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TITLE: Interpreting climate-driven aggradation and incision along the fringes of a decaying mountain range

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ABSTRACT BODY: Flights of terraces that flank range fronts throughout the Rocky Mountains record episodic stream incision over at least the past 1.5 Ma. Recent work using cosmogenic radionuclides to date the ages of terraces in the Denver Basin along the Colorado Front Range suggests that these high surfaces were formed during glacial intervals and rapidly incised during interglacials. Climate change related to glacial-interglacial cycles has been suggested as a possible driver for the repeated aggradation and incision of these high surfaces. Potential mechanisms for increasing sediment supply and transport in rivers include variations over time in (1) periglacial weathering and hillslope transport, (2) the magnitude and timing of runoff and stream flow, and (3) sediment flux from intermittently glaciated major valleys. Lower temperatures during glacial intervals may increase physical weathering and transport of regolith downslope through frost cracking and frost creep, respectively, thus supplying the upland rivers with sediment that can be delivered to the basins. Frozen ground could generate enhanced runoff, leading to increased peak stream discharge during glacial intervals, and allowing the rivers to flush sediment from the mountains to the plains more effectively. Cold-period aggradation of the high surfaces in the basins and in mountain channels could also be linked to enhanced sediment flux derived from glaciers in the headwaters of the catchment. These three possible mechanisms raise the question of which of them (if any) is primarily responsible for the cycles of aggradation and incision that appear to have created the staircase-like terrace surfaces along the range front.

In this study, we use a landscape evolution model to determine whether any of these processes, in isolation, is sufficient to explain the observed rates and patterns of terrace formation and abandonment along the Colorado piedmont. We also use the model to determine whether the presumed rapid incision rates of terraces during interglacials can be attributed to reduced sediment supply alone or whether changes in hydrology must be invoked. We study an idealized catchment in which the upper half lies on resistant rock (representing the crystalline mountain range) and the lower half lies on soft rock (representing the adjacent sedimentary basin). In the model calculations, the efficiency of soil creep on hillslopes was varied based on recent estimates of frost-creep efficiency as a function of mean annual temperature over glacial-interglacial timescales. Preliminary results show that increasing hillslope transport efficiency over the model domain causes deposition in river channels in the low-relief basin, especially along the range front. Deposition also occurs to a lesser degree in river channels in the mountains. The model calculations also predict migrating channel positions in the basin during periods of increased sediment supply, and channel stability and entrenchment during periods of low sediment supply. These results suggest that temporal changes in hillslope diffusivity alone play an important role in sedimentation and incision in mountain-bounded basins.

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