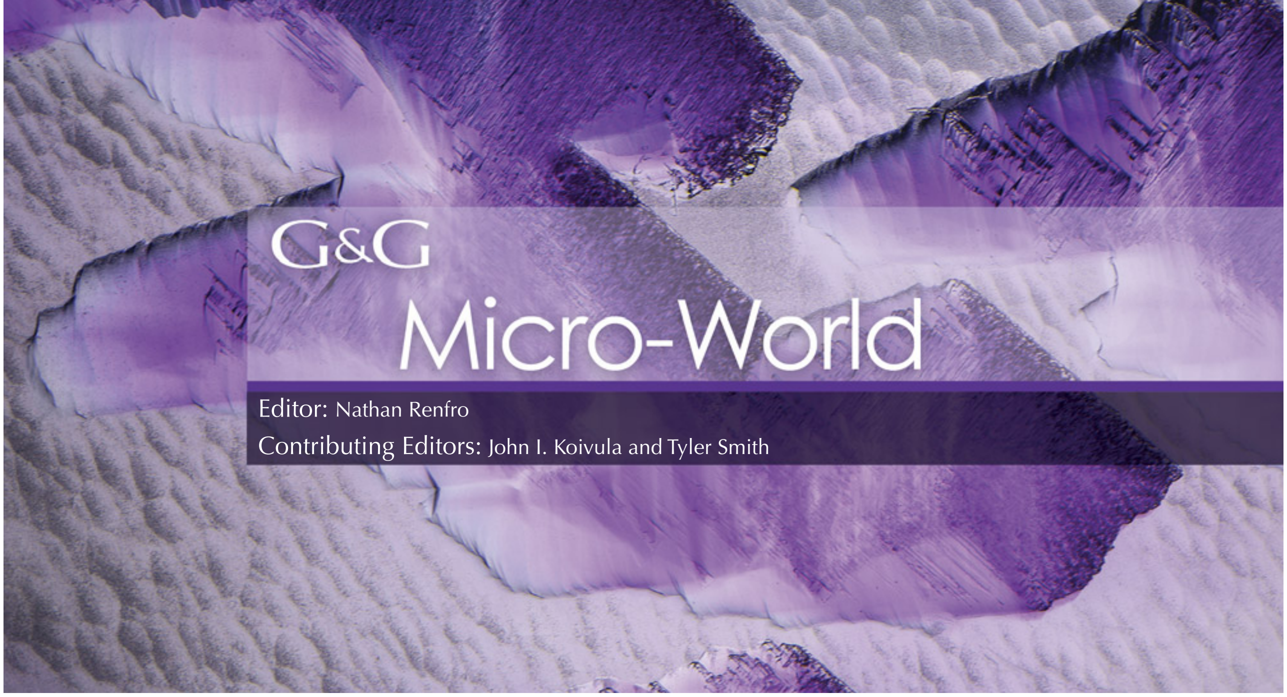


"Conch Shell" in Diamond

Surface-reaching fractures or breaks in diamonds are commonly known as feathers. The authors recently came across a feather with a surprising anatomy in a 0.41 ct natural diamond with G color and I_1 clarity. This structure resembled a conch shell (figure 1). The conch shell, also called a *shankha* in India, is used for religious purposes and as a musical instrument, and it is thought to bring good luck.

Tejas Jhaveri and Russel Carvalho
GIA, Mumbai

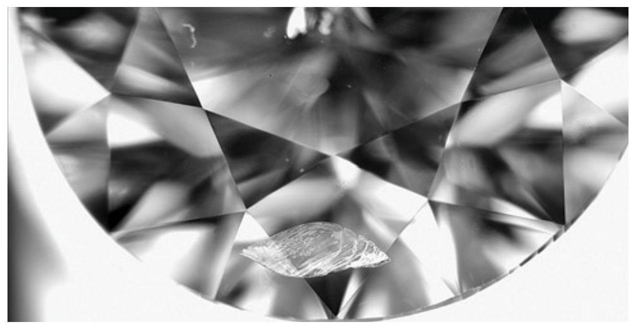


Figure 1. This transparent feather with noticeable depth, observed in a natural diamond, suggests a conch shell. The image was captured in monochrome. Photomicrograph by Tejas Jhaveri; field of view 2.50 mm.

Square-Shaped Cloud in Diamond

Polishers occasionally recognize a distinctive inclusion within a rough diamond and orient the faceting to highlight the unusual feature. One such example is the recently examined 0.34 ct round brilliant with I color shown in figure 2. Due to the prominent square-shaped cloud under the table (figure 2, left), the clarity grade of the stone was SI_2. Previously, gemologists have reported other natural diamonds with nominally similar-looking clouds oriented under the table facet (N. Renfro et al., "Inclusions in natural, synthetic, and treated diamond," Winter 2018 *G&G*, pp. 428–429; Spring 2021 *G&G* Micro-World, pp. 65–66).

The cloud appeared as a perfect square shape (the measured length along one side of the square was ~0.9 mm) when viewed through the table facet, but it appeared significantly more scattered when viewed through the pavilion (figure 2, right). Such features highlight the beneficial synergy between natural inclusions and skilled polishers.

Deepak Raj and Hardik Rathod
GIA, Surat

Sally Eaton-Magaña
GIA, Carlsbad

About the banner: This synthetic amethyst shows a flame-like color zoning along the rhombohedral crystal direction. These patterns are only seen in synthetic amethyst. Photomicrograph by Nathan Renfro; field of view 15.61 mm. Courtesy of the John Koivula inclusion collection.

GEMS & GEMOLOGY, VOL. 60, NO. 2, pp. 226–237.

