Mantle-Core Interactions Overview: The Os Isotope Perspective

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Coupled enrichments of $^{186}Os/^{188}Os$ and $^{187}Os/^{188}Os$ have been observed in lavas from 4 independent plume systems - 2.8 Ga Kostomuksha komatiites, 251 Ma Siberian Traps, 89 Ma Gorgona komatiites, and Recent Hawaiian picrites [1-3]. These coupled enrichments are consistent with elevated Pt/Re, Pt/Os and Re/Os predicted for the liquid outer core generated via progressive crystallization of a solid inner core over Earth history, and may result from core-mantle interactions in the source of these plumes. In contrast, the established geochemical behavior of Pt, Re, and Os in silicate systems predicts partial melts (crust) with subchondritic Pt/Re, but elevated Re/Os. These materials evolve to strongly enriched $^{187}Os/^{188}Os$ over time without commensurately strong enrichments in $^{186}Os/^{188}Os$, and do not appear to explain the coupled enrichments observed in the plume-derived materials [1]. Nevertheless, several models have been proposed to rationalize these coupled Os isotope enrichments from endogenous processes in the silicate mantle.

Any model that can predict the coupled enrichments of $^{186}Os/^{188}Os$ and $^{187}Os/^{188}Os$ must meet the following criteria. First, it must be homogenous in osmium isotopes to explain the different suites of data that plot along well-defined linear mixing arrays from normal mantle $^{186}Os/^{188}Os$ and $^{187}Os/^{188}Os$ end-members that converge to a common radiogenic end-member [2]. Second, the source must be pervasive in order to result in coupled enrichments from plume systems from widely dispersed locations [2]. Third, the model must be able to predict $^{186}Os/^{188}Os$ enrichments observed in the 2.8 Ga Kostomuksha komatiites, resulting from an elevated Pt/Os ratio in their source from at least as early as 4.2 to 3.4 Ga [3].

A variety of analytical and experimental tasks are being explored to test different aspects of both the core-mantle interaction and endogenous mantle processes models, to further constrain the behaviors of these elements, to understand the relationship between core crystallization rates and cooling in the Earth, and to determine interaction processes between the core and the lower most mantle. These endeavors may help to unravel the compositional complexities of plume-derived materials and their mantle sources, and ultimately provide important insights to processes operating within D″.

[1] Brandon et al. (l999) *EPSL* **174**, 25-42.
[2] Brandon et al. (2003) *EPSL* **206,** 411-426.
[3] Puchtel et al. (2005) *EPSL* **237**, 118-134.