Appraising a “late-middle-aged” Brent Group field

Reservoir learnings after nearly 20 years of Pelican field production

Jill Marriott
The Pelican Field

- The Pelican oil field is nearly 20 years old
- It is a subsea oil development tied back to the Cormorant Alpha Platform (now >35 years old)
- Located in SW corner of Quad 211 in the NNS Brent Group “heartland”
- Pelican and its neighbours (NW Hutton & Lyell) are deep Brent fields with low Recovery Factors (up to 15 %)
The Pelican field crest lies at a depth of 10,500 ft tvdss with a spillpoint at 12,300 ft tvdss.

This is 2,000 ft deeper than its nearest neighbour to the north, Cormorant Block 1.
Pelican Main has an active well stock of 8 crestal producers and 3 midflank injectors.

The first producer in Pelican North was drilled in 2013.

The well density is skewed towards shallow depths.

Classic Brent stratigraphy.
Marked reduction of permeability with depth

Led to the concept of an effective “production floor” at 11,800 ft tvdss

Causes: complex diagenesis including illite, kaolinite, burial quartz & compaction

Established thinking: early oil migration into the structure was able to preferentially inhibit diagenesis in the shallower parts of the field
Reservoir quality within a typical Pelican well shows the characteristic reduction of reservoir quality with depth.

This results in a top-heavy distribution of permeability throughout the Brent.

Best reservoir quality within Upper Ness sandstones.

How has this affected reservoir performance?
The early development strategy was to perforate all Brent layers in both producers and injectors. This led to water-injection over-ride in the highest permeability Upper Ness layers and bypass of the Lower Brent. Approximately 75% of the STOIIP in the Pelican Main Field is in the Lower Brent. Average field water-cut increased rapidly reaching 52% by mid 2001 (3 years after injection start-up), resulting in associated production impairment due to scaling.
Later field development strategy was to drill dedicated Lower Brent producers

TAQA acquired Pelican in late 2008 and continued this strategy
- Drilled and completed 3 producers and 1 injector in the Main Field, perforating only the Lower Brent

Between 2008 & 2011, average production from Pelican Main increased from 2500 to 7500 bopd

Average field water-cut went from 50% to 20% in the same period

TAQA drilled the first development well in Pelican North in 2013 (well PUP22S1)
The well penetrated a full Brent sequence (350 ft thick) at a depth of 11,350 ft tvdss

270 ft of core was acquired in the Tarbert, Ness & Etive Formations

Excellent reservoir properties were encountered in the Upper and Lower Ness

BUT, Etive character was different to most Pelican Main wells, twice as thick (>100 ft) and largely non-reservoir (<1 mD permeability)
- There is an extreme drop-off in permeability at the Ness/Etive boundary.

- Why is the Etive effectively non-reservoir (<1 mD)?

- Why is the Etive twice as thick as in other Pelican wells?

- Core description indicates that the Ness is dominated by medium-coarse grained fluvial channel sandstones whilst the Etive comprises fine-medium grained shoreface sandstones.

- Is facies important?
Pelican core dataset has limited coverage.

Released NW Hutton core data has been used to supplement it and it extends deeper.

Some NW Hutton cores extend into the water leg.
Significant erosion of the Etive took place prior to deposition of the Lower Ness. The Etive has been locally completely eroded at the crest of NW Hutton and thick Lower Ness lies directly on Rannoch.

This erosion generated an irregular incised valley topography onto which the Lower Ness was deposited.

Thick Etive in PUP22S1 is located in an interfluve position.
This poroperm plot highlights the strong contrast between the Etive shoreface sandstones and high energy fluvial channel sandstones from the Upper Ness.

Facies type clearly has an impact on reservoir quality.
The Etive is dominated by fine and fine-medium grained shallow marine middle to upper shoreface sandstones.

Typically planar laminated or massive (bioturbation/dewatering)

211/26a-13 Core Description

Middle to upper shoreface
The Ness is heterolithic.

The best reservoir quality is recorded within medium to coarse grained, cross-bedded sandstones. These represent high energy fluvial barforms.

Common in the Upper Ness and some parts of the Lower Ness.
The **Etive** shoreface sandstones show a steep permeability degradation gradient. They are non-reservoir below a depth of 11,500 ft tvdss.

The **Upper Ness** fluvial channel sandstones preserve net reservoir to at least 13,000 ft tvdss.

**BUT** only if channel sandstones are present (not always).

There is no relationship between fluid type (oil or water) and permeability.
The Upper Ness high energy fluvial channel sandstones are typically medium grained and well sorted with little detrital clay.

The pore system is “open”.

Feldspar has suffered grain dissolution but fluid flushing is thought to have prevented the formation of, or removed, diagenetic kaolinite.

Quartz overgrowths form rigid bridges between grains that help resist compaction.
The Etive shoreface sandstones are finer grained with locally abundant detrital clay matrix and smaller pore throats.

The pore system is “closed”.

Feldspar grain dissolution results in diagenetic kaolinite blocking pores.

Illitisation of kaolinite and detrital clays.

Quartz overgrowth development is inhibited where detrital clay matrix coats the grains. Where present this tends to occlude pore throats rather than preserving an open pore system.
Conclusions

- Reservoir quality degrades with depth
- However, grain size is the dominant control on “how”
- In shallower parts of the field any facies has the potential to form net reservoir
- In deep parts of the field only the coarser grained high energy fluvial channel sandstones can form effective reservoir (limited to the Upper Ness and some parts of the Lower Ness)
- Ness Formation high energy fluvial channel sandstones have the potential to form net reservoir below 13,000 ft tvdss
- Etive Formation shoreface sandstones are non-reservoir below 11,500 ft tvdss
- Potential opportunities, previously overlooked, might exist in deeper parts of the Pelican field but are reliant on encountering suitable channel facies (mostly in the Upper Ness)
- Early oil migration appears to have little or no impact on reservoir quality. Could this change exploration thinking in the basin?
Thank you

Dundas Consultants
  - Bernard Besly

TAQA
  - Derek Littlejohn
  - Thurza Frenz

Come and see for yourself - Pelican core in the Boyd Orr Hall!