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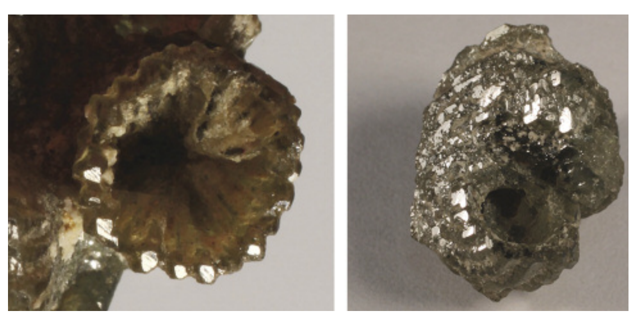
COLORED STONES AND ORGANIC MATERIALS

Demantoid garnet fossil pseudomorphs. In 2010, two extremely rare fossil pseudomorphs in demantoid garnet were acquired from the classic demantoid deposit in Ambanja, Madagascar. One resembled a gastropod, the other a coral (figure 1). The brilliance, lozenge-shaped crystal faces, and green color of these samples were all consistent with the demantoid variety of andradite; this was confirmed by Raman spectroscopy. Both samples clearly showed typical andradite bands at 371 and 516 cm^{-1}, with peaks at 817, 844, and 873 cm^{-1} forming a triplet. Additionally, an intense quartz signal at 464 cm^{-1} was observed. The general appearance was that of many small crystals (up to 1 mm in size) grown together, preserving the overall shape and some details of the fossils. Careful observation of neighboring microfacets in reflected light indicated that both pieces were actually single crystals of andradite (figure 2).

Figure 1. These coral (left) and gastropod (right) fossils are pseudomorphs in demantoid garnet from Ambanja, Madagascar. The coral measures 1.5 × 1 cm. Photo by Pierre-Yves Chatagnier.

It is surprising to observe demantoid replacing a fossil, but some pseudomorphs in gem minerals have been documented, such as pseudomorphs of snail-like gastropods in emerald (P. Vuillet et al., "Les émeraudes de Gachalá, Colombie; historique, genèse et découvertes paléontologiques," *Le Règne Minéral*, Vol. 46, 2002, pp. 5–18). Most surprising is that these pseudomorphs were monocrystals. To investigate how the fossils were replaced by demantoid, we submitted the pieces for X-ray tomography analysis to the Laboratoire Français de Gemmologie (LFG) in Paris. They used an RX-Solutions DeskTom 130 system; results are given in figure 3. There are no remains of the original fossil. The objects were formed entirely out of andradite, which apparently grew from the solid parts of the animal towards the outside of the shell, and inward toward the hollow parts. Hence, some of the hollow parts were not yet completely filled. Lighter shades of gray were due to less-dense material.

Figure 2. Both the coral (left) and the gastropod (right) appear to be single crystals, as revealed by concomitant light reflection (in white) on multiple, parallel rhomboidal crystal faces. Photos by Benjamin Rondeau (left) and Pierre-Yves Chatagnier (right).



Editors' note: Interested contributors should send information and illustrations to Justin Hunter at justin.hunter@gia.edu or GIA, The Robert Mouawad Campus, 5345 Armada Drive, Carlsbad, CA 92008.

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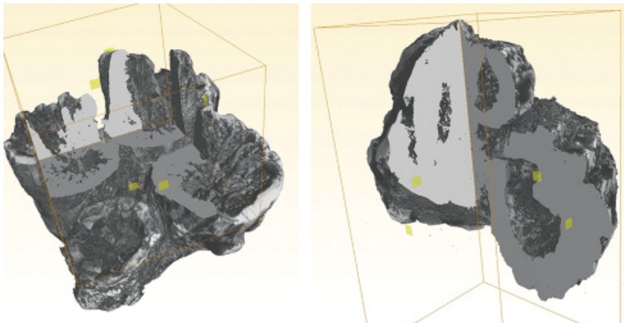

Figure 3. X-ray tomography revealed that both fossils are made entirely of demantoid, and that some internal cavities of the organism remained partially empty.

