Figure 2 Dissolved [Cl] plotted against dissolved [Na] (**A**) and [Ca] (**B**)

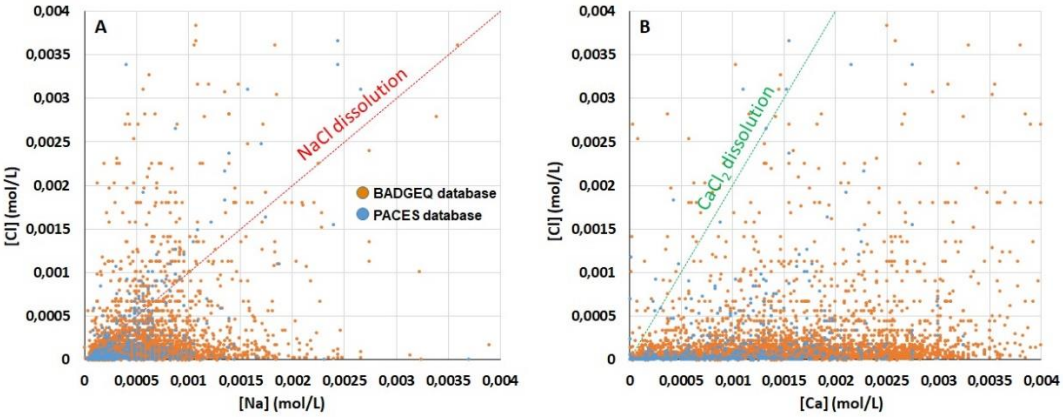


Figure 3 Dissolved [Cl] plotted against the sum of dissolved [Na] and [Ca]

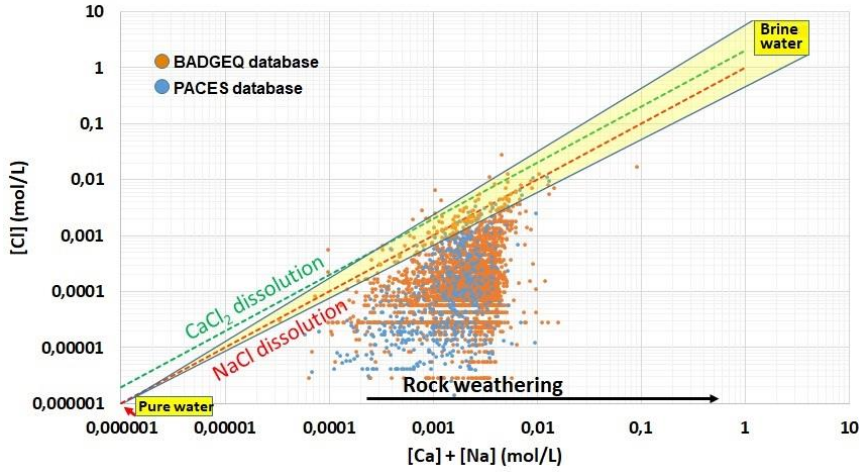
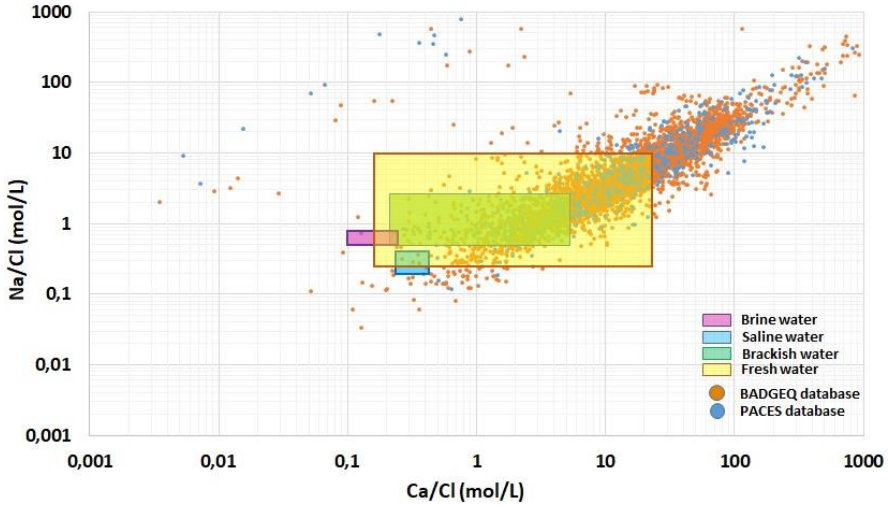


Figure 4 Na/Cl ratio plotted against Ca/Cl ratio



Opening remarks

The results of the study provide information aimed at elucidating the sources of chloride in the shallow aquifers of the Barlow-Ojibway Clay Belt. The preliminary interpretation of Cl^-, Na^+, Ca^{2+}, and $\delta^{37}Cl$ suggests the mixing of Cl^- from different sources, as de-icing salts and brines. Next steps will include GIS-based and statistical approaches to interpret the data considering the sampling sites hydrogeological contexts. A comprehensive understanding of the sources of chloride is mandatory to assure sound management of these shallow aquifers.

