

ATLANTIC IRELAND 2014

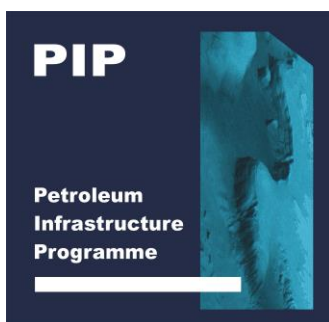
A One Day Conference and Exhibition on
Ireland's Offshore Hydrocarbon Potential
Sponsored by PIP-ISPSG

PROGRAMME AND SHORTS ABSTRACTS

Location: DoubleTree Hotel, Dublin, Ireland

Data: 20th October 2014 – 08.00 to 19.00hrs

Audience: Researcher, exploration companies, geophysical contractors, government departments and agencies, international guests



Edited by

Martin Davies & Tom Moore

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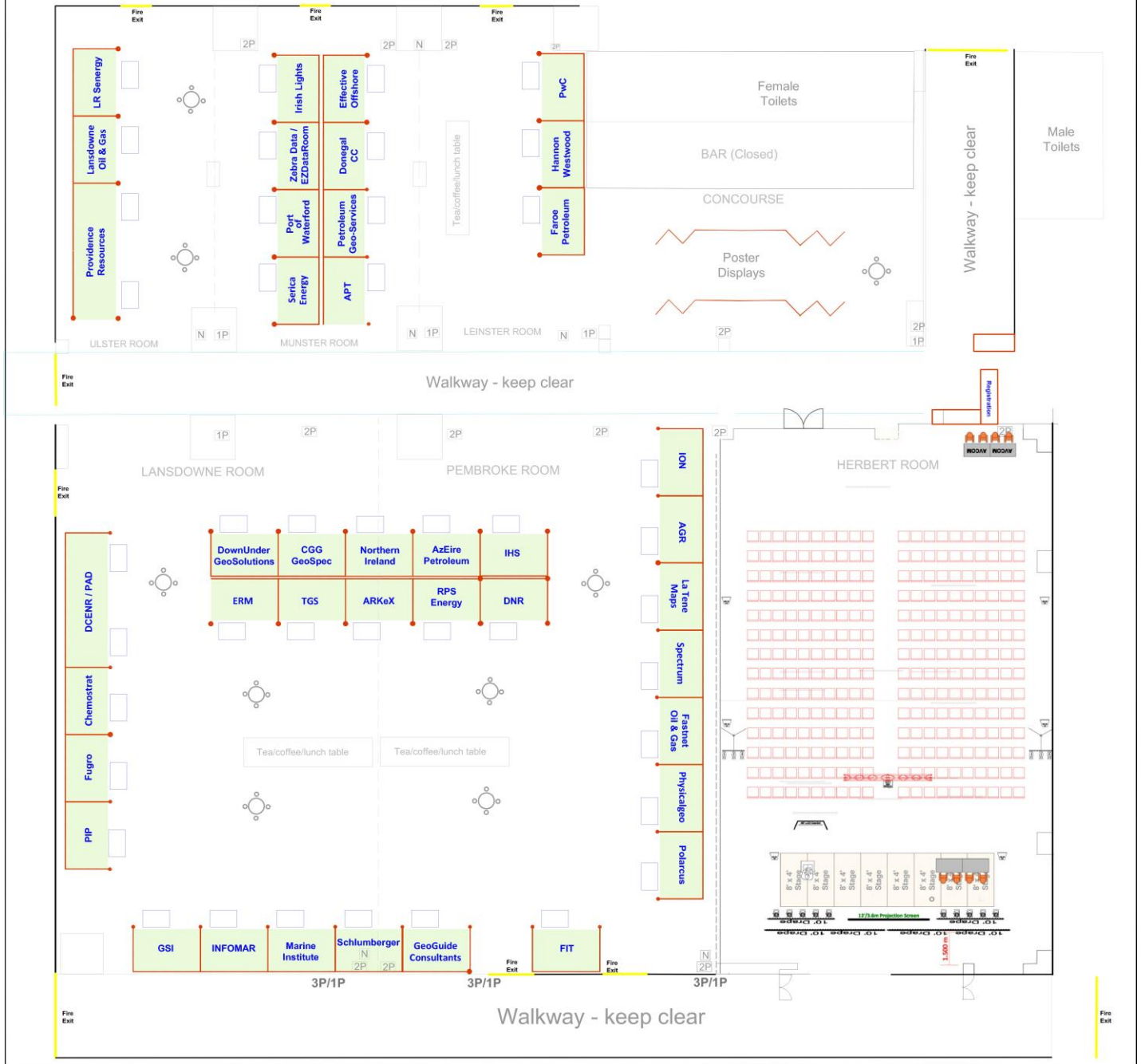
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Exhibition Layout

KEY:





DNR	Dept of Natural Resources, Newfoundland – Labrador
Donegal CC	Donegal County Council promoting the Port of Killybegs and Donegal Airport
FIT	Fluid Inclusion Technologies
APT	Applied Petroleum Technology
GSI	Geological Survey of Ireland
PAD	Petroleum Affairs Division, Dept of Communications, Energy & Natural Resources, Ireland
PIP	Irish Petroleum Infrastructure Programme

Scale 3m



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Technical Programme

		Monday 20th October Atlantic Ireland 2014 DoubleTree by Hilton Hotel Dublin - Burlington Road Upper Leeson Street, Dublin 4	
Atlantic Ireland Looking to the Future			
Provisional Programme Monday 20 th October 2014			
08.00 - 08.55	Registration – Coffee / Tea available in Exhibition Room and Poster Room		
08.55 - 09.00	Welcome to Delegates		
09.00 - 09.30	Minister of State's Speech		
09.30 – 10.45	Session 1 - New Government Initiatives and New Data <i>Chair – Michael Manley (DCENR)</i>		kindly sponsored by: 
Ciarán Ó hÓbáin (DCENR/PAD) – Policy and Regulatory Landscape – Recent Initiatives			
Mick Hanrahan / Clare Morgan (DCENR/PAD) – Status of Exploration Offshore Ireland and New Data			
Ian Atkinson (Nalcor Energy) – New seismic and research offshore Newfoundland-Labrador			
Nick O'Neill (PIP Secretariat) – The Irish Petroleum Infrastructure Programme – Current and Future Research			
Questions			
10.45 – 11.15	Tea / Coffee Break		kindly sponsored by 
11.15 – 12.50	Session 2 - Petroleum Systems <i>Chair – Pat Shannon (IOOA)</i>		kindly sponsored by: 
John Hopper (GEUS) – An overview of the NAG-TEC Atlas project			
Pat Barnard (APT) – Petroleum systems of the North Atlantic conjugate margins			
Stephen Rippington (ARKeX) – Re-evaluating the Tectonic Framework of Ireland and adjacent areas			
Ceri Roach (Chemostrat) – Initial results for an integrated chemostratigraphic and bio-stratigraphic study of Jurassic / Cretaceous strata of the Porcupine Basin			
Karyna Rodriguez (Spectrum) – Light Shed on New Mesozoic and Tertiary Leads in the South Irish Rockall Basin			
John O'Sullivan (Providence Resources) / Kiran Kamble (Consub) Purbeckian Oils and the Challenge of Waxy Crude Oil – Delivering Development Solutions			
Questions			



This annual event is organised by the Petroleum Infrastructure Programme (www.pip.ie)

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Atlantic Ireland Looking to the Future

Monday 20th October
Atlantic Ireland 2014

DoubleTree by Hilton Hotel Dublin - Burlington Road
Upper Leeson Street, Dublin 4

12.50 – 14.00

Lunch

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14.00 – 15.20

Session 3 - Innovation

Chair – Lorenzo Meciani (ENI)

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Dara Williams (MCS Kenny / Wood Group) – Ireland's Atlantic Margin – Development Options and Lessons Learned from Other Harsh Environment Locations

Eirik Flekkøy (Org Geophysical) – Induced Polarisation for Hydrocarbon Exploration: A Potential New De-Risking Tool for Offshore Ireland

Iain Buchan (Polarcus) – Broadband Marine Seismic Acquisition with Flat Streamers

Gareth Parry (Woodside Energy) – First use of combined high and low frequency moored Passive Acoustic Monitoring (PAM) instruments for cetacean detection offshore Ireland

Martin White (NUIG) – Monitoring and modelling acoustic noise from seismic surveys in Irish waters

Questions

15.20 – 16.00

Tea / Coffee Break

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16.00 – 17.00

Session 4 - Prospects2Go / Prospects and Opportunities

Chair – Gareth Parry (Woodside Energy)

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Graham Pritchard (Serica) – Prospects2Go paper – Atlantic Ireland Drilling Opportunities

Keith Byrne (Providence Resources) – Prospects2Go paper – The Newgrange Prospect – One of the largest undrilled Mesozoic four-way dip-closed structures on the Atlantic Margin

John Corr (Hannon Westwood) – The Irish Atlantic Margin: New Data, New Daw

Pat Shannon (UCD) - Irish Centre for Research in Applied Geosciences (iCRAG): an exciting industry-facing geoscience initiative

Closing Speech – Michael Manley (DCENR)

17.00 – 19.00

Posters and Reception

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ORAL ABSTRACTS (in order of presentation)

Speaker is underlined

Policy and Regulatory Landscape – Recent Initiatives

Ó hÓbáin, C.¹

¹ *Petroleum Affairs Division, Dept. of Communications, Energy and Natural Resources, 29-31 Adelaide Road, Dublin 2. Email: Ciaran.ohobain@dcenr.gov.ie*

Status of exploration Offshore Ireland and New Data

Hanrahan, M.¹, Morgan, C.¹

¹*Petroleum Affairs Division, Dept. of Communications, Energy and Natural Resources, 29-31 Adelaide Road, Dublin 2*

Successful promotion by the Irish Government in recent years, focussed principally on the prospectivity of Ireland's offshore, has been a positive factor in attracting increased interest in exploration investment. This was supported by research initiatives aimed at deepening the understanding of Ireland's offshore petroleum potential.

The results of the 2011 Atlantic Margin Licensing Round were positive. Ireland's 2011 Licensing Round resulted in 13 new exploration authorisations being awarded compared with 1 following the 2009 Round and 4 following the 2007 Round. The number of exploration authorisations now in place is at the highest level since exploration began in the 1970s. A wide variety of exploration targets are recognised from Tertiary to Permo-Triassic; from non-marine fluvial & aeolian to basin-floor fans with a significant proportion of the Licences having Cretaceous deep marine sandstone objectives. Furthermore, the recent entry of new exploration companies to the Irish Atlantic Margin, namely Cairn Energy, Kosmos Energy and Woodside Energy; all with significant international deepwater exploration experience is testament to the success of the Round. These new entrant companies are being attracted in part by new exploration targets.

Interest in the Celtic Sea area has re-ignited, partly due to the drilling success at Barryroe and a record number of new Licensing Options, with associated substantial work programmes, including seismic acquisition, have been awarded in the Celtic Sea and the Fastnet Basin.

2013 saw a marked increase in the level of new 2D and 3D seismic acquisition offshore Ireland and this trend continues into 2014. In 2013, 13,650 km of 2D seismic and 5,500 km² of 3D seismic was acquired. In 2013 the first phase of a major, Government designed, 2D regional seismic survey was carried out in the Atlantic, with over 10,000 km of new data acquired across the Atlantic basins including the Porcupine, Rockall, Hatton, Fastnet, Clare Basins and along the conjugate margin. The second phase of this survey was carried out in 2014 and 6800km of new data was acquired. This is the largest 2D seismic survey acquired to date in Irish waters. The new data from this survey will fill data gaps, aid research in petroleum systems and help inform applications to be made in the 2015 Licensing Round. In 2014, four seismic surveys were acquired offshore Ireland, three in the Porcupine Basin, and an approximate total of 11,300 km of 2D seismic and 5,500 km² of 3D seismic was acquired this year.

There is a recent upswing in exploration effort offshore Ireland, both in terms of number/strength of exploration companies active in the Irish offshore and in the level of new seismic acquisition which may in due course lead to increased drilling levels. Drilling levels, however, remain low but despite this, it is encouraging that the current exploration status offshore Ireland is healthy and the exploration momentum continues to increase.

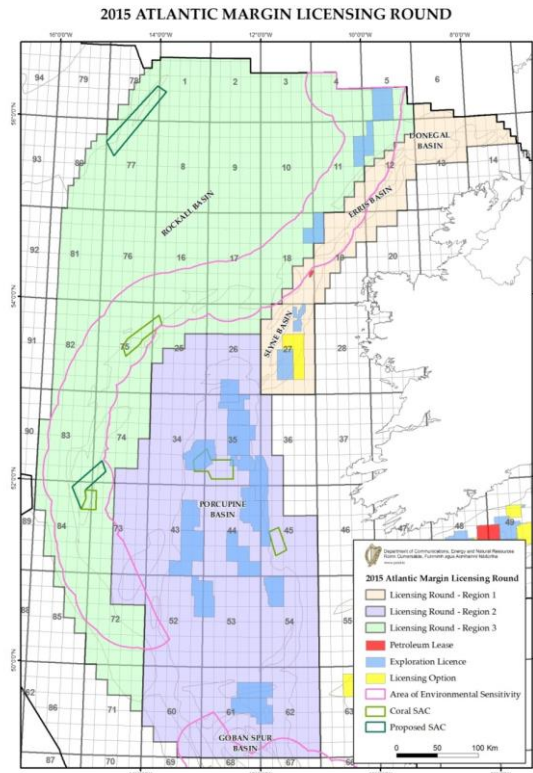
Ireland's next licensing Round will close in September 2015 and will include all of Ireland's Atlantic basins. The form of concession on offer will be a two year Licensing Option. For the 2015 Round the overall Atlantic Margin is divided into three regions. The maximum number of blocks that can be applied for in each region is as follows:

- For the Donegal Basin, Erris Basin and Slynne Basin Region, a limit of four blocks applies, due to the smaller size of these basins;
- For the Porcupine Basin and Goban Spur Basin Region, the approach of the 2011 Round is repeated and applications can be made for up to six blocks; and

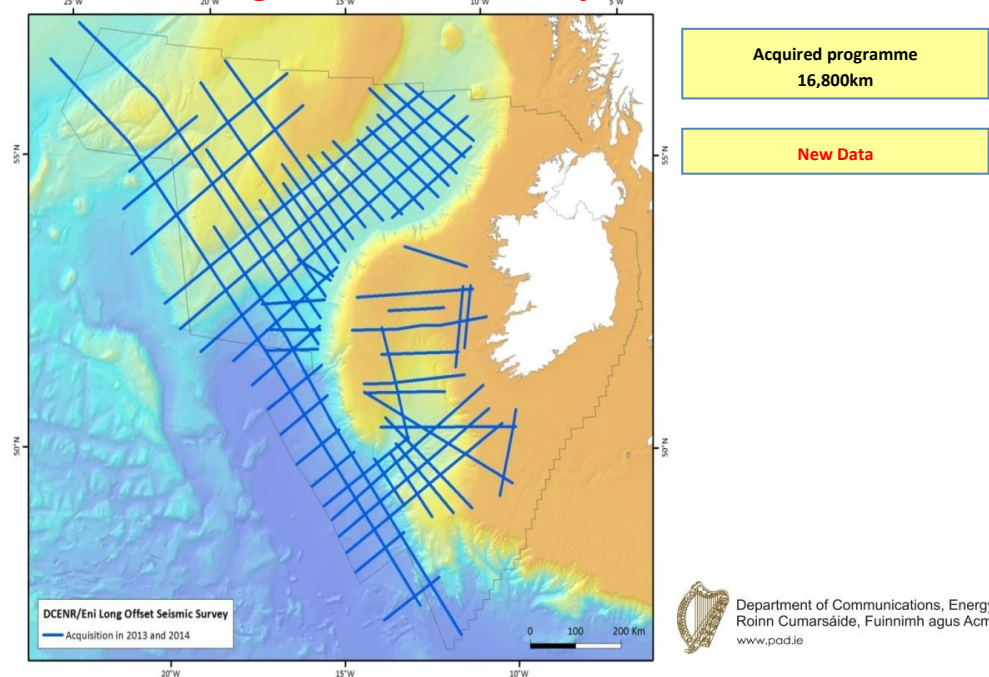
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- For the Rockall Basin Region, the maximum area that may be applied for in a single application is up to ten blocks. The increase in the maximum number of blocks per application to ten in the Rockall Basin is intended to stimulate exploration in a relatively underexplored frontier area of Ireland's offshore.

The 2015 Round aims to build on the success of the previous 2011 Atlantic Margin Licensing Round.



DCENR/Eni regional seismic survey 2013 /



Department of Communications, Energy and Natural Resources
Roinn Cumarsáide, Fuinnimh agus Acmhainní Nádurtha
www.pod.ie

New Seismic surveys and research offshore Newfoundland and Labrador

Atkinson, I.M.¹, Wright, R.¹

¹ *Nalcor Energy*

In 2009, Nalcor Energy Oil & Gas initiated an exploration strategy to better understand the frontier basins in the province's offshore through the acquisition of new geoscience data. The new data has provided new knowledge to help reduce exploration risk and stimulate more exploration activity. Nalcor has invested in the TGS-PGS multi-client survey (2011-2013) that has acquired 47,000 kms of long offset, broadband 2D seismic data from the tip of Labrador to the Flemish Cap and the Jeanne d'Arc Basin. The original regional seismic survey was guided by a satellite seep survey in 2010. Nalcor partnered with Astrium (now Airbus) to conduct the seeps survey. This satellite data identified repeated oil slicks that guided the early seismic line locations and pushed the seismic acquisition into the deeper waters off Labrador and northeastern Newfoundland where previously no data existed. The identification of oil slicks and seismic evidence of seabed seeps along the slope break and in the deepwater is an extremely important finding for the Labrador and northeast Newfoundland margin. Drilling on the Labrador Shelf in the 1970s had discovered over 4 TCF of gas and NGLs and left the impression that the Labrador margin was strictly gas prone.

In 2014, TGS-PGS has deployed two vessels to acquire an additional 33,000 kms of broadband 2D data. This year's survey will result in a 5 x 5 km grid over the Area of Interest (21,000 sq kms) in the Flemish Pass Basin where the C-NLPOB will offer Exploration Parcels for bidding in the 2015 Call for Bids land sale. An Area of Interest off Labrador will be covered by a 10 x 10 km grid. Parcels on the Labradors AOI will be offered in a land sale in 2017 (See figure 1).

To better understand the petroleum geology of the offshore basins of Newfoundland and Labrador and to help reduce exploration risk, Nalcor Energy has initiated a number of regional studies to integrate the new information from the seismic surveys with well, potential field and other data. These include:

- the geopressure study
- biostratigraphy review
- seabed coring and oil slick capture survey
- the rock physics study
- the metocean report
- geochemistry / source rock study

The Regional Geopressure Study and the Biostratigraphy Report are freely available for download on the Nalcor website (<http://www.nalcorenergy.com/OILGAS/studies-reports.asp>).

The Rock Physics Study is nearing completion. This study has developed regional models to permit a detailed analysis of the hundreds of AVO anomalies that the new data has identified. While not all of these AVO leads are expected to become potential prospects, early analysis of some of the better leads has proved positive. One of these examples will be presented.

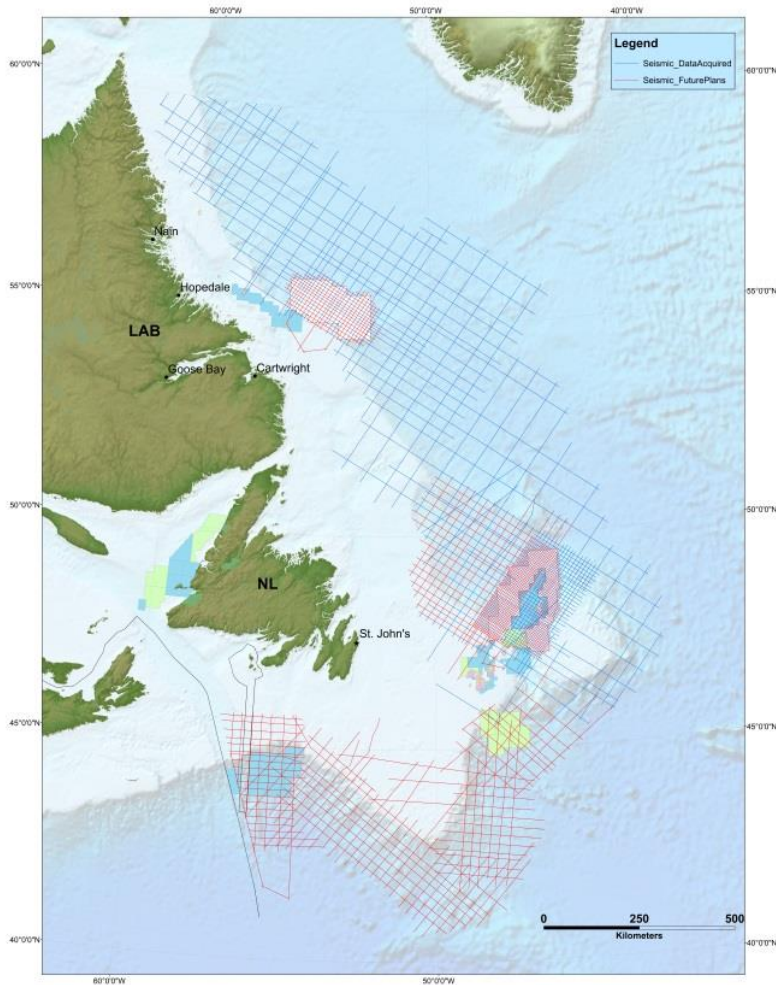


Figure 1: Regional map showing the multi-year TGS/PGS multi-client surveys offshore Newfoundland and Labrador. Large pink land blocks are the Areas of Interest (AOI's) in the Labrador and Flemish Pass basins. Red seismic lines are the ongoing 2014-2015 survey.

In addition to the studies identified above, Nalcor, in collaboration with the Department of Natural Resources of Newfoundland and Labrador, has continued the important research initiative with Ireland under NAPSA (North Atlantic Petroleum Systems Assessment). Two PIPCo projects under the current round are supported by Nalcor/DNR. In addition, the NAPSA meeting held during the recent 4th Atlantic Conjugate Margins Conference in St. John's developed plans to advance the regional source rock study and the hyper-extended basin study on the Orphan and Porcupine Basins. Future NAPSA initiatives will likely build on the Nalcor basin modelling project that will begin in late 2014.

The Irish Petroleum Infrastructure Programme – Current and Future Research

O'Neill, N.¹

¹*Petroleum Infrastructure Programme Secretariat*

The Irish Petroleum Infrastructure Programme (PIP) is a well established, well structured, fit for purpose petroleum research programme designed to address common petroleum exploration industry problems on Ireland's Atlantic Frontier. Critical to the success of PIP is the involvement of the oil companies who hold frontier exploration licences offshore Ireland.

More than 60 research projects have received in excess of €16m in funding over the last 16 years. The projects involve data gathering and studies in geology and geophysics aimed at improving knowledge of petroleum systems and exploration potential offshore Ireland. There have also been engineering studies to improve exploration and production cost effectiveness and deliver better procedures and practices. Environmental baseline studies and environmental monitoring projects contributed to the development of regional environmental impact assessment frameworks for the IOSEA process. Last year's very successful open call for projects has led to a significant increase in the level of research activity, not seen since the programme was first established for the Rockall licensing round in 1999. More than €2.5m will be spent on projects over the next three years.

A feature of PIP has been its ability to leverage additional funds by collaborating with other research programmes such as FP7 and SFI and using "vessels of opportunity", including the Irish Marine Institute research vessels, to conduct significant data gathering exercises on the Irish continental shelf. The PIP secretariat is actively involved in seeking opportunities to collaborate with other research programmes that share common aims and objectives.

PIP drives innovation by the practical application of creative ideas from academic research to provide exploration solutions. The creative ideas generated by academic research are immediately applied by oil company explorationists to test the validity of the current petroleum systems model for offshore Ireland.

Petroleum systems analysis is at the heart of the Irish Petroleum Infrastructure Programme and dictates the focus of funded research. In 2005 PIP consolidated and integrated the findings from the previous six years of its research into a petroleum systems analysis study of the Slyne, Erris, Donegal, Rockall and Porcupine Basins. This study identified the gaps in our understanding of the different petroleum systems offshore Ireland and informed the direction of subsequent PIP funded research. In 2010 a joint PIP/NAPSA plate tectonic reconstruction project again integrated the results of five years of PIP research into a new kinematic plate tectonic reconstruction model for the North Atlantic. The results of this project have informed the selection of projects funded under the recent open call.

PIP's continued success depends on the people involved, the drivers in Government and Industry with vision and energy who manage PIP, those committed oil company representatives who mentor PIP projects and the academics who continue to generate the creative ideas that are turned into practical solutions. Teamwork and collaboration with petroleum exploration colleagues in the UK, Canada and further afield adds value to PIP's research efforts. The involvement of new oil industry PIP members will shape the future work programme of PIP as we enter a newly invigorated phase of frontier exploration offshore Ireland.



Above: Founding members of PIP June 1997

An overview of the NAG-TEC Atlas project

Hopper, J.¹ and the NAG-TEC team

¹*GEUS, Copenhagen, Denmark*

The Northeast Atlantic Geoscience (NAG) co-operation framework was formed by the chief executives of the nine northern European Geological Surveys with strong interest in the North Atlantic margins. In the spring of 2009, representatives of these surveys met to discuss an initiative centred around the tectonic development of the North Atlantic with particular emphasis on continental margin evolution and understanding deep water basins along the continental margins. From the outset, a key emphasis was to identify and compare key conjugate margin pairs to understand the full rift system across the entire North Atlantic basin system. A number of problems were quickly identified, including: 1) the lack of an existing compilation of key geological and geophysical information over the whole region; 2) local nomenclature differences resulted in difficulties establishing regional correlations to identify commonalities and differences between areas; and 3) large areas with sparse data making it difficult to prioritise which data gaps were most important in terms of regional understanding.

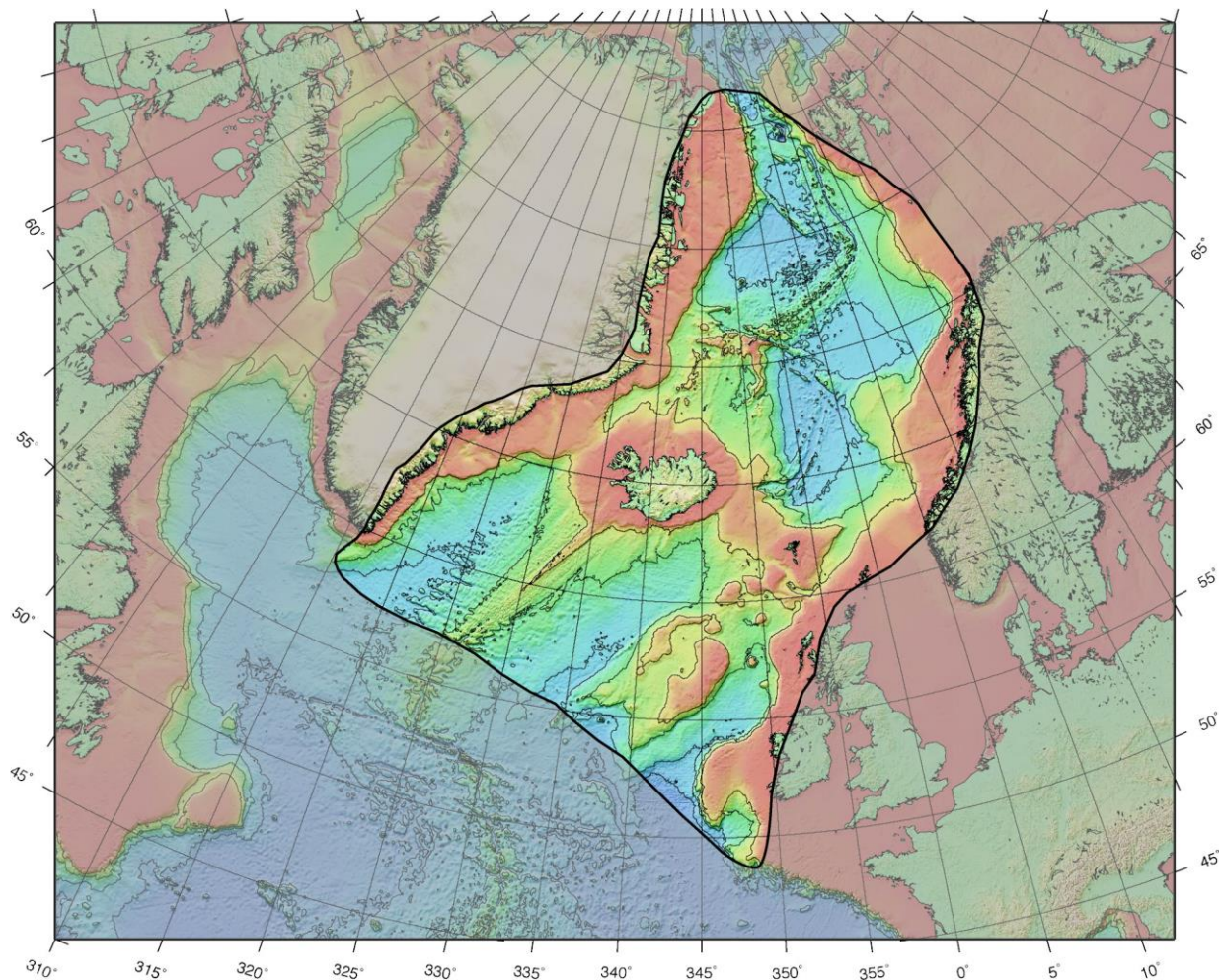
To address these problems, the group began to compile the data available and it became readily apparent that a new, comprehensive and up-to-date Tectonostratigraphic Atlas of the Northeast Atlantic region (Figure 1) was necessary and the NAG-TEC project was initiated. With strong support from industry, the project began in June 2011 and the main compilation and Atlas building phase took three years to complete.

The main objective was to compile available geophysical and geological data from the region to provide a consistent database of key information against which various hypotheses regarding the tectono-stratigraphic development of the region could be tested. To accomplish these goals, work was divided into thematic work packages with the main goal of identifying and compiling data and information available. From the outset, the focus was on compiling published and available data, and identifying the major data gaps and uncertainties, independent of any particular geological, geophysical, and geodynamic models. This provided the foundation for further synthesis,

interpretation, leading to an integrated model of the development of the North Atlantic from the Devonian to the present. The Atlas is intended to provide the framework for a quantitative assessment of key basin parameters and uncertainties on a regional scale and in this way aid in de-risking exploration in frontier areas.

The Atlas provides the most up-to-date and comprehensive synthesis of the Irish offshore geology, integrated in the context of the entire North Atlantic region north of the Charlie-Gibbs Fracture Zone. The crustal structure is documented, with differentially thinned continental crust beneath a number of the major hyperextended basins, and the continent-ocean transition across a complex seaward-dipping reflection zone. This provides the crustal template for the sedimentary and igneous development of the region which is described and figured in detail. Of particular significance are the geoseismic sections and correlation panels illustrating the tectono-stratigraphic variations both across and along the Atlantic Margin. The Atlas contains a vast array of data that will provide a template for research in the Irish offshore and will help in de-risking and hopefully further stimulate the momentum for petroleum exploration in the Irish offshore in the coming years.

Figure 1. Location of NAG-TEC study area along the Atlantic Margin



Petroleum systems of the North Atlantic conjugate margins

Barnard, P.¹, Cutler, I.¹, Thompson, S.¹, Kerr, H.¹

¹*Applied Petroleum Technology (UK) Limited*

A number of North Atlantic margin basins have proven to contain commercial quantities of hydrocarbons as evidenced by oil and gas production from the Jean d'Arc Basin on the west and the Faeroe-Shetland Basin and Mid Norway area on the east. All these basins produce fluids that have some affinities to, but also exhibit some distinct differences from, the hugely prolific North Sea basin.

Published biomarker studies of the oils from the Jean d'Arc Basin suggest sourcing within a restricted marine environment. Dual Upper and Middle Jurassic source rocks have been proposed although earlier studies suggested derivation from a marine Upper Jurassic source rock, the Egret Member, equivalent in age to the Kimmeridge Clay Formation.

Oils in the Mid Norway province are mostly attributed to a source within the Upper Jurassic Spekk (Draupne) Formation, a source rock equivalent in general age and type to the Upper Jurassic Kimmeridge Clay Formation which is generally considered to be the source of the bulk of the North Sea oil. The source of the gas in mid Norway and the neighbouring Møre Basin is less well characterised; in Mid Norway it has been assumed to be a combination of either primary generation from the coaly Are Formation or late stage maturation, or even cracking of, pre-existing oil from the Spekk Formation. Little information appears to be available about the source of the gas in the very large Ormen Lange gas field which is notionally within the Møre Basin which itself has been reported to be formed over Cretaceous oceanic crust.

It has similarly been reported that Porcupine Basin oils and shows have evidence for mixed source contributions and both Upper and Middle Jurassic contributions have been proposed.

Our recent studies have shown that the oils tested so far from the Porcupine Basin and extracted oils from shows fall into two main categories:

- The Connemara Field oils and most of the other flowed oils plus many of the shows have similar characteristics suggestive of a restricted marine depositional environment with some distinctive biomarkers present. However, the indicators are conflicting and consideration of the presently poorly described stratigraphy and depositional settings of the Jurassic in the basin means that there is still considerable uncertainty about the exact source of these oils.
- The second much smaller group has high wax content and biomarker characteristics more typical of non-marine source systems. A Middle Jurassic source seems likely.

Recent work comparing the Porcupine oils to East Canadian oils analysed by the same high quality laboratory have shown some marked similarities between the hydrocarbons. For those keen to see a geological rationale in the North Atlantic conjugate margin basins concept, this does then require a significantly better understanding of the diverse geological settings that can produce apparently similar oils.

This paper will attempt to shed some (dim) light on to the topic.

Re-evaluating the Tectonic Framework of Ireland and adjacent areas

Rippington, S.¹, Warner, S.¹, Herbert, H.¹, Rands, J.¹

¹ ARKeX Ltd., Newton House, Cambridge, UK. Stephen.rippington@arkex.com

Ireland and its continental shelves are located in a structurally complex part of the European North Atlantic Margin. The dominant structural grain of the region is inherited from the Caledonian Orogeny. However, the margin was also variably deformed by Variscan compression and multiple phases of extension and rifting, culminating in continental breakup, and magmatism attributed to the North Atlantic Igneous Province. The region was further deformed by phases of Cenozoic compression, which have been attributed to many different causes, including the far-field effects of the Alpine Orogeny (Doré *et al.* 1999).

Hydrocarbon exploration in the region has met with some success (e.g. Hanrahan & Morgan 2013). However, the region remains relatively underexplored. Although the overall plate tectonic context of the margin is well documented, many uncertainties surrounding the structural evolution of the margin, the distribution and maturity of potential source rocks and the distribution and quality of potential reservoirs persist (Knott *et al.* 1993, Laird *et al.* 2013, Spencer & MacTiernan 2001).

The ARKeX Tectonic Atlas of Ireland is based on an integrated interpretation of gravity, magnetic and seismic data. The project aims to combine the strengths of these different geophysical datasets to re-evaluate the structural framework that underpins hydrocarbon exploration on the Irish Shelf and adjacent areas of the Celtic Sea, Irish Sea and West of Britain. The study is based on a compilation of georeferenced maps and cross-sections, a newly merged dataset of Petroleum Affairs Division (PAD) marine gravity and aeromagnetic data, as well as seismic and public domain data gravity and magnetic data. All datasets have been combined in an easily accessible GIS framework for future use by explorationists in the area.

This work builds on previous potential field studies of the region (e.g. Kimbell *et al.* 2010). Gravity and magnetic data are used to interpolate between seismic lines and interpretations, to produce a structural elements map focussed on the Irish Marine Exclusive Economic Zone and immediately adjacent areas. Selected B.I.R.P.S seismic lines (Klemperer & Hobbs 1991) are used to produce regional 2D gravity and magnetic models and to quantify the crustal architecture of the Rockall, Porcupine, Celtic and Irish Sea basins. The objective of the Tectonic Atlas is a geological, exploration-focused interpretation that satisfies all of the geophysical data available, and provides explorationists with an easy-to-use, reliable, cohesive and consistent structural and tectonic framework with which they can review their geological concepts and exploration targets.

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Preliminary results from an integrated chemostratigraphic and biostratigraphic study carried out on the Cretaceous and Jurassic strata within the Porcupine Basin

Roach, C.¹, Butler, N.², Finlay, A.¹, Porter, S.¹, Harding, A.³, Pearce, T.¹

¹ Chemostrat Ltd, 1 Ravenscroft Court, Buttington Cross Enterprise Park, Welshpool, Powys, SY21 8SL, UK

² Petrostrat Ltd, Tan-y-Graig, Parc Caer Seion, Conwy, LL32 8FA, UK

³ Atlantic Petroleum, 26/28 Hammersmith Grove, London, W6 7BA, UK

The Porcupine Basin, located offshore Western Ireland has a proven hydrocarbon system, despite this, however, well penetrations are relatively scarce, particularly in the south of the basin. A firm understanding in the correlation of sediments across the area is vital for successful exploration and, whilst seismic acquisition is generally good, the ground-truthing of this data from penetrated sections is critical. Following funding from the Petroleum Infrastructure Programme (PIP) a combined chemostratigraphic and biostratigraphic study has been initiated, with a view of establishing an integrated, basin-wide correlation scheme for the Jurassic and Lower Cretaceous successions. This publication presents initial datasets and interpretations from this on-going study due for completion in 2015.

A full analytical programme, comprising geochemical (ICP-OES and ICP-MS), petrographical, XRD and micro, paly and nanno analysis will be applied to four key wells, namely, 26/28-1, 35/8-2, 35/8-1 and 43/13-1; these wells being chosen for their geographic and stratigraphic coverage (Fig. 1). The biostratigraphic data will provide an important chronostratigraphic framework to which the higher resolution chemostratigraphic data can then be tied. The integrated datasets from these type wells will be used as a reference section for a further eight wells within the Porcupine Basin and one well from the adjacent Slyne Basin (Fig. 1). These additional wells will be integrated into the correlation framework through the addition of new geochemical data and re-evaluated legacy biostratigraphic data.

Chemostratigraphy involves the characterisation and correlation of sedimentary rock successions based on stratigraphic variations in their inorganic geochemical data. Using this technique, variations in mineralogy, including clay minerals, heavy minerals and lithic components can be identified, which in turn can provide information of changes in palaeoclimate, palaeoenvironment, sediment provenance and any diagenesis or weathering that may have occurred. Chemostratigraphic zonations for the four key wells have been constructed using data acquired from the fine-grained lithologies, with this fraction often displaying a broader spatial distribution than the fine grained lithotypes, meaning their geochemical characteristics can be recognised over a wider region. At present, twelve Chemostratigraphic Packages can be identified, and through integration with the biostratigraphically-defined chronostratigraphy, are thought to be equivalent to individual stages or finer. However, the resolution and variability in the geochemical and biostratigraphical data acquired, suggests a higher resolution can be achieved.

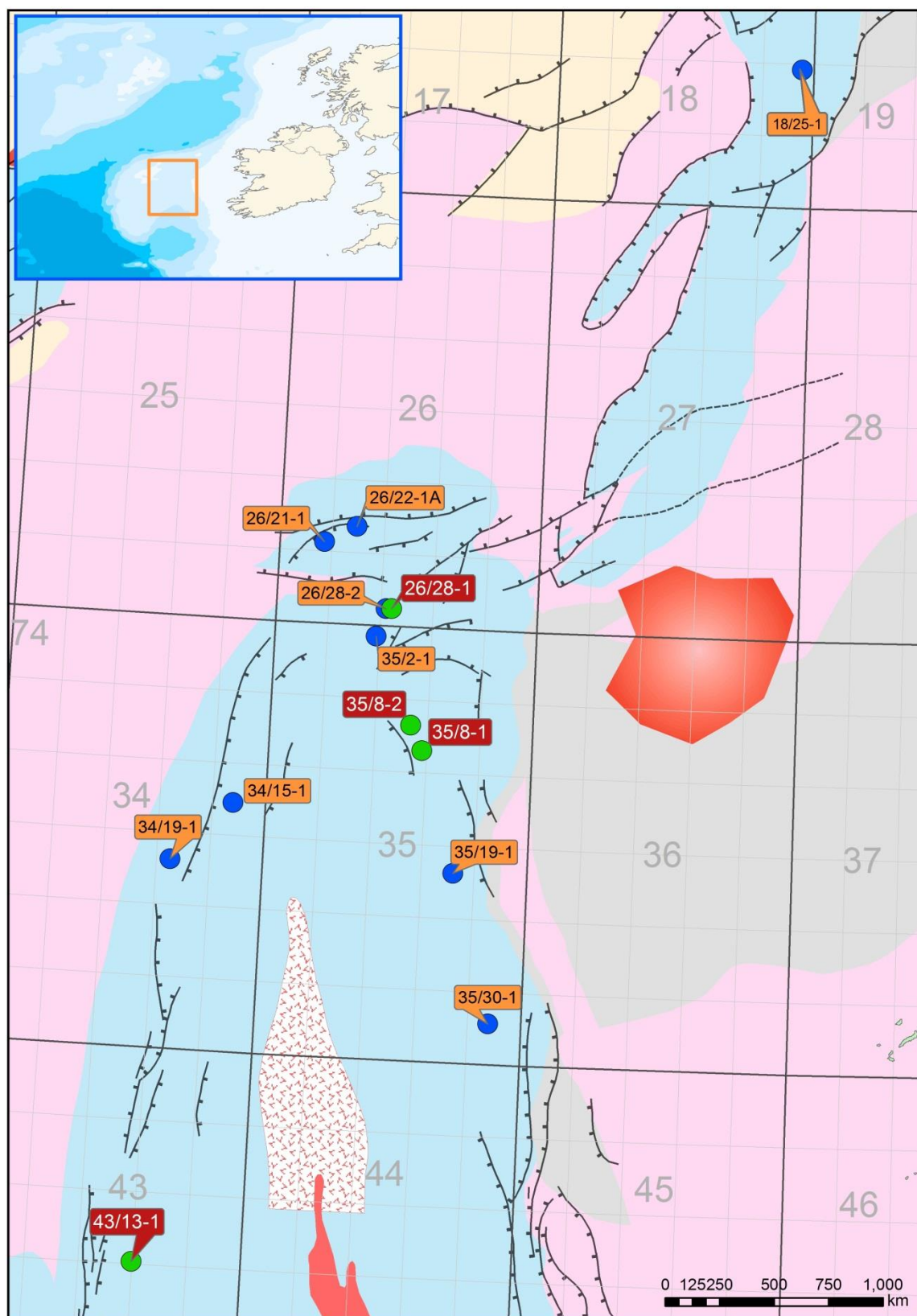


Fig. 1 – Study wells within the Porcupine and Slyne basins, offshore Ireland
(Wells outlined in red denote key 'type wells', whilst additional wells are outlined in orange)

Light Shed on New Mesozoic and Tertiary Leads in the South Irish Rockall Basin

Rodriguez, K.¹, Eastwell, D.¹, Nicholls, H.¹

¹*Spectrum Geo Ltd, Dukes Court, Duke St, Woking, Surrey, UK, GU21 5BH*

The South Irish Rockall basin is a largely underexplored frontier area with a proven hydrocarbon system and several inferred play types. The major risks, considered to be the poorly known nature of source and reservoir rocks, were somewhat reduced by the significant gas condensate column of over 200 m discovered in Triassic Reservoir rocks in the Dooish well first drilled in 2002 by Enterprise and re-entered by Shell in 2003, located on the eastern margin of the basin. Furthermore, conjugate basins offshore Canada have also yielded hydrocarbon discoveries. It is therefore highly likely that there are large remaining undiscovered accumulations in reservoirs of Triassic, Jurassic, Cretaceous and Tertiary age.

