



Structural inheritance during normal fault growth in multi-phase rifts; a case study from the Northern North Sea

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In multi-phase rift systems such as the northern North Sea rift, pre-existing basement structures influence the nucleation, growth and linkage of rift-related normal faults. However, our understanding of the degree of physical and kinematic linkage between basement and cover structures is limited, since deep structures are generally poorly imaged on seismic reflection data. In the North Sea Rift, two main phases of rifting are recognized in the Permian-Triassic and Middle Jurassic-to-Early Cretaceous. Moreover, prior to rifting, the area underwent multiple episodes of deformation during the Ordovician-Devonian Caledonian orogeny and Devonian extension. In this study we investigate the influence of pre-existing structures on the i) evolution of Permian-Triassic and Middle Jurassic-Early Cretaceous normal fault systems and ii) distribution of strain during reactivation of older structures in the northern North Sea rift. For this purpose we utilize 2D (-9 s TWT) and 3D seismic reflection and borehole data from the North Viking Graben, covering the Horda Platform in the east and the East Shetland Basin in the west. We show that low-angle ($< 30^\circ$) intrabasement reflections extend, in some areas, upward into the Triassic section. West-dipping and east-dipping intrabasement structures are identified in the Horda Platform and East Shetland Basin respectively, while in the Northern Viking Graben area both west and east-dipping structures are mapped. At depth, some of intrabasement structures terminate against high-amplitude reflections in the lower-crust. This study documents dissimilar development of intrabasement structures in the Horda Platform, Viking Graben and East Shetland Basin. In the Viking Graben and Horda Platform these structures are more developed and in some places cross-cut each other, while in the East Shetland Basin, only two sets of structures have been mapped. We also show that intrabasement structures in the Horda Platform are generally lower angle than those in the East Shetland Basin. Preliminary observations suggest a complex relationship between intrabasement structures and overlying Permian-Triassic rift-related normal faults, with physical linkage between the two locally occurring along strike. However, pre-existing basement structures seem to have played a significant role in controlling the location and the strike of major younger rift-related normal faults in the basin fill.