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Evidence for core-derived $\mu^{182}W$ anomalies in the Iceland mantle plume from combined ^{182}W-^{142}Nd and long-lived Sr-Nd-Pb isotope data

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Due to the long-term homogenization of Earth's mantle via convection and plate tectonics, it was long believed that Silicate Earth did not preserve its primordial differentiation products. Recognition of $\mu^{182}W$ and $\mu^{142}Nd$ anomalies (deviation from modern upper mantle values) in Archean cratons as well as Phanerozoic LIPs and OIBs provided one of the first pieces of evidence for the preservation of Hadean reservoirs in Earth's mantle. Anomalous $\mu^{182}W$ values alone were explained by variable addition of late accreted material to Earth's mantle or by core-mantle interaction, whereas coupled $\mu^{182}W$-$\mu^{142}Nd$ anomalies were likely established by Hadean silicate differentiation. Therefore, only combined investigation of these short-lived radiogenic nuclides with long-lived isotope tracers of silicate differentiation, allows to disentangle the nature of these anomalies and to infer information about the origin of such primordial reservoirs in the mantle.

This study provides the first combined $\mu^{182}W$-$\mu^{142}Nd$ dataset for the Iceland mantle plume, supplemented with long-lived Sr-Nd-Pb isotope and trace element data. Analysed samples include modern to Pliocene volcanics from all major Icelandic rift zones and today's plume center. Strontium-Pb isotope data define two differentiation trends for Iceland lavas [1], both for which $\mu^{182}W$ was analysed. For $\mu^{142}Nd$, no anomalies have been found, arguing against the presence of Hadean differentiation products in the Iceland plume source. The new $\mu^{182}W$ data show uniform, negative anomalies ($\mu^{182}W \approx -9$) in lavas of different mantle sources, reflecting a homogenous $\mu^{182}W$ composition of the younger Iceland plume. This contrasts with previous work [2], where a larger spread in $\mu^{182}W$ between lavas of different mantle sources was used to argue for mixing of mantle components with different $\mu^{182}W$ compositions. The new W isotope data lack a correlation with long-lived silicate differentiation tracers, showing that previous models [2, 3] based on mixing between mantle components of varying $\mu^{182}W$ compositions cannot fully explain the $\mu^{182}W$ patterns found in Iceland volcanics. Instead, we suggest a mantle source consisting of multiple endmembers, which were homogeneously overprinted by core-derived material deficient in ^{182}W.

[1] Harðardóttir et al. (2022) Chem.Geology 604

[2] Mundl-Petermeier et al. (2019) Chem.Geology 525

[3] Jackson et al. (2020) PNAS 117