



Tuesday 27<sup>th</sup> October

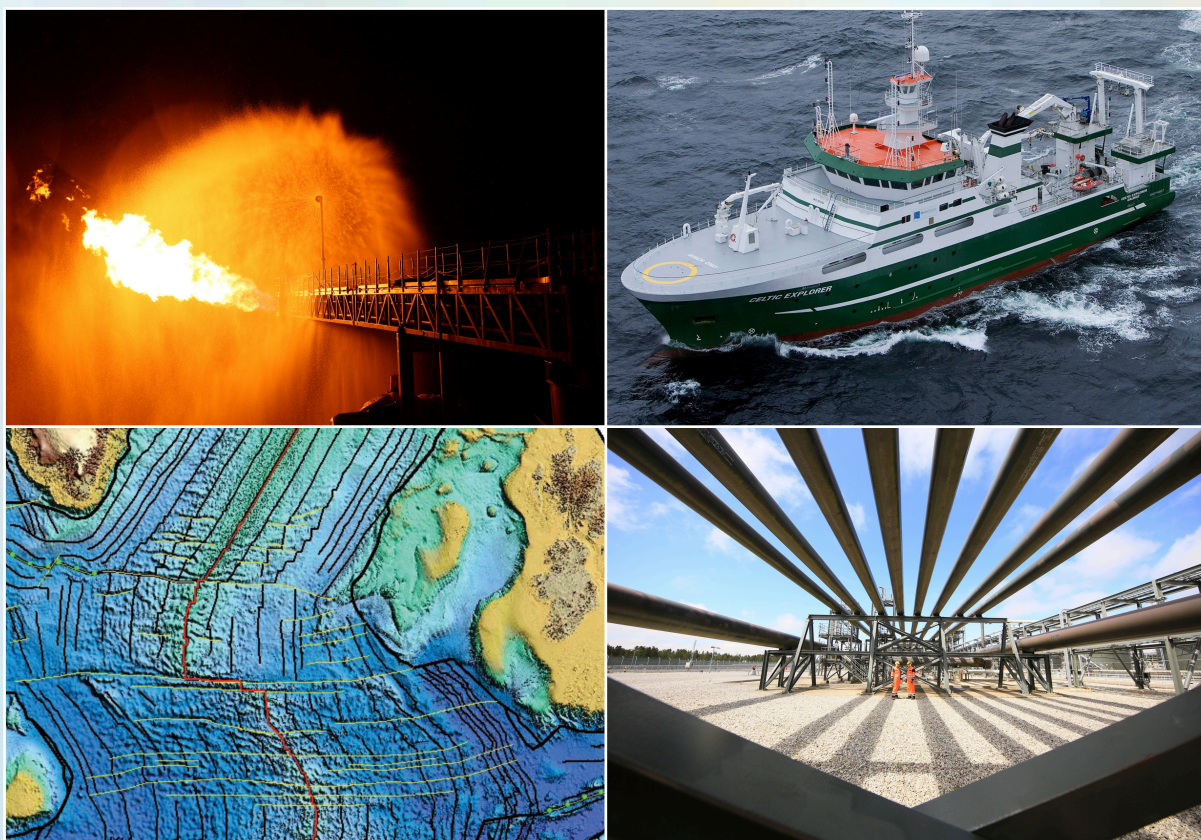
# Atlantic Ireland 2015

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

A Petroleum Conference  
Organised by PIP-IPSPG

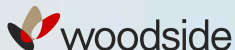
A one-day conference and exhibition on Ireland's offshore hydrocarbon potential

## Abstracts Volume



This annual event is organised by the  
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# ATLANTIC IRELAND 2015

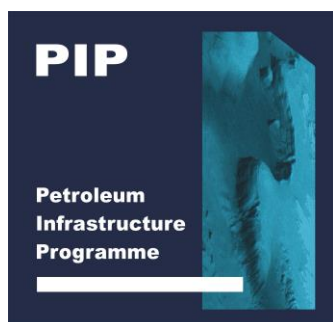
A One Day Conference and Exhibition on  
Ireland's Offshore Hydrocarbon Potential  
Sponsored by PIP-ISPSG

## PROGRAMME AND ABSTRACTS

**Location:** DoubleTree Hotel, Burlington Road, Dublin, Ireland

**Date:** 27<sup>th</sup> October 2015 – 08.00 to 19.00hrs

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



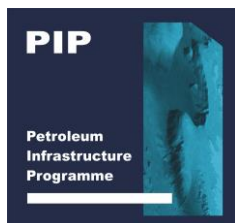
Edited by

Martin Davies & Tom Moore



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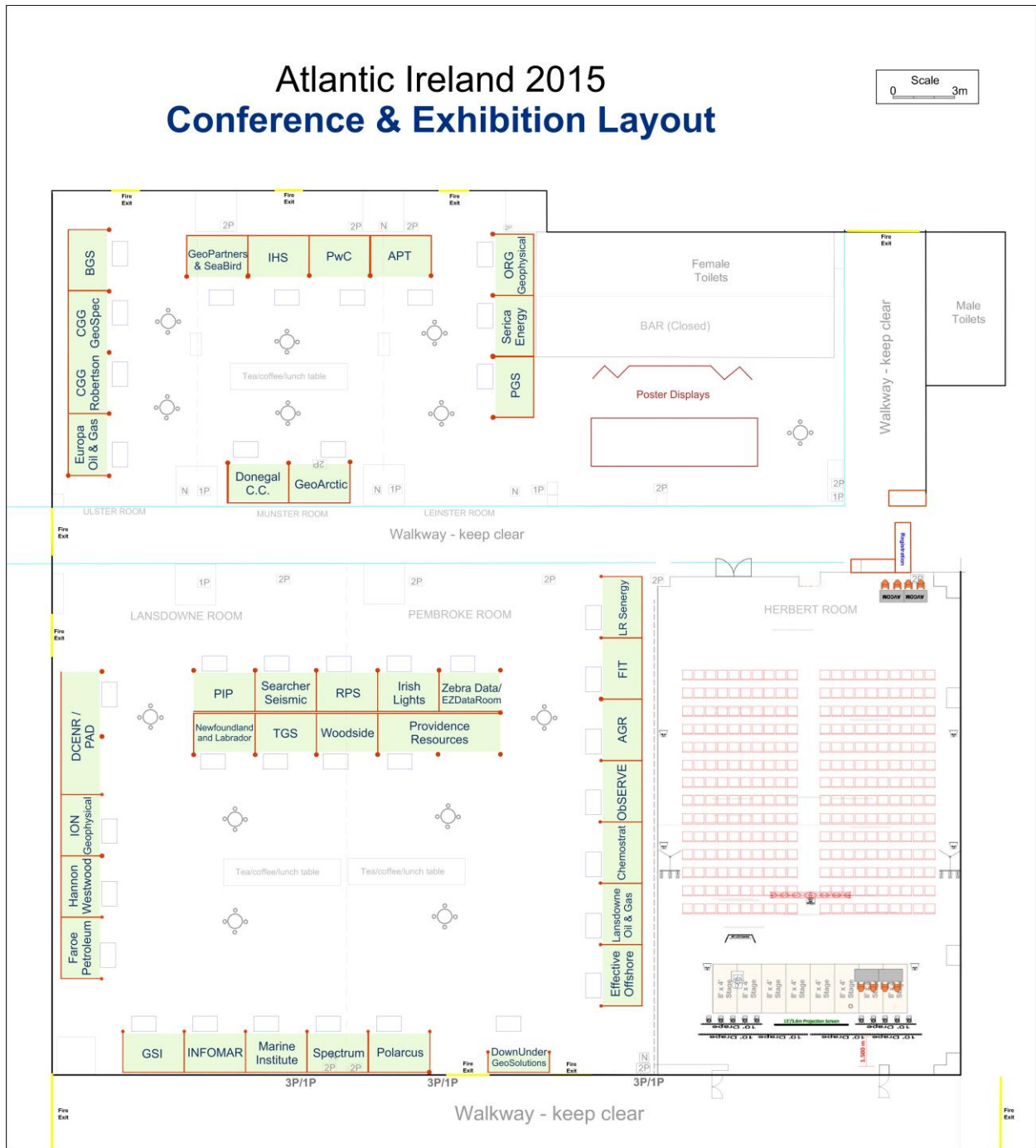
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## Exhibition Layout



## Technical Programme



A one-day conference and exhibition on Ireland's offshore hydrocarbon potential

### Provisional Programme

Tuesday 27<sup>th</sup> October 2015 - **Morning**

**08.00 - 08.55**

Reception – Coffee / Tea available in Exhibition Rooms

08.55 - 09.00

Welcome to Delegates

09.00 - 09.30

Address by Minister of State (DCENR) - Joe McHugh TD

**09.30 – 10.45**

**Session 1 - Government Initiatives and New Data**  
Chair - Clara Altobelli (Serica Energy)

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Ciarán Ó hÓbáin (DCENR/PAD) - "Update on Government Sectoral Policy Initiatives".

Clare Morgan (DCENR/PAD) - "Status of Exploration Offshore Ireland and the 2015 Irish Atlantic Margin Licensing Round"

Nick O'Neill (PIP Secretariat) - "The Irish Petroleum Infrastructure Programme – Current and Future Research"

Ian Atkinson (Nalcor Energy) - "Newfoundland and Labrador Update: Building Blocks for Future Exploration Success"

Questions

10.45 – 11.30

Coffee Break Kindly sponsored by:



**11.30 – 12.50**

**Session 2 - New Seismic Data**  
Chair - Pat Shannon (IOOA)

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Ken McDermott (ION) - "Stretched and squeezed? New structural and exploration insights for deep-imaged 2D and regionally calibrated 3D seismic, South Porcupine Basin offshore Ireland"

Jan Gunnar Opsal (Searcher Seismic) - "New insights offshore Ireland - Echidna the first Regional Broadband 2D seismic survey covering Slyne & Porcupine basins and the Goban Spur"

Hannah Kearns (Spectrum) - "Petroleum system insights from regional evaluation of volcanic seismic reflections over the eastern margin of the Irish Rockall Basin"

Gerrard Spear (Lyme Bay Consulting) "Ireland Northern Porcupine Basin: New Cretaceous and Tertiary prospectivity around the Spanish Point and Burren discoveries"

Manel Prada (DIAS) - "An integrated geophysical and geological study of the Porcupine Basin"

Questions



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A one-day conference and exhibition on Ireland's offshore hydrocarbon potential

## Provisional Programme

Tuesday 27<sup>th</sup> October 2015 - **Afternoon**

12.50 - 14.00

Lunch

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14.00 - 15.20

### Session 3 - New Research and Innovation

Chair - Jonathan Craig (ENI)

John Walsh (iCrag) - "iCrag - Progress to date and plans for 2016"

Anne McAfee (Core Lab) - "Tectono-stratigraphic evolution of the Porcupine Basin: observations and insights from a new rock-based regional study"

Richard Windmill (Robertson) - "A unified seismo-stratigraphic model for the North Atlantic Conjugate Margin basins coupled with palaeoclimate modelling: Implications for petroleum exploration in Atlantic Ireland"

John Quinn (UCC) - "Developing a tool to predict the distribution of seabirds"

Tim McCarthy (Maynooth) - "Spatial decision support for Oil Spill Management"

Questions

15.20 - 15.50

Coffee Break

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15.50 - 17.05

### Session 4 - Prospects2Go / Prospects and Opportunities

Chair - Ian Wilson (Faroe Petroleum)

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Graham Pritchard (Serica) - "There's more to Atlantic Ireland than Porcupine: The merits of the Slyne and Rockall Basins"

Mike Murray (Kinsale Energy) - "Midleton Well – Planning and Execution"

Hugh Mackay (Europa Oil & Gas) - "Recent developments in the Porcupine Basin"

Keith Byrne (Providence Resources) - "Southern Porcupine & Goban Spur prospects reviewed using new 2014 2D/3D seismic data"

Kachi Onyeagoro (Shell) - "Understanding the Corrib Field West of Ireland: The Power of Integration"

Closing Speech - Ian Wilson (Faroe Petroleum)

17.05 - 19.00

Posters and Reception

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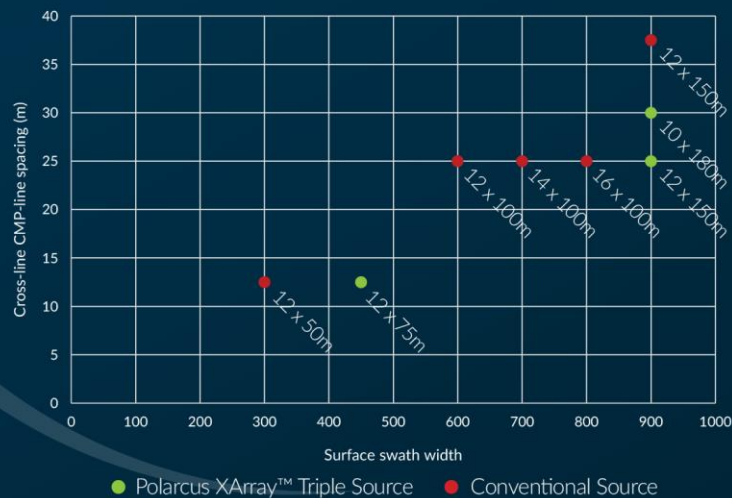
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## ORAL ABSTRACTS (in order of presentation)

Speaker is underlined

### Update on Government sectoral policy initiatives

Ó hÓbáin, C.<sup>1</sup>

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

Email: [Ciaran.ohobain@dcenr.gov.ie](mailto:Ciaran.ohobain@dcenr.gov.ie)



## Status of exploration Offshore Ireland and New Data

Morgan, C.<sup>1</sup>

<sup>1</sup> *Petroleum Affairs Division, Dept. of Communications, Energy and Natural Resources, 29-31 Adelaide Road, Dublin*  
Email: [Clare.Morgan@dcentr.gov.ie](mailto:Clare.Morgan@dcentr.gov.ie)

Successful promotion by the Irish Government in recent years, focused 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 one following the 2009 Round and four following the 2007 Round. The number of exploration authorisations now in place is at the highest level since exploration began in the 1970s. The results of the 2015 Atlantic Margin Licensing Round are even more positive with the receipt of 43 applications that are currently being evaluated. This represents a substantial increase in the number of applications received under previous Rounds making it Ireland's most successful Licensing Round. A wide variety of exploration targets are recognised including stratigraphic and structural traps. Furthermore, the recent applications include new exploration companies to the Irish Atlantic Margin, and there is a good distribution of applications from international majors, mid capital companies and smaller players across Ireland's frontier basins.

The Celtic Sea area continues to have substantial interest and a record number of new Licensing Options, with associated substantial work programmes, have been awarded in the basin in recent years focusing on both established and underexplored plays in the area.

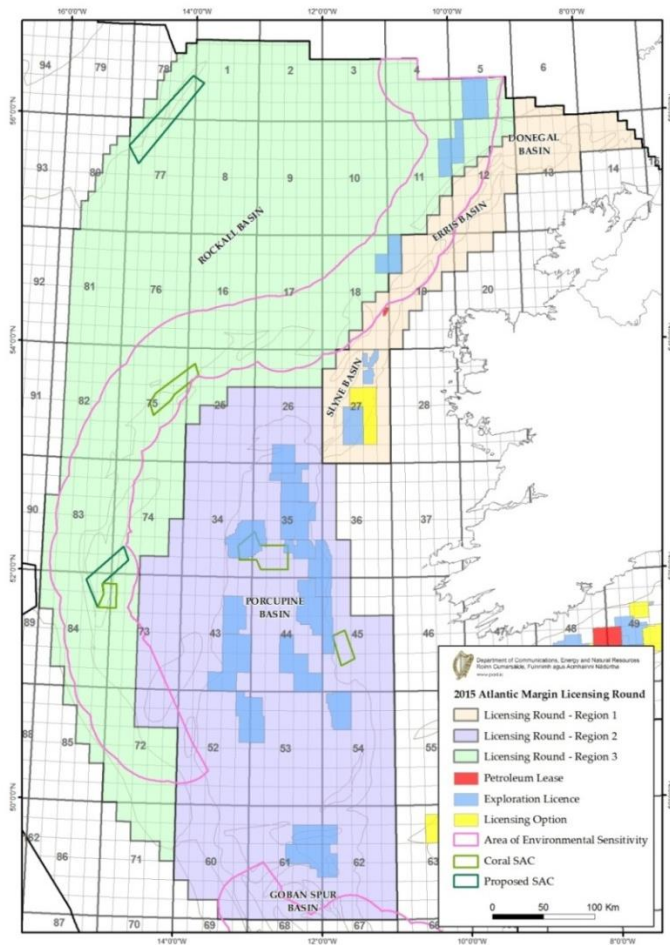
2013 saw a marked increase in the level of new 2D and 3D seismic acquisition offshore Ireland and this trend continued into 2014 and 2015. Two large regional long offset 2D seismic surveys were acquired in 2015, one in the Porcupine, Goban Spur and Slyne Basins and a separate survey in the Celtic Sea. 2013 saw the commencement of the Regional Seismic Survey Project that was completed in 2014. This was a major 2D seismic survey undertaken by the Department in conjunction with ENI Ireland BV. The survey acquired 16,800 km of full-fold 2D regional seismic data and gravity and magnetic data that has been made available to industry for purchase and to researchers. The new data was acquired across the Atlantic basins including the Porcupine, Rockall, Hatton, Fastnet, Clare Basins and along the conjugate margin. This is the largest 2D seismic survey acquired to date in Irish waters and achieved national recognition by winning the inaugural 2015 Maritime Industry Award in the Offshore Category. The new data from this survey fills data gaps, underpins research in petroleum systems and informed applications in the 2015 Licensing Round.

Only one well was drilled offshore Ireland in 2015. The 'Midleton' exploration well 49/11-3 in the Celtic Sea, which was operated by PSE Seven Heads Ltd, encountered good quality reservoirs in the Lower Cretaceous Greensand and Upper Wealden formations. While some gas was encountered in the Greensand, the volumes were not considered commercial and accordingly the well was plugged and abandoned. 2015 also saw the completion of the last of the existing Corrib wells (P2) as a gas producer.

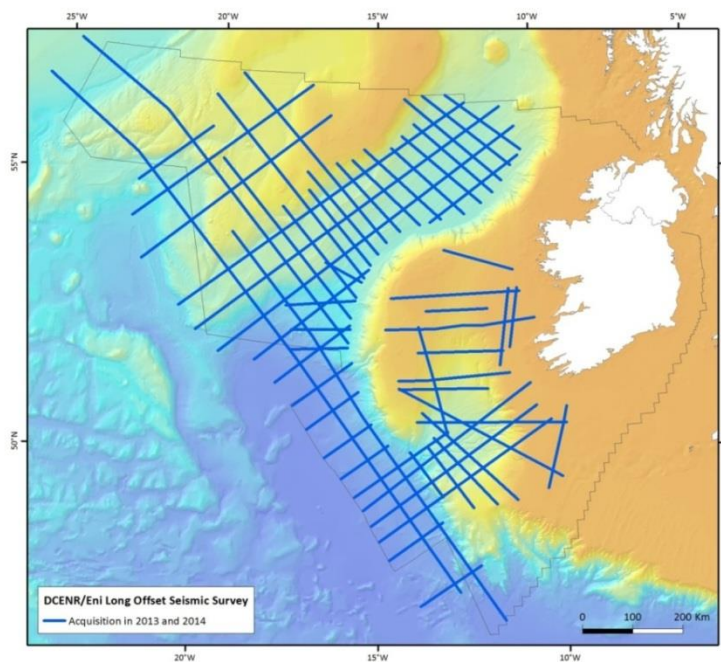
There is a recent upswing in exploration effort offshore Ireland, both in terms of number of exploration companies active in the Irish offshore and in the level of new seismic acquisition which may in due course lead to increased drilling activity. Drilling levels however, remain low but despite this, it is encouraging that the current exploration status offshore Ireland is healthy and the exploration momentum continues to increase, as reflected by the success of the 2015 Licensing Round.

# ATLANTIC IRELAND 2015

## 2015 Atlantic Margin Licensing Round



## DCENR/Eni regional seismic survey 2013 / 2014



Acquired programme  
16,800km

New Data



MARITIME INDUSTRY  
AWARDS 2015



Roinn Cumarsáide,  
Fuinnimh & Acmhainní Nádurtha  
Department of Communications,  
Energy & Natural Resources

## **The Irish Petroleum Infrastructure Programme (PIP): Current and Future Research**

O'Neill, N.<sup>1</sup>

<sup>1</sup>PIP Secretariat. Email: [noneill@pip.ie](mailto:noneill@pip.ie)

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.

This conference provides us an opportunity to showcase this research through presentations and poster displays outside which I urge you to look at. This is where you will find creative ideas and new technologies being applied to improve our understanding of the petroleum systems offshore Ireland. Specific issues that reduce risk and uncertainty in our exploration efforts are addressed. I can guarantee that you will find inspiration and support for your prospect development amongst these posters.

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.

