

A comparison between lithospheric scale numerical and analogue models

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Both analogue and numerical methods seek to address similar problems, for example, how continental lithosphere stretches, deforms and subsides to form sedimentary basins. It is therefore reasonable to assume that these methods will generate similar results when applied to an identical problem. Some authors have already considered crustal scale comparisons with relative success. Such comparisons are especially beneficial for numerical codes, as no analytical solutions exist for problems of such complexity. In lieu of analytic solutions, analogue models can provide, in essence, a crude benchmark.

This study extends the previous crustal scale comparisons to the lithospheric scale, in an extensional context, using analogue models performed at the Vrije University Amsterdam and the numerical code **Gale**, which has been made available to researchers by the Computational Infrastructure for Geodynamics (CIG). This is an area which presents challenging problems in terms of boundary conditions for both methods. As far as possible, measured parameters for the analogue models are replicated in the numerical models to ensure a valid comparison.

Results are seen to be broadly similar, which provides encouragement in the consistency of both methods. It can be seen that **Gale** is capable of reproducing the gross geometry of the analogue model; however the faulting which occurs in brittle materials still remains a challenge.

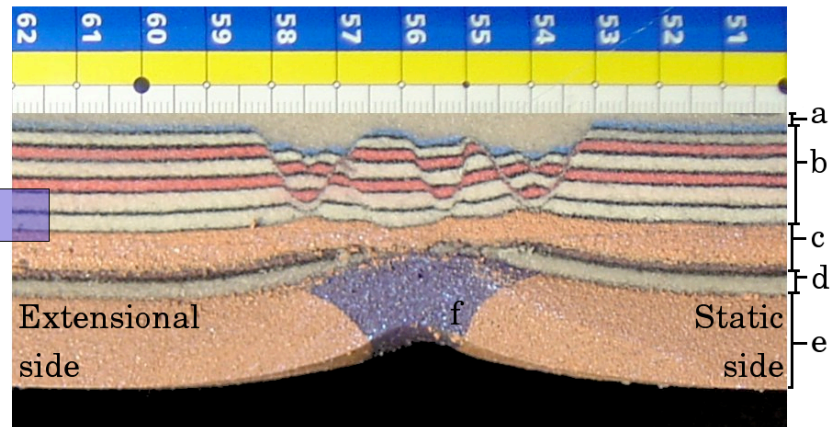


Figure 1

Figure 1: This is a section through the centre of an extensional, Lithospheric scale, analogue experiment in the direction of extension, post run. The labels are: a - quartz covering applied to model after extension to preserve surface features; b - brittle crust (feldspar); c - ductile crust ($\rho = 1350 \text{ kg/m}^3$, $\eta = 3 \times 10^4 \text{ Pa s}$); d - brittle mantle (quartz); e - ductile mantle ($\rho = 1489 \text{ kg/m}^3$, $\eta = 9 \times 10^4 \text{ Pa s}$); f - the weakened zone in the ductile mantle ($\rho = 1364 \text{ kg/m}^3$, $\eta = 1.9 \times 10^4 \text{ Pa s}$). The blue arrow indicates direction of extension (2.5 cm/hr).

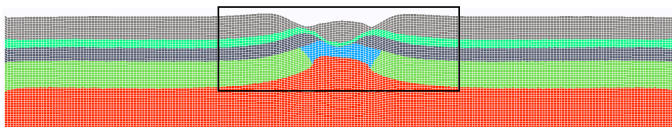


Figure 2a (with grid)

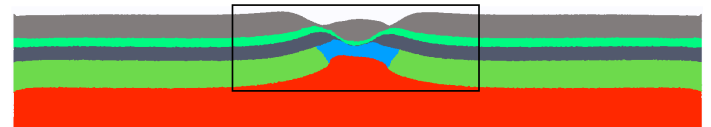


Figure 2a (without grid)

Figure 2a: Geometry of simulation of analogue model, with the portion contained in the black box corresponding to the portion of the analogue model shown in Figure 1. The layers are from top down, brittle crust, ductile crust, brittle mantle, ductile mantle and asthenosphere. Physical parameters such as density, velocity, and viscosity of the ductile layers are inherited from the analogue model. The brittle layers are modelled with Mohr-Coulomb yielding and an artificial viscosity of $5 \times 10^6 \text{ Pa s}$. The grid resolution is 240×80 with 30 sample points per grid element.

Figure 2b: Numerical models are able to display additional information such as viscosity, which regions of the model are exceeding the yield value and in this case the second strain rate invariant.

