Shifts in riverine phosphorus fluxes and storage with ice sheet retreat

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Proglacial rivers draining the Greenland Ice Sheet (GrIS) transport large quantities of phosphorus (P) and iron (Fe) to the coastal ocean. However, fluxes may be altered as ice retreat exposes landscapes disconnected from the ice sheet (deglaciated watersheds) where chemical weathering may differ from proglacial watersheds. We examine impacts of ice sheet retreat on Fe and P dynamics by comparing sediments from nonglacial streams in southwest Greenland (Sisimiut) that have been exposed for ~10.4 ka to sediments from a proglacial river (Watson River). Using sequential leaching procedures, we separated P into exchangeable, Fe-/Al-bound, and Ca-/Mg-bound fractions. While total inorganic P content is similar between proglacial and nonglacial stream sediments, bioavailable (exchangeable and Fe-/Al- bound) fractions differ. Proglacial river samples contain relatively greater concentrations of exchangeable P, but this fraction comprises <1% of total inorganic P for both watershed types. Nonglacial streams contain greater amounts of Fe-/Al-bound P (26.1±15.4 µg/g, up to 9% of total) than proglacial river samples (4.2±2.5 µg/g, 2% of total). These results suggest that differences in chemical weathering between watershed types promotes formation of reactive iron phases in non-glacial streams, enhancing storage of bioavailable P. P retention in expanding deglaciated watersheds may thus decrease oceanic fluxes but increase terrestrial stocks of bioavailable P, a limiting marine and terrestrial nutrient. The switch from predominately proglacial to non-glacial streams during ice sheet retreat may thus limit oceanic primary productivity and support expanded terrestrial vegetation.