THE MINERALOGICAL RECORD

MAY–JUNE 2010 • VOLUME 41 • NUMBER 3

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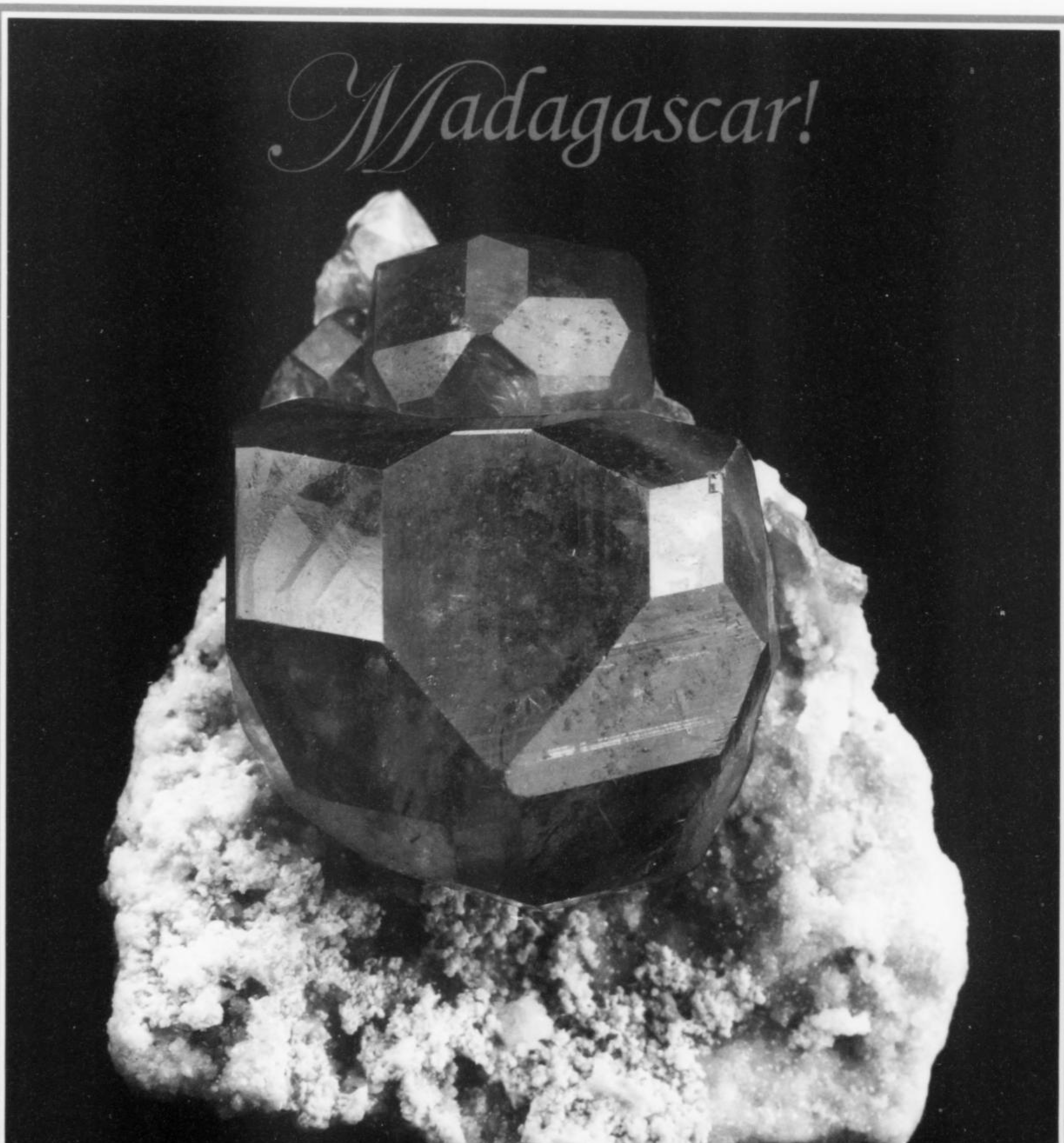

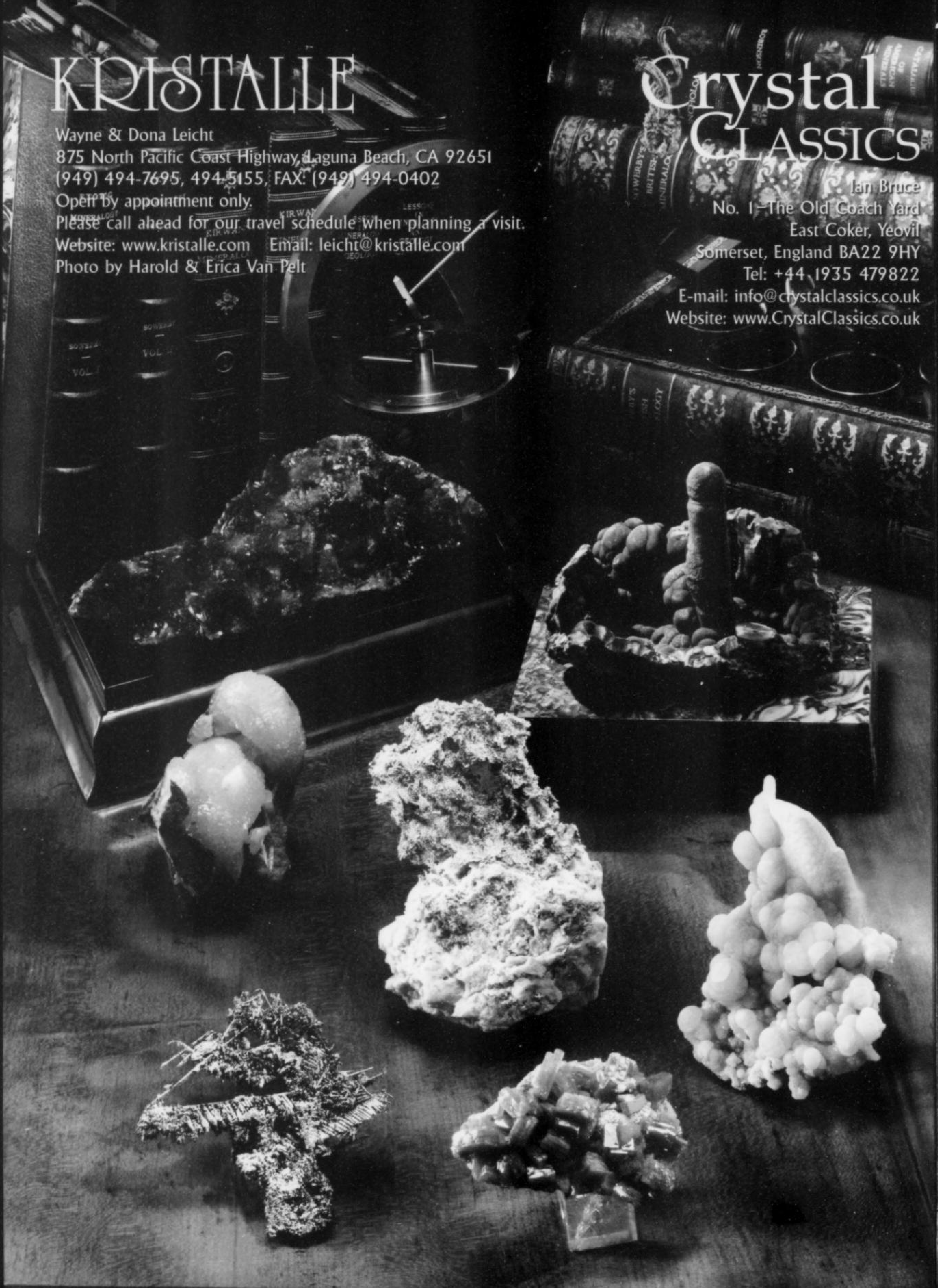
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The

Mineralogical Record

The International Magazine for Mineral Collectors

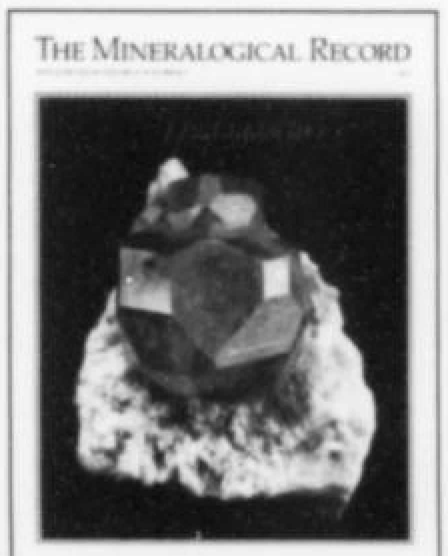
VOLUME 41 • NUMBER 3 MAY–JUNE 2010

Continued on page facing inside back cover

Articles

Columns

This issue was made possible in part by contributions from Philip G. Rust and the Fellows of the Mineralogical Record



COVER: ANDRADITE (var. demantoid) 2.9 cm, from Antetezambato, Madagascar. See the article in this issue beginning on page 209. Daniel Trinchillo (Fine Minerals International) specimen; Roberto Appiani photo.

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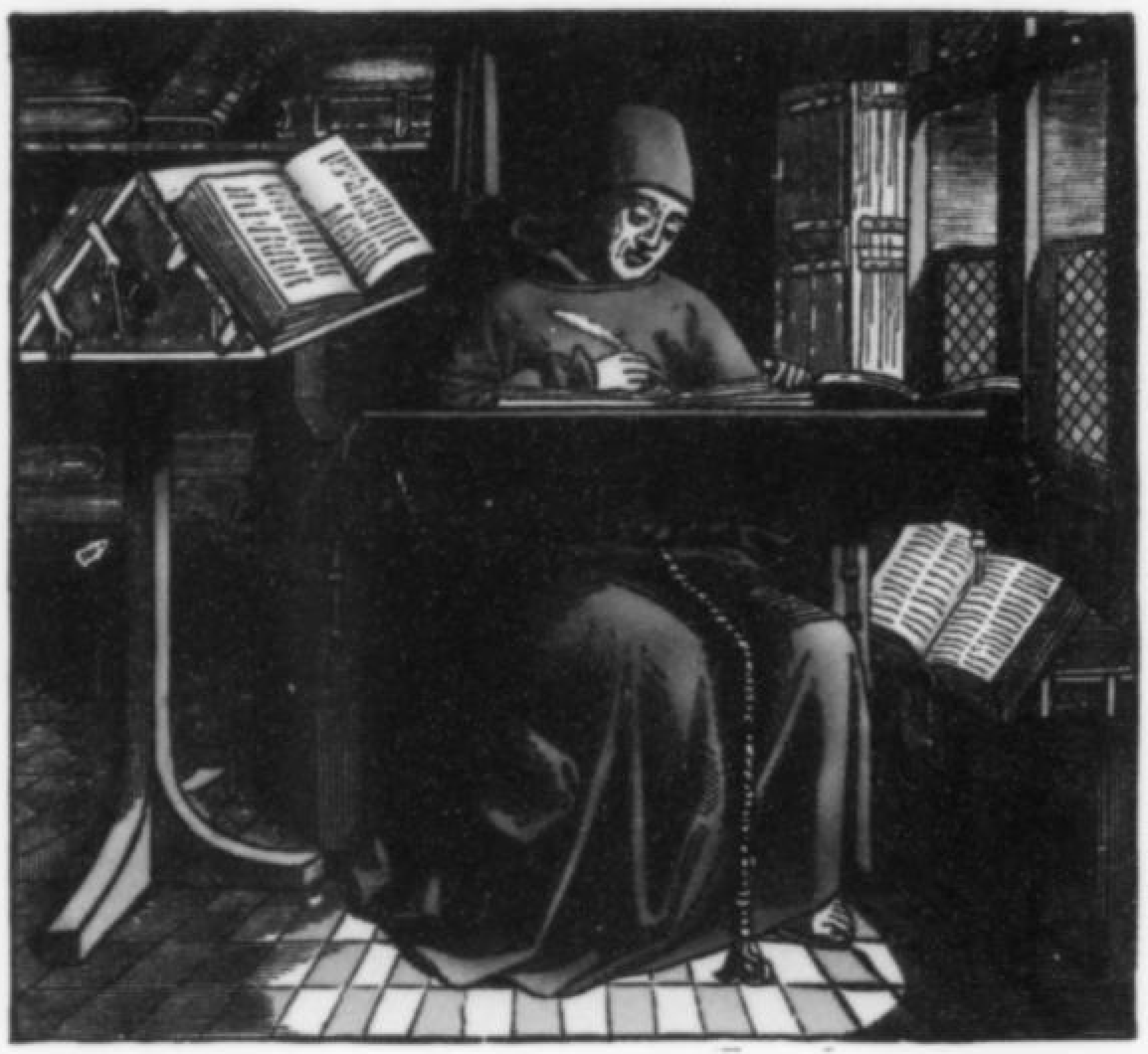


Notes from the Editors

Mahogany mineral cabinet by David Llewellyn, West Creek Studio, Berkshire, New York.

Mineral Cabinets (XIV)

I believe this is the 14th entry in our periodic discussion of mineral cases and cabinets in the "Notes from the Editors" column.* This time we have a real beauty, built from figured Honduran mahogany by David Llewellyn (West Creek Studio in Berkshire, New York; www.WestCreekStudio.com). It measures 47 inches high, 34 inches wide and 20 inches deep. The entire piece is solid mahogany, including all the drawer parts and the back. The drawer columns and the display area lock independently, and the display area is lighted. The cabinet has hand-cut case joints and hand-cut dovetails on the drawers.

David has been designing and building functional woodwork since 1990. His basic approach to woodwork is to choose premium materials, and execute simple designs with strong joinery. Beautiful wood, he believes, can speak for itself, and doesn't require embellishments or decorations. Most of his work has a natural wood finish that is hand-rubbed with linseed oil; he generally does not use dyes, stains or veneers.

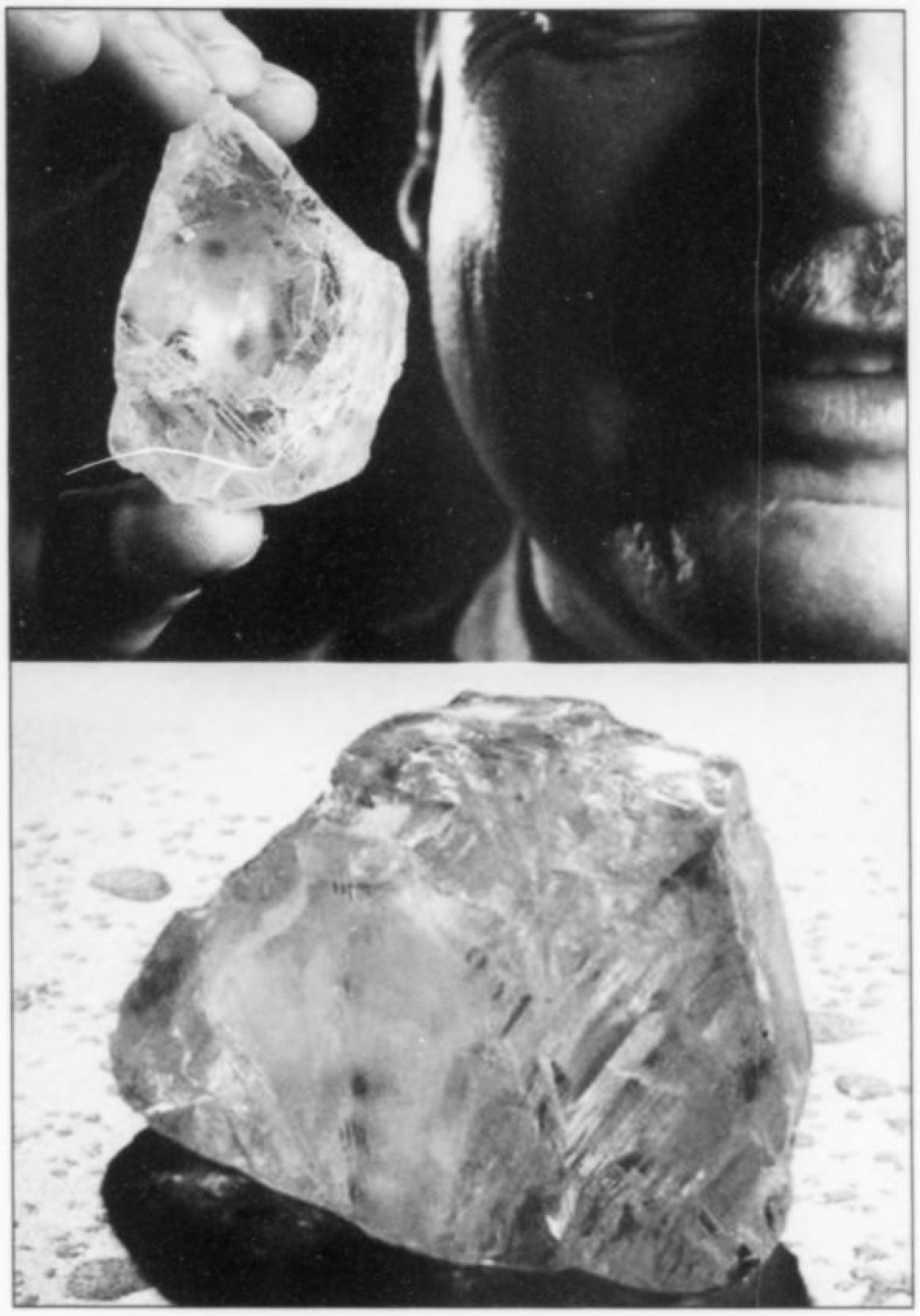
Fine artisanal craftsmanship like this does not come cheap. A cabinet like the pictured example would be priced at around $9,500. David also specializes in "jewel cases" which are essentially identical to what we would call thumbnail cabinets, 16 to 20 inches wide, with three to six drawers—or, probably, however many you want. Each drawer is velvet-lined, with adjustable wood dividers. Four-drawer chests in cherry start at $740 and go (way) up for other woods, sizes and arched-apron designs. These beautiful cases (you can see many styles on his website) have comprised a major portion of his business for the last 15 years, and he has sold literally hundreds of them throughout the country. If you don't mind paying a premium price to house your treasures, you can acquire a real artwork of a cabinet from David. Stock pieces may be available, and custom inquiries are welcome, but please remember that large pieces require time to design and execute, so patience is sometimes required. He can be contacted at david@westcreekstudio.com, but be sure to check out his website first to see other examples.

*The others were in vol. 41/n.2, 41/n.1, 40/n.3, 39/n.4, 38/n.3, 33/n.2, 28/n.5, 28/n.3, 28/n.2, 27/n.6, 27/n.5, 27/n.4, and 27/n.3.

Expensive Crystal

In the mood for a really expensive addition to your collection of miniatures? Got just the thing: A 507-carat, 3.53-ounce diamond crystal—actually it is probably just a fragment of an even larger crystal—recovered in September at the Cullinan (formerly the Premier) diamond mine in South Africa. Purchased in February for $35.3 million by the Chow Tai Fook Jewelry Company in Hong Kong, it qualifies as the 19th largest diamond crystal ever found. That selling price is the highest ever paid for an uncut diamond—or, should we say, a nice albeit somewhat damaged crystal specimen. They say it has the potential to become one of the most important gems ever cut, so it may not remain a crystal specimen for long.

A consortium headed by the Petra Diamond Corporation Ltd. purchased the Cullinan mine from De Beers in 2007 for $148 million. Last year the mine produced a rare 7-carat blue diamond which sold for $9.4 million, so the purchase of the old property appears to be paying off for Petra. The Cullinan mine is the same mine that in 1905 yielded the largest diamond ever found, the famous 3,106-carat Cullinan diamond—which itself was also just a fragment of a larger crystal. It seems unlikely that a diamond crystal or fragment could actually be destroyed during the emplacement of a kimberlite pipe, so the odds are that the other parts of the original Cullinan diamond still exist somewhere. Kimberlite diatremes were emplaced



The "Cullinan Heritage" diamond (507 carats).

at relatively low, non-magmatic temperatures and are thought to have churned and mixed violently. Who knows—perhaps the new diamond (named the "Cullinan Heritage") is indeed a long-lost piece of the Cullinan diamond.

Historical item: Wells College Collection

The following article [with insertions added for clarity] appeared in the April 26, 1871 issue of *The New York Times*, headlined "A Mineral Cabinet for Wells College, Aurora":

> The venerable Henry Wells, founder of Wells College, Aurora, New-York, father, so to speak, of the great Express Company of the United States [=American Express], Wells, Fargo & Co., and a life-long and intimate friend of Hon. Wm. H. Seward [12th Governor of New York and Secretary of State under Abraham Lincoln], has been spending some months in California, and leaves for his home in New-York to-morrow. During his stay in California Mr. Wells has been making a collection of specimens of gold, silver, copper, iron and lead, and other ores and minerals generally, from different parts of the Pacific coast, for the college which bears his name, having succeeded in obtaining two entire collections of considerable extent and rare excellence. He is desirous of increasing the collection by specimens of all kinds, until it will form a cabinet of high scientific value, and the trustees will make an appeal for that purpose to mine-owners and others on the Pacific coast who may have specimens which they are willing to contribute. Any of the agents of Wells, Fargo & Co. will receive specimens, single or in numbers, and transmit them to San Francisco, to be forwarded to the college.
>
> Wells College was founded for the purpose of giving young ladies the advantage of a thorough scientific education [the college finally became coeducational in 2005], and stands high among the useful educational institutions of America. The collection will be seen by thousands of people annually, and will serve to give a large class of influential and wealthy people an adequate idea of the value and extent of the mineral resources of the Pacific States. Parties contributing to the collection will in doing so render a service to the cause of liberal education, and at the same time confer an indirect but positive benefit on the Pacific States. The better our resources are known abroad, the greater will be the immigration to this coast, and the more willing capitalists and men of energy and enterprise to invest money, skill and labor in legitimate enterprises with us.

One must assume that Wells' approach worked, as there was certainly a subsequent immigration of capitalists to the West Coast! Today Wells College offers no courses in Geology or Earth Science (much less Mineralogy), nor does anyone there know what became of the mineral collection assembled for the college by Henry Wells.

The "Mini Illuminated Microscope" by SE—$6.

Illuminated Hand Lens

Here is an idea that makes you wonder why someone hasn't thought of it before: an LED-illuminated hand lens. It's called the "Mini Illuminated Microscope," and boasts 45X magnification. I bought one to test, and it works just fine. I can't verify the 45X, but it is certainly more powerful than my trusty old 10X hand lens. The light source (two very bright LEDs) and battery case are mounted on a hinge that allows the angle of lighting to be adjusted, and the ocular slides up and down for fine-scale focus adjustment, producing an image that is sharp and clear. The lens assembly is just 1.5 inches tall. Batteries (three LR927s) are included, as well as a little leather carrying pouch.

Manufactured in China and marketed by SE, Santa Fe Springs, California 90670, this little gadget is easy to use and sells for about $6. Yes, that's correct, six dollars—an amazing value. You can order it from hobbytoolsupply via Amazon.com.

Supplements

Our thanks once again to all of the people who have supported the cost of producing our various supplements. We certainly couldn't have produced those beautiful publications without them. Like last year's *Texas Collections* supplement, the *Classic Minerals of Northern England* supplement has been very well received by our readers, and we are grateful to everyone involved. What other magazine that you might subscribe to sends a free book of any sort to its readers every now and then?

Incidentally, there is a good reason why we refer to these extra publications as "supplements." That's not our word; it is the term required by the U.S. Postal Service for separate (not bound together) items that are mailed with a regular issue of a magazine. If we don't label them that way, the extra postage required for the addition of the supplement to the envelope would be calculated at the regular package service rate instead of at the non-profit second-class-mail magazine rate, resulting in a substantial additional charge. In the case of the *Northern England* supplement, for example, the extra charge for *not* using that word would have been over $3,700. Even something like the one-page framing print in recent issues must be labeled as a "supplement" to the issue, or it would have been charged several hundred dollars extra for postage. We've given up questioning the reason behind such requirements; we just comply.

Mineral Evolution

Those of us chiefly interested in the Mineral Kingdom are apt to think of the term "evolution" only as applicable (scientifically) to the time-bound story of living things. But an article in the March 2010 *Scientific American*, "Evolution of Minerals," by Robert M. Hazen, invites us to think differently. By describing the probable course of evolution of the mineralogical composition of the Earth's crust since the planet's formation, Hazen corrects our easy notions of minerals as somehow unrelated to biological differentiation. Indeed he notes that (in the *Scientific American* editors' summary) "more than half of the mineral species on Earth [today] owe their existence to life, which began transforming the planet's geology more than two billion years ago."

The majority of the presently known 4,400+ earthly mineral species did not exist during very early Earth history. For much of the Hadean Eon (4.6–3.8 billion years ago), the crust consisted of black basalt, and there were about 250 primordial mineral species. Intense meteoric bombardment and repeated crustal melting inaugurated the slow differentiation of granitic from basaltic rocks, and this, together with the first chemical weathering after the first oceans formed, gave rise to "granitic" minerals (quartz, feldspars, micas, etc.) and some of their alteration products. Incipient plate tectonics meanwhile created the first major concentrations of trace elements, and thus were born beryl, topaz, tourmaline, etc., and the first metallic oxides and sulfides.

And then came life, and its slow addition of oxygen to the atmosphere. Banded iron formations and calcium carbonate reef deposits as old as 3.5 billion years give signs of the first organically produced oxygen—but this long ago the atmosphere still was largely anoxic. Then, about 2.2 billion years ago, there appeared new kinds of photosynthetic algae, and a (geologically) sudden "Great Oxidation Event" occurred. A new, much more oxygen-rich atmosphere then made possible the evolution of more than 2,500 new minerals—hydrated, oxidized weathering products of earlier minerals. The planet "rusted" as the ferrous iron of common basalt oxidized to hematite and other compounds of ferric iron. Earth seen from space may then have looked something like smaller, chemically simpler Mars looks today.

About 800 million years ago, plate-tectonic movements caused the breakup of a supercontinent (which has been named "Rodinia"), and the resultant longer coastlines, greater rainfall, and faster erosion caused wild swings in atmospheric carbon dioxide levels. The planet went into a rapid alternation between global "snowball" and "hothouse" phases, perhaps four of each. Life, adapting fast, became more diversified and complex. By the early Cambrian (550 million years ago), sea creatures had developed hard shells, and massive limestone deposits were starting to form; O_2 in the atmosphere meanwhile had reached 15%. More oxygen aloft meant that an ozone layer could form, and the planet's surface was shielded for the first time from the sun's ultraviolet rays. Continents became habitable. As living things spread to the Earth's land surfaces, biochemical weathering greatly increased the breakdown of rocks, with mineral diversity reaching almost its present extent as the land "went green." By the mid-Devonian Period (400 million years ago) there were probably about as many mineral species as exist today.

Thus Hazen interweaves the familiar Story of Life with a much less familiar narrative of the Mineral World evolving in tandem with life, the two processes intimately connected.

The February issue of *Elements* (the group publication of the Mineralogical Society of America and ten other international societies) expands upon this topic with seven articles on different aspects by Hazen and other authors.

More Musings on Minerals

We tend to think of the mineral world and the biological world as being not only separate but also intrinsically different. However, there are many parallels between living species and mineral species. Here are six such parallels to consider.

(1) Mineral species form and exist within the equivalent of an ecology or habitat: that is, a set of environmental conditions in which they coexist in stable equilibrium with other species.

(2) Mineral crystals grow by consuming nutrients which they utilize to build larger versions of themselves.

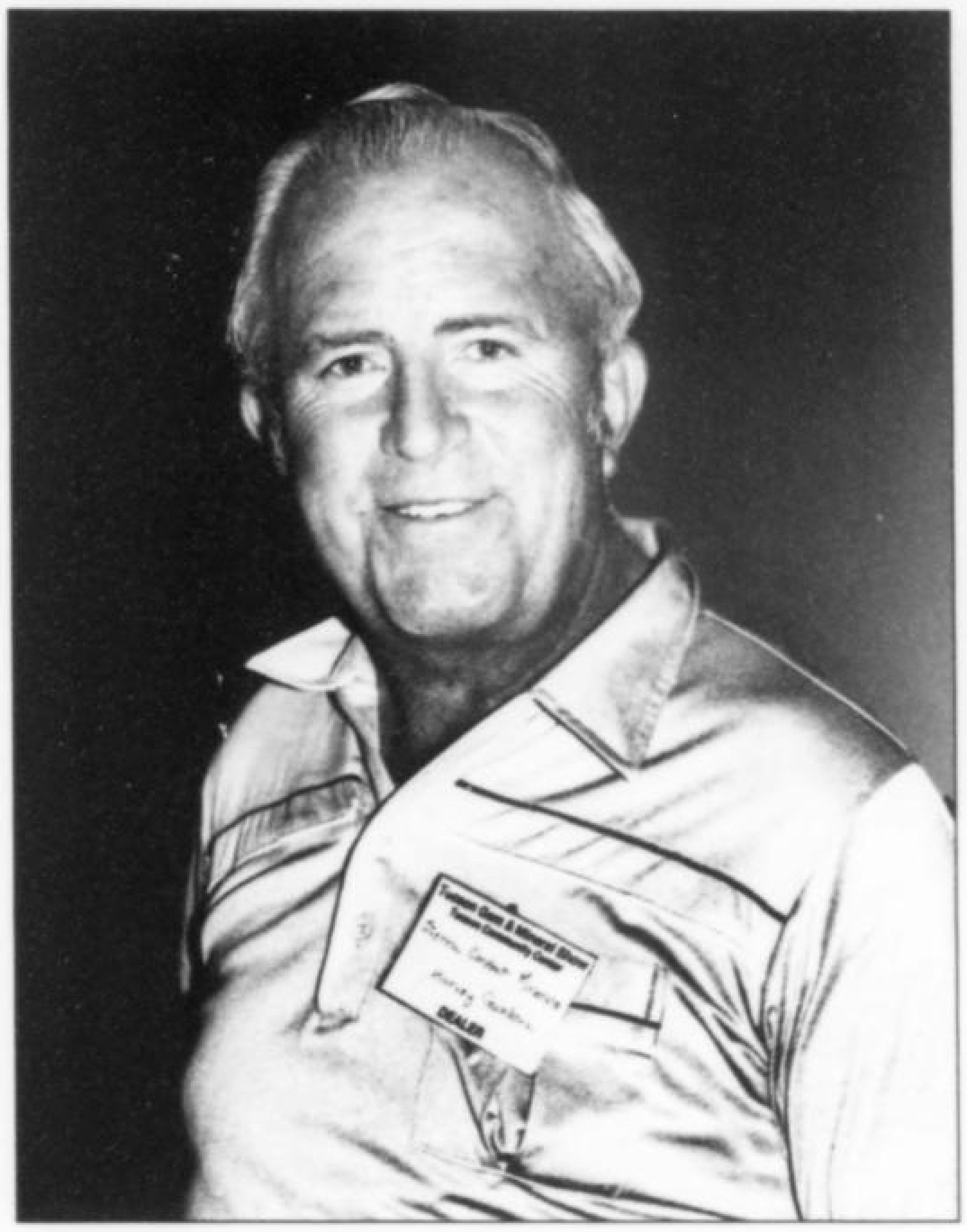
(3) As Robert Hazen has pointed out (see above), minerals and mineral assemblages also "evolve" as earth conditions change. Over time, mineral evolution progresses from a few simple species to more numerous and complex species. The process can be observed in action even today, as primary sulfide deposits are altered by weathering into much more complex suites of secondary minerals with longer formulas. Sometimes new species that have never before existed on earth suddenly appear when the conditions have finally become just right.

(4) "Fossil" minerals exist in the form of pseudomorphs. The original species is gone, replaced by other minerals that preserve only the outward form, or a chemical similarity.

(5) Minerals can even be "cloned" (naturally or synthetically) through the mechanism of seed crystals around which new and larger crystals can grow.

(6) Mineral species can become extinct. For example, if a rare environment exists in only one place on earth it may harbor a mineral species that can form and exist only there. If all specimens are destroyed, along with that environment, the species is effectively extinct. If the environment is destroyed or completely collected out, but specimens still exist in collections, we may say that the species is effectively "extinct in the wild" and exists only in "captivity." In fact, it is almost certain that there have been environments in the distant past that harbored unique minerals which have been destroyed over geologic time and no longer exist. It is interesting to ponder what long-lost beauties of the mineral world we will never see or know of.

Of course, minerals don't reproduce the way life forms do. Too bad! Otherwise we could perhaps breed a few more phosphophyllite twins. But then, minerals can't die either; they can "live" forever if they are properly protected from physical damage and destruction. That is their great advantage over living species, an advantage which we as mineral collectors are pledged to support and nurture.



Harvey Gordon (1935–2010)

Died, Harvey Gordon, 74

To those of us in the mineral collecting community who were fortunate to know him, he was a trusted dealer in fine minerals, an indefatigable field collector, a mentor and a dear friend. Harvey Gordon ("Harv" to most of us) passed away at his home in Reno, Nevada on January 26, 2010.

The cancer that eventually took his life first revealed itself seven years ago, while Harvey was setting up for the 2003 Tucson Gem and Mineral Show. During all the time since then, courageously and without complaint, he battled the disease, and more than once he appeared to have beaten the odds, only to see it return. Harvey was not one to give up easily, whether it be to a life-threatening disease or a particularly stubborn boulder.

Harvey Maurice Gordon, Jr. was born on January 30, 1935 in Devil's Lake, North Dakota to Alma (Wickum) and Harvey M. Gordon, Sr. When he was seven, the family moved to Hawthorne, Nevada, which by that time was booming thanks to the construction of the Naval Ammunition Depot. Like many boys his age, he probably developed an early interest in rocks and minerals. After high school, Harvey attended the University of Nevada in Reno, where he obtained a business degree in 1958. It was there that he met and married Lola Ann Honey, his wife of over 52 years. After graduating, Harvey served two years in the Army, his duties eventually landing the couple in Anchorage, Alaska. After his discharge, they moved back to Reno where Harvey put his business degree to use working for John Ascuaga's Nugget Casino as payroll manager. Harvey and Lola raised three children there, Marvin, Cindy, and Paul; Lola later retired as a teacher in the Reno School system.

By the early 1970s, Harvey's entrepreneurial drive and developing passion for minerals resulted in his starting his own mineral business in Reno. As documented by a succession of specimen labels, Harvey conducted his mineral business under a number of names, including Wildlife Limited, Sierra Nevada Minerals, Sierra Nevada Mineral Company, Sierra Contact Minerals and Harvey Gordon Minerals. More recently, Harvey became affiliated with another Reno company, Lithosphere Minerals.

During his career as a dealer Harvey handled many fine and important mineral specimens, many of which now reside in museums throughout the world. He is perhaps most remembered for introducing world-class Bunker Hill pyromorphites to the collecting world at the 1982 Tucson Gem and Mineral Show. That year, Harvey was dealing out of a room at what was then known as the Travelodge. Once word got out, a line soon formed at the door and business was brisk to say the least. In 1998, Harvey brought a suite of Meikle mine (Nevada) barites, among the finest for the species, to the main Tucson Show.

Harvey was a dealer at most of the important mineral shows in the U.S., including Tucson, Denver, Detroit, Cincinnati, Springfield, and Pasadena, and did a number of smaller shows as well. He would travel to these shows in his pickup camper, towing a trailer full of minerals and shelving, and dining on baloney sandwiches to save money. The camper must have suited him, because he more than once declined an offer to stay at the home of a friend when doing a show. A number of us at one time or another became members of his "roadie" crew, helping him set up, sell minerals and tear down at various mineral shows. Set-up day, I remember, was always an adventure.

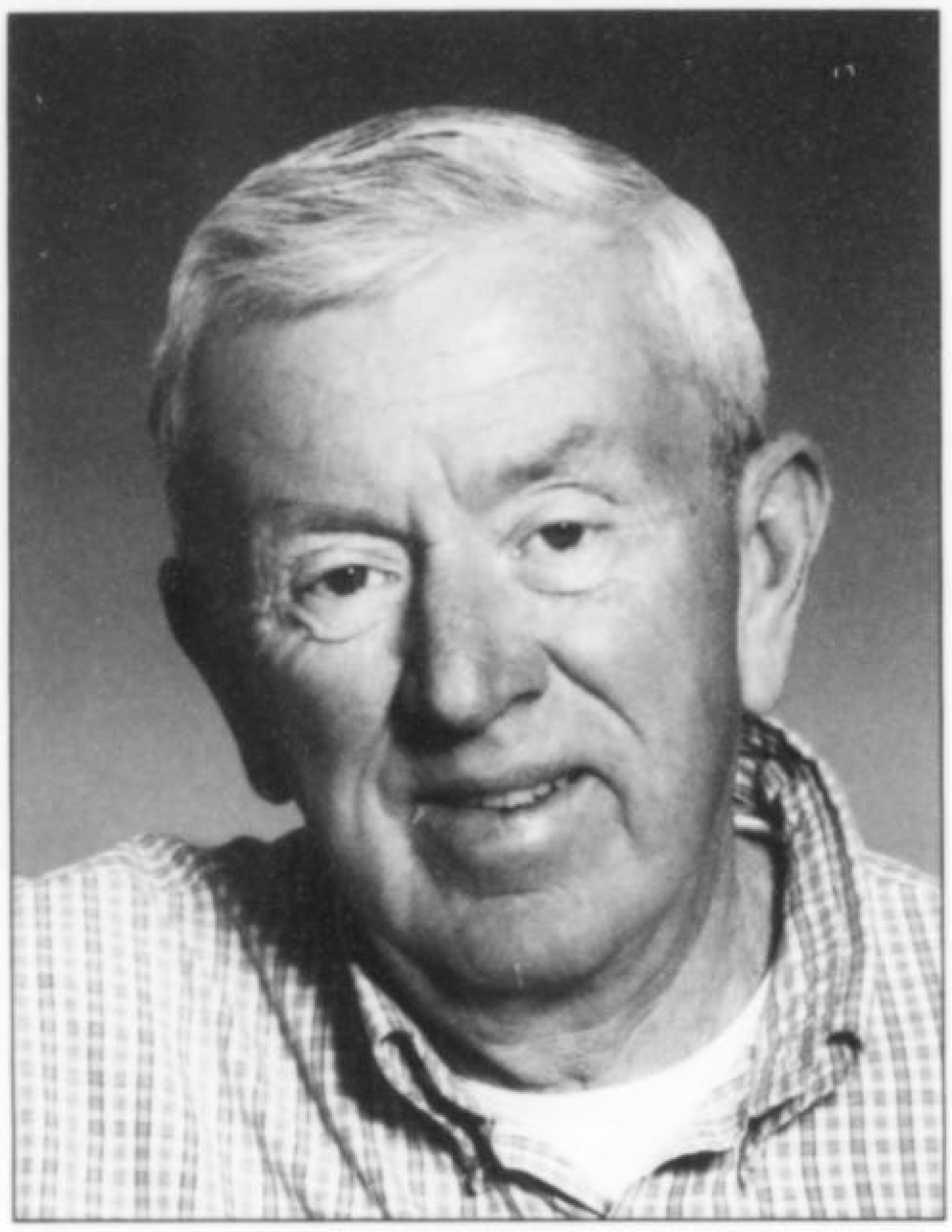
Harvey was a very enthusiastic and successful field collector. He conducted specimen mining operations at a number of localities throughout the west, including Colorado for rhodochrosite, Idaho for barite, and his home state of Nevada for a variety of minerals. Most notable among these was the epidote from the Lola claim and topaz, smoky quartz and amazonite from the Zapot claim, both near Hawthorne. He was very proud of these operations, and he discovered and marketed many fine specimens. I accompanied Harvey on a number of collecting trips near Hawthorne and the tiny community of Silver Peak, Nevada, where I lived. In his prime, the man could move a lot of rock in a day.

Harvey served as a mentor and advisor to many collectors new to the hobby. The last time I saw him, in December of this past year, he was still giving me advice. He definitely influenced how I now collect minerals. For many years my focus was primarily small cabinet specimens, but by the early 1980s my tastes had begun to exceed my ability to afford them, and I began to wonder what to do about my collection. By that time, I was making regular trips to Reno as part of my job and always made it a point to stop at Harvey's shop on South Wells Avenue to see what new things he had or just to visit with him. On one such stop, he took me in the back and showed me a couple of thumbnails he had just gotten in: a Tsumeb azurite and a Mexican arsenopyrite, which had previously been in the Bolick collection. They were perfect, and affordably priced. I had an epiphany then and there. Since then, I have collected only thumbnails, and still have those first two specimens. I am sure Harvey influenced others in a similar way.

Harvey had other interests outside of minerals. He was an avid hunter and fisherman. He was also an active member of the Kerak Shrine in Reno, and was particularly fond of playing the musette with his fellow Arabians for children in the Shriners' hospitals. His skill as a bartender was also appreciated by his friends at the shrine temple.

Over the years, Harvey developed many lasting friendships. He was a kind-hearted and generous man, and loved a good joke. One could not help but like him. We will miss you, Harv.

Allan Young



Bill Forrest (1940–2009)

Died, Bill Forrest, 68

On May 9, 2009 William Clyde "Bill" Forrest passed away at his home in Clovis, California surrounded by his loving family, after a courageous battle against lung cancer.

He was born on August 13, 1940 in Merced, California, the son of Edna (Cline) Forrest and Roy Forrest, a grocery store owner. Bill grew up in Chowchilla, and attended Coalinga and Fresno City Colleges. In the mid-1960s, he went to work for Laval Underground Surveys, where he met Elvis "Buzz" Gray, who shared an interest in mining and prospecting. At first, many of the trips these two shared were to explore for minerals and sluice for gold in the Mother Lode country.

Soon they began searching further afield, and in 1966 they came across the Benitoite Gem mine, where they became acquainted with the lessee, Clarence Cole. Upon Cole's death in 1967, Bill and Buzz leased the mined from the owners, and started production once again. They purchased the mine outright in 1986, and, using heavy machinery and processing equipment, uncovered thousands of specimens from the veins and alluvium. Bill was particularly good at preparing specimens for sale to collectors and museums. They sold the mine in 2000.

Bill and Buzz's interest in mining extended beyond benitoite. In 1979 they purchased and developed the Colorado Quartz mine, an underground crystallized-gold mine in Mariposa County, California, along with Bryant Harris, Dave Eidahl, and Tom Smith. After mining it for a few years, they sold the property in 1985, but Bill's interest in gold mining continued throughout the rest of his life. After the sale of the Benitoite Gem mine, Bill's expertise with heavy equipment led him once again to the gold areas of the Sierra foothills, where he worked a number of gold properties, most notably with Ed Coogan and Pat Franco, until the last few months of his life.

Bill owned and operated the Fresno Powder and Equipment company, and delivered dynamite to almost all of the active gold mines in the central region of California. While visiting these mines he would talk to the miners to see what was coming out, and was able to purchase many fine specimens of crystallized gold to sell to collectors.

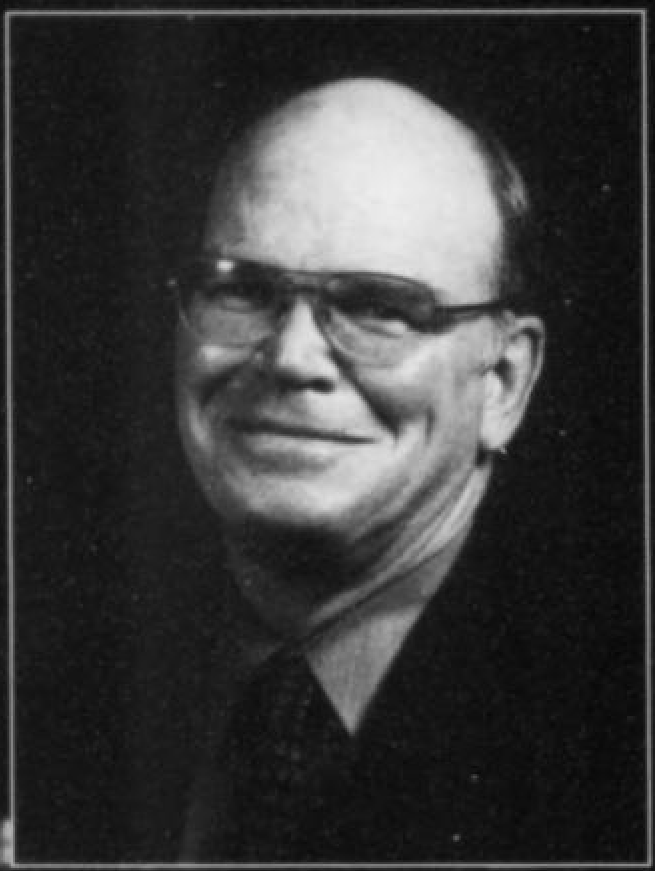
Bill enjoyed many things in life, including salmon fishing and RV traveling. He loved spending time with his family, especially his grandchildren. He is survived by Hilda, his high school sweetheart and wife of 47 years, his sons, Scott Forrest of Clovis and John Forrest and wife Susie of Bakersfield, grandchildren Branden, Andrea and Troy Forrest, and sister Margy Meredith and her husband Tom Sanger.

Mike Gray

Call for Papers on the Minerals of California

The thirty-second annual Friends of Mineralogy symposium will be held in conjunction with the Tucson Gem and Mineral Show on Saturday, February 12, 2011. It is sponsored by the Friends of Mineralogy, the Tucson Gem and Mineral Society, and the Mineralogical Society of America. The symposium theme is the same as the show theme: *Minerals of California.* Presentations on descriptive mineralogy, paragenesis, classic and new locations, and related subjects are welcome. An audience of amateur and professional mineralogists and geologists is expected.

Anyone wanting to present a paper should submit a 200–300 word abstract to Julian C. Gray, Tellus Science Museum, P.O. Box 3663, Cartersville, Georgia, 30120; phone 770-606-5700, ext. 415; fax 770-386-0600; email juliang@tellusmuseum.org. Presentations will be twenty minutes in length, followed by a period for questions. Abstracts must be submitted by October 1, 2010.



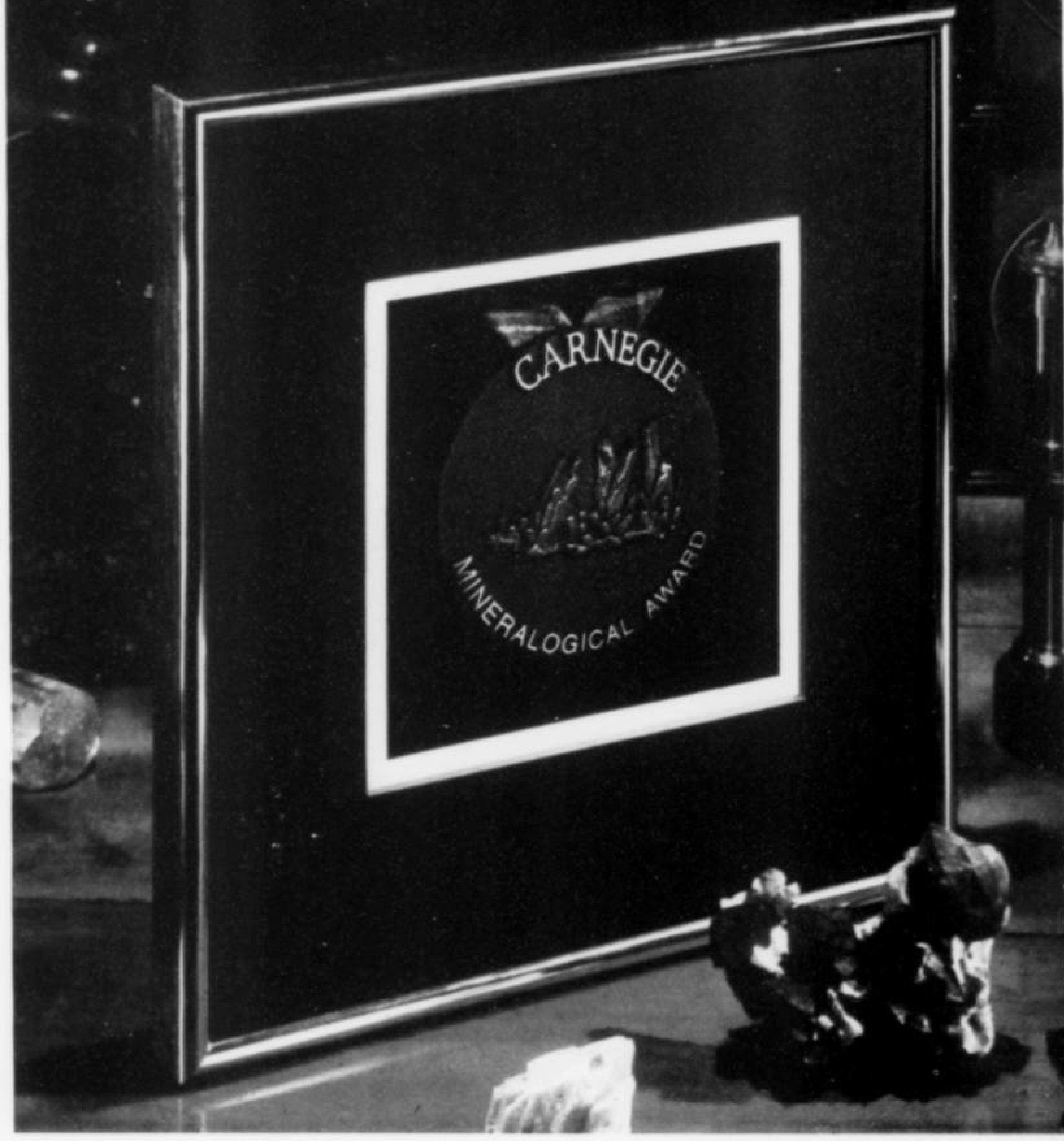
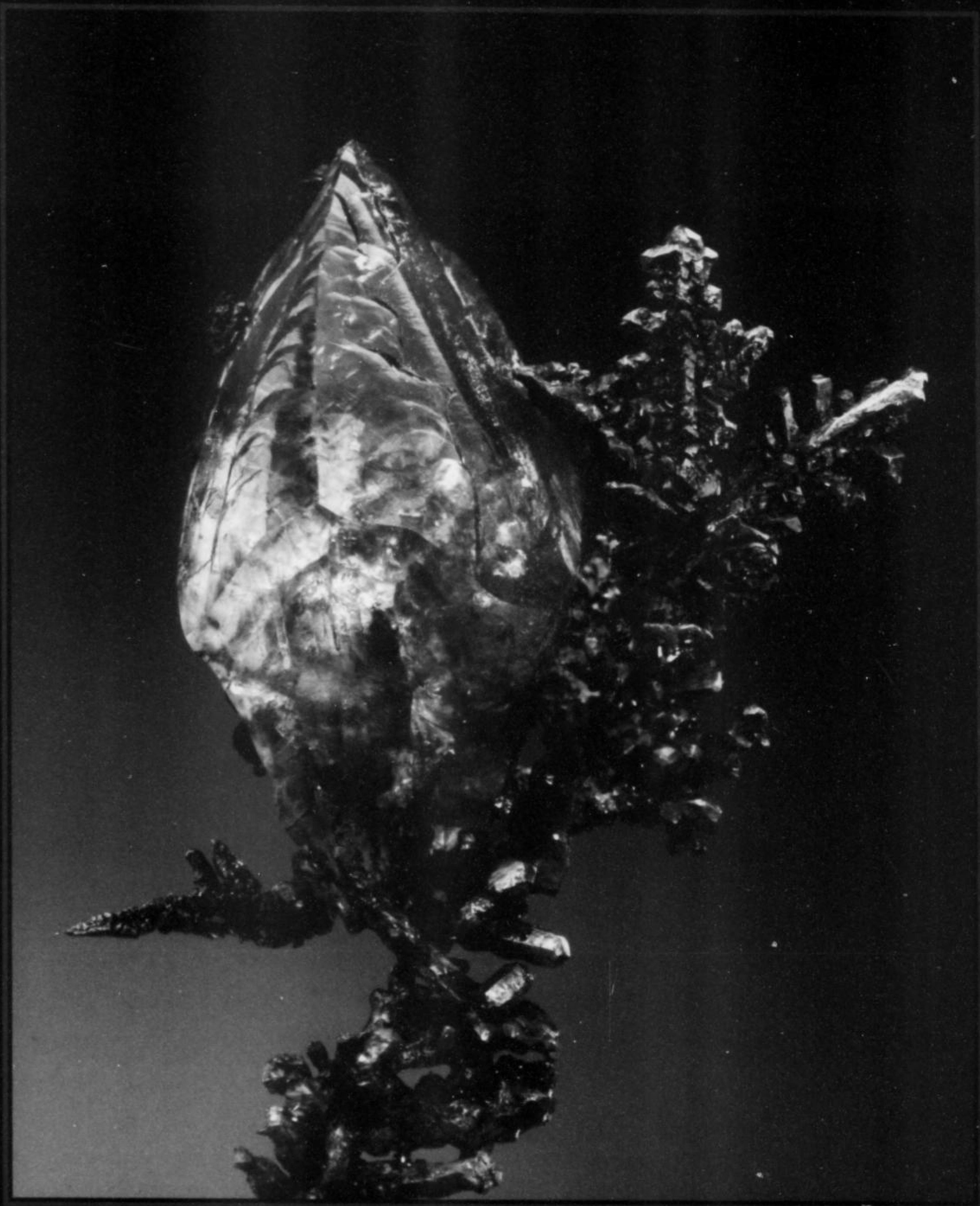
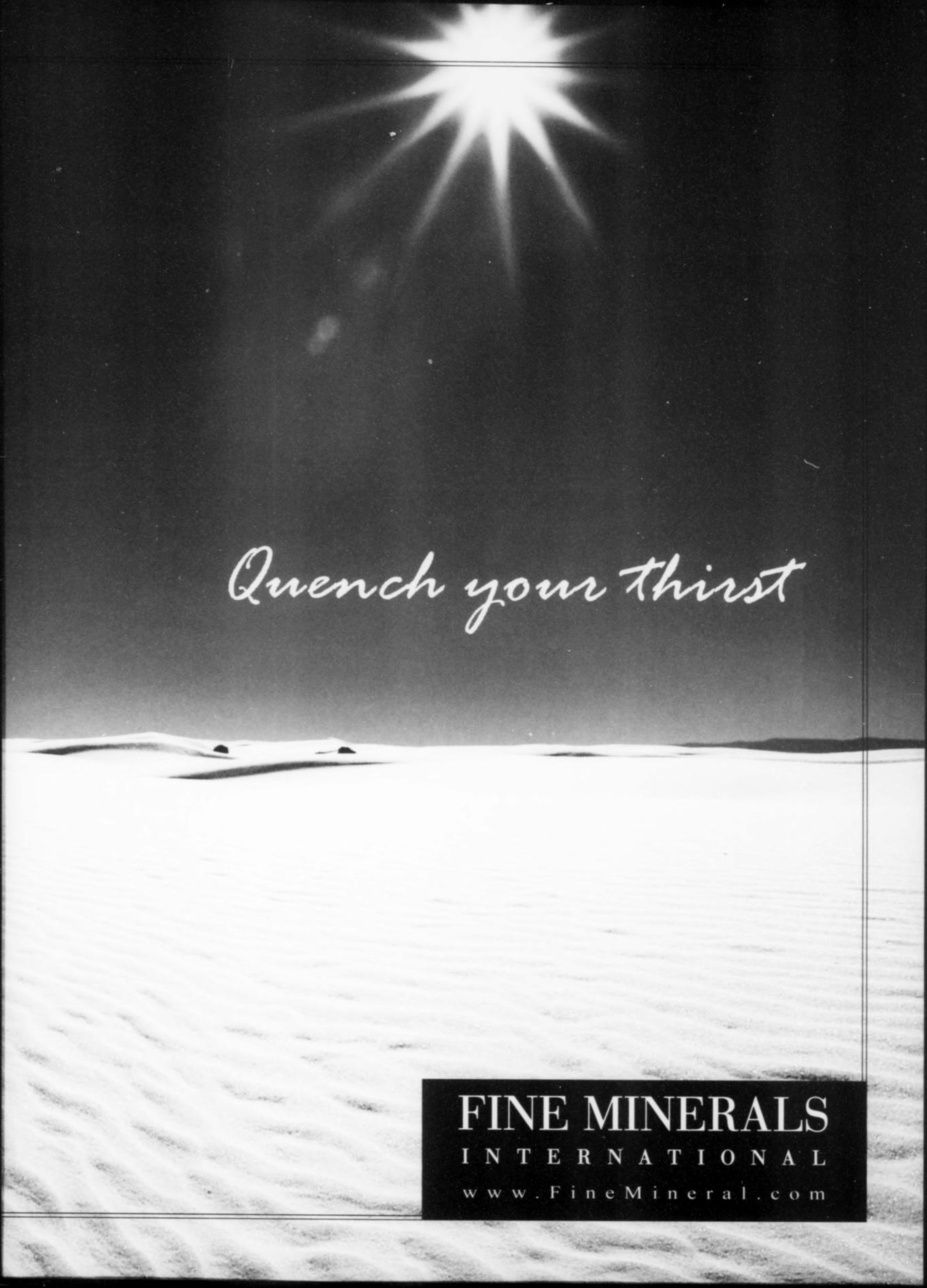


Photo by Harold and Erica Van Pelt

JEFF SCOVIL PHOTO



COPPER IN CALCITE, 5.1 CM, ONGANJA, NAMIBIA. FROM STUART WILENSKY (2008). [illegible] COLLECTION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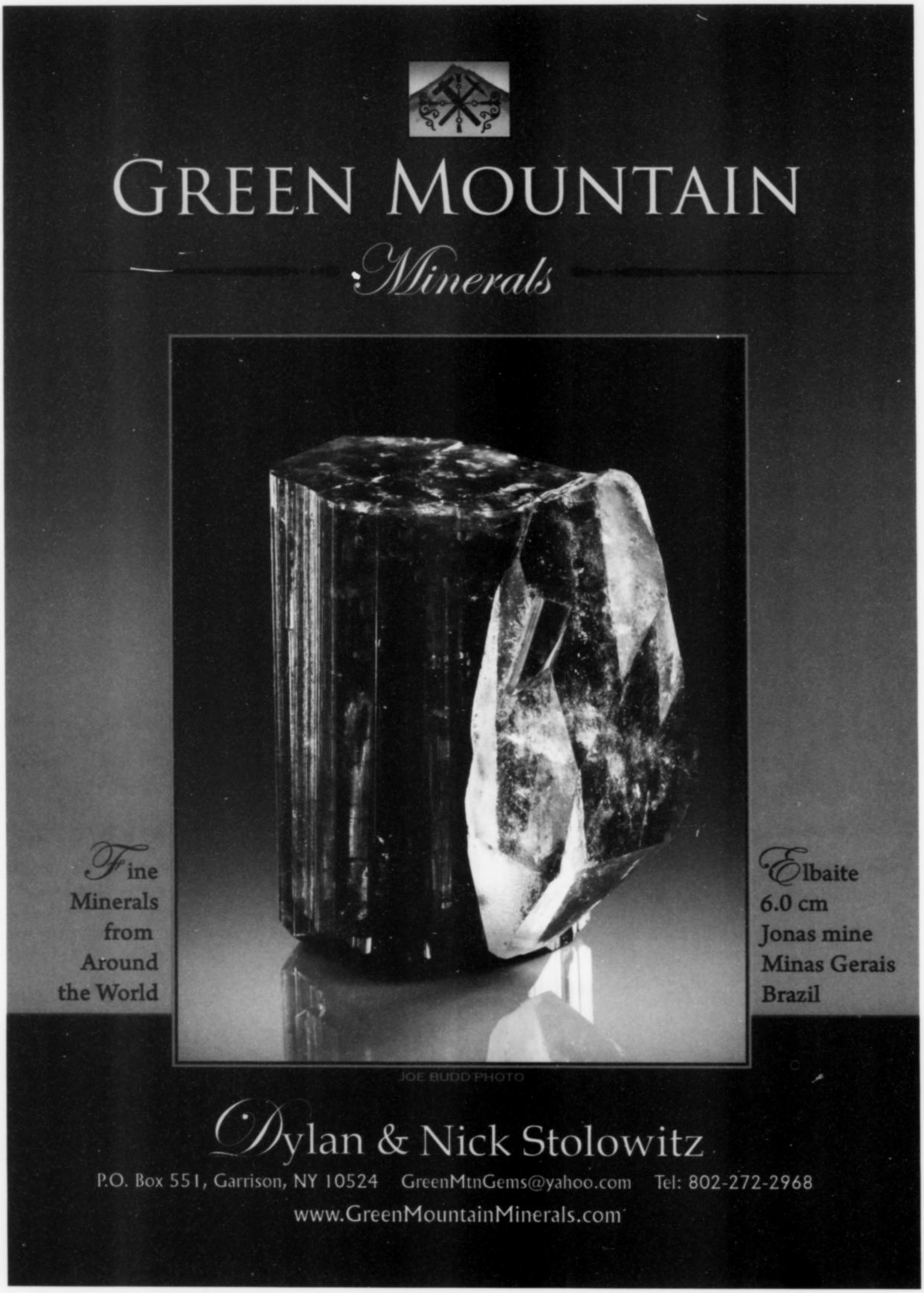
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Andradite

from

Antetezambato, North Madagascar

Federico Pezzotta
Museo di Storia Naturale
Corso Venezia 55, 20121 Milano
fpezzotta@yahoo.com

In 2009 some of the world's finest specimens of green and yellow andradite crystals on matrix were found in a mangrove swamp near Antetezambato in the extreme northern area of Madagascar. The workings are constantly being flooded by tidal waters, and are inaccessible during the rainy season. Because of the primitive hand-mining methods in use, it may not be possible to re-open the workings.

INTRODUCTION

A new deposit of andradite garnet of the demantoid and topazolite varieties has recently been discovered in Antetezambato, Ambanja area, Antsiranana province, North Madagascar. The mining activity is mostly devoted to the extraction of rough stones for the gem market but, since April–May 2009, a significant quantity of collector-quality crystal specimens, from thumbnails and miniatures to large cabinet specimens, has emerged as well. Some of these specimens, because of their complex crystal shapes and extraordinary color, luster and transparency, are among the finest andradites in the world.

LOCATION

The new demantoid-topazolite deposit in Madagascar is located about 2.5 km west of Antetezambato village, in the Ambanja area, Diana region, Antsiranana province, North Madagascar. The productive area lies mostly in a mangrove swamp about 5 km from the northwestern coast of Madagascar and extends westward to the slope of a gentle hill. The mined area covers a surface of several tens of acres with its center at 13°30.460' S and 48°32.652' E.

The town of Ambanja is about 20 km south of Antetezambato, on the road that runs along the northwest coast of the island connecting the large towns of Mahajanga and Antsiranana (known formerly as Diego Suarez). The area is rather sparsely inhabited, with an economy based on local products such as coffee, raffia, seafood, fruit, etc. Foreigners occasionally come to visit nearby Nosy Be island or the d'Ambre Massif Natural Park located between the towns of Ambilobe and Antsiranana.

The climate is characterized by a winter season from May to October which is rather dry and windy with mild temperatures, and a summer season from November to April which is typically hot and humid. From December to February, strong rains characterize the so-called "rainy season" or "cyclonic (hurricane) season." Vegetation is typical of wet-subtropical areas, with mangrove forests along the

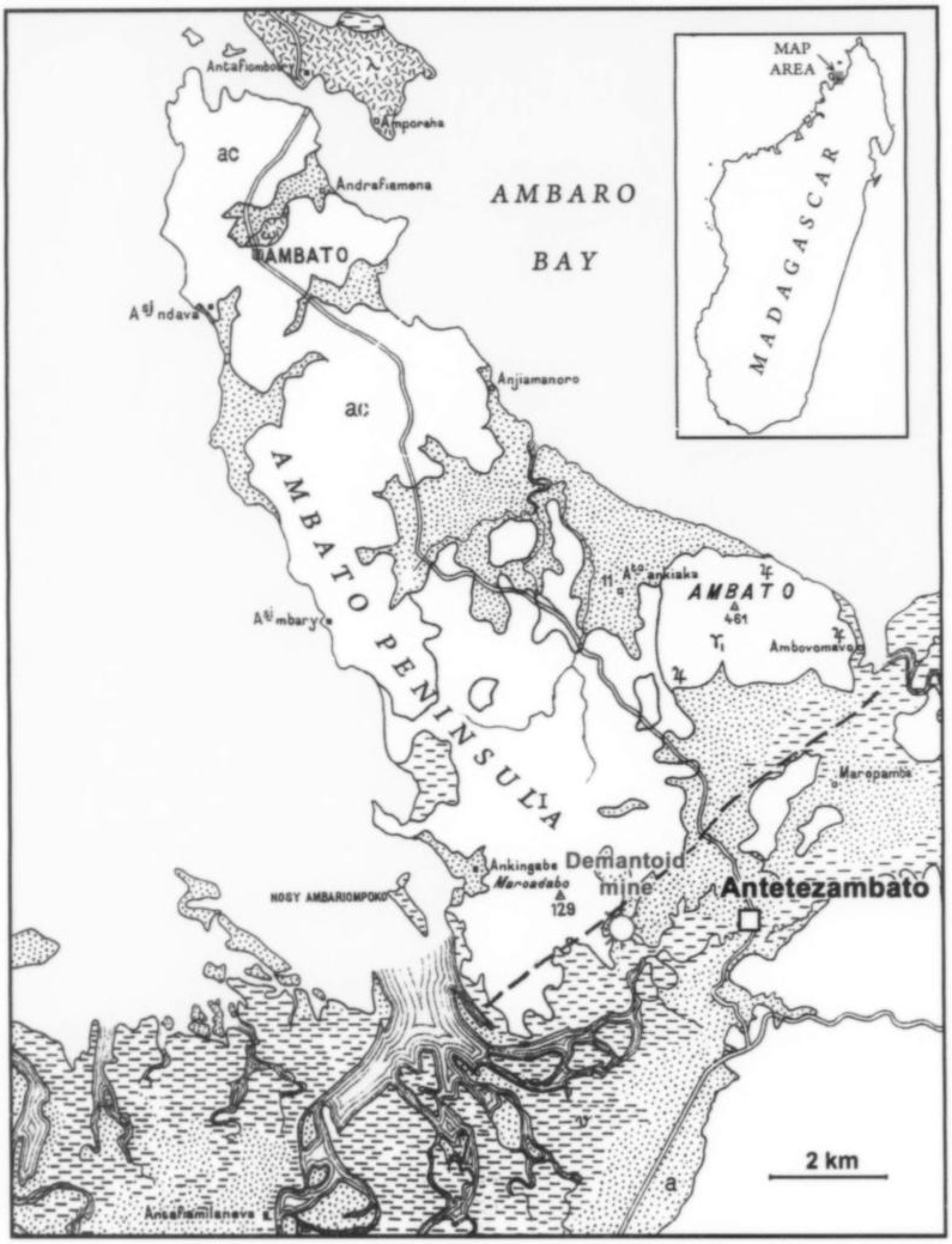


Figure 1. **Location map showing the andradite deposit in a mangrove swamp west of Antetezambato village.**

shore and thick primary forest covering the coastal plains. Steep mountains occur as isolated massifs and as a wide mountainous belt to the east.

The northwestern coast of Madagascar is subjected to sea tides ranging from about 2.5 meters to over 4 meters. This phenomenon explains the extensive occurrence of mangrove forests along the shore and the presence of complex networks of seawater drainage channels cutting the plains along the coast. The Antetezambato garnet deposit is situated mostly within one of these large mangrove swamps, and is invaded by 50 to 80 centimeters of seawater at high tide every day. The tidewaters reach the garnet deposit through a 5-km complex of channels in the mangrove forest. The tidal surge decreases to a minimum only during very short periods of the year.

HISTORY AND MINING ACTIVITY

Lacroix (1922) described garnet occurrences in Madagascar, especially andradite in igneous rocks, and reported the discovery of some crystals of pale green andradite lining cavities in a nepheline-bearing syenite at Mount Bezavona. This intrusive massif of Cretaceous age is located south of Nosy Be island, and forms the Ampasimena Peninsula. Before the discovery at Antetezambato, the information reported in Lacroix (1922) was the only evidence of the occurrence of green andradite in Madagascar. The green gem-grade garnets found in Madagascar at Gogogogo, in the Toliara region (Mercier *et al.*, 1997), and at Itrafo, south of Betafo, in the Antananarivo region (Adamo *et al.*, in preparation), are not andradite but rather grossular with more or less significant vanadium and chromium contents (the tsavorite variety).

In June 2006, news was circulating among local gem and mineral dealers in Antananarivo about the discovery of small fragments of "green tourmaline of good color" in the Ambanja area. However, no samples were available for analyses and the information was considered unreliable. During the following two years, a few local workers at Antetezambato (at the time a small village of about twenty cabins) produced a very limited quantity of what was being called "green zircon" or "green sapphire" in the local market in Ambanja. Nevertheless, no one bothered to analyze this gem rough and it generated no economic interest. The first fragments of these stones were probably found by natives involved in charcoal production, while they were cutting mangrove wood and digging small terraces at the limit of the swamp for burning the wood. This activity, rather common in the area, involved the local removal of surface soil and probably led to the discovery of the first "green stones." Danet (2009), however, reported a different story, suggesting that the first stones were found by crab fishermen in late 2008.