The fact that the present pieces appear polycrystalline but display evidence of being single crystals suggests that the original fossil was replaced by the growth of many small garnet crystals of random orientation. By that theory, they later coalesced and evolved into a single crystal through the process known as Ostwald ripening (I. Sunagawa, *Crystals*, Cambridge University Press, 2005, p. 258). These pieces are therefore not a pseudomorph stricto senso, as details of the hard parts are lost, but more exactly, recrystallized pseudomorphs with relatively well-developed crystal faces.

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"Gran Dama" brooch featuring large Melo pearl. After a surge in popularity during the 19th century, Melo pearls reemerged on the gem market in the 1990s. These exceedingly rare pearls are produced by the Indian volute, a sea snail indigenous to Southeast Asia. The pearls themselves are non-nacreous and found in shades of orange, yellow, gray, and brown. Upon acquiring a 98.67 ct Melo pearl, thought to be one of the largest in the world, acclaimed jewelry designer Gianmaria Buccellati created the "Gran Dama" brooch to showcase this exceptional gem (figure 4).

Created to honor the power of pregnancy, the brooch epitomizes, in Buccellati's own words, "the highest and purest, I dare say divine, human state." While many years were invested in the concept design and inspiration, the brooch itself required three years to complete, from original design to finished piece. The Melo pearl, representing the womb of the expectant mother, is accentuated by its setting in yellow, pink, and white gold, surrounded by 410 round brilliant diamonds and 139 fancy-color diamonds. The pear-shaped, 18.21 ct South Sea cultured pearl used for the brooch's head provides a striking visual contrast with the orange, spherical pearl at the centerpiece of this work of art.

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Greenish blue spodumene. Green and yellow colors of spodumene, in addition to the widely known violet-pink variety kunzite, are now familiar to the trade and often submitted to gem labs. Recently, this contributor examined a greenish blue stone (figure 5) that unexpectedly turned out to be spodumene.

The 40.50 ct oval mixed-cut specimen measured 24.50 × 10.60 × 10.42 mm. It appeared quite dull, with areas of extinction caused by gray overtones and improper fashioning. The face-up color was heavily influenced by the two pleochroic colors, green and blue. The specimen's overall appearance was similar to tourmaline, though gemological examination ruled out that possibility. The following gemological properties were recorded: optic figure—biaxial; RI—1.660–1.675; birefringence—0.015; hydrostatic SG—3.19; fluorescence—inert; and weak absorption bands in

Figure 4. Designed by Gianmaria Buccellati, the "Gran Dama" brooch celebrates pregnancy through its centerpiece 98.67 ct Melo pearl. Photo by Orasa Weldon.

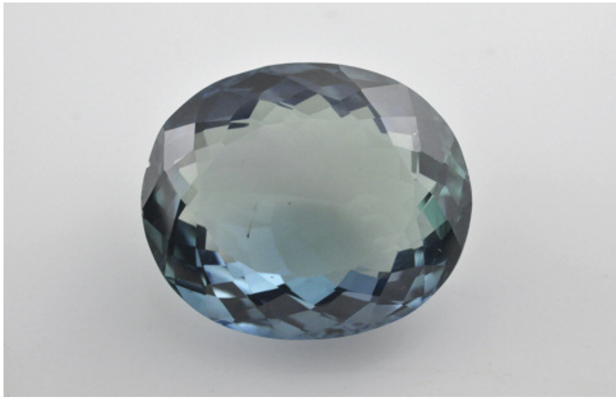

Figure 5. This 40.50 ct greenish blue specimen was identified as irradiated spodumene. Photo by Gagan Choudhary.

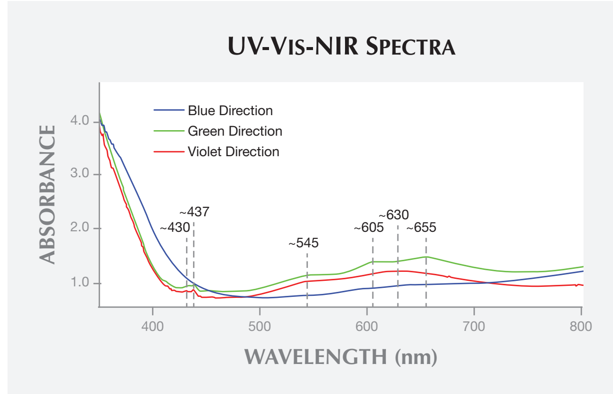

Figure 7. Polarized UV-Vis-NIR spectra of the greenish blue spodumene display bands related to Fe^{3+}, Mn^{2+}, Mn^{3+}, and Mn^{4+}. The band at ~630 nm is related to an irradiation-produced defect.

