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100-kyr fluvial fill terrace cycles since the Middle Pleistocene in the southern Central Andes, Toro Basin, NW Argentina

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Fluvial fill terraces in intermontane basins are valuable sedimentary and geomorphic archives that record tectonic and/or climate- driven changes of river networks and their adjacent hillslopes. However, the rarely complete preservation of such geomorphic features, often combined with large distances from sediment source areas, complicates the identification of causal links between tectonic/climatic forcing mechanisms and landscape response, especially over timescales of 10^5 to 10^6 years.

The intermontane Quebrada del Toro Basin in the Eastern Cordillera of NW Argentina contains at least five fluvial terrace-surface remnants that have been sculpted into a succession of several-hundred-meter-thick Quaternary gravel conglomerate. These terraces can be followed over several tens of kilometers and are located in the higher part of the basin, close to the sediment source areas. In this study, we determined the onset of multiple river incision phases by dating the abandonment of the three most extensive and best preserved terrace surfaces with nine cosmogenic ^{10}Be-depth profiles. The timing of terrace-gravel deposition is based on four cosmogenic ^{26}Al/^{10}Be burial ages and U-Pb zircon age estimates of three intercalated volcanic ashes in the conglomeratic fill.

The ^{10}Be depth profile ages suggest a successive abandonment of these terrace surfaces with a 100-kyr-cyclicity between 487 $\pm$ 34 ka and 75 $\pm$ 7 ka. Depositional ages of the conglomerates, determined by ^{26}Al/^{10}Be burial samples and U-Pb zircon ages, range from 936 $\pm$ 170 ka to 18 $\pm$ 141ka. They show a clear overlap with the terrace-surface abandonment ages and thus indicate the existence of multiple cut-and-fill cycles.

Although the initial onset of aggradation of the Quaternary gravel conglomerate at $\sim$1 Ma and the overall net fluvial incision since $\sim$0.5 Ma can be linked to tectonic processes affecting the narrow basin outlet, the superimposed 100-kyr-cycles of aggradation and incision are best explained by eccentricity-driven climate change. Within these cycles, the onset of river incision can be correlated with global cold periods that are linked with regional humid phases recorded on the Bolivian Altiplano, 1000 km north of the Toro Basin. Deposition, on the other hand, occurs mainly during more arid conditions on the Altiplano (regional) and global interglacial periods.

We suggest that enhanced runoff during global cold phases – due to increased regional precipitation, reduced evapotranspiration, or both – resulted in increased sediment-transport capacity in the Toro Basin, which outweighed any possible increases in upstream sediment supply and thus triggered incision. On the other hand during arid phases, the river runoff decreases and the still high sediment supply rates result in overall aggradation. Although located far from major ice-sheets, our study shows that global eccentricity-driven glacial-interglacial cycles also result in significant variations in the sediment-transport system in high mountains of the sub-tropics.