EGU General Assembly 2020

EGU2020-17481
https://doi.org/10.5194/egusphere-egu2020-17481
EGU General Assembly 2020

Feedbacks between internal fluvial drainage and high-plateau tectonic growth. A mechanistic perspective.

Daniel Garcia-Castellanos[1], Weiming Liu[2], Zhongping Lai[3], Ivone Jiménez-Munt[1], Lucía Struth[1], Laura Rodríguez-Rodríguez[4], Gang Hu[5], Ping Wang[5], and Gema Llorens[1]

[1]CSIC - ICTJA, Barcelona, Spain, ICTJA - Inst. Ciencias de la Tierra Jaume Almera, Barcelona, Spain (danielgc@ictja.csic.es)
[2]CAS Key Laboratory of Mountain Hazards and Surface Process, Institute of Mountain Hazards and Environment, Chinese Academy of Sciences, Chengdu 610041, China
[3]Institute of Marine Science, Shantou University, Shantou, China
[4]Centre National de la Recherche Scientifique Meudon, FRANCE
[5]State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration, Beijing 100029, P. R. China

High-plateaus are relatively flat areas at high elevations. The stream-power river-incision law predicts that surface water incises the landscape proportionally to local river slope, and therefore the margins of high-plateaus are prone to a river erosion that should terminate the low relief of the highlands that characterizes the plateau. This means that long-lived high-plateaus need an additional mechanism to compete with river incision.

In absence of tectonic deformation, river networks propagate into the plateau via a retrogressive wave of river incision. A well-constrained non-tectonic scenario is provided by the Neogene Duero and Ebro sedimentary basins in N Iberia, where ongoing incision rates presently range from .02 (Duero) to .5 m/kyr (Ebro) and have propagated upstream at similar rates of up to 0.2 km/kyr, based on cosmogenic dating studies combined with numerical modeling. These rates started with the transition from internal (endorheic) to external (exorheic) drainage of both basins sometime between 8 and 12 million years ago. Interestingly, while the pre-exorheic Ebro Basin sedimentary plateau has been mostly obliterated by erosion, the Duero Basin still preserves large areas of low relief, in spite of the very similar geological setting. The causes will be discussed using landscape evolution numerical modeling.

In contrast, tectonically active regions can counteract river incision and preserve high plateaus by longer time periods. Recent studies based on sedimentary stratigraphy of endorheic basins suggest that large areas of the Tibetan high plateau remain internally drained since ca 35 Ma. In the Altiplano/Puna plateau region internal drainage dates to ~15 Ma and the majority of the topographic uplift has taken place after 10 Ma. Computer models have shown that tectonic deformation is sensitive to internal drainage, because endorheism implies a nearly perfect sediment trap that effectively reduces the output of orogenic erosion to zero. The cancellation of orogen-scale erosion can severely modify tectonic deformation patterns, increase topography and propagate deformation further into the undeformed forelands of the orogenic system.

Symmetrically, internal drainage is also promoted by the orographic rain shadow due to the growth of topography in the early stages of tectonism.

Numerical models coupling the aforementioned mechanisms have shown that, as sediment transport and accumulation within the endorheic region progresses, the propagation of deformation to areas more distal to the tectonic plate boundary can lead to a lower-relief landscape. A recent reassessment of the ages of the Tibetan plateau sedimentary record in the Lunpola Basin seems consistent with an early onset of low relief and internal drainage. Finally, as topography and crustal thickness increase, lower crust flow is facilitated by the lower viscosity implied by higher pressure, favoring a further reduction of local relief within the highlands.