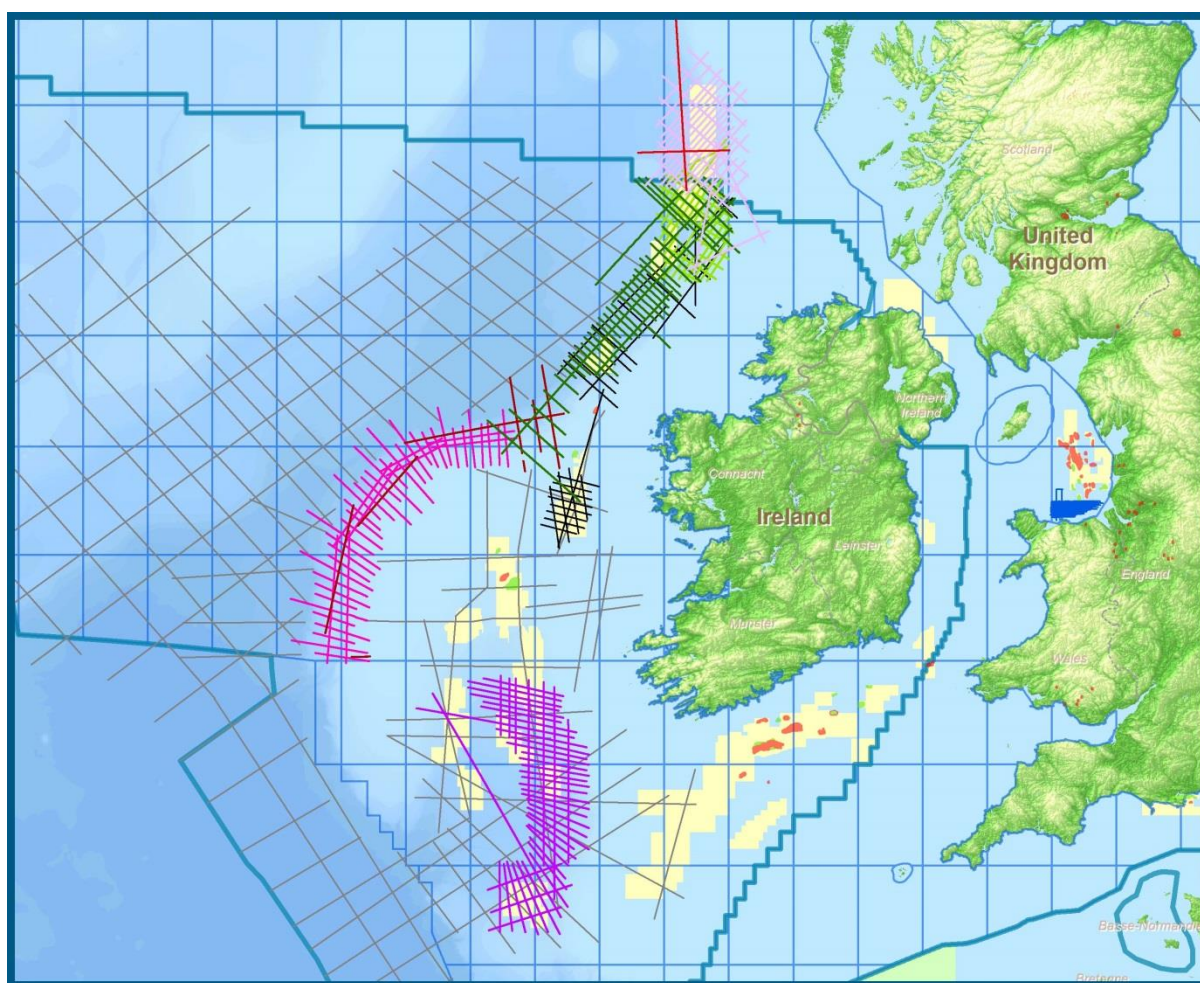


Figure 1 - Spectrum 2D Multi-Client Seismic Coverage Offshore Ireland

Extending along the eastern flank of the Irish Rockall Basin 2,926 km of 2D seismic acquired in 1996 (Figure 1), has been reprocessed in 2014. Re-processing has significantly enhanced the overall imaging, in particular, good improvements in de-multiple, increased frequency content and improved character of events. This is due to application of more modern processing techniques such as SRME, Radon & PSTM, which allows superior imaging through better multiple attenuation and velocity control. Structural highs and half grabens in particular are now much better imaged revealing previously unseen stratigraphy (Figure 2).

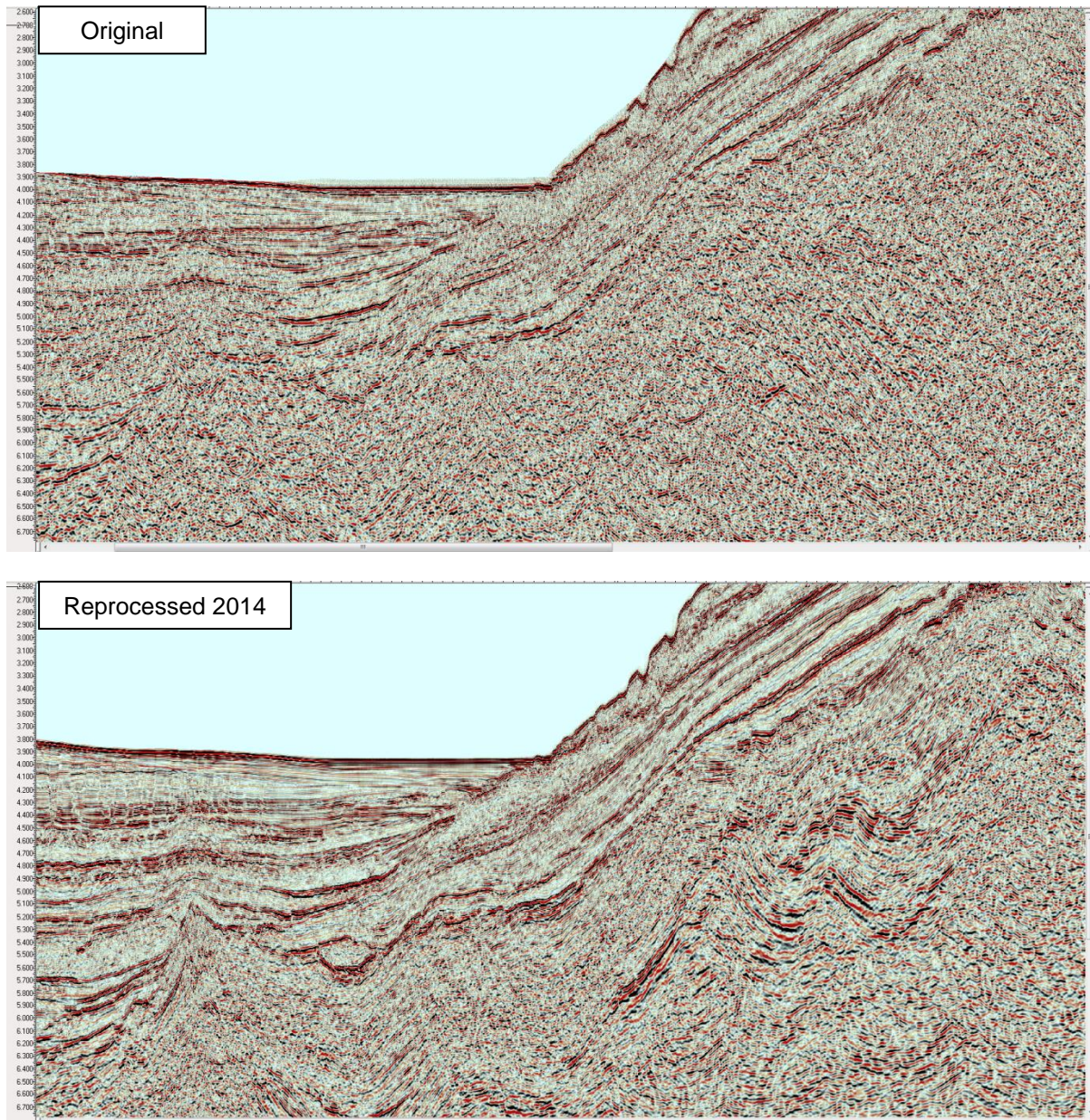


Figure 2 - Original and 2014 Reprocessed Lines

Enriched seismic imaging has enabled the interpretation of major seismic sequence boundaries which, despite lack of well control in the area of the survey, have been compared to the neighbouring Porcupine Basin potentially inferring Jurassic oil-prone source rocks in pre-rift stratigraphy in tilted fault blocks.

A suite of both structural and stratigraphic leads have been identified, some supported by amplitude anomalies and likely AVO response confirmed by angle stack analysis, establishing large hydrocarbon potential with the most modern seismic dataset available in the area.

Developing the Purbeckian-sourced waxy crudes of the North Celtic Basin, offshore Ireland – A case study from the Barryroe Field

O'Sullivan, J.¹, Kamble, K.², Meehan, D.¹, McNaught, R.², Blackmore, M.²

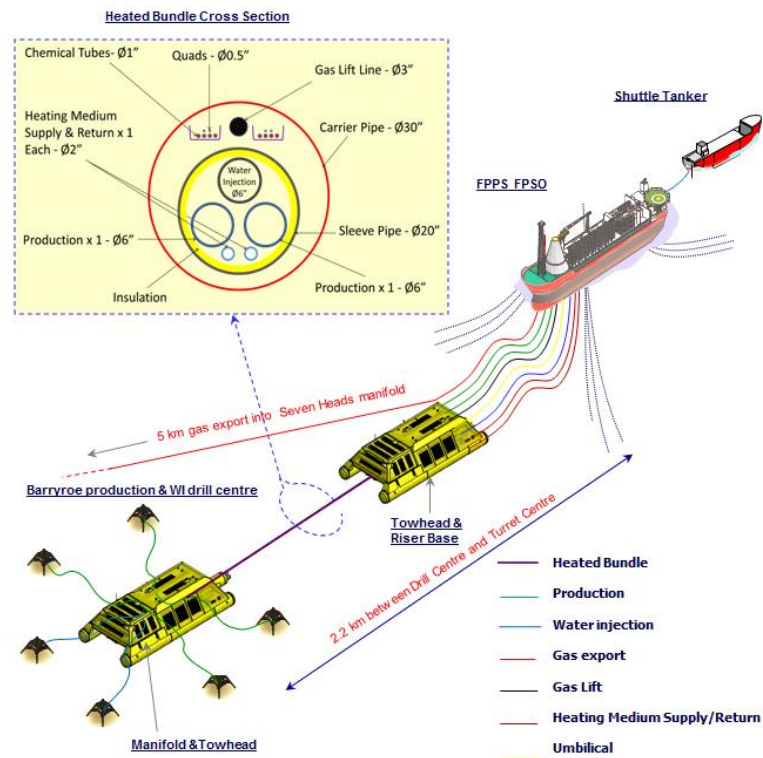
¹ *Providence Resources Plc*

² *CONSUB Limited*

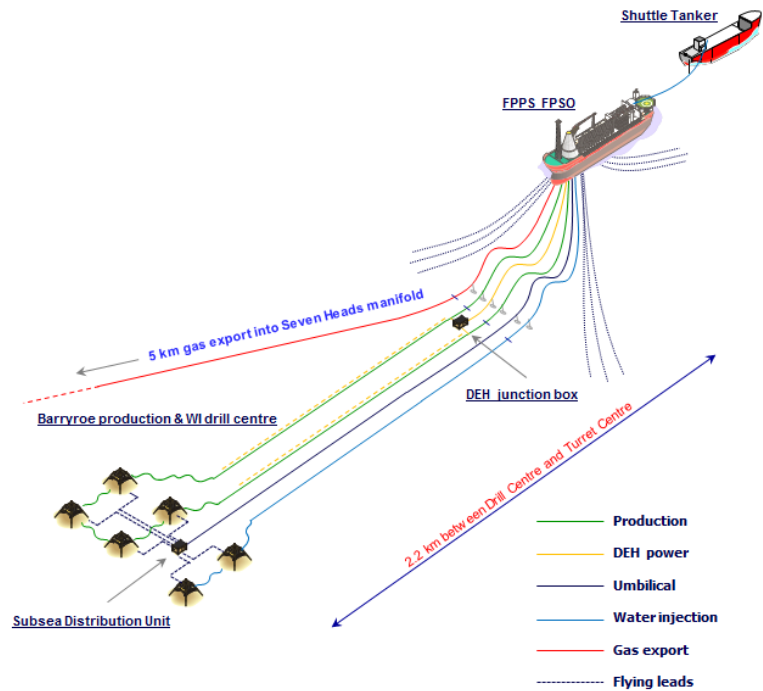
The North Celtic Sea Basin hosts a thick section of Purbeckian-aged (Tithonian/Berriasian) oil-prone shales that were deposited in a predominantly arid lacustrine environment. Mapping of available regional exploration well data indicates that this depositional system covered a total area of up to c. 10,000 km². Published burial history modelling demonstrates that these shales have reached peak maturity for oil generation in the basin centre. Crude oil samples recovered from overlying Lower Cretaceous-aged sandstone reservoirs in the Barryroe Field have been geochemically typed to have been sourced from these underlying shales. The Barryroe crudes are isotopically light with a gravity of 44° API however wax content by weight is significant, ranging 17-21%. The oils have a relatively high pour point (80°F), and wax appearance temperature (117°F), however in-situ viscosities are low (0.8 cP) due to a combination of high reservoir temperatures (150°F) and solution GOR (700 SCF/BBL). Given their relatively high cloud point versus the majority of North Sea crudes, these oils have been previously overlooked in terms of economic development. However, recent higher oil prices together with new production technologies have brought these resources back into industry focus. In addition, assays of the Barryroe crudes indicate that these oils are also likely to trade at a premium to the Brent benchmark oil price.

In terms of field development, the critical flow assurance issues which may affect concept selection with such crudes include wax deposition, wax gelation and hydrate formation. The key risks to be taken into consideration when considering potential field development scenarios include water depth, distance of the host facility from the reservoir, well completion details and extended export pipelines, all of which expose the oil flow to ambient seabed conditions. Hence it is essential to understand the design options, in order to mitigate flow assurance challenges and to remediate against any unavoidable circumstances. This paper highlights the development challenges associated with producing, processing and transporting waxy crude and offers deliverable field development solutions for mitigating and remediating the risks of wax deposition and wax gelation for the development of the Barryroe Field. A thermal hydraulic integrated production system modelling (IPSM) simulator was used to assess the feasibility of the First Phase Production System (FPPS) development concept. Production profiles were predicted subject to multiple constraints, including processing capacity and flow assurance operability limits. The thermal modelling indicated a positive outcome to overcoming the flow assurance challenges of waxy oil by utilising field proven technology such as pipeline bundles or electrically heated flow-lines.

1. Field Subsea Architecture – Pipeline Bundle Option



2. Field Subsea Architecture – Pipeline Direct Electric Heating (DEH) Option



Ireland's Atlantic Margin – Development Options and Lessons Learned from Other Harsh Environment Locations

Williams, D.¹

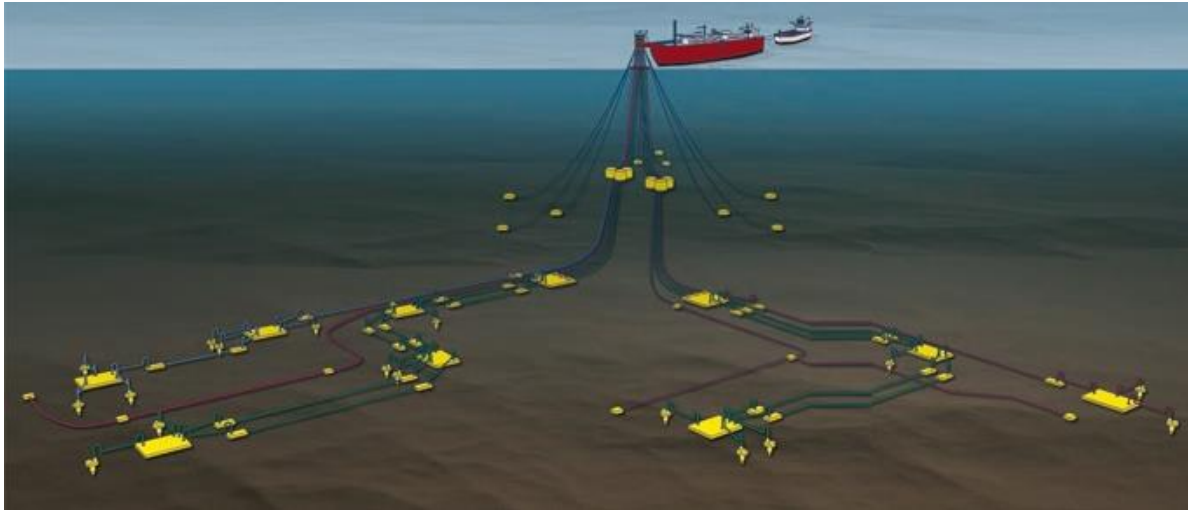
¹ *Wood Group Kenny, Galway Technology Park, Parkmore, Co. Galway*

The Irish offshore region represents a huge area approximately six times the size of the North Sea. To date, it remains relatively unexplored in comparison to major oil and gas-producing offshore regions around the world. Approximately 160 wells have been drilled in that last 50 years with only 3 commercial discoveries. In the so-called Atlantic Margin region, 43 exploration wells have been drilled with a number of oil and gas finds but with only 1 commercial development so far in the Corrib field. Much of the exploration carried out offshore Ireland was undertaken between the 1970s and the 1990s. Since then, the offshore oil & gas industry has made significant advances in exploration and production technology that have successfully unlocked additional global reserves, with much of these reserves being found in deep water and harsh environment locations. These are locations that share many characteristics with Ireland's Atlantic Margin. The technological advances have re-ignited interest in previously-explored fields that were deemed non-commercial with the technology of the day but which now, with more advanced assessment techniques, show real commercial potential. As more operators begin to get involved in exploration in the Atlantic Margin region, the discovery of a major commercial find in this harsh region becomes a real possibility.

The first step of any exploration campaign is the selection of a suitable drilling rig and identification of suitable opportunities for carrying out drilling. Frequently, seasonal variations dictate when drilling operations can be carried out; in particular the winter months pose severe challenges when older, less-capable drilling rigs are employed. The offshore drilling industry is, however, rapidly building up expertise in deep water and harsh environment regions such as the Atlantic Margin with experience of drilling campaigns west of the Shetland Isles and offshore eastern Canada, even in the challenging winter months. Meanwhile the construction of new build harsh environment capable drilling rigs continues apace.

In a similar vein, recent years have seen a number of deepwater and ultra-deepwater developments in the "golden triangle" of the US Gulf of Mexico, West Africa and offshore Brazil. Whilst these developments are not subject to the harsh environments expected in the Atlantic Margin region, significant learnings and technological breakthroughs have been achieved that are key to any proposed development offshore Ireland. In harsh environment regions, there have been a number of developments in water depths of up to 600m with environments comparable to offshore Ireland, most notably in the North Sea. In addition, a number of developments are planned for deepwater harsh environment regions such as West of Shetlands and the Southern Atlantic Ocean which could serve as a template for similar developments offshore Ireland.

This presentation will discuss the key technical challenges that must be overcome to develop any large oil or gas find in deep water in Ireland's Atlantic Margin region. A range of different development scenarios will be outlined, with the advantages and disadvantages of each examined. In particular, lessons learned from Wood Group Kenny experience in other deep water and harsh environment locations around the globe where developments have taken place or are planned will be highlighted, with emphasis on their relevance to potential developments offshore Ireland.



Notes

Wood Group Kenny is the world's largest independent specialist subsea, pipeline and riser engineering and management contractor employing more than 2,900 people worldwide, part of international energy services company, Wood Group.

www.woodgroupkenny.com

Induced Polarisation for Hydrocarbon Exploration: A New De-risking Tool for Offshore Ireland

Flekkøy, E. G.¹

¹Org Geophysical

Introduction

This presentation will overview how an established mineral exploration technique has been adapted for Hydrocarbon Exploration. Recent verification studies deploying the marine towed system Offshore Norway and relating to known fields and Exploration activity have been very encouraging, suggesting this is a powerful new de-risking tool for wider Exploration in North West Europe.

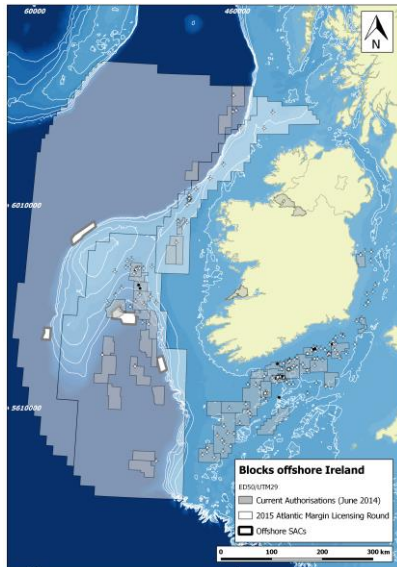


Figure 1 Areas offshore Ireland currently accessible to IP de-risking.

The Differentially Normalized Method of Electrical Prospecting (DNME) combines the basic principles of controlled source electromagnetism (CSEM) with another proven principle for hydrocarbon detection, namely Induced Polarization (IP) (Veeken 2009). While CSEM measures resistivity changes directly in the reservoir, IP measures mineralogical changes at much shallower depths. These smaller depths allow for a cost-efficient, towed system to be applied. The method has been successfully applied both onshore and offshore. DNME represents a new way of using IP and CSEM together, focusing on indicators to the presence of hydrocarbons in the overburden.

Whilst currently being restricted to a 600 m water depth due to deployment limitations, plans are forthcoming for an acquisition campaign Offshore Ireland next year.

Method

The geological background for the method, which comprises different signatures of hydrocarbon seeps, is illustrated in Figure 2. Over geological times the hydrocarbon micro-seepage upwards from a reservoir will produce both the IP active mineral, pyrite, and the magnetisable mineral magnetite. These minerals occur in the reducing zone that typically extend up to a few hundred meters below sea level, and they may come from the fact that the hydrocarbons supply sulphur to the chemical environment, but there are also mechanisms where hydrocarbon-feeding bacteria give rise to pyrite. Our measurements rely on electromagnetic processes created by the passing of a current through a pyrite grain. These are quite similar to what happens on the surface of an electrode in a battery (Flekkøy 2013), and the large-scale effects are well described by a frequency

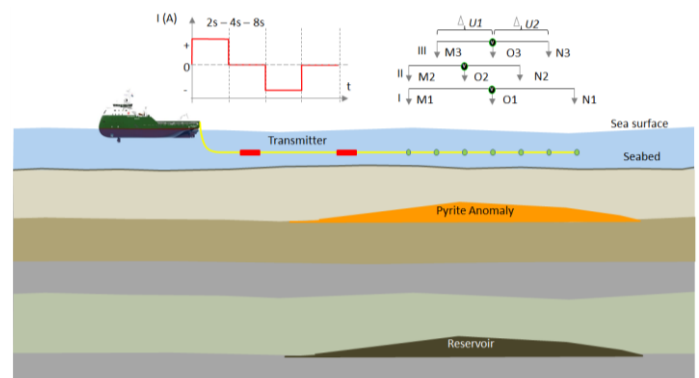


Figure 2 The geological background for the method is seepage from hydrocarbon reservoirs. The receiver and transmitter system are designed to detect IP-anomalies, such as those created by pyrite accumulations. The separation between the transmitter and receiver electrodes is 250 m. The green O1--O3 circles show the location of voltmeters between the electrodes, and the red curve shows the pulse signal as a function of time.

dependent electrical conductivity. The IP signature of the pyrite is relatively easily measurable with the DNME technology. In fact, the IP effect has traditionally been considered a contamination of conventional EM signals, as it often dominates at late times.

The technology is based on tools that are medium sized and can be used from ordinary supply vessels and do not require specialised ships. It is a method that can be applied for preliminary surveys in new frontier basins, in conjunction with other methods for exploration and for de-risking prospects. The IP method is entirely complementary to CSEM; it measures a different effect at a different location. The system presently being used for detecting IP-anomalies is entirely towed with an 800 m long transmitter followed by a 1200 m long receiver system of electrodes as is illustrated in Figure 2. This relatively small system allows for an efficient survey procedure. Since the IP-response is particularly pronounced, and even dominating at short offsets and late times, the system is optimised to measure this. The offset between transmitter and receivers is short, only 200 m, and the transmitted signal has listening periods where the current is off. In addition the receiver electrodes are connected in groups of three to voltmeters in such a way as to measure field gradients directly. Onshore, a similar arrangement is used with a spatial distribution of electrodes and receivers. As an important data-processing step, the measured fields are normalised by their initial values. This is achieved by dividing the measured fields by their values at the time when the transmitter signal is shut off. The result is to reduce the effect of motion induced disturbances, or perturbations, in the receiver system. In its present design the system operates at water depths between 30 m and 600 m as in the North Sea. The present system can be towed at speeds ranging from 2 to 5 knots using a survey vessel of 60 - 90 m. During the North and Barents Sea operations in 2012 and 2013, data collection was carried out in wave heights up to 5 meters.

Example

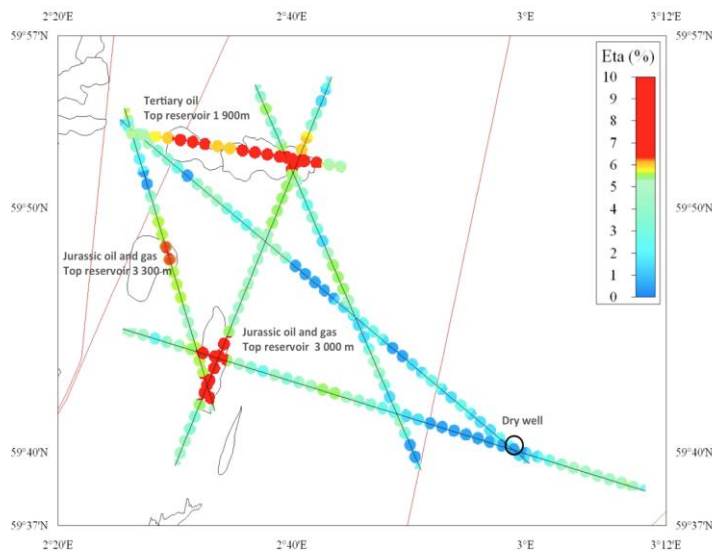


Figure 3 Chargeability variations across three known discoveries in the Frigg area. The chargeability eta is located in the third layer of the geo-electrical model. Red lines show pipelines, black lines prospect boundaries

The field example presented here is from the North Sea, and based on 2012 surveys that were designed to validate the method in Norwegian waters. Figure 3 shows results from the Frigg area. It illustrates the general trend of agreement that was found comparing chargeability anomalies with known prospect boundaries and discoveries. Only recently has it been possible to confirm predictions made by the DNME method prior to drilling. In Norwegian waters 12 out of 13 predictions have been correct. Out of the 12 correct predictions, 7 have been discoveries

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Broadband Marine Seismic Acquisition with Flat Streamers

Buchan, I.¹

¹Polarcus UK Ltd, The Beehive, City Place, Gatwick Airport, RH6 0PA

The past few years have seen a revolution in the marine seismic acquisition industry, with a move towards seismic methods that yield hitherto unachievable bandwidths, with extensions at both high and, crucially, low, ends of the spectrum. There are a number of different techniques involved, some of which require specialised hardware technologies, but all of which depend on advances in seismic data processing. This paper describes one particular approach to designing survey configurations to optimise broadband data response, which is being employed in major exploration programmes in the Porcupine Basin offshore Ireland.

Technology advances for single sensor streamers

The key technology enhancements that have made broadband acquisition viable are firstly the enormous advances in computing power seen in the last 10 years, but also improvements in the technology of the streamer systems themselves. The 24-bit digital streamers now in use have a significantly extended dynamic range – up to 120 dB – which allows for recording at very high-fidelity for high frequencies, typically a 200 Hz anti-alias filter for 2ms data sampling. Solid streamers are now in widespread use, their very low self-noise, especially at low frequencies, giving superior signal-to-noise performance than was previously possible.

Ghosting and de-ghosting

'Ghosting' is a characteristic of marine streamer seismic acquisition. Since the energy source and receiver streamer cables are both below the water surface, the source output signal and the receiver waveband are affected by both constructive and destructive interference caused by reflection from the air-water interface. This produces the ghost notches that are characteristic of marine streamer seismic data.

Figure 1 shows the theoretical amplitude spectrum output from an airgun array, followed by displays showing the effects of the source and streamer ghosts respectively. The position of the notch in the spectrum depends essentially on the depth of the source or streamer below sea level. The severe impact of ghosting on recorded seismic data spectra can clearly be seen. Currently the primary focus of the marine streamer seismic industry is to find means of removing the ghost effects from data, to give a flat, balanced spectrum across a broad bandwidth. There are techniques based on multi-sensor hardware solutions, others on slanted or curved streamers, yet others employing more conventional deep-towed flat streamer configurations. All methods ultimately depend on advanced data processing algorithms designed to recover and enhance signal in the notches. Further, as with all seismic techniques, maintaining good signal-to-noise is the most important criterion.

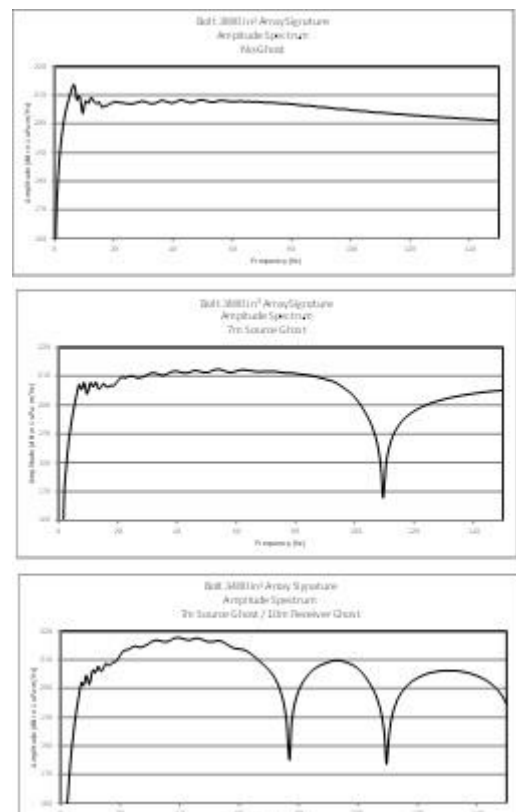


Figure 1: Source and streamer ghost notches

Polarcus' philosophy is encapsulated in the RightBand proposition. The principle features of this are to:

- Tow 'flat' streamers relatively deeply to improve signal-to-noise and open up low frequency reception.
- Employ modern single-sensor solid streamers with lowest levels of self-noise
- Tow sources at 'standard' depths to optimise low-frequency output.
- Set the streamer depth to be 2 or 3 times the source depth.
- Process data through a modern de-ghosting algorithm to produce broadband data with geophysically correct earth-response.

How do we arrive at this proposition?

Towing seismic streamers deeply so as to avoid the influence of surface swell noise is an eminently sensible approach to improving signal-to-noise and probably needs no explanation. However, it can be shown that in deep open water with long surface swells – the Atlantic offshore Ireland, for instance – beyond a certain depth, say 15-20m, there is very little to be gained by towing streamers any deeper, as it is practically impossible to escape the effects of the swell altogether.

It might be thought that towing sources deeply will give better low-frequency output, however it can be shown that beyond about 8m the increase in hydrostatic pressure of the water negates any such effects, and in a practical sense there is no low-end uplift by going any deeper.

What is often forgotten is that ghosting does not only have negative effects. In contrast to the destructive interference that produces the notches, there is a boost in energy caused by constructive interference at the halfway point between the notches. Therefore the source and streamer depths are selected such that the peak of the source output corresponds with the notch in the receiver band. In practice this means having the streamer depth at an integer multiple of the source depth.

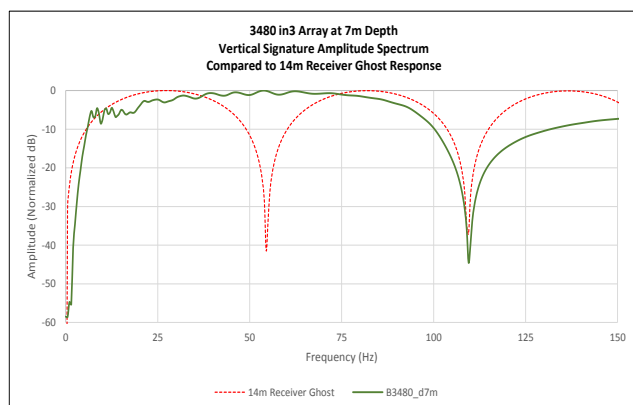


Figure 2 – Typical RightBand Modelled Spectra

Coincident notches?

What might appear to be an issue is that the first source ghost and the second receiver ghost coincide. In practice this is not really a problem. The modelling assumes a perfect reflection from the sea surface and takes no account of the angular dependence of energy emitted from the source, so in reality the source ghost notch is very shallow. Further, one has to consider the likely bandwidth to be returned from the geology: in the example shown in Fig 2 we are seeing a pretty flat response out to about 100 Hz, easily containing sufficient bandwidth for the majority of geophysical scenarios, especially for deeper targets.

Conclusion and examples

Numerous projects in the past few years have been acquired using this RightBand approach around the world, on both Multi-client and proprietary surveys. Evidence shows that the superior signal to noise performance from the use of solid streamers towed at depth, coupled with the latest processing algorithms, produces clean, easily interpretable data, suitable for initial exploration, prospect

evaluation and field development. Figure 3 shows example sections showing the high quality of final data. These techniques have been applied on the large scale seismic programmes acquired over the Porcupine Basin this summer.

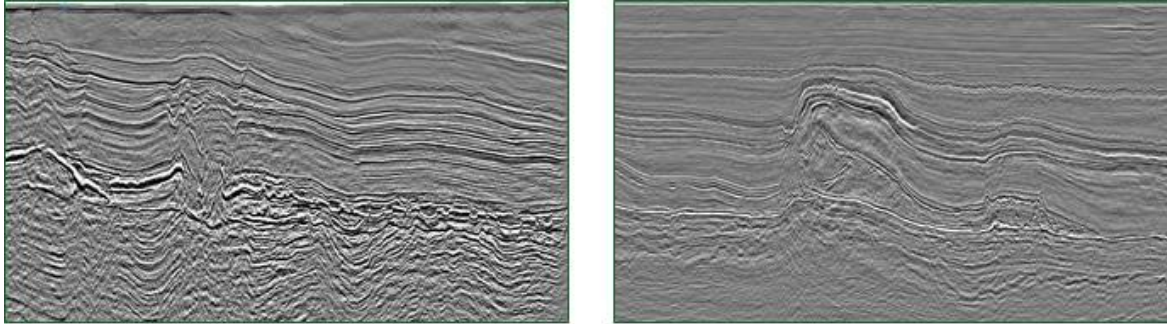


Figure 3 – Data Examples from North West Europe

Acknowledgements

Thanks are due to the Polarcus Multi-Client group for permission to show data examples, to Polarcus' Chief Geophysicist, Phil Fontana, whose work this paper reflects, and finally to the crews of the Polarcus vessels and personnel of our processing partners who are ultimately responsible for the high quality of the data shown here.

First use of combined high and low frequency moored Passive Acoustic Monitoring (PAM) instruments for cetacean detection in offshore Ireland

Parry, G.¹

¹ *Woodside Energy (Ireland) Pty Ltd and Partners*

Woodside is building an international exploration portfolio characterised by materiality and depth, with greater emphasis on emerging petroleum provinces.

Our acreage position in Ireland presents an opportunity to leverage our deepwater capabilities in the underexplored Porcupine basin.

As we expand internationally we do so with the belief that our long-term success depends not only on the oil and gas we produce, but in doing what's right. We take this approach wherever we go.

Across all of our business, we are committed to understanding the environment and minimising any impact from our operations. This is not something we take lightly.

In support of this commitment, in 2014, we completed the field component of a study to assess cetacean occurrence, seasonality and abundance in the Porcupine basin and surrounds.

The study primarily employs passive acoustic loggers to record cetacean songs, calls and clicks, thus enabling the identification of individual cetaceans in and adjacent to our permit areas. Loggers have been deployed during the time of year with peak exploration activities (May to September).

Two types of loggers have been deployed:

- 1) low frequency loggers to record singing or communicating cetaceans; and
- 2) high frequency loggers to record cetaceans using echo-location for prey detection.

The logger arrays are located in three areas (see map);

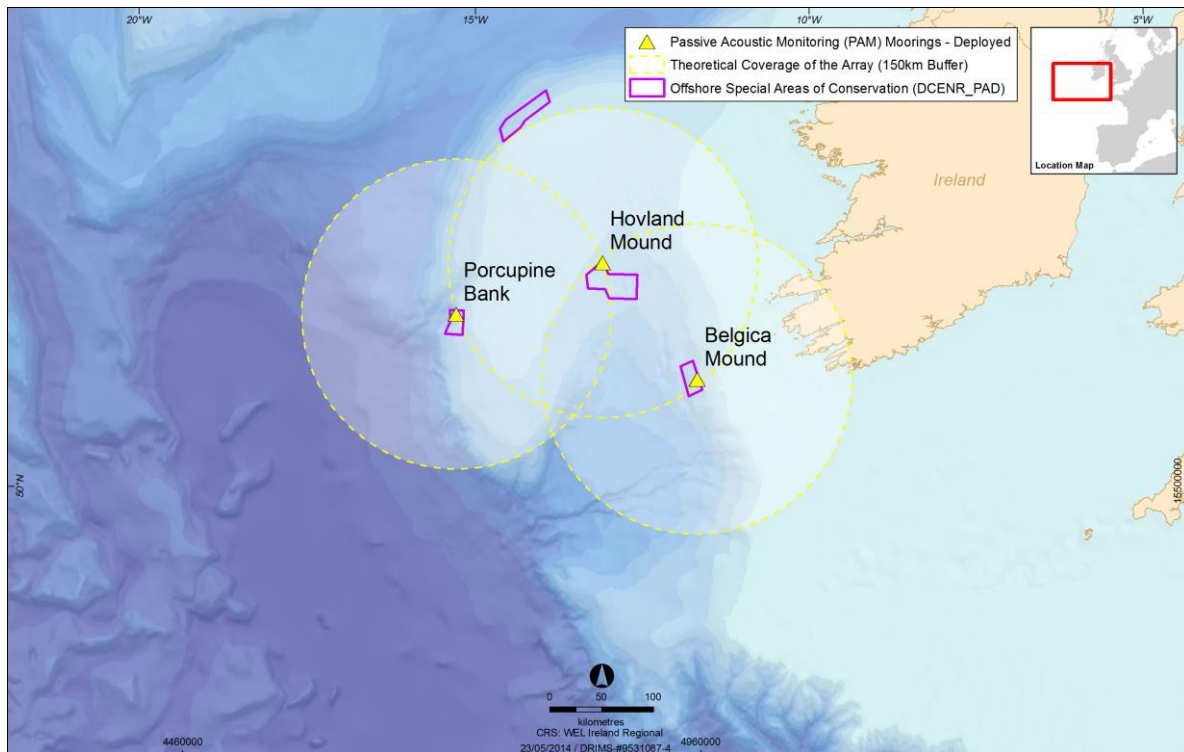
- 1) within Woodside permit areas,
- 2) in shallower waters to the east, and
- 3) between two canyon features on the western margin of the Porcupine bank.

The loggers were successfully recovered in September 2014 and the data recorded will be analysed to identify species, intra-summer seasonality (during the time of deployment) and where possible relative abundance.

This program is a partnership between the Marine Institute, Galway-Mayo Institute of Technology, Curtin University (Australia) and the Woodside (Ireland) Pty Ltd Joint Venture Partners (JVPs); AzEire Petroleum* and Petrel Resources PLC.

This study provides a model of how environmental studies can be completed in a technically robust and cost-effective manner.

**AzEire Petroleum's Ireland assets are held through Strike Oil and Charge Oil.'*



Monitoring and modelling acoustic noise from seismic surveys in Irish waters

White, M.¹, McKeown, E.², Crawford, S.¹, Stapleton, F.², Lee, G.³, Nolan, G.⁴, Brown, C.¹

¹ *Earth and Ocean Sciences, School of Natural Sciences, Ryan Institute, NUI, Galway*

² *RPS, Lyrr 2, IDA Business and Technology Park, Mervue, Galway*

³ *School of Environmental Sciences. University of East Anglia, UK*

⁴ *Ocean Science and Information Services, Marine Institute, Rinville, Oranmore, Co Galway*

This study, funded by the Petroleum Infrastructure Programme (PIP), aims to provide the first validated underwater noise propagation study in Irish waters through the integration of acoustic noise observations from offshore seismic surveys and development of an acoustic noise propagation model for Irish waters.

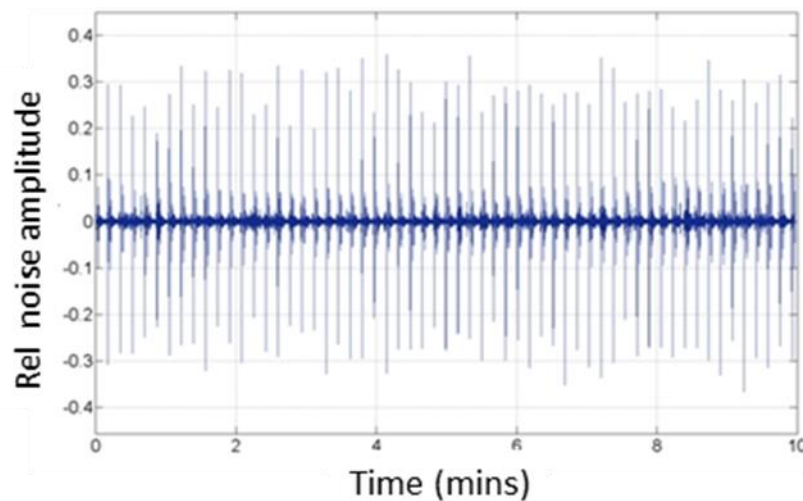
A field survey was carried out in July 2014 with the objectives to monitor a 3D seismic survey in the SW Porcupine Sea Bight. The survey objectives were to obtain seismic noise data at varying distances and depths from the seismic air gun source to both calibrate and validate the noise propagation/attenuation model, as well as acquiring a first seismic noise data set for Irish waters.

Noise observations were made at distances ranging from 2.5 nm up to the shelf edge 80 nm distance and beyond onto shelf waters, such that the influence of varying bathymetry and seabed type on noise attenuation could be quantified. As a test of potential future acoustic monitoring techniques, the survey included the use of a Kongsberg Sea Glider, equipped with a passive acoustic monitor, to enable acquisition of concurrent water column structure and noise levels in the upper 1000 m for 4 days some 30 nm from the acoustic source.

Initial acoustic data quality assessment indicated that the attenuation properties with distance would be resolved post survey. Early analysis has shown that a distinct air gun pulse can be recognised in deep water up to 30 nm from the source. In addition it is suggested that deep water noise attenuation

close to the survey area essentially followed a predictable logarithmic decay, but attenuation was amplified above a standard logarithmic relation for depths < 1000 m. Calibration exercises and more detailed analysis together with use of the acoustic model will be required to identify and quantify the exact attenuation processes. Hydrographic measurements conducted during the survey have characterised the water masses and general hydrographic structure in the experiment region. Preliminary results have indicated potential influence of oceanic structures, such as internal solitons/waves, in modulating acoustic transmission loss near the source in the upper layers associated with the region of the seasonal thermocline.

During the course of the project, acoustic data will be used to prepare, calibrate and validate a model of noise levels in Irish waters resulting from offshore seismic operations. Modelling will be developed in conjunction with Curtin University collaborators. Ultimately, the project aims to provide data and model predictions to support future based decisions for operational exclusion zones management of sensitive areas such as SACs and provide a database of offshore noise levels to integrate with other research.

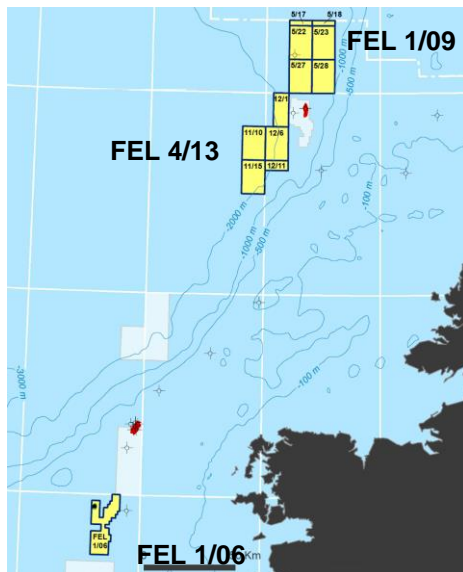


Above: The Polarcus Amani conducting seismic survey (the acoustic monitoring buoy can just be seen in the foreground), and
Bottom: An example of uncalibrated recorded data 5nm from acoustic source.

Prospects 2 Go (Serica Energy) - Atlantic Ireland Drilling Opportunities

Pritchard, G.¹

¹ Serica Energy, 52 George Street, London, W1U 7EA

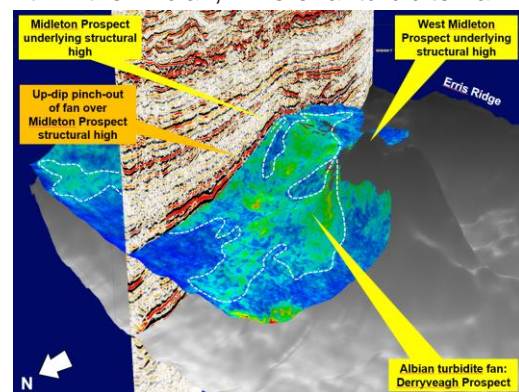
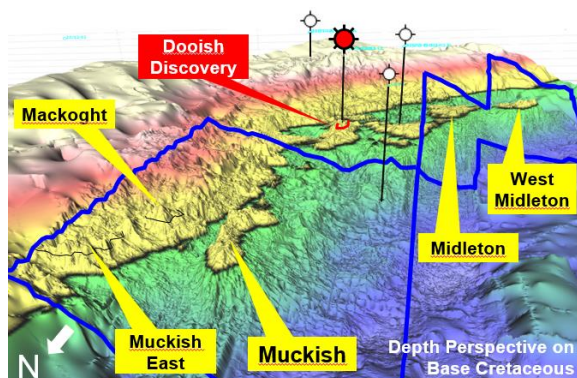


In the Rockall Basin, Serica (100%, operator) is offering significant equity in return for partial funding of an exploration well on either the Muckish and/or the Midleton Prospect, located in licences FEL 1/09 and FEL 4/13 respectively.