Heliodor and Aquamarine with Surface Etching

During an ongoing beryl characterization project, aquamarine and heliodor beryl samples from the GIA Museum col-

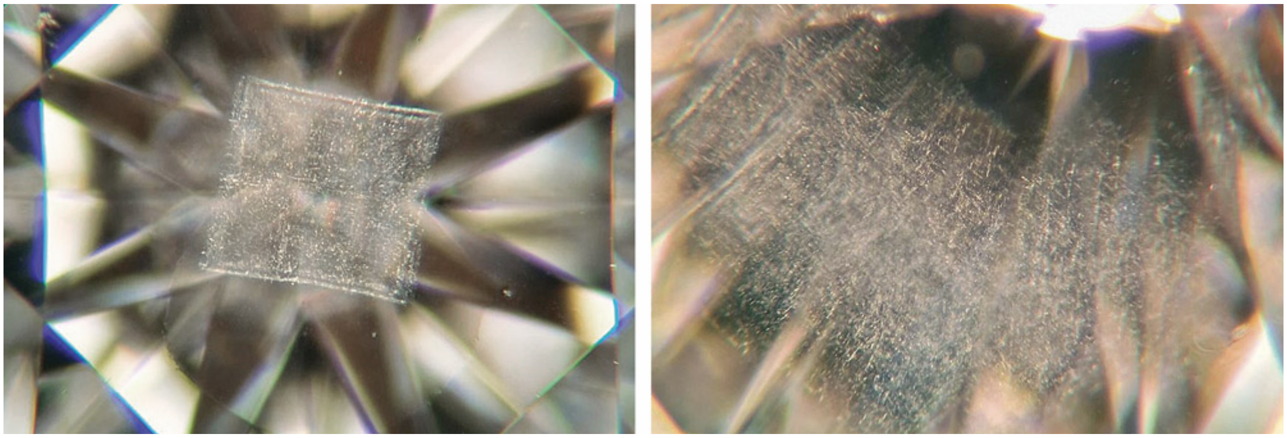


Figure 2. Left: Table-up view of a 0.34 ct round brilliant with SI_2 clarity possessing a square-shaped cloud; field of view ~2.9 mm. Right: When viewed through the pavilion, the cloud feature appears much less ordered; field of view ~1.6 mm. Photomicrographs by Deepak Raj.

lection (figure 3) revealed distinctive etch features on each of their crystal faces. These two samples were reported by the donor as being from China.

The etch pits seen on these samples are markedly different from those of Ukrainian heliodor (G. Franz et al., "Etch pits in heliodor and green beryl from the Volyn pegmatites, northwest Ukraine: A diagnostic feature," Fall 2023 *G&G*, pp. 324–339). While Ukrainian heliodor exhibits a more rectangular etching, these specimens have rounded six-sided shapes akin to a compressed hexagon

Figure 3. These aquamarine (left) and heliodor (right) crystals reported to be from China, measuring approximately 2 cm long and 0.4 cm wide, display distinctive etch pits. Photo by Adriana Robinson. Gift of Zeng Jiliang, GIA Museum nos. 20633 (left) and 20630 (right).

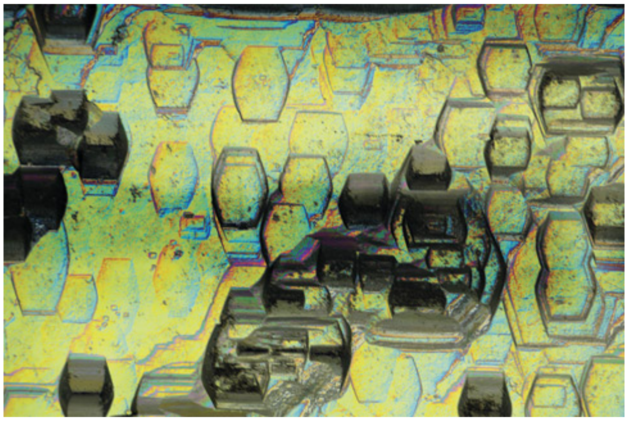


Figure 4. Heliodor viewed with differential interference contrast filters. Compressed hexagonal etch features exist on every prismatic face and run the length of the crystal. Photomicrograph by Rhiana Henry; field of view 2.88 mm.

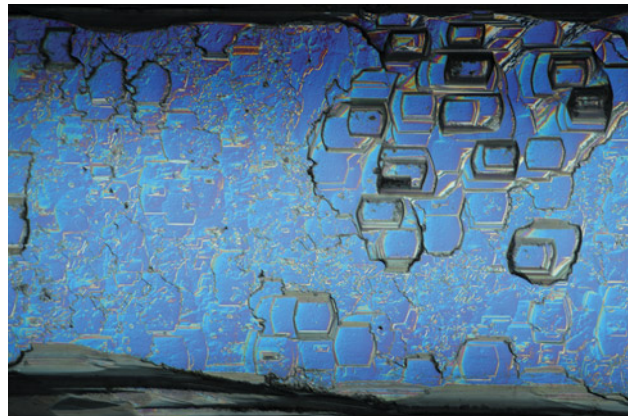


Figure 5. Aquamarine viewed with differential interference contrast filters. Hexagonal, pseudorectangular, and uneven etch features exist on every prismatic face and run the length of the crystal. Photomicrograph by Rhiana Henry; field of view 2.88 mm.

adorning their prismatic faces (figure 4). The six-sided deeper etch features are sometimes superimposed upon irregularly shaped etch features, or have ragged edges, and these are displayed more prominently on the aquamarine sample (figure 5) than on the heliodor. In both samples, the six-sided shapes are superimposed on each other in some cases, creating deep grooves within the crystal. Some etch shapes exhibit a line separating regions, which runs parallel to the *c*-axis of the crystal. The etch pits are detectable to the eye but require a microscope to see the compressed hexagons in detail.

