Exploring the effects of bedrock nutrient density on life and topography in the Sierra Nevada Batholith, California

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As primary producers, plants form the basis of ecosystems. Plants themselves, however, depend on underlying substrates for mineral nutrients, which are ultimately derived from weathering of local bedrock and influxes of allocthonous dust [1]. Substrates that lack essential nutrients may preclude colonization of plant life. Where plants are absent, soil production and retention are hindered, leading to exposure of bedrock, which in turn inhibits erosion relative to surrounding soil-mantled, vegetated terrain [2]. This raises the possibility of a feedback wherein exposed bedrock hillslopes emerge in relief as stable features due to low intrinsic nutrient density. We explore the potential for such a feedback in the Sierra Nevada Batholith, California, which provides a natural laboratory for studying how gradients in intrinsic nutrient density correspond with gradients in vegetation. We restrict our analysis of controls on vegetation to minimally disturbed, unglaciated terrain, thus eliminating potentially confounding effects of intensive land use and glacial scour. We measured bedrock bulk geochemistry for slopes spanning a wide range in above-ground biomass, thus quantifying variations in intrinsic nutrient density. We leverage these point measurements of geochemistry with existing geochemical databases and geologic maps. Using spatial analysis we compare our geochemical data with measurements of above-ground biomass, net primary productivity, and remotely sensed vegetation density. Across our study area, nutrient density, as revealed by concentrations of phosphorus and magnesium in bedrock, varies by more than an order of magnitude. Biomass likewise varies widely, ranging in extremes from densely vegetated giant sequoia (*Sequoiadendron giganteum*) groves to sparsely distributed stands of stunted conifers within otherwise bare-bedrock landscapes. We find that bedrock with low intrinsic nutrient density is often associated with low biomass per unit area at sites where local climate is similar to that of forests with high biomass and productivity. This implies that bedrock nutrient density may serve as a first-order control on vegetation distributions across some portions of our study area. Our measurements of cosmogenic nuclides from exposed bedrock surfaces indicate that they are eroding slower than surrounding soil-mantled terrain, confirming that linkages between intrinsic nutrient density and vegetation could regulate relief at hillslope to mountain scales.

[1] Chadwick, Derry, Vitousek, Huebert, and Hedin (1999) *Nature* **397**, 491-497.
[2] Portenga and Bierman (2011) *GSA Today* **21**, 4-10.