GEM NEWS International

2010 TUCSON

Dealers at this year's Tucson gem and mineral shows had low sales expectations, but many were pleasantly surprised given the slow recovery from the global economic downturn. Although attendance was rather low, vendors with unusual and/or attractive merchandise at good prices were typically successful. The shows featured a vast array of crystals, jewelry, and gems, and particularly widespread were Tanzanian spinels (e.g., figure 1). A relatively new product consisted of "Soufflé" cultured freshwater pearls from China, which were notable for their large size, varied colors, and relatively light heft, leading some people to suspect they were hollow (see report on pp. 61–63 of this issue). Several other items seen in Tucson are described in the following pages and will also be documented in future issues of *G&G*.

The theme of this year's Tucson Gem and Mineral Society show was of particular interest to gemologists: "Gems and Gem Minerals." The theme of next year's TGMS show will be "Minerals of California."

Figure 1. Spinel from Tanzania was prevalent at this year's Tucson gem shows. These attractive pieces from Mahenge each weigh ~20 ct. Courtesy of Dudley Blauwet Gems, Louisville, Colorado (left), and Evan Caplan and Omi Gems Inc., Los Angeles (right); photo by Robert Weldon.

G&G appreciates the assistance of the many friends who shared material and information with us this year, and also thanks the American Gem Trade Association for providing space to photograph these items during the AGTA show.

COLORED STONES AND ORGANIC MATERIALS

Update on ametrine from the Yuruty mine, Bolivia. During the Tucson gem shows, Hugo Marancenbau (Steinmar Ltd., Santa Cruz, Bolivia) provided an update on ametrine from the Yuruty mine in Bolivia (see Summer 2000 Gem News, p. 163). This deposit was initially claimed in the mid-1990s and is located ~50 km north of the famous Anahí ametrine mine. Mining at Yuruty has been intermittent, although commercial production was resumed during the past two years. The deposit is exploited by ~100 people in underground workings consisting of a 90 m shaft and four horizontal tunnels up to 200 m long. The mine produces an average of ~40 tonnes/month of mixed-grade material, approximately 3% of which is facetable. Although Mr. Marancenbau's company plans to sell the ametrine in the rough form only, they have test faceted a few thousand carats (weighing 3–30 ct each) that

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

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Figure 2. This ametrine (6.46–35.59 ct) was recently mined from the Yuruty deposit in Bolivia. Photo by Robert Weldon.

were sold at the JOGS show. He indicated that it was the first time ametrine from this mine was sold in Tucson.

Mr. Marancenbau kindly donated several rough and cut pieces of ametrine to the GIA Collection. The faceted stones (figure 2) contained varying amounts of purple and yellow, with a sharp color boundary visible face-up in one of the samples. None of them had the distinctive smoky layers seen previously in Yuruty material (see the Summer 2000 Gem News entry).

With several tonnes of rough material stockpiled and good reserves that are inferred to remain underground, the Yuruty deposit appears poised to become an important supplier of ametrine.

Brendan M. Laurs

Andradite from China. At the 2009 and 2010 AGTA shows in Tucson, Eric Braunwart (Columbia Gem House, Vancouver, Washington) had andradite from what he believed to be a new find in China. According to his supplier, the material was initially mined in late 2007 by hand methods in a remote region of western China. The rough consists of well-formed crystals that were apparently derived from a skarn-type deposit. Although referred to as "demantoid" by the miners, none of the garnet appeared green enough to be considered as such.

Mr. Braunwart reported that he faceted ~5,000 carats from his first shipment of rough. Although stones up to 4 ct have been cut, smaller gems up to 1.5 ct typically show the best color and brilliance. Most of the material averages 0.75 ct (5 mm diameter) and ranges from medium greenish yellow to dark brownish yellow to brown and brownish red. At Mr. Braunwart's factory in China, the cutters typically seek the largest size that should yield an attractive stone, and then recut any over-dark gems until their appearance is optimized.

Six faceted samples of the andradite (0.30–1.58 ct; figure 3) were loaned to GIA for characterization, and the following properties were recorded: color—green-yellow to greenish yellow-brown; RI—over the limits of the standard refractometer; hydrostatic SG—3.91 (on the largest stone only); and strong absorption below 450 nm visible with a desk-model spectroscope. These properties are consistent with those reported for andradite by M. O'Donoghue (*Gems*, 6th ed., Butterworth-Heinemann, Oxford, UK, 2006, pp. 206–210), except the SG values in that publication are somewhat lower (3.82–3.85). The fluorescence of the samples ranged from inert to very weak red under long-wave UV, and inert to weak red under short-wave UV radiation. Microscopic examination revealed scattered metallic black crystals (figure 4), randomly oriented transparent colorless needles, and "fingerprints." Two stones also contained low-relief fractures that showed evidence of clarity enhancement. The reaction of the filler to hot-point testing suggested some type of oil.

In the spring of 2009, Mr. Braunwart's supplier provided another parcel of rough, which was very similar to the original material. The individual pieces were significantly smaller, but the supplier indicated that more of the andradite could be produced to meet market demand.

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Brendan M. Laurs

Figure 3. These andradites (0.30–1.58 ct), reportedly from a new deposit in western China, were selected to show the material's typical range of color. Photo by Robert Weldon.

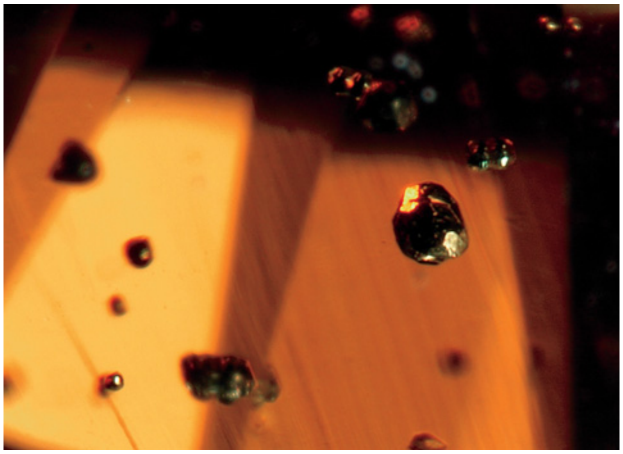


Figure 4. Scattered metallic black inclusions were seen in the Chinese andradite. Photomicrograph by N. Renfro; magnified 60×.

Barite from Brazil. Barite ($BaSO_4$) is a common mineral that is rarely faceted due to its typically opaque appearance, low hardness (Mohs 3–3½), and two good cleavage directions. It was surprising, therefore, to see large clean faceted barites in a variety of colors in Tucson this year. These stones were offered by Luciana Barbosa (Gemological Center, Belo Horizonte, Brazil) at the Gem & Jewelry Exchange (GJX) show, and by Dilermando Rodrigues de Melo Filho (Geometa Ltda., Governador Valadares, Brazil) at the Arizona Mineral & Fossil Show (Hotel Tucson City Center, formerly Inn Suites).

Figure 5. Barite from a new deposit in Acre State, Brazil, is notable for its large size and range of colors. The crystal has a distinct blue zone in the lower right (and an iron stain on the lower left); the cut stones weigh 25.9–51.7 ct. Courtesy of Gemological Center; photo by Robert Weldon.

