Investigating the dynamic equilibrium between erosion and tectonic uplift within the Ventura Basin and implications for seismic hazards in southern California

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Project aim:
To quantify total cosmogenic nuclide (TCN)-derived erosion rates from various catchments along strike in the hanging wall of several seismically active reverse faults in the Ventura basin, California, USA. Erosion rates can be compared to morphometric landscape parameters and rates of tectonic uplift at various temporal scales to investigate the landscape response to active faulting.

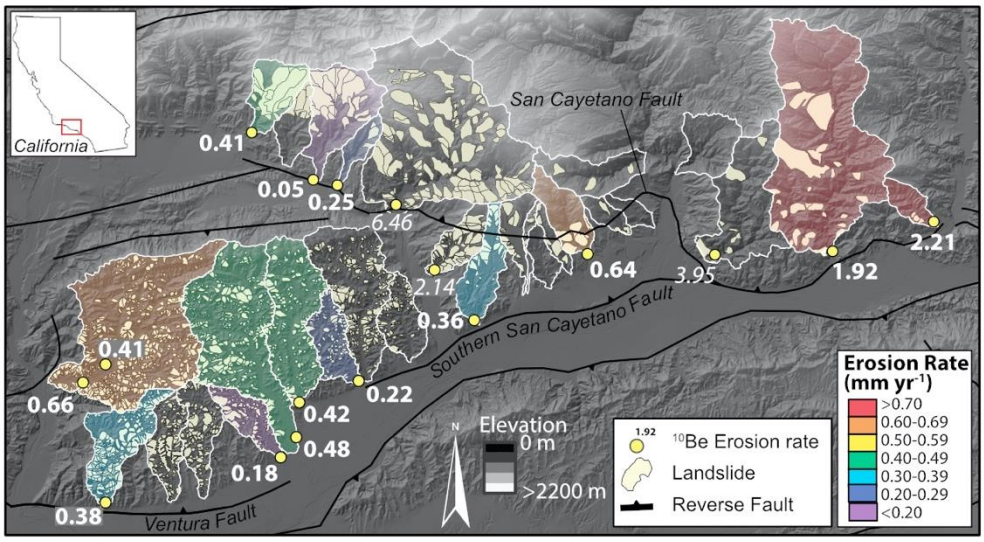

Figure 1 Map of catchments in the study area showing the location of erosion rate samples in relation to the major faults.

Methodology:
Bedrock in an actively eroding landscape accumulates ^{10}Be as it passes upwards through the production zone of cosmogenic nuclides before being eroded from the hillslope, transported, and deposited as sediment in an active channel. In eroding landscapes, the concentration of ^{10}Be in sediments from an active fluvial channel is proportional to the catchment-averaged ^{10}Be production rate and is inversely proportional to the spatially averaged erosion rate. Using this relationship, rapidly eroding catchments will have low nuclide concentrations and slowly eroding catchments will have high nuclide concentrations. We collected 200 g of sand from active bars and channels from 18 catchments in the hanging wall of the Ventura, San Cayetano, and Southern San Cayetano faults (Fig. 1) to measure erosion rates. Samples were processed in the CosmIC laboratory at Imperial College London to isolate ^{10}Be and nuclide concentrations were measured by accelerator mass spectrometry at Lawrence Livermore National Laboratory AMS facility.

Main Findings:
Landslides are ubiquitous throughout the study area (Fig. 1) and we interpreted anomalously high modelled erosion rates in three catchments to have been artificially increased by landslides in close proximity to the sample location. Erosion rates from the remaining fifteen catchments are in the range 0.05–2.21 mm yr^{-1} and showed a systematic variation in the hanging wall of the Ventura and San Cayetano faults. Specifically, erosion rates in the hanging wall of the San Cayetano fault increase eastwards along strike. This eastward increase is consistent with an eastward increase in tectonic uplift rates and an eastward decrease in the strength of the eroding rocks. Annual precipitation also decreases eastwards, which indicates that the spatial variations in erosion rates are responding to tectonic and rock-strength signals rather than precipitation gradients.
In the hanging wall of the Ventura fault, erosion rates and are in the range 0.18–0.66 mm yr^{-1} and erosion rate is correlated with upstream drainage area. Surface uplift related to the Ventura fault is thought to have commenced around 380 ka but the largest catchments in the hanging wall of the Ventura fault have older faults to the north located in the upper reaches of the catchments. Therefore, we interpret the erosion rates in the hanging wall of the Ventura fault to be recording the inherited uplift signal from the older tectonic regime.

Funding from the BSG was essential for covering transport costs to travel to the USA to collect samples. The samples collected provided this basis for a chapter of a PhD thesis, which is currently being written up for a paper intended for submission to GSA Bulletin.