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高温高圧下における溶融金属鉄－珪酸塩融体間のカリウム分配への溶融鉄中軽元素の影響
Effect of light elements on partitioning of potassium between liquid iron alloys and silicate melts

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The Earth's core is mainly composed of Fe and its density is smaller than that of pure Fe under the core conditions. Therefore, the core has been considered to contain light elements, such as H, S, Si, C, and O (e.g., Poirier, 1994). It has been suggested that the core might include radioactive elements as heat sources (e.g., Labrosse et al., 2001). Potassium (K), one of the radioactive elements, is depleted in the mantle compared to C1-chondrite. Volatile elements are depleted as well but the quantity of depleted potassium is more than the other volatile elements (e.g., Corgne et al., 2007). Therefore, there is a possibility that K is included into the Earth's core.

Several partitioning experiments on K between liquid iron and silicate melts have been performed using a multi anvil press (MA) and a diamond anvil cell (DAC). Explored pressures in the MA experiments were limited to be less than 26 GPa (e.g., Ito et al., 1993). Although DAC experiments were conducted up to 135 GPa (Hirao et al., 2005), the metallic composition was pure Fe. The compositions of the metal were only pure Fe or Fe-FeS system in the previous studies. We carried out partitioning experiments between iron-light element (O, C, or Si) alloys and silicate melts as candidate materials of the core using a laser heated DAC (LHDAC).

Chemical compositions of starting materials of metals are powder mixtures of Fe and FeO ($Fe_{75}O_{25}$), Fe and FeSi ($Fe_{75}Si_{25}$), and Fe_3C. A silicate phase of the starting material is a natural Adularia ($KAlSi_3O_8$, Switzerland). A symmetric type DAC was used to generate high pressure and a Nd:YAG laser or a fiber laser was employed to generate high temperature. Pressure was measured based on Raman T_{2g} mode at the culet of the diamond anvil (Akahama & Kawamura, 2004) and temperature was measured by a spectrometric method using radiation spectrometry. Pressure conditions were between 25 and 50 GPa and temperature conditions were between 2500 and 4500 K. Recovered sample were cut by a focused ion beam (FIB) system and analyzed by an electron probe micro analyzer (EPMA).

The effect of temperature on distribution coefficients of K, D_K, in Fe-C system was slightly positive, which is consistent with previous studies on temperature effect on D_K. C and Si do not change D_K significantly compared to pure Fe under explored pressure conditions. On the other hand, the effect of O in liquid Fe on D_K is positive, which is the same as the effect of S (Bouhifd et al., 2007). O (and S) may increase the amount of K in the Earth's core although Si and C may not affect on the amount of K in the core. Therefore, S and O are the important light elements with respect to the amount of potassium in the core.

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