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Limits of Soil Production and the Couplings with Hillslope Hydrology
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Rocky mountain ranges are broken down to sediment that is ultimately removed to the sea. Tectonic forces continually push mountains up, while physical and chemical processes continually transform bedrock to sediment and move it down. This simple sounding cycle is thought to regulate global climate over long timescales, while also responding to climate forcing itself, although the causal direction remain a mystery despite decades of sleuthing. Similarly mysterious are the connections between mechanisms of sediment production and the responses of watersheds to changes driven by humans, climate, or tectonics.

To address some of the potential connections between sediment production and hillslope hydrology, I focus here on soil mantled and steeply sloped landscapes from around the world, some thought to be at a critical threshold of soil cover. Observations reveal that even in the most rapidly eroding landscape there are significant areas mantled with soil that fit the conceptual framework of a physically mobile layer derived from the underlying parent material with some locally-derived organic content. The extent and persistence of such soils depends on the long-term balance between soil production and erosion despite the perceived discrepancy between high erosion and low soil production rates. I present cosmogenic Be-10-derived soil production and erosion rates that show that soil production increases with catchment-averaged erosion, suggesting a feedback that enhances soil-cover persistence, even in threshold landscapes. I also show that a process transistion to landslide-dominated erosion results in thinner, patchier soils and rockier topography, but find that there is no sudden transition to bedrock landscapes. The landslide modeling is combined with a detailed quantification of bedrock exposure for these steep, mountainous landscapes.

To conclude, I draw an important conclusion connecting the physical processes producing and transporting soil and the chemical processes weathering the parent material by measuring parent material strength across three different field settings. Parent material strength is observed to increase with overlying soil thickness and, therefore, the weathered extent of the saprolite. Soil production rates, thus, decrease with increasing parent material competence. These observation highlight the importance of quantifying hillslope hydrologic processes where such multi-facted measurements are made.

キーワード: Soil erosion, Soil production, Critical Zone, Weathering, Hillslope hydrology, Saprolite
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