Chlorine ($\delta^{37}Cl$) stable isotope distribution in the groundwaters of the Oak Ridges Moraine, southern Ontario, Canada

L. LABELLE[1]*, S. FRAPE[1], N. ISAACS[1] & R. GERBER[2]
[1]Department of Earth Science, University of Waterloo, Waterloo, Ontario, Canada
(*correspondence: lori.labelle@uwaterloo.ca)
[2]Oak Ridges Moraine Hydrogeology Program, Toronto, Ontario, Canada

The Oak Ridges Moraine (ORM) is recognized as a major regionally significant domestic groundwater resource for the Toronto Region, Canada. It is essential to water management to understand the elements derived from natural and anthropogenic sources that infiltrate this groundwater system.

In the last 50 years, the application of de-icing chemicals to southern Ontario roadways has become standard practice during the winter season. Approximately 4.9 million tonnes of salt is applied annually to Canadian roadways [1].

This study determines what contributes to the presence of chloride in groundwaters of the ORM. The $\delta^{37}Cl$ signature of road salt is ±0.2‰ SMOC [2]. Samples of salts and bedrock brines, in addition to suspected anthropogenic contributors, are compared with groundwater and porewater samples from a number of regional and municipal wells across the ORM.

The impact of each potential source is assessed using an appropriate comparison of isotopic ratios and geochemical plots which identify these sources. The highest chloride concentrations (800-1400 mg/L) are found at shallow depths and carry the localized isotopic signature (±0.2‰, SMOC) for road salt. However, high concentrations (>200 mg/L) are also found in both older and recently recharged waters up to 170 m. in depth, some of which carry the road salt signature. This suggests high chloride concentrations are not limited to shallow depths where anthropogenic input occurs, but also are present at greater depths as a result of natural and anthropogenic sources. Other sources of Cl at depth can be attributed to upward diffusion of highly concentrated bedrock sources. These underlying units often have distinctive $\delta^{37}Cl$ isotopic signatures and can be distinguished from salts used in road de-icing. This study's findings suggest that both natural and anthropogenic sources need to be considered in the monitoring of chloride in the groundwaters of the ORM.

[1] Environment Canada (2001) Technical Report.
[2] Rosen (1999). M.Sc. Thesis, University of Waterloo.