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Weathering, Soil Depth and Erosion in the San Gabriel Mountains: The Tectonic Signature on Chemical Weathering

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It is broadly understood that external forcings, such as climate and tectonics, influence the pace and pattern of landscape evolution by their control on physical and chemical processes that move soil and dissolve bedrock. Recent work in the Sierra Nevada quantified the potential role of climate in controlling chemical weathering rates, and suggested that strong erosion-weathering feedbacks control the landscape's response. Here, we explore the tectonic signature on weathering in the San Gabriel Mountains (SGM), using bulk elemental analyses of soils and bedrock and cosmogenic ^{10}Be derived rates of soil production. The SGM are located along a restraining bend in the San Andreas Fault, resulting in tectonic forcing on erosion and relief. We quantified chemical weathering across this landscape using six sites that bracket the low-gradient hillslopes of the stable upland plateau and the transient hillslopes at the margins of the incising landscape. On low gradient hillslopes (<30°), τ_{Si}—the fractional loss or gain of Si from parent material—averaged -0.32, and generally increased with increasing distance from the hillcrest and increasing slope. Across a threshold hillslope angle of 30°, soil weathering intensities decreases as erosion rates increase and soils thin. We find distinct patterns of erosion and weathering rates on high and low gradient slopes, and these patterns are consistent with a previously published predictive model for denudation-weathering relationships based on mineral weathering kinetics. Together, these data give new insight into the degree to which tectonics influences soil weathering, through its control on erosion rates, transport processes and soil thickness. Furthermore, this work provides a field-based quantification of the complex relationship between soil erosion and chemical weathering, and supports recent suggestions that this relationship is critical to our understanding of the fundamental controls on chemical weathering.