Crystal size distribution and compositional zoning of garnet formed by two-stage growth in the Kotsu eclogite and basic schist, Sanbagawa belt

OTGONBAYAR DANDAR[1*], ATSUSHI OKAMOTO[1], MASAOKI UNO[1]

[1] Department of Earth Science, Graduate School of Environmental Studies, Tohoku University

The nucleation and growth history of crystals during metamorphism are recorded both as crystal size distribution (CSD) and compositional zoning from core to rim. In particular, the crystal size distribution of garnet has been investigated and modeled by relative rate of nucleation and growth, and coupled with diffusion. As garnet is commonly formed during prograde metamorphism, the incremental amount of the garnet growth at individual P-T conditions is essential information to elucidate the water release at the subduction interfaces. Conventionally, there are two type models on CSD; one is the nucleation and growth rates are defined as a function of time (e.g., Špillar V. & Dolejš D. 2013), and the other one is growth rate is defined as the size (Eberl et al., 1998). However, it is still uncertain which model is more appropriate, as the data aquations of CSD from thin sections and the composition of "true" core are very difficult due to the cut effects. In this contribution, we showed the detailed data showing the relationship between CSD and compositional zoning of garnet in the Kotsu eclogite and basic schist in the Sanbagawa metamorphic belt, Japan. This eclogite sample is suitable to this trial, because garnet grains show euhedral shape and record two-stage growth history composed of the core containing abundant mineral inclusions (epidote, plagioclase, chlorite, carbonate, titanite, quartz, and omphacite) and poor-rim.

The crystal growth of garnet in the eclogite is divided into two stages. The garnet grains are euhedral and composed of the inclusion-rich core (stage 1) and poor-rim (stage 2). The core shows prograde zoning (from core to rim), characterized by decrease of X_{Mn} (0.025 to 0.005), increase of X_{Mg} (0.06 to 0.12), decrease of X_{Fe} (0.65-0.55), and almost constant of X_{Ca} (0.27-0.35). The smaller cores have lower Mn and higher Mg contents, suggesting that nucleation at the later stage. All grains have an inclusion-poor rim showing Mn increase. Similarly, the crystal growth of garnet in the basic schist is divided into two stages: core showing increase of X_{Fe} (0.52-0.65) and rim displaying decrease of X_{Fe} (0.65-0.56). One of the interesting observations is a positive relationship between the diameter of the inclusion-rich core and the growth width of the inclusion-poor rim, meaning that the growth rate is proportional to the grain size. We will construct the nucleation and growth model to reproduce the CSD and the trend of growth zoning, and discuss the mechanism and water production history.

Keywords: Crystal size distribution, Compositional zoning, the Kotsu eclogite, Sanbagawa belt
*Corresponding author: dandar.otgonbayar.a7@tohoku.ac.jp