

Exploration watch

West of Shetland: Space for independents?

West of Shetland remains the least-developed area of the UKCS despite the first significant discovery occurring there almost 40 years ago. A combination of technical challenges means the region has remained relatively immature, with an estimated 95% of resources yet to be developed. Until recently only three fields, the BP-operated Foinaven/Loyal and Schiehallion, were in production. Joined in early 2016 by Total's Laggan-Tormore gas field and Premier's Solan project, only the latter is a notable successful development by an independent to date. However, recent independent activity includes Hurricane Energy's appraisal of the 207mmboe Lancaster discovery and Chrysaor's Mustard discovery within tie-back distance of Solan.

Infrastructure is key

West of Shetland is a technically challenging region, with deep water of up to 1,500m in places and extreme metocean conditions that necessitate a restricted operating window. In addition, the region had to wait for advances in seismic technology and a build-up of detailed geological knowledge for success rates to improve in the area. The lack of infrastructure remains a key barrier to commercial success, particularly for gas discoveries, with the Laggan-Tormore gas pipeline the first in the region. However, the independents covered in this report hold licences that are clustered together and could be developed as hubs in the case of success.

Independents active in the 28th round

In the 28th Offshore Licensing round, licences were awarded to just three independent operators:

Hurricane Energy is focused on fractured basement plays in the UKCS, recognised as a key underexplored region by the Oil & Gas Authority (OGA). The company is focusing on developing Lancaster, having established commercial rates from horizontal appraisal well 205/21a-6 in 2014, and is now seeking a farm out to fund an Early Production System (EPS). Beyond Lancaster, analogous prospects Lincoln and Warwick sit within tie-back distance of the proposed EPS.

Parkmead Group is at an earlier stage of development with prospects Davaar, Sanda North and Sanda South clustered together and with combined P50 recoverable resources of 312mmbbls. Identified from similar AVO anomalies to that seen in Foinaven/Schiehallion, work is ongoing to de-risk the prospects.

Chrysaor is a private company and operator of the Mustard oil discovery, announced in September 2015. The company is reviewing the well data before releasing any resource estimates. Mustard sits 15km east of the Solan development and could be tied back in the case of commerciality.

11 January 2016

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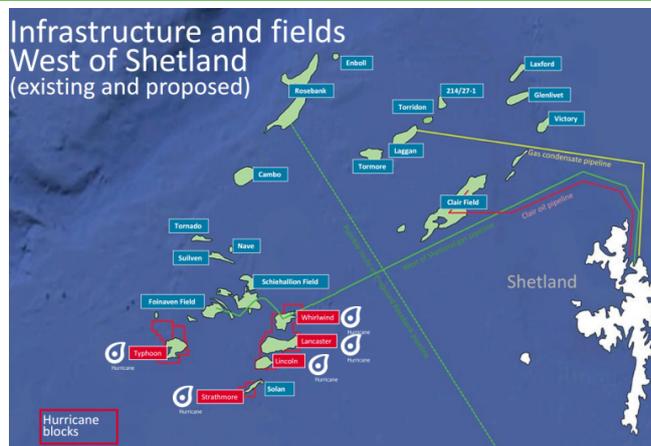
EXPLORATION WATCH

A periodic look ahead from our in-house petroleum engineer, Elaine Reynolds, focusing on interesting exploration activities with significant potential impact on E&P equities.

West of Shetland: Remains underdeveloped

Exploration drilling began in the West of Shetland area in the 1970s, with the Clair field being the first significant discovery in 1977. Even so, it was another 20 years before any oil was produced from the region when the Foinaven and Schiehallion fields were brought onstream in 1997 and 1998 respectively. To date these remain the only fields in production West of Shetland and all are operated by supermajor BP. By early 2016, however, two further fields are due to come onstream; Premier Oil's Solan field and the region's first gas/condensate development, Total's Laggan/Tormore. Meanwhile, the sanctioning of Chevron's 240mmboe Rosebank, believed to be the largest undeveloped discovery West of Shetland, was postponed in 2013 while the company looked at ways to reduce development costs.

