Relinquishment Report

Licence P.059
Block 22/3a

Chevron North Sea Limited

Chevron North Sea Limited
Gaz de France Britain Limited

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1. Synopsis

Licence P059, block 22/3a was acquired by Chevron North Sea Ltd (operator) effective from 18th July 2000. Gaz de France Britain Ltd joined as partners through a farm in arrangement with Chevron North Sea Ltd on 6th June 2001 with 50% equity.

At the time of acquisition, potential hydrocarbon prospectivity had been identified in the Jurassic, Lower Cretaceous and Palaeocene intervals. The subsequent work programme has focused on these sections. Evaluation of the Jurassic indicated the presence of several fault block traps. The Macduff lead was considered to show the most potential. Further analysis of this lead, however, revealed a very low geological chance of success reflecting the high risk associated with trap integrity, and reservoir quality due to significant depth of burial. Reservoir sands in the Lower Cretaceous Britannia Formation and in the Late Palaeocene Forties Formation may contain hydrocarbons in simple anticlinal structures but trap sizes are very small. A decision to relinquish the licence followed, becoming effective on 24th November 2006.

2. Introduction

2.1 Licence Terms

Licence P059, block 22/3a is located in the Fisher Bank Basin which is part of the North Sea Central Graben system (Figure 1). It was acquired by Chevron North Sea Ltd (operator) effective from 18th July 2000 and there were no outstanding work obligations at the time of acquisition. Gaz de France Britain Ltd joined as partners through a farm in arrangement with Chevron North Sea Ltd on 6th June 2001 with 50% equity. Relinquishment of the license was effective on 24th November 2006.

2.2 Database

The seismic data coverage for the area includes a 3D PSDM which comprises a merge of five 3D surveys from the Fisher Bank Basin, and an inversion cube of the data. These projects were completed in 2001 and the area covered is illustrated in Figure 2. A 2D long offset survey that covers the block was acquired in 2003. These lines are displayed in Figure 3. Figure 4 shows the well database that was utilised for regional evaluations of the Jurassic in the Fisher Bank Basin.
3. Exploration Activities

3.1 3D Pre-Stack Depth Migration

A PSDM project was carried out, over part of the Fisher Bank Basin including most of the Licence area, by WesternGeco and completed in February 2001. The input data for the PSDM consisted of 5 3D surveys that were shot between 1993 and 1997. A fully 3D pre-stack depth migrated image for an output area of approximately 709 km² was produced (Figure 2).

3.2 3D Seismic Inversion

A seismic data cube from the Fisher Bank Basin (Figure 2) was inverted by Odegaard UK Ltd in 2001 using their proprietary ISIS global seismic inversion software. A total of 1,143,940 traces were inverted covering the window from 2.5-5.2 s TWT and targeting the Upper Jurassic sands in the basin centre. Data had been supplied for seven wells.

3.3 2D Seismic Acquisition, Processing and Inversion

3.3.1 Acquisition

A long offset (8km) 2D seismic survey was acquired over block 22/3a and 22/2b by WesternGeco in August 2003 in order to better resolve the deep (Jurassic) reservoir section. The seismic coverage is shown in Figure 3.

3.3.2 Processing

Processing was carried out by Veritas DGC Ltd and completed in April 2004. The aims for the processing were as follows:
- Retain the data on the long offset for AVO purposes
- Apply a processing route that is AVO friendly
- Get a good resolution of the main target (between 3 and 5 seconds on all lines)

3.3.3 Inversion

The seismic data cube from the 2D survey was inverted by Odegaard using their proprietary ISIS global seismic inversion software. A total of 77,000 traces were inverted covering the window from 2.5-5.0 s TWT and targeting the Upper Jurassic sands.

Sonic, density, gamma-ray and resistivity logs, and check-shot data were supplied for 7 wells: 22/2-2, 22/2-3, 22/3a-1, 22/7-2RE, 22/9-5, 16/27-1A and 16/17b-4Z.
4. Prospectivity Analysis

At the time of acquisition, potential hydrocarbon prospectivity had been identified within the Upper Jurassic, Lower Cretaceous and Tertiary. The subsequent work programme has concentrated on these intervals.

Interpreted horizons included Top Pentland Formation, BCU, Top Britannia Sands, Base Chalk, Top Chalk, Top Forties, Near Top Eocene and Top Oligocene.

4.1 Upper Jurassic

Sequence Stratigraphy and Palaeogeography

The Chevron sequence stratigraphic framework for the Upper Jurassic in this area is shown in Figure 5. Palaeogeographic maps of these Upper Jurassic sequences (Figure 6), based exclusively on well control, show a progressively deepening depositional environment in the larger Fisher Bank Basin area.

