# Iron isotope fractionation in subglacial systems

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We present evidence of iron stable isotope fractionation in subglacial streams. We measure $\delta^{56}Fe$ [$(\delta^{56}Fe, ‰ = (^{56}Fe/^{54}Fe)_{sample}/(^{56}Fe/^{54}Fe)_{standard}-1) \times 10^3$] compositions of both the dissolved load and suspended sediments in the bulk subglacial outflow. We sample from five distinct land-terminating glaciers draining the Greenland Ice Sheet (GIS), which vary geologically, geographically and with local climate. Suspended sediments have $\delta^{56}Fe$ compositions that predominantly lie within the crustal igneous array ($\delta^{56}Fe \sim 0$). In contrast, the $\delta^{56}Fe$ composition of all dissolved loads are consistently < 0 ‰, and highly variable both geographically and temporally (daily), reaching as low as -2.1 ‰.

Using major element chemistry and mineral saturation state modeling we identify incongruent silicate weathering processes and sulphide oxidation as drivers of subglacial stream Fe chemistry, the extent of which is variable between sites. We find the degree of chemical weathering influences the $\delta^{56}Fe$ of aqueous Fe. The largest isotopic fractionation, between suspended sediment and dissolved load is found in the inferred least chemically weathered outflow (southwest GIS), where $\delta^{56}Fe = -2.1$ ‰. More mature subglacial systems have dissolved loads with $\delta^{56}Fe \sim 0$ ‰, and tend to be indistinguishable from suspended sediment counterparts.

Ultimatley, the dissolved Fe in modern subglacial runoff from the GIS was a previously unrecognized source of isotopically light Fe into the hydrosphere, and these data show that the dissolved Fe supplied from glaciers can take highly negative $\delta^{56}Fe$ compositions. As a result $\delta^{56}Fe$ isotopes may be used in the future to trace Fe loss from subglacial streams downstream to the coastal oceans to place better constraints on the chemical processing of Fe loss and/or the degree of bioavailability.