Controls on relict landscape response to knickpoint migration, Roan Plateau, western Colorado

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Abstract:

The morphology of relict landscapes may provide important insight into erosion rates and processes prior to base level fall (or rock uplift). However, preservation of a relict landscape is limited by the rate and style of upstream migration of fluvial knickpoints. We explore the response of the Roan Plateau in western Colorado to late Cenozoic incision of the upper Colorado River along its southern edge. Base level fall appears to have triggered the formation and retreat of knickpoints on multiple tributary streams draining the Roan Plateau. The knickpoints (100-m waterfalls) have migrated tens of kilometers from the Colorado River through Eocene shales and sandstones, and now separate a low-relief, upland landscape from incised canyons 500-1000 m in relief below. Knickpoint positions have been modeled as a function of the history of contributing drainage area, indicating that these knickpoints likely mark the upstream extent of a transient wave of incision (Berlin and Anderson, 2007). We use 10-m digital elevation model (DEM) data to document channel oversteepening extending several kilometers upstream of waterfalls, and corresponding to tens of meters of enhanced incision at the waterfall lip. Topography generated from Airborne Laser Swath Mapping (ALSM) at 1-m resolution also reveals an increase in channel slope toward the waterfall lip. These observations suggest that information about incision has leaked upstream of the knickpoints, rejuvenating at least some portion of the fluvial network on top of the plateau. Using this landscape as a test case, we compare two mechanisms for generating an oversteepened reach upstream of a waterfall. The first relies upon a recently proposed model for erosion amplification due to flow acceleration at the waterfall lip (Haviv et al., 2006). The second acknowledges the influence of subtle structural dip and relative rock susceptibility to erosion in dictating the elevation of the waterfall lip as it migrates upstream. Numerical modeling suggests that the latter mechanism may more readily allow for the development of long, mildly oversteepened reaches consistent with those observed upstream of Roan Plateau waterfalls. The use of relict landscapes in geomorphology studies should be undertaken with care, as oversteepened channel reaches may negate the use of some outer edge of the relict landscape.

References:
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