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. PIP will contribute €2.4m in cash and significant benefit in kind value in the form of data to the new SFI Irish Centre for Research in Applied Geosciences (iCrag).

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.

PIP is currently negotiating a contract for the delivery of an Atlas of Source Rocks, Oil Characteristics and Oil-Source Rock Correlation in Mesozoic Basins of the North Atlantic Conjugate Margin, Offshore Newfoundland-Labrador and Offshore Ireland. This comprehensive re-examination of source rock geochemistry and oil generation history of the North Atlantic Conjugate Margin Basins is jointly funded by Ireland and Newfoundland and Labrador.

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 oil industry PIP members will shape the future work programme of PIP as we enter a newly invigorated phase of frontier exploration offshore Ireland.



## **Newfoundland and Labrador Update: Building Blocks for Future Exploration Success**

Atkinson, I.M.<sup>1</sup>, Wright, R.<sup>1</sup>

<sup>1</sup>Nalcor Energy. Email: [IanAtkinson@nalcorenergy.com](mailto:IanAtkinson@nalcorenergy.com)

In 2009, Nalcor Energy initiated an exploration strategy to improve our geological understanding of the province's numerous onshore and offshore basins. The components of this strategy include the acquisition of new datasets, the completion of regional studies and the ongoing participation in focused R&D projects. The keys to the success of this strategy have been the partnerships established with service providers and global experts and the relationships with university researchers at Memorial University and other universities and research institutes around the world. The datasets provide the new insights, but it is the ideas that arise from analysis and interpretation that adds value to the data and creates new knowledge of the basins' petroleum potential. Building our partnerships with industry and academia has helped Nalcor Energy establish exploration momentum that is producing positive results.

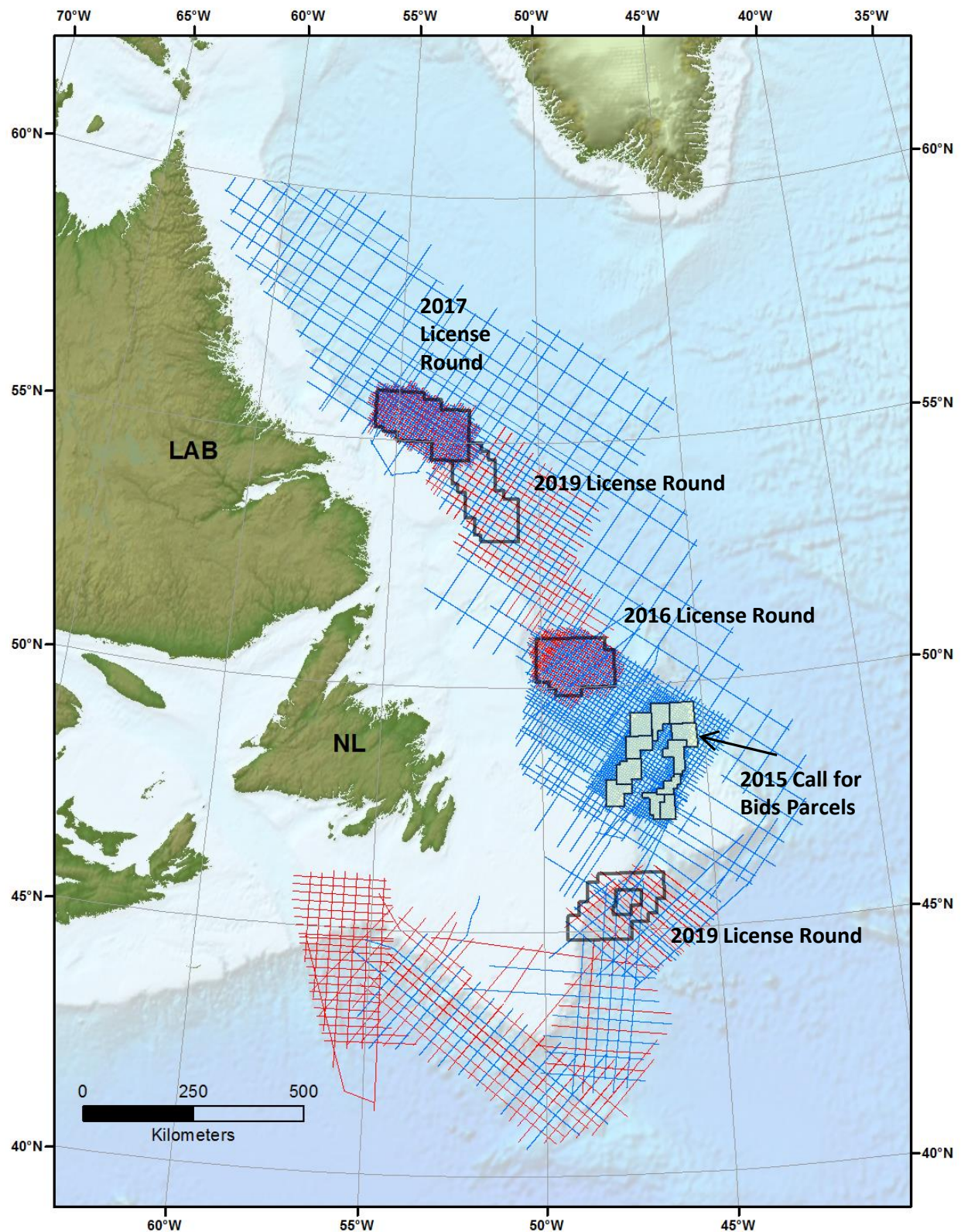
The recently completed resource assessment of the 2015 Call for Bids area of the Flemish Pass Basin incorporated all of our current knowledge and understanding of that basin by integrating the datasets and previous studies into a comprehensive Reliable Reference Geological Model (RRGM). This model was developed by BeicipFranlab using their DionisosFlow™ and TemisFlow™ 3D software. Over the coming years, as future land sale areas are announced, a similar resource assessment will be conducted for each area. In this systematic way, the province's resource potential will be scientifically analysed and assessed using our most up to date data and studies.

Since 2011, the TGS / PGS partnerships has acquired over 80,000 kilometres of long offset, broadband multi-client 2D seismic data and, this year, a 4800 sq. km. multi-client 3D survey. In 2014, EMGS acquired a 3D CSEM survey over discoveries and prospects in the Flemish Pass that demonstrated this technology can be reliably applied in these plays. This year MG3 and AGI conducted a multi-client seabed coring/slick capture survey off southern Labrador and NW Orphan. These new datasets are available to industry under license agreements. However, segments of the data could be incorporated into R&D projects if separate research agreements with universities can be negotiated. Delivering modern datasets to academia will greatly enhance their research capabilities and provide students with the most current images of the subsurface. Training the next generation of geoscientists and engineers is just as important for future exploration success as the other components. Nalcor Energy will make the effort to expand our relationships with universities and ensure that future generations are trained and ready to support our industry. The North Atlantic Petroleum Systems Assessment (NAPSA) can play a major role to facilitate some of these R&D projects. NAPSA was established in 2007 to increase the collaboration between researchers in Ireland and Newfoundland and Labrador. It is an excellent vehicle to help researchers access funding for new R&D initiatives.

Nalcor Energy's exploration strategy has successfully acquired new data and completed major regional studies, but it is our relationships with industry service providers and researchers that is the most important building block for future success. Good people deliver strong results. Nalcor will continue to invest in all of the building blocks to maintain positive growth for our shareholders, the people of this province.

# ATLANTIC IRELAND 2015

Figure 1. Map of TGS/PGS seismic data acquisition to 2015 showing the upcoming licensing rounds



### **Stretched and squeezed? New structural and exploration insights for deep-imaged 2D and regionally calibrated 3D seismic, South Porcupine Basin offshore Ireland**

McDermott, K.<sup>1</sup>

<sup>1</sup> ION. Email: [Ken.McDermott@iongeo.com](mailto:Ken.McDermott@iongeo.com)

The Porcupine Basin, west of Ireland, is a North–South trending, V-shaped basin formed through multiple extensional episodes during the late Palaeozoic and Mesozoic. The main phase of extension occurred during the Late Jurassic – earliest Cretaceous and led to crustal hyper-extension and mantle serpentinisation at the basin's centre, as observed on ION's Porcupine SPAN data as well as the RAPIDS4 wide-angle profile across the Porcupine Arch.

ION, together with partners Polarcus, GeoPartners, and Seabird Exploration, acquired in 2014, 3D and regional 2D PreStack Time Migration (PSTM) seismic data in the South Porcupine Basin. These data provide new insights into the syn-rift and post-rift structural evolution of the basin. For the first time, large-scale slump and gravity collapse features are identified along the Lower Cretaceous basin margins. These gravity collapse systems are observed on both the western and eastern margins of the basin and are sampled in high-resolution on both the 2D and the 3D datasets.

These new data also offer new exploration insights for traditional exploration plays within the syn- and post-rift intervals. In light of recent well results, new potential plays are emerging in the basin. The carbonate build-up drilled by the Dunquin-1 exploration well is reported to have identified a viable carbonate play, encountering residual oil and excellent reservoir properties. The carbonate build up above the Porcupine Median Ridge is well imaged on these data and improves our understanding of this structure's development. The 3D survey acquired over the Drombeg Prospect and adjacent area, demonstrates the prospectivity of several Cretaceous turbidite systems that onlap the Porcupine High, as well as to help demonstrate the important role that slumping plays within this petroleum system.



## New insights offshore Ireland – Echidna the first Regional Broadband 2D seismic survey covering Slyne and Porcupine basins and the Goban Spur

Opsal, J. G<sup>1</sup>

<sup>1</sup> Searcher Seismic. Email: [jg.opsal@searcherseismic.com](mailto:jg.opsal@searcherseismic.com)



Figure 1. The Echidna survey covering Slyne and Porcupine Basins and Goban Spur in the south.

Searcher Seismic recently completed acquisition of the Echidna Regional Broadband 2D seismic survey, covering the Porcupine and Slyne Basins and the Goban Spur on the Atlantic Margin offshore Ireland, in cooperation with project partner MAGE.

The survey comprises 9,100 km of high quality, long-offset broadband 2D seismic data over the Goban Spur area, Porcupine and Slyne Basins, and includes ties to over 30 exploration wells, as well as the Connemara and Burren oil fields and the Spanish Point gas discovery. The survey was designed to complement and integrate with the existing PAD 2D seismic dataset in the area. In addition, great care was taken to avoid any environmental sensitive areas.

The rift systems associated with these basins are among the most interesting exploration targets in the North Atlantic, with recent drilling results indicating considerable oil potential. The prolific Flemish Basin on the Canadian side of the Atlantic Rift was located adjacent to the Goban Spur / Southern Porcupine Basins until Aptian time, suggesting the possibility that similar play types may be revealed within the Echidna survey area.

The survey was acquired with a 10 km streamer - longer than most of the existing surveys in the area. This cable length, combined with the latest broadband processing techniques, provides high resolution imaging of the basins and creates a unique opportunity to conduct an integrated evaluation of this prospective acreage.

Searcher Geoservices is evaluating and interpreting the Echidna dataset and the seismic quality is extremely good. Several positive indications regarding existing source rock and new traps are observed and mapped. The evaluation is ongoing and when the final dataset is ready for delivery in April 2016 Searcher Geoservice expect to have a good understanding of the basin development, prospectivity and the different basement types in the Echidna survey area.

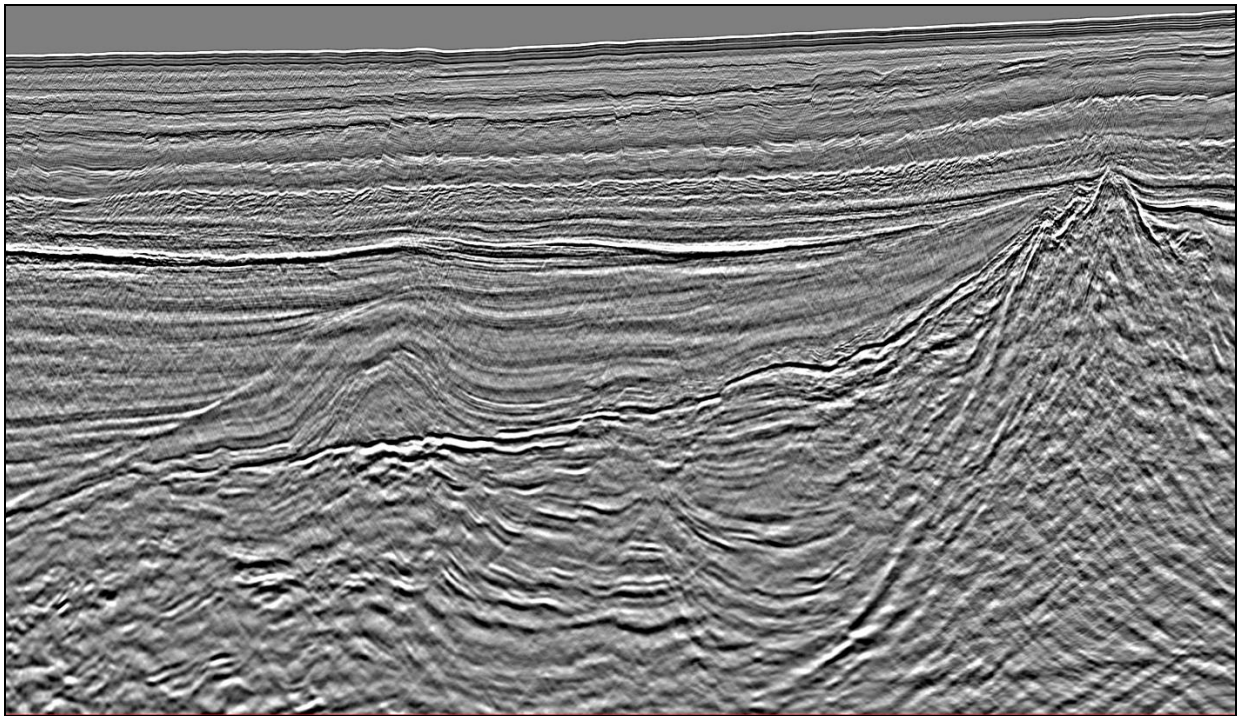


Figure 2. Seismic example from the Echidna survey.



## Petroleum System Insights from Regional Evaluation of Volcanic Seismic Reflections over the Eastern Margin Irish Rockall Basin

Kearns, H.<sup>1</sup>, Marszalek, A.<sup>1</sup>, Rodriguez, K.<sup>1</sup>

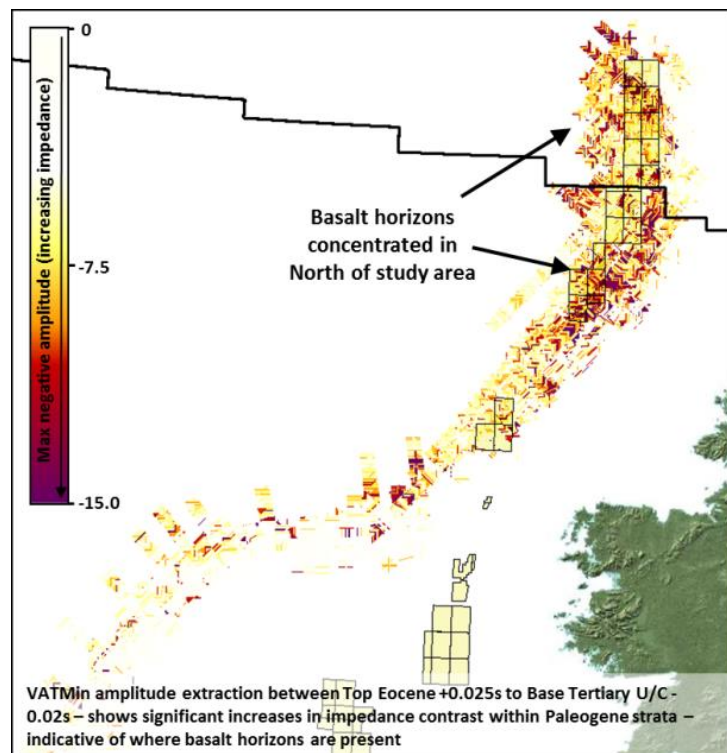
<sup>1</sup> Spectrum. Email: [Hannah.Kearns@spectrumgeo.com](mailto:Hannah.Kearns@spectrumgeo.com)

Despite limited exploration drilling in the Slyne-Erris and Irish Rockall basins, the presence and effectiveness of several reservoirs, source rocks and seals, has already been proven by the Corrib, Dooish and Bandon discoveries. These include reservoir-quality sediments in Triassic Sherwood Sandstones and Permian-Mid Jurassic fluvial sandstones, with Mesozoic arkosic sandstones sourced from Archean-Paleoproterozoic rocks of the Lewisian Complex in NW Scotland (Tyrrell et al, 2010). Also, source rocks present in Carboniferous mudstones and coals have generated gas-condensate at Dooish and gas at Corrib, respectively, and Early Jurassic shales have generated oil at Bandon. Syn-rift (Late Jurassic to Early Cretaceous) marine shales described in shallow borehole data may provide an additional oil source in the basin.

Paleocene to Eocene transient epeirogenic uplift and igneous activity related to convection of anomalously hot mantle (Icelandic plume theory) was responsible for subaerial flood basalts, submarine lavas, sill intrusions, central igneous complexes and seaward-dipping wedges of flood-basalt, and gave rise to the British Tertiary Volcanic Province (BTVP) (Spencer et al, 1999). Until recently, the role of Paleogene volcanism in the Rockall basin and its influence on the petroleum system has been largely overlooked.

In 2014, Spectrum reprocessed legacy 2D seismic data located on the shelf break and slope to deep transition on the eastern margin of the Rockall Trough. The 2D seismic data provide an essential linkage from the Rockall Trough to the Slyne-Erris and Porcupine Basins, complementing the 2013 Atlantic Margin regional survey acquired by Ireland's Petroleum Affairs Division and ENI. In 2015, Spectrum undertook a regional evaluation based on interpretation of the reprocessed data, integrated with wells, potential field data, and a satellite seep study. The improved imaging of prospective syn-rift half grabens along the eastern margin has uncovered large rollover anticline structures and previously unseen stratigraphy beneath the Paleogene basalts. Improved imaging also allowed identification of extensive Cretaceous fan pinch-out plays and Paleogene channel complexes.

However, one of the most striking findings resulted from seismic character and amplitude preservation improvements, which allowed us to identify and map igneous intrusion networks and extrusive basalts (Figure 1) and assess their previously overlooked contribution to geological models and the working hydrocarbon system.





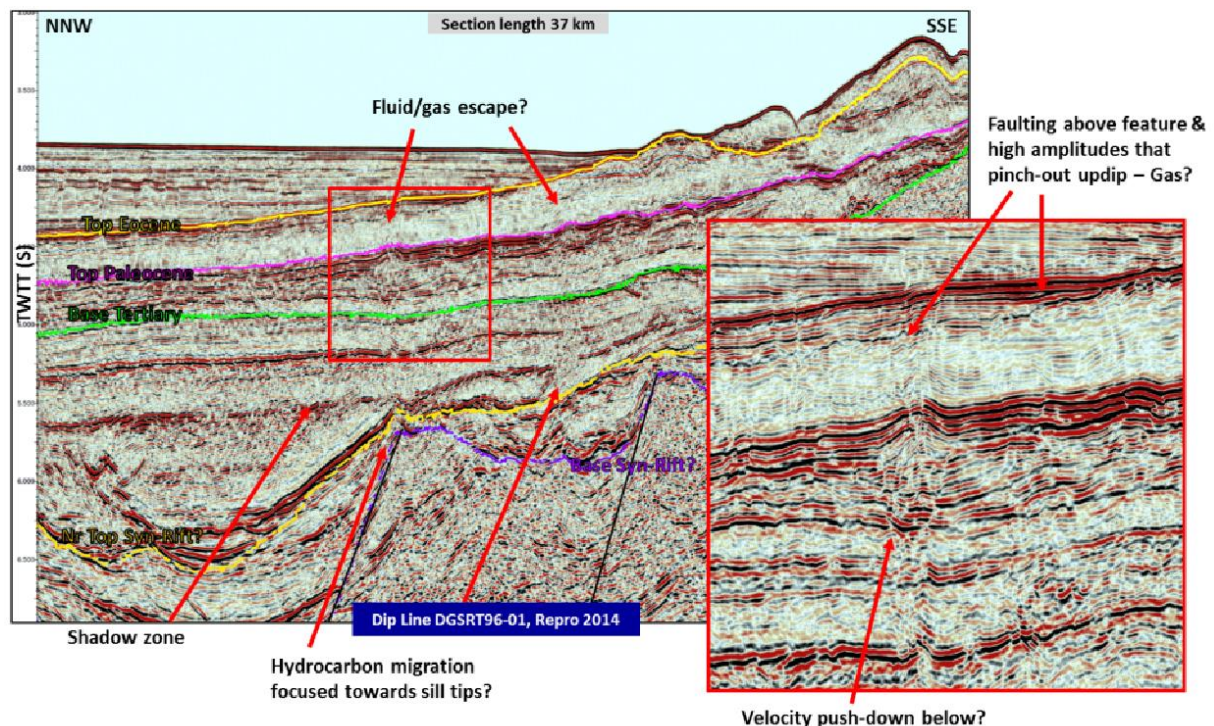
## Lithology and Structural Indicators

Sills may exploit softer horizons and existing basin structure, which act as paths of least resistance to intrusions. The exploitation of faults by intrusions can have implications for fault seal.

