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Palaeoweathering and Si isotopes: a record of δ^{30}Si values in metasediments and weathering crusts from the Eoarchaean to the Proterozoic

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Silicate weathering is known to play a critical role in Earth's elemental cycles and climate, yet the secular evolution of Earth's dominant weathering regime remains poorly understood. Particularly, there is little understanding of how the intensity or style of weathering shifted during the period when Earth's atmosphere transitioned from dominantly anoxic to the oxygen-rich one prevailing today. Chemically weathered Archaean-Palaeoproterozoic rocks, including inferred ancient weathering crusts [1], are useful tools for investigating this transition, as they record geochemical signatures that can be interpreted to reflect palaeoenvironmental conditions.

Here we have analysed stable silicon isotopes (δ^{30}Si) in palaeoweathering crusts from the Fennoscandian Arctic Russia–Drilling Early Earth Project (FAR-DEEP), spanning Earth's anoxic to oxic transition. The Si isotope system is used to estimate the degree of weathering in modern sediments because of the strong Si isotope fractionation that occurs during clay neoformation [2], hence we aim to establish whether clay-forming processes imparted similar compositions in the FAR-DEEP material. To assess the evolution of weathering intensity throughout early Earth history, we also compare the Fennoscandian weathering crust data to Si isotope compositions of Eoarchaean metasediments from the Isua Supracrustal Belt and Neoarchaean supracrustal gneisses from the Lewisian Gneiss Complex.

We find that Si isotopes in FAR-DEEP weathering crusts do not definitively suggest strong weathering-induced desilication or secondary mineral formation, due to their bulk silicate Earth (BSE)-like values, hovering around $\delta^{30}Si = -0.29 \pm 0.07$‰ [3]. However, coupled Si isotopes and Al/Si ratios of the FAR-DEEP samples potentially indicate deposition under cool, dry climatic conditions. The δ^{30}Si values of the older Archaean metasediments are likely dominantly controlled by source rock lithology, such as banded iron formations (BIFs) in their provenance, or moderate weathering conditions. In sum, the Si isotope compositions of ancient chemically weathered rocks so far analysed appear to record local influences or a moderate degree of weathering rather than a fundamental shift in Earth's weathering intensity across the Archaean-Proterozoic transition.

[1] Kirsimae and Melezhik (2013) *Reading the Archive of Earth's Oxygenatio*n 3, 1407-1456.

[2] Ziegler et al. (2005) *GCA* 69 (19), 4597-4610

[3] Savage et al. (2014) *Lithos* 190, 500-519