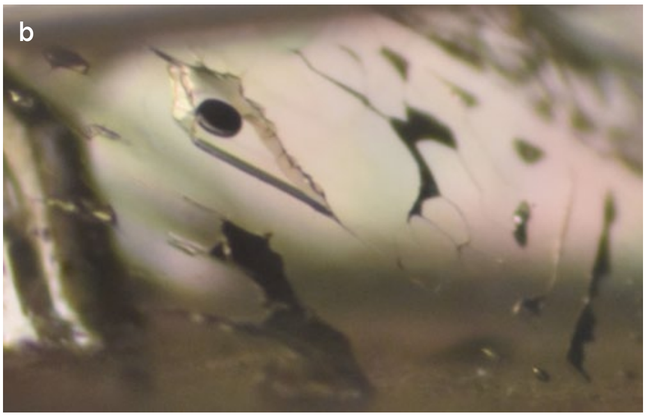

Figure 13: The euclase contains (**a**) a partially healed fissure composed of two-phase fluid inclusions arranged in 'fingerprints', and (**b**) larger two-phase inclusions with fluid and gas phases. Photomicrographs by Sandeep Kumar Vijay; image widths 3.2 mm (a) and 4 mm (b).

consistent with the euclase reference in our database. Chemical analysis with EDXRF spectroscopy using a Shimadzu EDX-8000 unit showed traces of Fe, consistent with the blue colouration of euclase (Stocklmayer 1998). The pure blue colour of this specimen, combined with the distinct colourless and blue zoning, is consistent with a Zimbabwe origin (cf. Stocklmayer 1998).

Euclase is rarely faceted as stones weighing more than 2 ct, making this 11.77 ct stone notable. By comparison, the next largest euclase documented in the literature to the authors' knowledge is a greenish blue Colombian stone weighing 9.50 ct (Sauer 2006).

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Chromium-bearing Translucent Green Common Opal

Green common opal is best known to gemmologists as 'prase opal', which is coloured by Ni-bearing impurities and has a similar colour appearance to chrysoprase chalcedony. To date, Cr has only rarely been found to be a significant cause of green body colour in opal. Only a few occurrences have been documented: chatoyant stones from Bahia, Brazil (Santiago 2015) and opaque to partially translucent samples from two localities in Turkey (Bank *et al*. 1997; Fritsch *et al*. 2011).

Figure 14: These green opals (1.26 ct pear and 1.76 ct oval), reportedly from Peru, were studied for this report and proved to be coloured mainly by Cr^{3+}. Photo by K. Feral.

Since 2018, the author has performed a comprehensive search for green opal gems sold online that are potentially coloured by Cr. The stones' reported country of origin was provided by the online retail sellers, but unfortunately no information was available regarding their specific locality, geological setting or production quantity. In early 2022, the author acquired several dark green common opals (e.g. Figure 14), reportedly from Peru, which proved to be the first examples of semi-transparent opal documented to be Cr-bearing and comparable in colour to chrome chalcedony. Multiple translucent opals from other localities obtained since 2018 also proved to contain Cr. These were mostly yellowish green with varying tone and saturation, and

Figure 15: Also obtained by the author were translucent yellowish green opals from various stated localities (back row, left to right: 6.31 ct from Turkey, 1.52 ct from Peru and 0.81 ct from Brazil; front row, left to right: 4.45 and 6.17 ct from Ethiopia, and 5.92 ct from Tanzania). Their colour may be due to a combination of Cr, Ni and Fe. Photo by K. Feral.

were represented as being from Peru, Brazil, Turkey, Tanzania and Ethiopia (e.g. Figure 15).

The Peruvian opals ranged from light yellow-green to dark green, with the latter being least common. Gemmological properties obtained for the two Peruvian opals shown in Figure 14 are highlighted in this report. Both gems had an RI of 1.45 and a hydrostatic SG of 2.13, consistent with opal. Under the Chelsea Colour Filter, the pear-shaped gem appeared moderate red and the oval was strong red, suggesting significant Cr content. The stones fluoresced moderate yellow-green to long-wave UV and weak yellow-green to short-wave UV radiation.

No indication of green dye was detected in these gems. Soak tests demonstrated these were not hydrophane opals and thus not easily receptive to dyeing. In addition, careful examination with magnification in immersion (in water) showed no colour concentration along fractures or in scratches or pits, and also no evidence of surface-conformal green colouration. Instead, the green colour was unevenly distributed in cloudy translucent areas of the stones. Soaking them in acetone for 24 hours had no effect on their colour, and no green staining of the acetone was noted either.

UV-Vis-NIR absorption spectroscopy of both opals performed with a GL Gem Spectrometer showed features characteristic of green gem materials coloured by Cr: a transmission window between about 480 and 540 nm in the green region of the spectrum, along with a small, distinct absorption peak in the red at 678 nm specific to Cr^{3+} (Figure 16).

The transition-metal content of the two opals was analysed at Stone Group Labs (Jefferson City, Missouri, USA) using EDXRF spectroscopy. Traces of Cr, Ni and Fe were detected, with Cr as the principal metallic component (Figure 17). No V was detected, nor any radioactive actinides such as U. Both opal samples were diamagnetic, indicating that the combined magnetic susceptibility of Cr, Ni and Fe oxides was below the level of detection by a strong N52 neodymium magnet using the flotation method.