In the Slyne basin, Serica Energy (50%, Operator) and RWE (50%) are jointly seeking a partner to participate in the drilling of an exploration well on the Boyne Prospect, in return for significant equity in the licence.

FEL 1/09 and FEL 4/13, Rockall Basin, Atlantic Ireland

The Muckish and Midleton prospects are significant pre-rift tilted fault block structures that are structurally analogous to the nearby Dooish Discovery. The prospects are located in approximately 1500m water depth, and are mapped on excellent-quality 3D seismic data. By analogy with the Dooish 12/2-1,1z discovery, wet gas-condensate charged sandstone reservoirs of Permian to Middle Jurassic age are anticipated, although reservoirs of other ages are also possible. Muckish carries a P₅₀ resource potential of 85 mmbbls condensate + 1.3 tcf gas, and Midleton carries a potential P₅₀ resource potential of 94 mmbbls condensate and 1.4 tcf gas. Additional prospectivity is also recognised in the early Cretaceous, in particular, within the Albian, where a turbidite fan (the



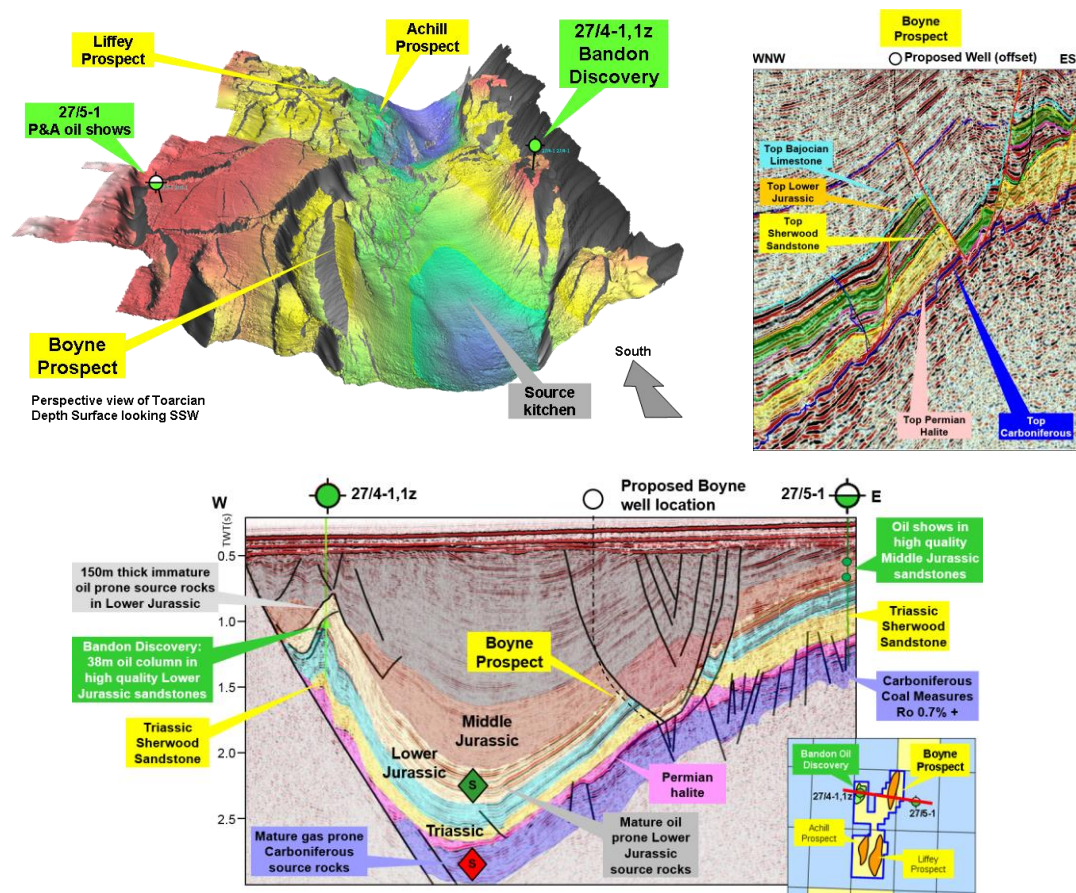
Derryveagh Prospect) has been mapped on-lapping the flanks of the Midleton structure. This fan,

which is supported by an AVO anomaly, could be tested by a single exploration well targeted to investigate the deeper Middleton Prospect

FEL 1/06, Slyne Basin, Atlantic Ireland

The Boyne Prospect is located to the east of the nearby Bandon oil discovery (27/4-1,1z), drilled by Serica in 2009, which encountered a 38m oil column within high-quality early Jurassic sandstones. Wells 27/4-1 and nearby 27/5-1 also encountered reservoir quality Triassic Sherwood Sandstone, which forms the reservoir in the Corrib Gas Field some 40 kms to the north.

The Boyne Prospect is a clearly defined tilted fault block, with stacked reservoir potential at both early Jurassic and Triassic levels. It carries a recoverable resource range of 9 – 31 – 96 mmbo in the Jurassic, and 33 – 200 – 1213 bcf in the Triassic ($P_{90} - P_{50} - P_{10}$ range; Serica in-house estimates). The Boyne Prospect, which is located in water depths of around 230m, is ready to drill.



In the event of success at Boyne, there is substantial upside potential in the form of the nearby Liffey and Achill Prospects.

Companies interested in pursuing this opportunity should contact:

Clara Altobell, International Asset Manager

Tel: +44 (0) 207 487 7300,

Email: clara.altobell@serica-energy.com

Serica Energy, 52 George Street, London, W1U 7EA

Prospects 2 Go – The Newgrange Prospect – One of the largest undrilled Mesozoic four-way-dip-closed structures on the Atlantic Margin

Byrne, K.¹

¹ *Providence Resources plc*

The Newgrange prospect is located in the Goban Spur Basin c. 260 kilometres off the south-west coast of Ireland. The prospect is situated in c. 1,000 metre water depth within Frontier Exploration Licence (FEL) 6/14, which was granted to Providence Resources (80%, Operator) and Sosina Exploration (20%) as a successor authorisation to a previous Licensing Option awarded as part of the 2011 Irish Atlantic Margin Licensing Round.

Previous deep exploration drilling and shallow seabed coring have revealed that the Goban Spur basin is floored with a Devonian red-bed sequence with the fill ranging from Mesozoic to Recent in age. Potentially important hydrocarbon source rocks were encountered in the Esso Exploration-operated 62/7-1 well (1981) within a sequence of Lower Jurassic marine shales, with hydrocarbon shows recorded from thin sands and carbonates. Other potential hydrocarbon sources are postulated such as Cretaceous coals encountered in the 62/7-1 well together with possible Upper Jurassic shales and biogenic sourcing from the adjacent southern Porcupine Basin. Reservoir quality sands and carbonates were also encountered in this well in the Middle Jurassic and Cretaceous respectively, and the recent 44/23-1 Dunquin well proved an active hydrocarbon system and thick, high porosity Cretaceous carbonates.

Seismic interpretation and mapping based on vintage 2D seismic profiles together with more recent (2006) long offset data has confirmed the presence of a large four way dip closed structure at Base Cretaceous and an overlying Cretaceous carbonate build-up. The carbonate closure extends over a c. 1,200 km² area with up to c. 300 metres of vertical relief and a potential seismically imaged 'flat-spot' has been noted on a number of profiles close to the mapped structural closure. The recent (2006) long offset data also shows anomalous low seismic velocities over the prospect indicating potential hydrocarbon charge. The crest of the Cretaceous carbonate build-up is located just c. 400 metres BML and therefore presents an economically attractive target for drilling. Caprock seal analysis based on regional well control suggests that the Cenozoic interval could seal a vertical gas column of c. 300 metres. Volumetric estimates for the Cretaceous carbonate build-up, based on only a 150m hydrocarbon column, have a Pmean of 7.7 TCF GIIP.

The main risks associated with the Newgrange prospect are considered to be source adequacy and access with either thermogenic or biogenic sourcing from the adjacent southern Porcupine Basin considered to a requirement in order to generate meaningful volumes. Source rock evaluation and AFTA analysis from Esso Exploration-operated 62/7-1 well (1981) is being conducted to provide input to a regional thermal history and maturation model.

Providence also recently completed a new long offset 2D seismic programme extending from the Newgrange prospect into the southern Porcupine Basin which is designed to provide critical source and migration information and progress the project to drilling.

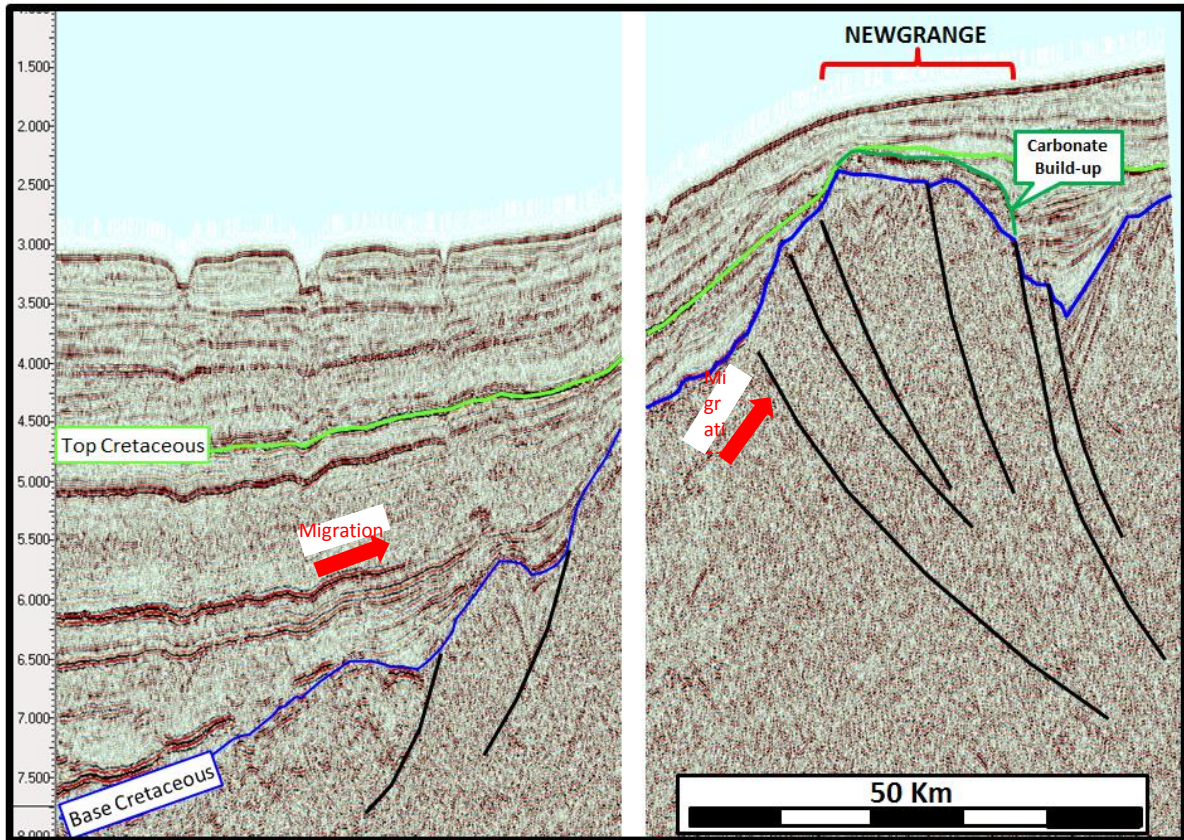


Figure: Composite 2D seismic line from southern Porcupine Basin to the Newgrange prospect, courtesy PAD.

Prospects 2 Go – The Irish Atlantic Margin, New Data, New Dawn

Corr, J.¹, Vinall, A.¹

¹ Hannon Westwood

The Irish Atlantic Margin covers an area nearly one and a half times that of the UK equivalent, yet since offshore exploration commenced the UK has enjoyed significantly more attention by the oil companies than Ireland. In total, some 158 E&A wells have been drilled in the entirety of offshore Ireland, of which around 34% (54 wells) are located in the Atlantic region. The majority of Atlantic Margin wells are restricted to the northern part of the Porcupine Basin. By comparison 162 exploration wells have been drilled offshore Atlantic UK. The last Atlantic Margin licensing round in 2011 was successful in that it stimulated renewed interest in the region. Prior to the holding of the Licensing Round approximately 11,307 km² of acreage was licensed however, today, over 18,500 km² of acreage is licensed whilst another 1,000 km² of acreage is held under a single licensing option giving an indication of the level of interest in the

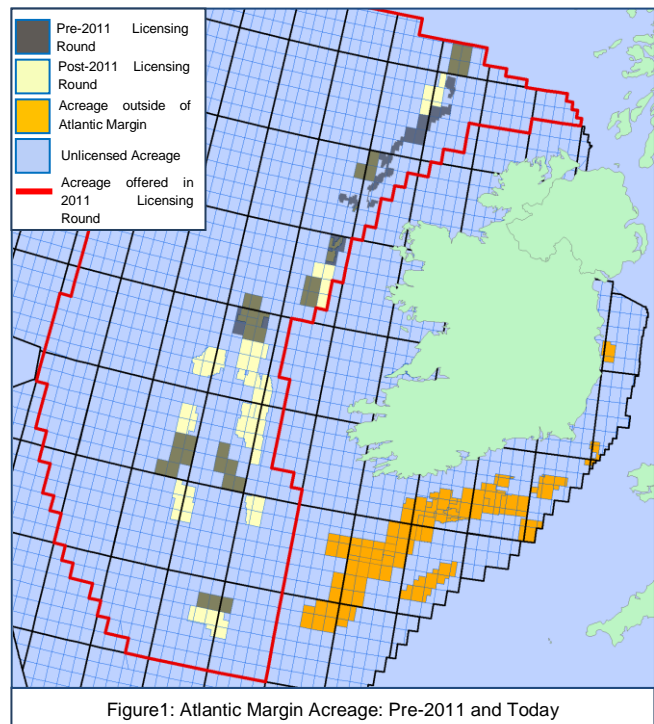


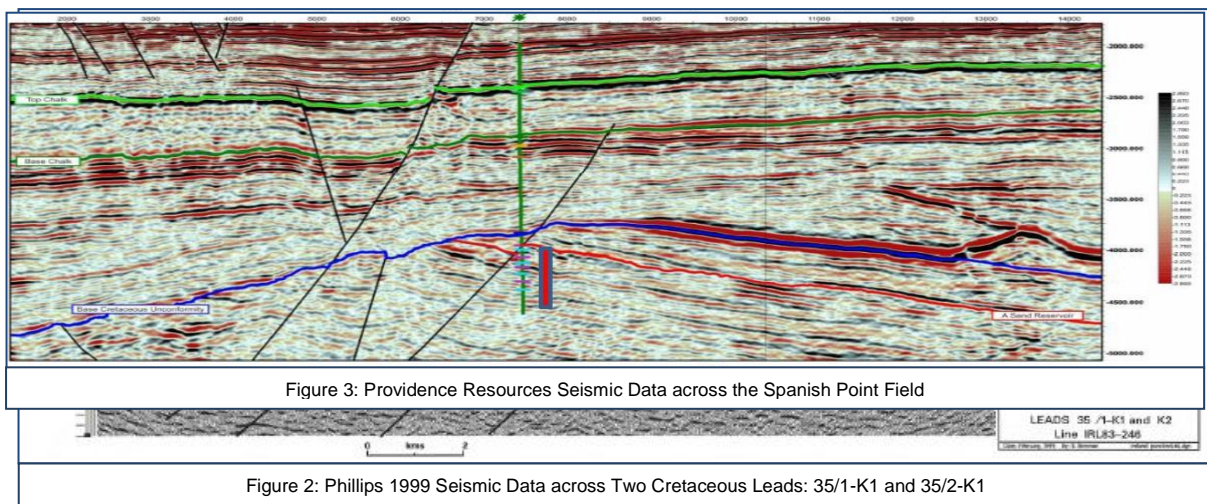
Figure1: Atlantic Margin Acreage: Pre-2011 and Today

Round (Figure 1). Today there are more active licences in Ireland than at any previous time. The work committed by the licensees in this Round has attracted further inward investment by larger companies that have enjoyed significant success chasing Lower Cretaceous to Tertiary plays along the African Atlantic margin.

This talk aims to address three key aspects, namely: what does the historic drilling in the Irish Atlantic Margin tell us about which plays have been tested, what has changed with respect to both the play concepts and the Atlantic Margin as a whole since the 2011 Licensing Round and, finally, what do we know about the potential undrilled resource thought to be present in existing tested and untested plays.

Whilst the results of the 2011 Atlantic Margin Licensing Round were positive, with 12 new two year Licensing Options awarded, activity remains disappointingly low, with only two wells drilled in the region in the last four years. However much has occurred since the 2011 Round which is encouraging for the area. A large quantity of new seismic data has been acquired, for the first time much of it in 3D surveys. For example some 18,000 km of 2D seismic was shot in 2013/14 by the PAD, including areas across the Rockall and Porcupine basins, and, in addition, the largest 3D seismic survey ever acquired in the Porcupine Basin was shot by Kosmos. Of the 43 exploration wells drilled across the Irish Atlantic Margin eight have made discoveries and 29 have recorded shows, giving a technical success rate of approximately 19%, which is comparable with other basins including both the UK and Norway where average success rates vary geographically, from basin to basin, between 25 and 45%. In the UK Atlantic Margin the technical success rate is 32%. In total 693 mmboe (14.4 mmboe/well) have been discovered in the Irish Atlantic Margin compared with 4,238 mmboe (26.2 mmboe/well) in the UK.

Although the amount of resource found and the finding rate is comparatively lower on the Irish Atlantic Margin when compared with the UK, companies are for the first time employing cutting edge technology to understand and define the geology offshore Ireland better. Figure 2 illustrates legacy seismic data, shot by Phillips in 1999 west of the Spanish Point Discovery. Only the large gross structures, such as the Base Cretaceous Unconformity (BCU) and tilted fault blocks below, are readily identifiable but much detail is lost at depth. Figure 3 shows 2006 data, courtesy of Providence Resources, shot across the Spanish Point Discovery with a notable increase in definition of the sub-BCU reflectors. More recently long offset 2D and broadband 3D seismic has been acquired further enhancing subsurface resolution, with more 3D seismic acquired in 2013 than at any other time in the province's history.



The conjugate margin regions of Newfoundland and Labrador are currently experiencing the highest levels of exploration and development drilling seen to date whilst elsewhere, the Flemish Pass has had three large discoveries in as many years, namely Mizzen (200 mmbbls recoverable oil), Bay du Nord (300-600 mmbbls recoverable 34° API oil) and Harpoon. All of these are located in the Newfoundland Labrador Late Jurassic Source Rock Superhighway which is the subject of a geochemical study to determine if it extends to the Porcupine, Rockall and Orphan basins. Huge success off the coast of West Africa has also spurred entry into the Irish Atlantic Margin by companies such as Cairn, Kosmos and Woodside, which are attempting to extend successful plays northward into Irish waters. These plays are innovative, with these companies applying lessons learned from offshore West Africa and chasing large stratigraphic traps, something which can only be done using the new seismic data which is being acquired.

In Ireland, key discoveries have been made in a number of plays including the Permian, Triassic, Jurassic and Cretaceous and mapped prospectivity is also present in the Tertiary. Exciting opportunities exist and whilst costs for the more challenging plays can be high (Dunquin exceeded \$200 million), the potential prize could be large, with the Irish Department of Communications, Energy and Natural Resources estimating some 10 billion boe of risked YTF resource to exist along the Atlantic Margin. Of the exploration wells drilled in the Atlantic Margin 27 were drilled before the first modern 3D seismic was acquired in 1991 and, of the remainder, the two thirds that were drilled with the benefit of 3D seismic showed an increase in technical success to 30%. Only time will tell if the new data being acquired truly is the key to unlocking this resource but it is undoubtedly a very positive step in the right direction.

STANDS (in alphabetical order)

AGR Stand



AGR. Here for your next upstream project.

AGR is the leading well and reservoir management service company delivering solutions for the entire field life cycle. We also provide tailored training, software and consultancy manpower for our clients globally.

AGR has experience delivering wells safely and cost-effectively offshore Ireland.

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AGR has created a dedicated Rig Team to try to ensure that the best available rigs are secured for our clients' projects.

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Aberdeen AB10 1SL
Scotland, UK
Tel: +44 (0)1224 629000
www.agr.com

Triggs Turner House,
128 High Street, Guildford,
Surrey, GU1 3HH, UK
Tel: +44 (0)1483 397 100



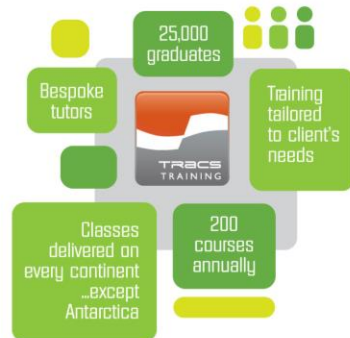


Meet AGR's team at Atlantic Ireland 2014.

RESERVOIR MANAGEMENT

AGR provides independent reservoir management advice to our clients, which includes international oil companies, national oil companies, independent operators and investment groups.

AGR's TRACS Evaluations can provide a range of services to support Acquisitions and Divestments, reserves-based lending and other commercial activities.

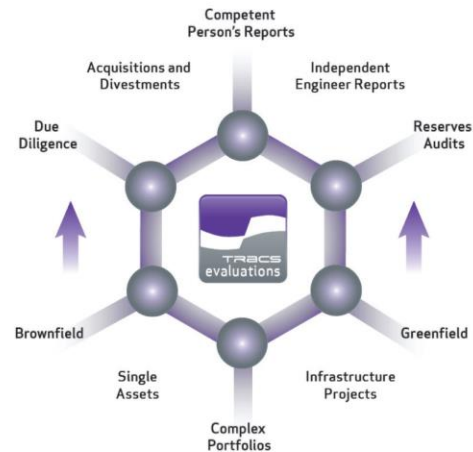


TAILORED TRAINING

AGR's Training division, TRACS Training is unique in providing customised courses tailored to each client's specific needs. It is regularly called upon by HR departments to assist with the development of in-house training programmes.

All trainers have worked for international E&P majors, are practising engineers and geoscientists and on average have more than 15 years' experience.

AGR's Training division has provided courses to more than 25,000 people in 45 countries.



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AGR Consultancy is a preferred global provider of recruitment and consultancy solutions to the upstream oil and gas industry:

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APT Stand

APT (UK) Ltd delivers organic geochemistry laboratory services and consultancy of the highest standards. Based in North Wales and employing a team of 8 experienced geochemists, APT offers a full range of analytical and interpretive services for source rocks, kerogens, spore colour, hydrocarbon isotopes and biomarkers.

Proprietary projects undertaken along the Atlantic Margin and across the UKCS at basin, prospect and reservoir scale.

Multi client studies are available along the Atlantic margins of the UK and Ireland building an integrated geochemical picture of a complex petroleum frontier.

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Specialist capabilities in:

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- Reservoir geochemistry services
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- Vintage data “translation” a speciality to derive maximum value from existing datasets

APT are exhibiting at Atlantic Ireland, Stand 28, do call in and find out more.

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2nd Floor, 14 Wynnstay Road

Colwyn Bay

LL29 8NB

Tel. & Fax: +44 (0)1492 533 007

Mobile: +44 (0)7906 000826

Website: www.aptec.no

Contact person - Patrick Barnard

Email - patrick.barnard@aptuk.co.uk

APT UK Ltd incorporated in England and Wales (company number 5814934).

ARKeX Stand

ARKeX is a geophysical service company for the oil & gas exploration industry. It specialises in the acquisition, processing and interpretation of Full Tensor Gravity Gradiometry (FTG) and conventional gravity/magnetic data. ARKeX also brokers gravity and magnetic data for seismic companies and government agencies, provides interpretation software and data management services.

For more information please contact:

Lyndsey Smith

Tel: +44 (0)1908 518 359 (direct)

Mob: +44 (0) 7711 590 180

E-mail: lyndsey.smith@arkex.com

Web: www.arkex.com

Gravity Gradiometry Data

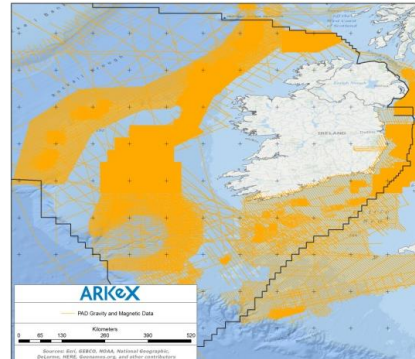
Full Tensor Gravity Gradiometry (FTG) measures variations in the earth's gravitational field and is a direct measure of the density distribution of the subsurface. This information helps to build a picture of subsurface anomalies to more accurately target hydrocarbon bearing deposits. The ultra-high resolution FTG data is acquired from a ship or aircraft in either multi-client or proprietary modes.



Data Brokerage

As well as being a release agent for offshore gravity and magnetic data on the behalf of UK and Irish government agencies, ARKeX can also supply non-exclusive gravity and magnetic data on behalf of the BGS and most of the major seismic companies.

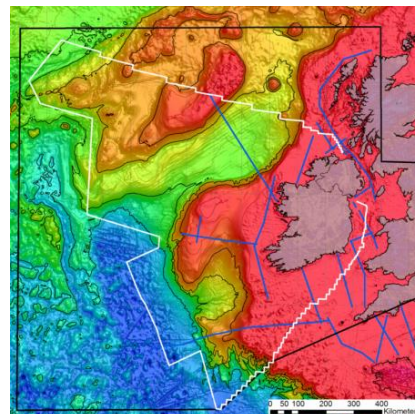
ARKeX offers processing and re-processing of gravity and magnetic data, and are able to merge overlapping data of different vintages into one contiguous data set.



Tectonic Atlas of the Irish Shelf

Focussed interpretation of the gravity and magnetic data over the petroleum basins of the Irish Shelf

The Atlantic Margin of Ireland is underexplored, but has great potential for future hydrocarbon discoveries. The aim of this project is to re-evaluate the tectonic framework of the region and to produce a robust and consistent tectonic elements map of the basins offshore Ireland, to help exploration geoscientists review their geological concepts and exploration targets. The project builds on the success of our work in the Faroe-Shetland region, where a newly merged high resolution gravity and magnetic dataset was used to constrain the tectonic evolution of the margin.



West of Shetlands Tectonic Atlas

A regional gravity and magnetic interpretation study in the petroleum basins of the West of Shetlands

The aim of this innovative project is to robustly and consistently map and model (1) the crustal architecture of West of Shetlands passive margin and (2) the structure and distribution of petroleum basins in the area of interest. The primary objective of Tectonic Atlas is to provide exploration geoscientists with a robust, cohesive and consistent structural, tectonic and kinematic framework, with which they can review their geological concepts and exploration target

Interpretation Software – XField

XField is a powerful geophysical modelling tool that enables explorationists to analyse and seamlessly integrate potential field data alongside available seismic data. Geological models can be generated with more accuracy and confidence than was previously possible, reducing exploration uncertainty, risk and cost.

2D/2.5D geological models may be created in either time or depth through the integration of all available datasets (e.g. gravity, magnetics, gravity gradiometry, 2D seismic, 3D seismic, well log data, geological horizons, previous interpretations, topography) in a 3D interpretation workspace.

XField is available as a plugin to the Petrel* E&P software platform and OpendTect's comprehensive seismic interpretation suite.

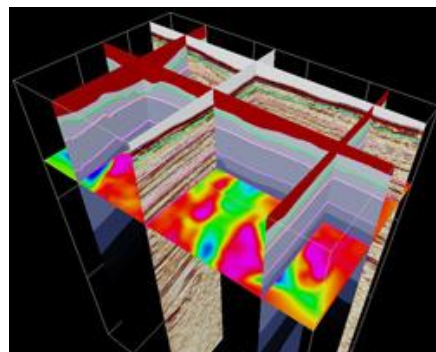
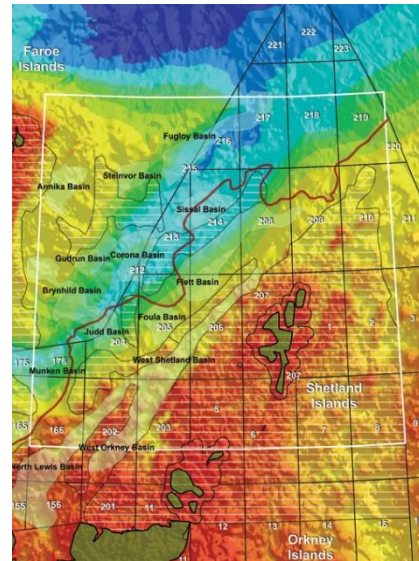
<http://xfield.arkex.com/>

Data Management

FieldBank is a data management service for gravity and magnetic exploration data, providing data discovery and retrieval via the web. FieldBank allows you to store and rapidly access all your gravity and magnetic data holdings in your area of interest via your web browser. Once your proprietary data is loaded into FieldBank, it can be searched and retrieved through a secure web page by you and other members of your company.

FieldBank can take care of all your data management requirements, such as the organisation, conditioning and loading of exploration data. This frees you from a data management overhead and ensures that the data are readily accessible on demand from the secure central database server.

<http://www.fieldbank.com>



AzEire Stand

AzEire Petroleum is an exploration focused oil & gas company with significant interests in two licence options offshore Ireland in the Fastnet and North Celtic Sea Basins. AzEire is focused on rapidly progressing the exciting opportunities offshore Ireland by using advanced geoscience technology to prepare for an exploration drilling campaign.

AzEire is an Oil & Gas Exploration Exploration & Production company focused on offshore Ireland. AzEire has acreage positions in the North Celtic Sea and Fastnet Basins, offshore the south coast of the Republic of Ireland.

AzEire Petroleum is focused on generating exceptional value for its stakeholders through the extensive use of advanced seismic data and other geophysical de-risking technologies ahead of drilling high-impact oil & gas exploration wells.

The AzEire Petroleum assets are managed by senior explorationists who have been involved in over numerous discoveries, have over 150 years of collective worldwide oil and gas exploration experience and have diverse energy operating backgrounds with companies that include, among others, Amerada Hess, BP plc, ConocoPhillips, PetroKazakhstan, Ukrnafta, Schlumberger, Petroleum Geo-Services, Chevron and Royal Dutch Shell plc

CGG Geospec Stand

CGG is a fully integrated Geoscience company providing leading geological, geophysical and reservoir capabilities to its broad base of customers primarily from the global oil and gas industry. Through its three complementary business divisions of Equipment, Acquisition and Geology, Geophysics & Reservoir (GGR), CGG brings value across all aspects of natural resource exploration and exploitation.

Innovative Equipment

Our Equipment Division, Sercel, designs, manufactures and markets a comprehensive range of innovative and reliable seismic systems and reservoir monitoring instruments. Oilfield service companies and geophysical contractors from across the globe use our equipment for seismic exploration and reservoir monitoring in onshore, offshore, transition zone and downhole environments.

Acquisition in every Environment

Marine

CGG's high-end fleet includes vessels specially designed and fully equipped to record state-of-the-art narrow-, wide- and full-azimuth broadband seismic data. Potential field data can be recorded with seismic surveys or stand-alone, to obtain a better understanding of the subsurface. Our joint venture with Fugro, Seabed Geosolutions, offers Ocean Bottom Cable, Node (OBC and OBN) and shallow water acquisition services.

Land

Our land crews operate with the latest technologies to acquire high-density broadband seismic data in high-productivity mode. Complementary geophysical surveys can be performed for better characterization of near-surface variations and to measure additional subsurface physical parameters.

Airborne

We can select the most effective combination of gravity, magnetic, electromagnetic, and radiometric surveys using the most comprehensive and advanced range of airborne fixed-wing or helicopter systems, to visualize oil, gas or mining subsurface objectives over large acreages in a short timeframe.

Geology, Geophysics & Reservoir – Cross-disciplinary expertise from exploration to asset optimization

Subsurface Imaging

We turn geophysical data into actionable information. Our Subsurface Imaging staff at over 40 centers worldwide produce extremely precise images of the Earth's subsurface with our industry-leading geovation software, even in areas of complex overburdens.

GeoSoftware

Our geoscientists develop sophisticated algorithms and intuitive interfaces to reveal key information from geophysical data. Hampson-Russell, Jason and Insight Earth are globally respected brands providing a comprehensive set of software tools and support for multidisciplinary teamwork including well log analysis, seismic reservoir characterization, petrophysics, structural and seismic interpretation, and reservoir modeling.

GeoConsulting

Our consulting services provide comprehensive reservoir knowledge that helps our clients better understand their reservoirs and maximize ultimate recovery. With our sound know-how in seismic reservoir characterization and the consulting expertise of Robertson, from global tectonics to samples analysis, geochemistry, petroleum engineering and economics, we offer a truly integrated interpretation of the reservoir that maximizes production and reduces risks. Additionally, NPA Satellite Mapping interprets and distributes satellite imagery to provide mapping solutions, including a unique global hydrocarbon seeps database.

Multi-Client Data Library

We offer our clients the industry's most recent and technologically advanced seismic, gravity, magnetic and well data in the world's key locations to evaluate the acreage potential worldwide.

Data Management

We transform data into knowledge by providing validated, interpretation-ready data, consultancy and training. Our services include physical asset management and National Data Repositories design, implementation and operation.

Chemostrat Ltd Stand

Chemostrat Ltd. is a specialist geological consultancy, internationally renowned for providing high quality stratigraphic services. The company is in a leading position providing multi-disciplinary services matrix that incorporates both traditional geological techniques and a world class laboratory that provides data to tackle a wide range of geological challenges. At Chemostrat we focus on providing real value, cost effective, promptly delivered, workable solutions for our clients from both in the laboratory and at wellsite.

Chemostrat portfolio of services is based on the interpretation of high resolution elemental, mineralogical and isotopic datasets (provided by our own laboratory division Origin Analytical). We have unrivalled analytical capacity to ensure rapid turnaround and our data quality is consistently deemed to be amongst the best in the world. These analytical resources are matched by an impressive team of specialist geologists, expertly trained in correlation, provenance, Isotope scientists. Our teams work together to provide much desired integration of their work at an unrivalled level whilst maintaining the need to deliver within commercial time frames.

Chemostrat is renowned for the delivery of chemostratigraphic correlations from high resolution ICP-OES and ICP-MS and XRF alike. Chemostratigraphy involves the characterisation and correlation of sedimentary rock successions based on stratigraphic variations in their inorganic geochemical data. Using this technique, variations in mineralogy, including clay minerals, heavy minerals and lithic components can be identified, which in turn can provide information of changes in palaeoclimate, palaeoenvironment, sediment provenance and any diagenesis or weathering that may have occurred.

Significantly, chemostratigraphy is a very flexible technique which can be applied to any lithology, of any age, deposited in any setting, and can be employed on core, cuttings and outcrop samples alike. Furthermore data can be acquired rapidly (2-3 wells per week) ensuring that stratigraphic correlations can be processed promptly. In addition to correlation, the elemental data employed for a chemostratigraphy forms a important resource for interpretative strategies such as provenance, paleoenvironmental modelling, diagenesis and reservoir quality. For example, variations in key elemental ratios (such as Th/Sc, sum REEs, La/Sc, Cr/Y and Nb/Th) can be used to map turbidite sediment dispersal patterns. Selected elemental data can be used to model anoxia and TOC and can be used to screen wells for source potential. Furthermore, the chemostratigraphic elemental data can also be used to predict the mineralogy of all samples analysed, resulting in the construction of a mineralogical log for each well section. Furthermore, it also provides a dataset that can screen a well for mineralogical changes and be used to help calibrate the mineralogy model established by petrophysicists from wireline response and is a quicker and cheaper alternative to XRD.

Chemostrat has provided the industry with high quality, integrated non-proprietary studies. These studies are on a regional to sub-regional scale, with content ranging from inorganic chemostratigraphy only, to fully integrated multi-disciplinary studies that investigate provenance, palaeogeography and sedimentology. The library currently consists of >20 non-proprietary studies covering the more traditional UKCS, Southern North Sea and Norwegian Continental Shelf, but also more frontier areas such as the Norwegian Barents Sea, the Vøring Basin, Faroe-Shetland Basin (UK), as well as the North Grand Banks area (Newfoundland). Additional studies are underway in the Duvernay area (Canada) and Tanzanian Indian Ocean Margin, while extensions to the Faroe-Shetland and Grand Banks studies have also been completed.

This comprehensive chemostratigraphic workflow has also been applied in conjunction with biostratigraphy to Mesozoic sequences from the Porcupine Basin. The basin has a proven hydrocarbon system. Despite this, however, well penetrations are relatively scarce, particularly in the south of the basin. This study provides a robust chronostratigraphic frame work that can be used to constrain provenance and palaeo-environmental and to improve the targeting of exploration wells. This study follows on from previous work carried out on the conjugate Grand Banks area (Eastern Canada) and it is hoped the results will be integrated into the overall understanding of this margin. This project has been commissioned by PIP.

One significant component of the multi-disciplinary service matrix has been the establishment of a Provenance Unit 'Sandtrak' to provide a more detailed forensic level characterisation of sand composition. The methodology involves applying an appropriate combination of services, such as high resolution chemostratigraphy, high resolution petrographic analysis, silt provenance analysis,

high resolution heavy mineral analysis, grain chemistry and grain geochronology from the service matrix. This approach can be applied to both the field scale, to improve the modelling of reservoir architecture correlation, and to basin scale with GIS based mapping of sediment dispersal patterns, sediment input points along base and margins, to model the history of sedimentation and its relationship to tectonic activity.

In addition, the company has also established an isotopic dating and elemental fingerprinting service for oils and source rocks, which can be integrated with traditional organic geochemistry and maturity data to assist in establishing petroleum systems in frontier basins. The new Chemostrat OSMR (Oil-Source-Migration-Reservoir) service is used to assess uncertainties regarding the timing of oil generation and the source of the generated oil. OSMR fingerprints the chemical composition of petroleum source rocks and relates them to their associated oils providing critical information regarding the temporal and spatial controls on the formation of hydrocarbon deposits. Further, direct radiometric dating (rhenium-osmium (Re-Os) geochronometer) of hydrocarbons yields the timing of oil generation and so provides a robust temporal constraint on the timing of oil formation and migration within the petroleum system. This technique also benefits from being able to utilise drill chippings from potential source units rather than relying on core. By applying the above we will produce a new model for oil generation across the IAM which will both constrain the timing of oil generation as well as identify the dominant source units within the petroleum system. PIP have commissioned this project.

The shale gas revolution has only served to highlight the need to increase the understanding of shale composition and physical properties to improve exploration, drilling and production. Chemostrat is demonstrating the value of elemental data in shale resource applications, and our new service matrix can be applied to provide a bespoke shale service work programme 'Shale Solutions' that can be applicable to exploration, geosteering and completions optimisation. This work programme can be adapted for basin scale and involves chemostratigraphic, palaeomagnetism and isotopic correlation and palaeo-environmental modelling (C, O, S and Re-Os isotopic analysis), elemental mapping of anoxia, organic preservation, productivity and terrigenous input in conjunction with TOC, XRD and FTIR data for basin evaluation. Furthermore, the acquisition of real time chemostratigraphic data at well-site can be employed to aid geosteering and the optimisation of field development with improved planning of targeted lateral wells. Chemostrat has also established a work programme to integrate elemental and mineralogical data with petrophysical parameters to enhance reservoir quality modelling. For example, elemental data can also be used to calculate mineralogy and provide an estimate of TOC and proxy for relative brittleness (RBI) that following calibration ensures elemental data can be multipurpose, practical and more cost effective as a means of modelling which is critical for well completions in shale plays.

The company has also invested heavily in research and development resulting in the establishment of a comprehensive suite of calibrated portable and field ready analysers. Chemostrat can provide wellsite XRF and FTIR for geosteering, mineralogy, organics and rock properties studies', and hand-held XRF and magnetic susceptibility measurements for high resolution core and cuttings analysis in the field remote core stores and the laboratory.

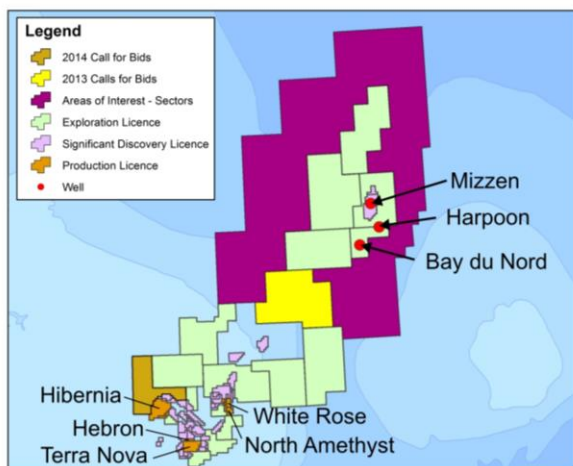


DNR Stand



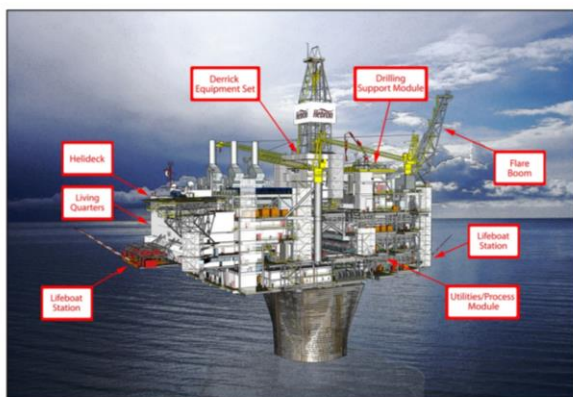
Regional Overview

The Province of Newfoundland and Labrador, located on the east coast of North America, is Canada's offshore oil producing region. Since first oil seventeen years ago the province's four fields in the Jeanne d'Arc Basin; Hibernia, Terra Nova, White Rose and North Amethyst have produced approximately 1.5 billion barrels of oil. Discovered reserves/resources now total 3.6 billion barrels of oil and 12.2 trillion cubic feet of natural gas. Opportunities exist for new discoveries as geoscience data indicate that a further 6 billion barrels of oil and 60 trillion cubic feet of natural gas remain undiscovered.



New Field Development

Hebron, expected to be the province's fifth producing field, is currently under development. Construction of the gravity base structure at the local Bull Arm Fabrication site continues. The field has estimated recoverable reserves of 707 million barrels and first oil is expected in 2017.

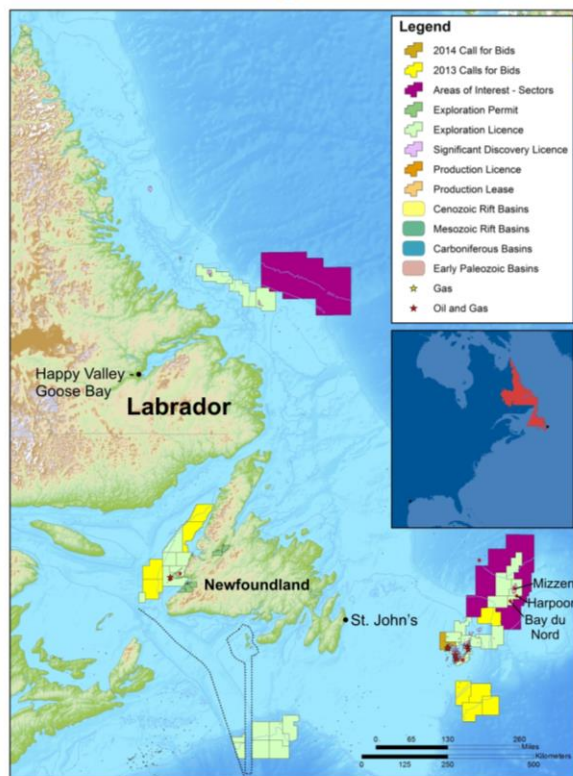


New Discoveries

Further development is expected in the region as Statoil have recently announced new oil discoveries at their Mizzen, Harpoon and Bay du Nord exploration wells in the Flemish Pass Basin. While no assessment has been released on the size of the Harpoon discovery, Statoil has estimated that the Mizzen and Bay du Nord fields contain recoverable oil reserves between 400 and 800 million barrels. Statoil has formed a multi-disciplinary task force to assess the feasibility of an accelerated development including an exploration and appraisal program commencing in 2014.

New Scheduled Land Tenure System

A new Scheduled Land Tenure System was recently announced for the Province's offshore area. This new system divides the offshore into eight regions and categorizes them based on the level of historical exploration activity. Scheduled licensing rounds will be held in each region, on either a one, two or four year cycle. This new system provides additional time for explorers to evaluate the resource potential and opportunities in the lesser explored basins of the province. To find out more visit: www.gov.nl.ca/nr



Newfoundland and Labrador Basins Map



Department of Natural Resources
www.gov.nl.ca/nr



Donegal County Council Stand

The Donegal County Council stand promotes the facilities available to the offshore oil industry in the County, particularly Killybegs Supply Base which operates in the deep water port of Killybegs and also the airport at Carrickfinn.

Killybegs has a modern, vibrant and forward-looking harbour operation. Located on the northwest coast of Ireland, it is very well placed for servicing offshore energy exploration along Ireland's west coast and Europe's western approaches.

