Experimental investigations into the fate of water in Earth's transition zone

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The transition zone differs from the upper or lower mantle in that its major constituent minerals wadsleyite and ringwoodite can accommodate a significant amount of hydrogen in the crystalline structures. Translated into water storage capacities, hydrous wadsleyite or ringwoodite may contain several weight percent water, whereas the dominant minerals above or below the transition zone are nominally dry. The recent discovery of hydrous ringwoodite brought to the surface by a super-deep diamond indicates that transition zone is likely a sub-surface hydrosphere containing a comparable amount of water to the surface oceans. As a result of large contrast in water storage capacities, a wet transition zone is expected to dehydrate and form partially molten layers near its upper and lower boundaries when the interfaces are pushed downwards by descending slabs or upwards by rising plumes. Convection-induced dehydration of a wet transition zone may explain the seismically detected low-velocity zones near 410 and 660 km depths. In this study we test the hypothesis that dehydration is not limited to the interfaces but can take place in the interior of the transition zone following incipient melting of carbon-bearing materials that are carried to mid-mantle by subducted slabs. Experiments have been conducted using a multi-anvil apparatus to investigate the partitioning of hydrogen between hydrous wadsleyite or ringwoodite and coexisting carbonates or iron-carbon mixture at relevant high pressures and high temperatures. The results will be applied to understand the sources and sinks of water in Earth's transition zone and to elucidate the connections between the surficial and internal hydrospheres.

Keywords: transition zone, water, hydrous wadsleyite and ringwoodite, carbonates, iron-carbon mixture, melting

