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Project Title: Is Railroad Valley an anomaly?: Using mountain geomorphology and basin stratigraphy to identify buried mega-landslides

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Overview

In this project we are evaluating mountain geomorphology and basin stratigraphy to develop critical indicators of buried large-scale landslide deposits in the Basin and Range of the western USA. Buried landslide blocks house half of the hydrocarbons that have been produced in Nevada, but these deposits are difficult to identify with traditional geophysical methods. Graduate student Nick Ferry joined the project last fall, working on landslide modeling with collaborator Dylan Ward and field analysis of the Blue Diamond landslide. A second graduate student, Adam Jones, joined the project this fall. He will work on DEM modeling and field analysis of landslides. This project has already had a great impact on my career and the career of my students. Though we are still in the middle of the project, we have presented initial results at national meetings for the Geological Society of America, American Association of Petroleum Geologists, and Association of Environmental & Engineering Geologists. These presentations have received internal press coverage (https://www.uc.edu/news/articles/2018/11/n2047817.html) and an award for best poster presentation to grad student Nick Ferry at the AEG meeting. I anticipate that we will submit several manuscripts to peer-reviewed journals within the next year as we complete portions of the project. Additionally, this work will lead to more grant proposals and further research. Below is a summary of progress on each of the main portions of the proposed work:

Landsliding model development

In this period, we have made significant progress on building a module of functions to bring deep-seated bedrock landsliding to the LandLab landscape evolution model framework (Figure 1). The module can be imported into a Python environment alongside the LandLab modules and coupled via a driver script to a landscape evolution model, with other landscape processes handled by LandLab functions. Currently, the landslide module implements deep-seated landsliding using a Culling threshold-height criterion, which is calculated based on an infinite-slope approximation for stability. The implementation chooses grid points at random in each timestep and determines whether they are contiguous with higher cells that lie above the plane of internal friction and reach above the threshold height. If so, the probability of failure is based on the height of this patch of cells relative to the threshold height. The stability equation includes terms for cohesion, internal friction, and can be modified to include a pore-pressure term to incorporate the effects of climate; all of these terms can vary across the model grid. In addition, the failure plane is not strictly the plane of internal friction but can be modified based on the orientation of bedding planes that are within a threshold of being coplanar with the friction plane. These features will allow us to explore the effects of structural geology and rainfall patterns on the landsliding patterns, and their effects on the rangefront morphology.

Landslide Inventory and DEM analysis

We are building a database of known mega-landslides in Nevada. Compiled data on these landslides will be made publicly available as a layer in the MyHazards web mapping application hosted by the Nevada Bureau of Mines and Geology. Grad students Adam Jones and Chris Sheehan will use these landslides as a guide for DEM analysis of known landslide-producing rangefronts. Key criteria from these rangefronts will be used analyze rangefronts across Nevada for evidence of landslide activity.

Field analysis of landslides

We conducted field reconnaissance of approximately one dozen large-scale landslides in California and Nevada. We a currently conducting detailed analysis of the Blue Diamond mega-landslide near Las Vegas (Figure 2) and we have collected a new suite of samples to directly date the Blackhawk landslide using ^{36}Cl. The Blue Diamond

landslide is estimated to cover at least ~25 km^2, with deposition of brecciated middle Paleozoic carbonates onto Triassic carbonates and Cenozoic(?) alluvium.

