Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37745

Crustal recycling during the Cryogenian: Interplay between glacial erosion and tectonics

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Zircon preserves geochemical signatures that reflect crustal recycling processes linking surface environments to the mantle. Coupled $\delta^{18}O$–εHf systematics provide constraints on magmatic sources and trace crustal recycling through time. Building on previous studies, we applied statistical analyses to a global compilation of zircon U–Pb, $\delta^{18}O$, and Lu–Hf data, revealing potential temporal shifts across the Neoproterozoic.

Between 750 and 705 Ma, decreasing crustal residence ages indicate enhanced recycling of juvenile crust into subduction zones. This interval overlaps with the onset of the Sturtian glaciation and may be linked to intensified erosion of Tonian basaltic provinces. After 705 Ma, crustal residence ages increase, possibly indicating greater recycling of evolved crustal components during the Sturtian glaciation and Marinoan glaciation. This shift is further supported by εHf and $\delta^{18}O$ change points at ca. 690 Ma identified using the conjugate partitioned recursion algorithm (CPR) and locally estimated scatterplot smoothing (LOESS). An increased contribution of ancient sedimentary material may be consistent with tectonic reorganization during the breakup of Rodinia, potentially amplified by glacially driven erosion. Overall, these results highlight dynamic interactions among tectonics, climate, and large igneous province activity in modulating Neoproterozoic crustal evolution.