Killybegs has a deep-water, all-weather natural harbour. The experience of many local contractors in the offshore industry, coupled with the excellent engineering expertise has enabled Killybegs to develop as the major port for all energy industries on the west coast of Ireland. The town has a proud maritime heritage, which was developed initially as a fishing port. Since 1997, it has played a pivotal role in facilitating offshore exploration, and in particular the development of the Corrib gas field. The seasonal nature of both fishing and oil and gas industries are very complimentary to each other ensuring facilities for all. It is also the port of choice for wind-farm developers, with importation of wind turbines for delivery throughout the county. Killybegs now features on the itinerary as a stop for many cruise liners that benefit from modern secure berthing and quayside facilities, and access to the highlands of Donegal.



Killybegs has evolved into a multi-functional port servicing the fishing, oil and gas, renewables and cruise sectors. Expertise, adaptability and flexibility ensure that Killybegs can meet any challenge. The companies listed below have used Killybegs to support their offshore activities:-

Exploration & Production Companies:

Shell E&P
Statoil
Lundin
Serica / AGR
Eni

Subsea / Offshore Construction Companies:

DOF Subsea
Allseas
Technip
Van Oord
CTC Marine

Seismic Companies:

BGP
PGS
Seabird Exploration
CGG
Fugro

Renewable Energy Companies:

Enercon
Nordex
Gamesa
GE Wind Energy
Siemens
Vestas
Wavebob

In recent years Donegal Airport at Carrickfinn (CFN) has been the airport / heliport for offshore oil and gas industry for many of the major oil companies. It is strategically located for the support of air services to offshore installations operating on the west and northwest coast of Ireland. Helicopters are based at the airport and fixed-wing charters operate to/from Aberdeen. Other airport services include SAR services, air corps, private charters and general aviation.

DownUnder Geosolutions Stand

DownUnder GeoSolutions is an innovative geosciences company with a diverse range of capabilities. Our products and services are at the cutting edge of exploration and production services to the global oil and gas industry. Our strength is the integrated approach across our comprehensive service offering:

Illumination Studies

- Handling all types of acquisition design, both land and marine
- Both effective and total illumination can be modelled

Seismic Data Processing

- Using DUG software
- Experienced team processing 2D & 3D, land, marine & OBC, PP & PS, narrow, wide and multi-azimuth data
- DUG Broad - physics-based deghosting
- Latest algorithms including award winning True Azimuth 3D SRME, advanced noise removal and regularisation
- From small boutique to large surveys. 14,700 sq km is our largest project to date

Depth Imaging

- DUG Kirchhoff, Beam and RTM migrations
- DUG Reflection Tomography and model building tools
- Isotropic and anisotropic (VTI, TTI and Tilted Orthorhombic)

Petrophysical Processing and Interpretation

- Individual well petrophysics
- Integrated regional petrophysical studies
- Operational petrophysics
- Production of final elastic logs including infill of missing data and bad hole, environmental and invasion corrections

Quantitative Interpretation Services

- Constrained seismic attributes
- Rock physics
- Modelling
- Various inversion approaches and algorithms
- Probabilistic lithology and fluid prediction

Geostatistical Depth Conversion

- Reliable depth conversion away from well locations
- Accurate depth conversions at well locations

Multi-client Studies

- All services available as multi-client studies
- Many studies currently available
- We are interested in talking to you about potential new studies from illumination through inversion

Full range of DUG Software for all activities

- Fully-featured 2D / 3D / pre-stack interpretation system
- Modules for rock physics, modelling, depth imaging and more

The key to DownUnder GeoSolutions' success is our people. We have managed to put together an enviable team of highly experienced professionals and top-level recent graduates. Our team has experience and expertise working on projects the world over. Whilst we are a 100% Australian-owned company, we are truly a global enterprise. We have offices in Perth, Brisbane, Kuala Lumpur, Jakarta, Singapore, Houston and London."

Effective Offshore Stand

Effective Offshore provides a wide range of Health and Safety training courses that are essential in order to be able to work in the offshore oil and gas sector. These training courses which include **MIST** (Minimum Industry Safety Training) and **BOSIET** (Basic Offshore Safety Induction & Emergency Training) are run weekly in our state of training centre in Falcarragh, Co. Donegal. Effective Offshore can also offer the new **CA EBS** (Compressed Air Emergency Breathing System) which is required for all personnel to work in the North Sea from 1st January 2015.

Our experienced team can also provide personnel that are looking to enter the market or upskill within the sector with additional training in areas such as Rigging and Lifting, Banksman/Slinger and Rope Access Training along with the required Oil and Gas UK medical that is required to work in the offshore sector.

With the ever increasing demand for labour in the sector and with the growing activity of exploration in Irish waters, Effective Offshore is well positioned to provide the necessary people with the correct skills to be able to work in and meet the industry's growing staffing needs.

For more information please contact jason@effectiveoffshore.ie or call 074 9135999 or visit our website www.effectiveoffshore.ie

ERM Stand

Atlantic Margin – a challenging environment

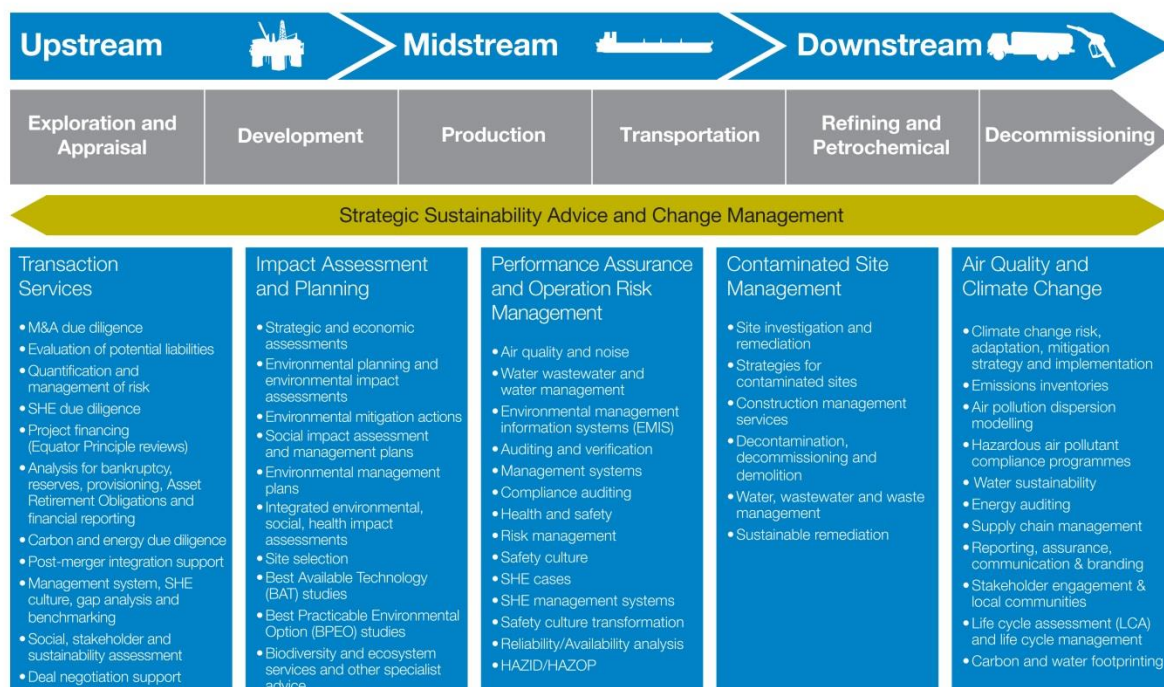
The Irish Government has been busy in recent years enhancing the attraction of Ireland as a location for exploration investment. It is expected that the 2015 Atlantic Margin Oil and gas Exploration Licensing Round will surpass that of 2011, capitalising on recent data acquisition and a clearer understanding of the potential resources that lie off the west coast of Ireland.

Although it is speculated that Irish oil and gas plays could prove very fruitful, operators need to be mindful that there are various risks specific to operating in the Irish Atlantic Margin.

Non-technical risks

A big challenge for companies moving into the region is managing what can best be described as the non-technical risks associated with their plans. While new technologies and higher energy prices have helped to extend the boundaries of exploration, companies still need to demonstrate that they are responsible citizens to a range of stakeholder groups, including regulators, well organized NGOs and local communities.

ERM has extensive experience working with clients to manage the gamut of risks associated with oil and gas exploration in frontier areas. These can range from managing stakeholder consultation which is considered a crucial element of the licensing regime, to providing core services in such fields as oil spill contingency planning, contractor and management system auditing, preparation of safety cases and environmental and social impact assessments. In addition to our direct experience supporting the planning and permitting of Irish oil and gas projects, we bring a 40 year track record supporting E&P projects around the world.



We believe that our experience as both an advisor and local partner can deliver tangible benefits to companies seeking to harness the potential of the Atlantic Margin. Faced not only with challenging operating conditions but also local sensitivities in relation to proposed drilling activities, operators

must demonstrate that they are well prepared with actions and forward planning to manage any adverse risks and impacts.

Effective engagement

As has been shown recently in relation to drilling applications for the region, the flip side of this coin can be strong opposition and even stronger criticisms when a license is granted with what is seen to be an inadequate assessment of potential impacts. This can be the case, for example, if a drilling operation is proposed close to the shore or a clean-up strategy is considered inadequate. Only through effective engagement with stakeholders and transparency (flexibility) in relation to plans can this type of opposition be overcome. Being seen to be responsible and alert to local sensitivities is a key requirement in relation to any application.

In fact, demonstrating that you can operate in fragile environments without adversely impacting on local communities is now seen as an essential element of an operator's licence to operate. This can apply at all stages of the permitting process and as part of an increasingly tough and testing oil and gas operating environment.

As operations in the Atlantic Margin expand, a key challenge will be for operators to demonstrate that they are giving sufficient priority to social and environmental considerations, including the management of risks throughout the project cycle. What communications strategy should be adopted? What will be the impact of seismic acquisition and drilling on biodiversity and ecosystems? How will the operator mitigate the risk of an oil spill? How will waste be managed? What impact will there be on the local population and what are the broader climate change implications? What is required of the new safety case regime? Operators must be prepared well in advance for these and many other challenges when applying for a new drilling permit.

The New Operating Environment

As a leading sustainability consultancy, ERM offers a unique combination of disciplines to help meet the needs of oil and gas clients in Ireland. ERM is currently engaged on the safety cases, impact assessments, stakeholder engagement and the various permitting requirements for several oil and gas projects in Ireland and is assisting its clients, their partners and contractors in developing robust systems in which management can have confidence and on which external stakeholders, including regulators, pressure groups and shareholders can rely.

ERM is able to combine local knowledge with a proven international capability – acquired by working on some of the most controversial projects in the world – to produce solutions that satisfy all stakeholders. This means working with clients to identify both risks and opportunities relating to a project, ensuring that proposals are supported by sound technical knowledge and helping to convey what are frequently complex sustainability messages.

Please speak with us at our stand if you are interested in joining our Breakfast Seminar: *Planning & Permitting for Oil and Gas Exploration in Ireland* on Tuesday 21st October at the DoubleTree by Hilton Dublin, Burlington Road.

Faroe Petroleum Stand

Faroe Petroleum has, through successive licence applications and acquisitions, built a substantial, diversified portfolio of exploration, appraisal, development and production assets across the Atlantic margin, the UK and Norwegian North Sea, Norwegian Sea, Barents Sea and offshore Iceland. Faroe Petroleum has extensive experience working with major and independent oil companies and its joint venture partners include BP, Centrica, DONG, E.ON Ruhrgas, GDF, OMV, Repsol, RWE Dea, Statoil and Wintershall.

The Company's licence portfolio provides considerable spread of risk and reward, encompassing over 60 licences. Faroe has a very active drilling programme ahead and it currently has interests in four principal producing oil and gas fields in the UK and Norway, including interests in the Blane oil field in the UK, and interests in the producing Njord, Brage and Ringhorne East fields in Norway, which collectively produced on average 6,059 boepd (economic production) in 2013. Full year average production for 2014 is estimated to be between 7,000 boepd and 10,000 boepd following the acquisition of the Schooner and Ketch operated interests.

Norway operates a tax efficient system which incentivises exploration, through reimbursement of 78% of costs in the subsequent year.

Faroe Petroleum is quoted on the AIM Market of London Stock Exchange plc with offices in Aberdeen, Stavanger, London and Torshavn. The Company is funded from cash reserves, increased by £65 million in a placing undertaken in June 2014, cash flow and has access to an undrawn \$250 million borrowing base facility. Faroe has highly experienced technical teams who are leaders in the areas of seismic and geological interpretation, reservoir engineering and field development, focused on creating exceptional value for its shareholders.

Faroe's exploration led and production backed strategy is delivering exceptional results

Significant recent exploration successes in Snilehorn and Pil

Substantial potential being realised across portfolio

Faroe has built an outstanding portfolio

Largest acreage position in Norway of any London quoted independent

Balanced portfolio of assets

Ongoing drilling programme targeting up to 5 wells per annum, funded from cash flow

Material, well balanced, tax efficient production

Fastnet Oil and Gas Plc Stand

Fastnet Oil & Gas plc is an independent oil and gas exploration company focused on early stage exploration and appraisal opportunities in Africa and Ireland. The Company completed its IPO in June 2012 and its shares are traded on the AIM market of the London Stock Exchange and ESM market of the Irish Stock Exchange.

Fastnet has a highly experienced management team with a proven track record of generating significant shareholder value in the oil and gas industry. The Company has moved quickly to assemble an exciting portfolio of exploration prospects both onshore and offshore Morocco and in the Celtic Sea, offshore Ireland.

Fastnet's current assets include:

A 12.5% Gross (9.375% net) carried interest in the Fom Assaka licence area, offshore Morocco. The licence operator is Kosmos Energy who hold a 40% Gross (29.925% net) working interest while BP hold a 35% Gross (26.325% net) working interest.

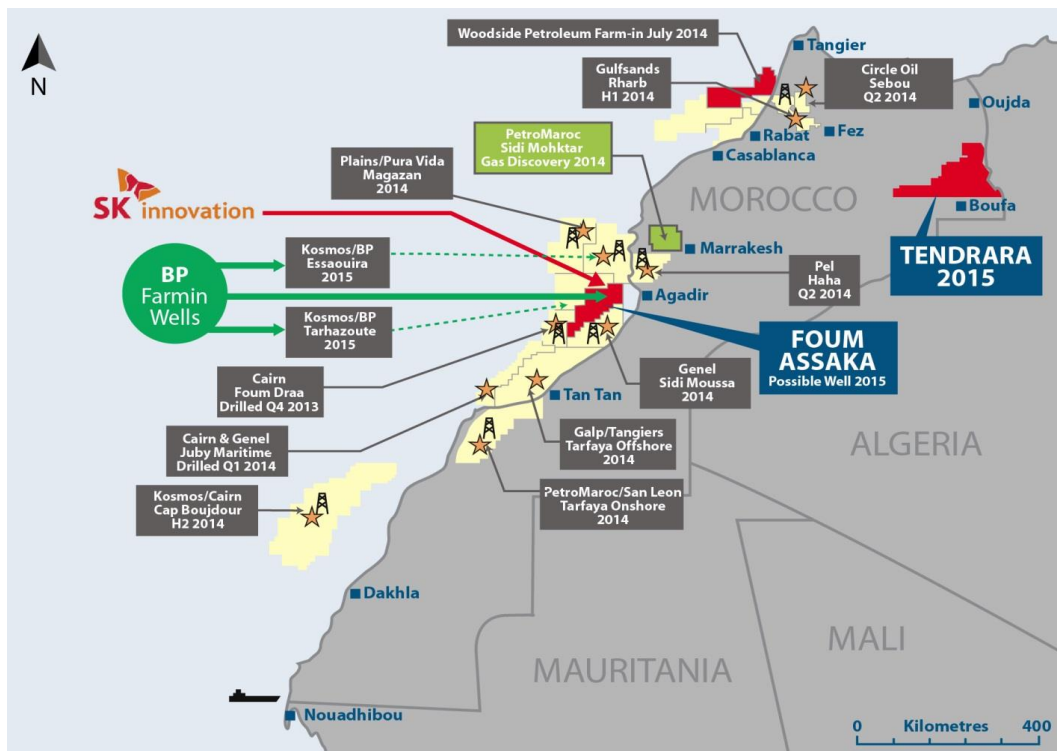
A gross interest of 66.67% in the Tendrara licence onshore Morocco (net interest 50% after including the ONHYM carry through exploration of 25%) after exercise of exclusive option and receipt of regulatory approvals.

Five offshore licensing options in the Celtic Sea (Molly Malone, Mizzen, Mizzen East, Shanagarry and Block 49/13).

An exclusive option with PETRONAS to farm-into the Deep Kinsale Prospect in the Celtic Sea.

An interest in a net profit bonus arrangement relating to the Connemara FEL 1/04 Licence in the Porcupine Basin offshore Ireland.

Morocco



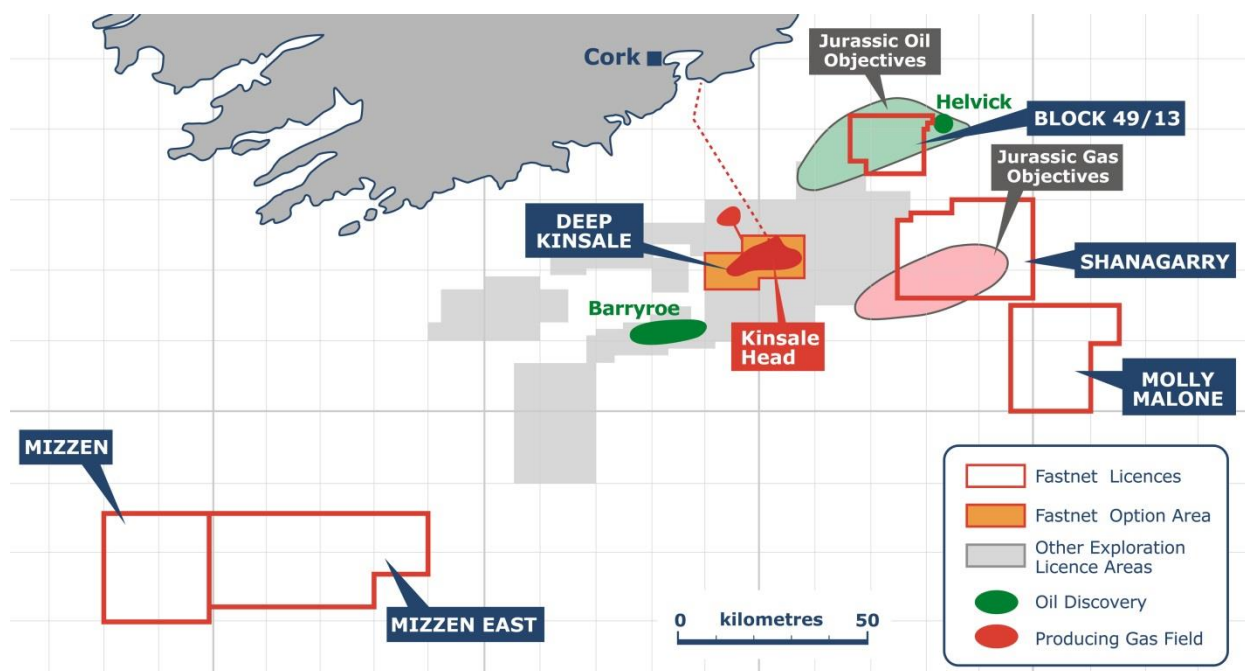
ATLANTIC IRELAND 2014

Fastnet, through acquisition of Pathfinder Hydrocarbon Ventures Ltd in July 2012, entered Morocco in May 2011 when Pathfinder was awarded the highly prospective Fom Assaka offshore licence. Since then there has been significant activity in this historically underexplored region. A multi-well drilling programme commenced in 2013 and is currently in its early stages. Drilling is continuing with at least 4 high-profile wells committed to in 2015 in the offshore..

The Fom Assaka Offshore Licence consists of four exploration permits in the North-West Agadir Basin, to the south-west of the Moroccan port of Agadir. The licence area covers an area of 4,858km². The FA-1 exploration well failed to discover commercial volumes of hydrocarbons in the Operator's primary target. Pathfinder's secondary target in the Early Cretaceous was not targeted at an optimum location given the requirement to give preference to the Operator's primary objective. Salt was encountered approximately 300 meters higher than the pre-drill prognosis and resulted in the failure to penetrate the deep objective. However live oil shows were encountered in fine sand reservoirs above the salt proving for the first time in the deepwater Agadir Basin that all aspects of the Lower Cretaceous petroleum system exist for the secondary objective. Pathfinder's post-well studies are focused on the potential for thicker and more permeable sands downdip from the FA-1 well and in the area to the SSE of the well with a view to proposing a follow-up well for 2016.

The Tendirra Lakbir Onshore Licence covers an area of 14,548 sq. km. It covers the majority of the Tendirra Basin, which lies between the Middle Atlas to the north and the High Atlas to the south and which is one of Morocco's prospective basins for Triassic gas. Six out of seven wells drilled within the Licence Area have encountered gas-bearing Triassic sands of the Tagi Formation (the "Tagi"). The Tagi is the host reservoir for Morocco's producing Meskala gas field, along strike to the west in the Essaouira Basin. All these gas discoveries have been charged from the prolific Silurian source rocks that are an integral part of the proven Palaeozoic-Early Mesozoic petroleum systems covering large parts of Libya, Algeria and Morocco. Fastnet is partnered with OGIF (25%) and ONHYM (25%) in the Tendirra Lakbir Onshore Licence and aims to drill up to two appraisal wells in H1 2015 with a strategic drilling partner capable of developing the gas field for the indigenous power generation market in the event of successful appraisal wells, each tested at a minimum of 4 mm cfgpd..

Celtic Sea



ATLANTIC IRELAND 2014

With an area of 4,027 km² under licence, Fastnet has one of the largest and most geologically diverse acreage positions of any independent in the Celtic Sea. The licences granted to Fastnet were selected due to their attractive petroleum geology and major reserves potential and based on our management's past experience in these specific areas.

In March 2013 the Company committed to undertake an extensive 3D seismic survey on Deep Kinsale and the Mizzen Basin to establish for the first time a modern 3D seismic database in our area of interest. The completion of the 3D seismic survey has significantly enhanced our ability to attract larger oil companies to partner with us to help unlock the potential of our materially significant prospects and leads.

Over Deep Kinsale the 3D seismic has confirmed five possible reservoir targets with potential for substantial in-place oil based on structural size, up to 92km². It has also confirmed potential for reservoir development and has significantly reduced the risk of reservoir compartmentalisation, two legacy issues that have previously held back farm-out efforts, which were based only on limited 2D seismic coverage. Modern log analysis has confirmed logged oil over an interval of 500+ feet in the first off-structure well drilled in the Kinsale Gas Structure. For the first time this potential oil column can be correlated with mapped structural closure below the shallow producing gas field.

Over Mizzen the 3D seismic has confirmed the potential for a new frontier exploration basin that is the conjugate margin equivalent of the Flemish Pass and Jeanne d'Arc Basins of Eastern Canada, which hold large hydrocarbon fields and recent discoveries. In 2013 Statoil made the Bay du Nord oil discovery (up to 600mm BO recoverable) in the Flemish Pass Basin, the largest oil discovery made in 2013. Fastnet's 3D seismic survey has defined new amplitude-supported potential gas structures and large stratigraphic traps (covering 138 sq. km.), with multiple prospects and leads with potential for multi-Trillion Cubic Feet ("TCF") in-place gas in addition to potential oil traps. The Mizzen prospects are receiving significant interest from the industry due to their analogous geological setting to the major oil and gas discoveries of Eastern Canada.

Fluid Inclusion Technologies (FIT) Stand

Fluid Inclusion Technologies (FIT), Inc., is a laboratory-based petroleum service organisation offering a variety of analytical services including some previously proprietary technologies. The most widely applicable of these new technologies is Fluid Inclusion Stratigraphy (FIS) - a rapid analytical technique that involves the automated analysis of volatile compounds trapped within micron-sized cavities in rock material taken from well cuttings, core or outcrop samples. These "fluid inclusions" are representative samples of subsurface fluids, and are not subject to fractionation during sampling or evaporative loss during sample storage for any length of time. The new procedure yields valuable information on Pay/Bypassed-Pay, Product Type, Migration, and Seal Integrity, unattainable via more traditional methods and, over the past ten years, has been instrumental in the discovery of significant petroleum reserves, influenced exploration and acreage acquisition decisions and provided innovative options for resource estimation, petroleum production and enhanced oil recovery operations.

An equally impressive aspect of FIS technology is the rapid turnaround time: large sample sets (i.e., 100s to 1000s of samples) from single or multiple wells can be analysed, the results interpreted, and the findings delivered virtually anywhere in the world in a matter of days. Thus, the results can play a crucial role in decision making regarding current plays as well as provide valuable new insights through the analysis of archived cuttings.

The geochemical services offered by Fluid Inclusion Technologies (FIT), Inc., including FIS Analysis are variable and problem specific. By combining patented techniques, emerging geochemical methodology and standard microscopic methods, all of which complement each other, we provide a unique and unequalled industry product. A partial listing of proven applications of our analytical services includes:

- petroleum migration pathway mapping
- characterisation of seals to oil and gas
- identification of dry holes proximal to undiscovered hydrocarbons
- delineation of pay or bypassed pay within penetrated sections
- identification of fluid pressure compartments
- characterisation of petroleum-water transition zones
- delineation of reservoir compartmentalisation

For further information including applications and more technical aspects of the geochemical and petrological services we provide, please browse through our [Slideshow Overview of Fluid Inclusion Technologies](#). This presentation is available on CD and in some cases as a command performance.

Fugro Stand

www.fugro.com

Fugro provides the people, equipment, expertise and technology to support the exploration, development, production and transportation of our world's natural resources. We supply the technical data and information required to design, construct and maintain structures and infrastructure in a safe, reliable and efficient manner.

Fugro delivers Earth and engineering data services, from project preparation through to data acquisition, processing, analysis and interpretation, reporting and consulting.

Fugro's services are specifically designed to support client's engineering design and large structure building projects. The aim is to de-risk major investment decisions and field development structures. We also go further to undertake related inspection, maintenance, repair, installation and light construction support services.

GeoConsulting Services

Fugro's consulting services merge the talents of Fugro's Geophysics, Geology, Geohazards and Geotechnical Engineering consultancy resources. This creates a consultancy service which can provide the complete integrated solution for identifying and quantifying seabed and sub-seabed risks. Our expertise offers a multitude of services including Desk Top Studies, Shallow Regional and Wellsite Geohazard Assessments, Site Investigation and Laboratory Testing, Data Interpretation and Integration, Geotechnical Analysis and Foundation Engineering.

The benefits derived from this integrated approach are numerous, and include:

- Early understanding of shallow geohazards
- Optimised survey programmes
- Enhancing the value of the datasets through more effective integration
- Fit for purpose foundations
- Optimised project solutions

Survey Services

Fugro provides a wide range of offshore survey and positioning services including; geophysical, geotechnical and environmental surveys; pipeline & cable route surveys; acoustic pipeline inspection; hi-res shallow seismic; offshore positioning and construction support services including positioning for rig moves, heavy lift, pipe/cable lay and field development support. The company operates a large fleet of dedicated geophysical survey vessels; the latest and best equipped fleet of its kind in the region. In addition Fugro also owns and operates two 'state of the art' Autonomous Underwater Vehicles (AUVs) which are typically deployed for deepwater surveys.

Metocean Services

A good understanding of meteorological and oceanographic (metocean) conditions reduces uncertainty in engineering specifications, provides help in operational planning, leads to reduced costs, and enhances safety and operational efficiency. Fugro provides commercial metocean services and systems on a fully integrated world-wide basis to meet and support clients' needs in offshore and coastal environments

Measurements Services

From challenging deepwater locations to shallow and coastal waters, Fugro's extensive experience can be applied in any region around the world. The measurement service covers the entire range of metocean parameters, including physical oceanographic measurements (currents, waves, water levels) and meteorological measurements (wind, pressure, air temperature, etc.)

Metocean Criteria and Desk Studies

The understanding of metocean conditions, gained from analysis and interpretation, allows the derivation of realistic design and operating criteria. Fugro provides a full range of metocean consultancy and modelling services to support a broad spectrum of marine industries.

Weather Forecasting

Fugro provides a complete marine weather forecast service tailored for operations in the offshore environment. Advance knowledge of the wind and wave conditions leads to safer, more efficient offshore operations, and potentially enormous cost savings for exploration drilling rigs, FPSOs, seismic and survey vessels, pipe-lay and construction barges, cable installation and repair vessels.

Marine Environmental Services

Fugro's comprehensive marine environmental services integrate consultancy with ecological surveys and laboratory testing. These services support infrastructure planning, consenting and development, environmental protection and resource management.

GeoGuide Stand

GeoGuide provides internationally based experienced consultants for the design, management, supervision and quality assurance of land and marine based seismic surveys together with Technical Audit. GeoGuide can assist with the control of the seismic processing, both in the field, on-board the vessel or when being performed at in-house processing centres.

Our consultants are selected for each project based on their broad experience and supported by excellent management and communication skills. Their expertise covers all aspects of Land, Marine and Transition Zone surveys. This includes explosives, airgun and Vibroseis sources.

All GeoGuide consultants who work offshore have up to date medical certification to UKOOA or equivalent standard and valid offshore survival and fire fighting certificates including HUET.

We are therefore able to offer the following service provisions:

Seismic Project Management

All of GeoGuide's consultants have many years experience in the seismic industry. Project managers are experienced field supervisors with additional geophysical and project planning skills. Often these consultants have significant Operations Geo experience and the positions they fill are largely in that role or similar. This therefore also requires a strong and proven interest in HSE management, good organisational skills and experience in contract/tender work.

Survey Planning and Design

The right design is essential; A compromise between the most appropriate geophysical parameters and economically viable cost, whilst still fulfilling the clients geological and geophysical needs. Our design team can do just that, with a wealth of experience in the survey design of 2D and 3D Land,

Marine and TZ projects worldwide. We use the latest versions of Gedco's OMNI design and Claritas processing software packages to assist in the design study. Our philosophy is to fully integrate the client in the project with discussions prior and whilst the work is being performed, with a presentation of the final results at the clients offices.

Seismic In-Field Supervision

Technically capable, diligent, pro-active, organised and a good communicator. This describes the professional skills required of our in-field supervisors. If these guys were in any other business they would be CEOs and company chairmen. What is it about the seismic industry that keeps them so focused on the teamwork and the satisfaction of a job-well-done? Thank goodness they do.

Survey Positioning QC

We include the invaluable work done by our positioning specialists in the supervision group described above. It is also worth noting that we can also evaluate and reprocess navigation data. Each of our navigation specialists is familiar with several of the nav-processing and QC tools available.

Technical Audit

We believe very strongly of the good sense in performing a check of the equipment and set-ups at the start of the survey. While GeoGuide has several very good audit engineers we are quite happy to also bring in help from other companies if they have better availability or particular skills.

HSE

GeoGuide recognises in this modern age that Health, Safety and Environmental consideration is becoming an important and necessary requirement to all major and minor Oil Companies. We are therefore pleased to be able to offer as a continued improvement of our services to existing and future clients, high quality HSE QC Consultants for both on and offshore seismic projects. All HSE consultants currently listed with us are trained to NEBOSH standard and we believe that this additional facility will complement our already existing range of services.

Contract (ITT) Preparation and Bid Evaluation

For both Acquisition, and Processing projects a competitive tendering process is recommended to elicit the best bids and to ensure the client is not left commercially disadvantaged. GeoGuide Consultants can assist in producing and evaluating the Invitation to Tender (ITT) documents. The ITT will detail the scope of work, geological setting, survey objectives, acquisition parameters, technical specifications and contractual requirements. The contractors capable of undertaking the work to the required standards will be invited to tender for the work. Following the receipt of proposals a full technical and commercial review would be performed. GeoGuide consultants, on behalf of, and in discussion with, the client can negotiate tender clarifications and costs such that ultimately the final contract can be awarded.

Data Processing Supervision

GeoGuide provides Data Processing specialists for in-field work and for the QC of data processing at processing centres and client offices. It may not always be necessary to have a data processing specialist on every acquisition crew but there are many fast-turnaround jobs and surveys in which processed results affect the further acquisition that it is critical to ensure that the work is correctly performed. It is a miniscule insurance cost when viewed in proportion to the cost of a modern seismic survey.

Specialist In-House Processing Services (including AVO and Inversion)

GeoGuide have hands-on processing experience. An in-house team of processing experts which, using Claritas software, have the ability to undertake processing projects; small scale 2D production processing jobs, through to 3D merges. We can also undertake more specialised AVO and Inversion work using Hampson Russell software. Our Processing Consultants can also assist the Client in

production of the Processing ITT and can evaluate the contractors proposals and negotiate final contract conditions.

Marine Environmental Services

MMO's and PAM Operators, PAM Equipment and Technical Support, ESAS Seabird Observers, Wind Farm Seabird and Marine Mammal Surveys, Environmental Scientists, Fisheries Liaison Officers, Environmental Impact Assessments.

See www.geoquide.co.uk

GSI Stand

The **GEOLOGICAL SURVEY OF IRELAND (GSI)**, founded in 1845, is Ireland's Earth Science Agency. It is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geology. It is a division of the Department of Communications, Energy & Natural Resources (DCENR) and currently has about 60 multi-disciplinary staff and provides the majority of its data online for free via www.gsi.ie

GSI serves its customer needs through a range of operational programmes and support services: The Information Management Programme underpins all of our activities in the delivery of geological information to our customers, and is recognised as the most important corporate priority. The Surveying Programmes; Land Mapping (Bedrock & Quaternary Geology) and Marine (INFOMAR), are long-term, and feed information to the Applied Programmes, as well as producing maps and reports used directly by a wide range of external customers. The Applied Programmes (Groundwater, Minerals, Geotechnical, Geological Heritage, Geohazards) are largely project-oriented, and provide solutions to specific stakeholder needs, their various activities helping to build their respective databases. Research - GSI both fund and engage in relevant research, and manage the Griffiths Geoscience Research Programme.

Among GSI's current projects of relevance to Atlantic Ireland attendees are:

In 2014 GSI built on the successful Tellus Border project, an airborne geophysics and ground geochemistry initiative, by commencing **Tellus North Midlands**. This €2 million mapping project is collecting scientific data, including magnetics, radiometrics and electromagnetic, as well as soil geochemistry across three counties – Longford, Westmeath and Roscommon. Information from the project will help manage the environment and support sustainable development of our natural resources. Information and data from this and Tellus Border project is available online at tellus.ie and tellusborder.eu

NAGTEC: GSI is a partner in the NAG initiative, a cooperative framework of North Atlantic Geological surveys. This group recently completed the NAGTEC project, producing a new tectono-stratigraphic atlas and web GIS detailing the development of the North Atlantic with new data compilations and interpretations, covering an area from Ireland to Spitsbergen, and East Greenland to West Norway. NAGTEC was funded by the NAG Surveys and a consortium of oil and gas companies and in Ireland was managed by GSI and included UCD and PAD as research partners and key data providers respectively. The final products were released to partners in September 2014, a world class A3 atlas and Web GIS, which have a moratorium of two and five years respectfully. Companies may access the products by joining the consortium. The researchers involved expect to produce a Special Volume based on the project in 2016 and are currently developing the NagTec2 Project. Please see nagtec.org for more information or visit GSI stand.

Hannon Westwood Stand

About Hannon Westwood



Hannon Westwood provides unique and comprehensive intelligence services, data and strategic consultancy covering North-West Europe to the E&P and Financial sectors. In an environment where rapid market access and effective growth strategies are crucial, our services will give you a real competitive advantage.

Our Directors and team include former senior oil and gas company managers, geoscientists and analysts with extensive upstream and transactional experience.

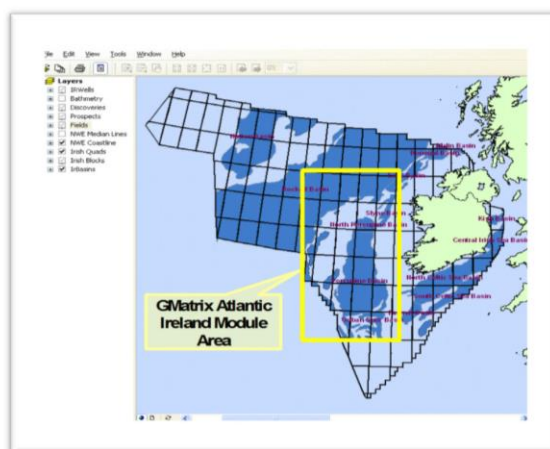
Producing incisively written intelligence reports, commentary and analyses, giving insight into core acreage, company strategy, oil and gas resource, deals and opportunities, we provide clients with a service that meets their strategic needs

GMatrix Ireland

In a Frontier province such as Ireland it is critical that companies looking to invest have access to the most comprehensive and up to date information available. Hannon Westwood's GMatrix Ireland provides an analytical resource database that contains over 30 years of exploration data.

GMatrix Ireland has been developed together with the Petroleum Affairs Division (PAD) of the Irish Department for Communications, Energy and Natural Resources.

Our unique access to the Petroleum Data Archive places the full Irish knowledge base at your fingertips. GMatrix Ireland is a desktop GIS resource database for Ireland.



The Atlantic Ireland Module provides insight into the resource potential of the area

Atlas Intelligence Service for the UK and Norway - now available On-line



Our Atlas Intelligence Services provide clients with both historical and forward-looking intelligence. Derived from meetings with asset owners, public domain and other sources and then interpreted through a thorough understanding of the commercial framework for the areas covered, our insight will inform and guide strategy. Clients find the service a valuable tool when carrying out strategic planning, benchmarking reviews and generating opportunities ahead of the market.



Analytical - Opportunity - Well Activity - Monthly Market Activity - Library and GIS Map - Expertise

UK Prospect & Discovery Datasets – Norway available November 2014



Hannon Westwood's Prospect and Discovery Geodatabases, GIS Files and Datasets, updated quarterly at the end of each January, April, July and October, are derived from our proprietary Database and are available to buy either separately or together. The data is collated from various sources including meetings with oil and gas companies, scouting and public domain information and is audited, reviewed and updated monthly by our team of industry experts.

Prospect Datasets Include

Prospect Name	Area and Block	Corporate Name	Equity
Resource Alias	Operator	Initial Reserves Liquid & Gas	Initial Reserves Total
Licence	Reservoir Condition	Reservoir Age	Type
Core/non Core	Fallow Class	Map Vintage	Lat/Long

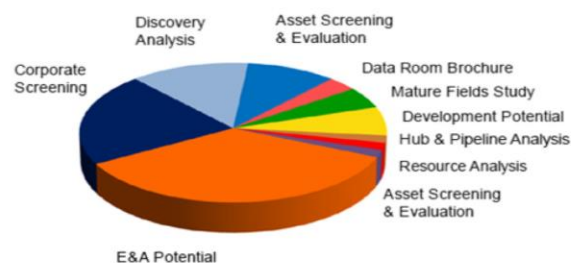
Discovery Datasets Include

Discovery Name	Area and Block	Corporate Name	Equity
Status	Operator	Initial Reserves Liquid & Gas	Initial Reserves Total
Well	Well Start & End Date	Original Well Operator	Type
Licence	Reservoir Condition	Reservoir Age Parent	Reservoir Age
Core/non Core	Fallow Class	Fallow Date	Lat/Long

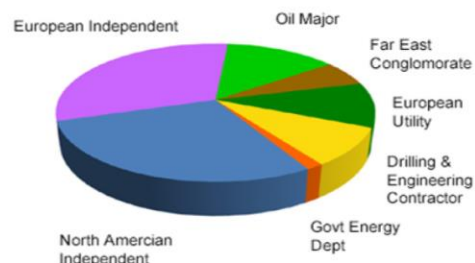
Consultancy and A&D Services

Hannon Westwood is established as the foremost Oil and Gas consultancy in North West Europe focusing on all aspects of mature basin E&P, from exploration prospectively to decommissioning issues, informed by its deep technical and commercial expertise. Our client base ranges from potential investors, new entrants and small start-ups to established international companies and government agencies.

70 Projects in 5 Years



Projects by Client Types



Our A&D service is supported by the in-house team of industry experts, proprietary database and the unique analytical software that underpins all our consultancy and intelligence services. An extensive client base and experience in a wide variety of projects has provided us with a pervasive network of contracts across the industry.

Our team includes former oil and gas company technical and commercial managers with extensive experience of acquisition and divestments.



For more information regarding our products and services please contact:
Karen Alford – karenalford@hannonwestwood.com - Tel: +44 141 534 7903

IHS Stand

IHS is a global information company with world-class experts in the pivotal areas shaping today's business landscape; energy, economics, geopolitical risk, sustainability and supply chain management. Businesses and governments rely on our products, services and solutions to make faster and more confident decisions. From prospecting to market, energy businesses turn to IHS for analysis, critical information and analytical software to make high-impact decisions that develop strategies with speed and confidence.

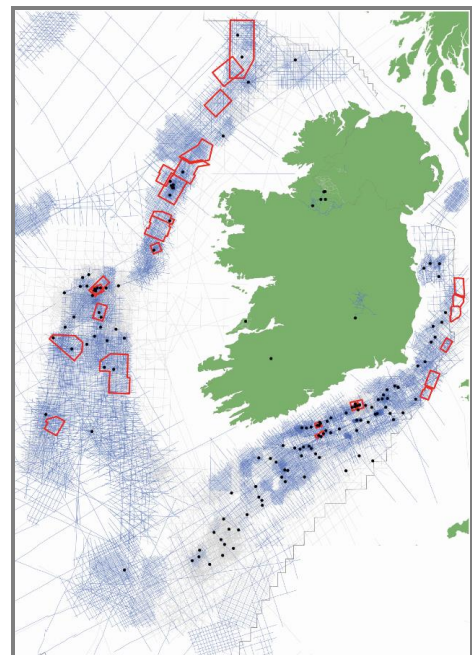
Our International Energy information provides global coverage of energy data sourced through both the public and private domain using an unparalleled communication network with operators, national oil companies, government agencies and service companies. Our data is gathered and reported daily by more than 140 in-country correspondents and experts ensuring that the depth and breadth of our coverage is second to none.

Irish Released Data

As the official and sole data release agent for Ireland's Department of Communications, Energy and Natural Resources, IHS has all the released Irish 2D/3D seismic surveys and well data available, to help you assess an area quickly and cost effectively.

Provided in workstation-ready format, our complete content offering underpins faster and more efficient workflows, to enable;

- Improved understanding of reservoir formation geometry and characterisation
- Accurate delineation of any hydrocarbons present
- Increased accuracy of play fairway analysis
- More effective well planning and reservoir management
- Low risk asset acquisition

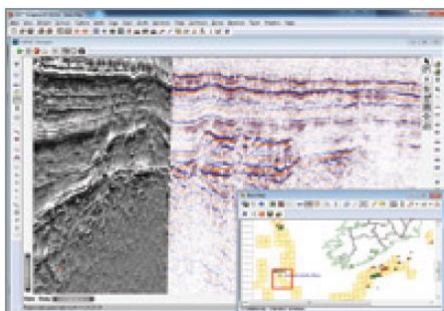


Location of 2D and 3D seismic surveys and wells in Ireland

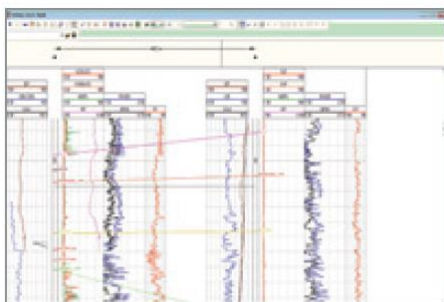
This comprehensive dataset covers all of Ireland's major prospective basins in the following data types:

- **Seismic Data** – Original SEG-Y data, reconstructions of paper/film and IHS Kingdom[®] exported data with navigation in trace headers. Delivered via DVD or hard-drive.
- **Released Well Data** – Scans of original logs and reports in TIFF and PDF format.
- **Digital Well Logs** – Merged and edited into workstation ready LAS format.
- **Digital Well Attribute Data** – Directional Surveys, Checkshot Surveys, Core Header and Analysis Data in workstation ready formats.
- **Pressure Data** – Sourced from well data, all fracture and formation pressures tests and LC/KICK events are interpreted and qualified using IHS flags for QC. All geopressure related drilling events are also captured and categorised before being presented in a consistent and standardised format.

IHS Energy Information and Geoscience Software



2D Irish seismic displayed in IHS Kingdom



Well correlation using IHS Kingdom and Wireline log data

Enhance your interpretations with IHS critical information and IHS Kingdom software.

IHS Kingdom provides geoscientists and asset teams with the breadth of functionality needed for all aspects of their portfolio management from prospect to production. Kingdom provides tools for both quick-look and in-depth geophysical and geological data interpretation, resulting in faster interpretation and modeling, simplified sharing of complex data, and more confident decision making.

In addition, with the new IHS Kingdom Gateway plug-in for Petrel* software, you are now free to use the industry-leading seismic and geological interpretation tools in Kingdom with a seamless connection to the modeling capabilities in Petrel software. Interpreters will no longer have to break their interpretive train of thought to move critical information between Kingdom and Petrel software.

** is a mark of Schlumberger.*



Other IHS Energy Services

IHS Energy is responsible for developing and supporting products to serve the complete oil and gas asset lifecycle. These products include information, software, solutions and insight that are critical for oil and gas professionals to make the decisions needed to manage their assets, from strategic planning through exploration, production and delivery.