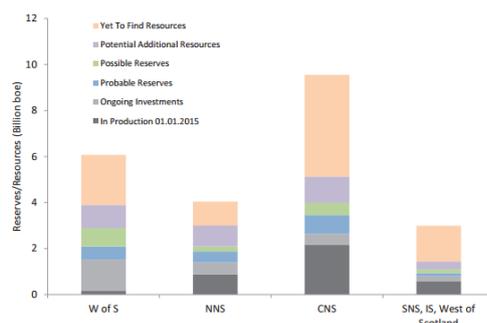
Exhibit 1: West of Shetland infrastructure and fields (existing and proposed)



Source: Hurricane Energy

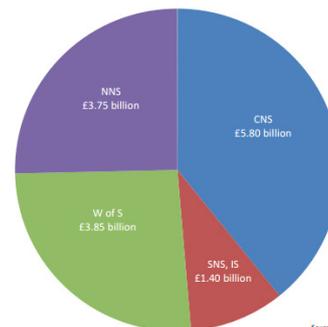
The area is therefore relatively immature, with 95% of its resources yet to be developed. From Exhibit 1, it can be seen that the Central North Sea is estimated to hold greater yet-to-find resources; however, it is believed that there is greater potential for individual discoveries to be of a more significant size in the West of Shetlands, and the region attracted £4bn of capital investment in 2014, second only to the Central North Sea in the UKCS. Here we look at the particular challenges that have led to the slow pace of development West of Shetland and assess the outlook for independent companies operating in an area that has been dominated by major companies. In particular, we look at Hurricane Energy and Parkmead Group, which, along with private company Chrysaor, were the only independent operators to be awarded acreage West of Shetland in the recent 28th Offshore Licensing round.

Exhibit 2: UKCS reserves and resources growth by region



Source: Oil & Gas UK, DECC

Exhibit 3: Capital investment by UKCS region in 2014



Source: Oil & Gas UK

Technically demanding

There are a number of technical challenges to operating West of Shetland that are not present in other sectors of the North Sea. The area is mainly, though not exclusively, a deep-water environment with water depths greater than 1,500m in places. Metocean conditions are extreme, and activity is restricted to a six-month operating window, requiring more expensive specialist deep water rigs as well as resulting in delays to exploration programmes.

Initial exploration in the region concentrated on drilling simple tilted fault blocks on structural highs on the assumption that the geology would be analogous to that found in the rest of the North Sea, rather than being based on detailed geological knowledge. This resulted in a string of failures due to the presence of non-reservoir quality sands, with the exception of Clair which, although successful, was not brought onstream until 28 years after discovery due to a combination of the challenging fractured and compartmentalised reservoir and the technical limits of the time.

In the 1990s, exploration interest switched to stratigraphic traps in the Paleocene, encouraged by the play opening Foinaven discovery in 1992 and made possible by advances in seismic technology and deep water drilling. The subsequent 16th round in 1995 saw a high level of interest in the West of Shetlands. Very few of the resulting wells drilled to test pinch-out plays were successful, however, although the area benefitted from this renewed interest with the acquisition of significant 3D seismic data. This led to the search for seismic characteristics similar to those found in Foinaven and Schiehallion. However, the drilling of seismic anomalies in the area has often been unsuccessful, with direct hydrocarbon indicators turning out to have different causes. Today it is generally accepted that an integrated geological and geophysical evaluation is needed to minimise the risk associated with drilling such anomalies. Sparse well control remains an issue, with few offset wells available for seismic calibration.

A further challenge to drilling is the presence of a thick basalt layer over the north-western flank of the region, which absorbs and scatters the seismic energy used to image reservoirs below. The problem is similar, although more complex, to that encountered with sub-salt imaging in the Gulf of Mexico. Efforts to provide improved images focus on generating, retaining and enhancing as much low frequency energy as possible. In the Rosebank field for example the reservoir sands are situated both below and inter-bedded with basalt layers, and techniques such as ocean bottom seismic nodes have been used to try to improve the sub-basalt imaging.

Lack of infrastructure holding back development

Foinaven and Schiehallion were brought onstream in 1997 and 1998 respectively, only five years after discovery. This has not been typical for the region, however, with the only other producing field, Clair, taking 28 years to first oil. Imminent project Solan was initially discovered in 1990, while Laggan was discovered in 1986 and had to wait for the 2007 Tormore discovery to be considered commercial. Meanwhile, the 240mmboe Rosebank field, expected to take around seven years to first oil when first discovered in 2004, has yet to be sanctioned.

