
Sound velocity of iron-light element compounds and composition of the inner core

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Abstract

The seismological and mineral physics studies indicate that the Earth's core consists of iron-nickel alloys containing light elements. The major candidates of the light elements in the core may be S, Si, O, and H. Recent studies on melting of the Fe-Si-O and Fe-Si-S-O systems revealed that Si and O are mutually exclusive in metallic liquid [1], and silicates such as SiO₂ (e.g., [2]) or FeSiO₃ were precipitated during cooling of the liquid core. Therefore, the metallic inner core crystallizing from liquid outer core should be composed of either Fe-O-S or Fe-Si-S alloys.

Our sound velocity measurements revealed that both compressional velocity (V_p) and density of pure hcp-Fe are greater than those of the PREM inner core indicating that the major light elements in the inner core must reduce both compressional velocity and density of hcp-FeNi alloy [3]. Our sound velocity measurements of iron-light element compounds revealed that S, Si and H can meet with this requirement [3], whereas the sound velocity of FeO is very high compared to the PREM inner core [4]. Thus, O may not be the major light element of the inner core.

The experiments on the solid-liquid partitioning of S and Si together with the sound velocity measurements of iron-light element alloys at high pressure and temperature revealed that the major element of the inner core is Si whereas that of the outer core is S, and an iron-nickel alloy with about 3-6 wt.% of Si and 0.1 wt. % of S with additional Ni of 0-8 wt.% can explain both the density and compressional velocity of the PREM inner core assuming that the inner core does not contain hydrogen.

References: [1] Sakai, T. et al. (2006). *Geophys. Res. Lett.*, 33, L15317. [2] Hirose, K. et al. (2017). *Nature*, 543, 99–102. [3] Sakamaki, T, et al. (2016) *Sci. Adv.*, 2: e1500802. [4] Tanaka, R et al., (2016) AGU Fall Meeting 2016, Dec 12-16, San Francisco.

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