**The effect of Bed Thickness on Hillslope Morphology and Sediment Size in Last Chance Canyon, New Mexico**

**ABSTRACT**

Here we explore the effect that variance in bed thickness has on sediment flux, g and rain size distributions, and hillslope form in Last Chance canyon, New Mexico, USA. Many studies assume that diffusive soil mantled landscapes produce convex hillslopes. However, in Last Chance canyon, predominantly bedrock hillslopes in the more thinly bedded sandstones have a form similar to a diffusive soil mantled landscape, while hillslopes in the more thickly bedded carbonates resemble a dramatic bedrock landscape. In this study, we identify distributions of bed thicknesses and the corresponding hillslope curvature and slope, and alluvial grain size distributions. To accomplish this, we used drone photos to construct high resolution orthomosaics to measure bed thicknesses on several hillslopes and grain size distributions at the base of each hillslope. We used the same drone surveys to build high resolution digital elevation models (DEMs) to measure slope, curvature, and other topographic metrics. With these methods, we plan to determine 1) the effect of bed thickness on slope and curvature at different scales, 2) how distributions of bedrock thickness affect proximal alluvial sizes, and 3) how the combined effect of differently sized alluvial armor and differently thick bedrock has influenced landscape form. This study will help to constrain relevant bedrock properties have on landscape morphology and elucidate geomorphic processes between hillslopes and channels.

**INTRODUCTION**

Variance in relevant bedrock properties influences the production and size of sediment on hillslopes (Johnstone and Hilley, 2015), erosion rates (Dixon et al, 2012), and landscape form (Glade, 2017; Hurst, 2013). Rock properties, specifically fracture spacing, has been shown to influence rock surface slope (e.g., Brook and Tippett, 2002; Matasci et al., 2015; Moore et al., 2009; Selby, 1980), erosion, and imprints its signature into the topography (Molnar et al., 2007; Clarke and Burbank, 2011; St. Clair et al., 2015; Voigtlander et al., 2017; Eppes and Keanini, 2017; Eppes et al., 2018). Soil depth, a function of both soil production and erosion rate, has been shown to affect hillslope convexity (Roering, 2008). Soil mantled hillslopes are thought to generate convex hillslopes, however, in Last Chance canyon, sandstone hillslopes with predominantly exposed bedrock are convex in shape and resemble soil mantled hillslopes. But what about these bedrock hillslopes causes them to look like soil mantled hillslopes? Why do predominantly sandstone hillslopes appear diffusive while carbonate hillslopes are steep and shear?

In this study, we seek to understand the effect that changes in rock properties have on sediment production and erosion. More specifically, we ask what controls weathering, soil production, and sediment movement on hillslopes with high spatial variability in rock properties? how is sediment removed so that diffusive looking landscapes are generated in thinly bedded sandstone and not in the more thickly bedded carbonates? To answer these questions, we will couple a hillslope sheet wash component with the overland flow model to explore sediment delivery from hillslopes to channels. We will inform our model runs with realistic hydrographs reconstructions and field measurements of sediment size. and distance between bedrock beds. We will also measure sediment depth, bulk lithology of less than gravel sized colluvium, and the lithology of larger sized sediment.

**FIELD AREA**

This study focuses on 2 different, first to second order watersheds with intermittent flow in Last Chance canyon (Figure 1). During Permian time, a shallow lagoon existed behind a reef complex to the south and deposited what would become interbedded carbonate and siliciclastic bedrock of various thicknesses (Hill, 2000; Phelps et al., 2008; Kerans et al., 2017). The Guadalupe mountains were uplifted during basin and range extension beginning 27 million years ago, exposing the previously buried bedrock (Chapin and Cather, 1994; Ricketts et al.., 2014, Hoffman, 2014; Decker et al., 2018).

Because of their differing morphology and grain size distributions, we use data gathered from different sections of two watersheds, called LC1 and LC3 (grain size figure, chi, and steepness vs grain size). In both watersheds, grain size distributions increase with channel steepness. This simple variation in grain size distribution makes LC1 and 3 ideal locations to explore the effect of varying sediment sizes on stream channel morphology.

**METHODS**

We used a DJI mavik 2 pro to take photos of seven segments of each of the two watersheds from elevations of approximately 20 meters above LC1 and LC3. We then used Agisoft Metashape software to process these images and to produce orthomosaics and DEM’s with a spatial resolution that varied from # to #. We used the PebbleCounts image analysis package (Purinton and Bookhagen, 2019), to determine the a and b axis diameter of alluvium.

**ANALYSIS**

To link interplay between rock properties and the storm properties to hillslope morphology, we model sediment flux from different rock types for different storms. Preliminary analysis has demonstrated that hillslopes steepen in more thickly bedded rock and appear more diffusive in more thinly bedded rock (figure 9). Both the scales and resolution at which hillslopes are measured will affect analysis. Hillslope profiles measured at lower resolutions (figure 9) or larger scales (figure 8) blur changes in local slope. Storms which pluck colluvium from the two different lithologies will have different recurrence intervals. More frequent, less intense storms should be able to pluck bedrock from the sandstone hillslopes more often than in carbonates. Infiltration will be considered within the model equations. We expect that precipitation more readily infiltrates into sandstones, widening and generating new fractures, and making bedrock more erodible. We will compare modeled sediment size distributions and bedding plane thicknesses between sandstones and carbonates. This approach will help elucidate how variance in bed spacing allows for diffusive hillslopes to be generated from bedrock.