

Effects of H₂O and pressure on the chemistry of bridgmanite in the deep lower mantle

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The lower mantle is a potential water reservoir. The compositional models of the lower mantle are largely dependent on the chemical and physical properties of bridgmanite throughout the entire lower mantle down to the top of D'' layer. Bridgmanite is nearly dry in coexistence with a hydrous phase [1]. Under the deep lower mantle conditions, the alumina-rich niccolite-type silica phase (Nt-phase) can contain up to 4.6 wt.% water via the $\text{Si}^{4+} = \text{Al}^{3+} + \text{H}^+$ charge-coupled substitution [2]. In our experiments, we found that the presence of H₂O changes the chemistry of bridgmanite under high-pressure and high-temperature conditions of the deep lower mantle. In contrast to iron-depletion in dry bridgmanite under similar pressure-temperature conditions [3], we found that ferrous iron is stable in bridgmanite under hydrous conditions. With multigrain diffraction methods allowing separation of individual grains in a multiphase assemblage, in combination with chemical analysis on recovered samples [4], we obtained the effects of H₂O and pressure on the chemistry of bridgmanite under deep lower mantle conditions. The H₂O-induced iron-enrichment and stability of ferrous-iron in bridgmanite would provide an explanation for the nature of the low-shear-velocity anomalies at the base of the lower mantle. Our results imply that the existence of deep water reservoir might be a major origin of lateral heterogeneity in the deep lower mantle.

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