polarized light, with orange-red $\|\varepsilon$ and purple-violet $\|\omega$.

CHEMICAL COMPOSITION

Crystals of pezzottaite were analyzed with an ARL-SEMQ electron microprobe operating in the wavelength-dispersion mode, with an accelerating voltage of 25 kV (15 kV for Na), a beam current of 15 nA, and a beam diameter of 3 µm. Both minerals and synthetic compounds were used as standards. The data were reduced and corrected by the ZAF method and are given in Table 1, together with Li_2O determined by ICP. The amount of H_2O was determined by LOI (Loss On Ignition) and by crystal-structure refinement (Hawthorne and Grice, 1990); the value obtained by LOI was 1.72 weight %, but this value is not representative of the amount of H_2O in the pezzottaite structure. First, the channel in the structure is nearly filled with Cs and other alkali cations, and there is no room for H_2O in the amount suggested by the LOI value. Second, careful examination of pezzottaite shows the common presence of large numbers of elongated fluid inclusions, suggesting that this high value is due to fluid inclusions rather than structural H_2O. The value of 0.28 weight % H_2O obtained by crystal-structure refinement is more reliable. Pezzottaite was also analyzed by LA-ICP-MS (Laser-Ablation Inductively Coupled Plasma Mass-Spectrometer), and the resultant chemical composition is given in Table 1. Chemical formulae were calculated on the basis of 18 O atoms (excluding H_2O) and are also given in Table 1. The end-member formula of pezzottaite is $Cs\,(Be_2\,Li)\,Al_2\,Si_6\,O_{18}$.

X-RAY POWDER DIFFRACTION

The powder-diffraction pattern was recorded with a Siemens D-5000 X-ray powder diffractometer equipped with an incident-beam monochrometer, a Peltier detector and CuK_{-1} X-rays. Reflections were indexed by comparison of the observed pattern with the pattern calculated from the refined crystal structure of pezzottaite. Table 2 shows the X-ray powder-diffraction data and the refined unit-cell dimensions of pezzottaite, and a comparison of the beryl and pezzottaite diffraction patterns is shown in Figure 14.

INFRARED SPECTRUM

The infrared spectrum is shown in Figure 15. The pattern generally resembles that of beryl, but some bands are somewhat shifted in frequency from those of beryl. The broad envelope

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

$I_{est.}$	$d_{meas.}$ (Å)	$d_{calc.}$ (Å)	*h*	*k*	*l*	$I_{est.}$	$d_{meas.}$ (Å)	$d_{calc.}$ (Å)	*h*	*k*	*l*
<1	7.992	7.987	1	1	0	3	1.834	1.834	$\bar{4}$	8	6
4	4.642	4.643	0	0	6	6	1.801	1.801	$\bar{2}$	7	9
10	4.611	4.617	0	3	0	12	1.749	1.749	$\bar{3}$	6	12
2	4.013	4.010	$\bar{1}$	2	6	12	1.743	1.743	$\bar{3}$	9	0
2	3.993	3.993	$\bar{2}$	4	0	10	1.713	1.713	$\bar{3}$	9	3
100	3.271	3.272	0	3	6	9	1.704	1.704	$\bar{1}$	8	6
41	3.027	3.028	$\bar{2}$	4	6	14	1.636	1.635	0	6	12
29	3.019	3.019	$\bar{1}$	5	0	6	1.632	1.632	$\bar{3}$	9	6
52	2.871	2.872	$\bar{1}$	5	3	2	1.581	1.582	$\bar{1}$	5	15
9	2.662	2.662	$\bar{3}$	6	0	3	1.577	1.577	$\bar{1}$	8	9
6	2.321	2.321	0	0	12	2	1.547	1.547	0	0	18
6	2.309	2.309	$\bar{3}$	6	6	11	1.518	1.519	$\bar{3}$	9	9
4	2.305	2.305	0	6	0	1	1.514	1.514	$\bar{4}$	8	12
12	2.229	2.229	$\bar{1}$	2	12	4	1.509	1.509	$\bar{2}$	10	0
14	2.215	2.215	$\bar{2}$	7	0	2	1.490	1.490	$\bar{8}$	10	3
6	2.155	2.155	$\bar{2}$	7	3	7	1.467	1.467	0	3	18
9	2.065	2.065	0	6	6	6	1.459	1.459	0	9	6
2	1.999	1.999	$\bar{2}$	7	6	2	1.443	1.443	$\bar{2}$	4	18
5	1.840	1.840	$\bar{1}$	5	12						

a 15.973(4), *c* 27.849(11) Å, *V* 6153.1(3) Å^3, $R\bar{3}m$.

***Table 3.* The minerals of the beryl group.**

	Beryl[1]	*Bazzite*[2]	*Stoppaniite*[3]	*Indialite*[4]	*Pezzottaite*[5]
a (Å)	9.21	9.501	9.397	9.8	15.946
c	9.194	9.178	9.202	9.345	27.803
V (Å^3)	675.4	717.5	703.7	777.3	6122
Space group	*P6/mcc*	*P6/mcc*	*P6/mcc*	*P6/mcc*	$R\bar{3}c$
Σ	1.577	1.607	1.619	1.532	1.611
ω	1.58	1.628	1.625	1.537	1.620
D (g/cm^3)	2.66	2.77	2.79	2.51	3.10
Z	2	2	2	2	18
2a	—	—	—	—	[Cs]
Be	Be_3	Be_3	Be_3	Al_2Si	[Be_2Li]
Al	Al_2	Sc_2	Fe_2^{3+}	Mg_2	[Al_2]

[1]Aurisicchio, *et al.* (1988); [2]Armbruster, *et al.* (1995); [3]Della Ventura, *et al.* (2000), Ferraris, *et al.* (1998); [4]Meagher & Gibbs (1977); [5]this work, values correspond to the most Cs-rich sample.

End-member formulae:					
Beryl:	—	Be_3	Al_2	Si_6	O_{18}
Bazzite:	—	Be_3	Sc_2	Si_6	O_{18}
Stoppaniite:	—	Be_3	Fe_2^{3+}	Si_6	O_{18}
Indialite	—	(Al_2Si)	Mg_2	(Al_2Si_4)	O_{18}
Pezzottaite:	Cs	Be_2Li	Al_2	Si_6	O_{18}

centered at ~3600 cm^{-1} and the weak band at 1620 cm^{-1} indicate the presence of water (such as fluid inclusions), and the weak but sharp features between 3500 and 3600 cm^{-1} are from H_2O groups bound in the channels of the structure.

RELATED MINERALS

Pezzottaite, ideally $CsBe_2LiAl_2Si_6O_{18}$, is not isostructural with beryl, ideally $Be_3Al_2Si_6O_{18}$. However, the arrangement of the atoms in each structure is very similar, and the structures can be considered as very closely related. Table 3 lists the minerals that are isostructural with beryl, together with the minerals that have the same bond topology but different symmetry. Beryl ($Be_3Al_2Si_6O_{18}$), bazzite ($Be_3Sc_2Si_6O_{18}$), stoppaniite ($Be_3Fe_2^{3+}Si_6O_{18}$) and indialite ($Al_2SiMg_2Al_2Si_4O_{18}$) are isostructural with space group symmetry *P6$_3$/mcc*, whereas pezzottaite, $CsBe_2LiAl_2Si_6O_{18}$, is rhombohedral with space group symmetry $R\bar{3}c$. In beryl, Be occurs at one distinct position in the structure. In pezzottaite, one out of every three Be atoms is replaced by Li. The site occupied by Li is not symmetrically equivalent to the site occupied by Be, thus causing a difference in symmetry between the two structures. This change in symmetry is accompanied by a change in the size and orientation of the unit cell (Table 3). In beryl, Cs is incorporated into the channel at the 2a position (Hawthorne and Černý, 1977). Cesium occupies the analogous position in the pezzottaite structure, complete details of which will be presented in a future publication.

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[*Editor's note:* The crest on the title page is that of the Madagascar province of Fianarantsoa, wherein is located the type locality.]

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Fine specimens of epidote and Japan-law twinned quartz from Prince of Wales Island, Alaska have long been familiar to collectors, despite having appeared only sparingly on the specimen market since the locality was discovered early in the 20th century. In recent decades the patented epidote claims on Green Monster Mountain have yielded many more fine specimens including not only world-class epidote and quartz but also magnetite rosettes, goethite pseudomorphs after pyrite, grossular, calcite, amphibole pseudomorphs after pyroxene, and the finest known crystal groups of clintonite.

INTRODUCTION

In the summer of 1967, Peter B. Leavens and Richard W. Thomssen undertook a Smithsonian-sponsored expedition to do mineralogical field work and gather mineral specimens on Copper Mountain and Green Monster Mountain, Prince of Wales Island, Alaska. In their ensuing article in the *Mineralogical Record* (1977), Leavens and Thomssen wrote that these two occurrences constitute "one of the great mineral localities of the world"—a judgment apparently shared by Peter Bancroft, who included a chapter on Prince of Wales Island in his book *Gem and Crystal Treasures* (1984).

It was my privilege—in fact, it was the adventure of a lifetime—to be the third member of that field party in 1967. Subsequently, after nearly a decade of struggles and false starts, I leased the Green Monster claims. Another incredible stroke of good fortune later occurred when my friend Tom Hanna and I were able to purchase the Green Monster property. Tom and I have traveled to the site numerous times over the years, and yet we are still enthralled and excited by the isolation and rugged beauty of this island, which we like to call our "home in the heavens."

I have learned a great deal since my first encounter with Green Monster Mountain; it seems to me that a first-person description of mineral collecting at the locality as Tom and I have come to know it during these intervening years is in order, if not long overdue.

LOCATION

Green Monster Mountain (899 meters in elevation) on Prince of Wales Island is located about 52 kilometers west-southwest of Ketchikan, Alaska. Prince of Wales Island is the largest island in southeastern Alaska, and the third largest in the United States. Covering more than 4,190 square km, it is approximately 210 km

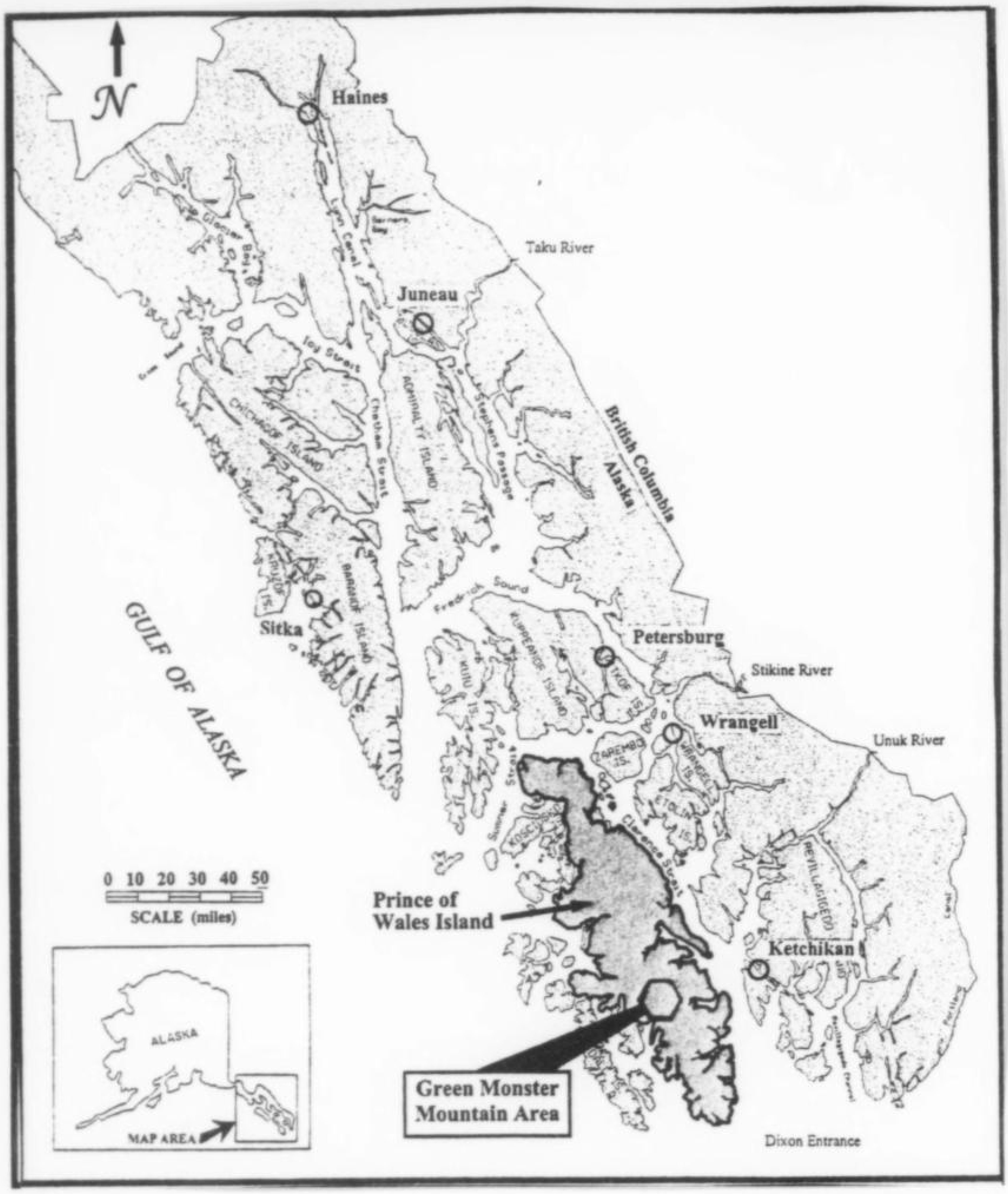

Figure 1. **Location of Prince of Wales Island in the southern panhandle of Alaska, and of the epidote mining area.**

long and up to 75 km wide. Pleistocene glaciers covered all but the tops of the island's tallest peaks, and numerous fiords extend deep into the mountainous island to create a highly diverse landscape (USFS, 1994).

Green Monster Mountain lies immediately south of a 4 km-long portage near sea level that separates Hetta Inlet on the Island's west side from the West Arm of Cholmondeley Sound on the east side. Copper Mountain (the other famous epidote occurrence on Prince of Wales Island) is 5 km to the west of Green Monster Mountain and, at 1,194 meters, is the second highest peak on the island. Lakes formed by Pleistocene and Little Ice Age glaciers immediately surround Green Monster Mountain on three sides, and the terrain rises steeply from the south shore of the West Arm to the near-summit elevations of the epidote claim. Access is by helicopter or seaplane; only a few logging roads near sea level exist in this remote area.

Rainfall estimates for the mountain vary from about 500 cm to 600 cm a year, earning it the dubious distinction of being one of the wettest places on the planet. Snowpack typically begins to accumulate in October and remains until early summer. Swarms of biting insects are a major threat to sanity throughout the collecting months.

Presently the Green Monster Mountain property is under careful and systematic exploitation; no trespassing is allowed, and prospecting and collecting by visitors are strictly forbidden.

HISTORY

From 1902 to 1923, chalcopyrite was mined in the Copper Mountain mining district on Prince of Wales Island. The major mine, the Jumbo, produced 5,000 tons of copper and minor but important amounts of gold and silver during that period. It was during these decades that epidote and quartz crystal specimens were first encountered on the island. Since the locality is remote, the topography rugged and access extremely difficult, serious collecting took place very infrequently in the following decades. One major expedition was mounted in 1935 by the famous collecting team of Edwin Over and Arthur Montgomery, who recovered many fine specimens from both Green Monster Mountain and Copper Mountain (Montgomery, 1937).

In 1967 our Smithsonian party spent two midsummer months on the Island, investigating the geology and mineralogy of the Copper Mountain mining area. (Old epidote specimens from both localities are sometimes labeled "Sulzer," after an abandoned mining settlement at the head of Hetta Inlet several kilometers to the northwest of Copper Mountain.) Of the hundreds of samples of epidote, quartz, pyrite, clintonite, orthoclase and other species we recovered, only a small percentage were specimen-quality. Virtually everything we collected went to the Smithsonian Institution, although a few specimens followed Peter Leavens and me to the University of Delaware (where he was an associate professor and I an undergraduate geology major) to join the

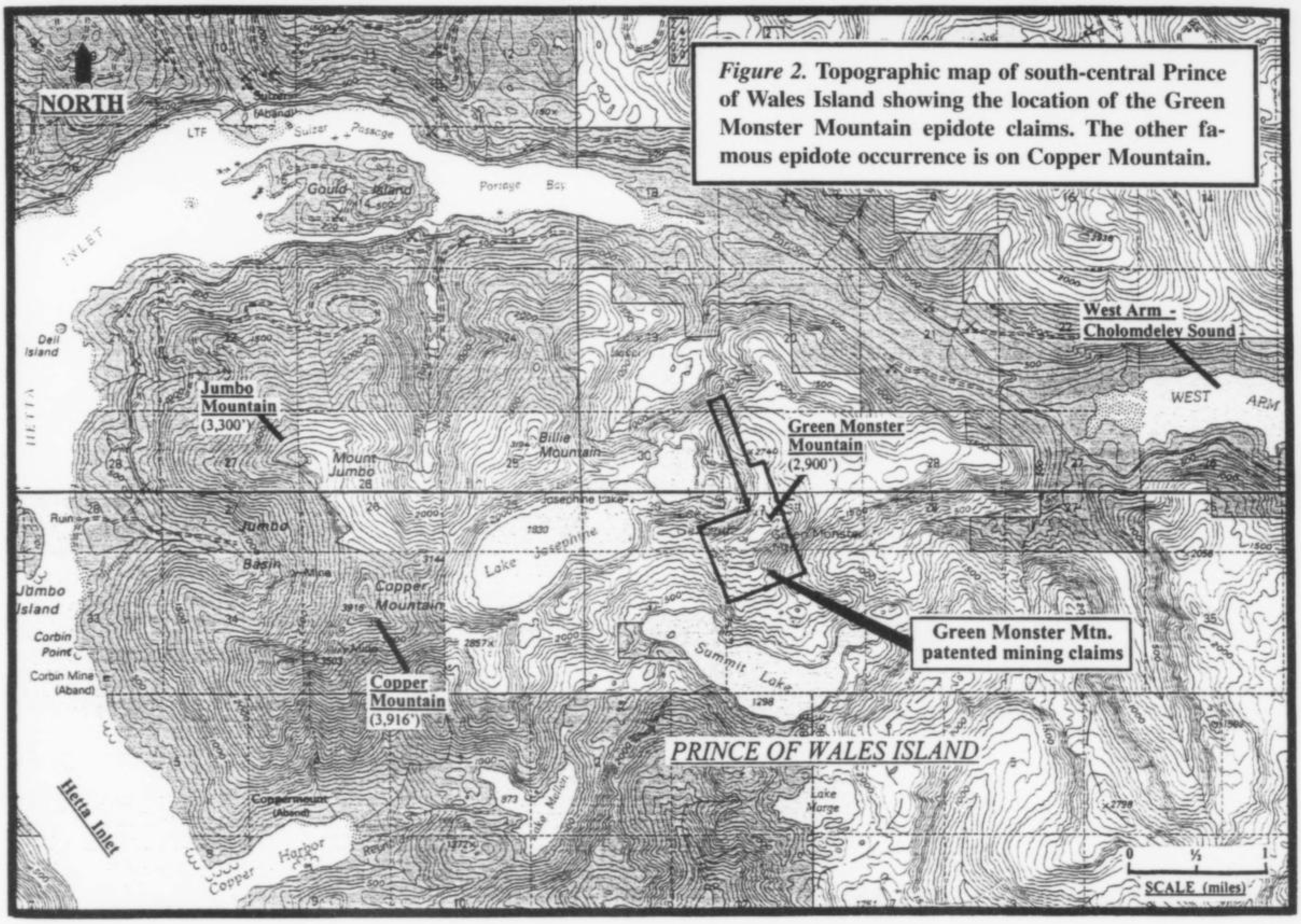

***Figure 2.* Topographic map of south-central Prince of Wales Island showing the location of the Green Monster Mountain epidote claims. The other famous epidote occurrence is on Copper Mountain.**

Ireneé DuPont Mineral Collection, a recent bequest to the University.

While digging on the mountains on Prince of Wales Island that summer, I thought I missed my home in Delaware, but after arriving home I realized I no longer "belonged" back East. I had bonded to that distant Alaskan island and dearly missed it. And so I returned to the remote and magnificent place several times during the next eight years. I eventually discovered that the Green Monster and Copper Mountain claims were the private property of Mr. Eskil Anderson of Spokane, Washington, and that since the early 1960's the Green Monster claims had been leased to Lee Myers and his partner, Virgil Gile, both of Wrangell, Alaska.

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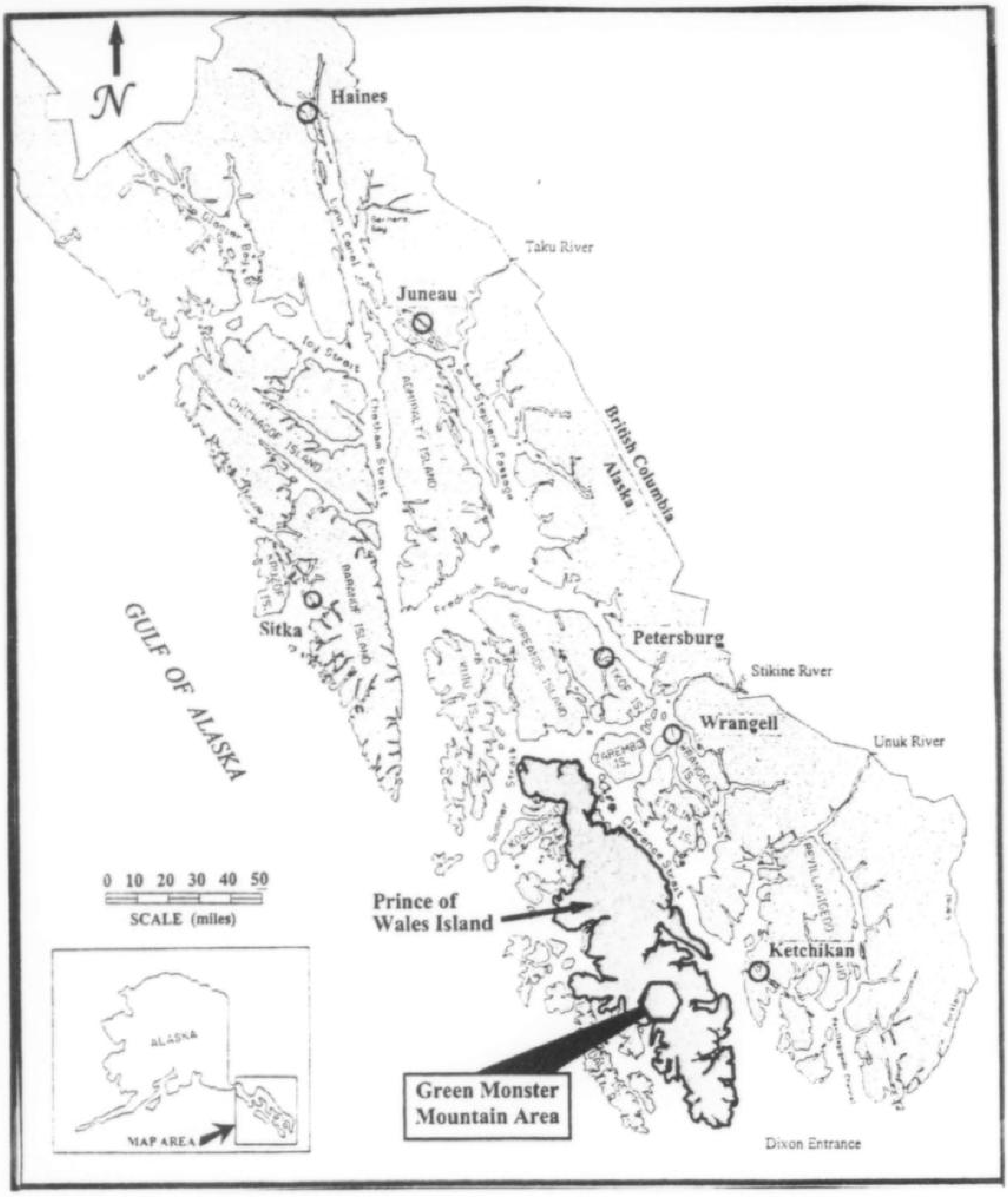
After we closed on the purchase, Tom went to the relevant government agencies to obtain title insurance and to officially record the transfer of ownership of our newly purchased property. He was shocked to discover that the Green Monster property had been quit-claimed to another party by a document that had not been found in a title search by the title insurance company! Eskil Anderson was equally shocked because someone had *forged* his signature to the quit-claim document and had back-dated it to six months before our date of purchase. The recording agencies had somehow accepted this fraudulent deed and had filed it according to date. Had Tom not spotted the discrepancy, we could have lost the property at any time and been open to a lawsuit for all mineral value we had ever recovered. After months of legal and investigative action, we gained clear title to the property through the Alaska courts. During the investigation, several other problems having to do with the title were also found and cleared up, so whoever had attempted the fraud had actually done us a favor.

In 1986, as a result of the Alaska Native Lands Settlement, all private holdings within the Tongass National Forest were resurveyed. The Green Monster property lines were reestablished, a



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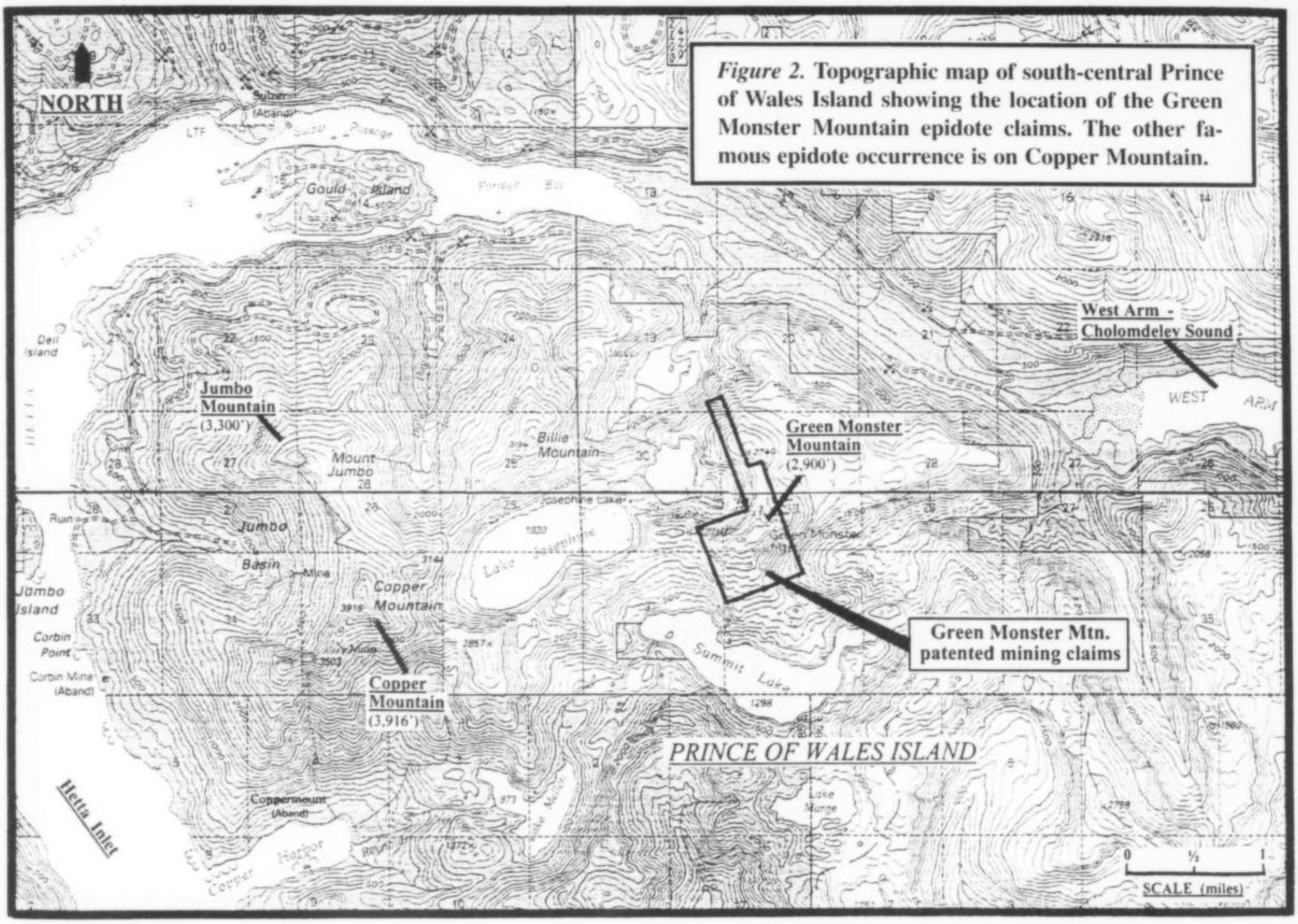

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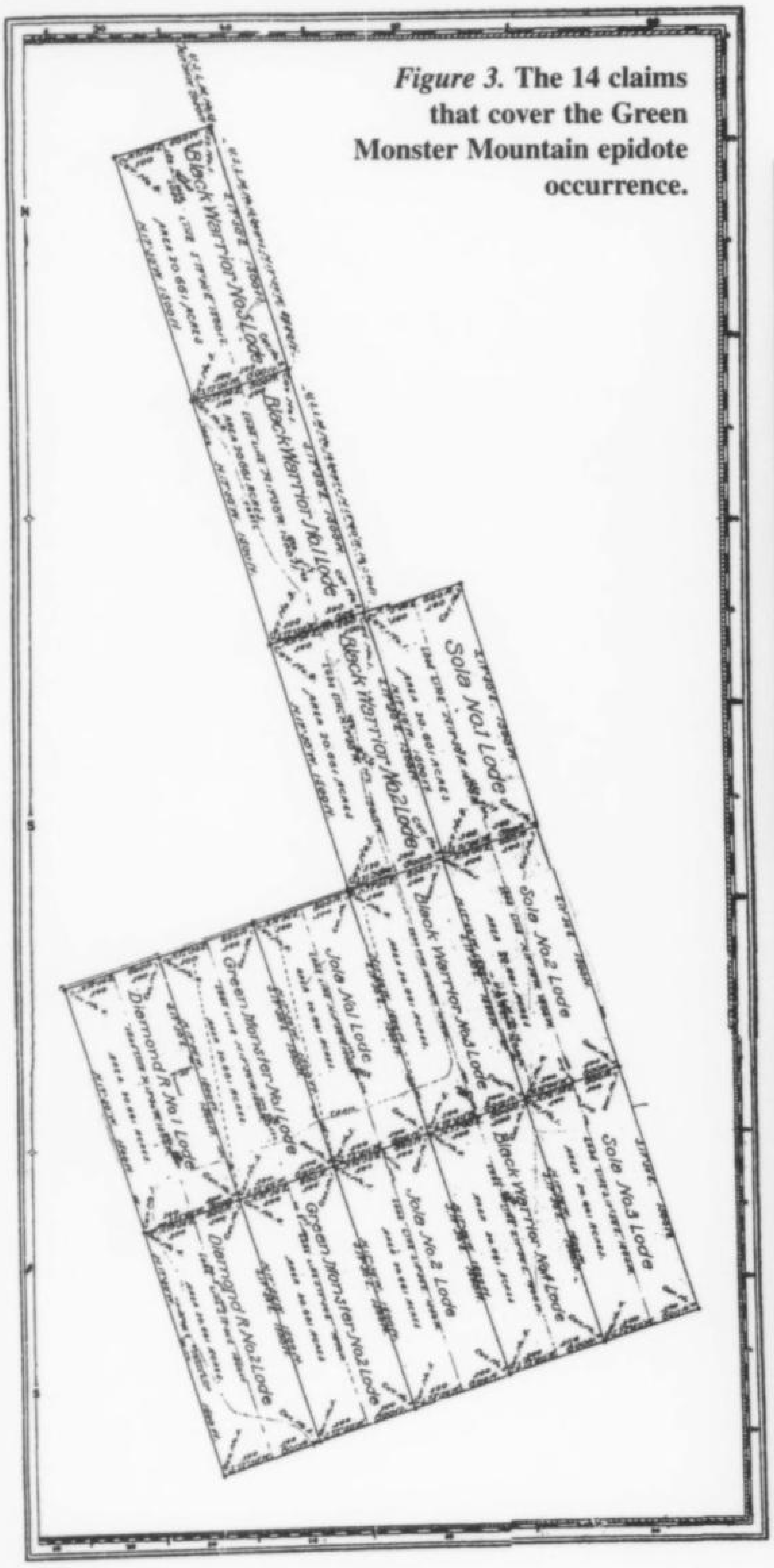


Figure 3. **The 14 claims that cover the Green Monster Mountain epidote occurrence.**

Figure 4. **Beautiful view of Summit Lake from the upper workings on Green Monster. Doug Toland photo.**

move that eventually led to the accurate placement of our property on the latest land ownership maps.

As a condition of his partnership with me, Tom Hanna insisted that the property be closed to other collectors. Reluctantly I agreed to this condition, as it would protect our considerable investment. Over the years our decision to keep the claims closed has proven wise. For one thing, it might well have saved some lives: the isolated and dangerous terrain is no place for the unfamiliar and uninitiated (Culp, 1972), and the chronically cold, wet and windy weather could delay an emergency evacuation for days (our 1967 expedition had been extended four and a half days by a vigorous storm, after we had run out of food). On another trip, this time in October, Tom and I were nearly blown off the ridge in our tent by a particularly nasty storm. We were also stormbound over four days beyond our scheduled pickup and had run out of food, except for a box of soggy rye crisp and a six-pack of Rainier Ale that we found bobbing near the shore of Lake Josephine. Restricting collector access to the locality was important also because good specimens from the mountain are a rare and finite resource which could be exhausted in very short order if too many "guest" collectors are allowed to work there.

Although we continue to enlarge the most productive area, we are finding fewer crystals each year. Our primary work site, which we have partitioned into three areas—the upper, middle and lower workings—is now approximately 150 meters long and from 5 to 20 meters wide. We have sawed, chipped, chiseled, plug-and-feathered, drilled and blasted through a relatively thin weathered zone and into underlying fresher skarn. The newly exposed, less weathered garnetiferous rock consists mostly of vuggy, coarsely crystalline, reddish brown to deep molasses-colored grossular-andradite interspersed with irregular areas of amphibole. This rock quickly wears out steel tools. Even diamond saw blades (at $150 a pop) last less than half as long as they normally would elsewhere. Tom Hanna and I prefer to describe this skarn rock not so much in geologic terms but in visceral ones, e.g. "unyielding, flesh-eating, tool-wrecking, clothes-shredding, gritty, grimy crud." And because it is a third again as heavy as "normal" rock such as granite, the skarn is a backbreaker to shovel and move in wheelbarrows!

Figure 5. **Green Monster Mountain as seen from summit of Copper Mountain in 1977. The edidote workings are visible near the peak. Tom Hanna photo.**

Figure 6. **Tom Hanna at the lower workings on Green Monster Mountain in 1996. Doug Toland photo.**

GEOLOGY

The following two paragraphs summarize Leavens and Thomssen's description (1977) of the general geology of The Copper Mountain Mining District and the mineral paragenesis there.

The rocks in this portion of the island are intensely metamorphosed and folded sediments of the (probably pre-Silurian) Wales group which occupies the core of the Prince of Wales-Kuiu anticlinorium, a structural arch which trends northwest for several hundred kilometers through southeastern Alaska's coastal islands. Composite igneous stocks, consisting primarily of granodiorite but also including gabbro and syenite units, were intruded during the lower Cretaceous, further deforming the Wales group metasediments. Skarns and aureoles of metasomatic minerals formed at the contacts between the intrusive igneous rocks and the marbles and calcareous schists of the Wales group; smaller dikes composed of granite, basalt and lamprophyre further intruded the assemblage, some before the main contact-metasomatic activity, some subsequent to it.

Two main mineralized pocket zones in the Copper Mountain and Green Monster Mountain skarns resulted from this metasomatic activity. On the west flank of Copper Mountain, where a 3 km-long roof pendant of marble and schist was isolated and engulfed by granodiorite, a particularly rich, vuggy, predominantly grossular-

Figure 7. **Tom Hanna beside the "blown" 1993 pocket in the lower workings, on a typical rainy foggy day in 1996. Doug Toland photo.**

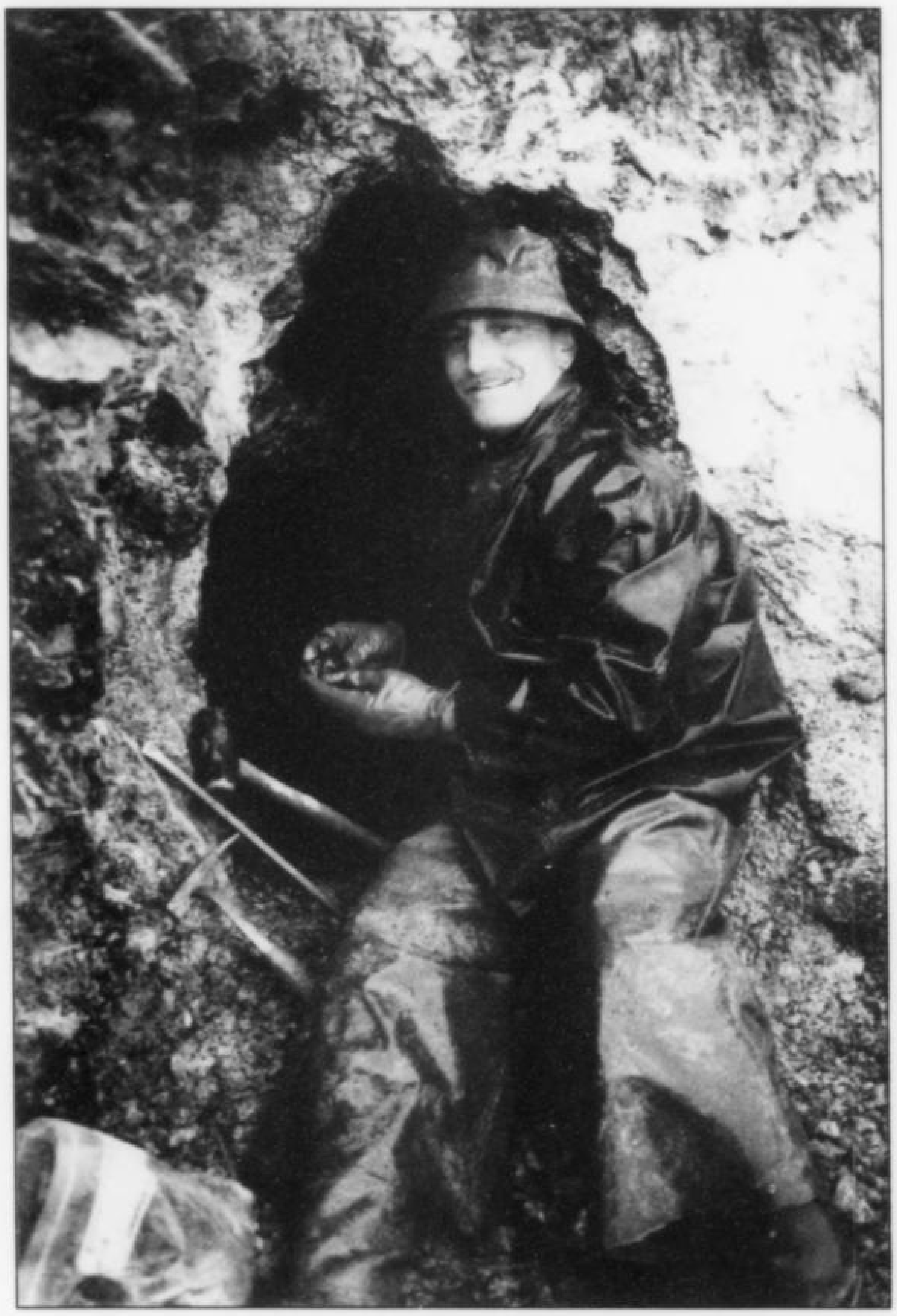


Figure 8. **Tom Hanna, in typical collecting gear, removing a nice amphibole-included quartz crystal in 1996. Doug Toland photo.**

andradite skarn developed, with diopside, quartz, magnetite, epidote, orthoclase (variety adularia), and "uralite" (amphibole pseudomorphs after diopside) crystals being quite well developed in the vugs. Hydrothermal activity also introduced and concentrated chalcopyrite and other sulfides which were exploited for copper and minor amounts of gold and silver by the Jumbo and other small mine operations. A second pocket-rich skarn, remarkable for its epidote but also containing quartz, magnetite, altered pyrite, clintonite and amphibole crystals, is exposed on Green Monster Mountain.

