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The geochemical impact of glaciation on the Beerenberg stratovolcano, Jan Mayen

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Glacierized landscapes and volcanos have potential for enhanced chemical activity. In volcanos, freshly formed Earth materials are ripe for chemical leaching, resulting in approximately one third of global atmospheric CO_2 drawdown occurring in fresh volcanic terrains [1]. Glaciers enhance weathering through the production of ultra-fine material through physical weathering, and rates of silicate weathering under glaciers and ice sheets exceeds that of comparable non-glacierized terrain [2,3]. The interaction of glaciers and fresh volcanic rock may therefore be an important enhancement to global geochemical cycling.

We examined the mineralogy, water chemistry, and stable isotope (dD, $d^{18}O$) chemistry of several Beerenberg glaciers over the 2021 and 2022 field seasons. Sampling focused most heavily on the largest glacier, Sørbreen, but several neighboring glaciers were sampled as well. The chemical and isotopic composition of subglacial meltwater was compared with spot samples from snow, ice, precipitation, glacial surface streams, lakes, and non-glacial streams and springs to assess the spatial trends in chemistry and water isotopes of Beerenberg. Mineral material suspended in the waters and in the streambanks was also collected. Sørbreen has an irregular snowline, uneven glacier surface topography, frequent cloud cover and summer temperature inversion that complicates isotopic hydrograph separation.

The subglacial waters have a distinct chemical and isotopic signature, with high quantities of dissolved Si and cations in line with the mineral substrate. This differs from the glacial surface and non-glacial waters, whose chemical composition is far more aligned to input from the marine environment. The primary anion in subglacial waters is bicarbonate, suggesting drawdown of atmospheric CO_2 as the primary weathering mechanism. These results are similar to the those in Iceland and basalt-covered portions of Greenland. The comparison to non-glacial waters suggests that glaciers do enhance weathering in volcanic environments and that glacier-volcano interactions are important weathering mechanisms in cold regions.

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