

no Cu was detected by this technique (or by EDXRF spectroscopy), the analyses revealed relatively high Mn and Ti, significant Ca and very low Fe (i.e. 3.90–5.80 wt.% MnO, 0.30–0.46 wt.% TiO₂, 1.35–1.57 wt.% CaO and 0.03–0.08 wt.% FeO). Overall, the composition was similar to yellow tourmaline that these authors have analysed previously from Mozambique (Muva), Russia (Malkhan District), Madagascar (Tsilaisina) and Nepal. The Ca contents were higher than in yellow tourmaline from certain localities such as Zambia (Canary mine), Italy (Elba) and the USA (Himalaya mine in San Diego County, California). Nevertheless, the Mavuco material still plotted well inside the elbaite field, corresponding to a ratio of approximately 3:1 for elbaite:liddicoatite.

Although yellow Cu-bearing tourmaline is known—although uncommon—from Mozambique (see the 43.40 ct stone in ‘Pala’s Featured Stones’

section of www.palagems.com/gem-news-2017-02#featured-stones), the lack of Cu in this production of brownish yellow material from Mavuco is consistent with previous reports that the mineralization in the pegmatites there is unrelated to the adjacent alluvial deposits that have been mined for Paraíba-type tourmaline. The original primary source of the Cu-bearing tourmaline remains unknown.

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References

- Laurs B.M., 2012. Gem News International: Aquamarine from Mavuco, Mozambique. *Gems & Gemology*, **48**(1), 55.
- Laurs B.M., Zwaan J.C., Breeding C.M., Simmons W.B., Beaton D., Rijdsdijk K.F., Befi R. and Falster A.U., 2008. Copper-bearing (Paraíba-type) tourmaline from Mozambique. *Gems & Gemology*, **44**(1), 4–30, <http://dx.doi.org/10.5741/GEMS.44.1.4>.

More Tremolite from Tanzania

A recent report in *The Journal* (Zwaan, 2015) described facet-grade tremolite from Mwajanga, Tanzania, which was encountered at the February 2015 gem shows in Tucson, Arizona, USA. Since gem-quality tremolite is uncommon, we were surprised to learn from gem dealer Dudley Blauwet about some additional tremolite from Tanzania that was somewhat different from the material described by Zwaan (2015). Blauwet first encountered it during the 2015 Tucson shows, when he was shown a parcel of rough material that his East African supplier thought was diopside. While some of the pieces appeared to be diopside, others had a flattened shape with cleavages that were characteristic of an amphibole mineral. Blauwet purchased 76.6 g of the amphibole-like material, and sent 26 pieces totalling 33.5 g to his cutting factory. Due to the brittle nature and well-developed cleavage, the cutting process yielded only 14 faceted stones ranging from 0.40 to 1.80 ct, with a total weight of 11.10 carats. During the 2016 Tucson shows, Blauwet’s supplier showed him some more of this material, and stated that it came from the Merelani area (though presumably not from the tanzanite mines). Interestingly, a recent find of some dark green crystal clusters of tremolite was reported by Moore (2017) as coming from near



Figure 14: This tremolite from Tanzania consists of a 1.80 ct faceted stone and four cleavage fragments weighing 0.81–1.01 g. Photo by Dean Brennan.

the town of Mpwapwa in the Dodoma region of central Tanzania.

Blauwet loaned one oval faceted stone and four rough samples to authors CW and BW for examination (Figure 14). The faceted stone weighed 1.80 ct, measured 7.82 × 7.03 × 5.38 mm and was a moderate, slightly greyish, yellowish green. The rough weighed 0.81–1.01 g and consisted of wedge-shaped cleavage fragments that were up to 15.86 mm long. The colour of the rough appeared slightly deeper green with more