The igneous rocks which intruded the metasediments (creating textbook examples of contact metamorphism) emanated from the Copper Mountain and Jumbo Mountain pluton (mostly diorite), whose eastern margin impinges upon Green Monster's complex assemblage of impure marble and schist (Wright, 1915). In my opinion (from field observations extending well beyond those of my predecessors), most of the rocks which crop out on the productive western flanks of Green Monster Mountain are products of assimilation into the contact skarn. We have not encountered any recognizable dikes or tension fissures in the prime epidote-producing areas. Along the lower perimeter of the middle and bottom workings we have encountered a distinctly different skarn assemblage consisting of rhodonite, massive epidote, and a chocolate-brown mineral in a fine-textured gray-green matrix (see under diopside).

The Copper Mountain pluton did not do all the heavy lifting to form Green Monster's skarn. The complexity of the contact rock, the diversity of crystal forms, and the paragenesis of minerals all

Figure 9. Tom Hanna in the 1995 "Papa" pocket. The 2001 pocket that contained the large sulfide concentration is below him to the right. Doug Toland photo.

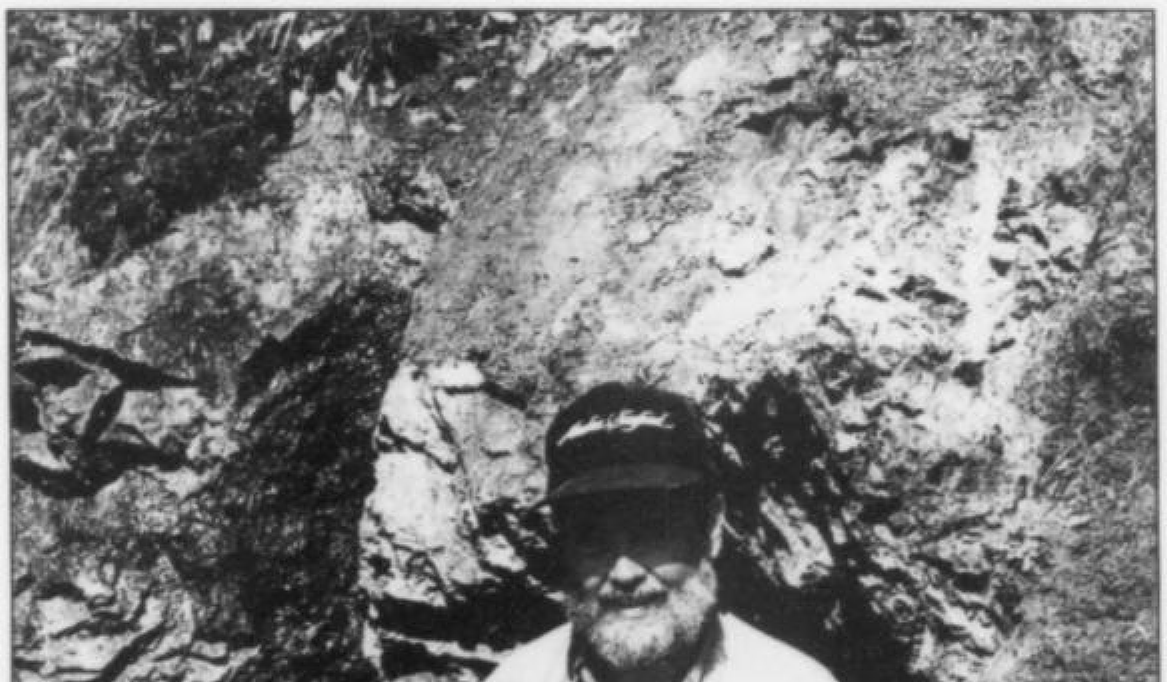


Figure 10. Doug Toland with a freshly collected epidote specimen from one of the 1984 pockets. Tom Hanna photo.

imply that an additional and perhaps more complex relationship exists with a relatively small igneous (diorite?) plug that penetrates the Green Monster metasediments just west of the summit and extends under the summit on its north side. A curious mineral transition is associated with this plug: the skarn to the east contains no free quartz, little epidote, and a higher-temperature mineral assemblage. Leavens and Thomssen (1977) note a resemblance between this iron-poor, magnesium/calcium-rich skarn and the Crestmore, California skarn. The skarn to the west, by contrast, contains a wide distribution of quartz, epidote, magnetite, and iron-rich sulfides along with products of their oxidation.

A well-developed, several-hectare field of karst terrain abuts the south and southwest margins of the plug. Specimen-quality crystals have never been found along the contact with the karst terrain; however, excavations might confirm a potential for crystals in this area.

Diorite also crops out a short distance downslope from the productive area, implying that this portion of the contact was squeezed from three sides by intrusive magma. Thus caught in a compressive vise, the wedge of productive skarn was almost completely mobilized and metasomatized, then recrystallized. Volatiles released in the process could only ascend, and their ascent created several convoluted, tube-like channels or pipes that extend sinuously from the lower right to the upper left of the work site. The presence of igneous intrusive rocks on three sides of the crystal-producing area also suggests that the pocket area is more limited in extent than we had first expected.

The contact between the skarn and the igneous rock becomes difficult to trace in places as it plunges down both sides of Green Monster Mountain's western ridge. On one side, the contact is exposed in a high-angle slope. Rasmussen once thought that this side should contain pockets, but it was too steep to be explored properly without climbing gear. The productive side is only slightly less steep. When I first located the epidote area in 1967, I clung to alpine vegetation with one hand while trying to hack some footholds using a pick with the other. Over the years, we have sculpted the precipitous slope into terraces with high walls that unfortunately increase the risk of falling rock.

Figure 11. **Tom Hanna working with hand tools in the middle workings, 1996. Doug Toland photo.**

THE CRYSTAL POCKETS

Significant pockets, which range in size from a few tens of centimeters to (very rarely) as big as bathtubs, seem to fall into two categories: pockets in tandem associated with what may have been hydrothermal conduits, and isolated pockets not obviously associated with structural features. A third category is possible: pockets near or adjacent to conduits that exhibit both conduit and isolated properties. Admittedly, these categories are speculative, but they do offer an empirical explanation of the occurrences and contents of the pockets.

(1) Conduit pockets. Tube-like conduits or pipes were created by the ascent of volatiles released when intrusive igneous magma compressed and remobilized the skarn zone. I suspect that a relationship exists between the conduits and a fault system which bisects the three work areas. The faulting is inferred from linear zones of pale tan gouge and hydrothermally altered skarn. As seen today, these highly convoluted pipes are generally between 50 cm and 1 meter in diameter. Of the four pipes we have encountered, two may be as much as 15 meters in length; however, we have not definitively located either their beginnings or endings. Associated pockets have been somewhat open-ended, allowing corrosive hydrothermal and/or meteoric solutions to move through them. In many cases these solutions have attacked exposed crystal faces during and after the final growth stages, producing "Janus-faced" epidote crystals (crystals with poor luster on one side and excellent luster on the opposite side). Moreover, epidote crystal habits progressively change over the length of the conduit pockets: the further removed from the fault system where, presumably, the conduits originate, the more elongated are the epidote crystals. Twinned crystals become rarer at distance also, whereas in the areas of the conduits closest to the fault system, virtually all epidote crystals are twinned.

Late solutions circulating in conduit pockets precipitated additional quartz and other minerals from elements leached from the epidote and host skarn, and likely from the intrusive body as well. Two such minerals, chlorite and a dark fibrous amphibole, occasionally interfere with late-stage epidote growth. On the positive side, chlorite commonly forms attractive inclusions in quartz. Many pockets within and along the conduits yield large quantities of quartz crystals presenting a stunning array of habits and inclusions. However, these pockets have yet to yield any magnetite or Japan-law twins of quartz.

Most of the Green Monster Mountain sulfides occur in pockets associated with the hydrothermal conduits. Specifically, sulfides (and their oxidation products) are concentrated in—and sometimes extend beyond—the top left portions of conduit pockets. They can occupy up to perhaps a fourth of the pocket volume. Five times we have exhumed from such pockets large masses of pyrite, chalcopyrite, iron hydroxides, and minor amounts of secondary copper

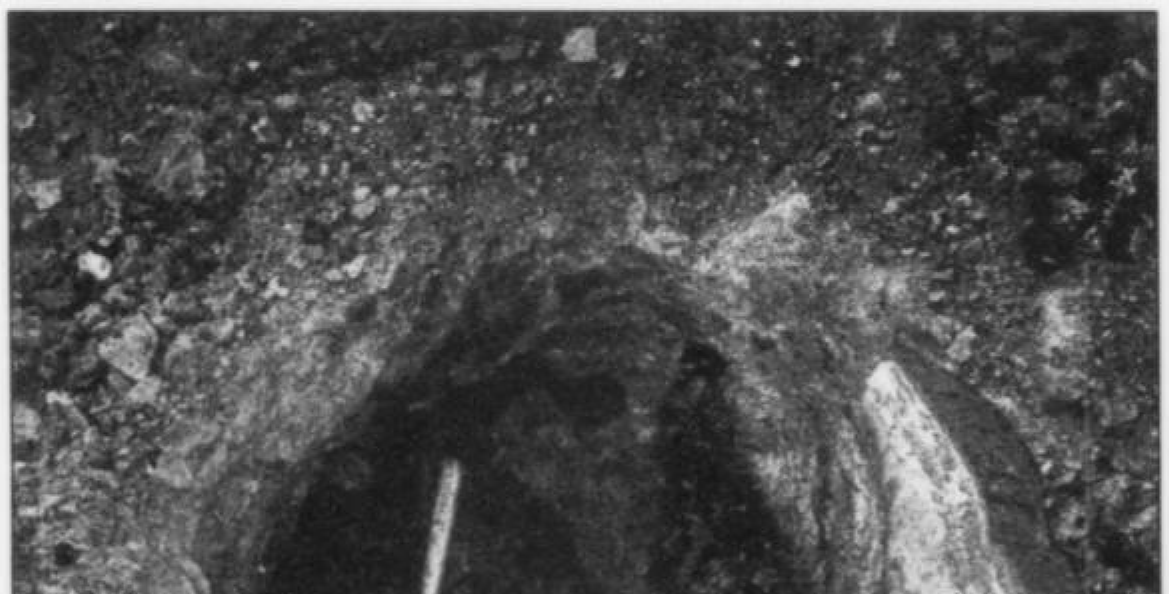


Figure 12. **Tom Hanna excavating the "blown" pocket in 1993. Doug Toland photo.**

Figure 13. **Doug Toland in the upper workings with specimens removed from the "Janus-faced" pocket in 1994. Tom Hanna photo.**

Figure 14. **Typical collecting position on Green Monster Mountain with feet protruding from a hole.**

minerals; the largest of these masses was found in 2001 and weighed more than 50 kilograms.

Two pockets associated with a high-angle conduit in the lower workings contain an abundance of limonite and minor chrysocolla. In part because of hydration, the limonite completely plugged over 2 meters of the conduit, effectively cutting off the flow of corrosive fluids. In 1990, I found sharp, bright epidote crystals and crystal fragments—remains of a long-gone pocket—so tightly packed in the limonite that I risked breaking them during extraction. Sulfides and euhedral pseudomorphs after sulfides are virtually absent in the bottom area.

(2) Isolated pockets. Isolated, seemingly randomly distributed pockets have been formed by the dissolution of calcite blebs; such pockets have no obvious structural interrelationship, and no direct connection to hydrothermal conduits. The calcite blebs were produced during the mobilization of calcium carbonate during contact metamorphism, and the subsequent recrystallization in what is now the pocket zone of the skarn. Eventually the calcite crystals dissolved, leaving garnet-lined voids that became host to a sequence of minerals precipitated from later hydrothermal fluids. Many of the isolated pockets were once lined with a second generation of calcite which also later dissolved away.

Isolated-pocket contents also show other differences from the contents of conduit pockets: they are not as rich in sulfides, they usually contain quartz twins, and they have produced attractive magnetite rosettes. Quartz and magnetite formed contemporaneously with epidote and with a third generation of calcite as euhedral crystals. Some of the quartz and calcite crystals contain magnetite and epidote inclusions. Late-stage minerals found in these pockets are the result of more limited quantities of nutrients drawn from the host rock and from minerals such as calcite, already formed in the pockets. Some quartz crystals grew as doubly terminated floaters or aggregates of floaters directly from residual pocket juices, and most incorporate inclusions of chlorite. Quartz crystals with inclusions from the earlier epidote and quartz growth phases often continued to grow, encapsulating chlorite in their outer portions and occasionally producing exceptionally sharp *en echelon* phantoms. When held to a bright light, these prisms reveal the sequence of inclusions. Earlier inclusions of actinolite "hair," magnetite, and, more rarely, epidote are predominant within the clearer crystal cores. During the final stages of crystal growth, chlorite became the predominant inclusion, clouding the outer areas and terminations of the prisms.

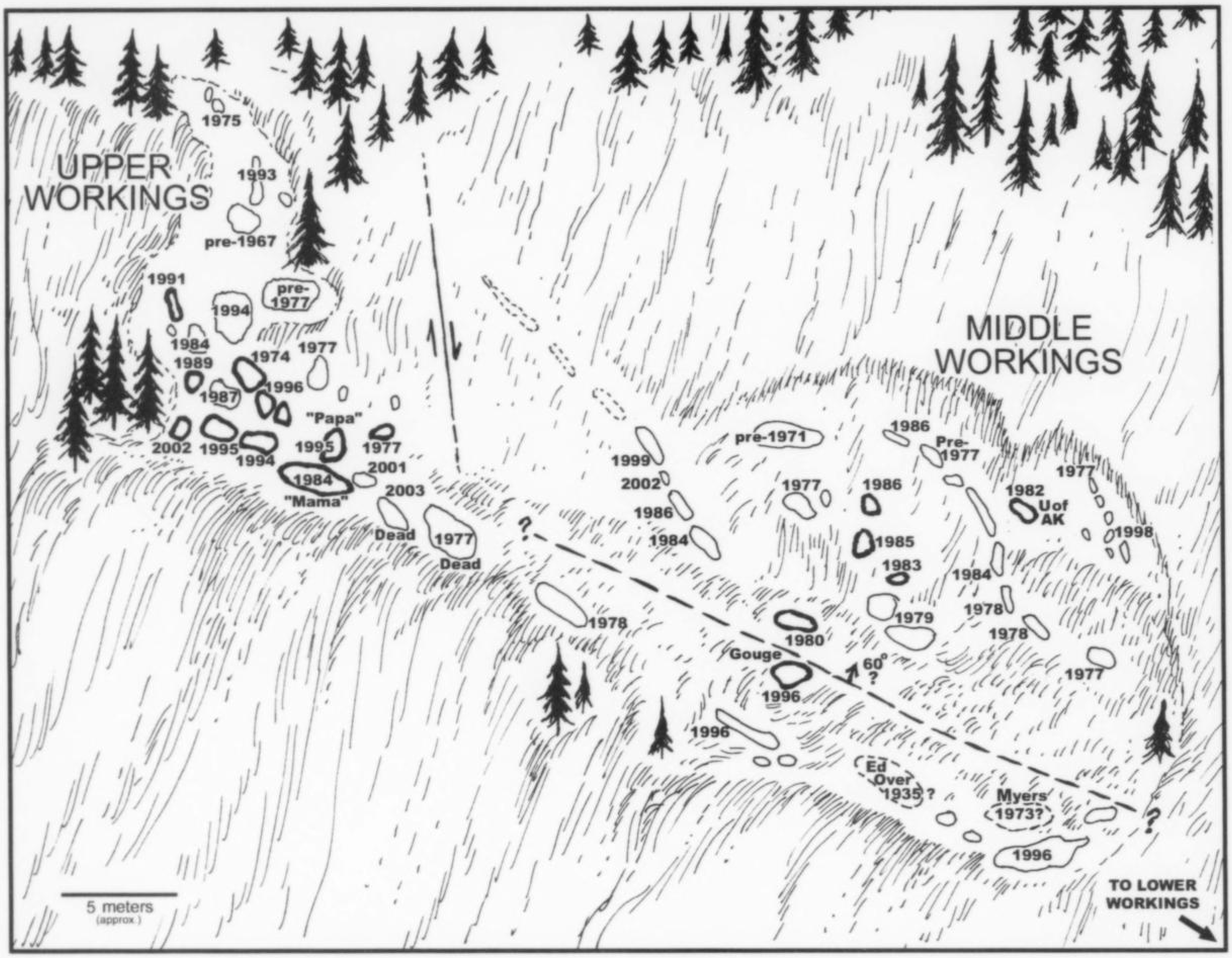
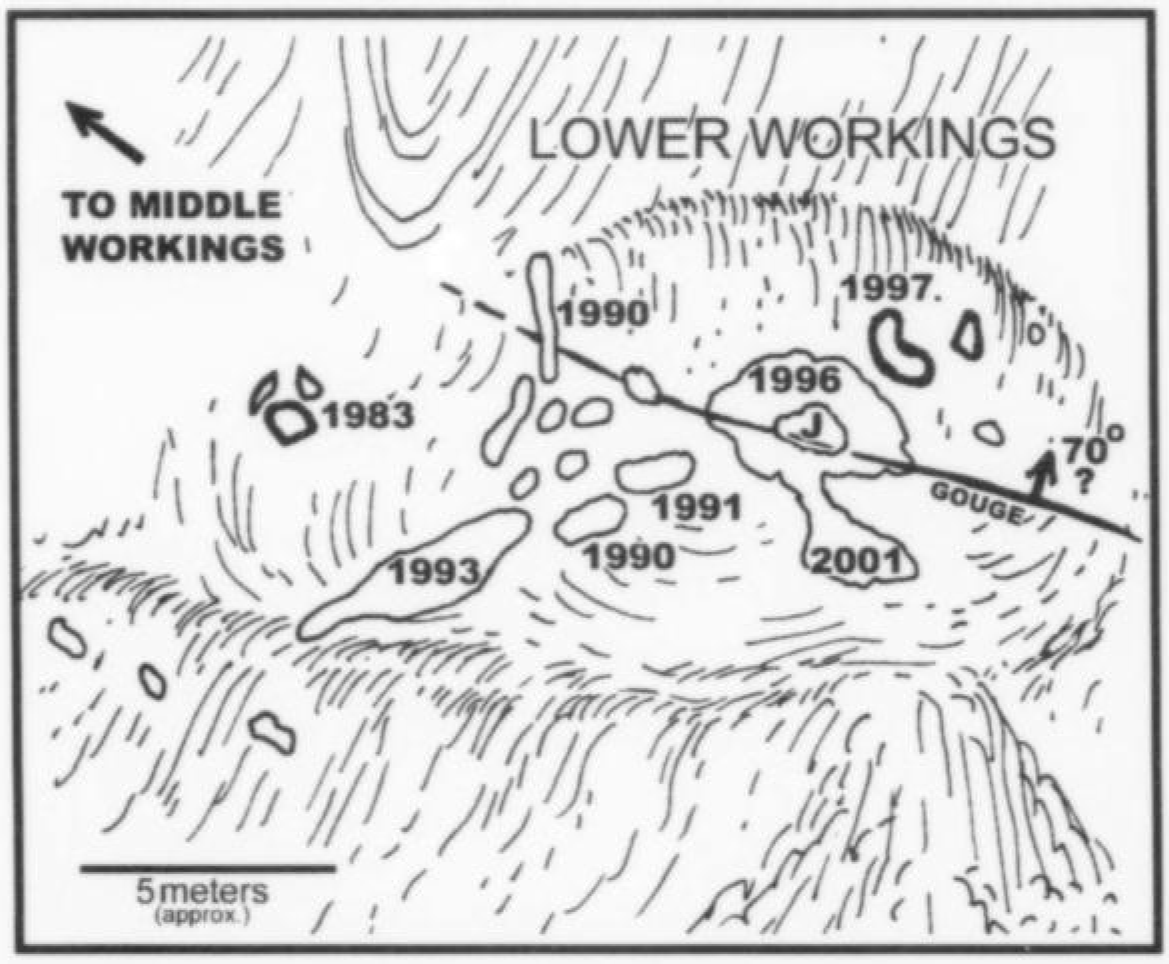


Figure 15. (above and right) **Field sketch of the Green Monster Mountain workings showing the location and date of many pockets. Pockets of the "isolated" type are shown with heavy outline; the others are all "conduit"-type pockets. Approximate fault locations are also shown.**



A few of the isolated pockets have been disrupted by faulting. A high-angle fault which cuts between the upper and middle workings has caused the chemical destruction of at least three large pockets nearby, including my corroded "Mama" pocket of 1977. The strike of another and more important fault, the one that appears to be structurally and hydrothermally involved with the conduit pockets, extends through the middle of our productive ground and, as best we can determine, runs parallel to the strike of the productive area; that is, it traverses the slope from the lower right to the upper left. This fault is presumed to have extended the exposure of nearby pockets to hydrothermal solutions, sometimes nourishing epidote crystal growth and sometimes corroding the crystals. While this fault had sufficient displacement to produce varying amounts of crushed and altered skarn, only slight lateral displacement is evident. It is possible that much of the displacement occurred normal to the hill slope, i.e. the fault projects toward our faces. The gouge reveals that movement along this fault continued after the skarn crystallized. The majority of pocket contents in closest proximity to the fault have been crushed, and their crystals are either shattered or decomposed. Many of the broken crystals that survived have rehealed fracture surfaces, suggesting that crystals continued to grow while movement on the fault was still taking place.

While the immediate region surrounding Green Monster Mountain and Copper Mountain has no recent history of seismic activity, earthquakes still occur relatively frequently under the ocean floor west of Prince of Wales Island and are presumed to be associated with a southern extension of the dynamic Fairweather Fault. Evidence that earthquakes shook the localities for a long time includes a few adjacent epidote crystals with deeply abraded

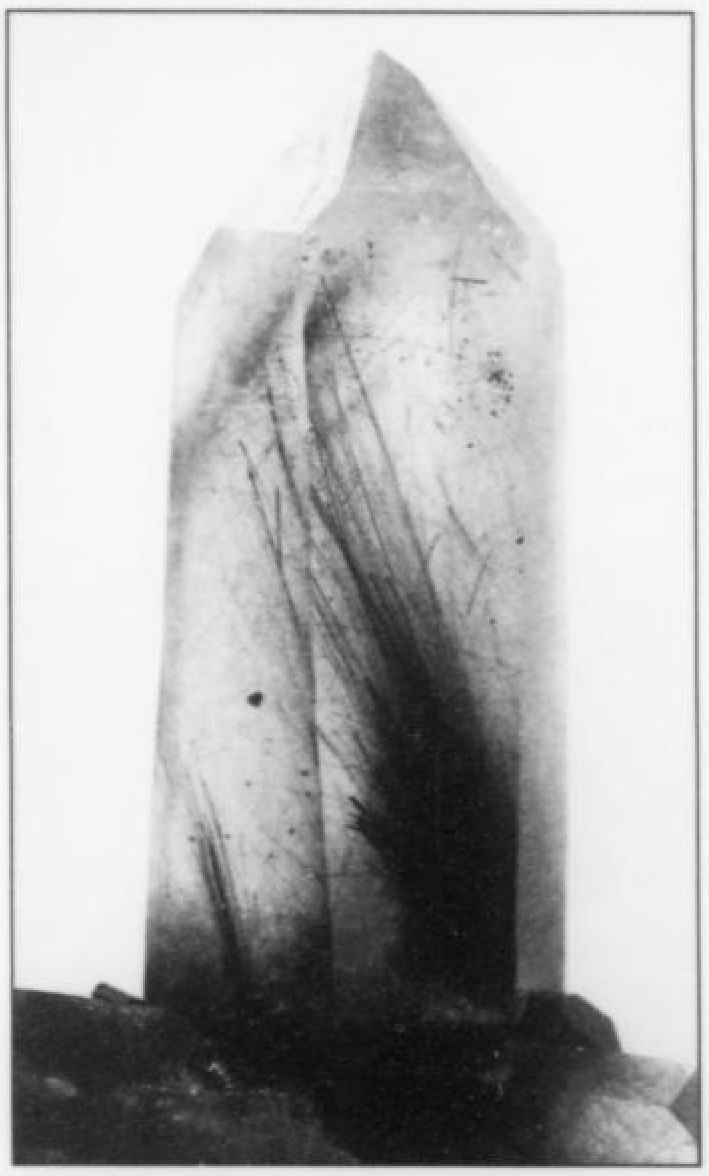


***Figure 16 (left).* Quartz prism, 4.8 cm, with "byssolite" inclusions, from a small isolated pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.**

***Figure 17 (below).* Quartz crystals and clusters to 5.5 cm, heavily included with "byssolite," from a small isolated pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.**

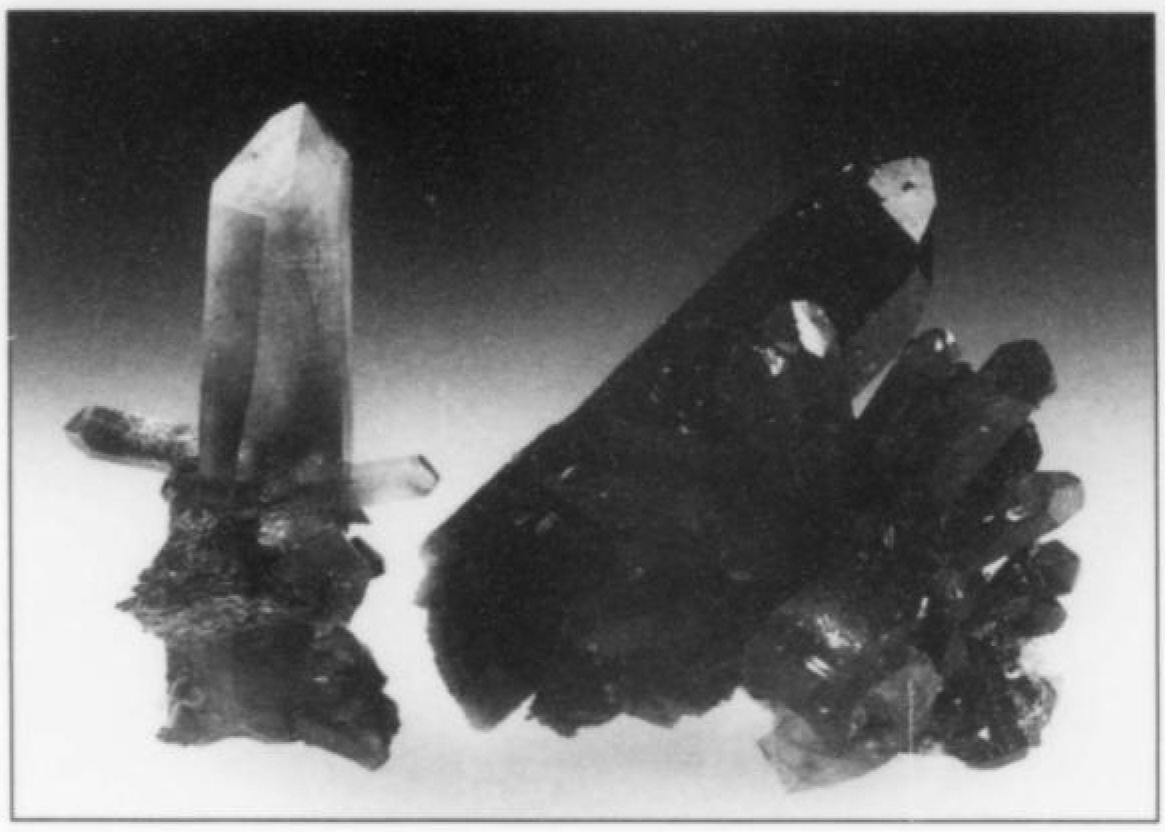


***Figure 18.* Quartz crystals to 8.7 cm, heavily included with "byssolite." The left specimen is from the 2003 "jackstraw" pocket, and the other is from a 1996 pocket in the lower workings. Tom Hanna collection; Wendell Wilson photo.**

"touch points" where eons of earthquakes rubbed them together following collapse of the pocket contents.

(3) Pockets exhibiting conduit and isolated characteristics. We have encountered several pockets that exhibit both isolated and conduit characteristics, particularly in the upper workings where the skarn looks like a train wreck, with few recognizable patterns. Here the skarn, with its relatively abundant pockets of all sizes and varieties of contents, is severely distorted, leaving us less certain about structural patterns and pocket relationships. Pockets with blocky, Janus-faced epidote crystals with quartz twins and an abundance of chlorite were found next to pockets containing sharp, untwinned and elongated epidote prisms and quartz twins. All but one of the 12 sizeable pockets that I am aware of having been found in this roughly 10 x 30-meter area contained Japan-law twins; Tom Hanna's "Papa" pocket of 1995, which yielded perhaps the most spectacular cluster of epidote, calcite and quartz ever to come off the mountain, had no quartz twins (see discussion of this specimen under epidote).

MINERALS

Actinolite $Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$

The fibrous "byssolite" variety of this amphibole referred to by Leavens and Thomssen (1977) occurs rarely and sporadically, mostly as crushed tufts in small, isolated pockets farthest removed from surface weathering. Before weathering, this actinolite was a widely distributed pocket mineral, as evidenced by beautiful green sprays and by fibers included in quartz prisms recovered from several pockets, particularly in the lower workings. One gemologist, Joe Taylor of Fairbanks, has cut lovely green gems to 20 carats from this quartz.

Actinolite may be the dominant amphibole species in the material long called "uralite"—fibrous, dull grayish green, woody-looking pseudomorphs of amphibole after pyroxene crystals (most of them probably diopside). In the middle and upper workings, euhedral uralite "crystals" to three centimeters have been found sparingly in small pockets along with "byssolite"-included quartz. I cannot recall finding uralite with epidote. I retrieved what had once been a "byssolite"-included quartz group in two parts because a uralite crystal which had formed a weak link between the two pieces had broken; where the uralite grew against the quartz crystals, dense sprays of "byssolite" inclusions extend into the quartz.

Some 20 years ago, Tom explored the skarn/diorite contact to its end northeast of the summit. In the process, he found a solution pocket lined with mostly small, dull uralite crystals averaging less than 3 cm, and looking very much like the well-known uralite from the Calumet iron mine in Colorado. However, several specimens further in the pocket were fresher, with attractive, thin-bladed, dark green 2-cm crystals covering the matrix. Many of the crystal groups were attached to hunks of amphibole matrix weighing 5 kilograms or more. After hauling several of these hunks over 2 km back to base camp, Tom swore that one specimen grew to weigh at least 50 kg. We wondered then if they were worth the effort; the fact that over the years we have sold only one or two confirms our doubts.

Calcite $CaCO_3$

As previously mentioned, calcite recrystallized from marble was originally disseminated as massive blebs throughout the skarn. When this calcite dissolved, garnet-lined voids were left behind, and later hydrothermal activity turned these into crystal pockets. We have opened a few pockets containing gray-white solution-sculpted vestiges of the original calcite blebs coated with a sticky black mud. Only two of these pockets contained sharp epidote crystals.

The earliest phase of crystal growth in the voids began with a new generation of calcite and minor amounts of quartz and magnetite, creating an (unfortunately) unstable base for the later phase of crystal growth, when milky gray-white to translucent white scalenohedral calcite crystals to 12 cm developed. These "dogtooth" crystals are contemporaneous with the quartz, epidote, magnetite and pyrite crystals for which the locality is famous.

The first calcite crystals recovered from Green Monster that I am aware of were found in 1974. In 1984 I hand-chiseled into a pocket in the upper workings that contained the largest calcite crystals yet found on the mountain: pale gray, slightly resorbed individuals to 14 cm on matrix with epidote, quartz and magnetite. After a bath in dilute hydrochloric acid, some of the broken scalenohedrons revealed epidote, quartz and magnetite inclusions. This bathtub-size pocket, found only 3 meters above the dead "Mama" pocket of 1977, produced exceptional specimens of all four minerals. Tom Hanna's smaller but important "Papa" 1995 pocket was discovered less than 2 meters away.

We found no calcite crystals on this mountain in 1967 because we worked almost entirely in near-surface pockets where meteoric water had dissolved the calcite. Specimens recovered from most near-surface pockets are found in collapsed jumbles on the pocket floors, since the early rind of calcite which once held the crystals to the pocket walls had disappeared. In some cases, late-stage hydrothermal fluids and not meteoric water may have removed the calcite. Most specimens found in pockets that were subjected to either solvent have distressed epidote and unfortunate voids where significant calcite crystals once existed. Some of these specimens still have chunks of garnet matrix barely attached to shells of quartz and epidote; the calcite rind completely dissolved and left wide gaps between the crystal shells and the matrix. These specimens are fragile and frustratingly difficult to field-wrap and transport.

In the lower workings last year, we spotted several gray, simple rhombohedral calcite crystals up to 2 cm long, in the farthest reaches of a tubular pocket over 1.5 meters long. Several quartz prisms from this pocket have rhombohedral voids where calcite crystals were once included. This pocket produced unique "jack-straw" fans of epidote (see later under Epidote).

Chalcopyrite $CuFeS_2$

In the early 1980's, Tom Hanna and I found a few dozen nodules of chalcopyrite near the extreme southern property line. Isolated floaters in calcite, they had been freed by weathering. Ranging in weight from a few grams to a kilogram or more, the nodules are surficially oxidized and have a bronze patina. A 20-meter exploratory adit cut into the site suggests that the early prospectors must also have found some of these nodules of potential copper ore.

Only four pockets contained chalcopyrite and its oxidization byproducts as significant components of their sulfide zones. All other pocket-hosted sulfide zones found to date showed little to no evidence of copper mineralization. Tom Hanna recalls finding a single weathered chalcopyrite crystal measuring 3 cm in a uralite pocket on the northeast side of the Green Monster summit.

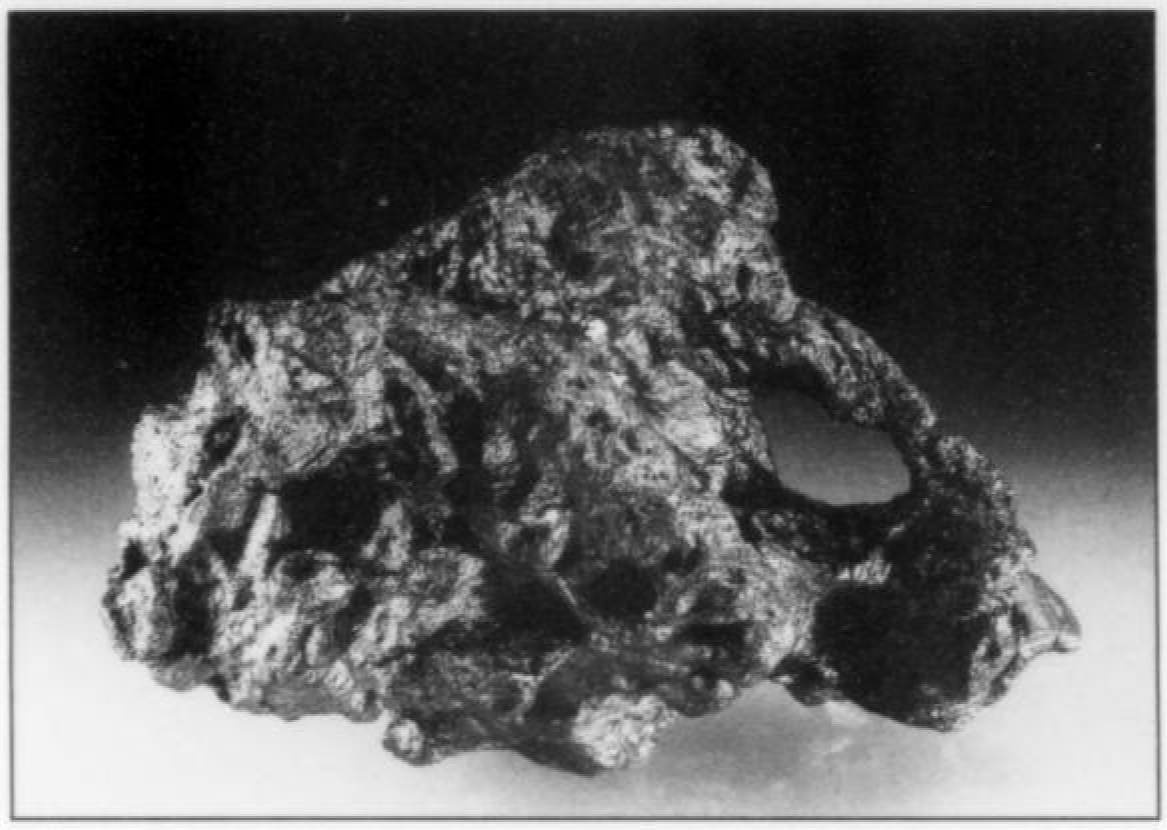


Figure 19. **Rounded chalcopyrite "nugget," 7 cm, from a 1989 pocket in the lower workings. A thin layer oxidation patina has been removed. Tom Hanna collection; Wendell Wilson photo.**

Chlorite Group

Chloritic clay, a product of low-temperature retrograde metamorphism and possibly also of corrosive meteoric water, occurs in many pockets as milky green to dark green, fine-grained inclusions imparting a greenish color to quartz. Chlorite-group minerals also occur as components of muddy pocket residues. Pockets with "chloritic quartz" typically contain epidote that has been dulled and rounded by chemical dissolution, suggesting that the corrosion of epidote may have contributed to the formation of chlorite.

