



#### EDITOR

Brendan M. Laurs (blaurs@gia.edu)

#### CONTRIBUTING EDITORS

Emmanuel Fritsch, *IMN, University of Nantes, France* (fritsch@cnrs-immn.fr)

Henry A. Hänni, *SSEF, Basel, Switzerland* (gemlab@ssef.ch)

Franck Notari, *Geneva, Switzerland* (franck.notari@bluewin.ch)

Kenneth V. G. Scarratt, *GIA Research, Bangkok, Thailand* (ken.scarratt@gia.edu)

## Tucson

2007

The 2007 Tucson gem shows brought together the usual fantastic quality and quantity of gems and minerals, but there was little in the way of new gem localities or varieties. Instead, additional production from known localities was brought to market, with the most exciting example being the widespread availability of copper-bearing tourmaline from Mozambique (see *Gem News International*, Winter 2005, pp. 360–361, and Spring 2006, p. 62), which was available from numerous dealers mainly as heated blue-to-green material. One notable stone at this year's American Gem Trade Association (AGTA) show was a 325.13 ct tsavorite

*Figure 1. This 325.13 ct tsavorite is from Merelani, Tanzania. Courtesy of Michael Couch & Associates, West Des Moines, Iowa; photo by Robert Weldon.*



from Merelani, Tanzania (figure 1), that was reportedly cut from the same piece of rough as the 62.81 ct stone pictured in last year's Tucson report (Spring 2006 GNI, pp. 62–63). Also of interest were two enormous slabs of Australian tiger's-eye in jasper (e.g., figure 2) that were displayed at the 53rd Tucson Gem & Mineral Show, where this year's theme was the minerals of Australia. The specimens were mined from the Marra Mamba Formation at Mt. Brockman in Western Australia. Another example of minerals at Tucson on a grand scale are the amethyst and citrine crystal "cathedrals" from Brazil in figure 3, which were on display at the JG & M Expo show. Additional items are described below, with more to be included in the Summer 2007 GNI section. *G&G* thanks the many friends who shared material and information with us this year.

#### COLORED STONES AND ORGANIC MATERIALS

**"Emerald" green fluorite from India.** Although green fluorite is rather common, saturated "emerald" green stones are known mainly from the emerald mines of Colombia

*Editor's note: The initials at the end of each item identify the editor or contributing editor who provided it. Full names and affiliations are given for other contributors.*

*Interested contributors should send information and illustrations to Brendan Laurs at blaurs@gia.edu or GIA, The Robert Mouawad Campus, 5345 Armada Drive, Carlsbad, CA 92008. Original photos can be returned after consideration or publication.*

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Figure 2. Shown here is one of two large slabs of Australian tiger's-eye in jasper (220 cm × 50 cm × 4 cm) that were displayed at this year's Tucson Gem & Mineral Show. The photo on the right highlights some of the details of the piece. Courtesy of David Vaughan, Australian Outback Mining, Perth, Western Australia; photos by Robert Weldon.

(see, e.g., P. Vuillet, "La fluorite verte de Peñas Blancas," *Revue de Gemmologie*, No. 140, 2000, pp. 21–25). We were therefore interested to receive a 3.99 ct bright green fluorite (figure 4) reportedly from Bihar, India, that was donated to GIA by Dudley Blauwet (Dudley Blauwet Gems, Louisville, Colorado) at the AGTA show. Mr. Blauwet obtained the stone in Jaipur, India, in November 2006. He was shown approximately 1,000 carats of the cut green fluorite, and obtained 200–300 carats ranging from 2 to 58 ct each. The material showed various degrees of saturation of the green color, and some of the larger stones were color zoned, with blue bands seen in certain orientations. No treatments were indicated by the dealer.

Examination of the 3.99 ct fluorite by one of us (EAF) showed the following properties: color—green; R.I.—1.439;

hydrostatic S.G.—3.19; Chelsea filter reaction—none; fluorescence—inert to long- and short-wave UV radiation; and no absorption lines visible with the desk-model spectroscope. Microscopic examination revealed planar fluid inclusions, traces of the characteristic cleavage exhibited by fluorite, and minute primary three-phase inclusions (figure 5). Many of these inclusions exhibited a tetrahedral or modified tetrahedral habit, which is a relatively well-known identifying characteristic of fluorite. Judging from the low relief of the fluid inclusions, the liquid filling them appeared to be a saturated brine with a refractive index less than, but very near to, that of the fluorite host. In addition to the transparent daughter phase(s), some of the three-phase inclusions appeared to contain a tiny opaque solid phase with a brassy color and metallic luster (probably a sulfide mineral). Vuillet (2000) also reported seeing three-phase inclusions in green fluorite from Colombia. However, several other properties

Figure 3. Displayed within their shipping crates are three large crystal "cathedrals" of amethyst and citrine, with owner Tina Sim shown for scale. The citrine color was created in Brazil by heating amethyst; it undoubtedly required a very large oven. Courtesy of Gemstone Material Interiors, Tucson, Arizona; photo by B. Laurs.



Figure 4. This 3.99 ct "emerald" green fluorite is reportedly from Bihar, India. Gift of Dudley Blauwet, GIA Collection no. 36751; photo by C. D. Mengason.



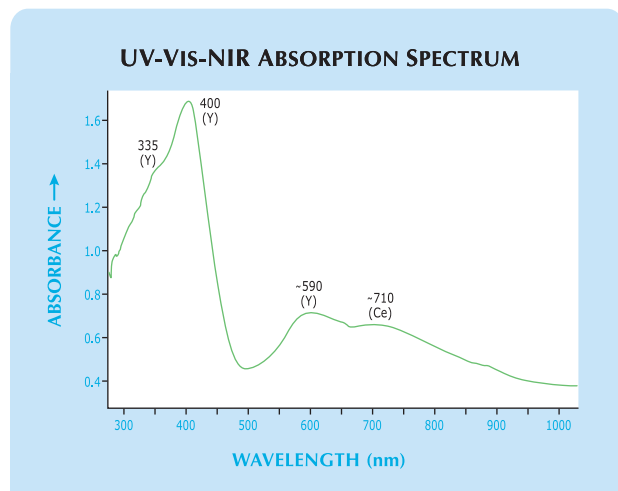


Figure 5. The green fluorite contained numerous tiny three-phase inclusions. Photomicrograph by John I. Koivula; magnified 40 $\times$ .

reported by Vuillet (2000) were not observed in our green fluorite: a “rose” Chelsea filter reaction, absorption at 560–580 nm, intense blue long-wave UV fluorescence, and moderate blue-violet short-wave UV fluorescence. Therefore, we suspected that the origin of color in the Indian fluorite might be different from that of the Colombian material examined by Vuillet.

Fluorite can show a variety of colors that are caused by complex centers involving rare-earth ions and/or oxygen; green is commonly due to traces of  $\text{Sm}^{2+}$  (H. Bill and G. Calas, “Color centers, associated rare-earth ions and the origin of coloration in natural fluorites,” *Physics and Chemistry of Minerals*, Vol. 3, 1978, pp. 117–131). Indeed, Vuillet (2000) indicated that the green fluorite from Colombia is colored by  $\text{Sm}^{2+}$  (green), with a blue-violet component caused by luminescence from traces of  $\text{Eu}^{2+}$ . However, a UV-Vis-NIR spectrum of our 3.99 ct fluorite

Figure 6. This UV-Vis-NIR spectrum of the green fluorite shows absorption features at 335, 400, ~590, and ~710 nm, which are consistent with yttrium- and cerium-associated color centers as the cause of the bright green coloration.



(figure 6) did not show features consistent with  $\text{Sm}^{2+}$ . Instead, the spectrum indicated the presence of yttrium (Y)- and cerium (Ce)-associated centers (Bill and Calas, 1978), with absorptions recorded at 335, 400, ~590, and ~710 nm. As expected, EDXRF spectroscopy showed traces of Y and very minute amounts of Ce; no Sm was detected. According to Bill and Calas (1978), the production of deep green to yellowish green coloration in fluorite by Y- and Ce-associated centers is quite rare.

Eric A. Fritz ([eric.fritz@gia.edu](mailto:eric.fritz@gia.edu))  
and John I. Koivula  
GIA Laboratory, Carlsbad  
BML

**Cat’s-eye leifite from Mont Saint-Hilaire, Canada.** Leifite,  $\text{Na}_2(\text{Si,Al,Be})_7(\text{O,OH,F})_{14}$ , is an alkali pegmatite mineral that has been found rarely as transparent facetable pieces at Mont Saint-Hilaire, Quebec, Canada (see Gem News, Spring 1993, p. 60, and Spring 1995, pp. 65–67). At the Gem & Jewelry Exchange (GJX) show, gem cutter Brad Wilson (Coast to Coast Rare Stones International, Kingston, Ontario, Canada) showed this contributor two cat’s-eye leifite cabochons that he had recently cut from Mont Saint-Hilaire material. He noticed the potential for chatoyancy in a few small pieces of rough that he acquired over the past few years, and stabilized this fibrous material with epoxy prior to cutting. So far he has cut seven pieces of the cat’s-eye leifite, ranging from approximately 0.5 to 2.78 ct; the best two stones are shown in figure 7. Mr. Wilson reported that most of the leifite production at Mont Saint-Hilaire took place between 1988 and 1991, and that the fibrous

Figure 7. These cabochons of the rare mineral leifite (1.60 and 0.62 ct) are notable for their chatoyancy. Courtesy of Coast to Coast Rare Stones International; photo by Robert Weldon.







Figure 8. These recently mined opals from Piauí, Brazil, are notable for their high quality, as shown by their strong play-of-color (left, 38.36 ct), transparency (center, 18.42 ct), and even chatoyancy (above, 15.90 ct). Courtesy of Opalas Pedro II; photos by Robert Weldon.

material was found at the end of this period. The leifite finds in 1988–1990 were described by L. Horváth and R. A. Gault (“The mineralogy of Mont Saint-Hilaire, Quebec,” *Mineralogical Record*, Vol. 21, No. 4, 1990, pp. 284–359). While the transparent leifite documented in the Spring 1995 Gem News entry was light purplish pink, all the fibrous material obtained by Mr. Wilson was white to light gray.

BML

**Play-of-color opal from Piauí, Brazil.** A variety of opals are known from Brazil’s Piauí State, which is that country’s most important source for this gem (see J. Knigge and C. C. Milisenda, “Brazilian opals from Pedro II,” *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 46, No. 2, 1997, pp. 99–105). These include white or

light opal (see reference above and Spring 1991 Gem News, p. 49, as well as Spring 1999 Gem News International, pp. 53), fire opal (“Reporter’s Notebook,” *Colored Stone*, Vol. 15, No. 3, 2002, p. 44–45), and matrix opals (Fall 2002 Gem News International, pp. 268–269).

During the AGTA show, Juscelino Souza (Opalas Pedro II, Pedro II, Piauí, Brazil) and Robb Darula (From Earth To Art and Mystic Jewelry and Gemstones, Mystic, Connecticut) showed this contributor some rough and cut play-of-color Piauí opals that were notable for their unusually high quality, including one cabochon with a cat’s-eye (figure 8). Their samples were obtained since mid-2006 from some new mines in the same area near Pedro II (or Pedro Segundo) that has historically produced play-of-color opal (e.g., figures 9–10). The gentlemen had approximately



Figure 9. Workers use hand tools and dry sieves to mine for opals at this alluvial deposit near Pedro II in Piauí, Brazil. Courtesy of Opalas Pedro II.



Figure 10. This alluvial mining operation for Piauí opal employs a pump to remove groundwater from the workings. Courtesy of Opalas Pedro II.

2,000 carats of polished opal that were cut from the top 2% of the production. The samples were derived from about 30 mining sites that are exploring alluvial deposits. The opal is typically recovered at least 0.5 m below the surface, with some of the pits reaching as deep as 3 m. There has also been opal production from primary deposits in the area.

Carvings of some older Piauí opal were featured in a jewelry series called the Opal Natural Wonder Collection that was also seen in Tucson. The pieces were created by

Judy Wallace (Wallace Goldsmithing, Sarasota, Florida) using material that was mined in the early 1970s, and demonstrated how the opal carvings can be creatively incorporated into wearable designs (e.g., figure 11).

In the future, more opal production from the Pedro II area is anticipated as additional mines are rejuvenated. Mr. Darula reported that the renewed mining efforts are in part due to cooperation from the state government, which is interested in promoting awareness of Piauí's opals and has recently published a pamphlet on them in Portuguese (*Pedra Primeira de Pedro Segundo, Serviço de Apoio às Micro e Pequenas Empresas do Piauí, Sebrae, Piauí, 2007, 44 pp.*).

