THE MINERALOGICAL RECORD

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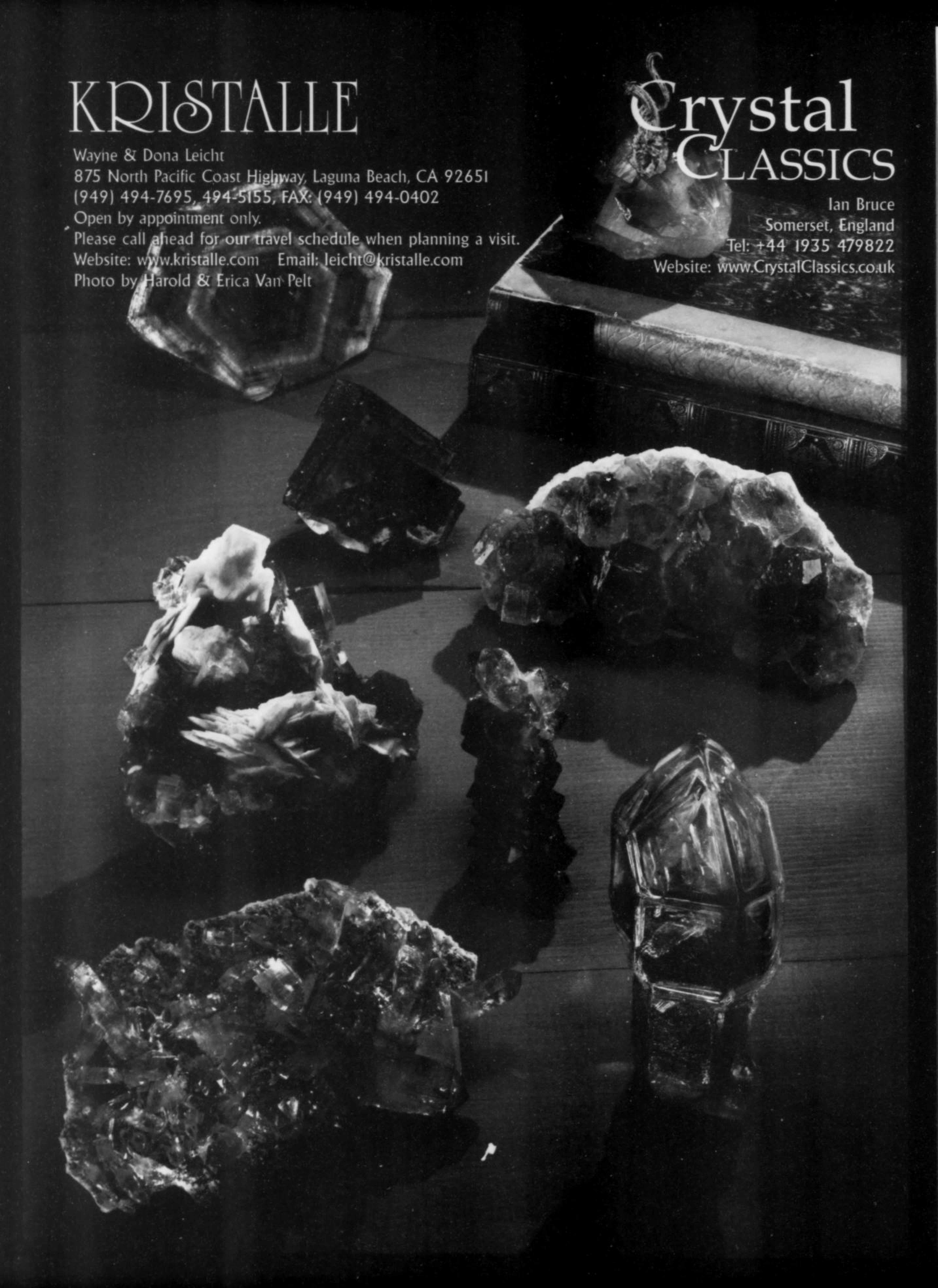
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The

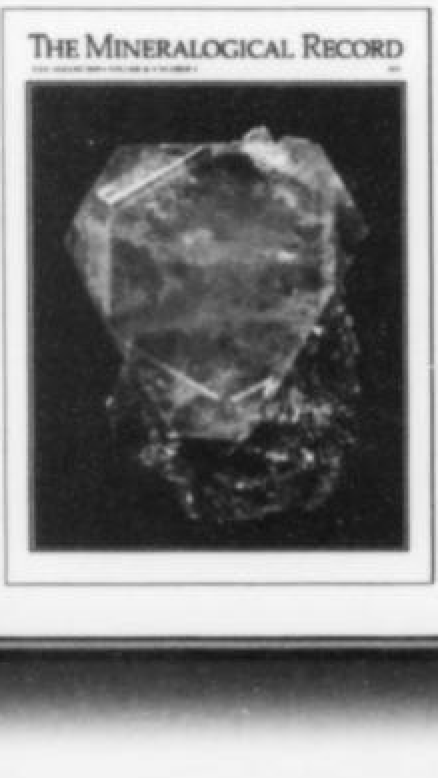
Mineralogical Record

The International Magazine for Mineral Collectors

VOLUME 40 • NUMBER 4 JULY–AUGUST 2009

Articles

Columns



COVER: AQUAMARINE beryl crystal, 10.5 cm, on muscovite, from Mount Xuebaoding, Pingwu County, Sichuan Province, China. Rob Lavinsky collection, ex James Horner collection; Joe Budd photo. See the article on this locality in vol. 36/ no. 1 (January–February 2005).

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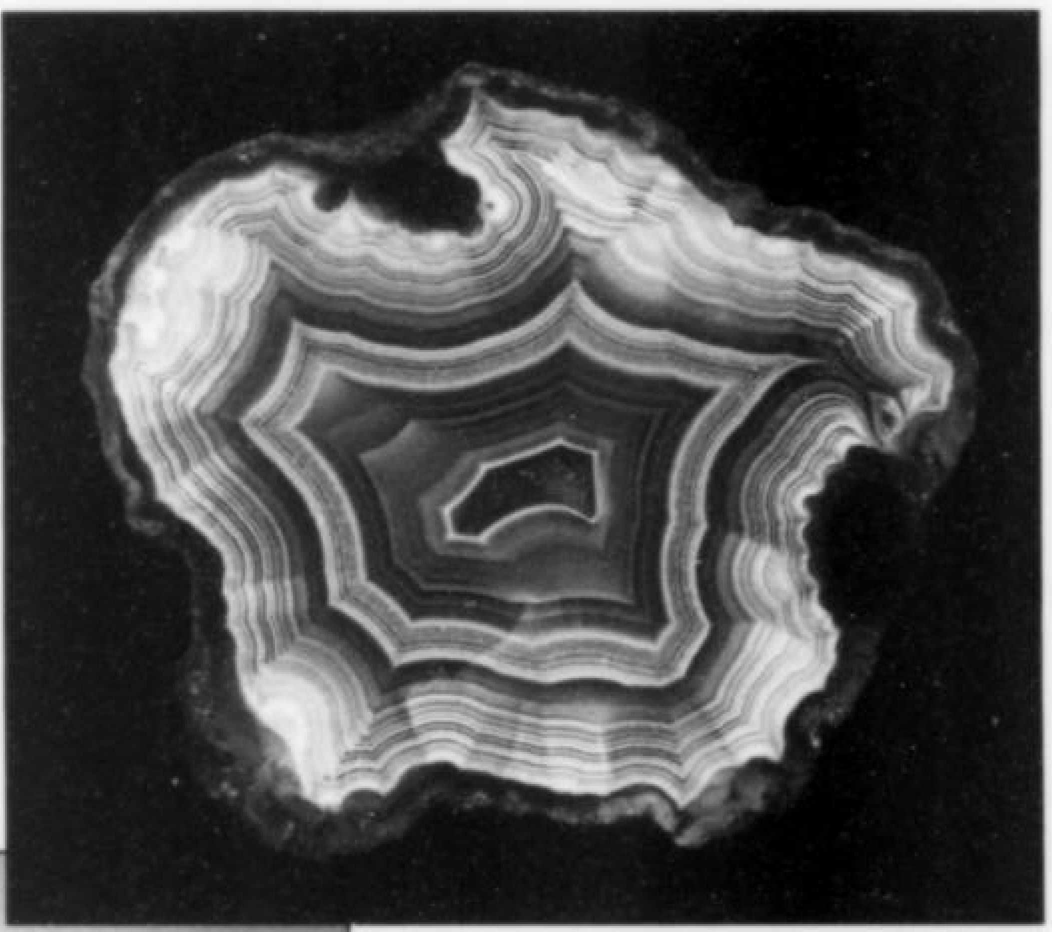
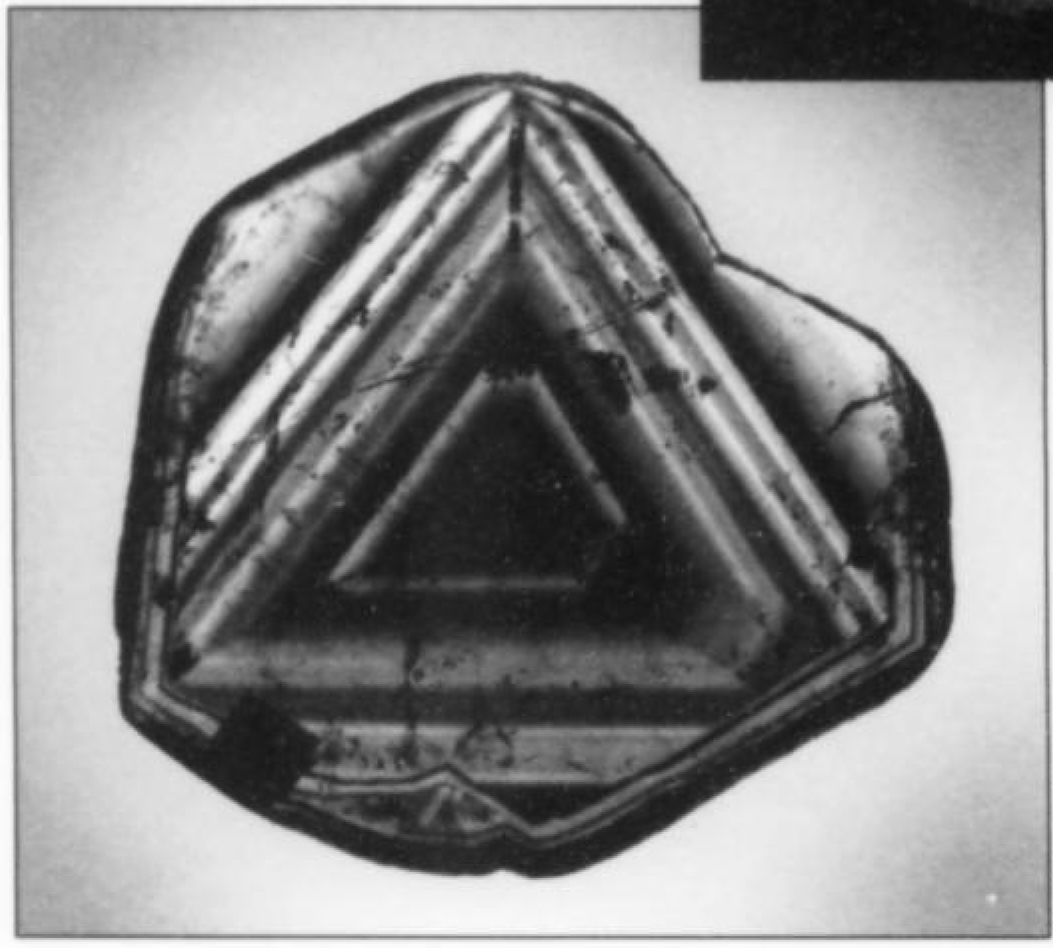
Editorial:
Polished Specimens

The Mexico-V Issue (November–December 2008) contained an article on Mexican agates which, personally, we found fascinating and interesting. But it was unusual for the *Mineralogical Record* in that it dealt with *polished* mineral specimens. We were braced for a possible backlash from readers, who might have suspected that we had sold our souls to the lapidary gods, but none was forthcoming, and the article seems to have been well accepted as part of the documentation of Mexico's mineral heritage.

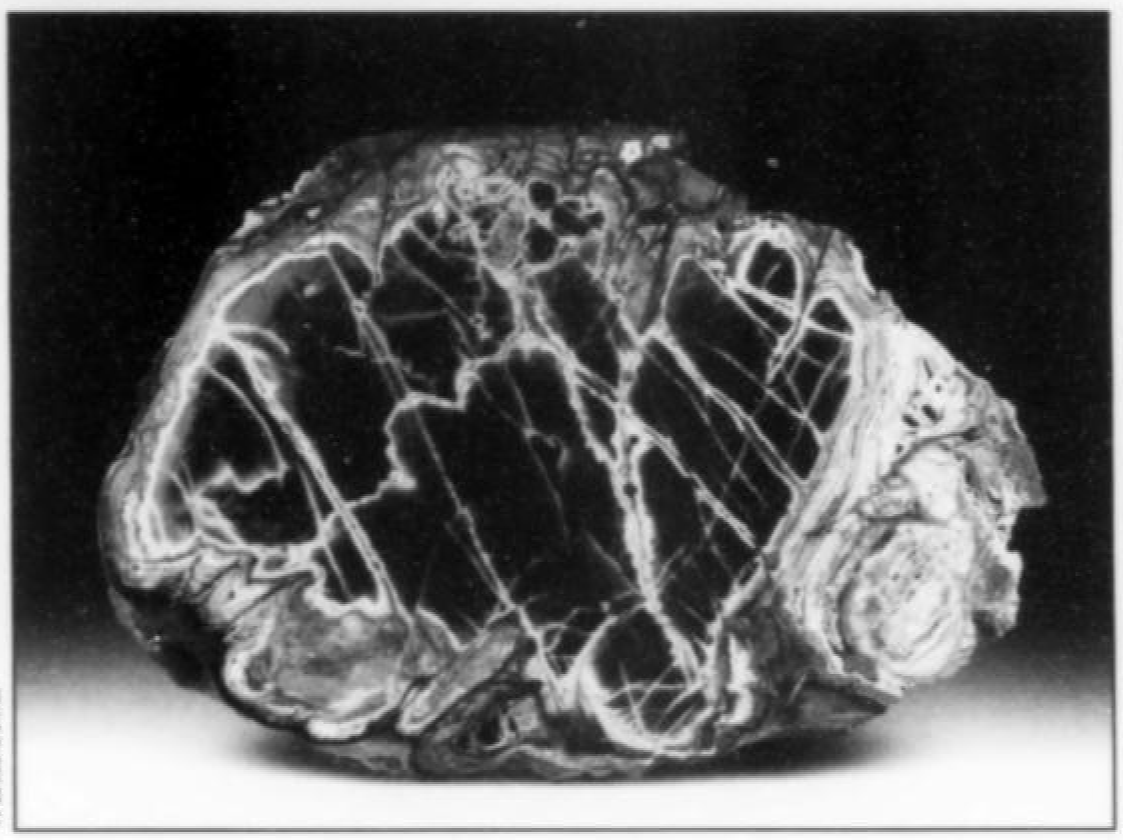
The items in that article were dealt with strictly as mineral specimens, not as examples of the lapidary or jewelry arts. In the "old days" there was a certain antipathy among many serious mineral collectors to anything cut and polished, especially agates. I think this is (or was) a carry-over from the post-war decades when unsophisticated "rockhounding" was sweeping the country as a hobby, and many people were looking for anything that would "take a polish." They would gather up rocks and stones from the desert or from local quarries and then slice and dice them in their garage to make all manner of kitschy objects, from bookends to bola ties to imitation food items, just for the handicrafty fun of it. People enjoyed (and still do enjoy) finding raw material for free while out rooting around in nature, and then being able to fashion it with their own hands into something attractive or interesting.



AGATE



LIDDICOATITE



VARISCITE

We as serious mineral collectors were (and still are) heavily outnumbered by the lapidary fraternity, and we have perhaps gone out of our way to demonstrate that we have no interests in common with them. The fact is, however, that we do share some common ground besides the simple appreciation of earth materials. Some mineral specimens, it turns out, can *only* be properly appreciated if a flat face is cut on them and polished. Slabs of liddicoatite from Madagascar and variscite nodules from Fairfield, Utah have always had an honored place in the cabinets of mineral collectors. The complex color zoning in liddicoatite crystals can only be viewed in this way; uncut crystals typically appear black and are unable to display their striking internal beauty.

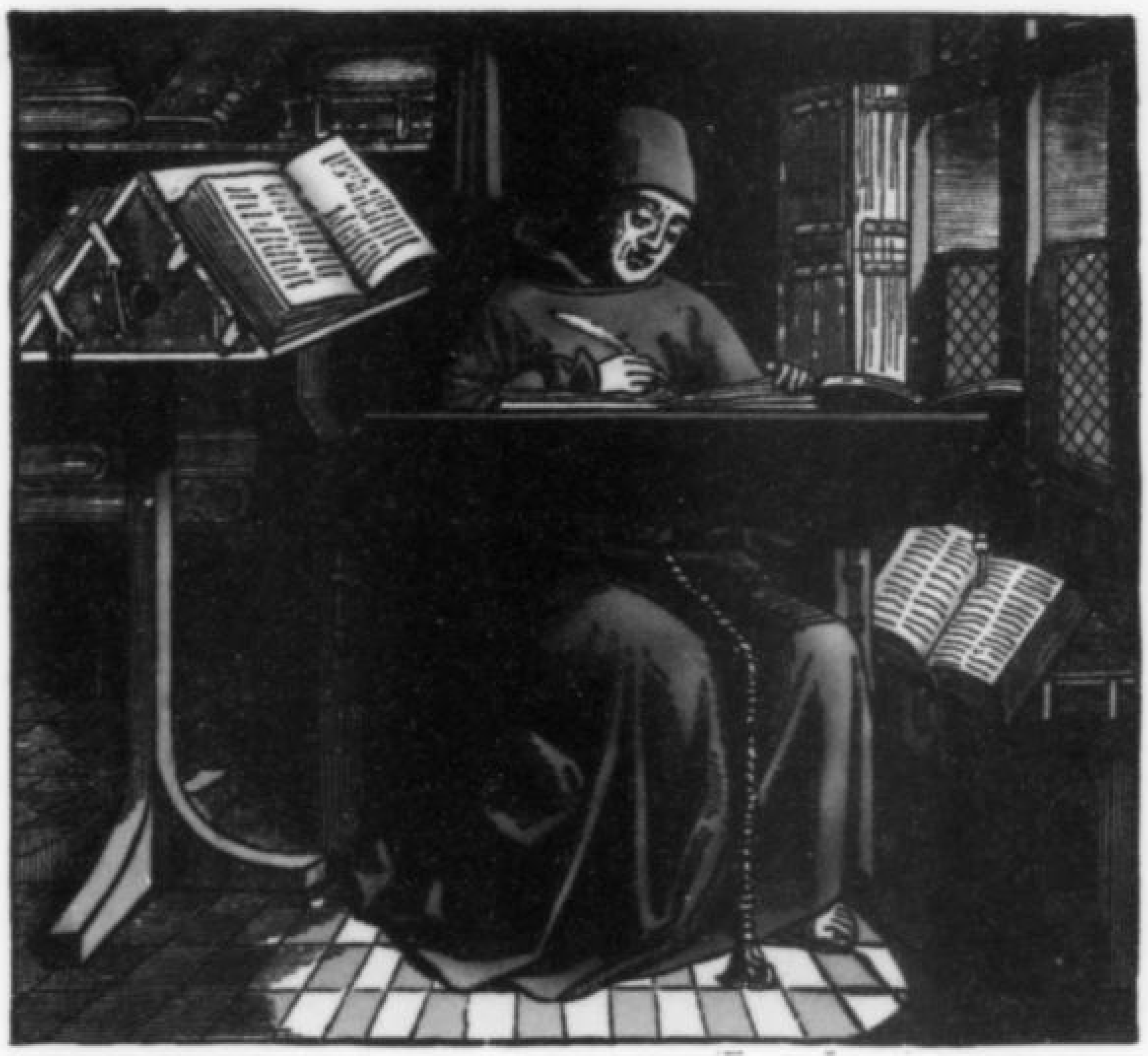
One compelling reason for our usual avoidance of anything polished is that it smells to us like fakery. We like to appreciate the naturally beautiful and lustrous faces on a crystal, marveling at how nature could precipitate a surface so pristine and fascinating right down to the microscopic level. The horror we experience at the idea of unscrupulous individuals *polishing* crystal faces and passing them off as natural is part of our being. But we have to take care not to mindlessly allow that aversion to carry over into areas where it does not apply. No one, for example, is ever going to mistake the cut and polished flat surface on a variscite nodule or an agate as natural! The cut merely allows us to see into the specimen in a new way and appreciate the wonder of its internal structure.

As a geologist I have occasionally seen great mountain roadcuts where huge machines have sliced through the bedrock, creating a flat surface several tens of feet high. It is truly a joy to behold, where oftentimes you can see powerful earth forces at work but frozen in time. For a mini-version of this thrill, visit a dealership in granite countertops, where you can go out in the back lot and see 8-foot polished slabs of beautiful stone with all the dynamism of churning orogeny preserved like a snapshot.

On the small scale, what collector of jewel-like thumbnail crystals has not occasionally cast a longing eye at real polished gemstones? If you appreciate color and clarity and form, the attraction can be strong. Many of us avoid collecting gemstones simply because we cannot afford to do justice to two fields at the same time, but other, better funded collectors often dive in.

For our role model as mineral connoisseurs we can look to the well-known mineral collector David P. Wilber—one of the all-time great collectors of the 20th and now the 21st century. Never one to worry about artificial barriers in collecting, he has a *fabulous* (his favorite word) collection of Mexican agates, some of which were illustrated in the Mexico-V issue. Thanks once again, Dave, for showing us that passion is its own justification as well as its own reward, and that we as mineral collectors need not regard polished specimens as guilty pleasures.

WEW



Notes from the Editors

Fellows of the Mineralogical Record

As readers may have noticed, the list of Fellows and supporting organizations shown on our title page has grown since we first announced the program in the July–August 2008 issue. We offer our deepest thanks to these generous and civic-minded supporters. Within the last year these people have each contributed $1000 to our Endowment Fund, in order to help guarantee the long-term survival of the *Mineralogical Record* as the premier knowledge base for mineral collectors, mineral curators, mineralogical historians and specimen-oriented mineralogists worldwide. This is an important cause—supporting your favorite mineral magazine and its massive online databases to make your collecting more interesting and more well-informed. Unlike the *American Mineralogist*, for example, the *Mineralogical Record* has no supporting organization like the Mineralogical Society of America behind it; therefore support from its readers is critical.

The year in which each person or couple made their Fellowship donation is given, and they are then listed on the masthead as Fellows for the following six issues. In fact, some of the listed Fellows have already renewed their fellowship for a second year, as shown by the "2008–2009" after their name. (Should they

eventually renew for a third year, the dates would be changed to "2008–2010," and so on.)

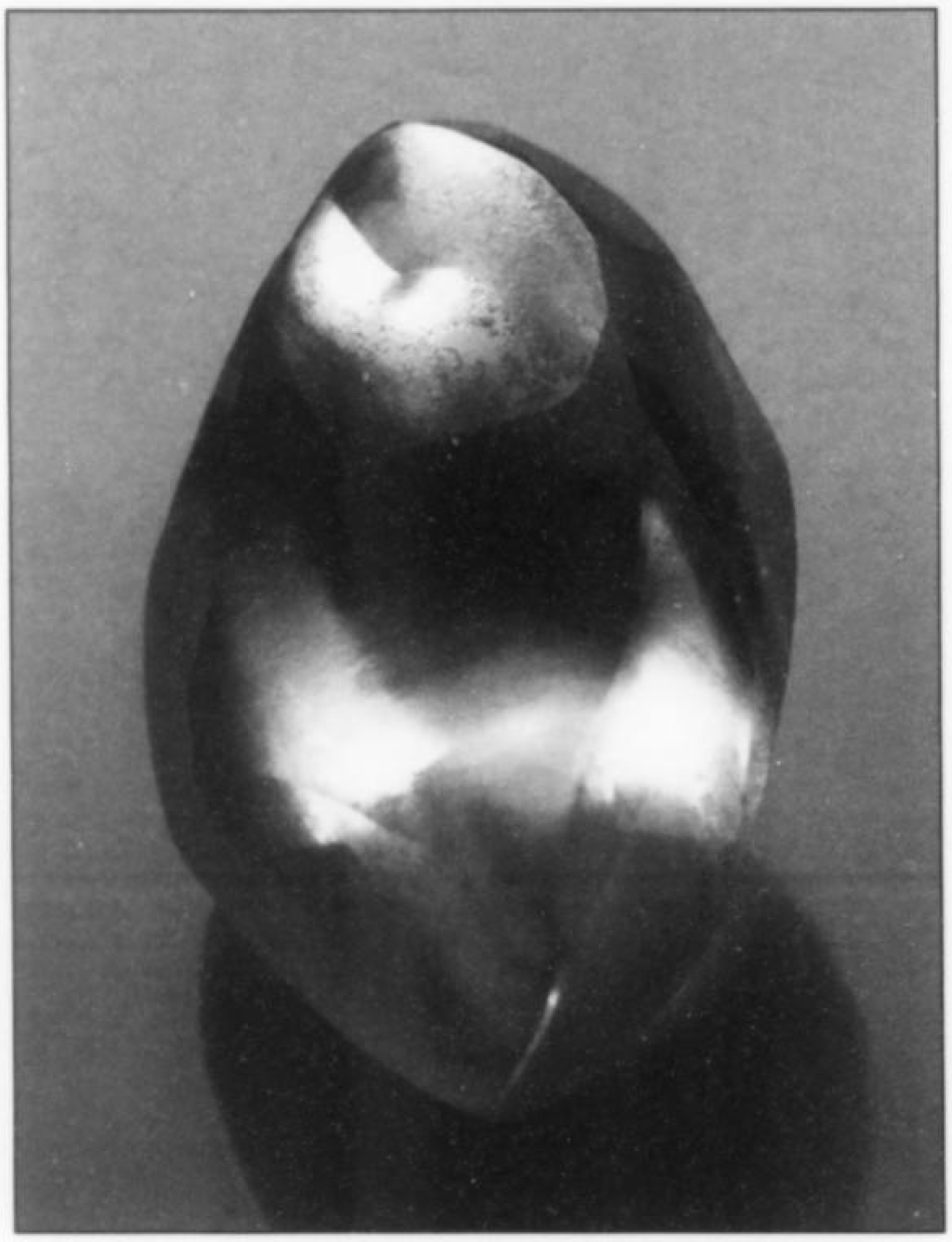
We would be delighted to welcome additional members to this elite group. As a Fellow you will receive a handsome certificate that can be proudly displayed in your collection room, office or shop, as proof that you are a patron of mineralogy. There will also be other benefits that we're working on.

Although only a person can be a Fellow, any organization contributing $1000 will also be listed, under "Sponsoring Organizations." If your mineral club or society would like to contribute and be listed, please let us know.

To become a Fellow, send your check, made out to the Mineralogical Record, to the Editor at 4631 Paseo Tubutama, Tucson, AZ 85750, or pay by VISA or MC though the secure "Support the Mineralogical Record" page on our website at www.MineralogicalRecord.com. You will then receive by return mail your certificate and a letter verifying your donation for tax purposes. The Mineralogical Record is a 501c(3) non-profit scientific educational organization, and donations are accordingly tax-deductible for qualifying U.S. citizens. If you have any questions, feel free to contact us: Dr. Wendell Wilson, Publisher, at minrecord@comcast.net, or Thomas Gressman, Associate Publisher, at tgressman@comcast.net.

Diamond Found in Arkansas

Glenn Worthington of Springdale, Arkansas, author of *A Thorough and Accurate History of Diamonds in Arkansas* (2003) (see the article "The Arkansas diamond rush continues! A book review and an update" by Jim Houran in vol. 37, no. 6, p. 505–510) has visited Arkansas's Crater of Diamonds State Park many times over the last 30 years. His time spent prospecting in the park's 37.5-acre diamond search area has been rewarded many times with diamond finds. However, all but one of his diamonds have weighed under a carat. In April Worthington discovered the largest of all his diamond finds, a stunning 2.04-carat canary-yellow diamond crystal.



Worthington was washing gravel that he'd dug out of the park's east drain, a low area in the park's diamond search area, when he found the yellow diamond in his screen. It was in the last bucket he planned to wash before shutting down for the Easter weekend. The elongated, complete diamond crystal has a smooth, lustrous surface with no cracks or internal spots of graphite. Glenn and his wife Cindy do not plan to cut or sell it.

Besides his book, Worthington has produced a DVD that teaches others how to find diamonds in Arkansas. Margi Jenks, one of the park geological interpreters on staff at the Crater of Diamonds State Park, said "It is Glenn's persistence and passion for the Crater of Diamonds State Park that finally paid off with this beautiful gem."

Crater of Diamonds State Park is the world's only diamond-producing site open to the public. Diamonds there come in all colors of the rainbow. The three most common colors found at the park are white, brown and yellow, in that order. An average of two diamonds per day are found by park visitors at the Crater of Diamonds. According to park records, during 2008 a total of 946 diamonds were found at the park. Twenty-seven of those diamonds weighed over one carat. Thus far, Worthington's 2.04-carat Diamond is the largest of the 296 diamonds found at the park in 2009.

Thumbnail Collectors' Organization

A new organization has recently been formed specifically for collectors who specialize in thumbnail-size mineral specimens (specimens no larger than about 1 × 1 × 1 inch). It's called the International Thumbnail Mineral Collectors Association (ITMCA), and they have established a dedicated new website at www.thumbnails.crocoite.com. Their main emphasis is on education, and on the buying, selling and trading of thumbnails. No fees or dues are required, and the last time I looked they had already signed up over 60 members, including some well-known major collectors. Click on "member list" and you can see who has registered, including their email addresses. Some people have even posted lists of specimens for sale or trade, and pictures of specimens in their collections. A few mini-articles have been posted by members as well, including one by Rock Currier on the origin of the "perky box" for thumbnails. Anyone who wants to join can do so by contacting the association's founder, Larry Rush, at larryrush@worldnet.att.net, and supplying their name, region, email address, interest in trading or selling, collecting specialty, and personal website (if any). Looks like it could be fun.

Organizations You Never Heard Of

It sounded like a good idea at the time. In February 1966, Frederick Pough organized the first big micromount symposium held on the West Coast, in Santa Barbara; it attracted over 100 attendees. At the dinner meeting, Pough, Paul Desautels and Richard M. Pearl (all now deceased) announced the formation of the "Society for the Preservation of Specimen Mineralogy." As Richard Bideaux later reported in Bisbee's *Brewery Gulch Gazette* (February 24, 1966), it was to be a "loose organization, more a frame of mind than anything else, which will have no dues or membership criteria other than mutual interest, and no meetings, except when two or more like-minded collectors get together." As it turned out, the organization was so loose that it seems to have evaporated before anything was actually accomplished.

However, discussions were also held on the need for a magazine to better serve the needs of the "advanced amateur collector." Apparently several people present had made unsuccessful attempts in that direction, and they recounted the difficulties they had experienced. It was proposed by Don MacLachlen, publisher of the now-defunct *Gems & Minerals* magazine, that authors send him articles aimed at advanced mineral collectors and he would publish them in that magazine. And in fact he did later publish some good articles, but clearly the thought of a magazine *just* for mineral collectors had become uppermost in many people's minds. It was just four years later that John White, with Dick Bideaux's encouragement and Arthur Montgomery's financial assistance, published the first issue of *The Mineralogical Record*. So maybe the "frame of mind" of the ephemeral Society for the Preservation of Specimen Mineralogy ultimately had an effect after all.

UA Mineral Museum Saved—For Now

The current hard economic times are particularly dangerous for institutional mineral collections. For example, the University of Wyoming Geological Museum, with more than 50,000 mineral, rock and fossil specimens, was closed as of June due to lack of funding. In Tucson the University of Arizona's 117-year-old Mineral Museum (see vol. 11, no. 4) was closed in May for the same reason. Collection Manager Sven Bailey was expected to be laid off, the entire Flandrau Science Center in which the museum collection has been housed and displayed had been closed, and there was a danger that the collection might be put into permanent storage. At the last minute the Freeport-McMoRan mining company came through with a grant that will allow the mineral museum to reopen and maintain operations for one more year.

The UA Mineral Museum has never had an endowment fund to rely on in emergencies. In the face of massive budget cuts imposed by a State Legislature determined not to raise taxes, the University administration decided that the Museum was not sufficiently important to the University's mission, regardless of how important it might be to the community at large, and was ready to let it expire. That would have been a tragedy of enormous proportions, as the

Museum houses one of the finest mineral collections of its kind in any academic department in the country.

The University of Arizona began with an act of the Arizona State Legislature establishing a School of Mines in Tucson, Arizona Territory, in 1885. The main building opened for classes in 1891, and Arizona became a state 21 years later, in 1912. The original building, known today as "Old Main," still stands at the center of the sprawling University of Arizona campus.

Mineralogy was one of the original subjects taught at the University, and a proper collection of minerals was deemed essential for teaching purposes. The 1892 *University of Arizona Register* states: "In addition to collections made by Prof. Blandy, formerly Territorial Geologist, the private collections of the Director of the School of Mines (Dr. Theo. Comstock) are on deposit in the Museum." This is the first reference to the Mineral Museum, and suggests that it was established prior to 1892.

In 1893 the Territorial Museum was established on campus, incorporating not just the growing mineral collection but also ethnographic artifacts and historical documents. The mineral collection was the responsibility of William Phipps Blake who arrived in 1895 as the new Director of the School of Mines, as geology and mining instructor, and as the first Territorial Geologist. He took an active interest in the Territorial Museum, and increased the size and scope of the mineral collection. By 1900 many fine specimens of Arizona minerals were on display; "Among these may be mentioned particularly superb specimens from the mines of the Copper Queen at Bisbee."

The Territorial Museum was moved to new quarters in 1905, in 1915, and again in 1919 when the new Mines and Engineering Building was completed and the Mineral Museum once again became a formal entity of its own. In 1957 the collection was finally given spacious, well-lit quarters and refurbished cases in the newly completed Geology Building, where it resided until being transferred in 1993 to equally spacious quarters on the lower level of the Flandrau Science Center.

Over the years the University's students and alumni, the State of Arizona, the Tucson Gem and Mineral Society, and local mining companies (including especially Phelps Dodge Corporation) have all assisted the continued growth of the collection. Other donors have included Boodle Lane, Susie Davis, Richard Bideaux and even this writer. A portion of the extraordinary collection of Mexican specimens formed by the late Miguel Romero, Mexico's leading mineral collector, was donated recently by his family; and a multi-million-dollar collection was recently received as a bequest from Hubert de Monmonier.

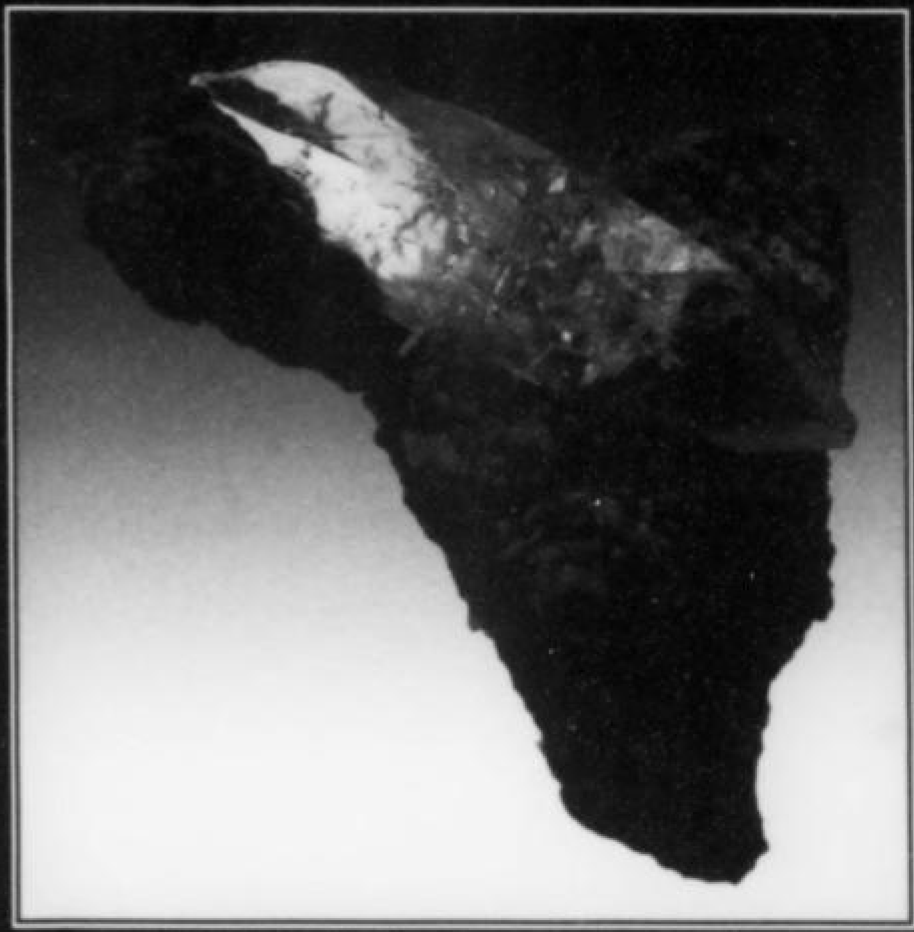
Today the Mineral Museum contains over 19,000 specimens in the main collection and over 7,000 in the micromount collection, including over 1,500 different species. Over 2,000 specimens are currently on display, and minerals from famous Arizona localities such as Bisbee and Tiger have special exhibit cases.

Enormous credit is due Freeport-McMoRan for helping save this historic and unique repository of mineral and mining heritage. Freeport-McMoRan Copper & Gold Inc., often called simply Freeport, is the world's lowest-cost copper producer, one of the world's largest producers of gold, and is the largest publicly traded copper and molybdenum producer in the world. Formerly based in New Orleans, the company recently moved its headquarters to Phoenix, Arizona after acquiring copper producer Phelps Dodge Corporation in 2007.

The Freeport grant, however, covers only one more year. Additional benefactors must step forward to help the University of Arizona Mineral Museum develop an endowment fund that will protect it in perpetuity. If you would like to be a part of saving this unique resource, contact the Curator, Prof. Robert Downs, at rdowns@email.arizona.edu.

GARNET, Russell, Mass., 5.5 cm

ELBAITE, San Diego Co., CA 10 cm



PHOSPHOPHYLLITE, Potosi, Bolivia, 4 cm

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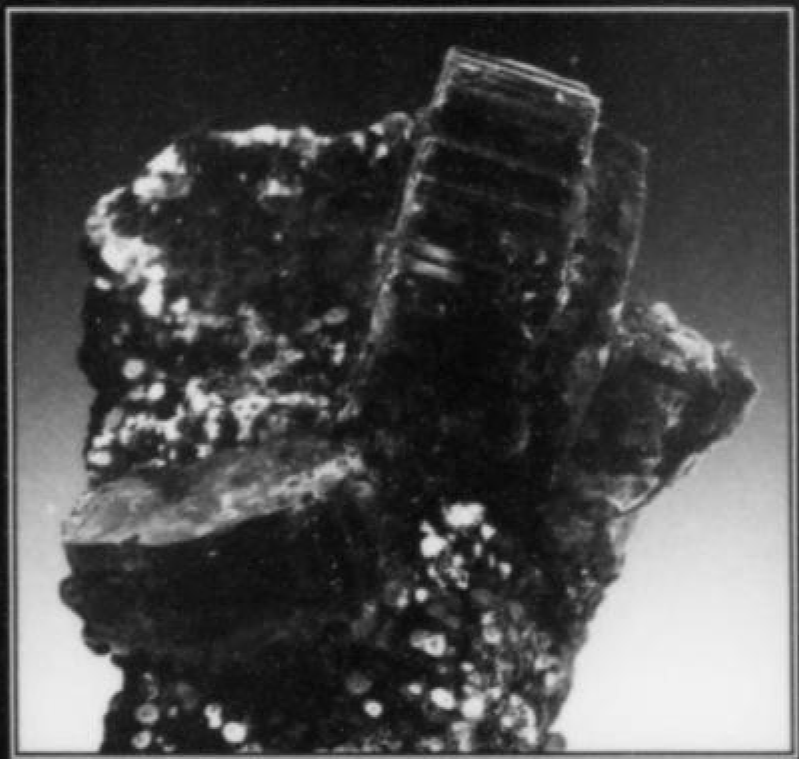
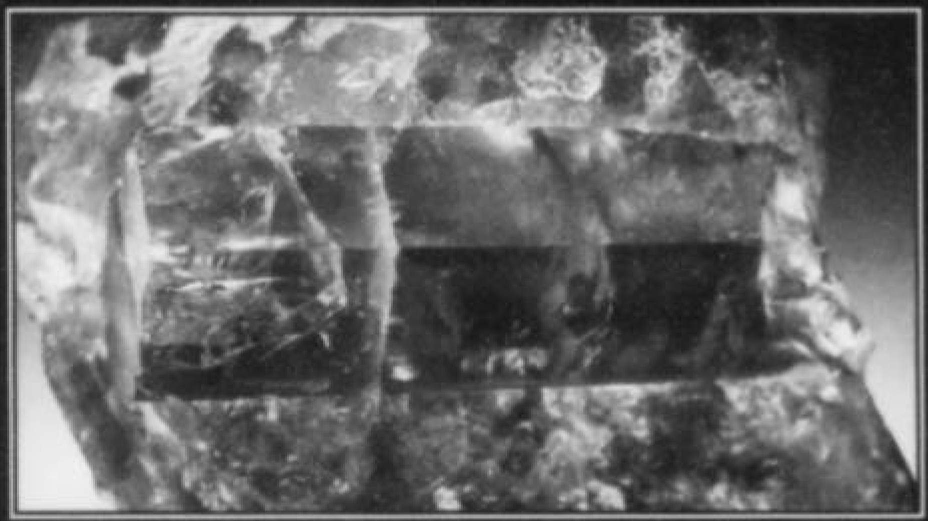
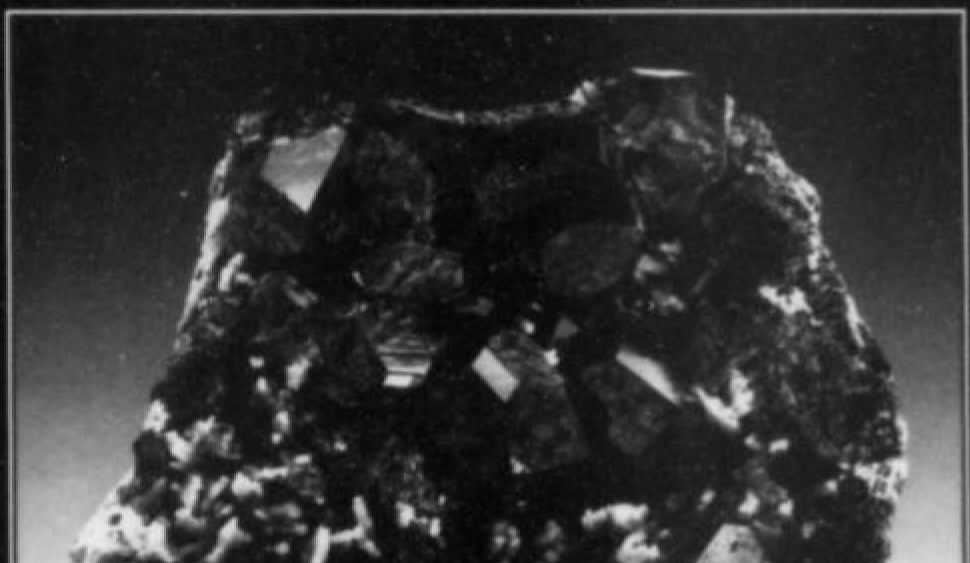


APATITE, Maine, 6 cm

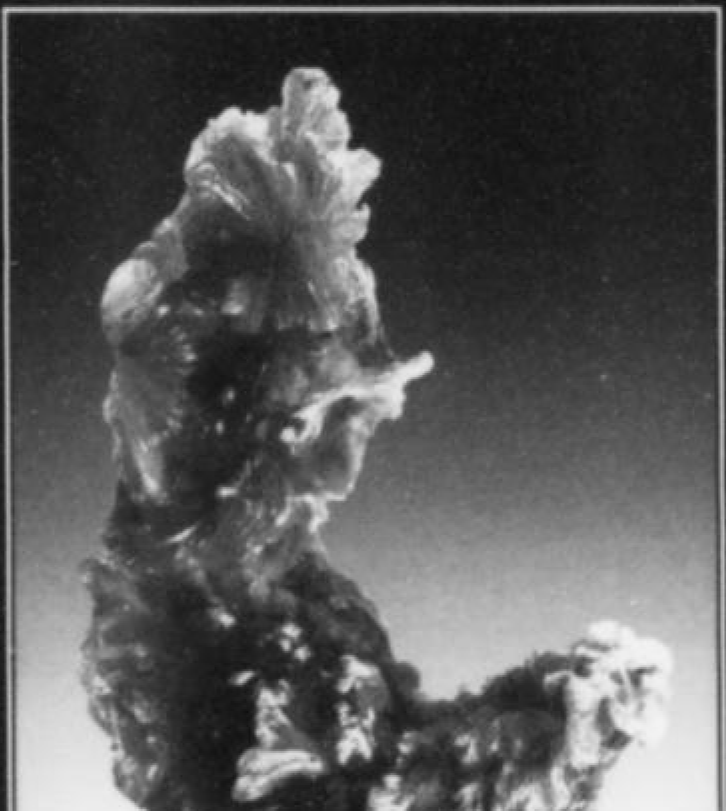


AQUAMARINE, Maine, 3 cm

ELBAITE, Mt. Apatite, ME, 6.5 cm

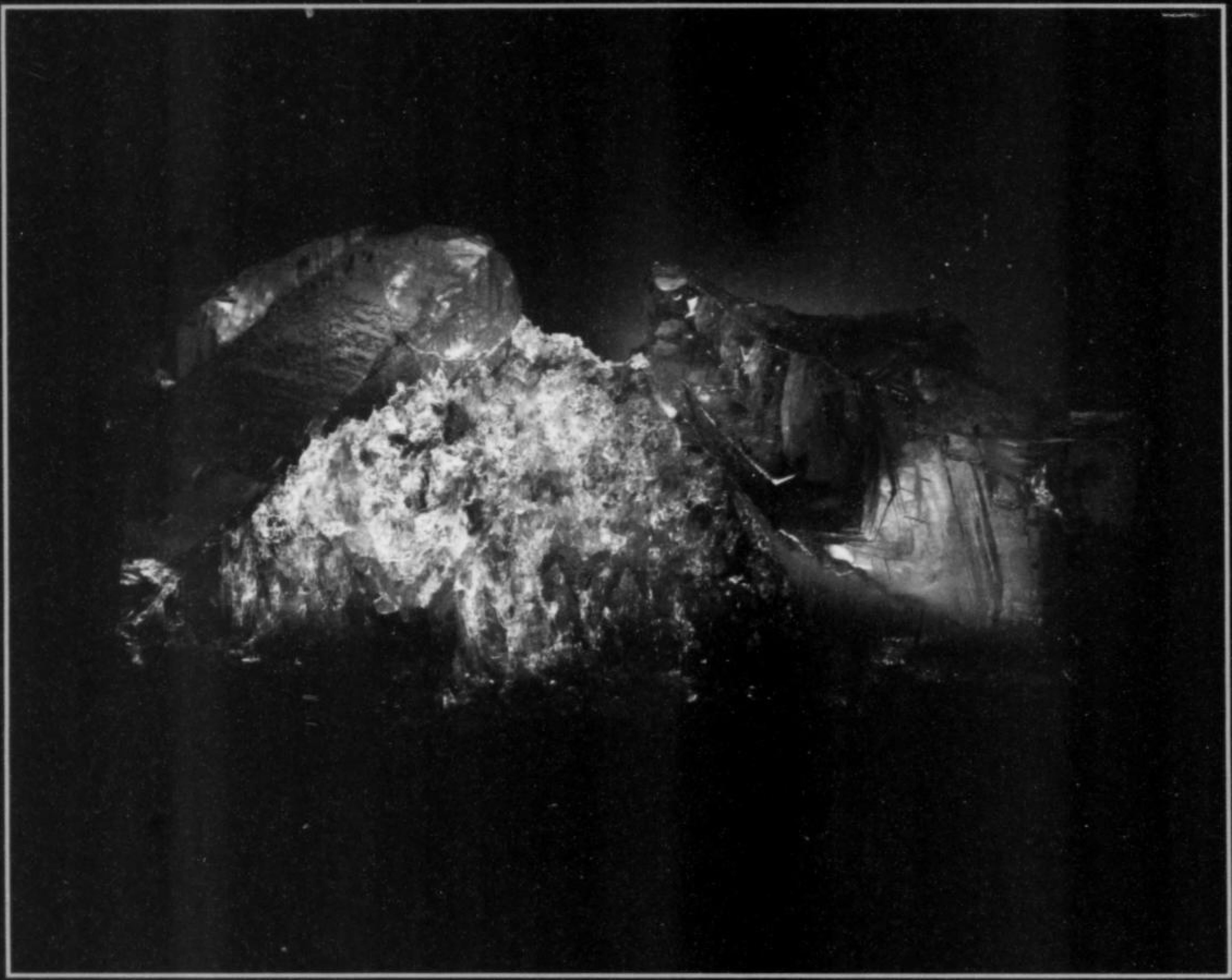


GARNET, Eden Mills, VT, 8.5 cm

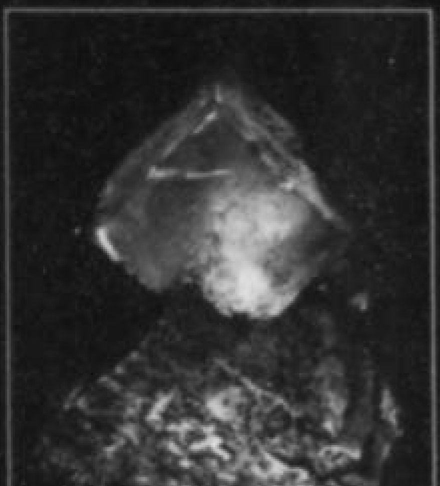


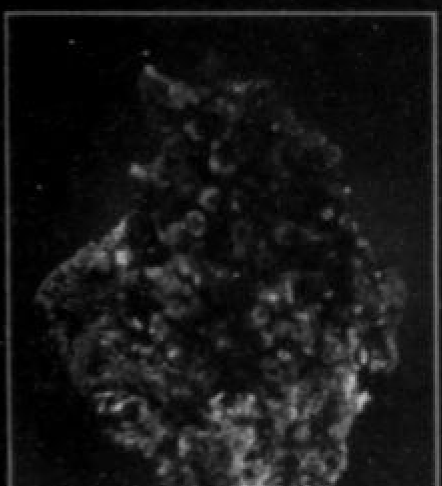
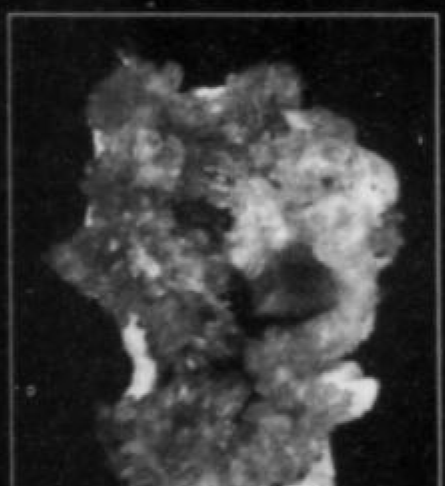
TALC, Rochester, VT, 6 cm

www.iRocks.com



FLUORITE, 15.8 cm, Elmwood mine, stope 20-78 #2, Smith Co., Tennessee



Famous Mineral Localities:

The Sapo Mine

Ferruginha District, Conselheiro Pena Minas Gerais, Brazil

Luiz Menezes
Rua Esmeralda, no. 534
Bairro Prado, Belo Horizonte
Minas Gerais, Brazil 30410-080
Email: lmenezesminerals@uol.com.br

The Sapo mine exploits a thick sub-horizontal pegmatite that was discovered in 1985 and has produced large pockets of quartz crystals, several important pockets of tourmaline and, recently, two large cavities containing excellent crystals of apatite-(CaOH) and a very important find of apatite-(CaF).

INTRODUCTION

Visitors to major mineral shows late in 2005 were intrigued by unusual-looking "apatite" specimens recently found at Brazil's Sapo mine, near Goiabera, in Minas Gerais. The specimens show green and yellow color-zoned, discoidal crystals (low-angle hexagonal dipyramids) to 3 cm pleasingly set on feldspar matrix. A similar surprise awaited collectors at the 2007 Denver Show, where there appeared generous numbers of extremely fine specimens showing sharp, lustrous, dark green hexagonal-tabular crystals of "apatite" from the Sapo mine, in loose groups and on albite-rich matrix. Recent analytical work has shown that some Sapo mine "apatite" is apatite-(CaOH) (formerly known as hydroxylapatite), some is apatite-(CaF) (formerly known as fluorapatite), and some crystals contain zones of both species. Thus the Sapo mine joins the roster of localities for world-class apatite-group minerals; it had also been known previously for its giant specimens of quartz and for excellent, gem-quality, "blue-cap" elbaite, both still emerging today.

LOCATION

Figure 1 shows the location of the Sapo mine about 40 km northeast of the town of Conselheiro Pena, in the important pegmatite province that extends from around Governador Valadares eastward to the border of Espírito Santo state. The various pegmatite bodies fall within the *municípios* (counties) of Divino das Laranjeiras, Mendes Pimentel, Galiléia, São Geraldo do Baixio, Conselheiro Pena, Goiabeira and Mantena.

In the past I had always believed the Sapo mine to be in the município of Goiabeira, but when I visited the locality recently with a GPS (Global Positioning System) I discovered that it is actually in the município of Conselheiro Pena. The reason for the confusion is that, until eight years ago, Goiabeira was merely a district of Conselehiro Pena, but in a referendum the population voted to split Goiabeira off from Conselheiro Pena as a new município. Meanwhile, residents in the Ferruginha district, located 10 km north of the Sapo mine, voted to remain a part of Conselheiro Pena. This left the remaining two portions of the município of Conselheiro Pena separated from each other by the new município of Goiabeira, so a narrow strip of land had to be designated along the northern border of Goiabeira in order to connect Ferruginha with the rest of Conselheiro Pena—and the Sapo mine just happens to be within this narrow strip.

