Seafloor sediment supply of nutrient silicon on the Greenland margin

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The biogeochemical cycling of nutrient silicon (Si) in the northern high latitudes has received increasing attention over recent years. This is in large part due to the discovery of silicon limitation of diatoms over seasonal timescales, the potential role of melting glaciers in supplying a significant amount of this nutrient to the coastal ocean, and the rapid environmental changes the polar ocean is experiencing as a result of global climate warming. However, our understanding of the nutrient Si in the polar ocean is severely restricted by the lack of knowledge of the benthic Si cycling and its controlling processes, which is due to the limited number of seafloor observations in the region. In this study, we address this knowledge gap through the acquisition of sediment pore water profiles and the execution of incubation experiments on sediment cores collected from the Greenland continental margin and the Labrador Sea.

Our results indicate a net (benthic) flux of dissolved silica (DSi) out of the sediment into the overlying seawater at the study sites. A new global compilation also reveals that benthic Si flux observed at our marginal sites are substantially higher than in the open ocean. This is likely because benthic flux in the open ocean is solely maintained by molecular diffusion along a concentration gradient, while there are additional processes: pore water advection and rapid dissolution of certain siliceous sponge groups, and other reactive silica phases, that contribute to the elevated benthic Si flux on the Greenland margin. This finding has important implications for existing evaluations of oceanic Si budgets, which have not accounted for any processes other than diffusion in the global estimation of benthic Si flux. Our results also suggest that strong benthic Si flux observed on the Greenland margin, combined with wind-driven coastal upwelling, could be a significant source of this nutrient to both the diverse (benthic) sponge communities and (planktonic) diatom productivity in the region. The magnitude of this benthic cycling could potentially rival the other continental inputs of Si in the northern high latitudes, as the first estimation of total benthic Si flux from the western Greenland shelf alone (0.04–0.27 Tmol year−1) is in the same order of magnitude as the total Si export from Greenland Ice Sheet (0.2 Tmol year−1) and the pan-Arctic rivers (0.35 Tmol year−1) respectively.