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Quantifying Subsurface Biogeochemical Variability in a High Altitude Watershed During Winter Isolation

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Subsurface ecosystems in high-altitude watersheds are influenced by hydrologic events that drive the availability of compounds for biotic and abiotic chemistry. Much of this biogeochemistry occurs in the dynamic hyporheic zone (the interface of the river sediment and groundwater) and in groundwater. Hyporheic systems are conspicuously responsive to hydrologic events, and therefore have the ability to alter surface ecosystem geochemistry. High-altitude systems experience isolation during the wintertime due to unsafe or inclement conditions that prevent access to the watershed for research, and consequently many of these systems are not sampled during the winter months. This isolation leads to a distinct gap in biogeochemical knowledge of these systems, which ultimately affects the accuracy and confidence in which these systems are computationally modeled. We deployed and subsequently retrieved OsmoSamplers from the East River (ER), CO watershed to study the aqueous and gaseous chemistry of the waters from the aquifer, river, and hyporheic zone during the winter. Our Shumway well sampler detected ca. 10x higher concentrations in Cl^- at the end of winter than during the rest of the year, adding to data previously collected only when the well could be accessed. The sampler also validated sustained low levels of $SO4^{-2}$ in groundwater through late fall and winter months showing an upward trend as summer started. Methane in the well was near saturating levels through the year. Our 10-month sampler installments in the ER surface water revealed up to 50 µM levels of methane in July through September, an increase compared to ca. 5 µM during most months. In contrast, samples from 20-cm deep in the hyporheic zone showed a spring-to-early summer peak in methane (< 65 µM) before declining. A second set of OsmoSamplers is being used to study the microbiome and metatranscriptome of the ER system. These measurements aim to accurately capture the biogeochemistry of the dynamic hyporheic ecosystem's response to hydrologic seasonality in high-altitude watersheds, strengthening our understanding of these systems during the winter months.