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Geomorphic expressions of collisional tectonics in the Qilian Shan, North East Tibetan Plateau

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The Qilian Shan, North East Tibetan Plateau, is an area of active deformation, caused by the India-Eurasia collision. Geomorphic indices are used to highlight variations in landscape maturity across the Qilian Shan, and interpret the results in terms of potential tectonic and climatic drivers. We use the geomorphic indices of hypsometric index (HI), normalised steepness (Ksn), elevation-relief ratio (ZR) and surface roughness (SR) (calculated as standard deviation of slope).

Areas of active uplift are concentrated in the Northern and Southern margins of the range, in the hanging walls of thrust faults. The landscape of the central region is shown to be mature, with little active uplift (Ksn < 50, HI < 0.1). Drainage in the area is controlled by the active faulting. Drainage isolation has caused the central region, around Lake Hala and Lake Qinghai, to become flatter and less active. Higher HI (> 0.15) and Ksn (> 100) values in the Eastern region are attributed to the greater erosive potential of the Yellow River which drains these areas. The Western region shows localised high HI and Ksn values at the Altyn Tagh fault. The East-West precipitation gradient across the Qilian Shan appears to be insufficient to have a control on the regional landscape.

There is a statistically significant abrupt northwards transition from high to low HI, Ksn and roughness and low to high ZR coincident with the left-lateral Haiyuan Fault, confirmed by a novel application of the t-test, applied over a moving area. This pattern may be due to the different properties of the rivers on either side of the fault, which forms a drainage divide, but between drainage basins that are all externally-drained. Alternatively, the change in geomorphic index values may represent a difference in active uplift rates across the area. We suggest that the latter is the more likely explanation, because if the pattern was controlled simply by drainage divide, the biggest difference would be expected to the south of the Haiyuan Fault, at the change from external to internal drainage. A transition from creeping to brittle behaviour on an underlying detachment thrust has previously been suggested to occur along the intersection of this thrust detachment with the overlying Haiyuan Fault, thereby providing a potential explanation for the location of the geomorphic change. Our results suggest that landscape is sensitive to deep tectonic drivers in collision zones, and provides information on these processes.