HISTORY

In 1985 a local farmer found signs of green tourmaline outside an ant colony on his property, just across a hill from the present Sapo mine. The pegmatite was named *Lavra da Formiga* (*lavra* = "mine," *formiga* = "ant"), and hundreds of itinerant miners (*garim-*

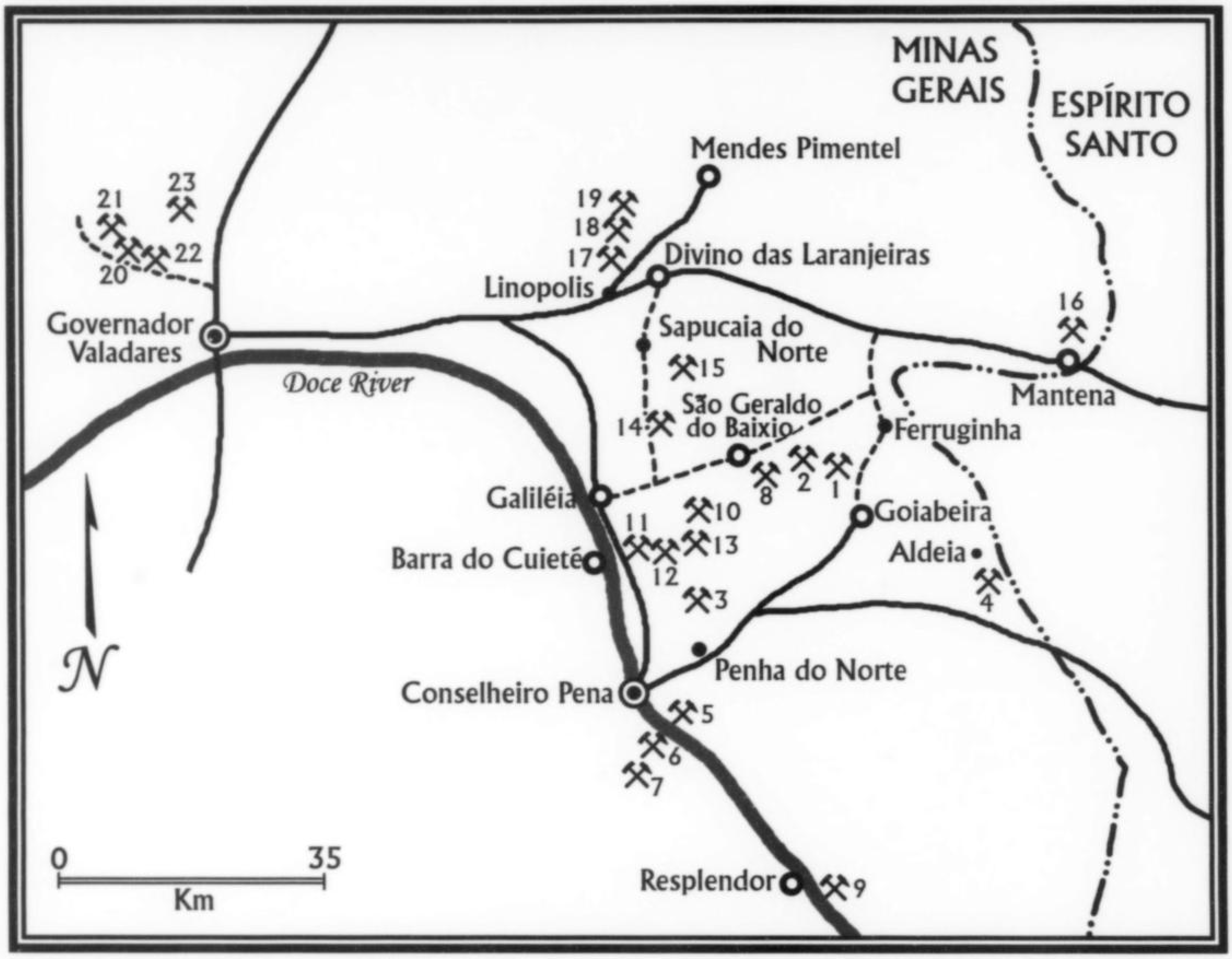


Figure 1. **Important pegmatite localities in the southeastern portion of the Eastern Brazilian [Oriental] Pegmatite Province.**

Conselheiro Pena Area
(1) Sapo mine (elbaite, quartz, apatite)
(2) Macaco mine (smoky quartz)
(3) Navegadora mine (spessartine, quartz, helvite)
(4) José Pinto mine (apatite, muscovite)
(5) Vista do Rio mine (morganite)
(6) Jonas mine (rubellite)
(7) Itatiaia mine (elbaite, beryl)

São Geraldo do Baixo Area
(8) Pedra Alta mines (quartz, elbaite)

Resplendor Area
(9) Jairo Linguiça mine (kunzite, goshenite)

Galiléia Area
(10) Urucum mine (kunzite, morganite, stokesite)
(11) Cigana mine (vivianite, hureaulite)
(12) Boa Vista mine (phosphates)
(13) Pitorra mine (rose quartz)
(14) Sapucaia mine (phosphates)
(15) Berilo Branco mine (rose quartz, elbaite)

Mantena area
(16) Mantena mine (schorl, fluorite)

Divino das Laranjeiras Area
(17) Linopolis district mines (quartz, elbaite, phosphates)
(18) Telírio mine (brazilianite, beryllonite, montebrasite)
(19) Córrego Frio mine (brazilianite type locality)

Governador Valadares Area
(20) Golconda mine (elbaite, bertrandite, quartz)
(21) Escondido mine (quartz, elbaite)
(22) Several mines (purple apatite, schorl, bertrandite)
(23) Ipé mine (microlite, beryl, quartz)

peiros) were attracted to it. Dozens of short vertical shafts were dug, resulting in the production of several hundred kilograms of green, blue and bicolored (red-green or blue-green) tourmaline crystals. Because so many garimpeiros had appeared, there was insufficient land available to accommodate everyone who wanted to dig, so some of the garimpeiros obtained permission from the farmer to dig on the other side of the hill. As a result of their efforts the Sapo pegmatite was discovered.

Sapo means "frog"—the pegmatite is located under a marsh which is home to many frogs. Small pockets of tourmaline and quartz were found during early work in the pegmatite, but this work was minimal since Horácio Creek runs through the marsh and the area is frequently flooded during the rainy seasons.

In 1992, Clovis Martins Coelho (nicknamed Clovis "Baiano" because he was born in the state of Bahia) received a lease and sank a new shaft which intersected the Sapo pegmatite at a depth of 5 meters below the surface. This proved to be a very successful mining operation: besides several dozen tons of large quartz crystals

Figure 2. **Horacio Creek, downhill from the Sapo mine workings, is visible at the bottom of this photo. At right under the rubble scarp is the collapsed adit no. 1; at top left is the white dump from Shaft no. 3; and the adit no. 2 entrance is located under the slanting gray roof downhill to the left. Luiz Menezes photo.**

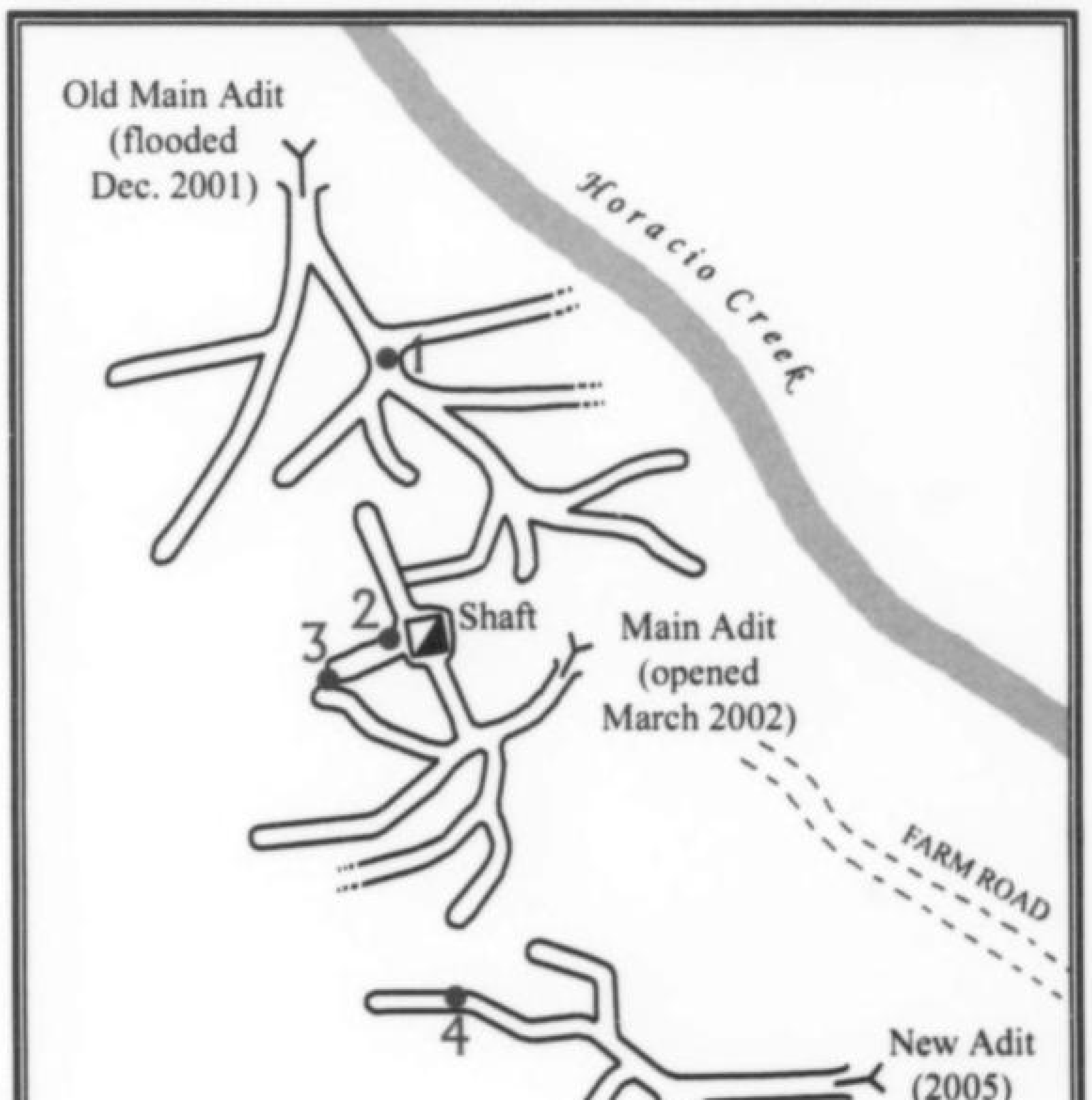


Figure 3. **Sapo mine workings and the locations of discoveries: (1) Elbaite pocket, February 1997. (2) Giant quartz pocket (300 tons of quartz mined), June 2005. (3) Large apatite pocket, August 2005. (4) Large apatite pocket, June 2007.**

(colorless, citrine, smoky, "alligator," and "cathedral" quartz), Clovis also found many pockets of green, blue, green-red and "watermelon" elbaite crystals, as well as the now-famous "blue-cap" crystals.

Just before Christmas 2001, a torrential rain caused Horácio Creek to overflow its banks, flooding the mine completely and filling the tunnels and the access shaft with hundreds of tons of sediment. The garimpeiros were fortunate in that, this being Christmas break, nobody was working in the mine at the time, but several small portable drills, air pipes and tools were buried inside the old tunnels. Clovis and his crew decided not to clean up the mess; instead they opened another tunnel near the base of the adjacent hill, where future flooding would be less likely.

Figure 4. **Shaft no. 3; a *garimpeiro* is operating the hoist. Luiz Menezes photo.**

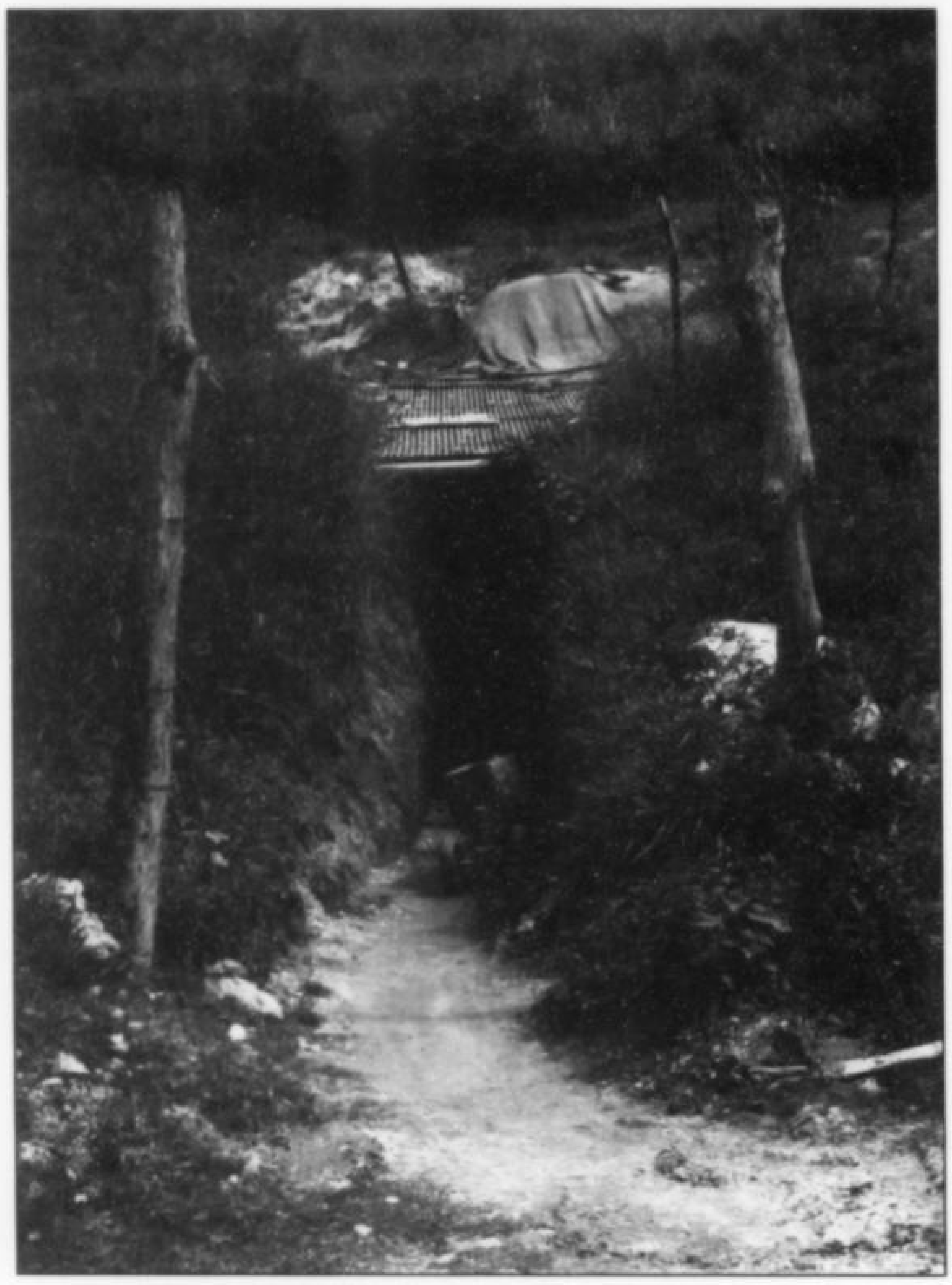


Figure 5. **Portal of adit no. 4, where the great apatite pocket of June 2007 was found. Luiz Menezes photo.**

In June 2005 the new tunnel intersected a giant pocket containing almost 300 tons of quartz crystals, plus more than 200 tons of clusters of albite, muscovite and microcline crystals. Later, a few meters into the left wall of this pocket and still inside the quartz core of the pegmatite, another cavity was found. This one contained hundreds of kilograms of microcline crystals, plus microcline crystal fragments partially coated with pyramidal green apatite-(CaOH) crystals—one of the most important finds of this species ever made.

In 2005 Adalberto Cunha, the farm owner, allowed another crew of garimpeiros to open another tunnel 150 meters away from Clovis's new shaft. Since then, in this new mining operation, several small to medium-size pockets of quartz have been found (at this locality "medium-size" means several hundreds of kilograms). A large pocket found in December 2006 contained several tons of quartz, and 20 meters farther on from it, at the end of June 2007, a rich cavity was found which measured 1.5 × 2.5 × 4.5 meters. This cavity was totally filled with albite and muscovite crystals partially coated with sharp, dark green apatite-(CaF) crystals and exquisite, curving, linear stack-like clusters of apatite-(CaF). The latter, because of their unusual shape, have been referred to as "snakes" and "scorpion-tails"; they measure up to 30 cm long, and most of them have hollow centers. These remarkable specimens rank the Sapo mine as one of the finest and most interesting occurrences of apatite ever found, as judged by the generous numbers of specimens (from a single pocket), the high quality of the crystals, and the uniqueness of the long snake-like crystal clusters.

GEOLOGY

The Sapo pegmatite was intruded into biotite schists of the Paraiba Group. These schists, formed during the Lower Precambrian, are around 2 billion years old. Granitic intrusions dating between 550

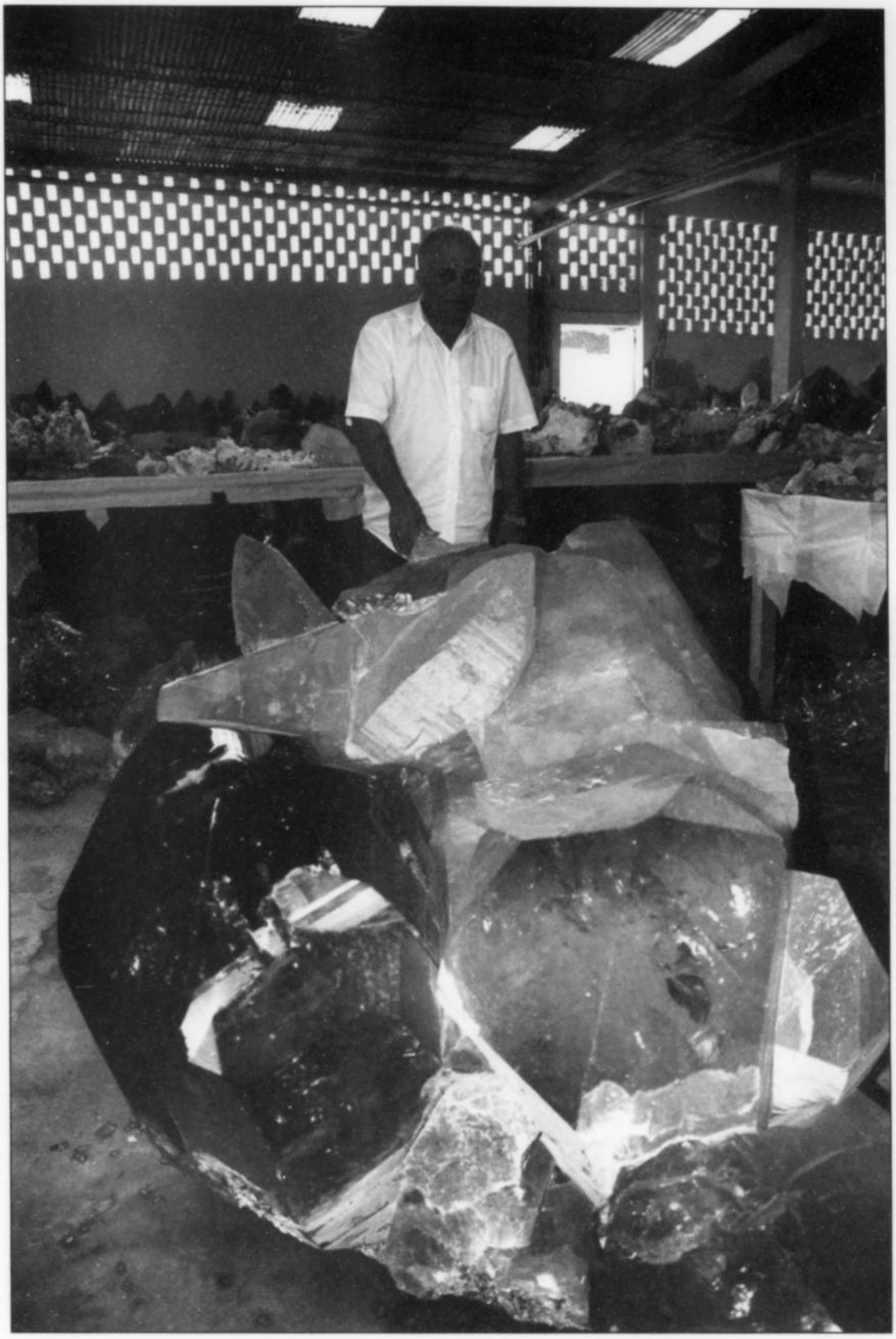


Figure 6. **Clovis Baiano with a giant smoky quartz cluster (near 3 tons) from the pocket mined in June 2005. Photo by Carlos Cornejo, from the book *Minerais e Pedras Preciosas do Brasil* (2009, in press).**

and 600 million years old (the Galileia Tonalite and the Palmital Granodiorite) exuded the fluids that formed the Sapo pegmatite and other pegmatites in the region.

The Sapo pegmatite is concordant with the schist foliation; the strike is nearly N-S, and the dip is 10°E. The width of the pegmatite cannot be precisely measured because the hanging wall and the foot wall are nowhere to be seen simultaneously. The pegmatite's average thickness is estimated at about 5 meters, but in the areas where the huge quartz pockets were found it can be as thick as 15 meters.

The pegmatite is zoned: the contact zone consists of fine-grained microcline, dark muscovite, quartz and scarce, fine-grained schorl; the intermediate zone contains larger microcline crystals, coarse quartz, albite, gray muscovite plates and small to medium-size schorl crystals with scarce grains of green apatite. The quartz cores are lenticular and discontinuous, associated with abundant albite, microcline, coarse gray to yellowish muscovite plates, and schorl crystals, some quite thick.

Most of the large crystal-lined quartz cavities were found inside the quartz cores, which can thicken significantly in areas where the pegmatite dip increases to 20° or more. The large cavities occur within the more steeply dipping portions, and also in the adjacent, more flat-lying portions of the pegmatite layer. However, the three best tourmaline pockets, recovered in February and March 1997 in the old (later flooded) tunnel, were found in areas where the thickness of the pegmatite was only around 5 meters and the dip was around 10°.

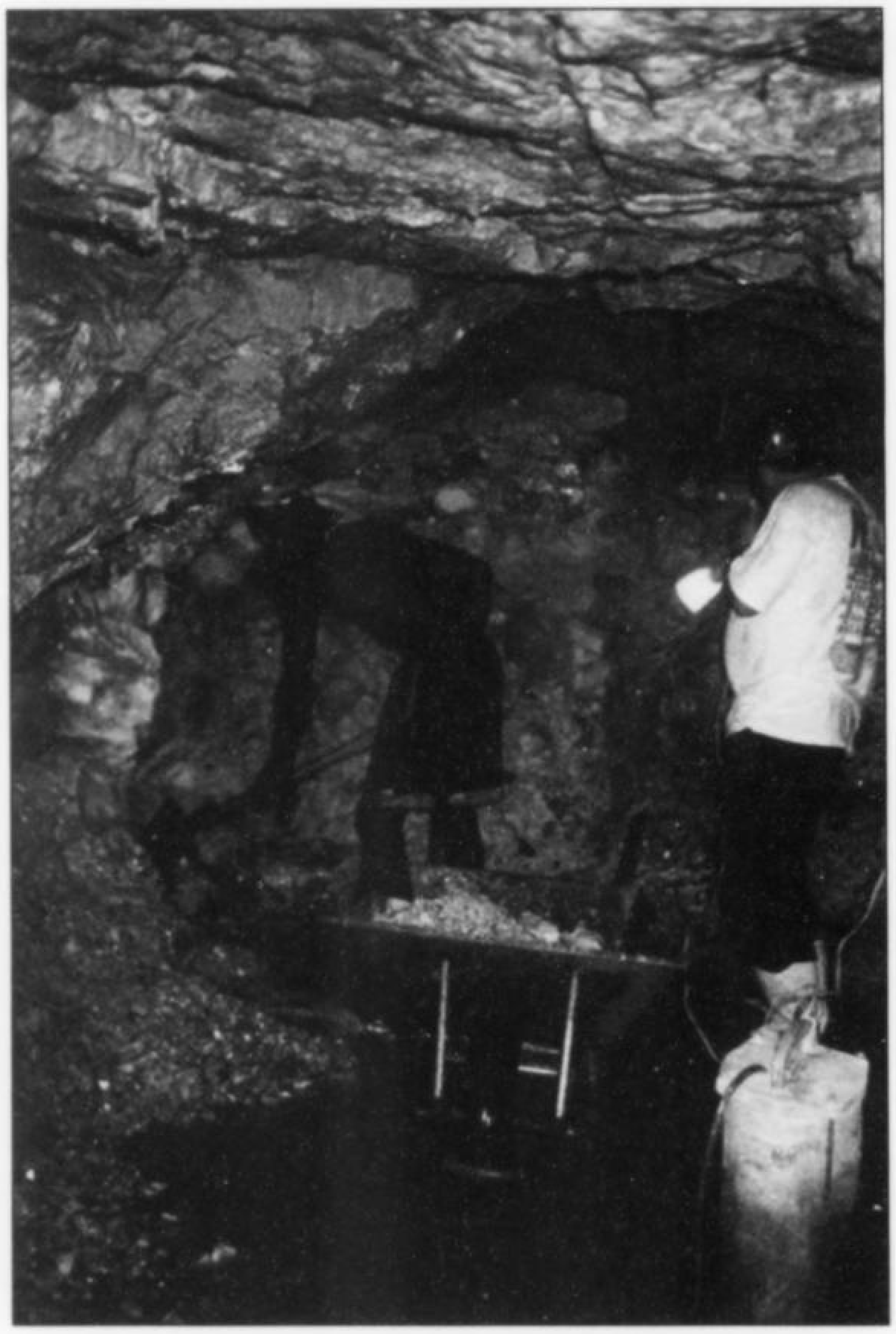


Figure 7. **Working underground at the Sapo mine in 1998. Guido Steger photo.**

Thick, pale bluish green beryl crystals have been found adjacent to the quartz cores, but never any spodumene.

MINERALOGY

During the past 23 years of mining operations the most economically important minerals have been quartz, tourmaline and apatite.

Albite $NaAlSi_3O_8$
and Microcline $KAlSi_3O_8$

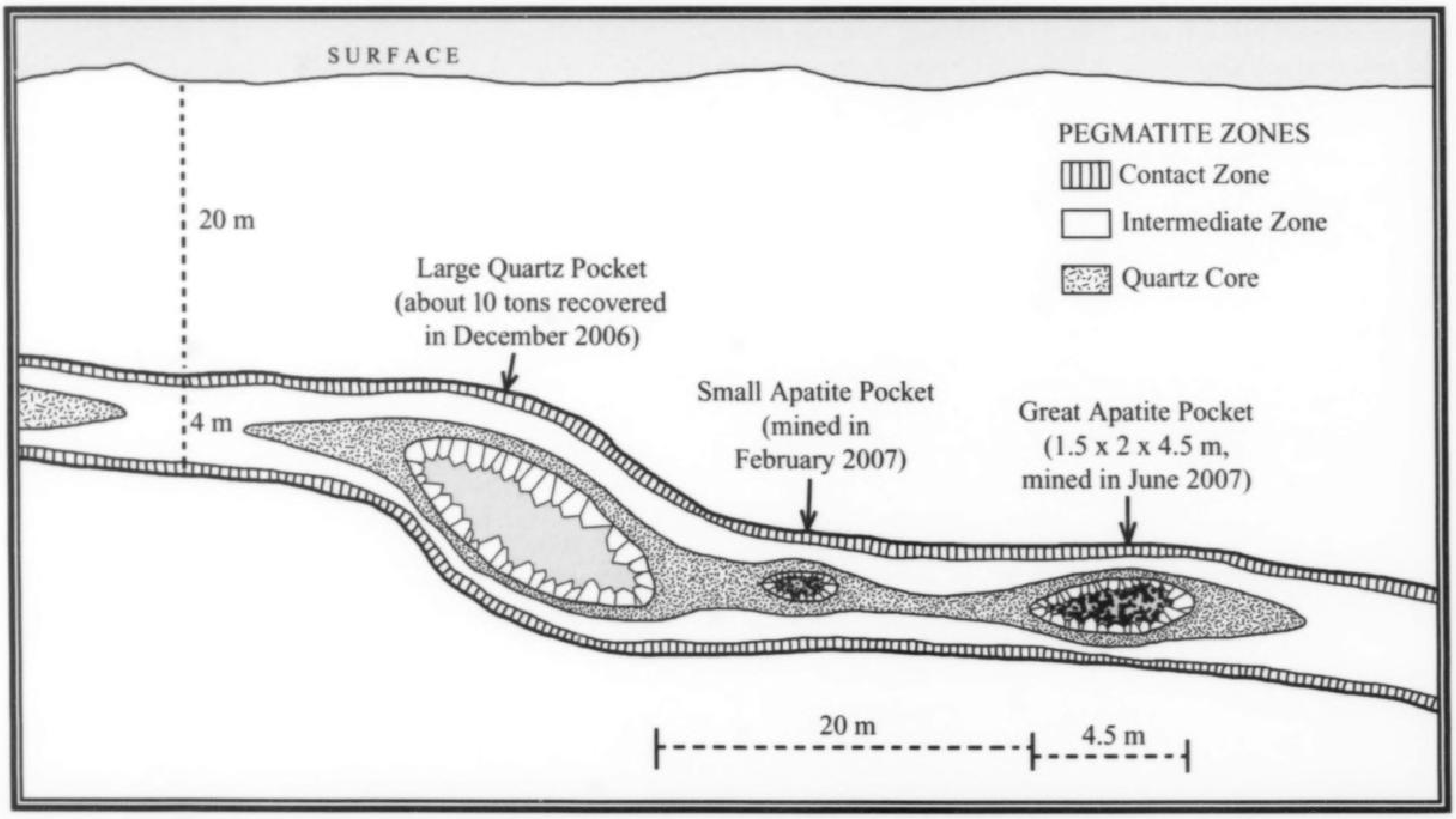
Albite and microcline crystals are abundant, especially in the walls of the large quartz-bearing cavities. Albite is found mostly as the platy cleavelandite variety: clusters of tabular white to pale bluish crystals in the shape of open books.

The most dramatic albite find was made inside the huge quartz pocket opened in June 2005: nearly 200 tons of albite were recovered, together with 300 tons of quartz and several dozen tons of associated muscovite and microcline. Many of these albite specimens show conical or elliptical cylindrical aggregates of intergrown cleavelandite and muscovite crystals with hollow central voids having rectangular cross-sections. These are probably molds after spodumene crystals that have since been dissolved away. The molds reach 1 meter long; their interior surfaces display aggregates of crystals of cleavelandite, muscovite, quartz and microcline.

Microcline was also found in the June 2005 pocket as very large crystals (up to 1 meter long), pinkish tan-colored and commonly twinned on the Baveno law.

Dozens of other, smaller pockets have also yielded large numbers of well-formed microcline and cleavelandite crystals.

Figure 8. **Vertical section through the gently dipping Sapo pegmatite showing the location of crystal pockets. The pegmatite is about 4 meters thick for most of its length, swelling to 10 meters thick in the vicinity of the large quartz pocket.**



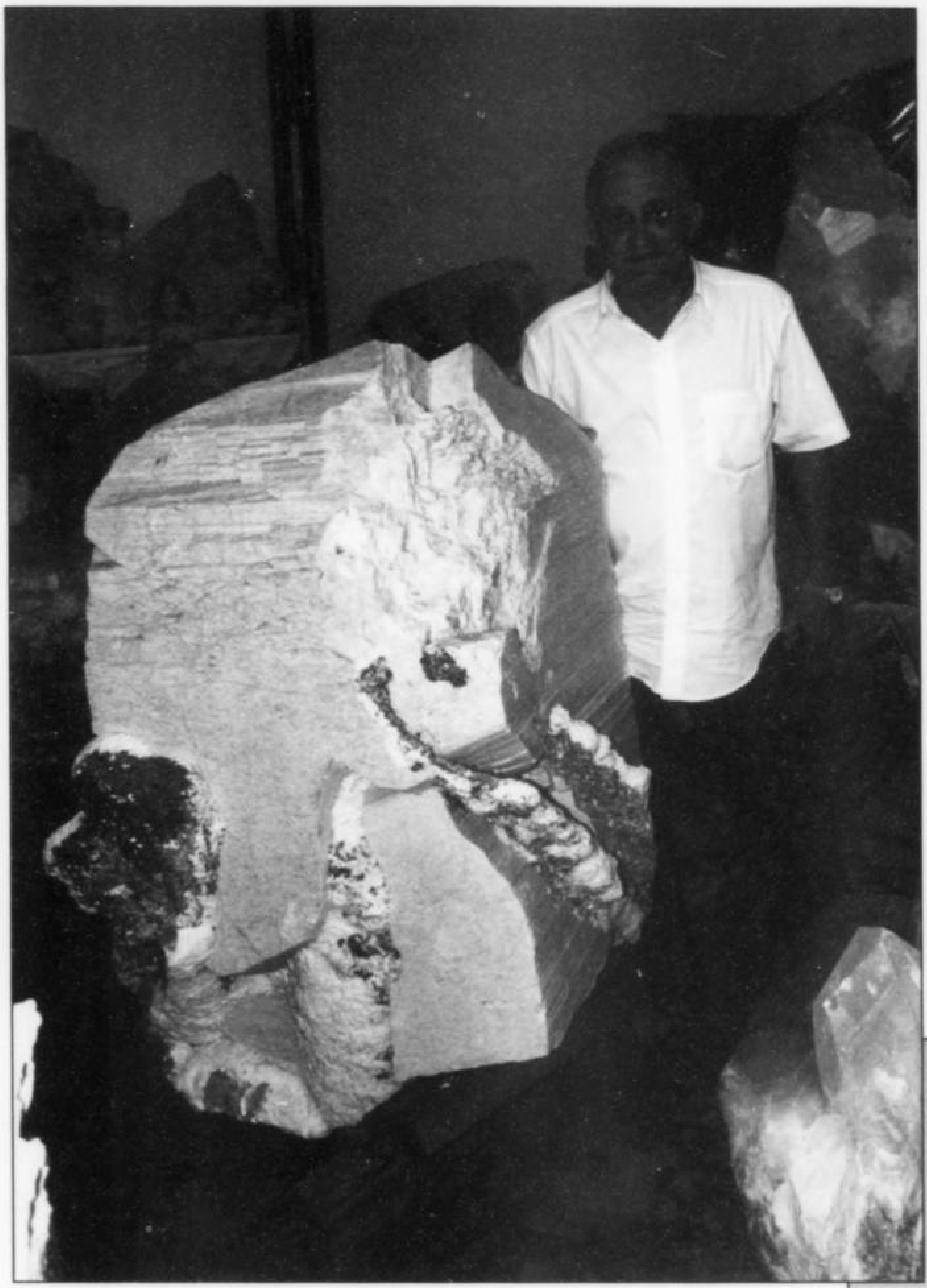


Figure 9. **Clovis Baiano with a giant microcline crystal (1.2 meters long), from the June 2005 quartz pocket. Photo by Carlos Cornejo, from the book *Minerais e Pedras Preciosas do Brasil* (2009, in press).**

Figure 10. **Clovis Baiano with a hollow albite cylinder, 70 cm tall, from the giant June 2005 quartz pocket. Photo by Carlos Cornejo, from the book *Minerais e Pedras Preciosas do Brasil* (2009, in press).**

Apatite-(CaF) $Ca_5(PO_4)_3F$
and Apatite-(CaOH) $Ca_5(PO_4)_3(OH)$

Small pockets of apatite-(CaF) have been found since the earliest days of working the Sapo mine, but until 2005 the pockets were relatively small and did not produce any substantial earnings for the mine owners.

The first big find of apatite came in June 2005—in a cavity measuring about 2 × 5 × 10 meters, adjacent to the huge quartz/albite/muscovite pocket described above. Crystals of apatite-(CaOH) from this cavity are short and bipyramidal to discoidal, with a deep oil-green color, and reach 4 × 5 cm. Though not especially lustrous, the specimens are among the best in the world for this species. Most specimens show the apatite-(CaOH) crystals resting on microcline crystals or cleavelandite plates, and in a smaller number of specimens the crystals are perched on quartz, muscovite or albite.

Specimens from this find were sold at the 2005 Munich Show as "carbonate-fluorapatite," but the identification turned out to be incorrect: at the 2006 Tucson Show Frank Hawthorne informed me that he had determined a ratio of approximately 3 parts of (OH) to 1 part of F, as measured on a small crystal he had obtained from me at Munich, but at the end of the same show Marcus Origlieri advised me that he had obtained an F-dominant analysis for the core of another crystal. They both were right. Apatite-(CaOH) from the June 2005 cavity was studied later by John Rakovan and Greg Schmidt of Miami University (Oxford, Ohio); they determined by single crystal X-ray diffraction (structure refinement), Raman

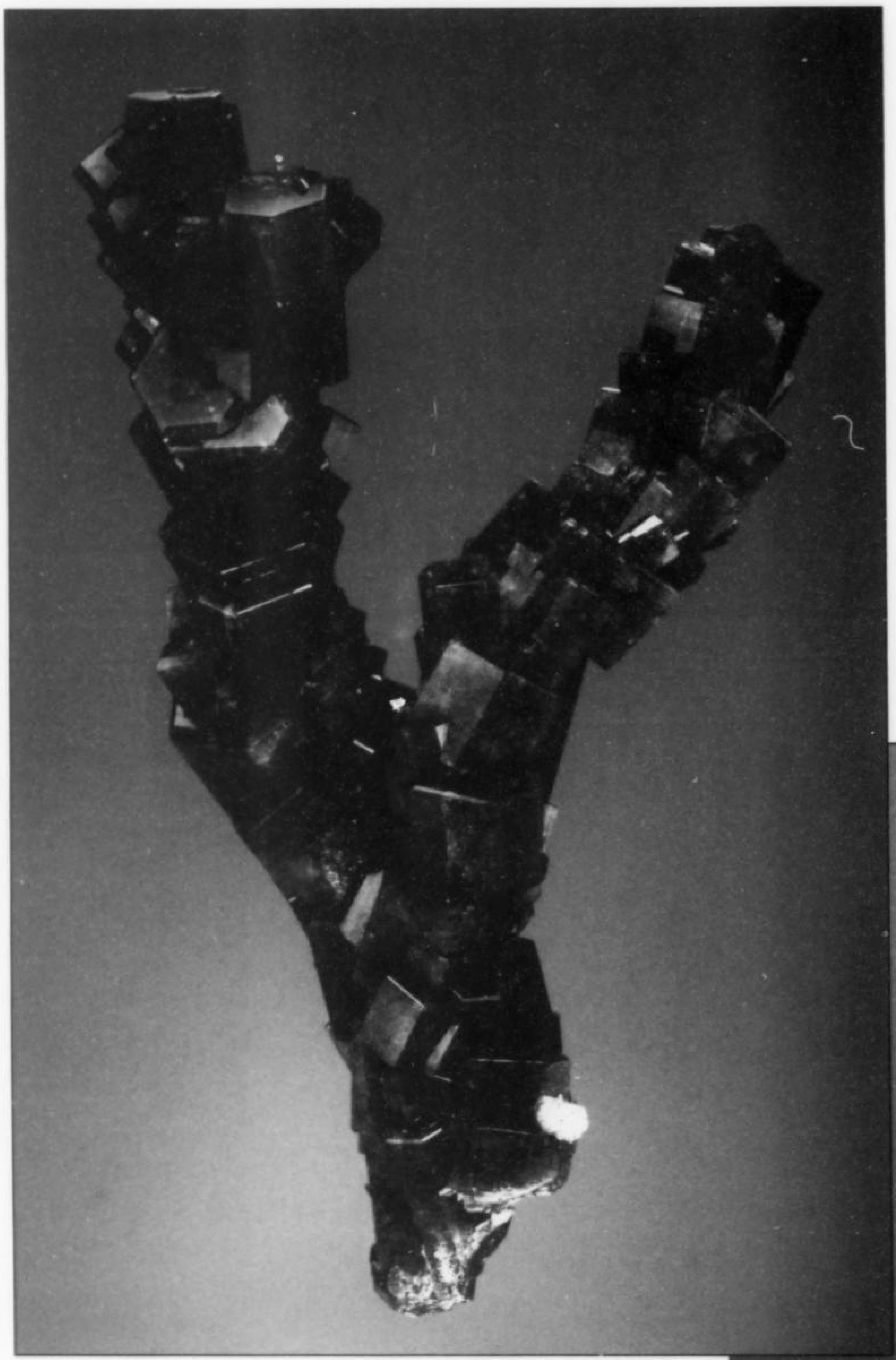
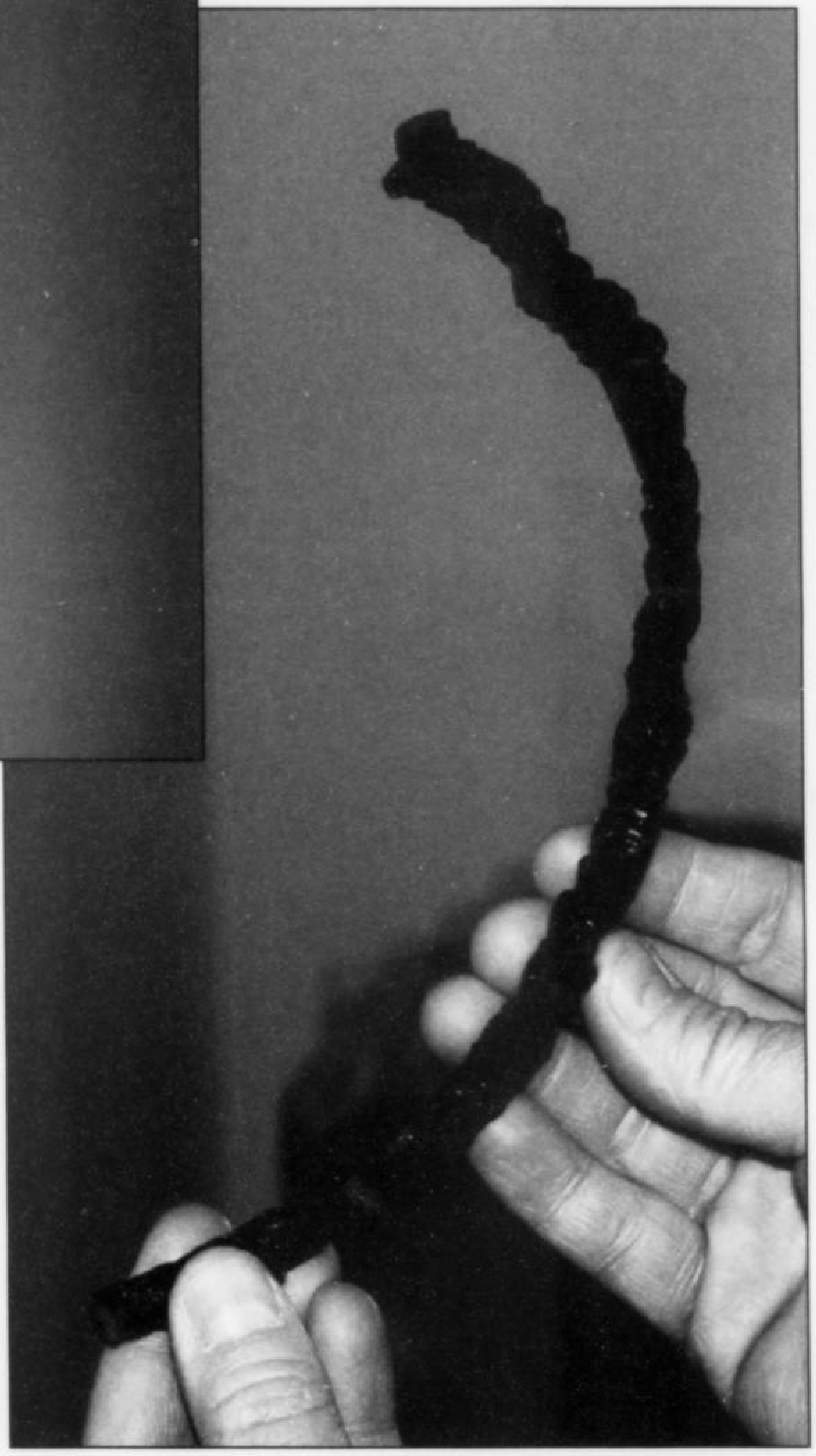


Figure 11. **The "Apatite Tree" specimen (habit 2), showing branches growing from a common trunk; 18 cm, from the June 2007 pocket at the Sapo mine. James and Gail Spann collection; Jeff Scovil photo.**

Figure 12. **Long, thin stack of apatite-(CaF) crystals (habit 3), 22.5 cm, called the "New Moon" apatite, from the Sapo mine. Collector's Edge Minerals, Inc. specimen, from the collection of Luiz Menezes and Frank Melanson; Jolyon Ralph photo.**



spectroscopy and EDS analysis that the Sapo apatite crystals are compositionally zoned. The yellow core of the crystals is apatite-(CaF) and the green overgrowth is apatite-(CaOH).

The second important find came in November 2006 in the new adit financed and operated by another crew, about 150 meters away from Clovis's shaft. In 2005 these miners had found one medium-size quartz pocket, and after emptying it they had decided to dig into one of the walls of the pocket. A few meters in, while still inside the quartz core of the pegmatite, they found another cavity containing wormlike stacks of pale gray apatite-(CaF) crystals on microcline crystals. They also collected several hundred small (2 to 5-cm) wormlike aggregates of greenish gray apatite crystals. Most of the stacks, showing hollow centers, were found loose inside the cavity. The interesting feature of the wormlike aggregates is that they all show two different stacks of crystals crossing at an angle of about 60°, raising the speculation that they are compound twins of some kind. At the 2007 Tucson Show, however, the material was shown

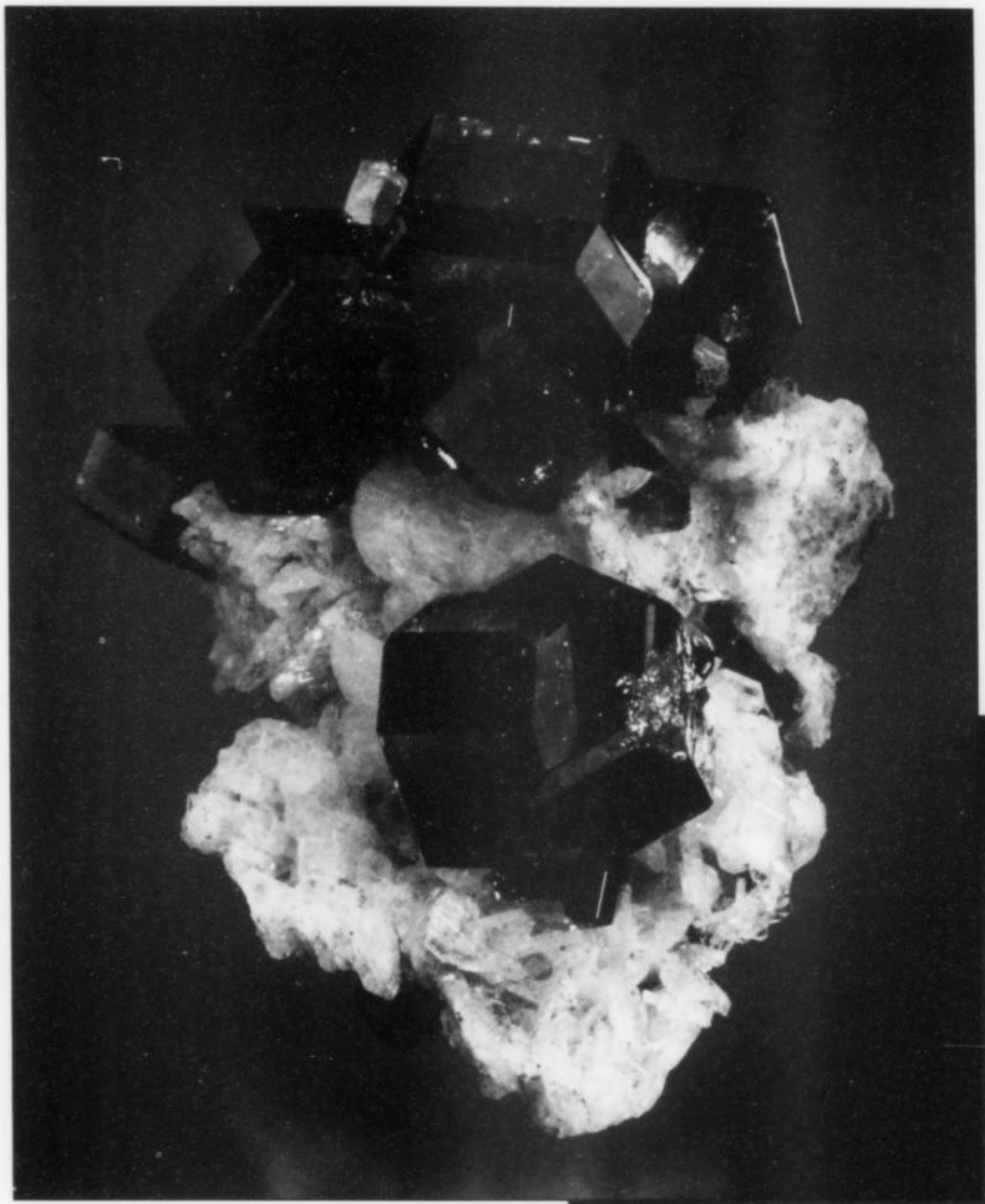


Figure 13. **Sharp cluster of dark green apatite-(CaF) crystals (habit 1) on cleavelandite, 8 cm, from the Sapo mine. Jeff Scovil photo.**

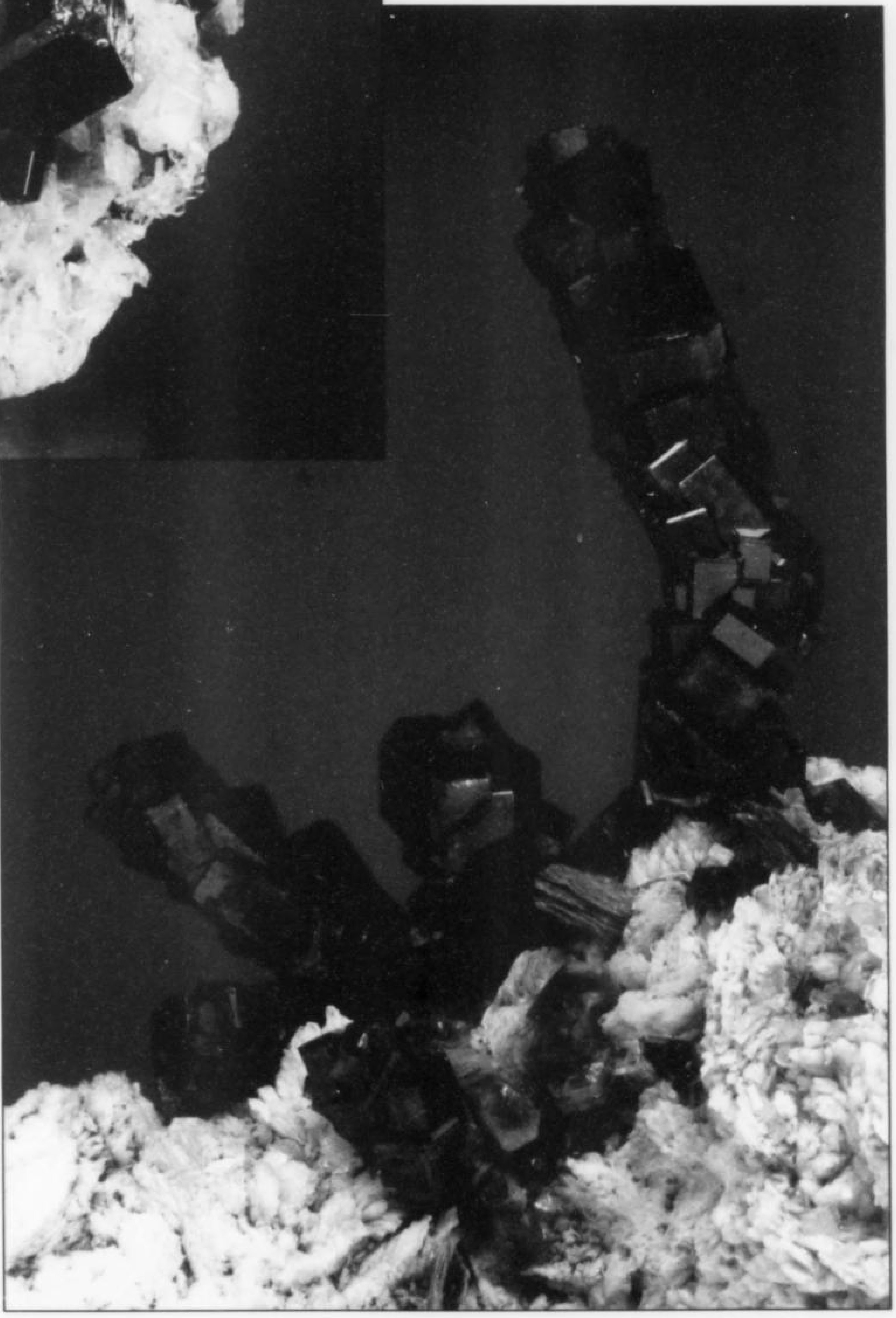


Figure 14. **The "Omigod" apatite, 18.5 cm, with three dark, solid crystal stacks (habit 2) on albite matrix, from the Sapo mine. Collector's Edge Minerals, Inc. specimen, from the collection of Luiz Menezes and Frank Melanson; Jeff Scovil photo.**

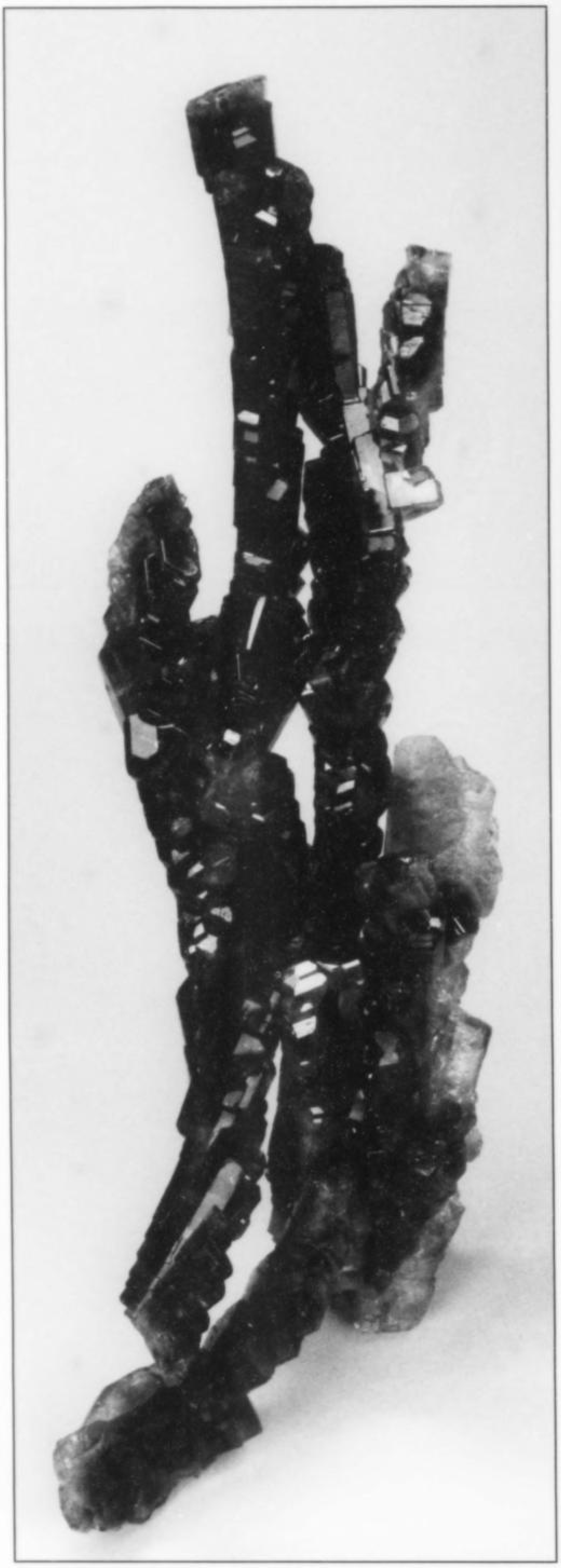


Figure 15. **The "Sapo Queen" apatite, a cluster of six different crystal stacks (habit 3) measuring 10 × 20 cm, re-assembled from 14 fragments. Collector's Edge Minerals, Inc. specimen, from the collection of Luiz Menezes and Frank Melanson; Richard Jackson photo.**

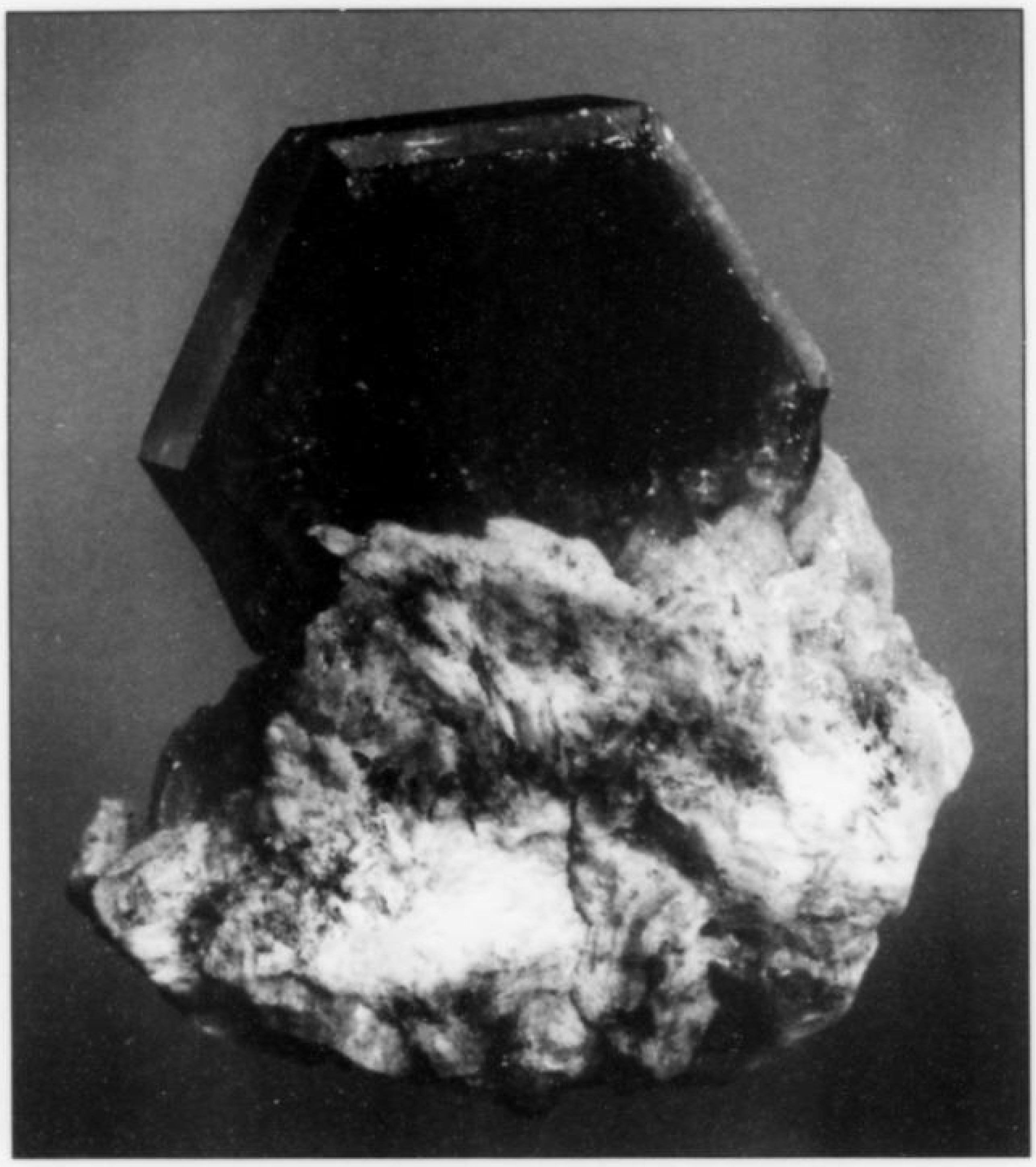


Figure 16. **Large, single, color-zoned crystal of apatite-(CaF) (habit 1) on cleavelandite, 3.5 cm, from the Sapo mine. Jeff Scovil photo.**

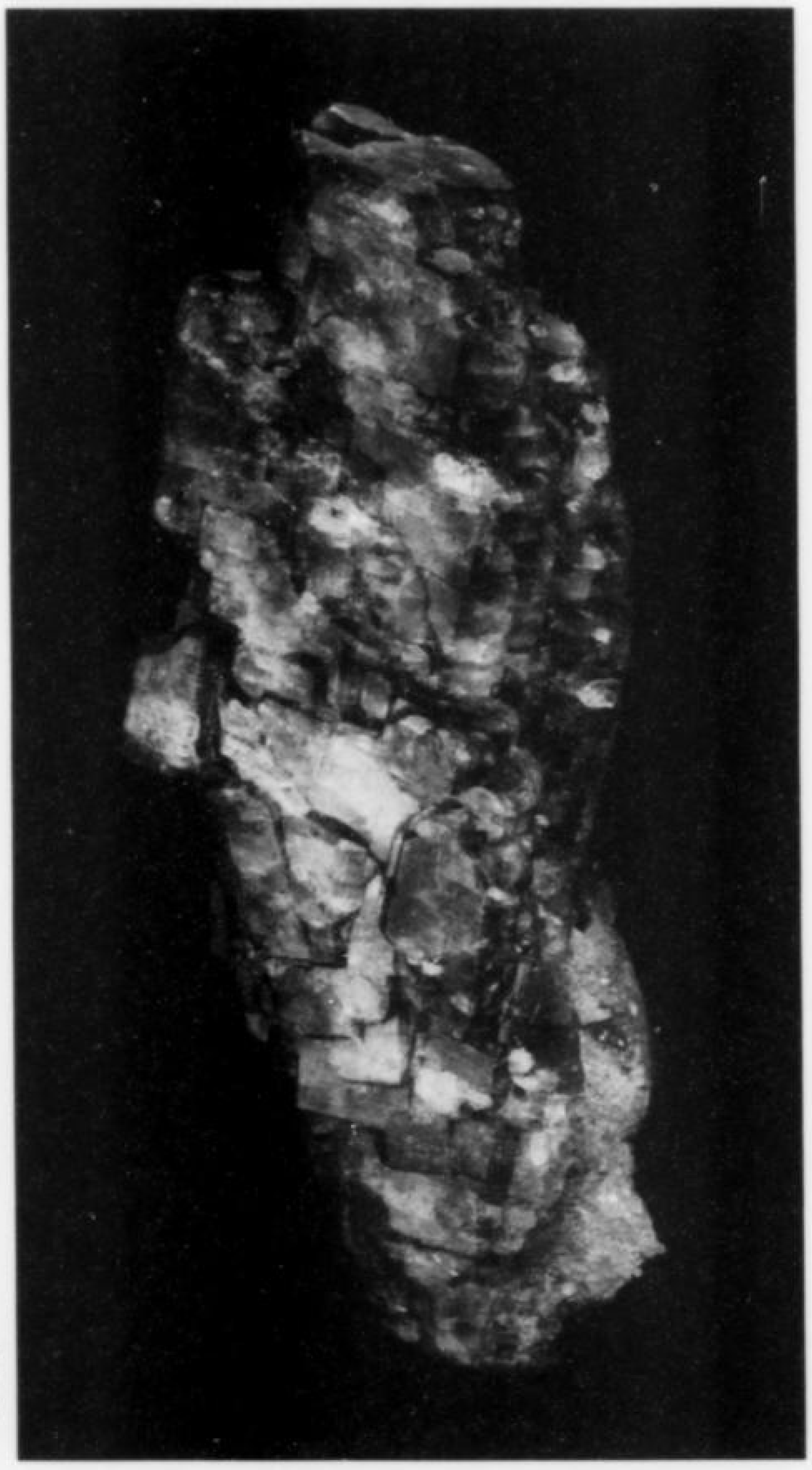


Figure 17. **Elongated 22-cm parallel crystal cluster of green apatite-(CaOH) crystals (habit 5) from the Sapo mine. Jeff Fast specimen; Jeff Scovil photo.**

Figure 18. The "Sapo King" apatite on cleavelandite and muscovite matrix, 48 cm, with sharp, dark green apatite-(CaF) crystals up to 5 cm (habit 1) and a bicolored 6-cm crystal (habit 6) at top left; from the Sapo mine. Collector's Edge Minerals, Inc. specimen, from the collection of Luiz Menezes and Frank Melanson; Jeff Scovil photo.