Acknowledgements

This project was possible due to funding from the Natural Sciences and Engineering Research Council of Canada (NSERC discovery grant to V Cloutier). The authors acknowledge the financial contribution of the *Ministère de l'Environnement et de la Lutte contre les changements climatiques du Québec* (MELCC) through the *Programme d'acquisition des connaissances sur les eaux souterraines* (PACES).

References

Alcalá, F.J., Custodio, E., 2008. Using the Cl/Br ratio as a tracer to identify the origin of salinity in aquifers in Spain and Portugal. Volume 359, Issues 1–2, 15 September 2008, Pages 189-207.

Bondu, R., Cloutier, V., Rosa, E., 2018. Occurrence of geogenic contaminants in private wells from a crystalline bedrock aquifer in western Quebec: geochemical sources and risks. J. Hydrol. 559 :627-637.

Cloutier, V., Rosa, E., Roy, M., Nadeau, S., Blanchette, Dallaire, P.L., Derrien, G., and Veillette, J.J., 2016. Atlas hydrogéologique de l'Abitibi-Témiscamingue. Presses de l'Université du Québec. ISBN 978-2-7605-4507-6.

Frape, S.K., Fritz, P., McNutt, R.T., 1984. Water-rock interaction and chemistry of groundwaters from the Canadian Shield. Geochimica et Cosmochimica Acta, 48(8), 1617-1627.

Gaillardet, J., Viers, J., Dupré, B., 2005. Trace elements in river waters. In Drever, J.I. (Ed.), H.D Holland, K.K. Turekian (executive Ed.), vol 5, Treatise on geochemistry (pp. 225–272). Netherlands: Elsevier.

Hem, J.D., 1985. Study and interpretation of the chemical characteristics of natural water (Vol. 2254). Department of the Interior, US Geological Survey.

Howard, K.W., Haynes, J., 1993. Groundwater contamination due to road de-icing chemicals—salt balance implications. Geoscience Canada.

Kaufmann, R.S., Long, A., Campbell, D.J., 1988. Chlorine isotope distribution in formation waters, Texas and Louisiana. AAPG Bulletin, 72(7), 839-844.

Kloppmann, W., Negrel, Ph., Casanova, J., Klinge, H., Schelkes, K., Guerrot, C., 2001. Halite dissolution derived brines in the vicinity of a Permian salt dome (N German Basin). Evidence from boron, strontium, oxygen, and hydrogen isotopes. Geochimica et Cosmochimica Acta 65 (22), 4087–4101

Lalonde, J.P., Chouinard, N., Bergeron, R., 1980. Atlas géochimique des eaux souterraines, région de l'Abitibi. Ministère de l'Energie et des Ressources, Québec. DPV-725.

Lalonde J.P., Pelletier, M., 1983. Atlas géochimique des eaux souterraines et des sols, région du Témiscamingue. Ministère de l'Energie et des Ressources Québec. DV-83-02.

Marques, J.E., Marques, J.M., Carvalho, A., Carreira, P.M., Moura, R., Mansilha, C., 2019. Groundwater resources in a Mediterranean mountainous region: environmental impact of road de-icing. Sustainable Water Resources Management, 5(1), 305-317.

Perera, N., Gharabaghi, B., Howard, K., 2013. Groundwater chloride response in the highland creek watershed due to road salt application: a re-assessment after 20 years. J Hydrol 479:159–168.

Pollock, S.J., Toler, L.G., 1973. Effects of highway de-icing salts on groundwater and water supplies in Massachusetts. Highway Research Record, (425).

Rey N., 2020. Traçage hydrogéochimique des systèmes aquiferes-aquitards de la ceinture argileuse Barlow-Ojibway. Ph.D. Thesis, UQAT.

Trenouth, W.R., Gharabaghi, B., Perera, N., 2015. Road salt application planning tool for winter de-icing operations. J Hydrol 524:401–410.

Walter, L.M., Martini, M.M., Stueber, A.M., Moldovanyi, E.P., 1993. Saline formation waters: new constraints on origin and migration from comparisons at the basin scale. Geol Soc Am Abs Prog 25(6):1–23.