EVALUATING THE DEPENDENCE OF SEDIMENT CALIBER ON EROSION RATE IN A COASTAL MOUNTAIN RANGE, CENTRAL CALIFORNIA

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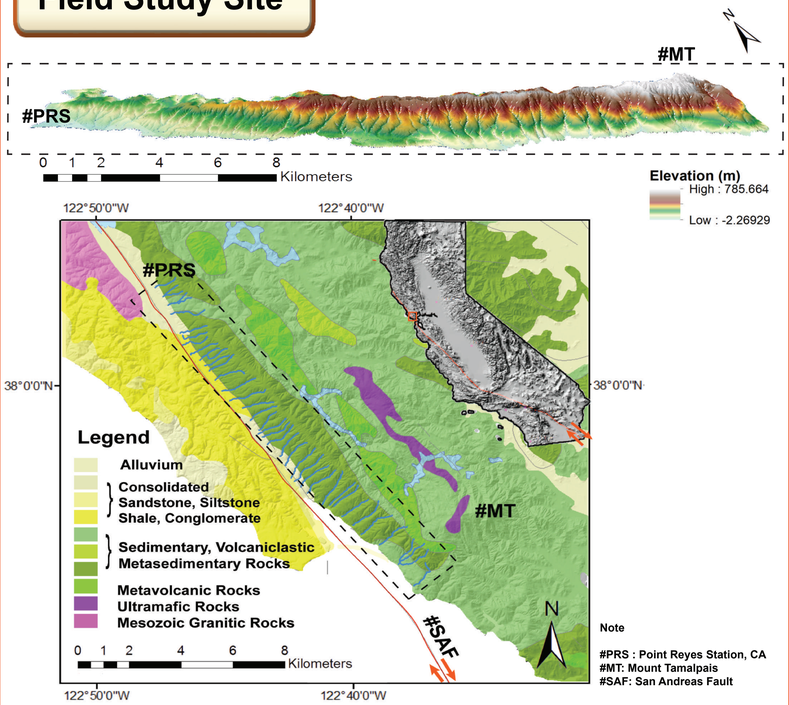
Research Motivation and Overview

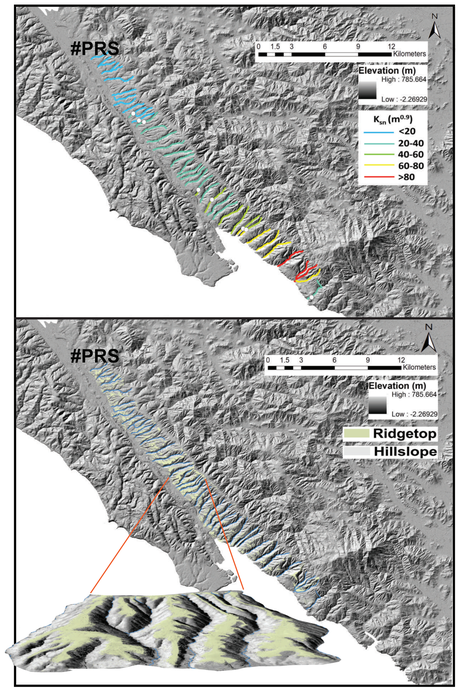
Over the past several decades, a large body of work explored the rates and patterns of landscape deformation in tectonically active orogenic systems where boundary conditions are known from both theoretical framework and observations. These works reveal that landscape relief adjustment to differential rock uplift is largely governed by the response of channel networks. This effect represents as a positive, non-linear scaling relationship between channel steepness (a measure of channel gradient normalized for differences in contributing drainage areas) and erosion rate (e.g. *Kirby and Whipple,* 2012). This reflects the relative influences of variable channel discharge, rock mass quality, and thresholds for erosion and sediment transport (e.g. *Lague et al.,* 2005; *DiBiase and Whipple,* 2011). Although the grain size distribution of sediment supplied by hillslope controls hillslope transport and channel incision, characterization of systematic variation in grain size on differential rock uplift and/or erosion rates has proven difficult in most field sites.

