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## DIAMONDS

**Colored diamonds break \$1 million per carat with record auction prices.** The fall 2007 auction season saw several colored diamonds achieve per-carat prices over \$1 million. A 6.04 ct Fancy Vivid blue, internally flawless diamond (figure 1, left) set a new world-record per-carat auction price for a gemstone on October 8, when Sotheby's Hong Kong sold the stone for US\$7.98 million—\$1.32 million per carat. The seller was described by Sotheby's as a "private Asian client"; the buyer was London jeweler Alisa Moussaieff.

Several weeks later, another Fancy Vivid blue weighing 4.16 ct (figure 1, center) drew a winning bid of \$4.73 million (\$1.14 million per carat) at Sotheby's November 14 Geneva sale. The buyer of the pear-shaped diamond was London jeweler Laurence Graff. The following day, at

Christie's Geneva auction, Graff paid \$2.67 million (\$1.18 million per carat) for a 2.26 ct Fancy purplish red diamond (figure 1, right), the highest price ever paid for a red diamond at auction.

Colorless diamonds saw near-record prices as well. Apparel magnate Georges Marciano paid \$16.19 million for an 84.37 ct D-Flawless round brilliant (figure 2, left) at the Sotheby's auction in Geneva. He christened the stone the "Chloe Diamond," after his daughter. Sotheby's said the Chloe was the second most expensive diamond ever sold at public auction, the top spot belonging to the 100.1 ct Star of the Season purchased by Saudi jeweler Ahmed Fitaihi at a Sotheby's sale in 1995.

Graff completed a busy week by paying \$10.4 million at a rough diamond tender sale in Antwerp for the 493 ct

Figure 1. Exceptional colored diamonds sold at auction in the fall of 2007 for record or near-record prices. The center stone in the ring on the left is a 6.04 ct Fancy Vivid blue diamond. The Fancy Vivid blue pear shape in the ring at center weighs 4.16 ct. At right, the 2.26 ct modified octagon-shaped diamond was graded Fancy purplish red. Photos courtesy of Sotheby's Hong Kong (left), Sotheby's (center), and Christie's Images (right).





Figure 2. Two notable colorless diamonds also were sold recently. On the left is the 84.37 ct D-Flawless *Chloe* diamond; at right, the 493 ct *Letšeng Legacy* crystal was found earlier this year at the *Letšeng* mine in Lesotho. Photos courtesy of Sotheby's (left, by Donald B. Woodrow) and the Antwerp World Diamond Centre (right).

Letšeng Legacy (figure 2, right) found earlier this year in the Letšeng mine in Lesotho. Graff had also purchased the 603 ct Lesotho Promise, which was found at the same mine in 2006.

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**Namibian diamond mining by Namdeb.** In the Winter 1995 issue of *G&G* (pp. 228–255), A. J. A. (Bram) Janse's review of African diamond sources included a brief history of diamond mining in Namibia, from the discovery of diamonds in the coastal sands near Kolmanskop in 1908 to the formation of Namdeb Diamond Corp. in November 1994. Namdeb, created under Namibia's post-independence mining legislation as an equal partnership between De Beers Centenary and the national government, took over all the mining licenses and related rights of the De Beers subsidiary Consolidated Diamond Mines (CDM).

By all measures, diamond mining in Namibia has thrived under Namdeb. Today, the company is clearly the most important element of Namibia's economy, accounting for more than 10% of the country's gross domestic product and more than 40% of its export revenues. Diamond production has reached unprecedented levels, thanks in large part to offshore production by De Beers Marine Namibia, operating as an exclusive partner to Namdeb.

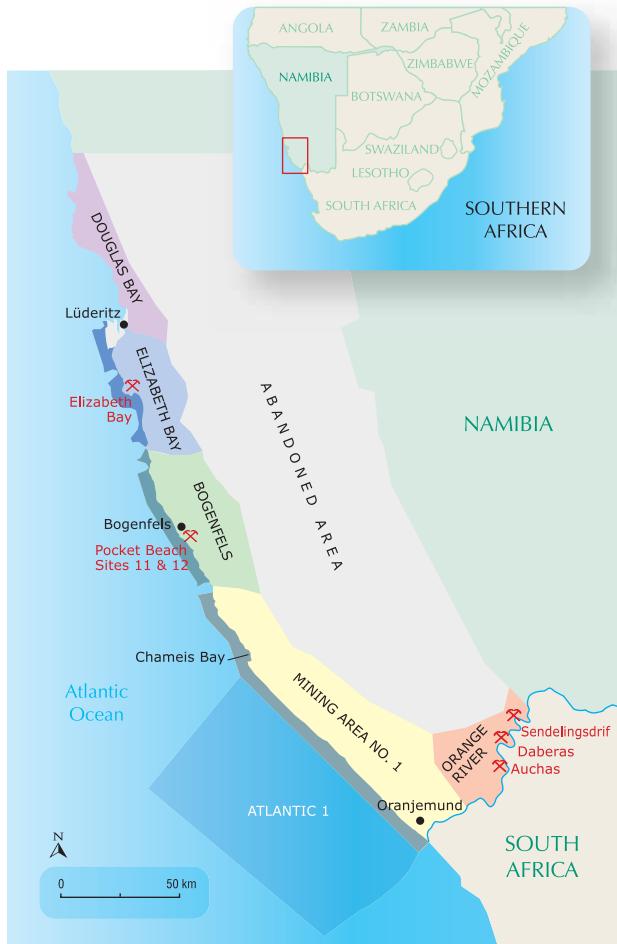
*Editor's note:* Interested contributors should send information and illustrations to Brendan Laurs at [blaurs@gia.edu](mailto:blaurs@gia.edu) or GIA, The Robert Mouawad Campus, 5345 Armada Drive, Carlsbad, CA 92008. Original photos can be returned after consideration or publication.

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The NamGem Diamond Manufacturing Co., created in 1998 as a wholly owned subsidiary of Namdeb, is the country's first diamond cutting operation. The factory is located in Okahandja, about 70 km north of Windhoek, and when it reaches full production it is expected to produce more than US\$15 million worth of finished diamonds per year. The 2006 signing of the Namdeb Sales Agreement, negotiated between the government and De Beers, led to the creation of a new joint venture, the Namibia Diamond Trading Co. (NDTC), which will be responsible for sorting, valuing, and marketing diamonds. Together, Namdeb, De Beers Marine Namibia, NamGem, and NDTC employ more than 3,000 people, most of them Namibian citizens, making the group one of the country's largest employers.

Namdeb holds diamond mining licenses for six areas (figure 3). Except for the Atlantic 1 license, these are contained within the 26,000 km<sup>2</sup> *Sperrgebiet* (German for "forbidden area"), which was originally designated as such in 1908 to control access to the diamond-producing areas. In 2004, the Namibian government declared the *Sperrgebiet* a national park, and portions not being mined are open to visitors.

The world's greatest marine diamond deposits are located in Mining Area No. 1 (figure 4). These have been, and continue to be, the mainstay of Namdeb's production. The Plio-Pleistocene (1–5 million years [Ma] old) marine gravel deposits in Mining Area No. 1 extend almost continuously for 120 km along the coastline. Apart from the area at the mouth of the Orange River, the marine deposits lie unconformably on Late Proterozoic (650–500 Ma) bedrock of the Gariep Complex, where gullies act as trapsites that further promote diamond concentration. Onshore, the bulk of these placer deposits have been mined out, as production has been continuous since 1935. The intertidal and near-shore subtidal platform gravels, which also host significant diamond concentrations, are not accessible via conventional mining methods. A system designed to perform wet sampling in the



intertidal corridor is being tested. The "Jet Rig" is an eight-legged, self-elevating mobile platform with two jet-pump sampling tools and an onboard primary screening plant. It is hoped that the Jet Rig will be the prototype for an eventual mining system.

For more than two decades, Namdeb has been investigating the feasibility of mining "pocket beach" diamond deposits at Chameis Bay in Mining Area No. 1 north to Bogenfels. These gravel deposits (6,500–135,000 years old)

*Figure 3. Diamonds are recovered from a variety of operations in southern Namibia. The Mining Area No. 1, Bogenfels, and Elizabeth Bay mining licenses extend from the Orange River in the south to the city of Lüderitz in the north, and from ~5.5 km offshore to 20–35 km inland. The Douglas Bay license extends from Lüderitz north to 26°S and from the low water mark of the Atlantic Ocean to approximately 15 km inland. The Orange River license extends along the river to about 50 km inland from the Mining Area No. 1 boundary. The Atlantic 1 license encompasses a portion of the middle shelf of the ocean, from the boundary of Mining Area No. 1 to about 65 km offshore. Except for the Atlantic 1 license, these areas are contained within the 26,000 km<sup>2</sup> Sperrgebiet.*



*Figure 4. Mining Area No. 1, Namibia's most important diamond-producing region, contains the richest marine deposits in the world. This aerial view is looking to the east from an area approximately over the beach. Photo by A. R. Kampf.*



Figure 5. Elizabeth Bay is Namdeb's northernmost diamond mine in Namibia. The current operation is the third and most successful mine on this site since 1908. Photo by A. R. Kampf.

are confined to coastal embayments bounded by rocky headlands. The diamonds occur in thin, ribbon-shaped gravel bodies below the water table, deeply buried by dunes and marine sand. The geologic setting, coupled with the area's remoteness and lack of infrastructure, has presented significant challenges. Of 14 pocket beach sites identified, sites 11 and 12 are considered particularly promising because of the erosion and longshore transport of older gravels to favorable bedrock trapsites. Mining at these pocket beach sites is expected to create additional revenue at a time when production will decline at several of Namdeb's other land-based operations.

The northernmost gem in Namdeb's crown is the Elizabeth Bay mine (figure 5), situated about 25 km south of Lüderitz. It was in this area that the first Namibian diamonds were found in 1908, leading to the initial exploitation of the area by the Deutsche Kolonialgesellschaft für Südwestafrika (DKG) between 1911 and 1915. The second phase of mining, by CDM, lasted (with interruptions) from the early 1920s to 1948. The present Elizabeth Bay mine, opened in 1991, represents the third and most successful of the mining phases. The diamonds at Elizabeth Bay are found in ancient windblown (aeolian) sands that are significantly coarser than the desert sand. The diamonds recovered are small, averaging 0.1–0.3 ct, but the grades can be quite high. In the uppermost gray-colored grits, grades can reach 100 carats per hundred tonnes.

The lower Orange River was long considered barren of diamonds. It was not until the early 1960s that diamonds were found there and not until 1990 that the first mine, Auchas, went into production. Two principal types of diamond deposits flank the Orange River: The 17–19 Ma "Proto-Orange" terrace deposits more than 40 m above the river yield the bulk of the production, while the 2–5 Ma "Meso-Orange" deposits have only proved economic in localized areas. The Proto and Meso deposits both lie on eroded bedrock, where diamonds have been trapped in pot-holes and similar depressions. The Orange River deposits have relatively limited lifetimes. For example, after just 10 years of production, the Auchas mine ceased operations in

2000. Daberas (figure 6), which was started in 1999 and exploits the largest of the Proto-Orange deposits, is expected to have an 11-year life span. Sendelingsdrif, the second largest alluvial placer within Namdeb's license, is still in the sampling phase. The Orange River mines produce

Figure 6. The lower Orange River provides a minor but significant amount of Namibia's diamond production. The manager of the Orange River mines, Kakia Kakia, is shown here with a portion of the Daberas mine in the background. Photo by A. R. Kampf.



larger diamonds on average than those from the other Namdeb licenses. In 2005, the Orange River mines contributed 14.5% of Namdeb's total revenue and 7.3% of the total carats produced in Namibia.

With reduced production from onshore deposits, the offshore deposits clearly represent the future for Namdeb. In 1993, two decades of geologic research and prospecting in marine environments led to the initiation of successful mining operations in the Atlantic 1 license area. Since 2001, these have been conducted by the Windhoek-based De Beers Marine Namibia. Currently the company operates five mining vessels, four of which employ airlift drill technology and another that uses a track-mounted crawler. Mining is conducted up to 65 km from shore at depths ranging from 90 to 140 m. De Beers Marine Namibia also recently embarked on a near-shore pilot program that involves dredging diamondiferous material from the seabed and pumping it onshore for processing. Today, nearly half of Namibia's total annual diamond production is mined from the ocean, and this proportion is expected to increase in the years ahead.

**Acknowledgments:** Much of the information contained in this report was obtained on a Namdeb-sponsored visit to the area in October 2007. Special thanks are due to Chris Sivertsen, Namdeb general manager, and Kakia Kakia, manager of the Orange River mines, as well as to a host of Namdeb personnel who gave generously of their time, expertise, and hospitality.

