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DIAMONDS

Type Ib greenish brown diamonds with a color shift. Single substitutional nitrogen causes yellow color in diamond. Therefore, type Ib diamonds are often assumed to be yellow (so-called *canary* diamonds). While this is true for type Ib synthetic diamonds, only rarely do their natural counterparts exhibit a pure yellow color. The most common color of type Ib diamonds is "olive," a mixture of green, brown-yellow, and gray. Some natural type Ib diamonds contain mixed orange and yellow colors, though often with a brownish or greenish component. In our experience, pure brown samples are by far the rarest of the type Ib diamonds, and they are seldom larger than 0.25 ct.

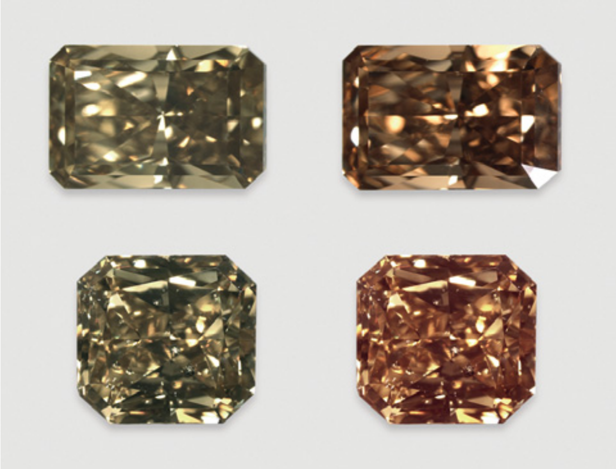
Recently, the GGTL laboratory received two greenish brown diamonds (1.22 and 3.01 ct) for analysis that were reportedly purchased directly from the mines in Simi, Sierra Leone. FTIR spectroscopy showed they were pure type Ib, with approximately 3.6 and 8 ppm, respectively, of single substitutional nitrogen. In daylight-equivalent illumination, the two diamonds were color graded Fancy Dark greenish brown and Fancy yellowish greenish brown. However, they showed a distinctly different coloration under incandescent light, where they appeared Fancy Dark orangy brown and Fancy orangy yellowish brown (figure 1).

When exposed to the 310–410 nm broadband illumination of our fluorescence microscope, both diamonds exhibited very distinct, rather homogenously distributed reddish orange luminescence. Exposure to standard UV radiation gave similar fluorescence reactions: orange to long-wave and a less intense orange to short-wave UV. Low-temperature (77 K) PL spectroscopy, using 405 and 532 nm excitation, identified the cause of the diamonds' luminescence as the NV^0 center (575 nm), which dominated their spectra (e.g., figure 2). In addition, the NV^- emission (637 nm) was detected with 532 nm excitation (figure 2, bottom).

The diamonds' UV-Vis-NIR spectra, obtained at 77 K inside an integrating sphere under intense incandescent illumination, showed the NV^0 and NV^- emissions were superimposed on the absorption continuum typical of brown diamonds. Intense incandescent light efficiently excited the NV^0 and NV^- fluorescence, influencing the apparent color of the diamonds.

It is important to note that the color grading of fancy-color diamonds actually includes the effect of fluorescence. For instance, purely yellow diamonds with strong green luminescence can receive green color grades, even though they do not have a greenish bodycolor. (However,

Figure 1. These 1.22 ct (top) and 3.01 ct (bottom) greenish brown type Ib diamonds, seen under daylight-equivalent illumination (left), become distinctly orangy brown under incandescent light (right). Photos by T. Hainschwang.



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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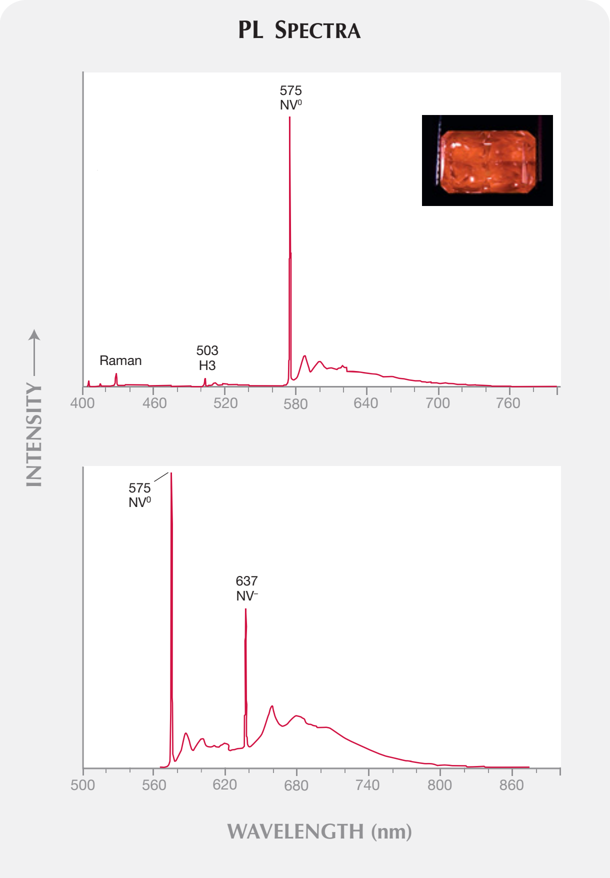

Figure 2. The low-temperature photoluminescence spectra of the 1.22 ct diamond at 405 nm (top) and 532 nm excitation (bottom) show that the orange luminescence (inset, photographed under 310–410 nm broadband excitation) is caused by the NV^0 defect. Inset photo by T. Hainschwang.

near-colorless diamonds with extremely strong blue fluorescence are not color graded blue.) A notable example of a diamond with this type of fluorescence-related color change is the light brown Tavernier diamond, which appears light pink in incandescent light (Y. Liu et al., "The alexandrite effect of the Tavernier diamond caused by fluorescence," *Color Research and Application*, Vol. 23, No. 5, 1998, pp. 323–327, http://dx.doi.org/10.1002/(SICI)1520-6378(199810)23:5<323::AID-COL8>3.0.CO;2-Y). However, the Tavernier is not considered a fancy-color diamond since it belongs to the D-to-Z range.

We informed the client of the observed color shift shown by the diamonds and noted the phenomenon on their reports, with a comment stating that it was related to fluorescence.

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COLORED STONES AND ORGANIC MATERIALS

Gem-quality afghanite from Afghanistan. At the 2011 Tucson gem shows, Dudley Blauwet (Dudley Blauwet Gems, Louisville, Colorado) exhibited several hundred afghanites with a light blue color similar to that of aquamarine (e.g., figure 3). Mr. Blauwet purchased his first rough piece of this material during a December 2009 trip to Peshawar, Pakistan. His supplier was not certain of the stone's identity, only that it came from a group of mines near the well-known Lajuar Madan lapis lazuli deposit in the Sar-e-Sang district of Afghanistan's Badakhshan Province. The crystal yielded a clean 1.16 ct trilliant.

On a return visit in November 2010, Mr. Blauwet purchased two additional lots of the material, 96 g in all, from a former partner of the original supplier. These were sold to him as afghanite, an identity confirmed by electron microprobe analysis (performed by Cannon Microprobe, Seattle, Washington) of two crystals. They exhibited hexagonal pyramidal terminations, which is typical of afghanite. From this rough parcel, about 45 carats of clean stones were cut, the two largest weighing 1.16 and 1.18 ct. Later in November, Mr. Blauwet returned to Peshawar and obtained another 320 g of rough sorted into four lots of various qualities. Some of these pieces also displayed the distinctive hexagonal pyramidal terminations. The two better lots, which totaled about 65 g, featured clean facet-grade material, including one piece that may eventually yield a 3.5 ct gem. Most of the lesser-quality rough was translucent, with some appearing silky.

Figure 3. These light blue afghanites (0.50, 1.16, and 0.23 ct) were faceted from material reportedly found recently in Afghanistan's Badakhshan Province. Photo by Robert Weldon.

Afghanite typically has a dark blue color, and gem-quality stones are considered very rare (see Spring 2008 GNI, pp. 79–80). Mr. Blauwet noted a strong demand for this brightly colored afghanite in Tucson.

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Iridescent ammonite from Madagascar. At the 2011 Tucson Gem shows, Marco Campos Venuti (Seville, Spain) had iri-

Figure 4. Ammonite from Madagascar showing attractive iridescence is now being cut into cabochons, in addition to the polished fossils seen previously. The specimens shown here range from 2.8 to 6.4 cm long. Photo by Jeff Scovil.

descent fossil ammonites from southern Madagascar as whole polished pieces as well as cabochons (figure 4). Although this type of ammonite has been known for more than a decade (see, e.g., Fall 2000 GNI, pp. 267–268), this was the first time that this author has seen it fashioned into cabochons for jewelry use. Mr. Campos Venuti marketed this material as "Madammolite," and had about 50 cabochons that were cut into various shapes, as well as 100 matched pairs, ranging from 15 to 40 mm in longest dimension. He stated that the outer surface of the fossil must be polished off to reveal the underlying iridescence; no stabilization or other treatments are performed on the material. All of the pieces displayed red-orange iridescence, and small areas of green and blue also were seen in a few cabochons. The iridescent layer was very thin (<1 mm), and was better developed on one side of the fossil than the other, which created difficulty in cutting matched pairs. Fractures in the material created an additional challenges for shaping the cabochons. The iridescent patterns ranged from smooth and homogenous to a pleasing ridged appearance.

The availability in a variety of shapes and matched pairs gives designers interesting opportunities to incorporate these iridescent gems into jewelry, provided they are properly protected from scratching or impacts that could break the thin nacreous layer.

Brendan M. Laurs

Aquamarine from Thanh Hoa Province, Vietnam: Mining update. In May 2011, this contributor visited the aquamarine deposits on the west side of Thanh Hoa Province in northern Vietnam (see L. T.-T. Huong et al., "Aquamarine from the Thuong Xuan District, Thanh Hoa Province, Vietnam," Spring 2011 *G&G*, pp. 42–48, http://dx.doi.org/10.5741/GEMS.47.1.42). The journey started in Hanoi, the home of Mr. Lai Duy, a close friend and guide for the trip. We drove south on the main highway for about five hours to Thanh Hoa city. Continuing on narrow side roads, we passed lush rice fields and beautiful karst (weathered limestone) landscapes en route to the remote mountains that host the aquamarine-bearing granitic pegmatites. From the village of Xuan Le, motorbikes were used to traverse the final 7–8 km to the base of the mountains, along a narrow dirt track that crossed several streams on rickety 1-m-wide wooden bridges.

A steep slippery footpath led from Lang Ben village up to the mining area. After climbing slowly in the tropical heat for about 1 hour and 40 minutes—and passing an area that reportedly was mined for topaz—the trail emerged from the jungle into an area containing dozens of shallow pits mined for the aquamarine (e.g., figure 5). The workings were sporadically distributed over a distance of ~400 m, extending from an elevation of 592 m (1,943 ft) to 621 m (2,039 ft). The pegmatites dipped almost vertically and were highly decomposed. The shafts reached depths up to 15 m (figure 6), and horizontal tunnels were present at the bottom of some shafts. There were no timbers or other supports, but the tunnels did not appear in danger of collapsing. No pumps or any other mechanized equipment were present, probably due to the difficulty of the climb, and the fact that hand tools were sufficient for digging through the

Figure 5. Aquamarine workings in Vietnam's Thanh Hoa Province consist of small pits surrounded by dense jungle. Photo by D. Blauwet.

