Groundwater dynamics and transport processes in a discontinuous permafrost environment

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With increasing concerns of global warming, the influence of permafrost degradation on groundwater quality is of growing interest. In this context, a detailed field study on groundwater dynamics in a discontinuous permafrost environment is being conducted in a small 2-km^2 watershed in northern Québec, Canada. Groundwater origin and evolution, as well as flow dynamics and residence times within the watershed are being investigated using hydrogeochemical tracers such as major ions, water stable isotopes ($\delta^{18}O_{H2O}$ and $\delta^{2}H_{H2O}$), carbon phases (DIC, DOC, POC) and their stable carbon isotopes ($\delta^{13}C$), and dating tools (radiocarbon and tritium-helium methods).

Groundwater types mainly fall into the Ca-HCO_3 field. Sample mineralisation is close to the composition of rain and snow, 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 in groundwater due to suppressed biological activity in the catchment. Stream-water samples at the watershed outlet had similar hydrochemical composition when compared to groundwaters. Preliminary $\delta^{18}O_{H2O}$ and $\delta^{2}H_{H2O}$ results suggest that ice lenses within the top four meters of permafrost are under the influence of modern water. Moreover, stream water sampled in July appears to be influenced by a snowmelt signature whereas water isotope ratios from thermokarst lakes show an influence of evaporation. Combined with further hydrogeochemical data analyses and numerical modelling, these results will help to provide insight into the groundwater flow dynamics and thermal regime in this watershed of degrading discontinuous permafrost. This will enable assessment of groundwater availability, including for use as a drinking water resource in northern communities.