Geophysical Research Abstracts
Vol. 12, EGU2010-5735, 2010
EGU General Assembly 2010
© Author(s) 2010

Hyperextension and partial mantle serpentinization – a paradigm for compressional deformation of magma-poor basins and margins

Erik Lundin (1) and Tony Doré (2)
(1) Statoil ASA, Trondheim, Norway (erlun@statoil.com), (2) Statoil USA & Mexico, Houston, USA (agdo@statoil.com)

Hyperextension in magma-poor settings inevitably leads to significant lithospheric strength reduction by thinning of the load-bearing upper crust and by associated partial serpentinization of the load-bearing upper mantle; the so-called "jelly sandwich" is reduced to mainly jelly. For most hyperextended margins the strength reduction should be maintained even after thermal cooling since the crustal thickness is never restored and dehydration of the mantle requires temperatures in excess of 700 C to convert all serpentine minerals back to peridotite. The magma-poor chains of Cretaceous rifts that stretched from the West Orphan Basin, via Rockall Trough, the Faroe margin, mid-Norwegian margin, probably the NE Greenland margin, and into the Tromsø and Bjørnøya Basins of the SW Barents Sea all overlie severely thinned crust. An abnormally wide lower crustal body (LCB) is constrained by wide angle data beneath large parts of the mid-Norwegian margin. In many accounts this body has been interpreted as magmatic underplating emplaced during Early Cenozoic break-up of the NE Atlantic. We judge this interpretation to be unlikely since the crustal thinning event that governed the Cretaceous basin subsidence occurred some 70 m.y. prior to the break-up event that supposedly caused the decompressional melts. Whereas geophysical data such as P-wave velocity, or Vp/Vs ratio, are ambiguous characteristics for distinguishing between an underplated gabbroic underplated body/intruded lower crust and partially serpentinized mantle, the genetic relationship between Cretaceous crustal thinning and its overlying basin on one hand and the LCB on the other hand is a strong discriminator. The mid-Norwegian margin provides an interesting example of a magma-poor rift system subsequently overprinted by a magma-rich break-up event. We relate an inner wide LCB under the Cretaceous basins to partial serpentinization during Cretaceous hyperextension and an outer narrow LCB to magmatic underplating (or lower crustal intrusion) during Early Cenozoic break-up. We provide examples of compressional deformation within the weakened hyperextended Cretaceous basin chain: 1) Late Cretaceous basin-scale folding and 2) smaller scale widely distributed Middle to Late Cenozoic folds. The former we associate with transpression driven by opening of the Labrador Sea and rotation of Greenland against Eurasia, and the second to a body force from the emerging the Iceland Insular Margin. We propose that proneness to compressive deformation by comparatively small-scale compressional forces is an a priori indicator of a buried hyperextended basin or margin.