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Stability, composition, and crystal structure of Fe-bearing Phase E in the transition zone

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Abstract

Fe-bearing phase E coexisting with ringwoodite and wadsleyite has been synthesized at near-geotherm temperatures in hydrous KLB-1 peridotite compositions held at 18 and 19 GPa, and 1400 °C for 27 h. The long heating duration time of syntheses implies that phase E can be a stable component of the mantle under hydrous conditions. Single-crystal X-ray diffraction analyses show that the M1 octahedral site is 72.1–75.2 at% occupied, whereas the M2 and tetrahedral Si sites are 2.4–2.9 at% and 18.9–19.8 at% occupied, respectively. The M1 site occupancies show a positive correlation with Fe/Mg molar ratios, indicating that Fe mainly occupies the M1 site in the phase E structure. High-pressure Raman spectroscopy shows that the framework Raman frequencies of Fe-bearing phase E increase continuously with increasing pressures up to 19 GPa at room temperature, and there is no indication for a major change in the crystal structure. If transition-zone regions adjacent to subducting slabs are hydrated by fluids generated at the top of the lower mantle, Fe-bearing phase E is expected to occur at wadsleyite-ringwoodite phase transition boundary (about 520 km) as an important phase for incorporating water.

Keywords: Phase E, transition zone, X-ray diffraction, high-pressure Raman spectroscopy