How primitive is the "primitive" mantle?

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A recurrent question in planetary sciences is: what is the nature of the "late veneer"? Indeed this late extra-terrestrial addition to the Earth is seen as the carrier of water and possibly the life seeds on earth. However as recently summarized [1] the nature of this late component remains elusive and constraints from various geochemical systems seem at first glance contradictory. Especially, the primitive upper mantle Os composition rules out carbonaceous chondrites – the only wet chondrites - as the source of the `late veneer'. However, one may wonder about the robustness and significance of the PUM estimate wich is heavily based on 2 mantle suites: The Pyreneans lherzolites and the Kilbourne Hole xenoliths.

Recent work has unfold a unique set of convergent structural and geochemical arguments showing that the Lherz' lherzolites are secondary rocks formed at the expense of the harzburgites via a refertilization reaction involving precipitation of pyroxene (±spinel) and sulfide [2]. Chalcophile and highly siderophile elements (HSE) strongly support this scenario. *In situ* measurement of the Os isotopic composition of sulfides in the harzburgites yield a constant unradiogenic composition indicating a Re depletion age $\approx$2 Ga. While the lherzolites sulfides show a large spread of Os compositions, with two sulfide populations, one residual similar to the one found in harzburgite; and a second one showing (extremely) radiogenic compositions probably related to the pyroxenite suites.

Kilbourne hole xenoliths - as almost all alkali-hosted xenoliths [3] - show two sulfides population (residual and metasomatic) characterised by drastically different HSE and $^{187}Os/^{188}Os$ composition.

These suggest that HSE-Os "resetting" mechanism via sulfide enrichment promoted by melt-rock reaction occur worldwide, casting thus strong doubt on the relevance and significance of the PUM concept itself at least for the absolute and relative HSE abundances and $^{187}Os/^{188}Os$ composition of the Earth'primitive mantle.

[1] Drake & Righter (2002) *Nature* **416**, 39-43. [2] Le Roux *et al.* (2007) *EPSL* **259**, 599-612.. [3] Alard *et al.* (2002) *EPSL* **203**, 651-663.