BML

**Prehnite from Merelani, Tanzania.** At the Pueblo Gem & Mineral Show, Steve Ulatowski (New Era Gems, Grass Valley, California) had rough and cut prehnite from the tanzanite mines at Merelani, Tanzania. He obtained a total of about 20 kg of mixed-grade rough prehnite while on buying trips to Tanzania in November 2006 and January 2007. The prehnite formed aggregates that were mostly yellow, with white areas on some pieces. Some of these aggregates were intergrown with violet tanzanite, gray graphite, and/or pale green diopside (identified based on their visual appearance and typical mineral association at Merelani). So far, he has cut five pieces into faceted stones and cabochons.

Mr. Ulatowski loaned one faceted stone, one cabochon, and several pieces of rough to GIA for examination (e.g., figure 12). Characterization of the two polished stones by one of us (EAF) showed the following properties: color—greenish yellow, with no pleochroism; R.I.—1.617 to 1.639 and a spot reading of 1.62; birefringence 0.022; hydrostatic

Figure 11. Carved Piauí opals have been incorporated into some creative jewelry designs. The opal in the moth brooch weighs 25.00 ct, and the frog is 43.88 ct. Courtesy of Wallace Goldsmithing; photos by Robert Weldon.





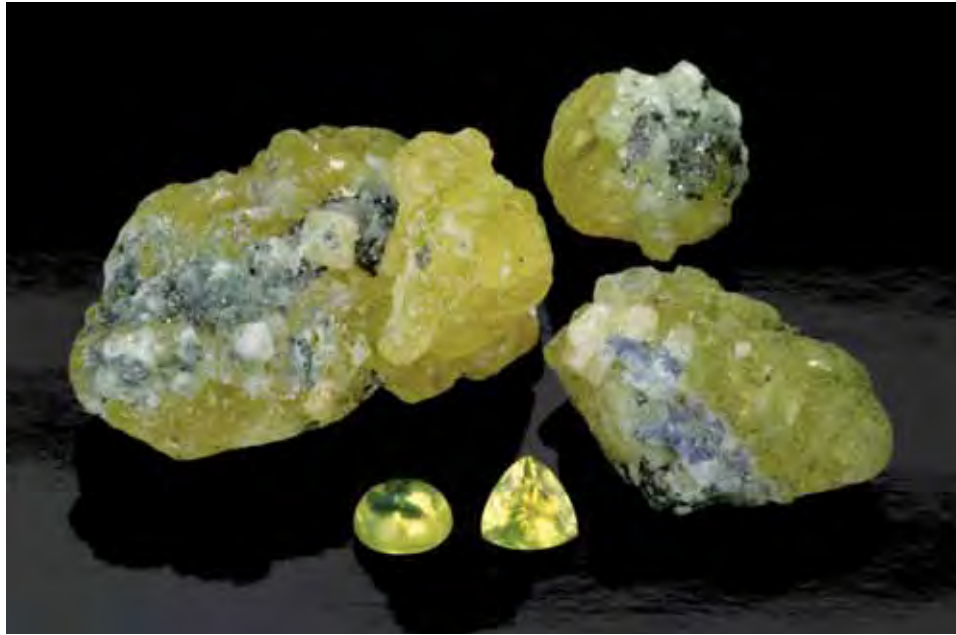


Figure 12. The tanzanite mines at Merelani, Tanzania, are the source of this prehnite. The polished stones weigh 1.62 and 2.14 ct. The rough pieces consist of yellow-to-white prehnite aggregates that in some cases are intergrown with violet tanzanite, gray graphite, and/or pale green diopside. Courtesy of New Era Gems; photo by Robert Weldon.

S.G.—2.91 and 2.96; Chelsea filter reaction—none; fluorescence—inert to long-wave UV radiation and weak yellow to short-wave UV; and no absorption features visible with the desk-model spectroscope. Microscopic examination revealed fine oriented fibers throughout the stones, numerous fractures, and planar fluid inclusions. These properties are comparable to prehnite from Mali (see Summer 2006 Gem News International, pp. 178–179), and similar to prehnite from Australia (see Spring 2001 GNI section, pp. 71–72), except for the fluorescence; the Australian stones described in 2001 fluoresced weak yellow to long-wave UV radiation and weak orange to short-wave UV.

To the best of our knowledge, this is the first report of gem-quality prehnite from Tanzania.

*Eric A. Fritz and BML*

**Colorado rhodochrosite near end of availability.** The Sweet Home mine in Colorado’s Alma mining district has been known since 1872, when it was initially exploited for silver. More recently, however, the mine has become famous for producing world-class rhodochrosite crystals (see T. Moore et al., “The Sweet Home mine,” *Mineralogical Record*, Vol. 29, No. 4, 1998, entire issue). In their best qualities, rhodochrosite crystals from Sweet Home are well-formed, largely translucent-to-transparent rhombohedrons, with a saturated orangy red color (e.g., figure 13).

In 1991 the mine was taken over by an investment corporation called Sweet Home Rhodo Inc. and overseen by veteran miner Bryan Lees (The Collector’s Edge, Golden, Colorado). In 1992, the company reached its heyday after producing a series of magnificent crystal specimens. Although the corporation’s main objective was to recover mineral specimens for collectors, broken crystals were sent for cutting; approximately 100 cut stones over half a carat were produced annually between 1992 and 1996 (K. Knox and B. Lees, “Gem rhodochrosite from the Sweet

Home mine, Colorado,” Summer 1997 *Gems & Gemology*, pp. 122–133). The Sweet Home mine finally ceased operations after the 2004 mining season and the site has been

Figure 13. A gem rhodochrosite crystal (33.9 g, with embedded tetrahedrite crystals) from the Sweet Home mine in Colorado is shown here with a trilliant weighing 7.14 ct. Courtesy of Beija-flor Gems; photo by R. Weldon.



reclaimed, including the closure of the portal and removal of the dumps. Mr. Lees' company still owns the mine and the property, and he is investigating ways of turning the site into an open-space park.

The cut rhodochrosite and material suitable for cutting was sold to a group of investors that includes gem dealer Robert Van Wagoner (Beija-flor Gems, Haiku, Hawaii), who was exhibiting at the GJX show. Because the stock was sold to the group as a single parcel, and because the mine is no longer in production, Mr. Van Wagoner and his associates are now the main dealers trading in cut rhodochrosite from the Sweet Home mine.

Rhodochrosite is soft and has perfect cleavage in three directions, so it is notoriously difficult to facet (again, see Knox and Lees, 1997). Mr. Van Wagoner reported that cut yields can range between 5% and 20%, depending on the quality of the rough and the expertise of the cutter. The smaller material (i.e., <2 ct) is faceted into calibrated sizes, in 0.5 mm increments, as oval, round, princess, cushion, and emerald cuts, as well as some trilliant. Stones >2 ct are cut in free sizes (again, see figure 13); so far, the largest clean rhodochrosite they have cut weighed 12 ct, although they have faceted heavily included gems up to 30–40 ct. In addition, cabochons (in both calibrated and free sizes) and polished rhombohedra are produced. Mr. Van Wagoner indicated that some of the cabochons have shown chatoyancy and four-rayed stars. He added that some of the cabochons and polished rhombohedrons are stabilized during the cutting process, while the faceted stones are completely untreated.

The cut rhodochrosite is being sold by Mr. Van Wagoner and his associates mostly as loose gems, although

some jewelry pieces have been manufactured from the material. They expect that stocks of cut Sweet Home rhodochrosite will not last beyond two-to-three years, after which relatively few stones will be available in the market.

*Robert Weldon (rweldon@gia.edu)  
GIA Library, Carlsbad*

**Serpentinite from Argentina, marketed as “Andes Jade.”** At the Arizona Mineral & Fossil Show (InnSuites Hotel venue) and Tucson Electric Park, Jorge Dascal (Patagonia Minerals, Buenos Aires, Argentina) had some serpentinite from central-western Argentina that he was selling with the marketing name “Andes Jade.” The material ranged from light-to-dark green, to bluish green, to black; Mr. Dascal has recognized 12 specific color varieties. The diaphaneity was nearly opaque to translucent. He had 11 tonnes available in Tucson, as rough blocks (25 × 20 × 20 cm to 50 × 40 × 35 cm), broken polished pieces (15 × 10 × 10 cm), sawn slices, and a few cabochons, as well as an interesting carving that was crafted by Mark Zirinsky of Denver, Colorado (figure 14).

Mr. Dascal indicated that X-ray diffraction analyses of several samples performed at the University of Bonn in Germany showed the material to be a mixture of the serpentine minerals antigorite and lizardite, together with magnesite and minor magnetite. Some of the pieces were strongly magnetic. Light red-brown specks in some of the

*Figure 14. A variety of colors and textures are shown by this serpentinite from Argentina, which is marketed as “Andes Jade.” The image on the right shows the translucency and execution of detail in the carving by Mark Zirinsky, which measures 5.5 × 3.5 cm. Courtesy of Patagonia Minerals; photos © Jeff Scovil.*





serpentinite were identified as garnets by a local university laboratory. A Mohs hardness of 5½–6 has been suggested by experienced local artisans and Chinese carvers, with the lighter green material being harder than the darker colors.

Mr. Dascal reported that he first found the Andes Jade in early 2004, received mining rights in early 2006, and constructed a road to the deposit in preparation for mining in late 2006. The deposit has been worked as an open cut, using hand tools and pneumatic drills. The reserves appear to be extensive, and Mr. Dascal plans to start mining soon on a full-time, year-long basis.

BML

**New variscite production from Western Australia.** At the Arizona Mineral & Fossil Show (Mineral & Fossil Marketplace venue), Glenn Archer and David Vaughan (Australian Outback Mining, Perth, Western Australia) had some attractive green variscite that they recently mined from the Meekatharra District in central Western Australia. Although variscite has been known from this area for decades, they have been exploring a part of the district that had not previously been mined, at Woodlands Station, located 100 km east of Mt. Augustus. They started prospecting in 2002 in an area where a mining company had mapped a phosphatic shale horizon, but it took more than a year of exploration before they found a vein system containing high-quality variscite. After a lengthy process that involved pegging the claim, negotiating for the native title, and obtaining the necessary permits, they began exploratory mining with a backhoe in late 2004. However, little production was obtained initially due to the very hard nature of the rock.

In 2005 they brought in larger machinery, including a D-8 bulldozer, and produced 8 tonnes of various grades of variscite mixed with matrix material. Mining in 2006 yielded 4–5 tonnes of mixed-grade variscite, which was greener and of better quality than the previous material. Although this material was obtained from a maximum depth of just 3 m, it required moving a substantial amount of overburden to follow the vein system under the neighboring hillside.

The variscite has been recovered from a <1-m-wide layer containing several veins ranging from 2.5 to nearly 4 cm thick. So far the variscite has been mined over a 50-m-long area of the vein system, but the material is present along strike for 8,500 m. Due to the remoteness of the area and the oppressively hot climate, mining has taken place for only a 10-day period once a year during the cool season (May through September). During the 2006 campaign, the mining crew consisted of five people and employed a bulldozer, backhoe, and two trucks.

The variscite from Australian Outback Mining's claim was first sold at the 2006 Tucson show as broken pieces, slabs, and partially polished pieces. During the 2007 show, they had both rough and polished variscite; they reported that about 10 kg had been fashioned thus far as cabochons and carvings (see, e.g., figures 15–16). The color ranged from light-to-dark yellowish green, with attractive pat-



Figure 15. Attractive patterning and a range of color is shown by this variscite, which was recently mined from a new claim in central Western Australia. The cabochon in the center is 56 × 25 mm; the specimen on the left was carved by Dalan Hargrave. Courtesy of Australian Outback Mining; photo © Jeff Scovil.

terns created by orangy brown veining. The variscite reportedly is not treated or stabilized in any way.

In March 2007, particles of native gold were discovered in this variscite by researchers at CSIRO (Australia's Commonwealth Scientific and Industrial Research Organisation). Working under a funded research grant, the origin, characterization, and formation of the gold particles in the variscite is being investigated by Drs. Ernie Nickel,

Figure 16. This toad (5 × 7 × 8 cm) was carved from the new Australian variscite in Idar-Oberstein, Germany. Courtesy of Australian Outback Mining; photo by Robert Weldon.





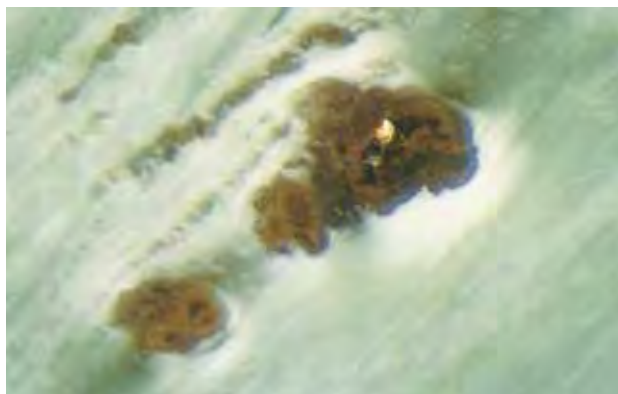


Figure 17. Tiny inclusions of native gold are present in some of the Australian variscite. Photomicrograph by J. I. Koivula; magnified 20 $\times$ .

