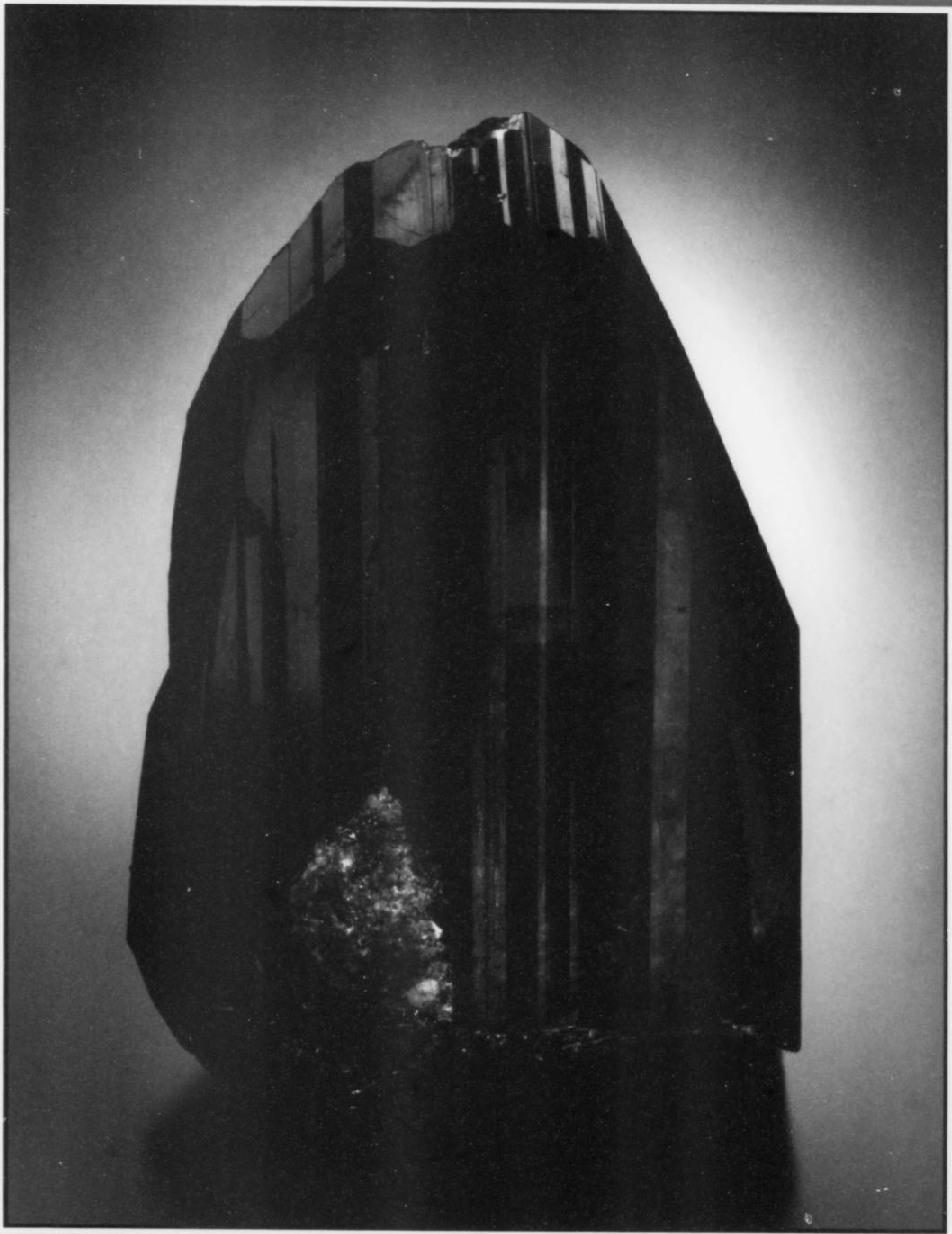
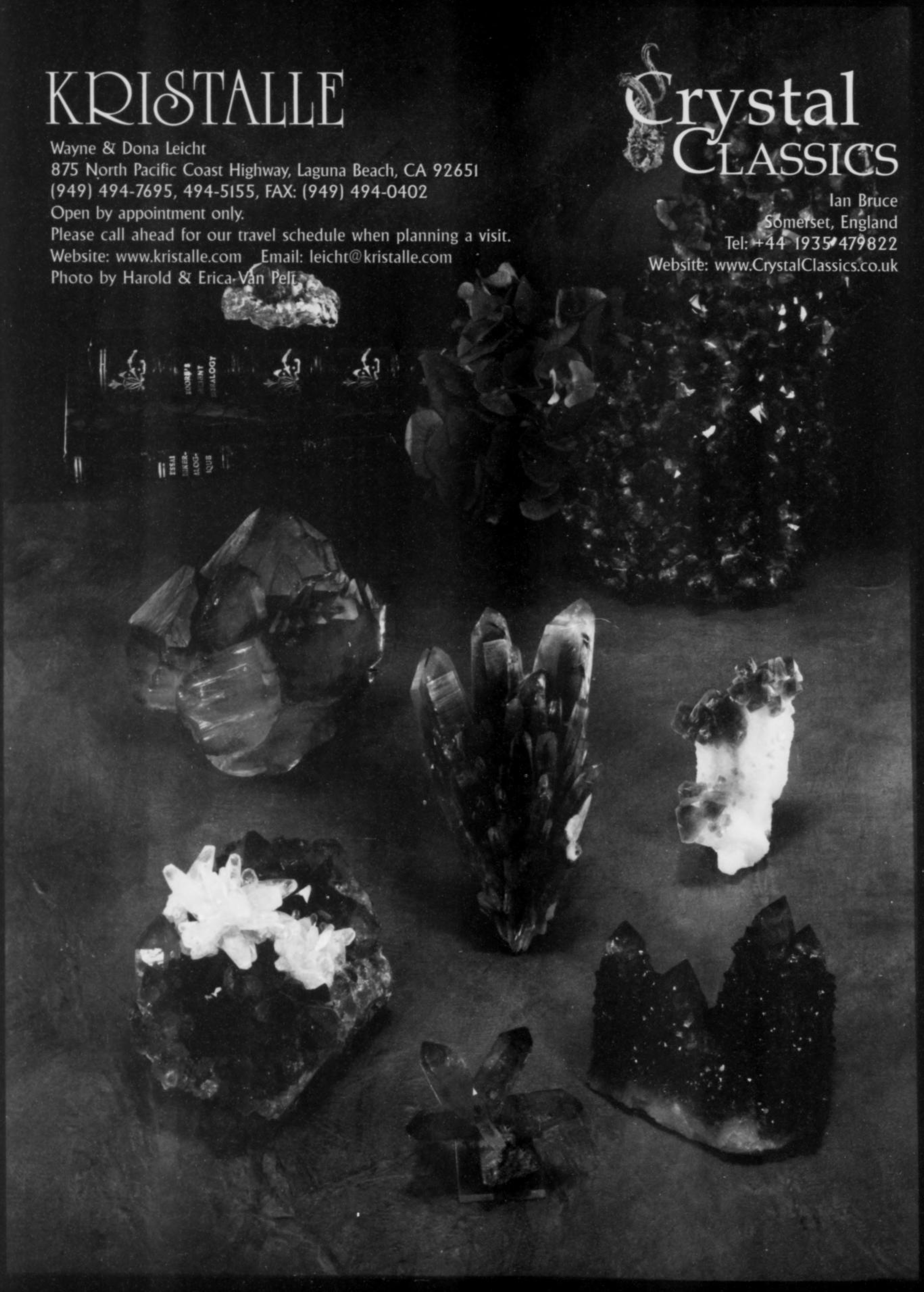
MERELANI, TANZANIA



THE MINERALOGICAL RECORD

SEPTEMBER–OCTOBER 2009 VOLUME 40, NUMBER 5 $18


KRISTALLE
Wayne & Dona Leicht
875 North Pacific Coast Highway, Laguna Beach, CA 92651
(949) 494-7695, 494-5155, FAX: (949) 494-0402
Open by appointment only.
Please call ahead for our travel schedule when planning a visit.
Website: www.kristalle.com Email: leicht@kristalle.com
Photo by Harold & Erica Van Pelt
Crystal Classics
Ian Bruce
Somerset, England
Tel: +44 1935 479822
Website: www.CrystalClassics.co.uk

Tanzania

A gem crystal paradise

Thanks to an ancient and massive orogenic episode, called the Pan-African Tectonothermal Event, Tanzania today is home to an extensive constellation of important metamorphic gem and mineral localities of which Merelani is the jewel in the crown. The discovery there of tanzanite, the gorgeous blue-purple variety of zoisite, has spawned a whole gemological industry since 1967, and at the same time has yielded thousands of superb collector-quality crystals of zoisite and several other species, including many world-class specimens. This issue is devoted to that remarkable deposit, but it also presents an opportunity to review briefly, in an introductory fashion, some of the other Tanzanian minerals and mineral occurrences of importance to collectors.

Among the best known is the vanadium-rich grossular garnet known by the varietal name of tsavorite. Discovered in 1967 by the British geologist Campbell R. Bridges in the Lemshuku area of northeastern Tanzania (and close to Kenya's Tsavo West National Park), tsavorite's beautiful deep green color has made it a popular gem. Thus far, around 50 deposits containing tsavorite have been found in Tanzania (including the Merelani, Umba River, Ruangwa, and Tunduru areas), Kenya, Madagascar and even Zambia, though good collector-quality crystals remain rare.

Most recently, remarkable, partially gemmy, trapezohedral spessartine crystals of a bright mandarin-orange color, up to the size of baseballs, have been found about 35 km northeast of Loliondo, close to the Kenya border. Local natives were able to collect hundreds of fine crystals right off the surface when the occurrence was first discovered in 2007. The deposit reportedly consists of a weathered, 100-meter-wide quartz mass or vein that is cut by veinlets of hematite containing the spessartine crystals.

The Longido ruby deposit (the one everybody now knows as the "ruby-in-zoisite" deposit), located 73 km north of Arusha, was discovered in 1949 by a British prospector named Tom Blevins. While traversing the low hills near the Kenya border north of Arusha he came upon a small, flat depression, devoid of any plants, extending for several meters to the base of a green rock outcrop. The basin was lined with a breathtaking accumulation of sharp, tabular-hexagonal corundum crystals of a deep ruby-red color, and up to 5 cm across. The crystals had weathered out of the massive green zoisite matrix, and others could be seen sticking out of the green rock. These proved to be the best free crystals ever found at the locality; crystals still embedded in zoisite could not be easily removed. Nevertheless, the red and green combination still found today makes for some dramatic specimens.

Other gem mineral deposits include the Mpwapwa district in the Dodoma region (for yellow scapolite crystals), Babati in the Manyara region (dichroic cordierite), the Sumbawanga and Lake Manyara deposits (emerald and alexandrite), the sapphire, tourmaline and alexandrite deposits of Songea and Tunduru in the Ruvuma region, the Williamson (Mwadui) diamond deposit (the world's largest exploitable kimberlite pipe) in the Tabora region, the Umba River deposit in the Tanga region (sapphire, "umbalite" variety of almandine, and chromium-rich elbaite), Sangasanga in the Morogoro region (liddicoatite and rossmanite), and the Ipanko mines near Mahenge (big red spinel crystals)—among others. And if you don't like gem minerals, uranium minerals have been found at Morogoro in the Uluguru Mountains (it's the type locality for rutherfordine).

Tanzania is indeed a gem crystal paradise these days, a favorite of the gem industry and a source of attractive crystal specimens. And, as mentioned above, Merelani is the brightest star in that constellation of gems, and also the largest mine in the country. Nearby Arusha is a hub for African tourism; a visit is recommended. But if you are not in a position to hop the next plane for the African outback, perusing the next few pages will give you some idea of the mineralogical splendor of Merelani.

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

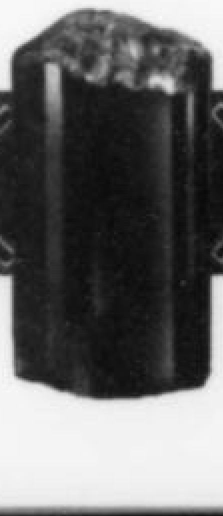


Figure 1. **Manuel de Souza (left), with the District Secretary for Arusha, at his tanzanite claim ca. 1968. Second from right is de Souza's junior partner, Daudi Mayaya, and on the far right is Maasai tribal leader Daniel Saitore Kaaya. Photo courtesy of TanzaniteOne corporation.**

Famous Mineral Localities:

THE MERELANI TANZANITE MINES

Lelatema Mountains, Arusha Region, Tanzania

Wendell E. Wilson[1]
John M. Saul[2]
Vincent Pardieu[3]
Richard W. Hughes[4]

Since their discovery in the 1960s, the Merelani tanzanite deposits have produced countless thousands of beautiful crystals of gem-grade zoisite in a range of colors, including the coveted deep purplish blue material called tanzanite. Other highly attractive minerals have been found there as well, including chromium-green diopside, the green tsavorite variety of grossular, blue apatite-(CaF), gemmy grass-green tremolite and the new species magnesioaxinite—since renamed axinite-(Mg). Despite decades of intensive mining, the deposits continue to produce superb specimen crystals and gemstones. New reserves have been discovered in recent years, and the color of the tanzanite crystals appears to be improving with depth.

THE MINERALOGICAL RECORD
TUCSON, ARIZONA
2009

Figure 2. **Merelani miners' dwellings, with 19,300-foot Mount Kilimanjaro in the distance. The summit of Kilimanjaro, one of the largest stratovolcanoes in the world, is the highest peak in Africa. Richard Hughes photo, 2007.**

INTRODUCTION

The Merelani mines in Tanzania are, by and large, a locality for single crystals off matrix; but what crystals they are! Tanzanite, the vanadium-rich, purplish blue variety of zoisite, is one of the world's most popular gemstones, and holds at least equal status as extraordinarily beautiful crystal specimens for mineral collectors. Uncut crystals (and the much rarer matrix specimens and crystal clusters), from small thumbnail to cabinet sizes, make incredibly attractive display pieces that are considered to be among the top specimens in many public and private collections around the world. Considering the size, luster, gemminess and, especially, the *color* of the crystals, it's no wonder they are so highly regarded: fine tanzanite has a richness and depth of color that even the finest sapphire cannot match. And Merelani is the only significant locality in the world for such crystals, although a few inky blue gem zoisite specimens have been recovered from the Tsavo region of Kenya, and there is an occurrence of dark blue non-gem zoisite in the Uluguru Mountains of central Tanzania.

In recent years a number of other species have also been recovered from the Merelani deposit in collector-quality crystals, not to mention some of the finest graphite crystal clusters known. The Merelani mines are indeed one of the world's most important mineral localities, and will remain so long after they have been exhausted and their specimens have passed into the status of priceless Old Classics.

LOCATION

Merelani's tanzanite mines lie within a slender strip of ground, just 2 km wide by 8 km long. This is Tanzania's most important gem mining area, with an estimated 50,000 people in Merelani earning their incomes from tanzanite. As of 2003, about 14,000 people were licensed to conduct mining operations at Merelani.

The Merelani mining area is located in the Merelani Hills, on the western slope of the Lelatema Mountains, Arusha Region, about 60 km south-southwest of Mount Kilimanjaro, 70 km southeast of the town of Arusha (at latitude 3°33–37′ S, longitude 36°57′ to 37°04′ E). This is today in the Simanjiro District, although when the initial discoveries were made it was part of the Maasai (Monduli) district. Passengers on planes landing from the west at Kilimanjaro International Airport can see the diggings some 16 kms to the south from the starboard side of the cabin.

Mining started as a haphazard collection of small diggings and open pits in alluvium and bedrock but has expanded continuously

[1]Mineralogical Record, 4631 Paseo Tubutama, Tucson, Arizona 85750. Email: minrecord@comcast.net

[2]ORYX, 3 rue Bourdaloue, F-75009 Paris, France. Email: tanzanite@swalagemtraders.co.tz

[3]GIA Research Thailand, 10th Floor U-Chu-Liang Building, 968 Rama IV Road, Silom Bangrak, Bangkok, Thailand 10500 Thailand. Email: vince@fieldgemology.org

[4]Grand Langsuan Condominium, Unit 94, 52/94 Langsuan Road, Pathumwan, Bangkok 10330 Thailand. Email: rubydick@ruby-sapphire.com

into several major workings and many hundreds of small operations. Though many of the open pits have evolved into underground operations, they are still traditionally referred to as pits rather than mines.

The Merelani mine today consists of four major parcels referred to as Block A, Block B, Block C and Block D, each exploiting veins that go successively deeper (from A to D). There are also several extensions, and the Machakecho workings, just to the west, where small-scale miners have exploited an alluvial deposit of tanzanite. Because of the mechanized mining technology utilized in Block C, most collector-quality uncut crystals reaching the market are from the "native blocks" (Block B and Block D) where mining is conducted by hand.

HISTORY

The history of the Merelani[5] mines makes for a complex and intriguing story. Legend has it that brown zoisite crystals exposed on the surface were caught in a fire set by lightning that swept across the grass-covered hills; the heat is said to have caused many of the crystals to turn blue. Some people doubt this story, but certain grasses (e.g. Arizona buffelgrass) can burn at over 540° C, sufficient to cause a color change in only two or three minutes, so it is indeed possible, especially considering that crystals weathered out on the surface were surely there long enough to be exposed to repeated grass fires. In any case, though freshly exposed crystals are usually brown, some of the first crystals picked up off the ground at Merelani were a beautiful, trichroic blue/purple/salmon.

The area is part of Northern Maasailand, or the Maasai Steppe, and before 1967 was nearly uninhabited because of the lack of water. Seminomadic Maasai herders occasionally passed through and no doubt encountered the Merelani zoisite crystals repeatedly over the years but thought nothing of them. The more recent history, pieced together here from numerous sources,[6] involves many individuals, some known and some unknown:

The USGS Specimen (1959)

At least one person appears to have collected a specimen of gem zoisite prior to the 1960s. William Pecora (1913–1972), namesake of the mineral *pecoraite* and a well-known mineralogist with the U.S. Geological Survey, reported that someone had submitted a sample of gemmy zoisite similar to the ones found in 1967 to the USGS for identification—in 1959. The locality was not given, however, and the sample was quickly forgotten until the new ones turned up eight years later (Edward Swoboda, personal communication). Unfortunately, enquiries with the USGS regarding the person who submitted that specimen for testing have been unproductive; his name may be lost to history.

Figure 3. **Dr. William T. Pecora (1913–1972), Chief of the U.S. Geological Survey's Geochemistry and Petrology Branch in 1959 (and later Director of the Survey), may have been the first person to identify gem zoisite from Merelani—though the person who sent him the sample to be tested remains unknown.**

The Kruchuk Specimens (1962)

Specimens of gem zoisite were identified by a Polish refugee in Tanzania named George Kruchuk [Kruchik, Kruchiuk] in 1962. John Patrick (1985) wrote:

> [Gem zoisite was first recognized by] George Kruchuk, an expatriate Pole, who was in partnership with George Krokowski [or Krokosky], another expatriate Pole. They had a curio and cutting shop in Arusha, Tanganyika (later to become Tanzania) in which Krokowski managed the shop and Kruchuk managed the prospecting. They hired various groups of natives for prospecting and mining in different areas in Tanganyika and were mostly interested in commercial minerals. My wife and I were there in August 1962 and Kruchuk had just had the material in question X-ray identified by Dr. Ian McCloud as zoisite. Dr. McCloud was at that time in charge of the Geological Survey at Dodoma, Tanganyika. We bought a couple of the zoisite stones that were cut by Mrs. Kruchuk, and we still have these two stones in our possession. They aren't too impressive because at the time of acquisition it was not known that through heating they would turn the beautiful blue-purple that was to be named tanzanite several years later.

There is no evidence that Kruchuk himself discovered the site of the occurrence, or even that he knew where it was. The actual finder, probably a local Maasai, remains unknown; Kruchuk may simply have acquired specimens from local people who had picked them up.

---

[5] *Merelani* is a phonetic spelling of the Maasai name for a species of tree common to the area. Alternate spellings sometimes seen include Miralani, Mirelani and Mererani. Merelani, however, is the most common spelling in gem and mineral literature.

[6] Summarized here from many sources including Anonymous (1998), Chachage (1995), Coakley (1996), Crowningshield (1967), Denniblog (online weblog, 2008), Dirlam *et al.* (1992), Federman (1991), Ihucha (2005), Kane *et al.* (1990), Koivula and Kammerling (1991), Kondo (2005a, 2005b), Lange (2006), Larenaudie (2007), Masland (2005), Mushi (2008), Nyambura (2004), Patrick (1985), Rees-Mogg (2005), Rukonge (2006), Sanga (2006), E. Saul (2008), J. Saul (2007 revised), Smith and Smith (1994), Thompson (1969), Venter (2007), and Yager (2004).

The Liddicoat Specimen (1963)

Richard Liddicoat briefly described a gemmy yellow faceted zoisite in 1963, mentioning no locality. He published only a crude absorption spectrum, but his description of a gemmy yellow zoisite fits no other occurrence.

Manuel de Souza's Discovery (1967)

The first person to have come across the primary and alluvial deposits of zoisite crystals at Merelani, recognized them as potentially valuable, and filed a claim on them was Manuel de Souza (also spelled De Souza and D'Souza) (1913–1969), an immigrant from Goa, India. De Souza was a tailor by profession (he made uniforms for the Army) but had a penchant for prospecting. He arrived in Babati from Dar es Salaam in November 1966 and soon staked a garnet claim, taking on a local man, Daudi Mayaya, as an unpaid 10% partner to work the deposit. John Saul knew de Souza and his family well, and gives this account of the discovery as told to him by de Souza and his sons (Saul, 2007):

> [Manuel de Souza's] prospecting adventures began in the Lupa Goldfields of western Tanganyika [now Tanzania] in 1939 but when it became unprofitable to mine gold after World War II, he moved to Dar es Salaam on the Indian Ocean coast and went back to tailoring. As there were no minerals to seek in the coastal region, he soon departed for the Shinyanga diamond fields but, as I myself learned from personal experience in the 1960s, Tanzanian prospecting licenses for diamonds were nearly impossible to get due to the monopoly influence of the Williamson Diamond Mines.
>
> Following a period during which he combined tailoring and prospecting in the region of Lake Victoria, Manuel moved to Arusha to try his luck in the Kilimanjaro area. On Easter weekend in 1967, his feet got particularly itchy and, missing a family reunion, he hired a pickup and driver to drop him and his equipment at a destination he had selected southeast of Arusha. Not having anticipated how bad the roads were, the driver refused to go further than a village called Mtakuja, deep in Maasai country, and there, tens of miles short of the agreed-upon destination, Manuel was unceremoniously off-loaded.
>
> The place appealed to him in any case, so instead of attempting to move on he concentrated his efforts there. Serendipity had brought him to a spot about four miles from the future

Figure 4. Manuel de Souza (1913–1969) the tailor from India who registered the first claim on the Merelani deposit in July 1967.

Figure 5. The main camp of the de Souza claims under construction, 1967. Photo courtesy of Angelo de Souza.

Figure 6. **Workers posing by the de Souza pit, ca. 1968. Back row, from left: Raphaeli, Saidi Mtuti, Mohamed Ali, unknown, Rashidi Esmaili, Mesembere. Front row: Mohamadi Sulemani and Melkizedeki "Malek" Marandu (with shotgun). Photo courtesy of Angelo de Souza.**

Figure 7. **Surface excavations following the tanzanite vein on the de Souza claim, December 1968. Photo courtesy of Angelo de Souza.**

tanzanite find. Thus it was that around noontime July 7th, accompanied by four men he had hired in Mtakuja for 4 shillings a day (a good local wage in those days but probably less than the proverbial dollar a day) Manuel came across a transparent blue stone sitting on the surface of the ground. From the color he guessed it was sapphire but he dismissed the idea as soon as he tested its hardness.

Back in Arusha he consulted the only mineralogy book in his possession, and decided that olivine was the closest match. Tanzanian law required that prospectors specify the mineral or minerals for which each mining claim was registered.

Manuel de Souza's first and only published interview took place in late 1968 or early 1969 (Thompson, 1969). The article described the discovery as follows:

In July 1967 Manuel was prospecting about 40 miles southeast of Arusha, following up a third- or fourth-hand rumor of a possible ruby deposit. "I turned left instead of right and I got lost. I came to a deserted Maasai village. Some natives

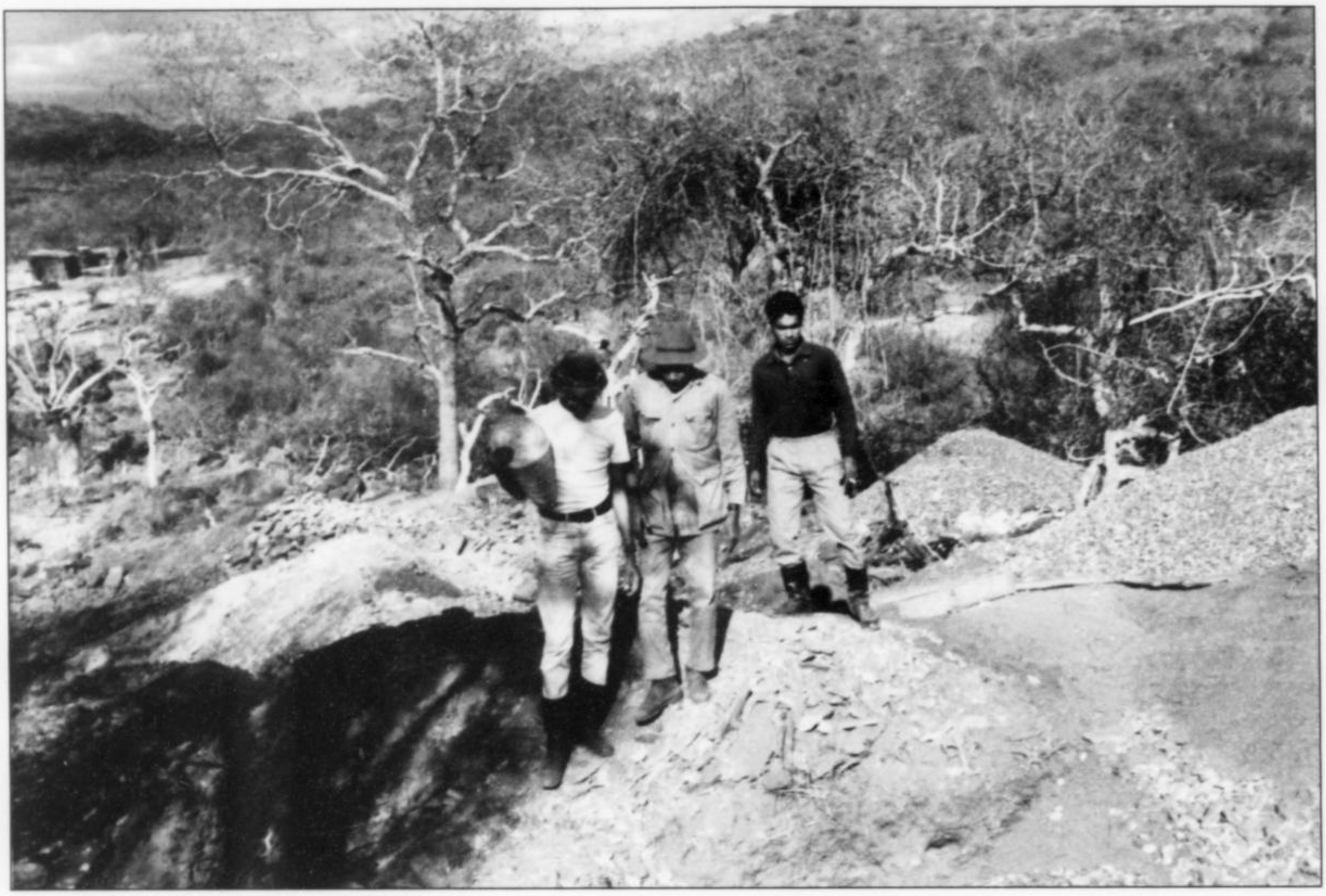


Figure 8. Cosma (left) and Manuel de Souza (center) on Ally Juyawatu's claim, November 1968. Photo courtesy of Angelo de Souza.

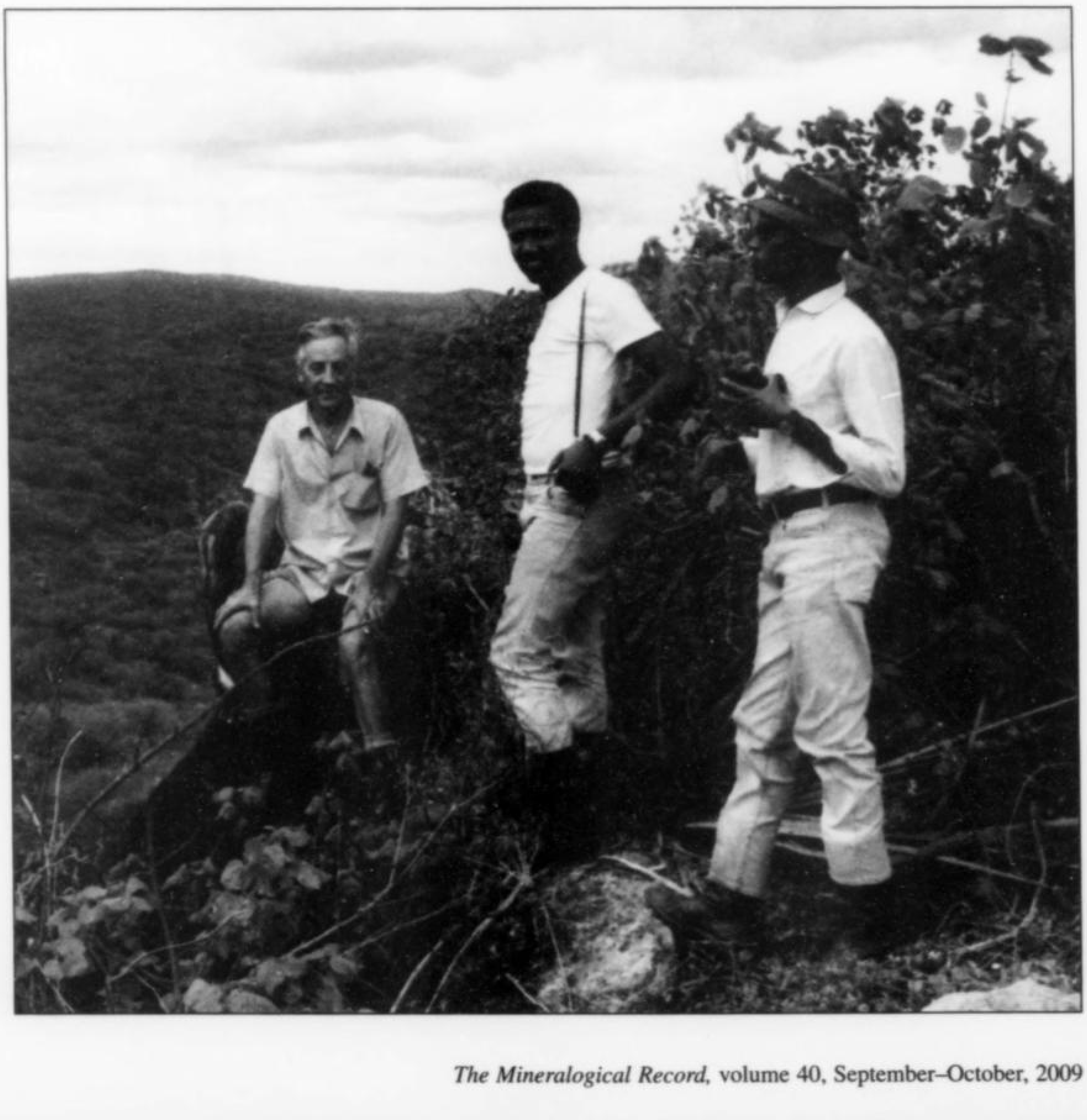


Figure 9. German mineralogist Hugo Strunz (1910–2006) visiting the de Souza claims, with Angelo and Cosma de Souza, ca. 1968. He described tanzanite from Merelani in a 1969 article. Photo courtesy of Angelo de Souza.

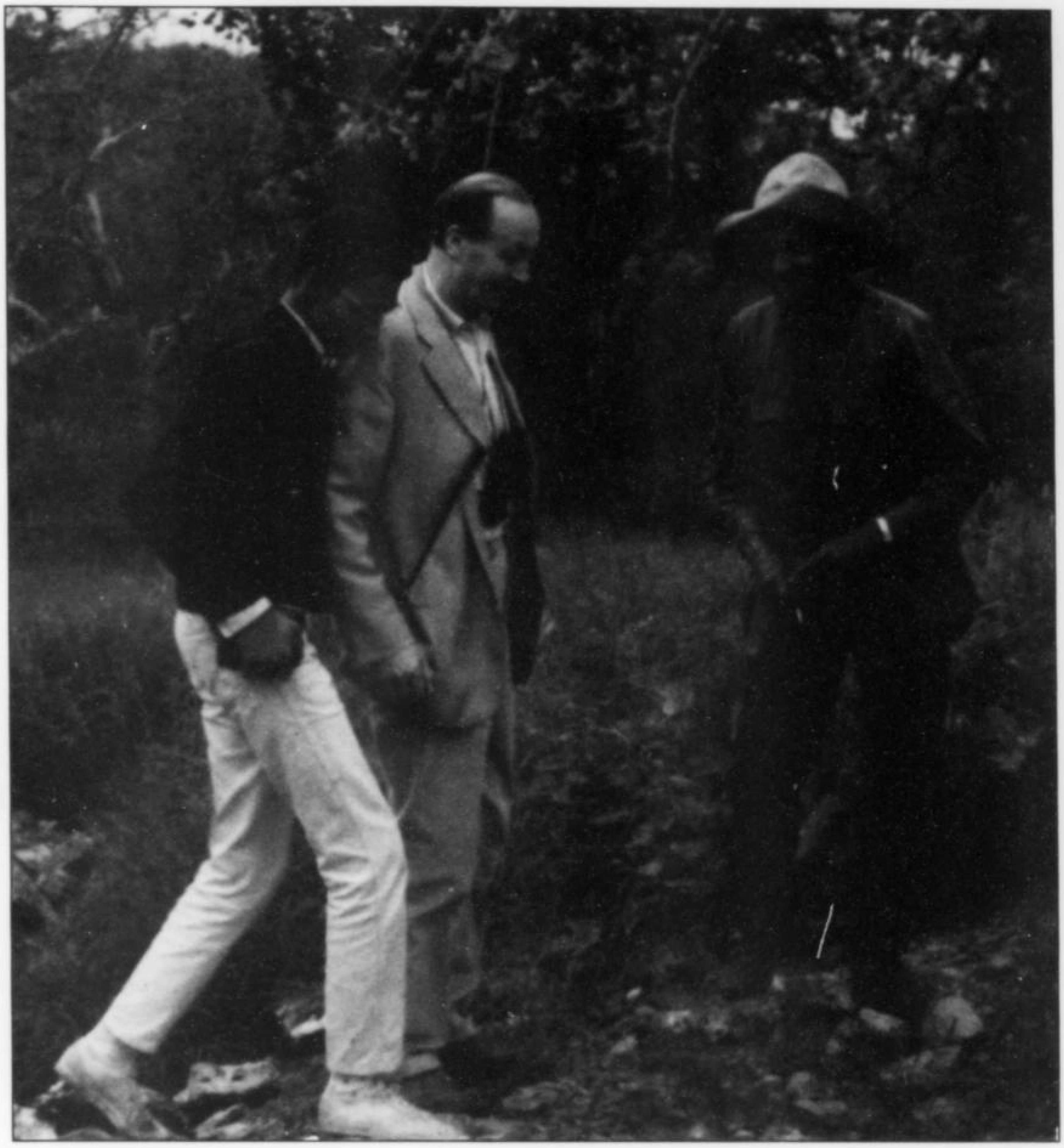


Figure 10. **Prince Stefan of Liechtenstein visiting the de Souza claims in October 1967, with Cosma and Manuel de Souza (with hat). Prince Stefan was a relative of Prince Constantine of Liechtenstein, who was involved in the Trans-Gem Corporation of Liechtenstein, in short-lived partnership with de Souza. Photo courtesy of Angelo de Souza.**

turned up and showed me some stones. They thought I was a smuggler. The stones were worthless, and I explained that I was not a smuggler, I was a prospector, and did they know any places where other rocks could be found? They said they did, but it was a long way." . . . They came to a place where on the ground were little blue stones dancing in the morning sun. Manuel's heart leaped. His first thought was they were sapphires, huge sapphires.

So it seems de Souza did not *personally* discover the tanzanite deposit, as many later writers have suggested, but rather was led to it by the unnamed "four men from Mtakuja," who had previously known of it but had no interest in it.

California dealer and collector Edward Swoboda also knew de Souza well, and remembers him saying that he discovered the tanzanites where a dry stream bed passed over a near-vertical outcrop, where surface pockets were exposed, with brilliant blue gem fragments scattered in the outwash gravels from occasional flash floods. Not knowing what the mineral was, de Souza filed four mining claims for "olivine" with the Government Mines and Geology office on July 25, 1967 (recorded as claims 29211–29214 in the *Gazette*[7] on December 8). In order to correct his original error regarding "olivine," de Souza refiled the same four claims for zoisite on April 17, 1968 (recorded as claims 29931–29934 in the *Gazette* on January 24, 1969).

The true original discoverer of the tanzanite deposit will probably remain forever unknown, but de Souza appears to have been widely accepted as the *de facto* original discoverer, and indeed he deserves credit for having filed the first claim and opened up the first workings, regardless of what casual finds may have taken place earlier. When he died following a one-car accident on the road to Dar es Salaam two years later, a local paper (the *Northern News,* August 29, 1969) headlined his obituary: "Hero of the Tanzanite Rush Dies."

Daudi Mayaya

Unfortunately, de Souza could not keep close watch on his claims, and soon poachers were mining crystals in his absence, staking claims nearby, and even moving his claim stakes. Various people have also tried to claim priority over de Souza's discovery. Chachage (1995) assigns the first discovery to Daudi Shija Mayaya who, as mentioned, was actually a junior (10%) partner of Manuel de Souza, brought in after the discovery to work on the tanzanite claim. Mayaya was subsequently awarded a 40% share in the partnership with de Souza under the terms of President Julius Nyerere's "Arusha Declaration" of February 5, 1967, an edict designed to promote "African Socialism" through seizures and reorganizations to benefit black Africans. A few months later all the claims were nationalized.

[7] Commonly referred to simply as the *Gazette* or the *Government Gazette,* it is *The Gazette of the United Republic of Tanzania.* In 1970 it became an all-Swahili publication, and its title was accordingly changed to *Gazeti la Jamhuri ya Muungano wa Tanzania.*

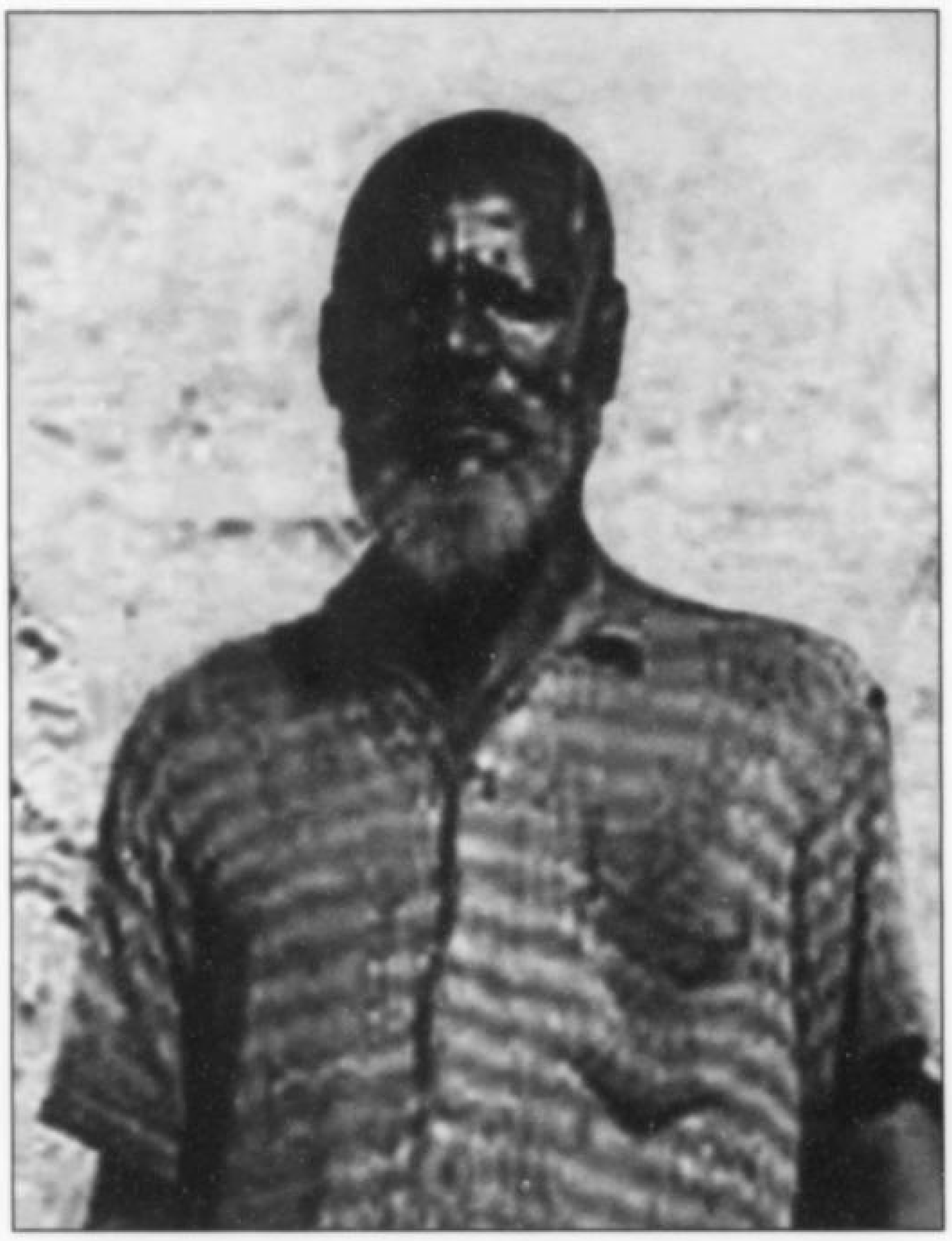


Figure 11. **Daudi Mayaya, junior partner with Manuel de Souza, was brought in to oversee the mining of tanzanite on de Souza's claim.**

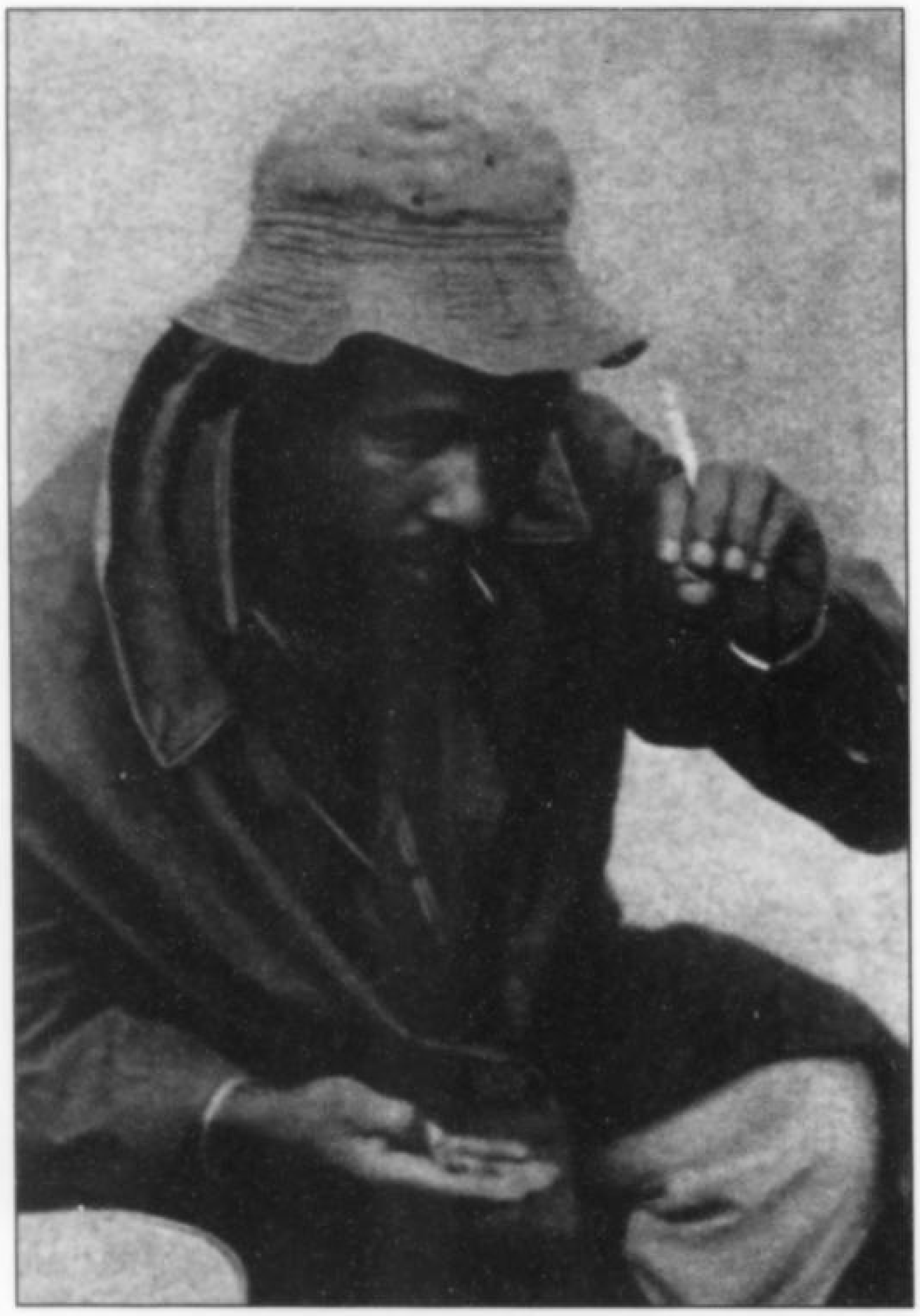


Figure 12. **Ally Juyawatu filed claims adjacent to the de Souza claims and mined a significant amount of tanzanite (from Thompson, 1969).**

Ally Juyawatu

Ally Juyawatu, a former game warden from the Umba region, has also been said to have made the first discovery of the tanzanite deposit. The story as told by local Maasai goes that he showed his specimens to Manuel de Souza, who then filed a claim in his own (de Souza's) name. However, neither Juyawatu nor his partner, Alloys Anthony Duwe, ever mentioned anyone but de Souza as the original discoverer in their private conversations with John Saul or the de Souzas (Angelo de Souza, personal communication). Juyawatu knew how to file his own claims, and in fact about ten months later he filed for several that were adjacent to de Souza's claims.

De Souza estimated that 80% to 90% of his gem production was being stolen by his own workers, who then sold them for a few shillings in a nearby village nicknamed "Smuggler's Cove." De Souza enlisted his two sons to guard the workings with loaded rifles, and hired other security men to search his workers after shifts, but some of the security officers then started stealing from the thieves. Juyawatu was having the same problem on his claim, losing up to 95% of his output to thieves—despite having posted his aged mother at the mine to ward off unauthorized persons by throwing rocks at them. Tanzanian police occasionally raided Smuggler's Cove, chasing people into the nearby marshes where the traders hurriedly emptied their pockets of the incriminating crystals (which presumably are still there, lost in the mud).

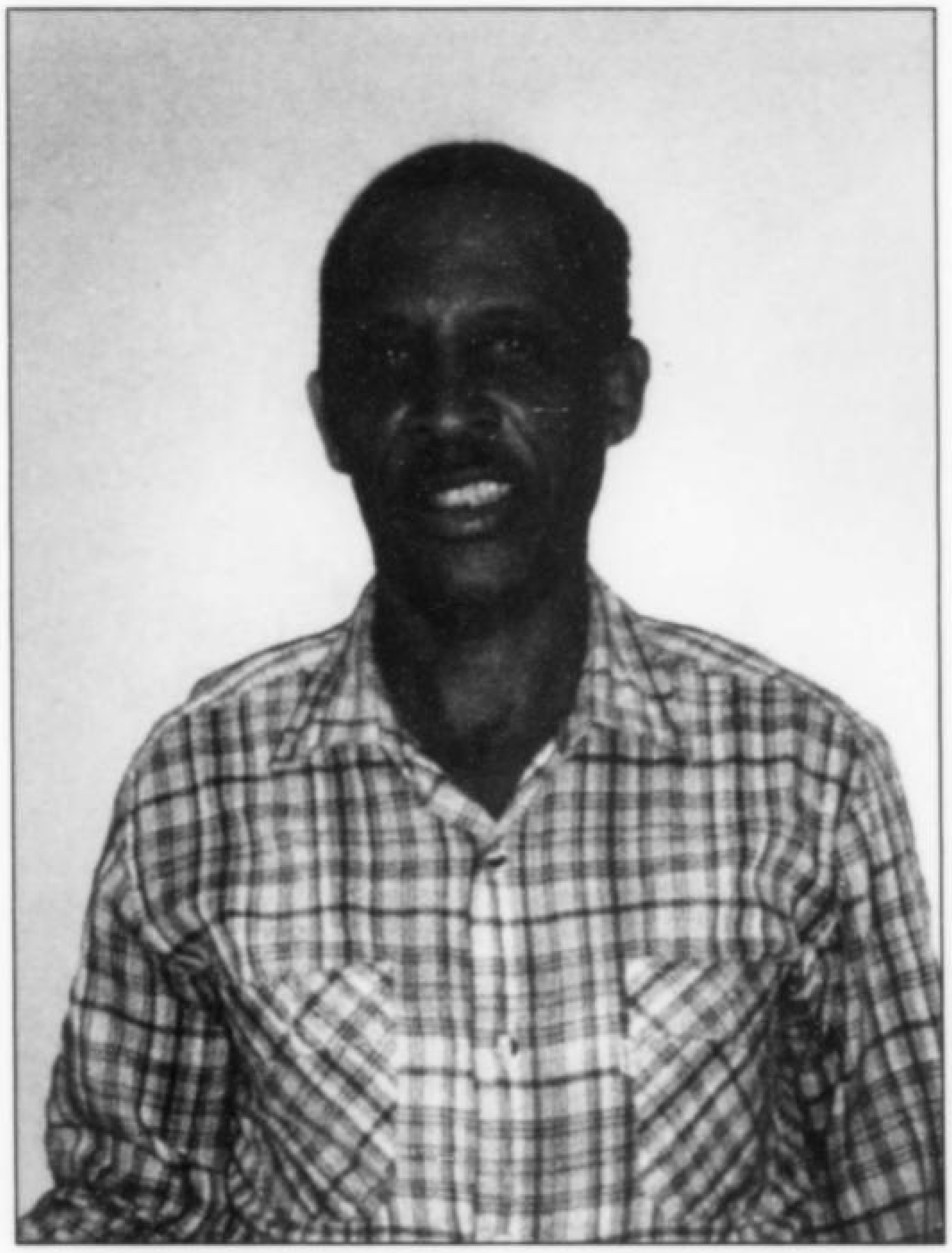


Figure 13. **Jumanne Mhero Ngoma, a gypsum miner from Makanyo Same, south-southeast of Mt. Kilimanjaro, who attempted to stake a claim over the de Souza claim and assert priority. Valerio Zancanella photo.**

Jumanne Ngoma

Jumanne Mhero Ngoma, a local gypsum miner, has been the most vocal in demanding recognition. In a 2000 interview (Zancanella, 2004), Ngoma stated that he had found the tanzanite deposit in January 1967, six months before de Souza's claim was filed. He said he collected about 5 kg (over 11 pounds) of crystals, including a gemmy blue crystal "as big as my arm," in just a few hours. He subsequently gave the specimens away (there is no evidence that they ever surfaced on the market), saving a few to show to "Mr. Bills"[8] in Moshi, and then waited ten months before filing a claim—on top of de Souza's claim. In an interview with the Swahili-language weekly newspaper *Rai Gazeti*[9] (Mayage, 2008), Ngoma said that in September he went to the zoisite discovery area and pegged it as a claim—not mentioning the fact that it had been independently discovered and claimed two months earlier by Manuel de Souza, whose claim markers were surely visible. In early 1968 Ngoma, who had returned to work his gypsum claim, learned that some people were mining zoisite near Merelani, so he went out there and found three miners working under Daudi Mayaya. He took all of them to the mining office in Moshi and accused them of illegally mining "his" claim. The four men contacted their employer, Manuel de Souza, who provided documentation to verify his own earlier claims filed the previous July. Consequently Ngoma's claims filed in September were declared to be invalid and his claim markers were ordered removed from the site. Nevertheless, in 1984 the Tanzanian government inexplicably declared Ngoma to be the original discoverer of tanzanite—though that decision conferred no legal rights to the deposit.

