Stratigraphic control of landscape response to base-level fall, Young Womans Creek, Pennsylvania, USA

Roman A. DiBiase[1, 2], Alison R. Denn[3], Paul R. Bierman[3], Eric Kirby[4], Nicole West[5], Alan J. Hidy[6]

[1]*Department of Geosciences, Pennsylvania State University, University Park, Pennsylvania, USA 16802*

[2]*Earth and Environmental Systems Institute, Pennsylvania State University, University Park, Pennsylvania, USA 16802*

[3]*Department of Geology, University of Vermont, Burlington, Vermont, USA 05405*

[4]*College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, Oregon, USA 97331*

[5]*Department of Earth and Atmospheric Sciences, Central Michigan University, Mount Pleasant, Michigan, USA 48859*

[6]*Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, California, USA 94550*

Landscapes are thought to respond to changes in relative base level through the upstream propagation of a boundary that delineates relict from adjusting topography. However, spatially-variable rock strength can influence the topographic expression of such transient landscapes, especially in layered rocks, where strength variations can mask topographic signals expected due to changes in climate or tectonics. Here, we analyze the landscape response to base-level fall in Young Womans Creek, a 220 km^2 catchment on the Appalachian Plateau, USA underlain by gently folded Paleozoic sedimentary rocks. We measured *in situ* ^{10}Be concentrations in stream sands from 17 nested watersheds, and used a spatially-distributed model of sediment and ^{10}Be production to constrain a threefold increase in the rate of base-level fall propagating upstream from the catchment outlet. Using lidar topography and a nearby detailed stratigraphic section, we map the extent of continuous, blocky, resistant sandstone strata that act as a caprock overlying more easily erodible sandstones and siltstones. The caprock influences landscape response in two ways. First, it serves as a boundary between slowly eroding (11.5 m Myr^{-1}), low-sloping (3-5°) areas of relict topography and lower, steeper portions of the landscape adjusting to base-level fall. Second, hillslopes supported by the overlying caprock are armored with coarse sediment and are significantly steeper (20-30°) than hillslopes where the caprock has been eroded (10°), despite having similar erosion rates (36 m Myr^{-1}) and bedrock substrate. Our results illustrate how gently dipping, layered rocks engender complicated relationships between lithology, topography and erosion rate, highlighting the importance of understanding how rock material properties influence surface processes and landscape evolution.