



G&G

# Micro-World

**Editor**

Nathan Renfro

**Contributing Editors**

Elise A. Skalwold and John I. Koivula

## Mushroom in Copal

Copal is widely popular among gem collectors due to its eclectic inclusion scenes. As a fossilized tree resin, copal can contain a wide range of flora, fauna, and inorganic materials. It is not uncommon to find spiders, termites, leaves, and petals inside this resinous gem. In a 19.83 ct brownish orangy yellow copal, the author recently observed a remarkably well-preserved mushroom that was easily seen with the naked eye and had a cap that was just over 5.5 mm in diameter. Stalks of broken mushrooms, miscellaneous plant materials, and gas bubbles were also found in this specimen. Interestingly, copal was also used for many years by some indigenous peoples in Mexico and Central America as incense for ceremonial purposes such as the sacred mushroom ceremony. The mushroom inclusion in this copal, reportedly from Mexico, may have a more significant meaning for the people of Mesoamerica that goes beyond a gemological standpoint (figure 1).

*Rebecca Tsang  
GIA, Carlsbad*



*Figure 1. This copal from Mexico contained a remarkably well-preserved eye-visible mushroom inclusion. Photomicrograph by Nathan Renfro; field of view 9.59 mm.*

## Gilalite Altered to Cuprite in Quartz

In 2004, gem-quality quartz that contained blue to green inclusions of the hydrated copper silicate mineral gilalite was found in Paraíba, Brazil. This material was sold as

“Medusa quartz,” so named for the medusa phase of a jellyfish, which has an umbrella-like shape similar to these brightly colored inclusions. One specimen of this material contained an unusual red inclusion with the same umbrella shape (figure 2). This red inclusion revealed a surface-reaching crack. Microscopic examination showed a granular texture in the red areas. Raman analysis identified the red mineral as the copper oxide cuprite. It was apparent that the gilalite had been altered by secondary fluids that entered the crack. Neighboring gilalite inclusions were pristine and unaltered. The underside of the umbrella-like structure also revealed a blue ring, indicating that the inclusion had not completely altered (figure 3). The high-contrast blue and red colors seen in this particular sample of Medusa quartz make it a most intriguing inclusion specimen.

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

*About the banner: The surface of a synthetic rock crystal quartz is shown in contrasting color using modified Rheinberg contrast. Three colored filters highlight different crystallographically oriented sets of crystal faces. Photomicrograph by Nathan Renfro; field of view 12.50 mm.*

*Editors' note: Interested contributors should contact Nathan Renfro at nrenfro@gia.edu and Jennifer-Lynn Archuleta at jennifer.archuleta@gia.edu for submission information.*

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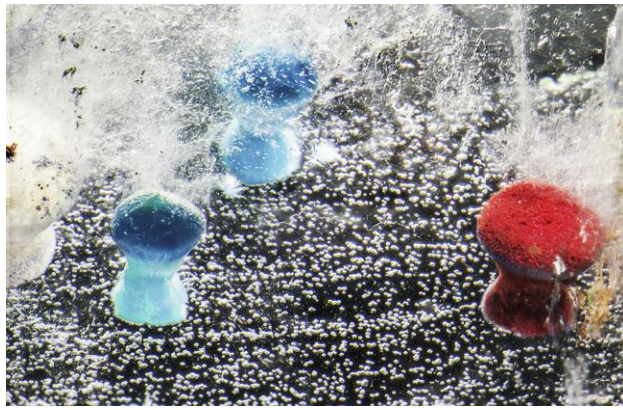


Figure 2. This quartz from Paraíba, Brazil, contains inclusions of the hydrated copper silicate mineral gilalite, with one inclusion altered to the red copper oxide mineral cuprite due to a crack that allowed secondary fluids to attack and alter the inclusion. Photomicrograph by Nathan Renfro; field of view 5.49 mm.

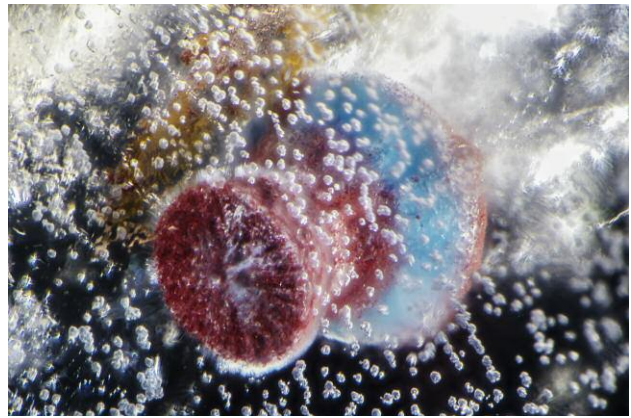


Figure 3. The red cuprite inclusion shows a blue ring of gilalite where there was incomplete alteration to cuprite. Also note the granular structure of the cuprite. Photomicrograph by Nathan Renfro; field of view 2.41 mm.

