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論 文 要 旨

THESIS SUMMARY

専攻： Department of	地球惑星科学 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （ 理学 ）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Because the chemical composition of the Earth's core and the structure of the core-mantle boundary (CMB) have a large influence on Earth's thermal evolution, it is important to constrain the history of the core from petrographic constraints placed by the high-pressure and high-temperature properties of materials near and below the CMB, and the behavior of the geomagnetic field. In "Reaching for the Core", I have used approaches from both fields to better constrain our knowledge of the history and structure of the Deep Earth. The thesis entitled "Reaching for Earth's core: combining the insights from ingle crystal paleomagnetism and high pressure experiments" consists of five chapters.

In Chapter 1, the current understanding of the present state and evolution of the Earth's core is summarized, and the aim of this thesis is stated. Previous studies including high pressure experiments, seismic observations, paleomagnetic studies and numerical dynamo simulations are reviewed. To explore the evolution of the core, we need to combine direct information provided by paleomagnetic measurements with results from realistic geophysical models of mantle influence that are based on parameters obtained by high pressure experiments and calculations. At present, the low number of reliable paleomagnetic studies from the Precambrian era limits our understanding of the long-term behavior of the geomagnetic field. On the other hand, modeling of the evolution of the Earth's deep interior involves large uncertainties because some fundamental parameters such as the chemical composition of the core and phase relations of the constituent materials are not determined. In this study, I developed a new method to constrain the long-term evolution of the geomagnetic paleointensity, and made contributions for the stable structure and compression behavior of iron hydride and for understanding the melting phase relations of lowermost mantle materials.

In Chapter 2, I studied the stable structure and compression behavior of iron hydride. Despite its importance as a candidate of the core material, the high pressure phase relations of iron hydride is poorly understood. I investigated the phase relation of nearly stoichiometric FeH_x and compression behavior of ferromagnetic and nonmagnetic face-centered cubic FeH_x up to 140 GPa by high -pressure and -temperature experiments using the laser-heated diamond

anvil cell (LHDAC) technique combined with *ab initio* calculations. The results provide fundamental information for exploring the chemical composition of the core, which may largely affect the estimation of the thermal evolution of the core.

In Chapter 3, I studied the melting phase relations of the FeO-SiO_2 system by high -pressure and -temperature experiments by LHDAC. Based on the results, I argued that melting of the banded iron formations subducted to the lowermost mantle may have enhanced the heterogeneity of the CMB. Heterogeneous distribution of FeO at the CMB could give rise to spatial variations in the CMB heat flow, which in turn influence the stability of the geodynamo.

Constraining the long-term trend of the geomagnetic field is one key for understanding the thermal evolution of Earth's core, because convection in the liquid outer core generates the geomagnetic dynamo. In Chapter 4, I conducted paleointensity experiments using single silicate crystals separated from the middle Cretaceous Iritono granite and demonstrated that an assemblage of plagioclase crystals could reproduce paleointensity consistent with the host whole-rock sample. This new method has the potential to provide better constraints on the behavior of the geomagnetic field through geological time by averaging out the short-term fluctuations of the geomagnetic field and avoiding the influence of undesirable magnetic components in the measurements. In addition, the results suggest a high time-averaged dipole field strength during the Cretaceous normal superchron, and imply an anticorrelation between magnetic polarity reversal frequency and field intensity.

Thermal evolution models of the deep earth inferred from high pressure petrographic constrains need to be verified by constrains by geological data. Long-term trends of the geomagnetic field obtained by paleomagnetic studies need to be interpreted by an evolution model for the core/mantle system. These are connected to each other through numerical dynamo models. In Chapter 5, I reviewed the influencing factors on the long-term change of the geomagnetic field from the dynamics of the core and mantle. The contributions of the present three studies to the investigations of inner core crystallization and CMB heat flow pattern are discussed.