Armbrusterite, K₂Na₃Mn³⁺Mn²⁺[Si₉O₂₄]₄(OH)₁₀·4H₂O, a new Mn hydrous heterophyllosilicate from the Khibiny alkaline massif, Kola Peninsula, Russia

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ABSTRACT

Armbrusterite, ideally K₂Na₃Mn³⁺Mn²⁺[Si₉O₂₄]₄(OH)₁₀·4H₂O, is a new silicate of potassium, sodium, and manganese found in a thin cancrinite-aegirine-microcline vein within urtite at Mt. Kukisvumchorr. The mineral occurs in intimate association with raite. Other associated minerals are lamprophyllite, mangan-zeptinitie, pectolite, calcite, molybdenite, galena, sphalerite, and fluorite. Armbrusterite occurs as split, curved crystals and spherulites (≤2 mm diameter). The mineral is translucent (transparent in thin fragments), dark reddish-brown. It has vitreous luster and light-brown streak. Cleavage is perfect on (001) and the fracture is uneven. Mohs hardness is about 3.5. In transmitted light, the mineral is reddish-brown, with strong pleochroism: X = light yellowish-brown, Y and Z = dark reddish-brown; dispersion r > v, weak. Armbrusterite is biaxial (−): α = 1.532(2), β = 1.560(2), γ = 1.564(2) (for λ = 589 nm), 2V varies from 10° to 20°. Optical orientation: X is perpendicular to (001). The mean chemical composition determined by electron microprobe and the Penfield method (for H₂O) is (wt%): Na₂O 5.26, MgO 0.19, Al₂O₃ 0.04, SiO₂ 56.02, K₂O 6.13, CaO 0.26, TiO₂ 0.04, MnO 23.62, Mn₂O₃ 2.07, FeO 0.65, ZnO 0.20, H₂O 4.1, sum. 98.58. Empirical formula calculated on the basis of Si = 36 is K₅.03Na₆.55(Mn³⁺₂.35Mn²⁺₁.01Fe²⁺₀.18Ca₀.18Zn₀.09Al₀.03Ti₀.02)₂/₃[Si₃₆O₈₈](OH)₁₀·₁₀⁺₃.75H₂O. Armbrusterite is monoclinic, C₂/m, a = 17.333(2), b = 23.539(3), c = 13.4895(17) Å, β = 115.069(9)°, V = 4985.4(11) Å³, Z = 2. The strongest X-ray powder-diffraction lines are [d in Å, (hkl)]: 12.28 (100) (001), 4.10 (10) (003), 3.562 (10) (113, 261), 3.260 (18) (114), 3.117 (13) (203), 3.077 (54) (004), 2.622 (10) (371). The crystal structure of armbrusterite was refined to R₁ = 0.085 on the basis of 3960 unique observed reflections. The structure is based upon double silicate [Si₉O₂₄] layers consisting of 5-, 6-, 7-, and 8-membered tetrahedra rings. The layers are linked via octahedral sheets formed by Na and Mn octahedra. The interior of the double silicate layers is occupied by K⁺ cations and H₂O molecules. The mineral is named in honor of Thomas Armbruster (b. 1950; University of Berne) for his outstanding contribution to structural mineralogy and crystallography, especially to the study of Mn-rich minerals.

Keywords: Armbrusterite, new mineral, sodium-potassium-manganese silicate, crystal structure, Khibiny massif, Kola Peninsula

INTRODUCTION

Hydrous manganese silicates represent an interesting class of phyllosilicate minerals (Liebau 1985; Guggenheim and Eggleton 1987, 1988; Hughes et al. 2003; Krivovichev et al. 2004). One of the most distinguishing structural features is the existence of complex types of silicate anions that result from inversion and tilting of silicate tetrahedra. Here we report the occurrence and crystal structure of armbrusterite, a new Mn silicate that contains a novel type of silicate anion of unusual complexity.

Armbrusterite was found in the Khibiny massif, Kola Peninsula, Russia. The genesis of Mn minerals differs between alkaline massifs of the Kola Peninsula. In particular, Mn minerals are uncommon in the Khibiny massif, whereas they are more abundant in the Lovozero massif. In Khibiny, Mn-dominant eudialyte, mangan-zeptinitie, and lävenite-normandite are primary minerals in foyaite, ijolite-urtite, and pegmatite veins. Other Mn minerals such as the labuntsovite-group minerals, manaksite, kupletskite, shafranovskite, tisinalite, zakharovite, raite, etc. occur as a result of Mn redistribution during secondary hydrothermal alteration of initial phases (Yakovenchuk et al. 2005).

In 1987, A.S. Podlesny discovered a cancrinite-aegirine-microcline vein within ijolite-urtite at Mt. Kukisvumchorr (Kirov Mine, horizon +252 m). He provided the first author with specimens for investigation. Electron microprobe analysis and powder X-ray diffraction indicated the presence of raite in intimate intergrowths with an unknown K, Na, and Mn silicate. At that time, we were unable to find sufficient material for a single-crystal X-ray structure study. In 2004, further review of these specimens revealed a single crystal of good quality, which