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Coastal erosion and mineral weathering at the seafloor generate significant cation and alkalinity fluxes to coastal seawater

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Due to glacial melting and ocean thermal expansion driven by climate warming, global mean sea level has risen by approximately 10 cm since 1970 [1], a trend expected to continue. Ongoing deglaciation and rising sea levels will accelerate coastal erosion, increasing the transport of terrigenous material to the coastal ocean. The land surface exposed by retreating glaciers is covered with glacial till rich in fine-grained silicate minerals, which are undersaturated in seawater and prone to dissolution (i.e., weathering) at the seafloor. As a result, accelerated coastal erosion and mineral weathering could generate an additional CO_2 sink and a source of alkalinity in coastal waters.

To test this hypothesis, we conducted a sediment geochemical study in the southwestern Baltic Sea, where coastal erosion of glacial till is the primary source of terrigenous sediment in offshore depocenters. Our results show increasing differences in geochemical and mineralogical composition between glacial till and marine sediments with distance from shore. Additionally, major cation anomalies (Mg^{2+}, K^{+}, Ca^{2+}) in the pore waters of surface sediments suggest that aluminosilicate and carbonate minerals from glacial till dissolve rapidly upon erosion and transport at the seafloor. However, the alkalinity generated through this process is partially offset by the precipitation of secondary minerals (i.e., reverse weathering).

We further examine the balance between weathering and reverse weathering in relation to sediment transport dynamics and biogenic sedimentation. Our findings indicate that under dynamic transport conditions and moderate organic matter turnover in sediments, silicate and carbonate weathering can significantly contribute to alkalinity fluxes into the coastal ocean. When extrapolated globally, these fluxes suggest that coastal erosion and seafloor weathering at high latitudes could act as a negative feedback mechanism to global warming and play a crucial role in regulating seawater cation budgets.

[1] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, USA, doi:10.1017/9781009157896.