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Surface water types in the Western Canadian Arctic: geochemical evolution and aquatic carbon transport

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Arctic surface waters are a substantial conduit for terrestrial C flow as well as a potential source of GHGs to the atmosphere – a significant positive feedback to global climate warming and a key component of the net ecosystem carbon balance in permafrost regions. As temperatures rise in the Arctic, permafrost thaw deepens releasing C from the landscape into the aquatic system making streams and lakes increasingly important conduits and reactors of both allochthonous and autochthonous C. The HYDRA project ("Permafrost catchments in transition: hydrological controls on carbon cycling and greenhouse gas budgets"), aims to quantify the assimilation of C and the controls of C movement between the plant-soil-water-atmosphere continuum. The specific aspect of the project presented here considers the different aquatic pathways in warming Arctic permafrost catchments, and the potential role that they play in GHG emissions and aquatic C cycling.

This study presents the surface water geochemistry of Siksik Creek, a small (<1 km^2) headwater tributary to Trail Valley Creek, and a neighbouring system of small lakes ($\sim$12 km^2) from two field seasons in the Western Canadian Arctic. The study area is underlain by a Miocene/Pliocene quartz-rich sedimentary formation and Quaternary Pleistocene till. The surface topography is dominated by organic-rich soils in a heterogeneous hummock-inter hummock morphology, with an average permafrost active layer depth of 40 cm in the hummocks, and 5 cm in the inter hummocks during the summer. The vegetation consists predominantly of sedges (*Eriophorum* and *Carex spp.*) and moss (*Sphagnum spp.*) with some areas of shrubs (*Alder* and *Birch spp.*). Six distinct water types were identified based on their landscape position: lake inflow, lake body, lake outflow, ice-wedge polygons, headwater stream (Siksik), and a larger stream system (Trail Valley Creek). Dissolved organic C (DOC), dissolved inorganic C (DIC), CO_2, CH_4, major cations and anions, trace metals, pH, EC, and temperature were measured in 374 stream and lake water samples across the six water types. The geochemistry of the water samples were compared within and between each water type (including rainfall chemistry) over the two sampling campaigns to explore the geochemical evolution and variation of surface waters in permafrost landscapes. Particular focus is placed on ion/Cl ratios to determine potential inputs from weathering products.

Our underlying analyses of the biogeochemistry of different water types associated with permafrost landscapes will be used to aid the interpretation of aquatic C (using ANOVA) and ^{14}C data, specifically to answer the following questions:
1. What are the sources of water in permafrost catchments, and how do these relate to concentrations and fluxes of transported C?
2. What are the pathways and apparent residence times of surface water flow in the catchments and how do these affect the geochemical evolution of the water, aquatic C concentrations, and mineralisation of organic C to CO_2?
3. How will a warming Arctic affect the relative importance of these flow paths, and what are the implications for water geochemistry and aquatic C transport?