G&G Micro-World

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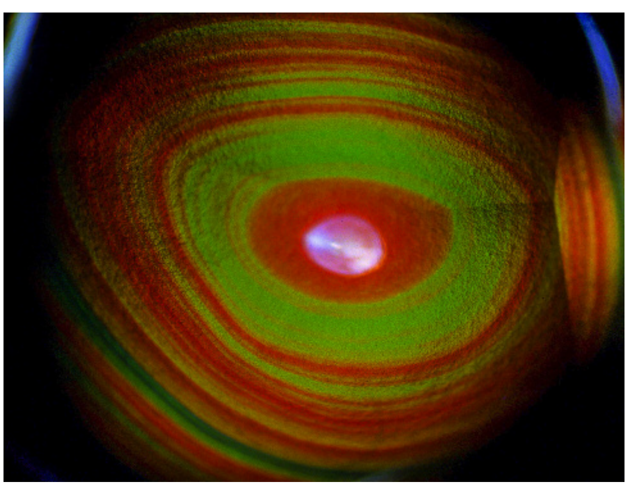
"Dragon's Eye" Fire Agate

Found in only a few places in the southwestern United States and Mexico, fire agate is a very finely layered golden brown to reddish brown agate with a botryoidal multi-layered structure. Each of the individual layers in a fire agate is dusted with the iron hydroxide mineral goethite, which provides the brown bodycolor.

What makes fire agate particularly special is that the ultra-thin coatings of goethite cause a very colorful iridescence, primarily in red, golden orange, and green, but occasionally in violet to blue. The vibrant colors result from interference between light rays that are reflected and refracted while traveling through the gem and reflecting from these ultra-thin layers.

The finest-quality fire agates can rival Australian black opal. Because they are a form of chalcedony quartz, fire agates are also more durable than opal, making them suitable for virtually any jewelry application.

Figure 1. Upon close examination, the polished botryoidal knob in this Mexican fire agate resembles a reptilian eye. Photomicrograph by John Koivula; field of view 8.12 mm.



The 4.62 ct (10.22 × 9.16 × 7.19 mm) Mexican fire agate studied here, a polished high-dome cabochon, is from the El Terrero mine in the Calvillo Mountains of Aguascalientes State, Mexico. Under close examination (figure 1), its somewhat ovoid botryoidal structure and fine granular texture, together with the banded red, orange, and green coloration, project the image of a reptilian "dragon's eye." As an added bonus, the hotspot created by the fiber-optic light at the apex of the gem adds an elegant finishing touch to the overall image.

John I. Koivula
GIA, Carlsbad

Red Heart Inclusion in Diamond

Diamonds, like colored gemstones, contain a variety of interesting inclusions. Although some would call them flaws, I prefer to think of them as Mother Nature's artwork or fingerprint. I have seen inclusions resembling angels and animals of all sorts, some requiring more imagination than others. It is fascinating to think of what might have been captured inside a diamond more than two billion years ago.

The 2.00 ct round brilliant diamond shown in figure 2 has I color, I_1 clarity, and a wonderful cut. But its most remarkable feature is a red heart-shaped inclusion, identified as pyrope garnet based on microscopic examination by GIA's Carlsbad laboratory. The inclusion is not visible to the eye but jumps out at 10× magnification. It measures approximately 140 microns across where it is exposed at

About the banner: Epigenetic iron oxide staining is seen in a thin section of chalcedony using polarized light and a quarter-wave plate. Photomicrograph by Nathan Renfro; field of view 0.25 mm.

