Feeding the 'aneursym': Orogen-parallel mass transport into Nanga Parbat and the western Himalayan syntaxis

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Elevations of mountain peaks in the Nanga Parbat-Haramosh massif (NPHM; western Himalayan syntaxis) are comparable to the highest elevations elsewhere in the Himalaya, but estimated exhumation rates of up to 13 mm/a over the last ~2 Ma are more than double those in the central Himalaya [1,2]. This suggests that the mass influx into the NPHM must exceed that in the adjacent Himalayan arc in order to sustain the high topography and rapid erosional exhumation rates. The 'tectonic aneurysm' model [3] provides a mechanism by which localized, rapid exhumation could occur in the NPHM, but the source of the excess mass into the NPHM is unclear. An alternative mechanism capable of supplying the requisite mass flux is strain partitioning as a result of oblique convergence across the Himalayan front. Conceptual and analogue models of strain partitioning along the arcuate Himalayan front have shown how mass could be translated along strike into the syntaxis region, where orogen-parallel (OP) shortening occurs in an orogen-normal trending shear zone as a result of reduction in the convergence obliquity angle [4,5]. Although this mechanism has the potential to produce localized rapid uplift and crustal thickening, conceptual models are unable to quantitatively demonstrate the viability of strain partitioning for sustaining the topography and rapid exhumation of the NPHM.

We use a simple 3D model of an obliquely convergent orogen to show that velocity/strain partitioning results in lateral (OP) transport of the converging crust toward the syntaxis, where the OP flow rate in the model decreases, thickening the crust and producing a structure similar to the NPHM. In the model, the resulting, localized crustal thickening provides the requisite excess mass to sustain rapid exhumation of this 'aneurysm', and similar behavior is suggested for the Himalaya. Normally, velocity/strain partitioning would be minimal along the Himalayan arc, where the convergence obliquity angle is no greater than ~40°, however we show analytically and numerically that the Himalayan orogen can act as a critical wedge with strain partitioning if both the basal decollement and rear of the orogenic wedge, where strain partitioning is accommodated, are very weak. In the numerical model, the angles of internal friction of the basal and rear shear zones must ~2.5° and 1-2°, respectively, suggesting the Himalayan equivalents, the Main Himalayan Thrust and Karakoram fault, must be similarly weak. In the model, a NPHM-type shortening structure can develop spontaneously if the orogenic wedge and bounding rear shear zone can strain-rate soften while active, although a similar structure may develop without a need for strain-rate softening in nature. These results lead us to question whether the position of the NPHM aneurysm is localized by river incision, as previously suggested, or by *a priori* focused tectonic shortening of the crust in the syntaxis region as demonstrated by our models.

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