【Grant-in-Aid for Scientific Research (S)】

Broad Section B

Title of Project : Material Science of Hydrogen in the deep earth and planets

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Research Project Number : 18H05224 Researcher Number : 70233666
Keyword : hydrogen, the earth's interior, planetary interior, neutron diffraction

【Purpose and Background of the Research】

Hydrogen is the most abundant element in the solar system and the simplest element containing only one electron. However, the chemical property of hydrogen has a wide variety caused by its multiple bonding nature. From these reasons, hydrogen can constrain the properties and structure of materials in the deep earth and planets. In this research project, we are going to solve fundamental questions on structures, properties and behaviors of hydrogen-containing minerals in the deep earth and planets from versatile experiments at high pressure and high temperature or low temperature. The purpose of the project is to clarify the thermodynamic stability, crystal structure, chemical composition of hydrogen-beading materials in the deep earth and planets. The targets of our project cover very wide range of materials as illustrated in Figure 1.

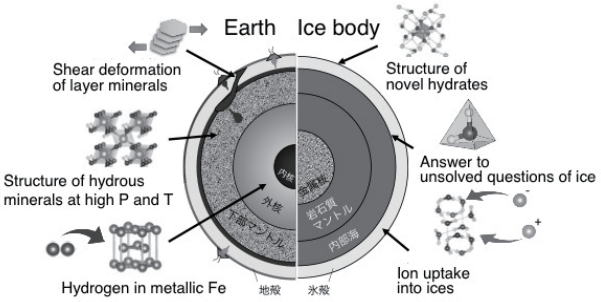

Figure 1 Targets of our research.

【Research Methods】

Main experimental method in this research project is neutron diffraction measurements at high pressure at the PLANET beamline (BL-11), MLF, J-PARC (see Figure 2). The PLANET beamline was constructed by a research consortium led by members in this research project. Crystal structures of the materials in the deep earth and planets will be solved from X-ray diffraction measurements at PF, KEK and local structure surrounding hydrogen atoms will be obtained from neutron diffraction measurements at MLF, J-PARC. In this research, laboratory-based instruments will be also installed to support the measurements at

Figure 2 BL-11 at MLF, J-PARC.

J-PARC and KEK, because beamtime distributed to us is very limited. In this project, we will solve the phase relationship of salt-water systems at high pressure and low temperature to clarify the internal structure of icy bodies. Moreover, the occupancy and local structure of hydrogen atoms in metallic iron will be clarified at high pressure and high temperature conditions.

【Expected Research Achievements and Scientific Significance】

Structure and chemical compositions of the earth's core and icy planets will be clarified from this research project.

【Publications Relevant to the Project】

・Hattori et al. (2015) Design and performance of high-pressure beamline PLANET launched at pulsed neutron source at J-PARC. NIM A, 780, 55.
・Iizuka-Oku et al. (2017) Hydrogenation of iron in the early stage of Earth's evolution. Nature Comm., 8, 14096, DOI: 10.1038/ncomms14096.

【Term of Project】 FY2018-2022

【Budget Allocation】 148,500 Thousand Yen

【Homepage Address and Other Contact Information】

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