Orogen-parallel mass transport along the arcuate Himalayan front into Nanga Parbat and the western Himalayan syntaxis

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Quaternary rates of rock exhumation in the western Himalayan syntaxis region are more than twice those observed along strike in the central Himalaya, yet the elevation of mountain peaks in both regions are comparable. This apparent disconnect suggests the western Himalayan syntaxis area requires an additional flux of crustal mass into the region to maintain high-elevation topography. One potential source of crustal mass is strain partitioning along strike in the arcuate orogen, where the orogen-parallel component of oblique convergence is accommodated on a strike-slip fault system at the rear of the Himalayan orogenic wedge resulting in an orogen-parallel mass flux into the syntaxis region, where the convergence obliquity then decreases and the mass accumulates.

Using a combination of analytical calculations and 3D numerical geodynamic models, I demonstrate that strain partitioning is expected for an arcuate Himalaya-like orogen and that the magnitude of orogen-parallel mass transport can balance rapid surface erosion in the western Himalayan syntaxis. Strain partitioning in the analytical force balance is driven by the shear force along the base of the orogenic wedge and resisted by the shear force on a strike-slip shear zone at the back of the wedge, and normal- and reverse-sense shear zones at the lateral ends of the obliquely congervent segment of the orogen. The force balance suggests strain partitioning will only occur when the rear shear zone is weak, with an internal angle of friction of $\phi_r < 5^\circ$. This result is supported by generic 3D numerical geodynamic models with a Himalaya-like geometry in which strain partitioning is observed when $\phi_r = 1 - 2^\circ$ and oblique thrusting (no partitioning) is observed for $\phi_r = 5^\circ$. When strain partitioning occurs in the models, I observe rates of orogen-parallel mass transport of 5-7 mm/a that produce local uplift rates in the western Himalayan syntaxis of 10-12 mm/a, comparable to the Quaternary rates of rock exhumation in this region. In addition, a strike-slip shear zone cutting obliquely across the orogen forms at the distal end from the syntaxis with a geometry remarkably like that of the recently documented Western Nepal Fault System. Combined, this suggests strain partitioning is a viable mechanism for supplying crustal mass to the western Himalayan syntaxis.