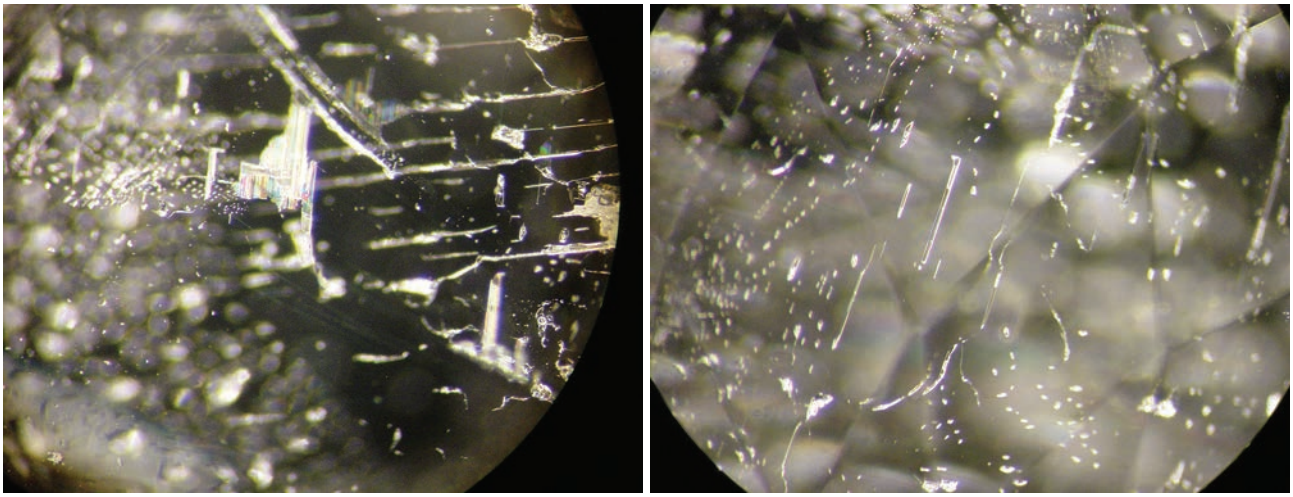

Figure 5: Internal features in the beryllonite consisted of iridescent planar fluid inclusions (left) and variably shaped two-phase inclusions (right). Photomicrographs by C. Williams; magnified 40×.

Numerous small inclusions were evident upon close examination of the stone without magnification. Microscopic observation with darkfield illumination revealed fluid-filled partially healed fissures, including one geometric-shaped iridescent inclusion that appeared to follow a cleavage plane (Figure 5, left). Also present were two-phase (fluid-gas) inclusions containing tiny bubbles (Figure 5, right).

Gem-quality beryllonite is known mainly from Afghanistan and Brazil, although Pakistan is also an occasional source of this rare gem material, as seen in this report.

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Apache Blue Stone (Chrysocolla) from Arizona, USA

The south-western USA is a well-known source of colourful secondary copper minerals such as malachite, azurite, chrysocolla, turquoise, etc. In 2013, a temporary partnership between a copper-mining company and Apache Way LLC (Chiricahua Apache Nde Nation, San Carlos Apache Reservation, Arizona) produced several tonnes of bright blue rough material from a large open pit located approximately 1 km from the now-inactive Sleeping Beauty turquoise mine. The appearance of the material varies from uniformly coloured to showing substantial amounts of matrix. Approximately 225 kg have been stabilized by polymer impregnation, and this material is being sold as Apache Blue Stone. More than 400 gems of various sizes and shapes have been cut and polished on the San Carlos Apache Reservation, with some contract cutting also being done overseas. In addition, silver- and gold-mounted jewellery and *objets d'art* are being manufactured and sold with Apache Blue Stone in indigenous and American heritage-inspired designs.

During the February 2017 Tucson gem shows, three pieces of rough were donated to Gem-A, and five cut-and-polished pieces were loaned for examination, by Charles Vargas and Warren Boyd (Apache Gems, San Carlos, Arizona). The rough material (Figure 6) was untreated, while the polished stones (Figure 7) had been stabilized by different polymer impregnation processes.

