

G&G

Micro-World

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Aquamarine with Fluorite Inclusions

The specimen shown in figure 1, weighing 1418 ct and measuring approximately 77 × 55 × 45 mm, is a sharp, well-formed hexagonal light blue aquamarine crystal with attached muscovite crystals. The sample is from the well-

Figure 1. Twelve white octahedral fluorite crystals ranging from 5 to 10 mm across are visible inside this well-formed aquamarine crystal. Photo by Russell E. Behnke.



known and highly productive Chumar Bakhoo mines of Pakistan's Hunza Valley in the Nagar district of Gilgit-Baltistan. A dozen white octahedral fluorite inclusions, identified as such based on their shape, hardness, and polarized light response (confirmed isometric), are visible throughout the crystal (figure 2).

Considering the Chumar Bakhoo mines have been in operation for the last four decades, this is a surprisingly one-of-a-kind specimen. A literature search failed to turn up any other examples of fluorite inclusions in aquamarine.

*Russell E. Behnke
Meriden, Connecticut*

Figure 2. Close-up of three fluorite crystals in aquamarine. Photomicrograph by Harold Moritz; field of view 15 mm.



About the banner: This etched surface of a diamond from Wyoming shows modified trigons. Photomicrograph by Nathan Renfro; field of view 1.14 mm.

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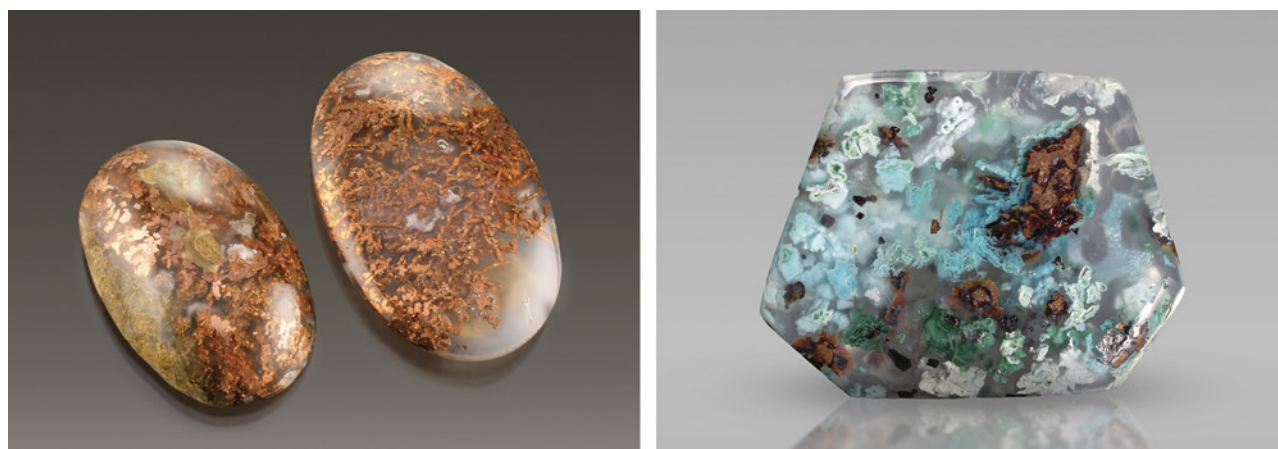


Figure 3. Left: Containing abundant amounts of native copper but no secondary copper minerals, these two chalcedony quartz cabochons, weighing more than 40 ct each, come from Lawang Kori, West Java Province, Indonesia. Right: This 16.91 ct chalcedony cabochon from Obi Island, Indonesia, on the other hand, contains secondary copper minerals including turquoise blue chrysocolla, green malachite, and a small amount of deep red cuprite. Photos by Annie Haynes (left) and Rhonda Wilson (right).

Copper in Indonesian Chalcedony

The authors recently examined two oval double cabochons consisting of chalcedony quartz, each with a multitude of glistening metallic native copper inclusions (figure 3, left). These gems were reportedly from Lawang Kori, Garut Regency, West Java Province, Indonesia, and weighed 43.04 and 46.68 ct, respectively, with corresponding measurements of $30.78 \times 20.46 \times 7.88$ mm and $36.21 \times 23.19 \times 7.88$ mm.

A chalcedony deposit was previously reported on Obi Island, Indonesia (J. Ivey and B.M. Laurs, "Copper minerals in chalcedony from Obi Island, Indonesia," *Journal of Gemmology*, Vol. 38, No. 5, 2023, pp. 512–521), producing material containing an abundance of azurite, chrysocolla, cuprite, malachite, and other secondary copper minerals (figure 3, right). However, these secondary copper minerals are absent in the Lawang Kori material (figure 4).

