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Exploring Structural Model of the Main Frontal Thrust along the Central Himalaya, through Geomorphic Analyses

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The Main Frontal Thrust (MFT) forms the youngest and southernmost active deformation front of the Himalaya, taking up a significant amount of the convergence between the Indo-Eurasian plates. Thrusting of Siwalik rocks over the Indo-Gangetic alluvium along the MFT has resulted in the generation of the Frontal Siwalik ranges that are distributed linearly along the Himalayan front. During early stages of topographic evolution, the development of fold-and-thrust belts is intricately connected to the underlying structures; thus, the frontal ranges which are in their early stage of development, form useful guides for understanding the structural evolution of the MFT.
In this study, we investigate the structural framework of the MFT in the central Himalaya - nearly 100 km SW of Kathmandu, in Nepal. The study area is marked by three distinct topographic segments, i.e. the South West Churia Range (SWCR), the Valmiki Nagar Range (VNR) and the South East Churia Range (SECR), that represent the Frontal Siwalik Ranges (locally known as the Frontal Churia Ranges – FCRs) in the region. These ranges bound the Chitwan intermontane valley to its south. They show a striking morphological variability in comparison to the Siwalik ranges of the northwest Himalaya, suggesting a variation in their structural styles along the Himalayan front. The study area is in a protected Wildlife Reserve Forest with very poor connectivity, making it difficult to carry out field investigations in this region. Therefore, geomorphic analyses (viz. morphometric indices, drainage anomalies, longitudinal river profiles, along and across strike topographic profiles, the study of catchment morphologies, etc.) of the FCRs is carried out to explore the structural model of the area.
The results show that the study area comprises of several individual MFT segments that have interacted to form the present-day topography. The SECR has developed by the lateral propagation of three MFT segments towards each other. The VNR has formed by growth along a single MFT segment. However, the growth of the SWCR is complex due to the presence of an older NW-SE trending tear fault (Gardi Tear Fault - GTF) in the central part of the range. It forms a barrier to the MFT segments associated with the SWCR. The topographic growth of the SECR and VNR also terminate near the GTF. Our study reveals that due to the overlapping of the frontal ranges there is stress partitioning along the faults thus impacting the overall growth of the FCRs. We conclude that the structural development of the study area is marked by a complex interaction of several MFT segments that either merge linearly or get truncated and relayed (with or without linkage) on opposite sides of a pre-existing tear fault (GTF).