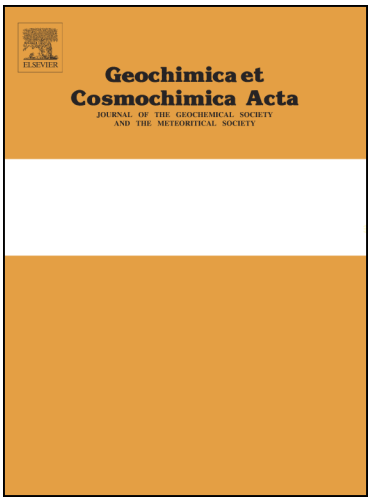

The iron isotopic composition of subglacial streams draining the Greenland ice sheet

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The iron isotopic composition of subglacial streams draining the Greenland ice sheet

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Abstract:

In this study, we present the first measurements of iron (Fe) stable isotopic composition (δ^{56}Fe) of subglacial streams draining the Greenland Ice Sheet (GIS). We measure the δ^{56}Fe values [(δ^{56}Fe, ‰ = $(^{56}Fe/^{54}Fe)_{sample}/(^{56}Fe/^{54}Fe)_{standard}$-1) x 10^3] of both dissolved and suspended sediment Fe in subglacial outflows from five distinct land-terminating glaciers. Suspended sediments have δ^{56}Fe values that lie within the crustal array (δ^{56}Fe ~0‰). In contrast, the δ^{56}Fe values of dissolved Fe in subglacial outflows are consistently less than 0‰, reaching a minimum of -2.1‰ in the outflow from the Russell Glacier. The δ^{56}Fe values of dissolved Fe vary geographically and on daily time scales. Major element chemistry and mineral saturation state modeling suggest that incongruent silicate weathering and sulfide oxidation are the likely drivers of subglacial stream Fe chemistry, and that the extent of chemical weathering influences the δ^{56}Fe of dissolved Fe. The largest difference in δ^{56}Fe between dissolved and suspended load is -2.1‰, and occurs in the subglacial system from the Russell glacier (southwest GIS). Major element chemistry indicates this outflow to be the least chemically weathered, while more mature subglacial systems (i.e., that exhibit greater extents of subglacial weathering) have dissolved loads with δ^{56}Fe that are indistinguishable from suspended sediments ($\Delta^{56}Fe_{suspended\text{-}dissolved}$ ~0‰). Ultimately, the dissolved Fe generated in some subglacial systems from the GIS is a previously unrecognized source of isotopically light Fe into the hydrosphere. The data illustrate that the dissolved Fe supplied by subglacial weathering can have variable δ^{56}Fe values depending on the degree of chemical weathering. Thus, Fe isotopes have potential as a proxy for subglacial chemical weathering intensity or mode. Finally, based on our regional Fe concentration measurements from each glacial outflow, we estimate a flux weighted continental scale dissolved iron export of 2.1 Gg Fe yr^{-1} to the coastal ocean, which is within the range of previous estimates.