According to Mr. Rodrigues, the barites came from a new deposit in Acre State, in Brazil's Amazon region. He was told that the stones were mined in August–September 2009 by local *garimpeiros*, and that ~30 kg of mixed-grade material was produced. Although both dealers reported that only a small percentage of the barite was facetable, some large stones have been cut (up to 700 ct), in colors ranging from near-colorless to pale brownish yellow ("champagne") and pale gray, green, and blue. Sharp color boundaries were displayed in some of the bicolored stones (e.g., figure 5). However, only a few bicolored gems were cut because the material is not commonly color zoned, or the color boundary is located near the outer edge of the crystals.

The potential for additional production of this interesting barite is unknown at this time.

Brendan M. Laurs

Hanksite as a gem material. At the GJX show, rare-stone specialist Arthur Birago (Freakingcat.com, Bangkok) had several pieces of faceted hanksite from Searles Lake in Trona, San Bernardino County, California. The stones typically weighed >10 ct, although one rather large one was >250 ct. In addition, faceted hanksite from Searles Lake has been offered for sale on various web sites. As hanksite is a soft and highly water-soluble evaporite mineral, its use in jewelry seems unlikely. In October 2009, this contributor visited Searles Lake and collected several hanksite crystals to investigate the feasibility of using this material as a gem.

Searles Lake—a dry lake bed located in Southern California's Mojave Desert—has produced industrial minerals such as borax for more than 100 years. It is also the source of other evaporite minerals such as halite, hanksite, trona, and sulfohalite. Hanksite, $Na_{22}K(SO_4)_9(CO_3)_2Cl$, contains both sulfate and carbonate groups, which makes it difficult to classify; most mineralogical texts group it with sulfates (see, e.g., E. S. Dana and W. E. Ford, *Textbook of Mineralogy*, 4th ed., John Wiley & Sons, New York, 1932, p. 755).

Because of ongoing commercial mining operations, the site is open to mineral collecting by the public for only one weekend each year, through the cooperation of Searles Valley Minerals. Although hanksite crystals up to several centimeters long can be found, smaller well-formed crystals are typically cleaner and more appropriate for faceting (e.g., figure 6).

This contributor faceted two samples (5.06 and 8.91 ct) of hanksite using standard lapidary techniques. The only modification was that, because of the material's solubility, water could not be used to remove swarf buildup from the lap; a saturated solution of dissolved hanksite was used instead. The stones were polished using 0.5 μm diamond abrasive and mineral oil as a lubricant. A satisfactory pol-

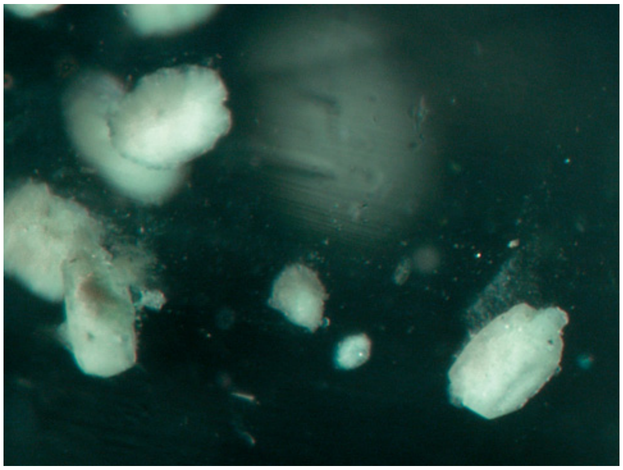
Figure 6. These four crystals (1.3–7.0 g) and faceted gems (5.06 and 8.91 ct) are hanksite from Searles Lake, California. Photo by Robert Weldon.

ish and well-defined facet junctions were achieved using this method, but it was almost impossible to avoid some scratching due to the mineral's low hardness (Mohs 3.5).

Not surprisingly, microscopic examination revealed chips, abrasions, scratches, and cleavage breaks on some surfaces of the faceted stones. Both samples contained similar inclusions, which mostly consisted of pale green angular crystals (figure 7). Raman analysis identified them as gaylussite, a hydrous Na-Ca-carbonate.

Standard gemological testing of the two stones gave the following properties, which were consistent with those published for hanksite in mineralogical textbooks: RI—1.469–1.481; SG (determined with a Sarin device, again because of the material's solubility)—~2.58; fluorescence—weak greenish yellow to long-wave UV and moderate greenish yellow to short-wave UV, with phosphorescence from the latter lasting ~3–5 seconds. Raman analysis confirmed the stones' identity as hanksite.

Figure 7. Pale green masses of gaylussite were the predominant inclusion in the faceted hanksite specimens. Photomicrograph by N. Renfro; magnified 60×.



Because of hanksite's solubility, softness, and typically abundant inclusions, it is poorly suited for jewelry use. Nevertheless, hanksite can be appreciated as a very unusual collector's gem.

Nathan Renfro

Lepidolite beads from Mozambique. Micas such as muscovite and lepidolite are not commonly used as gem materials, although they have been polished into cabochons and even faceted stones when found in attractively colored fine-grained masses (e.g., Fall 1993 Gem News, pp. 210–211; Spring 2006 Gem News International [GNI], pp. 65–66). At the Arizona Mineral & Fossil Show held at Hotel Tucson City Center, Giuseppe Agozzino (Geofil, Cascais, Portugal) showed this contributor some purple lepidolite beads from the Naipa mine in the Alto Ligonha region of Mozambique (figure 8). The beads were notable for their coarse-grained texture, which produced shiny reflections when viewed from certain directions. Mr. Agozzino indicated that ~200 strands of the beads had been manufactured, in diameters from 12 to 20 mm. In addition, some of the lepidolite was polished into spheres up to 12 cm in diameter.

While most coarse-grained lepidolite lacks the toughness necessary for a gem material, these beads were fashioned from compact spherical radial aggregates. The lepidolite "balls" may attain dimensions exceeding 14 cm (M. Battencourt Dias and W. Wilson, "The Alto Ligonha pegmatites, Mozambique," *Mineralogical Record*, Vol. 31, No. 6, pp. 459–497). The rough material was recovered several years ago from mine dumps. The Naipa deposit continues to be worked today for gem-quality tourmaline, beryl, and other minerals.

Brendan M. Laurs

"Soufflé" freshwater cultured pearls. At the AGTA show, Jack Lynch (Sea Hunt Pearls, San Francisco) had an attractive new product that he sold as "Soufflé pearls." They were notable for their size, up to 20 mm; their high luster; and their wide range of reportedly natural colors (figure 9). According to Mr. Lynch, they debuted with one supplier as "hollow keshi" at the September 2009 Hong Kong Jewellery and Gem Fair. This name probably came from their relatively light heft, leading the dealer to assume they were hollow. Yet other Chinese dealers insisted that producing such large hollow pearls was impossible. Mr. Lynch cut a few samples in half and found that the interiors indeed contained voids, with a dark matter lining the walls. However, when he returned to the United States

Figure 8. These beads (12 and 20 mm in diameter) were fashioned from coarse-grained lepidolite, such as the spherical aggregate shown here. Photo by Jeff Scovil.

and drilled some of the other pearls, he noticed that a black liquid bled from the drill holes. He speculated that they were produced by a new cultivation process, whereby an unconventional type of nucleus was inserted into pre-existing pearl sacs in the mollusks.

Mr. Lynch sent two undrilled samples and one sliced sample to each of these authors for examination. They ranged from 17.7 to 18.6 mm in maximum dimension and were white, light orangy pink, and light pink; all were baroque shaped. Microradiography by both authors revealed large irregular areas of a relatively uniform gray color in their interiors—that is, areas more translucent to X-rays than the surrounding nacre, along with smaller darker, more X-ray transparent areas (e.g., figure 10).

