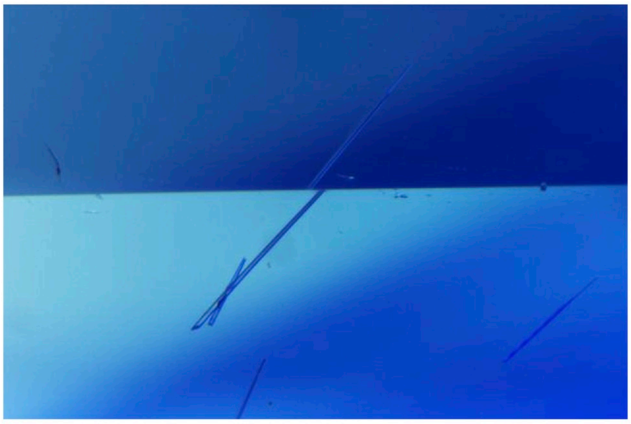

Figure 5. Lath-like mineral inclusions of grandidierite were seen in this sapphire at GIA's Carlsbad laboratory. Photomicrograph by Nathan Renfro; field of view 2.61 mm.

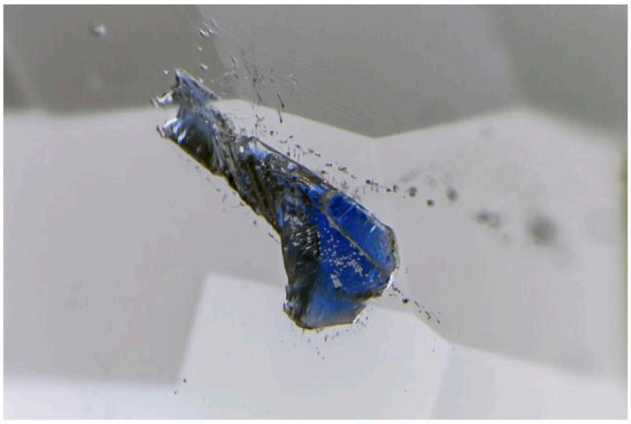

Figure 7. This light gray spinel from Mogok, Myanmar, contains a vibrant blue inclusion of lazurite. Photomicrograph by Nathan Renfro; field of view 1.59 mm. Courtesy of Mark Smith, Thai Lanka Trading Ltd.

examined by author MH in Carlsbad, California, contained colorless lath-like inclusions (figure 5). The sapphire examined by author EBH in Bangkok contained a colorless crystal that reached the surface of the sapphire host and displayed a duller luster in reflected light, and birefringent interference colors when examined using cross-polarized light (figure 6). Both observations are consistent with what one would expect for grandidierite.

Grandidierite, named after French naturalist Alfred Grandidier (1836–1921), is an extremely rare orthorhombic Mg-Fe aluminous borosilicate with the formula $(Mg,Fe)Al_3(BO_3)(SiO_4)O_2$. The mineral is described as bluish green to greenish blue; the blue color increases with Fe content. It is transparent to translucent with a pale yellow to colorless, greenish blue, and blue trichroism. Since its discovery, grandidierite has been found as a rare accessory mineral in aluminous boron-rich pegmatite; in aplite, gneiss, and crystalline rock associated with charnockite; and in rock subjected to local high-temperature, low-pressure metamorphism (contact aureoles and xenoliths). To the authors' knowledge, these are the first observations of grandidierite as an inclusion in sapphire.

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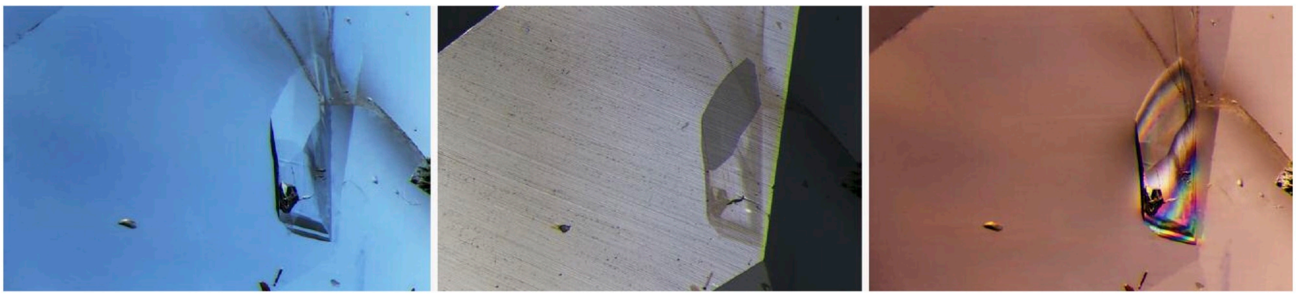
Lazurite in Spinel

