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Rain Cloud in Alexandrite

An example of nature imitating nature was seen in a 0.73 ct faceted alexandrite showcasing an inclusion reminiscent of a rain cloud (figure 1). The "cloud" was composed of white particles oriented as parallel bands that displayed a cloud-like silhouette when viewed at an angle. The "rain" was composed of fine oriented reflective needles commonly referred to as silk. Fiber-optic lighting allowed for a concentration of white light to be seen under the cloud, creating an appearance of lightning. The inclusion scene observed in this gem is an interesting novelty that any gemologist can appreciate.

Britni LeCroy
GIA, Carlsbad

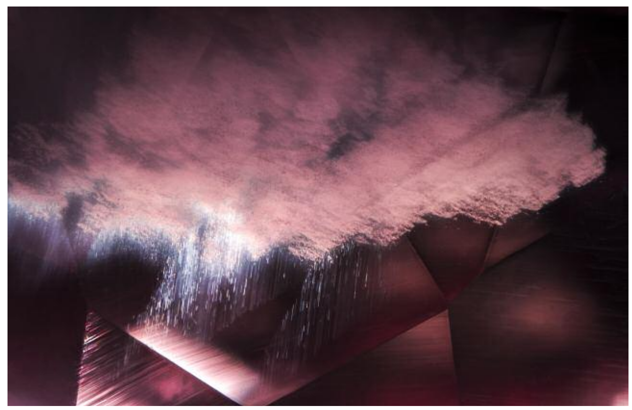

Figure 1. An alexandrite seen with fine milky particles and bands of silk resembling a rain cloud. Photomicrograph by Britni LeCroy; field of view 2.90 mm.

Conichalcite in Quartz Chalcedony

An interesting greenish blue cabochon of chalcedony was examined to determine the identity of some peculiar yellowish green inclusions. The bodycolor offered some clues, as the greenish blue variety of chalcedony, known as "gem silica," is commonly attributed to the copper mineral chrysocolla. Therefore, it was not a surprise when Raman spectrometry identified the yellowish green inclusions as another mineral that contained a significant amount of copper: conichalcite (figure 2).

Conichalcite, $CaCu(AsO_4)(OH)$, is a member of the adelite-descloizite group and occurs in colors from dominantly green to dominantly yellow, with either a yellow or green modifier. Conichalcite is reported to occur with chrysocolla from deposits in the United States (Utah, Arizona, and California), Germany, Peru, and Australia. This particular gem was reportedly from Concepcion Del Oro, Zacatecas, Mexico.

These vibrant inclusions were quite visually striking when seen along with their greenish blue host chalcedony. This is the first time the authors have identified inclusions of conichalcite in chalcedony.

Nathan Renfro and John I. Koivula
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About the banner: Fibers of actinolite radiate from a core crystal of chromite in a Russian demantoid garnet. These "horsetail" inclusions are common in demantoid from Russia. Photomicrograph by Nathan Renfro; field of view 1.53 mm. Courtesy of the John Koivula Inclusion Collection.

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

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Emerald in Rock Crystal Quartz

Rock crystal is a transparent and colorless macrocrystalline variety of quartz (SiO_2) that often has cavities containing liq-

Figure 2. Raman spectrometry identified the yellowish green inclusions in this chalcedony host as the copper mineral conichalcite. Photomicrograph by Nathan Renfro; field of view 7.20 mm.

uid and gas two-phase inclusions. Many different minerals also form as inclusions within rock crystal quartz. Typical varieties of included quartz for gem use are rutilated quartz, tourmalinated quartz, and strawberry quartz. Specimens may also contain several other types of mineral inclusions.

Recently, the author examined a 10.95 ct rock crystal quartz cabochon that contained elongate rod-shaped green crystals (figure 3). The green crystals showed hexagonal cross-section and were identified by Raman spectroscopy as beryl. Ultraviolet/visible/near-infrared (UV-Vis-NIR) spectroscopy showed a chromium (Cr) spectrum, which confirmed that the green crystals were emerald. This amazing inclusion has been previously reported in a rock crystal quartz specimen (Fall 2008 Lab Notes, p. 258), but this is the first time the author has examined a gem-quality rock crystal quartz cabochon with a perfectly hexagonal emerald crystal inclusion.

