Exploration opportunities in Denmark

Inger Salomonsen, Exploration Manager, Nordsøfonden
FORCE Seminar, 1st November 2018
Nordsøfonden – Danish State Company

- Independent state owned company with a Board of Directors
- Partner in all licences awarded since 2005 and partner in DUC with a 20% share
- Same rights and obligations as other companies, paying partner, non-operator
- 19 dedicated professionals make today’s Nordsøfonden, located in Copenhagen
Nordsøfonden - what we do

We strive to increase the value from oil and gas activities in Denmark

• Work as a full circle company - active in exploration, development and production
• Manage the sale of own share of produced oil and gas
• Active during execution of technical work programs and evaluations in the licences
• Wide expertise in legal and financial matters in relation to the business
Danish North Sea Area

Licences in Denmark

- License with Nordsøfonden participation
- Sole Concession with 20% participation of Nordsøfonden
- License without Nordsøfonden participation
- License with lower depth limit
- License with upper depth limit

October 2018
Data - in a mature basin?

More than 250 deep wells W of 6°15

3D seismic coverage

2D seismic coverage
Underexplored Plays

1 Ringkøbing Fyn High
- Sedimentary Basins
- Fractured Basement
- Tertiary Canyons

2 Middle Jurassic Sandstones
- Channel Systems
Underexplored Plays

1. Ringkøbing Fyn High
   - Sedimentary Basins
   - Fractured Basement
   - Tertiary Canyons

2. Middle Jurassic Sandstones
   - Channel Systems
Exploration wells in Denmark 1966-2018

- **160 Exploration & Appraisal wells in the Danish Central Graben**

- **39 Exploration & Appraisal wells on the RFH**

- **27 wells drilled in the Siri Fairway**

- **12 Exploration wells in the remaining area of 11,500 km²**
Modern 3D seismic coverage

Legend
- Base Zechstein (m)
  - 0 - 500
  - 500 - 750
  - 750 - 1000
  - 1000 - 1250
  - 1250 - 1500
  - 1500 - 2750
Prolific Petroleum System

Legend

Base Zechstein (m)

0 - 500
500 - 750
750 - 1000
1000 - 1250
1250 - 1500
1500 - 2750

Oil & Gas Fields

Oil Field
Gas Field

The Netherlands
UK
Germany
Denmark
Norway

6°15' E

Ringkøbing Fyn High

Coffee Soil Fault

Silt Canyon
Hydrocarbons on the Ringkøbing Fyn High
Simplified stratigraphic correlation

- Sandstones known as reservoir in Central Graben are seen in wells on RFH
Plays on the Ringkøbing Fyn High

Courtesy of TGS
Seismic profile across the Utsira High

Profile from Geo365.no. En ny skalp i beltet. 02-07-2014
Basement wells on RFH

The 4 wells on the Ringkøbing Fyn High all found highly fractured basement

Per-1 (Chevron, 1978) discovered strongly fractured basement at TD of 2781m (9123’). At TD the crystalline rock was dated as Precambrian

Ugle-1 (BP, 1985) discovered densely fractured and calcite veined metamorphic basement at TD of 3057m (10029’)

Sine-1x (Mærsk, 1998) discovered fractured gneiss at TD of 2840m (9318’)

Ibenholt-1 (Phillips, 1987) discovered fractured granitic gneiss at TD of 2530m (8300’)

Base Zechstein 1994

0 - 500
500 - 750
750 - 1000
1000 - 1250
1250 - 1500
1500 - 2750

The Netherlands

Germany

Norway

Coffee Soil Fault

JR Canyon

Ringkøbing Fyn High
Seismic example - 3D survey on RFH
PGS15-12300 Seismic Profile

Oscar-1

BCU

Tail End Graben

Ringkøbing Fyn High

Courtesy of PGS
Possible Analogue

Modified from Hurricane presentation, April 2017. Capital Markets Day
2D seismic - DKR13-1141

Tail End Graben

Ringkøbing Fyn High

BCU

Courtesy of TGS
World-wide basement discoveries

Countries with reported HC discoveries in basement rocks

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<th>Greenland</th>
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Info from GeoScience Limited, December 2013
Tertiary Canyons on the RFH
Underexplored Plays

1 Ringkøbing Fyn High
- Sedimentary Basins
- Fractured Basement
- Tertiary Canyons

2 Middle Jurassic Sandstones
- Channel Systems
Middle Jurassic Sand Fairway

- Two provinces; northern and southern province
- Sequence stratigraphic subdivision based on wells
- Fluvial and estuary sand in incised valleys
- Prograding deltas; sand in mouth-bars and distributary channels
- Deep incised valley in N, sand in channels and tidal bars
- High energy fluvial system in S, fluvial sand depot not yet found?
- Production in Lulita and Harald Fields
- Development of BroderTuck
Sand distribution in 4 Phases

- Phase 4; Callovian
- Phase 3; latest Bathonian – Early Callovian
- Phase 2B; Late Bathonian
- Phase 2A; Bathonian
- Phase 1; Bajocian?
Middle Jurassic - Phase 3

Palaeogeography Phase 3
(Late Bathonian - Early Callovian)

- Widespread erosion and incision
- Deep valley incision in the Søgne Basin
- Sand supplied by fluvial system from the North.
- High energy fluvial system in the South
- Sediment from the West and South
- Estuaries in incised valleys on Rosa Basin flanks
Palaeogeography Phase 4 (Mid - Late Callovian)

- Step-wise transgression of the Danish Central Graben
- Large-scale sand supply to the Søgne Basin
- Southern area becomes mud-prone
- Dominated by lagoons and swamps

- In the Søgne Basin transgression is repeatedly interrupted by regressive episodes
- Triggered by fault movements
- Delta progradation carries abundant sand
Summary - Still Underexplored

- Frontier exploration on the Ringkøbing-Fyn High
  - Weathered basement
  - Local sedimentary basins
  - Tertiary canyons
- More work to be done outside of the proven chalk play
  - Cenozoic shallow potentials
  - Lower Cretaceous tight chalk or sandstones
  - Upper Jurassic fan systems
  - Deep seated Middle Jurassic incised valleys
  - Older reservoirs - older sources still to be explored
Significant Potential

- More than 90 pct. of the production from Chalk
- 3 billion barrels oil equivalents in ground
- Remaining potential consists of a range of small and medium sized exploration targets
- Medium an larger sized stranded discoveries to be evaluated for appraisal and development
8th Licencing Round - Relevant players

- Legislation and regulation
- Conditions and further information
- Application
- Technical consultancy/G&G advisor
- Data provider
- State Partner (20 pct)
Still more to explore in the Danish Area

Thank you!
Inger Salomonsen, Exploration Manager
Søren Holm, Senior Geoscientist