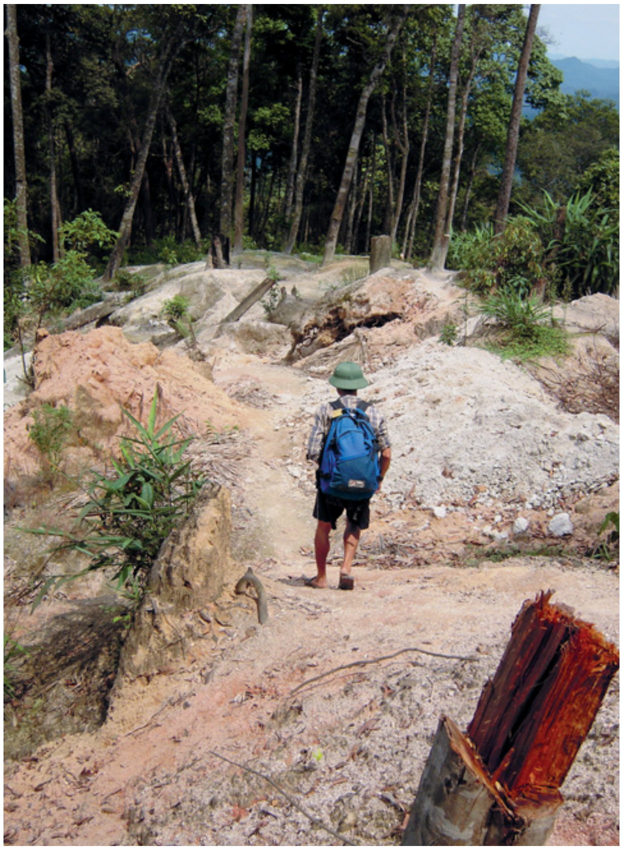

Figure 6. At the Thanh Hoa deposits, ropes are used to hoist aquamarine-bearing material from shafts (left). Some of the shafts reach depths of ~15 m (right). Photos by D. Blauwet.

weathered deposit. According to a local miner, this area had been worked for about four years, producing an estimated 50–60 kg annually of mixed-grade aquamarine.

Climbing higher up the mountain to an elevation of 811 m (2,661 ft; coordinates 19°50.7′ N, 105°09.7′ E) revealed an area that was actively being mined for aquamarine and topaz. These workings consisted of larger tunnels that penetrated deeper (15–20 m) into the hillside but at shallow angles. These pegmatites contained much more quartz, with broken fragments up to ~20 cm seen in the mine dumps. The quartz was generally opaque, white to light smoky, and partially crystallized. Approximately a dozen miners were active in this area, and they offered small parcels consisting of broken fragments (1–3 g) and a few complete crystals (up to ~7 cm long; figure 7) of attractive blue aquamarine. The crystals commonly had small fractures along their length that would restrict the cutting of clean stones to relatively small sizes but with good color saturation (again, see figure 7). Colorless topaz was occasionally found as small lustrous transparent crystals. The miners indicated this area had been worked for several months.

This fascinating—and arduous—expedition provided a first-hand view of these little-known aquamarine deposits, which appear to have good potential for producing gem- and specimen-quality material for many years to come.

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Purplish blue and red-brown chalcedony from Peru. While chalcedony often occurs in light blue hues, saturated blue specimens are known from just a few localities, such as Ysterputz in Namibia and Chikwawa in Malawi. Blue chalcedony was found in Peru several years ago, but the quality was not high and the material was only used locally. The exact locality is not publicly known, though initially it was believed to lie in the vicinity of Huachocolpa in the Huancavelica region. This contributor was recently informed by a reliable local dealer, who visited the locality, that the material comes from a site called Yanacodo, about 30 km west of the city of Huancavelica. Recent production from this deposit (since 2010) is comparable to the finest blue chalcedony from other sources (e.g., figure 8). While in Lima in February 2011, this contributor saw several hundred kilograms of rough and at least 50 cabochons measuring up to 4 cm across.

Ten pieces of rough and five cabochons were examined by this contributor for this report. All were purplish blue, and many displayed agate-like zoning. The samples had a spot refractive index of 1.54 and a specific gravity of 2.60–2.61, consistent with published values for chalcedony, and no features were seen with the hand spectroscope. As expected, the material showed an aggregate reaction in the polariscope, which confirmed its fibrous structure. The chalcedony was inert to UV radiation, although a few pieces contained veinlets that fluoresced white to both long- and short-wave UV radiation.

Another unusual chalcedony from Peru appeared in February 2011. It is reportedly from the vicinity of Santa Ana village, about 30 km southeast of Huancavelica. The chalcedony is red-brown and therefore can be described as sard or carnelian. It contains small cavities that are usually filled by colorless chalcedony. Although carnelian normally occurs as concretions in sedimentary rocks, here it forms crusts and rarely even stalactites up to 3 cm long (e.g., figure 9) within cavities hosted by volcanic rocks. From a study of three pieces of rough and three table cuts, its gemological properties were the same as for the blue variety, except that it fluoresced green to long-wave UV—particularly in lighter colored areas.

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Figure 7. These Vietnamese aquamarines range from 1.5 to 7.1 cm long (crystals) and 1.34 to 6.96 ct (cut stones). Photo by Robert Weldon.

Figure 8. Fine blue chalcedony such as these pieces (6.1 and 4.0 cm wide) became available from Peru in 2010. Gift of J. Hyršl, GIA Collection nos. 38420 and 38421; photo by Robert Weldon.

Update on emerald mining in Afghanistan. In May 2011, author VP traveled to Afghanistan to collect reference samples for GIA's laboratory. Unfortunately, due to the security situation in parts of Afghanistan, it was impossible to visit the ruby mining area near Jegdalek or the various deposits in Badakhshan. However, the authors spent three days in the emerald mining area near the village of Khenj in the Panjshir Valley (see, e.g., G. W. Bowersox et al., "Emeralds of the Panjshir Valley, Afghanistan," Spring 1991 *G&G*, pp. 26–39, http://dx.doi.org/10.5741/GEMS.27.1.26).

We witnessed about 400 miners working in the Khenj area. Mining is performed by groups of up to 20 people, some working in day/night shifts. The most active site was Kamar Safeed (figure 10), situated on cliffs at an elevation of 3,000 m. Up to 300 miners were working this site. Small groups were also active at Koskanda, Norola, Siakolo, Habal, and Batak. The Michalak area, where several hundred miners were said to be active in 2010, was practically abandoned. The Tartah and Dalnow deposits have reportedly been exhausted. Security concerns prevented a visit to the emerald mining areas in the Panjshir Valley located outside of the Khenj area (Dach Te Rivaat and Mukeni), where operations are reportedly limited.

Figure 9. Carnelian from Santa Ana, Peru (here, 10.5 cm wide), rarely displays finger-like formations. Photo by J. Hyršl.

All of the mining activities witnessed at Khenj were underground, in a maze of tunnels reaching 200 m deep. Because conventional explosives cannot be legally obtained in Afghanistan, miners were fabricating their own by mixing fertilizer with the contents of old unexploded Soviet military ordnance (figure 11). These mixtures are too powerful for gem mining, and many fine stones are consequently broken or fractured by the blasts.

Dealers in Kabul reported that emerald production had been good during the past few months, and this was confirmed by miners in Khenj. The emerald parcels were said to be exported to Pakistan or Dubai for faceting. The gems were typically light green to deep green, often with very good transparency. While most of the rough stones were small (less than 1 g), we also saw several large fine emerald crystals up to 6 g, as well as some attractive mineral specimens. A preliminary study of the emeralds obtained from the Khenj area (e.g., figure 12) revealed that their inclusions mirror those normally seen in Colombian emeralds.

The situation at the emerald mines has improved since VP's previous visit in 2006. Khenj can now be reached in three hours from Kabul using a new road. Small hydroelectric power stations have brought electricity to the valley, and the miners are using generators to light and ventilate the tunnels. While working the Panjshir emerald mines remains very difficult, the high-quality stones can provide good income.

Figure 10. Situated on steep cliffs, Kamar Safeed is the most active emerald mining area near Khenj, a village in the Panjshir Valley of Afghanistan. Photo by V. Pardieu.

Figure 11. Afghan emerald miners mix fertilizer with old Soviet military explosives for blasting purposes, which often damages the fragile crystals. Photo by V. Pardieu.

The Afghan government faces many challenges, one of which is replacing a complicated and inefficient rough stone export system. According to one government official, the tax value of a parcel for export must be negotiated and a 15% tariff paid, then another 9% is levied at the airport. In addition, several papers must be obtained from the Ministry of Mines and the Afghan Chamber of Commerce and Industry. The whole process takes anywhere from three days to a week. Streamlining the export process would encourage legal exports, benefiting the local gem industry and the country as a whole.

Figure 12. These emerald samples are from the Khenj area of the Panjshir Valley. The cut stones weigh ~1.5–2 ct. Photo by V. Pardieu.

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A deep green fuchsite-rich rock. The Ricerche e Analisi Gemmologiche (RAG) laboratory in Turin, Italy, received for identification three samples of a deep green material that resembled jadeite or nephrite (figure 13). No information was provided on the samples' source. The material consisted of thin slabs no more than a few millimeters thick, with a fine granular structure characterized by a deep green matrix and some very small white spots.

Figure 13. This polished slab (~32 mm long), resembling jadeite or nephrite, proved to be a rock composed of fuchsite, albite, and sphene. Photo by R. Navone.

The samples' RI, measured with a refractometer using the distant observation technique, was between 1.53 and 1.56. The SG was 2.78 and the Mohs hardness was 5–5½. The material was inert to long- and short-wave UV radiation, and the handheld spectroscope showed general absorption in the deep red region of the spectrum. The samples had a fairly even color distribution and no apparent cleavage. At first glance, they could have been either natural or artificial, as they resembled a compressed powder with some type of hardening media.

With the permission of the client, we cut a thin section from one of the slabs for examination with a polarizing microscope (figure 14). The matrix consisted of a colorless to green foliated aggregate with low relief and low-order interference colors, consistent with a mica-group mineral. The thin section was also studied at the University of Turin's mineralogy department with a Cambridge S-360 scanning electron microscope equipped with an Oxford INCA energy-dispersive spectrometer. SEM-EDS spectroscopy identified the material as fuchsite, the green chromium-bearing variety of muscovite (in this case,

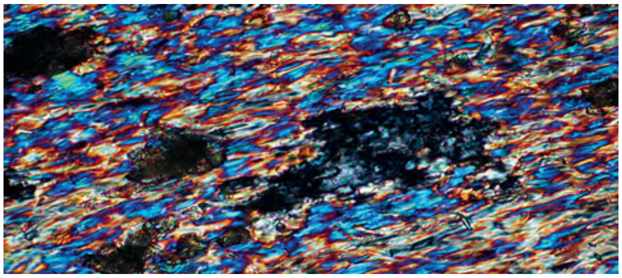

Figure 14. Viewed in cross-polarized light, this thin section of one of the slabs shows bright interference colors corresponding to Cr-bearing muscovite, gray low-relief areas of albite (center), and high-relief grains with high-order interference colors that are sphene. Photomicrograph by E. Costa; image width ~0.5 mm.

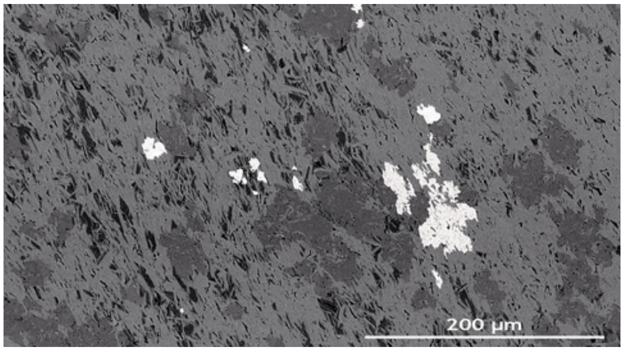

Figure 15. The texture of the green rock is well displayed in this backscattered electron image of the thin section in figure 14, which shows Cr-bearing muscovite (light gray), albite (dark gray), and sphene (white). The black areas are microscopic pores in the rock. Image by E. Costa.

