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How low can you go? Trace Element Biogeochemistry on the Living Skin of the Greenland Ice Sheet

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During the summer melt season, the bare ice ablation zone of the Greenland Ice Sheet is a "living skin" with productive microbial ecosystems consisting of algae, protozoa, bacteria, fungi, and viruses. These microbial blooms, dominated by pigmented algae, have a significant effect on the darkening (albedo) of the Greenland Ice Sheet surface[1–3]. Controls on the development, spatial extent, and density of microbial blooms on bare ice surfaces remain poorly understood, leading to high uncertainty in how microbial coverage of bare ice surfaces might change as snowlines retreat upwards due to climatic warming, and making estimates of possible microbial darkening contributions to future ice mass wastage difficult[4]. Previous work has demonstrated that the availability of liquid water, light, and macronutrients (N and P) control the development of these darkening algal blooms[5–7]. However, our understanding of potential micronutrient limitation of microbial blooms on bare ice surfaces is currently lacking due to a paucity of data. Here we present a dataset of potentially limiting micronutrients and source-tracing trace elements collected using strict clean sampling techniques from the dark zone on the surface of the Greenland Ice Sheet, with a complementary geochemical (major ions, macronutrients) and hydrological contextual dataset. We (i) highlight several candidate trace elements that might limit or co-limit microbial productivity or function on the Greenland Ice Sheet surface, and highlight potential future microbial growth scenarios based on the likely availability of these elements, and (ii) demonstrate the utility of leading-edge ICP-MS/MS instrumentation with NH_4, O_2, N_2O and He KED/reaction gases in ppq-level multi-element analysis of glacial meltwater.

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