Robert Hough, and Elena Hancock at the Australian Resources Research Centre in Perth. GIA also recently documented gold inclusions in the variscite, after receiving a donation of several polished plates from gem cutter Dalan Hargrave (GemStarz Jewelry, Spring Branch, Texas). Microscopic examination revealed isolated tiny brassy inclusions in three of the slabs (e.g., figure 17), and EDXRF spectroscopy detected traces of gold in those samples, along with Fe and As with the expected Al and P. LA-ICP-MS analysis of an inclusion in one sample by GIA research scientist Dr. Andy Shen confirmed its identity as gold.

BML, Eric A. Fritz, and John I. Koivula

## INSTRUMENTS AND TECHNIQUES

**Portable Raman spectrometer and the CrystalSleuth software.** At the AGTA show, Bear and Cara Williams (Bear Essentials, Jefferson City, Missouri) showed this contributor a portable Raman spectrometer (figure 18) they had recently purchased for their own gemological research and in-house laboratory. Their instrument, the Enwave Optronics EZRaman L System, uses a 785 nm laser excitation source (532 and 670 nm lasers are also available) and is operated with a standard laptop computer. It is used in conjunction with a comprehensive Raman spectral library that is freely downloadable from the RRUFF Project web site at [http://rruff.info/about/about\\_software.php](http://rruff.info/about/about_software.php). (For more on

the RRUFF Project, see the abstracts by R. T. Downs and M. B. Denton in the Fall 2006 issue of *G&G*, pp. 89–90.) The Windows-based software, called CrystalSleuth, is capable of analyzing and manipulating Raman spectra, as well as powder X-ray diffraction data. It can be used to remove background noise, compare multiple spectra, and identify an unknown sample by referencing peak positions against the on-line RRUFF Project database. While the current database is strongly oriented toward mineralogy, there are obvious overlaps with gemology.

Mr. Williams indicated that it typically takes about five minutes to get a well-defined Raman spectrum that can then be saved to his database or compared to the RRUFF database using the CrystalSleuth software. He is in the process of building his own Raman spectral database that includes information on the origin and any known treatment of every gem sample that he analyzes.

This portable Raman spectrometer was purchased for under \$20,000, and continued technological advances are expected to make such instrumentation even smaller and more affordable in the future. This, combined with the availability of the free CrystalSleuth software, is poised to make Raman spectroscopy a more accessible tool for the professional gemologist and conscientious gem dealer.

BML

Figure 18. Bear Williams set up his portable Raman spectrometer at the AGTA show in Tucson. Photo by Robert Weldon.



## GNI Regular Features

### COLORED STONES AND ORGANIC MATERIALS

**Amethyst from the Democratic Republic of the Congo.** During a buying trip to Tanzania in mid-2006, gem dealer Farooq Hashmi (Intimate Gems, Jamaica, New York) obtained some rough amethyst that was reportedly mined

from the Democratic Republic of the Congo. He noted that in recent years up to several hundred kilograms of gem-quality rough amethyst from the DRC has been sold in Tanzania annually, in addition to even larger quantities from Zambia.

Mr. Hashmi loaned us a crystal fragment and three faceted stones (3.31–22.11 ct; figure 19) that were representa-



Figure 19. This amethyst (3.31–22.11 ct) was reportedly sourced from the Democratic Republic of the Congo. Courtesy of Intimate Gems; photo by Robert Weldon.

tive of the more attractively colored DRC amethyst. The cut stones were examined by one of us (EAF), and gave typical properties for amethyst: color—purple; R.I.—1.546–1.555; birefringence—0.009; hydrostatic S.G.—2.65; and inert to both long- and short-wave UV radiation. Microscopic examination revealed “fingerprints” consisting of minute two-phase (liquid and gas) inclusions, as well as a few sprays of reddish needles (e.g., figure 20) that had the appearance of the hematite inclusions commonly found in amethyst (see also E. J. Gübelin and J. I. Koivula, *Photoatlas of Inclusions in Gemstones*, Vol. 2., Opinio Publishers, Basel, Switzerland, 2005, p. 562). The stones did not exhibit Brazil-law twinning in the polariscope, but they did produce a typical quartz “bull’s-eye” uniaxial optic figure. FTIR spectroscopy showed typical features for amethyst and no unusual peaks (e.g., no  $3543\text{ cm}^{-1}$  peak, as has been documented in material from a few localities as well as in some synthetic amethyst).

Eric A. Fritz and BML

Figure 21. These faceted brown-orange andradites from Iran (1.25 and 1.64 ct) contain striking green color zones. Photo by M. Douman.



Figure 20. The DRC amethyst contained sprays of reddish needles that resemble the hematite inclusions commonly encountered in amethyst. Photomicrograph by Robert Weldon; magnified 10 $\times$ .

#### Color-zoned andradite from Iran, with calcite inclusions.

The recent GIA Gemological Research Conference included a poster describing Iranian demantoid (G. Du Toit et al., “Demantoid from Iran,” Fall 2006 *Gems & Gemology*, p. 131). Since then, one of the poster authors and present contributors (MD) obtained some unusual andradite samples from Iran, including two faceted brown-orange stones (1.25 and 1.64 ct; figure 21) with distinct zones of green color centered under their tables. The 1.25 ct sample was examined in detail for this report. The specific gravity (3.79) and refractive index (1.86) values confirmed that it was andradite. Magnification revealed parallel, nearly parallel, and curved fibrous inclusions with some associated fractures (figure 22).

Figure 22. Parallel, nearly parallel, and curved fibrous inclusions were present in the color-zoned andradite, together with associated fractures. Photomicrograph by E. Gaillou; magnified 20 $\times$ .





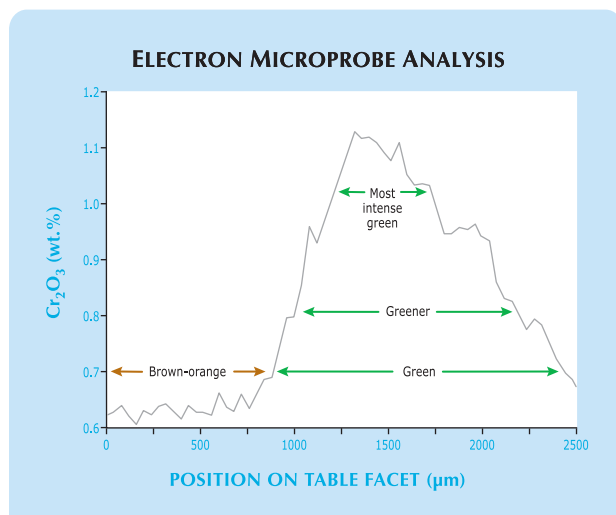


Figure 23. This graph shows the Cr<sub>2</sub>O<sub>3</sub> content inferred from 64 point analyses that were performed across the 2.5-mm-diameter table of the 1.25 ct color-zoned andradite. The green color was apparent in regions where the Cr<sub>2</sub>O<sub>3</sub> concentration exceeded 0.7 wt.%, and the saturation of the green color correlated well with chromium content.

To explore the possible correlation between chemical composition and color, we obtained numerous microanalyses of this sample using a Princeton Gamma Tech energy-dispersive detector attached to a JEOL 5800 scanning electron microscope. In addition to the Si, Ca, Fe, and Al expected for andradite, both the brown and green zones contained traces of Mg, Mn, and V. However, the green areas also contained Cr<sub>2</sub>O<sub>3</sub> concentrations above 0.7 wt.%, and the color intensity increased with chromium content (figure 23). There was no correlation between the green color and other

Figure 25. The emerald contained parallel jagged three-phase inclusions, as are commonly seen in Colombian emeralds. Photomicrograph by M. Vyas; magnified 25×.

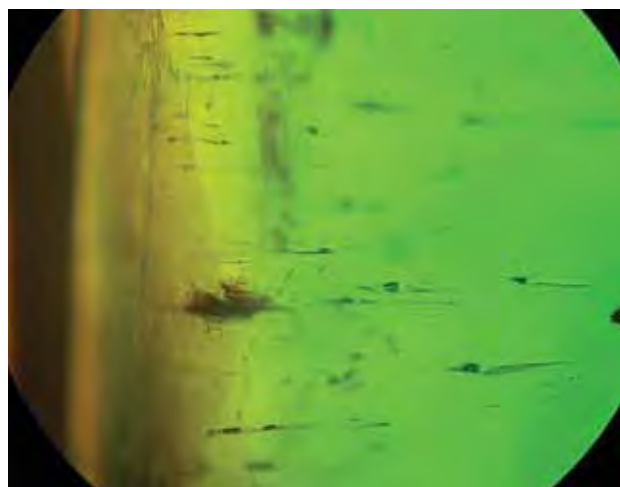


Figure 24. This 4.77 ct emerald exhibited some unusual growth features. Photo by G. Choudhary.

elements. This is in agreement with previous studies stating that the green color of demantoid is caused by Cr<sup>3+</sup> (see E. Fritsch and G. R. Rossman, "An update on color in gems. Part 3: Colors caused by band gaps and physical phenomena," Summer 1988 *Gems & Gemology*, pp. 81–102), and it was supported by visible absorption spectroscopy. The spectrum of the stone showed a broad band with two apparent maxima at 620 and 640 nm that are likely due to Cr<sup>3+</sup>. There was also total absorption in the violet and blue regions of the spectrum, presumably due to Fe<sup>2+</sup>-Ti<sup>4+</sup> charge transfer (see S. M. Mattson and G. R. Rossman, "Fe<sup>2+</sup>-Ti<sup>4+</sup> charge transfer in stoichiometric Fe<sup>2+</sup>, Ti<sup>4+</sup>-minerals," *Physics and Chemistry of Minerals*, Vol. 16, No. 1, 1988, pp. 78–82); this caused the areas of brown color in the stone.

The Raman spectrum of the entire 1.25 ct sample (taken without the use of a microscope) showed the

Figure 26. Rain-like growth tubes oriented parallel to the three-phase inclusions were also present in the emerald. Photomicrograph by G. Choudhary; magnified 30×.

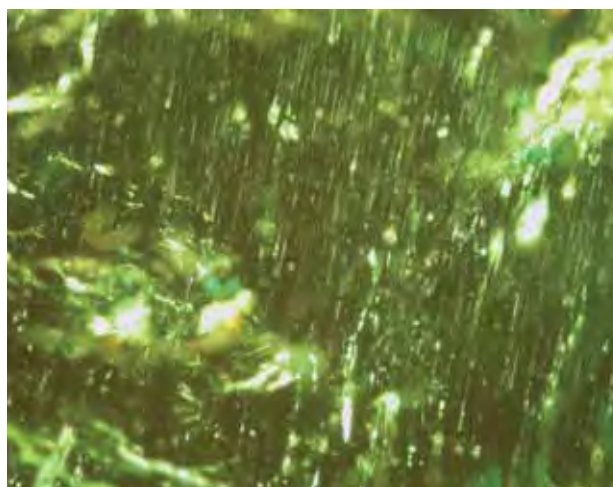
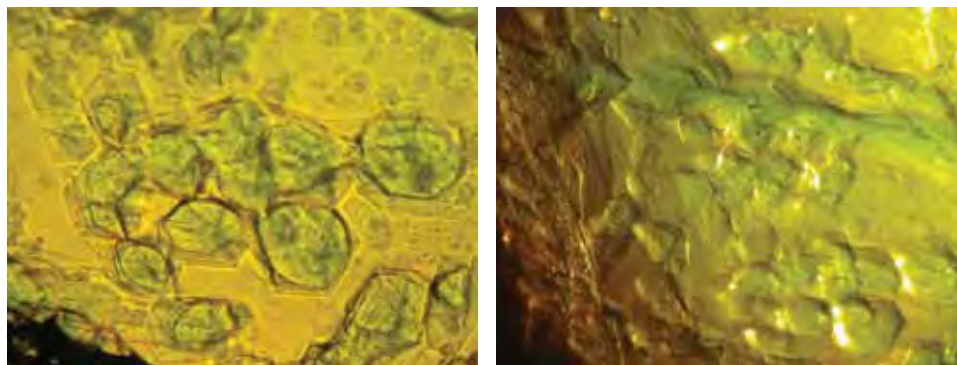


Figure 27. These unusual growth features in the emerald appear to be formed by an aggregation of hexagonal subcrystals. Also note the six-fold sector zoning within the individual subcrystals (left). Photomicrograph by G. Choudhary, magnified 40×, crossed polarizers (left); and C. Golecha, magnified 25×, transmitted light (right).



expected andradite peaks, as well as smaller peaks correlating to calcite. Although calcite inclusions have been described in garnet previously, they are found mostly in grossular (especially hessonite and tsavorite; E. J. Gübelin and J. I. Koivula, *Photoatlas of Inclusions in Gemstones*, Vol. 2, Opinio Publishers, Basel, Switzerland, 2005, pp. 471–475). To our knowledge, calcite has not been reported previously in demantoid. Further research is necessary to determine if the calcite is present as the fibrous inclusions mentioned above, or as micro-inclusions that were not visible with a gemological microscope. Additional research is also needed to determine if calcite is present in andradite/demantoid from other localities, or if it is characteristic of the material from Iran.

