

Silicon cycling from ice-sheet to coastal ocean: insights from isotope geochemistry

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The polar oceans are biologically productive and play a disproportionately important role in regional and global biogeochemical cycling. One of the most important nutrients, dissolved silicon (DSi), is required for the growth of siliceous phytoplankton, diatoms, which form a key component of the biological production in the polar seas. Glacial weathering is thought to be a significant source of dissolved silicon, or silicic acid, to coastal waters globally, and is especially important in regions of the Arctic that experience seasonal DSi limitation of diatom growth. However, there are several complex interactions between physical, biogeochemical and geological processes in arctic fjords and coastal regions that can modulate the supply of dissolved and particulate nutrients, including silicon, to downstream ecosystems. Here, we review the insights that silicon isotope geochemistry offer into this complex process interplay that drives silicon cycling in glaciated ocean margins. We show that applying stable and radioisotopic geochemical methods, in combination with biogeochemical modelling, can provide us with a mechanistic understanding of subglacial silica mobilisation and its cycling across the land-ocean continuum. Subglacial physical-chemical weathering produces isotopically light amorphous silica, which dissolves in saline water to release biologically available DSi. Our findings from southwest Greenland, for example, show that isotopically light, reactive, detrital silica – likely containing this glacial material – can readily reach the open ocean and from there could support a substantial proportion of diatom productivity. Biogeochemical

modelling is an important complementary tool for quantitatively constraining the dominant controls on DSi concentrations and stable isotope signatures which act upon these complex environments. Looking forward, outstanding questions about silicon cycling in these vulnerable ecosystems will only be answered through novel analytical techniques and collaborative cross-discipline research that overcomes traditionally viewed ecosystem boundaries in these crucial interface environments.