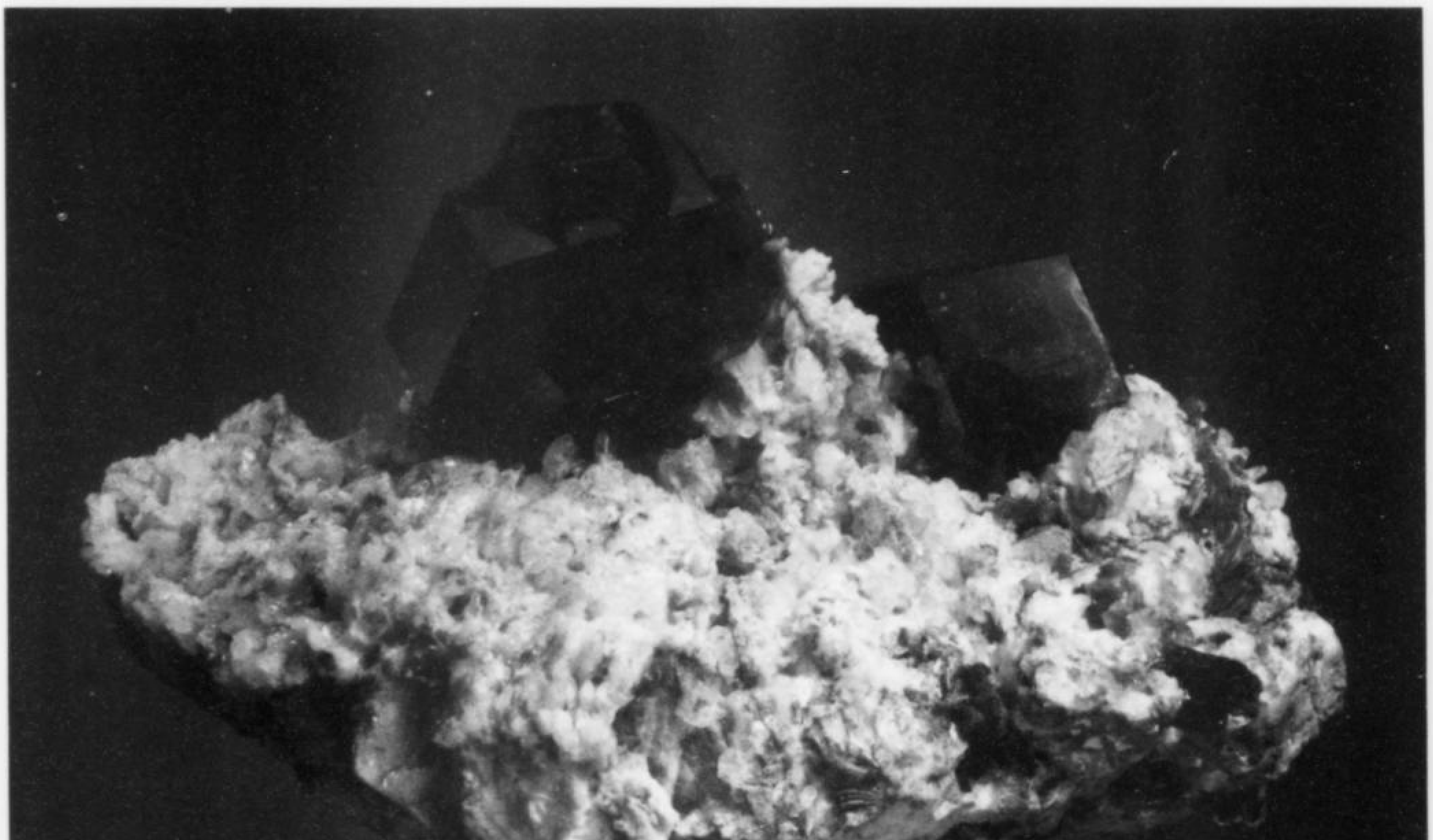


Figure 19. Sharp, dark green crystals of apatite-(CaF) on cleavelandite crystals, 21 cm, from the Sapo mine. Luiz Menezes specimen, now in the Houston Museum of Natural Science collection; Jeff Scovil photo.

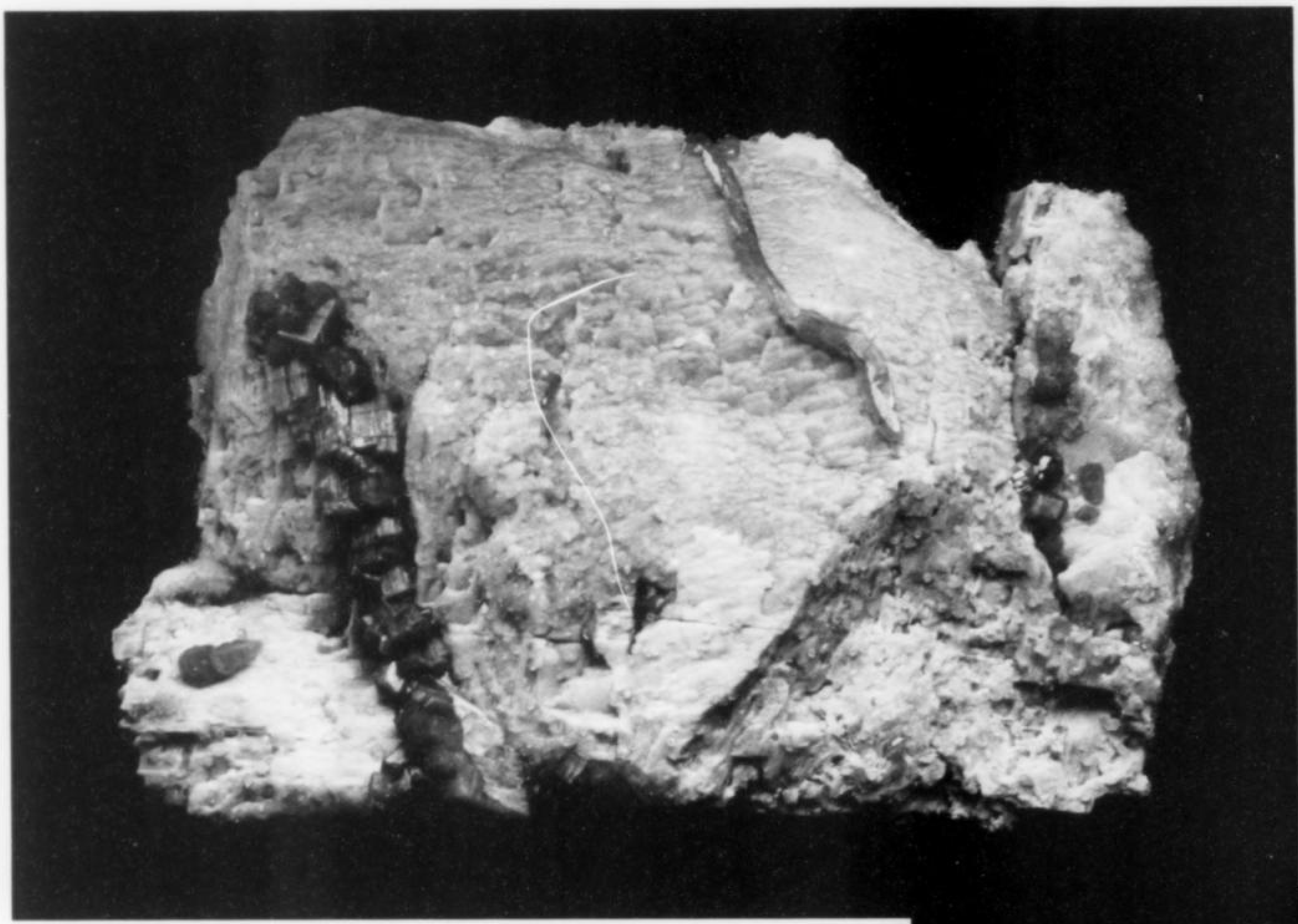


Figure 20. **Wormlike linear cluster of greenish gray apatite-(CaF) crystals, 9 cm long, on a 17-cm microcline crystal. Found at the Sapo mine in December 2006. Luiz Menezes collection; Jeff Scovil photo.**

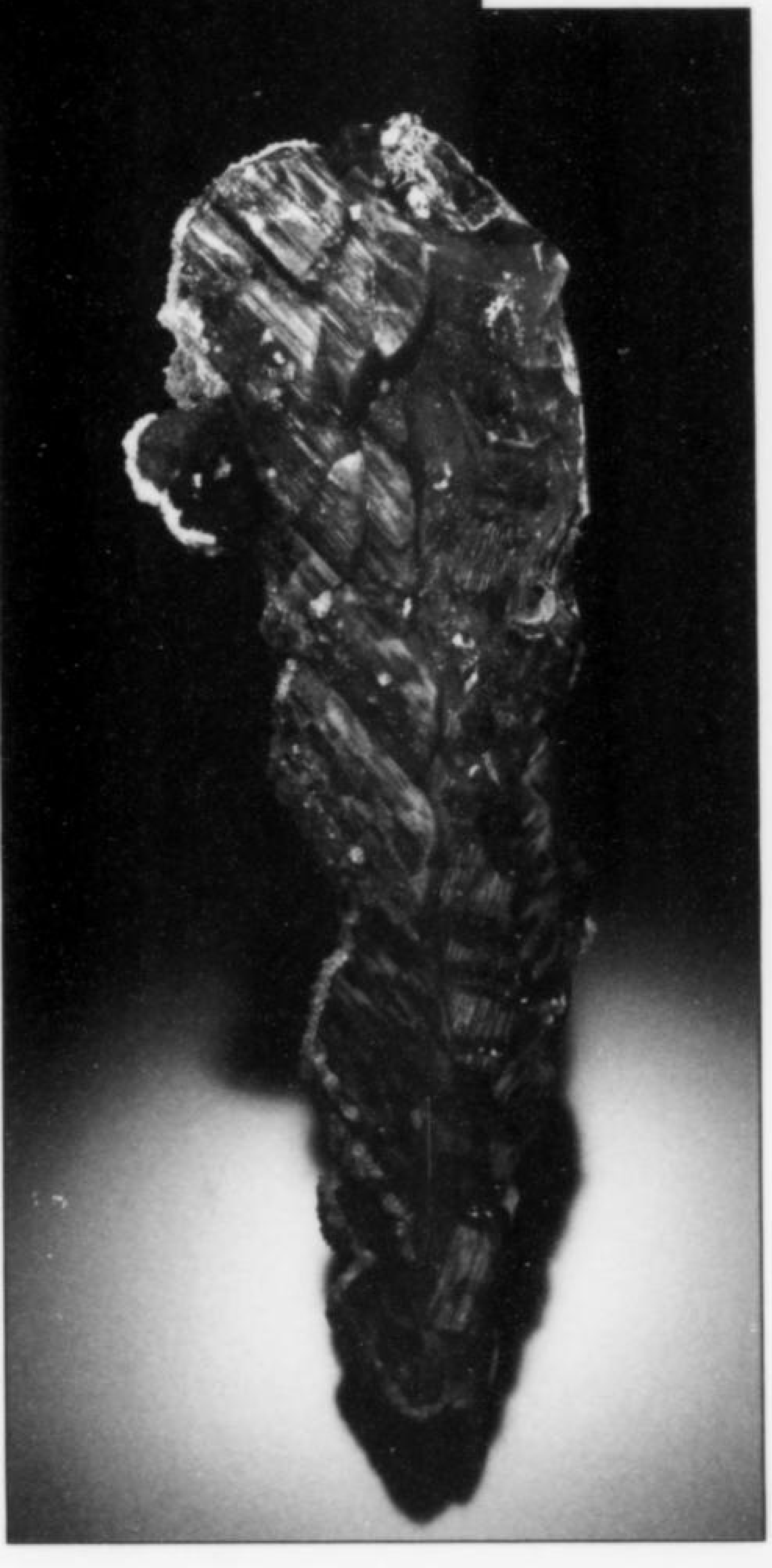


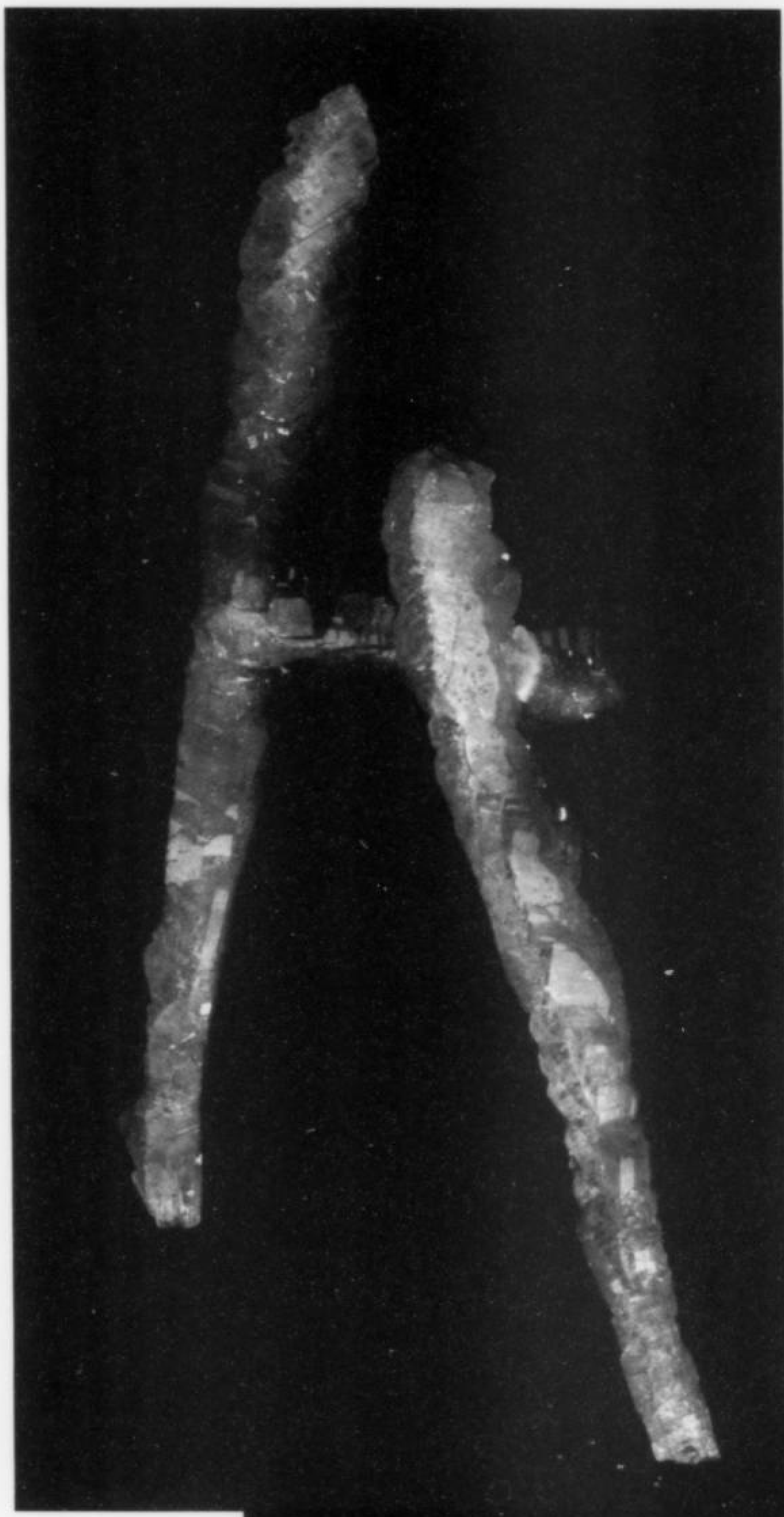
Figure 21. **Elongated, hollow cluster of apatite-(CaF) crystals showing a cat's-eye effect; 18 cm, found at the Sapo mine in February 2007. Luiz Menezes collection; Jeff Scovil photo.**

to several mineralogists, who all agreed that the crystal structure of apatite would not allow penetration twins of this sort.

Later, some specimens were sent to crystallographer R. Peter Richards (Heidelberg College, Tiffin, Ohio), who measured the angles between the stacks on several different specimens; he was able to rule out the possibility of twinning because the angles were not consistent. Similar wormlike apatite crystal aggregates have been found at the Palermo mine, New Hampsire, and yellow specimens are known from Fazenda Campolina, Medina, Minas Gerais. Furthermore, at the 2008 Denver Show there was a display case with a purple apatite aggregate on quartz from Afghanistan showing the same wormlike habit. There is still no explanation for this unusual aggregate habit (Rakovan, 2008).

The November 2006 pocket also produced a small number of transparent smoky quartz crystals with long, thin, pale gray and wormlike inclusions of apatite-(CaF).

At the end of 2006 an area in the pegmatite was reached where it dipped sharply and grew thicker; a huge quartz crystal pocket was found in this thicker portion (the same dipping and thickening had been observed in the case of the giant quartz pocket in Clovis's tunnel in 2005). Past this area the pegmatite returned to a near-horizontal orientation, and the crew resumed tunneling down-dip. After a few meters they found a small pocket which contained excellent clusters of pale gray apatite-(CaF) crystals. The clusters



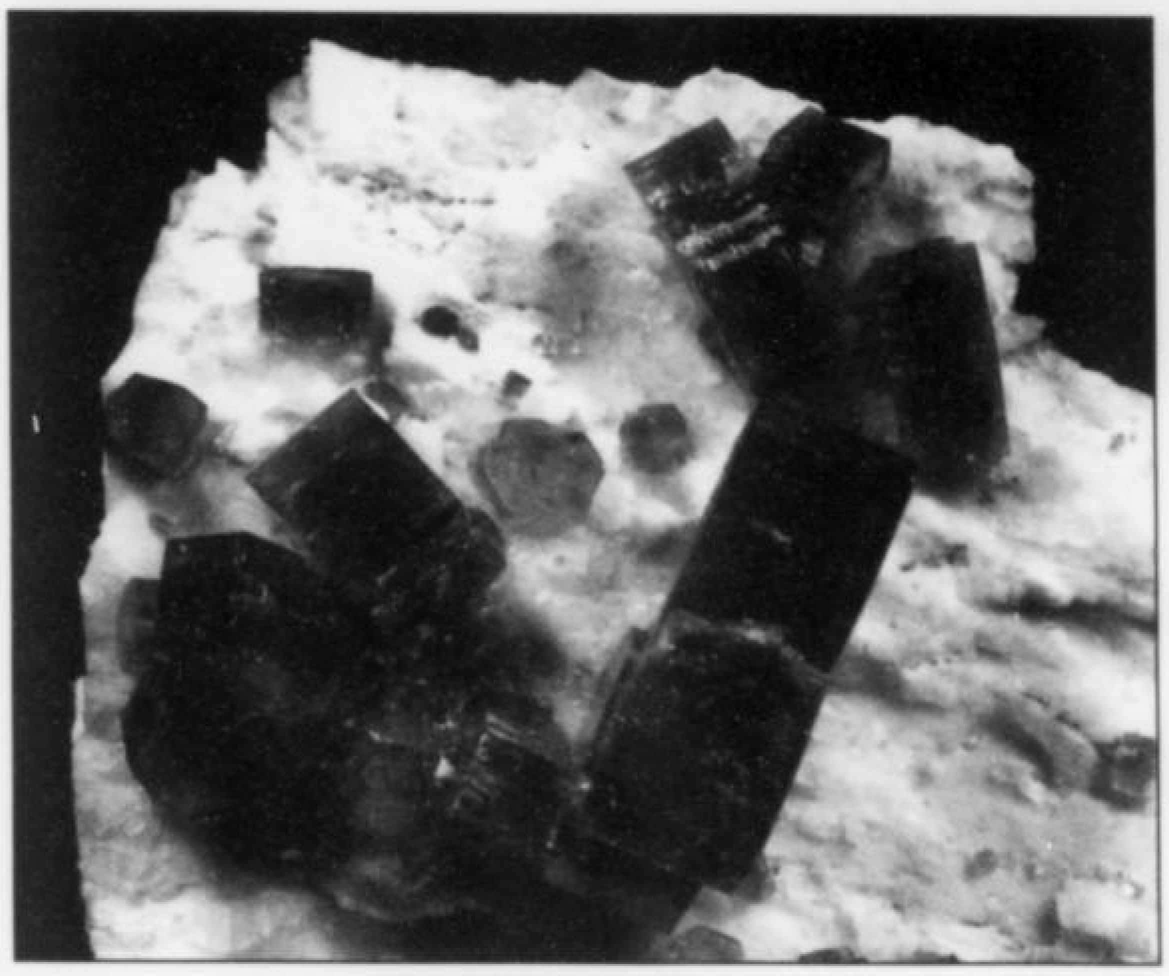
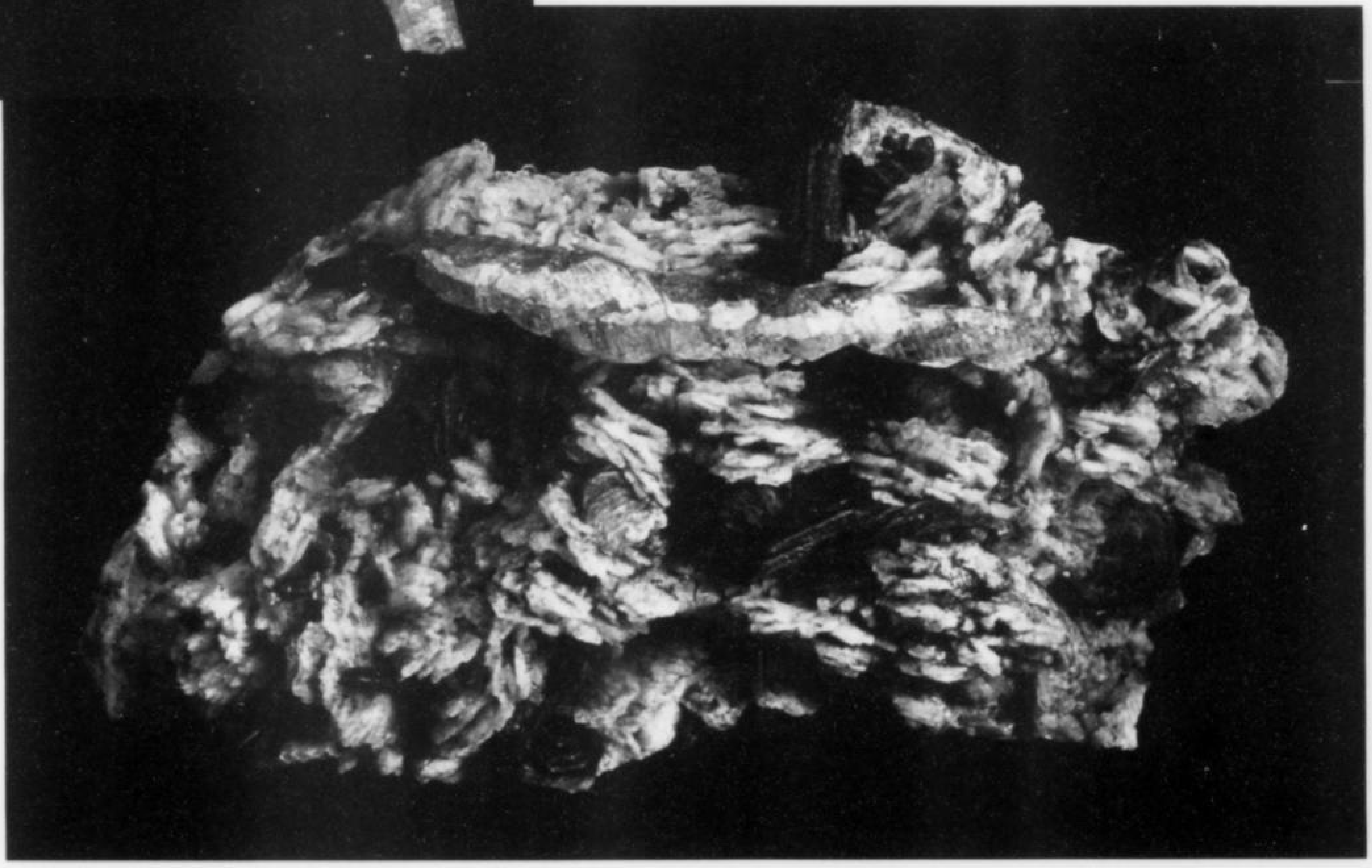


Figure 22. **Blue apatite-(CaF) crystals to 1.4 cm, on albite, from the Sapo mine. Ed Rosenzweig specimen and photo.**

Figure 23. **The "Apatite H" specimen (habit 4), 16 cm, consisting of three attached elongated stacks of apatite-(CaF) crystals, from the Sapo mine. Collector's Edge Minerals, Inc. specimen, from the collection of Luiz Menezes and Frank Melanson; Jeff Scovil photo.**

Figure 24. **The "Snake on Matrix" apatite specimen, an elongated 6-cm stack of apatite-(CaF) crystals (habit 4) lying horizontally on a 13-cm matrix of cleavelandite and muscovite crystals, from the Sapo mine. Luiz Menezes collection; Jeff Scovil photo.**



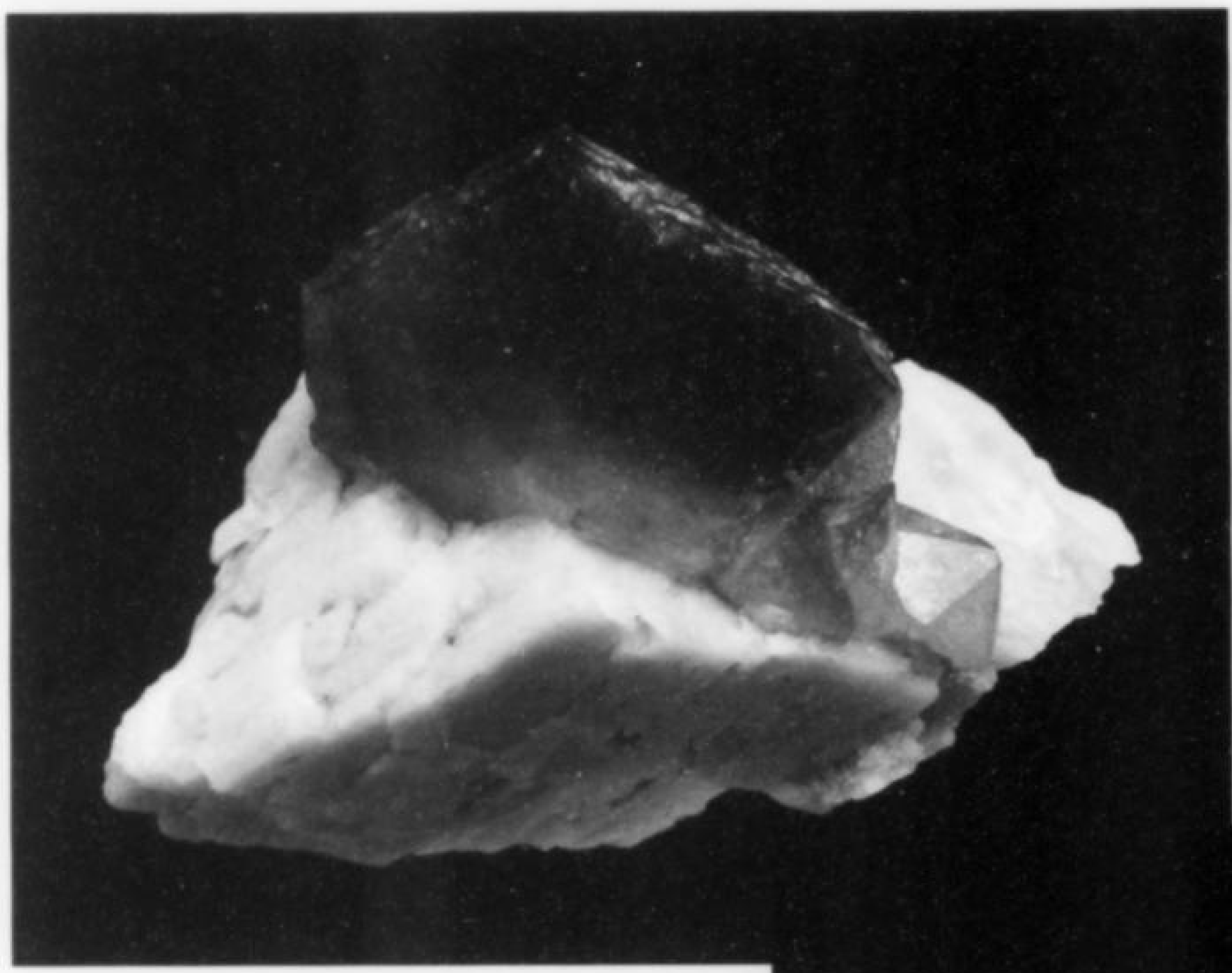
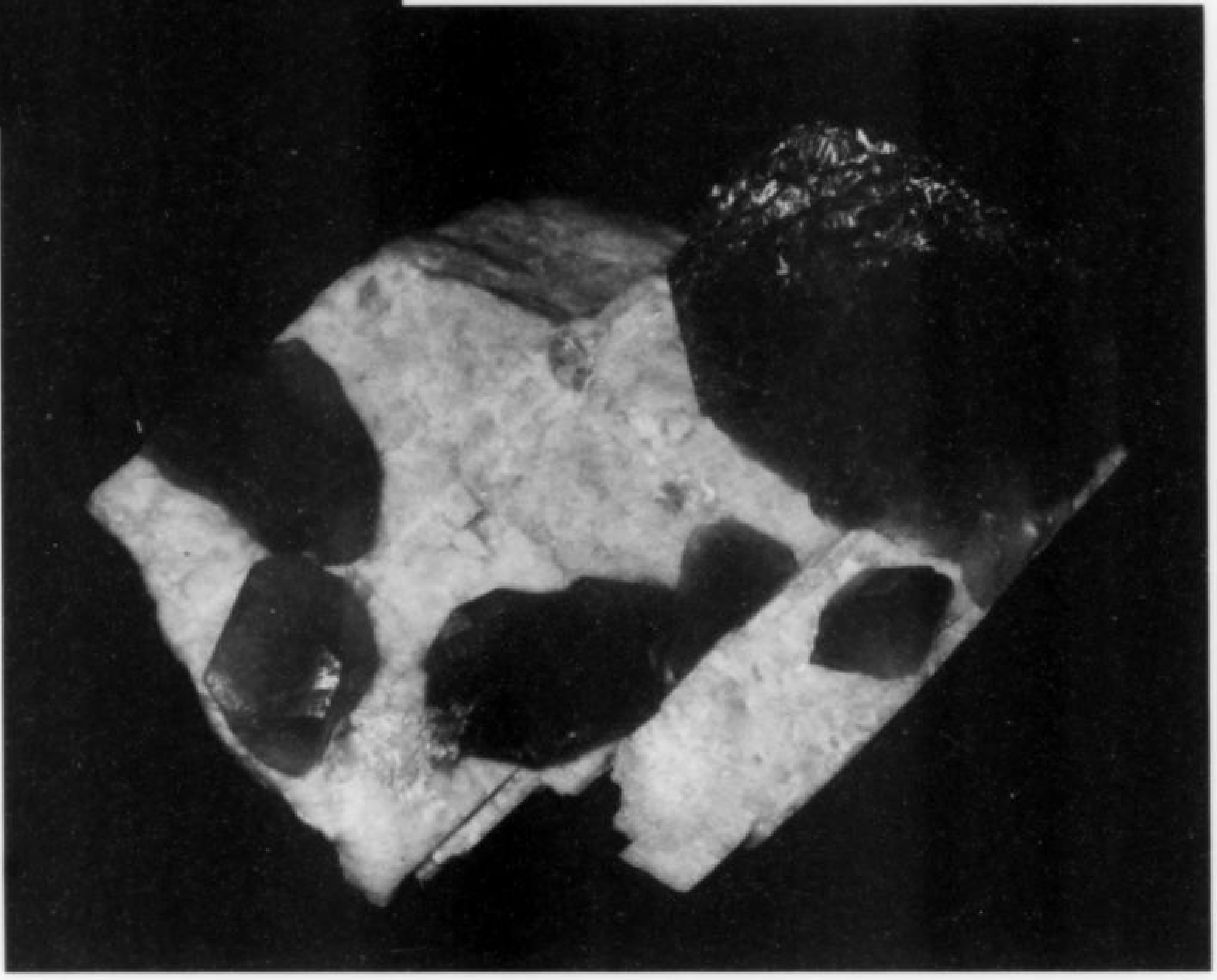


Figure 25. **Green apatite-(CaOH) crystal, 3.5 cm, with yellow apatite-(CaF) core, on microcline, from the June 2005 pocket at the Sapo mine. Jordi Fabre specimen and photo.**

Figure 26. **Green apatite-(CaOH) crystals to 2 cm, with yellow apatite-(CaF) cores, on microcline, from the June 2005 pocket at the Sapo mine. John Rakovan specimen and photo.**



measure up to 10 × 15 cm and are partially coated by tiny milky quartz crystals. Again, apatite crystal stacks which cross at an angle of around 60° were observed. The best specimen has a "V" shape and is 18 cm long. These apatite-(CaF) crystals contain microscopic acicular voids resulting in a "cat's eye" effect.

Finally, about 20 meters ahead and still inside the same quartz core, a huge pocket measuring about 1.5 × 2.5 × 4.5 meters was opened; the pocket walls consisted entirely of white albite and gray muscovite crystals, with a few milky to pale gray quartz crystals, richly coated by outstanding apatite-(CaF) crystals, sharp and bright, showing six different habits as follows:

Habit 1 is characterized by very sharp and lustrous, short-prismatic, dark green crystals with two very narrow pyramidal faces and a dominant basal pinacoid. These crystals are zoned, showing a dark green core and a very pale green rim. They fluoresce mustard-yellow (more strongly on the rim) in both shortwave and longwave ultraviolet light. Under the microscope a "cloud" of two-phase inclusions can be seen, and in one thumbnail-size crystal a movable air bubble is visible under a 10X hand loupe.

The size of the individual crystals ranges up to 4 × 7 cm. Hundreds of fine thumbnail to small cabinet-size specimens were recovered, most of them found loose inside the cavity, so they did not have to be trimmed. With these were more than 100 fine cabinet-size specimens and a few dozen larger pieces. The most dramatic piece (which has been named the "Apatite Sapo King") is a cluster of albite and muscovite crystals measuring 15 × 23 × 48 cm, richly coated with sharp apatite crystals up to 6 cm and, on top on the left side, one large bicolor apatite crystal (very pale tan with a dark green core) measuring 5 × 5 cm (habit 6; see below).

Habit 2 shows stacks of very sharp and lustrous dark green crystals attached, one over the other, at slightly varying angles, resulting in a snake-like habit of stacked crystals. The longest such aggregate found measures 2 × 21 cm; the most dramatic specimen of this group (named the "Apatite Tree") is now in the collection of Jim and Gail Spann; it consists of one apatite "trunk" which splits into 3 different "branches."

Nearly all of the solid crystal stacks were found loose inside the pocket; very few were found on matrix. The most spectacular matrix specimen of this sub-type (named the "Omigod" apatite) shows three crystal stacks, 3, 5 and 9 cm long, arcing above an albite matrix of 17 × 18.5 cm (all three stacks were found loose in the pocket and were later reattached to the original matrix).

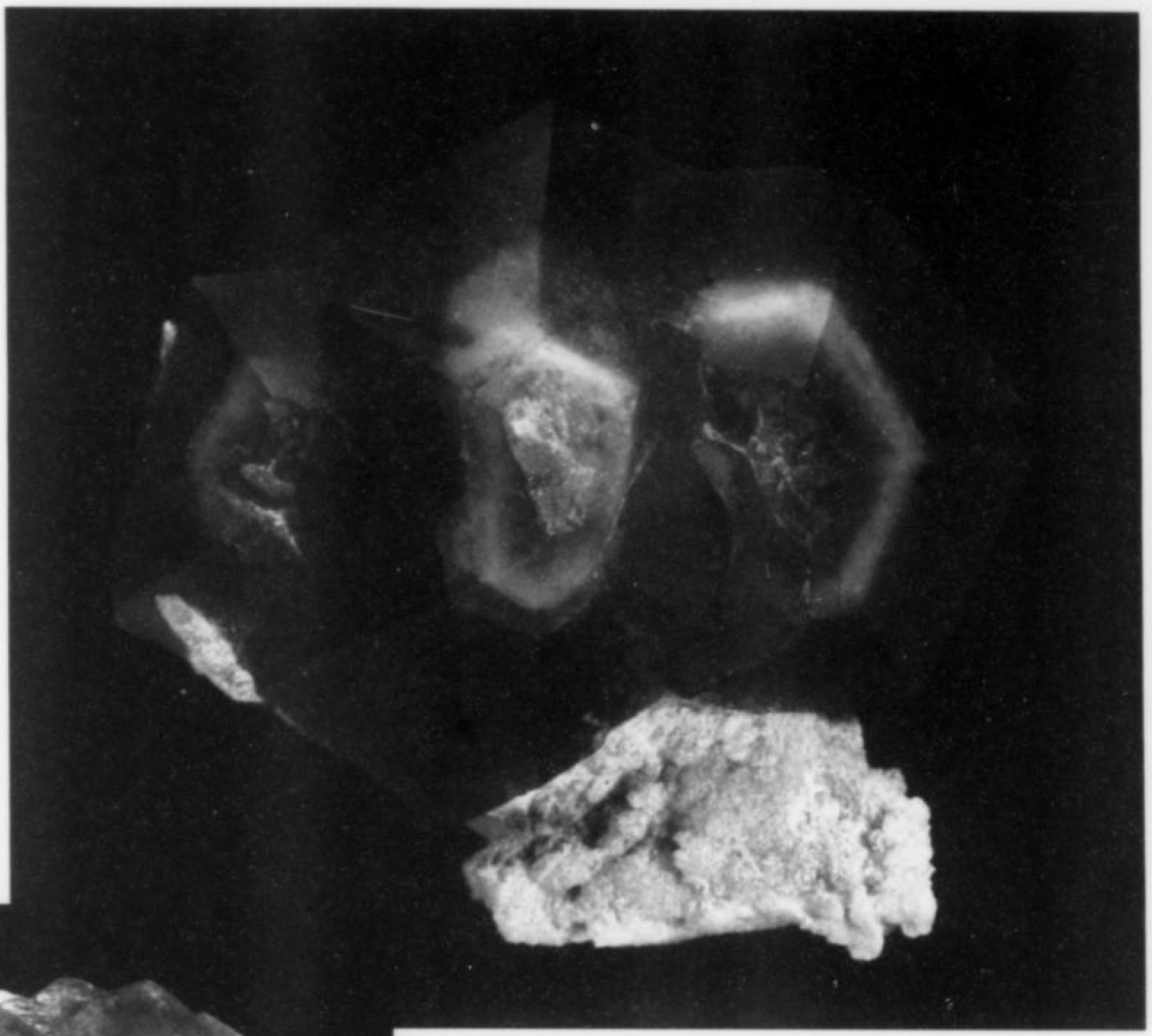


Figure 27. **Apatite crystal cluster, 5 cm, showing a green rim of apatite-Ca(OH) and yellow cores of apatite-(CaF). Mined in August 2006 at the Sapo mine. Luiz Menezes collection; Jeff Scovil photo.**

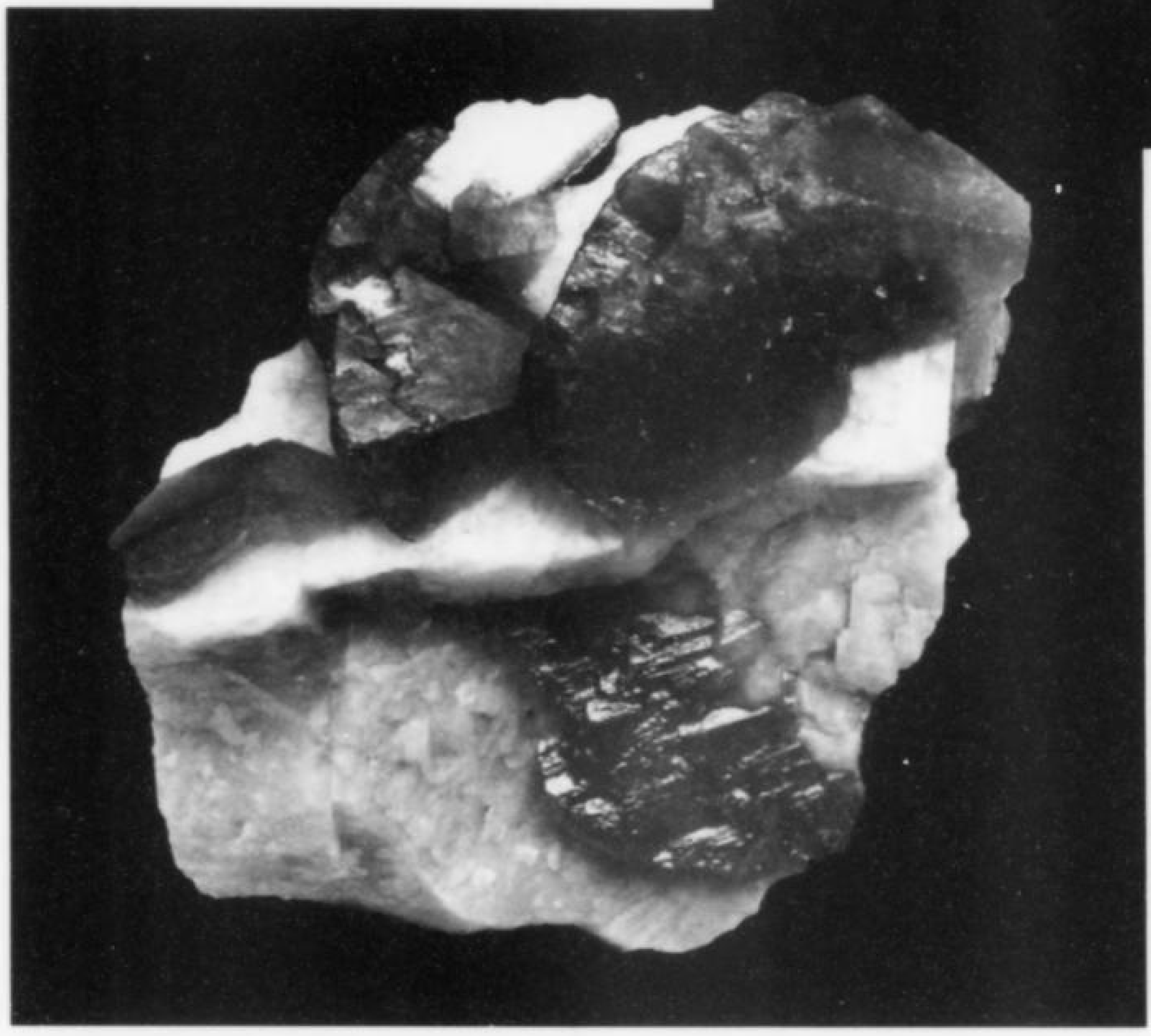


Figure 28. **Green apatite-(CaOH) crystals to 4 cm, with yellow apatite-(CaF) cores, on microcline, from the June 2005 pocket at the Sapo mine. Jordi Fabre specimen and photo.**

Like the gray wormlike clusters found in earlier and smaller pockets, the solid dark green crystal stacks consist of two different sets of crystals crossing each other at roughly 60°, but they do not have hollow centers.

Habit 3 consists of pale to medium-green snake-like crystal stacks to a few millimeters thick and always with hollow centers. These specimens also show the "V" shape of stacks crossing at around 60°. The stacks, however, are longer (up to 25 cm) and thinner (less than 2 cm) than the solid dark crystal stacks, and they were all found loose inside the pocket.

The largest intact specimen recovered measures 10 cm, but after the lot was cleaned, my wife, Maria Luisa Menezes, began to find pieces that fit together, so she undertook the patient work of reconstructing specimens. After months of work, several spectacular pieces had been reassembled: one called the "Apatite Sapo Queen" is a cluster of six different crystal stacks which measures 10 × 20 cm and was assembled from 14 fragments. The "Apatite New Moon" is an astonishing piece, 22.5 cm long, 1.9 cm thick and doubly terminated, which has been reassembled from five pieces. And finally, a piece 7 cm long is the only specimen featuring a pale green crystal stack attached to a thick, solid, dark green one, demonstrating that these two different sub-types of specimens were found in the same part of the pocket.

Most of the smaller sections that were assembled had partially rehealed ends, indicating that the pocket exploded during the late stages of its formation.

Habit 4 shows pale tan to nearly colorless snake-like crystal stacks, also with the "V"-shaped intersection pattern. These can be very long (up to 30 cm) after reconstruction, though the maximum size of the sections originally recovered from the pocket is around 10 cm. The best example of this habit is the "Apatite H," 7.5 × 16 cm, formed by three attached clusters (the longest measuring 13.5 cm) aligned almost perpendicularly to each other.

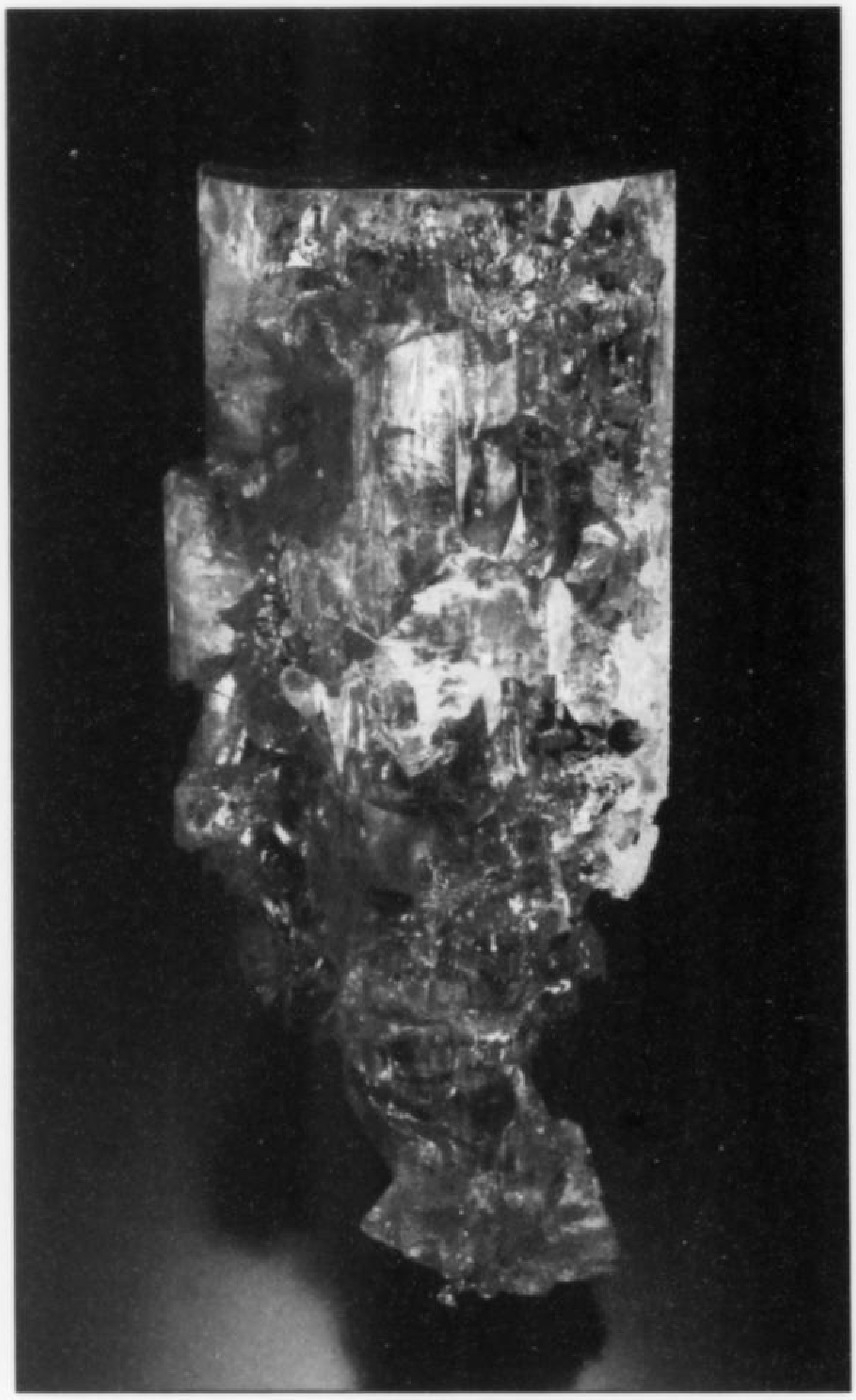


Figure 29. **Rare aquamarine beryl crystal, partially etched, 10.6 cm, from the Sapo mine. Luiz Menezes collection; Jeff Scovil photo.**

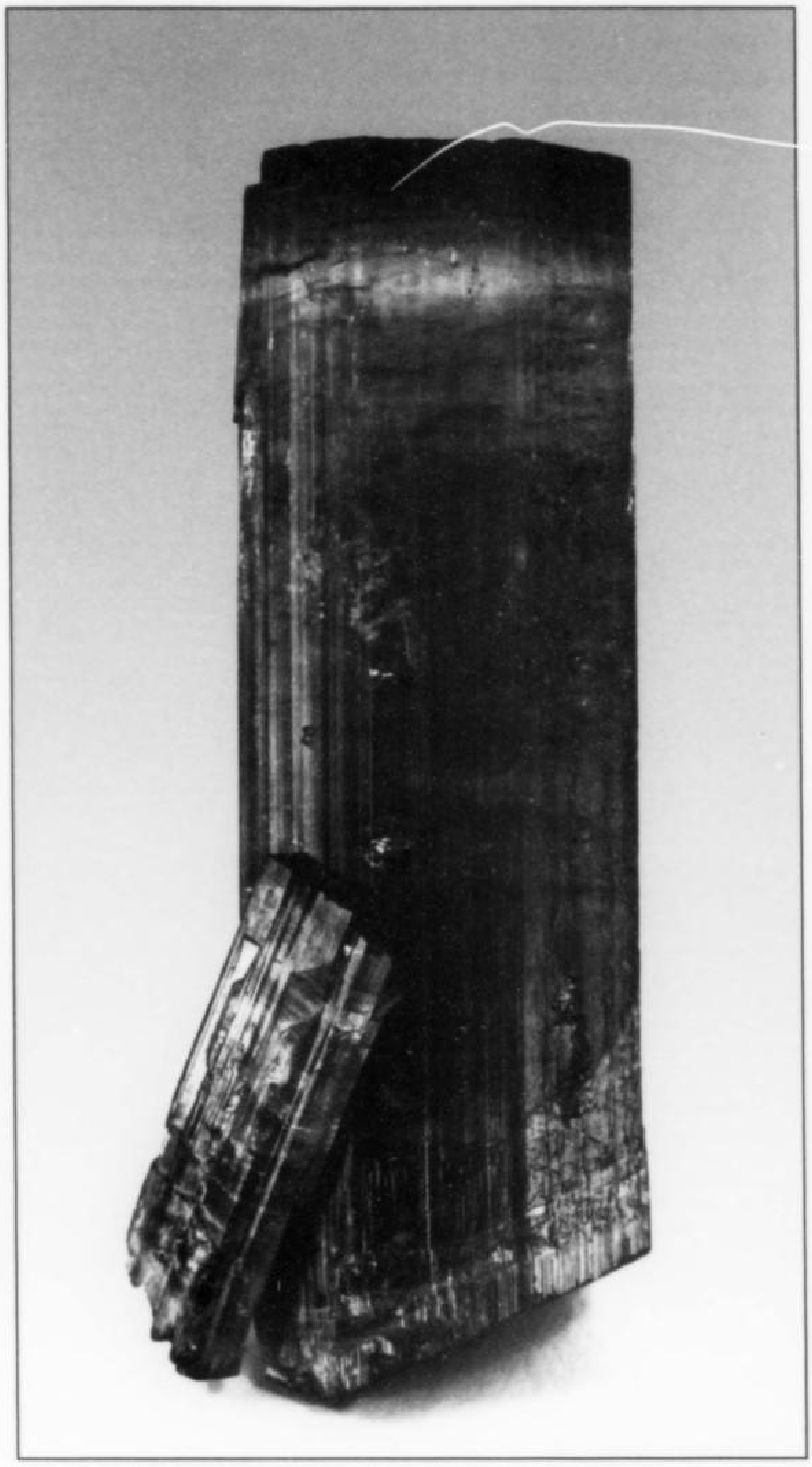


Figure 30. **"Blue-cap" elbaite crystal, 6 cm, from the Sapo mine. Rob Lavinsky specimen and photo.**

Another interesting feature of this sub-type is the hollow centers which are wider (up to 1 cm) than those in habit 3; also, the internal surfaces show crystal faces. I asked mineralogist David London of the University of Oklahoma what might be the cause of the hollow centers, and it is his opinion that the phenomenon is a result of very rapid growth, as in the cases of "skeletal" or "hopper" formations in other minerals. David thinks that a specimen like the "Apatite Snake," 30 cm long and 3 cm thick, may have formed in a matter of minutes!