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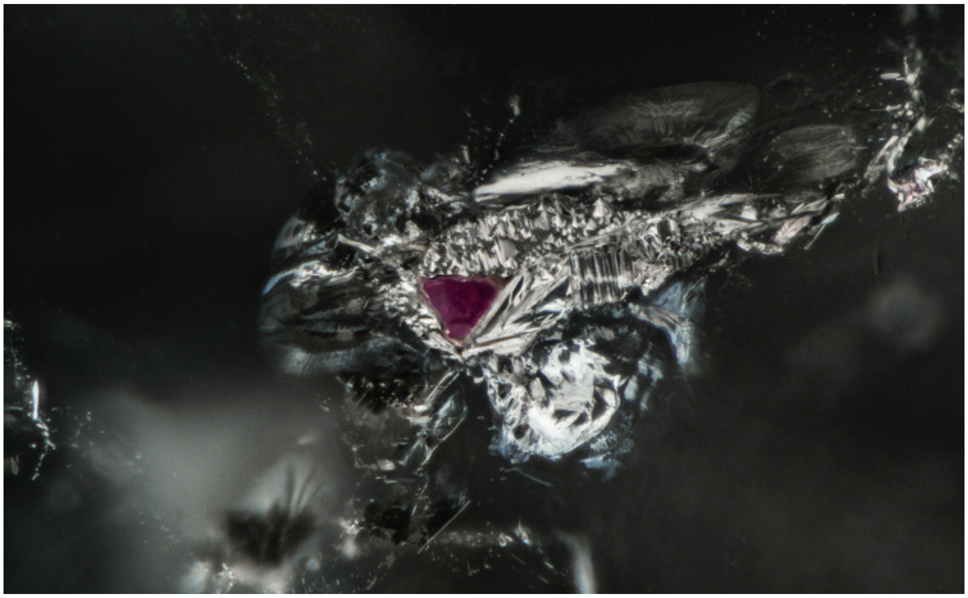

Figure 2. A unique expression of romance: Breaking the surface of this 2.00 ct diamond is a red heart-shaped inclusion. Photomicrograph by Nathan Renfro; field of view 1.58 mm.

the table facet. The inclusion is much larger and extends along almost half of the image frame, but the reflective interface makes it difficult to see the underlying garnet. We only see the pink color where the inclusion breaks the surface and the mirror-like interface has been removed.

With the combination of the red heart and diamond, both universal symbols of love, this is a one-of-a-kind gem. We have named it the Forsythe diamond and plan to auction it around Valentine's Day 2016, in keeping with the theme of romance, and part of the proceeds will go toward a local charity. How lucky are we to be able to work with beautiful gemstones containing hidden secrets just waiting to be unlocked every day.

Matt Wahl
Forsythe Jewelers
Pittsford, New York

Trapiche Muscovite

For collectors who appreciate crystals that display distinctive trapiche structure, muscovite offers a very interesting and unusual variety known to mineralogists as cerasite or "cherry blossom stones" due to its form. With a pseudohexagonal habit and a silvery luster, these muscovite pseudomorphs after indialite-cordierite intergrowths may, on rare occasion, show a well-developed trapiche structure (figure 3) virtually identical to that of fine-quality trapiche emerald.

Trapiche muscovites come from only one locality, the Japanese city of Kameoka in Kyoto Prefecture, where they are locally known as "cherry blossom stones" (*sakura-ishi* in Japanese). Small and attractive, well-formed specimens are occasionally found when they weather out of a contact metamorphic hornfels.

Figure 3. Muscovite mica, known from a single locality in Japan, can display trapiche structure with both open (left) and closed (right) centers. Photomicrographs by Nathan Renfro; field of view 4.05 mm (left) and 4.56 mm (right).

