1. Introduction and objectives

Lateral variation of strength in the lithosphere is an important factor controlling the localization of intra-plate deformation. Pre-existing heterogeneities can become reactivated in extension as well as in compression, governing the spatial and temporal development of intra-plate deformation. Analogue models investigating the deformation pattern and topography development of compressional intra-plate settings are presented. The initial scaling conditions are introduced lateral heterogeneity is striking perpendicular to the compression direction. All experiments have been performed under normal gravity field. Other investigated parameters have been the strain rate, the thickness of the brittle mantle and the rheology of the viscous upper mantle.

2. Experimental parameters

Figure 1: Strength profiles modified after Ziegler & Cloetingh 2004.

3. Analogue experiments: set-up

Figure 3: a) Sketch of the experimental set-up; b) representative strength profiles calculated for a convergence rate of 1 cm/h, describing the very initial deformation stage.

4. Results: intra-plate deformation in presence of a strong lithospheric section

Figure 4: representative cross sections and DEM (Digital Elevation Model) of the experiments’ surface at 20% BS (bulk shortening).

5. Comparison with previous experiments: intra-plate deformation with a pre-existing weak lithospheric section

Figure 5: intra-plate deformation with a pre-existing weak zone. Modified after Willingshofer et al., 2005.

6. Summary and Conclusions

In presence of a mechanically stronger old rift subject to compressional stresses deformation localizes along the basin margin facing the compression direction.

Strain rate governs the geometry of the deep lithospheric structure. An increase in convergence velocity results in a progressive increase in symmetry of the lithospheric root underlying the pop-down.

The brittle-ductile ratio in the lithospheric mantle determines the absence (low B/D) or presence (high B/D) of faults in the upper brittle mantle (Experiment 2, Experiment 3). For a low B/D ratio deformation in the mantle is accommodated by shear zones (Experiment 2).

Underneath the margin of the old rift is the main deformation mechanism in case of low strength brittle mantle and high convergence velocity (Experiment 2).

Figure 6: Effect of the lithospheric strength on the formation of a pop-down basin in the crust. A strong viscous upper mantle prevents the formation of a pop-down basin in the crust and underneath the basin margin (Experiment 4).

In presence of a mechanically weaker young rift subject to compressional stresses deformation starts along the rift margins and remains localized inside the weak plate leading to the development of pronounced topography, which is compensated by a lithospheric root (Willingshofer et al., 2005; Figure 5).

References


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