The 499th Geodynamics Seminar

Al partitioning between phase D and bridgmanite up to 31 GPa: Implications for high electrical conductivity, discontinuity and deep earthquakes occur between 670 to 850 km

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Dense hydrous magnesium silicates (DHMSs) are supposed to be one of the important water carriers to the deep Earth. Phase D (PhD) is the dominant high pressure phase among DHMSs in hydrous pyrolite composition from the shallow parts of the lower mantle to at least middle region, has been shown to coexist with bridgmanite (Brg), which is widely viewed as the most abundant mineral assemblage in the Earth's interior. The experimental result indicated that Brg is the main host for Al_2O_3 in the lower mantle (e.g. Irifune, 1994), and the recent study reported that Al-rich PhD stabilized up to 2000° C at 26 GPa in H_2O-bearing condition (Pamato et al., 2015). Therefore, partitioning of Al between Brg and PhD is particularly important to constrain water distribution in the deep mantle, especially because Al^{3+}+H^{+} substitutes for Si^{4+} in PhD greatly enhances its water content. However, direct experimental results are limited.

To systematically illustrate this issue, we performed high pressure and high temperature experiments in MgO-Al_2O_3-SiO_2-H_2O system to investigate the partitioning of Al between pyrolite type Brg and PhD in volume ratio of 4:1 up to 31 GPa by MA8-type (Kawai-type) apparatus. Our result shows that Al is strongly partitioned into PhD than coexisting Brg, and partition coefficient of Al (K_D) between PhD and Brg slightly decreases with increasing temperature. Al-bearing PhD totally decomposes around 28 GPa and 1350° C, in which Brg is found to be coexisting with a large amount of melt. At 31 GPa and 1350° C, Brg coexists with trace amount of melt and hydrous δ-AlOOH phase, which means some amount of water might be transported into the lower mantle.

The decomposition of Al-bearing PhD around 28 GPa may explain the discontinuity and the low-velocity zones around 800 km in Western Pacific Subduction Zones and shallower depth within Japan subduction zone (Liu et al., 2016). The released water together with melts will migrate upward, and possibly causes high electrical conductivity between 670 Km and 830 Km in northeast Japan (Shimizu et al., 2010) and generates a local discontinuity at a depth of around 780 km (Porritt et al., 2016), and even dehydration-linked deep earthquakes ~ 700 km (Frohlich, 1989).

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