American Mineralogist, Volume 101, pages 355–361, 2016

Maruyamaite, $K(MgAl_2)(Al_5Mg)Si_6O_{18}(BO_3)_3(OH)_3O$, a potassium-dominant tourmaline from the ultrahigh-pressure Kokchetav massif, northern Kazakhstan: Description and crystal structure

Aaron Lussier[1,†], Neil A. Ball[1], Frank C. Hawthorne[1,*], Darrell J. Henry[2], Rentaro Shimizu[3], Yoshihide Ogasawara[3], and Tsutomu Ota[4]

[1]Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada
[2]Department of Geology and Geophysics, Louisiana State University, Baton Rouge, Louisiana 70803, U.S.A.
[3]Department of Earth Sciences, Waseda University, 1-6-1 Nishiwaseda, Shinjuku-ku, Tokyo 169-8050, Japan
[4]Pheasant Memorial Laboratory for Geochemistry and Cosmochemistry, Institute for the Study of the Earth's Interior, Okayama University, Misasa, Tottori, 682-0193, Japan

Abstract

Maruyamaite, ideally $K(MgAl_2)(Al_5Mg)Si_6O_{18}(BO_3)_3(OH)_3O$, was recently approved as the first K-dominant mineral-species of the tourmaline supergroup. It occurs in ultrahigh-pressure quartzofeldspathic gneisses of the Kumdy-Kol area of the Kokchetav Massif, northern Kazakhstan. Maruyamaite contains inclusions of microdiamonds, and probably crystallized near the peak pressure conditions of UHP metamorphism in the stability field of diamond. Crystals occur as anhedral to euhedral grains up to 2 mm across, embedded in a matrix of anhedral quartz and K-feldspar. Maruyamaite is pale brown to brown with a white to very pale-brown streak and has a vitreous luster. It is brittle and has a Mohs hardness of ~7; it is non-fluorescent, has no observable cleavage or parting, and has a calculated density of 3.081 g/cm^3. In plane-polarized transmitted light, it is pleochroic, O = darkish brown, E = pale brown. Maruyamaite is uniaxial negative, $\omega = 1.634$, $\varepsilon = 1.652$, both ±0.002. It is rhombohedral, space group $R3m$, $a = 15.955(1)$, $c = 7.227(1)$ Å, $V = 1593(3)$ Å^3, $Z = 3$. The strongest 10 X-ray diffraction lines in the powder pattern are [d in Å(I)(hkl)]: 2.581(100)(051), 2.974(85)($\bar{1}$32), 3.995 (69)($\bar{2}$40), 4.237(59)($\bar{2}$31), 2.046(54)($\bar{1}$62), 3.498(42)(012), 1.923(36)($\bar{3}$72), 6.415(23)($\bar{1}$11), 1.595(22)($\bar{5}$.10.0), 5.002(21)(021), and 4.610(20)(030). The crystal structure of maruyamaite was refined to an R_1 index of 1.58% using 1149 unique reflections measured with Mo$K\alpha$ X-radiation. Analysis by a combination of electron microprobe and crystal-structure refinement gave SiO_2 36.37, Al_2O_3 31.50, TiO_2 1.09, Cr_2O_3 0.04, Fe_2O_3 0.33, FeO 4.01, MgO 9.00, CaO 1.47, Na_2O 0.60, K_2O 2.54, F 0.30, B_2O_3(calc) 10.58, H_2O(calc) 2.96, sum 100.67 wt%. The formula unit, calculated on the basis of 31 anions pfu with B = 3, OH = 3.24 apfu (derived from the crystal structure) and the site populations assigned to reflect the mean interatomic distances, is $(K_{0.53}Na_{0.19}Ca_{0.26}\square_{0.02})_{\Sigma X=1.00}(Mg_{1.19}Fe^{2+}_{0.55}Fe^{3+}_{0.05}Ti_{0.14}Al_{1.07})_{\Sigma Y=3.00}(Al_{5.00}Mg_{1.00})(Si_{5.97}Al_{0.03}O_{18})(BO_3)_3(OH)_3(O^{2-}_{0.60}F_{0.16}OH_{0.24})$. Maruyamaite, ideally $K(MgAl_2)(Al_5Mg)(BO_3)_3(Si_6O_{18})(OH)_3O$, is related to oxy-dravite: ideally $Na(MgAl_2)(Al_5Mg)(BO_3)_3(Si_6O_{18})(OH)_3O$, by the substitution $^{X}K \rightarrow {}^{X}Na$.

Keywords: Maruyamaite, tourmaline, new mineral, electron-microprobe analysis, optical properties, crystal-structure refinement, Kokchetav Massif, northern Kazakhstan, ultrahigh-pressure, microdiamond inclusions