Stefanos Karampelas (*steka@physics.auth.gr*)  
 Department of Geology  
 University of Thessaloniki, Greece;  
 Institut des Matériaux Jean Rouxel (IMN)  
 Université de Nantes, France

Eloïse Gaillou and EF  
 IMN

Makhmout Douman  
 Arzawa Mineralogical Inc., New York

**Emerald with unusual growth features.** Recently, the Gem Testing Laboratory, Jaipur, India, received a 4.77 ct green gem for identification (figure 24). Its refractive index was 1.571–1.577, giving a birefringence of 0.006; the hydrostatic S.G. was 2.67. The stone had a strong chromium spectrum and was inert to UV radiation. These properties are consistent with emerald, natural or synthetic. Notably, when viewed with the polariscope, it exhibited strong strain patterns with patches of color in the optic axis direction (i.e., perpendicular to the table facet).

With magnification, the stone revealed a number of jagged three-phase inclusions oriented parallel to the optic axis (figure 25). Such inclusions are common in Colombian emeralds. Parallel growth tubes with a rain-like appearance (figure 26) were present in the same orientation; these are often observed in beryl, but they are unusual in Colombian emerald. The stone also had a roiled appearance (or “heat-wave” effect) when viewed table-up.

Although the inclusions indicated a natural origin, the causes of the unusual polariscope reaction and heat-wave

effect were not clear. Examination of the stone with crossed polarizers while immersed in bromoform revealed a mosaic pattern when viewed along the optic axis (figure 27, left), somewhat similar to that seen in some Colombian emeralds (see, e.g., E. J. Gübelin and J. I. Koivula, *Photoatlas of Inclusions in Gemstones*, Vol. 1, ABC Edition, Zurich, p. 252). In plane-polarized transmitted light, these features appeared to be formed by the boundaries of intergrown columnar hexagonal subcrystals (figure 27, right). Most of these subcrystals followed the same orientation as the two-phase inclusions described above. When viewed with diffuse illumination (still in immersion), the hexagonal columns appeared slightly darker green than the interstitial areas and could be seen extending throughout the stone. Although the crystals followed the same orientation, some irregular boundaries between individual subcrystals were also visible, as was six-fold sector zoning (again, see figure 27, left).

It was clear that the roiled appearance of this emerald was due to intergrowth of the hexagonal subcrystals when viewed table-up (i.e., along the optic axis), while wavy growth features were seen in a direction perpendicular to the optic axis (figure 28). The latter patterns were similar to the chevron-like growth zoning that is typically seen in

Figure 28. Wavy growth features similar to the chevron-like growth zoning associated with synthetic emeralds were prominent when this natural emerald was viewed from the side (i.e., perpendicular to the optic axis). Such features indicate disturbed or rapid growth. Photomicrograph by C. Golecha; magnified 35×.

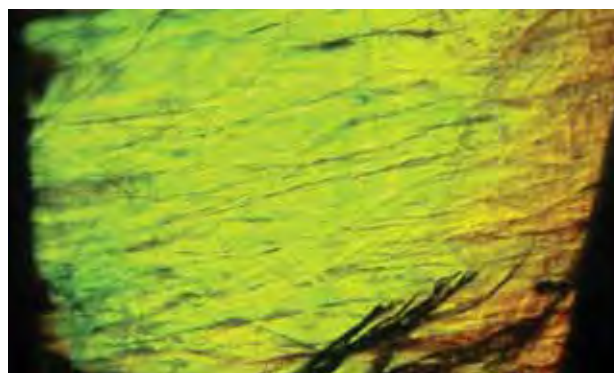






Figure 29. Attractive grossular (hessonite) has been produced recently from the Anza Borrego Desert in San Diego County, California. The cut stones shown here weigh 1.31–6.26 ct, and the etched crystal weighs 3.5 g. Courtesy of Paul Vollom; photo by R. Weldon.

synthetic emerald, and are indicative of disturbed or rapid growth. However, FTIR spectra taken in various directions showed that the strength of the peak at approximately  $5270\text{ cm}^{-1}$  was characteristic of natural emerald (see, e.g., Fall 2005 Gem News International, pp. 265–266). The IR spectrum, as well as the overall inclusion pattern, confirmed the natural origin of this emerald.

Gagan Choudhary and Chaman Golecha  
(gtl@gjepcindia.com)  
Gem Testing Laboratory, Jaipur, India

**Grossular and clinozoisite from San Diego County, California.** For decades, small quantities of gem-quality grossular (hessonite) have been intermittently produced from skarn deposits in southeastern San Diego County (J. Sinkankas, *Gemstones of North America*, Van Nostrand Co., Princeton, NJ, 1959, pp. 288–289). Since 2004, renewed mining at one such claim has yielded good-quality hessonite as well as facetable clinozoisite. Paul Vollom

Figure 31. In addition to “fingerprints,” one of the garnets contained a primary two-phase fluid inclusion. Photomicrograph by J. I. Koivula; magnified 20 $\times$ .

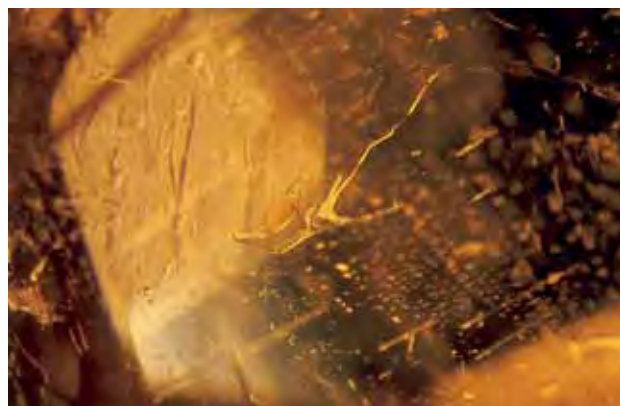


Figure 30. These 2.24 and 0.74 ct clinozoisite samples from the Anza Borrego Desert were examined for this report. Courtesy of Paul Vollom; photo by R. Weldon.

(Omega Gems & Minerals, San Diego) and Roger Smith (Bishop, California) have been working the claim using hand tools and a portable gasoline-powered drill and jackhammer. The deposit is situated in a rugged area east of Jacumba, near the border with Mexico, in the Anza Borrego Desert. In some regards, this area conspires to limit human access to its mineral wealth, presenting an array of obstacles such as huge boulders, cholla cacti, rattlesnakes, and scorpions. Nevertheless, Mr. Vollom has recovered 7 kg of hessonite (e.g., figure 29), including a 46.8 g etched crystal. He estimated that 2 kg of this production would be suitable for cutting cabochons between 0.33 and 0.50 ct, and 1 kg could be faceted into the following sizes: >5 ct (5%), 2–5 ct (20%), <2 ct (35%), with the remaining 40% consisting of smaller stones. So far he has cut 36 hessonites, most ranging from 2 to 6 ct each. In addition, he has obtained 50 g of clinozoisite, and by the end of 2006 he had faceted 10 stones weighing ~0.75–3.00 ct (e.g., figure 30).

In January 2007, Mr. Vollom supplied several rough and cut samples of each gem to GIA for examination. Four faceted hessonites (1.31–6.26 ct) and one etched

Figure 32. Lamellar color zoning is evident in this Anza Borrego hessonite. Photomicrograph by J. I. Koivula; magnified 10 $\times$ .



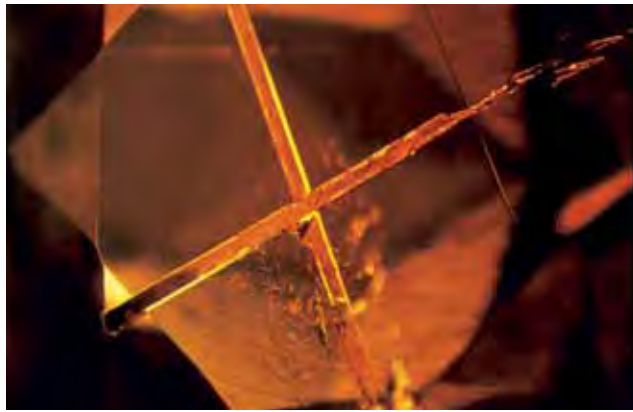


Figure 33. Needle-like quartz inclusions form a conspicuous intersection in the image on the left; the high relief and apparent orange color of these inclusions is due to the presence of an air interface with the host garnet. The more typical low-relief appearance of the quartz inclusions in the Anza Borrego hessonite is shown on the right. Photomicrographs by J. I. Koivula; magnified 10× (left) and 15× (right).

crystal (3.5 g), which represented the range of color from this locality (again, see figure 29), were selected for characterization by one of us (EAF). The following properties were obtained on the cut stones: color—yellowish orange to orange to reddish orange; R.I.—1.743 to 1.747; hydrostatic S.G.—3.63 to 3.65; fluorescence—inert to both long- and short-wave UV radiation; and weak general absorption to 520 nm observed with the desk-model spectroscope. These properties are consistent with those reported for grossular by C. M. Stockton and D. V. Manson (“A proposed new classification for gem-quality garnets,” Winter 1985 *Gems & Gemology*, pp. 205–218). Microscopic examination revealed growth tubes, two-phase (liquid and gas) inclusions (figure 31), transparent planar growth zoning, lamellar color zoning (figure 32), and colorless needles (figure 33) that were identified as quartz by Raman spectroscopy.

Examination of two cut clinozoisites (0.74 and 2.24 ct; again, see figure 30) showed the following properties: color—brownish greenish yellow to brownish yellow-green, with moderate colorless to greenish yellow or yellow-green pleochroism; R.I.— $n_o=1.711$  and  $1.712$ ,  $n_e=1.720$ ; birefringence—0.008 and 0.009; hydrostatic S.G.—3.40; Chelsea filter reaction—none; fluorescence—inert to long- and short-wave UV radiation; and an absorption line at 455 nm visible with the desk-model spectroscope. Microscopic examination revealed transparent angular growth structures and “fingerprints” consisting of two-phase (liquid and gas) inclusions. The physical properties are consistent with those reported for clinozoisite by W. A. Deer et al. (*Rock-Forming Minerals—Vol. 1B, Disilicates and Ring Silicates*, 2nd ed., The Geological Society, London, 1997, pp. 44–134). The R.I., birefringence, and S.G. of clinozoisite increase with iron content; the values of the samples tested here correlate to the lower range of iron that has been measured in clinozoisite (i.e., ~4 wt.%  $Fe_2O_3$ ; see Deer et al., 1997).

Eric A. Fritz, John I. Koivula,  
Robert Weldon, and BML

**New pegmatite gem production from Tsarafara, Madagascar.** Spodumene, tourmaline, and morganite were recently recovered as well-formed crystals and gem rough from a pegmatite at Tsarafara, near Mount Ibity in the Sahatany Valley of central Madagascar. The gems came from two pockets that were found in September 2006. The mine has been worked by local miners, using hand methods, in shafts down to 20 m deep (figure 34). This contributor visited the mine three times in October 2006 to document the production. Tsarafara is also known as Ankadilava or Ambalaroy in the literature.

Figure 34. A weathered pegmatite at Tsarafara, Madagascar, recently produced some fine spodumene, tourmaline, and morganite. The miners constructed a simple windlass to remove the material from each of the two shafts shown here. Photo by F. Danet.







Figure 35. This green spodumene crystal from Tsarafara measures 7 cm long. Photo by F. Danet.

The spodumene ranged from colorless to pale green (e.g., figure 35), pale blue, and pink (rarely bicolored blue-pink). At least 150 kg were produced, in translucent to eye-clean crystals up to 50 cm long. The largest crystal (not seen by this author) reportedly measured about 80 cm long. Most of the spodumene was exported as mineral specimens for collectors and as rough for Asian lapidaries; only a few cut stones have been seen in Madagascar.

