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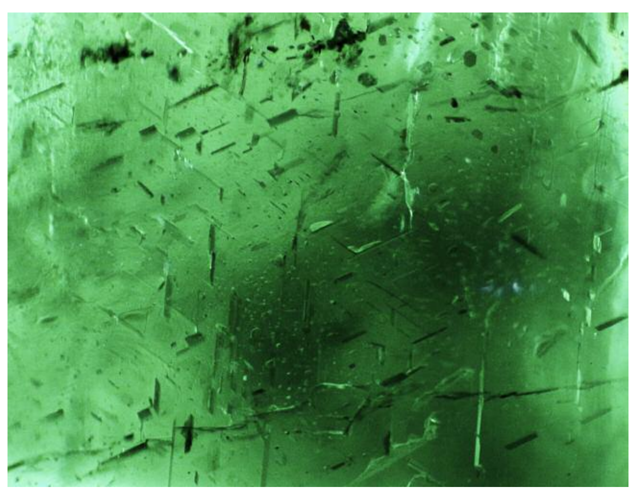
COLORED STONES AND ORGANIC MATERIALS

Natural emerald with inclusions along three directions. Recently, Guild Gem Laboratories received a 10.48 ct sugarloaf emerald (figure 1) for identification and origin determination. The refractive index (approximately 1.58) and specific gravity (approximately 2.80) fell within the range for beryl, and Fourier-transform infrared (FTIR) testing confirmed it as natural emerald. Additionally, energy-dispersive X-ray fluorescence (EDXRF) analysis revealed Fe, V, and Cr contents consistent with those in Zambian material.

The stone showed interference colors when placed under a polariscope with the bottom facing up. With a conoscope, the optic axis of this emerald was determined to be perpendicular to the bottom. Using the microscope, we found thin platy inclusions arranged in three directions intersected with each other at 60/120 degree angles (figure 2). Those inclusions were mainly dark brownish and transparent with well-formed rectangular shapes, some of which exhibited a light bodycolor resembling an unhealed fracture. Evenly distributed reflective light could be seen at certain angles. We deduced that those inclusions had relatively smooth surfaces, which means that their original crystal faces were not corroded during the emerald's formation. Further observation revealed hexagonal inclusions in the basal plane. Owing to uneven development during their crystalline formation, several of them were nearly triangular in shape. Their sides were parallel to the direction of the platy inclusions (figure 3, top). We also found distinct growth lines near the bottom of the sugarloaf perpendicular to the c-axis. These platy inclusions appeared to be concentrated sparsely in a thin layer with a thickness around 1.5–2.0 mm, as shown figure 3 (bottom). The sparseness of

Figure 1. This 10.48 ct sugarloaf emerald from Zambia shows a vivid and highly saturated green color. Photo by Yizhi Zhao.

Figure 2. Platy inclusions in the emerald in three directions, intersecting at 60/120 degree angles viewed along the c-axis. Photo by Yujie Gao; field of view 2.8 mm.



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

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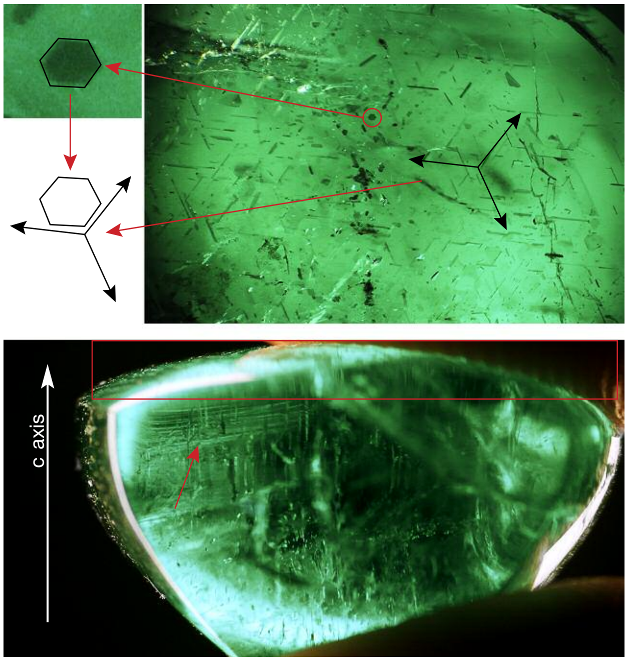

Figure 3. Top: The hexagonal inclusions in the basal plane are parallel to the orientation of the platy inclusion described in figure 2. Field of view 3.1 mm. Bottom: A thin layer exhibiting growth lines is perpendicular to the emerald's c-axis. Photos by Yujie Gao.

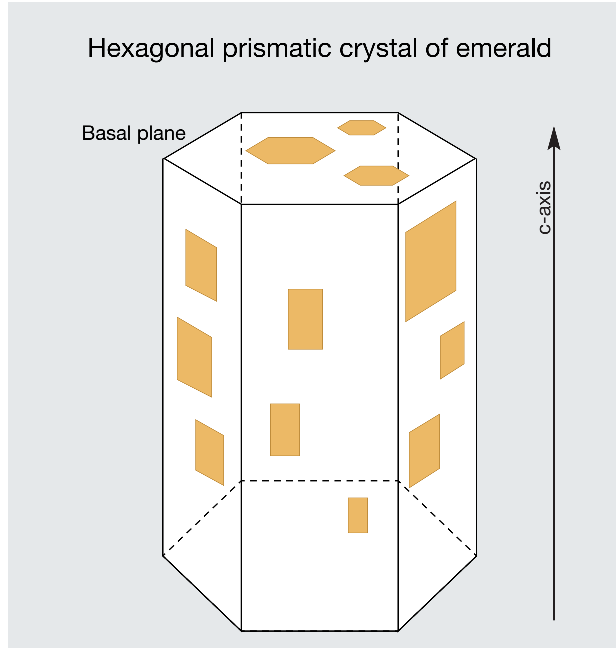

Figure 4. Proposed illustration of hexagonal inclusions in the basal plane and platy inclusions along the prismatic faces. Illustration by Yujie Gao.

the oriented inclusions resulted in the absence of asterism or cat's-eye phenomena.

Considering the optic axis, we concluded that the platy inclusions grew along the hexagonal prismatic emerald faces, with the hexagonal platy inclusion parallel to the basal plane, as illustrated in figure 4. However, it is still unclear whether they were syngenetic or exsolution, since their well-preserved shapes showed little evidence of corrosion and there was insufficient evidence of exsolution.

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DIAMONDS

Nominal type IaB diamond with detectable uncompensated boron. In recent years, nominal type IaAB and IIa diamonds with transient 2800 cm^{-1} FTIR absorption peaks arising from uncompensated boron produced under UV radiation have been reported (J. Li et al., "A diamond with a transient 2804 cm^{-1} absorption peak," *Journal of Gemmology*, Vol. 35, 2016, pp. 248–252; Winter 2016 Lab Notes, pp. 412–413). The National Center of Supervision and Inspection on Quality of Gold and Silver Products recently examined a type IaB diamond that exhibited instantaneous 2803 cm^{-1} FTIR absorption shortly after exposure to an ultra-short-wave (< 230 nm) UV source.

Under ultra-short-wave UV excitation, the 0.30 ct K-L diamond with faint brown color, mounted in an 18K gold prong setting (figure 5), showed strong blue fluorescence and strong greenish blue phosphorescence that lasted for approximately eight seconds (figure 6). Infrared absorption spectroscopy showed low concentrations of the hydrogen-related peak (3107 cm^{-1}) and nitrogen impurities in the B aggregates at 1174 cm^{-1} (figure 7), indicating a type IaB diamond (C.M. Breeding and J.E. Shigley, "The 'type' classi-

Figure 5. This 0.30 ct K-L diamond with faint brown color, mounted in an 18K gold prong setting, is a nominal type IaB diamond with detectable uncompensated boron. Photo by Wenqing Huang.

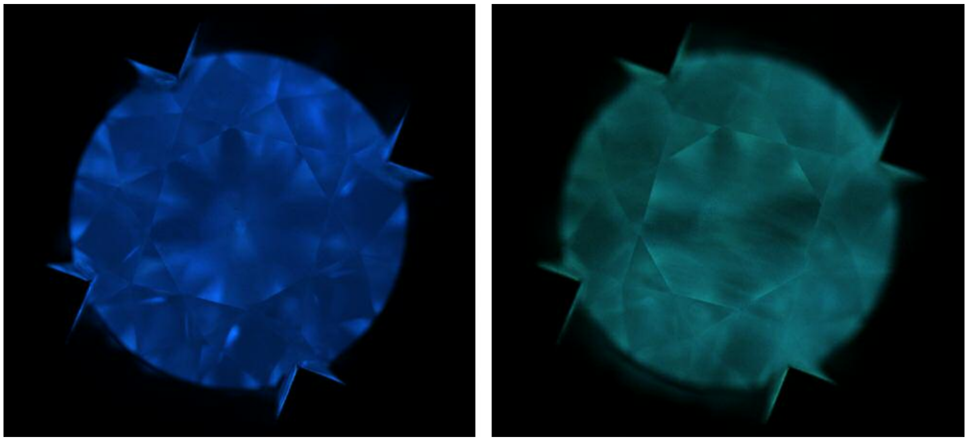


Figure 6. DiamondView imaging shows blue fluorescence (left) and greenish blue phosphorescence (right) in the natural type IaB diamond. Images by Wenqing Huang.

fication system of diamonds and its importance in gemology," Summer 2009 *G&G*, pp. 96–111); prior to ultra-short-wave UV excitation, we were unable to detect the presence of the B center. No boron-related absorption was detected before UV radiation exposure, due to uncompensated B concentrations below the detection level of the FTIR spectrometer. But shortly after ultra-short-wave UV exposure, the transient boron-related absorption peak was recorded at 2803 cm^{-1} (again, see figure 7). Nitrogen-related peaks were detected at 415.7, 428.5, 439.0, and 452.4 nm using photoluminescence (PL) spectroscopy (figure 8); the peak at 415.7 nm belongs to the zero-phonon line (ZPL), while the others belong to its associated phonon replicas (A.M. Zaitsev, *Optical Properties of Diamond: A Data Handbook*, Springer-Verlag, Berlin, 2000). PL and FTIR spectra confirmed the diamond's natural origin.