Figure 4. The chalcedony cabochons from Lawang Kori, Indonesia, contain an abundance of elemental copper but lack brightly colored secondary copper minerals. Photomicrograph by Nathan Renfro; field of view 5.63 mm.

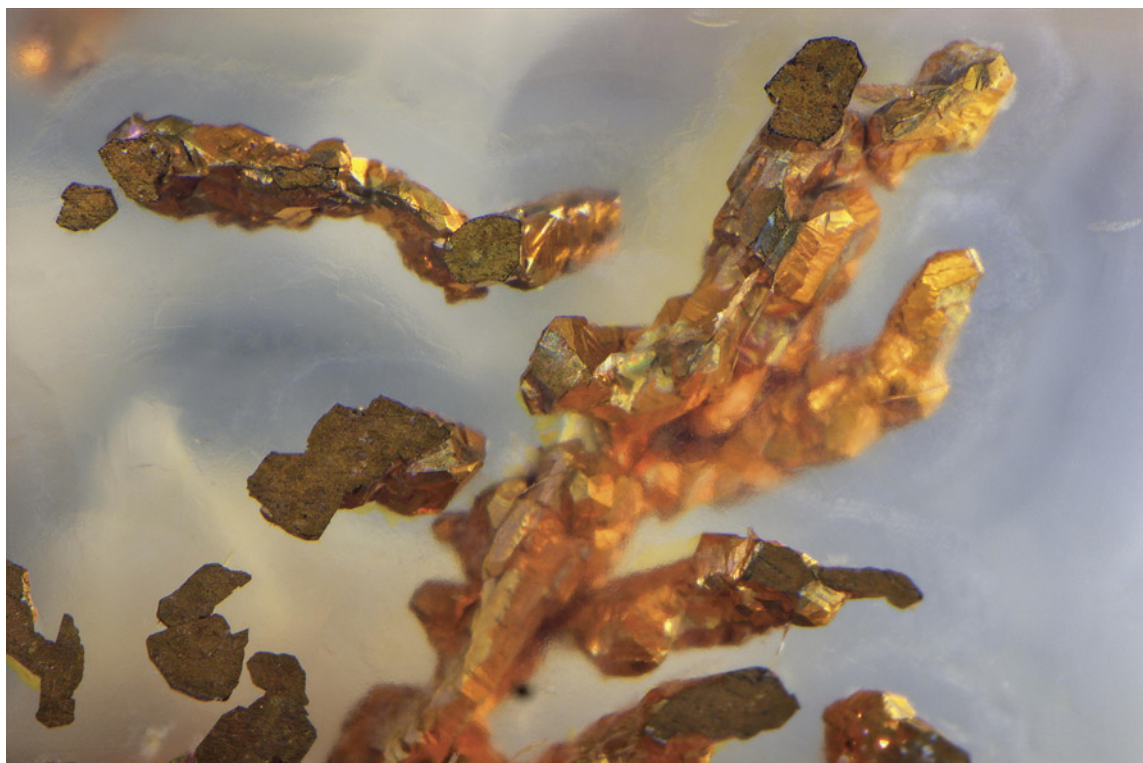




Figure 5. Crystal inclusions in a 0.50 ct natural diamond resembling a fly with mirror reflection and human eyes with prism reflection. Photomicrograph by Jignesh Sojitra.

This new material is ideal for cutting and takes an excellent polish, which should make it a marketable variety of chalcedony.

*John I. Koivula and Nathan Renfro
GIA, Carlsbad*

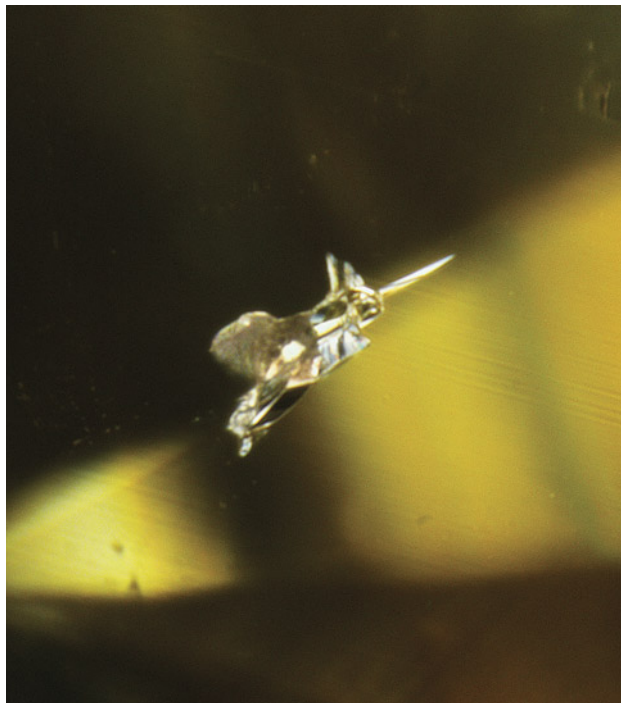


Figure 6. An omphacite inclusion surrounded by fractures in an orangy yellow diamond takes the shape of a hummingbird in flight. Photomicrograph by Mei Yan Lai; vertical field of view 0.99 mm.

