Investigations on core-mantle interaction with a tungsten isotopic tracer from Oceanic Island Basalts and an Oceanic Plateau

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The earth is composed of the crust, upper mantle, lower mantle, outer core, and inner core, revealed by seismic observations. Only the outer core is mainly molten metal, whereas mantle is solid rock which is partially melted. Three kinds of mantle convection model, whole mantle convection model (as one layered), two layered model and hybrid model (mixed one layer type and two layered type), have been proposed.

The heat fluid model or models based on calculation of the mantle convection and geophysical evidence, suggest that plumes rise up from the core-mantle boundary (CMB) (Tackley, 2002, etc). If the evidence of core-mantle interaction is found in the plumes, it can put strong constraints on mantle convection of the Earth.

The interaction at the CMB may involve disequilibrium chemical reactions (Knittle and Jeanloz, 1991) equilibrium chemical reactions (Walker, 2000, Rubie et al., 2004), isotopic exchange (Puchtel and Humayun, 2000), each of which may impart distinct isotopic and chemical signatures to the adjacent mantle. These phenomena are called as core-mantle interaction.

The signatures of the core-mantle interaction may be detected by investigating the chemistry of Oceanic Island Basalt (OIB) or Large Igneous Provinces (LIPs). To date ongoing geochemical researches are carried out in order to explore the origin of plumes. However, the question of these origins of plumes is still open.

In this research, we analyzed W isotope ratio of the OIBs of South Polynesia islands and a Hawaii island, Ontong Java Plateau of ODP samples, using the multi-collector type inductively-coupled-plasma mass spectrometer (MC-ICP-MS) . We modified the W separation method of Sahoo et al. (2006) to deal with OIBs.

The error of W isotope ratio measurements in this research has been estimated as 0.4 epsilon, and more than 1% contribution of core material is required to lower W isotope ratio by more than 0.4 epsilon. Therefore, if there is 1% or more of contribution of a core material, a core mantle interaction is detectable in this research.

However, no W negative isotope anomaly has been observed all samples.

These results suggest three possibilities about mantle convection and core mantle interaction.

1) These magma source does not fall to CMB and is not influenced by the core mantle interaction. It suggests that mantle convection may be two-layered type or mixed type (mixed two-layered with one-layered convection).

2) These magma source descended to CMB, and experienced a core mantle interaction, but afterward it mixed with surrounding mantle while a plume rose to the surface. The dilution by mantle W with normal isotope composition reduces the isotope shift caused by contribution of core material and made it impossible to detect a W isotope anomaly.

3) A core mantle interaction does not change W isotope ratio, as Humayun et al. (2004) pointed out. If this is the case, coupling between $^{182}W/^{184}W$, $^{186}Os/^{188}Os$ and Fe/Mn is not a prerequisite for evidence of core-mantle interaction.