Crystal chemistry of tourmalines from Mozambican pegmatites

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In the last few decades, Mozambique has become an important producer of high-quality tourmalines in the world. Most of these minerals formed within the granitic pegmatites of the Alto Ligonha region that is shared between the provinces of Zambezia and Nampula, in the northeastern part of the country. Minerals of the tourmaline supergroup are constituted by rhombohedral borosilicates with a R3*m* space group, and a general formula $XY_3Z_6[T_6O_{18}](BO_3)_3V_3W$ [1].

A set of tourmaline samples collected in September 2023 from various major deposits mainly located in the Alto Ligonha region has been analysed by electron-microprobe and LA-ICP-TOF-MS, in order to provide accurate data about the major and trace elements concentrations in each crystal. Compositions usually vary along the elbaite-schorl solid solution, with sometimes compositional zonings between both end-members. Several of these elbaites, showing a neon-blue colour similar to that observed in Paraiba tourmalines, are currently under investigation.

Elbaite-schorl samples from the Muhano and Naïpa deposits show similar trace element concentrations which implies that both deposits certainly formed under the same geological conditions. A more peculiar sample from the Mavuco pegmatite, located further to the North, turned out to be a liddicoatite. Compared to the Alto-Ligonha tourmalines, it showed a significant enrichment in Ca (2.21 wt% CaO), Pb (0.46 wt% PbO), Bi, Ga, and Sn. Values of 20 ppm Sr, 6 ppm Nb, 6 ppm In and 549 ppm Sb have also been measured, whereas rare-earth elements are reaching 177 ppm Sc, 103 ppm La, 289 ppm Ce, 28 ppm Pr, 56 ppm Nd, 4 ppm Sm, and 2 ppm Gd. This behaviour is similar, in a greater extent, to that of a Brazilian tourmaline from the Lavra do Urucum pegmatite, which also shows a compositional evolution towards the liddicoatite pole [2].

In order to refine their crystal structures, the tourmaline samples were investigated by single-crystal X-ray diffraction methods. Measured unit-cell parameters are consistent with elbaite-to-schorl compositions, and refined site populations have been calculated from the structural data and are similar to the assigned site populations given by the compositional analyses. Mean bond lengths determined through the refinement are also consistent with the calculated bond lengths, and bond-valence sums obtained for the different sites are close to the ideal theoretical values.

References:

[1] Hawthorne FC and Henry DJ (1999) Eur J Mineral 11(2): 201-215
[2] Bomal F (2021) Master thesis, University of Liège, 66 p.