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Extension on rifted continental margins: Observations vs. models.

Jakob Skogseid
Statoil ASA, RDI Exploration, Norway (jaksk@statoil.com)

Mapping the signature of extensional deformation on rifted margins is often hampered by thick sedimentary or volcanic successions, or because salt tectonics makes sub-salt seismic imaging challenging. Over the past 20 years the literature is witnessing that lack of mapable faults have resulted in a variety of numerical models based on the assumption that the upper crust takes little or no extensional thinning, while the observed reduction of crustal thickness is taken up in the middle and lower crust, as well as in the mantle. In this presentation two case studies are used to highlight the difference that 3D seismic data may have on our understanding. The small patches of 3D resolution data allow us to get a glance of the 'real' signature of extensional faulting, which by analogy can be extrapolate from one margin segment to the next.

In the South Atlantic salt tectonics represents a major problem for sub-salt imaging. The conjugate margins of Brazil and Angola are, however, characterized by pronounced crustal thinning as documented by crustal scale 2D reflection and refraction data. Off Angola the 3D 'reality' demonstrates that upper crustal extension by faulting is comparable to the full crustal, as well as lithospheric thinning as derived from refraction data and basin subsidence analysis. The mapped faults are listric low angle faults that seem to detach at mid crustal levels. 2D seismic has in the past been interpreted to indicate that almost no extensional faulting can be mapped towards the base of the so-called 'sag basin'. The whole concept of the 'sag basin', often ascribed to as crustal thinning without upper crustal deformation, is in fact related to this 'lack of observation', and furthermore, have caused the making of different types of dynamic models attempting to account for this.

In the NE Atlantic significant Paleocene extensional faulting is locally seen adjacent to the 50 to more than 200 km wide volcanic cover on each side of the breakup axis. The associated amount of lateral motion on these, mainly listric, normal faults represents several tens of km. These observations contrast with the general lack of observed faults along volcanic margins due to the overall problem with sub-basalt imaging. A variety of models with respect to mode and duration of extension, including narrow and fast breakup, melt generation by small scale convection, and different modes of mantle flow have been suggested. The interesting aspect is that it is all based on features we can't see.

Both study areas clearly points towards the importance of improved seismic imaging, a need for revised understanding of strain rates and strain partitioning during rift development, and the necessity of moving from 2D cross section modeling to more realistic 3D spatial distribution of rift elements and subsequent break-up processes. One important aspect is that both volcanic and non-volcanic margins are rifted margins formed by a protracted rift development.