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Crystal chemistry and origin of grandidierite, ominelite, boralsilite, and werdingite from the Bory Granulite Massif, Czech Republic

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Abstract

A mineral assemblage involving grandidierite, ominelite, boralsilite, werdingite, dumortierite (locally Sb,Ti-rich), tourmaline, and corundum, along with the matrix minerals K-feldspar, quartz, and plagioclase, was found in a veinlet cutting leucocratic granulite at Horní Bory, Bory Granulite Massif, Moldanubian Zone of the Bohemian Massif. Zoned crystals of primary grandidierite to ominelite enclosed in quartz are locally overgrown by prismatic crystals of boralsilite and Fe-rich werdingite. Boralsilite also occurs as separate cross-shaped plumose aggregates with Fe-rich werdingite in quartz. Grandidierite is commonly rimmed by a narrow zone of secondary tourmaline or is partially replaced by the assemblage tourmaline + corundum ± hercynite. Grandidierite (X_{Fe} = 0.34–0.71) exhibits dominant $FeMg_{-1}$ substitution and elevated contents of Li (120–1890 ppm). Boralsilite formula ranges from $Al_{15.97}B_{6.20}Si_{1.80}O_{37}$ to $Al_{15.65}B_{5.29}Si_{2.71}O_{37}$ and the formula of werdingite ranges from $(Fe,Mg)_{1.44}Al_{14.61}B_{4.00}Si_{3.80}O_{37}$ to $(Fe,Mg)_{1.22}Al_{14.86}B_{4.25}Si_{3.55}O_{37}$. Dumortierite and Sb,Ti-rich dumortierite occur as zoned crystals with zones poor in minor elements (≤0.12 apfu Fe+Mg) and zones enriched in Sb (≤0.46 apfu) and Ti (≤0.25 apfu). Secondary tourmaline (X_{Fe} = 0.44–0.75) of the schorl-magnesiofotite-foitite-olenite solid solution occurs as a replacement product of grandidierite, rarely boralsilite. Other accessory minerals in the veinlet include monazite-(Ce), ilmenite, rutile, ferberite, srilankite, löllingite, arsenopyrite, and apatite. Formation of the borosilicate-bearing veinlet post-dates the development of foliation in the host granulite and is related to the decompressional process. The assemblage most probably originated from a H_2O-poor system at T ~ 750 °C and P ~ 6–8 kbar. Textural relations as well as geological position of the borosilicate veinlet suggest that it represents the earliest intrusion related to pegmatites in the Bory Granulite Massif. Younger granitic pegmatites in the area are characterized by high contents of B, Al, P, Fe, and minor concentrations of W, Ti, Zr, Sc, and Sb. All pegmatite types probably formed within a short time period of ~5 Ma.

Keywords: Boron, grandidierite, ominelite, werdingite, boralsilite, granulite, partial melting, Moldanubicum, Bohemian Massif