Reconstructing temporal variations in fault slip from footwall topography: An example from Saline Valley, California (*Invited*)

Details

Meeting	2010 Fall Meeting
Section	Earth and Planetary Surface Processes
Session	Landscape Evolution in Response to Active Faulting II
Identifier	EP44A-05
Authors	Kirby, E*, Penn State University, University Park, PA, USA Regalla, C, Penn State University, University Park, PA, USA Ouimet, W B, Penn State University, University Park, PA, USA Bierman, P R, Univ. of Vermont, Burlington, VT, USA
Index Terms	Geomorphology: general [1824] Continental neotectonics [8107] Tectonics and landscape evolution [8175]

Abstract

It is becoming increasingly apparent that many intra-plate fault systems exhibit significant variability their rates of displacement over timescales ranging from 10^4 - 10^6 yr. Whether such variability arises simply as a consequence of fault system evolution or whether it reflects temporal changes in the rate of loading in the deep crust remains a first-order question. Because most records of fault slip at these timescales rely on geomorphic markers, inherently ephemeral features in the landscape, characterizing the history of fault slip through time can be difficult and is usually limited to environments with high rates of sediment deposition. In erosional landscapes, however, changes in the throw rates of fault systems are expected to engender systematic changes in landscape topography as channels and hillslopes adjust to changes in relative base level. Here we combine quantitative analysis of stream profiles with measurements of erosion rate (using detrital inventories of ^{10}Be in sediment) from footwall catchments in the Inyo Mountains, in eastern California, to recognize and place constraints on the timing and of a sustained acceleration in fault slip along the range-front fault system. The Inyo Mountains are the footwall block to an active fault system along the western margin of Saline Valley; relief between the range and valley floor averages ~3 km. Normal-oblique slip along the range-front fault is linked to strike-slip displacement on the Hunter Mountain fault. Estimates for the onset of slip along this system range from 2.8 - 4.0 Ma, implying average slip rates of 2.1 - 3.3 mm/yr. However, geodetic measures suggest modern slip rates reach or exceed ~4.5 mm/yr. Analysis of channel profiles draining the Inyo Range reveals pronounced knickpoints that separate relatively low-gradient headwater reaches from exceedingly steep lower reaches. Knickpoints are only present along channels that cross the range-front fault, are developed within a single lithology, and are distributed at uniform elevations throughout the range. Normalized steepness indices of upstream reaches are consistent across the range, and imply a quasi-equilibrium landscape that was perturbed by an sustained increase in relative base-level fall. Reconstruction of former profiles implies ~1000 m of differential rock uplift. We analyzed ^{10}Be concentrations from 15 samples collected from above and below knickpoints along the range front. Results reveal that low gradient upper reaches of these watersheds are characterized by relatively uniform, slow erosion rates of 50-100 m/Ma. Samples collected below knickpoints, however, suggest that average erosion rates in these watersheds are 400-700 m/Ma; deconvolution of area-weighted ^{10}Be inventories suggests that reaches below knickpoints are presently eroding at rates between 700-1200 m/Ma. Preliminary estimates of the response time of detachment-limited incision models suggest that transient profiles reflect an increase in fault slip at ca. 0.7 - 1.0 Ma. Overall, our results suggest that differences between geologic and geodetic rates of slip along this fault system are the result of true changes in deformation rate through time and illustrate the potential of quantitative geomorphic analysis to inform our understanding of active fault systems.

Cite as: Author(s) (2010), Title, Abstract EP44A-05 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13-17 Dec.