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Telescoping of isotherms beneath the South Tibetan Detachment, Mount Everest Massif: implications for magnitude of internal flow during extrusion of the Greater Himalayan Slab

R.D. Law (1), M.J. Jessup (2), M.P. Searle (3), J.M. Cottle (3) and D. Waters (3)

(1) Department of Geosciences, Virginia Tech, Blacksburg, VA24061, USA, (2) Department of Earth & Planetary Sciences, University of Tennessee, Knoxville, TN 37969, USA, (3) Department of Earth Sciences, University of Oxford, Oxford OX1 3PR, UK (rdlaw@vt.edu / Fax: 1 540 231 3386 / Phone: 1 540 231 6685).

Both petrologic and microstructural/crystal fabric data indicate that isotherms recorded in the schists and gneisses of the Greater Himalayan Slab (GHS) and located in the footwall to the South Tibetan Detachment System (STDS) have undergone extreme telescoping during penetrative flow associated with southward extrusion of the GHS from beneath the Tibetan Plateau. Within the Rongbuk Valley located to the north of Mount Everest we have made vertical sampling traverses working downward from the STDS into the GHS at Hermit's Gorge, Rongbuk Monastery and the northern entrance to Rongbuk Valley. Adopting the calibration of Kruhl (1998) and Law et al. (2004), deformation temperatures were estimated using the opening angle of cross girdle c-axis fabrics measured by optical microscopy in plastically deformed and dynamically recrystallized quartz grains in each sample. Traced from south to north, linear regression of the deformation temperature data indicates apparent thermal gradients of 420, 385 and 369 ˚C per km for the Hermit's Gorge, Rongbuk Monastery and northern sampling transects respectively. Isothermal surfaces projected between these three traverses have an apparent dip of c. 2˚ towards the NNE, parallel to the apparent sheet dip of foliation.

The observed telescoping of isotherms could be due to: a) penetrative strain asso-

ciated with extreme vertical thinning, b) chilling from juxtaposition against cooler hanging wall rocks, or c) downward increasing transport of material during penetrative flow associated with southward extrusion of the GHS as assumed, for example, in channel flow models. Vertical penetrative thinning requires strain ratios of between 100:1 and 250:1 measured in XZ sections for which there is no supporting field or microstructural evidence - assuming geothermal gradients of 40-25 ˚C per km during plane strain deformation (as indicated by the cross girdle fabrics) at constant volume. Chilling against cold hanging wall rocks is a possibility requiring further analysis, but in itself implies significant (at least tens of kilometers) transport in order to place hot GHS footwall rocks against cooler Tethyan hanging wall rocks. Adopting the differential transport model, simple geometric analysis using cross sections drawn parallel to the local 030˚ transport direction indicated by stretching lineations in the GHS suggests that detachment-parallel transport magnitudes of 25-85 km are needed to place rocks originally deforming at 675 ˚C at no more than 0.5 km beneath stationary rocks at 475 ˚C, assuming geothermal gradients of 40 to 25˚C and particle paths parallel to an overlying planar STDS dipping at between 10 and 5˚ to the north. Perhaps more realistically, if both the reference rock particles at 475 and 675 ˚C are moving during extrusion, and do not become coupled at a vertical spacing of 0.5 km until they pass through the brittle-ductile transition zone (c. 300 ˚C), then detachment parallel transport magnitudes of 85-170 and 45-85 km are indicated for the 675 and 475 ˚C reference particles respectively, with differential transport on the order of 45-85 km between these reference particles. These particle transport estimates are similar to those previously calculated from petrologically determined barometry data of GHS rocks in the Everest region (Searle et al. 2003) and are at least compatible with recently published channel flow models for extrusion and exhumation of the GHS.