Growth history of garnet inferred from microstructures in pelitic gneisses from Akarui Point of the Lützow-Holm Complex

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The Lützow-Holm Complex (LHC) of East Antarctica underwent a high to ultra-high temperature metamorphism. Garnet formed under such condition has been chemically homogenized, which causes difficulty to reveal the growth history of the garnet. Microstructure such as shape, size of inclusions, and their fabric, and chemical zoning of indiffusive elements such as phosphous help the reconstitution of growth history of garnet. We investigate garnets in pelitic gneisses from Akarui Point of the Lützow-Holm Complex, East Antarctica and find that the garnets is divided into two types (type-A and type-B). This study describes the mode of occurrence of these garnets and discuss their growth histories.

Microstructures

Garnet in each type preserved different shape and inclusion size. Type-A garnet coexists with biotite, plagioclase, quartz, K-feldspar, and sillimanite. Type-A garnet shows round shape and contain large amount of fine inclusions of quartz, plagioclase, apatite. Most inclusions are concentrated at the central part of the grain, of which envelop shows approximately hexagonal shape. Some inclusions also occur in the mantle part as a zone parallel to the hexagonal shape. Fine-grained aggregates of plagioclase, that show chain-like shape, locally occur as inclusion in type-A garnet. Type-B garnet coexists with biotite, plagioclase, quartz and doesn’t include the aggregates of plagioclase that occur in type-A garnet. Type-B garnet represents irregular shape and includes coarse grains of quartz and plagioclase sporadically.

Mineral Chemistry

Type-A garnet shows chemical heterogeneity such that X_{Ca} decreases from the core to rim. Furthermore, type-A garnet shows a decrease of X_{Ca} around the chain-like inclusion of plagioclase. Phosphorus contour in type-A garnet represents euhedral shape parallel to the zone of inclusion-rich area. Similarly, X_{Ca} in type-B garnet decreases from the core to rim. Depletion of X_{Ca} is also observed around plagioclase inclusions. Phosphorus in type-B garnet shows no zoning.

Discussion

Garnet of both types occur in the same exposure suggesting that both types experienced in same pressure (*P*) - temperature (*T*) path. Nevertheless, each garnet preserved different shape, inclusion size, and phosphorus zoning. Inclusions in type-B garnet are composed of single crystals neither poly grains nor poly minerals. This show these inclusion minerals were entrapped as a single coarse grain. This suggests that the matrix minerals were already being coarse when the garnet grew. The irregular shape of type-B garnet can be accounted for as half-entrapment of coarse-grained matrix mineral. In contrast, type-A garnet including fine inclusions grew when the matrix minerals were still fine - grained. This suggests type-A garnet started to grow at lower temperature than type-B garnet.

Euhedral chemical contour of phosphorus would indicate that the type-A garnet grew maintaining surface equilibrium during change in pressure-temperature condition. In contrast, absence of phosphorus zoning in type-B garnet show its growth without significant change in *P-T* condition. The argument leads the following conclusion that type-A garnet started grow at low temperature and grew with change in *P-T* condition, whereas type-B garnet nucleated and grew at high temperature without significant change in *P-T* condition.

Subsolidus continuous reaction could be responsible for the growth of type-A garnet. In contrast, solidification reaction of melt could be account for the formation of type-B garnet. Difference in bulk composition inferred from different mineral assemblage may cause different reaction to form different type garnet even both have experienced the same *P-T* path.