Geochemical evolution of groundwaters in the Michigan and Appalachian Basins, southwestern Ontario

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In Canada, the recommended approach for the long-term management of nuclear used fuel involves emplacement within a deep geologic repository in a crystalline or sedimentary rock setting at a nominal depth of between 500 and 1000 m. In assessing the safety of the Deep Geologic Repository concept, an understanding of groundwater flow system evolution is required at time frames of 100 000 years and beyond. During this timeframe, significant climate changes will likely occur as a result of glaciation/deglaciation cycles, the movement of coast lines due to sea level changes, and isostatic compression and uplift. The hydrologic and hydrogeologic changes imposed by these events could potentially cause changes in the geochemical conditions (e.g. salinity, redox conditions) at repository depths, which could in turn, impact the long-term performance of a deep geologic repository.

In this study, a synthesis of available hydrogeochemical information was conducted to provide an improved understanding of the geochemical evolution of groundwaters within the Paleozoic sedimentary rock formations underlying southwestern Ontario. As part of the synthesis, a geochemical database was compiled that includes both previously unpublished and published chemical and isotopic (^{3}H, $\delta^{2}H$, $\delta^{18}O$, $^{87/86}Sr$ and $\delta^{37}Cl$) analyses for groundwaters collected during more than 20 years of research from within formations in the Michigan and Appalachian Basins.

Relationships between the chemical and isotopic parameters measured for groundwaters in the extended database were used in conjunction with published literature to evaluate the geochemical evidence relating to the stability of the deep groundwater flow system underlying southwestern Ontario. This included an examination of the geochemical evidence for i) the depth of penetration of glacial waters into the sedimentary sequence in the past; ii) regional-scale mixing of groundwaters; and iii) cross-formational flow deep within the sedimentary sequence, with an emphasis on possible relationships to major structural features such as fractures and major tectonic boundaries in the crystalline basement.