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EP23G-2412: Expression of rock strength in the morphology, bedrock exposure, and erosion rate of steep hillslopes in southern California, USA

Tuesday, 11 December 2018
13:40 - 18:00
Walter E Washington Convention Center - Hall A-C (Poster Hall)

Although rock masses experience wide ranges of physical and chemical weakening during exhumation in steep landscapes, few studies quantify connections between rock strength, hillslope morphology, and the efficiency of soil formation. These insights are necessary to interpret rates of surface processes from topographic form and model sediment transport on steep hillslopes that commonly consist of a patchwork of rock and soil. To address this knowledge gap, we isolate rock strength controls on hillslope morphology in the Eastern San Gabriel Mountains and North San Jacinto Mountains of California. Both study areas are similarly steep, granitic, and semi-arid, but bedrock fracture density is 5-10x greater in the Eastern San Gabriel Mountains. Here, we present new detrital ^{10}Be-derived erosion rates from headwater catchments, where we used high-resolution (~10 cm) orthophotos to map exposed bedrock on hillslopes, and we analyzed the morphology of soil-mantled and bare-bedrock regions using lidar topography. For a similar range of mean hillslope angles (38-45°), catchments in the Northern San Jacinto Mountains erode at rates of 0.1-0.6 mm/yr (mean = 0.2 mm/yr), compared to 0.2-2.2 mm/yr (mean = 1.1 mm/yr) in the Eastern San Gabriel Mountains. Although eroding ~5x slower, more and steeper bedrock is exposed on hillslopes in the Northern San Jacinto Mountains, whereas soil mantled regions rarely exceed mean slopes of 37-39° in both landscapes. Sparser fracture spacing in the Northern San Jacinto Mountains supports steeper cliffs and reduces the efficiency of soil production; additionally, soil transport efficiency is reduced, likely due to coarser clasts that armor soil-mantled slopes. In steep landscapes, the relationship between mean hillslope angle and erosion rate seems to be dictated by (1) material property controls on threshold stability angles of soil and bedrock and (2) soil production and transport rates, which are also sensitive to rock properties, and determine the proportion of soil mantled and bedrock hillslopes.

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