The stability and the equation of state of superhydrous phase B by in situ x-ray diffraction

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Water is one of the main volatile components in the Earth and it is clearly shown that it affects the physical properties and the melting temperature of the Earth's minerals. Water has been supplied to the Earth's interior by subducted slab and thought to be formed the dense hydrous magnesium silicates (DHMS) such as hydrous wadsleyite and hydrous ringwoodite. One of the DHMS, superhydrous phase B (Mg10Si3H4O18) is the important high pressure hydrous phase, which may exist stably in the temperature and pressure equivalent to a mantle transition zone. The density of superhydrous phase B is 3.327g/cm3, the crystal system is orthorhombic and the water content is 5.8wt%. The purpose of this study is to investigate the stability fields and the physical properties, especially the bulk modulus and the thermal expansion, of superhydrous phase B.

The experiments were conducted by in situ X-ray diffraction measurements in SPring-8 between 13 and 23GPa and temperature up to 1673K. An additional experiment was also conducted by high temperature X-ray diffraction at atmospheric pressure in laboratory to determine the thermal expansion at 1 atm.

As the results, superhydrous phase B melted incongruently into wadsleyite+liquid at 1273K and 13GPa and melted incongruently into ringwoodite+liquid at 1473K and 20GPa. The bulk modulus of superhydrous phase B was 137GPa, the thermal expansion was 37.6x10-6K-1, and the temperature dependence of the bulk modulus (dK/dT) was -3.7x10-2GPa/K. These results imply that superhydrous phaseB is stable in low temperature region of the mantle transition zone, especially in subducted slab, but not in normal mantle. The density profile of model superhydrous phase B bearing subducted hydrous peridotile was calculated using the present result, and clarified that superhydrous phaseB bearing slab is denser than the surround mantle; it show that water can easily transport to the lower mantle by superhydrous phaseB.

In addition, the experimental technique using Ag-Pd capsule of in situ X-ray diffraction at high pressure and high temperature should become important to further investigate the mantel mineralogy in environment controlled condition.