For more information regarding our subsurface data, energy information or software, please call **+44 (0)1344 328 155** email emea.energy@ihs.com

INFOMAR Stand

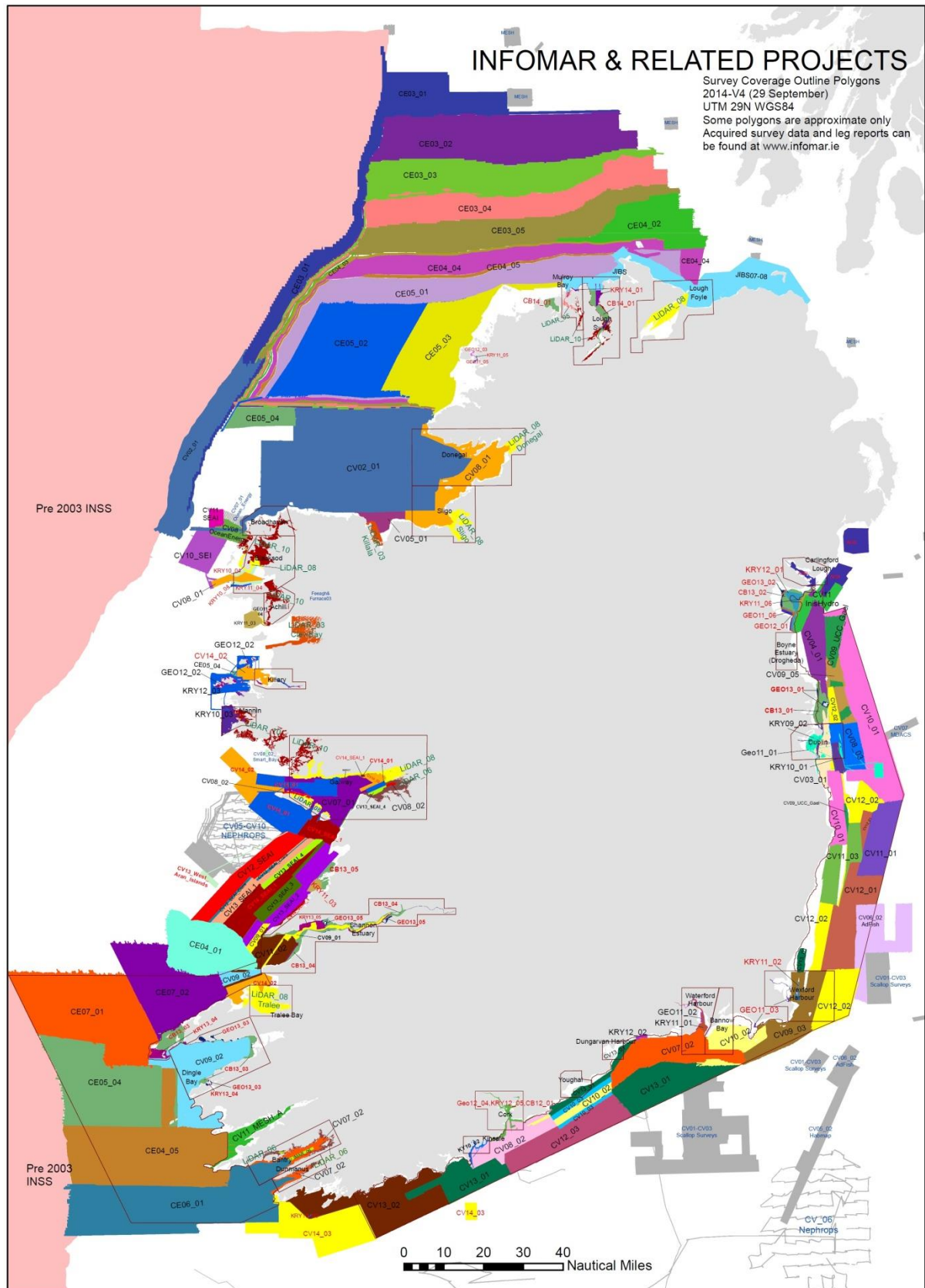
Integrated Mapping for the Sustainable Development of Ireland's Marine Resource (INFOMAR) is Ireland's National Marine Mapping Programme, the follow-on project to the Irish National Seabed Survey (INSS), and is a joint venture of the Geological Survey of Ireland (GSI), Department of Communications, Energy and Natural Resources and the Marine Institute (Department of Agriculture, Food and Marine). This project is currently scheduled to run for a twenty-year period (2006-2026) at c. €3m per annum with priority in the first ten years being given to mapping 26 Bays and three Marine Areas. INFOMAR is primarily a multibeam sonar survey and this acoustic technique is providing detailed bathymetry data and knowledge of the nature of the seabed and overlying sediment. Magnetic and gravity techniques are helping to evaluate the nature and structure of the deeper geology. The primary role of INFOMAR is to acquire baseline information to promote and encourage sustainable offshore development, comply with Irish Government commitments and goals and underpin research in marine science. The survey also represents an opportunity to build up national marine expertise and to disseminate strategically important information to government agencies, third level institutions and the private sector.

INFOMAR's annual stakeholder seminar will take place in Waterford on Oct 22nd and 23rd.

Products deriving from INFOMAR are available both in paper and digital form and downloadable for free from www.infomar.ie

For further information contact: archie.donovan@gsi.ie or Tel: +353 1 678 2798

ATLANTIC IRELAND 2014



ION Stand

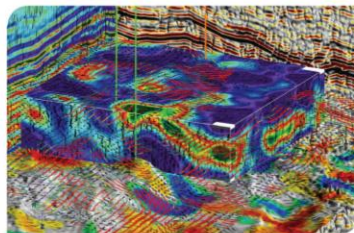
ION Corporate Fact Sheet

THE COMPANY

ION Geophysical Corporation (NYSE: IO) is a leading provider of geophysical technology, services, and solutions to the global oil & gas industry. ION's offerings are designed to allow E&P operators to obtain higher resolution images of the subsurface to reduce the risk of exploration and reservoir development, and to enable seismic contractors to acquire geophysical data safely and efficiently.

OUR STRATEGY

Since our founding in 1968 as Input/Output, a manufacturer of land seismic equipment, ION has evolved to become a leading provider of advanced, integrated geophysical solutions that help oil & gas companies and seismic contractors overcome their greatest imaging and operational challenges.



Proven Innovators

ION has a rich history of innovation. We were the first to commercialize MEMS digital sensors, cableless acquisition technology using digital sensors, and the first to make streamer steering technology available industry wide. Our streamer positioning systems and command & control software have become the industry standards aboard marine seismic vessels. We were at the forefront of multicomponent, wide-azimuth acquisition and processing, and the first to make reverse time migration (RTM) available on a commercial scale. Since 2002, our BasinSPANs seismic data libraries have provided E&P companies a superior alternative to traditional 2D spec data. And we are the only company with the technology to acquire seismic data under ice.

Unique Business Model

First and foremost, we are a technology company driven to develop and apply proven, innovative technologies and services to help our clients find and produce hydrocarbons as safely and efficiently as possible. Whether a company is sizing up the prospectivity of a frontier basin or working to extract maximum value from a mature reservoir, our team of experienced problem solvers can help them meet their objectives. Our strategy is to participate in the highest value of all aspects of the geophysical cycle - planning, acquisition, processing, and interpretation.

QUICK FACTS

- Technology-driven solutions provider to global E&P
- Founded in 1968 as Input/Output – renamed ION Geophysical in 2007
- Headquartered in Houston, Texas
- Listed on the NYSE (Ticker: IO) since 1994
- ~1,100 employees operating in 21 cities on six continents
- 2013 revenues of \$549 million
- CEO R. Brian Hanson

2013 HIGHLIGHTS

- Entered ocean bottom seismic market through OceanGeo joint venture
- Expanded data processing global footprint with offices in Perth and Oklahoma City
- Assisted the Tanzania Petroleum Development Corp. with launch of 4th Tanzania Offshore Licensing Round
- Introduced Narwhal™ for Ice Management
- Formed strategic alliance with Polarcus for 3D multi-client seismic
- Expanded 2D BasinSPAN™ library with programs offshore Australia, Uruguay and Labrador
- Opened new 120,000 square foot facility in Harahan, Louisiana
- Initiated our 50th WiBand™ broadband processing project
- Finished the year with a record quarter for revenues, operating income and data library sales



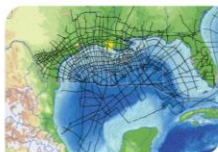
→ Charged to innovate. Driven to solve.™

Our Offerings



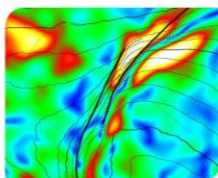
GEOVENTURES INTEGRATED GEOPHYSICAL PROGRAMS

ION's GeoVentures group develops and manages full-scope 2D and 3D multi-client and proprietary programs, including survey design and planning, data acquisition, project management, advanced processing services, reservoir characterization services, final image rendering and interpretation.



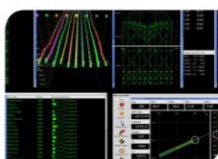
GEOVENTURES SEISMIC DATA LIBRARIES

Our global 2D BasinSPAN library consists of nearly 400,000 km of seismic data covering virtually all major offshore petroleum provinces. Our 3D ResSCAN™ land programs are designed to help operators in unconventional reservoirs make better drilling and completion engineering decisions, reducing development risk and cost.



GXT DATA PROCESSING AND INTERPRETATION SERVICES

Operating from processing service centers around the world, our GX Technology (GXT) group is one of the most technologically advanced seismic imaging teams in the industry. GXT undertakes complex land and marine imaging projects, applying advanced imaging techniques, including data conditioning, pre-stack depth migration (PreSDM), reverse time migration (RTM), tomographic and azimuthal velocity model building, and reservoir fracture detection.



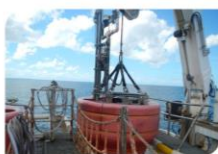
CONCEPT SYSTEMS SURVEY DESIGN AND OPTIMIZATION

ION's Concept Systems software products and advisory services help our customers design their seismic surveys and make the tradeoffs between subsurface image quality and cost. Our Concepts Systems group specializes in designing surveys for the most challenging imaging applications, including challenging environments such as the Arctic, and time-lapse (4D) programs.



MARINE SEISMIC DATA ACQUISITION EQUIPMENT

ION develops seismic imaging systems and software for both towed streamer and ocean bottom seismic acquisition. Our offerings include streamer positioning and control systems, streamer acquisition systems, ocean bottom cable acquisition systems, including industry-leading Calypso® and VSO systems, marine acquisition software and data integration and quality-assurance services.



OCEANGEO

With full ownership of OceanGeo, a multicomponent ocean bottom seismic (OBS) acquisition services company, ION now offers a complete suite of ocean bottom seismic services. The ION OBS solution includes survey planning and design, data acquisition using ION's VSO and Calypso technologies, and GXT data processing, interpretation and reservoir services.



INOVA

Since our founding as a land seismic equipment company, ION has been at the forefront of technological innovation in land seismic equipment. In 2010, ION and BGP (subsidiary of China National Petroleum Corporation) joined forces to form an independent land seismic equipment company, INOVA, whose product portfolio includes systems, sources, and sensors for onshore seismic data acquisition. ION owns 49% of INOVA, while BGP owns 51%.

CORPORATE LEADERSHIP

R. Brian Hanson
President, Chief Executive Officer
and Director

Steve Bate
Executive Vice President
and Chief Operating Officer,
Systems Division

Christopher T. Usher
Executive Vice President
and Chief Operating Officer,
GeoScience Division

Ken Williamson
Executive Vice President and
Chief Operating Officer,
GeoVentures Division

Lawrence Burke
Senior Vice President,
Global Human Resources

Gregory J. Heinlein
Senior Vice President
and Chief Financial Officer

Colin Hulme
Senior Vice President,
Ocean Bottom Services

Jacques Leveille
Senior Vice President,
Technology & Communications

David L. Roland
Senior Vice President,
General Counsel and
Corporate Secretary

CORPORATE HEADQUARTERS

2105 CityWest Blvd., Suite 400
Houston, TX 77042-2839 USA

Tel: +1 281 933 3339
Fax: +1 281 879 3626

www.iongeo.com



→ Charged to innovate. Driven to solve.™

Irish Lights Stand

The Commissioners of Irish Lights is the General Lighthouse Authority for all of Ireland, its adjacent seas and islands. CIL carry out the obligations of the British and Irish governments in relation to the provision of Aids to Navigation (AtoN) around the coast of Ireland commensurate with the amount of traffic and degree of risk under the Safety of Life at Sea Convention (SOLAS).

CIL's Vision Statement is to provide valuable Aids to Navigation and allied services while delivering an essential public safety service at an economic cost.

In addition, there is an obligation on CIL to inspect and approve the AtoN systems and to audit the subsequent management of AtoNs provided by Ports and Local Lighthouse Authorities. CIL also has obligations regarding the marking or removal of wrecks in areas of general navigation.

The legal basis for the operations of the Commissioners of Irish Lights dates back to an Act passed by the Irish Parliament sitting in Dublin in 1786 which set up a body called "The Corporation for Preserving and Improving the Port of Dublin". Various Acts were passed over the years and in 1867 a new Act separated the Port of Dublin Corporation from the Corporation for the Preserving and Improving the Port of Dublin. It was not until 1935, following Irish independence, that the functions of Irish Lights were finally regularised when adaptations were made by an Order of the Executive Council, entitled: Irish Lights Commissioners Adaptation Order, 1935.

The cost of the Service to mariners is met from the General Lighthouse Fund which derives its income mainly from light dues that are charged on commercial shipping calling at UK and Irish ports. The Irish Government contributes to the Fund under the terms of an agreed formula. The Irish Lights service is part of an integrated system of Aids to navigation around the coasts of Britain and Ireland. Trinity House and Northern Lighthouse Board are our sister providers.

Irish Lights affairs are run by a Board of 12 Commissioners, four Officials from Dublin Corporation, the Chief Executive and four Heads of Department.

Irish Lights is now based at Dun Laoghaire on Dublin Bay where the workshops, buoy yard and administration are all located on the same site. From here Irish Lights oversee the provision and maintenance of lighthouses, buoys, beacons and radio aids to marine navigation. There is a 24 hour monitoring service of the major AtoNs from this site. A contracted helicopter is used to transfer maintenance teams to and from offshore lighthouses. The dedicated vessel *Granuaile* is deployed to maintain and service the AtoNs provided, mainly buoyage, but is also engaged in project support, lighthouse replenishment, surveying and wreck marking or removal. *Granuaile* is also a strategic asset of the Irish State and is available for appropriate commercial contracts.

Contact:

Dave Ward,
Commercial Services Manager,
Commissioners of Irish Lights,
Harbour Road,
Dun Laoghaire,
Ireland
Tel: 01 271 5400
Email: dave.ward@cil.ie

La Tene Maps Stand

La Tene Maps is a knowledge based company based in Dublin, Ireland specialising in the research and production of maps, educational posters and associated data products. The company works mainly in many natural resource and energy areas including Aquaculture, Fisheries, Oil and Gas Exploration, Renewable Energy, Electricity and Power Generation.

We produce and publish a range of maps and posters for clients and ourselves. The company has a whole series of maps covering many parts of the world.

The company is also involved in production of confidential maps and graphics for clients and also sells a small range of maps and posters produced by itself and other companies through its secure online store.

The company's research arm is active in its own right and participates in EU research projects as well as research projects for Government departments, state bodies and private companies.

La Tene Maps has produced every full colour map on the Irish Oil and Gas exploration sector since the mid 1980s. At the 2014 Atlantic Ireland conference and exhibition the company will be displaying some maps on Irish natural resources including maps on mineral exploration and the latest edition of the "Ireland and the Irish Sea – Oil and Gas Exploration" an Oil and Gas Concession map for the Irish and West British Sectors. Also on display will be draft copies of the new "Onshore Britain – Oil and Gas Exploration and Production" and a new map which looks at North Sea Oil and Gas Production / Decommissioning.

Printed Oil & Gas exploration maps published by La Tene Maps are available free to bone-fide team members with operators or consortia members working in areas covered by the map. The maps are also distributed free at various conferences and exhibitions. Printed, Digital Print and pdf files are available for purchase by all interested persons.

For further information on our capabilities and/or the maps we produce contact:

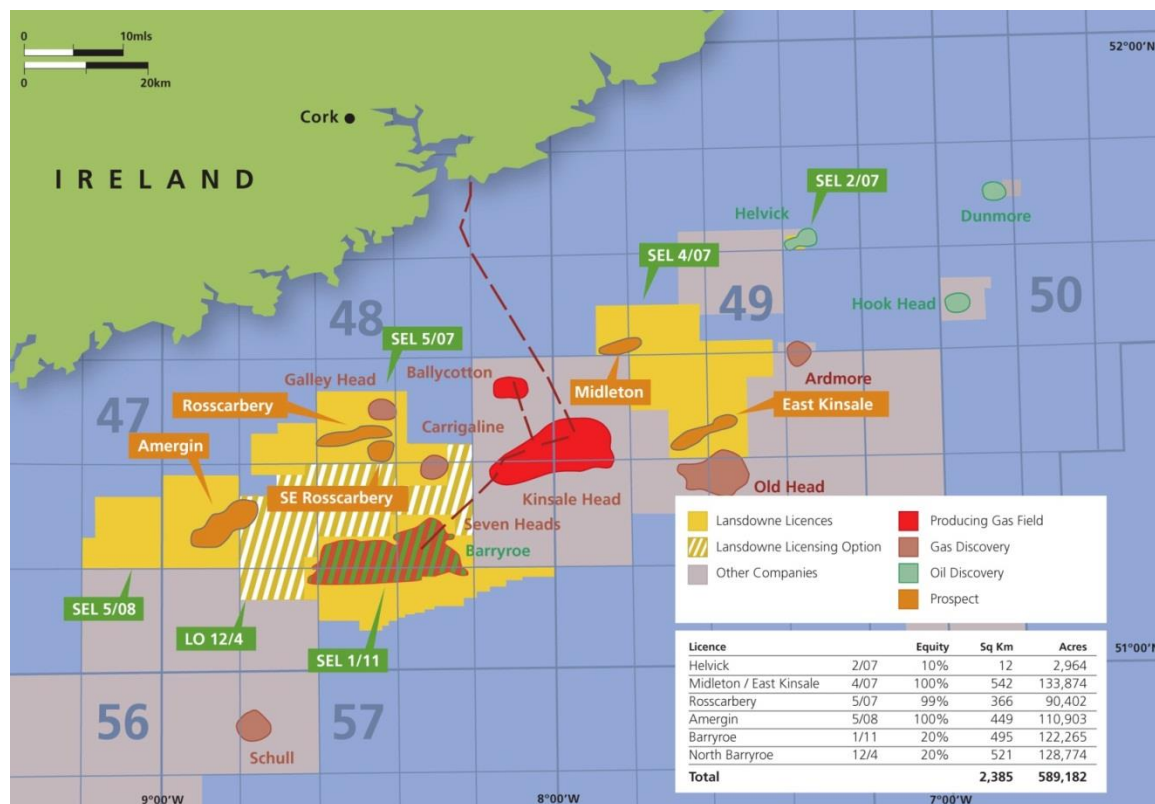
John Coleman, La Tene Maps

Station House, Shankill, Co, Dublin

Tel: +353 12847914 E: johncoleman@latene.com W: www.latene.com

Lansdowne Oil and Gas Stand

Lansdowne Oil & Gas plc holds rights, through its wholly owned subsidiaries, to five Standard Exploration Licences and one Licensing Option in the North Celtic Sea Basin ("NCSB"), off the south coast of Ireland.



Lansdowne holds a 20% equity interest in Standard Exploration Licence 1/11, containing the Barryroe Oilfield operated by Providence Resources. In 2012 the 48/24-10z Barryroe appraisal well successfully tested at a stabilised rate of 3,514 bopd and 2.93 mmscfd. Independent CPR estimates of Barryroe have yielded total gross on-block 2C recoverable resources of 346 MMBOE (69 MMBOE net to Lansdowne).

Recent improvements seen in seismic imaging from the use of modern 3D seismic acquisition and processing techniques has served to reduce the risk in the exploration for additional commercial oil and gas fields in Lansdowne's licensed areas.

Lansdowne has matured both oil (Amergin) and gas (Middleton and Rosscarbery area) prospects to be ready to drill and discussions with potential farm-in joint-venture partners are ongoing.

Contact Details:

Steve Boldy (CEO) - Stephen.boldy@lansdowneoilandgas.com

Richard Slape (Commercial Director) - Richard.slape@lansdowneoilandgas.com

Lansdowne Oil & Gas plc

6, Northbrook Road

Dublin 6

Ireland

Tel: + 353 (0) 1 495 9259

LR Senergy Stand

LR Senergy is a global provider of fully-integrated project and asset development services across the energy sector. The company's services encompass geosciences, reservoir engineering, geohazard assessment, marine site surveys, rig positioning, wells engineering and operations, production technology, core analysis, geomechanics, formation damage, reserve and asset evaluation, facilities engineering, project management, power engineering and alternative energy solutions. LR Senergy also develops and supports innovative software technologies including Interactive Petrophysics™ and Oilfield Data Manager™ and delivers a suite of associated technical training courses.

Its survey and geo-engineering capabilities, which serve both the oil and gas industry and renewable energy market, span: geophysics and geohazard assessment; geotechnical and foundation engineering studies; survey, positioning and inspection; data management and geographic information system (GIS) solutions; cable burial and trenching assessment; due diligence and expert witness; and environmental science.

Established in 2005 as Senergy, the company became LR Senergy after Lloyd's Register (LR) Group made a significant investment in the Aberdeen-headquartered company which has a global talent pool of more than 700 people across a network of locations in the UK, Scandinavia, the Middle East, Australia, South East Asia and the Americas.

While LR Senergy will continue to operate as an independent company until 2016, the company became a member of LR Group to provide a broad service portfolio to the oil and gas and broader energy market while LR has representation on LR Senergy's Board.

For more information, visit www.lr-senergy.com

Marine Institute Stand

The Marine Institute is Ireland's national agency responsible for Marine Research, Technology Development and Innovation (RTDI). They seek to assess and realise the economic potential of Ireland's 220 million acre marine resource; promote the sustainable development of marine industry through strategic funding programmes and essential scientific services; and safeguard our marine environment through research and environmental monitoring.

The Research Vessel Operations section of the Marine Institute operates two Research / Survey vessels, the 65 m RV Celtic Explorer and the 31 Meter RV Celtic Voyager. The Institute also operates a 3000m rated work class ROV. The vessels and ROV are available for use by both Government agencies, academia and commercial organisations.

The Marine Institute has provided a range of turnkey survey services to the oil and gas industry utilising both vessels over the past ten years including Analogue and HR digital site surveys, Acoustic Pipeline inspection surveys, ROV Pipeline and cable surveys, Pipeline route surveys, Geotechnical surveys and environmental surveys.

The RV Celtic Explorer is undergoing a major refit in 2015 which includes the installation of a 6000m rated deepwater Multibeam system (EM302), a high resolution multibeam (EM2040) and a deep water sub bottom profiler. This increased vessel capability together with its deepwater ROV and deepwater USBL system allows the RV Celtic Explorer to offer unique capability to operators operating in the deeper Irish Offshore. The vessel is routinely mobilised with seismic equipment to allow the acquisition of Digital and Analogue site surveys.



The 31m RV Celtic Voyager has recently been upgraded with a Kongsberg EM 2040 multibeam system which has greatly increased its capability for seabed mapping. The vessel is frequently used for analogue and environmental Site surveys in Irish waters.

The deepwater workclass ROV “Holland 1” can be configured with a full suite of equipment for pipeline inspection surveys. The system most recently completed a 150 km pipeline survey and jacket survey in the Celtic sea.

The Marine Institute advanced mapping section is a partner with GSI in the INFOMAR program which aims to map the remaining unmapped 13% of the Irish territorial seafloor, concentrating on specific areas of interest such as priority bays and areas of biological interest.

For further information please contact:

Aodhan Fitzgerald
Research Vessel Operations
Marine Institute
Renville,
Oranmore
+353 91 387200
afitzgerald@marine.ie
www.marine.ie



Northern Ireland Stand

Northern Ireland has a long heritage of engineering excellence in sectors such as aerospace, shipbuilding, ship repair and conversion, transport, quarrying & materials handling and power generation. Its companies and skilled labour force deliver engineering capability to offer globally competitive, innovative solutions to the oil and gas and sustainable energy sectors. Examples of supply chain capability include:

Belfast Harbour

Belfast Harbour covers an area of 2,000 acres, representing 20% of Belfast city area, and is Northern Ireland's logistics & distribution hub and home to major businesses including Bombardier and Harland and Wolff Heavy Industries. Through investment of £150m in recent years Belfast Harbour offers:

- Over 100 acres of strategically located development sites including one fronting the main deep water channel.
- 24/7 access, with maintained channel depth of 9.3m and berths extending to 11.5m with no air draft restrictions.
- 50 acres logistics and assembly site with 480m heavy duty quay fronting onto the port's main deep water channel
- 2 permanent heavy lift gantry cranes, capable of lifts up to 800 tonnes each, extensive dry dock facilities and over 100,000sqm of storage areas provided by Harland and Wolff.
- Ability to construct and deliver port infrastructure projects in a shortened time frame
- Spare high voltage electricity capacity to handle factory development loads.

Harland and Wolff Heavy Industries Ltd

Harland and Wolff have one of Europe's largest marine and offshore heavy engineering facilities, purposely developed to create some of the world's largest ocean-going vessels in a safe, productive and cost effective environment.

With over 150 years experience in marine design consultancy & engineering services, naval architecture and manufacture, the company delivers projects in design, conversion, repair and upgrade of vessels including FPSOs, FSU etc and oil and gas platforms; design and manufacture of offshore modules such as power generation, transformer and operations/accommodation platforms; offshore oil, gas and wind farm foundations including jackets under 10,000 tonnes, 'Universal Foundation' suction bucket foundations, monopiles, jackets, tripods/quadrupods and gravity bases.

Projects include dry docking and repair of the SeaRose FPSO for Husky Energy on an intensive 28 day programme, completed 4 days ahead of schedule with no lost time injuries; construction of 8 large pile sleeve clusters, buoyancy tanks and conductor tubes for Prime Contractor, Kvaerner Verdal AS for the Edvard Grieg and Martin Linge oil platform jackets for the North Sea; marine design engineering for the 'Petroleo Nautipa' upgrade.

Europa Valve

Europa Valve designs and manufactures bespoke non-slam nozzle check valves to customer specifications at its foundry in Newcastle, Co Down, ranging from 2" to 72" and weight range of 3kg to 10 tonnes in a range of materials from carbon steel to titanium.

Fast Tank

Designed and manufactured by Fast Engineering, the Fast Tank is a portable liquid containment and storage solution which can be rapidly assembled without tools and is used in oil and chemical spill clean up as well as the civil defence, fire fighting and international aid sectors in 120 countries worldwide. Other products in the range include decontamination tanks, secondary containment bunds and the 'Fast Asleep' high security bedding which is totally waterproof and tear resistant.

MMI Engineering

MMI Engineering, a wholly-owned subsidiary of US geo-environmental consulting firm, Geosyntec Consultants, provides technical consulting and engineering services to enable effective risk management through its offices in Northern Ireland, USA, GB, Malaysia and Australia. The company assists clients in the offshore energy sector in the analysis, mitigation and management of risks imposed by natural and man-made hazards bringing to bear its expertise in major hazard modelling and simulation, major hazard engineering for blast, fire, impact and earthquake, structural integrity assurance, fluid system mechanics and design and technical communications.

Pinsent Masons

Pinsent Masons' Belfast based Oil & Gas Team is recognised as one of the leading providers of legal services to the sector. With experience and capability covering both upstream and downstream activities in the UKCS and international markets, the Team has been involved in some of the world's largest oil and gas infrastructure projects. Experience includes domestic and cross border M&A, takeovers, public company listing and international joint ventures and the Team regularly works on the acquisition of large scale oil and gas exploration and production assets such as the purchase of MODU-Jackups and self erecting tender rigs as well as land drilling rigs.

www.investni.com/offshore

Sam Knox Tel: 02890 698851/07776254490 e: sam.knox@investni.com

Nick Turberville Tel: 020 72220599/07909874139 e: nick.turberville@investni.com.

PAD / DCENR Stand

The role of Petroleum Affairs Division (PAD)

The core role of the Petroleum Affairs Division of the Department of Communications, Energy and Natural Resources (DCENR) is to develop and implement policies which have the aim of maximising the benefits to Ireland from exploration for, and production (E&P) of, Ireland's indigenous oil and gas resources, while ensuring that activities are conducted with due regard to their impact on the environment and other land/sea users.

DCENR seeks to achieve this through a range of strategies which have the following key objectives:

- maximising the level of oil and gas exploration and production activities in Ireland with a view to optimising the return to the State.
- ensuring that the regulatory framework in place is robust, clear, promotes certainty and is in keeping with international best practice, while encouraging exploration, development and production activities to be carried out in an effective and timely manner.
- maximising the area of continental shelf under Irish jurisdiction.

In pursuing these strategies it is DCENR's aim to achieve the twin objectives of contributing to ensuring Ireland's security of energy supply while providing a fair financial return to the State from its natural resources.

The Petroleum Affairs Division of DCENR is responsible for promoting the opportunities for the private sector to invest in oil and gas E&P in Ireland and regulating such activity through its licensing terms and conditions. The Department actively promotes Ireland as an attractive location for international investment building on the outputs of applied research projects and focused interpretative reports, together with the release of basic geological, geophysical and well data to the industry.

DCENR's regulatory approach is primarily focused on ensuring effective and timely exploration. The department seeks to achieve this by agreeing appropriate work programmes with operators and monitoring delivery of the work programmes to ensure that they are carried out in full and in accordance with best industry practice, having particular regard to the environment and other land/sea users.

The PAD/DCENR Stand will display a series of posters covering promotion of exploration in Ireland's waters and on the new DCENR/ENI regional seismic survey.

The Integrated Petroleum Affairs System (IPAS) (www.pad.ie/ipas) provides access to information relating to authorisations, wells, potential field and seismic surveys using search screens or through map interface.

Petroleum Geo-Services Stand

Petroleum Geo-Services (PGS) offers a broad range of products including; seismic and electromagnetic services, data acquisition, processing, reservoir analysis/interpretation and MultiClient library data. We help oil companies to find oil and gas reserves offshore worldwide, utilising the industry's most advanced acquisition technology to yield a clearer image.

Overview

PGS was founded in Norway in 1991, with two seismic ships and some highly innovative ideas on how to reshape the industry. Today we share the same drive to innovate as inspired our founders, though the team is bigger:

- 13 offshore seismic vessels
- 21 data processing centres
- 35 offices worldwide, employing over 70 nationalities

PGS has a presence in over 22 countries with regional centres in London, Houston and Singapore. Our headquarters is in Oslo, Norway and the PGS share is listed on the Oslo stock exchange (OSE:PGS).

PGS possesses the world's most extensive 3D MultiClient data library comprising over 586,000 sq km* worldwide. Additionally the developing MultiClient 2D portfolio (over 350,000 line km*) is available in frontier and developing hydrocarbon areas and includes a growing proportion of GeoStreamer® data that demonstrates excellent imaging qualities. PGS MultiClient products also include the MegaSurvey, MegaSurveyPlus, and MegaProject data packages which provide contiguous 2D and 3D coverage across vast areas.

Recent work by PGS in Ireland has focused on the Atlantic Margin MegaProject -- a large database of 2D and 3D seismic data which has been assembled from released datasets and PGS MultiClient surveys. All the data has been matched, merged, and balanced to provide a regionally consistent, coherent seismic dataset. The Atlantic Margin MegaProject is being offered for licensing and includes 4,700 sq km of high-end 3D MultiClient data, a comprehensive 2D data package, and four regional gridded horizons.

Another recent 3,500 line km MultiClient 2D program in the Fastnet Basin involved simultaneous acquisition of high quality broadband seismic and towed streamer EM.

*Total acreage cited above includes data acquired with third parties.

Contact:

Petroleum Geo-Services

4, The Heights,
Brooklands, Weybridge,
Surrey, KT13 0NY
United Kingdom
Tel: +44 1932 376000
Fax: +44 1932 376111
Email: mceurope@pgs.com
www.pgs.com

Physicalgeo Stand

We are a small yet dynamic and driven oil and gas consultancy based in Berkshire, UK. Our focus is on quality geoscientific commercial consulting, non-exclusive reports and business development.

The principal consultant, Andre Stout, has been serving the community for over 18 years, for majors, minnows and all in between. He has a track record as an oil finder and is in high demand for his services.

Andre has worked on the Atlantic Margin from the Barents Sea to West Africa for companies such as Shell, BP, Chevron, Total, Maersk, Tullow and Nexen. He is familiar with the elements required for successful evaluation of potential; from field development and appraisal through to new basin entry.

Andre is a member of the SEG, EAGE and PESGB.

Contact Andre directly on andre@physicalgeo.com

Further business support is provided by Alison Egan, a marketing specialist with a history of excellent client management. She initially trained in Retail Management and followed this with a Diploma from the Chartered Institute of Marketing.

Contact Alison directly on alison@physicalgeo.com

Other specialists in the oil and gas industry are brought in as required, from data analysts to commercial engineers, using a network of trustworthy contacts.

South Porcupine Basin: Seismic interpretation and evaluation of prospectivity

In order to support the industry in the [2011 license round](#) (closed May 31st 2011), Physicalgeo prepared a comprehensive evaluation of this Mesozoic rift basin. We accessed ALL available seismic data (100,000km+) over this huge area and are in a unique position to support clients' evaluation of this exciting province.

The South Porcupine Basin, sometimes known as the Porcupine Seabight Basin, is a deepwater basin, 150km to the southwest of the Irish coast. Similar petroleum systems are present to those found in the shallower water North Porcupine Basin, where oil and gas fields have been discovered. Crucially, there is potential for better reservoir quality and more numerous source rocks than found in the North Porcupine Basin. The recent Dunquin well has revealed the potential for oil in Cretaceous reservoirs.

Clients who purchased this report successfully bid in the round and also attracted larger oil companies into lucrative farm-in deals that has led to significant 3D acquisition and could lead to drilling as early as 2015.

Rockall Basin: Seismic interpretation and evaluation of prospectivity (NEW)

In order to support the industry in the [2015 license round](#) (closes September 2015), Physicalgeo are now preparing a comprehensive evaluation of this basin. We have access to ALL available seismic data (2D and 3D data) over this huge area and are in a unique position to support clients' evaluation of this margin.

The Rockall Basin has proven petroleum systems at many levels, including the Carboniferous – Triassic gas play found at Corrib, that is about to come onstream in 2015. Oil source rocks in the Lower Jurassic (Bandon) and Upper Jurassic (West Dooish) wells has opened up significant oil

potential, that often lies above deeper gas plays. Huge structures have been identified that can justify the remote locations of some of these targets.

Physicalgeo are happy to work alongside clients' own evaluation of this area, as the project progresses. Discounts are also available to clients who are looking to acquire both of the above projects.

Please visit our stand to see how we can help you.

PIP Stand

The Petroleum Infrastructure Programme (PIP) was set up by the Petroleum Affairs Division (PAD) of the Department of Communications Energy and Natural Resources (DCENR) in 1997. The ISPSG Group, the successor to the joint industry Rockall Studies Group and Porcupine Studies Group, was set up in 2002 and concentrates on the regional exploration elements of the PIP objectives with an aim to address common industry problems anywhere in the Irish Offshore.

The overall aim of PIP is to promote hydrocarbon exploration and development activities by:

- Strengthening of local support structures
- Funding of research data gathering and 'land-based' research in Irish offshore areas
- Providing a forum for co-operation amongst explorationists and researchers

Research under the Programme goes beyond normal licence area-specific work and is designed so as not to duplicate the efforts of other groups or of commercial contractors. It is also considered essential that local researchers should be given an opportunity to participate in the research projects. PIP is funded by oil companies with licences offshore Ireland and the PAD.

The Open Call in 2013 sought project proposals under the following Themes:

- Regional geological and geophysical data gathering and studies aimed at improving knowledge of petroleum systems and exploration potential;
- Special engineering studies to improve Exploration and Production cost effectiveness and recommendations on better procedures and practices;
- Development of environmental monitoring techniques.

Fifteen research projects were awarded a total of €2.5m funding. For further information on the Petroleum Infrastructure Programme, please visit the website - www.pip.ie

The ISPSG currently (October 2014) comprises: Atlantic Petroleum (Ireland) Ltd, Cairn Energy Plc, Chrysaor E&P Ireland Ltd, Chevron North Sea Limited, ENI Ireland BV, Europa Oil & Gas Plc, ExxonMobil E&P Ireland (Offshore) Ltd, Husky Energy, Kosmos Energy LLC, Maersk Oil North Sea UK Ltd, Petroleum Affairs Division of the Department of Communications, Energy and Natural Resources, Providence Resources plc, Repsol Exploración SA, San Leon Energy Plc, Serica Energy Plc, Shell E&P Ireland Ltd, Sosina Exploration Ltd, Tullow Oil Plc and Woodside Energy (Ireland) Pty Ltd.

Polarcus Stand

Ireland-South Porcupine Basin

Multi-Client 2D and 3D Data

Polarcus is pleased to announce the availability of a major new multi-client seismic dataset in the South Porcupine Basin, offshore south-west Ireland. The South Porcupine Basin is an under explored rift basin with multiple exploration plays and Polarcus, in collaboration with its partners, has acquired 4,300 sq. km of 3D data and 4,500 km of 2D data in this area.

The 3D data provides coverage over the Drombeg exploration prospect and the attractive adjacent open acreage, and the 2D data provides a comprehensive regional database infilling the new PAD regional dataset and complementing ION's NE Atlantic SPAN data, allowing a better understanding of the basin and allowing companies to place the prospective plays and structures identified from the 3D dataset into a broader regional context.

The new data will be available in Q4 2014 to allow companies to fully evaluate this exciting exploration area for the 2015 Irish Atlantic Margin Licensing Round.

For further information contact:

Tony Pedley

tony.pedley@polarcus.com

+44 788 44 81747

Zyg Sarnowski

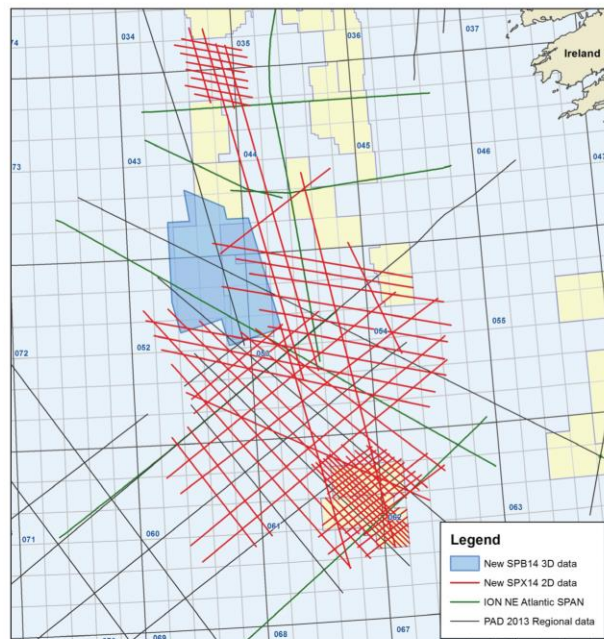
zyg.sarnowski@geopartnersltd.com

+44 1252 761314

Phill Houghton

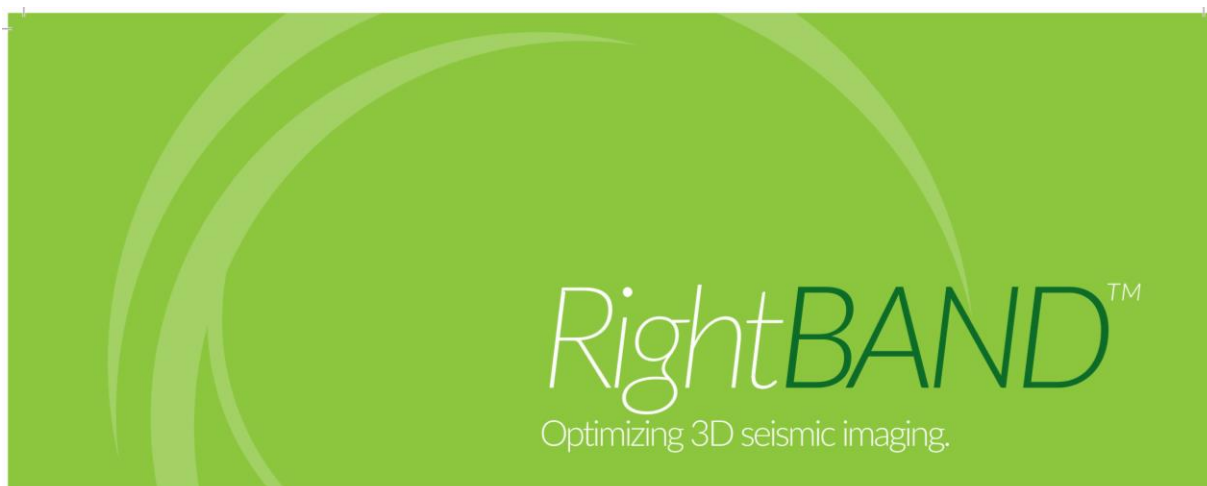
phill.houghton@iongeo.com

+44 1784 497475



www.polarcus.com/mc





Intelligent project design

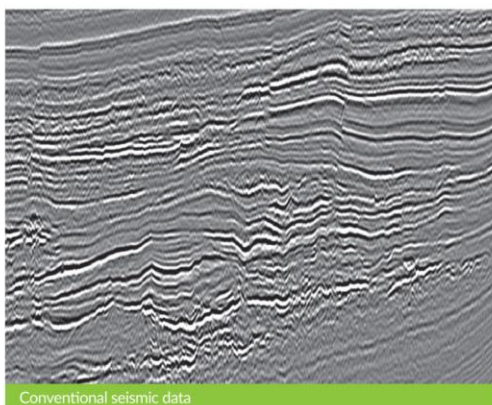
Broadening the frequency content of seismic datasets has recently become an essential technique for improving image quality and attribute extraction. Early solutions were highly engineered. Modern holistic solutions such as those offered by Polarcus can now deliver equivalent or better results. At the core of the Polarcus approach is our belief in the intelligent application of geophysical principles, involving each component of the seismic workflow.

It is widely recognized today that a high signal-to-noise ratio is the key defining element. Our custom-designed source arrays generate broadband signals tailored for the specific geological objectives of each project. Our low noise 2Hz true-solid streamers, deep-towed and recording in the ultra-silent environment created by our X-BOW™ vessel hulls, deliver optimized data with the lowest possible noise content across the entire frequency spectrum. Other benefits of this low noise environment include extended weather windows for acquisition and an optimized signal-to-noise ratio over the whole desired frequency spectrum, especially at the low end.

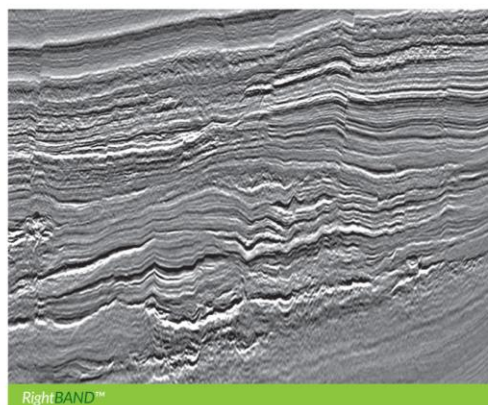
No magic black boxes or complex towing configurations needed. Just intelligent choices to deliver optimized high signal-to-noise ratio data to the data processing specialists.

For the highest quality broadband imaging, advanced processing methods are required to complement our optimized acquisition techniques. The resulting combination of optimally-acquired seismic data and advanced data processing techniques enables us to deliver the highest quality 3D RightBAND™ images, tailored to meet the specific objectives of each survey.

For more information talk to one of our local representatives or email us at rightband@polarcus.com.



Data courtesy of Ophir Energy.



Imaging tomorrow's energy™



Port of Waterford Stand



Gateway to Ireland's offshore oil and gas operations

- ✓ Waterford is a commercial, efficient, cost-effective customer focused port
- ✓ Excellent uncongested access infrastructure
- ✓ Out of town location with planning, zoning and extensive land banks for development
- ✓ Secure terminal facility with 24 hour security on-site
- ✓ Belview Terminal, the main centre of port activities, consists of over 1 kilometre of modern quays
- ✓ Choice of secure open storage locations for cargoes – long and short-term options
 - 7000m² approx. at Belview
 - 2.8 hectares (7 acres) and 2.22 hectares (5.6 acres) available at City Quays sites
- ✓ Storage capacity for 380,000sq.ft (bulk) and 270,000sq.ft. (palletised), with a further 104,000sq.ft. in specialised and ambient storage.
- ✓ Direct road and rail networks – served by motorway and national primary roads. Waterford's Belview terminal is rail connected, with 4 rail spurs, enabling multiple trains to be service together.
- ✓ Depth of 9.5m CD (subject to tide)
- ✓ Vessels may be handled at two locations in Waterford – Belview & City Quays
- ✓ Board and management are focused on new business opportunities

Location and Hinterland

- Belview facility is located 8 kilometres from Waterford, away from a busy urban environment.
- Connected to the main national road and rail network and is adjacent to Waterford Airport, providing good efficient routes to oilfield service company suppliers.
- Proximity to oil and gas exploration and development hotspots



Port of Waterford location
(Courtesy: Google Earth)

No Congestion

- The port has ample capacity and no congestion at berths, on quays or on access routes.