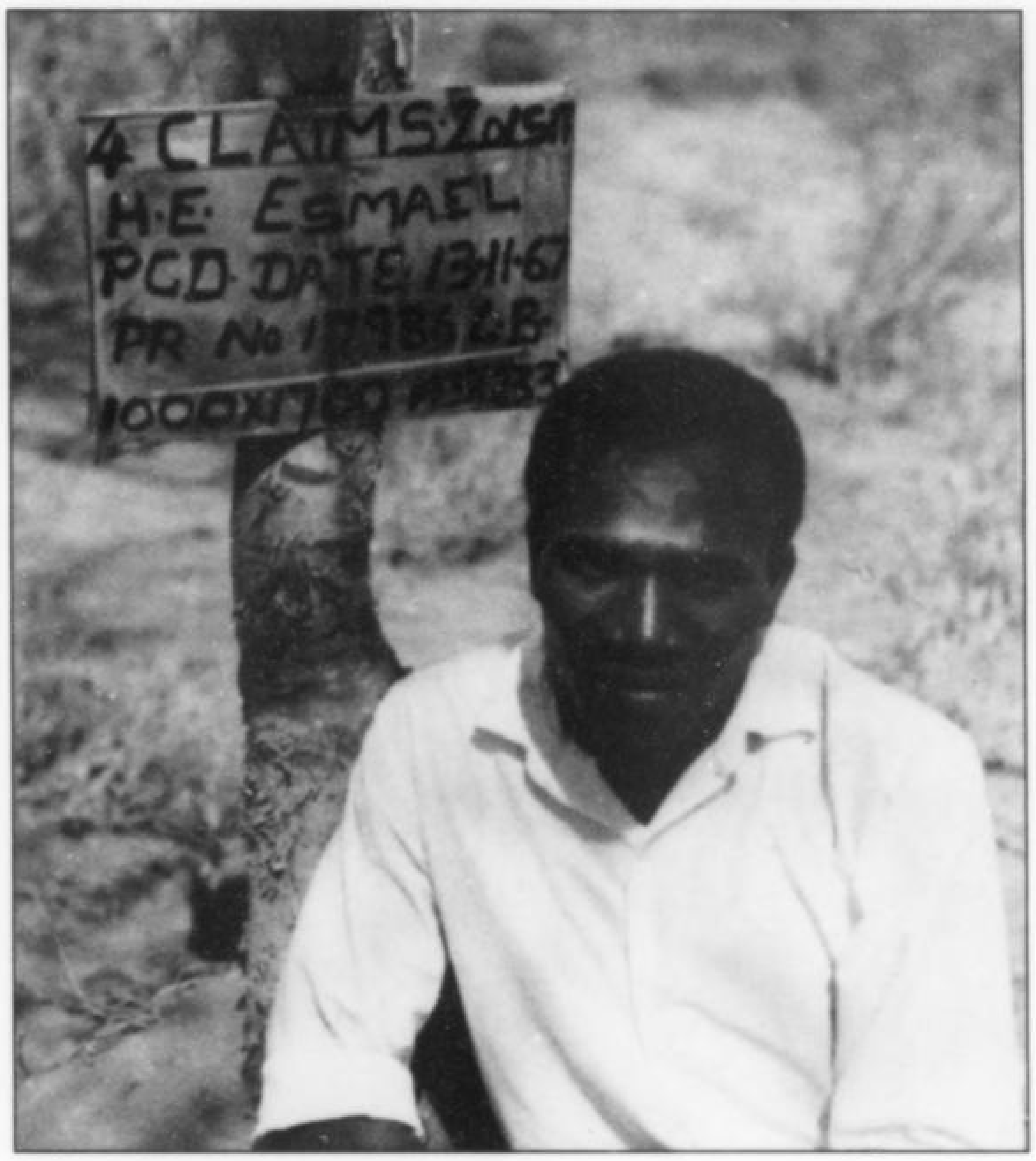


Figure 14. **Habib Esmael's claim sign for a zoisite claim supposedly registered in November 1967; records of the claim registration have not been found. Edward Swoboda photo. (The person pictured is not Esmail.)**

Habib Esmael

There was a large colony of Greeks living in East Africa at that time, many of them interested in mining opportunities; some of them employed locals as their agents. Habib Essaka Esmael is said to have been in the employ of a miner named George Pappas [Papaeliopoulos], operating under the business name of Gilevi Exploration & Mining Syndicate, Ltd. According to claim records, Esmael filed claims for zoisite over de Souza's "olivine" claims on August 22, 1967, registering them as claims 29473–29476 in the *Gazette* for March 15, 1968, about a month after de Souza's claims were filed. However, Esmael's claim was disallowed on March 6, 1968 according to the October 4, 1968 edition of the *Gazette*. The judgment of Paul Bomani, the well-respected Minister of Finance, was that Esmael's claim was merely an attempt to overpeg de Souza's original block of four "olivine" claims, based on the technicality that de Souza had misidentified the mineral. Thus a second attempt to jump de Souza's claim was successfully thwarted.

A photo taken by Edward Swoboda in late 1967 shows a claim sign indicating that Esmael had subsequently pegged another block of four claims for zoisite on November 13, 1967 but these claims, wherever they were located, do not appear to have ever been registered.

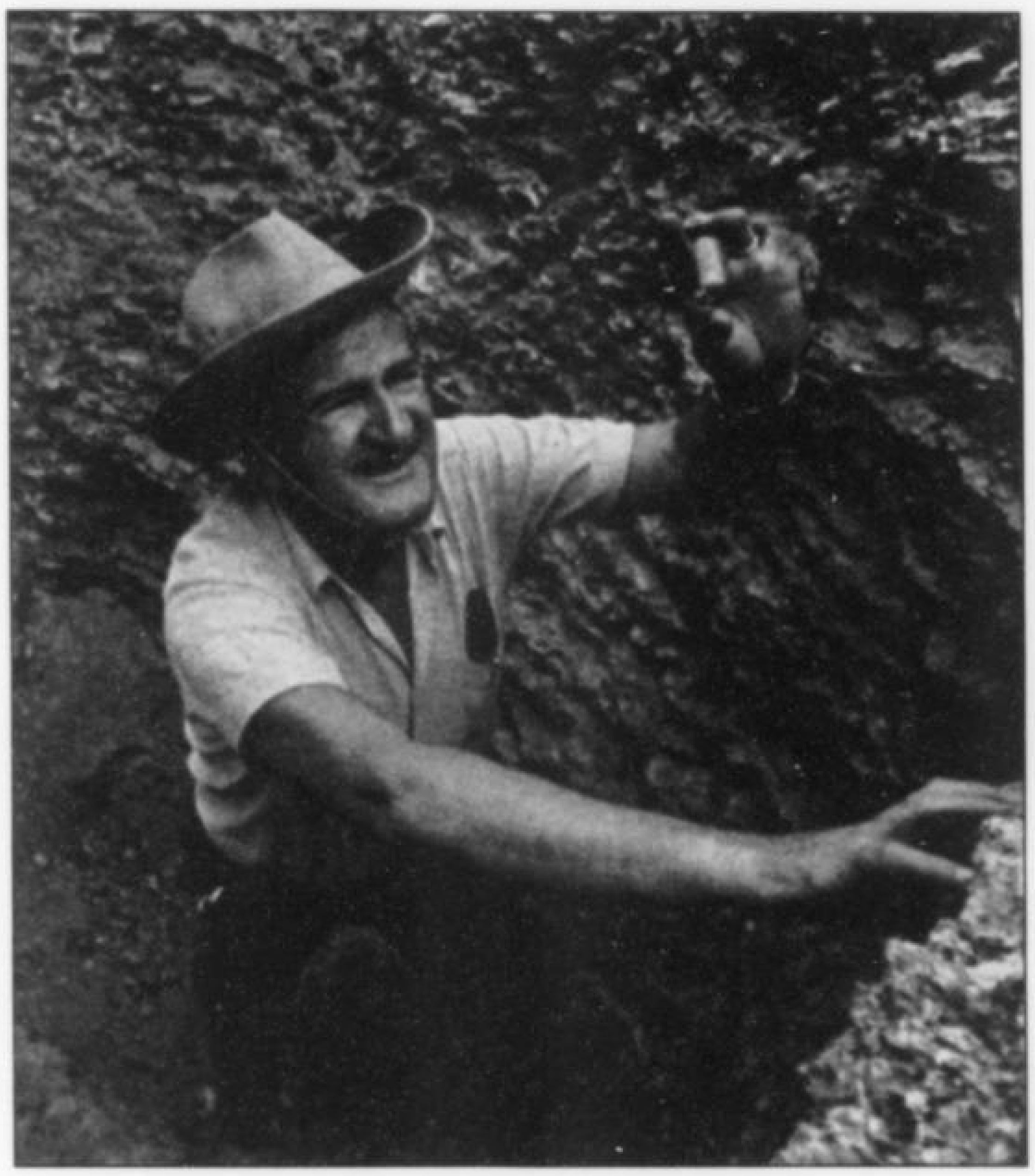


Figure 15. **Michael Papanicolaou filed claims adjacent to the de Souza claims, under the business name of Madini Mines, Ltd. (from Thompson, 1969).**

Norman Matthews and Michael Papanicolaou

Other early claims were made in the name of Madini Mines (Tanzania) Ltd., whose principals were a British merchant sailor named Norman Matthews and a former Greek army officer and hotelier, Michael Papanicolaou, who had already been involved in several gem ventures in East Africa (Bridges, 2009; Thompson, 1969; Angelo de Souza, personal communication). In mid-1968 Papanicolaou suggested that he, Matthews, de Souza and Juyawatu should join forces to form a corporation, pooling their tanzanite production for better marketing abroad. Matthews brought in Stefan Klein, said to have been a wartime captain in Britain's MI5 Military Intelligence Service. Klein was involved in a company called Trans-Gem Corporation of Liechtenstein, among whose associates was Prince Constantin, brother of the reigning monarch, Prince Franz Josef II of Liechtenstein. A deal was signed, with the partners authorizing Trans-Gem Corporation of Liechtenstein as

[8] L. Bills, Inspector of Mines, appointed 8 Nov. 1965
[9] Translation courtesy of Angelo de Souza.

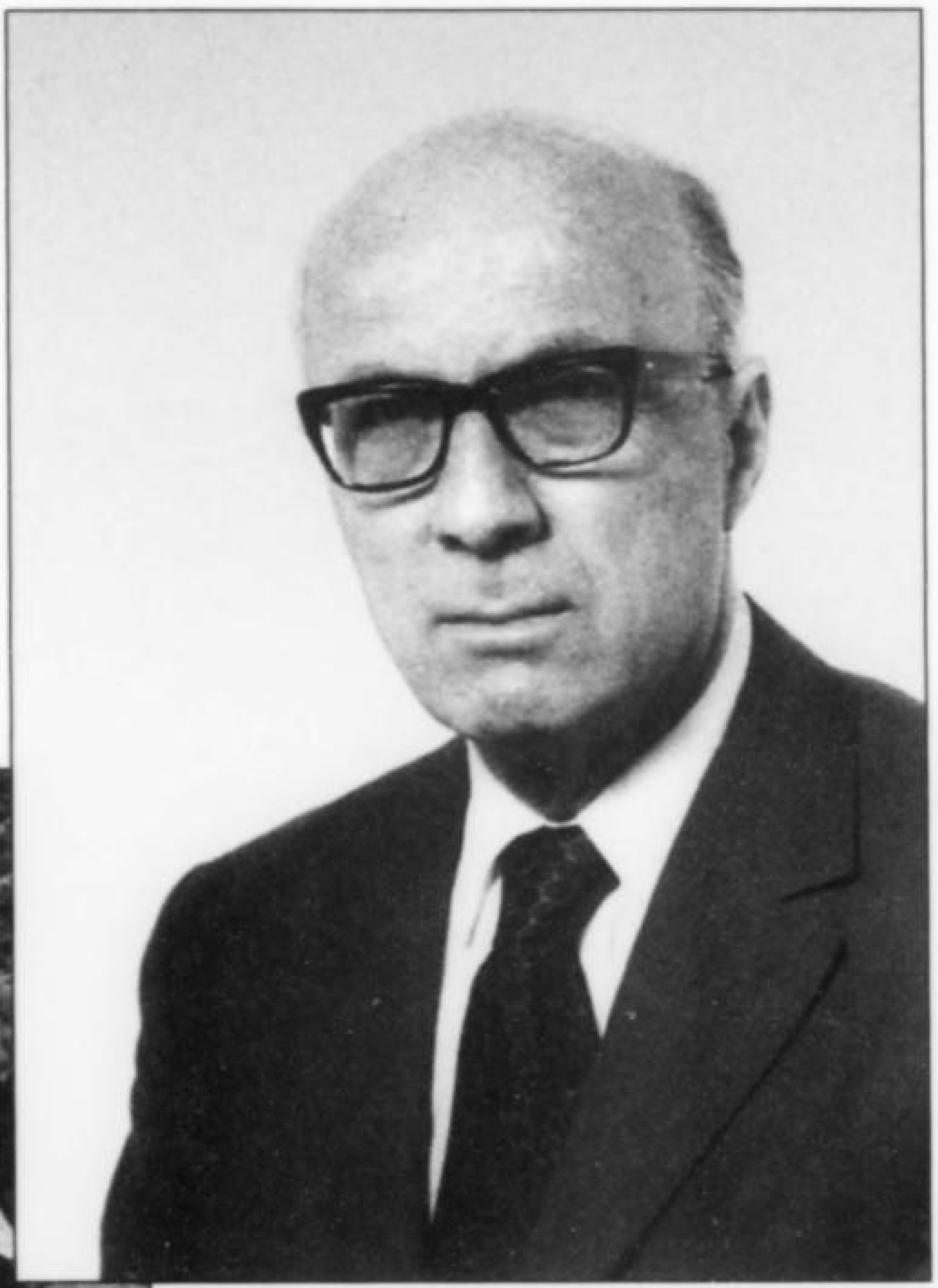


Figure 16. **Hyman Saul (1906–2003), Vice President of Saks Fifth Avenue in New York (and father of John Saul), brought tanzanite crystals to Saks and to G. Robert Crowningshield at the Gemological Institute of America in 1967.**

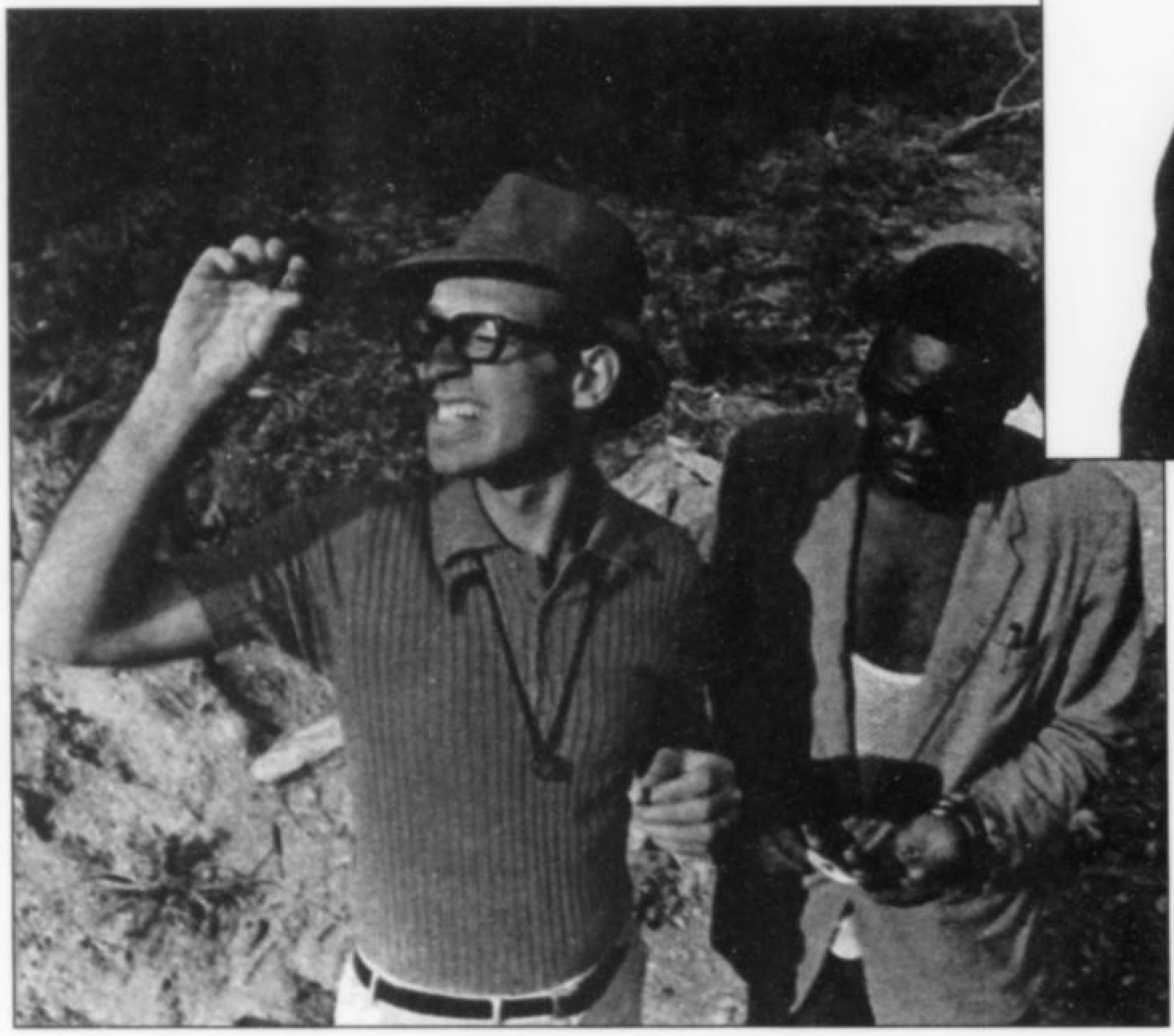


Figure 17. **John Saul (left) also attempted to file claims for gem zoisite but was disallowed on a residency technicality; he then purchased an interest in Ally Juyawatu's claims (from Thompson, 1969).**

their exclusive world marketing agents, but it all soon broke up and ended in court. Papanicolaou eventually made enough money from tanzanite to retire to a Mediterranean island, and to a considerable extent this was due to his role as an intermediary between Manuel de Souza and Ally Juyawatu, who had many interests in common but an intense dislike of one another and an inability to cooperate.

John and Hyman Saul

De Souza offered some of his zoisite specimens for sale to John Saul, a Nairobi-based consulting geologist and gemstone wholesaler with a PhD from the Massachusetts Institute of Technology. At that time Saul was mining for commercial beryl and aquamarine at a number of small pegmatite deposits near Mount Kenya, mostly self-discovered but including one which had been found by Senior Chief Paul Muindi Kilelo (1921–1975 ; see footnote 5, Table 1). (Saul subsequently discovered the ruby deposits in the Tsavo West area of Kenya—at what became the famous John Saul Ruby mine.) Saul bought some of de Souza's crystals, at that time labeled as dumortierite, and sent them to a number of people for a proper identification.

In September 1967, E. F. W. "Ted" Wolff, an Austrian or German Jewish refugee from Hitler's Europe who was in Nairobi, obtained some zoisite crystals. Wolff sent the specimens, labeled as "dumortierite," to the firm of Gebruder Bank in Idar-Oberstein, Germany for identification. Hermann Bank and Prof. Waldemar Berdesinski of the University of Heidelberg identified them as zoisite. A test lot was heated and turned "the nicest blue." The Bank firm received another parcel from Wolff, about a kilogram, the following month; after faceting the rough they sold some cut stones to Edward Gübelin, and others to some American buyers in November 1967.

Sensing that this was a discovery of major importance, Saul bought shares in Ally Juyawatu's tanzanite claim no. 29943, and later staked and tried to register a claim of his own, but it was disallowed due to an administrative irregularity in the address on the original Prospecting Right when issued in 1966, and repeated on subsequent renewals. John Saul's father Hyman Saul, Vice President of Saks Fifth Avenue, visited John in Nairobi, Kenya in late 1967 and brought some of the new stones back to New York. At the office of the Gemological Institute of America (GIA), Hyman showed the stones to G. Robert Crowningshield, who sent them to the GIA's Los Angeles office for X-ray identification as zoisite. Chemical analysis by Kurt Nassau at Bell Laboratories revealed the high trace content of vanadium.

Mineral dealer Martin Ehrmann saw one of the first lots received

***Table 1.* Early mining claims for zoisite in the Merelani area (and one gypsum claim), as reported in the *The Gazette of the United Republic of Tanzania*, except as noted.**

Claimant	*Date filed*	*Claim no.(s)*	*Status*
Jumanne Ngoma & Huseini Katumba	3 August 1966	27930	A ***Gypsum*** claim in the Pare District
Manuel de Souza (for "olivine")	25 July 1967	29211–29214	Forfeited 1 March 1968
Habib Essaka Esmael[1]	22 August 1967	29473–29476	Forfeited 6 March 1968
Madini Mines (Tanzania) Ltd.[2]	21 September 1967	29364–29365	Revoked by presidential order 2 April 1971
Habib Essaka Esmael	13 November 1967	[never registered; see Fig. 14]	
Manuel de Souza[3]	17 April 1968	29931–29934	Expired 31 March 1970
George Kyriakopoulos	17 April 1968	29936–29937	Expired or revoked
J & G Mines, Ltd.[4]	8 May 1968	29938–29942	Revoked by presidential order 2 April 1971
Ally Juyawatu & Alloys Duwe	8 May 1968	29943	Expired 31 March 1970
Madini Mines (Tanzania) Ltd.[3]	1 June 1968	30159–30160	Expired 31 March 1970
Costas Stavros Sideras	5 June 1968	30182–30183	Revoked by presidential order 2 April 1971
Cosma de Souza	10 July 1968	30201–30205	Expired 31 March 1970
East & Central Africa Mining Co.[5]	1 August 1968	30773	Pegged Feb. 1968 but registration delayed
Ally Juyawatu, Alloys Duwe	6 August 1968	30304	Revoked by presidential order 2 April 1971
Madini Mines (Tanzania) Ltd.[2]	31 August 1968	30554	Revoked by presidential order 2 April 1971
Building Utilities Ltd.	3 September 1968	30536–30539	Expired or revoked
Sotiris Sotiriades	8 September 1968	30507–30508	Expired or revoked
John Saul	20 September 1968	disallowed on the pretext of supposed non-residency	
Sotiris Sotiriades	25 September 1968	30509–30510	Expired or revoked
Building Utilities Ltd.	21 October 1968	30540	Expired or revoked
Madini Mines (Tanzania) Ltd.	24 October 1968	30528–30535	Revoked by presidential order 2 April 1971
Cornelis J. Van Rooyen	28 October 1968	30496–30497	Expired 31 March 1970
George Papatzimas	2 November 1968	30613	Expired 31 March 1970
Hassani Waziri	5 November 1968	30526	Expired 31 March 1970
Building Utilities Ltd.	7 November 1968	30541–30543	Revoked by presidential order 2 April 1971
Building Utilities Ltd.	15 November 1968	30544–30547	Revoked by presidential order 2 April 1971
Ferdinand Frederick Msaki	21 November 1968	31240	Expired or revoked
Cosma de Souza	14 December 1968	30504–30506	Expired 31 March 1970
Building Utilities Ltd.	16 December 1968	30548	Revoked by presidential order 2 April 1971
Zakaria Petro et al.	28 December 1968	30714	Expired or revoked
Alli Jutawatu	16 January 1969	30642	Expired or revoked
Jumane Ngoma[6]	20 April 1969	30715–30716	Expired or revoked

[1] Acting as agent for George Pappas
[2] Owned by Michael Papanicolau and Norman Matthews
[3] A refiling of the 25 July 1967 claim for "olivine" under the mineral name, zoisite
[4] Owned by brothers John and George Tsakiris
[5] Owned by the Kenyans Paul Kilelo and his wife Beth Muindi (and their Tanzanian associates)
[6] 69 other claims for zoisite were filed by other claimants in 1969, before July 24, 1969, when the area within a 10 mile radius of Manuel de Souza's original claims was closed to prospecting (General Notice No. 1748, D. S. Rwezahura, Controller of Mines). Prospecting was eventually allowed to resume.

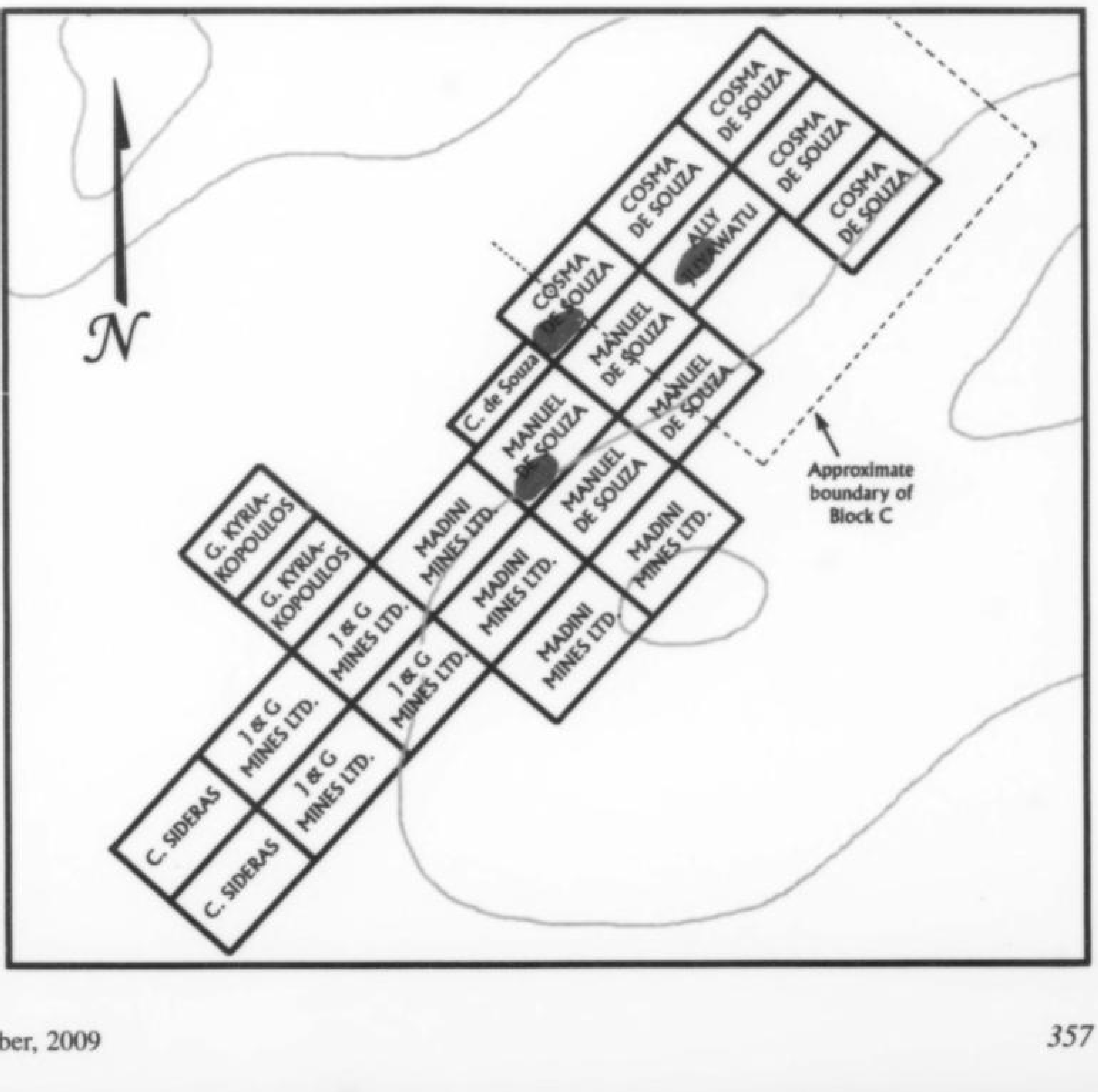


***Figure 18.* Map showing the first claims filed on the Merelani tanzanite deposit in 1967–1968. Most claims measure 1000 × 1700 feet. Purple = active pits in 1969. Data courtesy of Angelo de Souza.**

by Hyman Saul and offered him $5,000, but Saul refused the offer and instead took the crystals to Nish Vartanian of Vartanian & Sons on Fifth Avenue, not far from Saks. Unfortunately, the heat treating was mishandled by Paul Vartanian and the lot of crystals was ruined. Some crystals (probably recovered at the surface) needed no heat treatment, though, and a number of them were cut into fine stones by the Vartanians.

Figure 19. **Edward R. Swoboda (here shown with a group of Longido ruby specimens) brought tanzanite specimens to the U.S. for identification two days after Hyman Saul.**

Ed Swoboda

Two days after Saul's visit to the GIA in New York, the California collector and dealer Edward Swoboda arrived home from a trip to Tanzania and brought tanzanite specimens of his own to show his friend, Richard Liddicoat, Executive Director of the GIA's Los Angeles office. Swoboda was astounded to learn that Liddicoat had already heard of the material; he had received a call from Crowningshield just two days before, describing the gemmy blue crystals that Hyman Saul had shown him. Swoboda then took the specimens to William Pecora at the U.S. Geological Survey, and Pecora recognized them as being like the zoisite crystals he had seen and identified in 1959.

Beth Muindi

Not long after de Souza filed his claims, Beth Kabura Muindi (Fig. 21, born 1936), a wife of Senior Chief Paul Muindi Kilelo (1921–1975) and a gemstone dealer and small miner in her own right, brought John Saul a small lot of unusual gems that may also pre-date de Souza's claims. These included a canary-yellow gem zoisite crystal (Fig. 22), some other fragments of gem zoisite with unusual pale colors, and some fragments of lime-green grossular garnet which also had a somewhat unusual color. Despite their efforts, stretched out over a year or more, neither John Saul nor Beth Muindi was able to trace these stones back to their original finder, or their original locality which, however, was probably in the Merelani area. Among the loose fragments was one that had been broken off the yellow crystal. With heating, this became a very pale blue which gemologist/physicist Kurt Nassau suggested might make a suitable substitute for "blue white" diamonds.

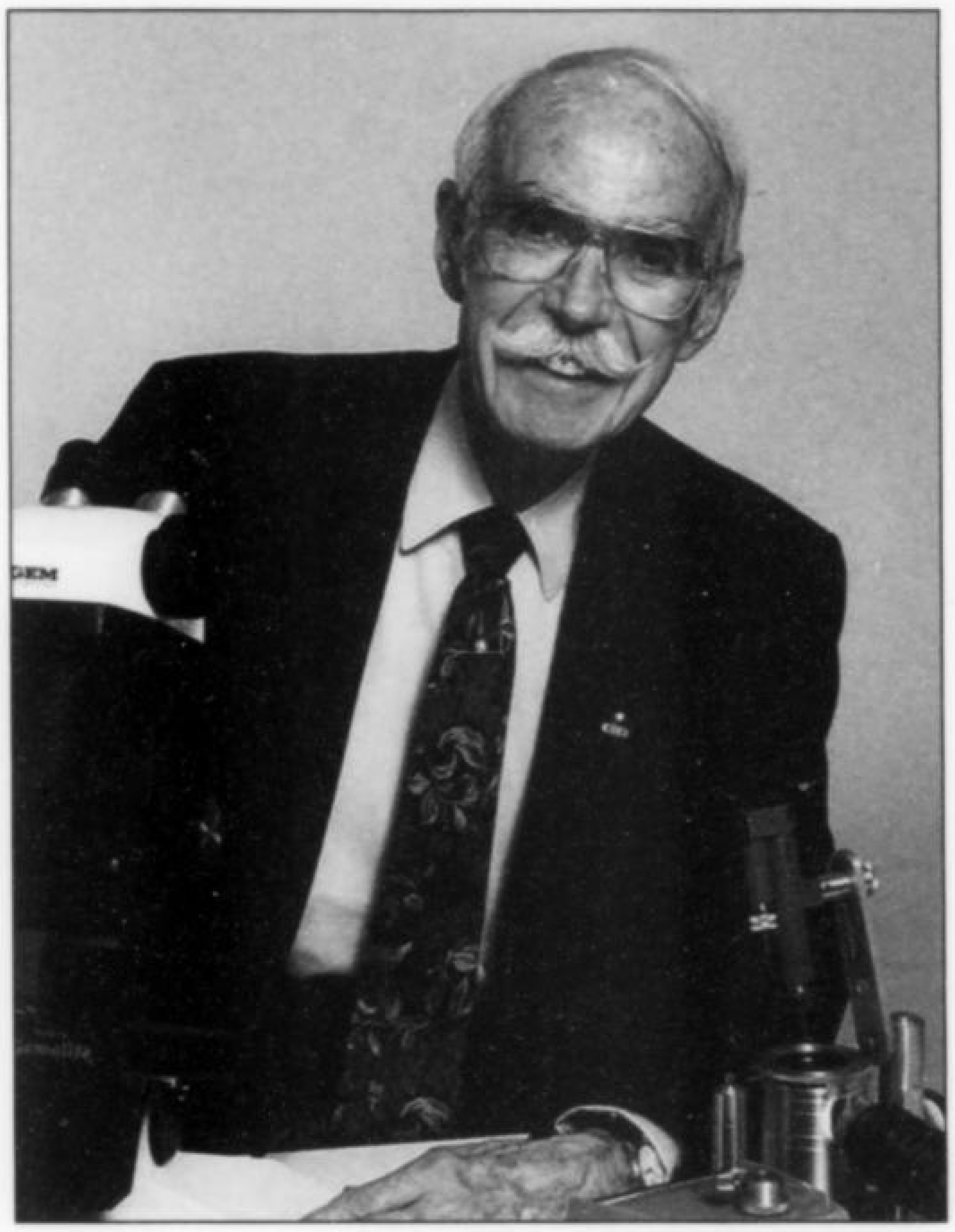


Figure 20. **Gemological Institute of America Vice President G. Robert Crowningshield was shown some of the first tanzanite specimens and arranged for an analysis. Photo © Gemological Institute of America, reprinted by permission.**

Henry Platt

After showing John Saul's stones to the GIA in 1967, Hyman Saul brought them "downstairs" to Jerome Kessler, the manager of the Saks jewelry department. Kessler liked the material but it was his feeling that Saks should not be in the rough stone business. Saul then brought them to Walter Hoving, President of Tiffany & Company, who passed them to Henry B. Platt (1935–2007), the great-grandson of Louis Comfort Tiffany. At the time Platt was Vice President of Tiffany & Company and their chief gem buyer. Platt was excited by the beautiful new gemstone, and decided that Tiffany's would embark on a major marketing campaign.

Campbell Bridges

Zoisite specimens soon came to the attention of the British geologist Campbell R. Bridges (1937–2009), whose name is associated with the discovery of deep green "tsavorite" grossular in Tanzania in 1967. Tiffany's had hired Bridges as their consulting geologist, so he brought specimens of the new gem zoisite to them first. After confirming its identity with Crowningshield, Bridges offered a thumbnail-sized, slightly stream-rounded trichroic zoisite crystal to George Switzer and Paul Desautels at the Smithsonian—it was the first blue zoisite they had ever seen. Judging by its description, this specimen may have been found in the alluvial deposits later called the Machakecho mine, located a short distance west from the outcrops of the veins. It was something of a rule at the beginning that parcels of gem zoisite would include a few well-rounded pieces among the sharply formed crystals. The de Souza family attributed

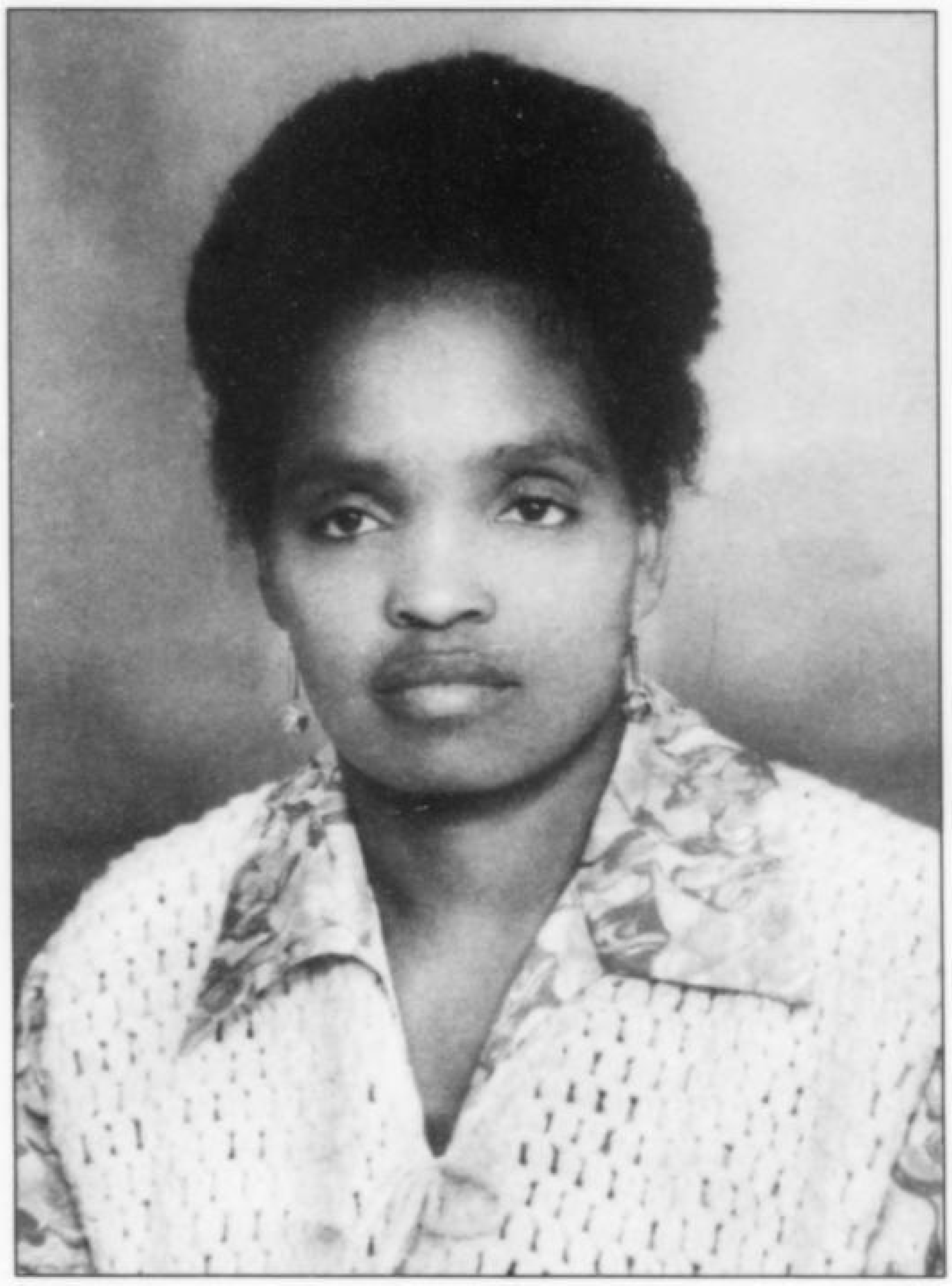


Figure 21. **Beth Kabura Muindi, co-owner of the East & Central Africa Mining Company, staked zoisite claims at Merelani in 1968. She supplied a yellow crystal of gem zoisite to John Saul in mid-1967, around the time of Manuel de Souza's discovery of the deposit.**

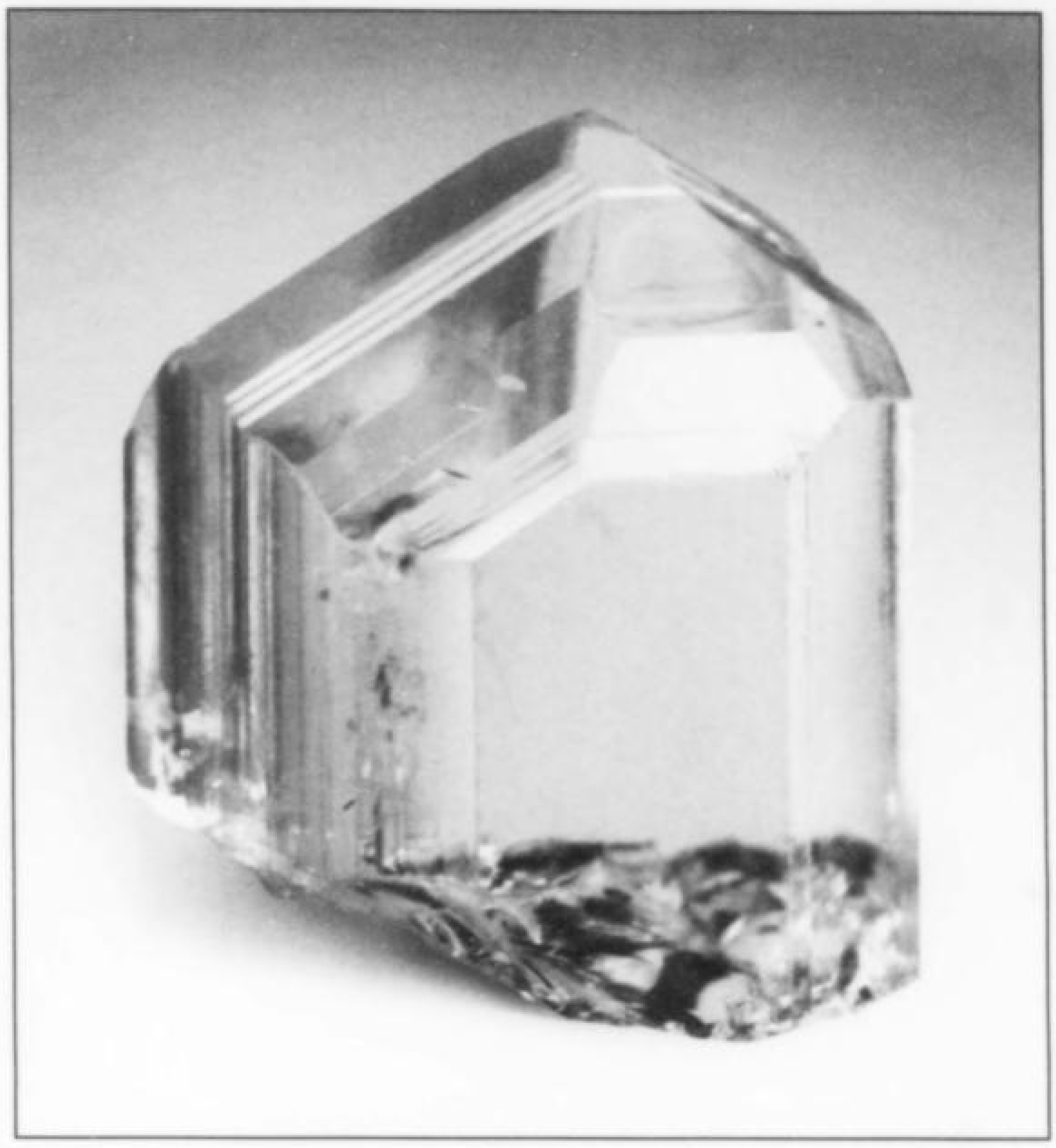


Figure 22. **Yellow zoisite crystal, 1 cm, tentatively determined to be from the Merelani area; it contains a characteristic trace amount of the rare-earth element neodymium and is quite similar to the crystal in Figure 118. Found around 1967 by persons unknown and sold to John Saul by Beth Muindi. Wendell Wilson photo.**

Figure 23. **Henry B. Platt (1935–2007) (*left*), President of Tiffany's, with Tiffany's consulting geologist Campbell Bridges (1937–2009) around 1974. Platt bestowed the varietal name "tanzanite" on gem-grade blue/purple zoisite, and also the name "tsavorite" on deep green vanadium-rich grossular. Photo courtesy of Bruce Bridges (*Tsavorite, USA, Inc.*).**

the rounding to periodic flash flooding, an interpretation that Saul has found difficult to accept because of the high degree of rounding and the short distances from the *in situ* deposit.

Tanzanite Enters the Lexicon

Tiffany's began cutting stones preparatory to a gala public offering, obtaining most of their cutting rough from Gebruder Bank, as well as cut stones from Martin Ehrmann via Vartanian & Sons. Henry Platt, however, was concerned that the correct mineralogical name, zoisite, sounded too much like "suicide," and would be a difficult sell with women. He decided that, for marketing purposes, a new gem variety name was needed, and christened the stones "tanzanite" after the country of origin (Liddicoat and Crowningshield, 1968). When the new gem was publicly unveiled by Tiffany's in October 1968, Platt remarked quite correctly that it "was the most beautiful blue gemstone discovered in over 2,000 years."

Figure 24. **Paul E. Desautels (1920–1991), Curator of Gems and Minerals at the Smithsonian Institution in Washington, DC, He acquired several of the first tanzanite crystals from John and Hyman Saul, including the crystal and cut stone pictured in Figure 26.**

Figure 25. **Prominent mineral dealer Martin Ehrmann (1904–1972) handled some of the first great crystals of tanzanite and helped arrange for their acquisition by the Smithsonian Institution.**

Figure 26. **Two of the first tanzanites brought out of Merelani in 1968; they were acquired by the Smithsonian Institution from Hyman and John Saul through exchange, with Martin Ehrmann acting as intermediary. The gemstone, cut from one of the crystals in Idar-Oberstein, weighs 122.7 carats; the crystal (NMNH# 123896) measures 5.2 cm. Wendell Wilson photo.**

Paul Desautels

In early 1968, John (and Hyman) Saul offered the Smithsonian two lots of significant, large crystals. When the second offer came, Desautels wrote back to Hyman as follows:

> In the past six months I have seen four lots of [tanzanite], have acquired two lots and have heard of still two others. All have apparently come through different channels, and each owner apparently felt he had a near monopoly on the material. The best of it we have came from your son John, and he certainly has been wonderful about getting it into our hands. . . . Of course we are very interested in having the two crystals you describe. At the moment, the best thing we can hope for is that you can make a deal to sell the lot to Martin Ehrmann. If you do, he has promised to send the two crystals to us and, as he often does, wait as long as necessary to get his money back. He has worked this way with us often in the past, as a sort of personal contribution to our progress.

Shortly thereafter, Martin Ehrmann obtained a large packet of extraordinary crystals and took them straight to the Smithsonian; Desautels kept two superb crystals and arranged for Ehrmann to have another crystal (priced at $60/carat) cut in Idar-Oberstein, yielding a 122.7-carat stone, but the rest he could not afford. Desautels, a consummate deal-maker, ended up paying no cash; he obtained the tanzanites via a three-way trade with Ehrmann and Oregon mineral dealer Walt Lidstrom.

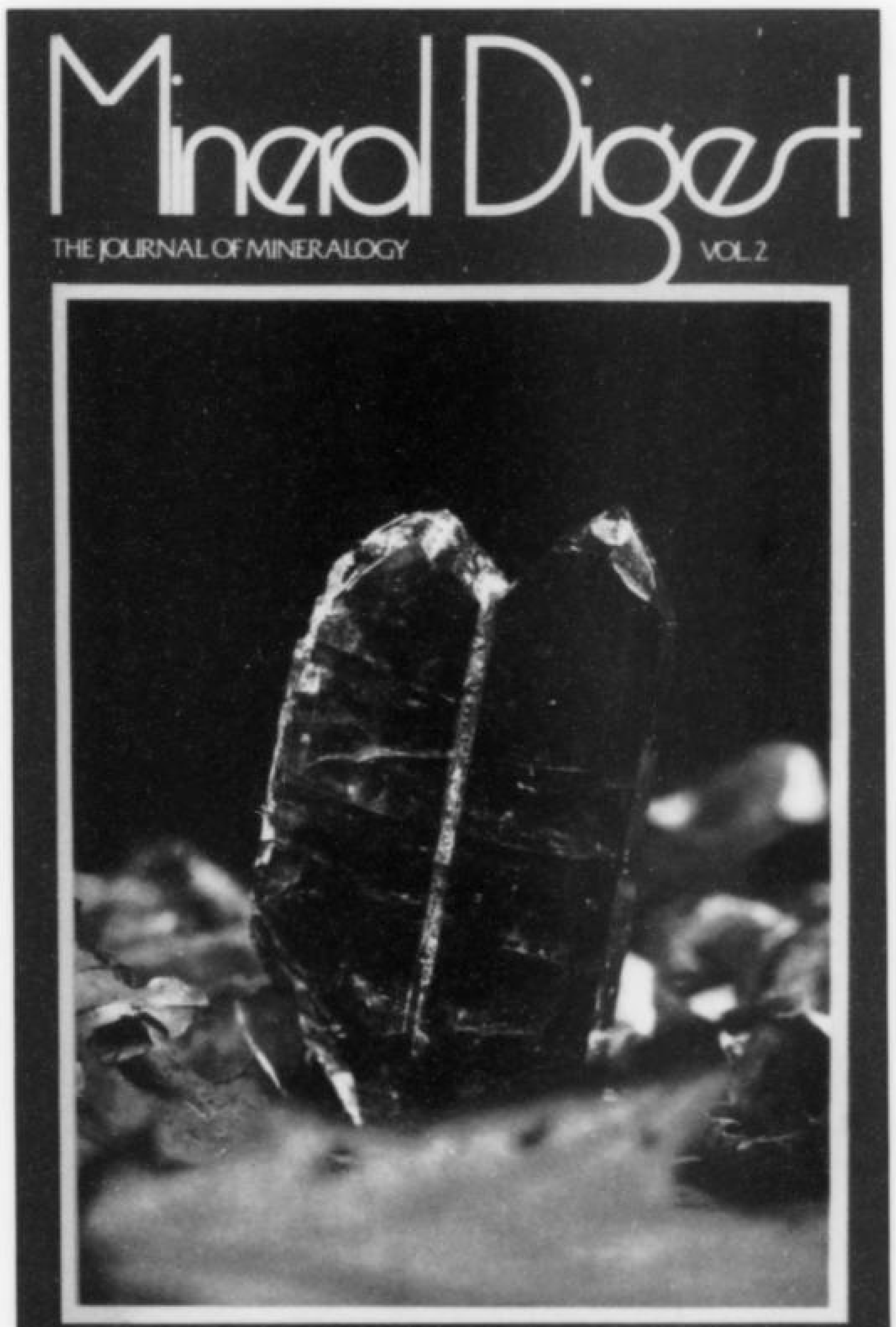


Figure 27. **One of the first tanzanite crystals obtained by Julio Tanjeloff in 1968, a 6-cm crystal from Merelani, was illustrated on the cover of the second issue of his magazine, *Mineral Digest,* in 1971. It is now in the collection of his grandson, Dennis Tanjeloff.**

Julio Tanjeloff

Julio Tanjeloff (1916–1988), a flamboyant Argentine gem and mineral dealer in New York, had obtained a single 155-carat crystal in 1968 and claimed to have been the first to offer it (as blue zoisite) to several American museums, but found no takers. When Tiffany's christened the material "tanzanite," Tanjeloff began a counter-campaign, offering the gem through his own outlets as "tanjeloffite" (Zara, 1971). But the name failed to catch on. Tiffany's dominant position in the gem and jewelry market made it no contest, despite Tanjeloff's efforts. Tanjeloff featured a crystal of "tanjeloffite" on the cover of his magazine, *Mineral Digest*, in 1971.

Figure 28. **Postage stamps that have depicted tanzanite from Merelani (Mineralogical Record Library).**

The Tanzanite Rush

By 1970 the crystals had already become famous in the mineral collecting world. Between 200 and 400 kg of crystals had been recovered by a host of registered and unregistered miners. In early 1970 the very first issue of the *Mineralogical Record* mentioned "the exciting new gem crystals of zoisite (tanzanite) from Tanzania."

Following the debut with Tiffany's, tanzanite rapidly became one of the world's most popular gemstones. The potential wealth quickly attracted outsiders, both Tanzanian and foreign, who pushed the original discoverers out. Not a single one of the early zoisite claimholders managed to retain his rights. Soon the Merelani Hills were awash with thousands of fortune seekers. The various workings began as small open pits, named after the men who originally filed mining claims on them; the most important of these were the de Souza pit no. 1, the Ally Juyawatu pit, the Papanicolaou pit, the Karo pit, the Georgi pit, and the de Souza pit no. 2.

In 1971 the tanzanite mines were nationalized, and their management was taken over by the parastatal company Tanzania Gemstone Industries (TGI), initially a subsidiary of the National Development Corporation, but placed under the authority of the State Mining Corporation (STAMICO) in 1972. Production over the next 20 years was very low, as a result of haphazard open-pit mining, bad management and theft.

By 1986 TGI had abandoned the property entirely to perhaps as many as 30,000 itinerant miners who dug a maze of narrow shafts and tunnels, some up to 60 meters deep, throughout the area in search of tanzanite veins. In 1990, the Tanzanian government decided to curb, or at least impose some organization on, what was euphemistically called "artisanal mining," and sent in 50 police officers to clear the area of the many miners who had come there to seek their fortunes. The Government demarcated the area into four major blocks: A, B, C and D. Mining rights to the blocks (for gems and for graphite) were awarded by the Ministry of Energy, Water and Minerals, according to the recommendations of a Special Committee of Principal Secretaries. Blocks A and B, on hilly land with difficult access, were assigned to private prospectors. Because of a thick overburden of soils and calcrete (caliche), the Block D area was deemed unsuitable for graphite mining and was awarded to a local miners' cooperative. Block C was considered the most amenable to open-pit mining of high-quality, coarse-flake industrial-grade graphite as well as tanzanite, and was awarded to a British-based mining company.

THE MINING BLOCKS

Block A

Block A, at the southwestern end of the deposit, was awarded to Kilimanjaro Mines Ltd., owned by a local businessman, Ernest Massawe. Massawe was initially in partnership with two Australians, Peter John Prickett and Janis Ann Healy. Prickett was jailed as a result of some kind of scandal in ruby mining, and in 1994 Prickett and Healy were formally forbidden from conducting any business on behalf of Kilimanjaro Mines, Ltd. Massawe later worked with a small Australian company called Diversified Minerals Resources.

The tanzanite deposits are leanest at this end, and during its first year of operation Block A yielded only 1.4 kg of tanzanite crystals. As of 2007, Block A (covering 0.8 km^2) and the Block A extension (1.8 km^2) were still being operated by Kilimanjaro Mines. It has never been a major producer, but is still yielding specimens.

