Blue Diopside from Russia

Violane (or *violan*) is a term used for violet to blue diopside with a massive polycrystalline texture that mainly has been mined from the Praborna manganese deposit in St Marcel, Italy, and is coloured by Mn (Mottana *et al.* 1979). Although known for decades, this ornamental material is rarely mentioned in the gemmological literature (cf. Webster 1949). The term *violane* has also been applied to massive polycrystalline blue diopside from Russia, particularly by sellers on the Internet. In addition, similar material is known from Baffin Island, Canada, which is coloured by Fe^{2+}–Ti^{4+} intervalence charge transfer (Herd *et al.* 2000).

During the February 2020 Tucson gem shows, Rare Earth Mining Co. (Trumbull, Connecticut, USA) displayed some blue and blue/white cabochons represented as violane. According to Rare Earth's Bill Heher, the rough material came to market in around August 2018 and was mined from the Lake Baikal region of Russia. So far he has cut a few hundred cabochons that ranged up to about 50 mm in maximum dimension.

Ornamental blue diopside is known from three localities in Russia: the Khakassia area of eastern Siberia (Shil'tsina & Vereshchagin 2000) and two areas near Lake Baikal (Zadov *et al.* 2004; Simakin *et al.* 2019). According to D. Belakovsky (pers. comm. 2020), the Lake Baikal deposits are hosted by (1) the Yoko-Dovyrenskiy (or Yoko-Dovyren) massif near the north end of the lake and (2) the Tazheranskiy (or Tazheran) massif near the lake's south end.

Heher loaned three samples for examination (Figure 8), and they were characterised by authors CW and BW. They consisted of a blue oval cabochon weighing 17.88 ct (27.50 × 21.27 mm), and a matched pair of bicoloured blue and white/tan rectangular cabochons with a total weight of 35.71 ct (each measuring approximately 26 × 15 mm). All displayed an obvious polycrystalline structure that was fine- to coarse-grained and showed variable depth of blue colour between grains in the blue portions (Figure 9). A few sparkles seen as the samples were moved apparently corresponded to cleavage fractures in some of the diopside grains. Viewed with the microscope, the blue areas of the samples also exhibited variations in surface lustre between grains (again, see Figure 9). Although individual grains were somewhat transparent, the presence of abundant polycrystalline grain boundaries created an overall semi-translucent appearance in the blue areas.

Figure 8: These three cabochons containing blue diopside (17.57–17.88 ct) are from Russia's Lake Baikal region and were studied for this report. Photo by B. Williams.

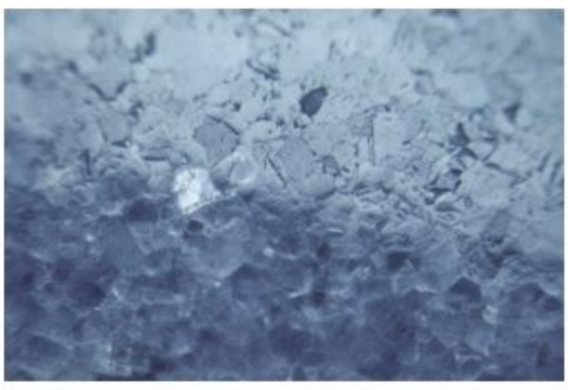

Figure 9: Microscopic examination of the blue diopside shows a polycrystalline texture with variations in surface lustre between grains and a reflection from a cleavage fracture (left centre). Photomicrograph by B. Williams and C. Williams, in reflected light; image width 9 mm.

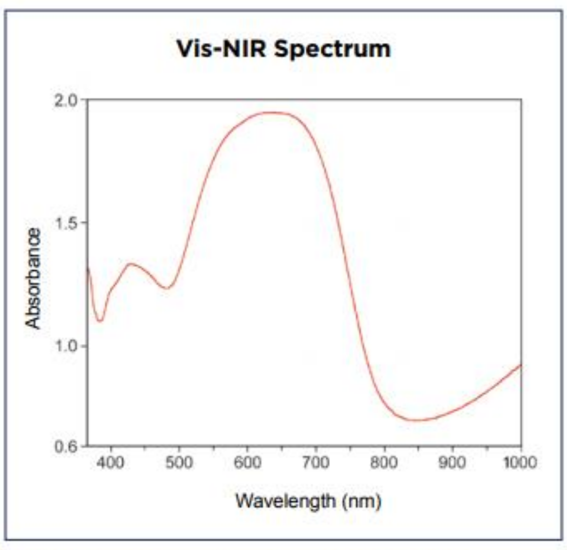

Figure 10: Vis-NIR spectroscopy of the blue diopside shows a large broad peak centred at about 630 nm and a smaller absorption at about 430 nm, consistent with colouration due to VO^{2+}.

All three samples were confirmed as diopside in the blue areas by Raman analysis using a Magilabs GemmoRaman-532SG spectrometer. A Raman peak shift was observed in the white/tan area of the bicoloured stones, which might be due to the presence of additional mineral phases occurring with the diopside. Indeed, Simakin *et al.* (2019) reported that 'bleached' metasomatised zones associated with blue diopside from Lake Baikal consist of recrystallised white diopside and monticellite, while Zadov *et al.* (2004) indicated that the light-coloured zones consisted of foshagite and other minerals.

Spot RI readings of the cabochons could not be obtained due to the polycrystalline nature of the material. The hydrostatic SG value of the blue sample was 3.23, which is slightly lower than the typical range for diopside (3.24–3.33) but consistent with its polycrystalline structure. The stones were inert to long- and short-wave UV radiation. Energy-dispersive X-ray fluorescence (EDXRF) chemical analysis of the blue sample performed with an Amptek X123-SDD spectrometer showed traces of the chromophoric elements V, Fe and Cr (as well as very small amounts of Pt, consistent with blue diopside from the Yoko-Dovyren massif documented by Simakin *et al.* 2019).

Simakin *et al.* (2019) reported an average of 345 ppm V in blue diopside from the Lake Baikal area, and attributed its colouration to VO^{2+}. Visible-near infrared (Vis-NIR) absorption spectroscopy of the present blue cabochon with a Magilabs GemmoSphere spectrometer showed a large broad peak centred at about 630 nm and a smaller absorption at about 430 nm (Figure 10). This pattern is indeed consistent with colouration due to tetravalent vanadium in the form of the vanadyl ion (VO^{2+}), as seen for example in cavansite (Rossman 2014). Vanadium-doped synthetic diopside also shows distinct blue colouration and a similar absorption spectrum (see, e.g., sample GRR 510 at https://minerals.gps.caltech.edu/FILES/Visible/pyroxene/Index.html). Taken together, all of these aspects provide confirmation that the blue colouration of the Russian diopside studied for this report is due to VO^{2+}.

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