Land Bank

- The port is well connected to the main national road and rail network and is adjacent to Waterford Airport, providing good efficient routes to oilfield service company suppliers
- 265 hectares of appropriately zoned laydown area available at quayside for consolidating cargo

Port Facilities

ATLANTIC IRELAND 2014

- 850m of quay with 8-10m draft
- Guaranteed access 24/7 stevedoring operations with quick turnaround
- ISPS compliant with comprehensive CCTV and access control systems
- Office accommodation: 4,099m² on four floors
- Accommodation for vessels up to 32,000 dwt, max draft 9.5m subject to tide
- Onsite customs and security
- 2 x 45 tonne widespan gantry cranes and 3 x Liebherr mobile harbour cranes (1 x 65 tonne; 2 x 35 tonne)

Supply Chain Services

- Transport and Logistics
- Oil Spill Response
- Waste Management
- Tank Cleaning
- Local ISO-approved Warehousing
- Manifesting and tracking of rental equipment
- Compliance Management Fuel (ISO 82172010), Water, Bulk supply
- OBM Transhipment Facilities



Supply Chain Companies

- Stokestown Port Services
- Southeast Port Services
- Store-All Warehousing and Logistics
- Waterford Container Terminal
- Fastnet Shipping
- South East Tugs

Health & Safety

- Port personnel are IOSH trained and certified
- Port Pass certification
- Port Safety Forum
- Ongoing port safety and quality training

Waterford Airport

- Proven track record in supporting the Marine Exploration Sector as an aviation base
- Support for crew operations, weather briefings and dedicated Crew Room
- Management of all administrative logistics:
 - Customs clearance
 - Immigration procedures
- One-off arrangements with key Irish government departments (Transport, Justice, etc.) e.g. carriage of commercial explosives
- Facilities for service aircraft from UK, Europe and the USA
- Transfer of exploration personnel
- Safety Briefings
- Organised and managed the use of immersion suits
- Hangar and re-fuelling for helicopters



(Courtesy: Waterford Airport)

Providence Resources Stand

The combination of board and management talent, together with Providence's major shareholder worldwide network, presents a unique ability to succeed on the international stage. Providence has appropriate experience in the financing of large developments and is well equipped to plan and access finance for a wide range of activities and projects. Providence has established banking relations with a number of leading international financial institutions.

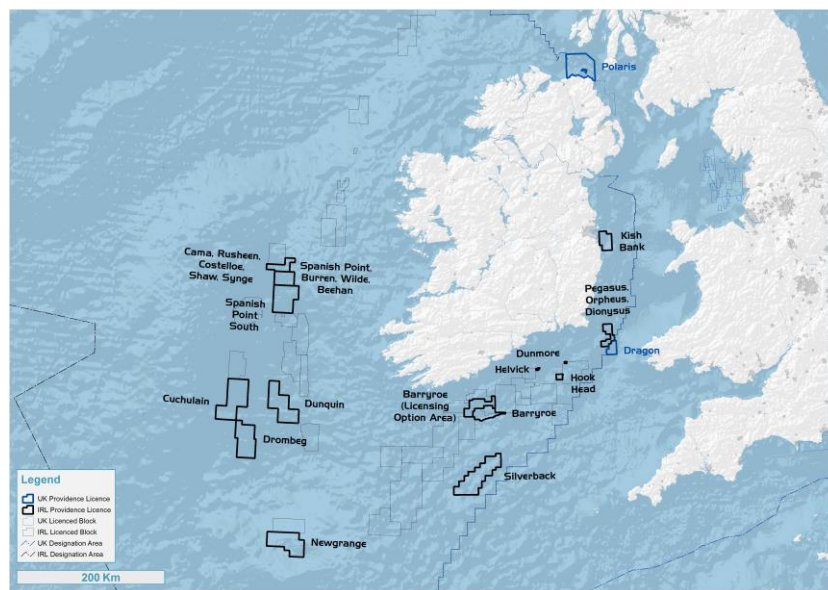
Since its formation, Providence has built a diversified portfolio of oil and gas exploration licences and concessions with the key focus being the pursuit of exploration and appraisal interests offshore Ireland. The Company's board and management have a well-established background in the oil and gas business having worked closely with many major companies throughout the world. Providence works with leading companies including ExxonMobil, Repsol, ENI, Petronas and Cairn.

Providence's oil and gas interests offshore Ireland and the United Kingdom includes a portfolio of appraisal and exploration oil and gas assets

We operate to a number of broad corporate strategic guidelines that have led us to the development of our current portfolio.

These guidelines may be summarised as follows:

- We are a front end E&P company, with a focus on early stage exploration and appraisal opportunities;
- We achieve a controlled and cost-effective expansion of our interests with a specific geographic focus on opportunities arising from our Irish and UK interests;
- We engage in strategic relationships/partnerships with third parties on a project-by-project basis with a view to controlling financial and project risk without compromising standards; and
- We establish ourselves, where appropriate, as operator and project leader, particularly at the early stages, with a view to being in a position to ensure the cost-effectiveness of projects and observance of best practice.



Barryroe

Proposed Drilling 2015



Spanish Point

Seismic Operations 2014
Proposed Drilling 2015



Drombeg

Polarcus Amani
Seismic Operations 2014



Dunquin

Eirik Raude
Drilling Operations 2013



PwC Stand

The energy industry contends with a great amount of uncertainty and risk, and yet companies have to focus on the future to ensure financial and operational success. At PwC, we study industry trends and issues closely, so that we can better understand the challenges that our clients face, and how we can best help them to achieve success.

The energy industry requires long lead times for new projects, and even though the current global economy is struggling, the world's population continues to grow. With this growth, energy demand will increase. Weighing the risks versus benefits of new projects, new products and how much capital to invest, energy companies also have to consider regulatory, safety and environmental concerns. Balancing the need to supply the world with hydrocarbons, companies are also looking at investments in alternative energy sources, including unconventional sources, biofuels, renewable energy sources, and ways to improve energy efficiency.

So at PwC, we are not only watching these developments in the industry, but we are analyzing these changes from the perspective of how they will impact our clients, and how we can best help companies prepare and manage the changes. We examine the issues, and build teams of subject matter specialists who develop appropriate solutions through our assurance, tax and advisory services. Our experienced professionals are on the ground in 158 countries around the world contributing local insight and understanding.

For further information please visit our stand or our website at www.pwc.ie

RPS Group Stand

RPS is an international consultancy providing advice upon the exploration and production of energy and other natural resources and the development and management of the built and natural environment. We employ 5,000 people in Ireland, the UK, the Netherlands, the United States, Canada, Brazil, Africa, the Middle East, Australia and Asia. (www.rpsgroup.com)



In Ireland, RPS is the leading environmental and oil and gas exploration consultancy. We have over 500 staff and eight offices throughout the country. Our international presence allows us to undertake co-ordinated and integrated projects throughout the world.



RPS provides integrated technical, commercial and project management support services in the fields of geoscience, engineering and HS&E. We help clients develop natural energy resources across the complete asset life cycle, combining technical and commercial skills with a wide knowledge of environmental issues.

We have an annual portfolio of over 500 projects, a client-focused organisation, adapting to clients' needs and provide a world-class flexible service to deliver projects on time and within budget.

Operations Support



For almost thirty years, RPS Energy (www.rpsgroup.com/energy) and its predecessors have provided a full range of operations support for international oil & gas projects. This includes projects in renewables and nuclear energy. The wide ranging expertise and experience of this group is a world-class resource that allows us to support the operations behind the exploration for, and development of, energy assets around the world, from consenting and licensing support, environmental support, geotechnical services, MetOcean, health and safety, technical support and project or operations management.

Technical Studies

RPS has worked in almost every petroleum basin in the world and has been involved in every Irish exploration operation since 2010. Every year we undertake hundreds of projects ranging from niche specialist work to large multi-disciplinary exploration and development studies. These include geophysics, petrophysics, biostratigraphy, reservoir engineering, sedimentology and sequence stratigraphy.



Advisory



RPS provides independent, technically-informed advice and management support, using experienced consultants to work individually or with our clients' teams. Whether working on business process or specific assets and portfolios, we can provide support across the complete oil & gas value chain, from E&P through to downstream strategy development projects. RPS also supports country entry, policy and fiscal development and regional and strategic assessments.

Integrated Risk Management Solutions

RPS Integrated Risk Management Solutions provides specialist HSE & risk management consultancy services to the energy industry and other major hazard industries. We specialise in the management of health, safety, environmental, social, security and other related business risks in the oil and gas, nuclear and renewable sectors.

Marine and Coastal Services

RPS is a leading provider of marine and coastal consultancy services to both public and private sectors. Our team of experts have extensive experience of holistic assessments in seas, coasts and estuaries, assisting developers with advice on all phases of a project lifecycle.

We undertake management of large-scale multi-disciplinary projects and we provide survey and consultancy support for planning applications, consents issues under the environmental permitting regulation (EPR) and marine construction consents through environmental impact assessments where required. We have a team of over 50 marine and coastal experts based in 10 offices across the UK and Ireland (www.rpsgroup.com/ireland), as well as marine teams based in Australia, the US and Canada making RPS well placed to take on any project.

Services include policy development and appraisal; planning and development control; conservation and biodiversity protection; risk, impact and liability assessment; environmental survey and monitoring; physical processes and modelling; coastal and marine engineering; economic, socio-economic and financial analysis; stakeholder engagement, and spatial analysis and data support.



Training Programmes

RPS has historically delivered training courses in our core discipline areas and as part of our knowledge transfer commitments, usually associated with the technical studies we undertake.

In 2011, Nautilus joined the RPS Group adding industry leading training capabilities across the E&P value chain. Training services can be accessed through scheduled programmes, or alternatively bespoke programmes, including competency assessment and capability development consultancy, can be built to meet specific client requirements (www.nautilusworld.com).

www.rpsgroup.com

Schlumberger Multiclient Stand

With more than 40 years of experience in seismic data acquisition, processing, and imaging, Schlumberger Multiclient offers the industry's most comprehensive 2D and 3D multiclient seismic data library of the world's major hydrocarbon basins.

Our library addresses all geophysical and geological challenges from basin-scale 2D surveys to full-azimuth broadband 3D prospecting and appraisal surveys.

Schlumberger Multiclient offers an integrated approach to multiclient surveys. Our services range from survey design and modelling to incorporation of multiple measurements and geological knowledge into a shared earth model, and they often employ the most advanced imaging techniques on the market today.

Schlumberger Multiclient experts work in industry-standard Petrel and Omega integrated software platforms, enabling clients to interact with the data and collaborate with our geologists and geophysicists during the imaging stages of projects.

Serica Energy Stand

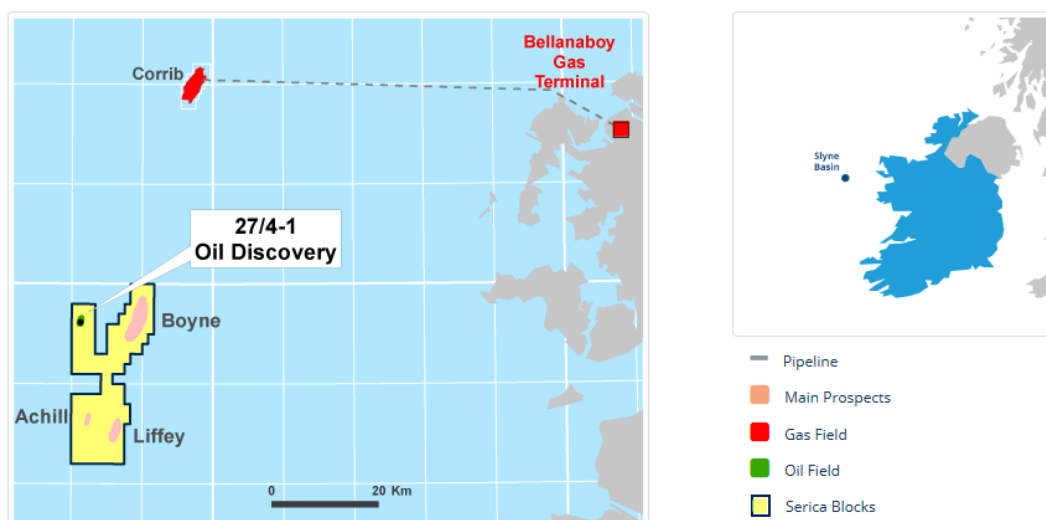
Serica Energy plc is an international exploration and production company with activities in the UKCS, Ireland and Africa. The Company is development operator for the Columbus gas-condensate field in the UK North Sea and has reached agreement to purchase 18% equity in the nearby producing Erskine Field (conditional on DECC and Erskine Partner approval). Serica is exploring for oil and gas in the UK North Sea and East Irish Sea, as well as in the Atlantic margin offshore Ireland, Morocco and Namibia, which it sees as emerging new play areas. Serica is listed on the London Stock Exchange and on the Toronto Stock Exchange in Canada, with the share symbol "SQZ" on both markets.

Serica Energy in Ireland

Serica Energy (UK) Ltd holds three licences in offshore Ireland; FEL 1/06, FEL 1/09 and FEL 4/13.

FEL 1/06: Blocks 24/4, 27/5 and 27/9

Bandon Oil Discovery; Boyne, Achill and Liffey Prospects



Serica and RWE are preparing to drill the Boyne exploration well in 2016 to follow the 27/4-1 Bandon oil discovery drilled on the licence. This licence benefits from exceptional fiscal terms (25% CT) and relatively shallow water (230m). Serica and RWE invite companies to join in the drilling with low entry cost terms.

Licence FEL 1/06 was awarded in December 2006, comprising blocks 27/4, 27/9 and part block 27/5, in the Slyne Basin off the west coast of Ireland. The blocks lie some 40 kilometres south of the Corrib discovery. Serica and RWE each hold 50% working interest.

In 2009 Serica operated the drilling of the Bandon exploration well (27/4-1 and 1z) which discovered oil in the Lower Jurassic Sandstone. This has opened-up a new oil play in the Slyne Basin and enhanced the prospectivity of the licence. Two deeper Jurassic oil prospects have now been identified at Boyne and Liffey, each with an underlying gas prospect in the Sherwood Triassic Sandstone, as proven by the Corrib field. Achill is an additional Triassic gas prospect on the licence. All prospects have been mapped on 3D PreSTM data and PreSDM data is now available. Site surveys have been carried out on Boyne and Liffey in preparation for drilling.

Rockall Basin: FEL 1/09 and FEL 11/1



FEL 1/09: Blocks 5/17, 5/18, 5/22, 5/23, 5/27 and 5/28,

Muckish Prospect

Licence FEL 1/09 was awarded to Serica in July 2009. The licence covers a total area of 993 square kilometres and lies in the north-eastern part of the offshore Rockall Basin. The Rockall Basin has an areal extent of over 100,000 square kilometres in which only three exploration wells have been drilled to date in the Irish sector; the basin is therefore highly underexplored.

FEL 1/09 contains a very large pre-Cretaceous fault block prospect (Muckish) covering an area of 31 square kilometres in a water depth of 1,450 metres. Muckish is analogous to the nearby gas-condensate bearing Dooish structure drilled by Enterprise in 2002, which encountered a 214 metre hydrocarbon column. Two further prospects, Muckish East and Mackoght have also been identified in the licence area and are obvious follow-on prospects, in the event of success at Muckish. Serica has acquired 2D long-offset seismic lines and reprocessed the existing 3D seismic volume, which has helped de-risk the Muckish prospect as it demonstrates distinct similarities to the nearby Dooish

discovery. Serica has developed plans to drill the Muckish prospects and is seeking partners to join the licence.

FEL 4/13 : Blocks 11/5, 11/10, 11/15, 12/1, 12/6 and 12/11 (part),

Derryveagh and Midleton Prospect

Licence FEL 4/13 covers an area of approximately 925 square kilometres in the Rockall Basin, south-west of the Dooish Discovery. The licence contains the Derryveagh and Midleton prospects mapped on good quality 3D data. The Derryveagh Prospect is an amplitude-supported Albian turbidite fan. It shows a strong Class I AVO anomaly (dimming on Far Angle Stacks) with a down-dip limit conformance to structure. The prospect is underlain by the Midleton Prospect, a large pre-Cretaceous tilted fault block analogous to the Dooish discovery. A single vertical well could test both Derryveagh and the underlying Midleton Prospect. The West Midleton Prospect is an additional pre-Cretaceous tilted fault, also analogous to the Dooish Prospect. All these prospects are in close proximity to Serica's licence FEL 1/09 to the north.

Spectrum Geo Stand

Company Overview

Spectrum is established as a key player in the seismic services market. The company focuses on delivering high-quality Multi-Client seismic data and holds one of the world's largest 2D marine libraries.

Spectrum is one of the seismic industry's fastest growing companies. The Spectrum group seeks to build on the company's reputation as a reliable seismic service provider and serves a global clientele from offices strategically located throughout the world.

We provide innovative Multi-Client seismic surveys and high quality Seismic Imaging services to the global oil and gas industry from offices in the UK, USA, Norway, Brazil, Australia and Singapore. The Spectrum group also includes substantial regional processing centres in Egypt and Indonesia, all with complete data processing capabilities.

The Spectrum library of Multi-Client data specialises in regional coverage and includes projects from many of the foremost oil producing regions of the world. Our experienced teams of geoscientists integrate seismic interpretation with well data and remote sensing information (gravity, magnetic, SAR seep, electro-magnetic, etc) to evaluate the hydrocarbon potential of the basins we work in. This information helps us to plan future Multi-Client projects targeting key plays and solving the imaging problems to provide a valuable exploration tool to our clients.

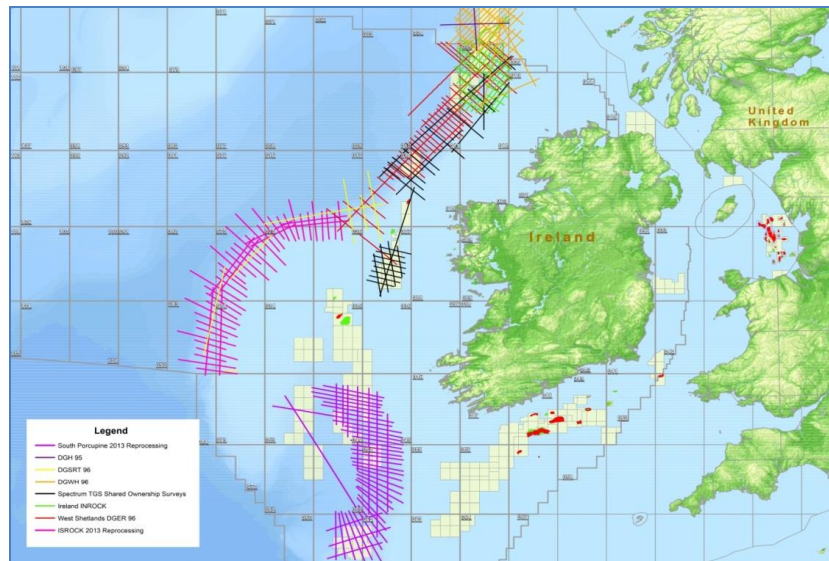
The company strategy focuses on both the major, established hydrocarbon-producing regions of the world in addition to key frontier areas identified by our experienced team of geoscientists. Data comprises new acquisition, reprocessing and interpretation reports. New projects are carefully selected to ensure they are relevant to future hydrocarbon exploration. The Multi-Client department often works closely with local governments to commission new surveys or reprocess archived data to successfully rejuvenate exploration interest within a region.

Ireland Multi-Client Coverage

The Spectrum Multi-Client library comprises over 1.2 million kilometres of high quality 2D and 3D marine seismic data. This includes significant coverage across the Atlantic Margin, off the Irish coast. Spectrum holds eight 2D Multi-Client surveys in total which exceed 14,000 km over the Porcupine,

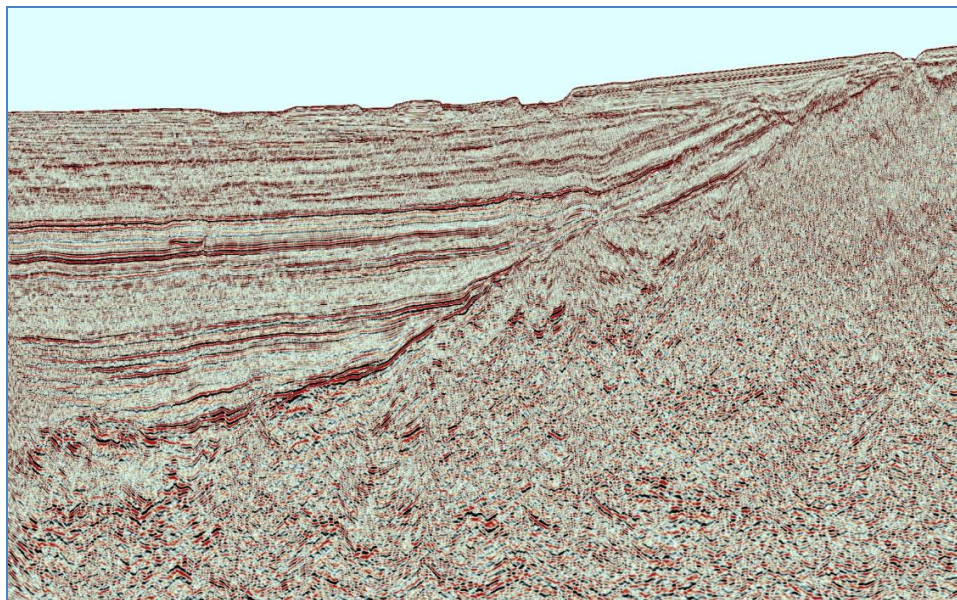
ATLANTIC IRELAND 2014

Erris and Rockall Basins. Much of this 1990s vintage data has since undergone modern seismic reprocessing including the Porcupine and ISROCK surveys which were updated as recently as 2013.



Spectrum Multi-Client coverage across Ireland

The deep water offshore Atlantic Margin of Ireland (Porcupine, Erris and Rockall Basins) is a vast underexplored area, with significant hydrocarbon prospectivity. Discoveries have already been made in the North Porcupine Basin, and the nearby Slyne Trough, plus along the UK Western Margin to the north. Conjugate basins offshore Canada have also yielded hydrocarbon discoveries. It is therefore highly likely that there are large remaining undiscovered accumulations in reservoirs of Triassic, Jurassic, Cretaceous and Tertiary age.



Spectrum reprocessed PSDM seismic example in the Porcupine Basin

For more information please contact: mike.johnson@spectrumasa.com
+44(0)1483 730201
www.spectrumasa.com

TGS Stand

TGS provides geoscience data and services to the global energy industry. TGS' geophysical and geological data products include multi-client seismic libraries, permanent reservoir monitoring, magnetic and gravity data, the industry's largest global database of digital well logs, and regional interpretive products. TGS also provides high-end depth imaging services to help solve complex seismic imaging problems.

Zebra Data Sciences / EzDataRoom Stand

Established in 2004, Zebra Data Sciences Ltd (ZDS), provides Licensing Round services to Countries and Divestment services to oil and gas companies that are looking to farm-out or farm-into assets. These specialist services, HydrocarbonAssets™ and EzDataRoom™, include preparation of asset information, provision of expert advisory services, design of promotional material / flyer / information memorandum, retrieval, assessment and conditioning of your data, classification and indexing of your data and production of digital data packages. In addition, remote workstation capabilities are offered via industry standard interpretation packages. Our **specialist virtual and physical data rooms, promotion** of projects via our world-renowned deal listing site, international exposure at conferences and **active project marketing** are well known and valued throughout the industry.

ZDS's role is to know more companies, the right people in those companies and, most importantly, the type of project they are looking for and where. Leveraging off our global opt-in client data base we will introduce your project to those who are seeking opportunities or you can invite selected companies personally and ZDS will introduce your project to the remainder. Alternatively, if your project needs to be handled more discreetly we can do that as well. We have been involved in over 690 farm-outs, asset sales and numerous licensing rounds. About 30% of these projects are PRIVATE, often large production/Development deals and are by personal invitation only.

Companies that ZDS work with vary from small exploration teams through to the super majors. To date ZDS has been involved with deals resulting in a cumulative value in excess of 6 billion dollars.

Completed projects include Production, Development, Appraisal, Exploration and Licensing Rounds.

If you are looking for acquisitions, JV partners, licensing round help, or data room services please feel free to stop by Booth or inquire at: +44 1732 220058

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POSTER ABSTRACTS (in alphabetical order)

Vertical wall assemblages in the Whittard Canyon, NE Atlantic Margin

Allcock, L.¹, O'Toole, F.¹, Johnson, M.¹, Tyrrell, S.¹, Wilson, A.¹, White, M.¹

¹ Ryan Institute and School of Natural Sciences, National University of Ireland, Galway, University Road, Galway, Ireland

A novel species assemblage dominated by the limid bivalve *Acesta excavata* and the deep-water oyster *Neopycnodonte zibrowii* was recently described from a single vertical wall at 600-800 m depth in the Whittard Canyon system on the North East Atlantic margin. The Whittard system has multiple canyon arms, the majority of which are characterized by an extensive area of vertical wall at these depths at their head. During an *RV Celtic Explorer* cruise to this area in June 2013 we explored four further vertical walls in three canyon arms with the deep-water ROV *Holland I*. Each wall was covered with dense assemblages suggesting this vulnerable marine ecosystem could be widespread along the Celtic margin. However, these assemblages differed subtly in composition. We characterize these differences through analysis of high definition video using multivariate statistics and consider the environmental factors such as underlying geology and hydrography that could be causative.

Using nanotechnology to treat wastewater from offshore oil and gas industry – a feasibility study

Asam, Z.¹, Zhang, H.¹, Lei, W.³, Chen, Y.³, Nizami, A.¹

¹ Department of Civil, Structural and Environmental Engineering, Trinity College Dublin

² Centre for Research on Adaptive Nanostructures and Nanodevices (Crann), Naughton Institute, Trinity College Dublin

³ Institute for Frontier Materials, Deakin University, Warun Ponds, Victoria 3216, Australia

⁴ Centre of Excellence in Environmental Studies (CEES), King Abdulaziz University, Jeddah, KSA

Treatment of wastewater from offshore oil and gas industry is one of the most significant challenges of today's and future generations. Water produced during oil and gas extraction operations, referred as produced water (PW), constitutes the industry's most important waste stream on the basis of volume. The EU Water Framework Directive (WFD) is committed to 'zero discharge' in response to the need for a more protective system to tackle aquatic pollution (Directive 2000/60/EC, 2000). Most oil and gas companies around the world are now working towards the implementation of 'zero-discharge' of contaminants in PW. Depending on geological conditions and field position, PW may have a complex composition including organic or inorganic ingredients such as salts, metals, oils, phenols, organic acids, dissolved hydrocarbons and some compounds which may be added to it during oil separation process. Until recently very little attention was given to dissolved organics and heavy metals in PW. Current researches are paying more attention to the consequences and long term effects of dissolved organic components and heavy metals on living organisms. In addition, efficient and cost effective ways to remove these hydrocarbons and heavy metals are being explored.

Commonly the dissolved pollutants are removed using adsorption, solvent extraction and ion exchange. Adsorption on activated carbon is one of the popular technique traditionally been used, however, activated carbon and other common absorbents including, zeolites and natural fibres suffer from low adsorption capacity and low separation selectivity. Nano-particles, with large surface areas and extremely high surface reactivity, could be an inexpensive and effective solution to treat PW and facilitate the achievement of "a zero environmental harmful discharge" goal in oil/gas industries. Recent researches suggest a number of nanomaterials have the potential to remove hydrocarbons

and heavy metals from wastewater. Some of these materials include porous boron nitride (BN) nanosheets, Zinc oxide (ZnO), Iron oxide (Fe₃O₄) and Titanium Oxide (TiO₂). The overall objective of this research project is to study the feasibility of using nano-particles to remove dissolved hydrocarbons and heavy metals from PW. The specific objectives are (a) to review the best available technologies for offshore PW treatment, (b) to identify, synthesise and characterise potential nano-particles for adsorption of dissolved hydrocarbons and heavy metals from PW and (c) to evaluate the efficiency and cost effectiveness of these nano-particles.

This research project (IS13/06) is funded by the Petroleum Infrastructure Program (PIP), Ireland. Trinity College Dublin is the lead institute for this project and research team has collaboration with Deakin University, Australia and King Abdulaziz University, KSA on various issues involved in carrying out the research work.

Revised structural evolution of the North Celtic Sea Basin based on modern 2D and 3D seismic data

Byrne, K.¹

¹ *School of Biological, Earth & Environmental Science, University College Cork*

The North Celtic Sea Basin (NCSB) is one of a number of basins related to Mesozoic extension across north-west Europe. Tucker & Arter (1987) describe the NCSB as having a conventional steep head geometry while other authors (Musgrove *et al.* 1995, Rowell 1995, Naylor & Shannon, 2011) describe how extension was accommodated on a large low angle normal fault that bounds the northern margin of the basin, leading to a half graben geometry. Deep reflection seismic data across the NCSB show a significant low angle detachment feature beneath the basin believed to be a Variscan thrust (BIRPS & ECORS, 1986; McGeary *et al.*, 1987), which was later reactivated to form the north bounding fault of the NCSB.

Seismic acquisition and processing improvements in the last decade have assisted in providing new insights into the structural evolution of the NCSB. The 2011 Barryroe 3D seismic survey provided the first 3D view of the Triassic section showing significant fault surfaces that demonstrate the importance of intra-basinal faulting. Interpretation from the Barryroe 3D seismic dataset has been extended using a modern 2D long-offset regional seismic survey acquired by TGS/Fugro in 2006 and a Merlin Profilers 1984 2D regional seismic dataset reprocessed by WesternGeco in 2014. The improved seismic imaging allows for a more robust regional interpretation of the structural evolution of both the North Celtic Sea Basin and adjacent South Celtic Sea Basin.

Seismic interpretation suggests significant rifting in the Triassic and earliest Jurassic as pre-existing Variscan thrust surfaces were reactivated to form a half graben geometry. Well 57/09-1 (1984) encountered over 1,000m of Triassic section and several units of massive halite, proving evaporite deposition in the NCSB. The seismic character of this interval on modern data is successfully utilised to identify the Triassic elsewhere in the basin. Minor localised halokinesis has also been identified which further supports the presence of halite within the Triassic section.

Rifting in the Upper Jurassic and Lower Cretaceous created localised back rotation of fault blocks and subsequent erosion at the basin flanks, however the centre of the NCSB was largely unaffected and a complete Cretaceous and Jurassic interval is preserved. Seismic evidence shows this phase of extension was accommodated predominantly by large mid-basinal faults, antithetic to the main half-graben fault. It is possible that halites within the Triassic section, which had been highly rotated in the previous rifting event, became a detachment zone for mid basinal normal faulting in the Upper Jurassic. A regional uplift at this time in north-west Europe, postulated to be a hot-spot related dome

(Underhill & Partington 1993), may be represented in the NCSB by a shift from Middle Jurassic marine facies to non-marine and lacustrine shales of the Purbeckian (Tithonian to Berriasian). Murdoch *et al.* (1995) described up to 1,100m of basin centred uplift and erosion in the Cenozoic while Tucker & Arter (1987) noted uplift was commonly associated with reverse faults. In this study the mid-basinal antithetic faults are preferentially reactivated during compression due to the presence of a detachment within Triassic halites. The seismic data shows significant reversal on these faults creating either broad mid-basinal anticlines, such as the Kinsale Head and Seven Heads structures, or smaller inversion flower structures.

The importance of these mid basinal antithetic faults and the evolution of the basin from a half graben to a full graben had not been recognised before. This study places greater focus on the role of mid basinal faulting on sedimentation in the Upper Jurassic and Lower Cretaceous and indeed structural evolution within the NCSB.

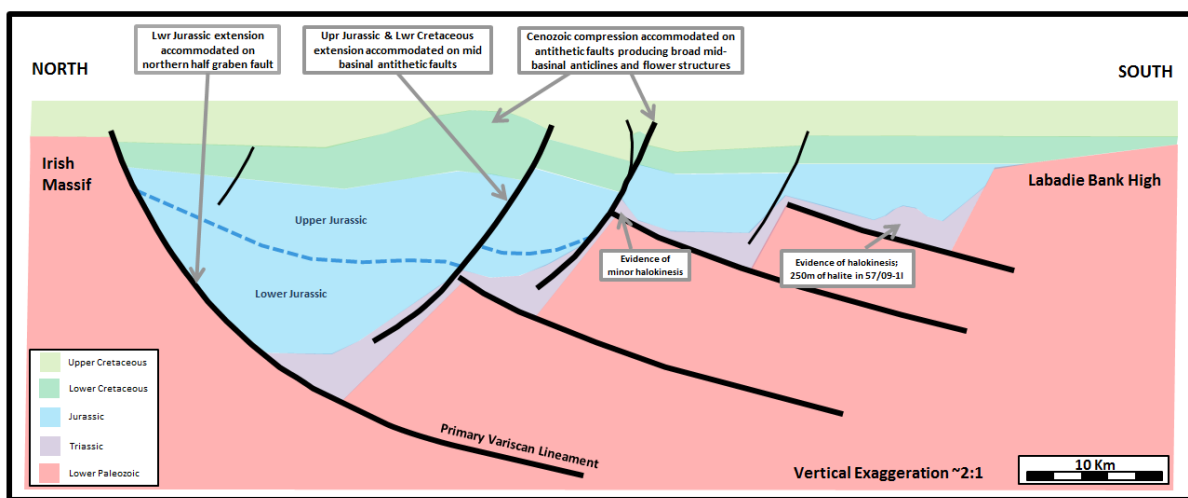


Figure 1: Geological cross-section through the NCSB.

Source Rock Geochemistry of the Central Atlantic Margin: Ireland

Carlisle, C.¹, Silva, R.L.¹, Wach, G.¹

¹*Basin and Reservoir Lab, Department of Earth Sciences, Faculty of Sciences,
Dalhousie University, Halifax, NS B3H 4R2 Canada.*

Email: charlie.carlisle@dal.ca; ricardo.silva@dal.ca; grant.wach@dal.ca

Source rock is a fundamental component of petroleum systems. In order to better understand the source rock potential of the Lower Jurassic interval in the Northern Central Atlantic Ocean sedimentary basins, the Basin and Reservoir Laboratory (Dalhousie University, Nova Scotia, Canada) initiated the “Source Rock and Geochemistry of the Central Atlantic Margins consortium”. This project will evaluate known, probable and possible source rocks in the Central Atlantic Margins shelves and deep water offshore areas. It is mostly focused in organic matter production and preservation, carbonate factories and morphological setting, with an emphasis in the Jurassic time interval. This study is based in the reanalysis of the existing and available organic geochemistry dataset, but it also includes the acquisition of novel geochemical data of selected cores and cuttings, and integration with known time-equivalent source rock outcrops in conjugate margins, namely Morocco, Portugal and Spain.

Of special interest in the Irish context are the Sinemurian–Toarcian organic-rich shales (e.g. Shannon et al., 2007), previously identified as being candidates for source rock in the Porcupine and Rockall Basins (PAD, 2006). In this study and to this moment, four wells have investigated and sampled for geochemistry analysis. Data is currently being collated or acquired (e.g. X-ray fluorescence), and available wireline data is being digitized for re-analysis. Preliminary elemental geochemistry allows to use the SandClass geochemical classification (Herron, 1988) and the determination of Mo and U allow some inferences about the depositional conditions (Algeo and Tribovillard, 2009).

This project is funded by Petroleum Infrastructure Programme under project IS13/16 with additional funding provided by the 2014 PIP-EOSG Scholarship and industrial sponsors.

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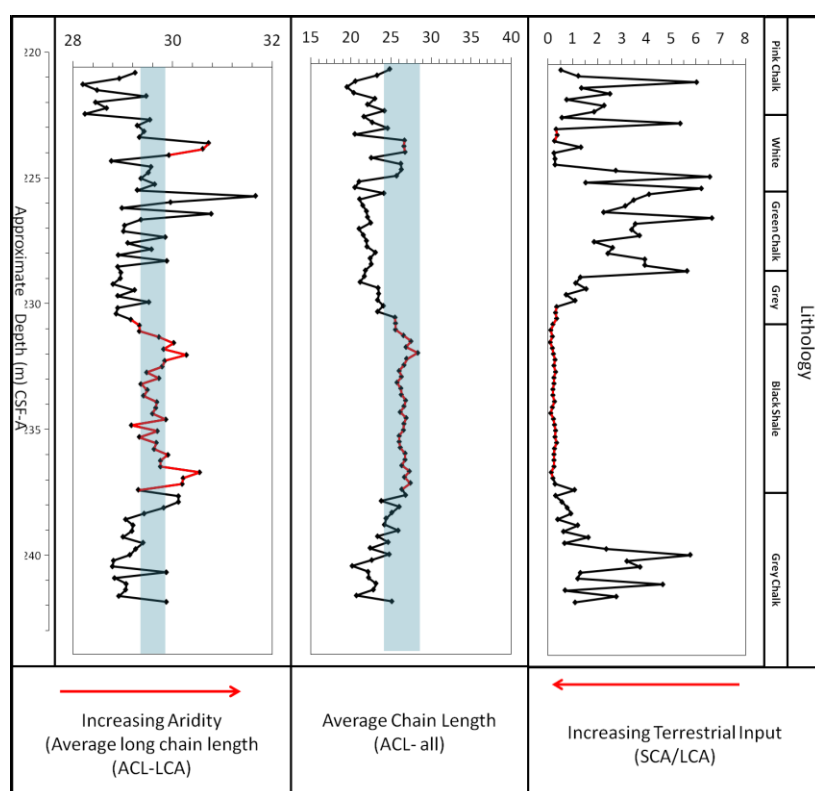
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Biomarker analyses of saturated hydrocarbons from the Newfoundland Basin – Implications for the source of organic matter and water column conditions across oceanic anoxic event 2

Frances, K.¹, Cody, D.¹

¹ School of Ocean and Earth Science, University of Southampton

Ratio analyses of saturated hydrocarbons, the *n*-alkanes, have been conducted on a section of organic-rich black shale from the Newfoundland Basin, representing oceanic anoxic event 2 (OAE2) in the mid-Cretaceous. *n*-alkanes have been applied to petroleum geochemistry successfully over the past four decades for various applications, including their use as indicators of organic matter sources, thermal maturities and also as environmental tracers for hydrocarbon pollution. As part of the Integrated Ocean Drilling Programme (IODP) expedition 342, three drill cores retrieved from the Newfoundland Basin in summer 2012 were found to contain OAE2 horizons. The presence of Cretaceous rocks in this shallowly-buried basin offer the potential to produce precise, high-resolution biomarker results with which to determine organic matter provenance, ocean chemistry, thermal maturity and to provide sea surface temperature data across the Cenomanian-Turonian boundary, ~93.5 Ma. Preliminary biomarker results of the aromatic hydrocarbon lipid fractions from this sequence appear to be at odds with the results of the *n*-alkane data from this study, namely in terms of the source of the organic matter. While previous biomarker analyses on the same cores have strongly indicated a marine source for the organic matter, the *n*-alkanes suggest a dominantly terrestrial organic matter source during OAE2. However, both groups of biomarkers indicate periods of anoxic and euxinic conditions in the water column which could potentially affect the sea surface temperature reconstructions (in the range 33-42 °C) produced for the Cenomanian-Turonian boundary using the TEX₈₆ index.



Panels (a) (b) and (c) show the results of three ratio analyses performed on the *n*-alkanes: the ACL-LCA, ACL and SCA/LCA. Samples connected by a red line indicate the presence of lycopane in the samples, a proxy for anoxia in the water column. Average chain lengths and the ratio of short to long chained *n*-alkanes indicates a terrestrial source for the biomarkers. Data points combined from both cores U1407A and U1407C combine to give an approximation of true stratigraphy

Thermal history of western Ireland

Cogné, N.¹, Chew, D.¹, Stuart, F.M.²

¹ *Geology Department, Trinity College Dublin*

² *SUERC, Scottish Enterprise Technology Park, East Kilbride G750QF, United Kingdom*

The thermal history of a passive margin yields key information on its tectonic evolution, as phases of tectonic activity (e.g. exhumation or burial) can be inferred from periods of enhanced cooling or heating. We present here the results of a thermochronological study (apatite fission track and U-Th/He dating) on selected targets along the western coast of Ireland (four vertical thermochronology profiles in Counties Kerry, Mayo and Donegal) and offshore on the Porcupine High (Fig. 1). The combined use of U-Th/He and vertical profiles for the first time in Ireland should allow us to constrain better phases of cooling / heating.

The fission track and U-Th/He ages range from the Late Jurassic to Early Cretaceous and show relatively little inter-sample variation. Inverse modelling of the age and track length data shows that during post-orogenic exhumation the samples cooled to temperatures of around 80°C. A rapid cooling event (down to temperatures as low as 20°C) occurred during the Late Jurassic to Early Cretaceous and is slightly diachronous from North to South. We attribute this cooling event to rift-shoulder related exhumation and erosion, which can be temporally linked to the main stage of rifting in the western Irish offshore (the Porcupine, Slyne and Erris basins).

During the Cretaceous and Early Tertiary slow reheating is inferred to temperatures of about 50-60°C, and is probably linked to a small pulse of sedimentation onshore. Finally a rapid cooling event during the Neogene is observed. This late cooling phase could be linked to a reactivation of the margin under compressive forces (i.e. due to Alpine collision and/or mid oceanic ridge-push). Onshore we have shown that the present day landscape of Ireland is relatively recent. Offshore the difference between Mebo and Ph samples (Fig.1) shows that the Porcupine High did not behave as a single continental block.

This study is now being complimented by a new thermochronological study in Central and Southeast Ireland to test our hypothesis of rift related exhumation. We are also conducting an offshore study on the wells of the western offshore basins to detect inversion episodes, and thus better constrained the Cenozoic history of Western Ireland.

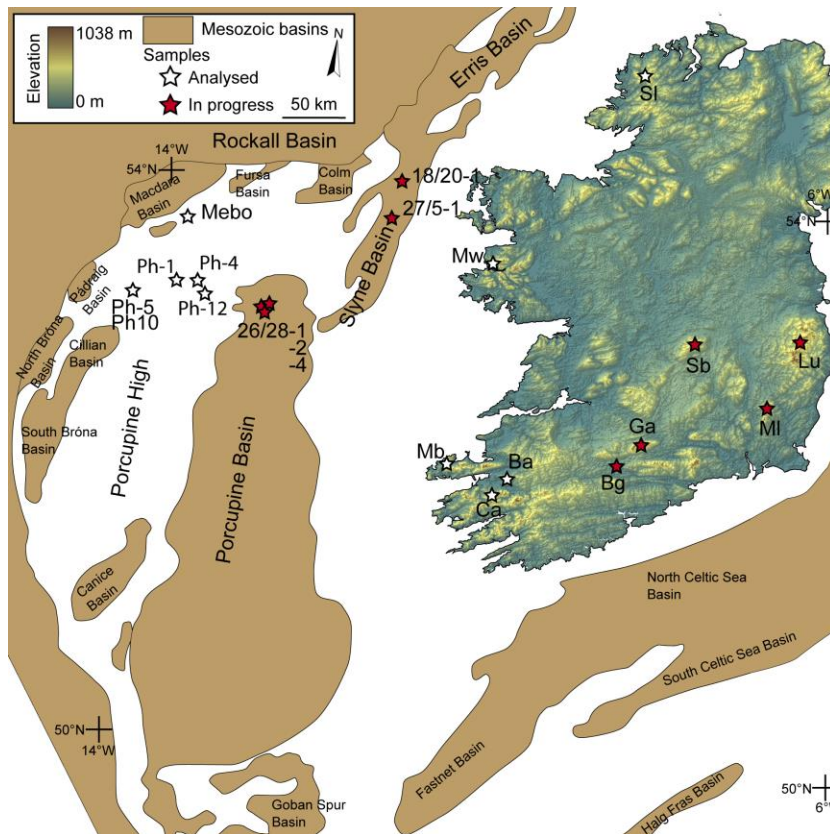


Figure 4: Map of the Irish Atlantic margin modified from Naylor and Shannon (2009). The onshore topography employs the SRTM, 3 arc-second (ca. 90 m) dataset. Ca: Carrauntoohill; Ba: Ballydeenlea; Mb: Mount Brandon; Mw: Mweelrea; Sl: Slieve Snaght; Ph: Porcupine High; Bg: Ballygiblin; Ga: Galtee; Sb: Slieve Bloom; MI: Mount Leinster; Lu: Lugnaquilla; 18/20-1: Number of offshore well.

