Active Uplift of Southern Tibet Revealed

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Supplementary Materials and Methods

Topographic Analysis:

Figs. 4 and 5 were produced using functions provided as part of the Topographic Analysis Kit (TAK; (Forte and Whipple, 2019)) and TopoToolbox (Schwanghart and Scherler, 2014). To produce Fig.4, a small circle was first fit to the frontal part of the topographic expression of the Himalaya (using 'BestFitSmallCircle' in TAK). This small circle was then used as a baseline for: 1) the generation of a set of 56, 20 km wide serial swaths (using 'MakeSerialSwath' in TAK), 2) the SRTM 90 meter topographic dataset, 3) the TRMM 2B31 precipitation dataset, and 4) a drainage raster delineating external and internal drainage areas determined from the USGS HydroSHEDS dataset (Lehner et al., 2006), HydroSHEDS Technical Documentation, World Wildlife Fund US, Washington, DC (available at http://hydrosheds.cr.usgs.gov).

Panel A of Fig.4 was calculated using values from swaths 40-56 (corresponding to the western third of the area sampled) for the topography and mean annual precipitation, followed by finding the mean of the means, the 1-σ standard deviation of the means, the minimum and maximum of the means, and the extremes (maximum of the maximums, minimum of the minimums).

Low temperature thermochronology data came from a variety of published sources compiled in Thiede & Ehlers (2013) and Laskowski et al., (2018). To produce panels C and D of Fig. 4, the sample locations for the individual apatite (4C) and zircon (4D) samples were projected along individual small circles (using 'ProjectSmallCircleOntoSwath' in TAK), which all share a center with the best fit small circle of the frontal Himalaya (found using 'BestFitSmallCircle' in TAK, circle center at 41.2396°N, 89.0609°E). This projection scheme was adopted to ensure that data projected onto regions was located in the correct structural and topographic domains. These data were projected onto a line running through the center of the total sampled region (i.e. swath 28) and are colored by their distance from this center line, measured along the small circles of projection. GPS data was taken from (Liang et al., 2013).

For panel F of Fig.4, vertical GPS data was projected exactly the same as for the thermochronology datasets. Based on visual inspection and important geologic features, we segmented the projected GPS profiles into regions and found means and standard deviations of these vertical velocities. For Panel E, we show both the raw north and east components of the horizontal GPS velocities (in open triangles) and projected versions of the velocity (in filled circles). To project the GPS data, we used the north and east components of individual stations to calculate the velocity component within the encompassing 20 km wide swath (using 'ProjectGPSOntoSwath' in TAK). Similarly, we found the slice of the error ellipse in the direction of the swath onto which the GPS velocity was projected. By definition, positive velocities were those directed towards the north end of the swath, and negative velocities were those directed towards the south end. These recalculated velocities and errors were then projected along small circles onto the center line of the sampled area. Note that not all GPS station locations have vertical velocities available. We used all available vertical velocities from Liang et al., (2013) in this analysis. Liang et al., (2013) present the GPS data in a regional and local reference frame. We display the vertical velocity data using the regional reference frame, but the choice of reference frame does not changes the results in this analysis.

To produce Fig. 5, the Yarlung river network was extracted from the HydroSHEDS DEM, and chi values were calculated using the elevation of the Yarlung river where it exits the main portion of the Himalaya as the base level. The longitudinal profile (panel B) and chi-elevation profile (panel E) were made using a minimum accumulation area of 1e9 m^2.

Supplementary Figure S1. Google Earth image along a north-striking rift-bounding fault in western region of the Lhasa terrane. Note the large terrace riser with an apparent dextral separation and the along-strike continuity of the fault scarp, consistent with a tectonic origin. Alternatively, northward tilting of the basin floor led to erosion and northward migration of the terrace riser. We do not favor this scenario because the active drainage is not ponding against the terrace riser.

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