### Uncommon Parallel Color Zoning in a Chameleon Diamond

As their name suggests, chameleon diamonds are a kind of thermo- and photosensitive colored diamond that change hue with gentle heating or when left in darkness for an extended period of time. A diamond must meet the following criteria to qualify for chameleon testing at GIA: a green or greenish component in the bodycolor, yellow or orange fluorescence under both long-wave and short-wave UV light, and persistent yellow phosphorescence following exposure to short-wave UV light. After heating or an extended stay in darkness, the green component of the stone disappears and gives way to a yellowish orange hue. The mechanism responsible for this change is not well understood.

The infrared spectrum of chameleon diamonds typically shows them to be type Ia with moderate nitrogen concentration. The dominant feature in the visible-light

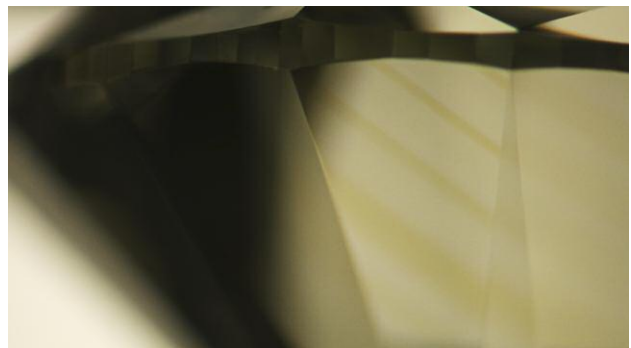
spectrum is a broad absorption band centered at 480 nm. Viewed face-up, most diamonds appear to have an even bodycolor to the unaided eye, but magnification reveals that the vast majority of diamonds with the 480 nm band defect show distinct color zoning with an amorphous distribution of color.

GIA's Carlsbad laboratory recently graded a Fancy Light grayish greenish yellow 1.06 ct round brilliant chameleon diamond that displayed this typical color zoning, but in a very distinctive pattern. Rather than the usual formless color distribution, the green color in this diamond was neatly confined to parallel bands (figure 4). The color-change effect caused by heating was correspondingly limited to these bands (figure 5). It is worth noting that the characteristic chameleon fluorescence and phosphorescence of this diamond were likewise confined to parallel zones as revealed by DiamondView imaging (figure 6). Al-

Figure 4. Parallel bands of green color in the 1.06 ct chameleon diamond at room temperature. Photomicrograph by Nathan Renfro; field of view 3.21 mm.



Figure 5. The green color changed to yellowish orange after about 15 seconds of gentle heating. Photomicrograph by Nathan Renfro; field of view 3.21 mm.



