Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37976

Role of hydrological regime on strontium-90 fate within wetlands

GEORGIA BARKER[1], MOKHLES RAHMAN[2], STEPHANE NGUELEU[2], BRENT SLEEP[1] AND ELODIE PASSEPORT[3]

[1]University of Toronto
[2]Canadian Nuclear Laboratories
[3]Rutgers University

Wetland environments provide an important sink for groundwater contaminated with strontium-90 (^{90}Sr) at legacy nuclear sites and can potentially mitigate downstream contamination, as observed at West Swamp, Chalk River (Canadian Nuclear Laboratory, CNL). With a $t_{1/2}$ of 28.8 years, ^{90}Sr, a beta emitter, is a key radionuclide in the contaminant inventory at Chalk River.

Onsite groundwater monitoring shows a positive correlation between the groundwater table elevation and groundwater gross beta concentration. The hydrologic regime of the West Swamp is characterised by a seasonally fluctuating water table, driven by sudden meltwater during the spring. To investigate the effect of a fluctuating water table on Sr fate, a 50-cm soil profile was excavated from the West Swamp. Mass exchange between the solid and liquid phases is expected to occur more frequently during cycles of inundation and recession. This study hypothesizes that water table fluctuations enable vertical Sr^{2+} migration and sorption along the soil column, reducing Sr^{2+} flux to surface water.

Homogenised soil was packed into two replicate acrylic columns under saturated conditions. Inert tracer tests (flow rate 0.5 ml/min) defined the porosity at 0.66 and bulk density at 1.2 g/cm^3. The initial geochemical conditions showed a column effluent gross beta at 241 ± 54 L Bq^{-1}, and dissolved organic (DOC) and inorganic carbon (DIC) concentrations at 6 and 52 mg L^{-1}, respectively. A redoximorphic profile under saturated conditions showed the two columns to be anoxic and indicates that the soil is in Fe/Mn reducing conditions.

To simulate ^{90}Sr infiltrating the subsurface, which accumulates in the topsoil via plant root uptake of Sr^{2+}, ^{85}Sr (gamma emitter, $t_{1/2}$ 65 days) was injected into the top of the column. One column is being subjected to a series of inundation and recession cycles to mimic a fluctuating water table, compared to a saturated column maintained under constant flow. Geochemical analyses including beta, gamma, DOC/DIC, major cations and anions will be conducted to determine controls on Sr fate. Mineral transformations will be identified via X-ray diffraction and X-ray fluorescence analysis. A reactive transport model evaluating Sr mobility at the sediment-water interface will be modelled using HYDRUS 1D.