What Topographic Metrics Most Strongly Correlate with Millennial Erosion Rates as Determined by Detrital CRN Analyses?

Details

Meeting	2006 Fall Meeting
Section	Hydrology
Session	New Tools to Study Drainage Basin Evolution II
Identifier	H21H-07
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Index Terms	Erosion [1815] Geomorphology: general [1824] River channels [1856] Tectonics and landscape evolution [8175] Tectonics and climatic interactions [8177]

Abstract

We report on millennial-scale, catchment-average erosion rates estimated from cosmogenic 10Be concentrations in detrital quartz sand from field sites in the Bolivian Andes and the San Gabriel Mountains of Southern California, USA. Topographic ruggedness, climatic conditions, and bedrock lithology vary greatly across the catchments sampled for detrital CRN analyses. CRN-determined erosion rates from these diverse landscapes range from 0.04 to 1.35 mm/yr in the Andes and 0.03 to 0.97 mm/yr in the San Gabriel Mountains. In both mountain ranges our data confirm the theoretical expectation that hillslope gradients will reach threshold values at relatively low erosion rates (around 0.2 - 0.3 mm/yr in both landscapes), and that further increases in erosion rates will be reflected in the frequency of landslides, percent rock exposure, and perhaps drainage density, but not in basin-average hillslope gradients. A lower threshold mean basin slope in the Andes may reflect wetter conditions and weaker rocks, but is likely largely an artifact of a lower resolution DEM (90m vs. 10m). Interestingly, in both mountain ranges our data reveal a monotonic, positive correlation between the channel steepness index determined from slope-area analysis of channel profiles and basin-average erosion rate. Additional data is required to determine if these relations are linear or sub-linear, and detailed field observations are required before we can assess the combination of factors (channel slope, width, % rock exposure, bed material size, roughness, etc) that lead to the observed relations. For instance, it is not clear yet why Andean drainages with comparable channel steepness index values are eroding less rapidly than their San Gabriel

cousins, despite wetter conditions and arguably weaker rocks. The channel steepness index can not readily be compared in different geologic and climatic settings.

Cite as: Author(s) (2006), Title, *Eos Trans. AGU, 87*(52), Fall Meet. Suppl., Abstract H21H-07
