Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.24444

Links between active layer weathering conditions and water chemistry in southwest Greenland

KELLY M DEUERLING[1], MADISON FLINT[2], ANDREA J PAIN[3], JONATHAN MARTIN[2] AND ELLEN MARTIN[2]

[1]University of Nebraska Omaha
[2]University of Florida
[3]University of Maryland Center for Environmental Science
Presenting Author: kdeuerling@unomaha.edu

Exchange of water in the hyporheic zone of permafrost-affected environments should depend on the depth of active layer (AL) thaw, moisture availability, and sediment permeability. Depending on biogeochemical reactions and connectivity this exchange may alter stream chemistry. We test the potential for AL water to alter stream chemistry through comparisons of AL and stream water chemical compositions and exchange potential in 1 proglacial and 3 deglaciated streams exposed following glacial retreat from ~7.3 ka to ~10.4 ka in southwest Greenland. Samples collected during the 2023 thaw season show higher solute concentrations in AL water compared to adjacent stream water, but the enrichments vary between proglacial and deglaciated watersheds. In the proglacial system, enrichment of AL waters suggests sulfuric acid production and preferential dissolution of easily weatherable minerals (e.g., biotite and calcite). Ratios of weathering-derived ions are similar between proglacial streams and AL waters, indicating evaporation and/or cryoconcentration may be the principal control of enrichment. The AL water in proglacial systems also experiences extensive hyporheic exchange in outwash plains as diurnal variations in discharge drive exchange between stream and AL water. In deglaciated watersheds, K and Ca are preferentially enriched in AL water compared to adjacent streams though the enrichment decreases with exposure age, suggesting a decrease in biotite and calcite weathering with increased exposure age. All deglaciated AL water shows Na-enrichment relative to stream waters suggesting a source from silicate mineral weathering. Deglaciated AL waters are consistently depleted in sulfate and exhibit lower dissolved oxygen (DO), higher organic matter content, and greater methane production compared to adjacent streams, indicating hypoxic conditions prevail in the deglaciated AL. Hypoxia may develop due to limited exchange between deglaciated AL waters and high DO streams, long residence times in fine-grained substrates, and/or microbial metabolism. Proglacial and deglaciated AL waters reflect distinct weathering pathways that, depending on the magnitude of hyporheic exchange, may alter stream water compositions and solute export from watersheds. The effects of hyporheic exchange differ in deglaciated watersheds, characterized by limited exchange and high solute concentrations compared with proglacial watersheds, characterized by extensive exchange but low solute concentrations.