Rhiana Elizabeth Henry and Adriana Robinson
GIA, Carlsbad

Hammered Effect in a Worked Pearl

The authors recently examined a white button-shaped pearl weighing 9.92 ct and measuring 11.76 × 11.20 × 10.62 mm (figure 6), which was identified as a natural pearl formed in a saltwater environment. One intriguing feature of the pearl was a distinctive pattern resembling the hammered surface commonly seen on brass and copper ornaments. The pearl's surface appeared to show a series of closely packed shallow indentations on the nacre surface, forming ridges in a mosaic pattern (P. Southgate and J. Lucas, *The Pearl Oyster*, 2008, p. 296).

Microscopic examination revealed that the hammered effect was subsurface and did not actually result in any ex-

Figure 6. This 9.92 ct white natural pearl displayed a subsurface hammered effect. Photo by Gaurav Bera.

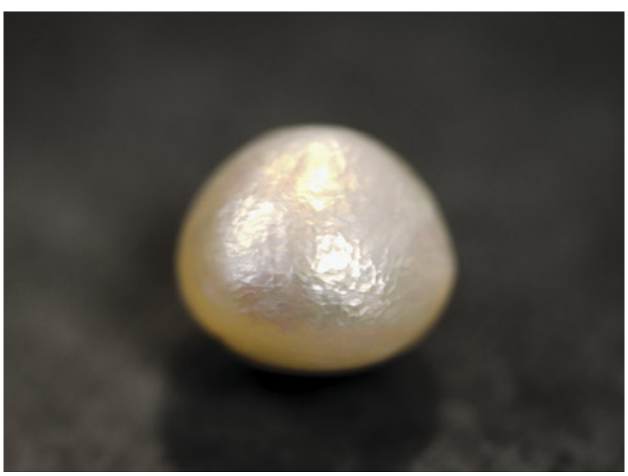
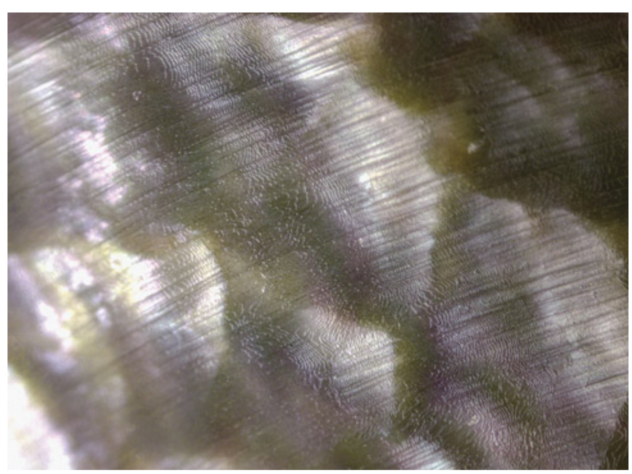


Figure 7. Worked lines observed on the pearl's surface along with a subsurface hammered effect. Photomicrograph by Nishka Vaz, field of view 1.8 mm.



terior indentations. However, the pearl's surface was covered in shallow worked lines, crisscrossing in angular directions with an attempt to create a smoother surface without any irregularities (figure 7).

The surface nacre layer of the pearl was translucent, making it easier to observe the pattern in the underlying nacre layers along with the strong orient caused by these subsurface indentations. Due to the worked surface of the pearl, the interaction of light with these layers created an optical illusion of a bumpy texture when viewed without magnification.

While the authors have previously encountered pearls with a subsurface hammered appearance, this effect combined with extensive working was notable.

Nishka Vaz and Abeer Al-Alawi
GIA, Mumbai

"Ruffles" on a Freshwater Pearl

Surface is one of GIA's 7 Pearl Value Factors describing the appearance of pearls. Because pearls are a product of nature, it is rather common to find blemishes or irregularities on the surface. However, the "ruffle" pattern exhibited by one particular pearl was fascinating.

The 4.61 ct non-bead cultured freshwater pearl's surface appeared unusually bumpy to the eye (figure 8). Microscopic examination under fiber-optic light revealed an interesting finding: a rainbow-colored wavy pattern under a translucent surface with no indication of treatment. Surprisingly, these ruffles were not caused by actual blemishes or irregularities on the pearl's outermost surface, but were formed by interactions between light and the unique nacre platelet arrangement under the pearl's surface (figure 9).

When light is projected onto a pearl's surface, iridescence can be observed due to diffraction and interference of white light caused by the layered arrangement of the nacre platelets (E. Fritsch and G.R. Rossman, "An update on color in gems. Part 3: Colors caused by band gaps and physical phenomena," Summer 1988 *G&G*, pp. 81–102). This underlying botryoidal feature on the surface may be explained by the special arrangement of nacre platelets that was determined by nature.

While similar features have previously been reported in akoya pearl (Fall 2021 *G&G* Micro-World, pp. 271–272), this is the author's first encounter with this intriguing appearance. The presence of these ruffles makes this freshwater pearl worth documenting.

Wing Kiu Fan
GIA, Hong Kong

Figure 8. A 4.61 ct non-bead cultured freshwater pearl with a bumpy surface. Photo by Wing Kiu Fan.

