Tectonic-Vs Climate-Forcing of Critical Taper Dynamics in Sikkim Himalaya

S. SINHA-ROY
Birla Institute of Scientific Research, Statue Circle, Jaipur 302001, India

Erosion of orogenic belts operates in a complex manner at various spatial and temporal scales. Unroofing of orogens is generally considered to be linked with tectonic-driven exhumation, but climate-forced focused erosion can cause isostatic rebound and vertical mass movement. Erosion exerts a strong control on particle pathways through an orogen, thus forcing orogenic wedge accretion and taper growth that are sensitive to mass redistribution by surface as well as internal processes. Tectonically-controlled accretion influx (Fa) and climate-induced erosion efflux (Fe) are key factors of orogenic wedge dynamics, and a balance between them decides the taper criticality. These aspects are discussed in the context of the Sikkim Himalaya where the wedge propagated towards the foreland since ca. 55 Ma.

The initial hinterland wedge of the Higher Himalaya attained supercriticality as it was floored by high-friction basal decollement (MHT) that actively accreted the Indian upper crustal material to the wedge. This wedge (Taper-1) collapsed at MCT ramp during 25-15 Ma when the wedge returned to critical state. During 15-8 Ma the wedge width increased due to rapid frontal accretion along low-friction MHT to give rise to a new foreland wedge (Taper -2). Active monsoon during 10-8 Ma caused high erosion of the wedge, the material having been deposited in the foreland Siwalik basin. High friction MBT ramp broke through Taper-2 at ca. 8 Ma, and caused thickening of the wedge, making it supercritical where Fa outpaced Fe. Hinterland crustal thickening and internal stress accumulation resulted in out-of-sequence MCT-II thrusting at ca. 6 Ma. Further accretion and internal wedge deformation formed MCT-III between 6-2 Ma.

Forelandward propagation of out-of-sequence thrusts and climate-forced high Fe at post-2 Ma time brought Taper-2 back to critical state when the frontal (MFT) and the piedmont (MPT) thrusts were generated. High erosion supplied sediments to the flexural Ganga foreland basin. Continued climate-induced high erosion has reduced the taper to the present subcritical state. The rate of southward wedge propagation between MCT-I and MFT is 4 mm/a which is comparable to the average rate of uplift of the orogen. This suggests that the wedge growth rate is controlled by a positive feedback where tectonic-forcing outpaced climate-forcing (Fa>Fe) in the long term.

Keywords : Tectonics, climate, critical taper, wedge propagation, Sikkim, Himalaya.