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Vanadio-oxy-chromium-dravite, $NaV_3(Cr_4Mg_2)(Si_6O_{18})(BO_3)_3(OH)_3O$, a new mineral species of the tourmaline supergroup

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Abstract

Vanadio-oxy-chromium-dravite, $NaV_3(Cr_4Mg_2)(Si_6O_{18})(BO_3)_3(OH)_3O$, is a new mineral of the tourmaline supergroup. It is found in metaquartzites of the Pereval marble quarry (Sludyanka, Lake Baikal, Russia) in association with quartz, Cr-V-bearing tremolite and muscovite-celadonite-chromphyllite-roscoelite, diopside-kosmochlor-natalyite, Cr-bearing goldmanite, escolaite-karelianite, dravite-oxy-vanadium-dravite, V-bearing titanite and rutile, ilmenite, oxyvanite-berdesinskiite, shreyerite, plagioclase, scapolite, zircon, pyrite, and an unnamed oxide of V, Cr, Ti, U, and Nb. Crystals are emerald green, transparent with a vitreous luster, pale green streak, and conchoidal fracture. Vanadio-oxy-chromium-dravite has a Mohs hardness of approximately 7½, and a calculated density of 3.3 g/cm^3. In plane-polarized light, vanadio-oxy-chromium-dravite is pleochroic (O = dark green, E = pale green) and uniaxial negative: $\omega = 1.767(5)$, $\varepsilon = 1.710(5)$. Vanadio-oxy-chromium-dravite is rhombohedral, space group $R3m$, with the unit-cell parameters $a = 16.1260(2)$, $c = 7.3759(1)$ Å, $V = 1661.11(4)$ Å^3, $Z = 3$. Crystal chemistry analysis resulted in the empirical structural formula:

$$^{X}(Na_{0.89}K_{0.06}\square_{0.05})\ ^{Y}(V^{3+}_{2.77}Mg_{0.17}Fe^{3+}_{0.06})\ ^{Z}(Cr^{3+}_{1.85}Al_{1.59}V^{3+}_{0.78}Mg_{1.78})\ ^{T}[(Si_{5.95}Al_{0.05})O_{18}]$$
$$^{B}(BO_3)_3\ ^{V}(OH_{2.91}O_{0.09})\ ^{W}(O_{0.86}F_{0.14}).$$

The crystal structure of vanadio-oxy-chromium-dravite was refined to a statistical index $R1$ of 1.16% using 2543 unique reflections collected with Mo$K\alpha$ X-radiation. Ideally, vanadio-oxy-chromium-dravite is related to oxy-chromium-dravite and oxy-vanadium-dravite by the homovalent substitution $V^{3+} \leftrightarrow Cr^{3+}$. Tourmaline with chemical compositions classified as vanadio-oxy-chromium-dravite can be either Cr^{3+}-dominant or V^{3+}-dominant as a result of the compositional boundaries along the solid solution between Cr^{3+} and V^{3+} that are determined at $^{Y+Z}(V_5Cr_2)$, corresponding to $Na^{Y}(V_3)^{Z}(V_2Cr_2Mg_2)Si_6O_{18}(BO_3)_3(OH)_3O$, and $^{Y+Z}(V_{1.5}Cr_{5.5})$, corresponding to $Na^{Y}(V_{1.5}Cr_{1.5})^{Z}(Cr_4Mg_2)Si_6O_{18}(BO_3)_3(OH)_3O$.

Keywords: Vanadio-oxy-chromium-dravite, tourmaline, new mineral species, crystal-structure refinement, electron microprobe, infrared spectroscopy, optical absorption spectroscopy