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Mengxianminite ($Ca_2Sn_2Mg_3Al_8[(BO_3)(BeO_4)O_6]_2$) a new borate mineral from Xianghualing skarn, Hunan Province, China, with a highly unusual chemical combination (B + Be + Sn)

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Abstract

Mengxianminite, ideally $Ca_2Sn_2Mg_3Al_8[(BO_3)(BeO_4)O_6]_2$, is a new borate mineral from Xianghualing skarn, Hunan Province, southern China. It occurs in the hsianghualite vein of Xianghualing skarn, associated with fluorite, phlogopite, hsianghualite, magnetite, dravite, magnesiotaaffeite-2*N*′2*S*, and calcite. Mengxianminite forms subhedral to euhedral green crystals from 20 to 200 μm long, translucent to transparent, with a vitreous luster. The crystals show perfect cleavage on {100} and good cleavage on {010}, and do not fluoresce in long- or short-wave ultraviolet light. The estimated Mohs hardness is 8, and the tenacity is brittle with irregular fracture. The calculated density is 4.170 g/cm^3. Optically, mengxianminite is biaxial (–), with $\alpha = 1.80(2)$, $\beta = 1.83(2)$, $\gamma = 1.84(2)$ (589 nm). The mean chemical composition of mengxianminite is Al_2O_3 40.00, SnO_2 25.96, MgO 6.57, CaO 8.56, FeO 4.83, B_2O_3 6.53, BeO 4.37, ZnO 1.81, MnO 1.23, Na_2O 1.13, TiO_2 0.10, SiO_2 0.04, sum 101.12 with a corresponding empirical formula calculated on the basis of 26 O atoms of $(Ca_{1.64},Na_{0.39})_{\Sigma 2.03}(Sn_{1.85},Zn_{0.24})_{\Sigma 2.09}(Mg_{1.75},Fe_{0.72},Al_{0.42},Mn_{0.19},Ti_{0.01})_{\Sigma 3.09}Al_8[(B_{1.01}O_3)(Be_{0.94}O_4)O_6]_2$. (Be and B were measured by secondary ion mass spectrometry, average of six electron microprobe analyze points and in wt%.) The strongest eight lines of the powder XRD pattern [*d* in Å (*I*)(*hkl*)] are: 3.000 (35)(16.2.0); 2.931 (100)(17.1.1); 2.475 (29)(022); 2.430 (30)(13.3.1); 2.375 (100)(14.0.2/640); 2.028 (52)(21.3.1); 1.807 (35)(913); 1.530 (98)(14.6.0/15.3.3). Mengxianminite is orthorhombic, space group *Fdd*2; unit-cell parameters refined from single-crystal X-ray diffraction data are: $a = 60.699(4)$, $b = 9.914(1)$, $c = 5.745(1)$ Å, $V = 3457.4(4)$ Å^3, and $Z = 8$. The structure of mengxianminite is characterized by the alternating O-T1-O-T2-O′-T2 layers stacked along the *a* axis, which are equal to two alternating modules: the module A (O-T1-O) corresponding to the spinel module with an additional O layer (AlO_6 octahedra layer), and the module B (T2-O′-T2) showing the simplified formula $CaSnAl(BeO_4)(BO_3)$, where SnO_6 octahedra are isolated in the T2 layers, connected via BeO_4 and CaO_{11} groups, and AlO_6 edge-sharing octahedra in the O′ layer form chains running along the {011} or {0$\bar{1}$1} direction, connected in the *c* direction by the BO_3 triangular groups. Mengxianminite is the first borate mineral with both Sn and Be, likely crystallized under F-rich conditions at late stages of the Xianghualing skarn.

Keywords: Mengxianminite, new mineral, Xianghualing skarn, Hunan province, China