1.0–1.5 wt.% Cr_2O_3). Also present was an anhedral gray to white mineral with low relief; it was shown to be albite. Finally, there were a number of high-relief inclusions, deep yellow to brown and brownish black, with high-order interference colors; these were identified as sphene.

Figure 15 shows an SEM backscattered electron image of the thin section, in which the gray tone is proportional to the mean atomic number of the phase. The light gray–appearing matrix is the Cr-bearing muscovite, the dark gray areas are albite, and the white portions represent sphene.

We detected no dyes, polymers, or other foreign media, and the texture of the minerals demonstrated the material's natural origin. We concluded that the slabs were cut and polished from a fine-grained metamorphic rock consisting predominantly of fuchsite. The material had an attractive green color and could be used for cabochons or carving, although with caution due to its relatively low hardness. Cabochons consisting of fuchsite aggregates have been seen previously (as emerald imitations; see Summer 2002 Gem News International [GNI], pp. 183–184), but those were more translucent than the material documented here, and they also contained inclusions of rutile and dolomite, rather than the albite and sphene impurities in the present samples.

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Color-change garnet from Nandagala, Tanzania. Mark Saul (Swala Gem Traders, Arusha, Tanzania) recently informed GIA's Bangkok lab about a new deposit of color-change garnet near Nandagala village, Lindi Province, southern Tanzania. According to Mr. Saul, the stones were believed to be alexandrite when first discovered in January 2011, resulting in a minor gem rush and several dealers overpaying for rough. The garnet comes from two diggings: A primary deposit where small (typically <0.2 g) dark-colored stones are found, and a nearby alluvial deposit that produces somewhat lighter pieces up to ~2 g. One large (>5 g) clean stone from the alluvial deposit was faceted into the 11.81 ct gem in figure 16. The alluvial deposit also produces clean but nonphenomenal brownish orange garnets, some of which exceed 20 g.

The five rough samples in figure 16 were purchased by GIA, and four were polished with parallel windows and examined for this report. Their color change was distinct, showing greenish blue in fluorescent light and purplish red or red in incandescent light. They had RI and SG values of 1.762 and 3.89, which are typical for color-change pyrope-spessartine (e.g., D. V. Manson and C. M. Stockton, "Pyrope-spessartine garnets with unusual color behavior," Winter 1984 *G&G*, pp. 200–207, http://dx.doi.org/10.5741/GEMS.20.4.200). They were inert to long- and short-wave UV radiation. With the desk-model spectroscope, the

Figure 16. Pyrope-spessartine from Nandagala, Tanzania, shows a distinct color change between daylight-equivalent fluorescent (left) and incandescent (right) light. The faceted stone weighs 11.81 ct and the rough pieces are 0.4–1.2 g. Photos by V. Pardieu.

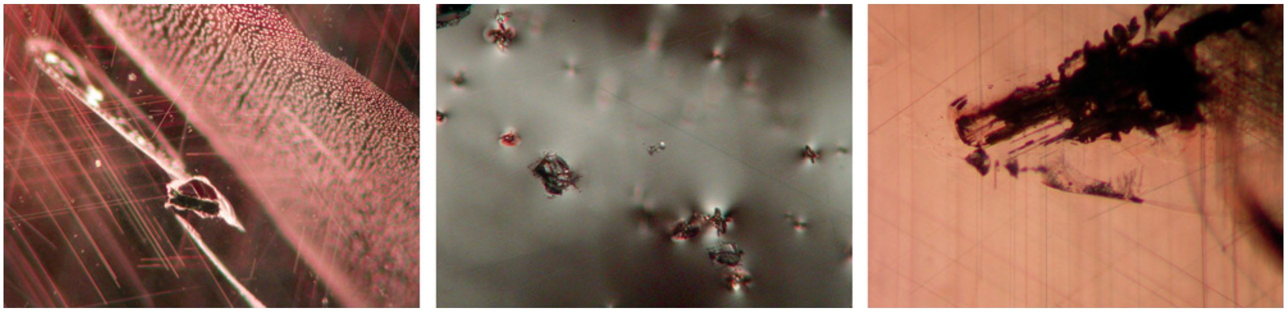


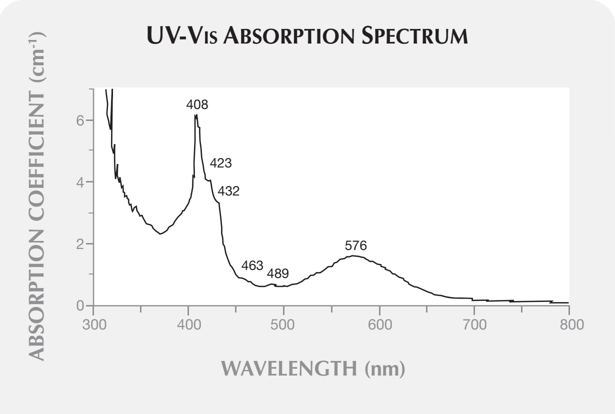
Figure 17. Partially healed fissures, needles, and black grains formed a typical inclusion scene in the color-change garnet samples (left). Also present were zircon-like crystals (center; cross-polarized light) and another type of dark reddish brown crystalline inclusion (right). Photomicrographs by V. Pardieu; magnified 40×.

darkest sample showed a band at ~400 nm and a broad absorption at ~570 nm; the latter feature was less obvious for lighter stones with a weaker color change. The inclusion scene (figure 17) was dominated by needles, zircon-like crystals, partially healed fissures, and negative crystals. We also saw some black opaque, reddish brown, and elongated greenish crystals. Unfortunately, the inclusions were too deep in the samples to be identified with Raman spectroscopy.

Chemical composition was measured using EDXRF spectroscopy and a Thermo X Series II LA-ICP-MS. The garnets had an average composition of $\mathrm{Pyp}_{51}\mathrm{Sps}_{40}$-$\mathrm{Grs}_{3.5}\mathrm{Alm}_{3}\mathrm{Gol}_{2}\mathrm{Uva}_{0.5}$ (with 7300 ppm V and 1100 ppm Cr). This was very similar to that reported for color-change garnets from Bekily, Madagascar (K. Schmetzer and H. J. Bernhardt, "Garnets from Madagascar with a color change of blue green to purple," Winter 1999 *G&G*, pp. 196–201, http://dx.doi.org/10.5741/GEMS.35.4.196).

UV-Vis absorption spectra were collected using a PerkinElmer Lambda 950 spectrometer. A strong absorption band at ~570 nm (due to V^{3+} and Cr^{3+}) dominated the spectra of all samples (e.g., figure 18). This band created two transmission windows, in the blue-green (~480 nm) and red (700 nm) regions, which are responsible for the color change. The darkest sample showed a cutoff at ~440 nm, while the lighter stones had a cutoff at ~310 nm and also showed absorptions due to Mn^{2+} (408, 423, and 489 nm), Fe^{3+} (432 nm), and Fe^{2+} (463 nm; see P. G. Manning, "The optical absorption spectra of the garnets almandine-pyrope, pyrope and spessartine and some structural interpretations of mineralogical significance," *Canadian Mineralogist*, Vol. 9, 1967, pp. 237–251).

Figure 18. This UV-Vis spectrum of a light-colored Nandagala garnet (3.3 mm thick) shows a broad absorption at ~570 nm due to V^{3+} and Cr^{3+}, creating transmission windows in the blue-green and red regions.



This new Tanzanian deposit joins Kenya and Madagascar as another source of color-change garnet in the East African region.

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An examination of some colorless gems from Myanmar. This contributor recently had the opportunity to examine rough and cut samples of four colorless gems—phenakite, petalite, pollucite, and goshenite beryl—recovered from granitic pegmatites located near Molo village in Momeik township, northern Shan State, Myanmar. At this locality, pegmatite dikes intrude a peridotite body that is hosted by gneiss, marble, and calc-silicate rocks of the Mogok Group. The pegmatites primarily produce gem-quality pink tourmaline, along with other minerals such as topaz, beryl, hambergite, quartz, and the colorless gems listed above (see, e.g., figure 19 and U H. Kyi et al., "The pegmatitic gem deposits of Molo [Momeik] and Sakhan-gyi [Mogok]," *Australian Gemmologist*, Vol. 22, No. 7, 2005, pp. 303–309).

The phenakite (Be_2SiO_4) crystals were distorted and some were twinned. They showed etch marks on their prism faces. The faceted gems usually weigh <1 ct. Inclusions consisted of small growth tubes and tiny irregular solid crystals.

The petalite ($LiAlSi_4O_{10}$) crystals showed etched cleavages with deep channels. The material is transparent in a range of sizes, yielding finished gems of 3–50 ct. Small solid colorless rounded inclusions were present.

The rough pollucite ($CsAlSi_2O_6 \cdot nH_2O$) did not show any crystal faces, and its surfaces were cracked, pitted, and

Figure 19. These samples of phenakite (2.5 ct), goshenite (4.9 ct), and pollucite (1.0 ct) are from the Momeik area near Mogok, Myanmar. Photo by U T. Hlaing.

iron stained. Cut gems generally range from 3 to 6 ct. Parallel lath-like solid inclusions and spiky crystals were seen.

The goshenite crystals were tabular and typically yield finished gems of 0.85–2.0 ct. The material was quite included, with internal features consisting of two-phase "fingerprints," distorted needle-shaped crystals in random orientations, and white opaque solids.

The gemological properties recorded from the phenakite, petalite, pollucite, and goshenite samples were within reported ranges. They can be differentiated from one another by their standard gemological properties (e.g., RI and/or SG values) and sometimes by their morphologic characteristics. The Burmese petalite is tabular to elongated with prominent cleavage, phenakite forms isolated prismatic crystals with rhombohedral terminations, goshenite typically consists of short prismatic crystals, and pollucite is recovered as broken pieces without any crystal faces.

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Nuummite from Mauritania. Iridescent orthoamphibole (anthophyllite-gedrite) as a gem material was first reported from Greenland nearly 25 years ago (P. W. Uitterdijk Appel and A. Jensen, "A new gem material from Greenland: Iridescent orthoamphibole," Spring 1987 *G&G*, pp. 36–42, http://dx.doi.org/10.5741/GEMS.23.1.36). Until fairly recently, this was the only known locality for this gem, called *Nuummite*. The Greenland material is notable for its golden iridescence, though blue iridescence has also been seen (Spring 2000 GNI, pp. 73–74).

In 2009, a new source of gem-quality iridescent orthoamphibole was discovered in the Sahara Desert of central Mauritania (see T. Kobayashi, "Iridescent Nuumite," *Gemmology*, Vol. 41, No. 486, Issue 3, pp. 14–15 [in Japanese]). Three faceted stones and a piece of rough were donated to GIA by G. Scott Davies (American-Thai Trading, Bangkok). His company has cut more than 3,000 carats of this Nuummite, showing iridescence that is mostly bluish green, although some stones appear golden yellow and a small percentage are a highly desirable pure blue (e.g., figure 20). Finished stones are typically cut to between 10 and 20 mm, corresponding to a weight range of ~8–20 ct in cabochon or faceted form. This size range is preferable because the iridescence is not apparent in smaller stones, and larger pieces can show an uneven color distribution.

Figure 20. These samples of Nuummite (an aggregate of iridescent orthoamphibole) from Mauritania weigh 9.20–16.03 ct and illustrate the variation in color of this material. Photo by, and gift of, G. Scott Davies; GIA Collection nos. 38384–38386.

