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The iron isotope composition of Northern Hemisphere glacial systems

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The iron stable isotope composition of subglacial streams draining the Greenland Icesheet (GIS) have been shown be highly variable, with dissolved load $\delta^{56}Fe$ [($\delta^{56}Fe$, ‰ = $(^{56}Fe/^{54}Fe)_{sample}/(^{56}Fe/^{54}Fe)_{IRMM\text{-}14}$-1) x 10^3] ranging from 0 to -2.1 ‰ [1]. Here we expand this data set, by systematically investigating the $\delta^{56}Fe$ compositions of dissolved loads, suspended sediments, and sediment leachates from glacial and proglacial environments, draining geographcially and geologically diverse Northern Hemisphere glaciers. Overall, glaciers draining the Juneau Icefield (JI, Alaska), and the Columbia Icefield (CI, Canada) have fairly invariable $\delta^{56}Fe$ compositions with both dissolved loads and suspended sediments ~0±0.2 ‰.

We utilized leaching techniques that specifically target different Fe-pools within suspended sediments: (i) amorphous Fe (oxy)hydroxides, (ii) crystalline Fe (hydr)oxides, and (iii) residual-Fe, from the GIS, JI and CI sites. Overall, the amorphous (oxy)hydroxides, which represent the most 'potentially bioavailable Fe' [1] are isotopically lighter than both crystalline and residual pools by ~0.1‰. Nevertheless there is overlap between the extracted pools, with all leaches and residual Fe pools falling within $\delta^{56}Fe$ ~0±0.2 ‰.

The experiments above define 'glacial end member' compositions, which may not describe the $\delta^{56}Fe$ composition and/or flux of Fe that is delivered downstream to the oceans. Therefore we additionally present two short downstream tranesects of Fe and $\delta^{56}Fe$ from two outflows draining the south (Qoorqup Sermia) and southeast (Glacier 'G') margins of the GIS, with a late melt season record of $\delta^{56}Fe$ from the Qoorqup Sermia. Where concurrent measurements have been made, we place the glacial $\delta^{56}Fe$ compositions in the context of $\delta^{34}S_{(SO4)}$ and $\delta^{18}O_{(SO4)}$ analyses and microbial metabolic function.

[1] Stevenson et al., Gold2016:abs:1718
[2] Bhatia et al., 2013, Nat. Geosci. v. 6, p274-278