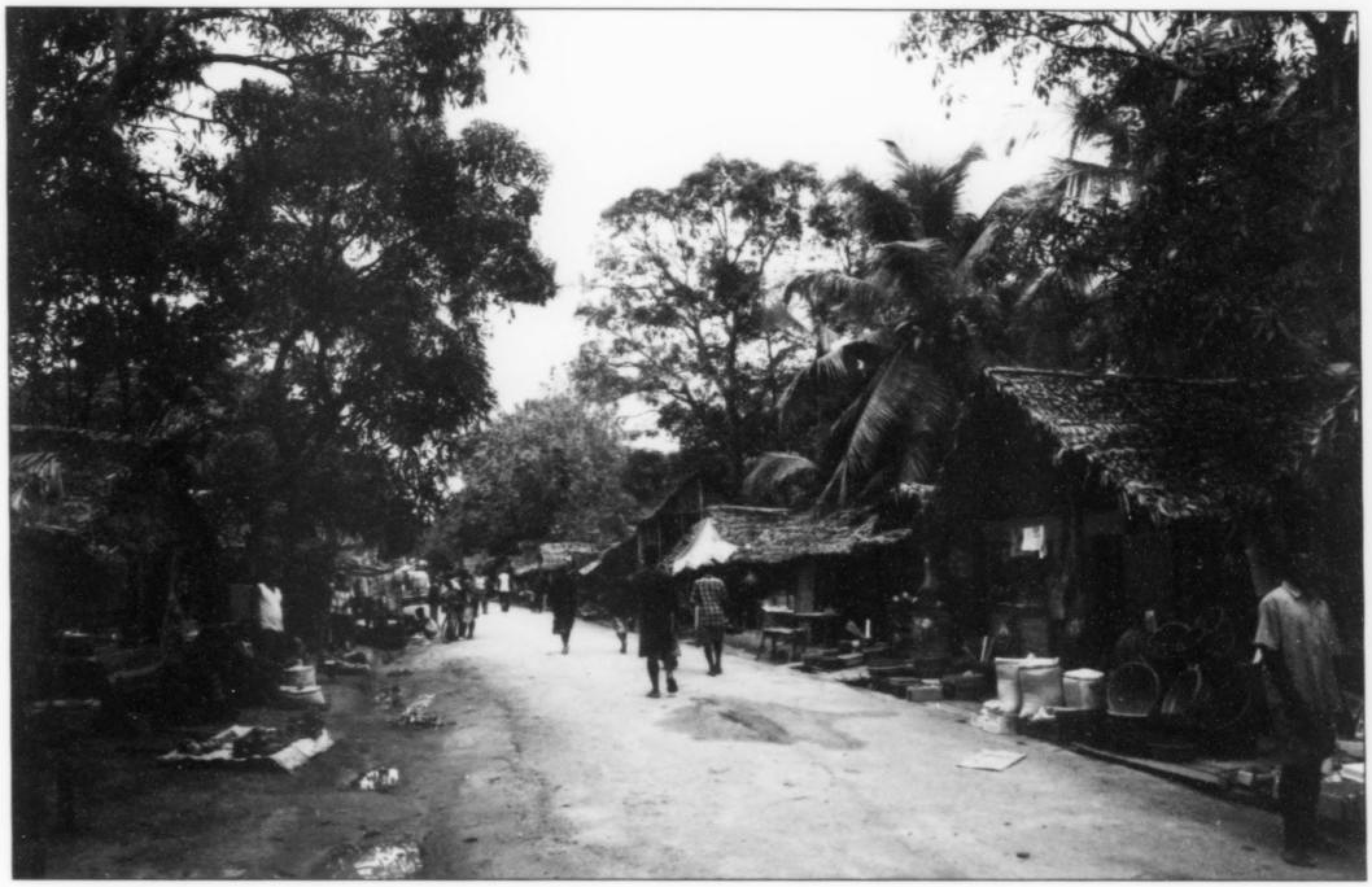


Figure 2. **Antetezambato village. Federico Pezzotta photo.**

It was only in November 2008 that French gem dealer Jacque le Quéré brought some rough and cut gemstones to the gemological school of the University of Nantes, where they were identified as the andradite variety demantoid (Mocquet *et al.*, 2009a). In the meantime, the first small lots of rough demantoid arrived at the gem market in Antananarivo where gemologist and gem dealer Giuseppe Pocobelli informed the author about the new discovery. Nothing significant was produced in Antetezambato during the next few months, probably because of the strong rains of the hurricane season. Nevertheless, beginning in April of 2009, rumors of the new find and of the new gemstone in Madagascar began circulating throughout the country and several hundred miners, buyers and brokers, both Malagasy and foreign, rushed to the site. Danet (2009) reported that in May 2009 about 2,000 miners were digging at the deposit and several thousand people (probably up to 10,000) were living in nearby Antetezambato village. Using hand tools (crowbars, buckets, etc.), the miners were digging pits at low tide up to 18 meters deep in the mangrove swamp, and also in the dry terrain at the foot of a nearby hill to the west. The better organized groups of miners used gasoline-powered pumps to help drain their pits.

Up to the end of May much of the work was in the superficial weathered zone, producing a large quantity (over 20 kilos of rough per week) of broken or loose crystals of value primarily as faceting rough. But in June the deepening pits began to enter unaltered rock containing increasingly fine mineral specimens. The author began visiting the Antetezambato mine in July, when the production of mineral specimens was probably at its peak, and at that time was able to see the extraction of some of the best mineral specimens ever found there.

Unfortunately, because of the unstable political situation in the country, the local authorities subsequently lost control of the area. The social situation degenerated, and much of the gem and specimen trade as well as the supplying of food and other needs of the miners and their families were taken over by organized crime, under the protection of corrupt politicians in Ambanja, Ambilobe, and various other regions in Madagascar. The area became extremely dangerous and several people, Malagasy and foreigners alike, including the author, were victims of armed attacks and robberies. Since October 2009, thanks to the bravery of a few people in the local police station, gendarmerie and tribunal, control has been regained to some extent and crime has been reduced, but the area must still be considered dangerous.

Since last October the production of garnet has significantly diminished, mostly because of the extremely difficult and dangerous mining conditions. Depending on the timing of the tide, the miner's work begins when the seawater level starts going down. At three or four o'clock in the morning, in the dark, the miners walk from the village to the mine bringing their equipment, including electric generators and pumps. They reach their pit and begin pumping out the water, trying not to flood adjacent pits being worked by other groups of miners. Small fish and crabs are everywhere. Pumping out a pit can require up to five hours; then an hour or two of work is required to muck out the mud brought in by the tidal waters. If the generator runs out of gas, or if there is an equipment breakdown requiring several hours for repairs, the day of work is lost. If all goes well, however, mining can then begin at the bottom of the pits and inside the small galleries up to 18 meters below the sea level. Fortunately the inflow of groundwater is very low.

But mining can go on for no more than three or four hours before the tide comes in again. Miners are accustomed to working right up to the moment when the tidal surge reaches the mouth of a pit and begins cascading in, bringing with it mud and rubble. The pits become filled with water and within a few minutes the entire mine area is flooded, with the exception of the small workings at the base of the hill to the west. During these few minutes all of the miners evacuate their pits with their equipment and, running between the other pits, make their way northward to an area where a small market has been established.

It must be mentioned that removal of the rocks and the mud in the course of mining is a huge problem for the miners because there

***Figure 3.* Pits and dumps at the Antetezambato garnet deposit. Federico Pezzotta photo.**

***Figure 4.* Pit dug on dry land adjacent to the swamp. Federico Pezzotta photo.**

is nowhere to dump it. The waste material is impossible to haul very far away, so the miners pile it between the pits in small ridges or in storage bunkers reinforced with wood piles and ropes. Such accumulations, continuously wet and washed by the movements of the seawater, are unstable and accidents are common.

With the arrival of the summer rainy season in December 2009, many of the workers left the area. At present (February 2010), the garnet deposit is flooded by seawater and by rainwater runoff coming from the nearby hills, and moreover it is totally buried in mud. It is unclear whether the local miners will return following the rainy season to begin work again and produce more mineral specimens and gem material.

Regarding ownership of the mine, some Malagasy individuals registered mining claims on the Antetezambato area with the Ministry of Energy and Mines in 2009. As typically happens in Madagascar when a new deposit is discovered, the claims were granted by the Ministry regardless of whether the boundaries of the claims as described actually included the deposits. But the owners of the claims use their authorization only for trading and exporting the products of the mines, and not for mining, so the discrepancies don't seem to matter. In any case, until the political situation in Madagascar stabilizes it is unlikely that any well-organized mining will take place at Antetezambato.

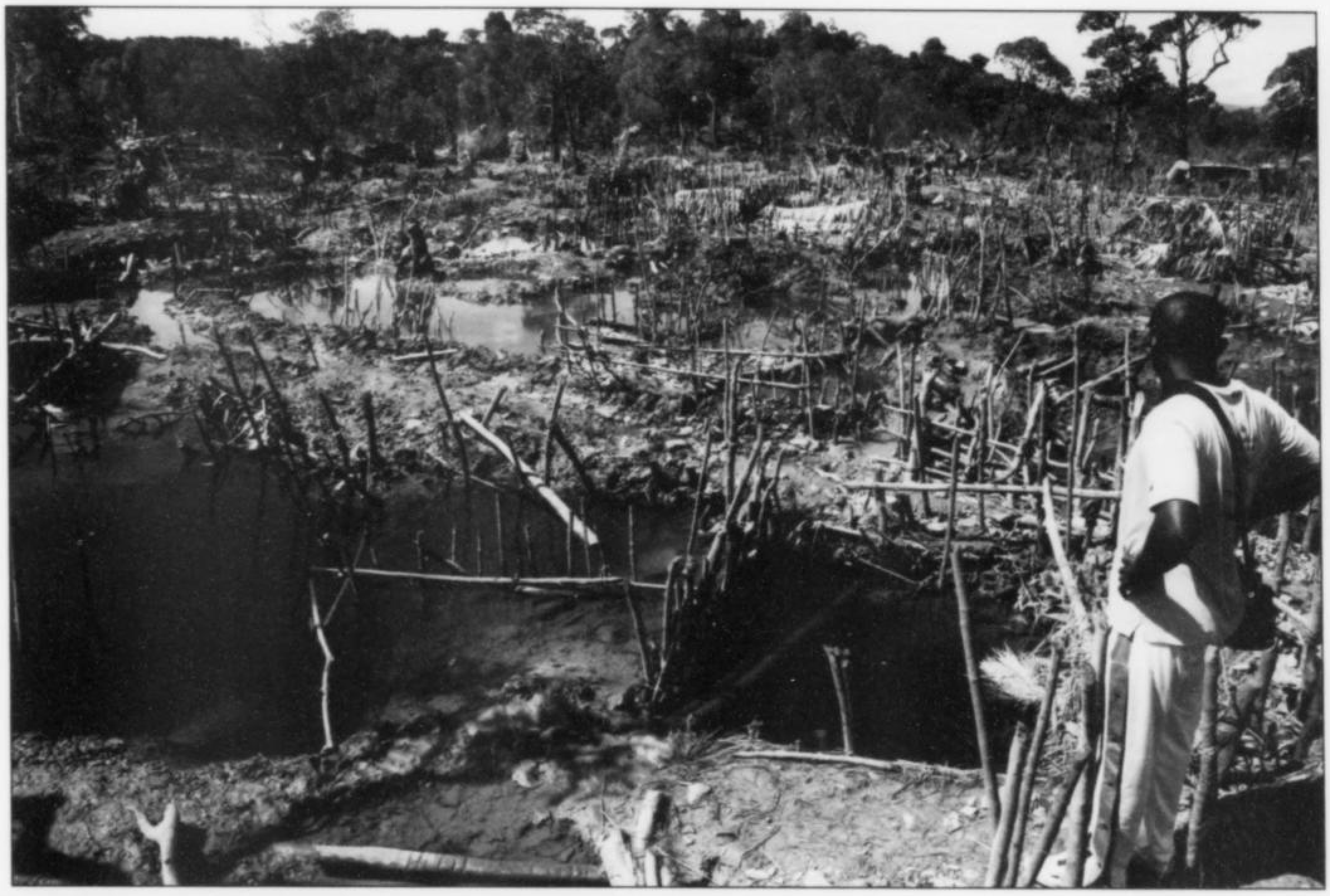


Figure 5. **Andradite workings flooded by rising tidal waters. Federico Pezzotta photo.**

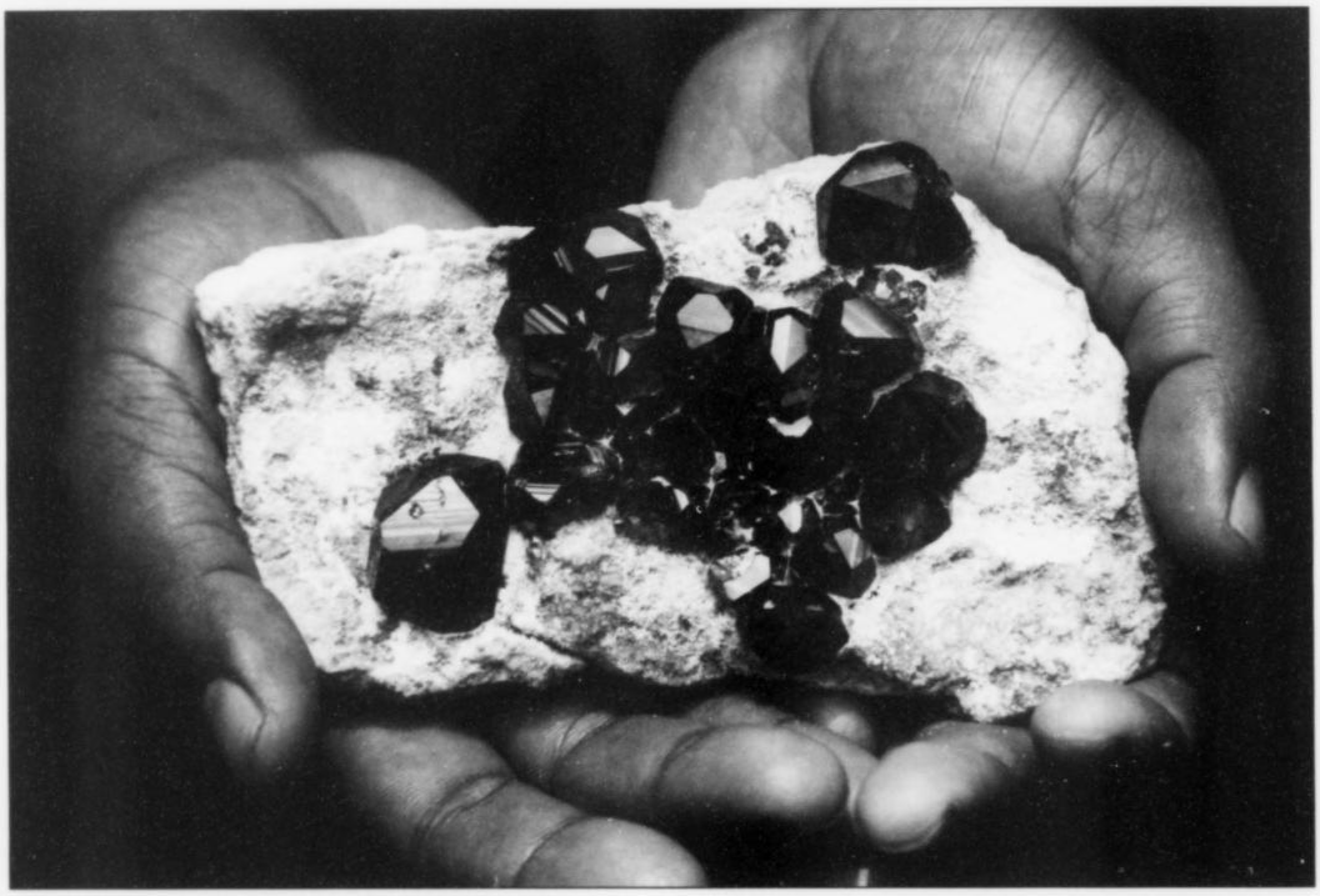
Figure 6. **Water channel built to carry water away from a pit that is being drained. Robert Zawadzki photo.**

GEOLOGY

Madagascar geology can be divided into two major domains: (1) the upper Proterozoic crystalline basement, characterized by high-grade metamorphic rocks of igneous and sedimentary origin, and by large gabbroic to granitic and syenitic plutons representing the roots of the axial zone of the East African orogenic belt; and (2) a Permian-Mesozoic to Tertiary sedimentary sequence, formed during more or less continuous subsidence of the Mahajanga, Morondava and Toliara basins, corresponding to the paleo-Mozambique channel. The crystalline basement is exposed over approximately two-thirds of the surface area of the island, and the sedimentary sequence crops out on the remaining third all along the western coast.

The famous mineral and gem localities in Madagascar, including all of the pegmatitic occurrences, were emplaced within the upper Proterozoic crystalline basement. Weathering and erosion (mostly during upper Permian to Triassic time) of these gemstone-rich crystalline rocks deposited coarse-grained sediments to form the Ilakaka gemstone deposits in southeastern Madagascar.

A renewed period of magmatism affected Madagascar during the Cretaceous period with the emplacement of doleritic dikes and the eruption of basaltic flows along the east coast and in the sedimentary basins of Mahajanga, Morondava and Toliara. Significant quantities of xenolithic sapphires were brought to the surface by the eruption of the basalts in north Madagascar, forming some significant sapphire deposits, including the locality of Ambondromifehy. Zoned ring plutons were emplaced north of Mahajanga (in the cape



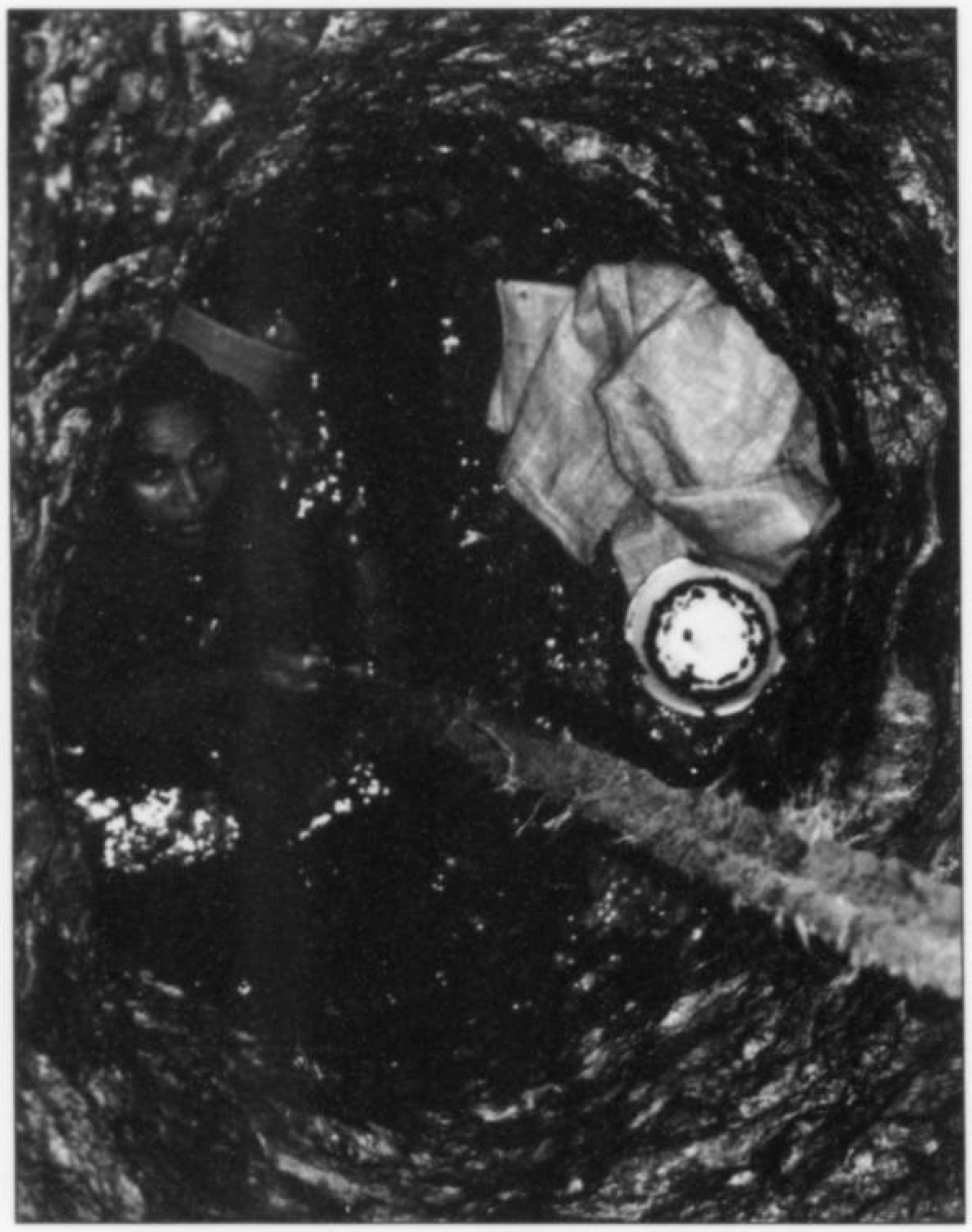


Figure 7. **The finest specimen of demantoid crystals on matrix thus far recovered. Daniel Trinchillo (Fine Minerals International) specimen; Federico Pezzotta photo.**

Figure 8. **An andradite miner in his pit. Water is being hoisted up manually in a blue bag. Robert Zawadzki photo.**

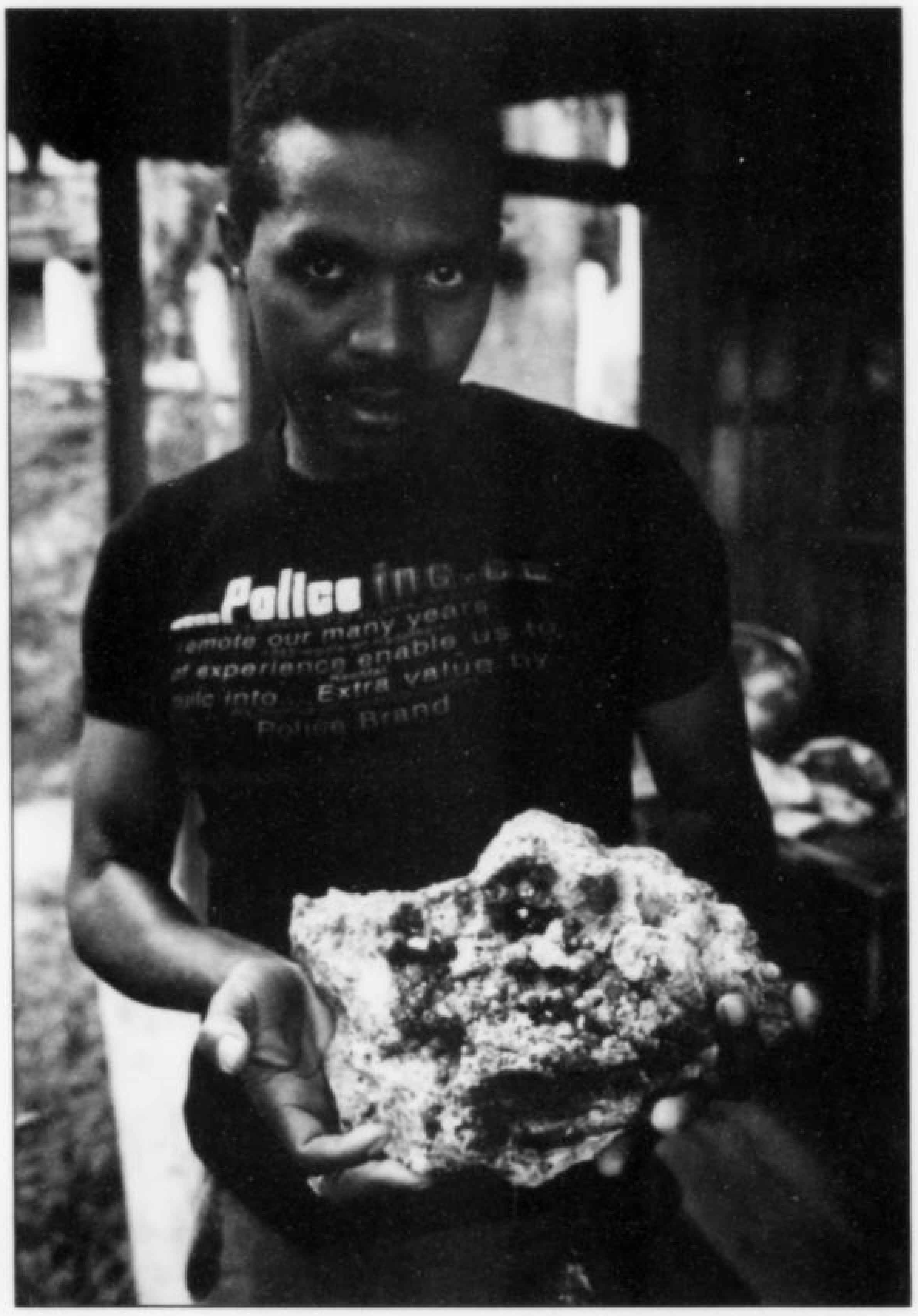


Figure 9. **A local andradite miner holding an excellent matrix specimen with demantoid crystals. Federico Pezzotta photo.**

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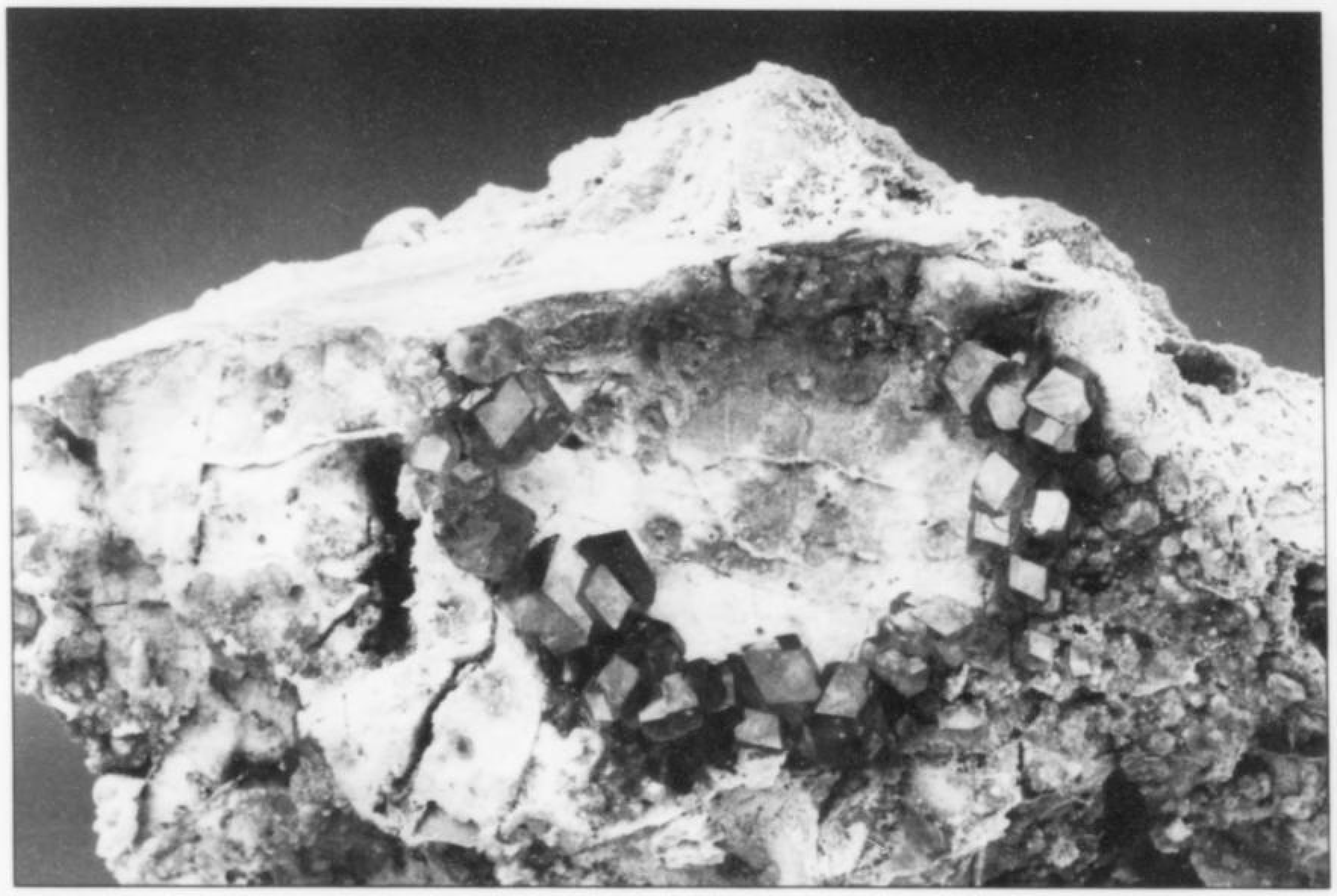


Figure 10. **Crystals of demantoid up to 1.4 cm across, distributed around a cavity probably originating from a fossil shell. Daniel Trinchillo (Fine Minerals International) specimen; Roberto Appiani photo.**

Figure 11. **Fossil shell transformed into garnet skarn (fine-grained grossular-andradite with minor quartz), partially covered by small crystals of andradite. Collection of the Museo Civico di Storia Naturale, Milan, Italy; Roberto Appiani photo.**

St-André area) and important sub-volcanic and volcanic alkaline massifs were emplaced in the Isalo sedimentary Permian-Triassic formation, in the area of the Ampasindava promontory, in the northwestern part of the island (BRGM, 1985). The Antetezambato garnet deposit occurs within the latter geological environment and is the first important mineral and gemstone deposit formed by contact metamorphism of the Permian-Mesozoic sediments to be discovered in Madagascar.

In the area of Antetezambato, the 1:100,000 geologic map (Besairie and BRP-IFP, 1962) shows the distribution of the sediments of the Isalo Formation (mostly sandstones). The nearest igneous intrusion shown on the map is the Ambato pluton, an alkaline-granite massif located about 5 km northeast of the garnet deposit.

Field mapping at the mine and observations made by the author inside the diggings indicate that the Antetezambato garnet deposit is characterized, below the superficial alteration layer, by a large block of layered sediments intruded by a network of lamprophyric dikes. The entire block of sediments is tilted, dipping to the south at an angle of 45 to 60 degrees, in contrast to the sub-horizontal regional attitude of the nearby sedimentary formations. The gray lamprophyric rock is rich in phenocrysts and igneous xenoliths, and appears to have a composition similar to that of a trachyte. These igneous rocks are connected to a significant mass of lamprophyric rocks (not shown on the above-mentioned geologic map) which border the garnet deposit to the north and to the west. The sediments, originally composed of interlayered fine to medium-grained fossiliferous sandstones and silica-rich limestones, locally with a nodular structure, have been affected by metasomatic alteration, concentrated along structural discontinuities such as layer boundaries, fractures and contacts with the lamprophyric intrusions. The metasomatic alteration resulted in a network of veins where the sedimentary rocks are transformed into a very fine-grained white to pale green skarn rock, locally rich in cavities containing crystals of demantoid garnet. The skarn rock consists of an aggregate of microcrystals of garnet, with or without quartz. Calcite occurs only in a limited area in the southwestern part of the deposit. Microprobe analyses and preliminary petrographic observations in thin sections indicate that the microcrystals of garnet constituting the massive rock are zoned, with compositions ranging from intermediate between grossular and andradite to nearly pure andradite.

The metasomatic process allowed the preservation of much of the original structure of the sedimentary rock, and even fossils have been replaced locally by the fine-grained skarn minerals. In a few cases, recognizable fossil shells, corals and even ammonites have been replaced by garnet and quartz, and form the matrix for demantoid crystals.

Genetic Model

It appears that the Antetezambato garnet deposit formed inside the sedimentary sequence during the sub-volcanic intrusion of lamprophyric igneous rocks. This intrusion phase activated a high-temperature pneumatolytic to hydrothermal circulation of fluids that was concentrated along rock discontinuities, metasomatically altering the sedimentary rock into a skarn and depositing andradite in cavities. As indicated by Fehr (2008), at atmospheric pressure, andradite is the most thermally stable species in the garnet group. For this reason it is possible that very shallow depth and correspondingly very low lithostatic pressure during garnet

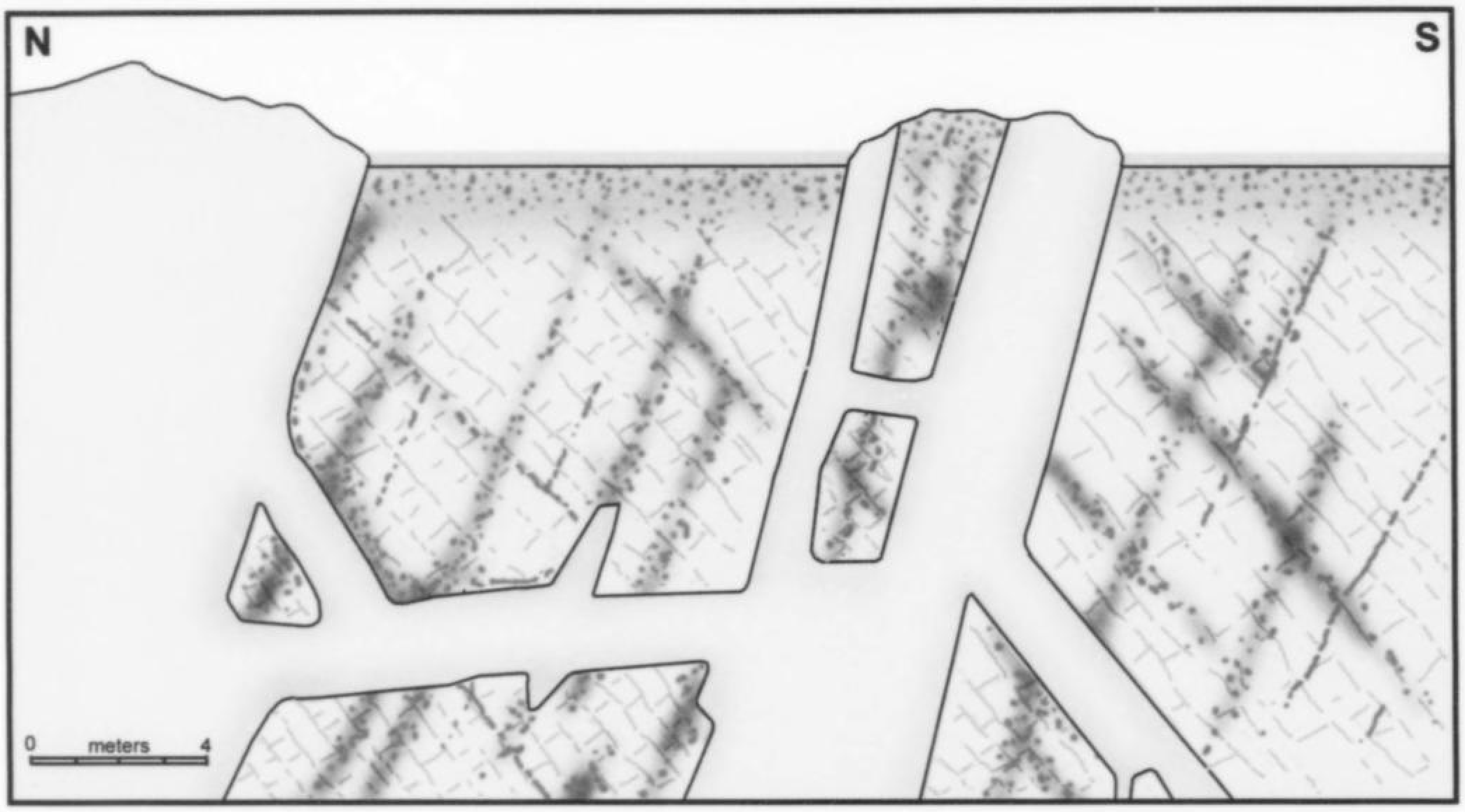


Figure 12. **Interpretive geologic cross-section through the northern part of the demantoid deposit, showing high tide water (blue), near surface eluvial horizon of weathered rock containing broken and dispersed demantoid crystals (brown), interbedded sandstone and limestone dipping 40° to 60° south (tan) with zones that have been metasomatized (green), and demantoid-rich skarn veins (stippled green) developed along fractures, metasomatized areas and igneous contacts with the lamprophyre intrusion (pink).**

formation at Antetezambato accounts for the near end-member andradite composition of the garnet. The absence of titanium in the sedimentary rocks accounts for the crystallization of the demantoid and topazolite varieties rather than the more common titanium-rich melanite variety of andradite.

The 1:100,000 geologic map indicates a Post-Liassic age for the Ambato pluton, corresponding to the Cretaceous magmatism reported by the BRGM (1985). Nevertheless, significant evidence of Pleistocene magmatism exists in the form of extensive outcrops of volcanic rocks in the region. Moreover, in the center of the garnet deposit, the author observed a small basaltic dike containing vugs rich in zeolites (probably scolecite) similar to those observed in recent basalts on the nearby islands of Nosy Faly and Nosy Be. To establish definitively the age of the Antetezambato lamprophyres and thereby the age of the formation of the andradite crystals, the author is currently conducting isotope-geochronological analyses on selected specimens, the results of which should be available soon.

The Antetezambato demantoid-topazolite skarn is genetically similar to the Namibian deposits and is significantly different from the serpentinite-hosted demantoid deposits at localities such as the Ural Mountains of Russia and Val Malenco, Italy.

VARIETAL NOMENCLATURE FOR ANDRADITE

Non-gem andradite is typically found in skarns, is opaque and is commonly a more or less brownish color. It has not been given a varietal name. However, the transparent, colored varieties of andradite are of importance in the field of gemology, and consequently the perpetuation of varietal terms for marketing purposes (onerous as that is to many mineralogists) is inevitable, and thoroughly entrenched in the literature. Thus there will be no attempt here to avoid the use of varietal names. The two andradite varieties of principal interest are demantoid and topazolite.

Demantoid

Demantoid is a variety of andradite [$Ca_3Fe_2(SiO_4)_3$] characterized by a deep, bright green to yellowish green color. It is the most famous and most precious of all the garnet varieties, sometimes selling for thousands of dollars per carat. Demantoid was first discovered in 1864 in the central Ural Mountains about 110 km north-northwest of Ekaterinburg. The name demantoid ("diamond-like") was proposed in 1878, in allusion to its high refractive index and its exceptional dispersion which is stronger than that of diamond. Because of its rarity and its brilliance when faceted, demantoid is among the most appreciated and highly priced of the garnet gemstones. (See Anderson, 1975; Stockon and Manson, 1983; Neuendorf *et al.*, 2005; Stephenson and Kouznetsov, 2009; Rouse, 1986; Kievlenko, 2003; Phillips and Talantsev, 1996; and Gill, 1978).

The most famous classic locality for collector-quality demantoid crystals is Val Malenco (Malenco Valley) in the Italian province of Sondrio, in the central Alps. Cossa (1880) provided the first description of the Val Malenco "green garnets." Several localities in the valley have yielded significant specimens in the 20th century, but the best of them came from the now-abandoned Sferlùn asbestos mine. In 1947 and again during the second half of the 1960s, well-formed demantoid crystals were collected there from asbestos-filled fractures cutting across serpentinite outcrops (Sigismund, 1948; Bedogné and Pagano, 1972; Amthauer *et al.*, 1974; Bedogné *et al.*, 1993; Bedogné *et al.*, 1999).

Demantoid has always been admired and sought after by mineral collectors. Demantoid gem rough is known from the famous deposits in the Ural Mountains, in Russia (Phillips and Talantsev, 1996), the area west of the Erongo mountains in Namibia (Johnson and Koivula, 1997; Von Bezing *et al.*, 2007), and the Soghan area, Kerman Province, southern Iran (Laurs, 2002; Karampelas *et al.*, 2007), but these localities have only rarely produced collectible crystals. Several other localities in the Italian Alps, San Benito County (California), the Stanley Buttes area (Arizona), Korea, the Democratic Republic

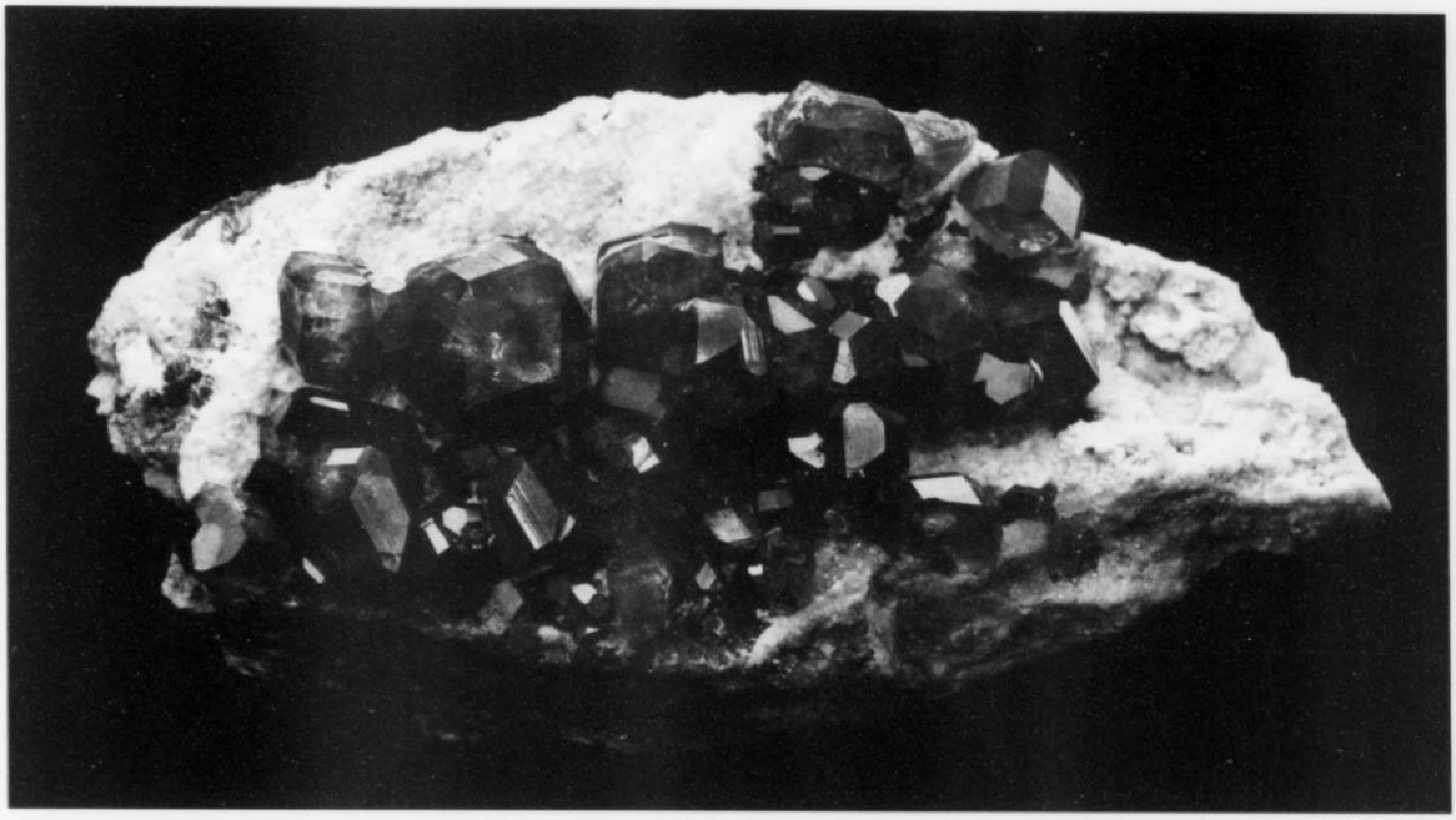


Figure 13. **Demantoid crystals on matrix, 10 cm, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**

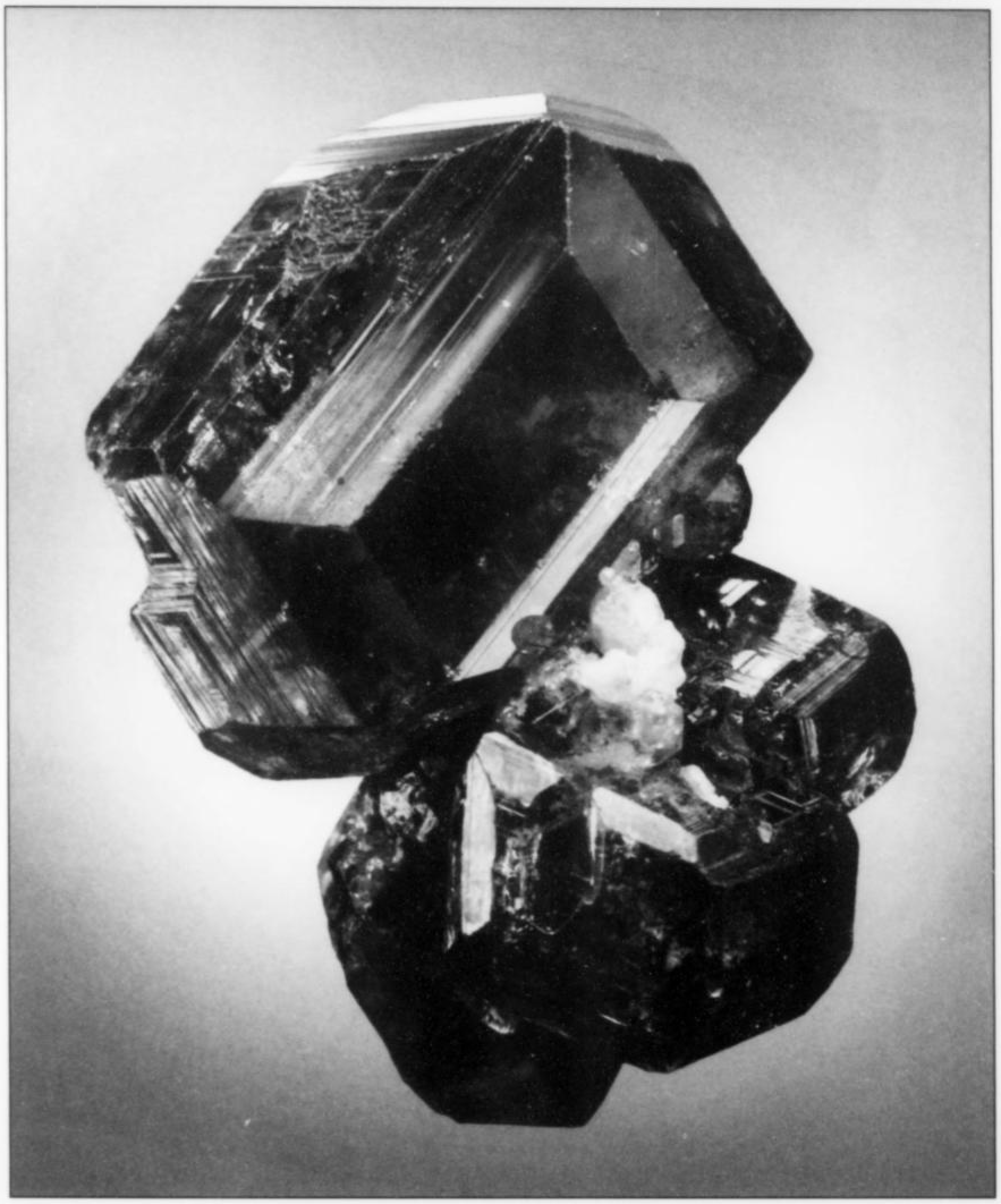


Figure 14. **Demantoid crystals to 2 cm, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**

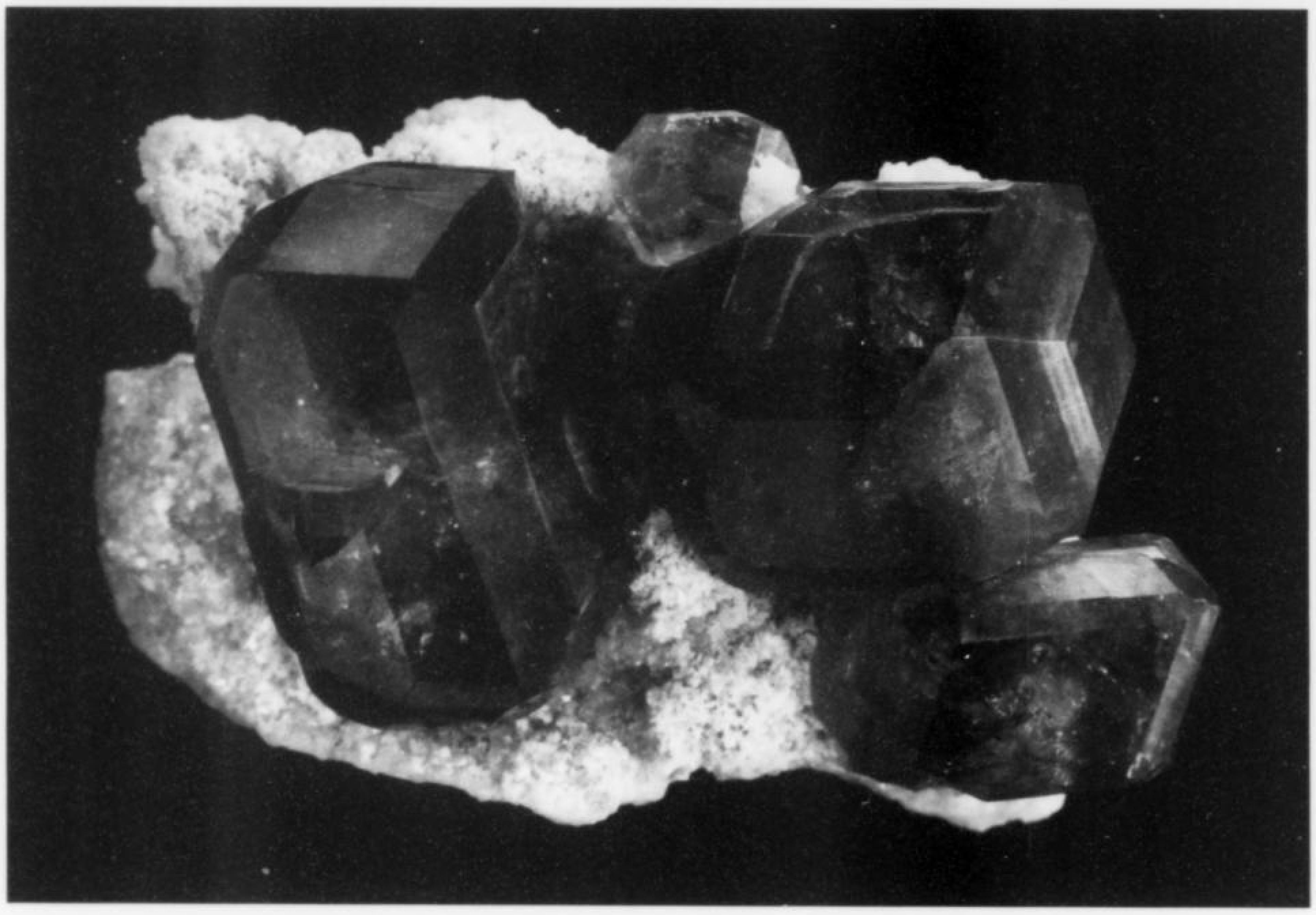


Figure 15. **Demantoid crystals on matrix, 6 cm, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**

Figure 16. **Demantoid crystals on matrix, 3.6 cm, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**

of the Congo, and Armenia have in the past produced demantoid gem rough and crystal specimens of minor interest (Rouse, 1986; Kievlenko, 2003). During the last decade the Lac d'Amiante mine in the Thetford Mines area of Québec has occasionally produced attractive, translucent, slightly grayish green demantoid crystals including a few very rare specimens of world-class quality (Amabili *et al.*, 2009). Despite all these occurrences, Val Malenco has remained the most important source of attractive collectible demantoid crystals until the recent discovery of the Madagascar occurrence.

Topazolite

Topazolite is another variety of andradite, characterized by a brownish orange color, sometimes with a greenish tint which grades into yellow-green demantoid (Gramaccioli, 1975; Rouse, 1986). Topazolite was initially described as a new species by Bonvoisin (1806), the name alluding to the topaz-like golden color and brilliance of crystals from the Ala Valley in Italy; it was later found to be identical to andradite.

Before the discovery of the Madagascar occurrence, topazolite was only very rarely found as attractive, collectible crystal specimens; moreover, this garnet variety has generally been considered to be of no gem interest (Anderson, 1975) and information in the literature is rather scarce. Rouse (1986) reports that the known demantoid occurrences have commonly produced much more yellow to greenish yellow andradite than green crystals that would qualify as demantoid. However, fine, pure yellow andradite

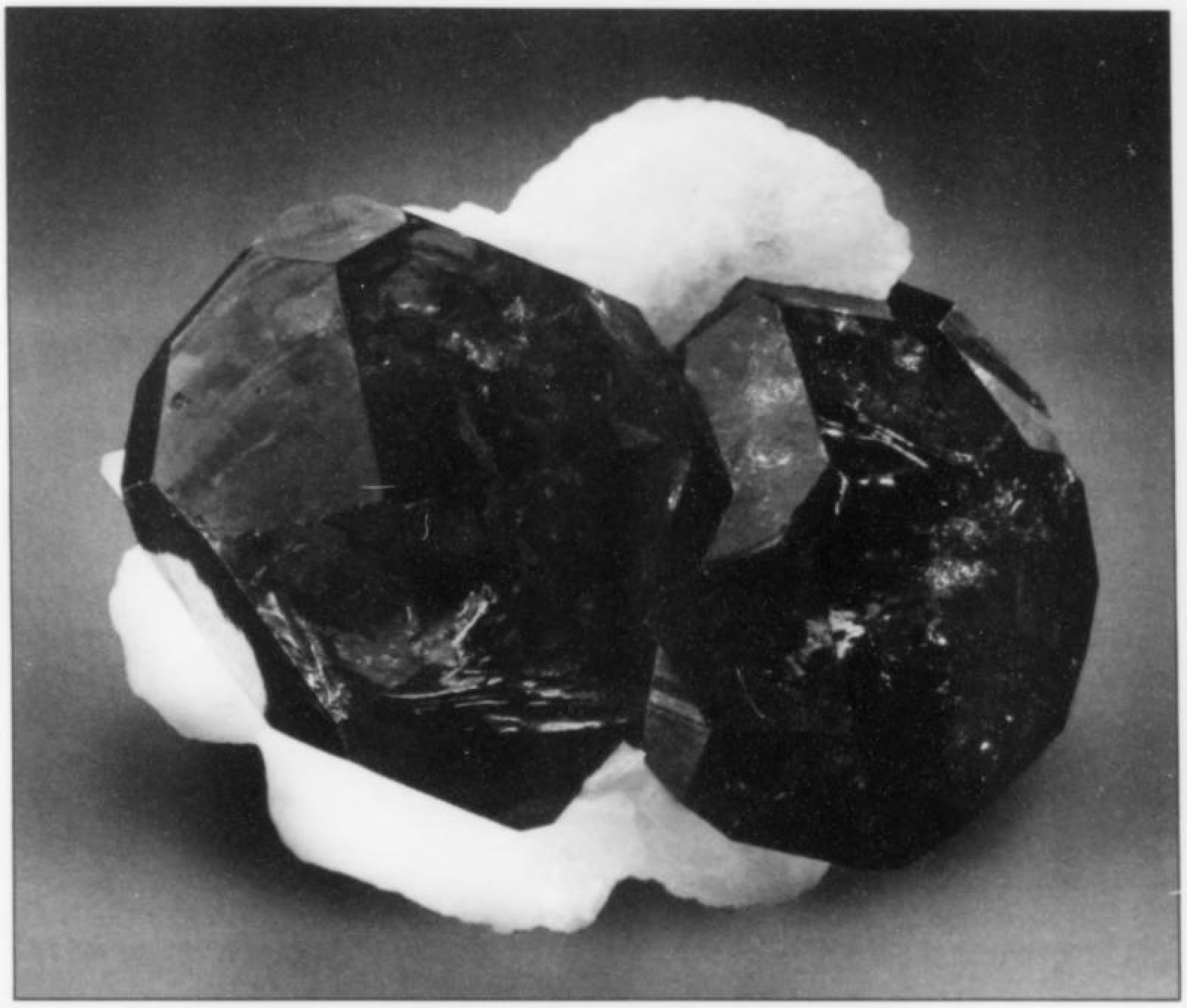


Figure 17. **Demantoid crystals on calcite, 2.8 cm, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**

Figure 18. **Demantoid crystal on matrix, 4.4 cm, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; Marco Amabili collection; James Elliott photo.**

crystals without any tint of green or brown are unusually rare. Rouse (1986) also reported topazolite from San Benito County, California.

The classic occurrence in Val d'Ala (the Ala Valley) in Piedmont, Italy remains one of the most significant sources of topazolite crystal specimens; Ala Valley topazolite has been found in crystals occasionally exceeding 1 cm in diameter, but only the smallest crystals are of gemmy quality. The best recent discovery consists of translucent yellow-brown crystals of topazolite to nearly 2 cm, found a few years ago by some local collectors at Monte Civrari in the Susa Valley, Piedmont. The composition of these garnets seems to be intermediate between andradite and grossular (Piccoli *et al.*, 2007). Some significant gemstones of topazolite were cut from rough material found after 1997 in the demantoid deposits

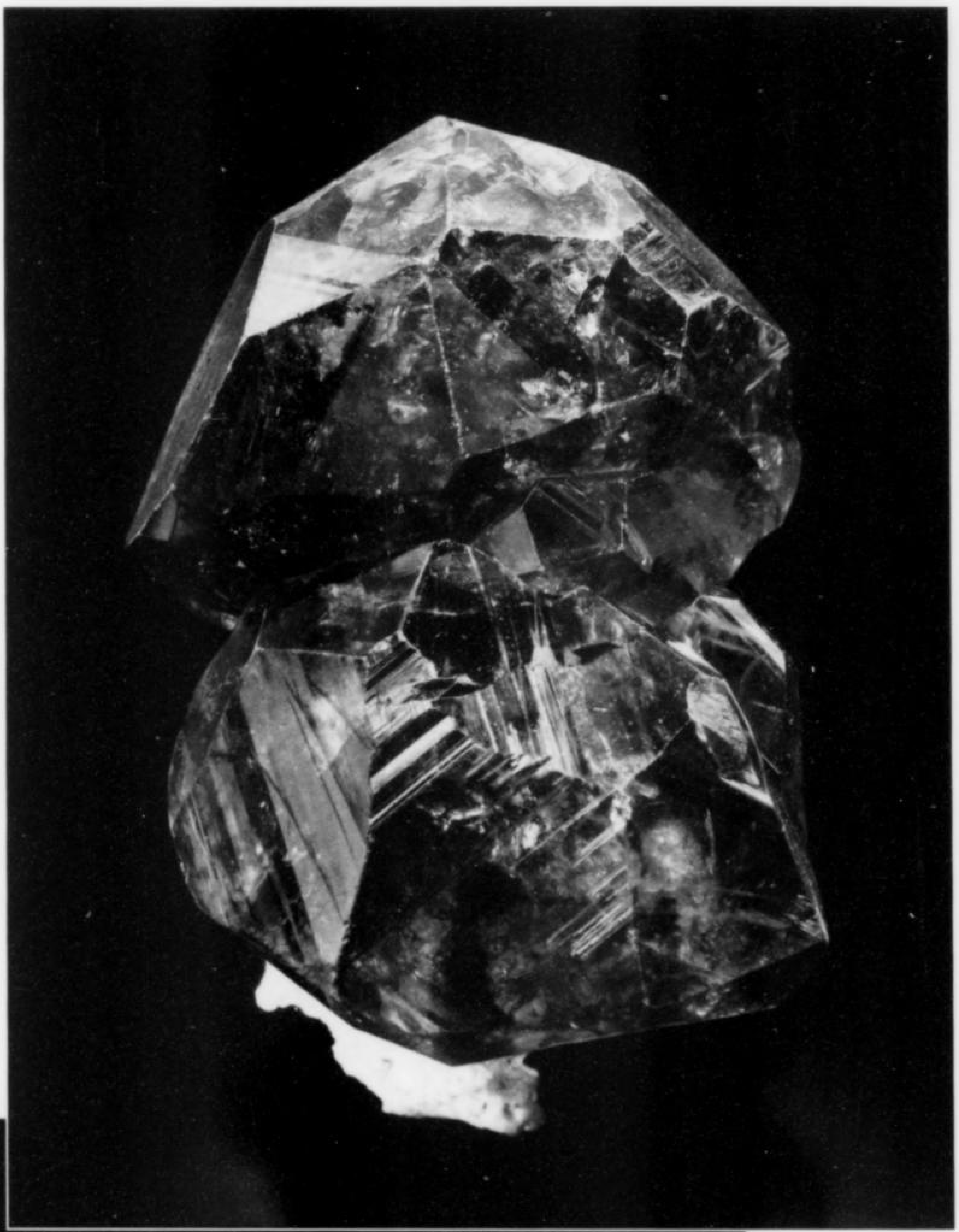
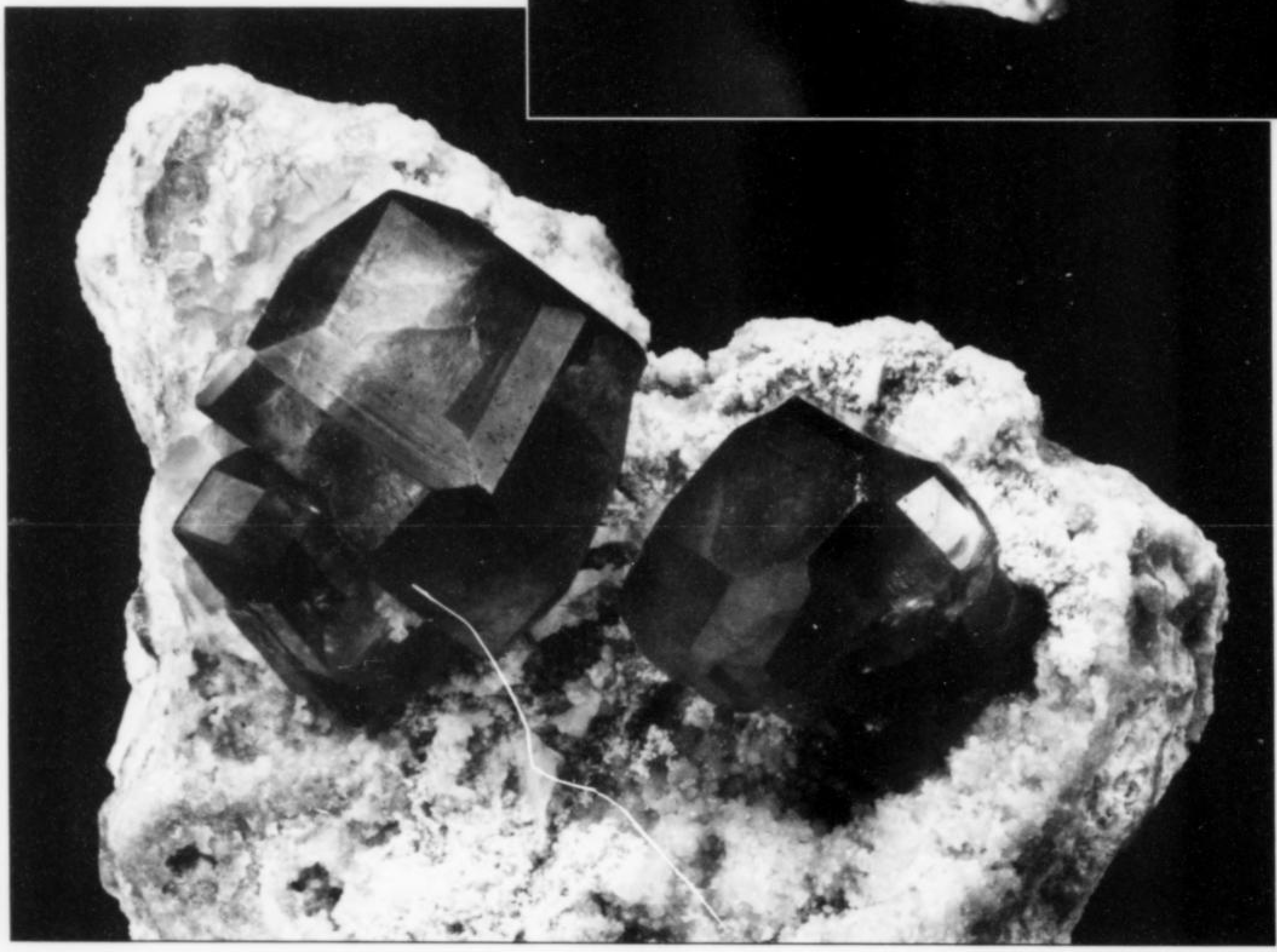


***Figure 19*. Demantoid crystal cluster, 4.1 cm, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**

***Figure 20*. Demantoid crystals to 1.3 cm on matrix, from Antetezambato. Watzl Minerals specimen; Roberto Appiani photo.**



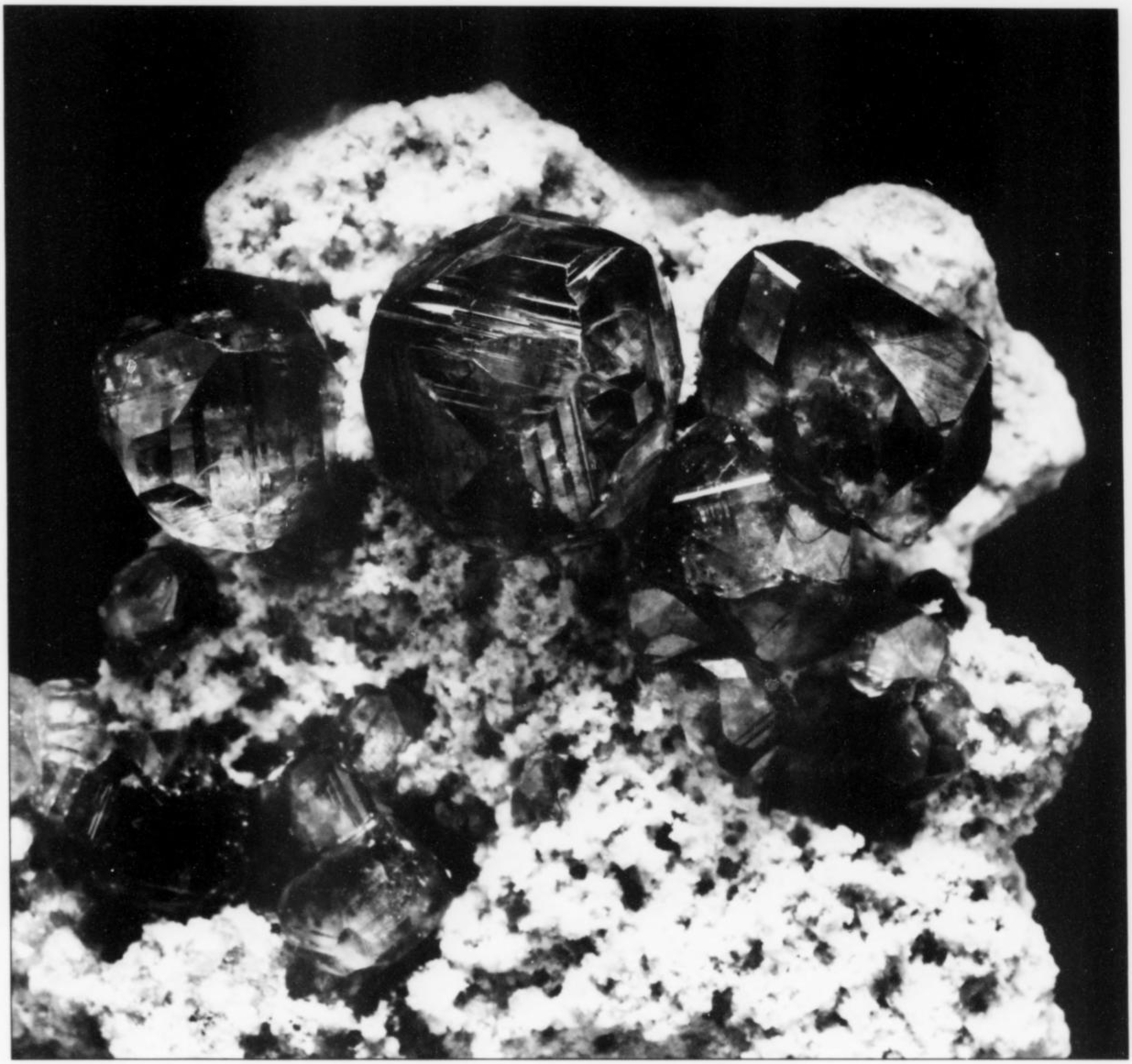


Figure 21. **Demantoid crystals on matrix, 3.3 cm, from Antetezambato. Spirifer specimen; Jeff Scovil photo.**

discovered west of the Erongo Mountains, in Namibia (Gernot Smolle, personal communication).

Chromophores

Black andradite, though not a gem material, has long been known among mineral collectors by the varietal name of *melanite*; it occurs in sharp, lustrous crystals in metamorphic rocks and in undersaturated alkaline igneous rocks. A significant titanium content (TiO_2 exceeding 5%, see discussion in Meagher, 1980) is responsible for the black color.

Gem varieties of andradite generally have compositions close to the ideal end-member composition (Adamo *et al.*, 2009; Adamo *et al.* in preparation); their color is controlled by stoichiometric Fe^{3+} (green-yellow) and by traces of Cr^{3+} (green) and probably Ti^{3+} and Ti^{4+} (brown color, see discussion in Meagher, 1980, for the presence of Ti^{3+} and Ti^{4+} in andradite).

Concerning the yellow and yellow-brown color varieties of gem andradite, there is general agreement among gemological writers on the varietal name *topazolite*, regardless of the causes of the color.

Rondeau *et al.* (2009) emphasized that there is no agreement in the literature about the definition of the varietal name *demantoid*. Some authors, such as Webster (1975), Bariand and Poirot (2004), and Rossman (2009), consider demantoid to be an andradite colored green by traces of chromium; other authors such as Anderson (1975), the GIA's *Gem Reference Guide* (1988), and the AGI's *Glossary of Geology* by Neuendorf *et al.* (2005a) define demantoid as a green to yellow-green andradite without requiring the presence of trace amounts of chromium as the chromophore.

Microchemical and spectroscopic studies (Rondeau *et al.*, 2009) of gem andradite crystals from Antetezambato, Madagascar—with color ranging from vivid green to yellow green to brown—attribute the green color to the presence of Fe^{3+}, and the brownish color to the charge transfer effect between iron and titanium (Fritsch and Rossman, 1993). On the basis of these results, Rondeau *et al.* (2009) suggest that the name demantoid be used for the green variety of andradite regardless of the chromophores(s) involved. The present author is in agreement with this suggestion.

It is interesting to note that demantoid from Russia can be heat-treated at temperatures between 640° and 720°C, in a graphite-powder-reducing atmosphere, to enhance the color (Stephenson and Kouznetsov, 2009). This treatment is able to minimize, if not totally eliminate, the yellow component of the color, yielding gemstones of a pure green color. Studies regarding the effect of such a treatment on Madagascar demantoid are in progress.