The generally accepted mechanism for interpreting the phosphorescence in type IIb diamonds is donor-acceptor pair recombination processes involving boron and other defects (P.J. Dean, "Bound excitons and donor-acceptor pairs in natural and synthetic diamond," *Physical Review*, Vol. 139, 1965, pp. A588–A602). Boron is deemed as the acceptor in the model, where the donor is believed to be nitrogen related, either as isolated nitrogen, aggregated nitrogen, or a plastic deformation–related defect (S. Eaton-Magaña and R. Lu, "Phosphorescence of type IIb diamonds," *Diamond and Related Materials*, Vol. 20, 2011, pp. 983–989; E. Gaillou et al., "Boron in natural type IIb blue diamonds: Chemical and spectroscopic measurements," *American Mineralogist*, Vol. 97, 2012, pp. 1–18).

Figure 7. The FTIR spectra reveal low concentrations of the hydrogen peak (3107 cm^{-1}) and nitrogen impurities in the B aggregates (1174 cm^{-1}) (blue line). Shortly after ultra-short-wave (< 230 nm) UV exposure, the transient boron-related absorption was recorded at 2803 cm^{-1} (red line). Spectra have been offset vertically for clarity.

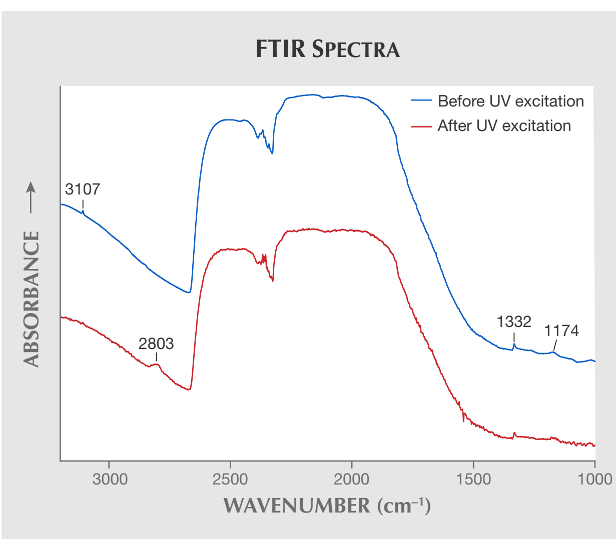
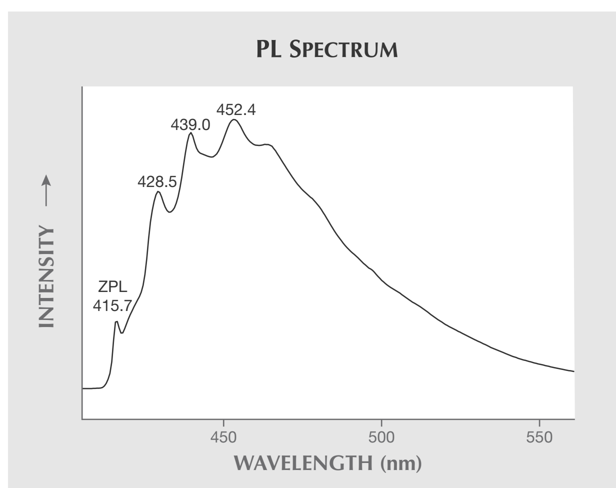


Figure 8. The photoluminescence spectrum of the sample excited at room temperature with a 405 nm laser reveals an N3 center with its zero-phonon line (ZPL) at 415.7 nm and its associated phonon replicas with peaks at 428.5, 439.0, and 452.4 nm.



When almost all of the boron impurities received electrons from donors, almost no uncompensated boron (B_0) was left behind, and therefore no boron-related absorption peaks were recorded. When the diamond was exposed to ultra-short-wave UV excitation, some of the compensated boron converted to an uncompensated state due to a charge transfer process between compensated boron and ionized donors, which could be recorded before the phosphorescence decayed. This mechanism is also suitable for interpreting the observed phenomenon of this specimen.

Natural diamonds with long-lasting phosphorescence under UV excitation are typically type IIb or chameleon diamonds (J.M. King et al., "Characterizing natural-color type IIb blue diamonds," Winter 1998 *G&G*, pp. 246–268; T. Hainschwang et al., "A gemological study of a collection of chameleon diamonds," Spring 2005 *G&G*, pp. 20–35). It is rare to find diamonds of other types, especially type IaB diamonds, showing this phenomenon. Finding a detectable, if temporary, B_0 defect in a type IaB diamond is also unusual.

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Figure 9. Qinglong, the site of the Guizhou Jade deposit, is located in southwestern China.

Guizhou Jade from Qinglong, China. A green-blue quartzite produced in the Qinglong antimony deposit, in southwestern Guizhou Province, is called Guizhou Jade in the trade. The source area is located in the middle of the Yunnan-Guizhou Plateau at 25°N latitude, rising 1,600 meters (5,250 ft) above sea level (figure 9). This material was discovered in the 1950s, when the antimony deposit was economically more important to the area. The accompanying blue quartzite was only commercially mined as a decorative material. Later, it was used as a gem material, and it has been popular in Chinese jade markets since about 2011 (figure 10).

In June 2018, the authors went to the source to inspect the antimony deposit and conduct exploration and collection for Guizhou Jade in the mine. The host rocks are mainly pyroclastic (breccia) rocks, breccia clay rocks of the Dachang layer, and bio-limestones of the Maokou Formation. The Dachang layer is the main ore-bearing layer of the antimony deposit, which is a set of pyroclastic and chemical deposits, and subjected to alteration to siliceous and clay rocks (J.C. Cao, "The dyeing mechanism and cause of Guicui," *Acta Mineralogica Sinica*, No. 3, 1983, pp. 183–192).

The authors observed that in the mine, this material has a close relationship with stibnite. It is mostly developed in the interlayer fissures, fracture zones, and areas where brecciation has taken place. The material occurs as blocks and/or veins (figure 11). In the ores, there are calcite- and gypsum-filled cracks and voids. Green or white clay minerals are often found in the micro-cracks or small holes in the gem material.

Guizhou Jade is translucent to opaque, with a refractive index of about 1.54 (spot reading), a specific gravity of 2.62, and a Mohs hardness of 6.5–7. According to the infrared

Figure 10. This Guizhou Jade ornament, typical in the Chinese jade markets, stands about 11 cm high. Photo by Yushan Dai.

Figure 11. Left: In the mine, Guizhou Jade is mostly developed in the interlaminar fissures and closely related to stibnite. Right: Guizhou Jade, which develops between layers of stibnite, is massive and can be seen in some small holes in the surface. Photos by Yushan Dai.

spectrum, the main constituent mineral is quartz, and its infrared spectrum matches the α-quartz standard infrared spectrum, including several obvious absorption peaks at 1172, 1124, 1085, 798, 781, 540, and 478 cm^{-1} (figure 12). Quartzite is generally cryptocrystalline. Its colors range from light green-blue to dark green-blue. The most sought-after color is ocean blue, as shown in figure 10.

UV-Vis-NIR absorption spectra (figure 13) of both samples show an obvious 415 nm absorption band and a strong absorption band at 590–620 nm, located in the blue-green range of visible light. The absorption intensity of the light-colored sample is significantly lower than that of the deep-colored sample. The 415 nm absorption band is caused by $^4A_{2g}\rightarrow{}^4T_{1g}$ transition and $^4A_{2g}\rightarrow{}^4T_{2g}$ transition of Cr^{3+}. The strong absorption band at 590 to 620 nm is caused by charge transfer between $Fe^{2+}\rightarrow Ti^{4+}$ and $^4A_{2g}\rightarrow{}^4T_{2g}$ transition of Cr^{3+} (J. Liu, "The color formation of common green quartz jade," *Ming Ri Feng Shang*, No. 3, 2017, pp. 368–371).

High-quality Guizhou Jade is rich in color and loved by collectors. It has been widely used in necklaces, bracelets, earrings, and other items.

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SYNTHETICS AND SIMULANTS

Single HPHT synthetic diamond mixed in natural diamond ring. Recently, a ring with 195 mounted colorless and near-colorless stones (figure 14) was submitted to Dubai Central Laboratory for identification. The ring con-

Figure 12. The infrared spectrum of a Guizhou Jade sample.

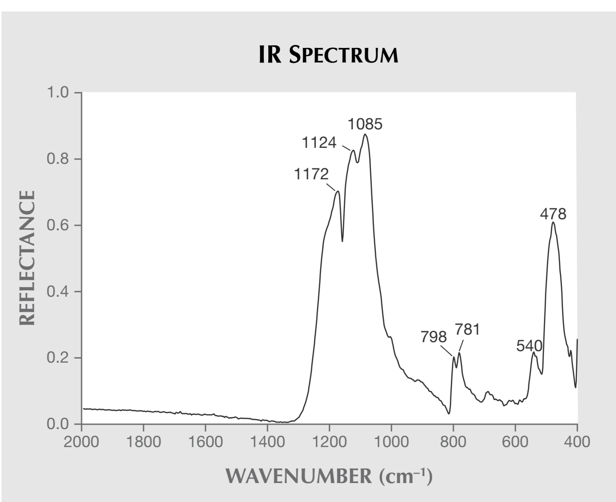

Figure 13. The UV-Vis-NIR spectra of both Guizhou Jades show a 415 nm absorption band and a strong absorption band at 590–620 nm.

