Controls on Sand Deposition Patterns by 3-Surfaces: A Case Study from the South Viking Graben, North Sea

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Changes in the palaeobathymetry related to tectonics are crucial parameters controlling the sediment deposition patterns. The South Viking Graben, offshore Norway, is a key area to study the interaction between tectonics and sedimentation. This mid-to-late Jurassic extensional basin with N- to NE-trending normal faults underwent a period of inversion during the Late Jurassicduring which anticlines and thrusts formed in the basin or along the basin margin. Salt tectonics also played a role as the Zechstein salt acted like a decollement and mini basins have formed after salt retreat. These tectonic events shaped the margin and controlled the evolution of sand deposition patterns.

The aim of this study was to model sand deposition patterns on restored palaeobathymetries at the time of deposition of Upper Jurassic target sand reservoirs. In a first step restoration of 2D seismic lines was performed by sequential backstripping up to the desired palaeosurface, to determine which algorithms were more suitable. The same workflow was applied to the full 3D model in order to obtain restored palaeobathymetric surfaces. The restoration results helped to assess the deformation style at the scale of the study area and the sequence of deformation events which led to the development of the present-day structural geometry.

The second step was to forward model turbidity flows and deposits on the restored palaeobathymetric surfaces to predict the spatial distribution of sand-rich deposits. The sediment dispersal modelling was carried out using 4DSediment software. Multiple scenarios were tested to assess the influence of the input parameters such as: restoration algorithms used, flow dimensions, flow volume, direction and origin of the flow as well as grain size distribution. A Monte Carlo simulation was applied to find the set of flow parameters that produces a flow which best matches the sand fraction and deposit thicknesses in the available wells. Forward modelling of multiple stacked flows was used to study the spatial and temporal variations of the deposits as turbidites accumulated.

The sediment deposition is greatly controlled by the palaeosurface topography, which is itself controlled by folding, faulting, or salt tectonic. Formation of sediment waves was also observed and is interpreted to reflect subtle topographic changes of the palaeosurface. The latter in turn can be linked to small-scale folds related to salt movement and inversion.