Play fairway mapping in the Northeast Atlantic Margin
Comparison between mature and immature basins

David Mudge, Joanne Cranswick
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Regional Play Fairway Studies

Ternan Regional Multi-Client Reports

1. UK & Norwegian North Sea
2. Norwegian Sea
3. UK Atlantic Margin
4. Atlantic Ireland

North Sea Reports:

- UK Central North Sea
- UK Northern North Sea
- Norwegian North Sea
- 2015 Integrated North Sea
North Sea Interpreted Well Database

- UK Northern North Sea: 581
- UK Central North Sea: 1270
- Norwegian North Sea: 793

Total Database: 2644
Play Fairway Mapping
Upper Jurassic Shelf
<table>
<thead>
<tr>
<th>AGE</th>
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<th>Reservoir Units</th>
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<td>Basement</td>
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</table>
Palaeocene-Eocene Reservoir Distribution

Sandstone Thickness maps

- Complex patterns of sand facies in the North Sea basin
- Rapid changes in sand distribution as the basin evolved during the Palaeocene & Eocene.

**Balmoral**
Scale 0-800m sst thickness
2 large deep water fans & feeder channels
Regional fault control

**Forties**
200m max thickness
1 major deep water fan with some shelf sst

**Frigg**
Scale 0-200m sst thickness
Fragmented deep water sst,
Significant shelf sst
Palaeocene-Eocene Remaining Prospectivity

Composite Play Fairway Map

Area with enhanced remaining hydrocarbon potential
NE Atlantic Margin

Stratigraphic Analysis

Interpreted Database

- Well database: 500+
- BGS & NGU shallow boreholes for UK Atlantic Margin
- Onshore NE Greenland Tertiary & Mesozoic outcrops
NE Atlantic Margin
Seismic Interpretation

Interpreted Database

- Well database: 500+
- BGS & NGU shallow boreholes for UK Atlantic Margin
- Onshore NE Greenland Tertiary & Mesozoic outcrops
- Extensive seismic database
NE Atlantic Margin

Tectonic Elements

- NE Atlantic province contains a series of linked Triassic – Lower Cretaceous basins
- Overprinted by deep Upper Cretaceous – Tertiary basin system

[Map showing tectonic elements with labels for Lofoten Margin and Irish Margin]
NE Atlantic
Sediment Thickness

Based on BGS regional 3D gravity modelling

Ternan  North Sea  Northeast Atlantic  Play Fairway Mapping  Conclusion
NE Atlantic
Deep Structure

Based on BGS regional 3D gravity modelling

Ternan  North Sea  Northeast Atlantic  Play Fairway Mapping  Conclusion
NE Atlantic Margin

Tectonic Elements
NE Atlantic Margin

Lavas

- Land/platform/high (sediments thin or absent)
- Sedimentary basin
- Lower Eocene breakup lavas
- Upper Palaeocene lavas

Fault
- Continent/ocean boundary (COB)
- Oceanic fracture zone

Ternan North Sea Northeast Atlantic Play Fairway Mapping Conclusion
Early Ypresian (54 Ma)

- Mesozoic + Tertiary plate reconstructions by the NGU in Trondheim
- NW Europe plate fixed; movement of Greenland plate determines overall width and morphology of NE Atlantic seaway
- Interpretation uses Ternan mapping in Atlantic Ireland, UK Atlantic margin, Norwegian Sea and North Sea
Conjugate NE Greenland & Norwegian margins but line of breakup follows SW-NE Caledonian trend cutting across the basin system.

Jan Mayen restored to Eocene position.

Gap between SE Greenland and Faroe-Hatton margins: may be due to earlier Palaeocene start of sea-floor spreading along Rekjanes Ridge.

Line of pre-breakup Palaeocene volcanic centres from W Greenland to Hebrides.
NE Atlantic Margin
Plate Reconstruction at 85 Ma

Santonian (85 Ma)

Includes data from Norwegian Geological Survey
NE Atlantic Margin
Plate Reconstruction at 140 Ma

Berriasian (140 Ma)
Early Ypresian (54 Ma)

- Effects of Palaeocene thermal uplift in NE Rockall-Faroe Shetland areas removed.
- Rockall High moved SE to allow for major early Cretaceous extension.
- Simple seaway/basin system from Barents Sea to N Atlantic margin bifurcating into North Sea along Møre-Trondelag FZ
- To south of MTFZ, W margin of basin system lies on NW Europe plate; to north of MTFZ, it lies on Greenland plate.
Play Fairway Work Programme

North Sea

- Stratigraphic Analysis
- Well Interpretation
- Regional Unconformities
- Basin History
- Play Definition
- Regional Play Mapping
- Depositional Environments
- Reservoir Distribution
- Source Rock Distribution
- Play Fairway Mapping
- Regional Play Prospectivity
- Regional Play Risk
- Basin Modelling
- Hydrocarbon Charge Distribution
Play Fairway Work Programme
Northeast Atlantic Margin

Stratigraphic Analysis
Well Interpretation
Regional Unconformities
Basin History

Regional Play Mapping
Plate Reconstruction
Palaeogeography
Depositional Environments

Seismic, Gravity & Magnetics Mapping
Basin Modelling

Structural Elements
Basin Architecture

Reservoir Distribution
Source Rock Distribution

Play Fairway Mapping

Play Definition

Regional Play Prospectivity
Regional Play Risk
# NE Atlantic Margin

## Source Rocks

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<tr>
<th>STRATIGRAPHIC COLUMN</th>
<th>ATLANTIC IRELAND</th>
<th>UK ATLANTIC MARGIN</th>
<th>NORWEGIAN SEA</th>
<th>LOFOTEN W BARENTS SEA</th>
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<tbody>
<tr>
<td>EOCENE</td>
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<td>Kimmeridge Clay Fm U Kimmeridgian-Tithonian</td>
<td>Spekk Fm U Oxfordian-Kimmeridgian</td>
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<td>Toarcian Shale Unit</td>
<td>Stack Skerry Fm Sinemurian + Toarcian</td>
<td>Åre + Ror Fms Sinemurian + Toarcian</td>
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<td>TRIASSIC</td>
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<td>PRECAMBRIAN</td>
<td>L Pliensbachian U Sinemurian</td>
<td>Pabba Shale Fm</td>
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### NE Atlantic Margin Reservoirs

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<th>LOFOTEN W BARENTS SEA</th>
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<td>Ypresian-Lutetian shelf/slope plays</td>
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<td>Berrias-Aptian basin play</td>
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**Fields & Significant Discoveries**
- Oil
- Gas
- Gas Condensate
Conclusion

- NE Atlantic margin basins contain major hydrocarbon resources.

- Large areas of the NE Atlantic margin remain undrilled. Compared to the North Sea, individual basins have far fewer wells.

- Understanding the complex tectonic history is required before mapping the depositional history and correctly mapping the hydrocarbon plays.

- Ternan has successfully applied North Sea play fairway mapping techniques to basins on the NE Atlantic margin.

- A new Integrated North Sea Ternan report is being finalised, with updated databases and interpretation.
Acknowledgements

David Mudge

Ternan
LR Senergy

Data:
British Geological Survey
Norwegian Geological Survey
Fugro, PGS, Spectrum, TGSNopec,
Veritas, Western Geco, NPD