Magnesium Isotopes as an Environmental Tracer to Assess Solute Migration within a Deep-Seated Sedimentary Aquiclude

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Site characterisation activities associated with a proposed Deep Geologic Repository (DGR) for Low and Intermediate Level Radioactive Waste within extremely low permeability Ordovician age sediments has provided a unique opportunity to examine solute migration on time and space scales not previously achievable. Within the 840 m thick Paleozoic sequence, the DGR would be positioned in a massive argillaceous limestone at a depth of approximately 680 m. The sediments at this depth contain post-dolomitic brines (<5M ionic strength) that are believed to represent evaporated Silurian seawater altered by rock water interaction with residence times exceeding 260 Ma[1]. Extensive investigation of the vertical distribution of elemental and isotopic porewater compositions through the entire 34 formation Devonian to Cambrian age sequence in the context of formation transport properties and solute migration processes has previously been reported[1, 2].

Magnesium isotopes are an emerging tool in the study of dolomite formation, magnesium cycling, and past continental weathering fluxes. This study has generated detailed vertical profiles of the magnesium isotopic compositions of pore and groundwaters recovered from the Michigan Basin strata to further constrain solute migration at the Bruce nuclear site. These δ^{25}Mg and δ^{26}Mg profiles are consistent with a porewater system that has remained diffusion-dominated[1,2], and provide further evidence into the initial state and subsequent water-rock interactions occuring at this site.

[1] Clark, Al, Jensen, Kennell, Mazurek, Mohapatra & Raven (2013), *Geology* 41, 951-954. [2] Al, Clark, Kennell, Jensen & Raven (2015), *Chemical Geology* 404, 1-17.