The relationship between the extent of retrograde reaction and pull-apart structure of amphibole in basic schists

Atsushi Okamoto[1], Mitsuhiro Toriumi[2]

[1] Earth and Planetary Sci., Tokyo Univ, [2] Complexity S and E., Univ. Tokyo

The surface area of reactant and the amount of grain boundaries may dominate the extent of reaction, if metamorphic reaction proceeds under near equilibrium condition. Therefore incerease of surface area of reactant mineral due to brittle deformation may enhance the reaction. In this study, the relationship of grain size reduction of hornblende and the extent of retrograde reaction is investigated for the basic schists of the Sanbagawa metamorphic belt.

The basic schists analyzed in this study were collected from the Besshi area, in the central Shikoku, Japan. In the Sanbagawa schists, amphibole is one of the most common minerals and has commonly conspicuous zonings. Our previous thermodynamic calibrations for the assemblage of amphibole-epidote-chlorite-plagioclase-quartz- water provide us the decompression P-T paths from common amphibole zonings (barroisite-hornblende-actinolite, winchite-actinolite:from core to rim). The images of zonal structures are useful to investigate the extent of reactions for individual rocks. Since retrograde metamorphism of the Sanbagawa schists is characterized by the net-transfer reaction, which produces actinolite and chlorite by consuming hornblende. Thus, we define the proportion of the amount of actinolite in amphibole, Xact, as the indicator of the extent of reaction. Amphibole grain elongate parallel with the C-axis, and some of them are broken perpendicular to this directions (pull-apart structure). Pulled apart grains are filled by later compositions of amphibole, from which P-T conditions during the deformation can be identified.

In this study, we analyzed 25 basic schists containing amphiboles, which have hornblende cores rimed by actinolite, using the chemical images of EPMA. The procedures are as follows.

(1) The sums of areas of hornblende and actinolite, (Ahbl, Aact) and the sum of the length of grain boundary of hornblende were measured. These values yield Xact (= Aact/(Ahbl+ Aact)) and Ghbl (=Ahbl/Lhbl). Ghbl implies the average grain size of hornblende.

(2) Strain is obtained from individual pull-apart grains. Here, strain is defined by e = dl/dl0.

(3) Mineral modes of minerals in individual samples were measured from thin sections.

We obtained the following results:

(1) As Ghbl decreases, Xact and amount of chlorite (Mchl/Mamp) increase.

(2) Strain obtained from pulled apart amphibole grains ranges from 0.05 - 3.5. As Xact of the bulk rock increases, strain of increases.

The values of Xact and Mchl/Mamp reflect the extent of retrograde reaction. Therefore result (1) indicates that the extend of grain size reduction of hornblende corresponds to the extend of retrograde reaction during the exhumation of metamorphic body. Common pull-apart structures indicate that the brittle deformation is one of the main processes of grain size reduction of hornblende. Furthermore, if grain size reduction is due to the brittle deformation of amphibole grain, the result (2) indicates the probability that the extents of retrograde reaction imply the relative differences in strain of basic rocks in the specific P-T fields. However, it is necessary to evaluate the amount of the consumption of hornblende during the retrograde reaction, so as to discuss the relationships of grain size reduction and the extent of reaction. We will evaluate the amount of consumed hornblende by the mass balance equations for the multi-component system.