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Role of lower crustal flow during post-rift sedimentary basin evolution

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Extension of the continental lithosphere results in the formation of sedimentary basins such as the Vøring basin offshore Norway. In most cases the basin topography is associated with horizontal pressure gradients in the middle and lower crusts. It is well known that these pressure gradients can, under suitable conditions, result in lower crustal flow which in turn can modify the crustal structure. Sedimentation during the syn- and post-rift phases may modify these pressure gradients. However, middle and lower crustal flow are ignored in routine kinematic basin modelling. Here, we study the importance of middle and lower crustal flow in the post-rift evolution during and after sedimentation by using forward dynamic models based on the finite element method.

Fully coupled thermo-mechanical models of a post-rift basin, filled with sediments, are run where the end of syn-rift geometry of the basin is prescribed. The crust and the mantle lithosphere are characterized by a visco-elasto-plastic rheology. The viscosity is temperature-dependent. In order to simulate faulting in the brittle parts of the lithosphere, a Drucker-Prager plastic rheology is included. The transition from viscous deformation to plastic deformation is controlled by local temperature and stress conditions. The weight of sediments is modelled by a lithostatic pressure applied at the surface of the basin. Gravity and isostasy are taken into account. The final resulting equilibrium basin geometry is then backstripped and compared to end of syn-rift crustal structure. Implications for kinematic models that ignore lower crustal flow and the associated error in estimates of subsidence and heat flow coming from these models will be discussed.