Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08969, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08969
EGU General Assembly 2008
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Forward models for the tectonic subsidence and the thermal history in the Orange Basin with implications from vitrinites reflectance data

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Although the development of passive margins has been extensively studied over a number of decades, significant questions remain on how mantle and crustal dynamics interact to generate the observed margin geometries. Here, we investigate the Orange Basin which is located on the south-west African continental margin and contains the stratigraphic record from lithospheric extension and rift tectonics throughout a fully evolved post-break-up setting, and thus provides an ideal area to study the evolution of a "passive" continental margin.

A combined approach of subsidence analysis and crustal modelling was chosen to gain better insight into the interplay of rift tectonics and subsidence-controlling mechanisms.

Forward models of basin subsidence have been calculated for several wells, which are calibrated to temperatures and measured vitrinite reflectance data. These forward models do not only incorporate a variety of tectonic scenarios such as rifting in the beginning of basin development, but also integrate the effect of emplacement of underplated material in early stages of basin development. The thickness of the underplated material was obtained from 3D-gravity modelling which mapped the high density material in the lower crust throughout the southern Orange Basin (Hirsch et al., 2007). We also find the present day depth of the basin less deep than expected from thermal cooling occurring subsequent to continental rifting. This effect might be linked to mantle upwelling in later stages of the basin evolution, which hampered the younger basin subsidence and overprinted the maturity of the organic matter.

For each well we predict the heat flow history, temperature development through time and show the evolution of the maturity of the organic matter.

From the interpretation of seismic lines, a 3D Geomodel was calculated which in turn was used to derive an equidistant grid of closely spaced synthetic wells across the basin. These wells give us indication of the temperature and heat flow variation not only in time but also in space and therefore predict the spatial distribution of the maturity of the organic matter. From the basement history which is reconstructed for each well we can distinguish between local and regional phases of margin movements and give information on the crustal parameters which describe the rifting process, such as the stretching factor beta.

Hirsch, K.K., Scheck-Wenderoth, M., Paton, D.A., and Bauer, K. (2007): Crustal structure of the Orange Basin derived from 3D gravity models. South African Journal of Geology, 110,2-3,249-260.