Bioturbated Dry Ravel and Soil Mixing in a Post-Wildfire Environment

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Wildfires act as potent agents of weathering and erosion, triggering the mobilization of dry ravel sediment and often resulting in temporary increases in sediment transport rates and associated debris-flow hazards. Existing hillslope sediment flux models fail to adequately capture the complex dynamics between erosion and deposition, particularly after wildfires and in landscapes dominated by processes such as bioturbation, tree falls, or other disturbances. To better understand bioturbated dry ravel and subsurface soil properties, we seek to study two hillslopes affected by the 2020 Santa Clara Unit Lightning Complex Fire at the University of California Blue Oak Ranch Reserve near San Jose, CA, by employing a novel application of short-lived radionuclides to characterize dry ravel transport processes. We used gamma spectroscopy on soil cores and recently excavated material from squirrel burrows, sampled along transects from the channel to the ridge on two opposing hillslopes to determine the concentrations of short-lived meteoric radionuclide 210Pb.

Our initial findings indicate that the excess 210Pb in soil core sediment varies from the hillslope ridge to toe. In the ridge soil cores, concentrations initially increase within the top 5 cm, followed by a sharp exponential decline with depth. However, the toe soil cores show a sharp exponential decrease in concentrations from the soil surface to ~35-45 cm depth. The toe cores have a concentration of ~ 80 Bq/kg near the surface, while the ridge cores have a much lower concentration of ~ 30 Bq/kg. Based on this preliminary data, we infer that deposition of lower-concentration soil excavated from squirrel burrows leads to

mixing of the upper soil layers. In contrast, the well-preserved exponential decay profile and higher surface concentrations at the steeper toe locations indicate less mixing overall. These initial findings warrant further examination of sediment characteristics at various depths through continued gamma spectroscopy and comparative analysis of shallow subsurface structure from ground-penetrating radar. These observations enhance our understanding of the roles of surface gradient and bioturbation in post-fire steepland sediment dynamics.

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