Evidence for a Silicon-depleted inner core: shear and compressional velocities of Fe and Fe-8.6wt% Si up to 216 GPa and 4,000K

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It is well known that the re-distribution of the light elements in the core causes the chemically driven convection in Earth's liquid outer core, powering a long-living geodynamo since the crystallization of the inner core. However, the identity and amount of light elements in the inner core still remain an enigma due to lack of the properties of shear velocity (V_s) and compressional velocity (V_p) for iron alloys at simultaneously high pressure and temperature. Here, we measured V_s and V_p of Fe and Fe-8.6wt% Si up to ~216 GPa and ~4,000 K by a dynamic compression technique before shock melting. Both V_p of solid Fe and Fe-8.6wt%Si increase linearly with density, namely, follow Birch's Law at high temperature and pressure. Comparing to the data at room temperature, V_p are independent of temperature, while V_s decrease as a function of second order in temperature. At 360 GPa and 6,200 K, V_p of Fe-Si system remain nearly constant, and V_s of Fe-Si decrease with the increasing Si content, but they are both larger than the observed data of inner core. These results effectively rule out Si as the dominant light element in the solid inner core, implying a complex reduction-oxidation process during the early Earth accretion.