Effect of Light Elements on the Sound Velocities in Solid Iron: Implications for the Composition of Earth's Core

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We measured compressional sound velocities in light-element alloys of iron (FeO, FeSi, FeS, and FeS_2) at high pressure by inelastic x-ray scattering. This data set provides a mineralogical constraint on the composition of Earth's core, and completes the previous set formed by the pressure–density systematics for these compounds. Based on the combination of these data sets and their comparison with radial seismic models, we propose an average composition model of Earth's core. We show that sulphur cannot be the only light alloying element in the core, because it cannot satisfy both the compressibility, sound velocity and while retaining a reasonable abundance based on cosmochemical models. On the other hand, the incorporation of small amounts of silicon or oxygen is compatible with geophysical observations and geochemical abundances. From our data, the inner core contains 2.3 wt% silicon or 1.6 wt% oxygen. A theoretical study predicted that the (molar) partition coefficient of oxygen between liquid and solid iron is 40, basically ruling out oxygen as a light element in the inner core. We therefore propose a preferred model, where the inner core contains 2.3 wt% silicon and traces of oxygen, whereas the outer core contains 8 wt% oxygen and 2.7 wt% silicon.

References

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