ABSTRACT

Because moraines preserve a record of the extent and location of previous glaciers, surface dating of their regolith is used to determine a climatic history for a region. Study into the extent and effects of Pleistocene glaciations in North America has had a long research history since Blackwelder (1931) did some of the earliest mapping of moraines in the eastern Sierra Nevada. In the advance of surface dating using cosmogenic isotopes, the discussion over the timing of the glacial fluctuations that caused the conditions of glacial advances and retreats have grown controversial, due to the variability of published results.

However, as discussed in Hallet and Pulkonen (1994), when topographic degradation acts on the material that moraines consist of, the surface is eroded at variable rates. So paradoxically the best record of previous glaciations is altered by the topographic diffusion of the materials the recording landform is made of. Hence this case speaks to the broader scientific question of how the dynamics of hillside degradation affect landscape evolution. It also speaks to practical problem of surface dating moraines and how best to understand their surface degradation, so that appropriate sampling can be done. Since both issues play key roles in landscape evolution modeling, addressing them both would improve understanding of landscape changes in different environments.

Study Area

Moraines in the region including Mono Basin and Bishop, CA record a history of Quaternary glaciations in western North America. Indicative of the impact that fluctuating climates left on the landscape. Research over the century has tried to correlate different moraines through mapping and surface dating, but many uncertainties remain.

II. Methods

To investigate the rates, volumes, sizes and patterns of sediment transported in topographic diffusion over different sloping surfaces of different landforms, terrestrial LiDAR scans, sediment traps, and erosion markers were used.

Sediment traps and transport markers (photos right) provide raw data on erosion rates. Minimal calculations can be made using topographic diffusivity formulations (Culling, 1960). These calculations will be compared with similar calculations of surface change in the MatLab models.

Terrestrial LiDAR scans (see instrument above, point cloud right) provide additive areas and high resolution records by which sediment transport paths and rates can be measured.

(Left) Point clouds recorded with a 945nm LiDAR indicate surface change. Coordinate in Cytospace software are imported to MatLab where surfaces are created and post processed

Evidence for Sediment Transport in Mono Basin

• Using the sediment flux equation (below), the volume of sediment transport represented by sediment collected by the sediment traps was determined to be on the order of 0.77 m3/yr/m2, which represents only an average and a minimal value of sediment transport for the Mono Basin moraines.

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rate_{soil} = \frac{\text{d}m}{\text{d}t}
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• Through the use of painted pebbles as transport markers and repeat photos, transport of cm-sized clasts was also supported.

• The high resolution topographic sampling performed by the LiDAR provided evidence for an average loss of 4 mm/m².

• The preliminary evidence supports significant sediment transport at multiple spatial scales over 1 year in Mono Basin, suggesting that the landscape is actively degrading currently.

IV. Discussion/Questions/Future Directions

• The ability to determine topographic differences with such a high resolution, allowed by the LiDAR scanning, means that there will be a much higher number of instances of sediment flux over a given area. Even though the instances are small, many more are recorded, resulting in a significantly higher volume for a given area over a defined time interval. Sediment transport data at this scale has never before been collected.

• How can sediment transport rates be compared at different spatial and temporal scales on landforms with different origins and histories in order to model landscape evolution?

• Collecting and compiling sediment transport data over different slopes of a landform and over different landforms over a region will allow comparisons to be made and determinations that will be used to model the variations in landscape degradation.

Studying different landforms.

In addition to analyzing sediment transport and topographic diffusivity of moraines, scans were performed on hillslopes formed by different geological processes related to the region. These landforms will be studied to determine how degradation processes operate and compare with moraines in the area.