Modelling microbial processes during soil formation in a High-Arctic glacier forefield

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Soils exposed following glacier retreat exhibit successional characteristics in microbiology and geochemisrty over timescales of decades to centuries. The characterisation of thse soils is important for our understanding of the cycling of organic matter under extreme environmental and nutrient limiting conditions, and their potential contribution to global biogeochemical cycles, particularly since these new areas will become more geographically expansive with continued ice retreat.

We integrated modelling using SHIMMER [1] with empirical observations and measurements from a chronosequence from the forefield of Midtre Lovénbreen, Svalbard (78°N), to investigate the first 120 years of soil development. We used laboratory-derived measurements to refine the model. We show that biomass accumulates with soil age, and that the bacterial production is dominated by autotrophy (rather than heterotrophy). Heterotrophic production in young soils (0-20 years) is supported by labile substrate, whereas carbon stocks in older soils (60-120 years) are more refractory. Nitrogen-fixing organisms are responsible for the initial accumulation of available nitrates in the soil. We also infer that allochthonous deposition of organic material may play a significant contributory role that could accelerate or facilitate further microbial growth.

This integrated model-data approach provides a quantitative evaluation on the dynamics of glacier forefield systems that have previously largely been explored through qualitative interpretation of datasets.

[1] Bradley J.A., Anesio A.M., Singarayer J.S., Heath M.R., Arndt S. (2015) SHIMMER (1.0): a novel mathematical model for microbial and biogeochemical dynamics in glacier forefield ecosystems. *Geosci Model Dev* **8**(10), 3441-3470. doi:10.5194/gmd-8-3441-2015