

Phase Stability and Thermal Equation of State of δ -AlOOH: Implication for Origin of the ULVZ

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The bottom lower mantle above the core-mantle boundary (CMB) is one of the most mysterious regions in the Earth. In particular, seismic studies have identified a number of thin patches with a thickness of 5-40 km at various locations above the CMB which are characterized by a 10-30% reduction in compressional and shear wave velocities. The origin of these ultralow velocity zones (ULVZ) has been under debate for years. Although the presence of water has been proposed to trigger partial melting or reacts with Fe to form the FeO_2Hx phase, leading to the formation of ULVZ, how to transport water to the deepest lower mantle is not clear. Here we reported high pressure-temperature experimental results on the stability and thermal elastic properties of δ -AlOOH. δ -AlOOH together with phase D and phase H are the few hydrous phases which can be stable at relevant pressure and temperature conditions of the lower mantle. In contrast to phase D and H which will dehydrate at mid-lower mantle, δ -AlOOH can coexist with lower-mantle bridgmanite and is stable up to the deepest lower mantle. We performed high pressure-temperature X-ray diffraction experiments using laser-heated diamond anvil cells to constrain the dehydration line of δ -AlOOH up to 142 and 2500 K. Although δ -AlOOH is stable at the whole lower-mantle pressure-temperature conditions above the D" layer, a dramatic increase in temperature from the silicate mantle to metallic outer core across the CMB will lead to the decomposition of δ -AlOOH in the region. Water released from the breakdown of δ -AlOOH could trigger partial melting or react with metallic Fe to form the FeO_2Hx phase. The presence of partial melting or the accumulation of the FeO_2Hx phase may be the origin of the ULVZ.

Keywords: δ -AlOOH, water, ULVZ, high pressure temperature