Microbial physiology in subglacial aquatic environments: an unexplored part of the low-energy biosphere

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Subglacial Lake Whillans (SLW) is one of more than 350 subglacial lakes under the Antarctic ice sheet. The lake, which regularly drains to the ocean downstream and refills from upstream meltwater, hosts a microbial ecosystem dominated by chemoautorophs, which support heterotrophic carbon demand. Despite abundant dissolved organic carbon, heterotrophic cellular turnover times calculated from ^{3}H-leucine incorporation rates, were on the order of hundreds of days. Doubling times were 118 days, indicating sufficient growth rates for population turnover and selection during lake water residence time (~10 years). Growth rates (~0.0024 d^{-1}) obtained from the same incubations, were an order of magnitude lower than those measured in Antarctic surface lakes and similar to estimates for the deep biosphere; coupled with low bacterial growth efficiency (8%), these data indicate that microbial populations in SLW partition a majority of their carbon demand to activities other than cellular growth. Additions of inorganic macronutrients stimulated ^{3}H-leucine incorporation by 36% relative to unamended controls; ^{3}H-leucine incorporation also increased with temperature (Q10 = 2.3), suggesting possible physicochemical controls on heterotrophic activity. A mass-balance of subglacial oxygen dynamics showed that despite low growth rates, microbial activity in SLW will deplete oxygen supplied by subglacial meltwater within <5 years; if oxygen-rich source water does not enter the lake, we expect significant turnover in microbial communities and functions; specific consequences for microbial energetics and metabolisms were modeled using ΔG_R. Subglacial lakes serve as important natural laboratories for physiological and biogeochemical studies of microorganisms in energy limited environments.