Specimens of habit 4 fluoresce pale orange in both shortwave and longwave ultraviolet light. No specimens were found in which the crystal stacks rise vertically from matrix, but in some cases the stacks lie flat on albite, e.g. the "Apatite Snake on Matrix" (Fig. 24).

Habit 5 occurs as large apatite-(CaF) crystals with prism faces as long or longer than the basal pinacoids. The color may vary in the same crystal from pale to medium green, and the crystals commonly form parallel clusters; the longest of these clusters measures 7 × 22 cm.

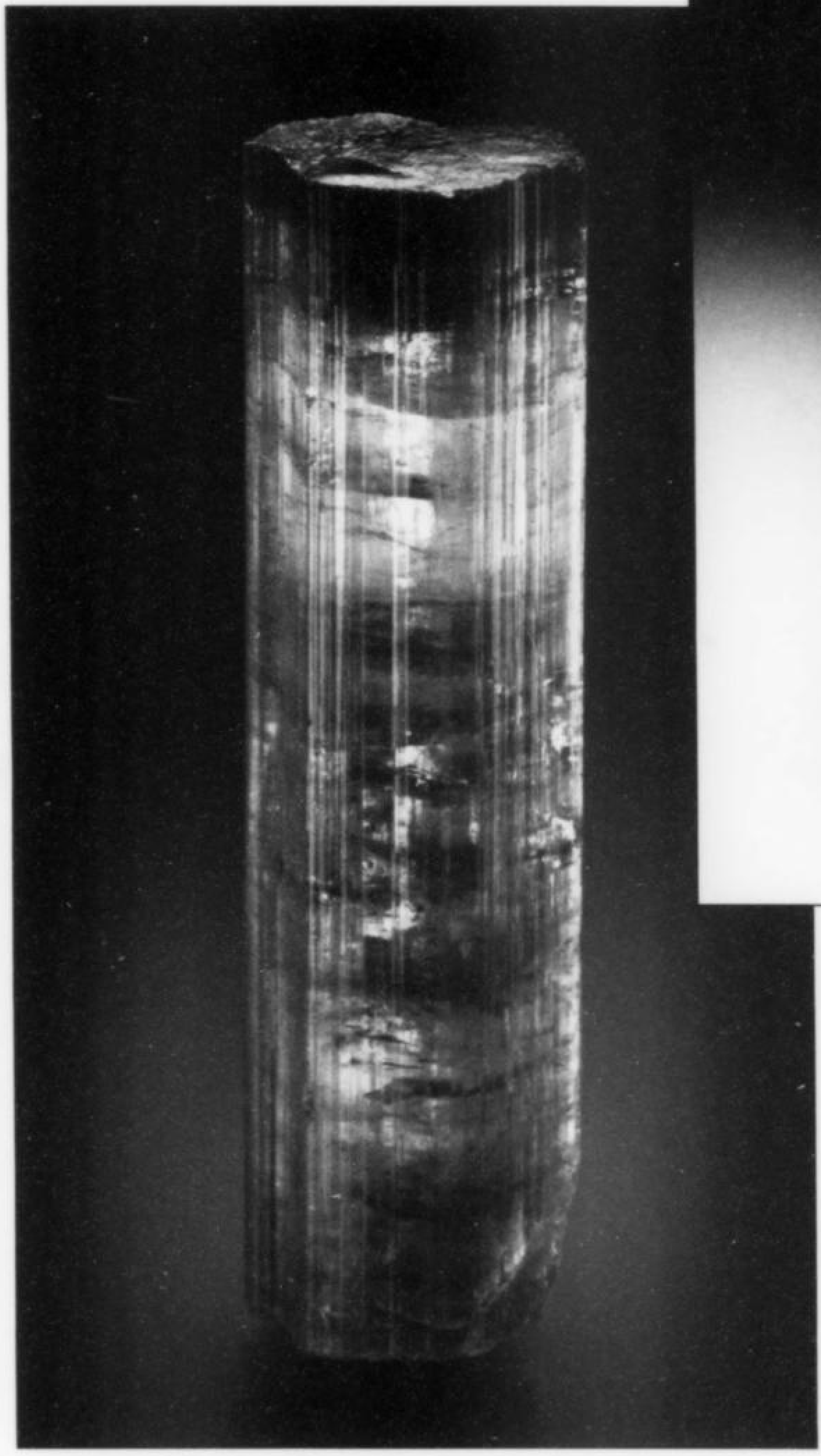
Habit 6 crystals are bicolored apatite-(CaF) showing very pale gray outer zones and dark green cores. The crystals have short prisms and small basal pinacoids, and their pyramidal faces are complex, combining several small pyramidal forms at different angles, such that the crystals look rounded. Very few crystals of this sub-type have been found; the best is the crystal, 5 × 5 cm, that rests on the top left side of the "Apatite Sapo King."

The amount of material recovered inside a single pocket, the quality of the specimens and the variety of the habits, make this one of the best discoveries of green apatite specimens ever made in the world.

Some attractive bright blue, tabular apatite-(CaF) crystals on white feldspar matrix have also been found: Alvaro Lucio and his son Eduardo had several excellent specimens at the 2009 Tucson Show. The color of the crystals is an outstanding, rich, vibrant blue, and the contrast with the white feldspar is very aesthetic. The largest crystals measure 1.4 cm across, on a 6-cm feldspar crystal, and are quite gemmy (Edward Rosenzweig, *Edward's Minerals*).

Beryl $Be_3Al_2Si_6O_{18}$

Beryl crystals measuring up to several tens of centimeters can be found embedded in quartz, albite or microcline in the central areas of the pegmatite. Rarely these beryl crystals are blue and can be cobbed into small, clean internal "eyes" which can be cut into aquamarine gemstones.



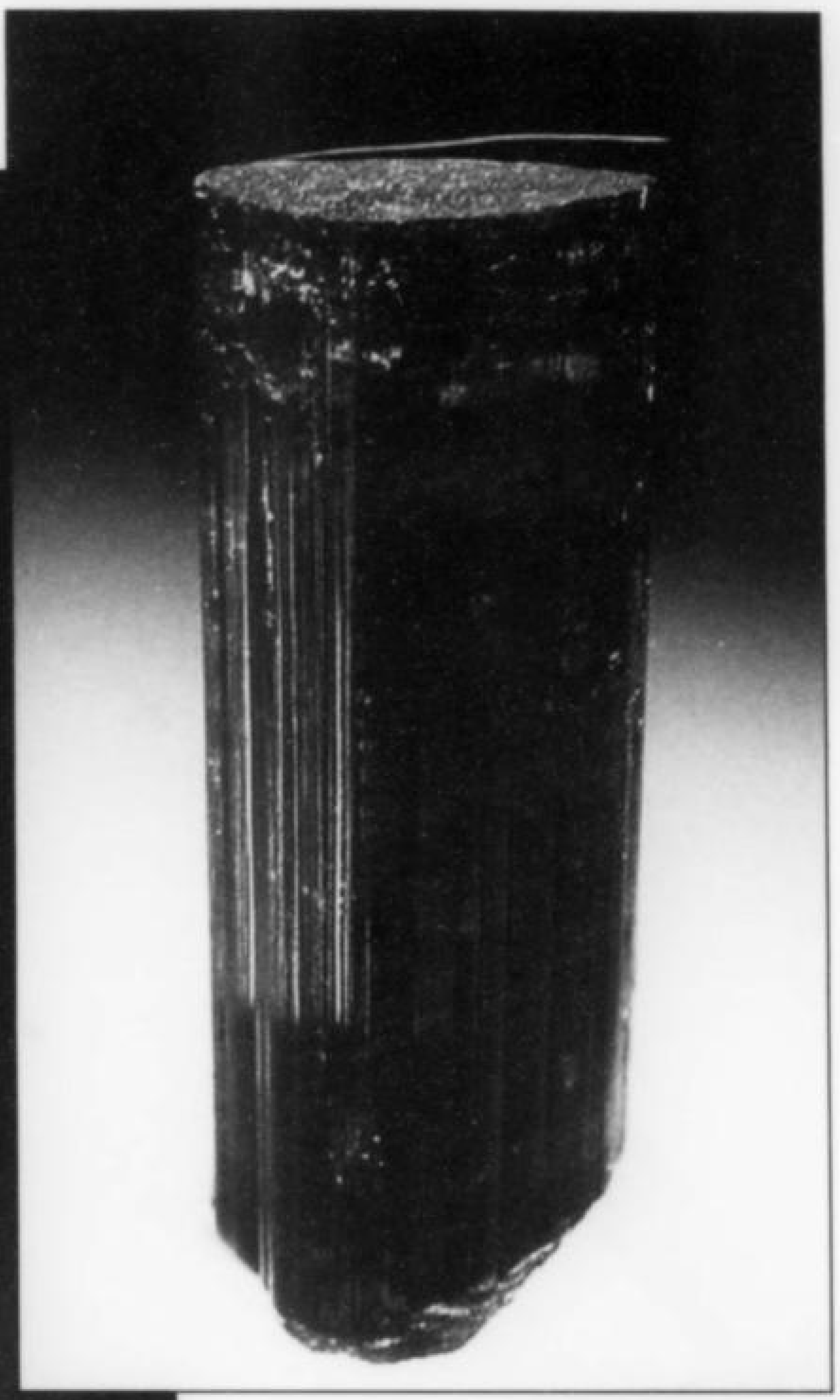


Figure 32. **"Watermelon" elbaite crystal, 3.8 cm, from the Sapo mine. John Veevaert specimen and photo.**

Figure 31. **"Blue-cap" elbaite crystal, 3.1 cm, from the Sapo mine. Kiyoshi Kikuni specimen and photo.**

The best beryl specimen found at Sapo is an etched blue aquamarine crystal measuring 20 × 20 cm and weighing 5.2 kg. One small pocket found in March 2008 produced several prismatic, etched, pale greenish blue aquamarine crystals; the best one measures 4 × 10 cm (Fig. 29).

Columbite-Tantalite

Minerals of the columbite-tantalite series are found as accessories in the intermediate zones. Sharp crystals are rare but can measure up to 5 cm.

Figure 33. **Indicolite (blue elbaite) cluster, 11.9 cm, from the Sapo mine. Collected from a series of three interconnected pockets found in February 1997. Alvaro Lucio collection; photo by Marcelo Lerner, from the book *Minerais e Pedras Preciosas do Brasil* (2009, in press).**

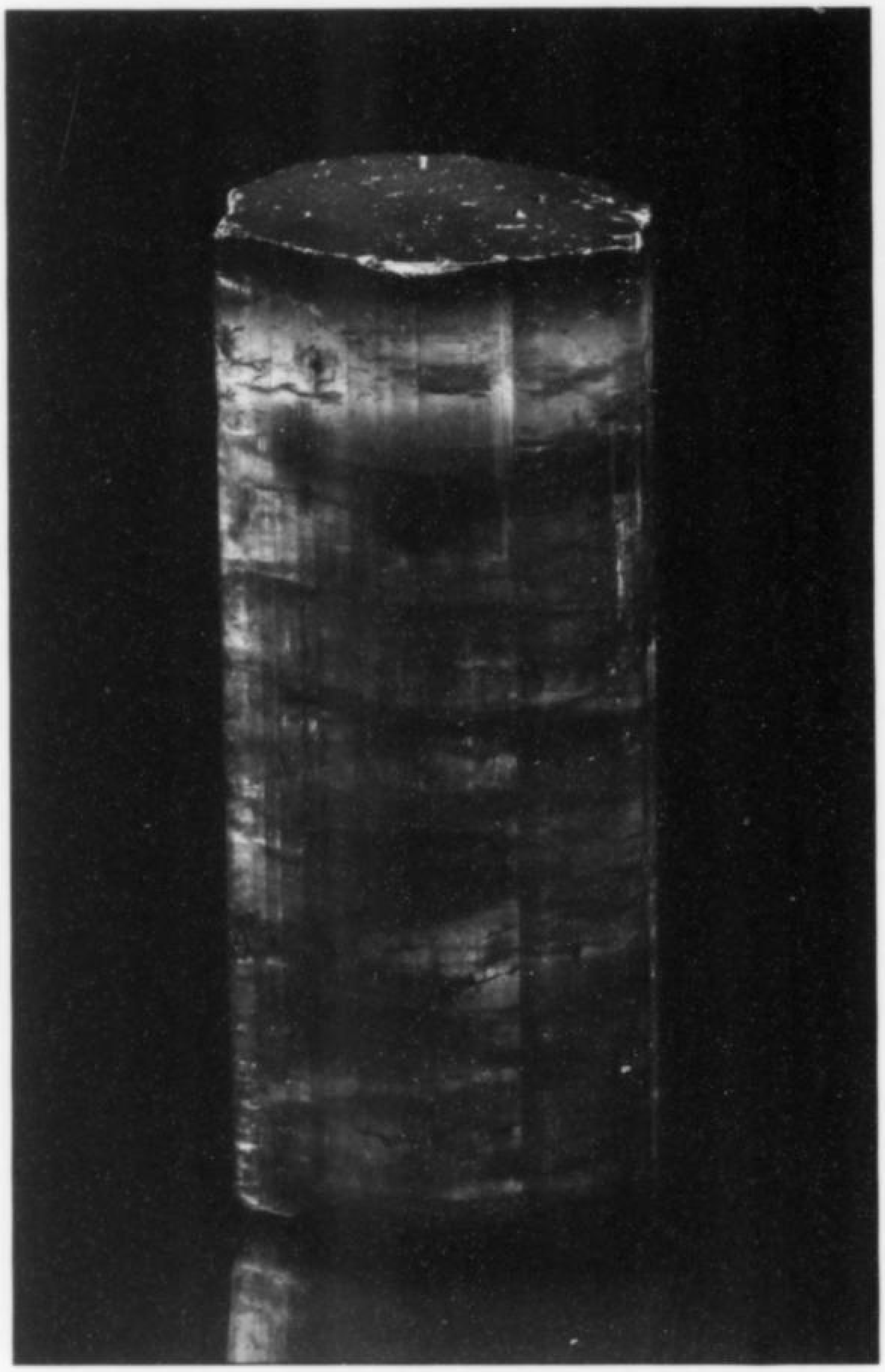


Figure 34. **"Blue-cap" elbaite crystal, 4.5 cm, from the Sapo mine. Gus Eifler collection; Joe Budd photo.**

Elbaite $Na(Al_{1.5}Li_{1.5})Al_6(BO_3)_3[Si_6O_{18}](OH)_4$

Sapo is among the important producers of Brazilian tourmaline. Most of the revenue thus far produced by the mine has come from small pockets of green to bluish green to blue single elbaite crystals which are cut immediately. Very few uncut crystals have reached the specimen market.

In February 1997, three adjacent elbaite-rich pockets were discovered. The first produced clusters of bicolor (red-green) elbaite crystals with a "shaving-brush" shape (similar to clusters found in the 1970's at the Santa Rosa mine), measuring up to 30 cm. The second pocket yielded attractive blue ("indicolite") crystals as well as some medium-blue crystal clusters measuring up to 15 cm. The third pocket contained the famous "blue-cap" Sapo tourmalines, mostly single crystals and a very few clusters, the singles reaching 15 cm long. The basal terminations of these crystals are dark blue; most of the mass of the crystals is green; the cores are pink (so that the crystals may be called "watermelon-plus"). There are also narrow, pale yellow zones just outside the pink cores, so that these crystals actually display four colors.

In all, about 350 kg of tourmaline were recovered from these three pockets. In addition to this extraordinary find, several other, smaller pockets in the Sapo mine have produced attractive green, bicolored or blue crystals, most of them loose but in some cases resting on albite or quartz matrix.

Figure 35. **Vinicius Costa Pereira, son of the well-known dealer Joao das Mossas of Governador Valadares, with a 10-kg, 35-cm, euhedral hydroxylherderite crystal from the Sapo mine, collected in 2000. Guido Steger photo.**

Black schorl, $Na(Fe^{2+})_3Al_6(BO_3)_3[Si_6O_{18}](OH)_4$, is also abundant, as single crystals and clusters measuring up to 30 cm, on quartz, albite and microcline crystals.

Hydroxylherderite $CaBe(PO_4)(OH)$

Hydroxylherderite is a rare accessory mineral, found normally close to or inside the tourmaline-bearing cavities. The color is normally pale brown, sometimes pale yellow, and the crystals are commonly twinned. The largest crystal recovered measures 35 cm and is dark tan (Fig. 35).

Mica and Chlorite Groups

Muscovite is abundant inside the large quartz-bearing pockets. Pseudo-hexagonal crystals up to 10 cm have been found perched on groups of cleavelandite crystals, and forming loose clusters.

Lepidolite is occasionally found in gem tourmaline-bearing pockets, but the purple color is generally not as intense as in other Brazilian lepidolite/tourmaline occurrences.

The most common chlorite-group mineral is cookeite, often one of the latest minerals to have formed in elbaite or schorl-bearing cavities.

The huge apatite-(CaF) pocket of June 2007 contained dark green chlorite partially coating the albite and muscovite matrix, and also coating some apatite crystals (chlorite was even found inside the hollow crystal clusters). As yet there has been no positive identification of the chlorite-group species in question.

Pyrite and Arsenopyrite

Pyrite and arsenopyrite are found rarely as irregular masses inside the intermediate zones. Remarkably, a sharp 6-cm cubic crystal of pyrite on microcline matrix was found in 2002. This may well be the finest pyrite specimen ever found in a Brazilian pegmatite.

Quartz SiO_2

The Sapo mine is one of the most prolific producers of quartz in the Eastern Brazilian Pegmatite province (also called the Oriental

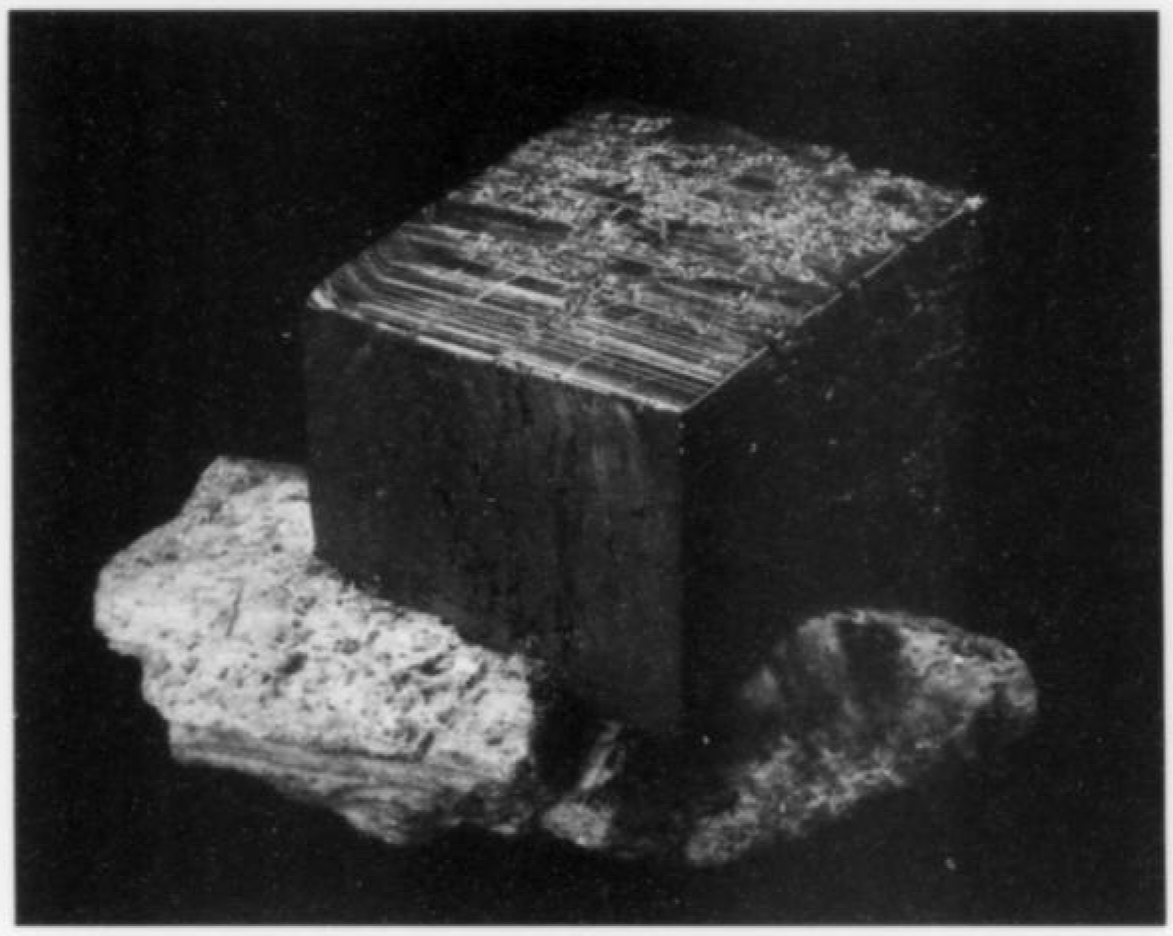


Figure 36. Pyrite crystal, 6 cm, on microcline, from the Sapo mine—perhaps the finest known pyrite crystal from any Brazilian pegmatite. Luiz Menezes collection; photo by Marcelo Lerner, from the book *Minerais e Pedras Preciosas do Brasil* (2009, in press).

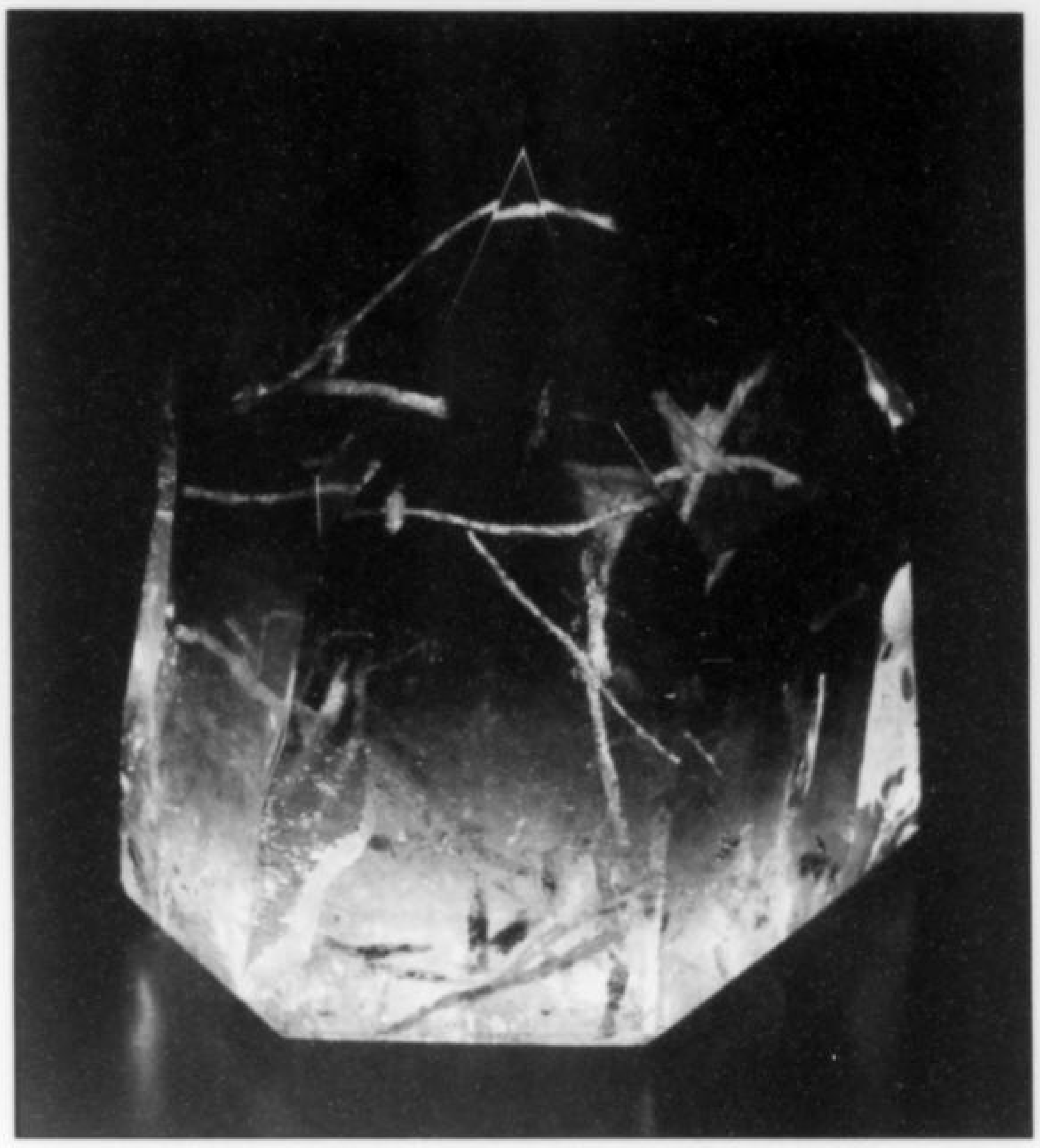


Figure 37. Polished smoky quartz crystal with wormlike apatite inclusions, 9 cm. Mined in December 2006. Luiz Menezes collection; Jeff Scovil photo.

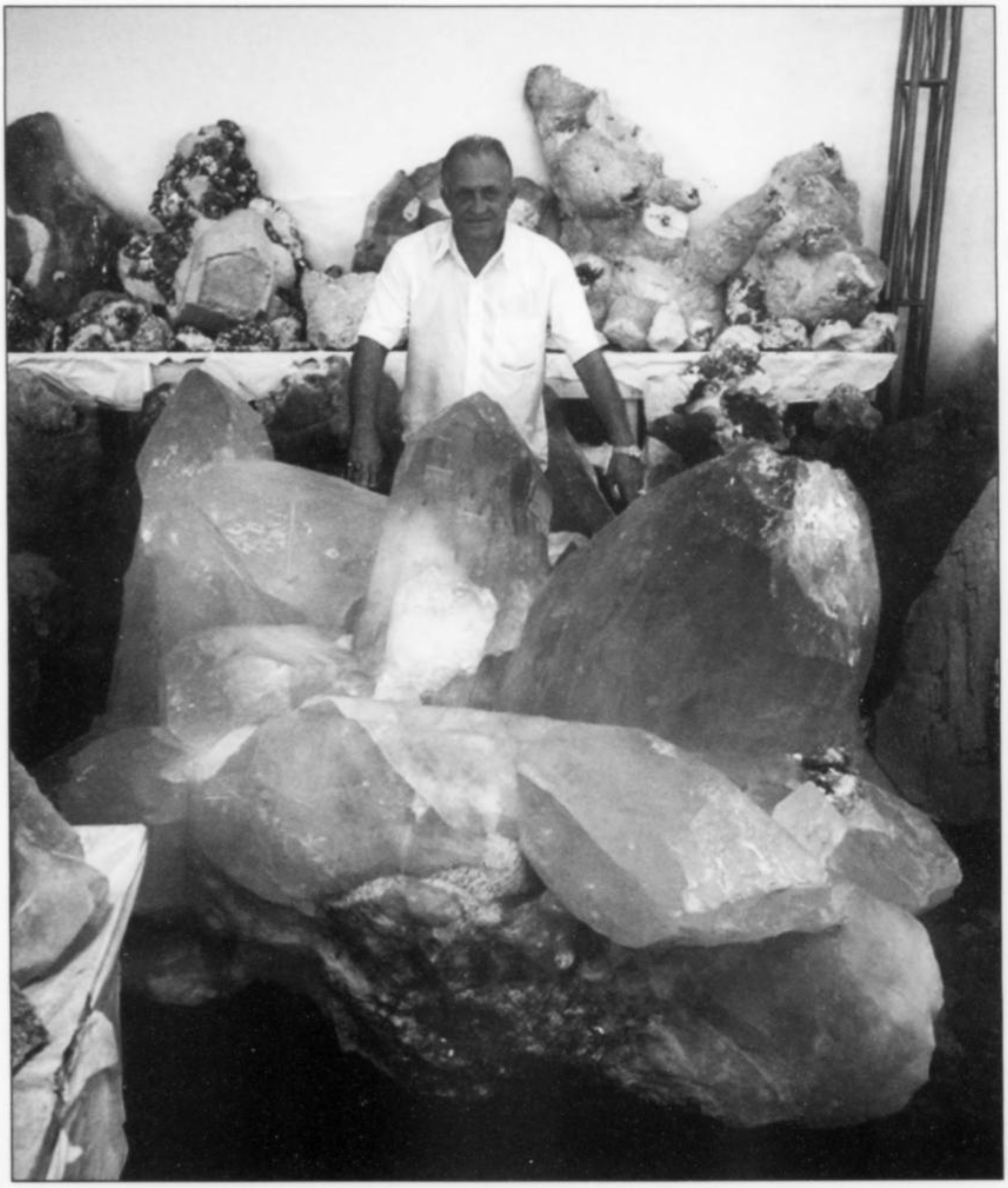


Figure 38. Clovis Baiano standing beside a giant cluster of "cathedral" quartz crystals which weighs almost two tons, from the June 2005 find. Several albite-microcline-muscovite clusters from the same find are arrayed along the shelf behind him. Photo by Carlos Cornejo, from the book *Minerais e Pedras Preciosas do Brasil* (2009, in press).

pegmatite province) of northeastern Minas Gerais; the larger pockets produced quartz crystals measuring up to 1 meter long and weighing several hundred kilograms.

The most common habits are "cathedral quartz," "alligator quartz" ("quartzo jacaré" in Portuguese), "obelisk quartz," and conventional hexagonal prisms with rhombohedral terminations. The colors vary from smoky to citrine to colorless; the most valuable pockets are those with citrine or colorless crystals.

In many pockets the large quartz crystals are found perched on clusters of cleavelandite crystals and on mixtures of albite, muscovite and microcline. The largest find of quartz occurred in June 2005, when a giant cavity measuring about 10 × 10 × 30 meters was opened. Nearly 300 tons of quartz and 200 tons of albite/muscovite/microcline crystals were recovered from this cavity. The quartz crystals are up to a meter long, and many were found standing on clusters of albite and muscovite, with minor microcline, showing conical external shapes and hollow centers: these are casts after vanished spodumene crystals, as discussed above (under albite) (see also Steger, 2009).

Citrine is the least common but most valuable type of quartz found at the Sapo mine. Clovis recalls individual crystals measuring up to a meter long and weighing up to 350 kilograms. Most commonly citrine crystals or clusters are of the "cathedral" or "obelisk" types.

"Alligator smoky quartz" (also known as "skeletal quartz" or "elestials") is also abundant at the Sapo mine, but the value of this type of quartz is much lower than the value of "cathedral" quartz.

Most of the quartz production is sold to China, which since the mid-1990s has been the world's largest consumer of Brazilian rough quartz for cutting.

Quartz crystals to 8 cm heavily impregnated with dark bluish green needle crystals of tourmaline have also been found in the Sapo mine (see Steger, 2009); specimens of this material were available at the 2003 Tucson Show. Doubly terminated scepter quartz crystals on a mass of bluish green tourmaline are filled with green and blue tourmaline crystals which protrude from almost all of the quartz faces (Russell G. Rizzo, *Cal Neva Minerals*).

ACKNOWLEDGMENTS

I would like to thank R. Pete Richards and John Rakovan for their help in the study of the oddly shaped apatites; David London, Vandall King and Skip Simmons for their discussions with me about the formation of the apatite stacks; John Rakovan, Frank Hawthorne and Marcus Origlieri for their chemical analyses of the apatite-(CaOH); Frank and Wendy Melanson for their help in reviewing the text and for their business partnership on the big lot of apatite specimens; and Jacques P. Cassedanne for providing information about the regional geology.

I owe very special thanks to my wife, Maria Luisa Menezes, who did an unbelievably patient and skillful job of assembling hundreds of small apatite pieces into larger specimens. She began this job in August 2007 and has not finished it yet; her work has made possible the restoration of the magnificent "Apatite Tree," "Apatite Omigod," "Apatite New Moon," and "Apatite Sapo Queen" specimens, as well as hundreds of smaller specimens—helping to open a new chapter in the study of the apatite-group minerals.

I am grateful for the work of Collector's Edge Minerals, Inc., on the final restoration of several of the best apatite specimens, and the work of my employee, Marcio Henrique Rodrigues, in finding the missing parts allowing the restoration of the "Apatite Sapo King." Finally I thank Carlos Menezes for his continuous support of my mineral business.

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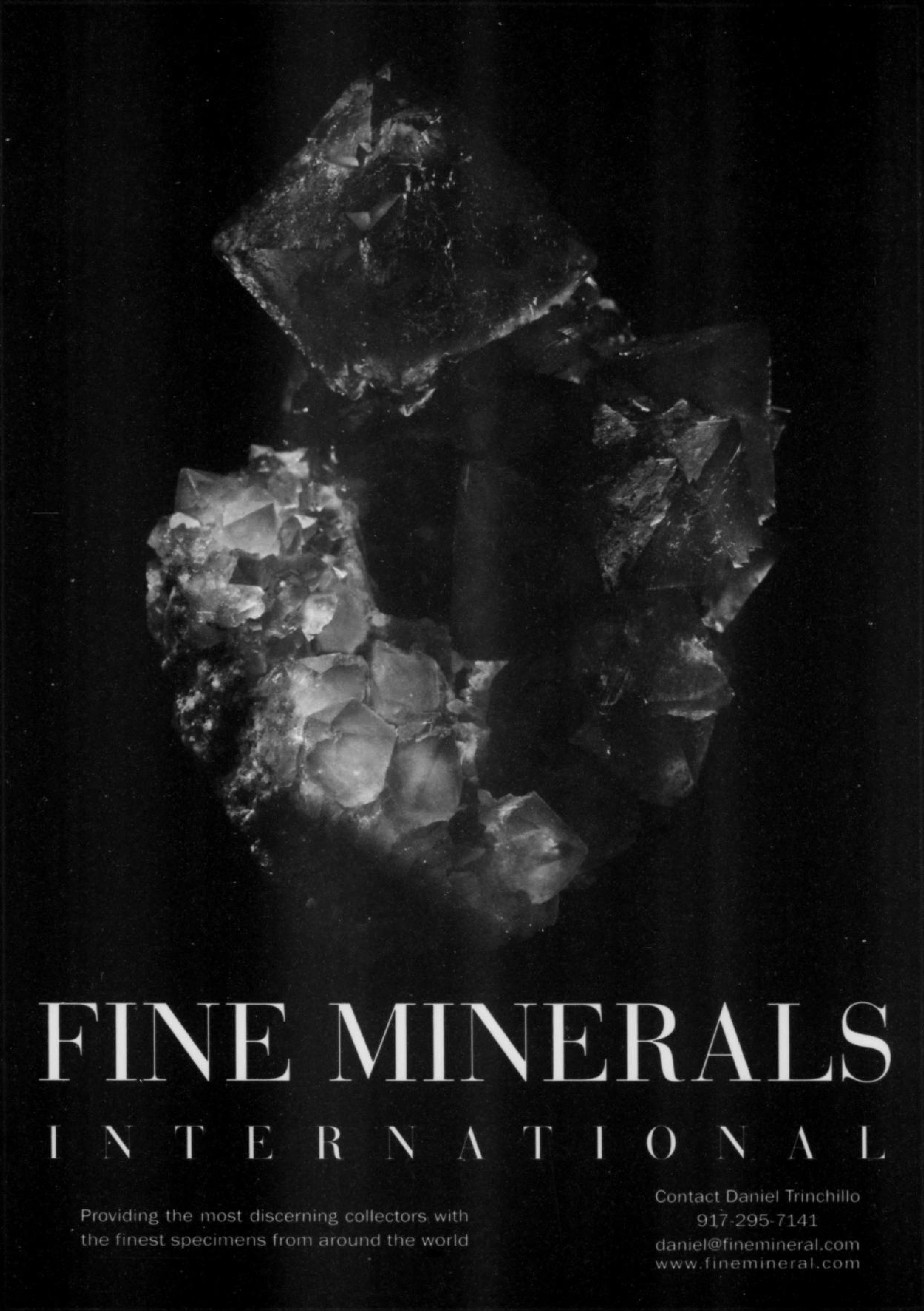
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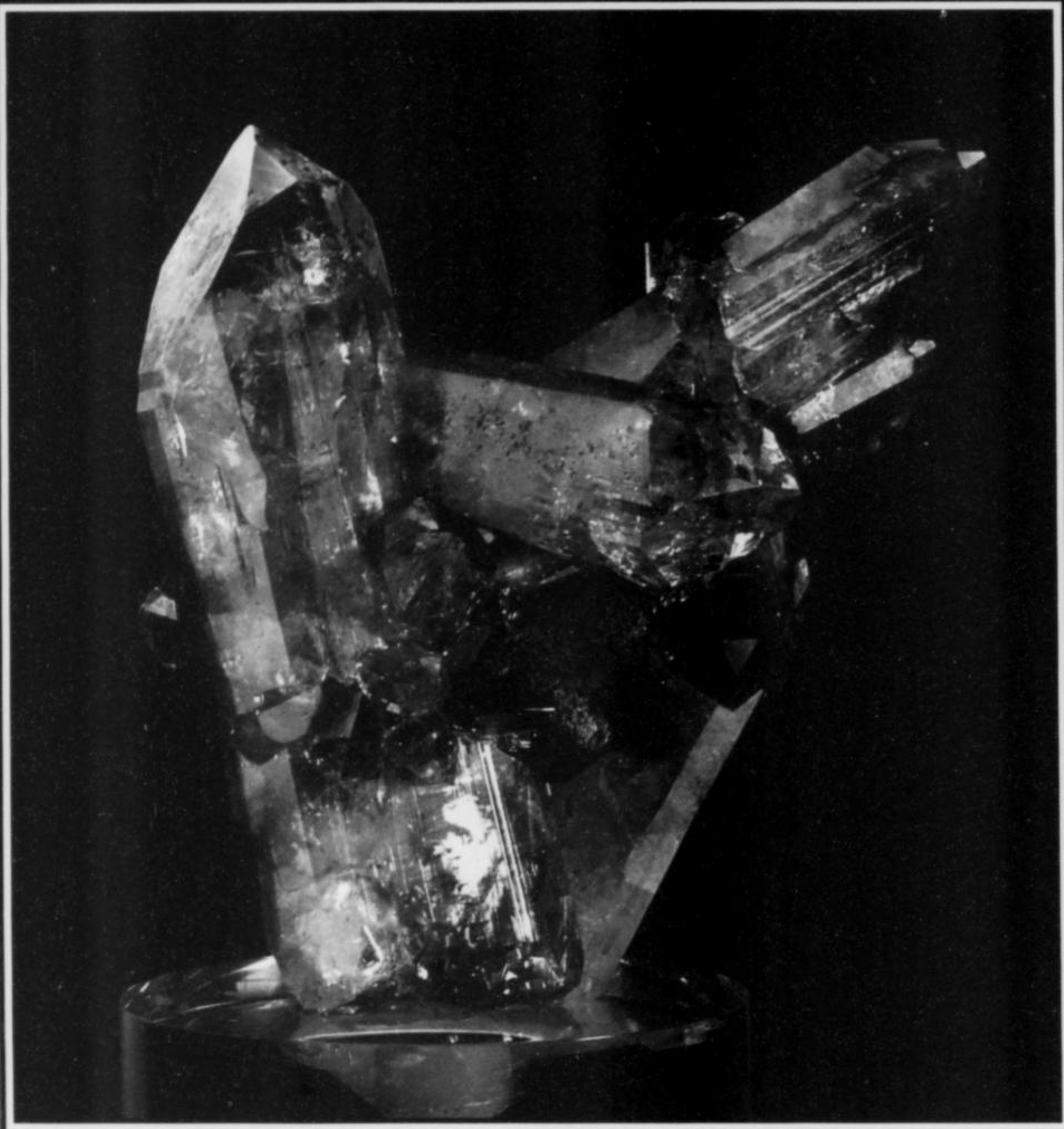

ANGLESITE, Touissit, Morocco

Famous Mineral Localities:

THE LAC D'AMIANTE MINE

Black Lake, Thetford Mines, Québec,

Marco Amabili[1]
Francesco Spertini[2]
Marc B. Auguste[3]
Gilles Bonin[4]

The Lac D'Amiante mine is a huge asbestos mine in Québec. Many other asbestos and chromite mines, all now closed, are located within a few square kilometers around the mine, in the municipality of Thetford Mines. During the last ten years the Lac D'Amiante mine has produced world-class green andradite crystals and the best suolunite specimens ever found.

INTRODUCTION

Since 2001 the village of Black Lake has been part of the municipality of Thetford Mines, which has a population of about 26,000 inhabitants. The village is about a three-hour drive east of Montreal and about 6 kilometers from the town of Thetford Mines, in the French-speaking Canadian province of Québec, Canada. The Lac d'Amiante ("Lake Asbestos") mine is easily accessible via highway 112 connecting Disraeli with Thetford Mines. The belvedere of the mine, at point 41 on the area map (Fig. 2), offers a breathtaking view (Figs. 3 and 4).

South and east of the village of Black Lake lie two huge asbestos (chrysotile) open pits, the Lac d'Amiante and British Canadian mines, as well as at least seven smaller asbestos mines and prospects (Edith, Murphy Hill-Sud, Union, Maple Leaf, Southwark, Poudrier, and Reed). In the same area there are eight mines and prospects (Standard, Ward-Ross, Old Greenshields, Greenshield, Provençal Hill, Lambly-Nadeau et Victoria, Fréchette) which were worked for chromite at the end of the 19th century and during the two world wars. Except for the Lac d'Amiante mine, all mines in the Black Lake area are now closed, and their huge dumps have formed hills which dominate the landscape. The Lac d'Amiante mine, operated by the Lake Asbestos Bell (LAB) Chrysotile, Inc. has been worked for 4 months each year since 2003; the reduced activity is a consequence of the depressed asbestos market.

MINING ACTIVITY IN THE THETFORD MINES AREA

Around the town of Thetford Mines there were several other asbestos mines (Bell, Johnson, King, Beaver 1, Beaver 2, Bennett-Martin, Flinkote, Pennington, National) and chromite mines and

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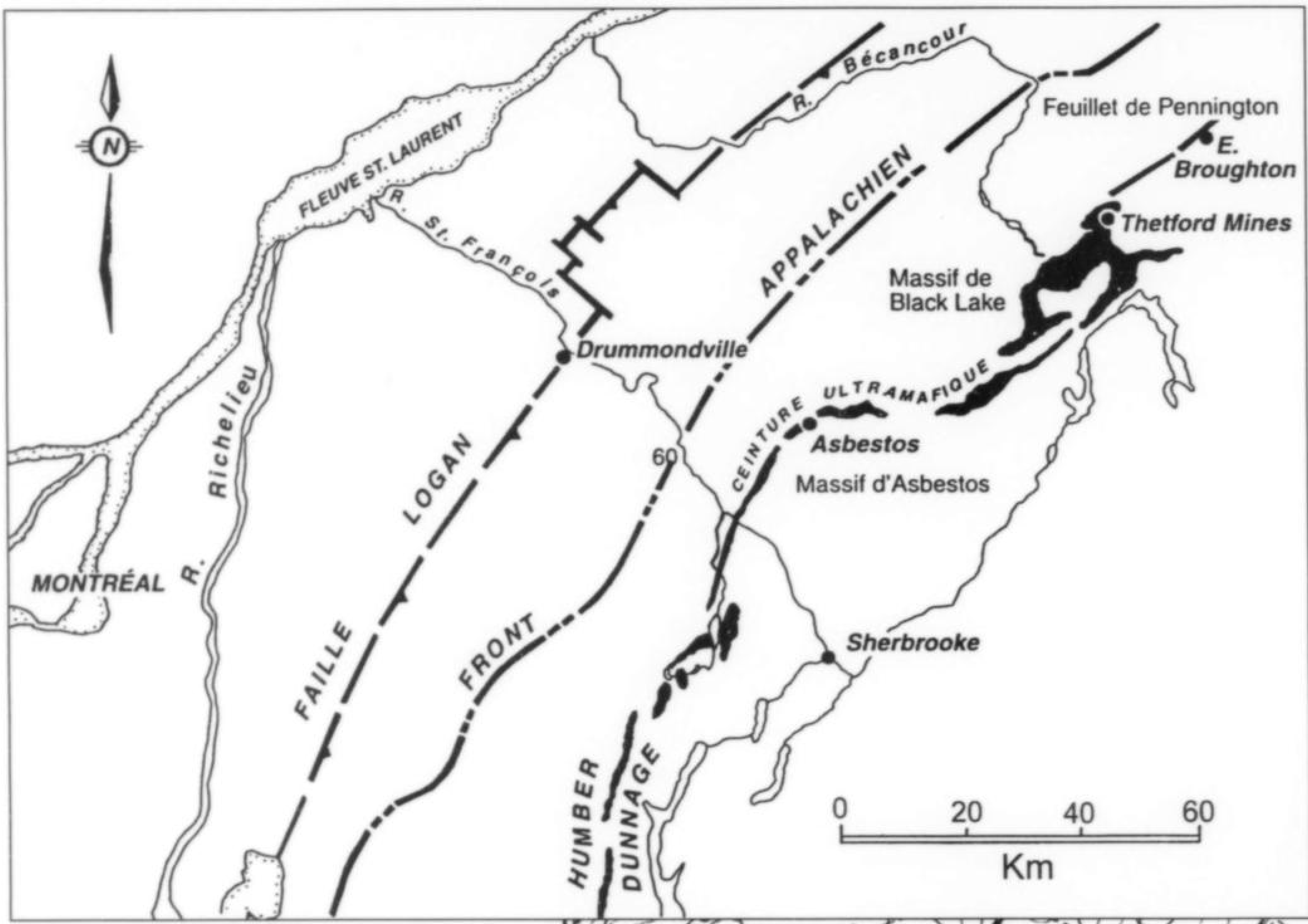
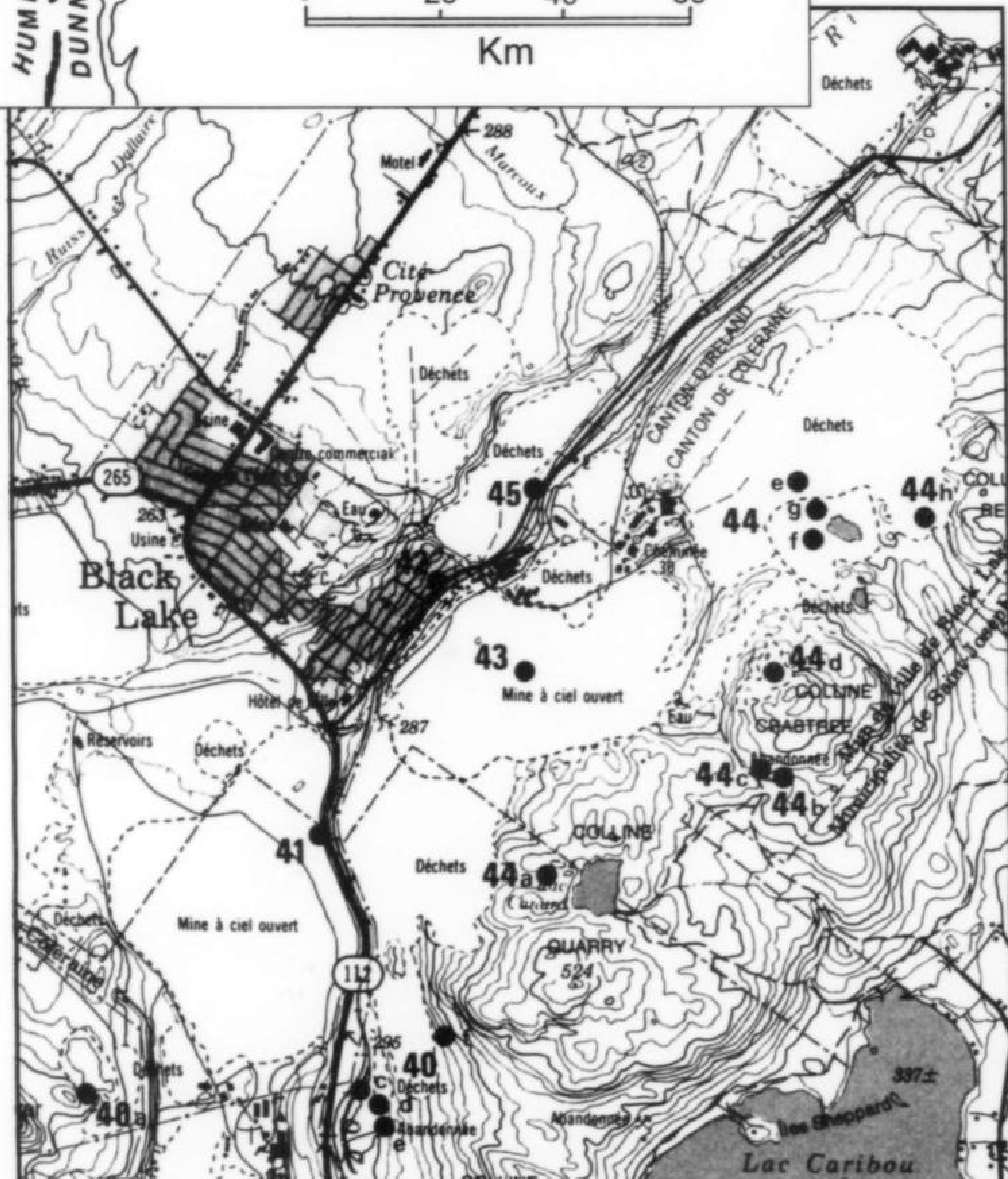


Figure 1. **Location map, showing the ultramafic belt and the main geological features. From Bonin (2001).**



Extrait de la carte 22IL/3 du ministère de l'Énergie, des Mines et des Ressources

Figure 2. **Map of the area around the village of Black Lake. Symbols: 40, mines around the Lac Noir; a, Edith; b, Old Greenshields; c, Greenshields; d, Provençal-Hill; e, Lambly-Nadeau et Victoria; f, Fréchette; 41, belvedere of the Lac d'Amiante mine; 42, the old Black Lake village; 43, British Canadian (B.C.) mine; 44, mines at the back of the B.C. mine; a, Standard; b, Ward Ross; c, Murphy Hill-Sud; d, Union; e, Maple Leaf; f, Southwark; g, Poudrier; h, Reed; 45, mine dump. Adapted from Gaudard (1993).**

Figure 3. **View of the Lac d'Amiante mine as it was a few years ago. Photo courtesy of Tourism Amiante, Thetford Mines**

prospects (Hall, Stewart, Lemelin), as well as a few quarries. In 2007 LAB Chrysotile decided to close the last of these mines, the Bell mine. This very large mine was begun in 1878 (just one year later than the Johnson mine, the region's first asbestos mine), and after 1951 it was exclusively an underground operation. The Bell mine, incredibly, produced only one known fine mineral specimen in so many years of activity: a cluster of green grossular garnets associated with white acicular diopside crystals.

Five additional asbestos mines are located in the few kilometers between Black Lake and the town of Coleraine; these are the Belmina, Windsor, Continental, Vimy Ridge, and Normandie mines. In the same area there are 14 chromite mines: Nadeau Hill, Huard, Gagné, Reed-Bélanger, Caribou, Dumais, Vaillancourt, Noël, Bennett-Martin, Woolsey, Nadeau, Montagne Caribou, Parent and Montreal-Coleraine, also known as the Montreal chrome pit. Several other asbestos and talc mines were located around the nearby town of East Broughton; the last of these mines (Carey-Boston) was closed in 1986. This extensive mining activity over a span of 130 years places Thetford Mines among the elite of historic mining localities.

As already stated, there are two huge asbestos mines at the village of Black Lake: the British Canadian (B.C.) and Lac d'Amiante. The British Canadian mine has been the source of attractive clusters of lustrous green grossular crystals, with individuals around 2 or 3 mm, associated in some cases with white acicular diopside crystals. These specimens were collected in the 1990s and sometimes mislabeled in the international market as specimens from the Jeffrey mine at Asbestos (which is about an hour's drive west of Black Lake). The British Canadian mine, opened at the end of the 19th century, was closed in 1997 and is now flooded. The Standard and the Union mines, which lie very close to the British Canadian mine, have been abandoned for decades. These two mines were the source of the "colerainite" variety of clinochlore (named for the nearby town of Coleraine; Black Lake was in the Municipality of Coleraine at the beginning of 1900). Described as a new mineral in 1918, "colerainite" was discredited as a variety of clinochlore in 1970 (Horváth, 2003). The Montreal-Coleraine mine, also known as the Montreal chrome pit, was the source of an emerald-green, chromium-bearing variety of vesuvianite named "chrome-idocrase" in 1913 (Horváth, 2003). Superb specimens of emerald-green vesuvianite have been collected during the last few years at the Jeffrey mine at Asbestos (Amabili, Spertini and Miglioli, 2004; Amabili and Spertini, 2004).