Block B

Block B (1.3 km^2) includes the Opec pits (formerly one of the de Souza pits), and is known for producing a limited amount of green zoisite as well as tanzanite. It was originally licensed to

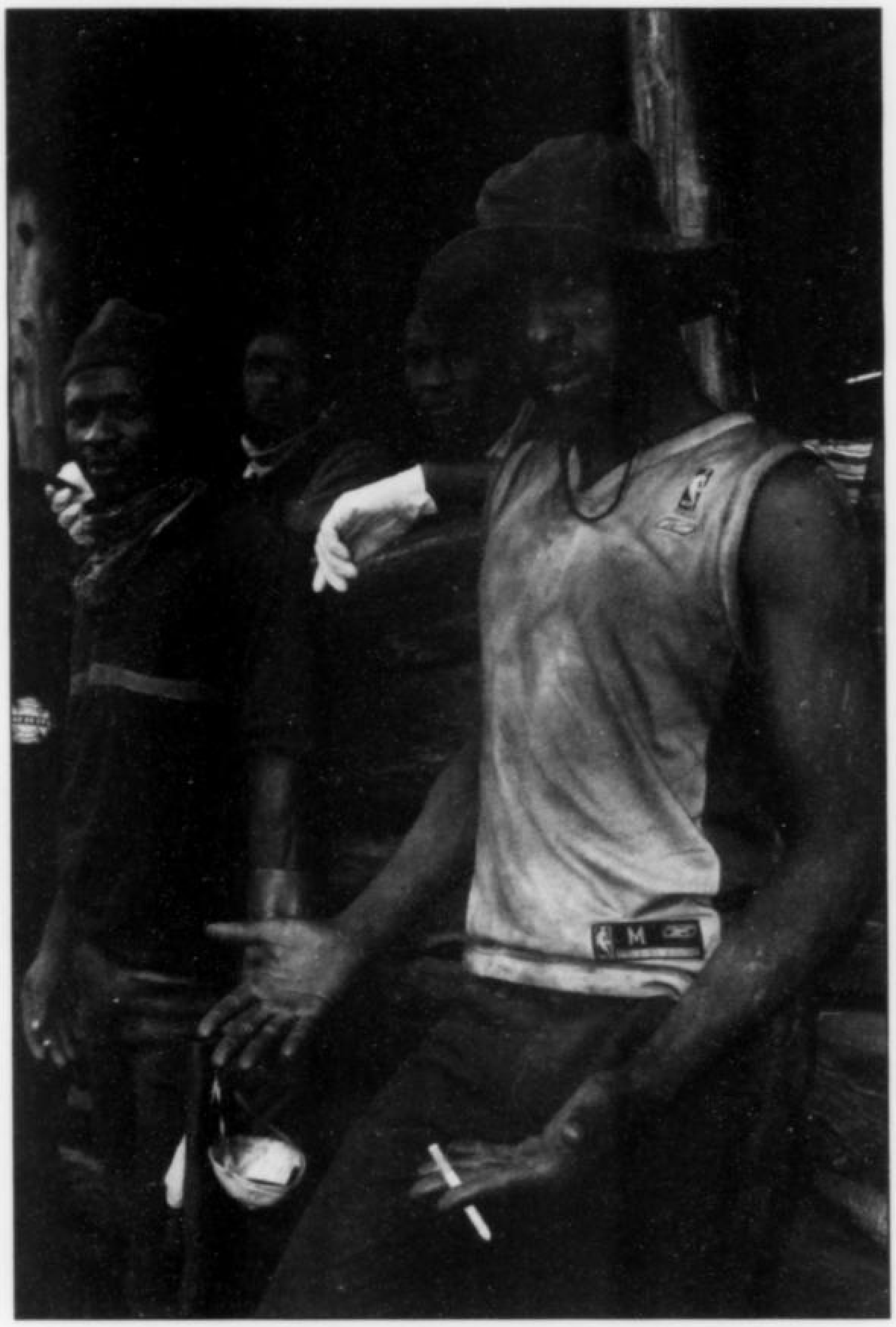


***Figure 29.* Miners from the small-scale workings of Block B.**

Building Utilities, Ltd., owned by a local businessman named Misha Fainzilber, a Jewish refugee from Hungary or Czechoslovakia. Fainzilber was active in a variety of businesses, including mining and the export of tropical fish and rare seashells for collectors. He was well-connected to the government because of his role in the Zanzibar Revolution of 1964. Fainzilber is said to have spoken 14 languages including German; he was an early period scuba diver, a Makondi art historian/collector who loaned his collection to museums worldwide, an ex-sisal plantation owner and the long-time manager of the Silver Sands Hotel in Dar es Salaam. There was an incident and a conflict with the small-scale miners, however, and his brother's wife blamed it on a curse related to the gemstones. In 1995 the government confiscated Block B and Fainzilber sued, but later settled out of court. The block was transferred to a large number of small-scale individual miners represented by the Arusha Regional Miners Association (AREMA). Block B soon became riddled with primitive, dangerous, hand-dug shafts, tunnels and rat-holes. Today Block B is operated by a collection of six companies and over 600 individual small-scale miners.

A mining disaster took place on April 9, 1998 when flash floods pouring into 17 shafts in Block B drowned as many as 200 miners working underground. There were also people sleeping underground, either to get out of the rain or simply between shifts. Operations there are normally accessed by ladder via a single shaft, with no alternative egress. The shafts at that time extended to depths of 90 meters or more. When the floods hit there was no one trained in mine rescue operations on hand for these primitive workings, and

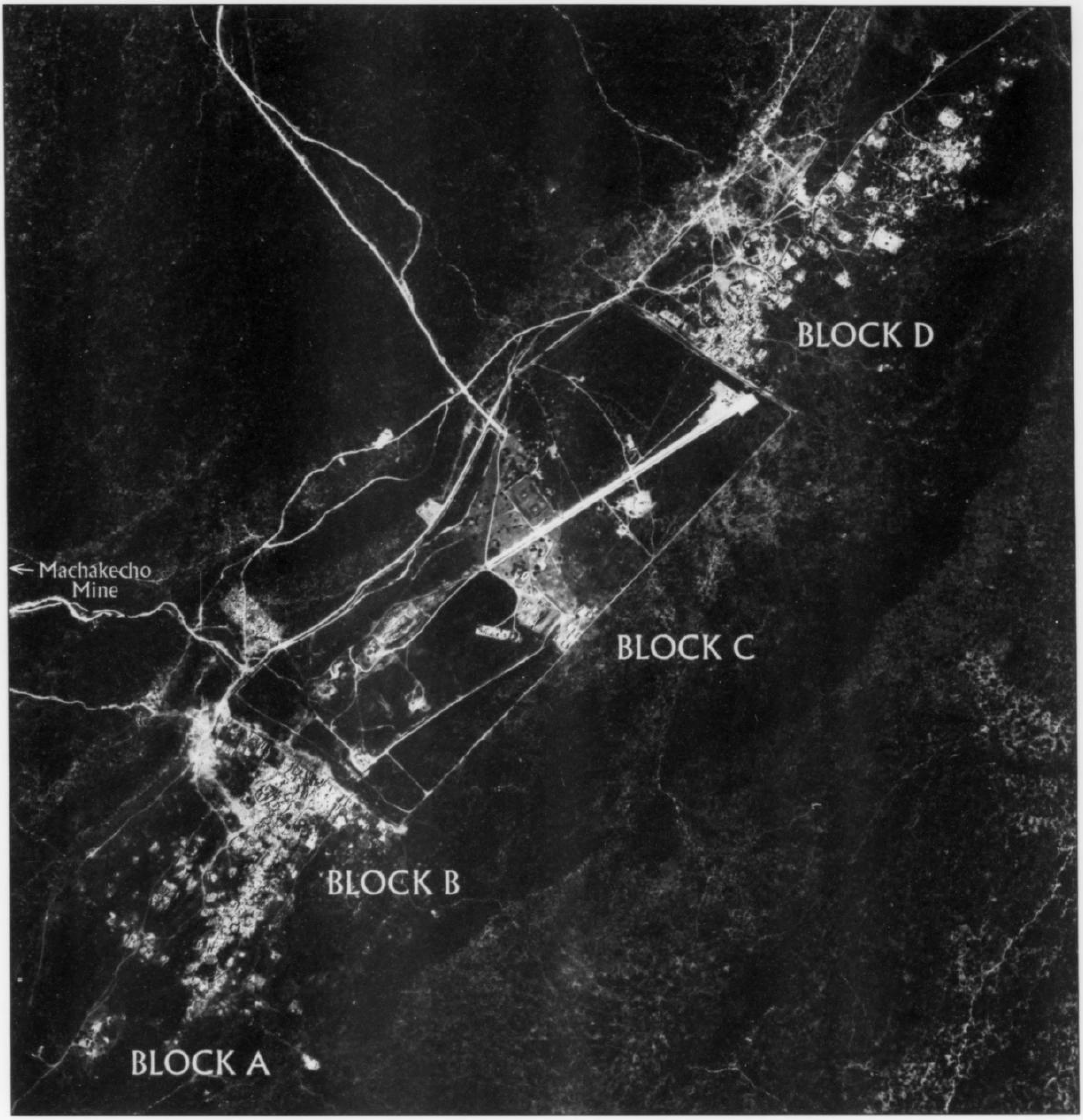


***Figure 30.* Satellite photo showing the workings on the Merelani deposit. Block C is the modern TanzaniteOne concession, complete with airstrip. Blocks B and D are the so-called "native blocks" operated by small-scale "artisanal" miners.**

rescue attempts were hampered by a lack of heavy-duty pumps to draw water from the shafts.

The disastrous flooding was repeated ten years later, on March 28, 2008, when water from a torrential downpour flooded into the Block B workings again, killing 74 miners. The underground flooding was so severe that water poured through connecting passages into the Bravo shaft, level 17, of the Block C workings operated by the TanzaniteOne Corporation, though no one was injured there. TanzaniteOne flew in several pumps to help dewater the Block B and C workings, and assisted as best it could with relief efforts in Block B.

Block C

Block C (2.3 km^2) was originally licensed to Graphtan, Ltd.—a joint venture of London-based Samax, Ltd. (75%), Tanzania Gemstone Industries, Ltd. (10%), and Africa Gems of UK (15%). Samax was to take the graphite for industrial use, and TGI was to take the gemstones, while Africa Gems would handle the marketing of the stones. Graphtan was never a successful operation. Mining began in 1995, and yielded 6,776 tons of graphite in 1996. However, in late 1996 Graphtan had to suspend its underground mining operations, and filled in all the workings on its property, including 750 pits and shafts that had been dug by illegal miners. Despite an effort to close

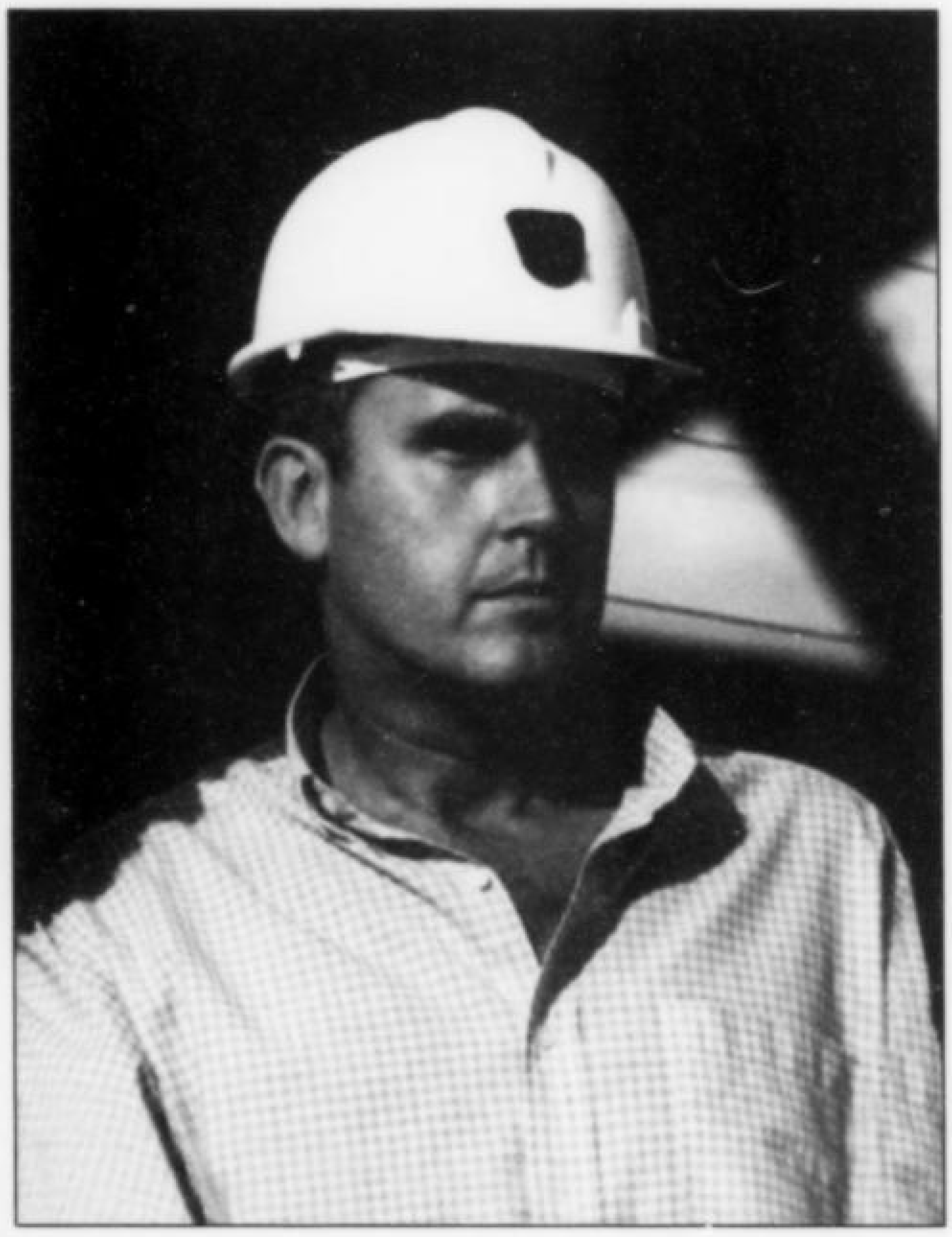


Figure 32. **TanzaniteOne CEO Ian Harebottle was in charge of operations for a number of years. He recently left the corporation to join Gemfields Resources, PLC as CEO. Photo courtesy of TanzaniteOne.**

Figure 31. **Old open cut and entrances to underground workings at the Samax mine in Merelani Block A. Anthony Kampf photo, 1995.**

Figure 33. **Miners drilling at the working face of TanzaniteOne's Block C operation. Unlike in the "native blocks," mining conditions at Block C are excellent and the company has a fine safety record. Photo courtesy of TanzaniteOne.**

Figure 34. The largest gem-grade tanzanite ever found, named "Mawenzi" after one of the three peaks of Mt. Kilimanjaro, is 22 cm long and weighs over 3 kg. It was found on the 270-meter level of the Bravo shaft in the TanzaniteOne mine, Block C, Merelani, in July 2005, and is currently kept in a vault in the mine office. Photo courtesy of TanzaniteOne.

Figure 35. A miner from TanzaniteOne's Block C operation holding the "Mawenzi" crystal of tanzanite. Photo courtesy of TanzaniteOne.

Figure 36. Five large (but broken) gem-grade tanzanite crystals from the "Mawenzi" find in July 2005. Photo courtesy of TanzaniteOne.

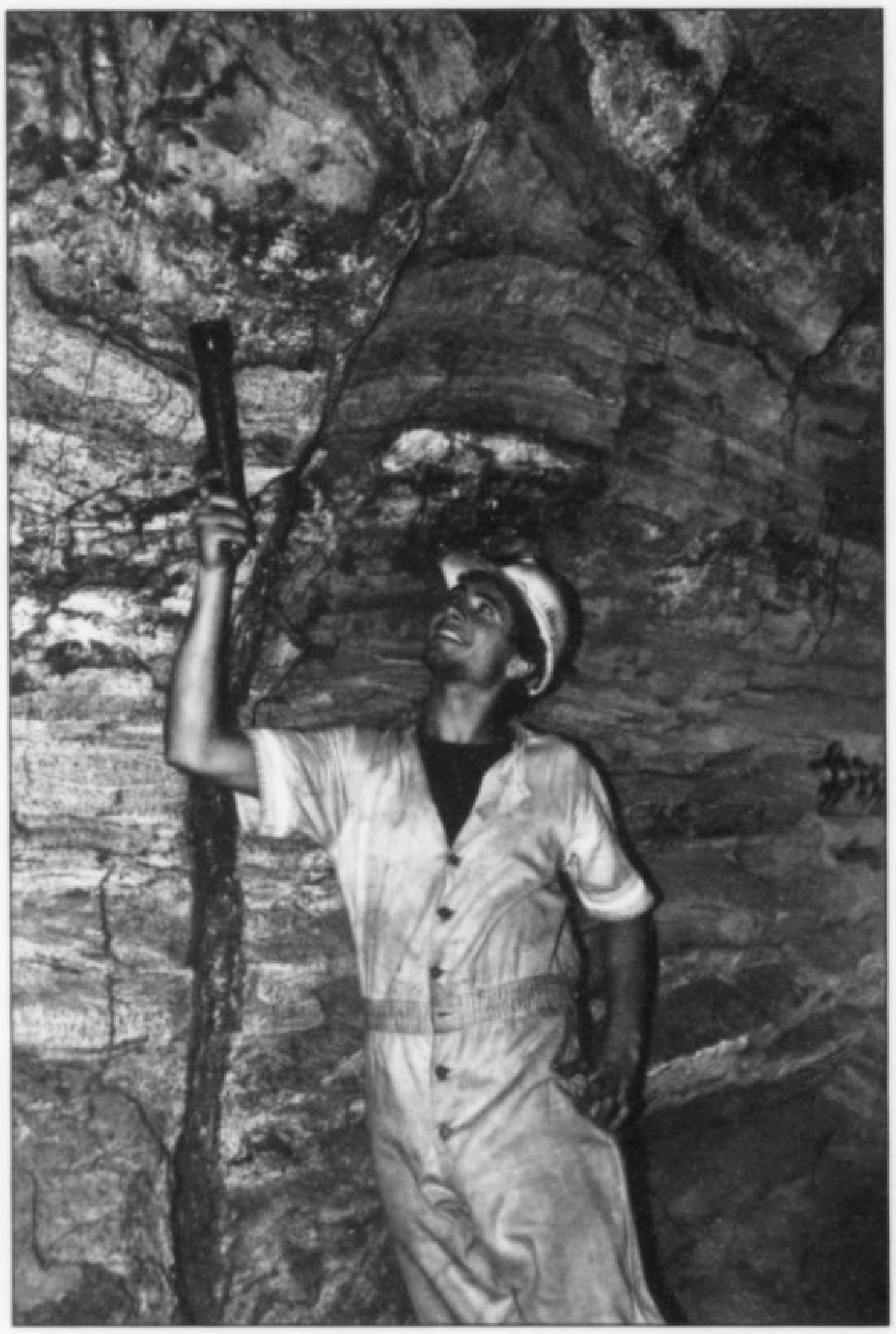


Figure 37. **Robert Grafen-Greany, Chief Geologist for TanzaniteOne, points out boudins where tanzanite crystals are found. Richard Hughes photo.**

unauthorized mining on Block C, it was still being accessed illegally after 1995 via underground tunnels up to 300 meters long extending from Block B, and disputes over this encroachment lasted at least until 2005 when Government intervention was requested.

In 1999 mining at Block C resumed under a South African entrepreneur, Mike Nunn, who had been buying tanzanite from local miners, and studying the mining operations. Having visited the Block D zone (reserved for small-scale miners), he was headed to Block B (a second area designated for small-scale miners). But between them was Block C, an abandoned stretch with no mining activity going on. Seeing an opportunity, he assembled a group of private South African investors under the name African Gem Resources, Ltd. (Afgem) and acquired the mining rights for Block C in mid 1999; mining began in January 2000. In 2004, the TanzaniteOne Group, a publicly traded company, acquired Afgem's tanzanite business and assets, and today controls 50% to 60% of the known tanzanite reserves. The TanzaniteOne mine today is the largest mine in Tanzania, and is impressive, to say the least. Indeed, the entire operation exudes class, from the mining conditions underground to the promotional efforts of the Tanzanite Foundation, a non-profit organization dedicated to promoting tanzanite and assisting the people who mine it.

According to recent reports on Block C, there are three main shafts known as the "Main," "Bravo" and "Delta" shafts. The "Main" shaft, situated near the middle of the Block, extends for about 400 meters along a 41° incline, reaching a vertical depth of 275 meters. "Bravo" shaft to the south is 300 meters in length and reaches a depth of 200 meters, as does the "Delta" shaft to the north. The "JW" cross-cut intersects the "Main" shaft at a depth of 200 meters. This cross-cut has thus far produced Block C's highest yield of tanzanite, around 60 carats per ton, vs. around 22 carats per ton elsewhere in Block C. The deepest workings are currently over 300 meters (1,000 feet) below the surface.

The TanzaniteOne Corporation expects to produce about 1.7 million carats of tanzanite in 2009; this will be a significant increase over the 1.2-million carats produced in 2006, and the 1.4 million carats recovered in 2005. However, revenue decreased from $42.6 million in 2007 to $26.9 million in 2008, due to the economic slowdown, causing TanzaniteOne to cut staffing by 28% and delay plans for increasing annual production to 5 million carats until 2012. Since 2006, TanzaniteOne has continued to produce an increasing percentage of the district's output, thanks to an improved geological understanding, improved mining efficiencies and the implementation of improved sorting systems. In addition, production from the more primitive workings in the neighboring blocks has diminished as a result of the increasing danger and difficulty of hand-mining at greater depths.

Figure 38. **A grim-faced miner at Block B, in March 2008, fearing the worst for three of his companions still trapped underground by water from a flash flood. Reuters photo.**

Figure 39. **A miner, covered in graphite dust, emerging from the Kikuyu mine in Block D following a shift. Richard Hughes photo.**

Figure 40. **Barefoot miners 450 meters underground in Block B.**

Block D

Block D was awarded to the Arusha Region Miners' Association. The block was then divided into small parcels that were distributed among the association members, who initiated old-style small-scale individual mining of the most primitive type: narrow vertical shafts, lit by small kerosene lamps. By 1991 there were already around 350 pits in the block, being worked by over 4,000 miners. For the underground miners, their equipment consists of hand-mining tools, a soft cap and a flashlight strapped on with strips of rubber cut from an old bicycle tire inner tube. Most miners work without shoes.

Block D has since been subdivided into three separate properties: **Block D-1** (1.81 km^2) is being mined by various small-scale miners; the very small **Block D-2** (0.04 km^2) is under the control of Osoit Pusu, Ltd.; the even smaller **Block D-3** (0.003 km^2) is being mined by Gem & Rock Ventures, Ltd.

Block D Extensions

The first Block D Extension (0.59 km^2) tract was awarded to Tanzanite Africa, Ltd. The claimholder, J. S. Megezi, is a Tanzanian in his late 60s who initially lacked the money to start production. In 2002 he entered into partnership with Reginald Mengi (said to be the most prominent businessman in Tanzania), who covered all start-up expenses for the hiring of drillers, geologists and exploration engineers from South Africa. By 2006 there were 60 employees at the operation.

Since then, three more extensions of Block D have been created. **Block D-extension-1** (0.59 km^2) is operated by J. S. Magezi & Sons; **Block D-extension-2** (0.4 km^2) is licensed to Paradiso Minerals, Ltd.; **Block D-extension-3** (0.28 km^2) is controlled by Gem & Rock Ventures, Ltd.; and **Block D-extension-4** (0.19 km^2) is being mined by Tanzanite Africa, Ltd. Five to six thousand miners are now said to work at Block D alone, which is the area where the deepest shafts and workings are found, as the deposit trends downward from Blocks A through D.

Many of the most recently found collector-quality crystals (diopside, tsavorite, apatite, graphite crystals) came from several recent finds in the Karo pit, at a depth of 230 to 260 meters.

As of 2004, as many as 10,000 miners working in small-scale mines in Blocks B and D accounted for most of the country's tanzanite production, but the professionally run TanzaniteOne operation on Block C has since become the leading producer.

MINING AND DISTRIBUTION

The TanzaniteOne operation in Block C is a modern, highly professional mining and marketing organization with its own system for recovery, grading, sorting and sales of gemstones. For the "native blocks," however, a complexly structured mining and distribution system for tanzanite and other gem species has evolved over time. At the beginning of the chain are the plot owners for each plot or pit (a "pit" is generally now an underground operation rather than an open pit). These owners employ people called "detectors" (serving in the role of geologists) who determine the best direction for mining to proceed. Miners then go to work, and are normally paid on commission by the mine owners, who provide tools, medicines, water and one meal a day. The miners are assisted by *nyoka* or "snake boys," whose job is to climb immediately into freshly blasted rock rubble and lead the way for miners. Snake boys also slither down narrow shafts and tunnels to dig out sand and fine rubble, which is then examined above ground for small gem fragments.

In Merelani these small-scale mining crews are referred to as *wana-apollo (wana-appolo)*. Once a vein is found, miners sometimes use a system called *bing (bingo)*, a bucket brigade of several groups of *wana-apollo* to exploit the vein and carry out rubble. New workings at Merelani are started when a plot owner engages a number of *wana-apollo* to begin making exploratory excavations in search of a workable tanzanite vein on his property. It may take up to a year before the new workings become productive. In addition to the miners working the pits, there are also "take-aways," or unemployed *wana-apollo* miners, outside privately owned mines in Blocks A and D. They search the tailings of the mines there for small pieces of tanzanite overlooked by the regular miners.

Once gem crystals start to emerge, they are taken to local brokers to sell. In 2006 there were over 500 brokers buying tanzanite from miners in the native blocks at Merelani. Many of the major buyers are Kenyans and Tanzanians of the Luo and the Maasai ethnic groups, of which the Maasai buyers are the wealthiest. Renowned in Africa as fierce warriors who once speared lions to death as a rite of passage, the Maasai (at least those in Merelani) have exchanged their nomadic way of life for the more profitable gem trade. While Africans from other tribes work deep in the mines, most Maasai consider themselves too dignified for manual labor. They typically invest their profits in cattle, and then take loans against their herds to raise cash as necessary for gem purchases.

Arusha and (to a lesser extent) the city of Nairobi, across the border in Kenya, are the prime markets for mineral dealing. Gem crystals can also be sold at a branch office or exported directly to a foreign buyer. At the top of the local food-chain is a group of licensed "Master Dealers" in Arusha and elsewhere in Tanzania who buy gemstones at registered offices.

In early 2003, the Government instituted new measures to regulate tanzanite mining that included the establishment of the Tanzanite Advisory Board, increased security at the mines, a system of identification for miners, and safety regulations. The Tanzanite Advisory Board has participated in formulating mining and safety regulations and assisting small-scale miners. The Government has restricted access to blocks A, B, and D, and has instituted a new system of formal employment at the mines.

Figure 41. **Maasai tanzanite brokers at work in Merelani. Hamza Kondo photo, 2002.**

GEOLOGY

Mozambique Orogenic Belt

The oldest rocks in the area are part of the Precambian (late Archean) Usagaran System (corresponding to the Turoka Group in neighboring Kenya). The original calcareous, arenaceous and pelitic sediments were probably rich in bauxite or kaolinite and intercalated organic material (Cilek, 1980). The Merelani tanzanite deposits are the result of massive tectonic activity that created one of the most gemologically interesting zones in the world—the Mozambique Orogenic Belt. This structure consists of a Proterozoic-age vanadium-rich sedimentary series metamorphosed to the granulite facies but most commonly found as retrograde kyanite-almandine-subfacies rocks of the upper amphibolite facies. Malisa (1987) concluded that the peak of metamorphism reached temperatures between 520° and 730°C, and a pressure of 7.7 to 9.1 bars. Beds of massive, coarse-grained crystalline limestone, commonly dolomitic and siliceous, are prominent; MacFarlane (1975) found ubiquitous dispersed flakes of phlogopite and graphite in the limestone, along with lesser amounts of apatite, scapolite, tremolite, diopside, forsterite, hornblende and garnet. Bands of graphite gneiss, quartzo-feldspathic gneiss and kyanite gneiss are intercalated with the limestone.

The Mozambique Orogenic Belt encompasses nearly all of Tanzania's gem deposits. It cuts a 200 to 300-km-wide north-south swath through the central and eastern part of the country. Running all the way from Mozambique in the south, to the Sudan and Ethiopia in

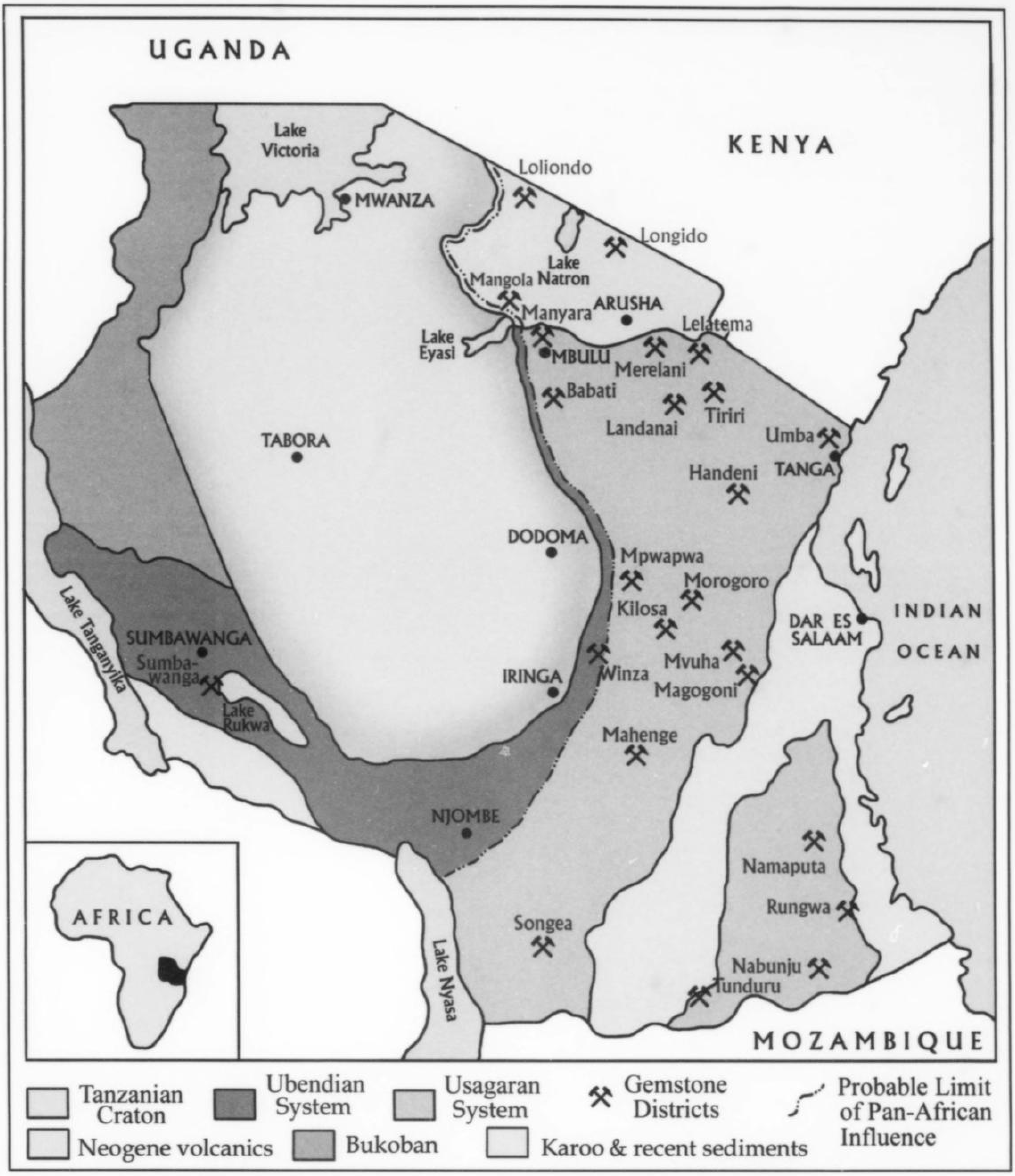


***Figure 42*. Geologic sketch map of Tanzania showing the Mozambique Orogenic Belt (pale gray) and some of the numerous gem mining localities of interest to collectors. Adapted from Malisa and Muhongo (1990) and Dirlam *et al.* (1992).**

the north, it is home to most of the colored gemstone localities in Mozambique, Kenya and Tanzania.

Rocks in this belt underwent several different cycles of tectonism, as well as extensive metamorphism, plutonism, folding and faulting, with thrust-faulting playing a particularly important role in the localization of primary gemstone deposits. (The area is still seismically active.) The general structure of the deposit is a combination of recumbent and isoclinal folds that have been deformed into open-style folds and cut by a system of parallel and transverse faults (Cilek, 1980).

Vanadium, chromium and other elements which were dissolved or leached from some minerals were subsequently incorporated into the crystallization of new minerals. This recrystallization phase took place during the Mozambique Orogeny around 600 million years ago, following the main phase of the Pan-African tectonothermal event, but before the formation of today's Rift Valley System in Karoo-Tertiary times (Naeser and Saul, 1974; Malisa and Muhongo, 1990).

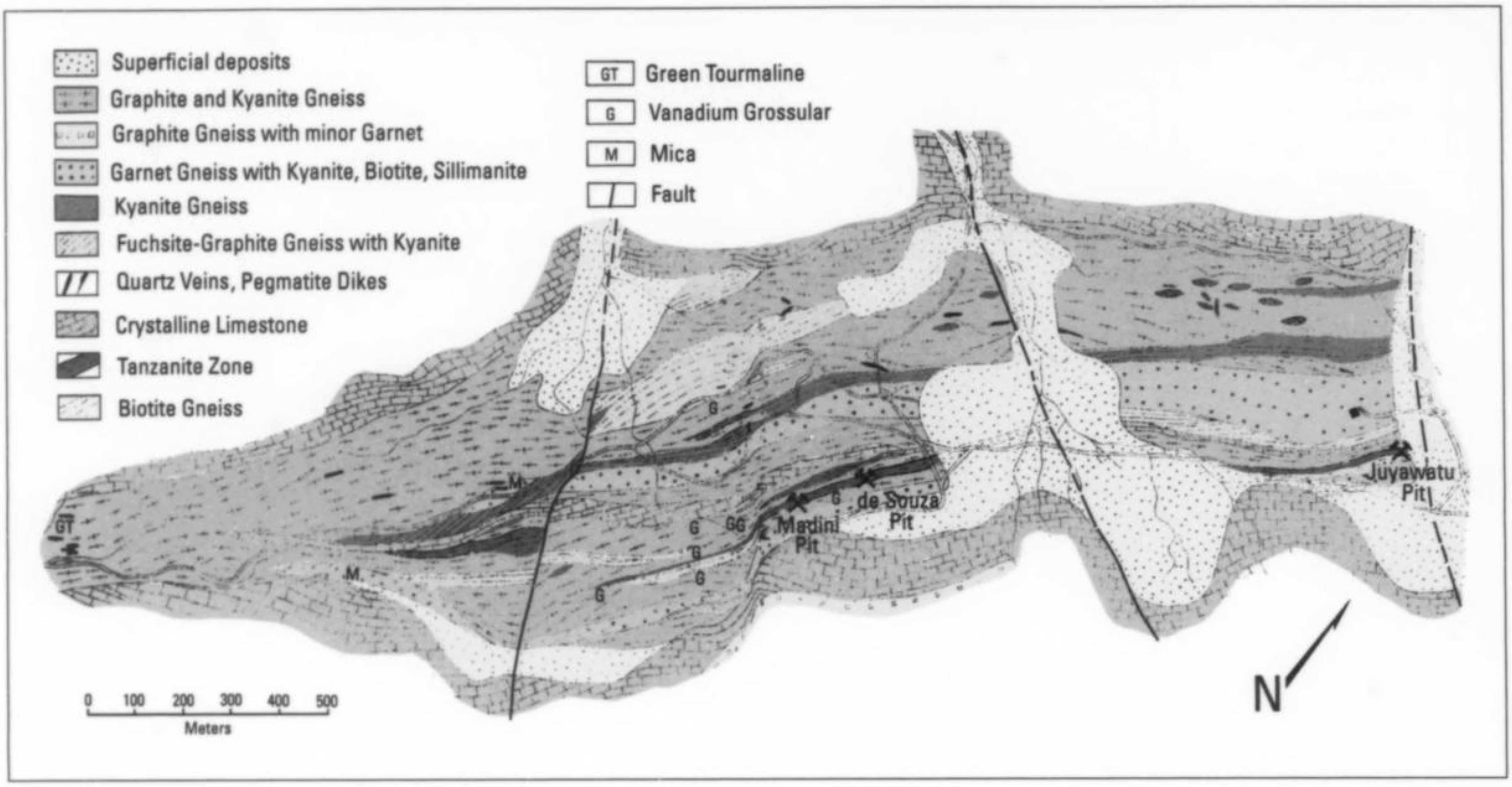


Figure 43. **Geologic map of the central portion of the Merelani deposit (Cílek, 1980).**

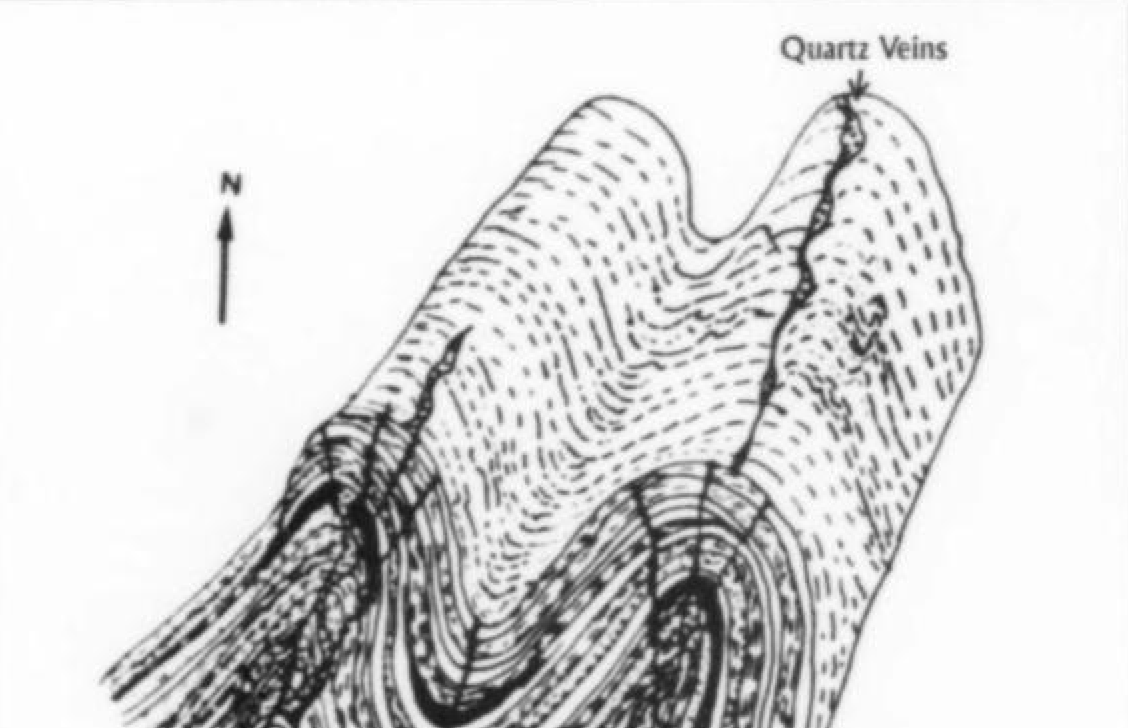


Figure 44. **Schematic cross-sections illustrating structural features present in the main hydrothermal zone in the Merelani area. (A) Inclined fold with fissures (arrows); boudinaged quartz veins are present in the fold hinge. Gem-quality zoisite and grossular are found in cavities and at the margins of quartz veins. (B) Fold core filled with diopside rock containing clay, carbonates, gypsum and iron oxides (from Malisa and Muhongo, 1990).**

Mineralization

The tanzanite deposits occur in the crest of the large Lelatema fold or antiform, which is bounded by major faults parallel to the schistosity. The axes of the productive fold hinges plunge at about 40 degrees, extending progressively deeper from Block A toward Block D.

Scheepers (2006) considers the mineralization style visible in Block D to be typical of the deposit as a whole: dolomitic marble units, dipping roughly 45° northwest, flank the deposit on the west and east sides, and are paralleled by sillimanite-kyanite-garnet gneiss. Within and parallel to this gneiss are zones of graphite-kyanite gneiss hosting several subparallel layers of metasomatic rocks containing zoisite, grossular, diopside and calcium plagioclase. This tanzanite-rich horizon of altered graphite gneiss, about 4 meters in width, is referred to by Davies and Chase (1994) as the "Ali Juu Ya Watu zone."

Distributed throughout the metasomatic rocks of the zone are sausage-shaped boudins believed to be the relicts of less competent units sandwiched between more competent kyanite gneiss layers. The boudin layer, broken up under severe tectonic stress and plastic deformation, became lodged in tight isoclinal Z-shaped folds. In trap sites in the hinges of the folds associated with the boudinage and hydrothermal fracture zones, vanadium-bearing green grossular (tsavorite) formed; over considerable time the grossular reacted to form calcite, quartz and vanadium-bearing zoisite (tanzanite).

Davies and Chase (1994) observed that the tanzanite has crystallized within widely spaced pockets or pods forming a dense network. These pockets each have an amorphous epidote-rich core containing heavily fractured quartz and pyrite, surrounded by a graphite-rich layer, rimmed in alternating limonite-rich and epidote-rich bands set in a white carbonate matrix. Tanzanite crystals are found both at the edges and in the center of the pockets, as well-formed crystals and as porphyroblastic grains and nuggets. Local miners believe that quartz/pyrite and carbonate/quartz "leaders" are indicators of tanzanite mineralization, and that a widening of these leaders indicates the close proximity of a gem pocket. Tanzanite pockets are usually found every 3 to 7 meters along the zone.

Fluid-inclusion studies suggest that tanzanite crystallized at a temperature of 390° to 440°C, from a hydrocarbon-rich fluid containing CH_4-C_2H_{10} and possibly also higher hydrocarbons such as C_3H_8 and C_4H_{10} (Malisa *et al.*, 1986; Malisa, 1998).

A later series of shearing events created secondary boudins and activated the crystallization of second-generation tanzanite via retrograde metasomatism. The result is that associated lenses of pyrite and vanadium-bearing pyrrhotite are cross-cut by quartz veins rich in graphite, tanzanite and other minerals (see also Scheepers and Olivier, 2003; Giuliani *et al.*, 2008, Malisa, 2003a, and Malisa, 2003b).

Graphite and the Protolith

Graphite occurrences are widespread in eastern Tanzania. The graphite is generally believed to have been derived from the protolith of the host rock, a black shale rich in carbonaceous sedimentary organic matter that was deposited in a geosynclinal environment around 1.8 to 2 billion years ago. Carbon isotope data showing that $\delta^{13}C = -24.0 \pm 1.0‰$ are indicative of a sedimentary origin of the carbon (Giuliani *et al.*, 2008). In black shales, vanadium is generally linked to organic matter and may become concentrated in clays. The presence of organic matter and vanadium enrichment is further evidence for a sedimentary depositional environment under reducing conditions (Vine and Tourtelot, 1970; Giuliani *et al.*, 2000; Ripley et al., 1990; Breit and Wanty, 1991). The presence, at vein margins, of pure V_2O_3 (the rare mineral karelianite) and vanadian phlogopite with a V_2O_3 content between 4 and 11 weight percent has been taken as evidence of a high vanadium content in the original sediments. This vanadium was scavenged by circulating fluids and provided the coloring agent for zoisite, tremolite, and grossular.

There is also, however, a controversial theory which one of us (JMS) does not wish to exclude, that the carbon may have been abiogenic in ultimate origin,[10] with the vanadium provided by vanadium-porphyrin complexes.

Reserves

TanzaniteOne has been working to delineate the tanzanite reserves in Block C. Core drilling, geophysical prospecting, geochemical analyses, and structural and geological mapping have all contributed new knowledge. The 2005 drilling program revealed that the lower horizon, which hosts the most profitable tanzanite mineralization, extends much further down dip than initially thought. Consequently the life expectancy of the mine has been extended by more than 20 years, and TanzaniteOne's 2004 estimate of reserves (63–83 million carats of tanzanite worth nearly $1 billion) has been increased as well.

***Figure 45.* Two blue apatite-(CaF) crystals, 2.2 cm, from the December 2007 pocket in the Karo pit, Block D, Merelani. Mike Keim (*Marin Minerals*) specimens and photo.**

MINERALS

Apatite-(CaF) $Ca_5(PO_4)_3F$

A remarkable graphite/diopside pocket opened in the Karo pit in December 2007 gave up a very small number of isolated, gemmy blue-gray, prismatic fluorapatite crystals to 2.5 cm. The best of these crystals are lustrous, pale blue, and totally gemmy; they were marketed at the 2008 Denver show (Moore, 2009). The morphology consists of a hexagonal prism and basal pinacoid modified by complex terminations consisting of up to three or four hexagonal dipyramid forms.

Axinite-(Mg) $Ca_2MgAl_2BO(OH)(Si_2O_7)_2$

The Merelani deposit is the type locality for magnesioaxinite (Jobbins *et al.*, 1975), now referred to as axinite-(Mg). Thin, ax-shaped crystals of axinite-(Mg) to 19 cm have been found at Merelani in varying colors of brown to salmon, pale blue, pale lavender and colorless. The first specimen was brought to the attention of a researcher by Campbell Bridges; it is pale blue in daylight but appears pale violet under tungsten lighting. Other specimens offered at the 2002 Bad Ems show display the same strong "alexandrite effect," appearing pale blue in daylight and violet in artificial light (Jahn, 2002). Pale salmon-colored, tabular crystals were recovered from the December 2007 pocket found in the Karo pit, Block D. The mineral fluoresces a distinctive red-orange under longwave ultraviolet light.

Axinite-(Mg) crystals closely resemble tanzanite crystals in index of refraction, specific gravity and even color and, before being described as a new species, they were thought to be oddly shaped tanzanite crystals (Fleischer and Cabri, 1976). However, their failure to change color when heat-treated suggested they might be a different mineral.

Andreozzi *et al.* (2000) provided a chemical analysis of the

[10] The principal proponent of the theory is Thomas Gold (1920–2004), who achieved fame for his 1992 paper "The Deep Hot Biosphere," which proposed an abiogenic origin of coal, oil, and gas deposits. The theory suggests that such deposits originated from non-biologically-produced natural gas flows which fed bacteria living at extreme depths.

Figure 46. **Blue apatite-(CaF) crystals on a tanzanite crystal, 3 cm, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.**

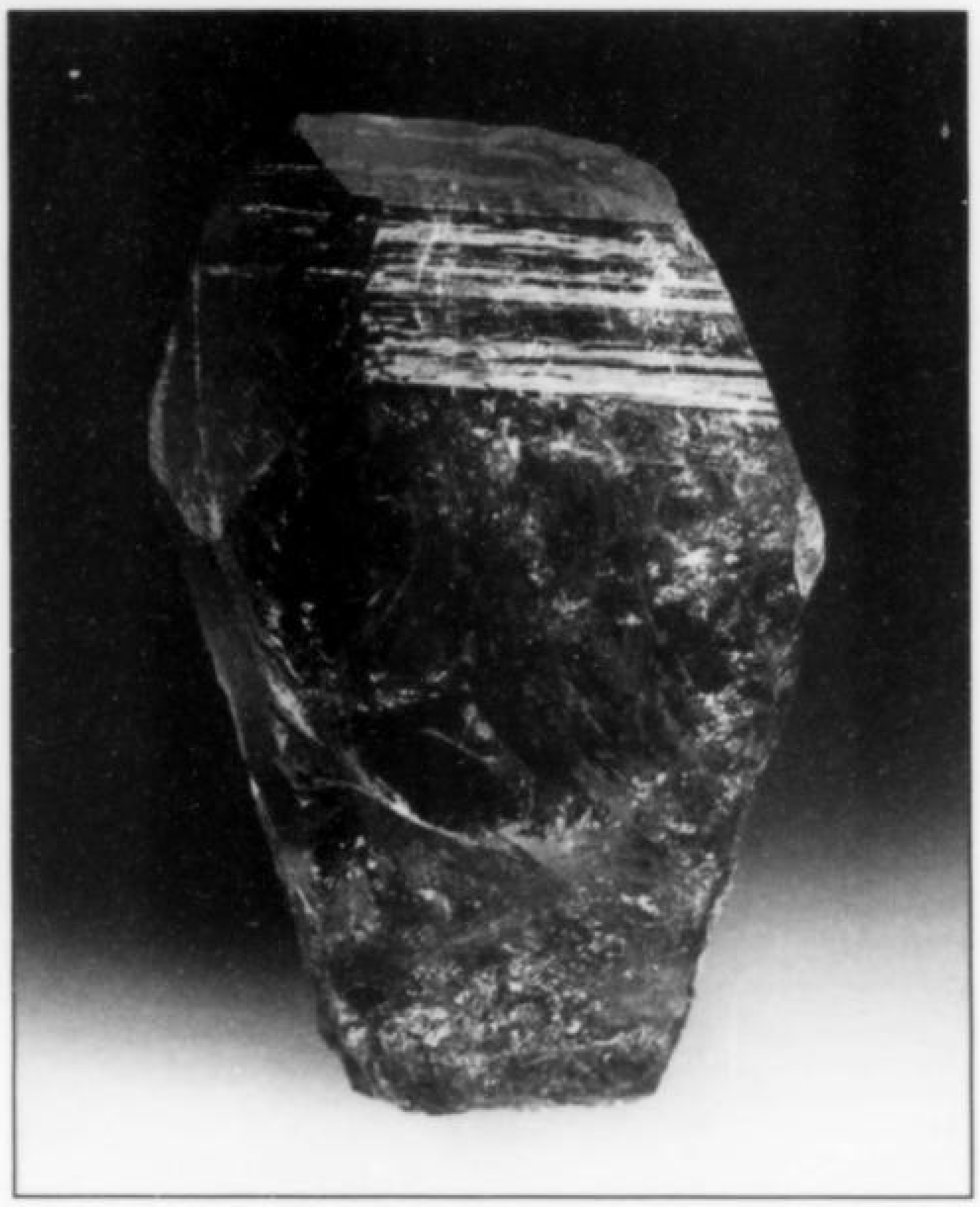


Figure 48. **Axinite-(Mg) crystal, 3.3 cm, from Merelani. Ed Rosenzweig (*Edward's Minerals*) specimen and photo.**

Merelani axinite-(Mg) (Table 2). Of the six localities studied by Novák and Filip (2002), the axinite-(Mg) from Merelani proved to be the closest to end-member composition.

Table 2. **Chemical analysis of Merelani axinite-(Mg) (from Jobbins et al, 1975, and Andreozzi *et al.,* 2000).**

	Jobbins	*Andreozzi*
SiO_2	44.0	44.80
TiO_2	0.03	n.d.
Al_2O_3	17.9	18.90
V_2O_3	0.13	0.23
Cr_2O_3	n.d.	0.08
CaO	21.7	20.60
MgO	6.9	7.18
FeO_2	n.d.	n.d.
MnO	0.4	0.50
ZnO	0.06	n.d.
K_2O	0.01	n.d.
B_2O_3	*	6.50
H_2O	n.d.	1.60
Total	91.13	100.39

*Trace amount confirmed by wet chemical analysis.

Figure 47. **Axinite-(Mg) crystal, 2.2 cm, from Merelani. Werner Radl (*Mawingu Gems*) specimen and photo.**

Chrome Tourmaline (see under Dravite)

Diopside $CaMgSi_2O_6$

The Merelani mines had already been famous for tanzanite for a long time when, in the mid-1990's, they also began to release very beautiful specimens of gemmy green diopside onto the market. A single 4.5-cm diopside crystal, lime-green and entirely gemmy, from Merelani was displayed by Phoenix collector Gene Meieran at the Tucson Show in 1996 (Moore, 1996), and soon specimens were appearing in which small, gemmy diopside crystals perch on tanzanite crystals in sparkling black graphite matrix (Moore, 1997).

