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Partitioning of Si, Fe, Co, and Ni between metallic liquids and silicate liquids under high-pressure and temperature

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The Earth's outer core is thought to contain about 5-10 wt% of one or more light elements, because its density is lower than that of pure iron by 10 percent. Si is one of the candidates for the light elements contained in the core, which is depleted in the Earth's mantle relative to CI chondrites. The redox condition during core formation is important to clarify whether Si incorporated into the core or not. We have studied experimentally the partitioning of Si between liquid metals and silicate melts under high pressure and temperature by using a KAWAI type multianvil apparatus. We used two kinds of starting materials: one is the mixture of KLB-2 and Fe, the other is KLB-2 and Fe, Co, Ni, and Si. They were contained in graphite capsules. Oxygen fugacity was controlled by varying the Si content in the metallic phase. Partitioning experiments were conducted at 6 GPa and 2100 K, and the recovered quench samples were examined by an electron microprobe. EPMA analysis provided the partition coefficients of Si, Fe, Co, and Ni between metallic melt and silicate melt. The partition coefficients are dependent on oxygen fugacity and the contents in metallic phase of these elements at log fO_2 = IW-3 are higher than those at IW-2 by 1 log unit. We evaluated the Si contents of mantle equilibrated with the core by mass balance calculations using the Si partition coefficients, and found they are apparently higher than the mantle abundance. In order to attain the Si mantle abundance, it is necessary that the mantle would equilibrate with the core at more reducing condition.

Keywords: Siderophile element, core-mantle equilibrium