Subglacial methane cycling under the Greenland Ice Sheet

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Glaciers and ice sheets cover around 10% of the Earth’s surface and the Greenland Ice Sheet (GrIS) is the largest ice mass in the Northern hemisphere, but is melting at an increasing rate, losing ~400 km$^3$ annually. There have been recent studies linking subglacial environments of the GrIS with methane (CH$_4$) production and release, presenting a possible positive climate feedback. Previous work has linked organic carbon in subglacial environments with significant CH$_4$ export via methanogenesis. It has been hypothesised that the GrIS overlies a methanogenically active wetland environment, and thus needs to be included in the global CH$_4$ budget.

However, the subglacial system of the GrIS is complex and highly heterogenous, hosting oxic and anoxic ecosystems, which have developed over a range of timescales. There are still questions outstanding surrounding the ubiquity of CH$_4$ release from the GrIS, mainly because of the limited understanding of subglacial carbon cycling and the potential sources of CH$_4$ in these environments.

We present the first data from two new, complimentary projects investigating CH$_4$ release from the GrIS margin, where we aim to quantify the production and release of CH$_4$ into the atmosphere from the GrIS. We have developed an ambitious temporal and spatial sampling regime to evaluate the CH$_4$ release along the western margin of the GrIS. We present the first radiocarbon ($^{14}$C) dated CH$_4$ samples from Greenland, helping to shed light on the carbon cycling processes occurring under the ice sheet. We analyse a mixture of atmospheric CH$_4$ exported from subglacial ice caves and dissolved CH$_4$ from proglacial rivers draining subglacial portals to explore the age of subglacially sourced CH$_4$.

We can combine the carbon age of exported CH$_4$ with microbial analysis and stable isotope data to improve our understanding of the environmental controls on and microbial sources of subglacial CH$_4$ production and export. Understanding the mechanisms behind subglacial CH$_4$ export is crucial when attempting to upscale the point source data that is available currently and we consider whether the GrIS could be a potentially important source of CH$_4$, leading to a substantial,
yet currently understudied climatic feedback.