The underlying Middle Jurassic Pentland Formation was characterised by fluvio-deltaic deposits. This was followed by deposition of the Upper Jurassic Oxfordian shallow-marine sands of the Fulmar Formation representing transgression of the marine system from the north. In the early stages of transgression (UJ1.1-UJ4) sand deposition covered a wide area of the basin. Subsequent drowning confined the deposition of shallow marine sands to the edges of the Fisher Bank Basin (UJ5-UJ8.b). Deeper marine sediments of the Heather and Kimmeridge Clay formations were deposited in the central parts of the basin, eventually transgressing its margins to form the regional top seal to the Upper Jurassic reservoir (UJ9.1-LK4).

Jurassic Leads

Three Jurassic highs had initially been identified and regarded as leads within the Licence area. Further analyses of these structures indicated reservoir presence to be very high risk. However, another lead (Macduff) was identified within a fault terrace area where the deposition of reservoir sands was considered to be more likely.

MacDuff Lead

The HPHT Macduff Lead is shown on the Top Pentland map (Figure 7). It is located in a fault terrace on the western flank of the Fisher Bank Basin. The structure is defined by faults to the west and south with two-way dip closure to the north and east. The prospect is upthrown in relation to the fault to the south. Mapping suggests the western margin of the prospect comprises two faults separated by a relay ramp. This results in the northern part of the lead displaying a downthrown position and the southern part an upthrown position with respect to the western margin boundary faults (Figure 7). Cross sections of the MacDuff Lead are illustrated in Figure 8.
Upper Jurassic shallow marine Fulmar Formation sands are predicted to form the reservoir section for the MacDuff Lead. Regional Facies distribution mapping [Ichron] suggests that lower shoreface to transition zone Fulmar Formation sands are present within the licence area (Figure 9). Lower shoreface gas saturated sands of the same age have been identified to the west of the Licence area in well 22/2-2. However, these sands are thin (35’ gross thickness) representing a condensed Fulmar Formation sand section due to deposition on a gentle topographic high, and they display an average porosity and permeability of 12% and 3.99 mD respectively (at 8% phie cutoff). The reservoir model shows that the lower shoreface sandstone forming the Macduff Lead reservoir to be even more distal than in well 22/2-2. In addition, the predicted reservoir section for the MacDuff Lead lies at approximately 19000’ depth so is buried 2000’ deeper than the Fulmar interval in well 22/2-2. Reservoir quality for the Fulmar section within the MacDuff Lead is therefore predicted to be poor. This is represented by allocation of a high reservoir risk. The 2D long offset data did not alter the risk on the presence of Fulmar reservoir.

High TOC, mature Upper Jurassic Kimmeridge Clay source rock is modelled to be present within the Fisher Bank Basin. These marine shales could provide gas charge into the structure. Pentland Formation non-marine clays may also provide a source. Migration up-dip and along faults into the Lead reservoir from the deeper Fisher Bank Basin is likely to have occurred during early Tertiary time, after the fault trap was in place. In well 22/2-2, immediately to the west of the Licence area, there is a small gas accumulation in the Fulmar sands.

Upper Jurassic shales (Heather and Kimmeridge Clay Formations) are predicted to form the top seal. The Kimmeridge shales are a proven top-seal in the area and considered to be very low risk. The E/W fault to the south is likely to seal against Upper Jurassic shales. The critical seal is the N/S trending fault that separates the lead from the regional dip to the west. The possibility of two separate faults separated by a relay ramp increases the potential for leakage updip presenting a high risk for this side seal.

Results of the volumetric calculations for the MacDuff Lead indicate mean recoverable reserves of 8.2 MMboe.

Hydrocarbon charge from the deep Fisher Bank Basin is considered to be extremely likely and the prospect is fairly well resolved with the 3D PSDM. However, reservoir quality and trap integrity are significant concerns for the MacDuff Lead and so are characterised by high risks. Overall, the geological chance of success is calculated at only 9%, giving a success rate of 1 in 11.5.

### 4.2 Lower Cretaceous

**Depositional Model**

The presence and quality of the Lower Cretaceous reservoir sands within the block was assessed. During the Lower Cretaceous, submarine fan sandstones of the Britannia Formation formed massively thick accumulations immediately to the north of block 22/3a and have been identified, often with shows, in well penetrations within the Fisher Bank Basin.
A stratigraphic and sedimentological evaluation of the Lower Cretaceous (Late Barremian to Late Aptian) Britannia sands covering block 22/3a and the surrounding area was undertaken in 2003. The study identified individual sand bodies and modelled sand dispersal patterns using the Britannia Reservoir zonation scheme. This model suggests Britannia Formation turbidites are likely to be present over the northern part of block 22/3a (Figure 10) comprising of clean HDT and slurry flow sands that will potentially form good quality reservoirs. These sands are interpreted to be predominantly sourced from the north-west, although in block 22/3a in the Early Aptian unit, the sands are difficult to correlate regionally. These Early Aptian unit sands could have been derived from the east, although it is also equally likely that they were derived from the Britannia system to the north and northwest. Well 22/3a-1 penetrated and partly cored Britannia Formation Sandstone containing some oil shows. These sands (Figure 11) were thin (26' net sand) reflecting their location on the southern margin of the depocentre. The cored sands within this well comprised mainly mixed slurried, and debris flows.

