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

SIT037-P03 Room: Convention Hall Time: May 26 17:15-18:45

An experimentally study on kinetics of spinel-garnet lherzolite phase transformation

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Pressure increase by collision of continents and subduction of plates causes the phase transformation from spinel lherzolite to garnet lherzolite, in which spinel reacts with pyroxenes to form garnet. Although previous studies have reported the reaction textures from natural peridotite rock samples (e.g., Obata and Morten, 1987), and experimentally determined phase boundary of the spinel-garnet lherzolite transformation (e.g., Walter et al., 2002), the kinetics of this reaction has not been examined. In order to study the kinetics of this reaction, we conducted transformation experiments in the garnet lherzolite stability field (3.2 GPa and 1273-1473K for 1-20 hours) with a spinel single crystal embedded into powder mixture of orthopyroxene and clinopyroxene. Microstructural observations of recovered samples revealed that garnet reaction rim was formed between single crystalline spinel and polycrystalline pyroxenes. The kinetics of the reaction rim growth can be described by $[x(t)]^2 = 1.4*10^{-8} m^2 s^{-1} \exp(-189 kJmol^{-1}/RT)t$, where x(t) is the growth distance at time t, based on the diffusion-controlled growth mechanism.
Previous studies have found development of corona textures around spinel with garnet reaction rims from Alpine-type peridotite rocks and mantle xenoliths. We experimentally reproduced the formation of corona texture and clarified the kinetics of the diffusion-controlled garnet rim growth. Our results can constrain the P-T-t paths of mantle rocks and contribute to a better understanding of mantle flow across the spinel-garnet lherzolite boundary.