G&G Micro-World

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Blue Apatite in Pyrope-Spessartine Garnet

The author recently had the opportunity to examine and facet a piece of garnet rough. The garnet, reportedly from Madagascar, was acquired from gem cutter and dealer Desmond Chan of Los Angeles. The rough was selected for the unusual blue apatite crystal nearly reaching the surface. Laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) chemical analysis indicated the rough to be a pyrope-spessartine variety. When orienting the stone in preparation for faceting, the author wanted the apatite inclusion to be the main focus of the gemstone. After slow and careful execution, a cut-cornered mixed-cut faceted gem was achieved, with the apatite eye-visible just under the table facet (figure 1). Oblique fiber-optic illumination was used to observe the world inside the gemstone, revealing a scene consisting of the blue euhedral apatite crystal paired with numerous iridescent intersecting needles of rutile (figure 2). This is one of the most unusual inclusions the author has seen in a garnet, and it is also notable as the gem was faceted to showcase the inclusion rather than hide or remove it.

Jessa Rizzo
GIA, Carlsbad

Figure 1. This 5.33 ct red pyrope-spessartine garnet was faceted by the author to display the unusual blue apatite crystal within. Photo by Diego Sanchez.

CVD Landscape

Fluorescence is an integral part of diamond analysis that displays varying growth defects. Each color provides visual clues to the growth chemistries and defects formed. Gemologists use this data along with other spectroscopic features to determine a diamond's origin and treatment history. The

Figure 2. A blue apatite crystal associated with intersecting iridescent needles was showcased. Photomicrograph by Jessa Rizzo; field of view 2.90 mm.

About the banner: Platy inclusions of covellite appear a vibrant pink color in this quartz from Brazil. Photomicrograph by Nathan Renfro; field of view 3.83 mm. Stone courtesy of the John Koivula Inclusion Collection.

Editors' note: Interested contributors should contact Nathan Renfro at nrenfro@gia.edu and Stuart Overlin at soverlin@gia.edu for submission information.

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Figure 3. GIA-grown rough CVD diamond weighing 5.8 ct, photographed under daylight conditions. Photo by Towfiq Ahmed.

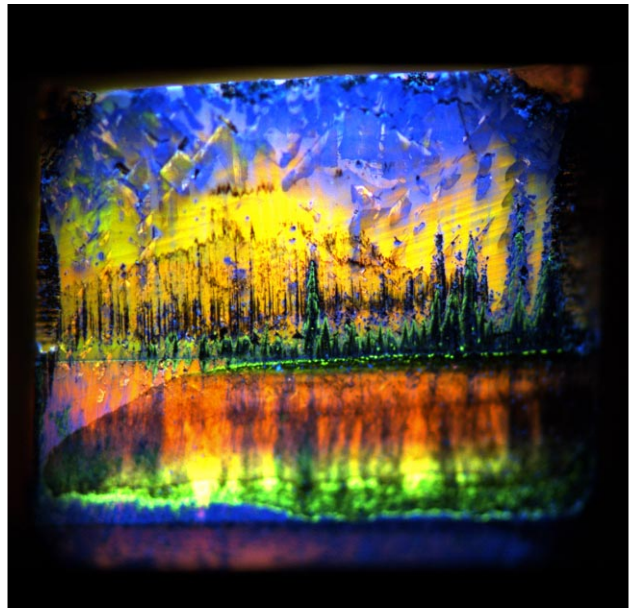


Figure 4. DiamondView fluorescence image of a 5.8 ct GIA-grown CVD block measuring 7 × 7 × 7 mm. Photomicrograph by Stephanie Persaud.

fluorescence features in this experimental CVD block grown by GIA (figure 3) are reminiscent of a landscape with trees reflecting into a lake during a sunset (figure 4, illuminated using a DiamondView equipped with a UV light).

CVD diamond technologies have improved vastly over the last decade. Researchers at GIA grew this CVD block over several growth runs to gain a better understanding of CVD diamonds. This block captures the essence of nature within a laboratory setting.