Spinel is often inclusion free but occasionally showcases unusual inclusions. This was the case with a 1.02 ct light gray Burmese spinel from Mogok, courtesy of Mark Smith (Thai Lanka Trading Ltd., Bangkok), that was recently examined by the authors. A striking vibrant blue inclusion reached the surface of the pavilion, making Raman analysis straightforward (figure 7). The identity of the blue in-

Figure 6. A colorless grandidierite crystal was seen in a sapphire examined by author EBH at Lotus Gemology in Bangkok (left). In reflected light, the grandidierite inclusion showed a duller luster than the sapphire host (center) and cross-polarized light revealed birefringent interference colors (right). Photomicrographs by E. Billie Hughes; field of view 1.7 mm.



clusion was confirmed to be lazurite. The mineral has previously been found as an inclusion in Burmese ruby (Spring 2012 Lab Notes, pp. 51–52), but this is the first instance of a lazurite inclusion in spinel that we are aware of.

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Fossil Insect in Opal

The authors recently examined a most unusual opal. The mottled brown polished free-form stone appeared to contain a trapped insect, which one might expect to find in fossil amber or copal (figure 8). However, noticeable play-of-color made it obvious that the host material for the insect was precious opal, which was further confirmed by standard gemological testing. Its refractive index of 1.45, weak white long-wave fluorescence, and Raman spectrum were all consistent with natural opal. No microscopic evidence of any type of treatment was detected.

Play-of-color was strongest in the darker brown portions toward the base but also appeared in shallow fissures around the insect's appendages. The insect broke the surface, resulting in some of its legs and underside being cut through during polishing (figure 9, left). An apparent set of mouth parts was clearly observed, but the position of some pits on the surface partially obscured the view. Fine hairs, or setae, were found along the legs (figure 9, center). The setae closest to the surface were surrounded by a grainy white material that resembled desiccated opal. A slightly contorted abdomen was observed alongside a pair of rear legs (figure 9, right).

Precious opal formation is not fully understood, but several mechanisms have been proposed (B.Y. Lynne et al., "Diagenesis of 1900-year-old siliceous sinter (opal-A to quartz) at Opal Mound, Roosevelt Hot Springs, Utah, U.S.A.," *Sedimentary Geology*, Vol. 179, Nos. 3-4, 2005, pp. 249–278; B. Pewkliang et al., "The formation of precious opal: Clues from the opalization of bone," *The Canadian Mineralogist*, Vol. 46, No. 1, 2008, pp. 139–149). One possible explanation is that low-pH groundwater percolated through the soil, accruing colloidal silica into a silica-rich fluid. This gel then underwent polymerization within cavities and voids to form microspheres of opal-A. One could imagine a scenario where the insect was entrapped by an intrusion of this gel, rapidly enveloping the insect and allowing it to avoid decomposition.

Figure 8. A polished free-form opal encapsulating an insect. Play-of-color is shown at the bottom. Photo by Jian Xin (Jae) Liao. Stone courtesy of Brian Berger.

Figure 9. An unidentified insect encapsulated in opal. Left: A head and mouth are visible along with several legs covered in fine hair-like structures, or setae. The leg in the foreground was partially cut through during polishing. Field of view 6.39 mm. Center: Setae branching from an appendage; field of view 2.57 mm. Right: The thorax of the insect is visible, though partially contorted. A grainy white layer coats and partially obscures the surface-reaching appendages and abdomen. Field of view 11.50 mm. Photomicrographs by Nathan Renfro (left and center) and Tyler Smith (right).