the blue, green, and yellow-orange regions at around 440, 545, and 600–650 nm in the desk-model spectroscope. The RI and SG values are consistent with those reported for spodumene in the gemological literature. Magnification revealed a few long, conical growth tubes below the table facet and cleavage planes along the girdle edge—inclusions typical for spodumene. The most striking feature of the specimen was its strong pleochroism (figure 6), which displayed three colors: green, blue, and violet. Infrared and Raman spectroscopy further confirmed the sample as spodumene. EDXRF analysis revealed the presence of Al, Si, Fe, and Mn, with a higher amount of Fe than Mn. Polarized UV-visible-NIR spectroscopy in the 200–800 nm region (figure 7) revealed a difference in absorption patterns. The violet and green directions displayed small peaks at ~430 and 437 nm, and absorption bands in the region 500–700 nm. The violet direction showed broad features at ~545 and 630 nm, the green direction at ~545, 605, and 655 nm. The feature at ~437 nm has been assigned to Fe^{3+} (R. Lu, "Color origin of lavender jadeite: An alternative approach," Winter 2012 *G&G*, pp. 273–278). The feature at ~430 nm has been assigned to Mn^{2+} and those in the 500–700 nm region to various states of Mn (Mn^{3+}/Mn^{4+}) and its sites in the structure (see I. Petrov, "Role of natural radiation in tourmaline coloration: Discussion," *American Mineralogist*, Vol. 75, 1990, pp. 237–239). The peak at ~630 nm indicates a defect usually produced by irradiation (E.W. Claffy, "Composition, tenebrescence and luminescence of spodumene minerals," www.minsocam.org/ammin/AM38/AM38_919.pdf). These samples were irradiated via X-ray.

It is widely known that green spodumene without chromium as the chromophore often results from irradiation, but this contributor had never observed a greenish blue color in spodumene. Irradiated green spodumene typically displays a strong blue pleochroic color along the c-axis. In this case, the c-axis was not determined, but one direction displayed a strong blue color, which was further supported by the peak at ~630 nm.

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DIAMOND

Bright yellow diamonds from Sierra Leone. Diamonds referred to in the trade as "Canary yellow" are highly valued for their saturated yellow color, caused by isolated nitrogen

Figure 6. The artificially irradiated greenish blue spodumene displayed strong pleochroism, exhibiting three colors: blue (left), violet (center), and green (right). Photos by Gagan Choudhary.

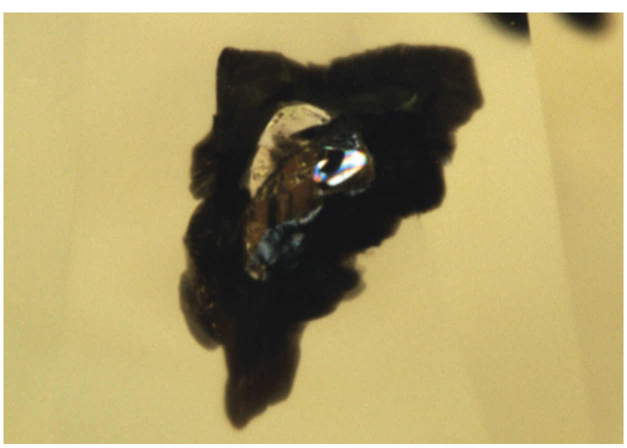
Figure 8. These two bright yellow diamonds (1.03 and 1.02 ct) are from alluvial deposits in the Zimmi mining area in southern Sierra Leone. In the rectangular stone, several black graphitized feather inclusions are visible. Photo by Robert Weldon.

impurities. When faceted, they can exhibit colors ranging from Fancy Intense to Fancy Vivid yellow in GIA's colored diamond grading system. It is unusual to see a group of these rare colored diamonds from a known mining locality (figure 8).

