



Figure 16. This 0.81 ct piece of light blue rough, originally sold as tanzanite, proved to be manganaxinite. Photo by J.-M. Arlabosse.

**A blue manganaxinite.** While inspecting a parcel of rough tanzanite, one of these contributors (J-MA) noticed a pale blue sample (figure 16) that stood out from the others because of its moderate-to-strong orange-red fluorescence to long-wave UV radiation (the other pieces were inert). The sample's refractive indices, measured on a polished face, were  $n_{\alpha} = 1.665$ ,  $n_{\beta} = 1.672$ , and  $n_{\gamma} = 1.679$ , yielding a birefringence of 0.014, but it was difficult to determine whether the optic sign was biaxial positive or negative. We measured a specific gravity of 3.24 and observed distinct trichroism (blue to brown to purple).

These results were not consistent with zoisite, but instead suggested a member of the axinite group. While kornerupine has similar RI and SG ranges and may also fluoresce orange to long-wave UV, it has different pleochroism. The color was zoned in two faint blue bands, and there were no noticeable inclusions. With a handheld spectroscope, the sample showed only one weak sharp line at about 415 nm. This indicated that it contained  $Mn^{2+}$ , so we speculated that it might be manganaxinite. By comparison, a nongem reference sample of blue magnesio-axinite from Tanzania had similar properties, including red fluorescence to long-wave UV, but no 415 nm line. In addition, faceted Tanzanian magnesio-axinite with similar properties (orangy pink UV fluorescence and a 410 nm line) was reported recently (see Winter 2007 GNI, pp. 373–375); those samples were also found in a parcel of tanzanite.

To confirm the identity, we performed quantitative chemical analysis using a JEOL 5800 scanning electron microscope (SEM) with a high-resolution Princeton Gamma Tech IMIX-PTS germanium detector. The results were consistent with axinite: 6.9 wt.% MnO, 2.7 wt.% MgO, and only 0.7 wt.% FeO. The Mn/Mg ratio (~1.5) clearly classified this sample as manganaxinite. Using long count times, we also detected approximately 0.1 wt.%  $V_2O_5$ , as well as traces of chromium that were too small to be quantified.

The UV-Vis absorption spectrum (figure 17) was dominated by a broad band with a maximum at about 597

nm, creating a transmission window in the blue region at about 475 nm. There were also two weak sharp bands at 355 and 368 nm, a moderate sharp band at 413 nm (confirming the handheld spectroscope observations) with a shoulder at 421 nm, and two weak broad bands at approximately 515 and 733 nm. These sharp peaks and the weak broad bands could all be due to  $Mn^{2+}$  (R. G. Burns, *Mineralogical Applications of Crystal Field Theory*, 2nd ed., Cambridge University Press, 1993), but they were too weak to affect the color. The broad band around 597 nm is probably from  $V^{3+}$ . Even if  $Cr^{3+}$  was present, no distinct  $Cr^{3+}$ -forbidden transitions could be detected at around 700 nm.

The orange-red fluorescence appeared to be zoned, with a weaker emission in the bluer parts of the sample. The reaction was too weak to obtain a fluorescence spectrum, and we can only hypothesize that its origin might be  $Mn^{2+}$ , with possibly a red component imparted by  $Cr^{3+}$ .

To our knowledge, this is the first report of manganaxinite colored by vanadium. It is also surprising to have two gem materials with such similar properties—the manganaxinite described here and the magnesio-axinite in the Winter 2007 GNI entry—recently appearing in parcels of tanzanite.

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Figure 17. The UV-Vis absorption spectrum of the blue manganaxinite shows a broad band with a maximum at approximately 597 nm (due to  $V^{3+}$ ) that accounts for the color. The sharp peaks at 355, 368, 413, and 421 nm could be due to  $Mn^{2+}$ , as could the two broad bands at 515 and 733 nm.

