Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SCG63-P08 Room:Convention Hall Time:May 22 18:15-19:30

Dihedral angle of garnet-H2O fluid in eclogite: Implication for low S-wave velocity regions at lowermost upper mantle

Mika Hashimoto[1*], Kyoko N. Matsukage[2]

[1]Department of Earth Sciences, Ehime University, [2]Geodynamics Research Center, Ehime University

Seismology have observed low shear-wave velocity region at depth of 300-400km in some of wedge mantle, where mantle rock is considered to contain small amount of aqueous fluid (or hydrous melt) in the grain boundary of minerals [e.g., 1]. Seismic behavior of fluid bearing system is highly influenced by a connectivity of fluid [e.g., 2]. The connectivity of aqueous fluid in a rock under mantle conditions is controlled by dihedral angle (= h), what is defined by the solid-liquid interfacial energy. A small amount of fluid can connect in grain boundaries and migrate if a value of h is less than 60 degree. To investigate connectivity of aqueous fluid in garnet-rich rocks, we measure the h for the garnet-aqueous fluid in eclogite bulk composition at upper mantle condition, and then, discuss the behavior of aqueous fluid in wedge mantle.

The target composition of starting material was MORB + 3.5 wt% of H2O, which prepared by mixing of JB-2 and Mg(OH)2. High-pressure experiments were performed using the multi-anvil apparatus (ORANGE1000) at pressure of 4 to 13 GPa at constant temperature of 1000 degree C. Run duration was 24 hour. Au/Pt double capsule was used as sample containers to eliminate the Fe-loss. To control oxygen fugacity, NiO + Ni + Ni(OH)2 powder was stuffed the space between Au and Pt capsules. Dihedral angle measurements were made from secondary-electron images at >5000* taken by field emission scanning electron microscope (FE-SEM). In a large population of over 200, measurements were carried out for each sample in the random cross section, using Scion Image software of NIH. A true dihedral angle was adopted as the median of apparent angles on the polished section. Mineral chemistry was analyzed by using scanning electron microscope with energy dispersive spectrometer (SEM-EDS).

At lower pressure (4-8 GPa), there are garnet, pyroxene, coesite, and rutile. At high pressure (10-13 GPa), majorite component in garnet increase with increasing pressure, and modal composition of pyroxene amount decrease. More than 10 GPa, FeTi-hydroxide is observed instead of rutile. In all run products, we observed quench crystal, quench glass and pore at garnet grain boundaries. Below 8 GPa, part of fluid separate from coexisting minerals to high temperature side in sample capsule. The fluid form connected network at garnet rich part. This connected network cannot observe pyroxene-pyroxene grain boundary. Therefore we regard as h > 60 degree at pyroxene-H2O fluid. Over 10 GPa, fluid does not separate in sample capsule. It suggests that fluid network does not connect in the higher pressure. It has possibility that the fluid contains silicate components because it was observed large amount of quench crystal. The h of garnet-fluid is 45 degree at 4 GPa. It increases with increasing pressure, and is maximum (h = ˜66 degree) at about 10 GPa. It suggested that garnet rich rocks are possible to trap fluid in a rock at ˜10 GPa (= ˜300 km in deep). We also pointed out that the dihedral angle of clinopyroxene should be larger than garnet. Therefore we conclude that shear wave velocity possible to decrease and attenuate at lowermost upper mantle, if garnet and pyroxene rich rocks exist at there.

[1]Revenaugh & Sipkin(1994), Nature , 369, 9
[2]Takei(2005), JGR, 110
[3]Yoshino et al. (2007), EPSL,256, 466
[4]Mibe et al. (2003), JGR,108
[5]Ono et al. (2002), EPSL,203, 895

Keywords: Dihedral angle, H2O-fluid, seismic low velocity zone, garnet, wedge mantle, connectivity