Tectonic advection controls drainage divide asymmetry patterns in the Longmenshan, SE Tibet, China

Other Conference Item

Author(s):
Gelwick, Katrina; Wang, Yanyan; Metzger, Sabrina; Huppert, Kimberly; Yang, Rong; Willett, Sean

Publication date:
2024

Permanent link:
https://doi.org/10.3929/ethz-b-000705158

Originally published in:
EGUsphere, https://doi.org/10.5194/egusphere-egu24-10973

Funding acknowledgement:
189846 - Landscape Evolution of the Hengduan Mountains (SNF)

EGU General Assembly 2024

EGU24-10973, updated on 03 Dec 2024
https://doi.org/10.5194/egusphere-egu24-10973
EGU General Assembly 2024

Tectonic advection controls drainage divide asymmetry patterns in the Longmenshan, SE Tibet, China

Katrina Gelwick[1,2], Yanyan Wang[1], Sabrina Metzger[2], Kimberly Huppert[3], Rong Yang[4], and Sean Willett[1]

[1]Geological Institute, ETH Zürich, Zürich, Switzerland (kgelwick@ethz.ch)
[2]Lithosphere Dynamics, GFZ Potsdam, Potsdam, Germany
[3]Earth & Atmospheric Science, The City College of New York, New York, USA
[4]School of Earth Sciences, Zhejiang University, Hangzhou, China

The lateral movement of Earth's crust through tectonic advection plays an important role in shaping topography in many active orogens worldwide. Numerical modelling and select field studies have shown that tectonic advection can alter topography and thereby create asymmetric drainage divides. Divide migration typically occurs opposite to the direction of tectonic advection, however, in many mountain belts, the wedge-tip propagation towards the foreland outpaces the rate of convergence, in which case the direction of topographic asymmetry should be reversed.

We combine geomorphic and geodetic analyses with numerical models to test whether topographic asymmetry in the Longmenshan region of Southeast Tibet is dominated by advection of the crust from the ongoing India-Eurasia collision, movement of river base-level with the propagation of the thrust front into the Sichuan Basin, or other tectonic and climatic factors. We measure the magnitude and direction of drainage divide asymmetry using geomorphic metrics and compare these to horizontal GNSS velocities, which measure tectonic advection and shortening relative to the stable Sichuan Basin block. Geologic studies estimate that wedge-tip propagation toward the Sichuan Basin has been negligible since ~5-10 Ma.

Our results show that drainage divide asymmetries in the Longmenshan and Bayankala tectonic blocks indicate a dominantly northwest divide migration direction relative to the underlying rock. This is opposite to the dominantly southeast-pointing GNSS rates and suggests that within-wedge shortening and southward surface advection are more important than wedge-tip propagation. These findings also indicate that topography in the Longmenshan and Bayankala blocks has already adjusted to the current kinematics. Inconsistencies in the signal can be explained by localized deformation and uplift from faulting and other small-scale transient adjustments in the river network, such as those caused by stream captures. We compare these results to a series of numerical model scenarios with varying advection and wedge-tip propagation velocities to discern the relative influence of tectonic advection and thrust-front dynamics on the region's topography. Our study highlights the critical role tectonic advection plays in shaping topography on the Southeast Tibetan Plateau and it provides a comparative framework for distinguishing the relative

rates of advection and wedge-tip propagation.