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酸化・還元環境における炭素過剰条件でのMg-Fe-Si-O-C系の相平衡関係：カーボンプラネットへの適用

Phase relation in the C-rich Mg-Fe-Si-O-C system under various redox conditions.:Implication for 'Carbon Planet'.

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Recently, exoplanets have been discovered and observed actively based on the spectroscopic observation. It is reported that carbon-rich circumstellar gas may exist around the beta-Pictoris one of the star which has exoplanets. In such a field, carbon-enriched planet, 'Carbon-planet' may exist. Carbon-bearing phase, such as carbide, carbonate and carbon (Graphite and Diamond) are likely to compose the Carbon-planet interior. Therefore, it is important to investigate phase relations of Carbon-rich system under high pressure conditions in order to understand the internal structure of the Carbon-planet. In this study, C-enriched Mg-Si-Fe-O-C system was investigated at high pressure and temperature.

High pressure experiments were conducted in the system of Mg-Fe-Si-O-C at 4 GPa and 1600 C using MgO capsule. For the starting material, several different pairs of oxide (MgO, SiO_2), silicate ($(Mg,Fe)_2SiO_4$), carbonate ($MgCO_3$) or metal (Fe, Si) were used to modify the oxygen fugacity(fO_2) in the sample. MgO capsule enables us to estimate oxygen fugacity in the sample. Electron probe microanalyses (EPMA) with an Energy-dispersive spectroscopy (EDS) and wavelength-dispersive spectroscopy (WDS) and Micro-focus X-ray diffraction were performed for the recovered samples to obtain the chemical compositions and structures of the stable phases. The amount of C in the metal was also estimated by EPMA.

Change in mineral assemblages and their compositions was observed in the recovered samples depending on reducing and oxidizing conditions. The compositions of metallic phase in the recovered samples are different as follows; in reducing conditions, the metallic part is Fe-Si-C alloy (Si = ~21 wt.%, C = ~5.7 wt.%) and in oxidizing conditions, the metallic part is Fe-C alloy (C = ~8.2 wt.%). Only olivine was observed in the silicate phase even in the case of the starting material containing Si. Solubility of C into the Fe-alloy phase increases (C = 1.7-8.2 wt.%) with increasing fO_2(deltaIW = -4.8--1.7). We could not detect any carbonates under the present experimental conditions. Therefore, it is concluded that carbon-bearing phases are graphite and Fe-C alloy or Fe-Si-C alloy in the present oxygen fugacites at 4 GPa. Carbon may dissolve in the core or exist as Graphite or Diamond layer in the Carbon planet interior.

キーワード:系外惑星,炭素,カーボンプラネット,酸素分圧

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