THE BALVENIE PROSPECT
UKCS OFFSHORE PRODUCTION LICENCE P2331

FARM-IN OPPORTUNITY
DECEMBER 2018

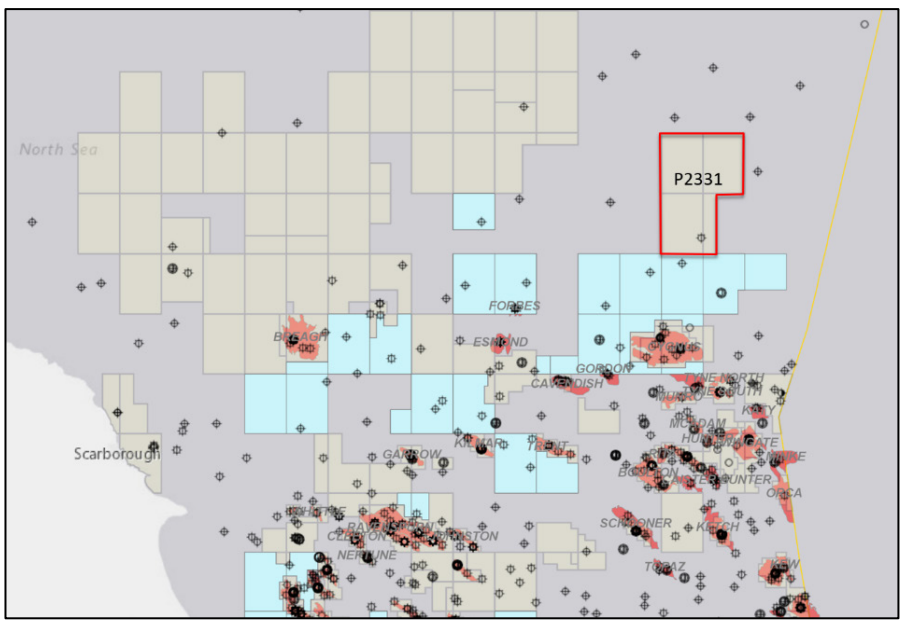
OFFSHORE UKCS
PRODUCTION LICENCE P2331 – BALVENIE PROSPECT
LOW COST - HIGH IMPACT OPPORTUNITY

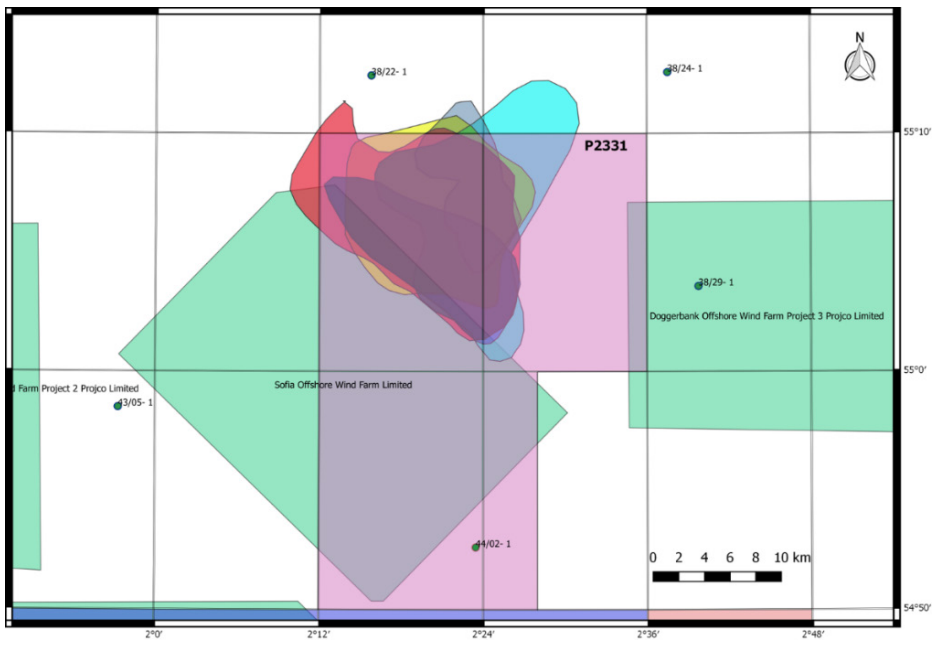
Draupner Energy is pleased to offer the opportunity to explore the very large multi-target Balvenie prospect in the UK sector of the Southern North Sea (SNS). The main potential - in excess of 1 tcf of recoverable gas - has been identified in Zechstein Hauptdolomit carbonates with additional potential in other formations, particularly the Devonian and fractured Basement. Due to a favourable gas charge and reservoir development location and there being a multi-target prospect, there is the rare opportunity of both a high-volume potential and relatively low geological risk. Having recognised the high potential within this play, Draupner Energy has applied for additional acreage nearby P2331 in the 31st Licensing Round containing the Durham Hauptdolomit prospect with follow-up potential of ca. 0.75 tcf recoverable gas (pending licence award).

1. Introduction

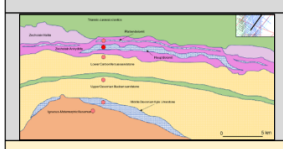
Production licence P2331 was awarded on 15 May 2017 to Draupner Energy Limited ("Draupner Energy") in the 29th Seaward Licensing Round. The license consists of blocks 38/27, 38/28, 44/2 and 44/3a and totals 791 km^2. P2331 is located on the south-eastern part of the Mid North Sea High ca. 40 km north of the Cygnus field, one of the largest producing gas fields on the UKCS.

The initial term for the licence is 9 years, with a firm phase A and optional phases B and C, each with a length of 3 years. The firm phase A work commitment consists of obtaining 2,000 km legacy 2D seismic and all well data relevant for the area, and complete G&G studies. Draupner Energy has completed the phase A work commitment by obtaining more than 5,800 km additional 2D seismic data and data for 5 more wells and has completed G&G studies (seismic interpretation and mapping in time and depth, source rock modelling, reservoir evaluation, and prospect evaluation). The results of these studies have revealed a very large remaining hydrocarbon potential in a multi-target 4-way dip closure named Balvenie, which is located in the northern part of the licence. Balvenie has hydrocarbon potential in up to six different formations, with the Zechstein Hauptdolomit as the primary objective with a mean potential of 1,160 bcf of recoverable gas at a depth of ca. 2000 m. Additional potential of the same magnitude is present in a deeper sequence comprised of Upper Devonian Buchan sandstones, Middle Devonian Kyle carbonates and fractured Basement at ca. 2400-2700 m depth.





