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Incision migration across Eastern Tibet controlled by monsoonal climate, not tectonics?

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The formation and uplift history of the Tibetan Plateau, driven by the India-Eurasia collision, is the subject of intense research. Geomorphic indices capture the landscape response to competition between climate and tectonics and reflect the spatial distribution of erosion. We analyse the link between climate and tectonics in the eastern part of the Tibetan Plateau using the mean annual precipitation, digital elevation data, and by calculating the geomorphic indices hypsometric integral (HI), surface roughness (SR) and elevation relief ratio (ZR). This is a region where competing tectonic models suggest either early Cenozoic plateau growth, or a late phase of crustal thickening, surface uplift and plateau growth driven by lower crustal flow ("channel flow").

Swath profiles of rainfall, elevation and the geomorphic indices were constructed, orthogonal to the internal drainage boundary. Each profile was analysed to find the location of maximum change in trend. A broad transition zone is present in the landscape, where changes in landscape and precipitation are grouped and in alignment. The zone cuts across structural boundaries. It represents, from East to West, a sharp decline in precipitation below ~650 mm/yr (interpreted as the western extent of the East Asian monsoon), a change from a high relief landscape to smoother elevations at 4500-5000 m, a transition to low HI (< 0.05), a decrease in SR and an increase in ZR. This zone is not a drainage divide: the main rivers have their headwaters further West, in the interior of the plateau.

We argue that this geomorphic-climatic transition zone represents a change from incised to non-incised landscapes, the location of which is controlled by the western extent of the monsoon. Published low temperature thermochronology data suggest the plateau had reached its modern extent at the Eocene, but has been exhumed since ~15 Ma to the East of the transition zone, at least along major drainage networks. We therefore also suggest that the transition zone is the current position of a long-term wave of incision that has migrated from East to West, driven by late Cenozoic intensification of the monsoon climate. This work supports a model of early Cenozoic growth of the eastern Tibetan Plateau, superimposed by incision driven by climate change; it does not support the channel flow model.

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