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INSIGHTS INTO OROGENESIS USING THE HIMALAYAN SYNTAXES AS GEODYNAMIC LABORATORIES

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Both ends of the Himalaya terminate in broad structural and topographic syntaxes that reflect their proximity to a plate corner, where complex, variable, and active lithospheric deformation is underway. More locally, both ends of the Himalayan terminate in active metamorphic massifs marked by rapid rock uplift, pronounced relief, vigorous erosion, and active deformation. At both these scales, interactions between Earth-surface and solid-Earth processes have shaped lithospheric and topographic evolution.

We have conducted multidisciplinary studies on each syntaxis, using them as natural laboratories to study orogenic processes in the detail that the good exposure, young rocks and active geology of these regions make possible. The Nanga Parbat Continental Dynamics Project (~1994 to 1998) used the Nanga Parbat massif to study how metamorphic, surface, and other orogenic processes cause continental lithosphere to be “reworked,” that is, how ancient basement is structurally, petrologically, and chemically overprinted. The project “Geodynamics of Indentor Corners” (2001 to present) is a broader study of how deformation in both mantle and crustal lithosphere is partitioned near a plate corner, and to what extent surface processes play a driving role in orogeny. Both projects have involved contributions from many disciplines, including geochronology, geophysics, petrology, structural geology and tectonics, surface processes, and modeling.

We have found that tectonic and surface processes interact at many scales to produce characteristic landscapes. In the syntaxes, deformation provides the framework for surface morphology, but erosion is occurring at rates that lead to geodynamically significant mass removal, with large rivers playing an important part. Locally erosion can induce intense crustal overprinting through feedbacks involving thermally controlled rheological changes that couple with the large through-going fluvial networks cut into the syntaxes. The regional consequences of these processes can include the formation of elevated surfaces of surprising youth and patterns of erosion and deformation that are highly variable in space and time. We have also found that at least in SE Tibet, deformation in crust and mantle seems coherent, suggesting a considerable degree of mechanical coupling.

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