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Chemical reaction between ferropericlase (Mg,Fe)O and water under high pressure-temperature conditions of the deep lower mantle

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Abstract

The presence of water may contribute to compositional heterogeneities observed in the deep lower mantle. Mg-rich ferropericlase (Fp) (Mg,Fe)O in the rock-salt structure is the second most abundant phase in a pyrolitic lower mantle model. To constrain water storage in the deep lower mantle, experiments on the chemical reaction between (Mg,Fe)O and H_2O were performed in a laser-heated diamond-anvil cell at 95–121 GPa and 2000–2250 K, and the run products were characterized combining in situ synchrotron X-ray diffraction measurements with ex-situ chemical analysis on the recovered samples. The pyrite-structured phase FeO_2H_x ($x \leq 1$, Py-phase) containing a negligible amount of Mg (<1 at%) was formed at the expense of iron content in the Fp-phase through the reaction between (Mg,Fe)O and H_2O, thus serving as water storage in the deepest lower mantle. The formation and segregation of nearly Mg-free Py-phase to the base of the lower mantle might provide a new insight into the deep oxygen and hydrogen cycles.

Keywords: Deep lower mantle, chemical reaction, ferropericlase, hydrous phases, hydrogen cycle