Hundreds of tourmaline crystals were produced, commonly with a black “skin” and concentric internal layers of violet-pink, dark green, grayish green to bluish green, brownish yellow, and/or colorless. Although some of the tourmaline has been faceted into multicolored gems (grayish green, dark green, and violet) weighing up to 30 ct, a significant amount of the material has been cut into attractive slices that typically measure 1–8 cm in diameter (e.g., figure 36). Most of the rough, which was of low quality and recovered in small sizes, was sold to African traders for the Asian market (to make carvings and beads).

The Tsarafara pegmatite also yielded a few kilograms of morganite, mostly with a pale yellowish orange color. The best morganite consisted of eye-clean orangy pink

Figure 37. The best-quality morganite from Tsarafara is notable for its transparency and orangy pink color (here, 31.8 ct). Photo by F. Danet.



Figure 36. Tourmaline from Tsarafara has been cut into colorful slices (here, 1–4 cm in diameter). Photo by F. Danet.

crystals that measured up to 10 cm in diameter. In December 2006, this contributor saw a clean 66 g yellowish orange piece of morganite that would probably yield an ~100 ct faceted stone. Most of the well-formed crystals have been retained as specimens for collectors, with some broken pieces cut into faceted stones (e.g., figure 37).

By the end of 2006, almost all of the deep workings had collapsed due to flooding from the rainy season. The miners therefore shifted to higher ground in the southern part of the mine, where they found narrow, elongate crystals of multicolored tourmaline (brown, grayish green, violet, and pink). The termination of some of the crystals contained abundant hollow tubes that created chatoyancy when cut into cabochons. Nearly all of the workings were subsequently destroyed during heavy rains in early 2007.

*Fabrice Danet (fabdanet@wanadoo.mg)  
Style Gems, Antsirabe, Madagascar*

**Pezzottaite from Myanmar.** In late 2006, small pink beryl-like crystals (e.g., figure 38) were recovered from Khat-Chel, near Molo, in the Momeik area of Myanmar’s Mogok District. They were brought to the attention of these contributors by Patrick de Koenigswarter of MinerK, St. Julia de Gras Capou, France, who suspected that they were pezzottaite. They reportedly came from a granitic pegmatite known to have produced near-colorless twinned phenakite crystals, fibrous pink “mushroom” tourmaline, and other minerals such as petalite and hambergite.

Six crystals and crystal groups were studied for this report. Individual crystals were slightly tabular and composed mainly of basal pinacoid faces combined with prismatic faces; no pyramidal faces were observed. Composite basal terminations were occasionally present; these appeared flower-like and were very slightly concave (again, see figure 38). There were no signs of corrosion on the crystal surfaces. Some of these crystals were of gem quality or had portions that were transparent enough to be faceted.

Strong pinkish orange (“salmon”) to purplish pink dichroism was visible, even to the unaided eye. When viewed with magnification and polarizing filters, or a dichroscope, the pleochroism was very strong, shifting from orange to purple in all samples (e.g., figure 39).

The refractive indices were 1.594–1.609, with a birefringence of 0.015. The crystals were uniaxial negative, and specific gravity ranged from 2.92 to 2.95. These properties are very high for beryl, but within the lower range of those described for pezzottaite (B. M. Laurs et al., “Pezzottaite from Ambatovita, Madagascar: A new gem mineral,” Winter 2003 *Gems & Gemology*, pp. 284–301; H. Hänni and M. S. Krzemnicki, “Caesium-rich morganite from Afghanistan and Madagascar,” *Journal of Gemmology*, Vol. 28, No. 7, 2003, pp. 417–429). The very strong pleochroism is also distinctive for pezzottaite. Some samples showed weak greenish white fluorescence to short-wave UV radiation only, with no phosphorescence. We have often observed such short-wave-only UV fluorescence of various colors (orange to yellow to green) in near-colorless morganite.

A surface parallel to the c-axis was polished on two crystals, exposing inhomogeneous color distribution and an hourglass growth pattern, both of which are common in beryl-group minerals. Growth sectors under basal faces contained more inclusions than those under prism faces, and a darker pink color was seen in growth sectors parallel to the basal face.

To confirm the presence of pezzottaite, we performed X-ray diffraction, chemical analyses, and Raman spectroscopy. X-ray diffractograms obtained at Blaise Pascal University using a CRG Sigma 2080 powder diffractometer on several portions of a crystal clearly showed the splitting of peaks indicative of the presence of a trigonal phase (such as pezzottaite, compared to hexagonal beryl). Quantitative chemical analyses were obtained on the same crystal at Blaise Pascal University (on a Cameca SX100 electron microprobe), and on the crystal shown in figure 38 at the University of Nantes (with a PGT energy-dispersive detector attached to a Jeol 5800 scanning electron microscope); similar results were obtained from both samples. The crystals were strongly zoned in Cs content, ranging from 5.12 to 9.97 wt.% Cs<sub>2</sub>O for the one studied in Nantes and 2.5 to 12 wt.% Cs<sub>2</sub>O for the one analyzed in Clermont Ferrand (figure 40). The trace-element (Na, Rb, Ca) contents were also consistent with published analyses of pezzottaite (from Madagascar).

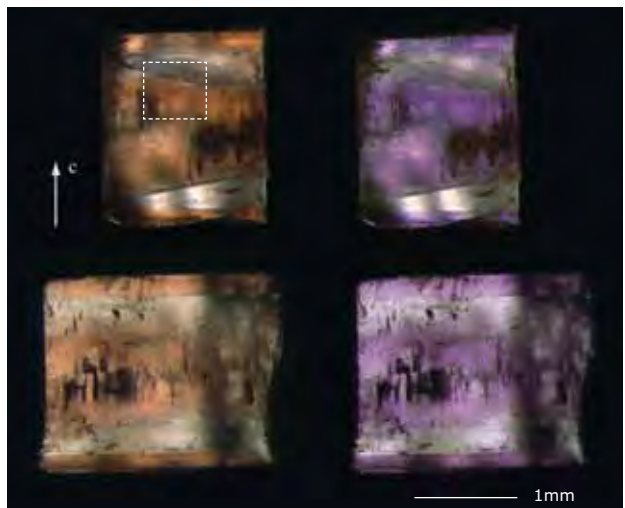
Using a Jobin Yvon T6400 dispersive Raman spectrometer, Raman spectra were obtained on several points of the crystal studied in Nantes, corresponding to locations of variable Cs content. All spectra were very similar to those published by Laurs et al. (2003), and all showed the peak at about 1103 cm<sup>-1</sup>, reported as being indicative of the pezzottaite structure.

These analyses were sufficient to confirm that the crystals were dominantly pezzottaite (with the possible presence of a small amount of beryl). This is the third



Figure 38. This crystal of pezzottaite (8.2 × 6.2 mm) was recovered from the Momeik area near Mogok, Myanmar. The use of plane-polarized light shows the pleochroic colors of the material. Note the very slightly concave surface formed by the composite basal termination on the right side of the crystal. Courtesy of P. de Koenigswarter; photo by E. Fritsch.

Figure 39. This composite photo of two polished faces containing the c-axis (at about 90° to one another) of one crystal taken through a polarizing filter (ordinary ray, left; extraordinary ray, right) shows the very strong orange and purple pleochroism of the pezzottaite. An “hour-glass” growth pattern is also visible, as well as pink growth bands parallel to the c-axis. The dashed square (upper left photo) marks the area analyzed by SEM in figure 40. Photos by B. Devouard.





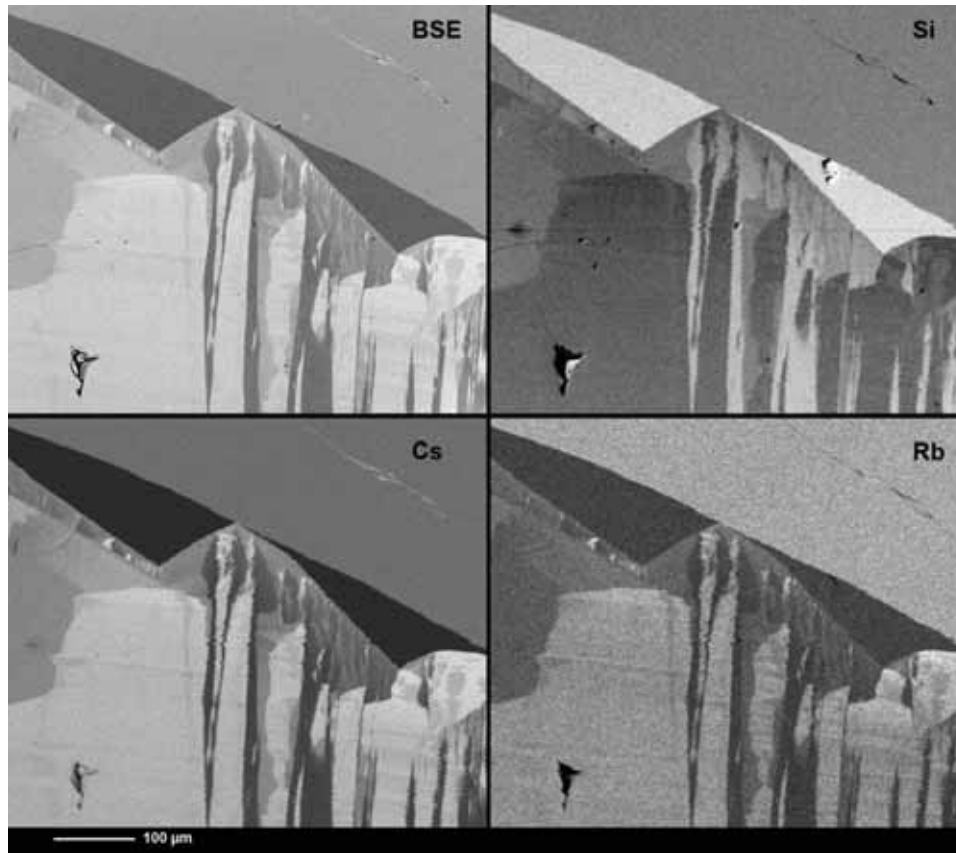


Figure 40. Strong chemical zoning is apparent in these SEM images of the Burmese pezzottaite. The image taken in backscattered electron (BSE) mode illustrates variations in overall atomic number, with lighter areas containing heavier elements (i.e., Cs). The distributions of Si, Cs, and Rb are also shown, with lighter areas corresponding to higher concentrations of those elements. The images reveal complex growth patterns. Images by B. Devouard.

reported occurrence for pezzottaite, after Madagascar and Afghanistan, and the first in Myanmar. The Burmese pezzottaite first debuted at the Munich gem show in early November 2006 (R. De Ascensão Guedes and L.-D. Bayle, "Munich 3–5 novembre 2006," *Le Règne Minéral*, No. 72, 2006, pp. 4–15), where it was represented as being from Kaha Chee in the Momeik area of the Mogok District.

Bertrand Devouard and Jean-Luc Devidal  
([devouard@opgc.univ-bpclermont.fr](mailto:devouard@opgc.univ-bpclermont.fr))  
Blaise Pascal University  
Clermont Ferrand, France

Yves Lulzac  
Nantes, France  
EF

**Cat's-eye prehnite.** Recently, the Dubai Gemstone Laboratory received three translucent oval grayish yellowish green chatoyant cabochons for identification (4.95–5.40 ct; figure 41). At first glance, they resembled cat's-eye quartz in their chatoyancy and coloration. However, standard gemological testing proved that all three stones were cat's-eye prehnite.

All showed a spot R.I. of 1.62, with hydrostatic S.G. values ranging from 2.87 to 2.92. They were inert to both long- and short-wave UV radiation, and showed no pleochroism, no characteristic absorption spectrum, and no reaction to the Chelsea color filter. These properties are

comparable to those reported for prehnite by R. Webster (*Gems*, 5th ed., revised by P. G. Read, Butterworth-Heinemann, Oxford, U.K., 1994, p. 361). Microscopic examination of the three samples revealed numerous extremely thin parallel channels or platelets as the cause of the chatoyancy, as well as small fissures (figure 42).

Reflectance IR spectroscopy and Raman analysis confirmed the identification as prehnite. EDXRF chemical analysis revealed the expected Ca, Si, and Al, as well as minor amounts of Fe.

Figure 41. These three chatoyant cabochons (5.40, 5.02, and 4.95 ct) were identified as cat's-eye prehnite. Photo by S. Singbamroong, © Dubai Gemstone Laboratory.

