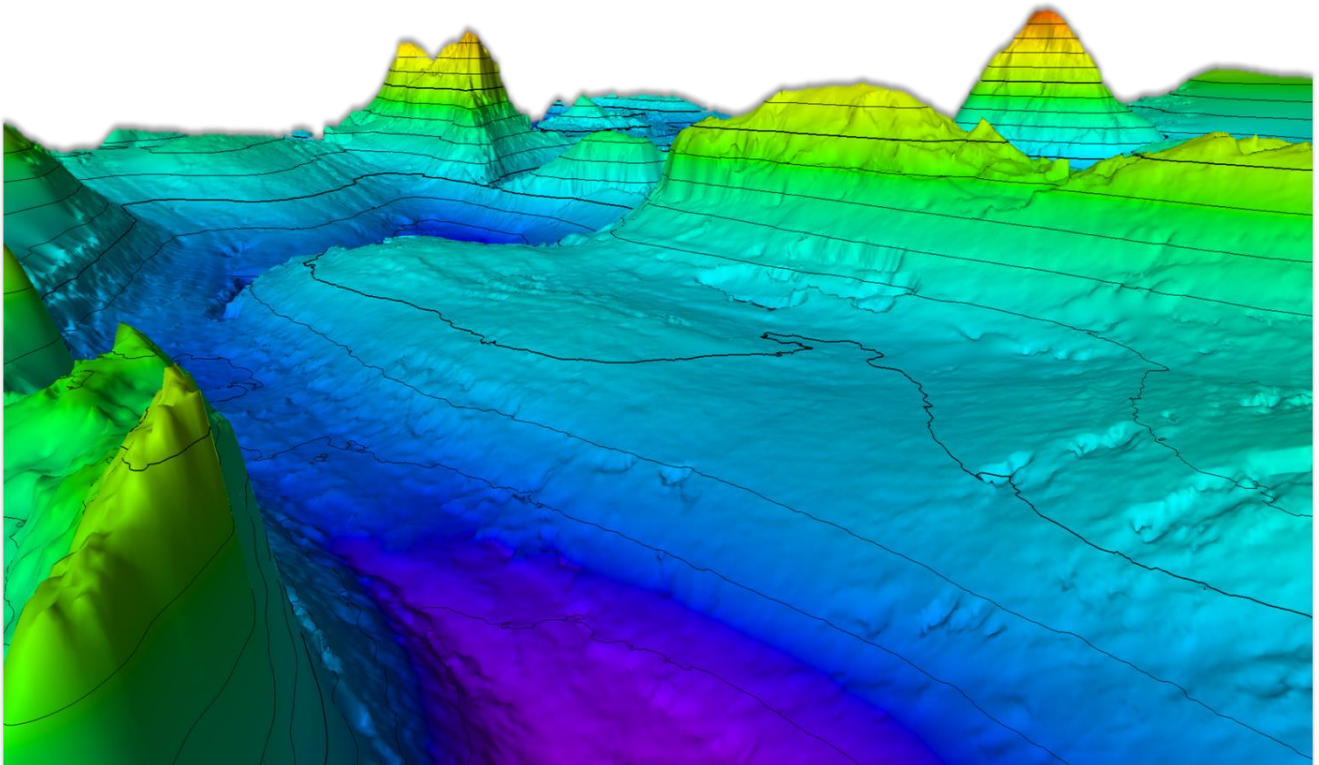


COMMA



In the COMMA Project we investigated the Upper Jurassic and Lower Cretaceous in the Terschelling Basin located in the Dutch offshore. The main aim of the project is to provide new insights on the regional and local stratigraphic, depositional and syn-depositional settings within the basin, with a special focus on the margins of the basin where poorly understood sand accumulations may be present.

Despite having numerous known reservoirs, the Upper Jurassic and

Lower Cretaceous stratigraphic interval still holds key remaining questions regarding its depositional environments and the preservation of sandy strata. The correlation of these strata across the basin, and locally on the neighboring platforms, requires new analysis and insights that this project offers. The study area encompasses three main structural provinces, 1) the Terschelling Basin, 2) its surrounding platforms (the Schill Grund Platform to the north; the Ameland Block to the west; and the Friesland Platform to the south) and 3) the Dutch Central Graben to the west.

The main stratigraphic interval of interest is the Upper Jurassic and Lower Cretaceous, which is divided into three sequences (Sequences 1, 2 and 3) that contain sand-rich reservoir intervals such as the Lower, Middle and Upper Graben Formations, the Frieze Front Formation, the Terschelling Sandstone Member and the Scruff Greensand Formation. In the Terschelling Basin the main reservoir intervals present are the latter two that are part of Sequence 2 (for the Terschelling Sandstone Member) and Sequence 3 (for the Scruff Greensand Formation). Note that a third sandy interval, the Noordvaarder Member, is also observed in the

northern part of the Terschelling Basin in Sequence 2.

This project includes biostratigraphic, stratigraphic and structural analysis of subsurface data including cores, cuttings, wireline logs and seismic data. The project started in December 2015 and lasted until November 2016. The present report summarizes and compiles the results obtained by the TNO Basin Analysis Team. It describes the multidisciplinary approach that was used to analyze the complex interplays between the depositional systems, active structures and paleotopographic reliefs.