Chrysocolla $(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$

Chrysocolla occurs sparingly in the bottom workings as a late-stage oxidation product, primarily coating quartz and epidote crystals. The occurrence is restricted to a few interconnected pockets farthest removed from the surface. Quartz/epidote specimens with a wet-looking, sky-blue chrysocolla coating were stunningly beautiful when first brought to light in 1993. After drying out, however, most of the coating spalled off. Epidote surfaces beneath this chrysocolla layer possess the highest luster of any epidote we have found.

In the upper workings, minor amounts of chrysocolla were found in a collapsed portion of the sulfide/oxide bleb associated with the 2001 pocket. This is the only occurrence of chrysocolla in the upper area.

Clintonite $CaMg_2AlAl_3SiO_{10}(OH)_2$

A very limited number of excellent clintonite specimens, with sharp, lustrous, intensely green rosettes to 1.5 cm, have been found to the east of Green Monster Mountain's igneous plug. Most specimens were found in 1967, weathered free of enclosing calcite and lying loose in the soil. Over the years we have exposed a tough, calcite-rich, non-garnetiferous skarn that had two small residual calcite blebs enclosing several fine specimens of clintonite. Prospects for additional specimens from this area of the skarn are slim.

Ambiguities in nomenclature have historically arisen in the classification of the trioctahedral brittle micas: seybertite, valuevite, brandisite, holmite, xanthophyllite and others have all been used in the past to denote separate mica species. Forman *et al.* (1967) conclude that all of these terms, most of which have referred simply to differences in the colors of specimens, should denote varieties of the single species clintonite. Nevertheless, Thomsen

Figure 20. **Clintonite crystals to 1.5 cm on an 8-cm matrix from near the summit of Green Monster Mountain. Tom Hanna and Doug Toland specimen; Wendell Wilson photo.**

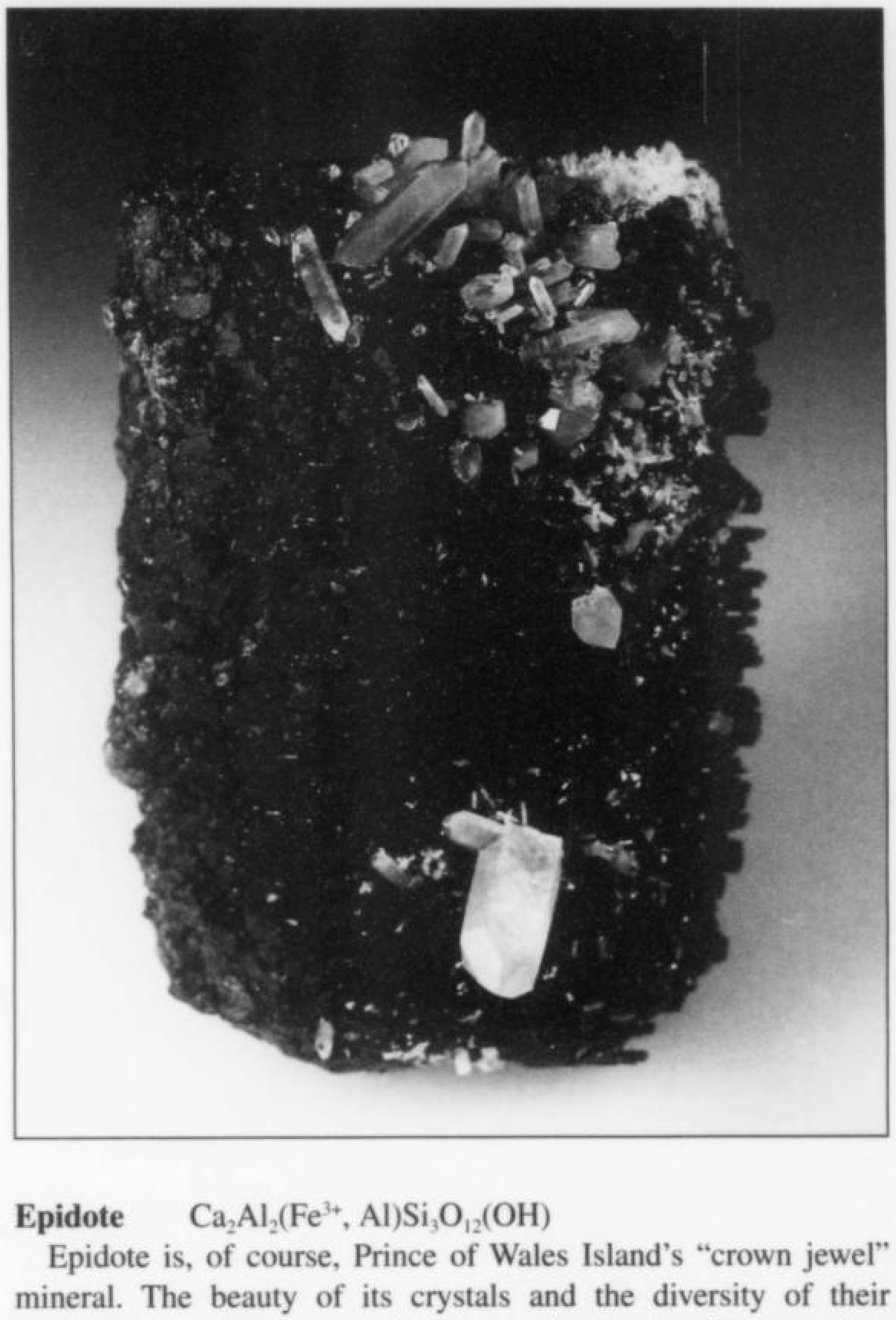


Figure 21. **A large compound epidote crystal measuring 13 cm diagonally, with quartz (including a Japan-law twin at the bottom) from a 1996 pocket in the middle workings. Tom Hanna collection; Wendell Wilson photo.**

and Leavens (1977) still referred to the deep green rosettes from Prince of Wales Island as "xanthophyllite." Bayliss (2000) declares "xanthophyllite" an obsolete synonym for clintonite.

Tom Hanna and I have not seen clintonite from any other locality with such rich green color and perfect rosette form.

In 1977, Dick Derrickson of Wasilla, Alaska, a friend of Clayton Rasmussen, found one small zone with pale green clintonite sheets and partial rosettes associated with pale grossular crystals similar in color to Asbestos, Quebec specimens. To my knowledge, only one good clintonite specimen of this type was found.

Diopside $CaMgSi_2O_6$

Wright (1915) reports that diopside "is of widespread occurrence in the Copper Mountain area." It seems logical, therefore, that the Green Monster skarn would contain appreciable amounts of this pyroxene. Unless I am blind or just haven't been looking closely, diopside is rare on Green Monster Mountain. Careful examination may reveal more occurrences of diopside, but I recall only small subhedral to anhedral grains of what appears to be diopside associated with small hercynite octahedrons and clintonite rosettes near the summit.

Two small exposures of atypical, grayish green, aphanitic skarn that host splotches of pink rhodonite, massive epidote and an unknown brown mineral have been exposed at the lowest peripheries of both the middle and lower workings (see under Rhodonite). Tests are needed to determine whether this grayish green host skarn is composed primarily of diopside.

Epidote $Ca_2Al_2(Fe^{3+}, Al)Si_3O_{12}(OH)$

Epidote is, of course, Prince of Wales Island's "crown jewel" mineral. The beauty of its crystals and the diversity of their arrangements amaze us each time we find a significant pocket. Such an event happens roughly once every five years.

The Green Monster claim has produced epidote crystals in a wide range of sizes, from microcrystals forming druses on quartz to individual crystals that are among the largest in the world. A specimen I found in 1982, now on display in the University of

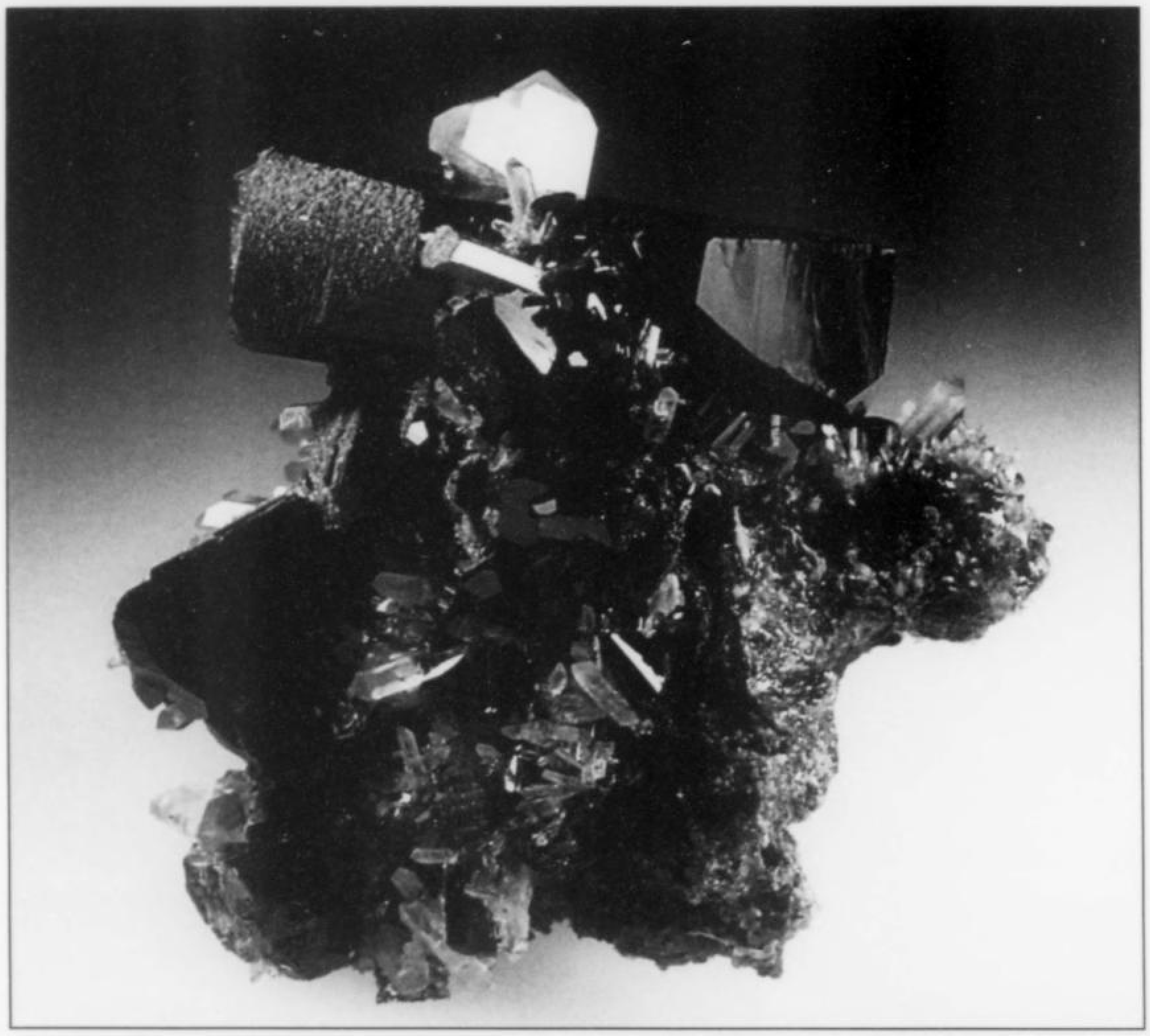


Figure 22. **An extraordinary, doubly terminated epidote crystal 6.5 cm long, capped by a Japan-law quartz twin, on a cluster of more epidote crystals on grossular-andradite matrix from a 1987 pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.**

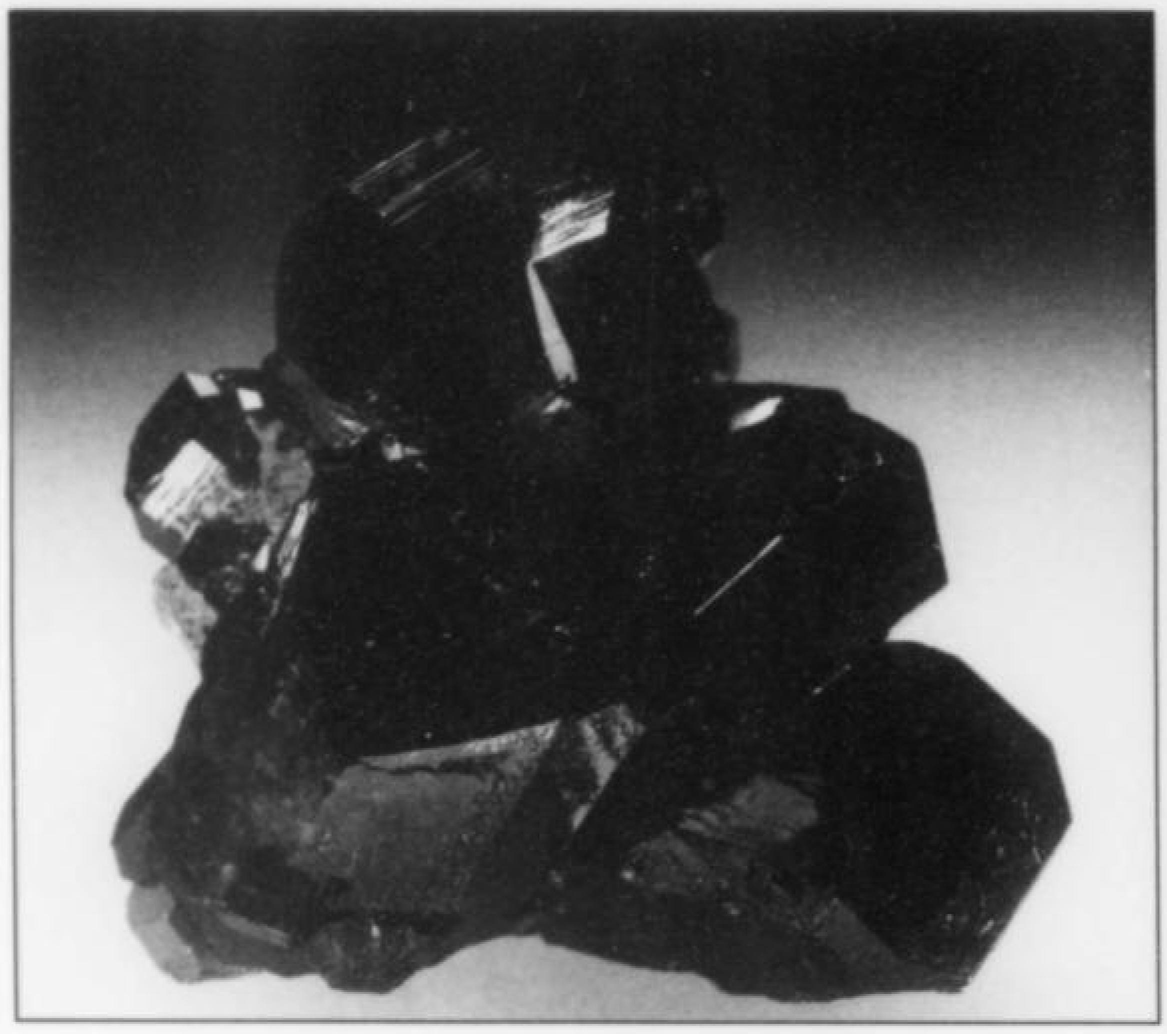


Figure 23. **A cluster of lustrous, blocky epidote crystals (elongated on the *a* axis), 4.8 cm, from a limonite-choked 1990 pocket in the lower workings. Wendell Wilson collection and photo.**

Figure 24. **Large epidote crystal, 7.7 cm, in a cluster of other epidote crystals from Tom Hanna's 1995 "Papa" pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.**

Alaska's Fairbanks museum, has a perfect centerpiece crystal 15 cm long and weighing approximately 3 kg. A damaged and incomplete crystal found earlier in the upper workings weighs over 3 kg.

As we penetrate into deeper and fresher skarn, we are finding brighter and less damaged crystals than those found in earlier years. Tom Hanna and I now expect to see at least a few specimens of epidote crystals on garnet matrix in the deeper pockets, whereas none of the 1967 epidote crystals and groups came out on matrix.

However, it isn't always the case that fresher, brighter crystals and matrix specimens are found below the surface weathering zone. About half the pockets we have encountered appear to have been affected by late-stage hydrothermal conditions unrelated to surface weathering. These are the hydrothermal conduit pockets that produced the "Janus-faced" epidote: dulled, rounded, and often coated with low-temperature minerals on one side, and perfectly bright on the protected side. The most seriously affected crystal surfaces are oriented face-up in the pockets. Some epidote crystals in these conduit pockets show various degrees of arrested

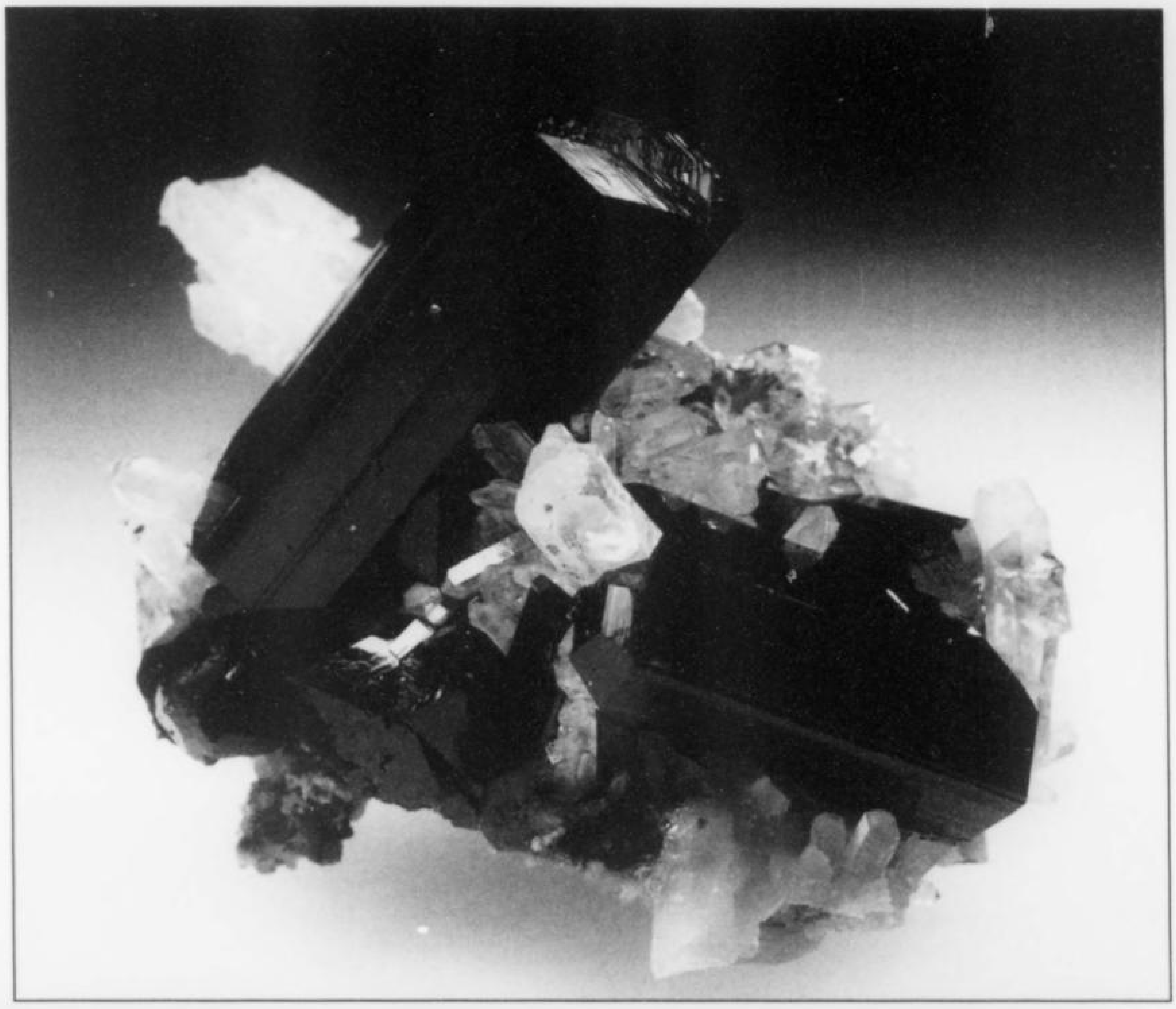
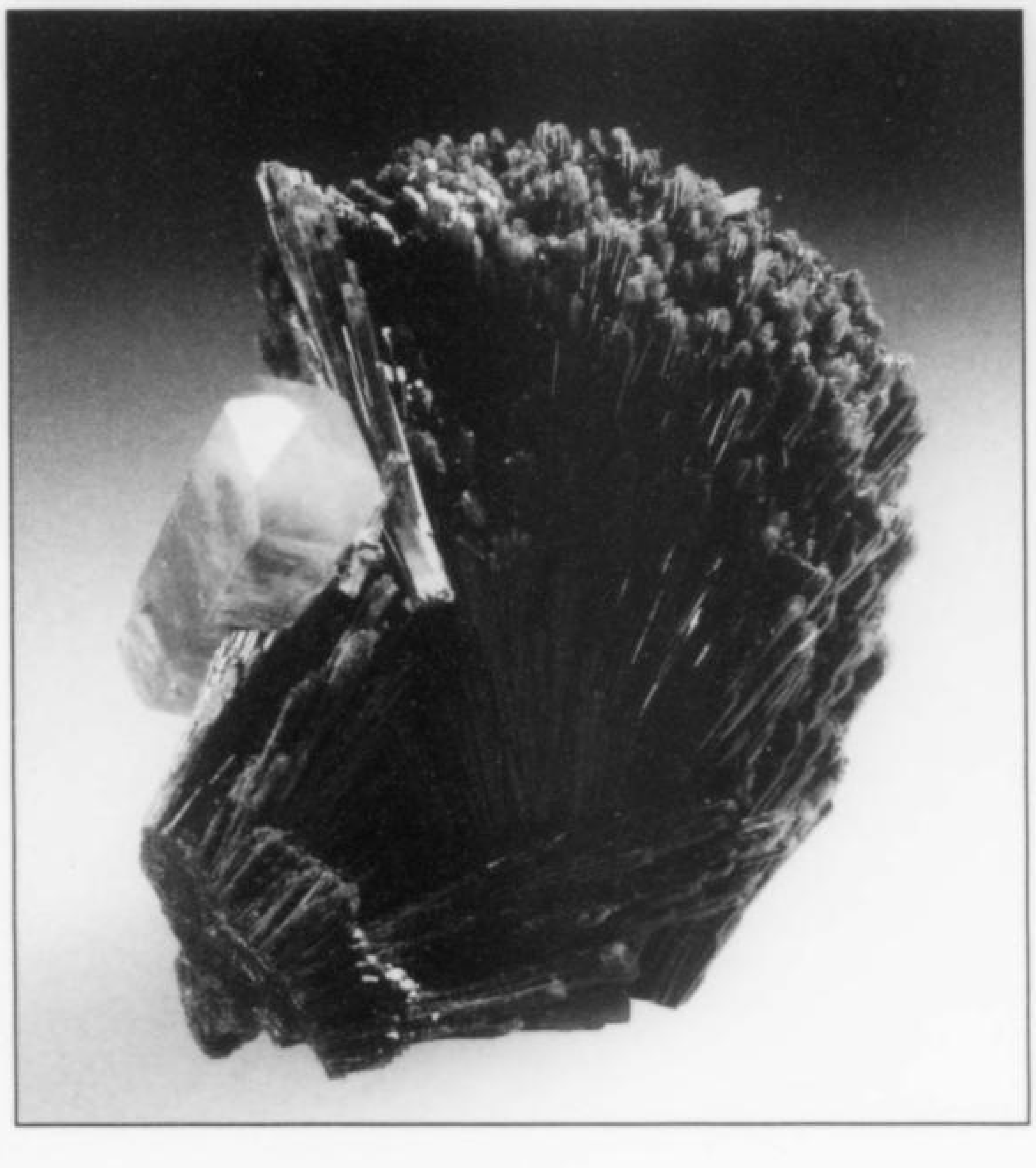


Figure 25. **Doubly terminated epidote crystals to 5.1 cm with quartz from a small 1993 pocket in the lower workings. Doug Toland collection; Wendell Wilson photo.**

Figure 26. **Epidote with quartz, 6 cm, from the 2003 "jackstraw" pocket in the lower workings. Marshall Koval collection; Wendell Wilson photo.**



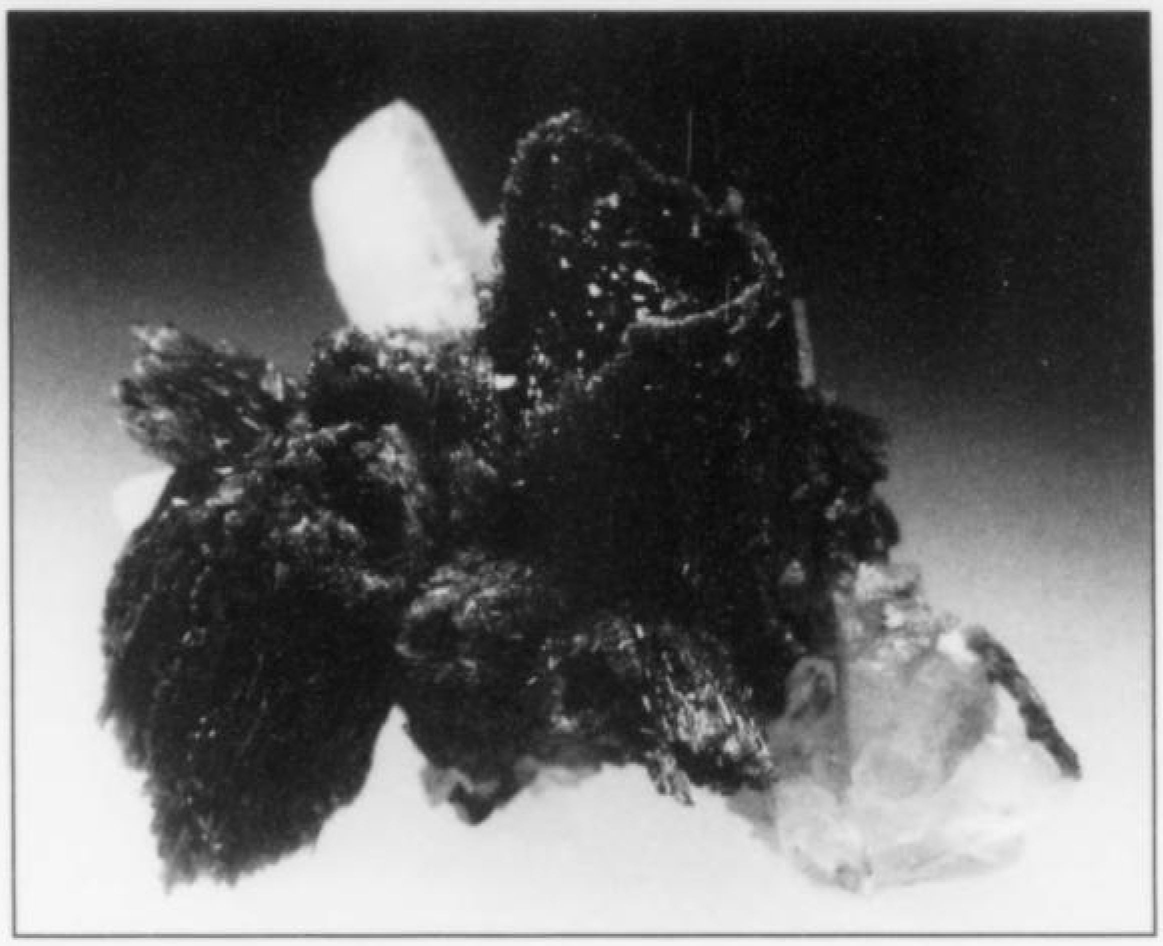


Figure 27. **Quartz with partially dissolved and regrown epidote shells, 4 cm, from a 1998 pocket located between the upper and middle workings. Tom Hanna collection; Wendell Wilson photo.**

corrosive attack and regrowth; in one such pocket in the core of the middle workings, Tom Hanna found a serrated single crystal nearly 15 centimeters long that is textured by dissolution and regrowth. In many cases, associated quartz prisms may contain up to six *en echelon* phantoms.

The locality has produced epidote crystals in an extraordinary variety of habits. A 2 x 3 x 4-meter zone in the lower workings has produced the blocky tabular crystals for which the locality is famous, as well as unusual crystals elongated on the *a* axis, with {001} and {102} termination faces; slender twinned prisms with "feathered" terminations; highly elongated prismatic crystals measuring to 8 cm with "stepped" terminations and associated with chloritic and byssolitic quartz; flattened and slightly curved, smaller crystals nearly identical to those found in Copper Mountain's Jumbo #4 mine; one or two black, nearly opaque, flat, dime-sized, pseudo-hexagonal tablets; and unusual fans and aggregated fans of bi-colored "jackstraw" crystals, some of which penetrate, or are penetrated by, single prismatic crystals and crystal clusters of heavily included quartz.

The jackstraw epidote is so distinctive that it deserves special mention. Some of the fans appear as dark green, partially flat, hollow shells with pale yellowish green, fragile, weakly connected crystal "splinters" partially filling the hollow core. Most fans under 6 cm in length are flat and presumed to be solid. A few doubly terminated fans reveal a starting point (literally) from which the tightly interwoven, parallel to subparallel "crystallites" extend and diverge, forming a classic fan or spray shape with an array of tiny bi-colored terminations around the arc perimeter. Several fans resemble interpenetrating twins that intersect obliquely at approximately 70 and 110 degrees.

I discovered the jackstraw epidote pocket in the lower workings in the summer of 2003, while hand-chiseling in the far end of a pocket Tom Hanna had opened with the Punjar chipper in 1996. Each year since then we have worked in this old pocket, a ritual that starts by shoveling slough out of the 1996 cavity (the slough is deposited by winter avalanches crashing down the steep hillside). We are not completely masochistic. Each year we motivate ourselves to muck out the old pocket because it is nearly in the center of a pocket-rich zone; clearing it out also gives us hope that we will eventually carve out a place in which to huddle and gain partial respite from the bugs during dry weather or the cold rain and wind during storms. (On Green Monster Mountain, either the bugs or the bad weather get you; there is no relief.)

The 1996 pocket begins in and extends just beyond a fault with a gouge zone up to 20 cm wide, and much of its contents were crushed by movement along the fault. Pocket detritus in the gouge yielded an occasional intact single crystal tightly crunched together with the sorry remains of bygone crystals. The intact portion of the pocket—the part we muck out each year—produced slender, prismatic but mostly broken epidote associated with the mountain's largest and perhaps most pleasing green chloritic quartz crystals.

In 2003, after shoveling the crud out for what seemed like "the hundredth time" and then chiseling for hours while crouched in very uncomfortable positions, I encountered a small area in the furthest corner of the void that contained dense chloritic mud enclosing quartz crystals. At this point I was already some four meters into the mountain, a distance attained by 25+ years of intermittent hard labor. I followed the quartz lead until it revealed a soft, tube-shaped area 50 cm in diameter and completely filled with chlorite, partially altered frowzy actinolite, heavily included quartz, many crystal fragments, and many jackstraw epidote specimens from microcrystals to crystal clusters some 30 cm in diameter. Indeed, this pocket never really opened up; it just "softened up." Most of the epidote fans recovered are Janus-faced and damaged, compromising their appeal. Nevertheless, enough quality specimens were recovered to earn this pocket and its nearby companions a prominent place in the mountain's history.

The emptied tube, which we could barely widen, was just wide enough to crawl into (provided we kept our arms in front of us). It extended over a meter and a half straight into the mountain—up to the place where Tom Hanna found an adjoining pocket that went for another meter and a half at a right angle. By now, we had to pretzel our bodies at the waist to get around the right angle, keeping arms outstretched so that we could do wrist-action chiseling and not get stuck, hold a flashlight in our teeth and somehow extricate specimens while dirt fell in our ears, mouth and eyes. Space was so tight that I had to cut a hammer's handle in half and use shortened chisels to work down the rock walls. We also had to back out frequently to allow fresh air inside.

As an encore, I spotted several quartz prisms jammed together halfway back in the roof of Tom Hanna's pocket. When I gently wiggled a couple of the prisms, about two handfuls of specimens suddenly broke loose and tumbled down. I tried to slow the jackpot with a twisted backhand but could only watch in dismay as the specimens cascaded to the floor.

This assemblage of pockets is associated with a hydrothermal conduit, as evidenced by the differentially corroded epidote, the tubular shape of the pocket zone, the voids occurring in sequence, the absence of Japan-law twins, and the gradation of the epidote crystals from blocky to acicular habit. This system differs from the two confirmed conduit systems in the middle work area in that it is horizontal and extends almost directly into the mountain. The other bottom-area conduit, three meters to the left, was also different, being near-vertical and mostly plugged with limonite and minor amounts of chrysocolla.

Years of toil have shown us that the majority of the Green Monster claim's most spectacular matrix specimens occur in isolated, relatively unweathered pockets with no obvious connection to the hydrothermal conduits. One such specimen, a plate over 30 centimeters wide, is covered with brilliant epidote crystals to 10 cm, clear quartz crystals, and two translucent, only slightly etched calcite scalenohedrons, each measuring over 5 cm. This piece is now is on display at the Rice Northwest Museum of Rocks and Minerals in Hillsboro, Oregon. It came from Tom Hanna's isolated 1995 "Papa" pocket that was tucked deep within the high wall of the upper workings. Curiously, this pocket contained no Japan-law quartz twins whereas every other pocket in the immediate vicinity produced more than a few twins.

An anomalous toilet-bowl-sized pocket was found within a horizontal cleft on the west side of the north face of Green Monster Mountain's igneous plug. It was mostly filled with pulverulent actinolite and poorly formed blocky crystals of epidote to 10 cm exhibiting severe interference from "byssolite," but it contained minor, broken quartz. The horizontal cleft that hosts the pocket is poorly defined and extends for several meters along the near-vertical wall some two meters above a steep but vegetated talus slope.

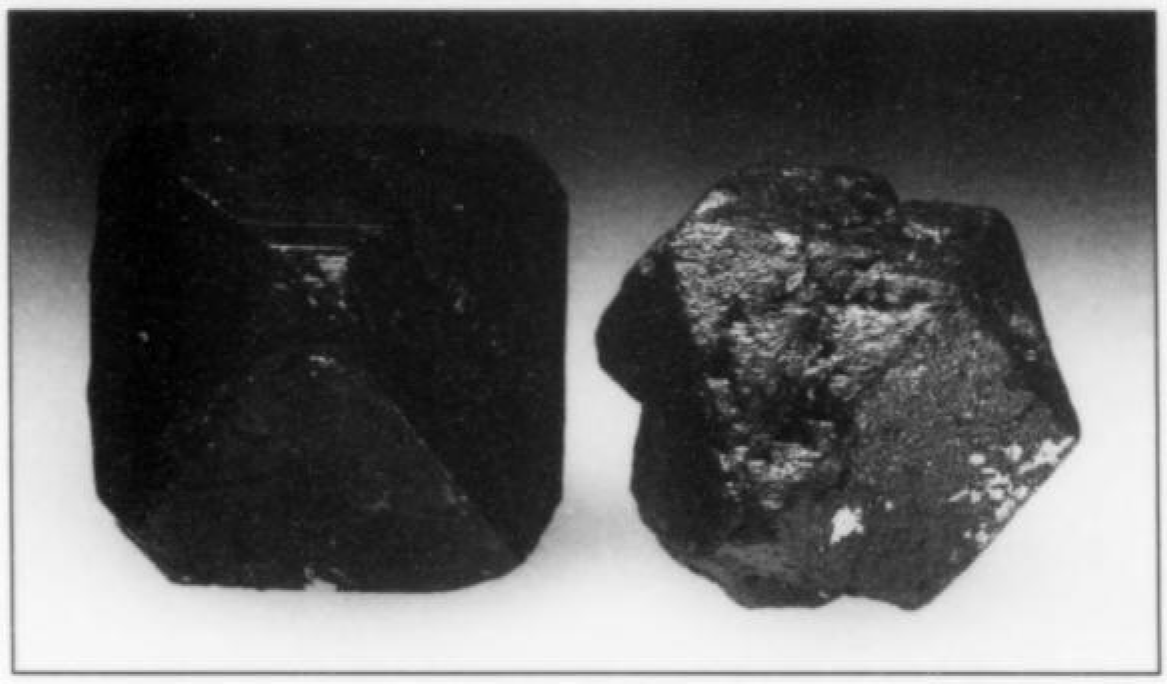


***Figure 28.* Goethite-coated pyrite crystal (left, 4.5 cm) from a 1977 pocket in the middle workings, and a cuboctahedral goethite pseudomorph after pyrite (right, 3.8 cm) from a 1982 pocket. Doug Toland collection; Wendell Wilson photo.**

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

Goethite pseudomorphs after euhedral pyrite crystals are common in the middle and upper workings, especially in most of the larger epidote pockets. No pseudomorphs have been found in the lower workings. The pseudomorphic crystals are dark chocolate-brown to gunmetal-blue, thumbnail to miniature-size floaters, and in most cases are quite sharp, although some are slightly rounded, having begun to weather to mixed iron oxides ("limonite"). The largest pseudomorph I have seen is a deeply weathered cube almost 8 cm on edge. It was nestled in limonitic soil at the site of the 1977 "Mama" pocket which was ruined by an adjacent fault long ago.