By comparison, the translucent yellowish green opals that the author obtained since 2018 showed varying intensities of pink (rather than red) under the Chelsea Colour Filter, and only a very tiny Cr^{3+} peak at 678 nm in their UV-Vis-NIR spectra. Additionally, EDXRF spectroscopy of selected samples revealed considerably higher Ni and Fe. Consistent with the greater amounts of paramagnetic oxides of these metals, the samples from Ethiopia, Tanzania and Brazil showed weak attraction to the magnet using the flotation method.

The relatively high transparency combined with dark green colouration due mainly to Cr^{3+} in the two characterised stones reportedly from Peru is notable

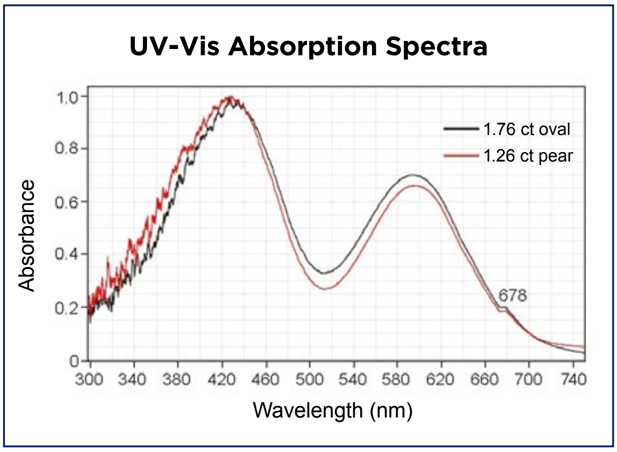

Figure 16: UV-Vis absorption spectra of the two green opals from Peru show features indicative of Cr^{3+}, including a transmission window in the 480–540 nm region and a small peak at 678 nm. The path length of the beam was approximately 6 mm for the oval cut and 4 mm for the pear-shaped stone.

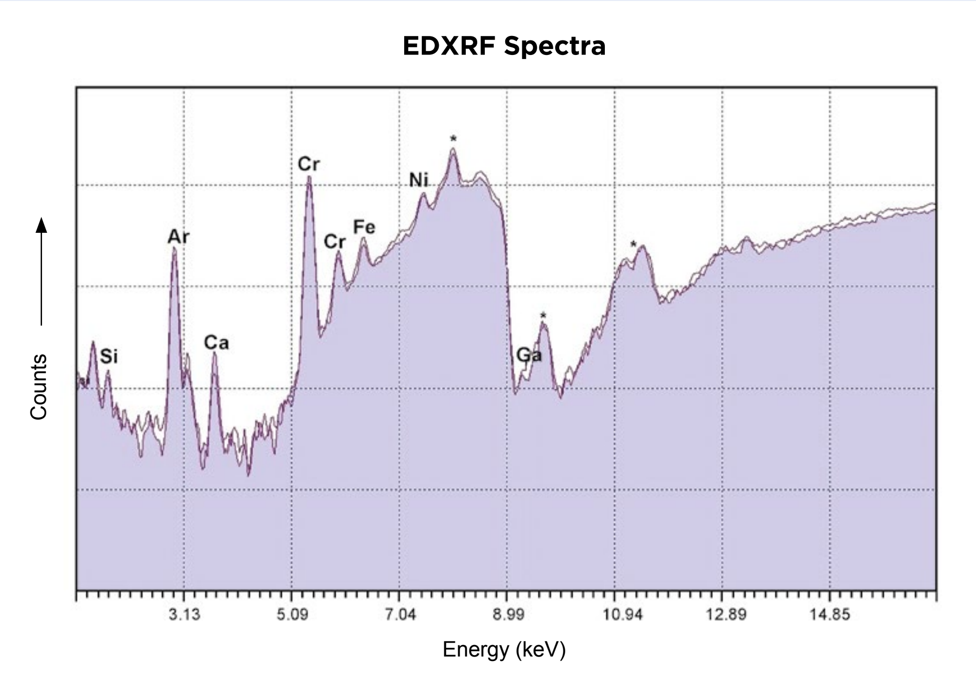

Figure 17: EDXRF spectroscopy of the two green opals from Peru shows the presence of Cr as the principal transition metal, with lesser amounts of Ni and Fe. The asterisks are instrumental artefacts and the Ar peak is due to the analysis taking place in air.

for common opal. Because the principal chromophore in these gems was identified as Cr, the author refers to them as 'chrome opal'. However, the yellowish green opals tested for this report were found to be coloured by Cr with additional possible contributions from Ni and Fe, and therefore the author refers to them as 'chromium-bearing green opal' rather than 'chrome opal' or 'prase opal'.

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Blue Sapphires Reportedly from Azad Kashmir

Sapphires from the legendary locality of Kashmir are famous for their attractive velvety appearance and have been pursued by gem connoisseurs for more than a century. The so-called Kashmir sapphires were discovered in 1881 (Atkinson & Kothavala 1983), and initially the locality referred only to the Kashmir valley located in Jammu and Kashmir, a disputed region between India and Pakistan. More recently, some stones from neighbouring areas (e.g. Figure 18) such as the Batakundi-Basil region in the Pakistani-controlled part of Azad Kashmir,

Figure 18: These sapphires, reportedly from Azad Kashmir (left 1.77 ct and right 2.22 ct), were examined for this report. Photo by Huixin Zhao.