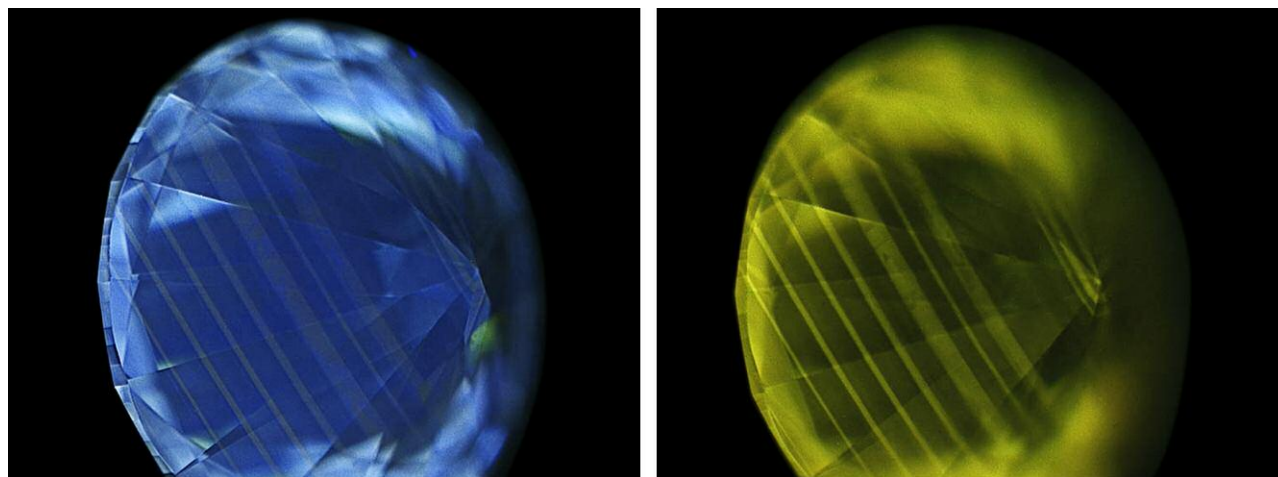


Figure 6. DiamondView images showing characteristic chameleon fluorescence (left) and phosphorescence (right) zoned in parallel bands. Images by Hollie McBride.

though parallel features are not rare in diamonds due to the inherent planes of weakness within their crystal structure, it is uncommon to see this pattern in chameleon stones. We took the opportunity to capture video of the chameleon effect in this distinctive stone while heating it in real time, something GIA has not previously endeavored. View the video at [www.gia.edu/gems-gemology/summer-2018-micro-world-uncommon-parallel-color-zoning-in-a-chameleon-diamond](http://www.gia.edu/gems-gemology/summer-2018-micro-world-uncommon-parallel-color-zoning-in-a-chameleon-diamond).

Hollie McBride  
GIA, Carlsbad

### Merelaniite Inclusions in Tanzanite

Tanzanite, the blue to violet transparent variety of the mineral zoisite, was discovered in Tanzania around 1967. Since tanzanite seldom contains significant inclusions, the authors were surprised to examine a tanzanite cabochon that contained myriad dense whisker-like inclusions. The whiskers were cylindrical in shape, typically gently curved along their length, and displayed a metallic luster. At first glance, the whiskers were interpreted to be composed of graphite, as it is one of the more common opaque black mineral inclusions found in tanzanite. However, the elongate, curvilinear morphology suggested they were likely something else.

Merelaniite, a new molybdenum-essential member of the cylindrite group, was recently identified by coauthor JAJ and colleagues and approved in 2016 by the Commission of New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association (IMA). The new mineral is sporadically found in specimens from the tanzanite mines near Merelani, Tanzania. It can be associated with a wide variety of minerals from the Merelani mines and has also been noted as being enclosed in calcite, quartz, chabazite, fluorapatite, prehnite, and zoisite. All the specimens identified so far have been obtained from secondary mineral markets, and the exact geo-

logical location of any specimen known to contain merelaniite is so far undocumented and unknown. Merelaniite occurs individually and in clusters as dark gray metallic whiskers of circular cross-section. The whiskers are composed of crystal lamellae that are tightly rolled in a “scroll-like” manner similar in appearance to the related mineral cylindrite (J.A. Jaszczak et al., “Merelaniite,  $\text{Mo}_4\text{Pb}_4\text{VSbS}_{15}$ , a new molybdenum-essential member of the cylindrite group, from the Merelani tanzanite deposit, Lelatema Mountains, Manyara region, Tanzania,” *Minerals*, 2016, Vol. 6, No. 4, 115).

This tanzanite cabochon sample revealed similar whisker-like inclusions accompanied by growth blockages, dark platy crystals, and fractures. The whiskers varied in diameter and length, and tended to branch out intermittently. The length was generally over a millimeter (figure 7). Growth blockages were fluid filled and also contained

Figure 7. Merelaniite whisker inclusions in the tanzanite cabochon. Photomicrograph by Augusto Castillo; field of view 3.57 mm.





Figure 8. A growth blockage results from the suspension of zoisite growth when the crystal is interrupted by a foreign body. In this case, the foreign body is a merelaniite whisker. Photomicrograph by Tyler Smith; field of view 1.99 mm.

dark solids (figure 8). The presence of intact liquid inclusions was a strong indicator that this tanzanite had not undergone heat treatment. Small granular crystals were observed in between fractures associated with the whisker inclusions. Raman spectroscopy confirmed these opaque whisker-like inclusions to be merelaniite, and platelets that were associated with the whiskers might be unwound layers of merelaniite.

Coincidentally, two unusual specimens of tanzanite crystals containing merelaniite whiskers were found by one of the coauthors (JAJ) among a gem and mineral

dealer's stock at one of the mineral shows held in Tucson, Arizona, in February 2018. Also relatively unusual is that these crystals were still on matrix composed primarily of calcite and graphite (figure 9).

