

Elemental and Li isotopic investigation of a proglacial river system provides insights to modern chemical weathering processes

VENKATA SAILAJA PAPPALA¹, PROF. XIAO-MING LIU, PHD², SARAH M. AARONS³ AND CARLI A. ARENDT¹

¹North Carolina State University

²University of North Carolina at Chapel Hill

³Scripps Institution of Oceanography, University of California San Diego

Presenting Author: vpappal@ncsu.edu

Glaciers worldwide are experiencing accelerated ice loss, resulting in increased meltwater fluxes, exposure of fresh mineral surfaces, and shifting water-rock interaction times thereby altering weathering processes. To examine the impact of ongoing warming on glacial weathering processes, we collected dissolved and suspended sediment samples from the 121-km proglacial Matanuska River and associated tributaries in southcentral Alaska (USA), in July 2019. Recent studies showed $\delta^7\text{Li}$ as a promising tracer of weathering processes [1,2]. We utilized Li elemental and isotopic ($\delta^7\text{Li}$) compositions of the dissolved load and XRD analyses of the suspended load to interpret weathering processes in this system. We observe large variability in dissolved Li isotopic ($\delta^7\text{Li}_{\text{diss}}$) compositions (+6.1‰ to +16.8‰) and Li/Na ratios (0.001-0.012) within 10 km of the Matanuska Glacier terminus. In samples > 10 km from the glacier terminus, the $\delta^7\text{Li}_{\text{diss}}$ and elemental ratio remained relatively constant at $\sim +17\text{‰}$ and 0.002, respectively. The sample closest to the glacier terminus had the highest pH (9) and reflects the influence of subglacial weathering processes on the $\delta^7\text{Li}_{\text{diss}}$ composition (+14.5‰) and Li/Na ratio (0.008). The tributary samples have pH values < 8 and elevated $\delta^7\text{Li}_{\text{diss}}$ compositions (average +21‰) and a lower Li/Na ratio (0.001) compared to the Matanuska mainstream. The variability observed in this study cannot be explained by changes in source inputs (lithology, tributaries) and fluid residence time alone, but rather reflects the isotopic fractionation via adsorption of lighter isotope (^6Li) onto secondary minerals formed during chemical weathering. Isotopic fractionation models show that Rayleigh-type fractionation controls the removal of Li from river water, with a calculated fractionation factor (α) for the Matanuska River ranging between 0.994 and 0.997. This is supported by XRD analysis of the suspended load where the presence of goethite and chlorite secondary minerals explain the observed $\delta^7\text{Li}_{\text{diss}}$ variability. The dissolved Li and $\delta^7\text{Li}$ measurements suggest that adsorption of Li onto secondary mineral phases is most active in close proximity (<10 km) to the glacial terminus, and has implications for the effects of climate induced glacial weathering in fluvial environments.

[1] Huh et al., 2001 EPSL, 194(1-2), 189-199. [2] Li and Liu, 2020 GCA, 284, 156-172.