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A numerical approach to thermal history modelling in an extensional basin

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Temperature plays an important role in many geological phenomena. In sedimentary basins, maturation of hydrocarbon source rocks depends on the temperature history after deposition. Sedimentation rate, geothermal gradient and duration of sedimentation are therefore key parameters controlling the thermal evolution. The McKenzie model is a widely accepted model for extensional basin formation which can be used for estimating post-rift subsidence, rate of sedimentation and basal heat flow.

In this work, a numerical model in 1D has been implemented based on McKenzie's model and allows for the estimation of the thermal evolution of post-rift sediments and the rate of subsidence. The finite difference method is used to solve the heat equation in the sediments, crust and upper mantle. At each time step, subsidence due to thermal relaxation is calculated and added to the system. In this way the generalised moving boundary thermal diffusion problem is solved. Heat generated due to radioactivity may also be taken into account.

The numerical model when compared to the McKenzie model gives significantly lower thermal subsidence estimates. Final thermal subsidence for the two models are compared with respect to the stretching factor. This model shows that significantly higher stretching is required to achieve the same level of thermal subsidence when compared to the McKenzie model. For example in the McKenzie model a 5 km of thermal subsidence is achieved with 280% stretching whereas this model requires 450% stretching.