Figure 29. **Platy gray magnetite (upper left) with epidote and quartz, 7 cm, from a 1994 pocket in the upper workings. Tom Hanna collection; Wendell Wilson photo.**

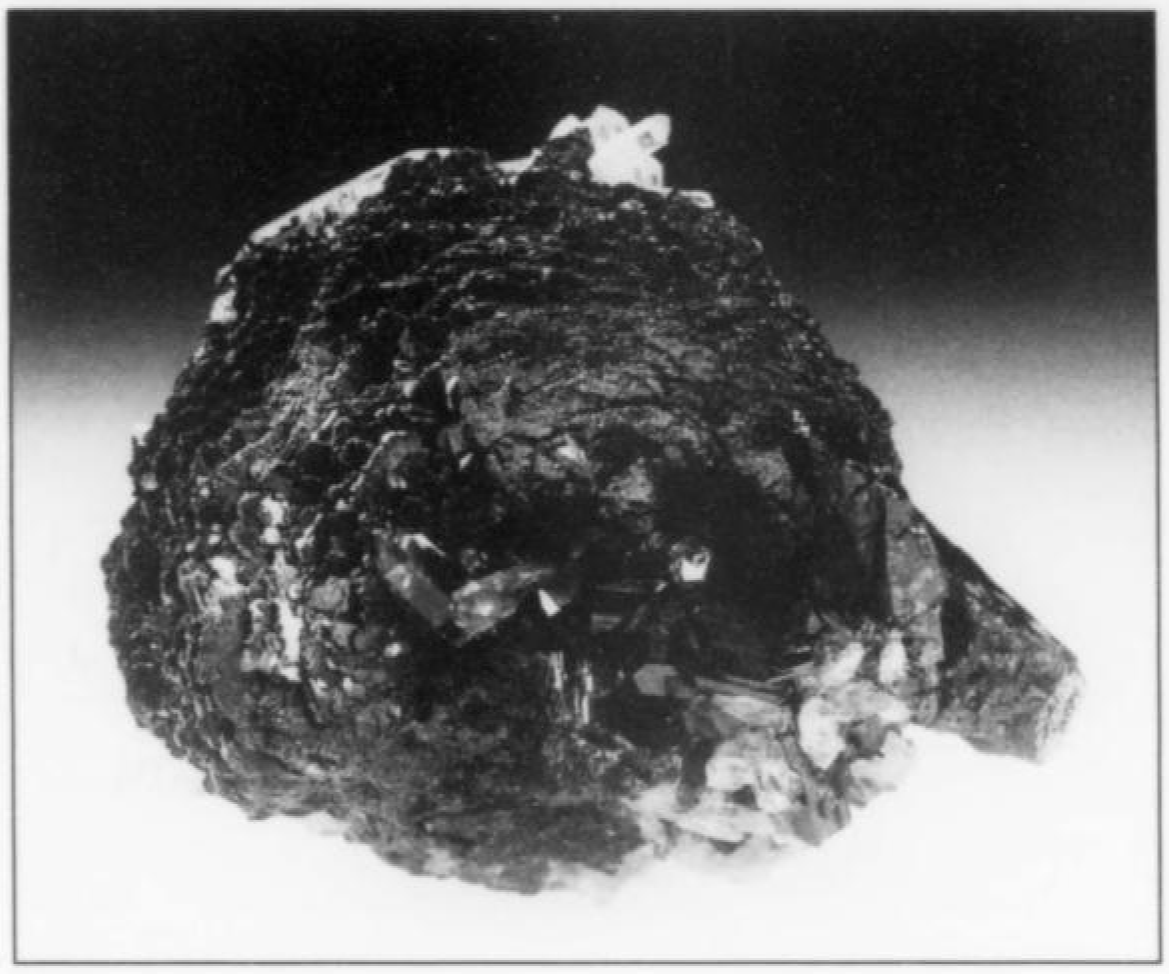


Figure 30. **A rosette of magnetite, 5 cm, with small Japan-law quartz crystal, from an isolated 1995 pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.**

A limited number of goethite pseudomorphs measuring 2 cm or more have been found in a sulfide-rich, iron-gossan-stained zone a few meters wide which cuts across the ridge above and to the northeast of the epidote area and to within a few meters of a site which produced ochre-included quartz.

Infrequently, goethite pseudomorphs after pyrite rest on epidote crystals, and vice versa. While the pseudomorphs do occur in pockets with quartz and/or magnetite, they have not been found attached to crystals of these species.

Gold Au

Gold occurs very sparingly in the masses of sulfide and oxidation products that are found in the conduit pockets. In 2002, I noticed several very small (less than 0.5 mm) gold crystals attached to a 2-cm goethite pseudomorph after pyrite found in a particularly large sulfide zone of a pocket we had uncovered the year before. I have crushed several samples of the oxidized sulfide material from this pocket and panned out gold specks. We have shoveled most of this kind of material, along with waste rock, down the debris slope over the years, and Tom and I sometimes wonder how many kilograms of copper and troy ounces of gold we have thrown away.

Grossular $Ca_3Al_2(SiO_4)_3$

Up to 80% of the skarn in and around the epidote area is composed of grossular-andradite garnet, with grossular predominating. On rare occasions we have found dark brown, subhedral, rough-surfaced dodecahedral crystals lining small pockets. The largest crystal is a fragment speckled with several small magnetite rosettes. Had it been a complete garnet crystal it would have been nearly 30 cm in diameter. However, most individuals are usually less than 5 cm. Specimen-quality epidote is not usually found in these pockets; it is likely that the garnet pocket linings and any associated grossular crystals had to be dissolved in order to provide at least some of the elements needed to precipitate the prized epidote, quartz, calcite and magnetite crystals.

Small chunks (to 5 cm) of grossular with surfaces comprised of tightly intergrown dodecahedral crystals occur near the east summit of Green Monster Mountain. Viable specimens have formed where there was just enough interstitial calcite to allow a few crystals to grow without touching. Derrickson's specimen of pale grossular and clintonite (see above under Clintonite) appears to have been an anomaly; however, additional work here might uncover a few more sherry-colored grossular specimens.

Hematite Fe_2O_3

Splendent pseudomorphs of goethite and hematite after pyrite crystals to 6 cm were once found near the summit of Copper Mountain. On Green Monster Mountain, however, hematite is found only as small patches of reddish ocherous soil containing quartz crystals, and as ocherous inclusions that give these quartz crystals a reddish color. Along the ridge above the primary epidote area and just east of the iron gossan zone, a collapsed surface pocket yielded many such quartz crystals, some doubly terminated, to 10 cm, of rose-red to russet-red hues; a few of the crystals also have partial coatings of green drusy epidote. Unfortunately, all but a handful of the crystals have dull surfaces. We believe that Virgil Gile found the majority of these specimens in the mid-1970's.

Another set of small surface pockets crops out along a very steep slope a few dozen meters to the northeast of this site. Here I have found small, slender, grayish-pink, hematite-included quartz crystals to 3 cm long, and a few frost-damaged clusters of the same crystals on weathered epidote matrix. The host rock here suggests a potential for additional pockets.

Hercynite $Fe^{2+}Al_2O_4$

Sharp black octahedral crystals of the iron-rich spinel hercynite and small grains of what may be diopside have been found loose in the thin alpine soil along the west slope of Green Monster's summit plateau some 40 meters southwest of the clintonite site. Most of the hercynite crystals measure less than 5 mm, although exceptionally they reach nearly 1 cm.

Humite (?) $Mg_7(SiO_4)_3(F,OH)_2$

At the clintonite site we have found small, brown, stubby and somewhat flattened monoclinic crystals (a few measuring to 1 cm) occurring both enclosed in calcite and loose in the soil and often intergrown with clintonite. We believe they are a species belonging to the humite group, but we are not aware of any determinative work having been done on them. Weathering and (we believe) organic acids have weakened and partially dissolved many of the crystals.

Laumontite $Ca_4[Al_8Si_{16}O_{48}]\cdot 18H_2O$

Over the years, Tom and I have encountered just one zeolite, laumontite, on Green Monster Mountain. In most cases the species occurs as crystalline coatings and as slender, unattached, white to pale tan, translucent prisms to 1.5 cm. Within hours of their removal from pockets the prisms dehydrate, turn an opaque off-white and start to decrepitate. The laumontite coatings typically are admixed with final-stage quartz and form a tenacious "skin" on epidote groups that had the misfortune of ending up on the floors of pockets. Invariably the surfaces of epidote crystals beneath the laumontite/quartz coating are either damaged or corroded, suggesting that both late-term species may have grown parasitically on the epidote.

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

Fine specimens of magnetite occur in many of the fresher isolated epidote pockets. To my knowledge, magnetite has not been found in conduit pockets. Rosettes of black to dark silvery gray, very thin platy magnetite crystals exceptionally reach 5 cm across. Prismatic quartz crystals commonly lie on, and sometimes project from, the magnetite aggregates. Rarely, Japan-law quartz twins perch upright on them. Magnetite rosettes (or "wheels") have been found in close association with epidote only in the middle and upper workings. Indeed, no magnetite at all has been found in the lower workings, only some 50 meters distant. Several small pockets have produced magnetite rosettes with varying numbers of quartz crystals and only minor amounts of epidote; at times the magnetite is still attached to the grossular-andradite pocket linings.

Leavens and Thomssen (1977) initially thought the specimens to be hematite "roses," since they looked so similar to Swiss specimens. At some point I tested several of the rosettes with a magnet and found them to be strongly magnetic. What appear to be tiny distorted octahedral faces along the outer edges of the rosette lamellae argue against the notion that the magnetite replaced hematite. Leavens (personal communication) suggests that the rosettes exemplify extreme spinel-law twinning.

In 1977, I found several splendent magnetite rosette "floaters" up to 3 cm in diameter along the crest of the ridge above the epidote site. This partially decomposed pocket was within 2 meters of one of our 1967 holes which had produced a few poor-quality weathered epidote crystal shards. Several of the magnetite rosettes were affixed to a 25-cm fragment of a single crude garnet crystal. This pocket also contained a considerable number of off-white to pale green chloritic quartz clusters up to 3 cm; these had partially overgrown fragments of relatively fresh-looking grossular-andradite.

Aggregates of magnetite octahedrons averaging less than 2 mm with a few individuals to several millimeters occur sparingly along the central part of Green Monster's plateau summit. This magnetite occurrence is associated with small mafic dikes.

Malachite $Cu^{2+}_2(CO_3)(OH)_2$

Malachite has been found in only two pockets to date. Distinct, splendent, deep emerald-green, slender, acicular prisms of malachite (?) crystals grouped in tufts to almost 1 mm were recovered from a relatively large sulfide/oxide bleb that occurred with a large epidote pocket found in the upper workings in 2001. Within this pocket, malachite also formed minute botryoidal crusts on dark brown to black iron oxide and manganese oxide breccia, and massive malachite occasionally filled small interstices. Several years earlier a collapsed pocket in the middle workings produced minor amounts of malachite coloration admixed with iron hydroxides. Careful analyses of the minerals from the malachite occurrences may reveal other species of secondary copper minerals.

Orthoclase $KAlSi_3O_8$

Although we have not found orthoclase as recognizable crystals on Green Monster Mountain, the species is mentioned here because of the many excellent specimens of complexly twinned translucent crystals that were recovered years ago on nearby Copper Mountain (see photographs in Leavens and Thomssen, 1977). Because the two skarns occur on opposite sides of the same igneous intrusion, it is possible (and we hope) that areas of feldspar enrichment containing euhedral crystals exist somewhere within or adjacent to the Green Monster contact zone.

Pyrite FeS_2

Fresh sulfides have rarely been found on Green Monster Mountain, although we have found several sharp pyrite crystals with only a thin skin of goethite. I have two uncoated, unaltered pyrite specimens, a thumbnail dodecahedron and an aggregate of crystals from a conduit in the middle workings.

Most Green Monster Mountain pyrite occurs in sulfide blebs admixed with secondary minerals resulting from sulfide oxidation and infrequently with chalcopyrite. Goethite pseudomorphs after pyrite reveal a characteristic that the original pyrite shared with the locality's quartz and epidote: a propensity to crystallize in widely varying forms. Although very rare, highly stepped iron-cross twins occur here, as do cubes, cuboctahedrons, octahedrons and dodecahedrons. We have not found pyritohedrons.

Pyrrhotite $Fe_{1-x}S$

An apparently isolated mass of crystalline pyrrhotite occurs within a nearly black gossan-covered polysulfide orebody located some 50 meters southwest of the Green Monster Mountain summit plateau. This rusty "sore" covers just a few square meters at the surface and appears to contain pyrrhotite, pyrite, magnetite, chalcopyrite, and probably some manganese oxides, in unknown proportions. The early prospectors stockpiled several tons of the ore that they excavated from a small prospect pit and then marked the heap prominently on their claims survey. The extent of the mass, which plunges almost vertically, has not been determined. The U.S. Forest Service surveyor used the stockpile as a known reference while remapping the property in 1986. However, the magnetic mineralization in the area required him to compensate for his non-functioning compass.

Figure 31. Japan-law quartz twin (left, 3.5 cm) with other quartz crystals and skeletal regrown epidote crystals, 10 cm, from an isolated 1977 pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.

Figure 32. Unusual four-way Japan-law quartz twin, each member of the twin extending on boths sides from the crossing point, 3.1 cm, from a minor pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.

Figure 33. Several fine Japan-law quartz twins perched on an epidote crystal, 5.6 cm, from a 1996 pocket in the upper workings. Tom Hanna collection; Wendell Wilson photo.

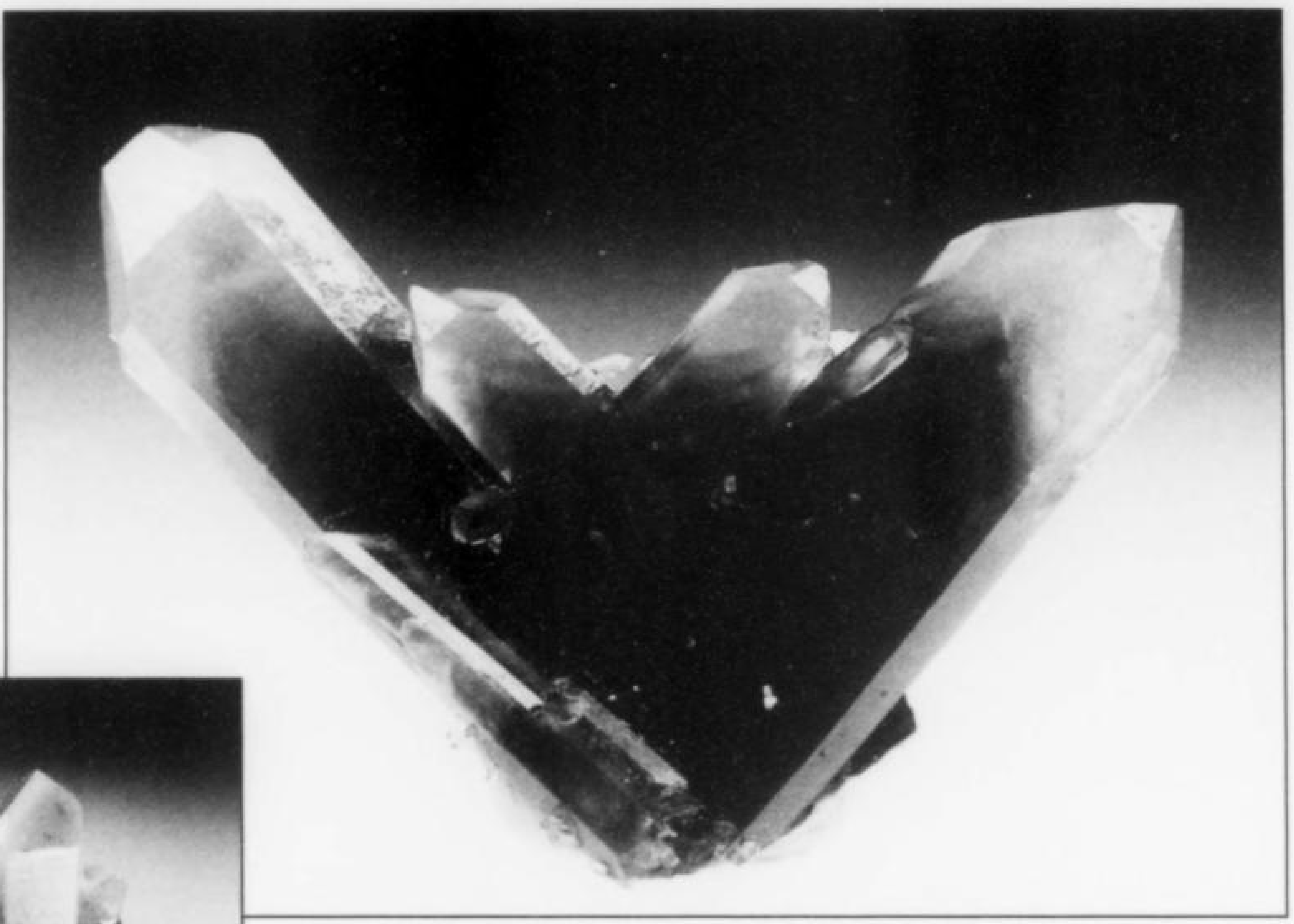


Figure 34. **Twinned epidote crystal (left, 3.5 cm) from a 1998 pocket in the middle workings, and epidote with Japan-law twinned quartz (right, 5 cm) from an isolated 1982 pocket in the middle workings. Doug Toland collection; Wendell Wilson photo.**

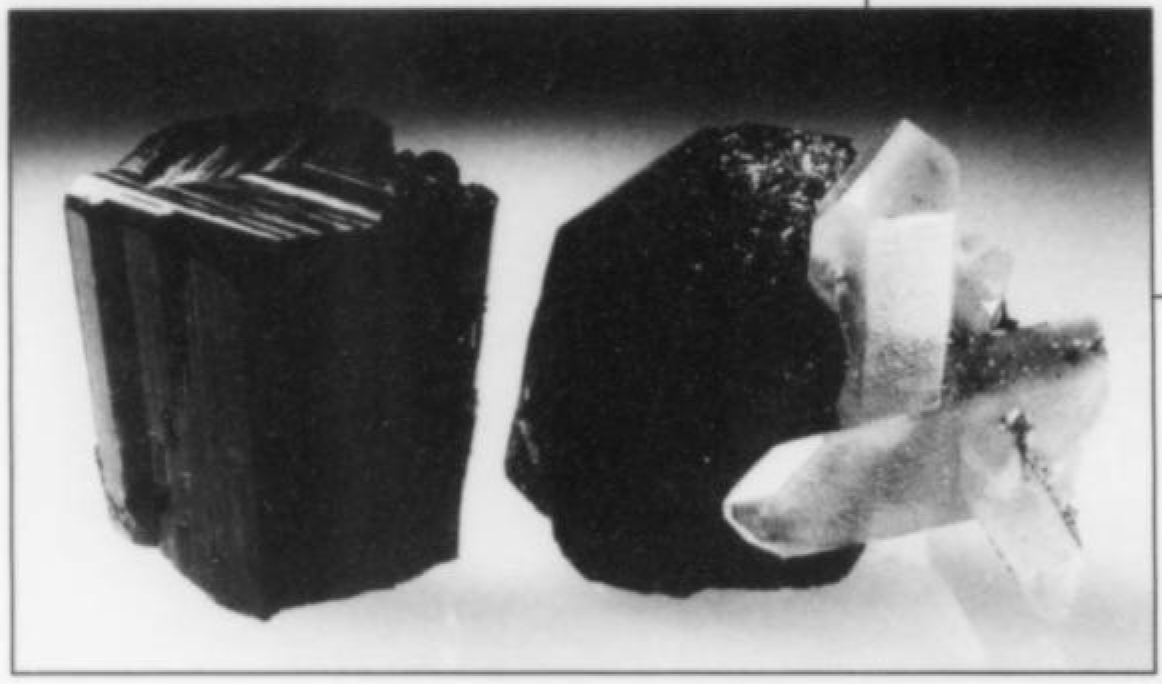


Figure 35. **Remarkable nested Japan-law quartz twins, 3.8 cm, heavily included with chlorite, from an isolated 1995 pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.**

Figure 36. **Two intergrown Japan-law twins (left, 3.2 cm) from a 1979 pocket, and a Japan-law quartz twin with chlorite phantoms (right, 3.3 cm) from a one-specimen isolated 1979 pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.**

Figure 37. **Doubly terminated quartz crystal, 6.3 cm, with reddish iron oxide inclusions and phantoms, from a 1977 pocket in the ridge above the primary epidote area. Doug Toland collection; Wendell Wilson photo.**

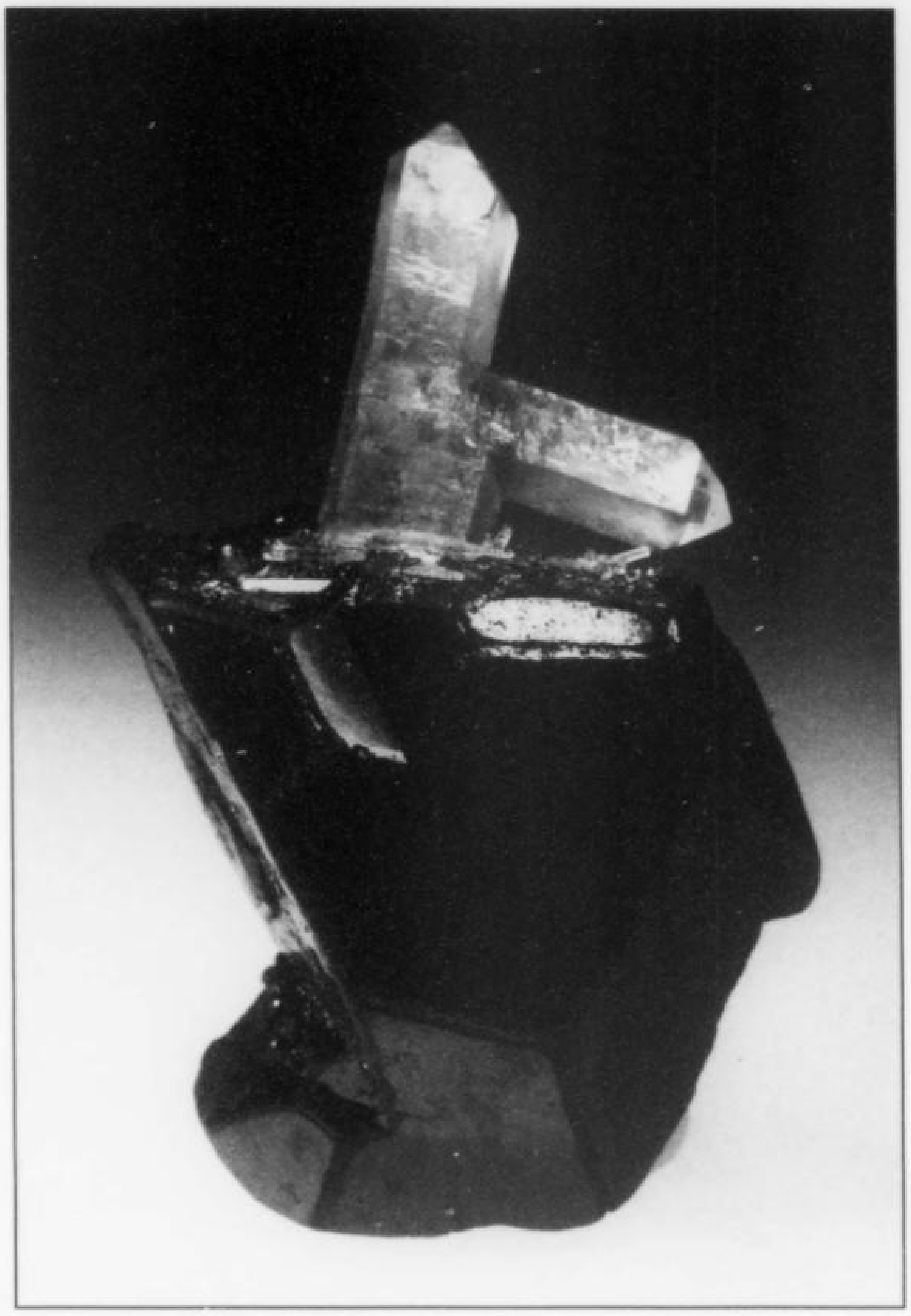


Figure 38. **Japan-law quartz twin on a twinned epidote crystal, 5 cm, from an isolated 1977 pocket in the upper workings. Doug Toland collection; Wendell Wilson photo.**

Quartz SiO_2

I almost prefer finding a pocket of aesthetic quartz crystals to finding a pocket of sharp, glassy epidote . . . almost. Attractive and rich in crystal forms, Green Monster Mountain quartz deserves more recognition than it has generally received among mineral collectors. It is distributed throughout the epidote area and has been found in every producing pocket.

It might be easiest to list varieties of quartz *not* found on Green Monster Mountain. We have not found gwindels, smoky quartz, citrine, agate, faden quartz, beta quartz, globular quartz, "hopper" crystals or scepters. We have found crystals resembling "rocket quartz" crystals (described by Dibble, 2002), with prisms widening toward the terminations such that the crystals are commonly mistaken for scepters, and we found reverse scepters in the jackstraw epidote pocket.

Nowhere on Green Monster Mountain have we seen quartz as a primary skarn mineral, and it has yet to be recognized east of Green Monster's igneous plug. However, quartz grew during every phase of hydrothermal mineralization in the skarn to the west of the igneous plug, and consequently its varying habits and variety of inclusions serve as important indicators of sequential hydrothermal activity and weathering processes that have affected the host pockets.

The only downside to specimen quartz from Green Monster is that the crystals are relatively small: individuals rarely exceed 5 cm. However, prisms exceeding 12 cm have been retrieved from the lower workings, where hundreds of quartz and quartz/epidote specimens have been found. Almost all the quartz from the lower workings is heavily included with chlorite and, more rarely, actinolite, epidote and one or two minerals yet to be identified. Many of the epidote clusters from this area feature quartz points larger than those from the middle and upper workings. We have also found prisms with fensters resulting from incomplete overgrowths. Reverse-scepter crystals, and single crystals containing inclusions of tiny white monoclinic crystals of an unknown species, are both unique to the lower workings. Curiously, I have never found a Japan-law twin, or quartz grown epitactically on epidote, in this area. (Tom Hanna insists that he has found one or two Japan-law twins here, so I am keeping an open mind.)

In the middle and upper workings, we have found several variations on Japan-law quartz twinning, including one or two that have not, to my knowledge, been reported from elsewhere. The upper workings have produced the majority of specimens of quartz twins and of epitactic quartz on epidote. Several exceptionally rare four-way (X-shaped) Japan-law twin floaters with inclusions of cloudy gray-green chlorite have been found here. Most pockets in this area have yielded at least a few Japan-law twins. In 1991, a narrow tubular pocket less than a meter long yielded over two dozen Japan-law twins, some with clusters of slender epidote crystals and untwinned quartz crystals.

A letter dated June 23, 1992 by Si and Ann Frazier (to Richard Thomssen and Michael Kokinos) regarding a treatise by Rudolf Rykart (1989) helps to better understand Green Monster Mountain quartz. Translated and summarized by the Fraziers, Rykart's treatise categorizes quartz from Alpine veins (Zerrkluft) in two distinct etiological and morphological systems designated as "Bambauer" and "Friedlander" quartz. According to Rykart (1989), "Differences in Bambauer and Friedlander quartz structures are of fundamental importance to many aspects of mineralogy and geology." Bambauer quartz typically forms as long prismatic crystals in lower-temperature, vein-associated cavities that underwent a "changeable milieu." Bambauer crystals grow relatively rapidly and not uniformly, often nucleate spontaneously to form doubly terminated floaters, and exhibit Dauphiné, Brazil-law and Japan-law twinning.

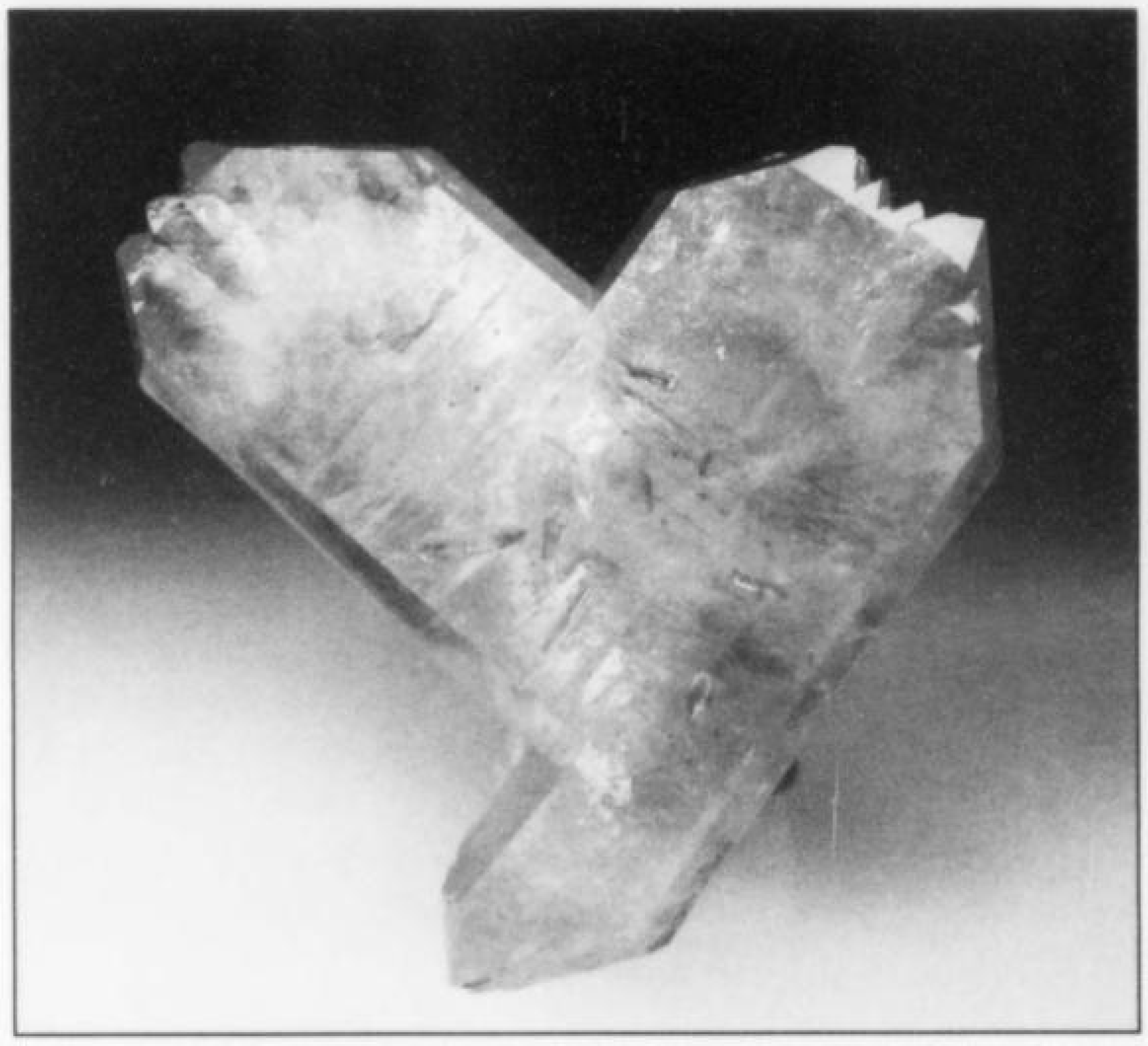


Figure 39. **Japan-law quartz twin, 4.5 cm, from a small 1993 pocket in the upper workings. Tom Hanna collection; Wendell Wilson photo.**

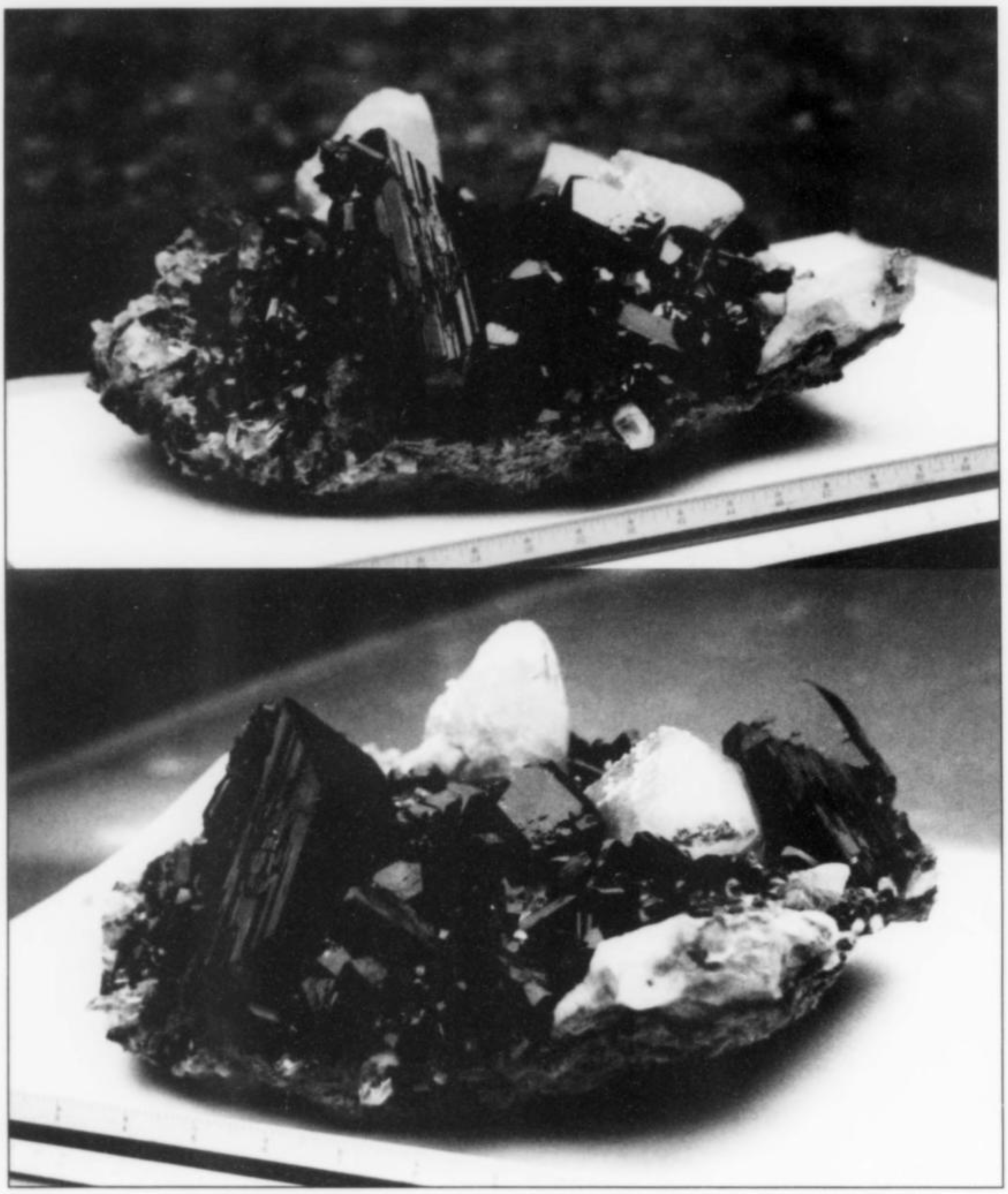


Figure 40. **Two views of a remarkable 28-cm (nearly a foot long) specimen of epidote, quartz and large white calcite crystals recovered from Tom's 1995 "Papa" pocket. The main epidote crystal measures 9.4 cm. Small (0.2 to 0.4 mm) yellow crystals of titanite occur widely dispersed among the smaller epidote and quartz crystals. The specimen weighs about 7 kg (15 pounds), and was found wedged upside down along the top of a partially collapsed medium-size pocket. The specimen is now in the collection of the Rice Northwest Museum of Rocks and Minerals, Hillsboro, Oregon.**

In Friedlander quartz, crystal growth rates are slow, and the crystals always develop from pre-existing quartz grains and splinters. Brazil-law twins are rare, and Japan-law twins do not occur. Crystals often show strongly distorted tips and prismatic to steep rhombohedral habit. Gwindels occur only in Friedlander quartz.

The Bambauer description seems to approximate most closely the quartz found in both conduit and isolated pockets on Green Monster Mountain. However, there are notable differences in the quartz from conduit pockets. For example, we have rarely, if ever, found Japan-law twins in them; prisms frequently display features that indicate prolonged growth, such as multiple layers of inclusions and aberrant growth features (e.g., "bent" or distorted prisms resulting from dislocation in the pockets and growth interference from adjacent or attached crystals). The crystals are also consistently larger than those found in isolated pockets, and doubly terminated "floaters" are rare to nonexistent, although some "doubly terminated" prism sections have resulted from the rehealing of break surfaces.

At some juncture, we hope to do a more thorough investigation of Green Monster quartz with respect to Rykart's categories. In so doing, we may come to better understand the sequence of events that produced Green Monster's remarkable specimens.

Rhodonite $MnSiO_3$

Ten years ago we encountered rhodonite in the lower workings. It occurs sparingly as irregular, crystalline blebs in a very tough, gray-green portion of the skarn, on the downhill side and to within a meter of epidote pockets (see under Diopside). The rhodonite blebs typically are less than 2 x 5 cm, are a warm but irregular pink, and are admixed with minor amounts of other minerals including quartz grains to 3 mm. Some of the blebs are sandwiched in a narrow, 4 to 8-cm vein and possess an irregular rind of chalk-white and rootbeer-brown minerals; portions of the rind also contain compression folds. (My wife Mary says this rhodonite looks like dollops of raspberry sorbet surrounded by vanilla ice cream and light chocolate.)

Within the past three years we exposed a similar vein or dike hosting smaller inclusions of pale pink rhodonite in the extreme lower margin of the middle workings. This assemblage also occurs along the outer margins of a pocket-rich area. The site of Over and Montgomery's big find in 1935 is less than 10 meters to the upper left of this exposure. This part of the middle area is also closest to the lower workings, suggesting that the two rhodonite occurrences could be part of the same lithologic unit.

(continued on p. 419

Alpine Milarite

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Milarite, characterized as a species in 1870, is more familiar to micromounters than to collectors of larger specimens: crystals larger than 1 cm are rare. There are numerous world localities, but most of the best milarite specimens come from clefts in alkaline igneous rocks in the Alps, and are collected by mountaineering Strahlers. *Over the past 25 years there have been several exciting new discoveries of Alpine milarite in Italy, Austria and Switzerland—including a crystal on matrix, found in 2000 in Val Giuv, Switzerland, which may be the world's finest milarite specimen.*

INTRODUCTION

For about a century after its formal characterization by Kenngott (1870), milarite was generally regarded by mineral collectors as a very rare species occurring only in tiny (if pretty) crystals—a species "made" for the micromounter. Considering that it has been found in mountainous regions of Switzerland from the beginning, milarite might also be called a species made for the *Strahler*. For these mountain men there is, as one of them writes, "something magical about this mineral" (Sialm-Bossard, 2004a), and indeed a puckish magic seems to have influenced even the naming of the species. In 1868 the *Strahler* Giachen Fidel Caveng collected small crystals of the then-unknown mineral in Val Giuv, Graubünden, Switzerland—still the world's best milarite locality—but to protect his discovery site he deliberately cited a false locality in Val Milà, a parallel valley just west of Val Giuv. When Kenngott published the new species two years later, he named it *milarite* after what he thought was the type locality—where to this day the mineral has not been found (Wilhelm, 1972; Stalder *et al*., 1998).