grey compared to the cut stone. The RIs of the faceted stone were 1.609–1.631, and the SG of the largest crystal was measured hydrostatically as 3.01. These values are consistent with the calcic amphiboles tremolite-actinolite, and the RIs correspond to a tremolite-rich composition (cf. Nesse, 1986). The faceted sample contained no visible inclusions when examined with the gemmological microscope; the rough pieces also had good clarity and contained only incipient cleavages. The GemmoRaman-532SG and the Enwave 789 nm Raman spectrometer both confirmed the identification as tremolite, based on comparisons with the RRUFF database. Chemical analysis with an Amptek X123-SDD EDXRF unit revealed the expected significant Ca and Fe contents, as well as traces of Cu, Ti and Cr. Although the presence of Fe suggests the actinolite end of this isomorphous series, Mg is only marginally detectable with this EDXRF unit, so the chemical composition obtained with this instrumentation was not entirely consistent with tremolite.

To confirm the identification as tremolite, electron microprobe analysis by authors FCH and MD yielded the following composition: $(\text{Na}_{0.38}\text{K}_{0.04}\text{Ca}_{0.42})_{2}(\text{Ca}_{1.58}\text{Na}_{0.32}\text{Fe}^{2+}_{0.10})_{2}(\text{Mg}_{4.69}\text{Al}_{0.18}\text{Fe}^{2+}_{0.10}\text{Ti}_{0.03})_{5}(\text{Si}_{7.68}\text{Al}_{0.32})_{8}\text{O}_{22}(\text{OH}_{1.69}\text{F}_{0.28}\text{Cl}_{0.03})_{2}$. This composition corresponds to that of tremolite (Hawthorne et al., 2012).

The colour of this tremolite is similar to that documented by Zwaan (2015) from Mwajanga, although the latter had a somewhat lighter tone and was available as well-formed prismatic crystals, unlike the cleavage fragments shown by the present material.

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References

- Hawthorne F.C., Oberti R., Harlow G.E., Maresch W., Martin R.F., Schumacher J.C. and Welch M.D., 2012. Nomenclature of the amphibole supergroup. *American Mineralogist*, **97**(11–12), 2031–2048, <http://dx.doi.org/10.2138/am.2012.4276>.
- Moore T.P., 2017. Munich Show 2016. *Mineralogical Record*, **48**(1), 141–156 (see p. 145).
- Nesse W.D., 1986. *Introduction to Optical Mineralogy*. Oxford University Press, New York, New York, USA, 325 pp.
- Zwaan J.C., 2015. Gem Notes: Tremolite from Mwajanga, Tanzania. *Journal of Gemmology*, **34**(7), 569–571.

Tsavorite Reportedly from Ethiopia

Tsavorite, the green grossular garnet originally found in the Tsavo area of Kenya, today comes mainly from various mines situated in the East Africa region, including Kenya, Tanzania and Madagascar; additional occurrences are known in Pakistan and eastern Antarctica (Feneyrol et al., 2014). However, a new mining area reportedly in Ethiopia recently has produced gem-grade tsavorite, and some of the authors acquired samples from various sources for analysis. The Bahrain Institute for Pearls & Gemstones (DANAT) received three rough samples (0.2–1.4 g; Figure 15, top) from Simon-Bruce Lockhart (Chanthaburi, Thailand), and Stone Group Laboratories received three faceted samples from Jason Doubrava (Poway, California, USA) and seven faceted samples from Meg Berry (Megagem, Fallbrook, California). The faceted samples weighed 0.25–3.56 ct, and were cut from several pieces of rough obtained by Steve Ulatowski (New Era Gems, Grass Valley, California, USA; see, e.g., Figure 15, bottom). The

Figure 15: These crystal fragments and broken pieces of Ethiopian tsavorite weigh 0.2–1.4 g (top) and 1.4–4.5 g (bottom). Samples courtesy of Simon-Bruce Lockhart (top) and New Era Gems (bottom); photos by Hasan Abdulla © DANAT (top) and Jordan Wilkins (bottom).



garnets ranged from yellow-green to deep green, sometimes resembling the colour of tsavorite from other sources (Figures 15 and 16).

