https://doi.org/10.7185/gold2025.27028

Signatures of Hadean mantle extraction in the sources of Indian komatiites from combined $\mu^{182}W$-$\delta^{186/184}W$ systematics

ARATHY RAVINDRAN[1], RUIYU YANG[1], FRANK WOMBACHER[1], SUKALPA CHATTERJEE[2], NANILA SASI[3] AND CARSTEN MÜNKER[1]

[1]University of Cologne
[2]University of Cambridge
[3]Pondicherry Central University

Heterogeneities in $\mu^{182}W$ in Archean rocks relative to modern mantle values allow valuable insights into Hadean mantle differentiation processes on Earth, and the evolution of different mantle reservoirs with time that led to the formation of the first continents. Possible processes explaining $\mu^{182}W$ anomalies are early silicate differentiation, missing late veneer or core contributions. Early- to mid-Archean komatiites, which are high-temperature high-degree melts that best represent the primary mantle, have previously shown evidence for compositional heterogeneities. Komatiites from the Dharwar and Singhbhum cratons in India with a late Hadean mantle extraction age of ~4.19-4.15 Ga [1, 2] examined for the first time do not show $\mu^{182}W$ anomalies. However, robust assessments of primary $\mu^{182}W$ signatures have been challenging in Archean komatiites, due to the open system behaviour of W [3, 4]. An efficient proxy to assess W mobility at lower temperatures are variations of the $\mu^{182}W$ signatures with stable $\delta^{186/184}W$ values that provide direct insights on the effect of metasomatic or secondary processes in the W budget of the rocks [5].

High-precision MC-ICP-MS measurements of radiogenic $^{182}W/^{184}W$ and stable $\delta^{186/184}W$ compositions of Indian komatiites with variable W/Th acquired through isotope composition [4] and double-spike [6] techniques yielded uniform $\mu^{182}W$ values with an average of -1.0±2.3 (95% CI) and $\delta^{186/184}W$ ranging from -0.088±0.012‰ to 0.264±0.016‰ (2SE). Komatiites affected by secondary W mineralisation (W/Th ~1600) also display no discernible $\mu^{182}W$ anomalies. Weak correlations are observed between the $\delta^{186/184}W$ values of some of the Dharwar komatiites and their W/Th and W, but not with their respective $\mu^{182}W$ values (cf. [3]) or proxies for magmatic differentiation. Therefore, the source(s) of secondary W likely tap country rocks, where, unlike for $\mu^{182}W$ signatures, mass-dependant $\delta^{186/184}W$ are fractionated to a certain extent, confirming a primary Hadean signature observed in the Indian komatiites and an overall homogeneity of $\mu^{182}W$.

[1] Ravindran et al. (2024), **G-cubed** *25*

[2] Maltese et al. (2022), **Communications Earth and Environment** *3*

[3] Messling et al. (2023), **G-cubed** *24*

[4] Tusch et al. (2022), **PNAS** *119*

[5] Kurzweil et al. (2020), **GPL** *14*

[6] Kurzweil et al. (2018), **CG** *476*