Geophysical Research Abstracts
Vol. 19, EGU2017-916-1, 2017
EGU General Assembly 2017

Effect of footwall structures on kinematic evolution of dominant thrusts from hinterland of an orogenic wedge: Insights from Sikkim Himalayan FTB

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Deformation profile of a thrust sheet is generally characterized by a dominance of simple-shear toward the base and pure-shear higher up. In this study, we attempt to examine the effect of underlying footwall structure on the evolution of such a deformation profile with time. We focus on two dominant thrusts of the Sikkim Himalayan FTB, the northern most Main Central thrust (MCT) and its major footwall thrust, the Pelling thrust (PT). The MCT and the PT sheets are folded in an E-W trending antiform-synform pair by the growth of the underlying Lesser Himalayan duplex. The PT acts as the roof thrust of the duplex.

The coarse-grained, quartzo-feldspathic gneissic protoliths transform into quartz-mica mylonite forming ∼1170m thick amphibolite facies MCT zone and ∼938m thick greenschist facies PT zone. Due to the forelandward progression of deformation front, the overlying MCT foliation is superposed by the underlying PT foliation. Within both the fault zones, quartz has undergone grain-size reduction dominantly by dislocation creep, and feldspar by fracturing mechanism. Interestingly, microfracturing is more dominant in MCT zone than in the PT zone. Additionally, pressure solution is significantly higher in the PT zone than in the MCT. Thus, there is a spatial variation in deformation mechanisms within the MCT and PT zones. Based on recrystallized quartz grain-sizes, we estimate deformation temperatures of ∼430°C-510°C and ∼400°C-430°C within the MCT and the PT, respectively.

Both quartz and feldspar grains record a higher flattening strain in the MCT zone than in the PT zone. We infer fracturing and pressure solution accommodated a significant amount of strain, thereby under-representing the viscoplastic strain. Estimation of kinematic vorticity from two different incremental strain markers, namely oblique-fabric and subgrains, indicate both the MCT and the PT zones record a progressively higher pure-shear dominated deformation with time. The PT zone records a higher pure-shear than the MCT zone. Therefore, integration of structural geometry, microstructure and kinematic data suggest that the PT fault zone records the effect of footwall duplex more prominently than the MCT fault zone. We attribute the temporal evolution toward a pure-shear dominated deformation within the PT zone due to the growth of the underlying Lesser Himalayan duplex.