Hydrated mantle transition zone and hydrous magmas in the deep mantle

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Several geophysical observations suggest that the mantle transition zone beneath subduction zone is hydrated at least locally. The observations also suggest existence of regions with low seismic wave velocity at the base of the upper mantle (1) and the top of the lower mantle (2) suggesting existence of fluids or hydrous magmas at these depths. The big mantle wedge (BMW) model (3) suggested dehydration from the wet stagnant slabs in the mantle transition zone. Some modifications of the model will be presented based on recent experimental results. Existence of dense hydrous magmas containing 8 wt.% of water has been proposed (4) at around the 660 km discontinuity along the normal mantle geotherm, i.e., 24 GPa and 1870 K (5). This estimation contradicts with the melting experiments on the hydrous peridotite i.e., the liquidus temperature of pyrolite with 2 wt.% water is around 2370-2470 K and temperature at least 2330 K is needed to generate hydrous melts containing water less than 8 wt.% (6). However, such high temperatures at the top of the lower mantle might be realized due to a possible compositional stratification and layered convective pattern in the mantle transition zone and lower mantle (7, 8, 9). Such high temperatures above 2300 K at the top of the lower mantle might be consistent with the melting relation of hydrous peridotite and formation of gravitationally stable dense hydrous magmas.

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