Variation of microstructure of garnet in pelitic gneisses from Akarui Point of the Lützow-Holm Complex, East Antarctica : Insight from minimization of surface energy

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Metamorphic rocks have been considered to preserve the mineral assemblage and composition of minerals at the peak metamorphism during their pressure (*P*) –temperature (*T*) path. However, we found that different *P-T* conditions were obtained for rocks even from the same outcrop and based on the same geothermobarometers.

We discuss the reason of this difference in terms of different growth history of garnet. We dealt with pelitic gneisses in Akarui Point of the Lützow-Holm Complex, East Antarctica.

The rocks recording different *P-T* conditions show different microstructures of garnets. We divided the garnets into two types (type-A and type-B). Type-A garnet shows round shape and contain large amount of fine inclusions of quartz. Most inclusions are concentrated at the central part of the grain. Type-B garnet represents irregular shape and includes coarse grains of quartz and plagioclase sporadically. Both types of garnet don’t preserve the chemical composition during growth because the diffusion of elements in garnet has progressed.

Geothermobarometry indicates significant difference in *P-T* condition. That is, garnet-biotite geothermometer (Hodges and Spear., 1982) and garnet-biotite-plagioclase-quartz geobarometer (Hoisch., 1990) show 828 - 855 ℃ at 7.2 - 7.8 kbar for the type-A Grt-bg. sample 685 - 718 ℃ at 6.4 - 6.6 kbar for the type-B Grt-bg. sample. This implies that the timing of garnet formation can be different.

Based on the different features of the amount and size of inclusions, we characterized the total surface energy (Helmholtz free energy at constant *T* and total volume) under the various geometrical configuration between inclusion and host minerals. Consider two particles with different size in surroundings of matrix minerals. The larger and smaller ones correspond to garnet and inclusion mineral. Three kinds of interface can be defined such as garnet-inclusion, garnet-matrix, and inclusion-matrix. We obtained the geometrical condition with minimum surface energy, which depends on the ratios between surface energies of these interfaces. As a result, we found three regimes for stable geometry, that is, a smaller particle is fully included in garnet, partially included and not included at all. Based on porphyroblastic habit of garnet, the interface with garnet is considered to have high surface energy. The present study expects that such garnet will never include small mineral partially nor at all. This conclusion is not consistent with the natural observations. This suggests that another factors such as growth rate are necessary to account for the entrapment phenomena.

Keywords: Garnet, inclusion, surface energy