Raman spectra of the iridescent laths were consistent with anthophyllite and gedrite, which are orthorhombic members in the magnesium-iron-manganese-lithium amphibole group. The samples had RI measurements between 1.649 and 1.669, consistent with the Raman identification. A second shadow edge also was noted at 1.54, due to an additional mineral component in the rock. Brassy metallic mineral grains, presumably pyrite, were also seen in the samples. Hydrostatic SG was 2.98 ± 0.05, and all three stones were inert to long- and short-wave UV radiation. With magnification, the iridescent phenomenon closely resembled that of labradorite. It therefore seems likely that the iridescence is caused by a lamellar structure

Figure 21. These Nuummite orthoamphibole laths show blue iridescence on the outer perimeter that shifts to greenish yellow toward the interior, suggesting a chemical variation within the crystal. Photomicrograph by N. Renfro; magnified 20×.

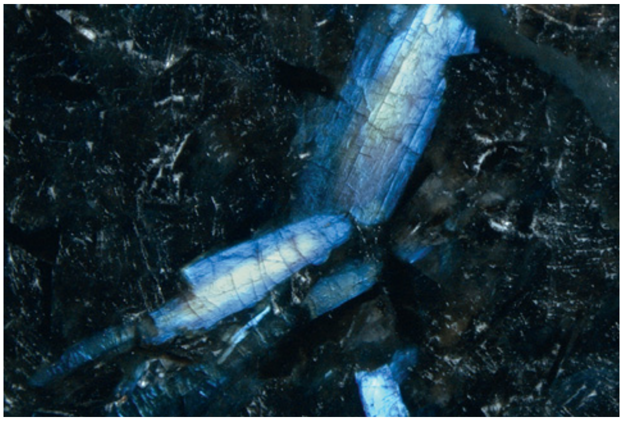

Figure 22. Mechanized mining is once again producing blue opal from Sinaloa, Mexico (left). The opal is hosted by rhyolite, and the adjacent matrix is commonly silicified into perlite (right). Courtesy of Blue Opal Light Co.

of the orthoamphibole mineral grains. The iridescence displayed color zoning from blue to greenish yellow toward the core of the crystals (figure 21). This type of concentric zoning suggests a chemical variation in the amphibole.

This new find of iridescent orthoamphibole makes for an interesting and unusual gem. This material has also been offered by online dealers as spheres several centimeters in diameter.

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Blue opal showing play-of-color from Sinaloa, Mexico. Mexican opal is known mainly from Querétaro and Jalisco States, which are most recognized for producing "fire" and "crystal" varieties. Recently the owners of an opal mine in Sinaloa State (Bertha Almaral, Marco Reyes, and Juan Vital) showed this contributor a number of specimens that displayed a blue bodycolor and an attractive play-of-color.

The volcanic-hosted deposit is located near the town of Cosalá, approximately 137 km (85 miles) north of Mazatlan. Although the site was discovered 25 years ago, mining activity has been sporadic and limited to hand methods. Under the ownership of Blue Opal Light Co. since April 2011, operations have become mechanized. A backhoe fitted with a hydraulic hammer is used to break up the host rhyolite in search of opal concentrations (figure 22, left). This opal forms nodules and infillings in a rhyolite lava flow, and is commonly surrounded by perlite (figure 22, right). The owners estimate that only 10% of the deposit has been mined.

Two cabochons (one loose and one mounted) were briefly examined at GIA, and they had spot RI values of 1.46 and 1.47. The hydrostatic SG of the unmounted sample was 2.32, but this value is not reliable due to the presence of some matrix material in the cabochon. Both samples—as well as several rough pieces—showed interesting UV fluorescence: They were inert to long-wave but luminesced strong green to short-wave UV, with no phosphorescence.

The opals (figure 23) are reportedly stable, as pieces discovered two decades ago have not shown any crazing. The material will be marketed as Lightning Blue Opal, starting in late 2011.

Stuart D. Overlin

Pallasite pendants. Bob and Carol Falls of Rock Falls Designs (Colorado Springs, Colorado) recently showed GIA some interesting pendants (e.g., figure 24) set with pallasite from the Esquel meteorite. Pallasite is a rare type of stony iron meteorite containing inclusions of transparent crystalline olivine (peridot) in an iron-nickel matrix (for more information on pallasitic peridot, see the article by A. Shen et al. on pp. 208–213 of this issue). Faceted pallasitic peridot, though rare, has seen jewelry use in the past. These pendants were unusual in that they combined polished pieces of pallasite with mother-of-pearl to create an attractive optical effect.

According to Mr. Falls, slices of pallasite were selected based on the characteristics of the olivine crystals, which need to be sufficiently large and transparent. These were then polished and mounted on top of iridescent slabs of mother-of-pearl, which were selected based on the pattern and positioning of the iridescent areas. The sheen from the mother-of-pearl helps to reflect light back through the olivine crystals; the backs of the pendants also are left open to allow light in from behind.

Mr. Falls reported that five of these pendants have been produced to date, ranging from 2 to 5 cm long. They plan to continue production as long as sufficient Esquel material is available.

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Figure 23. These opals from Sinaloa represent higher-quality material from the deposit. The loose cabochon weighs 30.41 ct, and the matrix specimen is 8.7 cm long. The earrings in the inset contain opals measuring 21 × 12 mm. Samples courtesy of Blue Opal Light Co.; photos by Robert Weldon.

Figure 24. This unusual pendant (2.5 × 3.0 cm) is mounted with polished pallasite over mother-of-pearl. Photo by Robert Weldon.

Figure 25. These Chinese freshwater cultured pearls (17–21 mm long) proved to be beaded by baroque cultured pearls. Photo by E. Strack.

Chinese freshwater cultured pearls beaded with baroque freshwater cultured pearls. This contributor recently examined a strand of Chinese freshwater cultured pearls loaned by Jeremy Shepherd of Pearl Paradise, Los Angeles, California. According to Mr. Shepherd, they were produced at the same farm in Jiangsu Province that was the source of the so-called "Soufflé pearls" ("beaded" with mud) that began appearing on the market in September 2009 (see Spring 2010 GNI, pp. 61–63).

The strand (figure 25) originally consisted of 23 cultured pearls weighing a total of 66.8 g; two were subsequently sacrificed for destructive testing (see below). They were of baroque shape, ranging from 17.0 × 12.0 mm to 21.0 × 13.6 mm. Colors varied from white with a distinct purplish green overtone to light purple, purplish green, orange, and bronze with varying overtones. The five cultured pearls with a white bodycolor all showed strong blue fluorescence to long-wave UV radiation; the others were inert. All displayed a pronounced metallic luster (again, see figure 25).

Thirteen of the 23 cultured pearls were examined by X-radiography. Strangely, all the X-radiographs showed beads with an off-round shape (figure 26, left). In particular, the internal features of the beads strongly suggested that non-beaded freshwater cultured pearls had been used. To further investigate this possibility, one sample was sawn in half (figure 26, center), revealing a concentric structure surrounded by an outer rim of nacre. The rim was clearly distinguishable from the inner portions and appeared more yellowish with a uniform color distribution; its thickness varied from 0.6 to 1.2 mm. A second sample was broken apart with a jeweler's hammer, confirming that a white freshwater cultured pearl of baroque shape had been used as a bead (figure 26, right).

According to Mr. Shepherd, these cultured pearls were produced using the same type of mussel as the "Soufflés," which some believe to be a hybrid of the Chinese *Hyriopsis cumingii* and the Japanese *Hyriopsis schlegelii*, though it may be a local variety of *H. cumingii*. This mussel shell shows a strange curvature on its outer rim that

Figure 26. The X-radiograph of the cultured pearls (left) revealed off-round beads displaying concentric growth structures that were clearly visible when one sample was cut in half (center, 15.7 × 12.5 mm). When another sample was broken apart (right, originally 17 × 12 mm), a baroque freshwater cultured pearl bead was exposed. Photos by E. Strack.

Figure 27. The alleged hybrid of Hyriopsis cumingii *and* Hyriopsis schlegelii *used to produce these cultured pearls shows an unexplained curvature at the rim (see arrow) and intense iridescence. The shell (13 × 19 cm) contains a blister pearl on the left (26.3 mm long), and is shown with an assortment of mostly "Soufflé pearls" that are 10–17 mm long. Photo by Jeremy Shepherd.*

lacks explanation so far (figure 27). Similar curvatures have been observed in old European pearl mussel shells (*Margaritifera margaritifera*). It is also interesting to note that the interior of the shell shows an array of intense spectral colors. The cause of these metallic colors, which are also visible in the resulting cultured pearls, has not yet been determined. It is highly probable that both the "Soufflé pearls" and the "pearl-beaded" samples described here are produced inside the mantle, probably in a later growth phase, by making use of existing pearl sacks that stemmed from a previous harvest.

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Quartz with spessartine inclusions. Brazil's Navegadora mine (Lavra da Navegadora) in the Conselheiro Pena area of Minas Gerais State has been an important producer of spessartine, mainly as etched crystals that are sought by mineral collectors (e.g., J. S. White, "Spessartine from the Navegadora mine, Minas Gerais, Brazil," *Rocks & Minerals*, Vol. 84, No. 1, 2009, pp. 42–45, http://dx.doi.org/10.3200/RMIN.84.1.42-45). The mine has also produced attractive quartz with inclusions of spessartine, as displayed at the 2011 Tucson gem shows by Luciana Barbosa (Gemological Center, Los Angeles). She indicated that the material has been sporadically produced, but became significantly more available between 2009 and 2010. She obtained enough rough material to cut and polish about 15–20 pieces. This quartz has been worked into a wide range of products (e.g., figure 28), ranging from 5 ct gems to faceted stones in the 100 ct range and large polished crystal points and spheres.

Although euhedral syngenetic spessartine has been reported previously as inclusions in quartz (e.g., E. J. Gübelin and J. I. Koivula, *Photoatlas of Inclusions in Gemstones*, ABC Edition, Zurich, Switzerland, 1986, p. 159), the availability of this material in significant quantities and sizes is notable.

Brendan M. Laurs

Pink cat's-eye quartz, with color and chatoyancy caused by tourmaline needles. Chatoyant quartz is widely available in gray, yellow, and green, and it is often misrepresented as chatoyant chrysoberyl. Recently, this contributor examined a pink cat's-eye quartz that proved interesting because of the unusual cause of the color and chatoyancy.

The 34.65 ct specimen (figure 29) displayed a broad but distinct chatoyant band with a dull vitreous luster. At first glance, it was reminiscent of chatoyant tourmaline because of its color. Closer examination with the unaided eye showed color concentrations in various areas, especially toward the sides. This suggested the presence of a dye along the growth tubes/surface breaks. The specimen appeared anisotropic under crossed polarizers, with some interference colors perpendicular to the chatoyant band or along the direction of the needles. This suggested a uniaxial mineral, although a clear optic figure could not be resolved due to the dense inclusions. Spot RI and hydro-

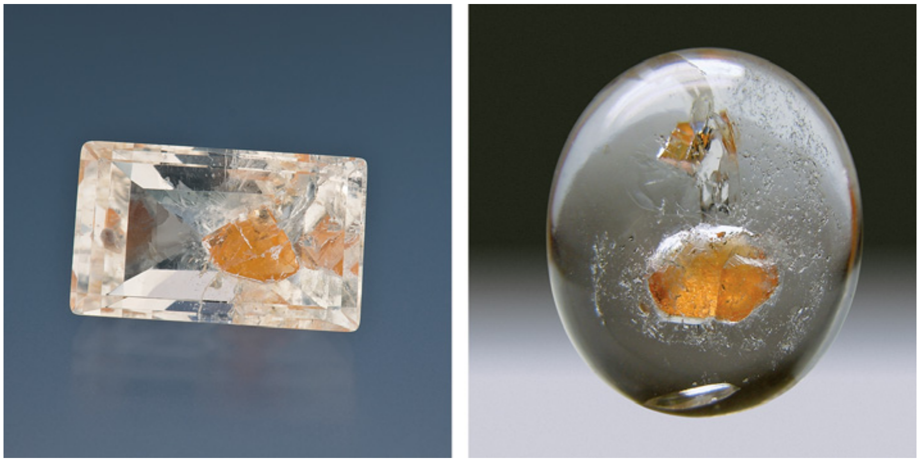


Figure 28. These quartz specimens from Brazil contain well-formed inclusions of spessartine. The faceted stone weighs 18.60 ct (photo by Robert Weldon) and the cabochon weighs 25.60 ct (photo by Luciana Barbosa).