Key to this rate of development is the lack of infrastructure in the region. Exhibit 1 shows that, at present, only two pipelines are in operation: the west of Shetland gas pipeline, connecting Foinaven and Schiehallion to Sullom Voe and the Clair oil pipeline. Laggan/Tormore will be the first gas development in the area and will export gas/condensate via a new pipeline when it comes onstream in early 2016. This in turn will unlock the development of Glenlivet, planned to be tied back to Laggan/Tormore in 2017 and followed by Edradour, to be tied back to Glenlivet in 2018. Similarly, the potential development of Rosebank will require a new gas pipeline and would allow nearby discoveries Cambo and Tornado to be exploited.

Infrastructure remains project related and not strategic, to the detriment of currently stranded discoveries. This is not specific to West of Shetland, but an issue across the UKCS. The Wood

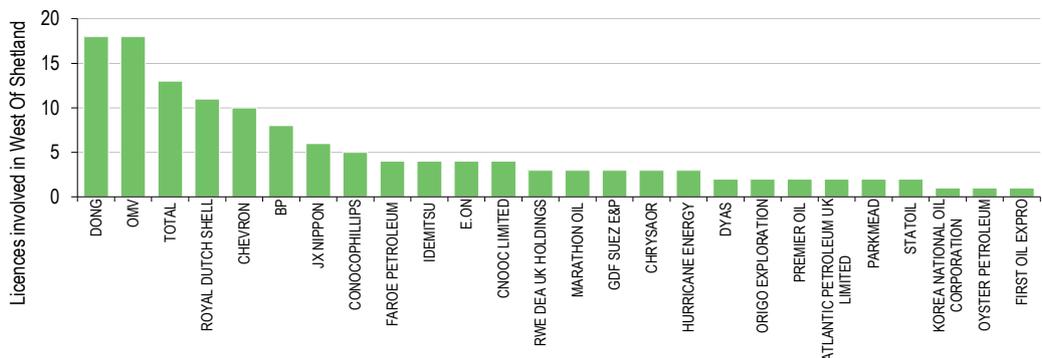
Review, published in 2014, highlighted this as a key industry concern and, in response, the OGA was established in 2015 with greater powers to encourage infrastructure sharing and cooperation between companies. It is too early to tell if this will be sufficient to improve the situation, but we expect that any initial shifts in infrastructure sharing and planning strategy will occur in the more densely developed areas of the North Sea.

Companies with exposure to West of Shetland

Activity West of Shetland is dominated by major companies, as can be seen in Exhibit 4. DONG Energy and OMV hold the most licences in the area and both view the region as core to their businesses. Dong is a partner in eight discoveries: Laggan-Tormore, Rosebank, Edradour, Glenlivet (as operator), Cambo, Tornado and Tobermory and as such is involved in the majority of recent and potential developments in the region. OMV is a partner in Schiehallion and holds 50% WI in Rosebank, although it is looking to reduce this stake by 10-20% as part of a cost-cutting exercise. It is also a partner in Cambo, Suilven and Tornado, which could be developed together as a hub.

Long-time West of Shetland producer BP, together with partners Shell and OMV, has also demonstrated its commitment to the region with a seven year drilling programme that began in 2015 as part of its redevelopment of Schiehallion and Loyal. Project Quad 204 aims to access the estimated 450mmbbls remaining in these fields, at a cost of £3bn. Other major players include Total, the operator of Laggan-Tormore and Chevron, operator of Rosebank and partner in Clair Ridge.

Exhibit 4: Licence holders West of Shetland



Source: DECC, Edison Investment Research

In such a technically demanding and high-cost environment, it has so far been rare for an independent company to succeed West of Shetland. Premier is a notable exception with the Solan development coming onstream in January 2016. The difficulty can be seen in the experience of Faroe Petroleum, a company that was active in the region in recent years. Faroe drilled six exploration wells from 2009, of which two were discoveries, but in 2015 it announced that exploration in the UK Atlantic Margin was no longer a principal focus area, given the relatively low regional success record in recent years and the high costs associated with drilling in deep water.