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*Figure 7. The emergence of a parasitic nematode from the abdomen of its host fly is well preserved in this Baltic amber. Photomicrograph by G. Poinar, magnified 35×; sample from the Poinar amber collection, maintained at Oregon State University (accession no. N-3-76).*



## COLORED STONES AND ORGANIC MATERIALS

**Double jeopardy in amber.** One of the wonderful aspects of amber preservation is that it fixes its victims so rapidly that various types of otherwise transient natural associations are often preserved. This includes a variety of parasitic associations, such as that seen in a 13 × 8 mm piece of Baltic amber from the Kaliningrad region of Russia (figure 7). About 40 million years ago—the age determined for Baltic amber by studying trace fossils (foraminifera) in the amber-bearing beds—a parasitic nematode belonging to the family Mermithidae was trapped while emerging from its host, a nonbiting midge belonging to the family Chironomidae. Midge-nematode associations have been reported previously in Baltic amber, but we believe this is the first to show the parasite and host still connected together.

In the normal life cycle of this nematode, a newly hatched worm lives on the bottom of a body of water until it encounters a fly larva. The nematode bores into the larva and remains there through the fly's adult stage, feeding on its nonvital tissues. When the nematode has finished growing, it emerges and searches for the nearest water source. However, when this fly landed on a drop of resin, the parasite exited through the host's body wall and found itself trapped in the resin as well. The midge made a valiant effort to escape from its parasite, as well as from the sticky trap. While it managed to pull away from the nematode, a coagulated strand of its blood still connected the two. In the final death stance, the fly appears to be pulling its parasite behind it.

From a biological point of view, it is astonishing to realize that the large nematode was coiled up in the abdomen of such a small fly. But a close examination of the midge's body cavity shows it to be empty, since all available protein and fat had been absorbed by the parasite. If the parasite had exited under normal circumstances (into a water source), it would have entered the mud, molted twice and searched for a mate. If it was a female, it would have deposited its eggs in the water and the hatching microscopic nematodes would have searched for another midge larva to start the cycle anew.

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**Inclusions in andradite from Namibia.** At the 2007 Tucson gem shows, GIA received a donation from one of these contributors (CLJ) of several dozen crystal specimens of demantoid (the green variety of andradite that is colored by Cr and/or V) and eight cut stones that ranged from brownish red to yellowish green (0.10–5.51 ct; figure 8). These garnets were obtained from his Green Dragon mine,



Figure 8. These andradite samples (including the demantoid variety) were recently mined in Namibia, and contain needle-like inclusions. The cut stones weigh 0.10–5.51 ct (left), and the crystal is ~2 cm tall (right). Gift of Christopher L. Johnston, GIA Collection nos. 36713 (crystal), 36716 (brownish yellow cut stone), and 36741 (all the other cut stones); photos by Robert Weldon.

located approximately 12 km west of the Erongo Mountains and 28 km northeast of Klein Spitzkoppe in Namibia's Namib Desert. The andradite is hosted by a skarn-type deposit, where it forms euhedral-to-subhedral crystals that are fully enclosed within the calc-silicate units, as well as euhedral crystals in enrichment zones at the contacts between the calc-silicate units and various other rock types including granite, granodiorite, and schist. To date the largest concentration of andradite found at the mine measured approximately 1 m<sup>3</sup> and consisted of intergrown calcite and garnet.

Many of the andradites in the GIA donation were selected for their inclusions—some of which appeared quite similar to rutile needles. Since rutilated andradite/demantoid has not been documented previously, one of us (EAF) performed a detailed examination of the needle-like features in 50 samples (42 brownish green to yellowish green crystals and all eight faceted stones). The following gemological properties were collected on the brownish yellow, brownish yellowish green, and yellowish green cut stones (0.10–1.47 ct; figure 8): RI—over the limits of a standard refractometer; hydrostatic SG—3.83–3.85; Chelsea filter reaction—none; fluorescence— inert to long- and short-wave UV radiation; and a cutoff at 460 nm and a weak “chrome line” visible with the desk-model spectroscope. These properties are consistent

with those previously reported for Namibian demantoid (see Fall 1997 Gem News, pp. 222–223; T. Lind et al., “New occurrence of demantoid in Namibia,” *Australian Gemmologist*, Vol. 20, No. 2, 1998, pp. 75–79). Microscopic examination revealed the presence of long, fine “needles” (figure 9), curved fibers (figure 10), “fingerprints” composed of two-phase (liquid-gas) inclusions, and small crystals. The curved fibers appeared similar to the individual acicular inclusions that constitute “horse-tail” inclusions found in demantoid from other localities. However, horsetails were not present in these samples, and they have not been previously documented in Namibian demantoid (M. Furuya, *Demantoid Garnet—The Legendary Gemstone Aroused from a Century of Sleep*, 2<sup>nd</sup> ed., Japan Germany Gemmological Laboratory, Yamanashi-ken, Japan, 2006, 31 pp.).

The properties of the five faceted brownish orange to brown-red andradites (1.19–5.51 ct; again, see figure 8) were the same as the other cut stones except for: hydrostatic SG—3.85–3.88, and a cutoff at 520 nm (reddish stones) or 460 nm (orangy stones) visible with the desk-model spectroscope. These properties are consistent with those previously reported for andradite in the Fall 1997 Gem News item cited above. Magnification revealed transparent angular growth zoning, “fingerprints” composed of two-phase (liquid-gas) inclusions, iridescence



Figure 9. Long, fine “needles” in the demantoid samples (left) proved to be hollow tubes. Minute holes are seen in reflected light where they intersect the polished surface of this sample (right). Photomicrographs by J. I. Koivula; field of view 4.4 mm.

along growth planes (rainbow graining), and crystallographic trace lines (figure 11). Trace lines are internal representations of external crystal forms; such features are commonly seen as “phantoms” in crystals such as quartz, but trace lines also have been documented in pyralspite garnets (see E. J. Gübelin and J. I. Koivula, *Photoatlas of Inclusions in Gemstones*, Vol. 2, Opinio Publishers, Basel, Switzerland, 2005, pp. 22 and 446). The curved fibers and very fine needles noted in the demantoid samples tested were not seen in these brownish orange to brown-red andradites.

Surface-reaching needles in 12 rough and cut Namibian demantoid samples were tested by Raman analysis. Most of the features selected for analysis turned out to be empty holes when viewed with the microscope (again, see figure 9). However, the Raman spectra did indicate the presence of andradite, quartz (rough samples only), or diamond (cut samples only). The presence of quartz was not surprising, since it was found as an over-

growth on many of the crystals. The diamond apparently represents contamination from the faceting process.

With no clear information on the identity of the needles, we used a lap wheel to grind down portions of four of the demantoid crystals to expose their inclusions. Observation of the polished surfaces in reflected light showed minute openings or holes where the inclusions intersected the surface. In addition, we noted elongate surface channels in several places where the needles had been oriented parallel to the polished faces. This confirmed that the needles were actually hollow tubes, rather than mineral inclusions. Additional evidence for this conclusion was provided by powder X-ray diffraction (XRD) analysis of a demantoid crystal containing abundant needles by one of us (MG). The diffraction pattern showed only peaks corresponding to andradite, and no rutile or other minerals.

A demantoid pocket found in August 2007 contained some colorless fibrous crystal aggregates (figure 12), which

Figure 10. Curved fibers were present in two of the andradite samples shown in figure 8. Photomicrograph by E. A. Fritz; field of view 2.1 mm.

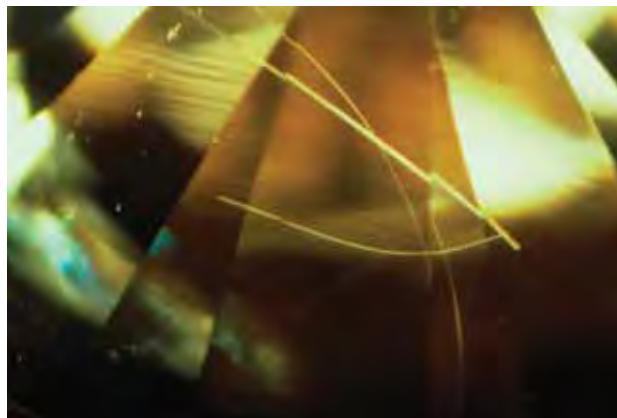


Figure 11. Rainbow graining and crystallographic trace lines are two of the features seen in the brownish orange to brown-red andradites. Photomicrograph by E. A. Fritz; field of view 4.8 mm.

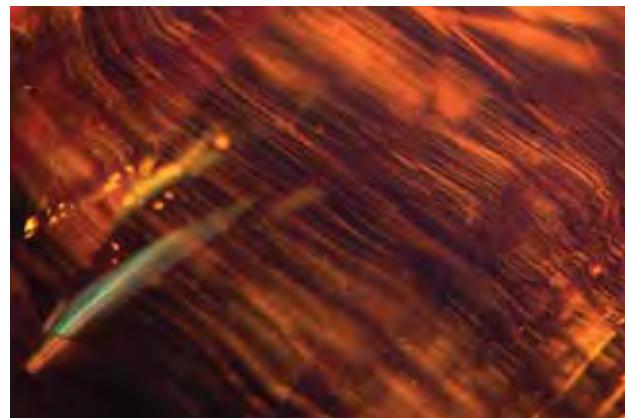




Figure 12. The fibrous crystals on this andradite specimen were identified as a mixture of calcite and asbestosiform amphiboles. Photomicrograph by J. I. Koivula; field of view ~5.1 mm.

were identified as a mixture of calcite and asbestosiform amphiboles (by MG) using a combination of XRD analysis and scanning electron microscopy. It is possible that needles of one or both of these minerals formed inclusions in the garnet that were subsequently etched away by late-stage hydrothermal fluids and/or weathering, leaving the empty channels documented in our samples.

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**Andradite from Baluchistan, Pakistan.** In recent years, some unusual gem materials have been found in Pakistan's Baluchistan region, such as quartz with petroleum inclusions (Spring 2004 Gem News International, pp. 79–81) and color-zoned axinite (Fall 2007 GNI, pp. 254–255). We were therefore curious to examine three unidentified faceted stones from Baluchistan that were loaned to GIA by Farooq Hashmi (Intimate Gems, Jamaica, New York). He obtained ~0.5 kg of the rough material in 2004 in Peshawar, Pakistan; the lot consisted of opaque dodecahedral crystals and gemmy broken pieces weighing 1–4 g.

Examination of the cut stones (0.65–0.99 ct; figure 13) showed the following properties: color—brownish yellow-orange to yellowish orange-brown; RI—over the limits of the standard gemological refractometer; hydrostatic SG—3.87–3.94; Chelsea filter reaction—none; fluorescence—inert to long- and short-wave UV radiation; and

absorption to 500 nm visible with the desk-model spectroscope. These properties are consistent with those reported for andradite 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 planes of one-, two-, and three-phase inclusions, as well as transparent angular graining.

Mr. Hashmi indicated that he has not seen any more of this andradite in the Peshawar market, although occasionally a similar "honey" colored garnet (grossular) has been produced from an area near the bastnäsite mines in the Peshawar region (H. Obodda and P. Leavens, "Zagi Mountain, Northwest Frontier Province, Pakistan," *Mineralogical Record*, Vol. 35, No. 3, 2004, pp. 205–220).

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**Two axinite species from Tanzania.** Axinite,  $\text{Ca}_3\text{Al}_2\text{BSi}_4\text{O}_{15}(\text{OH})$ , is an uncommon biaxial gem material with a triclinic crystal habit. Much variation in the composition can occur, owing to the replacement of Ca by Fe, Mg, or Mn (W. A. Deer et al., *Rock-forming Minerals*:

Figure 13. These three gems (0.65–0.99 ct) from Baluchistan, Pakistan, proved to be andradite. Courtesy of Intimate Gems; faceted by Matt Dunkle (Aztec, New Mexico). Photo by Robert Weldon.





Figure 14. These three magnesio-axinites (0.20–0.42 ct) from Tanzania were characterized for this report. Courtesy of Rock Logic; photo by Robert Weldon.



Figure 15. These ferro-axinites (1.30 and 4.40 ct) are also from Tanzania. Courtesy of Intimate Gems; photo by Robert Weldon.

*Disilicates and Ring Silicates*, 2nd ed., The Geological Society, London, Vol. 1B, 1997, pp. 603–623). Ferro-axinite is the species that is most commonly cut into gems (e.g., Fall 2007 Gem News International, pp. 254–255), while magnesio-axinite has been faceted only rarely (see Summer 2005 Lab Notes, pp. 170–171).

