FORWARD CALCULATION AND SOME PRELIMINARY ANALYSES ON THE GROWTH RATE AND CHEMICAL COMPOSITION OF GARNET

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Concentric chemical zoning retained in garnet is useful to reconstruct temperature and pressure history during garnet growth, assuming chemical equilibrium between garnet surface and other matrix minerals. Inverse and forward calculations have been applied to many garnet-bearing metamorphic rocks to derive the P-T trajectory. Forward calculation is mostly used just to support the results of inversions, that is, to show the possible mineral assemblage or define the P-T boundary. It is clear that detailed forward calculation provides much more quantitative information that can help unravelling the process of garnet growth: e. g., absolute P-T values, amount of garnet growth during certain P-T changes (INUI & TORIUMI, 2004). Change in the growth amount of garnet is especially of interest, since the formation of garnet is one of the dominant dehydration reactions in the subducting oceanic sediments and therefore may control the mass transfer in the subduction zone (e. g., TORIUMI & INUI, 2001). However, the modelled and the natural garnet behaviour still need to be calibrated with each other.

In order to provide the needed information, sensitivity analyses were firstly carried out on the forward model. Forward calculation by INUI & TORIUMI (2004) was performed to model the formation of zoned Mg-Fe-Mn-Ca garnet, applying published thermodynamic data set (e. g., HOLLAND & POWELL, 1998). The bell-shaped profile of Mn was reconstructed in response to heating and compression path of the Sambagawa metamorphic belt, SW Japan. Calculations were carried out varying the thermodynamic property data of minerals, P-T condition, and the initial chlorite composition. It was confirmed that variations concerning Mn influenced almost exclusively the core composition of garnet, whereas the uncertainty concerning Mg and Fe generally influenced the Mg/Fe ratio of garnet by a few mole%. In all calculated results, however, the amount of growth maximized when the Mg/Fe ratio in garnet started increasing rapidly. The volume of garnet crystal having certain compositional range (the amount of growth at a certain condition) was measured using the compositional mapping images of natural garnet from the Sambagawa metamorphic belt. The history of growth amount change was compared to that predicted by the forward calculation, using the P-T trajectory of the grains derived by the inverse analyses (INUI & TORIUMI, 2002) applied on the identical grain. It was shown that the volume of garnet maximized where Mg/Fe ratio started increasing rapidly, which was consistent with the behaviour predicted above. It suggests that garnet formation, and therefore the dehydration from metamorphic rocks, occurred within a narrow temperature range during subduction.

References

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