I075-026 Room: IC Time: May 28 14:00-14:15

A new petrogenetic grid for hydrous slab peridotite down to 800 km depth.

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Here we report a new petrogenetic grid for hydrous slab peridotite down to 800 km depth constructed by Schreinemakers analysis of the earlier experimental results of Irifune et al. (1998) and Ohtani et al. (2001). In this study, hydrous slab peridotite is assumed by the model system MgO-SiO2-H2O (MSH). Using this grid, we discuss the stability relations of dense hydrous magnesium silicates (DHMSs). The phases appeared in the grid are antigorite (Atg), enstatite (En), forsterite (Fo), phase A (A), phase D (D), phase E (E), superhydrous phase B (shB), stishovite (St), brucite (Br), Akimotoite (Aki), Mg-perovskite (Pv), periclase (Pc), hydrous wadsleyite (hy-Wad), hydrous ringwoodite (hy-Rin), and water (H2O).

Phase E dehydrates toward low-T side of the dehydration curve (E = A + En + H2O, E = A + D + H2O), although most hydrous minerals dehydrate toward high-T side. High-pressure limit of phase E is defined by the reactions E = shB + D + H2O and E = shB + St + H2O up to 21 GPa, 1100C. In the descending slab with the bulk composition on the tie-line of phase A-enstatite is discussed here. Phase E appears by the solid-solid reaction A + En = E + shB. The disappearance of phase E depends on the bulk Mg/Si ratio. With Mg/Si ratio of serpentine (Mg/Si = 1.5), the phase E disappears by the solid-solid reaction E + hy-Wad = shB + St. With Mg/Si ratio higher than that of Fo-H2O tie-line (Mg/Si = 2), the monomineralic dehydration of phase E occurs (E = shB + D + H2O).

The thermal stability limit of phase D is about 1100C between 21 and 25 GPa. At this condition, phase D dehydrates by the reactions D = shB + St + H2O and D = Aki/Pv + St + H2O. Low-pressure stability of phase D is predicted to be about 12 GPa at 700C by the reaction D = En + St + H2O, and high-pressure stability is much higher than 30 GPa (D = Pv + St + H2O).

Superhydrous phase B defines the thermal stability limits of DHMSs in the mantle boundary layer (MBL). In the present study, the high-T limit of shB is predicted to be 1400C at 24 GPa by the reaction shB = hy-Rin + Pc + H2O.

Wadsleyite and ringwoodite in our petrogenetic grid are assumed to be hydrous. This leads the different topology from that in dry Mg2SiO4 system. For example, the postspinel transformation in the system Mg2SiO4 + H2O is divided into two reactions: hy-Rin = Pv + Pc + H2O (dehydration) and hy-Rin = shB + Pv + Pc (water-conserving), whereas in dry Mg2SiO4 system, this transformation is a single reaction Rin = Pv + Pc. These two hydrous transformations intersect at the invariant point estimated to locate 24 GPa, 1400C. Similarly, Rin + St = Aki in dry MgSiO3 system becomes two reactions in the system MgSiO3 + H2O: hy-Rin + St = Aki + H2O and hy-Rin + St = shB + Aki.

In cold subducted slab, the mineral assemblage after antigorite breakdown considered here is phase A + enstatite + water. If this water escapes because of its low density, the mineral assemblage would become phase A + enstatite with 3.67 wt.% bulk water content. The changes in the mineral assemblages in this bulk composition from low pressure up to 24 GPa are: A + En, E + shB + En, E + hy-Wad + En, E + hy-Wad + St, shB + hy-Rin + St, suB + Aki + St, and shB + D + Aki. These changes are bounded by only solid-solid reactions. If stagnant slab is heated at the mantle boundary layer (MBL), a series of the dehydration reactions of DHMSs would occur. From low temperature, D + shB = Aki + H2O (1100C), shB + Aki = hy-Rin + H2O (1200C), shB = Pv + Pc + H2O (1400C).

Two large fluxes of free water from slab peridotite occur during subduction. They are at the initiation of subduction (antigorite) and at the final of subduction at MBL (DHMSs). The free water from antigorite would circulate to surface, whereas that from DHMSs at MBL would be bound in beta, gamma phases of olivine in the mantle transition zone. In addition, this depth-distribution at that the dehydration occurs is consistent with the mode of deep-focus earthquakes.