American Mineralogist, Volume 89, pages 819–831, 2004

Compositional characteristics and paragenetic relations of magnesiohögbomite in aluminous amphibolites from the Belomorian complex, Baltic Shield, Russia

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Abstract

This study investigates the compositional characteristics, parageneses, and stability relations of some högbomite-bearing assemblages in coarse-grained corundum-garnet amphibolites from a blackwall zone that separates troctolitic metagabbro from kyanite-bearing paragneiss at Diadina Mountain, Belomorian Belt, Russia. The blackwall zone presumably was formed through infiltration driven metasomatism during the Svecofennian metamorphic event at ~1.9 Ga. Euhedral högbomite grains (up to 15 mm in size) occur in domains of coarse tschermakitic amphibole, biotite, and spinel with minor rutile and ilmenite in the two blackwall varieties having contrasting bulk compositions. The other minerals in the two associations include corundum + garnet ± cordierite + chlorite + plagioclase + carbonate and spinel ± gedrite + sapphirine + chlorite + carbonate.

The studied högbomite belongs to the magnesiohögbomite-2*N*3*S* polysome type [$P\bar{3}m1$ with a = 5.721(1) Å, c = 23.045(1) Å] and exhibits compositions that are poor in Zn (0.05–0.42 wt% ZnO) and Ni (0.20–0.50 wt% NiO) [$(Fe^{2+}_{2.7-3.1}Mn_{0.01}Ni_{0.04-0.1}Zn_{0.01-0.1})Mg_{4.8-3.7}(Al_{18.1-18.8}Cr_{0.1-0.2}Fe^{3+}_{0.4-0.9})Ti_{1.6-1.2}O_{38}(OH)_2$]. Compositional variation is controlled by the substitution $Ti^{4+} + R^{2+} \leftrightarrow 2R^{3+}$. Systematic partitioning data for Fe^{2+}, Mg, and Zn indicate attainment of chemical equilibrium between magnesiohögbomite and the associated minerals (Spl, Hbl, Ged, Grt, Spr, Bt) on the thin section scale. Textural relations suggest growth of magnesiohögbomite under amphibolite-facies conditions (6 ± 1 kbar, 600 ± 50 °C) through complex mineral-fluid equilibria involving oxide (Crn, Spl, Rt, Ilm), silicate (Am, Bt, Spr), and carbonate (Cal, Dol, Mgs) phases. A partial $\log f_{O_2}$-$\log f_{S_2}$ diagram for the system FeO-Al_2O_3-TiO_2-O_2-S_2-H_2O shows that growth of magnesiohögbomite from Crn + Ilm and Spl + Rt is restricted to a narrow f_{O_2}-window and low f_{S_2}. The topological constraints, together with petrological data, suggest that magnesiohögbomite is formed in titanian and aluminous protoliths under greenschist-to amphibolite-facies conditions if f_{H_2O} is high, f_{S_2} low, and f_{O_2} is defined by the paragenesis ilmenite + rutile + magnetite.