B24B-05 Seasonal Snowmelt Drives Hydrologic Connectivity, Microbial Activity, Oxygen Depletion, and Iron Species Redistribution in a Schist-derived Hillslope under Mixed Conifer Forest

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17:00 - 17:15

150 B (Convention Center)

Abstract

Seasonal snowmelt in a sub-humid mixed conifer zero-order basin (ZOB) generates a prolonged period of soil pore water saturation above low permeability bedrock which results in lateral soil through-flux combined with steady, but temperature-limited microbial respiration and associated mineral weathering at depth. We hypothesized that the increased hydraulic connectivity across a hillslope catena during sub-surface saturated conditions would result in lateral transport of solutes, largely derived from vertical weathering profiles, which accumulate and potentially precipitate in the toe-slope before being periodically removed during groundwater discharge to an ephemeral stream. Total Fe concentrations in the stream during snowmelt increase 5x from 200ug/L to 1000ug/L while groundwater discharge also increases 5x (from 1 to 5cfs), and this positive 1:1 relationship between concentration and discharge motivated us to consider how freely Fe moves through the catena during snowmelt. Data from instrumented pedons (co-located temperature, moisture and gas sensors, pore water samplers, and gas wells) at the ridge and toe of a north-facing hillslope within the ZOB show distinct biogeochemical behaviors, specifically regarding their differences in oxygen availability. In the bottom 50 cm of the toeslope, prolonged (multiple month) periods of suboxic soil conditions increase the concentration of ferrous (Fe^{II}) in pore waters from reductive dissolution, which has enabled the migration of Fe over pedogenic time periods and left behind a fingerprint in CZ chemical structure. Depth-weighted average Fe *tau* values from mass balance calculations for the ridge, mid, and toeslope of the ZOB are +0.50, -0.08, and -0.07, respectively, indicating a greater extent of Fe depletion further downslope where more water tends to accumulate. In this way, the different biogeochemical responses to snowmelt in each landscape position are related to the long-term structural evolution of the critical zone, and through situating Fe speciation and distribution within the broader weathering environment (provided by XRF and XRD), we can assess how 2D catchment-scale connectivity during snowmelt leaves behind a signal in the pedogenic record.

Plain-language Summary

In a mixed conifer forest basin, what kind of environmental conditions result in the connectivity of the Critical Zone? We postulate that the subsurface saturation resulting from seasonal snowmelt drives lateral flow that connects the basin hydrologically, thus enabling the free movement of solutes from the top to the bottom of the catchment. Through focusing on the distribution of iron (Fe) in the Critical Zone, we are able to draw linkages between seasonal fluxes and the physical-chemical evolution of the Critical Zone over geologic time periods. A combination of sensor data, pore water analysis, and stream measurements guide our interpretation of seasonal biogeochemical processes, which leave behind a fingerprint in the mineralogical and chemical composition of the basin.

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