

# Seasonal Dynamics of Selenium and Vanadium in Subarctic Thermokarst Ponds

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In the northern hemisphere, subarctic wetlands lying on sporadic permafrost are currently undergoing rapid transformation, including a reduction in ice coverage, warmer summers and increase mobility of organic matter. These impact redox conditions and the mobility of redox-sensitive elements. Here, we aim to better understand the geochemical cycling of selenium (Se) and vanadium (V), two oxyanions-forming elements whose mobility is influenced by seasonal changes in the water chemistry.

This study focuses on four ponds within a peatland area with contrasting oxygenation conditions near Kuujuarapik, Nunavik, Canada. We measured physicochemical parameters, major (C, S, Fe, Mn, Al), and trace element (Se, V, As) concentrations in the water-column and sediment porewater during summer and winter. The speciation of Se was calculated using thermodynamic models with measured water chemistry as inputs. Net-rates of Se and V reactions were estimated using an inverse modeling approach with diffusion coefficients and sediment porosity as input, yielding net reaction rates and fluxes across the sediment-water interface.

Our results indicated that Se mobility is influenced by both changes in water temperature and dissolved oxygen concentrations. This is illustrated by Se concentration in the water column decreasing from 11 nM in the summer to 1 nM in the winter, concurrent with a change in Se speciation from selenate in oxygenated surface water to selenide in anoxic porewater. Such changes in Se speciation and distribution are the results of flux of Se from the water column to the sediment, which increase from 33 to 56 nmol cm<sup>-3</sup> yr<sup>-1</sup> from the summer to the winter.

Vanadium, conversely to Se, is less impacted by seasonal dynamics, with concentrations of 10 ± 1 nM throughout the year. The distribution of V in 2 ponds closely matches that of dissolved Fe (linear regression: R<sup>2</sup> = 0.9, p-value <0.0001), suggesting recycling with Fe (oxy)hydroxides. Our results highlight the clear contrast in the behavior of redox-sensitive oxyanions of Se and V – with Se distribution being highly dependent on seasonal variation. We hypothesize that a warmer