Significance and rosbustness of the highly siderophyle elements and $^{187}Os/^{188}Os$ primitve mantle estimates

O. ALARD[1]* AND J.P. LORAND[2]

[1]Géosciences Montpellier, U. Montpellier II, UMR 5243 CNRS, Montpellier, Fr. (oalard@gm.univ-montp2.fr)

[2]Muséum National d'Histoire Naturelle de Paris, UMR7160, Fr.

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 (PUM) highly siderophile elements (HSE) abundance and $^{187}Os/^{188}Os$ 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.

Indeed we will present several examples (i.e. Lherz peridotite massif [2], Oman ophiolite [3], Montferrier and Kilbourne Hole xenoliths), in which despite multiple and obvious évidence of considerable modifications by partial melting and by percolation-reaction of sulfide bearing-melt or by metasomatism with S-bearing volatile rich fluid(s), still display HSE and $^{187}Os/^{188}Os$ composition very akin to recently refined estimates for the Earth'PUM [4, 5].

These suggest that HSE-Os 'resetting' mechanism [6, 7] via sulfide enrichment promoted by melt/fluid-rock reaction occur worldwide [8], casting thus strong doubt on the relevance and significance of the PUM at least for the absolute and relative HSE abundances and $^{187}Os/^{188}Os$ composition of the Earth'primitive mantle. Therefore the $^{187}Os/^{188}Os$ and HSE composition of the PUM as defined today cannot be used to ruled out any type of chondrite.

[1] Drake & Righter (2002) *Nature* **416**, 39-43; [2] Le Roux *et al*. (2007) EPSL **259**, 599-612; [3] Lorand *et al.* (2009) *Terra Nova* **21**, 35-40; [4] Becker *et al.* (2006) *Geochim. Cosmochim. Acta* **70**, 4528-4550; [5] Meisel et al., (2001) *Geochim. Cosmochim. Acta* **65**, 1311-1323 [6] Alard et *al*. (2000) Nature **407**, 891-894; [7] Alard et *al*. (2002) *Earth Planet. Sci. Lett.* **203**, 651-663; [8] Lorand *et al.,* (2008) *Elements* **21**, 35-40.

The accretion of volatiles in terrestrial planets

FRANCIS ALBAREDE

Ecole Normale Supérieure and Université Claude Bernard, UMR 5570, Lyon, France (jblicher@ens-lyon.fr)

Planetary accretion left the terrestrial planets depleted in volatile components. As shown by the isotope compositions of K and Zn in planetary objects, such depletion does not result from volatilization but from early removal of the nebular gas by T-Tauri winds before accretion was complete. Accretion was largely a stepwise process which, for the material that eventually formed the Earth, stopped when the temperature reached ~1000 K. The narrow temperature ranges of condensation (30-150 K) of the elements suggest a stepwise accretion with temperature gaps: for terrestrial planets, accretion failed before water could condense. At the time of the lunar giant impact and core segregation (~30 Ma after CAIs), both the Moon and the proto-Earth were essentially dry and only later gained volatile elements through accretion of material from the asteroid belt and beyond (the late veneer). The U/Pb ratios of both planetary bodies were very high. As indicated by U-Pb and I-Xe chronologies, late veneer accretion took place 100 ± 50 Ma after isolation of the Solar System. Late delivery not only affected water, but also elements such as Zn, Pb, and S, which were replenished by the late veneer. The 'young Pb-Pb age of the Earth' is in fact the age at which asteroidal Pb was reset by impacts. The proto-Earth must, therefore, have been quickly covered with a water ocean, and interaction with the underlying magma ocean during asteroidal showers must have released a steady flow of hydrogen into the atmosphere. Over geological history, enough water entered the mantle for plate tectonics to function and our planet is about half way to losing its water by subduction. The ocean is not outgassed from the mantle but entrained into it, carried by hydrous minerals such as phase D. On Mars, in contrast, the stagnant lid regime resulting from a dry mantle choked the dynamo and the resulting loss of a magnetosphere caused the quick erosion of the atmosphere by the solar wind. I suggest that Venus may have lost all water to its mantle, thereby promoting the vigorous convection of wet mantle material, which explains the recent resurfacing of the planet.