【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Mathematical and physical sciences)

Title of Project : Chemical composition of the lower mantle and differentiation of the early Earth

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Research Area : Earth and Pranetary Sciences
Keyword : Geodynamics, Mineral physics, Ultrahigh-pressure experiment

【Purpose and Background of the Research】

Chemical composition of the Earth's lower mantle has been a matter of debate in the last several decades. Some propose that the lower mantle has a pyrolitic composition similar to the upper mantle, while others claim that the composition of the lower mantle is more Si-rich and may have a perovskite-like composition (perovskitite).

To constrain the composition of the Earth's interior, it is a common practice to compare seismologically observed sound velocities and density with those experimentally derived on the candidate lithologies. We developed techniques to precisely measure the sound velocities and density by a combination of synchrotron in situ X-ray observations, multianvil technology, and ultrasonic measurements. These enabled us to constrain the chemical composition of the mantle transition region, and now we are ready to apply these techniques to the lower mantle mineralogy.

【Research Methods】

We use anvils made of conventional tungsten carbide, sintered polycrystalline diamond, and nano-polycrystalline diamond invented by ourselves, dependent on the pressure ranges in the lower mantle, ranging from 24 GPa to 136 GPa, for multianvil experiments. Precise measurements of sound velocities and density of pyrolite and related high-pressure phases will be made by these techniques, combined with synchrotron X-ray and ultrasonic interferometry. Quench method is also adopted, and the TEM and SEM analyses of the recovered samples will be conducted to determine the chemical compositions of the coexisting phases.

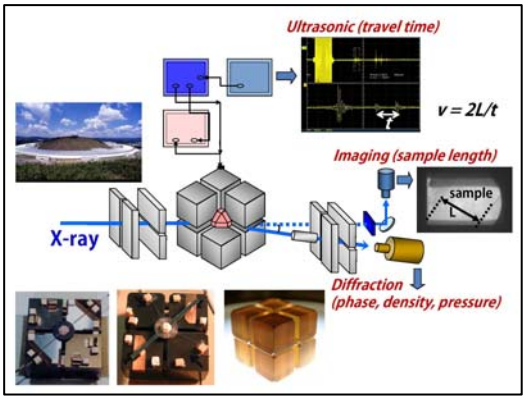

Fig. 1 High-pressure ultrasonic interferometry.

【Expected Research Achievements and Scientific Significance】

Based on the experimental results, we will constrain the chemical composition of the lower mantle by comparing these data with those obtained seiemologically. This leads to the estimation of the bulk mantle composition and thereby to the constraints on the current mode of mantle convection, chemical composition of the primitive Earth, differentiation of the early Earth.

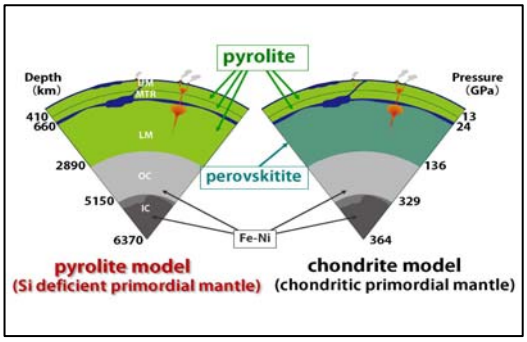

Fig.2 Chemical models of the lower mantle.

【Publications Relevant to the Project】

・T. Irifune, et al., Iron partitioning and density changes of pyrolite in Earth's lower mantle, Science 327, 193-195, 2010.
・T. Irifune, et al., Sound velocities of majorite garnet and the composition of the mantle transition region, Nature, 451, 814-817, 2008.

【Term of Project】 FY2013-2017

【Budget Allocation】 167, 800 Thousand Yen

【Homepage Address and Other Contact Information】

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