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ザクロ石の組成累帯構造と包有物から見たボヘミア地塊Lhenice shear zoneの泥質片麻岩の変成履歴
Metamorphic history of Grt-rich gneiss in Lhenice shear zone, Bohemian Massif inferred from inclusions and zoning of Grt

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Multiple equilibrium stages were identified from peraluminous garnet (Grt)-rich gneiss at Ktis in the Lhenice shear zone, located between Blansky les and Prachatice granulite massifs in the southern Bohemian Massif, Czech Republic (e.g. Rajlich et al., 1986). The matrix of the rock mainly comprises cordierite (Crd), sillimanite (Sil), biotite (Bt), Grt, quartz (Qtz), K-feldspar (Kfs) and plagioclase (Pl) along with accessory minerals such as spinel (Spl), apatite (Ap), monazite (Mnz) and zircon (Zrn). Bt, Sil, kyanite (Ky) and Pl occur as inclusion phases in Grt. Crd occurs only in the matrix both as isolated grains and as reaction coronas developed around Grt. Spl is closely correlated with the Crd corona. Some coarse-grained ($>$ 3 mm) Grts show chemical heterogeneity both in major and trace elements. Grossular (Grs)-content is homogeneous and high (Xgrs = 0.27) in a center of the grain and smoothly decreases towards the grain margin (Xgrs = 0.02). However, pyrope (Prp)-content shows an inverse pattern against Grs-content; i.e., Prp-content is low and constant (Xprp = 0.03) in the center of the grain and gradually increases towards the margin (up to Xprp = 0.28). The contours of Grs and Prp contents show symmetrical hexagonal shapes. The distribution pattern of phosphorus, however, shows a striking contrast against Grs-content. The core of the grain is characterized by low-phosphorus content almost below the detection limit of the EPMA analysis but it is armored by the high-phosphorus rim accompanying with local development of phosphorus-poor outermost rim. Phosphates, such as Ap and Mnz, with large amounts of CO_2-N_2 fluid inclusions are abundant in the phosphorus-poor core but are lacking in the phosphorus-rich rim. The outline of phosphorus-poor core shows a hexagonal shape, which is symmetrical to those of Grs and Prp content contours, but it is located outside of higher Xgrs (=0.27)- and lower Xprp (= 0.03)-content contours. These observations suggest that the outline of phosphorus-poor core should indicate the original shape of Grs-rich garnet developed during an early stage of the metamorphism. The zoning pattern of major/trace elements in garnet and the mode of occurrence of constituent minerals suggest that the studied rock experienced three equilibrium stages represented by following mineral assemblages with excess of Bt, Pl, Qtz and Kfs:

Stage 1: Xgrs-rich (= 0.27) and phosphorus-poor Grt core + Ky + Ap+ Mnz + CO_2-N_2 fluid
Stage 2: Xgrs-poor (= ca. 0.05) and phosphorus-rich Grt rim + Ky/Sil
Stage 3: Xgrs-poor (= 0.02) and phosphorus-poor Grt outermost rim + Sil + Crd +/- Spl + Mnz

The geothermobarometory gives following P-T conditions for each stage: 1.5-2.3 GPa at 700-900 ^{o}C for Stage 1, 730-830 ^{o}C and 1.0-1.3 GPa for Stage 2, and 740-850 ^{o}C and 0.6-0.8 GPa for Stage 3. The P-T conditions for the Stage 2 are slightly higher than the peak P-T conditions for gneisses of the Varied /Monotonous Units in the literatures and the P-conditions for the Stage 1 are similar to those of HP-granulite in the Gfoehl Unit. The inferred P-T conditions both by a model petrogenetic grid and a pseudosection analysis suggest that the studied rock experienced the isothermal decompression at least from the Grt rim stage (Stage 2, 1.0-1.3 GPa) to the matrix stage (Stage 3, 0.6-0.8 GPa). This decompression path would overstep following dehydration melting reactions at different depths: Ms + Qtz = Grt + Bt + Sil + Kfs + Liq at 1.0-1.2 GPa and Bt + Sil + Qtz = Grt + Crd + Kfs + Liq at 0.3-0.6 GPa. Furthermore, phosphorus-poor core includes Ap and Mnz, but the phosphorus-richest rim is free of them. This kind of zoning of phosphorus in Grt was probably formed related to the partial melting reaction including phosphate minerals. The high-phosphorus Grt rim should be formed through these reactions, in other words, higher-phosphorus content of Grt can be used as an indicator of partial melting of the host rock.
Keywords: Bohemian Massif, Lhenice shear zone, Partial melting, Phosphate, Phosphorus, Fluid inclusion