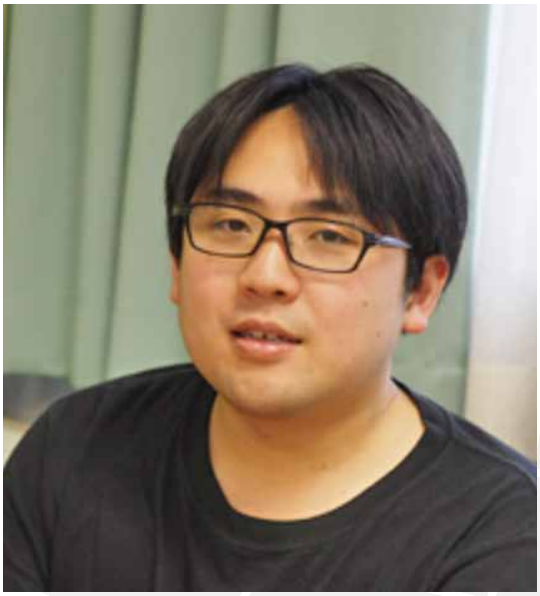

Trace element partitioning between bridgmanite and silicate melt up to CMB pressure and the origin of the Hf-Nd mantle array.

Dr. Keisuke Ozawa
JSPS Post-doctoral fellow
Geodynamics Research Center

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Crystallization in the magma ocean and the segregation of melt from crystals must have created large-scale chemical heterogeneities in the mantle. The FeO-rich heavy magma residue (known as a basal magma ocean) formed at that time may still be present in the lowermost mantle and be an unsampled geochemical reservoir enriched in incompatible elements. In order to quantitatively evaluate the chemical characteristics of such a hidden reservoir, it is necessary to understand the partitioning behaviors of key trace elements under high pressures corresponding to the present lower mantle conditions. However, the partitioning of trace elements between bridgmanite, a primary lower-mantle mineral, and melt has been previously examined only up to 27 GPa.

Here we performed melting experiments on a pyrolitic mantle material doped with trace elements (Nd, Sm, Lu, and Hf) at 24–132 GPa and 3300–4610 K, covering entire lower mantle conditions.. The results demonstrate that with increasing pressure to more than ~60 GPa, both Lu and Hf change from compatible (D > 1) to incompatible (D < 1) and DLu becomes greater than DHf. We also found that pressure effects on DSm and DNd are smaller and DSm is equivalent to DNd. It is known that the terrestrial Hf-Nd isotope array lies slightly above the bulk silicate earth (BSE) composition. The possible hidden geochemical reservoir formed from a basal magma ocean could have low Lu/Hf ratio and similar Sm/Nd ratio compared to the BSE, which explains the discrepancy between the BSE and the mantle array.

Contact: Steeve Gréaux, PhD. (e-mail: greaux@ehime-u.ac.jp)