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Letter

Synthesis and crystal structure of Pb-dominant tourmaline

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Abstract

Pb-dominant tourmaline was synthesized at 700 °C and 200 MPa in two hydrothermal experiments in the system MgO-Al_2O_3-B_2O_3-SiO_2-PbO-H_2O (run OV-4-2) and MgO-Al_2O_3-B_2O_3-SiO_2-PbO-CaO-Na_2O-H_2O (run OV-5-3), respectively. Run OV-4-2 forms needle-like (lengths up to 7 μm), lead-rich (up to 13.3 wt% PbO) crystals that are chemically homogeneous. Run OV-5-3 forms columnar (lengths up to 400 μm) crystals that are chemically zoned (Pb-rich cores, up to 14.7 wt% PbO, and Pb-poor rims, ~2 wt% PbO). Additional phases that form in trace amounts are Pb-feldspar, quartz, diaspore (in OV-4-2) and talc, mullite, spinel, quartz (in OV-5-3). Single-crystal structure refinement (SREF) of the central zone of Pb-rich tourmaline from the run OV-5-3 proves that Pb^{2+} cations occupy the *X*-site in the tourmaline structure. The unit-cell parameters of the studied tourmaline are: a = 15.9508(10) Å, c = 7.2024(6) Å. The formula derived from SREF results of this Pb-rich tourmaline is ${}^{X}(Pb_{0.63}\square_{0.37})$ ${}^{Y}(Al_{1.71}Mg_{1.29})$ ${}^{Z}(Al_{5.04}Mg_{0.96})$ ${}^{T}(Si_{6.00}O_{18})$ $(BO_3)_3$ ${}^{V}(OH)_{3.00}$ ${}^{W}(O_{1.00})$. Accordingly, the studied crystal is a Pb-analog of hypothetical "oxy-uvite," and thus referred to here as "Pb-oxy-uvite." Similarities between (1) the paragenesis of Minh Tien tourmaline, and (2) the final experimental phase assemblages observed here, indicate comparable *P*-*T* conditions of formation.

Keywords: Tourmaline, Pb, crystal chemistry, lead end-member, synthesis