Figure 3. A prismatic emerald crystal within a rock crystal quartz. Photomicrograph by Nattida Ng-Pooresatien; field of view 12.5 mm.

Nattida Ng-Pooresatien
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Iolite-Sunstone Intergrowth and Inclusions

At the GIA Carlsbad laboratory, the authors recently examined a cabochon of "bloodshot" iolite (containing red, eye-visible platelets of hematite) intergrown with a sunstone (figure 4). This material was reportedly sourced from India. Cordierite (iolite) and plagioclase feldspar is a common metamorphic mineral assemblage, and similar material reportedly from India has been documented in the past (Winter 1991 Gem News, pp. 261–262).

This "double" gem specimen displays a mixture of an attractive bluish violet dichroic color with red hematite platelet inclusions in the iolite half, combined with an orange aventurescence effect from numerous tiny copper-colored hematite platelets in the sunstone half.

Figure 4. An iolite-sunstone overgrowth crystal specimen. Photo by Kevin Schumacher.

Figure 5. This colorful inclusion scene showcases an anthophyllite crystal inclusion, which exhibits high transparency, several cleavage planes, and a thin/bladed prismatic crystal form. Photomicrograph by Jonathan Muyal; field of view 2.34 mm.

Viewing the stone under magnification offers an inclusion scene with a variety of well-formed hematite platelets, crystals, and liquid inclusions. Of particular interest was a fine elongated single-crystal inclusion of anthophyllite (figure 5).

The crystal shape of the anthophyllite could easily be mistaken for phlogopite, which has been documented in cordierite (E.J. Gübelin and J.I. Koivula, *Photoatlas of Inclusions in Gems*, Vol. 1, ABC Edition, Zurich, 1986, p. 268). In fact, several greenish brown prismatic phlogopite crystal inclusions were also observed inside the same specimen. Nevertheless, the anthophyllite crystal was conclusively identified by Raman microspectrometry analysis. The anthophyllite crystal inclusion showed a bladed prismatic crystal form, orangy yellow color, transparency, and several cleavage planes.

Although amphibole mineral inclusions have been documented extensively, distinct prismatic anthophyllite crystal inclusions are very rare and few references are found in the literature. Anthophyllite is more common in lamellar or fibrous form, classified as asbestos.

This combination iolite-sunstone specimen and its inclusions offer a unique visual composition that makes it a desirable piece for a gem collection.

Jonathan Muyal and Paul Mattlin
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Merelaniite in Gem Diopside from Merelani, Tanzania

A recent Micro-World entry (Summer 2018 *G&G*, pp. 226–227) described merelaniite occurring as dense inclusions in a tanzanite cabochon and as inclusions in two gem tanzanite crystals. While the Merelani tanzanite mines have also become well known for green diopside in recent years, in July 2019 the authors observed, for the first time, dense inclusions of fine merelaniite whiskers in gem-quality yellow-green, prismatic diopside crystals (figure 6, left).

Seven merelaniite-included diopside crystals, reportedly mined in 2018 and obtained by one of the authors (WR),

Figure 6. Left: Prismatic diopside crystal (1.5 cm tall) included with abundant merelaniite whiskers, associated with graphite at the termination, and aggregates of radiating white acicular mesolite crystals on some prism faces. Photo by Tom Stephan. Top right: Close-up of the merelaniite inclusion (field of view ~8 mm), viewed through one polarizer to reduce the effects of diopside's birefringence. Bottom right: Detail of some of the merelaniite inclusions showing spindle structures due to non-uniform layer growth around the whisker axes (field of view 1.5 mm). Photomicrographs by J.A. Jaszczak.

