Geophysical Research Abstracts, Vol. 8, 08681, 2006
SRef-ID: 1607-7962/gra/EGU06-A-08681

Mode selection during crustal extension expressed in the formation of sedimentary basins

Susanne J.H. Buiter (1), Ritske S. Huismans (2), Christopher Beaumont (2)

(1) Centre for Geodynamics, Geological Survey of Norway, Leiv Eirikssons vei 39, 7491 Trondheim, Norway (susanne.buiter@ngu.no), (2) Geodynamics Group, Department of Oceanography, Dalhousie University, Halifax, Canada

Observations show that extension of the Earth's lithosphere typically leads to localisation of deformation in the crust in the form of sedimentary basins bound by extensional faults. Concentration of deformation in a limited region leads to the development of only a few basins (narrow rifts), while delocalisation of strain results in faulting over a large area (wide rifts). The relative strengths of brittle and ductile layers forms an important control on these styles of crustal faulting. Our aim is to provide an improved understanding of the dynamic development of (arrays of) sedimentary basins. To this purpose, we view the formation of sedimentary basins as a surface expression of mode selection occurring on a crustal scale.

We examine simple two-layer crustal-scale models. These consist of a frictional-plastic crust bonded to a linear viscous lower crust of equal thickness. It is assumed that the frictional-plastic material weakens with strain. Following our previous work, we use an analytical analysis of the rate of internal dissipation of energy to predict the mode of deformation. For strain-weakening models we predict the following modes of crustal extension with decreasing viscosity of the lower layer: (1) pure shear, (2) multiple conjugate or parallel shear zones ('wide rift'), (3) two shear zones, which form either one symmetric basin or two asymmetric basins ('narrow rift'), and (4) a single shear zone forming an asymmetric basin. We perform finite element experiments of equivalent simple two-layer models and show that the numerical results agree with the analytical mode predictions. The 'wide' mode with multiple shear zones and the 'narrow' mode with a few basins are also seen in published examples of analogue models of (frictional-plastic) sand overlying (viscous) silicone. We use our numerical models to investigate the effects of surface processes on mode transitions. Sedimentation

localises deformation and favours the formation of deep symmetric basins.