Recently, GIA's Carlsbad laboratory had the opportunity to examine eight faceted and five rough diamonds reportedly found in alluvial deposits in the Zimmi mining area in the Pujehun district of southern Sierra Leone. They were loaned to us for study by Israel Eliezri (Coldiam Ltd., Ramat Gan, Israel). According to Mr. Eliezri, bright yellow rough diamonds are recovered on a recurring basis from the Zimmi region.

The diamonds we examined showed highly saturated yellow colors and weighed between ~0.10 ct and just over 1.00 ct. Rough diamonds recovered from this locality are reported to occur in sizes up to about 4 ct. Under magnification, they often contain what appear to be crystalline sulfide mineral inclusions, with graphitized feathers extending outward (figure 9). Infrared spectroscopy analysis indicated that the samples ranged from pure type Ib to variable proportions of type Ib and IaA. Total nitrogen impurity concentrations varied from 8 ppm (all as type Ib) to ~340 ppm (~35 ppm type Ib, ~305 ppm type IaA). Hydrogen impurities were also detected in the samples with high total nitrogen content. Visible spectroscopy showed only gradually increasing absorption toward the violet end of the spectrum due to the isolated nitrogen.

Figure 9. This diamond contains what is believed to be a metallic sulfide mineral inclusion, surrounded by a black, graphitized feather. Photomicrograph by Nathan Renfro; horizontal field of view is 1.08 mm.



Many yellow natural diamonds with isolated nitrogen occur as irregularly shaped rough crystals, often with inward faces in the form of re-entrant cubes. The rough diamonds from the Zimmi mine, however, showed smooth and rounded dodecahedral shapes. This rounded shape makes them much more suitable for cutting with minimal weight loss.

Type Ib diamonds are uncommon because with time and heat, isolated nitrogen impurities in the lattice tend to aggregate, forming more-complex defects that are characteristic of type IaA and IaB diamonds. The youngest dated diamonds are about a billion years old, and the youngest emplacement ages of diamondiferous kimberlites are less than 80 million years old. This suggests that nearly all diamonds spend most of their existence at great depths in the lower crust and upper mantle. It is unclear exactly how the isolated nitrogen impurities in type Ib diamonds avoided the aggregation process. This mystery makes the discovery of many "Canary yellow" diamonds from a single mine in Sierra Leone even more interesting, offering a potential tool for research into the formation and survival of type Ib diamonds in nature.

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INCLUSIONS IN GEMS

Scheelite and hübnerite inclusions in quartz from China. Scheelite, a very popular mineral among collectors, is very rarely found as an inclusion in quartz (J. Hyršl and G. Niedermayr, *Magic World: Inclusions in Quartz*, Bode Verlag, Haltern, Germany, 2003, p. 147). One such quartz specimen, measuring 4.5 cm high and with very high luster (figure 10,

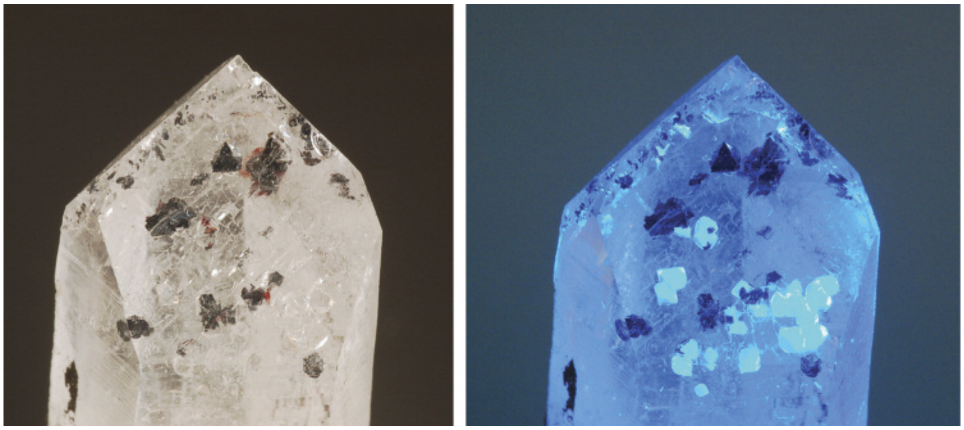

Figure 10. Quartz with scheelite and hübnerite inclusions from China, 2.3 cm wide, in daylight (left) and under short-wave UV light (right). Photos by Jaroslav Hyršl.

left), was collected in 2010 from the famous tungsten deposit at Yaogangxian in Hunan Province, China.

