Abstract

Soil development along an elevational transect on the western slopes of the central Sierra Nevada was investigated to assess the effects of climate on soil properties and processes. The transect of seven soils formed in granitic residuum spans elevations from 198 to 2865 m with mean annual temperature and precipitation differences of 13°C (3.9-16.7) and 94 cm (33-127), respectively. Soil pH decreased by about two units and base saturation decreased from 90 to 10% with increasing elevation. Concentrations of organic C in the solum increased with elevation, with the largest single increase occurring between the oak woodland (5-6 kg C/m 2) and mixed-conifer sites (10-15 kg C/m2). Clay mineralogy showed a general trend of desilication and hydroxy-Al interlayering of 2 : 1 layer silicates with increasing elevation. The degree of chemical weathering, based on clay and secondary Fe oxide concentrations in the solum, showed a maximum (clay = 536 kg/m a and Fe oxides = 24 kg/m 2) at mid-elevations having intermediate levels of precipitation and temperature. While some soil properties show a continuous progression (e.g., organic carbon, base saturation, clay mineralogy) with elevation, other properties (e.g., pH, soil color, clay and secondary Fe oxide concentrations) show a pronounced change (threshold-type step) over a short distance at about 1600 m. The explanation for the abrupt nature of this shift is

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not known; however, it coincides with the approximate elevation of the present-day average

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Soil development along an elevational transect in the western Sierra Nevada, California

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Abstract

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Improvement in quantifying debris flow risk for post-wildfire emergency response

Jerome V De Graff[1,2]

Abstract

Floods and debris flows are recognized post-fire responses to rainfall within burned watersheds. The ability of debris flows to travel rapidly over significant distances from the area of initiation and their destructive force make them a hazard of particular concern. Individuals and organizations responsible for infrastructure, property, and public safety along the potential path of post-fire debris flows must understand the risk posed in order to design and implement suitable mitigating measures. Effective mitigation necessitates a rapid assessment of risk because only weeks or months separate the wildfire incident and the possible occurrence of a debris-flow initiating storm event. In the mountainous western United States, better risk assessment is crucial due to the combination of an expanding wildland-urban interface and more frequent large wildfires. Over the last 30 years, technological improvements in mapping fire effects, advances in our scientific understanding of post-fire debris flow occurrence, and development of empirical models to predict debris flow probability and volume have improved quantification of debris flow risk and facilitated more effective debris flow mitigation. How these advances have improved emergency response assessment efforts is exemplified by comparing assessment of debris flow risk for two large wildfires which occurred 26 years apart and affected much of the same area in the Sierra Nevada of California.

Keywords: Debris flows; Wildfires; Western United States; Prediction; Models; Emergency response

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Bedrock composition regulates mountain ecosystems and landscape evolution

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Earth's land surface teems with life. Although the distribution of ecosystems is largely explained by temperature and precipitation, vegetation can vary markedly with little variation in climate. Here we explore the role of bedrock in governing the distribution of forest cover across the Sierra Nevada Batholith, California. Our sites span a narrow range of elevations and thus a narrow range in climate. However, land cover varies from Giant Sequoia (*Sequoiadendron giganteum*), the largest trees on Earth, to vegetation-free swaths that are visible from space. Meanwhile, underlying bedrock spans nearly the entire compositional range of granitic bedrock in the western North American cordillera. We explored connections between lithology and vegetation using measurements of bedrock geochemistry and forest productivity. Tree-canopy cover, a proxy for forest productivity, varies by more than an order of magnitude across our sites, changing abruptly at mapped contacts between plutons and correlating with bedrock concentrations of major and minor elements, including the plant-essential nutrient phosphorus. Nutrient-poor areas that lack vegetation and soil are eroding more than two times slower on average than surrounding, more nutrient-rich, soil-mantled bedrock. This suggests that bedrock geochemistry can influence landscape evolution through an intrinsic limitation on primary productivity. Our results are consistent with widespread bottom-up lithologic control on the distribution and diversity of vegetation in mountainous terrain.

midelevations, reflecting a tradeoff between decreasing temperature and increasing precipitation with altitude (15). However, even at the highly productive midelevations, vegetation varies markedly without major differences in climate. For example, Giant Sequoia, the largest trees on Earth, grow in groves adjacent to barren patches where soil is absent and bedrock is exposed (Fig. 1 *C* and *D*). The bare and vegetated areas lie at similar elevations, ruling out altitudinal differences in climate as a plausible explanation for the variations in canopy cover (Fig. 1*E*). Rather, it appears that vegetation is strongly influenced by underlying bedrock; the contacts between different plutons (13, 14) often coincide with sharp ecotones between densely forested, soil-mantled slopes and sparsely vegetated, mostly soil-free bedrock (Fig. 1 *C* and *D*).

Other factors besides lithology fail to explain observed differences in vegetation. For example, Shuteye Peak, Bald Mountain, and Snow Corral Meadow were not glaciated in the Pleistocene (12). However, today they stand largely devoid of vegetation (Fig. 1 *C* and *D*). Moreover, we observe no evidence of recent high-intensity fire or widespread anthropogenic disturbance that might explain the variable presence–absence of vegetation and soil (*SI Text*). To rule out local variations in climate and topography as possible explanations, we polled the Kings and San Joaquin watersheds for areas that have the same multivariate probability distribution of elevation, aspect, and slope as the Bald Mountain Granite (Fig. 1*D*), which is exposed

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