Inverted temperature fields: peak metamorphic and deformational temperatures across the Lesser Himalayan Sequence

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To explain the formation of an inverted metamorphic sequence we performed a study, which combined geothermometry with the thermochronology. The data are evaluated trough thermokinematic forward and inverse modeling to constrain the ranges of important geological parameters such as fault slip rates, the location and rates of localized crustal accretion, and the thermal properties of the crust. The case study was performed along a transect across the Lesser Himalayan Sequence (LHS) of the eastern Bhutan. The geothermometry included the Raman spectroscopy of carbonaceous material (RSCM) to determine the peak metamorphic temperatures and Ti-in-quartz thermobarometry to determine the deformation temperatures. The thermal kinematic modeling was performed with PECUBE software and as thermochronologic constraints we used apatite and zircon U-Th/He and fission-track data and $^{40}Ar/^{39}Ar$ dating of muscovite. The spatial pattern of peak temperatures across the LHS, acquired by RSCM indicates that there are two temperature field sequences separated by a major thrust. Internal temperature sequence shows an inverted temperature field gradient of 12 °C/km; in the external one the peak temperatures are same with the structural sequence. Thermo-kinematic modeling shows that the thermochronologic and thermobarometric data can be well fit by a two-stage evolutionary scenario: an Early-Middle Miocene phase of overthrusting of a hot hanging wall over a downgoing footwall and inversion of the synkinematic isotherms, followed by the formation of the external duplex developed by basal accretion. To reconcile our observations and the experimental data we suggest that the pervasive ductile deformation within the upper LHS and along the Main Central thrust zone at its top stopped at ~11 Ma when the deformation shifted and focused until after ~ 6 Ma within the external duplex.