The occurrence of merelaniite in tanzanite is very rare. This is the first time GIA has identified this new mineral in gem-quality tanzanite.

Augusto Castillo and Tyler Smith  
GIA, New York

John A. Jaszczak (jaszczak@mtu.edu)  
Michigan Technological University  
Houghton, Michigan

### Microlite Crystals in Topaz from Pakistan

Microlite,  $\text{NaCaTa}_2\text{O}_6(\text{OH})$ , is a typical mineral of highly developed lithium pegmatites, known from many localities worldwide. It always forms yellow to orange octahedral crystals. It was already known as inclusions in quartz from Pakistan (J. Hyršl and G. Niedermayr, "Einschlüsse im 'Allerweltsmineral' quartz," *Mineralien-Welt*, Vol. 18, No. 2, 2007, pp. 44–55), but much more beautiful are microlite inclusions in topaz (figure 10), examples of which were sold in Tucson in January 2018. Shigar Valley in northern Pakistan was reported as the locality. Both minerals were confirmed by Raman spectroscopy.

Topaz forms loose, very light brown crystals up to about 2 cm, and microlite forms sharp transparent orange octahedrons in sizes up to about 1.5 mm. The inclusions grew both on the surface and inside the topaz crystals (figure 11). Several topaz crystals were faceted, and the stones

Figure 9. A merelaniite-included tanzanite crystal (2.2 cm tall, left) on a matrix of calcite and graphite. The calcite also contains merelaniite inclusions. The close-up field of view (right) is 6.55 mm wide. Photos by J.A. Jaszczak.

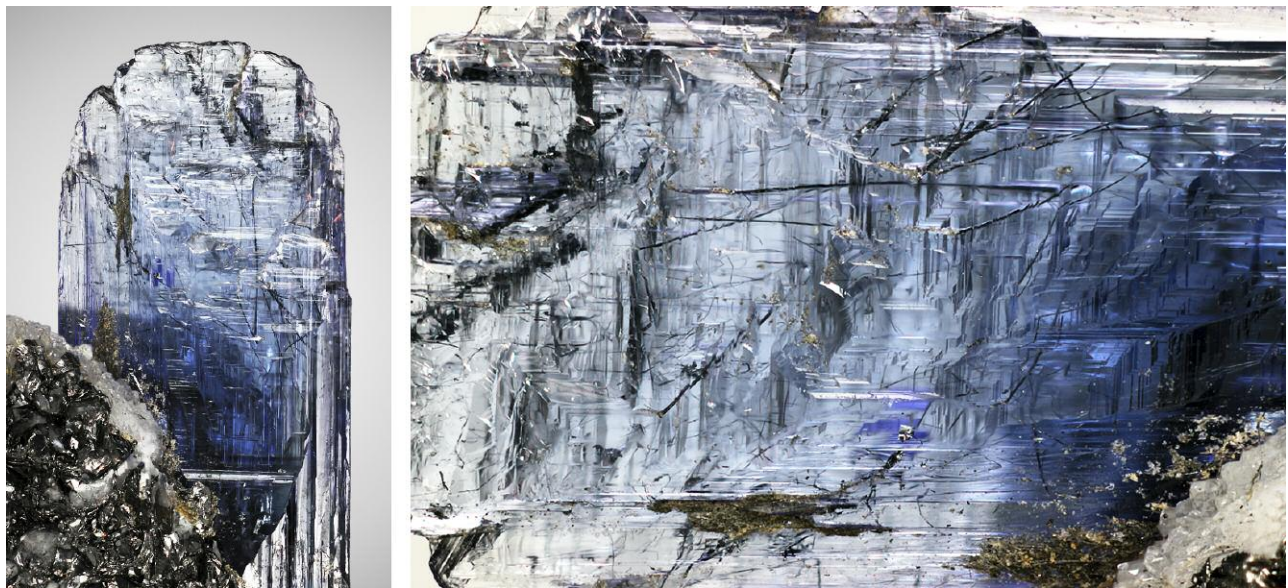




Figure 10. A 16 mm topaz crystal and an 8.69 ct faceted topaz, both with microlite inclusions, from Pakistan. Photo by J. Hyršl.



Figure 11. A microlite crystal, measuring 1 mm across, in a topaz from Pakistan. Photo by J. Hyršl.

host some of the most aesthetically pleasing inclusions found during the several last years.