## Reservoir Potential

Stacked Paleogene basalts may be interbedded with sandstone layers (Rosebank analogue). Regional Paleogene uplift followed by basin subsidence may have increased fracturing in older sediments, increasing the permeability.

Figure 2. Fluid/Gas escape structures in Cenozoic associated with Paleogene volcanism. Forced fold traps may occur in overlying sediments



## Seal Potential

Vertical conductivity of fluids through known sill complexes has been observed to be poor in outcrops. However, fluid conductivity may increase where irregular cooling has occurred laterally over a sill (Rateau et al, 2013). Fractures in sills may be filled by recrystallised minerals from post-intrusion fluid migration. Sills can therefore act as conduits or as baffles and barriers to fluid flow, sealing faults, affecting trap charge, risk and volumetric analysis, and may alter migration pathways.

## Trap Creation and Migration

Some Early Eocene sills have created forced fold anticlines, which may be suitable for hydrocarbons to accumulate in (Figure 2). Saucer-shaped sills may create stratigraphic traps by focusing hydrocarbon migration towards the tips of the intrusion; creating a shadow zone above where no oil and gas may migrate to after they are in place (Rateau et al, 2013) (Figure 3).

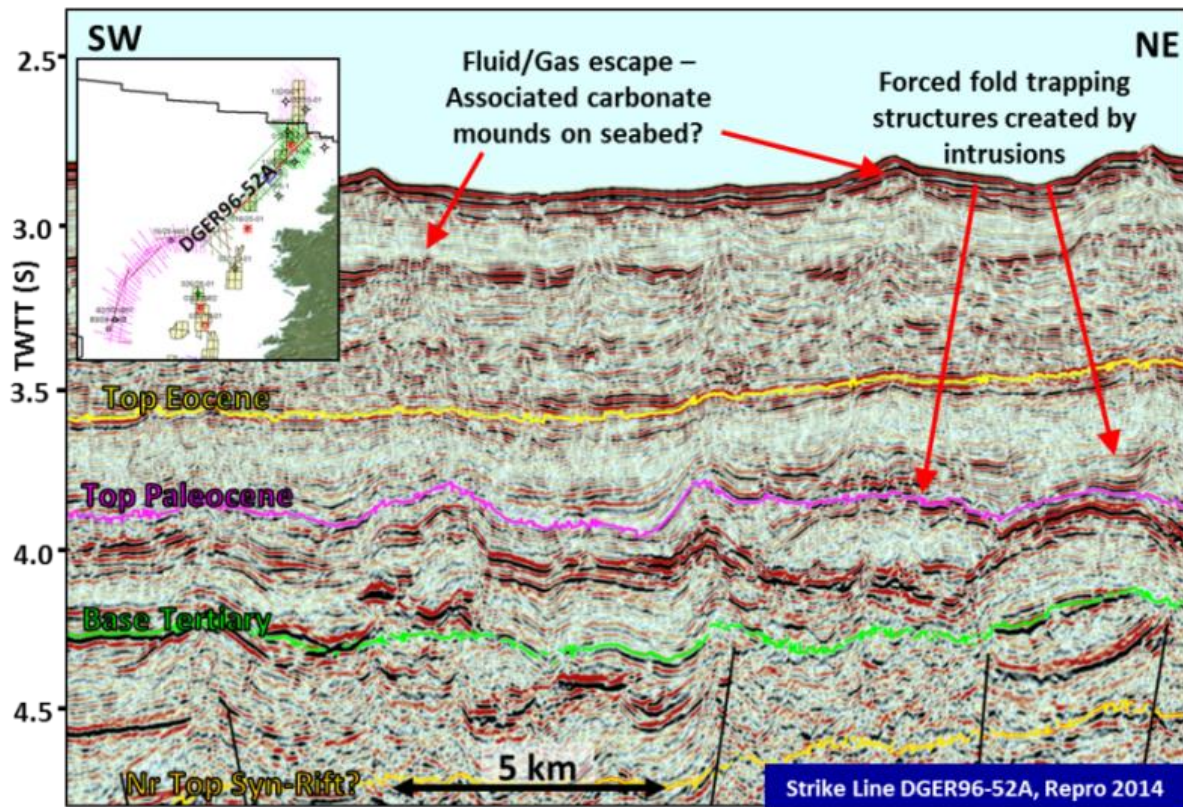


Figure 3. Possible evidence of a saucer-shaped sill influencing fluid/gas migration; acoustically quiet zone above sill is likely to be a shadow zone, fluid/gas escape feature may be a result of hydrocarbon migration focused towards the sill tip.

#### Hydrocarbon Maturation and Generation

The thermal effect of sills is reportedly limited, unless they occur in high numbers or surround a localised high magma volume conduit (Rohrman, 2007; Thomson, 2005). Sills can impact the thermal maturation of carbon-rich sediments on a localised scale. The contact metamorphic zone which forms around intrusions may cause reservoir compartmentalisation.

The majority of igneous sills observed in the study area are concentrated within Cretaceous sediments. Fluid/gas escape features in overlying Cenozoic sediments may be linked to hydrocarbon concentrations focused towards sill tips (Figure 3). Some structures with bathymetric expression may be authigenic carbonate build-ups related to thermogenic gas seeps. Observed polygonal faulting and dewatering structures in Cenozoic sediments, which may be a response to a build-up of pressure, have been encountered in volcanic basins to the north.

#### Conclusion

Improved seismic imaging has allowed a detailed understanding of different play types by uncovering large faulted rollover anticline structures, previously unseen stratigraphy beneath Paleogene basalts and identification of extensive Cretaceous fan pinch-out plays and Paleogene channel complexes. However, we have also gained a detailed understanding of the possible influence of volcanism on the petroleum system from clear imaging of volcanic seismic reflections. We expect this will help to de-risk this frontier basin and provide an important framework for future exploration in the area.



## **Ireland Northern Porcupine Basin: New Cretaceous and Tertiary prospectivity around the Spanish Point and Burren discoveries**

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<sup>1</sup> Capricorn Ireland Ltd.

<sup>2</sup> Lyme Bay Consulting Ltd. Email: [gerrard.spear@lymebayconsulting.com](mailto:gerrard.spear@lymebayconsulting.com)

Capricorn Ireland Ltd, the wholly owned subsidiary of Cairn Energy PLC, and partners Providence Resources PLC and Sosina Exploration Ltd hold the licenses to FEL 2/04, 4/08 and 1/14, containing the 35/8-2 Spanish Point gas condensate discovery and the 35/8-1 Burren oil discovery, approximately 170km off the west coast of Ireland.

In 2014 the partnership acquired and processed a proprietary 3D seismic survey in FEL1/14 and merged the data with previous 3D surveys in FEL's 2/04 and 4/08 to create a combined 1463 km<sup>2</sup> data set. They then engaged the services of Lyme Bay Consulting to apply their proprietary Detailed Reconnaissance Study (DRS) workflow as a preliminary screening tool to identify any additional prospectivity in the post rift Cretaceous and Tertiary sequences.

The DRS builds a geological representation of the underlying seismic data, a GeoModel, which calculates and correlates the relationship between 3D seismic points according to the similarity of the wavelets and their distance from each other.

This maps each event within the seismic volume and a relative geological time/depth (dependent on input data) is computed for every point to produce a horizon for each and every reflector within the dataset, typically between two and three hundred, over which any attribute can be draped to deliver a high resolution reconnaissance tool that will identify any and every structural and stratigraphic feature within the 3D volume, notably identifying intra-formation features that may be missed during traditional interpretation.

Figure 1 is an example of the RMS Amplitude Horizon Stack showing a subset of the horizons generated from the DRS GeoModel, and shows the order of magnitude greater resolution that can be achieved with the DRS workflow to identify intra-formation leads and prospects over and above the traditional interpretation approach in a fraction of the time.

The DRS results show some key features in the data in these sequences. Figure 2 is an extracted Horizon showing sub-aerial erosion features in the north, dipping down to evidence of a paleo-shoreline, shelf edge then prograding slope. This type of depositional model helps the geoscientist determine the facies types expected in the leads and prospects identified in the seismic data.

Figure 3 is another example of a large Oligocene channel system not previously mapped, with great detail allowing identification of fourth-order channel systems and bright amplitude events within the data.

Figure 4 shows a series of Lower Cretaceous channel systems similar to those seen in the 35/8-1 Burren oil discovery.

The DRS is a fast and accurate method of identifying leads and prospects and potential drilling hazards within seismic data. One of the additional benefits is that Lyme Bay Consulting have successfully mapped all the igneous intrusions within the area. This information will be valuable input to the ongoing PSDM processing of these data.



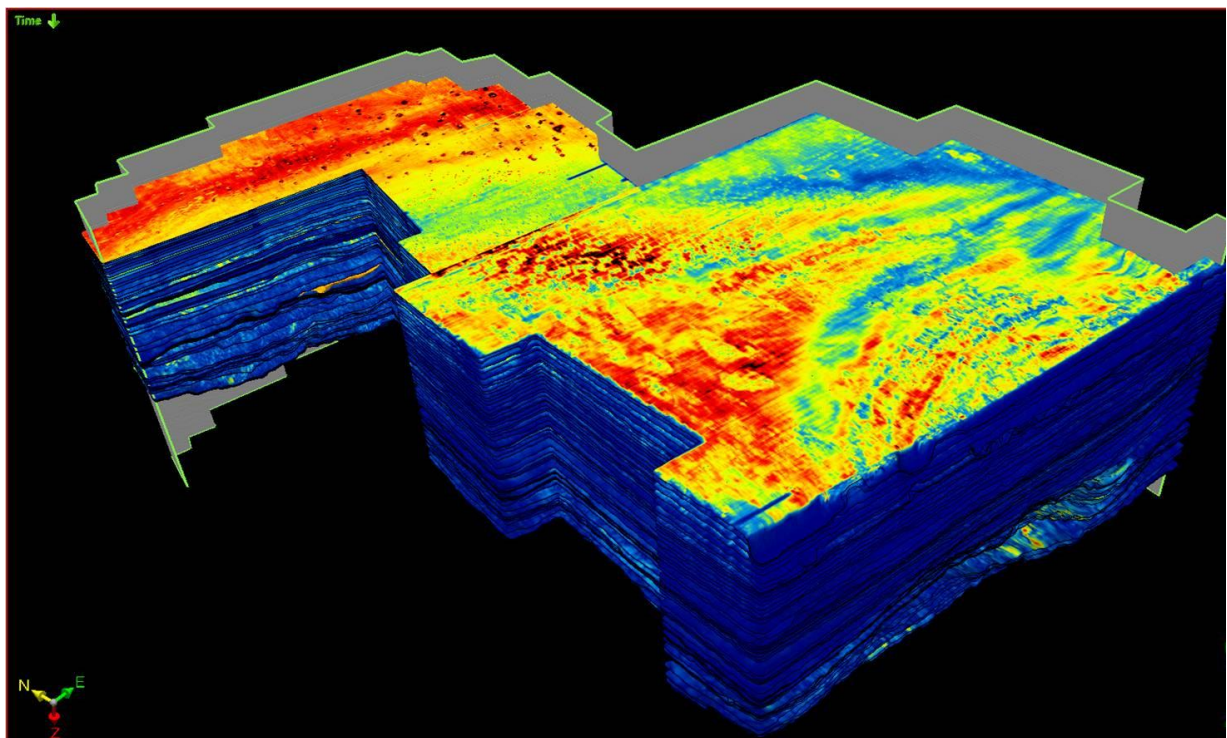


Figure 1. Spanish Point 3D GeoModel Horizon Stack example

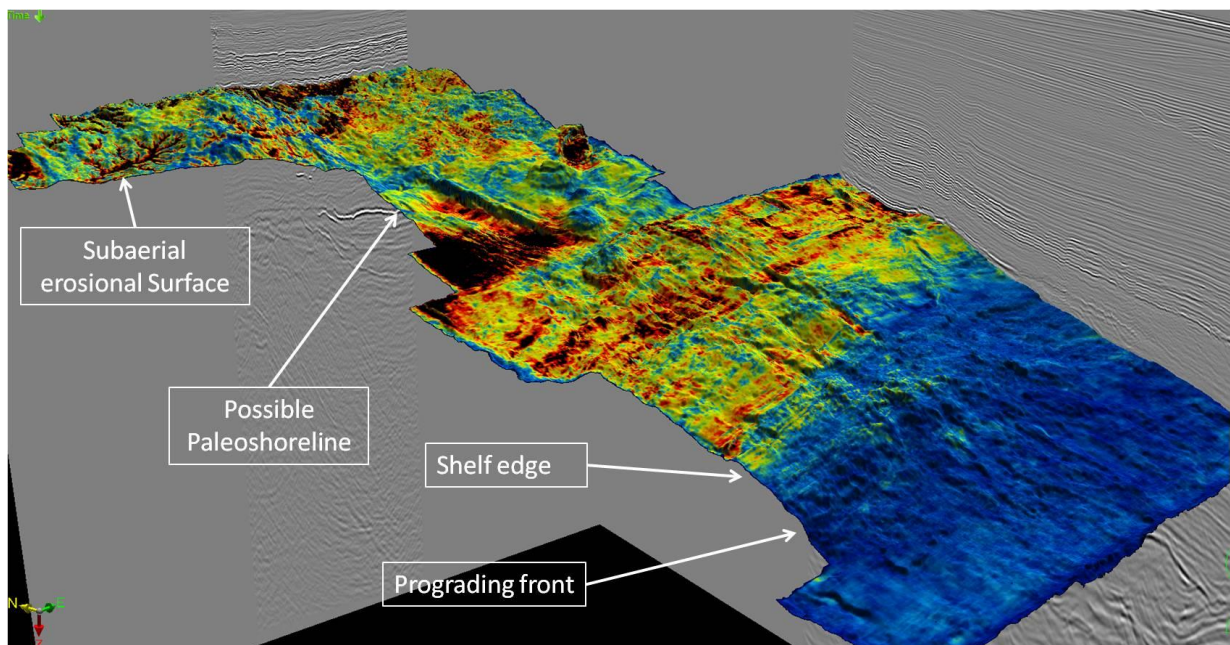


Figure 2. Paleogene Horizon extract - Sub-aerial exposure to slope

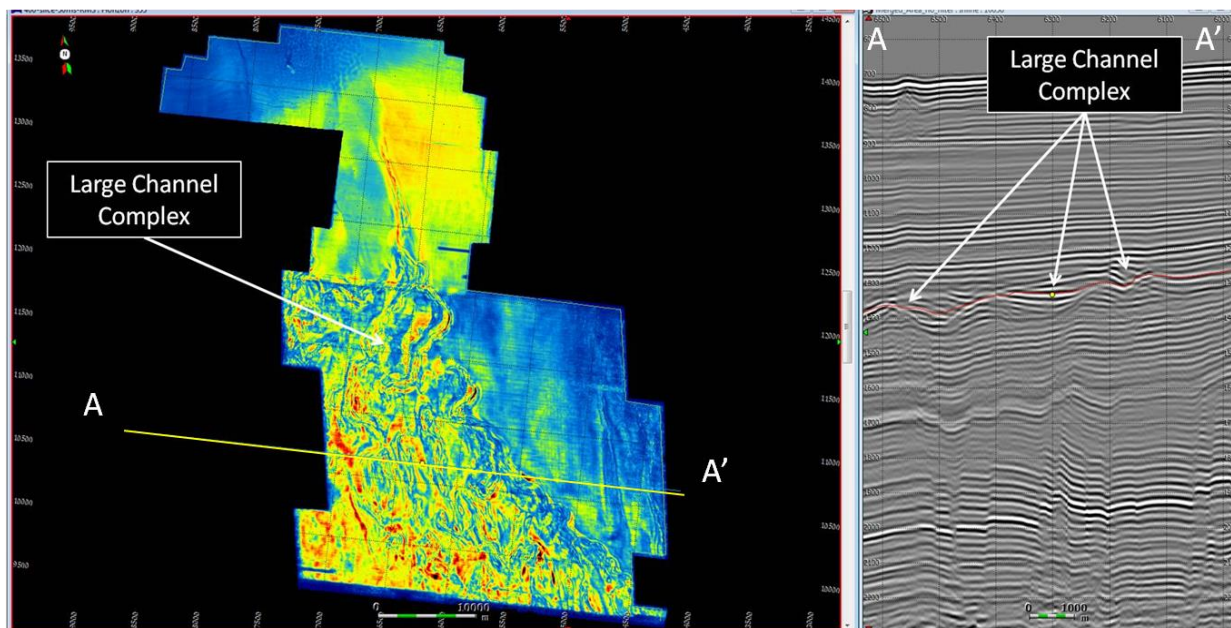


Figure 3. Extensive Oligocene channel system

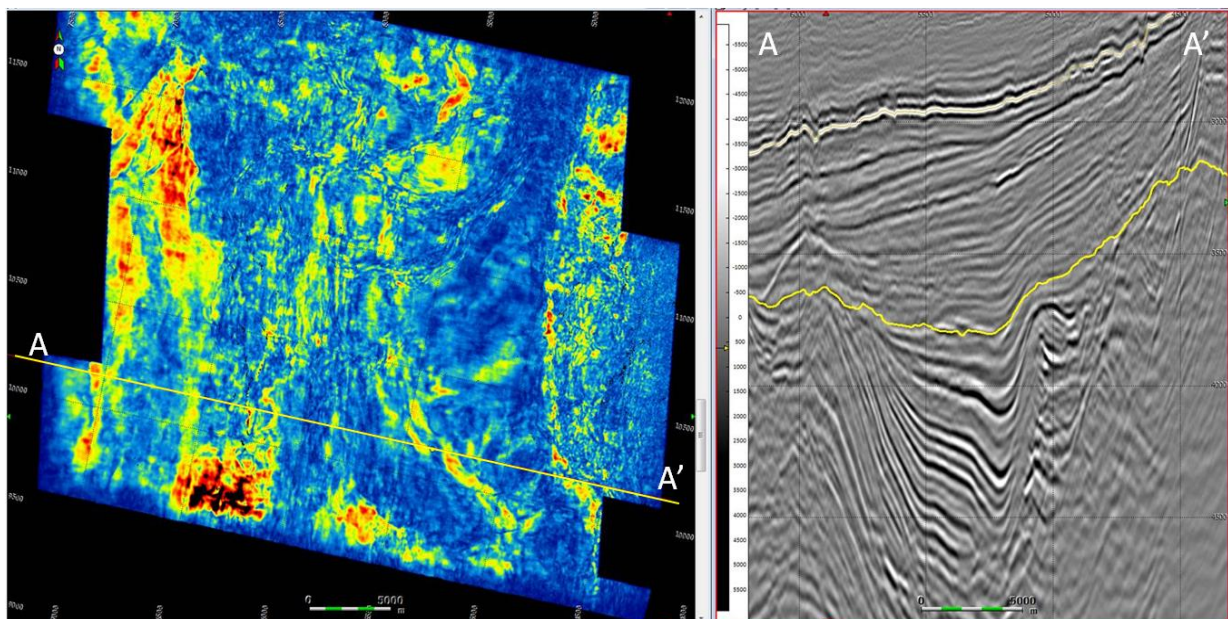


Figure 4. Cretaceous Channel System example



## Deep structure of the northern Porcupine Basin from wide angle seismic and multichannel seismic data

Prada, M.<sup>1</sup>, Watremez, L.<sup>2</sup>, Chen, C.<sup>2,3</sup>, O'Reilly, B.<sup>1</sup>, Minshull, T.<sup>2</sup>, Reston, T.<sup>4</sup>, Wagner, G.<sup>5</sup>, Gaw, V.<sup>5</sup>, Kläschen, D.<sup>5</sup>, Shannon, P.<sup>6</sup>

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<sup>2</sup> University of Southampton

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<sup>6</sup> University College Dublin

The Porcupine Basin is a triangular-shaped basin located southwest of Ireland in the Atlantic margin. Its formation is the result of several rifting and subsidence phases during Late Palaeozoic and Cenozoic, with the most pronounced rift phase occurring in Late Jurassic–Early Cretaceous times. The sedimentary sequence and tectonic structure in the northern part of the basin are reasonably constrained by a large amount of reflection seismic and borehole data. However, there is a large uncertainty concerning the central and southern parts of the basin. For instance, there is still ongoing debate concerning the nature of the Porcupine Median ridge (PMR), a NS-ridge feature that extends southwards in the basin. This ridge has been interpreted during the last three decades variously as a volcanic structure, a partially serpentinised mantle diapir, or as a tilted continental block [Reston et al., 2004; Calves et al., 2012]. Other uncertainties concern crustal thickness variations and the extent of mantle serpentinisation. Previous work, focusing on wide angle seismic (WAS) and potential field data, suggests that the crust is extremely thin in the central part of the basin and that the underlying mantle might be serpentinised [O'Reilly et al., 2006; Readman et al., 2005]. However, variations in crustal thickness and the extent of serpentinisation along the basin axis are still poorly constrained. All these aspects, the nature of the PMR, along-axis crustal thickness variations, and mantle serpentinisation are all important questions that need to be addressed to constrain the rift and thermal evolution of the basin.