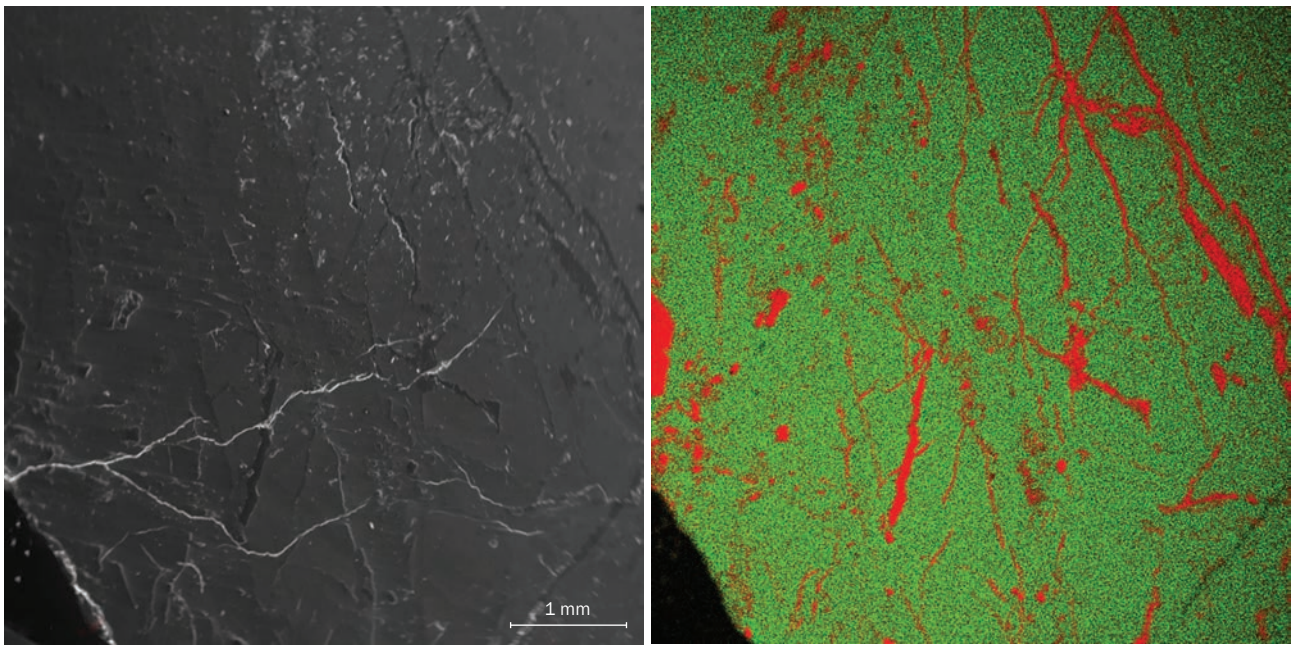
The samples were characterized by authors CW and BW. The rough stones were vibrant blue

Figure 6: These untreated rough pieces of Apache Blue Stone range from 4.4 g (~2 × 2 cm) to 90.3 g (~6 cm in maximum dimension). Gift of Charles Vargas; photo by Dean Brennan.

Figure 7: These polished samples consist of Apache Blue Stone that has been stabilized by polymer impregnation. The pieces on top (23.4 × 5.6 mm) were treated by the currently used stabilization method, while those on the bottom (drop shapes of 22.0 × 14.0 mm and an oval cut of 12.3 × 9.4 mm) were treated by an older polymer impregnation technique that partially darkened their colour. Photo by Dean Brennan.

to greenish blue. One rough sample appeared to consist of a brecciated rock with blue colour running in veins and along areas of the surface. The other pieces appeared more homogeneous, with translucent colourless areas of quartz. All of them had a chalky texture. Standard-based scanning electron microscopy–energy-dispersive spectroscopy (SEM-EDS) chemical analysis (Figure 8) of a rough sample by author AUF (using a Jeol JSM-6400 instrument with the Iridium Ultra software package by IXRF Systems Inc.) revealed major amounts of Si and high Cu contents (40.03–40.79 wt.% CuO). There also was minor Ca (~1 wt.% CaO) and traces of Mg, Fe and Mn. This composition is consistent with chrysocolla, and the identification was confirmed by Raman spectroscopy with a GemmoRaman-532SG instrument.

Figure 8: SEM-EDS imaging of the rough Apache Blue Stone showed features consistent with chrysocolla that is veined with quartz. The backscattered electron image on the left shows variations in overall atomic number (with darker areas corresponding to lower values, and vice versa), and the X-ray map on the right of the same area has been colourized according to contents of Cu (green) and Si (red). Images by A. U. Falster.



Of the five polished samples examined, three were treated using an older, now-discontinued process, and they showed areas of darker and lighter blue to greenish blue. Raman analysis identified the samples as chrysocolla, regardless of colour intensity. In addition, Fourier-transform infrared (FTIR) spectroscopy revealed bands associated with serpentine in some areas of these stones, as well as the expected presence of artificial resin that was used for stabilizing the material. EDXRF spectroscopy showed traces of K in these three samples, which may be due to mineral impurities. The other two polished samples were treated by the currently used stabilization method, and they displayed a lighter shade of blue (similar to the rough material) and contained quartz veining with some brown matrix. FTIR spectroscopy revealed artificial resin associated with the stabilization, but no K was detected with EDXRF analysis. Although RI readings could not be obtained from most of the samples, one of them yielded an approximate spot RI of 1.53. Hydrostatic SG was not measured due to the porosity of the material (rough) or the presence of polymer impregnation (polished samples).

