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Small-scale convection produces sedimentary sequences

© S. Nielsen¹, K. Petersen¹, O. Clausen¹, R. Stephenson², T. Gerya³, 2010

¹Aarhus University, Department of Earth Sciences, Denmark
sbn@geo.au.dk
kenni@geo.au.dk
orc@geo.au.dk

²Geology and Petroleum Geology, School of Geosciences, College of Physical Sciences, Meston Building, King's College, Aberdeen, Scotland
r.stephenson@abdn.ac.uk

³Department of Geosciences, ETH-Zürich, Zürich, Switzerland
taras.gerya@erdw.ethz.ch

It is generally acknowledged that heat transfer in the sub-lithospheric mantle is dominated by convection that maintains an adiabatic temperature gradient close to 0.6 K/km. Transfer of the advected heat to the conductive lithosphere takes place at the base of the lithosphere, which is maintained at a relatively constant temperature in the vicinity of 1300 °C. However, the thermo-mechanical details of this highly dynamic boundary condition at the base of the lithosphere are frequently approximated by a fixed temperature at the assumed long-term equilibrium depth of the base of the lithosphere (the

plate model). The present contribution investigates this approximation. We apply a two-dimensional, numerical, thermo-mechanical model of the lithosphere and upper mantle [Petersen, 2010] to assess the effects resulting from a more correct representation of the sub-lithospheric small-scale convection, which is responsible for heat transfer in the sub-lithospheric mantle. Given a particular mantle rheology, our model shows small-scale convection, and converges over time towards a self-consistent, quasi-steady-state with a stable lithosphere, the thickness of which depends on the chosen creep

parameters (within experimental constraints) and hence on the vigour of small scale convection and the heat transfer. At the base of the long term stable lithosphere, a thermal boundary layer is formed in which the heat exchange between the convecting sub-lithospheric mantle and the lithosphere takes place. Small ascending diapirs of warmer material slow down and spread out laterally at the base of the lithosphere, peeling off colder material that descends back into the upper mantle. The buoyancy effects of this partly chaotic mass movements cause low-amplitude and relatively rapid vertical movements of the surface of the lithosphere, which show only limited horizontal correlation. The faster vertical movements occur with periods from 2—20 Myr and have amplitudes up to 20—40 m. Long term surface movements have higher amplitudes and are caused by quasi-static organisation of the convective pattern in the sub-lithospheric mantle, which last long enough to influence the thermal state of the lithosphere. Because of the visco-elastic nature of the lithosphere, the more rapid buoyancy changes are filtered by a stiffer lithosphere than long term buoyancy changes. The shorter periods therefore correlate for slightly larger distances.

Extension of the convecting equilibrium model causes fault-controlled continental rifting and subsidence, followed by protracted thermal subsidence,

much like the well-known plate model. However, in contrast to the plate model, the elevated 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 slower and more linear post-rift subsidence. This model exhibits improved consistency with subsidence data from several rifted margins and intra-continental basins. Because of the small scale convection the long-term subsidence pattern in the presence of small-scale convection is superimposed by the aforementioned low-amplitude vertical movements due to convection dynamics at the base of the lithosphere. These movements are a recurrent and a potential cause for the development of stratigraphic sequences at similar time scale. Such sequences are commonly assumed to be caused by eustatic variations. The results therefore have important implications for inferences on global eustatic variations inferred from sedimentary sequences by e.g. back stripping analyses and assumptions about the thermal subsidence history based on the plate model of lithospheric cooling. Our results are furthermore important for the assessment of hydrocarbon potential of sedimentary basins in terms of stratigraphic correlation and thermal maturation.

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Nature of sources of the magnetic anomalies in the Central Depression of the Dnieper-Donets Aulacogen

© *M. Orliuk, 2010*

Institute of Geophysics, National Academy of Sciences of Ukraine, Kiev, Ukraine
orlyuk@igph.kiev.ua

The nature of sources of the local and regional magnetic anomalies is an important element of the fundamental and applied studies aimed at elucidating the deep structure, composition and evolution of the Earth's crust. The present paper investigates the nature of the magnetization of different crustal layers of the Central Depression (CD) of the Dnieper-Donets Aulacogen (DDA) with special emphasis on elaboration of regional and local geomagnet-

ic criteria for prognosing the oil and gas potential of the Earth's crust of the study area [Orliuk, 1994; Orliuk, Pashkevich, 1996; Orliuk et al., 1998; 2000]. The CD is situated between the cities Ichnya and Poltava [Chirvinskaya, Sollogub, 1980]. The crystalline basement surface is situated at depths from 2 km in the Aulacogen boundary areas and at 5—12 km in the central part. A regular basement depth increases from N to SE is observed [Ilchenko, 1997;