METAL-SILICATE PARTITIONING OF PLATINUM AT CORE FORMATION CONDITIONS.

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Introduction: Understanding the origin of the highly siderophile elements (HSEs) in the Earth's mantle can provide insights into the accretion and differentiation of the Earth. Though depleted relative to chondrites, the HSEs are present in the primitive upper mantle in abundances that are several orders or magnitude higher than expected from metal-silicate partition coefficients measured at 1 bar [e.g., 1]. The HSEs are also present in the mantle in near-chondritic proportions and appear to be relatively unfractionated by core formation. These observations led to the 'late veneer' hypothesis which is linked to the late accretion of volatiles to the Earth [2]. The HSEs in the mantle are then assumed to represent the mass of material (~0.5 % Earth masses) accreted to the Earth after core formation ceased [3]. However, the contribution of core-mantle equilibration to the mantle composition of the moderately siderophile elements, eg. Ni and Co, [4,5], has led to speculation that the mantle's HSEs signature may also reflect this process. Results from metal-silicate partitioning experiments of HSEs done in large volume expriments (pressures of up to 20 GPa and temperatures of up to 2573 K) also suggest lowered siderophile tendencies [6,7]. In this work we assess the contribution of core-mantle equilibration to the mantle's HSEs content by conducting metal-silicate partitioning experiments on platinum at the putative conditions of core formation.

Methods: Experiments were carried out in a laser heated-diamond anvil cell (LH-DAC) at pressures between 40 and 110 GPa and temperatures from 3600 to 4300 K. The starting material consisted of an FePt (~45 % Pt) alloy of 10 microns in thickness and natural MORB platelets of about 15 microns in thickness. The alloy was sandwiched between two MORB platelets and placed in a pre-indented rhenium gasket inside a DAC. Once compressed, a 200 Watt fiber laser was used to heat the volume of contact between the metal and silicate. The experiments were carried out at superliquidus conditions and full equilibration between metal and surrounding silicate is expected to have occurred. After quench, the samples were recovered with a focused ion beam and analyzed by EDX and NanoSIMS. NanoSIMS has the spatial resolution to quantify the composition of DAC samples and very high sensitivity for measuring platinum in silicates melts.

Discussion: The metal-silicate partitioning values that we obtained are in good agreement with the predictions made by works carried out at lower pressures and temperatures in large volume cells, e.g.[6, 7]. These partition coefficients are combined with those from previous studies on platinum partitioning in order to assess temperature and pressure dependencies in the range of conditions relevant to core formation. The analysis shows that platinum becomes much less siderophile with increasing temperatures. Consequently, core-mantle equilibration would overenrich the mantle in platinum relative to observations unless there is partial equilibration during core formation. In the case of partial equilibration, the mantle's platinum content could be established by a sum of the residue of differentiation and late accretion. Alternatively, a mechanism to remove excess platinum (and by association the other HSEs) from the mantle to the core such as a late sulfide segregation [7] could potentially reconcile the experimental results with the geochemical observations.

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