At the 2007 Tucson gem shows, Alexandra Woodmansee (Rock Logic, Glencoe, Minnesota) had some light bluish violet magnesio-axinite that was reportedly from the tanzanite mining area at Merelani, Tanzania. She initially obtained a faceted example (0.72 ct) of this magnesio-axinite in the mid-1980s. However, additional material did not become available until a small quantity of rough appeared at the 2006 Tucson shows. In Tanzania, the rough has been sold inadvertently as low-quality tanzanite, but it can be easily separated by its orangy pink UV fluorescence and subtle color shift (see below). From a total of 29 grams of rough, Ms. Woodmansee has cut about two dozen stones, typically weighing <1 ct, although a few larger included stones up to ~2 ct also were faceted.

Ms. Woodmansee loaned 11 faceted magnesio-axinites to GIA for examination, and we obtained gemological properties on three of them (0.20, 0.23, and 0.42 ct; figure 14). In daylight-equivalent illumination, they ranged from pale violet to pale grayish violetish blue with weak pleochroism in shades of light purple, yellow, and yellowish green. In incandescent light, all of the samples shifted to a more intense and uniform violet. The stones showed the following properties: RI—1.660–1.672; birefringence—0.012; hydrostatic SG—3.08–3.30; fluorescence—strong to very strong orangy pink to long-wave UV radiation, and medium orangy pink to short-wave UV; and an absorption line at 410 nm with a weak 580 nm cut-off seen with the desk-model spectroscope. These properties are comparable with those reported for a 0.78 ct transparent magnesio-axinite by E. A. Jobbins et al. ("Magnesioaxinite, a new mineral found as a blue gemstone from Tanzania,"

*Journal of Gemmology*, Vol. 14, 1975, pp. 368–375), who gave RIs of 1.656–1.668 (birefringence of 0.012) and an SG value of 3.18. Our variable SG values are probably due to the effect of the numerous fractures and inclusions in the stones we examined. Microscopic examination revealed fluid-filled "fingerprints" composed of thread-like and two-phase inclusions, thin fluid films with polygonal shapes, and numerous fractures and cavities with dark brown staining.

Tanzania is also the source of some very different axinite, which gem dealer Farooq Hashmi obtained in Arusha in 2006. It had a brown color that resembled zoisite before it is heat treated to tanzanite, and its trichroism could easily cause further confusion with zoisite. Although the material was offered as tanzanite, Mr. Hashmi suspected that it was axinite and therefore obtained only a small amount of the cobbed rough from which two stones were faceted (figure 15).

Mr. Hashmi loaned the two cut stones (1.30 and 4.40 ct) to GIA for examination, and we obtained the following properties: color—brown to reddish brown (showing no significant color shift in different light sources), with strong purple, yellow, and brownish orange pleochroism; RI—1.668–1.680; birefringence—0.012; hydrostatic SG—3.20; fluorescence—inert to both long- and short-wave UV radiation; and a weak 415 nm absorption line seen with the desk-model spectroscope. These properties are comparable to those reported for ferro-axinite by M. O'Donoghue (*Gems*, 6th ed., Butterworth-Heinemann, Oxford, UK, 2006, p. 386), except that publication listed somewhat higher RI and SG values, as well as additional absorption features at 444, 512, and 532 nm, with two broader bands at 466 and 492 nm. Microscopic examination revealed large fractures, "fingerprints" consisting of orderly parallel inclusions (figure 16), and thread-like or irregular fluid remnant inclusions (figure 17). There was also subtle straight and angular growth zoning in both stones.



Figure 16. The ferro-axinite contains "fingerprints" composed of orderly parallel inclusions. Photomicrograph by D. Beaton; field of view 4.8 mm.



Figure 17. Thread-like and irregular fluid inclusions are visible through the bezel of this ferro-axinite. Photomicrograph by D. Beaton; field of view 7.2 mm.

Electron-microprobe analyses (table 1) of one sample each of magnesio- and ferro-axinite showed similar compositions to those reported for these minerals by Jobbins et al. (1975) and Deer et al. (1997), except that the magnesio-axinite analyzed for this study contained somewhat more

Mn (~2.0 vs. 0.4 wt.% MnO). The composition of the ferro-axinite closely resembled that of the material from Pakistan reported in the Fall 2007 GNI entry.

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**TABLE 1.** Average electron-microprobe analyses of two axinites from Tanzania.<sup>a</sup>

| Chemical composition                | Magnesio-axinite<br>0.42 ct | Ferro-axinite<br>1.30 ct |
|-------------------------------------|-----------------------------|--------------------------|
| <b>Oxides (wt.%)</b>                |                             |                          |
| SiO <sub>2</sub>                    | 43.84                       | 42.97                    |
| B <sub>2</sub> O <sub>3</sub> calc. | 6.35                        | 6.22                     |
| Al <sub>2</sub> O <sub>3</sub>      | 18.56                       | 17.77                    |
| FeO                                 | 0.05                        | 7.80                     |
| MnO                                 | 1.99                        | 0.62                     |
| MgO                                 | 6.27                        | 2.94                     |
| CaO                                 | 20.46                       | 20.10                    |
| Na <sub>2</sub> O                   | 0.02                        | 0.05                     |
| K <sub>2</sub> O                    | 0.02                        | 0.04                     |
| H <sub>2</sub> O calc.              | 1.64                        | 1.61                     |
| Total                               | 99.22                       | 100.12                   |
| <b>Ions per 16 (O,OH,F)</b>         |                             |                          |
| Si                                  | 3.998                       | 3.999                    |
| B calc.                             | 1.000                       | 1.000                    |
| Al                                  | 1.995                       | 1.950                    |
| Fe <sup>2+</sup>                    | 0.004                       | 0.607                    |
| Mn                                  | 0.154                       | 0.049                    |
| Mg                                  | 0.852                       | 0.408                    |
| Ca                                  | 1.999                       | 2.005                    |
| Na                                  | 0.004                       | 0.009                    |
| K                                   | 0.002                       | 0.005                    |
| OH calc.                            | 1.000                       | 1.000                    |

<sup>a</sup>Average of five points per stone. Ti, Cr, V, Bi, Pb, Zn, and F were analyzed, but not detected.

**Baddeleyite from Mogok, Myanmar.** Baddeleyite was first documented in faceted form in the Fall 2001 Lab Notes section (p. 212), as a 0.54 ct very dark greenish brown cushion cut that was represented as being from Sri Lanka. More recently, baddeleyite was recognized as a mineral associated with painite from Myanmar (unpublished data; see also Winter 2005 Gem News International, p. 356). Small quantities of baddeleyite from the Thurien-taung painite deposit in the western Mogok area have been faceted recently for gem collectors, according to Mark Smith (Thai Lanka Trading Ltd., Bangkok, Thailand). Mr. Smith reported that the rough baddeleyite is sometimes mixed in parcels of rutile, black amphibole, and schorl fragments, but it can be easily separated according to its higher specific gravity, as well as the distinctive bladed crystal shape and submetallic luster. The crystals are black (dark brown on a thin edge) and measure up to 2.5 cm long; some are intergrown with small red spinel crystals.

Since mid-2005, Mr. Smith has faceted nearly 100 pieces of the baddeleyite. The cutting yield is very low due to cracking and the thin bladed shape of the rough. Most of the stones were cut from broken crystals weighing 0.2–1 g. The shape of these pieces is most conducive to cutting flat rectangular stones. Most of the cut gems ranged from 0.2 to 3 ct, and a few weighed 5–6 ct. In addition, one exceptional faceted stone weighed 26.36 ct; it was cut from a broken piece of rough that was much larger than any other pieces Mr. Smith has seen.



Figure 18. These faceted stones (0.56–1.95 ct) are baddeleyite from the Thurien-taung painite deposit in Myanmar. Gift of Mark Smith, GIA Collection nos. 37141–37143; photo by Kevin Schumacher.

Mr. Smith donated three faceted stones (0.56–1.95 ct; figure 18) to GIA, and the following properties were determined: color—black, with no pleochroism; RI—over the limits of a standard gemological refractometer; hydrostatic SG—5.84–5.92; fluorescence—inert to long-wave UV radiation and very weak yellow-green to short-wave UV; and no spectrum visible with the desk-model spectroscope. These properties are consistent with those reported for baddeleyite in the Fall 2001 Lab Note, except that the Burmese stones were too opaque to view any color, pleochroism, or absorption spectrum. However, a reddish brown color was apparent with high-power fiber-optic illumination. Microscopic examination revealed numerous fractures, and small stringers of fine particles could be seen in the semitransparent edges of the stones.

The Burmese baddeleyite was produced as a byproduct of mining for painite, and Mr. Smith reported that it has become difficult to find rough baddeleyite in the Asian marketplace because of the decreased production of (and demand for) painite.

*Editor's note:* U.S. law covering import of Burmese gem materials was in the process of being reevaluated when this issue went to press. At the time GIA examined these stones, their import into the U.S. was permitted by existing law.

Eric A. Fritz and Brendan M. Laurs

**Chrysocolla chalcedony from Iran/Armenia area.** The majority of gem-quality chrysocolla chalcedony comes from Mexico and Arizona (e.g., Gem News, Spring 1992, pp. 59–60; Summer 1996, pp. 129–130). A new source reportedly was discovered recently in the border region between Iran and Armenia, according to Jack Lowell (Colorado Gem & Mineral Co., Tempe, Arizona). Mr. Lowell's supplier indicated that ~1,100 kg have been mined so far. Chalcedony has been previously reported from Iran (see Winter 2004 Gem News International, p. 337), but as adularescent material with a considerably paler blue color.

Mr. Lowell loaned two cabochons (8.86 and 3.17 ct) and a rough piece of the chalcedony to GIA for examination (figure 19). The following properties were obtained on the cabochons (with those for the larger cabochon given first here): color—green-blue and blue-green; diaphaneity—semitransparent to translucent; RI—1.54; hydrostatic SG—2.60 and 2.62; Chelsea filter reaction—none; fluorescence—inert to both long- and short-wave UV radiation. A 650 nm cutoff was observed with a desk-model spectroscope. Microscopic examination revealed spotty green

Figure 19. These samples of chrysocolla chalcedony came from a newly discovered source near the Iran/Armenia border. The cabochons weigh 8.86 and 3.17 ct, and the slab measures 5.5 × 3.7 cm. Courtesy of Jack Lowell; photo by Robert Weldon.



inclusions (chrysocolla particles). Raman analysis of both samples showed a close match to chalcedony spectra on file. Energy-dispersive X-ray fluorescence (EDXRF) spectroscopy of the two samples indicated major amounts of Si and Cu, and traces of Fe. Absorption spectroscopy showed typical features for chrysocolla chalcedony, with absorptions at 527–1176 nm ( $\text{Cu}^{2+}$ ), 1370–1600 nm (total OH), and 1850–2120 nm (molecular water), and 2128–2355 nm (or 4700–4245  $\text{cm}^{-1}$ ; structurally bonded OH).

The  $\text{Cu}^{2+}$  band recorded from UV-Vis-NIR absorption spectroscopy can be used to determine the presence of dye (see A. Shen et al., "Identification of dyed chrysocolla chalcedony," Fall 2006 *Gems & Gemology*, p. 140), by calculating the ratio of the integrated intensity of the  $\text{Cu}^{2+}$  band compared to that of the structurally bonded OH band. The Shen et al. results showed a ratio between 0.5 and 3 for dyed chalcedony and between 7 and 44 for natural-color chrysocolla. The present samples had ratios of 15.7 and 7.4, establishing that they were not dyed.

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**Yellow-green clinohumite and yellow chondrodite from Tanzania.** During a buying trip to Tanzania in 2006, gem dealer Farooq Hashmi obtained some brownish yellow and yellow-green rough from a few small parcels that were represented as tourmaline from a new deposit at Sumbawanga in west-central Tanzania. All of the rough consisted of broken pieces (figures 20 and 21), so it was not possible to determine if they originated from primary or secondary deposits. Most of the pieces weighed  $<1$  g, and there was an approximately equal percentage of the two colors available in each parcel. The appearance and properties of the material were not typical of tourmaline normally found in Tanzania, so Mr. Hashmi loaned several rough and cut examples of each color for examination at GIA.

