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Active normal faults and river damming: the importance of tectonics and climate in shaping the landscape of the southern Tibetan plateau

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Understanding the interaction between tectonics, climate and erosion is key to unravel the geodynamic evolution of rapidly evolving landscapes. Normal faulting along the Ama Drime and fluvial incision of the Arun river are used to better describe the recent evolution of the south-central Tibetan plateau. The Arun catchment can be separated in two parts, an upper catchment characterized by the presence of abandoned shorelines testifying of the presence of a paleolake, and a lower basin with deep gorges characterized by strong fluvial incision. This geometry implies ancient damming of the Arun river in the vicinity of the Kharta normal fault. Two shorelines, the highest at 4400 m asl and a major one at 4260 m a.s.l. have been dated at about 200-250 ka and at 80-120 ka using both OSL and 10Be cosmogenic dating methods of surface and subsurface samples.
In the south Kharta basin, river terraces $\sim$100 m above the present riverbed are offset between 10 and 15 m by one branch of the normal fault. 10Be cosmogenic nuclide exposure ages of these terraces range between 9 and 11 ka, consistent with aggradation after the Last Glacial Maximum (LGM $\sim$20 ka), followed by rapid incision of the Arun. A few kilometres south of Kharta, the normal fault offsets by about 30 m abandoned lateral moraines with ages ranging from 20 to 70 ka. These measurements constrain the rates of vertical displacement along the normal faults to range between 0.7 and 1.4 mm/yr since 10-15 ka. The 20-70 ka rate is less well constrained but is of the same order. To the north, the range of ages (30 to 166 ka) of a terrace offset by 150 m suggests a formation during MIS-5e, and thus a vertical slip-rate of about 1$\pm$0.5 mm/yr. 70 kilometres farther north-east, moraines are offset by 20-40 m across the Mabja west-dipping normal fault in the nothward prologation of the Kharta fault. If the moraines are correlated with the LGM advance the Mabja fault vertical slip-rate is similar to that of the Kharta fault. All these data indicate vertical rates on the order of 0.6 to 1.7 mm/yr on the North-Ssouth active faults in the Ama Drime area.
The peculiar course of the Arun river meandering within gorges into the footwall of the Kharta fault downstream of the paleolake remnants indicates interaction between river damming and active normal faulting. The high lake stands may be correlated to the penultimate and last interglacial stages corresponding to enhance moisture across the Himalayas. It further suggest dam buildup during cold and dry glacial stages favoring diminished fluvial erosion and enhanced morainic debris accumulation in the gorge during continuous tectonic uplift. The end of the last lake high-stand (100-120ka) is in agreement with the highest and oldest evidence of fluvial terraces downstream of the gorge. These results show the importance of fluvial and tectonic interaction in connecting closed basins to drained valleys and thus in shaping large parts of the Tibetan plateau.