Microbial succession from ice to vegetated soils in response to glacial retreat in the Arctic

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Glaciers in the Northern Hemisphere are retreating and their forefields present a unique opportunity to investigate the initial phases of soil weathering/formation and microbial succession in terrestrial cold habitats. The importance of primary autotrophic microbial colonisers (e.g., cyanobacteria) relative to allochthonous sources and compared to recycling of ancient organic carbon during the initial phase of soil establishment in Arctic environments is still debated. In glacial forefields, microbes that have colonised both glacial surfaces and subglacial debris may provide an important inoculum for the development of microbial communities. In this study, during the summer in 2013, we collected soil samples along replicated transects from the margin of the Mitdre Lovénbreen glacier (Svalbard, Norway), representing a chronosequence between 0 and ~ 2000 years. Furthermore, we collected samples from the glacial surface and basal sediments for comparison. Analyses of microbial community composition (ssu rRNA gene and metagenomes), activity (C fluxes, N-fixation, bacterial secondary production and C utilisation) and geochemistry/mineralogy (e.g., elemental and mineralogical composition) show some similarities with previous studies conducted in the Alps where there is an increase in a variety of microbial proxies, such as microbial enzymatic activity, respiration and diversity, in relation to years of exposure after glacial retreat. Our study shows a succession of microbial communities with age where communities in soils previously overridden by the ice (strongly represented by Betaproteobacteria) are important colonizers of new exposed soils up to 5 years after glacier retreat. Thereafter, presence of typical soil communities such as Acidobacteria and Actinobacteria become more prevalent. Despite the fact that the speed of glacial retreat and thus succession between Alpine and Arctic glaciers may be substantially different, this study demonstrates that there are clear feedback mechanisms between geochemistry and microbial colonisation during soil development after glacial retreat.

Numerical Model Linking the Temporal Evolution of the Geohydrologic Cycle and Ocean Chemistry Over the Past 150 Ma

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