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**LETTER**

# Synthesis of K-dominant tourmaline

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## ABSTRACT

K-dominant tourmaline was synthesized in the system MgO-$Al_2O_3$-$B_2O_3$-$SiO_2$-KCl-$H_2O$ at 700 °C and 4.0 GPa. The crystals were zoned and characterized by less-potassic cores (1.46 wt% $K_2O$) and more-potassic rims (up to 3.44 wt% $K_2O$). The K-dominant tourmaline rims are represented by the average structural formula $(K_{0.60(3)}\square_{0.36(3)})(Mg_{2.60(7)}Al_{0.40(7)})(Al_{5.98(3)}Si_{0.02(3)})Si_6O_{18}(BO_3)_3(OH)_{3.92(7)}O_{0.08(8)}$, which is analogous to the structural formula of dravite and is referred to here as "K-dravite"; the maximum analyzed K content (3.44 wt% $K_2O$) represents occupancy of the X site by 0.71 K pfu. The addition of Na to the system in approximately equal molar proportions to K results in the crystallization of K-bearing, Na-rich dravitic tourmaline, dramatically reducing the K content to an average value of 0.47 wt% $K_2O$, corresponding to 0.10 K pfu. This suggests that a K-dominated bulk composition is necessary for K-dominant tourmaline crystallization. Compositional zoning shows that solid solution exists between end-member compositions of "K-dravite" $[KMg_3Al_6Si_6O_{18}(BO_3)_3(OH)_3(OH)]$ and dravite via the isovalent exchange $^{X}K(^{X}Na)_{-1}$, magnesio-foitite via the coupled substitution $^{X}K^{Y}Mg(^{X}\square^{Y}Al)_{-1}$, and "K-olenite" via the coupled substitution $^{Y}MgOH(^{Y}AlO)_{-1}$. Structural refinement of the powder X-ray diffraction data provides a unit-cell volume for the synthesized "K-dravite" of 1580.1(5) $Å^3$, which is greater than that determined for K-bearing dravitic tourmaline synthesized at the same conditions [1574.9(4) $Å^3$]. We interpret this to reflect expansion of the crystal structure due to incorporation of the relatively large $K^+$ ion.

**Keywords:** Tourmaline, potassium end-member, high pressure, synthesis, Na-K solid solution