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Geomicrobiology of basal ice in a temperate glacier: implications for primary microbial production and export, elemental cycling and soil formation

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Basal ice is a significant sub-glacial component of glaciers and ice sheets that arises from ice-bedrock/substrate interaction. As a result, basal ice of a glacier retains a distinctive physical and chemical signature characterised by a high sediment- and low bubble-content and selective ionic enrichment. Previous research concluded that sediment entrapped in the basal ice matrix originates from the bedrock/substrate, and harbours an active microbial community. However, the nature and significance of the microbial community inhabiting basal ice facies remains poorly characterised. This paper reports on an integrated chemical, mineralogical, and microbial community analysis of basal ice in the subglacial environment at Svínafellsjökull, in south-east Iceland. Basal ice sediment supported 10E7 cells ĝ-1 and, based on glacier velocity and sediment flux, an estimated 10E17 cells â-1 are exported to the glacier foreland. Furthermore, 16S rRNA gene analysis highlighted a glacier basal ice bacterial community dominated by Proteobacteria, Acidobacteria, Actinobacteria, and Chloroflexi. Sequences ascribed to chemolithotrophic-related species (Thiobacillus, Syderoxidans) were highly abundant. Minerological analyses of basal ice sediment confirmed dominant silicates and iron-containing minerals that represent susceptible substrates open to oxidation by the aforementioned chemolithotrophs. Previous studies have suggested that basal ice could constitute a good analogue for astrobiology. Svínafellsjökull and Mars geology are similar – volcanically derived rocks with a high abundance of silicates and iron-rich minerals, reinforcing this idea. Understanding where the limits of life in extreme environments, such as debris-rich basal ice, could help to unravel how life on other planets could succeed, and could help to identify which markers to use in order to find it. In dark and isolated basal ice niches, the dominating chemolithotrophic bacterial community are likely to act as primary producers, fixing carbon while weathering minerals and thus providing a plausible mechanism to explain how a basal ice microbial ecosystem can be sustained.