What controls the Mo stable isotopic composition of MORBs?

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Molybdenum (Mo) stable isotopes hold strong potential for the investigation of the nature and conditions of early planetary processes such as core formation [e.g., 1, 2]. However their use is currently restrained by the lack of understanding of the dominant processes driving mass dependent Mo fractionations in the main silicate reservoirs. The Earth's igneous rocks exhibit Mo isotopic variations of more than 1‰ [e.g., 2-6], which likely either result from isotopic fractionation during magma production and differentiation, or from isotopic heterogeneities in the mantle source created by crustal recycling. Here we investigate the role of magmatic processes and crustal recycling on the Mo isotope composition ($\delta^{98/95}$Mo) of Mid-Ocean Ridges Basalts (MORBs) using samples from two contrasting ridge segments: (1) the extremely fast spreading Pacific-Antarctic (66-41°S) section devoid of plume influence and; (2) the slow spreading Mohns-Knipovich segment (77-71°N) intercepted by the Jan Mayen plume (71°N).

We show that significant $\delta^{98/95}$Mo variations exist in MORBs with compositions ranging from -0.24‰ to +0.15‰ (relative to NIST SRM3134). The absence of correlation between $\delta^{98/95}$Mo and indices of magma differentiation or partial melting suggest a negligible impact of these processes on the isotopic variations observed. On the other hand, $\delta^{98/95}$Mo globally correlates with radiogenic isotope signatures and rare-earth element ratios (e.g., $(La/Sm)_N$), suggesting mantle source heterogeneities as a dominant factor for the $\delta^{98/95}$Mo variations amongst MORBs. The heaviest $\delta^{98/95}$Mo correspond to the most enriched signatures, suggesting that recycled crustal components are isotopically heavy compared to the uncontaminated depleted mantle. The uncontaminated depleted mantle shows sub-chondritic $\delta^{98/95}$Mo, which cannot be produced by core formation and is, therefore, inferred to result from extensive anterior partial melting of the mantle.

[1] Hin *et al* (2013) *EPSL* **379**, 38-48. [2] Burkhardt *et al* (2014) *EPSL* **391**, 201-211. [3] Voegelin *et al.* (2014) *Lithos* **190-191**, 440-448. [4] Greber *et al* (2015) *EPSL* **421**, 129-138. [5] Freymuth *et al.* (2015) *EPSL* **432**, 176-186. [6] Yang *et al.* (2015) *GCA* **162**, 126-136.