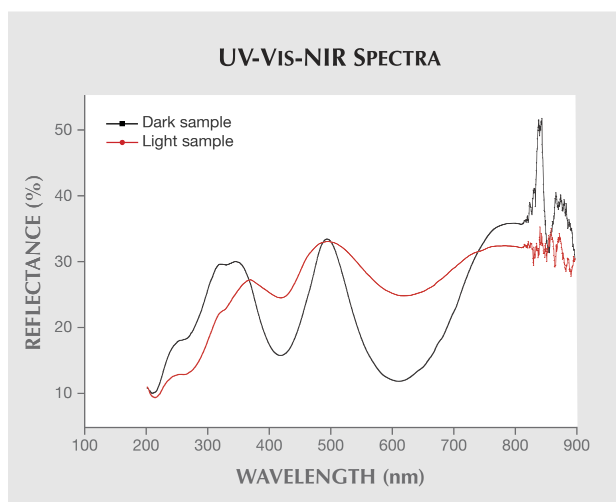

Figure 14. The ring with 194 natural diamonds and one HPHT-grown specimen. Photo by Nazar Ahmed Ambalathveettil.

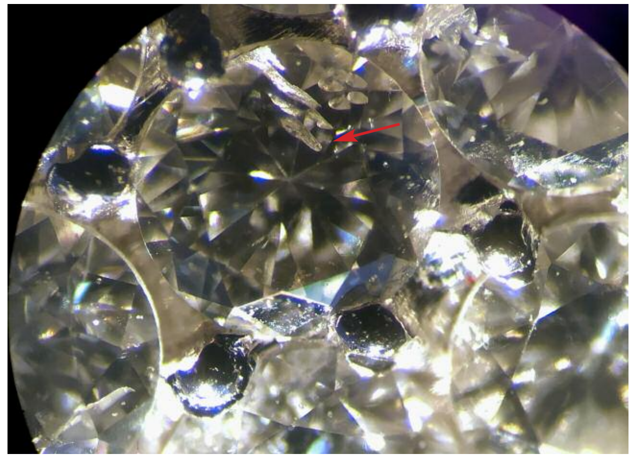

Figure 15. These metallic flux inclusions that are associated with feathers show high reflection in oblique light. Photo by Nazar Ahmed Ambalathveettil.

tained round-brilliant-cut diamond melee arranged in rows. Testing with the DiamondSure instrument identified 194 of them as natural diamond, and the remaining melee was referred for further testing.

The sample's setting in the ring restricted us to FTIR spectroscopy in reflection mode to determine its identity. Solid metallic inclusions were revealed under the microscope (figure 15). The specimen displayed strong yellow and moderate greenish yellow fluorescence under long-wave UV and short-wave UV, respectively (figure 16). The inclusions and fluorescence suggested HPHT-grown diamond, which generally shows a stronger fluorescence reaction to short-wave UV than to long-wave UV. The vast majority of HPHT synthetics in the "colorless" range exhibit no detectable fluorescence to long-wave UV (S. Eaton-Magaña et al., "Observations on HPHT-grown synthetic diamonds: A review," Fall 2017 *G&G*, pp. 262–284), but this one showed strong fluorescence under long-wave UV.

The stone was further examined with DiamondView imaging and photoluminescence (PL) spectroscopy. Strong yellowish green fluorescence and blue phosphorescence were observed with the DiamondView, but the growth sector pattern typical of HPHT-grown diamond was not visible because of the stone's size. PL spectroscopy showed nickel-related peaks at 882/884 nm. Based on these results, we concluded that this was an HPHT laboratory-grown diamond.

We later learned that the customer had given the ring to a jewelry repair shop to replace a broken diamond, which may account for the single lab-grown specimen. This is a good example of the need for vigilance in every stage of diamond jewelry making.

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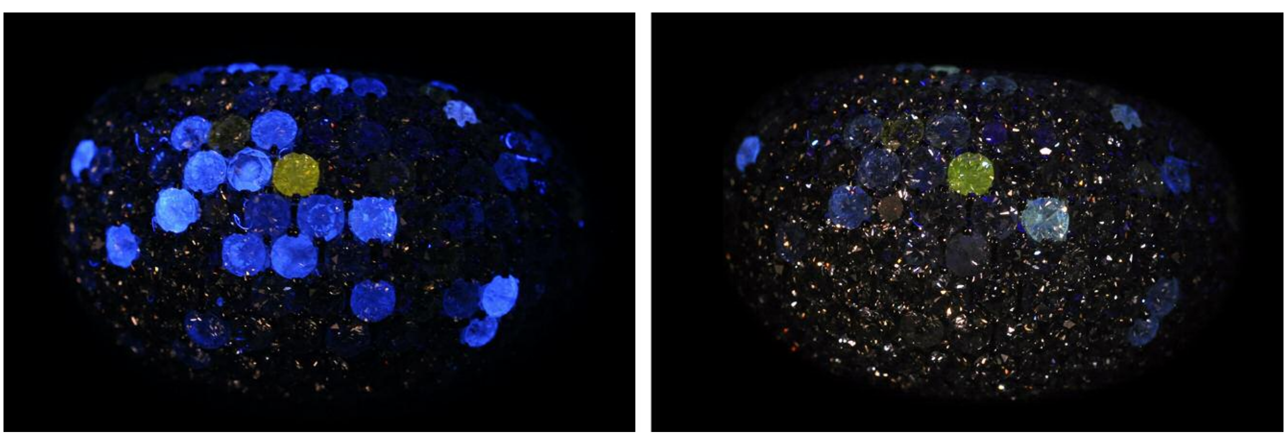
Figure 16. The laboratory-grown diamond fluoresced yellow under long-wave UV (left) and greenish yellow under short-wave UV light (right). Photos by Nazar Ahmed Ambalathveettil.



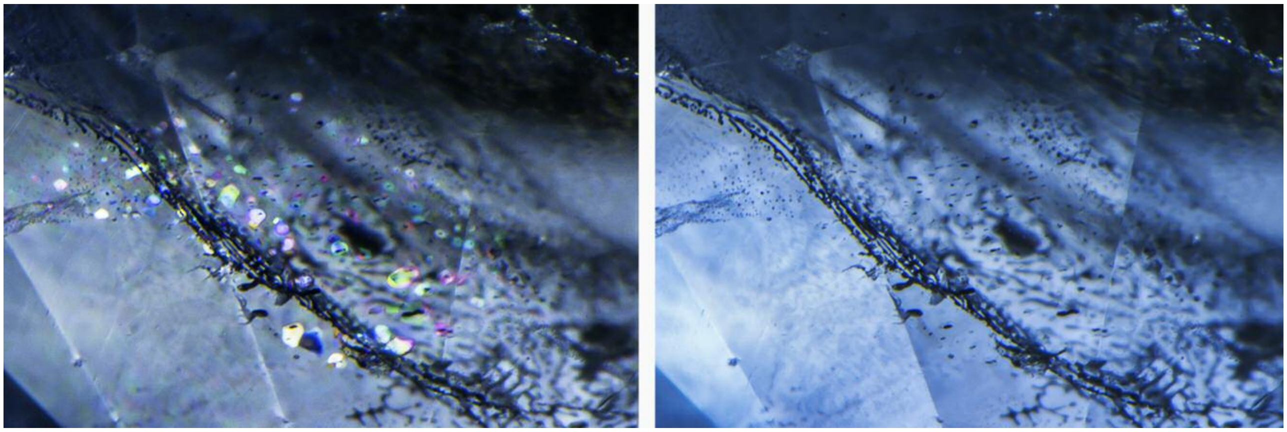


Figure 17. This sapphire that was treated with heat and pressure contained small birefringent crystals (left) that were nearly invisible with unpolarized light, as seen in the brightfield image (right). Photomicrographs by Nathan Renfro; field of view 1.81 mm.

TREATMENTS

Microscopic observations of blue sapphires treated with heat and pressure. In recent months, sapphires treated under heat and pressure have been documented in the trade. This material is reported to be treated under pressure of 1 kbar at temperatures between 1200 and 1800°C by HB Laboratory Co. Ltd. of Korea (H. Choi et al., "Sri Lankan sapphire enhanced by heat with pressure," *The Journal of the Gemmological Association of Hong Kong*, Vol. 39, 2018, pp. 16–25). This process is used to improve blue coloration and potentially heal any fractures within the stones.

GIA acquired from Sri Lankan gem dealer Imam Faris of Imam Gems (Pvt) Ltd. six samples that were said to have been treated under the conditions mentioned above. The samples were examined using a standard gemological microscope to look for any unusual features resulting from this type of treatment. Five of the six sapphires showed a feature that to our knowledge has not been reported before. Viewed in polarized light (figure 17, left), planes of small crystallites were observed as bright spots against a dark background when the host corundum was in the extinct position. But under unpolarized light (figure 17, right), the crystallites were either invisible or nearly so, and only visible from a low-relief interface between the crystallite and the host corundum. Due to the extremely low relief of these inclusions, the author speculates that these inclusions are corundum crystals that originated from fractures and were healed by recrystallization of the corundum. While it is certainly possible to have birefringent crystals of corundum in untreated corundum, the consistent observation of the planes of birefringent crystals by the author suggests that this feature could be a useful indicator for corundum treated with heat and pressure. These preliminary observations offer some interesting clues, but further research will be needed to fully characterize corundum treated with this technique.