In this talk we present the initial results of an integrated geophysical and geological study that tackles these issues by quantifying variations in crustal geometry, and seismic properties along the basin axis and towards mainland Ireland. The main data set of this study consist of WAS data acquired in 2004 along 5 transects across and along the basin, and recorded by both ocean-bottom seismic receivers and land stations (Fig.1). We have used a joint travel time inversion method to model the WAS data and retrieve the 2D P-wave velocity ( $V_p$ ) structure of the crust and uppermost mantle, together with the geometry of major geological interfaces (e.g. Moho). The outcome is then combined with coincident seismic reflection profiles to each WAS line and additional borehole information to better constrain the crustal structure of the basin. Here we present the results obtained along lines P1-5, P3, and P6 (Fig.1).



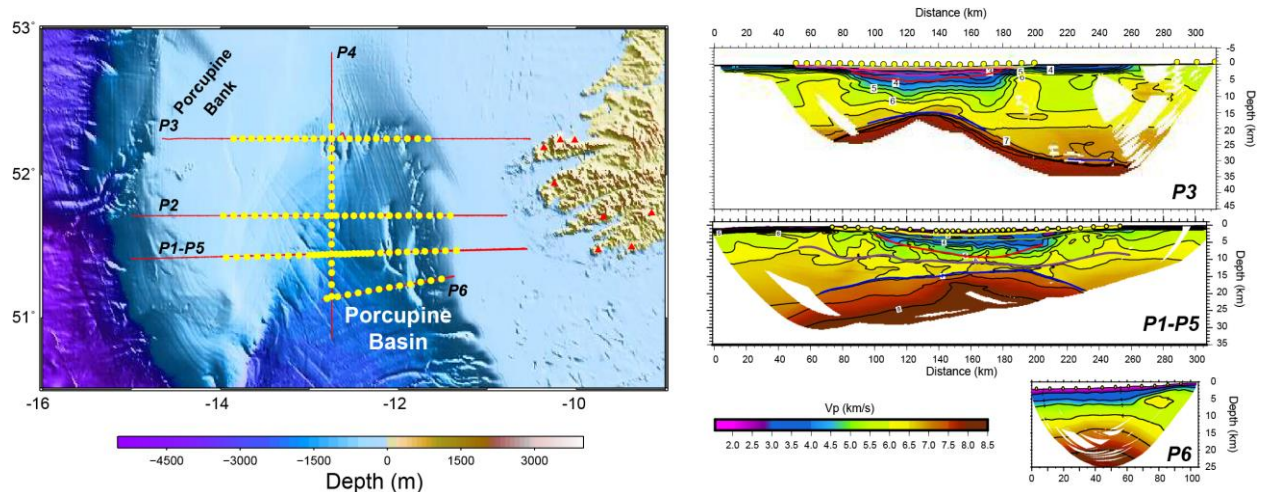


Figure 1. (Left) Bathymetry map of the Porcupine Basin depicting the location of WAS lines of the project (red lines), as well as the location of ocean bottom seismometers (yellow circles) and land stations (red triangles) used to record the data. (Right) From top to bottom, P-wave velocity models of lines P3, P1-5, and P6. Models P3 and P1-5 also include the geometry of several sedimentary reflectors and the Moho (blue line).

Overall, the three Vp tomography models display the geometry of a thick (5-8 km) sedimentary basin with Vp that varies between 1.5 km s<sup>-1</sup> at the top to 4.5-5.0 km s<sup>-1</sup> at bottom (Fig. 1). The velocity structure of the underlying crust, down to the Moho shows Vp between 5.5 to ~7.0 km s<sup>-1</sup> (Fig. 1). Below this, the mantle shows Vp between 7.5 and 8.0 km s<sup>-1</sup>. These are anomalously slow for normal mantle and might indicate serpentinisation. However, the uncertainty of these Vp needs to be carefully analysed as this part of the model is not so well constrained due to sparse ray density. Crustal thickness variations show an asymmetric crustal thinning that is particularly obvious along transect P1-5. The minimum stretching factor ( $\beta$ ) along the basin axis varies from 5-6 in the north to >10 in the south. These values are well within the range of crustal extension ( $\beta \sim 3.5$ ; Perez-Gussinye et al., 2003) at which the crust becomes entirely brittle allowing the formation of major crustal faulting and serpentinisation of the mantle. Interestingly, the PMR is imaged showing Vp of 5.0-5.7 km s<sup>-1</sup>. These velocities can support either of the three possible interpretations aforementioned. However, the presence of high velocities in the sedimentary layer coinciding with sill-like reflections in the seismic reflection profile suggests the presence of volcanism in the area, which would support the volcanic nature of the ridge. Further analysis of S-waves might provide more information to this issue.

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

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## **iCRAG – Progress to date and plans for 2016**

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iCRAG is a newly formed national centre for applied geoscience research in Ireland, performing research which is designed to deliver economic impact for a broad range of application areas and industries. Supported by Science Foundation Ireland and industry partners for the next six years, and conducted by academics in all of the geoscience schools in Irish universities (UCD, TCD, NUIG, UCC, NUIM and DIAS), iCRAG's research programme consists of four cohesive topics or 'spokes' in the areas of groundwater, hydrocarbons, marine geoscience and raw materials, which are built around four enabling technology and equipment based 'platforms' which focus on geophysical sensing and imaging, geochemistry, 3D geological modelling and public perception and understanding. iCRAG's research will capitalise on Ireland's unique geological resources, including its unusually extensive and highly prospective offshore basins, its world-class base metal deposits and its world-class lowland karst and fractured bedrock aquifers. The principal goal is to embed the outcomes of high quality research within industry practice in Ireland and overseas.

This talk focuses on our hydrocarbons and marine research 'spokes', outlining a variety of recently initiated and planned PhD and Post-Doc projects within the following Targeted Projects: (i) Sediment tracking, (ii) Basin evolution and petroleum systems, (iii) Reservoir modelling and software development, (iv) Unconventional hydrocarbons, (v) Global Subsurface Training Centre in Clare, (vi) Marine Acoustics, (vii) Enhancing knowledge and understanding of Ireland's seabed and (viii) Marine remote sensing applications. Whilst the research will be conducted in several so-called Targeted Projects, the research programme will be multi-disciplinary in nature, promoting the development of across-spoke and inter-project technical linkages.

## **Tectono-stratigraphic evolution of the Porcupine Basin: observations and insights from a new rock based regional study**

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Recent renewed industry focus on Atlantic Ireland has engendered multiple new seismic studies in the Porcupine Basin, so it is imperative that we revisit the rock record at this time, in order to provide 'ground truth' constraint for new and evolving regional exploration models. Although the Porcupine Basin has been subject to hydrocarbon exploration for many years, the basin as a whole is still greatly under-explored with scope for much additional geological knowledge to be gained, particularly regarding the controls on development and preservation of reservoir, source and seal rock facies across the region. While the previous exploration campaigns had limited commercial success, the rock samples and well log data generated by these earlier drilling phases constitute a highly valuable source of geological information and thus can be closely investigated for clues to the tectonic evolution of the basin.

The geological datasets from the 30 released wells in the Porcupine Basin include an impressively archived suite of high quality geological reports, representing numerous operator and contractor specialist studies. However, most projects were performed as single well or single discipline evaluations spanning several decades, and so datasets are preserved in a variety of (mainly non-digital) formats which do not readily facilitate integration and interpretation. So, in response to the industry requirement for a fully integrated geological evaluation of the basin, and also following on from the success of our regional geological studies across the South, Equatorial and Central Atlantic Margins, we have recently completed a new comprehensive rock-based study of the Porcupine Basin, representing the first phase of our North Atlantic Margin evaluation.

Systematic evaluation of all the existing geological information in the basin, combined with new stratigraphical interpretation and new sedimentological, petrographical and seal rock analyses, has facilitated the reconstruction of a detailed tectonic-stratigraphic history for the Carboniferous to Late Tertiary basin-fill succession and has allowed mapping of reservoir and seal rock distribution across the region. In particular, detailed well to well correlation of facies through successive stratigraphically-defined, depositional packages has allowed delineation of sediment transport pathways from basin margin sources to inner and axial basin depocentres and has highlighted the presence of significant rift and post-rift structural features which created a highly segmented basin and caused marked lateral variations in preservation of reservoir and source/seal rock facies. Construction of sedimentary logs for the full drilled succession in each well, combined with new detailed interpretation of all core material, has also provided interesting insights into the controls on sedimentation patterns throughout basin evolution, particularly during the main Jurassic rift phase and succeeding prolonged Early Cretaceous 'rift transition' phase, when the basin was characterised by a complex system of variably interconnected shallow and deepwater basins, with partly restricted, and often tortuous, marine circulation patterns.



### **A unified seismo-stratigraphic model for the North Atlantic Conjugate Margin Basins coupled with palaeoclimate modelling: Implications for petroleum exploration in Atlantic Ireland**

Windmill, R.<sup>1</sup>, Fowler, A.<sup>1</sup>, Caughtry, N.<sup>1</sup>, Cherry, S.<sup>1</sup>, Davison, S.<sup>1</sup>, Fenton, J.<sup>1</sup>, Fielding, L.<sup>1</sup>, Ford, J.<sup>1</sup>, Gilman, C.<sup>1</sup>, Graham, R.<sup>1</sup>, Harris, J.<sup>1</sup>, Healey, F.<sup>1</sup>, Humphreys, S.<sup>1</sup>, Jarvis, E.<sup>1</sup>, Papworth, T.<sup>2</sup>, Peacock, L.<sup>1</sup>, Pyman, S.<sup>1</sup>, Swierczek, M.<sup>1</sup>

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<sup>2</sup>Consultant Geophysicist

The break-up history of the North Atlantic Conjugate Margin, coupled with modelled palaeoclimatic variation, provides fundamental controls on petroleum systems in the Atlantic Ireland, Canadian and Iberian Basins. The timing and geometry of the break-up has been modelled and in this light a new unified stratigraphic model has been developed for the conjugate margin basins, built on a unique stratigraphic knowledge base in this area; where required, new analysis of biostratigraphic data and geochemical samples provided by PAD, CNLOPB and ENMC has been undertaken together with the re-interpretation of legacy reports. The biostratigraphic database comprises some 60 wells, including ca. 27 wells in offshore Irish basins, ca. 23 wells from offshore Newfoundland and ca. 8 wells from basins offshore Portugal. A substantial in-house geochemical database has been supplemented by new geochemistry data from ca. 7 wells in offshore Irish basins, ca. 8 wells from offshore Newfoundland and ca. 7 wells from basins offshore Portugal. Together these datasets underpin new concepts for the development of hydrocarbon charge in the Atlantic Ireland basins. Seismic interpretation of new as well as vintage seismic using biostratigraphically defined events has been undertaken in Ireland, Canada, and Portugal. These data have allowed hiatal surfaces to be picked across the conjugate margin. The identification of the geographical extent and genetic relationships between the pre-rift, syn-rift and post-rift stratigraphy has provided new insights into the rift – drift history of the North Atlantic region that have important implications for future exploration. Coupled with regional palaeogeographic mapping and palaeoclimate modelling this approach provides unique regional insights that have direct implications for exploration in Atlantic Ireland.

## Developing a tool to predict the distribution of seabirds

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<sup>1</sup> University College Cork. Email: [J.Quinn@ucc.ie](mailto:J.Quinn@ucc.ie)

### Introduction

Seabird populations are protected under EU legislation and in the event of accidental oil pollution are very much in the spotlight. With the steadily growing fossil fuel industry in Ireland, and the obligation to protect its globally significant seabird populations, stakeholders need to ensure suitable management plans are in place and improved wherever possible. Seabirds breed on the coast where their population sizes are for many species reasonably well known. However they spend the majority of their life at sea, though exactly where is poorly known. This project combines state of the art GPS tracking with new modelling approaches to determine abundance and diversity hot-spots of seabirds along the Irish West Coast in a time- and cost-efficient manner.

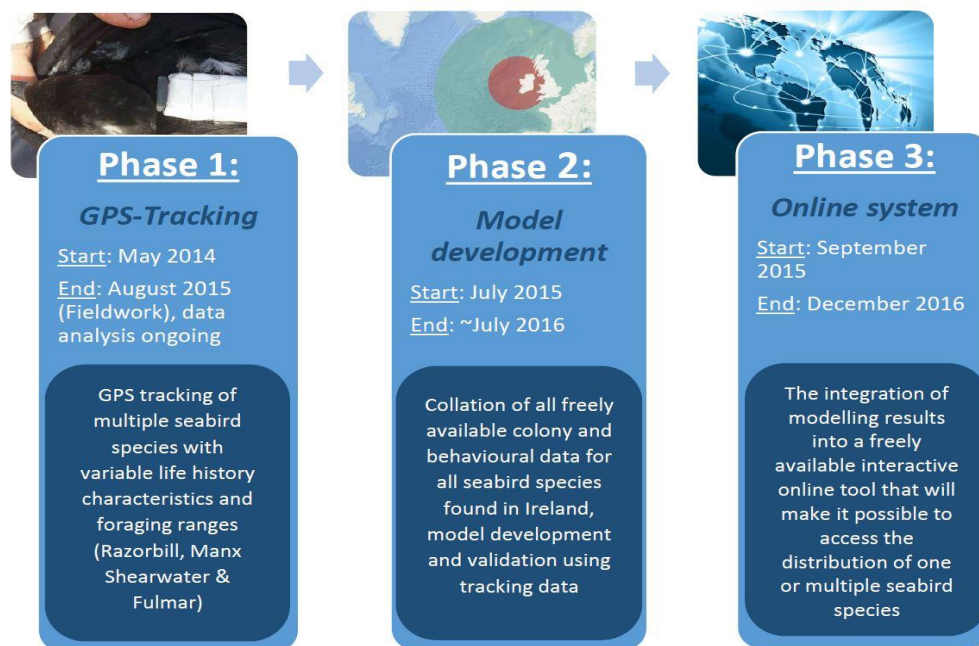


Figure 1. Phases of project

### Phase 1: GPS-Tracking

GPS tracking of local seabirds is essential for the model validation process and improves the general understanding of their at-sea behaviour.

During the first field season in the summer of 2014, tracking and surveying of chick-rearing adult Razorbills, a short-ranging seabird, on Great Saltee, Co. Wexford showed consistent departure directions and foraging sites in a 60km radius around the colony (Figure 2).

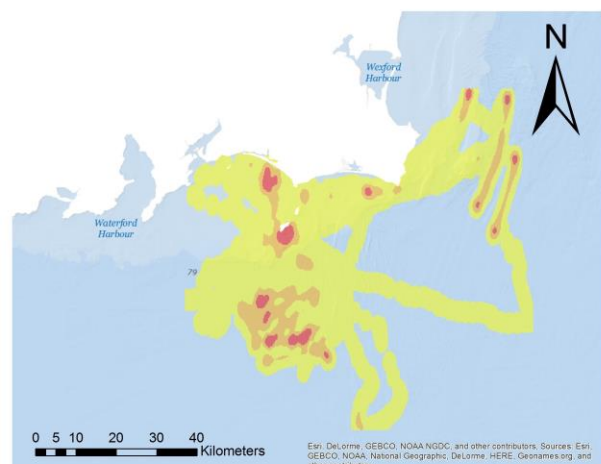


Figure 2. Kernel density estimation for tracked Razorbills (N=13)

In addition, tracking of 12 chick-rearing Manx Shearwater at two sites along the Irish West Coast (Great Blasket, Co. Kerry, and High Island, Co. Galway) revealed foraging trips up 3400 km to the Mid-Atlantic, four times longer than previously observed for this species, underlining the importance of local data for model validation. Other consistent foraging areas in Galway Bay and close to the Outer Hebrides, UK, could be identified (Figure 3).

During the summer of 2015 a further 63 GPS tags were successfully deployed on the same species on both Islands. With about 200 individual tracks this comprises one of the biggest tracking data sets ever collected for a seabird species during one field season. The data is currently being analysed and prepared for publication.

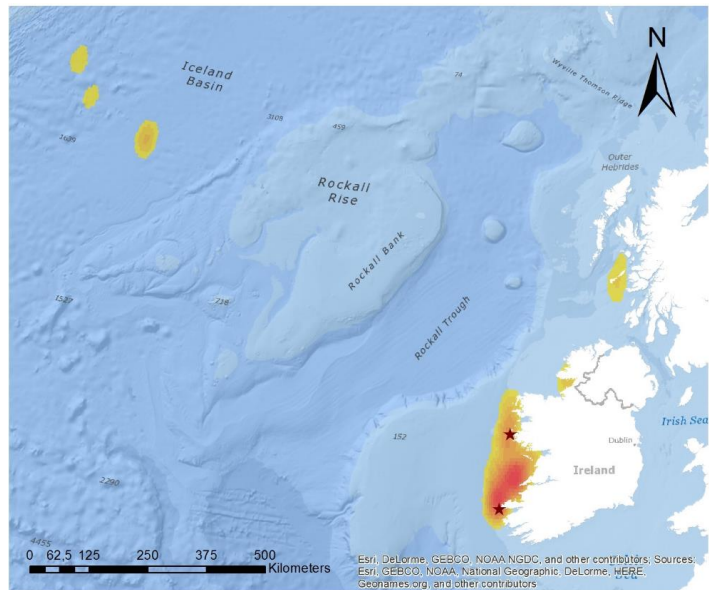


Figure 3. Kernel density estimation for Manx Shearwater tracked 2014. Stars indicate study sites. (N=12)

## Phase 2: Database collation and model construction

A predictive distribution model is being developed that will produce maps showing both the extent and density of birds in 1km<sup>2</sup> grid squares up to a distance of 400km from the colony. The model will be developed in stages, with greater complexity being added at each successive stage – incorporating data on colony locations, size and species foraging behaviour (Figure 4). Predictive distribution maps will be produced for key seabird species found on the west coast of Ireland.

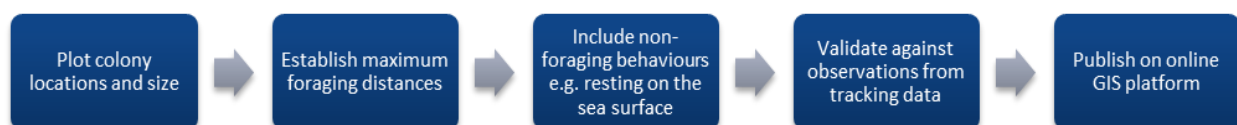


Figure 4. Schematic of model development process

## Phase 3: Building an online system

The distribution maps produced from the model will be incorporated into an online GIS platform. From a drop-down menu users will be able to select whether to view distribution maps for an individual species or to overlay maps for all / groups of species, identifying areas with high densities of the most vulnerable species. It will be possible to group species according to foraging behaviour (e.g. surface feeders vs. divers) or conservation significance.

This project is funded by the Petroleum Infrastructure Programme (PIP) and has indirectly led to the funding of two parallel and complementary projects by Science Foundation Ireland (SFI) and National Parks & Wildlife Services (NPWS).



## **Spatial decision support for oil spill management**

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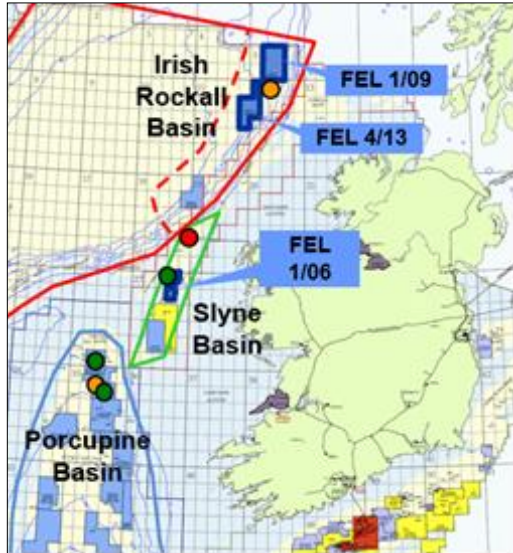
The main aim of this project is to develop a prototype geospatial decision support platform to provide more effective information management when responding to oil-pollution incidents in the marine environment. The research objectives include designing, building and assessing a scalable cloud-based Geoinformatics platform architecture using a real-world oil-spill exercise. Particular focus has revolved around role of data inputs from Satellite Remote Sensing, Drones and Mobile Devices e.g. Smartphone App.