ANDRADITE AT ANTETEZAMBATO

Specimen Types and Sizes

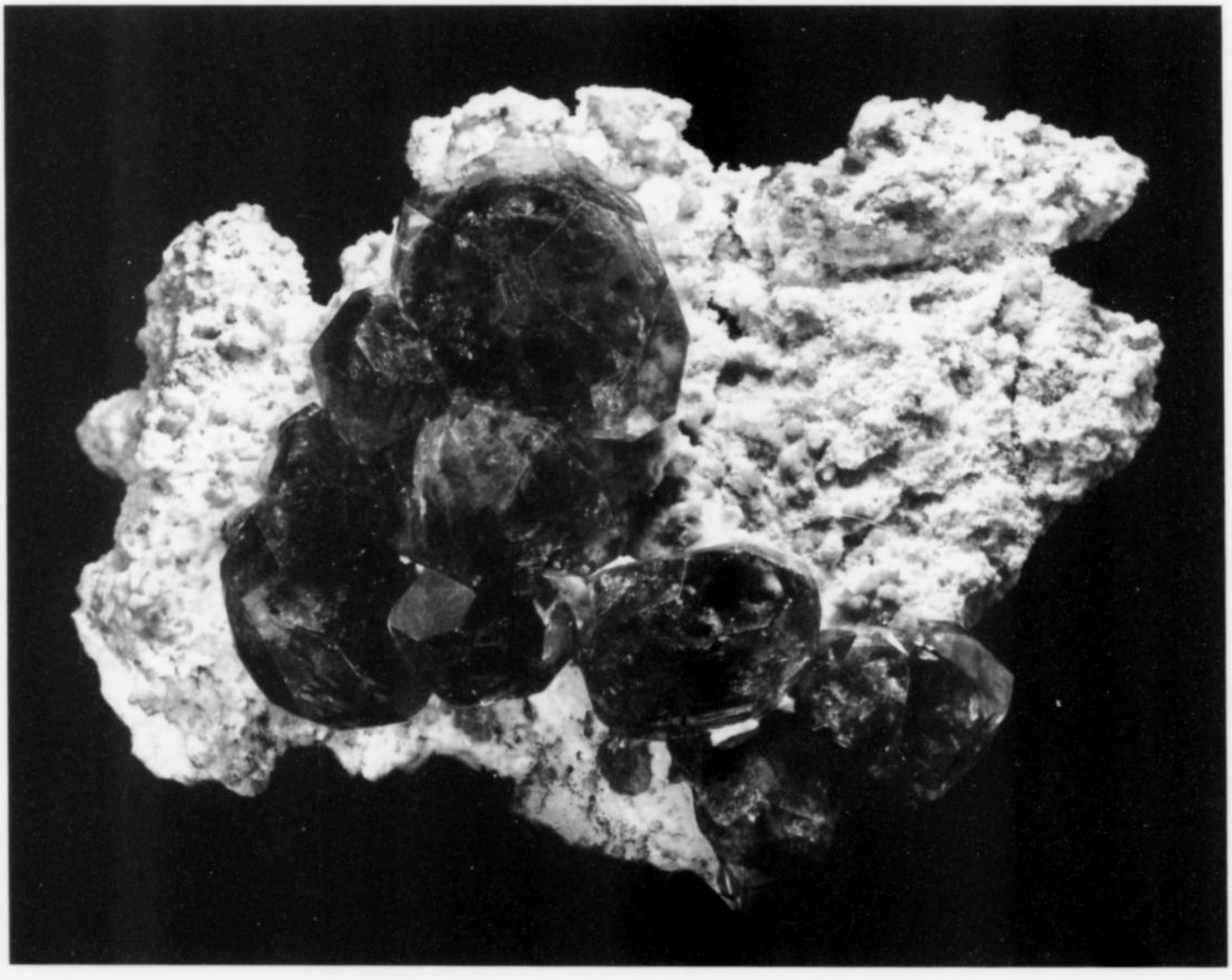
Andradite [$Ca_3Fe_2^{3+}(SiO_4)_3$] crystals of the demantoid and topazolite varieties are found at Antetezambato as detached crystals and crystal groups, but most commonly as matrix specimens in all sizes from thumbnails to large cabinet specimens. Crystal size ranges from a few millimeters to nearly 3 cm in diameter, topazolite crystals being generally of the largest size. The luster is normally good and some varieties are characterized by crystals with extraordinarily bright faces.

The garnet crystals occur in cavities of various types, depending on the size of the vein and the structure, texture and mineralogy of the altered sedimentary rock. Each vein or vein-system produces distinctive mineral specimens with garnets having their own particular crystal morphology, color, brightness, and associations.

In massive impure sandstone, garnet veins contain fissure-shaped

Figure 22. **Andradite crystal with green demantoid core and brown topazolite outer zone, 1.5 cm, from Antetezambato. Riccardo Caprilli collection; Roberto Appiani photo.**

Figure 23. **Demantoid crystals to 2 cm on matrix, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**



cavities 2 to 30 mm wide and up to a meter or more in length. The best garnet crystallizations occur at the intersections of two or more of the fissure-like cavities. Such fissures are generally lined with microcrystals of pale green garnet, on which are isolated large crystals and clusters of gem varieties of andradite.

In the more structurally and compositionally heterogeneous sediments, garnet veining is more complex and large volumes of rock can be altered. At Antetezambato, quartz and chalcedony together with very fine garnet aggregates of whitish color are abundant, and large cavities up to several cubic meters in volume can occur. Such cavities, known among the miners as "caves," are partially filled by fine-grained corroded quartz mixed with clay minerals. This pocket fill typically contains large quantities of irregularly shaped fragments of snow-white matrix carrying crystals of gem varieties of andradite and also crystals of quartz.

A wide variety of other types have also been found, including specimens with (1) spongy grey matrix, (2) brecciated matrix, (3) spongy matrix composed of fine to medium-grained green crystals of garnet, (4) spongy matrix composed of partially altered fossiliferous sandstone, (5) massive matrix composed of fine-grained aggregates of garnet and calcite, crosscut by coarse-grained veins of spathic calcite, and so on. Isolated crystals or crystal groups of gem varieties of andradite are abundant in all of these occurrences.

Composition

Preliminary data have been published by researchers at the gemological school of the University of Nantes (France) (Mocquet *et al.*, 2009a and 2009b; Rondeau *et al.*, 2009a and 2009b). The analytical results reported in these publications, obtained using an EDS microprobe, and those made by the author, obtained using

Figure 24. **Topazolite crystals on matrix, 3 cm, from Antetezambato. Demineralia specimen; Roberto Appiani photo.**

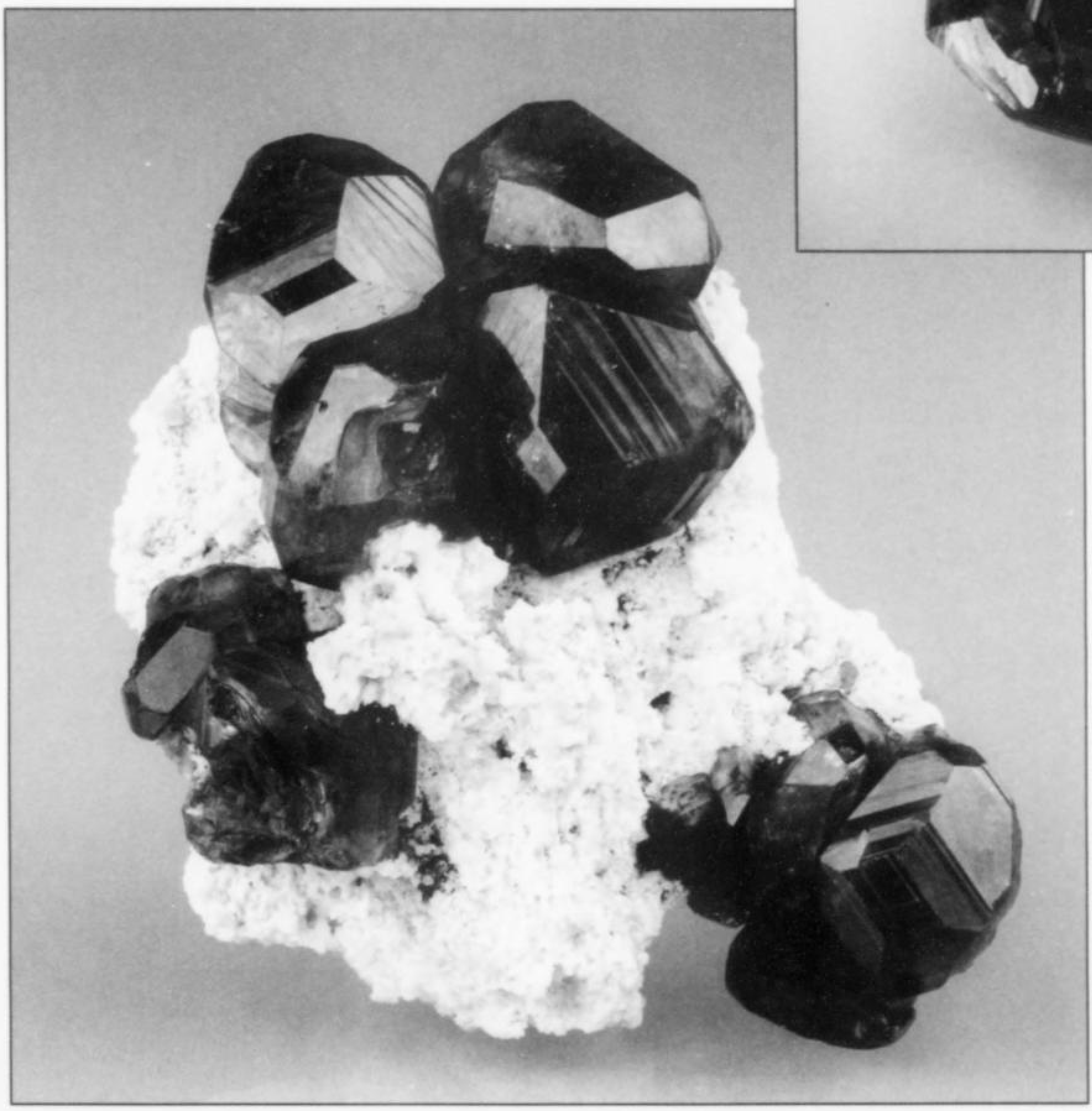


Figure 25. **Topazolite crystals to 1.8 cm each on matrix, from Antetezambato. Demineralia specimen; Roberto Appiani photo.**

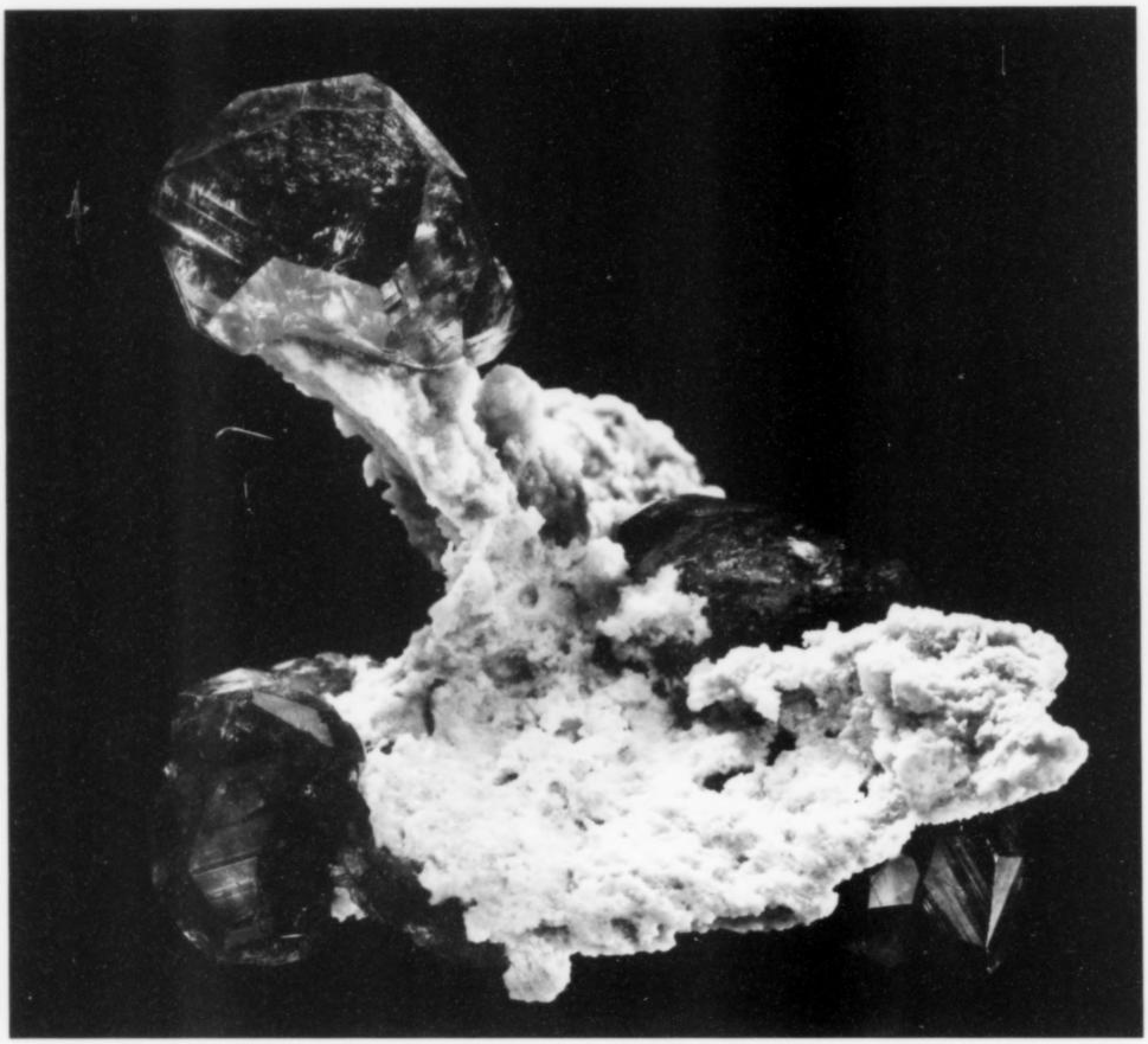


Figure 26.
Topazolite crystals to 2 cm, on matrix, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.

both EDS and WDS microprobes, indicate that the garnet crystals from Antetezambato are always very pure andradite, regardless of their colors. For the detection and quantification of trace elements, new investigations using the laser ablation technique are in progress by the author in collaboration with the researchers of the CNR of Milano. Thus far, the only available data regarding trace elements in gem crystals of andradite come from one EDS microprobe analyses (made by Giancarlo Parodi of the Museum de Histoire Naturelle, Paris) on one inclusion inside a garnet crystal, containing significant quantities of chromium. Some EDS microprobe spectra (requiring confirmation) indicate very minimal traces of titanium in one brownish crystal (topazolite), and titanium, vanadium and copper in one vivid green crystal with a bluish tint (demantoid). Small and opaque crystals of pale green, pale gray, pale yellow and pale pink color covering the matrix of some specimens were shown to be andradite with a significant content of aluminum (the grossular component).

Color

Gem andradite crystals from Antetezambato can be divided into (1) the *demantoid* variety of yellow-green to army-green, grass-green, emerald-green, and bluish green color, often of low to moderate saturation, and (2) the *topazolite* variety of honey-yellow, amber-yellow, brownish yellow and brown color. Some rare crystals of brownish red color are known, occasionally even in gem quality, and must be referred to simply as andradite.

Transparent, color-zoned crystals are rather common, typically with a green or greenish core and a more brownish rim. The first generation of garnet growth was greener in color whereas the second generation was more yellow-brown. In some veins it is not uncommon to find crystals with a topazolite zone surrounding a demantoid core. Thick polished sections of such crystals reveal a complex multiple color zoning which indicates inhomogeneities in the distribution of the trace elements (still to be defined, as previously discussed), as described in Meagher (1980). As pointed out by Rondeau *et al.* (2009a), between crossed polarizers, these garnets show an anomalous double refraction with undulating extinction and the so-called "tatami" features. This phenomenon is typical of andradite and has been described several times in the literature (e.g. Meagher, 1980).

An alexandrite-like color-change resembling that described in demantoid from some other localities (e.g. Amabili *et al.*, 2009) is also seen in some demantoid and topazolite crystals from Antetezambato. This effect is more evident for crystals which are distinctly greenish yellow under daylight and become reddish yellow under incandescent light. The unusual bluish hue of some green crystals is evident only in daylight and not under incandescent light. This effect seems to be rather different from the one described by Ahn and Park (2008) and it is probably the result of a different mechanism.

Crystal Morphology

Andradite crystals from Antetezambato display an exceptionally interesting variety of crystal habits and forms. The most common forms are the dodecahedron {110} and trapezohedron {211} in various combinations, the first being more typical for demantoid and the second for topazolite. Cube faces {100} are very rare and have been observed by the author only in two demantoid crystals. Many crystals, mostly of the topazolite variety, show modifications by several hexoctahedral forms and, in rare cases, the crystals can display only a single hexoctahedron form. Goniometric measure-

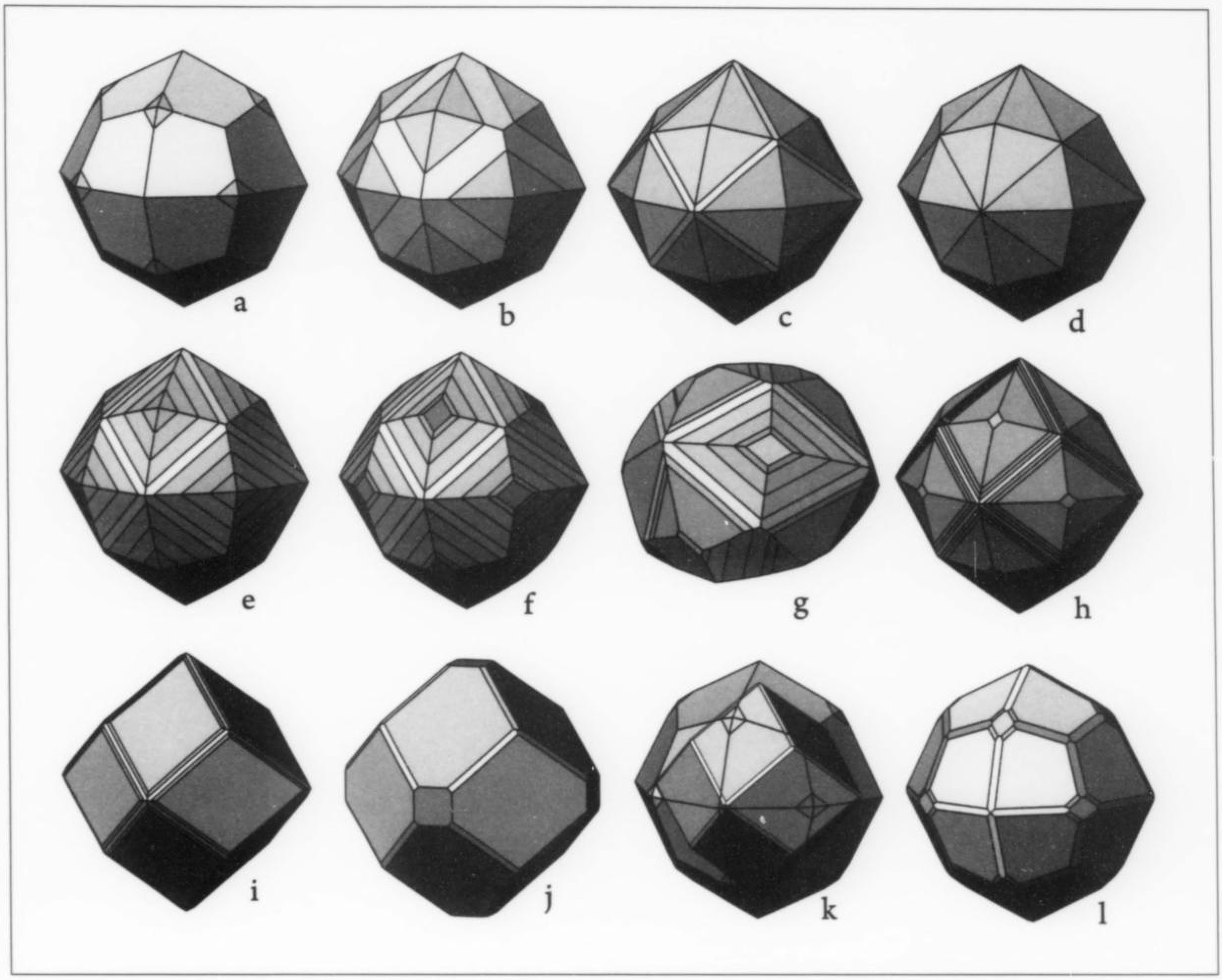


Figure 27. **Crystal drawings depicting some of the crystal habits seen in andradite from Antetezambato: (a, b, c) trapezohedron {211} (tan) and hexoctahedron {954} (medium orange); (d) hexoctahedron {954}; (e) trapezohedron {211} and hexoctahedrons {954}, {532} and {321}; (f, g, h) trapezohedron {211}, hexoctahedrons {954}, {532} and {321}, and dodecahedron {110} (green); (i) dominant dodecahedron {110} modified by trapezohedron {211} and hexoctahedron {954}; (j) dodecahedron {110} and narrow trapezohedron {211}, modified by cube {100} faces (very rare in garnet); (k) modified dodecahedron phantom of demantoid (green) inside a modified trapezohedron of topazolite (orange); (l) trapezohedron {211} modified by the dodecahedron {110} (green), trisoctahedron {332} (orange), and tetrahexahedron {210} (yellow).**

ments have yet to be performed, but computer-generated drawings using the KRISTALL 2000 program can closely approximate the Antetezambato crystals with combinations of the {321}, {532} and {954} hexoctahedra. A few topazolite crystals recovered in December 2009 are modified by the trisoctahedron {332} and tetrahexahedron {210}.

Other unusual and interesting morphological variations have been observed in Antetezambato andradites, including:

(1) Transparent trapezohedral topazolite crystals showing at the center a large green demantoid phantom with dodecahedral form.

(2) Large trapezohedral topazolite or army-green demantoid crystals growing on the end of a small grass-green dodecahedral demantoid crystal which is elongated along the [111] axis, resulting in a scepter shape.

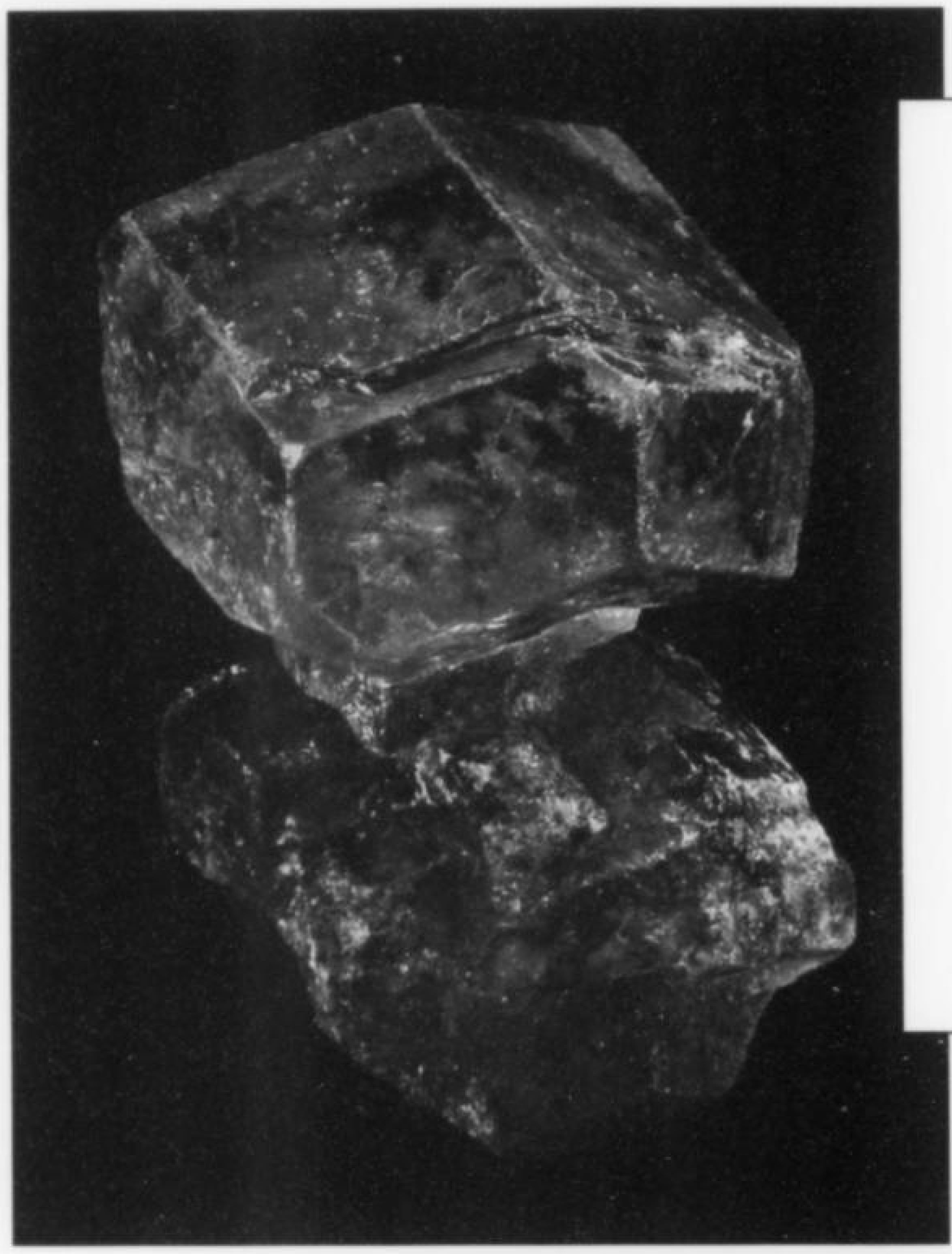
(3) Two dodecahedral demantoid crystals growing on the ends of another dodecahedral demantoid crystal elongated along the [111] axis, resulting in a dumbbell shape.

(4) Some crystals of topazolite found in small fissures have developed extremely flattened shapes, with or without skeletal growth. Such crystals, occasionally very gemmy and with very good luster, can reach a diameter of over 3 cm with a thickness of only 1 mm.

OTHER MINERALS

Quartz SiO_2

Quartz is the most common mineral associated with andradite crystals (mostly of the demantoid variety) at Antetezambato. Where demantoid crystals are of high quality, the quality of the associated quartz tends to be low, and when quartz occurs in beautiful crystals, the quality of the demantoid is low. Quartz crystals are generally elongated, dull-lustered and rather milky. They can reach 10 cm in length and, in a few cases, they display traces of amethyst color. Typically flattened Japan-law twins are found as well.



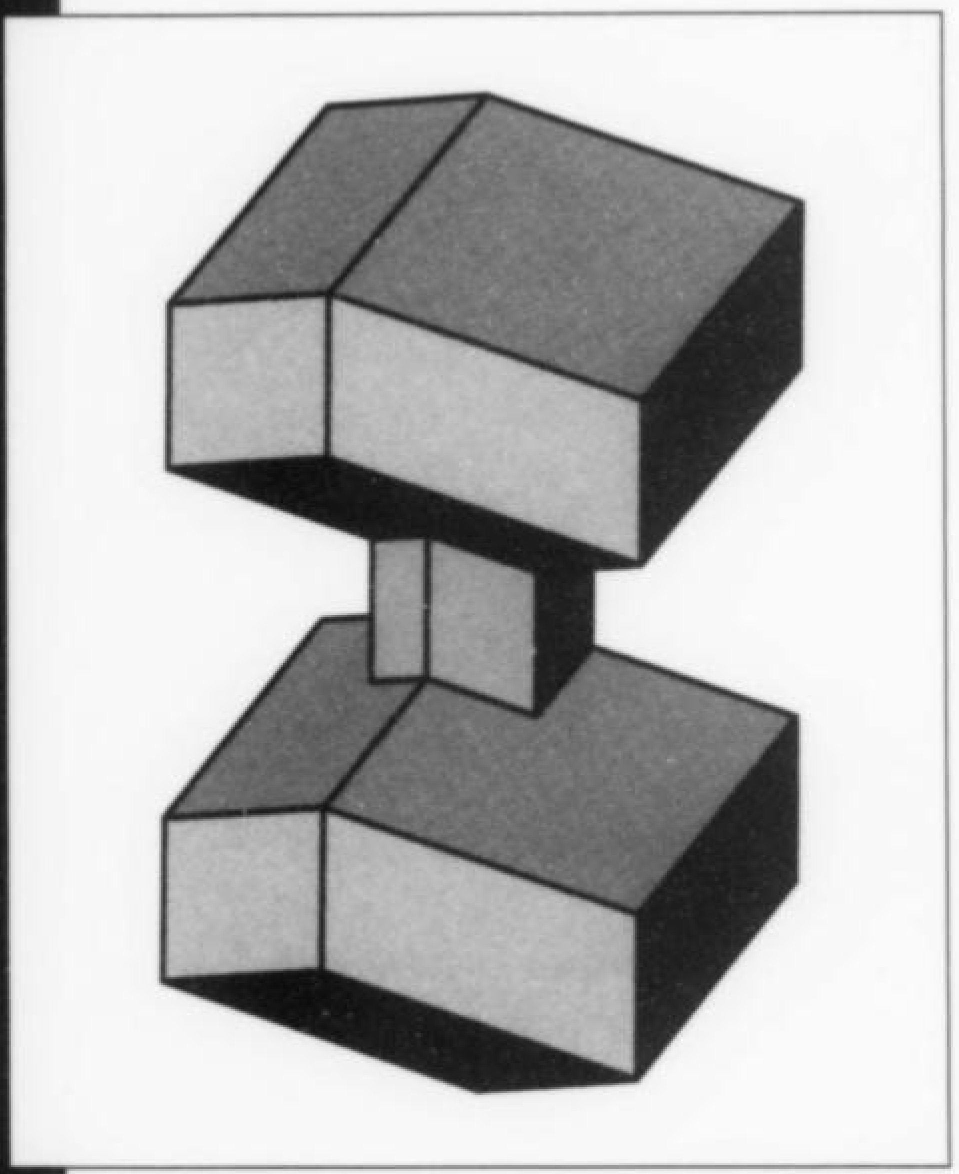


Figure 28. **Dumbbell-shaped demantoid crystal, 2.3 cm. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.** ***Inset:*** **comparable crystal drawing.**

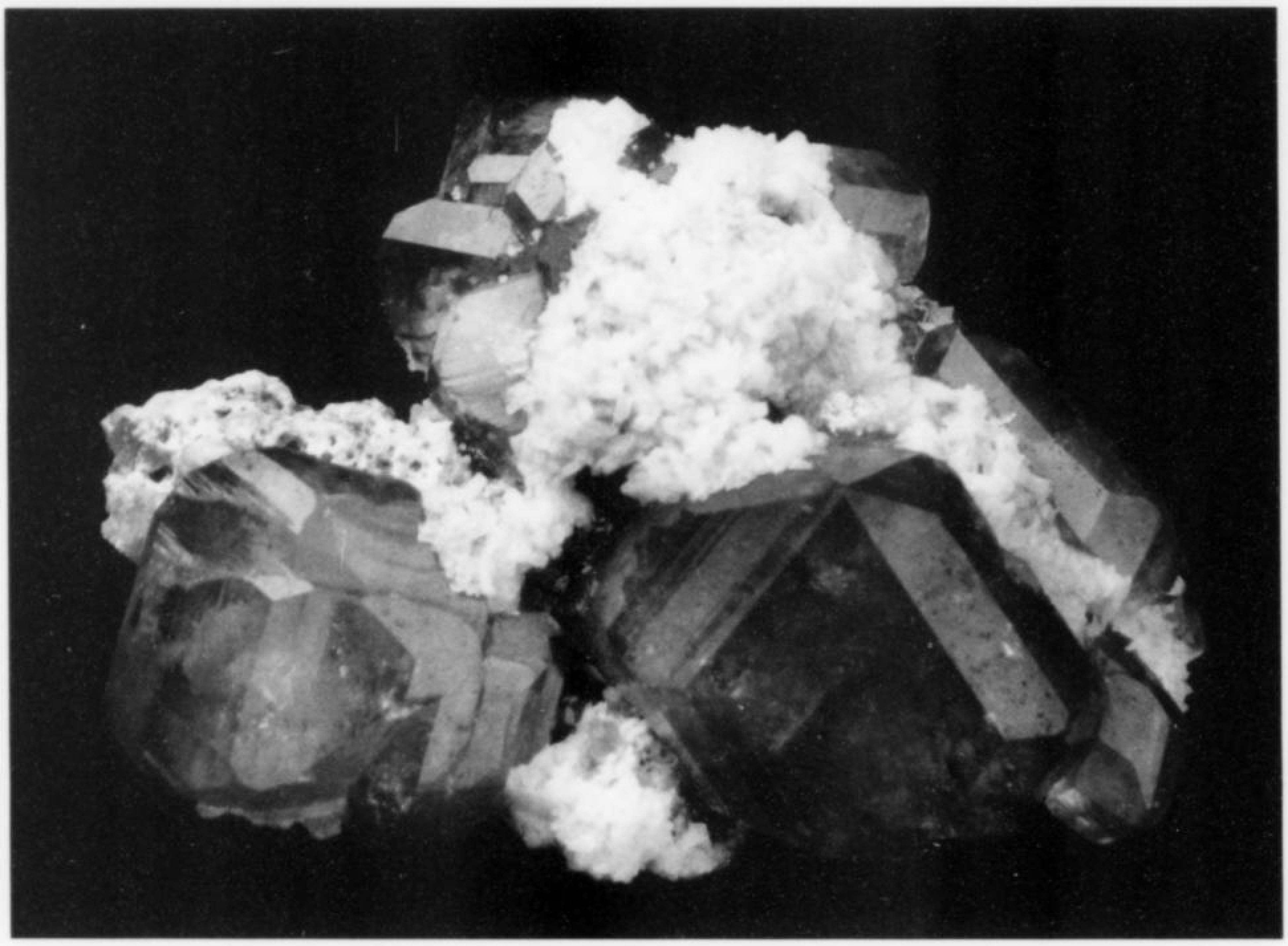


Figure 29. **Demantoid crystals with white stilbite crystals, 3.2 cm, from Antetezambato. Demineralia specimen; Roberto Appiani photo.**

Chalcedony of a whitish color is present in some garnet veins as a constituent of the matrix hosting the andradite crystals, more or less in association with quartz. In some cases, chalcedony in globular whitish and translucent aggregates also encrusts demantoid and topazolite. Occasionally, what appear to be chalcedony masses of lower density have been found, but these are actually opal.

Calcite $CaCO_3$

Calcite is common in only a few veins in the deposit. The most typical crystals are milky white rhombohedrons rimmed by a short hexagonal prism. The normal size is around 1 cm in diameter but, one pocket found in November 2009 contained lustrous, transparent calcite crystals to 10 cm.

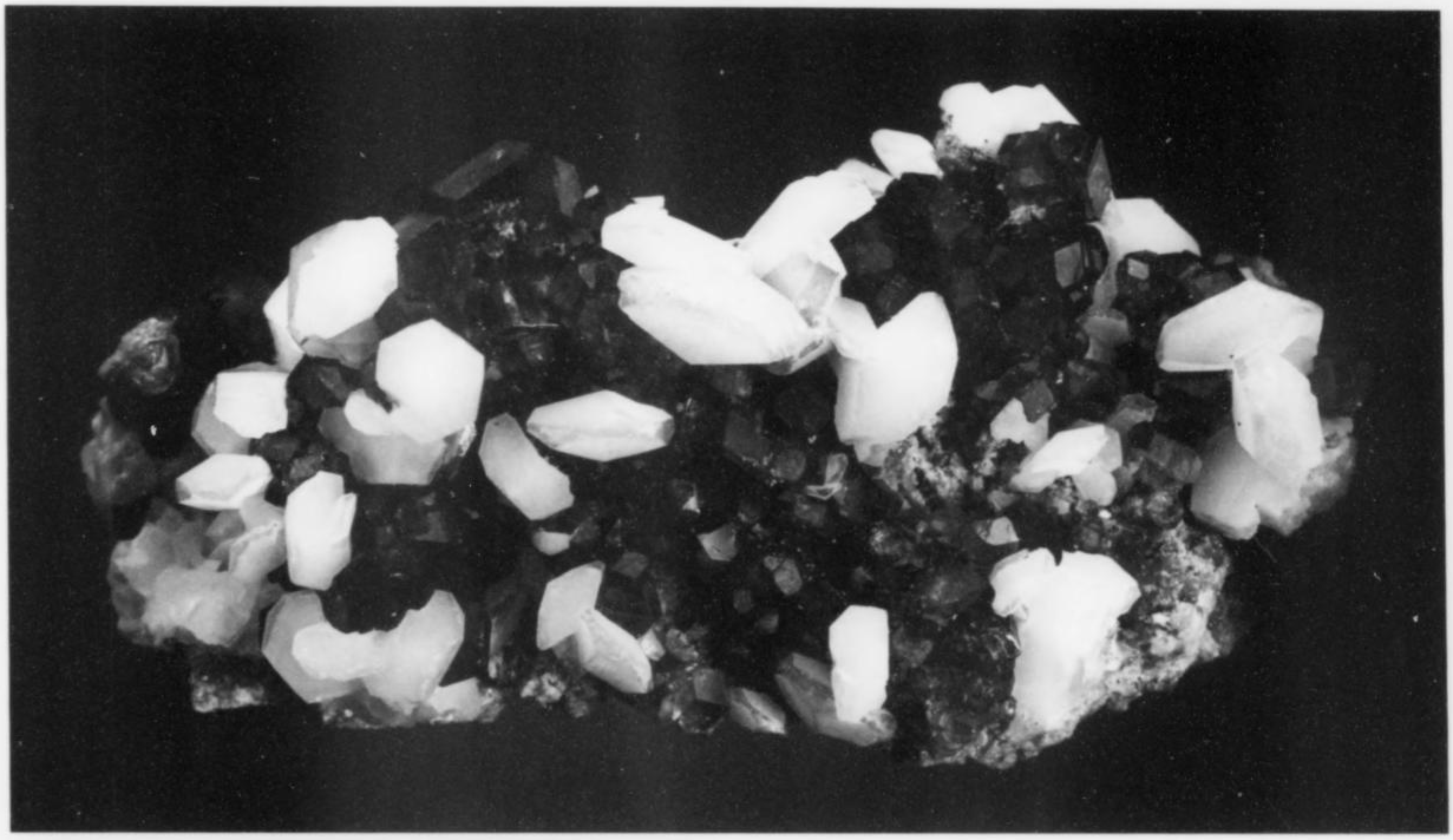
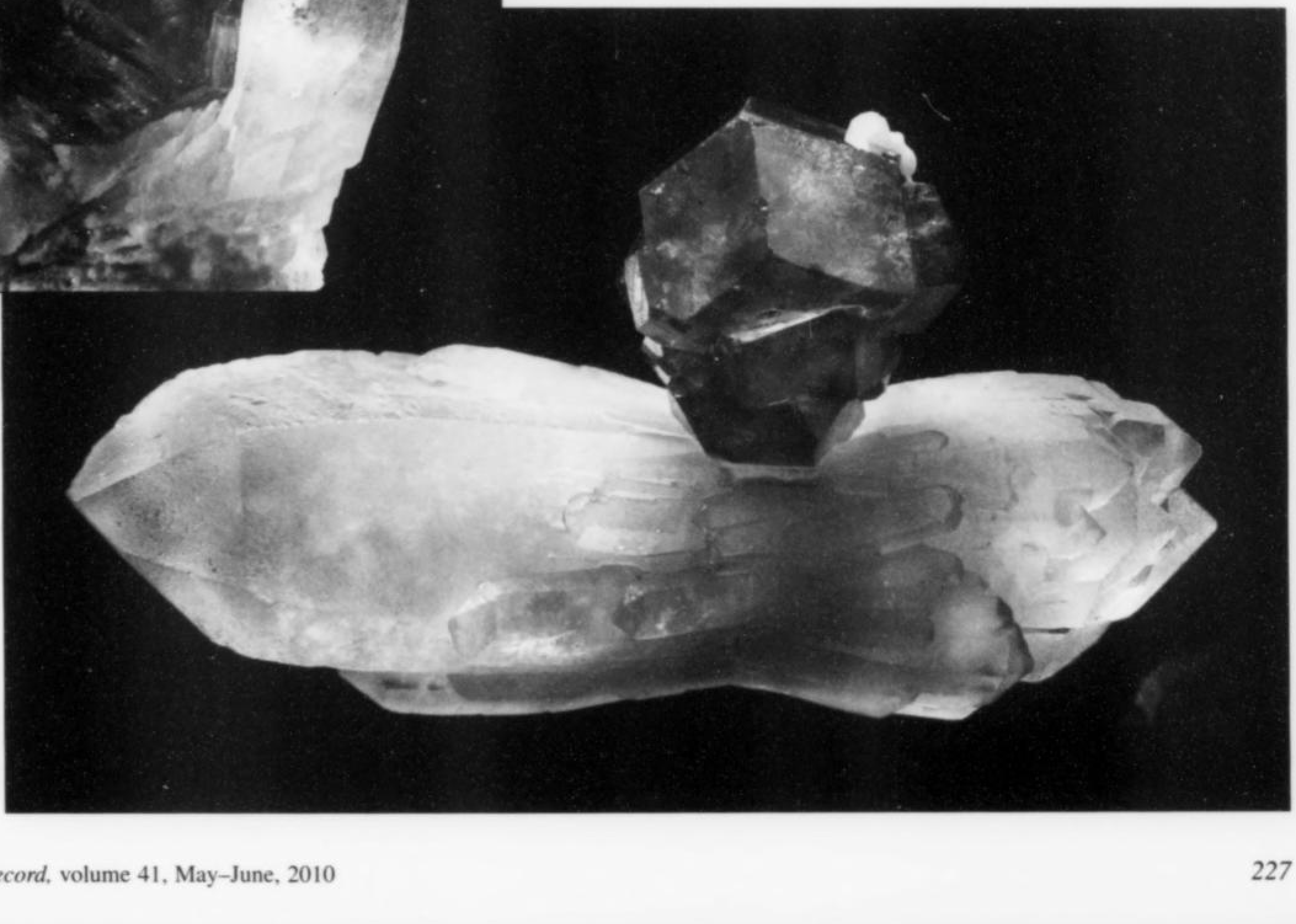


Figure 30. **Calcite crystals on demantoid crystals, 9.3 cm, from Antetezambato. Marcus Budil specimen; Jeff Scovil photo.**

Figure 31. **Demantoid with quartz crystal, 2.2 cm across, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**

Figure 32. **Demantoid crystal on doubly terminated amethyst crystal, 2.8 cm across, from Antetezambato. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**



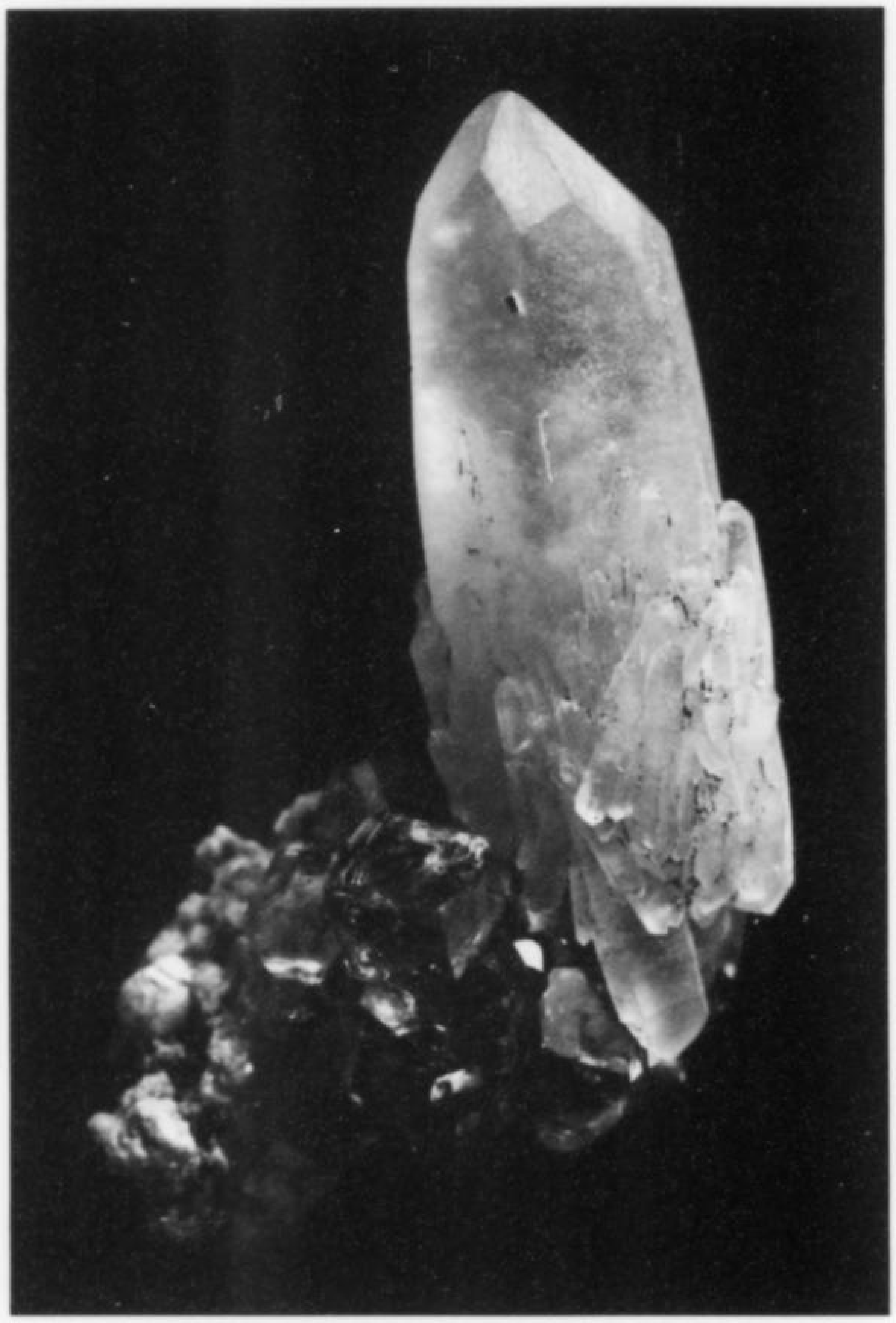


Figure 33. **Amethyst crystal on demantoid crystals, 3.7 cm, from Antetezambato. The termination of the amethyst crystal shows signs of having been ground down (re-terminated). Spirifer specimen; Jeff Scovil photo.**

Stilbite-Ca $NaCa_4[Al_9Si_{27}O_{72}]\cdot 28H_2O$

Stilbite-Ca is occasionally present as isolated crystals or as crystal druses up to 5 mm in length encrusting demantoid and topazolite. This association can produce rather aesthetic specimens.

Pyrite FeS_2

Pyrite is present inside the sedimentary rock as aggregates and swarms of cubic crystals up to a few millimeters across. Pyrite and its alteration product (goethite) are occasionally found encrusting crystals of andradite in cavities.

Wollastonite (?) $CaSiO_3$

Sprays of whitish needles and fibers visible as inclusions in gem crystals of demantoid and topazolite are probably wollastonite. But preliminary microprobe analyses and micro-Raman spectroscopy on polished sections have been unable to confirm the presence of wollastonite, though quartz was identified. It is possible that the original fibrous mineral has been replaced by quartz via hydrothermal alteration.

FAKES

Sometimes the natives glue garnet crystals onto suitable matrix that may already be carrying crystals of low quality. The specimens can be difficult to recognize, as the natives have developed some sophisticated techniques using different types of glue and cement mixed with dust collected from the pockets. Such fakes circulate both in the area of the mine and in the capital city, and are offered mainly to inexperienced tourists.

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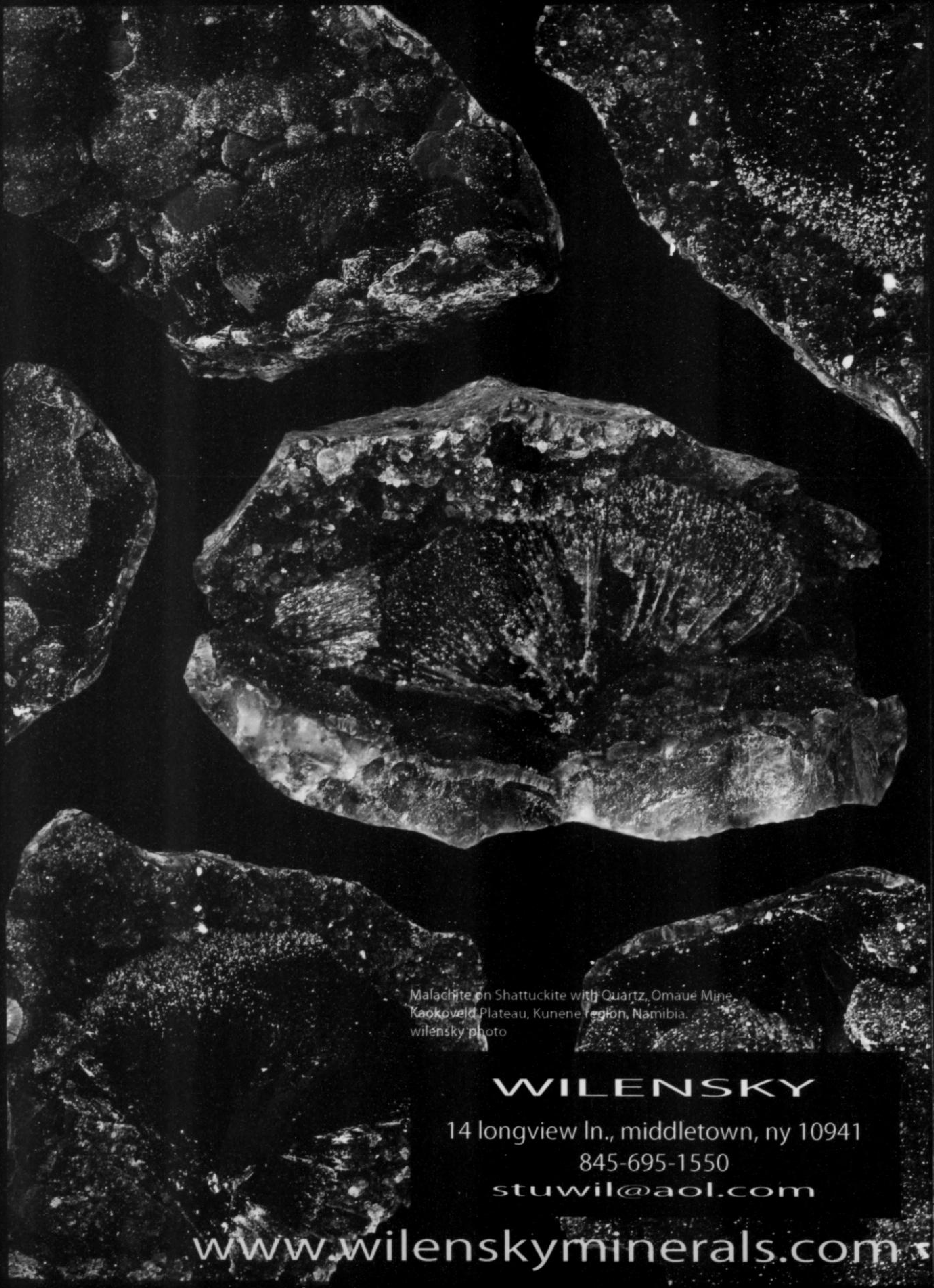

Malachite on Shattuckite with Quartz, Omaue Mine,
Kaokoveld Plateau, Kunene region, Namibia.
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Visiting Antetezambato North Madagascar

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Visiting the site of Madagascar's new demantoid locality near the village of Antetezambato is a memorable adventure. The authors' 2009 visit came at the height of specimen production.

During our most recent expedition to Madagascar in the summer of 2009 we decided to visit, among many other localities of geological interest, the new locality for demantoid: Antetezambato. This village lies in northern Madagascar, on the western coast, not far from the town of Ambanja.

We set out directly for Antetezambato from Nosy Komba, a paradisaical island overgrown by cocoa palms and surrounded by bright blue ocean and coral reefs. As we do every year, we had enjoyed a few quiet days there between strenuous, weeks-long stretches of field work. On a sunny August morning, in a motor boat belonging to our friend Laurent, we embarked from this beautiful island and headed for Antetezambato. We made very fast progress, slicing efficiently through the blue water, although at one point we had to stop for some dolphins which leaped from the sea very near our boat. After about an hour and a half we were approaching the coast of mainland Madagascar at a point near a small peninsula wherein lies the village of Antetezambato, a few kilometers from the seacoast. Nevertheless one still reaches the village by boat—that is, by way of a contorted watercourse through a mangrove forest, along a channel or (as the case may be) across a shallow mudflat during low tide. Our peculiar journey along this watercourse consumed the next 40 minutes. Finally we came to a bridge that spanned a canal. On the bridge was the name of the village where we were headed: Antetezambato ("place of the bridge on the rocks" in the Malagasy language).

Like the Wild West

Our friend Laurent's wife is from this village, and from her we learned that the formerly tiny settlement of a few huts had very suddenly become the center of a crazy world of gem-seeking. Although we'd known what awaited us, coming onto the reality was a shock. Despite the many years we had already spent in Madagascar we had never seen such a phenomenon as the "new" Antetezambato.

No sooner had we left the boat and entered the main street than we were completely convinced that no trace remained of the formerly peaceful little village. The street itself was remarkable—wide, smooth, and easy even for cars lacking four-wheel drive to negotiate (such a street is a real rarity in Madagascar). On both sides of the bridge and almost to the horizon there were wide tracts filled with rudimentary huts made of palm leaves. On both sides of the street, life flourished: dozens of stands, booths, shops, bars, and great numbers of people. By Madagascar standards, Antetezambato is a real city!

A few minutes after we'd left the boat we were already being besieged by a crowd of dealers. The news that we had arrived and that we wanted to see good specimens had traveled like the wind. Continually surrounded by a variety of hopeful sellers, we moved slowly in the direction of the center of town.

Intolerable heat, importunate people, and the inspection of thousands of specimens (mostly of very low quality) that the people kept pressing into our hands had wholly exhausted us after just half an

Figure 1. **Bridge after which the village of Antetezambato was named. Asia Gajowniczek photo.**

hour. We sought shelter in a little bar where we drank a cold Coke, thus giving ourselves a break from the noisy crowds outside. For a moment things were almost quiet and we had a chance to look out over Antetezambato. The short walk up to now had shown us how much this place differed from the rest of Madagascar. Because of the lack of readily available electricity, owners of generators make unbelievable profits: they have shops in which they charge mobile phones for exorbitant fees. Prepaid telephone cards worth 1,000 *Ariary* (about 46¢ in the local currency) are sold for 12,000 *Ariary* ($5.50), etc.

Within a few more minutes we were encircled again by a crowd, and they stayed with us all the way to the "demantoid market." Situated along the back road leading to the diggings, this market consisted of a row of little stands where merchants bought and sold single crystals, mostly intended as cutting material. There were a few collector pieces, with crystals on matrix, but all of these were of low quality: low luster, poor color and much damage.

But fortunately there began to appear in the crowd (which grew more numerous by the minute) some specimens of better quality. These displayed garnet crystals to 1.5 cm with high luster and

Figure 2. **Drainage ditches, muck bunkers and pump hoses around pits in the mangrove swamp. Asia Gajowniczek photo.**

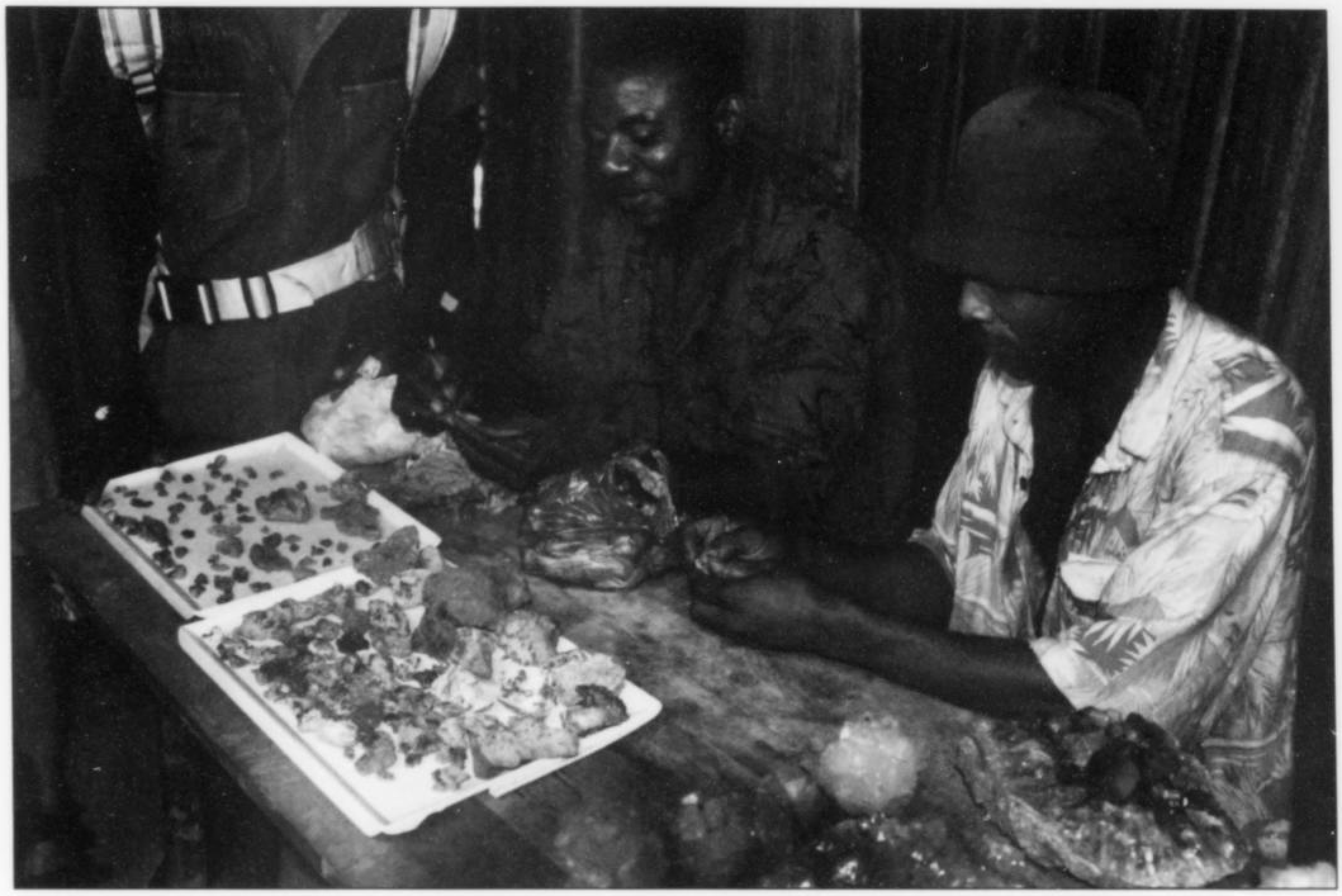

Figure 3. **Specimen dealers in Antetezambato. Asia Gajowniczek photo.**

beautiful pale green to olive-green color. Among the best specimens were also a few fakes, with fine crystals glued to matrix. Some of these fakes were so well executed that without a loupe it would have been impossible to distinguish them from real specimens. Local "producers" had used ground-up rock mixed with glue and pressed the crystals into the mixture to affix them to matrix. The fact that the original matrix material is granular, rough and porous makes production of these fake specimens that much easier—it is only under strong magnification that the matrix looks artificial (shiny and moist, because of the glue). Later, when we returned to Europe, we saw fake specimens like these, presumably purchased in good faith in Antetezambato, being offered on the mineral market. We don't mean to suggest that the European dealers themselves are dishonest—the fakes are simply so well done that they are very difficult to recognize.

Back at the market, after another hour in the midst of the increasingly pushy crowd, we decided to flee. Besides, we wanted to visit the demantoid mines themselves. Our guide took us onto a fairly wide path which led off in the direction of some nearby hills. The crowd of insistent sellers surrounding us gradually grew smaller, and after about 500 meters we were once again left in peace: what a relief!

The miners' path

The path we were now following was even more crowded with people than the main street of Antetezambato. Dozens of gemstone diggers carrying hammers, crowbars, pump parts, and even huge generators passed us en route. Some of these people offered us freshly mined specimens, of which very few were of good quality. From the fact that the miners were carrying heavy equipment we inferred that we we were still far from our destination—but we were wrong.

The path took us to the top of a nearby hill, but its end was nowhere in sight. It was about mid-day, and the temperature had reached an unbearable level. In the truest sense of the term, we were bathed in sweat. Our respect for the miners who carried huge generators increased—they looked as if they were out on a pleasant walk with friends. Finally the path led downwards, towards a basin where the first diggings came into view. By the time we reached our goal the heat and exertion had left us totally drained, although we had come only 2.5 kilometers. After a brief rest we began to investigate the area.

Mining amidst the mangroves

The area of the diggings looked like the proverbial moonscape: thousands of pits overflowing with turbid water and mud; the stumps of fallen mangrove trees; old, abandoned diggings filled with foul water; and a huge number of men who were living in these conditions. Although in our travels around the world we had seen hundreds of mining areas, we had never even dreamed of scenes like this. If I had to summarize all my impressions of this place in a single phrase I would choose "chaos amid foul slime."

For the most part the pits are located on a tidal plain which was once occupied solely by mangrove trees. Such areas are usually very swampy, and they flood regularly during high tides. The land in which most of the pits have been dug is saturated with sea water during a normal high tide, and is wholly flooded when the tide is exceptionally high. Some of the miners told us that after a very high tide they usually find salt water fish in their pits. The whole system of mining is regulated by the tidal cycles. The miners leave their pits during high tide, and it is only when the tide ebbs that they can begin to dewater the pits. The better financed teams use generator-powered pumps for this purpose; the poorer ones take out the water in buckets and sacks. The water is channeled into a system of canals which ends at the sea. The layout is such that the men can empty their own pits without flooding others. But the time that passes between tidal influxes is so short (just a few hours) that after the pits are pumped out very little time remains in which to actually dig for gems.

The mineralized horizon lies at a depth between 6 and 15 meters; usually the pits are between 10 and 15 meters deep. For a three to

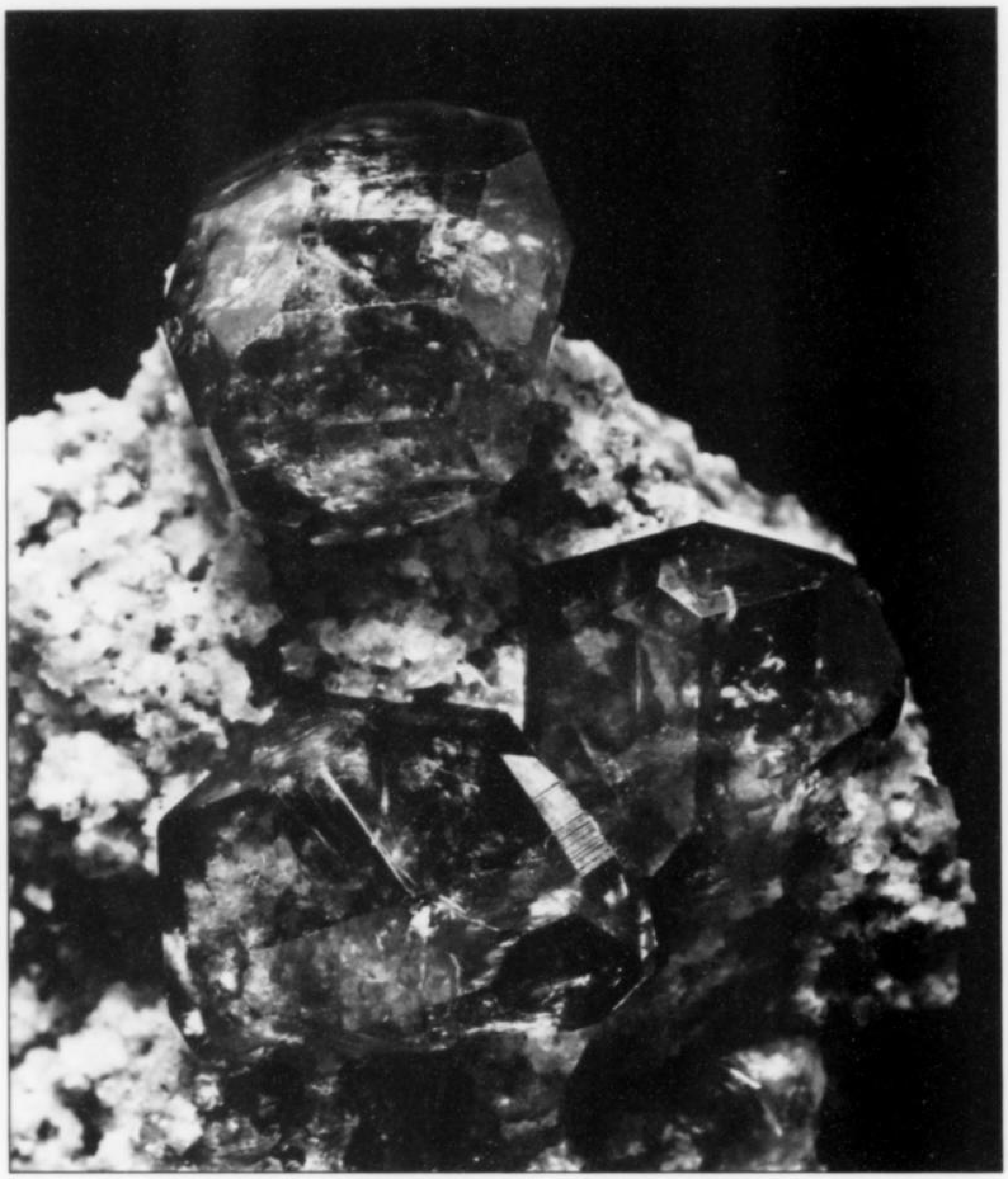

Figure 4. **Gemmy demantoid crystals on white matrix, from Antetezambato. The portion shown is 3.5 cm tall. Spirifer specimen; Jeff Scovil photo.**

five-person team to dig a pit that deep under these difficult conditions takes between two and three months!

Exploitation of the small portion of the garnet-bearing horizon at the bottom of the pit, once it has been reached, normally takes only one to three days. Then the miners abandon their hard-won pit and begin to dig a new one. Unfortunately, the garnet-bearing horizon often contains only poor-quality garnets, or may contain none at all. Truly first-class demantoid finds are rare, but they are the "paydays" after months of hard work under extreme conditions.

During our stay we came to look with great respect on the hundreds of gemstone diggers who work with smiles, and with great energy, in the face of very hostile conditions. With pride they explained to us how they deal with the problems of tides and flooding in their diggings, and with the challenges posed by occasional hard, tough rocks. Our visit to the mine site lasted just a few hours, but it radically changed our attitudes concerning prices of specimens from Antetezambato. We think unanimously that if we ourselves had to work under such conditions we would never sell our hard-won specimens so cheaply.

Since our visit to the workings, we have thought more and more how remarkable it really is that such tiny crystals were found in the midst of a muddy mangrove thicket at all.

From hell back to paradise

We spent a few more hours in the mining area but, having a long way to go, we decided at about 4:00 P.M. to begin heading back to the town. And again we were accompanied by dozens of gem diggers, all carrying pumps, generators and other pieces of heavy equipment. When we reached the main street, a crowd of sellers again surrounded us in a flash. We bought a few of their specimens—not bargaining very hard for them this time. Finally we reached the harbor where our motorboat awaited us. After such an eventful, adventurous day we allowed ourselves a slow return trip through the labyrinth of canals in the mangrove swamp.

When we came out onto the open sea it grew increasingly gusty. High waves tossed our boat back and forth, retarding our progress. Every time our bow sliced through a wave a large quantity of water entered the boat. After just a few minutes on the open water we were wholly soaked and frozen. Finally, after more than two hours—by which time it was totally dark—we reached Nosy Komba and our comfortable hotel. After quick showers to wash the salt from our skins, we concluded this exciting day with a dinner of grilled crabs, crayfish, shrimp and fish.

When we awoke the next day and gazed dreamily from the windows over the cocoa palms and blue water, the "Antetezambato world" seemed very far away. But we knew that just 15 kilometers from us, another day of the demantoid miners' struggle with the powers of nature was beginning. Even though good specimens from the place could be obtained more easily from mineral dealers in the capital city, we made up our minds to return very soon to Antetezambato.

Acknowledgment

Our sincere thanks to *Mineralien-Welt* editor Rainer Bode for permission to translate and reprint this article from his January–February 2010 issue. The translation is by Tom Moore.

Calcite and Zeolites

from

Sambava, Madagascar

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Spectacular specimens of morphologically complex, multiply twinned, deep yellow gemmy calcite from basalt cavities in the Sambava area of Madagascar appeared on the mineral market in 2004. The locality now appears to be exhausted.

INTRODUCTION

Madagascar is a rich source of many different and highly collectible mineral species, especially those found in pegmatites. Significant mineral occurrences in the country's non-igneous and non-metamorphic rocks are uncommon, although beautiful celestine specimens come from sedimentary rocks (marls) near Majunga, and well-crystallized zeolites such as gmelinite, analcime and chabazite were found in volcanic rocks at some historical localities (Lacroix, 1922–23; Behier, 1960). Jasper and agates are also found in some volcanic rocks.

A basalt quarry near the town of Sambava is the site of Madagascar's first known occurrence of calcite, stilbite, laumontite and heulandite in fine specimens. The calcites from Sambava deserve special attention because they display very complex and beautiful multiple twins. Although the quarry has provided a relatively small number of specimens, and is now exhausted, it has become a "classic" in the minds of calcite collectors.

LOCATION

The quarry lies 2.5 km west of a large village called Ambariomiambana on the coast of the Indian Ocean in northeastern Madagascar, 8 km east of Sambava (one of the larger towns in the area). The terrain to the west is mountainous and is covered by jungle and, to a lesser extent, by rain forest. This region is famous for its huge vanilla crops. The quarry site is several dozen meters south of the right bank of the Sambava River, on the northern slope of a small hill near the main asphalt road between Sambava and Andapa; its GPS co-ordinates are 14°16'34" S, 50°03'57" E. The Malagasy residents find the site quite easily accessible: a paved road which leads from the asphalt road to the quarry is used by trucks which haul out the basalt gravel which is the quarry's main commercial product.

Work in the quarry is completely unmechanized. The workers use long, very heavy crowbars to separate blocks of basalt from the quarry walls; then, on the floor of the quarry, they use large hammers to break the blocks into large pieces. Women and children then break the pieces down into a prescribed size. Every day or two a large truck arrives to collect the output.