When one of the samples was cut in half, a dark, viscous liquid was noted that quickly dried into the gray matter that filled the pearl's interior (figure 11, left). It could easily have fallen out or been removed during drilling, leaving a void (lined with organic substance) and an irregular nacre thickness of 1.2 to 4 mm. The gray matter, totally separate from the outer layers of the pearl, displayed a brittle, mortar-like structure when viewed with a gemological microscope as well as a scanning electron microscope (SEM; figure 11, right). Energy-dispersive spectroscopy of the gray matter with the SEM showed that the major components were Si and Al, with traces of K, Fe,

Figure 9. These new "Soufflé" freshwater cultured pearls are relatively large (here, ~14 to 20 mm) and come in a wide range of hues with highly lustrous surfaces. Photo by Jack Lynch.

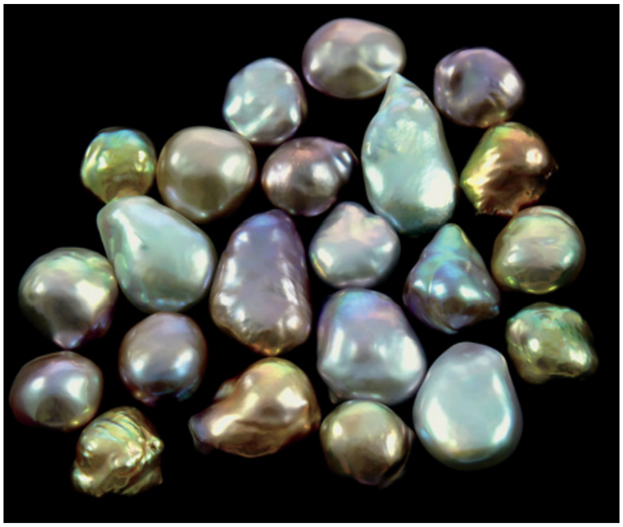
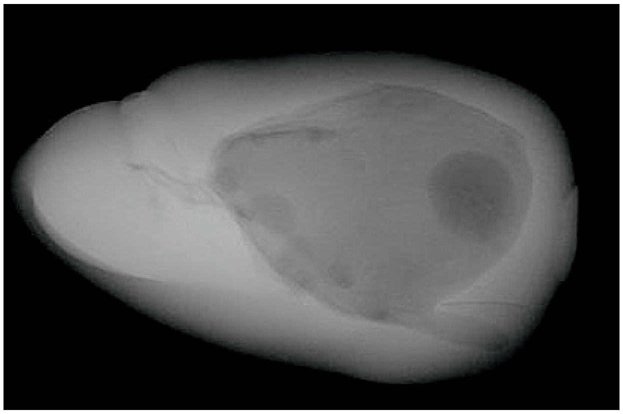


Figure 10. This microradiograph of a "Soufflé pearl" (18 mm long) shows a central gray area that also contains a darker spherical area to the right (possibly a gaseous or liquid phase).



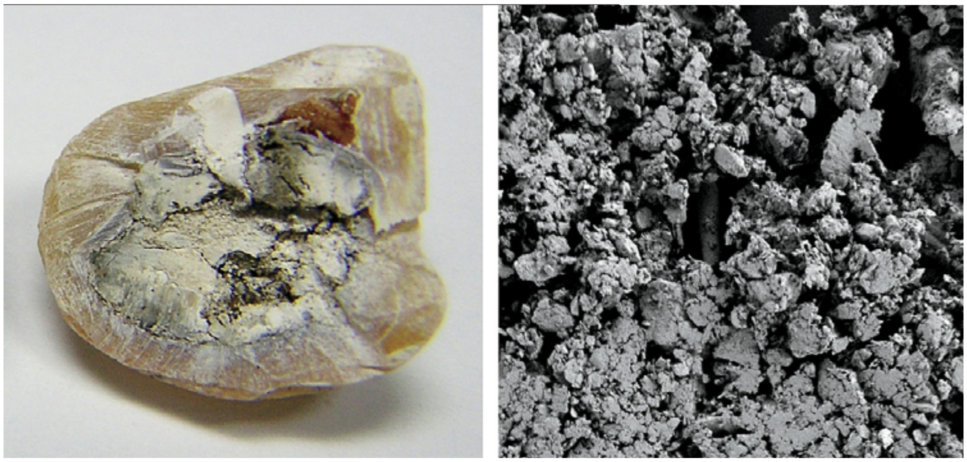


Figure 11. A mud-like core is evident in this section of a "Soufflé pearl" (left, 13.7 × 11.1 mm; photo by E. Strack), with the porous, powdery texture evident in the SEM image (right, magnified 2000×).

Mg, and Na. While this did not identify the material, it did prove that the substance was not a calcium carbonate or organic material connected to pearls or mollusks.

Mr. Lynch's supplier subsequently informed him that "muck," possibly pond mud, had been used to initiate pearl growth. Since this material was deliberately placed within existing pearl sacs in the host mollusks, the resulting cultured pearls cannot be classified as "keshi." Instead, they appear to represent an interesting twist on pearl cultivation. The "nuclei" are unstable to drilling and may not be present in the drilled cultured pearls. This would explain why the strands have a relatively low heft, a fact that—among other attributes—prompted Mr. Lynch to embark on further testing.

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"Churrasco quartz" with tourmaline and chamosite inclusions from Brazil. In May 2009, Denilson Henrique Salomão (Hercules Gems, Teófilo Otoni, Brazil) recovered 700 kg of colorless-to-smoky quartz containing black needles and hexagonal crystals from the Chapada Diamantina area in Bahia State. The parcel included broken pieces and prismatic crystals; only a few had their natural terminations. Approximately 100 kg were suitable for cutting into cabochons and faceted gems (e.g., figure 12), while the remaining 600 kg were reserved for carving. Mr. Salomão sold the material in Tucson at the GJX show, and he also donated some samples to the Mineralogy Museum at the University of Rome "La Sapienza" that were examined for this report.

Two cabochons were characterized using standard gemological techniques, an FEI Quanta 400 scanning electron microscope, and a Cameca SX 50 electron microprobe at the Italian National Research Council's Institute of Environmental Geology and Geoengineering (IGAG-CNR) in Rome, as well as with a Seifert MZIV X-ray diffractometer at the University of Rome "La Sapienza." The gemological properties were consistent with quartz. The black needles ranged from 0.1 to 5 cm long and 50 to 150 μm in diameter. The hexagonal inclusions were tabular and 0.1–1 cm in diameter. Electron microprobe analyses (see G&G Data Depository at www.gia.edu/gandg) identified the needles as schorl tourmaline and the hexagonal inclusions as chamosite (an Fe-rich chlorite-group mineral that forms a series with clinochlore). Since the chamosite contained an unusually low amount of Mg, powder X-ray diffraction analysis was used to confirm its identity.

The tourmaline needles commonly intersected the chamosite inclusions. The resemblance to *churrasco* Brazilian cuisine, in which meat is grilled on a skewer, led Mr. Salomão and one of these authors (MM) to call the material "Churrasco quartz." To the best of our knowledge, this is the first report of chamosite in quartz. The unusually low Mg content of the chamosite inclusions, and their association with tourmaline, are also noteworthy.

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Figure 12. This 17.44 ct cabochon of "Churrasco quartz" contains a chamosite crystal that is intersected by a needle of schorl. Photo by M. Macrì.

