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Bedrock Channel Response to Tectonic Forcing

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Bedrock channel morphology is controlled by climatic and tectonic conditions and substrate properties. While climatic and substrate controls have been addressed in many studies, knowledge on tectonic controls is scarce. This is partly due to the slow tectonic rates and long response times and partly to the difficulty in isolating and constraining tectonic conditions in the field.

In this study we use experimental, theoretical and numerical results to develop a conceptional model of bedrock channel response to tectonic forcing. Both width and slope of a channel can respond in three different domains to tectonic forcing: for low uplift rates the response is limited by the erosion threshold and increasing uplift rates have little effect on channel geometry. This domain is called threshold-dominated. For intermediate uplift rates the response is dominated by the tectonic forcing (uplift-dominated) and width decreases with increasing uplift rate with a power law, while slope increases. For high uplift rates the channel may reach a configuration where slope reaches the stable angle of the substrate, and any further tendency of the channel to narrow will be counteracted by the rapidly increasing shear stress on the channel walls. Channel morphology is limited by its own geometry (geometry-dominated).

Combining these results the channel can respond to tectonic forcing by either adjusting slope, width, neither or both. This is consistent with field observations. It seems likely that the response of the whole landscape to tectonic forcing can be classed in similar domains.