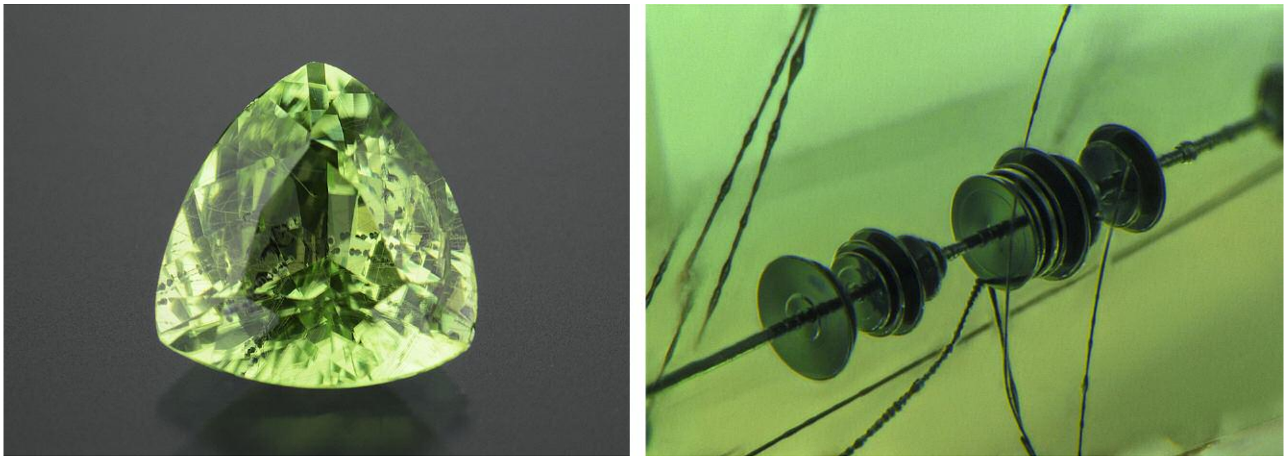

Figure 7. Left: A 1.35 ct faceted gem diopside containing merelaniite inclusions. Photo by Diego Sanchez. Right: Close-up of wheel and whisker morphology of the included merelaniite. Photomicrograph by Nathan Renfro; field of view 1.03 mm. Stone courtesy of Bill Vance.

ranged in size from approximately 1 to 5 cm long. Apart from the merelaniite inclusions, all but the largest had excellent clarity, although one 1.7 cm crystal was so densely filled with merelaniite that half of the sample appeared very dark. Similar to the inclusions observed in tanzanite, the merelaniite inclusions in diopside were predominantly cylindrical whiskers with metallic luster and variable diameters and lengths. The longest whiskers in the largest diopside spanned up to 2 cm (figure 6, top right), and many extended to the surface, where they terminated. Some of the merelaniite whiskers showed a spindle- or wheel-type structure with diameter that varied along the axis of even a single whisker (figure 6, bottom right). Some ribbon-like inclusions also occurred that were likely merelaniite. All of the diopsides were also associated with white spheroidal clusters of radiating acicular mesolite crystals, while several crystals were associated with graphite and one was associated with a transparent blue fluorapatite crystal.

While reviewing an earlier version of this report, GIA's Nathan Renfro made the connection between these included diopside crystals and a faceted Merelani diopside gemstone (figure 7, left) containing dark whisker inclusions. Author JIK obtained that diopside from Bill Vance, the stone's cutter, in approximately 2012. The whiskers in this 1.35 ct stone, some of which were surrounded by remarkable dark circular growths (figure 7, right), have also been confirmed by Raman spectroscopy as merelaniite.

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Dravite from Mozambique with an Abundance of Pyrite Inclusions

In the summer of 2017, author JP encountered a parcel of transparent yellow to brownish yellow tourmalines at the gemstone market in Chanthaburi, Thailand. The six faceted tourmalines shown in figure 8 revealed properties consistent with tourmaline. LA-ICP-MS analysis was performed to determine their major chemical components, which were: 11.56–12.31% MgO, 9.98–10.34% B_2O_3, 2.62–

Figure 8. Six yellow to brownish yellow faceted dravite tourmalines (0.47–2.8 ct) from Mozambique, many of which contained distinct metallic inclusions of pyrite. Photo by Weizhi Huang.

