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Experimental evidence for climatically controlled changes between lateral erosion and incision of actively uplifting folds

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The understanding of the incision and lateral erosion of rivers provides key data for the interpretation of landscapes as recorders of climatic and tectonic processes. We present results from six physical experiments on the erosion of a simple growing fold by antecedent streams. By varying uplift rates, sediment flux, and the width of alluvial fans upstream of the uplift, we produced a range of morphologies from narrow canyons through the fold to erosion of the entire uplift. The fraction of the uplift that was beveled by the river can be predicted by a dimensionless parameter linking the mobility of channels (strongly dependent on the sediment flux) and the rock-uplift rate. We apply these findings to a series of active folds in the foreland of the Tian Shan in NW China. Whereas the folds are incised today, they preserve uplifted, kilometer-wide beveled platforms. In the light of the experimental results, lateral migration rates required to explain such extensive beveling are similar to the lateral mobility of alluvial streams in areas much wetter than the presently arid northwestern Tarim Basin and suggest that major changes in water and sediment influxes are the probable cause of switches between lateral erosion and incision of active uplifts in the foreland of the Tian Shan. This finding is supported by the clustering of ages of fluvial terrace and alluvial fan deposition in that region.