Stephanie Persaud
GIA, New York

Unmasking Emerald Filler

Of the treatments we see in the laboratory, fissure filling has become one of the most ubiquitous. We have observed this treatment in a variety of stones, including emerald, ruby, sapphire, spinel, tourmaline, tanzanite, and more. The filling of fractures minimizes their appearance, making the gems appear cleaner. Fissure filling can be detected

Figure 5. An emerald with irregularly shaped cavities, shown in darkfield illumination. Photomicrograph by E. Billie Hughes; field of view 4 mm.

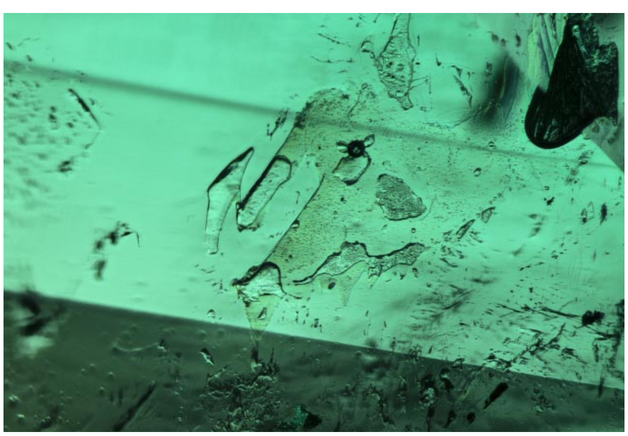


Figure 6. When the same inclusion scene is lit with a long-wave ultraviolet flashlight, it becomes evident that the cavity contains a filler that fluoresces a chalky blue color in long-wave illumination. The irregular shapes can also be seen to contain rounded gas bubbles. Photomicrograph by E. Billie Hughes; field of view 4 mm.

with a variety of methods. One way is to examine the infrared spectrum, where some fillers display distinctive peaks. Another is the hot point method, where oils can be observed leaking out in droplets. Some fillers are unmasked with simple observation in the microscope, because they display flashes of color or because they include visible dyes.

In addition to these methods, another tool in our arsenal is the long-wave ultraviolet flashlight, which can be used in conjunction with the microscope. Because some fillers display a chalky fluorescence when illuminated with long-wave UV light, shining a long-wave UV flashlight at the specimen is a simple technique that helps us to not only to detect the filler, but also to see its exact location in the stone. This helps the gemologist gauge the extent of filling and its impact on the stone's overall appearance.

Figure 5 (see p. 527) offers a great example of this. This inclusion scene in emerald shows an irregular cavity. When illuminated with a long-wave UV flashlight (figure 6), it is immediately evident that the cavity is filled with a substance that displays a chalky blue fluorescence. Observation under long-wave UV light also makes it easier to observe gas bubbles in the filled areas.

E. Billie Hughes
Lotus Gemology, Bangkok

Figure 8. A negative crystal surrounded by iridescent thin films. Photomicrograph by Charuwan Khowpong; field of view 1.20 mm.

Inclusions in Kenyan Rubies from the John Saul Mine

Rubies from the John Saul mine have been available in the market since the 1970s. The gems are found in a pegmatite-like vein that intrudes an ultrabasic body within the country rock (Winter 1999 Gem News, pp. 213–215). While the mine has produced a large quantity of ruby with fine color, only a small part of the production is fine quality and suitable for faceting, with most of the samples being cut into cabochons. Production has declined, and the material is seen less nowadays.