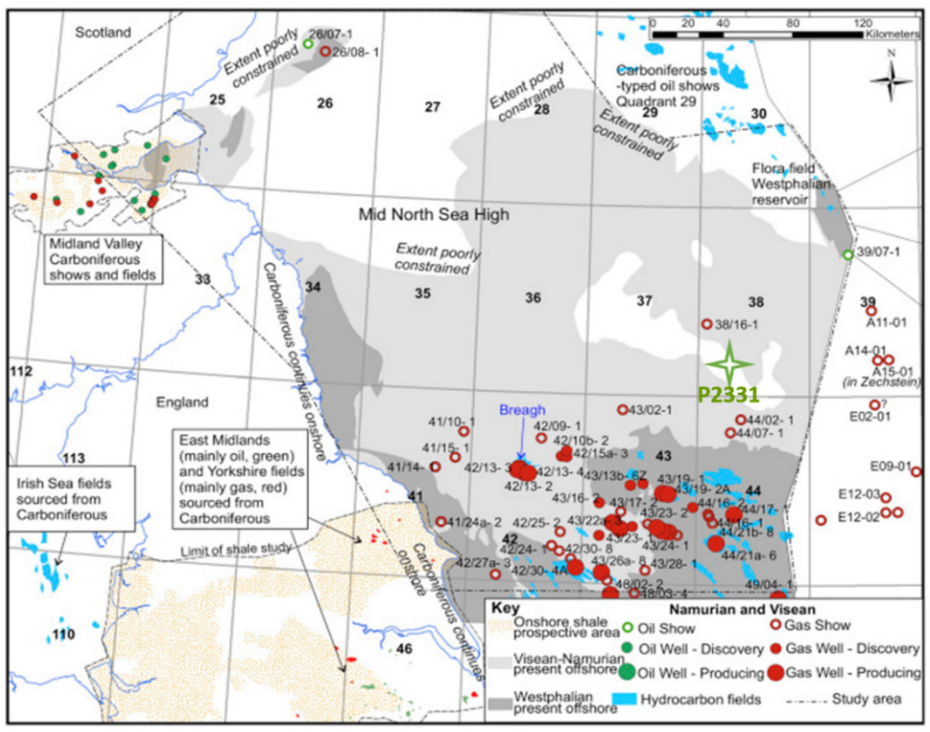
Draupner Energy has also applied for additional acreage in the 31st Licensing Round where the Durham prospect was identified and evaluated. As for the Balvenie prospect, the main target in Durham is the Hauptdolomit carbonates with a mean recoverable potential of 723 bcf gas, with upside in Upper Zechstein carbonates and Lower Carboniferous sandstones. In an ultimate success case the Balvenie and Durham prospects could yield ca. 3 tcf of recoverable gas.

Target	Lithology	Mean Recoverable Gas Volume (bcf)	
		P2331 Balvenie Prospect	31st Round Acreage Durham Prospect
Upper Zechstein Plattendolomit	Dolomite	398	265
Middle Zechstein Hauptdolomit	**Dolomite**	**1160**	**723**
Lower Carboniferous Scremerston	Sandstone	42	107
Upper Devonian Buchan	Sandstone	870	-
Middle Devonian Kyle	Limestone	312	-
Fractured Basement	Granitic	1271	-

P2331 is located in shallow water (ca. 30 m), near existing gas production and export infrastructure with spare capacity for a potential tie-back development. The Balvenie prospect is located outside of the planned offshore wind farms in nearby areas and can hence be explored and developed without interfering with these projects.

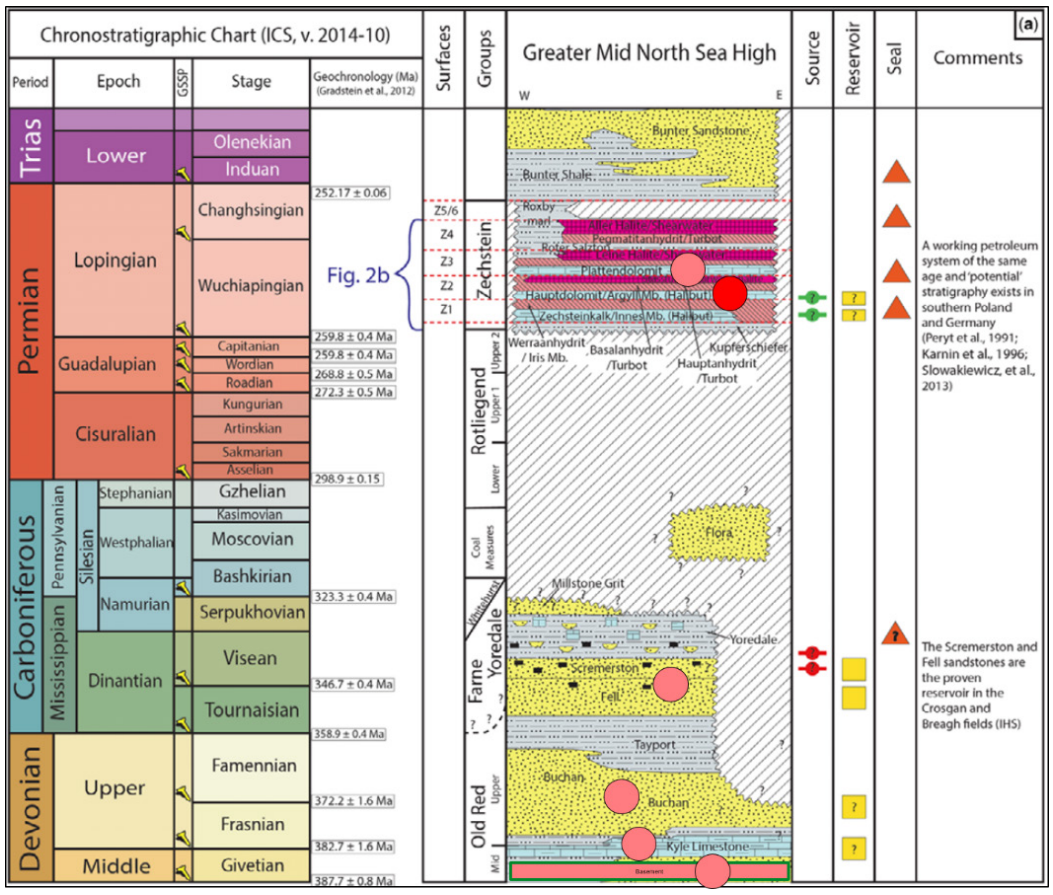
2. Regional geology and main petroleum plays

The area covered by P2331 is located in the SNS and geologically part of the large positive structure called the Mid North Sea High. The southern North Sea sedimentary basin originated in Devonian times following the collapse of the Caledonian orogeny. The proven petroleum systems are located within the Upper Paleozoic and lowermost Mesozoic and the petroleum activity in the area is dominated by gas production from Upper Paleozoic and Triassic plays. The primary reservoirs are the Lower Permian Leman and Rotliegendes sandstones (e.g. the Leman Field), the Lower Triassic Bunter sandstone reservoirs (e.g. the Gordon Field), and Upper Carboniferous sandstones (e.g. the Cygnus Field), with minor production from Lower Carboniferous sandstones (e.g. the Breagh Field) and Upper Permian Zechstein dolomites (e.g. the Hewett Field). Yet unproven plays may exist in the clastics and carbonates of the Devonian interval and possibly fractured/weathered Basement.