Jaroslav Hyršl  
Prague

### Perettiite-(Y) and Tusionite Inclusions in Phenakite from Myanmar

Every year about 100 new minerals are described, but few have been discovered as inclusions in gemstones (e.g., carmichaelite in chrome pyrope from Arizona and protoenstatite in labradorite from Oregon). In 2015, a new mineral—perettiite-(Y)—was described as inclusions in phenakite crystals from pegmatites by Khetchel village in the Molo area

near Momeik, about 100 km northeast of Mogok (R.M. Danisi et al., “Perettiite-(Y),  $Y_2Mn_4Fe^{2+}[Si_2B_8O_{24}]$ , a new mineral from Momeik, Myanmar,” *European Journal of Mineralogy*, Vol. 27, No. 6, pp. 793–803). It was named after Swiss gemologist Adolf Peretti, head of the GemResearch Swisslab, who found the first specimens.

Perettiite-(Y) has a very unusual composition,  $Y_2Mn_4Fe[Si_2B_8O_{24}]$ . It forms strongly tapered yellow needles up to several millimeters long; only very rarely do they form beautiful bundles (figure 12, left). Several other inclusions were also found in phenakite from the same locality, including the very rare tin borate tusionite, which forms groups of mica-like yellow plates (figure 12, right). Phenakite itself is also unusual, because it often forms

Figure 12. Left: Perettiite-(Y) bundle in phenakite from Khetchel, Myanmar; image width 3.8 mm. Right: Tusionite plates in phenakite from Khetchel; image width 2.5 mm. Photomicrographs by P. Škácha.





Figure 13. Phenakite twin, measuring 1.35 cm high, with a "drill bit" termination and perettiite-(Y) inclusions. Photo by J. Hyršl. From the author's collection.

twins with very strange "drill bit" termination (figure 13). Unfortunately, perettiite-(Y) and tusionite inclusions (figure 14) are extremely rare, found in just a few pieces in a thousand phenakite crystals, so cut stones will remain a valuable collector's rarity (figure 14).

Jaroslav Hyršl

### A Horse-Shaped Inclusion in Pink Sapphire from Mozambique

Recently, GIA's Bangkok lab received a 0.58 ct pink sapphire with a unique inclusion. Microscopic observation revealed needles, platelets, and particles, all of which are common inclusions found in Mozambican ruby and pink sapphire. The most interesting inclusion was found near the stone's girdle. The crystal, which resembled a horse, was identified as phlogopite (figure 15). The most common mineral inclusions in Mozambican rubies are crystals of

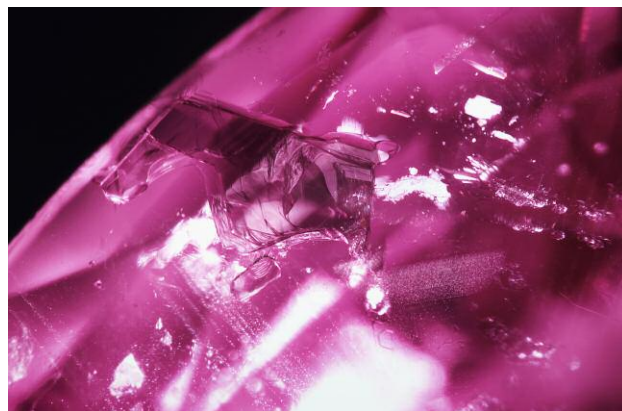


Figure 14. Phenakite with tusionite (left) and perettiite-(Y) inclusions (right). The specimen on the left weighs 1.77 ct, and the one on the right weighs 2.31 ct. Photo by J. Hyršl. From the author's collection.

amphibole and mica (V. Pardieu et al., "Rubies from the Montepuez area (Mozambique)," 2013, [www.gia.edu/gia-rubies-from-montepuez-area](http://www.gia.edu/gia-rubies-from-montepuez-area); V. Pardieu et al., "GIA lab reports on low-temperature heat treatment of Mozambique ruby," 2015, [www.gia.edu/gia-news-research-low-temperature-heat-treatment-mozambique-ruby](http://www.gia.edu/gia-news-research-low-temperature-heat-treatment-mozambique-ruby)). Most of the mica inclusions are margarite or muscovite, typically with a lighter color and pseudo-hexagonal shape. Phlogopite is another end member of the mica series, but with a very different chemical composition from muscovite. To our knowledge, phlogopite mica has not been reported in Mozambican rubies or pink sapphires.

Charuwan Khowpong  
GIA, Bangkok

Figure 15. The horse-shaped inclusion of phlogopite mica identified by Raman analysis. Photomicrograph by Charuwan Khowpong; field of view 2.40 mm.



