Sources and Sinks of Carbon and Nitrogen in Antarctic Subglacial Aquatic Environments

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Recent recognition of the widespread nature of liquid water beneath the Antarctic ice sheet has generated new interest in subglacial aquatic environments as microbial habitats. These environments have been shown to contain active ecosystems and encompass stores of organic matter and nutrients of unquantified significance to Earth's biogeochemical cycles. We report here on microbial transformations of organic matter in Subglacial Lake Whillans (SLW), which lies beneath ~800 m of ice in West Antarctica in a relic marine embayment.

Heterotrophic C production and respiration (estimated as incorporation + respiration of ^{14}C-labelled leucine) together represent a C sink of ~8 x 10^{11} μmol C yr^{-1} over the 60 km^2 area of SLW. Freshly produced organic C derived from chemoautotrophic primary production (estimated from ^{14}C-bicarbonate incorporation in the dark) provides ~1 x 10^{11} μmol C yr^{-1}. Upward diffusion from the underlying sediments provides an additional source of dissolved organic C (~2 x 10^{10} μmol C yr^{-1}). These data together with results of excitation-emission matrix spectroscopy indicate that contemporary chemosynthetic production in the water column is the main organic carbon source in SLW.

Microbial diversity data and $\Delta^{17}O$ of NO_3^- of ~0‰ indicate that ammonia oxidizing Archaea are important primary producers and that microbial activity is the primary source of nitrate in the SLW water column, respectively. Primary production in SLW was sensitive to the addition of nitrapyrin, a known inhibitor of ammonium oxidation. Rates of ammonium utilization, which include ammonium oxidation and metabolic incorporation, were nine times greater than rates of microbial ammonium regeneration suggesting that the major source of ammonium is relic material stored in the SLW sediments rather than microbial recycling within the water column. Collectively, our data suggest that the SLW ecosystem is supported by a combination in *in situ* production and organic matter stored in the relic marine sediments underlying the lake.