Wet or dry? Compositional constraints on late accreted material

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The excess of highly siderophile elements (HSE, the platinum group elements, Re and Au) and chondritic ratios of many of these elements in rocks from the Earth's mantle led to the idea that after segregation of metal into the core, Earth's mantle became re-enriched in these elements by late accretion of primitive material ('late veneer hypothesis'). HSE data on other differentiated bodies hint that late accretion may have been prevalent in the inner solar system. N-body modeling also suggests that late accretion is a likely outcome of planet formation. However, the detailed processes, timing of accretion, origin and composition of these materials may have varied in the solar system.

For the Earth, a composition of late accreted material similar to ordinary or enstatite chondrites (based on the Re/Os ratio of the mantle) or carbonaceous chondrites (based on S/Se and Se/Te of the mantle) has been proposed. Ruthenium and Pd display suprachondritic ratios with other HSE, which has been explained by preferred retention of these elements in the mantle during segregation of sulfide melt into the core, or alternatively, by late accretion of differentiated core material. HSE in the Martian mantle may be chondritic (based on the SNC model, Pd/Pt and $^{187}Os/^{188}Os$) and suggest that late accreted material may comprise 0.3 % of Mars' mass. The strong depletion of Te in the Martian mantle indicated by new data is best explained by core formation and volatile element depletion in Mars' late accreted material. Thus, Mars and Earth show differences in the composition of late accreted material. Isotopic compositions of relevant refractory and volatile elements add complexity to compositional constraints. For instance, nucleosynthetic variations of Ru and Mo isotopes rule out carbonaceous chondrites as significant ingredient of late accreted material. At the same time volatile elements such as Te show no resolvable difference in mass-independent isotopic compositions of Earth's mantle and chondrites. We will discuss these constraints and open questions.