This motif of tricky elusiveness persists today: *Strahlers* who have sought milarite in Val Giuv for the past several decades routinely complain that productive clefts are rare, the collecting ground is picked over, the syenite rock is extremely hard, and collecting conditions are difficult even when the snowpack recedes, since then the fields of loose scree become treacherous (Sialm-Bossard, 2004b). Milarite pocket discoveries are rare enough to be famous events, and local lore whispers that near Val Giuv, in houses and huts in the adjoining valley called Tujetsch (formerly Val Tavetsch), in secret collection drawers, there repose wondrous specimens of milarite which no one has ever seen. Once a *Strahler* named Tumaisch Beer collected very large milarite crystals from Muota #3 at Val Giuv, and Victor Sialm-Bossard (2004a) reports having once seen the crystals. But Tumaisch Beer died without his crystals ever having been shown publicly or documented, and today their whereabouts are unknown. "You can't look for milarite, you can only find it," one *Strahler* knowingly reminds another (Sialm-Bossard, 2004a).

In 1971, John White, in an early "What's New in Minerals" report in the very young *Mineralogical Record*, began to retire the myth of milarite's extreme rarity by noting a "string of . . . recent discoveries," with the milarite crystals exceeding 1 cm in two of

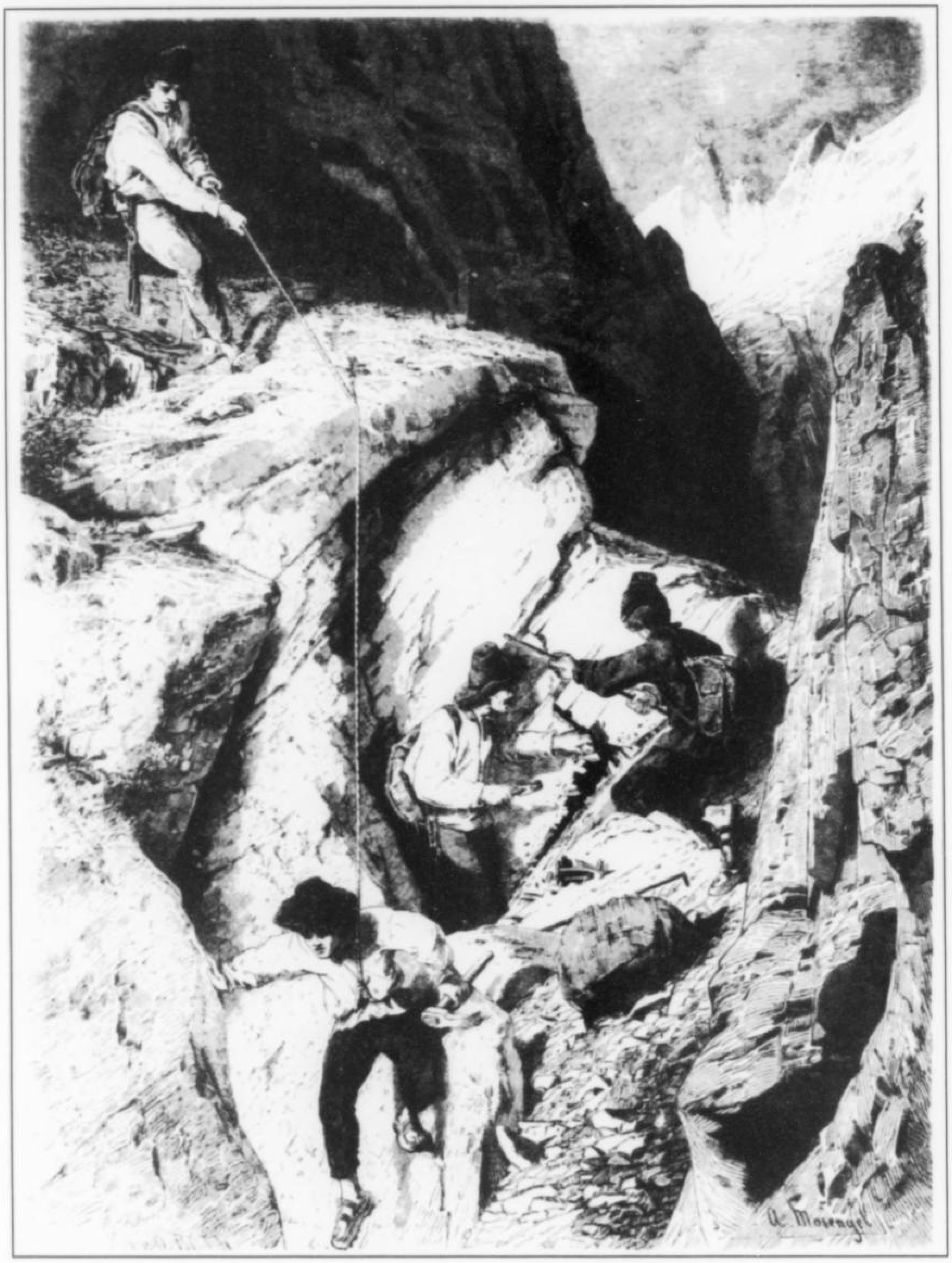


Figure 1. **Early engraving showing Alpine Strahlers at work.**

the new localities. For a while it looked as though either the Valenciana mine at Guanajauato, Mexico, or the Rössing mine, Namibia, or both, might surpass any Alpine locality. And then in 1980–1981 it looked as though the world's forever-best milarite crystals might be those just found in the Jaguaraçu pegmatite in Minas Gerais, Brazil.

But the 1980's, 1990's and early 2000's have seen a remarkable milarite renaissance in the Swiss, Austrian and Italian Alps, including a wonderful strike in 2004 at Val Giuv, the original locality: to a proud European it now seems safe to say that "the biggest and best milarite specimens from the Alps are also the biggest and best in the world" (Weiss, 2004). This article will support that assertion, first by glancing at a few world localities for milarite, then by taking a more detailed look at Alpine discoveries, especially some spectacular ones made since the early 1980's.

AN OVERVIEW OF THE SPECIES

Milarite, a member of the osumilite group, is a hydrous silicate of potassium, calcium, aluminum and beryllium: $KCa_2AlBe_2Si_{12}O_{30}\cdot 0.5H_2O$. Stalder *et al.* (1998) observe that its chemistry took mineralogists much longer to understand than did its relatively simple crystallography. Like beryl, milarite is a cyclosilicate, having SiO_4 tetahedrons linked in six-sided rings of the anion complex $[Si_{12}O_{30}]^{12-}$. Vertical channels run down through the rings, and during crystal growth these axial channels (or "canals") are sites where metallic cations may be mobilized and exchanged, rather as Na and Ca are exchanged in the structural channels within zeolites. There is a rough equilibrium of exchange; for example, partial substitution of trivalent yttrium for divalent calcium is coupled with the partial substitution of divalent beryllium for trivalent aluminum (Černý, 2002).

Milarite can form in solutions which range in pH from neutral

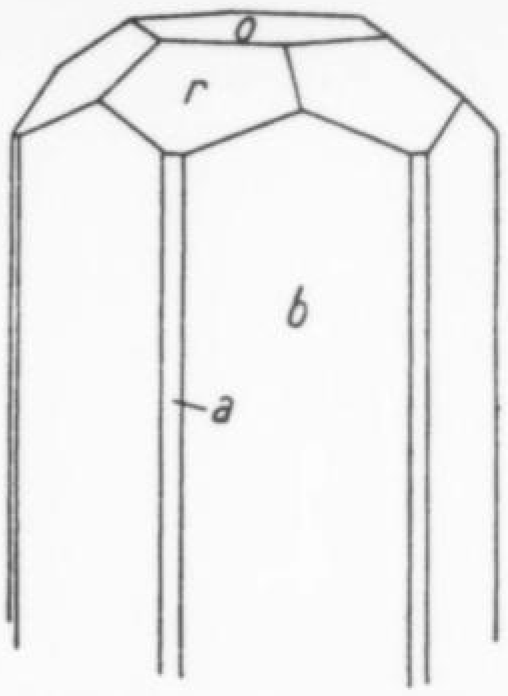


***Figure 2.* Typical morphology of milarite crystals from Val Giuv. Forms: *a* $\{10\bar{1}0\}$, *b* $\{11\bar{2}0\}$, *o* $\{0001\}$, *r* $\{10\bar{1}1\}$ (Wagner, 1979).**

(7) to slightly alkaline (9), and in varying mineral assemblages (Černý, 2002; Weiss, 2004). The best milarite crystals seem to come from the more alkaline environments: Weiss (2004) suggests that the smooth-faced crystals from the alkaline syenite of Val Giuv formed in something close to the mineral's "ideal" conditions in a quartz-poor environment, while by contrast the milarite crystals from the South Tyrol, some of which are associated with quartz, display countless lancet-shaped vicinal faces, reflecting uneven patterns of growth.

Milarite is hexagonal, its crystals nearly always being simple hexagonal prisms displaying at most four forms: two prisms, $\{10\bar{1}0\}$ and $\{11\bar{2}0\}$; one basal pinacoid, $\{0001\}$; and one dipyramid, $\{10\bar{1}2\}$. The crystals are almost always elongated, and they tend to grow singly or at least to diverge widely from the bases of small clusters, so that each crystal is quite fully realized; in short, milarite resembles beryl both in morphology and in habit.

In some cases, milarite is a product of the alteration of beryl in weathered pegmatites. But this secondary milarite generally does not occur in attractive macrocrystals: the larger, gemmy milarite crystals of highest interest to collectors have crystallized directly from hydrothermal solutions. As a mineral of Alpine-type clefts, milarite occurs chiefly in intrusive bodies of syenite or in miarolitic cavities in aplite veins, commonly associated with translucent or transparent orthoclase crystals, finely fibrous gray-green actinolite (commonly called "byssolite" in the United States), titanite, calcite, apatite, zeolites and, in some cases, quartz. The bane of the milarite-seeking *Strahler* is chlorite-group minerals which coat, invest, and partially replace milarite in a majority of the pocket occurrences. Chlorite turns the milarite crystals from gemmy, lustrous and limpid, pale yellow or yellow-green things of beauty into turbid, dull-faced, and milky grayish green things merely of "interest." And yet many chloritized milarite crystals remain quite sharp, and may still make for very impressive specimens, as at Wiesbachrinne, Habachtal, Austria (see later).

MILARITE LOCALITIES OUTSIDE THE ALPS

The survey below is by no means exhaustive: its purpose is simply to sketch a worldwide context for a more restricted survey of Alpine localities for milarite.

The lithium pegmatite of the Foote mine, near Kings Mountain, Cleveland County, **North Carolina** was among the "new" milarite localities noted by John White in 1971. Those specimens consist of white hexagonal-prismatic milarite crystals to 3 mm associated with albite (White, 1971).

The Conway and Mount Osceola granites of southern **New Hampshire** produced good crystals of milarite from at least two sites. Moat Mountain, in Carroll County, produced divergent groups of colorless long-hexagonal prisms to 2 cm (Samuelson *et al.*, 1990); Neil Yedlin reported seeing these "first-ever" specimens from the locality in the early 1970's (Yedlin, 1973). In 1970 and 1973, Ernie Schlichter collected similar crystal sprays at the Government Pit, Carroll County (Henderson, 1983; Samuelson *et al.*, 1990).

Another of the "new" localities noted by White (1971) was the old (begun in 1760) Valenciana silver mine at Guanajuato, **Mexico**, where a few veins of alpine-type mineralization were found crossing the gangue zones of hydrothermal metallic ore veins. In these milarite specimens, lime-green to yellow-green crystals to 3 cm are intimately intergrown with snow-white crystals of orthoclase (sometimes called "valencianite" in the past). Tiny quartz crystals rise from the prism faces of the milarite crystals, but not from the pinacoids. Cabinet specimens measuring up to a foot across were once available on the market (White, 1971; Weiss, 2004).

Milarite might be expected in the complex hyperalkaline intrusive bodies at Mont Saint-Hilaire, **Quebec**. The mineral has indeed been found there, as aggregates of crude hexagonal prisms to 3 mm in parallel growth on pectolite crystals in marble xenoliths (these having been thermally metamorphosed by syenite intrusions). The white to colorless, translucent to opaque, silky looking microcrystals of milarite are fluorescent blue-white under shortwave ultraviolet light (Horváth and Gault, 1990).

The third of White's 1971 "new" localities was Klein Spitzkopje, **Namibia**; this occurrence is in a uranium-enriched syenite, and is

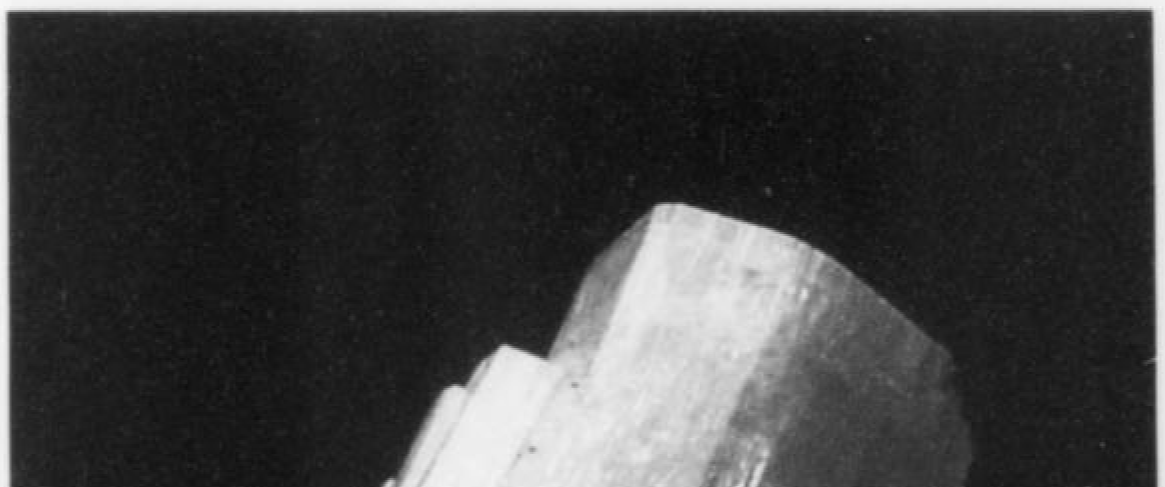


***Figure 3.* Milarite crystal, 2.5 cm, from the Jaguaraçu pegmatite, Minas Gerais, Brazil. Carlos Barbosa specimen; Wendell Wilson photo.**

sometimes called the Rössing uranium mine. "Excellent" milarite specimens were collected here in the late 1960's (White, 1970); at around this time the Smithsonian acquired fifty fine specimens which a dealer had offered as chrysoberyl. Beautiful yellow-green milarite crystals, in part gemmy, to 2.5 cm long are found embedded in calcite and associated with quartz and albite crystals (White, 1971). Further discoveries in the 1970's and 1980's yielded short-prismatic crystals to 2 cm; enriched in yttrium, these crystals are bright yellow to honey-brown (Weiss, 2004).

Surely the best milarite outside of the Alps is that first found in 1980–1981 at the Jaguaraçu pegmatite east of Belo Horizonte, Minas Gerais, **Brazil**. This rare-earth pegmatite was mined for beryl and mica ca. 1945–1970, then closed, then opened again to be reworked for mineral specimens. Most milarite crystals collected from vugs in albite during the brief 1980–1981 time-window are tan, but some are a beautiful yellow-green. They are smooth-faced or lightly striated, simple hexagonal prisms to 3 cm long. The crystals display a pleasing silky luster but are opaque except for thin zones just under the basal pinacoid terminations, these zones being paler-colored and translucent to transparent yellow (Cassedanne and Alves, 1994). A few further trickles of excellent milarite specimens from Jaguaraçu appeared on the market in the late 1990's, including one milarite crystal measuring 2 x 4.5 cm (Moore, 1997).

Černý (1974) writes that there are "at least four" milarite localities in what was then the U.S.S.R.—in Kazakhstan, the Kola Peninsula (Russia), Siberia (Russia) and "Central Asia." According to Pekov (1994), the beryllium-rich pegmatites of Kent, **Kazakhstan**, produce crystals of smoky quartz with inclusions of sharp, terminated, hexagonal prisms of milarite to 2 cm long. In **Russia**, milarite has come from the Olenii Ridge and Zapadnye Keivy, West Keivy, both in the Kola Peninsula. In the Ermakovskoye deposit in the Ural Mountains, split prismatic crystals of milarite to 4 cm long occur with bavenite (Pekov, 1994).

A letter to the *Mineralogical Record* by Černý, (1974) notes that milarite has been found in three pegmatites in what at the time was **Czechoslovakia**: the earliest locality is Věžná, the later two are Maršikov and Radkovice. Further, according to Černý (1974), the Grorud district and the Nedre Lapplaegret pegmatite in **Norway**, and Linkinhorne, Cornwall and Meldon, Devonshire, in **England**, produced milarite.

In the famous Langesundsfjord region of alkaline intrusive rocks in southern **Norway**, long-prismatic, colorless to opaque white milarite crystals to 7 mm have come from miarolitic cavities in syenite in the Himberg quarry, Ramnes. Near Fuglevika in Langesundsfjord, colorless milarite crystals to 3 mm occur in syenite pegmatites with microcline, albite, aegirine, and many rare species (Andersen, 1996).

Unusually large milarite crystals were found in 1993 in an abandoned pegmatite quarry at Högsbo, Gothenburg, western **Sweden**. First, grayish white to greenish yellow milarite crystals to 5 mm were found; later, crude crystals to 2.5 cm were discovered by collectors (Cooper, 1996). 20 km west of Stockholm, a limestone quarry called Stora Vika produced specimens of a yttrian milarite during the early 1990's (Cooper, 1996).

In **Germany** there are four milarite localities, all outside the Alpine belt. In aplite veins in a quarry near Henneberg in the Thüringer Wald, south of Jena in the former East Germany, transparent pale green milarite microcrystals were once found with beryl (Haake *et al.*, 1994). In the Bayerischer Wald (in Bavaria, the former West Germany), the Himmelleitenbruch diorite quarry near Rossbach ceased operations in 1984, but examination of altered pegmatitic material once collected in its lowermost levels revealed colorless, water-clear, long-prismatic milarite crystals to 0.5 mm embedded in 1.5-cm aggregates of fibrous bavenite crystals (Bode and Wittern, 1989; Sperling and Zahnleiter, 1992). The best-known German source for milarite is the beryllium pegmatite once exploited in the Krennbruch and Kusserbruch quarries near Tittling, in the Bayerischer Wald north of Passau. Here, white to water-clear milarite crystals to 5 mm, formed from the alteration of beryl, were found with rosettes of bavenite crystals and bavenite pseudomorphs after beryl (Hochleitner, 1978; Bode and Wittern, 1989). Finally, in the early 1990's, colorless, long-prismatic milarite crystals to 2 mm were found with quartz, bavenite and moraesite in the Eitzing granite quarry at Oberfrauenwald, a few kilometers east of Tittling in the Bayerischer Wald (Habel, 1995).

MILARITE LOCALITIES IN THE ALPS

The heading above limns a hopeless task: the large volumes on Swiss minerals by Niggli *et al.* (1940) and Stalder *et al.* (1998) together list dozens of localities and sub-localities for milarite in Switzerland alone; the Alpine regions of Austria and Italy are not as prolific per square kilometer, but offer dozens more. Only those Alpine occurrences important or prolific enough to have been treated in the fairly recent literature will be surveyed here.

France

One of the most hallowed Alpine mineral-collecting regions is the **Mont Blanc massif**, whose peaks tower over the ski-resort town of Chamonix and run for about 12 km northeast and southwest from the point where France, Switzerland and Italy meet. Systematically searched for crystal clefts since at least the 18th century (Schwab, 1998), the massif yielded its first known milarite only in 1995: crystals to 3 mm on pink fluorite crystals, found on Chardonnet Peak, on the French side of Mont Blanc (Ansermet *et al.*, 1996).

Italy

Italy's first milarite was discovered around 1980 in a pegmatite at **Tanno** near Chiavenna, north of Lake Como in extreme northern Lombardy. Here a small druse of colorless, prismatic microcrystals with basal pinacoid terminations was found on feldspar, with thin-tabular bavenite microcrystals (Boscardin and Mattioli, 1982).

The **Vigezzo Valley** (Valle Vigezzo) runs east-west for about 40 km between Locarno, Switzerland and Domodossola, Piedmont, Italy. Since the beginning of the 20th century it has been a fruitful collecting area, yielding fine crystals of euxenite, gadolinite, allanite, aeschynite, fersmite and many other species from its rare-earth-enriched pegmatites. In the mid-1990's two peaks rising above the valley, Alpe Rosso and Pizzo Marcio, produced subparallel groups of colorless milarite microcrystals, and on a single specimen collected by V. Mattioli in the tributary Valle di Crana, milarite appears as crystals to 1 mm on albite with bavenite, quartz, fluorite and spessartine (Albertini, 1996).

The border between the Italian province of Piedmont and the Swiss canton of Wallis (Valais) runs over the crest of **Monte Cervandone** (German: Cherbadung). This mountain, long known as the source of the world's best cafarsite crystals, stands at the head of the Swiss Binntal (Binn Valley), where many more unusual arsenic species are found, most famously in the Lengenbach quarry. In the summer of 1989, D. Faeti discovered milarite on Monte Cervandone—as colorless to milky white crystals measuring 1 to 2 mm resting singly and in clusters on gneiss, with muscovite, stilbite, quartz, titanite and hematite (Albertini, 1994).

Italy's best milarite occurrence by far, discovered in 1983, is a site known as **Windtal, Valle Aurina, South Tyrol**. Because the South Tyrol is German-speaking (having been taken by Italy from

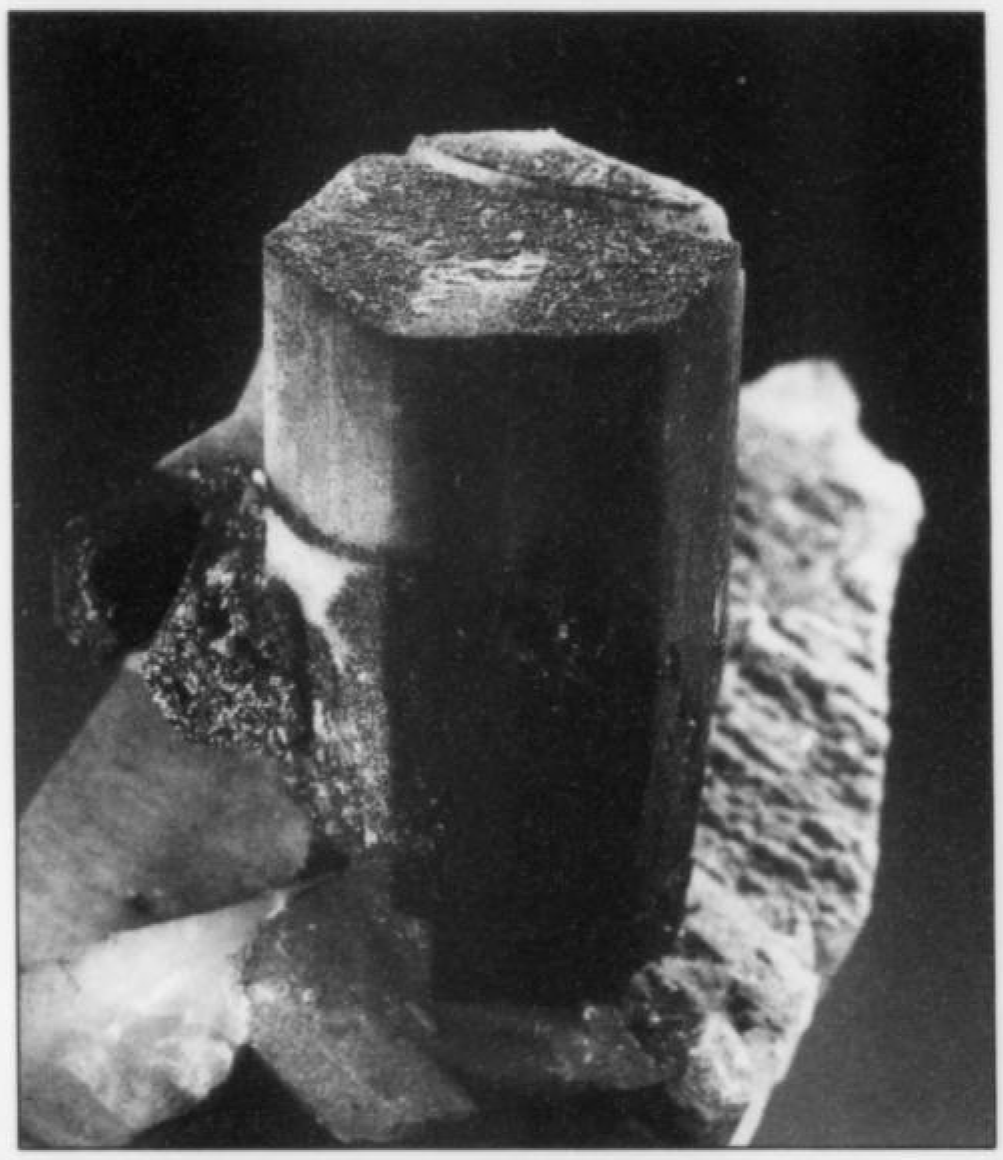
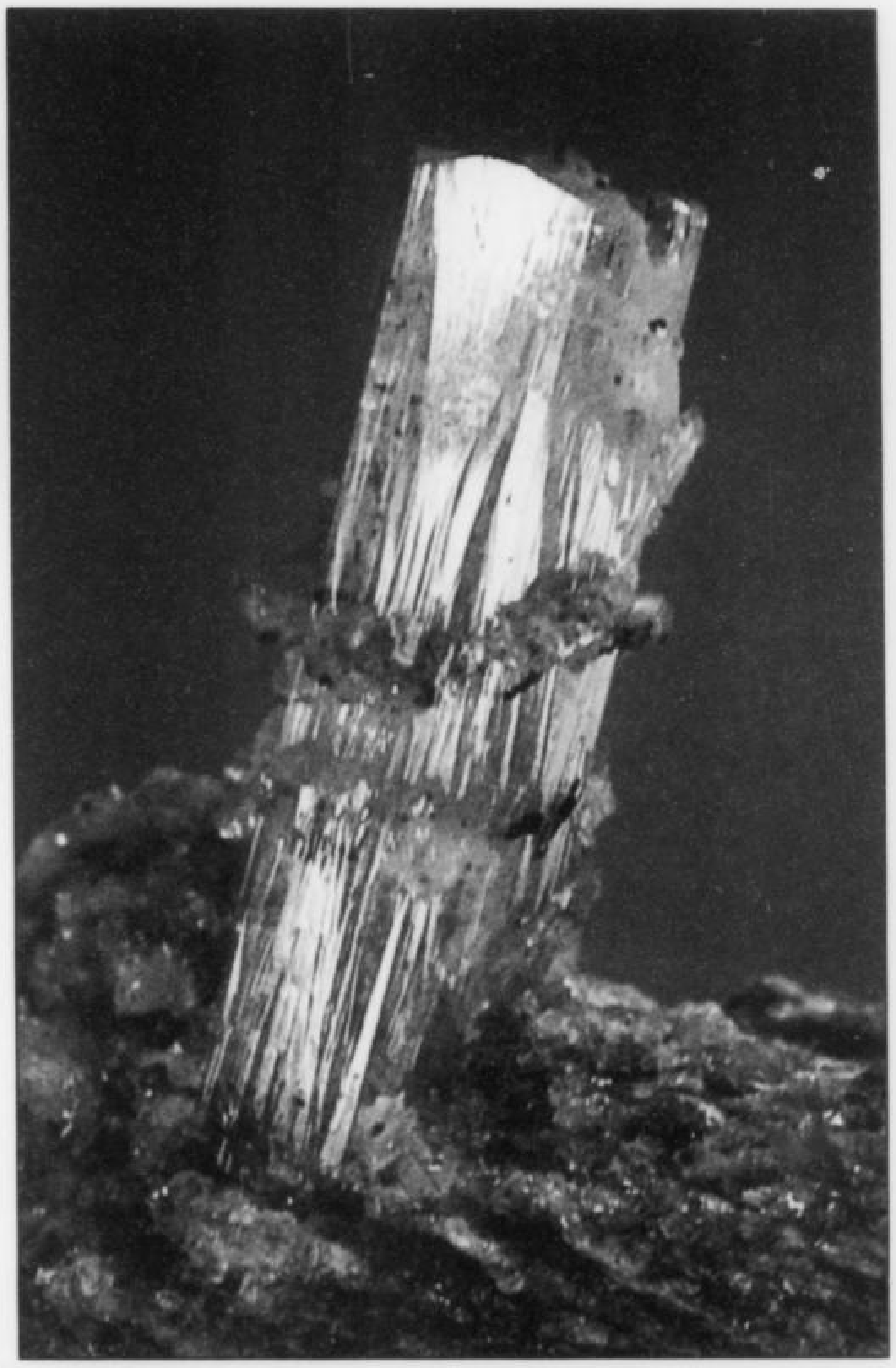


Figure 4. **Milarite crystal, 4 cm, partially chloritized, on orthoclase from Windtal, Ahrntal (Valle Aurina), South Tyrol, Italy. Franz Innerbichler collection; Stefan Weiss photo (courtesy of *Lapis* magazine).**

Figure 5. **Milarite crystal, 2 cm, on gneiss, from Windtal, Ahrntal (Valle Aurina), South Tyrol, Italy (found in 1992). Specimen and photo: Stefan Weiss (courtesy of *Lapis* magazine).**



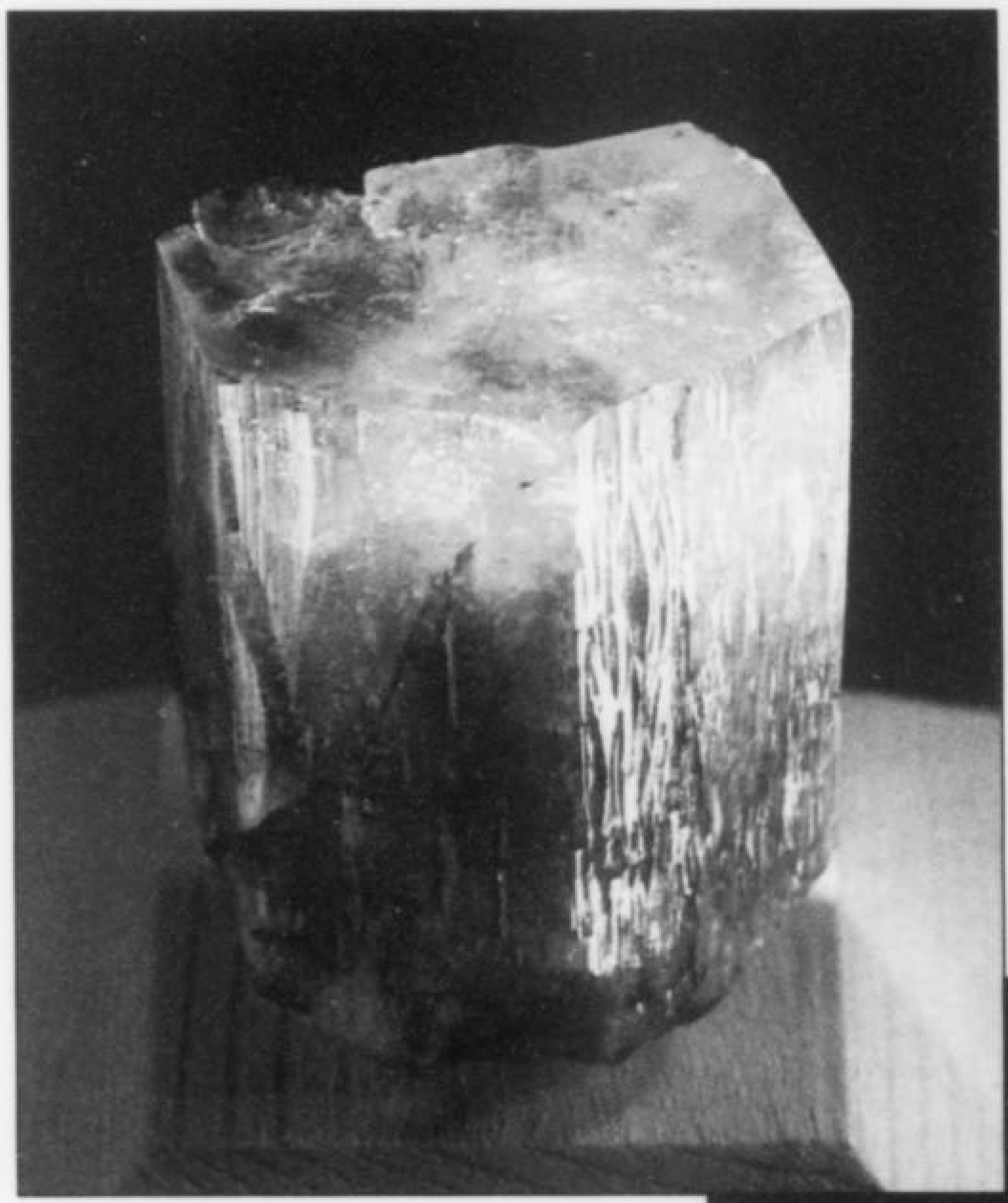


Figure 6. **Milarite crystal, 2 x 2.4 cm, colored orange by high trace yttrium content, from Windtal, Ahrntal (Valle Aurina), South Tyrol Italy. Franz Innerbichler collection; Stefan Weiss photo (courtesy of *Lapis* magazine).**

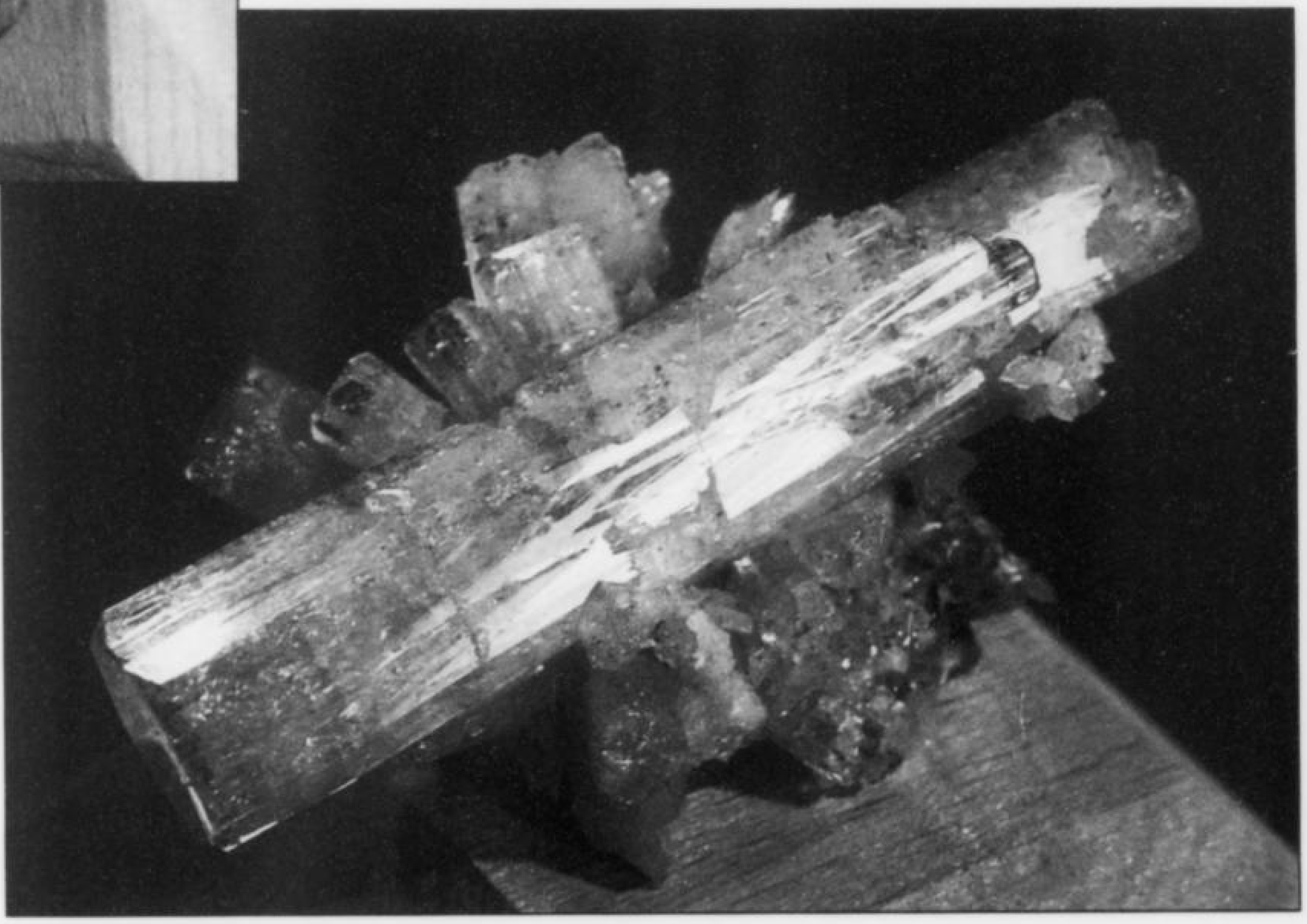


Figure 7. **Milarite, floater crystal group with orthoclase, 4.8 cm, from Windtal, Ahrntal (Valle Aurina), South Tyrol, Italy. Franz Innerbichler collection; Stefan Weiss photo (courtesy *Lapis* magazine).**

Hapsburg Austria only in 1918), the Valle Aurina is more often called by its German name, the Ahrntal: this is the valley of the little Ahrn River, which flows south from Dreiherrn peak where the very northernmost point of Italy meets Austria. In 1983, wonderful milarite specimens, with crystals to 3.5 cm, were discovered at a place about 3,200 meters high in the "hintersten Ahrntal" (uppermost Valle Aurina). The productive cleft, largely filled with a mixture of chlorite sand and permafrost, was found in a band of aplite in amphibolite gneiss at the head of a moraine of stony debris at the edge of a glacier. The milarite crystals are short-hexagonal prisms forming parallel-growth aggregates to 5.5 cm; the crystals are sharp, lightly striated, translucent white to yellowish, and highly lustrous. A few crystals are partly chloritized, and greenish; a few are colored intense dark yellow by high amounts of trace yttrium (Weiss, 2004). Matrix specimens display associated crystals of calcite, orthoclase and smoky quartz, but "floater" milarite crystals and groups are more common than matrix pieces; one doubly terminated floater crystal measures 1.2 x 3.5 cm (Weerth, 1993).