Diamond Inclusions “Watching a Fly”

Examination of a 0.50 ct H-color type Ia natural diamond with SI₂ clarity recently revealed intriguing inclusions. Under the microscope, one crystal inclusion seen with a mirror reflection resembled a fly or similar winged insect (figure 5). Nearby, another crystal resembling an eye topped off with an eyebrow was duplicated by a prism image. The serendipitous combination of these features caused the whole scene to evoke a pair of eyes watching an insect. This inclusion scene invites the viewer to look closely at the diamond and appreciate details that might have gone unnoticed.

*Jignesh Sojitra and Manohar Chache
GIA, Surat*

“Hummingbird” in Orangy Yellow Diamond

The authors recently studied a 1.29 ct natural Fancy Intense orangy yellow diamond containing a pale grayish green mineral inclusion, identified by Raman spectroscopy as omphacite. This inclusion was surrounded by several fractures, which together had the appearance of a hummingbird in flight (figure 6).

Omphacite is a sodium-rich variety of clinopyroxene derived from eclogite, a mantle rock formed through high-

pressure and high-temperature metamorphism of subducted oceanic crust. Consequently, this small hummingbird-shaped inclusion reveals the recycling of crustal material into the deep earth millions or billions of years ago.

*Matthew F. Hardman and Mei Yan Lai
GIA, Carlsbad*

Rose-Shaped Cloud Inclusion in Diamond

Recently, the authors examined a 0.36 ct diamond with D color and SI₂ clarity. The diamond contained a cluster of cloud inclusions arranged to form an interesting pattern (figure 7). Best observed through the pavilion facets, the inclusion displayed a spiraled, petal-like structure conforming to a triangular outline. Overall, the impurity cloud gave the impression of a delicate rose, a rewarding sight for a gemologist who thoroughly examines their subject.

*Satyam Soni and Deepak Raj
GIA, Surat*



Figure 7. A cloud in a 0.36 ct diamond with SI₂ clarity resembling a rose. Photomicrograph by Deepak Raj.

Dendritic Patterns in Emerald

Dendritic, or tree-like, patterned inclusions are captivating features found in emeralds that significantly enhance their beauty and uniqueness. Typically composed of iron, manganese, or other trace elements, these minerals crystallize into intricate patterns that resemble natural foliage or tree branches. Dendritic patterns form under specific geological conditions, where variations in temperature, pressure, and the presence of different minerals can create such striking formations.

Alternatively, dendritic inclusions can result from clarity-enhancing treatments, where oils or resins are introduced to improve the visual quality of the emerald (figure 8). When these substances dry, they can leave behind patterns that closely resemble some natural inclusions.

