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Postglacial weathering inputs and their role in boosting primary production in the Northern Baltic Sea: Insights from sedimentary Si phase separation

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Dissolved silica (DSi), originating from the dissolution of biogenic silica (BSi) and lithogenic silicate minerals (LSi), is a vital nutrient to sustain primary production in marine ecosystems. The BSi and DSi inputs from rivers are a major source to the oceanic Si budget and promote the formation of amorphous secondary silica phases (ASSi). This latter process is called reverse weathering, which, in contrast to so called forward silicate weathering, consumes cations and alkalinity, and releases CO_2 to the water column. The connection between terrestrial to marine processes and reverse to forward weathering is described as a silicate weathering continuum. However, this continuum has never been explicitly investigated in the Baltic Sea. We hypothesize that the increased input of weathering products after the retreat of the Fennoscandian ice sheet might have boosted primary production and subsequent accumulation of particulate organic carbon (POC) and BSi in the Baltic Sea.

We apply wet-chemical sequential leaching (modified after [1]) on a sediment core from the Bothnian Bay (Northern Baltic Sea). Downcore sediment samples were sequentially treated with HCl, Na_2CO_3, and NaOH to extract and quantify silicate phases (ASSi, BSi, and LSi). Distinct BSi and POC peaks at 30 cm below seafloor (cmbsf) suggests a high accumulation of organic carbon due to elevated primary production. Around the same depth (20-60 cmbsf), the leached ASSi and LSi phases reveal high metal concentrations (Fe, Mn, Mg, and K). Based on these findings, we propose that, over this period, increased weathering of Fe-rich bedrock and subsequent riverine transport of these critical nutrients boosted primary production and the burial of POC.

Our results highlight how the silicate weathering continuum tightly links terrestrial weathering (e.g., nutrient transport via rivers) and marine silicate alteration processes (e.g., nutrient release and burial of ASSi and BSi on the seafloor). To further quantify Fe and Si input and availability, we aim to conduct targeted analyses of dissolved, particulate, and mineral phases of weathering products in the Baltic Sea catchment area.

[1] Huang, Tzu-Hao, et al. "Separating Si phases from diagenetically-modified sediments through sequential leaching." Chemical Geology 637 (2023): 121681.