

High-precision tungsten stable isotope measurements using a ^{180}W - ^{183}W double-spike

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The geochemical cycle of W in the crust/mantle system and in the modern/ancient low-temperature environments is so far poorly understood. Tungsten stable isotopes represent a potential tool to better constrain this cycle. However, first tungsten stable isotope data of terrestrial standard materials show inconsistent results [1, 2, 3], which highlights the analytical challenge for sufficiently accurate measurements.

We employ a newly calibrated ^{180}W - ^{183}W double-spike to assess natural mass-dependent isotope fractionation and to correct for fractionation induced during chemical purification and mass spectrometric measurement. We found a total spread in $\delta^{186}\text{W}/^{184}\text{W}$ of 0.150 ‰ having a resolution of ± 0.016 ‰ (long-term 2 s.d. of standard measurements), which allows the discrimination between different rock reservoirs.

Relative to NIST SRM 3136, the highest $\delta^{186/184}\text{W}$ values of +0.155 ‰ were observed in Pacific manganese crusts (NOD-P). Respective crusts from the Atlantic (NOD-A) show a significantly lower $\delta^{186}\text{W}/^{184}\text{W}$ value of +0.025 ‰, which tentatively indicates a heterogeneous distribution of tungsten in the modern oceans. Magmatic rocks also show a resolvable range in $\delta^{186}\text{W}/^{184}\text{W}$ values. The Andesite AGV-2 has a lower $\delta^{186}\text{W}/^{184}\text{W}$ value of +0.010 ‰ compared to the basalt BHVO-2 (+0.082 ‰) or the diabase W-2a (+0.080 ‰). Mica schist SDC-1 and the shale SCo-2 show intermediate $\delta^{186}\text{W}/^{184}\text{W}$ values of +0.039 ‰ and +0.042 ‰, respectively. Our standard results are only consistent with those of [3], but contradict with [1] and [2]. The observed variability in $\delta^{186}\text{W}/^{184}\text{W}$ values indicates resolvable isotope fractionation during igneous processes, possibly due to magmatic differentiation. Alternatively, the mobilization of crustal tungsten by magmatic/hydrothermal fluids may represent a process causing W isotope fractionation.

[1] Breton and Quitté (2014) *J. Anal. At. Spectrom.* **29**, 2284-2293. [2] Abraham et al. (2015) *J. Anal. At. Spectrom.* **30**, 2334-2342. [3] Krabbe et al. (2017) *Chem. Geol.* **450**, 135-144.