Light elements in the core based on elemental partitioning experiments between Fe-S melts and silicate magma

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The compositions of Earth's core are important research topics to understand the Earth's deep interior and evolution. Seismological observations provided density and sound velocity data of the Earth's interior. Comparing with experimental studies on density of Fe under the core conditions, the observed Earth's core densities are smaller than those of pure Fe. These results implied an existence of light elements in the core and the species and amount of light elements have remained still unknown.
The terrestrial magma ocean was formed in the early Earth. During the core separation from the magma ocean, elements are assumed to be partitioned between molten iron and silicates melts at the base of the magma ocean. Therefore, clarification of partitioning behavior of the Earth materials at high pressure and temperature is important for understanding characteristics of the Earth's core.
In this study, partitioning experiments between silicate (garnet) melts and metallic liquids (Fe-8wt%Sulfur) were conducted by using a diamond anvil cell combined with a fiber laser heating system. The experiments were carried out at the pressures between 52 and 76 GPa and the temperatures between 3140 and 5140 K. Recovered samples were cut and polished by FIB. Chemical analyses were performed using FE-SEM/EDS and metal/silicate partitioning coefficients (D_{Si}) and exchange partitioning coefficients (K_D) of silicon were determined.
The results demonstrated a strong oxygen fugacity dependence of D_{Si} to be negative and a positive temperature dependency of K_{DSi}. In this study, Si was less partitioned in the metal phase than previous studies of partitioning using Sulfur-free iron as a metal, suggesting less Si in the metal phase which S is included in. The present result suggests that the existence of S in the metal phase might affect the partitioning behavior of Si during the magma ocean. Assuming the values of Si content in the core and oxygen fugacity from geochemical constraints, 2.3~6.1wt% of S in the core can explain the partition between the core and mantle at 4200 K. When the estimated temperature of the bottom of the magma ocean was lower, the abundance of S would be smaller.

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