

Refining the average upper crustal ^{182}W and ^{142}Nd compositions through the Archean-Proterozoic Eons

JOSUA PAKULLA¹, NIKLAS KALLNIK¹, MARIO FISCHER-GÖDDE¹, SIMON V. HOHL², ALBERTUS J.B. SMITH³, SEBASTIAN VIEHMANN⁴, GUANGYI WEI⁵, FRANK WOMBACHER¹ AND CARSTEN MÜNKER¹

¹University of Cologne

²Tongji University

³University of Johannesburg

⁴Leibniz University Hanover

⁵Nanjing University

Short-lived radioactive decay systems have become pivotal tools in understanding Hadean and Archean geodynamic processes, including core formation, silicate differentiation, continental crust formation, and the onset of (modern-style) plate tectonics. Specifically, the ^{182}Hf - ^{182}W and ^{146}Sm - ^{142}Nd isotope systems track the interaction and evolution of the core-mantle-crust system during the Hadean due to their geochemical properties and half-lives of 8.9 Myr and ~100 Myr, respectively.

Here, we present new high-precision $\mu^{182}\text{W}$ and $\mu^{142}\text{Nd}$ data for Archean and Proterozoic shales, cherts, siltstones, sandstones, and Banded Iron Formations from the Kaapvaal Craton (South Africa) and the Yangtze Block (South China), representing the regional erosional products of the uppermost continental landmasses from 3.2 to 1.2 Ga. Previous U-Pb zircon provenance data of Archean and post-Archean sedimentary rocks of the investigated formations suggest inheritance from sedimentary material as old as 3.5 Ga derived from multiple cratons. However, newly obtained Nd model ages (T_{BSE} & T_{CHUR}) are comparable, within their uncertainty, to the depositional ages (3.2 to 1.2 Ga) indicating input of dominantly juvenile materials. A positive co-variation between W and Zr abundances, Sm/Yb, and Th/Sc ratios suggests that the W inventory is predominantly influenced by more felsic source rocks. A positive co-variation between W and Th, combined with near-canonical W/Th ratios (0.1–0.5) and W concentrations exceeding those found in comparable felsic source rocks, suggests the transport of W and Th primarily in weathering-resistant detrital mineral phases. The measured $\mu^{182}\text{W}$ and $\mu^{142}\text{Nd}$ values of all sedimentary rocks, except for one shale sample, are indistinguishable from modern upper mantle compositions. Our data represent regionally integrated crustal averages from 3.2 to 1.2 Ga, suggesting that the average regional upper crust and its corresponding average mantle source were likely not anomalous in ^{182}W and ^{142}Nd . We propose that previously identified anomalies in sedimentary rocks for both isotope systems [1-3] likely originated from locally restricted and isolated mantle sources during Earth's history.

[1] Mundl et al. 2018; Chem. Geol., 495

[2] Tusch et al. 2022, PNAS, 119

[3] Schneider et al. 2018, EPSL, 487