HISTORY OF THE LAC D'AMIANTE MINE

The Lac d'Amiante mine, now operated by LAB Chrysotile, Inc., is a huge open pit of about 1,875 × 1,560 meters, with a depth of 375 meters. Mining for chrysotile began in 1958. Looking now at the mine, it is difficult to imagine that until the mid-1950s the site was occupied by a lake, named Black Lake, surrounded by a forest of black pines and maple trees, with cottages sparsely scattered along the shore. In the summers people used to swim and fish in the lake,

Figure 4. **Belvedere of the Lac d'Amiante mine in November 2007, maintained by Tourism Amiante, Thetford Mines. Marco Amabili photo.**

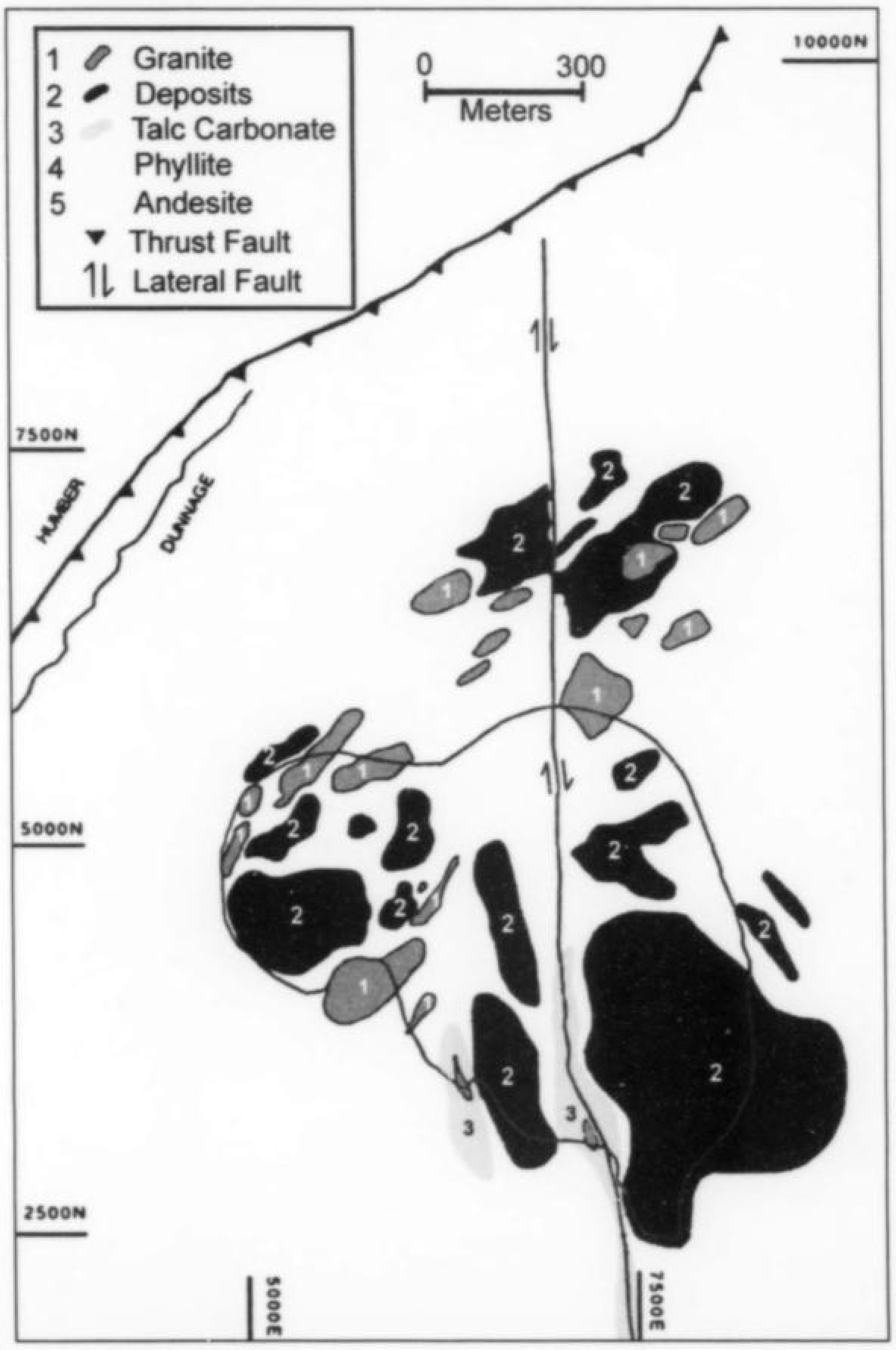


Figure 5. **Geology at the Lac d'Amiante mine; section at level 270 (after Bonin, 2001).**

whose water looked black: hence the name of the village of Black Lake, officially founded in 1906. The lake was not large—1.75 km long, 1 km wide, and about 14 meters deep—but the layer of clay and other sediments on the lake bottom was 33 meters thick.

By 1951, when the American Smelting and Refining Company (ASARCO) obtained from United Asbestos the mining rights for the region surrounding the lake, plans had already been made for the exploitation of the 60-million-ton asbestos orebody. In 1951 the geologist Stephen Ogryzlo of ASARCO studied the deposit and made 17 drill probes around the lake; the results regarding the potential of the deposit agreed with those of Théodore Koulomzine, who had done a magnetometer study of Black Lake for United Asbestos in 1949. Ogryzlo confirmed that beneath the lake there was an asbestos orebody of at least 60 million tons. In order to exploit this orebody, enormous and expensive preliminary work would have to be done: the lake's water and the clay lakebed would have to be removed, as would the river which fed the lake, and the provincial road which passed nearby. The cost of the operation would be $35 million.

The draining of the lake began on June 6, 1955, with an official ceremony attended by the president of ASARCO, C. Pryer. A machine called "Fleur de Lys" (named after the symbol of the province of Québec), able to pump 5,000 gallons/minute, was the star of the operations. It took three and a half years to remove the 38 million gallons of mud and clean the lake's bottom. During the draining operations, ASARCO built a modern plant to process 5,000

Figure 6. **Green andradite, 5.6 cm, from the Lac d'Amiante mine. Marco Amabili collection; Jeff Scovil photo.**

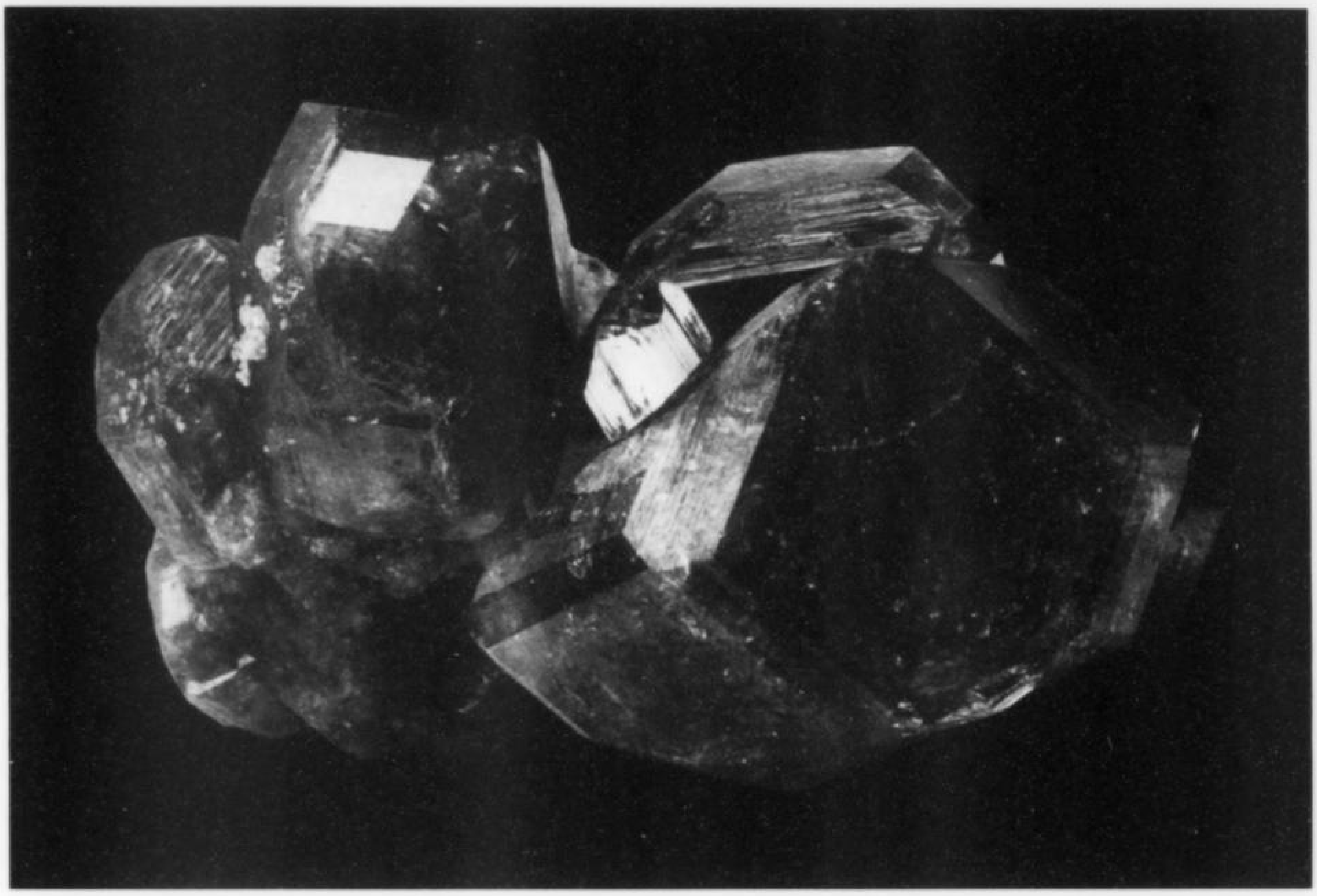


Figure 7. **Green andradite, 5.6 cm, from the Lac d'Amiante mine. Marco Amabili collection; Roberto Appiani photo.**

tons of ore per day. The plant started operation in June 1958, and at once the Lac d'Amiante mine became the third largest producer of asbestos in the world (after the Asbest deposit in the Urals and the Jeffrey mine in the nearby town of Asbestos). Between 1958 and 1979 the Lac d'Amiante mine produced 60 million tons of asbestos ore.

GEOLOGY

The rocks of the Québec Appalachians, Cambrian and Ordovician in age, are grouped into three major tectonic domains (Saint-Julien and Hubert, 1975). From west-northwest to east-southeast, these are the Autochthonous domain, the External domain and the Internal domain. The Autochthonous domain rests on a Precambrian Grenville-like basement and contains three recognized lithostratigraphic assemblages: (1) sandstones and carbonates (the shelf sequence), (2) shale and mudstone (the flysch sequence) and (3) red and green shales (the regressive sequence). These rock units have experienced almost no folding.

The External domain is divided into two zones: an outer belt of thrust-imbricated structures very similar to the lithologic assemblages of the Autochthonous domain, and an inner belt of nappes emplaced by gravity and composed of flysch, limestone, feldspathic sandstone and shale. The typical units of the Internal domain are shale-melange, slate-sandstone-tuff, calc-alkaline

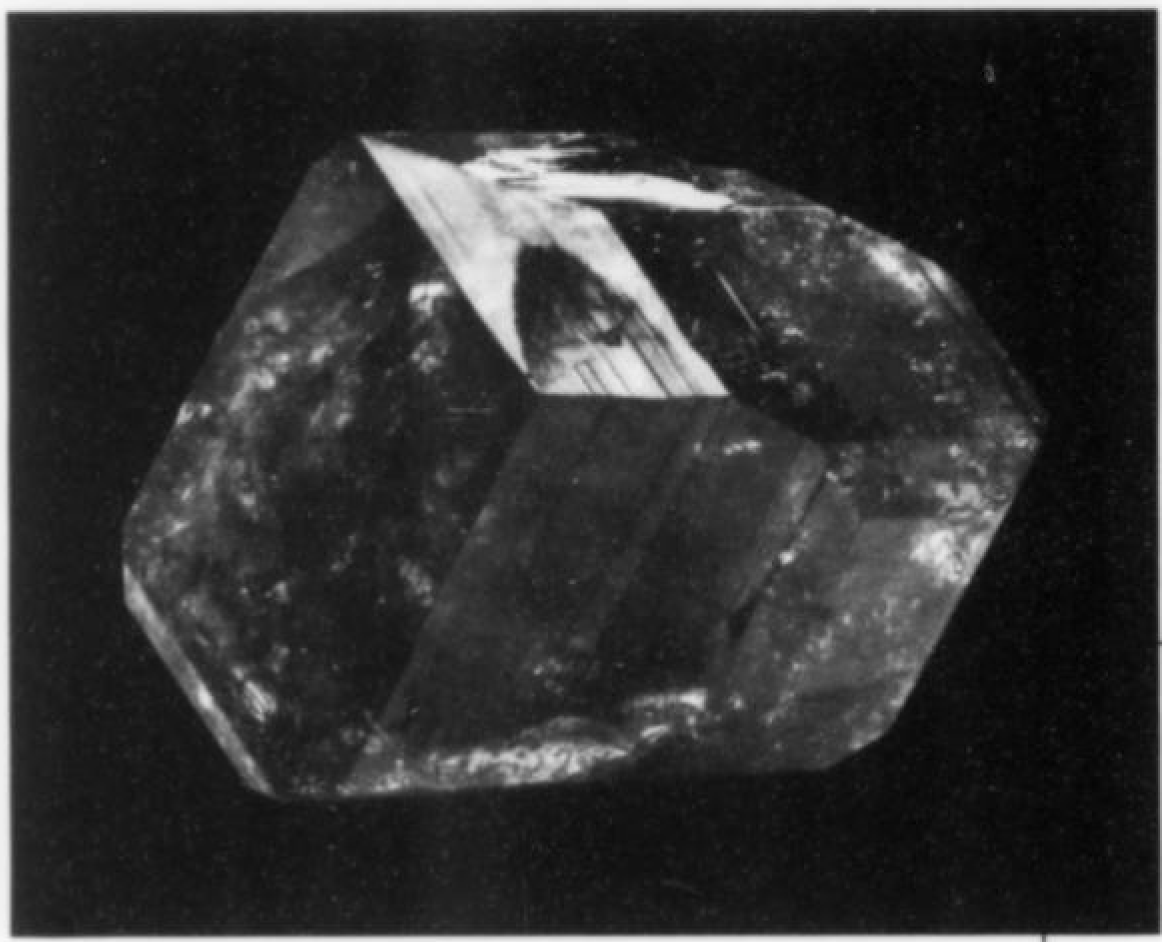


Figure 8. **Green andradite, 3.0 cm, from the Lac d'Amiante mine. Marco Amabili collection; Roberto Appiani photo.**

Figure 9. **Green andradite crystal group, 2.7 cm, from the Lac d'Amiante mine, Black Lake, Québec. Marco Amabili collection; Robert Appiani photo.**

Québec border and into Vermont's Green Mountains, and to the northeast as far as Newfoundland. The ophiolite marks the suture zone of a proto-Atlantic ocean named Iapetus. Working from K-Ar age determinations on hornblende and amphibolites from Asbestos, Laurent and Vallerand (1974) proposed an age of 550 million years for the ophiolitic rocks.

In the Lac d'Amiante mine there are three major ore zones. As in most asbestos deposits found in ophiolites, asbestos orebodies occur about 800 meters from the fault contact separating the enclosing volcanic assemblages and ophiolites. The ophiolitic complex lies structurally above the slate-graywacke assemblage of the Caldwell Group and is overlain by the rocks of the St. Daniel Formation, which is in contact on its southeast with the Beauceville Formation (Magog Group). All of these lithostratigraphic assemblages were shifted, slightly folded and metamorphosed 450 million years ago during the Taconian Orogeny, the first phase of the creation of the Québec Appalachians. This event began at the end of the Lower Ordovician period and finished in early Silurian time (Saint-Julien and Hubert, 1975).

A second phase in the evolution of the Québec Appalachians took place during the Acadian Orogeny, 400 to 360 million years ago. Important granitic intrusions, 380 to 370 million years old, were emplaced during that period.

The asbestos deposits of southern Québec are situated in a zone of mafic and ultramafic rocks called ophiolitic complexes. According to plate tectonic theory, ophiolites are remnants of oceanic crust trapped during orogenic events. These rocks are composed of marine sediments, basaltic pillow lavas, gabbro and diabase intrusions and ultramafic rocks of the earth's upper mantle. Ophiolites are rarely preserved as oceanic crust because they are swallowed in the subduction zones by the continuing movement of the oceanic plates. This is the case for the ultramafic formations associated with the folded rocks of the Sutton Notre Dame Mountains.

The ophiolite zone can be followed to the southwest, beyond the ultramafites from the older metasedimentary units. The host rock consists mainly of serpentinized peridotite (harzburgite). It still contains remnants of the original pyroxene, giving a coarse-grained mottled texture. Along the western margin of the deposit the rock is more intensely serpentinized; it is mostly glassy dark green or black serpentinite, with local alteration by granite dikes and sills.

The most prominent structural feature within the mine property is a faulted talc-carbonate zone striking nearly north-south and separating two orebodies. The footwall of the mining operations to the southwest could be a subsidiary of the main faulted talc-carbonate zone. The talc-carbonate unit is commonly highly foliated, with intercalated bands of felsic material. A second important structure is the series of intrusive dikes of granite and other felsic rocks, located on the western and northern sides of the mine. The dikes have a predominant 30° to 60° NE strike, and dip to the northwest. The collector-quality garnets, diopsides, vesuvianites, etc. are hosted by rodingite dikes that were formed by the hydrothermal alteration of some of the granitic dikes during serpentinization. The structure of the deposit is shown in Figure 5.

MINERALS

Andradite $Ca_3Fe_2^{3+}(SiO_4)_3$

Opaque brown andradite crystals, most commonly rhombic-dodecahedral, are not uncommon in the mine, but the beautiful,

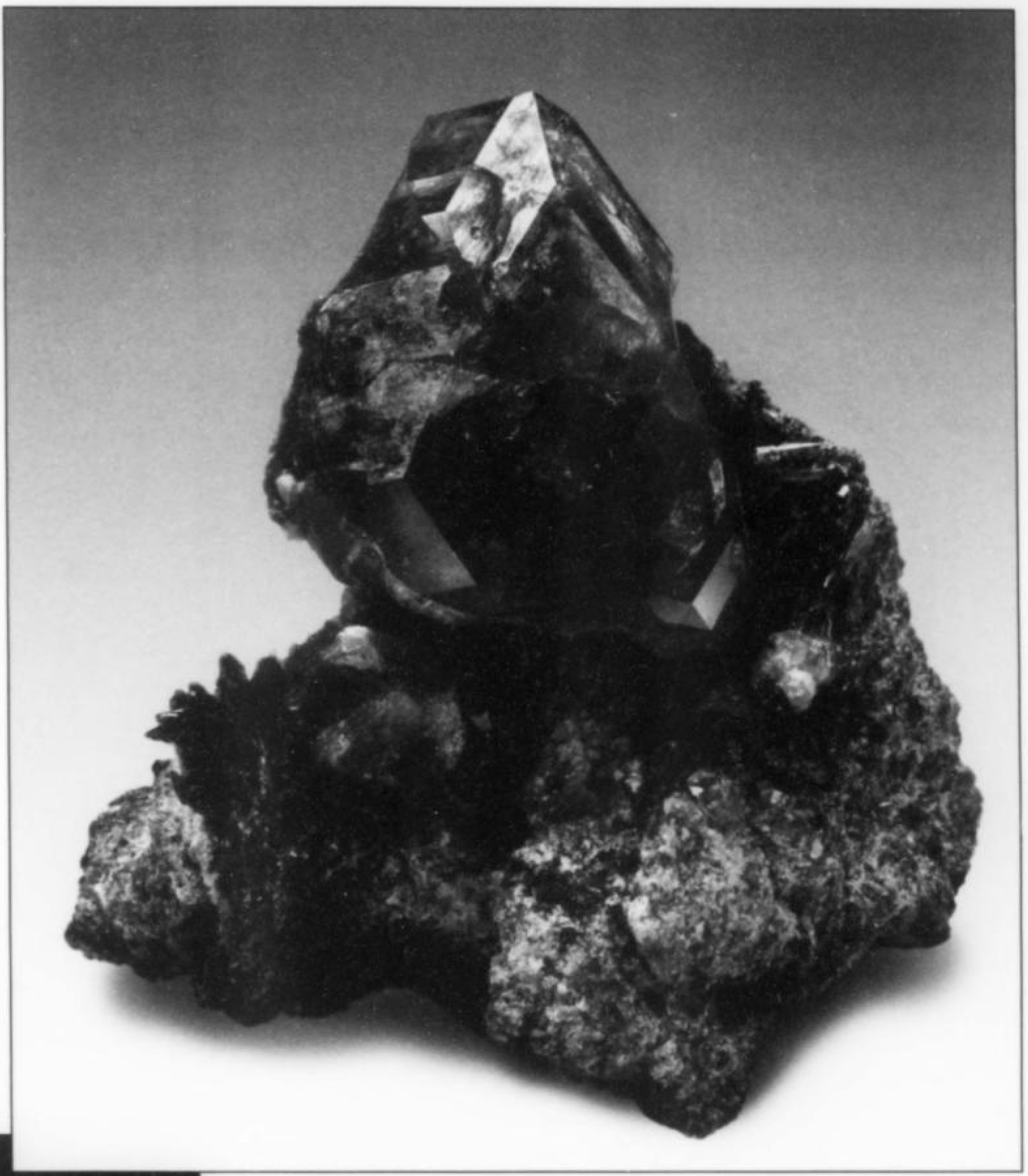


Figure 10. **Green andradite, 4.4 cm, from the Lac d'Amiante mine. Marco Amabili collection; Roberto Appiani photo.**

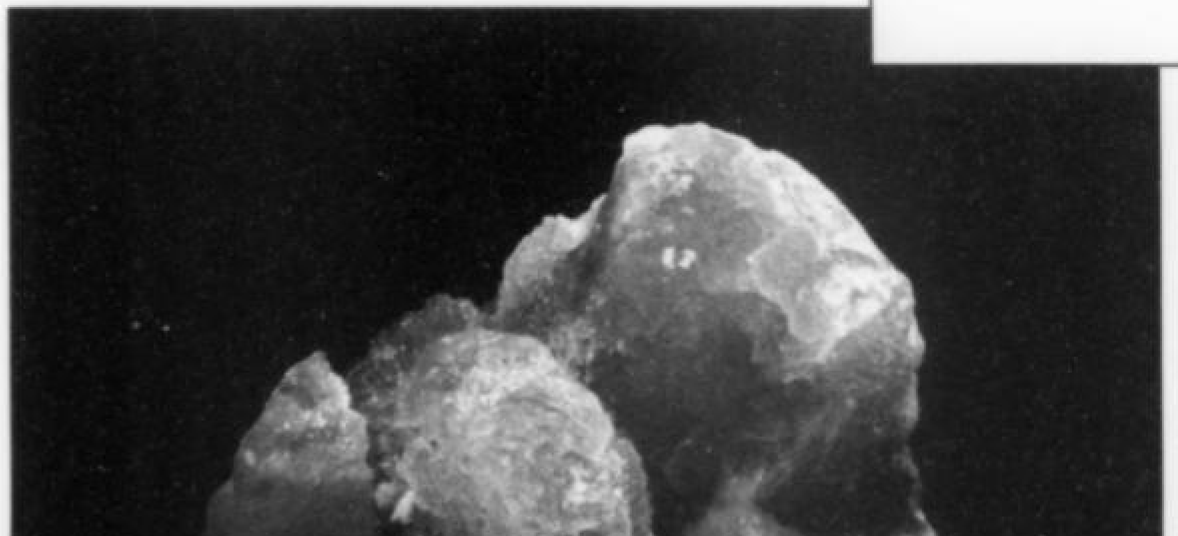


Figure 11. **Suolunite, 12 cm, from the Lac d'Amiante mine. Marco Amabili collection; Roberto Appiani photo.**

gemmy green trapezohedral crystals of the demantoid variety are extremely rare. Most demantoid crystals from Lac d'Amiante are only translucent, or are filled with internal fractures.

All green andradite crystals from Lac d'Amiante vary in color depending upon the light source (a property called metamerism), appearing pale green to emerald-green in sunlight and under neon lamps, and pale bluish gray-green to bluish green under incandescent and halogen lamps. The composition of the andradite crystals has recently been analyzed by Federico Pezzotta, using an EDS microprobe in the laboratory of the Natural History Museum of Milan, Italy. The analysis confirmed the presence only of calcium, iron and silica in stoichiometric quantities for garnet, indicating a composition close to end-member andradite.

Matrix specimens showing sharp, lustrous demantoid crystals of lovely emerald-green color (in sunlight) up to 2.5 cm were collected around 1997 (Figs. 9, 10). The first discovery of similar crystals at Lac d'Amiante had been made only a few years earlier. The total number of specimens recovered in the late 1990s was very small. After that time, green andradite garnets of good quality have been found only once, in September 2006, when loose crystals to 3 cm were collected, a few of these making it to the 2007 Tucson Show (Moore, 2007). Most of these crystals have a beautiful emerald-green color (in sunlight), ranking them among the finest demantoid crystals ever found.

A few of the demantoid specimens are associated with small, dark, acicular crystals, probably of vesuvianite. One unique specimen (Figs. 6 and 7) is a 2.7 × 5.6-cm group of six sharp, lustrous, emerald-green andradite crystals to 3 cm, joined by a white albite blade; this specimen was brought to the 2007 Sainte Marie-aux-

Mines show (Larson, 2007), and a photo of it was published in the same year in *Le Régne Minéral* (no. 76, page 17) and *Rivista Mineralogica Italiana* (vol. 31, no. 4, page 285). This is the only demantoid specimen recovered at that time which is not a single loose crystal.

Suolunite $Ca_2Si_2O_5(OH)_2 \cdot H_2O$

Suolunite was described from a locality in Inner Mongolia (China), but the only collector-quality specimens known are from a single isolated occurrence at the Lac d'Amiante mine. About 30 cabinet-size specimens offered by a Canadian dealer at the 2002 Tucson Show display suolunite microcrystals packed into deep purple-blue to pale lilac mammillary crusts with glittering surfaces, mostly without matrix (Moore, 2002). The specimens came from a collecting site in the mine (now completely exhausted) discovered at some time between 1996 and 1999 by a young geologist from Thetford Mines, who originally classified the mineral as prehnite.

Some specimens from the find, considered not valuable, were sold to well-known collector and mineral dealer Charles Key, who had them analyzed. When Key sold his collection of Canadian minerals to the Royal Ontario Museum in Toronto, the occurrence of suolunite in the Lac d'Amiante mine became publicly known. In February 2001 the Royal Ontario Museum exhibited at the Tucson Show the just-acquired Charles Key collection, including suolunite specimens from Black Lake.

Figure 12. **Stellerite crystals to 5 mm on yellow calcite, from the Lac d'Amiante mine. Marco Amabili collection; Roberto Appiani photo.**

Other Species

The Lac d'Amiante mine is listed in several classical mineral books as the source of huge **natrolite** crystals, not found recently. Moreover, the mine has yielded good, gemmy orange **grossular** crystals, paler than similar crystals from the Jeffrey mine at Asbestos. It has also produced (as mentioned) brown opaque **andradite** garnets, globular **prehnite**, colorless and transparent **apophyllite-(KF)**, **stilbite**, **stellerite**, **chabazite-Ca**, dark **vesuvianite** in acicular crystals, **zoisite** (as the pink variety "thulite"), **albite**, **clinochlore**, **antigorite**, **nephrite**, **chrysotile**, **rutile**, **galena**, **pyrite**, **magnetite**, **chromite**, **diopside**, **aragonite**, fine yellow **calcite** and **quartz** (andradite, calcite and quartz are very rare at the famous Jeffrey mine at Asbestos).

Fine yellow calcite crystals associated with white stellerite were collected in 1999 (Fig. 12). The list of minerals could be expanded, but the mineralogy of the mine has not yet been accurately studied. The presence of minerals of the zeolite group is quite interesting, as well as the presence of both green andradite and orange grossular of gem quality. An interesting suite of minerals from the mine is owned by the *Musée Minéralogique et Minier* in Thetford Mines, but the world-class green andradite crystals can be seen only in a few private collections.

CONCLUSION

Unfortunately, the depressed market for asbestos has led to a cutback in mining at Black Lake. Future discoveries of minerals at the mine may have to wait for an increase in the demand for asbestos. During the current period of reduced, intermittent mining activity, which began in 2003, about 400 miners have been employed at the mine.

ACKNOWLEDGMENTS

The authors thank Dr. Federico Pezzotta of the Natural History Museum of Milan, Italy, for the analysis of the green andradite crystals.

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APATITE-(CaF) with Siderite and Arsenopyrite, 6.5 cm, from Panasqueira, Portugal
Acquired from Rene Daulon in February 2000. Jeff Scovil photo.

Fluorite from Riemvasmaak

Northern Cape Province, South Africa

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The isolated settlement of Riemvasmaak has become famous in recent times for the vibrant green fluorite collected in the region. Octahedral and modified cuboctahedral crystals are the most common, though other crystal habits and colors including blue, purple, orange, yellow and colorless have been found there.

INTRODUCTION

Riemvasmaak (pronounced "reem-fuss-mark") is located 57 km northwest of Kakamas in the Northern Cape Province of South Africa, between the Orange River and the Molopo River. The present-day settlement is a few kilometers north of the Molopo River. Riemvasmaak can be reached via a dirt road from Kakamas, arriving at a boomed entrance where a fee is payable. This allows access to the local area, and most visitors then proceed on to the motoring or the hiking trails in the area. At Riemvasmaak, there is a small village housing about 1,500 residents, some of whom explore the surrounding areas and dig for mineral specimens.

The literal translation of *Riemvasmaak* is "to tie with rawhide." The name[1] supposedly dates back to the 1900s when some Bushmen who lived in the area were caught stealing the local community's livestock. They were tied to a large boulder in the Molopo River with rawhide thongs (called *rieme* in Afrikaans), but they escaped. From that time on, the area is said to have been known as Riemvasmaak and the community members as the "Riemvasmakers." An alternate explanation is that it simply refers to tying one's horse up to a hitching post. Yet another theory is that it refers to the tying of oxen with leather thongs to an ox wagon. It seems that tying things up was a common preoccupation of people in the region, because a nearby locality is called "Bokvasmaak" which translates into "tie up the goat."

[1] http://www.openafrica.org/participant/riemvasmaak-ecotourism-project.

HISTORY

Though Riemvasmaak is famous now among mineral collectors, its political history is rather infamous. In 1933, governmental permission was given to people of four different ethnic groups (namely the Xhosas, Damara, Nama and Herero) to settle and farm in the Riemvasmaak area. However, 40 years later, in 1973 and 1974, under the apartheid policy of the former Nationalist South African government, the people of Riemvasmaak were forcibly removed from their land. The Xhosa people were moved to the Eastern Cape Province where they originally came from and the Damara, Nama and Herero people were relocated back to Namibia, their ancestral land. Their houses were burned down to ensure that there was nothing left for them to return to. To make matters worse, these people

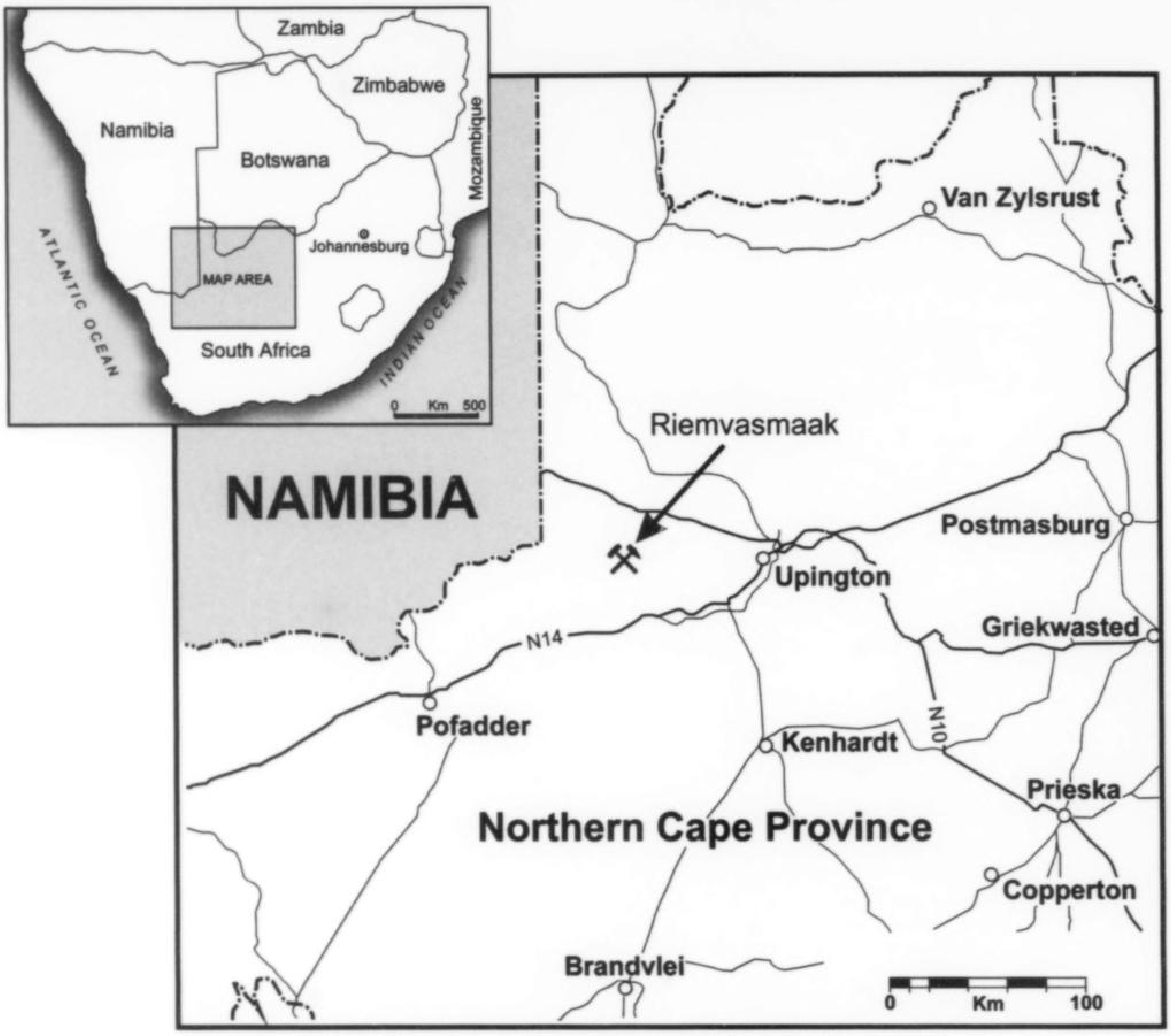


Figure 1. **Location map of Riemvasmaak in the Northern Cape Province of South Africa.**

were treated with open hostility by the communities already living in Namibia and the Eastern Cape.[2] After the local residents had been deported, the South African Defence Force used Riemvasmaak as a military zone and training ground because of its proximity to the Namibian border. Later, in 1984, a portion of Riemvasmaak known as Melkbosrand, was incorporated into the adjacent Augrabies Falls National Park in 1982 (SADF, 1990).

In February 1994, the newly elected democratic government decided to give Riemvasmaak back to its original occupants. This was part of the still-ongoing land reclamation program that followed the downfall of the apartheid government. Riemvasmaak was one of the first land restitution projects under the democratic dispensation, and had a high political profile. The land returned to the community covers about 75,000 hectares in the Northern Cape Province. The reclaimed land is adjacent to the Augrabies Falls National Park (Immink, 1976) and is bordered by the Orange River in the south, private farms in the north and Namibia in the west (Macleod, 2004). The formal handing-over ceremony took place in 2008 (Botha, 2008). Today the land returned to the Riemvasmakers is being farmed for export grapes and dried peaches, and is valued at R28 million (about $3.5 million). A trust managed by members of the local community has been formed to protect the interests of the people.

[2]http://www.tvsa.co.za/forum/calendar.

Riemvasmaak today is a tourist destination favored by the off-road four-wheel drive fraternity because the rugged, mountainous terrain is well suited for this kind of adventure. There are rustic chalets close to a hot spring on the Molopo River and several hiking trails in the area. The arid climate can be challenging, with mid-summer temperatures averaging around 100°F and the summer maximum reaching close to 122°F. The average annual rainfall is barely 100 mm, but some years may pass with no rainfall at all.

A comprehensive survey of the area's natural resources, including a summary of the local geology, is contained in Hoffman *et al.*, (1995).

GEOLOGY

The Riemvasmaak fluorite deposit is located in the Namaqua-Natal Metamorphic Province (NNMP), dated at 1.30 to 1.03 billion years. The province has been subdivided into three zones, the Areachap, Kakamas and Bushmanland terranes (Thomas *et al.*, 1994); the Kakamas terrane contains the fluorite deposits. The NNMP is a high-grade metamorphic terrane that has been subjected to multiple episodes of metamorphism, structural deformation and intrusion by syntectonic and post-tectonic granitoids (Geringer and Botha, 1977). Because of its geological complexity and tectonic origin, the NNMP has been studied for decades, as summarized by van Niekerk (2006).

The local Kakamas terrane geology at Riemvasmaak consists

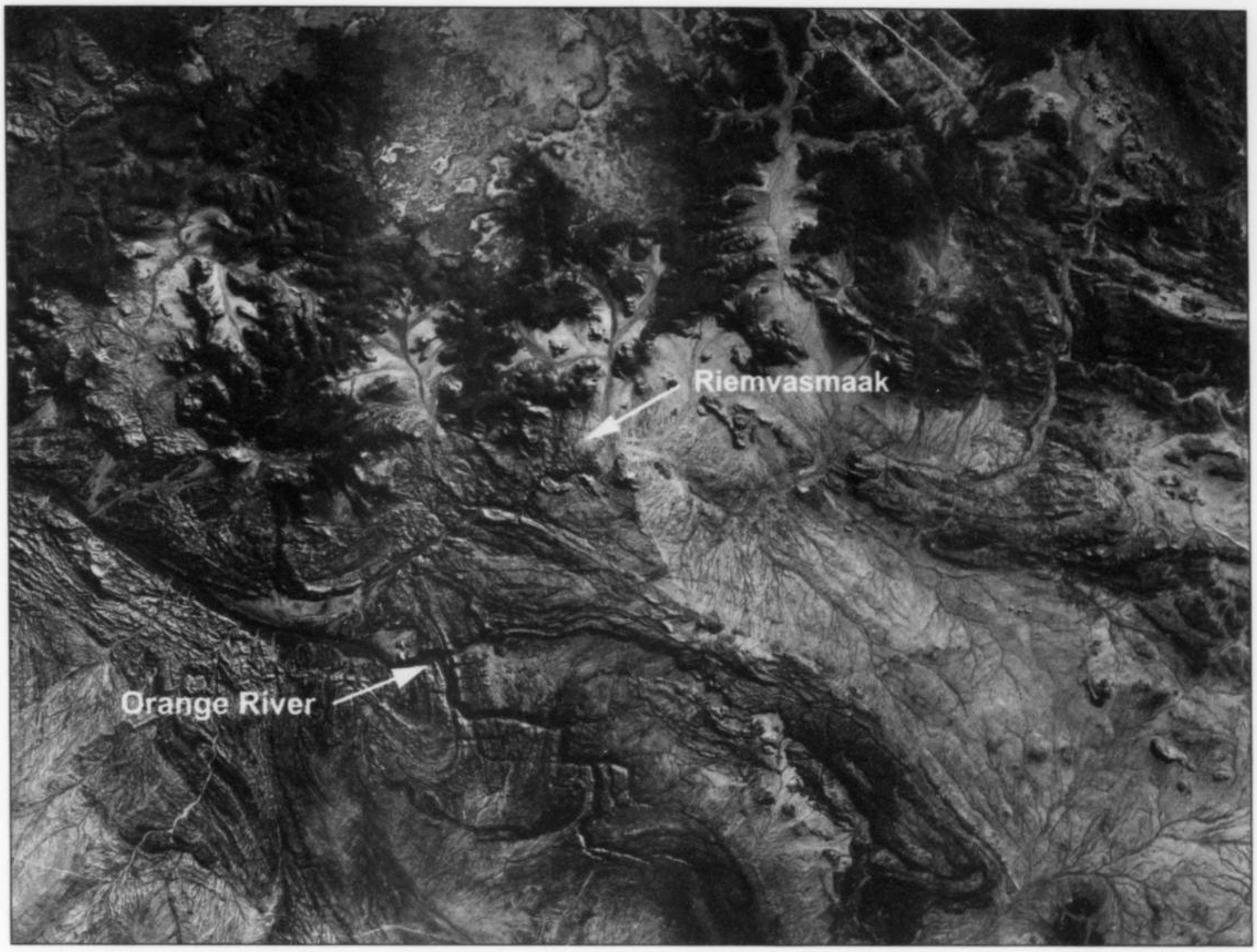


Figure 2. **Landsat image of geology and topography of Riemvasmaak and surrounding terrain. Source: https://zulu.ssc.nasa.gov/mrsid**

Figure 3. **Entrance sign to Riemvasmaak village. Bruce Cairncross photo.**

mainly of pink granitic gneisses known collectively as the Kokerberg Gneiss, which is equivalent to the Riemvasmaak Formation (Geringer and Botha, 1976a, 1976b). Syntectonic and late-tectonic granites have intruded into these gneisses. Covering these ancient rocks, to the west and northwest of Riemvasmaak, are much younger (550 million years) sedimentary rocks of the Nama Group. These consist of sandstone, shale and conglomerate, and form the flat-lying plateau escarpment.

The NNMP rocks that surround the Orange River in general are characterized by hundreds of pegmatites and a myriad of smaller

***Figure 4.* View looking towards the northwest from one of the hills where fluorite is being recovered in the Riemvasmaak area. Paul Balayer photo.**

quartz veins (Hugo, 1969). At Riemvasmaak, some of these are hosted in the pink gneiss, and others in intrusive grey gneiss, granulite, and amphibolite as well as schist (von Backström, 1962 and 1967). Many are small, uneconomical pegmatites but some, close to Riemvasmaak village, have been exploited in the past, such as the Riemvasmaak and Mosterhoek pegmatites (Hugo, 1969). Approximately 40 pegmatites crop out to the north of Riemvasmaak; the Riemvasmaak pegmatite *per se* is 60 meters long and 3 meters wide, and is one of the larger pegmatites exposed 3 km north of the Riemvasmaak village.

Rare-earth element minerals including gadolinite were sporadically mined at the Riemvasmaak pegmatite over 50 years ago. Approximately 140 kg of gadolinite was produced during 1945 from a small mineralized portion of the pegmatite estimated to contain 0.1 % rare earth minerals.

The Mosterthoek pegmatite is situated approximately 10 km west of the Riemvasmaak pegmatite and was mined for beryl. It is 1000 meters long and 7 to 30 meters wide. The pegmatite is hosted in gray gneiss and consists of albite, cleavelandite, quartz, muscovite, beryl, schorl and columbite-tantalite. Some of the beryl crystals found there were up to 1 meter in diameter. According to Hugo (1969):

> Fluo-spar [sic] occurs only in the complex and poorly zoned homogeneous pegmatites. It commonly forms irregular aggregates, in places several feet in diameter, in the quartz-perthite cores. In general, these masses seem to have partially replaced the minerals in the cores.

***Figure 5.* An excavated fluorite pocket at Riemvasmaak. Fernando Abrandis photo.**

Although fluorite is present in some pegmatites, it has never been commercially mined because the distribution is too patchy and irregular to yield minable tonnages.

Of interest in this arid region is a thermal hot water spring, located a few kilometers from the Riemvasmaak settlement. Water flows out from the pink gneiss in the bed of the Molopo River in the bottom of a scenic canyon. Water temperatures reach 38°C (101°F). This spring is the only local, natural source of perennial

Figure 6. **Local diggers extracting fluorite from Fernando Abrandis' diggings in the Riemvasmaak area. Fernando Abrandis photo.**

Figure 7. **Extensive diggings exploiting fluorite pockets at Riemvasmaak. Fernando Abrandis photo.**

water; the next closest water is in the Orange River. The spring is estimated to yield approximately 1800 liters/hour (von Backström, 1962). The point of emergence of the spring is not associated with any clearly definable geological feature such as a fault or joint. The thermal water appears to be meteoric (rainfall) in origin, having percolated to sufficient depth along suitable fractures and joints to achieve the high temperature.

FLUORITE

For a few years now, fluorite specimens have been trickling out of the "Orange River" area, and Riemvasmaak is certainly not the only place where specimens can be collected. But it is now the best known, because of the vibrant green octahedral and modified cuboctahedral crystals that have reached the specimen market in recent years (Cairncross, 2006; Wilson, 2006; Polityka, 2007; Moore, 2007). Other localities producing fluorite are nearby

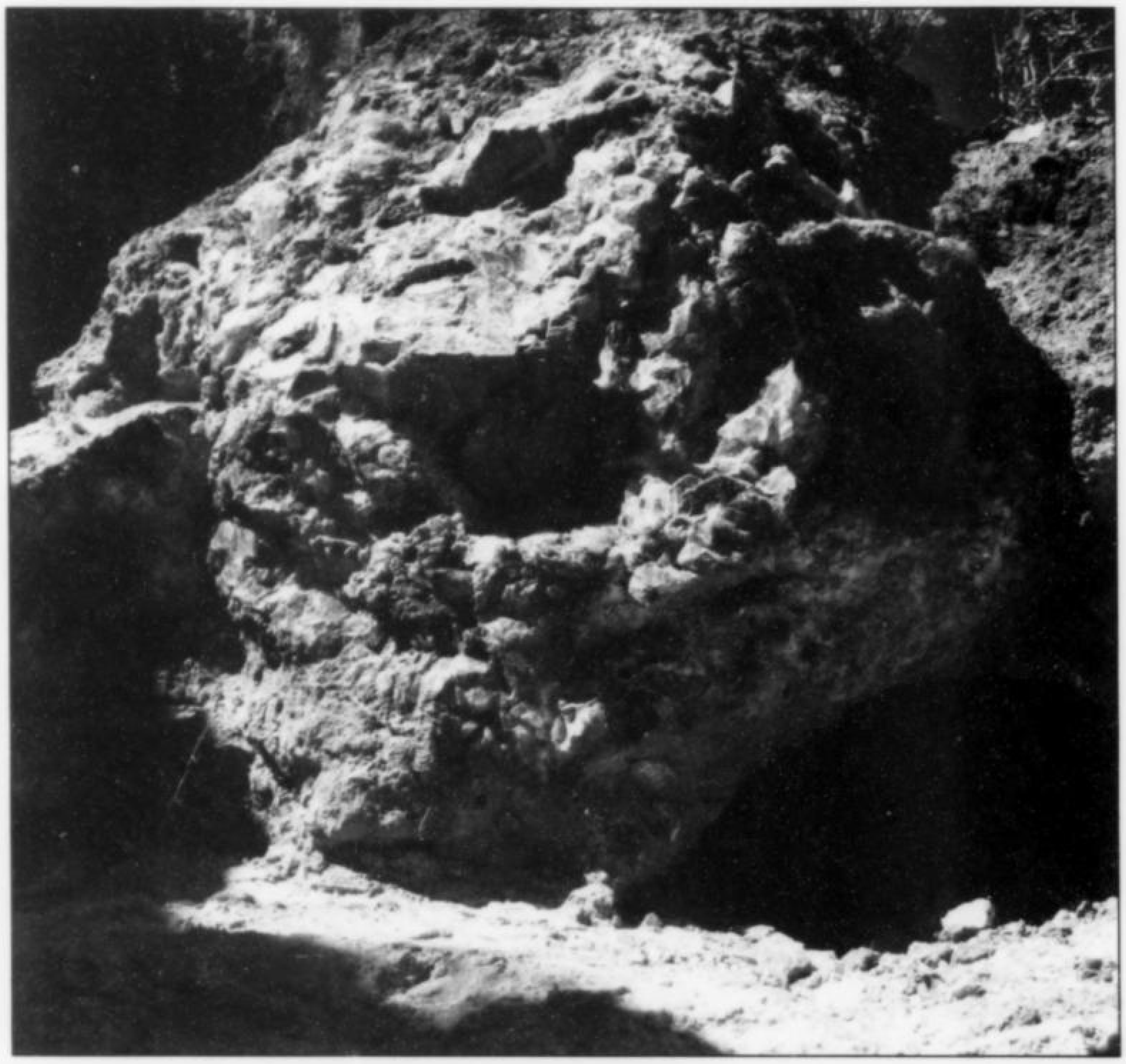
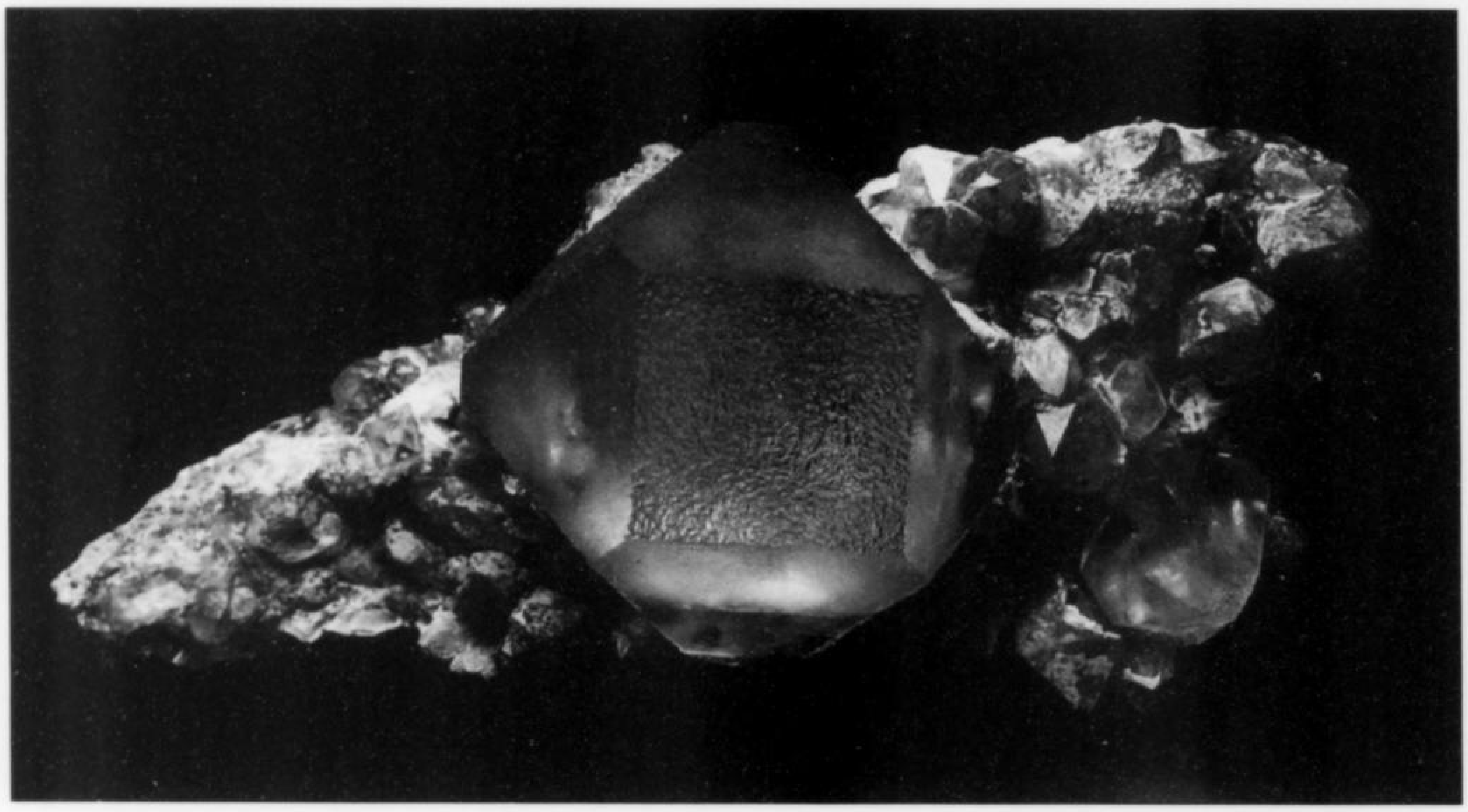


Figure 8. **Exposed Riemvasmaak pocket lined with quartz-coated octahedral fluorite crystals. Fernando Abrandis photo.**

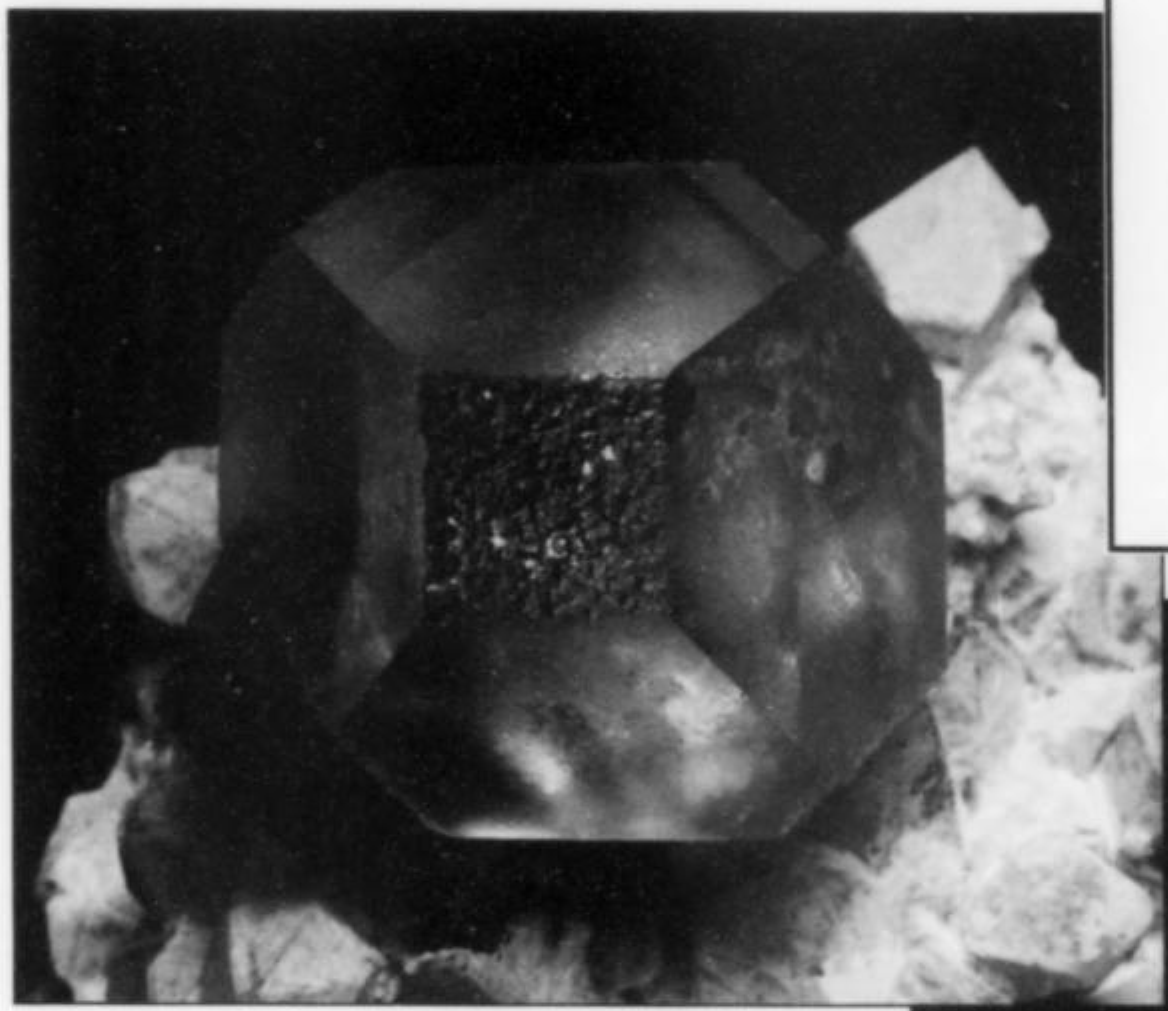
Figure 9. **Modified cuboctahedral fluorite on quartz, 13.5 cm, from Riemvasmaak, Northern Cape Province, South Africa. Desmond Sacco collection; Bruce Cairncross photo.**



Warmbad on the Namibian side of the Orange River, and various diggings close to Pella.

In general, the fluorite matrix consists of euhedral quartz crystals or host-rock granitic gneiss. The quartz crystals from the Warmbad area tend to be transparent to translucent and aesthetic while the Riemvasmaak matrix quartz is more milky. Apart from fluorite, hematite-included red quartz also occurs with the fluorite at Riemvasmaak, as it does in many other localities, hence the general description of "Orange River quartz" for these specimens. Sporadically, during 2006, green octahedral fluorite was found on purple amethyst and/or overgrowing earlier-formed purple fluorite. These color combinations, of green fluorite, purple amethyst and red hematite-included quartz, produce aesthetic specimens. Rarely, dark purple amethystine quartz is intergrown with the red hematite-included quartz. Where this material is associated with green fluorite, the color combinations are striking.