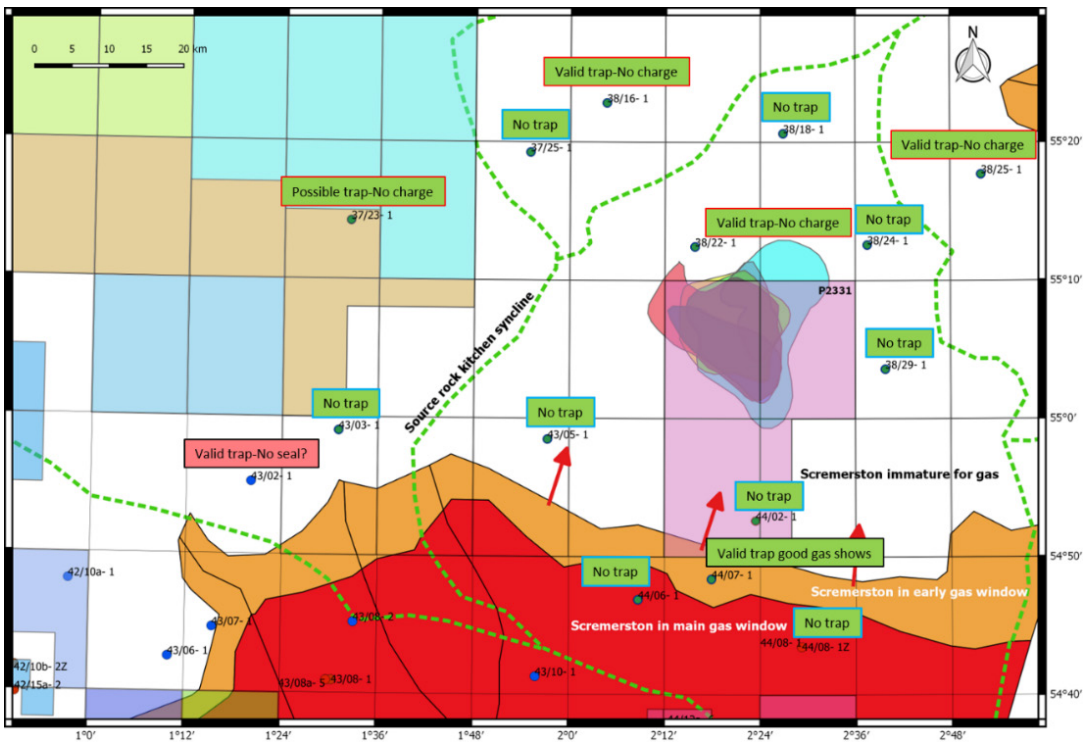
Gas and minor condensate is sourced from the Upper Carboniferous coals and organic rich shales of the Westphalian coal seams with some contribution from the Lower Carboniferous Scremerston Formation (e.g. Breagh). A Devonian source rock has been proven in the Inner Moray Firth area (e.g. the Beatrice

Field) but has not yet been proven in the SNS. The Upper Permian basal Zechstein Marl Slate (Kupferschiefer) has excellent oil potential but is thin (only a few meters) and has only generated small amounts of hydrocarbons. The area is hence primarily dominated by good quality dry gas with minor amounts of CO_2 and N_2 and a low content of H_2S. Most of the hydrocarbon accumulations are structural in nature, *i*.e. they have a 4-way dip closure at top reservoir. A stratigraphic trap component has been reported for some fields, with the coals and shales of the Carboniferous creating base seals in truncation traps. Accumulations in the Zechstein Hauptdolomit and Plattendolomit rely on anhydrite or halite top seals and potentially side seals. The Upper Permian Zechstein evaporites also provide the main top seal for the Lower Permian and Carboniferous reservoirs with Carboniferous intraformational seals creating stacked pay zones in fields like Cygnus.



3. Exploration history and dry wells review

The Mid North Sea High was the scene for some of the earliest offshore hydrocarbon exploration starting in 1964 (well 38/29-1) and the drilling of 13 exploration wells before 1970. At this time the seismic data was widely spaced, and of poor quality with no reliable image below top Zechstein. The pursued plays were mainly based on analogy with the discoveries made in the Netherlands, predominantly in Permian clastics and carbonates with the Carboniferous as an upside. None of these wells were successful although shows of gas and some oil were encountered in some of the wells. In hindsight many of the operators concluded that they had drilled outside structural closure (e.g. well 38/29-1) and hence had not performed a valid test of the petroleum potential. With the advent of better-quality seismic data and the discovery of large gas fields on the UKCS farther to the south (e.g. Gordon, Cygnus) five more exploration wells were drilled between 1983 and 1994, but still with limited technical success and no commercial success. Prior to applying for acreage Draupner Energy performed a dry hole analysis and concluded that most of the wells failed due to the lack of a structurally closed trap. This work was subsequently updated after the award of P2331 and regional re-mapping of the area. The conclusion of this work supported the earlier conclusion but provided more detail: none of the wells located south of P2331 drilled structural 4-way dip closures



