Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34472

# Iron-sulfur chemistry drives divergent trace metal behaviour in the sediments of a High Arctic lake historically eutrophied by organic matter inputs

**FLORENCE MERCIER**[1,2,3,4], FELIX CLOUTIER-ARTIWAT[1,2,3,4], ANNE-SOPHIE LACHANCE[1,2,3,4], PÉNÉLOPE BLACKBURN-DESBIENS[2,3,5], CATHERINE GIRARD[2,3,6] AND RAOUL-MARIE COUTURE[1,2,3,4]

[1]Department of Chemistry, Université Laval
[2]Centre for Northern Studies (CEN)
[3]Interuniversity Research Group in Limnology (GRIL)
[4]Takuvik International Research Laboratory
[5]Department of Fundamental Sciences, Université du Québec à Chicoutimi
[6]Department of Biochemistry, Microbiology, and Bio-informatics, Université Laval

Although human activity is expected to increase markedly over the coming decades at northern latitudes, the response of Arctic lakes to anthropogenic disturbances remains poorly understood. Meretta Lake (74°42'N, Nunavut, Canada) provides a rare opportunity to examine this response through the geochemical legacy of historical organic matter loading. The Upper Basin (6.5 m depth) received direct inputs of untreated sewage between 1949 and 1998, whereas the downstream Lower Basin (9 m depth) did not.

We collected sediment cores from both basins for porewater (-2 to 10 cm depth) and sediment (upper 20 cm) analyses. We measured dissolved concentrations of nutrients ($NH_4^+$, $PO_4^{3-}$), redox-sensitive elements (Mn, Fe), sulfur species ($SO_4^{2-}$, $S_2O_3^{2-}$, $\Sigma HS^-$), and trace elements (V, As, Cd, Pb). Solid-phase analyses included bulk composition (C, N, S), reduced inorganic sulfur speciation (AVS, CRS, ES), and sequential metal extractions.

Our findings suggest contrasting iron-sulfur regimes between the basins. The Upper Basin is depleted in Fe (porewater Fe <12 µM) but exhibits elevated $\Sigma HS^-$ (up to ~17 µM) and pyrite ($FeS_2$), which accounts for most of its solid-phase reduced sulfur pool (~80-91% CRS). In contrast, the Lower Basin contains abundant Fe (porewater Fe up to ~210 µM), low $\Sigma HS^-$ (<3 µM), and higher proportions of iron monosulfide (FeS) phases (~60-80% AVS). These conditions influence trace element behaviour. In the Upper Basin, V and As are more mobile, with porewater concentrations respectively 6- and 2-fold higher than in the Lower Basin. In the latter basin, both elements are scavenged through sorption onto Fe oxyhydroxide and sulfide precipitation. We propose two concurrent mechanisms to explain this contrast. First, differences in sub-catchment bedrock geology may have predisposed the basins for divergent diagenetic trajectories. Second, organic carbon inputs from sewage likely drove the exhaustion of reactive Fe in the Upper Basin through sustained anoxia and pyrite precipitation. Excess Fe diffused towards the hypolimnion and was shuttled to the Lower Basin, where it subsequently precipitated. These results demonstrate that iron-sulfur stoichiometry, rather than proximity to the historic contamination source, now governs trace element mobility in these Arctic lake sediments.