Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30798

Mineral Tracers of Chemical Weathering Under the Greenland Ice Sheet

JOSEPH GRALY[1], REBECCA MCCERERY[1], KAYLA WOODIE[2], CHRIS COX[3], ALICIA RUTLEDGE[3], KATHY LICHT[2], HANNAH BAHRANI[1], CALVIN OSBORNE[1], MOSES JATTA[2], CHRIS HANSEN[4], JEFF R. HAVIG[4], WILLIAM P GILHOOLY III[2], TRINITY L. HAMILTON[4] AND KATE WINTER[1]

[1]Northumbria University
[2]Indiana University Indianapolis
[3]Northern Arizona University
[4]University of Minnesota

Subglacial environments are increasingly understood as regions of active chemical weathering. The constant comminution of glacial sediments along with the input of highly dilute meltwater and the gases dissolved therein allow for a significant degree of chemical activity, despite the steady near-freezing temperatures these environments entail. However, direct mineral evidence of chemical weathering is sometimes scarce, as glaciers can also perform physical weathering on a prodigious scale, causing physically derived minerals to predominate in many glacial sediments.

To investigate the effects of glacial environments on the mineral substrate of the Greenland Ice Sheet, we sampled sediment emerging from the Greenland Ice Sheet and in the glacial forefield at two land terminating outlet glaciers in Western Greenland: Isunnguata Sermia and Leverett Glacier. Samples were collected from moraines, outwash, suspended sediment and sediment frozen into accreted ice. Outflowing sediments were collected over a variety of seasonal hydrological regimes, including winter water stored under naled ice, early spring, and late summer flow. The physical and mineral characteristics of the samples were investigated by scanning electron microscopy, particle size analysis and by a variety of mineral identification and characterisation techniques.

The results show that the vast mass of sediment in the glacial forefield is sand-sized material, depleted of chemical weathering products. This is equally true of sediments transported by water and by ice, with grain micromorphology suggesting all sediments have had significant transport by water. This is suggestive of substantial recycling of glacial outwash sediments, perhaps over multiple glacial cycles. However, fine materials found either in suspended sediment or where glacial water is able to slowly settle do contain substantial chemical alteration products, including authigenic clays, oxides, and amorphous silica. This fraction of sediment derived from chemical weathering is particularly significant in low flow conditions, suggesting a balance between high flow mobilisation of a deep reservoir of sand and more continuous chemical processes operating beneath the ice sheet.