The geospatial platform, comprising; ingestion, storage, discovery, fusion, analysis, visualisation and reporting modules, has been completed. These modules are designed around a Common Operational Picture (COP) structure where an Administrator or Emergency Coordinator can input team members, configure response logistics, initiate incidents, mobilise teams, task responders and observers, collate 'live' information from the field, carry-out damage-assessment, implement response plans and record all activity. The platform, Smartphone app was tested using a live Oil-Spill exercise in April 2015. Technology and work-flow refinements, identified during that exercise, are currently being applied to the systems. A number of organisations have already registered interest in this emergency pollution response platform.

## Prospects 2 Go - There's more to Atlantic Ireland than Porcupine: The merits of the Slyne and Rockall basins

Pritchard, G. <sup>1</sup>

<sup>1</sup>Serica Energy. Email: [graham.pritchard@serica-energy.com](mailto:graham.pritchard@serica-energy.com)

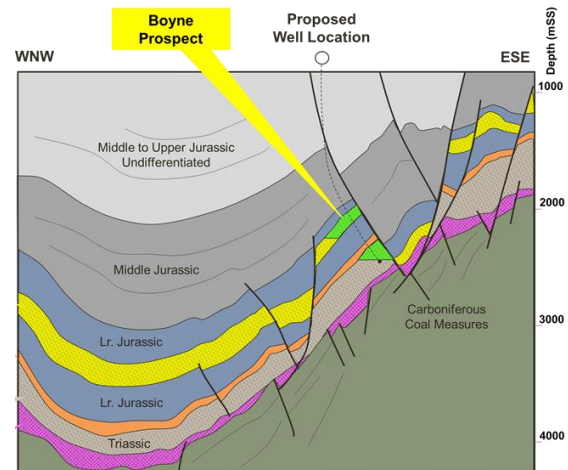


### Basin

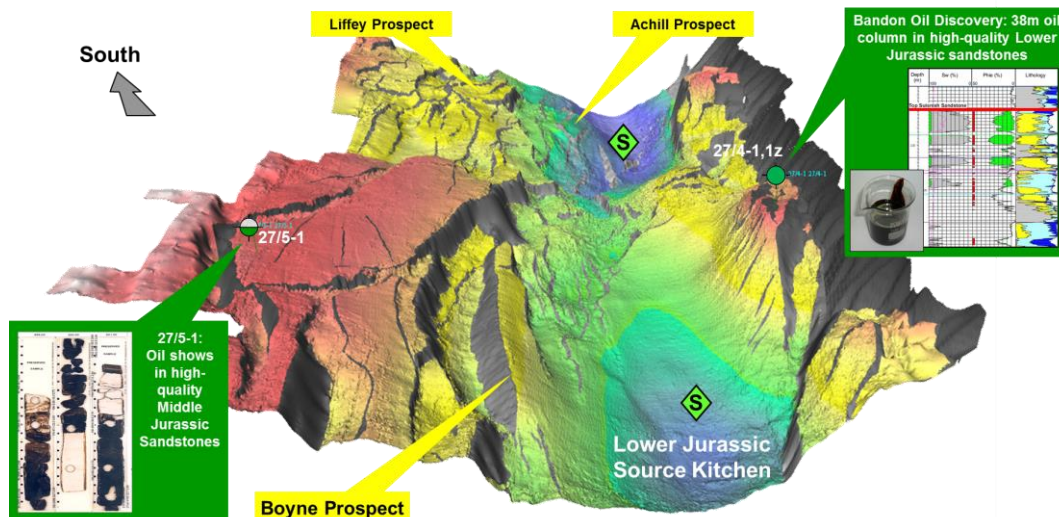
The Slyne Basin contains the Bandon oil discovery (27/4-1,1z), drilled by Serica in 2009, which encountered a 38m oil column within a high-quality early Jurassic sandstone reservoir, and the Corrib Gas Field, some 40kms to the north of Bandon, which has over 1tcf recoverable gas within a thick Triassic Sherwood Sandstone reservoir.

The Irish Atlantic Porcupine, Slyne and Rockall basins lie on trend with other proven prospective North Atlantic basins NW Europe, including those of the West of Shetlands, Faroes and Norwegian margins. All three Irish Atlantic basins contain hydrocarbon discoveries at numerous geological levels. The Slyne and Rockall basins can be viewed as a northerly continuation of the Porcupine Basin and contain similarly diverse plays. Proven reservoirs range from Carboniferous, Permian, Triassic, Jurassic and Cretaceous, with proven source rocks in the Carboniferous, Lower Jurassic and Upper Jurassic.

### Slyne



The Boyne Prospect is located within licence FEL 1/06, half way between the 27/4-1 Bandon Discovery and the 27/5-1 well. It is a clearly defined tilted fault block mapped on 3D seismic data, with reservoir potential at both Jurassic and Triassic levels. It carries a P<sub>50</sub> potentially-recoverable resource of 67mmbo in the Jurassic, and 49mmbo in the Triassic (Serica in-house estimates). The Boyne Prospect, which is located in water depths of around 230m, is ready to drill.

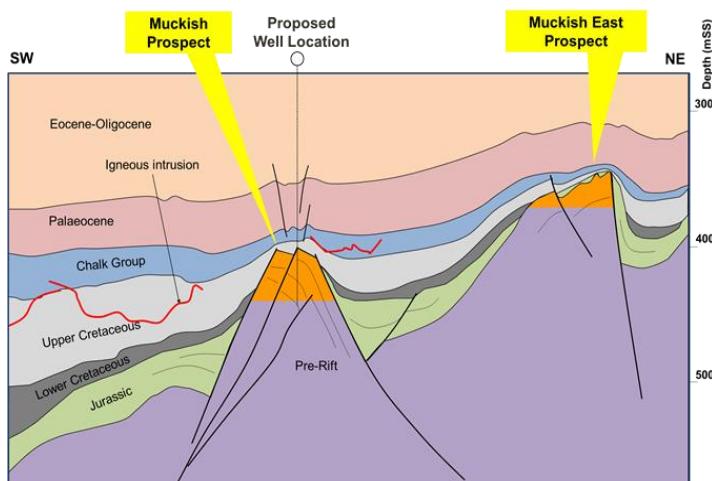
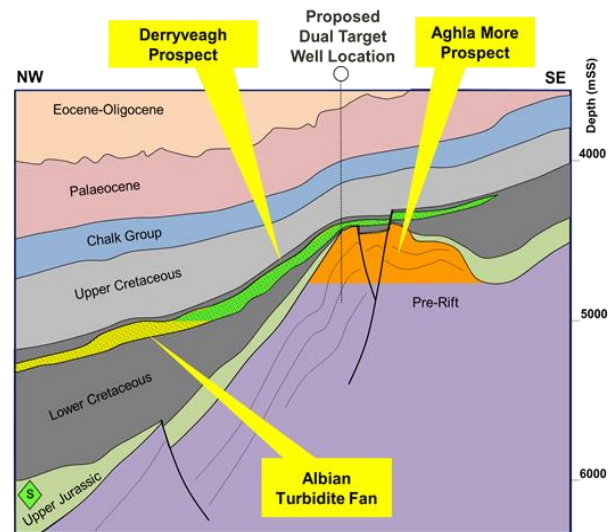


## Rockall Basin

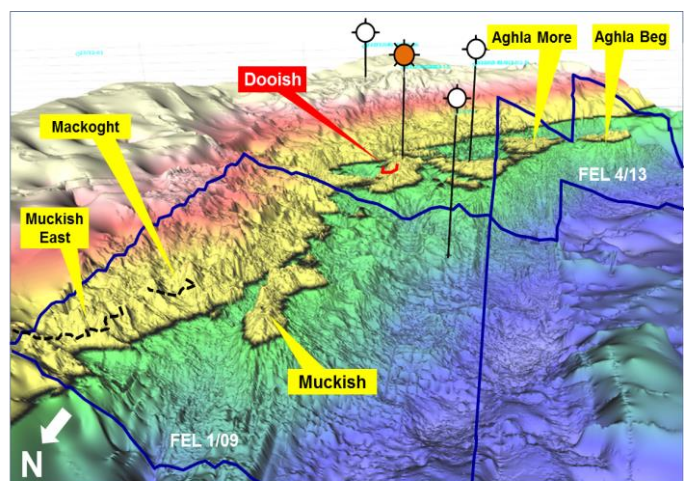
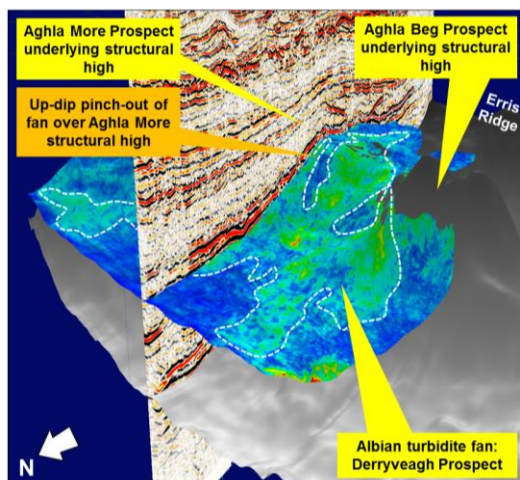
The Rockall Basin contains the Dooish Discovery, with 265bcf gas and 17mmmbbls condensate contained within thick sandstone reservoirs of Permian and Middle Jurassic age.

Licence FEL 4/13 is located immediately to the west of Dooish. It contains a significant early Cretaceous stratigraphic target in the form of a turbidite fan (the Derryveagh Prospect) mapped on 3D seismic data at Albion level onlapping the flanks of the underlying Aghla More structure.

Both the Derryveagh fan and the underlying Aghla More Prospect could be targeted with a single exploration well. Derryveagh carries a  $P_{50}$  potentially-recoverable resource of 84 mmmbbls condensate + 1.3 tcf gas and Aghla More carries a  $P_{50}$  potentially-recoverable resource of 94 mmmbbls condensate and 1.4 tcf gas.



Licence FEL 1/09 lies immediately to the north of Dooish, and contains the Muckish Prospect, a significant pre-rift tilted fault block structure mapped on 3D seismic data. The structure is analogous to Dooish, and by analogy, gas-condensate charged sandstone reservoirs of Permian to Middle Jurassic age are anticipated, although reservoirs of other ages are also possible. Muckish carries a  $P_{50}$  potentially-recoverable resource of 85 mmmbbls condensate + 1.3 tcf gas.





## Prospects 2 Go - Midleton Well – Planning and Execution

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The Midleton exploration well – 49/11-3 – was the first well drilled in the Celtic Sea since 2011 and only the ninth well in 10 years in the North Celtic Sea basin. It is also the first exploration well drilled offshore Ireland since the introduction of the Petroleum Safety Framework (PSF) regime in 2013.

The well was drilled to target Lower Cretaceous Greensand and Upper Wealden sands on a trend of inverted structures along the northern margin of the basin. The prospect was included in a 3D seismic survey undertaken by Lansdowne Oil & Gas, the previous operators of Standard Exploration Licence 04/07, prior to a farm-in by PSE Kinsale Energy (a subsidiary of PETRONAS) in early 2015.

The Licence obligation is to drill an exploration well by end-2016 and initial well planning was undertaken on this basis. However, an opportunity arose to contract a drilling rig being mobilised to Ireland in 2015 for Shell and the well schedule was accelerated accordingly. The decision to plan for a 2015 well slot was confirmed in Feb 2015, with a target spud date at the end of July, to match the expected completion of Shell's Corrib Field program. This gave a window of six months to complete all of the preparatory work including:

- Preparation of Environmental and Appropriate Assessment documents
- Preparation of Safety Cases
- Well Design and Verification

- Operational Planning
- Organisational Planning
- Equipment and Services Procurement
- Rig Contracting

The paper describes the approach taken to achieve these challenging milestones and ensure that the risks associated with such a tight schedule were adequately anticipated and risk mitigations implemented.

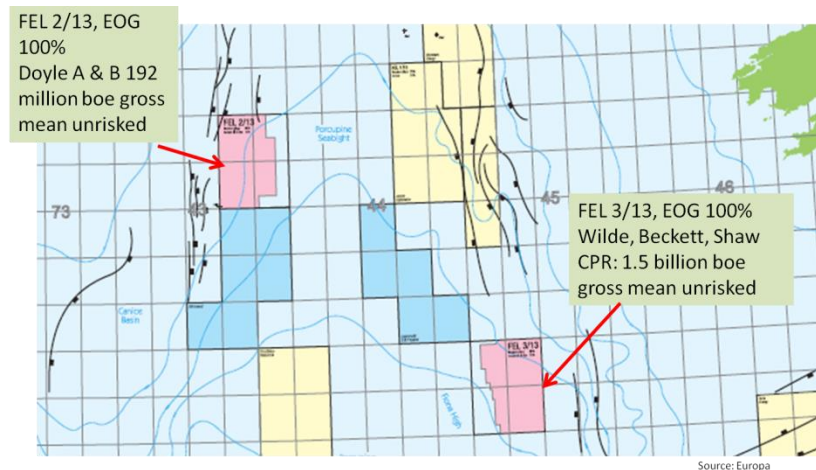
The well was an operational success and was drilled in the period July-August 2015. A brief summary of well operations is also provided.

## Prospects 2 Go - Recent developments in the Porcupine Basin

Mackay, H.<sup>1</sup>

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Europa Oil & Gas (Holdings) plc, the AIM quoted oil and gas company with producing and exploration assets in Europe, announces that, subject to an application being made to the Irish Authorities and approval granted, it intends to assume 100% interest in, and operatorship of, licences FEL 2/13 and FEL 3/13 in the Porcupine Basin, offshore Ireland. This follows Kosmos Energy Ireland's ('Kosmos') decision to exercise its option to withdraw from the Joint Operating Agreements for both licences. Europa intends to seek farm-in partners with whom to share the future exploration of these licences.



The exploration model for these licences is the Cretaceous stratigraphic play: comprising Early Cretaceous turbidite sandstone reservoirs; charged by mature Late Jurassic and Early Cretaceous source rocks and contained in stratigraphic traps with elements of structural closure. The Cretaceous play in Ireland is essentially undrilled and is considered to be analogous to the same play in the equatorial Atlantic Margin province that has delivered the Jubilee and Mahogany oil fields.

2,565 km<sup>2</sup> of 3D seismic data was acquired in H2 2013 over FEL 2/13 and 3/13. The final processed data set was delivered in Q2 2014 and the operator Kosmos delivered a prospect inventory in Q4 2014 (see RNS of 8 December 2014). Europa followed on from this work by Kosmos and conducted its own independent prospect mapping over both licences. This mapping provided the basis for a Competent Persons Report (CPR) by ERC Equipoise (ERCE) on the prospects and risks in FEL 3/13. A summary of the CPR is tabulated below and was provided to the market in an RNS dated 12 May 2015. The CPR identifies gross mean un-risked Prospective Resources of approximately 1.5 billion barrels of oil equivalent (boe) across three prospects in FEL 3/13 and gross mean risked Prospective Resources of 235 million boe.

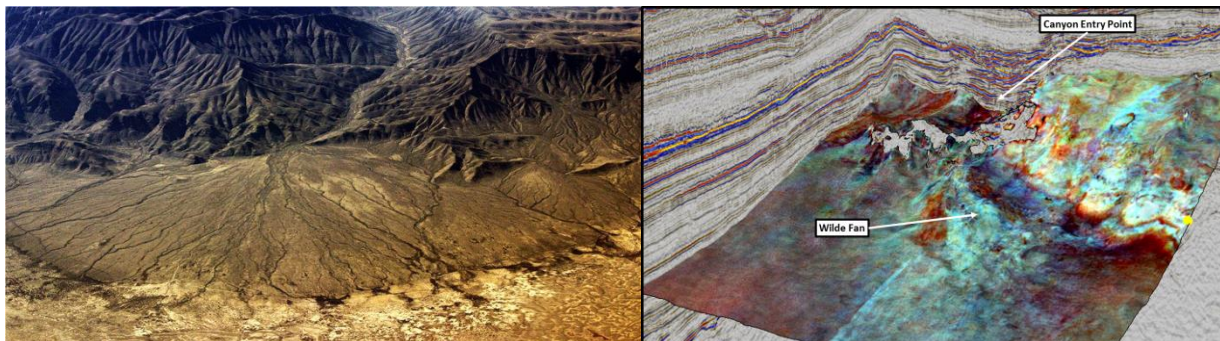
FEL 3/13	Gross Prospective Resources mmbœ*						
	Un-risked				Chance of success	1 in	Gross mean risked
Prospect	Low	Best	High	Mean			
Wilde	61	239	952	428	19%	5.3	81
Beckett	109	424	1661	749	15%	6.7	112
Shaw	57	198	681	315	13%	7.7	41
<b>Total</b>	<b>227</b>	<b>861</b>	<b>3294</b>	<b>1492</b>			<b>235</b>

\*million barrels of oil equivalent, using a conversion factor of 6 mscf per stb. The hydrocarbon system is considered an oil play. However, due to significant uncertainties in the available geological information, there is a possibility of a gas charge. Note: the Total row is a deterministic sum



## ATLANTIC IRELAND 2015

The three prospects Beckett, Wilde and Shaw have Cretaceous submarine fan sandstone reservoirs and are part of the Cretaceous submarine fan hydrocarbon play. As a consequence of its detailed work in preparation for the CPR Europa has identified both a prospect and shotpoint location for what would be a play-opening first well in FEL 3/13.



In addition to the CPR Europa also commissioned ERCE to complete an independent assessment of the value of its then 15% carried interest in FEL 3/13. The results of the study were released to the market in an RNS on 16 June 2015 and ERCE estimated a mean un-risked Net Present Value ('NPV') of approximately US\$1.6 billion to Europa's 15% net interest in three prospects; Wilde, Beckett and Shaw. On a risked basis the results of this study estimate a mean risked NPV of US\$251 million. These prospects are at the pre-drill stage and realisation of this potential value will require the drilling of exploration wells. Un-risked and risked NPV at a 10% discount rate (NPV10) for a 15% carried interest as at 1 January 2015 for the Low, Best and High estimates of Prospective Resources are tabulated below:

	Gross Prospective Resources mmboe*			Net Un-risked NPV10 (US\$ million)				Chance of Success	Net Risked NPV10 (US\$ million)
Prospect	Low	Best	High	Low	Best	High	Mean	(%)	Mean
Wilde	61	239	952	- 10	109	1,227	408	19%	78
Beckett	109	424	1661	- 10	400	2,366	867	15%	130
Shaw	57	198	681	- 10	110	970	332	13%	43
Total							1607		251

In FEL 2/13 Kosmos had previously identified gross mean Prospective Resources of 123 mmbo in Prospect Doyle A and 69 mmbo in Doyle B. Europa has identified additional prospectivity at other stratigraphic levels and further technical work will be completed before considering commissioning a CPR on this licence.

Subject to approval of the Irish Government for the transfer of interest and operatorship Europa's next steps on assuming 100% interest will be to open a farm-out data room with the purpose of obtaining partners for the licences. The formal opening of the data room will most likely follow announcement of awards in the 2015 Atlantic Margin Licensing Round.

## Prospects 2 Go - Southern Porcupine and Goban Spur prospects reviewed using new 2014 2D/3D seismic data

Byrne, K.<sup>1</sup>

<sup>1</sup> Providence Resources plc. Email: [kbyrne@providenceresources.com](mailto:kbyrne@providenceresources.com)

Since first entering the area in 2004, Providence Resources and Sosina Exploration have become the leading acreage holders in the frontier deep-water southern Porcupine and Goban Spur basins. In the interim, the companies have acquired and/or underwritten the acquisition of both 2D as well as 3D seismic data in these basins. Providence/Sosina were also responsible for the generation of the **Dunquin North** Lower Cretaceous carbonate exploration prospect (which was drilled by ExxonMobil in 2013) and also hold a significant acreage position in the adjacent northern Porcupine Basin (where three 3D seismic surveys have been acquired in the **Spanish Point** area since 2009). This presentation will provide an initial review of the 2D and 3D seismic data acquired in 2014 in the southern Porcupine and Goban Spur basins over the Paleocene **Druid** and Lower Cretaceous **Drombeg** and **Newgrange** exploration prospects. All three prospects are operated by Providence (80%) on behalf of its partner Sosina Exploration (20%).

