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A hidden fold and thrust belt south of the Himalayan morphological front: The examples of Central Nepal and Darjeeling piedmonts

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The morphological boundary between the Himalayas and the foreland plain is well expressed and most often corresponds to the frontal emergence of the Main Himalayan Thrust (MHT). This boundary is thus affected by surface ruptures during very large Himalayan earthquakes (Mw > 8) which regularly induce (with a recurrence of the order of 500 to 1200 years) the uplift of the foothills relative to the plain.

However, a thrust fold system is hidden beneath the plain and has been imaged by oil-companies' seismic profiles, in East/Central Nepal or by H/V passive geophysical techniques in Darjeeling. Its long-term kinematic evolution is slow, with a tectonic uplift of the hangingwall lower than the subsidence rate of the foreland basin, i.e., less than ~ half a millimeter by year. During phases of low sedimentation controlled by climatic fluctuations, the morphological surfaces of the piedmont are nonetheless incised by several tens of meters by the large rivers. Thus, structures hidden under the sediments slightly emerge in the plain.

The evolution of the hidden structures corresponds to that of a proto-thrust belt affected by a layer parallel shortening (LPS) acting in the long term with a shortening rate of the order of 1-2 mm/yr, i.e., of 5-10% of the shortening rate of the Himalayan thrust system. Comparison of the long term structural evolution with geodetic, geomorphological and paleoseismological studies suggests several deformation components:

i) an aseismic deformation is associated with the LPS structures; at present, it is not proven that it occurs in a continuous manner and the data are also consistent with a deformation of limited duration – less than 15 years – and a multi-centimeter scale amplitude. The aseismic deformation could absorb the entire deformation of the proto-thrust belt in east-central Nepal. The amplitude of this aseismic deformation is nonetheless too limited to significantly reduce the seismic hazard in the seismic gaps;

ii) in some portions of the Himalayan front, such as the Darjeeling (India), the thrust deformation related to great earthquakes propagates ahead of the morphological front, in the zone previously affected by the LPS and induces multi-meter surface ruptures in the piedmont;

iii) last, pre-existing faults in the bedrock of the Indian craton, often oblique to the Himalayan structures, are locally reactivated beneath the foreland plain with low velocities.

Mots-Clés : Himalayan front, aseismic deformation, blind thrusts, geomorphology, proto-thrust wedge

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