

Detailed Kinematic Restoration of a Structural Transect from the Baltic Sea

Jan Witte,⁽¹⁾ Arezki Ioughlissen,⁽²⁾ Cornelius Rott,⁽²⁾ and Alula Damte⁽²⁾

(1) Consultant

(2) Central European Petroleum

Abstract

We present a sequential kinematic restoration of a 35km long structural transect, based on a 2D seismic line from the southern Baltic Sea (German offshore sector). The line is located in the northern part of the central European Zechstein basin. The restoration allows us to reconstruct the structural history of this particular line and also provides valuable insight into the regional tectonic history of this part of the Zechstein basin, from Variscan (pre-Permian) times to the present-day configuration. In order to achieve the sequential restoration the SEG-Y data was loaded into a structural modelling software, together with bathymetry data and formation tops from nearby wells. The following workflow was applied:

Firstly, a detailed static structural interpretation was conducted, based on the stratigraphic ties from nearby wells. The seismic section was interpreted along with several other seismic lines in this area. Particular emphasis was given to a consistent and robust structural model, using similar structural styles, fault angles and detachment levels in the entire data volume.

Secondly, a sequential kinematic restoration was conducted, including back-stripping of the sedimentary packages. Different restoration algorithms were applied, such as “simple shear, unfold to target” and “fault-parallel flow”. A total of 95 individual kinematic increments were developed, out of which 60 are shown here. The kinematic restoration is presented here as a “step-by-step” movie.

The restoration enables us to reconstruct the tectonic history of this area in great detail, including Variscan peneplanation, Lower Permian (Rotliegend) oblique rifting, Upper Permian (Zechstein) sag and associated evaporate deposition, local post-A2/Na2 normal faulting, early onset of salt movements due to differential loading of Lower Triassic (Buntsandstein) sediments, Middle and Upper Triassic (Muschelkalk, Keuper) deposition, Upper Triassic (Keuper) regional extension and related salt-pillow collapse with associated anomalously thick Keuper sediments in salt-cored half-grabens, Jurassic sag, formation of the Base Cretaceous unconformity, Cretaceous deposition, onset of Alpine inversion (transpression), Tertiary deposition and minor recent structural modifications.

Our results have significant implications for hydrocarbon exploration, as they allow us to determine trap timing and help us to better understand migration pathways and other exploration risks.