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The influence of melting on the kinematic development of the Himalayan crystalline core

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Current hypotheses for the development and emplacement of the Himalayan crystalline core are 1) models with intense upper plate out-of-sequence activity (i.e. tunneling of channel flow, and some modes of critical taper wedge behavior) and 2) models in which the upper plate mainly records basal accretion of horses (i.e. duplexing). The two concepts can be considered end-members. A signal difference between these two models is the role of melting. The intense upper plate deformation envisioned in the first set of models has been hypothesized to be largely a product of partial melting, particularly in channel flow models. Specifically, the persistent presence of melt in the middle crust of the upper plate may dramatically lower the viscosity of these rocks, allowing distributed deformation. The second set of models – duplexing – predicts in-sequence thrusting with only minor out-of-sequence deformation. Stacking of a duplex acts like a deli cheese-slicing machine: slice after slice is cut from the intact block to a stack of slices, but neither the block (∼down-going plate) nor the stack (∼upper plate) features much internal deformation. In this model, partial melting produces no significant kinematic impact. The dominant preserved structural elements across the Himalayan crystalline core rocks are flattening and L-S fabrics. Structurally high portions of the crystalline core locally display complex outcrop-scale deformation associated with migmatitic rocks, and contain km-scale leucogranite bodies; both features developed in the early to middle Miocene. The flattening and L-S fabrics have been interpreted to record either (A) southwards channel tunneling across the upper plate, or (B) fabric development during metamorphism of the down-going plate, prior to accretion to the upper plate. The deformation of migmatitic rock and emplacement of leucogranite have been interpreted in support of widespread distributed deformation. Alternatively, these features may have accumulated from increments of melting and crystallization which did not produce sufficient melt during any one period to significantly alter viscosity at >100 m scales. Recent work integrating monazite and zircon geochronology with structural records shows that the Himalayan middle crust has been assembled along a series of mainly southwards-younging thrust faults throughout the early to middle Miocene. The thrust faults separate 1-5 km thick panels that experienced similar metamorphic cycles during different time periods. At this scale, out-of-sequence deformation is rare, with its apparent significance enhanced because of the high throw-to-heave ratio of out-of-sequence thrusting. These findings support the duplexing model and indicate that melting did not have a significant impact on the kinematic development of the Himalayan crystalline core.