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

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The Himalayan syntaxes have been the focus of much previous research, in part owing to the extreme rates of rock exhumation observed within the core of the syntaxes, the powerful river systems cutting across them, and the resulting spectacular relief produced. Quaternary rates of rock exhumation in the western Himalayan syntaxis, for example, exceed 10 mm/a. Combined with mountain peak elevations comparable to the central Himalaya, these high rates require a source of rock flux greater than that added to the Himalayan orogenic wedge elsewhere along strike to compensate for rapid denudation. One potential source of mass is along-strike translation of the orogenic wedge toward the western Himalayan syntaxis as a result of strain partitioning across the thrust front. Where convergence across the thrust front is oblique, strain partitioning can partially or completely divert the component of convergence parallel to the frontal thrust into an orogen-parallel velocity in the orogenic wedge. This results in mass being driven along strike into the syntaxis where the convergence obliquity decreases and the crustal mass accumulates. Active faults like the Karakoram Fault and Western Nepal Fault system provide evidence of strain partitioning in the western Himalaya, but the rate of orogen-parallel wedge transport is debated. This rate is central to a test of the viability of strain partitioning as a source of crustal mass into the western Himalayan syntaxis.

Preliminary results from 3D numerical geodynamic modelling experiments demonstrate that moderate strain partitioning can be expected in some cases for a geometry similar to the Himalayan arc, though the uplift rate in the model syntaxis as a result of strain partitioning is lower than observed in the western Himalayan syntaxis. We consider a $1600 \times 1600 \times 80$km crustal block corresponding to the western half of the Himalayan arc with pre-defined zones where frictional material strengths can be varied. The two main zones correspond to the basal décollement beneath the Himalayan orogenic wedge and the Indus-Yarlung suture zone/Karakoram fault region at the rear of the wedge. When the model suture zone is relatively strong (friction angle $\phi \geq 5°$) no strain partitioning is observed, resulting in no enhanced uplift in the syntaxis. When that region is weaker ($\phi = 4°$), partial strain partitioning is observed along $\sim$80% of the arcuate thrust front, producing orogen-parallel mass transport into the syntaxis region at $\sim$3 mm/a. This results in uplift locally within the syntaxis at rates of $4-5$ mm/a compared to rates of $2-4$ mm/a elsewhere along strike. Although uplift rates in the model syntaxis are up to double the rates observed along much of the arc, they are still below the rates observed in the western Himalayan syntaxis. This demonstrates that strain partitioning is a potential mechanism for supplying mass to the western Himalayan syntaxis, but additional work is needed to determine the conditions under which strain partitioning is more complete, resulting in a larger rate of orogen-parallel wedge translation and more rapid uplift in the syntaxis.