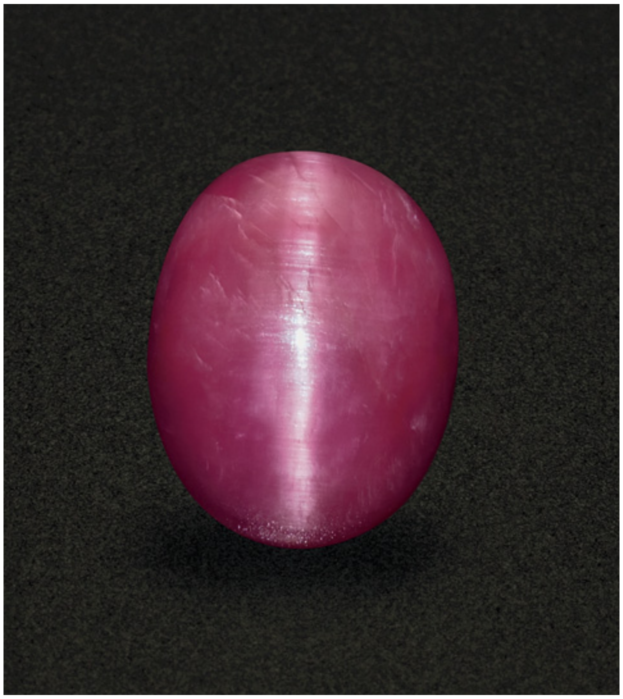


Figure 13. This cat's-eye rhodonite (6.93 ct) from Brazil shows good chatoyancy. Photo by Robert Weldon.

Cat's-eye rhodonite. Rhodonite ($MnSiO_3$) is an attractive pink-to-red mineral that is often sold as mineral specimens or ornamental material, but seldom as a gemstone, since it is typically opaque and has perfect cleavage in two directions. Facetable material is very rare, and small amounts are occasionally produced from just two localities—Broken Hill, Australia, and Minas Gerais, Brazil (see, e.g., P. W. Millsteed, "Faceting transparent rhodonite from Broken Hill, New South Wales, Australia," Summer 2006 *G&G*, pp. 151–158; and Fall 2004 GNI, pp. 260–261). Some polished rhodonite has a saturated color that resembles fine spinel or rhodochrosite.

At the GJX show, Luciana Barbosa had some attractive rhodonite cabochons showing good chatoyancy (e.g., figure 13). She reported that the material was found in 2009 at Morro da Mina, near Conselheiro Lafaiete in Minas Gerais. The rhodonite is recovered as a byproduct of manganese mining, in a large open pit that is operated by Companhia Vale do Rio Doce. Ms. Barbosa knew of ~30 pieces of the cat's-eye rhodonite (ranging from ~2 to 40 ct), and she had not seen the material previously. To her knowledge, the stones were all untreated. She indicated that the identity of the rhodonite had been confirmed by X-ray diffraction analysis.

We believe this is the first report of cat's-eye rhodonite.

Brendan M. Laurs

GNI REGULAR FEATURES

DIAMONDS

A large hydrogen-rich diamond with a cuboid phantom cloud. In late 2009, the Gübelin Gem Lab received a 41.54 ct brownish greenish yellow brilliant-cut diamond for routine analysis (figure 14). The cushion-shaped stone measured ~24.4 × 21.4 × 12.0 mm. The client informed us that it was purchased in the early 1970s.

Microscopic examination revealed a cuboid-shaped phantom cloud, which was particularly evident with darkfield illumination (figure 15). The cuboid shape, rarely seen with optical microscopy, is more often noted using X-ray topography; it results from the growth of undulating surfaces with an average orientation corresponding to a cube face. This growth is typically associated with unusually high concentrations of hydrogen (e.g., E. Fritsch et al., "Hydrogen-related optical centers in natural diamond: An update," *New Diamond and Frontier Carbon Technology*, Vol. 17, No. 2, 2007, pp. 63–89). Hydrogen-rich diamonds often have distinctive gemological properties, such as desaturated colors and pinpoint inclusions, typically with yellow UV luminescence. This diamond weakly fluoresced chalky yellow to long-wave UV and faint orange to short-wave UV, with no phosphorescence.

Hydrogen-rich diamonds also have a well-documented

Figure 14. This 41.54 ct brownish greenish yellow diamond is the second-largest documented member of the brown to grayish yellow to green "family" of H-rich diamonds. Photo by Evelyne Murer.

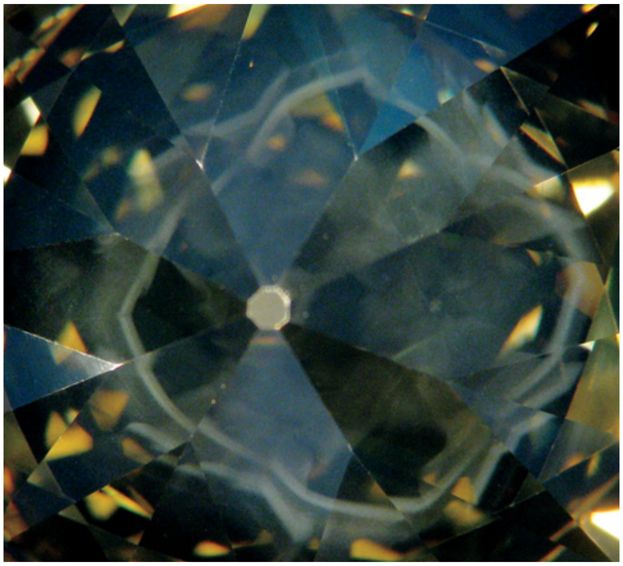
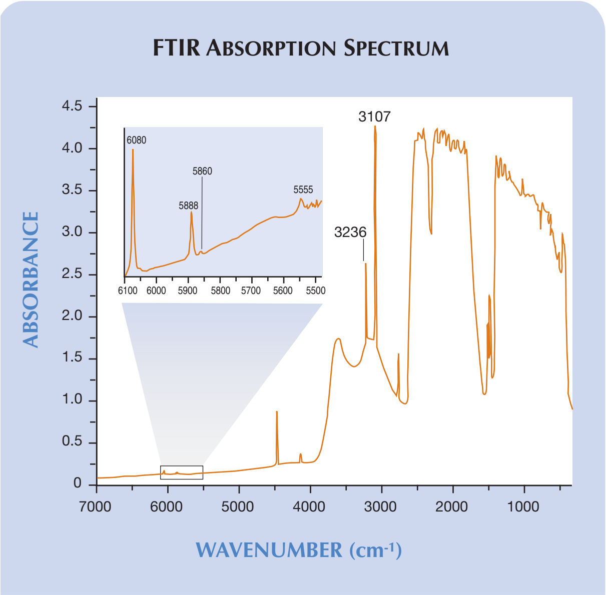


Figure 15. With darkfield illumination, the diamond in figure 14 displays a cuboid phantom cloud (5 mm wide) typical of H-rich diamonds. Photomicrograph by P. Hardy.

set of UV, visible, and IR absorption features. They have been grouped into three "families" according to their UV-visible absorption: (1) brown to grayish yellow to green, (2) gray to blue to violet, and (3) chameleon (see again Fritsch et al., 2007). The UV-Vis-NIR spectrum of this stone showed the N3 (~415 nm) and N2 (~478 nm) bands, which together caused the yellow color. Also present was a continuum of absorption throughout the visible spectrum, giving the brown color component. A broad band centered at ~730 nm was responsible for the green color component, and there was an additional broad band at ~830 nm. This spectrum is typical of diamonds from the brown to grayish yellow to green family. Because it was similar in appearance to some chameleon diamonds, the stone was tested for chameleon behavior, but no change in color was observed when it was placed on a hot plate.

