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Landscape Response to Glacial-Interglacial Climate Forcing From Fluvial Fill Terraces: Humahuaca Basin, E Cordillera, NW Argentina

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Fluvial fill terraces record changes in sediment production and/or transport in response to external forcing. Worldwide, climate shifts associated with glacial-interglacial cycles have often been linked to fill terrace formation, making them promising features for recording landscape responses to millennial-scale climate changes. Within the southern Central Andes, glacial intervals are marked by pronounced increases in rainfall, which in some places have been correlated with increased landslide activity.

The N-S oriented, semi-arid Humahuaca intermontane basin parallels the eastern margin of the Andean Plateau (Puna) and is known for frequent landslides and debris flows during the wet season. Fill terraces along tributaries (20-1100 km2 catchments) to the trunk stream have been dated with OSL to between ~30 and 120 ka. Curiously, aggradation phases in terraces on the west side of the basin correlate with past wet periods, while those on the east side correlate with past dry periods. While yearly rainfall and lithology on either side of the basin are similar, the tributary geometries are different: the east side tributaries contain perched sedimentary basins that are separated from the main valley by narrow bedrock gorges, while the west side tributaries have a relatively simple form, without perched basins or prominent gorges.

From modern sediments exiting the tributaries, denudation rates calculated from cosmogenic nuclide (10Be) concentrations of pebbles (1-3 cm) are 1.2 to 4x higher than those derived from sand (< 0.7 cm), which could reflect the importance of mass movements today. From terraces on the west side of the valley (wet-phase terraces), denudation rates are higher than those from modern streams, with strong grain-size dependence and very high scatter, which may reflect an even greater importance of mass movements during past wetter periods. In contrast, from terraces on the east side of the valley (dry-phase terraces), pebble and sand denudation rates overlap with modern rates. We interpret the data to imply that landslides are triggered throughout the landscape during wet phases and induce aggradation, but along the eastern side of the valley, landslides block the narrow gorges between the headwaters and the outlets, causing sediment to remain within the perched basins. In contrast, during drier phases with reduced landslide frequency, clearing of landslide blockages and slow re-excavation of stored sediments from the perched basins leads to increased 10Be concentrations in the sediment and sediment delivery to the main valley. Overall, while landslides appear to be triggered throughout the landscape during wetter climate phases, the valley geometry dictates when sediment is evacuated from the tributary valleys into the main valley. Such behavior at an orogen-scale could attenuate or mask landscape responses to climate forcing in older sedimentary archives.