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Emeralds filled with epoxy resin: DiamondView observations. Emeralds from all sources routinely contain surface-reaching fissures, and as a result are subjected to clarity enhancement processes (oiling or resin filling) to improve their appearance. The quantity and variety of emerald-filling substances undoubtedly affects the final market value (M.L. Johnson et al., "On the identification of various emerald filling substances," Summer 1999 *G&G*, pp. 82–107). Recently, the Lai Tai-An Gem Lab received a stone—reported as an emerald by the client—for identification services, with a request to focus on the degree of clarity enhancement. DiamondView imaging allowed us to visually explain the degree of filling in a way the client was quickly able to understand.

The transparent emerald-cut stone weighed 16.15 ct and measured 16.80 × 14.07 × 9.48 mm. It exhibited a light to medium green saturation and contained white hazy inclusions that were visible to the eye (figure 18). Standard

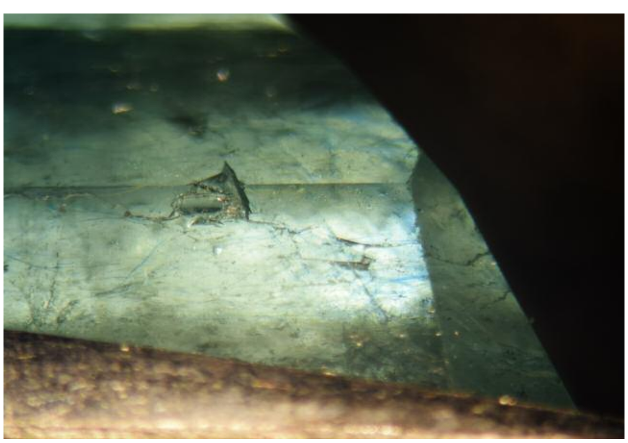
Figure 18. This 16.15 ct emerald was filled with epoxy resin. Photo by Lai Tai-An Gem Lab.

gemological testing revealed an RI of 1.570–1.575, an SG of approximately 2.66, and a weak yellowish green reaction under long-wave ultraviolet radiation. Magnification with a gemological microscope revealed fluid and three-phase inclusions typical of natural emeralds. When turning the specimen, "blue flashes" characteristic of resin-filled material were seen within many of the fissures (figure 19). These results confirmed that the stone was a natural, clarity-enhanced emerald. Infrared spectrometry was subsequently performed to analyze the filling in more detail. Epoxy resin peaks at 3061, 3040, 2965, 2930, and 2870 cm^{-1} (figure 20) confirmed the epoxy resin treatment of the stone, as indicated by the initial microscopy.

Although it may not be difficult for experienced gemologists to identify various emerald-filling substances using high-end equipment like Fourier-transform infrared (FTIR) or Raman spectroscopy, we wanted to check on the suitability of another tool to assist in identifying fillers and to help see the extent and degree of filling applied. We turned to the DiamondView and obtained some interesting images for this clarity-enhanced emerald.

The stone's surface was first observed in different directions under the DiamondView's visible light source until obvious surface-reaching fissures appeared. Subsequent exposure to the unit's ultra-short energy UV light clearly revealed the epoxy resin filler within the fissures as a series of blue lines extending over the entire surface against the beryl's orange-fluorescing bodycolor. The more severe (quantity in relation to width and depth) the treated fissures were, the stronger the blue reaction (figure 21). The results of this simple test show how the DiamondView may be applied. Although the DiamondView cannot precisely identify the fillers, it does provide a means of detection that can be applied to a variety of gems. The option of ultra-short-wave radiation should be considered, as

Figure 19. When viewed through a gemological microscope, "blue flashes" characteristic of resin-filled emeralds are clearly visible. Photo by Lai Tai-An Gem Lab; field of view 8.8 mm.



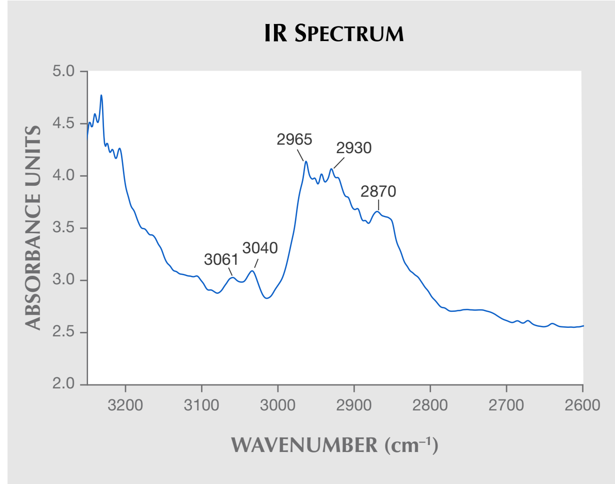


Figure 20. Characteristic epoxy resin peaks were detected at 3061, 3040, 2965, 2930, and 2870 cm^{-1} with FTIR spectrometry.

there may be concerns about the color and structural durability of host and fillers that have not been fully taken into account.

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Coated pink synthetic moissanite. The French Gemmological Laboratory (LFG) recently received a 0.41 ct pink stone resembling a pink diamond (figure 22) for identification. The surface of the stone showed numerous patches (figure 23), casting doubts about the natural origin of its color.

Figure 21. Surface-reaching fissures with greater concentrations reveal a stronger blue reaction when observed in different directions under the DiamondView's visible light (left) and when exposed to the unit's ultra-short-wave UV energy (right).

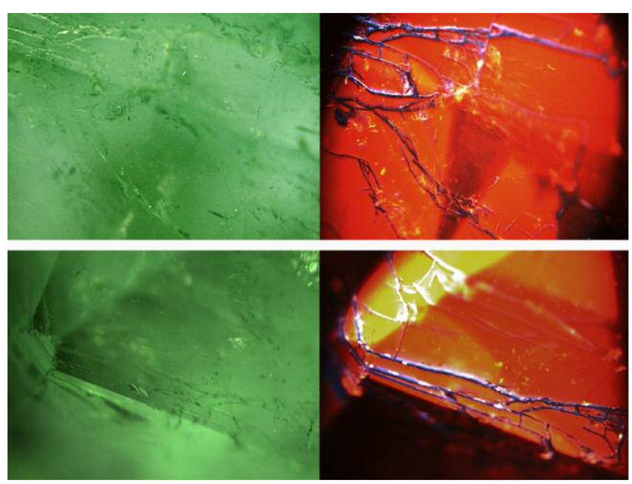


Figure 22. This 0.41 ct pink stone was revealed to be a coated synthetic moissanite. Photo by Aurélien Delaunay.

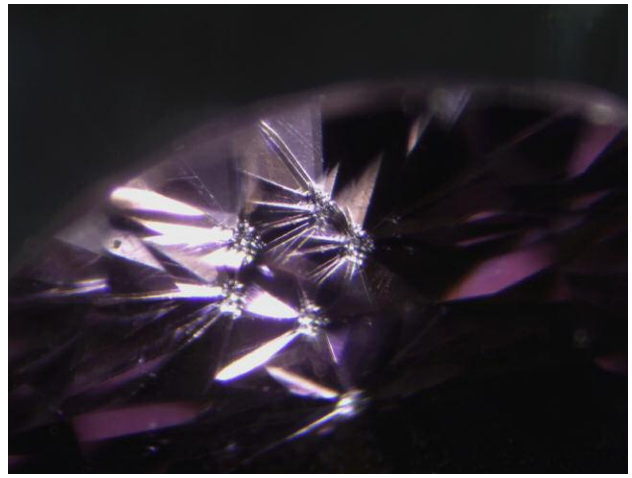
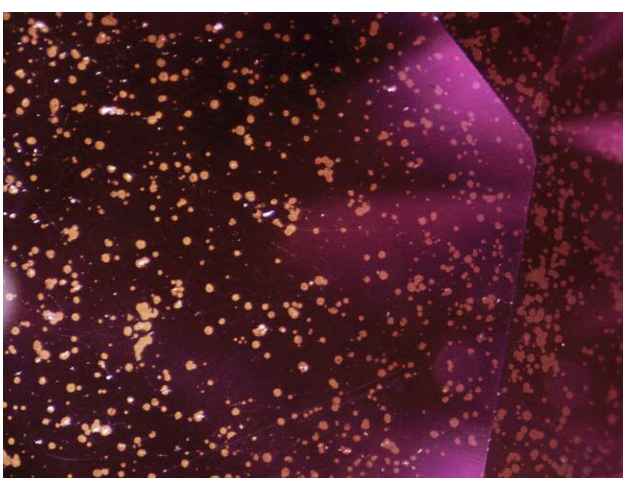


Figure 24. Doubling of the edges, observed near the crown in this synthetic moissanite. Photomicrograph by Aurélien Delaunay; field of view approximately 3.4 mm.

Under the microscope, these flakes showed metallic luster. Furthermore, the pink color appeared concentrated at the surface. Some unevenness in the color was observed due to scratches of this film. When observed through the crown, the gem showed a clear doubling of its edges, indicating an anisotropic material. These observations confirmed the client's doubts that the gem was a pink diamond (figure 24).

The sample was analyzed using infrared, UV-visible, and Raman spectrometers. All the spectra collected indicated a synthetic moissanite coated with a colored film. Chemical study of this film acquired with an EDXRF spectrometer revealed that iron and titanium were responsible for the color of the calcium-rich film.

Figure 23. Metallic flakes on the surface raised questions about the origin of the pink color. Photomicrograph by Aurélien Delaunay; field of view approximately 1.8 mm.



This is the first example the LFG has seen of synthetic moissanite coated with a thin colored film. This type of treatment is not rare with topaz, quartz, diamond, or tanzanite. Gemologists must remain vigilant because this treatment can be performed on all gems, natural or synthetic.

