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Climatic imprint on landscape morphology in the western escarpment of the Andes

M. Trauerstein (1), K. P. Norton (2), F. Schlunegger (1), and F. Preusser (3)

(1) Institute of Geological Sciences, University of Bern, Baltzerstrasse 1-3, CH-3012 Bern, (2) School of Geography, Environment and Earth Sciences, PO Box 600, NZ-6140 Wellington, (3) Department of Physical Geography and Quaternary Geology, S-10691 Stockholm

Over human timescales, the processes responsible for the long-term topographic evolution of a mountain range are typically not observable and hence, poorly constrained. Here we perform a space-for-time substitution with the western flank of the Peruvian Andes to identify which are the formative mechanisms. We carried out a morphometric analysis of 36 watersheds, each separated in segments below and above the escarpment edge, in an effort to detect possible imprints of tectonics, lithology and climate on the landscape. We find that topographic relief grows with increasing precipitation to $\sim$400 mm/yr, after which further increases in precipitation lead to topographic decay, independent of either the underlying lithology or prevailing rock uplift pattern. We show that these trends result from a change in bottom-up processes to top-down processes as the topography evolves. During the initial transient phase, relief growth is controlled by stream incision and knickpoint retreat into a largely undissected plateau. With higher precipitation rates, the drainage network saturates the landscape and relief is set by the steepness of graded streams and the rates of sediment production and transport on hillslopes. We can identify these trends along a spatial transect in the western Andes. The N-S variations in topography can also be interpreted in temporal terms, in which the higher precipitation towards the south result in faster response times, such that the western flank of the Peruvian Andes represents the initial, transient stage of relief development and the western flank of the central Chilean Andes a steady state system. We anticipate that these changes have also operated during the formation and destruction of other mountainous plateau landscapes.