New insights into the geochemical behaviour of W by high precision isotope dilution measurements

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The geochemical behaviour of W during silicate Earth differentiation is only poorly constrained, largely due to its low abundance that makes high precision measurements difficult. Previous results (e.g., [1]) indicate a lower W/Th of the mantle (ca. 0.19) compared to the Earth’s crust, (ca. 0.26), suggesting that W appears to be more incompatible than Th. New data for MORB [2], however, demonstrate that W/Th is not significantly fractionated during dry peridotite melting, rather suggesting a fractionation of the two elements during crust formation by subduction related processes.

In order to assess the geochemical behaviour of W closer, we determined concentrations of W together with those of other high field strength elements by isotope dilution, using a mixed 183W-180Ta-24Zr-180Hf-176Lu tracer and multiple collector inductively coupled plasma mass spectrometry (MC-ICPMS). In contrast to concentrations of other HFSE, which typically can be reproduced to within ±1%, W concentrations obtained for replicates display a larger scatter, ranging up to a few percent. The external reproducibility obtained for W concentrations (typically 3-4% 2σ) appears to depend on petrological properties, suggesting an influence of sample heterogeneity effects. For the BHVO-2 standard, significant variations in both Ta and W concentrations can be observed between multiple analyses. However, whereas measured W concentrations display large variations (200 – 350 ppb), Ta/W ratios (4.96-5.16) still yield an external reproducibility of ±4% (2σ). Altogether, our results confirm a similar compatibility of Th-W and Ta that is also reported for variably depleted MORBs [2], where measured Ta/W ratios only range from 4 – 6.

First Ta-W abundances determined in basaltic glasses and whole rock powders from various island arc settings display Ta/W ratios of 0.6 – 1.7, significantly lower than the values reported for MORB. These systematic differences indicate a higher mobility of W relative to Ta in subduction related processes, which possibly causes the selective W enrichment in the continental crust.

References