More milarite-bearing clefts have been found at the Windtal collecting site since its discovery, and crystal sizes have surpassed themselves. In the mid-1990's, groups with milarite crystals to 4.8 cm long (nearly 2 inches!), as well as an amazing milky green (chloritized) floater crystal measuring 2 cm thick and 8 cm long, were collected (Weiss, 2004).

Austria

Laperwitzbachgraben near Kals, East Tyrol is one of the better localities in the Alps for fine, gemmy yellow-green fishtail-twinned crystals of titanite, and Niedermayr (1986) mentions that large milarite (and scheelite) crystals also have come from here. Dump material from a cleaned-out cleft at Laperwitzbachgraben once yielded albite (variety pericline) crystals accompanying milarite crystals to almost 2 cm (Steckbrief, *Lapis* **4**, 1979; *extraLapis* **5**, 1993).

In the province of Salzburg, just beyond the eastern end of the Hohe Tauern range, lies a stream valley, the Gasteinertal, best known for clefts near **Bad Gastein** and **Böckstein** in which fine, large, octahedral fluorite crystals of many hues occur. Gneissic rocks in the region are beryllium-rich, and in about ten of their outcrops, especially in small stream valleys south and west of Böckstein, milarite microcrystals have been found. Probably the best of the sub-localities is the one called **Bärenfall**, whose sharp, transparent milarite crystals occasionally exceed 1 cm in length (Winkler, 1987). Construction of a tunnel near Böckstein called the **Haitzingalmstollen** revealed a few clefts with sharp, transparent, colorless milarite prisms to about 4 mm, associated with titanite (Niedermayr, 1984).

Microcrystals of milarite have occasionally been found in the Habachtal, Salzburg—one of the small stream valleys which run down from the peaks of the Hohe Tauern and north to the Salzach Valley. In the mid-1970's a few milarite crystals were found in the mica schist of the famous emerald and phenakite occurrence at **Leckbachrinne, Habachtal** (Koller, 1978), and more microcrystals have been found at **Breitfuss, Habachtal** (Steckbrief, *Lapis*, **4**, p. 8).

The best milarite locality in Austria—and one of the best in the world—has quite recently produced dramatic matrix specimens, reaching small-cabinet size, of chloritized milarite crystals to very large sizes rising from blankets of orthoclase crystals. This collecting site is a small outcrop of gneiss in a stream gully, not far from where the gully descends from the east to meet the Habach River; it is called **Wiesbachrinne, Habachtal**. Hochleitner (1989) reports long-prismatic, opaque gray-green milarite crystals to more than

Figure 8. **Milarite, chloritized crystals in parallel growth, 2.5 cm, from Wiesbachrinne, Habachtal, Austria (found in 1994). Alois Steiner collection; Rainer Bode photo.**

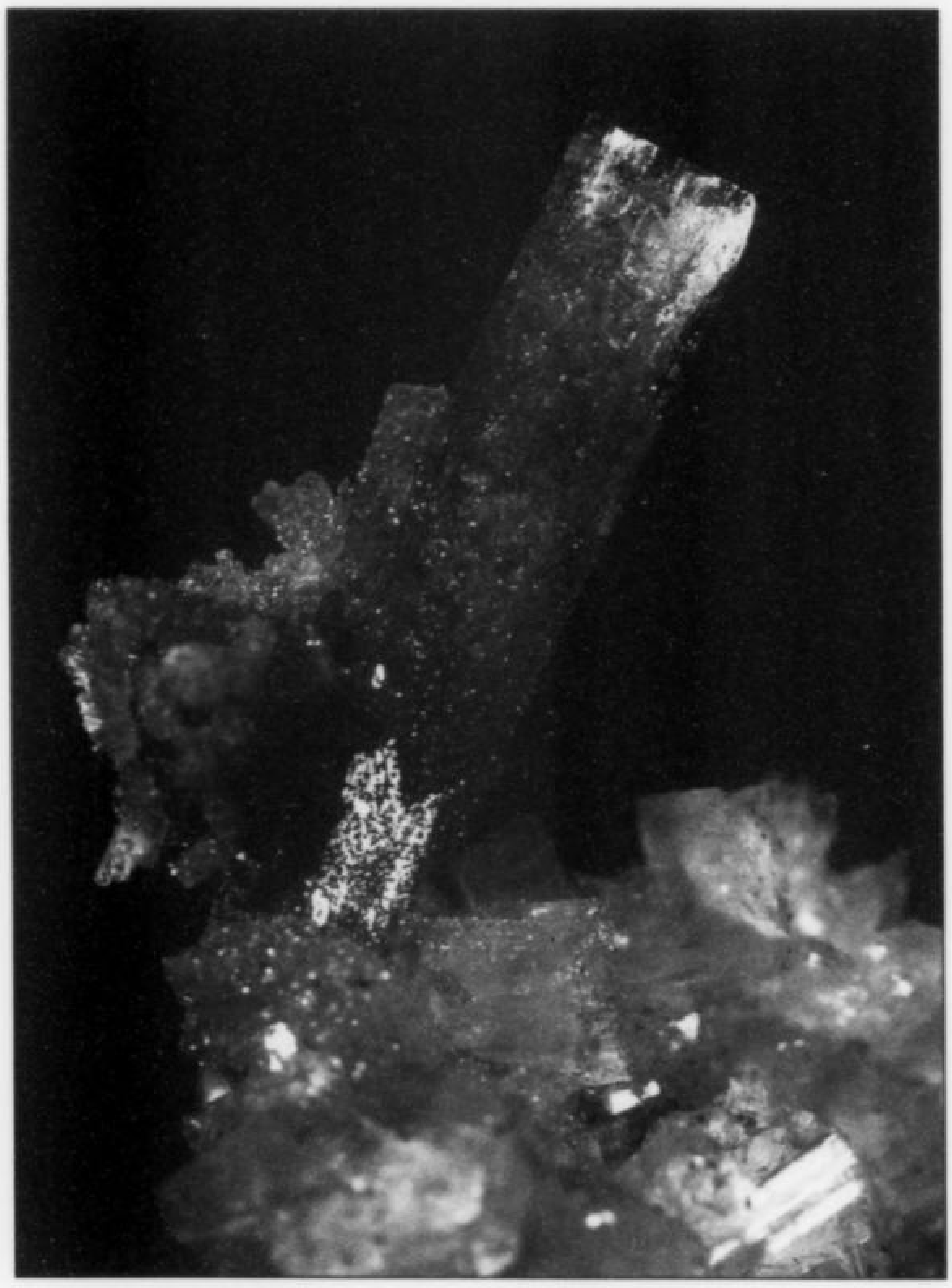


Figure 9. **Milarite crystal heavily included by chlorite, 2.2 cm, from Wiesbachrinne, Habachtal, Austria. Alois Steiner collection; Rainer Bode photo.**

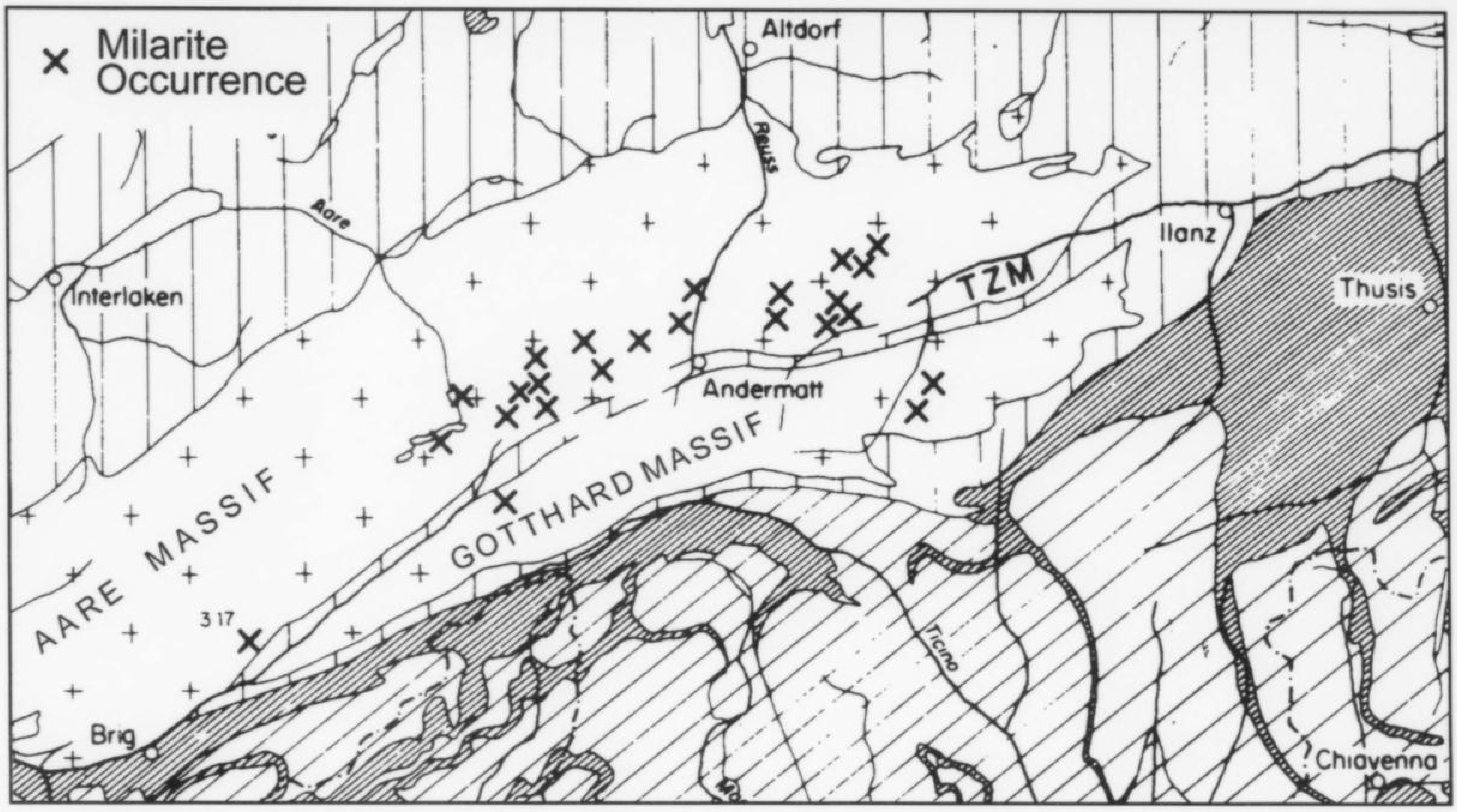


Figure 10. **Major milarite occurrences in central Switzerland.**

1 cm from Wiesbachrinne, but these earlier specimens pale beside those found at the end of April 1994 by Axel and Erich Mosser. Exploring a quartz vein in augen gneiss, they found that the vein suddenly widened, a pale brown soil showing up in its middle part, while bands of chlorite appeared in the country rock. Mediocre crystals of orthoclase led them to pursue the vein and its surrounding tension gashes, and soon they were opening a head-sized, chlorite-filled cavity. At first they mistook the gray-green chloritized prisms that rose in jumbled groups from the cavity-lining druses for large orthoclase crystals—but the crystals proved to be textbook-sharp, simple hexagonal prisms of milarite. A limited number of exceptional specimens was taken out; the largest and finest is a 7-cm matrix plate with sharply individualized, glittering greenish milarite crystals to 4.5 cm rising from a crust of snow-white orthoclase crystals (Mosser, 1996; Niedermayr, 2002; Weiss, 2004).

Switzerland

Most of Switzerland's milarite occurrences, including the three best known (Vorderen Zinggenstock, Fieschergletscher, Val Giuv), lie in the Aare massif, a mountainous, 100-kilometer arc of crystalline granite just north of the Vorderrhein (upper Rhine) river in central Switzerland. Rising just south of the river and striking parallel to the Aare massif is the narrower Gotthard massif, also mountainous, granitic, and rich in mineral occurrences. The type locality for milarite, as mentioned, is Val Giuv, in the Aare massif, where the species was found in 1868; in the Gotthard massif it was first found in 1937, on the right bank of **Val Cristallina** (only about 15 air-kilometers from Val Giuv but on the other side of the upper Rhine). Milarite crystals from Val Cristallina are sharp and reach 1 cm long; they are white, but most are tinted green by included chlorite. The major associated species are orthoclase, smoky quartz and apatite (Stalder *et al.*, 1998).

In the 1950's a few very tiny (to 0.5-mm) milarite crystals were found in a service tunnel associated with the **St. Gotthard Pass** railway tunnel, constructed around the turn of the 20th century. During the middle 1970's, when the *road* tunnel under the St. Gotthard Pass was being built, workers encountered many mineralized clefts, and good specimens of about 50 species were brought to light—but just one cleft contained milarite. Most of these crystals are chloritized, and the few which are colorless and transparent show considerable corrosion; the maximum crystal size is 1.1 cm (Stalder, 1984).

West-northwest of the St. Gotthard Pass and the town of Andermatt, in Canton Uri, lies the famous pink-fluorite mountain called **Göscheneralp**, with the Göschenertal (valley) at its foot. Weibel (1966) reports that milarite occurs "very sparingly" on the Göscheneralp, with quartz, fluorite and calcite; Stalder *et al.* (1998) report a large cleft in altered granite at Gwüest, Göschenertal, which yielded milarite crystals to 6 mm. Most interestingly, a *Lapis* "Steckbrief" (*Lapis* **4**, 1979) tells of a highway service tunnel near the Göscheneralpsee (a small lake 7 km west of Andermatt) where milarite crystals to 1 cm were once found.

Southwest of the Aare and Gotthard massifs, the complex ophiolitic rocks of the Pennine zone underlie most of Canton Wallis and continue into the Italian Piedmont. In this geologic province, a tunnel in the **Kriegalp, Binntal, Wallis** produced colorless, fibrous milarite crystals to 1 mm in 1987 (Graeser, 1995; Stalder *et al.*, 1998); and on the edge of the **Gischigletscher, Wallis** (*Gletscher* = glacier), near the Ritter Pass, milarite crystals to 4 mm associated with octahedral pink fluorite crystals were collected by Rudolf Geipel in 1982 (Graeser, 1995).

In the late 1970's the **Galmihorn, Wallis** produced milarite crystals to 3 mm; unusually, these are characterized by large dipyramidal faces and correspondingly small prism faces (Stalder *et al.*, 1998).

Val Giuv, in Graubünden, the original locality for milarite, was mentioned first in this article, and shall be revisited at the end. Of the remaining Swiss localities described below, all except Val Giuv lie in the great block of mountains, the eastern part of the Berner Alps, lying northwest of the Rhône and above the Grimsel Pass, in the Aare massif. The localities which are here called Rhônegletscher,

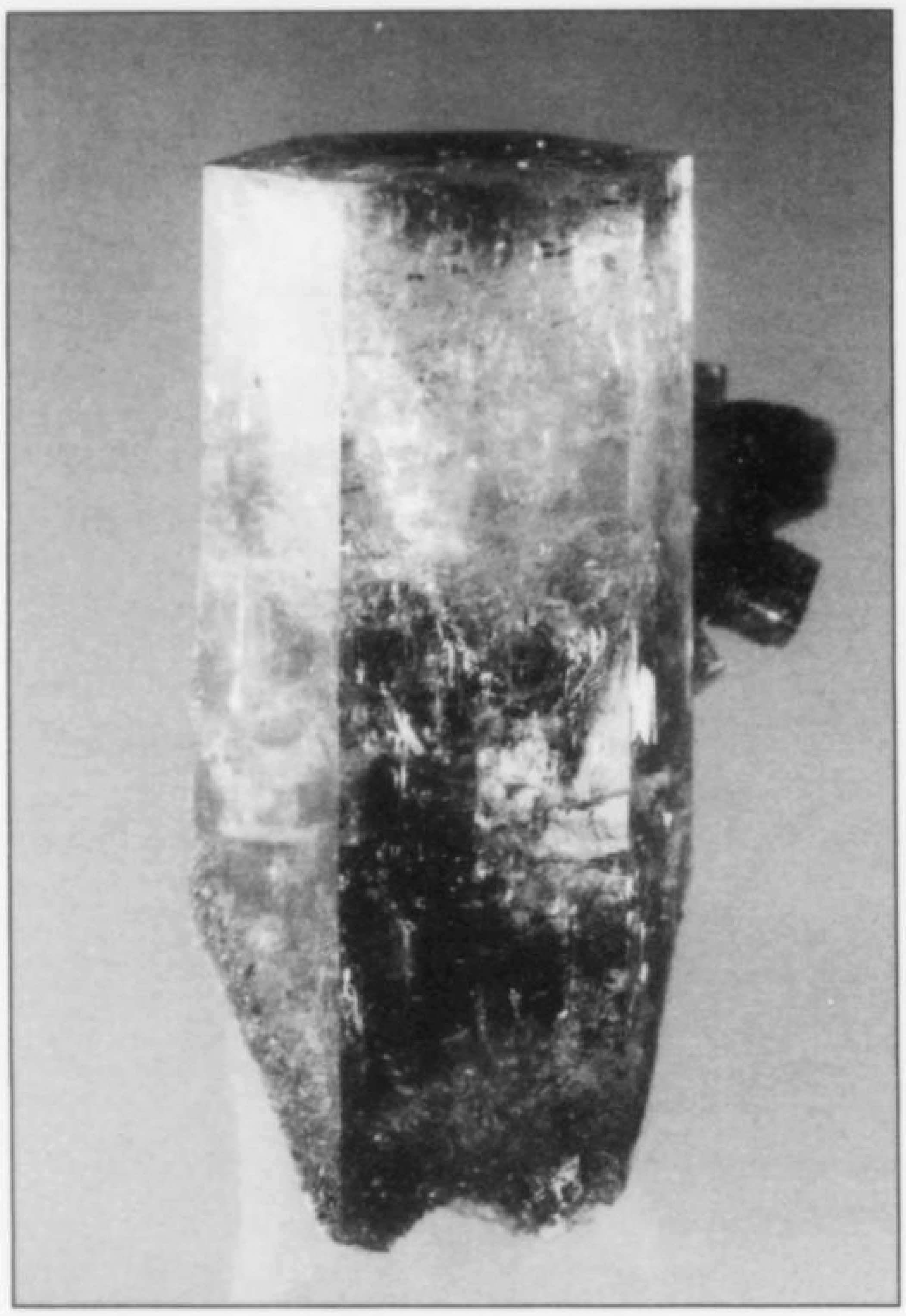


Figure 11. **Milarite crystal with chlorite inclusions, 1.6 cm, collected in 1980 near Gletsch on the Grimsel Pass, Valais, Switzerland. Kay Robertson collection; Wendell Wilson photo.**

Oberaar, Vorderen Zinggenstock and Fieschergletcher all lie within an area about 15 km on a side—a piece of "classic" Switzerland around the Grimsel Pass which, in mineralogical texts as elsewhere, is often called the **Grimselgebiet** (Grimsel area). Another term sometimes seen on specimen labels is **Goms**—the district of the Rhône Valley which borders the Grimselgebiet on the southeast.

The tongue of the **Rhônegletscher**, almost at the northern border of the Canton of Wallis, licks down from the heights just east of the Grimsel Pass; all around it, numerous small sites have yielded milarite crystals (Stalder *et al.*, 1998). West of the Pass, the areas around the **Unteraargletscher and Oberaargletscher**, in the Canton of Bern, have for some decades been interesting collecting sites, especially where excavations for water tunnels and hydroelectric power stations have exposed clefts in the granodiorite rocks, and fine specimens of (among other things) quartz, siderite, pink fluorite and muscovite have emerged. Since about 1925, syenitic intrusions exposed in work around the **Oberhasli and Oberaar power stations** have yielded small milarite crystals, and in 1949 or 1950 a tunnel working near the Oberaar power station produced a single, sharp, chloritized crystal 3.8 cm long (Stalder, 1979).

On August 16, 1994, one of the most prolific milarite clefts ever discovered in the Swiss Alps was entered by Bernhard Werner, a *Strahler* from Interlaken. A large, long ago worked-out cleft in granodiorite exposed on the surface at the **Vorderen Zinggenstock** yielded nothing to Werner, but just below it on the hillside was a fist-sized hole in detrital rubble, behind which was a fissure about 1 meter long and 3 to 4 cm wide. While Werner was clearing away the rubble with his bare hands, a 10 x 15-cm piece of rock came away, and he turned it over. Although he thought at first that the brilliant, colorless 1-cm crystals around its edge were orthoclase, he soon saw that they were milarite. The rest of the loose debris in the forward part of the fissure produced more wonderful specimens almost without Werner's having to use his pick and hammer: extremely fine, sharp, milarite crystals to 2 cm long, some with flat basal-pinacoid terminations and others with strongly developed pyramidal faces around small pinacoids, came to light by the hundreds. The largest matrix specimen is an 18 x 40-cm slab hosting about 60 milarite crystals measuring from 5 mm to 1 cm long (Werner and Hofmann, 1996). About 500 grams (over a pound) of milarite crystals emerged from this fissure (Werner and Hofmann, 1996; Stalder *et al.*, 1998; Weiss, 2004); the only associated species are orthoclase and quartz (smoky), as a few unremarkable crystals. Bernhard Werner carefully camouflaged the

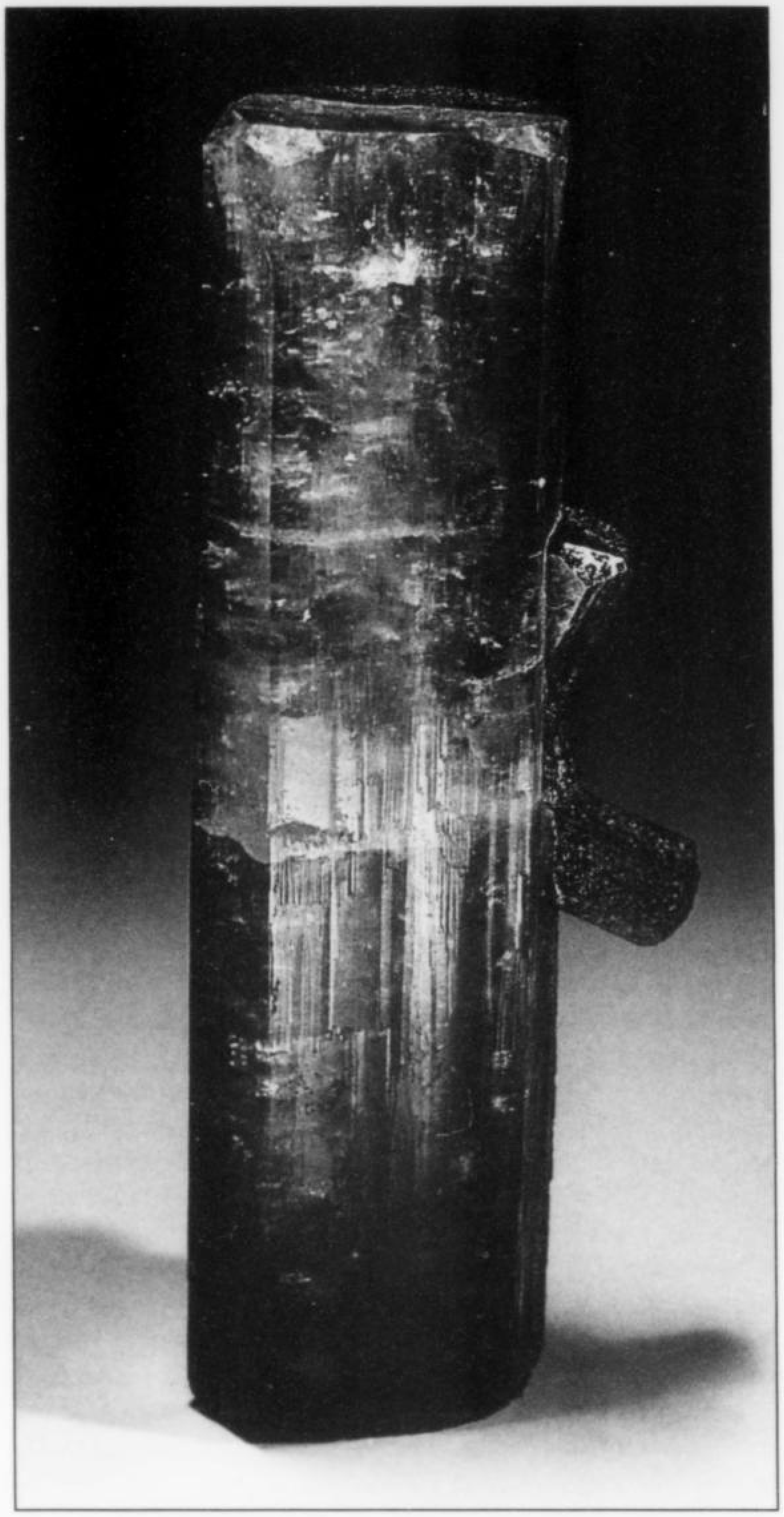


Figure 12. **Milarite, doubly terminated crystal 4.4 cm long, from Fieschergletscher, Wallis, Switzerland (found in 1995). Hubert Volker collection; Walter Gabriel photo (courtesy *Lapis* magazine).**

jackpot fissure before he left the site for the winter, and when he returned early in 1995 it had not been discovered by other collectors; however, it produced only a very few more milarite specimens (Werner and Hofmann, 1996).

In 1966, at **Fieschergletscher, Wallis**, the *Strahler* K. Währen recovered a 2.5-cm milarite crystal from an old orthoclase cleft (Weiss, 2004)—but in 1995 another *Strahler*, Hubert Volken, made a very much greater discovery in a 5 meter-long cleft exposed at the surface at the southwestern end of the glacier. Volken collected about 50 loose milarite crystals associated with crystals of orthoclase, epidote, hematite, and rounded aggregates of fibrous crystals of bavenite. A few of the milarite crystals are colorless and transparent, but most are partly chloritized and milky white to green; a few elite crystals are lustrous, sharp, doubly terminated, translucent dark green, and 4 to 5 cm long. While the average size of the Fieschergletscher milarite crystals is around 1.5 cm, one of them measures 3.3 x 9.2 cm—the largest known milarite crystal (now in a private collection in Zürich) (Graeser, 1998; Stalder *et al.*, 1998; Weiss, 2004).

Finally, there is **Val Giuv**, the original and best known, the most wonderfully lore-haunted, and still the most prolific locality in Switzerland for milarite.

On the westernmost end of Canton Graubünden, three little drainages descend, roughly in parallel, southwards to join the upper Rhine in the Tujetsch valley (Val Tavetsch); from west to east, they are Val Giuv, Val Milá, and Val Strem. Some minor milarite discoveries have been made in Val Strem, but none have yet been reported from Val Milá—the originally stated type locality for milarite, as per *Strahler* Caveng's lie in 1868. Those who climb up into Val Giuv will probably use as staging areas one of two villages, Ruèras or Sedrun, which lie at the base of the mountains in Tujetsch. As the ascent proceeds towards the peaks of Giuvstöckli,

***Figure 13.* Milarite crystal, 1 cm, from Piz Giuv (= Giuv Peak), one of the peaks at the head of Val Giuv, Graubünden, Switzerland. Eric Offermann collection and photo.**

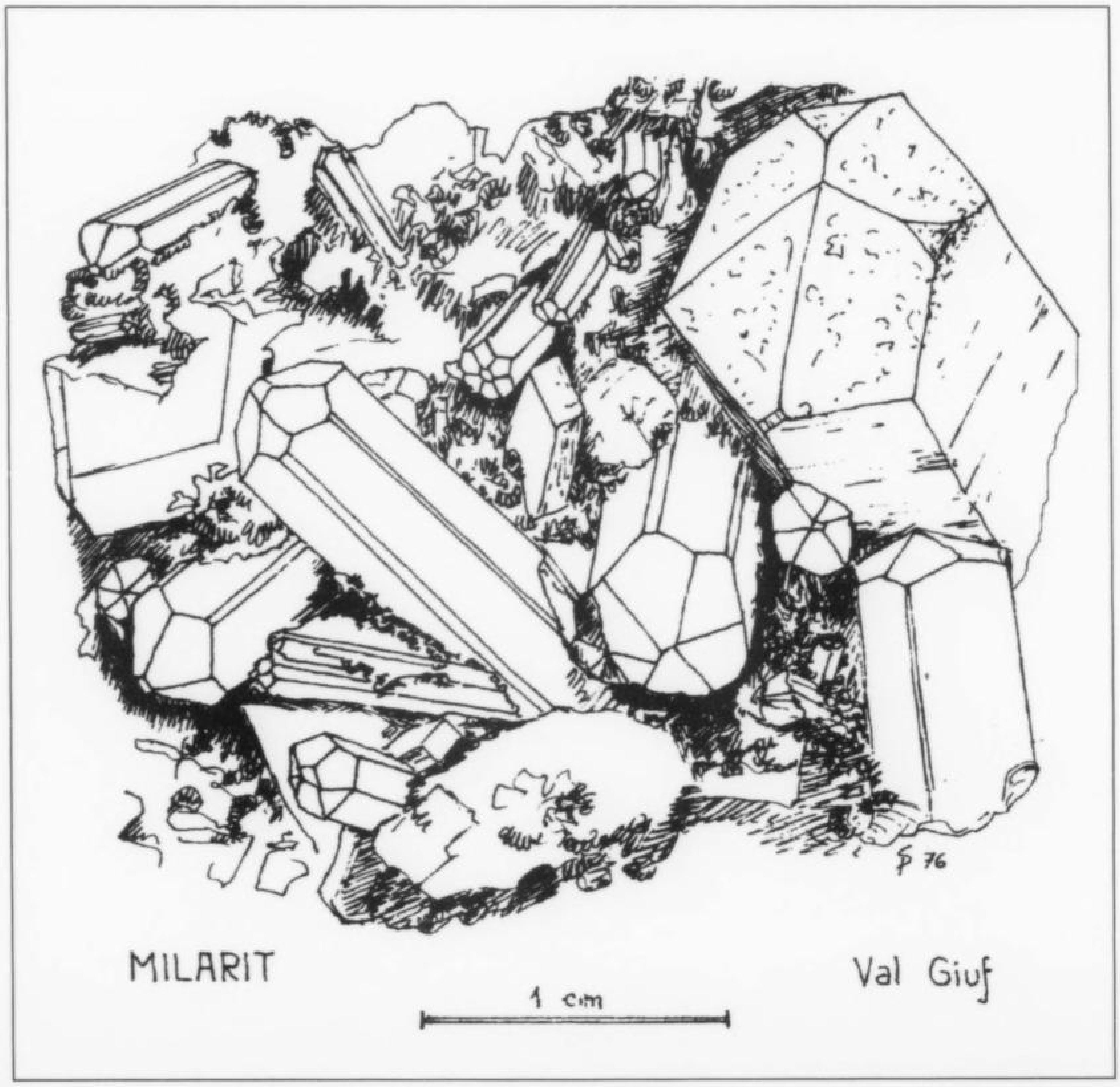


***Figure 14.* Sketch (by Peter Stuker) of a milarite crystal pocket from Val Giuv in the Alex Kipfer collection (Hügi and Rowe, 1976).**

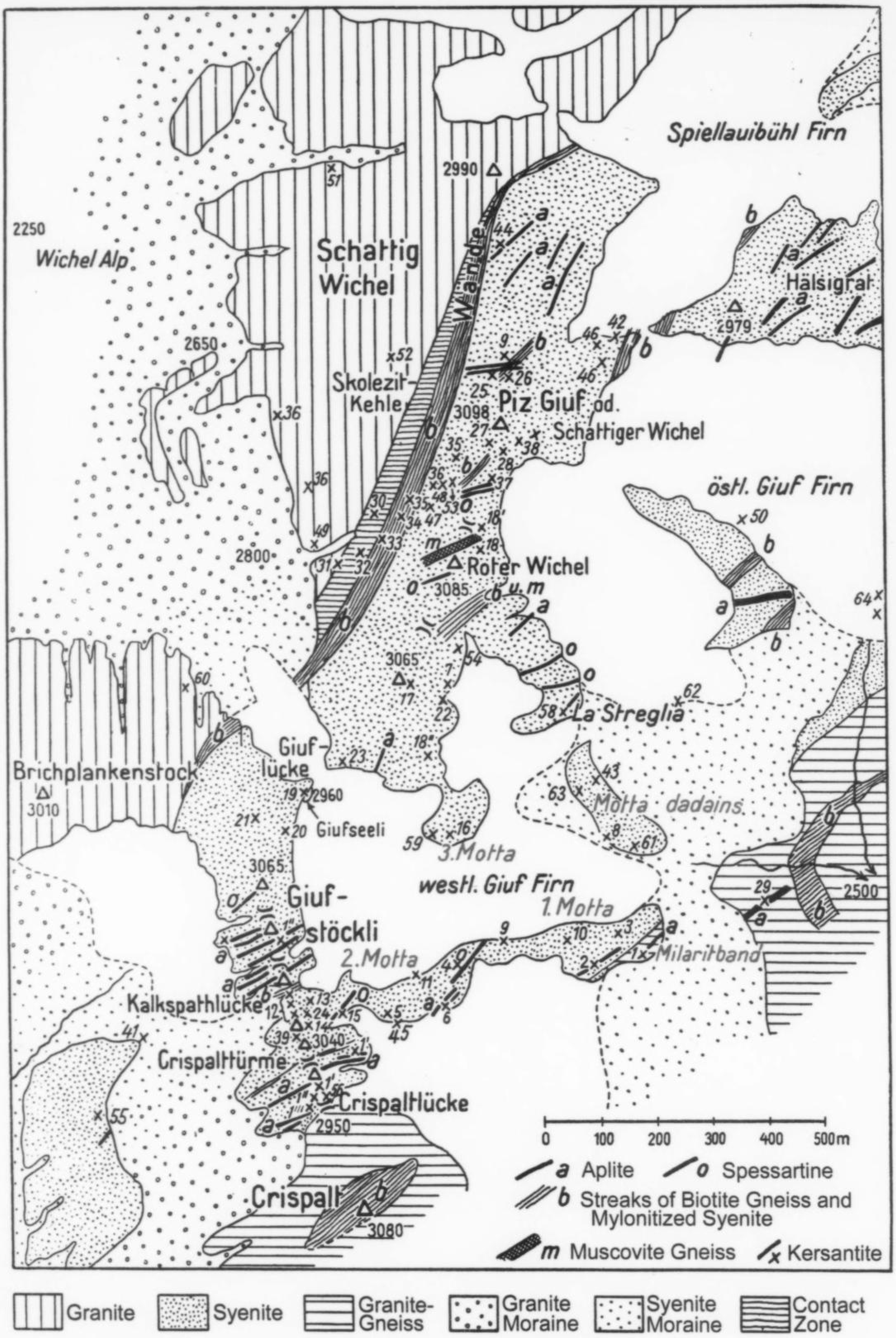


Figure 15. **Geologic sketch map of Val Giuv, with major collecting sites shown in red, and milarite-bearing clefts shown as slashes (Niggli *et al.*, 1940).**

Figure 16. **Milarite crystal, 4.3 cm, on syenite matrix from Muotas Dadens, Val Giuv, Graubünden, Switzerland. This is the "Muotas Milarite" collected by Conrad Berther on July 5, 2000. "La Truaisch" Museum, Sedrun, Tujetsch, Switzerland collection; Thomas Schüpbach photo (courtesy *Schweizer Strahler*).**

Rot Wichel and Piz Giuv, the *Strahler* encounters the scarps called Emprema (First) Muota, Secunda (Second) Muota, Tiarza (Third) Muota, and Muotas Dadens, in all of which milarite clefts have been found: a map by Niggli *et al*. (1940) shows the whole area, in fact, speckled with clefts and clusters of clefts discovered by generations of *Strahlers*, and Wilhelm (1972) lists about 15 sites in Val Giuv (and 6 more in Val Strem) known to have once yielded milarite crystals. It is probable that Caveng's original 1868 specimens came from Secunda Muota (Steckbrief, *Lapis* **4**, 1979), and in 2000 Conrad Berther made his amazing find (see below) at Muotas Dadens. In 1971, on Emprema Muota, T. Curschella collected a few fine specimens with completely gemmy, light yellow milarite crystals to 1 cm rising at angles from syenite matrix (Wilhelm, 1972; Sialm-Bossard, 2004).

CONRAD BERTHER AND THE "MUOTAS MILARITE"

On July 5, 2000, from a 1.5 x 3-meter cleft at Muotas Dadens, Val Giuv, the *Strahler* Conrad Berther collected what probably ranks as the finest milarite specimen in the world. A single yellow milarite crystal measuring 4.3 cm long and 1.1 cm wide is attached, inclining at a slight angle, to a 1 x 6 x 9-cm matrix plate of syenite. On the matrix are scattered small crystals of orthoclase, apatite, and smoky quartz, and a little fibrous actinolite ("amiant"). The milarite crystal is a simple, lightly striated hexagonal prism with a basal pinacoid termination and very small faces of a single dipyramid; besides being stunningly large, the crystal is stunningly beautiful: sharp, highly lustrous, and translucent pale yellow. The specimen is now owned and displayed by a small museum, "La Truaisch," in the village of Sedrun, Tujetsch—only about 5 km from where it was found.

