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# Constraining Marine Silicate Weathering Reactions in Arctic Fjords of Western Svalbard

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Glaciated Arctic fjords receive seasonal pulses of glacially derived reactive sediments that are composed of lithogenic silicates, metal oxides, and amorphous silica. When combined with biogenic silica and organic carbon derived from phytoplankton, these sediments facilitate unique conditions for silicate diagenesis, i.e. marine forward and reverse weathering. To investigate reaction pathways and element sequestration/release, we conducted anoxic incubation experiments over six months using sediments collected near the termini of tidewater glaciers of four distinct fjords throughout Svalbard. Kongsfjorden, Lilliehöökfjorden and St. Jonsfjorden are underlain by sedimentary rocks (shale, sandstone, and carbonates) that have experienced varying degrees of metamorphism, whereas Van Keulenfjorden is underlain by unmetamorphosed sandstones and siltstones.

All incubation experiments exhibited initial increases in dissolved Si (0.64-4.38 μM Si/day), $Li^+$, and alkalinity but variable trends in $Rb^+$ during the first 3 weeks, indicating overall silicate dissolution and thus net forward silicate weathering, but also the dissolution of biogenic and amorphous silica. Further release of adsorbed cations may occur during the reductive dissolution of iron and manganese oxides and alkalinity is additionally produced through organic matter remineralization and carbonate dissolution. Observed declines in dissolved $Rb^+$ concentrations in fjord sediments (first 3 weeks) may reflect its incorporation into newly formed clay minerals such as illite during incongruent forward weathering.

Despite dissolved Si not reaching opaline silica saturation in any of these experiments, the initial increases in dissolved Si stabilized after ~3 weeks for all incubated sediments, potentially indicating a transition from forward weathering-dominated conditions to a balance between forward and reverse weathering. This increase in reverse weathering likely occurs in response to incongruent forward weathering, dissolution of biogenic and amorphous silica, and manganese and iron reduction (increases in dissolved $Mn^{2+}$ and $Fe^{2+}$) providing the cation-poor silica phases, alkalinity, and dissolved cations. Sediments from Van Keulenfjorden revealed the least variation in dissolved Si, $Fe^{2+}$, and total alkalinity throughout the time series, perhaps due to the supply of less reactive mineral phases to the fjord. This variation in reaction balance demonstrates the complex nature of early diagenetic silicate reactions that likely characterize Arctic fjords and their associated sediment source regions.