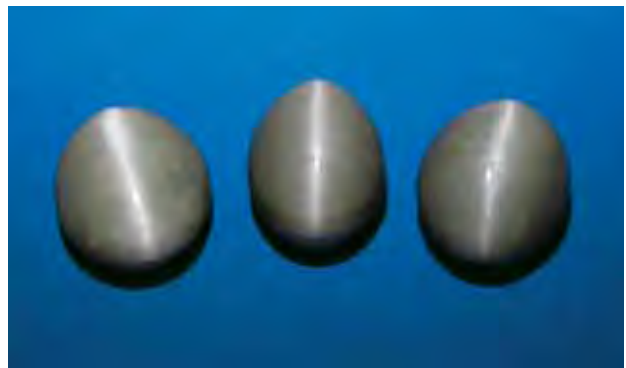




Figure 42. Numerous extremely thin parallel channels or platelets are the cause of the chatoyancy in the cat's-eye prehnite. Small fissures can also be seen near the right side of this view. Photomicrograph by S. Singbamroong, © Dubai Gemstone Laboratory; magnified 20 $\times$ .

Cat's-eye prehnite is quite rare, and this is the first time we have seen it in our laboratory. The origin of these stones is unknown.

Sutas Singbamroong (sssutas@dm.gov.ae)  
and Ayesha Rashid Ahmed  
Dubai Gemstone Laboratory  
Dubai, United Arab Emirates

**Cat's-eye topaz from Sri Lanka.** The Summer 1990 Gem News section (p. 164) reported on a 3.53 ct pale blue-green cat's-eye topaz with strong chatoyancy caused by a dense pattern of very fine, parallel etch ribbons. This was the first time that this rare gem material was reported in *Gems & Gemology*. We were therefore interested to examine another cat's-eye topaz, of significantly larger size (33.06 ct) and greater transparency, that was brought to our attention by Dudley Blauwet (Dudley Blauwet Gems, Louisville, Colorado). He obtained the cabochon (figure 43) while on a buying trip to Sri Lanka in late November 2006; the rough was reportedly recovered from the well-known gem mining area near Embilipitiya, in Uva Province, southern Sri Lanka.

Gemological testing clearly identified this gem as topaz. Microscopic examination revealed the cause of the chatoyancy to be numerous ultra-thin, parallel, acicular inclusions that appeared to be etch channels (figure 43, inset).

Mr. Blauwet's supplier indicated that a total of four pieces of the cat's-eye topaz were found, and that the other three samples were purchased by rare-stone dealers in Sri Lanka's capital city, Colombo.

BML and John I. Koivula

**Tourmaline (dravite and liddicoatite) from northeastern Mozambique.** Gem tourmaline is well known from granitic pegmatites in the Nampula and Zambézia provinces of Mozambique (S. Lächelt, *Geology and Mineral Resources of Mozambique*, Direcção Nacional de Geologia Moçambique, Maputo, 2004, 515 pp.). Cabo Delgado

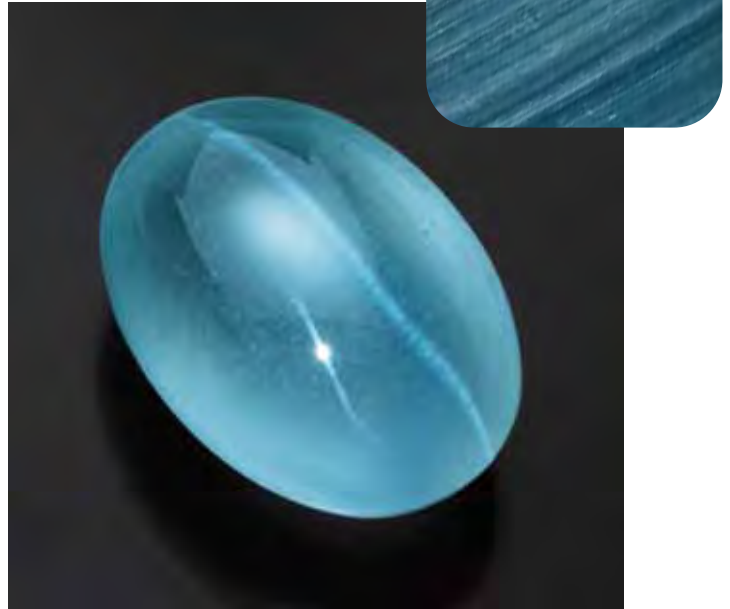


Figure 43. This 33.06 ct topaz from Sri Lanka is notable for its chatoyancy, transparency, and size. As shown in the inset, the chatoyancy is caused by numerous reflective, ultra-thin, parallel inclusions that appear to be etch channels. Courtesy of Dudley Blauwet, photo by Robert Weldon; photomicrograph by J. I. Koivula, magnified 30 $\times$ .

Province in northeastern Mozambique was mentioned by Lächelt (2004) as a pegmatite locality, but to our knowledge no gem tourmaline has been reported from there. However, Farooq Hashmi (Intimate Gems, Jamaica, New York) recently showed us some rough and cut samples of tourmaline that reportedly came from Cabo Delgado. Mr. Hashmi obtained two parcels of this tourmaline in Dar es Salaam, Tanzania, in mid-2006. One parcel consisted of about 2 kg

Figure 44. This tourmaline, showing a range of color from orangy yellow to green to orangy brown, was reportedly mined in Cabo Delgado Province, Mozambique. Chemical analysis showed that all of this tourmaline is dravite. The yellow trilliant weighs 1.67 ct and was cut by Matt Dunkle, Aztec, New Mexico. Courtesy of Intimate Gems; photo by C. D. Mengason.





of broken fragments that ranged from green to yellow, orange, and brown. Most of the rough was of cabochon quality, with individual pieces averaging 1–2 g. The other parcel contained more-transparent pieces that were water-worn; they averaged 3 g each and ranged from greenish brown to brownish or grayish green. Mr. Hashmi saw several 2–3 kg parcels of the latter material while in Tanzania, and more recently he has seen the rough appear in the New York market. Although he purchased all of these tourmaline samples in Tanzania, he was informed by multiple sources that the material in both parcels came from Cabo Delgado. Mr. Hashmi loaned GIA several fragments and one faceted stone from the first parcel (e.g., figure 44), and one piece of rough and several faceted stones that were cut from the second parcel (e.g., figure 45).

Examination of the cut stone from the first parcel by one of us (EAF) showed the following properties: color—orange yellow, with very weak colorless-to-yellow pleochroism; R.I.— $n_o=1.632$ ,  $n_e=1.612$ ; birefringence—0.020; hydrostatic S.G.—3.02; Chelsea filter reaction—none; fluorescence—inert to long-wave UV radiation and weak yellow to short-wave UV; and a weak absorption band at 500 nm visible with the desk-model spectroscope. Microscopic examination revealed numerous negative crystals and lint-like aggregates of colorless inclusions. The several rough pieces from the first parcel (green, greenish yellow, orange, orangy brown, and brown) that were briefly tested showed moderate-to-strong pleochroism, were inert to long-wave UV radiation, and fluoresced very weak to moderate yellow to short-wave UV. The lighter colored samples had a stronger reaction to short-wave UV. Microscopic examination revealed planes of fluid inclusions and some negative crystals (figure 46), as well as rare colorless low-relief crystals, black disks, and a rounded brassy inclusion (figure 47). A colorless low-relief inclusion in one of the rough pieces was identified as an amphibole by Raman analysis.

The properties reported above are consistent with tourmaline, and the samples were identified as dravite by LA-ICP-MS chemical analysis performed by Dr. Mike Breeding of the GIA Laboratory in Carlsbad. All of the stones contained minor amounts of Fe and traces of Ti, Ga, and Sr. While the color of some of this Mozambique tourmaline is similar to dravite-uvite from Kenya, the refractive indices reported for the latter are considerably higher ( $n_o=1.643$ – $1.646$  and  $n_e=1.622$ – $1.624$ ; see H. A. Hänni et al., “Golden yellow tourmaline of gem quality from Kenya,” *Journal of Gemmology*, Vol. 27, No. 7, 1981, pp. 437–442). However, the gemological properties of the Mozambique samples are comparable to those documented in samples with a similar hue range from Morogoro, Tanzania (Summer 2006 Gem News International, pp. 182–183).

LA-ICP-MS analysis of the cut stones and rough sample from the second parcel (again, see figure 45) showed that they consisted of either dravite or, surprisingly, liddicoatite. The three dravites were darker than most of the six liddicoatites that were tested.

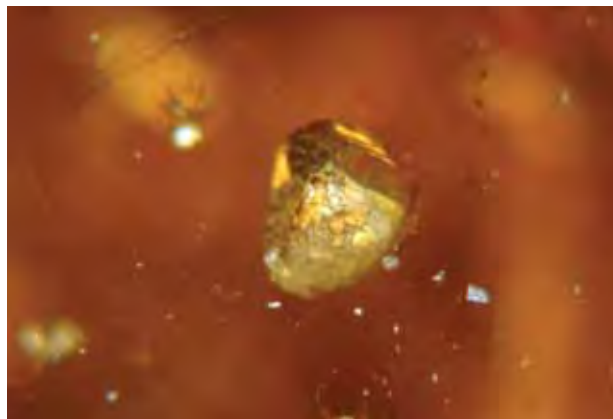


Figure 45. Also reportedly from Cabo Delgado, this greenish brown to brownish/grayish green tourmaline was loaned for study from a separate parcel. The six stones in the top two rows proved to be liddicoatite (3.08–5.09 ct, including the piece of rough on the upper right), while the three on the bottom are dravite (2.43–4.37 ct). Courtesy of Intimate Gems; photo by C. D. Mengason.

The dravite samples from the second parcel showed the following properties: color—dark brownish green to dark grayish green, with moderate green-to-colorless pleochroism; R.I.— $n_o=1.640$ ,  $n_e=1.620$ ; birefringence—0.020; hydrostatic S.G.—3.04–3.06; Chelsea filter reaction—none; fluorescence—inert to long- and short-wave UV radiation; and an absorption band at 500 nm visible with the desk-model spectroscope. Microscopic examination revealed only a very small “fingerprint” in one sample; no other inclusions or growth features were seen. LA-ICP-MS analysis showed that along with the elements normally associated with tourmaline, these dravite samples contained traces of Ti, Sr, and V.

The liddicoatite samples had the following properties: color—light brownish green to dark greenish brown, with

Figure 46. Negative crystals were common in some of the dravites shown in figure 44. Photomicrograph by Robert Weldon; magnified 15 $\times$ .



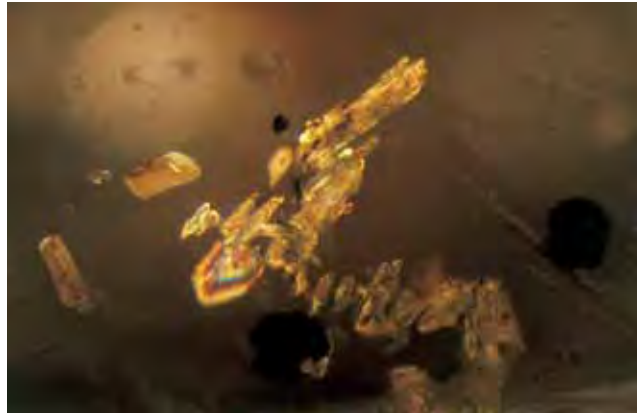


Figure 47. Also present in one of the dravite samples were colorless low-relief crystals (identified as an amphibole by Raman analysis), black disk-shaped crystals (probably graphite), and a minute rounded crystal with a brassy luster (probably pyrite; see arrow). The latter two inclusions were too deep in the stone for identification by Raman analysis. The birefringence of the amphibole inclusions is shown in the photo on the right, taken in cross-polarized light. Photomicrographs by J. I. Koivula; magnified 15 $\times$ .

weak-to-moderate green-to-colorless pleochroism; R.I.— $n_o=1.640$ ,  $n_e=1.620$ ; birefringence—0.020; hydrostatic S.G.—3.06; Chelsea filter reaction—none; fluorescence—inert to long- and short-wave UV radiation; and a weak absorption band at 500 nm visible with the desk-model spectroscope. In general, the stones were of high clarity; microscopic examination revealed angular color zoning, small transparent crystals, and growth tubes. Two of the stones contained a distinct dark green-to-brown triangular color zone (e.g., figure 48). The gemological properties are typical of liddicoatite (see D. M. Dirlam et al., “Liddicoatite tourmaline from Anjanabonoina, Madagascar,” *Spring 2002 Gems & Gemology*, pp. 28–53), but the homogeneous

Figure 48. A distinct triangular color zone is visible in this 3.08 ct liddicoatite when it is viewed at an angle to the table. Courtesy of Intimate Gems; photo by Robert Weldon.



brownish green to greenish brown coloration of most of the stones is rather unusual for gem-quality liddicoatite (see, e.g., Winter 2002 *Gem News International*, pp. 356–357).

