Exploring the influence of bedding and fracture orientation on weathering depth across a sedimentary ridge-valley system using near-surface geo-physics and drilling

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Abstract

Regional tectonics, geology, and climate all influence subsurface bedrock fracture density and orientation, and therefore the critical zone architecture. In sedimentary bedrock systems, the bedding and fracture orientations help shape the regional landscape, but the role of bedrock orientation in dictating weathering is poorly understood. Here we attempt to explain subsurface weathering patterns in a ridge-valley system in the Northern California Coast Ranges by comparing borehole observations to seismic refraction data. Borehole analysis revealed a dominant fracture plane orientation perpendicular to the north-south striking bedding. We conducted seismic surveys at different orientations relative to bedding and observed higher velocities for bedding-perpendicular profiles within the saprolite-weathered bedrock. We do not see a clear relationship between saprolite thickness and the angle between surface slope and bedding. However, the thickness of weathered material changes throughout the west-facing slope, reflecting the lithologic transition from shale to sandstone. Seismic and borehole data suggest that unweathered bedrock is observed above the height of the channel, however velocity remains below the expected values for fresh bedrock within our detection range, suggesting deeper fractures may be present. Despite a strong contrast in vegetation density and soil thickness with slope aspect, we do not find a significant difference in saprolite thickness with aspect. Our findings suggest that contemporary processes driving differences in soil thickness and vegetation with hillslope aspect do not control the thickness of the weathered zone at this site. Instead, lithology, fracture distribution, and chemical weathering may have a greater influence on bedrock weathering thickness.

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