# Tectonothermal modelling for Sikkim Himalaya: Implications for channel flow to thrust tectonics in collision zones

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One of the more significant discussions on the geodynamic evolution of continental collision zones in general and Himalayan orogen in particular is the relative importance of deformation along discrete thrust surfaces/narrow ductile shear zones, called here as “localized fault bounded slice tectonics” (LFBST, similar to deformation in fold-thrust-belts/critical taper/wedge tectonic models), vis-à-vis crustal-scale distributed deformation, such as channel flow. The Sikkim Himalaya (India) provides us with a unique opportunity to study both LFBST and channel flow styles of deformation. We adopt section-balancing techniques to characterize LFBST style of deformation and thermomechanical modelling of deep crustal processes to characterize channel flow style of deformation and metamorphism.

In Sikkim Himalaya, low to medium grade metamorphic rocks (Daling Group or Lesser Himalaya, LH) and high-grade metamorphic rocks (Darjeeling Gneiss or Greater Himalaya, GH) occur at successively higher structural levels. We find that the well-known Main Central Thrust (MCT) – an intracontinental thrust in the Himalayan orogen – can be marked at the contact between GH and LH at a place called Chungthang based on extensive mylonitazation of a thin sliver of granite gneiss (Chungthang gneiss) and protolith contrast suggested by ε-Nd isotopic signature.

A large body of petrological, structural, microstructural, thermobarometrical, geochonological and geospeedometic data have been used to characterize contrasting P-T paths, timescale of metamorphism and deformation mechanism of GH and LH occurring in the hangingwall and footwall, respectively, of MCT. In order to reconcile seemingly contrasting P-T-t histories and deformations in GH and LH, thermomechanical numerical simulations of an orogen are considered that are thermally, rheologically, temporarily and geometrically viable for a given set of convergence rate (7 cm/year), radioactive heating (5 $\mu W/m^3$) and lower crustal rheology ($An_{75}$). It is observed that in a continuously evolving collisional orogen, as in Himalayas, channel flow models are viable at high temperature at deeper level but LFBST is viable at shallow exhumation at lower temperature. The debate is thus not whether channel flow model or block-/thrust tectonics (LFBST) is appropriate tectonic model for the Himalaya. A combination of two models operating successively appears to explain observations most satisfactorily. We conclude that the channel flow model better describes observations on an orogen-wide (1000s of km) but LFBST is well suited for describing the geometry and kinematics of shallow exhumation of fault-bounded blocks of regional mapping scale, i.e., outcrop scale to several hundred km.