1) The **palynological analysis** gave new constrain to better understand the depositional environments and the climatic variations during the Late Jurassic-Early Cretaceous in the study area. These new palynological analyses help refining the chronostratigraphic controls of the sediments encountered at the locations of thirteen wells. These results were extremely valuable in constraining the regional stratigraphic correlations within such structurally complex basins that were affected by various tectonic events and growth structures (salt diapirs and active faults).

2) The **tectonic analysis** was carried out using 2D and 3D seismic analysis. Four seismic horizons were interpreted in the Terschelling basin as well as faults and salt structures (pillows, roller, diapirs, walls and welds). Isochore maps were produced to better understand the growth stratigraphy and the timing of active structures. Particular attention was given to the basin margins, the transitional zones between the Basin and its surrounding platforms.

3) The **stratigraphic correlation** of key surfaces and intervals (including the new biostratigraphic results) was achieved by correlating numerous wells along regional transects that

were also used for regional seismic transects analysis. This combined approach allows to better constrain the structural and paleotopographic variabilities between wells. This approach permits a robust stratigraphic analysis that includes seismically-controlled regional and local unconformities, that were often previously missed or underestimated, as well as better constrain on the complex interplays between active structures (salt bodies and faults) and syntectonically influenced depositional systems.

The results obtained from the combination and integration of these various analytical techniques are used to produce a new stratigraphic, tectono-stratigraphic and paleogeographic models for the Upper Jurassic and Lower Cretaceous in the Terschelling Basin. This project strongly improved the understanding of the Upper Jurassic and Lower Cretaceous in the Terschelling Basin by providing a calibrated tectono-stratigraphic framework based on modern concepts of sequence stratigraphy and syn-depositional tectonic models. The use of regional seismic and well correlation panels helped to better constrain the main depositional systems (Terschelling Sandstone Member, Noordvaarder Member and Scruff Greensand Formation) identified in the study area as well as their varying preservation potential within and outside the Basin. The new paleogeographic maps give a clear picture of the paleo-coastlines trajectories, their changes through time and the interplay between multiple sediment sources and depositional systems.

The Project

The project was executed in collaboration with Oranje Nassau Energy BV and EBN BV. Over the course of execution there were multiple interactive sessions in which experts from all different entities contributed and have helped to improve the overall result of the project.

CONTACT EN RAPPORTINFO

TNO APPLIED GEOSCIENCES
Princetonlaan 6
3584 CB Utrecht
P.O. Box 80015
3508 TA Utrecht

TNO-rapportnummer

TNO Report 2016 R11341

Opdrachtnummer

060.18836

Datum

28 maart 2017

Auteur(s)

Renaud Bouroullec, Roel Verreussel,
Tijs Boxem, Geert de Bruin, Mart Zijp,
Susan Kerstholt-Boegehold, Nico Jansen,
Dirk Munsterman, Pantelis Karamitopoulos and Stefan Peeters

During project execution, interim and preliminary results were shared with the parties in the project. There were several newsletters (12/2015, 02/2016 & 04/2016) which not only gave information on the state of the project, but also displayed useful – though preliminary – results which could be printed on A3 size to get the full graphic experience and ability to check and use.

Next to the newsletters, posters were shared, displayed larger and more complex results. In August of 2016 peculiar findings in the Terschelling Sandstone were shared, and in October 2016 the first results

of the seismic interpretation and stratigraphic correlation were shared.

Outside the project there were three scientific presentations based on the outcomes and findings of COMMA. All were given at the 'Mesozoic Resource Potential in the Southern Permian Basin' conference on London.

All results and findings are captured in an A3 (landscape), graphically focussed report of almost 200 pages, tailored to not only capture the work, but also contribute to the ease of use for those benefiting from the results.

CONTACT EN RAPPORTINFO

TNO APPLIED GEOSCIENCES
Princetonlaan 6
3584 CB Utrecht
P.O. Box 80015
3508 TA Utrecht

TNO-rapportnummer
TNO Report 2016 R11341

Opdrachtnummer
060.18836

Datum
28 maart 2017

Auteur(s)
Renaud Bouroullec, Roel Verreussel,
Thijs Boxem, Geert de Bruin, Mart Zijp,
Susan Kerstholt-Boegehold, Nico Jansen,
Dirk Munsterman, Pantelis Karamitopoulos and Stefan Peeters

COMMA

Project Manager

Thijs Boxem, TNO Applied Geosciences

Lead Scientist

Renaud Bouroullec, TNO Applied Geosciences

Projecttitel

Understanding Jurassic Sands of the Complex Margins of the eastern part of the Terschelling Basin during the Upper Jurassic and Lowermost Cretaceous

Projectnummer

060.18836 (RVO Referentie TEUG115003)

Projectplanning

Start: 01 November 2015

Gereed: 31 December 2016

Projectteam

Renaud Bouroullec, Roel Verreussel, Thijs Boxem, Geert de Bruin, Mart Zijp, Susan Kerstholt-Boegehold, Nico Janssen, Dirk Munsterman, Pantelis Karamitopoulos and Stefan Peeters

Het project is uitgevoerd met subsidie van het Ministerie van Economische Zaken, Nationale regelingen EZ-subsidies, Topsector Energie uitgevoerd door Rijksdienst voor Ondernemend Nederland.