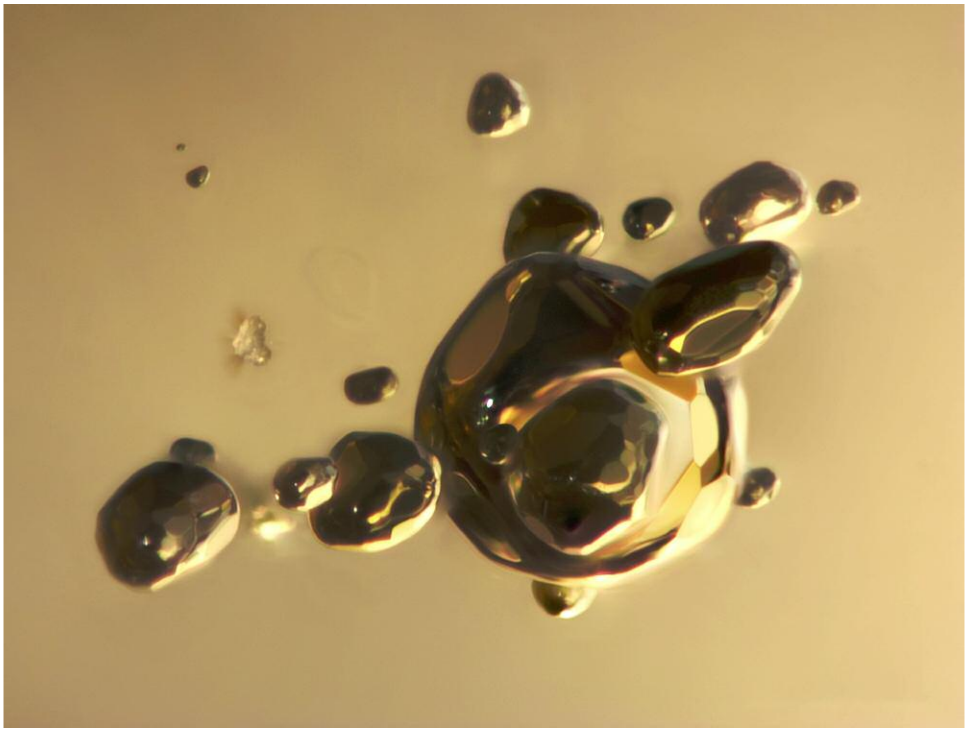

Figure 9. The dravites contained distinctive inclusions of pyrite, which were confirmed by Raman spectrometry. Photomicrograph by Weizhi Huang; field of view 0.8 mm.

2.82% Na_2O, 0.68–1.06% CaO, 0.17–0.45% TiO_2, and 0.11–0.25% FeO (total iron). Minor amounts of Li, K, V, Cr, Mn, Zn, Ga, and Sr were also detected, indicating dravite tourmaline.

These dravites were noteworthy for their numerous euhedral pyrite crystal inclusions (figure 9), confirmed by Raman. This was previously reported without Raman analysis (see Spring 2007 GNI, pp. 73–75). This is the first time the authors have seen so many intact pyrite crystals in yellow to brownish yellow gem-quality dravite from Mozambique.

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Dislocation Chain in Oregon Sunstone

The author recently examined a high-quality faceted orangy red Oregon sunstone weighing 6.77 ct. Examined under magnification with fiber-optic illumination, the stone displayed an unusual inclusion that consisted of a decorated dislocation string (figure 10). Copper exsolution platelets, which are common in Oregon sunstone, were also observed. In this example, the decorated dislocation followed a rectangular pattern, consistent with the crystal structure of the host feldspar. This unique light-scattering dislocation chain is the first that the author has encountered in Oregon sunstone.

