Mechanisms and kinetics of the eclogite-garnetite transformation.

Masayuki Nishi[1]; Tomoaki Kubo[2]; Takumi Kato[2]

[1] Earth and Planetary Sci, Kyushu Univ; [2] Kyushu Univ.

Introduction

Untransformed metastable minerals possibly exist in the cold subducting slabs because the mineral transformations are kinetically inhibited due to the low temperatures. Although equilibrium phase transformations in subducted oceanic crust (MORB) have been well studied, processes of these transformations are poorly known. Here we report the experimental results on mechanisms and kinetics of the eclogite-garnetite transformation.

Experiments

We synthesized eclogite (polycrystals of clinopyroxene (CPX) + garnet) from MORB glass as a starting material for the transformation experiments by using a MAX-90 multi-anvil high-pressure apparatus installed at Kyushu University. The transformation experiments were carried out at pressures of 11-15 GPa and temperatures of 1274-1823K for 10-180 minutes by using a multi-anvil high-pressure apparatus (Q-MAX) installed at Kyushu University. Two kinds of starting material were enclosed in a sample capsule for the transformation experiments. One is the synthetic eclogite to observe the transformation process and the other is the MORB glass to know equilibrium phase assemblages and chemical compositions at a given P-T condition. Textures and chemical compositions in recovered samples were examined by SEM-EDS.

Results and discussion

All of the run products from MORB glass consisted of majoritic garnet and CPX. The phase assemblages and these chemical compositions were consistent with the phase equilibria of the previous study. In the samples recovered from the synthetic eclogite, majoritic garnet was formed along grain boundaries of CPX. Chemical composition of CPX was also changed by the formation of the majortic garnet. On the other hand, chemical composition of original garnet remained unchanged. Therefore, the majoritic garnet was directly formed from CPX without reaction of original garnet in the synthetic eclogite.

The present study suggests that the eclogite-garnetite transformation proceeds by two stages as mentioned below.

(1) Direct formation of majoritic garnet from CPX

(2) Compositional homogenization between original garnet and majoritic garnet from CPX.

In the present study, the second stage of the eclogite-garnetite transformation was not confirmed even at high temperature of 1823K for 180 minutes heating although the first stage proceeded at 1273K on the same time scale. This suggests that the second stage is much slower than the first stage. Therefore, in the cold subducting plate, original garnet may metastably survive with the majoritic garnet and CPX. The density of the oceanic crust in the upper mantle is strongly affected by kinetics of the first stage of the eclogite-garnetite transformation because the density of garnet is much higher than CPX.