The enigma of large-scale Os isotopic homogeneity across the Solar System

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With exception of some ureilites [1], most bulk Solar System materials, including ordinary, enstatite, and carbonaceous chondrites, iron meteorites, and pallasites, exhibit Os isotopic compositions that are indistinguishable from bulk solar isotopic abundances [2-5]. In contrast, acid leachates and residues of primitive chondrites do show deficits of s-process Os components. This supports the idea that acid-resistant, carbonaceous presolar grains, such as SiC or graphite, are important carriers for nucleosynthetic isotopic anomalies of Os in chondrites [2,3]. The absence of Os isotopic anomalies in fully accessed chondrites, but also iron meteorites, pallasites and non-anomalous ureilites implies that the carriers of s- and r-process Os must have been effectively homogenized across the solar protoplanetary nebula. In contrast, large nucleosynthetic isotopic anomalies involving a deficit of s-process isotopes in bulk chondrites and achondrites are observed for siderophile elements Mo, Ru and Pd (e.g., [6]). While the relative proportions of presolar s- and r-process carriers of Os must have remained constant during nebular processes, this appears not to have been the case for Mo, Ru, and Pd, for which the range of isotopic anomalies appears to be in part controlled by the chemical properties of the elements and the nebular processing experienced by their carrier phase(s). Enigmatically, correlated Os isotope anomalies reaching up to $\mu^{186}Os_i$ ~336 ppm have been measured for some ureilites [1]. As these Os isotopic compositions are unlikely to be caused by nebular effects, this enrichment must result from planetary processing of the ureilite parent body, likely during the selective removal of r-process Os host phases (metal?) during rapid localized melting. This implies that planetary differentiation must now be considered a factor in expressing nucleosynthetic anomalies in differentiated meteorites.

[1] Goderis et al. (2015) EPSL 431, 110-118. [2] Brandon et al. (2005) *Science* 309, 1233-1236. [3] Yokoyama et al. (2007) *EPSL* 259, 567-580. [4] Walker (2012) *EPSL* 351-352, 36-44. [5] Wittig et al. (2013) *EPSL* 361, 152-161. [6] Mayer et al. (2015) A*strophys. J.* 809, 180.