Licence P1300 (Block 16/3e) was awarded in the 23rd Round of Licensing in December 2005 to Reach Exploration (100%). The licence was subsequently (mid 2007) divided into an upper and lower unit (14,000 ft TVDss boundary). At the time of relinquishment Reach had 100% of the upper portion, and the lower portion had the following equities as a result of a farm-out by Reach – Marathon (Operator) 33.38 %, Taqa 42.3%, Reach 10%, Centrica 7.03%, Nippon 5.53% and GdF 1.76%.

Synopsis

Block 16/3e lies between the North Brae and East Brae fields in the South Viking Graben (Fig. 1) and has both Upper Jurassic and Middle Jurassic prospectivity. However, it has proved difficult to find an economically attractive development option for the small Upper Jurassic oil discovery (Balfour). The potential volumes in an undrilled Middle Jurassic structure (Drum) have been deemed too small to drill economically from a floating rig and too risky (due to the unknown pressure regime) to drill from the East Brae Platform.

![Figure 1](image)

*Figure 1*  
Location of Block 16/3e in the Brae area of the South Viking Graben
Exploration activities

Four wells have previously been drilled in the Licence area. Wells 16/3a-4 and 16/3a-6 were drilled by Marathon in 1984 and 1985, resulting in an Upper Jurassic Brae Formation oil discovery (now termed Balfour). Wells 16/3a-E22 and 16/3a-E22Z were drilled by Marathon from the East Brae platform to investigate the Brae Formation potential; the Brae was found to be water-wet, but a small oil accumulation was discovered in Lower Cretaceous Skiff sandstones, which was deemed un-producible due to adverse reservoir quality.

The most recent seismic data shot over the licence area was a regional 3D survey acquired by Marathon and the Brae partners over the Brae fields in 2007 (Fig. 1). This survey includes the entirety of Block 16/3e; data covering this block and extending to the southwest over the nearby Beinn Field were provided to Reach. Recent evaluation of both the upper and lower portions of the block have been carried out using this 2007 3D data, as outlined below.

Prospectivity analysis

**Lower Unit – Drum Prospect**

**Introduction**

The Drum structure is a partly eroded Middle Jurassic anticline that lies adjacent to the South Viking Graben boundary fault system, 4 km southwest of the Upper Jurassic East Brae field (Fig. 2). The structure is defined by mapping the Top Sleipner Formation (Bathonian), which is a strong regional reflector that is readily interpreted throughout the area (Fig. 3). However, at the crest of the pronounced high at Drum, this reflector is absent due to late Jurassic erosion. Here, lower units of the Sleipner Formation are interpreted to be unconformably overlain by Heather or lower Kimmeridge Clay shales.

The primary reservoir target at Drum is the Callovian aged Hugin Formation which is interpreted to overlie the Sleipner Formation on the western and southern flanks of the structure and to be completely eroded from the crest of the structure (Fig. 4). The Hugin Formation is the productive reservoir at the Beinn Field beneath North Brae, approximately 7 km to the southwest of Drum. At Beinn, the top of the Hugin Formation is poorly imaged due to the limited acoustic impedance contrast between the Hugin sandstones and the overlying Heather shales (Fig. 3), therefore extrapolation of the Top Hugin pick away from Beinn well control, and hence the presence of Hugin reservoir at Drum, is somewhat tenuous.
Figure 2  Top Sleipner Formation (Bathonian) structure map showing location of the Drum structure in relation to the graben boundary and the Beinn structure.

Figure 3  Upper and Middle Jurassic structure between the Beinn field (Hugin production) and the Drum Prospect.
Trap type
The Drum trapping structure is illustrated in Figures 3 and 4. The structure is bounded to the north by the graben boundary fault system, against which the Middle Jurassic sequences are downthrown. To the south and east the structure is bounded by large intra-Jurassic down-to-the-graben faults (Kingfisher fault system) and to the southwest a structural saddle separates the Drum and Beinn structures (Fig. 2). Depth to the crest of the Middle Jurassic structure is approximately 14,100 ft TVDss and the relief between the crest and the saddle to the southwest exceeds 1,000 ft. It is likely that Zechstein salt bodies underlie both the Drum and Beinn structures, and are partly responsible for keeping these Middle Jurassic blocks at a relatively high level. The Kingfisher fault system has accommodated movement of the Middle Jurassic into the deeper parts of the graben to the south and east of Drum.

Reservoir
The Hugin Formation is regarded as the main target at Drum, although the Sleipner Formation could be an additional target. At the Beinn Field the Hugin Formation is the major productive unit, with the Sleipner Formation being very poorly productive (approximately 3 bcf wet gas produced).
At Beinn, the Hugin comprises a thick sequence (up to at least 850 ft) of stacked sandstone and siltstone units that are readily correlated within a 2.5 km diameter area at the crest of the structure. Sandstones are dominantly fine to medium grained, with porosities averaging 11-12% and permeabilities in the range 5 to 140 mD. The depositional environments were largely shallow marine (Cockings et al., 1992), with many of the sandstones being bioturbated or showing parallel- or cross-lamination. However, other beds are graded, which may indicate deposition of these sands below wave base from turbidity currents.

