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Elasticity of Phase H under the Mantle Temperatures and Pressures: Implications for Discontinuities and Water Transport in the Mid-Mantle

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Dense hydrous magnesium silicates (DHMSs) are considered to be the main carriers for transporting water to the Earth's interior. Phase H ($MgSiO_4H_2$), as one of the deepest forms of DHMSs, contains 15.3 wt% water and plays an important role in transporting water into the mid-mantle. In this work, we investigated the thermodynamic properties and elastic properties of phase H at high P-T conditions using first-principles calculations.

The dehydration of phase H into bridgmanite, which may occur at the depth of ~1300-1700 km in cold slabs, will cause an increase of 1.0%, 2.7%, 15% at 1500 km on V_P, V_s, and density, respectively. The impedance contrast for shear wave velocity by the dehydration of phase H is ~17%. Combining our results with seismic observations, the dehydration of the moderate amount of phase H could generate the seismic discontinuities at the depth of ~1300-1700 km detected in some subduction zones. Besides, the anisotropy of phase H is remarkable at the depths where phase H could exist stably and could be observed within slabs by seismology. Our results provide evidence for water transport in the mid-mantle.