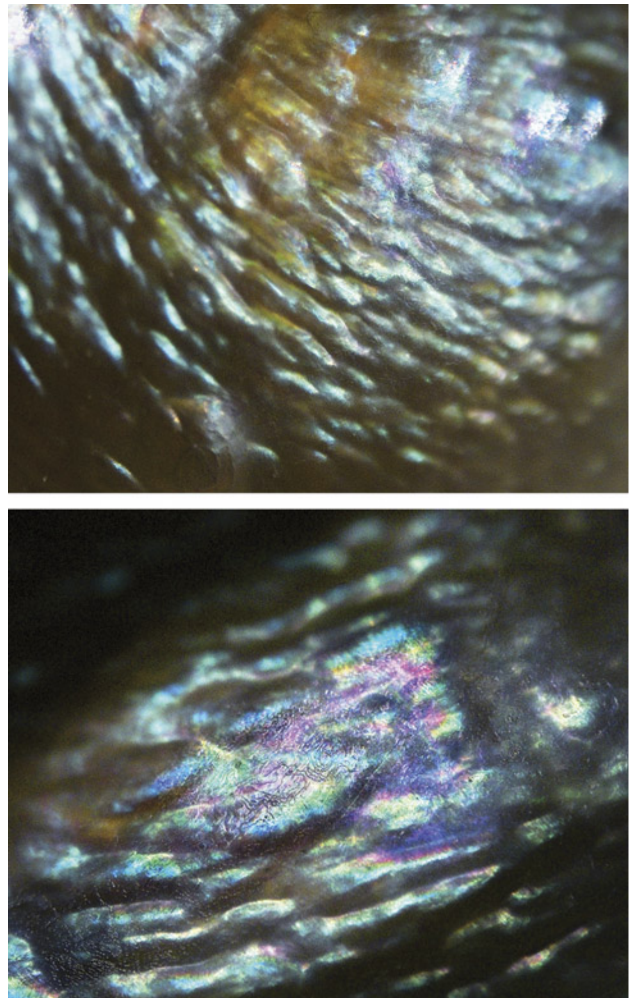


Figure 9. An iridescent wavy pattern and an overlapping nacre platelet structure (center part of the bottom image) were observed on the freshwater nacreous pearl. Photomicrographs by Wing Kiu Fan; field of view 4.00 mm (top) and 3.00 mm (bottom).

Fascinating Snakeskin Pattern on a Pen Shell

The pen shell, a member of the Pinnidae family, is distinguished by its thin, fragile walls and fan-shaped outline. While typically ranging from 30 to 50 cm in length, the pen shell can reach sizes up to 120 cm, making it one of the largest endemic bivalve mollusks of the Mediterranean Sea. It is usually found in estuaries and coastal waters (T. Capello et al., "Pen shell *Pinna nobilis* L. (Mollusca: Bivalvia) from different peculiar environments: Adaptive mechanisms of osmoregulation and neurotransmission," *European Zoological Journal*, Vol. 86, No. 1, 2019, pp. 333–342).

Pen shells are known for their intricate pattern of concentric growth lines, which form a visually captivating display, and their coloration ranging from brown to vibrant hues of yellow. GIA's Mumbai laboratory occasionally receives shells with intriguing features, one of them a pen shell with broken edges from Bahrain, measuring approximately 11.9 × 7.4 cm (figure 10). When viewed under magnification with fiber-optic illumination, a small area revealed an organized translucent yellow to brown cellular pattern, with vivid yellow outlines around each cell. These resembled a scale pattern, akin to the skin of a snake. Interestingly, a thick, milky white material filled the boundaries between the cells, giving the shell a shiny appearance. It was evident that the shell had been coated with varnish to enhance its aesthetic appeal (figure 11).

Figure 10. Pen shell from Bahrain, showing broken ends due to its fragile nature. Photo by Gaurav Bera.

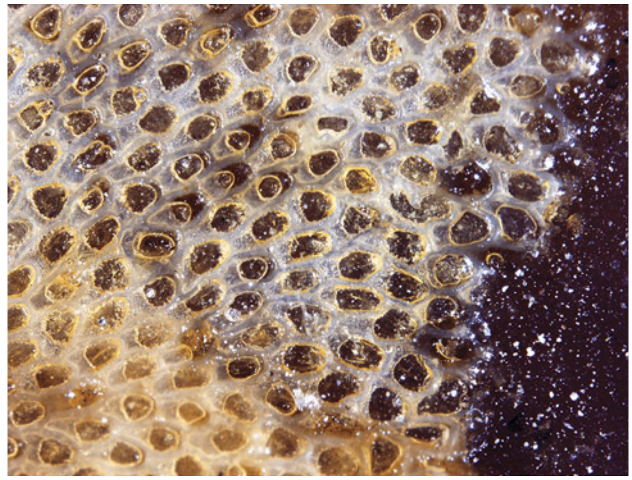


Figure 11. The pen shell's snakeskin pattern coated with varnish, shown under magnification. Photomicrograph by Pfokreni Nipuni; field of view 2.1 mm.

While shells can exhibit many different appearances, this snakeskin pattern is particularly fascinating.

Pfokreni Nipuni and Abeer Al-Alawi
GIA, Mumbai

Fireworks in Ruby

In the world of gemology, double-star corundum stands out as one of the rarest and most prized varieties of corundum, exhibiting two intersecting stars that dance across the surface. The effect resembles miniature fireworks in a gemstone. The double star is caused by needle-like inclusions of minerals such as rutile or hematite-ilmenite arranged in two orientations near the curved dome of the cabochon. When light reflects and scatters through these inclusions, it creates two intersecting white six-rayed stars.

