Grain boundary diffusion of W and Re in lower mantle phases

Takashi Yoshino*[1], Suzuki Toshihiro[2], and Takefumi Hirata[2]

[1]Institute for Planetary Materials, Okayama University – Japan
[2]School of Science, The University of Tokyo – Japan

Abstract

Tungsten and rhenium grain boundary diffusion coefficients in the lower mantle phases was determined at 25 GPa and temperatures ranging from 1,873 to 2,173 K using a Kawai-type multianvil press. Because grain-boundary concentrations are expected to be very low, multi-sink method was used to determine the diffusion profile. Pt particles with a size of 10 to 20 μm were used as sinking material for siderophile elements. High-pressure diffusion experiments were performed on pre-synthesized polycrystalline postspinel and bridgmanite with scattered Pt sink particles sandwiched by W and Re foils. Recovered samples were sectioned perpendicular to the diffusion interface and W and Re concentrations in Pt sink particles were examined by an electron microprobe and a laser ablation multi-collector inductively coupled plasma mass spectroscopy (LA ICP-MS). The diffusion coefficients determined at various temperatures were fitted with an Arrhenius equation. The grain boundary diffusion coefficients Dgb for W and Re at 25 GPa is determined to be 1.4 (± 0.7) x 10ˆ-7 (mˆ2/s) exp(- 485 (± 71) (kJ/mol) /RT) for W and 1.3 x 10ˆ-7 (mˆ2/s) exp(- 510 (kJ/mol) /RT) for Re, respectively. The effective diffusion distance allows modification of μ182W in considerable length scales from the core-mantle boundary through the whole Earth's history. Tungsten isotope data in modern flood basalts and oceanic island basalts reveal wide variety of μ182W ranging from negative to positive. The source regions of modern flood basalts with negative μ182W can be formed by ultra-low velocity zone just above the core-mantle boundary, whereas those of flood basalts with the positive μ182W could be originated from the large low shear velocity provinces.

*Speaker