In 2004, Victor Sialm-Bossard described and illustrated this specimen in articles in *Lapis* and *Schweizer Strahler*, and, in the latter, provided "background" on Conrad Berthens, his very successful collecting trip in 2000, and the general experience of *Strahlers* who hunt for milarite in Val Giuv. Below are some excerpts freely translated from these accounts:

> *Whoever goes looking for crystals in Val Giuv soon notices that almost every square meter has been looked over before, that the known milarite areas are barren, that the very hard rock cannot be easily worked with the usual tools, and that the*

great masses of scree are discouraging. The local Strahlers *estimate the ratio of the number of excursions to Val Giuv to the number of clefts opened there at ten to one. To this list of unpleasantnesses must be added the trek to the locality. Since grazing animals are no longer led to the head of the valley where the mountain walls converge, the* Strahlers *are troubled with scratching thistles, large tree roots and thick grass, the latter especially difficult to pass through when covered with morning dew. The former footpath has been almost completely covered over by rocky detritus. The return in the evening is torture: loose rocks make every step unsafe, and when there is greenery between the ground surface and the soles of the shoes, one goes into a slide . . . In past years, snowy winters delayed the retreat of the Giuv glacier, and the snow did not melt until well into the new year. These surely are the reasons why one seldom sees* Strahlers *in the neighborhood of the Muotas.*

A few decades ago, things were different, as can be seen in the diary entries of Gion Antoni Hitz (1873–1955), the famous Strahler *from Rueras. The folklorist Alfons Maissen—a brother of Pater Flurin Maissen—published, with commentary, the writings of Hitz the farmer, hunter, forester and* Strahler: *among other items, his correspondence with Professor Koenigsberger, his brief published notices about* Strahlers *from Tujetsch and their doings, his diary entries, and his major work,* Per crappa massel jeu bugen ("I'd like to go strahling again today")*, a primer on strahling in dialogue form—a book that Hitz wrote at the age of 77. These writings speak . . . of [Hitz's] keen insight as well as testifying to his high repute in his time; they comprise a fascinating, culturally meaningful document of their times. By the way, G. A. Hitz was one of four living sources which F. Maissen made use of while composing his dissertation . . .*

Both works [by Hitz and Maissen] stood on Conrad Berther's bookshelves; excepting only the works of Pater Placidus a Spescha [a famous 19th-century Strahler*], they were his favorite reading matter. Gion Antoni Hitz was no stranger in the Berther family. Berther's father and Hitz were bound by many common traits: both were farmers, naturalists, men of many interests; both undertook mountain tours, and both wrote books in their old age. Francestg Berther, local historian, in two chapters of his book about his youthful memories, mentions his colleague Gion Antoni Hitz (more than thirty years older than he), and mentions a famous mineral: the chapters in question are "Strahler, a dangerous profession" and "Milarite and similar treasures." But unlike G. A. Hitz, the elder Berther did not regard strahling as a source of supplemental income; he kept giving away as gifts the crystals he found. Francestg Berther often greeted the present author with a question: "So, have you finally found a milarite?" And after the inevitable answer No, he always told with a laugh and with much pride the story of his own milarite find on the Calmut. Conrad remembers that that milarite specimen lay for years in a drawer, then disappeared at some time or another. Once, during a mountain tour, Gion Antoni Hitz paused suddenly at a certain place and said, to his colleagues' amazement, that he now knew where the "aveina de milarit"—the milarite zone—would again appear. Since that day F. Berther repeatedly pressed his son Conrad to seek out and find that place. It never appeared. When Conrad made his great find—at a different place—he visited his father in an old people's home and reported to him that he had finally found "the" milarite.*

From Hitz's notes, Conrad Berther knew that Gion Antoni, who as an old man still retained a good memory, had known Val Giuv very well. Hitz wrote that he had gone strahling in this region over a span of fifty years. How important his finds had been for his subsistence was made clear by an observation he once made to a young farmer who lived across the road from him. Hitz said that he thought that working in Val Giuv was preferable to working on a farm; when he went to Val Giuv and collected everything shiny, he made more return than he did by staying at home. When told by the reproachful neighbor that it was smarter to work in the fields than to go for walks in Val Giuv, Hitz answered that today's find, which he had in his pocket, was something he would not trade for the finest steer in the pasture. That could only have been a large milarite . . .

The Collecting Trip of 5 July 2000

Because the winter of 1999/2000 had been snowy, the first collecting trips into Val Giuv in 2000 were late. On July 5, Conrad Berther made his third climb to the collecting area for that year. A cloudless morning sky promised fine weather. At 6:30 A.M. Berther parked his car in Mulinatsch and set out on foot. At the end of a rising meadow he suddenly had his hands full: a cow had fallen into the streambed of the Giuv and could not get out again. Some Alpine shepherds helped Berther to rescue the animal. Meanwhile the rising sun had not only cleared the peak of the Crispalt, but had progressed above the Muotas behind it, and placidly now it was casting shadows into the valley. Whoever ascends from the Giuv streambed will wish, from time to time, that the old footpath were still there to make the climb less arduous. Normally, however, one hardly looks back; one relinquishes thoughts of God and the world and dreams only of his coming Strahler's *luck ["Strahlerglück"]. Memories of the past arose for Berther: he himself had once been a shepherd with a large flock in the valleys north of Tujetsch, and it was during that time that he had come to know the Val Giuv.*

Today he was alone. Often his son-in-law Otto, and once in awhile his son Adrian, would accompany him. On those occasions the climb would be pleasantly marked with conversation, joking and laughing—at least until they would reach the granite scarp marking the boundary between the Aare massif and the Tavetsch intermediate massif: Stavel de Nuorsas, 2200 meters above sea level. After a short pause at this place, a look down the valley, and a rationed gulp from an aluminum thermos, Berther and his companions would go on. The climb up the valley would grow slowly but steadily steeper and the air thinner, and their voices would fall silent, everyone having enough to do by himself. After achieving the last, steepest part of the climb, they would stand before the Giuv glacier, 2600 meters high.

The hearty sixty-year-old held to all these rhythms himself today, but, as always, it took him a good two hours to reach Muotas Dadens. Still, he had been lucky: solidly frozen snow had made the climb easier. It was a wonderful summer day; the steel-blue sky, the undisturbed white glacier, and the unending stillness refreshed body and soul. The pinkness of the early morning had long since given way to a radiant whiteness.

Now the Strahler *was in his element. He made a short cellphone call to his wife Regina, to let her know he had reached his goal. Then he changed his clothes, sat down, satisfied his hunger, and quenched his thirst with a copious drink. A glance* *at his watch informed him that he was almost two hours behind schedule: it was 10:00 a.m. He readied his tools, looked closely over Muotas Dadens, and ascertained that only a few crevices were free of snow. From experience he knew that this early in the season his chances for success were slim. Any indications of clefts—for example, aplite and quartz veins, cracks or cleavages in the rock, certain kinds of alluvium—were for the most part still buried under the snow.*

The Strahler *therefore busied himself in an old cleft. Rocky rubble lay to the left and right, and the floor of the cleft was covered thickly with debris. Old clefts customarily awaken the curiosity of a* Strahler. *He wants to know what signs had led the earlier* Strahlers *to the cleft, what its extent is, and what minerals might already have been found in it. Also of interest is the rock in and around the cleft. By investigating such things the* Strahler *enlarges his experience and knowledge.*

Conrad Berther realized that this cleft was quite large: about three meters deep, 80 centimeters high and 1.5 meters wide. The fact that he saw no moss on its floor told him that minerals had been collected from it—to all appearances, it had yielded much smoky quartz—only about 50 years ago. In older clefts one can observe that moss has grown back extensively, and that the old Strahlers *had taken out only the obvious and dramatic material—in the cleft's inner reaches loose rock will be piled up and overgrown with moss. One hardly ever finds anything good in old clefts; a few decades' worth of weathering and erosion have destroyed whatever had not been removed.*

This morning, when Conrad Berther had first exposed the front part of the cleft, he appraised the syenite and the course of the veins of aplite and quartz. Then with his tools he probed the left side of the cleft, near the "teglia," or schistose layers; he cleared the loose, stony debris away and felt all over the exposed walls with his hands. In a fissure, at a depth of about two handbreadths, he felt a crystal about the size of a winebottle cork attached to the wall. He thought that what his fingers were touching was a smoky quartz prism. He dug forcefully around the object, and finally brought it into the light—and he could hardly believe what he saw. It was a yellow crystal attached to a palm-sized matrix plate of syenite, and the crystal was columnar, with a flat termination, and razor-sharp. His breathing halted, his pulse beat strongly, his temples pounded. His surroundings began to swim, and seemed almost to vanish. He was staring in disbelief at a thing he had never expected to find: "It's not real! It cannot be true!" His hands trembled, and an indescribable feeling of unearthly luck ran through his body. With all his senses he took in the beauty of this natural miracle—studied it, felt it, mused on it, thought about it—and recognized then the infinite greatness of the Creator. In his diary he had to record—as Hitz had—a "Heaven bless you!" in honor of almighty God. The cell-phone call to his wife took longer this time. The Strahler *wanted to share his joy.*

Then Berther photographed the specimen, carefully wrapped it in moist newspaper, and stowed it away in his backpack. At 10:30 he went immediately back to work. The old cleft was full of debris, including many leached stones, and a thick layer of chlorite covered the floor. About 1.2 meters from the place where he'd found the big crystal, Conrad Berther found another crystal attached to the cleft wall on the right side. It is not so symmetrical, and much smaller: about 1.4 cm long and 5 to 7 mm across, but with the typical features of a milarite crystal, so that the Strahler *considered it also a fine example of milarite.*

Then it was quitting time, and the clouds were on parade, and Berther strapped on his cross-country skis and, with a light heart, expressed gratitude to the abundant snow and to his light backpack as he made his way quickly to the Alpine huts at Mulinatsch. By 4:00 p.m. he was back at his home and, with his wife, admiring his unbelievable find, and beginning to digest his experience.

During many days following the discovery I heard, from the nearby Giuvstöckli, the sound of Berther's drilling machine in the Muotas Daden, where he was working again in the old cleft. A year later he found four more milarite crystals; two are still attached to syenite matrix while the other two are loose singles. All were lying loose in debris, and all measure less than 1 cm. By this time the great treasure was reposing, closely guarded, in a collection case; the second milarite crystal from July 5, 2000 was on display in a museum, and the four crystals found later were in Berther's showcase. After a while—three years by now have gone by since the big find—his wife Regina came to the opinion that the unique crystal should remain close to home, but that visitors to the valley should be able to see it. Thus it happened that the great "Muotas Milarite" took its place of honor in the "La Truaisch" museum in Sedrun.

CONCLUSION

The story above might be interpreted as showing—besides, of course, the patience and skill of the Alpine *Strahlers*—how the rest of us might do well to incorporate the verb "strahling" into our own jargon. We might perhaps hope to partake (by some sympathetic magic) in the sense of history and in the distinctive pride which informs the *Strahler* subculture—a subculture where a "good day in the field" is still as thrilling as it has been for centuries to collectors anywhere in the world.

As for milarite itself, it is truly a gorgeous mineral species, and thus far a generally underappreciated one—may the photographs here tell the tale.

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Green Monster Mountain *(continued from p. 404)*

A few small boulders of float containing fresh, rose-pink, coarsely crystalline rhodonite with minor splotches of a dark-brown semi-translucent mineral were found in the talus below the north-facing highwall of Green Monster Mountain's igneous plug. This rhodonite was easy to spot, as the pink color stood out like Easter eggs in the thinly vegetated talus. The source for this rhodonite has not been determined.

Scapolite Group

Tan to bone-white, intergrown and deeply striated spine-like crystals of a scapolite-group mineral to 10 cm, some with surface splotches of black manganese oxide and other minerals, were found loose in the soil just below the crest of the ridge and a few paces west of the iron-rich gossan zone and ocher quartz location. This area faces north and is snow-covered most of the year, which might explain how these crude but strangely appealing crystals went unnoticed for many years.

Titanite $CaTiOSiO_4$

Small pale tan to straw-yellow crystals presumed to be titanite are uncommon but widely distributed in pockets throughout the productive area. Most crystals are less than 3 mm, although one "giant" from the lower workings exceeds 1 cm. Tom Hanna's 1995 "Papa" pocket in the upper workings produced sharp, buff-yellow titanite crystals up to 8 mm perched on epidote. Some magnetite rosettes are generously speckled with microcrystals of titanite.

THE REGION TODAY

The region around Copper Mountain and Green Monster Mountain has changed noticeably since 1967, although the biting insects are as ferocious and the storms as persistent as ever. At the end of their article, Leavens and Thomssen (1977) report having heard wolves in the distance one rainy, lonely collecting day. Before 1996 but not since then, Tom and I have twice seen wolves less than 20 meters from us on our site. A huge black bear freely roamed our property for a decade, but I last saw him in 1988. I rather miss the old guy and the wild spirit he represented. Tom and I respect the remaining wildlife, mind our manners, and hope that the indigenous creatures will be allowed to carry on forever. Logging on Native corporation lands has resulted in large clear cuts to within 6 to 8 km from our property boundaries and, for the first time in our lengthy tenure, we sometimes hear faint sounds of machinery instead of the voices of animals while we are out on the mountain.

THE FUTURE

Much work remains to be done at the site. Because of the steep slopes, hard rock, and lack of roads, the complete extent of the remaining crystal-bearing ground may never be fully determined. Moreover, the steepness of the work areas places severe limits on any use of heavier equipment, and moving such equipment by using a helicopter and sling is prohibitively expensive—hence our present reliance on very small mechanized equipment and on hand tools. We often ponder our various options, knowing that all will require considerable effort, resources and planning. While we intend to continue refining our small-mechanized and hand-tool collecting techniques, we are no longer willing to risk drilling and blasting to expose the pockets. The destruction of a big bottom-area pocket in 1993 taught us in a very sad and costly way how easily explosives can ruin crystals. We unknowingly drilled to within 20 centimeters of the pocket chamber, loaded and lit the hole. In a microsecond, a great number of valuable specimens were turned into epidote chowder.

Tom and I still need to confirm the identities of several Green Monster Mountain mineral species. We also need to determine the structural relationship between the lower workings and the middle and upper workings. Subtle but distinct differences exist which, if better understood, may further our understanding of this mountain's remarkable specimens and their occurrences. For example, why is it that, with just one giant exception (the crystal on display in the University of Alaska Fairbanks Museum), epidote crystals elongated on the 'a' axis have been found only in the lower workings? And why do chalcopyrite, malachite, magnetite and goethite pseudomorphs after pyrite occur only in the middle and upper workings while limonite and chrysocolla are prominent only in the lower workings? Indeed, limonite in the high-angle lower workings conduit was so dense that it appears to have prevented the migration of later fluids that might otherwise have compromised many fine specimens. Except where faulting bisected our 1996 pocket, all but a few small surface pockets in the lower workings produced very sharp epidote. We have hopes that more pockets may be found under, between and beyond our three main work areas.

In the coming years, we expect more changes in the region surrounding our mountain. Eventual development of nearby lakes and streams for hydroelectric power is a near certainty, and further logging in the lower valleys of the region is likely. New prospecting and mining techniques will invite renewed production of important metals on the island, and expanded road systems will be built to support the needed infrastructure. Meanwhile, our activities on the top of Green Monster Mountain will continue to be compatible with the wild and remote beauty that still graces this region. We'll savor our search for crystals by employing small mechanized and hand tools whenever it is practicable to do so, and by applying our hard-won local knowledge and intuition. Our prime rewards are the delight of discovery and the privilege of witnessing the beauty and majesty of the land. We look forward to frequenting the Green Monster Mountain claim for as long as we can drag our wrinkled bodies to the work sites.

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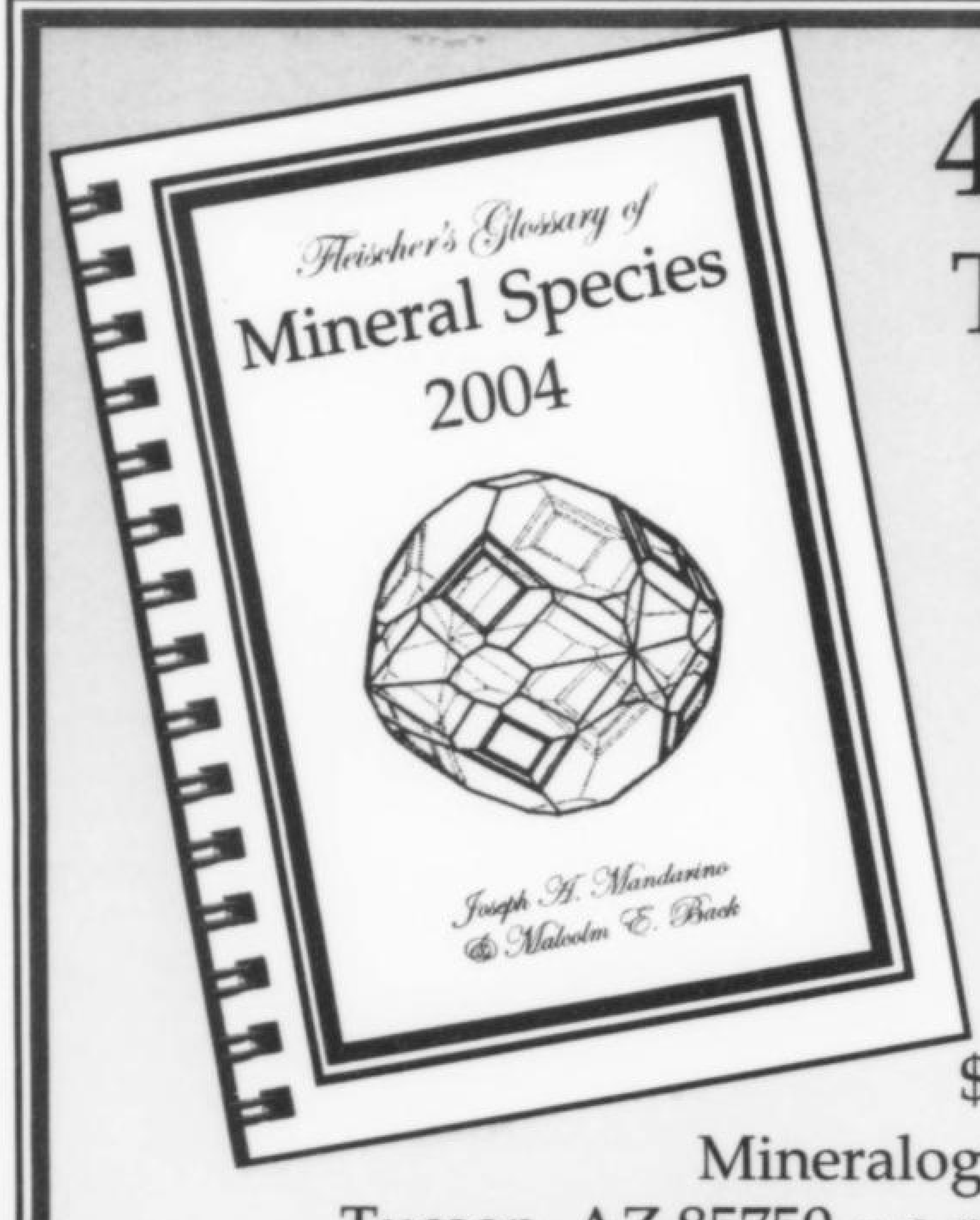

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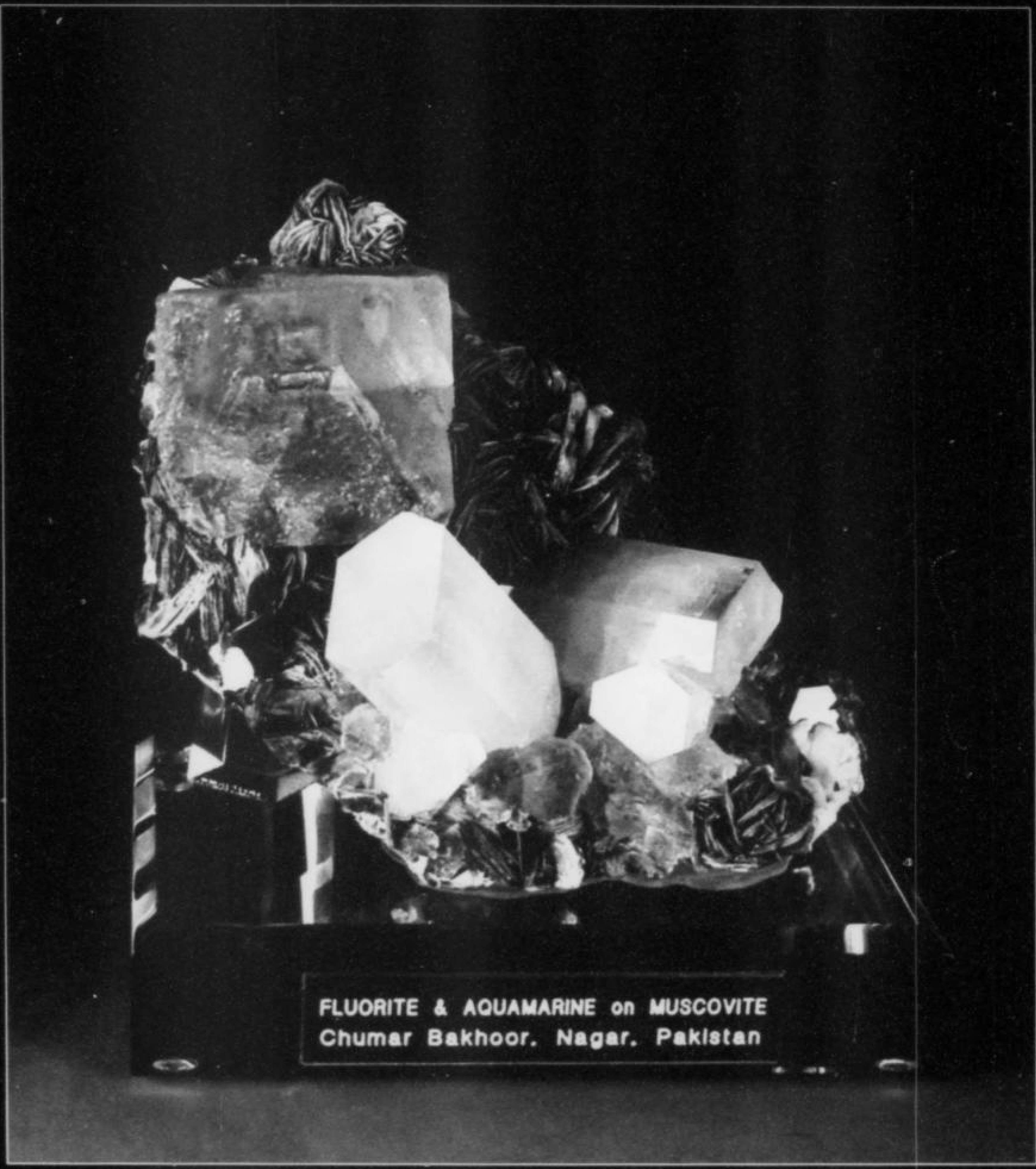

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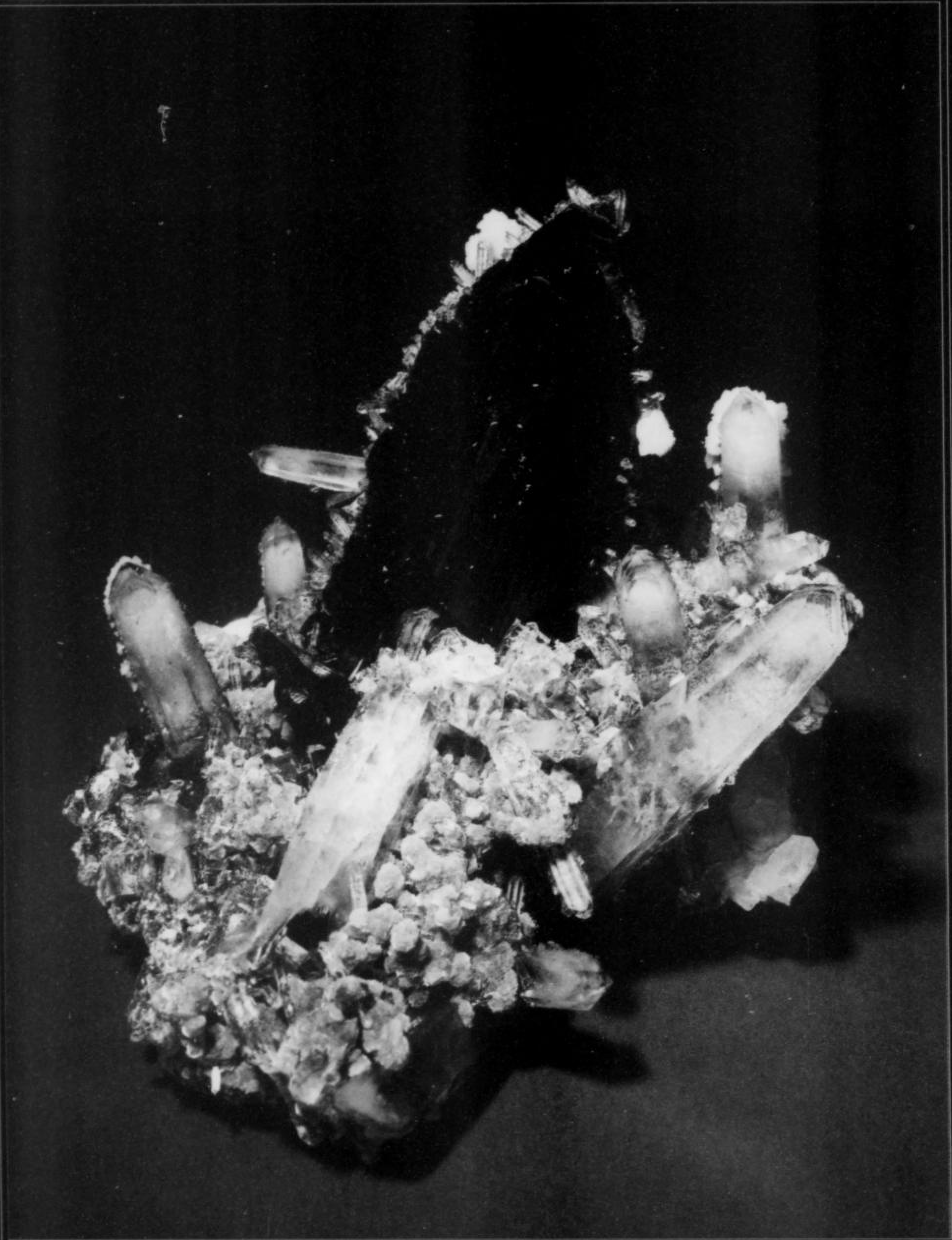

WOLFAMITE with Quartz and Fluorite, 5.5 inches, from Yaogangxian, China. Sandor Fuss Collection, July 2001.

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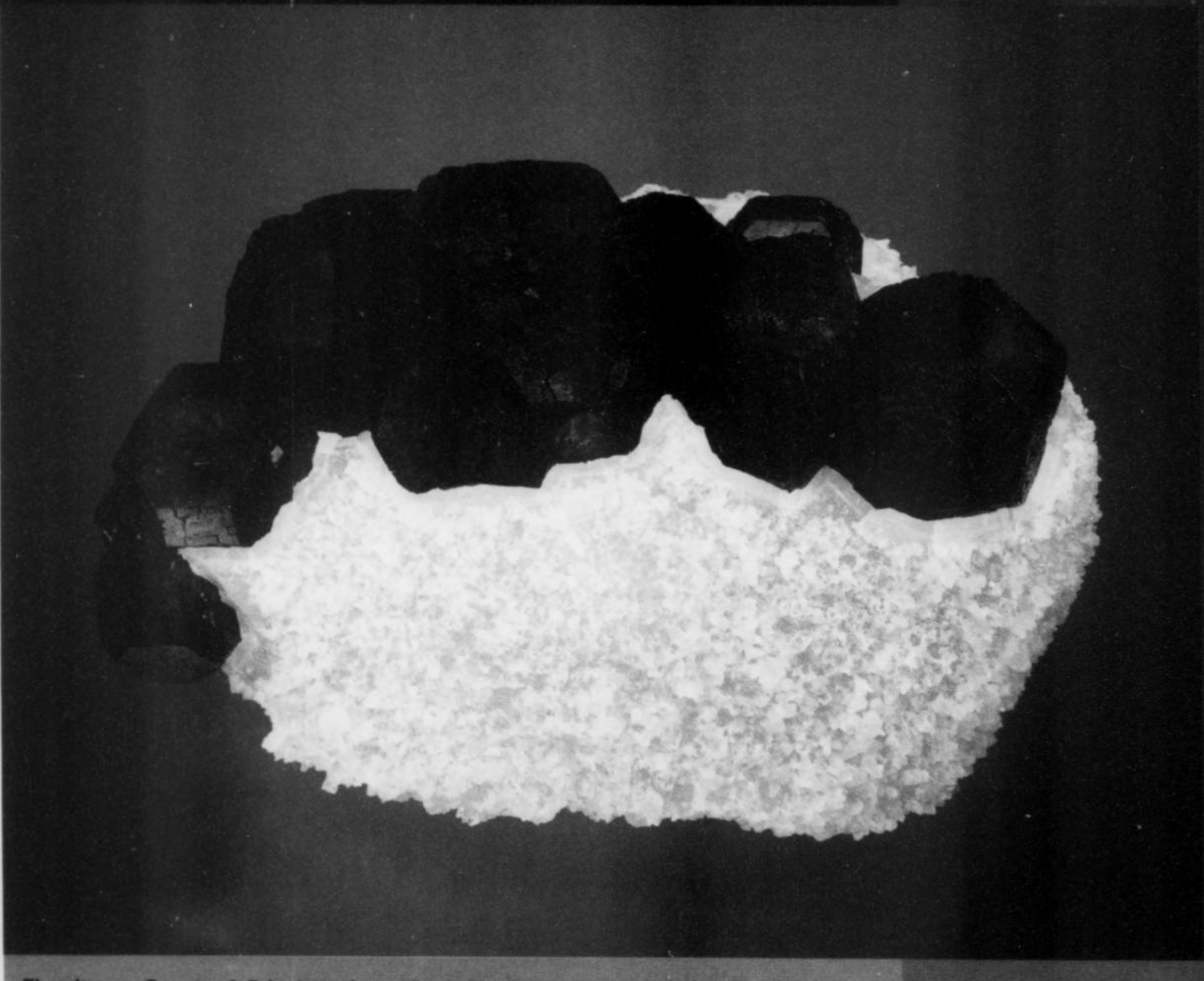
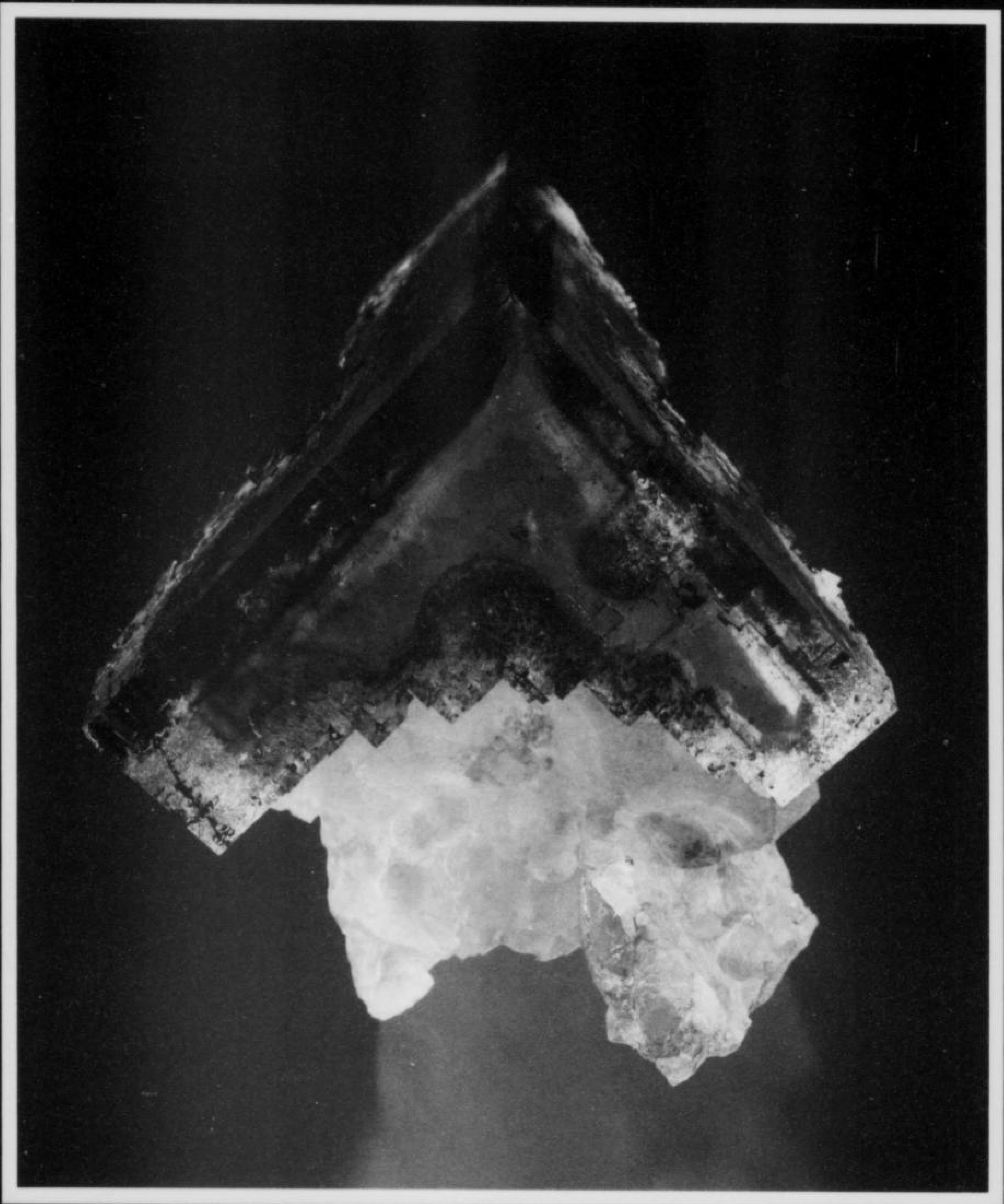


Fluorite on Quartz, 6.5 inches, from Yiwu, Zhejang, Guang Dong Prov., China.

Jeff Scovil photo.



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Fluorite, 16 cm, from the Minerva #1, Hardin Co., Illinois

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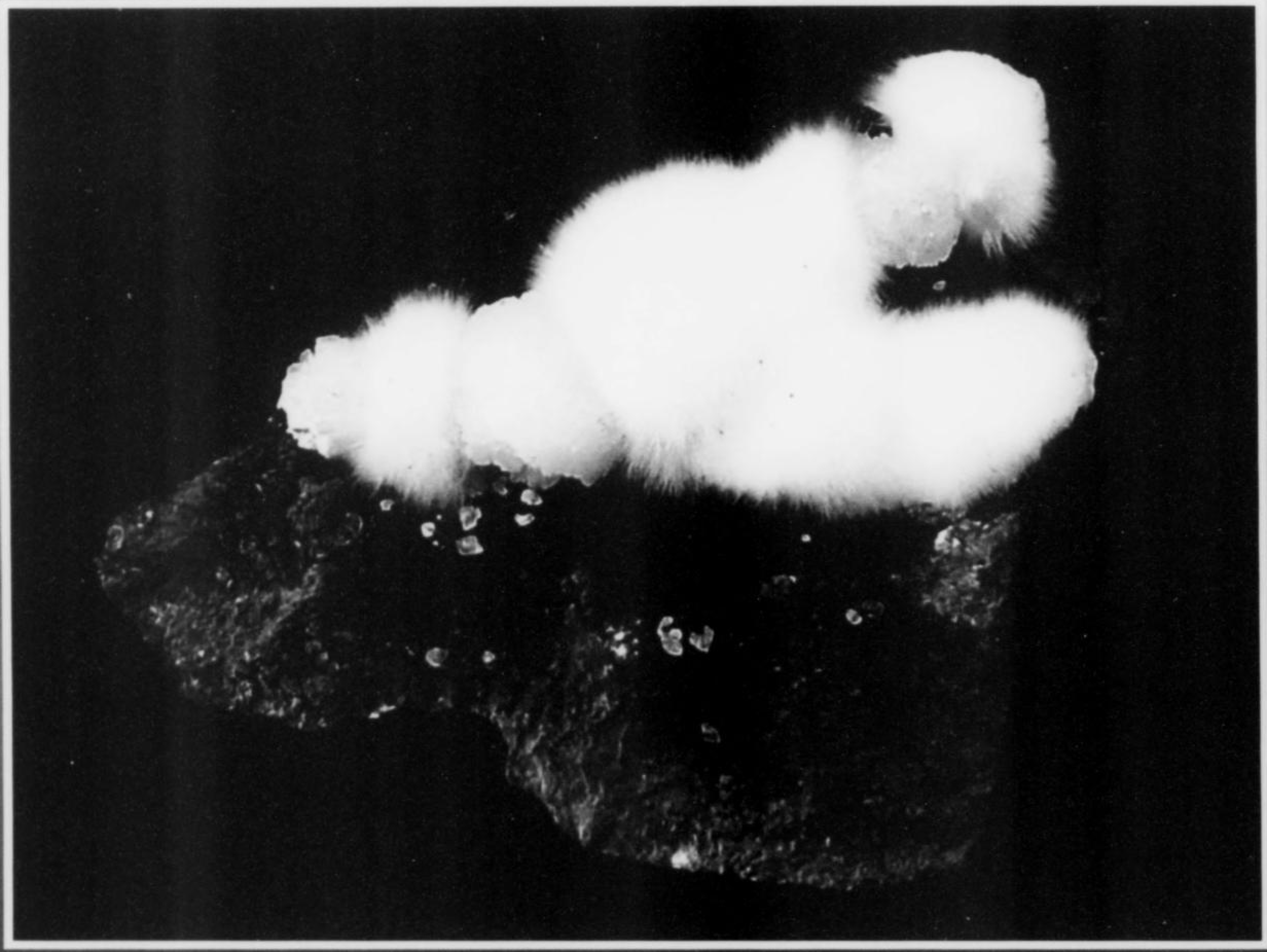

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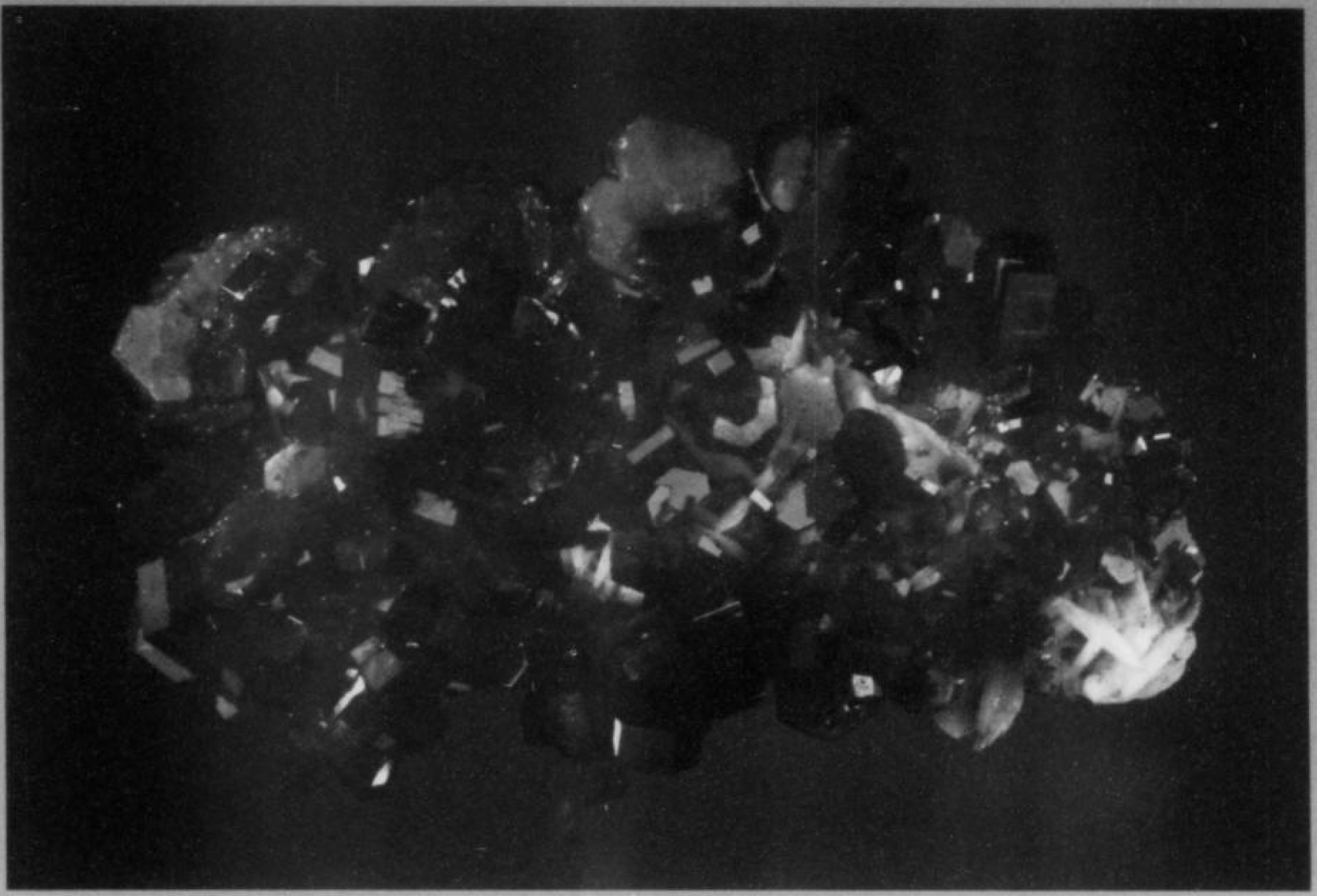

VANADINITE, 10 cm, from Mibladen, Morocco. Jeff Scovil photo.