The early 2000s saw the appearance of a few exceptional Merelani

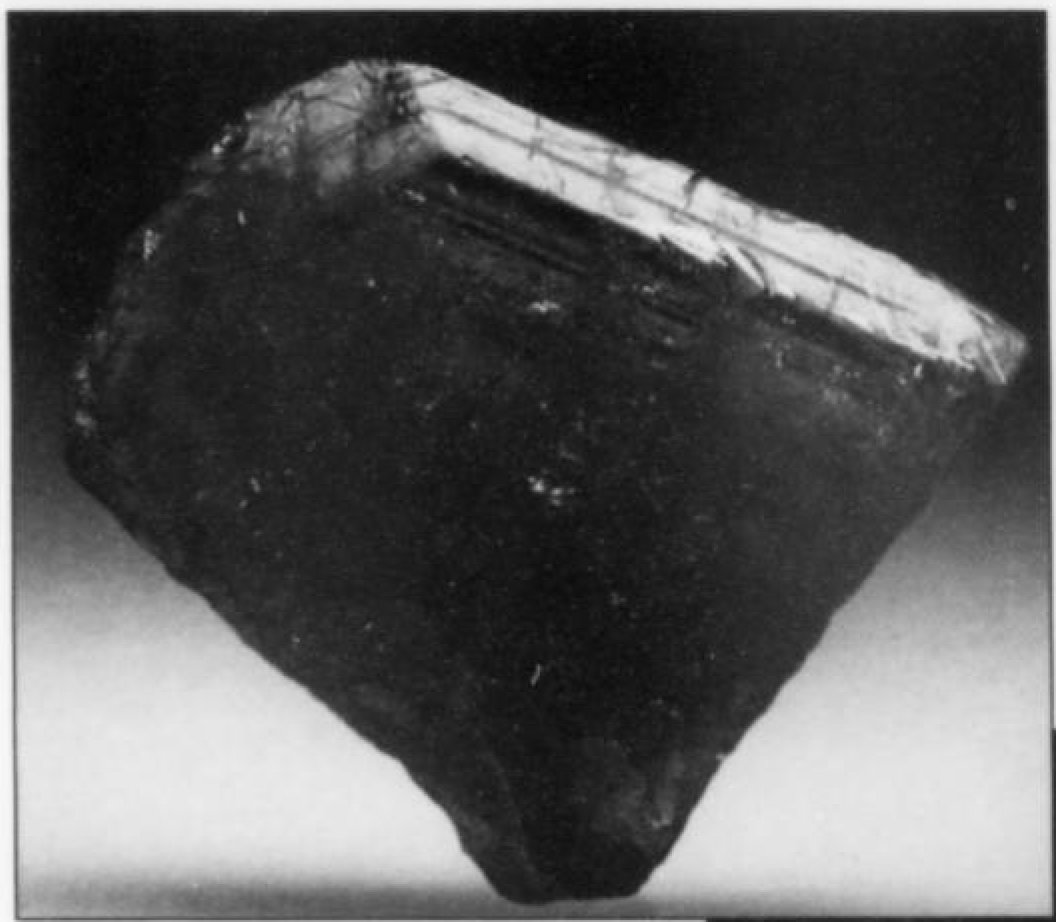


Figure 49. **Axinite-(Mg) crystal, 3 cm, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.**

Figure 50. **Axinite-(Mg) crystal, 4.1 cm, from Merelani. Rob Lavinsky (*The Arkenstone*) specimen; Jeff Scovil photo.**

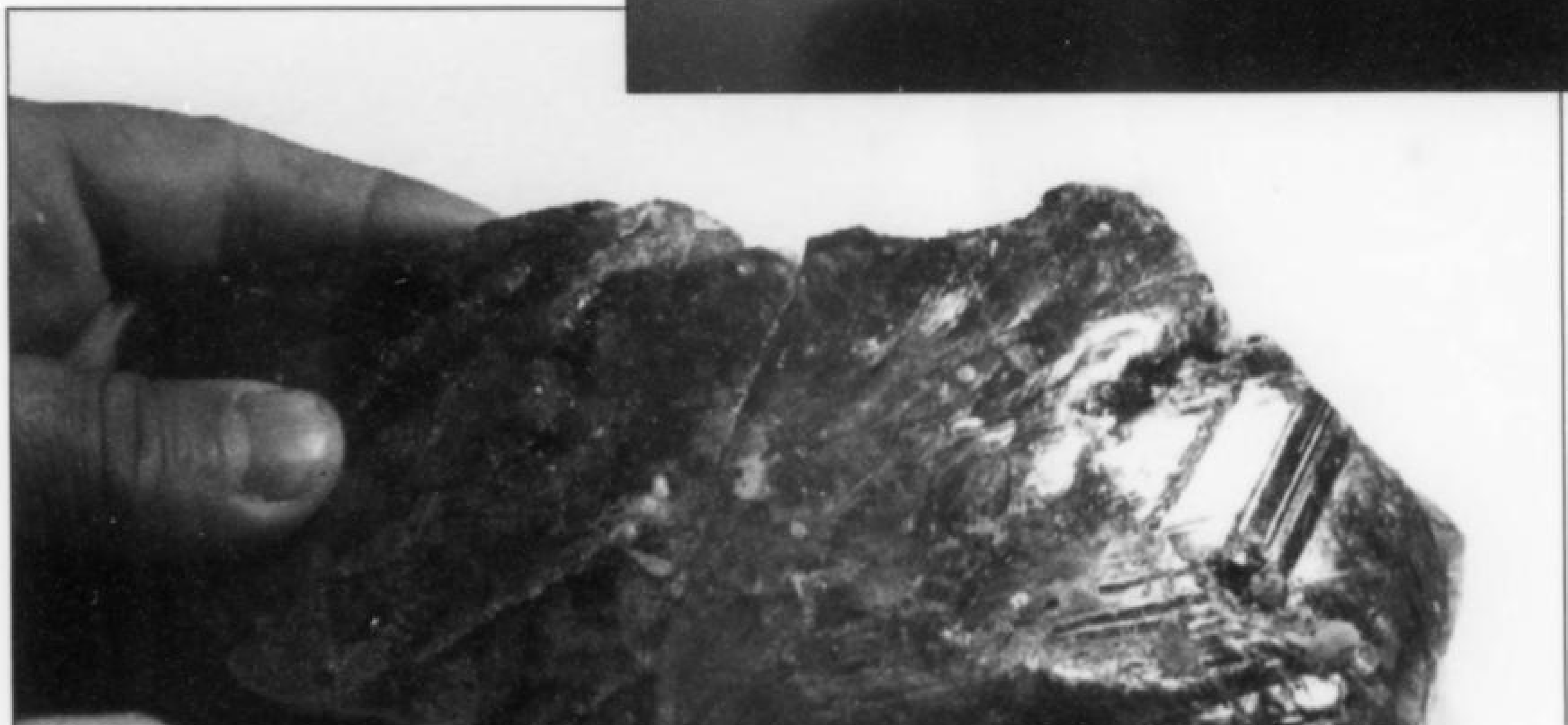


Figure 51. **Axinite-(Mg) crystal, 19 cm, from Merelani. Werner Radl (*Mawingu Gems*) specimen and photo.**

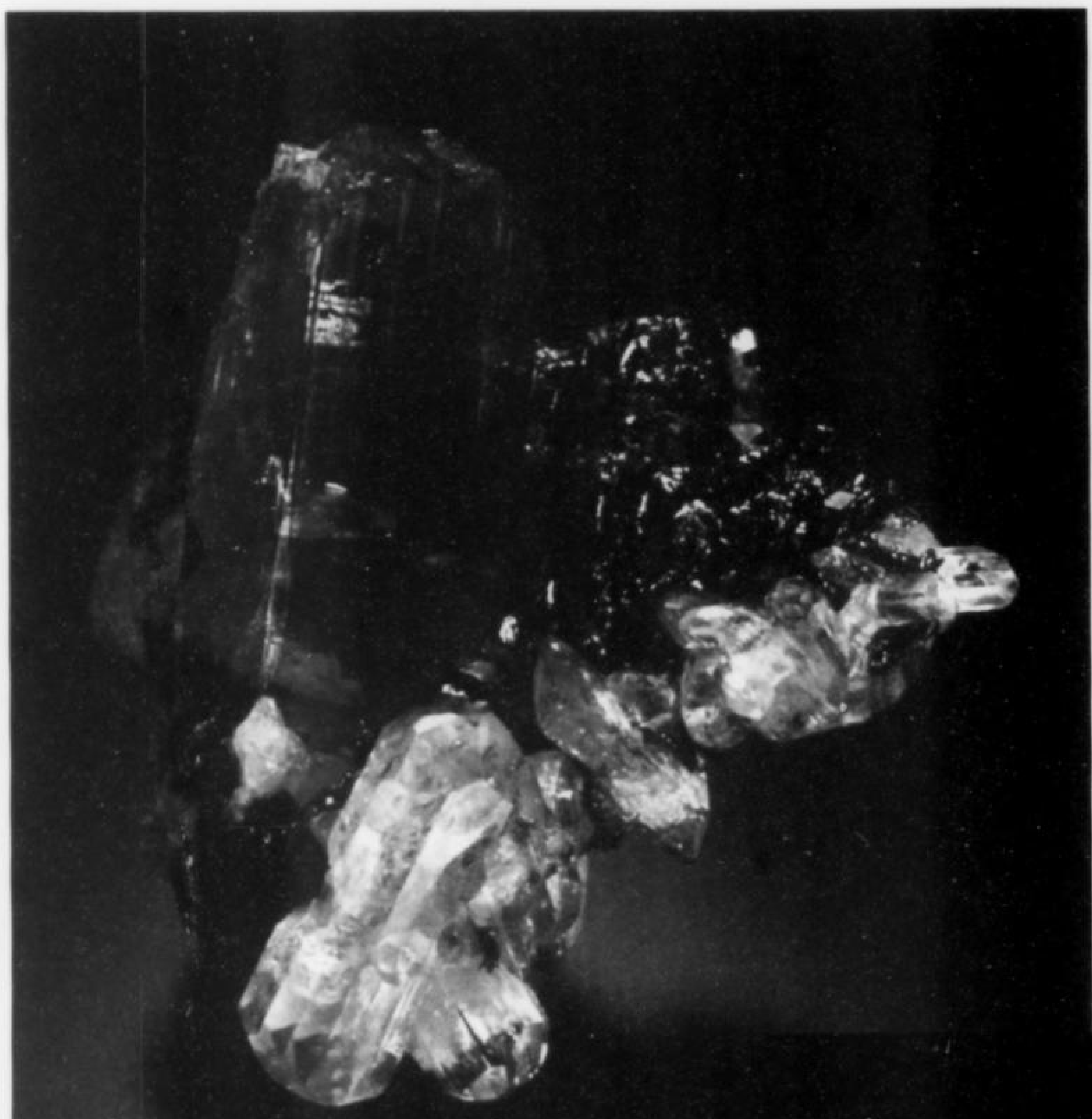


Figure 52. Diopside crystal, 2 cm, with brown zoisite crystal, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.

Figure 53. Diopside crystals with small, blue apatite-(CaF) crystal on tanzanite, 3.2 cm, from Merelani. High Mountain Minerals specimen; Jeff Scovil photo.

Figure 54. Pale diopside crystals on graphite matrix with green grossular, 5.4 cm, from Merelani. Andy Seibel specimen; Jeff Scovil photo.

Figure 55. Diopside crystal, 4 cm, from Merelani. Rob Lavinsky (*The Arkenstone*) specimen and photo.

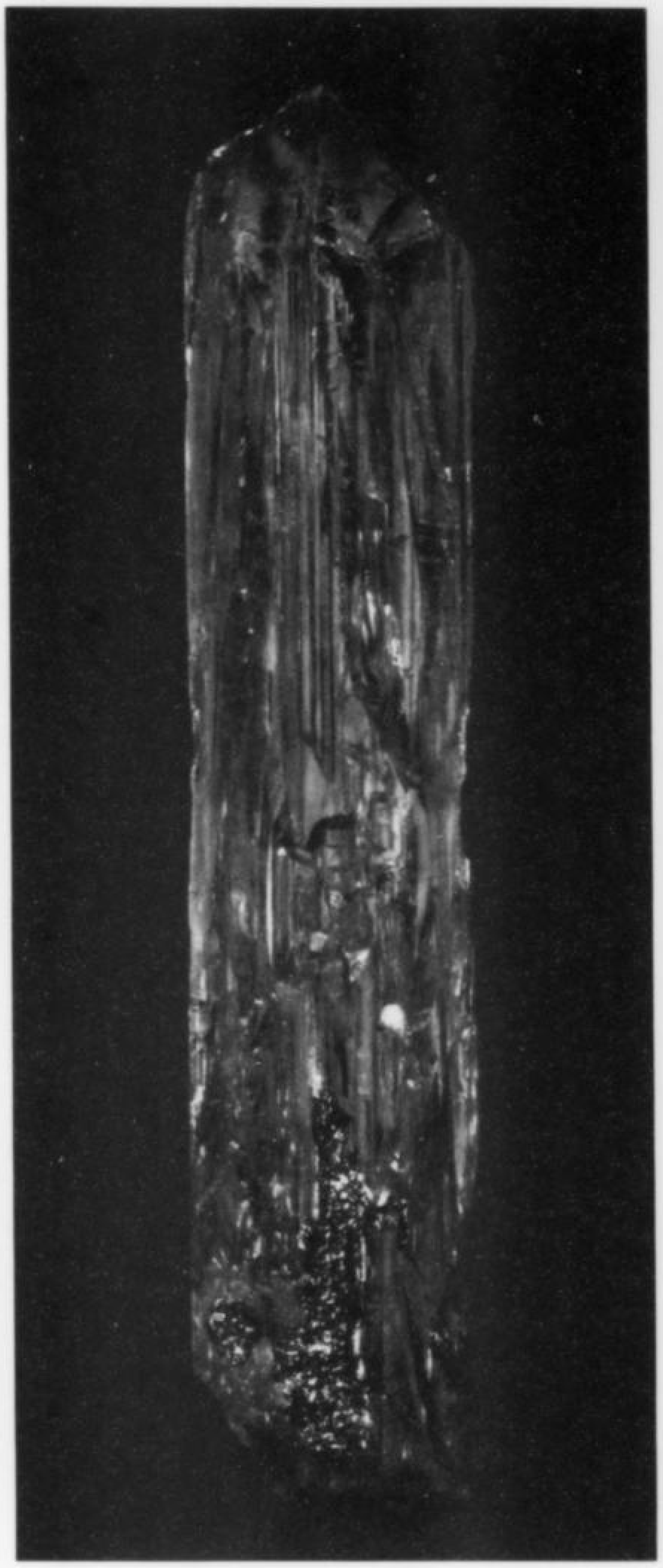
Figure 56. Diopside crystals to 4.5 cm on graphite crystal matrix from the December 2007 pocket in the Karo pit, Block D, Merelani. Scott Rudolph collection; Joe Budd photo.

Figure 57. Diopside crystal, 4.5 cm, from Merelani. Gene Meieran collection; Jeff Scovil photo.

Figure 58. Diopside crystal, 2.5 cm, from the December 2007 pocket in the Karo pit, Block D, Merelani. Daniel Trinchillo (*Fine Minerals International*) specimen; Wendell Wilson photo.

Figure 59. **Diopside crystals (from left: 3, 1.5, 3.3, 1.7 and 1.6 cm) from the December 2007 pocket in the Karo pit, Block D, Merelani. Mike Keim (*Marin Minerals*) specimens and photos.**

Figure 60. **Diopside crystals on chabazite, 5 cm, from the December 2007 pocket in the Karo pit, Block D, Merelani. Sandor Fuss specimen; Jeff Scovil photo.**



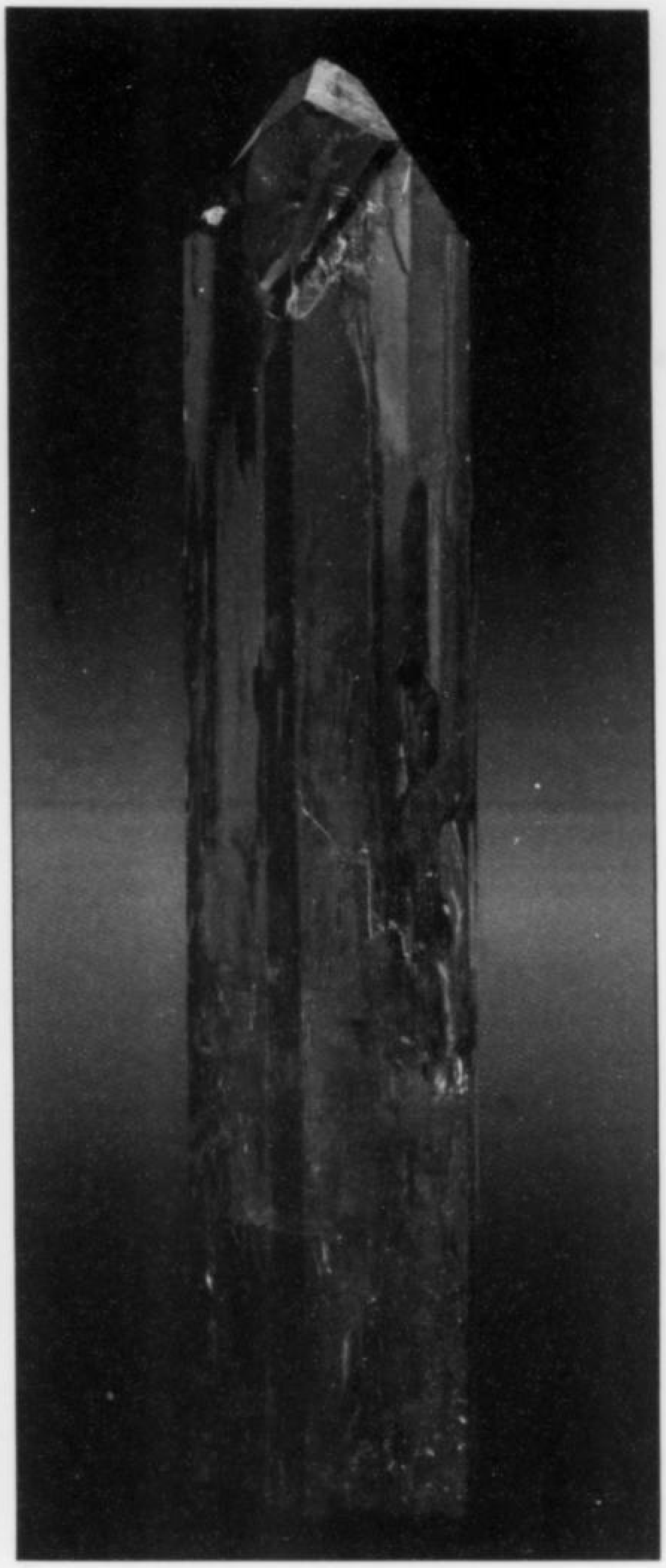


***Figure 61. (right)* Diopside crystal, 6.5 cm, from the December 2007 pocket in the Karo pit, Block D, Merelani. The crystal shows what appear to be corrosion or etch features on the surface. Private collection; Harold and Erica Van Pelt photo.**

***Figure 62. (far right)* Diopside crystal, 6.6 cm, from the December 2007 pocket in the Karo pit, Block D, Merelani. Daniel Trinchillo (*Fine Minerals International*) specimen, now in a private collection; James Elliott photo.**

mines diopside specimens, mostly thumbnail-size, showing sharp, lustrous, pristinely gemmy apple-green crystals, in some cases associated with tanzanite and/or in graphite matrix, mostly as one-of-a-kind (and very expensive) specimens (Moore, 2000). In the late summer and early fall of 2005, about 120 excellent gemmy diopside crystals, from 1 to 5 cm, were found in the Merelani mines, and 20 of them appeared in 2006 at the Tucson Show. All of the loose, singly terminated crystals are lustrous, brightly mint-green, and gemmy through at least 50% of their volumes (Moore, 2006).

In 2007, new finds from the Karo pit in the underground Block D workings at a depth of 230 to 260 meters, yielded sharp, lustrous, gemmy, lime-green diopside crystals to 6 cm. They are prismatic, with complex terminations, and show associated graphite crystals and tiny, lustrous, white calcite crystals. In December a pocket yielded about 50 top specimens showing gemmy, deep grass-green, highly lustrous, prismatic diopside crystals from 1 to 6 cm long. These are certainly among the most richly colored examples of the species ever found; the intense, grass-green color (as with Merelani tremolite, which it resembles) probably correlates with trace amounts of Cr^{3+} and V^{3+} in the octahedral site (Fritz *et al.*, 2007). The crystals fluoresce a very weak orange under longwave ultraviolet light, and a weak greenish yellow under shortwave ultraviolet light.

Most of the crystals are loose and singly terminated, but in some miniature specimens the gemmy green crystals rise from jumbles of thin-platy, metallic gray graphite crystals which are some of the best for that species known from any locality. These superb specimens of diopside and graphite, together with a few gemmy blue, thumbnail-size apatite crystals from the same pocket, were marketed at the 2008 Denver show by Daniel Trinchillo of *Fine Minerals International* (Moore, 2009).

Dravite $(NaCa)Mg_3Al_6(BO_3)_3[Si_6O_{18}](OH)_4$

Dolenc (1976) visited Merelani and reported green tourmaline, "very beautiful and transparent but rare," associated with the boudin structure of the deposit. Likewise Cilek (1980), who carried out field work at Merelani in 1974–1977 and published the first detailed geologic map of the Merelani area, reported:

> Pegmatites with quartz, microcline and mica are found in several areas of strong migmatization. Mica sheets and the presence of fuchsite are characteristic of some of these zones, in addition to large, oriented crystals of microcline. . . . Besides tanzanite, two other gemstones were collected from the deposit: green tourmaline and green garnet, the latter being produced until the present time. Green tourmaline of good quality but in small crystals occurs at the southwestern end of the main deposit, in pegmatite and quartz dikes.

Figure 63. **Green "chrome" tourmaline (dravite) crystal, 4.5 cm, from Merelani. Gene Meieran collection; Megan Foreman photo.**

Figure 64. **Green "chrome" tourmaline (dravite) crystal, 2.3 cm, from Merelani. Rob Lavinsky (*The Arkenstone*) specimen and photo.**

Cilek pinpointed the green tourmaline occurrence on his geologic map, in the extreme southwestern end of the central part of the deposit.

Merelani green tourmaline is generally referred to on the mineral and gem market as "chrome tourmaline,"[11] actually a variety of dravite; the identity of a Merelani specimen has been confirmed by Downs (2006). The deep emerald-green color is caused by trace amounts of vanadium and perhaps chromium (Wise, 2003); the similar green color in Merelani tremolite, diopside and grossular is due primarily to vanadium. Downs (2006) reports almost as much calcium as sodium in Merelani dravite, hence the corresponding modification in the above formula; Cr and V were not detected.

Merelani crystals tend to be rather stubby and are quite rare, probably having been found during a relatively short time period in the 1970s. The largest specimen we have seen is a 4.5-cm crystal in the Gene Meieran collection. "Chrome tourmaline" also comes from numerous other Tanzanian localities.

Figure 65. **Green "chrome" tourmaline (dravite) crystal, 3 cm, from Merelani. Oleg Lopatkine collection and photo.**

Graphite C

When matrix tanzanite specimens first reached the international market everyone was surprised to see that the most common matrix material was massive, silvery gray graphite. In fact, the deposit proved to be so rich in graphite that it constituted an ore mineral. Graphite also commonly occurs as microcrystal inclusions in tanzanite and tsavorite. The remarkable diopside pocket opened in December 2007 yielded what are easily some of the best graphite crystals ever found anywhere. The sharp, satiny black, very thin hexagonal plates of graphite measure around 5 mm individually, and stand on edge to compose attractive clusters to 7 cm across (Moore, 2009). Electron microscopy reveals that the graphite plates have dendritic crystalline overgrowths of graphite on the surface, looking like snowflake patterns standing out in relief (John Jaszczak, personal communication).

Inclusions of microscopic black, hexagonal crystals in tanzanite were noted by Liddicoat (1967) and Eppler (1969), and were identified as graphite plates by Dunn (1975), who noted a possible epitactic orientation of some plates parallel to the zoisite {010} face.

---

[11] Several deep green species from Merelani and elsewhere in Tanzania have informally been referred to as "chrome" varieties—an unfortunate usage because in most cases their color derives primarily from vanadium rather than chromium.

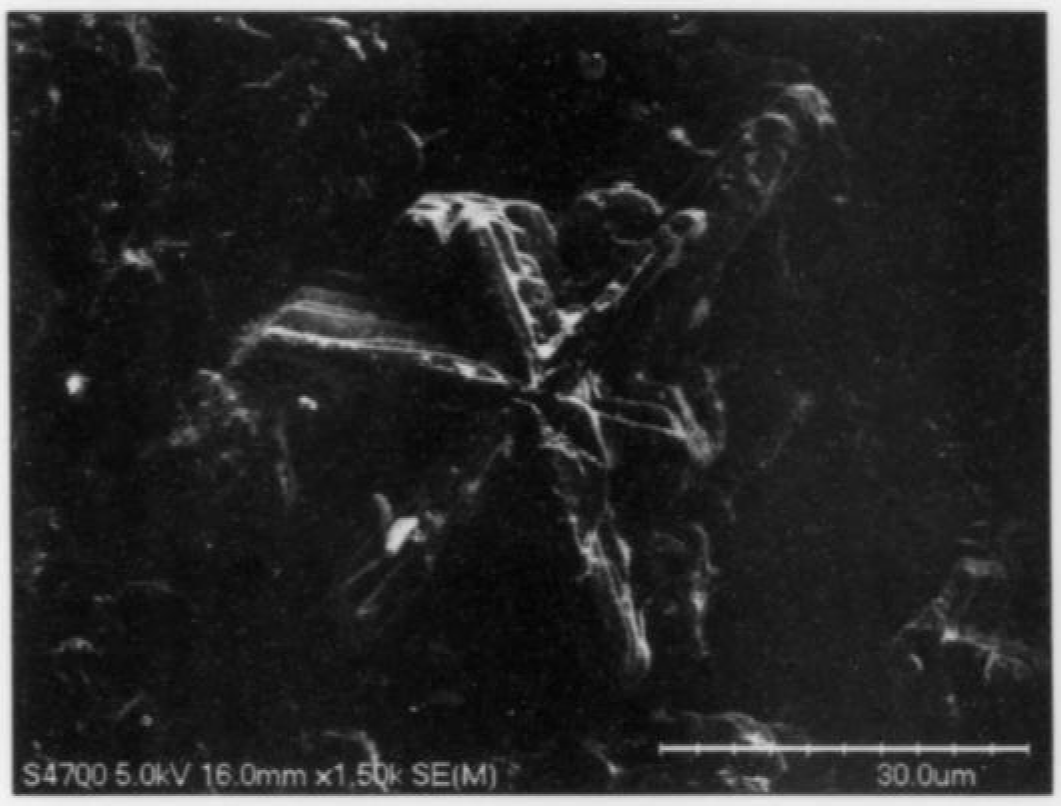


Figure 66. **Graphite crystal growth on the surface of a thin tabular graphite crystal. Seaman Mineral Museum specimen; John Jaszczak SEM image.**

Figure 67. (above) **Grossular crystal, 1.5 cm, from Merelani. François Lietard specimen; Jeff Scovil photo.**

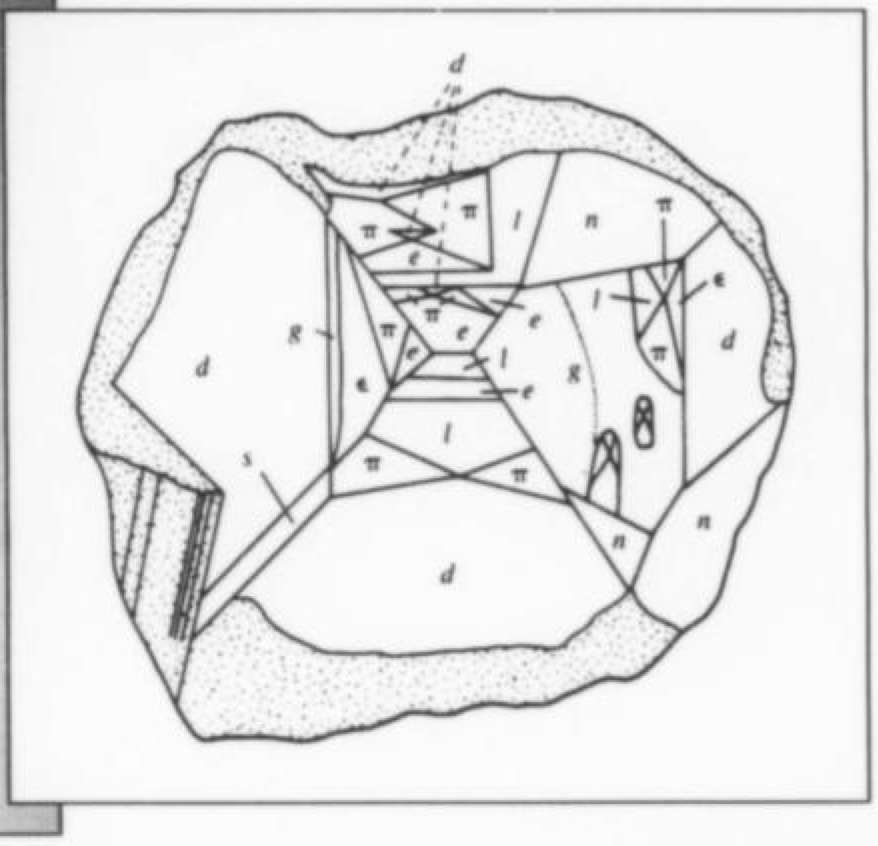


Figure 68. **Grossular ("tsavorite") crystal weighing 14 grams, from Merelani. Harold and Erica Van Pelt photo. *Inset:* Crystal drawing based on the same crystal (Kane *et al.*, 1990).**

Grossular $Ca_3Al_2(SiO_4)_3$

Since the 1960s, green grossular crystals and small, fractured masses have occasionally been found at Merelani—not surprising, as the locality is on the same geological trend and not far from the Komolo area (south of the Lelatema Hills) where East African tsavorite-type garnets were first mined. John Saul sold some pale green dodecahedral crystals to Martin Ehrmann around 1970, as well as a clean cut 18-carat grossular of a pale green shade. Beautiful, gemmy green grossular crystals from Merelani, found in early 1987 at the Karo pit, are sharp, lustrous, pale to deep green, transparent modified dodecahedrons exceeding 1 cm in some cases. Most marketed specimens are single crystals or loose groups free of matrix or associated species, although a few may have adhering flecks or patches of graphite.

Table 3. **Chemical analysis (in weight percent) of grossular from Merelani (column 1, tsavorite from the Karo pit, from Kane *et al.*, 1990; column 2, green grossular from Merelani, from Malisa *et al.*, 1986).**

SiO_2	40.33	40.43
TiO_2	0.28	0.32
Al_2O_3	22.49	21.85
V_2O_3	0.19	0.10
Fe_2O_3	0.26	0.15
Cr_2O_3	0.05	0.00
MgO	0.02	0.25
CaO	37.16	36.18
MnO	0.27	0.25
Na_2O	n.d.	0.56
K_2O	n.d.	0.04
P_2O_5	n.d.	0.05
H_2O	n.d.	0.16
Total	101.05	100.34

***Figure 69.* The world's largest tsavorite crystal was found in 2006 in the Karo pit at the border of Block D (the Block D extension), at a depth of 160 meters. The impressive size (185 grams) and saturated color, combined with remarkable clarity and transparency, made the uncut crystal unique. It was preformed and faceted at the Multicolour Gems office in Chantaburi, Thailand, resulting in a gemstone measuring 4.2 × 3.6 cm and weighing 325 carats—certainly the largest clean tsavorite gem in the world. Photo courtesy of Gemshare.**

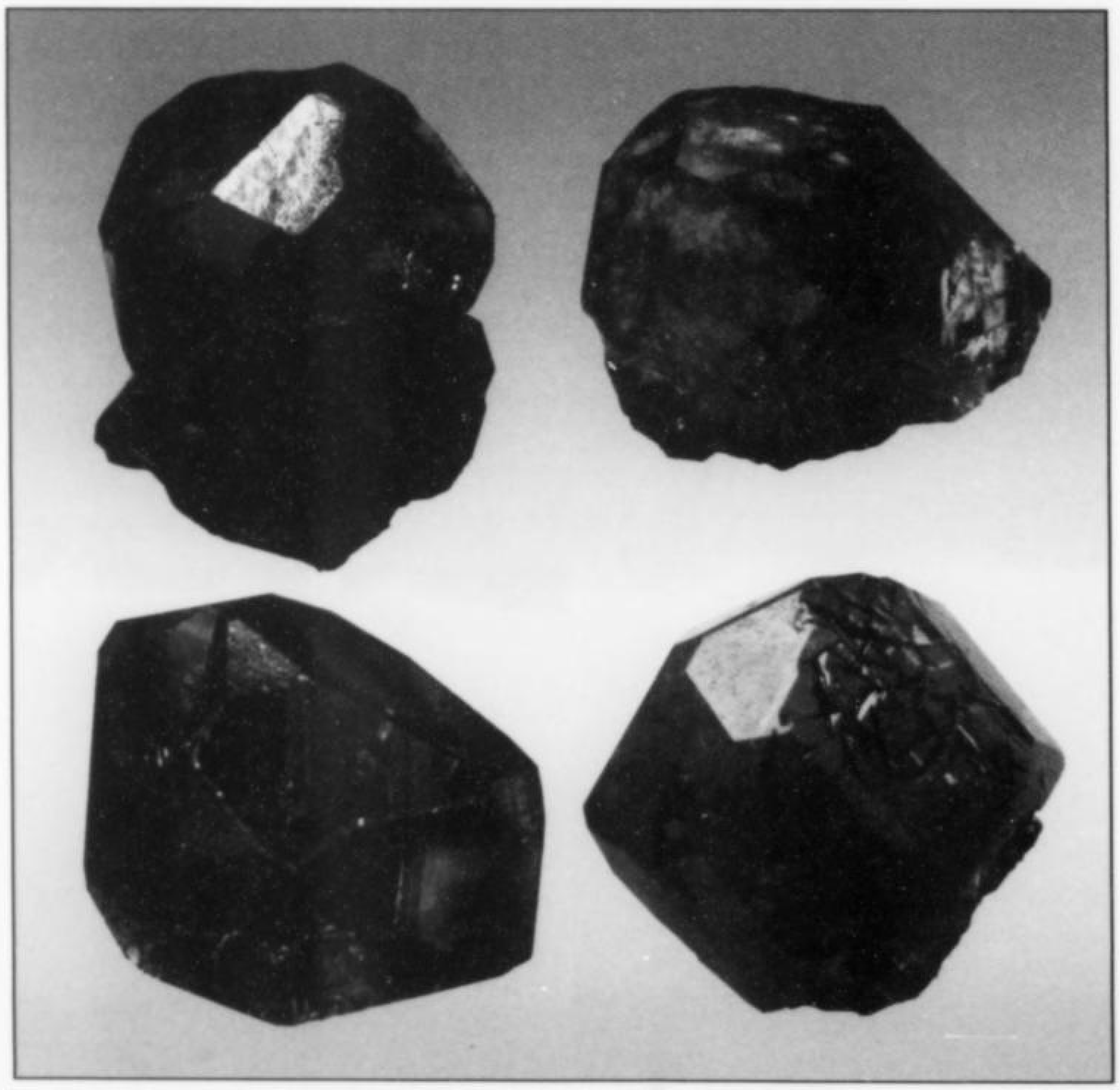


***Figure 70.* Grossular ("tsavorite") crystals from Merelani: upper and lower left: 9 mm each, Rob Lavinsky (*The Arkenstone*) specimen and photo; upper and lower right: 1 cm and 2.2 cm, Steve Ulatowski (*New Era Gems*) specimen and photo.**

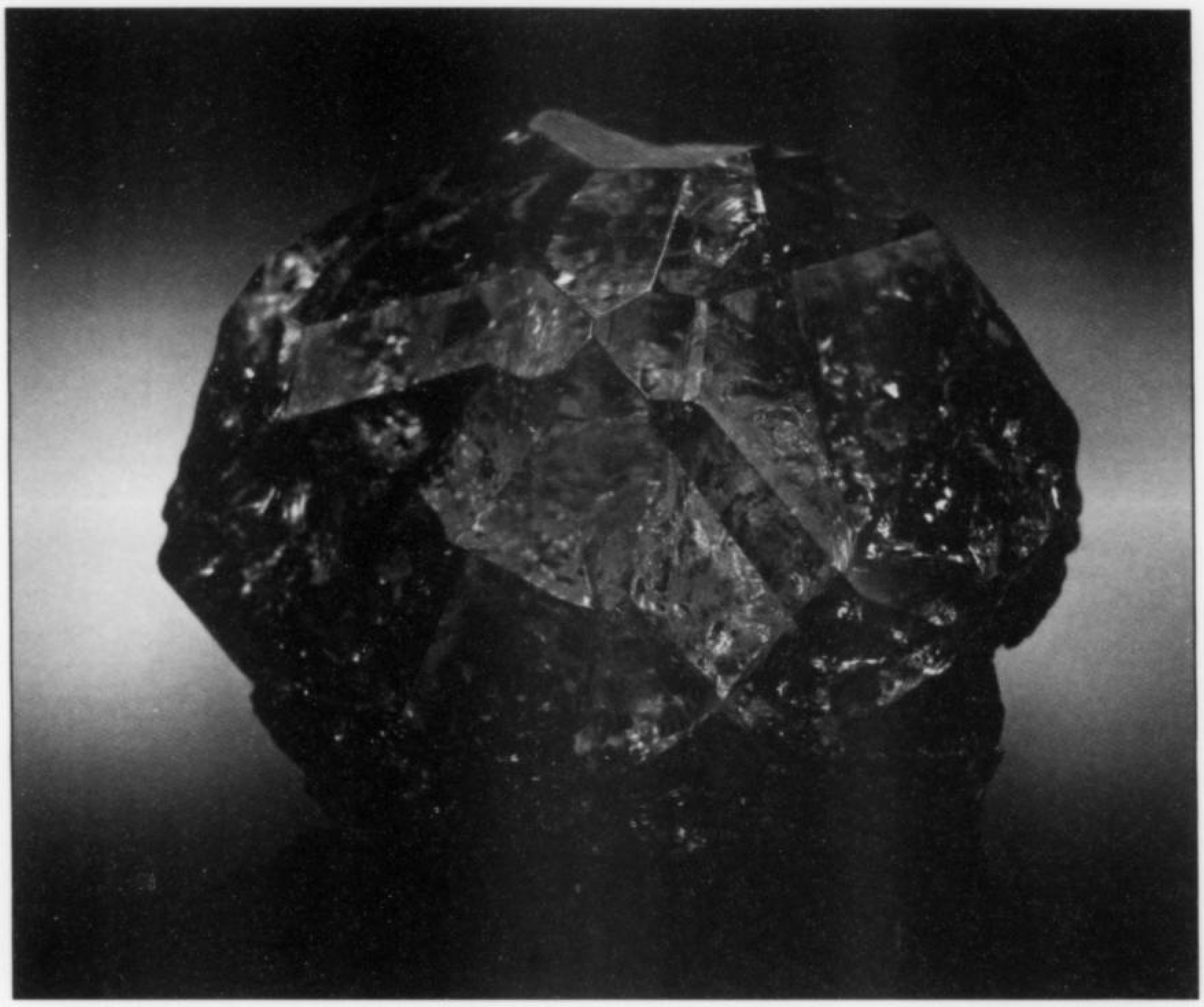


***Figure 71.* Grossular crystal, 3.9 cm, from the Karo pit, Block D, Merelani. Stuart Wilensky specimen, now in a private collection; James Elliott photo.**

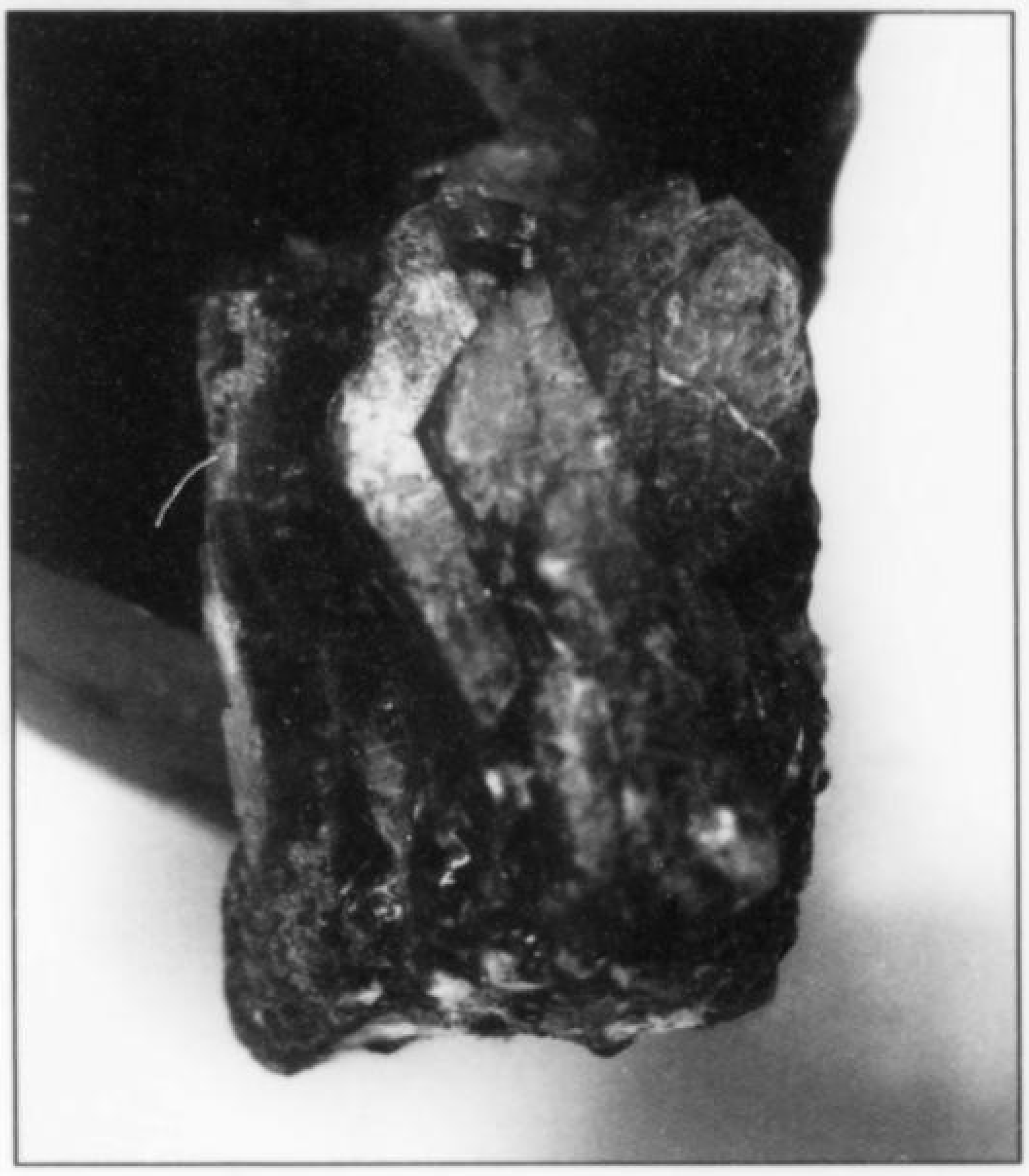


***Figure 72.* Heulandite crystals, 1.5 cm, on tanzanite with diopside and acicular tremolite, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.**

As elsewhere in Kenya and Tanzania, the Merelani grossular is very near end-member composition, with small but significant quantities of V_2O_3 and Cr_2O_3 as chromophores. The intensity of the color varies with the amounts of these elements. The Merelani crystals show lustrous faces and good dodecahedral form, in some cases with many small and complex modifications. Eight crystal forms were identified by Kane *et al.* (1990): *d* {011}, *e* {012}, *g* {023}, *l* {035}, ϵ {045}, *n* {112}, *s* {123} and π {1.10.16}.

Grossular specimens tend to appear in the same lots as the beautiful gem crystals of tanzanite, axinite-(Mg) and diopside (but not tourmaline) from the Merelani mines (Moore, 2000). When the green grossular crystals are sufficiently deeply colored they are marketed as "tsavorite," a varietal name bestowed by Tiffany's Henry Platt, who also named "tanzanite." An attractive pastel mint-green color is being marketed as "Merelani mint garnet." Merelani tsavorite strongly fluoresces orange in longwave and shortwave ultraviolet light. Tsavorite crystals with tanzanite cores have been found.

Heulandite-Ca $(Ca_{0.5},Na,K)_9[Al_9Si_{27}O_{72}]\cdot\sim24H_2O$

Brown crystals of heulandite-Ca to 1.5 cm have been identified by X-ray diffraction (courtesy of John Attard; Mike Keim, personal communication) in association with dark blue tanzanite, diopside and apatite-(CaF). A number of other zeolites have also been reported from Merelani, including laumontite and mesolite in tufts of acicular white crystals, and stilbite, scolecite and chabazite-(Ca). The chabazite-(Ca), mesolite and laumontite were identified by EDS and Raman spectroscopy in specimens from the Karo pit pocket of December 2007 (John Jaszczak, personal communication).

Prehnite $Ca_2Al_2Si_3O_{10}(OH)_2$

Around 2000 John Saul saw quite a few prehnite specimens from Merelani, but they were all badly battered. A number of attractive, pale yellow-green spheroidal clusters of prehnite crystals (looking very much like Ojuela mine adamite, except for the association with tanzanite) to 3 cm in diameter came out in September 2006, primarily through Steve Ulatowski at New Era Gems; he sold them wholesale to Rob Lavinsky, who offered them through his website. Some specimens are thumbnail and small miniature-size, loose spheres or clusters of two or three spheres; others show the prehnite resting on the characteristic diopside/graphite/quartz matrix of the Merelani mines. Two sizable lots of the new prehnite were offered at the 2007 Tucson Show (Moore, 2007), and more were sold on the web in the same year, the latter specimens said to have come from the *Mawaya pit* at Merelani.

From a separate find in the TanzaniteOne mine in Block C have come specimens of pale blue prehnite associated with tanzanite.

Figure 73. **White acicular mesolite and laumontite tufts to 7 mm on graphite plates with chromium-rich diopside, from the December 2007 pocket in the Karo pit, Block D, at Merelani. Seaman Mineral Museum specimen; John A. Jaszczak photo.**

Figure 74. **Prehnite cluster, 3.5 cm, from Merelani. Rob Lavinsky (*The Arkenstone*) specimen and photo.**

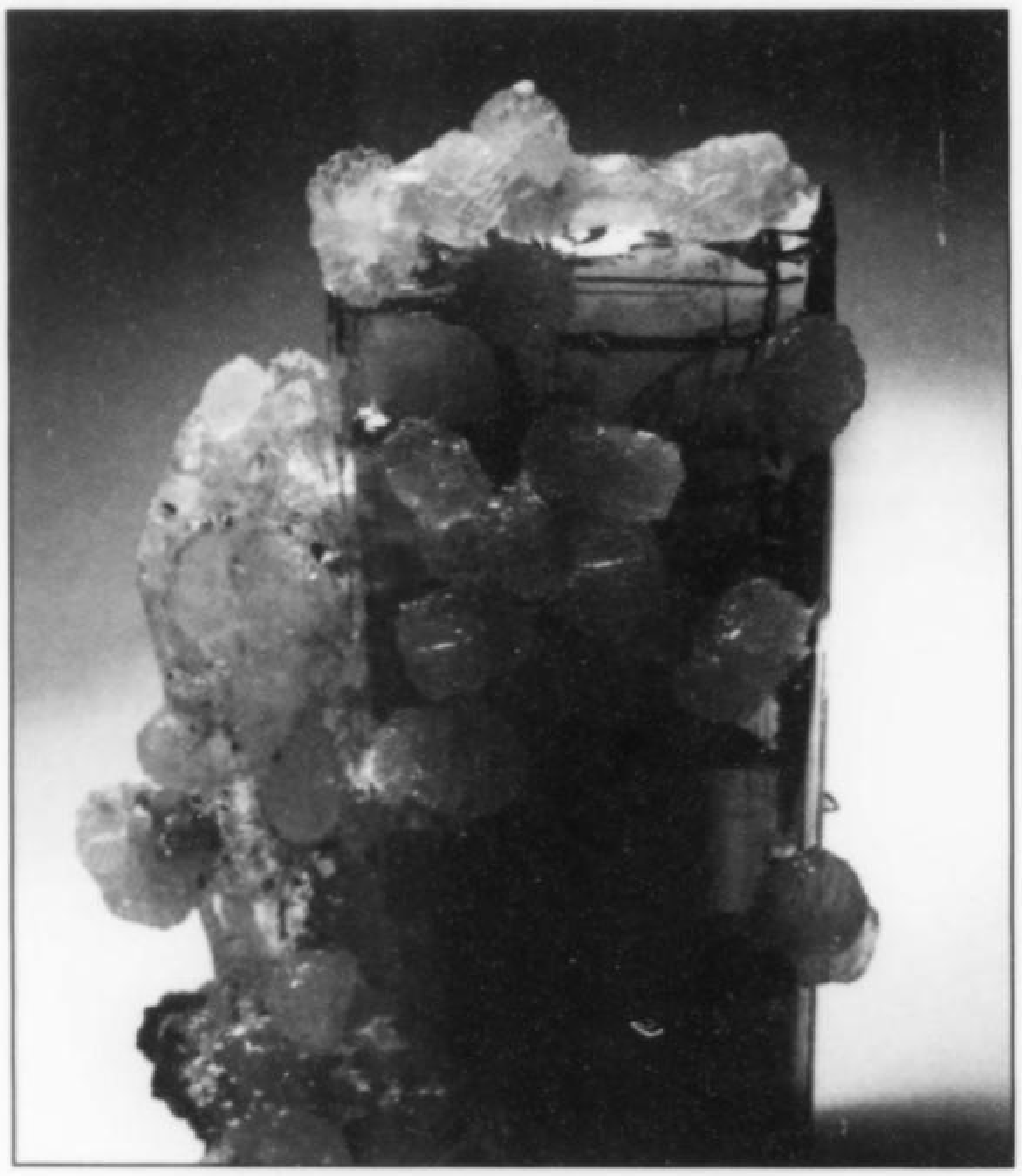


Figure 75. **Prehnite clusters on tanzanite and a quartz crystal, 7.2 cm, collected from the Karo pit, Block D, in early 2009. Private collection.**

Figure 76. **Tanzanite crystal with pale blue prehnite, 2.2 cm, from the TanzaniteOne mine in Block C, Merelani. Rob Lavinsky (*The Arkenstone*) specimen and photo.**

Pyrite FeS_2

Pyrite is not uncommon as embedded grains and masses in the metamorphic rocks of the Merelani area. A single well-formed cubic-pyritohedral crystal of pyrite measuring 5.2 cm was recently recovered from Merelani and was offered for sale by New Era Gems. Larger masses showing an occasional crystal face have occasionally been encountered. Many smaller cubic crystals have been found attached to tanzanite crystals. Tiny, lustrous, dominantly octahedral pyrite crystals occur on the graphite crystals from the December 2007 pocket discovered in the Karo pit.

Tremolite $Ca_2Mg_5Si_8O_{22}(OH)_2$

Vanadium-rich (and probably chromium-rich) tremolite in single crystals to 2.8 cm, and jumbled groups of splintery tremolite crystals of a pearl-white to apple-green color were available from Steve Ulatowski of *New Era Gems* at the 2006 Tucson Show, and several dealers (including Mike Keim of *Marin Mineral Company*) offered crystals up to 3 cm in 2009. Finely acicular crystals on tanzanite and heulandite have also been identified (by X-ray diffraction; courtesy of Mike Keim).

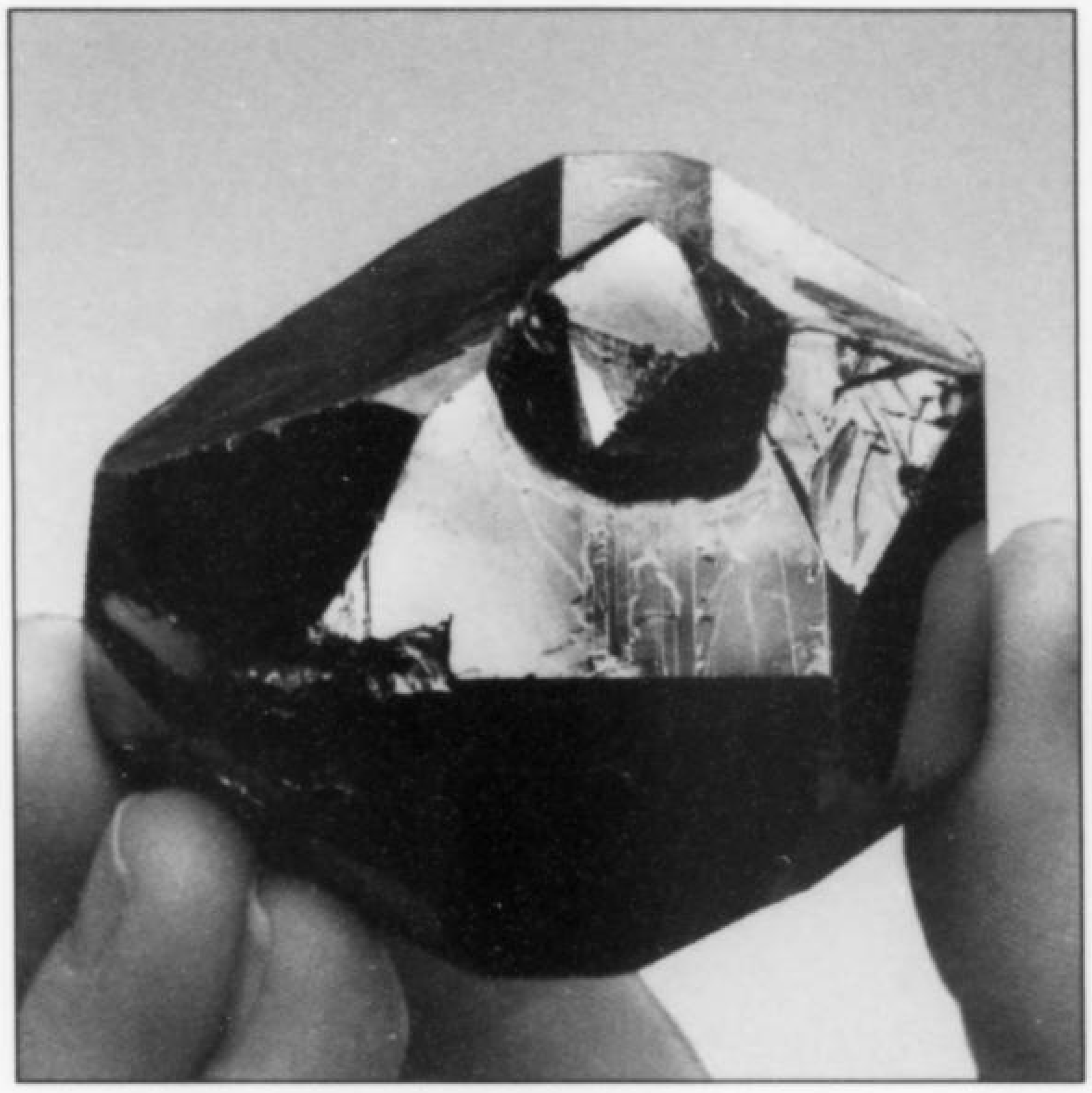


Figure 77. One of the largest pyrite crystals ever recovered from Merelani; 5.2 cm. Steve Ulatowski (*New Era Gems*) specimen and photo.

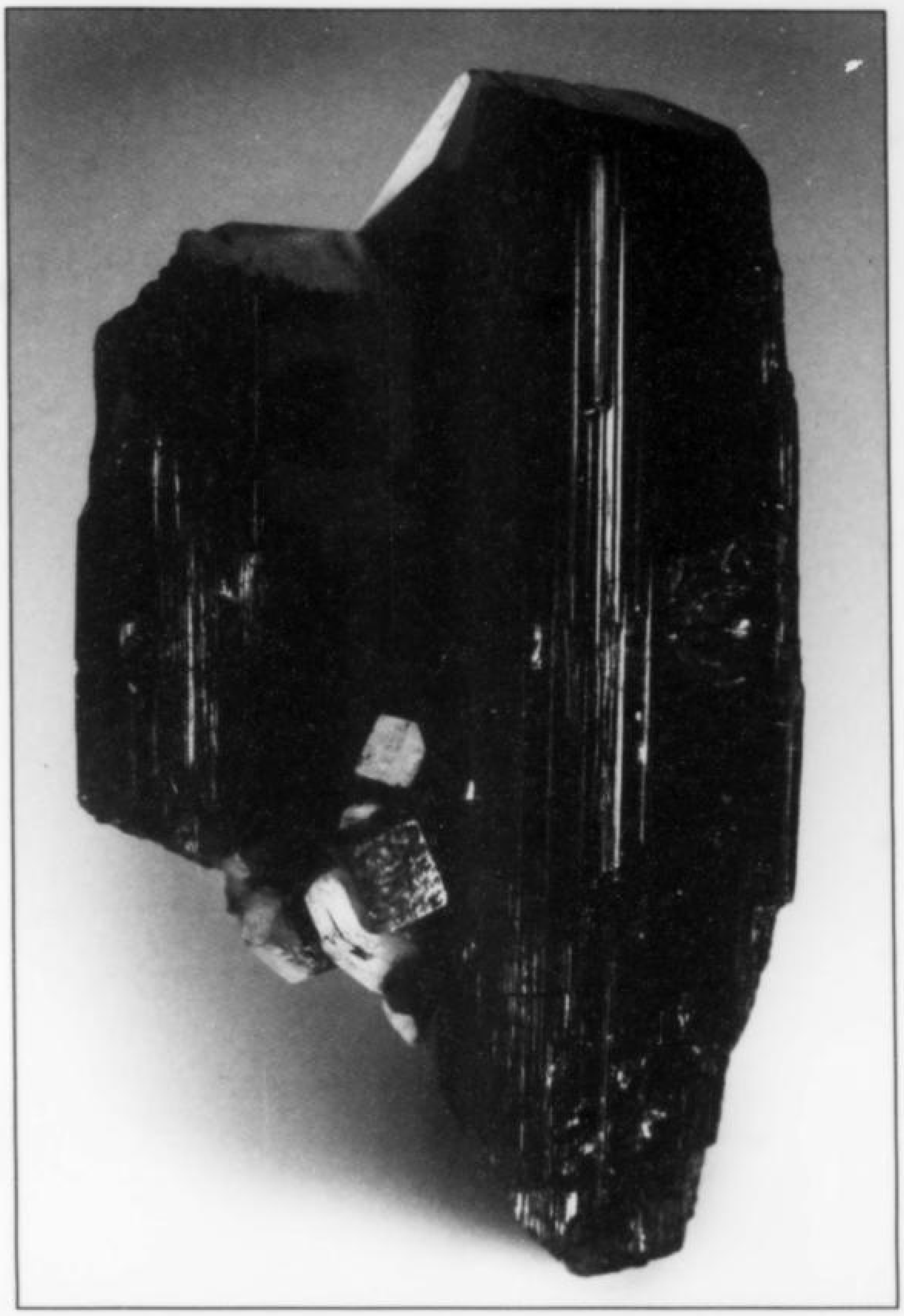


Figure 78. Tanzanite crystal group, 3.1 cm, with cubic pyrite crystals, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.

