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

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Along the length of the Himalayan arc, Quaternary rock exhumation rates are highest in the Himalayan syntaxes at the lateral ends of the arc. In the western Himalayan syntaxis, these rates may exceed 10 mm/a over the past 2 Ma, requiring an additional source of crustal mass into this region to maintain the high-elevation topography. We have previously demonstrated that strain partitioning of oblique convergence can produce a significant orogen-parallel mass flux into the syntaxis of a Himalaya-like orogen and balance the rapid rates of surface denudation. However, the magnitude of this orogen parallel mass flux and whether strain is partitioned across the Himalayan thrust front is affected by the strength of the material bounding and within the Himalayan orogenic wedge, the dip angle of the basal detachment and the convergence obliquity angle γ. Strain partitioning is expected for a finite-length Himalaya-like segmented linear orogen with an obliquity of $\gamma = 30 - 40°$, but the obliquity angle in the Himalayan arc varies from 0 at the center of the arc to $\sim 40°$ in the western Himalayan syntaxis region. Thus, the conditions in which strain partitioning will occur may not be met along much of the length of the arc.

Though there is clear evidence of strain partitioning in the Himalaya, preliminary results from 3D numerical geodynamic models of an orogen with an arcuate geometry based on the Himalaya suggest strain partitioning does not occur for the same conditions observed in earlier models of segmented linear orogens or orogens with a smaller arc radius. In those models, the proportion of the orogen length with a high obliquity angle was greater, which favors strain partitioning. In numerical experiments of an arcuate Himalayan orogen with weak material (friction angle $\phi \leq 5°$) at the back of the orogenic wedge, strain partitioning is only observed in the toe of the orogenic wedge (10-15 km from the thrust front) at the western end of the arc, rather than for the entire wedge. Decreasing the friction angle of the material at the back of the wedge to $\phi \leq 3°$ should make strain partitioning more favorable, but results in abandonment of the basal thrust and shortening at the back of the wedge. Increasing the strength of the basal shear zone to $\phi \geq 3°$ has the same effect, though it should also favor strain partitioning. A possible explanation for this behavior is that the forces resisting strain partitioning in these experiments are higher than those in the Himalaya. The size of the arcuate orogen in the experiments is scaled to roughly half the natural width of the Himalaya with the full Himalayan-scale orogenic wedge. This appears to result in larger forces resisting strain partitioning at the lateral ends of the arc than in nature. Ongoing work is (1) testing the geometries and combinations of material properties that may result in strain partitioning as observed in the Himalayan arc and (2) refining the analytical relationship for prediction of strain partitioning for application to arcuate plate margins and orogens.