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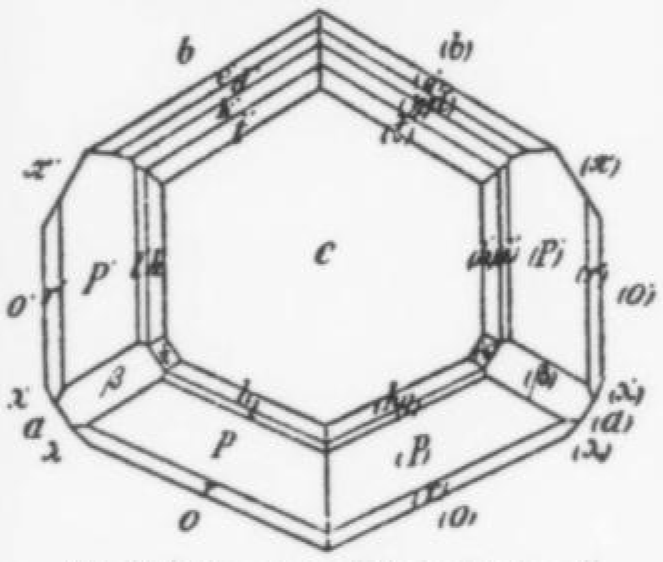

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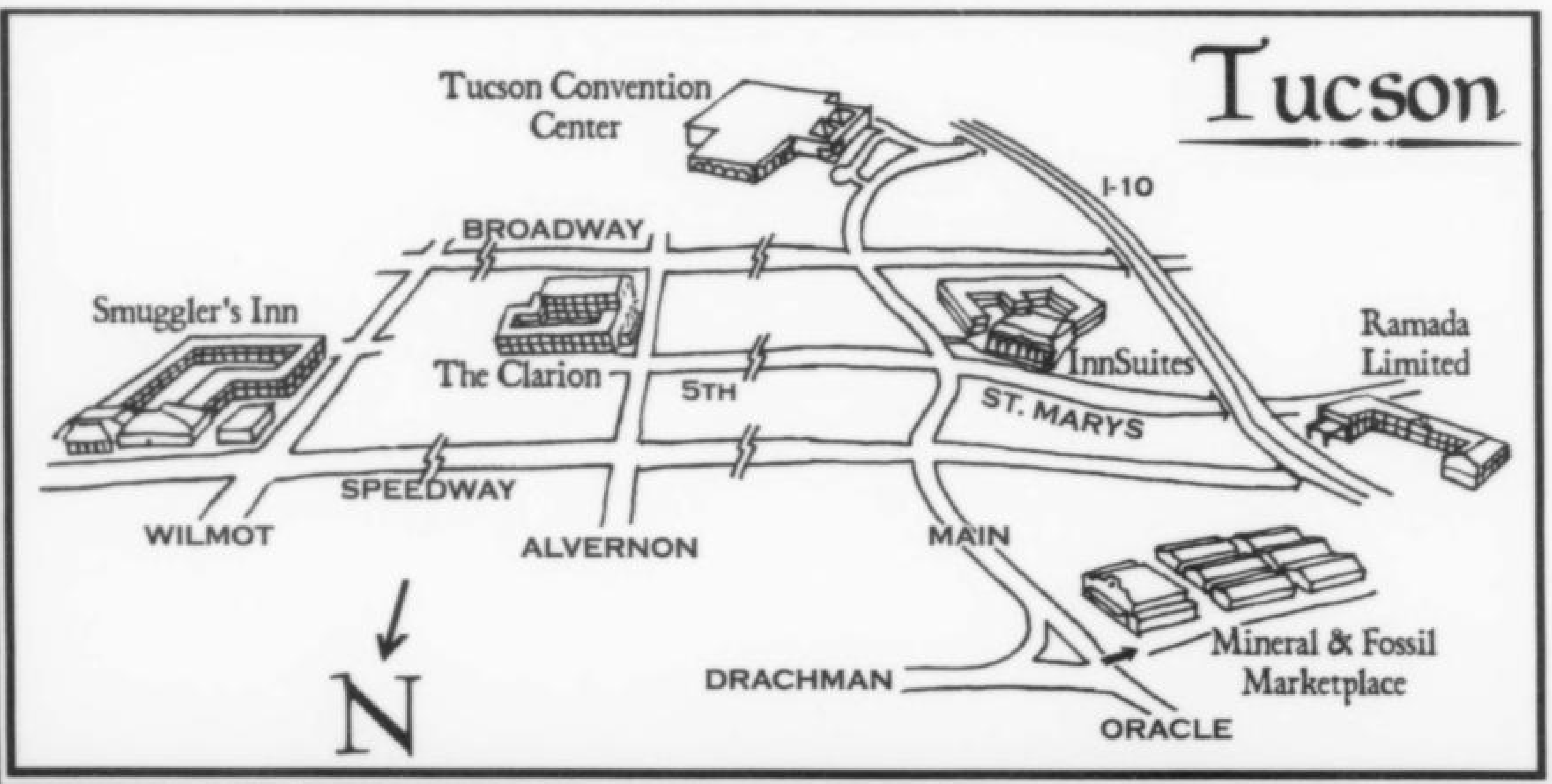

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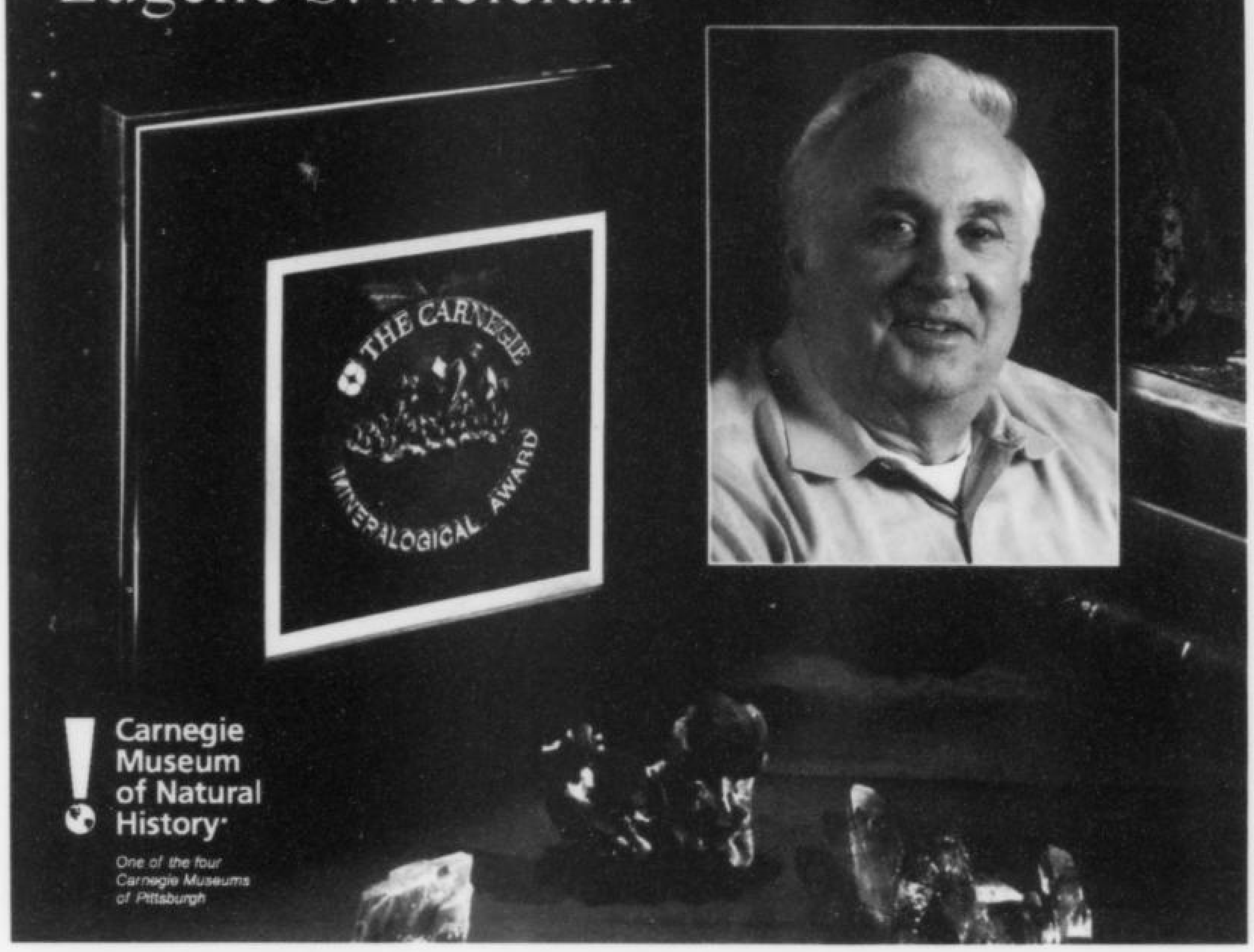

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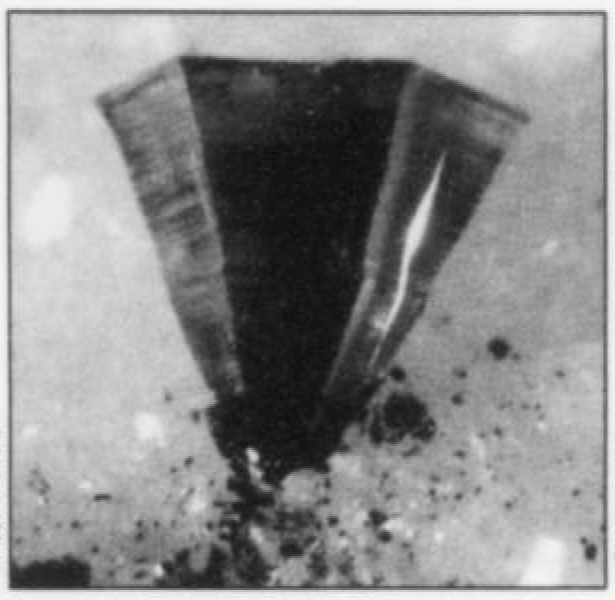
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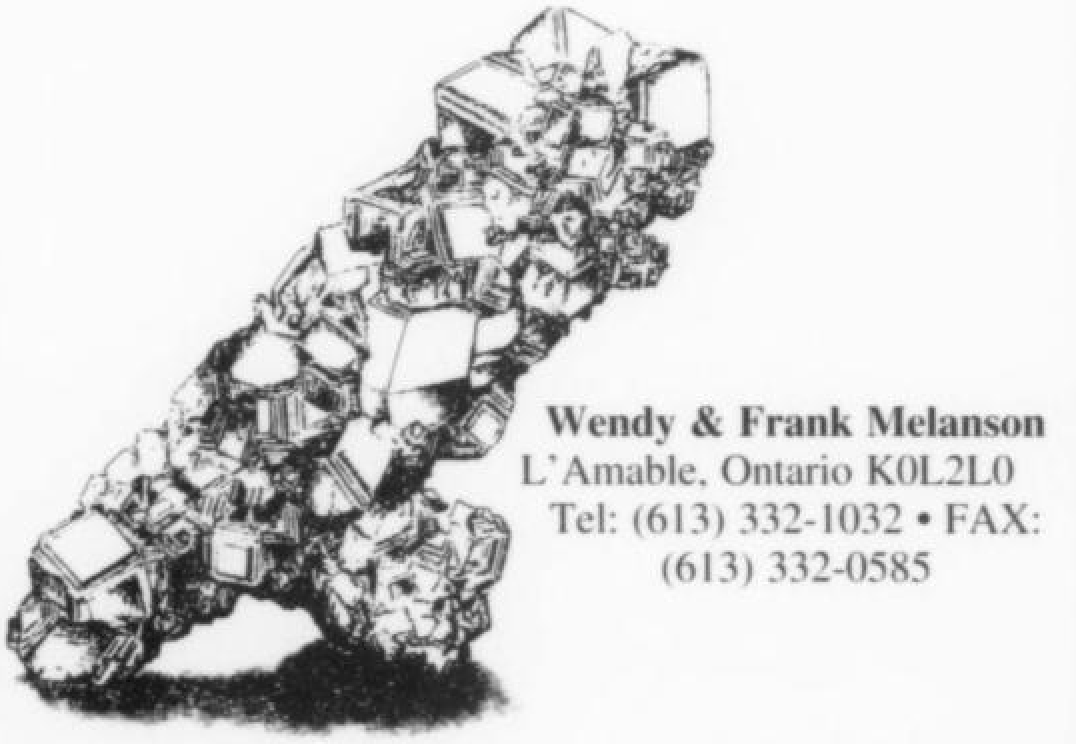

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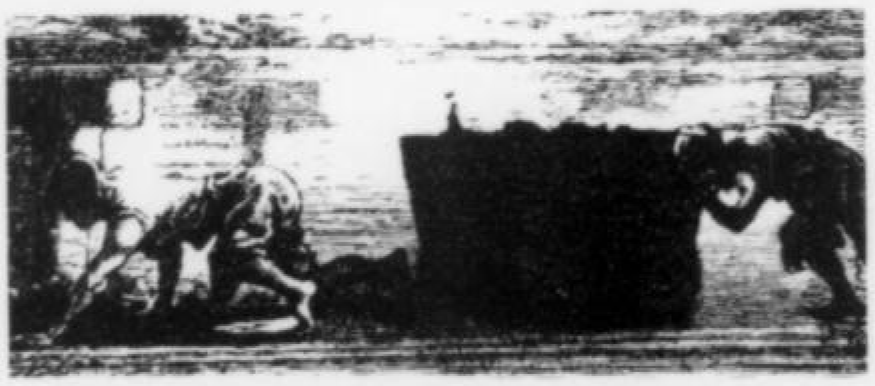

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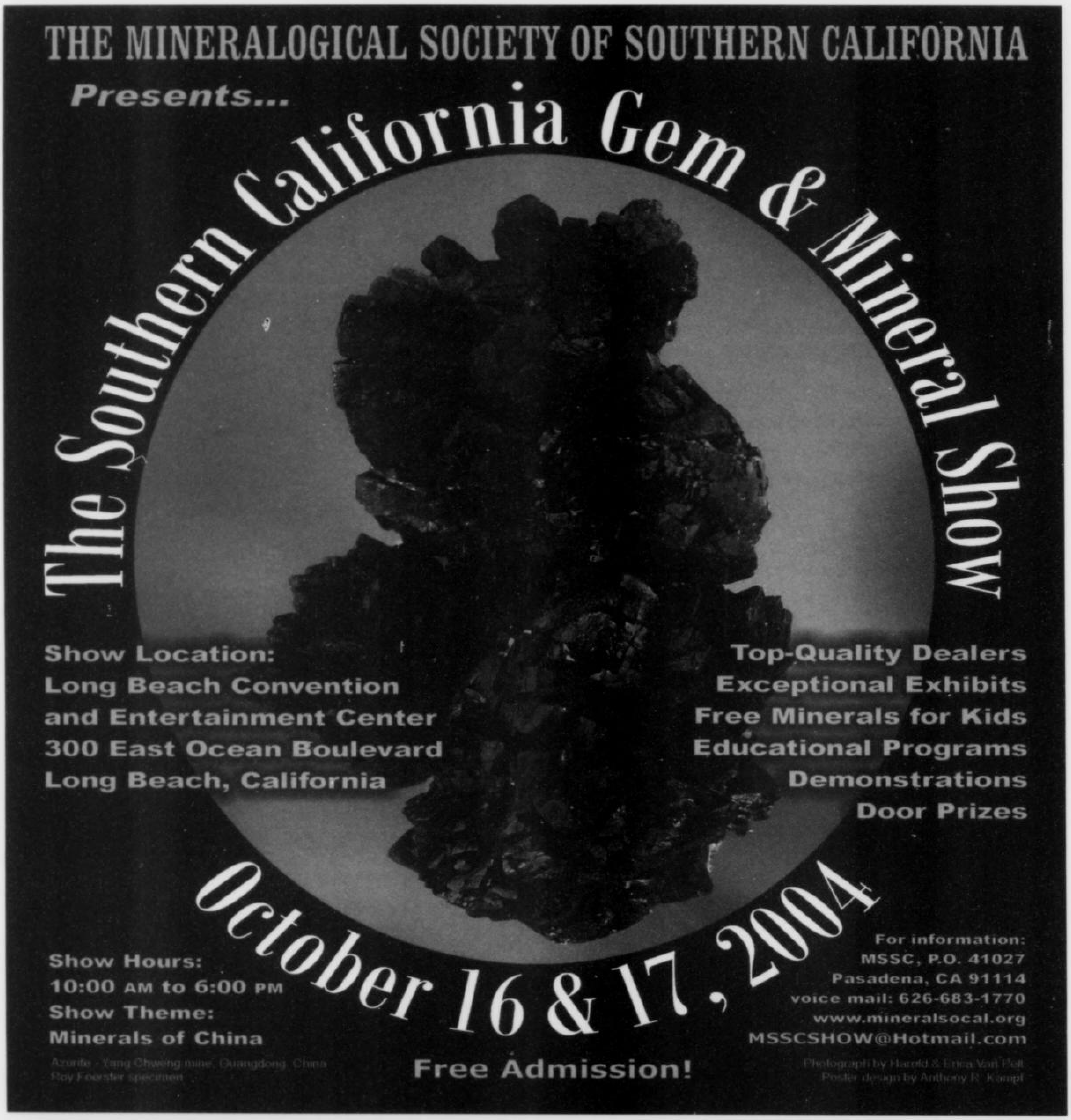

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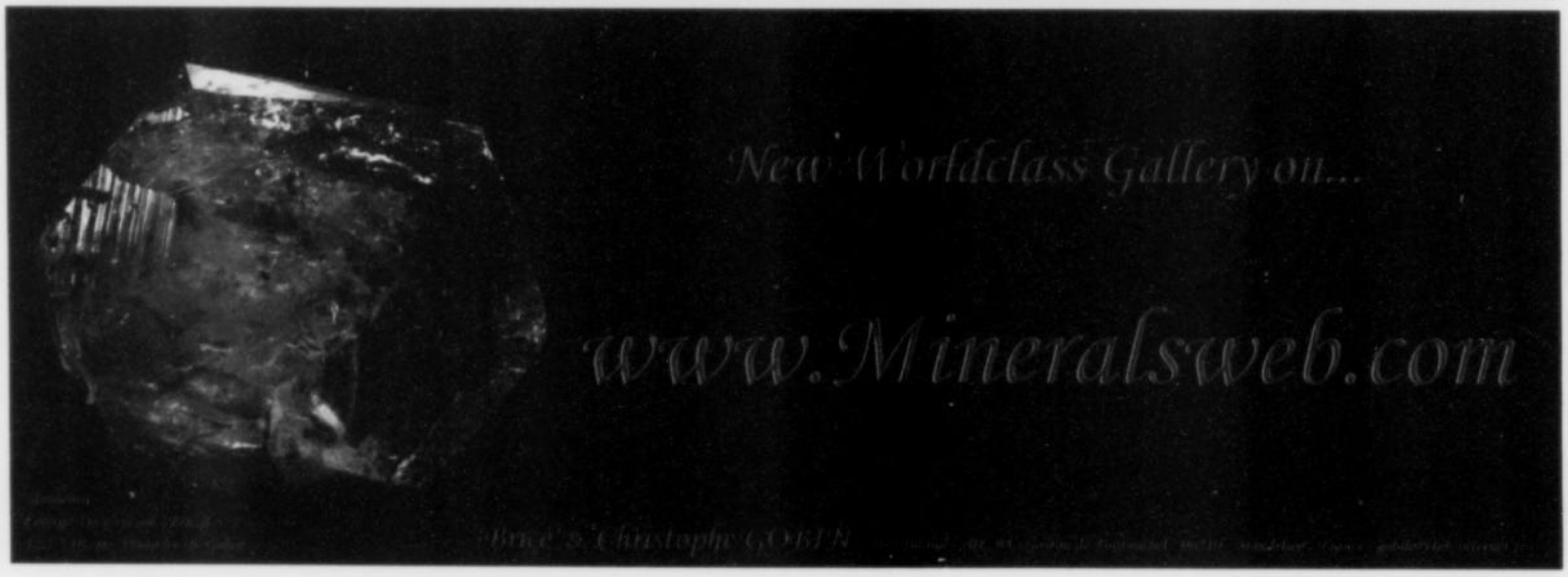

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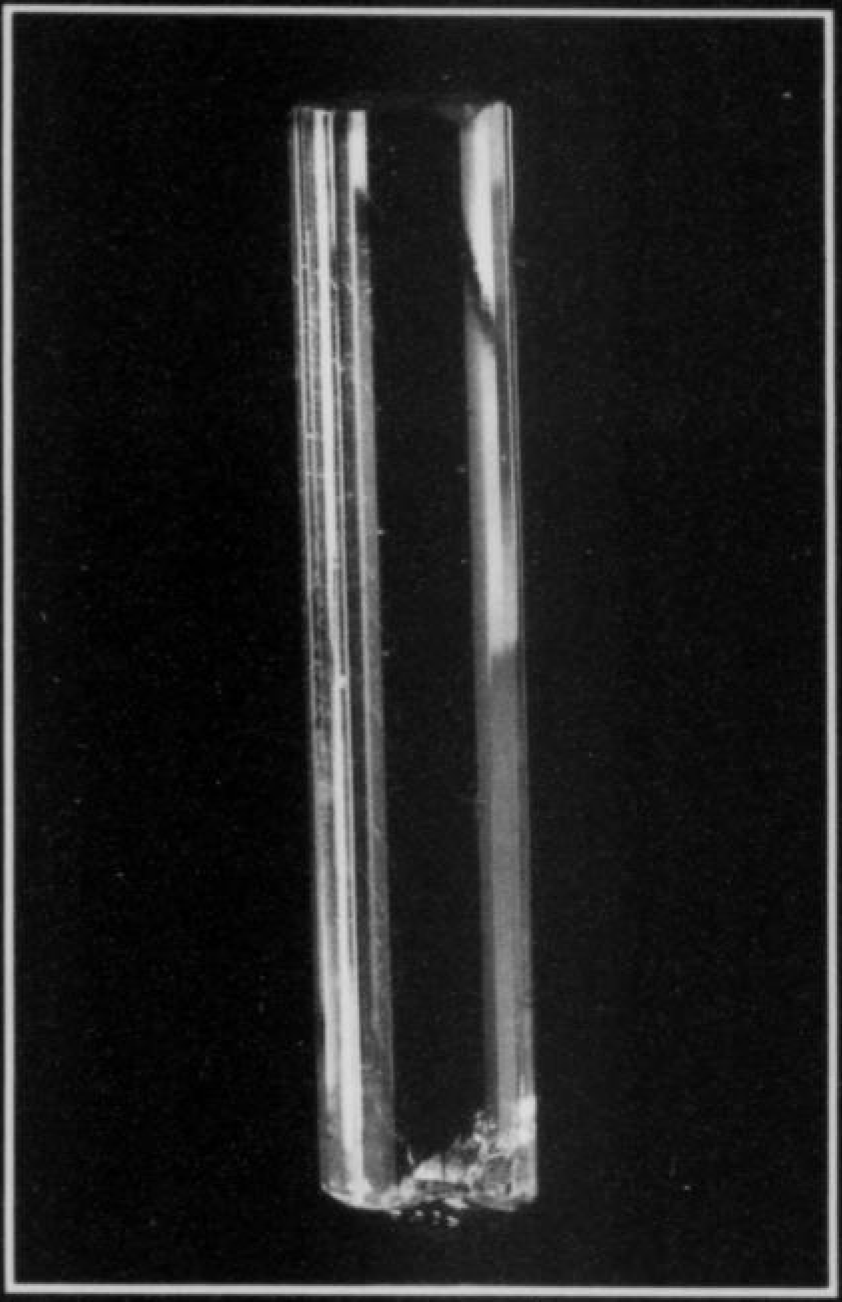

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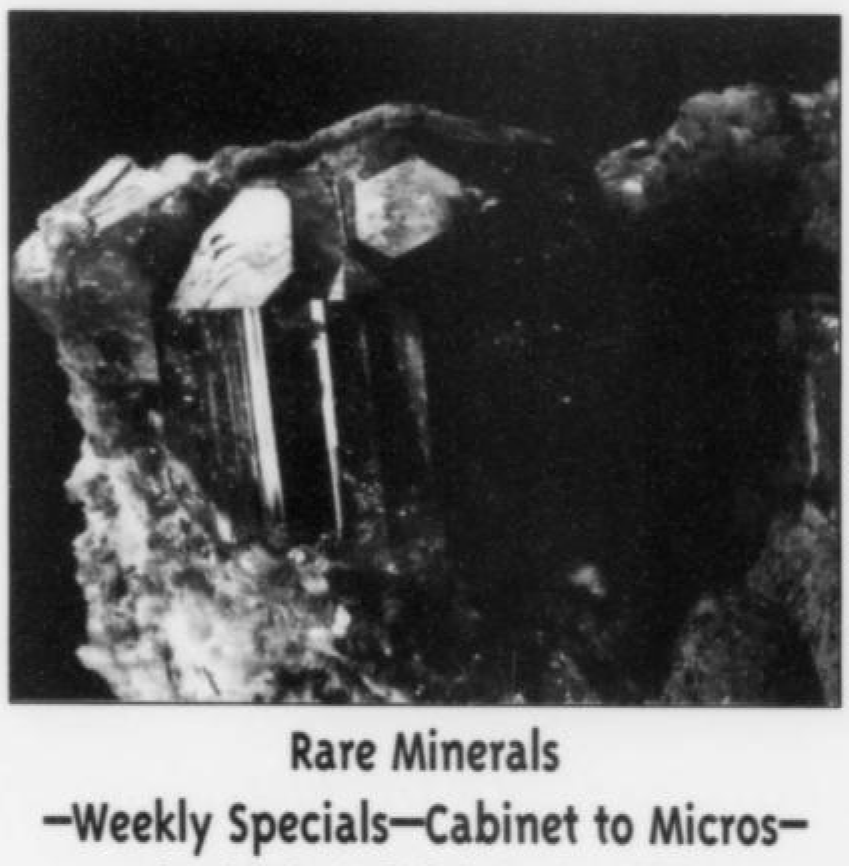

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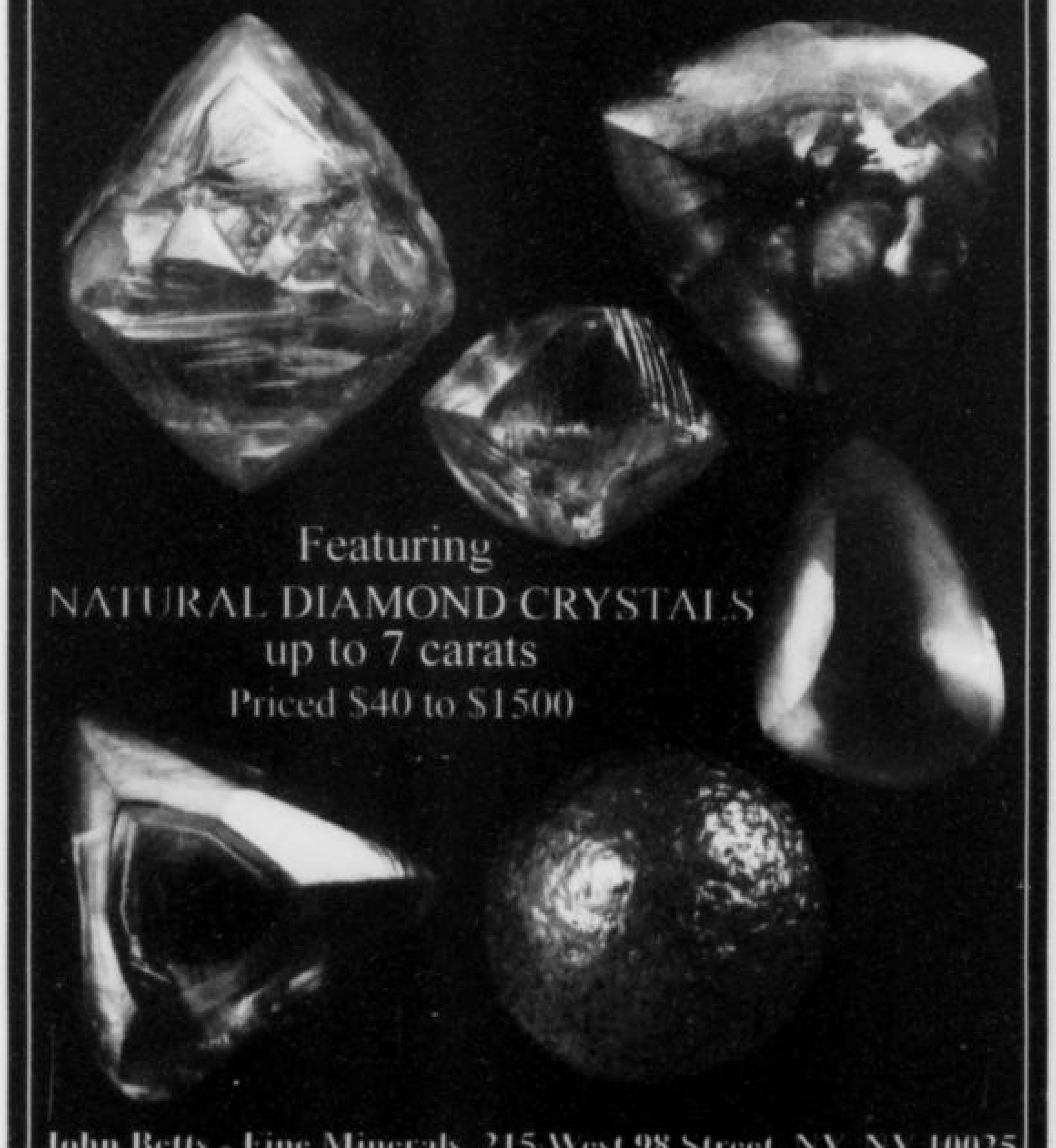

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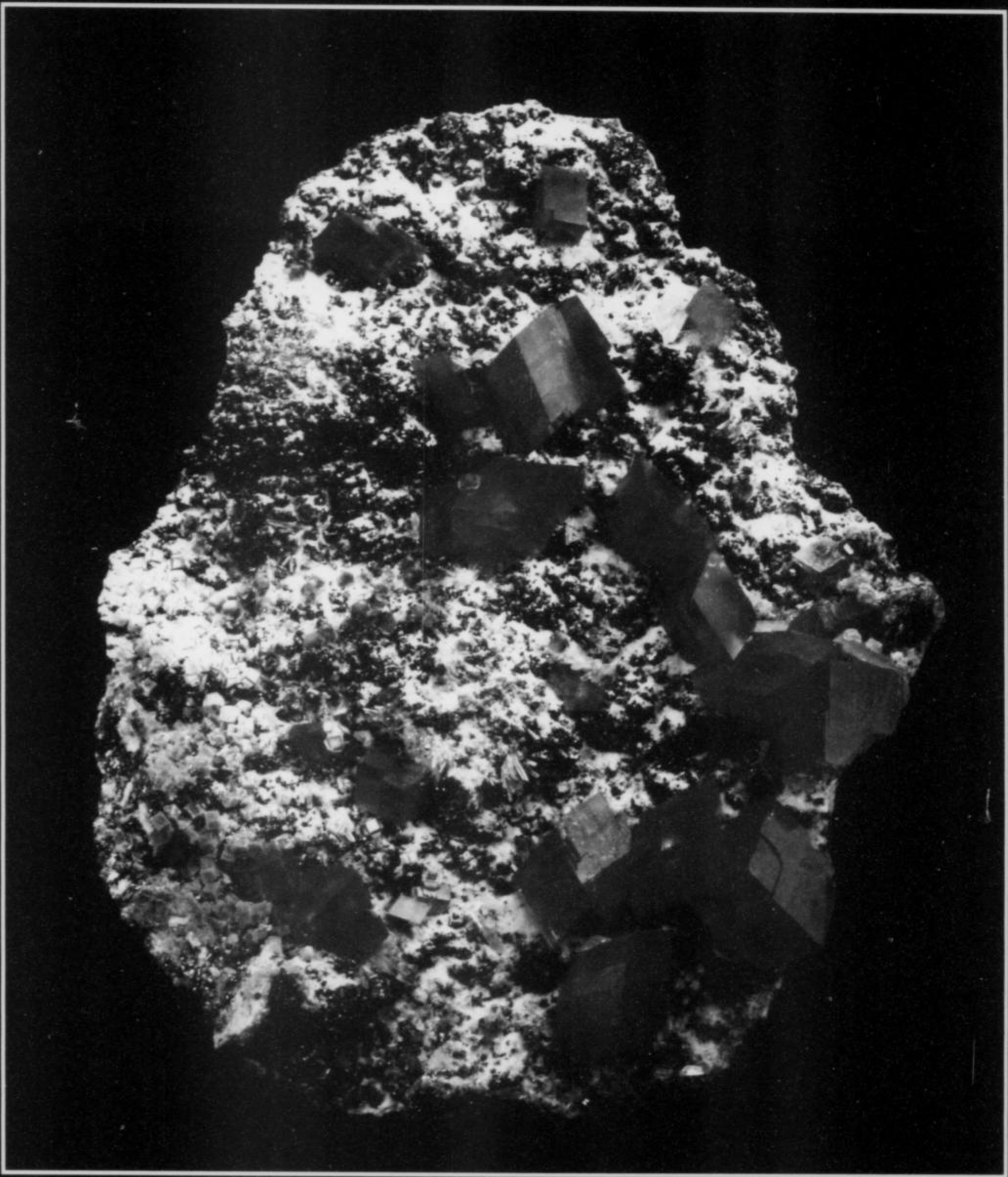

Rhodochrosite, Fluroite, Nate's Pocket, Sweet Home Mine Alma, Colorado; 25 cm; Jeff Scovil photo

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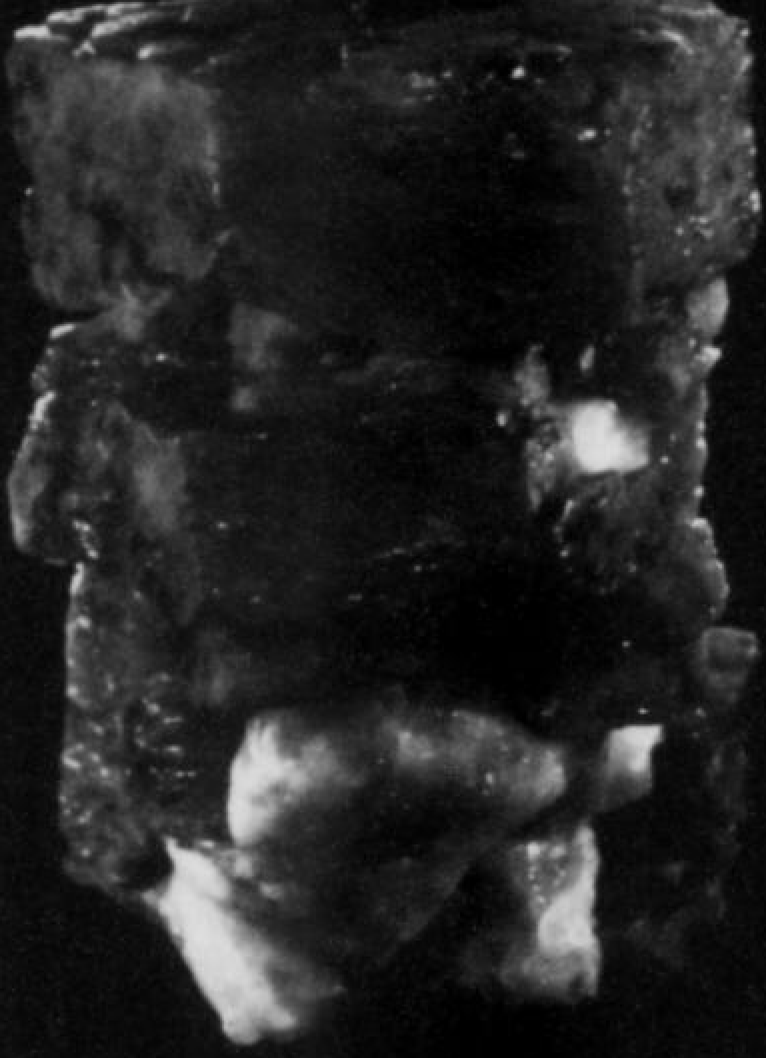

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