Experimental constraints on Ag isotope fractionation during planetary core formation

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A recent study [1] proposes a heterogeneous accretion scenario for the Earth, which is for the first time based on isotopic constraints from the short-lived Pd-Ag, Mn-Cr and Hf-W decay systems. The study concludes that the Earth inherited the major part of its moderately volatile element depletion from its building blocks. The model also requires a late addition of volatile-rich material while core formation was still active. These findings are in good agreement with work based on elemental abundances of the BSE (Bulk Silicate Earth) and partitioning experiments (e.g. [2]) as well as dynamic models of the accretion and planet formation [3]. The late addition of volatile-rich material is mainly required by the Pd-Ag decay system to explain the identical Ag isotope compositions but different Pd/Ag ratios of CI chondrites and BSE.

The need for a late volatile-rich addition can be relaxed by proposing that the true BSE Ag isotope composition is more radiogenic (~ +1.2 epsilon^{107}Ag/^{109}Ag) than the measured value (-2.2 ± 0.7 [1]), because the latter was modified by extraction of light Ag into the Earth's core. To explore this possibility, we performed experiments on mixtures of silicate, sulphide and metal in a piston-cylinder apparatus at 1.5 GPa and 1800 K. Metal and silicate phases of the run products were manually extracted and analysed for Ag isotopes on a MC-ICPMS following the protocol of [4]. The Ag isotope compositions obtained for metal and silicates were identical within the analytical uncertainty (± 0.5 epsilon). This demonstrates that Ag isotope fractionation is negligible at the investigated conditions. Isotope fractionation generally decreases with T^{-2} at the temperature range considered for metal-silicate equilibration in a deep magma ocean. Therefore it is likely that Ag isotopes do not fractionate at conditions predicted for terrestrial core formation (higher T and P). Moreover, the experimental results also show that Ag partitioning into the metal increases with sulphur content.

[1] Schönbächler *et al.* (2010) *Science* **328**, 884. [2] Wood *et al.* (2008) *GCA* **72**, 1415. [3] O'Brien *et al.* (2006) *Icarus* **184**, 36. [4] Schönbächler *et al.* (2007) *Int. J. Mass Spec.* **261**, 183.

Evidence of mantle heterogeneity underneath slow-spreading ridges? Case study at 45°N mid-Atlantic ridge

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Axial volcanic ridges (AVR) are a ubiquitous feature along mid-oceanic ridges. Although numerous studies have been performed on their structure and volcanic activity, many questions still remain unanswered, e.g. do AVR basalts have a common parental magma, and are the basalts derived from different magma chambers erupting at different times?

During cruise JC24 in 2008, nearly 300 basaltic samples were collected with the ROV ISIS in order to answer some of these questions.

A large dataset has now been compiled and some preliminary results will be presented. Rare earth element (REE) data coupled with trace element data of 30 samples revealed three different groups of samples. Group I is charaterized by low La/Yb, incompatible element concentrations between normal and enriched mid-oceanic ridge basalt (N- and E-MORB). Group III has highly elevated La/Yb ratios, and a pattern of incompatibles that is more enriched in light REE than E-MORB. Group II lies in between but shows clear gaps to both other groups.

As REEs are not available for all samples yet, the incompatible and alteration-resistant elements Nb-Zr-Y were used to extend the grouping to a further 230 samples analysed by XRF. The results are coherent with the REE groupings. In addition, groups II and III could be subsequently split into subgroups.

The most enriched samples occur on (1) flat-topped volcanoes, situated off-AVR, (2) in the median valley near these volcanoes, (3) in the median valley walls on the western side as well as in the western axial floor, and (4) at the northern tip of the main AVR structure. Group II occurs on the axial floor north and west of the AVR, in the western median valley wall, and at the northern and southern tips of the AVR.

It is the aim of this study to reveal connections between volcanic structures, as well as to define the various melt sources.

Wider implications of this study are insights into the magma storage and plumbing underneath the AVR, and a detailed geochemical map of a (typical) mid-Atlantic ridge segment.