In situ insights to partitioning of highly siderophile elements between silicate and iron rich liquids at extreme conditions

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Experimental data indicate that highly siderophile elements (HSE) sunk down with the iron in the Earth's core at the early stage of the Earth's formation [1]. Consequently, the Earth´s mantle and crust should be depleted in HSE. Thus, the apparent excess of these elements in the Earth´s upper mantle and crust has been a long-lasting enigma in the interpretation of geochemical signatures of the Earth's mantle and the geochemistry of core-mantle differentiation.

So far, all metal-silicate partitioning studies make use of 'classical' HP-HT techniques and therefore are limited to PT conditions of the Earth's upper mantle. There is urgent need for experiments at much higher pressures and temperatures to simulate conditions of core-mantle boundary because it remains unclear if determined metal-silicate partition coefficients of HSE can simply be extrapolated to lower mantle conditions. Here, we present first preliminary data on metal-silicate trace element partitioning from a new experimental approach to obtain *in-situ* information at simultaneous high pressures and high temperatures using synchrotron radiation (SR). First experiments were performed at beamline ID27 (ESRF, France) using laser-heated diamond-anvil cells up to ~50 GPa and 4200 K. Samples are analysed before, during and after laser heating by SR-μXRF/XRD. The sample chamber is loaded with a HSE- doped chondrite glass chip placed next to a HSE-free metal foil ($Fe_{90}Ni_{10}$). MgO is used as pressure media and insulator. Laser heating was performed at the interface between the chondrite glass and metal foil. During stepwise heating, *in-situ* μXRF spectra and μXRD pattern of the metal foil were synchronously collected. Fluorescence analysis is used to quantify trace element concentration whereas diffraction patterns give information on melting stage and appearance of high pressure phases in the laser spot. First qualitative analysis verify existing data and show a strong partitioning of HSE into the metal liquid with increasing temperature. Quantitative data analysis is currently in progress.

[1] Ertel et al. (1999). GCA, 63, 2439-2449

Heavy noble gases from the Northern Lau Basin: The Xenon perspective on mantle heterogeneity

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Constraining the Xenon isotopic composition of the MORB and plume sources is critical to understand Earth structure, mixing between different reservoirs in the mantle, and early degassing. Recent high-precision Xe measurements from Iceland by our group indicate that the $^{129}Xe/^{130}Xe$ ratio in the Iceland plume is low compared to MORBs because of a lower I/Xe ratio. Since ^{129}Xe is produced from now extinct ^{129}I, the Xe data limits the degree of mixing between the Iceland plume source and the MORB source over Earth history.

We will also present CO_2, and noble gas data (He, Ne, Ar and Xe) from gas-rich basalt glasses along the Rochambeau Rift (RR) in the Northern Lau Basin. Our goal is to investigate whether the Xe composition of the Iceland plume is representative of other mantle plumes.

The samples selected for the study have $^3He/^4He$ ratios between 15.8 to 28.2 R_A. Recent work suggests that the high $^3He/^4He$ ratios reflect the presence of a 'Samoan-like' OIB source in the northern Lau Basin [1]. The measured $^{129}Xe/^{130}Xe$ ratios in the 28.2 R_A sample reaches 7.01. Mixing systematics between Xenon and the other noble gases in the samples demonstrate that the maximum $^{129}Xe/^{130}Xe$ ratios in the mantle source is ~7.1**,** much lower than measured values in MORBs. Additionally, the $^4He/^{40}Ar$ ratio of one of the samples is ~3, indicating it to be largely undegassed. Data obtained by multiple step crushes of this sample display a linear trend in $^{129}Xe/^{130}Xe$ vs $^3He/^{130}Xe$ space that overlaps with the Iceland data, but is quite distinct from MORBs. Our new data corroborates observations from Iceland and suggests that OIBs and MORBs evolved with different I/Xe ratios. Further, Xe in the MORB source cannot be derived from the plume source, refuting predictions for the steady-state upper mantle model. Additional work is ongoing to characterize the Pu- to U-derived fission xenon in the RR samples.

[1] Lupton (2009) *GRL* **36**.