Jessa Rizzo
GIA, Carlsbad

Tourmaline Inclusion in Russian Alexandrite

Alexandrite is the color-change variety of the mineral chrysoberyl. The most coveted alexandrite exhibits a luscious green to greenish blue color in daylight and a warm raspberry red in incandescent light. This phenomenal color change is caused by the presence of trace Cr^{3+} substituting for Al^{3+} in the chrysoberyl crystal structure. Alexandrite was originally found in the Ural Mountains of Russia in

Figure 10. This orangy red Oregon sunstone contained an interesting decorated dislocation that was visible using fiber-optic illumination. Photomicrograph by Jessa Rizzo; field of view 4.79 mm.

Figure 11. The longest inclusion in this photomicrograph of a Russian alexandrite was conclusively identified as tourmaline. This tourmaline inclusion exhibits a well-formed prismatic/rod-like crystal shape. Darkfield illumination. Photomicrograph by Jonathan Muyal; field of view 1.44 mm.

the early nineteenth century and was named in honor of Czar Alexander II.

GIA recently examined several Russian alexandrite rough specimens. These were reportedly from the Tokovaya mining area in the Ural Mountains, located a few kilometers away from the city of Yekaterinburg. Closer microscopic examination revealed a brown, transparent, well-formed prismatic crystal inclusion with triangular termination, indicating it might belong to the trigonal crystal system (figure 11).

The inclusion proved to be doubly refractive when viewed between crossed polarizers. Raman microspectrometry analysis conclusively identified the inclusion as tourmaline. In order to validate the Raman results and further identify the tourmaline species, laser ablation–inductively coupled plasma–mass spectrometry (LA-ICP-MS) was used to obtain the chemistry of the inclusion (Z. Sun et al., "A new method for determining gem tourmaline species by LA-ICP-MS," Spring 2019 *G&G*, pp. 2–17). It was classified as dravite, a sodium- and magnesium-rich tourmaline species. The trace element chemistry of the host alexandrite matched well with GIA's Russian alexandrite chemistry reference data.

Inclusions in alexandrite from various localities have been reported (E.J. Gübelin and J.I. Koivula, *Photoatlas of Inclusions in Gemstones*, Vol. 1, ABC Edition, Zurich, 1986, pp. 265–267; Vol. 3, Opinio Publishers, Basel, Switzerland, 2008, pp. 372–405). However, tourmaline in an alexandrite host is rare.

Alexandrite is traditionally popular for its beautiful color-change phenomenon rather than its inclusion scenes. The fine tourmaline crystal inclusion in this Russian alexandrite makes it an unusual collector's gem specimen.

Jonathan Muyal and Ziyin Sun
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Phenakite with Tourmaline Inclusion Containing Spiral Growth

A helix stands in high relief against the orangy pink of a well-defined tourmaline crystal—impressive screw dislocation growth is one of the main identifying characteristics detailing the inner world of a phenakite specimen from Ambohimanambola, Madagascar (figure 12).

Previously in the collection of longtime California mineral collector Kay Robertson, the unique inclusions in this gem were discovered during digitization for the Los Angeles Museum of Natural History's Gem and Mineral Lab. After spotting a series of parti-color tourmaline needles with vivid interference patterns under crossed polarizers, magnification was subsequently increased to investigate further. Soon it became clear that the needles scattered throughout the phenakite crystal exhibited strongly pleochroic colors as well as distinctive growth features.

In the absence of polarized light, the needles appeared in desaturated orange to red and green to blue hues. When magnification was increased once again, the eclectic world of this phenakite unveiled another surprise: The tourmaline inclusions were not alone. Alongside and extending from the base of the striated needles were colorless euhedral crystals exhibiting hexagonal form and inclusions of their own. One pair of primary inclusions, a needle anchored to another stubby crystal, were of particular interest. Raman spectroscopy confirmed the identity of the needle-like inclusions as tourmaline, though it was not possible to confirm the identity of the colorless crystal.