Figure 16. The FTIR spectrum shows the H-related absorptions of the 3107 cm^{-1} system. In the inset, the elusive 5555 cm^{-1} band is well resolved. The presumed N-H band at 3236 cm^{-1} is also seen.



The FTIR spectrum obtained with the beam positioned through the girdle indicated a type IaAB diamond with high nitrogen and hydrogen content (figure 16). The H-related bands associated with the 3107 cm^{-1} system were present, including the elusive 5555 cm^{-1} band. Until now, this weak band has been found only in small diamonds of the gray-to-blue-to-violet family. Nevertheless, this is the most well-defined 5555 cm^{-1} band documented so far (figure 16, inset), presumably due to the diamond's size. Also, this is the second-largest documented member of the H-rich brown to grayish yellow to green family of diamonds, after the 61 ct brown Eye of the Tiger.

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COLORED STONES AND ORGANIC MATERIALS

Diopside from Ihosy, Madagascar. Several "olive" green samples were brought to our attention by gem dealer Farooq Hashmi (Intimate Gems, Jamaica, New York). The material was reportedly mined from the Ihosy region of south-central Madagascar. It was purchased in early 2007 as kornerupine, which is known to come from the same area of the country, but Mr. Hashmi's supplier was later informed that it was diopside. The parcel consisted of ~500 g of rough, in pieces weighing 5–20+ g, and about half of the material was facetable.

Two faceted samples, two well-formed prismatic crystals, and several small pieces of rough were loaned to GIA for gemological observation (e.g., figure 17). Examination of the two cut stones (5.93 and 6.50 ct) and some of the rough pieces showed the following properties: color—medium-dark yellowish green; pleochroism—very weak; RI—1.676–1.700; birefringence—0.024; hydrostatic SG—3.27–3.30; no reaction to the Chelsea filter; inert to long- and short-wave UV radiation; and absorption lines at 490 and 505 nm visible with the desk-model spectroscope. These properties were consistent with diopside (R. Webster, *Gems*, 5th ed., rev. by P. G. Read, Butterworth-Heinemann, Oxford, UK, 1994, pp. 330–331).

The two faceted samples contained only minor inclusions, consisting of a few "fingerprints" and some small

Figure 17. These samples of diopside were recovered from south-central Madagascar. The gemstones, faceted by Robert Buchannan, weigh 5.93 and 6.50 ct. Photo by Robert Weldon.

fractures. Iron-stained fractures and strings of pinpoints were visible in the rough material. Laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) analysis of one faceted sample showed major amounts of Si, Ca, and Mg, and minor Fe—as expected for diopside ($CaMgSi_2O_6$), which forms a series with hedenbergite ($CaFeSi_2O_6$). The relatively low RI values are consistent with a near–end member diopside composition (see W. A. Deer et al., *Rock-Forming Minerals—Single-Chain Silicates*, Vol. 2A, 2nd ed., John Wiley & Sons, New York, 1978, pp. 198–293).

Although gem-quality diopside from Madagascar has been reported previously in the literature (e.g., U. Henn and C. Milisenda, "The gemstone occurrences of Madagascar," *Australian Gemmologist*, Vol. 21, 2001, pp. 76–82), to our knowledge this is the first description of this material.

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Garnet and zircon from the Solomon Islands. Islands of the South Pacific are not known as sources of gem minerals, but in late 2007 GIA learned about new finds of garnet and zircon from the Solomon Islands. According to Brian Pepperall (BR Gemstones, Queensland, Australia), the gems come from the island of Malaita, where they have been gathered by hand as waterworn pebbles from stream gravels. The garnets are dark red and weigh up to 8 g, although the rough is commonly fractured. The zircon is colorless, and eye-clean pieces weigh up to 4 g. Mr. Pepperall estimates that the local people have collected no more than a few kilograms of the garnet and zircon. Although they are interested in pursuing a commercial venture, there are no plans for organized mining because the stones are so easily found on the surface, and they wish to preserve the integrity of their watercourse. A small amount of rough has been sold to Australian faceters, and some of the gems have been set in jewelry to test-market the material. To the best of Mr. Pepperall's knowledge, the stones have not been treated in any way.

Mr. Pepperall had several stones faceted in Australia, and he loaned some of each gem to GIA for examination. A study of three of the garnets (0.94–1.39 ct; figure 18) showed the following properties: color—dark red, RI—1.748, hydrostatic SG—3.73–3.79, fluorescence—inert to long- and short-wave UV radiation, and a dark diffuse band from the violet to the blue region visible with the desk-model spectroscope. These properties are generally consistent with those reported for pyrope-almandine by C. M. Stockton and D. V. Manson ("A proposed new classification for gem-quality garnets," Winter 1985 *G&G*, pp. 205–218). Microscopic examination revealed very small transparent crystals, fractures, and transparent growth features. Chemical analysis with LA-ICP-MS showed major amounts of Al, Si, Mg, and Fe (expected for pyrope-alman-

Figure 18. These garnets (0.94–1.39 ct) from the Solomon Islands proved to be pyrope-almandine. Photo by Robert Weldon.

Figure 19. Also recovered from the Solomon Islands are colorless zircons (here, 0.79–2.50 ct). Photo by Robert Weldon.

dine), minor Ca, and significant traces of Mn, Ti, Cr, and V.

Examination of three of the zircons (0.79–2.50 ct; figure 19) showed the following properties: color—colorless; RI—>1.81; hydrostatic SG—4.71–4.72; fluorescence—moderate white to short-wave UV radiation, and moderate yellowish orange to long-wave UV; and just two lines (in the red region, stronger at 653.5 nm) visible with the desk-model spectroscope. These properties are generally consistent with those reported for zircon by R. Webster (*Gems*, 5th ed., revised by P. G. Read, Butterworth-Heinemann, Oxford, UK, 1994, pp. 176–179). Magnification revealed a cloud of minute particles in two of the stones. LA-ICP-MS analyses showed major Si and Zr, minor Hf, and significant traces of Ti and Sc.

Although the Solomon Islands have the potential to become a supplier of dark red pyrope-almandine and colorless zircon, these gems will probably remain uncommon in the marketplace until further efforts are made for organized recovery.

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Tsavorite mining at Namalulu, northern Tanzania. In late August 2009, these contributors visited a relatively new tsavorite deposit located 110 km south of Arusha. The mines were situated 13 km south of the village of Nabarera, near Namalulu Village, at coordinates 4°18′57″ S, 36°56′42″ E, and 1550 m elevation. Tsavorite was reportedly discovered there in August 2008 by Masai herders. We were told mining activities peaked in December 2008 when there were ~500 people working the deposit, but this number soon decreased after the near-surface deposits were exhausted and underground hard-rock mining became necessary. In addition, at the end of 2008 most of the miners moved to the former Swala Gem Traders tsavorite mine at Lemshuku, near Komolo village, also in northern Tanzania (03°51′36″ S 36°51′34″ E), when Mark and Eric Saul decided not to renew their claims and stopped mining there.