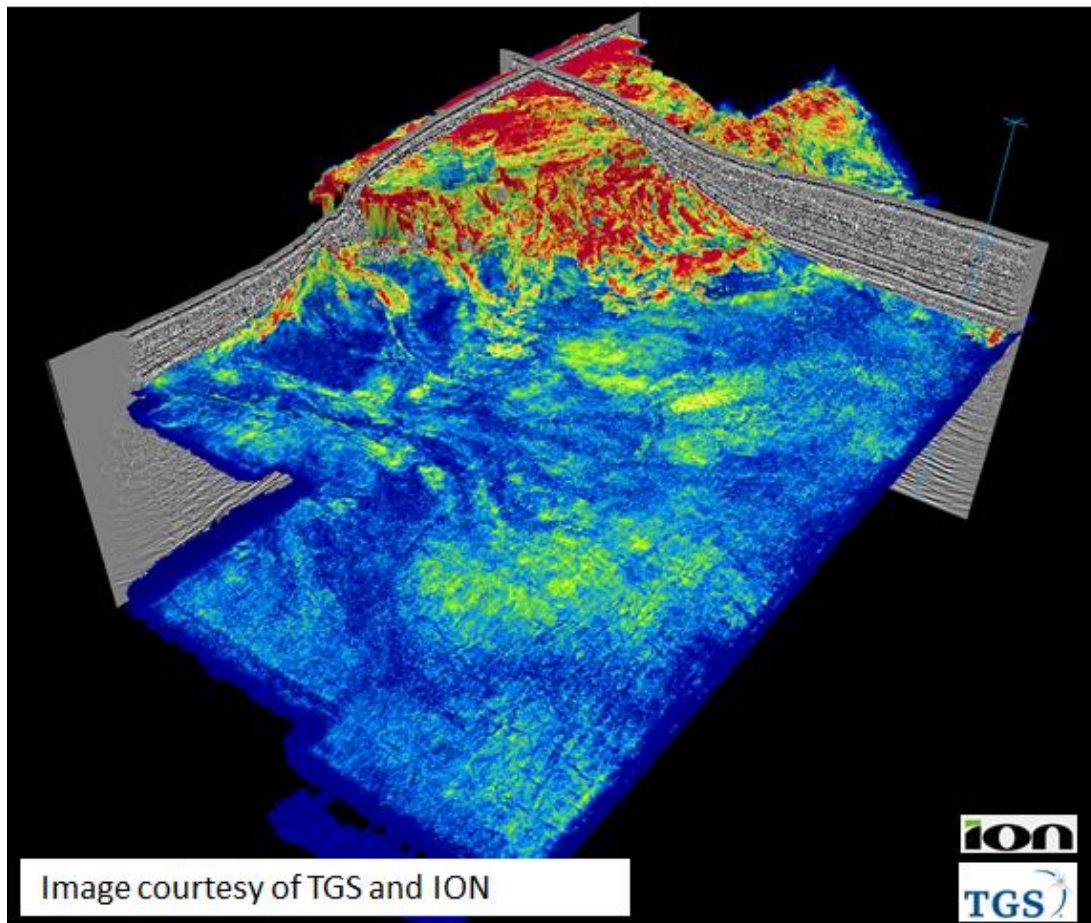


Figure 1. Drombeg Prospect - 3D seismic attribute display

### Drombeg and Druid Prospects

The **Drombeg** and **Druid** prospects located in FEL 2/14 are interpreted as vertically stacked Lower Cretaceous and Paleocene deep-water fan stratigraphic plays. The prospects are located c. 210 km offshore Ireland in c. 2,500m water depth. In 2014 Providence/Sosina underwrote a major c. 4,500



km<sup>2</sup> multi-client 3D seismic survey over the prospects and surrounding blocks (data owned in partnership by TGS and ION). These data confirm the previous 2D seismic interpretation which suggested the presence of a large deep-water fan system at each level (Figure 1, Lower Cretaceous). Anomalous offset-dependent seismic amplitude responses (Figure 2, Figure 3) which had been previously noted as potential direct hydrocarbon indicators have also been confirmed at the **Drombeg** and **Druid** prospects. The underlying deeply buried pre-Cretaceous **Diablo** ridge has also been confirmed as exhibiting a marked seismically imaged crestal fluid-escape feature (Figure 3) which may be acting as a hydrocarbon conduit into the overlying **Drombeg** and **Druid** fans.

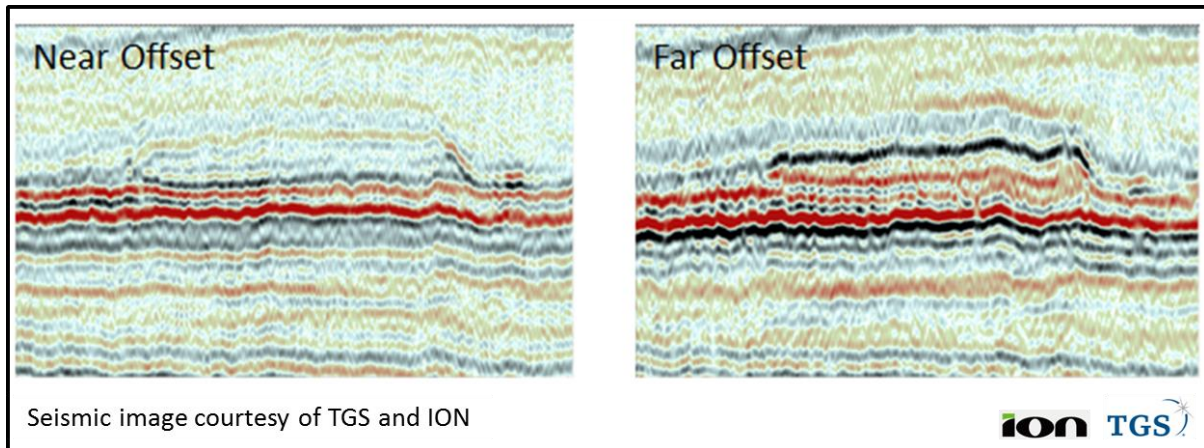


Figure 2. Paleocene Druid angle stack displays

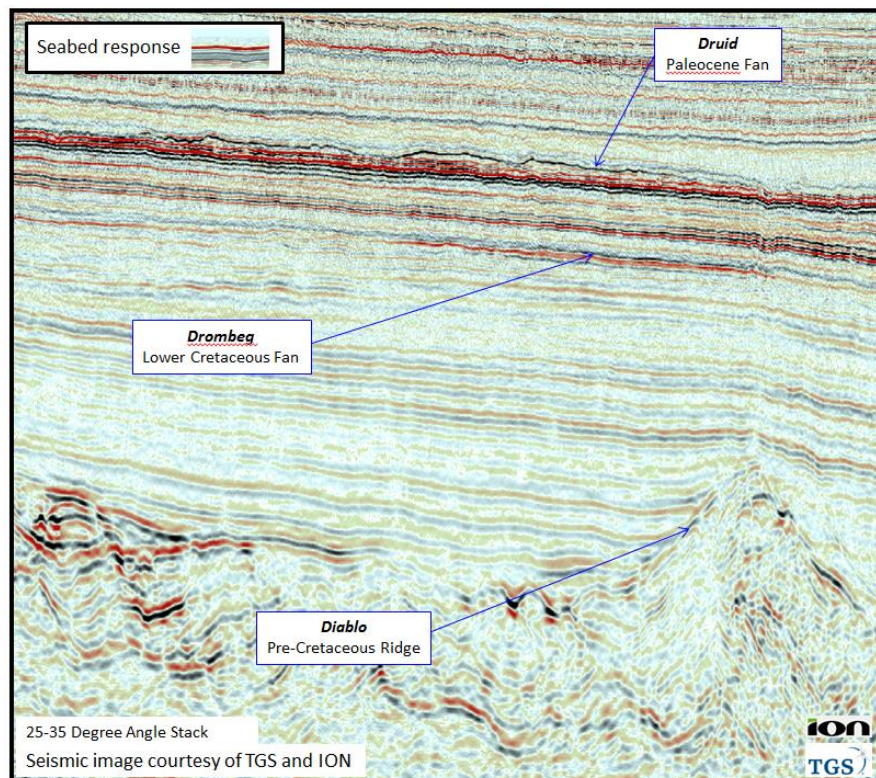


Figure 3. Far angle stack image through Diablo/Drombeg/Druid features

### Newgrange Prospect

The **Newgrange** exploration prospect in the Goban Spur Basin comprises a large Cretaceous carbonate four-way dip-closed structure covering a c. 1,200 km<sup>2</sup> area. The prospect is situated c. 270 km off the



south-west coast of Ireland and is located in c. 1000 m water depth with the structural crest being just c. 500 m BML. In 2014 Providence/Sosina underwrote a major c. 4,900 line km multi-client 2D seismic survey over the **Newgrange** prospect and surrounding area (data owned in partnership by TGS, ION and Seabird). These recently acquired long offset 2D seismic data confirm the presence of a significant Cretaceous areal closure and also demonstrate anomalous crestal brightening (Figure 4) at **Newgrange** with interval velocity analysis indicating potentially very high reservoir porosities.

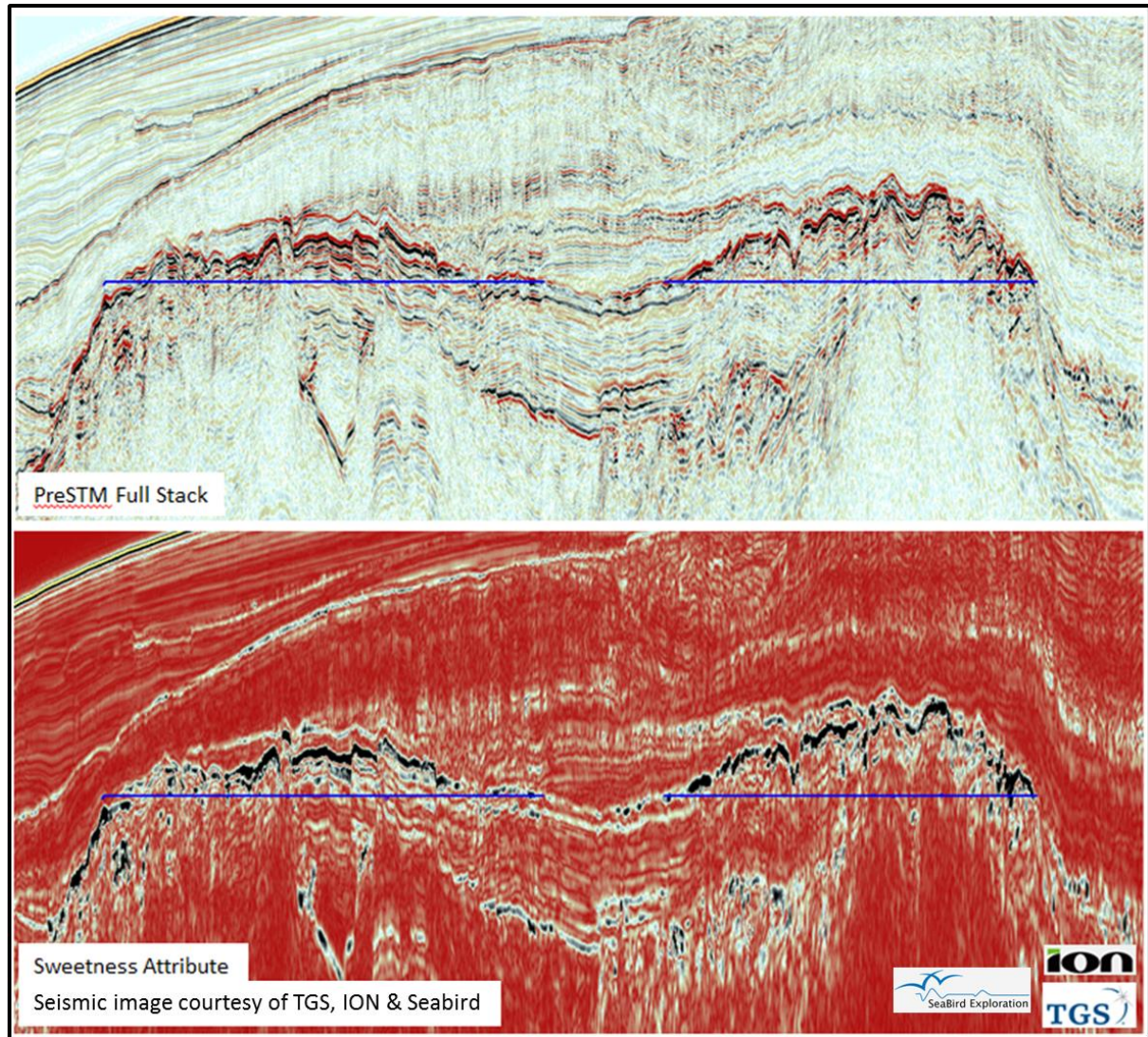


Figure 4. Seismic amplitude and attribute displays over the Newgrange prospect

The Providence/Sosina partnership is planning to run a farm-out process in order to secure a deep-water Operator for the drilling of both the **Drombeg/Druid** and **Newgrange** prospects. In preparation for the farm-out process, Providence has signed a strategic and incentivised exploration collaboration agreement with Schlumberger. Under this agreement Providence and Schlumberger experts are collaborating across the Petrel and Studio platforms to further de-risk at the basin and prospect level in domains such as petroleum systems modelling, rock physics, quantitative interpretation and geomechanics. This original technical work draws upon Providence's unique knowledge of the basin, and will underpin the farm-out process, which is due to kick off in Q1 2016 and will be managed by Schlumberger.

## Prospects 2 Go - Understanding Corrib Field in West of Ireland: The Power of Integration

Onyeagoro, K.<sup>1</sup>, Rogers, R.<sup>1</sup>, Davis, C.<sup>1</sup>, Harrison, J.<sup>1</sup>, Waring, O.<sup>1</sup>, Ypma, G.<sup>1</sup>, Smout, K.<sup>1</sup>, Mckie, T.<sup>1</sup>, Van Bergen, P.<sup>1</sup>, Ligtenag, M.<sup>1</sup>, Vaughan, A.<sup>1</sup>

<sup>1</sup>Shell. Email: [Kachi.Onyeagor@shell.com](mailto:Kachi.Onyeagor@shell.com)

The Corrib Gas field in Western Ireland (Figure 1) was discovered in 1996. Over the years, the Corrib subsurface picture has evolved with the latest (2013/2014) acquisition of an Ocean Bottom Cable (OBC) 3D Seismic survey. The data has provided a considerably clearer structural image of the subsurface. The Corrib Integrated Subsurface Team has now completed its interpretation and built new 3D static and dynamic reservoir models to assist with the future management of the field.

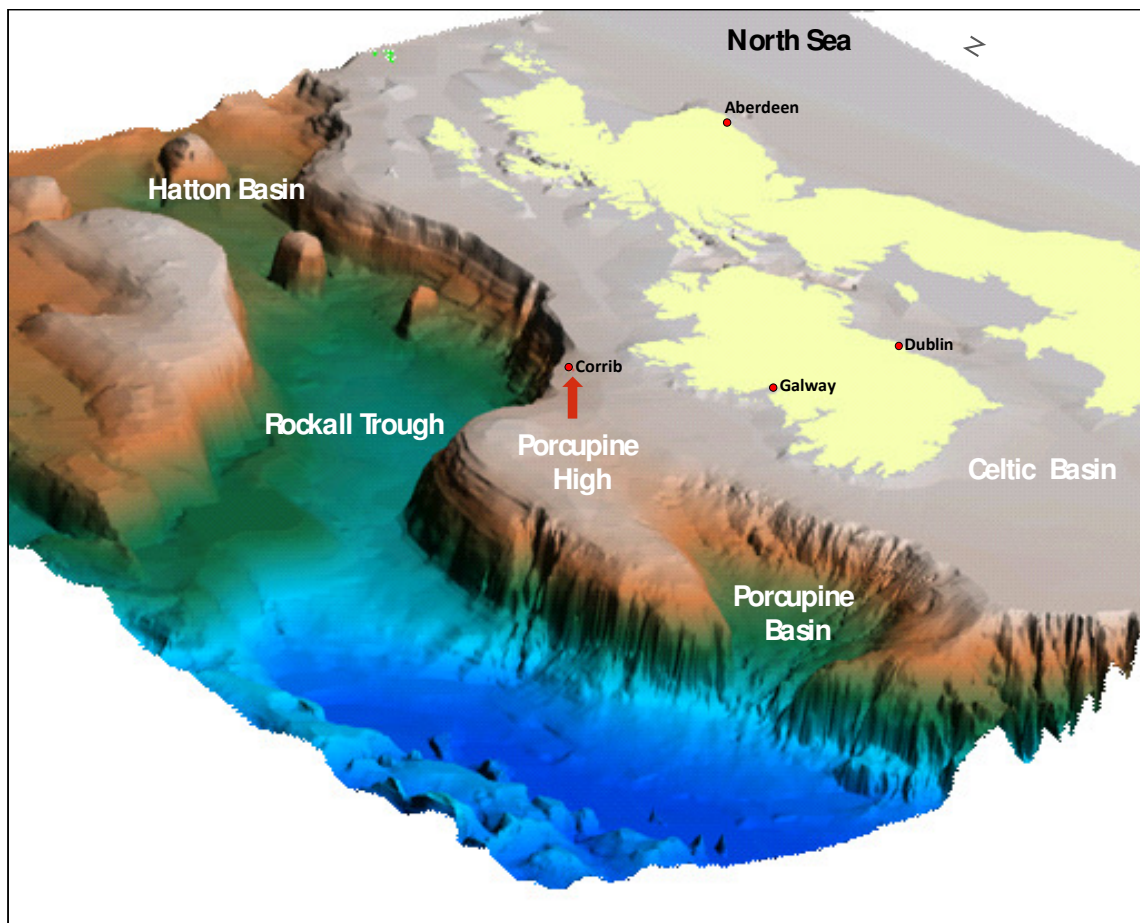


Figure 1. Corrib field setting in Western Ireland

The Corrib gas field is a subsea development that lies 70 km offshore west of Ireland in 360 metre water depths. A total of eight wells (two abandoned, one awaiting tie-in and five ready to produce) are drilled in the field. The main reservoir is the Triassic Sherwood Sandstone, deposited in a fluvial channel environment. It is overlain by the Upper Triassic Mercia Halite that forms the reservoir seal. This is directly overlain by the Lower Jurassic Broadford beds, a very hard layer which is challenging to drill through. The overburden is both hard and complex culminating in seabed Tertiary volcanics. This geological sequence results in a degradation of the seismic energy resulting in a poor seismic image from the previous conventional towed streamer survey. The OBC Seismic acquisition has provided a step change in image quality (Figure 2) and whilst some poorly imaged areas remain, the structural uncertainty in the field has been significantly reduced.



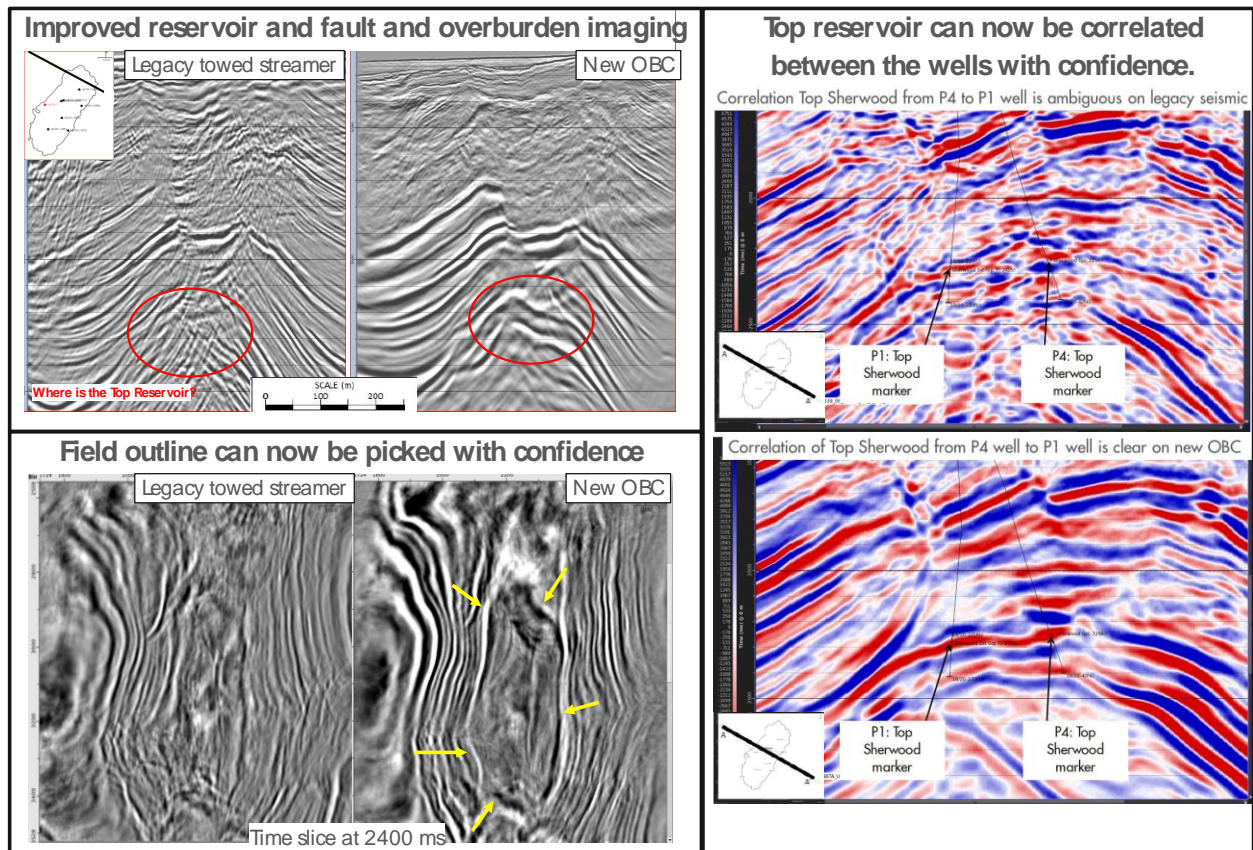


Figure 2. Seismic sections showing 15 years of seismic technology in Corrib Field and OBC Seismic improvements compared with legacy seismic data

In addition to the structural uncertainties, two wells in the southern part of the field show varying degrees of reservoir impairment compared to the rest of the field. This is expressed by poorer well test performance and reduced core plug porosities and permeabilities. The impairment is associated with an apparent diagenetic overprint of chlorite which is visually expressed in core and SEM/EDAX images by a pervasive dark grey colouration, in contrast to the typical red-bed appearance of the Sherwood reservoir elsewhere in the field. This chlorite phenomenon poses its own challenges to the development of the field. Other uncertainties such as fault behaviour, porosity and saturation variability also exist. Production data will assist in reducing these uncertainties further to calibrate the models (via history matching) with which to make robust decisions on the future development opportunities at Corrib.

