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The role of sediment in governing incision in paraglacial fluvial environments

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Paraglacial environments – those where landscape dynamics are forced by the effects of a recent deglaciation event – present ideal natural laboratories for understanding how landscape and fluvial systems readjust in response to change in boundary conditions. These environments offer a combination of imposed channel form and sediment load as left by the glaciers during retreat, along with typically decipherable uplift and base level histories recorded in datable terraces along the channel course. We have investigated recently deglaciated systems in both the Ladakhi Himalaya (NW India) and the Fagaras Alps (central Romania) with the aim of comparing and contrasting their responses post-ice retreat. Both field sites offer many parallel catchments for comparison, but the Ladakhi system is older, more heavily modified by subglacial abrasion and much more thickly blanketed in glacial sediments than the Romanian, as well as being larger and drier.

We show that although the general geomorphological structure of both catchment systems is similar, terrace arrangement in each location reveals significant qualitative and quantitative differences in erosional response occurring after deglaciation. The Ladakhi catchments show an incisional signal dominated by lowering of the profile convexities bevelled in by ice erosion, while the Romanian examples show a signal dominated by upstream horizontal retreat of these features. These responses are consistent with the predictions of Whipple and Tucker (2002) for the evolution of channel profiles within tectonically perturbed landscapes under the contrasting models of transport- and detachment-limited erosion, respectively. Degree of sediment cover on the beds of channels in each of the field sites correctly reflects the expected control of style of response by sediment loading as predicted by the models. We demonstrate that incision in the Ladakhi channels is quantitatively consistent with a thresholded transport-limited incision model.