Subglacial Aquatic Environments: Sources and Sinks of Carbon and Nitrogen


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Introduction

Nearly 400 subglacial lakes have been discovered beneath the Antarctic ice sheet. These environments contain active microbial ecosystems and encompass stores of organic matter and nutrients of unquantified significance to Earth's biogeochemical cycles. We quantified pools and biologically mediated transformations of C and N in Subglacial Lake Whillans (SLW; Fig. 1), an "active" subglacial lake that decadalflushes subglacial water to the Ross Sea.

Methods

We used a hot water drill to gain microbiologically clean access to SLW in January 2013. Shallow sediment cores (~40 cm) were collected using a UWicea multicorer. Water samples were collected with a Niskin bottle at mid-water column. Additional water samples used in N-cycling experiments were collected from the top of the multicorer and stored frozen until use. Chemolithoautotrophy was determined in ref. 2. Heterotrophic C uptake and respiration were determined on 14C-leucine amended water samples. NH4+ uptake (assimilation+nitrification) and regeneration were determined on 15N-NH4+ amended water samples.

Conclusions

The water column microbial communities are a sink for N and a source of DOC. At the estimated rates of ammonium uptake, the annual demand is greater than the fluxes and than the standing pool of ammonium, indicating that either the rates are over estimates, or that there is another source of ammonium to the water column, possibly dissimilatory nitrate reduction to ammonium, ice meltout or water from upstream. The relative increase in C/N ratio in the water column DON versus the flux ratio is also consistent with the idea that the water column is a sink for N, where N is consumed more quickly than C. The most abundant OTUs in the SLW water column, which account for ~20% of the community, are also likely to be important in N-cycling. Taken together, these data show that while the sediment pore waters, which represent the relict marine material beneath SLW, provide N to the water column, N is likely to limit microbial activity within the decadal scale flushing timeframe estimated for SLW.

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