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Phase transformation of hydrous ringwoodite to the lower-mantle phases and the formation of dense hydrous silica

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Abstract

To understand the effects of H_2O on the mineral phases forming under the pressure-temperature conditions of the lower mantle, we have conducted laser-heated diamond-anvil cell experiments on hydrous ringwoodite (Mg_2SiO_4 with 1.1 wt% H_2O) at pressures between 29 and 59 GPa and temperatures between 1200 and 2400 K. Our results show that hydrous ringwoodite (hRw) converts to crystalline dense hydrous silica, stishovite (Stv) or $CaCl_2$-type SiO_2 (mStv), containing 1 wt% H_2O together with Brd and MgO at the pressure-temperature conditions expected for shallow lower-mantle depths between approximately 660 to 1600 km. Considering the lack of sign for melting in our experiments, our preferred interpretation of the observation is that Brd partially breaks down to dense hydrous silica and periclase (Pc), forming the phase assembly Brd + Pc + Stv. The results may provide an explanation for the enigmatic coexistence of Stv and Fp inclusions in lower-mantle diamonds.

Keywords: Stishovite, ringwoodite, bridgmanite, periclase, water, mantle; Volatile Elements in Differentiated Planetary Interiors