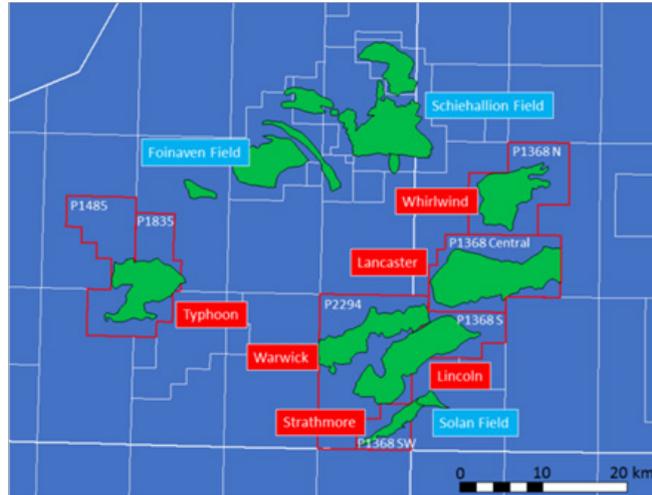
Against this backdrop, three independent companies were awarded licences in the 28th Offshore Licensing round: Hurricane Energy, Parkmead Group and private company Chrysaor.

Hurricane Energy: Fractured basement pioneer

Hurricane specialises in basement plays in the UKCS, and holds 100% of four licences West of Shetland. The company is focusing on developing its key asset, the 207mmboe Lancaster, which was successfully appraised in 2014 with a horizontal well that tested at a stabilised rate of

9,800bopd through an ESP, constrained by surface equipment. Other assets include Lincoln, Warwick, Whirlwind, Typhoon and the sandstone prospect, Strathmore.

Exhibit 5: Hurricane assets map

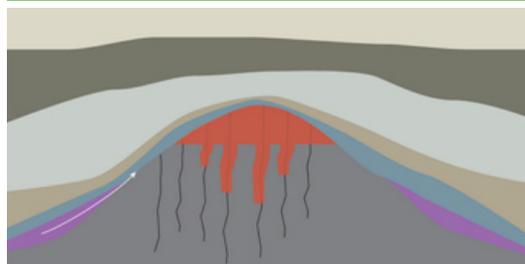


Source: Hurricane Energy

The assets sit along the same basic trend and are mainly located around 85km south-west of BP’s Clair Field on the Rona Ridge, a major NE-SW trending basement ridge between the Faroe-Shetland basin containing Foinaven and Schiehallion, and the West Shetland basin. Since the assets sit on a ridge, they benefit from being concentrated in an area of shallow water of 150m, with the exception of Typhoon, which sits in deeper water of c 450m. The area is also not covered by the thick basalt layer that can affect seismic acquisition and interpretation. The assets are therefore not subject to some of the issues that have affected exploration and development elsewhere in the West of Shetland region.

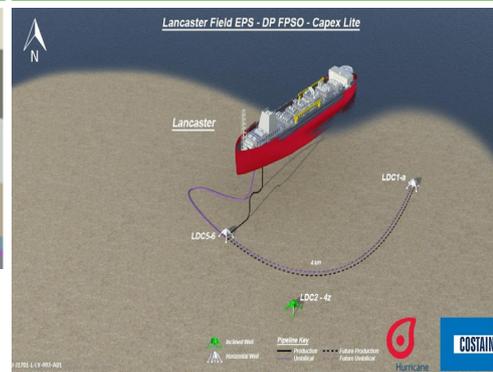
Hurricane is the first and, to date, only company to focus on fractured basement reservoirs in the UKCS. Although still relatively unknown here, it has been developed all over the world, with the closest analogue to Hurricane’s assets being the Bach Ho field in Vietnam. The play has been recognised by DECC and the industry as a key underexplored region of the UKCS. Fractured basement reservoirs are crystalline rock underlying the sedimentary overburden, which exhibit fractures relating to cooling, tectonic processes and fluid movement. As the rock is hard and brittle with low matrix porosity and permeability, oil storage and mobility entirely depends on the fracture network. The extremely long geological history of the Lancaster Field, including numerous tectonic events, has led to the generation of an extensive and extremely well-connected fracture system.