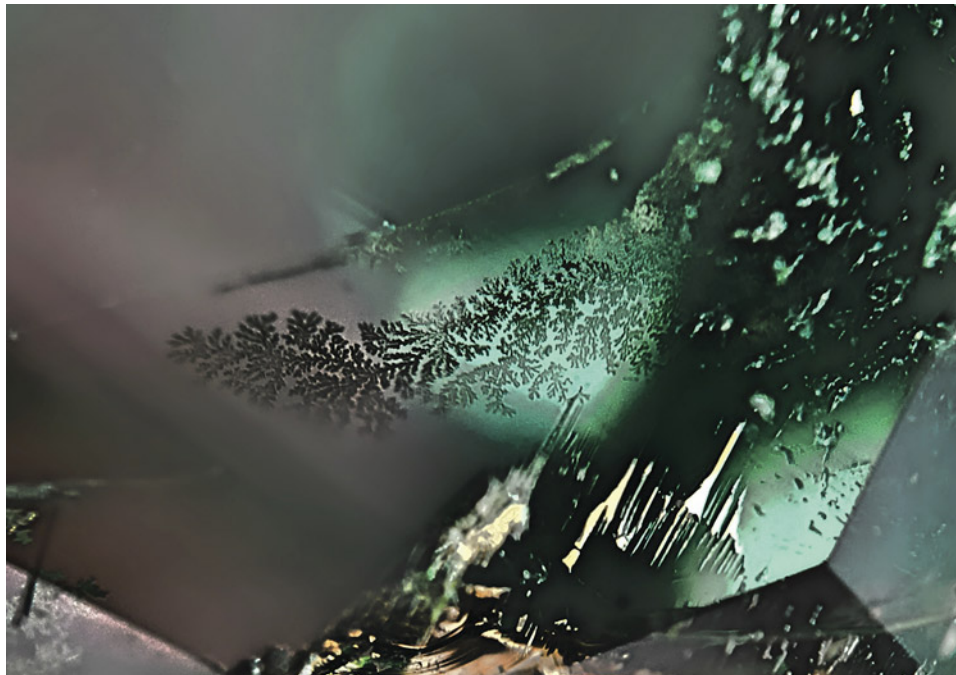


Figure 8. These dendritic patterns in a partially filled fissure in an emerald resemble natural foliage, also known as jardin. Photomicrograph by Sameer Din Faqir; field of view 2.50 mm.



Figure 9. Unique hollow channels resembling rime ice in a 1.78 ct jeremejevite. The vertical direction of this photo corresponds to the *c*-axis of the stone. Photomicrograph by Makoto Miura; field of view 1.48 mm.

This inclusion suite in emerald is commonly referred to as a *jardin*, which translates to “garden” in French. Each *jardin* tells a unique story, showcasing the complex interplay of geological processes and human intervention that contribute to its allure. As no two gardens are alike, each piece is truly one-of-a-kind.

Sameer Din Faqir
Metal Testing Gemological Laboratories
Jeddah, Saudi Arabia

“Rime Ice” on Trees in Jeremejevite

Jeremejevite is a rare aluminum borate mineral with an ideal chemical formula of $\text{Al}_6\text{B}_5\text{O}_{15}[\text{F},\text{OH}]_3$ (K. Scarratt et al., “Jeremejevite: A gemological update,” Fall 2001 *G&G*, pp. 206–211). Its crystal system is hexagonal, and this mineral tends to occur in pegmatitic or volcanic deposits as a prismatic crystal. The authors recently examined a violetish blue jeremejevite measuring $10.48 \times 4.98 \times 4.04$ mm and weighing 1.78 ct.

The stone contained unique dendritic inclusions resembling the encasing of a tree in ice, known as rime ice, along the *c*-axis (figure 9). The “trunk” was parallel to the direction of the *c*-axis, and the “branches” extended from the trunk at approximately a 60° angle. On the other side, a lightning-strike pattern was observed (figure 10). Specific Raman spectra were not detected from these inclusions, suggesting they may be a kind of hollow channel within the crystal. Similar internal features have been observed in Namibian materials and were likely formed by the “step”

growth of jeremejevite crystals (Scarratt et al., 2001; “Jeremejevite: A description of a 400 crystal collection from Namibia and a preliminary study of five color types,” *GIA Research News*, 2009). Crystal growth can create attractive patterns such as these unique inclusions in jeremejevite.

Makoto Miura and Yusuke Katsurada
GIA, Tokyo

Figure 10. Hollow channels form unique patterns resembling a lightning strike in the 1.78 ct jeremejevite. Photomicrograph by Makoto Miura; field of view 1.06 mm.



Snowflakes in Opal

Recently, the author examined a 6.85 ct black opal cabochon, likely from Ethiopia due to the digit pattern of its play-of-color (B. Rondeau et al., "Play-of-color opal from Wegel Tena, Wollo Province, Ethiopia," Summer 2010 *G&G*, pp. 90–105; B. Rondeau et al., "On the origin of digit patterns in gem opal," Fall 2013 *G&G*, pp. 138–146). This opal contained several inclusions, such as black spots concentrated along pits and scratches, indicating that it was treated to produce a darker color and enhance the play-of-color phenomenon. Additionally, metallic octahedral crystals were identified as pyrite by Raman analysis. Interestingly, fiber-optic illumination revealed whitish snowflake inclusions (figure 11), which were identified as aragonite through Raman analysis. To the author's knowledge, these are the first documented aragonite snowflake inclusions in opal.

