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Phase relations of peridotite and MORB under hydrous conditions and implications for mantle dynamics

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The phase relations in the peridotite-water and MORB-water systems have been clarifed to the top of the lower mantle. The experiments on the peridotite-water system revealed that certain amount of water can be transported into the transition zone by various hydrous minerals resulting in formation of hydrous transition zone. There are potential dehydration cites in the deep mantle; four cites along the descending slabs depending on the temperature profile of the slab, i.e., the mantle wedge of the subduction zone, mantle transitin zone, top of the lower mantle where hydrous ringwoodite and superhydrous B decompose, and deep in the lower mantle around 1200-1500 km depth where decomposition of phase D(G) occurs. We also expect one cite of dehydration melting at the base of the upper mantle where the hot mantle plume hydrated in the transition zone can be dehydrated. Some of the recent P-wave tomography images suggest existence of low velocity anomalies at the depths of these dehydration zones. Elevation of the 410km discontinuity and no clear evidence for metastable olivine wedge in the subducting slabs are consistent with the hydrated subducting slabs on the basis of the recent kinetic study on the effect of water on the olivine-wadsleyite transformation.

Former basaltic crust transforms to perovskite lithology at about 1~2 GPa lower under the hydrous conditions, remaining denser than peridotite part of the slabs under the geotherm of the subducting slab, i.e. there is no density crossover between peridotite and MORB under the hydrous conditions. Water can be readily provided by the dehydration reaction of the decomposition of superhydrous phase B and hydrous ringwoodite at the base of the transition zone and the top of the lower mantle. MORB thus hydrated would gravitationally sink into the lower mantle without density-crossover between peridotite and MORB. Accumulation of former basaltic crust near the 670 km boundary is possible under relatively dry conditions of subduction.