We were guided to Namalulu by local miner Rafael Manyosa and gem broker Abdul M'sellem. Upon our arrival we were met by several members of the Masai tribe (figure 20), who were dealers as well as miners there. We estimated that ~150 people were active in tsavorite mining or trading during our visit. The workings were confined to a narrow band ~100 m wide and 1 km long, oriented in the north-south direction. The geology of the area was described by J. Feneyrol et al. ("Lemshuku and Namalulu 'tsavorites,' Tanzania," poster presentation at the 31st International Gemmological Conference, Arusha, Tanzania, October 8–14, 2009), who visited there in October 2008. They found that the tsavorite crystallizes in veins associated with folded and metasomatized graphitic gneisses near dolomitic marbles.

Most of the mining has taken place during the dry season, from May to November. We visited three pits, which ranged from ~10 to 100 m deep. The largest pit consisted of a shaft and horizontal tunnels with an estimated total length of ~250 m. The shafts were accessible by ropes and followed the near-vertical graphitic gneiss layers downward. The excavations were mainly done using hand tools and explosives, except for one shaft where a compressor and a jackhammer were present.


Figure 20. Masai traders offer a parcel of rough tsavorite at Namalulu, Tanzania. Photo by V. Pardieu.

The miners reported finding good tsavorite every two days, on average, and we saw many attractive parcels while visiting the area. Most of the rough was vividly colored in yellowish green to deep green (figure 21), with some bluish green. We were told that pieces larger than 2 g had been recovered, but we only saw 0.6–0.8 g pieces that had fine color and acceptable clarity. After faceting, the tsavorites typically weigh <2 ct and contain eye-visible inclusions. Although clean material is rare, the deposit appears to show good potential for producing attractive smaller-sized tsavorite gems.

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Figure 21. Tsavorite from Namalulu shows good color and moderate transparency. Photo by V. Pardieu.

SYNTHETICS AND SIMULANTS

Treated CVD-grown pink synthetic diamond melee. The Gemmological Association of All Japan (GAAJ) – Zenhokyo Laboratory recently examined 48 small orangy pink round brilliants that were submitted for color origin identification (e.g., figure 22). They were represented as natural diamonds treated by a high-pressure, high-temperature (HPHT) process. Six were in the 0.20–0.27 ct range, and the remainder were melee size (<0.20 ct). Color grades ranged from Fancy Intense orangy pink to Fancy pinkish orange and Light pinkish orange. Thirteen pieces ≥0.10 ct were graded for clarity; of these, three were VVS$_2$, four VS$_1$, three VS$_2$, two SI$_1$, and one SI$_2$.

Microscopic examination revealed a few pinpoints in most of the samples. Several had black graphitization in cleavages and frosty etching on the surface—both signs of HPHT treatment. The pink color was evenly distributed. Most samples showed a streaked pattern of anomalous double refraction (ADR) that ran parallel to the growth direction of the {100} crystal face (figure 23), but some revealed a cross-hatched "tatami"-like pattern when observed in other directions. The samples fluoresced strong orange to long- and short-wave UV radiation, with no phosphorescence. In the DiamondView, the samples luminesced bright orange, and seven showed parallel laminated growth structures (figure 24). Cathodoluminescence imaging confirmed this structure in 15 of 26 samples. The streaked ADR pattern, fluorescence, and growth structures are consistent with CVD-grown synthetic diamonds.

Results from UV-Vis-NIR, FTIR, and photoluminescence (PL) spectroscopy of all samples are summarized in table 1. UV-Vis-NIR spectra (collected at room temperature) showed a broad absorption centered at ~500 nm (related to NV centers at 575 and 637 nm) that was the cause of the pink color and orange fluorescence. FTIR spectra (collected at room temperature with 1 cm^{-1} resolution) indicated that all samples were type IIa. Twenty-nine samples showed weak absorptions in the 3150–2700 cm^{-1} region, presumably caused by hydrogen impurities; a C-H absorption at 3107 cm^{-1}, common in natural diamond, was vaguely present in only some samples. An absorption at 3123 cm^{-1}, which has been reported as characteristic of

Figure 22. These eight representative samples of treated-color pink CVD synthetic diamonds range from 0.01 to 0.25 ct. Photo by M. Sasahara.

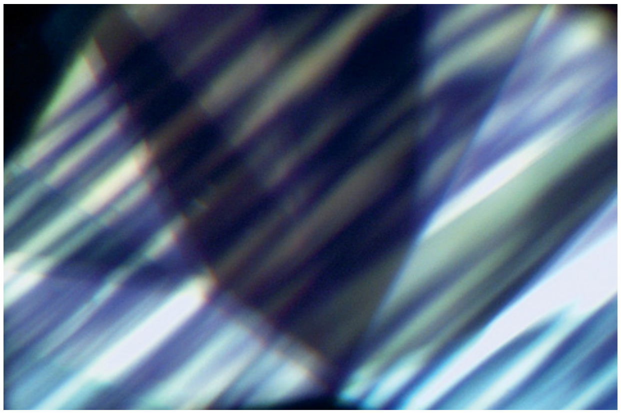

Figure 23. A characteristic streaked ADR pattern was observed in most of the CVD synthetic diamonds between crossed polarizing filters. The streaks run parallel to the growth direction of the crystal and are likely caused by dislocations during growth. Photomicrograph by A. Abduriyim; magnified 50×.

CVD synthetic diamond but annealed out by HPHT treatment (P. M. Martineau et al., "Identification of synthetic diamond grown using chemical vapor deposition [CVD], Spring 2004 *G&G*, pp. 2–25), was not detected. In all samples, PL spectroscopy with 633 nm excitation at liquid nitrogen temperature recorded Si-related defects (737 nm)—which are characteristic of CVD synthetic diamonds—as well as GR1 centers (741 nm) that are related to irradiation. Radiation-related features were also recorded in all samples with 325 nm excitation: a 389 nm line accompanied by numerous weak peaks in the 400–440 nm region. With 514.5 nm excitation, all samples showed NV centers at 575 and 637 nm.

The NV centers were apparently formed by irradiation and annealing of N-containing CVD synthetic diamonds (nitrogen gas is used to accelerate the growth rate). In addition, HPHT treatment was indicated by the lack of the 3123 cm^{-1} absorption in the FTIR spectra, as well as the graphitized cleavages and frosty surface etching. While these small treated pink CVD synthetic diamonds have not yet become common in the marketplace, material with similar properties was also recently documented by GIA (see W. Wang and P. Johnson, pp. 51–52 of this issue), and gemologists must be wary of them. A combination of growth-structure observations, pinpoint inclusions, strain patterns, specific IR absorption peaks in the 3150–2700 cm^{-1} range, and PL lines at 575, 637, and 737 nm, can be used to separate these CVD synthetics from natural pink diamonds.

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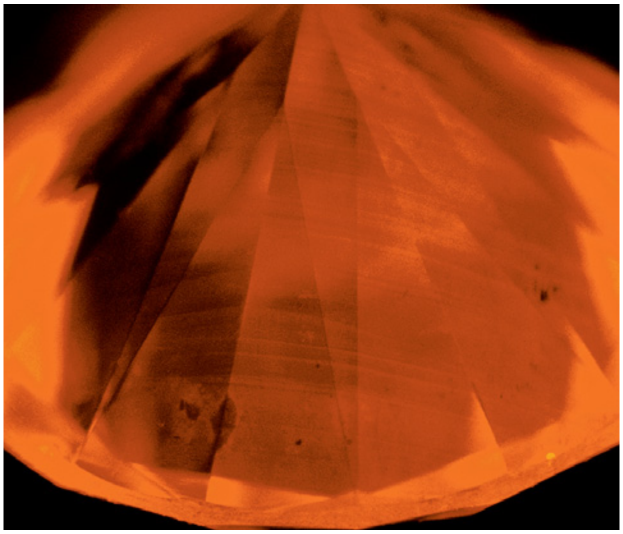


Figure 24. All the CVD-grown synthetic diamonds displayed strong orange fluorescence in the DiamondView. Parallel laminated growth structures also were observed in seven samples. Photo by J. Kawano; magnified 30×.

