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Phase transition of wadsleyite-ringwoodite in the Mg_2SiO_4-Fe_2SiO_4 system

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Abstract

The Fe-bearing wadsleyite-ringwoodite phase transition loop under dry conditions in a temperature range of 1473 and 1873 K was determined by in situ X-ray diffraction experiments at the synchrotron facility SPring-8. Pressure at high temperature was precisely determined within a 0.23 GPa error using in situ X-ray diffraction of MgO as a pressure standard. Under dry conditions, assuming an equilibrium chemical composition of wadsleyite and ringwoodite coexisting with garnet in a pyrolite model and an adiabatic temperature gradient with a potential temperature of 1550–1650 K, the phase transition depth and effective width of the seismic discontinuity were found to be 500–514 and 20–22 km, respectively. This effective width, which is three times greater than that of the olivine-wadsleyite phase boundary, can reflect a seismic wave of approximately 0.25 Hz. The wider transition loop between wadsleyite and ringwoodite could create a broad seismic discontinuity. Considering wet and oxidized conditions, the depth of the wadsleyite-ringwoodite phase boundary could be greater than 520 km assuming the small temperature dependency on water and oxygen fugacity effects. Variation in the depth of seismic anomaly may be attributed to water content or oxygen fugacity of the transition zone.

Keywords: Mantle, wadsleyite, ringwoodite, phase boundary loop, in-situ experiments