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EXPLORING VALIDITY OF LIDAR-BASED SURFACE ROUGHNESS ANALYSIS FOR RELATIVE AGE ASSIGNMENT OF QUATERNARY SURFACES IN ARID ENVIRONMENTS

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Surface roughness analysis is a routinely implemented tool, used to differentiate Quaternary surfaces in a range of applications such as neotectonics, landslide and debris flow mapping, and planetary geology. Surface roughness is calculated as the standard deviation of the slope of LiDAR (Light Detection and Ranging) topographic data; however, the physical characteristics that may influence surface roughness analysis results have not been properly investigated, such as (1) impact of vegetation removal during data processing, (2) entrenchment or re-roughening of older surfaces, (3) the influence of facies on roughness of a surface, and (4) the dimensionality of surface roughness as a parameter. This research explores these issues by comparing LiDAR-based surface roughness measurements with physical measurements and observations obtained at 1-m increments along 50 m transects across six Quaternary alluvial surfaces in the northern Coachella Valley, near Whitewater, CA. The surfaces, Qa1-Qa6, and their relative age relationships were established by inset relationships observed in 0.5 m resolution LiDAR data. We measured clast lithologies, sizes (lengths, widths, and heights), and depths of burial; matrix grain sizes and angularity, and vegetation types and sizes. Physical characteristics documented include the degree of varnish development and rubification on clasts, Av soil horizon development, and matrix color. Measurements were compared to surface roughness maps created using moving neighborhood sizes that ranged from 1 to 30 m. The measured surfaces show vast differences between units despite being close in relative age, exemplified through the characteristics of the two oldest units, Qa1 and Qa2. Qa1 has a clast size distribution of 1.1 cm^3 to 22.5 cm^3, clast burial depths of 0.7-2 cm, and matrix size range of very coarse to fine sand, forming dune like features around 80 cm in height. Qa2 has clast sizes from 0.6-54000 cm^3, clast burial depths of 0.5-22 cm, and matrix size range of granule to silt. When the LiDAR data analyzed using a 3x3 (1.5 m x 1.5 m) cell moving neighborhood, Qa1 has a mean roughness of 1.47° and Qa2 has a mean roughness of 1.03°. These characteristics suggest that alteration of Quaternary alluvial surfaces via wind and headward erosion impacts surface roughness accuracy and that the technique is most effective when combined with field studies.

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