American Mineralogist, Volume 88, pages 830–836, 2003

Borocookeite, a new member of the chlorite group from the Malkhan gem tourmaline deposit, Central Transbaikalia, Russia

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ABSTRACT

Borocookeite, ideally $Li_{1+3x}Al_{4-x}(BSi_3)O_{10}(OH,F)_8$ (where "x" varies in the range 0.00–0.33 apfu), in which $^{[4]}Al$ is replaced by B relative to cookeite, occurs as a late-stage pocket mineral in the Sosedka and Mokhovaya pegmatite veins, Malkhan gem tourmaline deposit, Chikoy district, Chita oblast, Russia. Borocookeite proper, as well as boron-rich cookeite, is light grey with a pinkish or yellow hue and occurs as a dense, massive crypto-flaky aggregate or thin crusts and snow-like coatings on crystals of quartz, tourmaline, and feldspars from miarolitic cavities. Fragments of elbaite, danburite, and albite are included in the borocookeite mass. In some pockets, the coating is composed of borocookeite and boron-rich muscovite (or boromuscovite) which are not distinguishable visually. Chemical analysis yields (wt%): SiO_2 34.19, TiO_2 0.02, Al_2O_3 41.77, FeO 0.06, MnO 0.07, MgO 0.04, CaO 0.08, Na_2O 0.01, K_2O < 0.01, Li_2O 4.65, Rb_2O 0.004, Cs_2O 0.005, B_2O_3 4.06, BeO 0.05, H_2O^+ 14.17, H_2O^- 0.11, F 1.22, –O = F 0.51, total 100.00. The empirical formula calculated on the basis of 28 positive charges is: $Li_{1.61}Al_{3.80}(Al_{0.44}B_{0.60}Be_{0.01}Si_{2.95})_{\Sigma 4.00}O_{10}[F_{0.33}(OH)_{7.81}]_{\Sigma 8.14}$. The unit-cell parameters, calculated from X-ray powder diffraction data, are a = 5.110(4), b = 8.856(3), c = 14.080(6) Å, β = 96.93°(4) these values are smaller than those for cookeite. D_{calc} = 2.69(1) g/cm^3. The mineral has a Mohs hardness of 3, light pinkish-grey streak, greasy luster, perfect (001) cleavage, and no parting or fracture. Optical properties (for white light): α = 1.574, β = 1.580, γ = 1.591 (all ± 0.002), $2V_{calc}$ = 72°, dispersion not determined. The optical sign and the angle of the optical axis were not measured because of the small size and strong curvature of the mineral flakes.

Borocookeite, as well as other boron-rich phyllosilicate minerals, crystallized from evolved residual solutions in miarolitic cavities at temperatures not less 265–240 °C. The ratio of activities of K, Li, B, F, and H_2O in the mineral-forming fluids of isolated evolving pockets determined whether borocookeite or boromuscovite formed separately or together.