The extent of the Hugin reservoir away from the Beinn structure is uncertain, partly due to the lack of clear seismic correlation and partly due to its absence from several wells within the basin to the southeast of Beinn and Drum, where Heather Formation shales directly overlie the Sleipner Formation. Deposition of the shallow marine Hugin sands may have been restricted to structurally high graben margin areas, possibly including the Drum area. A further sandstone unit of similar age to the Hugin is found within the Heather Formation in some of the Kingfisher wells (Spence and Kreutz, 2003). These sandstones are turbidites, which may be the deep water equivalent of the shallow marine Hugin sediments, although no direct connection has been proved.

At the Drum structure, it is possible that shallow marine Hugin sandstones, or indeed deeper marine turbidites, were deposited prior to the folding and erosion that preceded deposition of the latest Jurassic sediments that cap the Middle Jurassic sequences. However it is also possible that this area did not receive sand input at all during the Callovian.

The potential for the Sleipner Formation to provide good quality reservoir at Drum is doubtful. At Beinn, the strong seismic reflector at the top of the formation is due to a widespread coal that was deposited immediately prior to transgression of the area during the early Callovian. Beneath this coal, the Sleipner Formation at Beinn comprises several major stratigraphic intervals that contain variable amounts of sandstone or are entirely fine grained. Overall the net/gross reservoir potential in the upper part of the formation is moderate to low. The best quality reservoir occurs in a unit approximately 100 ft thick, some 450 ft below the top of the formation, where sandstones have average porosities of 14-15% and permeabilities of 1-2 mD. Assessment of the Sleipner Formation as an effective reservoir at Drum is also complicated by its geometry - i.e. the variable amount of erosion at the crest of the structure and the uncertain dips of the underlying Sleipner beds make it difficult to predict the likely location of individual sandstone units across the structure.

**Seal**

A seal above the unconformity for both the Hugin and Sleipner units is required for the Drum trap to be effective. The precise timing of the erosion of the Drum structure and the subsequent deposition is uncertain. Erosion clearly post-dated the Sleipner coal and probably also the deposition of the Hugin Formation. The most likely character of the overlying sediments is considered to be Oxfordian to Kimmeridgian shales of the Heather or lower Kimmeridge Clay formations. However, thick conglomerates of the Brae Formation were drilled at the base of both 16/7a-E22 and 16/7a-E22Z (to a maximum depth of approximately 14,000 feet TDVss), and it is
possible that such lithologies directly overlie the unconformity; these would probably not form an effective seal for any underlying reservoirs.

**Chance of success**
The overall chance of finding potentially producible hydrocarbons in the Hugin Formation at the Drum Prospect is set at 28%. The presence of adequate reservoir and the seal potential below the intra-Upper Jurassic unconformity are considered the main risks. Due to the poor production performance of the Sleipner Formation at the Beinn field, the chance of finding producible hydrocarbons in this formation at Drum is considered low.

**Upper Unit – Balfour Discovery**

*Introduction*
The Balfour oil discovery (originally termed E Prospect) occurs in a very thick interval of Upper Jurassic Brae Formation conglomerates and minor sandstones within a small Upper Jurassic anticline approximately half way between the North Brae and East Brae fields (Figs. 5 and 6). Marathon and partners drilled two wells into the structure in the mid 1980s (Fig. 7). Well 16/3a-4, drilled in 1984, encountered a gross oil column of approximately 250 ft, which tested at 1,588 bopd and 3.1 mmscf/d of gas. Well 16/3a-6, drilled down-dip of 16/3a-4 in 1985, encountered a thin (~20 ft) untested oil column which is pressure isolated from the 16/3a-4 accumulation. Reservoir pressures in both of these wells are higher than in the Brae Formation reservoirs of North Brae and East Brae. This, combined with the fact that the hydrocarbon in 16/3a-4 is oil rather than gas condensate as in North Brae and East Brae, suggests a relatively restricted reservoir extent and a local source for the oil from the Kimmeridge Clay adjacent to Balfour.

*Trap type*
The trap can clearly be seen on seismic at Top Brae Formation but the origin of the trap is unknown. It may have been formed by compactional drape over a thick Brae channel or by structural inversion along the graben bounding fault. The structure has an area of approximately 500 acres and relief of 200 feet at base Cretaceous, see Figure 5 and Figure 6.

*Reservoir*
The Brae Formation reservoir encountered in the well was tight conglomerates with an average 8.7% porosity, see Figure 7.

*Seal*
The seal for this discovery is provided by shales of the Kimmeridge Clay Formation.
Figure 5  Base Cretaceous Depth Structure Map. Red line indicates seismic in Figure 6

Figure 6  SW-NE seismic Line across Balfour
Figure 7  Upper Jurassic sections drilled in wells 16/3a-4 and 16/3a-6.

Reserves Summary

**Drum**
The Hugin Formation has been regarded as the main reservoir target at Drum. A probabilistic range of wet-gas-in-place volumes has been calculated as – P90 11 bcf, P50 30 bcf, Mean 40 bcf and P10 84 bcf.

**Balfour**
Deterministic reserves on Balfour are calculated at 4mmbo.
References