This presentation will give a subsurface overview of the Corrib field, highlighting the significant improvement in our understanding of the structure from the acquired OBC data and the integrated journey we have followed from interpretation and construction of new models in preparation for first gas.

## Acknowledgements

We wish to thank Shell E&P Ireland Limited for their continued support and input over the years. We would also like to thank Statoil and Vermilion for their contributions and for giving permission to publish and present this paper. Contributors from Statoil include; Silvan Hoth, Tore Håkon Hanssen, Hans Kristian Bjørnstad and David Hulme. Contributors from Vermilion include; John Simpson, Keith Fletcher, Eric Leoutre, Antoine Fletcher and Ian Millar.



## **STANDS (in alphabetical order)**

### **AGR Stand**

Global service company AGR is focused on the needs of its customers in the upstream Oil and Gas sector, delivering Well Engineering and Construction, Reservoir and Subsurface Management, Consultancy Services, bespoke Software Solutions and Training.

From frontier exploration and appraisal, development and production to late life asset development and finally field abandonment and decommissioning, AGR delivers tailored solutions throughout the life cycle, through value-added performance and operational safety.

With offices in all major petroleum provinces, AGR clients benefit from its impressive track record:

- No major HSEQ incidents/accidents
- More than 500 well projects spanning 6 continents
- 80 remote operations including, base set-up, equipment and personnel mobilisation and supply chain provision; Barents Sea to the Falkland Islands
- Over 70 wells deeper than 15,000 ft (4,572 m)
- Over 60 HPHT wells
- More than 1,000 reservoir studies in only five years
- 3,000 consultants placed in 100 locations through our Consultancy division
- Over 25,000 people trained in 45 countries
- Software products developed in collaboration with end users allowing significant operational cost reductions.

AGR is the leading global independent Well Management & Reservoir Management Company.

For enquiries please contact Nick Chilcott, [nick.chilcott@agr.com](mailto:nick.chilcott@agr.com), 01224 629000.

### **APT Stand**

With long standing experience in Irish sedimentary basins, adjacent basins and those of the conjugate margins, APT offers unique insights to exploration teams' active offshore Ireland. Multiclient studies are available for the Porcupine Basin and Celtic Sea. APT provides a full range of analytical and interpretive services for source rocks, kerogens, spore colour, hydrocarbon isotopes and biomarkers. We are renowned for laboratory services, microscopy and consultancy to the highest standards. Petroleum systems modelling and enhancing the understanding of legacy datasets is a specialty of the team of eight experienced geochemists backed up by a world class analytical capability.

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

## **BGS Stand**

BGS is a leading provider of applied geoscience services and has an extensive international programme of research, survey and monitoring, data management and dissemination, including major institutional strengthening programmes in the developing world.

Much of our work is directed towards development issues such as:

- helping developing countries realise sustainable benefits from their natural resources
- improving quality of life through improved access to water, food and energy
- helping communities deal with natural hazards
- understanding of global environmental change
- development of sustainable cities

We coordinate BGS experts to fulfil a wide range of international activities, working where appropriate with consultants, universities and private sector organisations that can provide additional specialist skills.

Projects range from short-term expert consultancies to work lasting several years. Our projects are funded by a number of different partners, including UK government, research councils and aid agencies, overseas government departments and private organisations.

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## **CGG GeoSpec / CGG Robertson 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.

### **Equipment**

Our Equipment division includes Sercel business entities as well as Metrolog, GRC and De Regt. Sercel is the world's leading designer and manufacturer of innovative seismic exploration equipment and reservoir monitoring instruments used by oilfield service companies and geophysical contractors in land, marine, ocean bottom, transition zone and downhole environments. De Regt offers a complementary portfolio of custom-designed subsea cable and umbilical systems for oil and energy, defence and seismic exploration applications.

### **Acquisition**

CGG has the full range of data acquisition capabilities to conduct all types of geophysical surveys, large or small, onshore, offshore and in the air. We are unique in being able to provide seamless coverage with a wide portfolio of seismic and geophysical methods in any environment.

### **Geology, Geophysics and Reservoir**

Our innovative thinking, region-specific expertise and game-changing technology allow us to deliver high-impact integrated solutions across the E&P chain.

As a recognised pioneer in geophysics for over 80 years, CGG remains at the forefront of advanced subsurface imaging, to help answer your increasingly complex challenges.

We also offer a full spectrum of consulting and software solutions for geology, geophysics and reservoir applications.

We offer high-end seismic, gravity, magnetic, well, geologic and satellite multi-client data and studies in the world's most prospective regions.

The efficient and integrated management of geological, geophysical and reservoir data is key to successful and prompt decision-making. Our data management experts offer a range of services to help you realise the true value of your data, no matter what the vintage or the scale.

## **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 and isotope science. 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.

### **Commissioners of Irish Lights (CIL) Stand**

We are a maritime organisation delivering an essential safety service around the coast of Ireland, protecting the marine environment, and supporting the marine industry and coastal communities. In recent years we have transformed how we deliver our services, putting the emphasis on efficiency, cost-effectiveness and sustainability, while exploiting new technology and new opportunities wherever possible.

We are responsible for providing marine aids to navigation (AtoN) under the Safety of Life at Sea (SOLAS) convention.

We provide and maintain over 300 general aids to navigation.

We manage about 4,000 local aids to navigation.

We mark or remove dangerous wrecks outside harbour areas around Ireland.

Our AtoN includes radio aids such as Differential GPS (DGPS), Radar Beacons (Racon), and Automatic Identification Systems (AIS), as well as more traditional visual aids such as lighthouses, buoys and beacons.

These AtoN complement Global Navigation Satellite Systems (GNSS), such as GPS, which are the primary means of navigation for most mariners. If satellites are not available, these AtoN provide position, spatial awareness, hazard marking and backup.

### **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 complementary 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.

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
- Seismic Data Processing
- Depth Imaging
- Petrophysical Processing and Interpretation
- Quantitative Interpretation Services
- Geostatistical Depth Conversion
- Multi-client Studies
- Full range of DUG Software for all activities

We have offices in Perth, Brisbane, Kuala Lumpur, Jakarta, Singapore, Houston and London. For more information and contact details go to [www.dugeo.com](http://www.dugeo.com)

### 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, gas and renewable energy sector. These training courses which include **MIST** (Minimum Industry Safety Training) and **BOSIET** (Basic Offshore Safety Induction and Emergency Training) are run weekly in our state of the art training centre in Falcarragh, Co. Donegal. Effective Offshore can also offer the new **CA EBS** (Compressed Air Emergency Breathing System) and **Bideltoid Shoulder Measurement** which is required for all personnel to work in the North Sea.

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. We are also Ireland's only training centre offering the RenewableUK and GWO Marine Safety Training/Sea Survival.

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](mailto:jason@effectiveoffshore.ie) or call 074 9135999 or visit our website [www.effectiveoffshore.ie](http://www.effectiveoffshore.ie)

## Europa Oil & Gas Stand

Europa Oil & Gas (Holdings) plc has a diversified portfolio of multi-stage hydrocarbon assets that includes production, exploration and development interests, in countries that are politically stable, have transparent licensing processes, and offer attractive terms. In 2015 Europa produced 141 boepd. Its highly prospective exploration projects include the Wressle discovery (recently drilled and tested at an aggregate of 710 boepd from 4 zones) in the UK; 100% owned gas exploration prospect (107 bcf) and appraisal project (CPR 277 bcf) in onshore France, a joint venture with Vermilion Energy also in onshore France; and two licenses in offshore Ireland with the potential to host gross mean un-risked Prospective Resources approximately 1.7 billion barrels across both licenses.

Europa has two licences in the Porcupine Basin offshore West Ireland; FELs 2/13 and 3/13. It was announced on 22 September 2015 that the operator of these licences, Kosmos Energy Ireland, was withdrawing from both licences. The process for transfer of Kosmos's interest and operatorship of FEL 2/13 and 3/13 to Europa is ongoing and is subject to obtaining relevant approval from the Irish Authorities. On completion of this process and assuming a successful outcome, Europa will have a 100% equity interest in each licence and will be seeking to farm-out some of its interest. The process for marketing the farm-out has begun and the dataroom will open in Q1 2016. FEL 3/13 has audited gross mean unrisked prospective resources of 1.5 billion boe.

## Faroe Petroleum Stand

Faroe Petroleum is an independent oil and gas company focusing principally on exploration, appraisal and production opportunities in Norway, the UK and Ireland. The Company has, through successive licence applications and acquisitions, built a substantial and diversified portfolio of exploration, appraisal, development and production assets across the Atlantic margin, the UK and Norwegian North Sea, Norwegian Sea, Barents Sea and the Celtic Sea. The Company's substantial licence portfolio provides considerable spread of risk and reward. Faroe has a very active drilling programme ahead and it currently has interests in six principal producing oil and gas fields in the UK and Norway.

Faroe's interests in Ireland comprise three Licensing Options in the North Celtic Sea Basin (LO14-1, LO14/2 and LO14/3), awarded on 1st October 2014. The Licensing Options are targeting the under-explored Triassic Play, comprising Sherwood Sandstone reservoir juxtaposed against Lower Jurassic oil prone source rocks. The age and configuration of source and reservoir bear many similarities to the Wytch Farm oil field, onshore UK. Initial interpretation of existing 2D seismic data has revealed the presence of a number of large structural traps within the Licensing Option areas. The ongoing work programme comprises 2D seismic reprocessing, basin modelling, structural restoration and sedimentological studies as well as evaluation of Jurassic and Cretaceous prospectivity in the Licence Option area.



## 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.

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.

## GeoArctic Stand

**GeoArctic: Deformable Plate Reconstruction Studies.** GeoArctic Ltd. has produced a series of multi-client deformable plate reconstruction studies for the North Atlantic, Labrador-Baffin Bay, and Arctic which form an integrated deformable plate model for the region. Please come and see us at our booth where we will be providing demonstrations of our studies and discussing the implications for Atlantic Ireland exploration.

At the core of these PlateDEF Studies is a non-rigid/deformable kinematic model developed from the integration of beta factors calculated from present day crustal thickness data and Euler poles of rotation describing post break-up plate motion. The model estimates the amount and direction of crustal thinning/thickening associated with lithospheric stretching/shortening through time. The non-rigid kinematic model is used to evaluate the tectonic development, basin geometry and depositional environments at key source rock and reservoir intervals.

Contact: Richard Whittaker, [rwhittaker@geoarctic.com](mailto:rwhittaker@geoarctic.com) Tel: +1 403 290 1320.

## 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](http://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.

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 [www.tellus.ie](http://www.tellus.ie) and [www.tellusborder.eu](http://www.tellusborder.eu)

## Hannon Westwood Stand

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.

Our proprietary databases for North West Europe offshore areas include, but are not limited to, historic, current and planned well data, resource information (discovered and yet-to-find), cultural data including licences and ownership, infrastructure (ownership, throughput, ullage availability and constraints etc.) and inventories of as yet undrilled prospects. Hannon Westwood is a respected commentator on the E&P sector and issues in Northwest Europe via its flagship Atlas Intelligence Service. Through this service and the company's consulting projects, Hannon Westwood routinely informs and advises clients on basin trends, particularly relating to exploration, based on in-depth analysis of its proprietary data. This includes:

- Licensing trends
- Ownership trends
- Exploration activity levels and performance trends
- Fiscal systems and their effectiveness – including incentives for exploration and development activity

- Infrastructure issues, including availability for 3<sup>rd</sup> party business

In analysing exploration performance trends the granularity of our data allows for assessment of trends by geological play, by area, by company and so on.

## IHS Stand

Every decision matters. That's why leaders rely on IHS to help them make the best choices. As the premier provider of global market, industry and technical expertise, we understand the rigour that goes into important decisions, guiding customers with thinking that matches the scope of their needs. Whether it is understanding rig locations and markets, refining locations and capacities, pipelines, your competitors' acreage portfolio, or the economic landscape, come to IHS.

IHS is the official well and seismic data release agent for Ireland's Department of Communications, Energy and Natural Resources, and we provide all the released Irish 2D/3D seismic surveys and well data available in workstation ready format to help you assess an area quickly and cost effectively.

Seismic Data – Original SEG-Y data, or if not available reconstructions of plots are provided with IHS Kingdom exported data with navigation in the trace headers. Delivered via DVD or hard-drive

Well Logs – 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 – A comprehensive compilation of formation, fracture, mud pressure and temperature data from test data, KICKS and LC datasets which have been analysed, interpreted and qualified using IHS quality control flags for consistency. Additional datasets are captured, such as gas events and related drilling comments which can provide an indication of the subsurface geopressure regimes and presented in a standardised format.

IHS Kingdom software provides the highly efficient suite of tools needed to work-up geophysical and geological data in order to identify and rank prospects. Kingdom has consistently been voted the interpreters' tool of choice in independent surveys (Welling Report). Kingdom is an inherently multi-user platform – minimising the needs for unwanted data management overheads. The Kingdom Gateway plug-in ensures seamless data connectivity to Petrel\* (\* Schlumberger trade mark) should more advanced modelling be required.

IHS Engineering Software also provides practical and advanced solutions for reservoir engineering and production optimisation, that will help you design and optimise producing oil and gas systems from the individual well level to the full production network. Realise increased productivity with workflows that access a full suite of empirical, analytical and numerical methods



## 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), the 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 October 22<sup>nd</sup> and 23<sup>rd</sup>.

Products deriving from INFOMAR are available both in paper and digital form and downloadable for free from [www.infomar.ie](http://www.infomar.ie)

**For further information contact:** [archie.donovan@gsi.ie](mailto:archie.donovan@gsi.ie) or Tel: +353 1 678 2798

## ION Stand

ION is a leading provider of technology-driven solutions to the global oil and gas industry. ION's offerings are designed to help companies reduce risk and optimise assets throughout the E&P lifecycle. For more information, visit [iongeo.com](http://iongeo.com)

ION has been active in offshore Ireland since 2007 when the Irish portion of the ground breaking NE Atlantic SPAN survey was acquired. The survey consisted of several deep, long offset regional lines across the Porcupine and Rockall basins. These data provided an image of the full basin and crustal section across the area and allowed for improved constraints on basin formation models and hence the thermal history of the basins. The survey also helped delineate all the different plays in the Porcupine which led to the development of plans to acquire further 2D and 3D surveys in the highly prospective South Porcupine Basin and Goban Spur area. Evaluation of these new data has been performed by many companies in support of their bids for the 2015 Atlantic Margin Oil and Gas Exploration Licensing Round.

## Contact Details

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VP Business Development, Europe/Africa

ION

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## 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 mmscf. 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 (Rosscarbery area) prospects to be ready to drill and discussions with potential farm-in joint-venture partners are ongoing.

Steve Boldy (CEO) - [Stephen.boldy@lansdowneoilandgas.com](mailto:Stephen.boldy@lansdowneoilandgas.com)

Richard Slape (Commercial Director) - [Richard.slape@lansdowneoilandgas.com](mailto: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](http://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 [afitzgerald@marine.ie](mailto:afitzgerald@marine.ie) [www.marine.ie](http://www.marine.ie)

## **Newfoundland-Labrador (DNR) Stand**

Newfoundland and Labrador is Canada's offshore oil producing region. Discovered reserves/resources now total 3.8 billion barrels of oil and 12.6 trillion cubic feet of natural gas. Since first oil eighteen years ago the province's four fields in the Jeanne d'Arc Basin; Hibernia, Terra Nova, White Rose and North Amethyst have produced in excess of 1.5 billion barrels of oil.

The Hebron field, currently under development, has estimated recoverable oil reserves of 707 million barrels, with first oil expected in 2017.

A Scheduled Land Tenure System for the province's offshore area divides it into eight regions based on the level of historical exploration activity. Scheduled licensing rounds are held on either a one, two or four year cycle, providing additional time for the evaluation of resource potential.



Statoil has announced new oil discoveries at their Mizzen, Harpoon and Bay du Nord prospects in the Flemish Pass Basin, estimating recoverable oil reserves between 400 and 800 million barrels.

The 2015 licensing round offers 11 parcels of land in the Flemish Pass Basin surrounding Statoil's recent discoveries. A resource assessment on the parcels estimates 12 billion barrels of oil and 113 trillion cubic feet of gas resource potential.

### **ObSERVE Stand**

In October, 2014, the Department of Communications, Energy and Natural Resources, in liaison with the Department of Arts, Heritage and the Gaeltacht (National Parks and Wildlife Service), established a significant data acquisition programme designed to acquire new baseline data, with the aim of filling existing data gaps with regard to protected marine species and sites in key offshore basins.

In consultation with NPWS, a programme of targeted acoustic and aerial surveys of Cetaceans and Seabirds in the Irish offshore was agreed. This programme has been given the title of ObSERVE.

Under the ObSERVE Programme, a total of eight (8) static (i.e. moored) and six towed acoustic surveys for cetaceans in selected Atlantic Margin waters between 2015 and 2016 will be undertaken. The study area broadly covers outer continental shelf, slope and deep oceanic waters stretching from the Hebrides Terrace to the Goban Spur and concentrated on about four key zones of interest.

The programme provides for both static and towed acoustic surveys to be carried out between the spring and autumn seasons with combined detailed coverage of two zones of interest to take place in each survey year, respectively. The core purpose of these surveys is to use acoustic sampling methods and a towed survey design of standard transect length to best describe animal occurrence, distribution, density and abundance (where possible, otherwise relative density/abundance) within the prescribed offshore area, based on the acoustic data acquired.

Under the ObSERVE Programme a series of four combined line-transect and strip-transect aerial surveys for cetaceans and seabirds, respectively, in Irish offshore waters will be undertaken. Each survey will be carried out within a prescribed season and so will comprise a single replicate coverage of the study area.

The aerial element of the programme is being led by University College Cork with partners Aerosotravia, IMARES, and ALNILAM and the acoustic element of the programme is led by the Galway-Mayo Institute of Technology (GMIT) in collaboration with the Marine Institute, Jasco Applied Science, SMRU Consulting and the Irish Whale and Dolphin Group.

Links to the websites for both the acoustic and aerial surveys have been registered at:

[www.observe-acoustic.ie](http://www.observe-acoustic.ie) and [www.observe-aerial.ie](http://www.observe-aerial.ie)

### **ORG Geophysical Stand**

ORG Geophysical offers Induced Polarisation (IP) technology for hydrocarbon exploration. Improving success rates for clients around the world, this method is rapidly developing an increasing demand. This IP method has been used for hydrocarbon exploration since 2003 and more than 40,000 line km of data has been collected and analysed with similar convincing results as found on the Norwegian Continental Shelf.

## **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](http://www.pad.ie/ipas)) provides access to information relating to authorisations, wells, potential field and seismic surveys using search screens or through map interface.

## PGS 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.

**Petroleum Geo-Services** Email: [mceurope@pgs.com](mailto:mceurope@pgs.com) [www.pgs.com](http://www.pgs.com)



## 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](http://www.pip.ie)

*The ISPSG currently (October 2015) 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, 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

An innovative marine geophysical company with a pioneering environmental agenda, delivering high-end towed streamer data acquisition and imaging services from Pole to Pole. Polarcus vision is to be a pioneer in an industry where the frontiers of seismic exploration are responsibly expanded without harm to our world. To achieve this vision we are committed to being at the leading edge of maritime and technological innovation, and have set ourselves an ambitious environmental agenda that aims to minimise our environmental footprint through a combination of reduction, recycling and emissions indexing.

We have invested in the latest new-build vessel designs and the most technologically advanced seismic and navigation systems available today to ensure that our seismic fleet is one of the most modern and

advanced fleets in the world, able to meet the current and projected future needs of the industry. We believe that our operations are amongst the cleanest in the offshore seismic industry, and capable of working in the broadest range of operating environments.

### **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.

### **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 analysing 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](http://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](http://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.

[www.rpsgroup.com](http://www.rpsgroup.com)

### **Seabird / GeoPartners Stand**

SeaBird is a global provider of marine 2D and 3D seismic data for the oil and gas industry. The company is the market leader in the high-end 2D seismic services segment.