Another type of double-star effect has two differently colored six-rayed stars, also known as dual-color double stars. One is a white star positioned near an upper layer of the cabochon's dome, while the other is a bodycolored star that seems to emanate from the back of the stone. This phenomenon occurs when light travels twice through the polished curved base of the cabochon, which contains needle-like inclusions and a matrix of corundum with trace elements determining its bodycolor. It produces a second star with color resulting from the host stone's color (K. Schmetzer et al., "Dual-color double stars in ruby, sapphire, and quartz: Cause and historical account," Summer 2015 *G&G*, pp. 112–143).

Figure 12. This unheated 11.43 ct purplish red round ruby cabochon displayed a white double-star phenomenon. Photo by Nuttapol Kitdee.

Figure 13. A six-rayed streamer-like pattern in the double-star ruby. Photomicrograph by Aprisara Semapongpan; field of view 7.20 mm.

Recently, the author examined an unheated 11.43 ct purplish red round ruby cabochon that displayed a double-star phenomenon (figure 12). The white color of this double star indicates that both stars formed near the curved dome surface. Alongside inclusions commonly found in rubies were interesting particle inclusions arranged in a streamer-like pattern revealed by fiber-optic illumination. These particles formed their very own six-rayed star pattern (figure 13), adding unexpected fireworks to the stone. This discovery serves as a reminder that nature is full of surprises just waiting to be uncovered.

Aprisara Semapongpan
GIA, Bangkok

Unique Fingerprint in Montana Sapphire

The group of fingerprint and crystal inclusions shown in figure 14 forms a unique and uncanny shape within a 6 × 4 mm heated Montana sapphire. The pattern displays a

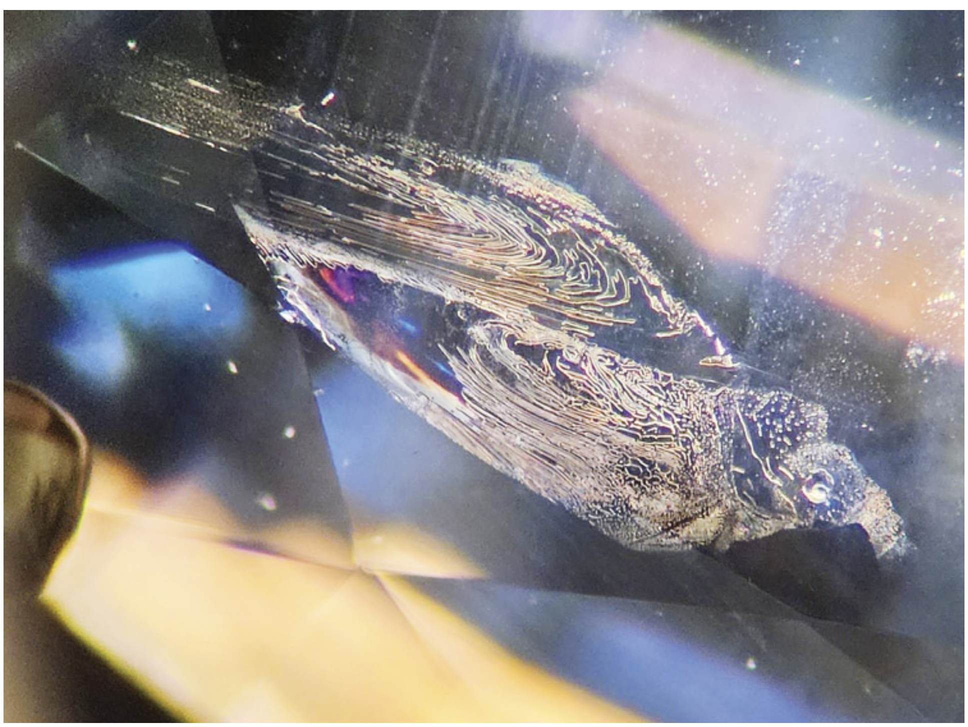


Figure 14. Inclusions combine to create a bird pattern inside a Montana sapphire. Photomicrograph by Isabelle Corvin; field of view 2.4 mm.

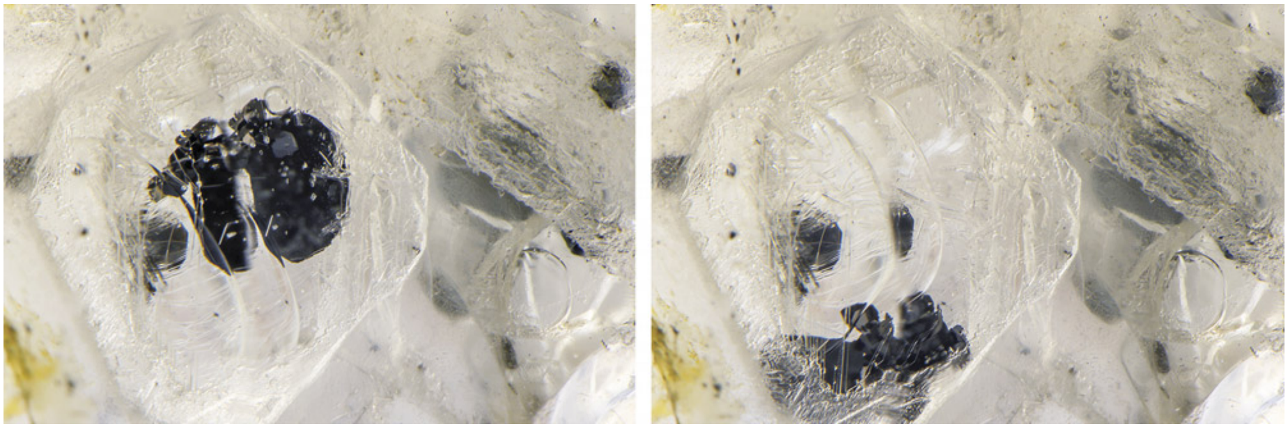


Figure 15. These two photomicrographs of a three-phase fluid inclusion in a Sri Lankan sapphire show that the opaque black graphite plates move freely within the void. Photomicrographs by Nathan Renfro; field of view 4.79 mm.

bird, complete with iridescence along the "wings" and a prominent included crystal as the "eye." The angle of the bird within the sapphire adds depth and movement to the pattern.

