Metamorphic History of the South Tibetan Detachment System, Mt. Everest Region, Revealed by RSCM Thermometry and Phase Equilibria Modeling

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Understanding the role of large-scale detachment fault systems in the development of collisional orogens is important; their structural history yields insight into the mechanisms by which crustal-scale extension is accommodated within a convergent system whereas their thermal history delineates the extent to which they facilitate the transfer of both heat and mass from the mid to upper crust. Such studies help to elucidate the tectonic evolution of mountain belts and also define important geologic boundary conditions from which large-scale geodynamic simulations can be constructed and to which the results of predictive models must be matched.

A key input into geodynamic models that attempt to explain the evolution of the Himalayan orogen, is knowledge of the structural and thermal history of the South Tibetan Detachment System (STDS). Numerous studies have addressed the kinematic evolution of the STDS, but its thermal structure is less well understood. This is in part due to the relative paucity of index minerals in many sections of the STDS. Exceptions to this include Zanskar (Searle and Rex, 1989), the Sutlej Valley in NW India (Chambers and others, 2009) and the Everest region (e.g. Hodges and others 1992; Jessup and others 2008) and Bhutan (e.g. Kellett and others, 2009). In these areas, detailed work has revealed a complex juxtaposition of Greater Himalayan Series (GHS) rocks with the overlying Tibetan Sedimentary sequence (TSS) during exhumation which progressed from a ductile shear zone into younger and structurally higher brittle detachment(s).

To further refine our understanding of the thermal history of the STD system this study combines micro-structural observations with Raman spectroscopy on carbonaceous material and phase equilibria modeling of rocks from a well-exposed section through the STDS in the Dzakaa Chu valley of Southern Tibet. In the hanging wall of the STDS, undeformed TSS rocks consistently record peak metamorphic temperatures of ~340^{o}C. Peak temperatures increase to ~410^{o}C in the upper 200m and ~630^{o}C at the base of the shear zone. These data document an apparent metamorphic field gradient of ~410ºC/km in the upper 200m of the shear zone and an average field gradient of at least 260ºC/km across the entire structure. The data indicates that this 1-kilometre-thick zone of distributed top-down-to-the northeast ductile shear was responsible for significant and complex juxtaposition of paleo-isotherms and/or excision of material along the upper margin of the GHS during the mid-Miocene. This segment of the shear zone therefore provides a record of the early stages of south-directed exhumation of footwall GHS rocks from beneath the Tibetan plateau that is elsewhere overprinted by later, brittle deformation features including discrete detachment faults.

References

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