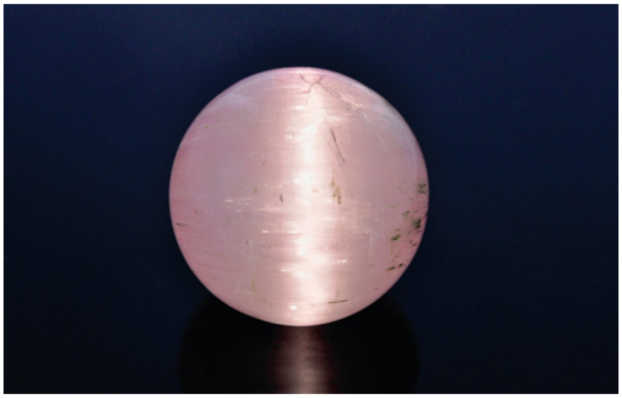


Figure 29. This 34.65 ct quartz specimen, despite its resemblance to rose quartz, owes its pink color and distinct chatoyant band to the presence of tourmaline needles. Photo by G. Choudhary.

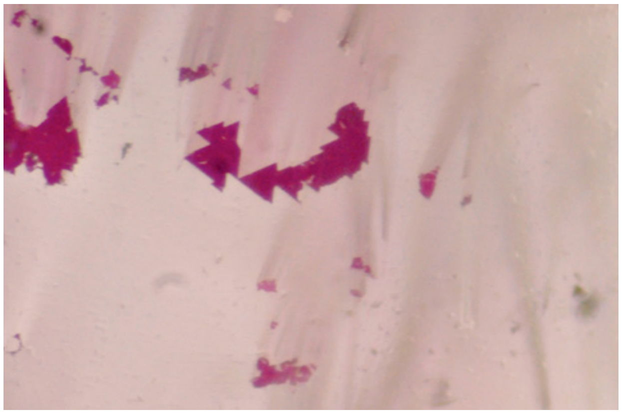


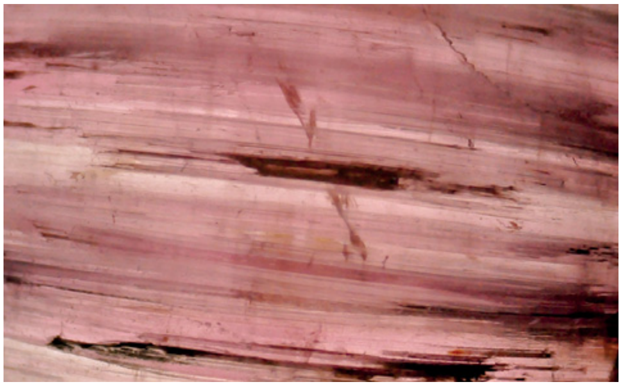
Figure 31. The cross-section of the needles in figure 30 displayed a perfect triangular shape typically associated with minerals belonging to the trigonal system, such as tourmaline. Photomicrograph by G. Choudhary; magnified 64×.

static SG were measured at approximately 1.54 and 2.68, respectively. The sample displayed no reaction to UV radiation, and no features were seen with the desk-model spectroscope. These properties indicated quartz, but further analysis was required.

With magnification, the sample displayed long tube or needle-like inclusions (figure 30). From the side, some pink color was observed along these tubes, which again raised suspicion regarding the cause of color. The cross-section of the tubes was even darker. At higher magnification, some appeared perfectly triangular (figure 31), a feature typically associated with trigonal minerals such as tourmaline. This was further supported by the color of the tubes and the absorption along the c-axis: The inclusions appeared darker when viewed in cross-section. Hence, the bodycolor of the sample was colorless but appeared pink due to the colored inclusions.

IR transmission spectra were obtained both parallel and perpendicular to the needles. In the parallel direction, two sets of distinct peaks were seen: in the 4800–4200 cm^{-1} region (4594, 4534, 4438, and 4343 cm^{-1}) and in the 3700–3000 cm^{-1} region (3585, 3563, 3480, 3379, 3300, and 3197 cm^{-1}). According to our database and past studies (see, e.g., L. T. M. Oanh et al., "Classification of natural tourmalines using near-infrared absorption spectroscopy," *VNU Journal of Science: Mathematics – Physics*, Vol. 26, 2010, pp. 207–212; G. Choudhary and S. Fernandes, "Spectroscopic examination of commercially available quartz varieties: A gemological perspective," Summer 2011 *G&G*, pp. 146–147), the first set of peaks is similar to those seen in tourmaline, while the second corresponds to those seen in quartz. In the perpendicular direction, only a broad absorption band was observed in the 3700–3000 cm^{-1} region, due to the lower degree of transmission in that orientation.

Figure 30. Viewed with magnification, the needles appeared pink while the rest of the sample was colorless. This suggested that the quartz's pink appearance was due to these inclusions. Photomicrograph by G. Choudhary; magnified 48×.



On the basis of microscopic examination and the infrared spectra, we identified this sample as quartz with inclusions of pink tourmaline. Tourmaline is a common mineral inclusion in quartz, but typically it is randomly oriented. Thus, this sample was interesting and unusual because of its pink color (though it was not rose quartz) and chatoyancy. Both were caused by the presence of parallel tourmaline needles.

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Gem Testing Laboratory, Jaipur, India

An exceptional rhodochrosite carving. Rhodochrosite, a manganese carbonate mineral known for its classic "rose"-red color, is often found as massive pink opaque or translucent specimens. Such material is available in large sizes and typically fashioned into ornamental carvings, beads, and cabochons. Transparent specimens, however, are relatively rare.

The Gem Testing Laboratory of Jaipur, India, recently tested a carved specimen (figure 32, left) that was remarkable for its size and fair degree of transparency. The color was uneven, ranging from brownish red to reddish brown to brownish pink. The specimen weighed 10.875 kg and measured approximately 21.60 × 20.50 × 15.60 cm. It was carved

Figure 32. This carved rhodochrosite is exceptional for its size (10.875 kg), rich brownish red color, transparency, and artistic quality. Photos by M. B. Vyas.

in the form of Lord Mahaveera, one of the ancient Indian sages who established the tenets of Jain Dharma. The piece was also noteworthy for the fine artistic work on the back, which is unusual (figure 32, right).

Although the bodycolor clearly suggested rhodochrosite, we conducted gemological tests to establish the identity. However, the carving's large size impeded our ability to measure all the properties. Its relatively dull luster indicated a low hardness, which was confirmed by scratching an inconspicuous spot on the base with fluorite. The spot RI of around 1.60 displayed a large birefringence blink, typically associated with carbonate minerals. A weak red reaction was visible with long- and short-wave UV radiation, and the handheld spectroscope showed strong absorption bands centered at ~460 and 550 nm. We could not measure the carving's specific gravity, but its heft indicated a somewhat high SG value. Examination with strong fiber-optic light and a loupe in relatively transparent areas revealed three directions of cleavage (figure 33), a feature associated with calcite-group minerals such as rhodochrosite. In addition, some portions on the back had rhodochrosite's characteristic irregular to wavy concentric banding patterns (figure 34).

Identifying this specimen was not particularly difficult, even though its size did not allow the measurement of all gemological properties. Encountering such a large and finely carved rhodochrosite with attractive color and transparency was truly a pleasure.

Gagan Choudhary and Meenu Brijesh Vyas
Gem Testing Laboratory, Jaipur, India

Sapphire and zircon from Ethiopia. In March 2010, Farooq Hashmi (Intimate Gems, Glen Cove, New York) loaned GIA several rough and faceted sapphires that he obtained on a buying trip to Ethiopia. According to Mr. Hashmi, the stones came from Yabelo in southern Ethiopia, 185 km northwest of the Moyale border with Kenya. The sapphires (figure 35) are associated with reddish brown zircon (figure 36) in secondary deposits. He reported that the rough zircon was generally available in the 0.5–3 g range, and that production of better-quality sapphire and zircon typically has been about 1 kg per month.

The sapphires ranged from yellow to brownish green to blue, and many of the rough pieces showed strong yellow and blue color zones. The four faceted sapphires examined (0.34–1.32 ct) were cut as round brilliants with the optic axis oriented approximately perpendicular to the table. They yielded the following properties: RI—n_o = 1.765, n_e = 1.775; birefringence—0.010; SG—3.95–4.03, with the more reliable values

Figure 33. Relatively transparent areas of the carving displayed the three directions of cleavage that are associated with the calcite group of minerals. Photo by M. B. Vyas.

Figure 34. Areas of the carving showed rhodochrosite's characteristic wavy to irregular growth banding. Photo by G. Choudhary.

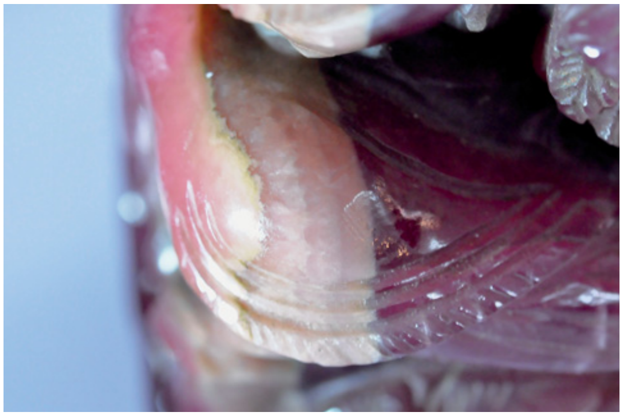

Figure 35. These sapphires are from a new deposit in Ethiopia. The four faceted samples (cut by Matt Dunkle, Aztec, New Mexico) range from 0.34 to 1.32 ct; the largest rough stone is 12.06 ct. Photo by Robert Weldon.

of 3.99 and 4.00 coming from the larger specimens; UV fluorescence—inert to both long- and short-wave UV radiation, except for one yellow stone that fluoresced very weak orange to long-wave UV; and bands at 450, 460, and 470 nm seen with the desk-model spectroscope. Microscopic examination (figure 37) revealed sparse long needles, dense clouds of short needles and particles, equatorial thin films, and reddish brown platelets of hematite (identified by Raman spectroscopy). Unidirectional twinning was also seen in one rough specimen.

UV-Vis-NIR spectroscopy of the sapphires confirmed the Fe^{3+} absorption features at 450 (very strong), 460, and 470 nm, as well as strong peaks at 376 and 386 nm attributed to Fe^{2+}-Ti^{4+} intervalence charge transfer. In addition, the blue to green stones exhibited a broad intervalence charge transfer absorption due to iron in the 800–900 nm range.

The trace-element composition of three representative sapphires measured by EDXRF spectroscopy showed relatively high levels of Fe in all colors, small amounts of Ga and Ti, no detectable V, and no Cr except in the yellow stone (table 1). These properties are consistent with sapphires of magmatic origin.

A 13.01 ct zircon (again, see figure 36) was also examined for this report. Its RI was >1.81, SG was 4.70, and it fluoresced weak orange with yellow chalkiness to short-wave UV radiation. Magnification revealed strong doubling and wispy stringers of reflective particles. Its properties are consistent with "high"-type (non-metamict) unheated zircon.

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Figure 36. Reddish brown zircon is mined with sapphire in the Ethiopian deposit. This unheated 13.01 ct oval brilliant was cut by Hassan Z. Hamza (Noble Gems Enterprises, Dar es Salaam, Tanzania) from the largest piece of rough seen by Mr. Hashmi. Photo by Robert Weldon.