Figure 79. Tremolite crystals (2.8, 2.6 and 3 cm) from the Karo pit, Block D, at Merelani. Mike Keim (*Marin Minerals*) specimens and photos.

The tremolite crystals, all thought to be from Block D (including some from the December 2007 pocket in the Karo pit), can be distinguished from similarly green-colored diopside prisms by their flattened or bladed shape and their diamond-shaped cross-section, which is typical of amphibole minerals. The pale green Merelani tremolite crystals contain 0.32 weight percent V_2O_3 and probably trace amounts of Cr_2O_3, which are thought to be the coloring agents. The deeper grass-green crystals probably contain more Cr_2O_3. The tremolite shows a weak orange fluorescence under longwave ultraviolet light, and a moderate greenish yellow fluorescence under shortwave ultraviolet light; the fluorescence of diopside is very weak in comparison (Fritz *et al.*, 2007).

Table 4. **Chemical analysis (in weight percent) of green tremolite from Merelani (Fritz *et al.*, 2007).**

SiO_2	52.34
Al_2O_3	6.70
V_2O_3	0.32
Cr_2O_3	n.d.
Fe_2O_3	n.d.
MgO	21.81
CaO	13.05
MnO	n.d.
ZnO	n.d.
Na_2O	0.73
K_2O	0.67
F	0.47
Total	96.09

Zoisite $Ca_2Al_3Si_3O_{12}(OH)$

Bank *et al.* (1967) and Anderson (1968) were the first to publish analyses of Merelani blue zoisite (tanzanite). Hurlbut (1969) provided one of the first detailed mineralogical descriptions, based primarily on crystals obtained from John Saul. Merelani zoisite proved to be extraordinarily rich in forms. From the crystals he studied Hurlbut was able to identify 40 different crystal forms: *a* {100}, *b* {010}, *l* {140}, *t* {130}, *r* {120}, {230} and *m* {110}, {870}, {430}, {320}, {530}, *q* {210}, *k* {310}, *h* {410}, {510}, {011}, *u* {021}, *x* {041}, {051}, {0.11.2}, *c* {061}, {081}, {0.10.1}, *w* {0.12.1}, {0.14.1}, {0.16.1}, {0.18.1}, {0.24.1}, *d* {101}, *o* {111}, {221}, *v* {121}, *p* {131}, *x* {141}, {151}, {144}, {313}, {323}, {211}, and {1.11.2} (lettered forms are identified on Hurlbut's crystal drawings, shown here). Strunz (1969), using a different setting, identified 23 forms: {001}, {100}, {101}, {102}, {103}, {201}, {301}, {401}, {111}, {211},{311}, {411}, {511}, {610}, {210}, {410}, {510}, {610}, {212}, {10.1.0}, {12.1.0}, {14.1.0}, and {321}. Many crystals are striated parallel to [001], [$\bar{1}$01] and [100]. There are two cleavage directions, parallel to {010} and {100}, but they are rarely seen; the common fracture surface is conchoidal.

The habits of zoisite crystals vary rather widely. Certain distinctive combinations of habit, color and zoning are probably characteristic of particular veins or pocket zones, but unfortunately there have never been any records of habits and pockets kept by the miners. Most crystals are elongated parallel to [001], though some show a cuboidal habit with equal development of {100} and {010}; others are flattened parallel to {100} or {010}, to the point of being bladed, or are wedge-shaped, with steep {0*kl*} faces dominated by *w* {0.12.1}.

In the early days many crystals were found with multiple small indentations on the large, flat faces that in size and form caused John Saul to refer to them as "rice grain indentations." These indentations were also noted by Crowningshield (1967). They are probably the attachment points of crystals of some other species that has since disappeared. A specimen in the Saul collection (shown here) shows the indentations, all oriented parallel to each other, suggesting an epitactic relationship. Indentations pictured by Crowningshield (1967) are randomly oriented.

Some crystals found in the early days of mining appear to have exfoliated their surface zones to become lustrous, rounded, egg-shaped gemmy nodules similar to tourmaline nodules. Other crystals appeared to be stream-rounded, with dull, abraded surfaces.

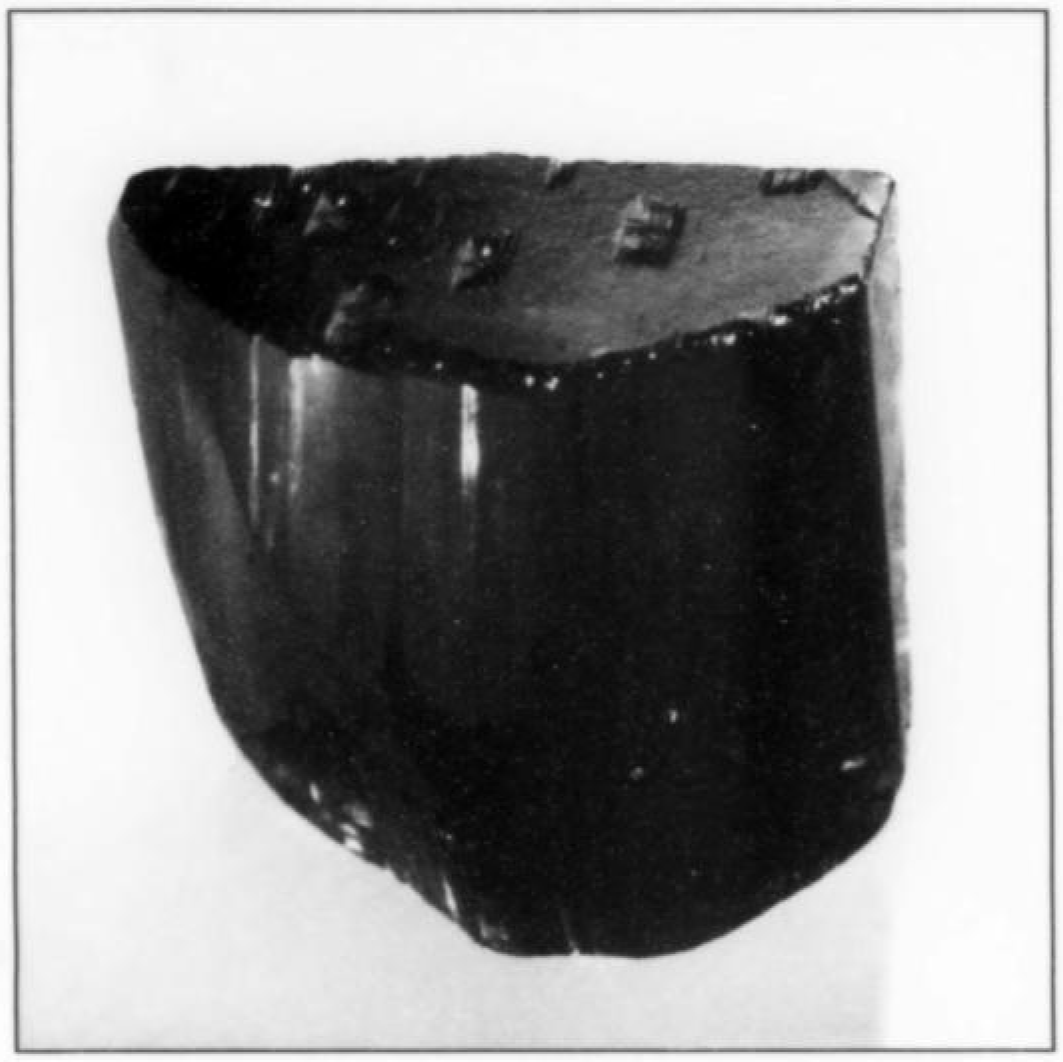


Figure 80. **Tanzanite crystal, 1.3 cm, showing oriented "rice-grain" indentations on a termination face, probably the scars left by crystals of another species that have since been dissolved. John Saul collection; Wendell Wilson photo.**

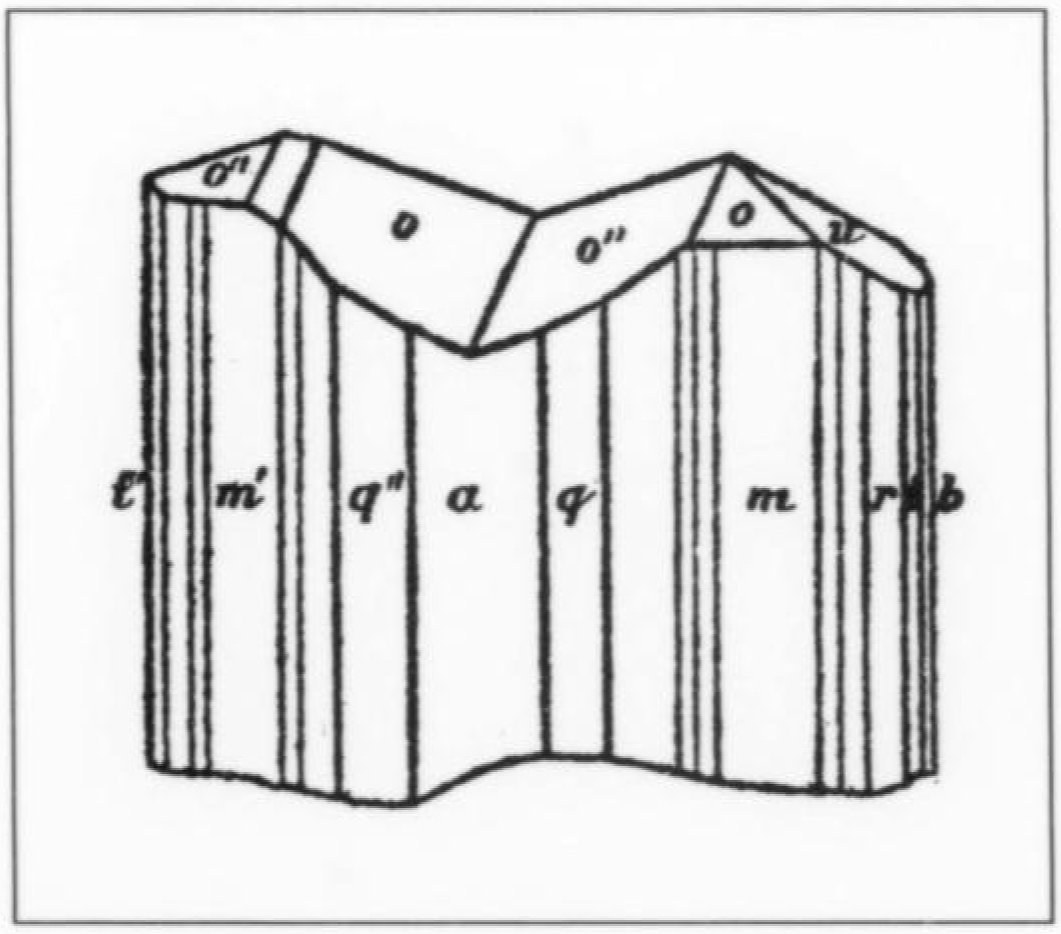


Figure 81. **Crystal drawing illustrating the "tandem termination" habit that is common in zoisite; from Tschermak and Sipöcz (1880), based on a crystal from Ducktown, Tennessee.**

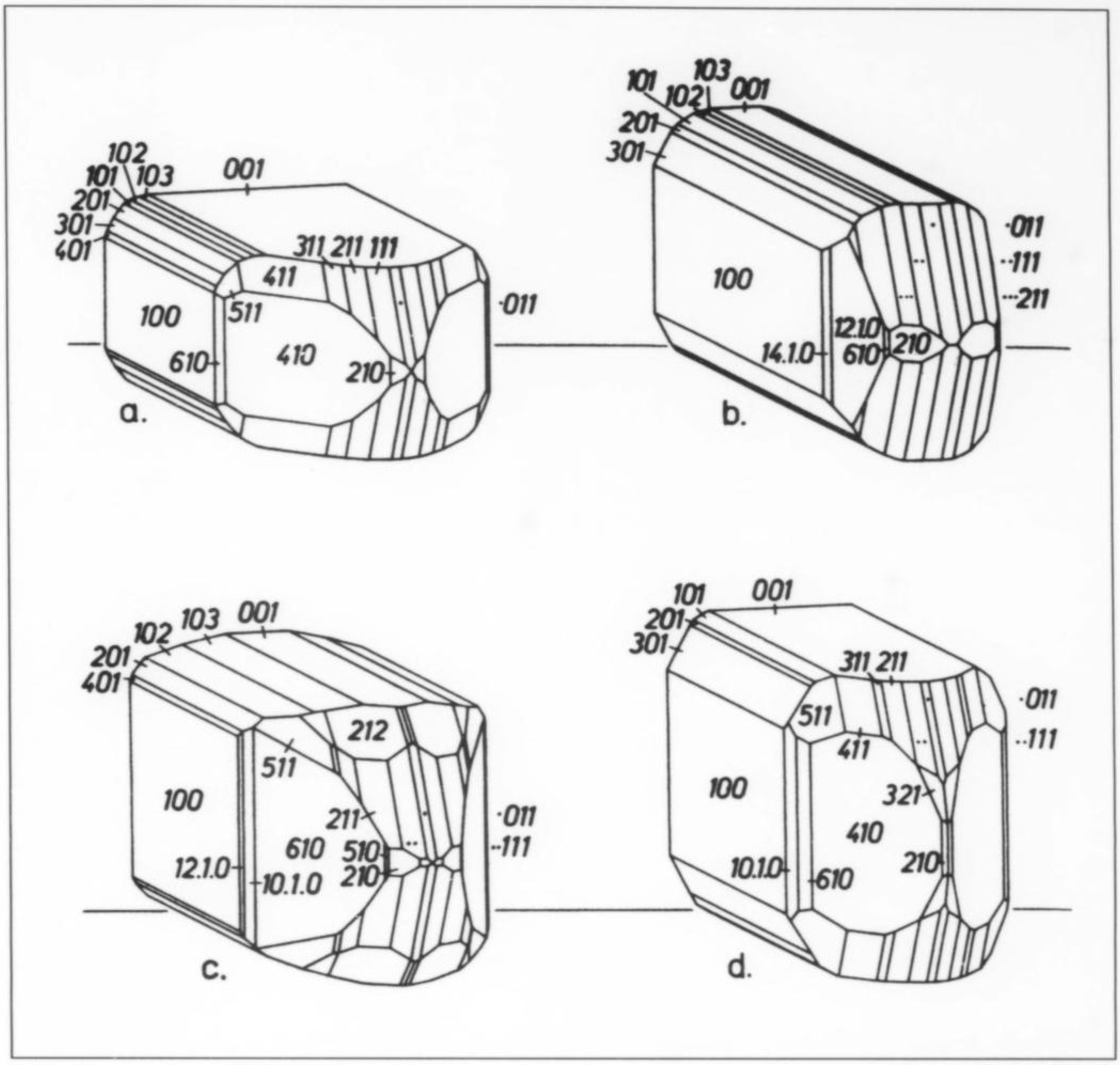


Figure 82. (above) **Crystal drawings of four habits of tanzanite from Merelani (Strunz, 1969). Note that the setting used is rotated from that used by Hurlbut (1969)** ***(left).***

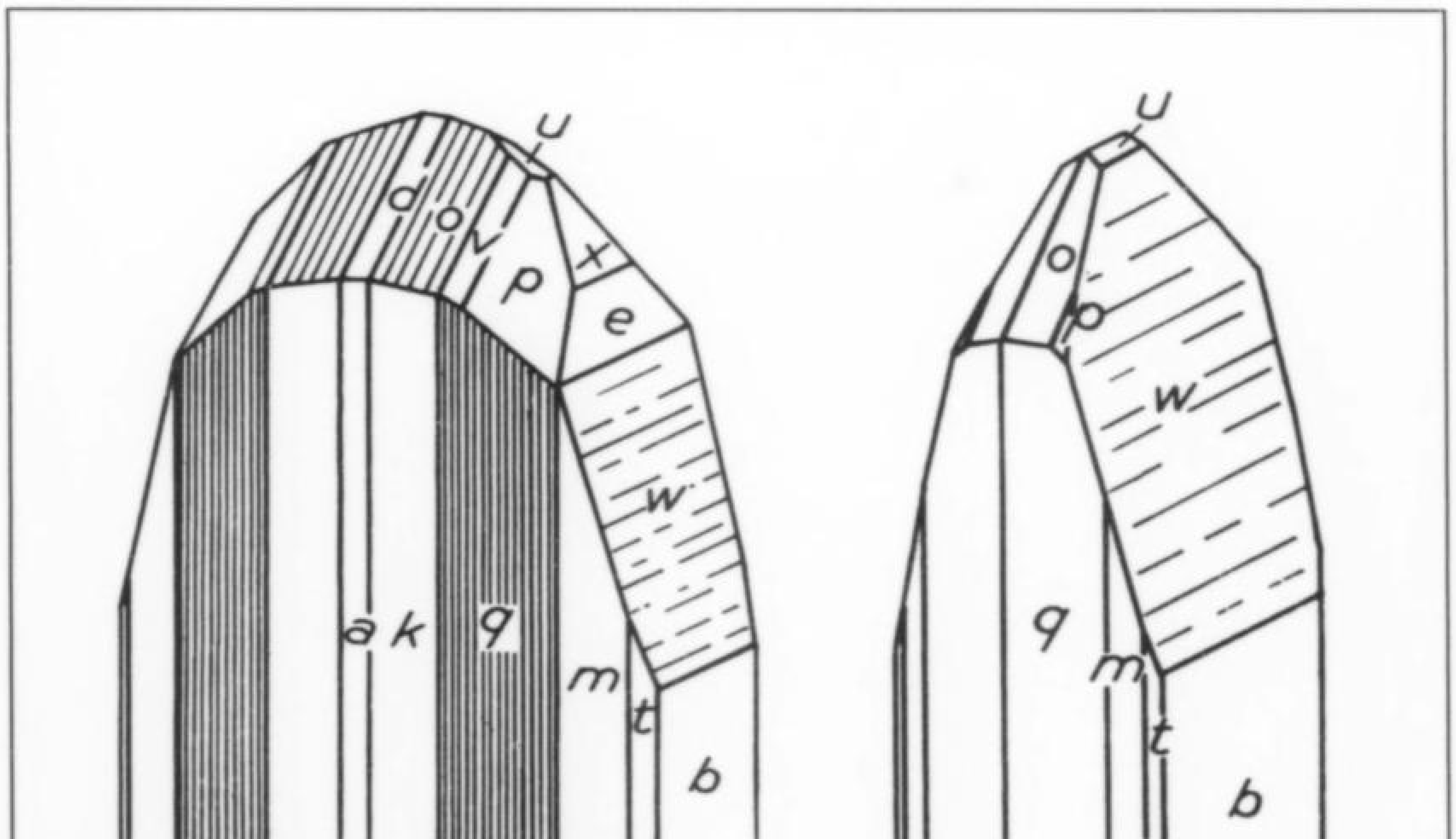
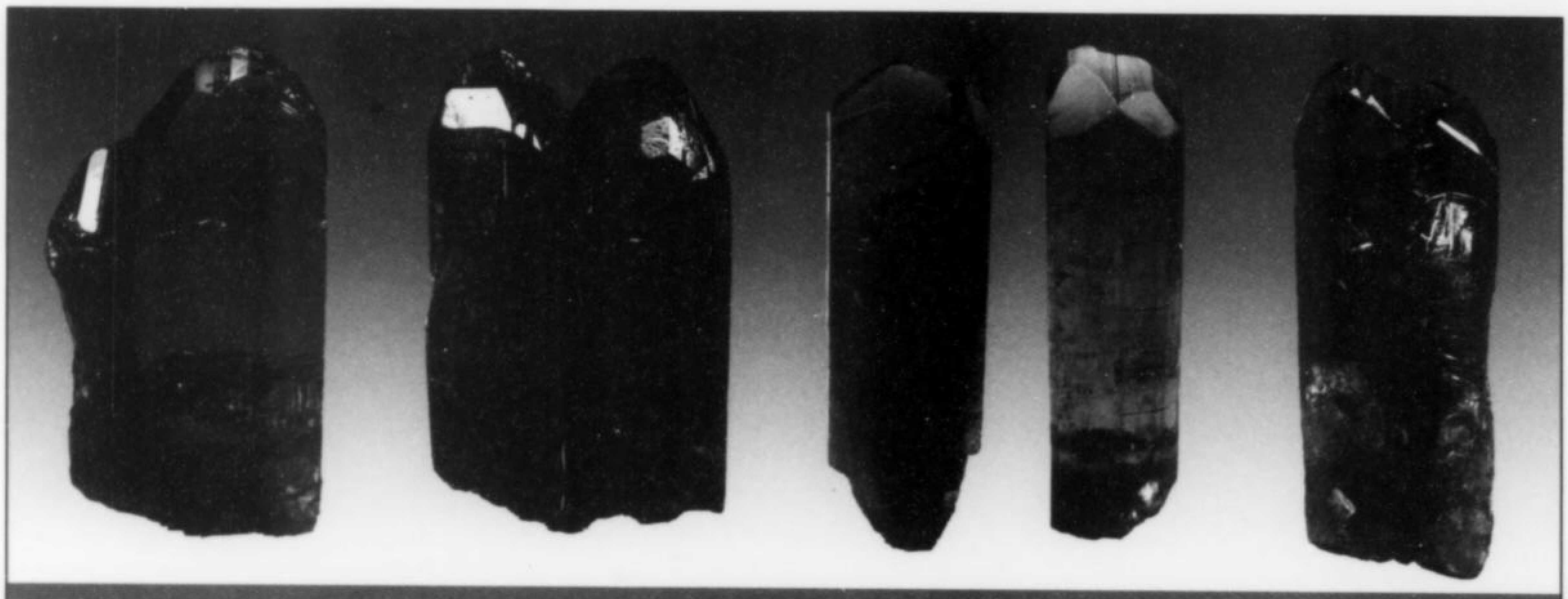
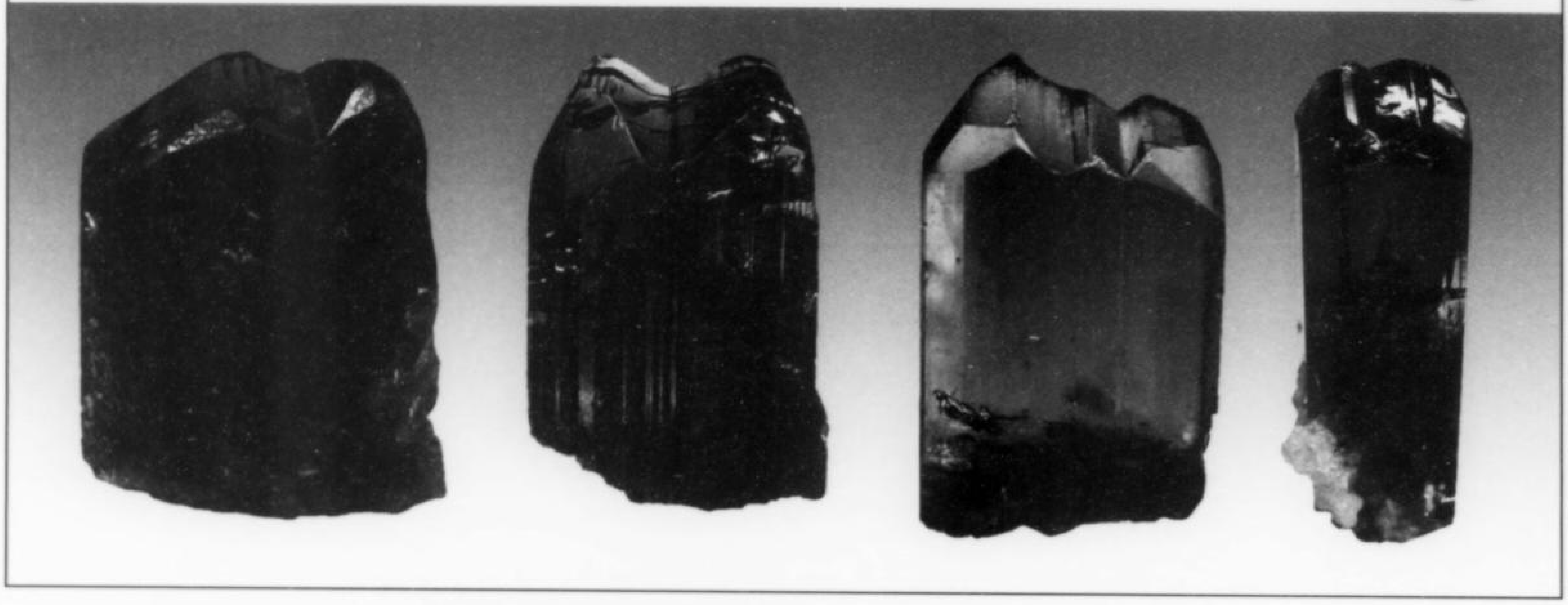
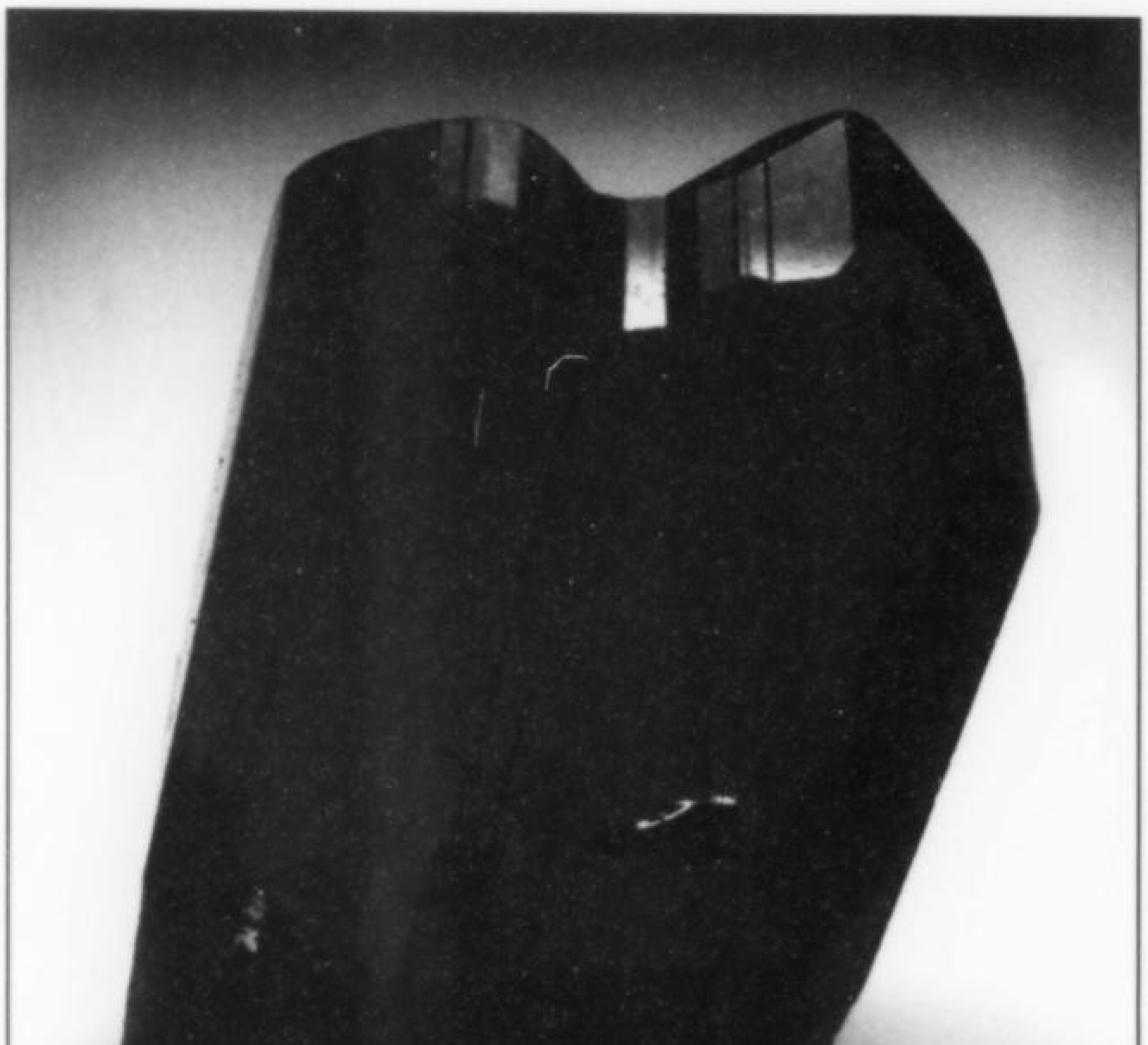


Figure 83. **Tanzanite crystal drawings showing typical habit and the forms** ***a*** **{100},** ***b*** **{010},** ***l*** **{140},** ***t*** **{130},** ***r*** **{120},** ***m*** **{110},** ***q*** **{210},** ***k*** **{310},** ***h*** **{410},** ***u*** **{021},** ***x*** **{041},** ***c*** **{061},** ***w*** **{0.12.1},** ***d*** **{101},** ***o*** **{111},** ***v*** **{121},** ***p*** **{131} and** ***x*** **{141} (Hurlbut, 1969).**







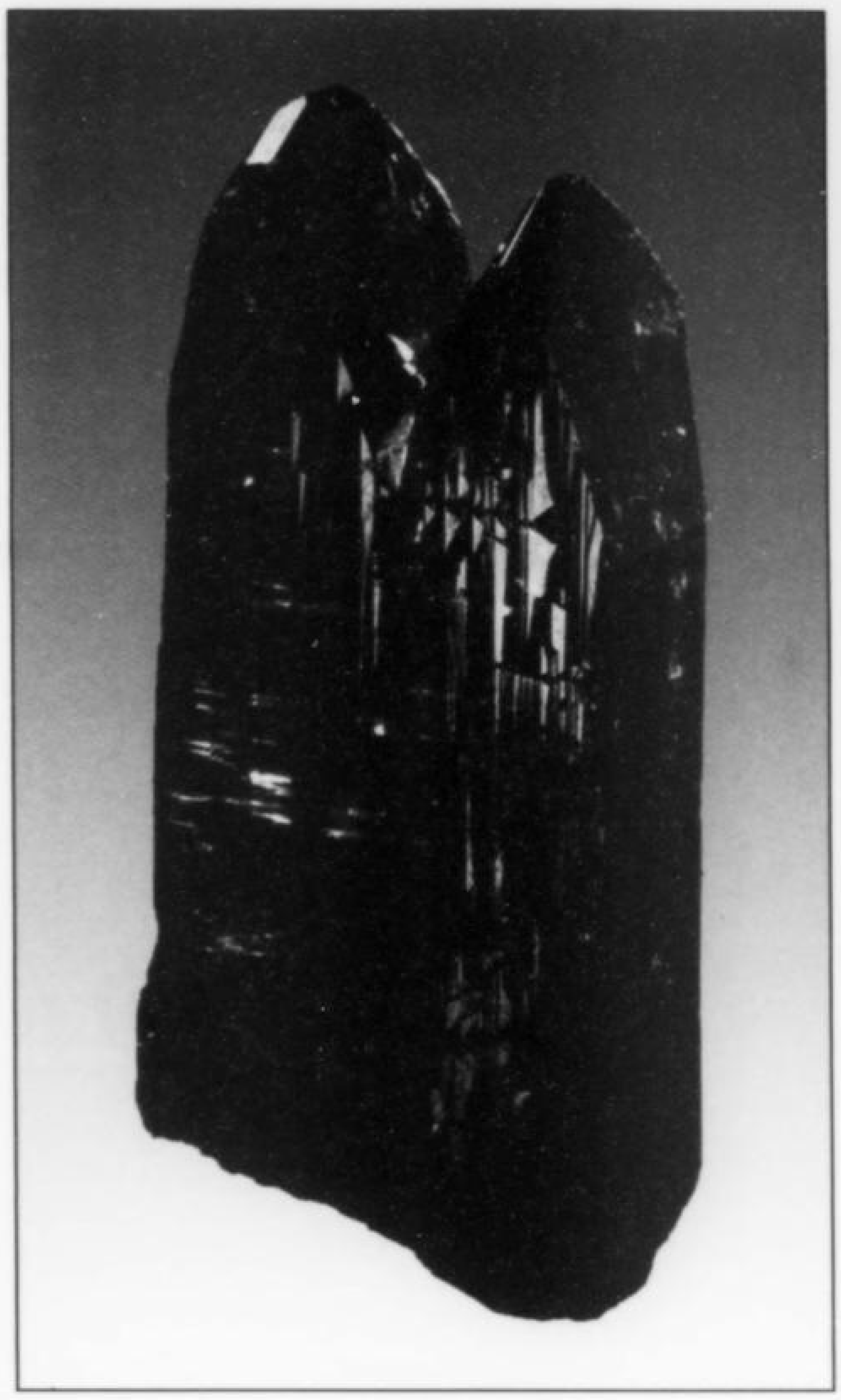


Figure 84. (facing page, top) **Nine tanzanite crystals showing varying development of re-entrant angles in the termination. (Top row: 4 cm, 3 cm, 2 cm, 2.6 cm and 2.6 cm; bottom row: 2 cm, 2.4 cm, 2.7 cm and 3 cm). Mike Keim (*Marin Minerals*) specimens and photos.**

Figure 85. (facing page, lower left) **Tanzanite crystal, 2.3 cm, with re-entrant angle in the termination, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.**

Figure 86. (facing page, lower right) **A crystal of tanzanite, 4.6 cm, showing what appears to be a twinning composition plane. Steve Ulatowski (*New Era Gems*) specimen and photo.**

Figure 87. (above) **An elongated tanzanite crystal, 7 cm, from Merelani, showing the double termination habit. Tom Spann (*Mineral Masterpiece*) specimen and photo.**

Figure 88. **Elongated tanzanite crystal with double termination, 7.7 cm, from Merelani. Carolyn Manchester collection; Jeff Scovil photo.**

Many crystals show what appears to be a re-entrant angle in the termination, resulting in what looks like two terminations in tandem, side-by-side, on one end of a single crystal. In some cases the V-shaped indentation is deep and pronounced, whereas in others it is just a small groove; a few rare crystals bear two or three indentations on the termination. This habit appears to be especially common in the crystals from some pocket zones, but is absent in other zones. The habit was first figured by Tschermak and Sipöcz (1880), based on a crystal from Ducktown, Tennessee. Some crystals, notably the Tanjeloff specimen (Fig. 27) and the one shown in Figure 86, display what would appear to be an obvious contact zone extending downward from the indentation, parallel to {100} or {010}. A crystal showing this habit has been positively identified by Raman analysis as zoisite rather than clinozoisite (Downs, 2006). Twinning on (100) is indeed possible for zoisite (R. Downs, personal communication), but many crystals showing this habit could instead be the result of parallel growth.

Chemical analyses conducted at Harvard have shown the blue tanzanite to contain 0.2 weight percent V_2O_3, a trace (0.05 weight percent) of SrO, and less than 0.01 weight percent chromium. Hurlbut (1969), Schmetzer and Bank (1979) and Faye and Nickel (1971) all believe the V substitutes for Al^{3+} in the formula, whereas Ghose and Tsang (1971) determined that it substitutes for Ca. In any case, the vanadium and, to a lesser extent, chromium are responsible for the striking colors seen in Merelani zoisite. The pronounced change in color and pleochroism when crystals are heat-treated is generally thought to be caused by a valence change from V^{3+} to V^{4+}, with a possible assist from Ti^{4+} (Faye and Nickel,

Table 5. **Chemical analysis of tanzanite (column 1 from Hurlbut, 1969, recalculated to 100%; column 2 from Malisa *et al.*, 1986; column 3 from Strunz, 1969) in weight percent.**

	*1**	*2*	*3*
SiO_2	39.67	39.99	37.905
Al_2O_3	33.49	34.24	34.065
V_2O_3	0.20	0.26	n.d.
Fe_2O_3	0.04	0.06	n.d.
CaO	24.52	24.40	24.745
MgO	0.07	0.04	0.08
K_2O	n.d.	0.06	n.d.
MnO	n.d.	0.04	n.d.
TiO_2	n.d.	0.05	n.d.
Cr_2O_3	n.d.	0.00	n.d.
P_2O_5	n.d.	0.07	n.d.
F	n.d.	0.05	n.d.
SrO	0.05	n.d.	0.24
H_2O	2.01	1.15	2.78
Total	100.00	100.41	99.815

*Spectrographic analysis indicates Sr < 0.1%; B, Cr, Mn, Ti, Ga, Sc, In, Yb, Y, Cu, Ni and Zn < 0.01%

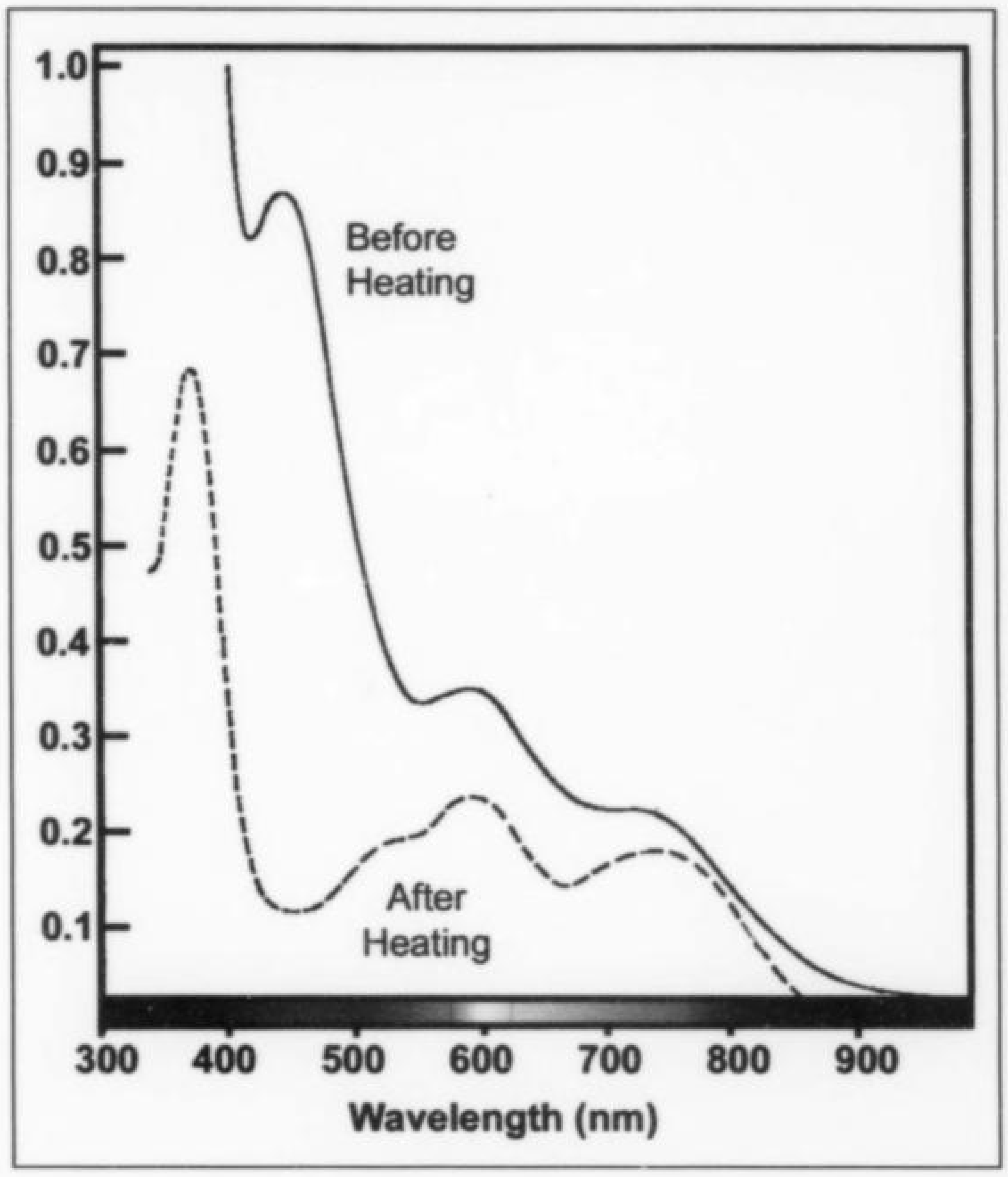


Figure 89. **Absorption spectra of a brown Merelani zoisite crystal (E // Z = a direction) before heating, and the resulting blue crystal after heating to 600°C. The decrease in absorption for wavelengths below 500 nm produces the "blue window" that accounts for much of the color change. Heating causes the spectrum in the E // Z = a direction to become essentially identical to the post-heating spectrum in the E//Y = c direction, accounting for the change in pleochroism from trichroic to dichroic (Faye and Nickel, 1971).**

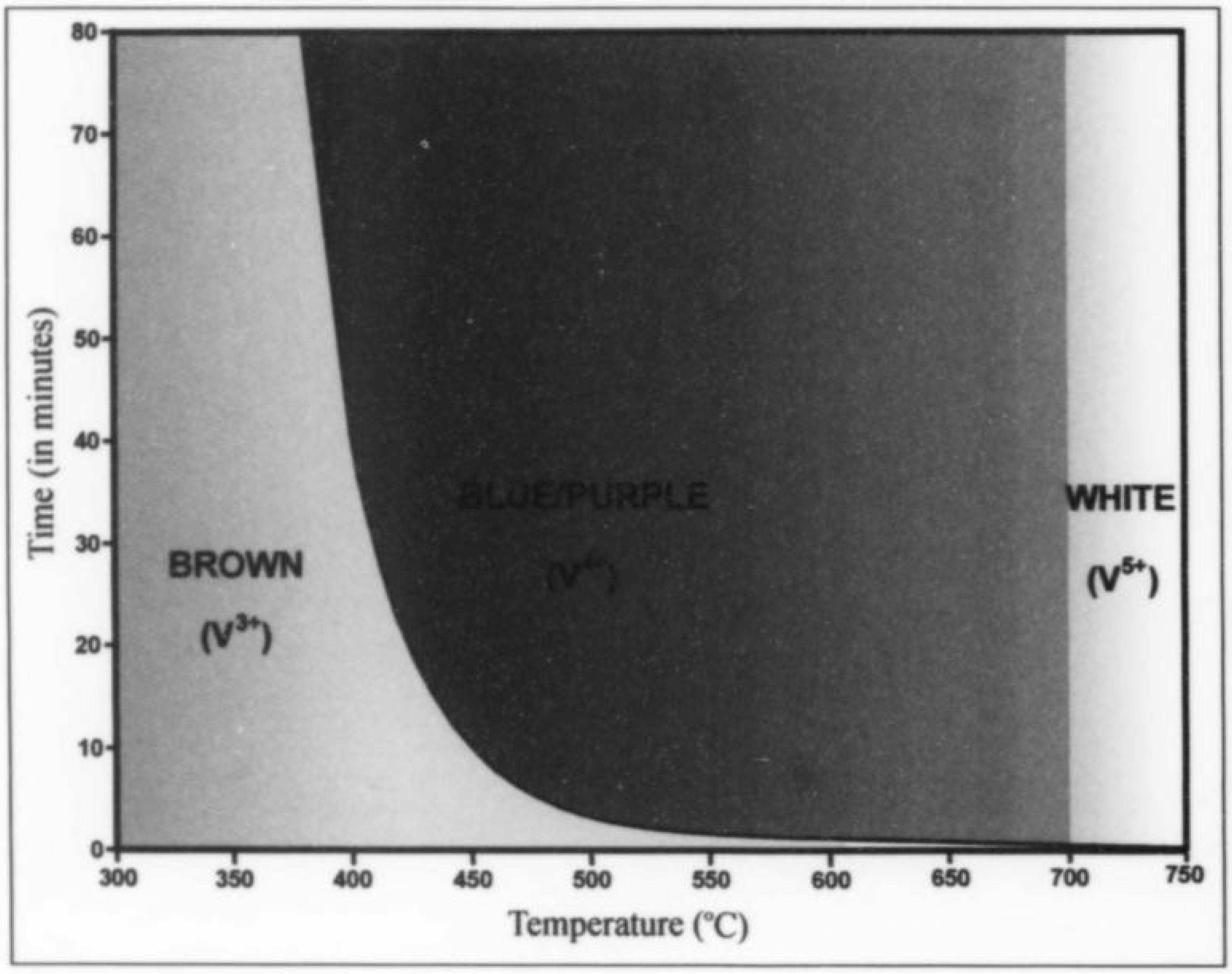


Figure 90. **Graph showing the relationship between temperature and the duration of time held at that temperature for achieving a color change in brown zoisite. Color change will not occur below 350°C; crystals turn colorless and crumble above 700°C (from Zancanella, 2004).**

1971). Malisa *et al.* (1986), however, attribute the color change to the breakdown of $HV_2O_5^{3-}$ to VO^{2+} (that is, with V^{4+} both before and after heating).

Heating to between 400° and 650° drives off the less desirable yellowish tones, resulting in beautiful shades of blue and purple. Experiments (Zancanella, 2004) show that the color change can require over an hour at 375°, but only a minute or two at 600°. Overheating (above 700°C) causes the crystals to crumble and turn colorless as V^{4+} changes to V^{5+}. Pale yellow to pink crystals, which are exceptionally low in V, tend to become colorless upon heat-treating.

Zoisite is orthorhombic, point group 2/m 2/m 2/m, but two types (designated α and β) have been described by Termier (1898), on the basis of differences in the relationship between their colors (and optic plane) and the unit cell. In the α type, the colors are blue and purple down the *b* and *c* morphological axes respectively, whereas the colors are reversed in the β type (as in the crystals from Merelani). Beckwith *et al.* (1972) suggest that the difference may be the result of varying structural distortions around the V and Cr ions.

The crude absorption spectrum published by Liddicoat (1963) for a gemmy yellow zoisite almost certainly from Merelani (though the locality was not given) shows a strong peak at 450–460 nm which is typical of unheated Merelani zoisite viewed down the *c* axis. Three spectra (one for each crystallographic direction) obtained on a trichroic yellow-green/blue/red-violet crystal by Rossman (2007) are distinctly different from each other, as would naturally

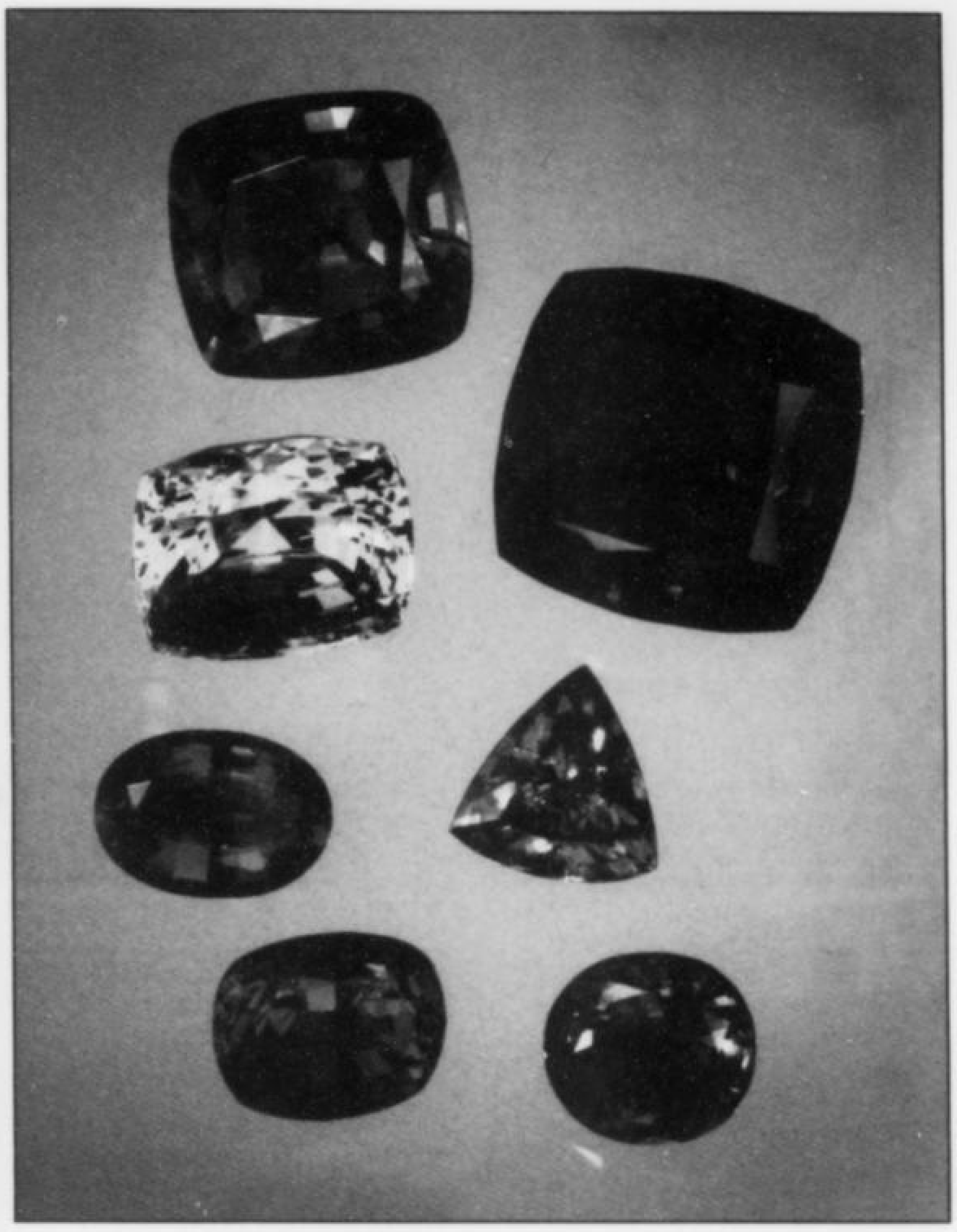


Figure 91. Faceted Merelani zoisites showing a range of color. The yellow stone weighs 9.36 carats. William Larson (*Pala International*) collection; Harold and Erica Van Pelt photo.

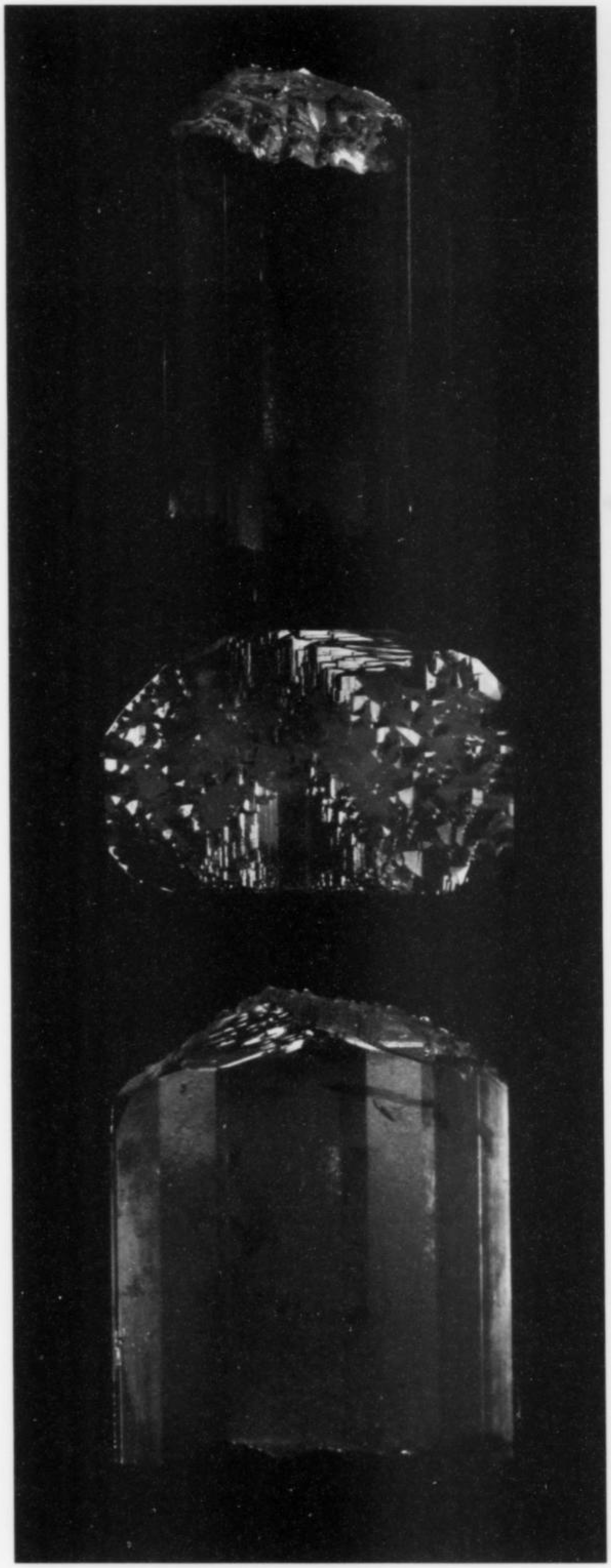


Figure 92. This single untreated Merelani tanzanite crystal, 5.5 cm (viewed from three directions to show the trichroism), is among the best known specimen crystals, thanks to the fine, often-published photo by Harold and Erica Van Pelt. It s history has been documented by Barlow (1996): It was found around 1990 and was acquired by a wealthy Arusha chicken farmer, Faye Cran (known locally as "Mama Kuku"). She took it to Mombasa, Kenya and sold it there to a Thai gem merchant, Dr. Apichart Fufuangvanich, who in turn sold it to gem dealer Dr. Horst Krupp in Idar-Oberstein. Krupp had intended to have it cut, but instead sold it to master gem-carver Hans-Jürgen Henn, who sold it to William Larson of Pala International. Larson sold it to Wisconsin collector F. John Barlow (1914–2004) at the 1991 Denver Gem & Mineral Show. It was sold again when the Barlow collection was dispersed, and is now in the collection of the Houston Museum of Natural Science.

be expected with a trichroic crystal. Similar results were obtained by Faye and Nickel (1971), who show how heating at 600° C destroys the 450–460 nm peak in one optical direction, resulting in enhancement of the blue/purple color.