The specimen contained about 25 small pseudo-octahedral crystals up to 2 mm with an adamantine luster. Most of the crystals were black, but some were colorless. Under long-wave UV light, both crystal types are inert; under short-wave UV light, the colorless crystals showed a strong bluish fluorescence, indicating scheelite (figure 10, right). Nevertheless, the black crystals were not fluorescent and their edges were red-brown, a typical color for Mn-rich members of the wolframite group, (Fe, Mn)WO_4. Raman testing (by Prof. Albert Gilg, Technical University of Munich) identified colorless crystals as scheelite (figure 11) and black crystals as the mineral hübnerite (figure 12), with the strongest peak at 877 cm^{-1}. Their pseudo-octahedral form confirmed their origin as a pseudomorph after scheelite.

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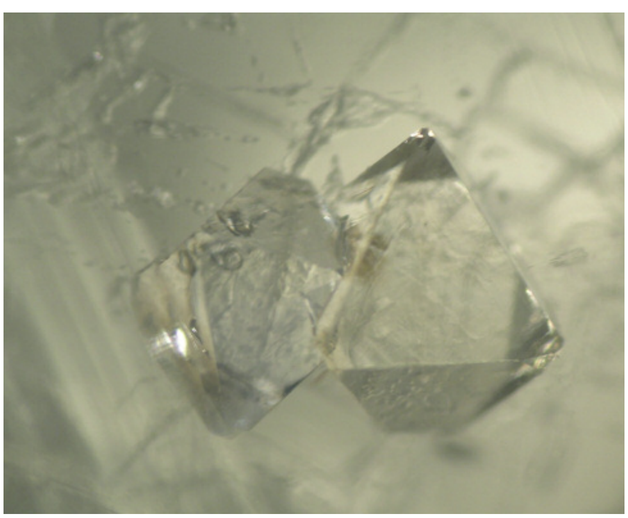
Figure 11. Two scheelite crystals in quartz, image width 2 mm. Photomicrograph by Jaroslav Hyršl.



LOCALITIES

Faceted wurtzite from Tanzania. Wurtzite is the hexagonal polymorph of ZnS. It is far less common than sphalerite, the cubic polymorph of ZnS. All previously identified wurtzite has been opaque to translucent, and therefore not facetable. Layers of wurtzite and sphalerite can alternate in so-called Schalenblende, a colloidal sphalerite variety used only rarely for cabochons. The first transparent wurtzite crystals were found in 2012, at the tanzanite deposit at Merelani Hills, south of Arusha, Tanzania (for identification, see www.rruff.info). The crystals, which measure up to 2 cm in diameter, are very rare. They have a tabular shape, with pyramidal faces. Some crystals from Merelani have clean parts, and several gemstones were faceted from them (figure 13).

Eight cut stones weighing 0.30–1.74 ct were studied. They were orange-brown, with a submetallic luster and very weak, almost invisible, pleochroism. Refractive indices of these stones were well over the refractometer limit, listed as 2.36 and 2.38 in the literature (J. Bernard and J. Hyršl, *Minerals and their Localities*, Granit, Czech Republic, 2004, p. 666). They had very low birefringence, confirmed by a lack of doubling of facet edges. The determined specific gravity values of two of the crystals were 3.78 and 3.85; their measured hardness was 3.5. The stones were uniaxial positive and inert under both long- and short-wave UV. Their UV-Vis-NIR (figure 14) exhibited a high cut-off at 545 nm. The stones showed anisotropic crystals and hexagonal growth structures when viewed under a microscope. Because of the rarity and high value of the Tanzanian crystals, the faceted wurtzites are sure to catch the attention of gemstone collectors.

