Composition of the core: Geochemical and mineral physics constraints

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The Earth’s core is believed to contain certain amount of light elements based on seismological observations and mineral physics data. The major potential candidates of the light elements of the core are considered to be S, Si and O. Recent studies on the Fe-Si-O system revealed that Si and O have mutual avoidable nature in metallic liquid (1,2), and precipitation of silicates such as SiO_2 or $FeSiO_3$ occurred during cooling of the liquid core (e.g., (3)). Therefore, the composition of the inner core coexisting with metallic liquid outer core should be ether Fe-O-S or Fe-Si-S alloy, i.e., coexistence of Si and O are prohibited to occur in the core crystallizing metallic solid inner core.
Our sound velocity measurements of FeO revealed that O is not likely to be the major light element of the inner core (4). Thus the most plausible candidates of the light elements in the core are likely to be S and Si, without O.
Based on our measurements of the sound velocity of iron (5), iron-silicon alloy (6), and Fe_3S (7), and the solid-liquid partitioning in the Fe-Si-S system at high pressure and temperature, we constrained the composition of the inner and outer cores. The present experiments on the solid-liquid partitioning of S and Si revealed that the major element of the inner core is silicon whereas that in the outer core is sulfur. The present results on sound velocity measurements and solid-liquid partitioning of iron alloy indicate that an iron alloy with about 5 wt.% of Si and 0.1 wt. % of S can explain the physical properties of the PREM inner core at the ICB condition, whereas the outer core contains both S and Si (about 7 wt.% S and 3 wt% Si) without O.

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