Narint Jaisanit
GIA, Bangkok

Spiral Patterns on a Non-Nacreous Pearl

Spiral patterns are frequently observed in nature, such as those in fingerprints, plant stems, shells, or even faraway galaxies. Recently, a collection of 35 pearls arranged in a necklace layout was submitted to GIA's Bangkok laboratory (see Lab Notes, pp. 66–68 of this issue). This submission included a 6.79 ct orange round non-nacreous

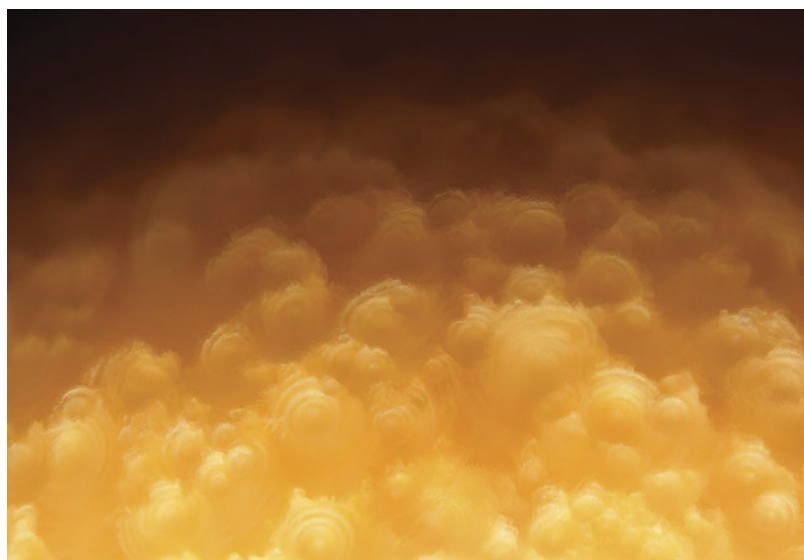
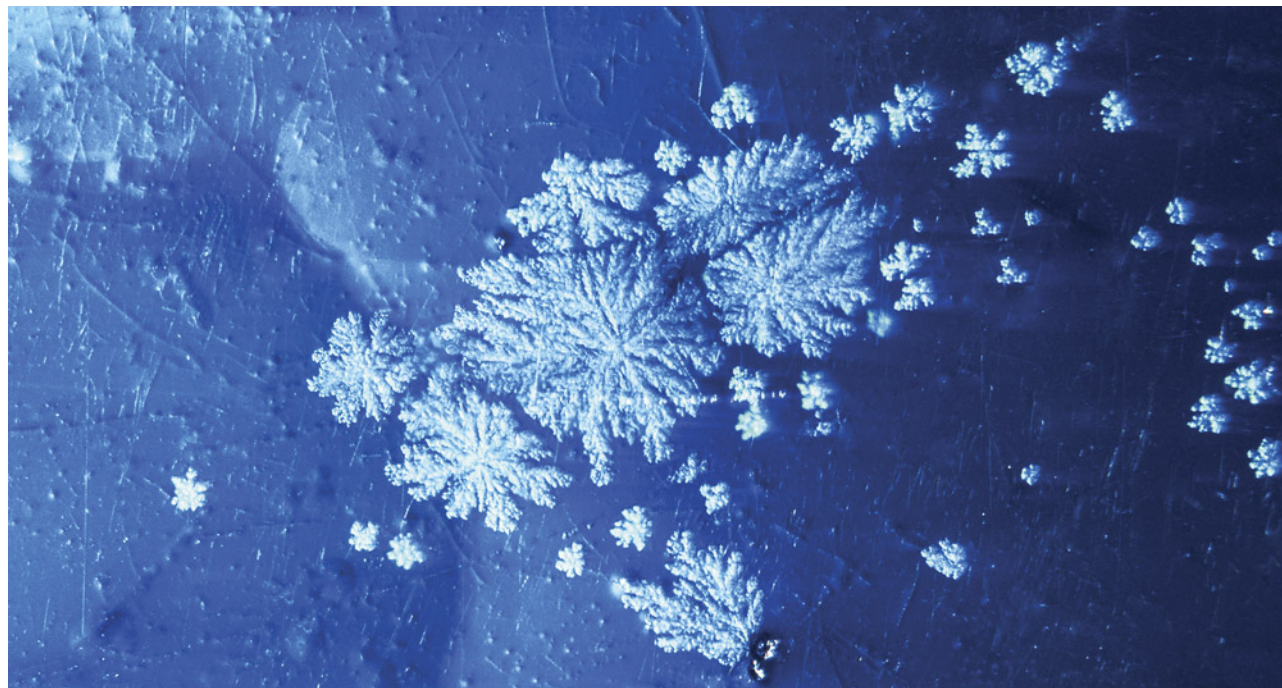


Figure 12. The spirals on the pearl display a scale-like pattern with short flames on the rim of each scale. Photomicrograph by Ravenya Atchalak; field of view 4.67 mm.

pearl that possessed an enchanting spiral surface structure. The pearl exhibited a noticeable patchy series of circular features covering the entire surface. Under 30× magnification, the circular features appeared scale-like, with a spiral pattern within each "scale" and short flames on the rims (figure 12). The pearl displayed no evidence of a worked

Figure 11. Group of aragonite snowflake inclusions in opal likely from Ethiopia. Photomicrograph by Narint Jaisanit; field of view 1.80 mm.



surface, only some fine visible scratches, suggesting the spiral structure was original to the pearl and not caused by any surface treatment.

