THE GEODYNAMICS SEMINAR

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The stability of hydrous SiO_2 stishovite in the deep mantle

The stabilities of the minerals that can hold water are important for understanding the distribution and transportation of water in Earth's deep interior. Water distribution in the lower mantle depends on the stability of water-bearing minerals in the subducting slab because the minerals in the surrounding lower mantle have very low water solubility. Some recent studies have reported that pure SiO_2 silica high-pressure phases can hold large amounts of water more than 3 wt%, but their experimental results are contradictory in terms of thermodynamic stability. In this study, the stability of hydrous SiO_2 stishovite in a water-saturated system were investigated at pressure of 13-29 GPa and up to temperature of 1300°C by in situ X-ray observation using a multi-anvil apparatus. Based on the experiments, we found that the unit-cell volume of stishovite is significantly greater than that of anhydrous stishovite (by 2.7% at the maximum: corresponding to 5.4 wt% H2O) at lower than 600°C. However, the excess volume rapidly decreased with increasing temperatures and volume was found to be approximately identical to anhydrous stishovite above 800°C. Time-resolved measurements at constant temperatures of 450 and 500°C, where excessive volume expansion was observed, showed that the unit-cell volume shrinks with time. This indicates that the dissolution of water into stishovite is a metastable phenomenon. These results indicate that SiO_2 stishovite in crustal materials subducting into the lower mantle is unlikely to retain more than 1 wt% of water as a stable phase.

Keywords: 1. SiO_2 high-pressure phase
2. Hydrous stishovite
3. Lower mantle