The rubies have an inclusion scene that typically includes short, iridescent needles associated with dense clouds of particles, often in bands (figure 7). Negative crystals surrounded by a plane of thin films are also typical (figure 8). These are very similar to the inclusion scenes in rubies from Mogok (Myanmar) and other marble-hosted deposits. The fact that the color and fluorescence, which is dictated by the trace element chemistry, are also similar to marble-related deposits makes separating them from

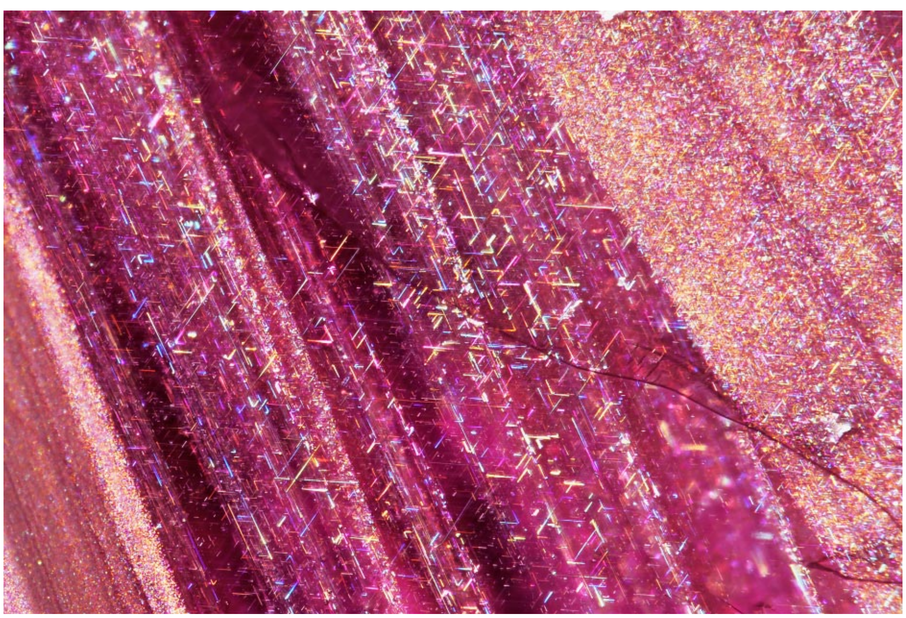


Figure 7. Bands of dense clouds of particles associated with iridescent short needles. Photomicrograph by Suwasan Wongchacree; field of view 1.75 mm.

Kenyan rubies even more challenging. This shows that similar inclusion scenes can form in very different geological environments and that the internal world of gemstones is not always a conclusive indicator of geographic origin.

Charuwan Khowpong
GIA, Bangkok

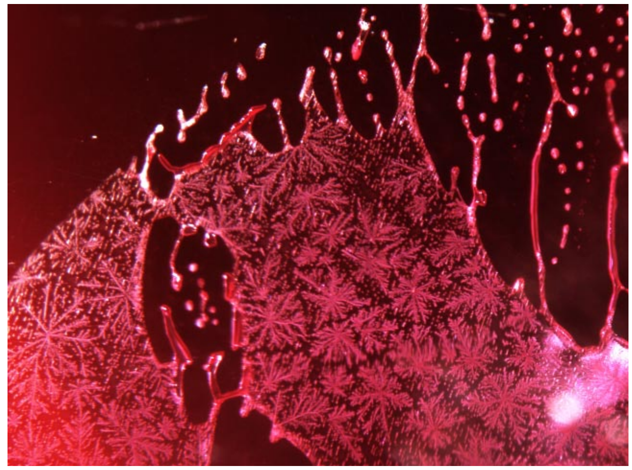


Figure 10. This partially healed fissure with a snowflake-like pattern is seen in a flux-heated Mong Hsu ruby. Photomicrograph by Nattida Ng-Pooresatien; field of view 1.3 mm.

