Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.24361

$^{40}Ca/^{44}Ca$ ratios from 3.5-2.6 Ga Minnesota River Valley TTGs: Implications for Archean crustal evolution

SAMUEL SKIDMORE[1], **AARON M SATKOSKI**[2] AND JOHN C. LASSITER[2]

[1]University of Texas at Austin
[2]The University of Texas at Austin
Presenting Author: satkoski@jsg.utexas.edu

Previous studies have suggested that Archean trondhjemite-tonalite-granodiorite terranes (TTGs) were generated either in modern-style subduction zone settings or by melting of overthickened basaltic crust through lower crustal delamination. A related question is the extent to which TTGs reflect juvenile inputs of mantle-derived melts (favored in subduction zone settings) or reworking of older basaltic or felsic crust (consistent with melting of thickened crust). We present new $^{40}Ca/^{44}Ca$ data from the 3.5-2.6 Ga TTGs of the Minnesota River Valley (MRV), USA. Because felsic rocks have much higher K/Ca than mafic/ultramafic rocks, reworking of older felsic material should be recorded by elevated $\varepsilon^{40}Ca$ relative to the mantle.

The oldest rocks in the MRV (3.5 Ga), primarily tonalite and trondhjemite, form a K-Ca isochron with an age (~3.78 Ga) consistent with SHRIMP U-Pb zircon ages, suggesting that the K-Ca system has not been significantly disturbed by later metamorphism. Initial $\varepsilon^{40}Ca$ values (relative to SRM 915a) range from +0.4 to -1.5, with most samples consistent with derivation from rocks with a juvenile basaltic composition (mantle $\varepsilon^{40}Ca$ = approx. -1.4). Further work is needed to evaluate if the spread in initial $\varepsilon^{40}Ca$ (3.5 Ga) values reflects some incorporation of older felsic material or more recent perturbation of the K-Ca system.

A 3.38 Ga granodiorite sample has an initial $\varepsilon^{40}Ca$ value of +0.7, consistent with remelting of the older 3.5 Ga rocks in a closed isotopic system. A mafic intrusion at 3.14 Ga has an initial $\varepsilon^{40}Ca$ value of -1.6, consistent with a mantle source. The youngest (2.6 Ga) rocks in the MRV are unmetamorphosed high-K granites with a wide range of initial $\varepsilon^{40}Ca$ values (+2.6 to +4.3), with the highest values falling along a crustal evolution curve initiating at 3.5 Ga. This likely reflects variable contributions of juvenile and recycled material in these granites. This is further supported by a broad negative correlation between $\varepsilon^{40}Ca(t)$ and $\varepsilon_{Nd}(t)$ in the complete suite.

The observed transition from closed-system to open-system dynamics at ~3.14 Ga is consistent with a suggested global change in crust formation around 3.2-3.0 Ga, possibly reflecting the onset of plate tectonics at this time.