TABLE 1. Characteristics of 48 treated-color pink CVD synthetic diamonds.

Weight	0.01–0.27 ct
Cut	Round brilliant
Color	Orangy pink to pinkish orange
Clarity	VVS$_2$ to SI$_2$ (≥0.10 ct)
Microscopic features	Pinpoints, graphitized cleavages, frosty surface etching, streaked and tatami-like ADR
UV fluorescence	
Long-wave	Strong orange
Short-wave	Strong orange
DiamondView	Bright orange luminescence; parallel growth layers in seven samples
UV-Vis-NIR spectroscopy	Broad absorption at 500 nm; peaks at 575 (NV^0), 595, 637 (NV$^-$), 741 (GR1) nm; some showed very weak peaks at 268 and 271 (isolated N), 392 (ND1), and 503 (H3) nm; no 737 nm peak detected in these room-temperature spectra
FTIR spectroscopy	Very weak bands at 3136, 3118, 3107, 3028, 2925, 2885, 2855, 2846, 2837, 2788, 2773, 2747, and 2724 cm^{-1} detected in some samples only; the N-related 1344 cm^{-1} band was not found
PL spectroscopy	
633 nm laser	740.9/744.3 nm doublet, 737 ([Si-V]$^-$) nm
514.5 nm laser	575 (NV^0) and 637 (NV$^-$) nm Very weak 737 nm in four samples, very weak 741 nm in six samples
325 nm laser	389, 409, 411, 413, 435, 438, 453, 496 (H4), 498, 503 (H3), and 505 nm; 415 (N3) nm in six samples

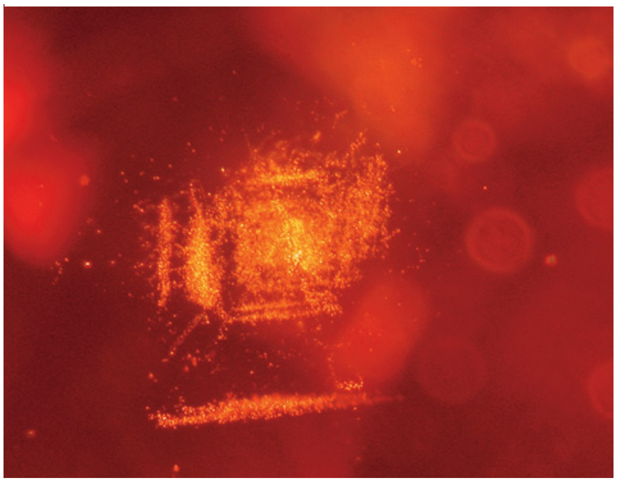
Figure 25. This 2.16 ct brownish orange sapphire displays a color typically associated with Be-diffusion treatment. Photo by G. Choudhary.

TREATMENTS

A Be-diffused sapphire with interesting zoning patterns. The Gem Testing Laboratory of Jaipur often receives gem materials with interesting and unusual internal features. One example was a 2.16 ct brownish orange sapphire, notable for its zoning pattern.

The oval mixed-cut stone, which measured 7.81 × 6.81 × 4.29 mm, had a color reminiscent of beryllium-diffused sapphire (figure 25). It was readily identified as corundum by RI readings of 1.760–1.768 and a hydrostatic SG of 3.98. In addition, weak lines in the red region of the spectrum were observed with the desk-model spectroscope, and the stone fluoresced a weak orange-red to long-wave UV radiation.

Figure 26. The sapphire contains nested zones of minute particles, such as those shown here with a slightly tilted rhomboid profile. Finer zones of particles extend from the lower-left corner of this inclusion cluster. Photomicrograph by G. Choudhary; magnified 65×.



With magnification, fine surface-reaching fingerprint-like inclusions were observed. Some had whitish bubble-like textures, such as those associated with high-temperature heat treatment, which suggested the presence of a foreign substance such as borax. Notably, fiber-optic lighting revealed a few zones of fine minute particles that formed nested patterns with unusual square/rectangular profiles, rather than the hexagonal or pseudohexagonal shapes that are expected in corundum. Viewed in some directions, the sides of some of the zones appeared oblique, forming slightly rhomboid shapes (e.g., figure 26).

Since this sapphire's color suggested beryllium diffusion, we expected to see surface-conformal color zoning. Immersion in methylene iodide in diffused lighting indeed revealed such color layers. (Additional evidence for beryllium diffusion was provided by some areas of recrystallization remaining on the surface of the sample, which are associated with the elevated temperatures used for this treatment.) The color zones were arranged in unusual concentric oval to cushion-shaped zones (figure 27). This contributor has never seen these concentric patterns in a natural sapphire, nor were any such reports found in the literature. Although similar curved color bands may be present in flame-fusion synthetic sapphires, the natural origin of this stone was demonstrated by the zones of minute particles described above.

In the absence of any other inclusion feature, the presence of the concentric colored bands in this Be-diffused natural sapphire could lead to its misidentification by an inexperienced gemologist as a flame-fusion synthetic.

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Figure 27. Immersed in methylene iodide, the Be-diffused sapphire displayed concentric oval to cushion-shaped color bands. Photomicrograph by G. Choudhary; magnified 45×.

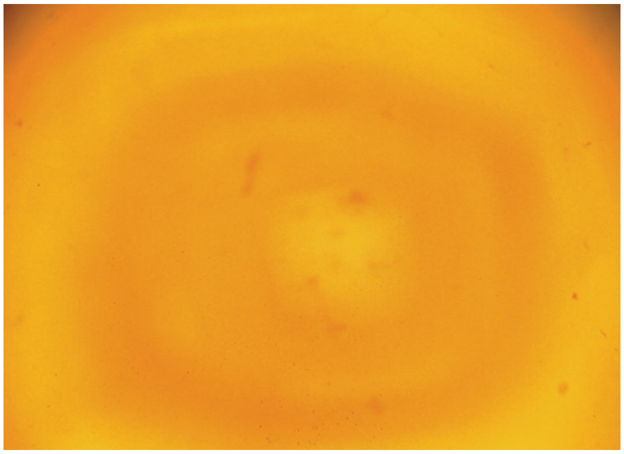

Figure 28. The "Golden Tridacna" beads on the left (7–8 mm in diameter), some with green patches, were fashioned from naturally colored conch shell. All the conch shell beads on the right were found to be dyed. Photo by Jun Su.

Dyed conch shell beads. In recent years, beads fashioned from contemporary conch shells that are represented as fossil conch from the Himalaya Mountains have been sold in the Chinese market as "Neptunian" or "Golden Tridacna" products (see, e.g., Winter 2008 GNI, pp. 376–377). They are usually orangy brown (sometimes orangy yellow or dark green) with off-white striae; the colored portions may have an attractive sheen. We are not aware of any genuine fossil conch shell beads; all the conch shell beads currently in the market appear to have been manufactured from contemporary material. Buddhists treasure these beads for their color patterns, which are similar to the Taiji (yin-yang) symbol, and there is good demand—especially for the more strongly colored pieces.

