Crystal chemistry of tourmalines from Mozambican pegmatites

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Minerals of the tourmaline supergroup are constituted by rhombohedral borosilicates with a R3m space group, and the general formula $XY_3Z_6[T_6O_{18}](BO_3)_3V_3W$ (Hawthorne & Henry, 1999).

Over the last decades, Mozambique has established itself as one of the important producers of high-quality tourmalines in the world. Although still poorly referenced, the tourmaline diversity encountered in the pegmatites of the Alto Ligonha region, in the northeastern part of the country, challenges the one found in Brazil. Mozambique can therefore be considered as one of the richest contexts to study the crystal chemistry of pegmatitic tourmalines.

With this in mind, a set of 68 tourmaline samples from several pegmatites of the Alto Ligonha area were investigated by several techniques including single-crystal X-ray structure refinements, electron-microprobe, and Laser Ablation Inductively Coupled Plasma Time-Of-Flight Mass Spectrometry (LA-ICP-TOF-MS). 19 of these samples were selected amongst the collections of the National Natural History Museum of Luxembourg. The remaining 49 crystals were collected on the field in order to refine the sampling. 15 pegmatites ranging from well-known to new deposits are represented. A cartography of the pegmatites has been made whenever it was possible and the position of each sample in its respective pegmatite is known.

Tourmaline varieties observed mainly display different shades of green, pink and blue colors. Unusual red, yellow and colorless tourmalines, as well as several elbaites showing a neon-blue colour similar to that observed in Paraiba tourmalines, are also under investigation. Optical zonations along and across the *c*-axis are common amongst the samples.

Chemically, most samples are Na dominant on the X site, and therefore belong to the alkali group. They correspond to fluor-elbaites or elbaites, where similar proportions of Al and Li are sharing the Y-positions. Elbaites are located close to the elbaitic end-member, with Fe^{2+} strongly depleted and the schorlitic component negligible, while fluor-elbaites tend to align along the fluor-elbaite to fluor schorl solid-solution.

For most samples, single-crystal data indicate *a* unit-cell parameters varying between 15.8647 and 15.9503 Å, and *c* parameters ranging from 7.107 to 7.1545 Å. These values are similar to those obtained for Brazilian tourmalines of the elbaite-schorl solid solution. However, two crystals from the Marinia pegmatite display very high unit-cell parameters values ($16.008 < a < 16.0474$ Å; $7.2193 < c < 7.2338$).

A detailed cation distribution has also been established, indicating that the B site is fully occupied by boron, that the T site is mainly occupied by Si and sometimes by minor amounts of Al, and that the Z site is mainly occupied by Al with sometimes minor amounts of Si. The X site contains vacancies, Na, K, and Ca, and the Y site is occupied by Li, Al, Fe^{2+}, and minor amounts of Mn^{2+}, Ti, and Mg.

Finally, the trace element contents, including REE, are discussed in detail, and appear to be influenced by both the geochemical pegmatitic context, and by crystal-chemical constraints.

References:

Hawthorne, F.C. and Henry, D.J. (1999). *European Journal of Mineralogy* 11(2): 201-215.