The discovery of collectable fluorite from the "Orange River" region was preceded by attractive hematite-included red and orange quartz crystals that entered the collector market *en masse* during the mid to late 1990s. The fluorite only appeared later, in about 2004, and then was not really appreciated until the drusy quartz coatings



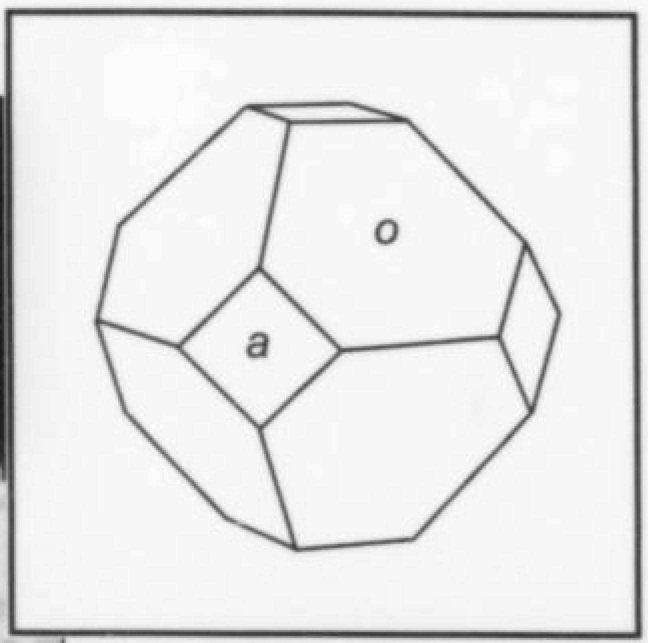


Figure 10. (left) **Transparent, modified cuboctahedral fluorite, 3.9 cm, on quartz from Riemvasmaak. Desmond Sacco collection; Bruce Cairncross photo.** ***(Inset)*** **Generic crystal drawing showing the Riemvasmaak fluorite habit (after Goldschmidt, 1918).**

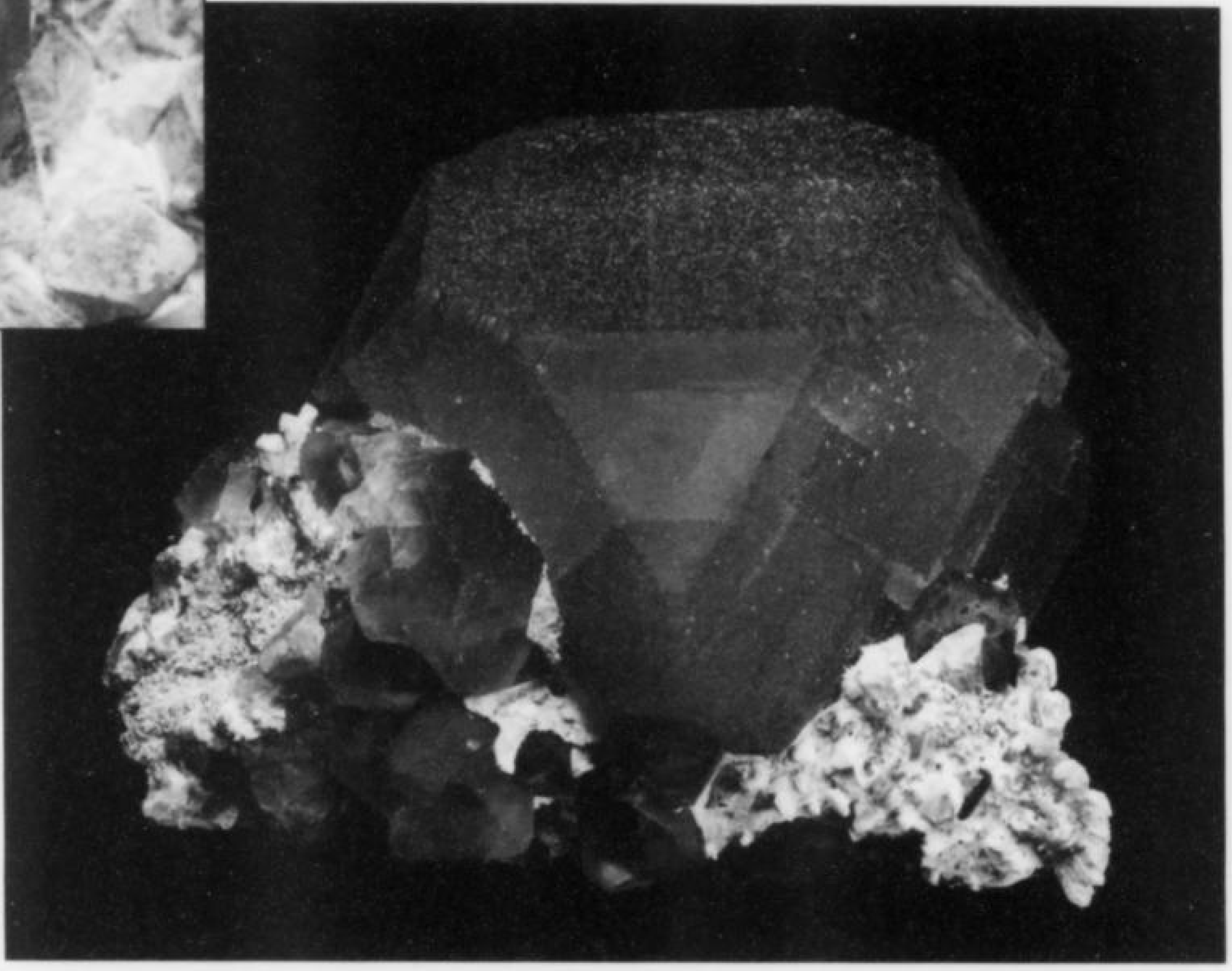


Figure 11. (right) **A large 10-cm diameter modified cuboctahedral fluorite on quartz, from Riemvasmaak. Desmond Sacco collection; Bruce Cairncross photo.**

Figure 12. (below) **Large group of octahedral fluorite crystals, 23.4 cm, from Riemvasmaak. Ronnie McKenzie collection; Bruce Cairncross photo.**

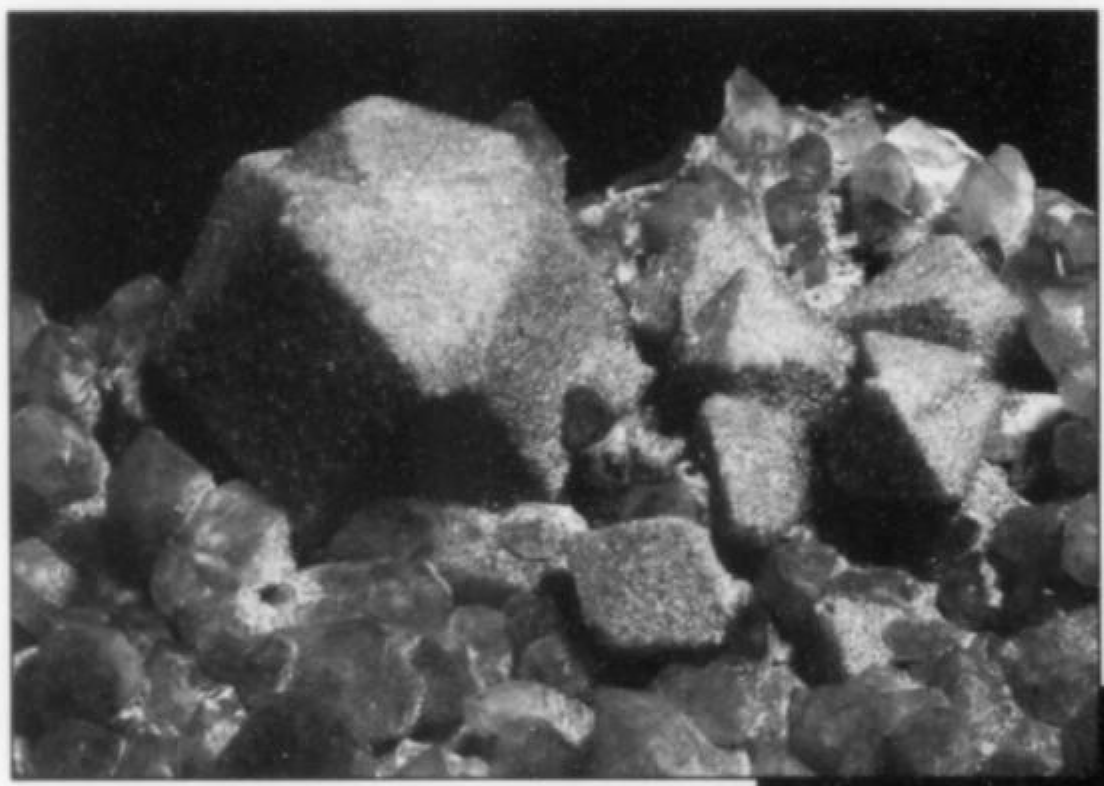
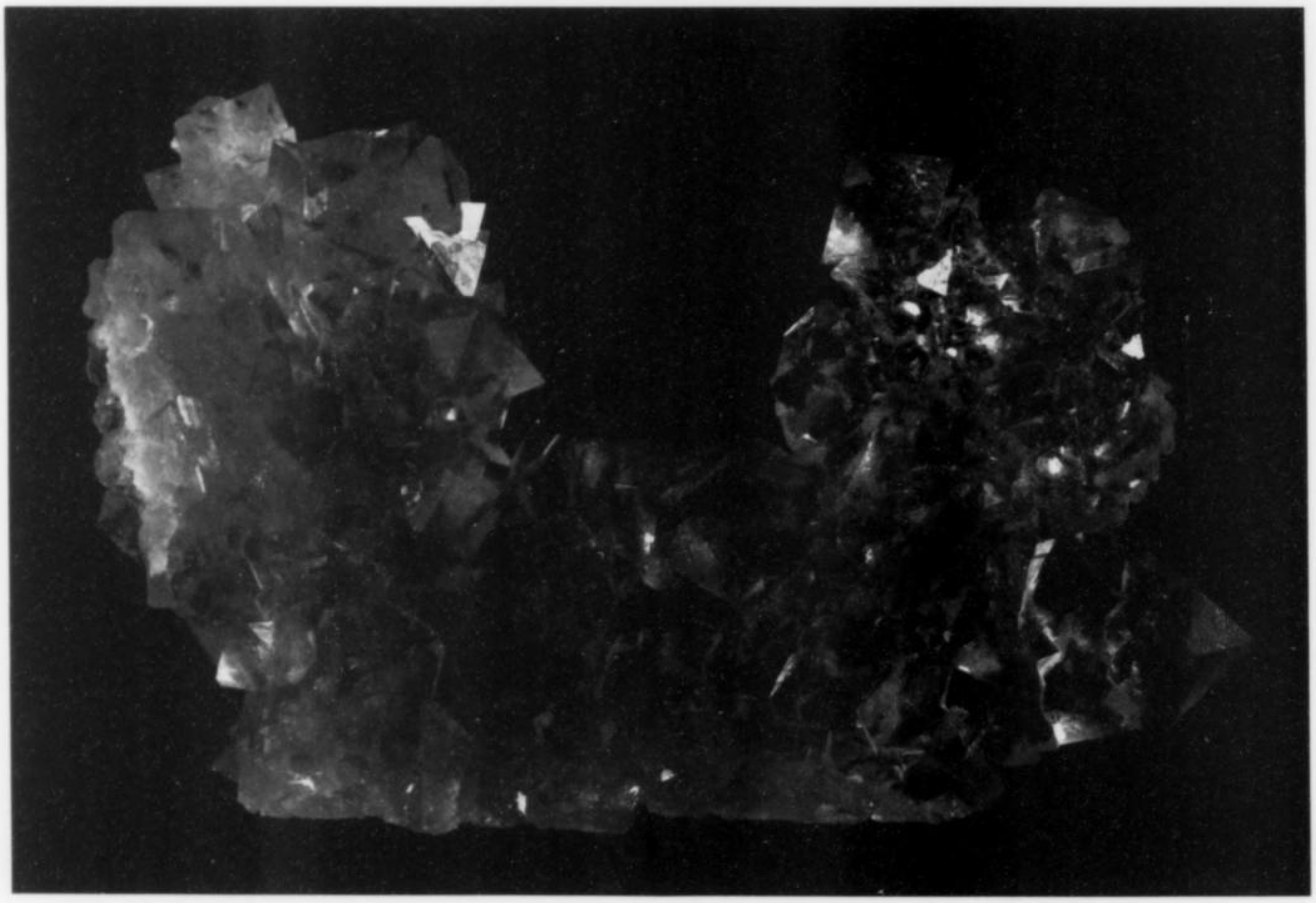


Figure 13. **An untreated specimen of fluorite on quartz, 14 cm, from Riemvasmaak. This piece is somewhat unusual because it contains octahedral fluorite together with the modified cuboctahedral habit on one specimen, a rare association. Bruce Cairncross collection and photo.**

Figure 14. **The same specimen as that shown above, after cleaning.**

Figure 15. **A cluster of glassy octahedral fluorite crystals, 6.8 cm, from Riemvasmaak. Ronnie McKenzie collection; Bruce Cairncross photo.**



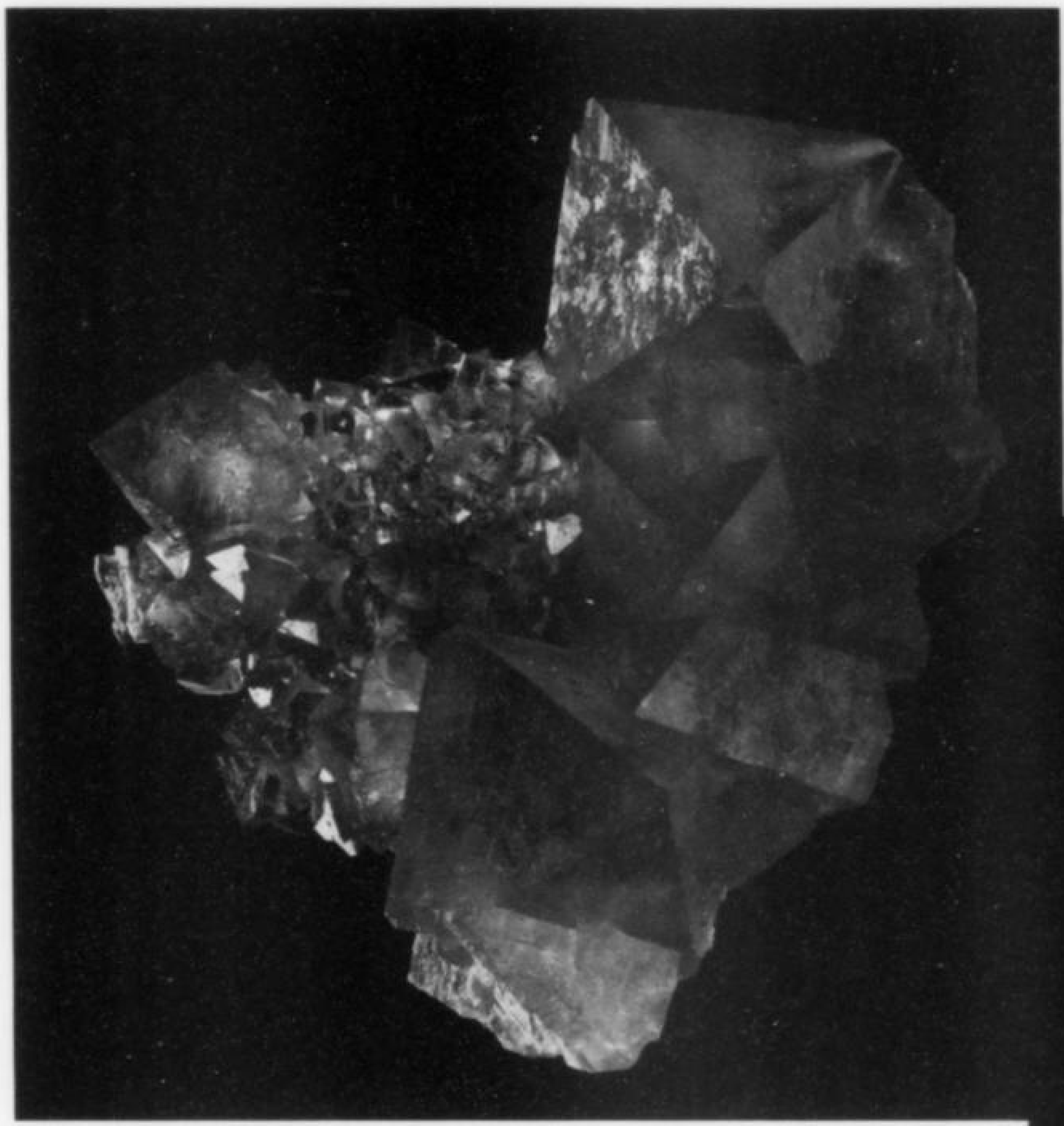


Figure 16. **Fluorite, 7.5 cm, from Riemvasmaak. Ronnie McKenzie collection; Bruce Cairncross photo.**

Figure 17. **Single octahedral fluorite perched on fluorite matrix, 3.4 cm, from Riemvasmaak. Uli Bahmann collection; Bruce Cairncross photo.**

Figure 18. **Isolated octahedral fluorite on quartz, 10.1 cm, from Riemvasmaak. Paul Balayer collection; Bruce Cairncross photo.**

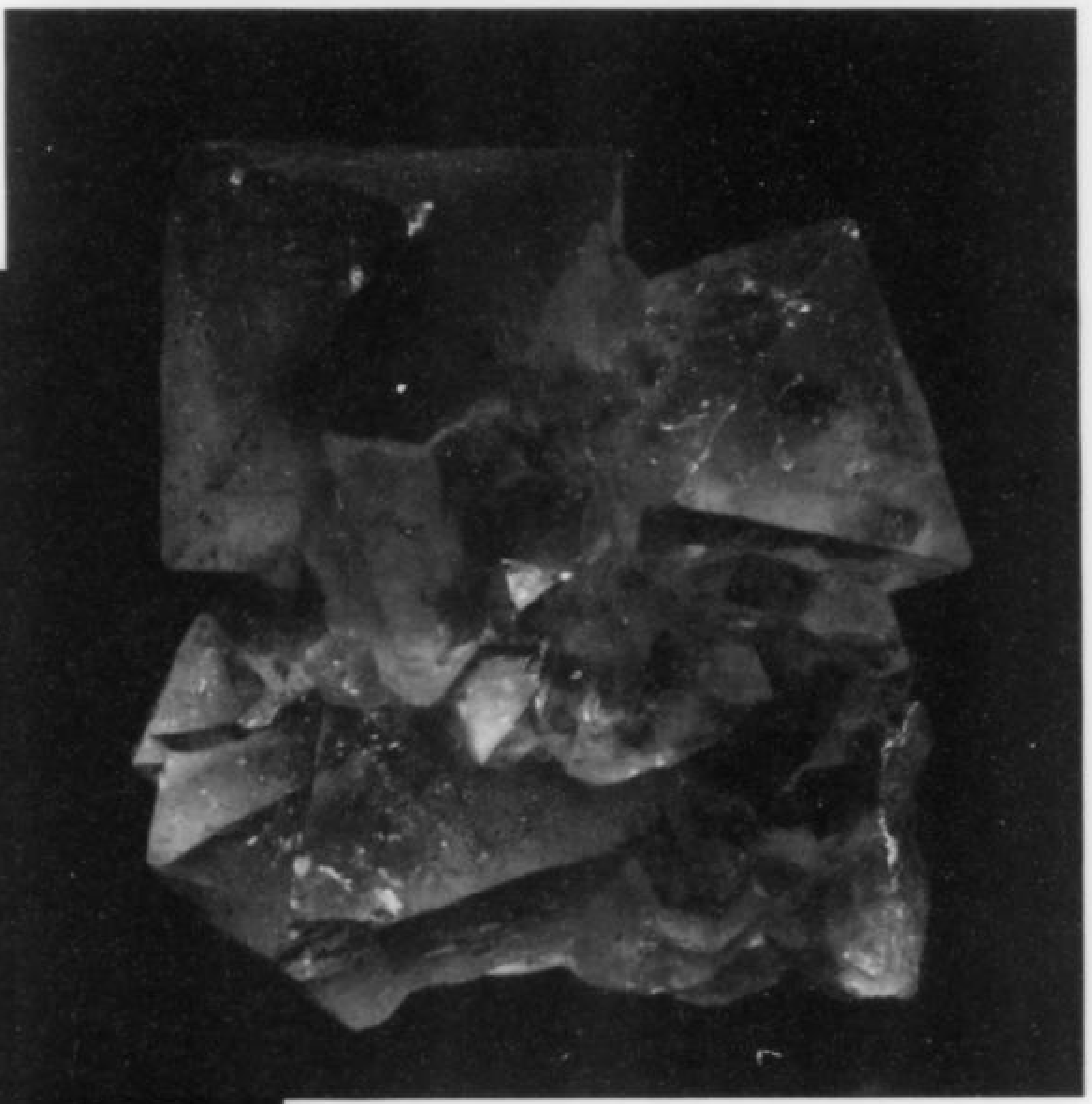
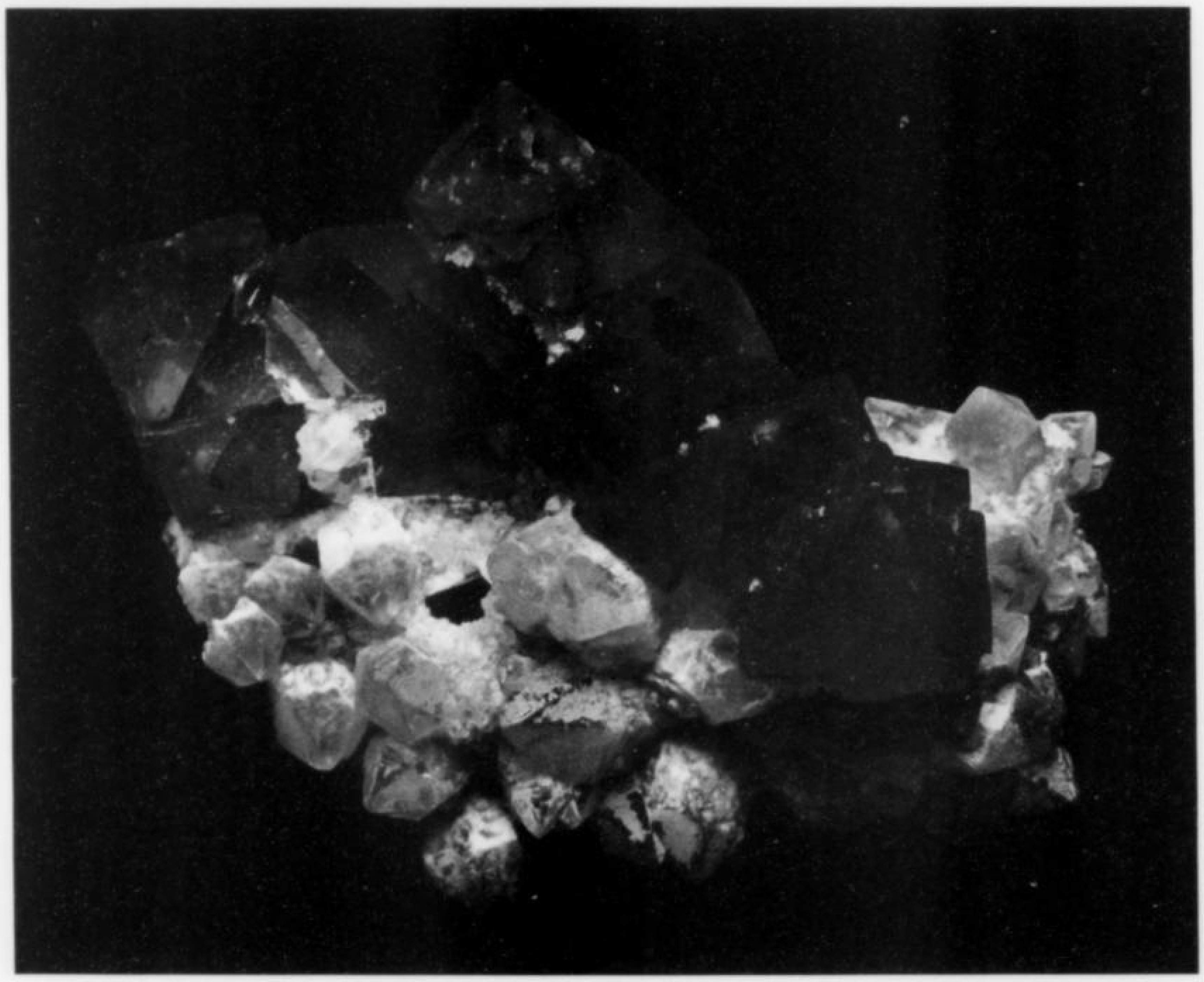
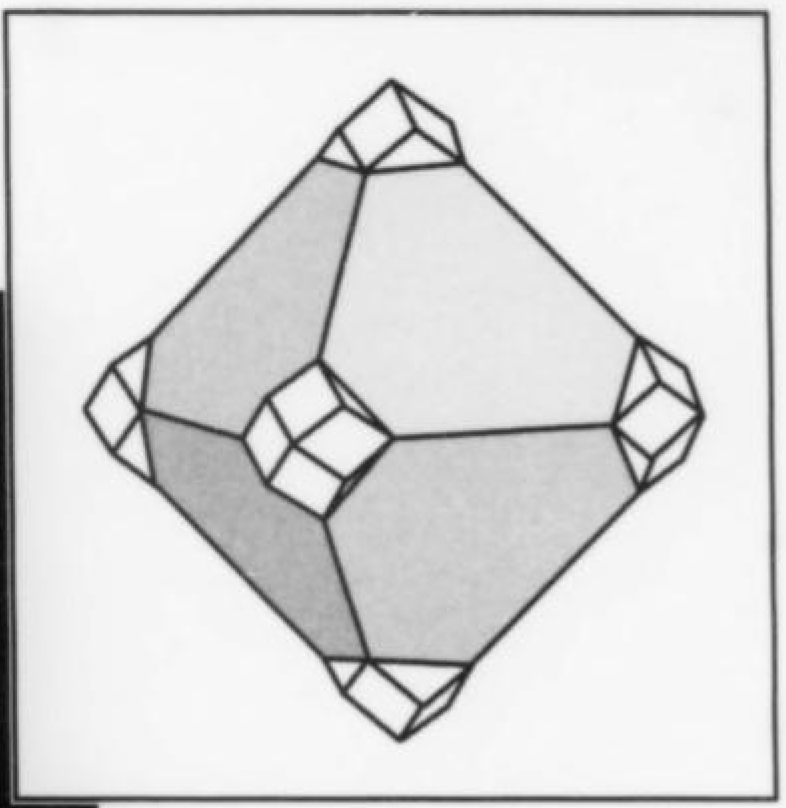


Figure 19. **Gemmy octahedral fluorite, 5.6 cm, from Riemvasmaak. Paul Balayer collection; Bruce Cairncross photo.**

Figure 20. **Stacked octahedral fluorite, 8.2 cm, from Riemvasmaak. Uli Bahmann collection; Bruce Cairncross photo.**

Figure 21. **Group of cascading, gemmy fluorite on quartz, 6.9 cm, from Riemvasmaak. Paul Balayer collection; Bruce Cairncross photo.**





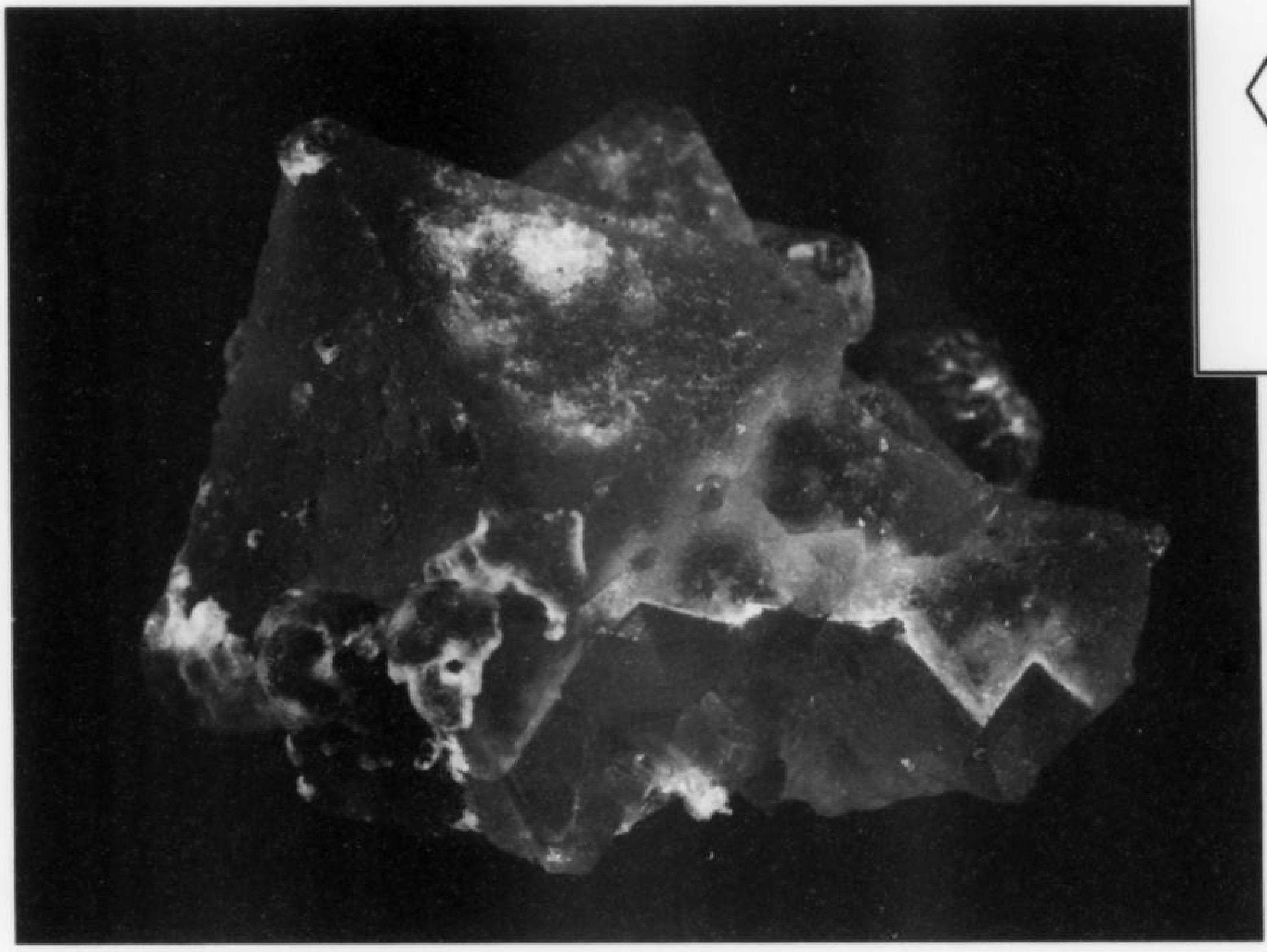
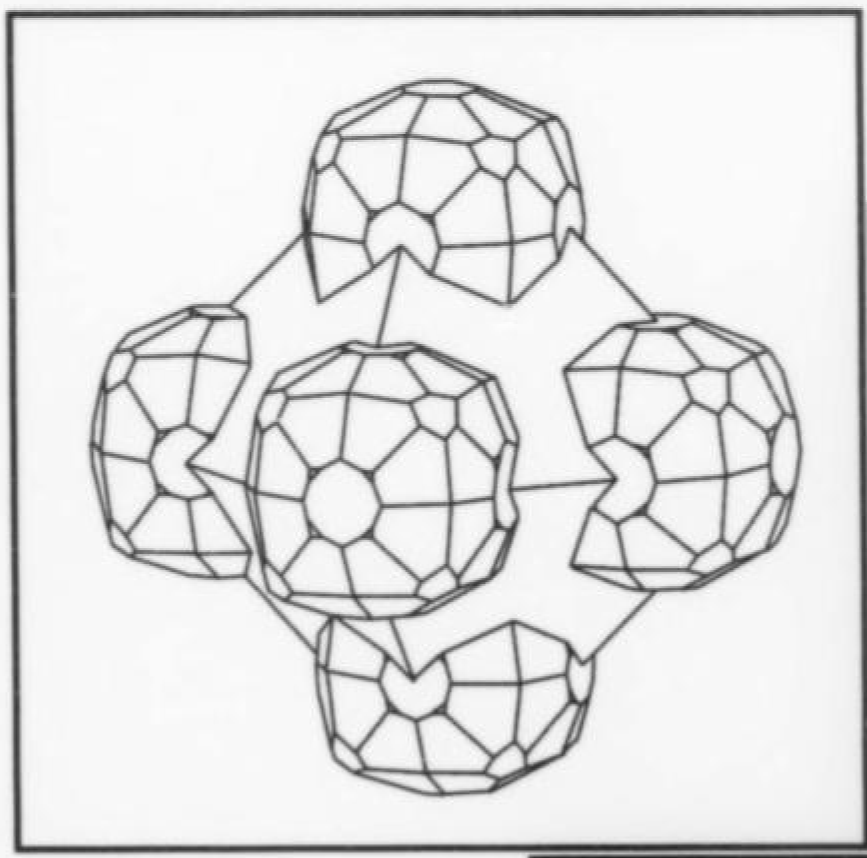


***Figure 22*. Octahedral fluorite with second-generation epitactic fluorite, 4.2 cm, from Riemvasmaak. Bruce Cairncross collection and photo. *(Inset:)* Fluorite crystal drawing after Goldschmidt (1918).**



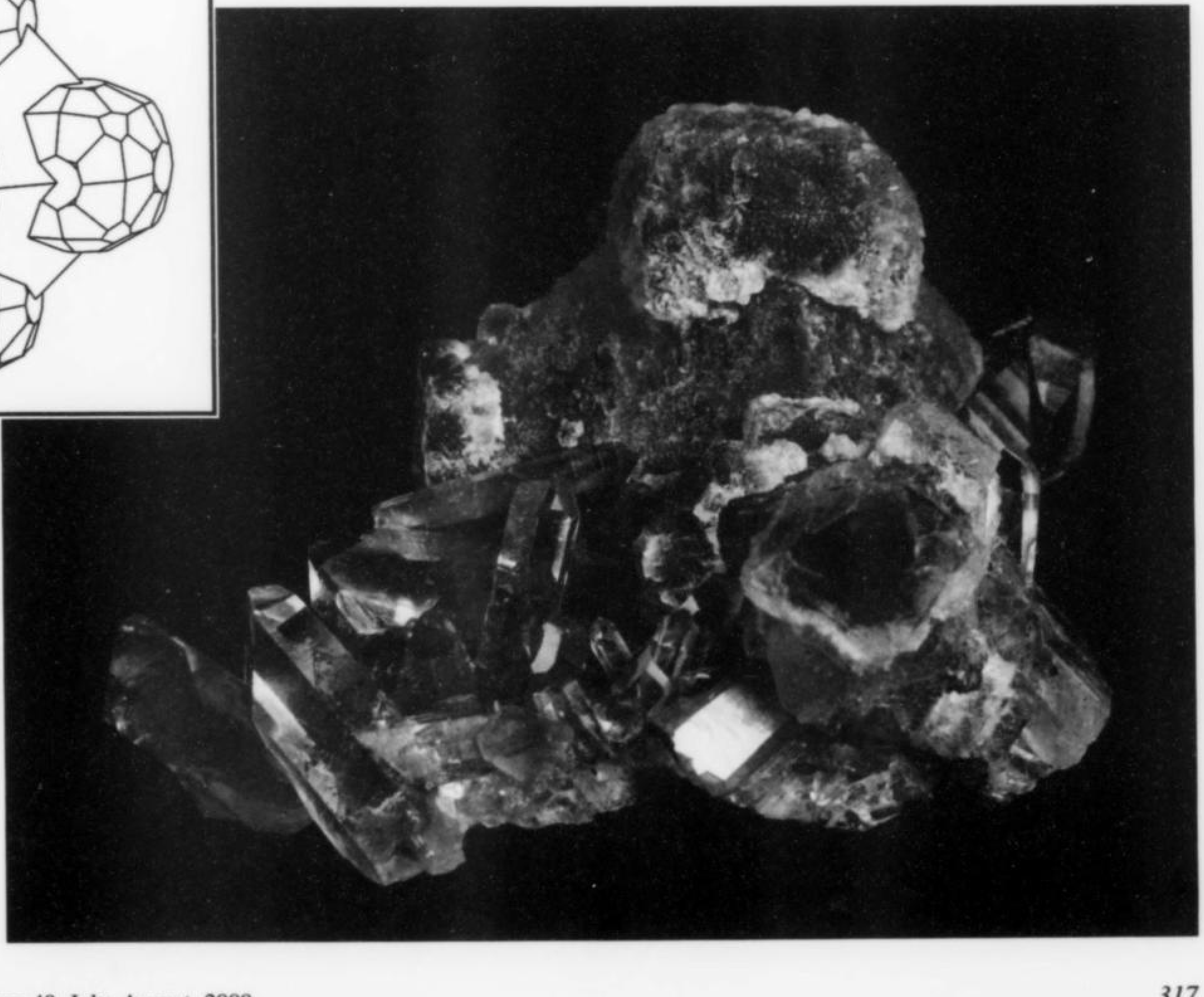


***Figure 23.* Hematite-included quartz with octahedral fluorite displaying second-generation epitactic fluorite, 4.2 cm, from Riemvasmaak. Bruce Cairncross collection and photo. *(Inset)* Fluorite crystal drawing after Goldschmidt (1918).**

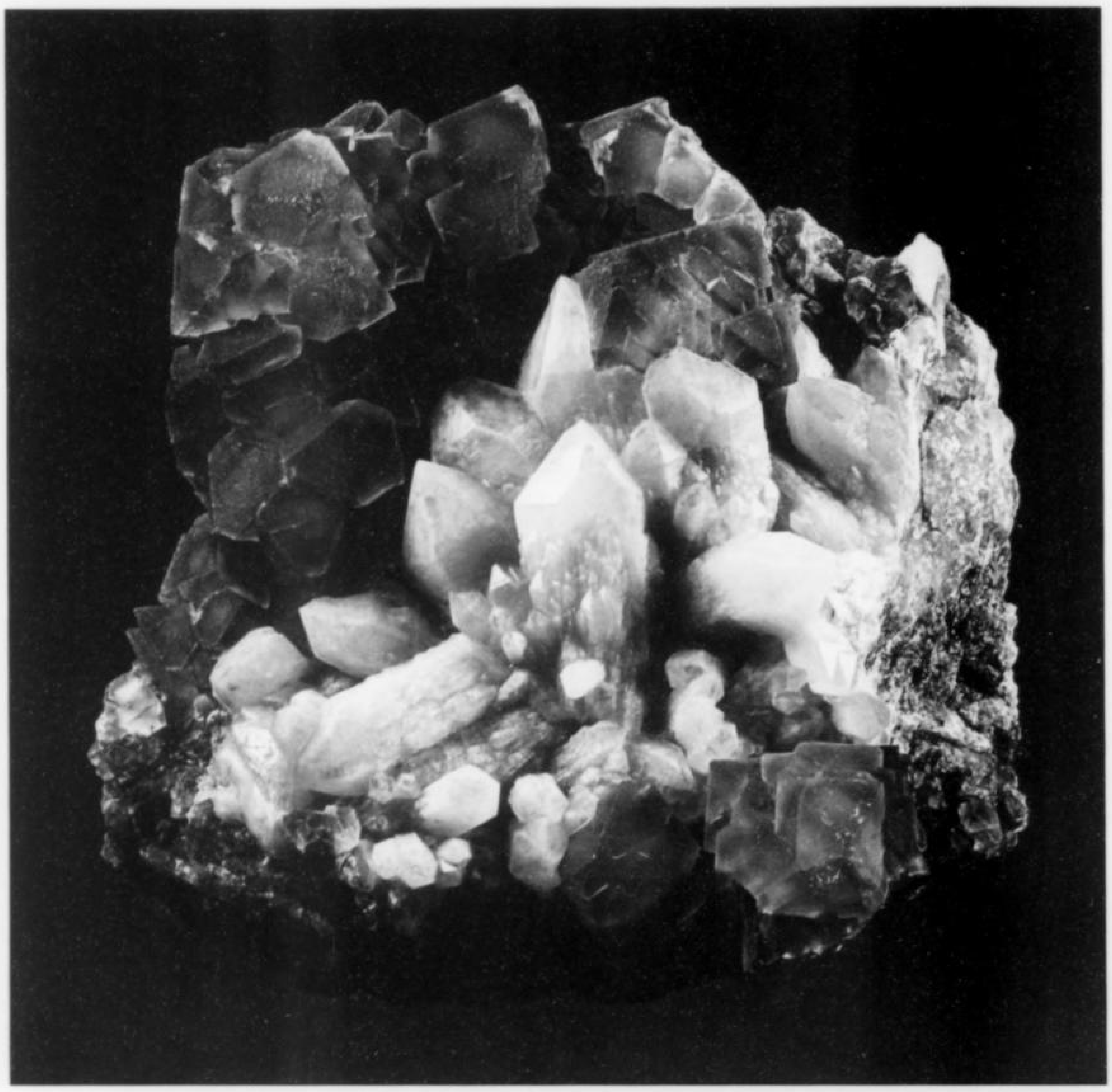
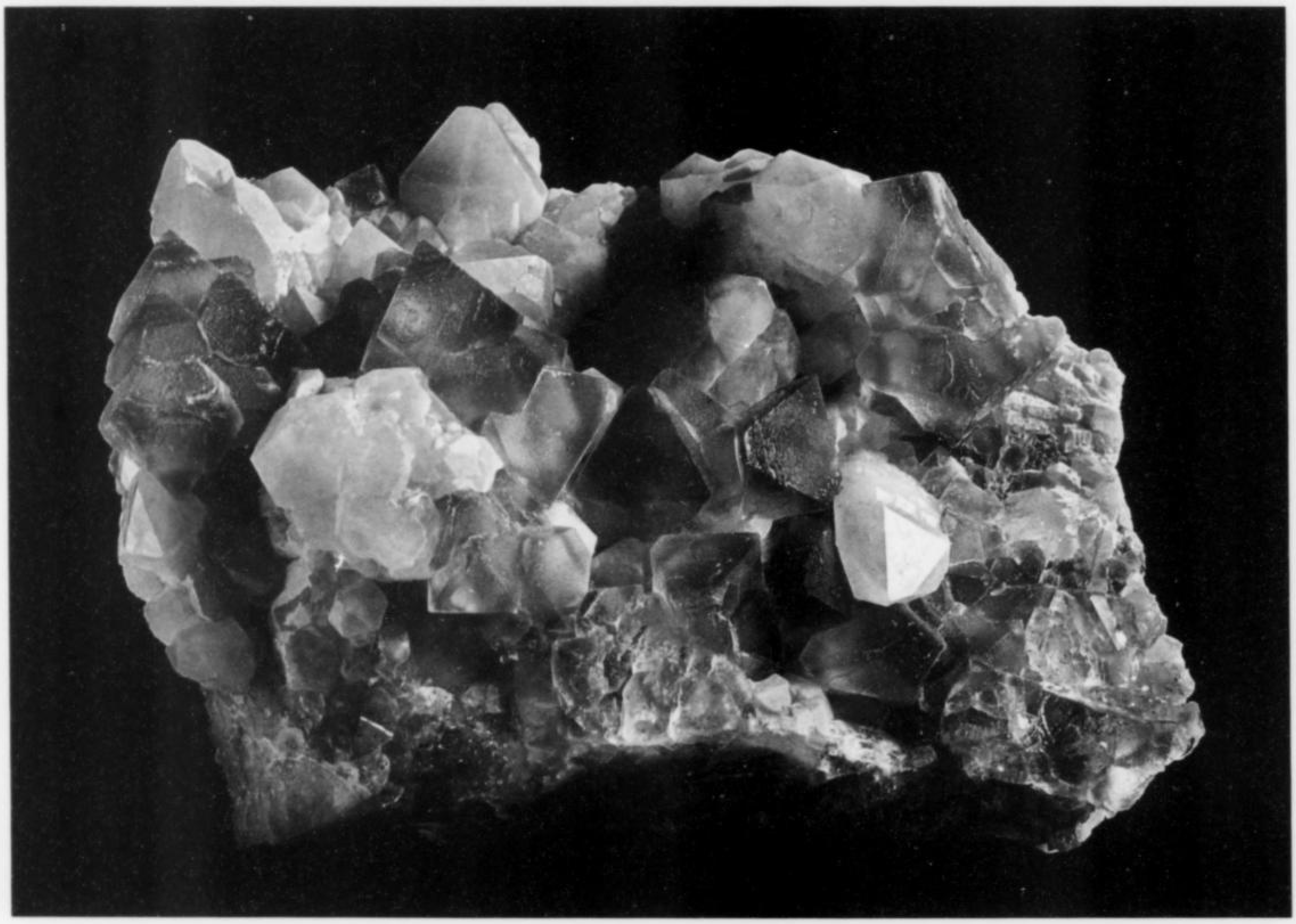
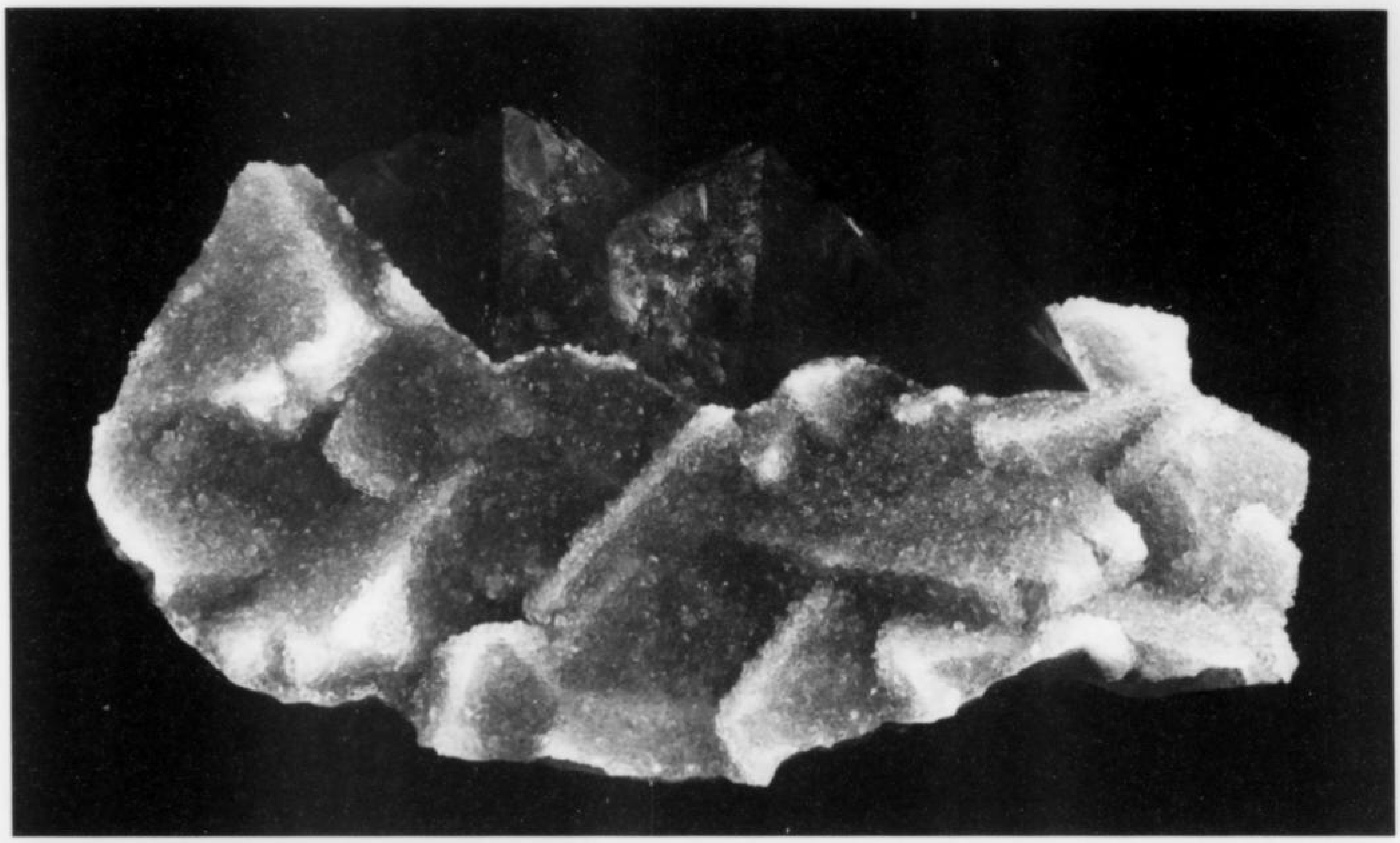


Figure 24. **Color-zoned octahedral fluorite with quartz, 13.4 cm, from Riemvasmaak. This specimen was collected in 2003. Bruce Cairncross collection and photo.**

Figure 25. **Octahedral fluorite displaying yellow-brown cores with green colored-zoned crystal corners, 13.2 cm, from Riemvasmaak. Bruce Cairncross collection and photo.**





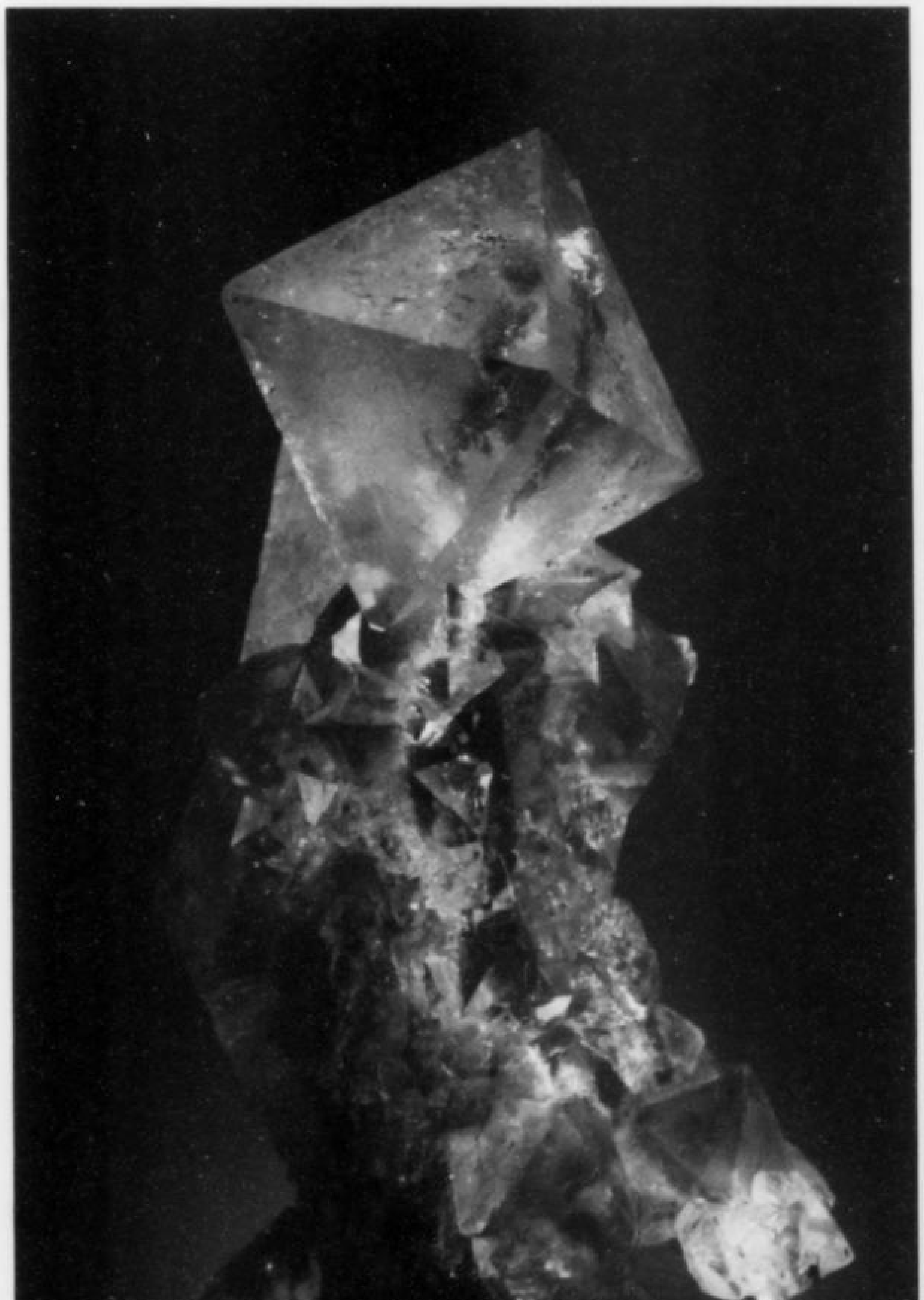
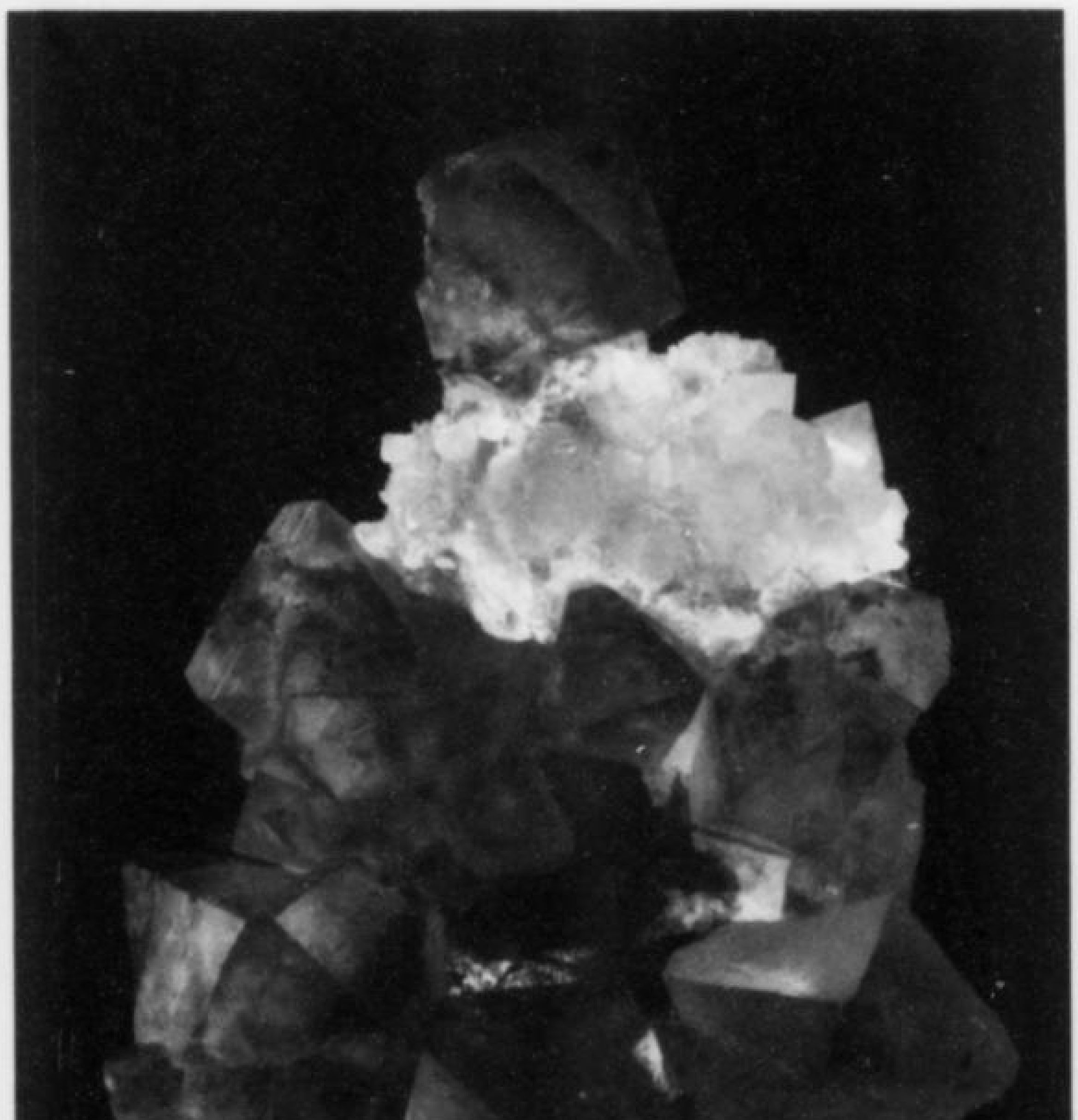


Figure 26. (above) Octahedral fluorite crystal group partially coated by drusy quartz, 13.5 cm, from Riemvasmaak. Collector's Edge Minerals specimen; Richard Jackson photo.

Figure 27. (left) Octahedral fluorite crystal group, 8.6 cm, from Riemvasmaak. Collector's Edge Minerals specimen; Kevin Dixon photo.

Figure 28. (below) Octahedral fluorite crystal group on quartz, 7.5 cm, from Riemvasmaak. Collector's Edge Minerals specimen; Richard Jackson photo.



