

[AGU Abstract Browser](#)

- [About](#)
- [Meetings](#)
- [Virtual Posters](#)
- [Sections](#)
- [Index Terms](#)

Slow Erosion Rates, Increasing Relief and Transient Landscape Evolution within the Central Range of Taiwan

Details

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Abstract

The relatively constant width of the Taiwan orogen and consistent elevation of the drainage divide has led numerous workers to argue for a topographic steady state over the last 5 Ma with the influx of material along the front and the base of the collision is balanced by erosion. This hypothesis, in combination with the fact that rates of erosion for Taiwan have are high (in excess of 3-5 mm/yr), leads to the expectation is that topography throughout Taiwan, particularly in the Central Range, should be consistently steep with rapidly incising bedrock river channels that efficiently transport sediment downstream and set the lower boundary for threshold hillslopes that experience frequent landslides. Here we present evidence arguing against complete, widespread topographic steady-state within the Taiwan orogen. We find numerous examples of anomalously low relief topography in the higher elevations of the Central Range of Taiwan. These areas of low relief straddle the topographic crest of the range and rivers that flow from them have knickpoints along their longitudinal river profiles separating low relief upland topography from steep terrain characterizing downstream reaches. Field work confirms that these low relief areas are characterized by low hillslope angles draped by clay-rich lateritic soils not seen in lower reaches, with few landslides and low-gradient, alluviated streams. The observed transition from low-relief topography to steeper lower reaches does not correspond to significant variations in lithology (it is consistently slate), or rainfall (annual or that experienced during Typhoon Morakot). Detrital cosmogenic analysis and exposure ages on bedrock outcrops (both ^{10}Be) within areas of subdued, low-relief topography indicate that they are eroding slowly (0.1-0.3 mm/yr) and sit isolated with landslide-dominated hillslopes and high rates of erosion (3-5 mm/yr) in directly adjacent areas. These differential erosion rates and the preservation of

anomalous, low-relief topography highlight transient landscape evolution and increasing relief within portions of the Central Range of Taiwan. Thermochronologic age-elevation data collected near the low relief topography (zircon fission track and (U-Th)/He) suggest an increase in the rate of exhumation from < 1 mm/yr to ~ 3 mm/yr. at about 2 Ma. We argue that areas of subdued, low-relief topography represent a relict landscape that formed prior to the recent acceleration in rock uplift and exhumation suggested in the thermochronology data. The high-slope, landslide-dominated terrain is rapidly dissecting areas of relict topography and will eventually erase geomorphic evidence of this relict landscape.

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