**Leads**

Three small structural closures were identified within the licence area on the top Britannia sandstone pick (Figure 12). The depositional model indicated that Britannia sands of reservoir quality are likely to be present. Top seal could be provided by the Rødby shale that has been proven to be an effective top seal to the Britannia Formation in the Britannia Field. The Upper Jurassic Kimmeridge Clay Formation, interpreted to be present in the area, could provide the charge. However, these structures are small in size.

### 4.3 Tertiary

The Palaeocene, Eocene and Oligocene intervals were assessed using the Western PSDM dataset. No prospectivity was identified within the Eocene and Oligocene sections. In the Late Palaeocene, a possible lead was identified in the Forties Sandstone Member.

#### 4.3.1 Late Palaeocene

Amplitude mapping of the top Forties horizon shows the presence of submarine channel systems which regionally, to the west and north-west, are characterised by a NW-SE trend. Regional analysis suggests that the deep water channels within block 22/3a are possibly a distal extension of the 15/29a-9 Ptarmigan turbidite sand fairway.

A semi-regional biostratigraphical and sand distribution mapping study of the Late Palaeocene Forties Sandstone Member [Ichron] identified two main sand units: The Lower Forties (S1a) and the Upper Forties (S1b). The sand isochores of these 2 units are shown in Figure 13 and display this predominant NW-SE trend. This model shows the centre of the Lower Forties Fan sand fairway to the west / south west of block 22/3a with block 22/3a lying on the north east flank of this channel (Figure 13). This is overlain by the Upper Forties NW-SE channel centred through the southern part of block 22/3a. Figure 14 illustrates the variations in thickness of the Lower and Upper Forties in this area.
**Powers Lead**

A four way dip structure (Figure 15) was identified on the Top Forties Depth map (SWIM velocity model). The depth conversion analysis compared the RDR and the SWIM velocity models and established that the SWIM model was the most robust. The Powers structure appears to lie within the Forties submarine channel sand fairway with the Lower Forties and Upper Forties each showing an estimated gross sand thickness of 50-100’. Hydrocarbons have been encountered in the Forties Member in this area, with well 22/2-2, to the west of the Powers Lead, displaying a 41’ oil column. The Forties Member in well 22/3a-1, located close to the southeast margin of the lead, contains minor hydrocarbon shows and a net sand thickness of 160’ (Figure 16). Recoverable reserves of 0.7 MMboe (mean) are estimated for this lead with a geological chance of success of 58% or 1 in 1.7.

### 5. Maps and Figures

![Location map for P059, Block 22/3a.](image-url)
Figure 2. Seismic data coverage for P059. The bold red line shows the outline of the 3D PSDM output and the area that was inverted for acoustic impedance.

Figure 3. Survey area for 2003 2D Seismic lines
Figure 4. Well database

Figure 5. Chevron sequence stratigraphic framework for the Upper Jurassic. The Maximum Flooding Surface 4 (MSF4) defines the top of the Fulmar Sands.
Figure 6: Palaeogeographic reconstruction from the Early Oxfordian to the Late Ryazanian. Reconstruction is based purely on well control assuming no significant influence on deposition from structural relief within the Fisher Bank Basin.

Shallow-marine transgressive shoreface sands of the Fulmar Formation (Early to Late Oxfordian) are covered by the deeper marine sediments of the Heather and Kimmeridge Clay formations (Late Oxfordian to Ryazanian). In the Kimmeridgian, the deposition of shallow marine sands was confined to the edges of the Fisher Bank Basin. The interpretation of Kimmeridgian turbidites in the Fisher Bank Basin is conceptual.
Figure 7. Top Pentland Depth Structure showing MacDuff Lead
Figure 8. Macduff Lead seismic sections.
Figure 9. Fulmar Facies distribution map.
Figure 10. Aptian Sand dispersal Patterns
Figure 11. Log CPI of the Britannia sands in well 22/3a-1.
Figure 12. Top Britannia sand structure map.
Figure 13. Schematic overview of Forties Sandstone Distribution.
Figure 14. Forties Sand Member well correlation panel.

Figure 15. Forties Depth Structure Map
Figure 16. CPI log of the Forties Sandstone section in well 22/3a-1.