Role of water on dynamics in the lower mantle and core-mantle boundary regions

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Recent experimental evidence indicated that the Earth’ s transition zone contains some amount of water at least locally. Subduction of the slabs into the lower mantle can transport water further into the lower mantle. One of the most important candidates of the water carrier into the lower mantle is hydrous phase delta-AlOOH and phase H-$MgSiO_4H_2$ solid solution. Our works on the stability of this solid solution revealed that it coexists with bridgmanite under the lower mantle conditions [1, 2].

We studied the hydrogen and aluminum partitioning between alumina and hydrogen between the delta-H solid solution and aluminous bridgmanite at high pressure and temperature. We observed that bridgmanite under the wet conditions depleted in aluminum, and it contains almost no water under the wet lower mantle conditions at 28 GPa and 800-1400°C. This partitioning of H and Al can provide significant effect on lower mantle dynamics through the change of the garnet-bridgmanite phase boundary, the pressure of the spin transition of both bridgmanite and delta-H solid solution, and bridganite-postperovskite transition.

The supply of water to the core-mantle boundary can create a reaction of water and iron in the core to produce FeO_2H and its reaction product postperovskite Fe_2O_3. These phases together with the delta-H solid solution can play important roles at the bottom of the lower mantle. Physical properties of these phases can account for the sound velocity and density anomalies in the regions such as ULVZ (ultra-low velocity zone) and LLSVP (large low shear velocity province) [3].

References:

[1] Ohira et al. (2014) Earth Planet. Sci. Lett., 401: 12–17, [2] Ohtani et al. (2018) Jour. Asian Earth Sci. 2018, [3] Yuan et al. (2018) Geophys. Res. Lett.,45. doi.org/10.1002/2017GL0757

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