Real-time X-ray microradiography, energy-dispersive X-ray fluorescence, and Raman spectroscopy indicated the pearl was of saltwater origin and natural color. Its high porcelain-like luster, spiky short flames, and orange body-color resembled some Melo (*Melo* species) and horse conch (*Fasciolarinae* subfamily) pearls. However, the spiral structure is rarely observed and has only been encountered in a few non-nacreous pearls previously studied by GIA. Therefore, the mollusk species that formed this pearl is currently undeterminable, and further study is required for precise mollusk determination. While the exact species that produced this special pearl remains inconclusive, its fascinating spiral pattern is undoubtedly worthy of note.

Ravenya Atchalak
GIA, Bangkok

Kyanite in Quartz

Although quartz is known to host a diverse assortment of mineral inclusions, well-formed bladed kyanite inclusions in quartz are rarely observed. At first glance, the 7.83 ct blue-colored stone in figure 13 appeared to contain dumortierite, but further inspection revealed distinct bladed blue crystals that deviated from the expected prismatic morphology of dumortierite.

Raman spectroscopy identified several minerals including quartz, kyanite, and some iron sulfides. Kyanite, an aluminum silicate mineral typically associated with metamorphic rocks, provided the stone's light blue color. Opaque metallic hexagonal sulfide crystals were scattered throughout the host. Occasional reddish orange crystals,

located too deep within the stone for identification with Raman, were likely mica given the mineral association and structure.

These eye-visible inclusions come together to form a brightly colored quartz with a slight shimmer and unique character.

Jeffrey Hernandez
GIA, Carlsbad

Devitrified Glass “Pom-Poms” in Ruby

The authors recently examined a 13.99 ct red cushion mixed cut, which revealed interesting inclusions upon microscopic examination. Standard gemological testing of the host material proved consistent with ruby but yielded some unusual results. When subjected to short-wave ultraviolet light, the stone displayed a chalky yellow fluorescence concentrated within surface-reaching fractures.

Magnification revealed a collection of fine particles and altered crystals with discoid fractures typical of some natural rubies after heat exposure. Curiously, the stone exhibited partially healed fractures with flux-like textures, with some fractures also containing round and flattened gas bubbles. The authors also observed structures of whitish acicular projections radiating outward that formed spiked spherical crystals resembling pom-poms or sea urchins (figure 14). These formations occurred within filled cavities that displayed visible luster differences from the host corundum. Laser ablation–inductively coupled plasma–mass spectrometry, Raman spectroscopy, and X-ray imaging confirmed the presence of a foreign material, and X-ray fluorescence identified bismuth within the filled cavities. The authors concluded that bismuth glass was present

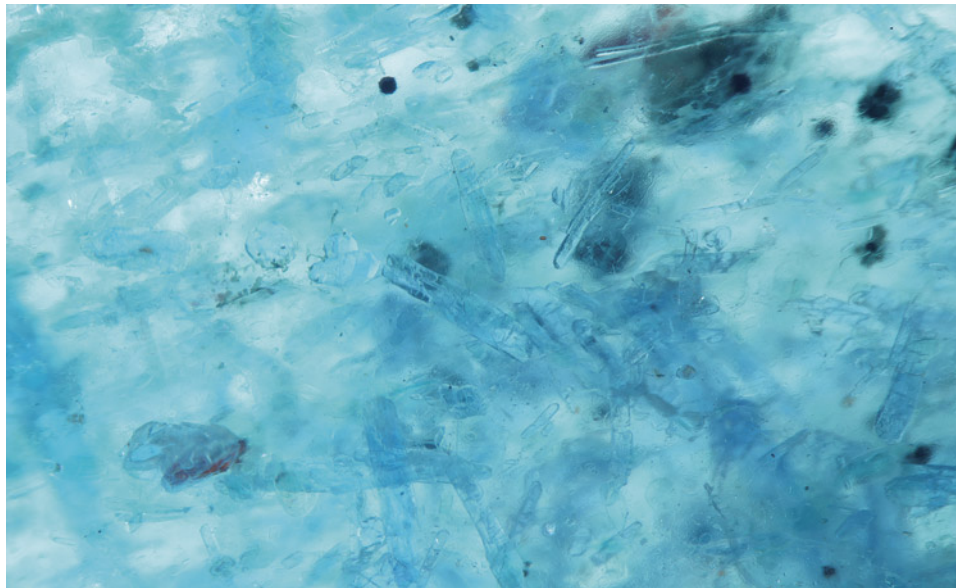


Figure 13. A chaotic assortment of crystal inclusions comprises the busy interior of this quartz. Photomicrograph by Jeffrey Hernandez; field of view 3.57 mm.



