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学位論文内容の要旨

Abstract of Doctoral Thesis

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Degree requested Doctor of Science Applicant name

学位論文題名

Title of Doctoral Thesis

Perovskite phase relations in the system of  
MgSiO<sub>3</sub>-MnSiO<sub>3</sub>-CaSiO<sub>3</sub> at the Earth's lower mantle conditions  
(下部マントル条件下における MgSiO<sub>3</sub>-MnSiO<sub>3</sub>-CaSiO<sub>3</sub>系ペロブスカイトの相関係)

Silicate perovskites of MgSiO<sub>3</sub> and CaSiO<sub>3</sub> are considered to be major constituent minerals in the Earth's lower mantle. These silicate perovskites are not chemically pure phases and should form a certain range of solid solutions with other cations. In this study, I investigated perovskite phase relations in the system of MgSiO<sub>3</sub>-MnSiO<sub>3</sub>-CaSiO<sub>3</sub> at the lower mantle conditions. Experimental synthesis of perovskite phases in this ternary system was performed at high pressure and high temperature, by using laser heated diamond anvil cell. Product phases were identified by in-situ synchrotron X-ray diffraction measurements and their chemical compositions were quantitatively analyzed mainly by analytical transmission electron microscopy (ATEM).

At first, perovskite phase relations on the MgSiO<sub>3</sub>-MnSiO<sub>3</sub> join were investigated. The existence of a complete solid solution was confirmed on this join. The (Mg,Mn)SiO<sub>3</sub> perovskite produced is orthorhombic and changes of the unit cell parameters of this perovskite as the proportion of Mn incorporated in the mineral lattice changes seems to obey Vegard's rule at 50 GPa. The orthorhombic distortion, judged from the axial ratios of  $a/b$  and  $\sqrt{2} a/c$ , monotonically decreases from MgSiO<sub>3</sub> to MnSiO<sub>3</sub> perovskite at 50 GPa. The orthorhombic distortion in (Mg<sub>0.5</sub>,Mn<sub>0.5</sub>)SiO<sub>3</sub> perovskite is almost unchanged with increasing pressure from 30 to 50 GPa. MnSiO<sub>3</sub> is the first chemical component confirmed to form a complete solid solution with MgSiO<sub>3</sub> perovskite at the P-T conditions of the lower mantle.

As for perovskite phase relations on the CaSiO<sub>3</sub>-MnSiO<sub>3</sub> join, quite wide range of solid solution was confirmed at 40-60 GPa. However, quantitative chemical analyses by ATEM indicated that there is an immiscibility gap in a compositional range from (Ca<sub>0.45</sub>,Mn<sub>0.55</sub>)SiO<sub>3</sub> to (Ca<sub>0.2</sub>,Mn<sub>0.8</sub>)SiO<sub>3</sub>, unlike the case of the MgSiO<sub>3</sub>-MnSiO<sub>3</sub> join. Judging from the extinction of specific peaks in the X-ray diffraction patterns, it was suggested that (Ca,Mn)SiO<sub>3</sub> perovskite on the CaSiO<sub>3</sub> side of the immiscibility gap is cubic, but on the other hand (Ca,Mn)SiO<sub>3</sub> perovskite on the MnSiO<sub>3</sub> side is orthorhombic. It should be noted that MnSiO<sub>3</sub> is the first chemical component confirmed to form such a wide compositional range of solid solution with CaSiO<sub>3</sub> perovskite at the P-T conditions corresponding to the lower mantle, because it has been known that CaSiO<sub>3</sub> perovskite is difficult to form solid solutions with other cations.

Finally, perovskite phase relations in the ternary system of MgSiO<sub>3</sub>-MnSiO<sub>3</sub>-CaSiO<sub>3</sub> were investigated. It was confirmed that the addition of MnSiO<sub>3</sub> component strongly affects the mutual solubility between MgSiO<sub>3</sub> and CaSiO<sub>3</sub>. There are two perovskite regions with an immiscibility gap between them in the ternary system. Crystal structure of Ca-bearing (Mg,Mn)SiO<sub>3</sub> perovskite

is orthorhombic, and that of Mg-bearing  $(\text{Ca,Mn})\text{SiO}_3$  perovskite is cubic. The compositional range of Mg-bearing  $(\text{Ca,Mn})\text{SiO}_3$  perovskite in the ternary system expands dramatically to the Mg-rich side with increasing  $\text{MnSiO}_3$  component.