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Hydrogeochemical characterisation of groundwater in a small watershed in a discontinuous permafrost zone.

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Impacts of climate change can already be seen in northern regions. However, the influence of increasing temperature and permafrost degradation on groundwater dynamics is still poorly understood. This study aims to improve knowledge on hydrogeological interactions in degrading permafrost environments using hydrogeochemical characterisation of groundwater.

This study is being conducted in a small 2-km^2 watershed, in a discontinuous permafrost zone located close to the Inuit community of Umiujaq, on the eastern shore of Hudson Bay in northern Québec, Canada. Two aquifers are being investigated, an unconfined shallow sandy aquifer located in the upper part of the watershed, and a deeper confined aquifer in sands and gravels located below the permafrost mounds. Precipitation, stream and surface water as well as ice-rich permafrost lenses were also sampled during field investigations.

Various hydrogeochemical tracers including major ions, water stable isotopes ($\delta^{18}OH_2O$ and $\delta^{2}HH_2O$), carbon phases (DIC, DOC, POC), their stable carbon isotopes ($\delta^{13}C$) and dating tracers (radiocarbon, tritium-helium and CFC/SF6) were analyzed. This characterisation has contributed to further understanding groundwater origin, evolution and residence time in the watershed.

Preliminary results show that groundwater has a mainly Ca-HCO_3 geochemical signature, typical for young and poorly evolved water. Furthermore, sample mineralisation is low, and is likely linked to limited bedrock weathering caused by short residence times, slow reaction rates as well as low levels of dissolved CO_2 due to suppressed biological activity in the catchment. Inter-annual variation of major ions in the deeper aquifer is low. All groundwater samples have significant tritium concentrations, around 8.5 TU, reflecting modern recharge. Ice-rich permafrost lenses within the top four meters of permafrost have a water stable isotope signature close to modern precipitation and groundwater. This indicates that either recharge conditions of permafrost ice were similar to current conditions, or freeze-thaw cycles have drawn modern water into the permafrost mounds. The stream appears to be fed by groundwater exfiltrating at the base of permafrost mounds in the lower part of the watershed.

Linking this hydrogeochemical characterisation to groundwater and thermal modelling at the watershed and permafrost mound scales will improve our knowledge on hydrogeological interactions in degrading permafrost environments.