Geophysical Research Abstracts
Vol. 13, EGU2011-12011, 2011
EGU General Assembly 2011

Extensional basin evolution in the presence of small-scale convection: Subsidence and stratigraphy

Kenni Dinesen Petersen (1), Søren Bom Nielsen (1), Ole Rønø Clausen (1), Randell Stephenson (2), Hans Thybo (3), and Taras Gerya (4)

(1) Department of Earth Science, Aarhus University, Geophysics, Aarhus C, Denmark (kenni@geo.au.dk), (2) Geology & Petroleum Geology, School of Geosciences, College of Physical Sciences, Meston Building, King's College, Aberdeen, AB24 3UE, Scotland, U.K., (3) Department of Geography og Geology, University of Copenhagen, Copenhagen, Denmark, (4) Department of Geosciences, ETH-Zurich, CH-8092 Zurich, Zurich, Switzerland

The plate model of Parsons & Sclater provides a generally accepted, quantitative framework for the thermal subsidence-evolution in extensional basins. It predicts an asymptotic evolution of the geotherm towards a steady state, featuring a constant lithospheric thickness and ceased subsidence. This is formulated by assuming that the temperature at a fixed depth (the asymptotic thickness of the lithosphere) is constant. It is implicitly assumed, that this temperature is maintained by sub-lithospheric, small-scale convection, but the dynamics, controlling this process, are not considered.
Here, we apply a two-dimensional, numerical, thermo-mechanical model of the lithosphere and upper mantle to asses the effects of small-scale convection. Given a particular mantle rheology, our model features such convection, and, over time, the horizontally averaged geotherm converges towards a self-consistent, quasi-steady-state. Extension of the convecting equilibrium model causes the formation of rifts or continental margins which, posterior to extension, cools and subsides as predicted by the plate model. However, in contrast to the plate model, the ascended asthenosphere is not instantaneously decoupled from the convecting upper mantle below, and cooling is thus not entirely conductive above the former base of the lithosphere. This causes significantly protracted cooling and subsidence. We show that our model features improved consistency with subsidence data from several rifted margins and intracontinental basins. Furthermore, our model shows that the long-term subsidence pattern in the presence of small-scale convection is superimposed by vertical movements at periods of 2-20 Myr due to convection dynamics at the base of the lithosphere. We show that these movements are a recurrent and potential cause for the development of stratigraphic sequences at similar time scale. Since such sequences are commonly assumed to be caused by eustatic variations, our results have important implications for inferences on the latter. Our results are furthermore important for the assessment of hydrocarbon potential of sedimentary basins in terms of stratigraphic correlation and thermal maturation.