Deconvolving glaciomarine sedimentary process in Petermann Fjord, Northwest Greenland, using particle size specific magnetic measurements

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Large calving events of the Petermann Ice Tongue, Northwest Greenland, in 2010 and 2012 seem unprecedented in the context of the limited historical record of Petermann ice tongue extents, dating back to the 1875-1876 British Arctic Expedition led by Sir Nares. Once considered a relatively stable marine-based sector of the Greenland Ice Sheet, studies in the last decade have demonstrated that Petermann Glacier is especially sensitive to ice-ocean interactions, leading many to speculate on its future stability. To place these observations in a more holistic context, a 2015 international and interdisciplinary expedition of the Swedish Ice Breaker Oden collected a suite of sediment cores spanning the mid- to late Holocene from Petermann Fjord. These cores reveal a more dynamic history for Petermann Glacier than would be expected based on the historical record alone, including the break-up of a paleo-ice tongue and eventual regrowth of the present ice-tongue observed in the historical record.

In addition to Petermann Glacier, several small glaciers that drain local ice caps, located on the Kane Plateau to the northeast and Petermann Halvø to the southwest, terminate in the fjord and are a significant source of sediment. These local ice caps erode Paleozoic carbonate rocks (low magnetic susceptibility, low Ti/Ca) that comprise both the local surficial geology and the up to ~900 m high walls of the fjord. Erratic granites and other crystalline rocks (high magnetic susceptibility, high Ti/Ca) are visibly identifiable in terrestrial Petermann glacial deposits, reflecting deeper excavation into basement rocks by the inland Greenland Ice Sheet. These two sources, with contrasts in magnetic mineral concentration, magnetic grain size, and geochemical properties, provide a unique opportunity to quantitatively assess the contribution of Petermann Glacier to a variety of glaciomarine sedimentary processes.

Here we report particle size specific magnetic measurements across nine size fractions in both terrestrial and marine sediments to investigate the influence on bulk signals of Petermann Glacier sourced sediments and the glacial processes they reflect. We focus on two core locations within Petermann Fjord from slight bathymetric highs, where the recovered sediments were primarily transported by turbid meltwater processes or as ice-rafted debris (IRD). We focus our more detailed analyses on the greater than 63 µm coarse fractions, which largely reflect IRD, and the 10-32 µm non-cohesive silt fractions, which reflect meltwater, sediment transport energy, and IRD. These data contribute new insight to the dynamics of Petermann Glacier over the Holocene, most notably a huge increase in the relative contribution of Petermann Glacier sourced IRD following the paleo-ice tongue collapse and eventual decrease to negligible Petermann Glacier IRD contributions with the establishment of the historical ice-tongue.