In-situ X-ray observation of the high pressure decomposition of antigorite

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The high pressure decomposition of antigorite (serpentine) was observed by in-situ X-ray diffraction method combining synchrotron radiation and multi-anvil high temperature and high pressure apparatus. Antigorite decomposed at 6.5GPa, 550C. We will report the positions of the decomposition curve of antigorite and the invariant point (antigorite, phase A, clinoenstatite, forsterite, and water) on this curve.

Dehydration reaction of antigorite that is the dominant phase of serpentinite (hydrated peridotite) in subducting slab and mantle wedge overlying the slab has the possibilities to be the trigger of the island arc magmatism (Ulmer & Trommsdorff 1995) and the mechanism to cause intra-slab double seismic plane (Seno & Yamanaka 1996; Omori et al. 2000) because of its wide region in pressure and strong dependence on temperature. In addition, on this dehydration reaction curve at high pressure, the most important invariant point controlling the transportation of water into the deep Earth's interior by the hydrated subducting peridotite layer occurs. This invariant point consists of antigorite, phase A, clinoenstatite, forsterite and water. Once slab's PT path goes higher temperature side of this invariant point (no hydrous phase), the peridotite layer of slab would be completely dehydrated. On the other hand, the peridotite layer that goes lower temperature side of this invariant point (phase A is stable hydrous phase) would be always hydrous down to mantle transition zone. Therefore, antigorite is very important mineral on the circulation of water in the solid Earth. However, the many results of quench experiments on this antigorite stability (Ulmer & Trommsdorff 1995; Wunder & Schreyer 1997; Bose & Navrotsky 1998) have large discrepancies, particularly in pressure with each other. This is probably because of the difficulty of pressure calibration at below 550C at each laboratory. All the starting materials used in these quench experiments were natural antigorites, except for only two runs using synthetic antigorites in Wunder & Schreyer (1997). Wunder & Schreyer (1997) suggested that the differences of experimental results on this antigorite dehydration curve might be due to the differences in composition of antigorites.

We conducted in-situ observation of the high pressure decomposition of antigorite by the combination of synchrotron radiation and multi-anvil apparatus at SPring-8. The starting materials were both synthetic and natural (MgO: 43.56, Al2O3: 1.86, FeO: 1.65, Fe2O3: 1.52, SiO2: 43.56 wt.%) antigorites. NaCl (Decker 1971) was used as a pressure scale. The reversal experiment was not operated because growth of antigorite was very sluggish. Therefore, we observed dehydration reaction at one P, T point in one high pressure run.

The results of two kinds of antigorite have no difference. Both antigorites decomposed into forsterite and clinoenstatite (and water) at 550C, 6.5GPa and 600C, 4.0GPa. Therefore, antigorite can survive up to about 6.3GPa (below 6.5GPa) at 550C. The dehydration curve of antigorite has no dependence on the composition.

Including the results of in-situ observation of phase A-forming reaction, we will discuss about the position of the decomposition curve of antigorite and the position of the invariant point described above with thermodynamic consistency.