Although Apache Blue Stone was reportedly mined within sight of the Sleeping Beauty mine, it is not related to turquoise other than exhibiting a similar colour and appearance. Due to overlapping values of RI and SG, and complications caused by the common presence of impregnation treatment, the identification of turquoise vs. chrysocolla is best determined by a well-equipped gemmological laboratory.

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Tianhuang, an Unusual Yellow Stone: Dickite or Nacrite?

In a collection of family heirloom jewellery that a client brought in for appraisal, we encountered an unusual yellow stone carving that we initially thought to be talc because of its soft and soapy feel. The yellow translucent stone—finely carved with a stylized lion—weighed 28.90 g and measured 44.90 × 26.58 × 12.19 mm (Figure 9). The object was typical for a Chinese stone seal, but its base was not yet engraved. It was slightly chipped due to wear and tear, and the softness of the material also was demonstrated by the presence of polishing marks and in the corresponding blurry reading on the refractometer caused by the poor polish. A faint shadow edge ranged from

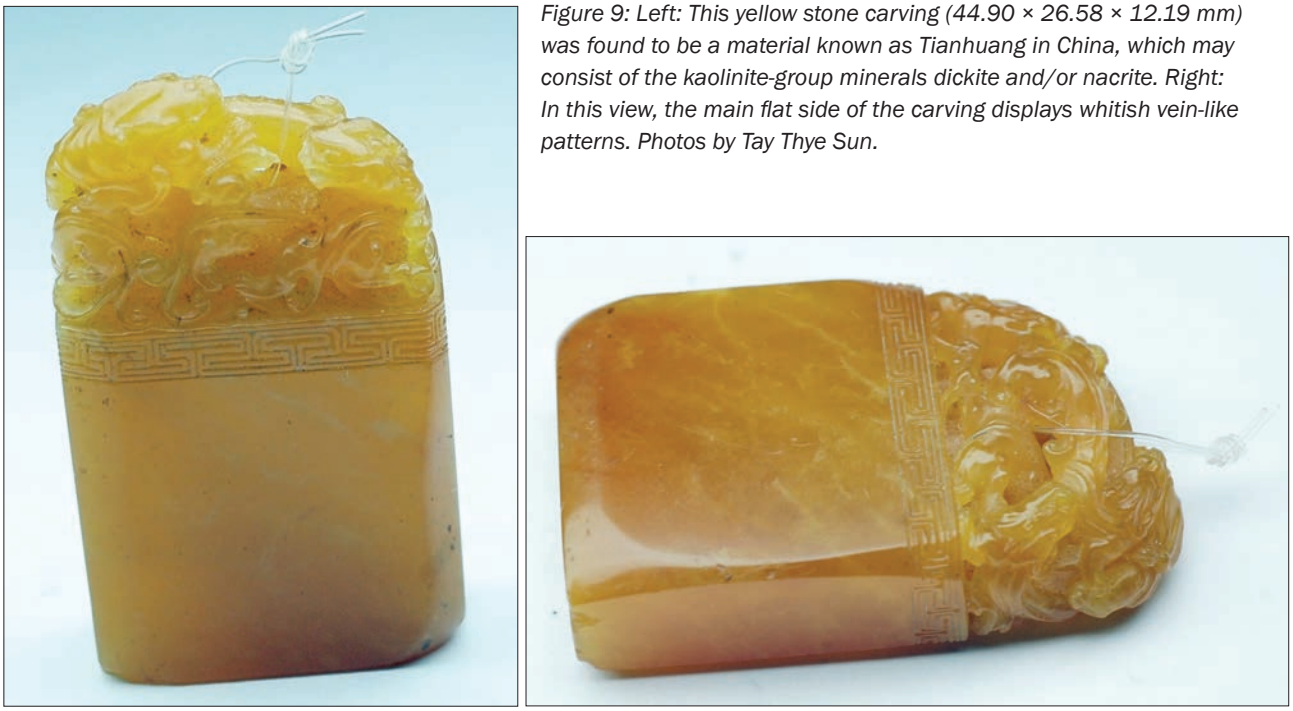

Figure 9: Left: This yellow stone carving (44.90 × 26.58 × 12.19 mm) was found to be a material known as Tianhuang in China, which may consist of the kaolinite-group minerals dickite and/or nacrite. Right: In this view, the main flat side of the carving displays whitish vein-like patterns. Photos by Tay Thye Sun.