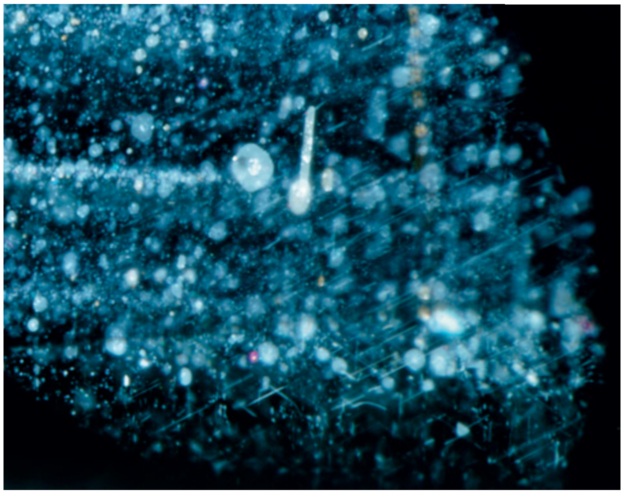


Figure 37. The faceted dark blue-green sapphire in figure 35 contained needles (probably rutile), clouds, and equatorial thin films. Photomicrograph by D. Beaton; image width 1.0 mm.

TABLE 1. Chemical composition of sapphires from Yabelo, Ethiopia.

Oxide (wt.%)	Olive green	Yellow	Dark blue-green
TiO_2	0.009	0.002	0.004
Cr_2O_3	nd[a]	0.001	nd
Fe_2O_3	1.438	1.037	0.928
Ga_2O_3	0.011	0.010	0.010

[a] nd = not detected.

Update on sapphire mining in Sri Lanka. In March–April 2011, this contributor visited several sapphire deposits in Sri Lanka to gather information and collect samples for the GIA laboratory reference collection. The trip assistants included recent graduates from GIA's Bangkok campus (Andrea Heather Go of Canada and Afsaneh Tazari of Iran), David Goubert of Switzerland, and Jeremy Brian and Jonathan Muyal of France. Our work was facilitated by ICA members Armil Samoon (Sapphire Cutters Ltd., Colombo) and Gamini Zoysa (Institute of Gemmological Sciences, Colombo).

The region around Ratnapura continues to be the most active gem mining area. We saw 14 mechanized operations in the area (e.g., figure 38), quite an increase compared to the author's previous visit in 2005 when only one such mine was working. Most of the operations use water

Figure 38. Several mechanized mines are active in Sri Lanka, including this operation at Kuruwita near Ratnapura. Photo by V. Pardieu.

cannons and gravel pumps inside the pits, and some use an excavator to bring the gem-bearing gravels (*illam*) to trommels and jigs for processing. We also witnessed traditional pit mining in paddy fields and rivers, and well as hillside mining that takes place where the gem-bearing layers are very close to the surface (figure 39). The area produces mainly blue (typically with some yellowish zones), yellow, pink, and geuda sapphires (e.g., figure 40). Gem mining and trading around Ratnapura is well regulated. Most operations possess mining licenses, and the production is usually sold through an auction system. The region hosts several busy gem markets, as well as cutting and treating centers. A number of treaters are active using both modern and traditional heating methods.

The second most active mining area is near Elahera (especially the Matale District). We visited nine mechanized operations scattered over a large area. Activities were somewhat limited due to early rains, and we were informed that 20–30 excavators are expected to be working in the area after seasonal agricultural activities are completed. In addition, several hundred small-scale traditional mines are anticipated. Unfortunately, a dam project near Elahera is expected to flood some potentially rich sapphire prospects, raising concerns among miners. This region is drier than Ratnapura and the gem gravels are not as deep. The miners usually dig during the dry season, stockpile the gem gravel, and then wash it during the rainy season. Production includes sapphire, ruby, garnet, tourmaline, zircon, chrysoberyl, and many other gems. The sapphires are mainly blue, geuda, and yellow; pink is least common. The blue sapphires can be extremely fine and are usually more evenly colored than those found around Ratnapura. The rubies (very rare) are usually pinkish with some blue zoning.

Our next stop was Hasalaka to the south in the highlands. There was little activity, reportedly due to the rice harvest; up to 3,000 people were said to be active there recently. We saw sapphires that were yellow, *ottu* type (blue on the surface with a colorless or yellowish core), and geuda; most had very good crystal shape.

Figure 39. Artisanal hillside mining in Sri Lanka involves digging shallow pits to reach gem-bearing horizons, as shown here near Balangoda, about 35 km east of Ratnapura. Photo by V. Pardieu.

Further southeast, we visited a large mechanized mine near Bibile where several excavators were being used to recover mainly geuda and yellow sapphires. The operation reportedly started about one year ago and was similar to the other large pits we saw near Ratnapura.

Continuing south, we documented some mechanized operations in paddy fields to the north of Passara. The production consisted mainly of yellow, geuda, pink, padparadscha, and some blue sapphires; most of the crystals were well formed. Further south toward the coast we visited Okkampitiya and Kataragama. Although we saw some evidence of mining in these areas, there was little activity due to heavy rains.

Vincent Pardieu

Green cat's-eye spodumene from Brazil. At the 2011 Tucson gem shows, Luciana Barbosa showed this contributor some green spodumene that displayed chatoyancy (e.g., figure 41). The material was reportedly mined from

Figure 40. These sapphires were seen near Niwitigala in the Ratnapura area. Photo by V. Pardieu.

Figure 41. This green spodumene from Brazil (4.35 and 6.15 ct) shows chatoyancy. Photo by Robert Weldon.

Figure 42. This 27.38 ct topaz shows unusual color zoning, with a pattern resembling that seen in sapphire. Photo by G. Choudhary.

the Neves pegmatite in the Araçuaí area of Minas Gerais State. Although the deposit has been a source of facet-grade green spodumene for years, Ms. Barbosa first saw small parcels of the chatoyant material in 2010; only about 5% of the production shows this effect, yielding enough rough material to polish about 25 cabochons. While clean faceted stones may reach 20+ ct, the cat's-eyes tend to be smaller, typically as cabochons weighing 5–8 ct. The material is reportedly not treated in any way.

Although GIA has seen several examples of cat's-eye kunzite, green spodumene showing chatoyancy is much more unusual (S. F. McClure, pers. comm., 2011). Chatoyant kunzite has been reported previously ("Kunzit-katzenaugen aus Brasilien [Kunzite cat's-eye from Brazil]," *Gemmologie: Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 46, No. 2, 1997, pp. 64–65, and references therein), but this is the first time that green material has been documented in the literature, to this author's knowledge.

Brendan M. Laurs

A color-zoned topaz. The Gem Testing Laboratory in Jaipur, India, received for identification a transparent yellowish to greenish brown specimen that was striking for its unusual color zoning. The oval mixed cut (figure 42) weighed 27.38 ct and measured 21.18 × 16.39 × 9.64 mm. The specimen initially appeared to be a sapphire because of the pattern of its color zoning, but the luster and brilliance were lower than would be expected.

The stone had refractive indices of 1.621–1.629, with a birefringence of 0.008 and a biaxial positive optic sign. The hydrostatic SG was 3.57, and moderate greenish brown to brown pleochroism was observed. The sample was inert to long-wave ultraviolet radiation and displayed a weak green reaction to short-wave UV. No absorption features were observed with the desk-model spectroscope. The RI and SG values were consistent with topaz; the RIs indicated an intermediate OH/F composition, while the SG was consistent with F-rich topaz (R. Webster, *Gems*, 5th ed., rev. by P. G. Read, Butterworth-Heinemann, Oxford, UK, 1994, pp. 150–163).

When the topaz was immersed in bromoform, the color zones became sharper and more prominent (figure 43), and they were still reminiscent of those seen in sapphire. The angles formed by the zones varied with viewing direction. Viewed from the table, the angles were approximately 40º/140° (figure 43, left); from the side, they were 70º/110° (figure 43, right). These angles are different from those seen in corundum (60º/120°). We were unable to find any reference in the literature to such angles formed by the crystal faces of topaz; the pyramidal faces {111} and $\{1\bar{1}1\}$ only form an angle of 39° (E. S. Dana, *Mineralogy*, 4th ed., rev. by W. E. Ford, Wiley Eastern Ltd., New Delhi, 1949, pp. 613–615). The intersection of the color zones did

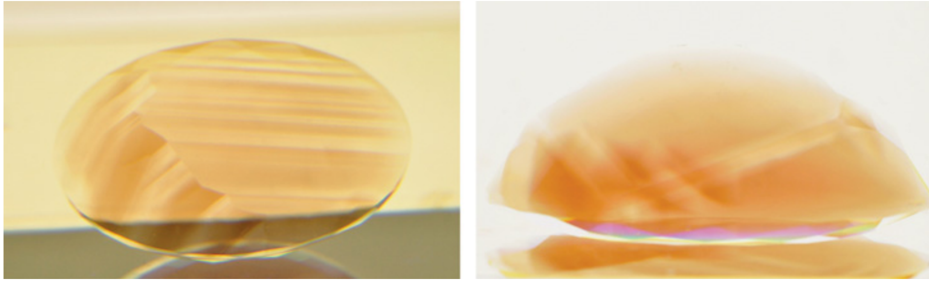


Figure 43. The angles formed by the color zones in the topaz were different when viewed from the table (left) and the side (right). Also note the planes of intersection, which form a zigzag pattern. Photos by G. Choudhary.

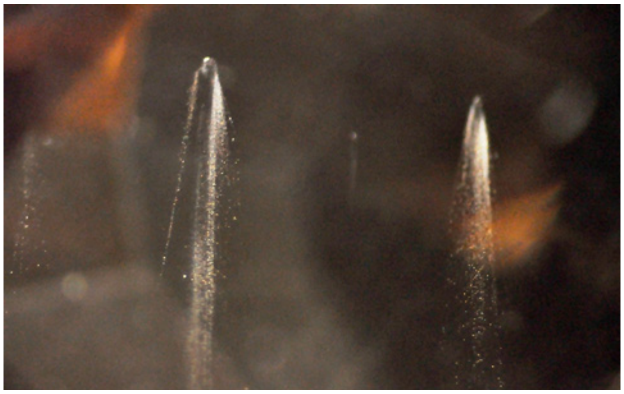


Figure 44. The topaz contained tiny transparent crystal inclusions associated with streams of fine pinpoints, forming "comet-tail" patterns. Photomicrograph by G. Choudhary; magnified 45×.

not form a smooth plane but rather a zigzag pattern (again, see figure 43, left). Therefore, the exact orientation of these color zones is unknown and can only be assumed to be aligned with the pyramidal faces.

With magnification, the sample was mostly clean, except for a few tiny transparent crystals associated with streams of fine pinpoints that formed comet-like patterns (figure 44). Similar inclusions were documented in topaz by E. J. Gübelin and J. I. Koivula (*Photoatlas of Inclusions in Gemstones*, Vol. 2, Opinio Publishers, Basel, Switzerland, 2005, pp. 751–752).

This is the first time this contributor has encountered topaz with a distinct color zoning pattern.

Gagan Choudhary

Variscite from Peru. Green variscite is a popular ornamental material that is best known for the attractive nodules from Clay Canyon, Utah (W. E. Wilson, "Famous mineral localities: The Clay Canyon variscite mine, Fairfield, Utah," *Mineralogical Record*, Vol. 41, No. 4, 2010, pp. 321–349). More recently, gem-quality variscite was found in the Meekatharra District in Western Australia (Spring 2007 GNI, pp. 63–64).

