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Mineralogical Controls on Subglacial Abrasion Products and their Role in Sustaining Subglacial Microbial Ecosystems

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Glaciers and ice-sheets are important agents of erosion and weathering, producing very fine and reactive “rock-flour”. The increased surface area and thus solubility of the rock flour is a source of solute that helps to sustain biogeochemical processes in these environments. However, recent research has shown that subglacial abrasion can also initiate mechanochemical reactions, which may too have a significant role in the biogeochemistry of these ecosystems. This study focuses on investigating the mineralogical controls on the products of subglacial abrasion, with a particular emphasis on the role of carbonates in mechanochemical reactions and reaction products.

We use a variety of natural rocks and minerals with different compositions to unravel the different factors that control the products of these mechanochemical reactions. Our results suggest that carbonate minerals play a crucial role in these reactions, particularly in the production of CH_4 and volatile fatty acids (VFAs), such as acetate and formate. We also discuss the effect of abrasion on sulfide containing sedimentary rocks. These rocks have the potential to produce higher concentrations of labile organic compounds (of the order of 100 nmol CH_4 g^{-1} and 1 μmol VFAs g^{-1}). However, factors such as the presence of carbonates, Fe-driven Fenton reactions and the pH of the solution are likely to be important in controlling both the initial rate of production and the subsequent rates of destruction via reactions involving H_2O_2, which is also produced during sulfide abrasion.

These findings have importance for our understanding of the biogeochemical processes that occur in subglacial environments. They highlight the potential importance of mechanochemical reactions in underpinning and sustaining these ecosystems, and provide new insights into the role of specific mineral phases in controlling the production of key solutes.