Exhibit 6: Jellyfish model



Source: Hurricane Energy

Exhibit 7: Lancaster EPS Capex Lite



Source: Hurricane Energy

The oil-producing rock forces out hydrocarbons that move up the flank and into the basement through the fracture network. Oil can be found outside structural closure as it backfills down through

the highly permeable fracture network. In the basement there is no permeability in the rock, so the oil cannot escape. Hurricane call this the “jellyfish” model.

Having established commercial rates with its 205/21a-6 horizontal well in 2014, Hurricane is now planning to produce Lancaster through an EPS to provide longer-term production data to support a full field development. The company’s ‘EPS Capex Lite’ scenario would involve producing initially from just one horizontal well, most likely the existing 205/21a-6 and exporting oil via an FPSO. This would be complemented by a second well to be drilled after six to 12 months of production from the first well. Hurricane is seeking a farm out to fund the EPS.

For a more detailed discussion of the technical aspects of fractured basement reservoirs and the Lancaster discovery in particular, please see our [June 2015 initiation report](#).

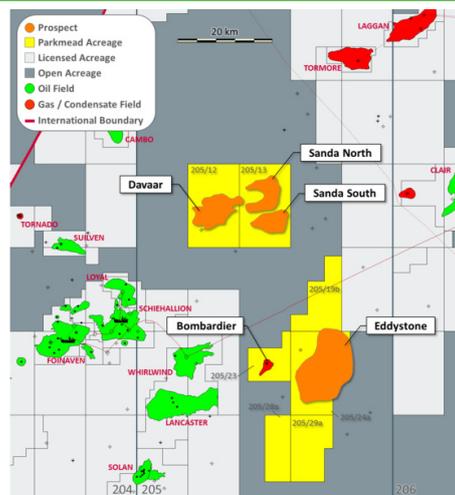
Beyond Lancaster, Hurricane’s portfolio includes the Lincoln and Warwick prospects, both of which are analogous to Lancaster and sit within tie-back distance of the proposed EPS. Lincoln holds P50 prospective recoverable resources of 150mmbbls. To the north of Lancaster, the Whirlwind discovery holds 2C contingent resources of 205mboe in the oil case. Further appraisal is necessary here, however, to establish if the reservoir fluid is volatile oil or gas condensate.

Parkmead Group

Parkmead entered the West of Shetland in the 27th round in 2012, with the award of six blocks covering large prospect Davaar in Block 205/12 (WI 30%) and the Eddystone lead (WI 43%) across Blocks 205/24-1 and 205/25-1. In July 2015, the company was awarded two further West of Shetland blocks in the 28th round, with Block 205/13 (WI 56%) adjacent to Davaar and containing the Sanda North and Sanda South prospects and Block 205/19b containing the northern extension of Eddystone. The company is operator of all of its West of Shetland licences.

Although Parkmead has yet to drill in the area, CEO Tom Cross and the Parkmead team have previous experience drilling in the area with Dana Petroleum, including the Tornado and Anne Marie discoveries. Dana was a partner in the 72mboe Tornado discovery in 2009 and located 30km north-west of Foinaven/Schiehallion. Tornado could be jointly developed with the Cambo discovery. Anne Marie was drilled in 2010 in 1,106m of water and 190km south-east of the Faroe Islands, but although a hydrocarbon column was encountered, the reservoir was not producible.

Exhibit 8: Parkmead West of Shetland licence map

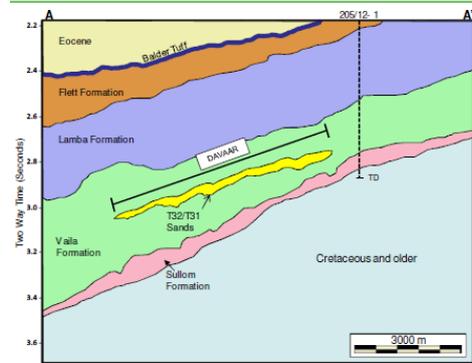


Source: Parkmead

The Davaar prospect sits in around 500m of water in the Faroe-Shetland Trough alongside producing oil fields Foinaven, Schiehallion and Loyal to the south-west and the Laggan-Tormore gas development to the north-east. The primary reservoir in all these fields is the Paleocene Vaila Formation and Parkmead has identified a feature at the Vaila level in Davaar. The area is covered