The RI of the Ethiopian samples fell within a narrow range of 1.740–1.745, and their hydrostatic SG values were 3.62–3.65. All were inert to long- and short-wave UV radiation, and they did not change colour under the Chelsea filter. Semi-quantitative EDXRF analysis revealed Ca, Al and Si as major elements and confirmed the samples as grossular. Compared to tsavorite from other localities, these Ethiopian samples contained very low V (<200 ppm) and relatively high Fe (up to 2%). Preliminary ultraviolet-visible–near infrared (UV-Vis-NIR) spectroscopy showed that their green colour is mainly due Cr³⁺, with absorption bands situated at ~430 and 600 nm. An absorption peak at ~370 nm also was observed and has been linked to Fe³⁺ (Schmetzer and Bank, 1982). In addition, a continuum of unknown origin that gradually increased in absorption from the UV to the NIR region was responsible for a yellowish hue in some samples. The exact role of iron in the coloration of the samples is still under discussion. The Raman spectra of our samples were consistent with tsavorite from Kenya (Figure 17) and Tanzania in our reference collections.

Some yellowish green to green grossular (tsavorite) with relatively high iron (up to 8%) has been found in Mali (Johnson et al., 1995). However, those stones contained a relatively large andradite

Figure 17: The Raman spectra of tsavorite from Ethiopia and Kenya are very similar.

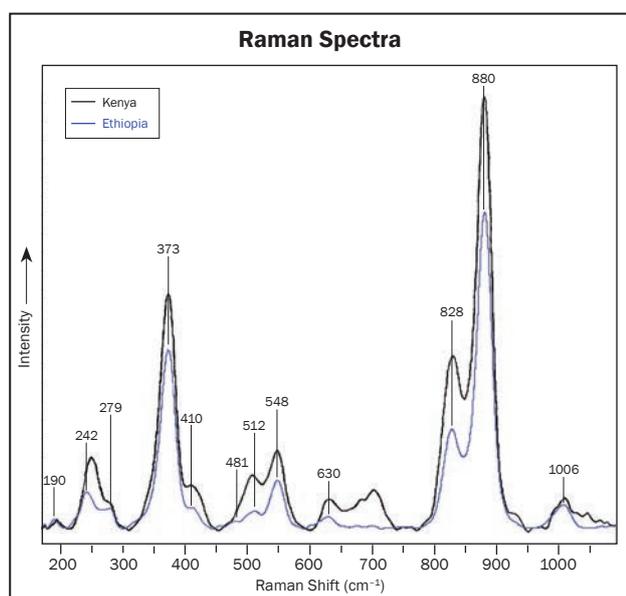


Figure 16: The three faceted gemstones in the top photo are all Ethiopian tsavorite (1.66–3.55 ct). In the bottom image, the stone on the left is a 0.60 ct Ethiopian tsavorite, and is shown for comparison with a 1.10 ct tsavorite from Kenya. Photos by Orasa Weldon (top) and B. Williams (bottom); the Ethiopian samples were faceted by Meg Berry.

component, as well as higher RI and SG values, compared to those from Ethiopia. The Ethiopian samples have similar characteristics (chemical composition, RI and SG) to green grossular from the Jeffrey mine (Quebec, Canada; Wight and Grice, 1982), although lower Ti.

It appears likely that the geological environment of Ethiopian tsavorite differs from that of the ‘classic’ tsavorite deposits in East Africa. More research is needed to better understand the geological origin and spectroscopic features of the Ethiopian tsavorite.

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References

Feneyrol J., Giuliani G., Ohnenstetter D., Rondeau B., Fritsch E., Fallick A.E., Ichang’i D., Omito E., Rakotondrazafy M., Ranatsenho M. and Lallier F., 2014. New typology and origin of tsavorite based on trace-element chemistry. *European Journal of Mineralogy*, **26**(2), 293–308, <http://dx.doi.org/10.1127/0935-1221/2014/0026-2367>.