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Synthetic moissanite coated with diamond film imitating rough diamond. A transparent yellowish octahedral (sawable) crystal (figure 25) weighing 5.35 ct was submitted as a rough diamond to the Far East Geological Institute (FEGI) for examination.

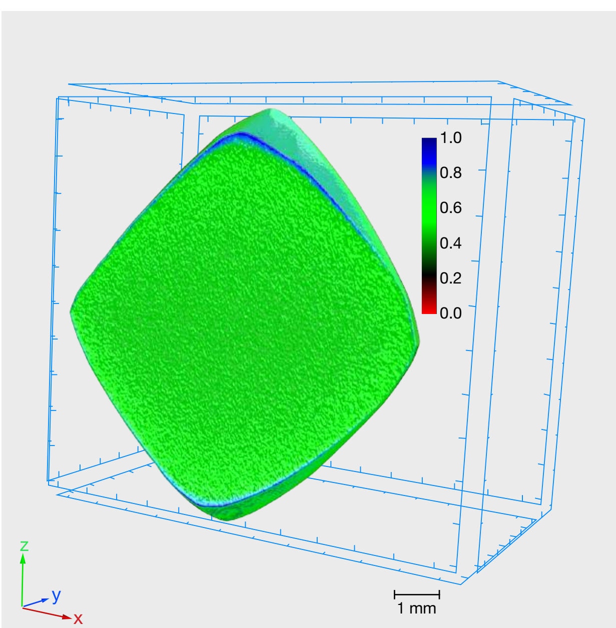
The faces of the octahedron showed a stepped appearance, and the edges had parallel grooves and combinational surfaces. The faces and edges were smooth except for one face where mechanical damage was noticeable. Initially, the specimen was examined using conventional gemological instruments. It was inert to long-wave UV (365 nm) and anisotropic. Thermal conductivity testing indicated diamond. Tests for electrical conductivity were not convincing, however: Some areas (mostly on the edges) corresponded to diamond, but others (on smooth faces and dimples) indicated synthetic moissanite. There were no inclusions associated with natural diamond. Only small parallel needle-like inclusions, typical for synthetic moissanite, were found using a gemological microscope (figure 26).

Figure 25. This 5.35 ct sample, submitted as a rough diamond, was identified as synthetic moissanite coated with a diamond film. Photo by V. Pakhomova.

Figure 26. Needle-like inclusions in the rough synthetic moissanite sample. Photo by V. Pakhomova.

X-ray tomography showed that the inner part of the sample was distinguished by its X-ray density from the outer shell, which had a variable thickness from 19 to 115 microns (figure 27). Microprobe analysis with a JEOL JXA-8100 four-channel microanalyzer revealed the presence of up to 61 wt.% silicon on some polished faces of the crystal, along with titanium in the composition of the surface layer (figure 28 and table 1). Some polished faces showed a diamond chemical signature.

Figure 27. Three-dimensional X-ray tomography rendering of the reconstructed sample. The coloring of the image corresponds to the degree of X-ray permeability. The green color represents the SiC crystal, and the blue color represents the film.



Based on these results, we identified the sample as synthetic moissanite that had been covered with a thin diamond film. Based on the study by T. Teraji et al. ("Chemical vapor deposition of ^{12}C isotopically enriched polycrystalline diamond," *Japanese Journal of Applied Physics*, No. 51, 090104, 2012, pp. 1–7), the diamond coating was likely applied using polycrystalline diamonds. The top layer was made of a composite material consisting of metal matrix and nano-diamond particles.

A diamond imitation such as synthetic moissanite coated with a thin diamond film is challenging to identify, since its luster and thermal properties correspond to diamond. Even with a very thin coating that did not exceed 0.001 mm, the sample tested positive for diamond. This

TABLE 1. Electron microprobe analysis of some parts of the surface of the "diamond" crystal.

Spectrum	C	O	Al	Si	Ti	Total
1	37.52	1.61	0.12	60.76	0	100
2	46.93	4.96	0.13	47.82	0.16	100
3	37.88	0.59	0.10	61.28	0.15	100
4	8.84	0	0.47	11.90	78.79	100
5	40.74	0	0.07	59.18	0	100
6	41.18	1.25	0.08	57.46	0.04	100

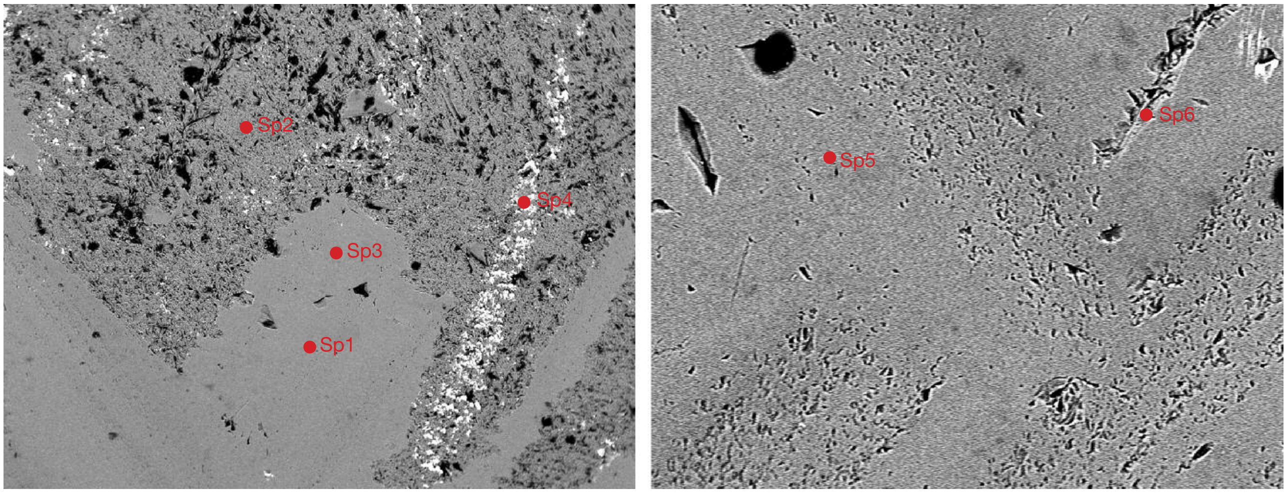


Figure 28. A fragment of the synthetic moissanite crystal, viewed with the electron probe microanalyzer. The crystal was analyzed on the surface. Spectrum numbers correspond to the analysis numbers in table 1.

application of thin diamond films onto non-diamond material could be an issue for gemologists in the future.

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CONFERENCE REPORTS

GSA 2018 report. The Geological Society of America (GSA) annual meeting took place in Indianapolis November 4–7. GIA participated as both exhibitor and technical session holder. In total, 21 presenters reported new findings on a broad range of research topics. The GIA booth and the two technical sessions attracted a large audience with an interest in gemology (figure 29).

The "Gemological Research in the 21st Century" technical program included both poster and speaker sessions. Seven posters were presented on the second day of the conference (figure 30). **Kyle Tollefson** (Louisiana State University) and **Phillip Ihinger** (University of Wisconsin-Eau Claire) reported their characterization study on watermelon tourmaline. Their spectroscopic measurements showed that the chromophores Fe and Mn correlate to green and pink colorations, as expected. The infrared spectroscopy and microprobe analyses showed similar trends of hydroxyl occupancy on the V site in this type of tourmaline. **Nikita Kepezhinskas** (University of Florida) presented the results of petrographic, geochemical, and isotopic analyses of moissanite and diamond from the shoshonite dike in eastern Finnmark, Norway. The shoshonite host of these minerals is a type of Mg- and K-rich basaltic rock, which is indicative of a subduction-modified mantle source. This study proved that carbonate recycling into the lower mantle through subduction, followed by the formation of superdeep diamonds, moissanite, and other carbides, plays an important role in the global carbon cycle. **Paul Johnson** and **Kyaw Soe Moe** (GIA, New York) showed an unusual find of a natural diamond with a cuboctahedral growth habit. This diamond should alert gem labs to the fact that cuboctahedral growth does not occur just in HPHT synthetic diamonds. This special diamond also indicated a potentially very interesting and uncommon growth history before it was lifted to the surface of the earth. **Richard Berg** (Montana Bureau of Mines and Geology) described significant magmatic splitting of sapphire xenocrysts in basaltic trachyandesite sill. Through extremely careful examination of *in situ* sapphires in their host rock and advanced instrument analyses such as SEM, XRD, and EDS, he was able to assemble a sequence of what happened to the sapphires before emplacement into their current location. **Ying Song** (China University of Petroleum) introduced a newly designed and developed computer-vision based intelligent RI measuring system. This system aimed to enhance the clarity and efficiency of RI and other optical measurements. Classroom demonstration, rapid crystal identification, optic axis characterization, and crystal orientation determination are the four modes currently implemented in this instrument. **Ziyin Sun** and coauthors (GIA, Carlsbad) displayed their study on chromophore strength in pyralspite garnet. Since multiple color-causing elements work singularly or together to color garnets, the authors isolated each of them and performed quantitative study by experimenting with various combinations of these chromophores' UV-Vis-NIR

Figure 29. Each year, the GIA booth at the GSA exhibition hall attracts participants from all over the world. Here, Paula Rucinski (left) and Dona Dirlam (right) speak with a visitor to the booth. Photo by Cathy Jonathan.

spectra under different lighting conditions. **Aaron Palke** and coauthors (GIA, Carlsbad) reported on a Montana sapphire study aiming to unravel its gemological mysteries. Based on their inclusion and geochemical study, the authors proposed a new model of sapphire formation through peritectic melting reactions during partial melting of an Al-rich protolith.