In 2009, a new find of variscite was discovered in Peru. The material was initially thought to be green turquoise, and its locality was kept secret. An abundance of rough came to market in early 2011, reportedly from the vicinity of Yauli, 20 km east of the city of Huancavelica and ~200 km southeast of Lima. The geological position of the find is not known, but variscite normally originates near the earth's surface from the interaction of Al-rich rocks with meteoric phosphate-bearing waters. The Peruvian rough forms veins rather than nodules, and is usually light green or rarely gray-green (figure 45). It typically contains hollow cavities, which can be up to 2 cm long; these diminish a specimen's value. Nevertheless, cabochons can be quite attractive. Some of the gray-green material shows a lamellar agate-like structure (see the stone on the right in figure 45). While in Lima in February 2011, this contributor saw at least 100 kg of rough, although much more material has probably been produced since then.

Ten rough pieces and six cabochons (up to 4 cm across) were examined for this report. All were identified as variscite by X-ray diffraction, regardless of their color. The cabochons yielded the following gemological properties: spot RI—1.55–1.56; SG—2.12–2.23 (lower for material with cavities); Mohs hardness—3½–4; streak—colorless; UV fluorescence—weak green-yellow reaction to long-wave and inert to short-wave UV; and no features seen with the hand spectroscope. While these samples were not treated, polymers can enhance variscite's durability and utility for jewelry.

Jaroslav Hyršl

SYNTHETICS AND SIMULANTS

An accidental corundum and lead glass triplet? In December 2010, one of these contributors (P-YC) acquired a parcel of six oval black cabochons—sold as star sapphires—through several dealers from Chanthaburi, Thailand via eBay. Since the Gemmological Association of All Japan (GAAJ) laboratory had described black star sapphires treated with lead glass ("Lead glass filled black star sapphire," *Gemmology*, Vol. 39, No. 470, issue 11, 2008, p. 2), the parcel was inspected carefully, and one cabochon exhibited an unusual feature. At 10× magnification, the 6.01 ct stone appeared to have a thin transparent section through the center, roughly parallel to its base and ~0.5 mm thick at its widest point (figure 46). Standard gemological testing gave the expected spot RI of ~1.76 and a hydrostatic specific gravity of 4.00. Some fractures contained a foreign material with an RI close to that of corundum, as evidenced by their similar luster in reflected light. The unusual transparent layer appeared yellow and con-

Figure 45. These variscites are from a new find in Peru. The pear-shape cabochon is 14.76 ct and the oval is 9.81 ct. Gift of J. Hyršl, GIA Collection nos. 38422 and 38423; photo by Robert Weldon.

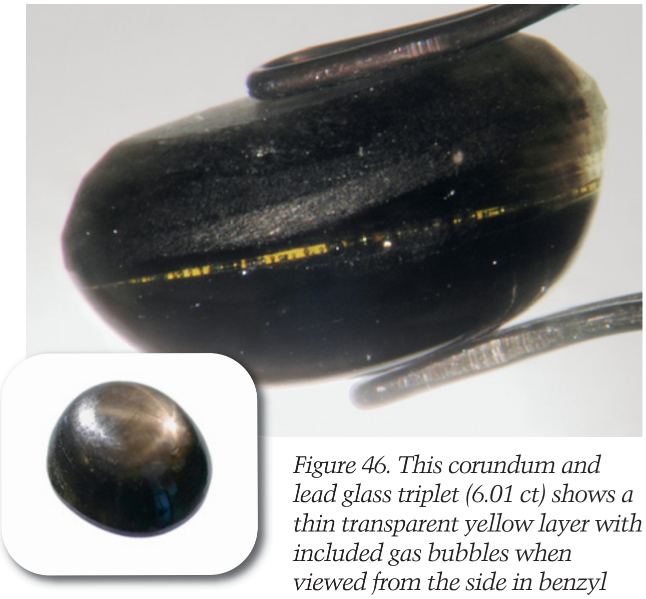
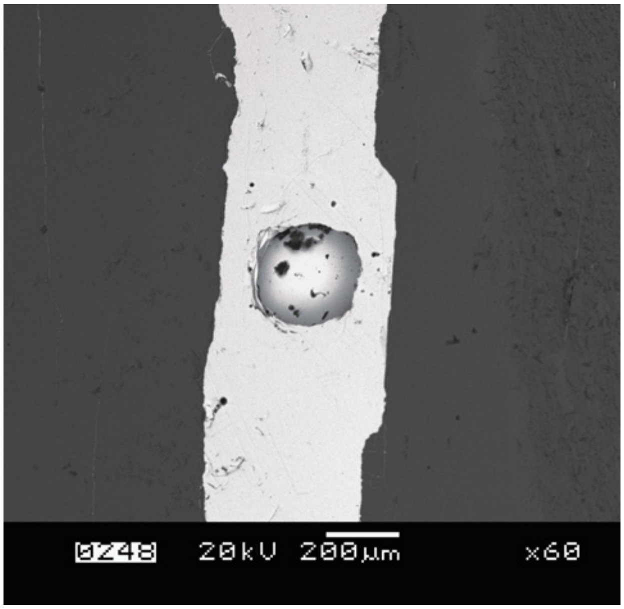


Figure 46. This corundum and lead glass triplet (6.01 ct) shows a thin transparent yellow layer with included gas bubbles when viewed from the side in benzyl benzoate immersion. The cabochon's general appearance is typical of black star sapphires from Thailand (inset). Photos by E. Fritsch and B. Rondeau (inset).

tained numerous gas bubbles, suggesting a glass. Some of the bubbles reached the surface, creating cavities.

The stone was examined with a JEOL 5800 scanning electron microscope. The transparent section showed a contrasting tone, even in secondary electron imagery. The contrast was even more pronounced in a backscattered electron image (figure 47), which is sensitive to atomic number. Chemical analysis with a PGT IMIX secondary X-ray detector indicated that the transparent layer was composed of Pb, Si, Al, and O, strongly suggesting a lead-based glass. The matrix was clearly corundum—containing only aluminum and oxygen—but elsewhere in the stone the lead-based substance could be found in narrow fractures, mostly parallel to the base.

Figure 47. In this backscattered electron micrograph, the transparent layer in the black star sapphire shows a light tone indicative of a high atomic number, consistent with a high lead content. A surface-reaching bubble is seen in the center; note that the two sides of the fracture do not correspond in shape. Image by E. Fritsch.



Because the top and bottom edges of the transparent layer did not correspond in shape (again see figure 47), it was not a fracture filling in a single crystal. The relative crystallographic orientation of the two halves, examined using strong lateral fiber-optic illumination to reveal growth zones, also differed. The upper half showed a typical dark brown chevron, with one side roughly parallel to the long axis of the stone, while the bottom half had stripes that were nearly parallel to the short axis. This meant that both sections shared roughly the same optic axis plane, but were rotated ~30° from one another.

The two halves of this cabochon were likely treated with lead glass as part of a larger parcel of black star sapphire rough. By chance, two crystals showed parting perpendicular to the c-axis, and those two parting surfaces, both approximately flat, came in contact during the treatment. When the molten lead glass solidified, the two halves were fused together and cut into a cabochon, leaving a thin layer of lead glass between them. This cabochon, then, would be most properly described as a corundum-glass-corundum triplet.

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Glass triplet resembling coated "mystic topaz." Recently these contributors received from India a 10.32 ct oval mixed cut that had been purchased as a coated "mystic topaz." However, when viewed from the side, the sample's true nature as a triplet became apparent (figure 48). A thin iridescent layer ran through its center, between colorless top and bottom halves, and the "mystic" effect was reflected throughout the specimen. When placed in an immersion cell with water, the triplet lost most of its colorful appearance.

Both the top and bottom were singly refractive with an RI of 1.581, and the hydrostatic SG was ~2.47. In the polariscope, it displayed anomalous double refraction when

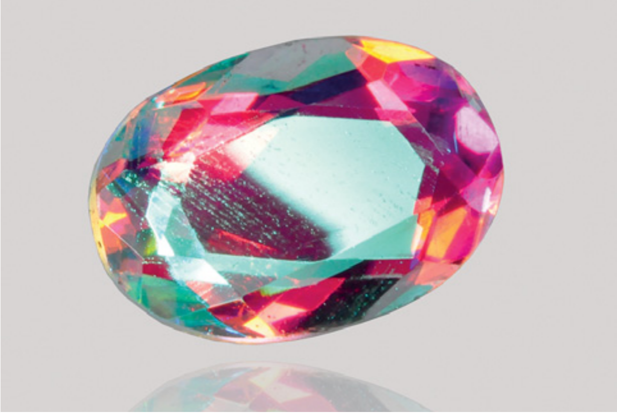
Figure 48. The two halves of this colorful glass triplet (12.28 × 17.33 × 7.92 mm) are easily visible to the naked eye. The junction between them is seen within the frosted girdle. Photo by O. Segura.

viewed from the side. We saw no internal characteristics with magnification, only some rounded facet junctions. All of these features are consistent with glass.

Energy-dispersive chemical analysis using an EDAX instrument revealed Si and K as major components, with impurities of Ti, Fe, Zn, and Zr. This composition is typical of glass, and has been seen previously in other glass imitations, although the Ti might be attributed to the layer creating the iridescent effect.

"Mystic topaz" was first introduced in 1998 by Azotic Coating Technology (Rochester, Minnesota) as an enhancement of colorless topaz with a thin-film coating of undisclosed material. Today, many firms worldwide use the same process with topaz, quartz, and glass. Although the coating is quite resistant, it can be scratched or damaged by abrasives, chemicals, or an ultrasonic cleaner. Thus, coated gems cannot be recut or repolished. Placing the iridescent layer inside a triplet creates a much more durable multicolor effect. However, since the coating is parallel to the table, it reflects and colors any surface scratches and breaks (figure 49), thus making these defects far more visible than on externally coated stones. Although such a triplet is not particularly difficult to design and produce, this is the first example we have seen.

Figure 49. Viewed face up, the internal iridescent layer in the glass triplet reflects scratches on the table. Photo by O. Segura.



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Emmanuel Fritsch

CONFERENCE REPORTS

ICA Congress 2011. Fair trade certification is not yet available for gemstones, but it is clear that the movement is gaining grassroots support. Fair trade, corporate social responsibility, and supply chain issues were central topics at the 14th biennial International Colored Gemstone Association (ICA) Congress in Rio de Janeiro, May 1–4. In the more than 20 presentations delivered at the conference, industry leaders urged ICA's international delegates, which include miners, gem wholesalers, and gemstone dealers, not to ignore these issues in the colored stone industry. Highlights of some of the presentations are given below.

Eli Izhakoff of the World Diamond Council, New York, a key player in developing the Kimberly Process certification scheme for diamonds, urged delegates to recognize problems and develop defensive strategies, much like the WDC does to stay ahead of issues with "conflict diamonds." **Andy Lucas** of GIA in Carlsbad used video examples of how rural communities develop skills through education and training, which he said leads to social sustainability and poverty alleviation in mining areas. He highlighted GIA's efforts at developing educational programs to meet those needs. **Vincent Pardieu** of GIA in Bangkok suggested that remote gem locales develop partnerships with existing civic groups, such as those protecting game reserves and national parks, to advance social and environmental responsibility. **This contributor** noted that in the absence of a fair trade label for gemstones, there are many things that small- and medium-scale miners can do to alleviate poverty, protect the environment, and ensure the supply chain from mine to market. Some miners and gem dealers are already creating a blueprint for "doing the right thing" in the gem business, such as Eric Braunwart of Columbia Gem House, who asks his suppliers, employees, and other stakeholders to sign and uphold a series of Quality Assurance and Fair Trade Gems Protocols.