The quarry is owned by a commune (in Malagasy, a *fokotany*). People work there on their own and pay a small tax to benefit the community. With the aim of increasing their effectiveness, the workers are divided into groups, usually consisting of family members

Figure 1. **Simplified map of Madagascar, showing the most important cities and occurrences of Cretaceous-Paleogenian-Neogenian volcanic rocks (based on Besairie, 1964, modified and simplified).**

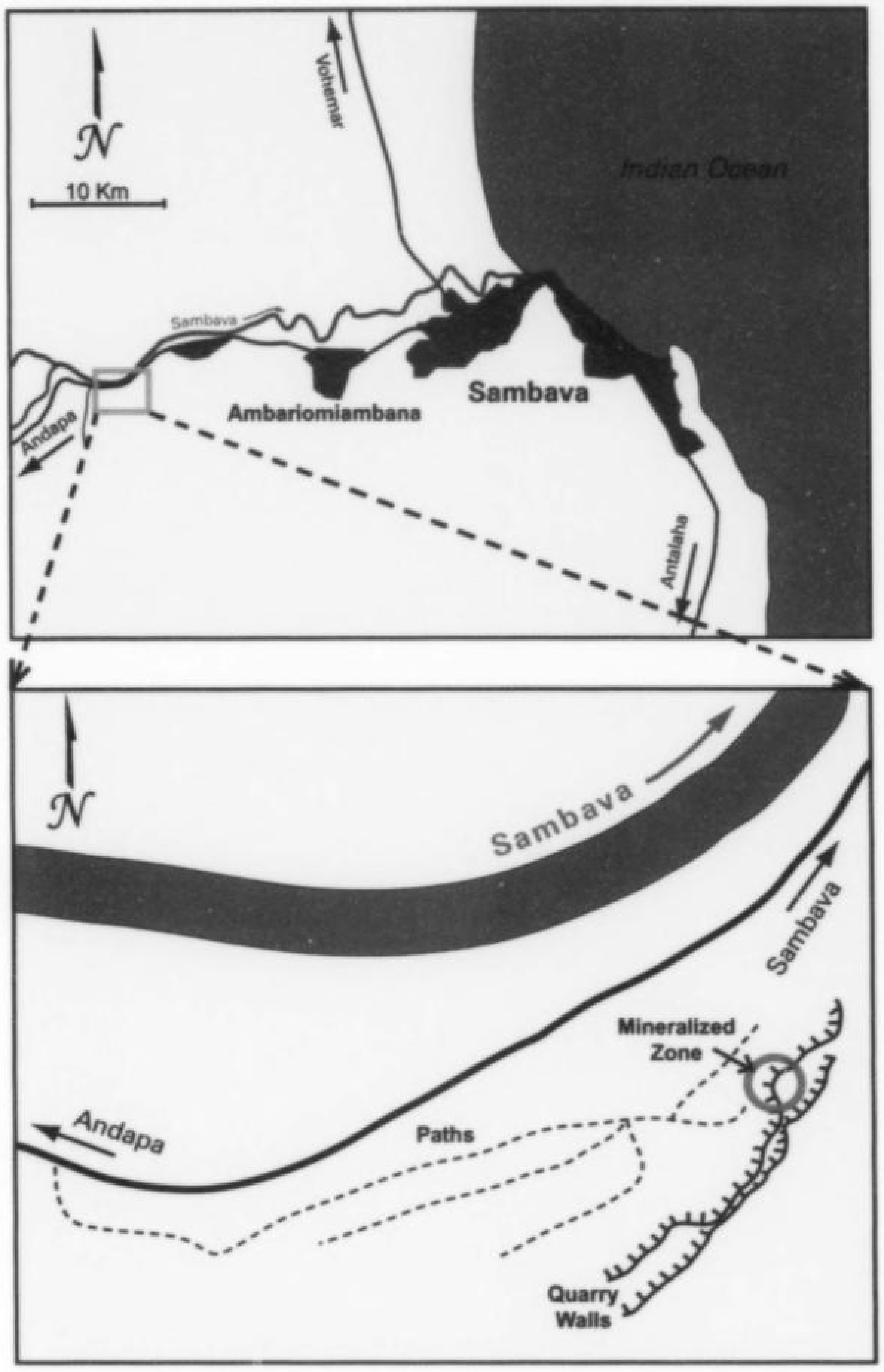


Figure 2. (top) **Part of the Sambava region, showing the location of the quarry.** ***(below)*** **Plan of the quarry showing the mineralized zone where the calcite specimens were found.**

and friends. Familial and social life goes on at the quarry: the women take care of small children and older children play together. Vendors sell food and cold drinks at the worksite.

HISTORY

Since 1999 the Spirifer Geological Society of Poland has been carrying on a geological research project in Madagascar. This project includes mineralogical as well as stratigraphical and paleontological studies. In 2000, during Research Expedition II, a Cretaceous volcanic province in the Sambava area was examined, and in the course of the work the members of the Expedition (Małgorzata Bieńkowska, Krzysztof Dembicz and Tomasz Praszkier) discovered the calcite locality described here: a quarry in basaltic rocks that had not previously been described in the literature. The quarry, which yields basaltic gravel for road construction, is quite large compared to other, similar quarries in Madagascar.

On examining the main wall of the quarry, geologist Krzysztof Dembicz of Spirifer discovered some small pockets containing quartz and apophyllite. Shortly thereafter, the group found a large zone rich in minerals including laumontite, stilbite, quartz, heulandite and (the most spectacular of them all) calcite. The zone is located in a corner on the first bench in a disused part of the quarry. It was exposed in two places: the upper part of the eastern wall of the corner (Site I) and the bottom part of the southern wall of the corner (Site II). Site II was much more easily accessible, but the most important and productive investigations took place at Site I, where the mineralization is more interesting. Because the Spirifer group had allocated very limited time to the Sambava area during the 2000 expedition, our team worked in the quarry for only two days. Nevertheless, we collected more than 100 specimens, including some of very good quality. The quarry workers reported that we were the first group of "white men" ever to visit the quarry, and that no one ever before had shown up to look for minerals or to conduct research.

Geologists from the Spirifer Society returned to the Sambava area in 2002 to conduct further research. During this visit we devoted almost all of our attention to Site I, collecting a few hundred specimens in a few days, including a number of calcites and heulandites of the best quality. We also created a video documentary of our activities.

In 2004, calcites from the Sambava region were displayed to the public for the first time at the Ste.-Marie-aux-Mines Show in France. A few specimens were photographed by Louis-Dominique Bayle, and these photos were published with a report on the show (Bayle *et al.*, 2004).

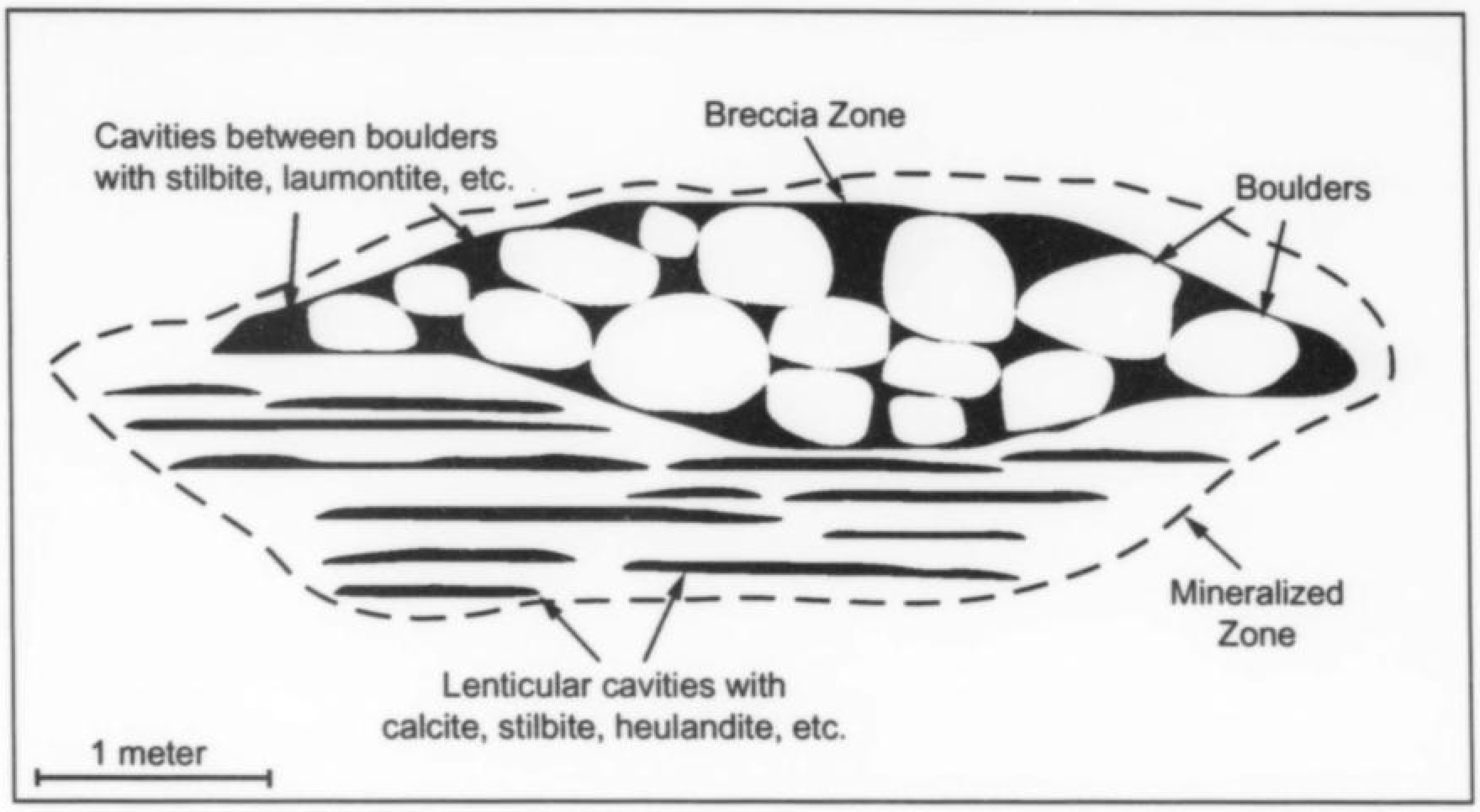


Figure 3. **Sketch of Site I showing the two-part mineralized zone: the upper part with breccia and boulders, and the lower part with lenticular pockets.**

Publication of those photos aroused the interest of Polychrome France, a commercial firm which mines and sells collector-quality mineral specimens in Madagascar. The owners of Polychrome France promptly leased a part of the quarry, calling it the "Calcite Twins mine." Polychrome France moved so quickly that at the Munich show of 2004 (a few months after the publication), the company was able to offer their first lot of Sambava calcites for sale.

The next published references to calcite specimens and other minerals from Sambava appeared in show reports in the *Mineralogical Record* (Larson, 2005; Moore, 2005) and *Le Règne Minéral* (Bayle and Goujou, 2004). The most recent discussion of the occurrence appeared in a note about Polychrome France in the Madagascar special issue of *Le Règne Minéral* (Thomas, 2008).

During the period of intensive work by Polychrome France the accessible part of Site I was almost completely exhausted of mineralization. Future specimen recovery there will require a serious mining project, with the aid of explosives. A recent examination of Site II was not encouraging (Laurent Thomas, personal communication). Therefore it may be assumed, at least for the present, that the superb calcites of the quarry have been completely mined out. The formerly productive sites are now abandoned.

GEOLOGY

The northeastern part of Madagascar is formed chiefly of Precambrian rocks, with various extrusive igneous rock types overlying them locally. In the area between Vohemar and Andapa, extrusive rocks form a long, thin belt parallel to the oceanic coast (see Figure 1). Within this belt in the Sambava area, Upper Cretaceous tholeiitic basalt and rhyolite are dominant. Detailed geochemical analysis has shown that the basalts from the Sambava region are of the mid-ocean ridge type (Torsvik *et al.*, 1998; Tamart, 2006).

The extrusive rocks of the Sambava-Vohemar area are products of volcanic activity related to the Marion Hotspot, which, it is believed, was very active in the Upper Cretaceous (Meert and Tamrat, 2006; Torsvik *et al.*, 1998). The high activity of the Marion Hotspot, as well as of the Crozet and Kerguelen Hotspots (on the same line as the Marion), was a byproduct of mantle convection and of the resultant tectonic movements which were responsible for the separation of India from Madagascar following the breakup of the Gondwana supercontinent.

It is worth mentioning that, according to the geophysical data, extrusive rocks forming the Deccan Plateau of India (famous for zeolites and associated minerals) are related to another hotspot active in the same region (but genetically younger at ~67 million years)—the Reunion Hotspot. The Indian craton was moving above this hotspot during the late Cretaceous and early Paleocene. Generally, the hotspot-related lava extrusions of this time are characterized as "flood basalts"; the magmas in question are of very low viscosity, and they spread rapidly, covering large areas, when they reached the surface.

Two conformable lava flows with highly visible thermal jointing are distinguishable in the quarry. Contacts of the basaltic rocks with the country rocks are not exposed.

POCKETS AND PARAGENESIS

The main mineralized zone

The main mineralized zone was located on the quarry's lower level, in the northeastern part of the pit. At the times when we visited the quarry this area was not being worked. The zone was exposed in two places (see "History," above) which lay a few dozen meters apart. It is likely that Site I and Site II represent two parts of a single pipe-shaped structure, but our investigations focused almost entirely on the more interesting mineralization at Site I.

Since Site I lies 6 to 7 meters above the quarry floor, gaining access to it proved difficult. The mineralized zone, 6 meters wide and 2 to 2.5 meters high in its central part, consists of a system of huge, partially interconnected cavities in two distinct sections. In the upper section, reaching about 1.5 meters in thickness, the rock is brecciated, with rounded basalt fragments to 50 cm across. The cavities in this section range in size from a few centimeters to about a meter; the cavity walls were covered with crystals of quartz and zeolites. Calcite crystals were seen very rarely. However, the best specimens of stilbite were collected in this upper section of Site I, as well as laumontite in richly pink, radial crystal clusters. In most cases the stilbite and laumontite crystals rested on chlorite-included quartz, or directly on the cavity walls. Heulandite was not found in this part of the mineralized zone.

The lower section of the mineralized zone at Site 1, characterized by abundant lenticular cavities in parallel alignment, turned out to be much more productive of high-quality specimens. The majority of the cavities were between 10 and 20 cm high, and some were more than a meter wide. The quarry's best specimens of calcite and heulandite were found in these cavities. In most cases the calcite crystals had grown from the cavity ceiling while stilbite and heulandite crystals had grown on the floor. Unfortunately, most of the larger calcite crystals had run out of space and were found attached at both ends to the cavity walls. Most of the calcite crystals were located in the outermost parts of the cavities and were heavily corroded, with rough crystal faces and dull luster. Good-quality heulandite, much rarer than good-quality calcite, was collected from just a few of the cavities.

Extracting fine specimens with calcite crystals on matrix proved very difficult, since heavy hammers and crowbars had to be used to break the extremely hard rock. The majority of the calcite crystals, some covered by thin quartz layers, were jarred loose from the matrix rock in the course of collecting; these crystals were later gathered by hand from the floors of the cavities.

Site II was characterized by much poorer mineralization and by an almost complete lack of voids—the cavities were entirely filled with massive calcite and other minerals. The mineral assemblage was very similar to that of Site I, except that heulandite was not found. No specimens of fine quality were collected at Site II, either by the Spirifer group or later by Polychrome France (Laurent Thomas, personal communication).

Although the mineral assemblage in the quarry is typical for volcanic environments, the origin of the tube-shaped mineralized zone partially filled with breccia in the upper section is still unexplained. It may be speculated that the tube-shaped zone represents the remains of a lava tunnel where lava still flowed (like a "lava river") after the surrounding lava had hardened. This phenomenon is a well-known feature in many volcanic areas.

Other parts of the quarry

In the lower lava flow as exposed in other parts of the quarry, small cavities appeared quite often. In most cases these cavities are not more than 10 cm in diameter, and their mineralization is much poorer and less interesting to mineralogists and collectors than that in the main mineralized zone. Typically these small cavities are lined by drusy quartz with individual quartz crystals reaching 1 cm; otherwise, only small crystals of calcite and apophyllite occur uncommonly. Interestingly, apophyllite was not observed in the main mineralized zone.

MINERALS

Apophyllite-(KF) $KCa_4Si_8O_{20}(F,OH)\cdot 8H_2O$

Apophyllite-(KF) was found only in small cavities in the main quarry wall, outside the main mineralized zone. It forms thick, tabular, colorless to pinkish, partially transparent crystals, most of them highly lustrous, rarely exceeding 3 cm. Most of the apophyllite-(KF) crystals were attached to the cavity walls at both ends; consequently, good specimens with complete, individualized, well-formed crystals were not found. The dominant crystallographic form is the pinacoid {001} with much smaller {110} faces.

Calcite $CaCO_3$

Calcite occurs in the main mineralized zone (Sites I and II), as well as in small cavities in other parts of the quarry. Since the appearance of calcite crystals varies from place to place, the detailed descriptions below are grouped by collecting sites.

Main Mineralized Zone, Site I

As mentioned above, it is only at Site I that high-quality mineral specimens have been collected. Calcite is one of the most common

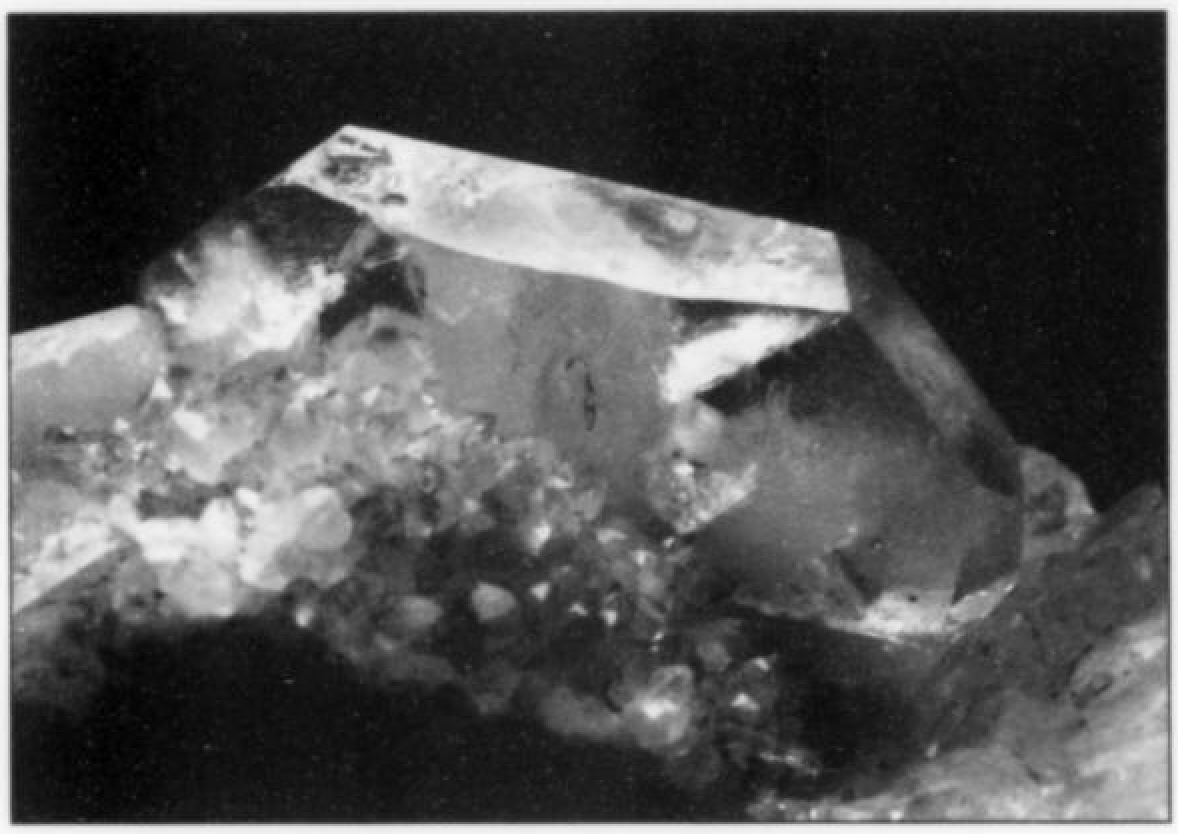


Figure 4. **Apophyllite-(KF) crystal, 2.8 cm, on drusy quartz from the Sambava quarry. Spirifer collection; G. Bijak photo.**

minerals found at this site, especially in its lower section, in the parallel, lenticular cavities under the breccia. Calcite specimens—ranging from small crystal groups to large clusters consisting of dozens of tightly intergrown groups—were collected from most of these cavities. Almost all of the calcite crystals grew downward from the upper surfaces in the cavities.

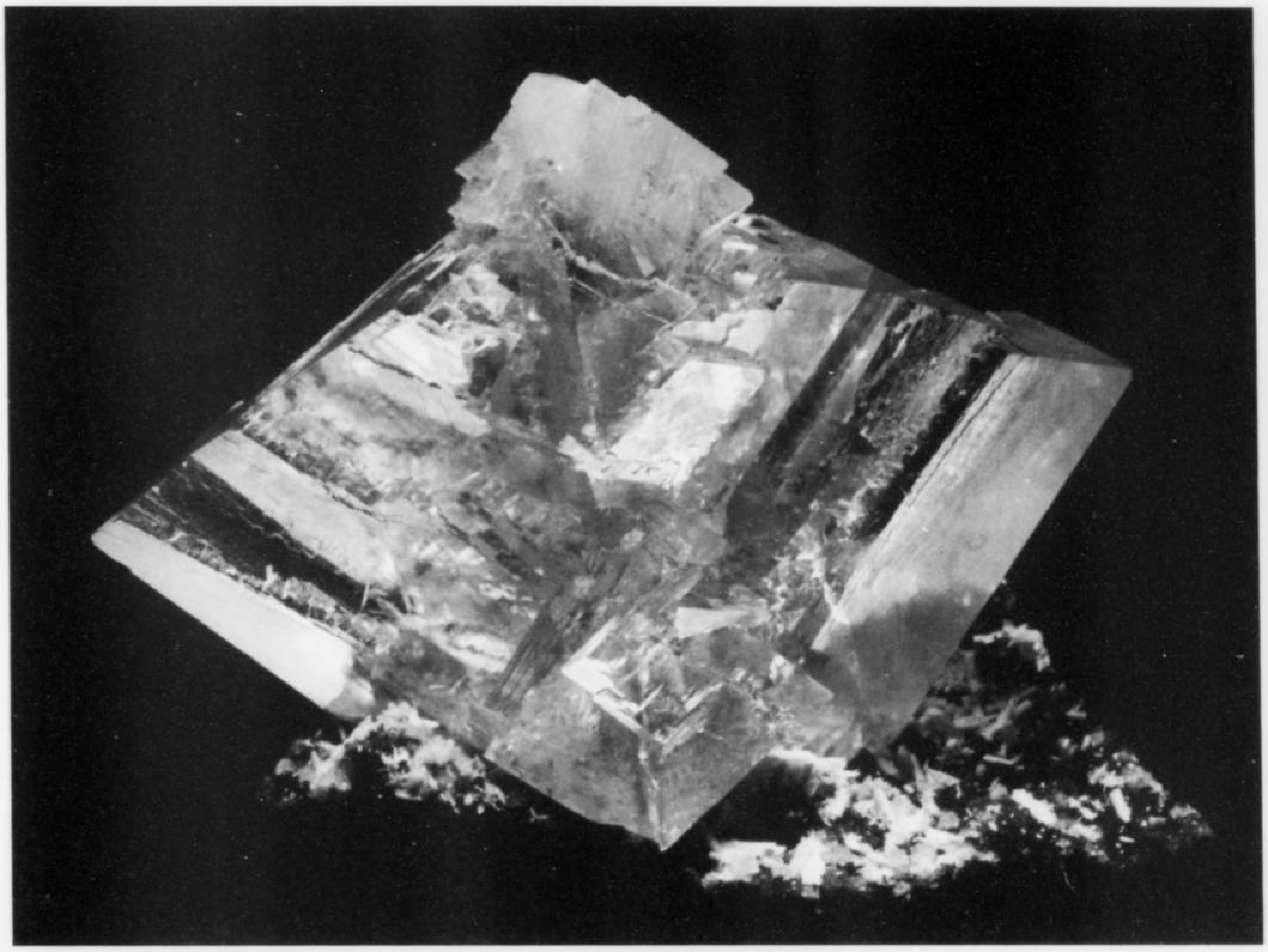
Three generations of calcite can be distinguished at Site I, with crystals differing in size, form, habit, color, degree of transparency and style of twinning. In most cases the younger calcite crystals grew on older crystals; rarely, crystals of the second or third generation grew directly on matrix.

Calcite crystals of the first generation are the most common, and reach the largest sizes. They also form the most attractive specimens, with extraordinary shapes resulting from multiple twinning and with fine color, sharpness, transparency and extremely high luster. Of course, not all of the collected specimens show every one of these features, but the majority of the unweathered calcite specimens taken from the inner parts of the cavities are of exceptionally high quality.

At first sight these calcite specimens give an impression of complex intergrowth and multiple twinning. Carefully detailed crystallographic study reveals that in every case what appears to be a "single" crystal, resembling a distorted rhombohedron, is actually an oriented intergrowth of several parallel twins having a common composition plane. The twinning of all crystals is based on a distorted positive $\{02\bar{2}1\}$ or negative $\{0\bar{2}21\}$ rhombohedron, and twinning has always occurred on (0001). The combination of several twinned crystals by parallel shifting of the individual domains perpendicular to the *c* axis results in single aggregates. Some crystals show skeletal growth. Very complex clusters can be formed by the intergrowth of single aggregates which are based on several parallel or skeletal twins. All twins in the various aggregates have the same twin plane.

This complicated combination of twinning and parallel growth of the calcite crystals results in extraordinary habits unknown from any other locality. Interestingly, untwinned calcite crystals are very rare at Site I. Those few which have been found are lusterless, elongated rhombohedrons reaching at most 1 cm; they rest directly on chlorite or quartz and are rich in mordenite inclusions.

The complex aggregates of twinned calcite crystals commonly measure between 5 and 10 cm, and exceptionally reach 20 cm. Most of the larger specimens are partially weathered, unfortunately, and have low luster; highly lustrous crystals do not exceed 10 cm. And



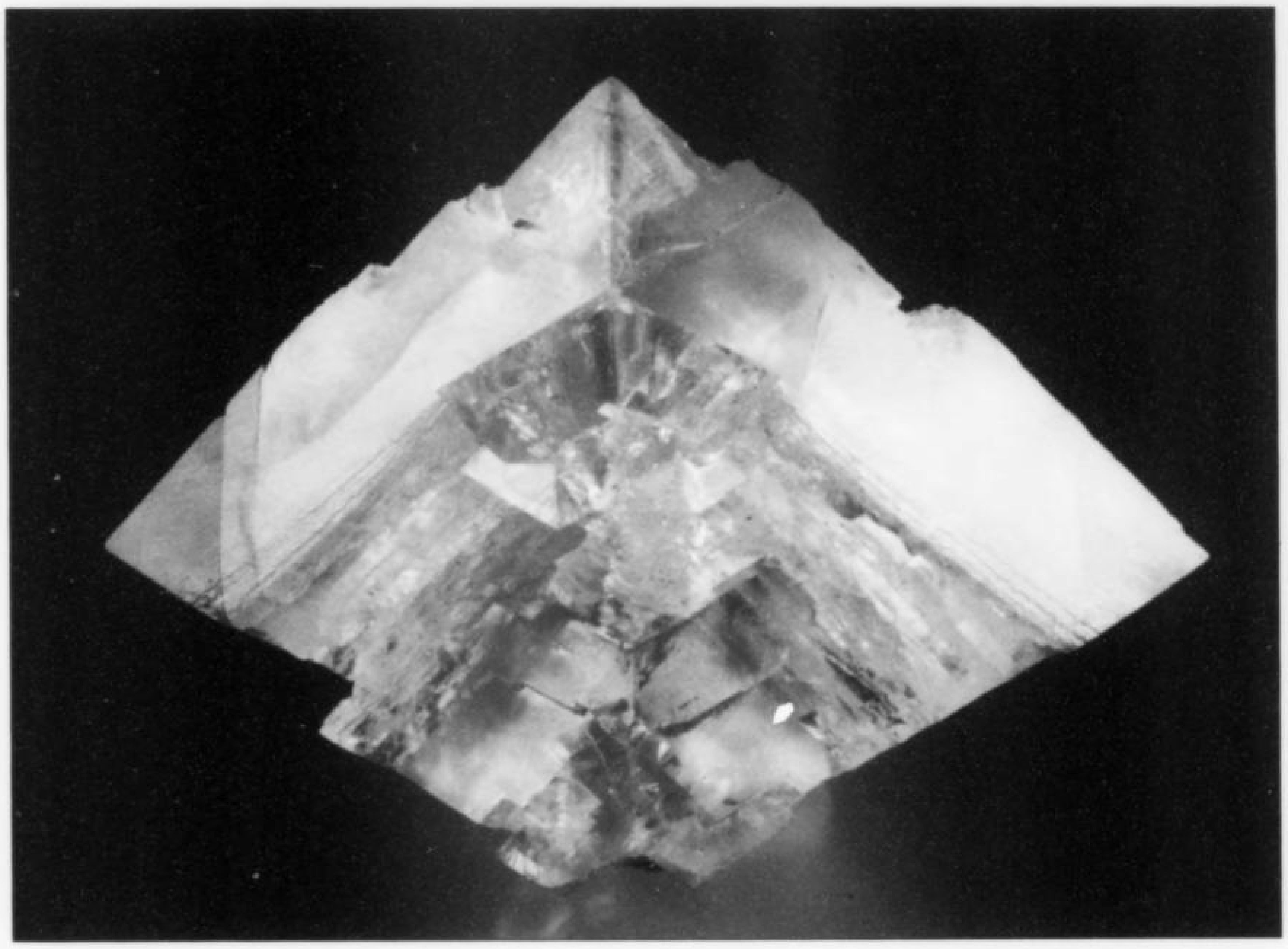


Figure 5. **Twinned calcite (generation I) on matrix, 8.9 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

Figure 6. **Twinned calcite (generation I), 11.3 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

as mentioned above, the majority of the larger crystals were found attached to the cavity walls at both ends.

In color the calcite crystals range from almost colorless through pale yellow to very intense yellow—the last are definitely the most attractive from the collector's point of view. The most intense yellow color shows best on crystals that are slightly weathered; these crystals generally do not show the highest luster. A small number of crystals show both high luster and intense color, but most of these are not completely transparent. Phantoms are not evident in any crystals, but in some cases the separate rhombohedrons in parallel alignments differ slightly in color. Most of the smaller specimens collected from the deeper parts of the cavities show a very high vitreous luster; in specimens collected from the front parts of cavities, weathering has imparted a frosty luster.

In the best of the specimens, the calcite crystals are completely transparent, such that any inclusions, as well as any underlying

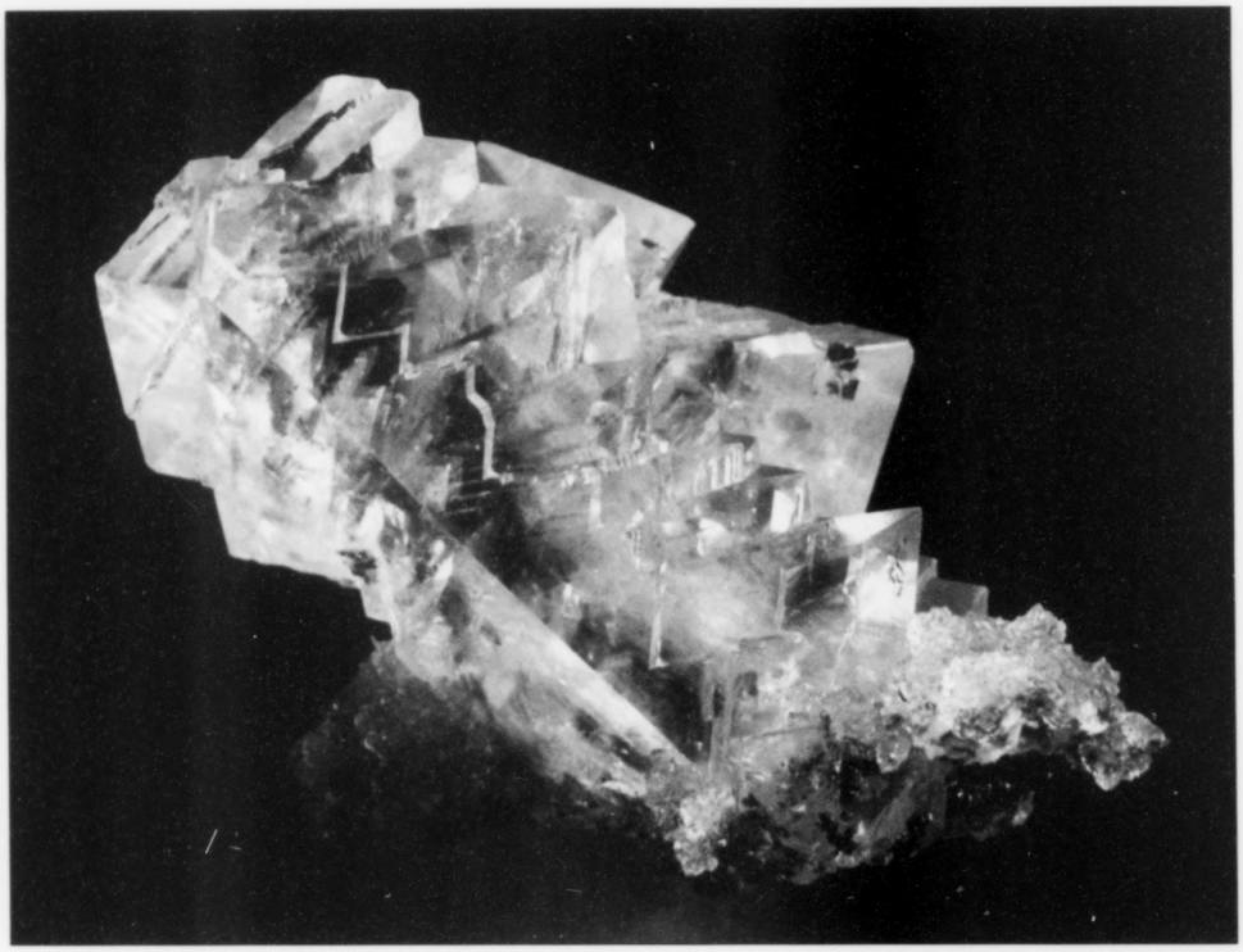


Figure 7. **Twinned calcite (generation I) on matrix with drusy quartz, 4.2 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

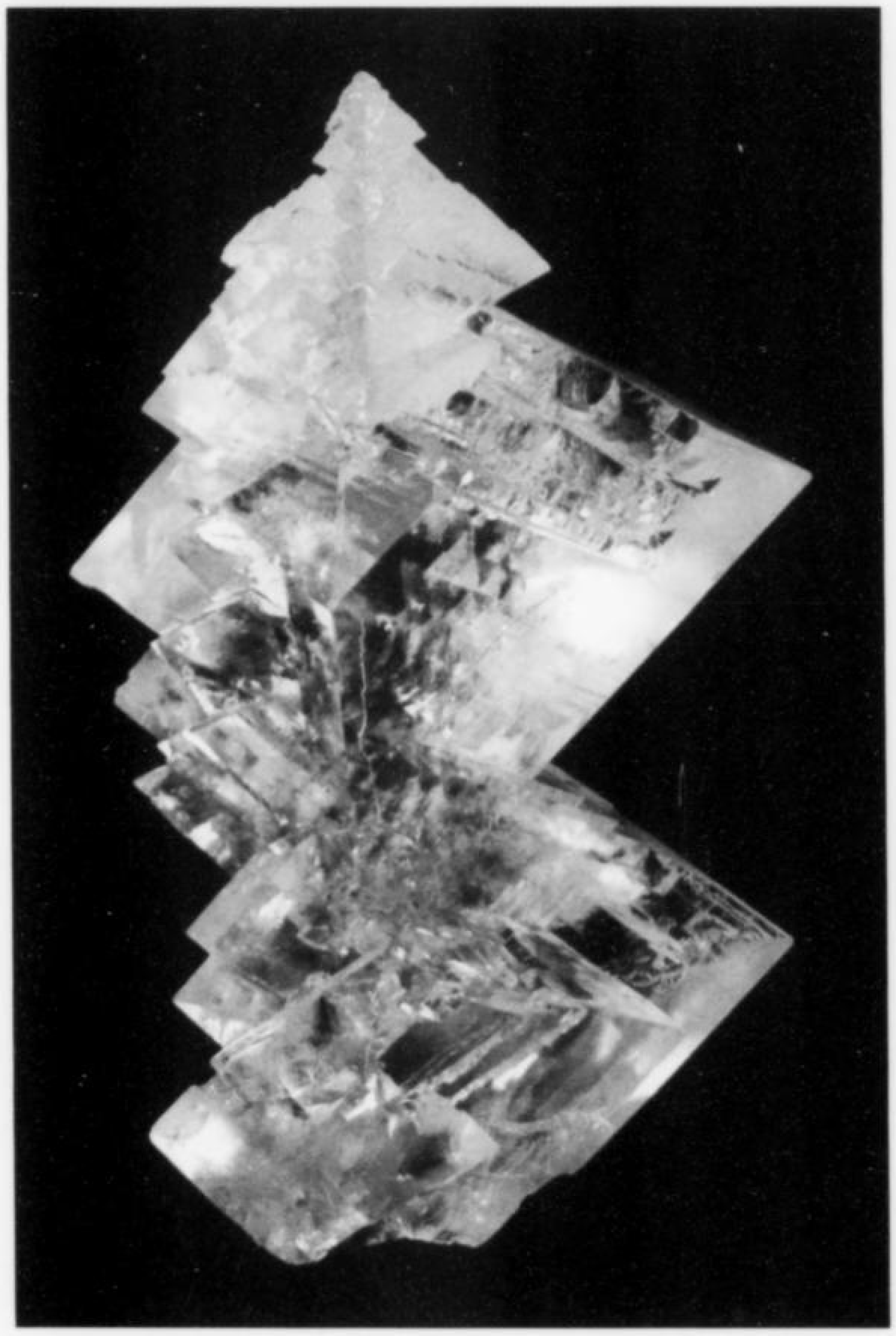


Figure 8. **Twinned calcite (generation I), 6.3 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

matrix materials, are easily visible. Because of the high birefringence of calcite, the rear faces and edges of the crystals appear doubled to an observer looking in from the front side. Unfortunately, in most cases the degree of transparency is inversely proportional to the depth of the color—the most transparent crystals are bright medium-yellow.

First-generation calcite is one of the oldest minerals in the assemblage. Its crystals grew directly on basaltic rock or chlorite, more rarely on a first generation of quartz. Fairly commonly, spheroidal clusters of mordenite crystals and/or small quartz crystal clusters appear as inclusions in the calcite crystals. Inclusions are most dense in the oldest parts of the calcite crystals, i.e. near their original points of attachment to matrix. Among the later minerals that have formed on surfaces of first-generation calcite crystals are quartz, laumontite, stilbite, heulandite and calcite of the second and third generations. Quartz commonly forms thin, sparkly, preferential coatings of microcrystals on some faces of first-generation calcite. These quartz coatings may be removed easily from the calcite faces, improving the quality of the specimens, since the underlying calcite faces still prove to be highly lustrous. Laumontite can likewise be removed very easily, especially after it has begun to dehydrate.

Second-generation calcite occurs much more rarely than first-generation calcite. They are fairly easy to distinguish, as second-generation calcite is dark yellow to yellow-orange to brownish yellow, and is never as transparent or highly lustrous as first-generation calcite. Calcite-II crystals generally range in size from 3 to 4 cm, exceptionally reaching 8 cm. The twinning of crystals of Calcite-II

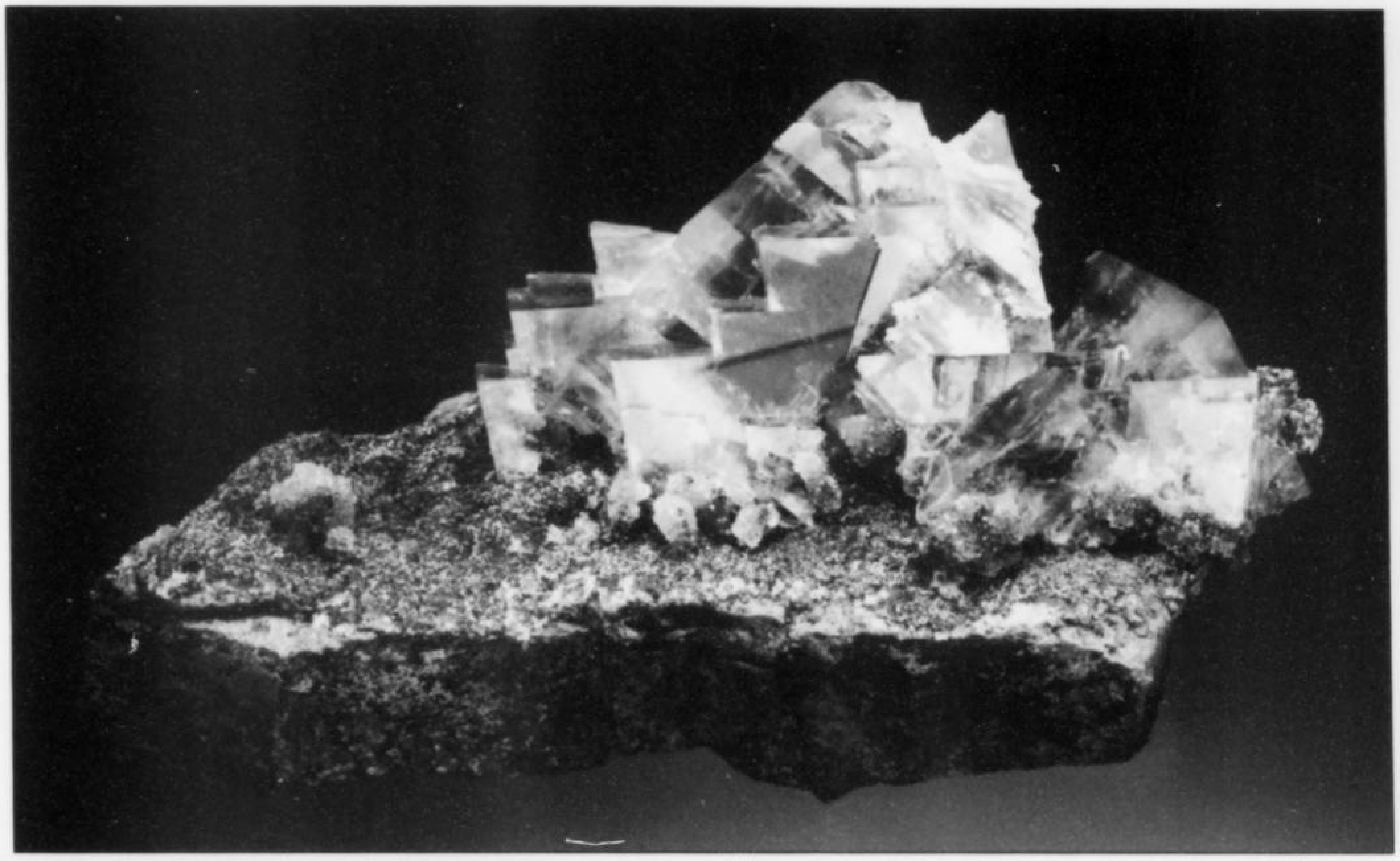


Figure 9. **Twinned calcite (generation I) on matrix with drusy quartz and chlorite, 10.2 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

Figure 10. **Twinned calcite (generation I), 4.1 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

is based on the same principles as that of Calcite-I, though the habits of intergrowth can be different.

Crystals of Calcite-II very commonly rest on faces of larger crystals of Calcite-I. In most cases they have grown epitactically on Calcite-I faces. Discoidal clusters of Calcite-II crystals rest on the edges of groups of Calcite-I crystals, with the long axes of the discoids parallel to the edges of the older groups.

Luster can also be used to distinguish between the first and second generations of calcite. Calcite-II crystals never have the high vitreous luster typical of Calcite-I; rather, almost all Calcite-II has medium to greasy luster. Similarly, the degree of transparency is never as high in Calcite-II as in Calcite-I; however, the larger rhombohedrons of Calcite-II (more than 2 cm) may be transparent.

Calcite-II crystals formed very soon after the underlying Calcite-I crystals. Other minerals typically found on crystals of Calcite-II are stilbite, laumontite and Calcite-III. No heulandite crystals have been found on Calcite-II crystals. Although Calcite-II is very interesting from a mineralogical point of view, its specimens do not compare in quality with the highly aesthetic, lustrous, transparent crystals of Calcite-I. For this reason dealers sometimes mechanically remove Calcite-II from specimens, which is easy to do. Usually, in these cases, no traces of the Calcite-II crystals remain on the faces of the older crystals.

Calcite crystals of the third generation are rarer than those of the second and first generations. They are also quite easy to distinguish from crystals of Calcite-I and Calcite-II, as they show completely different habits; they are always twinned on (0001).

All three generations of calcite from Site I display intense yellow-white fluorescence in ultraviolet light. This fluorescence, as well as the yellow color of these calcites in daylight, is caused by the presence of organic inclusions. Chromatographic analyses of hydrocarbons extracted from Calcite-I show that the dominant components of the hydrocarbons are n-alkans (fitans dominant over pristans); there are also aromatic hydrocarbons with dominant dibenzothiofene ($C_{12}H_8S$). The presence of these organic substances

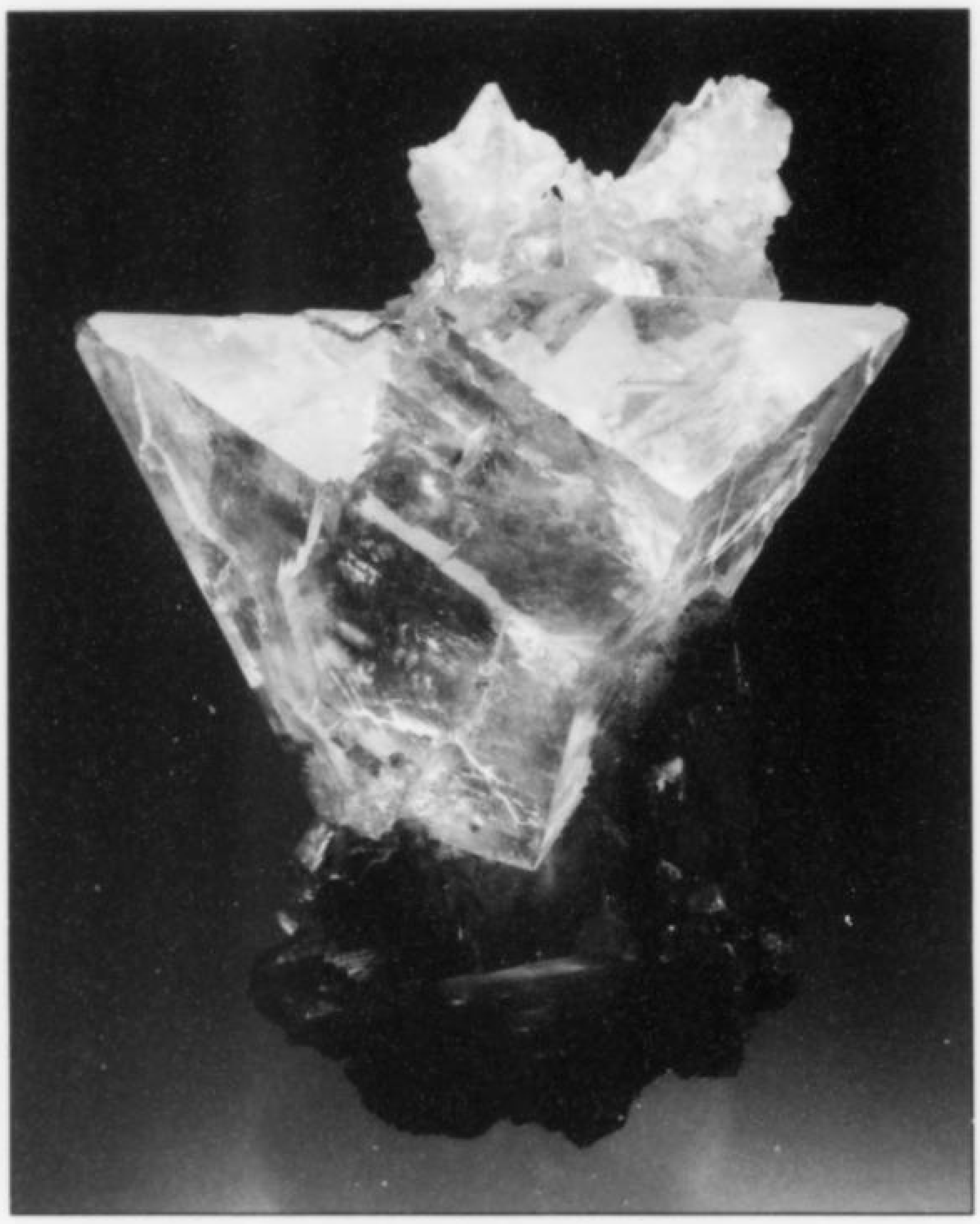


Figure 11. **Twinned calcite (generation I and II), 5 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

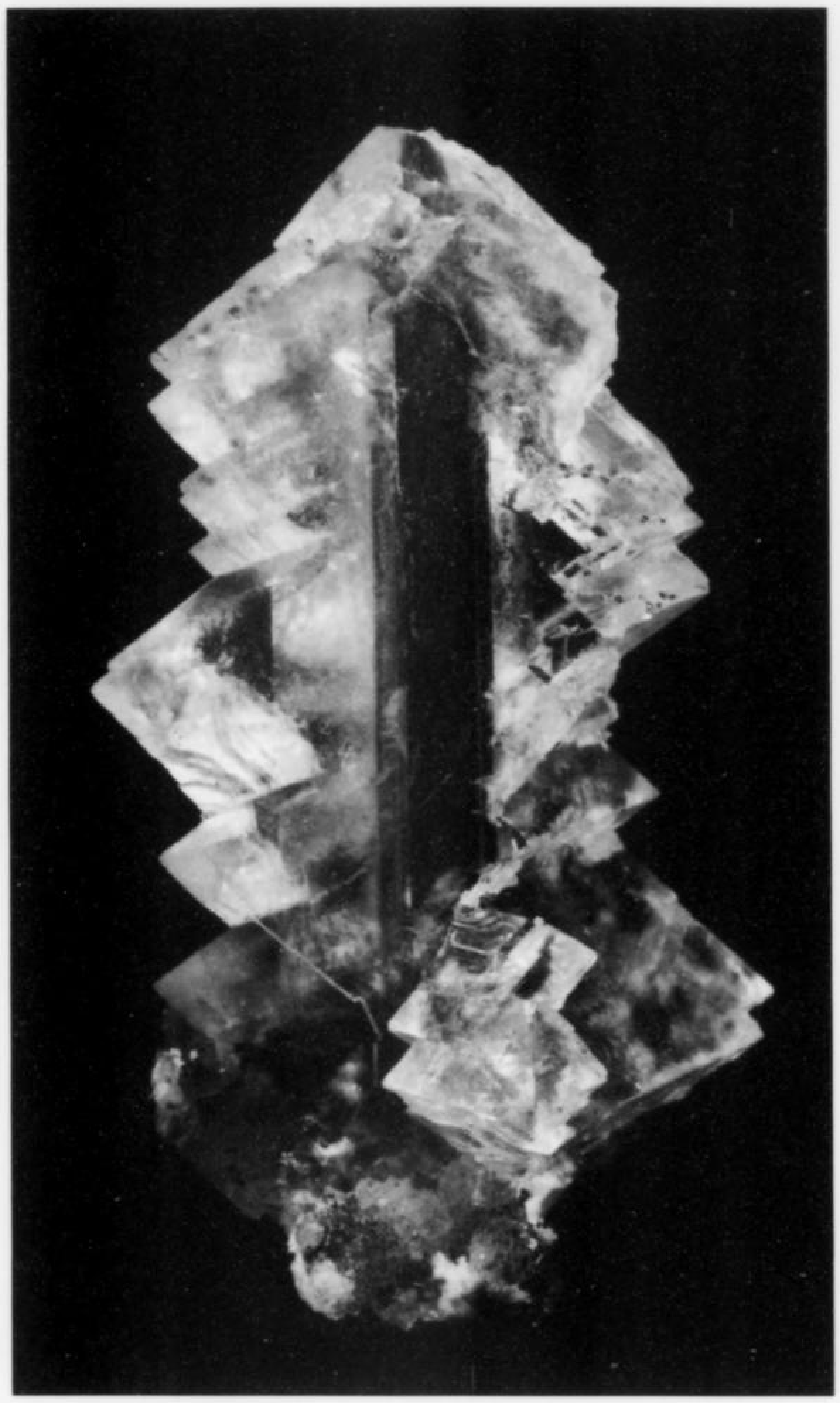


Figure 12. **Twinned calcite (generation I) grown around a central phantom of different habit, 3.2 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

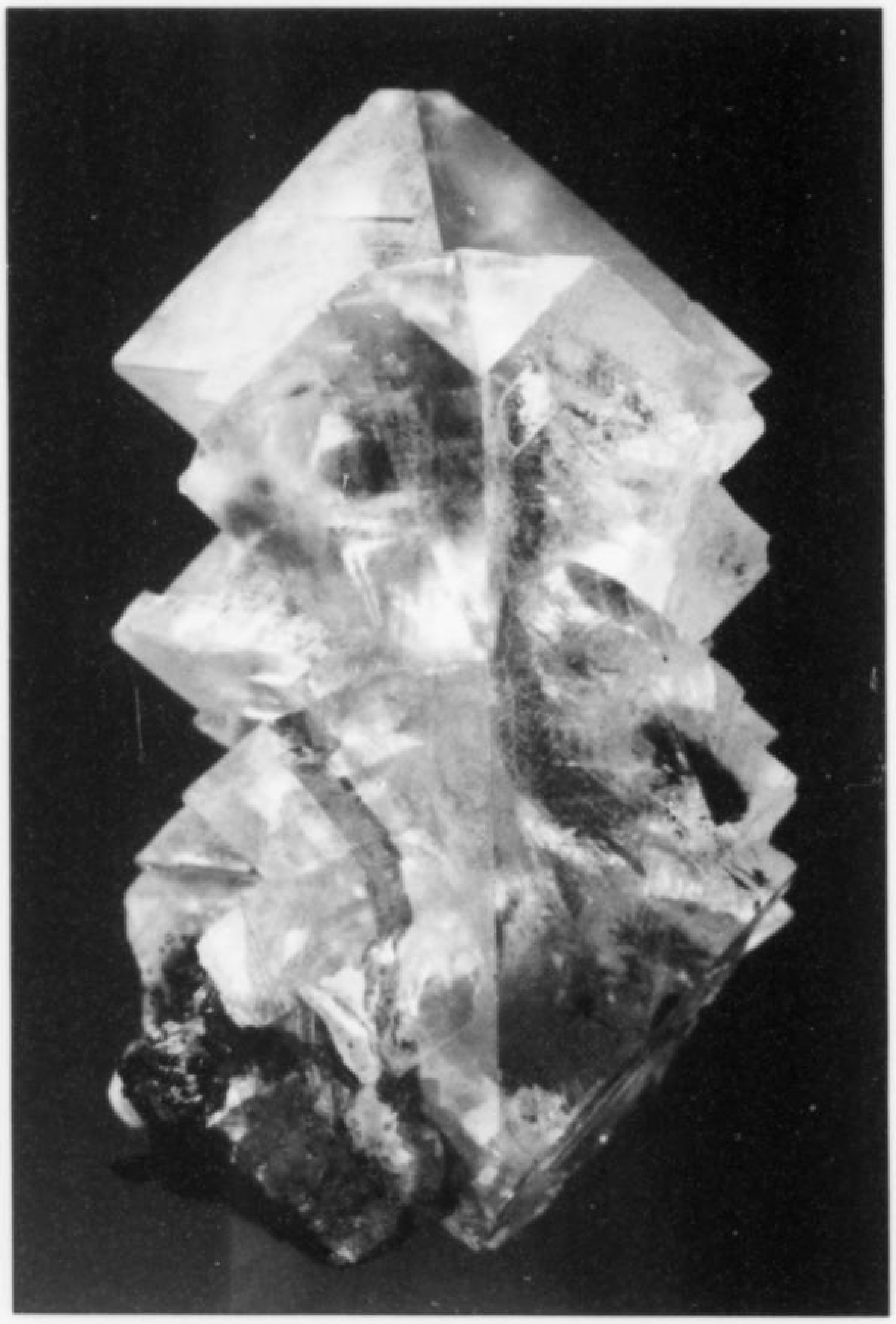


Figure 13. **Twinned calcite (generation I) on matrix, 4.2 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

causes Calcite-I to crystallize at very low temperatures, probably below 100°C. Above that temperature the steranes included in the calcite would decay.

Analyses of temperatures of crystallization based on classic geo-thermometers such as gas-fluid inclusions are planned for the future, and will be the theme of a separate report.

Main mineralized zone, Site II; and elsewhere in the quarry

Only cursory research and collecting has been done at Site II, where cavities are rare, and where the cavities which do exist are completely filled by masses of crystalline calcite.

In the central part of the quarry (outside the main mineralized zone), a few small calcite crystals were found in cavities. They are lustrous but opaque, honey-yellow, untwinned rhombohedrons to 3 cm with parquet patterns on their faces. The crystals rest on drusy quartz cavity linings.

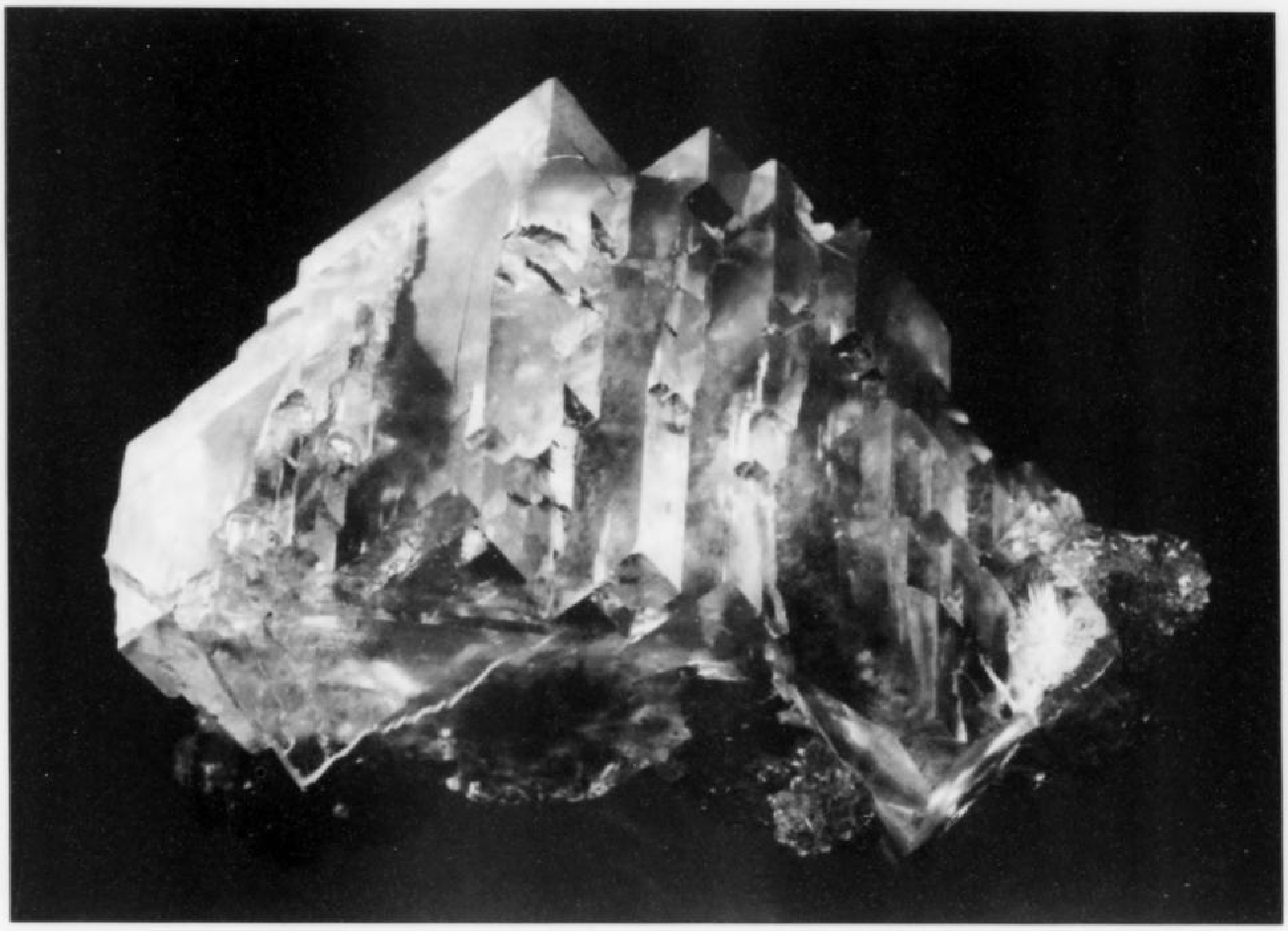


Figure 14. **Twinned calcite (generation I) with drusy quartz, 3.8 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

Figure 15. **Diagrams of a common habit of calcite crystal intergrowth (generation I) of three parallel domains (shown as orange, yellow and green) having a common twin plane. Three views of the same specimen are shown. Courtesy of Berthold Ottens.**

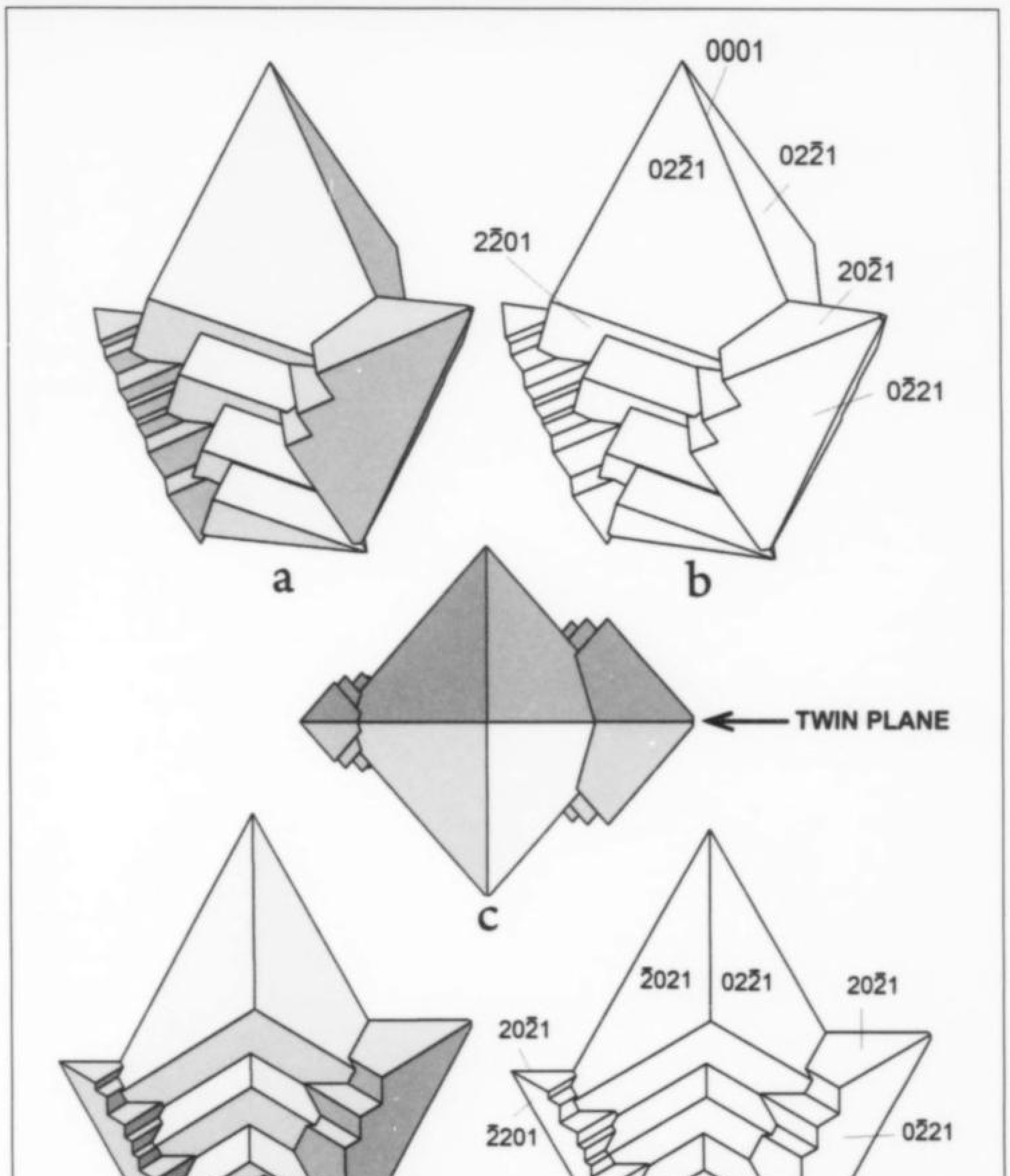


Figure 16. **Calcite crystals (generation III) on matrix with drusy quartz, 8.6 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

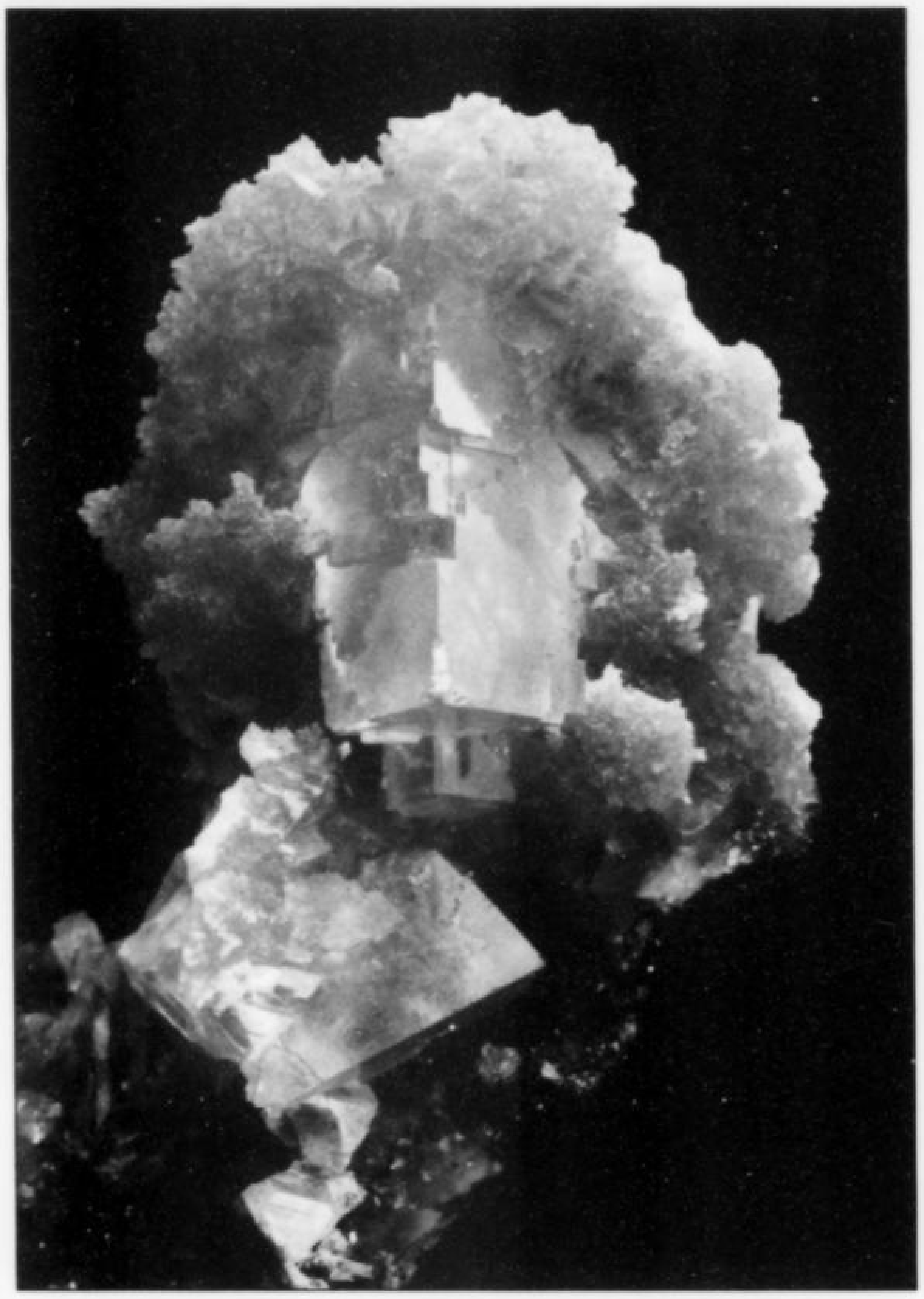


Figure 17. **Calcite crystals (generation II on generation I) on matrix, 3.6 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

Chlorite (iron-rich)

An undetermined black to greenish black species of the chlorite group forms very thin, tabular microcrystals comprising spherical clusters which line the walls of cavities, covering total surface areas up to 100 square meters. Sometimes the spherical clusters stack one on another, forming "snowman"-shaped pseudo-stalactites. Chlorite may also occur in small aggregates on the faces of crystals of Calcite-I, Calcite-II or quartz, and as inclusions in these crystals. Included chlorite has also been observed in crystals of heulandite-Ca.

Of all of the minerals in the assemblage, chlorite crystallized over the longest time period: it began to form simultaneously with the first generation of quartz, and finished during the second generation of quartz. We have not identified the specific chlorite-group species in question, but we have determined that Sambava chlorites are rich in Fe.

Heulandite-Ca $(Ca_{0.5},Na,K)_9[Al_9Si_{27}O_{72}]\cdot{\sim}24H_2O$

Heulandite is a relatively rare mineral in the quarry. It has been found only in the lower part of the Site I mineralized zone, in the large lenticular pockets, as typically coffin-shaped crystals with dominant forms {011}, {001}, {100} and {010}. Characteristically, heulandite crystals from Sambava show the {011} form very well developed (much more so than in, for instance, specimens from the Deccan Plateau of India). The crystals are terminated by smaller {101} faces, rarely with very small {112} faces. They have very high vitreous luster except on their {010} faces, where the luster is pearly, as is typical for the species. The {010} faces commonly show well developed mosaic textures.

The Sambava heulandite-Ca crystals are sometimes found in curtain-like clusters, with individual crystals reaching 1 cm-exceptionally more than 5 cm. More commonly, specimens show sharp, single, well-individualized heulandite crystals on matrix. Other specimens show the heulandite crystals in tight clusters densely grouped on matrix. Most of the heulandite is colorless and transparent (some is translucent) and highly lustrous. Specimens can be very aesthetic, especially when the matrix is dark. Black to greenish black aggregates of chlorite are included in some heulandite crystals, and are particularly aesthetic when the heulandite crystals are transparent.

Heulandite is one of the youngest of the zeolites at Sambava; it is commonly found resting on Calcite-I, Quartz-I and chlorite.