Isabelle Corvin
Olympia, Washington

Graphite in Sapphire

The gem deposits of Sri Lanka are known to contain graphite, which sometimes appears as inclusions in the sapphires Sri Lanka is famous for. We recently examined one such sapphire: a transparent to translucent, light brownish gray, waterworn single crystal section, with one polished window perpendicular to the optic-axis direction.

Weighing 4.94 ct and measuring 8.75 × 7.35 × 5.80 mm, the sapphire was purchased from Sajith Masilamani in Ratnapura, Sri Lanka. It was said to be from the Ratnapura District in Sabaragamuwa Province.

Under the microscope, the stone's inclusion scene proved quite interesting. On display was a large primary three-phase fluid inclusion containing water, liquid, and gaseous carbon dioxide, together with graphite as the solid phase. Of particular interest, as shown in figure 15, were loose graphite plates that moved freely in the confines of the fluid inclusion chamber.

In addition to the mobile graphite plates, the inclusion was quite active and appeared to "boil" while it homogenized under microscopic examination. A somewhat similar inclusion in a Sri Lankan sapphire is shown in *Photoatlas of Inclusions in Gemstones, Volume 3* (E.J. Gübelin and J.I. Koivula, 2005, Opinio Publishers, Basel, Switzerland, p. 280). Therefore, this particular inclusion with mobile graphite was unusual but not unique.

John I. Koivula and Nathan Renfro
GIA, Carlsbad

Transparent Spinel Inclusion in Pink Sapphire

The S Gemmological Institute Gem Lab recently examined 155 sapphires of assorted color, sourced from the Mogok Stone Tract in Myanmar. Among these, a pink sapphire weighing 1.166 ct exhibited a significant crystal inclusion extending to the table facet (figure 16). This transparent inclusion was identified by Raman spectroscopy as spinel. Internally, the inclusion appeared clear and smooth, while the surface-reaching face exhibited signs of scratching due to the low hardness of spinel compared to the sapphire host.

In the Mogok area, spinel inclusions in pink sapphire are not unusual, as both pink sapphire and spinel have been discovered in the marble-hosted formations. Although spinel inclusions have been previously reported in Burmese ruby (E.B. Hughes and W. Vertriest, "A canary in the ruby mine: Low-temperature heat treatment experiments on Burmese ruby," Winter 2022 *G&G*, pp. 400–423), and green gahnospinel inclusions have been documented in blue sapphire from Sri Lanka (Winter 2023 *G&G* Micro-World, p. 503), this spinel inclusion in a pink sapphire from Mogok was unusually large and distinct.

Sai Gon Khay and Kyaw Thu
S Gemmological Institute
Yangon, Myanmar

Star of David Pattern in Vietnamese Sapphire

Recently, the author examined a 3.18 ct bicolor yellow and blue-green basalt-related sapphire that was mined in southern Vietnam. Under brightfield illumination, the stone revealed partially healed fissures exhibiting an intriguing Star of David pattern matching the pinacoid face (figure 17).

This type of fissure often displays a geometric crystal structure, resembling either a hexagon or a triangle,

Figure 16. A large surface-reaching spinel inclusion in a Burmese pink sapphire from Mogok, shown in darkfield and oblique illumination. Photomicrograph by Kyaw Thu; field of view 1.3 mm.

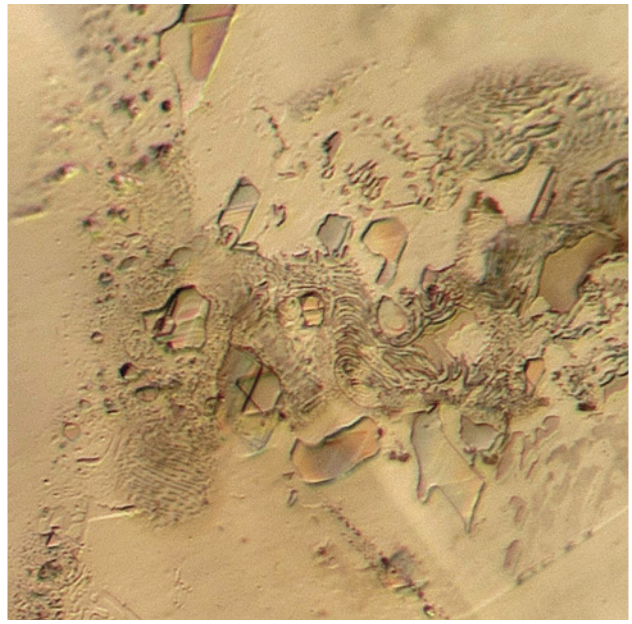


Figure 17. The fascinating Star of David pattern within partially healed fissures adds to the allure of this sapphire's micro-world. Under brightfield illumination, the grayish areas that remained unhealed were iridescent in some areas. Photomicrograph by Tinh Xuan Nguyen; field of view 1.8 mm.

when perpendicular to the *c*-axis. However, the pattern of interlocking triangles is rarely observed. These unique triangles probably resulted from defects in the crystal structure, which arose during oscillating growth between the rhombohedral and pinacoidal planes. The partial healing process made these features noticeable under the microscope.