Uncommon Inclusion of Lazurite in Ruby from Mogok, Myanmar

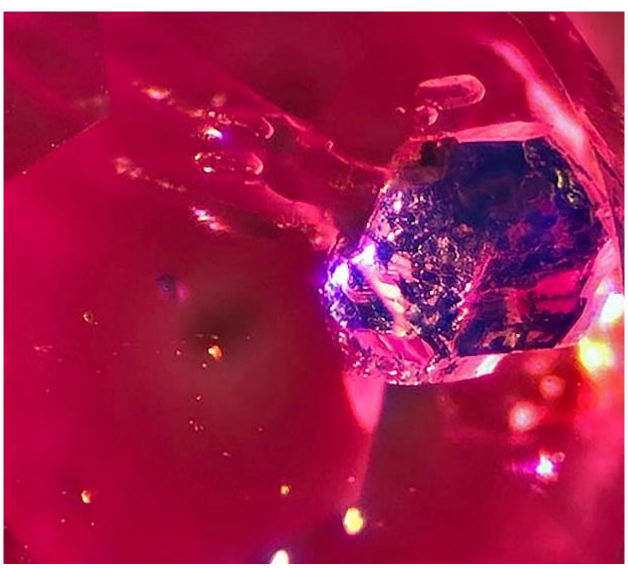
A parcel of small rubies was received for identification at the S Gemmological Institute (SGI) gem lab in Yangon, Myanmar. Based on chemical, spectroscopic, and standard gemological testing, they were determined to originate from the Mogok Stone Tract in Myanmar. One faceted ruby contained a small blue crystal inclusion with what appeared to be a pyritohedron shape but an uncommonly seen bright blue color (figure 9). This inclusion was identified by Raman spectroscopy as lazurite.

A blue lazurite inclusion was previously reported to have been found in a 5.09 ct Burmese ruby and a 1.40 ct ruby from Namya, Myanmar (Spring 2012 Lab Notes, pp. 51–52). Also, blue lazurite mineral has previously been detected in 1.02 ct light gray Burmese spinel (Spring 2019 Micro-World, pp. 112–113).

According to the literature and our knowledge of inclusions in rubies from Mogok, this blue mineral is rare as an inclusion in Burmese rubies.

Thuzar Aung
S Gemmological Institute (SGI), Yangon, Myanmar

Figure 9. Lazurite inclusion in Mogok ruby from Myanmar (transmitted light and oblique illumination). Photomicrograph by Kyaw Thu; field of view 0.25 mm.



Snowflake Inclusions in Mong Hsu Ruby

The two main sources of Burmese ruby today are Mogok and Mong Hsu. Mogok is the traditional source of gem-quality ruby. The rubies from Mong Hsu are generally not as high in quality as those from Mogok, and typically show distinctive zoning with dark violet cores, a cloudy appearance, and multiple fractures. As a result, most stones from this deposit are heat treated at moderate temperatures using flux to repair fractures, improve clarity, and remove any unwanted blue color. Unheated Mong Hsu rubies are generally considered quite rare.

The author recently examined a 0.79 ct sugarloaf cabochon of pigeon's blood ruby. Chemical analysis and gemological observation of internal features indicated that the origin of this stone was the Mong Hsu. Interestingly, microscopic examination with a combination of darkfield and oblique fiber-optic illumination revealed an open fissure with a snowflake-like pattern of flux residue (figure 10). The pattern is formed by the crystallization or devitrification of the glassy flux residue.

The snowflake is a symbol of the winter season and a traditional image associated with the Christmas holiday. This partially healed fissure resembling snowflakes is the first such feature the author has encountered in flux-heated ruby.

Nattida Ng-Pooresatien
GIA, Bangkok

Metal Sulfide Crystal in a Sapphire

The author recently examined a faceted sapphire from Sri Lanka. Gemological analysis confirmed that it was unheated. The sample contained a crystal that, when examined under the microscope using darkfield illumination and oblique fiber-optic illumination, exhibited a highly re-

