Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SIT037-04 Room: Exibition hall 7 subroom 2 Time: May 27 11:30-11:45

Mechanisms and kinetics of the eclogite-garnetite transformation in subducting oceanic crust

Masayuki Nishi[1*], Tomoaki Kubo[1], Takumi Kato[1], Aiko Tominaga[1], Hiroaki Ohfuji[2], Ken-ichi Funakoshi[3], Yuji Higo[3]

[1]Kyushu Univ., [2]Ehime Univ., [3]JASRI

Pyroxene and garnet is the major constituent of the upper mantle and the mantle transition zone conditions in subducting mid-ocean ridge basalt (MORB) (e.g., Irifune et al., 1986; Aoki and Takahashi, 2004). Experimental results show that the volume fraction of pyroxene gradually decrease and that of garnet increase with increasing pressure, and pyroxene-free majoritic garnetite is produced above 15 GPa (the eclogite-garnetite transformation). However, it has been suggested that the mineral transformations in subducting plates are kinetically inhibited and therefore low-pressure phases could metastably survive without transforming to its high-pressure phases (e.g., Sung and Burns, 1976).
The eclogite-garnetite transformation proceeds by two stages when the transformation kinetics is taken into account (Nishi et al., 2009). The 1st stage in the transformation is the exsolution of majoritic garnet from pyroxene. The 2nd stage in the transformation is the formation of majoritic garnet by absorbing pyroxene component in pyropic garnet, which is occurred by chemical diffusion of $Si^{4+} + M^{2+} <=> 2Al^{3+}$ (M = Mg + Fe + Ca) in garnet. Here we report the experimental results on kinetics of the dual stage transformation.
Exsolution mechanisms and kinetics of majoritic garnet from Al-rich clinopyroxene (the 1st stage in the eclogite-garnetite transformation) were examined at 12.5-14.5 GPa and 1100-1400C by time-resolved in-situ X-ray synchrotron diffraction measurements. Experiments were conducted using a Kawai-type high-pressure apparatus SPEED-1500 at SPring-8, Japan.
$Si^{4+} + Mg^{2+} <=> 2Al^{3+}$ diffusion rates in garnet (the 2nd stage in the eclogite-garnetite transformation) were determined at pressure of 15 GPa and temperatures of 1600 and 1900C using a Kawai-type multi-anvil high-pressure apparatus (QDES) at Kyushu University. Natural single crystal of pyropic garnet and MgSiO3 enstatite powder were used as starting materials. Diffusion profiles were obtained by using SEM-EDS and TEM-EDS
I constructed metastable phase relations of subducting MORB at 700-1350C taking these transformation kinetics into consideration. Our results indicated that the density of MORB based on the metastable phase relations is much lower than that based on the equilibrium phase relations. This suggests that metastable MORB may not have strong driving force of subduction at the mantle transition zone unlike previous studies of equilibrium MORB, which may contribute to plate stagnation around the mantle transition zone.

Keywords: transformation kinetics, diffusion, oceanic crust, eclogite, majorite, mantle transition zone