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Lithogenic controls on bedrock channel width & slope in a glaciated, postorogenic landscape; 18 rivers in west Scotland

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Lithogenic factors are widely accepted as being a strong control on landscapes shaped by rivers and glaciers. What is less clear is the spatial scale at which lithogenic factors exert control, and how rivers adjust their morphology, in terms of width and slope, along former glacial valley troughs. We investigate scaling relationships between lithogenic factors (i.e. rock-type and fault-related fracture) and morphometric variables across 18 catchments draining the western Scottish Highlands, a landscape with a strong glacial past. We use a DEM (5-m grid) and planimetric data, coupled with field measurements, to examine the influence of lithogenic factors on landscape morphology with the aim of identifying scale-related differences in the strength of lithogenic controls at catchment-, reach-, and channel-scales. Few of the study rivers exhibit smooth concave-up long profiles expected for steady state erosion of uniform substrate. Instead, interactions between lithogenic factors and the combined work of rivers and glaciers generate irregular long profiles with abundant convexities. We find that lithogenic factors dictate major aspects of catchment-scale landscape morphology, and zones of low-resistance (i.e. weaker/fractured rocks) strongly guide fluvial and glacial erosion. Using a simple unit stream power model, we then focus on reach-scale channel morphology with the aim of quantifying specific responses of bedrock channel width and gradient to erosion-resistant rocks. Lithogenic factors have a strong effect on reach-scale channel gradient, but less so on channel width, which appears to reflect other factors, such as sediment flux. We discuss the implications of these results for understanding bedrock river incision in landscapes inherited from glacial/paraglacial

regimes.