Contrasting exhumation histories and relief development within the Three Rivers Region (Southeast Tibet)

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The Southeast Tibet is characterized by extensive low-relief high-elevation surfaces that have been interpreted as “relict surfaces”, where thermochronological data generally show old ages and very little exhumation during the India-Asia collision. Those relict surfaces are proposed either to be formed at low elevation and then uplifted and dissected by large rivers since middle Miocene, or to inherit a pre-existing low-relief landscape by or prior to the collision, as revealed by stable-isotope paleoaltimetry. Among these relict surfaces, the BaimaXueshan low-relief (<600 m), moderate-elevation (~4500 m) massif is the closest to the Eastern Himalayan Syntaxis (EHS) in the Three Rivers Region, where Salween, Mekong and Yangtze rivers flow southward parallelly and closely, showing large-scale shortening during the collision. This region represents a transition between the strongly deformed zone around EHS and the less deformed southeast Tibetan plateau margin in Yunnan and Sichuan, and is an appropriate zone to examine the relief development and the interaction between pre-existing structures, Cenozoic tectonics and river incision during the Tibetan plateau growth.

We compile and model published thermochronometric ages for BaimaXueshan massif, east of the Mekong River, to constrain its exhumation and relief history using the thermo-kinematic code Pecube. Modelling results show regional rock uplift at a rate of 0.25 km/Myr since ~10 Ma, following slow exhumation at a rate of 0.01 km/Myr since at least 22 Ma. Estimated Mekong River incision accounts for a maximum of 30% of the total exhumation since 10 Ma. We interpret moderate exhumation of the BaimaXueshan massif since 10 Ma as a response to a regional uplift due to the continuous northward indentation of NE India in a zone around the Eastern Himalayan Syntaxis (EHS) and delimited by Longmucuo-Shuanghu suture in the north. Thus BaimaXueshan massif with significant exhumation could not be classified as “relict surface”, as proposed by previous studies and its low relief results from in part glacial “buzzsaw-like” processes at high elevation, enhancing since ~2 Ma. In contrast, modelling results for the high-relief, high-elevation Kawagebo massif to the west of the Mekong River, facing the BaimaXueshan massif, imply a similar contribution of Mekong River incision (25%) to exhumation, but much stronger local rock uplift at a rate of 0.45 km/Myr since at least 10 Ma, accelerating to 1.86 km/Myr since 1.6 Ma. We show that the thermochronometric ages are best reproduced by local rock uplift related to late Miocene reactivation of a kinked westward-dipping thrust, striking roughly parallel to the Mekong River, with a steep shallow segment flattening out at depth. Thus, the strong differences in
elevation and relief that characterize both massifs are linked to variable exhumation histories due to a strongly differing tectonic imprint.