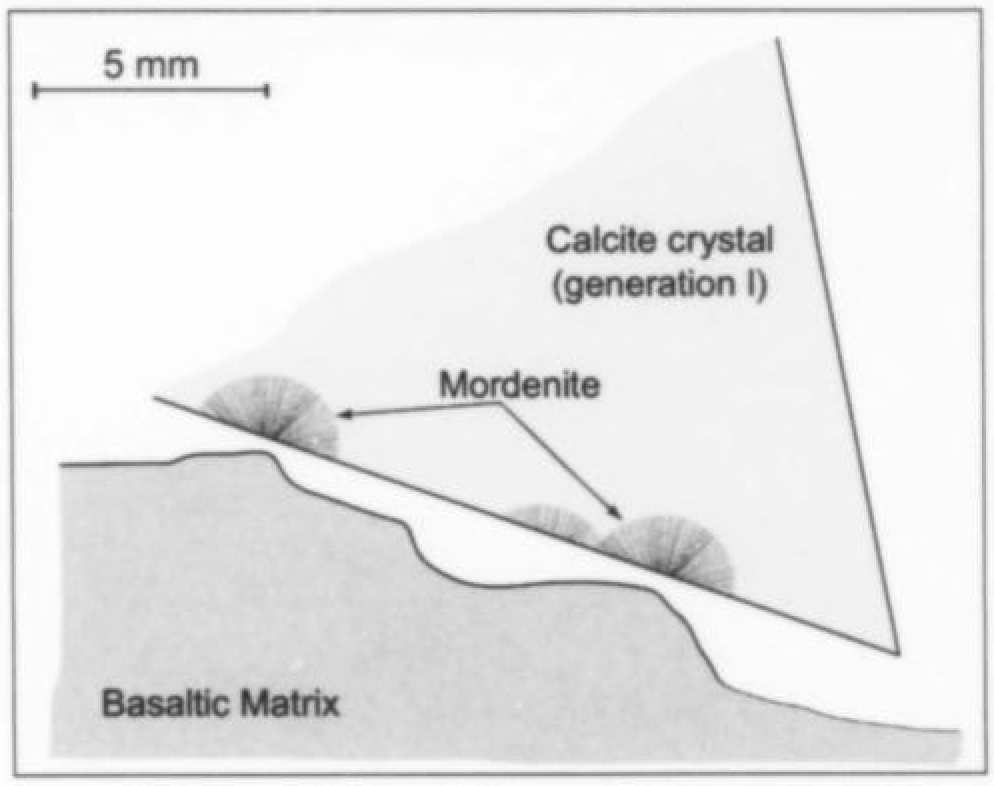
Laumontite $Ca_4[Al_8Si_{16}O_{48}]\cdot 18H_2O$

At Site I the main mineralized zone commonly contains massive laumontite in the large cavities. Between the breccia fragments of

Figure 18. **Heulandite crystals to 2.4 cm on chlorite-rich matrix with drusy quartz, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

Figure 19. **Doubly terminated white laumontite crystal, 3.5 cm, from the Sambava quarry. Spirifer specimen; Tomasz Praszkier photo.**

Figure 20. (above) **Acicular mordenite crystals to 3 mm, in calcite, from the Sambava quarry. Spirifer specimen; G. Bijak photo.** ***(Below)*** **Sketch showing how the mordenite crystals not enclosed in calcite have been dissolved away.**



Site I the mineral is found as spherical crystal clusters commonly reaching 2 cm in diameter and exceptionally reaching 4 cm. The clusters are medium pink near their centers, fading to white near their edges.

Laumontite also occurs as scattered, well individualized, sometimes doubly terminated crystals to 4 cm in calcite-rich cavities in the lower part of the mineralized zone. The monoclinic, elongated crystals show the typical {110} and {201} forms. The crystals are snow-white to cream-white, and (before they begin to dehydrate) highly lustrous.

Laumontite is the youngest mineral species at Sambava, having grown on all other minerals—most commonly on quartz, calcite and stilbite. In a single observed specimen, laumontite is partially included in the outer parts of a third-generation calcite crystal, implying that there was a short period when calcite and laumontite grew together.

The rapid dehydration of laumontite causes a radical decrease in the strength of its bonds and, as a result, whitened laumontite crystals immediately turn to powder with even the gentlest touch. It is therefore almost impossible to preserve laumontite in its original state. However, the dehydrated crystals are easily removed from attractive specimens of other minerals without leaving a trace.

Mordenite $(Na_2,Ca,K_2)_4[Al_8Si_{40}O_{96}]\cdot 28H_2O$

Mordenite is a common species at Sambava, seen always as inclusions in calcite (to secure mordenite samples for this study, the enclosing calcite had to be acid-etched away). Radial clusters of white, acicular crystals of mordenite range from 3 to 7 mm in diameter, but only the parts of the clusters which are enclosed in calcite now remain. Mordenite needles do not protrude beyond the surfaces even of unweathered calcite crystals. And mordenite needles completely enclosed inside calcite have not been found: the needles always reach the surfaces of the calcite crystals. Mordenite is one of the older species—its formation process was finished before Calcite-I crystals began to grow around it. Its relation to minerals older than calcite—such as chlorite and the oldest quartz—remains unknown. It may reasonably be assumed that dissolution of mordenite took place relatively early, during the period when hydrothermal waters were still circulating. The low solubility of mordenite, and the manner of its preservation as inclusions in unweathered Calcite-I crystals, imply that it could not have been dissolved during recent weathering processes.

Quartz SiO_2

Quartz is one of the most common minerals in the main mineralized zone as well as in cavities in other parts of the quarry. Two generations of quartz occur in the mineralized zone; their crystals are of such similar habits that macroscopic distinction between them is often impossible.

Quartz of the first generation is found very commonly in the main mineralized zone, chiefly as sparkling drusy crusts on cavity walls in the basalt. Individual Quartz-I crystals in these druses measure 2 to 3 mm, never exceeding 5 mm; they are colorless to gray, and highly lustrous. Quartz-I occurs also as groups of up to a dozen somewhat larger crystals resting on chlorite; these crystals are sharp, with well-developed prism faces, and are commonly doubly terminated. Such clusters occur also as one of the most common inclusions in calcite crystals of the first generation, and also on the faces of Calcite-I crystals. Dissolution figures have been observed on some of the faces of the quartz crystals.

The period of crystallization of Quartz-I was relatively long. Crystallization began after chlorite had formed, but was already in progress before the oldest calcites began to form, and continued after formation of the youngest crystals of Calcite-III. Accordingly, calcite crystals are seen resting on quartz crystals and vice versa, and included quartz is seen "suspended" in calcite.

Quartz of a second generation occurs only in some of the pockets in the main mineralized zone. Quartz-II forms layers up to 2 mm thick, composed of very small (1 to 2-mm) crystals, and these layers encrust some faces of Calcite-I and Calcite-III crystals (they have not been observed coating Calcite-II). The quartz layers grew preferentially on one or two crystallographic planes of the calcite crystals, and stilbite, heulandite and laumontite are sometimes found resting, in turn, on the layers. Fortunately for collectors, the very thin encrustations of Quartz-II are easy to remove—they often come off naturally when laumontite and stilbite are being removed from the faces of calcite crystals, leaving the calcite looking lustrous and fresh.

In the central part of the quarry, outside the main mineralized zone, some cavities are lined by colorless or bluish drusy quartz with individual crystals reaching about 1 cm. These crystals have grown together so densely that prism faces generally do not appear; only the pyramid faces which form terminations are well developed.

Stilbite-Ca $(Ca_{0.5},K,Na)_9[Al_9Si_{27}O_{72}]\cdot 28H_2O$

Stilbite-Ca, one of the most common minerals in the assemblage, is usually found as fresh, lustrous, unweathered crystals. These crystals occur in two common habits, the most common of which is the "sheaf-shaped" habit typical of the species. The stilbite sheaves reach over 10 cm, and are never smaller than about 3 cm. Whereas in many stilbite specimens (for example, in most from the Deccan Plateau of India), the concave area in the center of {010} rises towards the terminal {111} face, in Sambava stilbite the central concavity rises towards all edges of the crystal. Sheaf-shaped stilbite from Sambava is characterized by a termination with a well developed {111} form. Commonly the crystals are lustrous—some highly so—and show colors ranging through white, cream-yellow

Figure 21. **Stilbite crystal cluster on generation-II calcite, 5.5 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

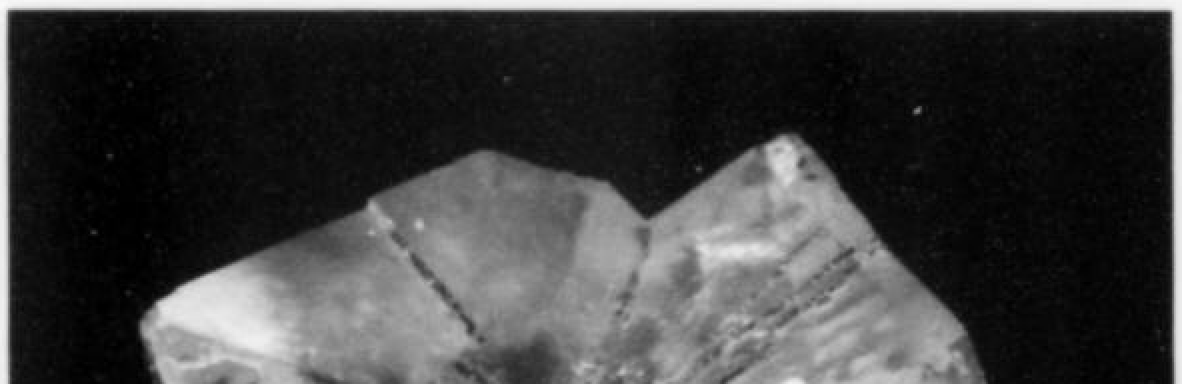


Figure 22. **Stilbite crystal cluster on generation-I calcite, 5.4 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

Figure 23. **Stilbite crystals on generation-I calcite, 12 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

Figure 24. **Stilbite crystal cluster with generation-I and II calcite, 7.7 cm, from the Sambava quarry. Spirifer specimen; Jeff Scovil photo.**

and pink. Some spectacular specimens show sheaf-shaped stilbite resting on calcite and/or quartz crystals. Occasionally the stilbite crystals are doubly terminated; most such crystals are small, but "bow-ties" to 10 cm long have been found very rarely—these are the finest stilbite specimens of the locality.

Stilbite-Ca also occurs in the quarry as single, platy, well individualized crystals measuring 2 to 3 cm. In these crystals the largest face, {010}, is relatively flat but shows well-developed parquet patterns. The pointed termination, {111}, is sharp, and many crystals are doubly terminated. Stilbite crystals of this habit are white to cream-yellow, and lustrous. Commonly they have inclusions forming a white hourglass figure on face {010}, with transparent or translucent triangular poles located in such a way that the longest edges are parallel to the edge of the {001} face. Many crystals of this habit rest directly on calcite (from which they are easily detached), creating highly aesthetic specimens. Stilbite of this habit is most common in the lower part of the mineralized zone, in the lenticular pockets of Site I, associated with well-formed calcite and laumontite crystals.

Stilbite also occurs in the quarry as crystals of an intermediate habit, characterized by a strongly developed parquet pattern grading into a sheaf-like shape. It is reasonable to assume that the habit began to change when the growing crystal reached some critical size—probably about 3 cm. Further growth of the crystal led to the development of the sheaf-like shape, with a deep concavity on the {010} face in the largest crystals.

Stilbite is one of the youngest minerals in the assemblage, only laumontite being younger. The precise time-relation between the growth of Calcite-III and stilbite is uncertain.

PARAGENESIS

Field observations and examinations of numerous specimens can be used to determine the paragenetic sequence at Site I in the main mineralized zone (see Fig. 25).

The first mineral to crystallize was the chlorite-group species found resting directly on cavity walls in basalt. Probably the growth of chlorite was fairly continuous over a long period: chlorite is found as inclusions in Calcite-I, Calcite-II and Quartz-I, and it is found under, as well as grown over, crystals of these minerals. The

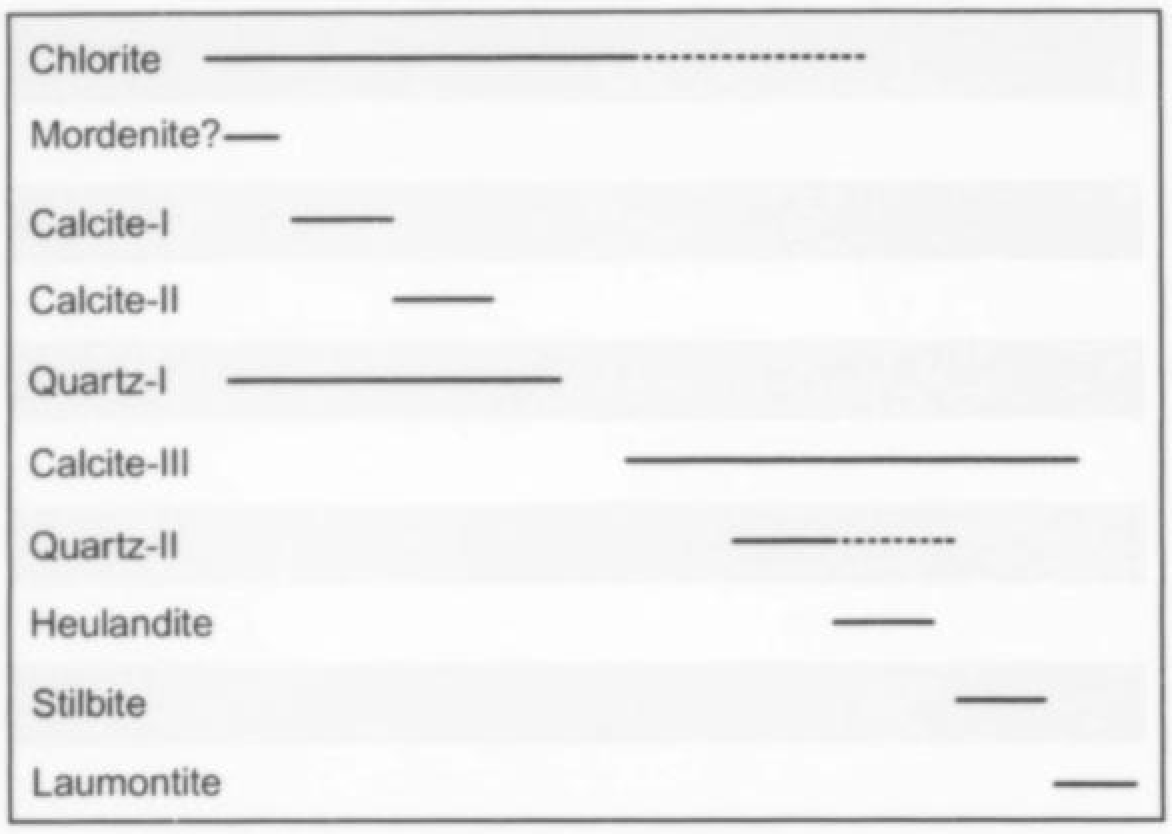


***Figure 25.* Sequence of crystallization at Site I, showing the multiple generations of quartz and calcite.**

time-relation between crystallization of chlorite and of Calcite-III and Quartz-II is unknown. Quartz-I formed next, probably almost simultaneously with Calcite-I; most crystals of Quartz-I are found resting directly on basalt matrix or on chlorite. Next, Calcite-II began crystallizing. Quartz-II probably began to grow simultaneously with, or just after, the first phase of Calcite-II (the precise time-relation here is impossible to reconstruct). The youngest chlorite grew on Quartz-II. Next, Calcite-III began to form. Because so few specimens of Calcite-III have been found, precise reconstruction of its time-relations to still later minerals has not been possible. Finally the zeolites began to crystallize in the following sequence: heulandite, stilbite, laumontite. The times of the crystallization and of the subsequent dissolution of mordenite are problematic, but it is certain that mordenite had finished crystallizing before Calcite I began doing so. Dissolution of mordenite took place at some time before the most recent weathering, but a more precise determination cannot be made.

SAMBAVA COMPARED TO THE DECCAN PLATEAU

The Sambava, Madagascar occurrence is clearly similar in many ways to the many calcite/zeolite occurrences of the Deccan Plateau of India (see Ottens, 2003). The Sambava assemblage is, of course, much poorer in mineral species, but hundreds of quarries, outcrops, wells, etc., dispersed over a huge area of the Deccan Plateau, have contributed species to the long Indian list. The Malagasy locality is, by contrast, only a single, small one, where commercial exploitation proceeds very slowly.

One major resemblance between Sambava and the Deccan Plateau occurrences is in their paragenetic sequences. In both cases the first calcites were formed very early, with later generations of calcite appearing in the sequence as well. And in both cases the sequence of crystallization of zeolites is heulandite-stilbite-laumontite.

The resemblances just noted are not surprising when we consider the similarities in the conditions of formation. The flood basalts of Sambava and of the Deccan Plateau formed at about the same time and in the same paleogeographical region, during the separation of India from Madagascar or soon after it.

CONCLUSION

Although the quarry near Sambava appears to have been exhausted of fine mineral specimens, the discovery of new zones with interesting mineralization can never be ruled out in a large flood-basalt environment. The finds at Sambava demonstrate that Madagascar is still poorly explored for mineral occurrences, and one can only guess how many localities on this beautiful island are still waiting to be discovered.

ACKNOWLEDGMENTS

I would like to thank Berthold Ottens for help in crystallographic descriptions and drawings, Marek Gola for analyses of organic inclusions, Rafał Siuda for constructive discussions, and Asia Gajowniczek for her help in translation, further smoothed out by Tom Moore and Wendell Wilson. I am also very grateful to Jeff Scovil and Grzegorz Bijak for providing the great photographs. Scott Werschky (Miner's Lunchbox) will be handling the sale of all extra calcite specimens collected by the Spirifer group.

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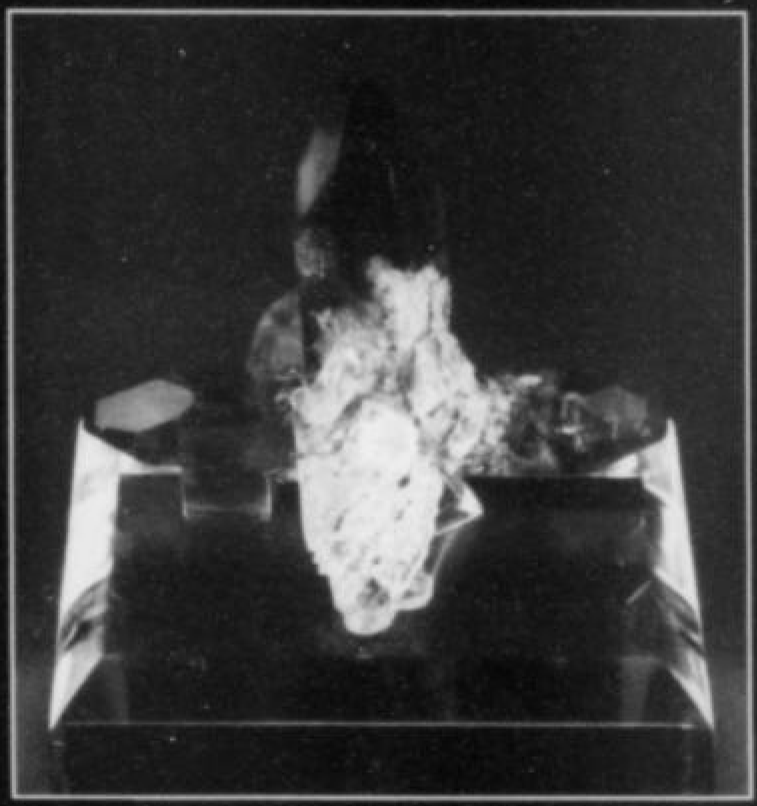
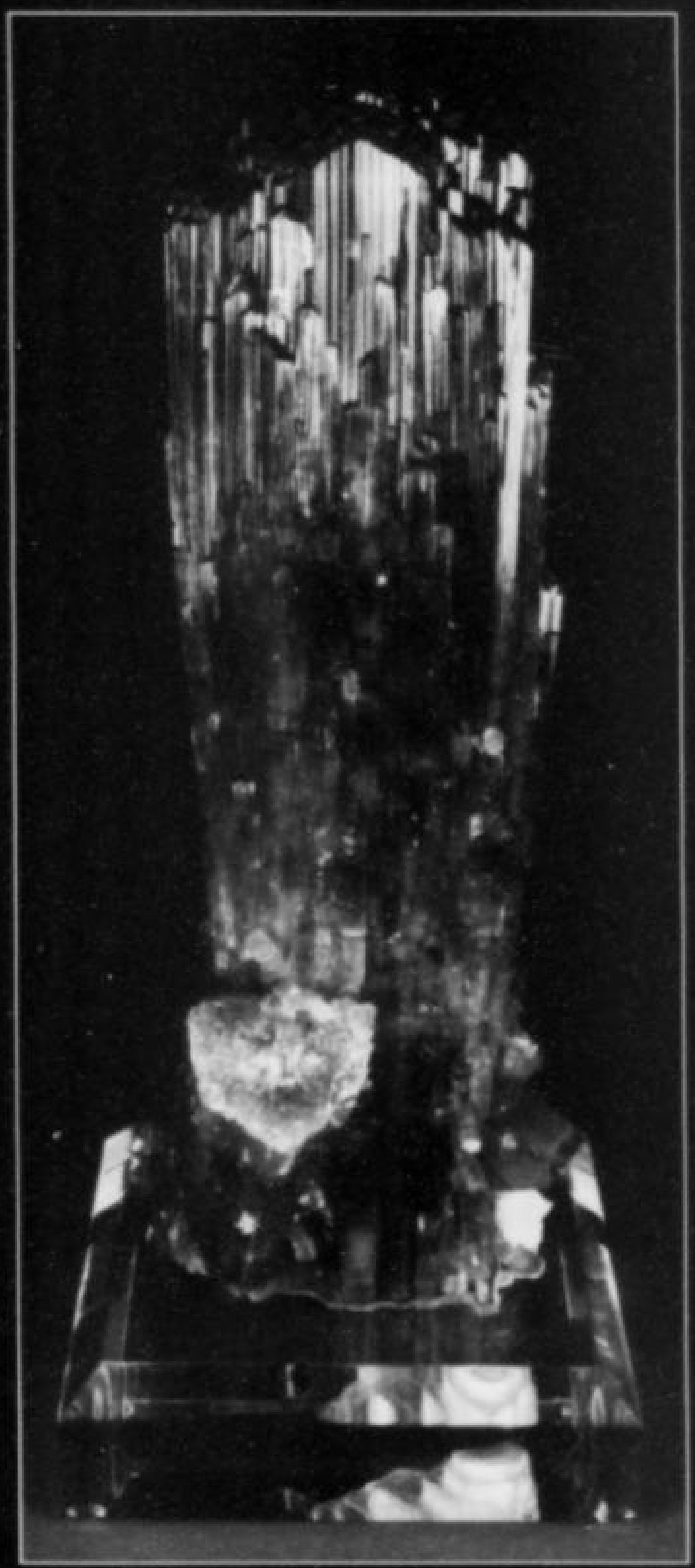
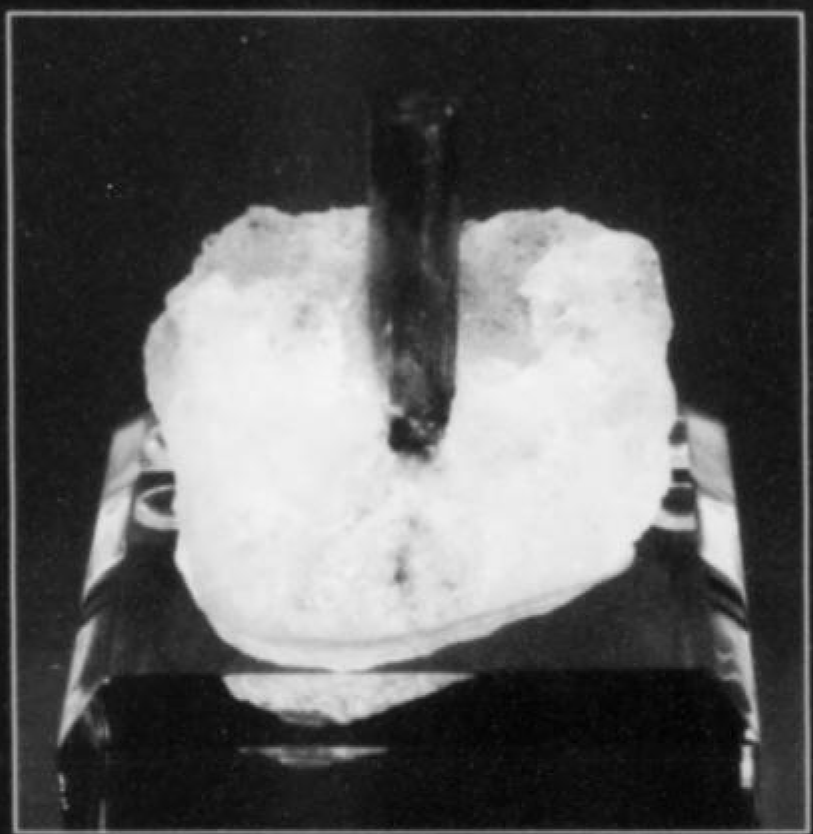


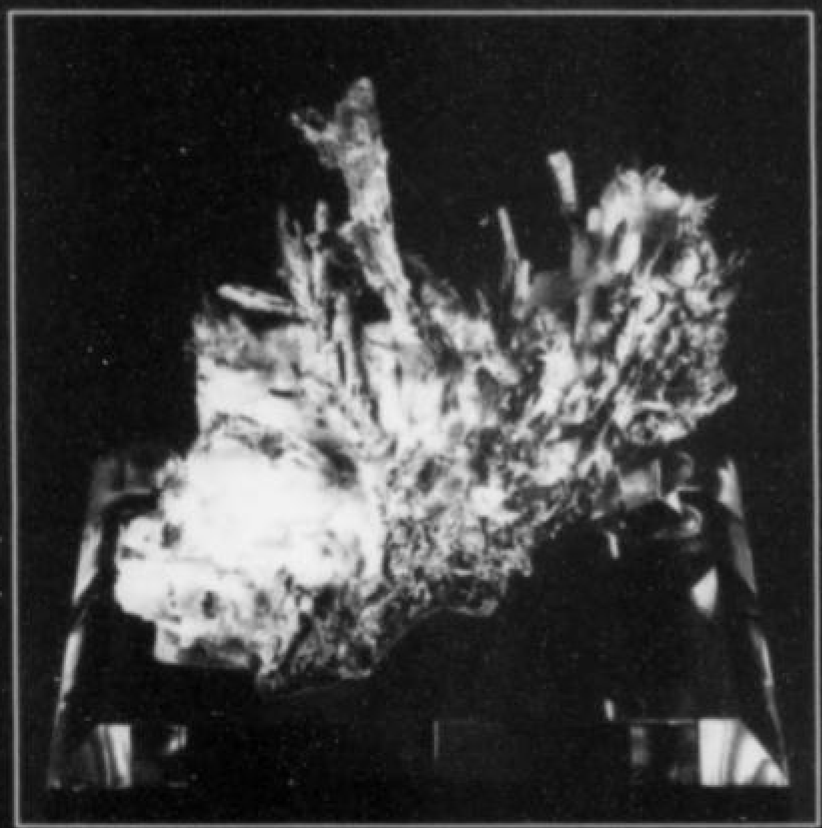
TOPAZ
Thomas Mountains, Utah



TOURMALINE
Paprok, Afghanistan



EMERALD in QUARTZ
Kagem Mine
Kafubu Area, Zambia



DYSCRASITE-ALLARGENTUM
Bouismas Mine
Bou Azzer Dist., Morocco

Tourmaline for Breakfast

a trip to

MADAGASCAR

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INTRODUCTION

Every summer I travel to Europe to photograph specimens for collectors, dealers and museums, and to attend the wonderful mineral show in Ste.-Marie-aux-Mines, France. At the end of the 2007 trip I traveled to southeastern Europe with my friend Tomasz Praszkier from Warsaw. Tomek (his nickname) is a geologist who travels around the world for work and pleasure. In 2008, after I finished my travels in Europe, I accompanied him and his girlfriend Asia on a new adventure—to Madagascar. This is the story of that trip.

Although Africa, which lies 600 kilometers to the west across the Mozambique Channel, is considered the cradle of mankind, Madagascar was not populated until about 2,000 years ago. The settlers were seafarers from Indonesia and the result is that much of the populace looks distinctly Asian. Some time after the initial settling of the island, people from Africa migrated there too. The Indonesian settlers brought with them rice, which remains a staple crop in Madagascar to this day. With a semitropical climate, other crops that can be grown include bananas, sugar cane, pineapples, cocoa, vanilla, manioc, mangos and even corn.

Madagascar, the fourth largest island in the world, broke away from the African continent in the middle Jurassic period and its ecosystem has remained fairly isolated ever since. Unique flora and fauna, including the famous lemurs, chameleons and baobab trees, have evolved there.

The country of Madagascar is officially called the Malagasy Republic, and the Malagasy language (with three major dialects) is spoken by 18 tribes. Since the country was a French colony for many years, French is also spoken by most people in the larger towns and cities. Because of this connection, most tourists are French. The majority of the Malagasy people (about 55%) practice traditional African religions emphasizing a cultic connection with deceased relatives; most of the rest are Christian, about equally divided between Catholic and Protestant, though the poorer people are predominantly Catholic. Wherever you go in major towns and cities you are beset by beggars and numerous people hawking local crafts, souvenirs and minerals. The beggars, ranging from small children to the very old, are everywhere in the cities, especially around hotels and restaurants. The poverty of the people can be heart-breaking.

A common mode of transportation in the major towns and cities is by the *pouse-pouse* (rickshaw). The pouse-pouse drivers, many of them barefoot, are seen everywhere and camp out by the hotels offering rides to anyone leaving. Cars are relatively few, as "luxury" imports for the rich are taxed at a rate of 100%!

ANTANANARIVO

On July 18th we departed from Paris on a ten-hour flight to Antananarivo, the capital of Madagascar. We arrived early the next morning and were met by Tony (pronounced "Toony") and his wife Noro (pronounced "Nooroo"). Tony is Tomek's driver whenever he comes to Madagascar. We made a quick stop at their house to look at some nice tourmalines they had just acquired for Tomek. We then stopped at a hotel to pick up Tomek's sister Kasia and brother-in-law Marcin, who had arrived about a week earlier. After a quick bite to eat we visited the warehouse where Tomek keeps the specimens he buys as well as the ammonite fossils he collects for his stratigraphy work. This was followed by a stop at the University of Antananarivo to visit an associate of his. While Tomek was busy the rest of us found a tank of formaldehyde in a hallway that contained the

Figure 1. **Mineral specimens for sale in Antsirabe. Jeff Scovil photo.**

famous coelacanth fish (a "living fossil") first discovered between the Comoro Islands and Madagascar in 1939.

Our next stop was the local outdoor market. It was a warren of stalls with everything you could imagine for sale. The mineral, gem and fossil dealers were concentrated in one area. There were hundreds of cut and polished ammonites, quartz crystals polished to reveal the phantoms inside, many kinds of cut stones, and also mineral specimens. Most of the latter were of poor quality, but if you looked you could find some nice pieces. You do not pay the asking price but must haggle, which I am not good at, so for the rest of the trip I let Tomek take care of the necessary haggling. We bought a few small tourmalines and then found our way back to the Toyota Land Cruiser and headed south out of the city.

ANTSIRABE

Our destination that evening was the city of Antsirabe, which is situated in the middle of a famous pegmatite region. We found our hotel, checked in and fell gratefully into our beds. After breakfast the next morning we were off to another market, this one devoted exclusively to "rocks." There was a single row of ramshackle booths selling all sorts of minerals, fossils and cut stones, generally of better quality than we saw in the market in Antananarivo. Tomek knows all of the dealers who carry better material and they know what sorts of things he buys. We looked at a lot of tourmalines, quartz crystals, rhodizites, spinels, microlites, morganites, titanites and quartz crystals. There was nothing really outstanding, but there were a few nice, small, single crystals of tourmaline as well as a good thumbnail phenakite from Anjanabonoina that I added to my collection that day.

Our lunch established a pattern for the rest of the trip. If we dined al fresco (which was frequent), a crowd of people would gather just outside the dining area. Some would have local crafts to offer and some would have minerals, gem rough or cut stones for sale. When we were finished eating we motioned to them that we were ready, and one at a time they showed us their wares. We passed on all the gems and gem rough, and seldom bought the crystals because of their low quality or damaged state. If a selection was made, bargaining commenced.

After lunch we took a short drive to the southeastern part of town and stopped at Lac Tritriva, which is a beautiful lake in a small volcanic caldera. Then we visited another lake of volcanic origin called Lac Andraikiba, a popular destination for picnickers and occasionally even for boaters. Near the bathhouse is an area set aside for the sale of minerals and gems. The quality of goods here is not as good as in the mineral market in Antsirabe, and I only bought a small group of quartz crystals as a gift for a friend.

The following morning several mineral dealers were waiting for us in the parking lot of the hotel, including one with a monster morganite crystal about 25 cm across. The fellow wanted an outrageous price and would not budge, so we passed on it. We did, however, buy several small, bi-colored tourmalines from another dealer that morning. Then our first real adventure began!

THE SAHATANY VALLEY

We finally left at about 9 a.m. under cloudy skies and headed southwest to the Sahatany Valley, famous for its numerous pegmatites. Overlooking the valley is the equally famous Mount Ibity (Mt. Bity). Tony dropped us off on a ridge overlooking the valley and we hoofed it the rest of the way over a steadily worsening road. The view of the valley was great! The sky had cleared, and it was a sunny, warm day. Houses and small villages were scattered amongst the terraced rice fields. We could see the white dumps of pegmatites on the far side of the valley. The valley is primarily metamorphic and the host rocks are quartzites, gneisses and marbles. At the first village we came to we were offered a number of tourmaline crystals, amongst which were several worth buying.

TSARAFARA PEGMATITE COMPLEX

After price negotiations and payment we left the dealers and a pack of children behind and waded across the shallow Sahatany River in our bare feet. We went on through several more small villages, repeating the experiences we'd had in the first, but finding

Figure 2. **The Sahatany Valley. Jeff Scovil photo. White dumps on the hillside indicate pegmatite workings.**

nothing more to buy. On the other side of the valley we came to the Tsarafara pegmatite complex. The fenced-off area is controlled by Italian mineralogist Federico Pezzotta. The gate, such as it was, was open, so we walked in and took a few photos of the workings and of a family that was screening the dumps looking for bits of facettable tourmaline.

The pegmatites have decomposed *in situ* and are mined via hundreds of vertical shafts going down over 20 meters through the laterite soil. At the top of each shaft is a crude windlass made of a log supported by forked sticks. The pegmatite area, which was not being actively worked at the time, looked like a battlefield, what with all of its pits and piles of waste rock. We spoke with the guard, satisfying him that we were not collecting anything more than photos, and then we were on our way.

ANTOKAMBOHITRA PEGMATITE

We then walked down the valley a short way to the Antokambohitra pegmatite, which was also temporarily inactive. En route we passed a church where the locals were singing hymns in Malagasy (it was Sunday). Marcin, who is principal violinist with the Breslau Symphony Orchestra, had to go in and record some of the wonderful music.

AMBOSITRA AND FIANARANTSOA

After crossing the river again and getting a shoe full of water, we climbed out of the valley and met Tony and the Land Cruiser at a different location. From there we drove south on National Route 7, stopping for a short while in the town of Ambositra which is known for its folk art, especially wood carving. The weather had turned rainy and we continued for another five hours to the city of Fianarantsoa. There we found a fine Chinese-run restaurant and our hotel (unheated as usual).

RANOMAFANA NATIONAL PARK

The next day continued rainy, but this did not dampen our spirits. A bit northwest of Fianarantsoa is Ranomafana National Park which is, appropriately, a rain forest. After buying what may have been the last available umbrellas in the local village, only Kasia, Marcin and I entered the rain forest with our guide. This is where we saw our first lemurs, geckos and chameleons. Kasia came out with a small hitchhiking leech on her calf.

After our return we found a nice resort hotel where we had a leisurely lunch and spent the rest of the afternoon sipping hot tea. Dusk found us back in the forest for a glimpse of the nightlife. We were not disappointed: we got to see one of the island's few predators—a civet. They are about the size of a house cat, with rows of spots running down their sides, and are a bit more lithe than the better-known predator called the *fosa* (pronounced "foosa"). On the way back, one must cross a small wooden footbridge over the rapids of a small, raging river. Standing in the middle of the bridge, looking at the mist-shrouded jungle in the dusk, with the roar of the rapids in your ears, you get a feeling of what the virgin jungle was like before man arrived.

ANJA PARK

The following day dawned bright and clear, and we continued southwest to nearby Anja Park, which consists of a small group

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The Sahatany Valley Pegmatites

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The central and eastern part of Madagascar is a shield formed by igneous and metamorphic Precambrian rocks. Some areas of Madagascar were intensively intruded during the Pan-African Orogeny (the episode responsible for creating the Gondwana supercontinent). In Madagascar the consequence of this long-lasting, multistage process is an abundance of large pegmatite fields and pegmatite-rich areas having extremely varied chemical and mineralogical compositions.

One of the most classic and best described pegmatite areas is the famous and still-productive Sahatany Valley. This huge valley is situated at the foot of Ibity Mountain (2,292 meters high), about 30 km south-southwest from Antsirabe (one of the biggest Malagasy towns). The Sahatany Valley is easily accessible on foot from Ibity village, which can be reached even by a small car from the main road (Route No. 7). The majority of Malagasy localities are very difficult to reach, even by four-wheel-drive vehicle. For this reason the Sahatany Valley is one of the most popular destinations for mineral collectors and mineral dealers, local and foreign.

The valley, formed by the Sahatany River, is about 30 km long and very wide. The bedrock is metamorphic and includes schists, quartzites, gneisses and marbles. This variety of rock types results in a very diverse landscape; the quartzites, being the most resistant to weathering, form the high, jagged Ibity and Kiboy Mountains, while the marbles and schists form gentle hills.

The Sahatany Valley pegmatite field extends over 150 square kilometers and contains over 100 larger pegmatites; these are typical vein pegmatites emplaced primarily in marble. The majority of pegmatites occurring in the Sahatany Valley are of the Complex Type (LCT) (lithium-cesium-tantalum) with subtypes rich in lepidolite, elbaite and danburite. The rest are of the Beryl Type (BCT) (beryl-columbite subtype) (Pezzotta, Simmons, 2001). In the older classifications they were considered typical sodalithic pegmatites, with characteristic dominance of albite over microcline, lepidolite over other micas, spessartine over almandine and elbaite over schorl.

The pegmatites vary in dip, from almost horizontal to vertical, and bear a diverse relationship to the relict bedding of the host rocks, from concordant to discordant. They also range in size from small (a few meters long) to quite large (several hundred meters long).

Some of the pegmatites in the area are very rich in gem crystals, which is the main reason they are mined. The most famous minerals are certainly tourmalines in multicolored, gemmy and lustrous, well-terminated crystals. The crystals range from green to pink, blue, yellow and violet. Moreover it is worth mentioning that one of the most spectacular tourmalines, the so-called "tsilaizite" (Mn-rich elbaite characterized by incredibly intense red/violet color) comes from the Tsilaizna pegmatite in the Sahatany Valley. The other gemstones mined in the valley are beryl (pink, blue and multicolored), danburite and kunzite spodumene. In the course of gemstone mining, a number of other interesting species have been extracted as well. The workings are mostly in the eroded (kaolinized) pegmatites. Because of this, most minerals are extracted as loose crystals, the most common being tourmaline, beryl and quartz. Multi-mineral specimens (such as quartz with tourmaline and /or beryl) are much rarer.

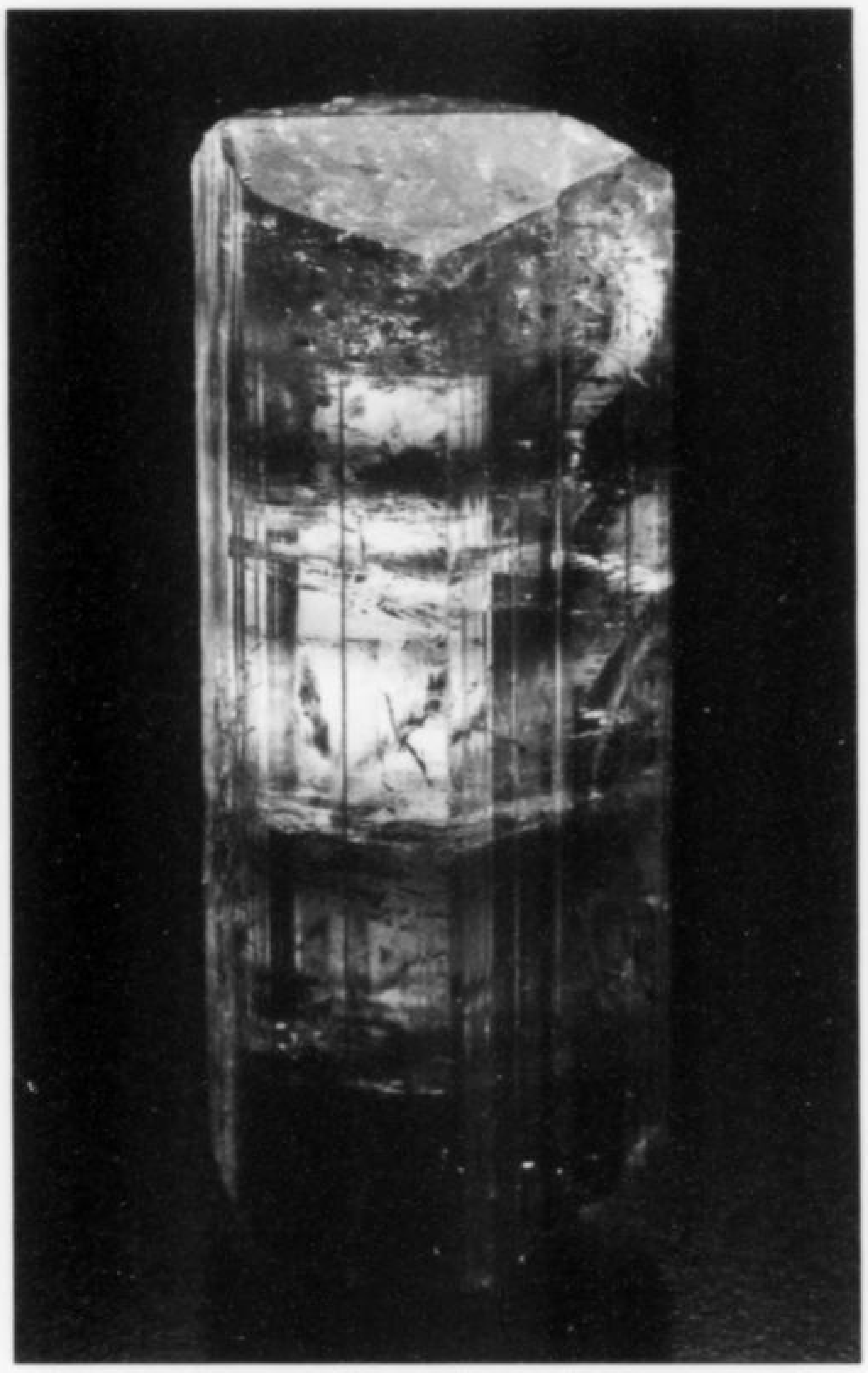


***Figure 3.* Liddicoatite crystal, 3.2 cm, from the Tsarafara pegmatite complex, Sahatany Valley, Madagascar. Spirifer collection; Jeff Scovil photo.**

Figure 4. **Liddicoatite crystals to 3.2 cm, from the Tsarafara pegmatite complex, Sahatany Valley, Madagascar. Spirifer collection; Jeff Scovil photo.**

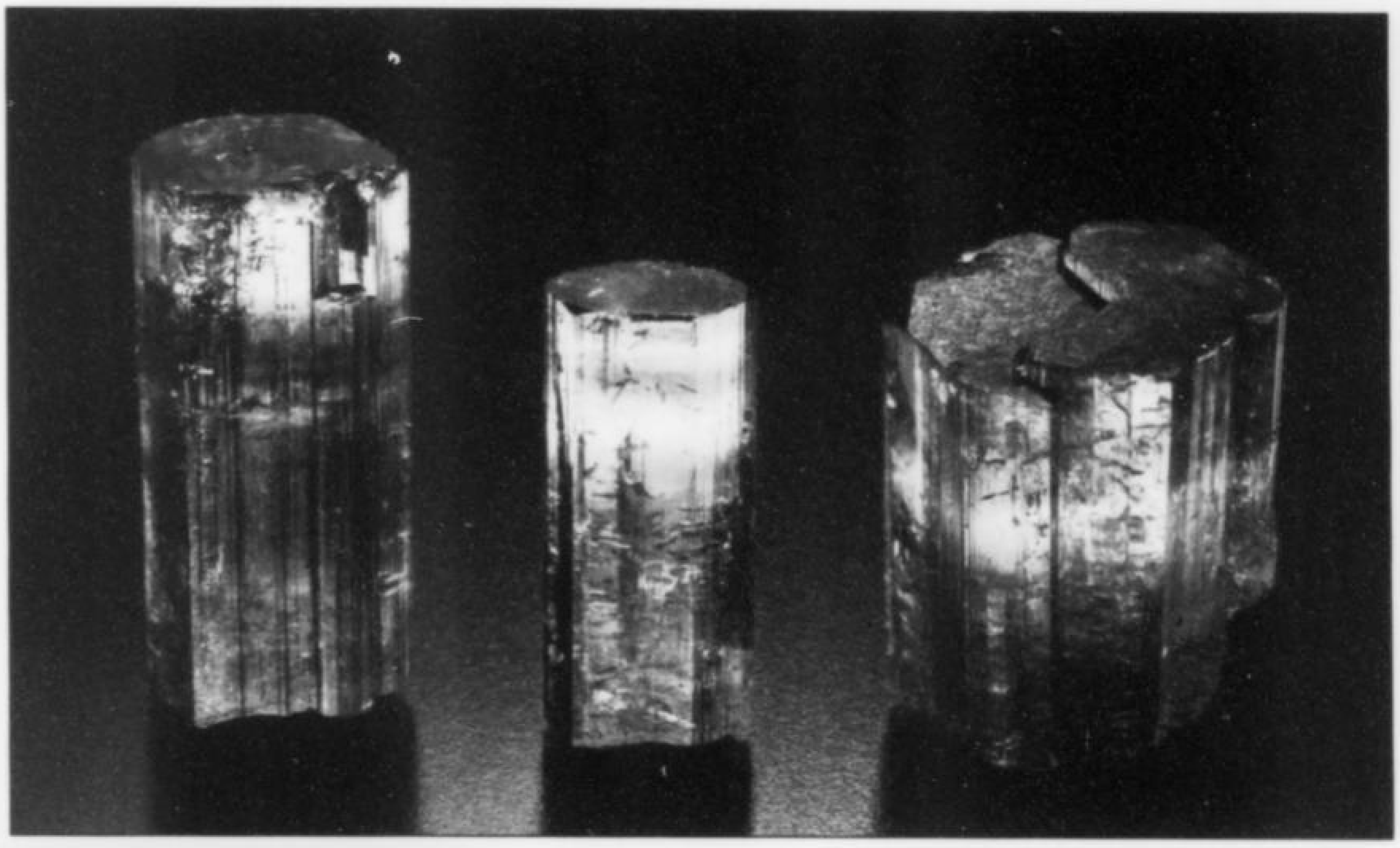
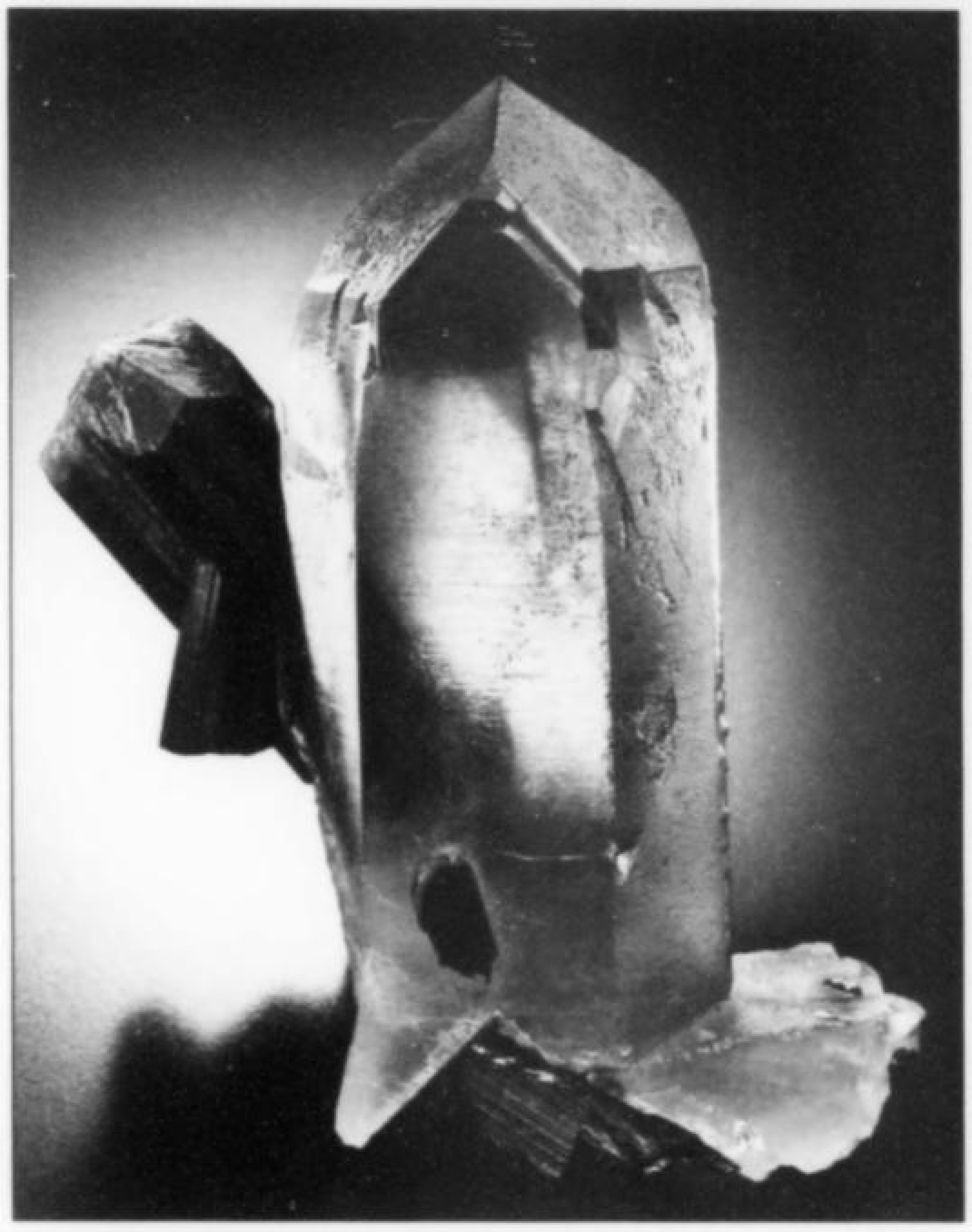


Figure 5. **Quartz and liddicoatite, 10.6 cm, from the Tsarafara pegmatite complex, Sahatany Valley, Madagascar. Spirifer collection; Jeff Scovil photo.**



Unfortunately, because of the very primitive mining methods and the focus on gem rough, most of the specimen crystals are damaged or incomplete.

The Sahatany Valley pegmatites are also the type localities for a number of mineralogical rarities such as londonite, manandonite and bityite (Antandrokomby pegmatite) and behierite (Manjaka pegmatite). Other rarities occurring in the pegmatites of this area include microlite, hambergite and rhodizite (Antandrokomby is one of the world's richest sources of this mineral). Periodically the mining activities focus on the recovery of such rare minerals purely as collectibles.

The Sahatany Valley has been an important source of gemstones and mineral specimens since the beginning of the 20th century. In the first decade of the 20th century most of the serious mining efforts were conducted by the French, primarily in the Maharitra and Ampatsikahitra pegmatites, and produced large quantities of gems. At the end of this period, the production in the area drastically decreased. Finally, in the 1970s, the deposits were turned over to the local communities and to regulation by the traditional land law, initiating a new period of mining: the locals started digging hundreds of small, chaotic, dangerous pits in the kaolinized pegmatites. In recent years production has been quite variable; each time a big find has been made, "tourmaline fever" has ensued and hundreds of people have descended on the area to dig numerous pits. In general, the miners in recent years have been much more focused on mineral specimens than in the past. Some spectacular mineralogical discoveries have occurred, and a number of fine specimens are found every year.

Recently the most intense mining activity has been taking place in one of the largest Sahatany pegmatites: the Tsarafara pegmatite, especially in its southern part, called Ankadilava. The area has produced a number of pockets with multicolored tourmaline, spodumene and beryl. Other important places that have been worked recently are Antandrokomby (producing rhodizite, manandonite and beryl), Antanetinilapa (worked for gems mainly in the alluvium downhill from the pegmatite), Ampatsikahitra (producing spessartite, tourmaline and beryl) and Antokambohitra (producing poor-quality gems and schorl). Other pegmatites have been worked with varying intensity and with varying results.

Pegmatites of the Sahatany Valley became well-known internationally via the detailed descriptions and research done by the famous French mineralogist Alfred Lacroix (1863–1948). An important part of his great three-volume work *Mineralogie de Madagascar* (1922–1923) is devoted to descriptions of the pegmatites and the mineralogy of the Sahatany Valley. Other important works on Malagasy mineralogy that deal with the Sahatany Valley deposits include the papers of Jean Behier (1903–1965), e.g. his *Contribution a la Minéralogie de Madagascar* (1960). More recent descriptive works of great importance include those of Federico Pezzotta, e.g. the *ExtraLapis English* issue *Madagascar, A Mineral and Gemstone Paradise* (2001).

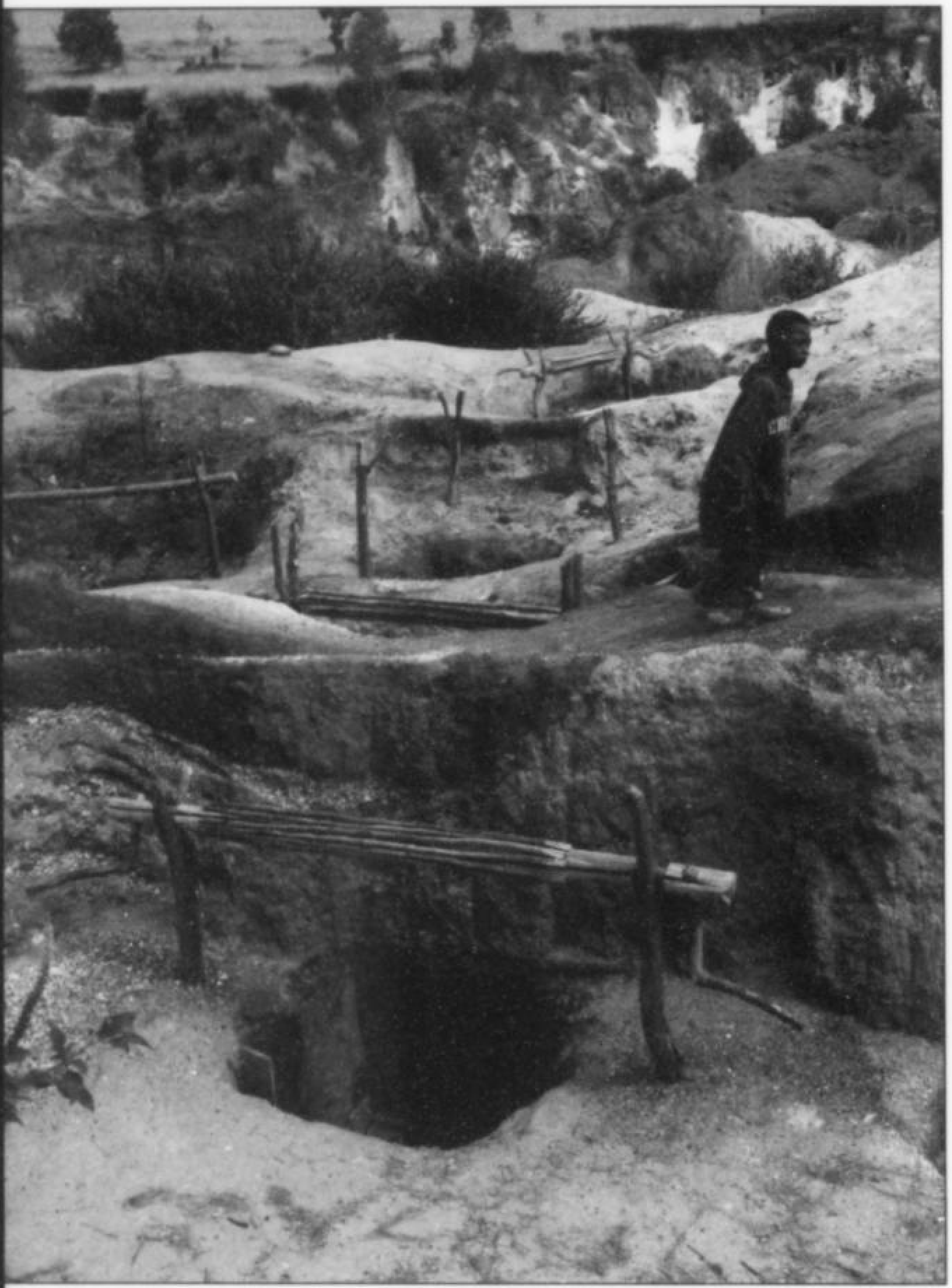


***Figure 6.* The Tsarafara pegmatite workings, Sahatany Valley, Madagascar. Jeff Scovil photo.**

Continued from page 257

of mostly bare granite mountains rising up from the plain. Here we saw our first ring-tailed lemurs, who ignored us from their perches in the branches, as it was nap time. We clambered up a naked granite monolith, and from its top we had a beautiful view of the countryside.

IHOSY

After leaving Anja Park we continued southwest and slowly descended from the central plateau that takes up much of Madagascar. The drop in altitude meant a welcome increase in temperature. Our next stop that afternoon was the small town of Ihosy, where we were shown some quartz crystals with phantoms. The sellers also had some unidentified equant, brown, translucent crystals in calcite veins that might have been uvite. We did not buy anything, but Tomek made a note to find the source of the unknown crystals.

ISALO NATIONAL PARK

That evening we stopped in the town of Ranohira, where we stayed in a hotel owned by Noro's family. The town is the jumping-off point for the wonderful Isalo National Park. A wall of cliffs cut by several small canyons rises out of the flat grasslands. With our guide, Jean Baptiste, we climbed up one of the valleys. On top, the terrain leveled out for some distance, then dropped off into a valley with a spectacular view of weird, weathered, multi-hued rock formations. We saw our first pachypodium (elephants foot) plant which looks like the bag from a bagpipe, with scraggly branches projecting from it, topped by bright yellow flowers.

We zigzagged down another small canyon and into another world. The valley was densely green with semitropical plants, in contrast to the surrounding near-barren, dry grasslands. Near the bottom of the valley we found a picnic ground with stone benches and tables where we stopped for lunch. There were brown lemurs snoozing in many of the trees. When they saw food, though, they came to life, scampering, swinging and leaping down from their perches in hope of a handout.

***Figure 7.* The Anja Park area, Madagascar. Jeff Scovil photo.**

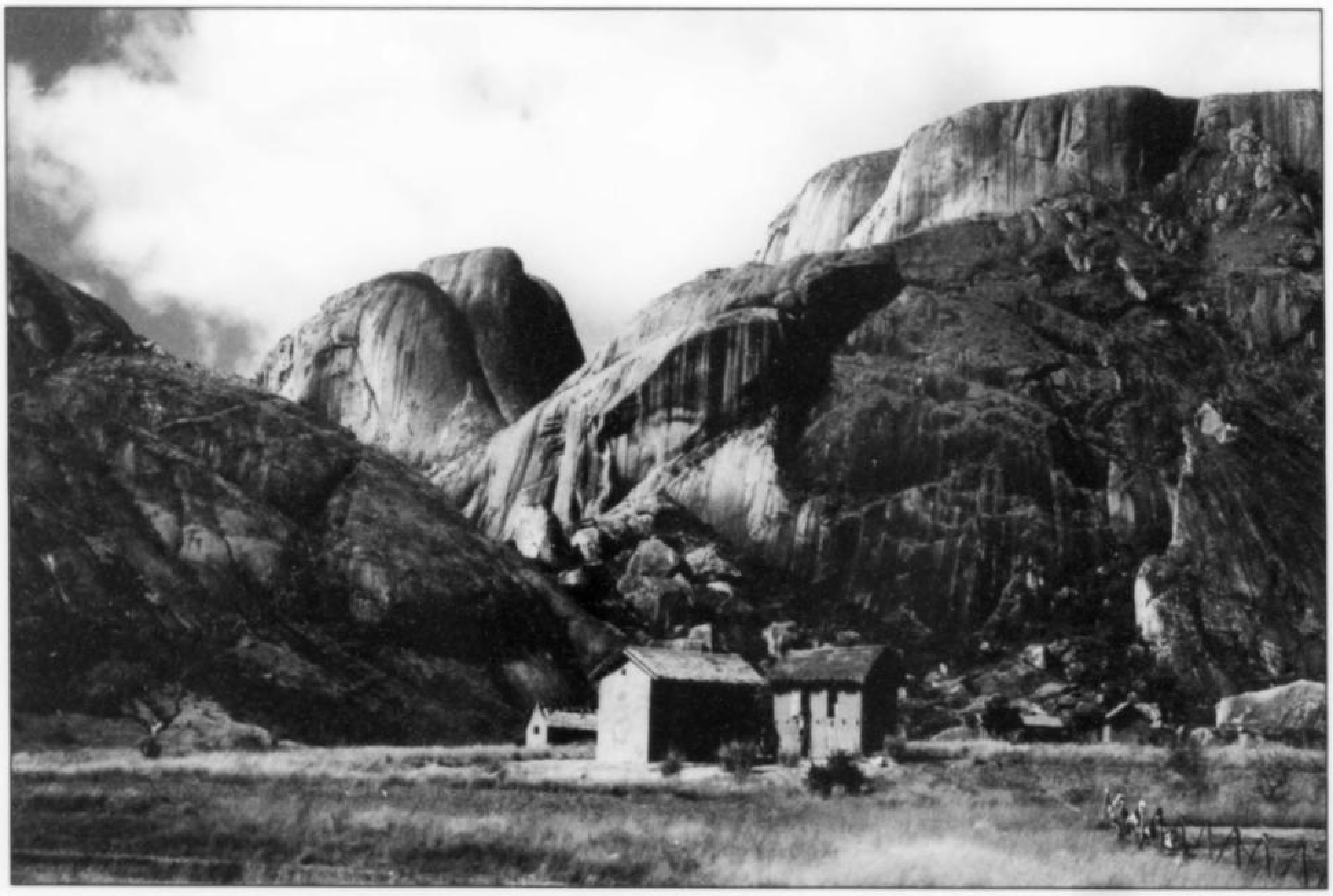


Figure 8. **A ring-tailed lemur in Isalo National Park, Madagascar. Jeff Scovil photo.**

You are not supposed to feed them, but it is hard to resist giving them a little bit of bread. They are quite friendly and brave, coming up to you and taking the food right out of your hands. I was holding my baguette sandwich behind me while I gave a piece of bread to one lemur, when another lemur sneaked up behind me and attacked my sandwich, resulting in a tug-of-war.

After lunch we walked up a small, lush, Eden-like valley with a beautiful stream flowing between the rock cliffs. After a bit of a hike we came upon two small, crystal-clear pools called Piscine Bleu and Piscine Noire nestled in the green foliage and rugged rocks. We lingered long enough to be told by a tourist from Cleveland who had dived into the water that it was really cold and he did not advise swimming. On the way out, after clambering over boulders and across rickety bridges of branches, we came back to the picnic area. The brown lemurs had disappeared and been replaced by ring-tailed lemurs who were just as good at posing for tourists.

ILAKAKA

We returned to the truck and continued southwest, making a quick stop in the town of Ilakaka in the middle of a broad, grassy valley. About ten years ago Ilakaka was just a sleepy little village, but then it was discovered that the ancient river gravels beneath the town were full of fine-quality gem sapphires. Overnight Ilakaka became a "Wild West " town with shootings, thefts and people pouring in from all over to find their fortune, including Chinese and Sri Lankan buyers.

SAKARAHA

A bit farther down the road, near the town of Sakaraha, we stopped to look at some of the traditional graves. Each grave is a stuccoed, walled enclosure filled nearly to the top with rocks. Projecting from the rocks are poles with figures carved on them and horned zebu skulls at their bases. The outsides of the walls are traditionally painted with scenes from the deceased person's life. Nowadays there are often figures from movies such as Rambo and Bruce Lee. It is considered taboo to photograph the graves.

SARANDRONO

Our goal that day was the small fishing village of Sarandrono on the southwest coast a short way south of the town of Toliara. Before driving out on the sandy spit where Sarondrano is located we picked up Tony's wife Noro, who had traveled there by public transportation. After a bumpy ride followed by very soft sand, we found a nice bungalow on the beach facing west toward the African continent across the Mozambique Channel. The bungalow rested on pilings above the sand dunes; it had woven reed walls and a thatched roof, and was encircled by an attached porch. There was no electricity, and lighting was either by kerosene lamp or candles. The bath was a small room on the veranda with a barrel of water and a ladle. The toilette was wherever you were comfortable out in the dunes.

The village of Sarondrano is home to fishermen—very basic and traditional. Brightly painted outrigger canoes carved from logs line the shore, and children run everywhere laughing and playing. The homes are made of a framework of slender logs planted in the ground and covered by thatched roofs and woven reed walls.

The next morning after breakfast we rented an outrigger and two paddlers and headed out onto the ocean. Tomek and Asia were brave enough to go snorkeling in the cold water while the rest of us were content to enjoy the experience vicariously. Back near the

Figure 9. **Our bungalow in Sarondrono, Madagascar. Jeff Scovil photo.**

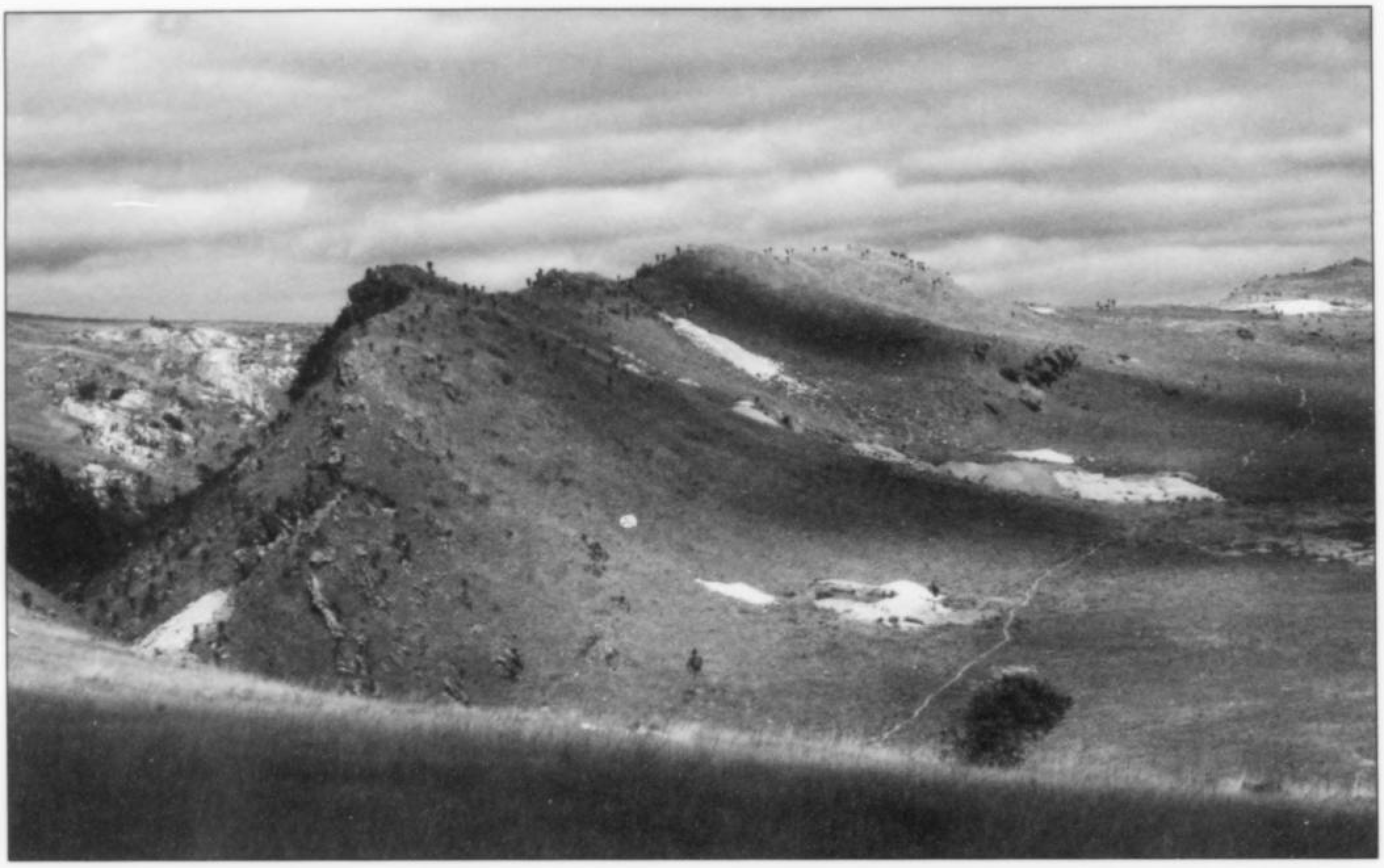


Figure 10. **Pegmatites (white scars) at Ambalamahatsara. Jeff Scovil photo.**

shore one of the paddlers jumped out, grabbed something off the sea bottom, tossed it into the bottom of the outrigger and leaped back in. The object in the bottom of the boat was an octopus hiding between a couple of mismatched shells. Tomek pried the octopus out and Kasia had a good time playing with it before putting it back on the boat bottom. I am sure the octopus ended up as someone's dinner that evening.

We then paddled across the small bay to the mainland where we visited a freshwater spring in a sinkhole just in from the shore. Called the *Grottes du Sarondrano*, it boasts crystal-clear water and colorful fish. Since this water was much warmer than the seawater, Kasia and I decided that the Grottes was a great place to snorkel. By the time we finished and were ready to leave, the tide had gone out and the water in the bay was so shallow that we had to get out and push in order to give our boat enough draft to clear the bottom.

That evening we dined again at the local restaurant, Auberge du Pecheure, and it was a wonderful ending to our visit to Sarondrano. A group of expatriate Frenchmen was also eating there that night, and one of them was celebrating a birthday. The staff came in with a birthday cake singing Happy Birthday in Malagasy. One of the Frenchmen pulled out a harmonica and another a soprano recorder, and they played several Malagasy folk songs. This was all that was needed for a group of Malagasy locals to start dancing just outside. The locals had brought with them a drum and something resembling a homemade guitar, and they took over after the Frenchmen finished playing.

Several of our group as well as the Frenchmen and locals were dancing in the sand under the starlit sky. Every song was fast-paced with energetic dancing, like a Malagasy version of Irish step dancing but with a bit more upper body movement. Marcin rushed back to the bungalow to get his sound recorder and we all enjoyed the wonderful, spontaneous, festive atmosphere.

