Role of Internal Thrusts in NW Sub-Himalaya, India, for SHA

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Continuous convergence of the Indian and Eurasian plates along the Himalayan arc is manifested as uplifted topography, short and long term shortening rates and inter-seismic strain. The proportion in which each of the above said elements contributes is, however, different along different sectors of the Himalaya. For example, the bulk shortening along the central part of the Himalaya is mainly accommodated along the Himalayan Frontal Thrust (HFT) (Wesnousky et al., 1999; Lave and Avouac, 2000). Accordingly, it has been hypothesized that the tectonic wedge of the Sub-Himalaya represents an expanding mountain front, in the central part. The present study is aimed at testing this hypothesis in the NW Himalaya of India by integrating field observations and results of geomorphic investigations.

The Himalayan arc is marked by significant along-strike lateral variations in the geology, structure and seismicity (Singh et al., 2012; Gahalaut and Arora, 2012). In the NW Sub-Himalaya of India the deformation front is conspicuously characterized by actively deforming frontal anticlines running parallel to the mountain front (Singh and Jain, 2012). Here the sedimentation pattern indicates fold growth initiation as young as 0.78 Ma (Rao et al., 1998). Field mapping and observations about the presence of typical geomorphic surfaces along mapped internal thrust faults, here, amply demonstrate that the deformation is not restricted to the HFT alone; rather it is distributed across different thrusts running parallel to the Sub-Himalayan belt. Previous work on the stream profiles by the authors had clearly indicated that major internal thrust fault, eg. Nahan Thrust, is active (or in fact reactivated) to absorb the impact of continuous convergence (Singh and Awasthi, 2010). However, the present work in detail has highlighted active shortening along the internal thrust system in the Kangra area. Many of these thrusts cut and/or override the Quaternary deposits to the north of the HFT. Studies on surficial deposits, geometrical patterns and morphological analyses of streams patterns indicate that such deformation have been going on even during the last few thousand years along these internal thrusts.

The new results draw us to infer that the tectonic wedge of the Sub-Himalayan Fold Thrust Belt is mechanically constrained internally by thrust faults other than the range-bounding HFT. Similar inferences have also been drawn, alternatively, by statistical analysis of the taper parameters of the tectonic wedge (Singh et al., 2012). However, owing to the curvilinear surface trace of the thrust faults, the internal thrusts tend to merge with the main range-bounding thrusts (HFT and MBT in the present case); thereby placing much importance (or prominence) to the range-bounding thrusts rather than the internal thrusts. In such a case, the role of internal thrusts that are relatively limited in spatial dimensions seem to be undermined. Moreover, in areas with widely spaced range-bounding thrusts, the impact of internal thrusts, though smaller in dimension but larger in number becomes significant. This observed scenario becomes important in evaluating the seismic hazard of any region characterized by a large number of internal thrusts. This becomes even more important where the width of the Sub-Himalayan belt varies significantly from as much as ~ 80 km in the Kangra sector to ~20 km in the Nahan sector of India. This present study emphasizes that the internal thrusts play a very significant role in the seismicity of the NW Sub-Himalaya of India. Also, it clearly indicates that the cumulative role/impact of the internal thrusts in the NW Himalaya is much more in accommodating the overall India-Asia convergence than the range bounding thrusts. Further, this style of deformation is in clear contrast to that observed in the Central Himalaya. It is therefore surmised that the internal thrusts should be seriously considered for any seismic hazard evaluation program to be more realistic and successful.

References

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