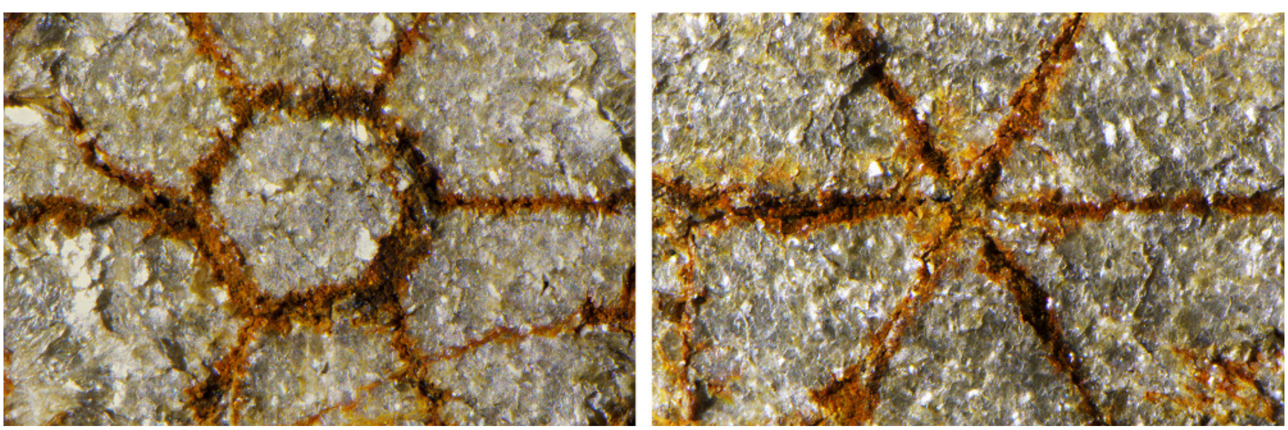

Figure 4. These muscovite trapiches, or "cherry blossom stones," formed through alteration of complex indialite-cordierite intergrowths. Photo by Nathan Renfro.

In figure 4, the closed-center specimen measures approximately 6.49 × 6.44 × 4.48 mm with a corresponding weight of 0.90 ct, while the one with the open center measures 4.71 × 4.27 × 5.21 mm and weighs 0.62 ct. Fine examples of these unusual muscovite pseudomorphs measuring over 6 mm and weighing over 1 ct are considered very rare.

John I. Koivula

Parisite in Colombian Quartz

The brownish rare earth carbonate parisite is known as an unusual Colombian mineral specimen, and as a diagnostic inclusion indicative of Colombian origin when observed in emeralds (E.J. Gübelin and J.I. Koivula, *Photoatlas of Inclusions in Gems*, Vol. 1, ABC Edition, Zurich, 1986, p. 252). This rare mineral has also been reported to occur in quartz from Muzo, Colombia (E.J. Gübelin and J.I. Koivula, *Photoatlas of Inclusions in Gemstones*, Vol. 2, Opinio Verlag, Basel, Switzerland, 2005, p. 621).

A particularly striking example of rock crystal quartz with numerous brown crystals of parisite (figure 5) was recently examined at GIA's Carlsbad laboratory, where the inclusions' identity was confirmed by Raman analysis. Interestingly, three of the most prominent parisite inclu-

Figure 5. These three crystals captured in Colombian rock crystal quartz host three crystal morphologies of the rare mineral parisite: bipyramidal, hexagonal tabular prism, and pyramidal forms. Photomicrograph by Jonathan Muyal; field of view 4.79 mm.