Jaroslav Hyršl

SYNTHETICS AND SIMULANTS

Composite amber with an unusual structure. With amber emerging as one of the most popular gems in the Chinese jewelry market, the quality of imitations also appears to be on the rise. Many of these simulants are composites

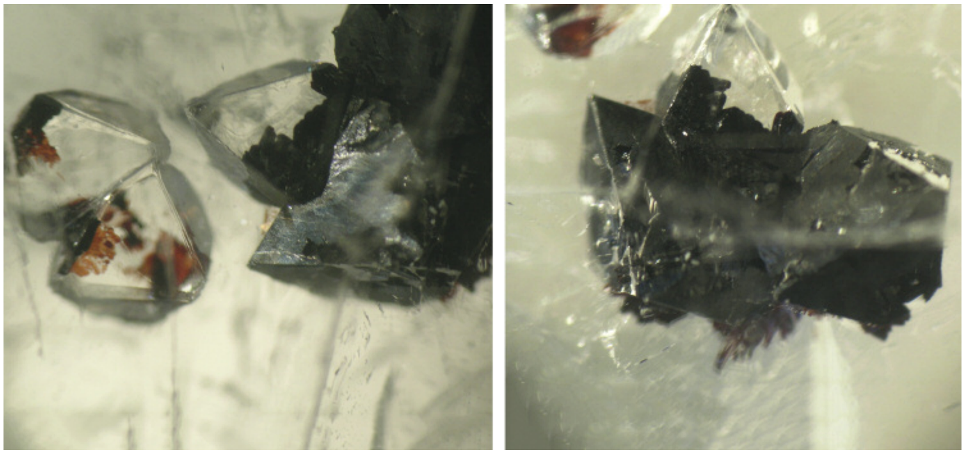


Figure 12. This group of scheelite crystals in quartz was partially replaced by hübnerite. Photomicrographs by Jaroslav Hyršl; image width 3 mm.

consisting of two or more substances, such as amber, copal, artificial resin, and plastic, joined together as a finished piece. Some composites incorporate small amber fragments. Manufacturers may also embed insect or lizard inclusions (Winter 2005 GNI, pp. 361–362). One notable composite amber specimen, a polished pebble-shaped pendant (figure 15), was recently identified at the National Gemstone Training Center (NGTC) lab in Beijing.

This specimen displayed no clear plane separating the two materials; instead there appeared to be an intersecting mixture of amber and polymer resin. The natural amber core had been covered by an outer shell of polymer resin, and about one-third of the natural amber was still exposed. Some of the small exposed portions were large enough for examination and identification. The most interesting aspect of the specimen was its pair of insect inclusions, one occurring naturally and the other artificially (figure 16).

The specimen had a waxy luster. Reflected light displayed scratches on the surface, suggesting a low hardness. It was relatively easy to observe the boundary between the natural and artificial resin sections using reflected light. Unlike most intersections found in such pieces, there were no air bubbles or other features, only clear lines. We also saw some small circular areas using transmitted and reflected light. These proved to be natural amber sections, both on the surface and within the sample, that had been polished and exposed during fashioning. The entire structure of this specimen was an intersection of two substances, identified as natural amber and polymer resin.

Observed under the microscope with transmitted light, part of the sample showed reddish brown curved lines; these were flow lines from natural amber. The two parts of the composite were clearly visible. The top part consisted of natural amber with a naturally deposited insect inclusion. The insect was translucent and partially broken. The larger insect inclusion in the bottom part was in much better condition, with an opaque transparency and clearer outline. The air bubbles around the larger insect were more spherical and

Figure 13. These wurtzites are from Merelani, Tanzania. The crystal measures 17 mm across, and the cut stones weigh 1.74 and 1.59 ct. Photo by Jaroslav Hyršl.

Figure 14. UV-Vis-NIR spectrum of a 1.74 ct cut wurtzite from Tanzania.

