Metal-silicate partitioning of HSE in S-bearing systems- Implications for Earth's accretion and core formation

VERA LAURENZ[1]*, DAVID C. RUBIE[1] AND DANIEL J. FROST[1]

[1]Bayerisches Geoinstitut, Universität Bayreuth, Universitätsstrasse 30, 95440 Bayreuth, Germany (*correspondence: vera.laurenz@uni-bayreuth.de)

The segregation of Fe-rich metal to form the Earth's core led to a strong depletion of the highly siderophile elements (HSEs - Os, Ir, Ru, Rh, Pt, Pd, Re, Au) in the Earth's mantle. Previous experimental work has shown that the HSEs display large differences in D_{HSE}, which would lead to highly fractionated HSE patterns in the Earth's mantle. It is widely accepted that the near-chondritic ratios of the HSEs estimated for the primitive upper mantle were established by a "late-veneer" of highly oxidized, chondritic

material, after core formation was complete. However, most experimental work on HSE partitioning has been carried out on S-free systems. As S is known to strongly influence the partitioning behaviour of chalcophile trace elements, it may also have played a significant role for the behaviour of the HSEs during core formation.

In order to investigate the effect of S on the behaviour of the HSEs during core formation, we have studied the metal-silicate and sulfide-silicate partitioning of Pt, Pd, Ru and Ir under high pressure-high temperature conditions. A molten peridotite was equilibrated with a range of compositions along the Fe-FeS binary (0 wt. % S - 36 wt%. S), doped with two of the HSEs at a time (10 wt. % each). All experiments were performed in a multianvil-apparatus at 2100-2400 °C and 11-21 GPa using single crystal MgO capsules. Quenched silicate and metal or sulfide were analysed by electron microprobe for their major element concentrations while trace element abundances were determined using LA-ICP-MS.

Overall, it can be observed that all HSEs become less siderophile with increasing S-concentration in the metal or sulfide. However, the least siderophile HSEs show only a small effect, while the more siderophile HSEs are strongly influenced. As a result, K_D of Pt, Pd, Ru and Ir converge with increasing S concentrations in the metal or sulfide phase. These results have important implications for our understanding of Earth's accretion and core formation history. Sulfur is thought to be added late during Earth's accretion, so that the the core-forming metal became more S-rich. The results of this study show that a S-rich melt segregationg to the core would only result in relatively small fractionation among HSEs, possibly explaining the observed near-chondritic ratios of the HSEs in the Earth's mantle.