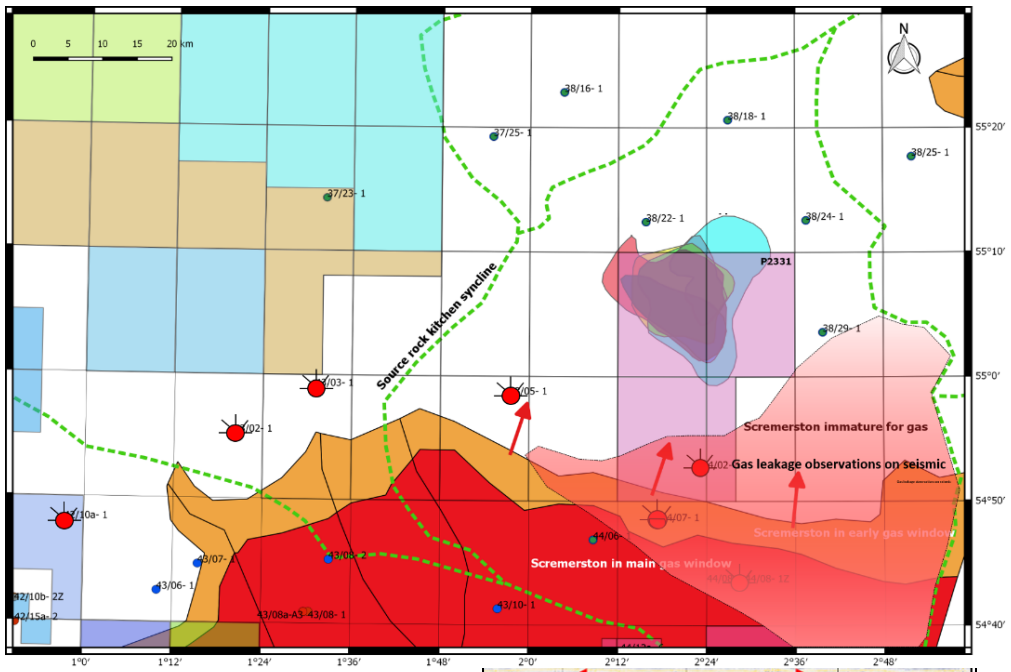
except for well 44/7-1, which however has excellent gas shows and a meter of oil in the cored Zechstein dolomites. The lack of success in wells drilled to the south of P2331 is hence likely to be due to the lack of valid closures, as a major gas generating area ("kitchen") is located south of P2331.

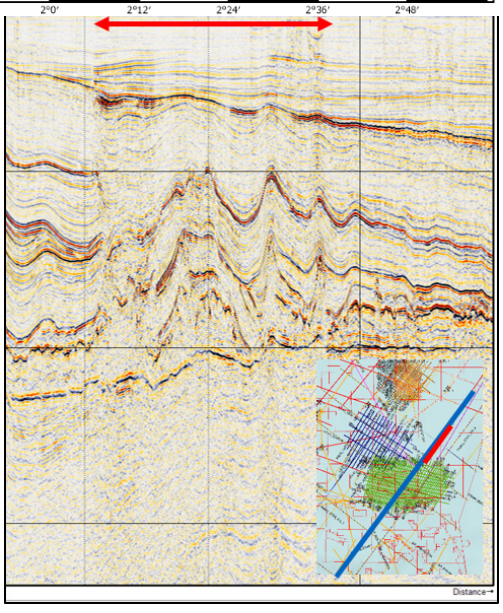
To the north of P2331 some wells were also drilled on targets without valid closures, however at least three of the wells drilled valid 4-way dip closures and had adequate reservoir properties but still failed to prove significant hydrocarbon occurrences, hence failure must be attributed to either seal failure, or lack of hydrocarbon charge, the latter being more likely.

4. Remaining prospectivity

4.1 Source and charge

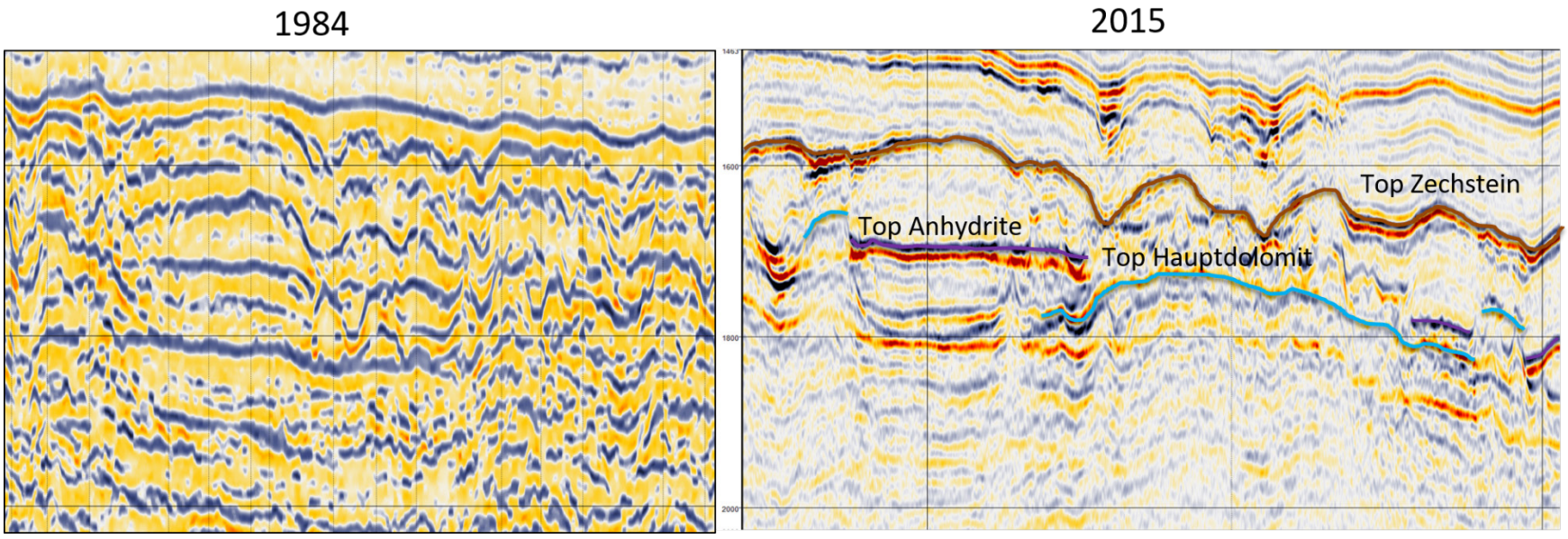
A very large gas generating kitchen area is located ca. 25 km south of the Balvenie prospect. The primary source rock is the Lower Carboniferous Scremerston Formation which contains coals and organic rich shales with TOC of up to 40% and HI of typically 250 (mgHC/gTOC). The median total amount of generated gas in the drainage area for the Balvenie prospect has been calculated to 135 tcf, providing a very large gas charge supply to Balvenie which has a most likely gas-in-place volume of about 1.5 tcf and maximum 7 tcf, hence an oversupply of 20-90 times the prospect volumes. The gas charge effectivity of the Scremerston Formation and active gas migration is further supported by the occurrence of gas shows in all wells south of P2331. As mentioned above, none of these wells except 44/7-1 did test valid 4-way dip closures and this is regarded as the reason for failure. Amplitude bright spots indicative of gas occurrence and leakage have been observed on seismic in an area stretching from well 43/5-1 in the west to 38/29-1 to the east and into the Dutch sector, further supporting the existence of active gas generation and migration. Migration of gas into the Balvenie prospect is rather straightforward with gas moving updip to the north and up-stratigraphy to the base of Zechstein evaporites. Charge into the Hauptdolomit can occur where it is located close to the base of the Zechstein group as seen in e.g. wells 44/7-1 and 44/2-1, alternatively farther north through a network of fracture systems. Onshore outcrops of the Roker Formation (local name for Hauptdolomit) show spectacular collapse breccias, and these breccias have also been seen in core specimens from e.g. well 38/24-1. These features may well have acted as gas migration conduits from the base Zechstein into the Hauptdolomit.





