Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.9093

Recent Uranium Mobility in the Kiggavik Region, Nunavut, Canada: Implications for the Effects of Glaciation on a DGR

IAN BURRON[1], MOSTAFA FAYEK[1] AND JULIE BROWN[2]

[1]University of Manitoba

[2]Canadian Nuclear Safety Commission

Presenting Author: ianmburron@gmail.com

The multi-decade technical consensus amongst waste management specialists is that a Deep (~500m) Geological Repository (DGR) is the preferred option for disposal of Used Nuclear Fuel (UNF). The DGR concept uses natural and engineered barriers to isolate and contain UNF from the biosphere for ≤1 Ma while radiotoxicity decays to safe levels. This time period is long enough for several glacial cycles to elapse; it is therefore important to understand how glaciation may impact a DGR through processes such as erosion and infiltration of fluids into the subsurface. Studying the history of uranium (U) minerals and natural radionuclides in U deposits, which have been impacted by Pleistocene glaciation provides a natural analogue to investigate the potential impacts of glaciation on a DGR.

Uranium deposits in the Kiggavik region, Nunavut, Canada occur from surface to ~500m depth and have been impacted by multiple post-depositional fluid events and glacial cycles. Uranium minerals comprising uraninite, coffinite, brannerite, and U-Th-Zr silicates are hosted by clay and hematite altered metasedimentary and granitic rocks. Early U minerals (U1+U2) yield ~1.55-0.3 Ga U-Pb ages and have been subjected to multiple fluid resetting events with limited evidence of U mobility. Late U minerals associated with goethite-bearing alteration (U3) generally occur within a few cm of U1/U2 mineralization and are concentrated along redox fronts in the host rocks. These redox boundaries are controlled by open fractures and porous veins. U3 minerals have $^{235}U/^{207}Pb$ ages of >0.6-65 Ma. Uranium-thorium disequilibrium geochronology, however, indicates widespread 34-494 Ka isotopic retting events, which correlate with episodes of rapid climate change during glacial periods. Oxygen and hydrogen stable isotopic values of Illite associated with U indicate isotopic exchange with high-latitude meteoric fluids (i.e. snow/glacial melt).

The history of U mobility in the Kiggavik region suggests oxidized glacial-derived fluids may infiltrate ≥500m into the subsurface along open fractures and mobilize radionuclides. This mobility occurs sporadically over multiple glacial cycles and may be linked to climate-induced perturbations to overlying ice sheets. The proximity of U3 to U1/U2 mineralization suggests transport distances are short (several cm), although longer distance transport from the system cannot be ruled out.