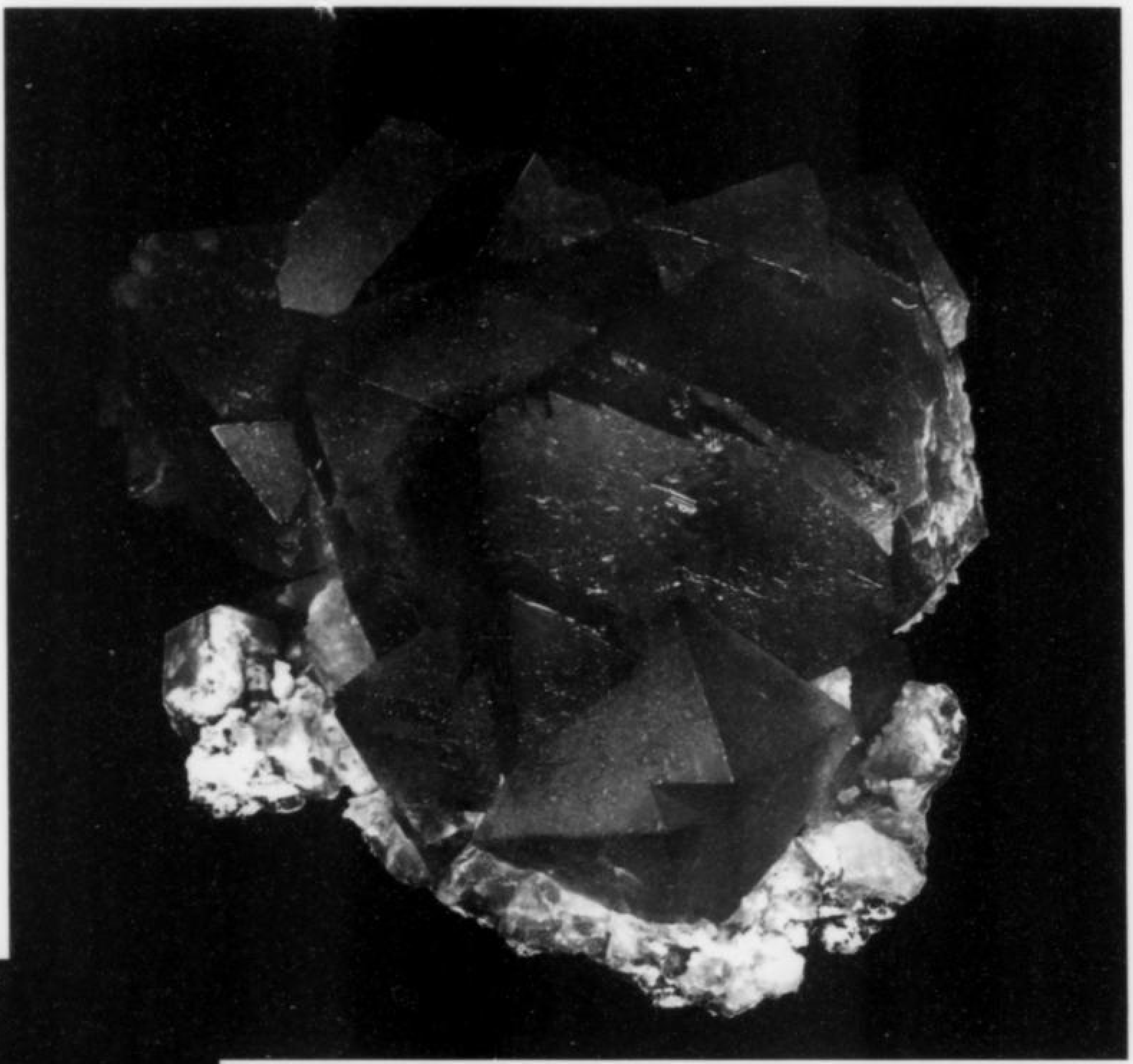


Figure 29. **Fluorite crystal cluster, 11 cm, from Riemvasmaak. Collector's Edge Minerals specimen; Richard Jackson photo.**

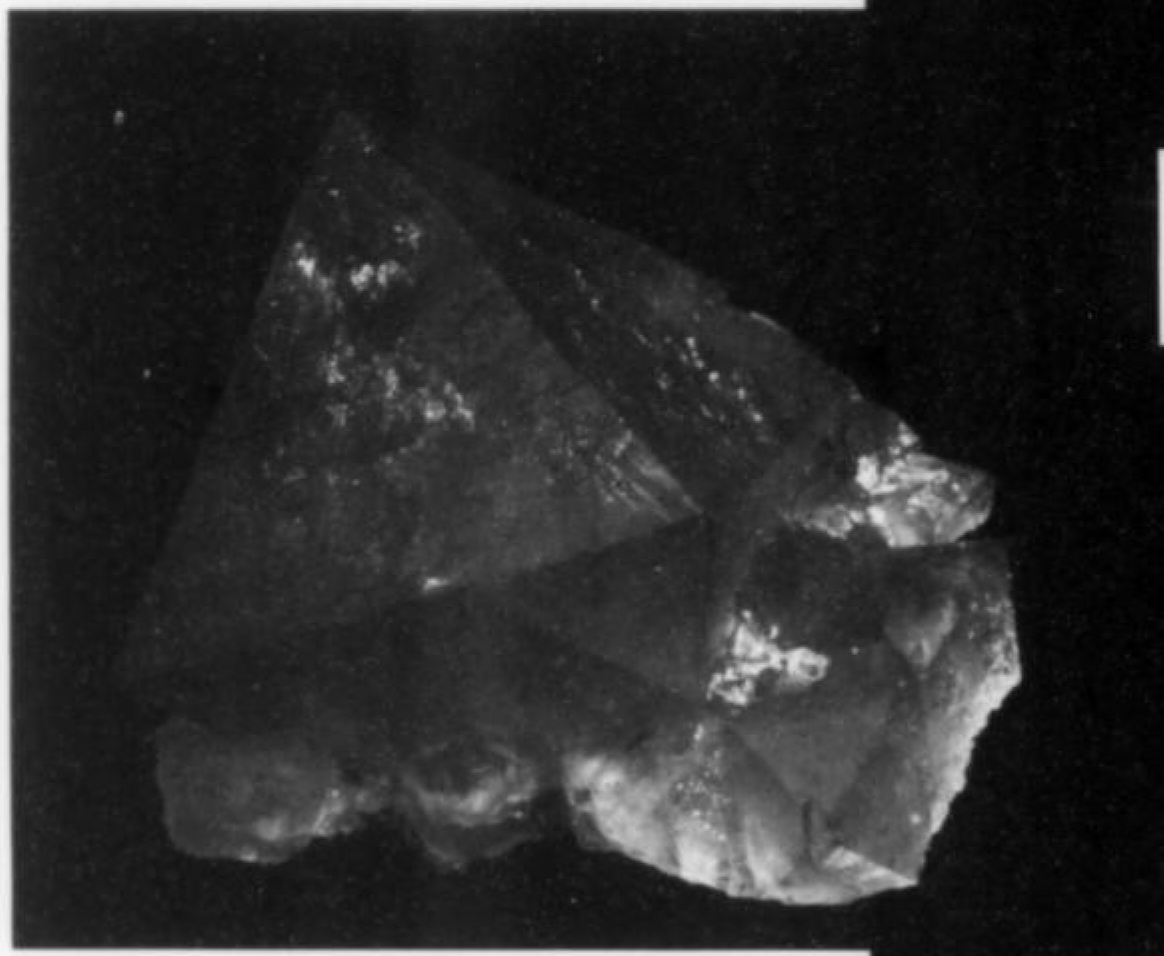


Figure 30. **Fluorite crystal cluster, 10 cm, from Riemvasmaak. H. Goings collection; Collector's Edge Minerals specimen; Richard Jackson photo.**

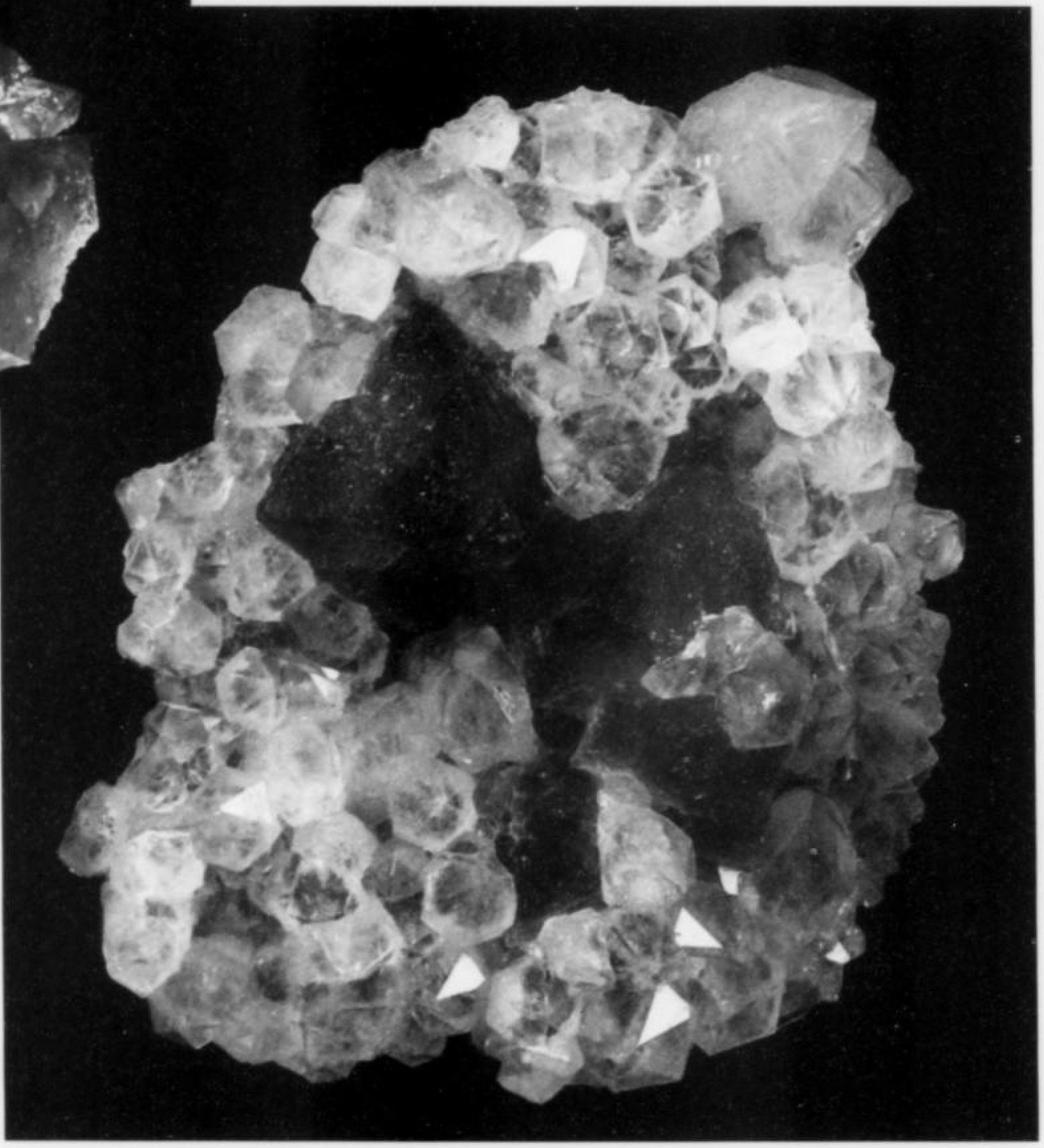


Figure 31. **Fluorite crystal cluster, 13 cm, from Riemvasmaak. Collector's Edge Minerals specimen; Richard Jackson photo.**

Figure 32. **A thin plate of yellow fluorite cubes (backlit to show the transparency), 15.1 cm, from Riemvasmaak. Uli Bahmann collection; Bruce Cairncross photo.**

Figure 33. **Intergrown cubic fluorite, 7.7 cm, from Riemvasmaak. Uli Bahmann collection; Bruce Cairncross photo.**

Figure 34. **Transparent fluorite on quartz matrix, 7.4 cm, from Riemvasmaak. Damian Kislig collection; Bruce Cairncross photo.**

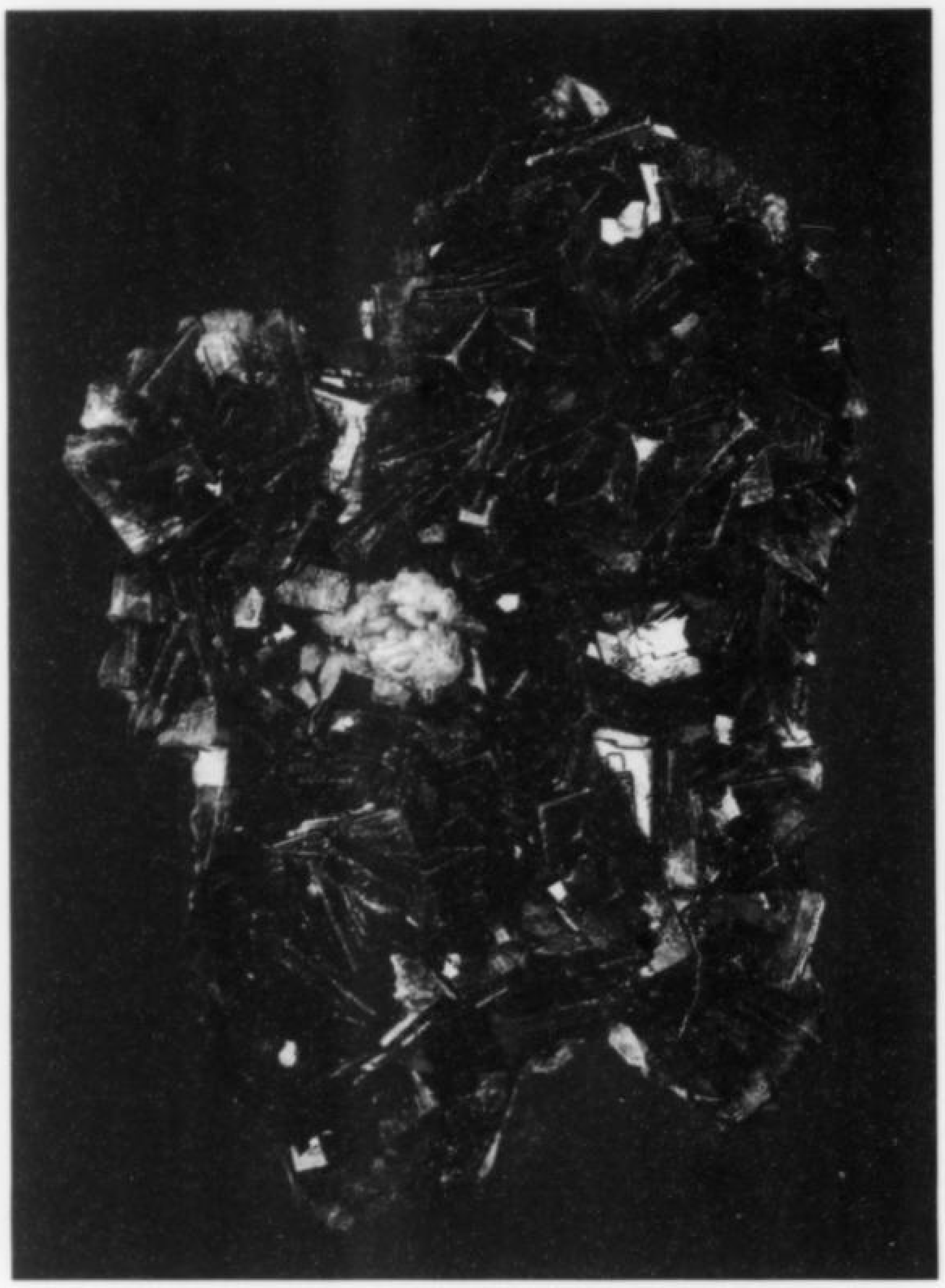


Figure 35. **Purple fluorite, 6.9 cm, from Riemvasmaak. Bruce Cairncross collection and photo.**

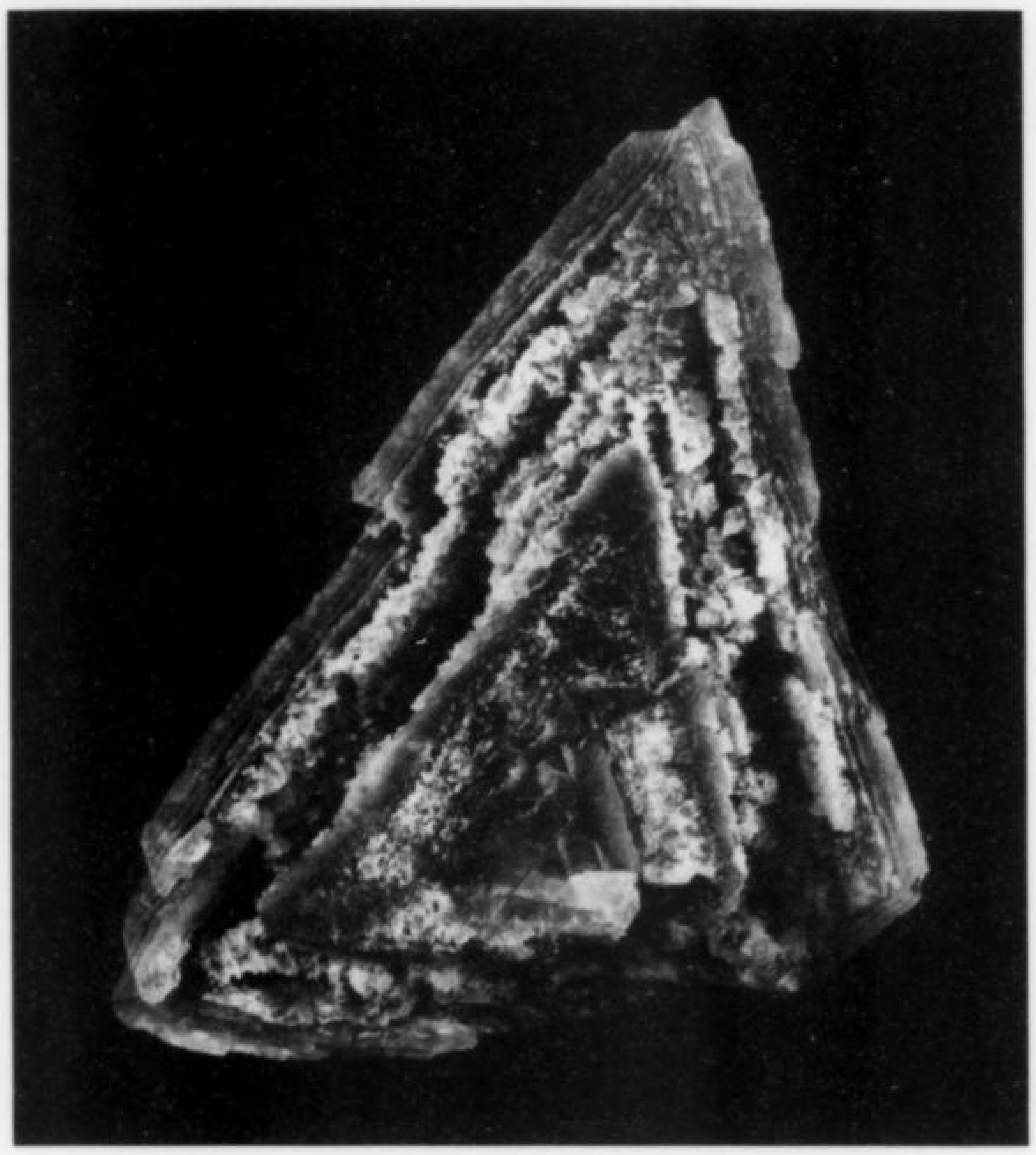


Figure 36. **A highly etched and corroded fluorite crystal, pale purple on the outside with a green core, 9.5 cm, from Riemvasmaak. The reverse side of the specimen still retains smooth, flat, unetched crystal faces. Uli Bahmann collection; Bruce Cairncross photo.**

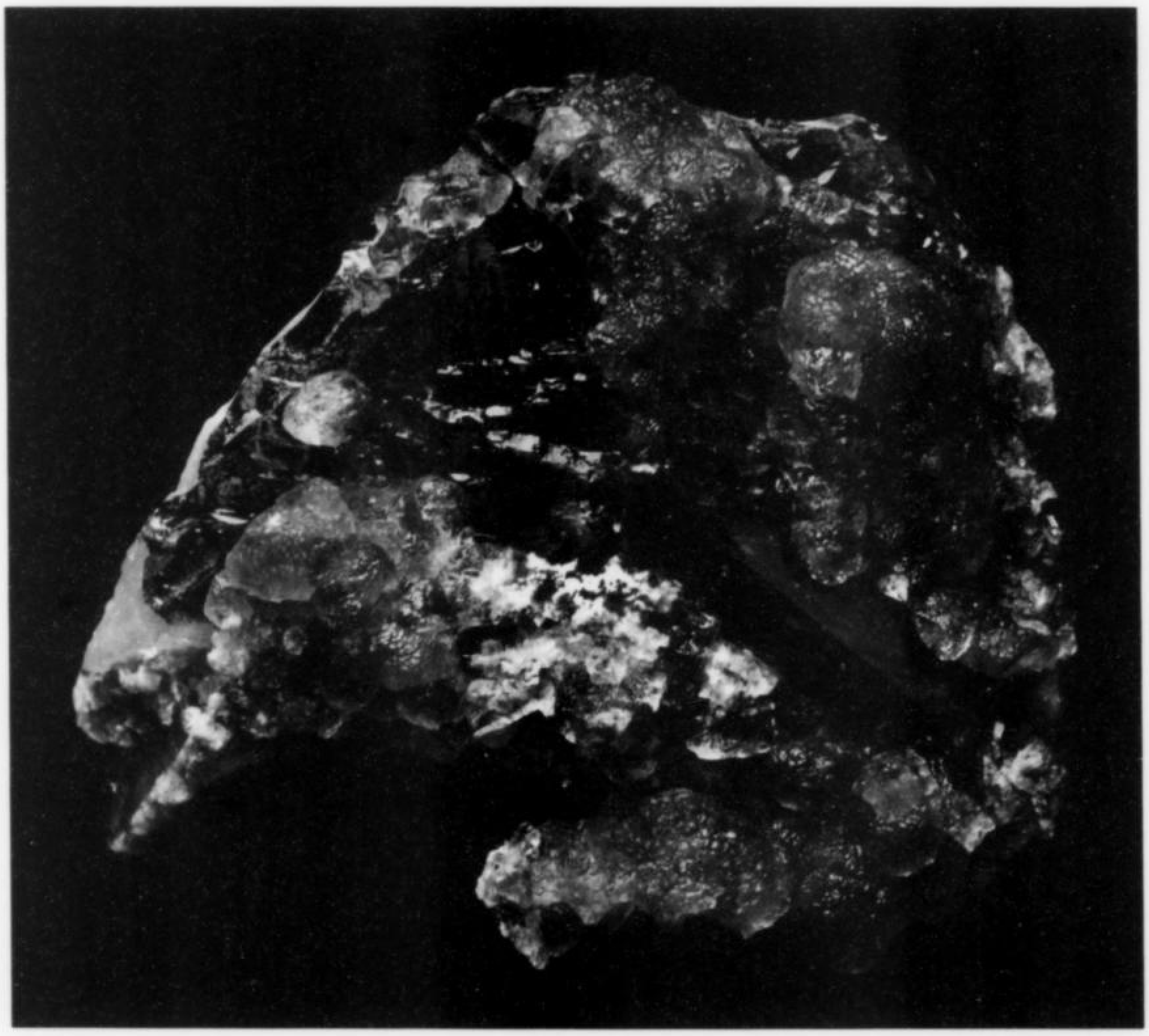


Figure 37. **Drusy purple fluorite partially coating dark red hematite included quartz, 4.6 cm, from Riemvasmaak. Damian Kislig collection; Bruce Cairncross photo.**

on the fluorite crystals were chemically removed. In most specimens, euhedral or massive quartz forms the matrix to the fluorite.

During the Munich Show in 2006, and a few months prior to the show, spectacular green fluorite crystals on euhedral quartz matrix made an impact in the collector market. The crystals all had similar habits—cubes modified on each corner by {111} octahedral faces. Individual crystal sizes vary from 5 mm to 15 cm on edge. It is worth noting that, although the vibrant green fluorites have been making an impact on the international collector market in the recent past, fluorite from Riemvasmaak and other "Orange River" pegmatites has been trickling out into the local southern African collector market for some years now. There are some specimens of fluorite from this Northern Cape region in the Johannesburg Geology Museum collection that date as far back as the 1970s.

Almost without exception, the fluorite is coated by a thin 0.5 to 3-mm layer of drusy quartz that has to be removed to reveal the fluorite beneath. Hydrofluoric acid is most commonly used for this task, but unless the specimens are well protected, much of the matrix becomes etched and white. Another aspect that needs to be taken into account when buying specimens that are quartz-coated is that the quality of the fluorite beneath the drusy quartz is highly variable. Some crystals are pristine with smooth, clean, shiny surfaces and the crystals have a beautiful green color. In other cases, however, the fluorite crystal faces are highly etched or corroded, the crystals can be fractured and partially cleaved, and the color can be pale green or even colorless. Octahedral crystals up to 30 cm on edge have been found; these are large but ugly and usually show damage, cleavage surfaces and surface coatings on the crystal faces.

Figure 38. **Modified cuboctahedral purple fluorite with a second-generation overgrowth of fluorite, 8.9 cm, from Riemvasmaak. Uli Bahmann collection; Bruce Cairncross photo.**

The cause of the green color is unknown but may perhaps be related to associated radioactive or rare-earth species. In order to test for the presence of certain trace elements which might be causing the vibrant color, samples were analyzed at the University of Johannesburg's centralized analytical facility. Isotopes were detected by analyzing a mass scan from material liberated from the sample in two different positions by means of Laser Ablation Induction coupled Plasma Mass Spectroscopy (LA-ICP-MS). The equipment used was a ThermoFisher X-Series^{II} Quadropole ICP-MS equipped with Collision Cell Technology and a New Wave UP-213 Nd:YAG Laser Ablation system with helium used as the carrier gas. A test for the presence of various elements yielded surprising results; isotopes in the rare-earth element lanthanide series—lanthanum, ytterbium, cerium, neodymium, samarium, europium, gadolinium and holmium—were detected. (The amounts and relative proportions were not determined.) Perhaps some of these elements are the source of the green color.

Another puzzling aspect is that only the fluorite crystals are preferentially covered in drusy quartz; the associated matrix and quartz crystals that host the fluorite are uncoated.

Although Riemvasmaak is best known for the green octahedral and cuboctahedral fluorite, other color varieties are found there as well. Colorless, transparent octahedral crystals with internal phantoms of purple modified cubes are known, as well as yellow and yellow-green intergrown cubic crystals and inclusions of tiny (less than 1 mm) pyrite crystals.

LABELING

The "Orange River" is often used as a generic locality for fluorite and quartz specimens collected at many sites close to and bordering the river. Collectors may be familiar with locality labels such as "Pella, Orange River," or "Steinkopf, Orange River" or merely "Orange River." Indeed, in some instances, this general locality description may be correct, as some of the pegmatites and quartz veins that produce specimens are close to the river but not to any major or minor town or settlement. Traveling west from Riemvasmaak, more or less along the confines of the Orange River, one passes through the tiny settlements of Onseepkans (pronounced "awn-searp-kaans"), Pella, Goodhouse and Vioolsdrif. The distance from Riemvasmaak to Vioolsdrif is approximately 250 km. Pella is 120 km from Riemvasmaak, so these two localities have nothing in common. This stretch of the Northern Cape Province contains hundreds of pegmatites and quartz veins (Hugo, 1969). It should also be noted that, although Riemvasmaak is located within the geological structure called the Namaqua-Natal Metamorphic Province, it is not located in the geographic area known as Namaqualand, as some labels state. Namaqualand *per se* begins 120 km to the west, at Pella, and extends to the western seaboard of South Africa. The correct label for specimens that originate from Riemvasmaak should therefore read:

Fluorite
Riemvasmaak
Kakamas district
Northern Cape Province
South Africa

ACKNOWLEDGEMENTS

Dr Herman van Niekerk, University of Johannesburg central analytical facility, conducted the isotope analyses. Damian Kislig, Uli Bahmann, Desmond Sacco and Ronnie McKenzie kindly loaned specimens for photography. Additional specimen photography was provided by Collector's Edge Minerals. Paul Balayer and Fernando Abrandis provided further information and photos of Riemvasmaak.

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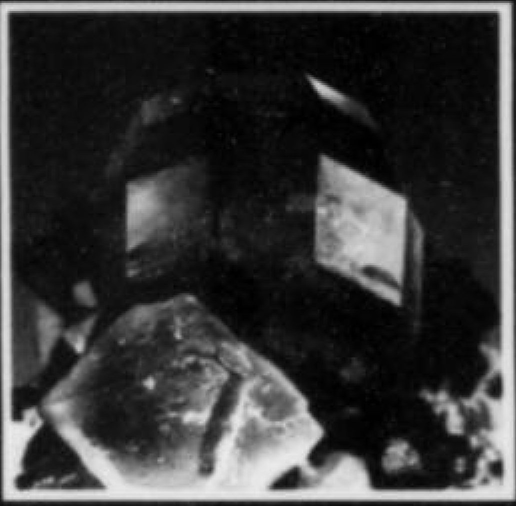
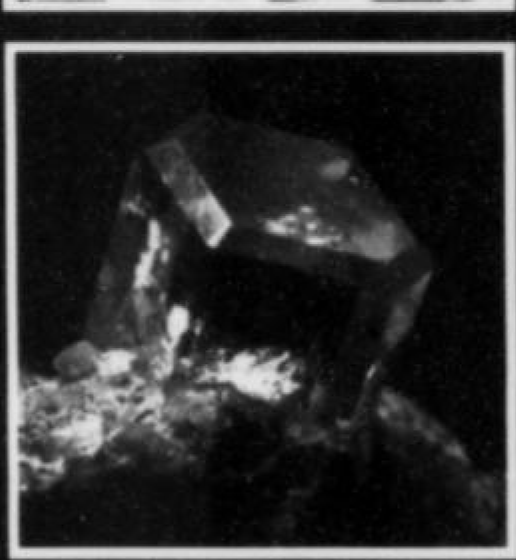
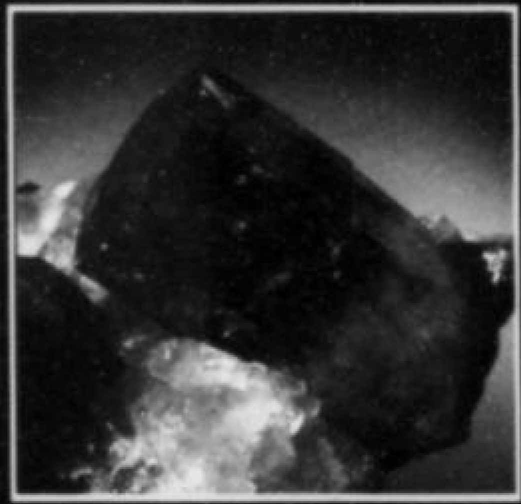
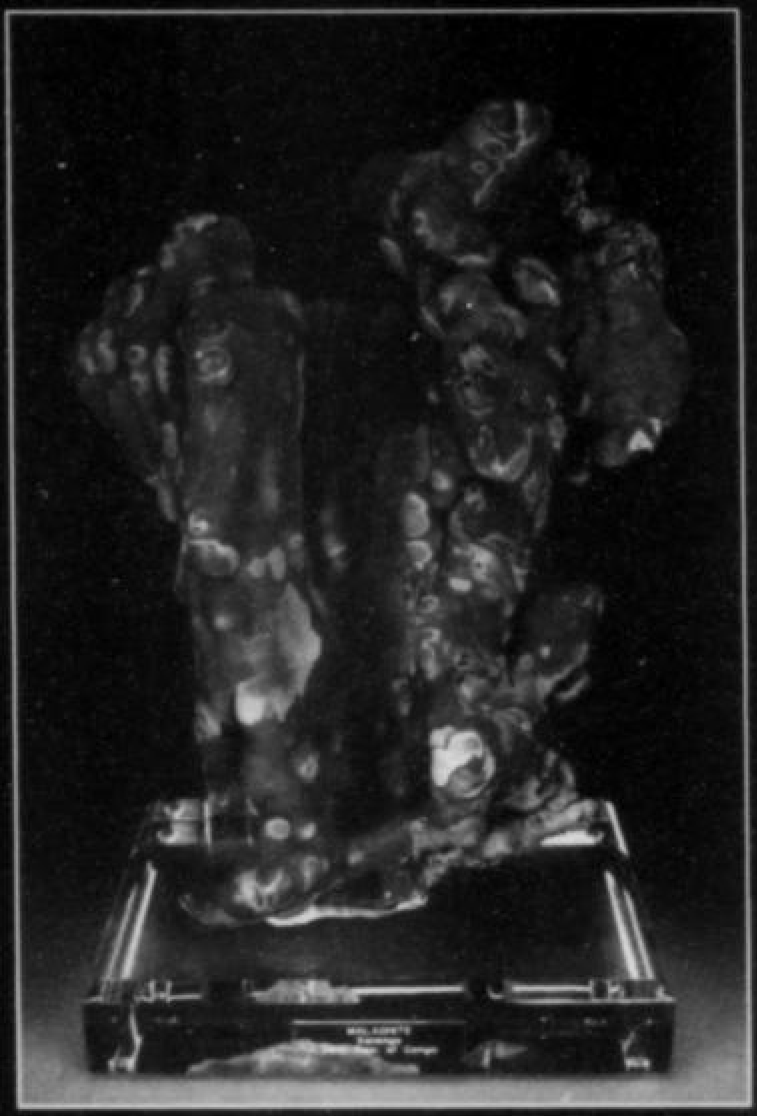
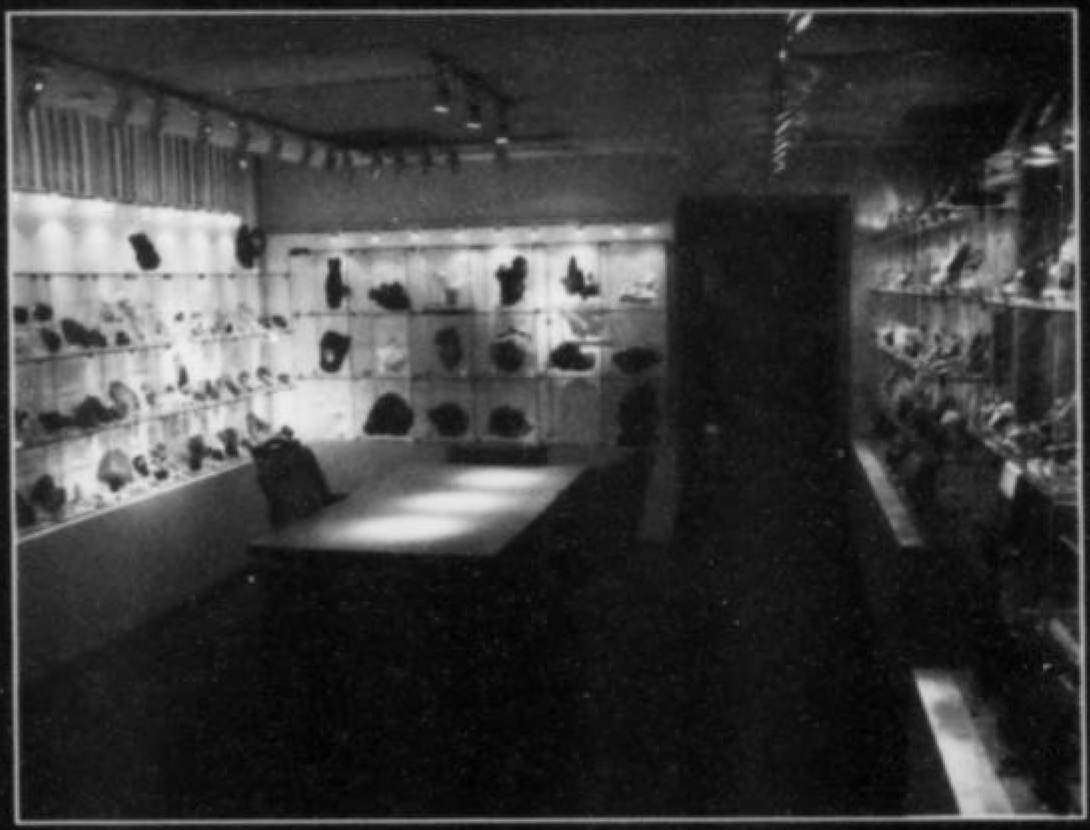


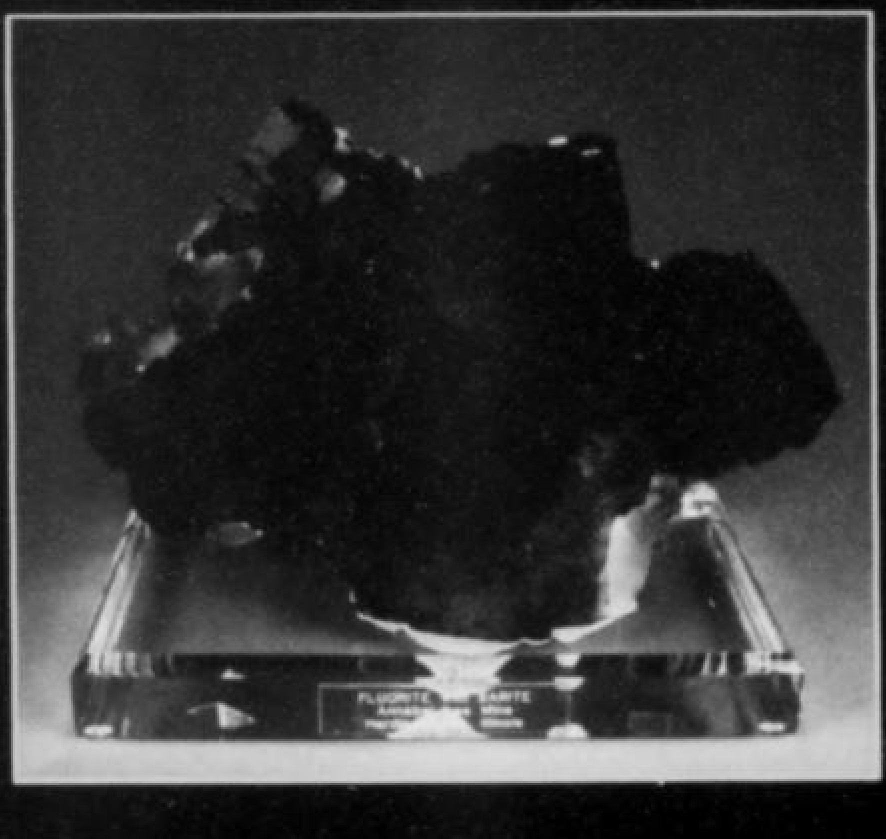


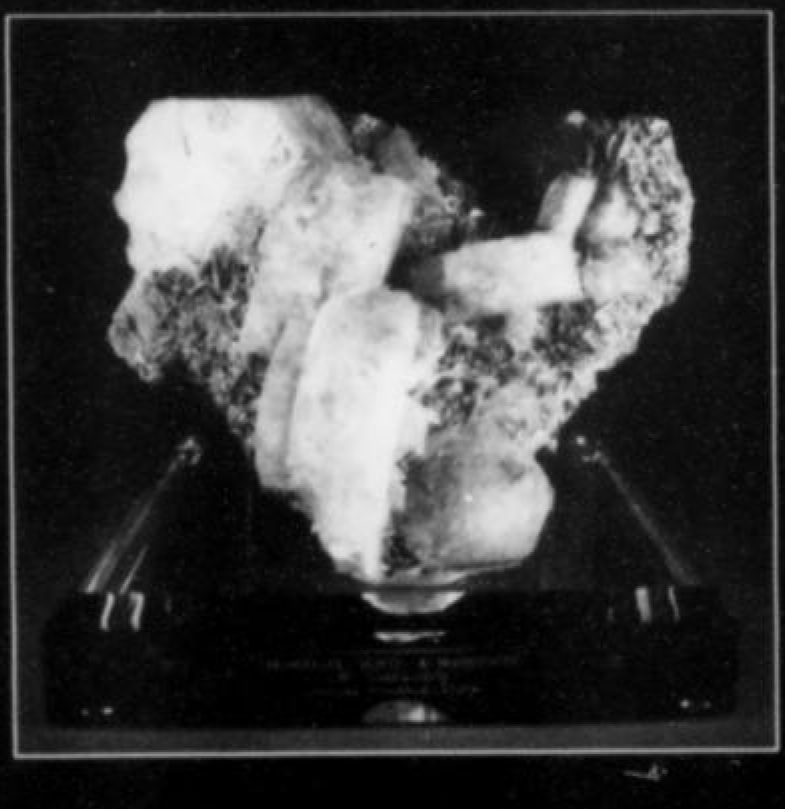


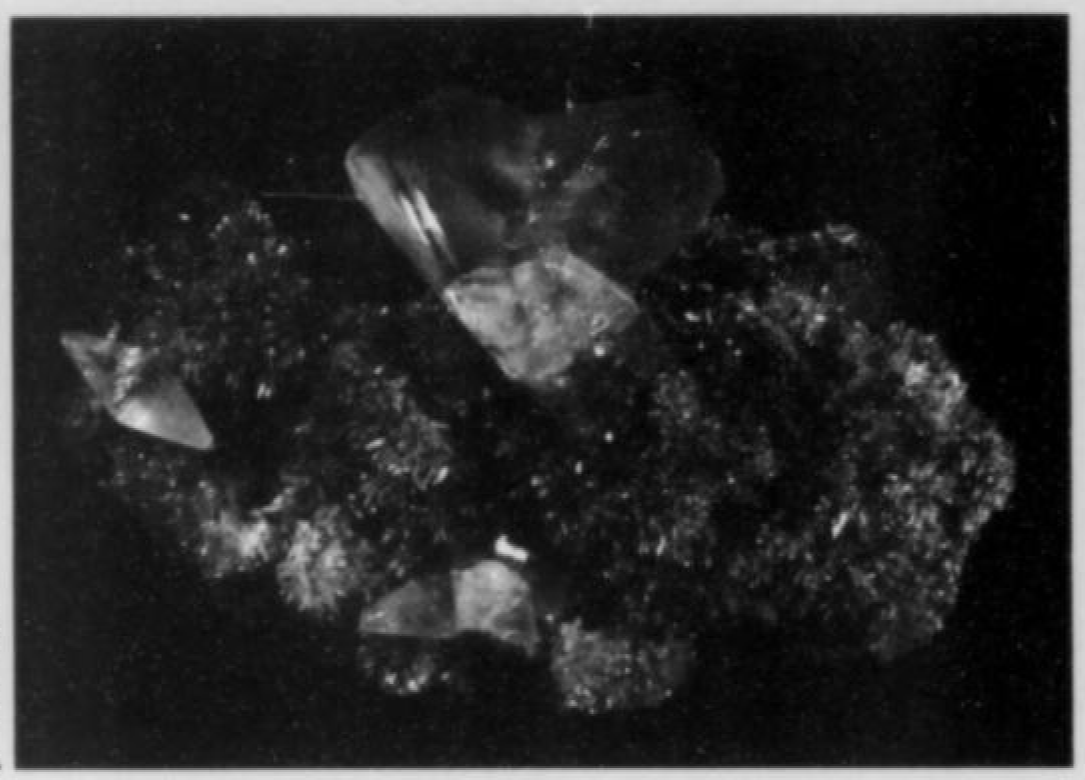




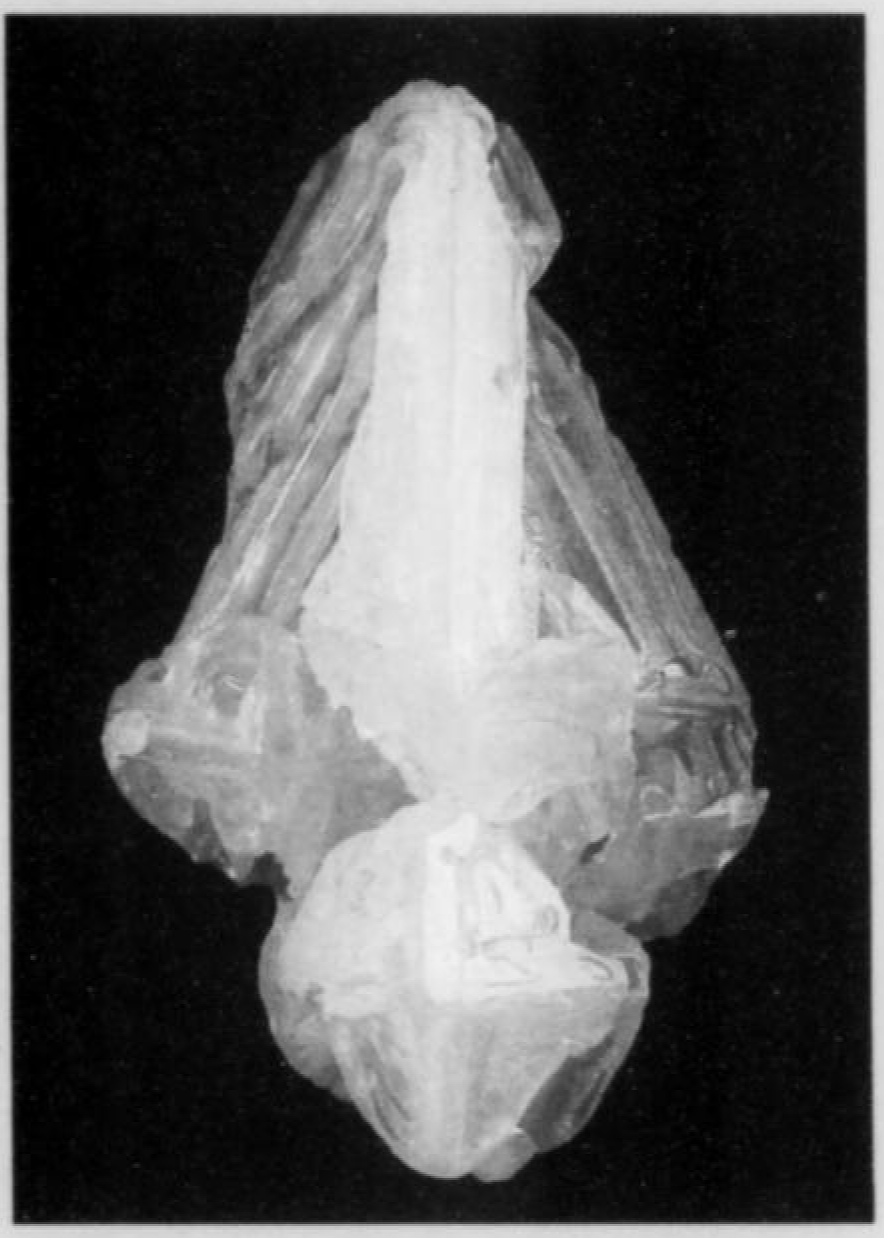
Showroom by Appoinment





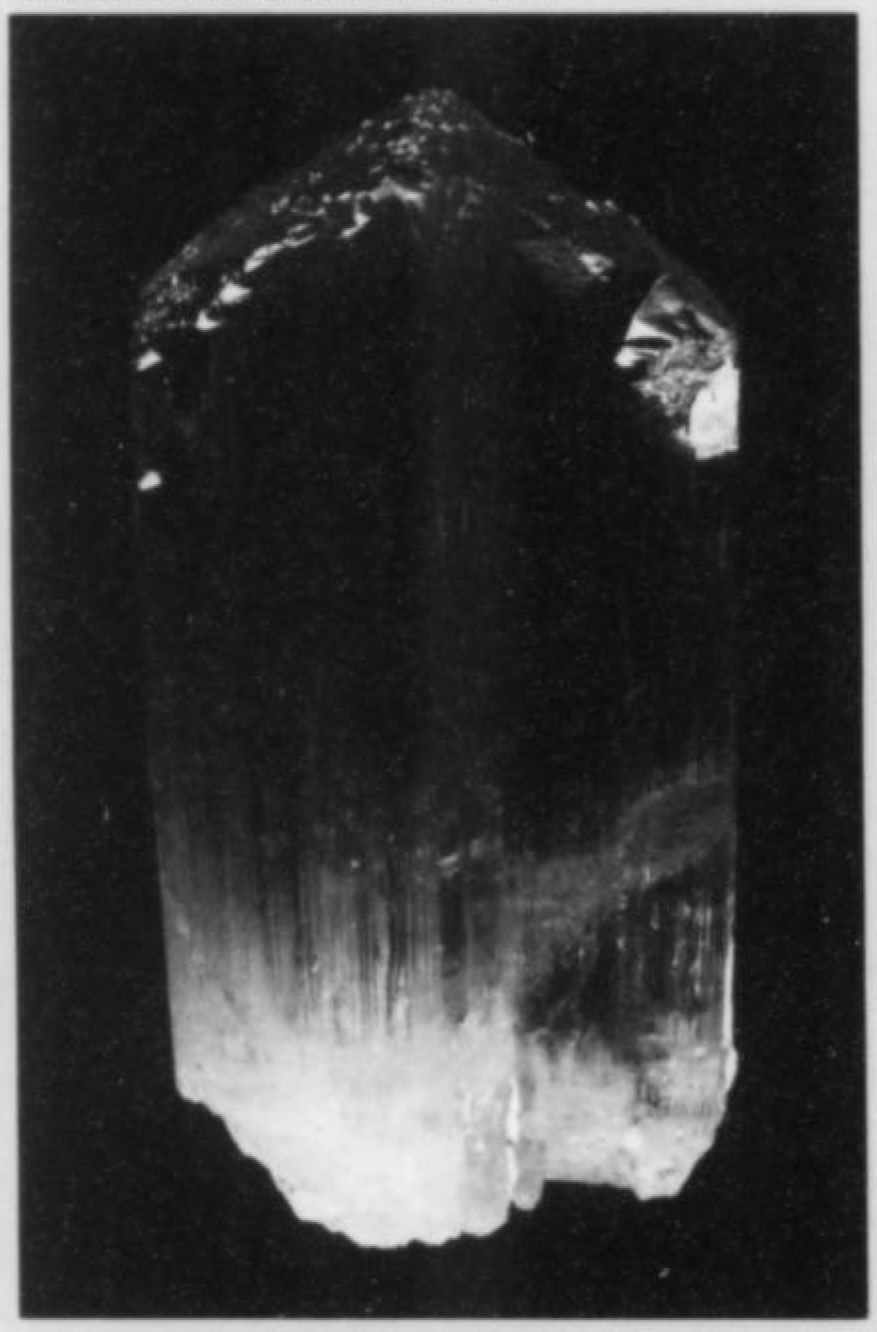


A lustrous and highly desirable Chinese butterfly twin of hematite-colored calcite on a matrix of untwinned calcite crystals 5 inches across.

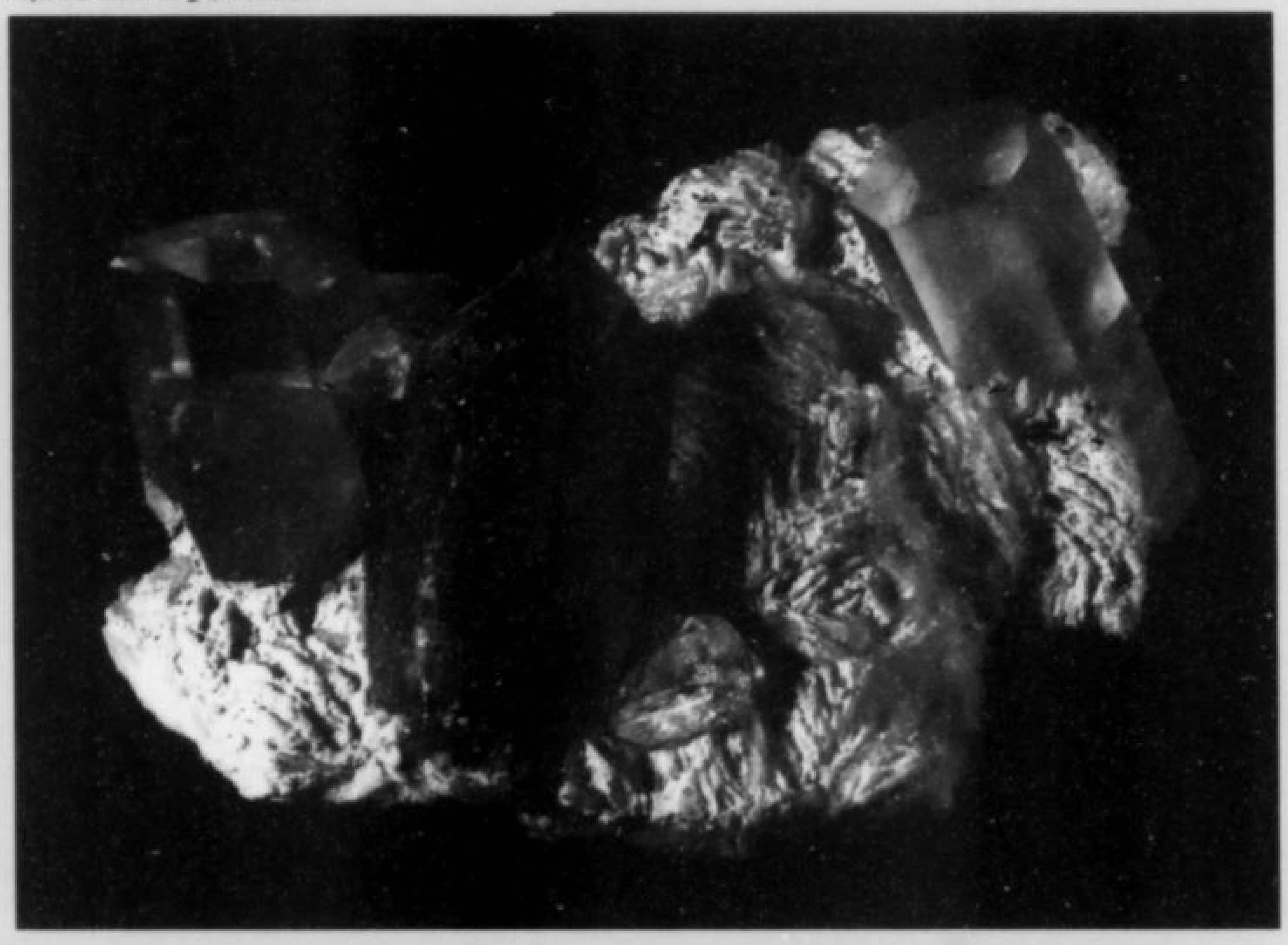


A 4-inch tall hoppered floater sulfur crystal of important size and quality from an old discovery at Steamboat Springs, Nevada.

A 5-inch tall flawless gem kunzite crystal of fine color from Mawi, Afghanistan and the renowned collection of Dr. Edward E. David.



An incredible combination of gem crystals of aquamarine and topaz on a 4.5-inch matrix of albite and quartz crystals from Gilgit, Pakistan.



What's New in Minerals

Houston Show 2009 by Thomas Moore

[May 1–3]

In the July–August 2008 issue I reported on the Dallas Fine Mineral Show of last year—Dave Waisman's debut venture to serve the burgeoning Texas mineral collecting community, and provide a nice weekend for any other collectors making the trip. Conceived by Dave as a small, high-quality show much along the lines of his February Westward Look Show in Tucson, the Dallas Show was held in an Embassy Suites Hotel which offered a "cushy, convenient and profoundly comfortable setting"—with three high tiers of rooms enfolding a deep central atrium, and dealers occupying all of the second and most of the third floors. About 50 mineral dealers, joined by a small minority of gem/lapidary and fossil purveyors, came to set up in Dallas, making for a fine small show of the high-end persuasion. However, attendance having turned out to be not quite what Dave had hoped for, he decided to move this year's show to *another* Embassy Suites Hotel in a nearby and larger city—thus the 2009 Houston Fine Mineral Show unfolded (as its predecessor had done) in the opening days of May.

The physical venue in Houston was so much like that in Dallas last year that upon first entering I had, for a panicked instant, the sense that I'd disembarked at the wrong airport. *This* Embassy Suites, just like *that* one, offered, just past the reception desk, a ground-floor lounge area (plastic palm trees and live, huge and complacent white swans preening in a reflecting pool; countless long, comfy sofas; a bar and cafe, and say, don't forget Happy Hour at 5:30)—the whole expanse ringed by six-story towers of room entrances, and the familiar dealers seen leaning and chatting and dealing (as dealers will) all along the balconies that ringed the second and third floors. One feature was different, though, and forward-looking: the Houston Gem and Mineral Society had a long table where eager members kept cheerfully going "hi-how-are-*you*-doing" to all visitors, including, it seemed, curiosity seekers who'd just wandered in from Sunday morning church services. Just to the right of these greeters' table, right by the elevators, Günther Neumeier was on hand with a spread of mineral books and of *ExtraLapis English* monographs. Meanwhile the elevators kept humming, and the show was altogether lively. At the end of the (third) day, Dave Waisman was looking pleased with attendance, as it had held up throughout the weekend; we may be sure that he'll do it again next year. That address, again, is the Embassy Suites Hotel, 2911 Sage Road (near the Galleria), Houston, Texas.

