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Knickpoint retreat and channel profile evolution in bedrock rivers on the Isle of Jura, Scotland

M. Castillo, P. Bishop, and J. Jansen
Department of Geographical and Earth Sciences, University of Glasgow, UK (Miguel.Castillo@ges.gla.ac.uk)

The understanding of knickpoint (KP) migration in bedrock channels is fundamental to understanding how long-profile disequilibrium is transmitted through the stream network. There are few models that explain KP retreat on bedrock channels, and, moreover, little attention has been paid to the morphological changes downstream of a KP after it has propagated upstream (i.e., to the degree of long-profile adjustment represented by the passage of a KP). We are studying the rivers of the Isle of Jura in western Scotland to explore this issue. Jura consists largely of a single lithology (quartzite) that dips more or less uniformly to the east along the length of the island. Glacio-isostatic surface uplift of ∼40 m since ∼16 ka has triggered KPs that are propagating headwards in the long-profiles above +40 m elevation; later KPs, triggered by later base-level falls, are propagating into the long-profile. For smaller streams these are mostly still located between +40 m and 0 m ASL, whereas in the larger streams these later KPs have upstream of the +40 m shoreline. The distance of KP propagation (D) in Jura, derived from long-profile analysis of high resolution DEM and air-photo, is satisfactorily explained by D_r=cA^b using the catchment area as a proxy for discharge. We also found that channel lowering below the KP, using a measure we call here the concavity area θ_a, is also a function of the discharge in the form θ_a=cA^d. Our results suggest that upstream propagation of a KP may not achieve the full response of the long-profile to base-level fall, especially for smaller streams with lower stream power. Intuitively, channel lowering below the KP should be more complete for larger streams (i.e., the larger streams are more able to achieve all the bed lowering triggered by the base-level fall), but in the case of ongoing surface uplift, as on Jura, such adjustment may be delayed and/or complicated by later KPs propagating headwards into the reach downstream of the first KP.