Role of strike-slip faulting in deformation of the Tibetan Plateau

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Because eastern Asia now serves as the prototype for large-scale intracontinental deformation, how the Asian continent deforms in response to the collision between the India and Eurasia plates influences how we understand the dynamics of continental deformation in general. Two influential end-member views of continental deformation have been debated during the last three decades: (1) deformation occurs primarily by regionally distributed (in the shallow brittle crust), essentially continuous deformation (at depth), or (2) the rules of plate tectonics can be applied to intracontinental deformation with major faults separating a small number of relatively rigid blocks. In the former view applied to eastern Asia, strike-slip faults separate deforming blocks, and rates of slip are not large (~10 mm/yr), so that they are comparable with rates of deformation across regions undergoing more distributed strain. In the latter view, slip rates on major faults not only can be large (~ 20-30 mm/yr), but also should be constant along the faults, so that deformation of regions between major faults accommodates only a small fraction of the displacement of India with respect to Eurasia. The major strike-slip fault thus plays a key role in testing these views. Based on analysis of Global Positioning System data and geological studies of active faulting, we show slip rates along major strike-slip faults in and around the Tibetan Plateau and its margins are indeed slow, in the range of less than ~10 mm/yr. This relatively low slip rates concur with deformation being distributed over the Tibetan Plateau rather than being so concentrated along major strike-slip faults that regions bounded by them can be treated as a rigid plate. Moreover, we also find that the slow rates cover time periods from decades to millions of years. Thus, slips on major strike-slip faults not only manifest temporal quasi-steady state, but also account for a significant but not dominant fraction of the present convergence between India and Eurasia. Our studies also show that slip rates decrease systematically from ~10 mm/yr to < 3 mm/yr at the eastern end of the major strike-slip faults, and suggested that the slip-rate gradients imply that regions surrounding the fault tip must be deforming internally in order to maintain strain compatibility. The major strike-slip faults, therefore do not seem to act as a transform fault that transfers a significant portion of the convergence between India and Asia into northeasterward “strike-slip extrusion” of Asian crust, at least to the extent that strike-slip extrusion implies conservation of surface area. Insofar as “strike-slip extrusion” does occur, it must be limited to the confines of the Tibetan Plateau, so that lateral transfer of material along the major strike-slip fault manifests itself as crustal thickening near their eastern ends, and hence as merely a redistribution of crustal thickening.