The following properties were recorded on three greenish yellow cut stones (figure 20): color—greenish yellow to yellow-green, with no obvious pleochroism; RI— $n_{\alpha}=1.620$  and  $n_{\gamma}=1.648–1.649$ ; birefringence—0.028–0.029; hydrostatic SG—3.21; Chelsea filter reaction—none; fluorescence—inert to long-wave UV radiation and very weak to weak yellow to short-wave UV; and a weak absorption band at 490 nm visible with the desk-model spectroscope. These properties are similar to those reported for clinohumite by M. O'Donoghue (*Gems*, 6th ed., Butterworth-Heinemann, Oxford, UK, 2006, p. 400), except that the colors were reported as yellow to orange or dark brown and the RI values were higher ( $n_{\alpha}=1.623–1.702$  and  $n_{\gamma}=1.651–1.728$ ). Microscopic examination revealed clouds of fine needles and flat, ribbon-like fluid inclusions. Electron backscatter diffraction analysis showed that these needles were parallel to the  $b$  axis (i.e., the 4.7 Å unit cell direction). All three samples were moderately abraded and contained numerous fractures.



Figure 20. The greenish yellow to yellow-green color of this clinohumite from Tanzania (cut stones 0.90–1.81 ct) is quite unusual. Courtesy of Intimate Gems; photo by Robert Weldon.

The properties of three brownish yellow cut stones (figure 21) were: color—brownish yellow, with weak yellow to colorless pleochroism; RI— $n_{\alpha}=1.589–1.593$  and  $n_{\gamma}=1.618–1.620$ ; birefringence—0.027–0.029; hydrostatic SG—3.20–3.24; Chelsea filter reaction—none; fluorescence—inert to long-wave UV radiation and moderate yellow to short-wave UV; and no features visible with the desk-model spectroscope. These properties are consistent with those reported for chondrodite by O'Donoghue (2006, p. 399), except the colors reported in that publication were deep red and orange brown, and the RI values were slightly higher ( $n_{\alpha}=1.592–1.643$  and  $n_{\gamma}=1.621–1.636$ ). Magnification revealed numerous abrasions, fractures,

Figure 21. These brownish yellow gems from Tanzania (cut stones 0.64–0.80 ct) were identified as chondrodite. Courtesy of Intimate Gems; photo by Robert Weldon.



screw dislocations, and planar fluid inclusions.

Electron-microprobe analyses were performed on the three cut clinohumites (15 analyses total) and on one faceted chondrodite (5 analyses), and all of the data points showed a homogenous composition within each mineral; average analyses are shown in table 1. In addition to the elements expected from the chemical formula,  $(\text{Mg}, \text{Fe}^{2+})_9(\text{SiO}_4)_4(\text{F}, \text{OH})_2$ , the clinohumites contained traces of Ti, Al, and K. Much lower Fe was present than in the data for clinohumite reported by W. A. Deer et al. (*Rock-Forming Minerals—Orthosilicates*, Vol. 1A, 2nd ed., Longman, London, 2001, pp. 381–417). The relatively small amount of Fe is responsible for the low RI values;

**TABLE 1.** Average electron-microprobe analyses of clinohumite and chondrodite from Tanzania.<sup>a</sup>

| Chemical composition           | Clinohumite <sup>b</sup><br>0.90 ct | Chondrodite <sup>c</sup><br>0.64 ct |
|--------------------------------|-------------------------------------|-------------------------------------|
| Oxides (wt.%)                  |                                     |                                     |
| SiO <sub>2</sub>               | 37.57                               | 33.50                               |
| TiO <sub>2</sub>               | 0.42                                | nd                                  |
| Al <sub>2</sub> O <sub>3</sub> | 0.18                                | 0.13                                |
| FeO                            | 0.31                                | 2.08                                |
| MnO                            | nd                                  | 0.11                                |
| MgO                            | 58.39                               | 56.00                               |
| CaO                            | nd                                  | 0.09                                |
| Na <sub>2</sub> O              | nd                                  | 0.02                                |
| K <sub>2</sub> O               | 0.02                                | 0.01                                |
| H <sub>2</sub> O calc.         | 2.41                                | 2.07                                |
| F                              | 1.01                                | 6.37                                |
| Subtotal                       | 100.31                              | 100.39                              |
| -O=F                           | 0.43                                | 2.68                                |
| Total                          | 99.88                               | 97.71                               |
| Ions per formula unit          |                                     |                                     |
| Si                             | 3.908                               | 1.975                               |
| Ti                             | 0.033                               | nd                                  |
| Al                             | 0.022                               | 0.009                               |
| Fe <sup>2+</sup>               | 0.027                               | 0.103                               |
| Mn                             | nd                                  | 0.005                               |
| Mg                             | 9.056                               | 4.921                               |
| Ca                             | nd                                  | 0.006                               |
| Na                             | nd                                  | 0.002                               |
| K                              | 0.003                               | 0.001                               |
| OH calc.                       | 1.668                               | 0.812                               |
| F                              | 0.332                               | 1.187                               |

<sup>a</sup>Abbreviation: nd = not detected. Cr, Bi, V, Pb, and Zn also were analyzed, but not detected.

<sup>b</sup>Ions were calculated using 18 (O, OH, F) per formula unit.

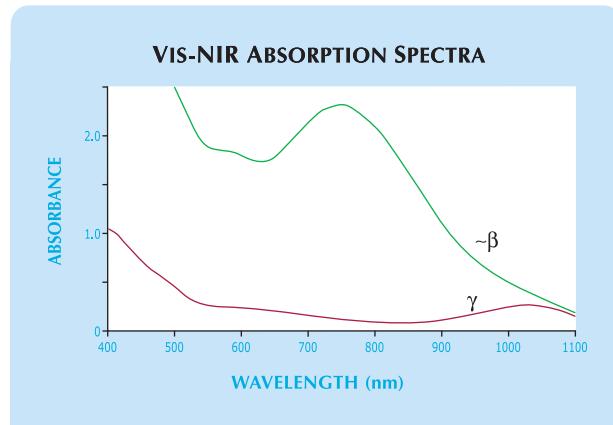
<sup>c</sup>Ions were calculated using 10 (O, OH, F) per formula unit. Similar chondrodite analyses where H<sub>2</sub>O is analyzed typically have 1–2 wt. % H<sub>2</sub>O, as well as additional O in the anion site. Thus, the water estimate here is probably somewhat high, since some O would be expected in the anion site. The slightly low total of the chondrodite analyses may reflect low F as a result of the standardization process.

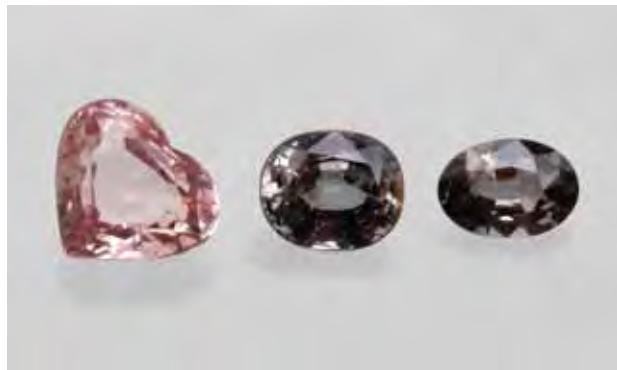
although fluorine-rich clinohumite may also show low RI values, these stones contained intermediate amounts of F. The chondrodite,  $(\text{Mg}, \text{Fe}^{2+})_5(\text{SiO}_4)_2(\text{F}, \text{OH})_2$ , contained traces of Al, Mn, Ca, Na, K, and Ti; the last element was present in considerably lower amounts than the range shown by Deer et al. (2001).

Vis-NIR spectroscopy of a polished piece of the rough clinohumite showed a broad peak centered at ~750 nm (figure 22)—quite unlike typical yellow-orange to orange clinohumite spectra, which are dominated by a peak at 435 nm related to Fe-Ti intervalence charge transfer (see K. Langer et al., “The crystal chemistry of the humite minerals: Fe<sup>2+</sup>-Ti<sup>4+</sup> charge transfer and structural allocation of Ti<sup>4+</sup> in chondrodite and clinohumite,” *European Journal of Mineralogy*, Vol. 14, No. 6, 2002, pp. 1027–1032). A weaker feature near 1040 nm is seen in most clinohumite spectra, including the Tanzanian specimen, but dominantly only in one orientation; absorption in this region is due to Fe<sup>2+</sup> (Langer et al., 2002). Further research is necessary to fully characterize the origin of the unusual yellow-green color in this clinohumite.

Clinohumite and chondrodite were recently documented from Tanzania by the SSEF laboratory in Basel, Switzerland (“Uncommon minerals as gemstones from Tanzania,” *SSEF Facette*, No. 14, 2007, p. 6). Similar “golden” yellow chondrodite is shown in that article (along with yellow-brown to brown, red, and near-colorless material), whereas the greenish yellow clinohumite

**Figure 22.** Polarized Vis-NIR absorption spectra of the clinohumite were obtained with a beam of light oriented nearly parallel to the *a* axis (i.e., the 13.84 Å unit cell direction). With this orientation, a spectrum ( $\gamma$  spectrum) nearly parallel to the *Z* indicatrix direction (*b* axis, or 4.7 Å unit cell direction) and a spectrum (~ $\beta$  spectrum) containing mostly the *Y* indicatrix direction, were obtained. A broad band centered at ~750 nm was recorded when the beam was polarized to obtain the ~ $\beta$  spectrum, and both spectra show an intense absorption in the 400 nm region. Sample thickness: 6.4 mm.





*Figure 23. These samples of dumortierite (2.06, 1.18, and 0.61 ct) are from Tunduru, Tanzania. Photo by H. A. Hänni; © SSEF.*

described here is quite different from the yellow-orange to orange stones shown in that report.

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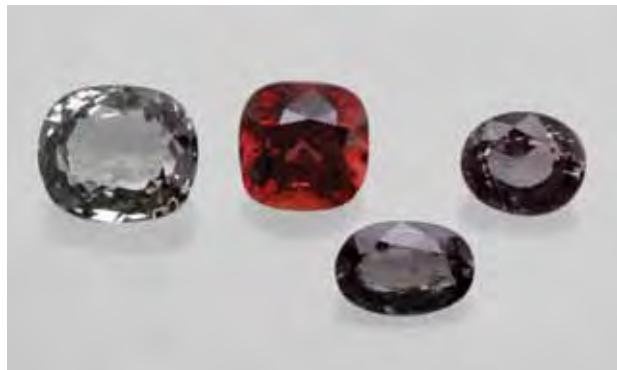
*Brendan M. Laurs*

*William B. (Skip) Simmons and Alexander U. Falster*

**Transparent dumortierite and sapphirine from Tanzania.** From time to time, the SSEF Swiss Gemmological Institute receives rough material for identification, often as parcels of pebbles, crystals, and fragments. Rough stone buyer Werner Spaltenstein, based in Chanthaburi, Thailand, is one source of such material, mainly from East Africa and Madagascar. In these lots, we have identified a number of uncommon and rare minerals. Here we report on two such transparent minerals found in gravels from Tunduru, Tanzania.

Dumortierite, an alumino-borosilicate, is best known as a polycrystalline blue ornamental stone, often mixed with quartz. The new material from Tunduru, however, was transparent and colored violetish gray and brownish pink. The three waterworn pebbles were identified by their SGs and Raman spectra; after faceting (figure 23), we obtained RI and birefringence values that were consistent with dumortierite. The following properties were recorded on the faceted stones: pleochroism—strong, light gray to red (pink stone); RI— $n_{\alpha}=1.679$ ,  $n_{\gamma}=1.709$ ; birefringence—0.030; SG—3.38–3.41; and UV fluorescence—inert to long-wave UV radiation and white to short-wave UV. The stones were nearly free of fluid or mineral inclusions. EDXRF analysis of all three samples showed major Al and Si, and traces of Ti and Ga in variable amounts (B cannot be detected by EDXRF); Ti is probably the chromophore of the pink stone.

Sapphirine, an aluminosilicate, is rarely transparent and is usually gray, green, or brownish violet. The samples from Tunduru consisted of four transparent waterworn pebbles ranging from gray to violet and red that came from parcels of rough spinel and sapphire. These samples were



*Figure 24. Tunduru is also the source of these sapphirine gems (2.14, 1.55, 0.67, and 0.93 ct). Photo by H. A. Hänni; © SSEF.*

also identified by their SG and Raman spectra and, after faceting (figure 24), they yielded RI and birefringence values that were consistent with sapphirine. The following properties were obtained: pleochroism—strong, light pink to dark red (red stone); RI— $n_{\alpha}=1.701$ –1.704,  $n_{\gamma}=1.708$ –1.711; birefringence—0.007; SG—3.49–3.50; UV fluorescence—inert (gray-to-violet stones), and dull red to long-wave and weak orange to short-wave UV radiation (red stone). No inclusions were seen in any of the samples with a gemological microscope. EDXRF analysis of all the stones showed major amounts of Mg, Al, and Si, and traces of Fe, Ti, Cr, and Ga. Their color range is most probably due to variable amounts of Fe and Cr, the latter element being the main cause of color in the red stone.