This year's speaker session attracted 14 presenters from multiple research institutes and universities (figure 31). **Mike Breeding** (GIA, Carlsbad) kicked off the session with an overview of colored diamonds formed at different depths within the earth. He elaborated on the defects that cause diamond's blue, pink, yellow, brown, and green colors. The audience was given a grand tour of colored diamond formation, from the transition zone all the way to the surface of the earth. Next, **Sally Eaton-Magaña** (GIA, Carlsbad) presented her photoluminescence study on pink diamonds based on GIA's uniquely large database. She explained the cause of pink color as a 550 nm absorption band and explored the difference of pink coloration in various diamond types. She also showed some visual clues that can help to separate pink diamonds from different sources. **Tyler Sundell** (Missouri State University) talked about the feasibility of using time-of-flight secondary ion mass spectrometry (ToF-SIMS) to image diamonds, especially on their trace-element composition and isotope analyses. Evaluation of this method focuses on its spatial resolution and analytical precision. Results show that this method lacks the precision to quantify carbon isotope values. **Karen Smit** (GIA, New York) presented her research on natural black diamonds found in the billion-year-old Marange conglomerate (Zimbabwe). Diamonds from this source are full of fractures and can be easily treated to achieve a more valuable fancy black color grade, which makes identification challenging with-

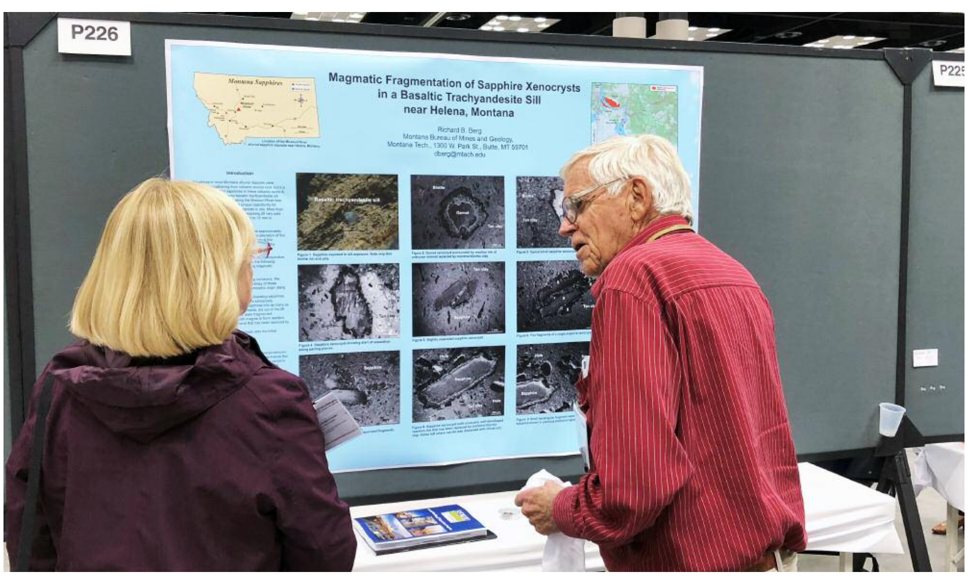


Figure 30. Richard Berg from the Montana Bureau of Mines and Geology presented his poster on Montana sapphires at the GSA annual meeting. Photo by Tao Hsu.

out characterization of the natural stones. Visual observation of graphite grain size and the detection of methane associated with the micro-inclusions are necessary to distinguish between natural and treated Marange diamonds. **Evan Smith** (GIA, New York) delivered his research on carbonatitic melt inclusions he discovered in partially healed cracks within a CLIPPIR diamond (for more on these diamonds, see Winter 2017 *G&G*, pp. 388–403). The characterization of these inclusions is consistent with carbonatitic melt, providing direct evidence of this melt's existence at mantle depths. **Russell Harmon** (North Carolina State University) evaluated the potential of handheld laser-induced breakdown spectroscopy (LIBS) to identify garnets associated with kimberlites, the host rock of most diamond deposits. This study aims to test whether this instrument will help diamond exploration in the field. Initial results showed that it works very well on garnets from the South Africa kimberlite field but not as well on some other samples, especially those from extensive solid solution. **Rod Smith** (Geological Survey of Canada) presented field and lab research on the Banks Island region in the western Canadian Arctic, aiming to find promising diamond-bearing kimberlite. Based on newly found stream sediments and till samples, geothermometry data, and Lu-Hf geochronology results, the research group demonstrated the need to continue the search for potential diamond-bearing kimberlite in this region and presented a potentially unknown kimberlite glacial dispersal model. **Tingting Gu** (GIA, New York) talked about inclusion studies on type IaB diamonds. This study offered the first piece of evidence that hydrous phosphate can subduct to the depth of the transition zone. It also showed the first ringwoodite found in diamond, which proved that this diamond formed in the deep mantle.

The second half of the speaker session started with **Mandy Krebs** (GIA, New York), who showed the application of Sr-Pb isotope data to colored gemstones' country-of-origin determination. The analyses were done by thermal ionization mass spectrometry (TIMS) to precisely measure the Sr-Pb isotope compositions in gem corundum for the first time. The separation is promising for certain sources but less so for others. **Rachelle Turnier** (University of Wisconsin-Madison) used Raman spectroscopy to evaluate the depth of zircon inclusion formation. These zircons are inclusions in corundum sourced from different deposits. Her study is based on an ideal linear upshift of Raman band of zircon with increasing pressure. However, many other factors can influence this ideal situation, such as radiation damage, stress, and internal heterogeneity. With careful consideration of these influencing factors, using Raman as a zircon barometer can help to distinguish corundum from various sources. **William Nachlas** (Syracuse University) presented the three different formation mechanisms for rutilated quartz. These include the overgrowth/entrapment mechanism, the precipitation mechanism, and the grain boundary migration mechanism, each with different relative timing of quartz and rutile growth. All three mechanisms were reproduced with well-designed experiments. **Peter Heaney** (Penn State University) explored the reason behind the striking iridescence displayed by some ochre-colored botryoidal goethite. Dr. Heaney applied focused ion beam (FIB) milling and scanning electron microscopy (SEM) to zoom in on the internal structure of this gem. With these powerful tools, some subsurface void layers were revealed to be responsible for the angle-independent iridescence. The origin of these voids remains a mystery. **Barbara Dutrow** (Louisiana State University) reported a geochemistry study on some uncommon tourmaline + corundum–bearing rocks from Afghanistan's Badakhshan Province with randomly oriented phlogopites as the matrix. Major, minor, and trace elements were measured with electron microprobe and laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS). The results indicate the involvement of boron-bearing fluids at the beginning of tourmaline growth and continuous infiltration of this fluid. The bulk composition of this rock is consistent with metasomatism of a clay-containing metacarbonate rock with a metamorphic overprint. **Chunhui Zhou** (GIA, New York) gave the first-ever pearl presentation in this technical session. Three American freshwater cultured pearls were sliced open and their oxygen isotopes were analyzed using SIMS, aiming to reconstruct the ambient water temperature when the nacre formed. This method is very useful in terms of growth cycle determination and can potentially shine a light on pearl origin determination.

Tao Hsu
GIA, Carlsbad

Meeting of the International Mineralogical Association. The 22nd meeting of the International Mineralogical Association (IMA), the first held in Australia and only the second in the Southern Hemisphere, took place in the Melbourne Convention and Exhibition Centre August 13–17, 2018. The meeting was hosted by the Geological Society of Australia.

Two technical sessions on gems were presented to about 100 attendees. The August 13 session, "Sciences Behind Gemstone Treatments," was chaired by **Andy Shen** (China University of Geosciences, Wuhan) and **Pornsawat Wathanakul** (Gem and Jewelry Institute of Thailand). The second day's session, titled "Recent Advances in Our Understanding of Gem Minerals" and led by **Ian Graham** (University of New South Wales, Australia), **Lee Groat** (University of British Columbia, Canada), and **Gaston Giuliani** (University of Lorraine, France), is detailed below.

The session consisted of 18 oral presentations covering several gem topics. **Frederick Sutherland** (Australian Museum, Sydney) opened with a keynote talk on the diversity in the geochemistry and inclusions of ruby from Myanmar and eastern Australia. He also discussed the ages of ruby formation through zircon ages and the *P-T* conditions through inclusion assemblages.

The other talks concerned different types of gems from supergene minerals up to corundum and spinel, including mining discoveries and activities from ancient and modern

Figure 31. Presenters, guests, and advocates from the GSA poster and speaker sessions. Left to right: Peter Heaney, Dona Dirlam, Mandy Krebs, Richard Berg, Mike Breeding, Jim Shigley, Tingting Gu, Tyler Sundell, Rachelle Turnier, Nancy McMillan, Evan Smith, Chunhui Zhou, Barbara Dutrow, and Sally Eaton-Magaña. Photo by Tao Hsu.

ages. **Ruslan Kostov** (Sofia University of Mining and Geology, Bulgaria) presented the archeological mineralogy of the Balkans through prehistoric (7 to 5 million BCE) gem minerals (nephrite, jadeite, talc, gabbros, jasper, and turquoise) and gold. **Lee Groat** revealed recent advances in colored gemstones in Canada, focusing on emerald from Yukon and blue spinel, sapphire, and scapolite from Baffin Island, as well as the use of different techniques such as drones for exploration. **Peter Lyckberg** (Luxembourg) offered a detailed state-of-the art presentation on the mining of gem pegmatites in Afghanistan and Pakistan, with amazing photos of aquamarine, kunzite, indicolite, and spessartine crystals from deposits in the High Karakoram range. **Wim Vertriest** (GIA, Bangkok) discussed the dynamics of gemstone discoveries and the challenges for research on the basis of timing the life of a deposit and the market perception of the gems' quality.

