Anisotropic growth of garnet grains during the Sambagawa metamorphism

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The high pressure metamorphis rocks as exemplified by the sambagawa metamorphic rocks are considered to be originated from the plate boundary zone. These rocks contain garnet and amphiboles which have chemical records accompanied by physical processes in the wide range of the pressure and temperature conditions. Garnet grew during prograde metamorphism and shows the chemical zoning that, from the core to the rim, Mn decreases gradually while Fe and Mg increase. By mean s of the chemical zoning in garnet, the pressure and temperature paths of the rocks have been quantitatively decided by applying the differential thermodynamic method (Gibbs method). As mentioned above, garnet is a useful mineral that holds the history of the subduction zone.

The elongated shapes of garnet grains found in the Sambagawa metamorphic belt were analyzed in detail. These elongated garnet display chemical zoning and euhedral outlines with the {110} growth surfaces. And it shows that the distances from the core to the rim are obviously different depending on the direction. Further, the composition of the rim is also the same anyplace. Therefore, the elongated garnet was formed by growing in anisotropy.

In order to confirm whether the elongated cross-section shape can be made according to the cut angle of garnet with ideal shape which displays a rhombic dodecahedron, the numerical calculation, cutting the garnet with ideal shape, was done. It was shown that most cross-section shape is hexagon, and the maximum aspect ratio of the shape is route 2. However, in the Sambagawa pelitic schists, there are garnet grains which the aspect ratio is over route 2, indicating the garnet grains found in the Sambagawa pelitic rocks have actually elongated outlines.

The method was developed to analyze anisotropic growth of garnet quantitatively, named as Anisotropic growth rate (RA). The change of Xsps is considered as a function of the distance from the core to the rim, and the ratio of the change rate is RA. The advantage of this method is to be able continuously to extract the ratio of growth ratio in a different direction from the core to the rim. It was shown that the direction of faster growth had changed with prograde metamorphism.

Two possible mechanisms of anisotropic growth of garnet were considered by this study as following:

(1) Anisotropic growth of garnet accompanied with deformation during shear flow.

It is possible to speculate the strain rate of the rock in addition to the pressure and temperature history obtained from the zonal structure within the garnet grains.

(2) Anisotropic growth of garnet related to fluid migration. It is possible to speculate the information about fluid migration which would have passed in the cracks. It is also possible to speculate the stress direction when the cracks open.