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Silicon isotopes highlight the complex role of glaciated fjords in high-latitude marine nutrient cycling

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Glacial meltwaters are enriched in key nutrients, including silicon and iron, forming a potentially important source of key biological elements for downstream ecosystems in high-latitude regions. Given current trends in environmental change, there is a need to understand the biogeochemical impact of enhanced glacial meltwater fluxes in these regions. The supply of silicon, in particular, could be critical in some regions of the subarctic, where there is evidence of at least seasonal limitation of diatom growth due to low availability of dissolved silicon (DSi). Whilst glacial meltwaters contain bioavailable silicon, the role of reactive solid silica phases in supplying DSi to coastal systems, and the relative role of terrigenous versus marine sources, are poorly understood and are the basis of ongoing research questions. Furthermore, it is likely that fjordic processes result in significant uptake of glacially-derived nutrients, limiting the extent to which terrigenous DSi reaches coastal marine systems.

Here, we use stable silicon isotope measurements of dissolved and particulate phases from two contrasting fjords in Southwest Greenland (Nuup Kangerlua and Ameralik Fjord), collected st different times of the year over 18 months, to investigate DSi cycling in these complex and heterogeneous coastal environments. Our new data reveal that the DSi in both fjords remains isotopically light despite nutrient drawdown, likely driven by a combination of biological uptake and non-biological processes such as dissolution and adsorption-desorption associated with other reactive phases in the water column and shallow sediments. We employ simple mixing and isotope fractionation models to demonstrate that both marine and glacial sources likely supply DSi to fjord surface waters. Simple water mass mixing cannot explain the DSi and silicon isotopic observations, indicating that there is active exchange between reactive phases, and biogeochemical modification of the silicon cycle within fjords. These complexities have implications for the response of fjord and coastal ecosystems to continued changes in meltwater and nutrient supply into the future.