Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.3806

Silica export due to biogeochemical weathering at Cascades Range glaciers

ALICIA M RUTLEDGE[1], BRIONY H. N. HORGAN[2], ELIZABETH B. RAMPE[3], NOEL A. SCUDDER[2], REBECCA J. SMITH[4], JEFF R. HAVIG[5] AND TRINITY L. HAMILTON[5]

[1]Northern Arizona University
[2]Purdue University
[3]NASA Johnson Space Center
[4]SUNY at Stony Brook
[5]University of Minnesota

Presenting Author: alicia.rutledge@gmail.com

Glaciated environments are important sources of lithogenic nutrients due to mechanical and chemical weathering and meltwater transport influencing downstream ecosystems. High physical weathering rates in subglacial environments due to bedrock grinding results in significant chemical weathering due to increased reactive mineral surface area. Until recently, glaciers and ice sheets were considered a minor part of the global Si cycle, in part because near-freezing conditions were thought to limit silicate weathering rates. However, recent research has shown that silicate dissolution is the predominant chemical weathering process in alpine glaciated catchments in the volcanoes of the Cascades Range, USA [1]. Alpine glacier systems may provide large fluxes of bioavailable Si similar to other recent findings [2,3].

To test this hypothesis, water and sediment samples were collected during the summers of 2016 and 2017 from glaciated volcanic catchments in the Three Sisters Wilderness, Oregon, U.S.A. Total dissolved cation concentrations range from 3 to 250 μeq/l and dissolved bicarbonate concentrations range from 2 to 200 μeq/l. Other dissolved anions are negligible compared to bicarbonate. Dissolved Si concentrations range from 2 to 260 μmol/l, comparable to total dissolved cation concentrations. The highest cation and silica concentrations were measured in moraine-sourced springs. Proglacial streams, springs, and lakes exhibit dissolved Si concentrations that are greater than observed in glacial snow/ice.

Weathering budgets indicate that the predominant form of chemical weathering in these systems is the carbonation of feldspar and volcanic glass. These mineral breakdown reactions are enhanced by microbial populations [4]. We also find poorly crystalline (X-ray amorphous) Fe-Al-Si weathering products consistent with rapid weathering of feldspars and glass. This cold-climate cycle is most likely driven by high fluxes of reactive mineral surfaces generated by glacial grinding, a lack of accessory minerals, relatively high water-rock ratios, and/or short residence times. This has wide-ranging implications as ice melt accelerates worldwide, and significantly impacts interpretations of rock records on planetary surfaces.

[1] Rutledge et al. (2018) *GRL* 45.

[2] Hawkings et al. (2017) *Nature Comm*. 8, 14198.

[3] Pryer et al. (2020) *Global Biogeochem. Cycles* 34, e2020GB006611.

[4] Havig & Hamilton (2019) *GCA* 247, 220-242.