River capture in the Easternmost Himalaya: Testing erosion-tectonic feedback models using palaeo-Brahmaputra deposits of the Bengal Basin, Bangladesh

Laura Bracciali[1,2], Yani Najman[2], Randall R. Parrish[1], and Matthew S.A. Horstwood[1]

[1] NERC Isotope Geosciences Laboratory, British Geological Survey, Keyworth, Nottingham, NG12 5GG, UK, laur@bgs.ac.uk
[2] Lancaster Environment Centre, Lancaster University, Lancaster, LA1 4YQ, UK

Fluvial drainages impact on, and are impacted by, surface uplift, exhumation and strain, and thus an investigation of their evolution provides a key to understanding crustal deformation processes and erosion-tectonic-climate interactions. In the context of the protracted India-Asia collision, the unusual drainage configuration near the eastern syntaxial region of the Himalaya (Fig. 1) has been interpreted either as distorted drainage resulting from crustal shortening and lateral extrusion of crustal material (Hallet and Molnar 2001) or as the result of river capture events tectonically induced by surface uplift, with the more northerly basins' evolution related to regional-scale uplift of Tibet, and the more southerly captures (including the Yarlung Tsangpo by the Irrawaddy and finally the Brahmaputra River) to sub-regional uplift at the eastern syntaxis (Clark et al. 2004). A further twist to the latter is that one such capture event, that of the Yarlung Tsangpo by the Brahmaputra, has potentially resulted in extremely rapid recent exhumation of the Indian plate metamorphic rocks of the Namche Barwa Eastern syntaxis by focused weakening of the crust due to very rapid fluvial incision and erosive thinning of strong upper crust due to the capture event (erosion-tectonic coupling model, Zeitler et al. 2001). Hence, determining if and when this river capture event occurred is key to testing these models of crustal deformation. Additionally, constraining the timing of the exceptionally rapid exhumation in the syntaxis that we see today, is crucial to relate or refute any connection of rapid erosion to a capture event.

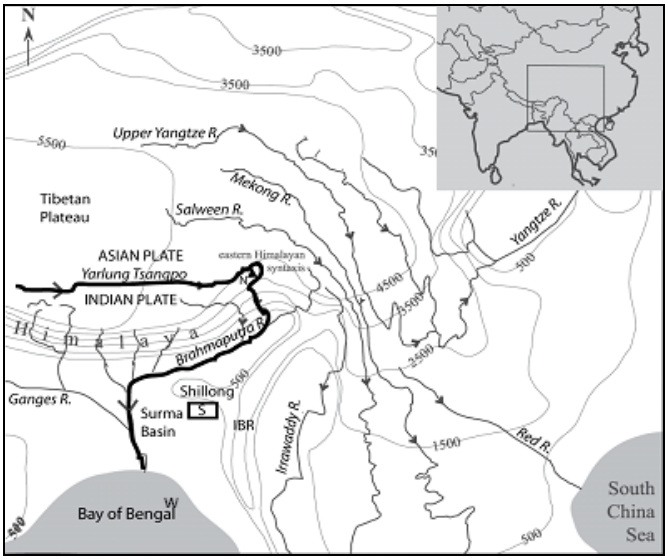

Figure 1. Major fluvial drainage systems of the eastern Himalayan-Tibet region (adapted from Clark et al. 2004). The Yarlung Tsangpo-Brahmaputra River is traced in thicker outline. The east-flowing Yarlung Tsangpo lies along the suture zone separating metamorphosed Indian plate Himalayan material to the south from Asian Plate Trans-Himalayan arc material to the north. The river then crosses the rapidly exhuming Namche Barwa of the Eastern Himalayan syntaxis (triangle with small 'N'). At this location the Yarlung drops into a steep gorge before flowing south, transverse to the Himalaya, as the Brahmaputra.
Rectangle labelled "S" is Surma Basin; Shillong = Shillong Plateau; IBR = Indo-Burman Ranges.

The Yarlung Tsangpo follows the line of the India-Asia suture zone, draining the Jurassic-Paleogene Trans-Himalayan arc of the Asian plate (Liang et al. 2008; Chiu et al 2009) to the north of the suture and the northern part of the Tethyan Himalaya of the Indian plate to the south of the suture (Hodges 2000). The Brahmaputra prior to capture would have drained the southern Himalayan slopes composed only of Precambrian-Palaeozoic Indian crust (Hodges 2000), much of it metamorphosed to high grade during the Oligo-mid-Miocene. On the assumption that capture took place, the first arrival of detritus carried by the Yarlung Tsangpo detritus (with its Cretaceous-Paleogene juvenile crust fingerprint) in the Neogene deposits of the palaeo-Brahmputra river in Bangladesh (Surma Basin, Fig. 1; Najman et al. 2008 and references therein) should date the capture event.

Input from the eastern syntaxis can be identified in the Brahmaputra sedimentary record by the appearance of rapidly exhumed mineral grains (those with short lag times, i.e. the difference between the

mineral cooling age and the host sediment depositional age) and very young grains (<10 Ma and in particular <6 Ma; Burg et al. 1998; Ding et al. 2001; Booth et al. 2004, 2009) which would demonstrate that the syntaxis has been rapidly exhuming since Plio-Pleistocene times (and possibly as early as late Miocene). This source now dominates the detritus in the Brahmaputra sediment budget downstream of the syntaxis with material from the Asian plate being subordinate (Stewart et al. 2008).

To address the river capture and the erosion-tectonic coupling hypotheses, U-Pb LA-MC-ICP-MS dating of detrital zircon grains (from palaeo-Brahmputra sediments as well as sands from modern rivers draining the Trans-Himalaya and Himalayan southern slopes) is integrated with microtextural analysis in a revised approach to the use of detrital zircon data as applied to provenance studies. Detrital zircon data (from mantles/cores of grains as well as from thin rims) are complemented by the novel application of U-Pb dating to rutile detrital grains. In this ongoing multi-technique study, Ar-Ar dating of detrital white mica and zircon fission-track thermochronology will also be used to assess the timing of rapid exhumation of the syntaxis.

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