River systems in Himalaya: looking into the past through the luminescence dating technique

Pradeep Srivastava[1], Yogesh Ray[1], Y.P. Sundriyal[2]

[1] Wadia Institute of Himalayan Geology, 33, GMS Road, Dehradun 248001, Pradeep@wihg.res.in
[2] Department of Geology, H.N.B. Garhwal University, Srinagar (Garhwal)- 246174.

Himalaya, the expression of continent-continent collision and related thrust tectonics, shows highest continental relief, experiences a significant E-W rainfall gradient and variations in surface processes. In an active orogen of such a kind, mass distribution, erosion, intensity of rainfall and their interaction decides upon its large-scale morphotectonic evolution. The river systems that drain through such neotectonically active thrusts bear potential to unravel the past climatic as well tectonic evolutionary history of Himalaya. Fluvial terraces are often used to decipher controlling factors like varying climate and tectonic pulses and time scales of river aggradation and incision in such a tectonically active setting. The researches suggest that the valley scale aggradations may represent the climatic impact while the fluvial incision into the bedrock equals the long-term uplift rate and thus the local rise of the incision rate can be interpreted as an effect of vertical motion along the active tectonic discontinuities and/or increased hydraulic efficiency.

Fluvial systems in the Himalaya are studied for their terrace configurations in terms of bedrock bench and overlying alluvial cover. Depending on the ratio of the thickness of alluvial cover and underlying bedrock, three different kinds of terrace configurations are identified: (1) Cut-fill terraces with thick alluvial cover over the thin bedrock bench; (2) terraces with almost equal thickness of alluvial cover and bedrock bench; and (3) terraces with thicker bedrock bench and thinner alluvial cover. An initiative with such a background combining field investigations and chronological studies on the geomorphological and sedimentological archives of major Himalayan river valleys of (i) Spiti (Arid-Trans-Himalaya, rainfall ~100 mm/a; Phartiyal et al., 2009), (ii) Mandakini, Alaknanda, Bhagirathi (NW Lesser Himalaya, rainfall ~1200 mm/a Ray and Srivastava, 2010), (iv) Nayar valley (monsoon dominated Garhwal Lesser Himalaya), (iii) Marsyandi (Humid, Central Himalaya, Nepal, rainfall 2000 mm/a, Pratt et al., 2004), (iv) Teesta (Eastern Himalaya, Sikkim, Rainfall ~2500 mm/a, Mukul et al., 2007) (v) Kameng and Brahmaputra (NE Himalaya, rainfall ~3000 mm/a; Srivastava et al., 2009; Srivastava and Misra, 2008) indicated that:

1. In the wetter part of the Himalaya, the Alaknanda-Bhagirathi valley experienced two-phased deglaciation from ~63-18 ka, supplied pulses of higher sediment loads and massive valley aggradation in NW Himalayan. The ~40 luminescence ages representing aggradation cluster 50-25 ka and 18-11 ka. The ten dated landslides in the same valley suggested no possible correlation to climate change and thus it is inferred that the rivers in the humidor part of the Himalaya in general follow glacial-periglacial hypothesis of valley developments.
2. The Spiti River, in the drier NW Himalaya, showed deviation nad aggraded till ~6 ka and the published records of palaeolandslide chronology in this region suggests that the valley aggradation was largely controlled by climate controlled phases of excessive landslides.
3. The rivers in NE Himalaya exhibit several phases of incision that are synchronous to aggradation in west. The higher precipitation in the region probably kept sediment-water ratio below a threshold of aggradation. This point towards relatively high erosional stress and associated deformation in the NE Himalaya.
4. Bedrock incision rates, as calculated from dated alluvial covers of strath surfaces indicated the values that are spatially variable and fall in the range of rates reported from across the Himalaya. These estimated rates however are higher than the basin average erosion rates calculated using isotopic mass balance in the riverbed sediments.

References

Mukul, M., Jaiswal, M.K., Singhvi, A.K., 2007, Timing of recent out-of-sequence deformation in the frontal Himalayan wedge: insights from Darjiling sub-Himalaya, India. Geology, 35, 999-1002.

Phartiyal, B., Sharma, A., Srivastava, P., Ray, Y., 2009, Chronology of relict lake deposits in the Spiti River, NW Trans Himalaya: Implications to Late Pleistocene-Holocene climate-tectonic perturbations. Geomorphology, 108, 268-272.

Pratt. S.B., Burbank, D.W., Heimsath, A., Ojha, T., 2004, Landscape disequilibrium on 1000-10,000 year scales Marsyandi River, Nepal, central Himalaya. Geomorphology, 58, 223-241.

Ray, Y., Srivastava, P., 2010, Widespread aggradation in the mountainous catchment of the Alaknanda-Ganga River System: Timescales and implications to Hinterland-foreland relationships. Quaternary Science Reviews, 29**,** 2238-2260.

Srivastava, P., Bhakuni, S.S., Luirei, K., Misra, D.K., 2009, Morpho-sedimentary records at the Brahmaputra River exit, NE Himalaya: climate-tectonic interplay during Late Pleistocene-Holocene. Journal of Quaternary Science, 24, 175-188.

Srivastava, P., Shukla, U.K., 2009, Quaternary Evolution of the Ganga River System: New Quartz Ages and a review of Luminescence Chronology. Himalayan Geology, 30, 85-94

Srivastava, P., Tripathi, J.K., Islam, R., Jaiswal, M.K., 2008, Fashion and phases of Late Pleistocene aggradation and incision in Alaknanda River, western Himalaya, India. Quaternary Research, 70, 68-80.

Srivastava, P., Misra, D.K., 2008, Morpho-sedimentary records of active tectonics at the Kameng river exit, NE Himalaya. Geomorphology, 96**,** 187-198.