Bumps in the long road to flat

Details

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Abstract

The persistence of topography along the ancient Appalachian orogen remains one of the outstanding questions in landscape evolution. Indeed, whether these ranges are in a state of quasi-equilibrium, decaying slowly over many millennia, or whether they have been rejuvenated during Neogene time, is unknown. Here we present quantitative geomorphic data from unglaciated portions of the Susquehanna River drainage basin of Pennsylvania that provide insight into these end-member models. Analysis of streams draining upland plateaus in the northern Valley and Ridge and Appalachian Plateau reveals transient profiles, characterized by steep reaches incised into narrow, steep-sided valleys below knickpoints that are not associated with lithologic contacts or contrasts in rock strength. Low-gradient streams atop the plateau drain a low-relief landscape. Watershed-averaged erosion rates from cosmogenic ^{10}Be meausured in quartz extracted from river sand are 7-28 m/Ma above knickpoints. Erosion rates below knickpoints, deconvolved using nested basin samples above knickpoints, are faster at 47-100 m/Ma. Erosion rates in tributary basins that enter trunk streams below knickpoints, but have concave stream profiles themselves, are 29-50 m/Ma. When normalized for drainage area, channel gradients correlate linearly with watershed-averaged erosion rates, suggesting that channel profiles are dynamically adjusting to match an imposed forcing. Reconstruction of relict channel profiles suggests that higher rates of incision are a response to ~200 m of relative base level fall. Preliminary results of a calibrated 1-D stream profile model suggest that the observed knickpoints may have begun propagating through the Susquehanna basin in the Miocene, perhaps in response to dynamic topography along the eastern seaboard or stream capture. Our results provide direct evidence that portions of the Appalachian landscape are still out of equilibrium.

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