Tinh Xuan Nguyen
PNJ Laboratory Company Limited
Ho Chi Minh City, Vietnam

Sapphire Displaying Tire Tracks in Snow

The author recently examined a 13.15 ct blue oval mixed-cut sapphire that contained a striking inclusion scene (figure 18). Careful microscopic observation revealed that the inclusions consisted of particle clouds close to the surface of the stone. The clouds featured a distinctive angular shape; they were aligned and stacked in a repeating pattern that suggested a Madagascar origin. The stone was faceted at an angle that accentuated these uniquely patterned particle clouds, which resembled tire tracks in snow.

Masumi Saito
GIA, Tokyo

Quartz with Sphalerite

The Taolin mine in Linxiang County, Hunan Province, China, is known to produce fine specimens of gemmy, brownish orange sphalerite, together with quartz. We re-

Figure 18. Clouds of particles in sapphire resembling tire marks in snow. Photomicrograph by Shunsuke Nagai, field of view 2.30 mm.

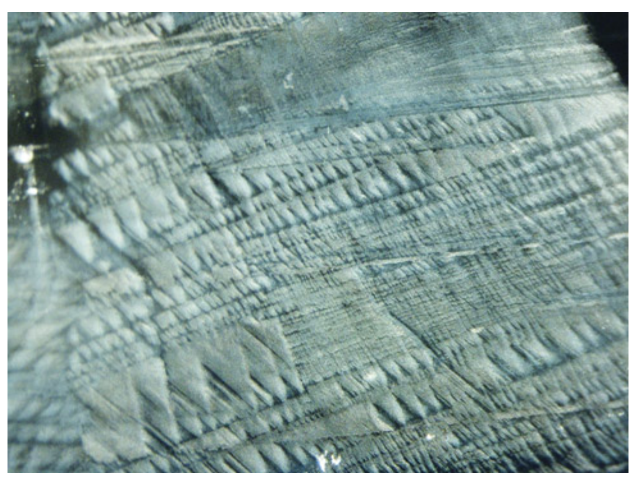


Figure 19. This 182.19 ct quartz cabochon hosts a brownish orange phantom with a netlike structural form. Photo by Adriana Robinson.

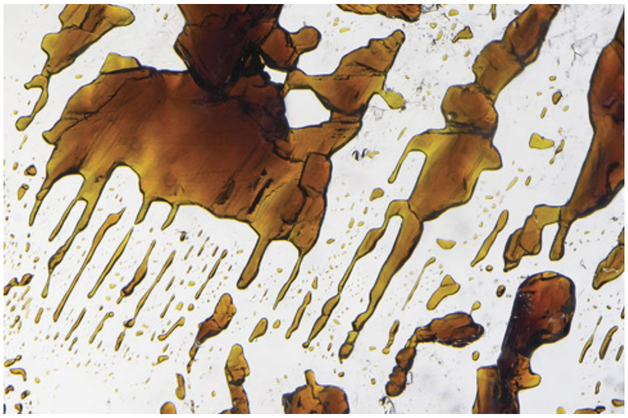


Figure 20. A network of rounded and stretched crystals, islands, and puddles of sphalerite that look as if they were once in a liquid state. Photomicrograph by Nathan Renfro; field of view 9.92 mm.

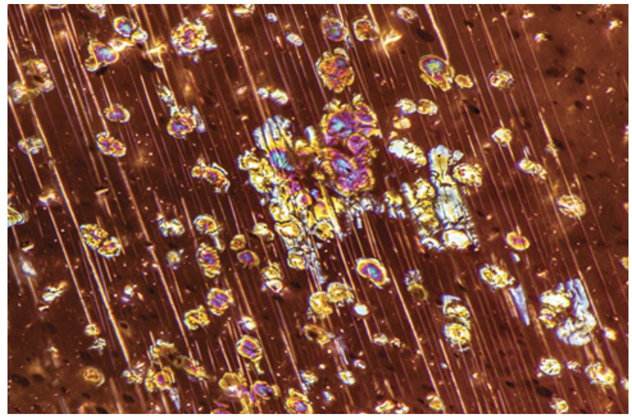


Figure 21. Reflected light reveals the metallic luster of these colorful inclusions in an Oregon sunstone. Photomicrograph by Rosie Young; field of view 1.26 mm. Courtesy of GIA Museum, collection no. 4735.

cently examined a transparent and colorless rectangular freeform double cabochon (figure 19) fashioned from a Taolin quartz crystal. The cabochon weighed 182.19 ct and measured 44.70 × 29.81 × 15.76 mm.

Interestingly, this specimen played host to a phantom of transparent brownish orange inclusions that formed as a network of rounded and stretched crystals, islands, and puddles. The appearance of these features suggested they were once in a liquid state (figure 20) and were originally deposited as a viscous liquid in the quartz.

Several parts of the phantom were near the surface of the host quartz, and some had been polished through and exposed at the surface. This made the inclusions ideal for Raman analysis, which proved that the phantom was made up of individual islands and tendrils of the mineral sphalerite.

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

Pyritic Inclusions in Oregon Sunstone

A sample of Oregon sunstone from the GIA Museum's collection was found to contain some unusual inclusions that appeared yellow in transmitted light and iridescent in reflected light. Vivid shades of yellow, blue, and purple were visible in a concentric pattern when illuminated with a fiber-optic light (figure 21). Some of the inclusions contained a metallic copper center and appeared darker than the surrounding inclusion under brightfield illumination (figure 22). The series of parallel lines pictured are also thought to be copper inclusions.

These inclusions looked pyritic in nature and possibly altered as a result of heating. This may well be natural heating from processes within the earth, as Oregon sunstone is not known to be treated.