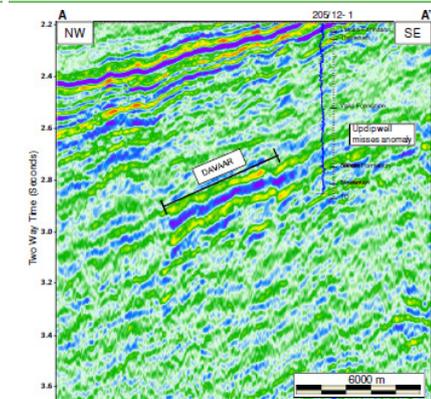
by 551km² of 3D seismic data together with an offset well, 205/12-1, drilled by Total in 1995. The well targeted a similar feature to Davaar, but is now believed to have been drilled in an up-dip location beyond the reservoir pinchout edge and so failed to encounter any reservoir sands.

Exhibit 9: Davaar schematic



Source: Parkmead

Exhibit 10: Davaar 3D seismic line with anomaly



Source: Parkmead

Davaar has been identified based on an AVO anomaly not penetrated by 205/12-1 and similar to that seen in Foinaven and Schiehallion. As discussed earlier, the poor historical success rate in drilling such anomalies in the region has highlighted the need for detailed and integrated geological and geophysical work evaluation to minimise risk. The anomaly could still be a lithological effect and this is reflected in the current chance of success (CoS) of 18% for Davaar, with reservoir presence seen as the key risk. Parkmead is working to generate and interpret offset stack data together with a rock physics study and a biostratigraphic study to try and mature the prospect to drillable status. At present, Davaar is estimated to contain P50 gross recoverable resources of 186mmbbls.

A similar anomaly in Block 205/13 seems to be split into two separate areas known as Sanda North and South. As in Davaar, offset stack data is required to mature these prospects, and the key risk is also reservoir presence. Both prospects are smaller than Davaar at P50 recoverable resources of 71mmbbls for Sanda North and 55mmbbls in Sanda South; however, the three prospects are close enough to be developed together in the case of success, with a combined P50 of 312mmbbls.

Eddystone

Eddystone is a 166mmbbl Cretaceous lead located in the West Shetland Basin to the east of Hurricane’s assets and south-west of the Clair oil field. Understanding of the Cretaceous in the basin is immature, and to date there are only two discoveries on this play. The gas condensate discovery Edradour and the gas discovery Victory sit to the north-east and on the opposite side of Clair from Eddystone. Parkmead believes that Eddystone is most likely to be oil bearing, as nearby well 205/20-1 encountered non-movable heavy oil in the Lower Cretaceous, although further work is required to derisk this play element. Eddystone has been identified as a bright amplitude anomaly on 2D seismic, but at this stage it is difficult to determine if this is due to hydrocarbons or lithology. The company is planning to acquire additional 2D seismic and carry out further technical studies to mature Eddystone to drillable status.

Atlantic Petroleum is a partner in Parkmead’s West of Shetland licences, holding 43% WI in Davaar and Sanda North and South, and 30%WI in Eddystone.

Chrysaor: 2015 Mustard discovery

Private UK-based oil company Chrysaor is focused on assets in the North Sea and Ireland. West of Shetland is a core area for the company, where it is looking to build a hub area around the Solan

facilities. The company held 40% of the Solan field until June 2015 when it sold its share to operator Premier in return for royalty and net production. Chrysaor also holds 50% WI and is operator of the Mustard oil discovery, the only exploration well to be drilled West of Shetland in 2015. Located about 15km east of the Solan field in 150m of water, the well was targeting an Upper Jurassic fan. The prospect was penetrated by original well 205/27-3 and the 205/27-3 sidetrack, with both encountering oil. A full set of data was gathered in both wells, including pressure data and good quality core and MDT samples; however, the company plans to review the data before releasing information regarding volumetrics and commerciality. Chrysaor also acquired 500km² of 3D seismic over licence P1932 during 2015. The licence covers blocks 202/4,202/5 and 203/1a, immediately to the south and south-west of Solan in Block 205/26a.

Origo Exploration, a recently established E&P company focused on the UK and Norway, acquired 25% of Mustard and P1932 in June 2015.

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