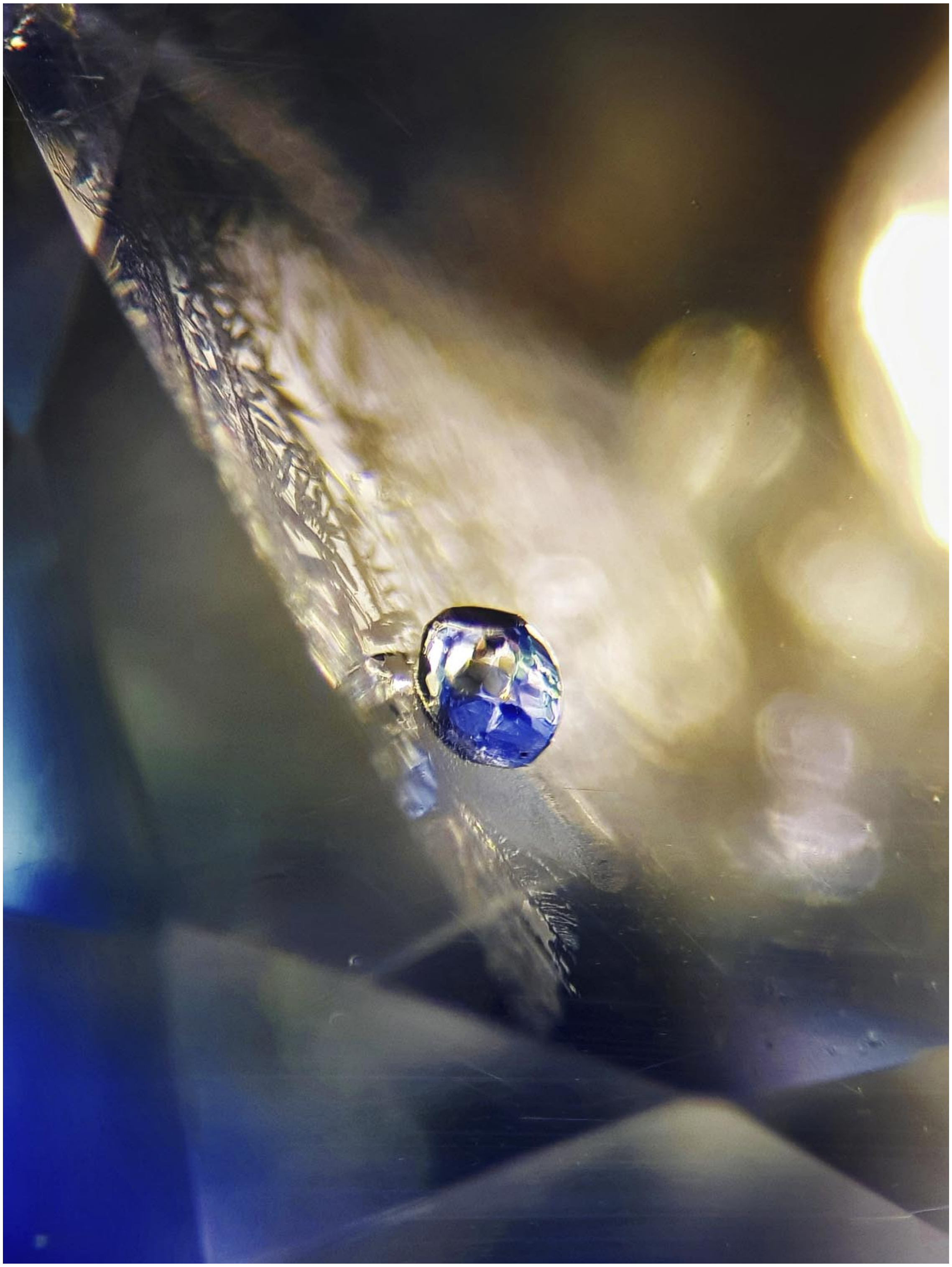


Figure 11. A rounded metal sulfide crystal displays a metallic luster within an unheated sapphire. Photomicrograph by Muzdareefah Thudsanapbunya; field of view 2.3 mm.

flective surface. The observations of the metallic luster and rounded appearance (figure 11) suggested that this inclusion was most likely an iron sulfide.

