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Transport of Hydrogen into the Deep Earth by Slab Penetration

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Hydrogen expands the stability field of wadsleyite and ringwoodite, resulting in elevation of the 41 0 km discontinuity and descent of the 660 km discontinuity. Results of mineral physics studies indicate that dehydration and dehydration melting can occur both at the base and the top of the transition zone, respectively. Recent seismological studies revealed a possible existence of the dehydrated fluids or melts both at the base and the top of the transition zone consistent with the mineral physics estimations based on the strong contrast of the water solubility in the transition zone minerals such as ringwoodite and the upper and lower mantle minerals such as olivine, ferropericlase and perovskite.
Phase D and delta-AlOOH are also the candidates of the carrier for transporting hydrogen into the lower mantle. Delta-AlOOH, which can accommodate the (Mg0.5Si0.5)OOH component as a solid solution, is a unique phase which is stable up to the base of the lower mantle and it can work as an absorber and a carrier of hydrogen in the lower mantle. The hydrogen formed by dehydration from phase D in the lower mantle could be trapped as delta-AlOOH, and can be transported further into the base of the lower mantle.
Partitioning of hydrogen between iron and hydrous minerals is important for transport of hydrogen into the planetary core. Fe or FeNi alloy coexisting with hydrous phases such as delta-AlOOH and hydrous ringwoodite absorbs hydrogen to form Iron hydride FeH and anhydrous phases, such as Al2O3 and ringwoodite. Thus hydrogen can be partitioned into the planetary core during the core formation stage and by reactions between the accumulated slab and the metallic iron core at the core-mantle boundary.

Keywords: hydrogen, slab, transition zone, lower mantle, delta-AlOOH, Iron Hydride