Different techniques for source determination of gems were also presented. **Hao Wang** (SSEF, Basel, Switzerland) related the advances in origin determination for gems using inductively coupled plasma time-of-flight (ICP-TOF) spectroscopy, with applications for blue sapphires and emeralds. **Zhiqing Zhang** (China University of Geosciences, Wuhan) used Fourier-transform infrared (FTIR) characteristics of amber from different areas of the world for origin determination. **Allan Pring** (Flinders University, Adelaide, Australia) related the use of multiple techniques on 200 opal samples of various origins, showing their similarities and differences. **Kemela Wijayanti** (Padjadjaran University, Indonesia) combined petrographic analysis with scanning electron microscopy (SEM) and X-ray fluorescence (XRF) techniques to characterize green jasper from southern Java. **Peter Downes** (Western Australian Museum, Perth) applied multiple techniques on variscite and associated phosphate minerals from the Mt. Deverell deposits in the Gascoyne region of Western Australia. **Isabella Pignatelli** (University of Lorraine) reported on the use of electron microprobe analysis, SEM, and X-ray tomographic images for characterizing trapiche ruby from Luc Yen in northern Vietnam.

New studies combining fieldwork with mineralogy and geochemistry were presented for several types of gems. **Philippe Belley** (University of British Columbia) discussed advances in trace-element fingerprinting for blue spinel and new insights into the origin of cobalt-blue spinel from Baffin Island in Canada. **This author** gave an update on gem demantoid garnet from Madagascar's Antetezambato deposit, based on new field data, and geochemical analysis of the most important demantoid deposits worldwide. **Simon Pecover** (Pan Gem Resources) coupled tectonic, hydrodynamic, rheologic, and shear-induced crystallization processes in the formation of opal veins in Australia, showing that the genetic model for the formation of Australian opal is more complex than previously known. **Ahmadjan**

Abduriyim (Tokyo Gem Science) used the U/Pb method on zircon inclusions for determining the formation ages of sapphires from the New England fields in New South Wales. **Kandy Wang** (University of New South Wales) presented data obtained on ruby from Paranesti, Greece, specifying the geographic typing of ruby via oxygen isotopes and trace elements. **Nick Raffan**, also of the University of New South Wales, combined fieldwork with remote sensing, petrographic analysis, and SEM to decipher the source of sapphires near tertiary volcanic plugs and Devonian conglomerates from Tomahawk Creek in central Queensland. **Ian Graham** related the presence of unusual alluvial sapphires from Orosmayo in Argentina using a multi-analytical approach to uncover their origin.

This session was followed by an evening meeting at the Gemmological Association of Australia (GAA) House in Melbourne, under the direction of **Margaret Blood**, president of the GAA's Victorian Division, and organized by **Andy Shen** and **Pornsawat Wathanakul**. The meeting was open to all researchers who participated in the two gem sessions of IMA and to Australian gemologists. The meeting consisted of three hour-long talks by **this author** on Colombian emeralds, **Lee Groat** on spinel and sapphire from Baffin Island, and **Brendan Laurs** (*Journal of Gemmology*) on pegmatites of Namibia.

Gaston Giuliani
University of Lorraine, France

Chicago Responsible Jewelry Conference. Held October 21 and 22 at Cinema Row, the Chicago Responsible Jewelry Conference drew 200 attendees who heard industry experts discuss safe, sustainable, ethical gem production and jewelry design.

Friday's session opened with a keynote address by **Mark Hanna** (Richline Group). "Our vision is the creation and maintenance of a *responsible*, worldwide supply chain that promotes trust in the global fine jewelry industry," Hanna announced. He discussed the ways blockchain technology is allowing for greater mine-to-market transparency. While there are communication and efficiency issues, as the various blockchains do not yet interact, open-source tracking does seem to be the wave of the future. Following Hanna's presentation, **Rolberto Alvarez** of Colombia's Mina Gualconda reported on the gold mine's transformation from a manual operation with mercury extraction (1974–2001) to an environmentally conscious, Fairmined-branded enterprise, supporting 12 families and using zero mercury.

Eric Braunwart (Columbia Gem House) moderated the first of several panels held during the conference. A group of gem cutters, representing four continents, discussed locale-based challenges that included the costs of replacing broken equipment, a lack of cutting knowledge and experience among locals, and recent restrictions on exporting rough from countries such as Tanzania. Panelists observed that clients also want corporate social responsibility (CSR) efforts to extend to cutters and reiterated what has been said at similar gatherings: The art of cutting involves more than just faceting a stone. Often cutters say the stones "speak" to them, telling them where to begin and end. The storytelling that has become part of the jewelry industry's outreach to customers should include tales of the cut as well.

Day one ended with the work of sustainability consultants The Dragonfly Initiative (TDI), which has developed the Coloured Gemstone Working Group (CGWG) to support the communities impacted by the colored gems sector. TDI's **Sarah Caven** posed the question: "Things are not perfect, and we can maybe never get perfection, but what can we do to improve transparency and do a better job in the supply chains?" She explained that the CGWG has created due diligence systems that are adaptable for everything from micro-businesses to large corporations, with commitments from 12 major luxury jewelry brands. With corporate partnerships, TDI has also launched artisanal and small-scale mining projects in Tanzania, Uganda, Kenya, and Brazil. **Brian Cook** (Nature's Geometry) spoke of his work as a consultant for TDI, investigating the financial records and environmental reclamation efforts of alluvial mining sites in Brazil. He also provided updates on the rutilated golden quartz community he established in Brazil's Bahia State.

The first day also featured the premiere of *River of Gold*, a documentary on illegal gold mining in the Amazon rainforest. The film shows the environmental devastation and human corruption that results from this form of gold exploitation. After the screening, sustainable jewelry consultant **Christina Miller** moderated a Q&A session with producer **Sarah DuPont**, joined by **Susan Egan Keane** (Natural Resources Defense Council) and **Nigel Pitman** (The Field Museum).

Day two opened with a panel in which jewelry designers described how they began working ethically sourced material. Moderated by jewelry designer and metalsmith **Alexandra Hart**, panelists told of humble beginnings in the responsible sourcing sphere; **Helene Grassin** (Paulette à Bicyclette) recalled sharing casting trees with other like-minded Parisian designers in order to afford the cost of ethically mined gold. The designers noted that their clientele know how to find them and were adamant about balancing bad news with transparency: If the customer cannot be told honestly that their materials are ethically sourced, they will often select a different metal or gemstone. They shared a desire to reach out to independent ethical, environmentally responsible gem suppliers so that designers and suppliers could join together to create a remarkable story for clientele. As one panelist stated, "We are the pioneers of creating these relationships."

Joanne Lebert (Impact) used a case study from the Democratic Republic of the Congo to explain how Impact believes ASM activity should operate. Borrowing the

Reagan-era dictum "Trust, but verify" allows the gemstone or jewelry piece's story to be told honestly and ethically. The Clinton campaign mantra "It's the economy, stupid!" reminds us that producers along the supply chain should be seen as economic actors who have a stake—and a final impact—on the material. Finally, Lebert's assertion that Obama focused on the good of the community as a whole reminds us that men and women in the mining and cutting sectors benefit differently from CSR efforts, a point examined further by the next speaker. **Glenn Lehrer** (Colourful Life Foundation) discussed the importance of giving back to communities that produce and work in the gem and jewelry industry. While the foundation is working in gem communities around the world, Lehrer focused on the schools it has opened for low-income children in Jaipur, India. Mothers of the children attending Colourful Life schools were provided with faceting training to prepare them for Jaipur's workforce. He was surprised to learn that the women rejected at-home training and workshop equipment. Going to school and work was a form of dignity for them, whereas Western workers often prefer the convenience of working remotely.

The last panel of the conference, moderated by **Monica Stephenson** (Anza Gems and iDazzle) focused on artisanal mining. Panelists recounted their personal experiences, challenges, and triumphs in the mining sector. Among the speakers was **Salma Kundi**, a tourmaline miner from Tanga, Tanzania, and secretary general of Tanzanian Women's Mining Association (TAWOMA); her group was involved in the Pact/GIA guidebook project (see below). Where Kundi comes from, a miner pays for a concession and a license and exploits the deposit with assistance. A mining license costs about US$400, a high price for a woman, and that does not cover mining and food expenses. Membership in TAWOMA allows for collective mining, enabling women to pay for licenses. Other challenges include a need to reach buyers beyond their local markets.

Robert Weldon spoke about GIA's collaboration with Washington, DC–based NGO Pact to create and distribute a rough gem guidebook among Tanzanian miners (Summer 2018 GNI, pp. 245–246). Since early 2017, GIA and Pact have provided training with the Swahili-language guidebook, which is accompanied by a tray for sorting gemstones using reflected and transmitted light. Follow-up surveys revealed a $12 social return on investment for every $1 invested in the program. As of October 2018, the guidebook has reached approximately 1,000 Tanzanian miners. The final speaker of the day, **Yianni Melas** (The Gem Explorer), recounted his experiences as a human rights advocate for gem and jewelry laborers, including a recent 31-day hunger strike that made international headlines.

Both days also featured a gem boutique, with information on ventures and gemstones available for sale. There were also optional lunch sessions that elaborated on topics that will affect the industry's future, such as the Jewelry Development Index, the flagship project of the University of Delaware's "Mines, Minerals and Society" program; the Mercury-Free Mining Challenge; and TrustChain, a collaboration between industry leaders and IBM to create a blockchain solution. As Mark Hanna said in opening the conference, "The challenge of our unknown future is so much more exciting than the stories of our accomplished past."

The 2019 Chicago Responsible Jewelry Conference is slated for Friday, October 25 and Saturday, October 26.