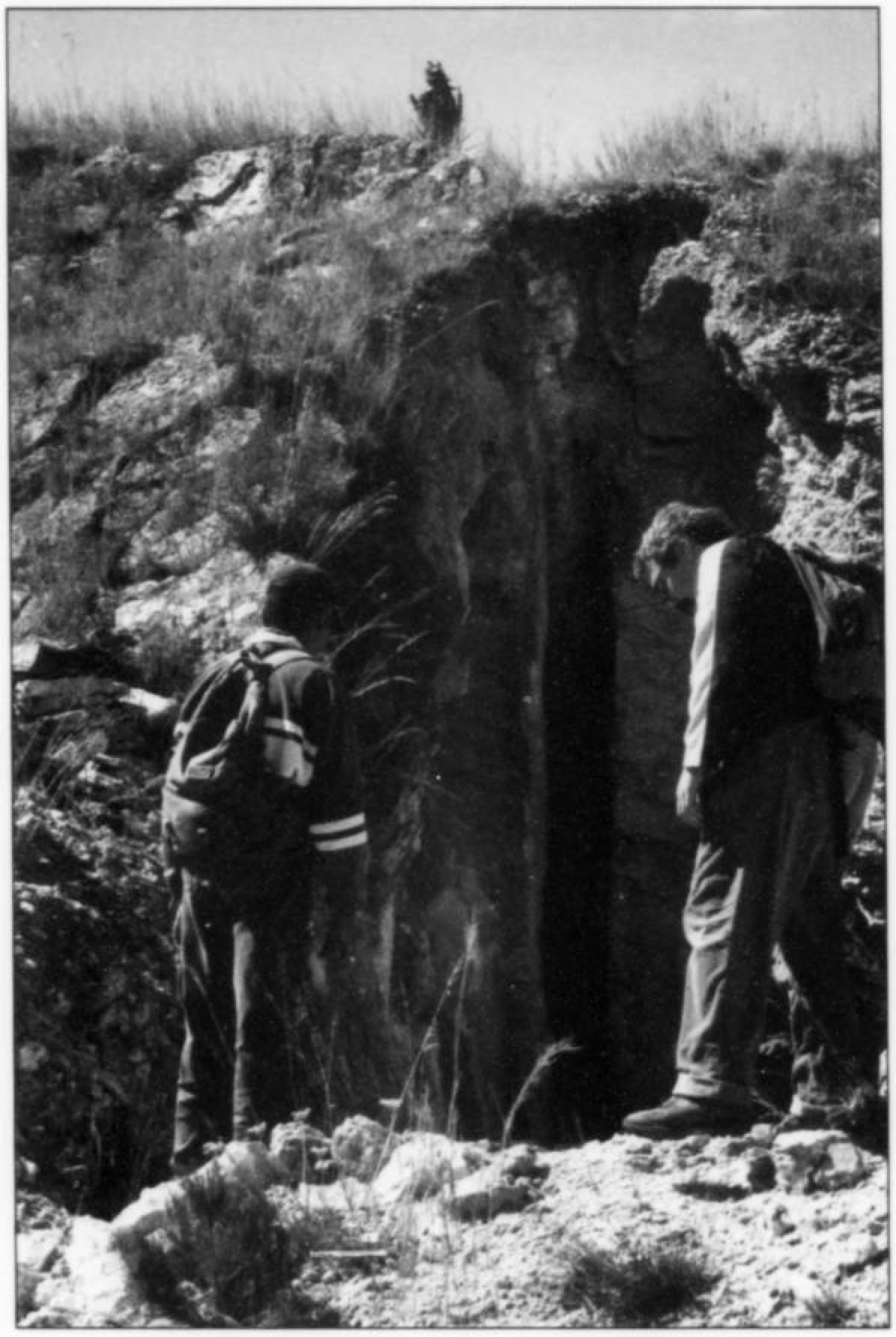


Figure 11. **Examining a pegmatite excavation at Ambalamahatsara, Madagascar. Jeff Scovil photo.**

TOLIARA

The following day we piled our gear back in the Toyota and made the long, bumpy ride back to the main road. From there it was a

Figure 12. **Morganite, lepidolite and tourmaline in a pegmatite at Ambalamahatsara, Madagascar. Jeff Scovil photo.**

short drive to the town of Toliara, which is the terminus for Rte. 7 on the coast. We made a quick stop at the local outdoor market where Kasia and Marcin bought a few gifts to bring home with them.

A short distance southeast of town we visited the Antsoky Arboretum. It was founded about 40 years ago by a Swiss botanist who spent much of his career studying the fascinating plants of Madagascar. The arboretum has many of the plants that are endemic to the spiny forests of Madagascar, including over 100 species of just the euphorbia group! Our last stop was the airport where we dropped off Kasia and Marcin for their return flight to Poland.

ZAZAFOTSY

We left the lovely seacoast and drove back along Rte. 7 to the northeast, stopping in Zazafotsy. There we were offered many of the tabular, dark red rubies that are found in quantity in the gneisses nearby. We came to Isalo Park just before sunset, which was perfect timing. Close to the road is the "Window of Isalo," which is a natural opening in a ridge of rock. The tourists were thick on the east side of the ridge, with cameras ready to catch the sunset through the Window.

AMBATOFINANDRAHANA

The next day we continued our drive to Fianarantsoa and then north. Just south of Ambositra we headed west. The pavement soon ended and we found ourselves in the small town of Ambatofinandrahana. I was pleasantly surprised when we pulled into the driveway of a nice house called the Marbre Auberge, which was to be our base of operations for the next two days. Many towns such as this have electricity for only part of the day, and running water can be problematic. It was back to the ladle and barrel of water for bathing.

AMBALAMAHATSARA

The following day we drove south with our new passenger, Toma, who is very familiar with the mineral localities in the area. Tony drove us to a nearby village called Ambalamahatsara where he left us to take off across the valley and inspect some of the numerous pegmatites found there. As in the Sahatany Valley, the host rock here is marble. Most of the pegmatites were not actively being mined, but one local we met showed us a *circa* 16-cm morganite he had exposed. Back at our "bed and breakfast" we had a late lunch, then began driving southeast to Tetikanana. It was near there, in an exposure of gneiss in the side of a wash, that the hematite crystals epitactic on rutile had been found several years ago. We found nothing, and French dealer Laurent Thomas, who had worked the locality, told me later that he did not think there was much left.

ITREMO

After tramping around all day looking at pegmatites, we met Tony and drove back to the Auberge du Marbre. We packed our belongings and headed west. Our next stop was the town of Itremo, which is in the center of a quartz crystal-producing district. The biggest dealer in town had thousands of single quartz crystals and clusters of all sizes. In an area behind his shop he had numerous baskets close to a meter in diameter, all lined with straw and filled with crystal groups; Tomek chose a number of specimens. Then we visited another dealer who had a batch of "pineapple" quartz. It looked a lot like the white-coated, rough-surfaced quartz that came out of Ouray, Colorado years ago. We continued west and stopped for lunch on the side of the road. Toma and I took a walk and found several pits surrounded by quartz dumps and rejected crystals up to 20 cm long.

We spent the rest of the afternoon driving west on a dirt road that got worse and worse. I have never seen a road that was so bad for so long; most of the time we were in four-wheel drive. We had to get out several times to give the Land Cruiser a little more clearance, and for the sake of safety. The whole day's driving only took us 100 km. If it had been the rainy season we might have covered only 20 km because of the mud.

AMBOROPOTSY

It was pretty late when we pulled into the small town of Amboropotsy. We found a very primitive "hotel" catering to the locals,

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Ambatofinandrahana Region

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Ambatofinandrahana is a small town on Route No. 35, located about 70 km from Route No. 7 to the west, with easy access (No. 35 is a comparatively good road by Madagascar standards). Around Ambatofinandrahana are numerous interesting localities producing various mineral species. This concentration of interesting localities is the product of a diverse geology. The most productive deposits in this area are pegmatite veins in metamorphic rocks and low-temperature hydrothermal veins. The relatively high population density (for Madagascar) and the easy access to the area (the majority of the localities can be reached with four-wheel drive) have led to thorough geological exploration and many mining projects.

Geologically, the rocks of the Ambatofinandrahana area are part of the Itremo Group (Antananarivo Block), which is characterized by Proterozoic shallow-marine sedimentary rocks (sandstones, limestones) which were metamorphosed to quartzite and marble during the amalgamation of the Gondwana supercontinent (Collins, 2006, and references therein). Magmatic intrusions were also emplaced during that event, and in fact it is likely that the majority of the mineralization in the area is related to this episode.

The Ambatofinandrahana region is most famous for quartz with and without inclusions, epitactic hematite on rutile, bastnäsite, tourmaline and beryl, including huge crystals of aquamarine, with dumortierite crystals, encased in solid pegmatite.

The three localities described below are typical and have been the most important producers in recent years.

TETIKANANA—RUTILE AND HEMATITE

The Tetikanana locality (named after a small village located about 1 km from Ambatofinandrahana on Route No. 35) is situated in a small valley between two gentle hills south of Ambatofinandrahana. The Tetikanana outcrop is in a big *lavaka* (the Malagasy term for a deep valley or canyon cut into laterite by erosion during the rainy season).

The area south of Ambatofinandrahana consists of metamorphic rocks, such as marble (forming hills) and quartzite with granitic intrusions. Weathered granites exposed at the

***Figure 13*. The Tetikanana rutile and hematite locality, Madagascar. Jeff Scovil photo.**

bottom of the lavaka contain hydrothermal mineralization and slickensides in faults. Rutile and hematite specimens have been found on fault surfaces and in small pockets filled with earthy hematite. Some are of very good quality, with small (usually 2 to 3 cm but reaching a maximum of nearly 10 cm), lustrous epitactic hematite crystals on rutile crystals. They were called "keys" by the locals because of their characteristic shape: a hexagonal, tabular hematite crystal perched atop a rutile "leg" to form a specimen shaped like a door key. Unfortunately those most interesting specimens were found only very rarely.

The Tetikanana locality was discovered by local miners a few years ago and was mined occasionally, but has since been abandoned.

In this same area, even within the town of Ambatofinandrahana, there are other outcrops carrying hematite-rutile mineralization. In some of them giant tabular hematite plates up to 40 cm have been found. Unfortunately, no good-quality epitactic intergrowths of those two species have been found there.

ITREMO–QUARTZ, QUARTZ, QUARTZ

The village of Itremo is situated about 30 km west of Ambatofinandrahana, 4 km from Route No. 35, at the foot of the jagged Itremo mountain range. Itremo is the "capital of quartz": there is even a group of quartz crystals mounted on a small monument in the central square of Itremo village. Mining and dealing in quartz is an important source of local income; you can find huge quantities of this mineral in almost every house. Of course, the majority is only rough material suitable for tumbling, carving, etc., but there are also large quantities of rock crystal and "pineapple" quartz. The rarest specimens include scepters, crystals with moveable gas bubbles in fluid inclusions, fuschite inclusions, and star-shaped hollandite inclusions. Smoky quartz crystals and quartz crystals with chlorite and/or iron oxide inclusions are also occasionally found. There are almost no continuously operating mines in the area; the majority are worked only occasionally or "on demand."

Figure 14. **Quartz sellers in the village of Itremo, Madagascar. Jeff Scovil photo.**

Figure 15. **A nice quartz cluster from Itremo, Madagascar. Jeff Scovil photo.**

The geology of the Itremo massif is not very complicated; most of the area consists of layered quartzite with well-preserved ripple marks and other sedimentary marine structures.

The quartzite is cut by countless hydrothermal quartz veins containing quartz crystal pockets. Geodes range in size from a few centimeters to a few meters and may contain quartz crystals to over 1 meter in size. The majority of the pockets contain opaque white crystals of poor quality, but because pockets are so numerous the number of good finds is high. Very often, interesting specimens of a particular type are found only in a single pocket and nowhere else. In other cases veins contain a series of pockets that may be mined for many years—for example the quartz crystals with hollandite "stars." Irregular and chaotic mining in countless veins spread over a large area, and the discovery of many new veins every year, generally result in different types of quartz being available during every visit to the Itremo area. The majority of Madagascar quartz specimens available on the international mineral market have come from this area.

Numerous pegmatites are also found in the Itremo massif, but they have not produced any good-quality specimens, only tourmaline and beryl rough.

AMBALAMAHATSARA—PEGMATITE MINERALS

Ambalamahatsara is a small village located about 25 km south of Ambatofinandrahana. There a system of pegmatite veins crosses white marble and schist in a group of hills about 1 km north of the village. The veins are comparatively thin, usually about 1 meter to a few meters thick, and the majority have been mined for gem rough.

The pegmatites consist of feldspars, quartz and lepidolite. In the central parts of the veins are numerous zones containing embedded tourmaline and beryl crystals. The tourmalines are usually green and pink; the beryl crystals are pink, green and colorless. The tourmaline and beryl crystals are usually over 10 cm in size, occasionally reaching over 20. Unfortunately, the crystals are not very well formed because of the almost total lack of voids, but huge quantities of rough material have been mined there. Rhodizite occurs in some veins (Besiere, 1965). Typically the marble has been metasomatically altered in the contact zones surrounding the pegmatites, resulting in numerous cavities containing wollastonite.

The Ambalamahatsara locality was an important subject of research during colonial times and had a great impact on the history of Malagasy mineralogical and geological research (for example, see Besiere, 1965; Guigues, 1953, 1954).

IALAMAITANA PEGMATITES

The Ialamaitana group of pegmatites is located in a mountainous area 2 km east of Sahanivotry village, which is on Route No. 7, about 35 km south of Antsirabe. The pegmatites occur in metamorphic rocks, in a geological situation similar to that of pegmatites in the Sahatany Valley. The difference between these areas is that in the Sahatany Valley the dominant pegmatite type is the Na-Li type (an old, mostly disused classification, but still very useful as a field term and for use by mineral collectors), whereas the Ialamaitana pegmatites are of the K type. The difference is that Na-Li pegmatites contain minerals such as albite (Na feldspar), lepidolite (Li-rich mica), tourmalines (often gem-grade), beryl varieties (goshenite and morganite but no aquamarines) and spessartine. K-type pegmatites contain K-feldspars (microcline), muscovite and/or biotite, tourmalines (generally only black schorl), beryl (almost solely aquamarine), and almandine.

The Ialamaitana pegmatite field contains a number of pegmatites of various sizes, from one to a dozen meters. Only a few of them have been mined. The largest quarry, recently abandoned, is in a big coarse-grained pegmatite containing large amounts of beryl (mined as industrial stone in colonial times) and rose quartz (mined recently as decorative stone). No interesting mineral specimens have been found in this quarry.

Most famous, and as well known as the Ialamaitana pegmatites, is a system of pegmatite veins mined for niobium-rich rutile called "strüverite" (described in the early 1900s as a new mineral species, but later discredited). Strüverite occurs there in a medium-grained pegmatite, in association with rare beryl, schorl and almandine. A lack of open pockets in the pegmatite means that crystals are frozen in solid rock. Because the pegmatite is highly weathered, the crystals contain many cracks, and specimens in matrix are almost impossible to collect. Strüverite crystals usually have a dull luster, gray color, and a size up to 5 cm. Crystals are typically not very sharp. It must be noted that the best strüverite crystals (up to 10 cm, black and lustrous) have been mined a few hundred kilometers north of Ialamaitana, but the dealers usually label them "Ialamaitana" as well, to keep the locality secret .

The last important pegmatite mined in this area, known as the Antsotsara pegmatite, is a small vein producing numerous, good-quality trapezohedral crystals of almandine. The crystals are usually 1 to 2 cm, but specimens up to 5 cm have also been found there. They are deep red or black with reddish internal reflections. The luster is good but not the equal of crystals from the world's best localities. Because the mined portion of this pegmatite is also weathered, most specimens are very fragile and the crystals are mostly loose, but there have also been some good-quality specimens on matrix mined, some of them containing schorl in association.

Continued from page 263

and it was full. We finally located a place to stay at a restaurant/home. It was a small, two-story building with a single small room for dining and a small entry area with various bottled beers and soft drinks on the wall. The owner gave up her bed for me, and Toma slept on a foam mattress on the floor next to the bed. In the dining room Tony and Noro slept on another foam mattress on the floor while Tomek and Asia slept in the Land Cruiser (I think they were the smart ones). The place was far from clean, but luckily I had a sleeping bag. The toilette facilities were particularly memorable: a hole in the floor of a collapsing, doorless adobe shack out back where the locals walking by could appraise your efforts.

The owner served us a late dinner of rice and pork with particularly greasy utensils and the usual sand. I did not sleep well because I woke up every five minutes thinking there were bugs on me. We got up early, had breakfast and left. It was a relief to get going and leave behind the less-than-stellar accommodations, although we did appreciate the efforts of our hostess.

MANDROSONORO

The following day was not much better. We continued west over more awful roads, making it to Mandrosonoro where we stopped for lunch and minerals, of course. We bought some nice amethyst scepters from a woman who invited us into her home, unwrapped many crystals and arrayed them on her bed. During lunch at a local restaurant two guys showed us some pale, lightly etched heliodor beryls, the biggest of which was about 4.5 cm. The two miners had a hard time agreeing on a price, and when they finally did it was pretty high. Tomek bought two small pieces and gave them some money to continue mining.

The road continued west and, dropping off the central plateau, was paved for a very pleasant, short distance! The asphalt did not last long, however, and after crossing a small stream we bottomed out against the center ridge of the road and damaged part of the truck's suspension. Noro, Tomek, Asia and I packed some necessities in our daypacks and walked down the road. Tony and Toma stayed behind to guard the truck and our gear. Just after sunset and a thirty-minute walk we came to a village. It was like stepping back in time—thatched roofs on mud-walled huts with chickens and pigs running around. I took a photo of all the curious children that came to stare at us, and they went crazy wanting their individual photos taken.

MALAIMBANDY

In the meantime Tomek and Noro made arrangements to rent two bull-drawn carts. One of these, with two men and food, went back to our Land Cruiser to spend the night with Tony and Toma. The other cart, with a layer of hay to sit on, was our transport to the next sizable town. For the next three and a half hours we sat in the cart under beautiful starry skies traveling over a mercifully not too rough dirt road. We made it to the town of Malaimbandy, which was dark and closed up at that hour. Just beyond the town we found a group of bungalows and roused the owner. She made us a late dinner and we gratefully settled into our quarters. Malaimbandy is at the junction of the horrible dirt road we had been on and a good paved road.

Sometime later that night Tony showed up at the bungalows, having left Toma behind with the vehicle. We made a number of cell phone calls the next morning to arrange for someone to get to the truck to repair it. In the meantime we had a schedule to keep, so we caught public transportation (a large truck, with many people in the back, called a *taxi brousse*) and headed west on the paved road. It was so potholed that it was better to drive on the shoulder than on the "pavement."

MORONDAVA

We finally got off at the port city of Morondava on the west coast of Madagascar, where another road headed north. We had arranged to meet a young man with a Renault sedan at that intersection. We traveled north on the dirt road to the Avenue of the Baobabs, where there are many of the strange trees that Madagascar is famous for. The magnificent and bizarre trees are usually "loners" and seldom grow in the concentration they are found in along this one stretch of road.

After taking many photographs we continued north to the town of Tsimifana on the banks of the Tsiribihina River and the terminus of a ferry. Luckily the ferry was ready to leave when our driver dropped us off there, so we climbed aboard in the dark. The ferry was small and consisted of two pontoons and a wooden deck big enough for maybe two vehicles and a few foot passengers. The crossing was not directly to the other side but took us several kilometers downstream, and so we had about a 40-minute ride. The ferry ride in the dark, starlit night was wonderful, with the stars reflecting off the water and the gentle waves lapping against the hull. I should say here that the estuaries along the coast are not a place for swimming, as they are populated by Nile crocodiles.

Figure 16. **"Avenue of the Baobabs," near Morondrava, Madagascar. Jeff Scovil photo.**

BELO

A friend of Tomek's named Olivier owns a hotel in the town of Belo on the other side of the river. He had not gotten the message to pick us up, so Tomek and Asia walked to town. I was left standing in the dark on the side of the dirt road by the river, with all the luggage. With every little noise I thought there might be a crocodile coming out to get a taste of tourist.

After about thirty minutes Olivier showed up in a pickup truck and we drove to the Hotel Suzanna. It was one of the best places we had stayed at so far: it even had electricity. The power was turned off by the town for several hours each night and there was no hot water, but the hotel had its own generators, so there was no break in electrical service.

The following morning we left in another four-wheel-drive pick-up and headed north. We made a quick stop at an area where fossils were weathering out of the sandstone. Lying on the ground were pelecypods, fragments of straight cephalopods, petrified wood with worm borings and casts of crab burrows. After a very dusty four-hour drive we came to the Manambolo River. The ferry was not due for a while, and since we did not have a lot of time we hired two men to take us across in *pirogues* (dug-out canoes). It only took a few minutes to cross the narrow river, and our driver and truck had to wait for the ferry.

TSINGY DE BEMARAHA NATIONAL PARK

Immediately on the other side is the entrance to the Tsingy de Bemaraha National Park, where we purchased tickets and hired a guide. Tsingy is a karst region that looks like something from a science fiction movie. The horizontal limestone beds have been weathered into giant, irregular blocks with vertical gaps between them that are up to several meters wide. The tops of the blocks are covered with thousands of spires up to several meters tall. We walked between the blocks and in places were able to climb up to

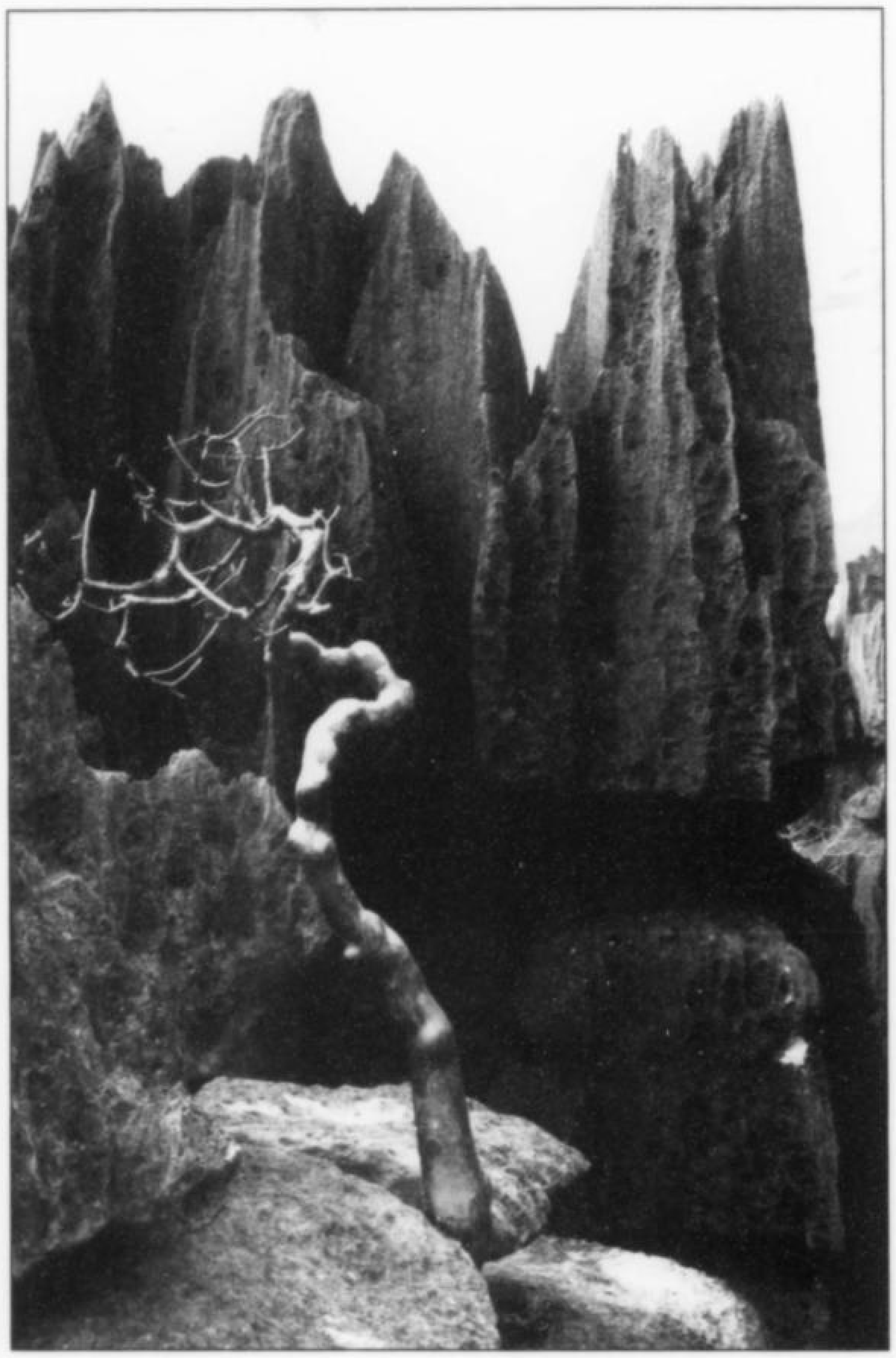

Figure 17. **Rock spires at Tsingy de Bemaraha National Park, Madagascar. Jeff Scovil photo.**

observation platforms set amongst the spires and view the surreal landscape from above. To add to the unreal atmosphere, some of the odd plants Madagascar is known for grow amongst and atop the stone formations. The strange outcrops are surrounded by a forest that is full of lemurs, geckoes and other interesting wildlife.

We spent that night in some nice thatched A-framed bungalows in the local town of Bekopaka. It was nice and rustic, and we each had real bathrooms with cold showers and mosquito netting over the beds. Electricity was provided by a generator from 5 to 10 in the evening only, and only in the office/restaurant.

The next morning we arose early and went back to the river where we hired two more *pirogues*. They took us upstream to where the limestone cliffs come right to the river's edge. There we visited two small caverns that had some nice cave formations.

Back at the ferry crossing we boarded our pickup truck and headed north for about another hour. We had spent the previous day in "Little Tsingy," which is the most visited part of the park because of its ease of access. That day we were to visit "Big Tsingy" a little to the north. As the name implies, it is bigger than Little Tsingy as well as more spectacular, rougher and less visited. We were required to wear safety harnesses and tie off to cables attached to the rock walls in places. We even ran into an inquisitive mongoose in one of the mini canyons.

Back at the park entrance we crossed the river once again and drove south back to the Hotel Suzanna in Belo. There we met Tony and Noro, who had arrived in the meantime. We were driven south back to the crossing at the Tsiribihina River where we boarded a much smaller canoe-like ferry with outriggers that took us across. Remember our disabled truck? The mechanic whom we had contacted via cell phone had come out to the truck on a motorcycle and had temporarily repaired it, so our trusty Toyota was waiting for us on the other side.

We drove south, passing through the baobabs again, and finally turned east where we had gotten off the *taxi brousse* two days earlier. The road was just as bad as I remembered, but the potholes finally disappeared and we had smooth sailing for a while. At dusk we reached Malaimbandy, where we had slept the night after the breakdown. On the side of the road was a guy looking for a ride to Antsirabe with several tons of gem-quality rose quartz! We ate dinner there, then continued on to Miandrivazo, where we spent the night. The bungalows there actually had solar water heaters and we had our first hot water showers in almost two weeks!

BACK TO ANTSIRABE

The following day we finished our drive back to Antsirabe and settled down in our old hotel, doing little for the rest of the day. That evening a dealer came to the hotel and showed us a lot of nice minerals, including some very nice garnets frozen in pegmatite matrix. We bought a number of specimens from the fellow and asked if he would show us the mine, which he readily agreed to do. After he left I took my first ride in a *pouse-pouse* to a nightclub for a taste of the local night life. The music was very enjoyable Malagasy pop, mixed with some western rock.

IBITY

In the morning we drove a short distance west to the town of Ibity. It was the weekly market day, and that is where we headed.

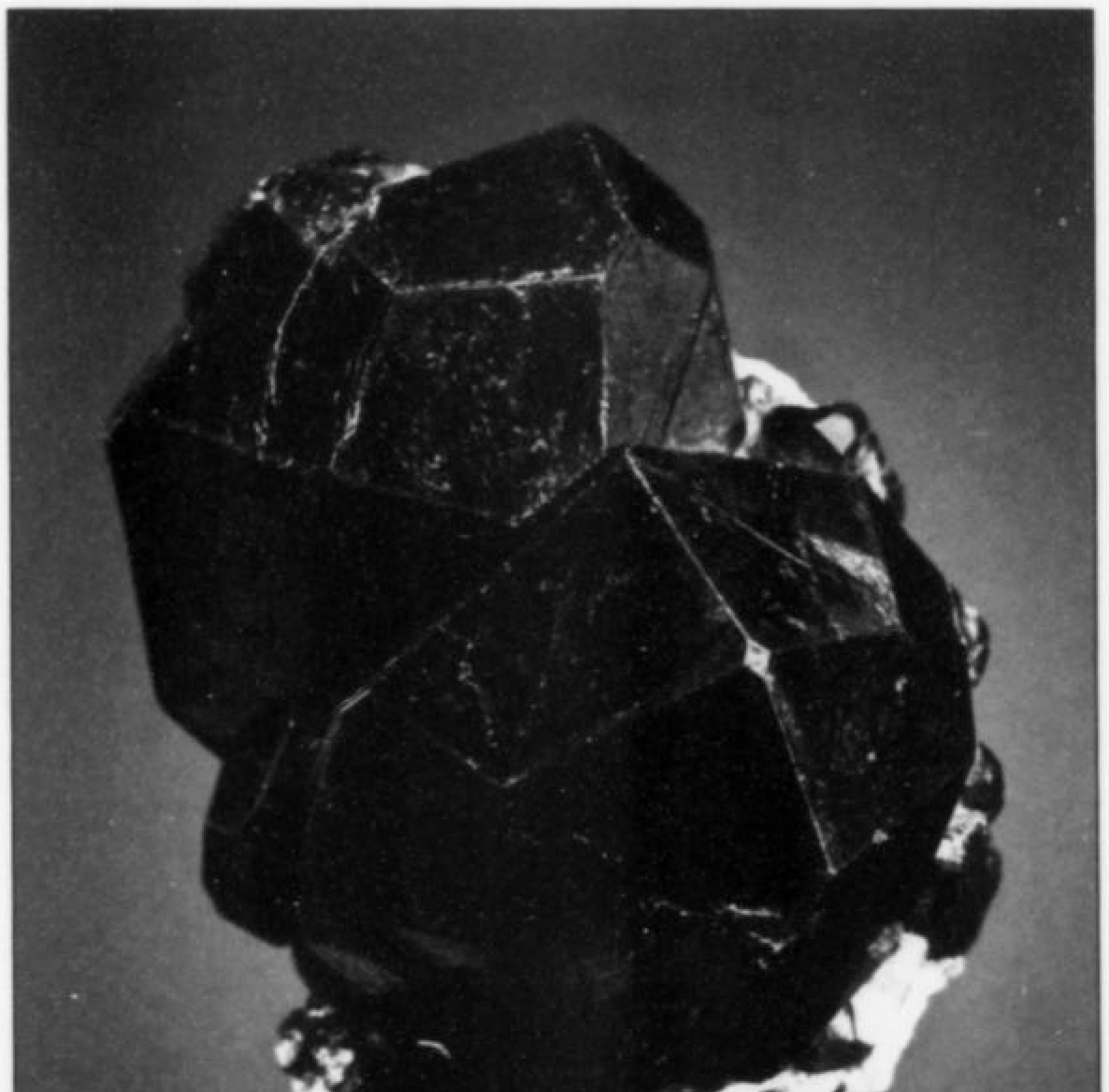

Figure 18. **Almandine crystal group, 5.5 cm, from the Antsotsara pegmatite, Sahanivotry, Madagascar. Spirifer collection; Jeff Scovil**

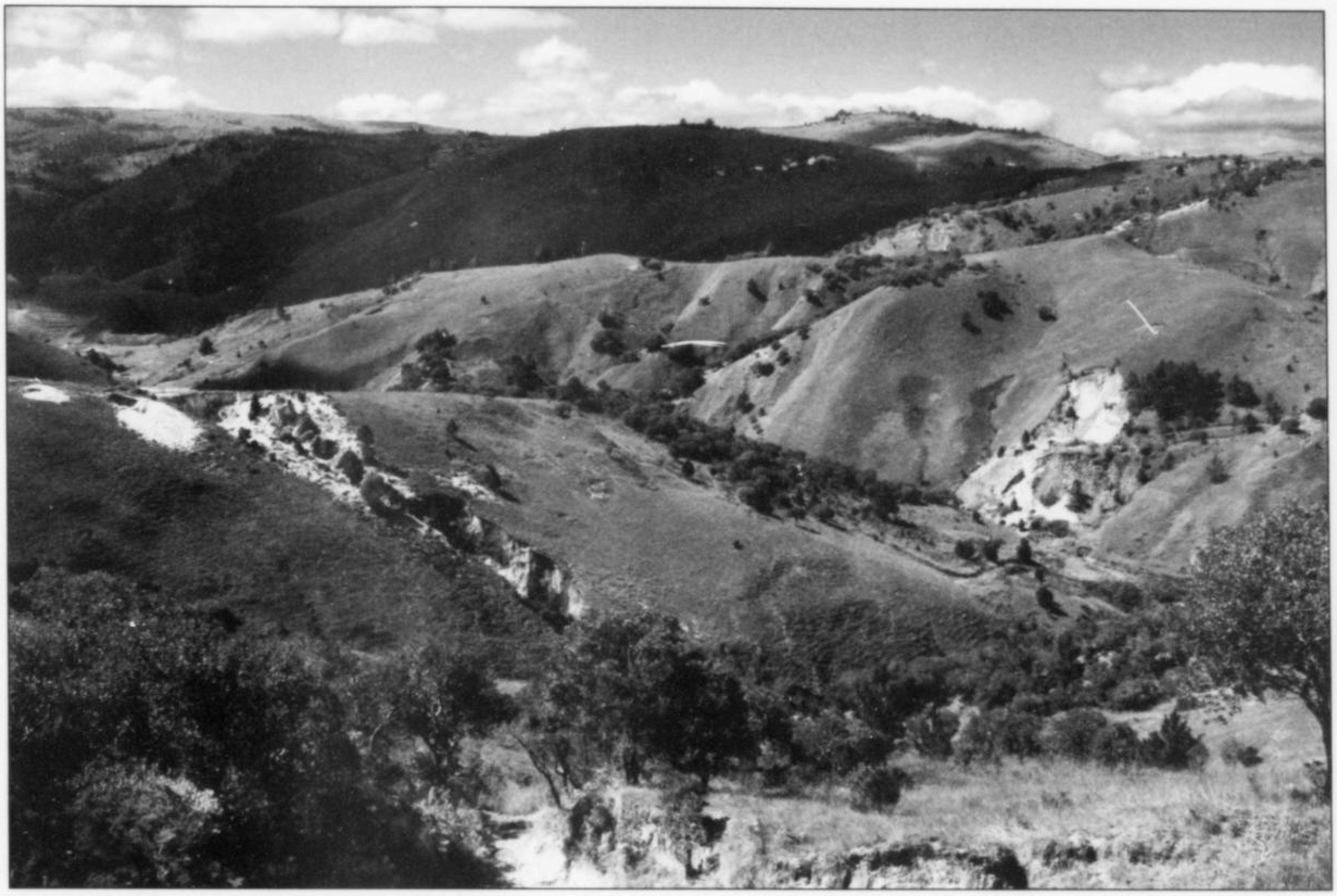

Figure 19. **Rose quartz pegmatite (white cuts on the left) at Sahanivotry, Madagascar. Jeff Scovil photo.**

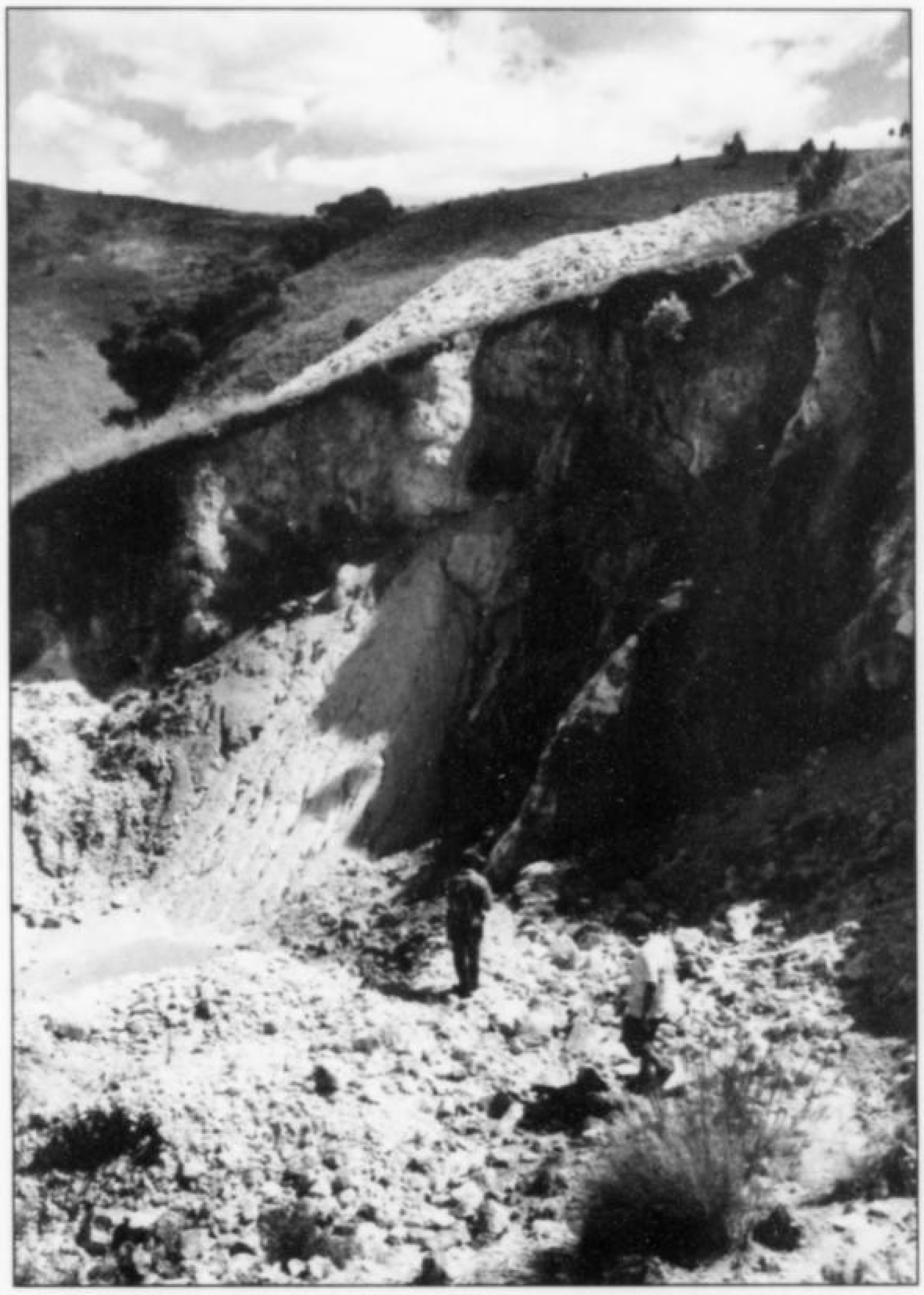

Figure 20. Rose quartz pegmatite at Sahanivotry, Madagascar. Jeff Scovil photo.

The market has no designated mineral/gem area, but once the word got out we were inundated with people with outstretched hands clutching their little treasures. They had mostly tourmaline crystals, and we bought several. Afterwards we walked around looking at the things being offered—homemade brooms, baskets, used clothing, unrefrigerated meat and really foul-smelling dried fish were just a few of the goods for sale.

SAHANIVOTRY

This was my last day in Madagascar and I was to get some real exercise. We drove 14 km south from Antsirabe to the small town of Sahanivotry. We picked up the garnet man there and headed up a dirt road toward the hills to the east. The road went bad quickly and we continued on foot. As we made the top of the first ridge we had a beautiful view back over the valley and Route 7. In the other direction was a panorama of mountains sprinkled with the white dumps of pegmatite mines. Our first stop was a rose quartz mine, and after much up and down hiking and numerous stops for the wheezing tourists to catch their breath we stopped at another pegmatite. This is the locality for ilmenorutile (aka strüverite) and consists of several pits along the strike of the pegmatite. Next to one pit was one of the saddest hovels I had seen on the trip. A man and his family lived there while working on the pegmatite. A shelf in the hut held the fruits of their labor, and we bought three thumbnail ilmenorutiles from the fellow.

We hiked back across the valley to a small stand of pine trees. Hidden among them was an adit that accessed the garnet pegmatite. We crawled on our bellies into a small stope, the walls of which were studded with thousands of garnets. Our guide had a single candle and Tomek, Asia and I had small flashlights. We took a few garnets but had not really come to collect—it was enough to see and photograph the locality, and we did not want to deprive our guide of his livelihood. After returning to the fresh air we made the long, strenuous trek back up the ridge and down to the valley where we met Tony with the truck.

BACK TO ANTANANARIVO

First thing in the morning, we were greeted in the hotel parking lot by at least six dealers, and I bought my last tourmaline. Tony then drove me to Antananarivo where I caught my ten-hour flight back to Paris. The trip was a great experience and a wonderful adventure but, like my trip to China, it also produced sensory overload. We walked our rear ends off, had our truck break down, rode in a wagon drawn by Zebu bulls under the starry skies, slept in someone's simple home, saw incredible sights and bought nice minerals. There was also little hot water, sometimes no running water, heat, cold, endless kilometers of horrible dirt roads, poverty, children and adults begging for food, diarrhea and some pretty sad hotels. We also saw a beautiful forest and beaches, fascinating wildlife and an amazing country. All in all it was a great trip that I will never forget, with tourmaline for breakfast, lunch and dinner (and a late night snack).

THE MUSEUM DIRECTORY

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Website: www.colburnmuseum.org
Pack Place Education,
Arts & Science Center
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Asheville, NC 28801
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Website: http://www.mbmg.mtech.edu/museum/museum.asp
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Send vital information, as shown, to the editor. There is a modest annual fee (lower than our regular advertising rates).

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E-mail: bbradford@stetson.edu
Associate Director: Dr. Karen Cole
Tel: (386) 822-7330
E-mail: kcole@stetson.edu
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[mailing: 421 N. Woodland Blvd., Unit 8403]
Hours: 10:00 AM–4:00 PM, Monday-Friday (closed during university holidays)
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E-mail: bgeller@mines.edu
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Curator & Professor of Mineralogy:
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E-mail: akampf@nhm.org
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Specialties: Calif. & worldwide minerals, gold, gem crystals, colored gemstones, micromounts
Support organization:
The Gem and Mineral Council

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Tel: 775-784-4528, Fax: 775-784-1766
E-mail: rdolbier@unr.edu
Website: http://mines.unr/edu/museum
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Specialty: Comstock ores, worldwide minerals, mining artifacts, Mackay silver

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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Tel: (520) 883-3033
E-mail: adomitrovic@desertmuseum.org
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Hours: 8:30–5 Daily (Oct.–Feb.) 7:30–5 Daily (Mar.–Sept.)
Specialty: Arizona minerals

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

Curator: Dr. Jeffrey E. Post
E-mail: minerals@nmnh.si.edu
Collection Managers: Paul Pohwat and Russell Feather
(Dept. of Mineral Sciences)
Washington, DC 20560-0119
Hours: 10 am–5:30 pm daily
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Curator: Julian Gray x415
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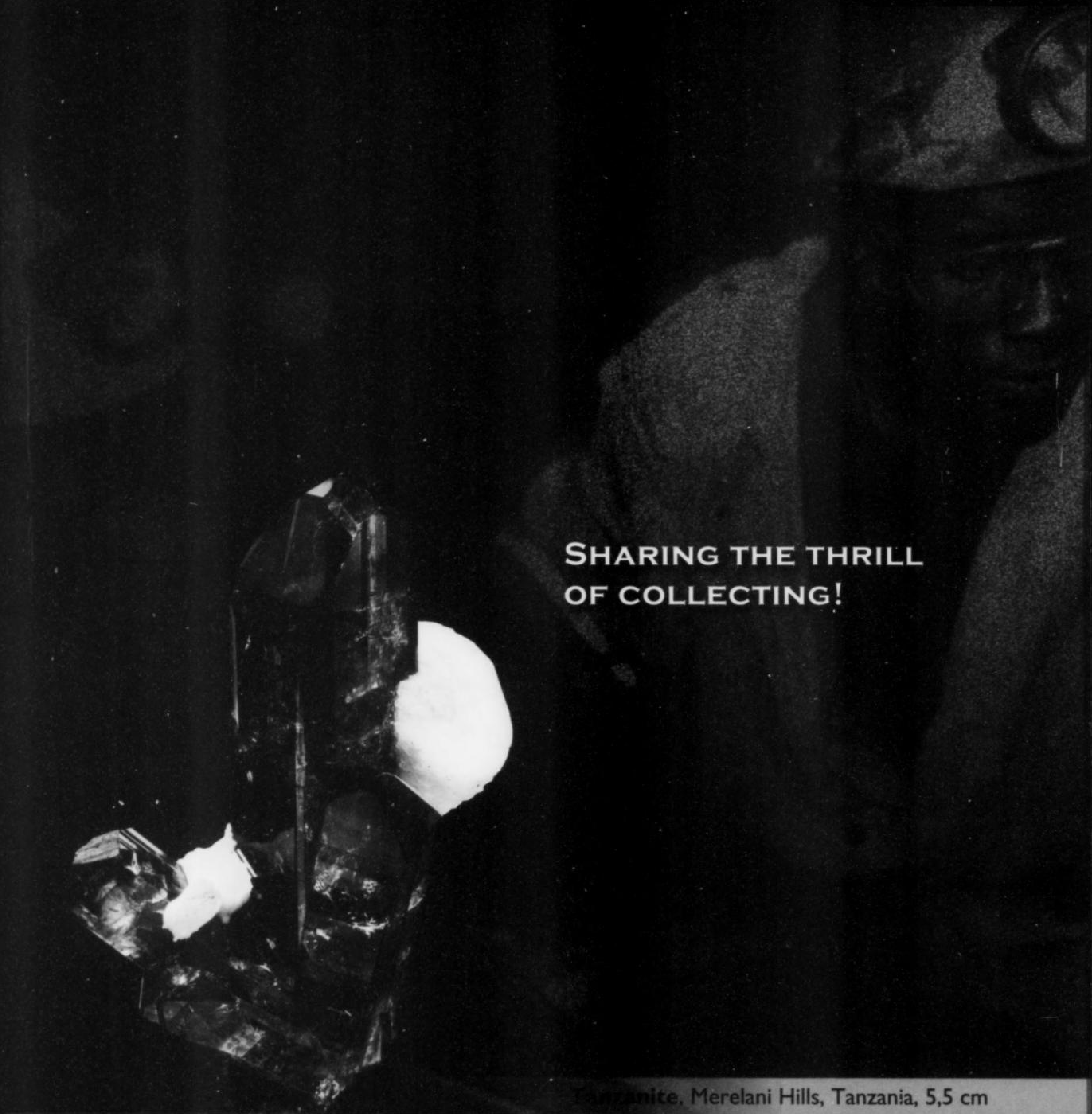


Tanzanite, Merelani Hills, Tanzania, 5,5 cm

Photo: M. Sickinger

Tucson Show 2010

by Thomas Moore

[January 30–February 14]

We Tucson residents have complex attitudes about our weather. Certainly we are understanding of those who flee town when temperatures top 100° F, as temperatures are apt to do on most days between mid-May and late September. But at the same time we cherish highly—in some cases, one might say, weather-snobbishly—all of the comfort and beauty that come with the rest of the year. As we welcome the great February burst of visitor-drawing, economy-spurring, carnival-like activity which is "The Tucson Gem, Mineral & Fossil Showcase," we glibly observe that our sunny skies and temperatures in the 70s are a main reason for the show's huge success these past 55 years. But in late January/early February 2010, as horrendous blizzards hit the east coast, especially the Washington-Baltimore-Philadelphia area, and it became clear that a great many visitors from the mid-Atlantic states would be unable to fly out to our Show as planned, complacency may have morphed to empathy and even compassion. At the Main Show, in one of the cases reserved for the Smithsonian Institution, there was a placard explaining that part of a planned display of gem crystals would not be appearing, i.e. was stuck in the airport snow back in Washington, D.C. The thought of all those wonders frozen in place back there may have chastened (rather than reinforcing) a hard case or two of weather-snobbery in these parts. As if for further chastening, the righteous weather gods sent down three atypical days of soaking, cold rain during early phases of the hotel show. Okay, we get it, we're to apply the ancient injunction *hic sic ex firmamentae nix hubris*, that is, Take not pride in thy weather, O desert peoples, for Weather is mightier, and let's just add ornerier, than thou art.

The Smithsonian people *were* able to bring out a few small things to fit this year's theme of "Gems and Gem Minerals"—such as for instance the diadem of the French Empress Josephine, presented to her in 1810 by Napoleon I, and also a stunning case full of faceted gems. In other words the Show did Go On, and indeed seemed healthy and full of pep at most of its many venues. The TGMS reports a robust figure of around 18,000 for Main Show attendance. A few hotel dealerships (e.g. *Edwards Minerals*, *Rocksaholics*, Mike Shannon) had moved this year from their former spots in the Executive Inn to larger rooms (fronting a pretty interior courtyard) at the Pueblo/Riverpark Inn show. Another change of note is that Marty Zinn's most mineral-rich hotel, the one with the comfy courtyard graced by orange trees, has had its name changed by management: it is no longer the InnSuites but the less distinctive "Hotel Tucson City Center." The entrance sign's fine print, though, still says "InnSuites," and I suspect that the faithful who come each year will continue to call the place that, at least for a while. On the traffic front the good news was that all of the downtown exits from I-10, along the west side of town, were open this year, following completion of a massive multi-year renovation of the freeway.

As already noted, "Gems and Gem Minerals" constituted the primary show theme at the Tucson Gem and Mineral Society's "Main Show" at the Convention Center, but an exhibition on another and more unusual topic, Mineral Art, also held sway both at the Main Show and at Dave Waisman's Westward Look Show on the weekend of February 5–7. A wide aisle at the Main Show

Figure 1. (above) **Some of the mineral paintings exhibited (one of three six-foot cases) at the Tucson Show by Wendell Wilson.** ***Upper left:*** **Wulfenite from the Hiltop mine, Arizona (oil on canvas; pictured on the cover of vol. 22, no. 6, 1991; Smithsonian specimen; painting from the Walter Dietrich collection).** ***Upper middle:*** **Gold from the Groundhog mine, Colorado (watercolor on sheepskin vellum; Smithsonian and Natural History Museum of Los Angeles County collections; painting from the Mark Hay collection).** ***Upper right:*** **Copper from the Ray mine, Arizona (watercolor and pencil on art board; specimen and painting from the Mark Hay collection).** ***Lower left:*** **Tanzanite from Merelani, Tanzania (oil on board; specimen and painting in the Daniel Trinchillo collection).** ***Lower middle:*** **Wulfenite from the 79 mine (oil on canvasboard; painting in the Daniel Trinchillo collection).** ***Lower right:*** **Rhodochrosite from the Sweet Home mine, Colorado (oil on canvasboard; pictured on the back cover of the Sweet Home issue, vol. 29, no. 4, 1998; Bill Larson collection).**

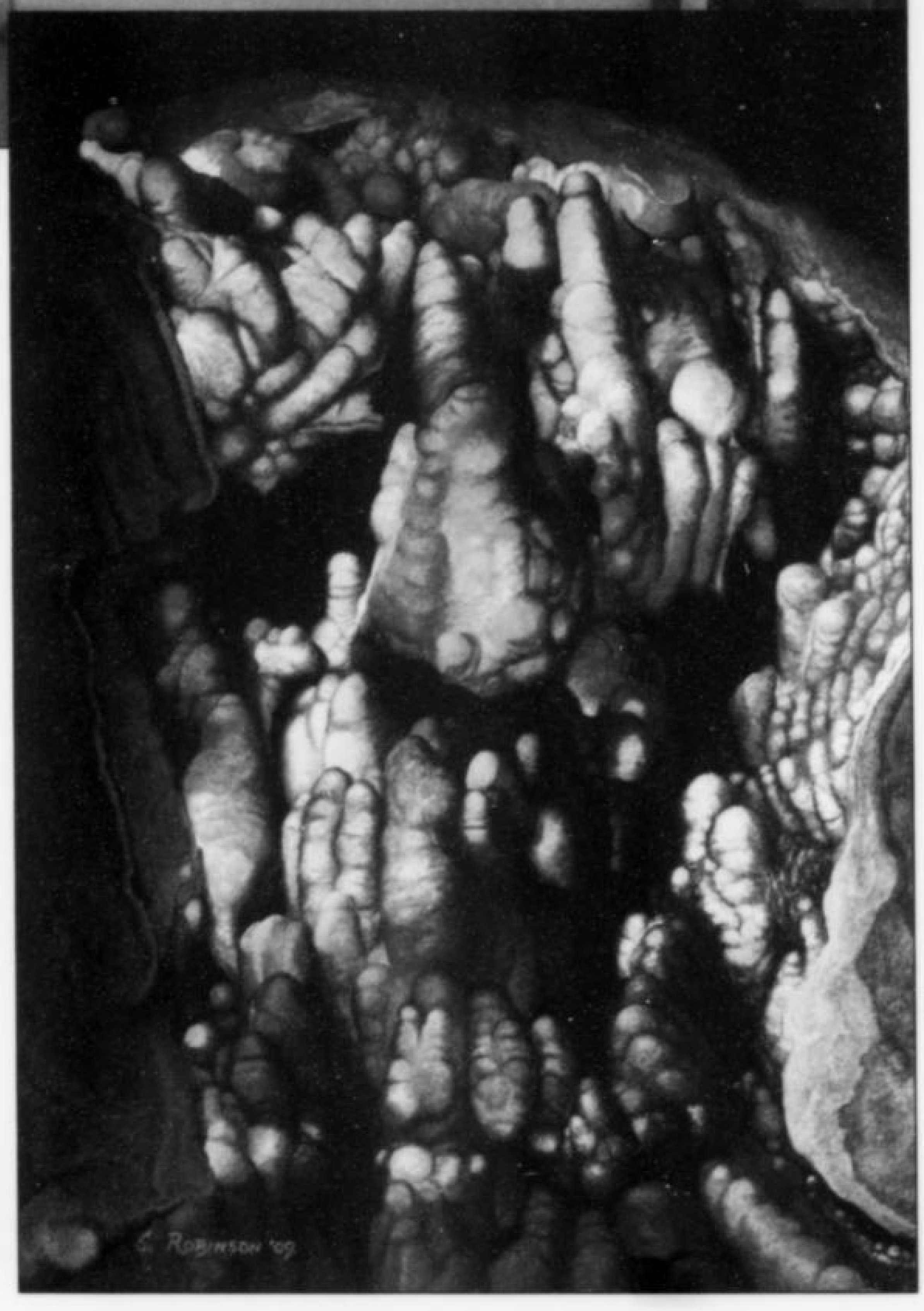


Figure 2. **One of the mineral paintings exhibited at the Tucson Show by Susan Robinson: Turgite from Graves Mountain, Georgia (acrylic on panel; specimen and painting from the John Medici collection).**

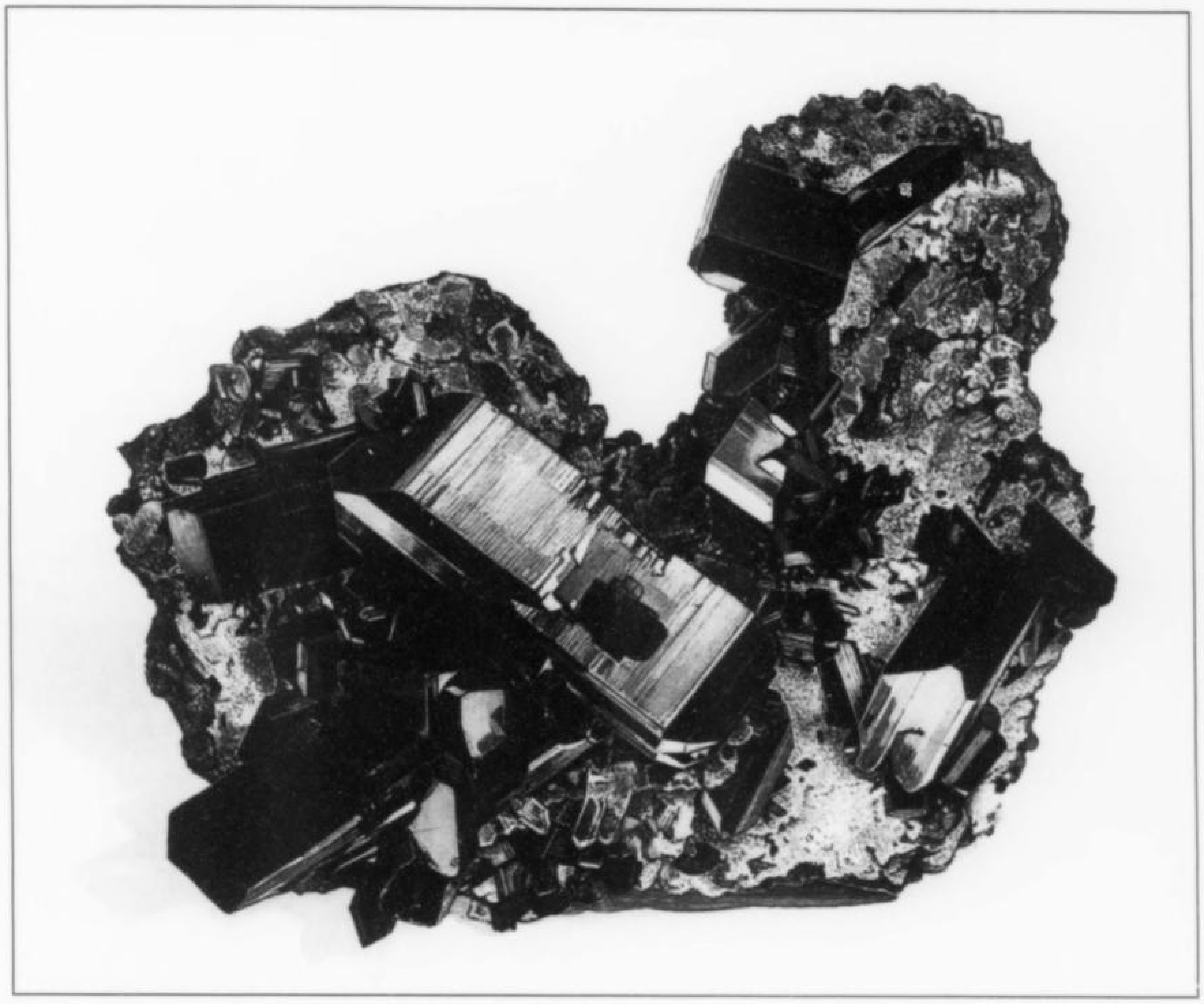


Figure 3. **One of the mineral paintings exhibited at the Tucson Show by Eberhard Equit: Azurite from Touissit, Morocco (watercolor and pencil on art board; specimen and painting from the Gil Emringer collection).**

Figure 4. **One of the mineral paintings exhibited at the Tucson Show by Hildegard Könighofer: Wulfenite from Los Lamentos, Mexico (watercolor and pencil on watercolor paper; specimen and painting from the Daniel Trinchillo collection).**

was lined on one side by 6 × 6-foot vertical cases holding paintings of mineral specimens and mineral-related subjects by four long-practiced, lavishly talented artists. Specifically, there were 17 (mostly oil) paintings of wulfenite, silver sulfosalts, tanzanite, mining scenes and other subjects by Wendell Wilson; there were 18 glowing acrylic paintings of specimens by Susan Robinson; there were 16 examples of Eberhard Equit's fantastically finely detailed watercolors of (mostly German) mineral specimens in their natural sizes; and there were 21 exquisite watercolor paintings, also natural size, by Hildegard Könighofer of Graz, Austria (who has, by the way, just published a new book of her mineral art). In many cases the specimen paintings were accompanied by the actual specimens depicted, and all in all this Main Show was rendered uniquely memorable by all the beautiful art.

At the Sunday night "mineral art" symposium at the Westward Look show, Wendell Wilson moderated a panel discussion among these same four artists, and gave a powerpoint presentation on the history of mineral art. Along one wall of the room were displayed

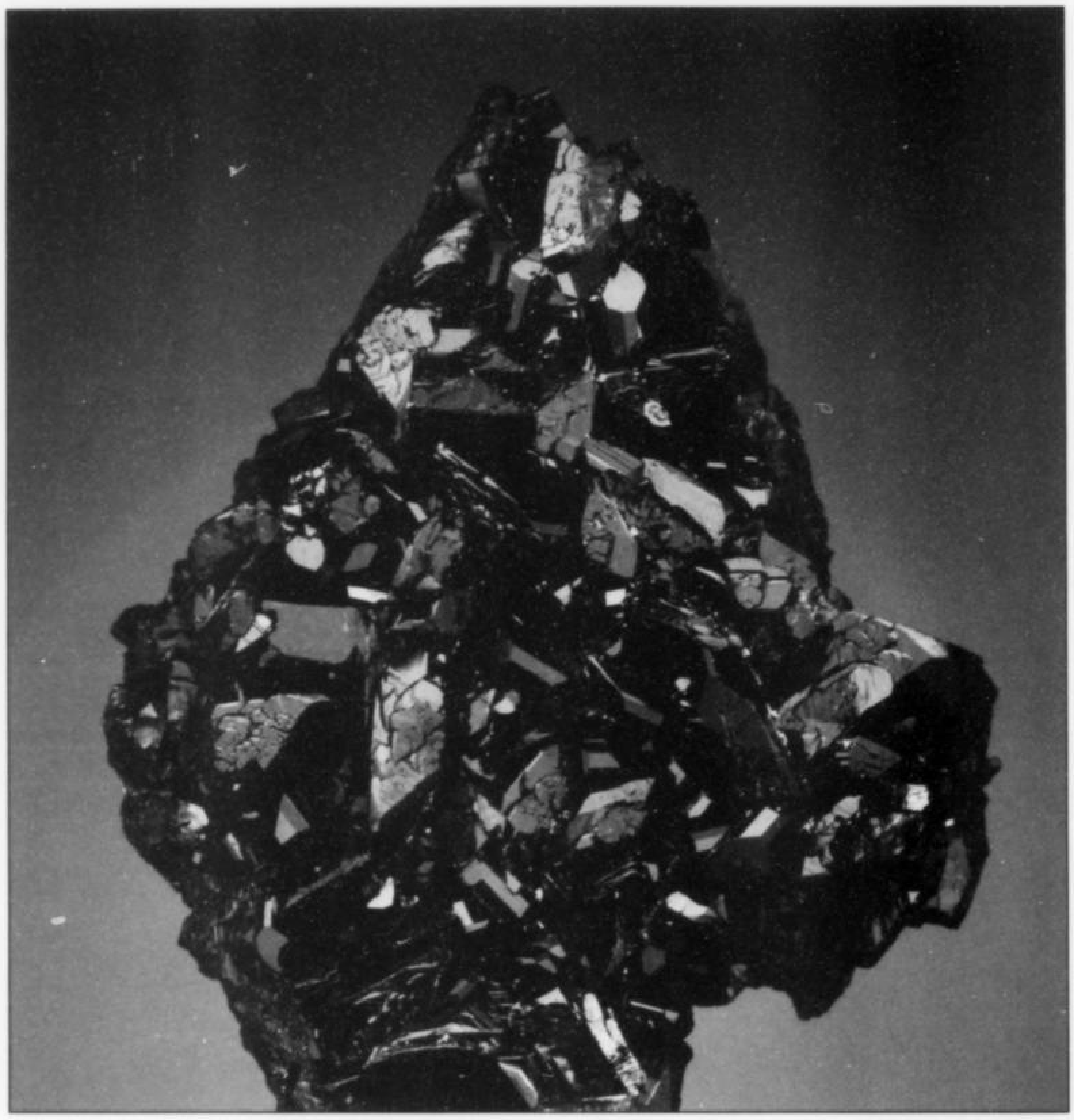


Figure 5. **Azurite, 7.1 cm, from the Carlota mine, Globe-Miami district, Gila County, Arizona. Mark Hay collection; Jeff Scovil photo.**

Figure 6. **Spodumene (kunzite), 4.2 cm, from the Oceanview mine, Pala, San Diego County, California. Mark Baker collection; Jeff Scovil photo.**

works by other mineral artists, including Gamini Ratnavira, Frederick Wilda, Brandy Naugle, Gail Spann, Chris Hughes, Sophia Kelly Shultz, Steve Sorrell and Sarah Sudcowsky. While on the subject of goings-on at the Westward Look I cannot neglect to mention that this year's featured private collector was Will Larson (son of Bill), who filled one of his two allotted cases in the hotel lobby with fine "general" specimens, and filled the other exclusively with specimens from Japan. A display is a special treat when it shows you things you hardly knew existed, and that's how it was, at least for this viewer, with Will's array of wonderful Japanese pieces, some old and classic, some new and very surprising.

There is much to review, so let the what's-new tour commence.

Arizona collector/dealer Evan Jones, well-known son of Bob Jones (evanabbottjones@gmail.com), showed up with the good news that this copper-rich state is not *yet* finished producing significant new finds of **azurite**. The Carlota copper mine near Miami in Gila County opened early last year, and on October 24, 2009 it gave up about 200 specimens showing bright, blocky, deep blue azurite crystals to 2.5 cm. The specimens that Evan had on hand at the Main Show range from thumbnail size to matrix plates 30 cm across covered with azurite crystals. In some cases the matrix is earthy green malachite, while in others it is massive azurite with white to yellow to pale green veinings of microcrystallized powellite. More rarely the pocket zone produced slightly rough **malachite pseudomorphs after azurite** to 7 cm: Evan had five miniature to small cabinet-size specimens showing the pseudocrystals. No further specimen-bearing pocket zones have been hit since October in the Carlota mine but, Evan says, there is hope for some projected mineralized zones on the next bench down from the present workings.

At the Westward Look Show, French dealer Alain Martaud (alain.martaud@wanadoo.fr) had some interesting specimens of **helvite** dug in 2002 from a single pocket in a calcite-filled vein at the Tungsten Hill mine, Gage, Victoria Mountains, Luna County, New Mexico. The small miniature-size matrix specimens display sharp, orange-brown to yellow, tetrahedral crystals of helvite to 1.5 cm resting on massive bluish white mixtures of calcite and quartz.

Now westward to California, from which Golden State there is much to tell of (including some gold) this time. First, in the Inn Suites ballroom, Doug Wallace of *Mineral Search, Inc.* (www.mineralsearchinc.com) had a few flats of excellent specimens of what's been analytically shown to be a niobium-rich **rutile** (with Nb content up to 25%), dug about 20 years ago by Bob Rudenz at an undisclosed site in Inyo County. The rutile crystals are sharp, dark reddish brown, and blocky to thick-tabular, with good submetallic luster, and reach 4 cm; they rest lightly in pale gray-brown matrix of what appears to be rhyolite. There were about 100 thumbnails and a few small miniatures with Doug. He said that Rob Lavinsky of *The Arkenstone* purchased a few of the larger pieces.

Late in the show, with action at the Convention Center already well under way, I got a call from Doug Wallace concerning three very unusual **gold** specimens that a grizzled old free-lance miner (actually I didn't see him, but let's stipulate that all free-lance gold miners are "grizzled" and "old") had just delivered to him at the InnSuites. The specimens are loose, flattened masses of vein gold with only traces of quartz. The two largest specimens measure 4 × 8 cm and 5 × 8 cm, and all along their top edges are brilliant druses of gold crystals to 5 mm individually. What had Doug (as well as curators Carl Francis and Anthony Kampf) enthused and perplexed is that the gold crystals are pseudo-hexagonal prisms, with morphologies just like typical, simple beryl or apatite crystals. John Rakovan's plausible speculation is that, in these distorted crystals, the "basal pinacoid" faces are really (111) octahedron faces and the "prisms" are really dodecahedron faces. In any case these are very fine gold specimens; their purported source is an outcropping quartz vein which overlooks a spot on the north fork of the Yuba River.

During the 2008 Tucson Show, Bill Larson brought to the Westward Look some nice specimens of aquamarine and morganite beryl which had lately been won from the pegmatite at the Ocean View mine, Pala district, San Diego County (see the show report in May–June 2008). This year the Ocean View mine came up with something a bit more surprising: its first significant production of **kunzite spodumene** since 1956. Most of the 50 or so kunzite crystals found in December 2009 were in the InnSuites room of *Bruce Wood Minerals* (www.brucewoodminerals.net), though a handful of the very best could be seen in a Main Show display case put in by Mark Mauthner. The crystals, ranging from 3 to 10 cm long, are partially etched but almost wholly gemmy, with a pale to medium purplish pink color; their prices start at $200 but climb rapidly from there. As we've been spoiled of late by giant gem kunzite crystals from Afghanistan with sharp, fully formed terminations, it's necessary to say that these California crystals have only rough terminations—but they are still among the best kunzites to have come from California in quite a few years.

Every October, cadres of California collectors who don't too much mind sinking up to their hamstrings in layers of dense saline mud go hunting for crystals of hanksite, northupite, sulphohalite and other water-soluble sulfates at Searles Lake, San Bernardino County. October 2009 was a very good month for these folks, as about 150 of the best-ever-found crystals and crystal clusters of **sulphohalite** were taken out, most of them by Steve Perry and John Seibel, and John had some of the best pieces in his room at the Inn Suites (johnseibel@hotmail.com). Offered here were sharp, pale yellow-brown and translucent, simple octahedral crystals of sulphohalite to 3 cm, either as single floaters or clustered in groups to 7 cm. A look with a loupe at some of the specimens reveals attached microcrystals of trona, halite and hanksite. John Seibel also had about 20 cabinet-size pieces of gray-brown volcanic breccia with embedded crystals of **orthoclase** in attractively ivory-white, sculpted-looking Carlsbad twins to 4 cm. The volcanic outcrop at Water Canyon, Cinco, Kern County, has yielded such specimens, John says, since about 1925, and continues generously to do so.

Finally there's a "teaser" from California that inspires hope for an exciting follow-up later this year, perhaps at the Denver Show. Late in 2009 Scott Kleine of *Great Basin Minerals* (www.greatbasinminerals.com) did some poking around in a roadcut somewhere in Nevada County, and in a quartz vein exposed there he found some gemmy, lustrous, rich brown crystals of **axinite** (probably axinite-Fe) averaging 2.5 cm, though the largest one of Scott's batch measures an impressive 4.5 cm. Associated with the loose crystals and crystal groups of axinite are lustrous, snow-white albite crystals to 1 cm. Nothing yet is for sale from the small stash of specimens which Scott had in a single flat under his bed at the InnSuites, but he is optimistic about what he'll find when he returns this summer to follow the quartz vein. These promising axinites resemble, though they are not to be confused with, the old-timers from New Melones Lake in Calaveras County.

Another attraction in Scott Kleine's *Great Basin Minerals* room was about 100 specimens, thumbnail size to 12 cm across, of **wulfenite** from the Mobile mine, Goodsprings district, Clark County, Nevada. The lustrous, thin to medium-thick, tabular wulfenite crystals reach 3 cm and are of a pleasant caramel-orange color; most are simply square in outline but a few are eight-sided "stopsigns." Most of Scott's specimens are thumbnail-size crystal groups without matrix, but the larger pieces show wulfenite crystals resting on buff-colored altered limestone with sparse white encrustations of aragonite. The Mobile mine has been abandoned since *ca.* the 1920s, but the new wulfenites were found recently in an old stope by Keith Wentz. Oh yes, and while in Nevada I will observe that Mike Bergmann (www.mikebergmannminerals.com) has come into a hoard of about 100 superb specimens of **gold** from the famous Round Mountain, Nevada locality (see Wendell Wilson's article in March–April 2008). The loose crystal groups, thumbnail to 5 cm in size, show very bright gold as loose leaves, dendrites, or hoppered octahedral crystals. The specimens were collected in 2007 and 2008, and were moving fast in Mike's room at the Westward Look Show.

