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Mn-tourmaline from island of Elba (Italy): Crystal chemistry

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ABSTRACT

The crystal chemistry of seven crystal fragments taken from differing regions of the same colorless to yellow-greenish tourmaline macro-crystal from pegmatite pockets in aplite veins (island of Elba, Italy) was studied with a multi-disciplinary (SREF, XRDT) and multi-analytical approach (EMPA, SIMS). EMPA and XRDT studies showed relationships between color and chemical zoning and crystal-growth evolution, indicating which fragments could be considered representative of the chemical evolution of the genetic micro-environment in which the crystal developed.

Results showed that the colorless fragment is an elbaite while the yellow-greenish crystal fragments are Mn^{2+}-rich (up to 1.34 apfu) and belong to the alkali group and fluor subgroup. They are characterized by dehydroxylation and alkali-defect type substitutions that cooperate in reducing Li and increasing Mn contents. The Y site is populated by Al, Li, and Mn^{2+}, and the Z site by Al and Mn^{2+} (up to 0.10 apfu). In contrast with data in the literature, Mn^{2+} populates both octahedral sites according to the order-disorder reaction: $^{Y}Mn + {}^{Z}Al \leftrightarrow {}^{Y}Al + {}^{Z}Mn$. As Mn^{2+} content increases, progressive disorder takes place. This disorder is quantitatively lower than that of the ^{Z}Mg in dravite, due to the low structural tolerance of the small Z cavity in the incorporation of larger cations by the $^{Z}R^{2+} \rightarrow {}^{Z}Al$ substitution. Relationships of direct proportionality between lattice parameters and both <Y-O> and <Z-O> are observed. The expansion of both octahedra, as well as of lattice parameters, increases linearly as a function of $^{Y}Mn^{2+}$ and $^{Z}Mn^{2+}$. The latter has greater weight in dictating unit-cell variations, due to the degree of size mismatch between $^{Z}Mn^{2+} \rightarrow {}^{Z}Al$ and $^{Y}Mn^{2+} \rightarrow {}^{Y}Li$ substitutions, and the way in which the Z octahedra are articulated in the structure.