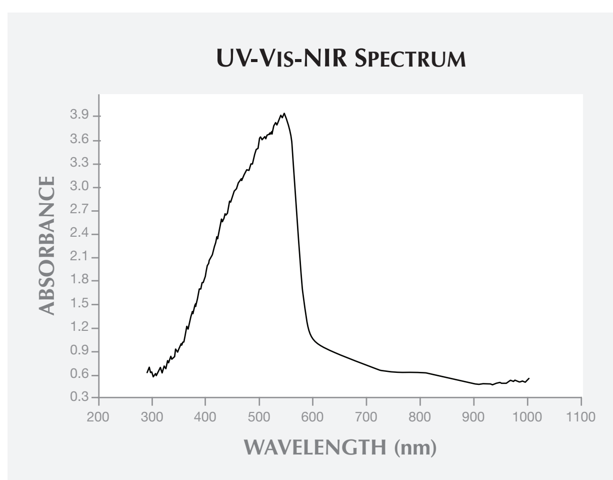


Figure 15. This pebble-shaped amber composite had a total weight of 9.12 g. Photo by Haibo Li.

concentrated, which is not typically seen in natural amber.

Under UV light, the composite gave an uneven fluorescence to long- and short-wave UV. The amber part showed a blue-white fluorescence, while the artificial resin fluoresced yellowish green.

To confirm the identity of the two different materials, we analyzed their infrared spectra (figure 17). Spectrum A displays main peaks at 1734.90 and 1160.99 cm^{-1}, typical of Baltic region amber. Spectrum B shows a series of peaks; after comparison with spectra of amber, copal and some other synthetic materials, we used spectrum B to identify this sample as polymer resin. With its combination of natural and imitation amber, accompanied by natural and artificial insect inclusions, the piece presented an interesting identification study.

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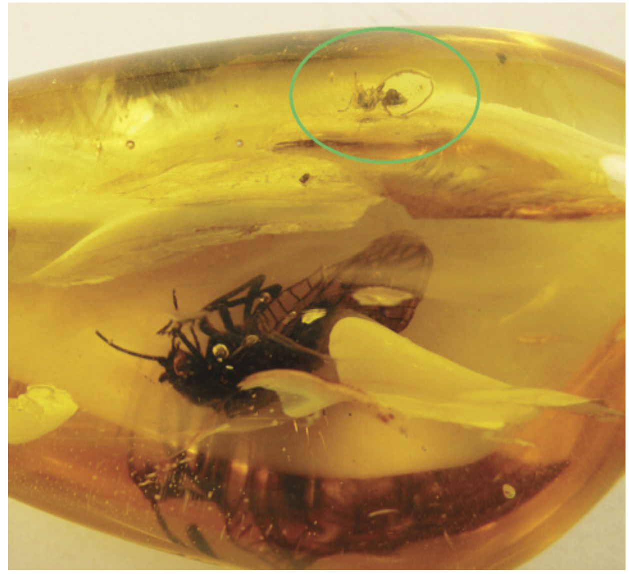

Figure 16. The smaller insect, circled in green, appeared in the natural amber part of the composite, while the larger one was artificially embedded in the surrounding resin. Photo by Haibo Li.

CONFERENCE REPORTS

2013 Gem-A Conference. The Gemmological Association of Great Britain Conference took place November 1–5, 2013, in London. Seminars and workshops were held November 1 at Gem-A headquarters, and presentations were delivered November 2–3 at the historic Goldsmiths' Hall. Field trips to the Victoria and Albert and Natural History Museums, as well as the Museum of London, were held on November 4–5. The conference also celebrated the cente-

