

Variation and significance of chemical zoning pattern of garnet in Nove Dvory eclogite, Moldanubian Zone of the Bohemia

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Nove Dvory eclogite recorded extremely high-P/T conditions, 4.5-4.9 GPa/1100°C (Nakamura et al., 2004). In spite of such high-T conditions, various zoning patterns of garnet are identified from the eclogite, i.e., homogeneous, pyrope-increasing with constant grossular content, pyrope-decreasing with constant grossular content, and grossular-increasing with constant almandine content (Nakamura et al., 2004). The preservation of such zonings infers the short duration of UHP metamorphism and subsequent granulite facies overprinting (Nakamura et al., 2011). The present study found a new type of garnet zoning from a Nove Dvory eclogite, i.e., grossular increasing and almandine decreasing type. Studied samples, collected from an outcrop with 1.5 x 3.0 m in a vertical cliff, can be classified into kyanite-bearing and kyanite-free eclogite. kyanite-free eclogites are characterized by higher modal amount of garnet, ca. > 60 vol %. Another main UHP phase is omphacite along with minor apatite. Pargasitic amphiboles are commonly identified as primary inclusions in several garnet grains. Garnet and omphacite were decomposed to kelyphite and symplectite, mainly composed of plagioclase, biotite, amphibole, spinel, corundum and K-feldspar, with various degrees. Main UHP minerals in kyanite-bearing eclogites are also garnet and omphacite with subordinate amount of kyanite and apatite with or without SiO₂ phase. Break-down products of garnet and omphacite are plagioclase, biotite, spinel amphibole, clinopyroxene, and orthopyroxene suggesting that the host eclogite experienced a granulite facies overprinting during the exhumation. The both types of eclogites contain garnets showing the new zoning type, but they show following distinct characters, i.e., garnet is almandine-rich and omphacite is jadeite-rich in the kyanite-free eclogite than those in the kyanite-bearing eclogite. The new type garnet grains in the kyanite-free eclogite vary their compositions from Alm₃₅₋₄₃Prp₃₀₋₃₅Gr₃₀ in the core to Alm₃₅Prp₃₀Gr₃₅ in the rim, instead those in the Ky-bearing eclogite vary their compositions from Alm₃₀Prp₄₀₋₄₅Gr₂₅₋₃₀ in the core to Alm₂₀₋₂₅Prp₃₀₋₃₃Gr₄₅₋₅₀ in the rim. These zoning patterns are generally identified in coarse-grains with > 2 mm in diameter. The core composition of fine-grained garnet (<2mm in diameter) is almost identical with the rim composition of coarse-grains. Most of garnet grains decrease their grossular content to partially developed outer rim, to Alm₃₃Prp₃₃Gr₃₃ in the kyanite-free eclogite and to Alm₂₅₋₃₂Prp₃₀₋₃₃Gr₃₅₋₄₅ in the kyanite-bearing eclogite. Jadeite and Ca-tschermakite content of omphacite inclusions in garnet of the kyanite-free eclogite are 0.43-0.48 and 0.02-0.04, respectively, and those of the kyanite-bearing eclogite are 0.25-0.38 and 0.04-0.05, respectively. There was a controversy on the origin of eclogite, high-P cumulate (Medaris et al., 1995) or low-P gabbro (Obata et al., 2006). These chemical characters obtained by this study also suggest that the studied eclogite has experienced the subduction as pointed out by Nakamura et al. (2004), and that compositions of garnet and omphacite in both types of the eclogite reflect differences in bulk compositions of the protolith. Thus, the protolith of kyanite-bearing eclogite should be derived from more primitive rock and that of the kyanite-free eclogite should be more differentiated one. The peak P-T conditions of the studied kyanite-bearing eclogite was estimated to be 4.1-4.3 GPa and 900-940°C by garnet-clinopyroxene-kyanite-SiO₂ phase geobarometer of Nakamura and Banno (1997) and garnet-clinopyroxene geothermometer of Nakamura (2009), and the equilibrium temperature of kyanite-free eclogite was estimated to be 1070-1080°C assuming the pressure within 4.1-4.3 GPa. These estimates are lower than those of Nakamura et al., (2004), i.e., 4.5-4.9 GPa and 1050-1150°C, probably caused by the serious composition modification of omphacite.

Keywords: UHP eclogite, Bohemian Massif, Garnet, Compositional zoning