Phase transitions across the 660-km discontinuity determined in the laser-heated diamond anvil cell

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The origin of a global seismic velocity discontinuity at a depth of 660 km has been the focus of studies for the properties and mantle dynamics, such as convection, chemical structure and chemical mixing. Earlier quench studies in multianvil press (MAP) suggested that the 660-discontinuity is mainly caused by the postspinel phase transition (Ringwoodite → Bridgmanite + Ferropericlase) with negative Clapeyron slope [e.g. Ito and Takahashi, 1989], and the 660-discontinuity is treated as the boundary between the upper and lower mantle [Tackley et al., 1993]. In contrast, *in situ* MAP studies reported that the depth and the Clapeyron slope of the postspinel boundary are significantly less than those of the 660-discontinuity inferred from seismic studies [e.g. Irifune et al., 1998]. On the other hand, the high-*P,T* experiments in laser-heated diamond anvil cell (LHDAC) on the compositions of Mg_2SiO_4 [Shim et al., 2001] and pyrolite [Ye et al., 2014] indicate that both the transition pressure and slope are consistent with the depth and topography of the 660-discontinuity. Hence, we could reconcile the postspinel phase transition from LHDAC experiments with the 660-discontinuity, and the elements of Fe and Al have little effect on the phase transition boundary. It is the discrepancy among the pressure scales of Pt, Au and MgO that limited our accurate laboratory experiments to the geophysical observations of Earth and planetary interiors (such as the 660-discontinuity) [Ye et al., 2017]. On the base of studying the postspinel phase transition, we further conducted LHDAC experiments to constrain the boundary of the post-garnet phase transition (Garnet → Bridgmanite) around the 660-discontinuity, as well as the stability pressure-temperature field of akimotoite in the lower mantle transition zone (MTZ) (at a depth of 520 ~ 660 km). These results are important to explore the evolution of the chemical composition of upwelling plumes through the 660-discontinuity into the MTZ layer [Cao et al., 2011].

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