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Incision of the Three Rivers Region, southeastern Tibetan Plateau, using low-temperature thermochronometry

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The time and geodynamic processes of building the Tibetan Plateau are still controversial despite decades of studies. The Three Rivers Region (TRR: (Yangtze, Mekong and Salween rivers), located at the southeastern margin of the Tibetan plateau in China, is characterized by spectacular erosion and relief increase where the old low-relief landscape defining the Tibetan plateau surface is currently being incised by drainage networks. Rapid fluvial incision by the three major rivers and their tributaries has created deep and narrow gorges up to 2 to 3 km in depth along this portion of the plateau margin, promoting efficient hillslope response. However, timing, forcing magnitude and potential triggers for this erosional response are still debated and require precise quantification of landscape evolution in the TRR area.

In this study, we report new apatite (U-Th)/He (AHe) and apatite fission track (AFT) ages from this region, collected mainly along the main trunk rivers with the objective of constraining the propagation of river incision from the plateau margin into its interior. Our AHe data range from $\sim$1 to >80 Ma, while our AFT ages are between $\sim$3 and 50 Ma. Old thermochronology ages >20 Ma indicate slow long-term erosion on the Tibetan plateau, while most of the ages along the trunk channels are younger than 10-15 Ma and clearly indicate exhumation related to plateau incision. Zircons are currently being analyzed by (U-Th)/He dating to get better timing for the onset of plateau incision. Composite age-elevation relationships from the three different rivers reveal mean exhumation rates of $\sim$0.15-0.25 km/Ma (AFT and AHe, respectively), for the Mekong river, and apparently higher rates for the Salween and Yangtze rivers (0.7 and 0.4 km/Ma, respectively). After compiling the existing low-temperature thermochronologic data, we used a linear inversion method to investigate the exhumation history in both space and time using the method of Fox et al. (2013). Our results show variable exhumation rates across the three rivers, with the lowest incision rates on the Yangtze for the last 4-6 Myr. The rates are faster in the Mekong and Salween, with a sharp increase up to 1 km/Ma in the last 2 Myr for the Mekong river. We infer that a spatial tectonic uplift gradient is the primary control on fluvial incision. By comparing the incision rates with the lithology and precipitation rates, there is no systematic correlation between them. Our data also reveal the propagation of the incision towards the plateau interior, clearly visible in the thermochronologic data along the Mekong river. The fluvial systems in the TRR are still in a transient state today and they will continue to erode towards the plateau interior.

Reference

Fox, M., Herman, F., Willett, S.D., May, D.A., 2013. A linear inversion method to infer exhumation rates in space and time from thermochronometric data. Earth Surf. Dynam. Discuss., 1, 207-259.