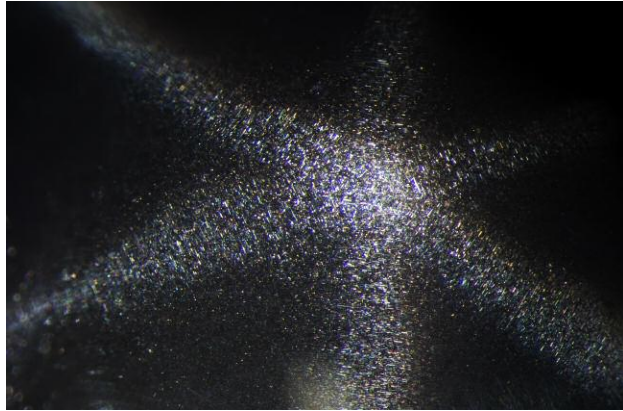


Figure 16. Fine needles create a six-rayed star in an untreated spinel. Photomicrograph by E. Billie Hughes; specimen courtesy of Global Spinel Gems.

### Star Spinel with Four and Six Rays

Lotus Gemology receives submissions of star stones on a regular basis, so when we first saw the specimen shown here, it appeared to be one among many of our usual stones to test. Upon closer examination, however, we realized it was not a star sapphire, but something much more rarely seen: star spinel.

Upon first glance at the cabochon's dome, the stone displays one six-rayed star (figure 16), similar to what we see in star corundum. But if we look on the sides of the stone, we can also see a four-rayed star (figure 17). These stars are both created from numerous dense, short needle-like particles. Once we examined a small polished area on the cabochon's base, we found that there are actually two dis-

Figure 17. When viewed in a different position, the spinel also displays a four-rayed star. Photomicrograph by E. Billie Hughes; specimen courtesy of Global Spinel Gems.

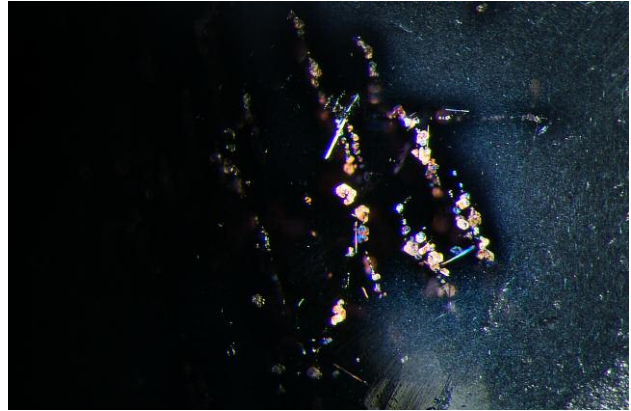
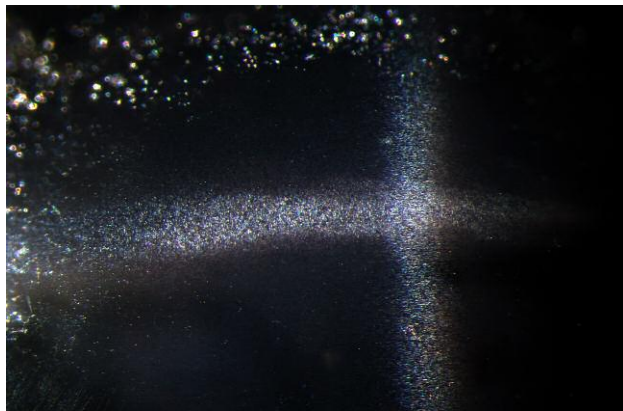


Figure 18. In the center of the image we can see larger reflective platelet inclusions in the untreated star spinel. On the right-hand side, we see much finer dense needles that form both six-rayed and four-rayed asterism. Photomicrograph by E. Billie Hughes; specimen courtesy of Global Spinel Gems.

tinct types of exsolution products in the stone. On the right side of figure 18, we can see the tiny, dense needles and particles that form both types of stars. In the center of the image we can see much larger, less densely dispersed platelets that resemble confetti.