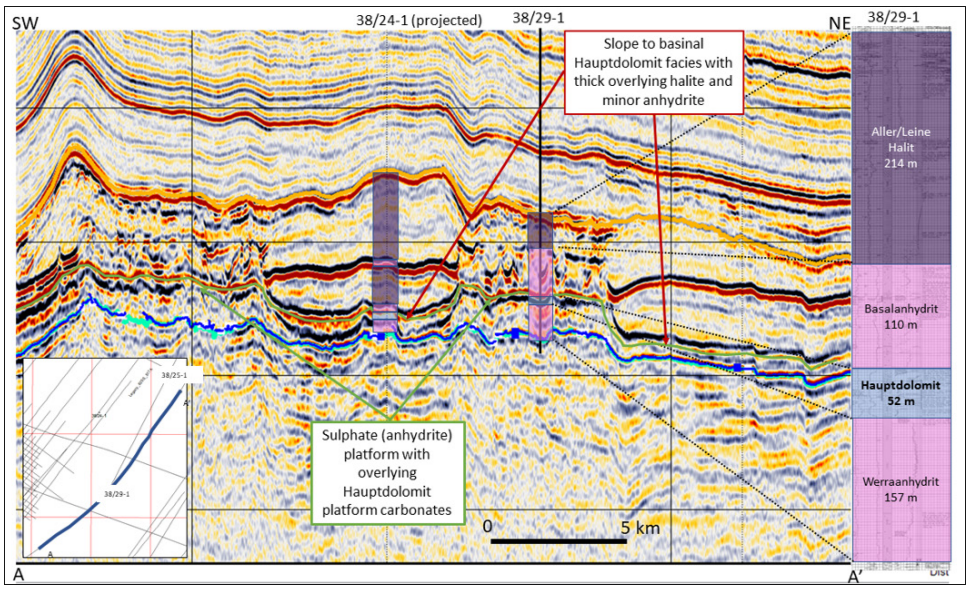
4.2 Seismic data quality, seismic stratigraphy and reservoir mapping

From the advent of exploration drilling in the early 1960's until the mid-1980's the seismic data quality in the area was generally poor, and only allowed adequate mapping of the top Zechstein and shallower horizons with confidence, and the targeted intra-Zechstein and sub-Zechstein targets were mainly based on an expected conformity with the top Zechstein.



As mentioned earlier, this approach failed. The reason for this is three-fold:

1. Firstly, the Hauptdolomit reservoir is best developed on paleo sulphate platforms with thin or no halite overburden, flanked by basinal areas with thick halite. Subsequent compressional structuration and halokinesis created structural closures at top Zechstein level preferably where there is thick halite, i.e. in basinal areas. Hence many wells targeting top Zechstein closures drilled through paleogeographic lows with only thin and poorly developed Hauptdolomit facies.
2. Secondly, the compressional structuration process created several top Zechstein closures that are not underlain by Hauptdolomit closures and vice versa, i.e. structural lows at top Zechstein level are often underlain by structural highs at top Hauptdolomit level, hence a number of Hauptdolomit closures remain undrilled (e.g. Balvenie).
3. Thirdly, the large lateral seismic velocity variations within the Zechstein evaporite sequence often leads to incorrect identification of sub-Zechstein closures on seismic time maps and even after depth conversion they remain elusive, with much uncertainty related to actual location and closure size.

