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New Constraints on Earth's Late Veneer from Metal-Silicate Partitioning of Gold and Rhenium

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The biggest chemical fractionation in Earth's history separated the silicate mantle from the iron-rich core 4.5 billion years ago. Elements were partitioned between the two reservoirs depending on their chemical affinity for silicate (lithophile element) or iron (siderophile element). Most of the respective compositions of the mantle and the core were established once the differentiation ceased, about a hundred million years after the beginning of accretion. However, the abundance of Highly Siderophile elements (HSEs) in the mantle is at odds with the generally accepted scenario, whereby siderophile elements segregated into the forming core. Indeed, they display a chondritic relative abundance in the mantle. To explain this, it was proposed that a "late accretion", or "late veneer", composed of carbonaceous meteorites bombarded the Earth, once the core formation ended, bringing HSEs to the Earth's mantle ([1],[2]). Thus, the abundance of HSE in the mantle would be a signature of this late accretion. Nevertheless, one possible explanation of the overabundance of HSE in the Earth's mantle could be that their core-mantle partitioning was affected by the extreme pressure and temperature of the Earth's differentiation, as it is the case for moderately siderophile elements (e.g. nickel, cobalt, [3]).

Here, we investigated the metal-silicate partitioning of gold and rhenium at the pressure and temperature prevailing for core-mantle differentiation using laser-heating diamond anvil cells. The recovered samples were cut using a Focused Ion Beam (FIB) into thin lamellae containing both the quenched metallic and the silicate phase. Chemical analyses were performed using electron microprobe for major elements, and nano X-ray fluorescence for trace elements. We will present the first results of the metal-silicate partitioning of gold and rhenium obtained at the putative conditions of core-mantle differentiation, and discuss their consequences on the history of the accretion of HSEs to the Earth.

[1] Chou et al. (1983), JGR 88 A507–A518

[2] Kimura et al. (1974), GCA 38, 683–701

[3] Siebert et al. (2012), EPSL 321–322, 189–197