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The origin and fate of organic matter in circum-Arctic subglacial ecosystems

Petra Vinsova¹, Myrna J. Simpson², Tiange Yuan², Irka Hajdas³, Lukas Falteisek¹, Tyler J. Kohler^{1,4}, Jacob C. Yde⁵, Jakub D. Zarsky¹, and Marek Stibal¹

¹Charles University, Faculty of Science, Department of Ecology, Prague, Czechia (vinsovap@natur.cuni.cz)

²Environmental NMR Centre and Department of Physical and Environmental Sciences, University of Toronto Scarborough, Toronto, Canada

³Laboratory of Ion Beam Physics, Zurich, Switzerland

⁴Stream Biofilm and Ecosystem Research Laboratory, School of Architecture, Civil and Environmental Engineering, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

⁵Department of Environmental Sciences, Western Norway University of Applied Sciences, Sogndal, Norway

Glacier and ice sheet beds represent important yet underresearched cryospheric ecosystems. Life in the subglacial environment is mostly dependent on organic matter (OM) overridden by ice during times of glacier advance, and the nature of subglacial OM is, therefore, likely to drive the ecosystem functionality. Here we describe the origin, degradation stage and environmental context of OM present underneath glaciers in the circum-Arctic, and their effects on the resident microbial communities.

In total, 19 glaciers from Alaska, Greenland, Iceland, Svalbard, and Norway were sampled for subglacial sediments. Biomarker analysis of the sediment samples was conducted using total solvent extraction, and copper (II) oxide (CuO) oxidation techniques yielding lipids and lignin-derived phenols. The extracts were analyzed by GC-MS to characterize the molecular-level composition of OM present. The biomarker data were then placed in the context of other environmental data, such as radiocarbon age, nutrient contents, and microbial community composition. The majority of OM in the samples was plant-derived, suggested by the dominance of long-chain *n*-alkanols over the microbial-specific short-chain *n*-alkanols. The composition of long-chain *n*-alkanes ($\geq C_{20}$), used as biomarkers for vascular plant waxes, in the solvent extracts suggested grass sources for samples from most Greenland glaciers and conifer sources for some glaciers from Norway, Alaska, and Disko Island (Qeqertarsuaq) in West Greenland. The rest of the OM in the subglacial samples was identified to have more general tree sources. The carbon preference index (CPI) of long-chain *n*-alkanes suggested a high degradation stage in most samples and was correlated with the radiocarbon age of the sediments' OC ($r = -0.68$). Sediments containing older and more degraded OM were found to host less diverse microbial communities compared to those of the younger sites.

In a rapidly warming climate, previously glacier-covered areas are being exposed as a consequence of glacier recession. This new land is standing at the onset of ecological succession

and pedogenesis. Our results contribute to the understanding of the potential ecological function of subglacial OM as an important source of carbon and driver of microbial community development after deglaciation in the circum-Arctic region.