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What can we learn from lithosphere-scale models of passive margins?

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To understand the present day structure and the mechanisms of subsidence at passive margins we assess first-order heterogeneities in the sediments, crust and upper mantle. Thus, we explore how far a good knowledge of the sedimentary and upper crustal configuration can provide constraints for the deeper parts of the system and how far the preserved record of deposits holds the key to unravel margin history. The present-day geometry and distribution of physical properties within the upper and middle crust is integrated into data-based, 3D structural models, which, in turn, provide the base for the analysis of the deep crust and the lithospheric mantle. Different configurations of the deep lithosphere can be tested against two independent observables: gravity and temperature, using isostatic, 3D gravity and 3D thermal modelling.

Results from the 55 mio year old Norwegian passive volcanic margin indicate that there, the oceanic lithospheric mantle is less dense than the continental lithospheric mantle (Maystrenko and Scheck-Wenderoth, 2009), that this is mainly due to thermal effects (Scheck-Wenderoth and Maystrenko, 2008) and that the transition between continental and oceanic lithosphere thickness is sharp (Maystrenko and Scheck-Wenderoth, 2009). Furthermore, the thickness of the young oceanic lithosphere in the North Atlantic is smaller than predicted by plate cooling models but consistent with seismologically derived estimates. We also find that the oceanic lithosphere-asthenosphere boundary strongly influences the shallow thermal field of the margin and that surface heat flow increases from the continent to the ocean. In contrast, at the South Atlantic margin offshore South Africa, a thicker and older (∼130 mio years) oceanic lithosphere is present. Based on previous studies of the crustal configuration (Hirsch et al., 2009), first lithosphere configurations have been tested. There the transition between continent and ocean appears equilibrated and surface heat flow increases in the opposite direction: from the ocean to the continent. We find that the thermal field at this older passive margin is controlled by the thickness of the crystalline crust and related radiogenic heat production.

References

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