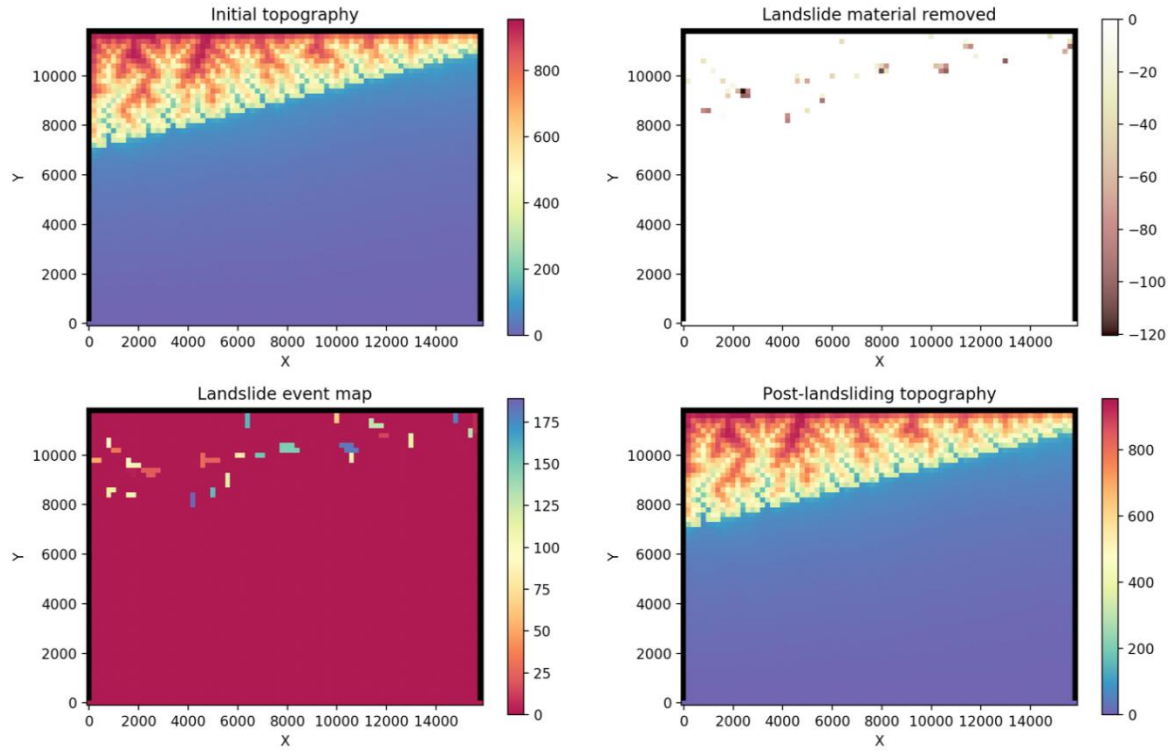

Figure 1. The effects of about 40 landslides on a LandLab-derived topographic grid (all units m).

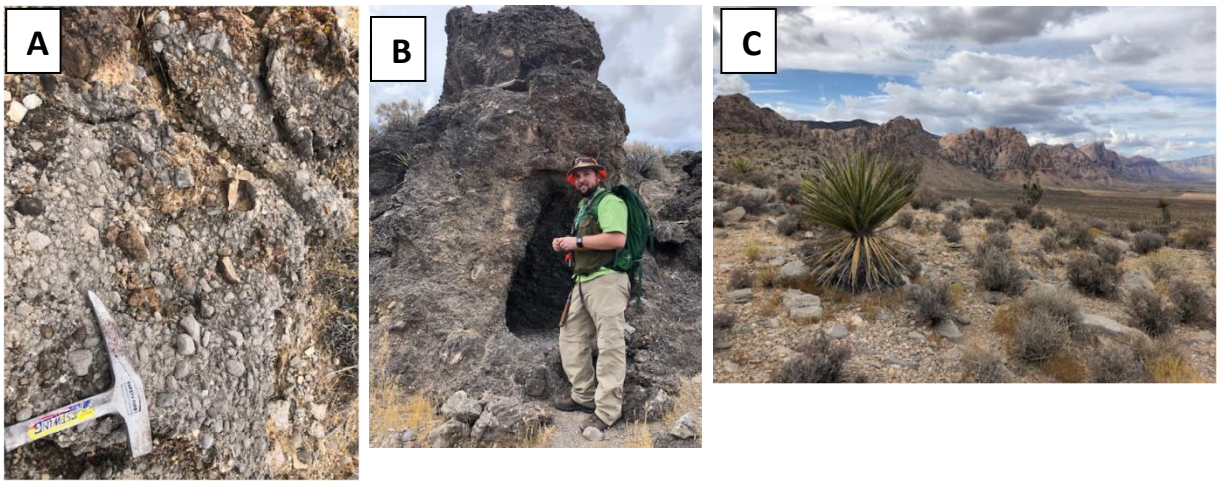

Figure 2. Photos of the Blue Diamond landslide, Clark County, NV. A. Breccia texture near the basal contact of the landslide. B. Cavernous porosity within the landslide deposit. C. Photo looking northwest from the landslide deposit toward the hypothesized source area (gray rocks above the red and tan Jurassic Aztec Sandstone cliffs). The source area is around 700 m higher in elevation than the deposit.