Benthic Fe-cycling in fjord sediments enhances the reactivity of glacially derived Fe in Arctic fjords of Svalbard

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Glacial runoff is a significant source of Fe to high-latitude marine environments. The amount and characteristics of glacially derived Fe depends on bedrock lithology, glacial comminution as well as glacier type. Because much of the Fe that comes from glaciers is in the particulate phase or will become particulate once in contact with saline and oxic fjord water, much of the glacial Fe ends up in fjord sediments in close proximity to the glaciers. Within these sediments, the glacially derived Fe undergoes redox-cycling driven by indirect (abiotic reaction with metabolic products, such as hydrogen sulfide) and direct interactions with microorganisms. This redox-cycling has the potential to alter the characteristics of the glacially derived Fe and thereby also its fate, for example if it is buried in the sediment or exported to the water column.

We investigated the amount and reactivity of Fe(III) minerals from the meltwater plume, meltwater streams, icebergs, and sediments at stations with increasing distance from the glacier in three different fjords on the west coast of Spitsbergen, Svalbard. Two of the fjords have large tidewater-glaciers at their head and possess differing bedrock lithology (Kongsfjorden and Lilliehöökfjorden). The third fjord, Dicksonfjorden, has land-terminating glaciers with a bedrock lithology similar to the glaciers at the head of Kongsfjorden, thus providing insight into the impact of glacial retreat on benthic biogeochemical processes. Results from sequential and time-course extractions showed that Fe(III)-mineral reactivity increased with distance from the glacier fronts and decreased with sediment depth at each station in all three fjords. Fe(III)-oxide reactivity from different glacial sources (meltwater plume and iceberg material from tidewater glaciers and meltwater stream material from land-terminating glaciers) differed based on source type and Fe(III) from all glacial sources was generally less reactive compared to surficial sediments distal to the glacier front. While the general trends were the same for all three fjords, based on pore water profiles of dissolved Fe, we found a lower potential for Fe-export to the water column when only land-terminating glaciers were present. This difference highlights that glacial retreat potentially impacts the function of fjord sediments as a source of Fe to the water column. We conclude that glacial runoff supplies large quantities of Fe minerals to fjord sediments, but benthic recycling of Fe by microorganisms transforms the relatively unreactive glacially-derived Fe(III)-oxides to a more reactive form. Microbially driven recycling of reactive Fe(III)-oxides in fjord sediments may play a role in liberating Fe to the water column, predominantly at the mouth of the fjord, and might...
represent an unquantified source of Fe to Fe-limited marine phytoplankton.