Turning rock into saprolite: Linking observations and models of vadose zone dynamics and chemical weathering

Abigail L. Langston[1], Gregory E. Tucker[1], Robert S. Anderson[2], and Suzanne P. Anderson[2]
Department of Geological Sciences and Cooperative Institute for Research in Environmental Sciences

Abstract. The chemical weathering of rock into saprolite requires contact between water and unweathered bedrock, which occurs frequently but discontinuously in the unsaturated zone. Saprolite is the direct precursor to mobile regolith, thus the distribution and rate of saprolite development plays a role in sediment production on hillslopes. We strive to understand both the timing and spatial distribution of saprolite development in the subsurface, which is controlled by the delivery of fresh water to unweathered rock. We hypothesize that the melt of a seasonal snow pack exerts the primary control on delivery of water to unweathered bedrock and on the rate of saprolite formation in semi-arid mountain climates. We also expect that subsurface flow paths are strongly modulated by the local fracture field, lending a strong heterogeneity to water delivery and weathering rates. To test this hypothesis, we link data collected in the Boulder Creek Critical Zone Observatory with a numerical model of fluid flow in the unsaturated zone. Measurements of snow depth and moisture content in soil and saprolite on north- and south-facing slopes of a small sub-catchment allow us to evaluate the impact the timing of melt-water delivery has on the depth to which water flows in the unsaturated zone. The model results show strong contrasts in the magnitude and spatial distribution of water in the vadose zone between north- and south-facing slopes. These results indicate that the development of saprolite is strongly controlled by the temporal distribution of precipitation throughout the year. This finding suggests an intriguing link between saprolite development and changes in the distribution of snow pack with a changing climate in mountain environments.

[1] Department of Geological Sciences and Cooperative Institute for Research in Environmental Sciences (CIRES)
[2] Institute for Arctic and Alpine Research (INSTAAR) and Department of Geological Sciences