【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Mathematics/Physics)

Title of Project： Behaviour of liquids under high pressure and the early evolution of the Earth

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Research Project Number：16H06285　Researcher Number：50270921
Research Area：Mathematics/Physics
Keyword：Early Earth, High pressure, Liquid

【Purpose and Background of the Research】

We have been working on static ultrahigh pressure and temperature experiments using laser-heated diamond-anvil cell (DAC) (Fig. 1). By using such techniques, materials and dynamics of the Earth's deep interior, in particular the deep lower mantle and metallic core have been examined. While these studies mainly aimed to understand the present-day Earth, this new project focuses on the "Early Earth". Melts and liquids were main players in the early evolution of the Earth. We will therefore measure physical and chemical properties of melts (liquids), such as crystallization, element partitioning, density, sound velocity, and thermal conductivity. These measurements will help understand magma ocean processes, separation of mantle and core, and core evolution and early dynamo.

図１． Fig. 1. Diamond-anvil cell (DAC) high-pressure device

【Research Methods】

We will perform a variety of measurements under high pressure and high temperature (*P-T*) in a laser-heated DAC (Fig. 1). With such techniques, materials property has been determined at high *P-T* even beyond the condition at the center of the Earth (364 GPa, ~6000 K). For high-pressure melting/crystallization experiments, a cross section of a tiny sample (~10 μm) that has been melted at high *P-T* will be precisely prepared by Focused Ion Beam and then examined for its texture and chemical composition under an electron microprobe (FE-EPMA and TEM). We will also introduce XAFS measurement system at the beamline BL10XU of SPring-8 synchrotron radiation facility. It enables us to determine the valence and electronic states of elements, which is important to better understand element partitioning during core formation and the solidification of magma ocean. We will also construct high-resolution imaging system at the BL10XU, with which we can determine the density and electrical/thermal conductivity.

【Expected Research Achievements and Scientific Significance】

The Earth was originally covered with a deep manga ocean. Its solidification defines the initial condition of the solid Earth. Understanding the solidification of the magma ocean is important also for better understanding of the present-day Earth. The segregation of the core from the mantle (core formation) is the biggest event on the early Earth. Its understanding is a key to the understanding of the initial condition for the core and its evolution. We will also try to clarify the mechanism of generation of geomagnetic field based on the examination of core compositional evolution before the birth of inner core.

【Publications Relevant to the Project】

Nomura, R., Hirose, K., Uesugi, K., Ohishi, Y., Tsuchiyama, A., Miyake, A., Low core-mantle boundary temperature inferred from the solidus of pyrolite, ***Science***, 343, 522-525, DOI: 10.1126/science.1248186, 2014.
Ohta, K., Kuwayama, Y., Hirose, K., Shimizu, K., Ohishi, Y., Experimental determination of the electrical resistivity of iron at Earth's core conditions, ***Nature***, 534, 95-98, doi:10.1038/nature17957, 2016.

【Term of Project】FY2016-2020
【Budget Allocation】387,500 Thousand Yen
【Homepage Address and Other Contact Information】

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