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Characterizing water mass origins and nutrient sources and sinks in Baffin Bay using multiple geochemical tracers

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Baffin Bay is a marginal sea between Greenland and Baffin Island that connects Pacific waters traveling through the Arctic to the North Atlantic Ocean. The long residence time of water in the deep basin allows distinctive geochemical signatures to accumulate [1,2], providing an opportunity to examine the impact of remineralization on nutrient inventories. Using a suite of biogeochemical tracers measured in Baffin Bay between 2015–2019, including concentration and isotopic measurements of nitrogen gas (N_2), nitrous oxide (N_2O), and nitrate (NO_3^-), we examined the relative contributions of Atlantic and Pacific waters, as well as the biogeochemical signatures of remineralization. We observed N:P ratios of 12:1 in bottom waters of Baffin Bay, reflecting sedimentary denitrification of organic matter, which regulates the nutrient inventories that are exchanged with adjacent oceanic regions [2]. Nitrate isotope measurements revealed bottom water $\delta^{15}N\text{-}NO_3^-$ of 7‰, suggesting that denitrification is fueled by organic matter produced in northern Baffin Bay and nutrients originating in the Pacific Ocean [2]. Nitrous oxide isotopocule measurements in bottom waters demonstrated elevated $\delta^{18}O\text{-}N_2O$ (~73‰) and $\delta^{15}N^{\alpha}\text{-}N_2O$ (~31‰), indicating that N_2O derived from incomplete sedimentary denitrification has diffused into the water column. We quantified the proportion of near-bottom N_2 generated through denitrification using clumped isotope measurements ($^{15}N^{15}N$) [3,4], the first application of this tracer in the ocean. The near-bottom $^{15}N^{15}N$ measurements indicate that 0.8–1.9% of the N_2 (10–24 μmol N kg^{-1}) is derived from denitrification. We compare the $^{15}N^{15}N$ measurements with N_2/Ar gas ratios, demonstrating the influence of physical processes on the N_2/Ar ratio in subsurface waters. Repeat measurements between 2015–2019 demonstrate that an intermediate water mass replacement occurred in northern Baffin Bay between 2017 and 2019, as reflected by changes in dissolved gas and nutrient concentrations between ~200–1000 m depth. By synthesizing the results from multiple biogeochemical tracers, this study provides novel insights into nutrient dynamics in a rapidly changing Arctic system.

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