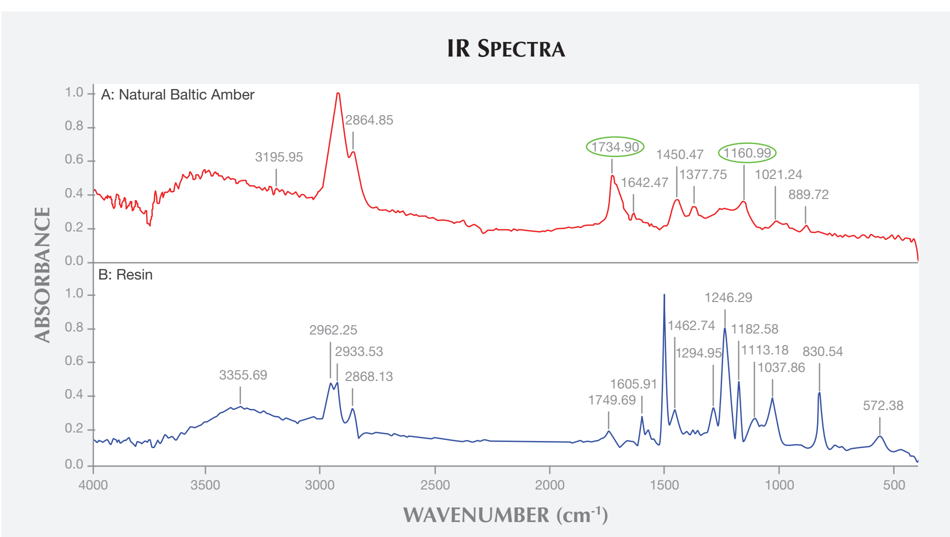

Figure 17. Reflected infrared spectra of the two parts of the specimen, with Kramers-Kronig (K-K) transformation method applied. Spectrum A represents natural amber, with typical peaks circled in green; spectrum B reveals many peaks, indicating the presence of polymer resin.

nary of the first Gemmology Diploma, as well as the 50th anniversary of the first Diamond Diploma.

Chris Sellors from C.W. Sellors Fine Jewellery (Derby, United Kingdom) reviewed the history of Blue John fluorite, noting that British Blue John got its name from *bleu-jaune* (French for "blue-yellow"), during its reported exportation to France in the late 18th century. Sellors was joined by **Rebecca Tucker** of W. Hamond (York, United Kingdom), who recounted the history of Whitby jet.

Sonny Rope of Suncrest Diamonds (Orem, Utah) discussed the effect of HPHT and irradiation treatments on colored diamonds, and explained how Suncrest uses these processes to treat different diamond types. **Gary Roskin** of the Roskin Gem News Report outlined the factors and challenges affecting diamond clarity grading.

Dr. Jack Ogden, a London-based jewelry historian, explained the history, origins, and cuts of the Cheapside Hoard gems. **David Callaghan** of the Institute of Registered Valuers described how renowned gemologist Basil Anderson founded London's Gem Testing Laboratory during the 1920s, in response to the highly profitable natural pearl trade. Washington State–based consultant **Dr. John Emmett** presented an in-depth study of the issues of testing gemstones to understand their color by the way they absorb light. Through the use of advanced equipment such as spectrometers and spectrophotometers, Emmett showed that absorption, combined with the relative concentrations of coloring elements, could be used to predict the shade and saturation of corundum.

Brian Jackson, chairman of the Scottish Gemmological Association, reviewed Scottish gemstones, including artifacts set with gems. CairnGorm Mountain has long been a source of beryl and topaz. He noted that while it is illegal to fish for them, Scotland's rivers do contain pearls. **Dr. Emmanuel Fritsch** (University of Nantes, France) discussed the use and effects of luminescence in gemology, and how it can be used to detect treatments in emeralds and glass-filled rubies.

Dr. James Shigley (GIA, Carlsbad) discussed gem identification challenges of the past 30 years. While fewer synthetic materials are on the market as compared to the 1960s and 1970s, an increase in the treatment of diamonds and colored stones makes it important to use scientific instruments in gem laboratories. **Martin Rapaport**, chairman of the Rapaport Group (Las Vegas, Nevada), compared prices of rough and polished diamonds, reviewed the causes of market fluctuations, and explored the current issues of the industry with regard to synthetic diamonds and retailer responsibility. **Shelly Sergent** of Somewhere In The Rainbow (Phoenix, Arizona) described the purpose and educational mission of the collection, pieces of which were showcased and available to the attendees.

Arthur Groom of Arthur Groom & Co. (Ridgewood, New Jersey) detailed major issues of emerald clarity enhancement, including materials historically used and the challenges of using different media. **John J. Bradshaw** of Coast-to-Coast Rarestones Intl. (Nashua, New Hampshire) explained the collector's market for non-traditional gemstones, and provided in-depth information on localities and cutting consideration of six different rare gem species.

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THANK YOU, REVIEWERS

GEMS & GEMOLOGY requires each manuscript submitted for publication to undergo a rigorous peer review process, in which each paper is evaluated by at least three experts in the field prior to acceptance. This is an essential process that contributes to the accuracy, integrity and readability of *G&G* content. In addition to our dedicated Editorial Review Board, we extend many thanks to the following individuals, who devoted their valuable time to reviewing manuscripts in 2013.

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