We could find only one literature reference to liddicoatite from Mozambique: a chemical analysis of a sample from Muiane, Zambézia Province (T. G. Sahama et al., “On tourmaline,” *Lithos*, Vol. 12, 1979, pp. 109–114). Gem dravite and liddicoatite are not geologically associated with one another in nature, so it is likely that the samples from that alluvial parcel originally came from different deposits in Mozambique. This is also suggested by the very different trace-element signature for the liddicoatite, as measured by LA-ICP-MS: Ti, Mn, Ga, Sr, Pb, and Bi.

Eric A. Fritz, BML, and John I. Koivula

**Turquoise from Nacoziari, Sonora, Mexico.** In October 2006, we were informed by Jack Lowell (Colorado Gem & Mineral Co., Tempe, Arizona) about new production of turquoise from a large open-pit copper mine located about 110 km south of the U.S. border from Douglas, Arizona. Mr. Lowell reported that the Nacoziari turquoise occurs in nodules that can weigh up to 1.4 kg, and that while much of the material is chalky, a significant portion is very hard with excellent color. He obtained about 30 kg of the turquoise, consisting of nodules (figure 49), samples that appear to be pseudomorphs after apatite (figure 50), and an unusual piece that contained abundant sulfide minerals (figure 51).

Mr. Lowell loaned GIA several rough and polished samples for examination, and the three polished stones (5.79–12.32 ct; figure 49) were characterized by one of us (EAF): color—greenish blue, with no pleochroism; spot R.I.—1.59 to 1.60, with no birefringence visible on the refractometer; hydrostatic S.G.—2.64 to 2.69; Chelsea filter reaction—none; fluorescence—uneven moderate chalky blue to long-wave UV radiation, and inert to short-wave UV; and an absorption band at 430 nm visible with the desk-model spectroscope. These properties are consistent with those reported for turquoise by M. O’Donoghue





Figure 49. Attractive turquoise has been produced recently from a copper mine at Nacozeni, Sonora, Mexico, south of Douglas, Arizona. The cabochons shown here weigh 5.79–12.32 ct, and the nodule is 123 g. Intergrowths of quartz (white) and molybdenite (gray) are visible in the nodule. Courtesy of Jack Lowell; photo by Robert Weldon.

Figure 50. The crystal form shown by these turquoise specimens (2.5–10 cm long) suggests that they are pseudomorphs after apatite. Photo by Jack Lowell.



Figure 51. This 59.59 ct freeform turquoise cabochon contains numerous sulfide inclusions. The dark spots are Superglue-filled cavities. Courtesy of Jack Lowell; photo by Robert Weldon.

(*Gems*, 6th ed., Butterworth-Heinemann, Oxford, U.K., 2006, pp. 323–328), except that the R.I. values of the Mexican material are slightly higher. However, in the experience of the GIA Laboratory, the lower R.I. values reported for turquoise in the literature are typical for chalky, less dense turquoise. Microscopic examination of the cabochons revealed small inclusions of rounded quartz grains, mica “books,” and anhedral pyrite grains (all of which were confirmed by Raman spectroscopy).

Three pieces of rough material (17–123 g) and one heavily included freeform cabochon (59.59 ct) were also examined. The morphology of two of the rough pieces was consistent with that of pseudomorphs after apatite; such pseudomorphs have also been documented from Anhui Province in China (see Q.-L. Chen and Y. Zhang, “Features of gem-mineralogy of apatite-pseudomorph turquoise,” *Journal of Gems & Gemmology*, Vol. 7, No. 4, 2005, pp. 13–16). All of the Nacozeni rough material exhibited reactions to long- and short-wave UV radiation that were similar to those of the cabochons described above, as well as the 430 nm absorption band with the desk-model spectroscope. The larger piece of rough (figure 49) contained inclusions and intergrowths of pyrite, quartz, mica, and molybdenite (confirmed by Raman analysis). The inclusions in the freeform cabochon (figure 51) were identified with Raman microspectroscopy as pyrite and covellite, while marcasite, molybdenite, and epoxy were detected in minute cavities in the sample (figure 52). The presence of epoxy can be explained by the fact that Mr. Lowell used Superglue to stabilize the sample and ensure that the pyrite grains would be retained during the polishing process. FTIR spectroscopy showed no evidence of polymers (or waxes) in any of the other samples.

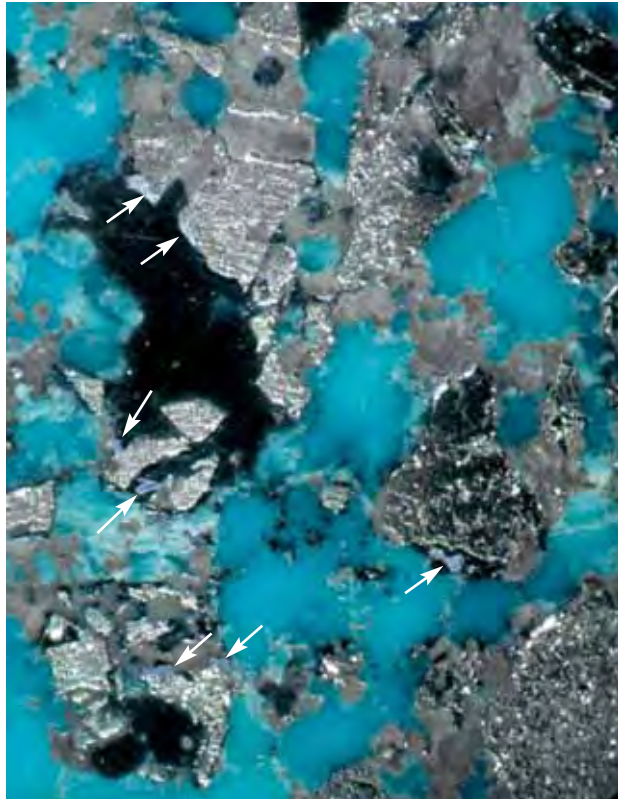


Figure 52. Raman analysis identified the inclusions in the turquoise cabochon in figure 51 as pyrite and covellite (silver metallic; see arrows). The dark areas are cavities that are filled with Superglue; Raman analysis of the cavity linings showed the presence of marcasite and molybdenite. The light brown areas consist of residue from the polishing wheel. Photomicrograph by J. I. Koivula; magnified 15 $\times$ .

Future production of turquoise from the Nacozari deposit is uncertain, since the miners prefer to avoid the turquoise-bearing zones because the mineralogy of those areas is unfavorable for the ore treatment processes used to obtain copper.

*Eric A. Fritz, John I. Koivula, BML*

## TREATMENTS

**Lead glass-filled rubies with hollow backs set in a closed-back mounting.** Recently, the SSEF Swiss Gemmological Institute received the ear pendant in figure 53 for analysis. It was set with what appeared to be three rubies and two diamonds. The ear pendant was purchased in the United States, and the client had been informed that it contained valuable Burmese rubies.

The red stones, which appeared to be rose cut, were set in a closed-back mounting, so it was necessary to unset them for analysis. This revealed the first of several surprises: Their bases had been carefully hollowed out, creating thin (~1 mm) concave ruby slices (figure 53, right). As the stones were heavily included, this deception was not apparent when they were mounted. An estimation of their weight based on measurable dimensions would have been overly high.

The red stones were easily identified as rubies based on standard gemological testing (R.I.—1.762–1.770; birefringence—0.008; hydrostatic S.G.—3.96; UV fluorescence—dull red to long-wave and inert to short-wave; and a Cr spectrum in a handheld spectroscope). A close look with the microscope revealed a narrow set of intersecting fissures along rhombohedral twinning planes; these fissures contained many gas bubbles and glassy swirls.

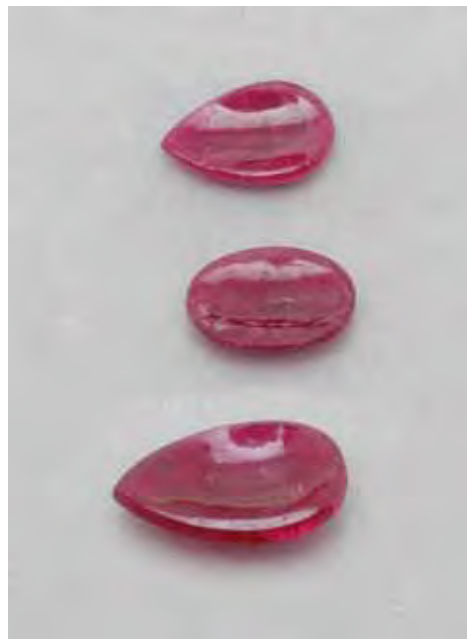


Figure 53. Although sold as a valuable jewel set with Burmese rubies, the ear pendant on the left turned out to be a clever fraud. When unmounted and observed from the back (right), the stones proved to be concave slices of lead glass-filled ruby. Photos by M. S. Krzemnicki, © SSEF.



Occasionally, blue flashes were observed. These features are well-known evidence of lead-glass filling in rubies (see, e.g., GAAJ Research Laboratory, "Lead glass impregnated ruby," [www.gaaj-zenhokyo.co.jp/researchroom/kanbetu/2004/gaaj\\_alert-040315en.html](http://www.gaaj-zenhokyo.co.jp/researchroom/kanbetu/2004/gaaj_alert-040315en.html), March 15, 2004; V. Pardieu, "Lead glass filled/repared rubies," [www.aigslaboratory.com/Filearticle/55.pdf](http://www.aigslaboratory.com/Filearticle/55.pdf), January 17, 2005; S. F. McClure et al., "Identification and durability of lead glass-filled rubies," Spring 2006 *Gems & Gemology*, pp. 22–34). Also noted were a hexagonal zoning pattern and linear particle trails with some rutile needles, indicating that the rubies probably had not been subjected to high-temperature heat treatment.

Chemical analysis of all three stones with EDXRF spectroscopy revealed chromium and iron as the main trace elements. Traces of gallium, very little titanium, and (with high excitation) very distinct lead peaks were also detected. Based on the microscopic observations and chemical analyses, the stones were identified as lead glass-filled rubies. Any filling of fissures with a glass involves heating. When the chemical composition of the stones was compared to those in the SSEF reference database, it matched that of material from Africa, such as from Madagascar or Tanzania. A Burmese origin could be excluded.

The degree of care and effort expended to produce this item was astonishing. Although ultimately the stones were easily identified, they proved unequivocally that the only way to evaluate gems presented in a closed-back setting is to unmount them. The risk of fraud is too great otherwise.

*Michael S. Krzemnicki (gemlab@ssef.ch)  
SSEF Swiss Gemmological Institute  
Basel, Switzerland*

## MISCELLANEOUS

**October 2006 Myanmar Gem Emporium, and other gem news from Myanmar.** Attended by 1,495 gem merchants from 10 countries, the second session of this twice-yearly government sale of Myanmar gem materials took place October 19–29 in the Myanmar Convention Center, Yangon. Colored gemstones and pearls were sold in both tender and competitive bidding. The stones sold in tender consisted of ruby (45%), blue sapphire (41%), and other gems (14%; e.g., purple, yellow, and colorless sapphire; spinel; zircon; moonstone; peridot; danburite; topaz; garnet; and aquamarine). Gems sold in competitive bidding included ruby, sapphire, spinel, peridot, and quartz.

Jadeite sales took place in a separate venue. Over the first eight months of the 2006–2007 budget year, Myanma Gem Enterprise (under the Ministry of Mines) reported sales of US\$300 million.

The Myanmar Pearl Enterprise (also under the Ministry of Mines) in February 2006 held the first cultured pearl sale for local merchants; the entire stock was sold for 2 million kyat (~US\$323,500). During a second sale in December 2006 (a tender system), most of the cultured pearls offered were "gold" colored, and 90% of the lots

sold. Myanmar is now producing cultured pearls from eight farms, of which three are government-run, two are managed by domestic private companies, and three are run by foreign firms. Total yearly production is estimated at 750 kg.

Petrified wood from Natogyi township, central Myanmar, has been selling well along the China-Myanmar border in Muse; it is used as a decorative stone. Some of the petrified wood is opalized, and pieces showing green color are the most highly prized.

The small gem shops in Yangon continue to sell synthetic material alongside natural gems. Those noted by this contributor included gadolinium gallium garnet (all colors), blue synthetic corundum (offered as irradiated blue topaz), and glass imitations of peridot. In addition, various small cultured pearls from India were available.

*U Tin Hlaing  
Dept. of Geology (retired)  
Panglong University, Myanmar*

## ANNOUNCEMENTS

**G&G online calendar.** A regularly updated list of conferences and museum exhibits pertaining to gems is now available on the G&G web site at [www.gia.edu/gemsandgemology](http://www.gia.edu/gemsandgemology).