Congress attendees also heard from other segments of the industry, including policy makers and gem miners. **Dr. Gaetano Cavalieri** of the World Jewellery Confederation (CIBJO), Milan, Italy, discussed the CIBJO Blue Books, which promote standards for nomenclature and disclosure codes for gem treatments. He described CIBJO's commitment to social and economic responsibility through the development of the World Jewelry Confederation Education Foundation under the auspices of the United Nations Millennium Development Goals. **Ian Harebottle**, CEO of Gemfields, London, which mines for emerald in Zambia, noted that his company focuses on social sustainability by supporting local schools, medical clinics, and farming projects, as well as working in partnership with other stakeholders. Gemfields sells off old equipment rather than discarding it, plants trees in waste dumps, and fills nonworking pits with water and stocks them with fish. He pointed out that such efforts also need to be economically sustainable: They are only made possible by mining consistent supplies of rough gems, investing in key resources, and developing marketing campaigns to ensure stable market prices.

Representatives from two laboratories pointed to their efforts in determining gemstone country of origin, which goes to the heart of supply chain issues, particularly in areas of conflict. **Dr. Dietmar Schwarz** of the Gübelin Gem Lab, Lucerne, Switzerland, spoke about global sources of corundum, while **Thomas Hainschwang** of GGTL Laboratories, Balzers, Lichtenstein, discussed their efforts to trace emeralds through observation, chemical composition, and spectroscopy.

Copies of some of the presentations delivered at the conference are available on the ICA website (visit www.gemstone.org, and click on "ICA Congress 2011" under Quick Links).

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Scottish Gemmological Conference 2011. This four-day SGA event was held in Perth, Scotland, on April 29–May 2 with more than 50 delegates in attendance. The first lecture, by **Dr. Marcia Pointon** (University of Manchester, U.K.), addressed the depiction of geologic features and mineral specimens by 19th century British artists.

Two lectures on alexandrite were given by **Dr. Karl Schmetzer** (Petershausen, Germany). The legend of alexandrite being discovered the same day that Russian crown prince Alexander came of age seems to be false, as records show it was found a year earlier. Historically, alexandrite production in Russia was a byproduct of emerald mining, and the gem was not considered important. The color change of alexandrite is best described as going from bluish green to purplish red. Stones showing a color change without a red component should simply be described as color-change chrysoberyl.

Alan Hodgkinson (SGA president, Edinburgh), discussed issues surrounding specific gravity testing. Traditional heavy liquids such as bromoform, methylene iodide, and Clerici solution are all toxic. A safer and more versatile liquid is sodium polytungstate (SG 2.9), which is water-soluble and also has a specific gravity that corresponds directly to its refractive index. Thus, if the liquid is adjusted so that a stone remains suspended, a drop of that liquid can be placed on a refractometer to determine the stone's RI. When working with mounted stones, RI can be determined from the point at which a stone "disappears" in the liquid. With traditional hydrostatic weighing, the use of pure water at 4°C and taking readings to at least two places to the right of the decimal point are important.

Dominic Mok (Asian Gemmological Institute & Laboratory, Hong Kong) discussed the laboratory situation in the Far East. There are now more than 20 labs in Hong Kong, as well as increased competition from China. Prices for services have fallen substantially, and customers are insisting that more advanced testing such as EDXRF analysis be shown on reports. Due to insurance considerations, more-expensive items cannot be kept overnight, so same-day service is required.

Market trends were addressed by **Stuart Robertson** (Gemworld International, Glenview, Illinois). Economic recovery is slow in the U.S. and Europe, while the Far East markets continue to be strong. Blue sapphire is still the best seller, with ruby drawing very high prices for extra fine color, and the emerald market is improving as a result of greater consumer acceptance of treatments and an increase in supply. Color substitutions are commonly being used to provide lower-cost alternatives (e.g., rubellite tourmaline and spinel instead of ruby, and apatite instead of Paraíba tourmaline). Treatments are creating a category best described as "Fashion Accessories," and such stones cannot be promoted as rare.

David Callaghan (retired jeweler, London) discussed the use of nature motifs in jewelry. He showed examples of flowers, insects, and animals that were depicted with gemstones or materials such as enamel and Bakelite.

In the closing two days, delegates had the option to attend various workshops and tour the mineral collection on display at the National Museum of Scotland in Edinburgh.

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GIA, London

Sinkankas Diamond Symposium 2011—Diamond. The ninth annual symposium in honor of John Sinkankas took place April 16 at GIA in Carlsbad. Co-hosted by GIA and the San Diego Mineral and Gem Society, the sold-out event was attended by 132 people.

After opening remarks by convener **Roger Merk** (Merk's Jade, San Diego, California), **Scott Sucher** (The Stonecutter, Tijeras, New Mexico) reviewed the fascinating history of diamond cutting up to 1750. The first record of diamond being "made" was in 1280 AD, when stones were "point cut" by grinding them on an iron plate with diamond grit. Major breakthroughs came with the development of the scaife in the 1400s and wire saws in the 1600s. **Al Gilbertson** (GIA, Carlsbad) continued with diamond cutting after 1750, following the development of the brilliant cut with contributions by John Mawe, Henry Morse, and Marcel Tolkowsky. In contemporary times, we have seen the development of laser cutting, proportion viewers, and automated scanners that provide a variety of possibilities for cutting rough into various fancy shapes.

Dr. James Shigley (GIA, Carlsbad) reviewed the geology and exploration of diamond deposits. An economic kimberlite pipe typically has a grade of only one part diamond per 1 million parts host rock (0.0001% by volume). **Dr. William "Skip" Simmons** (University of New Orleans) focused on diamond's crystal structure and mineralogy. Due to its high density, diamond has the highest RI of any natural colorless transparent material.

Dr. Sally Eaton-Magaña (GIA, Carlsbad) reviewed the production of synthetic diamond by chemical vapor deposition (CVD) and high pressure, high temperature (HPHT) growth techniques. For the latter process, it takes about 80 hours to grow a 3.5 ct crystal. **Dr. Christopher (Mike) Breeding** (GIA, Carlsbad) explained how treatments such as irradiation and heating (with or without accompanying high pressure)—and various combinations thereof—can change the color of diamond based on the characteristics of the starting material. For example, HPHT processing of type Ia pale yellow starting material containing nitrogen pairs can form defects consisting of isolated nitrogen atoms that are then irradiated and annealed to produce NV centers, which give rise to red coloration. **Dr. George Rossman** (California Institute of Technology, Pasadena) examined the causes of coloration in diamond. While the mechanisms involved in producing the color of yellow, blue, green, brown, and black stones are known, the color origin of blue-gray-violet, red-pink, and "chameleon" diamonds is not well understood.

Meg Berry (Mega Gem, Fallbrook, California) described her experience with diamond drills for processing and carving gem materials. She favors a 0.75-mm-diameter bit that is sintered with diamond particles, rather than being CVD coated. **John Koivula** (GIA, Carlsbad) illustrated the "microworld" of diamond, and emphasized that mineral inclusions are actually quite rare, with fissures/feathers and graphite being much more common. Certain mineral inclusions are indicative of a diamond's source rock, such as chromite (peridotite), omphacite (eclogite), and moissanite (deep mantle paragenesis).

Each attendee received a two-volume handout with presentation summaries as well as outside contributions; additional copies are available from Mr. Merk ($25 + shipping; merksjade@cox.net). Next year's Sinkankas symposium will take place April 21, and the theme will be topaz.

Brendan M. Laurs

MISCELLANEOUS

A jewel that survived 9/11. September 11, 2011, marked the 10-year anniversary of the terrorist attacks on New York and Washington, DC. In the aftermath of the New York attacks, a nine-story office building adjacent to the twin towers, 5 World Trade Center, partially collapsed but remained standing. The structure was ultimately demolished in January 2002. Buried under tons of rubble inside the building were 2,500 safety deposit boxes in the vault of a JPMorgan Chase branch. The vault sustained severe damage from the fires that burned for several days after the attacks.

The melted and semi-fused safety deposit boxes were subsequently moved as a unit to the basement of One Chase Manhattan Plaza. In early 2002, the bank began meeting with box owners to return any remaining contents. Charles Maikish, a JPMorgan Chase official, told the *New York Daily News* that workers had found mostly ashes in the boxes: "The only thing that would have survived was metal or stone."

Los Angeles gem specialist Robin Silvers recently brought to this contributor's attention a piece of jewelry that survived the disaster in one of these deposit boxes, a 1950s-era 14K white gold ribbon bow brooch (figure 50). A client of hers was hoping to restore the brooch. The client's father had recovered it with a few other jewelry articles during the very last appointment for retrieving possessions. The insurer had an appraisal done and returned the jewelry six months later.

This contributor's examination showed the following: The brooch measured 49.85 × 31.00 mm and contained 75 diamonds (2.78 carats estimated total weight) in a variety of cuts and settings, consisting of eight prong-set round brilliants, 41 bead-set round single cuts, seven prong-set marquise cuts, and 19 channel-set baguettes. It was missing one diamond (apparently lost before the terrorist attack). The metalwork was blackened, but remarkably the diamonds were in good condition and did not show any significant signs of degradation.

The client ultimately decided not to restore the piece, preferring instead to keep the brooch in its present condition so people can reflect on the ironic beauty of this blackened jewel that survived the tragic September 11 attacks.

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Gallery of Rare Jewels, Pacific Palisades, California

Update on Myanmar gem sales and production. The Myanma Gem Emporium conducted a special sale of jadeite, cultured pearls, and other gems July 3–13, 2011. According to an article in *Working People's Daily* (July 15, 2011, pp. 9, 16), a total of 22,317 lots of jade were offered, of which 17,449 sold. Of those, 17,222 lots sold by tender and 227 by competitive bidding. Attendance and buying, especially from China, was up from previous sales. On average, jade lots sold at 343% of reserve prices. A total of 38 lots of other gems were sold, and cultured pearls also were popular among buyers.

Production of jadeite in Myanmar remains strong, while figures reported for other gem materials show variable trends (see table 1).

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Figure 50. This white gold and diamond brooch (49.85 × 31.00 mm) was recovered from a melted safety deposit box at the World Trade Center site that was devastated by the September 11, 2001, terrorist attacks. The metalwork is blackened, but the diamonds are in good condition. Photo by Robert Weldon.

TABLE 1. Production of jadeite and other gems in Myanmar, 2005–2010.

Year	Jadeite (tons)	Ruby (carats)	Sapphire (carats)	Spinel (carats)	Peridot (carats)
2005–2006	20,005	2,298,413	428,891	–	125,755
2006–2007	20,458	1,555,596	715,160	833,218	344,471
2007–2008	20,266	1,518,854	308,642	925,050	732,442
2008–2009	32,921	1,821,085	1,234,596	363,260	583,215
2009–2010	25,795	1,692,587	1,081,773	429,312	21,160

ERRATA

Gems & Gemology regrets two incorrect figure captions in the Summer 2011 Symposium Proceedings issue.

1. In the abstract by C. P. Smith, "Natural-color tanzanite" (p. 119), the caption should have read as follows:

> Heating of zoisite produced little to no change in V^{3+} absorptions. A shift in the absorption edge was recorded along the alpha pleochroic direction, while additionally along the beta direction a band at 375 nm became apparent. The most significant change took place along the gamma direction, where the shift in the absorption edge revealed another band at ~380 nm, and the combined removal of the 455 nm band created a transmission window in the blue region of the spectrum. This caused the pleochroic hue to change dramatically from a brown-yellow or brownish greenish yellow to slightly greenish blue.

2. In the abstract by S. Gumpesberger, "Extreme conoscopy" (p. 147), the caption should have read as follows:

> An array of mini-sized spheres shows multiple uniaxial figures across the entire surface of the twinned amethyst slab on the left. The ametrine slab on the right exhibits typical uniaxial figures in Brazil law-twinned zones as well as uniaxial bull's-eye figures in untwinned areas. Amethyst can also exhibit twinned and untwinned zones in the same crystal. Photo by S. M. Gumpesberger; specimens courtesy of the Royal Ontario Museum, Toronto, Canada.

We thank Mr. Smith and Ms. Gumpesberger for bringing these corrections to our attention.