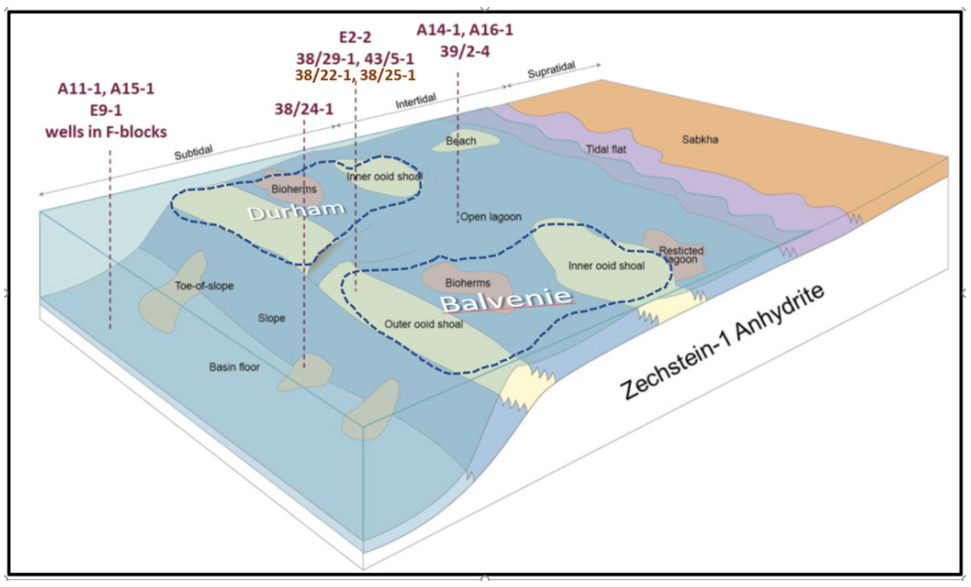


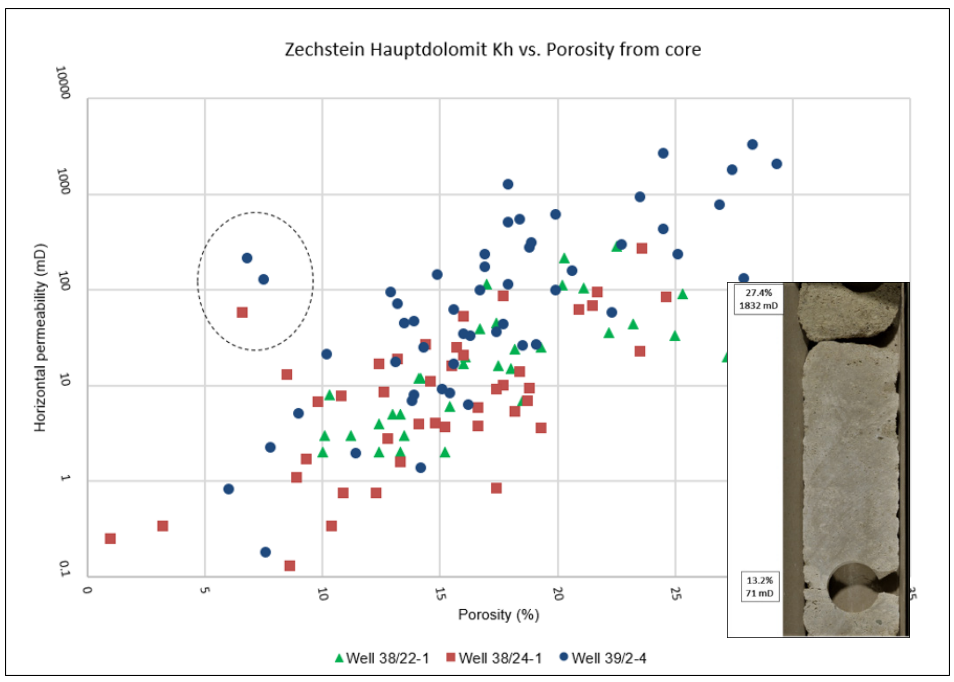
With the help of the 2015 broadband seismic data provided by the OGA in 2016 a clear Zechstein picture emerged allowing the identification of the main units and establishment of a seismic stratigraphic and geological framework. Sulphate platforms with well-developed Hauptdolomit platform dolomite facies could now easily be identified and mapped with confidence, also using vintage data calibrated with the high quality OGA data. The OGA data also made mapping of top basement and the identification of Mid-Devonian Kyle carbonates an easier task. The top of the Upper Devonian Buchan Formation cannot be mapped directly due to the lack of good reflectors and poor seismic quality at this level but has been inferred from geometric interpolation between the Base Zechstein and top Basement which both were better imaged on the OGA data.

4.3 Reservoir and top seal pairs

4.3.1 Zechstein Hauptdolomit

The best reservoir in the area is the Zechstein Hauptdolomit with a thickness of typically 40-65 m. It consists mainly of platform carbonates deposited as ooid and oncolite shoals in a platform and lagoon setting with local stromatolite development. The rocks are heavily dolomitised resulting in enhanced porosity and permeability. These rocks outcrop onshore in Northeast England allowing detailed investigation of the lateral and vertical facies relationships as well as fracture patterns. Field studies in England have shown good lateral extent of the carbonate platform facies for at least 15 km with a thickness close to what is seen offshore in our area of interest, ca. 50 m. These field studies, seismic stratigraphy and well core studies support the existence of large continuous platform reservoirs overlying the seismically mappable sulphate platforms in our area of interest.





Both offshore well data and onshore outcrops show good porosity of up to 25% and averaging ca. 16% with an average permeability of ca. 50 mD, with a good porosity-permeability relationship. Locally, the permeability is enhanced by fractures giving anomalously high permeability also in low porosity rocks. The Hauptdolomit is locally intensively fractured mainly by sets of near vertical fractures. The fracture patterns are well exposed in cliff exposures onshore and observed in core data, however because of the largely vertical nature of these fractures they are easily missed by a vertical wellbore. Drill stem tests performed in wells 38/16-1 and 44/7-1 with up to 1,440 bwpd support the flow potential of these reservoirs. Drilling of the Hauptdolomit in well 44/7-1 was also characterised by severe circulation losses indicative of permeable/fractured formation. The Hauptdolomit is overlain by anhydrite and/or halite belonging to the Basalanhydrit and Stassfurt Halite, respectively, representing excellent top seals for retainment of hydrocarbons.

4.3.2 Secondary reservoirs

Plattendolomit and Lower Carboniferous

In addition to the Hauptdolomit, dolomites and limestones with reservoir potential are occasionally also present at higher and lower stratigraphic levels within the Zechstein Group, namely the Plattendolomit (younger) and Zechsteinkalk (older). They are normally thin (ca. 10 m or less) and it has not been possible to map these potential secondary targets with the current database, and the Plattendolomit volume potential has been estimated using an iso-shift from top Zechstein. The Zechsteinkalk is located at the base of the Zechstein Group and may constitute an additional reservoir overlying truncated Lower Carboniferous sandstones, however, we have only been able to identify low relief closures with a limited volumetric potential at this level and hence not calculated any volumes for the Zechsteinkalk.

Devonian Buchan and Kyle, and Basement

The lowermost sedimentary package sequence consists of the Upper Devonian Buchan Formation sandstones and the Middle Devonian Kyle Formation limestones which overlie fractured/altered Basement. As the structural closures in Balvenie broaden and increase in size with depth below base

Buchan Formation

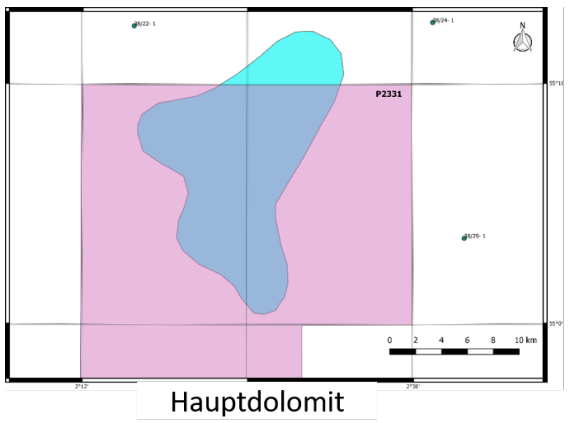
Kyle Formation

Fractured Basement

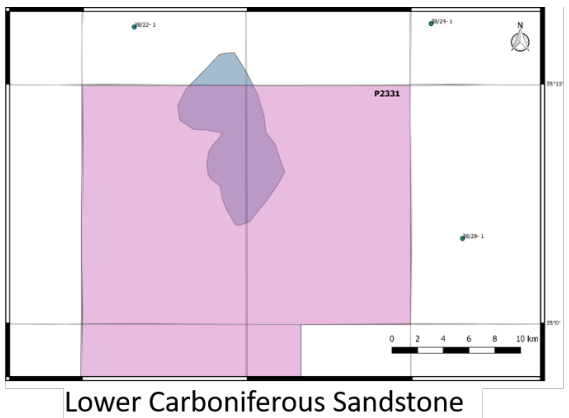
Zechstein, these reservoirs represent volumetrically interesting targets with a potential ranging between 312 bcf and 1277 bcf recoverable gas. Both the Buchan and fractured Basement are technically proven plays on the UKCS, and well 37/25-1 located northwest of P2331 penetrated the Buchan with fair porosity and had elevated gas shows in Basement rocks. The Kyle remains an unproven play but has producing analogues in the Timan-Pechora Basin in Russia as well as in western Canada. These formations all have low porosity mainly due to diagenesis, and hence technical and commercial success is dependent on fracture permeability. Within the Balvenie prospect the Buchan/Kyle/Basement package can be targeted by maintaining an option to run an additional casing string and deepening an exploration well by ca. 550 m below the base Zechstein to ca. 2700 m.