This *is* a small show, though, and it comes rather soon after Tucson, so it is not too surprising that the what's-new pickings were slim. The most interesting single item among them was a small stash of miniature and small-cabinet-size specimens of **celestine including sulfur** from a place called Jabal al Akhdar, Libya, brought to the show by Kevin Ward of *Exceptional Minerals* (www.exceptionalminerals.com). Kevin just recently picked up this lot from Steve Behling of *Collector's Edge*, but the specimens were collected (according to Steve) nearly half a century ago—in 1962—by a petroleum geologist named Oswald "Oz" Krebs, and have been stored away somewhere until this year. Krebs, it seems, had been working to evaluate an oil concession in the northeastern Libyan Desert, and he dug the crystals from an outcrop of Cretaceous-age limestone. The specimens show translucent, gray-blue, mirror-lustered celestine crystals in a sharp, doubly terminated, thick-prismatic habit reaching 9.5 cm, some as loose floaters and others perched smartly on earthy tan matrix, or in loose, very attractive, crisscrossed clusters. Most curiously, pale yellow native sulfur forms spherical, woolly shapes, like ranks of cumulus clouds in a faintly blue sky, just under the surfaces of the celestine crystals. I've very seldom seen prettier or more peculiar specimens of this species from any locality. *Exceptional Minerals* had fewer than ten Libyan celestine/sulfur specimens, and just a few more reside with *Collector's Edge*; according to Steve Behling, the 1962 haul came to something between 70 and 100 pieces in all.

Dr. Hemant Merchant of *Mineral Décor* in India (mindec10@hotmail.com) came to Houston with about 20 pretty cabinet-size specimens of stalactiform **chalcedony** found in late February of this year in a basalt quarry near Jamner, Maharashtra, India. Each pristinely snow-white specimen shows tiny, prickly, thin-prismatic to acicular forms which solidly coat, and stick out all over, a central stalk. There are no associated species. The stalks range between 10 and 30 cm long. I suspect—though Dr. Merchant could not confirm—that the tiny crystals originally were some zeolite (scolecite?), now replaced by the opaque white chalcedony. All surfaces of the long, bristling, warty, stalactiform columns glitter with sprinklings of microcrystals of quartz, to very attractive, wintry effect.

Dr. Merchant also brought news that some areas of basalt flows on the northern edge of the famous Deccan Plateau, just over the border from Maharashtra in the state of Madhya Pradesh, are now giving up substantial **amethyst** geodes, some with tabular aggregates of lustrous white calcite crystals on the purple mega-druses within. The five large—to 25 cm—specimens on hand in Houston, with dark, medium-lustrous amethyst "points" lining deep, dark cavities in basalt, could easily pass for not-quite-first-rate but nevertheless impressive open geodes from Rio Grande do Sul, Brazil. Dr. Merchant was thus pleased to be showing off at least *some* what's-new items from India, since, he says, much normal basalt-quarrying has ceased, temporarily at least, because of the economic hard times.

A newly discovered occurrence at Gongchen, Guangxi Zhuang Autonomous Region, China, is yielding specimens which show dense groups of short-prismatic **quartz** crystals, with individuals reaching 1.5 cm or so, rising vertically in parallel from crystal faces and cleavage surfaces of transparent lime-green **fluorite**. The quartz crystals are preferentially coated (and partially included) by brick-red hematite. These specimens present a pleasant red/green appearance, although they are not highly lustrous. The March–

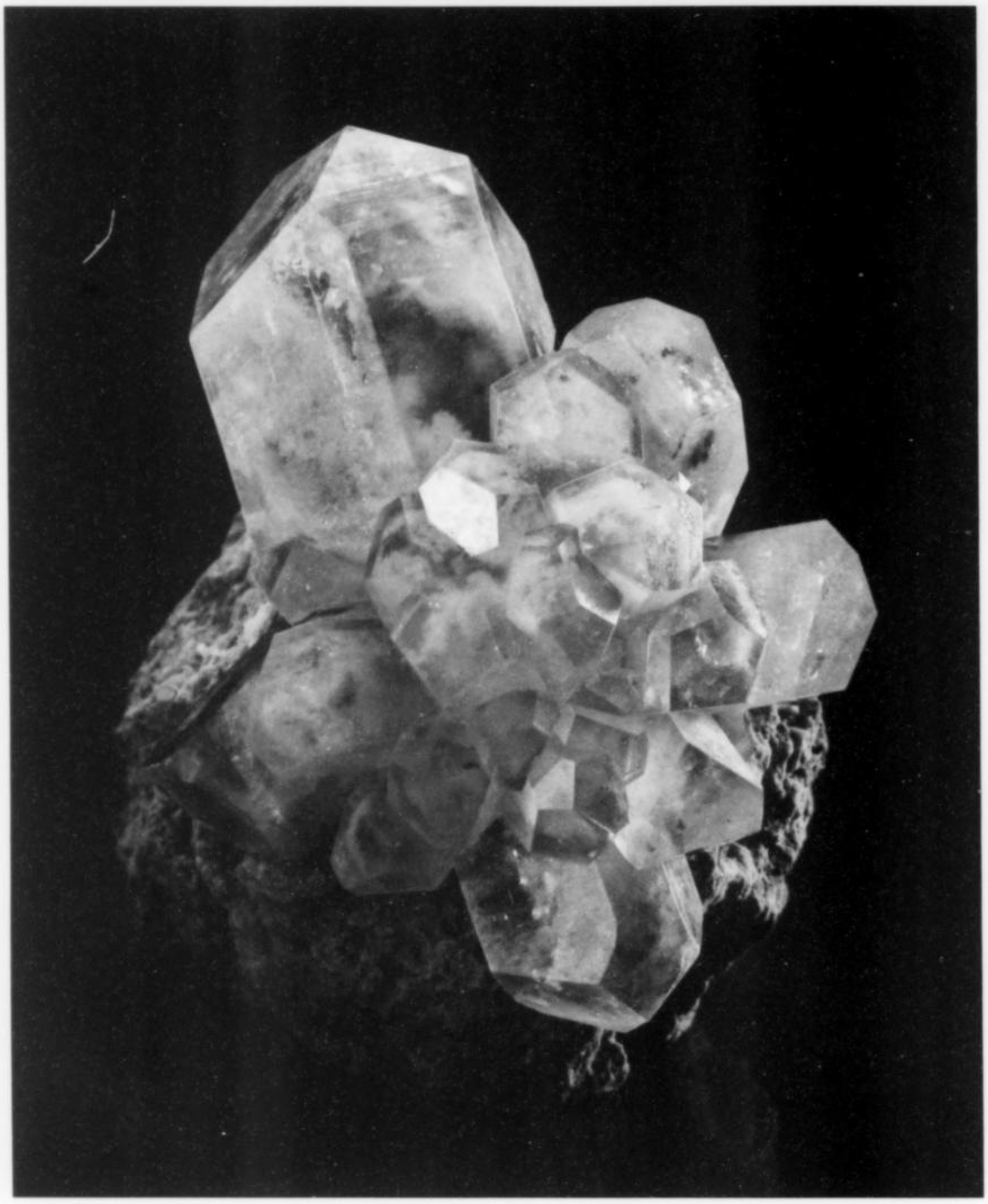


Figure 1. **Celestine crystal cluster with inclusions of sulfur, 5.5 cm, from Jabal al Akhdar, Libya. Kevin Ward (*Exceptional Minerals*) specimen and photo.**

April 2009 find yielded Chris Wright of *Wright's Rock Shop* (www.wrightsrockshop.com) about three flats of specimens, while two of the Chinese dealers at Houston also had small selections, the quartz/fluorite pieces in general ranging between 5 and 12 cm across.

Also with Chris Wright and with *Wendy's Minerals* (www.wendysminerals.com) were a few small-miniature specimens from a new find of **plumbogummite with pyromorphite** from the Daoping mine, Guilin, Guangxi—yes, this is the now-famous locality for the gorgeous pyromophite specimens commonly seen around the turn of the millennium but now not commonly seen (at least in world-class examples) at all. The Daoping mine is also one of the world's only two localities for really fine specimens of plumbogummite (the other is an antique one in Cumbria, England). In these new examples the rare Pb-Al phosphate forms botryoidal coatings on earthy brown limonite, and lustrous pale green pyromorphite prisms to a few millimeters each are littered all over the gray-blue to bright baby-blue plumbogummite encrustations.

Let us turn our attentions now to **zektzerite** (something we don't do very often). The very rare Li-Na-Zr silicate was first found in 1966 in Washington Pass, Okanogan County, Washington, in an arfvedsonite granite phase of the alkaline igneous complex forming the Golden Horn batholith. When formally described in 1977 the species was named for Jack Zektzer, one of the earliest and most successful gatherers of zektzerite, whose specimens seem especially made with advanced thumbnail collectors in mind: the best crystals are sharp, blocky to tabular, lustrous, white to pink to orange-tan in color, and reach more than 2 cm. During the 1970's, superb zektzerite specimens from Washington Pass were offered fairly abundantly by Bart Cannon and others, but they have largely disappeared from the market since then. So last summer's strike by John Lindell, at a site called Willow Basin, Washington Pass, is a worthy what's-new, even though the new specimens are not as fine as those from the 1970's. They are smallish thumbnails consisting of singles, loose clusters, and matrix pieces with medium-lustrous, opaque pinkish tan zektzerite crystals to 1.5 cm, most of them coated by gray mica flakes and thus devoid of luster. Jim McEwen of *Lehigh Minerals* (www.lehighminerals.com) had about 100 such zektzerite thumbnails at Houston, priced at between $25 and $250. Most of them are simply loose crystals, but a few show crystals resting on dull white euhedral microcline crystals. These are, according to Jim, the best zektzerite specimens found at Washington Pass in the last 20 years.

Both Adam Sotomayor of *Adam's Mountain Minerals* (adamsrarerocks@aol.com—also mentioned from Dallas last year) and

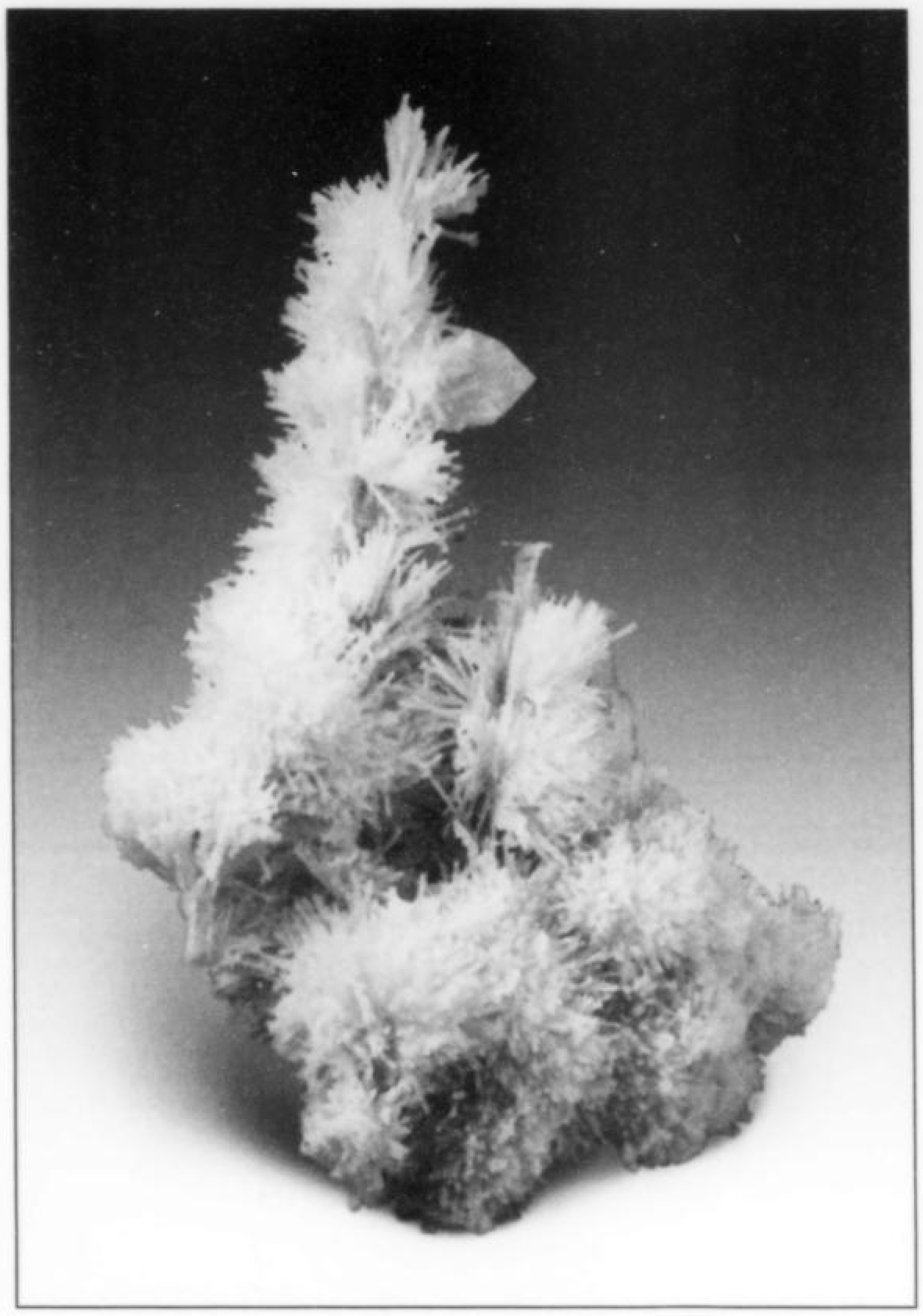


Figure 2. **Chalcedony covering a since-dissolved growth of an acicular zeolite, ca. 16 cm+, found in late February 2009 in a basalt quarry near Jamner, Maharashtra, India. Hemant Merchant (*Mineral Décor*) specimen; Tom Moore photo.**

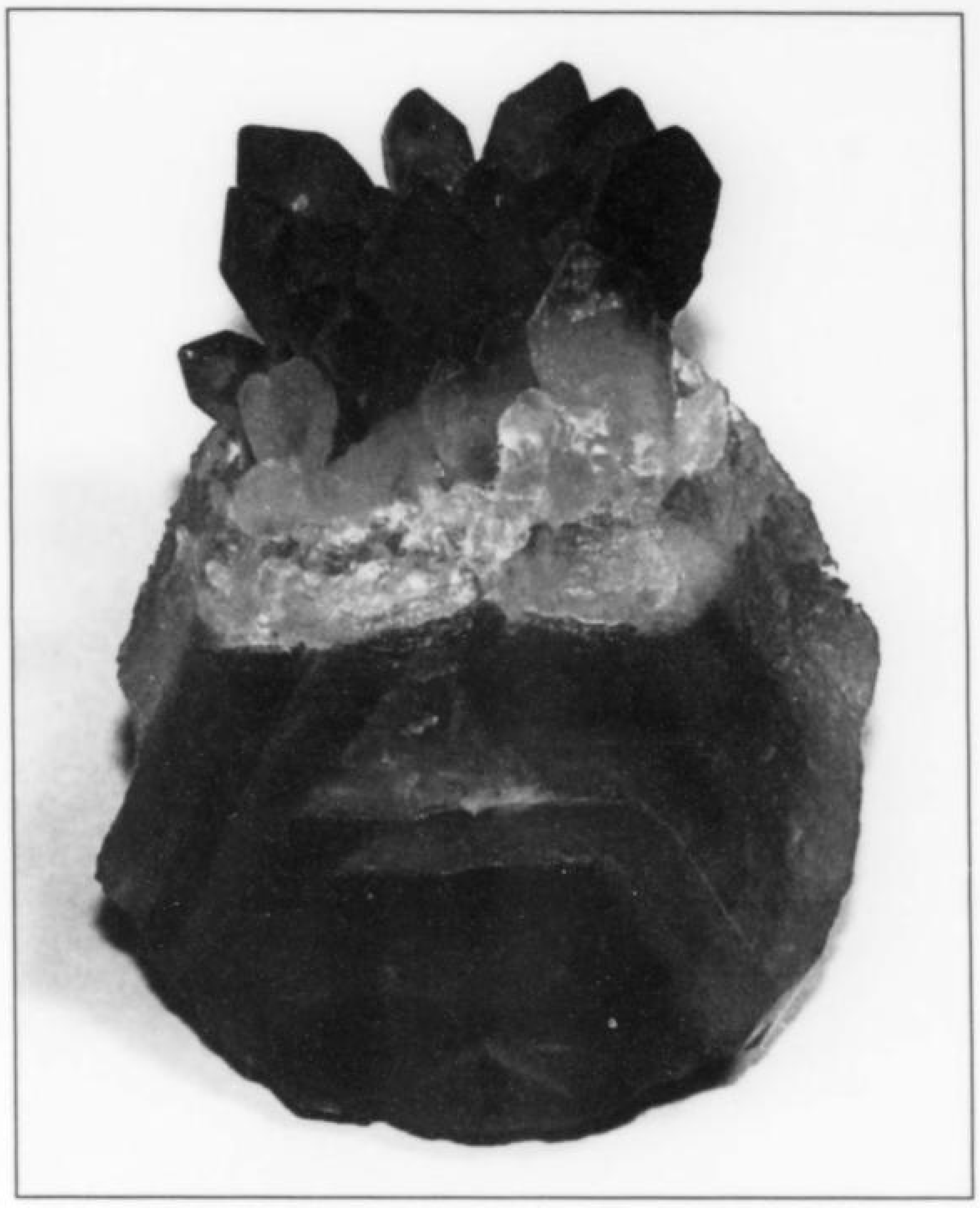


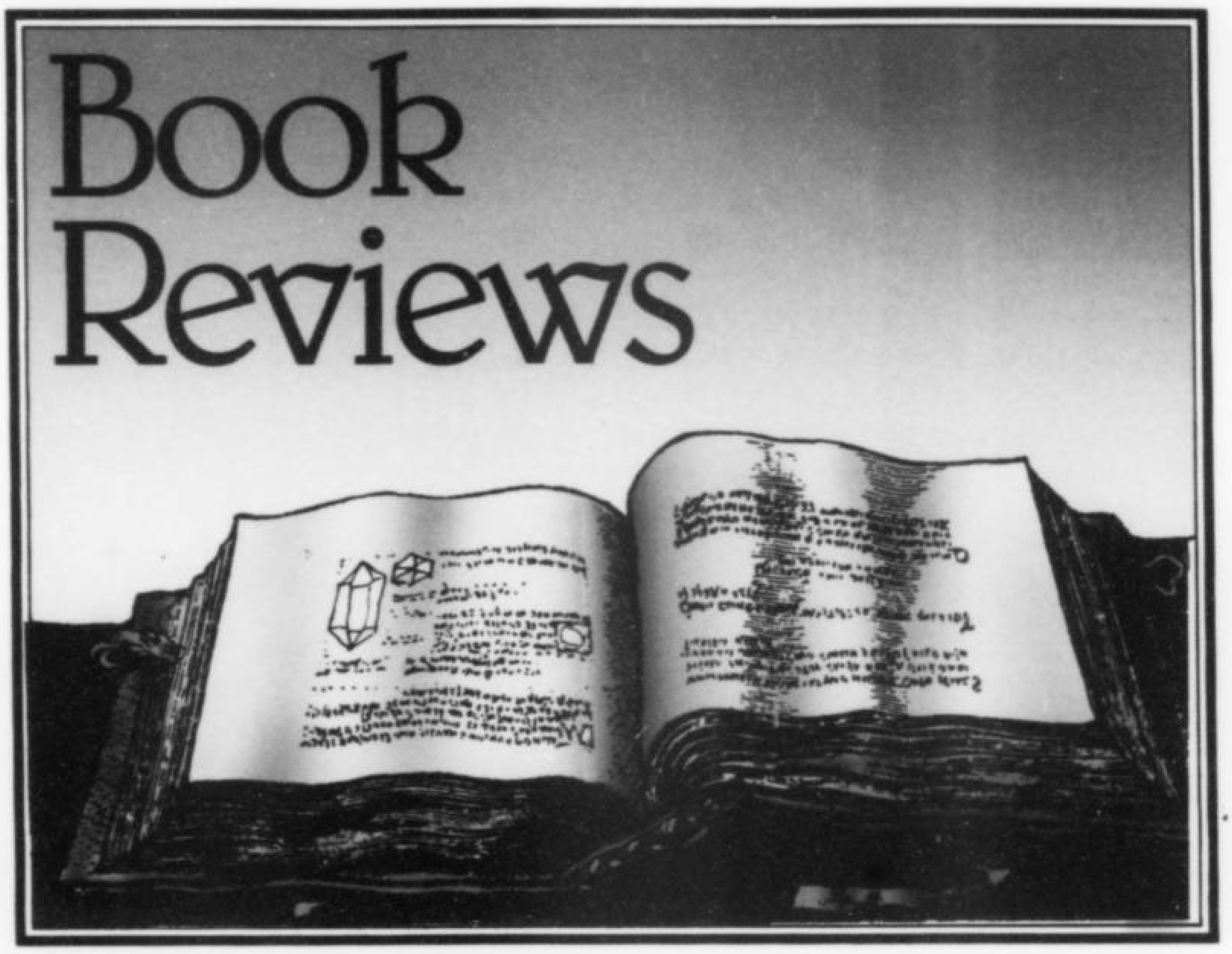
Figure 3. **Hematite-included red quartz crystals on green fluorite, 6 cm, from Gongchen, Guangxi Zhuang Autonomous Region, China. Chris Wright (*Wright's Rock Shop*) specimen and photo.**

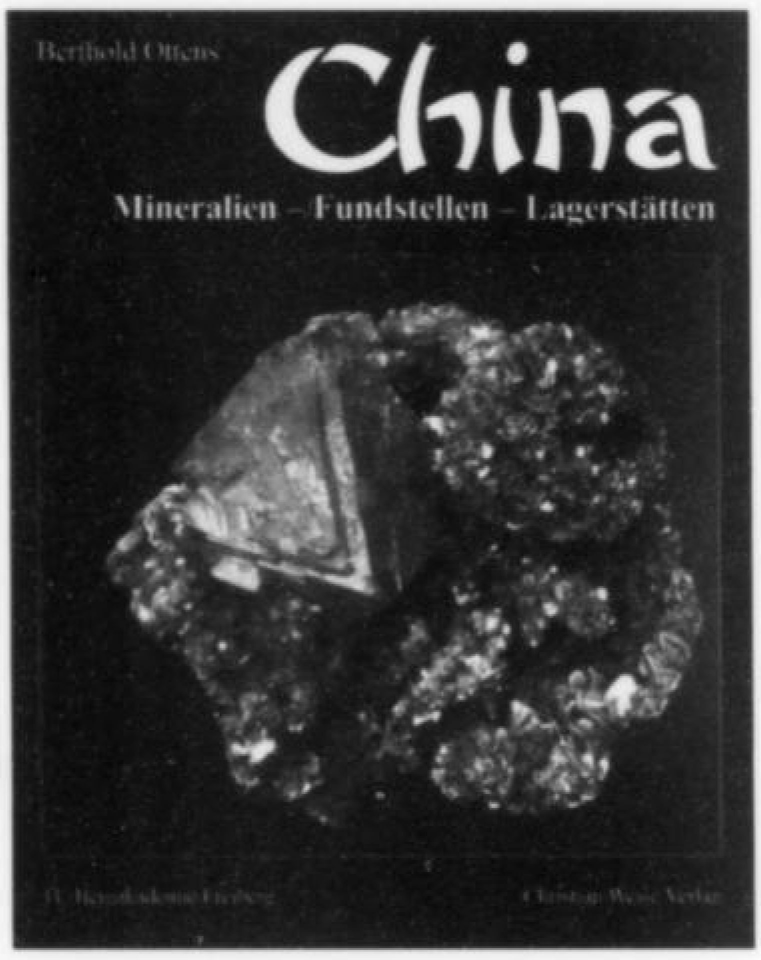
Mike Wild of *Atomic Perfection* (atomicgems@yahoo.com) brought to Houston some newly collected **smoky quartz with fluorite** specimens from the "Dream Time claim" in the Pikes Peak batholith of central Colorado. The specimens range up to cabinet size, showing smoky quartz in stout, very dark prisms with large, low-angle rhombohedral terminal faces, accompanied by fluorite in sharp, translucent, palest purple, penetration-twinned cubic crystals to 3 cm on edge, some showing the rose-pink to deep red core zones now recognized as signatures of "Dream Time" fluorite. And with Mike Wild there were a few loose, gleaming, dark brown sprays of bladed **goethite** crystals to 10 cm from a nearby excavation called the "Dark Night Pocket."

Finally, a topmost shelf in a glass wall case in the *Atomic Perfection* room displayed 13 superlative large specimens of **elbaite** collected 11 years ago at the famous Paprok pegmatite workings in Nuristan, Afghanistan: we have not seen such fine elbaites from Paprok in quite some time. The larger specimens consist of lustrous, translucent, pale pink, slightly divergent crystals in close, sub-parallel alignment, each one sporting a gemmy pale green "cap" on top. The bottoms of these compound crystals are broken but rehealed, and one even has a milky quartz crystal attached perpendicularly. Some of the smaller specimens are single, one-domain crystals, or two thick ones side by side, and these are gemmier than the larger pieces while being just as nicely bicolored pale pink and pale green. These beautiful items range between 7 and 20 cm long (and up to $15,000 in price), and they are a joy to behold—even if not exactly "new."

And that was the Houston Show . . . may it thrive again, and may it perhaps enjoy your attendance next year. Don't forget that while in Houston you can also visit the Houston Museum of Natural Science, home to an amazing array of mineral ikons and former cover specimens for the *Mineralogical Record*. A reception held there during the show was a highlight of the trip.

Crystalline Gold from the Round Mountain mine in Nye County, Nevada





China: Mineralien–Fundstellen–Lagerstätte (*"China: Minerals–Localities–Deposits"*)

by Berthold Ottens. Published (2008) by Christian Weise Verlag GmbH, Orleansstrasse 69, D-81667 München, in co-operation with TU Bergakademie Freiberg Sammlung Schloß Freudenstein. Hardcover, 28 × 24 cm, 552 pages, in German. Price: €59.00 plus shipping costs. For information and ordering go to www.lapis.de.

All who are reading this magazine are aware of the flood of Chinese minerals, most of them previously unfamiliar to us in the West, which immediately began to swell when China became more "open" culturally and economically in the 1980s. Now, twenty years later, the immense country is still in the early stages of modernization, gradually becoming more Westernized and capitalistic. We in the mineral world have observed that the Chinese are naturals when it comes to capitalism: organizational skill, energy, eagerness to market new finds, and (yes) enthusiasm for turning profits have marked the endeavors of Chinese mineral-handlers on every level, and we've been loving it, as all those wonderful specimens just keep on coming.

The Germans, of course, have their own long-standing reputation for organizational skill, energy, thoroughness, etc., and thus it seems apt that it is a German mineral connoisseur, Berthold Ottens, who has done the enormous legwork required to produce the book here under review, the best reference work we now have on Chinese minerals for the collector. In his Introduction to the 552-page volume, Ottens lets us know that he has traveled personally to *every one* of the 78 Chinese localities covered in separate chapters—from the Koktokay rare-earth deposit in the far northwest, where China, Russia, Mongolia and Kazakhstan meet, to the many neighboring, richly mineralized places in Hunan, Jiangxi, Guangdong and Fujian provinces in the far southeast. *Mineralogical Record* readers may recall Ottens as the author who once produced a similar review of the Deccan Plateau region of India (he is the sole author of our "Indian Zeolites" issue, vol. 34 no. 1), and who has written most of the articles in our two special issues on China (vol. 36 no. 1 and vol. 38 no. 1).

All of this energy, and the legwork it fuels, were certainly indispensible for the present project. So many new Chinese mineral occurrences are being found all the time, and so sparse is the relevant published literature in any Western language, that to produce the best possible "big picture" book on China *must* necessarily entail personally crisscrossing the country, as Ottens has done, with notebook and camera in hand. Before now, only Guanghua Liu's *Fine Minerals of China* (2006) attempted to offer an overview of Chinese minerals for collectors. Liu's book was an excellent start, but the Ottens book, which is far more generous with its text, expands, refines and updates Liu on every front. For the diversities of their pictures alone there is every good reason to have both books on our shelves—and don't worry too much about the fact that the Ottens book is in German. It is a clear and straightforward German, and with the help of your German-English dictionary you, too, can read it. Nor do you need proficiency in *any* language to relish another strong feature of both books, namely the hundreds of fine photographs. In the Ottens book more than half of the photos are the author's own, the rest being credited to about 35 other people, prominently including Jeff Scovil and Dan Weinrich, together with many Chinese and Europeans. The photos, scattered everywhere in the volume, show us not only fine Chinese mineral specimens but also Chinese people and places and things of all kinds, from snowcapped Shangri-la mountains to misty *karst* landscapes, to hairpin roads along cliffs, to village bazaars, Buddhist shrines, pink piles of crustaceans around streetside cook pots, panda bears, families at mealtime, outdoor "stone" markets, tourists debarking from buses, the author himself hiking into a town, monks at prayer, children at play, and ultra-mod women busily being beautiful on city streets. You can easily imagine that you've *been* to China yourself, the author having good-naturedly taken you there and shown you around.

The book has enjoyed outstanding support in its creation: financial backers credited include major mineral dealerships (*The Arkenstone, Fine Minerals International, Kristalle & Crystal Classics*), the *Mineralientage München* (Munich Mineral Show), and the Siemens Corporation. Prefatory remarks by the Finance Minister of Saxony and by the Rector of the Technical University of the Freiberg Mining Academy emphasize the increasing cultural and academic connections between China and Germany (the Finance Minister noting, for instance, that 58 Chinese students enrolled for study at Freiberg during the winter 2007–2008 semester). The book is a joint publishing venture of Christian Weise

Verlag (Munich) and the Freiberg Mining Academy, and so there is a beautiful, textless, 55-page photo portfolio of Chinese specimens (arranged by province) from the Erika Pohl (now Freiberg Academy) collection currently on view in Freudenstein Castle in Freiberg. The work thus feels anchored in two different worlds, an Old and a New, Freiberg to Fengjiashan; each cultural presence seems to acquire gravitas from the other, and it's a creative and happy marriage.

After the various short introductory essays, there is a 70-page stretch of short chapters in which Ottens surveys China's "Land and People, Geology, Ore Deposits, Raw Materials, Mines, Mineral Collecting and Dealing, Traveling in China." Some of this is material we have read before, in the author's writings for the *Mineralogical Record*. Next comes that photo portfolio of Chinese mineral specimens in the Pohl collection at Freiberg. And then comes the heart of the book: 78 chapters, filling 316 pages, on "Minerals, Localities and Deposits." The alphabetized chapter headings are sometimes names of large regions or geographical features (Gaoligongshan, Xuebaoding), sometimes names of cities or towns near the mines of interest (Malipo, Ximeng), sometimes names of counties or mining districts (Dongchuan, Nandan), sometimes names of individual mines (Shangbao, Shimen, Yaogangxian). I found such heterogeneous chapter titles confusing at first, but Ottens does provide a simple sketch map at the head of each chapter, making clear what the heading refers to, and once I learned to consult these maps I had no more problems with orientation. Some of the chapters are just a single page long, others many pages, the record being 18 pages for the Yaogangxian mine. The text of each chapter generalizes a bit at first, then offers detailed geographical and (sometimes) historical background before getting down to discussing the minerals, with species names shown helpfully in bold type. Of course, much space is given to photos of mineral specimens: many of these are of familiar kinds, but Ottens also shows things of which this reader (for one) had not seen the like anywhere, anytime, before opening this book.

Having finished learning about the scepter quartz crystals of Zhaotong, we finally leave the locality-chapter section behind, and come next upon a short but important chapter on *Fälschungen*—falsifications, fakes—wherein Ottens describes some commonly observed products of the Chinese fakers' art. This has always been a sore subject with me, and I am ever ready to wax eloquent in my indignation concerning, for instance, the widespread Chinese practice of oiling fluorite to improve its color. We owe Ottens much thanks for his careful descriptions of other, more complex chicaneries going on in the Chinese mineral market today.

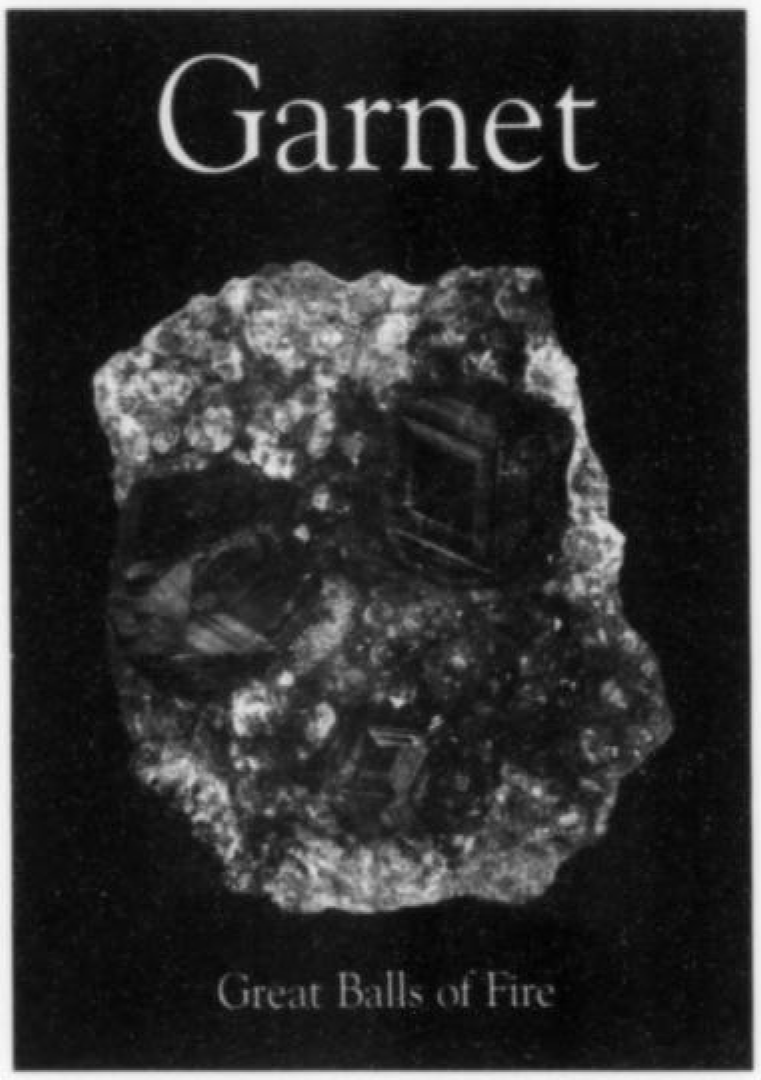
Next, 63 pages are filled by "Chinese Minerals from A to Z"—for purposes of cross-referencing with the earlier chapters on localities, this section briefly describes all known specimen-worthy Chinese minerals, each species getting an unbroken paragraph punctuated by names of localities in bold type. After that, in the Appendix section, there is a map key with a large fold-out reference map of China and an index of mineral species names. A crucial localities register keys on "search concepts" for localities (as in many of the chapter titles) with more precise or alternate terms, coordinates of the localities, and incorrect locality terms as sometimes seen on labels. I call this listing crucial because, like any large, mineral-rich country just starting out in Western-style mineral collecting, China brims with potential for incorrect locality attributions. The problem is exacerbated by the profound differences between the Chinese language and all Indo-European languages, not to mention the wide range of Chinese dialects and pronunciations. Many labeling errors produced by inaccurate transcription of information, improvised commercial arrangements, geographical vastness and rural living conditions, ignorance, rumor-mongering, secretiveness and duplicity may be set right for us if we consult this index.

A bibliography listing 95 published works, plus a thumbnail biography of the author, round out the book.

Of late I have been using *China: Mineralien–Funstellen–Lagerstätten* fairly intensively for a special project, and yet the only negative comment I can come up with is that sometimes there are small contradictions between the locality chapters and the later species listings (e.g. the chapter on Xuebaoding Mountain says that the K-feldspar occurring there is microcline, but in the species listing it is called orthoclase), and there are small inconsistencies such as are to be expected wherever such great masses of data have been so newly assembled. Just one example will do: under Scorodite in the mineral listing we read of the specimens found in the Pingtouling mine, Guangdong Province, but the photo at hand shows a scorodite from the newer discovery at Hezhou, Guangxi, and is captioned as such, though the text does not mention the Hezhou occurrence.

Such tiny flaws quite aside, this volume addresses magnificently the long-standing need for an omnibus book on Chinese specimen mineralogy. It is beautiful, authoritative and fun all at once, and thanks apparently to heavy subsidizing of production costs by the entities mentioned earlier, its price, €59, makes it one of the very best deals around.

Thomas P. Moore



Garnet: Great Balls of Fire

Edited by H. Albert Gilg, Daniel Kile, Suzanne Liebetrau, Pete Modreski, Günther Neumeier and Gloria Staebler. Published (2008) by Lithographie, LLC. Available from the online bookstore at www.MineralogicalRecord.com; or by regular mail: P.O. Box 35565, Tucson, AZ 85740; or by e-mail order: minrec@aol.com. Stiff softcover, 8.25 × 11.7 inches, 98 pages. Price $30.00.

It is getting harder to write original-sounding reviews of new volumes in the ExtraLapis English series, not because their quality is falling off—emphatically that is not the case—but because in many past reviews the apt superlatives have already done duty, and yet all still apply. *Garnet: Great Balls of Fire* (Number 11 in the series) is, like the others, a great burst of first-rate color photography and expert graphics, a knowledge-broadening treat for the mind, and a medley of fun facts dispersed throughout the quirkily organized chapters (this playful, not-quite-regular organization being by now a trademark of ExtraLapis English productions). For *Garnet*, Gloria Staebler and Günther Neumeier are joined by four co-editors in marshalling contributions by 24 authors and 40 illustrators, who all together explicate the 15 species of the garnet group: their chemical and crystallographic attributes, geologic settings, worldwide occurrences, history, lore, gemstone uses . . . and whatever combinations of these lead to interesting chapter arrangements. The project is touchingly dedicated to Mick Cooper (1946–2008), "author, photographer, editor, advisor and humorist," who helped with past ExtraLapis English projects and is, in the painful but valid cliché, greatly missed by all who knew him.

The introductory chapter, by Smithsonian collection manager Paul Powhat, is called "The Garnet Group: Fifteen Species, Endless Variety." To help memory order the six most important species, Powhat recommends the old nonce words "pyralspite" and "ugrandite," respectively for pyrope-almandine-spessartine, with Al in the second cation site, and uvarovite-grossular-andradite, with Ca in the first cation site (I recall consciously and earnestly learning these terms as a child, and now it's nice to see them again in such a respectable setting).

In the next chapter come "The Rare Garnets," including such oddities as morimotoite, katoite, calderite, majorite, knorringite—all of which are described concisely, and their worldwide occurrences listed. And here's what I mean about fun facts: we are authoritatively clued in about those intriguing, earthy gray-brown pseudocrystals from Siberia which are sometimes called "achtaragdite": they are pseudomorphs of an intermediary solid solution between grossular and katoite after euhedral crystals of mayenite, an extremely rare, poorly characterized Ca-Al oxide. Refine or rewrite your labels accordingly.

For each of the six major garnet species there is a "classic" chapter—e.g. "Classic Garnets: Almandine"—followed by one or more chapters on localities and/or pertinent history and lore. For almandine there's a chapter on "New England Garnet" (Russ Behnke), with photos of specimens of the wonderful old-timers from Russell, Massachusetts, and a chapter on "Idaho's 'Star' Garnet" (Mickey E. Gunter), offering well-illustrated discussion of what causes asterism in these well-known lovelies. Apropos of some species there are whole chapters on major localities: thus, following "Classic Garnets: Grossular" (Joachim Zang and Thomas Fehr) we find "Jeffrey and Lac d'Amiante" (Marco Amabili, Francesco Spertini and Marc B. Auguste) and "Grossular from Mali" (Bill Dameron); following "Classic Garnets: Spessartine" (six authors) we find "Spessartine from Tongbei" (Bert Ottens). For the most part pyrope does not occur in collectible crystals; nevertheless, in "Pyrope from the Dora-Maira Massif" (Gilla Simon) collectors can learn about a geologically unique occurrence in Italy, and in "The Fiery-Eyed Volcanoes of Bohemia" (Jirí Kouřimský and Jaroslav Hyršl) there's a sketch of the 2,000-year history of mining Bohemian gem pyropes which originate in Tertiary-age volcanic rocks.

Along the way there are chapters addressing subjects ranging through "Synthetic Garnet: Lasers and Imitation Gemstones" (Lothar Ackerman), "The Microworld of Garnet: Fingerprints, Fans and Haloes" (John I. Koivula), and "Anthrax, Carbunculus, and Granatus: Garnet in Ancient and Medieval Times" (H. Albert Gilg)—say, how *about* those elegant, 1.5 cm-wide garnet/gold figures of bees, buried with Merovingian monarch Childeric I (ca. 440 – ca. 481) but stolen, all but two, from the Bibliothèque Royale in Paris in 1831, and never recovered?

Of course I've omitted mention of plenty of other garnet-related topics which pop up throughout the 22 chapters that fill these 98 pages—and most topics are accompanied by beautiful illustrations. The book is loaded with pictures of world-class garnet specimens, and topping off the mind-feast is a bibliography of 123 entries. Great balls of fire! Get a copy of this one while (as they say) supplies last.

Thomas P. Moore

Legal Nuggets

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"My Word is My Bond"

"A verbal contract isn't worth the paper it's written on." So said Samuel Goldwyn, the film mogul from the 1920s and 1930s. Alas, poor Sam spoke from experience, as he had been forced out by his partners before they founded a new studio that ironically bore his name—you know it as Metro-Goldwyn-Mayer or MGM.

Now, you might think that with this bit of scandalous history and hundreds of millions of dollars at issue, oral contracts in Hollywood would be rarer than blue-capped tourmalines—and you would be wrong! Owing to the fast-paced and creative nature of the moviemaking industry, artists, studios and financiers often still rely on handshake deals. And they are not alone. To this day, it is common in New York City for diamond merchants to conclude an agreement with a handshake and the formal words *mazel u'bracha* ("luck and blessings"). Likewise, a recent study found that more than half the farm leasing contracts in Nebraska and South Dakota were still unwritten. Oral agreements still prevail on many stock exchanges, including the London Stock Exchange, whose motto, *dictum meum pactum,* is quoted (albeit in English) as the title of this installment. And, of course, oral agreements and mutual understandings are extremely common in the world of mineral collecting and mineral dealing.

So, this might persuade you to think that the law is very tolerant of oral contracts—and again you would be wrong! (My fault, of course). Because there are many thorny evidentiary problems associated with enforcing oral contracts, legislatures and judges show a strong preference for written contracts. These preferences ordinarily are reflected in state law, for it is that law, rather than federal law, which controls most contract disputes. These preferences arise both in statutes and in state "common law"—the latter constituting the body of legal customs and traditions derived from past judicial decisions.

So what are some of these legal preferences for written contracts? Some take the form of so-called "Statutes of Frauds." The first such statute was passed by the British Parliament way back in 1677. In modern form, these statutes commonly require that contracts, which cannot by their terms be performed within a year, be in writing and signed in order to be enforceable. The U.S. Uniform Commercial Code—a set of sample provisions drafted by legal experts that often are used by state legislatures as models for new laws—contains a Statute of Frauds provision for the sale of goods, requiring that all contracts for the sale of goods in excess of $500 be accompanied by a signed document as evidence of the sale to be enforced. Some state legislatures (including Arizona's) have relaxed this rule somewhat, particularly in situations in which the goods purchased are immediately transferred.[1] Nonetheless, potential bargainers are well-advised to be aware of the Statute of Frauds in the state in which they plan to transact business, particularly if they anticipate a long-term deal.

Next, we have "parol evidence rules." These rules take two forms—some come from statutes, while others derive solely from the common law. Under these rules, a written document takes precedence over any oral agreements entered into prior to the adoption of the writing and renders the oral agreements unenforceable. This rule can cause problems for the unwary, particularly when one contracting party thinks that a subsequent written agreement merely supplements a prior oral agreement, and the other party thinks that the written agreement totally replaces that earlier contract.

We are not done. State law also tends to favor written contracts in terms of the amount of time given a party to file suit for a breach of a contract—an issue controlled by what are known as statutes of limitations. In many states, the prescribed limitations periods are longer for written contracts than for oral ones. Under California law, for example, the statute of limitations for filing a breach of contract action is four years for a written contract, but only two years for an oral one. Some states, moreover, limit the types of judicial remedies that are available for a breach of contract depending upon whether the contract is written or oral. For example, some states permit a court to order the breaching party to perform a contract only if it is in writing; the party suing upon a breach of an oral contract is limited to damages. This distinction might be critical if what you want, in your breach of contract action, is the specimen you paid for (which has substantially increased in value since the purchase), rather than your money back.

With the legal deck stacked so heavily in favor of written contracts, why are "handshake deals" still so prevalent in certain quarters, even in high-priced deals? There are several reasons. First, most business deals are relatively short and simple. The typical retail sale of a mineral, for example, involves a quick exchange of the specimen for cash and thus is not impacted by laws like the Statute of Frauds. That sort of basic transaction also can trigger consumer protection laws that provide additional safeguards to the buyer, including several implied warranties (more on that in a later column). Second, in many transactions, the benefits associated with having a written contract are simply outweighed by the costs of having such an agreement prepared—costs framed either in terms

[1] *See* Arizona Rev. Stat. 44101.4.

of the expense associated with having an agreement drafted or of the opportunities lost while that drafting process occurs. In practical terms, it probably makes little sense to pay $1,000 or more to develop even the simplest of written contracts unless the financial exposure in the deal is substantial.

Care must also be taken in drafting those written contracts. This is not the time for "lunch hour law" (in law, you almost always get what you pay for). The law books, indeed, are brimming with cases in which poorly drafted agreements created problems that might have been avoided had the parties proceeded with a handshake.

Yet, these factors do not explain why some parties continue to use oral contracts for very large deals—those involving hundreds of thousands, if not millions of dollars. As it turns out, the use of these oral contracts often is promoted by the availability of effective non-legal enforcement mechanisms within relatively small and close-knit communities—communities in which a loss of reputation, occasioned by a breach of contract, means the certain death of a business. But, even in such communities, it is not always easy to tell who is in the right and who is in the wrong. That is why it is common in some industries for trade associations or other similar bodies to assist in resolving disputes among parties. Those alternative arbitration or resolution mechanisms, if well-administered and fair, have the potential for reducing transaction costs for everyone involved. With the advent of very highly priced "trophy rocks," a few mineral dealers have argued that such an association should be established in the mineral world. But, as yet, this is not a reality.

So where does this leave us? Without accounting for every idiosyncratic aspect of a given state's laws, there is at least significant indication that the wide majority of individual mineral sales, particularly those that involve no extended terms or complicated financial arrangements, need not be accompanied by a formal written contract. Under most state laws, a simple receipt will suffice. Beyond that, there is no easy answer. Certainly, parties contemplating a large deal ought to have some basic knowledge of the law, as there may be some circumstances in which an oral contract is simply unenforceable. Beyond this, the parties might want to conduct a cost-benefit analysis to determine whether it makes sense to have a written agreement prepared. Large dollar amounts and special financing or marketing arrangements, particularly those that extend over time, ought to tip the scale more in favor of having a written agreement. At the least, the presence of such features suggests that the oral agreement ought to be evidenced *somehow*—a check stub, a list of specimens, or even a sentence or two on a napkin is better than nothing. (Remember, in court, it is not what you know, but what you can prove.)

Even in the largest deals, however, you might encounter that proud soul who will react indignantly to any request for a written agreement, saying, in so many words: "Why? Don't you trust me?" And, in most situations, particularly where professional reputations are at stake, perhaps it is fine to extend a hand of trust and forego the written document. But, before you feel too guilty about insisting on something in writing, keep in mind a couple of last thoughts.

First, remember what Ralph Waldo Emerson once wrote: "All sensible people are selfish, and nature is tugging at every contract to make the terms of it fair." A student of human nature, Emerson apparently understood that perceptions of the fairness of a contract often shift over time—and with those shifting views often come misunderstandings as to what was originally agreed. To paraphrase Emerson, it is one thing to have our selfish human nature "tugging" at the clauses of a written contract, and quite another to have that happen with only the fuzzy recollections of an oral contract. (It never ceases to amaze me how recollections of the same conversation can so differ when people get into court.)

Second, before extending your hand, picture in your mind one of those cell phone commercials—you know, the ones in which friends and family are surrounded by a crowd of folks in white hard hats and red jumpsuits. Imagine that the crowd standing behind the person with whom you are about to deal represents his creditors and business partners. Because, in the end, it might not be the smiling person who is extending his hand to you, but one of the folks in that crowd (sans the red jumpsuit) who you will be facing when you try to explain why that flashy Kongsberg silver, about to be sold as collateral for a loan, actually belongs to you under an oral agreement. As Sam Goldwyn probably figured out, a friendly handshake sometimes is nothing more than an invitation to a round of arm-wrestling later in the courts.

NOTE: ***This column is for educational purposes only and is not legal advice, or a substitute for such advice. Readers who have questions on this topic should consult a qualified lawyer.***


Letters

About Mineral Collecting

First of all I would like to thank Rock Currier for his great series "About Mineral Collecting." It is probably the best text ever written as a general guide to this subject. As my reflection on the article I would like to add a few words regarding localities and labels.

As Rock mentioned in his text, the situations he describes are typical examples but are not the only ones. There are two very common problems connected with localities that cause a lot of difficulty for collectors and dealers. The first is localities which have changed names over time (sometimes repeatedly)—Dalnegorsk being a good example. Specimens that were distributed to collections around the world in the early 20th century are generally labeled Tetjuche (the Chinese name for the locality at that time), not Dalnegorsk. Similar confusion surrounds Striegau, the well-known locality in Poland. Striegau is a German name that was in use until the end of World War II. Since 1945 the town has been called Strzegom (in Polish), but in many reference works and famous collections the name Striegau has been retained because it is better known than Strzegom. The problem with names that have been changed over time is that nobody remembers all of the various historical names and their synonyms. Thus there is always the problem of which name to use on labels: the more famous "Striegau" that increases the value of the specimen, or the currently correct but relatively unknown "Strzegom"? In my opinion the most current names should be used.

The second big problem for collectors wishing to write correct labels is the lack of knowledge about political subdivisions in the countries of origin. Rock proposed citing the country, state, province, canton, department, district, town etc. and I think we can all agree that would be best. But the number of localities is increasing so fast and is so huge today that no reference work can be found which contains all of them, especially with all of the correct political subdivisions. Of course it is not so hard to find current and precise information about localities in the well-developed, well-explored countries, but finding the proper political subdivisions in countries like Madagascar, for instance, can be challenging.

Fortunately there is a light at the end of the tunnel. The mindat.org website is probably the world's largest continuously updated database of minerals and localities. One can find there information on political subdivisions, old and alternative locality names, and even the GPS data for some of them. The advantage of Mindat (and other encyclopedias such as Wikipedia etc.) is the ease of adding or altering information: every user can contribute to the content of this database. People who have special knowledge of particular localities or species can upgrade the data up to very high quality level. Because the users are from all over the world, some of them have knowledge about subjects which to others are like a closed book, and they can easily make corrections. The localities are the best example, especially those that are problematic for some reason. People who specialize in some of them or live in those countries where they are located may provide very complete information, including proper diacritic marks, GPS data, old names etc.—and they do!! For collectors who have only a general interest in those localities, that knowledge could be very difficult or even impossible to find from any other source.

I believe that Internet databases such as Mindat are the wave of the future, and it is up to us to determine how high the quality of the posted information will be. And believe me, it is very helpful when you want to make a proper label for your specimen. In fact, the Mindat database is becoming so popular that locality designations posted there are coming to be regarded as the "standard names" for the localities.

Tomasz Praszkier
"Spirifer" Geological Society, Poland

INTERNET DIRECTORY

THE MUSEUM DIRECTORY

Colburn Earth Science Museum

Curator: Phillip M. Potter
Tel: (828) 254-7162
Fax: (828) 257-4505
Website: www.colburnmuseum.org
Pack Place Education,
Arts & Science Center
2 South Pack Square
Asheville, NC 28801
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Curator: Dr. Richard Berg
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Fax: 406-496-4451
E-mail:dberg@mtech.edu
Program Director: Ginette Abdo
Tel: 406-496-4414
E-mail:gabdo@mtech.edu
Website: www.mbmg.mtech.edu
/museumm.htm
Montana Bureau of Mines & Geology
Montana Tech of UM,
1300 W. Park Street
Butte, Montana 59701
Hours: Mem/Day to Labor Day
9-6 daily; Rest of year M-F 9-4; Open Sat & Sun May, Sept &
Oct 1-5 pm
Specialties: Butte and Montana minerals, worldwide classics

Additional listings welcome!

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

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Bruce Bradford
Tel: (904) 822-7331
E-mail: bbradfor@stetson.edu
Assistant Director: Holli M. Vanater
Tel: (904) 822-7330
E-mail: hvanater@stetson.edu
Fax: (904) 822-7328
234 E. Michigan Avenue
[mailing: 421 N. Woodland Blvd.
Unit 8403]
DeLand, FL 32720-3757
Hours: 9-noon, 1–4 M-F; closed during univ. holidays, breaks, summer
Specialties: Worldwide comprehensive collection of rocks & minerals; Florida rocks, minerals & fossils; large historic fluorescent collection

Colorado School of Mines

Museum Director: Bruce Geller
Tel: (303) 273-3823
E-mail: bgeller@mines.edu
Website: www.mines.edu/academic/
geology/museum
Golden, Colorado 80401
Hours: 9–4 M–Sat., 1–4 Sun.
(closed on school holidays & Sundays in the summer)
Specialties: Worldwide minerals; Colorado mining & minerals

A. E. Seaman Mineral Museum

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

Houston Museum of Natural Science

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

Natural History Museum of Los Angeles County

Fax: (213) 749-4107
Website: http://nhm.org/research/minsci
Curator (Mineral Sciences):
Dr. Anthony R. Kampf
Tel: (213) 763-3328
E-mail: akampf@nhm.org
Collections Manager:
Alyssa R. Morgan
Tel: (213) 763-3327
E-mail: amorgan@nhm.org
900 Exposition Blvd.
Los Angeles, CA 90007
Hours: 9:30–5:00 Daily
Specialties: Calif. & worldwide minerals, gold, gem crystals, colored gemstones, micromounts
Support organization:
The Gem and Mineral Council

California State Mining and Mineral Museum

Curator: Darci Moore
Tel. (209) 742-7625
Fax: (209) 966-3597
Website: www.parks.ca.gov
Mailing: P.O. Box 1192
Mariposa, CA 95338
Hours: May 1–Sept. 30, open daily 10–6
Oct. 1–April 30, open 10–4, closed Tuesdays
Closed Christmas and Thanksgiving
Specialties: California & worldwide minerals, gold, gems, and mining

Museums listed alphabetically by city

THE MUSEUM DIRECTORY

University of Delaware Mineralogical Museum

Curator: Dr. Sharon Fitzgerald
Tel. (302) 831-6557
E-mail: slfitz@udel.edu
Penny Hall
Newark, DE 19716
Tel: (302)-831-8037
E-mail: universitymuseums@udel.edu
For information: www.udel.edu/museums
Specialty: Worldwide Classics & New Minerals

Matilda and Karl Pfeiffer Museum and Study Center

Executive Director: Teresa Taylor
Tel: (870) 598-3228
E-mail: pfeifferfnd@centurytel.net
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E-mail: rdolbier@unr.edu
Website: http://mines.unr/edu/museum
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University of Nevada, **Reno,** NV 89557
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New Mexico Bureau of Mines & Mineral Resources—Mineral Museum

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E-mail: vwlueth@nmt.edu
Fax: (505) 835-6333
Associate Curator: Robert Eveleth
Tel: (505) 835-5325
E-mail: beveleth@gis.nmt.edu
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Socorro, NM 87801
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E-mail: adomitrovic@desertmuseum.org
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E-mail: minerals@nmnh.si.edu
Collection Managers: Paul Pohwat and Russell Feather
(Dept. of Mineral Sciences)
Washington, DC 20560-0119
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Tellus: Northwest Georgia Science Museum

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Executive Director: Jose Santamaria x401
E-mail: joses@tellusmuseum.org
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100 Tellus Dr.
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