ABSTRACT

The Darjeeling – Sikkim Himalaya lies in the eastern part of the Himalayan fold-thrust belt (FTB) in a zone of high arc-perpendicular convergence between the Indian and Eurasian plates. In this region two distinct faults form the Main Central thrust (MCT), the structurally higher MCT1 and the lower MCT2; both these faults have translated the Greater Himalayan hanging wall rocks farther towards the foreland than in the western Himalaya. The width of the sub-MCT Lesser Himalayan rocks progressively decreases from the western Himalaya to this part of the eastern Himalaya, and as a result, the width of the FTB is narrower in this region compared to the western Himalaya.

Our structural analysis shows that in the Darjeeling – Sikkim Himalaya the sub-MCT Lesser Himalayan duplex is composed of two duplex systems and has a more complex geometry than in the rest of the Himalayan fold-thrust belt. The structurally higher Daling duplex is a hinterland-dipping duplex; the structurally lower Rangit duplex varies in geometry from a hinterland-dipping duplex in the north to an antiformal stack in the middle and a foreland-dipping duplex in the south. The MCT2 is the roof thrust of the Daling duplex and the Ramgarh thrust is the roof thrust of the Rangit duplex. In this region, the Ramgarh thrust has a complex structural history with continued reactivation during footwall imbrication. The foreland-dipping component of the Rangit duplex, along with the large displacement associated with the reactivation of the Ramgarh thrust accounts for the large translation of the MCT sheets in the Darjeeling – Sikkim Himalaya. The growth of the Lesser Himalayan duplex modified
the final geometry of the overlying MCT sheets, resulting in a plunge culmination that manifests itself as a broad N-S trending “anticline” in the Darjeeling – Sikkim Himalaya. This is not a “river anticline” as its trace lies west of the Teesta river.

A transport parallel balanced cross section across this region has accommodated a total minimum shortening of ~502 km (~82%) south of the South Tibetan Detachment system (STDS). Based on this shortening, the average long-term shortening rate is estimated to be ~22mm/yr in this region. The available shortening estimates from different parts of the Himalayan arc show significant variations in shortening, but based on the present available data, it is difficult to evaluate the primary cause for this variation. The shortening in the Himalayan fold-thrust belt (FTB) is highest in the middle of the Himalayan arc (western Nepal) and progressively decreases towards the two syntaxes. Although the width of the Lesser Himalayan belt decreases in the eastern Himalaya, the Lesser Himalayan shortening percentage remains approximately similar to that in the Nepal Himalaya. In addition, the shortening accommodated within the Lesser Himalayan duplex progressively increases from the western to the eastern Himalaya where it accommodates nearly half of the total shortening. The regional restorations suggest that the width of the original Lesser Himalayan basin may have played an important role in partitioning the shortening in the Himalayan FTB. In addition, the retrodeformed cross section in the Darjeeling – Sikkim Himalaya provides insights into the palinspastic reconstruction of the Gondwana basin of Peninsular India, suggesting that this basin extended ~150 km northward of its present northernmost exposure in this region.
The balanced cross section suggests that each of the MCT sheets has undergone translation of $\geq 100$km in this region. Although a regional scale flat-on-flat relationship is seen in the MCT sheets, there is a significant variation in overburden from the trailing portion to the leading edge of the MCT due to the geometry of the tapered crystalline orogenic wedge. Microstructural studies from three segments of the MCT2 fault zone suggest that the MCT2 zone has undergone strain softening by different mechanisms along different portions of its transport-parallel length, mainly as a result of changing overburden conditions. This regional strain softening provides a suitable explanation for the large translation of $\geq 100$ km along a relatively thin MCT2 fault zone in the Darjeeling – Sikkim Himalaya.