Johnson M.L., Boehm E., Krupp H., Zang J.W. and Kammerling R.C., 1995. Gem-quality grossular-andradite: A new garnet from Mali. *Gems & Gemology*, **31**(3), 152–166, <http://dx.doi.org/10.5741/gems.31.3.152>.
Schmetzer K. and Bank H., 1982. Gelbgrüner Grossu-

lar aus Ostafrika. *Zeitschrift der Deutschen Gemmologie Gesellschaft*, **31**(1–2), 81–84.
Wight W. and Grice J.D., 1982. Grossular garnet from the Jeffrey mine, Asbestos, Quebec, Canada. *Journal of Gemmology*, **18**(2), 126–130, <http://dx.doi.org/10.15506/JoG.1982.18.2.126>.

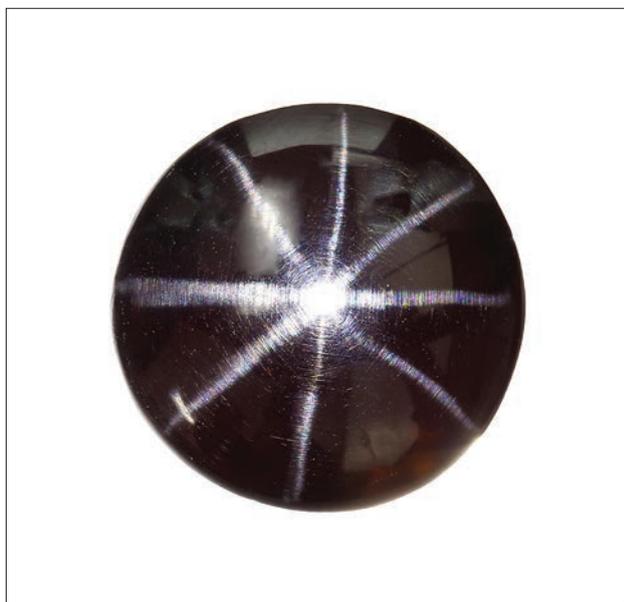
SYNTHETICS AND SIMULANTS

Black Star Cubic Zirconia Sold as Natural Star Rutile

In August 2017, a Canadian collector bought from a U.S. dealer a 10.67 ct black cabochon showing asterism (Figure 18) for US\$900. The gem was purchased as a natural star rutile from Sri Lanka, and submitted to CGL-GRS Swiss Canadian Gemlab for testing and a possible appraisal report.

The star displayed eight rays, and the cabochon was black in daylight but appeared translucent brownish red when viewed with strong illumination (Figure 19). Routine testing revealed that its RI was over the limit of the refractometer (consistent with its highly metallic lustre), its hydrostatic SG was very high (5.97) and it was inert to long- and short-wave UV radiation. By comparison, natural star rutile has a lower SG (4.20–4.30) and has been documented only as very rare four-rayed stones (Steinbach, 2016, pp. 667–670). Microscopic examination showed numerous highly reflective rounded gas bubbles (Figure 19), indicating a manufactured material.

Figure 18: This 10.67 ct black star CZ was recently sold as natural star rutile. Photo by Matthias Alessandri.



Vis-NIR spectroscopy was recorded with an SAS 2000 instrument (range 400–1000 nm, resolution 1 nm). The spectrum (Figure 20) matched that of cubic zirconia in our database, with a series of rare-earth element (REE) absorptions in the 730–900 nm range (cf. Turner et al., 2015).

Most CZs on the market are transparent and near colourless to imitate diamond, but it is known that CZ is manufactured in a wide range of colours. It is interesting to note that this black star CZ was 5% heavier than typical CZ (SG ~5.7). Nevertheless, Günther (1988) reported that some CZ (e.g. Zirkonia, Fianit) may have SG values up to 5.9 due to doping with Y, making it heavier than CZ containing Ca (SG of 5.6–5.7). Both Y and Ca have been used to stabilize CZ, and a study of three black (non-phenomenal) Russian-grown specimens doped with Y gave SG values of 5.93–5.94 (Kammerling et al., 1991), approaching the 5.97 value obtained for the present specimen.

Figure 19: Numerous rounded gas bubbles are present in the star CZ, which appears brownish red under strong illumination. Photomicrograph by B. Deljanin; magnified 30×.