E. Billie Hughes  
Lotus Gemology, Bangkok

### Wollastonite in Devitrified Glass, Imitating Horsetail Inclusions in Demantoid Garnet

A 13.12 ct transparent yellowish green gemstone with a beautiful internal scene was examined by the author. The specimen exhibited numerous elongated colorless crystals radiating from the center (figure 19), much like the horsetail inclusions of chrysotile that one would expect to find in Russian demantoid garnets. Standard gemological testing yielded surprising results: a single refractive index of 1.520, specific gravity of 2.50, and medium chalky green fluorescence under short-wave UV light. The specimen was inert to long-wave UV light. These properties indicated that the yellowish green cabochon stone was glass, whereas the masses of needle-like crystals (figure 20) were identified as calcium silicate wollastonite by Raman spectroscopy. Wollastonite inclusions have been reported as an indicator of the devitrification process (Winter 2017 *Micro-World*, pp. 469–470).

Other advanced techniques, including energy-dispersive X-ray fluorescence (EDXRF) and Fourier-transform infrared (FTIR) and Raman spectroscopy, were also carried out to confirm the cabochon's identity. FTIR and Raman spectroscopy showed a distinct and characteristic pattern of artificial glass. The nonquantitative EDXRF offers no

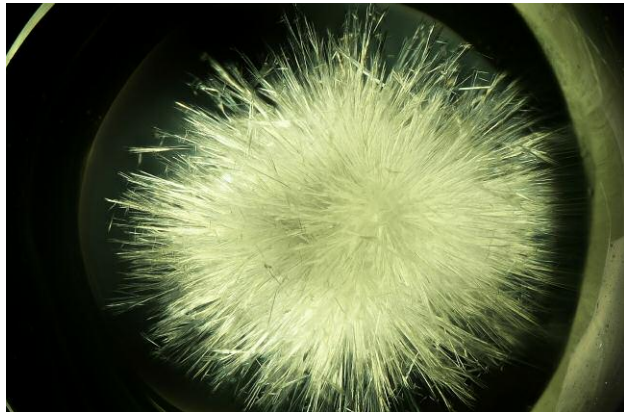


Figure 19. A yellowish green glass with numerous wollastonite needles radiating from the center, similar to the horsetail inclusions found in demantoid garnets. Photomicrograph by Ungkhana Atikarnsakul; field of view 14.4 mm.

additional value, as the elements detected are also present in demantoid garnets.

Although this is not the first time that wollastonite inclusions have been found in devitrified glasses, they formed in an interesting pattern in this yellowish green gemstone.

*Ungkhana Atikarnsakul  
GIA, Bangkok*

### Quarterly Crystal: Wurtzite Phantom in Quartz

Transparent colorless rock crystal quartz is a strong, durable mineral that makes a favorable host for a wide variety of inclusions (see the three-volume *Photoatlas of Inclusions*

Figure 20. Close-up view of the wollastonite crystals. Photomicrograph by Ungkhana Atikarnsakul; field of view 4.8 mm.

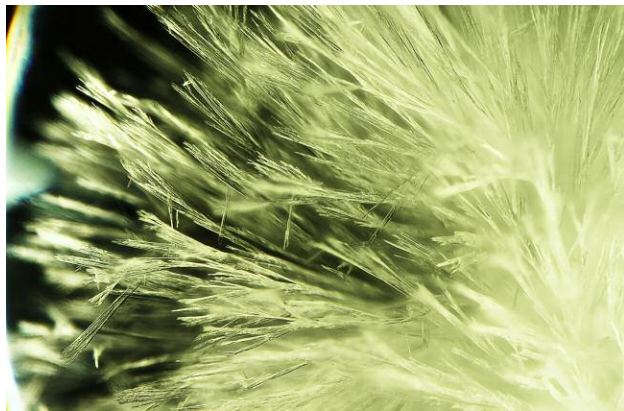


Figure 21. Measuring 86.38 mm and weighing 1,140 ct, this quartz crystal from British Columbia contains a three-sided phantom composed of an abundance of opaque black wurtzite inclusions. Photo by Robison McMurtry.

*in Gemstones* for examples). The geographic source of the crystal pictured in figure 21 is British Columbia, Canada. At 1,140 ct and 86.38 mm in length, this large example of rock crystal plays host to several near-surface opaque black hexagonal to trigonal crystals as large as 5.0 mm.

