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In situ ultrasonic velocity measurements across the olivine-spinel transformation in Fe_2SiO_4

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Abstract

Compressional (P) and shear (S) wave velocities across the olivine-spinel transformation in Fe_2SiO_4 were investigated in situ using combined synchrotron X-ray diffraction, X-ray imaging, and ultrasonic interferometry up to 5.5 GPa along the 1173 K isotherm. The onset of the spinel to olivine transformation at 4.5 GPa and olivine to spinel transition for Fe_2SiO_4 at 4.8 GPa was concurrently observed from X-ray diffraction, the amplitude of the ultrasonic signals, the calculated velocities, and the ratio of P and S wave velocities (v_P/v_S). No velocity softening was observed prior to the fayalite to spinel transition. The velocity contrasts across the Fe_2SiO_4 spinel to fayalite phase transition are derived directly from the measured velocities, which are 13 and 12% for P and S waves, respectively, together with a density contrast of 9.4%. A comparison with literature data indicates that the changes in compressional-wave velocity and density across the olivine-spinel transformation in Fe_2SiO_4 are comparable to those with different iron concentrations in the $(Mg,Fe)_2SiO_4$ solid solution, whereas the shear wave velocity contrast decreases slightly with increasing iron concentration.

Keywords: Olivine-spinel, phase transformation, Fe_2SiO_4, velocity contrasts, ultrasonic measurements, iron concentration