### Conferences

**Gem-A Scottish Branch Annual Conference.** A variety of topics will be covered at this conference, hosted by the Scottish Branch of the Gemmological Association and Gem Testing Laboratory of Great Britain, to be held May 4–7, 2007, in Perth, Scotland. Visit [www.scotgem.demon.co.uk/conf2007.html](http://www.scotgem.demon.co.uk/conf2007.html).

**2007 ICA Congress.** The International Colored Gemstone Association Congress will be held May 5–9 in Dubai, United Arab Emirates. The theme is "Embracing Global Trends from Mine to Market." Presentations will be given by industry leaders on gem sources, manufacturing centers, marketing, branding, laboratory services, and education/ethics/economics. Visit [www.gemstone.org/congress](http://www.gemstone.org/congress).

**Granitic Pegmatites: The State of the Art.** Held May 6–12, 2007, at the Universidade do Porto, Portugal, this workshop will focus on the study of granitic pegmatites, and will include a field trip to rare-element pegmatites in northeastern Portugal and central-western Spain. Visit [www.fc.up.pt/peg2007](http://www.fc.up.pt/peg2007).

**2007 GAA-NSW Conference.** This year's conference of the New South Wales division of the Gemmological Association of Australia will be held May 18–20 in Hobart, Tasmania. Subjects will include the history of gems and lapidary, rare ivories, and Art Deco/Art Nouveau jewelry. Visit [www.gem.org.au/conference.htm](http://www.gem.org.au/conference.htm).

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**Santa Fe Symposium 2007.** The 21st annual Santa Fe Symposium on jewelry manufacturing technology will be held in Albuquerque, New Mexico, May 20–23. Visit [www.santafesymposium.org](http://www.santafesymposium.org).

**GAC-MAC 2007.** This year's joint meeting of the Geological Association of Canada and the Mineralogical Association of Canada will take place May 23–25, in Yellowknife, Northwest Territories. The conference will include a session on Canadian diamonds. A "Geology of Gem Deposits" short course will take place May 21–22, and a post-conference fieldtrip to the Ekati and Diavik diamond mines is scheduled for May 26–27. Visit [www.nwtgeoscience.ca/yellowknife2007](http://www.nwtgeoscience.ca/yellowknife2007).

**Maine Pegmatite Workshop.** The 5th Maine Pegmatite Workshop will be held May 26–June 3, in Poland, Maine. In addition to the in-depth curriculum, field trips to gem-bearing pegmatites in New England are planned. Visit [homepage.mac.com/rasprague/PegShop](http://homepage.mac.com/rasprague/PegShop).

**New Diamond and Nanocarbons.** Held May 28–31, in Osaka, Japan, this conference will address recent developments in the growth and characterization of synthetic diamond. NDNC is a merger of the International Conference of New Diamond Science and Technology (ICNDST) and the Applied Diamond Conference (ADC). Visit [www2.convention.co.jp/NDNC2007](http://www2.convention.co.jp/NDNC2007).

**JCK Show-Las Vegas 2007.** Held June 1–5, this gem and jewelry trade show will also host a comprehensive educational program May 30–31. Seminars will cover industry trends, diamond cut, sales and marketing strategies, legal issues for retailers and manufacturers, and new developments in gemology. To register, call 203-840-5684 or visit [jckvegas2007.expoplanner.com](http://jckvegas2007.expoplanner.com).

**PegCamp 2007—West.** This one-week course, held June 3–10 in Mesa Grande, California, will cover the mineralogy, internal structure, and evolution of granitic pegmatites through the field examination of pegmatites and related granites. Visit [www.pegmatology.com/pegcamp.htm](http://www.pegmatology.com/pegcamp.htm).

**Essentials of Color Science.** Munsell Color Science Laboratory's *Summer Short Course 2007* will take place June 5–8 at the Rochester Institute of Technology, Rochester, New York. The session will include lectures on color perception and appearance, digital color imaging systems, colorimetry, spectrophotometry, and color appearance models. Visit [www.cis.rit.edu/mcsl/outreach/courses.php](http://www.cis.rit.edu/mcsl/outreach/courses.php).

**First European Gemmological Symposium: "Presence and Future of Gemmology."** Honoring the 75th Anniversary of the German Gemmological Association, this international symposium will take place June 22–24, in Idar-Oberstein, Germany, and will offer presentations by gemological

researchers and business leaders from the gem and jewelry industry. Visit [www.dgemg.de/gemmologen\\_75](http://www.dgemg.de/gemmologen_75).

**PegCamp 2007—Rockies.** This one-week course, held July 8–15 in Canon City, Colorado, will cover the mineralogy, internal structure, and evolution of granitic pegmatites through the field examination of pegmatites and related granites. Visit [www.pegmatology.com/pegcamp.htm](http://www.pegmatology.com/pegcamp.htm).

**30th International Gemmological Conference.** Held July 15–19 in Moscow, Russia, this conference will cover new gem deposits, synthetics, treatments, gem identification methods, and markets. Only IGC delegates may give presentations, but the conference is open to observers and students. E-mail [balvld@iem.ac.ru](mailto:balvld@iem.ac.ru).

**ECROFI-XIX: European Research on Fluid Inclusions.** This conference will be held on July 17–20 at the University of Bern in Bern, Switzerland. The program will include a session titled "LA-ICP-MS Workshop: Analysis and data interpretation of inclusions in minerals." A pre-conference field trip on July 16 will take participants to the Bernese Alps and will include a visit to a large Alpine cleft lined with quartz crystals and other minerals. Visit [illite.unibe.ch/ecrofi/index.htm](http://illite.unibe.ch/ecrofi/index.htm)

**AOGS2007.** The Asia Oceania Geosciences Society's 4th Annual Meeting will take place July 30–August 4 in Bangkok, Thailand. The conference will include a session titled "Gem Materials in Bio- and Geosphere." Visit [www.asiaoceania.org/aogs2007](http://www.asiaoceania.org/aogs2007).

**PegCamp 2007—East.** This one-week course, held August 6–13 in Poland, Maine, will cover the mineralogy, internal structure, and evolution of granitic pegmatites through the field examination of pegmatites and related granites. Visit [www.pegmatology.com/pegcamp.htm](http://www.pegmatology.com/pegcamp.htm).

**NAJA 28th Annual Mid-Year Education Conference.** The National Association of Jewelry Appraisers will hold this conference August 11–14 at the Cobb Galleria Convention Center in Atlanta, Georgia. Visit [www.NAJAappraisers.com](http://www.NAJAappraisers.com).

**Goldschmidt 2007.** The 17th Annual V. M. Goldschmidt Conference will take place August 19–24 in Cologne, Germany, and will feature a session titled "Applied geochemistry—from brines and rare-earth elements to diamonds" in honor of long-time *G&G* contributor Dr. Alfred A. Levinson. The session will consist of two parts: "Exploration Geochemistry" and "Gem Mineralogy, Diamonds and Gemstones." Visit [www.goldschmidt2007.org](http://www.goldschmidt2007.org).

**24th European Crystallographic Meeting.** Held August 22–27 in Marrakech, Morocco, this conference will include a session titled "Crystallography in Art and Archeology." Visit [www.ecm24.org](http://www.ecm24.org).



**Diamond Symposium in Kimberley.** The Geological Society of South Africa's Directorate of Professional Programmes will host this colloquium August 30–September 2 in Kimberley, South Africa. The conference program will include field trips to diamond deposits. Visit [www.gssa.org.za](http://www.gssa.org.za).

**IV International Conference on the Application of Raman Spectroscopy in Art and Archaeology.** This meeting, held September 5–8 in Modena, Italy, will explore current trends and advanced techniques in the application of Raman spectroscopy to art and cultural heritage research. Visit [www.chimica.unimore.it/RAA2007/raa2007.htm](http://www.chimica.unimore.it/RAA2007/raa2007.htm).

**Diamond 2007.** The 18th European Conference on Diamond, Diamond-like Materials, Carbon Nanotubes, and Nitrides will be held in Berlin, Germany, on September 9–14. Presentations on the growth, processing, and characterization of diamond will be given. Visit [www.diamond-conference.elsevier.com](http://www.diamond-conference.elsevier.com) or e-mail [diamond-conference@elsevier.com](mailto:diamond-conference@elsevier.com).

**II International Conference “Crystallogenesi and Mineralogy.”** Held October 1–5 in St. Petersburg, Russia, this conference will explore mineral formation, crystal growth in nature and the laboratory, and crystal morphology. Visit [www.minsoc.ru/KM2007](http://www.minsoc.ru/KM2007).

**CGA Gem Conference 2007.** The Canadian Gemmological Association's annual gemological conference will take place October 19–21 in Vancouver, British Columbia. Visit [www.gemconference2007.com](http://www.gemconference2007.com).

**Mineralientage München.** The 44th Munich mineral show in Germany will take place November 2–4 and feature a special exhibit on gem crystals from Pakistan. Visit [www.mineralientage.com](http://www.mineralientage.com).

**Art2008.** Scheduled for May 25–30, 2008, in Jerusalem, Israel, the 9th International Art Conference on Non-destructive Investigation and Analysis will focus on items of cultural heritage, but will have implications for gem testing. Visit [www.isas.co.il/art2008](http://www.isas.co.il/art2008).

**ICAM 2008.** Gems will be one of the subjects covered at the 9th International Congress for Applied Mineralogy on September 8–10, 2008, in Brisbane, Australia. Visit [www.icam2008.com](http://www.icam2008.com).

## Exhibits

**Colored diamonds at the London Natural History Museum.** On loan from Alan Bronstein and Harry Rodman, the Aurora Collection of 296 naturally colored diamonds is now on display at the Natural History Museum in London. Visit [www.nhm.ac.uk/about-us/news/2006/november/news\\_9996.html](http://www.nhm.ac.uk/about-us/news/2006/november/news_9996.html).

**Bernd Munsteiner carvings at the GIA Museum.** From mid-May 2007 to March 2008, “Reflections in Stone” will showcase gem carver Bernd Munsteiner's work during the period 1966–2003. The exhibit will include carved quartz, tourmaline, and beryl, ranging from pieces set in jewelry to large table-top sculptures. Advance reservations are required; to schedule a tour, call 760-603-4116 or e-mail [museum@gia.edu](mailto:museum@gia.edu).

**Symbols of Identity—Jewelry of Five Continents.** On display through May 31, 2007, at the Mingei International Museum in San Diego, this exhibit features examples of personal adornment from native cultures in North and South America, Africa, Asia, and Europe. Visit [www.mingei.org/curex.html](http://www.mingei.org/curex.html).

**French Jewelry at the Legion of Honor.** “Masterpieces of French Jewelry,” an exhibition of notable French jewelry pieces from American collectors, will be on display at the Legion of Honor art museum in San Francisco through June 7, 2007. Among the pieces included are the Taj Mahal diamond necklace by Cartier, given to actress Elizabeth Taylor by Richard Burton in the 1970s, and an Art Nouveau brooch owned by former first lady Jacqueline Kennedy Onassis. Visit [www.thinker.org/legion/exhibitions](http://www.thinker.org/legion/exhibitions).

**Native American Jewelry.** “Shared Images: The Jewelry of Yazzie Johnson and Gail Bird” will be on display through June 2007 at the Heard Museum in Phoenix, Arizona. The exhibit includes examples of their belts, earrings, bracelets, rings, and necklaces. Visit [www.heard.org](http://www.heard.org).

**Gold at AMNH.** “Gold,” an exhibition exploring the historical fascination with this precious metal, is on display at the American Museum of Natural History in New York through August 19, 2007. The exhibit includes both rare natural specimens and significant cultural artifacts. Visit [www.amnh.org/exhibitions/gold](http://www.amnh.org/exhibitions/gold).

**Jewelry of Ben Nighthorse.** Ben Nighthorse Campbell, who represented Colorado in the U.S. Senate from 1992 to 2004, has enjoyed a successful second career as an innovative jewelry designer. This collection of his work, which debuted at the Smithsonian Institution's National Museum of the American Indian in 2004, is on display at the Colorado History Museum in Denver through December 31, 2007. Visit [www.coloradohistory.org](http://www.coloradohistory.org).

## ERRATUM

The Summer 2006 issue contained a GNI entry on triploidite from China (pp. 183–184). Subsequent chemical analyses of this material showed that it is triplite, rather than triploidite. The chemical formula has been revised as follows:  $(\text{Mn}^{2+}_{1.60}\text{Fe}^{2+}_{0.21}\text{Mg}_{0.15}\text{Ca}_{0.04})(\text{P}_{1.00}\text{O}_4)(\text{F}_{0.80}(\text{OH})_{0.20})$ . The authors regret this error in the identification of the material.