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惑星核中の炭素
Carbon in Planetary Cores

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Carbon is one of the candidates for the light elements in the core. Phase relations of the Fe-C system have been studied to the lower mantle conditions. These studies revealed that Fe3C and Fe7C3 compounds can exist under the conditions. On the other hand, there are few data on the solubility of carbon in molten iron, and the effect of carbon on physical properties such as density and compressional wave velocity of molten iron at high pressure. Thus, we made experiments on partitioning of carbon and silicon between metallic iron and silicate under various oxygen fugacity conditions at high pressure. We made two sets of experiments. First is the density measurement of Fe-C liquid at high pressure using the sink-float test of a composite marker after quenching from high pressures and temperatures, and the in situ X-ray absorption imaging method. The second set of the experiments was to measure the solubility of carbon and silicon in molten iron coexisting with silicates at high pressure and temperature. The first result revealed that carbon can reduce density of the molten iron at high pressure, whereas it increases the velocity of molten iron. Thus, it can be a candidate of the light elements of the outer core. The second set of the experiments revealed that light elements dissolved into metallic iron change with the oxygen fugacity; i.e., under the extremely reducing conditions of fO2, about -4.5 log units below the iron-wustite buffer, only a limited amount of carbon can be dissolved into molten iron, whereas silicon is the major light elements dissolved into metallic iron. On the other hand, carbon can be dissolved into molten iron under relatively higher oxygen fugacity conditions. Thus, carbon can be a light element of the core only when the oxygen fugacity during the core formation is relatively high.

Keywords: Carbon, Core, phase relation, density, velocity, Fe-C liquid