Dumortierite and sapphirine are rare as faceted gemstones, and the occurrence of attractive pink dumortierite and red sapphirine was particularly surprising.

*Henry A. Hänni*

**Brazilian blue opal, with cristobalite and quartz.** At the 2007 Tucson gem shows, Si and Ann Frazier (El Cerrito, California) obtained two cabochons of a new Brazilian "opal" and loaned them to GIA for examination. One weighed 6.77 ct and was banded in light blue, white, light brown, and gray, while the other was a 6.84 ct light blue stone (figure 25).

We obtained the following properties on the cabochons: diaphaneity—translucent; spot RI—1.44 (blue portions), 1.54 (wide central light brown band), and 1.50 (darker brown area near the end of the cabochon). Hydrostatic SG was 2.25 for the blue cabochon and 2.53 for the banded specimen. Both stones were inert to long-wave UV radiation. The blue areas showed chalky very weak green-yellow fluorescence to short-wave UV, while the brown bands fluoresced weak-to-moderate green-yellow (brightest at the white transition zone to the blue area in the banded cabochon). No distinct absorption features were seen with a desk-model spectroscope.

Microscopic observation of the banded sample revealed that the narrow brown layer that transitioned to the light blue region contained pale brown transparent spherules



Figure 25. The blue portions of these two cabochons from Brazil (6.77 and 6.84 ct) appear to be a mixture of opal and cristobalite; the brown bands are quartz. Courtesy of Si and Ann Frazier; photo by Robert Weldon.

that were very small and densely packed. The darker brown band near the opposite end of the cabochon also contained these spherules (larger than the others) with milky white interstitial areas. Raman analysis of multiple areas of this band only gave spectral matches for quartz. The RI of 1.50 from this end of the banded cabochon could be due to the presence of both opal and quartz in this region (due to its amorphous nature, no Raman peaks would be expected for opal). The wide light brown band through the center of the cabochon contained no visible spherules or other structure, but it did have interstitial stubby white dendritic inclusions that suggested the location of grain boundaries. Raman analysis of this area also matched quartz, and the RI (1.54) of this region was consistent with quartz as well.

Microscopic examination of the blue areas of both cabochons revealed a milky nature, consistent with the scattering of light from submicroscopic particles. However, there were no visible inclusions in these areas other than a small surface fracture with brownish discoloration. The lower RI of these regions (1.44) is consistent with that of opal, and Raman analysis only yielded matches for cristobalite, a polymorph of quartz that is commonly found in opal. A high concentration of cristobalite (SG of 2.32–2.36) could explain the elevated SG (2.25) of the blue cabochon, since the SG of opal with lower RI values is typically closer to 2.0. *Gems & Gemology* previously reported on a cabochon that was a mixture of cristobalite and opal—a milky white specimen from Madagascar (see Winter 2004 Gem News International, pp. 339–340, for a more in-depth discussion of this type of material). Typically, we would expect a higher RI for a mixture of opal and cristobalite, to be consistent with the elevated SG value; however, both properties can be influenced by the amount of structural

water—and additional minerals—present. Further study is necessary to better understand the relationship between these properties and the factors affecting them. The presence of the quartz bands (SG of 2.66) would explain the even higher SG (intermediate between opal and quartz) of the oval cabochon.

To explore the cause of the blue color in our samples, we performed EDXRF analysis. Together with traces of several other elements, minute amounts of Cu and Fe were found in the blue cabochon. A trace of Fe was also found in the banded cabochon, but no Cu was detected (this was probably due to the brown quartz band dominating the area that was analyzed). Although the minute traces of these common chromophores may be contributing to the blue color of this material, we could not confirm this.

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**Otolith pendant.** Fish ear bones, called otoliths (from the Greek *oto* [ear] and *lithos* [stone]), are complex polycrystalline structures composed of calcium carbonate and organic material. Most fish have three pairs of otoliths—sagittae, lapilli, and asterisci—that are located behind the

Figure 26. This unusual pendant is set with a baroque-shaped fish ear bone, or otolith (24.1 ct; 25 × 14 × 12 mm). Photo by B. Mocquet.



brain in the inner ear and contribute to their sense of equilibrium. Otoliths are scientifically important because they grow continuously until death, providing valuable information on the fish's age and environment (see, e.g., N. H. Halden, "Coloured fish ears: Cathodoluminescence as a guide to variation in aqueous environments," *Newsletter of the Mineralogical Association of Canada*, No. 64, 2001, pp. 1, 3–4). Otoliths also have a history of use in jewelry by native peoples (R. E. Martin et al., Eds., *Marine and Freshwater Products Handbook*, Technomic Publishing Co., Lancaster, PA, 2000).

One of these contributors (BM) had an otolith mounted into a pendant (figure 26). This baroque-shaped otolith is from a South American silver croaker (*Plagioscion squamosissimus*) that lived in the Orinoco River of Venezuela more than 60 years ago. The silver croaker can reach lengths of 80 cm; in Venezuela, it is known as *curvinata*, and its otoliths are used for amulets or good luck charms in the southern states of Amazonas and Bolívar.

The size of the otolith in this pendant (25 × 14 × 12 mm) suggests that it is probably a sagitta, the largest of the three types. The otolith was removed from the setting for gemological examination. SG and RI values (by the spot method) were approximately 2.82 and 1.54 (with "blink" birefringence), respectively. It had a greasy luster and was inert to long- and short-wave UV radiation. The Raman spectrum (obtained without a microscope) displayed aragonite peaks, as well as peaks for organic matter. Fish otoliths are mainly aragonitic, but they may also be composed of other carbonate polymorphs such as calcite and vaterite (R. W. Gauldie, "Polymorphic crystalline structures of fish otoliths," *Journal of Morphology*, Vol. 218, No. 1, 1993, pp. 1–28).

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**Goethite and hematite inclusions in quartz from Mina da Batalha, Brazil.** Inclusions of native copper are well known in Paraíba tourmaline from Mina da Batalha (see, e.g., F. Brandstätter and G. Niedermayr, "Inclusions of native copper and tenorite in cuprian-elbaite tourmaline from Paraíba, Brazil," Fall 1994 *Gems & Gemology*, pp. 178–183). In June 2007, some pale amethyst and smoky quartz (e.g., figure 27) that contained copper-colored inclusions were recovered from a deeper level of this mine. Quartz containing Cu inclusions has not been documented previously from this locality, so Brian Cook (Nature's Geometry, Laguna Beach, California) donated two of the specimens to GIA to investigate this possibility.

Microscopic examination revealed scattered minute



Figure 27. This quartz specimen (8.0 cm tall) from Mina da Batalha, Paraíba State, contains microscopic inclusions with a general appearance that is similar to the native copper platelets seen in some tourmaline from this famous locality. Gift of Brian Cook, GIA Collection no. 37354; photo by Robert Weldon.

platy inclusions just beneath the surface of the amethyst crystals. These had a coppery metallic appearance in reflected light (figure 28, left), but in transmitted light they were dull red to earthy yellow and transparent to translucent (figure 28, right). This eliminated copper as a possibility. Also, unlike the copper inclusions seen in some tourmaline from this mine, these platelets were not oriented according to the crystallography of the host quartz, but instead appeared as randomly oriented inclusions on shallow prism and rhombohedral planes.

The platelets' appearance in transmitted light is indicative of a common alteration pattern among a number of iron oxides and hydroxides. In this case, the platelets appeared to be composed of a mixture of hematite (red) and goethite (brownish yellow). EDXRF chemical analysis of one of the quartz samples where the inclusions were located close to the surface revealed traces of Fe, as expected for hematite and goethite, but no Cu was detected. The inclusions were too deep in the quartz to obtain a clear signal with the Raman microspectrometer, so a small amount of one sample was ground off to expose one of the



*Figure 28. With reflected fiber-optic light (left), the platy inclusions in the Mina da Batalha amethyst have a coppery metallic appearance. In transmitted light (right), they are transparent to translucent and have a red to earthy brownish yellow color—consistent with goethite and hematite, rather than native copper. Photomicrographs by J. I. Koivula; field of view ~1.6 mm.*

platelets on the surface; it was identified as one of the two suspected minerals, goethite.

Eric A. Fritz, John I. Koivula, and Brendan M. Laurs

**Sinhalite from Myanmar.** Sinhalite was first recognized as a new mineral (in faceted form) in 1952, after having been misidentified for decades, most commonly as “brown peridot.” As early as 1912, a specimen of sinhalite at the British Museum that had originally been catalogued as chrysoberyl, and then “chrysolite,” was flagged for “further examination” because its properties did not match any then-known minerals (B. W. Anderson, “Two new gemstones: Taaffeite and sinhalite,” Summer 1952 *Gems & Gemology*, pp. 171–175). The name comes from the word *Sinhala*, the Sanskrit word for Ceylon (now Sri Lanka), which was at the time the only known locality. Gem-quality material has also been found in Mogok, Myanmar (C. J. Payne, “A crystal of sinhalite from Mogok, Burma,” *Mineralogical Magazine*, Vol. 31, 1958, pp. 978–979; M. Gunawardene and M. S. Rupasinghe, “The Elahera gem

*Figure 29. These attractive sinhalites (1.35–3.20 ct) are from Mogok, Myanmar. Courtesy of Bradley Payne; photo by Kevin Schumacher.*



field in central Sri Lanka,” Summer 1986 *Gems & Gemology*, pp. 80–95). Although sinhalite has been known from Myanmar for decades, it has not become available in the gem market until fairly recently.

Bradley J. Payne (The Gem Trader, Grand Rapids, Michigan) recently loaned seven faceted sinhalites (1.35–3.20 ct; figure 29) from Mogok for examination at GIA. While Burmese sinhalite is not new, we welcomed the opportunity to examine several such gemstones at the same time. The following properties were obtained: color—pale yellow to pale brownish yellow; pleochroism—very weak pale yellow and pale brown; RI— $n_a=1.666$ –1.668 and  $n_g=1.704$ –1.706; birefringence—0.038; optic character—biaxial negative; hydrostatic SG—3.48–3.50; fluorescence—inert to both long- and short-wave UV radiation; and absorption lines visible with the desk-model spectroscope at 452, 463, 475, and 493 nm, as well as a broad band in the violet range (up to 435 nm). Microscopic examination revealed clouds, fluid inclusions, two-phase inclusions, and colorless graining. These results are comparable to reported properties for sinhalite (R. Webster, *Gems*, 5th ed., revised by P. G. Read, Butterworth-Heinemann, Oxford, UK, 1994, p. 373).

The brown coloration in sinhalite has been attributed to iron (Webster, 1994). EDXRF analysis of three of the seven stones confirmed that they did indeed contain significant levels of iron. Other trace elements detected were Cr, Mn, Ga, and Zn.

According to suppliers in Myanmar, the source of the Burmese sinhalite is Ohn Gaing (Ongaing) in northern Mogok. The most recent finds have occurred since 2005, and stones up to 16+ ct have reportedly been faceted (pers. comms., 2007; Mark Smith; Dudley Blauwet, Dudley Blauwet Gems, Louisville, Colorado). Mr. Smith indicated that the Burmese sinhalite is also notable for commonly occurring as well-formed crystals, unlike the material from Sri Lanka, which is typically found as water-worn pebbles. He also stated that the color of Burmese material is lighter and more yellow than the general range from Sri Lanka.

*Editor’s note:* U.S. law covering import of Burmese gem materials was in the process of being reevaluated when this issue went to press. At the time GIA exam-

ined these stones, their import into the U.S. was permitted by existing law.

*Karen Chadwick (karen.chadwick@gia.edu)  
and Brendan M. Laurs*

**Field study of Cu-bearing tourmaline mines in Mozambique.** In late August and early September 2007, these contributors visited Mozambique's Cu-bearing tourmaline deposits to obtain information on their location, geology, and mining. We were hosted by personnel from Mozambique Gems (Nampula, Mozambique), which owns the first claim that was staked in the area for this tourmaline in 2003.