The color range appears empirically to correlate with trace element contents of vanadium and also strontium and chromium. Laser ablation trace element analyses by Zancanella (2004) indicate that dark blue tanzanite contains 3800–4900 ppm vanadium and around 1000 ppm strontium. Paler blue zoisite contains roughly equal amounts of vanadium and strontium (~1300–2000 ppm). Yellow zoisite contains more strontium (~2000–3000 ppm) than vanadium (<1000 ppm). And pink zoisite contains low levels of both elements

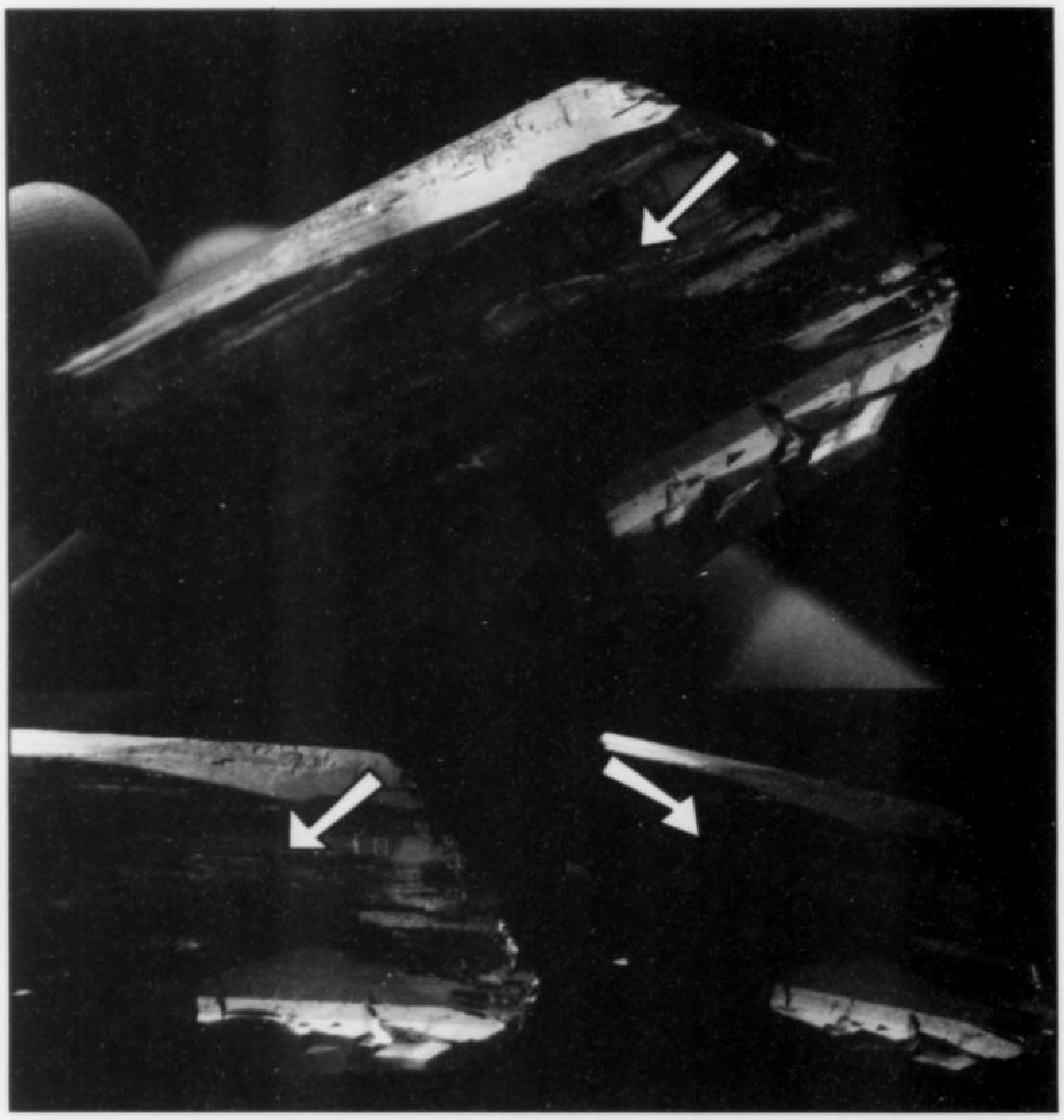
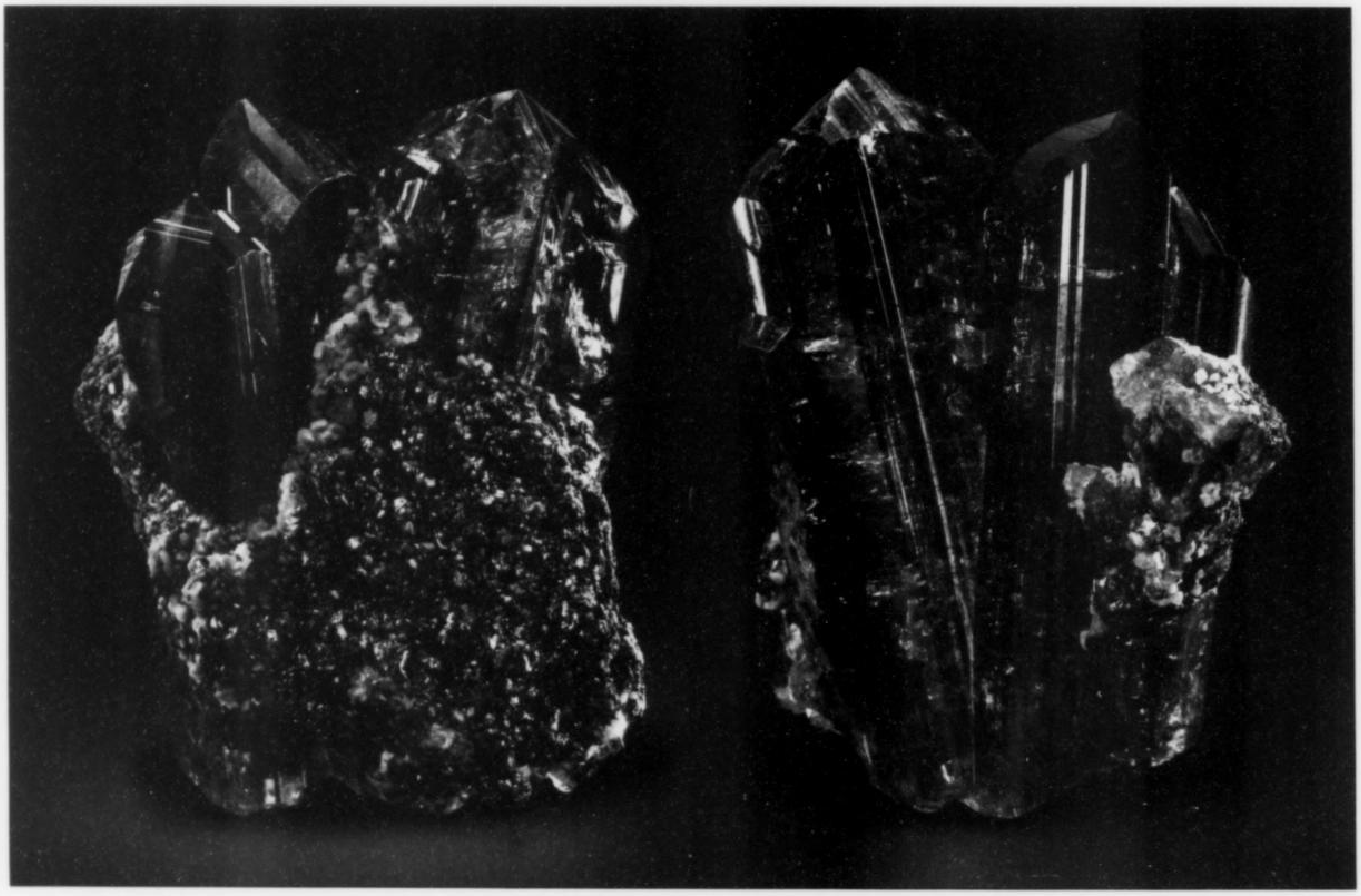


Figure 93. Tanzanite crystal from Merelani, 7 cm, containing a two-phase liquid inclusion with a movable vapor bubble. Steve Ulatowski (*New Era Gems*) specimen and photo.

Figure 94. A 5.5-cm tanzanite crystal cluster partially covered by calcite and graphite (front and back views) from the TanzaniteOne mine in Block C, Merelani; purchased from the Tanzanite Experience museum in Arusha. Kevin Ward and Ernst Matti specimen; Joe Budd photo.



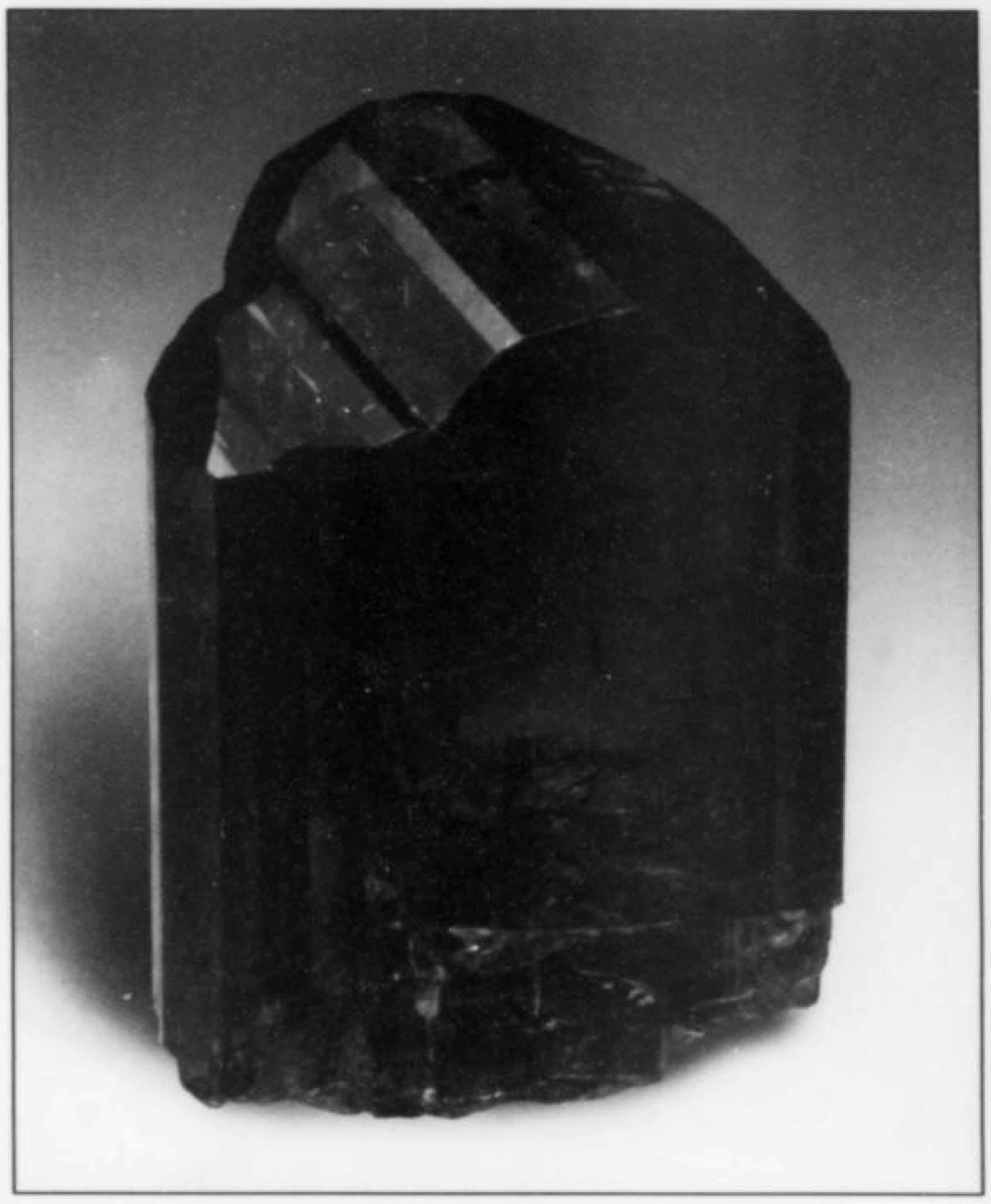


Figure 95. **Tanzanite crystal, 3.4 cm, from Merelani. Jim and Mary Fong Walker (*Ikon Minerals*) specimen; Wendell Wilson photo.**

Figure 96. **Tanzanite crystal, 1.9 cm, showing blue/purple dichroism, Merelani. Rick Kennedy collection; Jeff Scovil photo.**

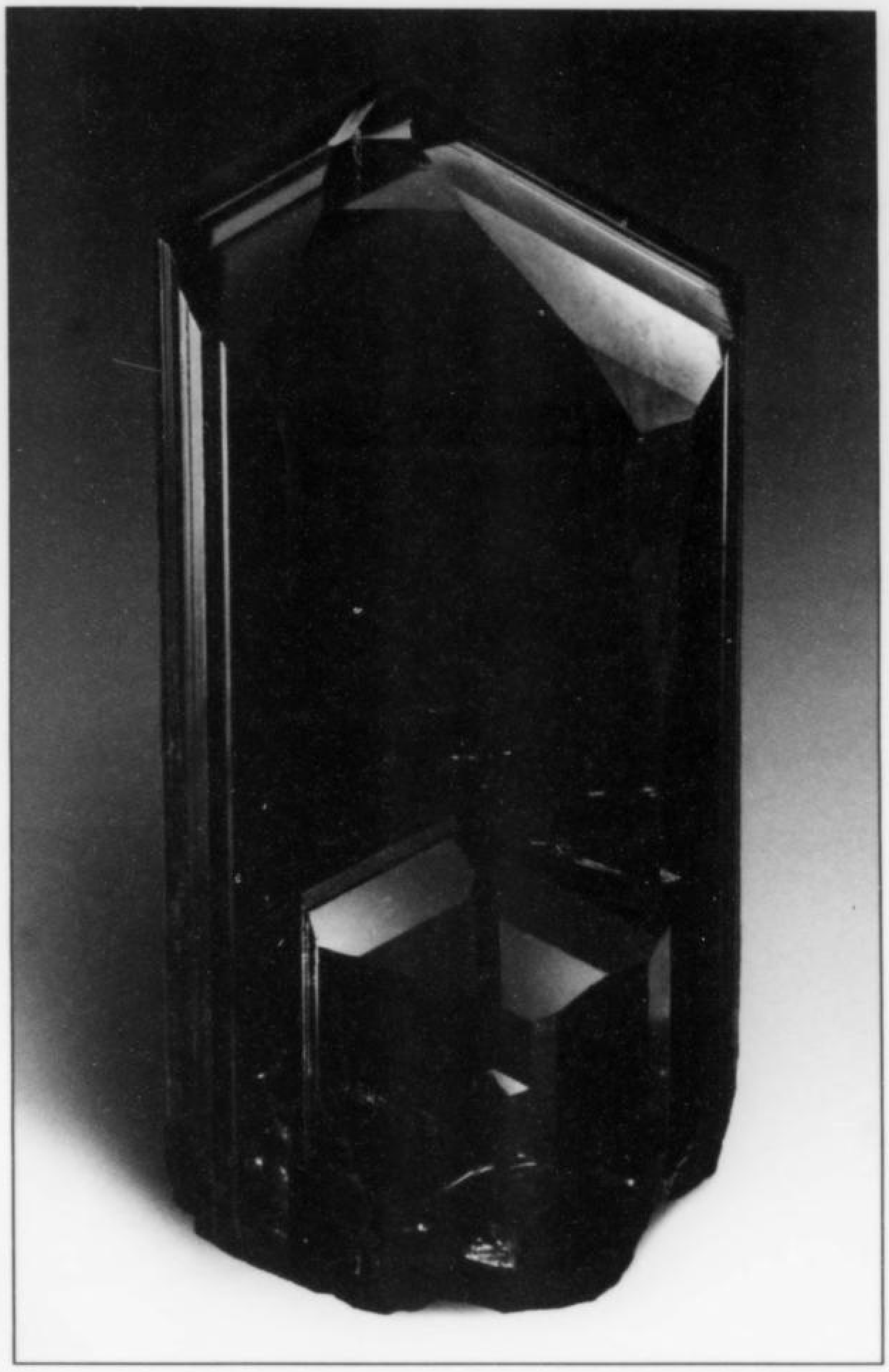


Figure 97. **Tanzanite crystal, 6.6 cm, from Merelani. Daniel Trinchillo (*Fine Minerals International*) specimen; James Elliott photo.**

(500 ppm V and 1000 ppm Sr). Chromium content also decreased through this color range, from 200+ ppm for the darkest blue crystals to $<$100 ppm for yellow crystals. An analysis of a pale yellow crystal supplied by John Saul (Fig. 22) yielded somewhat lower values ($V < 100$ ppm and $Sr < 750$ ppm), with strontium likewise in excess over vanadium (quantitative WDS analysis provided by Cannon Microprobe in Seattle). The fluorescence spectra that show up during the course of Raman analyses of the same crystal and others—not only of zoisite but also axinite-(Mg), tremolite, diopside and grossular from Merelani—show a distinctive content of neodymium (about 20 ppm, probably in substitution for Ca) which has not been seen in specimens of those species from other countries (Robert Downs, personal communication). Fluorescence causes the Nd peaks to be highly amplified in the Raman spectrum.

In transmitted light the Merelani zoisite crystals can show a variety of colors, including various shades of brown, yellow, yellow-green, green, greenish brown, turquoise blue, blue, bluish purple, purple, pink, red, reddish brown, gray, colorless and bi-colored crystals (combinations include purplish pink/yellow, violet-blue/yellow-green, etc.). Color zoning is common. Some untreated crystals show a striking trichroism, appearing grayish blue when viewed down the *a* axis, purple down the *b* axis, and red, salmon-pink, brown, green or yellow down the *c* axis. Heat treatment renders

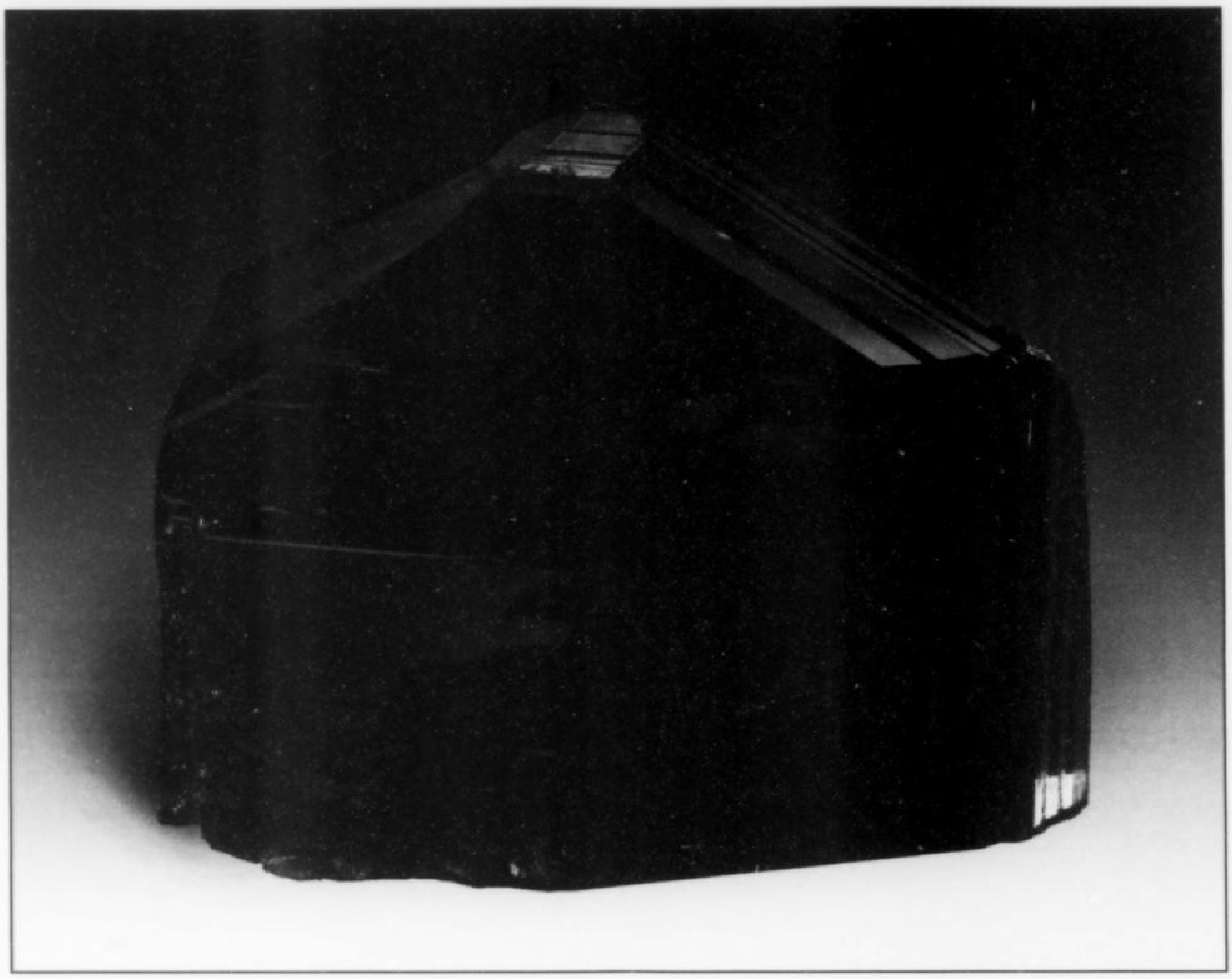


Figure 98. **Tanzanite crystal, 6.5 cm, from Merelani. Scott Rudolph collection; Joe Budd photo.**

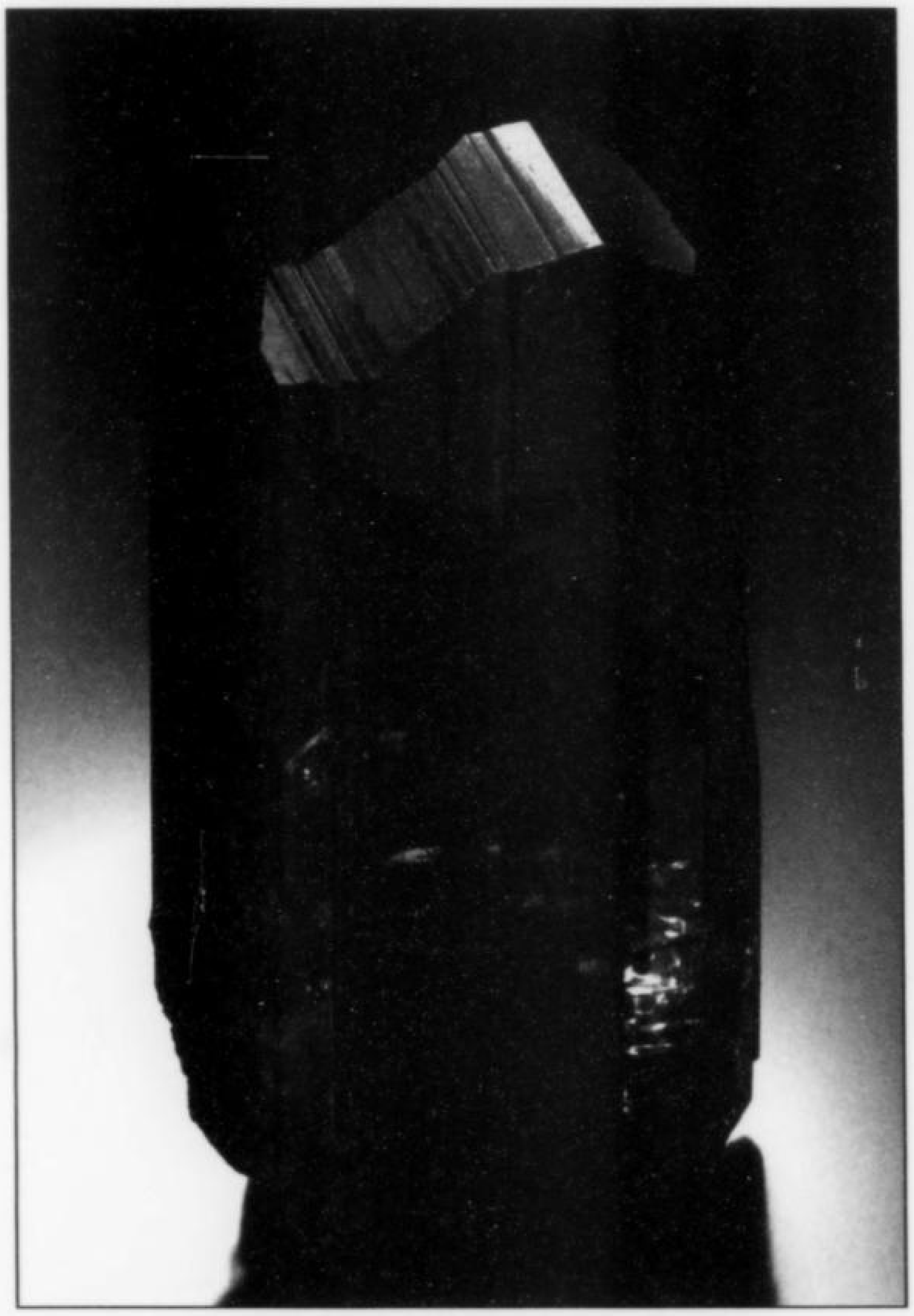
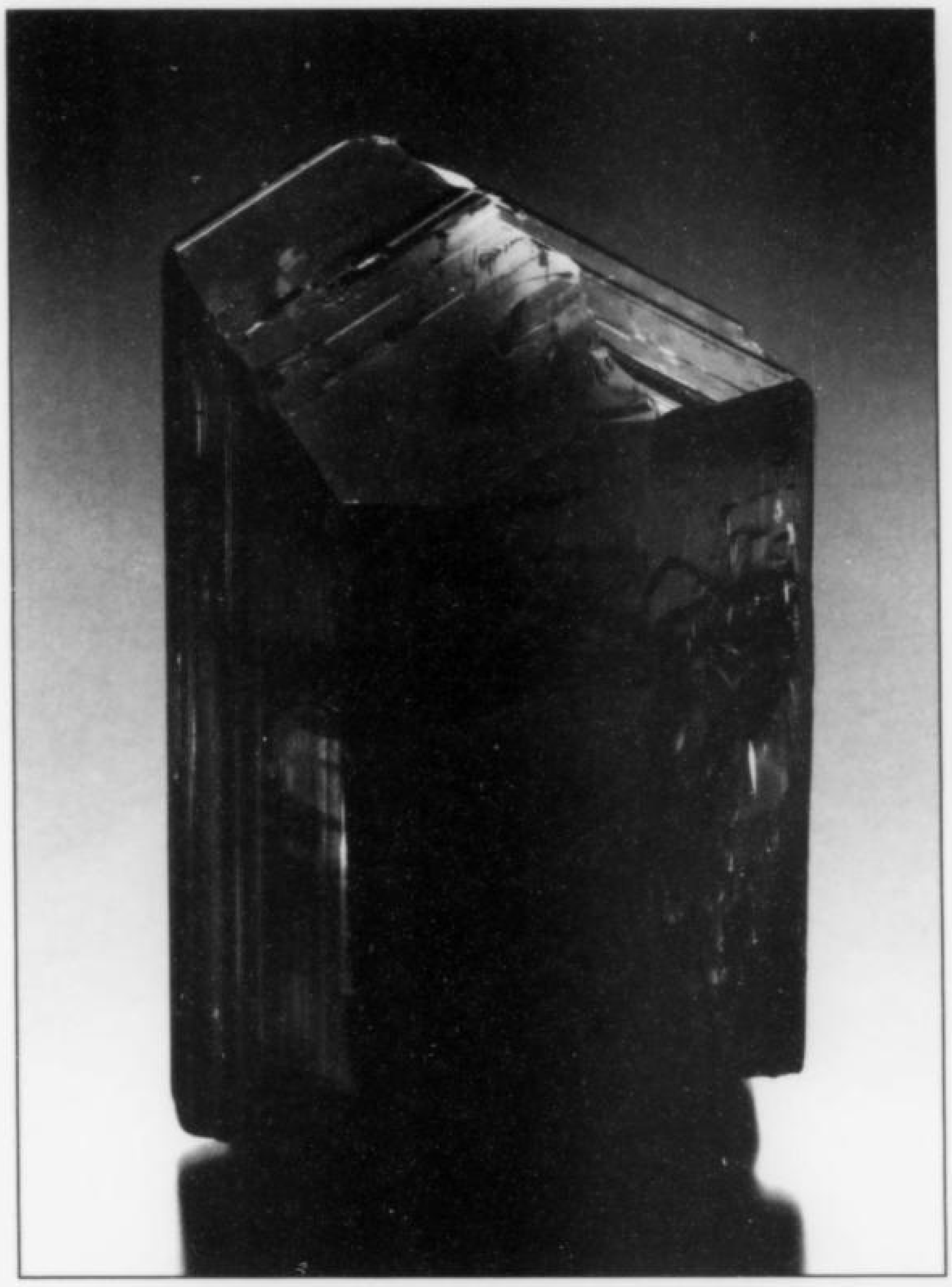


Figure 99. **Tanzanite crystal, 7.3 cm, from Merelani. Marc Weill collection; Jeff Scovil photo.**

the *a* and *b* axis colors more or less identical. Consequently any crystals with yellowish, brownish or reddish tones are certain to be untreated. The finest deep blue-purple zoisite comes primarily from the Block D workings.

Edward Swoboda purchased some of the first lots from Manuel de Souza. He reports that, with few exceptions, all of the earlier mined surface stones showed little evidence of the transient reddish purple color so prevalent in the more deeply mined material; they were cut and sold without being heat-treated. The colors ranged from the most valuable dark blue down to pale shades and near-colorless crystals, some with traces of a pale green color. Some clean crystal fragments, probably mined at shallow depths, were yellow to yellow-brown with no blue shades evident. Even after heat treating, these yellow-brown stones never turned to anything better than very pale blue shades. Some of the larger surface-mined crystals exhibited a nice array of color zones ranging from pale green to colorless, to medium pale blue.

Although Merelani zoisite comes in a variety of colors, the name "tanzanite" should be applied *only* to the blue-purple variety of (Gübelin, 1992; Neuendorf *et al.,* 2005). Unfortunately, marketing expediency has sometimes resulted in the other colors of zoisite being labeled pink tanzanite, green tanzanite, yellow tanzanite, white tanzanite, ultramarine tanzanite, etc. This usage is to be discouraged, as it amounts to designating a variety of a variety. The correct terms are green zoisite, yellow zoisite, etc. A massive green variety enclosing ruby crystals at nearby Longido has been called *anyolite* (after the Maasai word for "green"), and a massive, opaque, pink zoisite



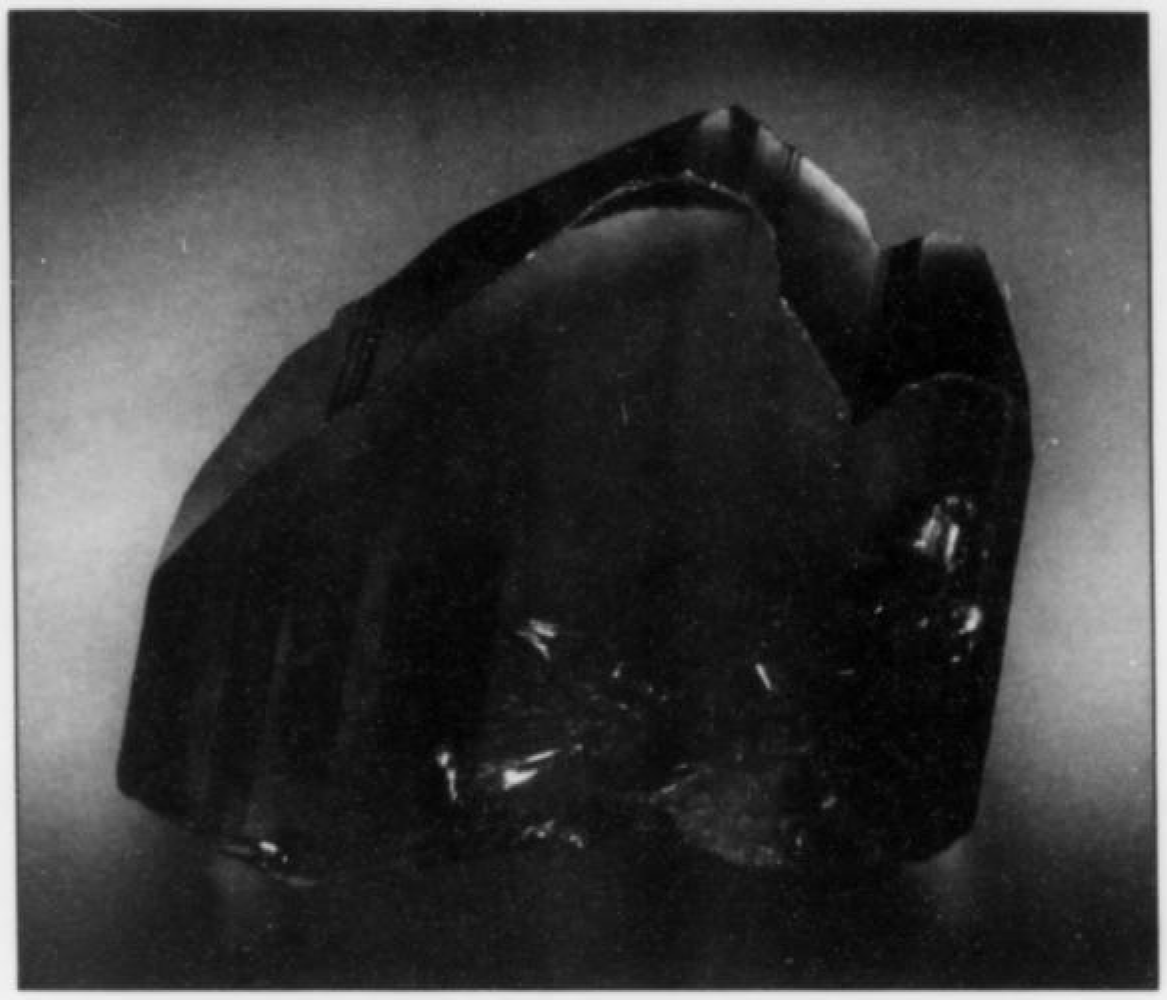


Figure 100. **Tanzanite crystal with re-entrant angle in the termination, 2.7 cm, from Merelani. Ralph Clark collection; Jeff Scovil photo.**

Figure 101. **Tanzanite crystal, 6.7 cm, from Merelani. Houston Museum of Natural Science collection; Jeff Scovil photo.**

Figure 102. **A pair of tanzanite crystals (two views, showing color change), 9 cm, from Merelani. Ex Rob Lavinsky collection, now in the Simon Lawrence collection; Joe Budd photos.**

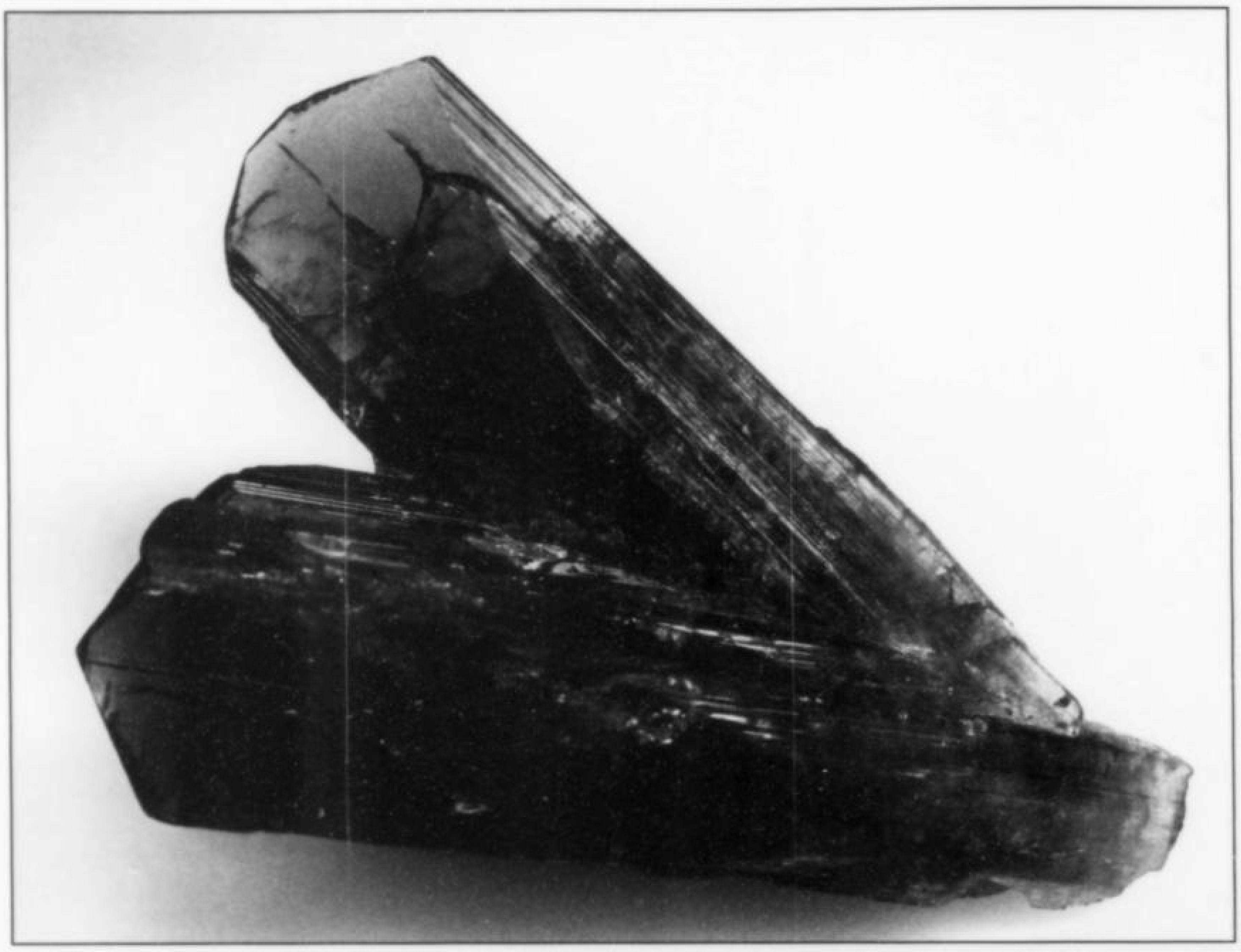


Figure 103. **Tanzanite crystal group, 4.4 cm, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.**

Figure 104. **Two intergrown tanzanite crystals, 7.9 cm, from Merelani. Wayne Thompson specimen; Jeff Scovil photo.**

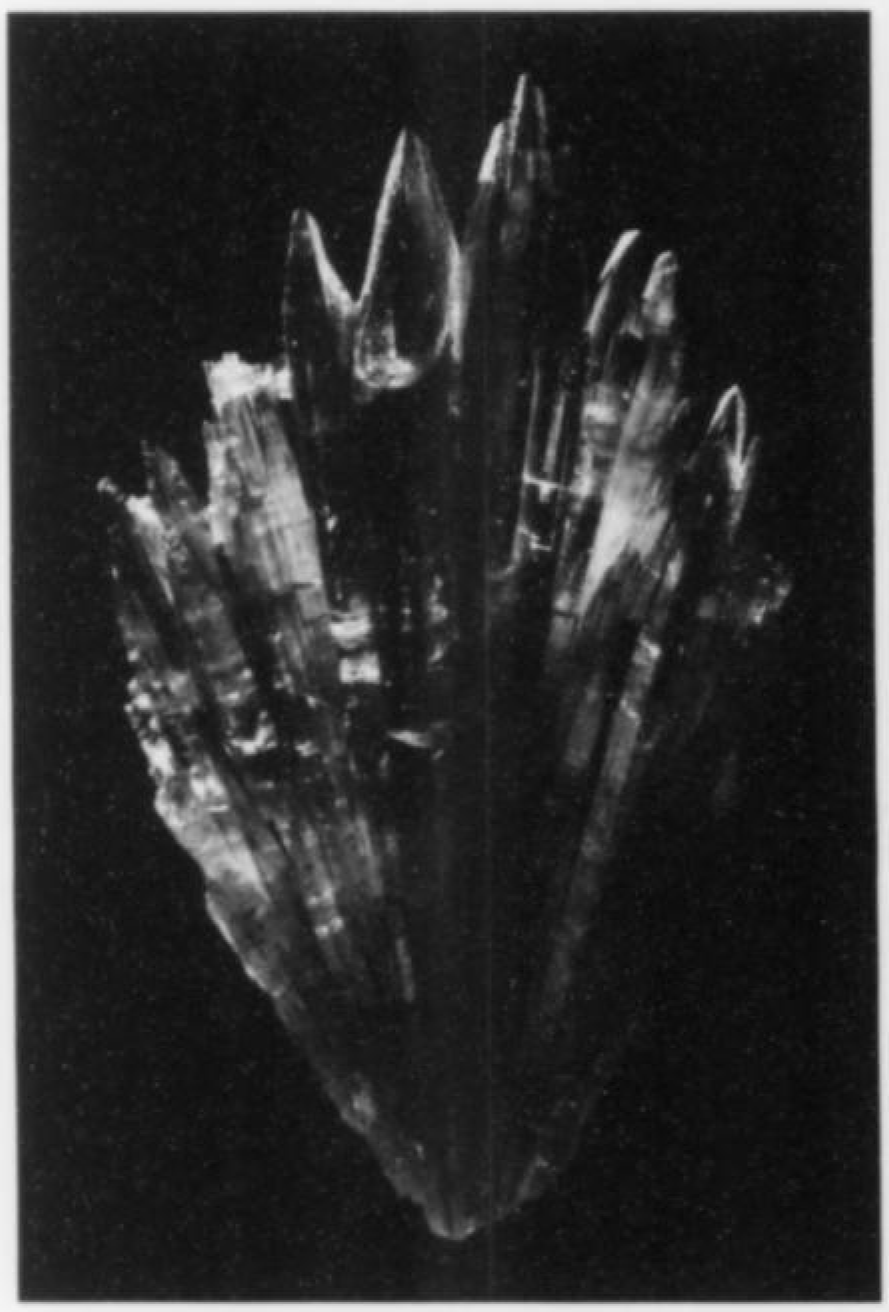


Figure 105. **Tanzanite fan-shaped cluster of crystals, 5 cm, from Merelani. William Larson (*Pala International*) collection; Jason Stephenson photo.**

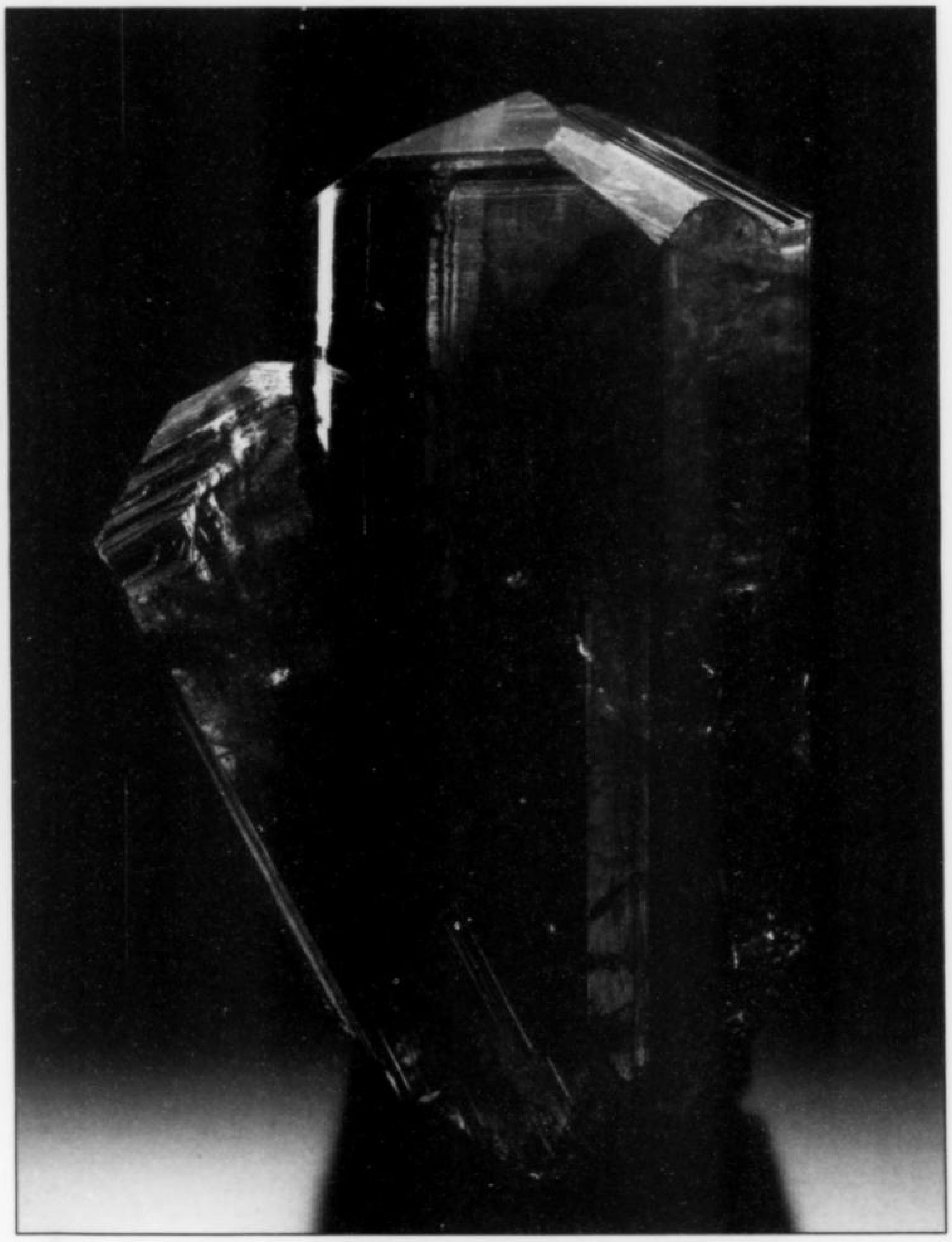


Figure 106. **Tanzanite crystal, 7.3 cm, from Merelani. Jack Halpern collection; Jeff Scovil photo. This specimen won the Lidstrom Award at the 2007 Tucson Gem and Mineral Show.**

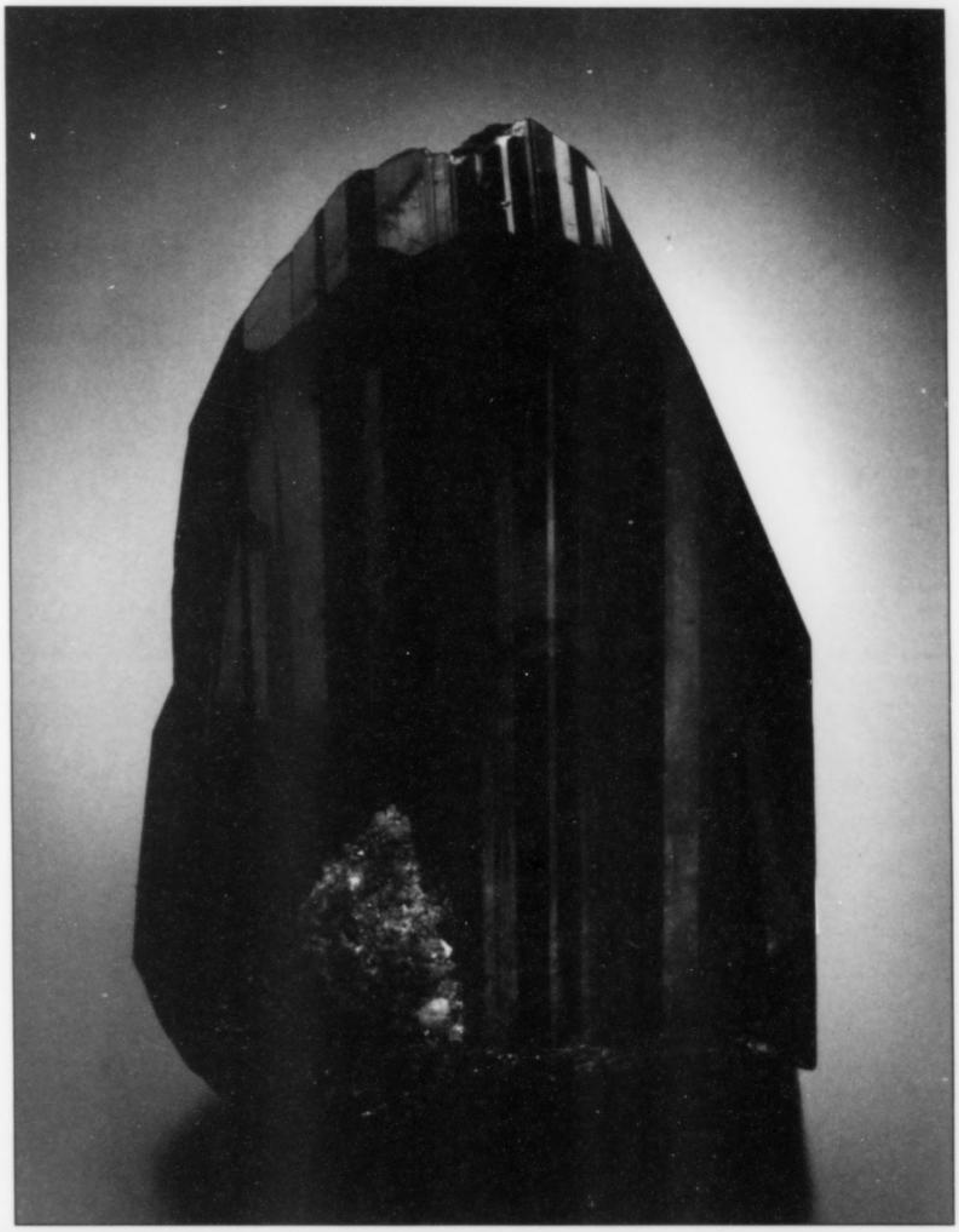
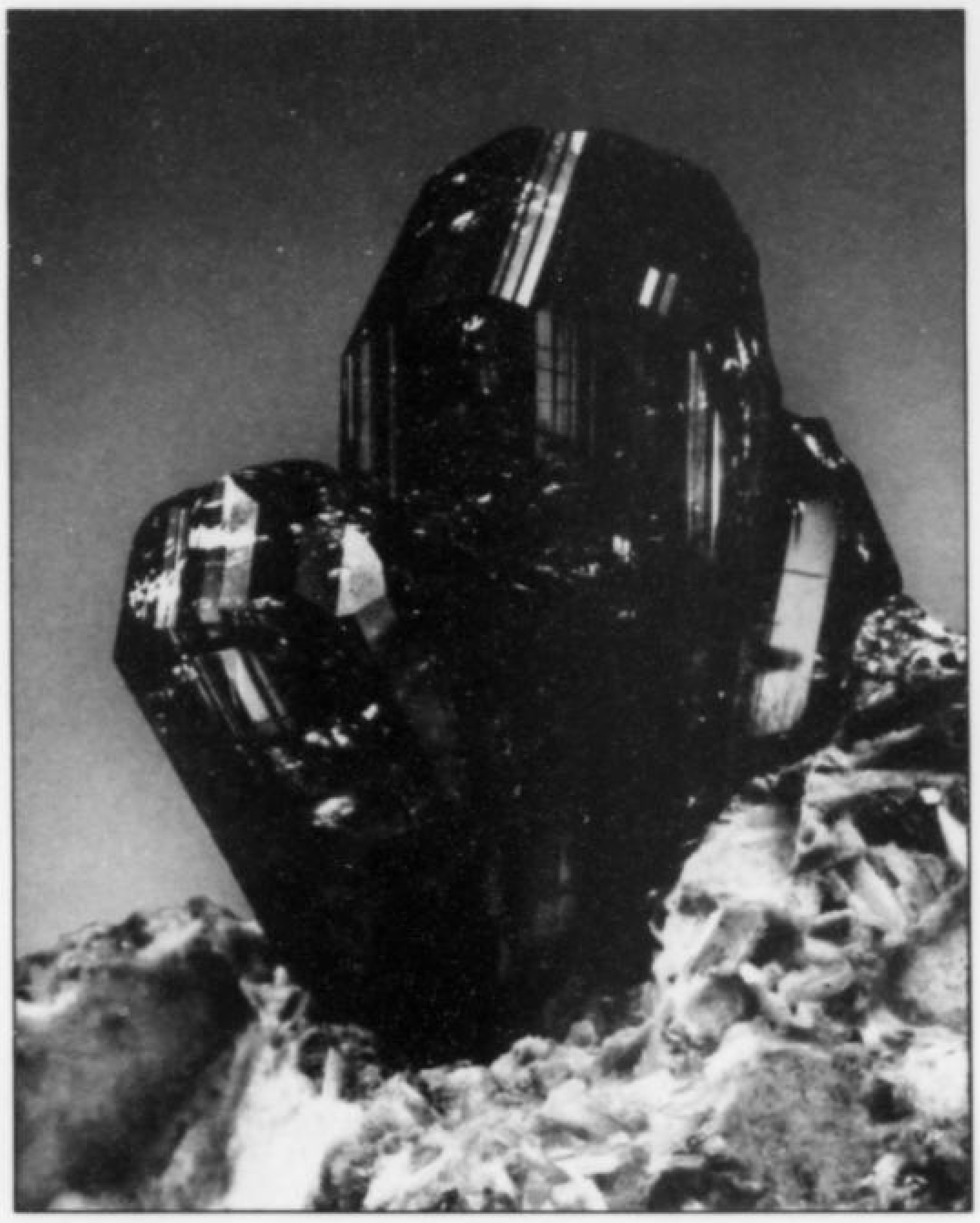


Figure 107. (below right) **Elongated tanzanite crystal (two views), 4.6 cm, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.**

Figure 108. (below) **Tanzanite crystal cluster, 2.5 cm, on calcite matrix, from Merelani. Marcus Budil specimen; Jeff Scovil photo.**



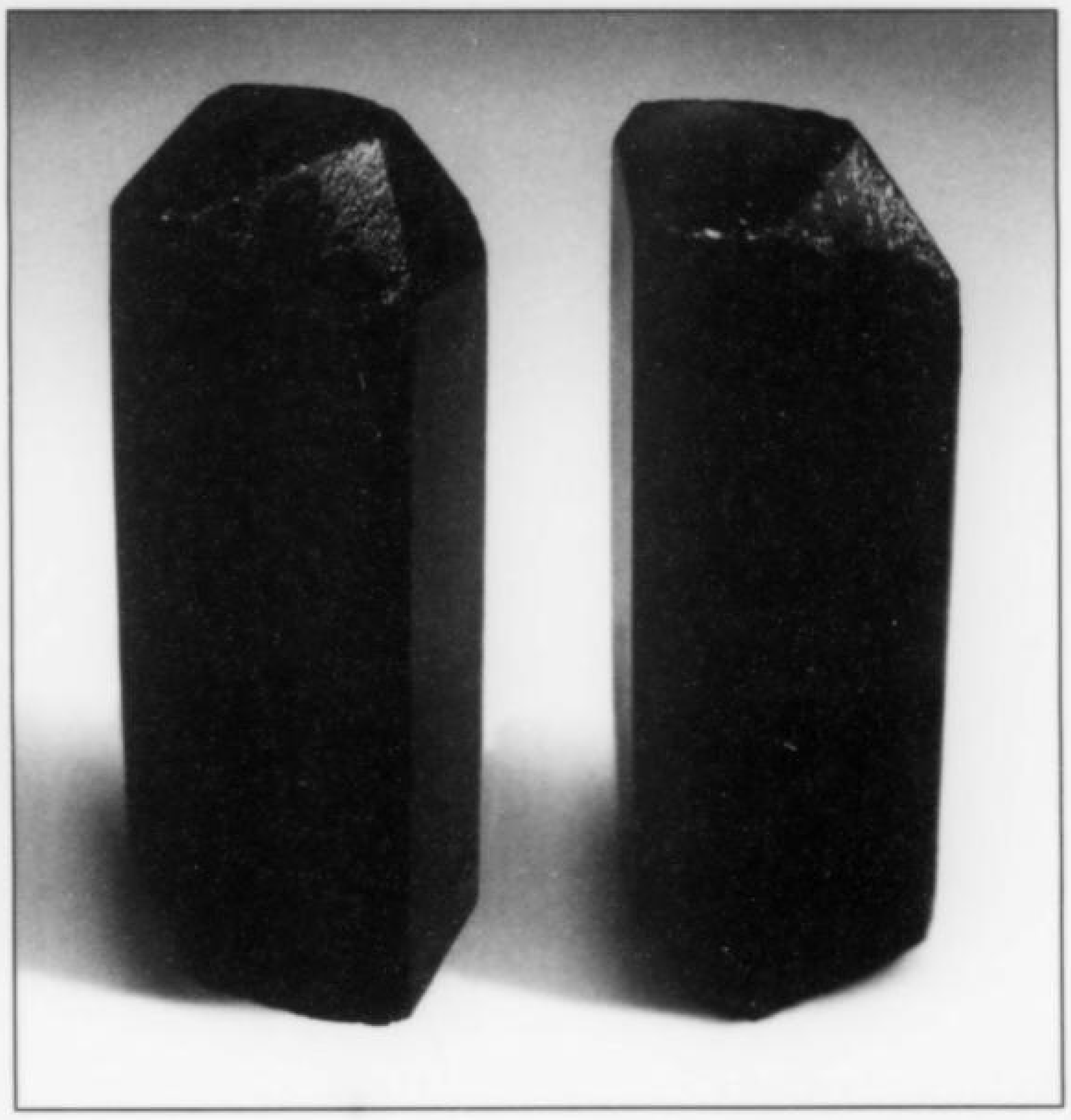


Figure 109. Color-zoned tanzanite crystal, 3.3 cm, from Merelani. Rob Lavinsky (*The Arkenstone*) specimen and photo.