Recently, a bracelet of baroque-shaped orangy brown beads was submitted to the Beijing laboratory of the National Gemstone Testing Centre (NGTC) for identification. Visual observation suggested the beads were fashioned from conch shell, though careful examination revealed concentrations of color in the surface cracks, which raised suspicions that they might have been dyed.

To further investigate the color origin of such products in the Chinese market, we obtained more than 100 "Golden Tridacna" and "Neptunian" samples from various sources (figures 28–30). These consisted of pale yellow and pale brown beads, some with light green patches—that is, with coloration expected for natural shell material—that did not show any visual evidence of dyeing (figure 28, left), as well as some distinctly colored yellow to orange-brown beads (figure 28, right).

Figure 29. When some of the shell beads were broken open, the pale-colored ones (left, 7 mm in diameter) did not show any features indicative of dyeing. However, the orange beads on the right had color concentrations in fractures, along the drill holes, and in some areas near their rims. Photo by Jun Su.

Figure 30. Color concentrations were seen in the surface-reaching fractures of the dyed beads. Photomicrograph by Jun Su; magnified 15×.

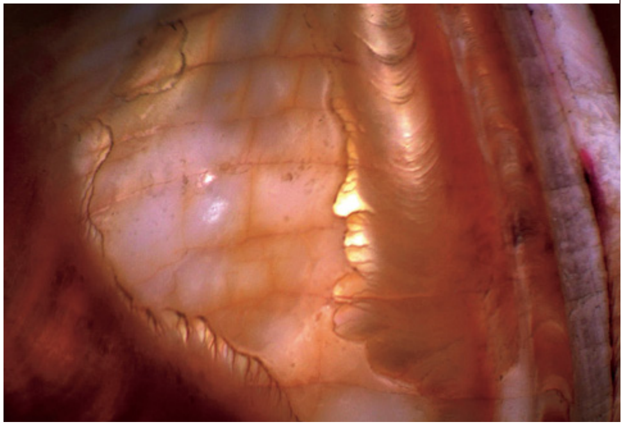

Figure 31. This gemstone tapestry (~106 × 60 cm) consists of diamonds, emeralds, and sapphires set in 18K gold. Photo by A. Malsy; © Gübelin Gem Lab.

The distinctly colored beads did not show any obvious evidence of dye when viewed from the exterior, but on breaking open three of them, we saw varying degrees of color concentrations near fractures, coating the drill hole, and along the outer edge of the broken surface, indicating that they had been dyed (figures 29 and 30). The dye only penetrated certain areas of the beads, leaving the white striae undyed (due to their more compact texture) except where penetrated by fractures.

Raman spectroscopy of five dyed beads revealed peaks at 1085 and 702 cm^{-1} that were attributed to aragonite. However, no features were seen at 1525 and 1134 cm^{-1}, which are related to carotenoids (organic pigments) and are usually associated with natural color in shells (Gang-sheng Zhang, "Study on mollusk shells by laser micro-Raman spectrometry," *Journal of Analytical Science*, Vol. 19, No. 1, 2003, pp. 27–29). Both of these carotenoid Raman peaks were recorded in a natural-colored yellow shell that was analyzed for comparison.

Our study found that all the distinctly colored "Neptunian" and "Golden Tridacna" beads we examined from the Chinese jewelry market, including the bracelet that was submitted for identification, consisted of dyed contemporary conch shell.

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MISCELLANEOUS

Unusual gemstone tapestry. Recently, the Gübelin Gem Lab (GGL) encountered a unique object: a decorative prayer rug (~106 cm × 60 cm) with 27,104 gemstones (figure 31). According to documentation that accompanied the tapestry, it also contains 15.90 kg of 18K yellow gold, which is used in the stone settings and in fringes consisting of delicate gold chains. According to the owner, Kathryn Bonanno, the tapestry was made in France during the 1980s–1990s. It reportedly took five years to gather and cut all the gemstones, and another five years to assemble the final piece. The workmanship is exceptional, with

Figure 32. The fine workmanship of the tapestry is seen in the uniform size, shape, and color of the gems (left), as well as the precise nature of their prong settings (right). Photos by L. Kiefert (left) and A. Malsy (right); © Gübelin Gem Lab.

the gems in perfect alignment, yielding attractive patterns and a smooth and even surface (figure 32).

In the tapestry we counted 1,242 diamonds, 4,580 emeralds, 1,888 rubies, 8,428 blue sapphires, 1,298 pink sapphires, and 9,668 yellow sapphires, with a total reported weight of >14,000 carats. All the stones were oval and measured ~6.0 × 4.0 mm. The diamonds were brilliant cut, while all the other stones had a brilliant-cut crown and step-cut pavilion. The gems were set with prongs in a fashion that is also used for fine bracelets (again, see figure 32), in patterns typical of those seen in prayer rugs.

GGL randomly examined ~1% of the stones in the tapestry by attaching a gemological microscope head to a metal plate with a rod, which was slid under the tapestry and moved along one side. The diamonds were observed with a loupe and a long-wave UV lamp. We did not see any evidence of treatment in the diamonds, while clarity enhancement in the emeralds ranged from none to moderate. The rubies showed indications of heating with minor-to-moderate residue in fissures, the blue and yellow sapphires were heated, and the pink sapphires were a mix of unheated and heated stones.

The beauty of this remarkable piece lies in the number of gemstones it contains and their uniformity, as well as in the patterns they form and the craftsmanship of the tapestry.

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LETTERS

DIFFRACTION GRATINGS ON DIAMOND SURFACES

In the article by A. Gilbertson et al. describing a combination of microlithography and plasma etching to improve dispersion in diamonds (Winter 2009 *G&G*, pp. 260–270), the authors describe some technological developments at the California Institute of Technology. Your readers may be interested to know that two of the coauthors were part of a team that recently published a patent application relating to the process described (G. Maltezos, A. Scherer, and J. Witzens, *Enhancing the Optical Characteristics of a Gemstone*, U.S. Patent Application 2007/0157667A1, July 12, 2007, and International Patent Application WO2007/067696A1, June 14, 2007). The patent documents provide schematic drawings of the various steps used to create the diffraction grating patterns. Further improvements on the techniques are discussed in a later application by Maltezos and Scherer (*Gemstones and Methods for Controlling the Appearance Thereof*, U.S. Patent Application 2009/0126402A1, May 21, 2009; International Patent Application WO2009/073576A2, June 11, 2009).

The 2007 Maltezos et al. application was mentioned in a review summarizing patent documents about various surface treatments of gemstones (K. Schmetzer, "Surface treatment of gemstones, especially topaz—An update of recent patent literature," *Journal of Gemmology*, Vol. 31, No. 1/2, 2008, pp. 7–13), which also provides additional information for the interested reader. A recently published patent application by G. L. W. Cross, W. McKenzie, and J. B. Pethica (*Process and System for Fabrication of Patterns on a Surface*, International Patent Application WO2010/003600A1, January 14, 2010, and European Patent Application EP 2 144 117 A1, January 13, 2010) describes further developments in the surface treatment of diamonds. Well-defined periodical patterns were prepared by treatment of the diamond's surface with a focused ion beam and subsequent plasma etching. These publications also present a general review of the technical literature dealing with surface patterning and nanostructuring.

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