Geophysical Research Abstracts
Vol. 17, EGU2015-12049, 2015
EGU General Assembly 2015
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The near-Top Oligocene unconformity in the Norwegian-Danish Basin: revisiting a major sequence boundary associated with fluid migration

Katrine Juul Andresen (1), Ole Rønø Clausen (1), Jens Peter Vind Hansen (2), and Mads Huuse (3)

(1) Aarhus University, Department of Geoscience, Aarhus C, Denmark (katrine.andresen@geo.au.dk), (2) DONG Energy, Exploration and Production, Gentofte, Denmark, (3) School of Earth, Atmospheric and Environmental Sciences, The University of Manchester, Manchester, UK

The near-Top Oligocene (NTO) unconformity is a well-known late Oligocene (Chattian) major sequence boundary associated with significant erosional truncations basinward of the clinoform breakpoint in the easternmost part of the North Sea. The surface features a number of discrete structures such as slides, localized incisions, and channels. Contourites are furthermore observed onlapping the NTO immediately basinward of the clinoform breakpoint, indicating a strong influence from contour parallel current systems. The previous observations are, however, disjointed due to the localised nature of 3D seismic data available. Having access to multiple high-quality 3D seismic surveys in an area covering approximately 3000 km2 and information from a number of wells from the Danish part of the Norwegian-Danish Basin enables us to present new detailed observations of features related to the NTO in a larger area, and to analyse the geological significance of the features and their mutual relations in a well-constrained regional context.

The appearance of pockmarks caused by fluid venting at the late Oligocene seafloor vary across the area, and landward of the NTO clinoform breakpoint the pockmarks are generally small and circular (c. 50 m in diameter) clustered in discrete pockmark fields and pockmark strings. Basinward of the clinoform breakpoint the pockmarks are large ellipsoidal (NW-SE striking) depressions (400-2500 m long and 100-150 m wide) elongated due to current scour by the prevailing contour current system as also reported for Miocene pockmarks from the Danish Central Graben area. Previous studies suggest that the NTO probably formed during a longer period of submarine non-deposition and therefore may be associated with a hiatus of several million years in the study area. The abundant pockmarks show that this period furthermore was characterised by significant fluid venting. Sub-circular features observed approximately at the clinoform breakpoint are mainly interpreted to represent minor (0.5-2.5 km in diameter) slump scars generated by local gravity induced slumping possibly triggered by fluid flow. Basinward of the slumps scars the clinoforms in the succession below the NTO appear bright on the seismic data probably due to shallow gas residing in the sediments. Other interesting features basinward of the clinoform breakpoint include a bright, probably gas-charged channel meandering southward towards a listric salt-detaching normal fault, and a straight WSW-going incised gully perpendicular to the strike of the clinoforms. The gully apparently crosses and hence post-dates the large elongated pockmarks. The meandering channel and the straight gully are only c. 30 km apart and thus evidence a great lateral variation over time (could be several millions of years) in the submarine environment basinward of the clinoform breakpoint suggesting a local salt tectonic influence added to the general interpretation of the paleobathymetry and contour currents being the main controlling parameter.

The analysis therefore gives a significant contribution to the full understanding of the depositional environment and sequence stratigraphic development of the pronounced surface and associated intervals during the latest Oligocene to earliest Miocene in the eastern North Sea Basin emphasizing the importance of fluid venting, basin floor topography, and contour currents.