5. Trap geometry

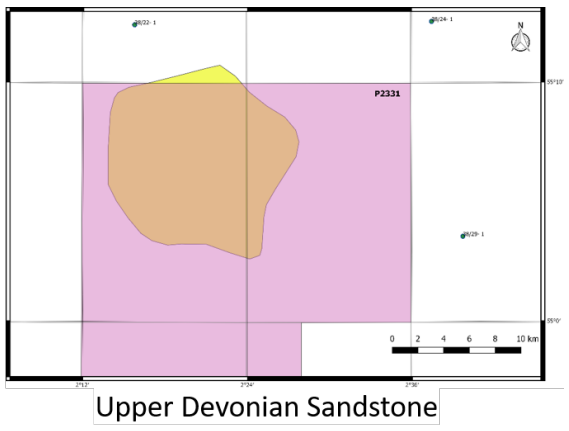
As mentioned above, the recent additional high-quality OGA seismic data allowed detailed mapping of the Zechstein interval with image uplifts also seen in deeper strata near top Basement level. After horizon interpretation, time maps were constructed, and depth converted in OpendTect Pro software. The velocity field was based on well check shot data averaged within the main lithological units and interpolated using seismic horizon constraints.



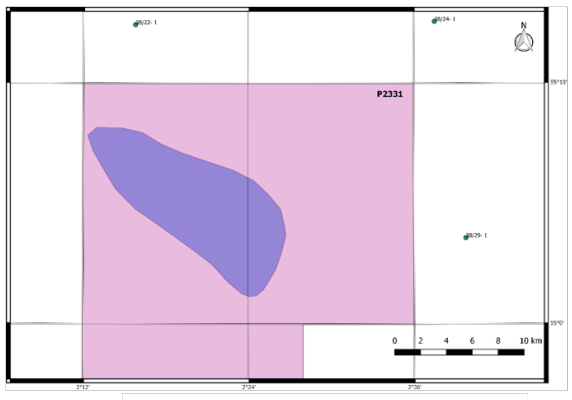
Hauptdolomit



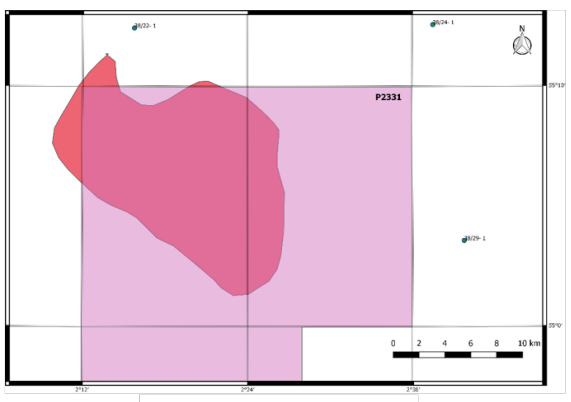
Lower Carboniferous Sandstone



Upper Devonian Sandstone

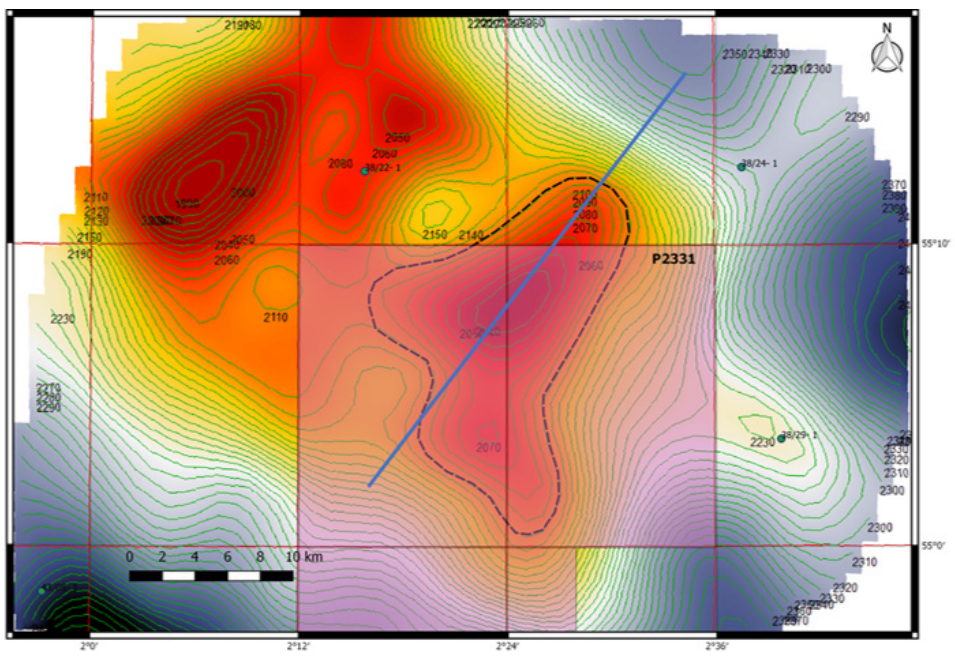


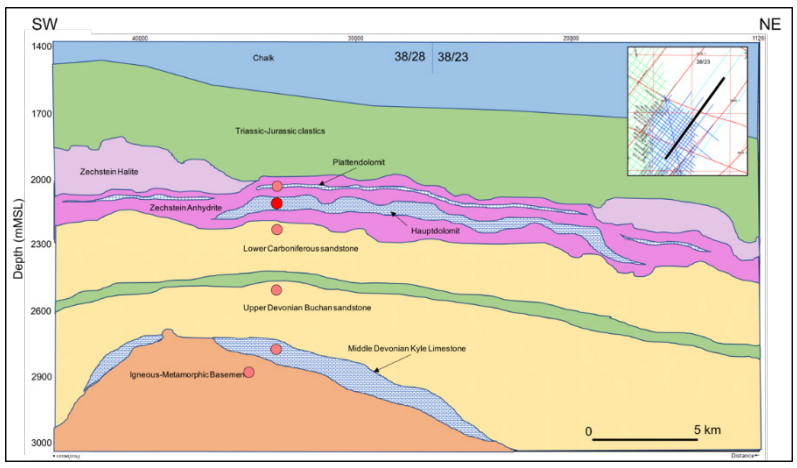
Mid-Devonian Kyle Limestone



Fractured Basement

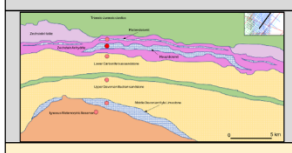
The resulting 4-way dip closures are very large, ranging between 97 km^2 and 197 km^2 with closure heights of 80 m or more, except for the Lower Carboniferous which is ca. 59 km^2 with ca. 35 m closure height. The Hauptdolomit structural depth map shown here has a well-defined closure of 178 km^2 with 80 m closure height. Except for the Plattendolomit, all targets are largely superimposed and can probably be targeted with a single exploration well.





6. Balvenie Prospect Summary and Way Forward

Through comprehensive geological and geophysical work, the P2331 Balvenie prospect has been matured into a High-Impact opportunity with more than a tcf of recoverable gas potential in its primary Hauptdolomit target and an equally large additional prize in its secondary Buchan/Kyle/Basement targets. Additional follow-up upside is represented by the Durham prospect located in acreage applied for in the 31st Round.

Target	Lithology	Mean Recoverable Gas Volume (bcf)	
		P2331 Balvenie Prospect	31st Round Acreage Durham Prospect
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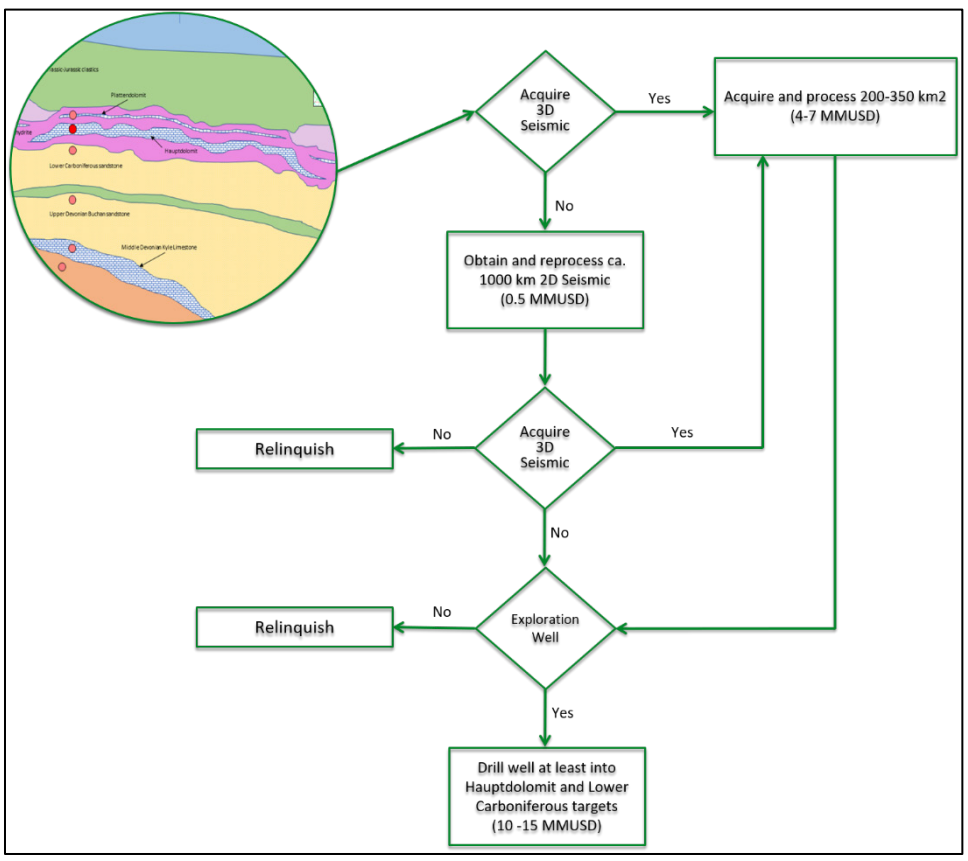

