Transition-Zone Hydrous Melts

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Water in earth's interior drastically lowers the solidus of the mantle. Subducted water-rich lithologies undergo dehydration reactions in the shallow upper mantle (< 150 km) generating bouyant hydrous partial melts responsible for arc volcanism. However, in the mantle portion of cooler slabs a significant fraction of water may survive slab dehydration beyond the volcanic front. Although relatively insoluble in upper and lower mantle minerals, water has a high solubility in wadsleyite and ringwoodite in the transition-zone (410-600 km) providing the capacity for storing several ocean masses of water. If the transition-zone is hydrous, then water can be released at its upper and lower boundaries as wadsleyite and ringwoodite transform to relatively anhydrous olivine or bridgmanite + ferropericlase during mantle upwelling or downwelling, respectively. Bercovici and Karato introduced this concept as the 'transition-zone water filter' with a neutrally buoyant hydrous melt layer residing above the 410 km discontinuity [1]. Seismic evidence supports the presence of melt above the 410 and below the 660 km discontinuities. Recent experiments reveal that melt compositions at 13 GPa and 1800 K will contain ~48 mol% H_2O with an Mg:Si ratio close to 2 (forsterite) [2].

In this communication, we report first principles atomistic simulations of melts under transition-zone conditions for a range of compositions in the system MgO-SiO_2-H_2O (MSH) with H_2O fractions from 25-60 mol%. Viscosities computed from the sheer-stress auto-correlation function reveal these melts are highly inviscid. The computed densities indicate MSH melts will be buyant throughout the mantle transition-zone. Only if these melts are Mg-free, with all Mg replaced by Fe, would they have the potential to be neutrally buoyant above the mantle transition-zone. Thus, if melts reside above and below the transition zone they are likely not hydrous.

[1] Bercovici, D. & Karato, S. 2003 *Nature* **425** 39
[2] Myhill R., Frost, D. J., Novella, D. 2017 *Geochim. Cosmochim. Acta* **200** 408