Thermodynamic modeling of the formation of corundum-bearing rocks within the Belomorian mobile belt using Perple_x software

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More than a dozen deposits of corundum-bearing rocks are known within the Belomorian mobile belt (references in Serebryakov, Rusinov, 2004); their genesis remains debatable. Some authors consider corundum-bearing rocks to be normal metamorphic rocks (for example, Lebedev et al., 1974), others suggest the metasomatic genesis of rocks with corundum: 1 – corundum-bearing rocks were formed as a result of high-temperature high-pressure (600 - 700ºC, 7 - 8 kbar) metasomatism which was accompanied by desilification and the introduction of Ca and Na (Serebryakov, Rusinov, 2004); 2 – these rocks are a product of hydrothermal alteration of gneisses by fluids associated with basic intrusions (Bindeman et al., 2014). All these assumptions were made without a detailed physicochemical analysis of the mineral parageneses of corundum-bearing rocks.

The Perple_X software package (Connolly, 2005) is discussed in some recent works as an effective tool for the thermodynamic modeling of the open systems (Goncalves et al., 2012, Manning, 2013). Using the Perple_X software package (version Perple_X 6.8.7, updated 04.07.2019) we constructed P-T, T-μ(SiO₂), and μ(SiO₂)-μ(Na₂O) pseudosections for a given chemical composition of kyanite-garnet-biotite gneiss of the Chupa sequence. The hp02ver.dat thermodynamic database was used, the diagram μ(SiO₂) - μ(Na₂O) was calculated for P = 8 kbar, T = 650ºC, in the presence of a carbonic-aqueous fluid with X(CO₂) = 0.3. Selected solid solution models are Ca-Amph(D) for hornblende, Gt(HP) for garnet, St(HP) for staurolite, Bi(HGP) for biotite, feldspar for feldspar, Sp(HP) for spinel.

The results show that the majority of corundum-bearing rocks varieties (amphibole-free corundum-bearing rock, amphibole-bearing rock with corundum, altered quartz-free kyanite-garnet-biotite gneiss, kyanite-garnet amphibolite) could be formed by metasomatic alteration of kyanite-garnet-biotite gneisses of the Chupa sequence. This process was characterized by a significant decrease in μ(SiO₂) and a slight increase in μ(Na₂O). Our conclusion is partly consistent with the hypothesis that corundum-bearing rocks were formed as a result of metasomatism, which was accompanied by desilification of Ky-Grt-Bt gneisses and the introduction of Na and Ca (Serebryakov, Rusinov, 2004).

The study was conducted according to the IPGG project 0153-2019-0004.

Bindeman I.N., Serebryakov N.S., Schmitt A.K. et al. (2014) Field and microanalytical isotopic


Manning C.E. (2013) Thermodynamic modeling of fluid-rock interaction at conditions of the earth’s middle crust to upper mantle. Reviews in Mineralogy & Geochemistry, 76, p. 135-164.