Preliminary model of transmission loss with slope using Acoustic Toolbox User – Interface and Post Processing (AcTUP)

Crawford, S.¹, Brown, C.¹, McKeown, E.², Stapleton, F.², Fabeta, M.¹, White, M.¹

¹ Earth and Ocean Science, School of Natural Sciences, Ryan Institute, N.U.I, Galway

² RPS Group, Galway, Ireland

The Porcupine Bank was one of the areas identified by the Department of Communications, Energy and Natural Resources as a hotspot for seismic activities to obtain 2D and 3D data (DCENR, 2007). Irish waters, however, are also some of the most important in Europe for a wide range of cetacean species, with a number of dolphin and baleen whale species recorded throughout the year in the IOSEA 2 study area (DCENR, 2007). McCauley *et al.* (2000) document the environmental implications of marine seismic surveys, highlighting alarmed and avoidance behaviour in several marine species as a common response to air gun signals while the European Commission has reported physiological effects and in some cases death (European Commission, 2010). The acoustic monitoring and mapping of areas of interest has been targeted as a research priority under the Marine Strategy Framework Directive (MSFD) by Task Group 11 (European Commission, 2010) as such research is essential for designing and implementing appropriate regulation. Here, the capabilities of the acoustic model RAMSGeo, available in the Acoustic Toolbox User Interface, were tested with preliminary, idealised bathymetry datasets to roughly gauge the range in transmission loss outputs across a range-dependent depth. Variation in transmission loss magnitude and pattern were observed across the 30km range with different slopes. The sound also appears channelled from the source vertically downwards to the seabed with transmission loss increasing conically with depth. Later stages of the project will involve further testing of the model's range-dependent capabilities with more realistic bathymetry files. Range-dependent water column data and sea-floor compositional attributes will be introduced to the model and the model's output will be validated with measured acoustic data.

Acknowledgements

We are grateful to RPS for the use of acoustic recorders, to the crew of the RV Celtic Voyager for assistance and support, to Polarcus for collaboration and sharing of data (such as real-time positional data) and to Curtin University for making accessible the AcTUP V2.21 software and user guide.

Sinéad Crawford's research is funded by the Petroleum Infrastructure Programme (PIP).

Reservoir connectivity and overpressure – Sable and Porcupine Basins

Dickson, C.¹, Wach, G.¹

¹ *Basin and Reservoir Lab, Dalhousie University, Halifax, Nova Scotia*

Overpressure has been identified as a serious risk element in several offshore basins worldwide including the Sable Basin (Nova Scotia), the Jeanne d'Arc Basin (Newfoundland) and the Porcupine Basin (Ireland). Overpressure may form through several mechanisms: undercompaction (rapid sedimentation), hydrocarbon generation, and clay-mineral phase change. It is expected that multiple mechanisms are occurring simultaneously or in series. Increased understanding of the context and contributing factors to overpressure can allow for increase safety for personnel and environment; optimise drilling through pressure control, mud program design, and well construction; and improve formation evaluation with fluid identification and production, reserves estimation, free-fluid level determination, compartmentalisation, reservoir pressure management, and mapping of pressure gradients. Overpressure is beneficial for resource development and production as it provides a natural lift-mechanism, eliminating the need for artificial help (i.e. nitrogen). This study uses Petrel™ and Techlog™ to complete a reservoir connectivity analysis, integrating stratigraphic, structural and pressure data into three-dimensional geometric models.

The Sable Basin is located within the Scotian Basin, and comprises Mesozoic and Cenozoic sediments overlying a Paleozoic basement, forming a structurally complex basin that contains ridges, platforms, carbonate banks, and sub-basins. Petroleum exploration in offshore Nova Scotia began in 1959, and to date includes 207 wells, meaning the basin is underexplored and can be data-challenged to complete analyses. Initial overpressure studies in the region initially focused on describing the location, magnitude, and depth of overpressure. With increased interest in the basin, several newer wells have been drilled and more seismic (three-dimensional) have been acquired, providing fresh additional data for this project.

The Porcupine Basin is a north-south trending basin, and comprises Mesozoic and Cenozoic sediments overlying a Paleozoic basement, similar to the Sable Basin. The Irish continental margin comprises a series of basins including the Porcupine, Rockall, Slyne, and Erris basins. These basins contain a preserved record of structural and stratigraphic episodes previous to and during the rifting and formation of the North Atlantic Ocean. The Porcupine Basin is also undergoing increased interest in offshore petroleum resources; therefore an improved understanding of overpressure will assist in future development of these resources.

Preliminary results are available from the Sable Basin with several important observations:

- overpressure does not appear to correlate with specific formations, burial depth, or temperature
- measurements recorded in wireline logs through overlying shales above sandstone reservoirs can be unrepresentative and do not indicate overpressure in the reservoir below
- pressure-depth plots demonstrate clustering of values, suggesting multiple pressure cells within a main reservoir

- the irregular behavior of overpressure suggests that the faults present throughout the basin are both static and dynamic barriers, leading to reservoir compartmentalisation

This project would like to acknowledge the generous funding and data from the following: Canada-Nova Scotia Offshore Petroleum Board, ExxonMobil Canada Properties Limited, Husky Energy Incorporated, Imperial Oil, Petroleum Infrastructure Programme (PIP), Petrocan (now part of Suncor Energy), Sable Offshore Energy Incorporated, Shell Canada Limited, and Texaco Limited (now part of Chevron Corporation).

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Downtime assessment for facilities offshore of Ireland - DAFOIL

Evans, I.¹, Lewis, T.¹, Alcorn, R.¹, Borthwick, A.²

¹ *Hydraulic and Maritime Research Centre, University College Cork*

² *University of Edinburgh (External Supervisor)*

Introduction

To exploit the offshore oil and gas reserves off the west coast of Ireland, the offshore industry must have confidence that its facilities, particularly ship-shaped facilities in deep water, can operate safely. Wave climate statistics have to be accurately assessed, especially for the likelihood of extreme water crest elevations and also the distribution of weather windows. These impact directly on the assessment of facilities' downtime periods. This proposal has arisen from discussions with Providence Resources and will build on the findings of a previous PIP Report, "Cost Effective Field Development Study for Atlantic-Ireland Basins", Challenge Energy (2009)¹ which emphasised the need for facilities' downtime analysis. The project is funded by the Petroleum Infrastructure Programme (PIP).

Aim and Objectives

The aim is to develop a validated methodology for the assessment of facilities downtime, applicable to oil and gas fields offshore Ireland.

The objectives are:

- To collate, archive, and interpret existing wave data from buoys in the Atlantic to the west of Ireland in terms of event statistics.
- To undertake physical wave model tests creating long simulations of irregular waves from which extreme events can be extracted, in order to validate the theory and to investigate facility response.
- To develop a wave climate model of the North Atlantic including regions overlapping oil and gas fields discovered off the west of Ireland.
- To determine parameters and limits by which facilities downtime can be assessed.
- To develop risk assessment tools.

Benefits

The offshore oil and gas industry would gain valuable insight into the expected temporal changes to sea states and facility responses over different time windows, allowing downtime periods to be predicted. The work would lead to improved confidence in the operability of maritime facilities in the deep water Atlantic, west of Ireland. It would also be possible to make rational decisions as to what levels of risk are tolerable to or affordable for high value maritime assets by integrating models for wave environment, system response, failure characteristics and consequences. The outputs will also contribute to the design methodology for maritime facilities offshore of Ireland. A coherent database of validated wave data would also result from this work.

Data

The Fugro metocean study (Fugro GEOS, 2001) used data up to 1999 from two of the K Buoys around Ireland. UCC has access to longer time series until 2008 from the K Buoys. We also have data from 2003 supplied by the Marine Institute M Buoy Data network, part of which overlaps the K Buoy data and is useful for validation purposes. The new M Buoys however show the extreme and directional data. We also have access to data from the newly installed wave measurement system at the Wave Energy Test Site in Belmullet since 2010 at 50m and 100m depths. Taken overall, we have a high quality, long duration data set for evaluation purposes. We also have access to the SWAN North Atlantic model outputs produced operationally by the Marine Institute since 2009.

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* Publication is not a public document

Geology of the 5/22-1 exploration well, Rockall Trough, offshore NW Ireland: The role of break-up magmatism on trap development

Jackson, C.¹, Magee, C.¹

¹ Basins research Group (BRG), Imperial College, Prince Consort Road, London, SW7 2BP

c.jackson@imperial.ac.uk

Magmatism is common during the break-up of continents, resulting from decompression melting of hot asthenospheric mantle that upwells beneath areas of stretched and thinned lithosphere. Intrusive and extrusive igneous bodies are thus common along many petroliferous continental margins and traditionally viewed as having a negative impact on petroleum system development. However, this negative outlook may be unfounded because there are relatively few case studies that document the geology of exploration wells in areas of breakup-related magmatism. The true risks associated with exploration along volcanically influenced passive margins are thus poorly constrained. In this paper we document the geology of well 5/22-1 (Errigal prospect), which is located in exploration licence PEL 6/97, NE Rockall Trough, offshore western Ireland. This well was drilled by Enterprise Energy Island Ltd and partners in 2001. The aim of the well was to test a large (c. 70 km²) structural (four-way dip) closure situated c. 42 km NNW of the Dooish discovery well (12/2-1), which was drilled in 2003 and was the first commercial discovery in this part of the of the basin. Well 5/22-1 took 26 days to drill to a total depth of 4070 m, in water depths >1500 m. The primary and secondary objectives were Upper and Lower Palaeocene deep-water sandstones, respectively, sealed by latest Palaeocene and Eocene shales, and underlain by an extensive, continental break-up related, igneous sill-complex; igneous features such as these are common along this volcanically-influenced margin. Oil was predicted to be the main hydrocarbon phase, sourced from marine shales in the Lower Jurassic (pre-rift) or Upper Jurassic (syn-rift) successions. The well reached Upper Cretaceous rocks and, despite penetrating a sandstone-bearing Palaeocene sequence, was plugged and abandoned as a dry hole, with only very minor traces of hydrocarbons being recorded in the target interval. The Errigal well thus cast doubt on the prospectivity of this part of the basin and, one may argue, the entire western Irish continental margin in general. To the best of our knowledge, the origin of the trap, and the role of break-up magmatism in the failure of this well, has never been examined. In this presentation we use 3D seismic reflection and borehole data to investigate the geology of the 5/22-1 exploration well, with a particular focus on the positive and negative role of break-up magmatism had, and may continue to have, on prospectivity along this deep-water margin.

Geochemical analysis of gas seepage features in Bantry Bay

Jordan, S.¹

¹ Environmental Researcher, School of Chemical Sciences, Dublin City University

Seismic signatures indicative of gas seepage within Bantry Bay prompted the geochemical analysis of gas and porewater samples obtained from vibrocores taken at the areas of interest. Analysis of gas samples by gas chromatography – flame ionization detection (GC-FID) confirmed methane as the source of the acoustic signatures. Trace levels of C₂ – C₄ hydrocarbons indicate a biogenic source. Analysis of sulphate and sulphide from porewater samples indicates that anaerobic oxidation of methane (AOM) results in the consumption of gas within the sediment column leaving little or no release to the water column, which agrees with geophysical data. Microbial ecology and lipid biomarker investigations in the future will aim to identify the bacteria and archaea involved in these processes.

Establishing provenance links between onshore and offshore sedimentary basins of southern Ireland: A detrital mica and zircon isotopic study

Kerrison, A.¹, Fairy, B.¹, Meere, P.¹, Mulchrone, K.²

¹ School of BEES, University College Cork, Distillery Fields, North Mall, Cork, Ireland

² School of Mathematical Sciences, Western Gateway Building, Western Road, University College Cork

Understanding the geological history of sedimentary basins is fundamental to improving exploration models for oil and gas. A key part of this history is determining the source of basin fill. In the case of the North Celtic Sea and South Porcupine Basins, it is postulated that the basin fill may consist of reworked sediment from the Upper Palaeozoic Dingle and Munster basins, therefore representing a minimum of two sedimentary cycles. Geochronological and thermochronological techniques are useful in assessing sediment source-to-sink routes, recycling events and help further constrain depositional ages of strata.

This study aims to establish the source of offshore basin fill in the Mesozoic South Porcupine, North Celtic Sea and Fastnet basins; providing a tectonostratigraphic model aimed at assisting hydrocarbon exploration strategies. Field and offshore well samples from specific age intervals across the Dingle, Munster, South Porcupine, North Celtic Sea and Fastnet basins have been collected and processed for mineral separation and analysis. This work augments existing data by expanding onshore detrital mica and zircon geochronology data sets to offshore basins. The hypothesis that the Dingle and Munster Basins were acting as a sediment source for the South Porcupine, North Celtic Sea and Fastnet basins is to be tested. Deposition into these offshore basins may represent the final stage of 'triple distilled' sediment recycling associated with the Caledonian, Acadian and Variscan Orogenies.

Acknowledgement: This project is funded by the Petroleum Infrastructure Programme (PIP).

Geodynamic assessment of maturation in the Irish Offshore (GAMIO)

Bonté, D.^{1,2}, Lavelle, C.¹, Pasquali, R.¹, van Wees, J.D.^{1,3}

¹ GeoServ, Dublin, Ireland

² Utrecht University, Utrecht, The Netherlands

³ TNO, Utrecht, The Netherlands

Introduction

The basins of the Atlantic Margin in Northern Europe extend from Norway to southern Ireland.

The inner basins of the Irish Atlantic margin have complex histories with phases of inversion (Corcoran and Clayton, 2001). The timing of these basin inversions has controlled to some extent the accumulation of gas resources. In some of the Norwegian Atlantic Margin basins, magmatic underplating has been observed to influence maturation (Wangen et al., 2011 and Fjeldskaar et al., 2003). In the Irish Atlantic Margin, there is ample evidence of magmatic activity on a number of scales.

The GAMIO project aims to understand the impact of geodynamic variations and magmatism on maturation by assessing the geodynamic evolution of the inner basins on the Irish Atlantic Margin (Porcupine, Erris and Slyne) at the lithospheric scale by means of tectonic heat flow modelling.

The inner basins of the North European Atlantic Margin

The opening of the North Atlantic involves multiphase rifting, culminating in Early Eocene crustal separation of Greenland and Europe. The result of this opening is a North West European continental

shelf 300-500 km wide with a complex structure composed of several basins developed from late Paleozoic to Cenozoic. The basins can be divided into two groups (see poster, Figure 1). The inner basins of Jurassic age include the Erris and Slyne Troughs and the larger Porcupine Basin in the Irish Margin and the Halten Terrace and Viking Graben in the Norwegian Margin. The Porcupine Basin has a length of c. 250 km and a width of up to 65 km. Its crustal thickness varies, and is thinnest in the south, where it is c.6-8 km (Readman et al., 2005). There are up to 10 km of preserved sediments in other areas (Shannon & Naylor, 1998). The Erris and Slyne Troughs are 'perched' basins with an average crustal thickness for their inner position of c. 20-25 km. The sediment thickness in both is c. 3-4 km.

Magmatism in the Atlantic Margin

Igneous bodies occur as lava flows, sills, dykes, igneous centres and stocks, through much of the Atlantic Margin region. In the basins of the Irish Atlantic Margin, two major magmatic elements can be observed: sills on one side and deep large-scale intrusion on the other. The dissemination of the sills is quite extensive and relates to the Porcupine and Slyne basins as well as the eastern edge of the Rockall Trough (Fernandes, 2011). The emplacement of these sills has been constrained to the Paleocene and Eocene. The thickness of the sills range between 50–300m and transgress an average of 500 m in the Porcupine Basin and 1300 m in the Slyne-Erris. The Porcupine Median Volcanic Ridge (PMVR) is a large buried extrusion beneath Early Cretaceous sediments; it has a thickness of 2 to 5.2 km, a length of 80 km and a width of 20 km. The origins of the ridge are disputed. Some authors suggest an amagmatic origin, which would have far reaching implications for hydrocarbon maturation (O' Sullivan et al., 2010).

Methodology

The methodology is summarised in Figure 1. In brief, the experimental tectonic subsidence curves and lithospheric parameters from literature are used to produce an inverted tectonic model. This model can be interrogated to yield an estimated heat flow. The heat flow values and VR data are then used together to produce a maturation model. This methodology has been used to the same end by previous authors (van Wees et al., 2009). The forward modelling approach is based on the pure-shear lithospheric thinning model of McKenzie (1978). Thermal transfer in the lithosphere and sediment column is affected by conduction and also radiogenic input. The sediment layers are defined as fractional proportions of eight basic lithologies (sandstone, shale, siltstone, limestone, salt, coal, anhydrite and dolomite).

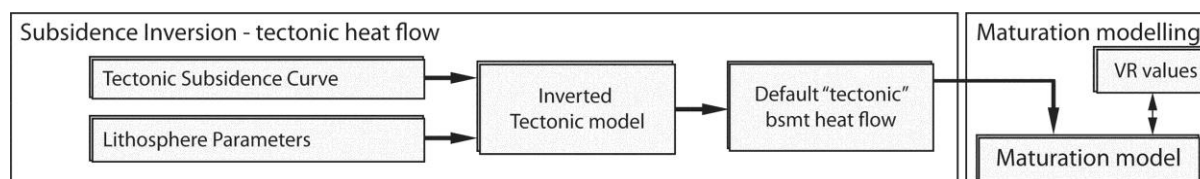


Figure 1. A summary of the workflow. Heat flow is inverse modelled. Heat flow and VR data are then used as inputs to build a maturation model.

Vitrinite reflectance (VR) data for calibration

In order to validate our model some data are required for calibration. The VR values are a product of the maximum temperature and therefore allow comparison with the maximum modelled temperature. The selection of wells for our modelling will be determined by the availability of VR data.

Vitrinite Reflectance data exist from multiple sources for some 29 wells in the Irish Atlantic Margin. These data are to be sourced from original drilling data, research publications and independent reports. The selection of wells to be used is being finalised on the basis of data quality and location.

Table 1 on the project poster lists the wells with VR data. Additional possible VR data sources are currently being considered and may be included in the final data selection process.

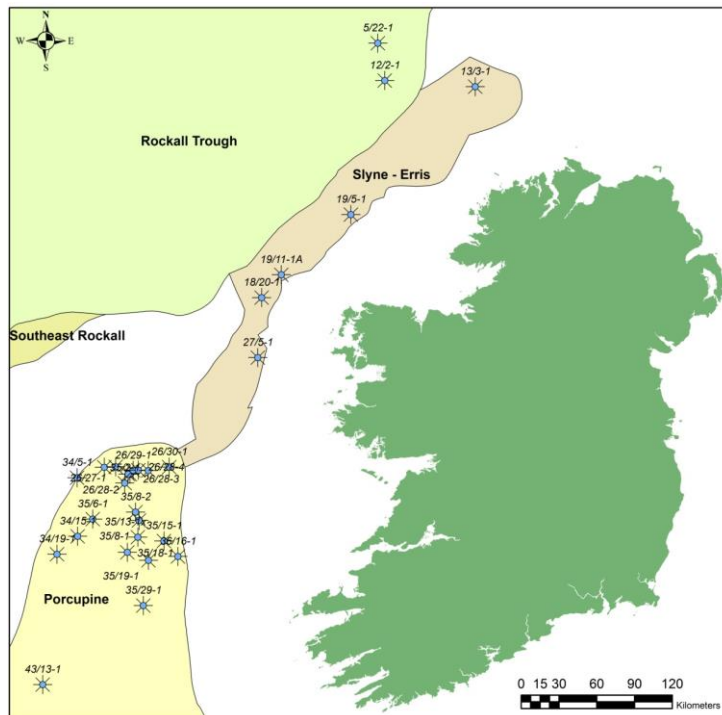


Figure 2. The locations of Irish Atlantic Margin wells for which VR data exist.

This project (IS13/18) is funded by the Petroleum Infrastructure Programme (PIP).

Diachronous sub-volcanic intrusion along deep water margins insights from the Irish Rockall Basin

Magee, C.¹, Jackson, C.¹

¹ *Department of Earth Science and Engineering, Imperial College, Prince Consort Road, London, SW7 2BP.*

Magma intrusion within the subsurface is heavily influenced by the pre-existing architecture of the upper crust and, depending on the emplacement mechanisms, may modify basin structure and fluid flow pathways. Seismic reflection data reveal that intrusive networks predominantly consist of interconnected, saucer-shaped sills that are often associated with dome-shaped 'forced' folds generated by intrusion-induced uplift. However, fold growth and the interplay between accompanying ductile and brittle deformation styles remains poorly understood. Here, we use 3D seismic reflection and borehole data from the Irish sector of the Rockall Basin, offshore western Ireland, to quantitatively study eighty-two igneous intrusions that either have saucer-shaped, climbing saucer-shaped, planar transgressive or strata-concordant morphologies. Overlying these intrusions are a series of broad, domal-folds (>20 km diameter) onto which smaller, 'parasitic', monoclinical and domal-folds (~5 km diameter) are superimposed. Preliminary results suggest that these are forced folds that formed to accommodate the emplacement of the underlying igneous intrusions. We show that emplacement depth below the palaeoseabed and vertical stacking of the sills strongly influences forced fold development. Furthermore, it is apparent that laterally adjacent folds interfere with each other to modify fold geometries and produce a broader dome-shaped fold. A key observation is that many forced folds show little evidence for the development of contemporaneous, outer arc extension-related, normal faulting, which is often observed on forced fold crests. We suggest that the lack of faulting indicates that several other mechanisms, such as layer-parallel slip and porosity reduction, may have acted to provide space for the intrusion volume. This study has important implications to our understanding of the impact of igneous intrusions on petroleum system development.

Thermal Maturity of the Carboniferous onshore basins in Ireland and its impact on carbon dioxide storage and methane recovery

Mancinelli, L.¹, Clayton, G.¹, Goodhue, R.¹, Eble, C.², Fernandes, P.³, Burden, E.⁴

¹ *Trinity College, University of Dublin, Ireland*

² *Kentucky Geological Survey, Lexington, Kentucky, USA*

³ *University of the Algarve, Faro, Portugal*

⁴ *Memorial University of Newfoundland, St Johns, Newfoundland, Canada*

Concerns that global climate change is linked to increased anthropogenic sourced carbon dioxide (CO₂) are driving research on different technologies to reduce atmospheric CO₂ emissions. At present, geological CO₂ sequestration options include CO₂ injection into saline aquifers, CO₂-EOR, CO₂-ECBM and many others. One option for storage and enhanced gas recovery may be by injection into organic-rich shales, in which the CO₂ is preferentially adsorbed, displacing methane. Factors that influence effective CO₂ injection and storage in the Carboniferous black shales of the Clare and Dublin Basins of Ireland have been assessed. Carboniferous black shales were collected from several locations in these basins and their thermal maturity determined by vitrinite reflectance and Rock-Eval pyrolysis. Total organic carbon and CO₂ adsorption were also determined for selected samples. Three new maturity maps for the Base Carboniferous, Base Viséan and the Base Westphalian were constructed for Ireland, integrating new and existing data. These maps together with the analytical results delimit potential for both carbon dioxide storage and shale gas in the Dublin and Clare basins.

Decision Support for Oil-Spills (DSOS)

McCarthy T.¹

¹ *National Centre for Geocomputation, Maynooth University, Maynooth, Co Kildare.*

Marine petroleum affects the environment, economy, and quality of life for coastal inhabitants leading to concerns that include resource exploration, recovery, transportation, and resultant oil spill contingency planning, mitigation, and remediation (Jensen et al., 1990). Oil spills have, for many decades, been a significant environmental risk within marine environment worldwide. In recent years we have seen vast improvements in safety standards leading to decreases in the number of accidents worldwide. Accidental oil spills such as the Deepwater Horizon incident in 2010 remind us of the dramatic impacts that oil can have on the environment. These events also remind us of the importance of efficient emergency planning & response management. Oil spills pose serious threats to the marine environment and place a lot of pressure on the entities that are responsible for the emergency response and clean-up operations, such as Oil companies and national authorities. Geospatial technologies such as Remote Sensing and GeoInformatics play an important role in helping collate, analyse and visualise information in order to make good decisions when managing offshore oil-spills.

The main aim of this project is to develop a prototype geospatial decision support platform to provide more effective information management when responding to oil-pollution incidents in the marine environment

- Design, construction of a novel spatial decision support platform for handling oils-spills in marine environments
- Evaluation of platform under real world conditions (carried out in conjunction with PIP partners, SmartBay & SEA-PT oil-spill exercise on West coast of Ireland)
- Assessment of new real-time sensor technologies including Remote Sensing satellites (e.g. Sentinel), low-altitude UAVs and In-Situ sensor networks

The core research activity comprises designing, building and assessing a self-organising, cloud-based geoinformatics platform architecture, based around the *Common Operational Picture* model. This platform will be used to host an online oil-spill incident response instance that can be accessed by coordinators, responders and observers alike whether in the command centre or out in the field.

- Assessment of integrated spaceborne and latest unmanned aircraft systems (UAS) platforms for acquiring relevant Remotely Sensed data
- Automated response team formation, tracking and coordination
- Rapid collation and presentation of relevant geospatial datasets
- Real-time analytics reporting on hazards, exposure & vulnerability
- Alert, Tasking, Observation and Resource management
- Comprehensive recording of entire incident from initial alert, to assessment through to recovery for post-event analysis
- Secure access control from computer, tablets and SmartPhone devices
- In-depth assessment of the platform through real-world exercises and testing in 2015

The expected outcomes of this project include developing a powerful prototype scalable platform to develop novel emergency response methodologies, carry out scenario simulation and train personnel. This prototype platform will, in turn, help build and integrate the offshore O&G industry's operational capability for emergency preparedness and response.

Multichannel Analysis of Surface Waves (MASW) For Offshore Geotechnical Investigations

McGrath, T.¹, O'Connor, P.², Trafford, A.², Long, M.¹

¹ *School of Civil, Structural & Environmental Engineering, University College Dublin*

² *APEX Geoservices Limited, Knockmullen Business Park, Gorey, Wexford, Ireland*

There are a significant number of organisations in the petroleum industry looking to construct relevant infrastructure in marine environments, such as oil platforms or pipelines. However determining the soil properties in these environments can be both time consuming and very expensive. As such there is a necessity to establish techniques which can facilitate surveying these environments.

An important property, for geotechnical and environmental characterisation of subsurface materials, is seismic shear wave (S-wave) velocity. Multichannel Analysis of Surface Waves (MASW) is a non-invasive geophysical survey technique used for the estimation of this characteristic. It is adapted from Spectral Analysis of Surface Waves and analyses the dispersive nature of surface waves and then an inversion creates a vertical S-wave velocity profile.

The overall objective of this collaborative project is to study the feasibility of using MASW to determine the small strain shear modulus of shallow marine subsurface layers. MASW results have been shown to agree with borehole measurements to within 15% using fundamental mode Rayleigh wave (Xia et al., 2002). As such it is intended to perform a number of surveys in marine environments, acquire data and then to compare this with the borehole measurements previously recorded.

For the first stage of this project, the chosen site is Dublin Bay as it has a wide variety of soil types and properties which will allow for a comprehensive test of the technique. Also there is good geotechnical information from boreholes drilled by Fugro and CDM (Ireland) Ltd., which can be used for comparison. The R.V. Keary (INFOMAR) will be used to access the sites and will aid in the deployment of a bay cable and pneumatic source, as required to acquire the necessary data.

This work is part of an MEngSc research project funded by the Petroleum Infrastructure Programme (PIP).

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Comparing shear-wave velocity profiles inverted from multichannel surface wave with borehole measurement
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The occurrence of PAHs and Faecal Sterols in Dublin Bay and their influence on sedimentary microbial communities

Murphy, B.T.¹, O'Reilly, S.S.¹, Reid, B.F.¹, Monteys, X.², Jordan, S.F.¹, Allen, C.³, McCaul, M.V.¹, Szpak, M.T.¹, Kelleher, B.P.¹

¹*School of Chemical Sciences, Dublin City University, Glasnevin, Dublin 9, Ireland*

²*Geological Survey of Ireland, Beggars Bush, Haddington Rd, Dublin 4, Ireland*

³*School of Biological Sciences, Queens University Belfast, Medical Biology Centre, Lisburn Rd, Belfast, N. Ireland*

Pollutants introduced to anthropogenic activities can alter the chemistry and microbiology of coastal marine environments. To assess organic pollution and its effect on microbial communities, sediment samples were collected from 30 stations in Dublin Bay aboard the R.V. Celtic Voyager (CV10_28). The potential impact of sewage discharge and polyaromatic hydrocarbons (PAHs) on sedimentary microbial populations was assessed using phospholipid fatty acids (PLFAs) as microbial biomarkers. Faecal sterols are used as indicators for sewage contamination in the Bay. The impact of particle size, %TOC, %H and %N were also considered. Faecal sterols were found to be highest around Howth Head and Dun Laoghaire and this is consistent with historical point sources of sewage discharge. PAH distribution were more strongly associated with areas of deposition containing a high %silt and %clay content, suggesting PAHs are from diffuse sources such as rainwater run-off and atmospheric deposition. The PAHs ranged from 12 to 3072 ng/g, with 11 stations exceeding the suggested effect range low (ERL) for PAHs in marine sediment's. PAH isomer pair ratios and sterol ratios were also used to determine the sources and extent of pollution. PLFA profiles confirmed that sedimentary microbial communities varied from station to station. PLFAs were not impacted by sediment type or depth but were strongly correlated to, and influenced by PAH and sewage levels. Certain biomarkers such as 10Me16:0, *i*17:0 and *a*17:0 were closely associated with PAH polluted sediments, while 16:1 ω 9, 16:1 ω 7c, Cy17:0, 18:1 ω 6, *i*16:0 and 15:0 all have strong positive correlations with faecal sterols.

Integrated geophysical and geological studies in the Porcupine Basin

O'Reilly, B.¹, Minshull, T.², Reston, T.³, Shannon, P.⁴, Lebedev, S.¹, Prada, M.^{1,2}, Watremaz, L.^{1,2}

¹*Geophysics Section, Dublin Institute for Advanced Studies*

²*National Oceanography Centre Southampton, University of Southampton*

³*Geosystems Research Group, School of Geography, Earth and Environmental Sciences, University of Birmingham*

⁴*Marine and Petroleum Geology Research Group. UCD School of Geological Sciences*

A new research project will investigate and re-evaluate the crustal structure of the Porcupine Basin using wide-angle seismic data not hitherto comprehensively analysed. The Porcupine Basin is a good sedimentary basin to investigate the processes involved in hyperextension within the North Atlantic region, where the crust becomes severely thinned during basin formation. Crustal-scale tectonic processes that lead to hyperextension are poorly understood, but are important in controlling deep-water petroleum systems. The Porcupine Basin, which is part of the frontier petroleum exploration province west of Ireland, may provide important insights into these processes because the degree of extension is known to vary dramatically from north to south in the basin. This project will resolve variations in crustal geometry and seismic properties along the basin axis and towards mainland Ireland. The project will determine the stratigraphic response to varying amounts of tectonic extension and its potential impact on petroleum systems. An integrated crustal model for the region will be produced (including gravity, magnetic and seismic stratigraphic data from industry and government sources).

The project will also provide new insights into the formation and thermal history of the Porcupine Basin as an analogue for failed and successful rifts elsewhere. It will help stimulate further exploration activity in the basin by providing a better understanding of how hyperextension evolves in the continental lithosphere. This Project began in September 2014 and is funded by the Irish Shelf Programme Studies Group (ISPSG) of the Petroleum Infrastructure Programme (PIP).

Providing a baseline for BACI design seabed monitoring and classification programmes

Patterson, A.¹, Allcock, L.¹, Johnson, M.¹

¹ *School of Natural Sciences, Ryan Institute, NUI Galway*

The increased interest in exploiting Ireland's off-shore petroleum resources requires the ability of environmental managers to predict and monitor potential impacts of exploration activities. The assessment of ecological changes in the marine environment has been the function of monitoring programmes which focus on fluctuations in water quality, sedimentary habitat and macrofaunal communities. Because benthic macrofaunal communities are usually sedentary at the sediment water interface they have to tolerate prevailing local conditions in the area of the sediment where many sources of stress accumulate. Macrofaunal community structures are considered to follow predictable patterns along gradients of organic and physical disturbance. The use of macrofaunal community structure as an indicator of benthic habitat quality persists as the central focus of most monitoring programmes.

Following a disturbance event, sediments become defaunated which frees up space for recolonisation. Following this initial disturbance, space is first occupied by shallow burrowing, small bodied, fast growing, stress tolerant, opportunist species. These occur in high densities but are poor competitors for resources. This situation is followed by a transitional stage where the burrowing activity of opportunistic species oxygenates the sediment sufficiently to allow for some free-living species and larger tube dwelling species to occupy the sediment. These species are typically subsurface deposit feeders which act to depress the depth of the redox potential discontinuity. The final stage is characterised by diverse communities, dominated by more deeply burrowing, larger bodied, longer lived, stress intolerant species which are good competitors for resources.

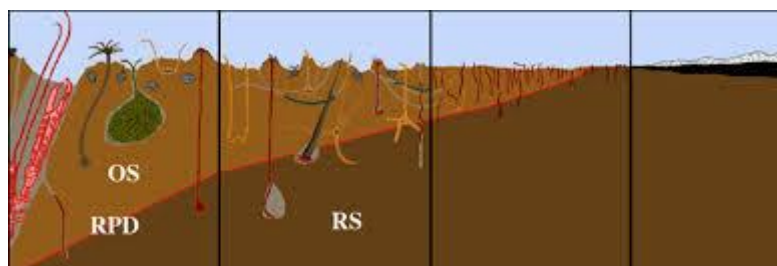
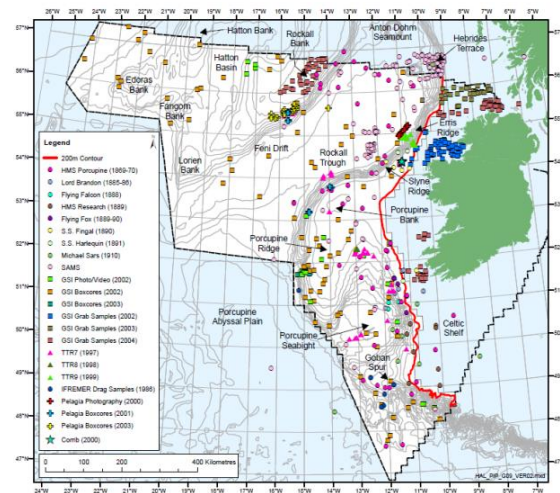


Image 1: Successional paradigm for the recovery of soft bottom communities following disturbance (Nilsson & Rosenberg, 1997).

Surveys employing the Before-After-Control-Impact (BACI) design are commonly used to monitor potential environmental impacts. The basis of such monitoring programmes relies on the environmental manager having a baseline against which impacts can be measured. This Petroleum Infrastructure Programme funded project will attempt to provide such a baseline using existing benthic data collected from the Irish Atlantic Margin and a cruise planned for October 2014 to the Porcupine Bank.

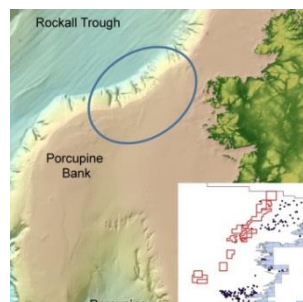
ATLANTIC IRELAND 2014

Much of the data collected thus far (Map 1) consists of unreplicated grab and core samples, dredges and trawls. Dredges and trawls are of limited use as they are generally non-quantitative and are not designed to sample the macrobenthos. The unreplicated grab and core samples are of more use as they are quantitative, however the lack of replication means they are not suitable for BACI style monitoring programmes. To compensate for these short-comings, it is proposed to use this historic data to create habitat maps of the Atlantic Margin based on EUNIS habitat classifications. The data from the grab and core samples will also be used to determine ecological status on the soft sea floor. Using the wealth of data on the structure of sediments, it is proposed to model macrofauna distributions with sediment type as a predictor.



Map 1: Map from “Report to the Irish Shelf Petroleum Studies Group Project IS03/21” outlining the distribution of benthic samples taken along the Atlantic Margin.

A cruise in October 2014 will undertake an intensive replicated sampling design survey of the soft sediments of the northeast Porcupine Bank (Map 2). The data collected on this cruise will provide the first replicated BACI style baseline for the Atlantic Margin and will serve as a model on which future ecological surveys will be based.



Map 2: Survey area of the October 2014 cruise to commence replicated sampling design survey on the Atlantic Margin.

Spatial and Temporal Understanding of Hydrocarbon Generation in the Irish Atlantic Margin

Porter, S.¹, Finlay, A.¹, Roach, C.¹, Harding, A.²

¹ *Chemostrat Ltd., 1 Ravenscroft Court, Buttington Cross Enterprise Park, Welshpool, Powys, UK.*

² *Atlantic Petroleum UK Ltd., 26/28 Hammersmith Grove, London, UK.*

To maximise our knowledge of subsurface petroleum systems it is imperative that we have a thorough understanding of the two key components: the hydrocarbon-generating source rock and the associated hydrocarbons. Understanding the chemical composition of petroleum source rocks and their associated oils provides critical information regarding the temporal and spatial controls on the formation of hydrocarbon deposits. Further, direct radiometric dating of hydrocarbons yields the timing of oil generation and so provides a robust temporal constraint on the timing of oil formation and migration within the petroleum system. Through the application of rhenium-osmium (Re-Os) geochronology and trace element geochemistry, this work produces a new model for oil generation across the IAM which constrains the timing of oil generation and aims to identify the dominant source units within the petroleum system.

Rhenium-osmium geochronology exploits the β decay of ^{187}Re to ^{187}Os . This decay system provides a useful chronometer and tracer tool, as both elements are highly enriched in organic-rich sedimentary units relative to upper continental crust, due to their organophilic nature. This enrichment likely occurs through the sequestration of Re and Os from the water column during sedimentation and under oxygen-limited conditions. The Re-Os geochronometer can also be used to directly date hydrocarbon deposits, thus constraining the timing of oil generation. This is due to the transferral of Re and Os from the source rock to the generated oil at the time of source rock maturation.

Preliminary Re-Os geochronology for a suite of IAM oils provides an age of 129 ± 23 Ma, indicating that at least one phase of oil generation in the IAM occurred in the Early Cretaceous. In addition, the Re-Os dataset not only shows that there is a strong possibility of oil mixing in the Porcupine Basin, but it enables us to resolve out these oil mixing events.

Trace element geochemistry has also been used to characterise this suite of oils. Considerable variation is observed between the trace element compositions of the different oil samples and the use of select trace element ratios indicates the presence of several distinct oil populations in the IAM. In accordance with the Re-Os dataset, this trace element work also demonstrates the likelihood of mixing of multiple oil populations in the Porcupine Basin. This data has been directly compared to trace element datasets for potential source rock units from several wells from the Porcupine Basin. Whilst there is strong compositional similarity between all of these potential source rock units, there are distinct differences between these units and the oils analysed. This may suggest that either: the source rock is not present in the wells analysed; the source unit has not been sampled in these wells; or only the thermally immature equivalent of the source has been analysed.

This work presents data and survey results acquired during a project undertaken on behalf of the Irish Shelf Petroleum Studies Group (ISPSG) of the Irish Petroleum Infrastructure Programme Group 4. The ISPSG comprises: Atlantic Petroleum (Ireland) Ltd, Cairn Energy Plc, Chrysaor E&P Ireland Ltd, Chevron North Sea Limited, ENI Ireland BV, ExxonMobil E&P Ireland (Offshore) Ltd., Husky Energy, Kosmos Energy LLC, Maersk Oil North Sea UK Ltd, Petroleum Affairs Division of the Department of Communications, Energy and Natural Resources, Providence Resources Plc, Repsol Exploración SA, San Leon Energy Plc, Serica Energy Plc, Shell E&P Ireland Ltd, Sosina Exploration Ltd.

Preliminary results from an integrated chemostratigraphic and biostratigraphic study carried out on the Cretaceous and Jurassic strata within the Porcupine Basin

Roach, C.¹, Butler, N.², Finlay, A.¹, Porter, S.¹, Harding, A.³, Pearce, T.¹

¹*Chemostrat Ltd, 1 Ravenscroft Court, Buttington Cross Enterprise Park, Welshpool, Powys, SY21 8SL, UK*

²*Petrostrat Ltd, Tan-y-Graig, Parc Caer Seion, Conwy, LL32 8FA, UK*

³*Atlantic Petroleum, 26/28 Hammersmith Grove, London, W6 7BA, UK*

The Porcupine Basin, located offshore Western Ireland has a proven hydrocarbon system. Despite this, however, well penetrations are relatively scarce, particularly in the south of the basin. A firm understanding in the correlation of sediments across the area is vital for successful exploration and, whilst seismic acquisition is generally good, the ground-truthing of this data from penetrated sections is critical. Following funding from the Petroleum Infrastructure Programme (PIP) a combined chemostratigraphic and biostratigraphic study has been initiated, with a view of establishing an integrated, basin-wide correlation scheme for the Jurassic and Lower Cretaceous successions. This publication provides initial datasets and interpretations from this on-going study due for completion in 2015.

A full analytical programme, comprising geochemical (ICP-OES and ICP-MS), petrographical, XRD and micro, paly and nanno analysis will be applied to four key wells, namely, 26/28-1, 35/8-2, 35/8-1 and 43/13-1; these wells being chosen for their geographic and stratigraphic coverage. The biostratigraphic data will provide an important chronostratigraphic framework to which the higher resolution chemostratigraphic data can then be tied. The integrated datasets from these type wells will be used as a reference section for a further eight wells within the Porcupine Basin and one well from the adjacent Slyne Basin. These additional wells will be integrated into the correlation framework through the addition of new geochemical data and re-evaluated legacy biostratigraphic data.

Chemostratigraphy involves the characterisation and correlation of sedimentary rock successions based on stratigraphic variations in their inorganic geochemical data. Using this technique, variations in mineralogy, including clay minerals, heavy minerals and lithic components can be identified, which in turn can provide information of changes in palaeoclimate, palaeoenvironment, sediment provenance and any diagenesis or weathering that may have occurred. Geochemical variations have been utilised to provide a robust correlation between chronostratigraphically similar successions encountered across the basin. In addition, however, lateral variations in the chemistry, fossil assemblages and preservation rates will also be assessed to provide important information on palaeoenvironment and sediment dispersal patterns along the basin margin.

The provenance and petrography of Early Tertiary sandstones in the northeast Porcupine Basin

Evans-Young, S.^{1,4}, Shannon, P.M.¹, Tyrell, S.², Naylor, D.³, Daly, J.S.¹

¹UCD School of Geological Sciences, University College Dublin, Belfield, Dublin 4, Ireland

²Earth and Ocean Sciences, National University of Ireland, Galway, Ireland

³Petrel Resources plc, 162 Clontarf Road, Dublin 3, Ireland

⁴Now at: Chemostrat Ltd. 2 Ravenscroft Court, Buttington Cross Enterprise Park, Welshpool, SY21 8SL, Wales

*Corresponding author: sophieevans-young@chemostrat.com

Introduction

The Porcupine Basin, a north-south oriented deep-water basin offshore west of Ireland, is one of the largest sedimentary basins in the North Atlantic (Fig. 1). A thick succession of Cretaceous and Tertiary sediments was deposited in a general thermal subsidence setting, interrupted by periods of minor rifting and regional epeirogenic movements and overprinted by eustatic sea-level changes (Naylor and Shannon, 2011). Exploration wells in the north of the basin have encountered reservoir quality sandstones of Early Tertiary age. However, little is known about the provenance and petrography of these sandstones. Determining the source(s) of the sandstones will allow a more accurate reconstruction of Tertiary palaeogeography, especially ancient drainage system scales and pathways, and will help constrain reservoir sand distribution and quality. Petrographic analyses will contribute towards identification of the potential reservoir quality of sandstones.

Methods

Sampling

An initial review of proprietary composite well log data and petrophysical analysis (provided by Petrel Resources plc.) guided identification of the depths and thicknesses of target reservoir sandstones for sampling. A total of 19 sandstone cuttings samples (provided by the Petroleum Affairs Division of the Irish Department of Communications, Energy and Natural Resources) from the Early-middle Eocene (deltaic and marine strata respectively) and Upper Paleocene intervals were analysed from five wells.

Petrography

The composition of the sandstones was analysed using standard optical petrography, scanning electron microscopy (SEM) - and energy dispersive x-ray spectroscopy (EDS). The proportions of matrix-cement and framework grains were estimated to assess their potential reservoir quality.

Provenance: Pb in K-feldspar

The utility of the Pb isotopic composition of detrital K-feldspars as a provenance tool has been proven in a number of studies. This single-grain geochemical provenance technique was pioneered at University College Dublin (UCD), Ireland, and holds several advantages over similar provenance methods. Its application is appropriate to sandstones in the northeast Porcupine Basin due to its

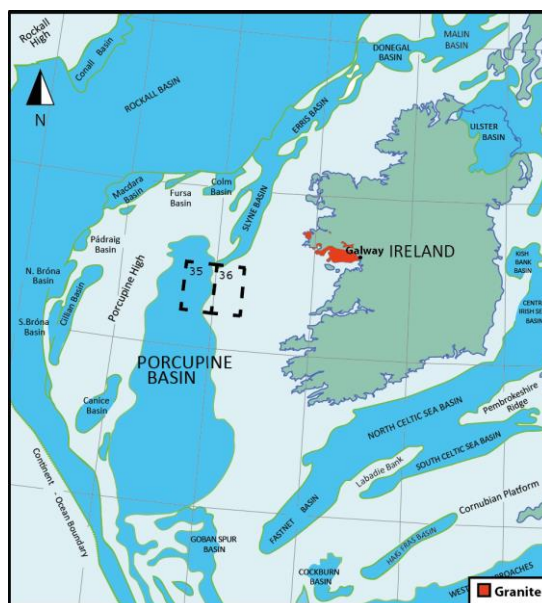


Figure 1: Map location of study area (quadrants 35, 36) in the northeast Porcupine Basin and the Galway granites, onshore Ireland (modified from Naylor and Shannon 2011).

ability to constrain medium to-large-scale drainage systems (Tyrrell et al., 2010; 2012). Feldspar grains are less stable in climates where chemical weathering outstrips mechanical weathering, and its presence is likely to indicate first cycle material, that can be related directly back to the source(s). Feldspars often represent a high proportion of framework grains (<25% in arkoses) and therefore source(s) can be ascribed to a significant proportion of the detrital sediment. In addition, feldspar contains Pb but insignificant uranium and thorium, hence there is negligible radiogenic growth within the crystal and Pb is largely unchanged since crystallisation of the feldspar in the source.

