Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35954

Decoding Makkovik's crustal evolution and uranium enrichment with isotopes

ANDREAS ZAMETZER[1], MICHAEL I. H. HARTNADY[1], JANNE LIEBMANN[1], CHRISTOPHER L. KIRKLAND[1], ALANA M HINCHEY[2], JAMES L. CROWLEY[3] AND NICOLE RAYNER[4]

[1]Timescales of Mineral Systems Group, Curtin University
[2]Geological Survey of Newfoundland and Labrador
[3]Boise State University
[4]Geological Survey of Canada

The formation of Proterozoic magmatic provinces marks a pivotal phase in Earth's evolution. These provinces record the widespread stabilization of continental lithosphere, the assembly of supercontinents, and the onset of more complex geodynamic and geochemical cycles that underpin plate tectonics and metallogenesis. In the Canadian Makkovik Province, a late Paleoproterozoic accretionary orogen along Laurentia's eastern margin, the links between crustal evolution and uranium mineralization remain unresolved. Here, we apply a multi-isotope approach combining zircon U–Pb geochronology, Hf and O isotopes in zircon, and Pb isotopes in orthoclase feldspar across 14 granitic, rhyolitic, and tuff samples from the Makkovik Province, spanning a key interval (ca. 1900–1800 Ma) in the assembly of the Nuna supercontinent. The samples investigated young from west to east and show a secular shift in zircon εHf values from unradiogenic (sub-chondritic) towards more radiogenic (juvenile) compositions. This shift in zircon Hf isotopic compositions is also positively correlated with a change in zircon $\delta^{18}O$ from mantle-like compositions (5.3 ± 0.6‰) to values as high as 7.47 ± 0.64‰, pointing to an increasing contribution of supracrustal material to the melt sources with time. Orthoclase Pb isotope compositions complement information from the other isotope systems and taken together, the results imply open-system behavior. A transition from extensive reworking of Archean crust at the margin of the North Atlantic Craton in the west of the province to the reworking of denudation products of younger juvenile crust towards the east is recorded in the samples. We model possible Pb isotopic resetting during the Grenvillian orogeny at ca. 1100 Ma and contrast it with open-system behavior with two distinct sources for the felsic melts. Mixing of low-μ ($^{238}U/^{204}Pb$), high-κ ($^{232}Th/^{238}U$) reworked Archean crust with a possible high-μ, low-κ Paleoproterozoic sedimentary source could explain Pb evolution towards increasingly radiogenic signatures in the younger ca. 1800 Ma samples. Volcano-sedimentary processes may represent fundamental mechanisms driving uranium enrichment during the post-collisional stages of Nuna assembly, potentially supporting the notion that the sedimentary cycle is a key agent of metal enrichment along the margins of thick continental lithosphere.