Slope aspect and weathering in the Colorado Front Range

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Slope aspect plays important roles in controlling the thermal state and moisture on hillslopes. In the Front Range of Colorado, vegetation often shows sharp contrasts on north-facing and south-facing slopes. These parameters affect rates and processes of sediment transport on slopes. We use aspect-controlled contrasts in these parameters to explore the influence of vegetation, moisture, soil temperature, and sediment transport on weathering.

Field site

Our project is in Gordon Gulch within the Boulder Creek Critical Zone Observatory (http://czo. colorado. edu). The catchment lies at 2450-2750 m in the upper montane forest of the Colorado Front Range, and is underlain by biotite gneiss. The catchment trends east-west, and so has predominantly north-facing or south-facing hillslopes (Fig. 1). Dense stands of lodgepole pine (*Pinus contorta*) are found on the north-facing slopes, while open ponderosa (*Pinus ponderosa*) woodlands are found on south-facing slopes.

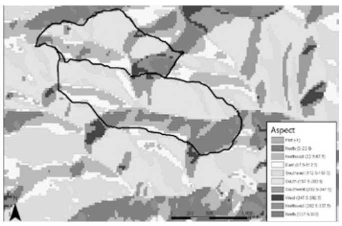

Figure 1: Slope aspects in Gordon Gulch. South-facing slopes are in lighter shades, while north-facing slopes are darker shades of gray. Watershed boundaries shown with black lines.

Findings

The mobile regolith layer is thicker and saprolite is deeper on north-facing slopes than south-facing slopes. South-facing slopes receive pulses of snow-melt throughout the winter, while north-facing slopes accumulate a snowpack that delivers water in fewer and more sustained melt events. The north-facing sites are colder, with freezing temperatures sustained for much of the winter to depths of 0.3 m. Outcrops (tors) are more common on the south-facing slopes, while tree-throw events appear to be evenly distributed. We are exploring hypotheses that 1) differences in sediment transport rates, or 2) differences in soil moisture flux control weathering and mobile regolith formation on these hillslopes.

Factors affecting the distribution of natural perchlorate in desert soils

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Perchlorate (ClO_4^-) occurrence is an important topic due to health concerns, evolving regulations for groundwater protection, and forensic investigations. ClO_4^- occurrence at the Amargosa Desert Research Site (ADRS) is being studied to improve understanding of deposition, accumulation, and biological cycling processes. Here we present initial results of an ongoing analysis of factors controlling the distribution of soil ClO_4^- in a desert landscape.

Precipitation at the ADRS averages 112 mm/yr. The ClO_4^- in bulk deposition averages 756 ± 481 ng/L. Surface soil (0-30 cm) samples were collected using feature-based and grid-type approaches. Feature-based settings were: (1) valley floor, (2) footslope, and (3) shoulder slope. Within each of these settings, replicate samples were collected (a) adjacent to plants and (b) from bare-soil interspaces at maximal distance (~3-5 m) from plants. To further assess ClO_4^- variability on hillslopes, a sampling grid (50 x 50 m; 9 ha area) was established spanning the footslope and shoulder slope locations.

For the valley-floor, there was a 14-fold difference between average interspace (4.1 μg/kg) and plant-adjacent (0.3 μg/kg) concentrations. In contrast, for the footslope, the difference between interspace and plant-adjacent averages was smaller (roughly 2-fold) and inverted (interspace 2.9 μg/kg; plant-adjacent 6.1 μg/kg). Shoulder slope values (interspace 1.8 μg/kg; plant-adjacent 2.6 μg/kg) were about half those for the footslope. This observation of lower concentrations at up-hillslope positions was supported by grid-sample results, which showed an inverse relation between concentration and land-surface elevation ($r = -0.42$, significant at 0.01, $n = 49$). Grid values typically ranged between 0.6 and 9 μg/kg. Soil sampling results and observed landscape-soil-plant patterns suggest a combination of factors is controlling the accumulation (and possibly redistribution) of soil ClO_4^-. Factors to be evaluated include soil texture, carbonate- and organic-carbon content, and terrain attributes. These factors will be discussed as suggestive of processes controlling occurrence of ClO_4^- in a desert landscape.