Among Utah's most famous mineralogical products are the bright orange, resplendently gemmy crystals of **topaz** from cavities in rhyolite in the Thomas Range, Juab County. These prismatic, well terminated crystals, some associated with sharp black cubic bixbyite crystals, are hardly "new," having been first discovered in 1859 (according to a 1979 article by Lanny Ream: see vol. 10, no. 5)—but hundreds of excellent specimens in a wide range of sizes were taken out by the hard-working specimen miners of *Collector's Edge Minerals* (www.collectorsedge.com) in the summer of 2009. The topaz crystals found at the collecting site (called Maynard's Claim, after the discoverer, Maynard Bixby) range from less than 1 cm to 7.5 cm. The thumbnail-size specimens are mostly single crystals perched on (and partly included by) pale gray rhyolite, but some miniatures are aesthetic "crosses" of doubly terminated topaz crystals. All of the crystals are of a lush, gemmy orange hue . . . and if their scrupulous owners will take care to store them in dark places their color is not likely to give out before the owners do.

Other long-familiar collectibles from the western U.S. are the goethite, blue-green microcline ("amazonite") and smoky quartz from miarolitic pockets in granite exposed at many sites in the Pikes Peak batholith of central Colorado. Well, the Smoky Hawk specimen mine, operated since 1998 by Joe Dorris, last summer produced some of the finest large **goethite** specimens ever found anywhere, and Joe was proudly offering some of these in the InnSuites room of his *Pinnacle 5 Minerals LLC* dealership (www.pinnacle5minerals.com). Brilliantly lustrous, brown-black, bladed goethite crystals and crystal sheaves to 3 cm line deep open cavities to 21 cm across in these large-cabinet pieces; in smaller specimens, orange-brown goethite blades form hedgehog-like aggregates perched on quartz crystals. The goethite-bearing cavities were found in the upper part of a mineralized zone in the Pikes Peak granite. Lower down in the zone, Joe collected beautiful groups of deep green **microcline** crystals (including some "whitecaps") to 6 cm individually, with smaller crystals of smoky quartz, albite and pale violet fluorite. This was the most impressive suite of newly collected Pikes Peak specimens I have seen in some time.

A final U.S. item likewise represents new finds at an old place—

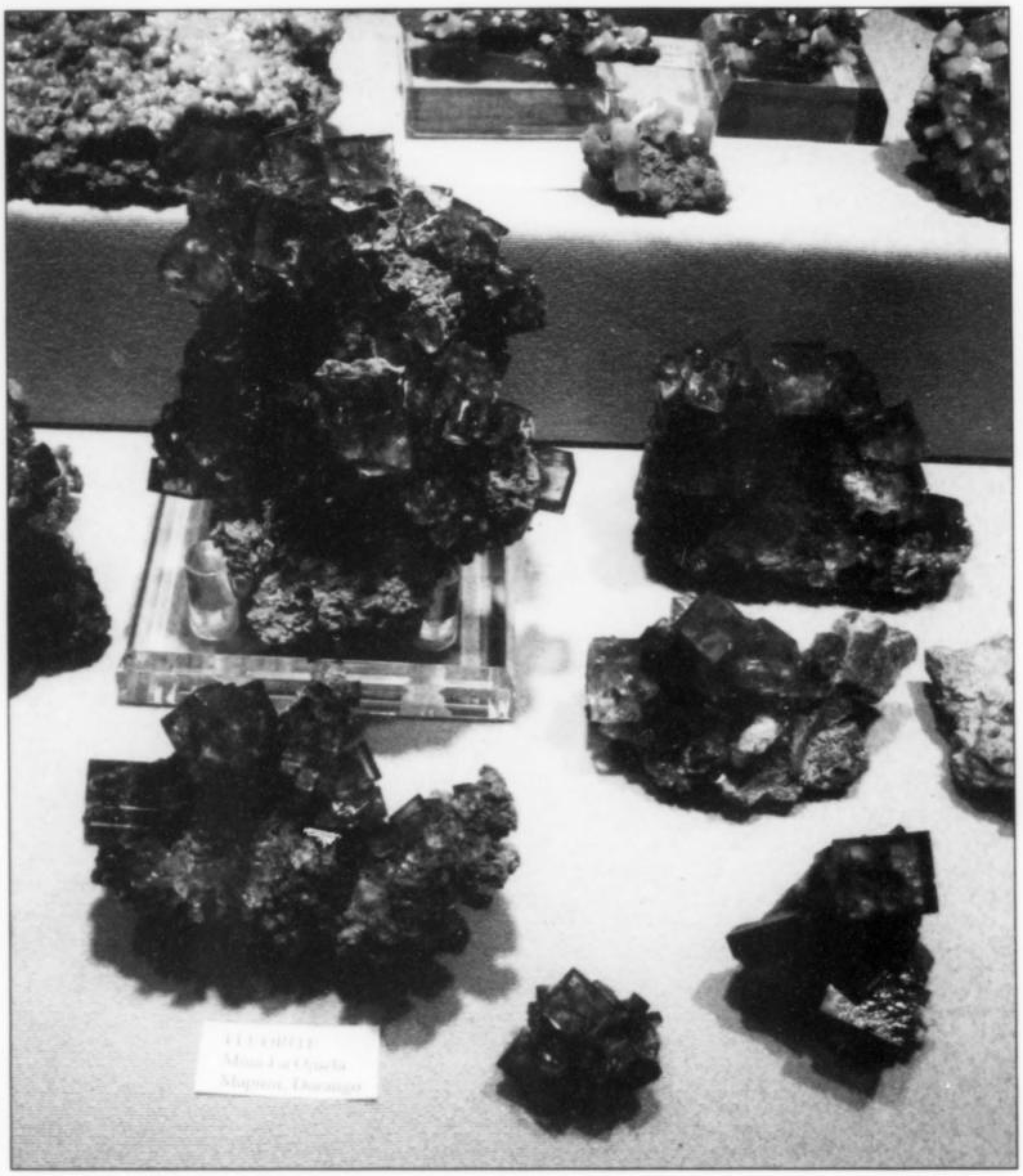


Figure 7. **Fluorite specimens, miniature to cabinet size, from the Ojuela mine, Mapimi, Durango, Mexico. Jason New exhibit at the Tucson Show; Wendell Wilson photo.**

this time on the other side of the country. At the Main Show, Kevin Downey of the *Well-Arranged Molecules* dealership (www .wellarrangedmolecules.com) was marketing about a dozen fine miniature to small cabinet-size specimens of **babingtonite** from the Lane traprock quarry at Westfield, Hampden County, Massachusetts. Now, we are all aware that the hands-down world's best babingtonites are those which have emerged from China in recent years, but the Lane quarry was the earlier champion occurrence. The quarry was in commercial operation in the late 19th century, then lay fallow for decades, then was revived in the mid-1990s, when notable babingtonite specimens trickled out once more (see the Springfield Show report in November–December 1999). The specimens that Kevin Downey brought to Tucson were collected about ten years ago from loose boulders in the quarry; they are sections of seams from which the white calcite has been partly etched out, revealing sharp, jet-black, wedge-shaped babingtonite crystals to about 2 cm in lustrous groups, many rising from a matrix of punky, pale green, much-weathered basalt. Kevin says that about three flats of top specimens were collected in all, ranging in size from small-miniature through 20 cm across.

Ross Lillie of *North Star Minerals* in West Bloomfield, Michigan (www.northstarminerals.com) usually has something new from Romania, Bulgaria, or the midwestern U.S., but this time, in his InnSuites room, he had specimens from a new find of **fluorite** in the La Farge Dundas quarry, Dundas, Ontario, Canada. These are the dozen or so best of about 125 pieces found in the quarry in August–September 2009. The fluorite comes out as highly lustrous, transparent (though with some internal crazing), simple cubic crystals to 4 cm on edge, of a very nice pale yellow-brown color. Some specimens are loose cubes of small-miniature size while others are matrix pieces to 15 cm across showing liberal numbers of gleaming fluorite cubes resting on pale brown, fine-grained limestone. Prices for these attractive additions to anyone's fluorite suite range between $50 and $450.

A still more beautiful **fluorite**, together with much else that is beautiful, is now emerging from the Ojuela mine, Mapimí, Durango, Mexico (will this 400-year-old locality *ever* run dry?). As you can read in our Mexico II special issue on the Ojuela mine (September–October 2003), fluorite specimens of varying styles have come intermittently from the mine for decades, the best ones, arguably, having been those showing gemmy deep purple cubo-dodecahedral crystals to 4 cm from the "San Carlos" section on Level 2. But now, from a mineralized zone between Levels 1 and 2, purple fluorite specimens putting the earlier ones to shame have emerged. They are loose crystal groups of miniature size and matrix specimens to about 12 cm across, the latter with fluorite crystals resting on typically earthy brown gossan. The simple cubic, deep purple fluorite crystals reach 3.5 cm on edge, and they are totally gemmy and of such high luster that they look oiled (but Jason New and his father Mike swear that the crystals have *not* been oiled, and we may certainly trust these honest fellows). Last year, at both the Denver and Munich shows, I saw foreshadowings of the new cubic, mega-bright Ojuela fluorites, and indeed Jason New's 15 or so absolutely top specimens all were found in spring 2009. The very best of them were on view in a knockout case by Jason at the Main Show, entitled, enticingly, "A Year of Mexican

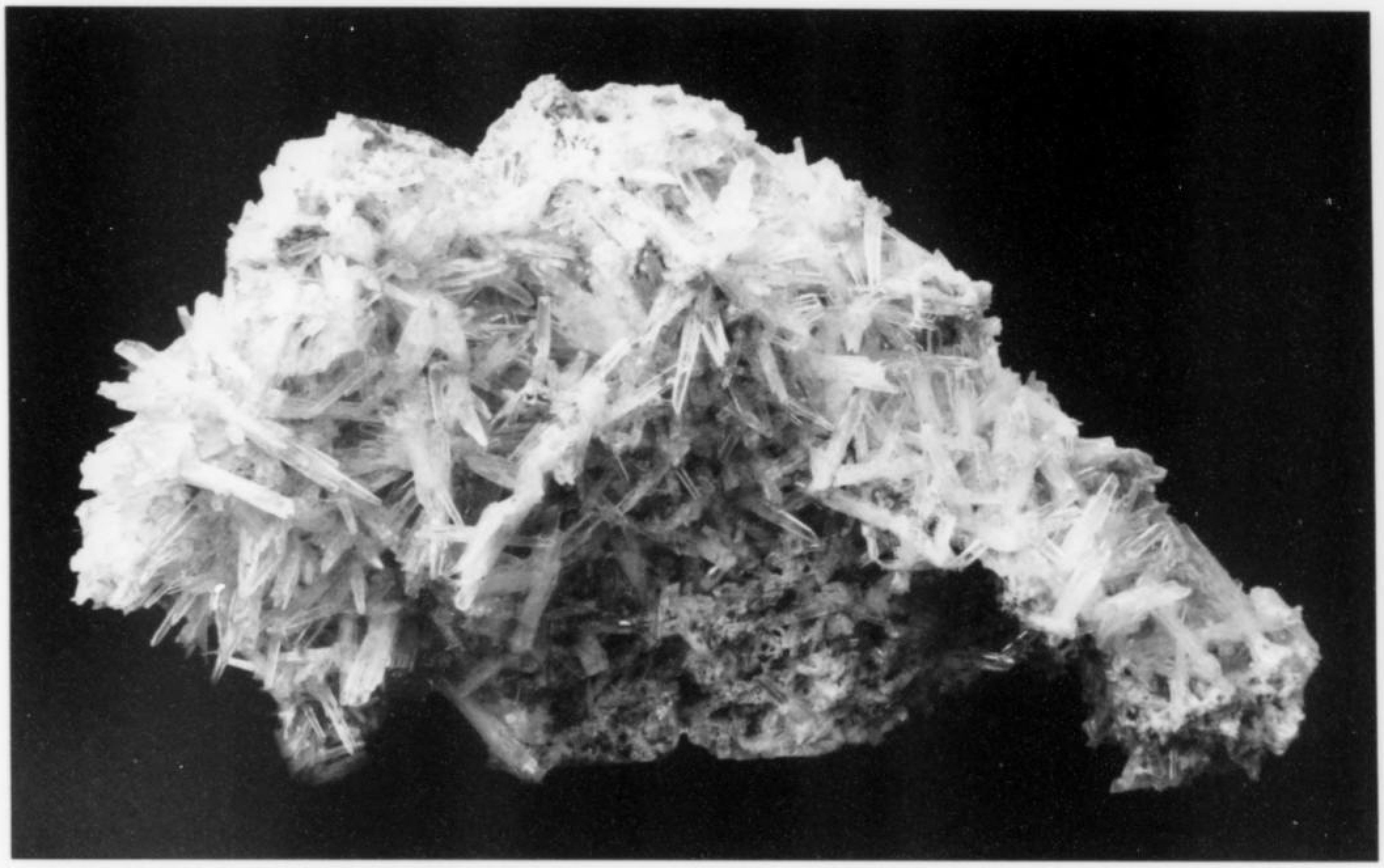


Figure 8. **Nifontovite crystals on matrix, 20 cm, from Charcas, San Luis Potosi, Mexico. Jase Minerals specimen; Jesus Salinas Estrada photo.**

Figure 9. **Rosasite, 4.7 cm, from the Ojuela mine, Mapimi, Durango, Mexico. Rob Lavinsky (The Arkenstone) specimen; Joe Budd photo.**

Minerals," since it held only Mexican specimens mined during the preceding twelve months. Besides the wonderful Ojuela fluorites the case held Ojuela **rosasite** specimens with smooth, baby-blue rosasite spheres to 4 cm diameter, some with thin, water-clear calcite crystals. There was also **malachite** in dark green, ropy flows and hemispheres coating cabinet-size pieces of matrix; fine examples of the now familiar Ojuela **wulfenite** and **aurichalcite-included calcite**; Milpillas mine **azurite**; 10-cm subparallel crests of white **barite** crystals on drusy amethyst (the first good barite from the amethyst fields of Las Vigas, Veracruz); spectacular Navidad mine, Durango **creedite** and Cerro de Mercado, Durango **fluorapatite** specimens . . . and still more. Jason New isn't selling off the very best of these items yet, but if you want to get his attention you may do so through his father, wholesaler Mike New of *Top Gem Minerals* (www.topgem.com).

Jesús Salinas Estrada of *Jase Minerals*, Guadalupe, Mexico (jaseminerales@hotmail.com) had an InnSuites room full of miscellaneous Mexican minerals, including the biggest and best specimens of the very rare borate **nifontovite** yet to appear from the mines of Charcas, San Luis Potosi. Nifontovite specimens, mostly transparent, colorless single prisms of thumbnail size, have been sparingly seen on the market since 2008, in the early part of which year a pocket of them was opened (see the 2009 Tucson Show report in May–June 2009)—but nothing bigger than Peter Megaw's fine 5.2-cm crystal group (pictured in May–June 2009) has appeared. Until now, that is: Señor Estrada had a shelf full of nifontovites to cabinet size, his top specimen, shown here, being about 20 cm across. Estrada was secretive (or didn't know), but probably the *Jase Minerals* specimens represent more recent—radically better—pocket discoveries at Charcas.

Remember the vivid rose-pink dodecahedral crystals of **grossular** which Benny Fenn recovered in quantity from his diggings in the Sierra de las Cruces range, Coahuila/Chihuahua, in the late 1990s? (If you don't, see the report on the 1997 Denver Show in

Figure 10. **Gold crystal cluster, 3.3 cm, from the Azpata mine, Santa Elena district, Bolivar, Venezuela. Alejandro Stern specimen; Jeff Scovil photo.**

the March–April 1998 issue.) These beautiful garnets have not been around in a while, but Dennis Beals of *Xtal* (www.xtal-dbeals.com) has returned to the site and is now just beginning to take out specimens, and he intends to return during summer 2010. In his InnSuites room Dennis had about 20 flats of loose grossular crystals of thumbnail dimensions, plus a few big hunks of white calcite with red grossular crystals (and a few brown vesuvianite crystals) investing them. The grossular crystals are not yet of top quality either for color or form, but the best that Dennis had are quite sharp and are clearly Thinking Red—stay tuned for developments.

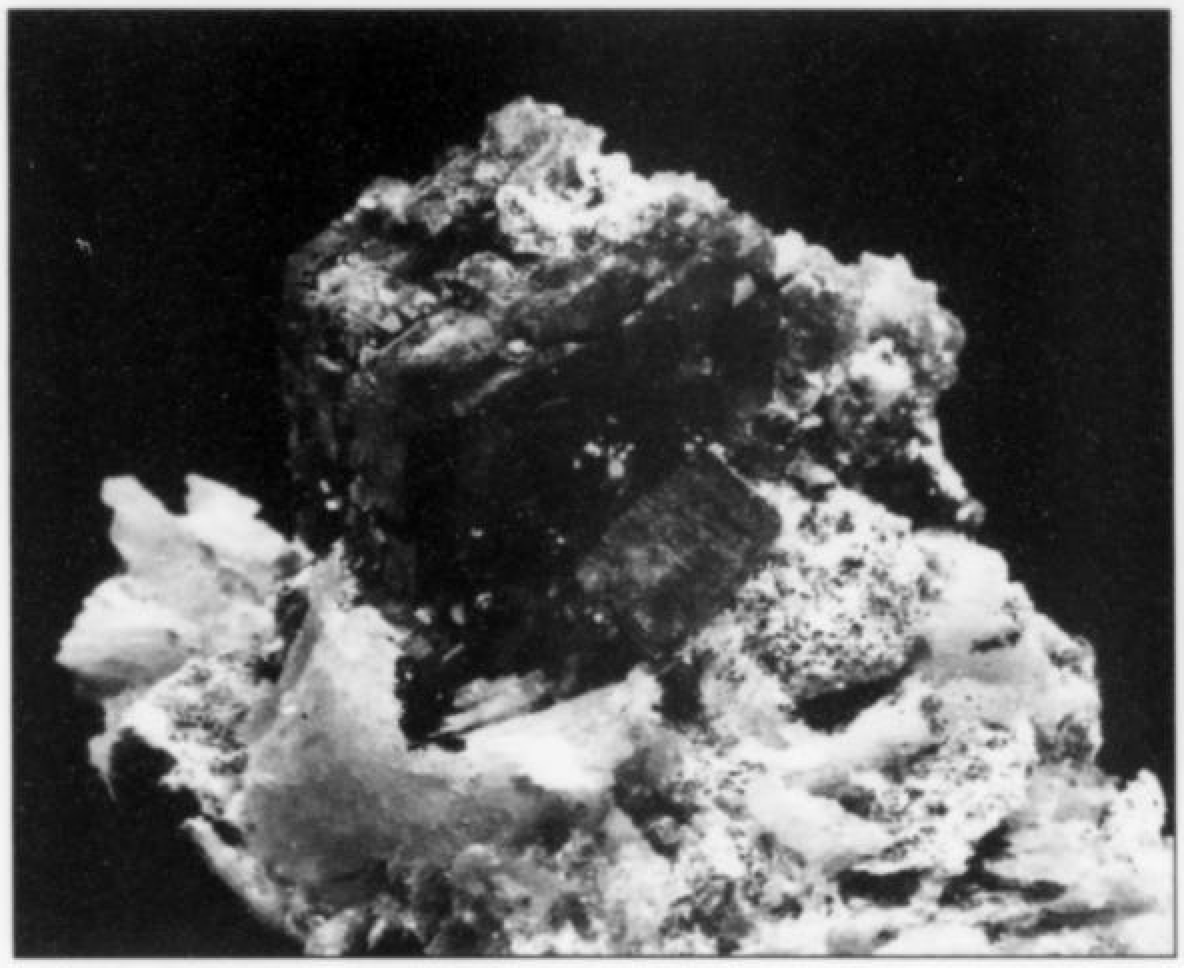
Looking in one day at the InnSuites room of Jeff Fast's *Mineral Movies* (www.mineralmovies.com), I was amazed to see a flat box containing about a dozen fabulous thumbnail-size crystals and crystal clusters of **gold** from the famous alluvial digging fields of Gran Sabana, in the Guyana Highlands near the town of Santa Elena, Bolivar state, southernmost Venezuela. The gold crystals are lustrous, pale to medium yellow, and (best of all) hardly rounded at all, with crisp lines to demarcate hopper edges and complex but rectilinear little pits. The best of the thumbnails (that is, the one I longed for most intensely) cost $6,000—well out of my range, but nevertheless a low price for a gold thumbnail of such quality. In the same room there was a little pile of many hundreds of tiny crystals and nuggets of alluvial gold, one kilogram in all; and then the man who had brought in all this gold introduced himself. He is Alejandro Stern, known to his many clients and friends as "the jungle buyer," and you may read about him in Michael Wachtler's article in the October 2009 issue of *Lapis* (an English-language offprint of this article, available from Jeff Fast, is called "The Jungle Buyer"). Alejandro, a former oil industry engineer who, the article says, "couldn't take it anymore" and turned instead to dealing in treasures from Venezuela's wild south, "always seems to have the best gold crystals and diamonds"—and back at the InnSuites he proved it, pulling out from his pocket a breathtakingly beautiful, brilliant group of gold crystals weighing 41.8 grams and measuring 3.3 cm across (see photo). I don't know about *that* specimen, but the gold thumbnails may be purchased from Alejandro through Jeff Fast. That is, they may if any are left by now: these probably constitute the finest lot of first-quality small specimens that I saw anywhere at the show.

Prolific Peru contributed much to interest shoppers at Tucson in 2010. I will summarize here just a few significant finds as seen in the InnSuites rooms of three dealers: Peruvian native Teodocio Ramos Cabrera of *Ramos Minerals* (ramosteo@hotmail.com); Luis Miguel Fernández Burillo of Spain (Paseo del Canal, s/n Urb. Pinar Canal, 24, 50720 Zaragoza); and tireless Czech native (and expert mineralogist) Jaroslav Hyršl (Heverova 222, Kolin, CZ-280 00). First, Ramos and Burillo had splendid specimens of **rhodochrosite** taken a year or so ago from the Manuelita mine, Yauli Province, Lima Department. These are clusters of sharp, opaque, baby-pink, rhombohedral crystals without matrix or associations: Teodocio Ramos had about 100 fine miniatures with rhombs to 3 cm, while Luis Burillo had three specimens from 9 to 12 cm across showing sharp, stacked rhodochrosite rhombs to 4.5 cm individually. From the Mundo Nuevo-Tamboras mining district, La Liberdad Department, Burillo had about 50 beautiful pieces, mined in September 2009, showing very sharp, bladed, lustrous red-brown **hübnerite** crystals to 1.5 cm standing up amidst bristly clusters of transparent, colorless quartz "needle" crystals. From the same pocket zone as the hübnerites came big specimens showing transparent, very pale green, octahedral **fluorite** crystals to 10 cm on edge, in tight groups with needle quartz—and Burillo had a few dramatic cabinet-size pieces of this description. Also from the Mundo Nuevo district there's **tetrahedrite with bournonite**, in specimens from 3 to 12 cm across which are clusters of sharp tetrahedral crystals of tetrahedrite completely coated by lustrous metallic black bournonite, the latter as microcrystal druses which roughen, but add interest to, the tetrahedrite faces—a single flat of these specimens was with Jaroslav Hyršl. Also with Jaroslav was a flat of appealing, thumbnail-size single crystals of **realgar** from the Palomo mine, Huachocolpa district, Huancavelica Department. These are medium-lustrous hoppered crystals with faint orange rims around their cherry-red, blocky bodies (see Jaroslav's article on this mine in the March–April 2008 issue). And Jaroslav had some nice thumbnails and miniatures from the Julcani district, Huancavelica, showing equant, translucent yellow-brown (though surficially frosted) rhombohedral crystals of **siderite** to 2 cm perched on subhedral chalcopyrite crystals. Finally, all three of these dealers had specimens of the **pink octahedral fluorite** discovered—more accurately, rediscovered—recently in the Huanzala mine, Dos de Mayo Province, Huanuco Department. The fluorite is less lustrous and more rough-faced than the pink crystals from the great find of the early 1980s, but quite as transparent, and commonly with spinel law-twinned galena crystals and cubic pyrite crystals perched on their faces. The fluorite crystals occasionally reach 8 cm on edge.

One important and very surprising Peruvian what's-new item rates a paragraph of its own. As Jaroslav Hyršl will soon explain in a new "Peru Update" article, there was a find, in November–December 2009 in the Javier mine, Ayacucho Department, of what are probably the finest crystal specimens of **coquimbite** yet found anywhere in the world. As early as the 1960s, splendid, pale violet crystals have been known from Chilean deposits, and smaller crystals (to 1.3 cm or so) have come intermittently from the Dexter #7 mine, San Rafael Swell, Emery County, Utah. Jaroslav's 50 or so coquimbite specimens from the Javier mine generated more buzz around the show than you'd expect for a water-soluble sulfate spe-

Figure 11. **Pink fluorite on sulfides, 16.6 cm, from the Huanzala mine, Huanuco, Peru. Rob Lavinsky (The Arkenstone) specimen; Joe Budd photo.**

Figure 12. **Coquimbite with chalcanthite, 7.9 cm, from the Javier mine, Ayacucho, Peru. Jaroslav Hyršl specimen; Jeff Scovil photo.**



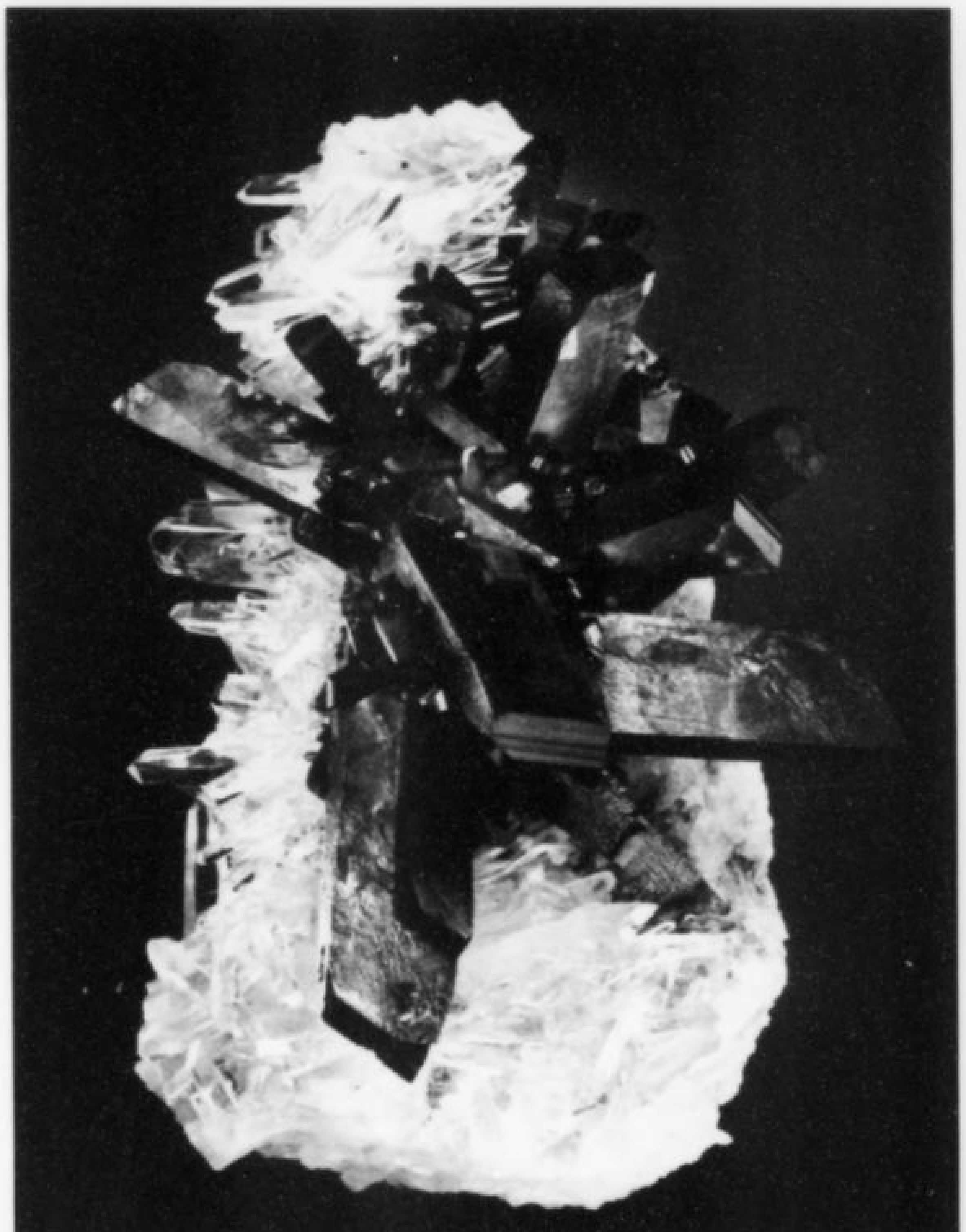


Figure 13. **Hübnerite with quartz, 8.5 cm, from the Mundo Nuevo mine, Huamachuco, La Libertad, Peru. Luis Miguel Fernandez Burillo specimen; Jeff Scovil photo.**

cies. The specimens are loose clusters of very sharp, hexagonal short-prismatic coquimbite crystals reaching a remarkable 5 cm long, the clusters measuring from small-miniature ("toenail") size to 15 cm across. They are somewhat shaggy-looking, as they are spotted by gray, white and greenish shards and subhedral crystals of other soluble sulfates such as alunogen and halotrichite . . . but the coquimbite crystals themselves are translucent to transparent, gratifyingly deep purple in naked sunlight and paler purple in incandescent light, and, as noted, impressively sharp. Some pieces which other dealers had scored from Jaroslav's lot had acquired rather stiff prices before show's end, but pricing in Jaroslav's InnSuites room was most civilized (see the HQLP report later). Now, of course, to acquire a coquimbite specimen is necessarily to risk losing it to eventual dehydration. John Sinkankas, in his *Mineralogy for Amateurs* (1964) says: "In dry air, this species loses water and assumes a white coating. It is common practice to preserve the specimens in air-tight containers or to immerse the entire piece in a dilute plastic solution to prevent loss of water or damage through contact with water." But in any case these are world-class representatives of a fairly rare species, and are quite pretty.

The report from the 2009 Tucson Show (May–June 2009) mentioned the newly discovered occurrence of **phosphophyllite** in

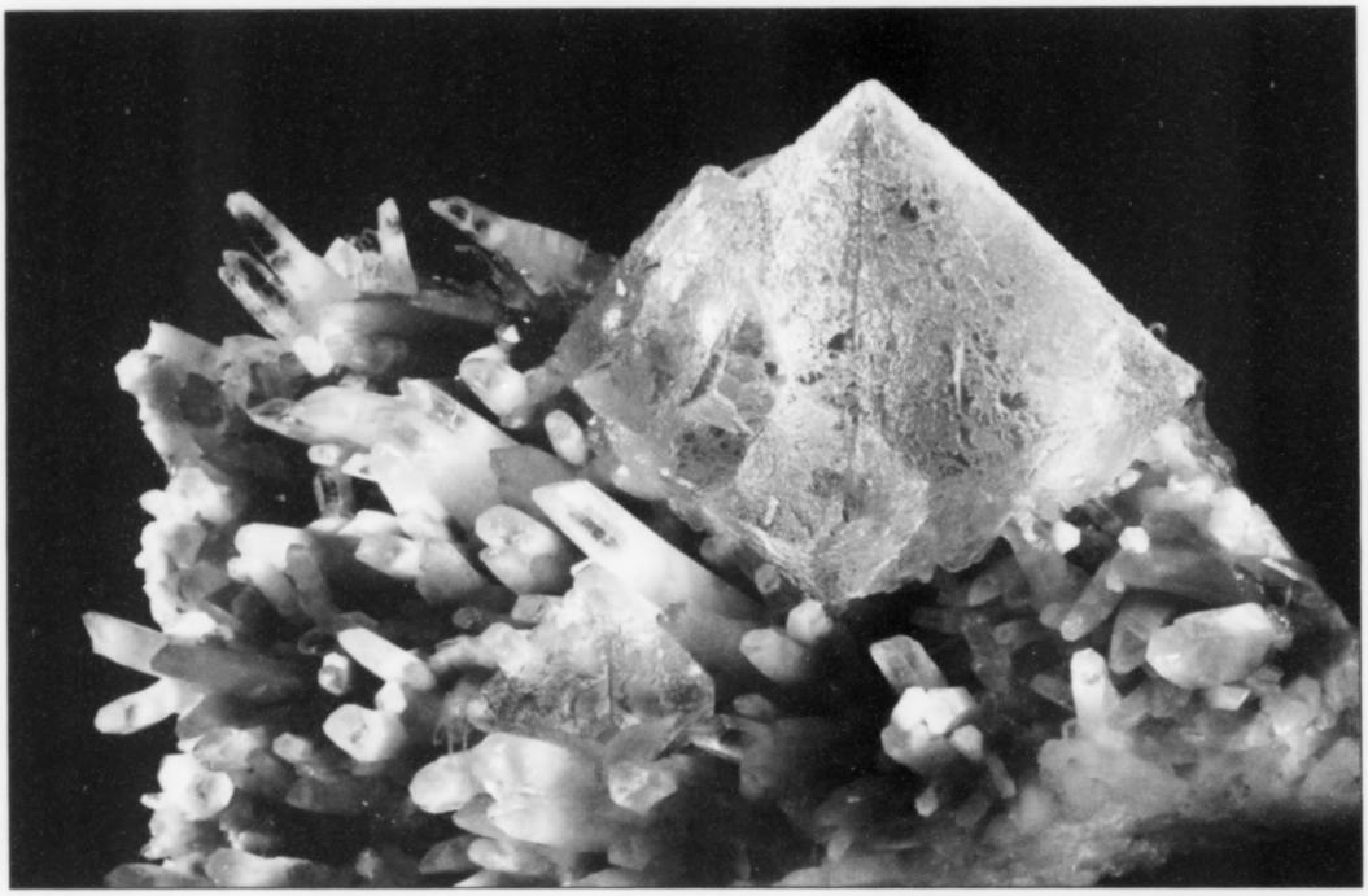


Figure 14. **Fluorite with quartz, 20.3 cm, from the Mundo Nuevo mine, Huamachuco, La Libertad, Peru. Luis Miguel Fernandez Burillo specimen; Jeff Scovil photo.**

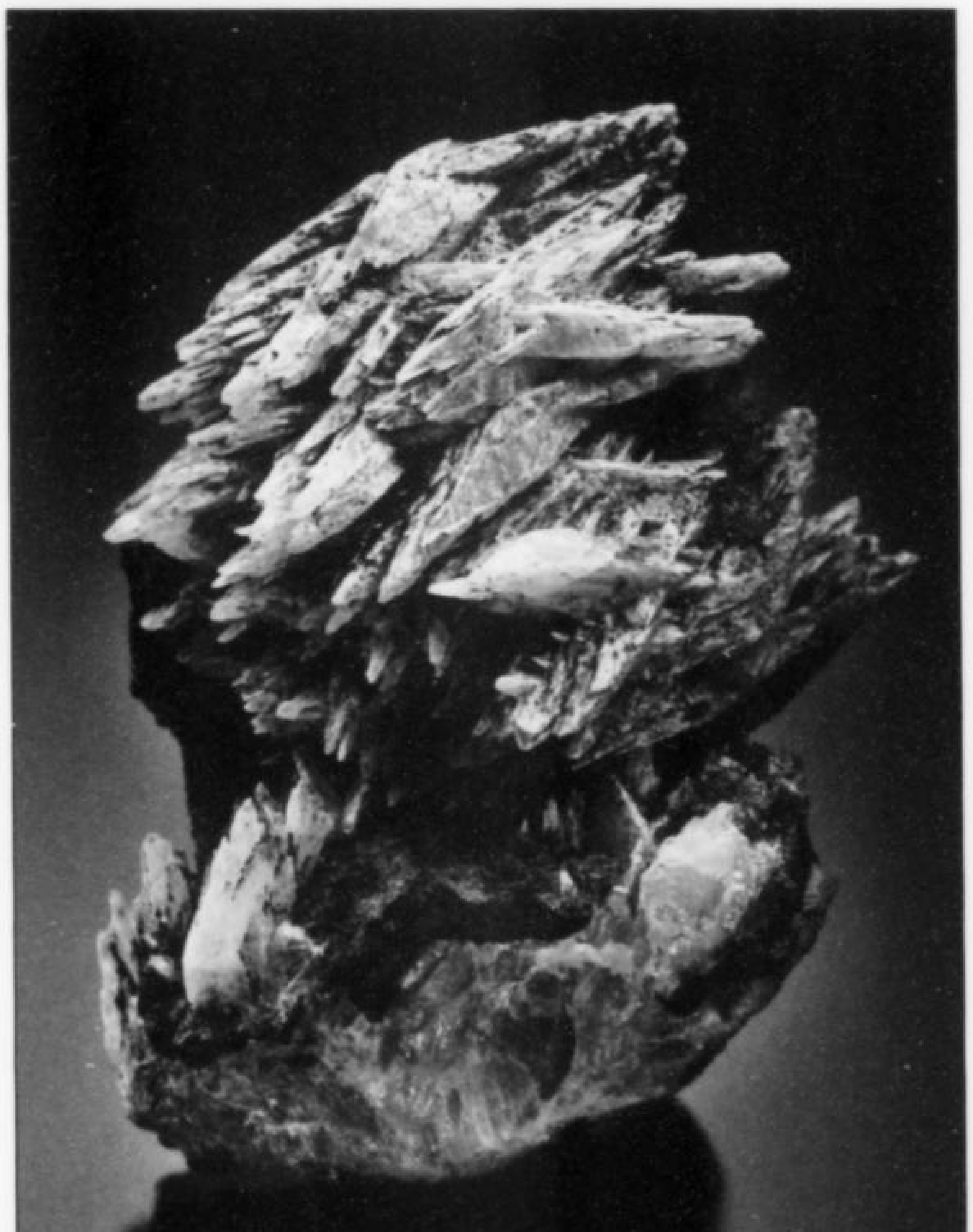


Figure 15. **Phosphophyllite cluster, 5 cm, from the Machacamarca District, Potosi, Bolivia. Alfredo Petrov specimen; Mark Mauthner photo.**

Bolivia, represented then by a few miniature-size specimens being offered by two or three dealers. This year, Luis Burillo and others had larger numbers of specimens, 2.5 to 7 cm, and though the average quality is a bit higher, they still pose no challenge to the famous old Cerro de Potosí specimens. My earlier description still applies: "Opaque, pale apple-green, greatly elongated, splintery-looking phosphophyllite crystals to 1.5 cm form dense matrix coverages . . . it's very difficult to remove the chalky white coatings of an unknown species [and therefore] most of the pieces [are] incompletely cleaned and not especially head-turning." Reportedly the specimens come from a near-surface zone of an ore deposit, so we may hope that later ones, found farther down, will not have the white to ocherous gunk on them and may be fresher-looking. There is some doubt about the identity of the mine: last year the "Infiernillos mine, Canutillos, Colavi district, Potosí" was given out, but Alfredo Petrov (who had about 15 of the phosphophyllites) now says that the source is probably the Wayllani mine, Cornelio Saabedra, Potosí. In a thumbnail that I acquired from Luis Burillo a couple of sharp, petite, palest green phosphophyllite V-twins about 2.5 mm long can be seen.

Speaking of Alfredo Petrov (alfredo@mindat.org), whose room at the InnSuites (and stand at the Main Show) is always rich in rare, slightly peculiar goodies, he had this year a small swarm of **stephanite** specimens found, just a few weeks before the show, in the Porco mine, Potosí, Bolivia—a silver mine inaugurated in 1549 by the *conquistador* Francisco Pizarro and still, Alfredo says, producing ore. The loose, columnar, metallic steel-gray stephanite crystals occur as well-terminated singles and as small parallel groups showing stepped terminations. Quite sharp, though their luster is less than brilliant, they make excellent thumbnails, the largest and best in Alfredo's keeping measuring about 2.2 cm and costing $250.

Of a generous number of mentionables from Brazil which came to Tucson this year, the most beautiful (in my opinion) are some loose **topaz** crystals found in October 2009 in one of the emerald mines

Figure 16. **Topaz crystal, 10.5 cm, from the Itabira-Nova Era district, Minas Gerais, Brazil. Rob Lavinsky (The Arkenstone) specimen; Joe Budd photo.**

of the Itabira-Nova Era mining district, Minas Gerais. Equant, hefty, lustrous and totally gemmy, the crystals range in size between 5 and more than 10 cm, and their color is a rich bluish green of the hue that painters call "seafoam" green. The crystals are all distorted to some degree and some faces are slightly curved, but what we have here are gorgeous hunks of pure gemminess—moreover, when did you last see a *green* topaz crystal? About 45 crystals came from the find, of which Rob Lavinsky of *The Arkenstone* (www.irocks.com) had three and Marcus Budil (budil@monaco.mc) had 11. Marcus, by the way, was enjoying his first year of merchandizing at the Westward Look Show, and had brought from his headquarters in Monaco an extremely pretty selection of high-end minerals to his room there.

Álvaro Lúcio (alucio@matrix.com.br) had about a dozen miniature and small cabinet-size specimens of **hydroxylherderite** from Virgem da Lapa, Minas Gerais, with lustrous, sharp, twinned crystals, color-zoned in pale violet and pale brown, to 4 × 8 cm, the matrix pieces showing attractive associations of sparkly white albite crystals and muscovite rosettes. We have learned over the years to refer to these familiar items, and indeed to refer to nearly all other "herderite" specimens, as hydroxylherderite: after all, the 2008 edition of *Fleischer's Glossary of Mineral Species* calls "herderite," with F exceeding OH, a "doubtful species." However, thanks to the industry of Luis Menezes, we may have to revise our thinking. In his room at the Inn Suites, Luis had 10 loose crystals, 3.5 to 12 cm, of a "herderite" which analysis has shown to contain 6.9% fluorine; as the boundary for "hydroxylherderite" composition is 5.86% F, these crystals would seem indeed to be "herderite." The crystals were found in 1995 at Medina, Minas Gerais. Grayish pale violet, just barely translucent and not highly lustrous, shot through with black acicular crystals of schorl, they are not much to look at, unfortunately, but they are apparently the only *herderite* crystals yet to see daylight.

Luis Menezes (lmenezesminerals@uol.com.br) had some other unusual things from Brazil. Strange-looking partial casts of **muscovite after feldspar** were found in October 2009 in the Xanda mine at Virgem da Lapa; they are loose, sharp hexagonal-tabular forms with shallow pits in their concave centers showing relict bits of white feldspar. Luis had about 20 specimens, most between 4 and 6 cm across and 2 cm thick, although there is one 22-cm specimen with three intergrown muscovite casts resting on some greenish white albite rosettes. Further, there are some specimens in which 5-cm sprays of dull brown, prismatic eosphorite crystals rest on microcline matrix plates to 12 cm across. The eosphorite crystals are dotted liberally with dark green 5-mm spheres of the very rare species **guimarãesite** (described in 2006), with guimarãesite grading to **greifensteinite** in the outer zones of the spheres. The locality for these specimens is given as Itinga, Minas Gerais. Then there was a single flat of miniature-size specimens of the K-Mn oxide **cryptomelane** (yes, it's a valid species) collected in 2002 from a single pocket in pegmatite (!) near the town of São Geraldo do Baixio, Minas Gerais. By the time I reached him, Luis had sold all but one of these pieces; the one still on hand is a 7-cm stem composed of silky black globular forms to which smaller, twig-like protuberances are attached. Luis calls it a "joshua tree" but I thought it more reminiscent of the inchoate seethings inside one of those lava lamps from the 1960s. Are these the *world's best* specimens of cryptomelane??

If you like really *large* Brazilian specimens you'd have done

Figure 17. **Guimarãesite with greifensteinite and eosphorite, 5.5 cm, from the Taquaral Seco mine, Itinga, Minas Gerais, Brazil. Luiz Menezes specimen; Jeff Scovil photo.**

well to check out one of the white tents in Marty Zinn's "Mineral Marketplace" venue, where Dominique Mauduit of *Roc 3000* (roc3000@wanadoo.fr) was selling a couple of tablesfull of **quartz pseudomorphs after anhydrite** from a locality 30 km south of the center of the Rio Grande do Sul amethyst-mining area. Opaque white, pale tan to pale pink, flat blades of quartz are hollow casts after what once were anhydrite crystals to 10 cm. The casts form well-individualized fan-sprays over pieces of matrix to 45 cm across. Just "decorator" specimens, you may say, but in fact these are fine examples of pseudomorphism—giant versions of much-prized specimens once collected in the basalts of the northern New Jersey quarries.

Road construction during the 1980s near the French town of Pau, 50 km north of the Spanish border in the department (province) of Pyreneés-Atlantique, turned up small numbers of specimens showing beautiful transparent, colorless, equant crystals of **calcite** in limestone matrix, but few specimens ever reached the collector market outside of France. This year, however, in the InnSuites "wholesale" room of Brice and Christophe Gobin (www.mineralsweb.com), I was pleased to discover about 10 flats of calcite specimens unearthed two years ago, during excavations for a parking lot in or near Pau. The specimens are open geodes from 5 to 20 cm across, lined by drusy calcite, each geode sporting one or two very sharp individual calcite crystals, the latter ranging up to 6 cm. The big calcite crystals are highly lustrous and limpidly colorless and transparent; some are fat scalenohedrons while others are face-rich, complex, nearly equant forms of generally rhombohedral aspect. Set against the earthy pale brown limestone of the geode walls, these crystals make splendid specimens from what we had thought was a one-shot occurrence.

The ever-enterprising *Collector's Edge* dealership (www.CollectorsEdge.com) scored two major coups in time for Tucson 2010. One is described later, in the Afghanistan section of this report; the other, from the Bouismas mine, Bou Azzer district, Morocco, was represented by about 30 remarkable specimens of **allargentum/dyscrasite/schachnerite/silver** on view both in the Westward Look room of *Collector's Edge* and at their stand—rather, their luxurious labyrinth of stand-up cases—at the Main Show. Okay, dyscrasite is Ag_3Sb, allargentum is $Ag_{1-x}Sb_x$, schachnerite is $Ag_{1.1}Hg_{0.9}$, and you know what silver is. Steve Behling of *Collector's Edge* assures us that analytical work is now under way in several facilities worldwide to sort out the species ratios in these specimens. Similar puzzles attended the somewhat similar-looking specimens found in the mid-1980s at Příbram, Czech Republic, but whereas the Příbram specimens finally were pegged as mostly either dyscrasite or silver pseudomorphs after dyscrasite, the case may be more complex for the new specimens from Morocco. (Most dealers have simply been calling the material dyscrasite up to now, and I have innocently called it that as well, in earlier show reports.) Anyway, the specimens range in size from 4.5 to about 25 cm across, and are quite dramatic, with large concentrations of brightly metallic, spiky, tin-white crystals in "nests" and dendritic filigrees rising from a matrix of white calcite. Specimen preparation consists of acid-etching away the calcite which once completely enclosed the metallic crystal formations. Very fine specimens from small-miniature to large-cabinet size may now be had.

Tanzania keeps up the generosity that it has shown us for some years now. The beautiful gemmy orange **spessartine** crystals from the Loliando area are quite widespread around the market (including matrix specimens). And, from a place which I'm told lies about 5 km from the main spessartine diggings, loose V-twins of **kyanite** have been lately emerging. Apparently they have weathered out of enclosing rock on their own, and were just waiting to be picked up. Almost all of the kyanite twins are of thumbnail dimensions, and they are a bit ragged on the terminations, but what's remarkable is that they are deep orange, and a few are gemmy. The biggest and best hoard of the orange kyanite specimens I saw this year belonged to a Czech dealership, *Zdenek Prokopec Minerals* (zprokopec@seznam.cz), in whose room at the InnSuites about 100 nifty orange kyanite thumbnails got sold between the first set-up day and the opening day of the hotel show.

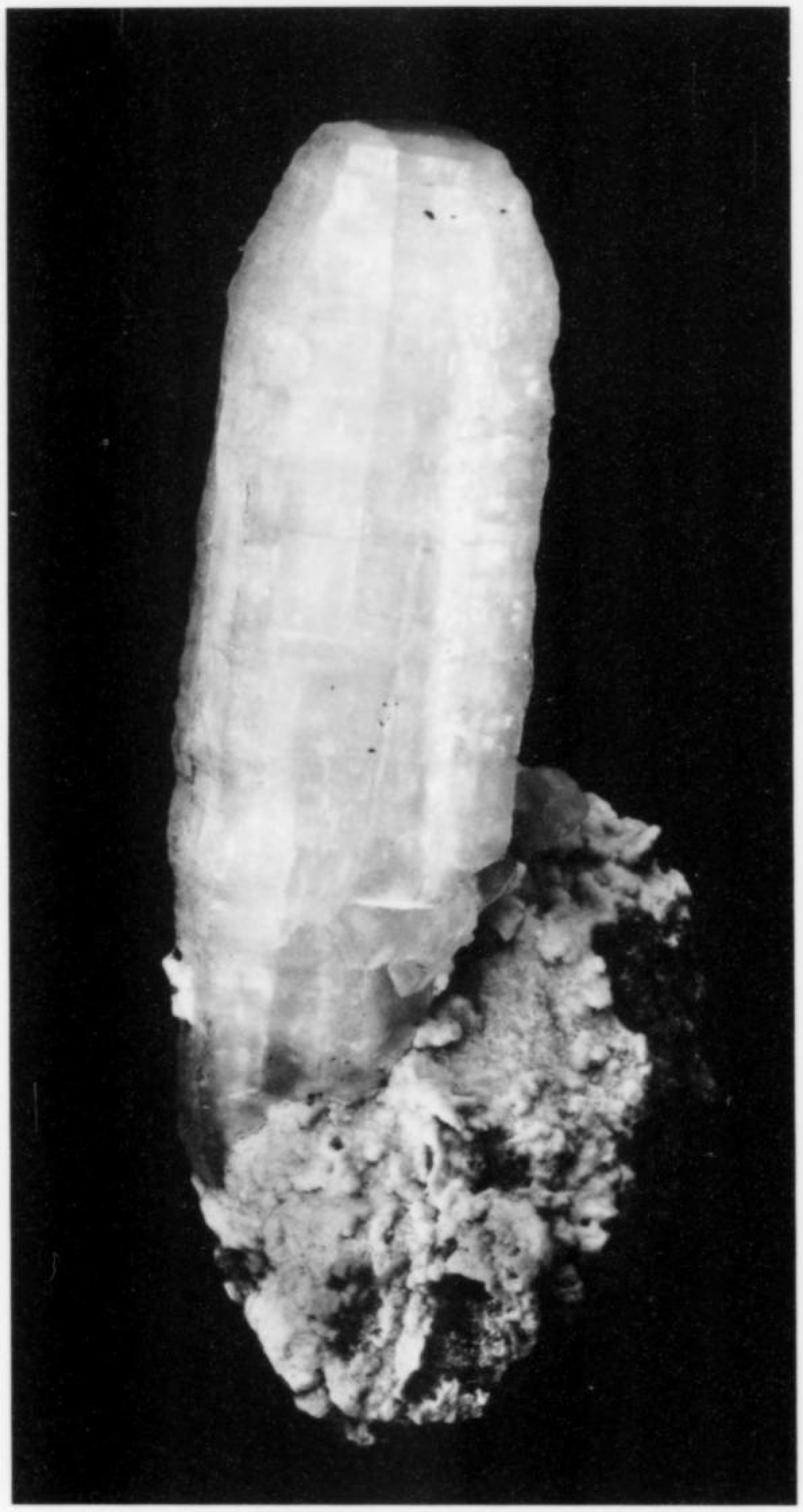


***Figure 18*. Ettringite crystal, 7.2 cm, from Kalahari Manganese Field, South Africa. Rob Lavinsky (The Arkenstone) specimen; Joe Budd photo.**

This same dealership, as well as Werner Radl's *Mawingu Gems* (W.radl@t-online.de), which was holding court at the Pueblo/Riverpark Inn show, had excellent thumbnail-size V-twins and sixling twins of **alexandrite chrysoberyl** from Lake Manyara, Arusha, Tanzania. For the most part these specimens are not gemmy and certainly are not cheap, but they are nearly complete all around, and show easily discernible color change when moved between sunlight and incandescent light. Also, several dealers, most notably Patrick Mayer of *Capetown Matrix Crystals* (cmatrixcrystals@gmail.com), had loose, classy-looking **spinel** octahedrons to 6 cm on edge from the Morogoro region of Tanzania. Nearly all of these crystals are slightly pebbly on surfaces (from the joinings of separate, coarse crystal domains), but they are a winsome pink to rose-red, and the best of them show considerable gemmy areas; oh yes, and they are fluorescent a rich ruby-red.

No really surprising new finds from Namibia showed up this time, but the beauty of dioptase and beryl, while not at all surprising, is always worth a gawk. Twenty or so small, sprightly specimens of **dioptase** from Charles Key's new diggings at the Omaue mine, Kaokoveld, Namibia, were brought to the InnSuites by Stefan Stolte of *Mineralien & Fossilien Galerie* (min.foss.gal@web-de). Very sharp, deep green, doubly terminated dioptase crystals from 1.5 to 3 cm perch on massive white calcite vein fillings in limestone matrix. The crystals are only medium-lustrous and not gemmy, but these matrix specimens, ranging from 2.5 to 10 cm, are aesthetically choice. And late in summer 2009 there was a small pocket find of lovely color-zoned **beryl** crystals somewhere in the Erongo Mountains, and Rob Lavinsky of *The Arkenstone* (www.irocks.com) had four fine cabinet specimens from this pocket at his stand at the Main Show. The sharp-edged hexagonal prisms reach 7.5 cm long, and most of their (part-gemmy) volumes are aquamarine-blue, but yellowish orange zones take over suddenly near the terminations.

While checking out Rob Lavinsky's Tucson 2010 offerings, let's admire also the excellent specimens of **hematite** and the jumbo-size **ettringite** crystal groups which came to Rob late last year from the N'Chwaning mine complex at Kuruman, Northern Cape Province, South Africa. The hematite specimens, in thumbnail to small-cabinet sizes, show tabular, mirror-faced and brilliantly lustrous, jet-black hematite crystals from 2 to 5 cm; some of the specimens are loose single crystals and crystal groups, while others show the hematite crystals, some partly overgrown by white **oyelite**, resting on matrix of black massive **hausmannite**. From a different pocket in the N'Chwaning complex of mines, Rob had world-class specimens of ettringite, with sharp prismatic crystals, a bit rounded on their ends, to 12 cm, in groups from 10 to 25 cm (!). Only the outer zones of these crystals consist of opaque, pale to medium yellow ettringite; their cores consist of transparent pale yellow **charlesite**.

Paul J. Botha (paul.botha@oribi.co.za) is a friendly fellow with a keen mineral-eye who usually has a room in the InnSuites—as he did this year—fairly crammed with modest but interesting items from southern Africa. This time Paul showed me flat after flat of good specimens, mostly thumbnail and miniature size, of **olmiite** from the N'Chwaning mine; **goshenite beryl** in sharp, lustrous, doubly terminated prisms to 2 cm with black schorl crystals, from the Erongo Mountains, Namibia; attractive pale apple-green **tarbuttite** in intergrown crystal sheaves partly coated by chalky white **skorpionite**, from the Skorpion mine, Namibia; pale brown fans of very thin, bladed crystals of **eudidymite** to 3 cm, from Mt. Malosa, Malawi; loose, crude, thumbnail-size, gray-green crystals of **kornerupine** from Betroka, Madagascar; loose, sharp crystals of **rutile** from Alto Ligonha, Mozambique; and plenty more.

Peculiar-looking but very pretty specimens of complexly twinned yellow **calcite** from a basalt quarry near Sambava, Antsiranana, northern Madagascar were first collected in 2003, and first hit the international market at the 2004 Munich Show; some say now that the occurrence is already exhausted. (See the article in this issue beginning on page 239.) These calcite specimens have never been abundant, so it was a nice surprise to find Victor Yount (victoryount@netzero.com) with about 40 of them at the Westward Look Show. Ranging between 8 and 30 cm, with individual calcite crystals to 8 cm, Victor's specimens are impressive although not as lustrous as smaller ones can be. Victor's pieces show intricate, generally triangular, multiple twins of the transparent, pale yellow to yellow-brown calcite, some crystals hosting snowy excrescences

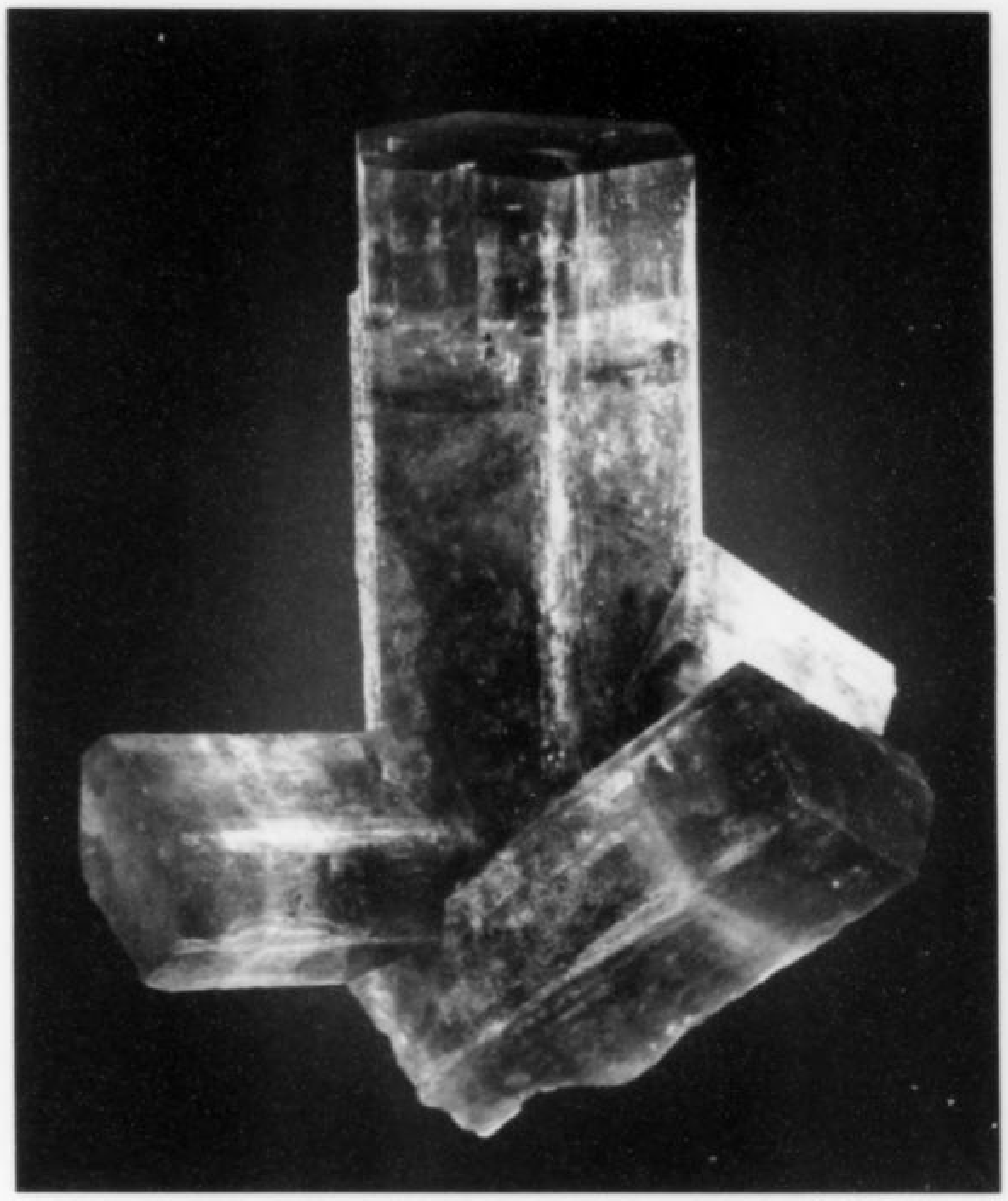


Figure 19. **Heliodor/aquamarine crystal group, 7.3 cm, from the Erongo Mountains, Namibia. Rob Lavinsky (The Arkenstone) specimen; Joe Budd photo.**

of tiny stilbite and laumontite crystals. In price the specimens range between $300 and $3,000.

One could not think of leaving Africa without a check-in on specimens from the new occurrence of gemmy green **andradite variety "demantoid"** at Antetezambato, Antsiranana, Madagascar. This is a field of diggings in a mangrove swamp, where hundreds of locals have thrown up a miners' "city" from which they come out to flounder in mud and extract gem crystals until the next ocean tide comes in to flood the pits. See the article by Federico Pezzotta elsewhere in this issue. Specimens of the material were to be found with dozens of dealers (including gem dealers) at various venues around Tucson. But immediately upon entering the big white house on Granada Street where Daniel Trinchillo conducts his *Fine Minerals International* business, one knew where The Best Ones were. Several shelves of a big glass wall case facing the front door were decked out in green and orange—superlative demantoid specimens alternating with big, gemmy trapezohedrons of Tanzanian spessartine. The demantoid crystals show combinations of isometric forms but are generally dodecahedral; they range in size between a few millimeters and 3 cm, and in color between grass-green ("demantoid") and a sort of oily, opulent-looking brown-orange ("topazolite"). Almost all of the crystals are highly lustrous, and most are gemmy in part or altogether. The best of the cabinet-size specimens show flashing green or brown clusters of crystals resting on matrix of pale yellow calcite or dark green massive andradite. Of course, the large and/or unusually gemmy specimens have prices which begin in the mid-four figures; nevertheless, at Daniel's and elsewhere, an excellent thumbnail might set you back only about $300.

Only one new item from Russia caught this investigator's eye in Tucson—withal that I'd also seen a few specimens from the find at the 2009 Munich Show. In mid-2009 a single small pocket in the Bor (boron) mine at Dalnegorsk, Primorskiy Kray, produced about 100

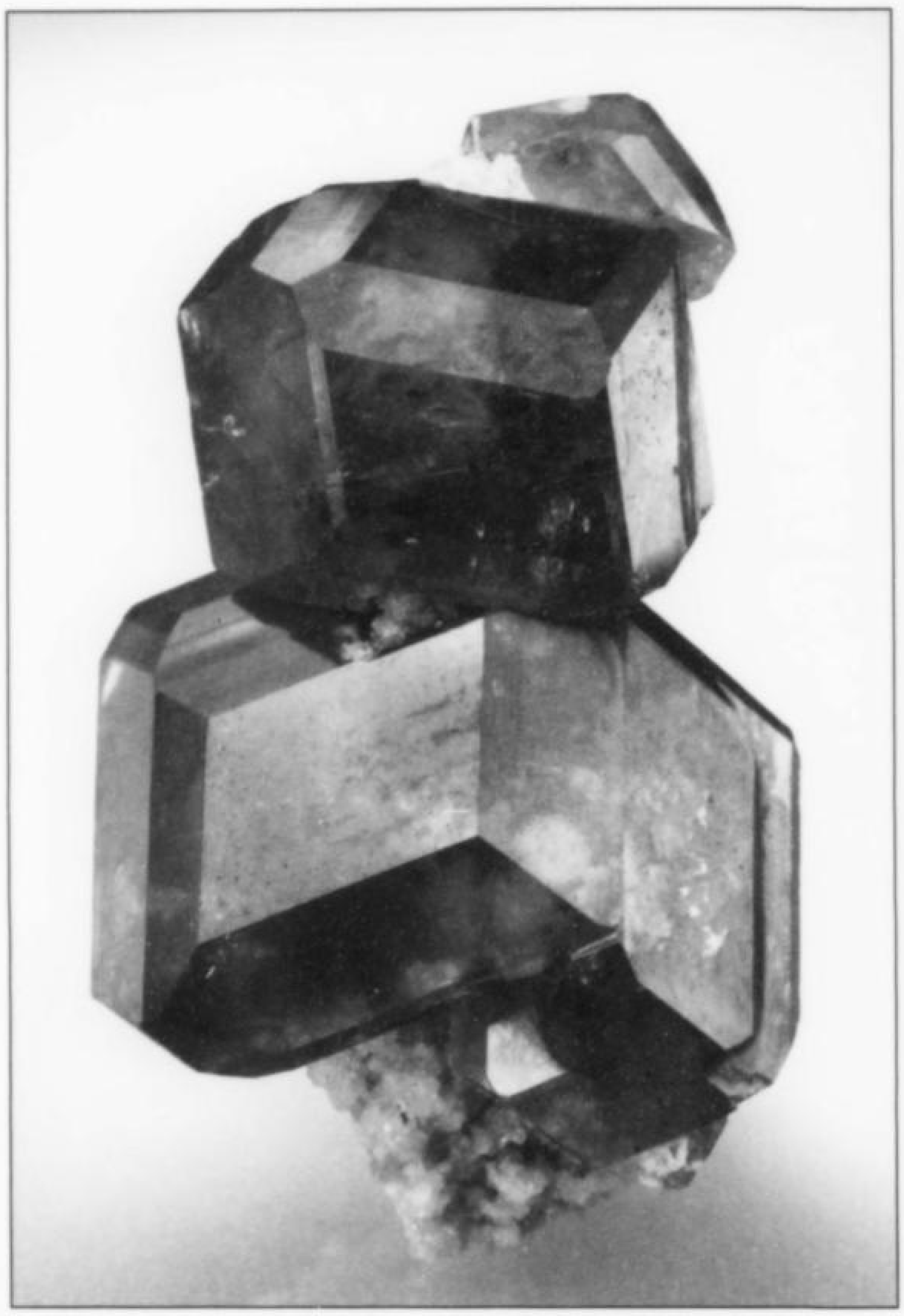


Figure 20. **Andradite (var. demantoid), 2.8 cm, from Antetezambato, Madagascar. Daniel Trinchillo (Fine Minerals International) specimen; Roberto Appiani photo.**

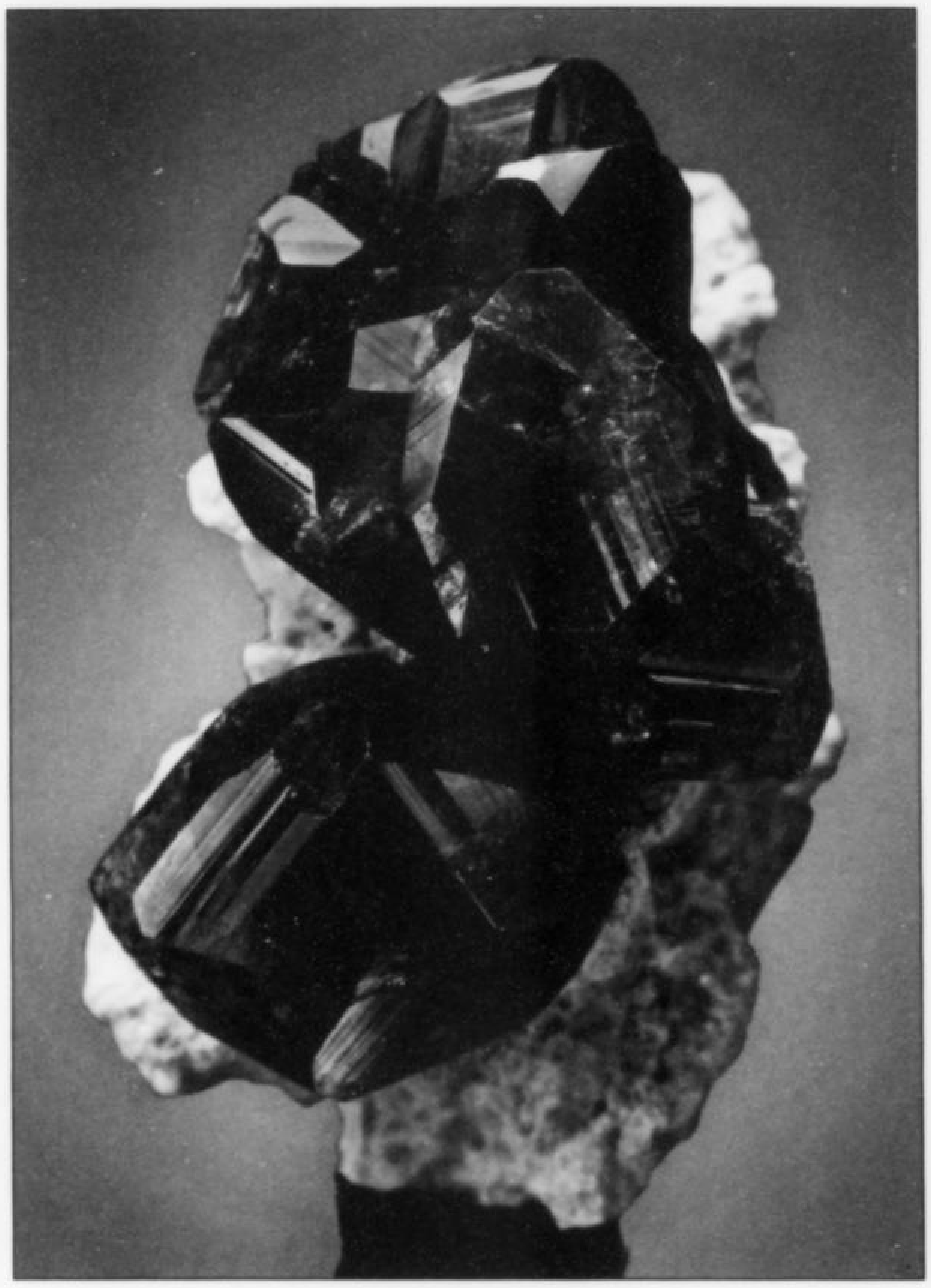


Figure 21. **Andradite (var. topazolite), 4 cm, from Antetezambato, Madagascar. Daniel Trinchillo (Fine Minerals International) specimen; James Elliott photo.**

thumbnails and a few miniatures of **datolite** of a quite new aspect for Dalnegorsk: highly lustrous, transparent, palest green datolite crystals to 1 cm forming pretty, loose clusters without associated species. The datolite crystals—unlike almost all earlier datolites from Dalnegorsk—are simple orthorhombic prisms with flat terminations. Fine specimens to 4 cm appeared with several Russian dealers in Tucson, but the best were at the Quality Inn with Victor Ponomarenko (mineralvvp@yandex.ru) of *"Axinite-PM Ltd."*

From Afghanistan there are two major discoveries to report. One is the second of the two big coups by *Collector's Edge* mentioned earlier (in connection with their "dyscrasites" from Bou Azzer): both at Westward Look and at the Main Show, Bryan Lees, Steve Behling and Richard Jackson were showing off some mega-specimens of **elbaite** from a large pocket hit a few months ago at the Paprok prospect, Kunar Province, Afghanistan. The Paprok pegmatite began producing world-class elbaites in the early 1990s, and finds since then have been intermittent, of course, with these latest specimens being among the best ever found there. The 12 cabinet-size specimens obtained by *Collector's Edge* are of two different types. In one type, stout, color-zoned elbaite crystals to 15 cm long end in flat basal pinacoid terminations; they are green at the tips but pink through the bulk of the prisms, with some yellow bands. In the second specimen type, the elbaite crystals have sloping trigonal terminations and are thinner, but they reach 45 cm long; these crystals are dark green at their ends and pink lower down. In both types, the crystals are lustrous and mostly gemmy, and some are attached to gemmy, pale **smoky quartz** crystals to 17 cm long, with sparkling white **albite** crystal rosettes as extra features. Finally, and most remarkably, none of these specimens has been repaired: the elbaite crystals were found unbroken, and thanks to careful collecting and handling they have stayed that way. Our hats are off to those highly skilled and careful Afghan specimen miners.