The mining area for the Paraiba-type tourmaline is located near the eastern border of the Alto Ligonha pegmatite district, adjacent to the village of Mavuco in northeastern Mozambique. An area of approximately 3 km<sup>2</sup> has been mined for the Cu-bearing tourmaline, which is hosted exclusively by secondary deposits (paleoplacers) that are buried beneath as much as 5 m of lateritic material. The paleoplacers rest directly on top of weathered bedrock (e.g., biotite schist). Although nearby granitic pegmatites have been mined for aquamarine and quartz, they are not a source of Cu-bearing tourmaline. The extent to which gem tourmaline is distributed in the paleoplacers has not yet been established. In some places along the edges of the currently mined area, however, the diggers reported encountering only black tourmaline and no gem material, leading them to search elsewhere.

To date, most of the tourmaline mining in the Mavuco region has taken place in the area to the south and east of the Mozambique Gems claim by local diggers using simple hand methods (figure 30). The miners use picks and shovels to remove the overburden. Upon encountering the tourmaline-bearing horizon, they dig through the material with their picks to look for the gems. Although many stones are probably overlooked in the process, water for washing the soil is scarce or unavailable to the artisanal miners during most of the year, and the paleoplacers are infiltrated by clay so dry screening is not feasible.

At the time of our visit, Mozambique Gems was preparing for a major mechanized operation on their 300 ha mining concession. They had completed a comprehensive environmental impact report and performed systematic mapping and test pitting of their claim. The extent of the tourmaline-bearing horizon was being refined through additional test pitting with a backhoe, followed by wet-screening (figure 31) using water from a river adjacent to their claim. They were also constructing a washing plant that will be capable of processing 150–200 tonnes of material per day (figure 32). Mozambique Gems expects to complete the washing plant in early to mid-2008, at which time they will begin mining and simultaneous reclamation of the pits. In addition, the owners of other claims in the surrounding area have consolidated their claims and are making preparations for mechanized mining.

While in the regional capital of Nampula (about 90 km



Figure 30. Most of the production of Cu-bearing tourmaline from Mozambique has come from artisanal miners using simple hand tools. Photo by B. M. Laurs.

Figure 31. Material from test pits on the Mozambique Gems claim is first wet-screened and then hand picked for tourmaline. Photo by J. C. Zwaan.





Figure 32. Future mining for Cu-bearing tourmaline by Mozambique Gems will employ this washing plant. Photo by B. M. Laurs.

north of Mavuco), we purchased samples from a parcel of rough material that was reportedly mined from the Mavuco area. The parcel consisted of waterworn pebbles—all reportedly unheated—showing a range of colors and sizes. From the smaller pieces (e.g., figure 33), we obtained samples that were representative of the color range in that parcel. Subsequent laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) analyses were done to chemically characterize the tourmaline, but the data showed that three of the 20 pebbles consisted of amethyst,

Figure 33. A variety of colors is seen in this parcel of waterworn pebbles represented as unheated Cu-bearing tourmaline from Mozambique. Three of the samples obtained from this parcel proved to be imitations: an amethyst, a light yellowish green fluorite, and a light bluish green manufactured glass. Photo by J. C. Zwaan.



light yellowish green fluorite, and light bluish green manufactured glass. A light green pebble that was obtained directly from one of the miners at the pits also was identified as fluorite. As with any gem mining area, the presence of imitations is of concern, regardless of whether they are unknowingly or intentionally offered to buyers. Separating out such imitations can be particularly challenging when dealing with multicolored parcels of waterworn rough.

The future production of Cu-bearing tourmaline from Mozambique should be bolstered by the mechanized mining activities that are due to commence in the coming months. Additional information on this tourmaline will appear in an article being prepared for submission to *Gems & Gemology*.

**Acknowledgments:** We appreciate the helpful assistance of Moses Konate, Salifou Konate, Chirindza Henrique, and Daniel Trinchillo in facilitating our visit to the mining area.

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J. C. (Hanco) Zwaan

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**New Cu-bearing tourmaline from Nigeria.** Copper-bearing (Paraíba-type) tourmaline is currently known from three countries: Brazil, Nigeria, and Mozambique. Within a given country, stones from different mines (in the case of Brazil and Nigeria) show variations in color and composition (e.g., A. Abduriyim et al., “Paraíba-type copper-bearing tourmaline from Brazil, Nigeria, and Mozambique: Chemical fingerprinting by LA-ICP-MS,” Spring 2006 *Gems & Gemology*, pp. 4–21). However, most of the Nigerian stones we have examined at GIA were remarkably consistent in color (light blue to green) and trace-element composition (enriched in Pb).

In October 2007, Bill Barker (Barker & Co., Scottsdale, Arizona) informed these contributors about a new source of Cu-bearing tourmaline in Nigeria that has produced material with a wide range of saturated colors similar to those from the original source of Paraíba tourmaline at Mina da Batalha, Paraíba State, Brazil. These colors were quite different from those seen previously in Nigerian material. According to his supplier, the stones came from a different area than those that have been mined previously for this tourmaline. All of the rough material consisted of broken fragments, so it was not possible to determine whether they originated from a primary or secondary deposit. So far Mr. Barker has obtained approximately 100 g of rough, from which 24 stones have been faceted in weights ranging from 0.2 to 4 ct.

Mr. Barker loaned 12 of the faceted stones (0.31–1.04 ct; figure 34) to GIA for examination. They showed highly saturated violet to bluish violet (five stones), blue (two), bluish green (one), green (two), and purple (two) colors that we had not previously seen in Nigerian Cu-bearing tourmaline. Only the two blue stones and one of the bluish green samples were reported to have been possibly heat treated. The following properties were obtained on the 12 samples: RI—1.620–1.643; SG—3.01–3.12; and inert to both long- and



Figure 34. These 12 intensely colored Cu-bearing tourmalines (0.31–1.04 ct) were reportedly produced from a new locality in Nigeria. Courtesy of Barker & Co.; photo by Robert Weldon.

short-wave UV radiation. Microscopic examination revealed typical "trichites," growth tubes, and two-phase (liquid and gas) inclusions in nearly all samples.

EDXRF chemical analysis confirmed that the tourmalines contained significant concentrations of Cu, and

LA-ICP-MS indicated Cu contents up to ~1.5 wt.%. Interestingly, most of these intensely colored tourmalines had relatively low Pb concentrations (<40 ppm). These new Nigerian stones show a strong resemblance to their Brazilian counterparts in both color and chemistry. They provide a good reminder of the difficulties associated with determining the country of origin for gems, given the almost inevitable discovery of new localities. Thorough characterization of gems as they are produced from new mines allows gemological laboratories to remain confident in their ability to determine their geographic origin.

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## SYNTHETICS AND SIMULANTS

New Tairus synthetic beryl simulating "Paraíba" tourmaline. The popularity of copper-bearing blue-to-green elbaite tourmaline, referred to as "Paraíba" in the trade, has increased remarkably in the last decade. This has led to a greater number of products intended to simulate it, such as apatite, glass, cubic zirconia, and beryl and topaz triplets. To this list we now add synthetic beryl.

At the September 2007 Bangkok Gem & Jewelry Fair, Tairus Created Gems (Novosibirsk, Russia) was selling a gem material they called "Synthetic Paraíba." A representative informed one of the authors (CG) that it was "Paraíba shade synthetic beryl," which Tairus had recently introduced into the market. The existence of a similar imitation from Tairus was mentioned by J. E. Shigley et al. ("An update on 'Paraíba' tourmaline from Brazil," Winter 2001 *Gems & Gemology*, pp. 260–276). At the Bangkok show, both crystals (~0.3–0.7 g) and cut specimens (~0.2–1 ct) of the bright greenish blue material were available. While only a minor amount of material was on display, we were told that any quantity could be made available upon ordering. Two samples (a 0.5 g crystal and a 0.42 ct oval cut; figure 35) were purchased for study and as reference material.



Figure 35. Tairus Created Gems represented this synthetic beryl crystal (0.5 g) and oval cut (0.42 ct) synthetic beryl as "Synthetic Paraíba," an imitation of the highly valued copper-colored tourmaline. The characteristic wavy surface of the crystal and the undulating chevron patterns in the faceted specimen indicate hydrothermal origin. Photos by C. Golecha.



Figure 36. Chevron growth patterns were obvious in the synthetic beryl with magnification. Photomicrograph by C. Golecha; magnified 35×.

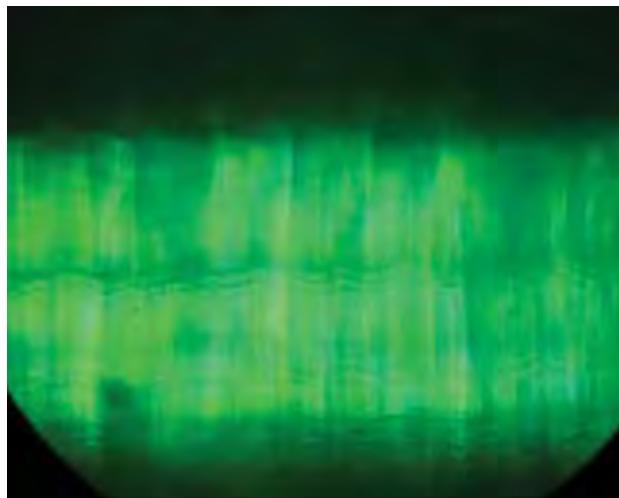


Figure 37. "Hounds-tooth" patterns were approximately 90° to the direction of the chevrons in the synthetic beryl. Photomicrograph by C. Golecha, immersion; magnified 25×.

The crystal was readily identifiable as a product of hydrothermal growth by the presence of wavy features on its surface (figure 35, left), similar to those seen on Tairus synthetic emeralds (K. Schmetzer et al., "A new type of Tairus hydrothermally-grown synthetic emerald, coloured by vanadium and copper," *Journal of Gemmology*, Vol. 30, No. 1/2, 2006, pp. 59–74). This pattern was expressed in the interior of both samples as (undulating) chevron features, some of which were visible even to the unaided eye (figure 35, right).

Both samples were greenish blue, with moderate light blue/greenish blue pleochroism. The faceted sample displayed a uniaxial optic figure, and it had refractive indices of 1.594–1.600. The hydrostatic SG of both samples was 2.75. These RI and SG values are much higher than those previously reported for synthetic aquamarine (e.g., K. Schmetzer, "Hydrothermally grown synthetic aquamarine manufactured in Novosibirsk, USSR," Fall 1990 *Gems & Gemology*, pp. 206–211; S. Smirnov et al., "New hydrothermal synthetic gemstones from Tairus, Novosibirsk, Russia," Fall 1999 *Gems & Gemology*, pp. 175–176). No absorption spectrum was visible in either sample with the desk-model spectroscope, and the samples were inert to long- and short-wave UV radiation.

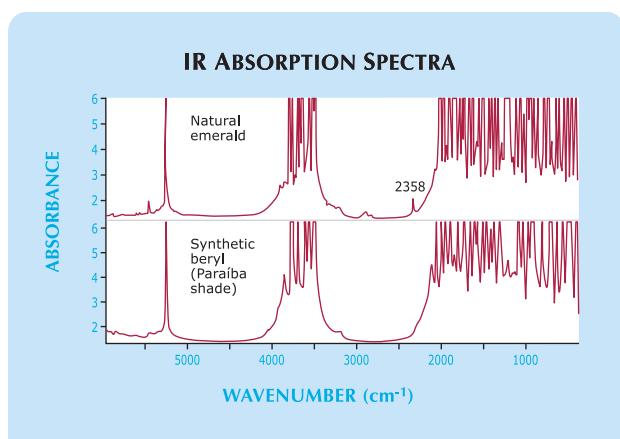
Strong chevron growth patterns were the main features seen in both samples when examined with magnification (figure 36); these have been described as irregularly changing subgrain boundaries between subindividuals (Schmetzer, 1990). The crystal also exhibited a "hounds-tooth" pattern originating from planes parallel to the wavy surface (figure 37). This pattern is generally indicative of synthetic origin, though similar-appearing conical features have been reported in natural emerald (see Fall 2005 *Gem News International*, pp. 265–266).