Iron sulfides are found as opaque mineral inclusions with metallic luster in corundum. The iron sulfides usually seen in corundum are pyrite (FeS_2) and pyrrhotite ($Fe_{1-x}S$)

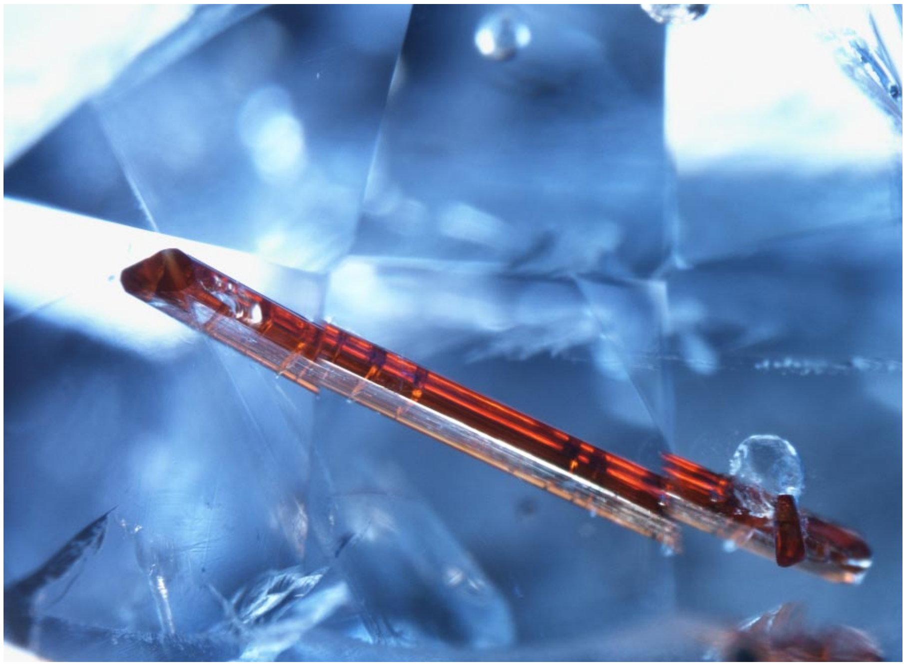


Figure 12. The elongated orange transparent rutile crystal observed in the faceted blue sapphire from Afghanistan. Photomicrograph by Nattida Ng-Pooresatien; field of view 3.0 mm.

(E.J. Gübelin and J.I. Koivula, *Photoatlas of Inclusions in Gemstones*, Vol. 3, Opinio Publishers, Basel, Switzerland, 2008, p. 285). Also present was a partially healed fracture, or fingerprint, next to this crystal, which made for an interesting inclusion scene.

Muzdareefah Thudsanapbunya
Bangkok

Elongated Rutile Crystal in Blue Sapphire from Afghanistan

Rutile, titanium dioxide (TiO_2), is a tetragonal mineral that generally occurs in corundum as silk (exsolution-formed needles), dust-like exsolution particles, or macroscopic crystal inclusions. Rutile crystals can have orange to deep red-brown coloration, and the crystal shapes can be rounded or euhedral.

The author recently examined a 4.24 ct faceted transparent blue sapphire from Afghanistan. The stone contained dusty flake-like inclusions, naturally healed fractures, lathe-like inclusions, twinning, rounded colorless crystals identified as apatite (RRUFF R040098), and an unusual long prismatic orange crystal identified as rutile (RRUFF R040049). This rutile crystal shape (figure 12) is not typical for corundum, particularly in blue sapphire.

Titapa Tanawansombat
GIA, Bangkok

Zircon in Jadeite Jade

One translucent green bangle bracelet recently examined by the author contained an interesting inclusion. The material was identified as dyed and polymer-impregnated jadeite jade using standard gemological testing and advanced spectroscopy, including UV-Vis, Raman, and infrared. This material would be classified as C-type jade in the trade.

