Tectono-thermal evolution of the Main Central Thrust (MCT) zone rocks of the Himalayan Crystalline Complex (*HCC*), Darjeeling-Sikkim Himalaya

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The rheology of the Himalayan Crystalline Complex (*HCC*) laying above the Main Central Thrust (MCT), is the key boundary condition for all the tectonic models that deals with extrusion of lower crustal material. Therefore, it is important to understand the intricate relationship between the processes of crustal thickening, Barrovian metamorphism and strain localization in the high-grade rocks of the *HCC* that controls the rheology of a deforming wedge. Initially deformation was distributed and a series of repeated folding leads to crustal thickening and pro-grade metamorphism. The similarity between the peak metamorphic and peak deformation temperature, as documented by frozen high-temperature microstructures is indicative of this phase. The ‘*locked in*’ deformation microstructures and syn-kinematic growth of metamorphic index minerals reveal that the MCT related shearing begins at or near the peak metamorphic condition (16-12 Ma), where grain size reduction by dislocation-controlled creep was the most effective mechanism for strain localization. The observed deformation microstructures and the available P-T data shows that the peak deformation and metamorphic condition progressively increases (~500 to >700°C) towards the mountain interior. It is further evident that the now-exposed *HCC* begun to extrude under dominantly ductile mid-crustal condition at a temperature >700°C, where the hotter mid-crustal rocks can flow in a viscous manner by melt enhanced depth-dependent ductile flow. Hence, initially the MCT represents a rheological and metamorphic boundary that separates material which can or cannot flow. Then with subsequent exhumation, cooling and strengthening of the *HCC* produced diffuse ductile shear zones along the same rheological boundary, where deformation was distributed for 4-6 km width (~ MCT zone). The base of the high strain zone is marked by base of the compressed reverse paleo-isograds that coincides with the SGR-GMB transition for quartz, leading to steep P-T gradient locally constrained within the MCT zone before it flattened in the migmatite gneisses. At further lowering of temperature (shallower depth), the MCT localized into narrow shear zone under dominantly brittle condition, transporting the entire *HCC* thrust sheets to the foreland.

Keywords: Himalaya, India-Asia collision, Superposed folding, Strain localization , Main Central Thrust Zone

