Constraints on the light elements in the core from partitioning and mineral physics data

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The Earth and other terrestial planets contains iron-dominant metallic cores. Percolative core formation and silicate-metal differentiation naturally lead to incorporation of light elements, such as S, Si, and O, in the core. Accretion process and conditions of the silicate-metal separation influence the constituents of the light elements in the core. Seismic observations provide direct measurements of the densities and sound velocities of Earth's liquid outer core and solid inner core. Any compositional models of the core must produce the correct density and sound velocity profiles of the core. While the compositional models of the liquid outer core and the solid inner core may be devided seperately by comparing the experimental mineral physics data on metallic liquid and solid with the observations, the compositional difference between the outer core and the inner core must be governed by partitioning of light elements between solid and liquid iron at the inner core boundary. In order to develop a core composition model that meets the geophysical constraints and the required element partitioning, we establish reliable density-velocity-pressure-temperature relationships for core materials by combining dynamic and static compression datasets, and conduct partitioning experiments using both multi-anvil apparatus and laser-heating diamond anvil cell. The emphasis has been to systematically determine the effect of S, Si, and O on the density and sound velocity of iron alloys and map out the possible composition space that can explain the observed density and sound velocity of the liquid outer core and solid inner core. These possible compositions are futher evaluated by element partitioning between liquid and solid metal at high pressure and temperature so that an optimal composition is obtained to meet both geophysical and petrological constraints.