Microscopic examination revealed a surprisingly well-formed transparent brownish crystal inclusion (figure 13). Raman analysis of the doubly terminated tetragonal prism revealed it to be "high" zircon ($ZrSiO_4$). To confirm this, the full width at half maximum (FWHM) of the internal stretching mode at 1008 cm^{-1} was calculated as 6.05 cm^{-1}, indicating a high level of crystallinity, as this band is known to broaden as metamictization occurs (L. Nasdala et al., "Metamictization and U-PB isotopic discordance in

Figure 13. This doubly terminated tetragonal crystal in jadeite jade was identified as "high" zircon using Raman spectroscopy. Photomicrograph by Tyler Smith; field of view 2.90 mm.

Figure 14. This aquamarine crystal plays host to several orange garnet crystals. Photo by Angelica Sanchez.

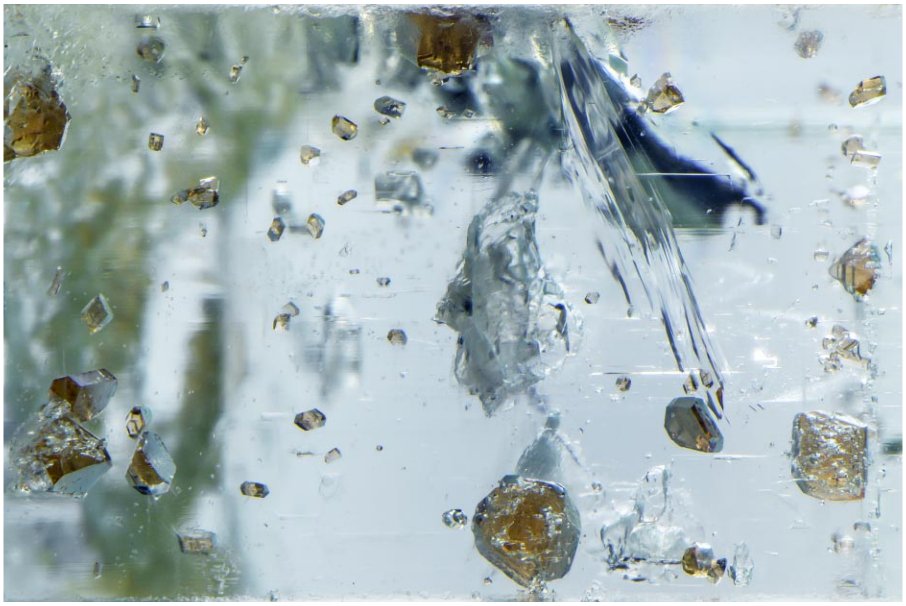


Figure 15. The garnets in the aquamarine were identified by Raman analysis as spessartine. Photomicrograph by Nathan Renfro; field of view 9.40 mm.

single zircons: A combined Raman microprobe and SHRIMP ion probe study," *Mineralogy and Petrology*, Vol. 62, 1998, pp. 1–27).

Although interstitial zircon grains are not uncommon in jadeites, such a euhedral crystal is rarely observed and is especially unexpected considering the various treatments its host had undergone.

Emily Jones
GIA, New York

Quarterly Crystal: Garnets in Aquamarine

For this quarterly crystal, we examined a transparent light blue-green hexagonal prism of aquamarine beryl terminated with a flat pinacoid (figure 14). The crystal weighed 26.16 ct with corresponding measurements of 25.93 × 11.64 × 9.08 mm. This aquamarine reportedly came from the Shigar Valley in the Skardu district, Gilgit-Baltistan territory of Pakistan, an area known to produce gemmy aquamarine crystals.

Magnification revealed numerous intense orange syngenetic garnet crystals near the base of the aquamarine. Raman analysis of the well-formed garnets identified them as spessartine (figure 15).

Garnet inclusions in beryl are rare. Having the opportunity to study this euhedral crystal gives us further insight into the pegmatitic origin of this aquamarine and its locality.

John Koivula
GIA, Carlsbad