Figure 14. Devitrified glass inclusions resembling pom-poms or sea urchins in a clarity-enhanced ruby. Photomicrograph by Kevin Bishop and Joseph Hukins; field of view 1.99 mm.

in the ruby as a clarity enhancement treatment. The acicular pom-pom formations were a result of devitrification of the bismuth glass filler at some stage in the annealing process, a likely unintended and unwelcome byproduct for a treater with the goal of clarity enhancement, but a visually appealing feature for a gemologist nonetheless.

*Kevin Bishop and Joseph Hukins
GIA, New York*

Evil Eye in a Flux-Healed Mong Hsu Ruby

As mined, Burmese ruby from Mong Hsu can be unattractive due to dense clouds and unusual blue cores, resulting in a low-grade cloudy material. Heat treatment is typically

performed to remove the blue color and silk, making the final product a rich, clear red. Because the majority of Mong Hsu rubies are heavily fractured, they are often heated with a flux such as borax to fill voids and allow the fractures to partially heal. The result is a much clearer and more durable product.

The fissures in a recently examined 1.22 ct heat-treated Mong Hsu ruby were also healed with residual flux. In this case, the mirror reflection of the flux-healed fissure from a step pavilion facet resulted in an inclusion resembling an evil eye (figure 15). When this stone is viewed under a microscope, an evil eye appears to be staring back at the observer.

*Ungkhana Atikarnsakul
GIA, Bangkok*



Figure 15. The reflection of a flux-healed fissure from a step pavilion facet in this Mong Hsu ruby resembles an evil eye. Photomicrograph by Ungkhana Atikarnsakul; field of view 1.07 mm.

Prismatic Zircon in Kashmir Sapphire

Recently, the author examined a faceted blue oval sapphire. Standard gemological properties and chemical analysis indicated a geographic origin of Kashmir. Microscopic examination revealed internal graining, fine particle banding, and fingerprint inclusions. Interestingly, elongated zircon inclusions were also observed, displaying attractive birefringent interference colors under cross-polarized filters caused by the splitting of light in the doubly refractive crystals (figure 16). Kashmir sapphire is one of the rarest and most valuable gemstones in the world, renowned for its beauty and quality, and this stone was no exception.

*Narint Jaisanit
GIA, Bangkok*

Lepidolite in Copper-Bearing Tourmaline

The author recently examined a 0.53 ct copper-bearing tourmaline with a well-formed transparent crystal (figure 17). Raman spectroscopy identified the crystal as lepidolite ($K(Li,Al)_3(Al,Si,Rb)_4O_{10}(F,OH)_2$), a member of the mica group. Lepidolite frequently occurs alongside tourmaline but is usually seen in lower-quality stones or collector specimens. Typical inclusions observed in gem-quality tourmalines include tubules, fine needles, and fluid inclusions. Lepidolite crystals in tourmaline have been observed in stones from multiple localities, so such an inclusion is not an indicator of geographic origin. Due to the preference of less included stones in jewelry, it is rare to encounter a sizeable, well-formed crystal in a faceted gem-quality tourmaline.

*Virginia Schneider
GIA, New York*



Figure 17. Prismatic colorless lepidolite crystal in a copper-bearing tourmaline. Photomicrograph by Virginia Schneider; field of view 1.58 mm.

Quarterly Crystal: Fluorite in Quartz from China

With its high degree of transparency and relatively good durability, colorless rock crystal quartz is the perfect host for a variety of mineral inclusions. As a common crustal mineral, it often forms as a single transparent crystal, sometimes of significant size.

This issue's Quarterly Crystal, a 3230.50 ct transparent crystal measuring $108.84 \times 97.42 \times 65.40$ mm (figure 18), comes from the Yaogangxian mine in Hunan Province, China. The singly terminated quartz specimen with eye-