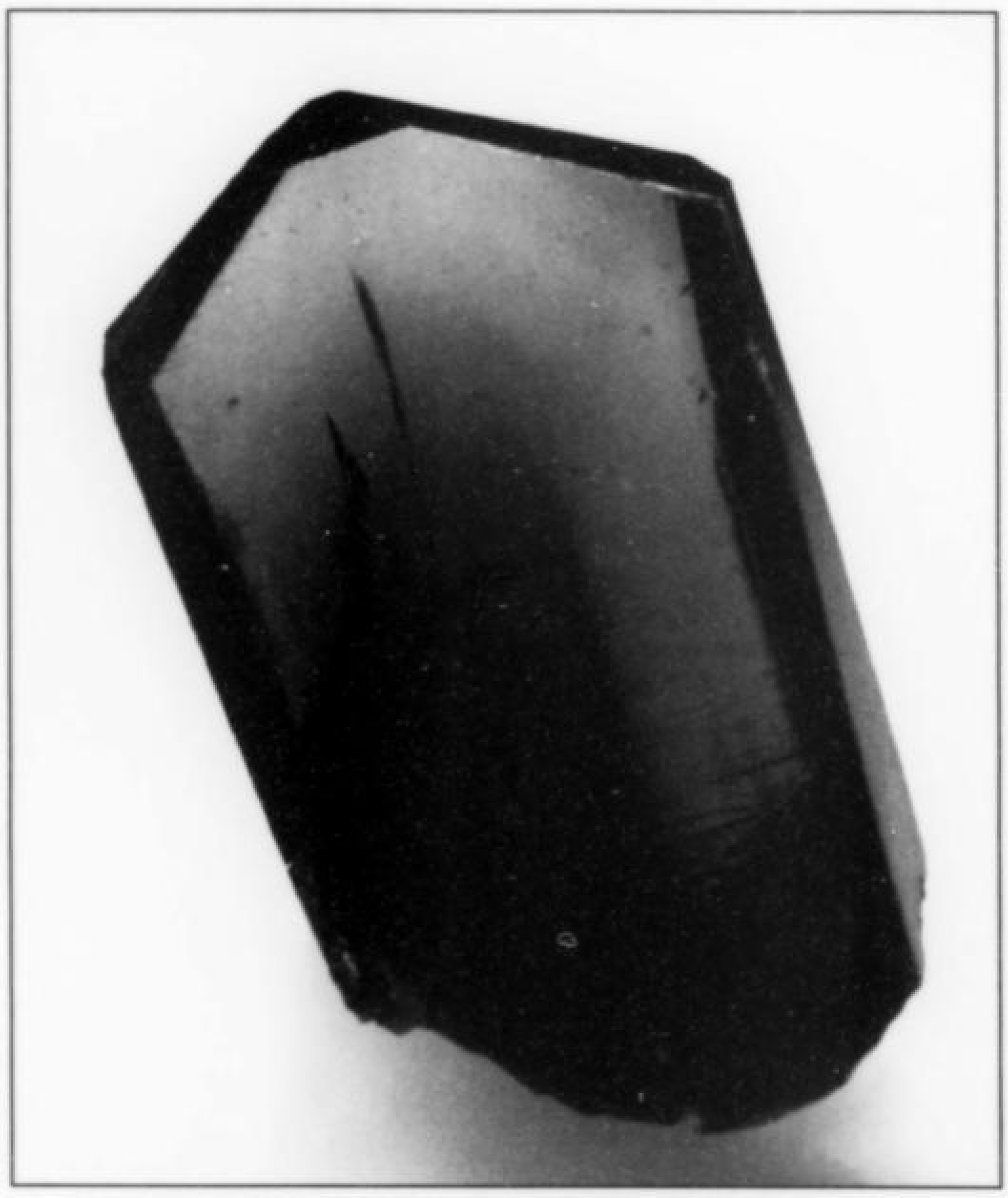
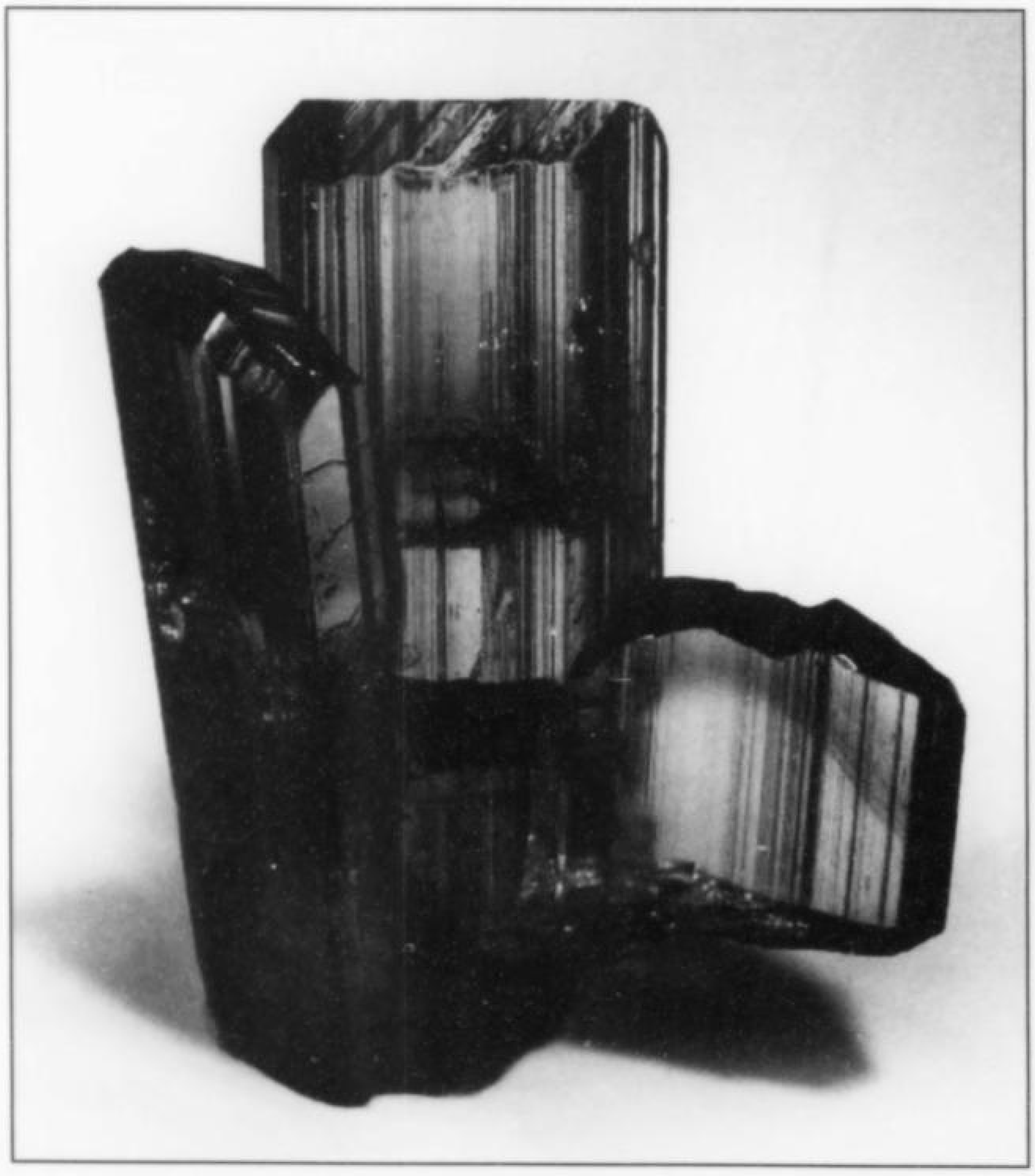


Figure 110. Color-zoned tanzanite crystal, 2.7 cm, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.

Figure 111. Tabular tanzanite crystals, 2.6 cm, from Merelani. Jeffrey Starr collection and photo.



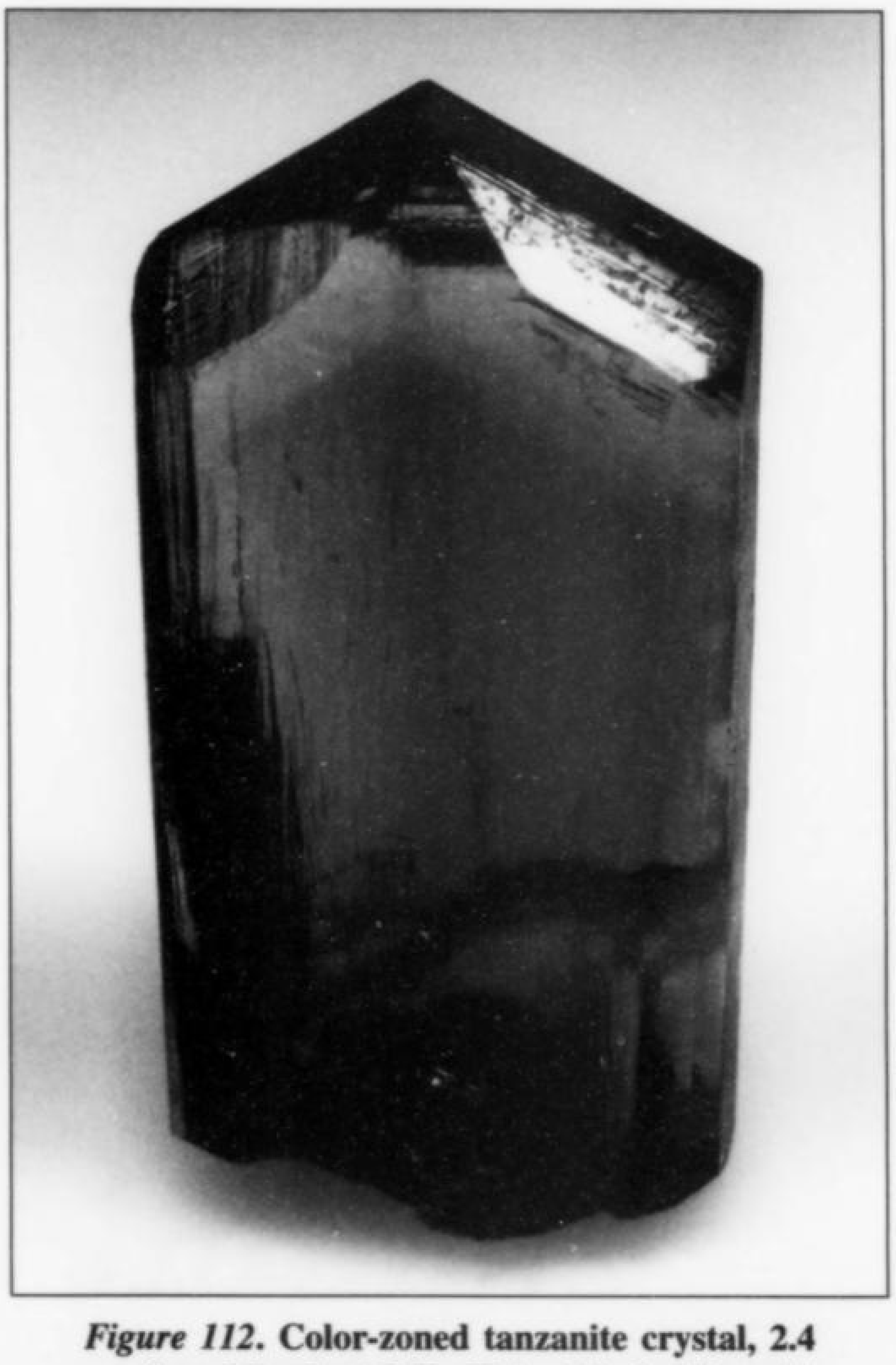


Figure 112. Color-zoned tanzanite crystal, 2.4 cm, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.

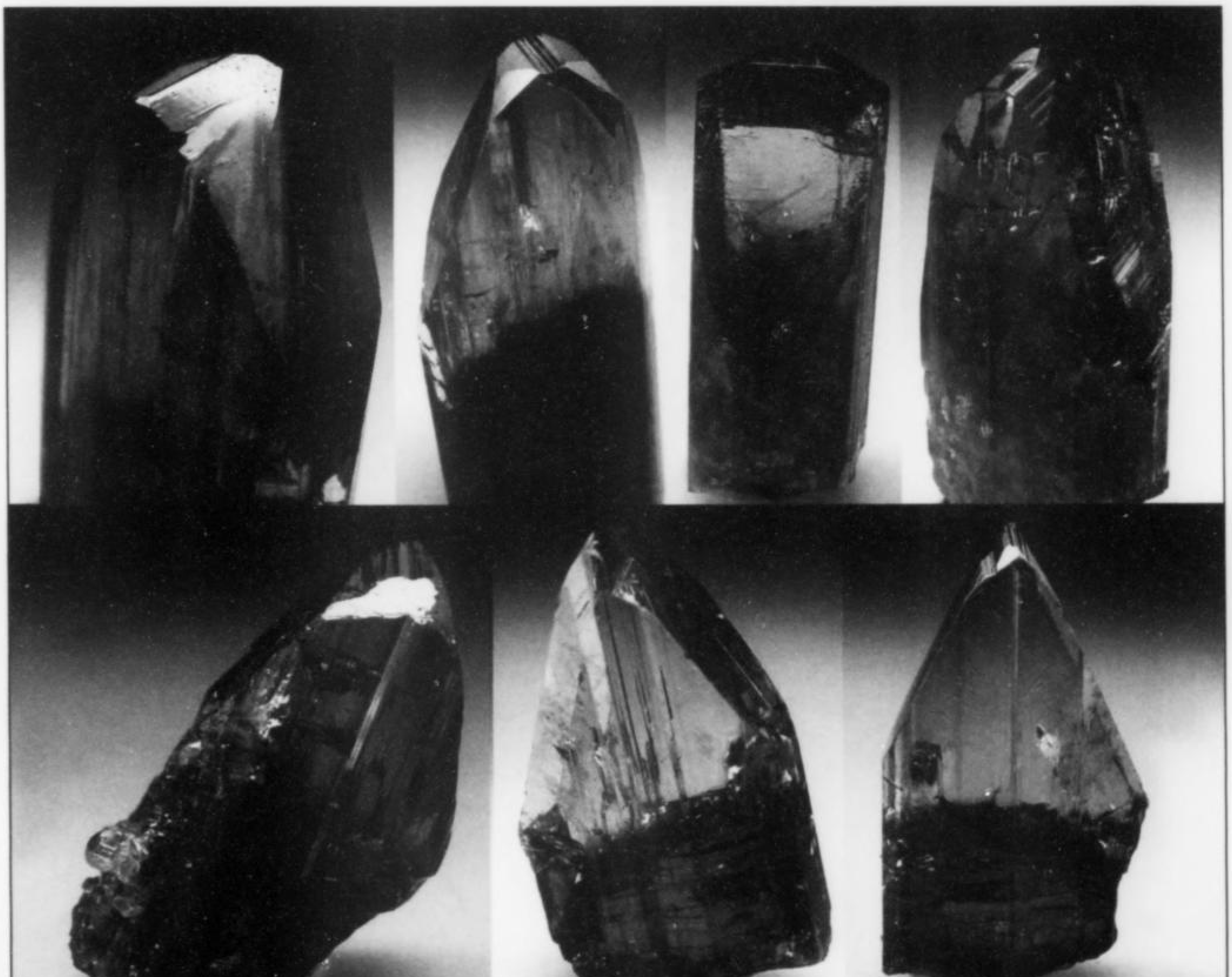
from Greenland has sometimes been called *thulite*, but these terms should likewise be avoided in describing Merelani crystals.

A lab-created non-pleochroic tanzanite simulant called "tanzanique" is actually a synthetic forsterite. Other materials that have been used to simulate tanzanite include leaded glass, Coranite (synthetic sapphire), Tanavyte (synthetic yttrium-aluminum garnet), Tanzation (synthetic spinel with cobalt glass) and cubic zirconia; they are easily recognized by differences in index of refraction. A device called a Hanneman Tanzanite Filter (Hanneman Gemological Instruments) is designed for detecting tanzanite simulants; it consists of a simple dichroscope plus a Hanneman Aqua-Filter designed for characterizing blue gems.

A transparent, chromium-rich variety of zoisite, sometimes called "chrome tanzanite," occurs in Block B; the color ranges from a dark petroleum-like green to olive-green, bluish green, bright green and greenish blue. The intensity of the green is a function of the ratio of chromium to vanadium present, the higher chromium content being correlated with deeper green color. The brightest green crystals contain up to 0.3 weight percent Cr_2O_3 and only 0.07 weight

***Figure 113.* Color-zoned tanzanite crystal, 7 cm, from Merelani. Rob Lavinsky (*The Arkenstone*) specimen; Jeff Scovil photo.**

***Figure 114.* Color-zoned tanzanite crystals, probably all from the same pocket at Merelani; upper left (two views): 3.4 cm; upper right (two views): 2.8 cm; lower left: 2.5 cm; lower right (two views): 2.1 cm. Mike Keim (*Marin Minerals*) specimens and photos.**



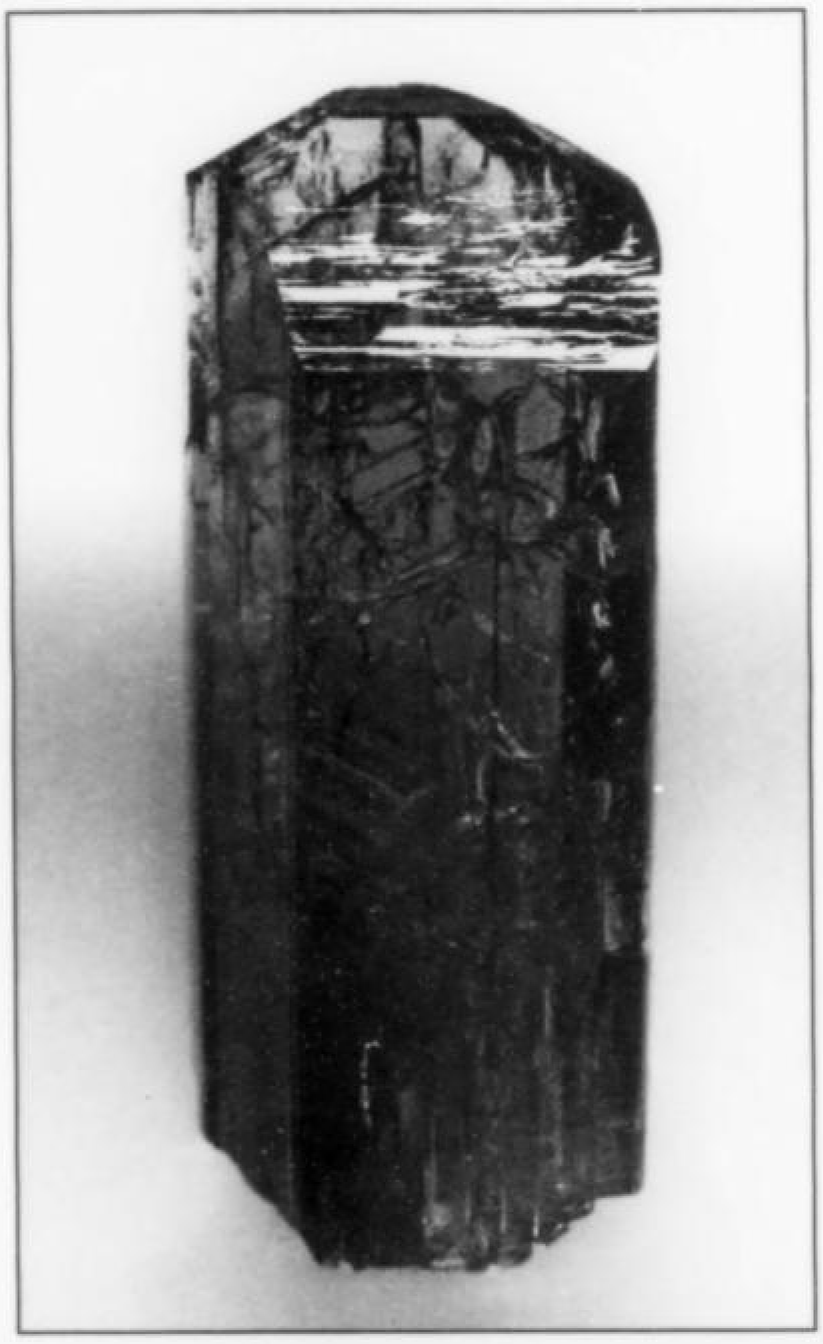


Figure 116. A yellow-green zoisite crystal, 7 cm, from Merelani. Werner Radl (*Mawingu Gems*) specimen and photo.

Figure 115. Brown zoisite crystal, 2.1 cm, with diopside crystals, from Merelani. Mike Keim (*Marin Minerals*) specimen and photo.

Figure 117. Yellow zoisite crystal, 9 cm, from Merelani. Stuart Wilensky specimen, now in a private collection; James Elliott photo.

Figure 118. A yellow zoisite crystal, 1.8 cm, from Merelani. Steve Ulatowski (*New Era Gems*) specimen and photo.

Figure 119. **A yellow zoisite crystal, 2.9 cm, from Merelani. William Larson (*Pala International*) specimen; now Rob Lavinsky (*The Arkenstone*) specimen; Wimon Minorotkul photo.**

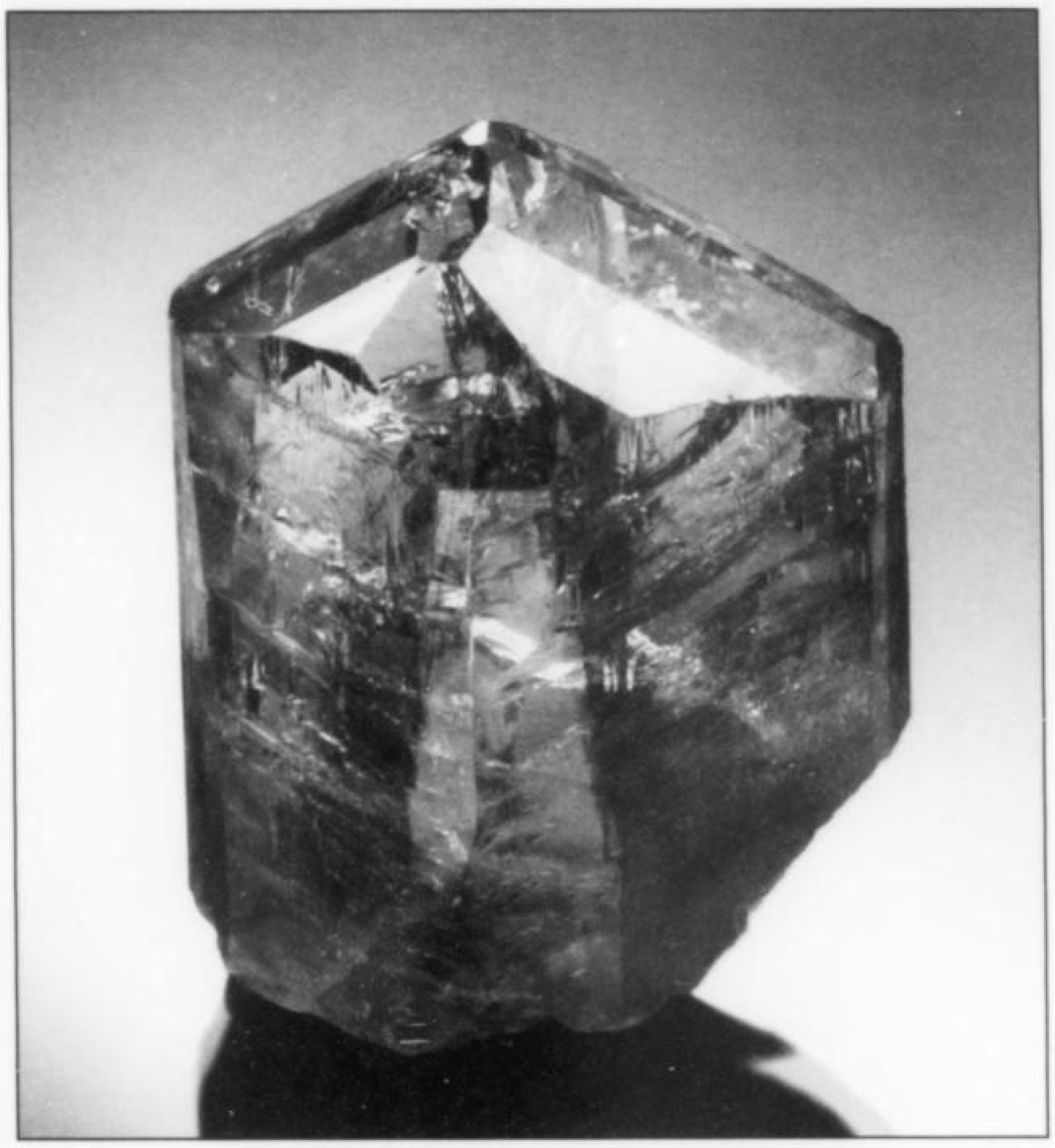
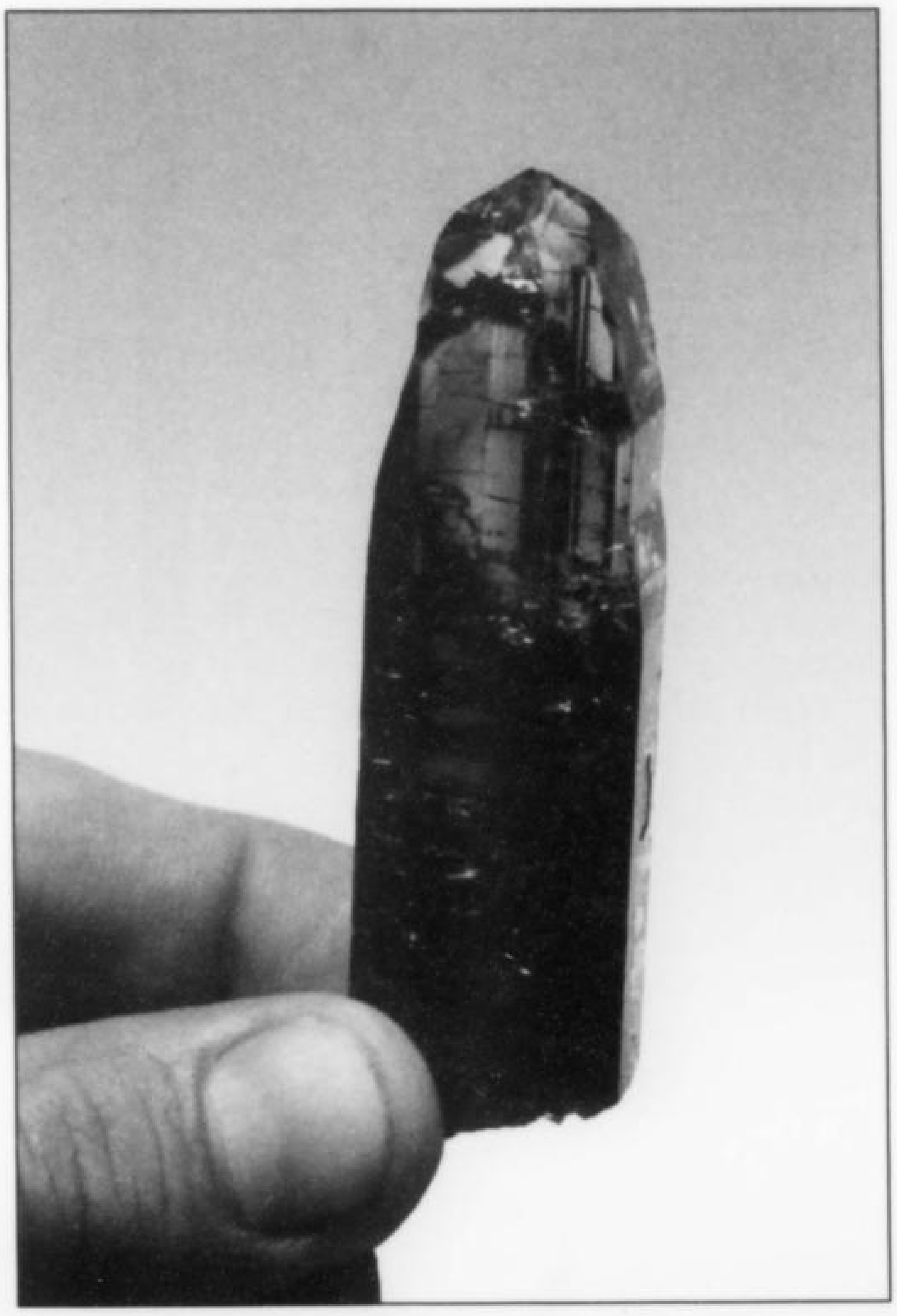


Figure 120. **A yellow zoisite crystal, 2.5 cm, from Merelani. Rob Lavinsky (*The Arkenstone*) specimen and photo.**

Figure 122. **A rare red zoisite crystal, 7 cm, from Merelani. Steve Ulatowski (*New Era Gems*) specimen and photo.**

Figure 121. **A pink zoisite crystal, 1.7 cm, from Merelani. Steve Ulatowski (*New Era Gems*) specimen and photo.**



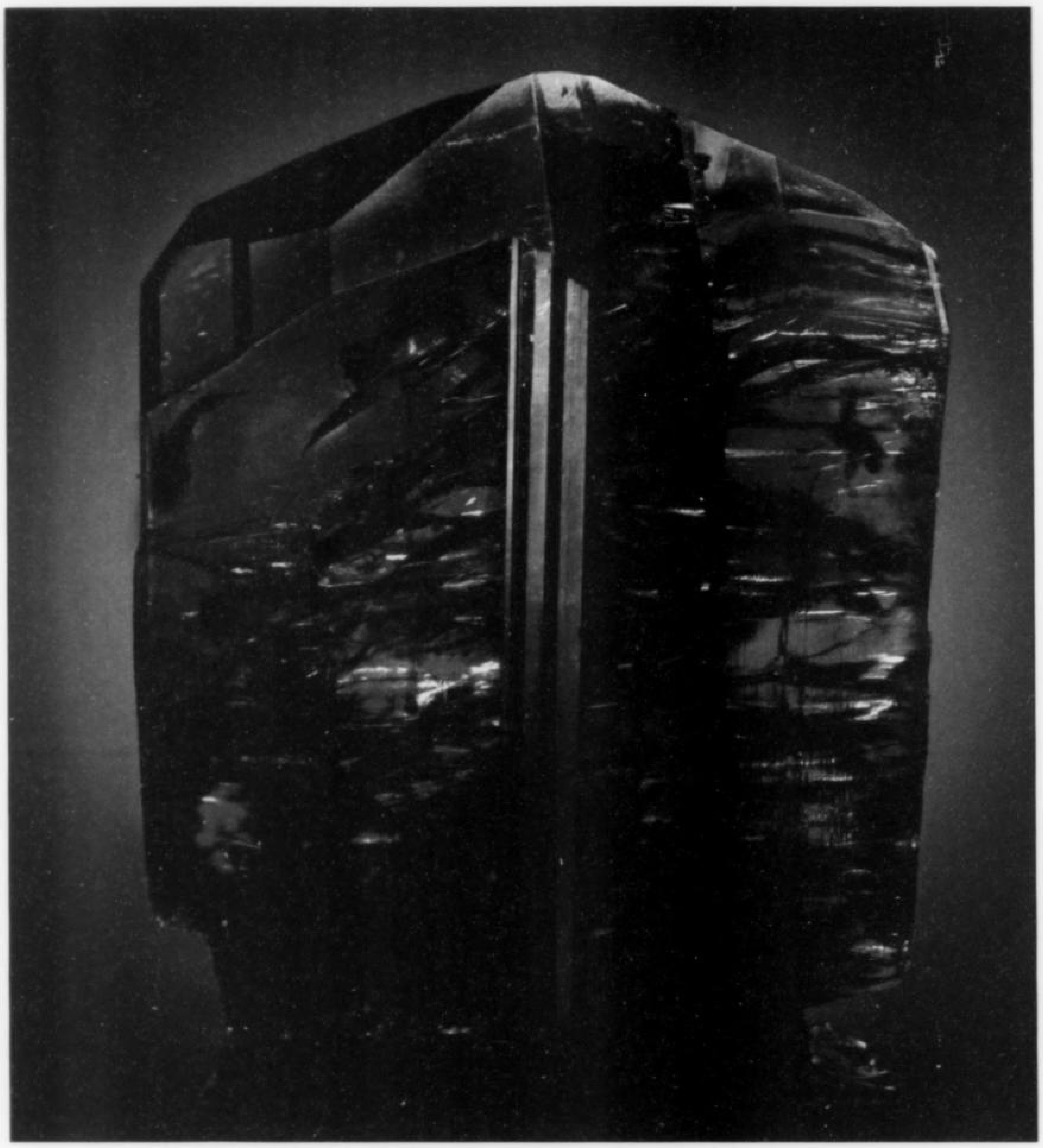


Figure 123. **Spectacular red and purple tanzanite crystal, 11 cm (4.3 inches), from Merelani. Yes, it really is that color; light passing vertically through the red direction is reflected out from internal fractures. Daniel Trinchillo specimen, now in a private collection; James Elliott photo.**

percent V_2O_3, and do not change color significantly in response to heat treatment. The trichroism is different as well: greenish yellow to yellowish brown down the *a* axis, yellowish green down the *b* axis, and bluish green to brownish green down the *c* axis (Schmetzer and Bank, 1979; Barot and Boehm, 1992).

Tanzanite crystals are usually found encased (free-growing pocket crystals are rare) in tough, graphite-rich bytownite-grossular-diopside-zoisite metamorphic vein rock (locally called "merelanite"), sometimes with a halo of white calcite which separates easily from the tanzanite surfaces. Quartz, graphite, pyrite, grossular, diopside, bytownite, dolomite and calcite are the most common associations. Most crystals which reach the specimen market are loose, but occasional matrix pieces show associations of micaceous silvery graphite and pale green gemmy diopside crystals (Moore, 1997). Inclusions observed include rutile, titanite, ilmenite, xenotime, diopside, quartz, calcite, gypsum, tremolite (Barot and Boehm, 1992), and graphite (Dunn, 1975). Two-phase fluid inclusions with movable bubbles are also known; and acicular inclusions aligned in parallel fashion can impart a cat's-eye effect (Bank, 1971).

The largest crystal of gem tanzanite known to survive uncut measures 7 × 8 × 22 cm and weighs more than 3 kg (16,839 carats). It was found in July 2005 at the 270-meter level of the Bravo shaft in Block C, and has been named the "Mawenzi," after Mount Kilimanjaro's second highest peak (leaving room for an even larger crystal to be found some day, and named "Uhuru" after the highest peak). The TanzaniteOne company has decided to retain the crystal in its uncut state, as an exhibit specimen, though it is currently kept in a vault because of its high value. There is talk of showing it at the Tanzanite Experience museum if adequate security measures can be put in place.

A still larger crystal, weighing 7 kg and said to possess excellent color and clarity, was reported by miners from the Vietnam Camp mine in Block D (Johnson and Koivula, 1996), but was never photographed and has probably been cut up. Generally the largest fine crystals measure no more than about 10 or 12 cm. One of the largest gem tanzanite crystals was found in the 1960s; it weighed 2,500 carats uncut, and yielded a 360-carat cut gemstone (Thompson, 1969). Another cut stone which was claimed to be the largest known is a 242-carat gem in the Michael Scott collection called the "Queen of Kilimanjaro," set in a tiara which is currently on exhibit in the Royal Ontario Museum. However, the Tanzanite Foundation exhibited an eye-clean, cushion-cut, 525.55-carat stone at the 2009 Gem and Jewelry Exchange (GJX) Show in Tucson last February; it measures 2.8 × 4.5 × 5.1 cm. The rough crystal was found in 2008 in Block C and was faceted in Jaipur, India.

Fine specimens, assuming good color and gemminess, are necessarily priced at their gem value, and consequently the vast majority are cut. Supplies of smaller-size collector crystals have fluctuated, of course, but satisfyingly generous lots have come through from time to time. Over the past 15 years or so, it has not been too unusual to see selections of beautiful blue, loose, singly terminated gem crystals in thumbnail sizes priced somewhere in the three to low four-figure range. Many crystals on the collector market come from the native blocks, especially Block D where the best color is found in the deepest shafts, but TanzaniteOne is now selling crystals from its Block C operation through the Tanzanite Experience museum in Arusha.

Mike Nunn, former Chief Executive of African Gem Resources Ltd., has estimated that the wholesale market for tanzanite is between $150 million and $300 million per year; others put the estimate at over $500 million in the U.S. alone. Production of tanzanite amounted to nearly 8,000 kg in 1997, but by 2005 had fallen to about 2,000 kg (Sanga, 2006). The majority of the TanzaniteOne Company's customers for rough tanzanite mined from Block C are based in India, and most have wholesale outlets in the U.S. It is estimated that at least 80% of all rough tanzanite is cut and polished in India for eventual sale, primarily to the U.S. but also to countries in the Far East.

Other Species

A number of other species have been reported from Merelani, though not in collector-quality crystals. Hematite and the sulfides chalcopyrite, pyrrhotite and sphalerite occur with pyrite in the

***Figure 124.* Lobby area in the Tanzanite Experience Museum in Arusha. Photo courtesy of TanzaniteOne.**

***Figure 125.* Display area in the Tanzanite Experience Museum in Arusha. Photo courtesy of TanzaniteOne.**

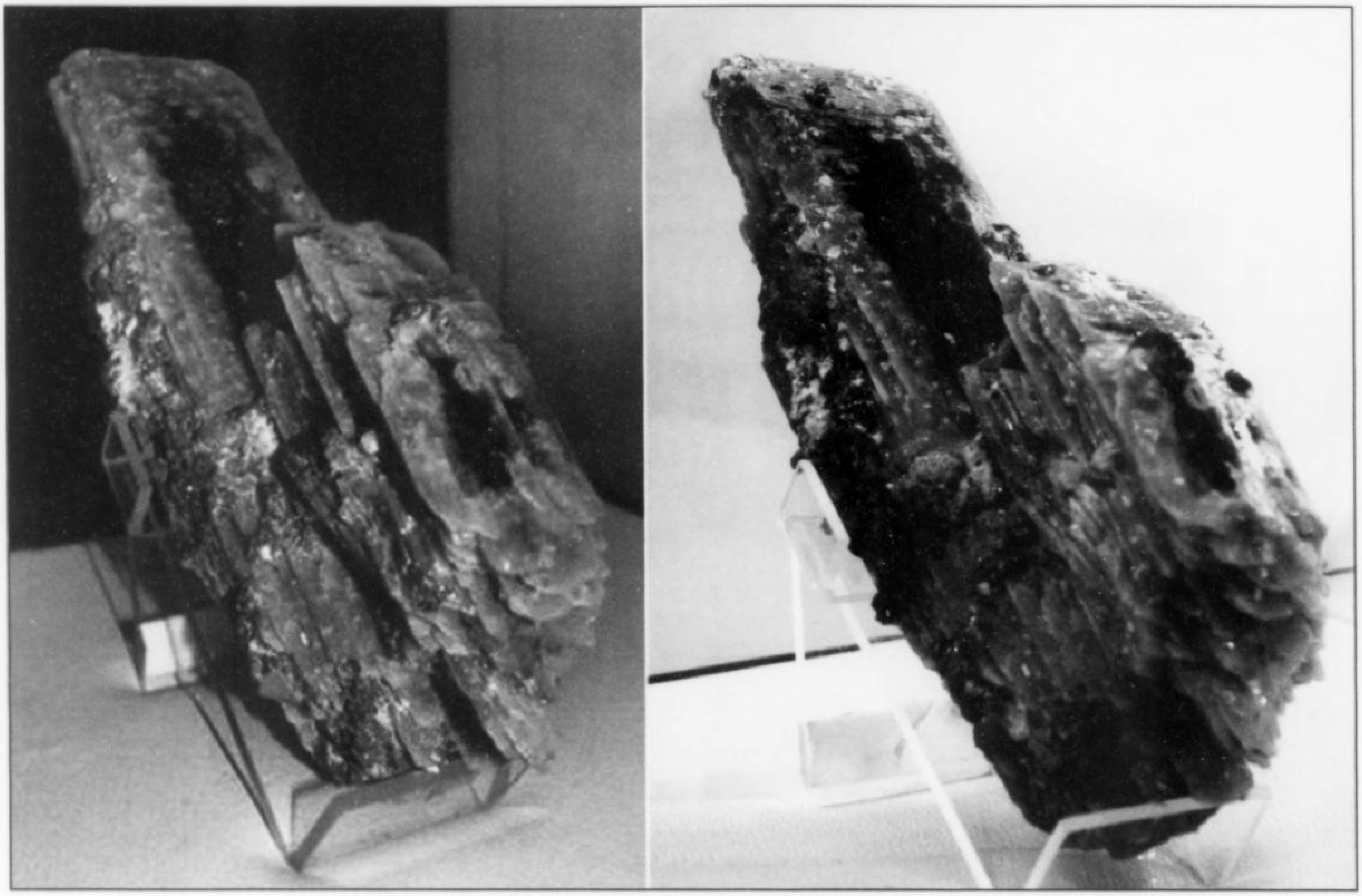


Figure 126. **Two views of the largest known tanzanite specimen from Merelani, found in the Main Shaft, Level 18, of the TanzaniteOne mine by Damian Masala on June 19, 2008. It weighs 6.5 kg (14.3 pounds), and is too heavily included to yield gem material, so it has been preserved as a museum specimen. Photos courtesy of the Tanzanite Experience Museum, Arusha.**

massive veins associated with the boudins. Calcite, siderite and gypsum occur as late-stage minerals, along with various zeolites. The rare vanadium oxide mineral karelianite (as black particulates) occurs near the boudins. Rock-forming minerals such as kyanite, vanadian phlogopite, fuchsite, quartz, sillimanite, and tourmaline group species occur in the vein rock. Pegmatitic zones may contain muscovite books and large microcline crystals.

Single crystals of a scapolite group mineral from the Merelani mines have been offered for sale by a number of dealers. The crystals are generally yellow to pale yellow, yellow-green, pale orange or red-orange, the red color said to come from inclusions of cinnabar; they also fluoresce red under shortwave ultraviolet light. The crystals are roughly equant to somewhat elongated, with striated prism faces and pyramidal terminations; they measure around 1 to 1.5 cm. Closely similar crystals are known from the Morogoro and Dodoma regions in Tanzania, and it is likely that the purported Merelani specimens are simply mislabeled. However, John Saul (personal communication) has a specimen of bluish massive material from the tanzanite ridge that has been identified by X-ray diffraction as scapolite, though it bears no resemblance to the pale yellow crystals.

Buyers of gem parcels from Merelani should be aware that fragments of clear, colorless glass are occasionally included in lots of tanzanite. Its origin is unclear; it contains bubbles, and at least one analysis has shown traces of lead, but the glass may also have graphite adhering to the surface. It has been suggested that the glass may be a byproduct of the heat treatment of tanzanite.

THE TANZANITE MUSEUM

In August 2008, TanzaniteOne opened the world's only tanzanite museum in Tanzania's tourist hub city of Arusha. Located on the third floor of the Blue Plaza building, next to the New Safari Hotel on India Street, this special museum, which has been christened "The Tanzanite Experience," operates under the auspices of the Tanzanite Foundation, a subsidiary of TanzaniteOne Mining Ltd.

The tanzanite museum incorporates, among other things, an auditorium capable of seating 25 people, with the latest audiovisual equipment. Visual and interactive exhibits and programs show representative crystals, unusual specimens, cut tanzanite gems and artifacts, and illustrations recounting the history of tanzanite discovery, mining and gemstone production. Faceted tanzanite gems as well as collector-quality crystals are available for sale in the museum. Zane Swanepoel is managing director for "The Tanzanite Experience," aimed primarily at the tourist market.

ACKNOWLEDGMENTS

We would like to thank Dr. Anthony Kampf, Dr. Robert Downs, Dr. Bruce Cairncross, Thomas Gressman and Thomas Moore for their assistance with the literature search and for reviewing the manuscript. Likewise Marcal "Angelo" de Souza kindly provided much early historical information and reviewed the manuscript, offering many helpful suggestions. Ed Swoboda recounted his early recollections and provided some illustrations; and Dennis Tanjeloff kindly provided information on his grandfather Julio's tanzanite specimens. We are also grateful to Dr. Robert Downs at the University of Arizona for

Visting Block D
(October 2007)

by Vincent Pardieu and Richard W. Hughes (adapted from Pardieu and Hughes, 2008)

Having already visited the highly modern and professional TanzaniteOne operation in Block C, we decided that we wanted to see how the other half lives down in Block D. We began at the local mining office in Merelani village in order to obtain their approval for our visit to the mines. Driving through the Merelani streets, it was clear we were a long, long way from the civilized and professional TanzaniteOne mining operation on the hill. We passed dilapidated saloons, pool halls, brothels and houses of worship. Like mining towns around the world, Merelani was equal parts sin and sincerity.

Leaving Merelani, we passed near Machakecho, a large mining area located on the way to the different mining blocks. Many small-scale miners there had dug hundreds of pits and holes in an alluvial deposit. The area was quite interesting, as we were lucky to have nice weather and could take some photos of tanzanite mining with Mount Kilimanjaro in the background.

With our guide leading the way and our permit in hand, we drove onward to Block D, skirting the razor wire boundary of TanzaniteOne's Block C. In numerous places, intruders had cut the fence. It was clear we were riding the border of two entirely different worlds—First and Third—with those on one side not content to stay put.

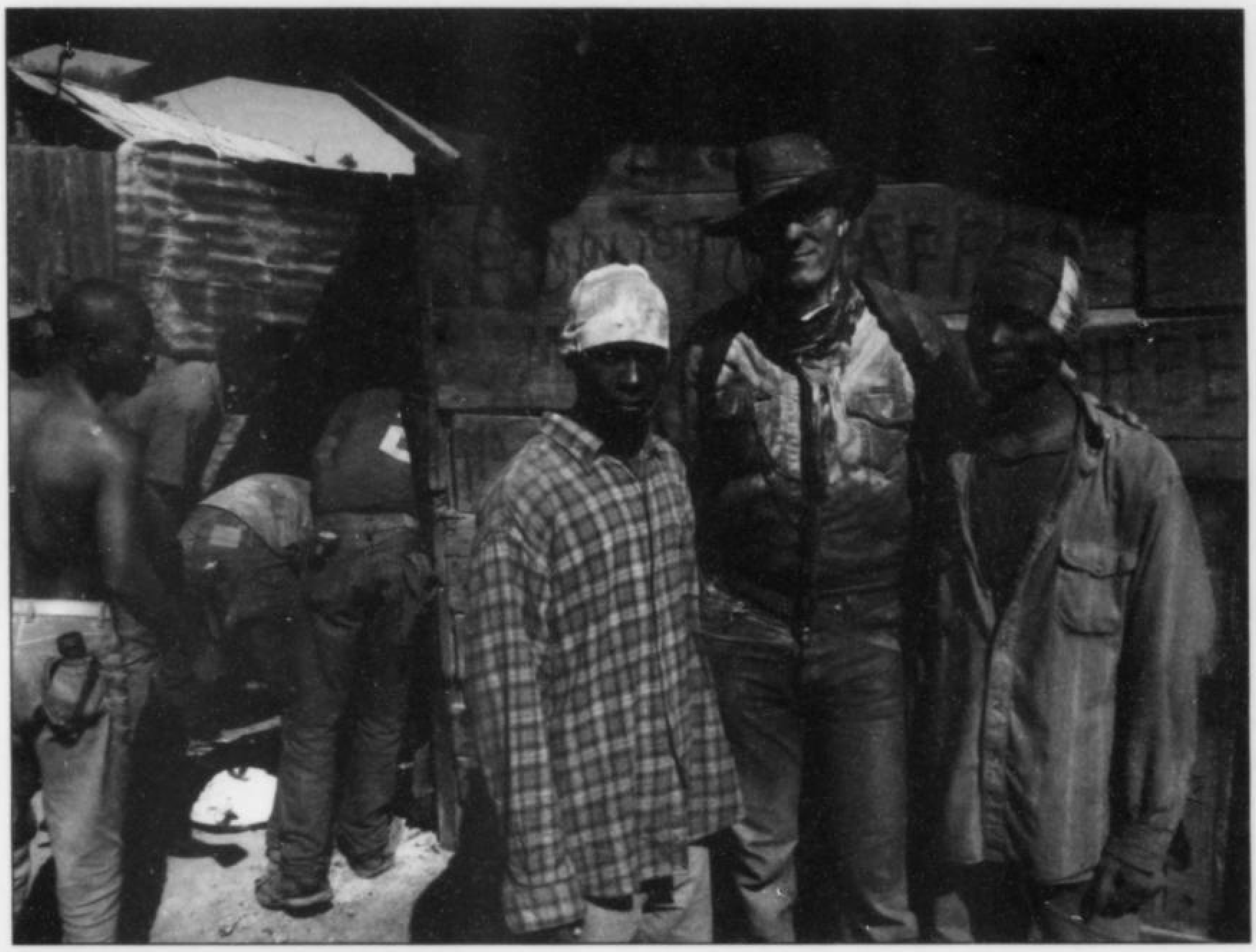


Figure 127. **Vincent Pardeiu with two of the miners in Block D. Richard Hughes photo.**

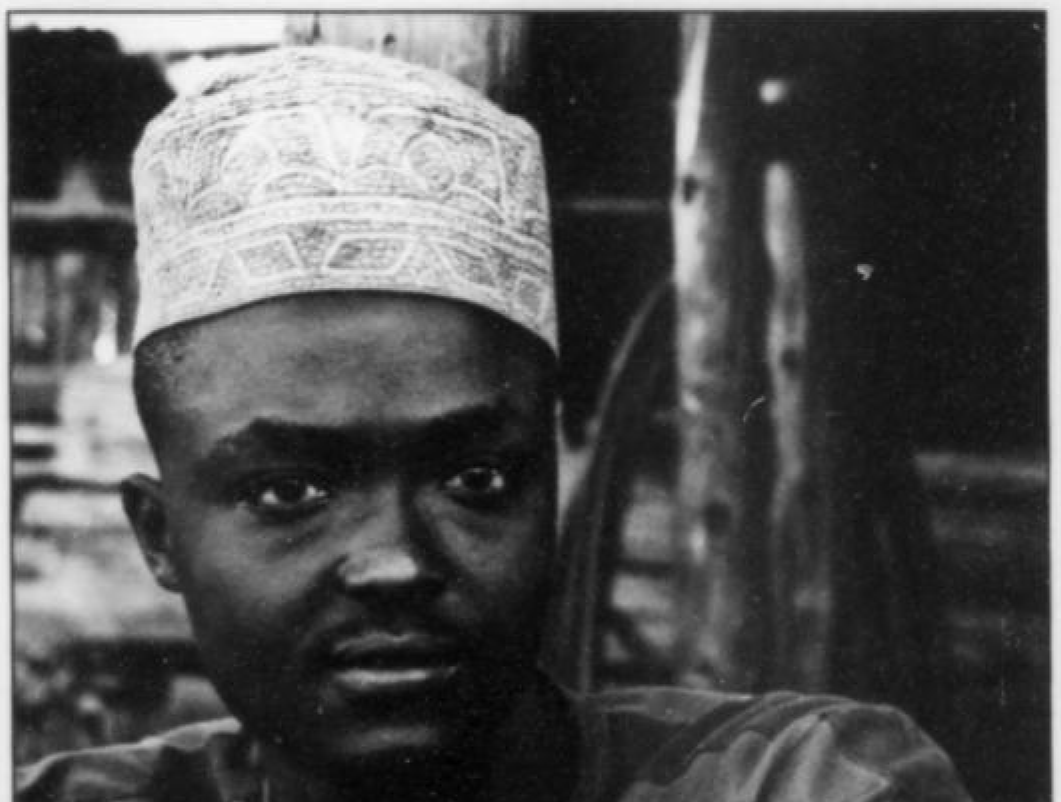


Figure 128. **Nixon Monga, owner of the Kikuyu mine in Block D. Richard Hughes photo.**

Merelani's Block D is a hodgepodge of hundreds of small claims stuffed into a few hundred square meters. Each claim is surrounded by barbed wire-topped tin siding. When we arrived at one called the Kikuyu mine, the gate was eased open and quickly slammed shut behind us. TanzaniteOne's mine was not the only one where claim-jumping was a problem. Indeed, in these "native blocks," the intrusions often come deep underground. Down in these dark tunnels, survival trumps political boundaries.

