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ABSTRACT

It has been believed that calcium exists in a separate phase, calcium silicate perovskite (CaPv), throughout the lower mantle together with other two main phases, bridgmanite (Brg) and ferropericlase (Fp). However, some data points in the existing literature indicate the possible absence of CaPv in the pyrolitic composition at some lower-mantle related conditions, and mineralogy has not been well explored at temperatures between 2000 K and solidus for the the deep mantle. We have conducted in situ X-ray diffraction experiments by using the laser-heated diamond-anvil cell at 35-100 GPa and 1700-2700 K, in order to investigate the possible solubility of Ca in Brg. In addition to pyrolite, we have studied a range of compositions to evaluate the effects of Fe and Al on the incorporation of Ca in Brg. We found formation of Brg with no CaPv in compositions with 10-14Fe# and 10-30Ca# and pyrolitic composition at 42-100 GPa and 2200-2700 K. CaPv was observed at below 42 GPa and 1700-2700 K and at below 2200 K at 35-100 GPa. These results suggest that Ca solubility in Brg might be sensitive to pressure, temperature and the concentration of Fe. Our chemical analysis by using energy dispersive spectroscopy (EDS) on one of the compositions where we observed the absence of the CaPv diffraction lines showed a significant amount of Ca in Brg. Our synchrotron Mossbauer measurements is currently under analysis, and we hope to see if there is any relation between the stability of Ca-Brg and the valence and spin states of Fe. If the Ca incorporation is sensitive to pressure and temperature, as our results so far indicate, it might be an important process to consider for understanding: 1. The low-velocity seismic anomalies in the deep mantle; 2. Thermal evolution of the lower mantle. The expanded crystal lattice of Ca-Brg may have increased storage capacity for large-sized heat-producing elements, such as U^{4+} and Th^{4+}, by substituting divalent cations in A site.