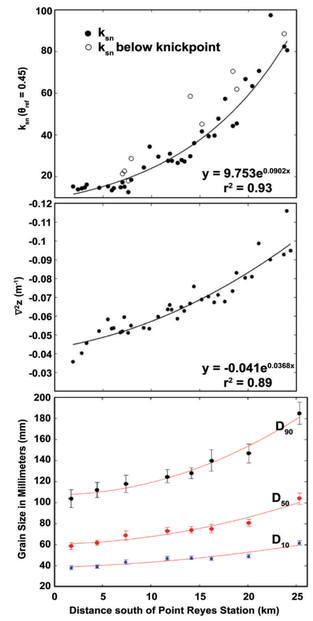
Here, we propose to evaluate the association among hillslope and channel morphology, sediment delivery, and erosion rate by combining topographic analysis of channel and hillslope morphology with a measurement of grain size distributions along a discernible field site of erosion rate gradient in a coastal mountain range, central California.

Field Study Site



Preliminary Observations





Normalized Channel Steepness Indices (k_{sn})

Ridgetop Curvature ($\nabla^2 z$)

Sediment Grain Size

- Normalized channel steepness indices (k_{sn}) derived from slope-area regression have been used to detect zones of differential rock uplift and/or erosion rate
- k_{sn} systematically increases fourfold to sixfold from north to south along the ridge
- Ridgetop curvatures have primarily changed when ridges respond to rock uplift and/or erosion rate
- Curvatures of ridgetop, illustrated as the average value for all individual data points with low values of the drainage area-gradient product, negatively increase from north to south
- Median of the grain size distribution (D_{50}) and the variance in the population (D_{10}- D_{90}) increase from north to south, implying increase in sediment transport thresholds toward the south

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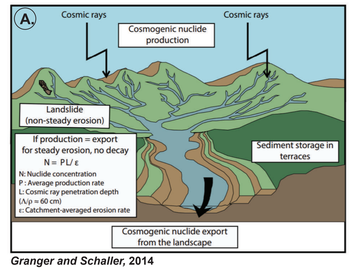
Preliminary Conclusions

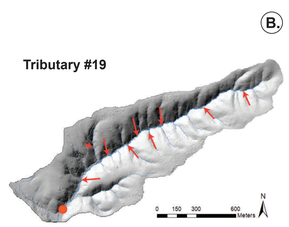
- Coordinated adjustment among channel steepness, interfluve curvature, and grain size variations reflects spatial variations in rock uplift and/or erosion rate toward the south
- Increase in median of grain size distribution and its variance suggests that the thresholds for sediment transport develop as a consequence of variable erosion rate
- Variations in thresholds for sediment transport could be an important control on the non-linear scaling relationship between channel steepness and erosion rate

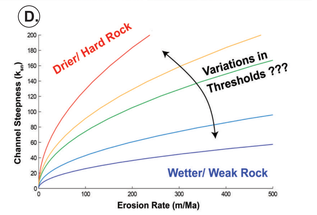
Future Work

- An estimate of catchment-averaged erosion rate by analyzing cosmogenic ^{10}Be concentration in quartz-bearing sediment from 12 active channels along the ridge
- The model of channel adjustment to erosion rate, incorporated with variable thresholds of sediment transport
- The degree to which grain size variations modulate the adjustment of channel steepness and hillslope morphology



Granger and Schaller, 2014





A. Sediment delivered from the eroded watershed can be used to determine erosion rate at watershed-scale that is inversely proportional to cosmogenic nuclide concentrations

B. Sediment samples were collected at the outlet of the watershed, as a representative of eroded sediment from upstream contributing area

C. Sampling channel sand for cosmogenic nuclide determination from first-order streams and watersheds along the ridge

D. Model of channel adjustment to erosion rate, incorporated with variable eorsion thresholds. The model will highlight a role of grain size in governing non-linear scaling relationship between channel steepness and erosion rate