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Late Pleistocene to recent incision dynamics near the western Tibetan Plateau margin, Zanskar, India

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Bedrock gorges are typically portrayed as natural conveyor belts for incoming lateral and upstream sediment. Their potential to store sediment has so far received lesser attention. Here we report on cyclic aggradation and re-incision of fluvial terraces in deeply incised bedrock gorges in the Ladakh and Zanskar Ranges of India. We infer that fluvial bedrock incision is highly episodic and buffered by intermittent sediment storage along the western Tibetan Plateau margin. Recently reported fluvial bedrock incision rates of up to 3 mm/yr derived from cosmogenic nuclide (10Be) exposure dating suggest highly localized transients in this (semi-)arid high-altitude mountain desert otherwise characterized by low ($\sim$0.02 mm/yr) denudation rates and some of the oldest glacial sediments in the Himalaya-Tibet orogen.

We test for this transience and present a first dataset of OSL-derived fluvial fill terrace ages together with new 10Be exposure ages from abandoned fluvially polished surfaces in the lower Zanskar gorge, a major tributary of the upper Indus River. Our data cover $\sim$30 km upstream of the confluence with the Indus and suggest that rates of aggradation and re-incision into fill terraces over comparable timescales range from 0.5 mm/yr to 2.6 mm/yr. Remnants of fluvial terraces are ubiquitous in the lower Zanskar gorge with elevations of up to >180 m above river level, and host sediments mainly originating from the High Himalaya, which constitutes only $\sim$30% of the upstream drainage area.

The dates from the fill terraces point to a phase of continuous aggradation from $\sim$60 ka to $\sim$12 ka, which we attribute either to a Late Glacial or postglacial sediment pulse from the Zanskar headwaters in the High Himalaya, or to natural damming downstream. Accounting for potential sediment cover effects, our incision rate estimates into these former valley fill are >1.8 mm/yr, and document at least two cut-and-fill cycles involving >40 m of vertical channel-bed migration since the late Pleistocene. Because of this sedimentary cover effect, we infer that the average 10Be-derived bedrock incision rate in the Zanskar has not exceeded 1 mm/yr over the last 60 ka, which is only but a fraction of the rates recently proposed for the Zanskar-Indus confluence.