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Orbital controls on paleo erosion rates in the Western Escarpment of the Andes at 13° latitude

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The formation of fluvial terrace sequences in mountainous areas requires that two boundary conditions have to be fulfilled. First, hilllslope material available for erosion needs to be sufficiently thick and abundant. Second stripping off of this regolith cover has to occur fast and within a short time period. Contrariwise, if hillslope erosion operates at a pace concordant with the fluvial regime and in equilibrium to the prevailing climate, then no terrace sequence will form. Here, we present a 10Be-based sediment budget from the cut-and-fill terrace sequences in the Pisco valley, and particularly the Minchin terrace sequence deposited between 48-36 ka, to illustrate how the erosional regime and the precipitation pattern has changed in response to orbitally-driven climate cycles. We find that the Minchin period was characterized by an erosional pulse along the Pacific coast during which denudation rates reached values as high as 600 mm/ka (provided that the lateral valley flanks have been the major sediment source) for a relatively short time span lasting a few thousands of years. This contrasts to the younger orbitally-controlled pluvial periods and the modern situation when 10Be-based sediment budgets yield nearly zero erosion at the Pacific coast. We interpret these contrasts to indicated different erosional conditions between the modern and the Minchin time. First, the sediment budget infers a precipitation pattern that is similar to the modern climate ca. 1000 km farther north near the boundary between Peru and Ecuador, where highly erratic and extreme El Niño-related precipitation are associated with landsliding and flooding along the coast. Second, the formation of a thick terrace sequence requires the supply of sufficient material through erosion on the catchment's hillslopes. It is likely that a relatively thick regolith sequence had accumulated before the start of the Minchin period, because this erosional epoch was preceded by a >50 ka-long time span with dry conditions, allowing for sufficient regolith to build up on the hillslopes. Finally, this study suggests a strong control of orbitally and ice sheet forced latitudinal shifts of the ITCZ on the erosional gradients and sediment production on the western escarpment of the Peruvian Andes at 13° during the Minchin period. Accordingly, cut-and-fill sequences cannot only be inverted into contrasting erosional regimes, but also into different paleogeographic and paleoecological conditions.