Chlorine and Bromine Isotopic Analyses of Groundwaters from the Bruce Nuclear Site,Canada

Y.Z. WANG[1*], S.K. FRAPE[1], L. KENNELL-MORRISON[2]

[1]Dept. of Earth and Environmental Sciences, University of Waterloo, Waterloo, ON, Canada N2L 3G1, (*correspondence: y526wang@uwaterloo.ca, shaun@uwaterloo.ca),

[2]Nuclear Waste Management Organization, Toronto, ON, Canada, M4T 2S3, (lkennell@nwmo.ca)

This research describes $\delta^{37}Cl$ and $\delta^{81}Br$ isotopic analyses for groundwaters from Paleozoic sedimentary rocks at the Bruce Nuclear Site, near Kincardine, Ontario, Canada. The stable isotopes of Cl and Br, in conjunction with their geochemical parameters, are examined to ascertain the origin of salts and fluids containing these elements, as well as to identify processes that cause isotopic fractionation. Results reveal that the sampled groundwaters (from boreholes DGR-3/4) have isotopic and geochemical signatures similar to formation fluids sampled from the same geological units elsewhere in the Michigan Basin, as documented within combined regional databases [1,2,3]. The Salina A1 samples appear to have been altered by halite dissolution and mixing with cold climate recharge. The Salina A1 and Guelph formation groundwaters, sourced within the Michigan Basin, are both isotopically depleted in $\delta^{81}Br$. In contrast, the Cambrian groundwaters show enriched Cl and Br isotopic signatures and are similar to Cambrian brines found in the Appalachian Basin to the east and south. The halide isotopic signatures of the Cambrian groundwaters suggest that these fluids may be very old, and their isotopic compositions maintained since emplacement during basinal fluid migration events occurring in the early Paleozoic. The Lower Silurian to Late Ordovician stratigraphic sequence (~400 m thick) at the site has been effectively defined as a diffusion-dominated system, and the Cambrian is characterized as a confined aquifer [4, 5]. Therefore, for this study, an increased understanding of transport processes, and the origin and relative ages of potential end-member fluids, can be gained through the analyses of porewater Cl and Br isotopes, which can be used to compliment chemical and isotopic parameters already used to assess solute longevity.

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