In this small compound, 60 miners were working underground in teams of 30, in six-hour shifts. The mine manager, Nixon Monga, was our gracious host. Since the death of his father nine years before, this 24-year-old had managed the mine with the help of two partners. He told us that miners had been working for the last two years but had found hardly

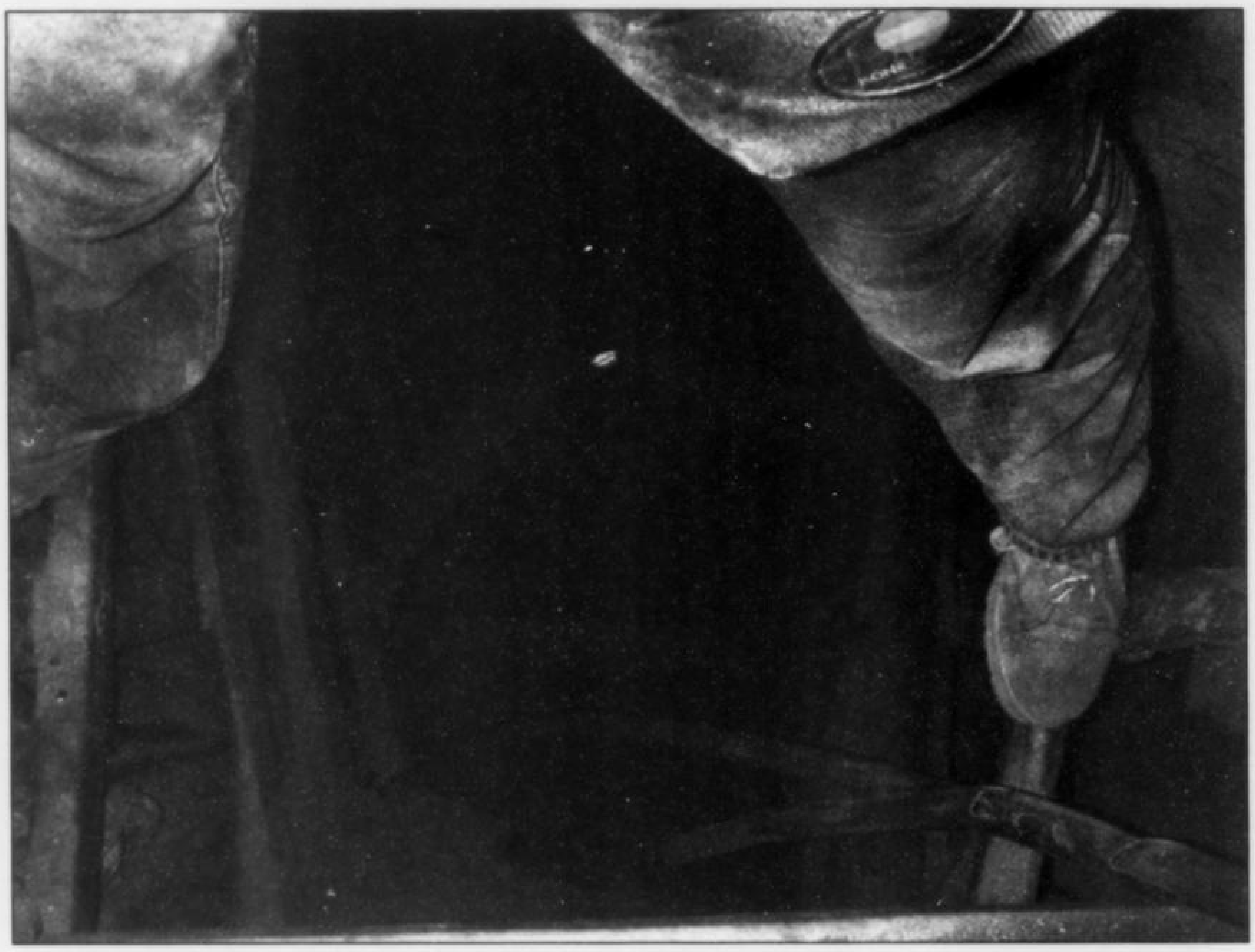


Figure 129. **Preparing to descend a primitive shaft in the Kikuyu mine, Block D. Vincent Pardieu photo.**

anything. The work was becoming increasingly difficult as the workings have gone deeper and deeper.

Going Underground in Block D

As our guides began wrapping their faces with bandanas, we were told that the main shaft begins with a vertical drop of some 100 meters deep, accessed by a wooden ladder. At the bottom the shaft connects to several narrow drifts that extend for some 200–300 meters to the current working face.

At this point three of our group (Richard Hughes, Warne Chitty and Monty Chitty) suggested that someone would certainly be needed to call a doctor should an accident arise. They quickly volunteered, and remained topside, ever vigilant, while the others (Vincent Pardieu, Guillaume Soubiraa, Michael Rogers and Philippe Brunot) proceeded underground.

Richard and Monte noticed that after the other five members of our party had disappeared down the rabbit hole, the occasional miner would emerge from the dark depths, coated head to foot in graphite dust. Following six hours underground, they ran for the fence, rushing to purchase a small bottle of milk or water. It was clear that the conditions underground were desperate.

The vertical descent began, but at intervals along the way down there were several small landings where one could stop and rest a bit. With no rope or hard hat, one could only pray that nobody above would fall or dislodge a large rock during the descent, for that would mean certain death for all unfortunate enough to be on the ladder below.

Arriving at the bottom of the vertical shaft, we were then forced to crawl through narrow passages that, while roughly horizontal, squirmed up and down in an irregular fashion. The task was all the more difficult for the tallest of us, as these passages were no more than a meter high, meaning we were not even able to crawl on hands and knees, but were forced to slither like snakes on our bellies. Occasional cramped encounters with miners passing in the opposite direction left each of us covered in the sweat and grime of the other.

So dense was the graphite-laden atmosphere that we soon had to remove our clogged masks, as breathing carbon was found more pleasant than not breathing at all. We now understood why miners were unwilling to wear helmets: the tunnel was solid rock, and so narrow that wearing a helmet would rapidly become annoying. Hard hats and masks are simply a hindrance when crawling like a rat in such narrow spaces.

After visiting secondary galleries, we arrived at the main working face, which was wider and slightly higher than the approach. A pleasant surprise was a hole from which cold air from the surface poured in. It was a pure wonder to breathe fresh air after an hour spent inhaling hot graphite.

At the working face, the men described what they were doing, excitedly pointing to veins they were mining, following the pyrite and the graphite. We could see in their eyes the excitement and only then did it become clear what was motivating them to work under such extreme conditions. Their fuel was hope—hope to hit a gem pocket, hope to become rich as had happened in the past to others, hope to escape from this carbon-laced tomb. They struggled to explain that, in their village or city slum, they had no chance at a future. But here, deep underground, with hard work and a bucketful of luck, they just might get enough money for a better life. We thought to ourselves that hope was a cruel mistress, but she was the only lady who would have them.

After hours underground, we began the long trip to the surface. Going up was much more difficult than going down. The tunnels were dry, dusty, and parched with graphite. Many times we had to stop simply to be able to breathe. The miners helping us smiled, explaining that this was normal for the first time, but we would get used to it. Could people really get used to this?

Eventually we reached the wooden ladder and began to climb. By now, exhaustion had set in and the only focus was

Figure 130. **Guillaume Soubiraa and Philippe Brunot (center) underground in the Kikuyu mine, Block D. Vincent Pardieu photo.**

on not falling. Meter by meter we ascended toward the light. The air gradually became better and, as we looked up, a tiny circle of light was becoming visible. Step by step we climbed, the circle growing ever larger. Just a few more steps . . .

Like black ghosts we emerged on the surface and collapsed, gasping for breath, without the strength even to hold the waiting water to our lips. The miners were smiling and laughing. Within a few hours they would go down again, not to visit, but to work, to break rocks in their search for a few sparkling crystals in a black world.

We have spent years visiting gem mines across the world and have borne witness to scenes of tremendous hardship. But on that October afternoon, none of us was prepared for the spectacle that unfolded as we watched miners crawl from the graphite-laced depths of Merelani. Gasping for air, covered with sweat, as they emerged from below and the sun's rays struck their skin, they sparkled! Each miner had, in a macabre sense, become a jewel—shining, shimmering and glittering.

In March 2008, several months following our departure, heavy rains swept across Tanzania. Once again, as had happened catastrophically in 1998, a number of the Merelani tanzanite mines were flooded and, tragically, many died, trapped deep underground. As we read of these tragedies, we were reminded of crawling through the terrible tanzanite tunnels ourselves. What if, instead of being dry, these shafts had been wet and slippery, with flash-flood waters pouring in? What if? It is simple. Some of us might have died. When we learned of the tragedy, we had no difficulty imagining what the miners' last moments must have been like.

Despite the deaths, miners continue to descend into Merelani's depths in search of tanzanite. Incredible stones, incredible conditions and incredible men to volunteer for such a hard job. We have tremendous admiration for these men. People like Izrael Deo and Tobias Stanslaus, the two who took us down into their world and brought us back alive. Izrael, a young educated Tanzanian, spoke good English. He told us that he decided to quit school and go mining with his father because he wanted to earn enough money for a good life in the future. Each time we see a tanzanite crystal or a large Merelani tsavorite we think about you guys—about you and about these tunnels. We wish you all the best.

providing the Raman analysis of the yellow zoisite, and Bart Cannon of Cannon Microprobe for the trace element analysis.

For the illustrations we are indebted to Bijoux Extraordinaire, Bruce Bridges, Joe Budd, Marcus Budil, Ralph Clark, the family of Manuel de Souza, James Elliott, Megan Foreman, Sandor Fuss, Gemshare, Dr. John Jaszczak, Dr. Anthony Kampf, Mike Keim, Rick Kennedy, Hamza Kondo, William Larson, Dr. Rob Lavinsky, Simon Lawrence, Carolyn Manchester, John McLean, Oleg Lopatkine, Dr. Gene Meieran, Wimon Minorotkul, Werner Radl, Edward Rosenzweig, Scott Rudolph, Eric Saul, Mark Saul, Jeff Scovil, Andy Seibel, Tom Spann, Jeffrey Starr, Jason Stephenson, Wayne Thompson, Daniel Trinchillo, Steve Ulatowski, Harold and Erica Van Pelt, Marc Weill, Dan Weinrich, Stuart Wilensky, Valerio Zancanella, the Houston Museum of Natural Science, and the Gemological Institute of America. We would also like to thank Zina Dale of the Tanzanite Experience museum in Arusha for information and photos.

Authors VP and RWH would like to thank all those who assisted in their journey: We extend gracious thanks to our guide, Abdul Y. Msellem, whose knowledge of Tanzania's gem mines is second to none. We also extend thanks to Mark and Eric Saul of Swala Gem Traders—who did everything in their power to make our journey a successful one—and to our drivers, Musa and Abel, who kept us on the proper path and made sure we did not get into more trouble than we deserved. And we wish to thank Kennedy and Suzie Kamwathi of Kennedy's Gems in Nairobi for all their help with our journey, as well as Nixon Monga, Izrael Deo and Tobias Stanslaus of Merelani's Block D mines. A very special thanks goes out to Ian Harebottle, Zane Swanepoel, Robert Grafen-Greaney, Gabriella Endlin, Hayley Henning and the rest of the TanzaniteOne and Tanzanite Foundation staff.

NOTE added in proof:

We regret to announce that the well-known British geologist and gem explorer Campbell R. Bridges (see page 358–359) was ambushed and murdered in Kenya on August 11 by an armed group of unlicensed miners who had been illegally digging gems on the family's 600-hectare mine concession. His son, Bruce Bridges, survived the attack. (*The Times*, London, August 13, 2009).

BIBLIOGRAPHY

ANDERSON, B. W. (1968) Triple bill: three items of interest to gemmologists. *Journal of Gemmology*, **11**, 1–3.

ANDREOZZI, G. B., LUCCHESI, S., and GRAZIANI, G. (2000) Structural study of magnesioaxinite and its crystal-chemical relations with axinite-group minerals. *European Journal of Mineralogy*, **12**, 1185–1194.

ANONYMOUS (1968) Tiffany discloses finding what may be a new gem. *Wall Street Journal*, October 14, p. 4.

ANONYMOUS (1998) Tanzania disaster. *The Mining Journal*, **330** (8476) (April 17).

ANONYMOUS (2009) Report: TanzaniteOne defers production. *National Jeweler* (nationaljewelnetwork.com), posted May 7.

BAGNALL, S. (1964) Geological relationships in N.E. Tanganyika and their bearing on the granulite problem. *University of Leeds, Research Institute on African Geology, Annual Report*, 35–36.

BANCROFT, P. (1984) Gem *and Crystal Treasures*. Western Enterprises/Mineralogical Record, Tucson, 303–306.

BANK, H., BERDESINSKI, W., and NUBER, B. (1967) Strontiumhaltiger trichroitischer Zoisit von Edelsteinqualität. *Zeitschrift der Deutschen Gesellschaft für Edelsteinkunde*, **61**, 27–29.

BANK, H. (1968) Neuer Varietätsname für trichroitischen strontiumhaltigen Zoisit von Edelsteinqualität—Tansanit? *Zeitschrift der Deutschen Gesellschaft für Edelsteinkunde*, **64**, 27–29.

BANK, H. (1969) Hellbrauner bis farbloser durchsichtiger Zoisit aus Tansania. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **18** (2), 61–65.

BANK, H., BERDESINSKI, W., and OTTEMANN, J. (1970) Durchsichtiger smaragdgrüner Grossular aus Tansania. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **19** (1), 4–7.

BANK, H. (1971) Zoisit-Katzenaugen aus Tansania. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **20** (4), 175–176.

BARLOW, F. J. (1996) *The F. John Barlow Mineral Collection*. Sanco Publishing, Appleton, Wisconsin, p. 98.

BAROT, N. R., and BOEHM, E. (1992) Gem-quality green zoisite. *Gems & Gemology*, **28** (1), 4–15.

BECKWITH, P. J., DUTTON, D. R., and TROUP, G. J. (1972) Optical and radio frequency spectroscopy of impurities in blue zoisite. *Australian Gemmologist*, **11**, 20–22.

BELOV, N. V., and RUMANOVA, I. M. (1953) Kristallocheskya struktura epidota $Ca_2Al_2FeSi_3O_{12}(OH)$. *Doklady Academia Nauk USSR*, **89** (5), 853–856.

BELOV, N. V., and RUMANOVA, I. M. (1954) Kristallocheskya struktura epidote. *Trudy Inst. Kristallography, Academia Nauk SSSR*, **9**, 103–164.

BREIT, G. N., and WANTY, R. B. (1991) Vanadium accumulation in carbonaceous rocks: a review of geochemical controls during deposition and diagenesis. *Chemical Geology*, **91**, 83–97.

BRIDGES, C. R. (1982) Gemstones of East Africa. *In* International Gemological Symposium Proceedings, Santa Monica, CA., Gemological Institute of America, pp. 266–275.

BRIDGES, C. R. (2009) Tanzanite. [Online article at www.tsavorite.com.]

BRUCE, G. A. (1968) Zoisite, a new gem discovery. *Rocks & Minerals*, **43**, 332–334.

CHACHAGE, S. L. (1995) The meek shall inherit the earth but not the mining rights: The mining industry and accumulation in Tanzania. *In* P. Gibbon (ed.), *Liberalised Development in Tanzania*. Uppsala: Nordiska Afrikainstitutet.

CHIKAYAMA, A. (1975) New localities of gemstones in eastern Africa. *Hō seki Gakkai shi [Gemmological Society of Japan]*, **2**, 3–14.

CÍLEK, V. (1980) The geology of the Merelani tanzanite deposit. *Sbornik Geologicktch Ved, Loziskova Geologie Mineralogie*, **21**, 183.

COAKLEY, G. J. (1996) *The Mineral Industry of Tanzania*. 4 p. Minerals .usgs.gov.

CROWNINGSHIELD, R. (1967) Developments and highlights at the gem trade lab in New York: Blue zoisite. *Gems & Gemology*, **12** (7), 201–204.

CROWNINGSHIELD, R. (1968) Developments and highlights at the gem trade lab in New York: Blue zoisite. *Gems & Gemology*, **12** (9), 277.

DAVIES, C., and CHASE, R. J. (1994) The Merelani graphite-tanzanite deposit, Tanzania: an exploration case history. *Exploration Mining Geology*, **3** (4), 371–382.

DIRLAM, D. M., MISIOROWSKI, E. B., TOZER, R., STARK, K. B., and BASSETT, A. M. (1992) Gem wealth of Tanzania. *Gems & Gemology*, **28** (Summer), 80–102.

DOLENC, M. (1976) Das tansanitvorkommen Merelani in Tanzania. *Zeitschrift der Deutsche Gemmologischen Gesellschaft*, **25**, 86–95.

DOWNS, R. T. (2006) The RRUFF Project: an integrated study of the chemistry, crystallography, Raman and infrared spectroscopy of minerals. *Program and Abstracts of the 19th General Meeting of the International Mineralogical Association in Kobe, Japan*. O03–13

DUNN, P. J. (1975) Notes on inclusions in tanzanite and tourmalinated quartz. *Journal of Gemmology*, **14**, 335–338.

EPPLER, W. F. (1969) Einschlüsse im blauen Zoisite. *Zeitschrift der Deutsche Gemmologischen Gesellschaft*, **18**, 56–60.

FAYE, G. H., and NICKEL, E. H. (1971) On the pleochroism of vanadium-bearing zoisite from Tanzania. *Canadian Mineralogist*, **10**, 812–821.

FEDERMAN, D. (1991) Update on Tanzania mining, in Gem news. *Gems & Gemology*, **27** (4), 262.

FESENKO, E. G., RUMANOVA, I. M., and BELOV, N. V. (1955) Kristallocheskya struktura tsoizita. *Doklady Academia Nauk USSR*, **102**, 275–278.

FLEISCHER, M., and CABRI, L. (1976) New mineral names. *American Mineralogist*, **61**, 502–504.

FRITZ, E. A., LAURS, B. M., DOWNS, R. T., and COSTON, G. (2007) Yellowish green diopside and tremolite from Merelani, Tanzania. *Gems & Gemology*, **43**, 146–148.

GHOSE, S., and SANG, T. (1971) Ordering of V^{2+}, Mn^{2+}, and Fe^{3+} ions in zoisite, $Ca_2Al_3Si_3O_{12}(OH)$. *Science*, **171**, 374–376.

GIULIANI, G., FRANCE-LANORD, C., CHEILLETZ, A., COGET, P., BRANQUET, Y., and LAUMONIER, B. (2000) Sulfate reduction by organic matter in Colombian emerald deposits: chemical and stable isotope (C, O, H) evidence. *Economic Geology*, **95**, 1129–1153.

GIULIANI, G., OHNENSTETTER, D., PALHOL, F., FENEYROL, J., BOUTROY, E., De BOISSEZON, H., and LHOMME, T. (2008) Karelianite and vanadian phlogopite from the Merelani Hills gem zoisite deposit, Tanzania. *Canadian Mineralogist*, **46** (5), 1183–1194.

GOLD, T. (1992) The deep hot biosphere. *Proceedings of the National Academy of Sciences*, **89** (13), 6045.

GÜBELIN, E. J., and WEIBEL, M. (1976) Neue Untersuchungen am blauen Zoisit (Tansanit). *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **25** (1), 23–32.

GÜBELIN, E. (1992) Green zoisite, *not* green tanzanite. *Gems & Gemology*, **28** (2), 140.

HURLBUT, C. S. (1969) Gem zoisite from Tanzania. *American Mineralogist*, **54** (5/6), 702–709.

HUTTON, D. R., TROUP, G. J., and STEWART, G. A. (1971) Paramagnetic ions in zoisite. *Science*, **174**, 1259.

IHUCHA, A. (2005) Tanzanite miners in bitter row over boundaries. IPP Media.

ITO, T. (1950) *X-ray Studies on Polymorphism*. Tokyo.

ITO, T., MORIMOTO, N., and SADANAGA, R. (1954) On the structure of epidote. *Acta Crystallographica*, **7**, 53–59.

JAHN, S. (2002) China und mehr—Neuigkeiten von der 24. Börse in Bad Ems 2002. *Mineralien Welt*, **13** (4), 4–5.

JOBBINS, E. A., TRESHAM, A., and YOUNG, B. R. (1975) Magnesioaxinite, a new mineral found as a blue gemstone from Tanzania. *Journal of Gemmology*, **14**, 368–375.

JOHNSON, M. L., and KOIVULA, J. I. (1996) Update on tanzanite mining, *in* Gem News. *Gems & Gemology*, **32** (2), 135.

KANE,R. E., KAMPF, A. R., and KTUPP, H. (1990) Well-formed tsavorite gem crystals from Tanzania. *Gems & Gemology*, **26** (2), 142–148.

KELLER, P. C. (1992) *Gemstones of East Africa*. Phoenix, Geoscience Press [with photos by E. J. Gübelin], 160 p.

KONDO, H. (2005a) The women of tanzanite. *Colored Stone.com*, July/August.

KONDO, H. (2005b) Mining interrupted. *Colored Stone.com*, July/August.

KOIVULA, J. I., and KAMMERLING, R. C. (1991) Update on tanzanite mining, *in* Gem News. *Gems & Gemology*, **27** (winter), 262.

LANGE, S. (2006) *Benefit Streams from Mining in Tanzania: Case Studies from Gaita and Mererani*. Chr. Michelsen Institute, Bergen, Norway.

LARENAUDIE, S. (2007) Romancing a new stone. *Time* magazine, Thursday, March 1.

LIDDICOAT, R. T. (1963) Developments and highlights at the gem trade lab in Los Angeles. *Gems & Gemology*, **11** (2), 55–56.

LIDDICOAT, R. T. (1967) Developments and highlights at the gem trade lab in Los Angeles: Blue zoisite. *Gems & Gemology*, **12** (8), 247–248.

LIDDICOAT, R. T., and CROWNINGSHIELD, G. R. (1968) More about zoisite. *Lapidary Journal*, **22** (September), 736–740.

MacFARLANE, A. (1975) Brief explanation of the geology of Q.D.S. 72, Arusha Chini geologic map, scale 1:125,000. Mineralogical Resources Division of Tanzania, Dodoma.

MALISA, E. P., KINNUNEN, K., and KOLJONEN, T. (1986) Notes on fluid inclusions of vanadiferous zoisite (tanzanite) and green grossular in the Merelani area, northern Tanzania. *Bulletin of the Geological Society of Finland*, **58** (2), 53–58.

MALISA, E. P. (1987) Geology of the Tanzanite Gemstone Deposits in the Lelatema Area, NE Tanzania. Ph.D. Thesis. *Ann. Academicae Scintiarum Fennicae* **111**, *Geologica-Geographica*, **146**, 160 pp.

MALISA, E. P., and MUHONGO, S. (1990) Tectonic setting of gemstone mineralization in Proterozoic metamorphic terrane of the Mozambique Belt in Tanzania. *Precambrian Research (III)*, **46** (1–2), 167–176.

MALISA, E. P. (1998) Application of graphite as a geothermometer in hydrothermally altered metamorphic rocks of the Merelani-Lelatema area, Mozambique Belt, northeastern Tanzania. *Journal of African Earth Sciences*, **26** (2), 313–316.

MALISA, E. P. (2003a) Trace elements characterization of the hydrothermally deposited tanzanite and green grossular in the Merelani–Lelatema shear zone, northeastern Tanzania. *Tanzania Journal of Science*, **29** (1), 45–60.

MALISA, E. P. (2003b) Petrology and lithogeochemistry of the mineralized tanzanite-grossular bearing rocks in the Merelani–Lelatema area, northeastern Tanzania. *Tanzania Journal of Science*, **29** (2), 55–70.

MASLAND, T. (2005) The dark side: dead for dollars. *Newsweek*, July 11.

MAYAGE, M. S. (2008) Jumanne Ngoma: Mgunduzi wa tanzanite anayeetaabika ("Jumanne Ngoma: The discoverer of tanzanite who is suffering"). *Rai Gazeti la kila wiki*, January 2, 2008.

MEEN, V. B. (1968) Zoisite—a newly found gem. *Lapidary Journal*, **22**, 636–637.

MOORE, T. P. (1996) What's new in minerals. *Mineralogical Record*, **27**, 220.

MOORE, T. P. (1997) What's new in minerals. *Mineralogical Record*, **28**, 60.

MOORE, T. P. (2000) What's new in minerals. *Mineralogical Record*, **31**, 280.

MOORE, T. P. (2006) What's new in minerals. *Mineralogical Record*, **37**, 245.

MOORE, T. P. (2007) What's new in minerals. *Mineralogical Record*, **38**, 220.

MOORE, T. P. (2009) What's new in minerals. *Mineralogical Record*, **40**, 76–77.

MUSHI, D. (2008) The Mererani gemstone mining site catastrophe. *Daily News Online*, April 2, 2008.

NAESER, C. W., and SAUL, J. M. (1974) Fission Track Dating of Tanzanite. *American Mineralogist*, **59**, 613–614.

NEUENDORF, K. K. E., MEHL, J. P., Jr., and JACKSON, J. A. (2005) *Glossary of Geology*. Fifth edition; American Geological Institute, Alexandria, Virginia, p. 656.

NOVÁK, M., and FILIP, J. (2002) Ferroan magnesioaxinite from hydrothermal veins at Lažany, Brno Batholith, Czech Republic. *Neues Jahrbuch für Mineralogy, Monatsheft*, **2002** (9, Sept.), 385–399.

NYAMBURA, H. (2004) From herders to gem dealers, Tanzania's Maasai reborn. *Reuters News Media*, December 10, 2004.

OLIVIER, B. (2006) The geology and petrology of the Merelani tanzanite deposit, NE Tanzania. PhD dissertation, Stellenbosch University, South Africa.

PARDIEU, V., and HUGHES, R. W. (2008) *Working the Blue Seam: The Tanzanite Mines of Merelani*. See: www.ruby-sapphire.com/tanzania-tanzanite-mines.htm and http://www.fieldgemology.org.

PATRICK, J. (1985) Letter to the editor. *Modern Jeweler*, **84** (1), 6–7.

REES-MOGG, A. (2005) Move over diamonds; it's tanzanite's turn to shine. *MoneyWeek*, December 15.

RIPLEY, E. M., SHAFFER, N. R., and GILSTRAP, M. S. (1990) Distribution and geochemical characteristics of metal enrichment in the New Albany shale (Devonian–Mississippian), Indiana. *Economic Geology*, **85**, 1790–1807.

RÖSCH, S. (1970) Die Farben des blauen Zoisits von Tansania. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **19**, 103–115.

ROSKIN, G. (2008) 57 dead, 17 missing from tanzanite mine floods. *Jewelers Circular Keystone*, JCKOnline.com, April 30.

ROSSMAN, G. (2007) Zoisite visible spectra (400–1000 nm). Caltech online mineral spectroscopy database.

RUKONGE, A. (2006) The Socio-economic Impact of Transnational Corporation on Mining Community and Artisanal Small-scale Miners. A case study of Mererani Tanzania. Master's Thesis, Jyväskylä University, Finland, 105 p.

SANGA, S. P. (2006) *The Role of Poor Governance in the Tanzanite-Al Qaeda Link Controversy, and Policy Options for Tanzania Enabling it to Escape from 'Curses' in the Mining Industry*. Center for Policy Studies, Open Society Institute International Policy Fellowship Program, 2006–2007, Budapest, Hungary, 85 p.

SARBAS, B., GEORG, U., AMSTUNTZ, G. C., SCHMETZER, K., and BANK, H. (1984) Zur Genese ostafrikanischer Grossular Vorkommen.

Zeitschrift der Deutschen Gemmologischen Gesellschaft, **33** (1–2), 48–62.

SARIA, J. L. (1973) The geology of the Merelani zoisite (tanzanite) bearing area. Unpublished Report JLS/7. Dodoma, Mineral Resources Division, Geological Survey Tanzania, 9 p.

SAUL, J. (2007) Tanzanite: its discovery and early days. *InColor,* Summer, 15–17. (Revised)

SAUL, E. (2008) Tanzanite—July 7, 1967: Tanzanite: something new out of Africa . . . but no one knew what it was . . . *swalagemtraders.com.*

SCHEEPERS, R., and OLIVIER, B. (2003) Geology and geochemistry of the Merelani tanzanite deposit. *Geoforum 2003*, held in Johannesburg, South Africa, June 25–27, p. 11.

SCHEEPERS, R. (2006) Controls on mineralization in Block D' of the Merelani tanzanite deposit, Tanzania. Poster Session Abstracts from the 2006 Gemological Research Council. *Gems & Gemology*, **42** (Fall) 150.

SCHMETZER, K., and BANK, H. (1978) Blaugrüner Zoisit aus Merelani, Tansania. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, **27**, 151–152.

SCHMETZER, K., and BANK, H. (1978–79) Bluish green zoisite from Merelani, Tanzania. *Journal of Gemmology*, **16**, 121–122.

SCHMETZER, K., and BANK, H. (1979) Bluish green zoisite from Merelani, Tansania. *Journal of Gemmology*, **16** (8), 512–513.

SCHMETZER, K. (1982) Absorptionsspectroskopie und Farbe von V^{3+} haltigen naturlichen Oxiden und Silikaten—ein Beitrag zur Kristallchemie des Vanadiums. *Neues Jahrbuch für Mineralogie Abhandlung*, **144**, 73–106.

SMITH, B., and SMITH, C. (1994) Martin Leo Ehrmann (1904-1972). *Mineralogical Record*, **25**, 347–370.

STRUNZ, H. (1935) Strukturelle und morphologische Beziehungen zwischen Epidot und Zoisit und zwischen Epidote und Ardennit. *Zeitschrift für Krystallographie*, **92**, 402–407.

STRUNZ, H. (1969) Der blaue Zoisit von Tansania. *Der Aufschluss*, **20**, 57–63.

SUNDBERG, M. R., and VALKONEN, J. (1988) Refinement of the structure of the heated (blue) form of zoisite (tanzanite). *Zeitschrift für Kristallographie*, **185**, 617.

TERMIER, M. P. (1898) Sur une variété de zoïzite des schistes métamorphiques des Alpes et sur les propriétés optiques de la zoïzite classique. *Bulletin de la Société française de Minéralogie et de Cristallographie*, **21**, 148–170.

THOMPSON, T. (1969) Tanzania to Tiffany's. *Life*, **66** (18), May 9, 70–76.

TSCHERMAK, G., and SIPÖCZ, L. (1880) *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien*, **82** (1).

VENTER, I. (2007) Tanzanian miner targets 5m carats in five years. *Mining Weekly*, March 30.

VINE, J. D., and TOURTELOT, E. B. (1970) Geochemistry of black shale deposits—a summary report. *Economic Geology*, **65**, 253–272.

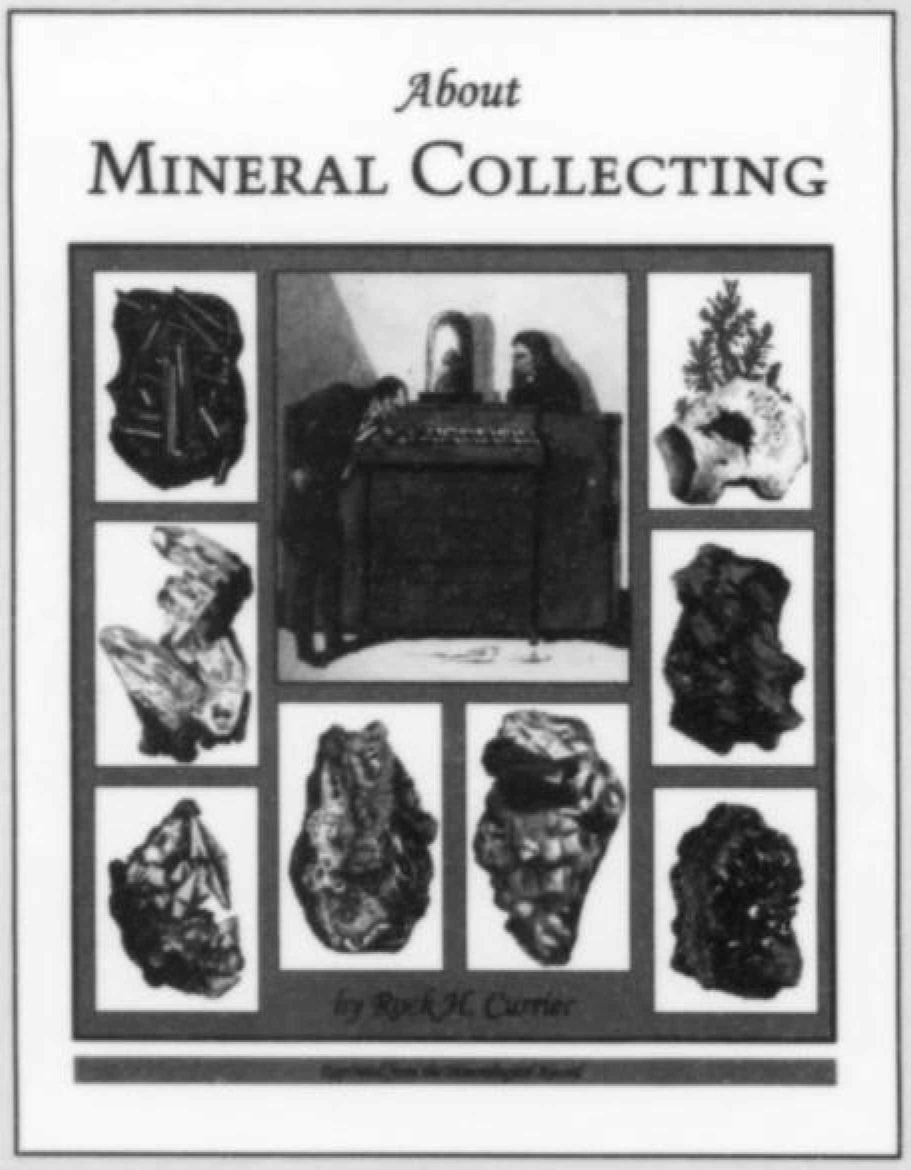
WISE, R. W. (2003) *Secrets of the Gem Trade: The Connoisseurs Guide To Precious Gemstones.* Brunswick House Press, Lenox, Mass., 292 p.

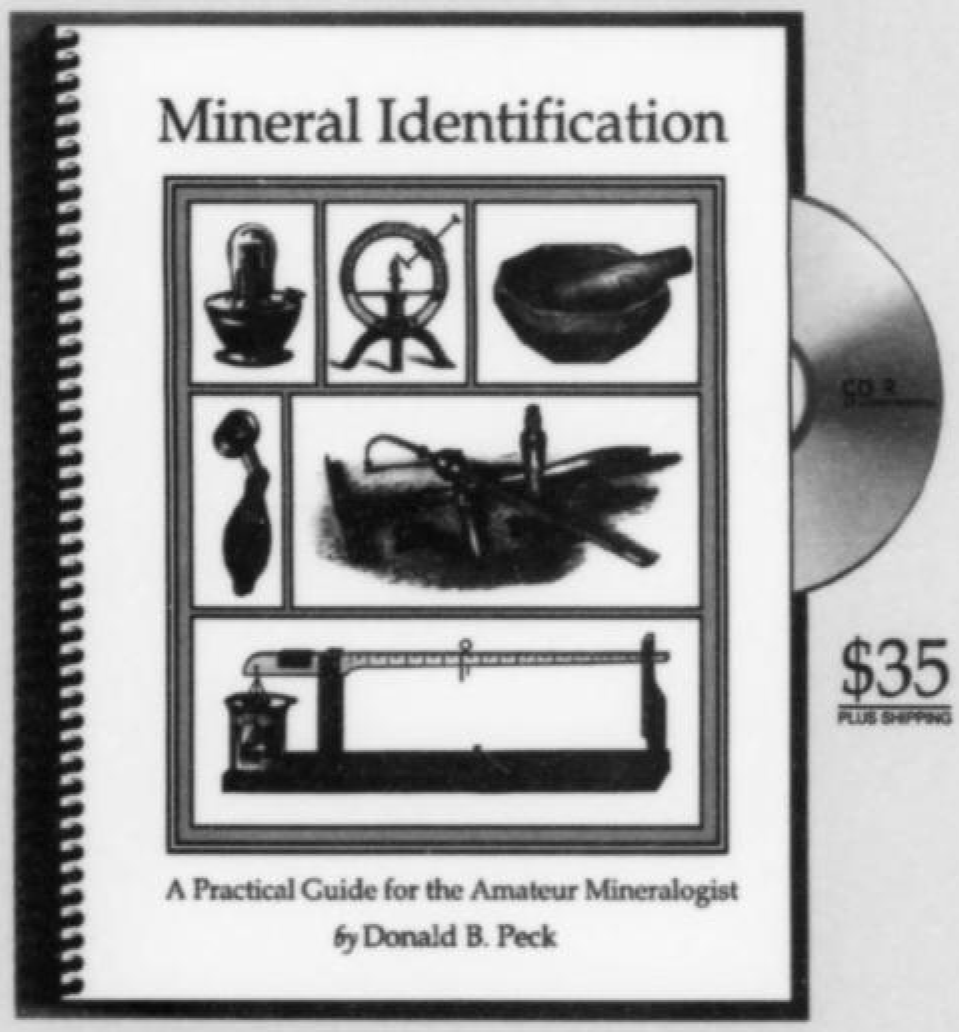
YAGER, T. R. (2004) The mineral industry of Tanzania. *U.S. Geological Survey Minerals Yearbook, 2003.*

ZANCANELLA, V., MERLI, M., and ZANETTI, A. (2000) The color change after heating at 380°C of tanzanite crystals from Merelani Arusha (Tanzania): Preliminary EMPA-SIMS-LAM-ICP-MS study on major, trace, light lithophile and volatile elements. *SIMP Congress,* Pavia, Italy, September 11–13, 2000.

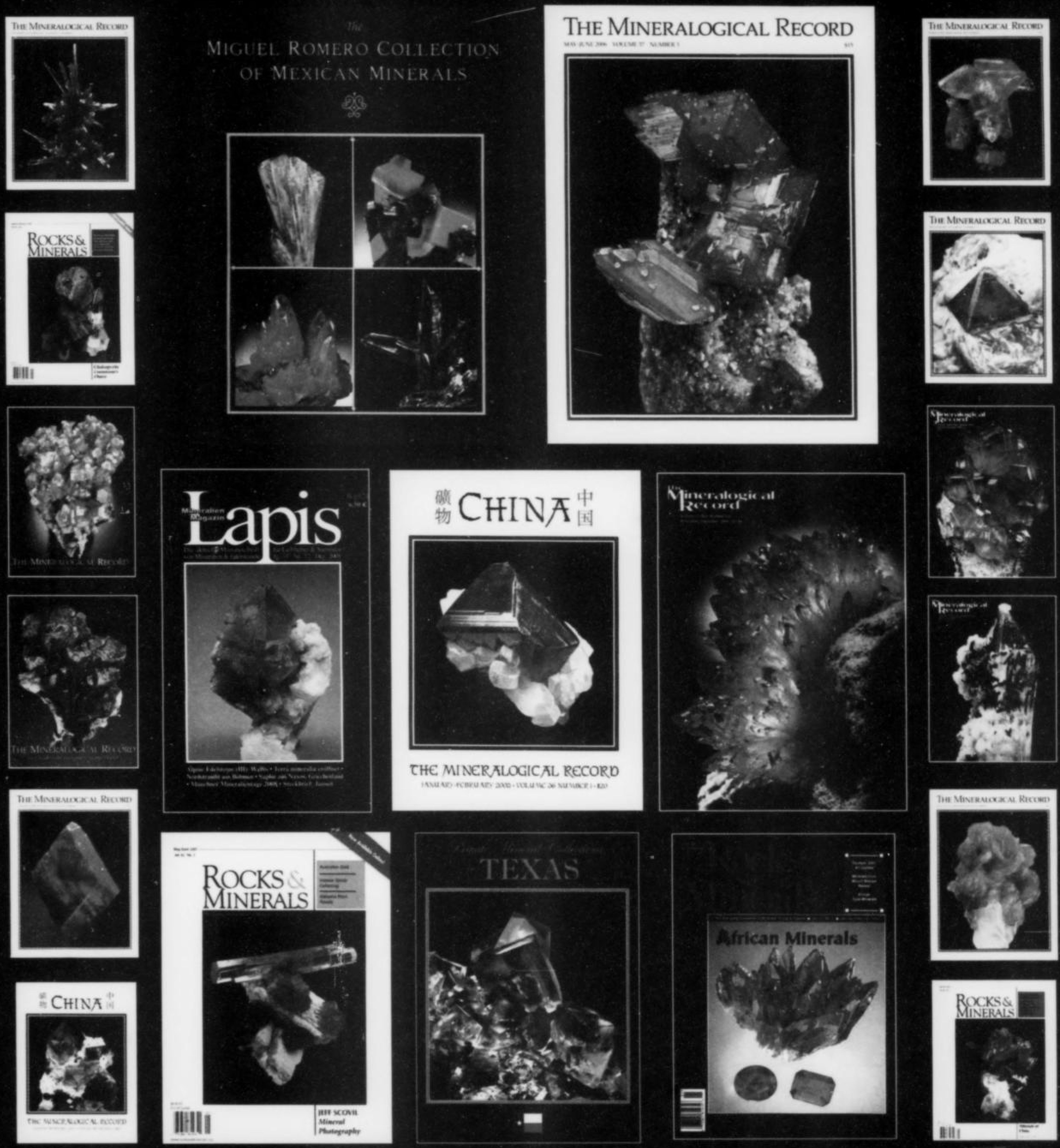
ZANCANELLA, V. (2004) *Tanzanite: All About One of the Most Fascinating Gemstones.* Published by the author, Cavalese, Italy, 120 pp. [Also published in Italian as *Tanzanite. Una tra le gemme più affascinanti* (2004).]

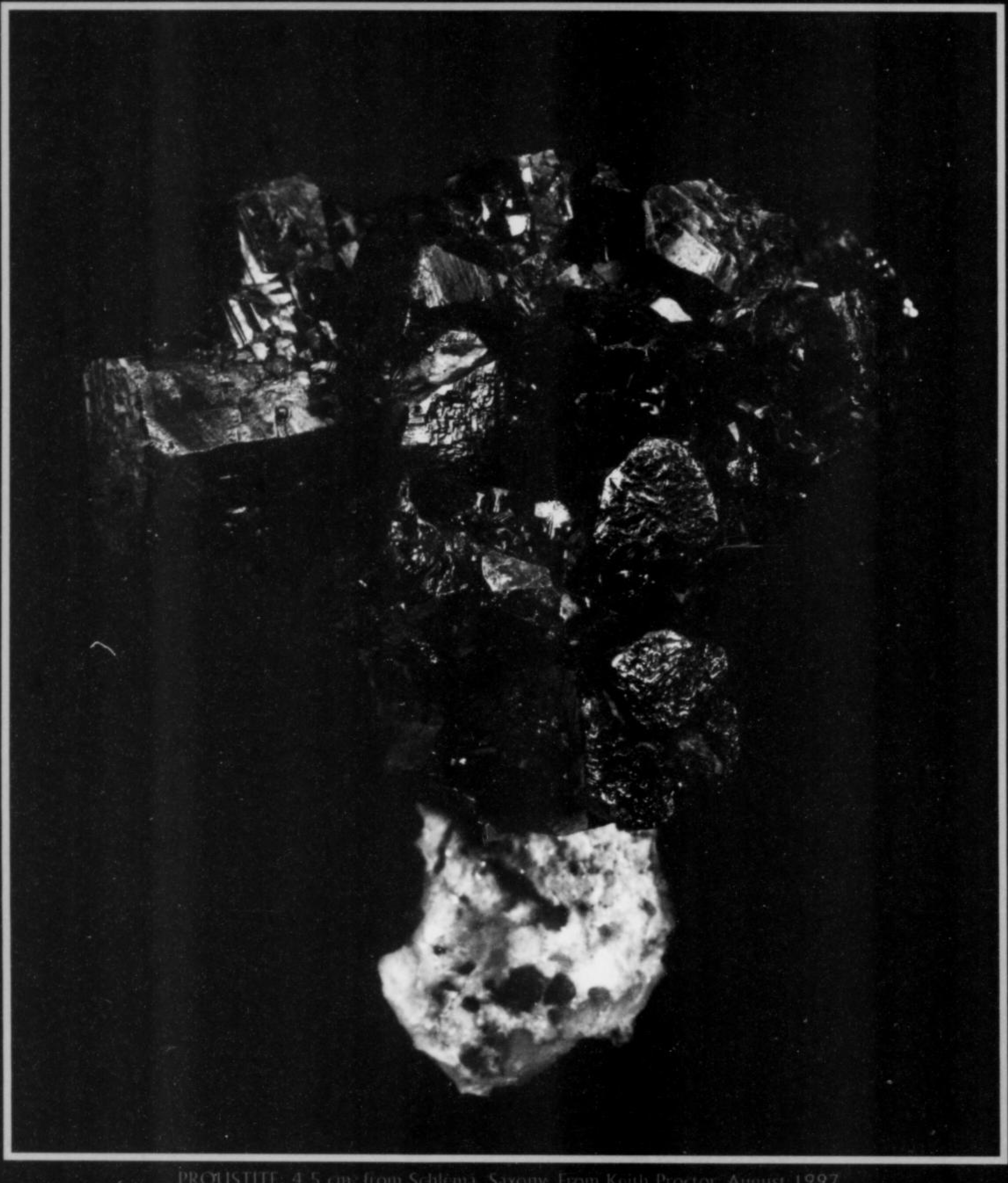
ZARA, L. (1971) Tanjeloffite and blue zoisite. *Mineral Digest*, **2**, 20–33.






www.finemineral.com


The Mineralogical Record
Miguel Romero Collection of Mexican Minerals
The Mineralogical Record
Rocks & Minerals
Lapis
CHINA
The Mineralogical Record
Texas
African Minerals
Rocks & Minerals
CHINA



PROUSTITE, 4.5 cm, from Schlema, Saxony. From Keith Proctor, August 1997

Clara & Steve Smale

COLLECTORS

THE MUSEUM DIRECTORY

Colburn Earth Science Museum

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

Montana Tech Mineral Museum

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

Additional listings welcome!

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

The Gillespie Museum of Minerals, Stetson University

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

Colorado School of Mines

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

A. E. Seaman Mineral Museum

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

Houston Museum of Natural Science

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

Natural History Museum of Los Angeles County

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

California State Mining and Mineral Museum

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

Museums listed alphabetically by city

THE MUSEUM DIRECTORY

University of Delaware Mineralogical Museum

Curator: Dr. Sharon Fitzgerald
Tel. (302) 831-6557
E-mail: slfitz@udel.edu
Penny Hall
Newark, DE 19716
Tel: (302)-831-8037
E-mail: universitymuseums@udel.edu
For information: www.udel.edu/museums
Worldwide fine minerals in a newly renovated, modern space

Matilda and Karl Pfeiffer Museum and Study Center

Executive Director: Teresa Taylor
Tel: (870) 598-3228
E-mail: pfeifferfnd@centurytel.net
P.O. Box 66
1071 Heritage Park Drive
Piggott, AR 72454
Hours: 9–4 Tues.–Fri., 11–4 Sat. (Daylight Savings Time)
Specialties: Fine collection of geodes from Keokuk, Iowa, area; worldwide collection of minerals

Carnegie Museum of Natural History

Head: Section of Minerals: Marc L. Wilson
Tel: (412) 622-3391
4400 Forbes Avenue
Pittsburgh, PA 15213
Hours: 10–5 Tues.–Sat., 10–8 Thurs., 12–5 Sun., closed Mon. & holidays
Specialty: Worldwide minerals & gems

W. M. Keck Earth Science & Engineering Museum

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

New Mexico Bureau of Mines & Mineral Resources—Mineral Museum

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

Arizona-Sonora Desert Museum

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

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

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

Tellus: Northwest Georgia Science Museum

Website: www.tellusmuseum.org
Tel. (770) 386-0576
Executive Director: Jose Santamaria x401
E-mail: joses@tellusmuseum.org
Curator: Julian Gray x415
E-mail: juliang@tellusmuseum.org
100 Tellus Dr.
White, GA 30184

Collection des Minéraux de l'Université Pierre et Marie Curie

(former Sorbonne Collection)
Director: Dr. Jean-Claude Boulliard
Tel: +33 144 275 288
E-mail: jean-claude.boulliard@impmc.jussieu.fr
4, Place Jussieu
75005 **Paris**, France
Hours: 1-6 pm daily, closed Tuesdays
Closed Mondays and Tuesdays in August
Specialties: French and worldwide minerals
Some of the finest to near-finest known specimens

Gargoti Mineral Museum

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


Mineralientage
München
Oct. 30 - Nov. 1, 2009
INDIA
Crystals & Gems
A6
46th int. Show for
Minerals, Fossils, Gems
Jewelry & Accessories
Europe's Top Show - www.mineralientage.com
GEOFA Dealers Day Fr. Oct. 30 Pre-registration requested. BÖRSE Public Fair Sa. Oct. 31 / Su. Nov. 1
DMF


The brand new KRISTALLE online gallery
together with CRYSTAL CLASSICS
bringing you the finest minerals to your door
KRISTALLE, Est. 1971
About us
Mineral Gallery
Gold Gallery
Books
News & Events
Welcome to KRISTALLE!
Welcome to the brand new Kristalle website!
We invite you to look around our new online shop. Each week we will have a new update of fine mineral specimens, plus the Gold specimens we are so well known for. We also have a section on books, both recent and antiquarian.
If you would like to be informed each time we update the website, please join our mailing list below.
We buy collections
People & Places
Links
Contact us
Crystal Classics
Search
Information
Basket
Account
Specimens
Join our mailing list
www.kristalle.com
www.crystalclassics.co.uk
regular updates ~ simple to search by mineral or location ~ easy to use
show reports and regular articles ~ prompt shipping ~ quick response to questions
visit us TODAY!

INTERNET DIRECTORY

ADVERTISERS

The
Mineralogical Record

The International Magazine for Mineral Collectors

VOLUME 40, NUMBER 5 • SEPTEMBER-OCTOBER 2009

COVER:
Tanzanite (zoisite) crystal,
7.3 cm, from Merelani, Tanzania.
Jack Halpern collection; Jeff Scovil photo.

Editing
Wendell E. Wilson
Thomas P. Moore
4631 Paseo Tubutama
Tucson, AZ 85750
Tel: 520-299-5274
email: minrecord@comcast.net

Advertising
Thomas P. Moore
2709 E. Exeter Street
Tucson, AZ 85716
Tel: 520-299-5274
email: tpmoore1@cox.net

Subscriptions, Back Issues
& Book Orders
Mary Lynn Michela
P.O. Box 35565
Tucson, AZ 85740
Tel.: 520-297-6709
minrec@aol.com

Subscriptions:
Individuals (U.S.): $58/year
or $106/2 years
Individuals: (outside the U.S.)
$65/year or $120/2 years
Libraries, companies &
institutions worldwide: $120/year

THE MINERALOGICAL RECORD
(ISSN 0026-4628)
is published bimonthly for
$58 per year (U.S.) by
Mineralogical Record, Inc.,
a 501c(3) non-profit scientific-educational
organization, 7413 N. Mowry Place,
Tucson, AZ 85741. Periodical
postage paid at Tucson, Arizona
and additional mailing offices.
Postmaster: Send address changes
to the above address.

For convenient online book orders,
back issue orders and subscriptions,
as well as numerous useful and
interesting databases, visit our website
at www.MineralogicalRecord.com