東南極リュツォ・ホルム岩体オングル島の超塩基性片麻岩のコロナ形成と粒径分布

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Formation of corona microstructure and crystal size distribution in ultramafic gneisses from Ongle Island in Lützow-Holm Complex, East Antarctica

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We report chemical composition and crystal size distribution (CSD) of biotite-plagioclase corona that formed between garnet and hornblende in hornblende-rich ultramafic gneiss from Ongle Island, Lützow-Holm Complex, East Antarctica. Mass balance equation based on the modal abundance and chemical composition of the constituent minerals suggests that the formation of the corona microstructure requires supply of K_2O and H_2O, probably as K_2O-rich aqueous fluid. Thermodynamic consideration indicates that such a fluid infiltration took place during isothermal decompression, which could well explain the following features: absence of garnet in the corona and the increase of anorthite content toward the rim. The thermodynamic analyses also suggest that supply of K_2O fluid caused partial melting of the rock. Provided that the fluid were supplied at the peak of metamorphism, garnet, plagioclase and biotite coexist with the melt. During decompression, modal abundance of melt and garnet decreases while that of biotite and plagioclase increases. Geothermometry applied to the pairs of orthopyroxene and biotite occurring in the matrix and corona yields 800^{o}C and 760^{o}C, respectively, which also supports isothermal formation of the corona.

Crystal size of whole grains of biotite in the corona shows a lognormal distribution. Mathematical consideration shows that the growing grains show lognormal distribution when the growth rate is in proportion to its grain size, which is referred to as law of proportionate effect: LPE (Eberl et al. 1998). Kile et al. (2000) experimentally produced lognormal distribution of calcite grains by continuous addition of nutrient solution, where they interpreted as a sigle nucleation event followed by LPE growth. Present results also show lognormal CSD, however, the fluid filtration caused partial melting but not complete melting, which suggests that biotite grains were not newly nucleated.

Apart from the present study, it is common that symplectic intergrowth of spinel, orthopyroxene and plagioclase occurs between garnet and hornblende in mafic to ultramafic gneisses in Lützow-Holm Complex, East Antarctica (e.g., Hiroi and Onuki 1985). This reaction microstructure has been employed to support decompression P-T path after peak of metamorphism. Absence of the common symplectite in spite of the presence of hornblende in the matrix implies the fluid infiltration, and resultant partial melting, preceded the reaction to form symplectite. These constraints suggest that the presence of melt prevented from the subsolidus reaction between garnet and matrix hornblende, and that the decreasing pressure enhanced overgrowth of biotite as well as plagioclase onto preexisting grains. Comparing with the experiments of Eberl et al. (1998), it may be suggested that continuous decrease of pressure maintained super-saturation, which has been obtained experimentally by continuous supply of nutrient solution. The single event of nucleation of Eberl et al. (1998) may correlate with the preexisting residual grains of biotite in the present study. As a result, the P-T evolution of the present sample, including partial melting, may be analogous to the experiments of Eberl et al. (1998) with regard to the suitable condition for LPE.

References

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