Subsidence and Heat Flow History Prediction for Hyper-thinned Continental Crust at Rifted Continental Margins

Nick J. Kusznir [1] and Alan Roberts [2]
[1]Earth and Ocean Sciences, University of Liverpool, Liverpool, United Kingdom.
[2]Badley Geoscience, Spilsby, United Kingdom.

Many rifted continental margins show broad regions of highly thinned continental crust, up to 300 km wide, between the OCT and the rifted margin hinge. This highly thinned continental crust, typically between 5 and 15 km thickness, is overlain by pre-breakup sag basins for which observed top basement extensional faulting is much less than that required to explain the observed crustal thinning and subsidence assuming depth-uniform (pure-shear) lithosphere stretching. Predicting syn- and post-breakup subsidence and heat flow histories for these margin regions, which show depth-dependent lithosphere stretching and thinning, presents a significant challenge in deep-water hydrocarbon exploration. We use SfMargin, a generalised kinematic model of continental lithosphere stretching and thinning leading to breakup and sea-floor spreading initiation, to determine subsidence and heat flow history at these rifted margins. Within the SfMargin model, lithosphere deformation occurs by a combination of depth-uniform stretching and thinning (pure-shear), buoyancy induced upwelling and upwelling divergent flow. The deformation model advects lithosphere and asthenosphere material and temperature in response to these deformation modes, and is used to predict the resulting rifted margin crustal thickness, OCT geometry, margin isostatic response, and subsidence and heat-flow history. The dominant deformation mechanism, both pre- and post-breakup, of the topmost cool brittle 10-15 km of the lithosphere is assumed to be by normal faulting, as observed not only in intra-continental rifting but also at slow spreading ocean ridges. Beneath this cool brittle upper lithosphere, pre-breakup continental lithosphere thinning is achieved by pure-shear and buoyancy induced upwelling, and post-breakup deformation by upwelling divergent flow (c.f. ocean ridge deformation). We apply this generalised lithosphere deformation model to the formation of magma poor margins. The model predicts depth-dependent lithosphere stretching and thinning, and the development of pre-breakup sag basins above broad regions of highly thinned continental crust. The model, constrained by observed bathymetry and gravity data, is used to predict subsidence and heat flow histories and their sensitivities.