Rosie Young
Gemmological Certification Services, London

Figure 22. Left: The yellow color of the inclusions can be seen with brightfield illumination, with those having a copper core appearing dark in the center. Right: The same view with reflected light shows the metallic luster of both the pyritic inclusions and the copper. Photomicrographs by Rosie Young; field of view 1.26 mm.

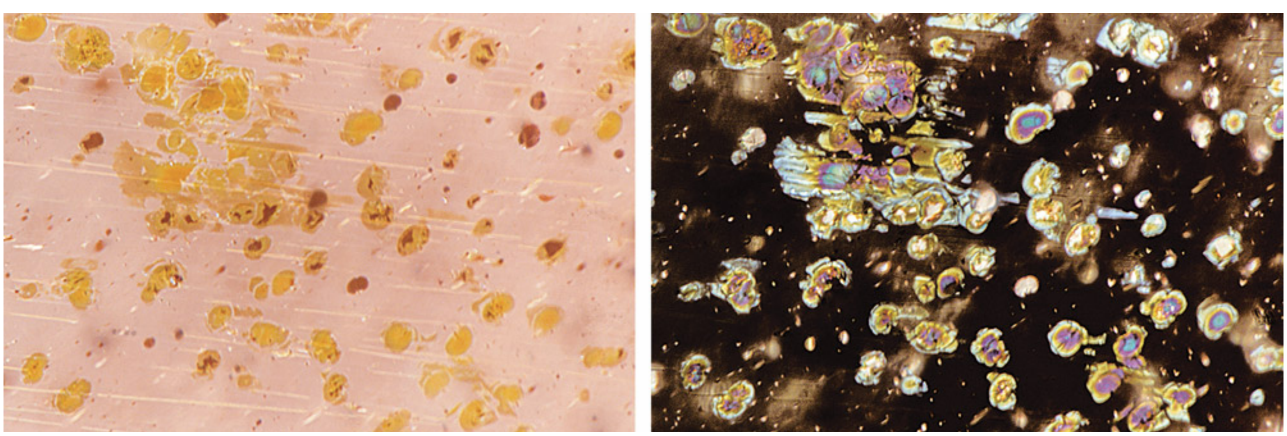


Figure 23. Weighing 178.42 ct and measuring 44.00 mm in length, this smoky brown quartz crystal from Ramona, California, hosts a 3.3 mm garnet. Photo by Annie Haynes.

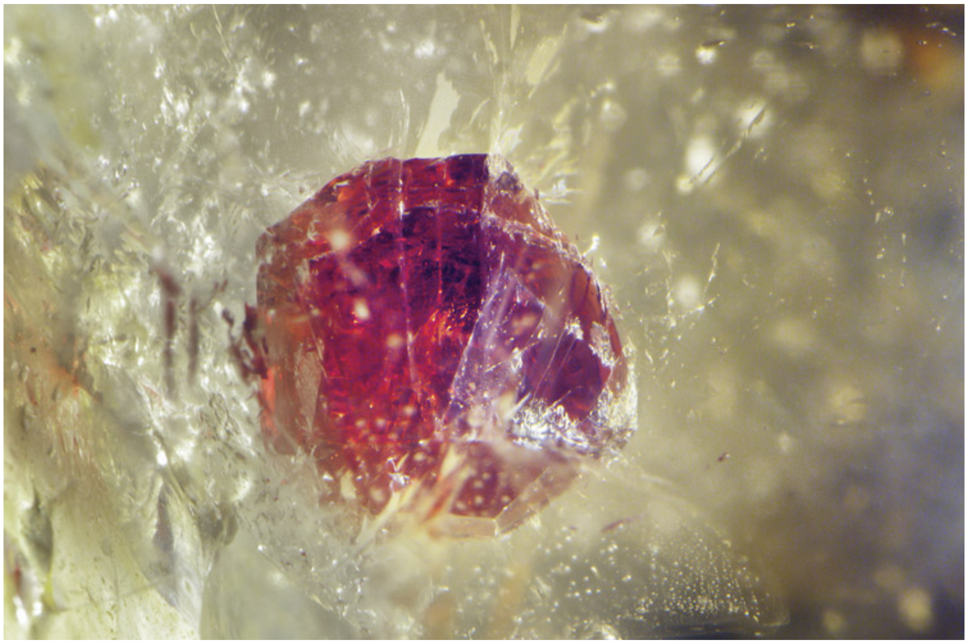


Figure 24. The 3.3 mm dark reddish orange isometric crystal in this smoky quartz was identified through Raman analysis as spessartine. Photomicrograph by Nathan Renfro; field of view 7.20 mm.

Quarterly Crystal: Spessartine in California Quartz

With silicon and oxygen as its building blocks, quartz is the single most abundant mineral in the earth's crust. When it forms as transparent crystals, it serves as an excellent and durable host for inclusions.

The 178.42 ct terminated smoky brown quartz crystal on a pegmatitic albite and muscovite matrix, measuring 44.00 mm long and shown in figure 23, came from the collection of noted gemologist, collector, and author Dr. John Sinkankas of San Diego, California. Dr. Sinkankas found the specimen at the Little Three mine in Ramona, near San Diego, while doing field research for his three-volume *Gemstones of North America*.

As shown microscopically in figure 24, the translucent, relatively large 3.3 mm dark reddish orange isometric inclusion appeared to be a garnet, since the pegmatitic Little Three mine is known to produce both quartz and spessartine. Raman analysis yielded an identification as spessartine, confirming our microscopic identification.

John I. Koivula, Nathan Renfro, and Maxwell Hain