Experimental evidence supporting global melt layer at the base of the Earth's upper mantle

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Abstract

The globally observed reduced seismic wave velocity (-4% for Vs) at mantle depths of 350-410 km, has been attributed to the presence of melt 1–3**. It has been proposed that mantle upwelling and subsequent release of free fluids, when hydrous wadsleyite transforms into olivine, is responsible for melting at the base of the Earth's upper mantle** 4**. Partial melting of peridotite at corresponding pressure and temperature, however, requires a substantial contribution from volatile components** 4 **and the produced melt needs to be neutrally buoyant in order to remain at the base of the upper mantle** 5**. In this study, we experimentally reproduced the phase transformation in the upwelling mantle at relevant mantle conditions and investigated the sound wave velocity during partial melting of hydrous peridotite. Our seismic velocity model indicates that the observed -4 % Vs anomaly can be explained with 0.7 melt fraction in peridotite. The resulting melt contains up to and 33 wt. % FeO. Based on the effect of H2O on melt density, the water contents of gravitationally stable melt are estimated to be within 13.3-19.3 wt. % for 0.7 % melt fraction. This translates the corresponding water content in the mantle transition zone (MTZ) to 0.22 ± 0.04 wt. %, significantly lower than the near water saturated conditions depicted by previous studies** 6,7**.**

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