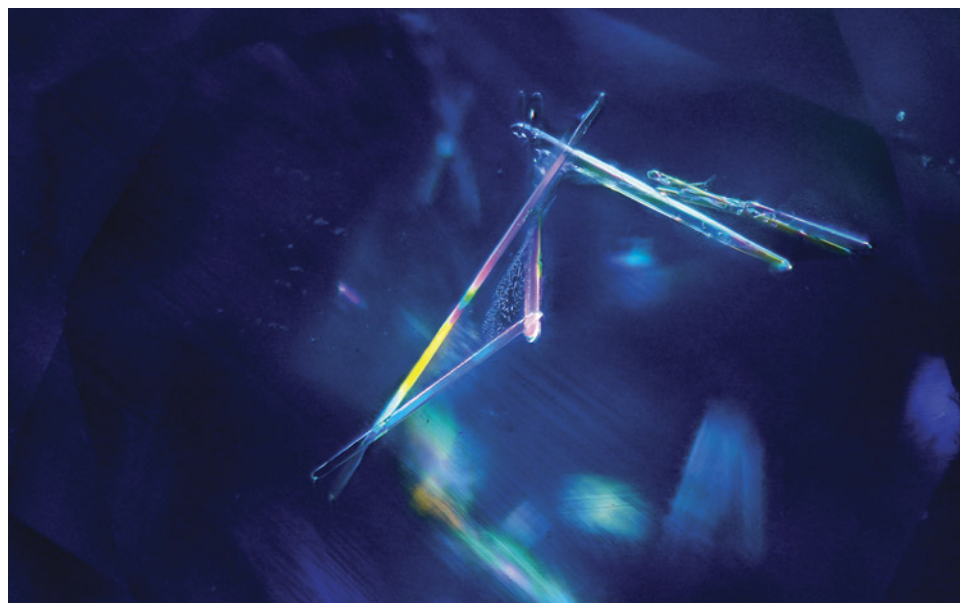


Figure 16. Prismatic elongated zircon in Kashmir sapphire. Photomicrograph by Narint Jaisanit; field of view 2.88 mm.



Figure 18. Transparent, colorless terminated 3230.50 ct single crystal of Chinese quartz with geometric growth features decorating the surface with eye-visible apple green inclusions. Photo by Annie Haynes.

visible apple green inclusions was purchased from Nabeel Ashraf of Poetry In Gems (San Diego, California).

As shown in figure 19, examination of the quartz crystal revealed numerous near-colorless to apple green, transparent to translucent, euhedral inclusions identified by Raman analysis as fluorite. These fluorite crystals showed directional deposition and were all present in a phantom plane, situated only on one side of the quartz specimen. This, to-

gether with the sharp-edged condition of the fluorite crystals, suggested that they were syngenetic with the quartz host.

While transparent colorless quartz is relatively common at the Yaogangxian mine, this large quartz crystal made a unique host for the numerous fluorite inclusions.

*John I. Koivula, Nathan Renfro, and Maxwell Hain
GIA, Carlsbad*

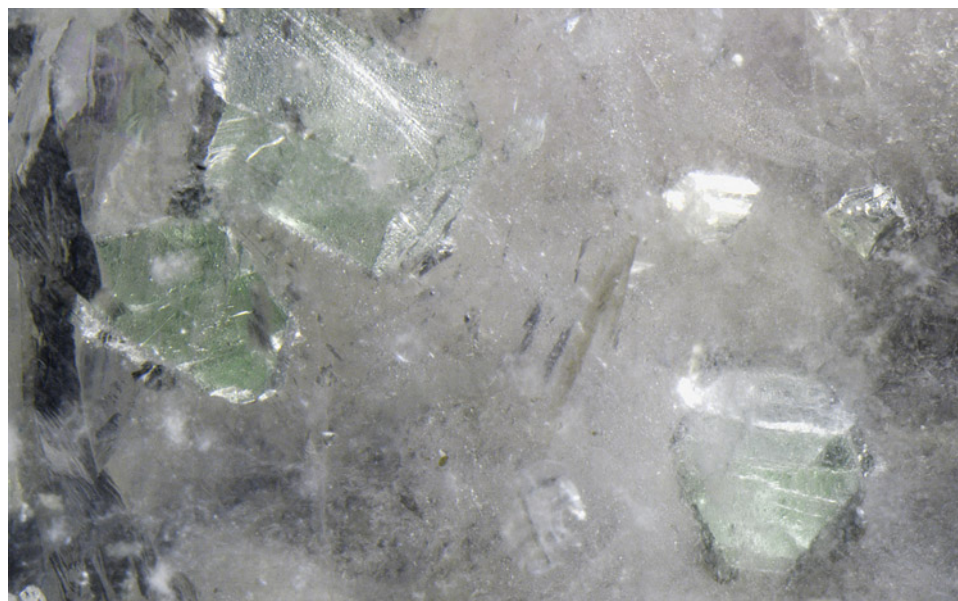


Figure 19. Scattered transparent to translucent, near-colorless to apple green crystals of isometric fluorite, the largest measuring 11.2 mm. The fluorite inclusions fluoresce a strong blue when exposed to UV radiation. Photomicrograph by Nathan Renfro; field of view 32 mm.