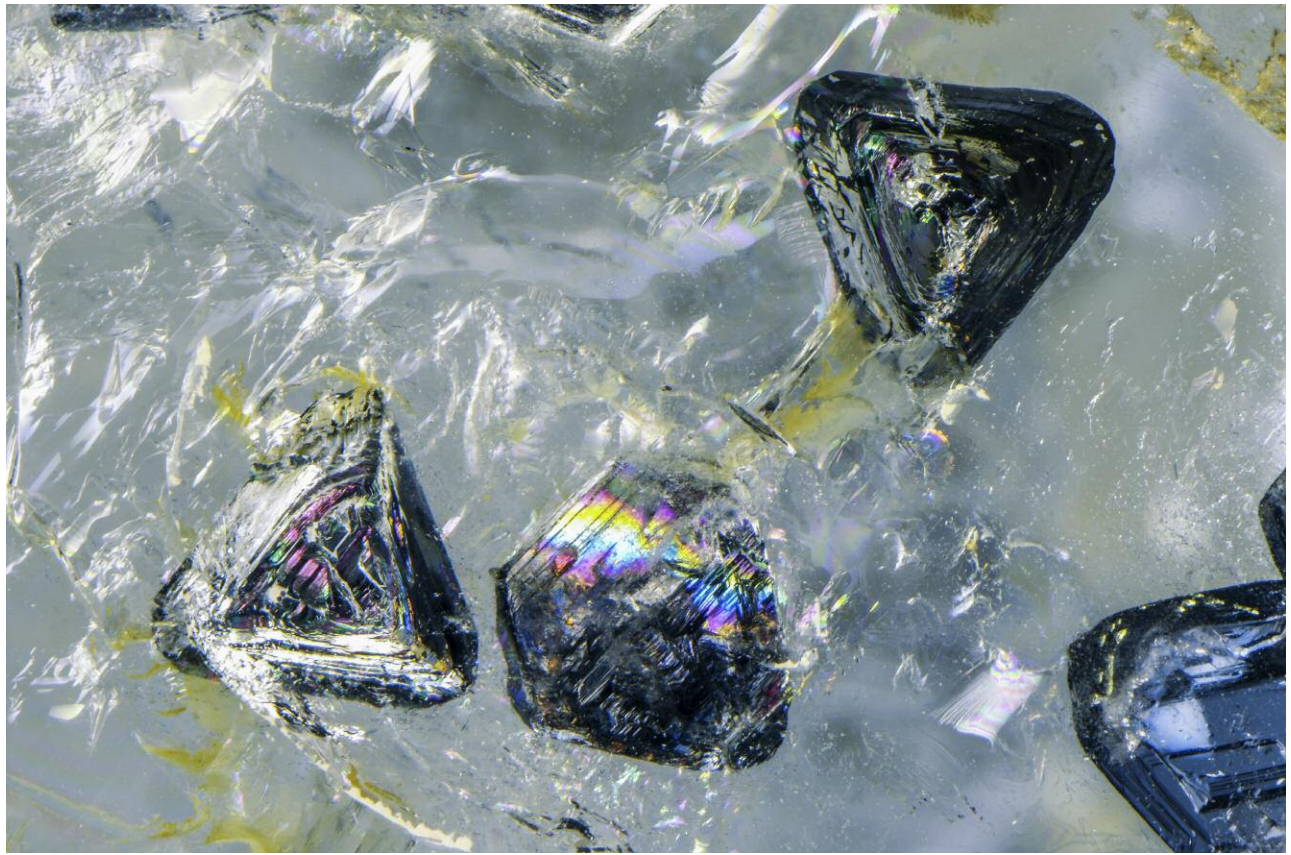


Figure 22. The crystals in this phantom plane in quartz were identified by Raman analysis as wurtzite. Photomicrograph by Nathan Renfro; field of view 19.2 mm.

As shown in figure 22, the micromorphology of the numerous inclusions, forming a three-sided phantom, suggests that they might be the zinc iron sulfide wurtzite. Laser Raman microspectrometry confirmed the identification of the inclusions as wurtzite. The euhedral inclusions were situated in the quartz crystal in the form of directional phantoms that developed through the directional deposition of the wurtzite on three consecutive surfaces of

the quartz, which then continued to grow, enveloping the wurtzite as inclusion planes tracing the form of the original quartz host. From what we can determine, this is the first time that wurtzite has been found as an inclusion in any gem material. Because of wurtzite's relationship to sphalerite, some inclusions previously identified as sphalerite may actually be wurtzite.

*John I. Koivula*

## For More on Micro-World

To see video of the chameleon effect in a Fancy Light grayish greenish yellow diamond, as featured in this section, please visit [www.gia.edu/gems\\_gemology/summer\\_2018\\_microworld\\_uncommon\\_parallel\\_color\\_zoning\\_in\\_a\\_chameleon\\_diamond](http://www.gia.edu/gems_gemology/summer_2018_microworld_uncommon_parallel_color_zoning_in_a_chameleon_diamond)

