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# Mercury cycling across Arctic Lakes of the Mackenzie Delta and biogeochemical controls

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Permafrost thaw is reshaping Arctic landscapes and influencing geochemical processes that control mercury (Hg) mobilization, speciation, and bioavailability in northern freshwater systems. However, the extent to which thermokarst development influences Hg distribution, methylation and bioavailability remains poorly constrained. We examined total Hg (THg) and methylmercury (MeHg) in three Mackenzie Delta lakes (Northwest Territories) spanning a thermokarst gradient: a permafrost-stable lake (Lake 129), an actively transitioning basin (Lake 280), and a mature thermokarst lake (Lake 520).

THg and MeHg were measured in sediments, catchment soils, plankton, and periphyton to evaluate Hg partitioning and transformation across the three lakes. The permafrost-stable Lake 129 exhibited low–moderate THg in soils (42 ± 4 ng $g^{-1}$) and sediments (71 ± 1 ng $g^{-1}$) and moderate plankton THg (77 ± 5 ng $g^{-1}$). The mature thermokarst Lake 520 had lower sediment THg (58 ± 8 ng $g^{-1}$) and slightly higher plankton THg (100 ± 10 ng $g^{-1}$), but the highest soil THg (110 ± 9 ng $g^{-1}$), consistent with its peat-rich catchment. In contrast, transitional Lake 280 showed substantially elevated plankton THg (240 ± 40 ng $g^{-1}$) despite sediment THg (57 ± 5 ng $g^{-1}$) comparable to Lake 520 and similarly low soil THg (38 ± 4 ng $g^{-1}$) to Lake 129. Across all lakes, MeHg comprised ≤2.5% of sediment and soil THg but was strongly enriched in plankton. Plankton %MeHg was similar in Lakes 129 and 520 (64 ± 3% and 68 ± 9%), but substantially higher in Lake 280 (97 ± 17%), potentially indicative of highly efficient methylation (possibly in the water column), preferential retention in pelagic biomass, and/or food web and bioaccumulation differences. These results suggest that lakes undergoing active thermokarst transition do not exhibit a direct link between sediment and soil Hg inventories and biological Hg uptake. Ongoing analyses of water-column and sediment geochemistry (organic matter composition, sulfate, phosphate, Fe) will further constrain controls on Hg mobilization and methylation. Collectively, these results identify transitional thermokarst lakes as potential hotspots of Hg bioaccumulation, with implications for Hg transfer to Arctic food webs as permafrost thaw accelerates.