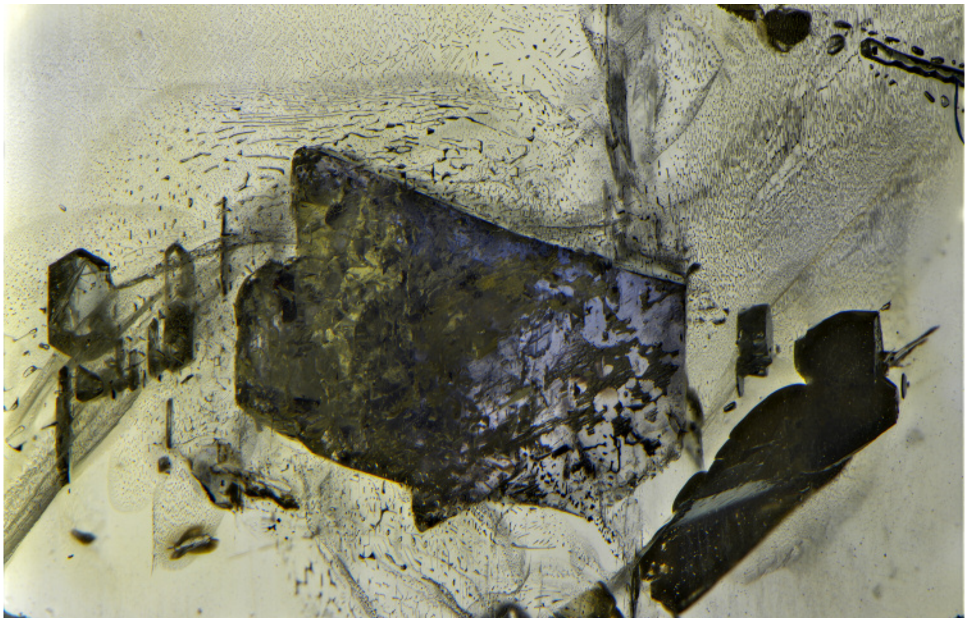

Figure 6. This violetish blue inclusion in a Sri Lankan yellow sapphire was identified as spinel. Photomicrograph by Nathan Renfro; field of view 5.63 mm.

sions in this rock crystal quartz displayed multiple crystal habits: a well-formed bipyramid, a tabular hexagonal prism, and a pyramidal form. Due to their euhedral nature, these inclusions are presumed have formed simultaneously with their host quartz and are therefore termed *syngenetic*. Also present in the stone were numerous fluid inclusions and an iridescent interface on the bipyramidal crystal.

This is the finest example of parisite as an inclusion in quartz that has been documented by GIA.

Jonathan Muyal
GIA, Carlsbad

Violetish Blue Spinel in Yellow Sapphire

Spinel as an inclusion in sapphire has been previously documented in blue and yellow sapphires from Sri Lanka (E.J. Gübelin and J.I. Koivula, *Photoatlas of Inclusions in Gemstones*, Vol. 1, ABC Edition, Zurich, 1986, pp. 353–354). Typically these inclusions are green zinc-rich ghanospinels. Recently the authors examined a transparent light yellow sapphire crystal with a prominent violetish blue octahedral inclusion (figure 6). Interestingly, microscopic examination showed the violetish blue inclusion to be an intergrowth of at least two gemmy crystals, with the larger one crystallographically aligned with negative crystals that were also present in the host.

When further examined with polarized light, the violetish blue inclusion appeared to be singly refractive, which meant spinel was a possibility, considering their similar formation environments. The sample was polished down to a plate in order to place the violetish blue inclusion closer to the surface for Raman analysis, which conclusively confirmed that it was spinel. Also present in this sapphire were numerous carbon dioxide–filled negative crystals, fingerprints, and open cracks. The presence of the intact CO_2 inclusions and the pristine condition of the spinel inclusion provided clear evidence that the sapphire host had not been subjected to any form of heat treatment. This is the first example of a violetish blue spinel inclusion in sapphire that the authors have examined.

Nathan Renfro and John Koivula
GIA, Carlsbad

Stars Are Out in Paraíba Tourmaline

The rarity of Brazilian Paraíba tourmaline, with its vibrant, almost unearthly colors, makes it a coveted gem the world over. What a delight to discover a pair of stars shining out from among many non-phenomenal stones in a parcel. This was a fruitful result of gemologist Elaine Rhorbach's regular use of a point-source light for examination of all materials she encounters in the marketplace. Wherever she is in the world, this former nurse carries her powerful otoscope—no longer examining ears, but rather checking for any optical phenomena in gems, even where none is expected.

The phenomenon of asterism is seen in a variety of gem materials fashioned as cabochons. The multiple chatoyant bands of light forming these stars are caused by the scattering of planar light by sets of parallel structures. These are often inclusions such as minerals, voids, and structural defects, but they may also be manifested by natural surface features of the crystal left intact on the gem's base (e.g., tourmaline prism face striations) or etched into the surface by hand. The crystal structure of the host dictates the number of bands, and with mineral inclusions in particular, the orientations are a result of complex chemical interactions between the inclusions and their host. Orientation of the cut gem also determines what effect is seen. For instance, multi-star quartz is a member of the same trigonal crystal class as tourmaline; it displays fourand six-ray stars, depending on viewing orientation in relation to its crystallographic axes of symmetry.