The pictured set of inclusions features an orangy pink tourmaline emerging from the body of a colorless crystal. The host specimen's high clarity highlights the growth fea-

Figure 12. A phenakite specimen from Ambohimanambola, Madagascar, contained a tourmaline with a spiral growth feature and a colorless crystal. Photomicrograph by Kimberly Abruzzo; field of view 0.88 mm.

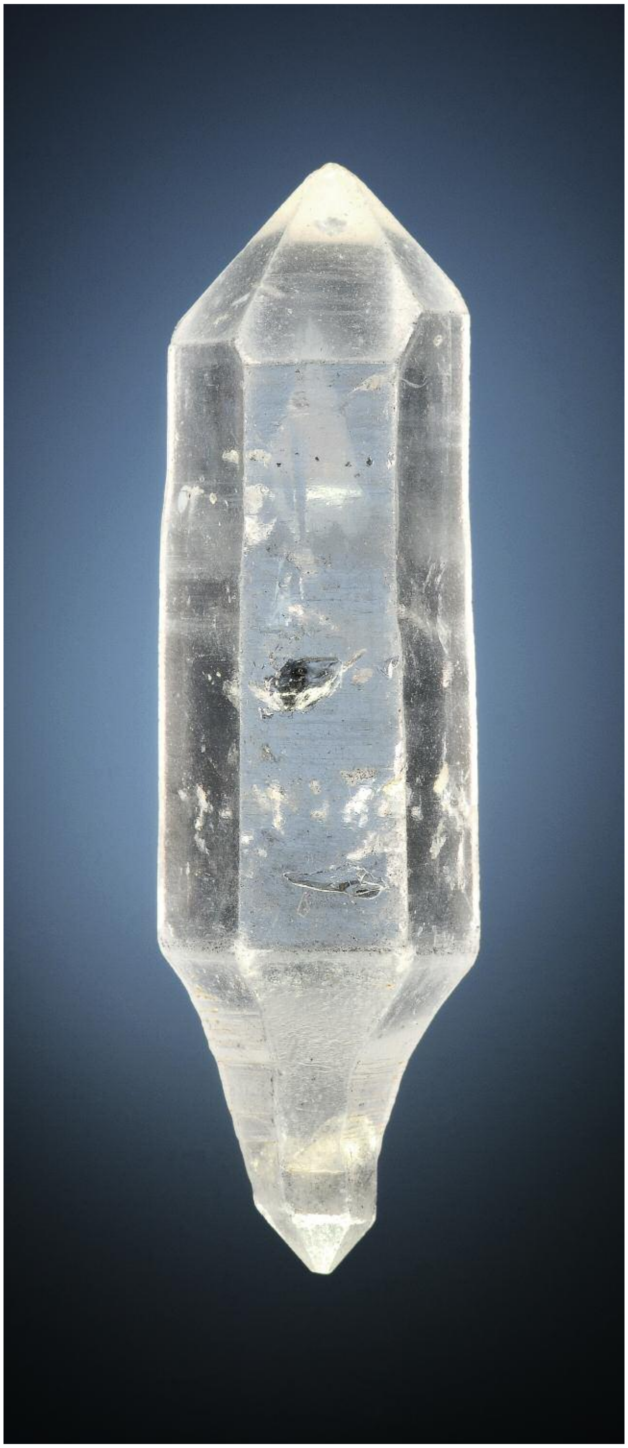


Figure 13. This doubly terminated scepter quartz crystal from Sichuan, China, weighs 200.28 ct and measures 75.03 mm in length. Photo by Diego Sanchez.

tures both inside and on the surface of its inclusions, not only showing striations parallel to the c-axis typical of tourmaline, but also more unusual "spiral" or screw dislocation growth. The entwined pair are crossed in the background by two larger dark greenish blue tourmaline needles that provide a striking geometric backdrop. Dislocation spirals like those seen here are formed when planes of atoms within a gemstone's crystal lattice are displaced during growth and rearrange themselves in a helical pattern corresponding to the direction of stress.