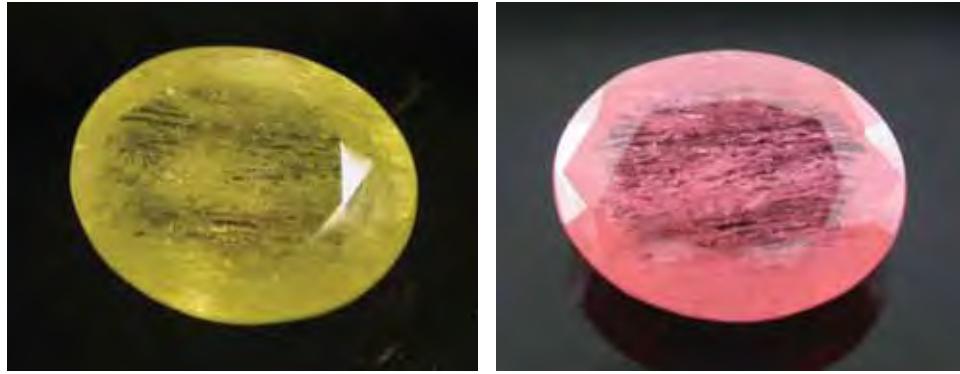
Qualitative EDXRF chemical analysis revealed the presence of Al and Si, as expected for beryl. (Be cannot be

detected by EDXRF spectroscopy.) Significant amounts of Fe and Cu were also detected. Fe is well known as the cause of color in aquamarine, while Cu has also been reported as the chromophore in synthetic blue beryl; (Schmetzer et al., 2006); the relatively high RI and SG values are possibly due to the presence of these impurities.

The FTIR absorption spectra of both samples exhibited a sharp peak at 5266 cm<sup>-1</sup>, an absorption band ranging from 4000 to 3400 cm<sup>-1</sup>, and general absorption below 2100 cm<sup>-1</sup> (figure 38). The overall absorption pattern resembled the spectrum of natural emerald more than that of typical hydrothermal synthetic emeralds. However, the spectral pattern in the 2600–2100 cm<sup>-1</sup> region revealed the difference (see also J. I. Koivula et al., "Gemological investigation

Figure 38. The infrared absorption spectra of the Tairus synthetic beryl crystal and natural emerald are quite similar. However, the absence of a peak at 2358 cm<sup>-1</sup> indicates synthetic origin.





*Figure 39. This 9.44 ct YAG was unusual due to its heavily included nature and its “reverse” color change: yellow in incandescent light (left) and sunlight, and orangy pink in daylight-equivalent fluorescent light (right). Photos by C. Golecha.*

tion of a new type of Russian hydrothermal emerald,” Spring 1996 *Gems & Gemology*, pp. 32–39).

Synthetic beryl has been known for decades, but the commercial availability of this particular color as a simulant for Paraíba tourmaline is a new development that is designed to capitalize on the popularity of this type of tourmaline.

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**An unusual YAG with a “reverse” color change.** Yttrium aluminum garnet (YAG) is manufactured primarily for industrial purposes, with some “leftovers” used as a gem simulant. Though YAG was first produced commercially in colorless form, it has since been seen in numerous hues, such as green, yellow, pink, red, blue, and “lilac.” Most YAGs are eye-clean, but a few included specimens have been reported (see, e.g., Winter 1993 Lab Notes, p. 284).

Recently, a 9.44 ct oval mixed cut gem was encountered at the Gem Testing Laboratory, Jaipur, India. Standard gemological testing identified it as YAG. In daylight the sample appeared yellow, with some tinges of orange, and it contained abundant eye-visible planes of inclusions (figure 39). The desk-model spectroscope revealed a series of strong lines and bands across the spectrum (i.e., a typical rare-earth spectrum). The sample fluoresced a reddish orange to UV radiation, stronger to short-wave than to long-wave.

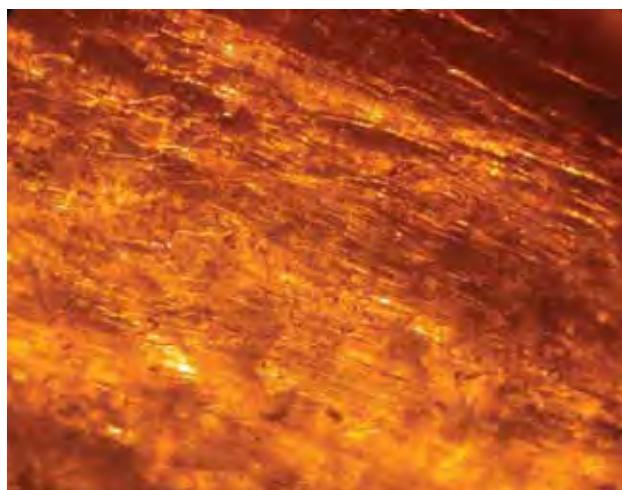
With magnification, the YAG displayed a complex array of etch channel-like inclusions (figure 40), gas bubbles and tube-like inclusions (figure 41), and angular growth zoning (figure 42). The etch channel-like inclusions were highly reflective, and appeared either opaque or flux-like depending on the viewing direction and illumination. Some cloudy patches were also seen. We have not observed such inclusions in YAG in our laboratory, although somewhat similar features have been reported (see the Lab Note cited above). The presence of gas bubbles indicated that it was a product of Czochralski pulling and not a flux growth process; however, the possibility of production via the floating zone technique cannot be ruled out.

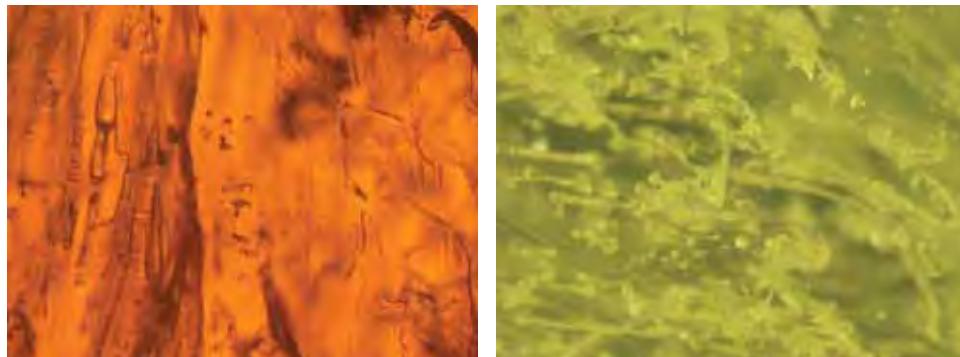
The sample became even more interesting when it was viewed with different types of illumination. In daylight-

equivalent fluorescent light, it appeared orangy pink (again, see figure 39). However, when viewed in incandescent light, it appeared yellow (as in sunlight). As such, this YAG showed a “reverse” effect, since color-change stones generally appear pink or red in incandescent light. This type of color change has been referred to as *type 2*, and is commonly seen in manufactured glasses and, rarely, in some other gems (e.g., Y. Liu and B. A. Fry, “A colorimetric study of a tourmaline from Mozambique which shows a reverse alexandrite effect,” *Journal of Gemmology*, Vol. 30, No. 3/4, 2006, pp. 201–206). Consistent with the YAG reported here, Liu and Fry (2006) indicated that type 2 stones show a color change between sunlight and daylight-equivalent fluorescent illumination, as well as between fluorescent and incandescent light, but not between sunlight and incandescent light. The cause of the type 2 color change in this YAG is not known.

*Gagan Choudhary and Chaman Golecha*

*Figure 40. Although YAG is typically flawless, this sample contained abundant inclusions with the appearance of etch channels. These features were highly reflective in certain directions. Photomicrograph by C. Golecha, immersion in di-iodo-methane; magnified 20×.*





*Figure 41. Numerous gas bubbles were present throughout the YAG, along with complex tube-like inclusions. Photomicrographs by C. Golecha; magnified 35× (left) and 30× (right).*

## CONFERENCE REPORTS

**Geological Society of America 2007.** The 119th Annual Meeting of the Geological Society of America was held October 28–31 at the Colorado Convention Center in Denver. This year's theme was Earth Sciences for Society and launched the International Year of Planet Earth. Nearly 7,000 geoscientists attended. Some presentations focused on gem topics, and a searchable database of all the conference abstracts is available on-line at <http://gsa.confex.com/gsa/2007AM/finalprogram>.

**Dr. John-Paul Zonneveld** (Geological Survey of Canada, Calgary) described the diamondiferous kimberlites of central Canada. The Fort à la Corne area contains unusually well-preserved examples of extrusive pyroclastic kimberlites. Volcanism occurred in this region during the Lower Cretaceous, approximately 100 million years ago (Ma), in coastal plain and shallow marine settings. Volcanically induced faulting caused elevation changes, allowing marine shale to cover and preserve these important diamond-bearing kimberlite deposits.

**Dr. Monaliza C. Sirbescu and James J. Student** (Central Michigan University, Mount Pleasant) explained the crystallization history of a granitic pegmatite dike (~2 m thick)

in northeastern Wisconsin using microthermometry and conductive-cooling numerical modeling. High cooling rates in the outer zone exceeded the crystal nucleation rate and caused a temperature differential between the inner and outer zones. This undercooling caused rapid disequilibrium crystallization, and solidification was estimated at about 10 days. Similar crystallization times may be inferred for gem-bearing pegmatite dikes of comparable thickness.

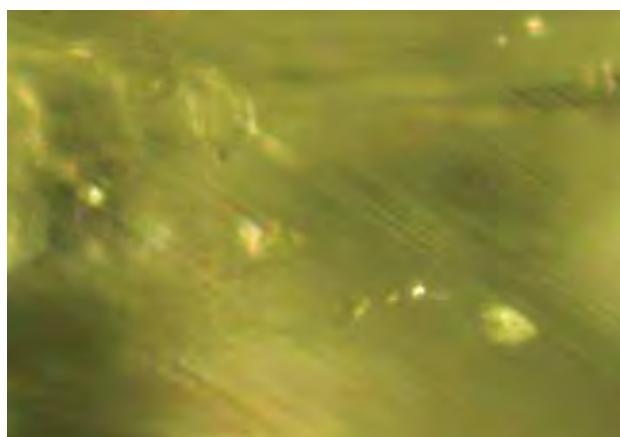
**Laura Bergen** (University of Manitoba, Canada) studied turquoise deposits in Nevada, California, Arizona, and New Mexico. The genesis of these deposits was influenced by tectonic, magmatic, and sedimentation events. This supports one hypothesis that turquoise formed by descending meteoric waters, a phenomenon known as supergene enrichment.

**Dr. George Harlow** (American Museum of Natural History, New York) gave two presentations on jadeite (a rock composed of jadeite and other minerals) and related rocks from central Guatemala. The first described the sediment signatures of two adjacent serpentinite mélange belts along the Motagua fault zone, which suggested that the jadeite originated "by precipitation from fluids coming off a subduction channel." The second looked at the geochronology of jadeite-bearing high-pressure, low-temperature metamorphic blocks along the Motagua fault zone. Using regional geology and chronology data, the study concluded that tectonic blocks (including jadeite) were metamorphosed during two tectonic events, one at ~130 Ma and the other at ~65 Ma.

**Dr. Stephen Peters** (U.S. Geological Survey, Denver, Colorado) spoke about the results of field studies to assess the non-fuel mineral resources of Afghanistan. There are known deposits of rubies, emeralds, tourmaline, and lapis lazuli; as-yet-undiscovered deposits of several commodities are likely. The full USGS report and supporting geologic studies are available at <http://afghanistan.cr.usgs.gov>.

**Dr. Nancy McMillan** (New Mexico State University, Las Cruces) presented a study on the use of laser-induced breakdown spectroscopy (LIBS) to rapidly identify carbonate and silicate minerals. Fifty-two minerals and their resultant spectra were analyzed; 95% of the minerals were correctly identified, with the other 5% misidentified as a mineral of similar composition from the same mineral family. The study suggests that LIBS may be useful in the future for the rapid identification of minerals in the field.

*Figure 42. Angular growth zoning, similar to that seen in some natural gems, was also present in the YAG. Photomicrograph by C. Golecha; magnified 30×.*



**Dr. Denise Battles** (University of Northern Colorado, Greeley) and **Dr. Jane Hudak** (Georgia Southern University, Statesboro) presented a proposal for a textbook on art and geology (with gemology as a key component), which would focus on the interdisciplinary relationship between the two. The textbook will fulfill a need for educational materials that support the concept of combined disciplines and will allow active learning with hands-on activities. The authors shared the first two chapters of the textbook prototype, one of which is richly illustrated with gems and includes a timeline showing jewelry through the ages.

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**Goldschmidt 2007.** The 17th Annual V. M. Goldschmidt Conference took place August 19–24 in Cologne, Germany, and featured 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. A portion of this session was devoted to the theme “Gem Mineralogy, Diamonds and Gemstones.” There also were presentations of interest to gem scientists in other conference sessions. Abstracts are available via a searchable database at [www.goldschmidt2007.org/abstracts.php](http://www.goldschmidt2007.org/abstracts.php).