In the case of the 1.06 and 0.90 ct Paraíba tourmaline cabochons seen in figure 7, the c-axis of the larger gem is along its length and that of the smaller specimen is across its width. Thus, the view from above is perpendicular to the crystal's c-axis. Fluid-filled inclusions paralleling the c-axis dominate the gems' microworld, causing a distinct chatoyant band perpendicular to the axis. A faint band seen crossing this appears to be caused by the slight widening of the fluid-filled inclusions (figure 8). Since the inclusions are roughly rectangular as they are aligned parallel to the c-axis of the crystal, they produce two directions of reflections oriented at 90°. The elongate direction has more reflective surface area and therefore produces a brighter chatoyant band, while the width has less surface area and produces a weaker chatoyant band from the same reflective inclusion set. While EDXRF detected the presence of copper in these vibrant gems, affirming their Paraíba nature, the subtle stars elevated them into the class of rarefied connoisseur gems—another example of the power of inclusions!

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Ithaca, New York

Nathan Renfro

Figure 7. Under point-source light, these 1.06 and 0.90 ct Paraíba tourmaline cabochons purchased in Brazil in the early 1990s display four-ray stars. Photo by Robert Weldon.

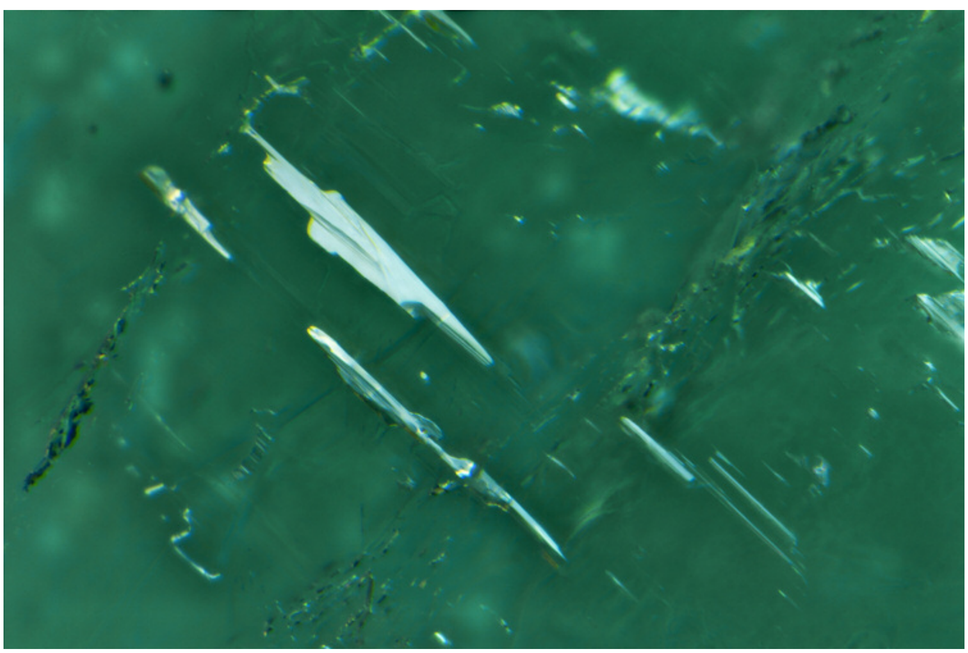

Figure 8. Reflective fluid-filled inclusions parallel to the c-axis of the Paraíba tourmaline scatter the light, forming the stronger chatoyant band. A faint band seems to be caused by a slight widening of these inclusions. Photomicrograph by Nathan Renfro; field of view 1.20 mm.