SEM analysis was used to identify and image detrital K-feldspar grains in the targeted sandstones. Pb isotope compositions were subsequently analysed by laser ablation multiple collector inductively coupled plasma mass spectrometry (LA-MC-ICPMS). The Pb isotopic signatures of the detrital feldspars were then compared with K-feldspar compositions from potential basement sources both onshore and offshore with a view to constraining sedimentary provenance.

Significant new Pb data from the Caledonian Galway granites on the west coast of Ireland were also collected via LA-MC-ICPMS, for comparison with detrital K-feldspar analyses. Existing data for the granites were sparse compared to other onshore sources, and systematic sampling of seven granitic plutons in the Galway area was carried out. Granite samples were analysed from the Errisbeg Townland (main), Errisbeg Townland (megacrystic), Roundstone, Carna, Shannaphaesteen, Costello Murvey (main) and Costello Murvey (porphyry) bodies. New data from these plutons helps constrain or exclude these granites as a source of detrital K-feldspar.



Figure 2: Photomicrograph of the Eocene marine sandstones showing Qmu (monocrystalline undulatory quartz), Qp>3 (polycrystalline quartz), Kf ((m) – microcline and (o)- orthoclase) and Ls (sedimentary lithics). Insert focuses on a sedimentary rock fragment.

Results

Petrographic results

Petrographic analysis demonstrates that the Early Tertiary framework grains consist primarily of quartz (both mono- and polycrystalline varieties), feldspar (predominantly K-feldspar) and lithic (igneous and metamorphic) fragments. Fossil fragments are also common and nummulites are abundant in the Eocene marine sandstone units. Diagenetic components include pore-filling calcite cement, glauconite and pyrite. The general mineralogical composition of the sandstones is similar, but their proportions vary both laterally between the wells and with depth in stratigraphic units.

In addition, the results of petrographic studies indicate the dominance of orthoclase in the majority of samples (Fig. 2), with microcline and plagioclase present at some stratigraphic levels. These trends are likely linked to the provenance of the K-feldspars and reflect the compositional nature of their source(s).

Provenance results

Pb isotopic data from detrital K-feldspars reveal three isotopic populations within the Eocene sandstones and two sub-populations, 2a and 2b (Fig. 3). Populations 1, 2 and 3 are major, distinct populations which are consistently present in both marine and deltaic sandstone strata. Two additional sub-populations 2a and 2b occur in the Eocene deltaic sandstones. These are subordinate populations and appear to be related to Population 2.

Population 1 has a Pb composition similar to Proterozoic crystalline basement sources such as the northern part of the Porcupine High, offshore Ireland. Population 2 represents the largest proportion of K-feldspars (75%) analysed and Populations 2, 2a and 2b correspond well with new data from the volumetrically significant Caledonian Galway granites, on the west coast of Ireland. The source of Population 3 is currently uncharacterised; however the Pb signature is similar, yet isotopically distinct, from some granitic plutons in Galway. Pb signatures from Costello Murvey (main and porphyry), Roundstone and Shannaphaesteen granites overlap partly with Populations 2 and 3. However, Population 3 is generally more radiogenic, and the linear trend defined by the data differs from that of the Galway granites.

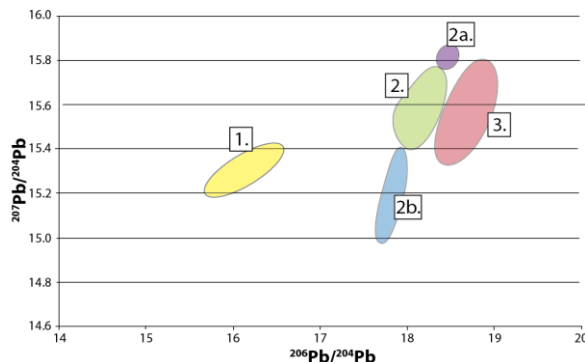


Figure 3: Detrital Pb populations from Tertiary K-feldspars in sandstones, shown on $^{207}\text{Pb}/^{204}\text{Pb}$ vs. $^{206}\text{Pb}/^{204}\text{Pb}$ scale. Several distinct populations (1, 2 and 3) and sub-populations (2a and 2b) are highlighted.

Preliminary data from Paleocene sandstones suggest that these share many of the same sources as the Eocene sandstones, indicating some continuity of sediment supply. However, Population 3 grains have so far not been identified in Paleocene sandstones, and there are indications of additional, as yet unclassified, populations at these levels.

Discussion

Several distinct K-feldspar populations are present in the Eocene sandstone samples and the relative and spatial distribution of these populations in each of the five wells suggests at least two sediment input directions. Previous studies have characterised north-south prograding fan structures in the north of the basin during the Tertiary. It is suggested that sediment generated from the Galway granites onshore in Ireland (Population 2/2a/2b grains) was transported westwards across the shelf to an entry position in the north of the basin, prior to southward dispersal down the basin axis. This dispersal pathway could also account for the presence of Population 1 grains. Interestingly, the higher proportion of Population 3 grains in wells adjacent to the east margin of the basin suggests a local source, and may be indicating derivation laterally into the basin from an as yet uncharacterised crystalline basement source on the continental shelf, east of the study area.

This work is part of an MSc research project funded by Petrel Resources plc.

The SPE Ireland Section

As most of you will be aware, the Society of Petroleum Engineers (SPE) is the largest individual member organisation serving managers, engineers, scientists and other professionals worldwide in the upstream segment of the oil and gas industry. SPE contributes to the upstream profession through its programmes and activities and its dedicated members. It has some 125,000 members, who are affiliated to nearly 200 Sections around the world. The SPE's mission is to collect, disseminate and exchange technical knowledge concerning the upstream industry for members' benefit, and to provide opportunities and resources for professionals to enhance their technical and professional knowledge and meet and engage with other upstream professionals.

There are a significant number of members of the SPE based in Ireland, and a new SPE Ireland section has recently been established with the support of these members. In addition an SPE Student Chapter has been formed at University College Dublin.

The purpose of this e-mail is to see if anyone who is not already a member of the SPE would be interested in joining. Details of how to join can be found on the following link: <http://www.spe.org/join/>

New members can expect to benefit from three formal SPE Ireland meetings each year, as well as informal drinks and networking evenings. New members will be invited to attend an informal drinks and networking meeting in a Dublin City Centre pub on Thursday 13th November 2014, to meet the SPE Ireland board and the other members of the SPE Ireland section. The SPE Ireland section formal opening meeting is planned to take place in late January 2015 in Dublin, at which a senior government figure and a prominent distinguished oil industry figure will speak alongside the SPE President.

We are looking for as many new interested members as possible so as to make the Irish Section of the SPE as successful as possible – it is an exciting time in the oil and gas sector in Ireland and we hope that the SPE will play an important part in its future development.

Please pass this letter onwards to anyone you feel may be interested in joining the SPE Ireland section, and feel free to contact us should you have any questions.

With kind regards,

Donal & Richard

SPE Ireland Membership Chairpersons

September 2014

Donal Meehan: dmeehan@providenceresources.com

Richard Vernon: rvernon@slrconsulting.com

SPE Ireland Section Board Membership and Responsibilities:

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SPE Website: www.spe.org

Mathematica code for Quantitative Characterisation of Sedimentary Grains

Tunwal M.^{1,2}, Mulchrone K.F.², Meere P.A.¹

¹*School of BEES, UCC, Distillery Fields, North Mall, Cork*

²*Department of Applied Mathematics, UCC, Western Gateway Building, Western Road, Cork*

A modular suite of code written in the Mathematica environment for quantitative characterisation of sedimentary grains is presented. A semi-automatic method is introduced for textural analysis of siliciclastic sedimentary rocks using information obtained from thin section images. Fully automatic techniques are likely to succeed using high definition images of rocks exhibiting a clear contrast between matrix and grains. However, such specimens rarely exist in nature. Therefore a semi-automatic approach is proposed here, whereby a human operator identifies grains boundaries and software automatically completes the mathematical analysis of grain shape and related parameters. Grain boundaries are identified by either manual tracing of grains on tracing paper followed digitalization or by direct tracing on a graphics tablet.

Roundness, Angularity, Irregularity, and Circularity are some of the conventional shape parameters available. Fourier Descriptors and Fractal Dimension are less-conventional parameters, possibly due to mathematical complexity and labour intensity, however they are available in this software and provide valuable information on grain morphology. Other common geometric shape parameters such as Aspect Ratio, Convexity, Solidity, Compactness, ModRatio and Rectangularity are not typically utilised but are included for completeness. Along with shape parameters, grain size is also extracted. The Mathematica package is designed for maximum user flexibility and users can choose amongst the available parameters. In future work this software will be applied to a detailed petrographical analysis of sandstones across onshore and offshore Basins of Ireland.

Acknowledgement: This project is funded by the Petroleum Infrastructure Programme (PIP).

Sourcelands, sand provenance and supply to North Atlantic margin basins: An integrated, multi-proxy approach

Tyrrell, S.¹, Barry, A.¹, Sun, K.¹, Chew, D.², Shannon P.M.³, Daly, J.S.³, Cogné, N.², Morton, A.^{4,5}, Sylvester, P.⁶

¹*Earth and Ocean Sciences, School of Natural Sciences, National University of Ireland, Galway, Ireland*

²*Department of Geology, Trinity College Dublin, Dublin 2, Ireland*

³*UCD School of Geological Sciences, University College Dublin, Dublin 4, Ireland*

⁴*HM Research Associates, 2 Clive Road, Balsall Common, West Midlands CV7 7DW, United Kingdom*

⁵*Cambridge Arctic Shelf Programme, University of Cambridge, United Kingdom*

⁶*Department of Geosciences, Texas Tech University, Lubbock, Texas, United States*

The geology of the North Atlantic region comprises underexplored sedimentary basins and poorly-characterised submarine basement highs, reflecting a complex assembly of terranes, multiple cycles of orogenesis and ocean opening/closure. These terranes are bounded by lineaments and sutures which are often well-constrained onshore, extend into the offshore and potentially link across the conjugate margins. Tracing the offshore continuation of such boundaries is clearly important as they define the extent of discrete crustal blocks, while also controlling structural trends, basin evolution and sediment transport pathways during the Mesozoic and Cenozoic.

Recent work has suggested that basement highs in the NE Atlantic Margins strongly influenced the supply of sediment to basins during the Mesozoic (Evans-Young, 2014; Tyrrell et al., 2007, 2010). Their composition, therefore, is a first-order control on the quality and distribution of potential reservoir sandstones in the adjacent Porcupine, Rockall and Slyne-Erris basins. Determining the age and affinity of the pre-Mesozoic rocks offshore western Ireland may allow for improved pre-rift correlation with the eastern conjugate margins, with implications for constraining shared basin histories between the Irish offshore and the Canadian Maritimes.

In order to address these issues a focused programme of research, funded through the Petroleum Infrastructure Programme, based at NUI Galway and in collaboration with researchers in UCD, TCD, Heavy Mineral Research Associates, the Cambridge Arctic Shelf Programme (CASP) and Texas Tech University, began in September 2014. The ultimate aim of this work is to understand the “source to sink” evolution of basins offshore western Ireland and to constrain the distribution and quality of potential reservoir sandstone intervals, with particular focus at Lower Cretaceous levels. This can only be achieved if the nature, palaeoposition and uplift history of potential sourcelands are better understood and delineated; hence there is a clear synergy between the characterisation of offshore basement highs, reconstruction of the pre-rift configuration of the conjugate margins and the assessment of sediment routing and sand dispersal patterns.

This research programme will, for the first time, employ a novel, multi-proxy geochemical approach, combining heavy mineral methods, in-situ analysis of individual sand components, and thermochronological techniques on both economic basement and detrital samples. The analytical methodology is designed such that signals can be interrogated in minerals with contrasting behaviour in the sedimentary environment (e.g. zircon, apatite, feldspar). As well as constraining sediment dispersal into the basins, this approach will provide insight into factors that influence and modify sand composition (e.g. sedimentary recycling, prolonged intermediary storage phases, mechanical versus chemical weathering). The programme is divided into two dovetailing work packages, one focused on **Basement geology of NE Atlantic Margins** and the second on **Cretaceous sand supply to the Porcupine and adjacent basins**. These work packages correspond to two research masters, due to be completed in August 2016.

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Impact on Ireland's hydrocarbon potential of Cenozoic deformation and faulting

Walsh, J.J.¹, Soden, A.M.¹, Childs, C.¹, Manzocchi, T.¹

¹*Fault Analysis Group, School of Geological Sciences, University College Dublin, Ireland*

In the NW European continental shelf hydrocarbons are often contained within Upper Jurassic traps, though increasing numbers of both structural and stratigraphic traps are hosted within younger Mesozoic and Cenozoic sequences. Three deformation events are thought to have controlled Cenozoic deformation in offshore and onshore Ireland; the relative importance of each is uncertain and likely to vary both spatially and temporally. Alpine-related deformation is apparent as regional scale basin inversion, compressional deformation against earlier normal faults either involving fault reactivation or hangingwall buttressing, and strike-slip faulting. Work by the Fault Analysis Group has shown that the latter is characterised by dextral movement (up to ~7km) on what appear to be newly formed faults, and sinistral displacements (up to ~2.5km) on pre-existing normal faults^[1]. Widespread igneous activity, manifest as regional dyke swarms, multiple igneous intrusive centres and locally thick sequences of basalt flows, attests to a prolonged period of Icelandic plume-related deformation mainly during the Paleocene. Finally, Atlantic spreading related deformation can be either extensional and linked to Atlantic rifting, or compressional arising from ridge-push related stresses or local plate reorganisation. Within the Porcupine Basin a phase of widespread Eocene extensional fault reactivation has been recognised by the Fault Analysis Group. Reactivated faults propagated upward into overlying Tertiary sequences as arrays of segmented faults, which with increasing displacement become linked by breaching of intervening relays. In some circumstances these faults are poorly linked, or not linked, with the underlying structure.

The linkage of Cenozoic structures to underlying faults or potential traps could play an important role in hydrocarbon leakage, either as fault flow pathways or by seal breach. The reactivation of trap-bounding faults is also a major risk to hydrocarbon preservation. However, not all faults reactivate nor do all reactivated faults leak. Previous studies have identified several factors that strongly influence fault reactivation and subsequent fault geometry (e.g. fault size, orientation, dip direction). Work examining hydrocarbon traps in the Timor Sea^[2] demonstrated the importance of the relationship between trap geometry and post-rift displacement distribution on bounding faults. Consequently, a number of simple models characterising fault and trap geometries were developed to risk trap integrity and hydrocarbon preservation. Central to determining trap integrity and hydrocarbon preservation is understanding the mechanisms of fault reactivation and the factors controlling the growth and geometry of reactivated faults. For example, reverse reactivation of faults and later compression-related folding could have very different impacts on the trapping potential in an area, leading to either trap leakage by up-fault flow or trap formation by the development of anticlinal or fault traps.

This project aims to establish much improved constraints on the geometry, kinematics and spatial distribution of Cenozoic structures in the major basins offshore Ireland, through a comprehensive structural analysis of 2D and 3D publically available seismic data. Where Cenozoic deformation is

identified we will investigate the links with underlying structures or potential traps, and the role of earlier structures in localising later deformation. For selected cases in which Cenozoic fault reactivation is linked to potential underlying fault traps, we will perform migration modelling to explore the potential geometry and scale of those traps using 3D flow modelling techniques^[3]. Our structural and migration analysis will underpin the development of a simple suite of geometric models that will act as a guide in assessing trap integrity and hydrocarbon potential in offshore Ireland.

This project is funded by the Petroleum Infrastructure Programme (PIP).

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Monitoring and modelling acoustic noise from seismic surveys in Irish waters

White, M.¹, McKeown, E.², Crawford, S.¹, Stapleton, F.², Lee, G.³, Nolan, G.⁴, Brown, C.¹

¹ Earth and Ocean Sciences, School of Natural Sciences, Ryan Institute, NUI, Galway

² RPS, Lyrr 2, IDA Business and Technology Park, Mervue, Galway

³ School of Environmental Sciences. University of East Anglia, UK

⁴ Ocean Science and Information Services, Marine Institute, Rinville, Oranmore, Co Galway

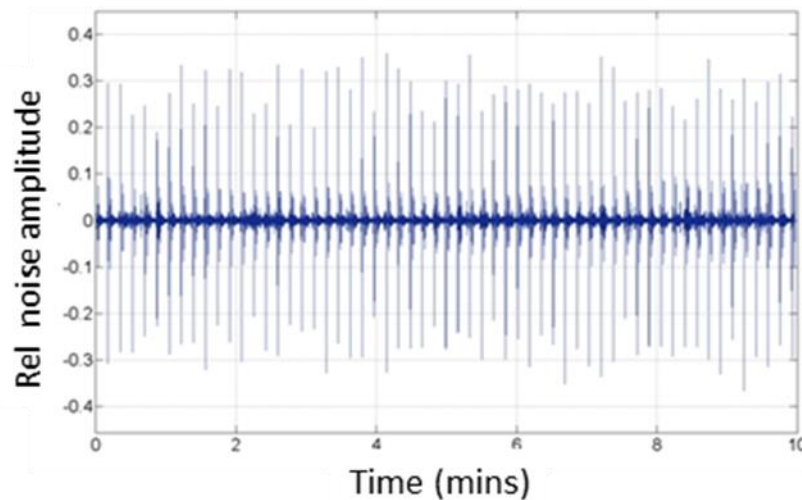
A field survey was carried out in July 2014 with the objectives to monitor a 3D seismic survey in the SW Porcupine Sea Bight. The survey objectives were to obtain seismic noise data at varying distances and depths from the seismic air gun source to both calibrate and validate the noise propagation/attenuation model, as well as acquiring a first seismic noise data set for Irish waters.

Noise observations were made at distances ranging from 2.5 nm up to the shelf edge 80 nm distance and beyond onto shelf waters, such that the influence of varying bathymetry and seabed type on noise attenuation could be quantified. As a test of potential future acoustic monitoring techniques, the survey included the use of a Kongsberg Sea Glider, equipped with a passive acoustic monitor, to enable acquisition of concurrent water column structure and noise levels in the upper 1000 m for 4 days some 30 nm from the acoustic source.

Initial acoustic data quality assessment indicated that the attenuation properties with distance would be resolved post survey. Early analysis has shown that a distinct air gun pulse can be recognised in deep water up to 30 nm from the source. In addition it is suggested that deep water noise attenuation close to the survey area essentially followed a predictable logarithmic decay, but attenuation was amplified above a standard logarithmic relation for depths < 1000 m. Calibration exercises and more detailed analysis together with use of the acoustic model will be required to identify and quantify the exact attenuation processes. Hydrographic measurements conducted during the survey have characterised the water masses and general hydrographic structure in the experiment region. Preliminary results have indicated potential influence of oceanic structures, such as internal solitons/waves, in modulating acoustic transmission loss near the source in the upper layers associated with the region of the seasonal thermocline.

During the course of the project, acoustic data will be used to prepare, calibrate and validate a model of noise levels in Irish waters resulting from offshore seismic operations. Modelling will be developed in conjunction with Curtin University collaborators. Ultimately, the project aims to provide data and model predictions to support future based decisions for operational exclusion zones management of

sensitive areas such as SACs and provide a database of offshore noise levels to integrate with other research.



Above: The Polarcus Amani conducting seismic survey (the acoustic monitoring buoy can just be seen in the foreground), and
Bottom: An example of uncalibrated recorded data 5 nm from acoustic source.

Developing a tool to predict seabird vulnerability to oil pollution

Wischnewski, S.¹, Jessopp, M.J.² and Quinn, J.L.¹

¹*School of Biological, Earth and Environmental Sciences, University College Cork, Distillery Fields, North Mall, Cork, Cork*

²*Coastal and Marine Research Centre, University College Cork, Irish Naval Base, Haulbowline, Cobh, Cork*

Seabirds are in the spotlight of attention when it comes to impacts of oil pollution on the environment. Due to its position at the edge of the Atlantic Ocean, Ireland has a large number of seabirds. With the obligation to protect its seabird populations under EU legislation, it is surprising that seabird research is very limited compared to other countries and even internationally important colonies on the west coast of Ireland are understudied. This makes it difficult for stakeholders, such as the oil industry, to reliably predict potential impacts of oil spills on seabirds and to develop appropriate mitigation measures.

Seabirds spend the majority of their life at sea in areas that are often excluded from management plans due to a lack of information about their location. Thus there is a major need to determine where these areas are in order to improve or ability to predict and manage the effects of oilspills.

The recent application of advanced tracking technologies has made it possible to gain valuable knowledge about the distribution and behaviour of seabird species at sea. Incorporating these new

insights into GIS (spatial) models to determine species hot-spots based on population and environmental parameters rather than direct observations is now possible (e.g. Grecian et al., 2012). This study will use a modelling approach to investigate the vulnerability of seabirds to oil spills including multiple seabird species with variable life history characteristics and foraging ranges.

It will consist of two major components:

- 1.) The development of the model using own and previously published data on colony distribution and size, foraging ranges, species sensitivity to oil pollution, species rarity, and environmental parameters (i.e. weather and season).
- 2.) The validation of the model using GPS tracking and land-based survey data collected on multiple field sites along the west coast of Ireland (Fig.1).

The results will provide a comprehensive model of at-sea seabird distribution, and will be used to create seabird “risk maps”, which will highlight hot-spots of seabird density as well as diversity, and provide a powerful tool to improve seabird management in regards to potential oil pollution risks.

What has been done so far...

From June to August 2014 GPS tags (iGotU GT120) have been deployed on Razorbills (*Alca Torda*) (June, Great Saltee) and Manx Shearwater (*Puffinus puffinus*) (July-August, Great Blasket and High Island) to track their foraging movements during chick rearing. Tags were successfully recovered from 13 (of 32 deployed) tags deployed on Razorbills and 14 (of 57 deployed) on Manx Shearwater (Fig.2 and 3).

Since previous tagging studies on Irish seabirds are limited, the collected data is not only essential for validation of the model, but it also provides new valuable information about the local foraging habits and highlights potential differences between Irish birds and birds from other locations. For example, whereas the Razorbill data mostly coincides with published data on foraging ranges and behavioural patterns, Manx Shearwaters tagged off the west coast displayed significantly greater foraging trip distances than previously recorded, highlighting the importance of local data for model validation.

Analysis of the data, preparation for publication, and the development of the spatial model are in progress. Additional species, such as Fulmars (*Fulmarus glacialis*), will be tracked in 2015 to collect more local data from a greater range of seabirds.

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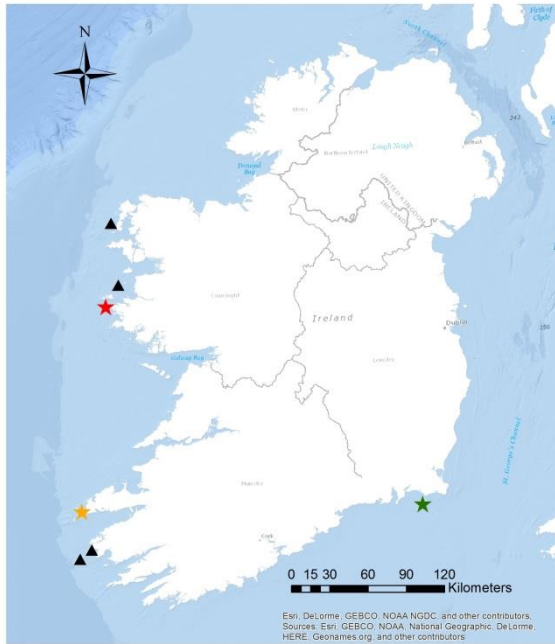


Figure 1 (top left). The location of study sites along the Irish coast. Stars indicate study sites (High Island=red; Great Blasket=yellow; Great Saltee=green.) Triangles show potential study sites for next year (from North to South: Inishkea, Inishturk, Puffin Island, Great Skellig).

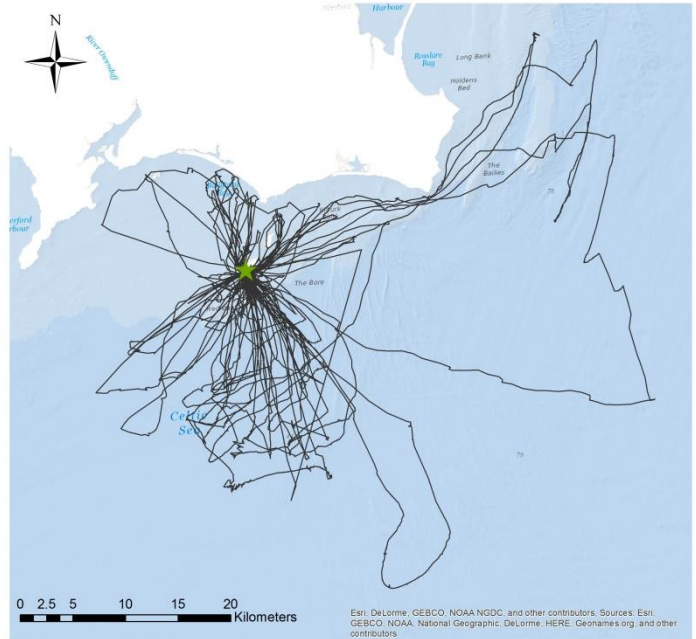


Figure 2 (top right). Razorbill foraging trips from Great Saltee during chick rearing in June 2014 (N=13). The green star indicates the study site. Each tracked bird contributed between 1-5 trips in a resolution of 1-2 minute intervals.

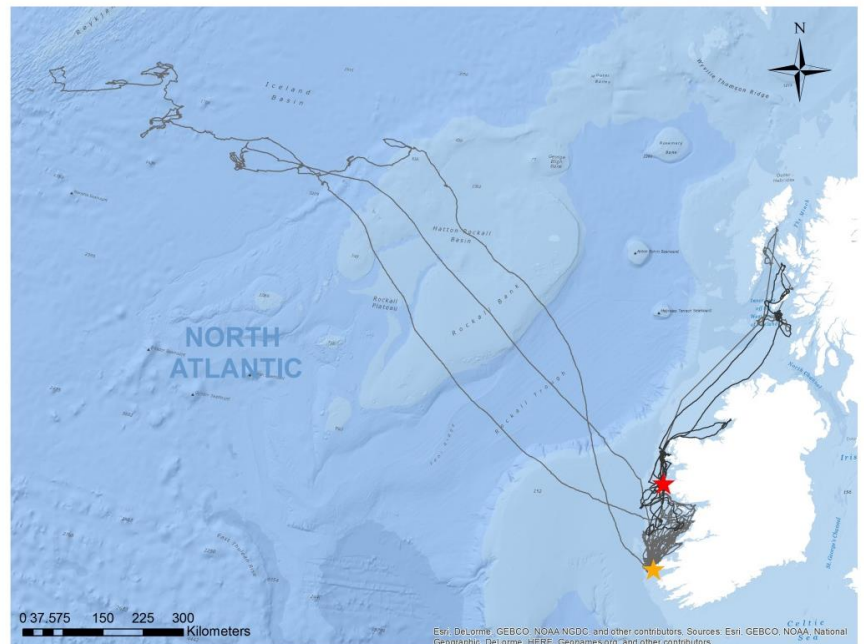


Figure 3(bottom).Manx Shearwater foraging trips from High Island and Great Blasket during chick rearing in July and August 2014 (N=14). The stars and track colours indicate study sites (red, dark tracks =High Island, yellow, light tracks=Great Blasket). Each tracked bird contributed between 1-8 trips in a resolution of 4 minute intervals.

List of Delegates

ATLANTIC IRELAND 2014

Name	Organisation
Gordon Donald	ADTI
Chris Rayburn	AGR Petroleum Services
Nick Chilcott	AGR Petroleum Services
Bryan Deegan	Altemar Environmental Consultants
Molly DeCoster	Amplified Geochemical Imaging
Helen Kerr	APT (UK) Ltd
Ian Cutler	APT (UK) Ltd
Patrick Barnard	APT (UK) Ltd
Cathal Jones	Ardilaun Energy Ltd
John McKeon	Ardilaun Energy Ltd
Karl Prenderville	Ardilaun Energy Ltd
Mark Pearson	Ardilaun Energy Ltd
Heidi Herbert	ARKeX
Lyndsey Smith	ARKeX
Stephen Rippington	ARKeX
Billy Tyrell	Arklow Marine Services
Alyson Harding	Atlantic Petroleum
Paul McEachern	Australian Embassy
Bernie Wayne	AzEire Petroleum Ltd
Daniel McKeown	AzEire Petroleum Ltd
Diz Mackewn	AzEire Petroleum Ltd
Henry Morris	AzEire Petroleum Ltd
Nick Terrell	AzEire Petroleum Ltd
Patrick Bailey	AzEire Petroleum Ltd
Andrew Barnwell	Barnwell Parker Geoscience
Iain Darby	Biznet
Dave Gaudoin	Bluestack Energy Ltd
Donal O'Driscoll	Bluestack Energy Ltd
John Robbins	Bluestack Energy Ltd
Malachy Donnelly	Brocagh Precision Engineering
Barry Ahern	Business Management Communications
Brian Robertson	Cairn Energy Plc
Keith Skinner	Cairn Energy Plc
Steve Laux	Cairn Energy Plc
Billy Clegg	Camarco
Gareth Crisford	CGG
Phil Baxter	CGG
Richard Windmill	CGG
Ceri Roach	Chemostrat Ltd
Sarah Porter	Chemostrat Ltd
Sophie Evans-Young	Chemostrat Ltd
Dave Walter	Chrysaor Limited
Karl Tolson	Chrysaor Limited
Mark Aldrich	Chrysaor Limited
Dave Ward	Commissioners of Irish Lights
John Burke	Commissioners of Irish Lights
Mark Devlin	Commissioners of Irish Lights
Matthew J Harvey	ConocoPhillips
Rui Lin	ConocoPhillips
Gareth Ll. Jones	Conodate Geology
Eamon Kelly	CONSUB Subsea Engineering

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Kiran Kamble	CONSUB Subsea Engineering
Malcolm Blackmore	CONSUB Subsea Engineering
Fintan Convery	Consultant
John F Ryan	Consultant
Viv Caston	Consultant
Stephen Corfield	Corfield Geoscience Ltd
Carla Dickson	Dalhousie University
Charlie Carlisle	Dalhousie University
John Frain	Davy Corporate Finance
Job Langbroek	Davy Research
Tomás Jones	Davy Research
Catherine Plowdon	Deloitte
Robyn Robertshaw	Deloitte
Mike Cooper	Deo
Eamonn Kelly	Department of Arts, Heritage and the Gaeltacht (DAHG)
Bill Morrissey	Department of Communications Energy & Natural Resources
Bob Hanna	Department of Communications Energy & Natural Resources
Clare Morgan	Department of Communications Energy & Natural Resources
David Fox	Department of Communications Energy & Natural Resources
Dean Ebbs	Department of Communications Energy & Natural Resources
Enda Gallagher	Department of Communications Energy & Natural Resources
Majella Dowling	Department of Communications Energy & Natural Resources
Michael Hanrahan	Department of Communications Energy & Natural Resources
Michael Manley	Department of Communications Energy & Natural Resources
Niamh Redmond	Department of Communications Energy & Natural Resources
Oonagh O'Loughlin	Department of Communications Energy & Natural Resources
Orla Ryan	Department of Communications Energy & Natural Resources
Shawna Cleary	Department of Communications Energy & Natural Resources
Sinéad O'Reilly	Department of Communications Energy & Natural Resources
Brad Kendell	Department of Natural Resources NL
Kim Welford	Department of Natural Resources NL
Brian O'Reilly	DIAS
Chris Yeomans	DIAS
Manel Prada	DIAS
Sergei Lebedev	DIAS
Emil Janson	Dolphin Geophysical
Stephen Grice	Dolphin Geophysical
Howard Davies	DownUnder GeoSolutions
Julian Sherriff	DownUnder GeoSolutions
Bruce Walker	Drilling Info
Brian Murphy	Dublin City University
Sean Jordan	Dublin City University
John Sayer	Earthworks Reservoir
Jason Foody	Effective Offshore
Khris Veldman	Effective Offshore
Bjorn Petter Lindhom	Electromagnetic Geoservices ASA
Lorenz Nehring	Electromagnetic Geoservices ASA
Gerry Mongey	Embassy of Canada
Przemysław Buczkowski	Embassy of Poland
David Davies	Endeavour Corp
David Taylor	Energy Institute
Sam Tobin	Energy Ireland

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Lorenzo Meciani	ENI
Sergio Scotto Di Minico	ENI
Laura Radcliffe	Envision
Mark Foster	EPI Group
David Ruddock	ERM
Joanne Sheahan	ERM
Martyn Ramsden	ERM
Nicola Lee	ERM
Walter Bruton	ERM
Murray Johnson	Europa Oil & Gas
Rowland Thomas	Europa Oil & Gas
Michael Seymour	Excalibur Exploration Ltd
Andy Wakelin	Faroe Petroleum plc
Ian Wilson	Faroe Petroleum plc
Paul Hawkes	Faroe Petroleum plc
Stuart Lawson	Faroe Petroleum plc
Kate Connolly	Fast Engineering Ltd
Kerry Smyth	Fast Engineering Ltd
Cathal Friel	Fastnet Oil & Gas Plc
Christian Klinkenberg	Fastnet Oil & Gas Plc
Michael Lynch	Fastnet Oil & Gas Plc
Will Holland	Fastnet Oil & Gas Plc
John Conneally	Fault Analysis Group UCD
Michael Snape	Fluid Inclusion Technologies Inc
Derek Giles	Fugro
Olwen Goss	Fugro
Steve Williams	Fugro
Andrew Briggs	Gardline Marine Services
Thomas Rutherford	Gardline Marine Services
Eoin O'Beirne	GEO International
Amanda Hyam	GeoGuide Consultants
Anna Hancock	GeoGuide Consultants
Lin Kenealy	GeoGuide Consultants
Sian Grant	Geokinetics Processing UK Ltd
Lee Toms	Geological consultant
Archie Donovan	Geological Survey of Ireland
Brian McConnell	Geological Survey of Ireland
Graham Ryan	Geological Survey of Ireland
Kim Cody	Geological Survey of Ireland
Maria Judge	Geological Survey of Ireland
Natalie Duncan	Geological Survey of Ireland
Ray Scanlon	Geological Survey of Ireland
Raymond Weafer	Geological Survey of Ireland
Xavier Monteys	Geological Survey of Ireland
Rob Raine	Geological Survey of Northern Ireland
Finn Delaney	Geo-Mara
Elwyn Jones	GeoPartners
Zyg Sarnowski	GeoPartners
Andrew Gaynor	Geoscience Ireland
Cormac Lavelle	GeoServ
Ric Pasquali	GeoServ
John R. Hopper	GEUS

ATLANTIC IRELAND 2014

Andrew Vinnall	Hannon-Westwood
John Corr	Hannon-Westwood
Billy McCracken	Harland and Wolff
Adrian Heafford	IHS
Alistair Rhodes	IHS
Bruno D'Antin	IHS
Cahir O'Neill	IHS
Christopher Pilsworth	IHS
Colin Gray	IHS
Debbie Taylor	IHS
Jack Rivers	IHS
Joy Heafford	IHS
Mikhail Mayzenberg	IHS
Richard Longhurst	IHS
Alexander Edwards	Ikon Science
Amanda Turner	Ikon Science
Rhydian Williams	Ikon Science
Andrew Botsford	INPEX
Hisashi Yamamoto	INPEX
Paul Bathurst	International Oil Ventures
Rory Brislane	Inver Energy Ltd
Janice Kerr	Invest Northern Ireland
Sam Knox	Invest Northern Ireland
Nick Blake	ION Geophysical
Phill Houghton	ION Geophysical
Pat Shannon	IOOA
Ciaran Lawless	iQshipman Ltd
Kate Hickey	Ireland Canada Business Association
David Kinsella	Irish Sea Contractors
Mark Tomasso	Kosmos Energy
Declan Sinnott	Kuehne + Nagel
John Coleman	La Tene Maps
Richard Slape	Lansdowne Oil & Gas Plc
Steve Boldy	Lansdowne Oil & Gas Plc
Con Casey	LHM Casey McGrath
Dave Breakell	LR Senergy
Patrick O'Donnell	LR Senergy
Richard Orren	LR Senergy
Aodhán Fitzgerald	Marine Institute
Fergal McGrath	Marine Institute
Margot Cronin	Marine Institute
Rosemarie Butler	Marine Institute
Aaron McGreevy	McGreevy Engineering Ltd
Tim Wright	Merlin Energy Resources
Nico Walle	M-I SWACO/Schlumberger
Ruth Jackson	Minerex Geophysics Ltd
Joe Heron	Murray Consultants
Ian Atkinson	Nalcor Energy
David Lyons	National Parks & Wildlife Service
Sarah Laird	Neftex Petroleum Consultants Ltd
Sonja Anttio	Neste Jacobs Finland
Fearghal Hayes	Nexen Petroleum UK Ltd

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Adrian Patterson	NUI Galway
Aron Barry	NUI Galway
Kerrymin Sun	NUI Galway
Martin White	NUI Galway
Peter Croot	NUI Galway
Shane Tyrrell	NUI Galway
Dáire Walsh	NUI Maynooth
Tim McCarthy	NUI Maynooth
Stuart Large	NuTech Energy Alliance
Eirik Grude Flekkoy	ORG Geophysical
Robert A. Lambert	Petra Petroleum
Dave Naylor	Petrel Resources
David Horgan	Petrel Resources
Ciaran Nolan	Petroceltic
Joe English	Petroceltic
Kara English	Petroceltic
Craig Jones	Petroleum Geo-Services
Joshua May	Petroleum Geo-Services
Kevin Shrimpton	Petroleum Geo-Services
Matthew Pyett	Petroleum Geo-Services
Thomas Hansen	Petroleum Geo-Services
Graeme Martin	PetroStrat
Nick Butler	PetroStrat
Andre Stout	Physicalgeo Ltd
Shirley Allen	Pinsent Masons LLP
Ciara Bannon	PIP Secretariat
Eamonn Kelly	PIP Secretariat
Eoin Walsh	PIP Secretariat
Martin Davies	PIP Secretariat
Miriam Golden	PIP Secretariat
Nick O'Neill	PIP Secretariat
Shane Lavery	PIP Secretariat
Tom Moore	PIP Secretariat
Viv Byrne	PIPco RSG Ltd
Brian Donnelly	Polarcus
Christian Fenwick	Polarcus
Iain Buchan	Polarcus
Ian Collins	Polarcus
Tony Pedley	Polarcus
Darren Doyle	Port of Waterford
Derek Madigan	Port of Waterford
Noel Collins	Port of Waterford
Stan McIlvenny	Port of Waterford
Alan Stringer	Precision Group
Patrick Kelly	Project Design Engineers
Andrew Clark	Prospectiuni
Annemarie Smyth	Providence Resources Plc
Donal Meehan	Providence Resources Plc
Jakub Czarcinski	Providence Resources Plc
John O'Sullivan	Providence Resources Plc
Keith Byrne	Providence Resources Plc
Myles Watson	Providence Resources Plc

ATLANTIC IRELAND 2014

Kieron Carroll	PSE Kinsale Energy Ltd
Mike Murray	PSE Kinsale Energy Ltd
Mary Honohan	PwC
Stephen Ruane	PwC
Nigel Ainsworth	Riley Geoscience
Pádraig Duggan	Rilta Environmental Ltd
David Coursey	RPS Energy
John Harrington	RPS Energy
Rachel Hooke	RPS Energy
Fiona Stapleton	RPS Group Plc
James Massey	RPS Group Plc
Nick Gibb	RWE Dea UK
Alan Campbell	San Leon Energy Plc
Chris Sanders	Sanders Research Associates Ltd
Capella Festa	Schlumberger
Terry Devine	Schlumberger
Aslak Myklebostad	SeaBird Exploration Norway AS
Toril Leite	SeaBird Exploration Norway AS
Jan Gunnar Opsal	Searcher Seismic Pty
Paul Larsen	Searcher Seismic Pty
Clara Atobell	Serica Energy
Graham Pritchard	Serica Energy
Kevin Conlon	SFI (Science Foundation Ireland)
Phil Hemmingway	SFI (Science Foundation Ireland)
Andrea Ahern	Shell
Colm Gormley	Shell
Gerry Costello	Shell
John Conroy	Shell
Niall Lawlor	Shell
Peter Colleran	Shell
Craig Howie	Shore Capital
Jerry Keen	Shore Capital
Graham Gillott	Signum Geophysical Ltd
Eimear Stafford	Sinbad Marine Services
Jim Parkinson	Sinbad Marine Services
Mark O'Reilly	Sinbad Marine Services
Alice Mitchinson	SLR Consulting
Hamish Wilson	SLR Consulting
Richard Vernon	SLR Consulting
Ian Kinstrie	Smiths Engineering Works (NI) Ltd
Carlos San Pedro Moller	Sosina Exploration
John Ødegaard	Sosina Exploration
Ulrik Danneskiold-Samsøe	Sosina Exploration
Glyn Roberts	Spec Partners
Gareth Morris	Spectrum
Karyna Rodriguez	Spectrum
Kim Gunn Maver	Spectrum
Stephen Donnelly	Star Instruments Ltd
Andrew Sanderson	Statoil
Chris Leppard	Statoil
Paul Doubleday	Statoil
Susie Irvine	Statoil

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Patrick C. Fahy	SVL Geophysical
Damian Dowling	TGS
Liz Orchard	TGS
Rob Hardy	Tonnta Energy
Cécile Damstra	Total E&P
Dominique Roy	Total E&P
Abigail Rooney	Trinity College Dublin
Catherine Rose	Trinity College Dublin
Chris Keely	Trinity College Dublin
Christopher Nicholas	Trinity College Dublin
David Chew	Trinity College Dublin
Derek Newport	Trinity College Dublin
Fei Gao	Trinity College Dublin
Gary O'Sullivan	Trinity College Dublin
John Paul Creagh	Trinity College Dublin
John Whelan	Trinity College Dublin
Liwen Xiao	Trinity College Dublin
Luca Mancinelli	Trinity College Dublin
Nathan Cogne	Trinity College Dublin
Robbie Goodhue	Trinity College Dublin
Nuno Pinto Da Costa	Tudor Hall Energy Ltd
Jim McCann	Tullow Oil
Jim Rice	Tullow Oil
Joe Mongan	Tullow Oil
Jonathan Leather	Tullow Oil
Shane Cowley	Tullow Oil
Aidan Kerrison	University College Cork
Andrew Wheeler	University College Cork
Brenton Fairey	University College Cork
Ian Evans	University College Cork
John Quinn	University College Cork
Kieran Mulchrone	University College Cork
Mark Jessopp	University College Cork
Mohit Tunwal	University College Cork
Pat Meere	University College Cork
Paul Leahy	University College Cork
Saskia Wischniewski	University College Cork
Tony Lewis	University College Cork
Aggie Georgiopoulou	University College Dublin
Aishling Soden	University College Dublin
Andrew Young	University College Dublin
Aoife Blowick	University College Dublin
Aoife Braiden	University College Dublin
Bernard Nwea-Ackah Mochiah	University College Dublin
Brendan Doyle	University College Dublin
Conrad Childs	University College Dublin
Deidre Walsh	University College Dublin
Eavan Collins	University College Dublin
Fionnan Kearney Cunningham	University College Dublin
Graham Johnson	University College Dublin
Helen Anthony	University College Dublin
Jack Bolger	University College Dublin

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Kevin Costello	University College Dublin
Keyla Ramirez	University College Dublin
Michael Owens	University College Dublin
Mike Long	University College Dublin
Miriam Colton	University College Dublin
Mojibola Aramide	University College Dublin
Noa Fernandez Troiteiro	University College Dublin
Nurfaraheeda Omar	University College Dublin
Orla Marnell	University College Dublin
Patrick Cruikshank	University College Dublin
Patrick Redmond	University College Dublin
Paul Richardson	University College Dublin
Stephen Daly	University College Dublin
Tom Manzocchi	University College Dublin
Tomás Mc Grath	University College Dublin
Catherine Caulfield	University of Aberdeen
Steve Jones	University of Birmingham
David Adley	University of Limerick
Edin Omerdic	University of Limerick
Joanna Bottomley	Upstream Consultants
Steve Bottomley	Upstream Consultants
Ivar Haaland	Valhalla Oil & Gas
Aidan Power	Waterford Airport
Brendan Ringrose	WhitneyMoore
Robert Marshall	Wilson Hartnell
Dara Williams	Wood Group Kenny
Kevin Whooley	Wood Group Kenny
Neivan Boroujerdi	Wood Mackenzie
Gareth Parry	Woodside Energy
Glen Bowman	Woodside Energy
Kim Emerson	Zebra Data Sciences / EZDataRoom
Neal Jones	Zebra Data Sciences / EZDataRoom
Brendan Tuohy	
Dominic Sherlock	
Kevin Lynch	
Michael O'Reilly	
Peter Fallon	
Richard Duggan	
Stephen Carroll	