Decomposition of hydrous phases and seismic reflectors in the lower mantle

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Seismic reflectors have been reported by several authors in various depths of the lower mantle. The reflectors might be caused by some heterogeneities in the lower mantle, although the cause is not yet identified. We have determined the stability of hydrous phases in the lower mantle conditions. We have clarified the stability field of superhydrous phase B, and phase G up to the pressure of 60 GPa and the temperatures form 1000 to 1600K by using the conventional quenching method together with the in situ X-ray diffraction study at high pressure using synchrotron radiation from PF and Spring 8.

The decomposition boundary of superhydrous phase B into phase G + perovskite + periclase was determined by in situ X-ray diffraction experiments using SPEED 1500 at Spring8 and MAX-III at PF. The boundary has a negative slope and can be expressed by the following equation, P(GPa) =-0.0037 (+-0.0017)T(C)+32.2(+-0.5), which was reported by Ohtani et al. (2003). We also clarified the stability of hydrous phase G by using the laser heated diamond anvil cell with the synchrotron X-ray radiation at PF up to a pressure of 60 GPa and 1500 K (Yokoyama et al., 2004). Phase G is stable up to c.a. 45 GPa and 1500 K and 50 GPa at 1300 K with a negative dT/dP, which is consistent with the previous results by Shieh (1998).

These results suggest that two major dehydration regions, the bottom of the transition zone and the deep lower mantle are expected to exist in the lower mantle, i.e., 700~900 km and 1300~1500 km depths. The depths of these decomposition reactions are consistent with the seismic reflectors (e.g., Niu et al., 2003). The fluid generated by the decomposition of the hydrous phases could be responsible for the anusual physical properties of seismic reflectors, density increase, Vs decrease, and constant Vp observed in some depths in the lower mantle.