

Geochemical Signature of Inner Core fractionation and Plume Source Region at CMB

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Coupled enrichments in the isotopic ratios of $^{186}\text{Os}/^{188}\text{Os}$ and $^{187}\text{Os}/^{188}\text{Os}$ have been reported in some plume magmas (Brandon et al., 2005). The partition behavior of Re, Pt, and Os between solid metallic iron and metallic liquid may produce such isotopic anomaly, since ^{187}Os is produced from ^{187}Re decay by beta emission, and ^{186}Os is produced from ^{190}Pt by alpha decay. The low pressure partitioning behaviors of these elements implies that Os are selectively partitioned to solid metallic iron compared to Pt and Re (e.g., Walker et al., 2000), and thus the isotopic anomaly may be developed by metal crystallization in the core. Thus, the isotopic anomaly may be the geochemical signature in the plume source region at CMB, which may be formed by contamination of about 1 wt. % of the outer core metallic melt, i.e., the isotopic anomaly may be interpreted as the outer core signature (Brandon et al., 2005). However, this estimation may not be correct in the Earth, since the solid iron in the previous experiments is a low pressure polymorph of iron (gamma iron) with a fcc structure, whereas metallic iron is epsilon-iron with a hcp structure under the core conditions.

We have conducted partitioning experiments of Re, Pt, and Os between epsilon-iron and Fe-S melt at 104 GPa by using a laser heated diamond anvil cell (LHDAC), in order to clarify the nature of inner core fractionation generated by the crystallization of epsilon-iron. A powdered mixture of Fe, FeS, Re, Os, and Pt was heated to the temperature above the melting point, i.e., 1823 K at 3 GPa for 2 minutes and quenched by shutting off the power supply at 3 GPa. The recovered sample was finely ground and used as the starting material for the LHDAC experiments. The composition of the starting material thus synthesized was measured by EPMA as Fe 84.85 %, S 5.99 %, Pt 2.93 %, Re 3.74 %, Os 2.96 % by weight. The powdered starting material was placed in the hole of the Re metal gasket. The alumina powder was placed between the diamond anvil surface and the metal sample as the thermal insulator. The pressure was measured before and after laser heating based on the pressure shift of the diamond T2g Raman mode (Kawamura et al., 2003). The experimental pressure thus measured was 104 GPa. The sample was heated by a Sm-YAG laser at high pressure, and the temperature was measured by a spectro-radiometric method. We increased the temperature to 2500 K for 3 min., then reduced to 2040-2330 K and kept constant for 8 min. The quenched sample was recovered, and prepared by FIB (focused ion beam) system for FE-SEM and EPMA analyses.

We observed a clear texture of partial melting, i.e., coexistence of solid metallic iron and quenched Fe-S melt. We measured the compositions of the solid metallic iron and quenched Fe-S melt using EPMA. The measurement revealed that Re, Pt, and Os concentrate to solid metallic iron relative to the Fe-S melt. The partition coefficients D (atm % in solid metal/ atm% in Fe-S melt) of Re, Pt, and Os at 104 GPa are 2.7, 2.6, and 2.5, respectively. The present experimental results indicate the chondritic relative ratios of Re/Os and Pt/Os are expected by the inner core fractionation, i.e., crystallization of the metallic iron. The present results reveal that a coupled Os isotopic anomaly can not be generated in the outer core by the inner core fractionation, and the Os isotopic anomaly observed in some plume basalts may not be a product of contamination of the outer core material at CMB.