Pre-Barrovian Thermal Perturbation in the Lesser Himalayan Sequence Mid-crust of Western Arunachal, India: Implication for the Origin of Himalayan Inverted Thermal Gradient

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In this work, we model the inverted thermal gradient during Himalayan metamorphism, using rocks of the Lesser and Greater Himalayan Sequences (LHS and GHS respectively) of the western Arunachal Himalaya (WAH). The investigated rocks are exposed along the transect, Sessa-Rupa-Bomdila-Dirang-Se La. Five metamorphic zones from garnet through kyanite, kyanite migmatite, kyanite-sillimanite migmatite to K-feldspar-kyanite-sillimanite migmatites are sequentially developed in the metamorphosed low-alumina pelites with increasing structural heights.

Integrated petrographic, mineral chemistry, geothermobarometric (conventional and Thermocalc average P-T methods) and P-T pseudosection modelling studies reveal near isobaric (at P~8 kbar) increase in peak metamorphic temperatures from ~550 ºC in the garnet-zone to ~700 ºC for kyanite-sillimanite migmatite zone and from ~750 ºC to ~800 ºC at ~10 kbar in the K-feldspar-kyanite-sillimanite-zone rocks. The metamorphic sequence of the LHS additionally records a near isobaric thermal gradient in the mid crust (at ~6 kbar) from ~525^{o} (in the lower garnet zone) to ~575^{o}C (in the kyanite zone, adjoining the Main Central Thrust), which pre-dated the peak Barrovian metamorphism. The deepest section of the GHS recorded lower crustal (kyanite-facies) prograde melting and subsequent near isothermal decompression and post-decompressional cooling P-T path.

Integration of the metamorphic information from the LHS and the GHS appears to suggest an early inversion of the thermal gradients in the studied transect due to footwall-directed heat conduction in the mid-crust from rapidly exhumed, high-T migmatites of the GHS and synchronous near isobaric heating of the footwall rocks. Further burial (along steep dP/dT gradient) to a uniform depth of ~8 kbar and prograde heating of the differentially heated LHS rocks led to the formation of near isobaric metamorphic field gradient in the Barrovian metamorphic zones of the WAH. A partially modified channel flow model is presented to explain the inverted metamorphic zonation of the rocks of the WAH.