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Further Development of Skua, a Mature Triassic HPHT Field in the Central North Sea

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Heron Cluster Sub-Sea Infrastructure

Eastern Trough Area Project
Cluster Summary

- Cluster has produced ~100MMbbl of light oil since 1998
- Triassic Skagerrak reservoirs, depths up to 15,000ft.
- High Pressure High Temperature Fields (12350psi, 350°F).
- Oil production is declining – depletion drive mechanism.
- Potential scope to drill and increase recovery?
Outline

• Regional Geological Picture
• Skua Field
  • Development History
  • Opportunities
  • Uncertainties
• Ongoing work
• Concluding Remarks
Stratigraphy

The Triassic Skagerrak Fm is equivalent to the Judy Sandstone Mbr.
Regional Geology - The Skagerrak Reservoir over ETAP

Neales River and Terminal Fan, Lake Eyre, Australia

γ N/D Δt 22/29-1S1

Lacustrine
Palustrine
Fluvial
Terminal splay
Playa

Upper
Splay
Playa
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Structural Framework

- Lark shales, Sele, Balder and Forties
- Skaggerak Sands (10-14° dip)
- Smith Bank Shale
- Jurassic
- Top Marnock Shale
- Chalk
- Basement (Permian)
- Zechstein Salt
SKUAS01S1 came on at ~16000bbl/d
- Initial reservoir pressure of 9350psi.
- Rapid pressure decline to ~5500psi in mid 2003.
- By mid 2004 became sub hydrostatic.
- Post 2004 well intervention, 4350psi recorded at wellhead & high (~50%) highly saline water production.
- Well shut-in in late 2004 and remains so.

- Estimated oil in place volume: ~115MMstb
- Produced Oil = 9.6MMstb
- Current Recovery Factor ~ 8%
Opportunities on Skua

1. Attic Volume
2. Northern infill target
3. Southern Infill target

4D RMS amplitude signal extracted between BCU + 10ms and +80ms

0.5km
1. Attic Opportunity – 3D Structure Interpretation

Line of section

W

E

SKS01S1

OWC @ 12075ft

BCU

Top Triassic

Top Marnock Sh
1. Attic Opportunity – 4D Interpretation

- Water flowing through higher perm units into well...

- Stratigraphic or structural reasons?

- BCU – Top Triassic surface

- ATTIC VOLUME

- Unpenetrated flank stratigraphy... Potential oil bearing Joanne sands?

- Heron Shale

- Middle Shale

- ATTIC VOLUME?

- OOWC in Lower Skagerrak?

- OOWC

- Water flowing through higher perm units into well...?

- Stratigraphic or structural reasons?
Amplitude map of post cursor amplitudes from BCU (Top reservoir).

Amplitude pattern follows subcropping pattern of Skagerrak sand-shale packages.

Observed Acoustic Impedence contrasts can be explained by shales vs oil bearing (rather than water) sands.
2 & 3. Infill Opportunities

1. Attic Volume
2. Northern infill target
3. Southern Infill target

4D RMS amplitude signal

0.5 km
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2. North/South Infill Targets - 4D Section

Is signal across fault real? Does this correspond to production from northern block?
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**Northern Flank Uncertainty**

2 Concepts: 1) Fault Seal (orange) and 2) Dip Closure (green) in the saddle area.

- **Volume gained in Fault Seal / Lost in Dip Closure**: $11 \times 10^6 \text{m}^3 (~3\text{MMstb STOIIP})$
- **Volume lost in Fault Seal / Gained in Dip Closure**: $6 \times 10^6 \text{m}^3 (1-2\text{MMstb STOIIP})$
Ongoing Work

- 4D reprocessing to better image possible depletion signal in North Block.
- Improvements to reservoir static/dynamic modelling.
- Geomechanical study to address pressure depletion estimates, stress arching.
- Well engineering studies to establish the drillability of partially depleted HPHT Skagerrak reservoirs.
- Production chemistry / Production Technology to assess the need for down-hole wash water injection and fully understand what happened to the SKS01S1 well.
- Facilities engineers to address the feasibility of gas lift installation.
Skua is a mature HPHT oil field in the Central North Sea whose one development well was characterised by a high initial production rate (~16,000bbl/d).

The well saw a rapid, high produced water cut in late 2004 and was shut-in.

Ongoing studies show several possible opportunities exist to increase field recovery.

But, realising these opportunities presents many major subsurface and engineering challenges.
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