Perhaps best known for their intricate liddicoatite crystals, the Anjanabonoina pegmatites in Madagascar also produce a wide array of other gem minerals such as phenakite, beryl, spodumene, and danburite, among others. This particular stone presents an excellent example of the diverse mineralization that occurs at Anjanabonoina, showing off the habit, optical properties, and growth features of two important gem silicates from this gemologically important locality.

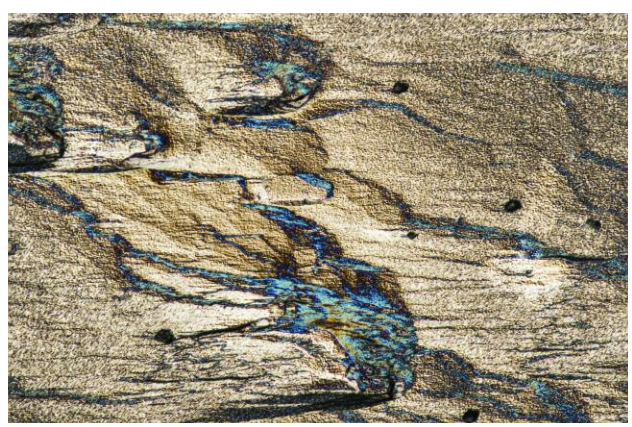
Kimberly Abruzzo
Natural History Museum of Los Angeles County

Quarterly Crystal: "Ball Bearing" in Quartz

Quartz crystals with three-phase fluid inclusions from the Jinkouhe mine in the Sichuan Province of China have been sold for many years at gem and mineral shows such as those held annually in Tucson, Arizona. Unfortunately, many of those crystals are damaged due to the mining methods used and the packing together of numerous crystals for transport. Good terminations on those crystals are few and far between, and the edges are generally chipped, while the broad flat crystal faces are often scratched and abraded.

So it was with high interest that we examined the relatively large doubly terminated scepter rock crystal quartz shown in figure 13. At 200.28 ct and measuring 75.03 × 21.76 × 17.98, this crystal was much larger than most others from the Jinkouhe mine. It was preserved in its own

Figure 14. Nomarski differential interference contrast revealed light etching on the prism faces of the quartz crystal. Photomicrograph by Nathan Renfro; field of view 0.72 mm.



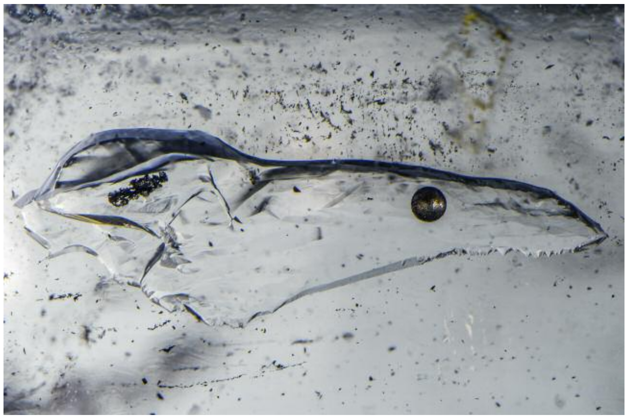


Figure 15. In this image, the silver-gray bubble can be seen at the right side of the liquid-filled void. The coating gives it the appearance of a small ball bearing. Photomicrograph by Nathan Renfro; field of view 7.42 mm.

Figure 16. The metallic-looking bubble has floated toward the left end of the fluid inclusion chamber. Photomicrograph by Nathan Renfro; field of view 7.42 mm.

cotton-lined box, and as shown in figure 13, essentially undamaged.

Microscopic examination of the crystal revealed light etching on the prism faces (figure 14), which was highlighted using Nomarski differential interference contrast. Internally there were several primary fluid inclusions, with typical black organic compounds as the solid phase. One fluid inclusion in particular contained a gas bubble (figure 15) that moved freely across the entire length of the void (figure 16). The bubble was coated with a metallic-looking substance that gave it the appearance of a small stainless steel ball bearing. We could not identify the coating but suspect that it was an organic compound.

John I. Koivula and Nathan Renfro

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