Draupner Energy now invites companies to join in to mature the Balvenie prospect further through additional seismic data acquisition. The preferred way forward is to acquire at least 200 km^2 and preferably ca. 350 km^2 3D seismic to reduce uncertainty on the extension and geometry of the Hauptdolomit target, improve the depth conversion model and reduce risk related to trap geometry and reservoir extent, thickness and properties. The acquisition of 3D seismic may be done in a traditional proprietary fashion but costs may alternatively be reduced, and risk shared through multi-client arrangements or other commercial arrangements. An alternative way forward is to mature Balvenie further by obtaining all available 2D seismic field data, reprocess and re-interpret the reprocessed seismic, and mature the Balvenie to drilling without acquiring 3D seismic data. This will be a lower cost option but inevitably carries a higher risk of a poorer pre-drill resource estimate and/or misplacing an exploration well. The farm-out process is as follows:

- Data package and data room available after signing of Confidentiality Agreement
- Timing: 12 December 2018 – 30 April 2019
- Deals can be made at any time on a *first come – first* serve basis
- Equity is available in exchange for coverage of historic costs, carry on work program elements, and/or a cash offer
- Available equity will be proportional to the cost of the work program elements agreed upon

Bid preference order:

- Full carry on 3D seismic acquisition and processing
- Coverage of historic costs and full carry on obtaining and reprocessing 2D seismic
- Cash offer

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Figure references

1. **Introduction**
   Figure 1 (Overview map): © Crown copyright 2015
2. **Regional geology and main petroleum plays**
   Figure 1 (MNSH map): *From* Monaghan, A.A., et al., 2017: Carboniferous petroleum systems around the Mid North Sea High, UK.
   Figure 2 (Stratigraphic column): *Modified from* Patruno, S., et al., 2017: New insights into the unexploited reservoir potential of the Mid North Sea High (UKCS quadrants 35–38 and 41–43): a newly described intra-Zechstein sulphate–carbonate platform complex.

4.3.1 Zechstein Hauptdolomit

Figure 2 (Depositional model block diagram): *From* EBN, 2016: Zechstein Carbonates revisited, new insights and new changes for an old play. *Dutch Exploration day 2016*

All core photographs from British Geological Survey materials © NERC

All seismic sections: © Crown copyright 2015

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