Geophysical Research Abstracts, Vol. 9, 06484, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06484

Fault reactivation and selective abandonment in the Central Indian Basin active deformation zone.

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The Central Indian basin between 75°E and the NinetyEast Ridge is a part of the diffuse intraplate deformation zone between India and Australia plates. N-S shortening is accommodated by a 1000 km wide thrust fault network clearly visible in seismic reflection datasets. In particular, a Miocene unconformity ubiquitous in the Bengal fan sediments marks the onset of deformation at 7.5-8 Ma ago. The fault population is now well constrained. Most faults are thrust faults with a minimum spacing of ˜2 km. A first order analysis of the fault population leads to the definition of two possible faults sets: (1) finely spaced faults with small vertical offsets, some of them clearly sealed soon after the onset of deformation and (2) more widely spaced (˜20 km) faults with large offsets bounding tilted sedimentary basins of the same size.

This dual fault population can be explained by the following scenario: The first population of faults corresponds to the original oceanic fabric developed at the ridge axis. These E-W striking normal paleofaults were reactivated with inverse motion at the onset of deformation in the Central Indian Basin, but few remained active beyond the time of the Miocene unconformity. The long-lived faults, being more widely spaced, constitute the presently active second set of faults.

A similar evolution of active fault population is observed in 2D Finite Element Models of lithosphere shortening in the presence of an original heterogeneity. We use the software LAYER (Neumann & Zuber, 1995), modified to include a pseudoplastic rheology with both strain and strain-rate weakening. Left to its own, strain-rate weakening results in a fault network with characteristic fault spacing around 20 km, as expected by the localization instability theory (Montesi and Zuber, 2003). The preexisting normal fault population is included in these models as an initial population of weak zones with ˜3 km spacing. Initially, these weak zones impose a deformation wavelength of ˜3km but as strain increases, the localization instability impose its 20 km wavelength on this network, leading to preferential activity on only a few widely spaced structures. When the strain on each structure is comparable to the strain at which strain-weakening saturates, the initial faults present between the large long-lived structures end all activity. Therefore, the maximum offset of the finely spaced fault set in the Central Indian Ocean constrains the critical offset over which strain weakening is active to be less than ˜50m.