**Dr. H. Sommer** (University of Botswana, Gaborone) described an ambitious new multidisciplinary endeavor—International Geological Correlation Programme Project 557, “Diamonds, Xenoliths and Kimberlites: A Window into the Earth’s Interior”—that will study diamond formation and the effect of kimberlite ascent rate on diamond preservation during eruption.

**Dr. S. Aulbach** (University of Alberta, Edmonton, Canada) studied the isotopic composition (Re-Os) of syn-genetic sulfide inclusions in diamonds from the Jagersfontein mine in South Africa. Several factors point toward diamond crystallization at multiple depths. In contrast to other eclogitic sulfide inclusion suites from the Kaapvaal craton, the absence of such suites of Archean age may relate to unique aspects of the Jagersfontein kimberlite (i.e., its transport and preservation of very deep diamonds, or its location on the edge of the craton).

**Dr. R. S. Harmon** (Army Research Office, Research Triangle Park, North Carolina) presented research conducted by **C. E. McManus** on the geographic origin determination of gem beryls with LIBS analysis. Considerable chemical variability was documented in beryls from just one locality in New Hampshire (Palemero No. 1 pegmatite), indicating the need for a large sample base to perform reliable origin identification.

**Dr. T. Tsujimori** (Okayama University, Tottori, Japan) presented **Dr. S. S. Sorensen's** work on the formation of jadeite and related rocks in Guatemala. The unusual geochemical signature of meta-ultramafic rocks adjacent to the jadeite bodies is apparently the result of interaction with metasomatic fluids that permeated along the contact

between the jadeite and host serpentinite.

**Dr. D. E. Jacob** (Johannes Gutenberg University, Mainz, Germany) examined the distribution and characteristics of vaterite (a polymorph of  $\text{CaCO}_3$ ) in freshwater cultured pearls from a *Hyriopsis* mollusk. In high-quality pearls, vaterite formed relatively small areas (1–1.5 mm diameter) near their center. However, low-quality samples were in some cases comprised mostly of vaterite. Detailed examination of growth rings in the cultured pearls suggested that vaterite and aragonite grew simultaneously, and that vaterite may not have been an initial template for aragonite growth.

**This contributor** provided a genetic model for the formation of yellow gem tourmaline at the Canary mine in Zambia (see article in this issue of *Gems & Gemology*).

*Brendan M. Laurs*

**The Madison Dialogue Ethical Jewelry Summit.** The Madison Dialogue ([www.madisondialogue.org](http://www.madisondialogue.org)) is a cross-sector initiative aimed at encouraging best practices in the gold, diamond, and other mineral industries by promoting communication and collaboration, sustainable economic development, and verifiable sources of responsibly mined materials. The initiative was launched at a meeting in New York (on Madison Avenue) in August 2006. On October 25–26, 2007, the Madison Dialogue Ethical Jewelry Summit took place at the World Bank headquarters in Washington, DC, to discuss ways to improve socioeconomic conditions for marginalized small-scale (artisanal) miners around the world. This meeting also sought to develop ethical standards for business conduct in source countries, with independent third-party verification systems. The overall goal was to lay the foundation for the manufacture of “ethical jewelry”—jewelry assembled in ways that meet environmental, social justice, and transparency standards along the supply chain from source countries to consuming nations.

Attendees included non-governmental organizations, such as Communities and Small Scale Mining (which hosted the forum), the Association for Responsible Mining, Earthworks, Partnership Africa Canada, Urth Solutions, Ethical Metalsmiths, and Fairtrade Labelling Organizations International. Among the mining (metal, diamond, and colored stone) concerns, gem dealers, and educational and jewelry trade organizations represented were the Council for Responsible Jewellery Practices, Jewelers of America, the De Beers Group, Rio Tinto, AngloGold Ashanti, Columbia Gem House, Nature’s Geometry, Rapaport Group, the Gemological Institute of America, and Oro Verde. The jewelers and jewelry manufacturers contingent included representatives from Ben Bridge, Cartier, Tiffany & Co., Leber Jeweler, Cred Jewellery, greenKarat, Finesse Diamonds, and Sterling.

Although many of the participants had already undertaken a variety of ethical initiatives on their own, the Madison Dialogue was the first such forum for this cross-section of global players to openly share knowledge and discuss the issues of ethical jewelry. Participants agreed on

a mutual goal of building confidence for all players in the gem and metals supply chain. Discussions made it clear, however, that methods of accomplishing this goal might differ. As some differences are rooted in language or cultural realities, Madison Dialogue organizers included an initial session to discuss nomenclature and clear definitions for such terms as *fair trade*, *environmental and social responsibility*, *sustainability*, and *third-party assurance systems*.

At the close of the two-day summit, participants agreed to release the following declaration: "We believe there is an opportunity to make a difference in the lives and communities of artisanal/small-scale miners and other marginalized workers worldwide by developing and implementing robust standards for the production of ethical and fair trade metals, diamonds, gems, and jewelry. We also encourage governments, where needed, to develop policies and regulations that protect these miners, workers, and their communities." Participants also agreed to form working groups to address issues specific to the mining of metals, diamonds, and colored stones, as well as the development of standards and third-party assurance systems.

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## ANNOUNCEMENTS

**Visit *Gems & Gemology* in Tucson.** Meet the editors and take advantage of special offers on subscriptions and back issues at the *GeG* booth in the publicly accessible Galleria section (middle floor) of the Tucson Convention Center during the AGTA show, February 6–11, 2007. GIA Education's traveling Extension classes will offer hands-on training with "Colored Stone Grading" (February 5–7), "Pearls" (February 8), and "Identifying Diamond Treatments" and "Identifying Ruby" (February 9). Several free seminars will also be offered by GIA staff February 10–11. To enroll, call 800-421-7250, ext. 4001. Outside the U.S. and Canada, call 760-603-4001. The GIA Alumni Association will host an auction and dance party at the Marriott University Park Hotel in Tucson on February 8, starting at 6:30 p.m. To reserve tickets, call 760-603-4204 or e-mail [events@gia.edu](mailto:events@gia.edu).

## Conferences

**NAJA annual conference.** The National Association of Jewelry Appraisers is holding its 29th annual Winter Educational Conference February 4–5, 2008, during the Tucson gem shows. Visit [www.najaappraisers.com](http://www.najaappraisers.com).

**Hasselt Diamond Workshop.** Held February 25–27, 2008 at Hasselt University, Diepenbeek-Hasselt, Belgium, this conference will cover a variety of diamond-related research subjects. Visit [www.imo.uhasselt.be/SBDD2008](http://www.imo.uhasselt.be/SBDD2008).

**PDAC 2008.** The Prospectors and Developers Association of Canada convention will take place March 2–5 in Toronto.

The technical session will include an update on the Canadian diamond industry (including progress at Snap Lake and Victor) and a review of current diamond prospecting in India. Visit [www.pdac.ca/pdac/conv](http://www.pdac.ca/pdac/conv).

**Bead Expo.** The 2008 International Bead Expo will be held in Portland, Oregon, March 27–30. Over 60 workshops and educational lectures on bead jewelry design and manufacture are scheduled. Visit [www.beadexpo.com](http://www.beadexpo.com).

**BASELWORLD 2008.** The BASELWORLD show will be held April 3–10 in Basel, Switzerland. During the show, *Gems & Gemology* editor-in-chief Alice Keller will be available at the GIA booth in Hall 2, Stand W23. Visit [www.baselshow.com](http://www.baselshow.com) or call 800-922-7359.

**35th Rochester Mineralogical Symposium.** A variety of gem and mineral topics will be presented at this symposium, held April 10–13, 2008, in Rochester, New York. Visit [www.rasny.org/MinSymposium/MineralSymp.htm](http://www.rasny.org/MinSymposium/MineralSymp.htm).

**Réunion des Sciences de la Terre.** This earth science conference will be held April 21–24, 2008, in Nancy, France. The program will include a session on gems. Visit [www.RST2008.u-nancy.fr](http://www.RST2008.u-nancy.fr).

**Sinkankas garnet symposium.** Garnet will be featured in the sixth annual John Sinkankas Memorial Symposium, held April 19, 2008 at GIA Carlsbad. A variety of experts will speak on garnet localities, inclusions, treatments, appraising, lapidary work, and literature at this all-day educational event. E-mail [merksjade@cox.net](mailto:merksjade@cox.net).

**CIM Conference and Exhibition.** Held May 4–7, in Edmonton, Alberta, the 2008 meeting of the Canadian Institute of Mining, Metallurgy and Petroleum will feature a session on the geology of diamonds in Canada. Visit [www.cim.org/edmonton2008](http://www.cim.org/edmonton2008).

**Art2008.** Held May 25–30 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).

**Quebec 2008: GAC-MAC-SEG-SGA.** Held May 26–28 in Quebec City, Canada, this joint conference organized by the Geological Association of Canada, Mineralogical Association of Canada, Society of Economic Geologists, and the Society for Geology Applied to Mineral Deposits will include special sessions on "Diamonds: from Mantle to Jewellery" and "Challenges to a Genetic Model for Pegmatites," as well as a short course called "Rough Diamond Handling." Visit [www.quebec2008.net](http://www.quebec2008.net).

**NDNC-2008.** The growth, processing, characterization,

properties, and applications of diamond and related materials will be covered at the 2nd International Conference on New Diamond and Nano Carbon, held May 26–29 in Taipei, Taiwan. Visit <http://diamond.iams.sinica.edu.tw/NDNC2008>.

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

**2009 GIA Gemological Research Conference.** The 2009 GRC will be held August 21–23, 2009 in San Diego, California. Further details will be made available as the date approaches. Visit <http://grc2009.gia.edu> or email [grc2009@gia.edu](mailto:grc2009@gia.edu).

## Exhibits

**Exhibits at the GIA Museum.** Through February 29, 2008, "Reflections in Stone" will showcase famed gem carver Bernd Munsteiner's work during the period 1966–2003. On display in the Mikimoto Rotunda, the exhibit includes carved quartz, tourmaline, and beryl, ranging from pieces set in jewelry to large table-top sculptures. From May 21 through December 2008, "Facets of GIA" will showcase

the various gemological services that GIA provides, including diamond grading, gem identification, education, and public outreach. As part of this exhibit, the Aurora Butterfly of Peace—a display comprised of 240 natural fancy-colored diamonds—will be featured through July 2008, courtesy of Alan Bronstein and Harry Rodman (see also the article on pp. 332–351 of this issue). Advance reservations are required; to schedule a tour, call 760-603-4116 or e-mail [museum@gia.edu](mailto:museum@gia.edu).

**Gems! Colors of Light and Stone.** The Michael Scott collection has returned to the Bowers Museum in Santa Ana, California, with an expanded display of rare colored stones, carvings, and sculptures. The exhibit will run until June 16, 2008. Visit [www.bowers.org](http://www.bowers.org).

**The Aurora Collection at The Vault.** "The Vault," a new permanent collection of rare gemstones and mineral specimens, is now open at the Natural History Museum in London. Headlining the initial exhibit is the Aurora Collection, currently comprising 296 naturally colored diamonds (267.45 carats total weight) assembled by diamond collectors Alan Bronstein and Harry Rodman. Also on display is the 47.69 ct Star of Africa, which helped launch the 1869 diamond rush in South Africa, and the 1,385.95 ct Devonshire emerald crystal. Visit [www.nhm.ac.uk/galleries](http://www.nhm.ac.uk/galleries).

The advertisement features a large image of a gem cutter working on a rough stone. A red banner with the letters "GRC" and a diamond icon is overlaid on the top left. Below the image, text reads: "GEMOLOGICAL RESEARCH CONFERENCE 2009 ▪ AUGUST 21 – 23, 2009 ▪ FOR FUTURE UPDATES, VISIT [WWW.GRC2009.GIA.EDU](http://WWW.GRC2009.GIA.EDU)". To the right, a large "GRC" logo is displayed with "GEMOLOGICAL RESEARCH CONFERENCE 2009 SAN DIEGO, CA ▪ AUGUST 21 – 23" underneath. To the right of the logo, the text "HOSTED BY" is followed by the GIA logo (a crest with the letters "GIA") and the word "GIA". A large blue diamond is shown next to the text "UNCOVER THE SCIENCE OF GEMOLOGY AT THE 2009 GEMOLOGICAL RESEARCH CONFERENCE". Below this, two columns of text describe the conference: "Cutting-edge oral and poster presentations on topics such as: diamond and colored stone treatments, geology of gem deposits, and identification instrumentation." and "Plus, insightful keynote presentations, international and multi-disciplinary participation, and field trips to gem pegmatite mines in San Diego County." A small "GRCW107" code is in the bottom right corner.