Effect of iron on the elastic properties of ringwoodite

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(Mg, Fe)2SiO4 ringwoodite is considered to be the most abundant mineral between 520km and 660km depth on the mantle transition zone, and it is important to clarify the elastic velocity in order to discuss the mantle mineralogy and the structure in the mantle transition. In the present study, elastic wave velocities of ringwoodite with compositions of Mg2SiO4, (Mg0.8, Fe0.2)2SiO4 and (Mg0.5, Fe0.5)2SiO4 have been measured to address the effect of iron on the elastic properties under pressure. Ultrasonic measurements on the specimens produced by hot-pressing at 18 GPa and at 1273-1473K were conducted at pressure up to 14GPa at room temperature in a multianvil apparatus. Pressure was estimated from the relationship between the travel time in the Al2O3 buffer rod and the pressure estimated from in-situ X-ray diffraction measurements. Thus measured bulk modulus (K) of ringwoodite increases and shear modulus (G) decreases significantly from K= 185, G=127 GPa for pure Mg2SiO4 to K=191 GPa, G=102 GPa for iron-bearing phase (Mg0.5, Fe0.5)2SiO4. Extrapolation of these data to high pressure and temperature indicates that the shear and the compressional impedance contrasts associated with the wadsleyite to ringwoodite transition are sufficient to produce an observable discontinuity at 520km depth, even with a moderate (30-50%) amount of olivine. However this cannot explain the observed large amplitude in the topography of the 520km discontinuity. On the other hand, the shear and compressional impedance contrasts associated with the ringwoodite to perovskite + magnesiowüstite transition cannot explain those observed at 660km discontinuity in a pyrolite mantle with 60% olivine, though the shear and compressional impedance contrasts have a strong dependency on iron content in this transition. The present results suggest that the study of the effect of other minerals (e.g. majorite) and volatile components (e.g. H2O) should be important clarifying for the details of the mineralogy and the constitution in the mantle transition zone.