Jennifer-Lynn Archuleta
GIA, Carlsbad

Second World Emerald Symposium. Hosted by Fedesmeraldas (the Colombian Emerald Federation), Acodes (the Emerald Exporter Association), Aprecol (the Emerald Producers Association), Asocoemeral (the Emerald Dealers Association), and Minminas (the Ministry of Mines), the second World Emerald Symposium was held in Bogotá October 12–14, 2018.

The inaugural event in 2015 was themed "Be part of the change." Three years later, the emphasis was on sustainability, blockchain, nanotechnology, and traceability. Does the community share the benefit from the companies? The future of the emerald industry should develop with the local communities through education, improving health care and working conditions. These questions/keywords were among the important topics expressed during this second edition of the symposium.

More than 60 Colombian and international speakers and panelists presented a wide variety of topics such as gemology, ethics, government, stakeholders, and marketing before a large audience from around the world and representing all levels in the emerald industry.

Day one began with opening talks by Colombian officials, symposium organizers, and presidents of gem and jewelry associations (ICA, CIBJO, and AGTA). This was followed by geology and mining sessions. **Gaston Giuliani** (IRD, CRPG, Nancy, France) again offered an exciting talk on world emerald deposits in the 21st century, assessing current knowledge, types of deposit, and exploration. **Lee Groat** (University of British Columbia, Vancouver) spoke on emerald occurrences in Canada's Yukon Territory and the challenges for exploration and exploitation. **Gian Carlo Parodi** (National Museum of Natural History, Paris) reviewed the species and varieties of the beryl group and shared photos of various rare collector specimens such as stoppaniite and bazzite.

In the afternoon session on gemology, **Gabriel Angarita** (CDTEC Gemlab, Bogotá) introduced a new treatment for emeralds coming onto the market called "Naturalys." He compared it to traditional oil treatment or resin and described its identification. **Taijin Lu** (NGTC, Beijing) discussed the recently formed Chinese national standard on emerald grading. **Vincent Pardieu** (DANAT, Bahrain) spoke on emerald from Madagascar and presented a well-made video from his most recent field expedition to Madagascar. **Olivier Segura** (L'École des Arts Joailliers, Paris) presented the school, which is supported by Van Cleef & Arpels, and its rich variety of classes such as jewelry history, gouache techniques, setting, gemology, and more.

Andy Lucas (Guild Gemlab, Shenzhen) talked about educating Chinese consumers on colored gemstones and China's potential as a luxury jewelry market. He concluded by introducing the new education programs offered by the Guild Institute of Gemology. **Alan Hart** (Gem-A, London) reviewed the association's heritage and long history. He also presented Gem-A resources such as its library, the *Journal of Gemmology*, and traditional education and alumni activities across the world.

This first day ended with two panel discussions, with **Ronald Ringsrud** and **Shane McClure** moderating the first. **Laurent Cartier** (SSEF, Basel), **Gagan Choudhary** (GTL, Jaipur), **Rodrigo Giraldo** (RGLAB, Bogotá), and **Aurélien Delaunay** (LFG, Paris) discussed laboratory reports on emerald treatments and the difficulties in determining the degree of enhancement. Is it a subjective call? Is a finding of minor, moderate, or significant enhancement sufficient, or would the addition of more degrees of enhancement on the reports be more accurate and benefit the industry? These were among the questions exchanged.

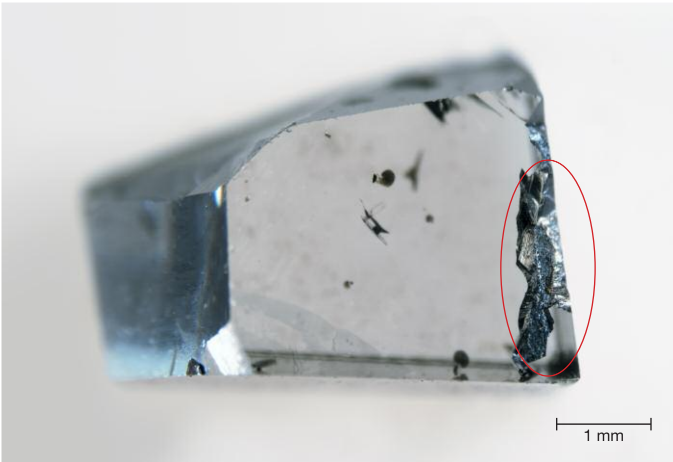
A second panel on gemology and origin (figure 32) was led by Shane McClure with panelists **Kenneth Scarratt** (DANAT), **Taijin Lu** (NGTC), and **Claudio Milisenda** (DSEF German Gem Lab). The group offered a frank discussion of many critical issues on country of origin determination. They also shared the difficulties gem labs encounter in building a reliable dataset to support country of origin determination. Potential solutions were also proposed.

The second day emphasized stakeholders' social responsibility, ethics, and marketing. The day began with speakers from mining companies. **Assheton Carter** (The Dragonfly Initiative), **Rosie Perkins** (FURA Gems), **German Forero** (Santa Rosa), and **Elena Basaglia** (Gemfields) talked about their respective projects on sustainability and development of social programs to support local communities. Projects included modernizing the mines, developing schools, and implementing health care systems. Independent consultant **Gerardo Vargas** concluded the session by discussing the importance of appellation of origin for Colombian emeralds and how it would benefit and protect the market, increase value, develop the industry, and give recognition to Colombian emeralds.

After the lunch break, the session continued with **Prida Tiasuwan** (Pranda Group) who offered insight on Thailand's gem and jewelry industry and its potential as a global gem and jewelry hub. Pointing at the duty-free, tax-free, and non-VAT trading system for gemstones, he talked about Thailand as a major center for colored stone education, cutting, manufacturing, and treatment.

Zhao Xin Hua presented information on the Gemstone Association of China and shared data and statistics on the Chinese colored gem market. **Liu Yi** (GAGCC) talked about the gem and jewelry investment hub opportunities

Figure 32. GIA's Shane McClure led the discussion panel on country of origin. Joining him, from left to right, were Kenneth Scarratt, Taijin Lu, and Claudio Milisenda. Photo by Tao Hsu.



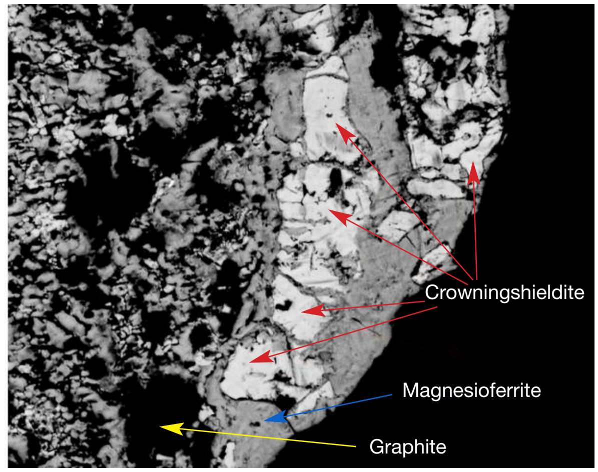


Figure 33. Left: A diamond sample from the Letšeng mine in Lesotho that contains the newly recognized mineral crowningshieldite, in the area circled in red. Right: Electron microscopy reveals individual grains of crowningshieldite in a fine-grained mixture with other minerals. Photos by Evan M. Smith (left) and Fabrizio Nestola (right).

with China. Next, **Laurent Cartier** (Gemstones and Sustainable Development Knowledge Hub) explained the organization's work and discussed the challenges regarding artisanal mining, short-life deposits, stock management, and consideration of quality over origin.

The last session was devoted to ethics and corporate social responsibility. **Cathlijne Klomp** (LVMH) spoke about responsible sourcing of colored gemstones as well as the challenges and opportunities for creating sustainable value. Next, **Charles Chaussepied** (Responsible Jewellery Council) explained the RJC's history, role, and mission. This last session was by a panel discussion regarding certifications with **Edwin Molina** (APRECOL) and **Charles Burgess** (Muzo MTC).

Day three was a half-day exploration of history. Independent jewelry specialist **Joanna Hardy** spoke on the Colombian emerald pocket watch from the Cheapside Hoard, the emerald and diamond parure of Empress Marie-Louise of France, and many other important antique emerald jewels. **Ronald Ringsrud** followed with more storytelling about people, miners, and emerald adventures. **Ioannis Alexandris** (Gemolithos) covered the magnificent Old Mine emeralds, historical jewelry featuring Colombian emeralds, and record-breaking auction sales. **Gerard Martayan** (Schlumberger) reviewed the rediscovery of the fascinating Chivor emerald mine.

Closing keynote addresses by **Shri Pramon Agrawal** (GJEPC), **Carlos Amaya** (governor of Boyacá), and **Oscar Baquero** (Fedesmeraldas) concluded the 2nd World Emerald Symposium.

Jonathan Muyal and Tao Hsu
GIA, Carlsbad

ANNOUNCEMENT

Crowningshieldite: A new mineral. GIA, in collaboration with researchers at the University of Padova, recently discovered crowningshieldite (figure 33), a new mineral named in honor of G. Robert Crowningshield (1919–2006), a pioneering researcher at GIA for more than 50 years. His many landmark contributions included the detection of irradiated diamonds, the initial report on General Electric's facet-quality synthetic diamonds, and the description of "padparadscha" sapphire's orangy pink to pinkish orange color. Crowningshieldite is a nickel sulfide mineral with a hexagonal crystal structure and can be regarded as the high-temperature polymorph of the mineral millerite. Discovered as an altered inclusion in two diamonds from the Letšeng mine in Lesotho, it was accepted as a mineral on September 18, 2018, by the International Mineralogical Association.