At the Main Show, French dealer François Lietard (francois .lietard@wanadoo.fr) and Colorado dealer Dudley Blauwet (mtnmin @attglobal.et) had between them about 30 specimens showing the new, highly lustrous, madly bright blue crystals of **sodalite** from a find somewhere in the Kokcha Valley, Badakhshan, Afghanistan. I mentioned this find in the 2009 Munich Show report, and can recall seeing one or two specimens with Rob Lavinsky at the last Denver Show (some with associations of native sulfur), but the examples on hand at Tucson are the first (to my knowledge) to show tiny orange bladed crystals of **wurtzite** cohabiting with the sodalite on white, pyrite-infused, marble matrix. François Lietard's specimens are all loose, sharp sodalite crystals reaching 1.5 cm, while Dudley Blauwet has matrix pieces from small-thumbnail size to 7 cm across, and showing the wurtzite association. Chiefly it's their vivid blue color that sets these sodalite crystals apart from earlier ones found in the lazurite-mining region of Badakhshan.

At Dudley Blauwet's *Mountain Minerals International* stand at the Main Show there were also some winning thumbnails and miniatures of **elbaite** and **almandine** taken last summer from the Namlook mine near Dassu, Gilgit-Baltistan, Pakistan. ("Gilgit-Baltistan" is

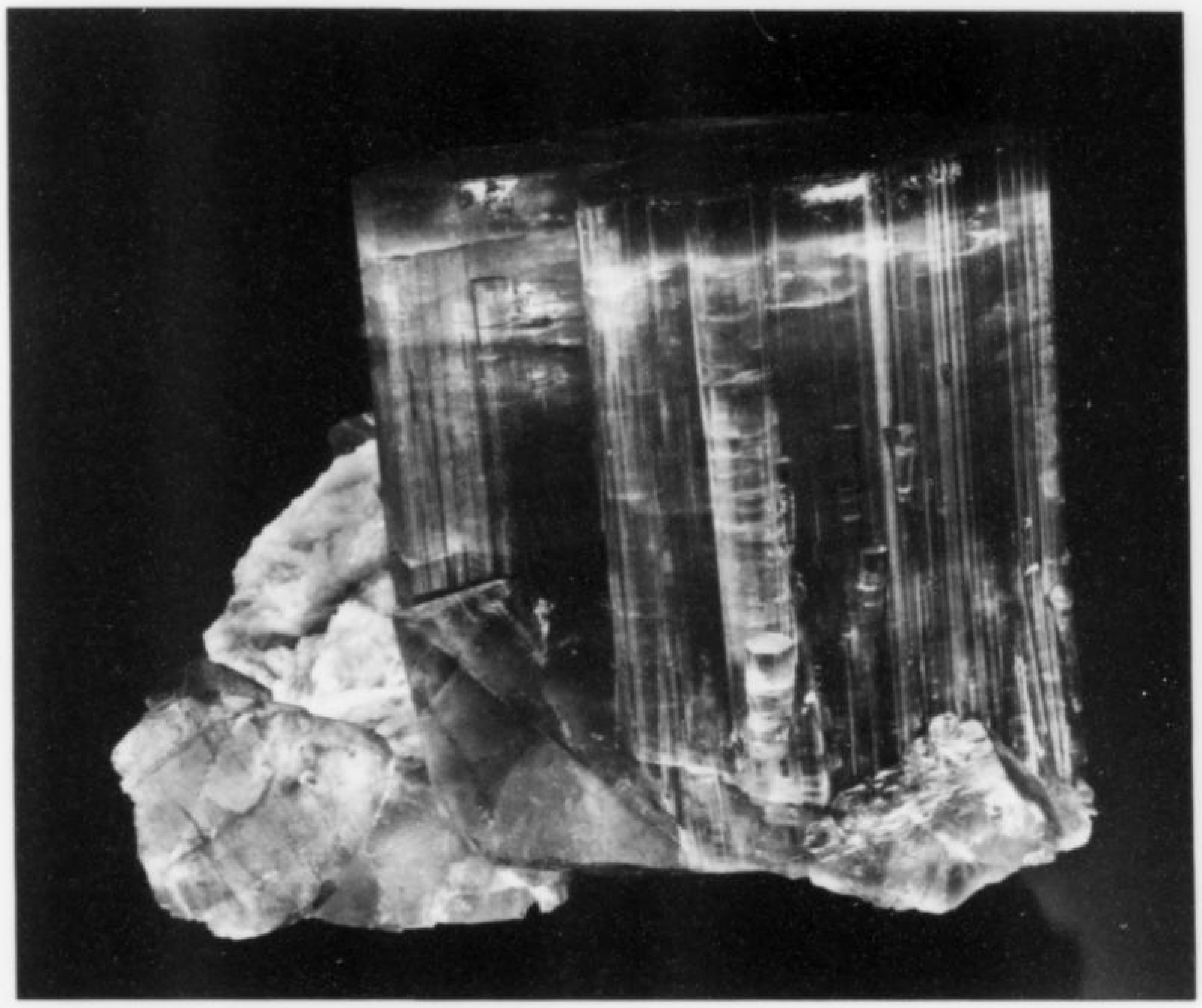


Figure 22. Elbaite with quartz, 12.6 cm, from Paprok, Nuristan, Afghanistan. Collector's Edge Minerals specimen, now in the Steve Neely collection; Jeff Scovil, photo.

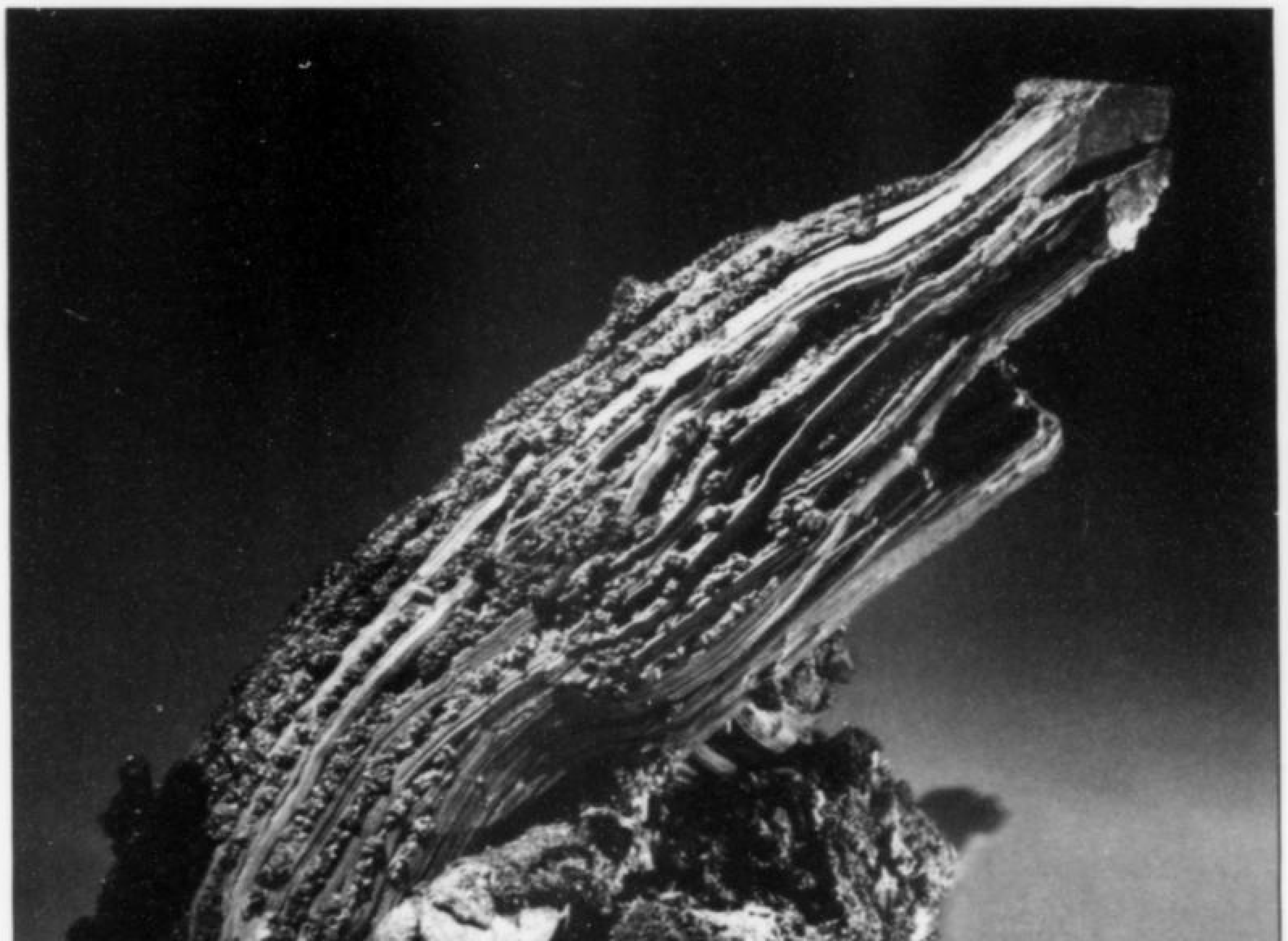


Figure 23. Goethite-coated pseudomorph of senarmontite and stibiconite (?) after stibnite with quartz, 10.1 cm, from Quinblong antimony mine in Dachang, Guizhou Province, China. Gene Schlepp (Western Minerals) specimen, now in the Carnegie Museum of Natural History collection (CM29587); Debra Wilson photo.

the new official name for what was formerly "Northern Areas"—so we now must change all of our labels.) The elbaite comes as loose, lustrous, gemmy prisms color-zoned from pale yellow-green smoothly through dark apple-green; the crystals reach 5 cm long, and a few are doubly terminated. The thumbnail-size almandine crystals are lustrous, partially gemmy, red-brown combinations of the dodecahedron and trapezohedron forms, with nice internal highlights. The single, loose crystals roll around seductively in their little white specimen boxes.

One item from India makes the news—and it's not from the zeolite-bearing basalts of the Deccan Plateau in Maharashtra but rather from an undisclosed place in the northern state of Himachal Pradesh, just south of Kashmir and over against the Himalayas. Alpine-type clefts somewhere in or near the mountains are producing highly lustrous and beautiful, Swiss-like crystals of **quartz** up to a meter long in some cases. The crystals are terminated prisms of conventional form, colorless and transparent although with scattered inclusions of chlorite and of metallic-looking flakes which are probably rutile or hematite. Striking-looking loose crystals and clusters of widely varying sizes, mostly found in June and July 2009, filled a whole room in the InnSuites—that of *Pentagrammaton Stonehouse* ("The Himalayan Quartz People," HimalayanClarity@gmail.com).

Just as bright and beautifully limpid as the quartz crystals from Himachal Pradesh are some which are presently being collected from pockets in granite in the Nshi-Okesendjyo area, Yamanashi Prefecture, Japan. Loose, crisp, transparent and colorless quartz crystals from this locality, 3 to 20 cm long, many tapered in the "Tessin habit," were on view in the InnSuites room of an intriguing dealership I have mentioned from earlier shows: *Takeda Mineral Specimens Co., Ltd.* (www.takeda-mineral.com). Gracious Mr. Kozo Takeda, after selling me one of the aforementioned "simple" quartz specimens from the new finds, proceeded to show me a handful of **Japan-law quartz twins** from the long-defunct type locality for such twins, the Otome mine, Yamanashi Prefecture. These are thick, sharp, lustrous, water-clear twins of thumbnail size; the best of them cost $300 but they are superb examples of one of Japan's most highly cherished old classics. Other Japanese items brought to Tucson by Mr. Takeda include some fine specimens of dark red-brown **vesuvianite** found three years ago in the old Kobushi mine, Nagano Prefecture, with sleek, lustrous tetragonal-prismatic crystals to 5 cm long; a couple of excellent thumbnails of **axinite-(Fe)** from the Obira mine, Oita Prefecture (another old classic); and plenty of good small specimens of **"rainbow" andradite** from Kitakado, **henmilite** from the Fuka mine, and crystallized **native arsenic** from the Akatani mine. Good Japanese minerals are very hard to come by on the commercial market, and so I recommend a visit to Mr. Takeda wherever and whenever he may appear at Western shows.

It has become my custom to end globe-girdling reports like this one in China. This year, unfortunately, not very much *really* new Chinese material was on hand, though Jordi Fabre's lone specimen of **atacamite** from a prospect near the Tonglushan mine, Daye, Hubei Province, is quite remarkable. The 10-cm specimen shows brilliant green acicular crystals of atacamite to 3 cm forming tight sprays which fill a cavity in massive cuprite. Jordi (www.fabreminerals.com) says that this is the best of about 15 such specimens found last year at the collecting site.

Another Chinese one-of-a-kinder will conclude the tour. Late in 2008, on the 1,500-meter level of the Chuxiong coal mine, Yunnan Province, an anamolous pocket of "cave" calcite was discovered. Most specimens which came out are hand-size, but the biggest, measuring 35 cm, is a remarkable thing which was in the mine owner's collection until it was picked up by Christophe and Brice Gobin (www.mineralsweb.com), who wowed me with its picture at the Main Show. Who has seen anything like this from a *coal* mine?

HQLP REPORT

There were many, many examples of HQLP (High-Quality-Low-Price) specimens around the show; the statement trembles indeed on the brink of cliché (but it's a *happy* cliché). In this sub-column, lately, I've been going on about how the careful, well-informed shopper can build a first-rate collection without spending more than $200 per specimen. To help make the point yet again, here's a list of some things described above but for which I didn't name prices:

A beautiful miniature from one of Evan Jones' flats of the brand-new Carlota mine, Arizona **azurite** specimens could be had for $100 to $200. John Seibel's new **sulphohalite** specimens from Searles Lake, California cost no more than $200 for a large miniature or small-cabinet-size crystal cluster. Excellent thumbnails and small miniatures of Scott Kleine's new **wulfenite** from the Mobile mine, Nevada, ran between $75 and $150. The best of the small-cabinet-size **babingtonites** from the Lane quarry, Massachusetts, brought to Tucson by Kevin Downey had prices hovering around $200. Dennis Beals was letting go thumbnail-size single crystals and miniature matrix specimens of the pretty pink **grossular** from Mexico for prices under $50. All sorts of bargains were to be found among the recent Peruvian finds brought in by Jaroslav Hyršl, and even a 10-cm crystal group of the world-class (and pretty!) **coquimbite** from the Javier mine asked no more than $200. For something between $100 and $150 in the Gobin brothers' wholesale room at the InnSuites, you could have had an open geode, say around 12 cm across the mouth, with a lovely, pellucid, complex **calcite** crystal of 3 or 4 or 5 cm inside, from the 2008 find at Pau, France. Two hundred dollars (or just a bit more) would have bought from Stefan Stolte a fine small-miniature-size matrix specimen of **dioptase** from the Omaue mine, Namibia, with a sharp, complete dioptase crystal to around 2 cm. Everything in my short list of southern African goodies brought in by Paul Botha could be had in superb small examples for well under $200, and for the most part under $100.

Still more: In the big white tent at Marty Zinn's "Mineral Marketplace" venue, *Roc 3000 France* (roc3000@wanadoo.fr) offered good prices on Peruvian things such as **scheelite** crystals on "needle" quartz from Mundo Nuevo, orange and blue **barite** from Cerro Warihuyn, and lustrous pink **rhodonite** from the San Martín (formerly Chiurucu) mine. These were all marked at $200 retail or less for a good miniature piece—and then *keystoned* (i.e. sold for half the marked price). In this tent, too, I picked up two absolutely top-quality thumbnails of Moroccan vanadinite, and $50 was the price for the pair.

First-rate, beautiful **azurite** and **pseudomorphous malachite** specimens from the Milpillas mine, Sonora, Mexico, continue to be widely available, and the very reasonable prices continue to amaze. A white tent just outside the main entrance to the InnSuites hotel harbored hundreds of Milpillas mine specimens (plus a few Ojuela mine wulfenites and adamites), the azurite miniatures and small-miniatures showing razor-sharp, gleaming, blocky or bladed, dark blue crystals to 3 cm. Such specimens cost from $100 to $200 from Mexican dealer Jesus Valenzuela or one of his helpers in the white tent (licetyenyhu@hotmail.com).

In his room at the InnSuites, Robert Stoufer of *Colorado Minerals* (www.coloradominerals.com) was selling off several flats of very attractive, sparkly specimens showing **quartz epimorphs after barite**, found in summer 2009 at the Dawn of Day mine (an old tungsten mine) on Cement Creek, San Juan County, Colorado. The clusters, to 30 cm across, show the former tabular barite crystals (to 4 cm) in ghostly terms of shapes now encrusted by glittering drusy quartz. Very nice 6 to 10-cm specimens of the material were priced between $50 and $100.

For only around $20 each, Luis Menezes was selling thumbnails and small miniatures of lustrous, highly etched, ice-clear **goshenite beryl** from finds in late 2008 at São Geraldo do Baixio, Minas Gerais, Brazil. For around $50, *KARP Minerals* (karp@iol.cz) would let you have a loose, lustrous, entirely complete, hexagonal-tabular **goshenite beryl** crystal as much as 4 cm across, from the Sakangyi mine, Burma (Myanmar).

It's easy enough to get jaded with Indian zeolites. But really, where is there a better deal than the $45 or so asked by Bill Butkowski (*The Mineral Cabinet*; www.themineralcabinet.com) and a few Indian dealers for exquisitely complete, gleaming milky white "bowties" of **stilbite**, 4 or 5 cm long, from Aurangabad?

At the Main Show, Dan and Diana Weinrich (www.danweinrich.com) lined up about 100 thumbnail specimens, all of them mounted in Perky boxes, from several former private collections they've

Figure 24. **Alex Schauss's Desautels-Award-winning case of thumbnails. Mark Mauthner photo.**

recently bought, and such were the bargains here that some compulsive HQLP thumbnail-shoppers kept coming around repeatedly. To cite a single example, one of those shoppers (OK, I'm talking about myself) obtained a complete, undamaged, beautiful 2-cm rosette of **azurite** from the now-defunct Boomerang mine, Mt. Isa-Cloncurry orefield, Queensland, Australia . . . for $60.

Now we come to what is, in my opinion, the star of this Tucson show's HQLP offerings. In November 2009, a large pocket in the hyperalkaline pegmatite of Mount Malosa, Zomba district, Malawi gave up a number of superb specimens of the amphibole species **arfvedsonite**: not, in general, a "pretty" or especially popular collector mineral, but capable, as in this case, of forming sleek, jet-black bladed crystals with major aesthetic appeal. The new specimens measure 7 to 12 cm, and one exceptional example measures 28 cm. Matrix consists of groups of euhedral, pale brown, blocky **orthoclase** crystals to 3 cm individually; from these bases rise glossy black, lightly striated crystals of arfvedsonite to 8 cm. Some of the arfvedsonite crystals have flat, lustrous terminations, but most end in raggedy thickets of terminated sub-individual crystals (similar to some dravite from Brumado, Bahia, Brazil). Luis Burillo had about 25 of the new arfvedsonite specimens in his InnSuites room, and, as highly attractive, fairly large specimens of a fairly rare species in what is perhaps its best development yet noted anywhere, these were incredible bargains at between $75 and $150.

EXHIBITS

As already noted, this year's theme at the Tucson Gem & Mineral Society's "Main Show" at the Tucson Convention Center was Gems & Gem Minerals—really a splendid theme, calling up dozens and dozens of splendid exhibits. And now, more than ever before, it is needful to apologize in advance to any exhibitor whose case I overlooked and have failed to mention below.

Among the big museums contributing gem-related cases were the Carnegie Museum, Pittsburgh; the Denver Museum of Nature and Science; the Cincinnati Museum Center; the American Museum of Natural History, New York; the Arizona-Sonora Desert Museum; Harvard; the Natural History Museum of Los Angeles County; and the Royal Ontario Museum (exotic gemstones: ever see a faceted leifite? catapleiite? serandite? suolunite?). Dudley Blauwet displayed gem crystals from Africa; Wendy and Frank Melanson displayed gem-quality grossular (and other minerals) from the Jeffrey mine, Quebec; Fine Minerals International displayed the three huge crystals of Ukrainian heliodor which appear on the cover of our November–December 2009 issue, plus a huge spidery elbaite matrix piece from the Pederneira mine, Brazil, and the great tanzanite crystal shown in Figure 97 in September–October 2009 (Wendell Wilson's oil painting of this crystal also was on exhibit elsewhere in the hall). Rob Lavinsky's exhibit case held just two specimens, each about the size of a decent portable television: an elbaite/quartz/albite from Pederneira and a quartz matrix bearing a gemmy pink morganite crystal about a foot across, from Pech, Afghanistan. The team of Gene and Roz Meieran and Bill and Will Larson had two big cases, organized by country, showing "Specimens from Worldwide Gemstone Localities," one of the cases taken up just by gem-crystal specimens from Pakistan and Brazil. A roped-off case with armed guards on station held many of the world's biggest and most famous crystals of gem tanzanite (and one faceted gem) from Merelani, Tanzania. Twenty majestic specimens filled the "Pegmatite Gems" case of the Wayne R. Sorensen Family Trust. And Keith and Mauna Proctor's accustomed big case of dazzlers this time included not only gem-crystal pieces but also about 100 gold specimens from worldwide localities, most of the golds being thumbnails and miniatures and almost all of them being absolutely top-class.

Cases showing mostly, or only, rough-and-cut pairs (natural crystals set beside faceted gems of the same mineral) were contributed by Ed Swoboda, Herb and Monika Obodda, Rick Kennedy, the MAD and HAMS groups from Texas (two big group cases), and Jim and Gail Spann. Among the amazements in the Spanns' case was a totally gemmy, lusciously deep orange grossular crystal 2.5 cm in diameter from Eden Mills, Vermont, and a fantastic matrix specimen of Madagascar pezzottaite, with a central, bright pink, tabular crystal about 5 cm across. Then there were the cases showing only cut gems—the Smithsonian case which made it out somehow from snowed-in D.C.; an interesting case by the Mineralogical Museum of Bonn University called "Real or Fake?" wherein natural and synthesized gemstones could be compared; and, by the Gemological Institute of America, a gorgeous gathering of cut stones from the Edward J. Gübelin collection, arranged literally in a rainbow arc. And the Natural History Museum of London brought over a single "historic" gem: the "Hope" chrysoberyl, a brilliant yellow-green fancy-cut stone of 44 carats fashioned in *ca.* 1821.

Figure 25. **Exhibit of gem minerals from the collections of Gene and Roz Meieran, and Bill and Will Larson. Wendell Wilson photo.**

Figure 26. **Exhibit of gem minerals by Daniel Trinchillo (Fine Minerals International). Wendell Wilson photo.**

I've already mentioned the long aisle lined with mineral art by four masters—but there were plenty of other wonderful non-gem exhibits as well. A good number of them concerned "local" minerals: Reyes Rock Shop showed minerals from Arizona and Mexico; Jim and Joyce Vacek showed azurite and wulfenite specimens ("$PbMoO_4$ Is Love," said the placard); the Bisbee Mining and Historical Museum had a handsome small case of Bisbee minerals and mementos; and Evan Jones had a case fairly crammed with sophisticated items from his Tiger, Arizona collection. The Arizona Mineral Collectors group put in a downright addictive case of worldwide azurite and malachite. And then there were cases about the southern Illinois fluorspar district (Ross Lillie); calcite specimens and faceted calcite gems (Victor Yount); corundum, from tiny alluvial gem crystals to ugly/lovable 50-pound beasts (Will and Herminia Heierman);

Figure 27. **Exhibit of "imperial" topaz from the Saramenha area, Minas Gerais, Brazil. Wendell Wilson photo.**

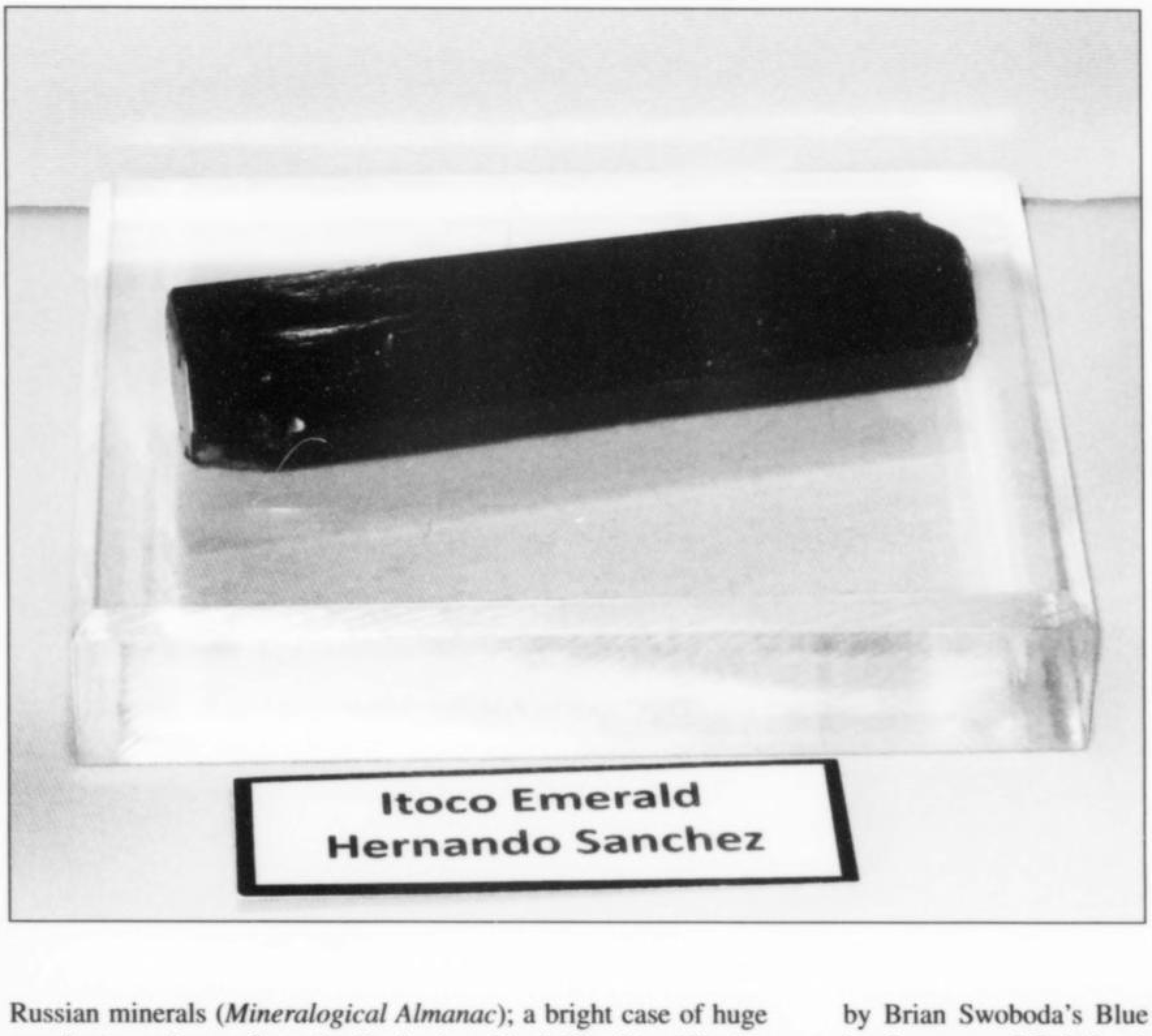


Figure 28. **The 10-cm, 472-carat "El Itoco" emerald, a single gem crystal of deep green color from the La Pita mine in the Muzo area, Boyacá, Colombia, exhibited by Hernando Sanchez, a shareholder in the mine. It was mined in August 2008.**

Russian minerals (*Mineralogical Almanac*); a bright case of huge amethyst specimens from the Reel mine, North Carolina (Charles and Cindy Cecil); Peruvian minerals (Luis Burillo); golden calcites from Gallatin County, Montana (John Cornish); Russian platinum crystals and nuggets (to 7 cm!) (KARP Minerals); a fine selection from the general mineral collection of Dan and Diana Weinrich; and, finally, two "competing" cases in which the idea was to show fine-looking minerals purchased for $99 or less (one of these was by Brian Swoboda's Blue Cap Productions Company, the other by the team of Rob Lavinsky, Wally Mann, Jeff Starr and Karl Warning).

Partly (yes) for personal reasons I felt a special attraction to a "Connoisseur Thumbnail" case organized by Jim Houran, Brian Swoboda and Jim Bleess. Twenty-one experienced thumbnail collectors were asked to contribute a few of their very best pieces, with the result that 80 thumbnails in all (plus a few that cross the line slightly into small-miniature size) reposed in the wide case where Jim and Jim had devoted much care to arranging them all to best aesthetic effect, and crowds gathered 'round pretty much all the time, and all of us who had put in specimens spent time trying to pry other specimens loose from others of us who had put them in, and adrenaline surged, and everyone had a fine time. During this year Brian Swoboda's Blue Cap Productions Company will be producing a video about thumbnail collections and collectors, with more extensive looks at some of the "connoisseur" collections here represented.

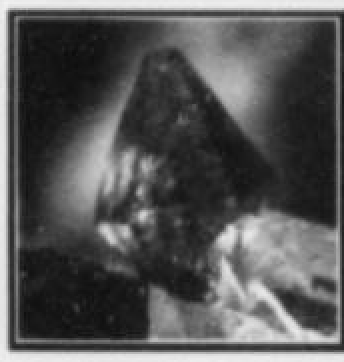
AWARDS

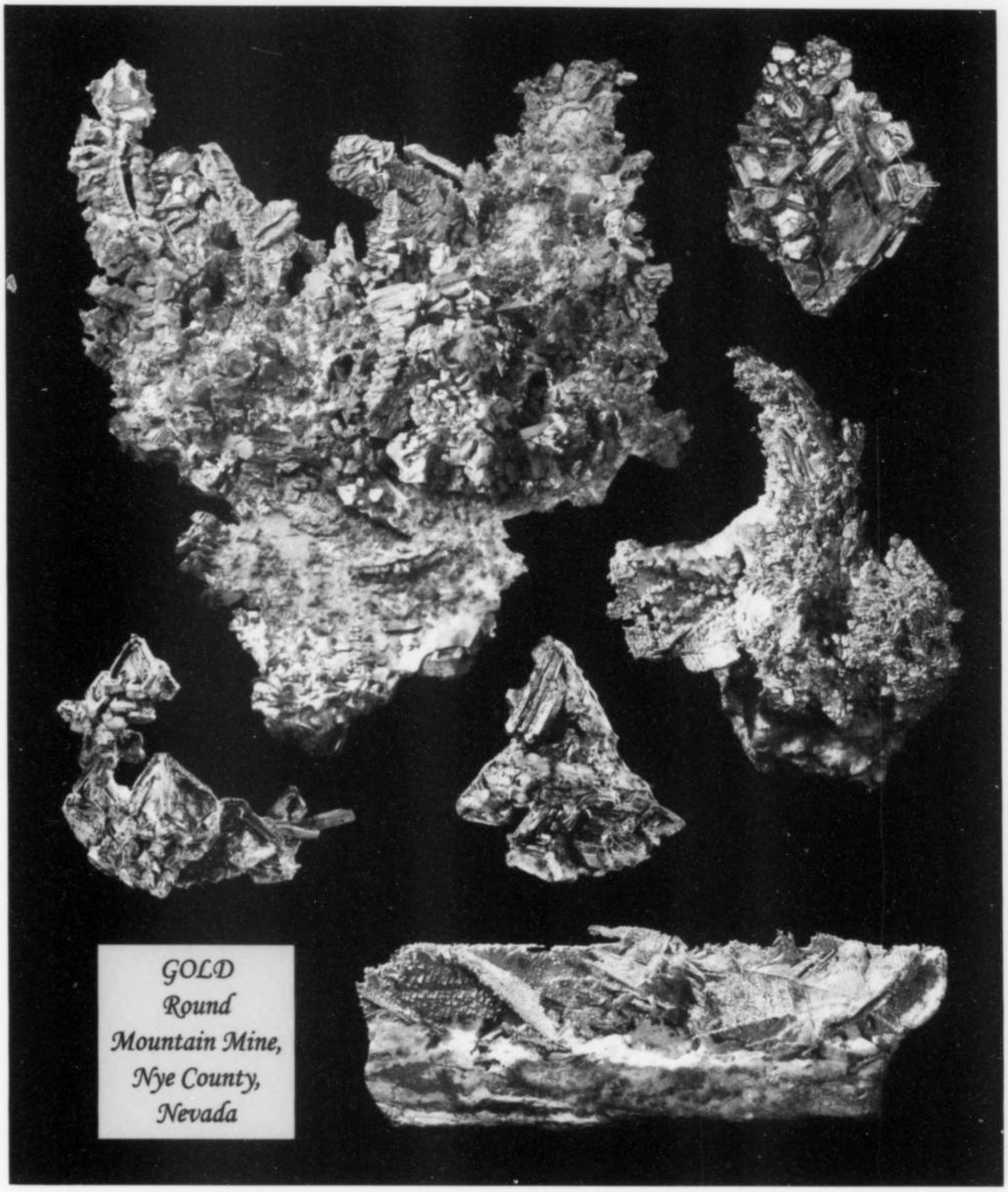
At the Saturday night awards ceremony the following people (and others) were recognized for the quality of their contributions to the Main Show and/or to mineral collecting in general. The Friends of Mineralogy gave its award for best educational case (individual) to Dr. Georg Gebhard; it gave its award for best educational case (institutional) to Jean Demouthe of the California Academy of Sciences. And the FM award for the best 2009 article in the *Mineralogical Record* went to Rock Currier for his five (very well-received) articles collectively called "About Mineral Collecting."

The TGMS judges awarded the Bideaux Trophy for best Arizona specimen in the show to Barbara Muntyan; they gave the Romero Trophy for best Mexican specimen to Scott Rudolph. The Lidstrom Tropy for best single specimen in a competitive exhibit went to Al and Sue Liebetrau, and the Desautels Trophy for the best "general" competitive case went to Alex Schuass (who also won first place in the Master competition).

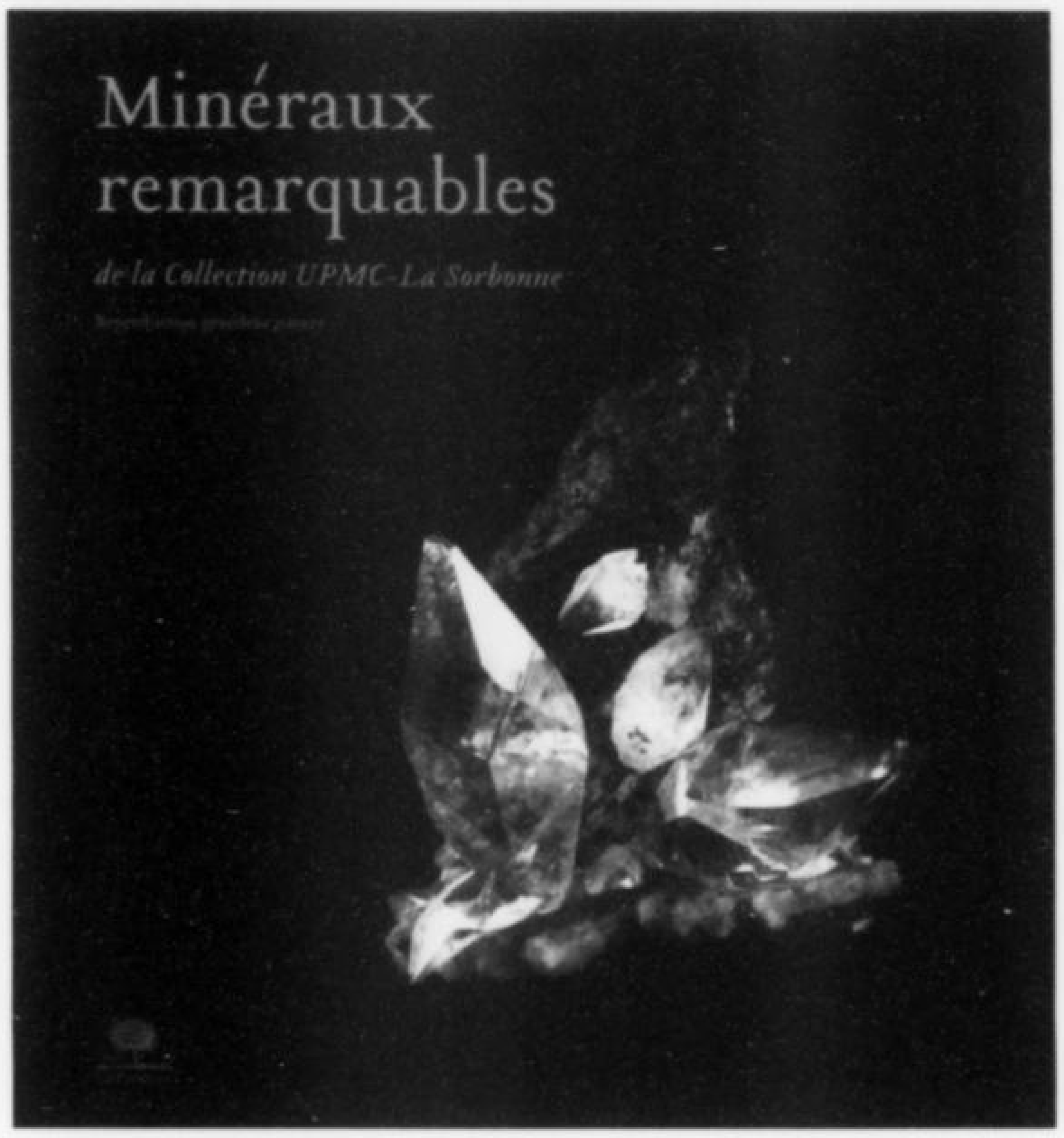
The most prestigious award of all, the Carnegie Mineralogical Award for "outstanding contributions in mineralogical preservation, conservation, and education," went this year to Dr. Peter Megaw of Tucson. Professional mineralogist and mining consultant, author, historian, longtime officer of the TGMS, and a top collector of Mexican minerals, Peter quite obviously deserves this award, and his acceptance speech was one of the most articulate, most gracious and funniest I have heard in more than a few years of attending the ceremony. Congratulations, amigo.

Next year the Main Show's theme will be "Minerals of California." See you all there!




GOLD
Round
Mountain Mine,
Nye County,
Nevada

Book Reviews



Minéraux remarquables de la collection UPMC-La Sorbonne

("Remarkable Minerals from the Collection of the University Pierre and Marie Curie—The Sorbonne") by Jean-Claude Boulliard with photographs by Orso Martinelli. Published (2009), with parallel text in French and English, for UPMC, Paris, by Editions Le Pommier; hardcover with dust jacket, 12 × 13 inches, 252 pages; price: €69 (about $94 plus shipping. ISBN 2746504510.

The Sorbonne collection in Paris is one of the world's great mineral collections, and has been the subject of numerous past articles and books, mostly by now-retired curator Pierre Bariand and his photographer/wife Nelly Bariand. (See, for example, their 1982 article on the collection in vol. 13, n. 1.) The current work, with text by their successor, Jean-Claude Boulliard, has the great advantages of duplicate text in French and English, a large-format page size and high-quality paper. Orso Martinelli's photography of the specimens is quite good; the choice to depict each one on a coal-black background is a valid alternative, eliminating potentially distracting background colors and shadows, though inevitably not every specimen looks good on black.

After a Foreword by Steve Smale and a Preface by the authors, an introductory essay discusses the Sorbonne (UPMC) collection and the difficulties involved in specimen preservation. The next 205 pages are devoted to a photo album of specimens, organized in chapters based on chemistry (native elements, sulfides, halides, oxides, etc.), similar to the way the minerals are presented in the museum. The short introductory text with each chapter is so rudimentary as to apparently be aimed at non-collectors. Boulliard's commentary on each piece, though brief (usually one paragraph), provides interesting background notes on history, rarity and other collector aspects.

The book concludes with a series of short unillustrated essays. Martinelli's insufferably pompous philosophical reflection on the nature of art vs. specimen aesthetics and specimen photography has a few good observations toward the end but is mostly arguable and over-reaching. The essay on the history of the Sorbonne collection (by Boulliard, as are the rest) is interesting and informative. The essay on the history of mineral collecting is a cogent and readable summary; the second half, in particular, contains many interesting comments and observations on the evolution of attitudes toward collecting among private collectors, scientists and museums during the last century. The final essay is an excellent commentary on collecting criteria which is reminiscent of the *Ikons* supplement published in this journal but with more emphasis on museum aspects and philosophy; the Sorbonne criteria for ranking mineral specimens is included. At the end are a short bibliography and an index.

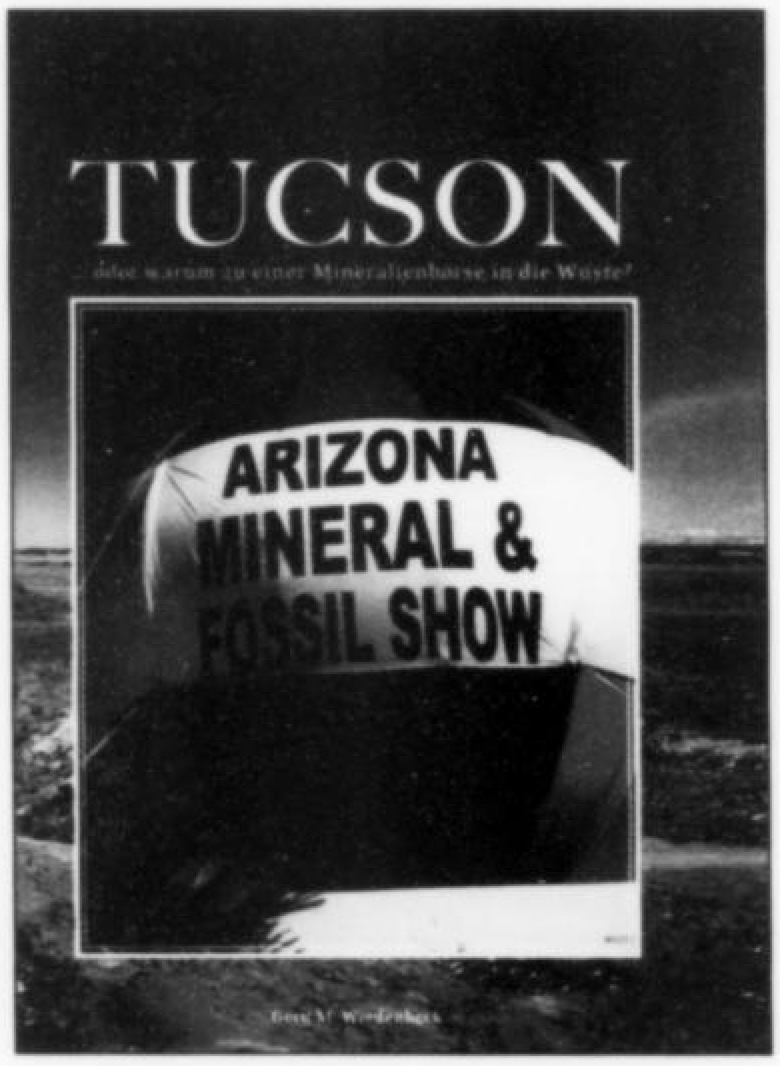
The book suffers from three serious flaws. The pale, metallic gold ink chosen for the text is difficult to read. Whether the text is in gold letters on a white background, or white letters on a gold background, lighting from the wrong angle causes the whole page to go white and become unreadable. Gold letters on a black background are also difficult to read.

Secondly, although the color printing is of reasonable (though not first-rate) quality, the matte finish of the pages, the dust jacket and the hardcover reduces the contrast in the images—the blacks appear gray—and it also seems to accentuate milky overall reflections from any angle which make the specimen photos seem dull and lifeless.

The aspect most objectionable to me, however, is the choice to depict all of the specimens actual-size. Martinelli and Boulliard's expressed rationale for this choice is to appeal to the "uninitiated majority," and to allow "collectors to compare their acquisitions directly with the specimens on the pages" while giving the reader "the same impression he would have in visiting the collection." But the flaw in this thinking is that specimens of different sizes demand to be viewed from different distances, as one would do in the museum. Pictures in a book do not permit that freedom. Attempting a close examination of a one-inch printed specimen image (as one would of the real specimen) just shows a lot of dots of ink from the half-toning process. The actual-size depiction is good for specimens that are full-page size, but what is the point of showing a 0.8-inch image of a phosphophyllite crystal or a 1.4-inch image of an andalusite crystal, each sitting totally alone (except for some caption text) on big black 12 × 13-inch pages? The 11 cumengites pictured on one page are individually as small as 0.7 inches, floating in a huge sea of black, without even text to help fill the void. Some pages contain no photo at all, and just a couple of paragraphs of caption text occupying a corner of the otherwise blank black page. "Negative space" has its place in graphic design, but in this book so much page space is wasted in this way that the reader begins to calculate in his mind how many dollars he has paid for all that black area. The "uninitiated majority" will certainly not be impressed, and the experienced collector will yearn for a much closer look at the smaller specimens. In consequence, the book becomes a tribute to large cabinet specimens, and the species that occur in that size, while the smaller specimens and rarer crystals become progressively harder to appreciate and study.

Boulliard's excellent essays notwithstanding, the principal function of this (fairly expensive) book is to show off the treasures of the Sorbonne collection, and in view of the defects in presentation it cannot be recommended. It is essential only for collectors trying to build a reference library on the world's major collections.

Wendell Wilson



Mythos Tucson . . .
Oder warum zu einer Mineralienbörse in die Wüste ["Or why go to a mineral show in the desert?"]

By Gerd M. Wiedenbeck. Published (2009) by U/C-Tec GmbH, Impexstr. 4, 69190 Walldorf, Germany (Info@uc-tec.de); price €70 plus shipping costs. Hardcover, 9.5 × 12.5 inches, 340 pages; order on www.mythos-tucson.de. [In German]

In 2004, the 50th anniversary year of the Tucson Show, Bob Jones delighted devotees of The Tucson Experience with his *Fifty-Year History of the Tucson Show*: an exhaustively researched, generously illustrated 183-page account of those busy 50 years (this immensely likable book is still available in the "Bookstore" section of the *Mineralogical Record* website). Now a new, somewhat different though equally fond take on the Tucson Experience is also in print (in German). This one is the longtime project of inveterate Tucson show-goer, southwestern-USA traveler and mineral collector Gerd M. Wiedenbeck of Heidelberg, Germany. The new book covers the Show only during Wiedenbeck's period of personal visits, from 1993 to the present, but its focus nevertheless is broader than that of Jones' book, since Wiedenbeck takes in not only the "Main Show" at the Tucson Convention Center but also the spectrum of satellite "hotel" shows and, in fact, the entire Tucson Gem and Mineral Showcase (as the Convention and Visitor's Bureau likes to call this huge confabulation of shows and events).

And yet only about half of the book's space describes the people, events and yearly specimen offerings of the Show. The rest recounts the adventures of Wiedenbeck and a changing cast of companions as they went off on ambitious side trips, first to Tucson's own notable tourist sites and sights, then to the Grand Canyon, Canyon de Chelly, the Petrified Forest, Meteor Crater, Tombstone, Bisbee and countless other interesting locales in Arizona . . . then on, in some cases repeatedly over several years, to Monument Valley, Las Vegas, Death Valley, the California sequoia forest, Santa Barbara, Los Angeles, Hollywood, and even a ten-day Hawaiian sojourn in 1994. This is a man who loves to travel, and his descriptions of his encounters with southwestern US subculture convey a certain complexity of response, and of irony, and of ever-increasing affection. The Introductory page shows a parodic scene of a man mock-dying of thirst in a sandy desert; we read repeatedly of the author's distaste for American fast food in general, and for bad gas-station coffee in paper or styrofoam cups in particular; he notes the "visits" of 4-centimeter cockroaches to his hotel room during one year; he even reproduces a photo of a poster in one tiny town, with a cartooned Hitler giving the Nazi salute beside the words "all in favor of 'gun control' raise your right hand." But to take any of this for the simple snobbery of an urbane European would miss the love and the joy-in-new-things that suffuses the whole.

Also, Wiedenbeck, a dedicated field-collector of minerals, excitedly describes his sidetrips to such places as the dumps of the Old Yuma and Rowley mines, the J. C. Holmes claim, and even the Red Cloud mine (during Wayne Thompson's final work there in the late 1990s), and he shows off his results in an eight-page portfolio of photos of "Eigenfunde" (self-collected specimens) in these and other meccas in Arizona, New Mexico and California. Elsewhere, a 13-page portfolio shows some of Wiedenbeck's silver-pick acquisitions at the Tucson Show, mostly as full-page-size photos of excellent quality. Then, placed seemingly randomly in the book, and with the effect of complete surprise at the turn of a page, are many more first-rate photos of first-rate mineral specimens, some selected to illustrate "what's new" excitements at Tucson over the years. In the text Wiedenbeck lingers on some of these excitements, and offers personal angles on them: for one, there's a good account of the Sweet Home Rhodochrosite fever that came to town in 1993, and later, echoing it, comes the story of Wiedenbeck's at last buying, from Bryan Lees in 2002, the (barely affordable) Sweet Home rhodochrosite specimen of his dreams.

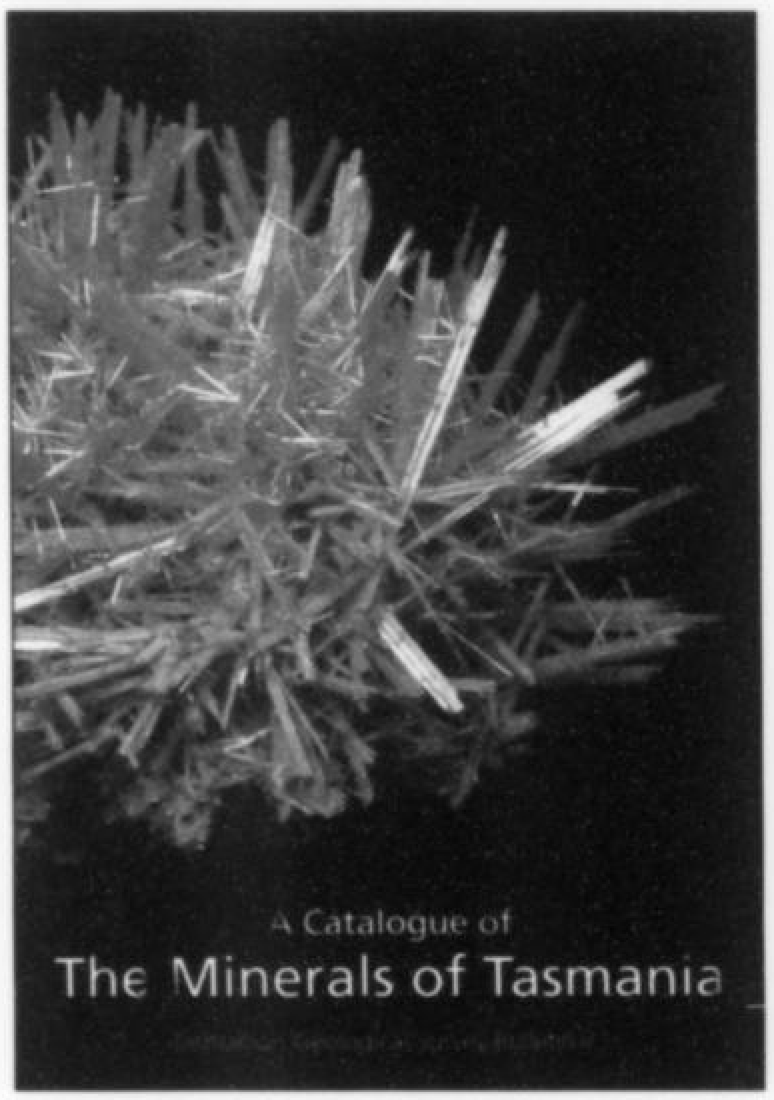
Pictures from the hotel shows and from the Main Show floor, and shots of luminaries like (to name just a few) F. John Barlow, Carl Francis, Gene Meieran, Helmut Brückner, Dawn Minette, Jack Halpern, Dave Wilbur, Joel Bartsch, Steve Smale, and Jim and Gail Spann, all in furious mid-show action, are here—and always there are vistas of saguaro forests and decidedly non-wintry skies a mere page or so further on.

The book's final main chapter offers voluminous "travelers' tips" for first-time German (or any foreign) visitors to the Show: included are sections on airline and hotel reservations, restaurants, car rentals, currency, customs-clearing pitfalls, and much more of the kind. As a guide and come-on to Europeans considering visiting Tucson in February for the first time, this is a valuable work, maybe even the best such "reference" work now in print.

For Americans or others who can't read German the book may, of course, lose some appeal, especially given its price and *especially* given the present horrendous exchange rate of the dollar vs. the euro. Even non-German-readers, though, may well find the book "worth it," if only for the joy of seeing so many fine pictures (mostly by the author, though Jeff Scovil too has contributed some) of everything from magnificent mineral specimens to old junked Model-A Fords in the desert, speed-freaking buggies on the Great Imperial Sand Dunes of California, moldering signs in crabby old ghost towns, Gila cliff dwellings, the dumps of famous old mines, Bryce Canyon vistas which go on forever, Hawaiian hula dancers in flickering firelight, or Navajos riding their horses through glowing red scrublands at sunset. Interesting, too, and not *that* hard to translate, are the many acute, invariably good-natured observations concerning differences between the American and European mineral-collecting scenes (one example, from page 52: "An American collector buys a specimen for $100,000 and a car for $5,000; for a German collector it's the reverse.").

Stout, and printed on high-quality glossy paper, the book is a technically fine production, and its text, what's more, has been carefully edited. I saw no misspellings of mineral names or of locality or other geographical terms . . . though typographical errors occasionally do creep into other names. This is a lovely book, and if you want to order it you may do so easily on the website specified in the heading above.

Tom Moore



A Catalogue of the Minerals of Tasmania

by R. S. Bottrill and W. E. Baker. Geological Survey of Tasmania Bulletin no. 73. Published (2008) by Mineral Resources Tasmania, Department of Infrastructure, Energy and Resources. ISBN 9780724640218. Available from the publisher (www.mrt.tas.gov.au) at P. O. Box 56, Rosny Park, Tasmania 7018, Australia. Softcover, 8.25 × 11.5 inches, 254 pages. Price $50 plus shipping.

To geographers, the Australian state of Tasmania is an island 240 kilometers south of the southeastern corner of the island continent, having 500,000 people thinly distributed over an area of 68,401 square kilometers (26,410 square miles). To mineral collectors, it is the end-of-the-earth place where the world's finest crocoite specimens have been found for more than a century, and are still being found, in small, mostly defunct lead mines near the town of Dundas. If we are aware of any other mineral localities in Tasmania it is likely to be as bare terms remembered from labels of loner specimens seen here and there—for example, the Mt. Bischoff mine (cassiterite), Colebrook Hill (axinite-Fe), Waddamana (chabazite), Cape Grim (natrolite), the Renison mine (fluorite) . . . and not many more. In fact, though, Tasmania is one of Australia's most richly mineralized states, with a history of large-scale mining more than a century old and with 483 confirmed mineral species plus 162 unconfirmed ones—and counting—from hundreds of localities scattered everywhere around the island.

The first omnibus catalog of Tasmanian minerals was assembled by William Petterd of the Tasmanian Department of Mines and published in 1910; the last comprehensive revision, by W. E. Baker (one of the present book's authors) was published by the Department in 1970. Thus, by now the new work was called for, and it conscientiously does its updating duty by flagging doubtful old information; taking account of the last four decades or so of advances in analytical techniques and changes in species nomenclature; posting notice of changes in the status of localities; even giving helpful advice to *fossickers* (the Australian term for field collectors) who might want to dig Tasmanian treasures for themselves.

In the book's early parts there are short chapters on the geology of Tasmania, fossicking in Tasmania, early research by William Petterd and others, and "Mining in Tasmania." The last-mentioned chapter is immensely interesting, and a reader will want to flip back to it many times while perusing the species descriptions. My only complaint is that, at just two pages, it's too short: one would like to know much more about the histories of these mines where major deposits were exploited. What big, bulging, untold stories of discovery, adventuring and profit lurk behind such brief passages as "Exploration by Aberfoyle Limited to the east of Waratah discovered the large Que River silver-lead-zinc ore body in 1974 and the nearby, even larger, Hellyer zinc-lead-silver ore body in 1984. These mines were exploited rapidly and were both closed by 2000 . . ."?

The alphabetized descriptions of mineral species comprise necessarily the catalog's core: 183 pages of densely packed information, acanthite through zunyite. Each description begins with a paragraph on the general nature and geological mode of occurrence of the species in question—a feature of use only by beginners, since the data here are not Tasmania-specific and are available readily elsewhere. Then, for each species, comes exhaustive information on occurrences in Tasmania, the older ones distinguished, often with specific dates, from the modern and contemporary. All of the species summaries are well anchored by citations to published literature, and there are generous numbers of color photographs. These latter are of superior quality, sharp, bright, beautiful, and as scientifically informative as one could wish—and most of the specimens themselves are superb and highly desirable. However, to learn their *sizes*, or to learn the names of their owners or of the photographers, one must flip to Appendix 5 near the back of the book. It would have been much handier had this caption information been shown directly under each picture.

The concluding 47 pages are rich with supplementary information. Among the Appendices are a glossary of geological, mineralogical and other terms; a listing of all known Tasmanian mineral species, including those still unconfirmed; a primer on recent changes in mineral nomenclature; two pages of safety precautions for fossickers; maps, plus a listing of localities with geographic co-ordinates; and a Bibliography with 395 entries. On the front cover, against a black background, is a kingly crocoite specimen; on the back cover we make the pictorial acquaintance of bismuthinite, cassiterite, fluorite and siderite from little-known Tasmanian places.

What better regional mineralogy can there be to add to our shelves than this new, exhaustive yet compact, well-organized, well-illustrated volume?

Tom Moore

The Mines and Minerals of Chester County, Pennsylvania

by Ronald A. Sloto. Self-published (2009) by Ronald A. Sloto. Softcover, 8.5 × 11 inches, 512 pages. Price $35, plus $5 shipping; order from Ron Sloto, P.O. Box 13, St. Peters, Pennsylvania 19470, or on www .rasloto.com/book/.

To quote from the Introduction to this impressive, massively researched new book, "Chester County has a rich mining and mineral history that spans more than two centuries . . . Historical information on Chester County mines and minerals is scattered [in] books, reports, journals, newsletters, and newspaper reports, many of which are now obscure. This book collects the historical information into a single source that documents Chester County's rich mining and mineral heritage."

Yes indeed: more than 400 mines and mineral localities in Chester County are treated in summaries whose lengths range from single short paragraphs to complete "articles" of more than 10 pages. Accompanying the summaries in most cases are (old) photographs of the mines in their working heydays and (newer) photographs of their dumps and remaining structures. Also scattered abundantly throughout the book are topographic maps on which the exact sites of the localities are pinpointed; pictures of old mining stock certificates and other (eminently collectible) documents and artifacts; old-time photos of picturesque towns near the mines; snapshots of field-trippers combing the dumps during times stretching well back into the 1800s; line drawings of orebodies, quarry layouts and mine plans; and hundreds of photos of mineral specimens from diverse private and public collections, some of these being specimens which came out of the ground 200 years ago. Mr. Sloto does not credit most of the specimen photos; presumably they are his own.

The "visuals" just mentioned are all in black-and-white, but wait! there is also a central portfolio of sixteen color plates showing mineral specimens from Chester County. Although these photographs, and the specimens which are their subjects, vary considerably in quality, some of the best of the latter are truly superb—the pyromorphites, anglesites, cerussites and wulfenites from Phoenixville, the pyrites and chalcopyrites from French Creek, the rutile from Parkesburg, such as the apatite-(CaF) from Cornog—while others are quite surprising, even to this Pennsylvania native, e.g. amethysts from the Painter Farm, microclines from the Poorhouse quarry, clinochlore variety kämmererite from the Scott mine, and others.

Near the end of the book, extensive appendices offer cross-referenced lists of localities and of the mineral species occurring in them. In the Bibliography I counted 710 titles, including selections from travelers' journals back to 1788 (the earliest date I saw), technical and hobbyists' articles, newspaper features, letters, industrial reports, and writings of varied kinds by Pennsylvania-minerals luminaries including Charles Wheatley, W. W. Jefferis, Samuel Gordon, Arthur Montgomery . . . and Sloto himself, author of the *Mineralogical Record*'s article on the Phoenixville mines (September-October 1989) and co-author of the article on the French Creek mines (March–April 1994).

This self-published, labor-of-love book shows very clearly the author's devotion to Chester County minerals, and more importantly it shows *why* this geologically complex, richly mineralized corner of southeastern Pennsylvania has what it takes to attract such devotion. Some of the "localities" in the book are simple limestone quarries, kaolin mines, and the like, and Sloto, while describing them faithfully, admits that they never produced any notable mineral specimens: they're here because their histories needed recording. On the other hand, the Phoenixville lead mine and the French Creek iron mine are famous, on at least a national scale, for their wonderful mineral specimens, and you will not find reader-friendlier accounts of these mines anywhere else (save perhaps in Sloto's own articles on them in our magazine). More likely to "educate" most readers are the sections on lesser-known but still mineralogically very interesting places, e.g. the Keystone Trappe Rock quarry at Cornog (exquisite small specimens of Alpine-type cleft minerals), Brinton's quarry at Darlington's Corners (the world's best large clinochlore crystals), the Poorhouse quarry, West Bradford Township (excellent microcline), Corundum Hill, Newlin Township (good corundum and superb diaspore crystals), the fields around Parkesburg where fine rutile crystals may still be found loose in the soil. If this list includes places you've never heard of, the book demonstrates that it's about time you did hear of and learn about them.

Just two years ago, a Utah dealer offered a small stash of specimens from Cornog, where the Alpine-type clefts yielded specimens only during the 1950s and 1960s, and where all quarrying ceased in 1968. If you saw these distinctive and pretty "adularia/byssolite" specimens at the time and (being a non-Pennsylvanian) wondered about their source, well, you can now read a fine account of that source, complete with a thrilling collecting story. In the end, all minerals, like all politics, may be called "local," and so we should always welcome good "local" mineralogies onto our library shelves, wherever it is that we ourselves call home. While not one of the splashiest or most expensive, this is one of the best such mineralogies/histories to have come along in a while.

Tom Moore

Legal Nuggets

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Specimen Defamation

"A lie can travel halfway around the world," Mark Twain once wrote, "while the truth is putting on its shoes." Anyone who has spent much time roaming about a major mineral show knows this. It is not unusual to have some rumor making the rounds: "Have you seen those Chinese silvers—they are molded and bent by little kids in Tianjin." "He's got a bunch of specimens marked as smithsonite from the Kelly Mine, but everyone knows they are hemimorphites from Wenshan." "That azurite most certainly is not from Bisbee."

Sometimes, the rumors are true. Other times, they are not. Oftentimes, the rumor is obviously part of a whispering campaign directed at the seller, perhaps with the intent of besmirching his business reputation. And with minerals fetching high prices, such rumors can be harmful, both personally and financially. So harmful, indeed, that what we are calling a "rumor" may be more accurately described, under the law, as "defamation"—also known, in various state laws, as calumny, vilification, slander (for spoken words), libel (for written words), or even product disparagement.

So what's an injured party to do? There's always that Roman maxim, *In ius voco spurious* ("I speak the law to the illegitimate"). You probably know it as: "Sue the b--tard!" But, before we rush to the conclusion that every "rumor" is an excuse for a lawsuit, let's cover a few basics, beginning with the elements of the so-called defamation torts (a "tort" is a civil wrong, other than a breach of contract, for which the law provides a remedy, usually in the form of damages).

State law controls the definition of these torts and that means there are some local variations. But, generally speaking, these torts have the following features:

(1) The comment must be of an injurious character.
(2) It must be false ("Truth is an absolute defense").
(3) It must be communicated to a third party in circumstances where it is reasonably foreseeable that it would be relied upon as true.
(4) The publication of the comment must result in a financial loss.
(5) Statements of opinion are generally not actionable.

At this point, the laws of the various states diverge. Most formulations of these torts require the defendant to have *wrongful intent.* But, in some instances, that person must know that the comment was false or act with reckless disregard of its truth or falsity, whereas in others, mere negligence is sufficient. Generally, the law requires a greater showing of culpability (e.g., that the defendant knew the comment was false) where the impact of the comment is financially limited, for example, where the comment is directed at a particular specimen; and a lesser showing where the potential harm is broader, as where the comment is directed at an entire business. Indeed, in some states, to prevail on a claim of product disparagement, a plaintiff must show that the statement was made with malice—a specific intent to harm. Substantial state variation also occurs in terms of proof of damages. Many states require that a plaintiff show that his or her damages were the natural and immediate consequence of the disparaging statement, a tough standard to meet. On the other hand, some states presume the existence of a basic level of damages if the statement impugns the integrity of the entire business.

Although there may have been such cases in the past, research has revealed no published opinions involving defamation and mineral specimens. The casebooks, however, are replete with decisions involving other collectibles, particularly art work, and especially cases involving auction houses, appraisers and critics. Importantly, these cases—among them *Hahn v. Duveen*, a famous dispute over the authenticity of an alleged DaVinci painting—draw distinctions between statements of fact and of opinion. As mentioned above (item 5), statements of opinion are generally not actionable, and some cases may invoke the First Amendment. The distinction between fact and opinion may be relevant when the comment made is that someone "thinks" a mineral is fake or misrepresented. But, take care, for at least some state courts have held that an opinion that implies that the speaker is privy to undisclosed facts (a so-called "mixed opinion") may still be actionable.

More recent cases add a novel twist: the possible application of federal trademark law, also known as the Lanham Act. The Act includes a provision that prohibits any use of a description or representation in commercial advertising or promotion that "misrepresents the nature, characteristics, qualities, or geographic origin of . . . goods." Damages have been assessed under this provision in cases in which published statements wrongly accused a work of being inauthentic or were viewed as impugning the integrity of a collection or collector. While the keen observer may have noted that this statute appears to be geared toward advertising, the world of the Internet likely has caused that distinction to be a bit fuzzier than it was before.

Legal niceties aside, there are some practical aspects that one should consider when deciding whether or not to sue (or even to threaten to sue). Consider three famous libel cases:

(1) *Marquis of Queensberry v. Oscar Wilde* (1895). Wilde, the Irish playwright, brought a libel suit against the Marquis (of boxing

rules fame) because the latter had publicly claimed that Wilde was a "ponce and a sodomite." During the trial, Wilde's carnal exploits were thoroughly explored. Newspapers in the United States and England reported on these lurid details of the testimony, creating an international sensation. The Marquis not only won the suit, but, based on the revelations at trial, Wilde was subsequently convicted on criminal charges and sentenced to two years at hard labor.[1]

(2) *Whistler v. Ruskin* (1878). Oxford poet John Ruskin (who was also a famous mineral collector) wrote a review about a painting by American artist James McNeil Whistler, in which Ruskin stated: "I never expected to hear a coxcomb ask two hundred guineas for flinging a pot of paint in the public's face." Whistler sued Ruskin for 1,000 pounds. The jury found against Ruskin—but awarded Whistler a mere farthing (¼ of a penny). Soon after the award, Whistler was forced to declare bankruptcy, causing one historian to observe: "it would have been much wiser on Mr. Whistler's part to feign indifference."[2]

(3) *Collier v. Postum* (1907). Charles Post claimed that eating his company's Grape Nuts breakfast cereal would avoid "the necessity of an operation for appendicitis." Robert Collier, publisher of Collier's magazine, called this "potentially deadly lying." Post responded with an advertising blitz aimed at Collier's. Collier's sued Post for libel and was awarded $50,000, at that time the largest verdict ever returned in New York City. However, the judgment—which *The New York Times* had characterized as an "important victory over the forces of fraud"—was later reversed on appeal for violation of a procedural rule and, after being remanded to the trial court, the case languished and eventually was dismissed.[3]

Each of these cases represents a mini-documentary on what can go wrong with a lawsuit.

Because truth is always a defense in defamation-type cases, anyone thinking of suing ought to consider (as poor Oscar Wilde failed to do) the prospect of having intimate details of one's dealings revealed in court. While there are limitations on how far a court will go, the standard employed in conducting "discovery" (the pretrial process of obtaining documents, admissions and testimony from an opponent) allows the opponent to probe not only for facts relevant to a case, but to obtain any documents or testimony that might lead to such relevant facts. Consequently, if there is any doubt as to the truth of the rumor or anything embarrassing (or worse) that might be revealed during discovery, a potential plaintiff should think twice before suing.

Furthermore, while anyone who has been unfairly impugned will naturally thirst for vindication, one seeking to sue should always conduct a basic cost/benefit analysis first. Sometimes, in trying to settle a case, I will bring a baseball bat to a meeting with the parties. I tell them that litigation is like getting hit in the head with that bat—for both the loser ***and*** the winner. A good attorney may be able to estimate your damages based upon verdict surveys, and any attorney ought to be able to give you a ballpark estimate of the costs of litigation. Generally, it would be a good thing if the former was larger than the latter—and considerably so, to account for the fact that recoveries tend to be overestimated and costs underestimated. Fail to ask about those numbers and you might find yourself like poor Whistler.

And then there are those procedural hurdles, like the one that apparently tripped up Mr. Collier. The problem, generally, is not a "technicality"; most lawyers worth their salt do not make those types of mistakes. That said, in court, there are rules that must be complied with. Among these is a detailed set of evidence rules that govern what is admissible in court. These rules are the prism through which you must view the potential evidence in your case. And if you are relying on a lot of hearsay (e.g., a statement from a third party introduced to prove the truth of the matter asserted) or other weak evidence, you may find your path to recovery blocked.

This all suggests that a person contemplating suing someone over a negative comment may want to consider other alternatives first. Perhaps an old-fashioned, face-to-face conversation; or perhaps the mediation of such disputes could be another task for a future mineral dealers' trade association. At the least, you might want to consider the old Chinese proverb: "Slander cannot destroy an honest man; when the flood recedes the rock is there." While this saying probably did not come from a mineral dealer, in the mineral world, as in other pursuits, true quality and professionalism tend to shine out and, over time, burn away the fog of even the most pernicious whispering campaign.

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 with a qualified lawyer.

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[1] 234 N.Y.S. 185 (N.Y. Sup. Ct. 1929).

[2] 15 U.S.C. ¶ 1125(a).

[3] Ruskin's mineral collection, also known as the Guild of St. George Collection, was acquired during his European travels. Parts of his collection are still displayed at the Museum in Sheffield, England. *See* http://www.museums-sheffield.org.uk/coresite/html/ruskinc.asp.

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