The interplay of regolith evolution and watershed hydrodynamics in a first-order watershed.

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The thickness, porosity and permeability of regolith and the underlying fresh bedrock act in concert to govern the groundwater (GW) table position and solute fluxes. To quantitatively model hydrogeologic systems in low-permeability upland systems that are actively eroding, it is imperative that we are able to predict the distribution of regolith on the landscape. Here we measure GW chemistry and relate it to patterns of deep weathering to develop conceptual models of fluid flow and regolith formation at the first-order shale-dominated catchment, Susquehanna Shale Hills Critical Zone Observatory.

SSHCZO provides an ideal platform to investigate deep weathering reactions and their relationship to the GW table and GW geochemistry. Here we have observed that the oxidation of pyrite and carbonate comprise the deepest reaction fronts and are coincident with the GW table under the ridges. Depletion in carbonate is superimposed on stratigraphically-controlled variations in protolith carbonate content. At the ridges, the position of the GW table sets these reaction fronts but under the valley, a more complex system of GW flow and composition cause dissolution and precipitation of carbonate and drive pyrite oxidation below the regional GW table. Loss of GW represents a flux of weathering elements leaving the catchment undetected by stream water monitoring. These GW fluxes comprise a component of regolith formation that must be understood in the context of quantitative models related to regolith-controlled fluxes.