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Plio-Pleistocene paleo-erosion rates as a recorder of orographic barrier uplift in the NW-Argentine Andes (Humahuaca Basin)

Heiko Pingel (1), Taylor Schildgen (1,2), and Hella Wittmann (2)

(1) Institute of Earth and Environmental Science, University of Potsdam, Potsdam, Germany, (2) Helmholtz Centre Potsdam, GFZ German Research Center for Geosciences, Potsdam, Germany

As an integral part of the Eastern Cordillera, the intermontane Humahuaca Basin in the NW Argentine Andes is located in transition between the arid and internally drained Puna Plateau to the west and the humid broken foreland to the east. In combination with moisture-bearing air masses sourced in the Atlantic Ocean and the Amazon Basin, the present-day topographic gradient of the eastern Andean margin comprises an efficient orographic barrier that results in a strong precipitation gradient, with rainfall of more than 2,000 mm/a along the eastern flanks and <200 mm/a on the plateau. Ultimately, variable moisture availability affects surface processes, such as fluvial erosion and transport of eroded material, with decreasing erosion rates towards the orogenic hinterland.
Paleoenvironmental reconstructions of the Humahuaca Basin suggest that this region became disconnected from the foreland during the Mio-Pliocene by the growth of fault-bounded mountain ranges. This led to an increase in accommodation space and enabled the trapping of largely fluvial, late Miocene to Quaternary basin filling units. Subsequently, the basin was uplifted and internally deformed. Fossil records, sedimentologic evidence, and stable-isotopes (δD from volcanic glass) moreover imply that the re-routing of the fluvial network, an initial increase in precipitation, and, as the windward ranges attained threshold elevations to incoming moisture, reduced moisture availability by ca. 3 Ma, were all a consequence of the Mio-Pliocene uplift.
In this study, we present first results of terrestrial cosmogenic nuclide-derived paleo-erosion rates from quartz-bearing fluvial sands and gravels of known stratigraphic age. In most cases, the age control is based on previously published U-Pb zircon data of intercalated volcanic ash deposits, but also utilizes new OSL and AMS14C ages. A reassessment of the sediment-accumulation history of the basin highlights important changes of the depositional system, apparently associated with the transformation from a humid foreland to a fluvially restricted and semi-arid intermontane basin. Similarly, our terrestrial cosmogenic nuclide-derived data indicate an order-of-magnitude decrease in erosion rates at ca. 3 Ma, which suggests a causal link between the onset of uplift-induced semi-arid conditions and decreasing sediment flux into the basin. Ultimately, this dataset may enable a systematic investigation of the long-term causes and consequences of orogenic growth and hydrological changes on spatio-temporal erosion patterns in active mountain areas.