Mantle heterogeneity under Hawaii site of M2M

*Shigeaki Ono[1]

1. Japan Agency for Marine-Earth Science and Technology

The project of MoHole to Mantle (M2M) has three candidates for the prospective drilling sites. North Arch of Hawaii is one of candidates, and the seismic site survey will be performed in the near future. Therefore, it is important to increase knowledge of the mantle materials under the Hawaii region. In this study, we discuss the chemical and petrological heterogeneity under the Hawaii region using the experimental data for physical properties of silica under high pressures and high temperatures.

We performed the high-pressure experiments using a multi-anvil high-pressure system combined with a synchrotron radiation source made it possible to acquire precise data from samples under high-pressure and high-temperature conditions. Experimental details have been described elsewhere [1,2]. The starting material was powdered silica to observe the phase transition from coesite to stishovite at around 10 GPa corresponding to ~300 km depth in the upper mantle.

The phase boundary between coesite and stishovite in SiO_2 was determined over the range of 1200–1700 K. The stability of each phase was determined by observing the powdered X-ray diffraction data. The transition boundary between the coesite and stishovite phases was found to occur at P (GPa) = 4.7 + 0.0031 x T (K). The phase transition determined in our study occurs at around 10 GPa at the normal mantle geotherm, coinciding with the seismic discontinuity around 300 km depth known as the X-discontinuity [3].

The silica minerals do not appear in normal mantle rocks, such as peridotite, under the upper mantle conditions. In contrast, it is known that the existence of silica minerals has been confirmed in the subducted oceanic crusts or sediments [4]. Previous studies of seismic observations inferred that the X-discontinuity was discovered under the Hawaii region [5]. According to these discussions, the compositional heterogeneity is necessary to explain the observations of the seismic X-discontinuity under the Hawaii region.

[1] S. Ono et al. (2011) Phys. Chem. Minerals, 38, 735-740.

[2] S. Ono et al. (2013) Phys. Chem. Minerals, 40, 811-816.

[3] S. Ono et al. (2017) Phys. Earth Planet. Inter., 264, 1-6.

[4] S. Ono (1998) J. Geophys. Res., 103, 18253-18267.

[5] N. Schmerr (2015) In: The earth’s heterogeneous mantle: A geophysical, geodynamical, and geochemical perspective, p. 79-104.

Keywords: Mantle drilling, Mantle heterogeneity, Phase transition, Silica, Oceanic plate

