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A study of flow system dynamics utilizing a diverse set of isotopic and geochemical methods; Oak Ridges Moraine, Ontario

Lori Labelle, Shaun Frape
Department of Earth and Environmental Science, University of Waterloo, Waterloo, Ontario, Canada
Rick Gerber
Oak Ridges Moraine Hydrogeology Program, Toronto, Ontario, Canada

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ABSTRACT

The Oak Ridges Moraine (ORM) is a 160-km long ridge a mixture of sand, silt and gravel deposits north of Lake Ontario, and extends west to east from the Niagara Escarpment to Peterborough and the Trent River. Understanding the complex flow system is complicated by the regional geology, which includes aquifers in the bedrock valleys, till aquifers, and eroded tunnel channels separated by aquitards. The Oak Ridges Moraine is recognized as a regionally significant groundwater recharge area and is an important source of domestic water for the Greater Toronto Region, along with providing base flow to hundreds of local streams.

This regional study examines a diverse moraine complex, consisting of sediments ranging from earlier glaciations (~130k) to considerably younger materials from recent glacial events (~20k) (Barnett *et al*. 1998). This results in a very complex flow system within the Oak Ridges Moraine, consisting of multiple aquifer/aquitard units and end members causing multiple potential mixing scenarios. To assess this complicated hydrostratigraphy a diverse range of age dating and isotopic methods have been used in the study. Naturally occurring stable isotopes can be used to trace groundwater flow paths and provide direct evidence of the vulnerability of an aquifer; as well as provide insight into flow systems at various scales within the moraine complex. Historically studies use environmental age tracers to examine flow and mixing in aquifers (Solomon *et al*. 1995), though on the scale of the Oak Ridges Moraine there have been few studies that have attempted to integrate such a diverse set of environmental isotopic and geochemical tracers to constrain groundwater pathways and ages.

Stable isotopic results from this study have defined three distinct groundwater types; post-glacially recharged waters with no tritium and depleted oxygen isotopic signatures, a minority of samples are recharged from waters having undergone evaporative processes and represent monitoring wells with a direct connection to surface waters and finally the majority of samples have measurable tritium (up to 183.5 TU), suggesting a large component of recently recharged meteoric water. As with Fritz *et al* 1987 these samples show isotopic change with geographical distribution across the study region. Mixing between these groundwater groups is prevalent as a result of usage. Rare gas data combined with stable isotopes and environmental tracers will help to understand the different flow systems within the ORM, mean residence time, temperature at the time of recharge and mixing.

3. References

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