ISOTOPE AND HYDROGEOCHEMICAL CHARACTERISATION OF GROUNDWATER IN A DEGRADING PERMAFROST ENVIRONMENT IN NORTHERN QUEBEC

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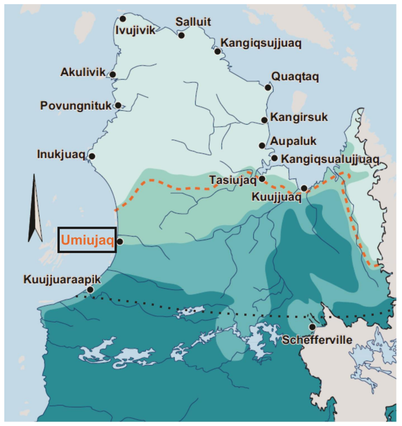
Introduction

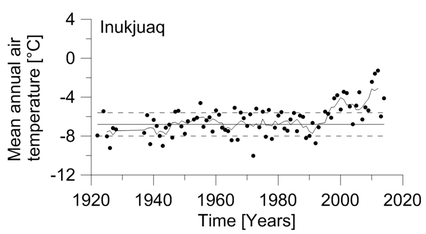
One consequence of global warming already being felt in northern Quebec is permafrost thaw. Although its influence on groundwater resources is still largely unknown, it will probably lead to increased groundwater recharge and changing flow dynamics (Michel & Van Everdingen, 1994; Quinton & Baltzer 2013).



Permafrost distribution in Nunavik

- Continuous
- Extensive discontinuous
- Sporadic discontinuous
- Isolated

Ouranos 2010, after Allard and Seguin (1987).

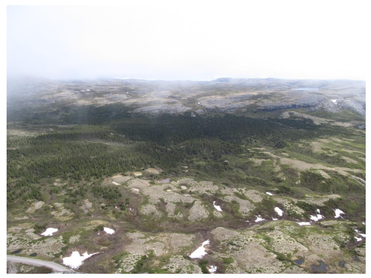


Data from Environment Canada

Objectives

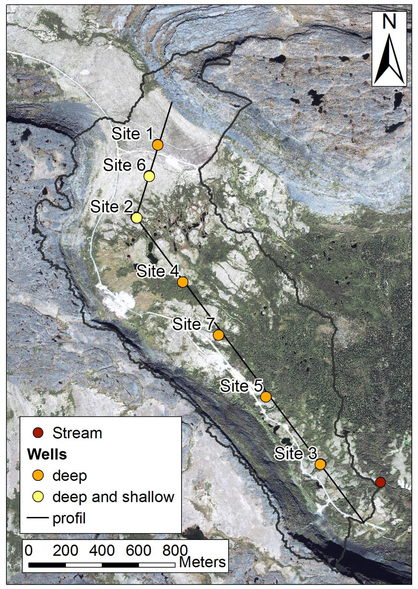
The characterization of groundwater flow with hydrogeochemical and isotopic tracers is helping to evaluate groundwater flow dynamics in a discontinuous permafrost zone affected by degradation.

Various tracers are being used to identify the origin of groundwater (i.e. proportions from rain, snow and permafrost), to characterize groundwater evolution along a primary flow path, and to understand seasonal dynamics together with determination of residence time.



Methods

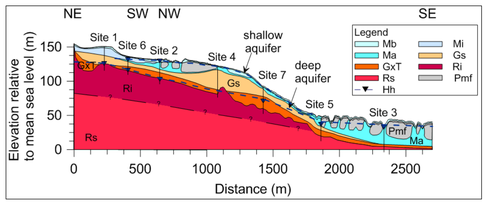
The Immatsiak well network, located close to the Inuit village of Umiujaq and belonging to the Quebec Ministry of Environment (MDDELCC), was used to sample groundwater. Surface water, precipitation and permafrost samples were collected during four field campaigns in the summers 2013, 2014, 2015 and in November 2014.



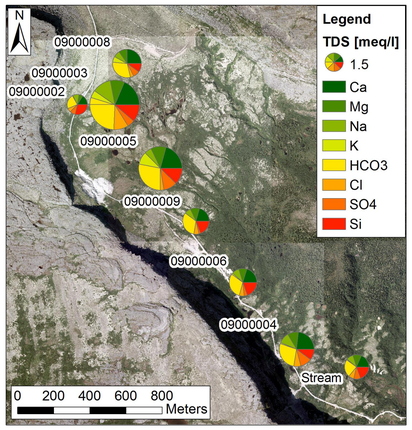
The Immatsiak well network close to the Inuit village of Umiujaq

The investigated parameters are listed below:

- Dissolved metals
- Major anions
- $\delta^{18}O$ and $\delta^{2}H$
- DIC, DOC, POC and their $\delta^{13}C$
- ^{14}C (DIC) and $^{3}H/^{3}He$
- Noble gas



A profile along the valley showing the wells, sediments and permafrost distribution. Vertical exageration 1:5.



First results

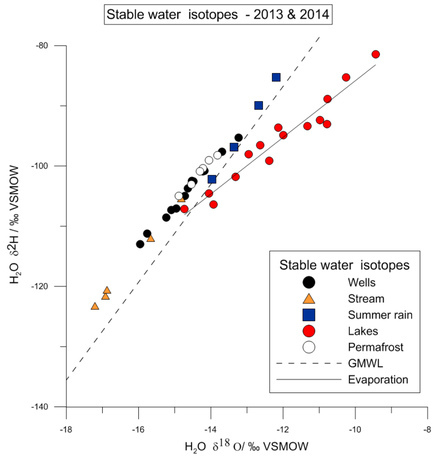
First results from groundwater hydrogeochemical data:

- Mainly Ca-HCO_3 water types.
- Groundwater with low TDS
- The shallow aquifer has lower concentrations in TDS
- Similar composition between 09000004 and the stream
- Two wells seem unconnected to the deep aquifer

First results

First results from water $\delta^{18}O$ and $\delta^{2}H$:

- Groundwater depletion compared to rain
- Permafrost signature is similar to groundwater
- Shallow thermokarst lakes show an enrichment resulting from evaporation



Conclusions

Key points from this preliminary hydrogeochemical study :

- The permafrost seems to be influenced by modern waters (groundwater and precipitation), being not as depleted in $\delta^{18}O$ and $\delta^{2}H$ as we had originally thought.
- Low TDS in groundwater (max 150 mg/l at site 3).
- Groundwater is influencing the stream chemical composition, with seasonal variations.

Further analysis of water and carbon isotopes, age dating, determination of the local meteoric water line for $\delta^{18}O$ and $\delta^{2}H$ and data treatment are needed to confirm these results and present a global picture of groundwater dynamics in this discontinuous permafrost zone affected by degradation.

References

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• Ouranos. *Savoir s'adapter aux changements climatiques, Réd: C. DesJarlais, M. Allard, D. Bélanger, A. Blondlot, A. Bouffard, A. Bourque,D. Chaumont, P. Gosselin, D. Houle, C. Larrivée, N. Lease, A.T. Pham, R. Roy, J.-P. Savard, R. Turcotte et C. Villeneuve, Montréal, 2010, 128 p.*
• Quinton, W. L., & Baltzer, J. L. 2013. The active-layer hydrology of a peat plateau with thawing permafrost (Scotty Creek, Canada). Hydrogeology Journal, 21, 201–220.