The company is also a leading provider of niche 3D and source vessel solutions.

SeaBird concentrates on contract seismic surveys, but is also actively engaged in the multi-client sector. The company is uniquely positioned with its industry-leading health, safety, security, environment and quality (HSSEQ) culture and accreditations. Operational excellence ensures best-in-class performance. SeaBird's focus on technological development ensures continuous service improvement.

GeoPartners Ltd is a new consultancy company, whose principals are highly experienced seismic industry professionals with a proven track record of establishing and developing new companies and business models in a wide range of commercial environments.

Specifically we will be leveraging our expertise, credibility, knowledge base, and government/ industry client network to build value with appropriate industry partners.



## **Searcher Seismic Stand**

Searcher Seismic is an independent multi-client company providing high quality, non-exclusive seismic datasets and associated products to the global oil and gas industry.

The Searcher data library consists of a full range of products derived from both 2D / 3D seismic reprocessing and 2D / 3D seismic acquisition. Searcher's extensive experience in the management of seismic acquisition and processing in a variety of geological settings makes us the data provider of choice for some of the largest oil and gas companies in the world.

Searcher's specialty is providing leading edge, non-exclusive seismic data that assists oil and gas companies to de-risk their exploration portfolios in a cost effective manner. A thorough evaluation and understanding of the geological objectives for each project allows Searcher to consistently provide the most relevant and useful datasets for both regional and acreage evaluation workflows.

In all markets in which we operate, Searcher is a trusted and valued supplier of high quality non-exclusive seismic data and is renowned for being a leader in project generation and new ventures.

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

For information contact Clara Altobell - [clara.altobell@serica-energy.com](mailto:clara.altobell@serica-energy.com)

## **Spectrum Geo Stand**

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.

For more information please contact: [mike.johnson@spectrumasa.com](mailto:mike.johnson@spectrumasa.com) [www.spectrumasa.com](http://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.

## **Woodside Stand**

Woodside is an Australian oil and gas company with a global presence, recognised for its world-class capabilities – as an explorer, a developer, a producer and a supplier. Our operations are characterised by strong safety and environmental performance in remote and challenging locations.

We are Australia's most experienced LNG operator and largest independent oil and gas company. Our proven track record and distinctive capabilities are underpinned by 60 years of experience, making us a partner of choice.

Woodside is building a global exploration portfolio and will continue to undertake a range of high-impact exploration activities to generate future growth opportunities for the company.

This diverse portfolio reflects the company's global exploration strategy – to grow and high grade our portfolio with a new emphasis on emerging petroleum provinces characterised by materiality.

Across our portfolio, we see an opportunity to leverage our core capabilities, particularly in deepwater exploration, technology and project development, and create value for our shareholders. Over a two-year period, we have acquired permits in eight new countries, resulting in a total global exploration acreage of 250,000 km<sup>2</sup> (gross).

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 is 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 2013 Woodside successfully farmed in to four authorisations in the Porcupine Basin, offshore Ireland. In 2014, in support of our commitment to the environment, Woodside and our joint venture partners completed the field component of a study to assess whale and dolphin occurrence, seasonality and abundance in the Porcupine Basin and surrounds. This involved the deployment of six noise loggers between May and September, to record ocean noises and to identify cetacean (whale) species, distribution and seasonality. Data analysis was completed in mid-2015. The results will contribute significantly to the understanding of whale and dolphin distribution and abundance in the offshore waters of Ireland and help us to better prepare for and manage our exploration activities.

### **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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<http://www.zebradata.com>





## POSTER ABSTRACTS (in alphabetical order)

### Potential of using nanomaterials to remove heavy metals from oil industry wastewater

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Treatment of wastewater from oil and gas industry is one of the most significant challenges of today's and future generations. 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). Current researches are paying more attention to the removal of dissolved organic components and heavy metals from wastewater and, therefore, efficient and cost effective ways to remove these hydrocarbons and heavy metals are being explored. Nano-particles, with large surface areas and extremely high surface reactivity, could be an inexpensive and effective solution to adsorb hydrocarbons and heavy metals from wastewater 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), and Iron oxide (Fe<sub>3</sub>O<sub>4</sub>). In this paper, a set of batch experiments was conducted in order to assess the heavy metals adsorption efficiencies of these nano-materials.

The results shown that BN nanosheet has significantly higher absorption capacity compared to the other two nanomaterials. The BN nanosheet average adsorption of Cd, Cr, Cu, Fe, Ni, Pb and Zn are 19.0, 13.8, 58.6, 0.1, 15.6, 0.1 and 24.6 (mg/g), respectively. Fe and Pb has lower adsorption probably their concentrations in the original solution were lower as they might have precipitated.

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

### Provenance of Lower Cretaceous sandstones, offshore western Ireland

Barry, A.<sup>1</sup>, Tyrrell, S.<sup>1</sup>, Morton, A.<sup>2,3</sup>, Robinson, P.<sup>2,3</sup>

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Western Irish offshore basins are generally equivalent in their basin development during the Cretaceous. Late Jurassic to Early Cretaceous rifting was followed by thermal subsidence with further rifting in the Late Cretaceous. The Lower Cretaceous in the Erris and Porcupine basins is dominated by a largely marine sequence, deep-water shales and turbidites, interrupted by fan delta systems linked to uplift of basin margins during Aptian-Albian times. A similar succession is inferred for the eastern margin of the Rockall Basin. Comparable Lower Cretaceous systems are prospective for hydrocarbons within basins along the eastern Atlantic Margin, hence there is increased interest in offshore western Ireland.

This project aims to establish the provenance of Lower Cretaceous sandstones in a range of basins offshore western Ireland via a multidisciplinary approach. This will, in turn, help constrain sediment pathways, the palaeogeography and potentially aid in well correlation for the Lower Cretaceous in these basins. Ultimately, these types of insight should help "de-risk" potential hydrocarbon resources in the

Irish offshore, as the approach will shed light on the distribution and quality of potential reservoir sandstones.

Cuttings samples were taken from a range of wells along the basins, including the Erris and Porcupine basins and from the Goban Spur (12/13-1a, 35/30-1, 35/6-1, 43/13-1 and 62/7-1). Heavy mineral analysis of these samples has revealed distinct assemblage variations through the stratigraphy in a number of wells (e.g. 12/13-1a, 43/13-1 and 62/7-1). These changes indicate source switching over time, perhaps reflecting uplift of the hinterland or more cryptic climatic fluctuations. Intriguingly, apatite is consistently sparse or absent in the sampled intervals across all wells. This could be due to periods of prolonged storage on the wide Irish Continental Shelf during lowstands, facilitating the weathering of this labile mineral and its selective removal prior to ultimate transport into the deep basin. In contrast to the heavy mineral data, Pb-in-K-feldspar data from well 12/13-1a reveals a constant supply within the sampled interval, suggesting more complex factors (e.g. sedimentary recycling) are impacting the composition of sand delivered to the basin. Future works will utilise zircon geochronology as an additional parameter to constrain sand sourcing and potentially identify/quantify the role of sedimentary recycling.

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

## Structure and seismicity of Ireland's crust

Bonadio, R.<sup>1</sup> Arroucau, P.<sup>1</sup>, Lebedev, S.<sup>1</sup>

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Accurate knowledge of the regional structure and seismicity of Ireland's crust are important for the assessment and exploration of Ireland's natural resources. Natural seismicity characterisation (epicentral location, depth, magnitude) is essential for establishing a baseline for monitoring induced seismicity due to resource exploration or exploitation. Both the structure and seismicity are poorly known at the regional scale at present, due to the lack of relevant seismic data until recently. This project uses abundant, newly available broadband data in order to produce an unprecedentedly detailed model of Ireland's crust. Different methods exploiting complementary data sensitivities are applied, including ambient-noise cross-correlations, array analysis of teleseismic surface waves, and waveform inversion. A detailed, new seismicity catalogue for Ireland and its offshore is being created using data from the dozens of recently installed stations.

## Thermal regime of the Irish Atlantic basins

Bonté, D.<sup>1,2</sup>, Lavelle, C.<sup>1</sup>, Pasquali, R.<sup>1</sup>

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The history of the Atlantic basins in the Irish offshore is related to the opening of the North Atlantic. These basins have experienced a series of depositional phases that have been recorded in the sedimentary record since the Devonian. This project combines these records with the state of the art understanding of the geodynamic evolution to model the tectonic evolution of the basin and the related heat flow. The assessment of the thermal component is extremely important in the understanding of the evolution of hydrocarbons within these basins.

Our area of interest covers the Porcupine Basin, Slyne Basin, Erris Basin, Donegal Basin and Goban Spur, and the north-east flank of the Rockall Basin close to the Erris Basin and Slyne Basin.

Vitrinite Reflectance (VR) data from wells from the Irish offshore was identified and assessed. The wells with the more reliable VR data were selected for modelling and their VR data used to calibrate the results of the derived tectonic-heat flow.

The VR data as well as information on data quality has been extensively reviewed and compiled as part of the well selection process, with data originating from well reports, AFT data analyses and subsequent research on the geochemistry and biostratigraphy of the Irish offshore basins. In total, 38 wells with VR data have been considered and could potentially be selected for modelling on the basis of the quality and number of VR data. The number of VR points in these wells varies from three to 111 with a large variability in data quality. The temperatures in the wells have also been collected as non-discriminant criteria for the selection of the wells but as a potential additional parameter for the calibration of the model.

The stratigraphic column (including the lithology) from top to basement has been compiled based on the composite well logs. The tectonic-heat flow modelling considers the evolution of the entire lithosphere. The different lithospheric layers have also been defined as part of the model inputs. These include: the lithospheric mantle, the lower crust, and the upper crust. The principal geodynamic steps that have influenced the evolution of the basins have been defined as part of the modelling. These steps include: the deposition at the Lower Carboniferous, a large erosion phase at the Upper Carboniferous/Early Permian boundary, two successive rifting phases in the Middle/Late Jurassic and Early Cretaceous, and an uplift at the Palaeocene that could have been the result of the Iceland Plume.

The results of the modelling in the northern part of the Porcupine Basin show an intense thermal activity at the end of the Carboniferous has occurred. The geological origin of this thermal activity has been related to magmatism related to the dismantlement of the Variscan orogeny.

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

### **Characterising the electrical resistivity distribution of the subsurface below the Loop Head Peninsula using electromagnetic geophysical data: Evaluating Ireland's potential for onshore carbon sequestration**

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Carbon capture, sequestration and long-term storage (CCS) is a critically important and technologically challenging bridging technology, which will assist in the migration from fossil fuels to green energy over the next half century. The IRECCSEM project ([www.ireccsem.ie](http://www.ireccsem.ie)) is a Science Foundation Ireland Investigator Project to evaluate Ireland's potential for onshore carbon sequestration in saline aquifers by integrating new electromagnetic geophysical data with existing geophysical and geological data.

During the summer of 2014, a magnetotelluric (MT) survey was carried out in the Loop Head Peninsula (Co. Clare, Ireland) in order to assess the potential of this geophysical method for reservoir characterisation. Data from a total of 140 sites were acquired, including audio-magnetotelluric (AMT), broadband magnetotelluric (BBMT) and long period magnetotelluric (LMT) data. The characterisation

was divided in four shallow studies constraining the electrical resistivity distribution below the Loop Head peninsula up to 3 km depth and a deep study constraining the subsurface up to 30 km depth. The obtained models were used to constrain the electrical properties of the main formations (Viséan Limestones, Clare Shale Formation, Ross Sandstone Formation, Gull Island Formation, and the Central Clare Group) and the basement below the basin. Results were compared with data from Doonbeg-1 borehole, a 2D reflection seismic study and with the location of synclines and anticlines of the area.

## **Source rock and Geochemistry of the Central Atlantic margins: Geochemical characterisation of Lower Jurassic organic-rich facies offshore Ireland**

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The Slyne Basin, a narrow Mesozoic basin located offshore Ireland, has been the subject of significant exploration with proven commercial hydrocarbon discoveries. While the Corrib gas field within the Slyne Basin is sourced from Westphalian Coal Measures, Lower Jurassic intervals are viable hydrocarbon source rocks of regional significance in the Irish offshore. Stable carbon isotope chemostratigraphy is a tool with a high potential to characterise organic-rich facies. It can be applied to characterise and/or to trace changes in the various hydrocarbon reservoirs, from continental environments and atmosphere to oceans and organisms. In marine environments, and particularly in epeiric sea settings, these processes are governed by the complex interplay of local (different carbonate producers, transgressive–regressive cycles) and/or global (worldwide preservation of organic matter, variation of continental weathering, input of volcanogenic light CO<sub>2</sub>) mechanisms.

In this study, we have analysed 17 cuttings samples from the interval between 2610– 2824 m of the well 18/25-1 (Slyne Basin). This interval has been dated as Pliensbachian–Toarcian. The selected cuttings were analysed by Continuous Flow–Isotope-ratio Mass Spectrometry (carbonates) and Elemental Analysis– Isotope-ratio Mass Spectrometry (organic matter) to determine <sup>13</sup>C/<sup>12</sup>C ratio and calculate δ<sup>13</sup>C. δ<sup>13</sup>C in carbonates varies from -5.16 to 2.22 ‰. A negative trend is observed from 2610 m to 2664 m. The determined δ<sup>13</sup>C tends to more positive values. The δ<sup>13</sup>C values determined in organic matter presents less variation: a negative trend is observed from 2610 m to 2688 m (-6.65 ‰) followed by a generally positive trend from 2694 m to 2824 m (+6.00 ‰). These δ<sup>13</sup>C range from -28.23 ‰ to -25.52 ‰.

The obtained data were integrated with pre-existing Total Organic Carbon, pyrolysis Rock-Eval and Vitrinite Reflectance data, in order to evaluate the origin of organic matter and potential to produce hydrocarbon. The negative excursion of the carbon isotope signature is thought to correspond to the T-OAE. Ongoing investigation will discern the conditions that lead to the occurrence of this organic-rich facies offshore Ireland.

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



## **Tomographic imaging of the North Atlantic lithosphere**

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The enormous volumes of newly available, broadband seismic data and the continuing development of waveform tomography techniques now make it possible to resolve the structure of the North Atlantic at a new level of detail. The evolution of the passive margins on both sides of the ocean, dynamics of the North Atlantic Ridge and the Iceland Hotspot, and the nature of the upper-mantle flow beneath the region can all be understood better using new, more detailed and accurate models of seismic structure and anisotropy within the lithosphere and underlying mantle. We assemble a very large waveform dataset including all publicly available data from Northern and Western Europe, Iceland, Canada, US, Greenland and Russia. Our tomographic model is constrained by vertical-component waveform fits computed using the Automated Multimode Inversion of surface, S and multiple S waves. The isotropic-average shear speeds reflect the temperature and composition of the rock at depth, offering important new information on both regional- and basin-scale lithospheric structure and evolution. Accurate knowledge of the thermal structure of the deep lithosphere will improve our understanding of the thermal structure and evolution of the basins within the region.

## **Seismic Structure of the Crust and Upper Mantle of Porcupine Basin from Wide-Angle Data**

Chen, C.<sup>1,2</sup>, Watremez, L.<sup>1</sup>, Prada, M.<sup>3</sup>, Minshull, T.<sup>1</sup>, Edwards, R.<sup>2</sup>, O'Reilly, B.<sup>3</sup>, Reston, T.<sup>4</sup>, Wagner, G.<sup>5</sup>, Gaw, V.<sup>5</sup>, Kläschen, D.<sup>5</sup>, Shannon, P.<sup>6</sup>

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The evolution of continental rifted margins plays an important role in understanding the geological process of continental extension. As a key rifted basin located to the southwest of Ireland, the Porcupine Basin is a large V-shaped sedimentary basin of Late Palaeozoic to Cenozoic age. It formed during the opening of Atlantic Ocean. A geological feature named Porcupine Median Ridge (PMR) is identified at the southernmost part of the basin. However, the origin of PMR has remained debated, with serpentinisation, volcanic activity and crustal faulting being suggested. Previous studies, mainly using seismic reflection and gravity data, show an increasing stretching factor from north to the south (from less than 1.5 to greater than 6). Wide-angle seismic data acquired along a ca. 100 km long profile across the basin axis yield new insights into the crustal and upper mantle structure. During this study, both refractions and reflections recorded by the OBS are used to perform a joint travel-time inversion, and a 2D P-wave velocity model has been obtained which contains information about the sedimentary, crustal and upper mantle structure. The tomographic model is consistent with the forward modelling result. Analysis of the velocity features from both models reveals the crustal thickness at the south Porcupine Basin is up to 12 km in the middle of the basin, then gradually decreases to ~10 km under the PMR. Thus, the stretching factor is lower than that inferred from former studies. Based on the results, we discuss the rifting process and the geological nature of the PMR. This project is funded by the Petroleum Infrastructure Programme (PIP).

## **Meso-Cenozoic exhumation of Ireland**

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<sup>2</sup> *Earth and Ocean Sciences, School of Natural Sciences, National University of Ireland, Galway, Ireland*

The thermal history of a passive margin yields key information on its tectonic evolution, as phases of tectonic activity can be inferred from periods of enhanced cooling or heating. The exhumation mechanisms can be deduced from the timing and regional extent of such events.

We have acquired a large thermochronological dataset for onshore Ireland using two techniques: fission track and U-Th/He analysis of apatite. We show that Ireland experienced a complex thermal history over the last 200 Ma. The Mesozoic exhumation pattern is linked to a complex rifting history and is visible everywhere onshore Ireland. In contrast, an Early Cenozoic cooling phase is restricted to eastern Ireland, and this pulse of exhumation is likely linked to the effects of the proto-Iceland Plume. A widespread Neogene exhumation phase, linked to far-field stress and enhanced erosion due to glaciation, explains the present day morphology of Ireland. We also have analysed dredge samples from the Porcupine High to compare its evolution with the mainland. The pattern of exhumation is complex, but clearly shows that this metamorphic basement high could have been an important source for sandstone reservoirs in the Porcupine and Rockall basins.

Finally, we have started a thermochronological study on offshore boreholes to determine the exact magnitude and timing of inversion episodes in the western offshore basins. Of the boreholes studied so far using conventional cores, only a few samples yielded enough apatites to undertake thermochronological analyses. Our main goal now is to extend this study by using drill cuttings to improve the apatite yield. Our aim is to better constrain, compare, and link the onshore thermal histories with the Porcupine High and the offshore basins.

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## **Sound propagation from a 3D seismic survey in the Porcupine Basin: a comparison of observed acoustic measurements with modelled results**

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The Porcupine Basin was included in the 2015 Atlantic Margin Oil and Gas Exploration Licensing Round, which allows companies to assess the petroleum potential of an area. Consequently, the Porcupine Basin continues to be a significant site for seismic exploration activities which use air guns as an impulsive sound source, obtaining 2D and 3D data, to investigate sub-bottom structure. Irish waters, however, are also some of the most important in Europe for a wide range of cetacean species, with up to 23 different species inhabiting our waters for at least part of the year. Recent literature has reported on the environmental implications of marine seismic surveys, highlighting alarmed and avoidance behaviour in several marine species as a common response to air gun signals. The European Habitats Directive (EC: 92/43/EEC) orders the protection of all cetacean species that inhabit European waters. In addition,

the European Commission has instructed that noise must not adversely affect the marine environment in order to achieve Good Environmental Status. As such, underwater acoustic monitoring and mapping has been targeted as a research priority under the Marine Strategy Framework Directive. Findings will be essential for designing and implementing appropriate regulation regarding underwater noise. In this study, the acoustic model RAMGeo, a range-dependent technique which employs the Parabolic Equation (PE) to model sound propagation, was used to model real, range-dependent 2D source-to-receiver sections from the Porcupine Basin, for which observed acoustic data has also been collected. The transmission loss values computed in the model are compared with their corresponding observed values, which were measured during a research cruise in July 2014 to coincide with 3D seismic operations in the area, at locations across the Basin. The findings and limitations of the study are evaluated before proposals for subsequent work, which will aim to calibrate the models using the measured acoustic data, are outlined.

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 post-cruise logs) and to CMST, Curtin University, for making accessible the AcTUP V2.2I software, for generating source waveforms using their Air Gun Simulator and for their provision of training and continued support in acoustic data analysis.

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

### **Modelling predictive distribution of seabirds at sea**

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The west coast of Ireland has a large population of seabirds, many of which spend a significant amount of time at sea, potentially encountering hazards such as oil pollution. A better understanding of where seabirds are found at sea will allow us to assess their vulnerability to such hazards. The distribution of seabirds can be monitored using GPS tracking or by conducting at sea surveys, but both of these methods can be difficult, time consuming and costly. As a result there is currently very little information available about where seabirds spend time at sea off the west coast of Ireland.

Predictive distribution models have the potential to be a much quicker and cost effective way of assessing at-sea distribution. Data on colony locations, size and species foraging behaviour will be used in a model to build predictive maps of seabird distribution, showing both the extent and density of birds in 1km<sup>2</sup> grid squares up to a distance of 400km from the colony. The predictive distribution model will be developed in stages, with greater complexity being added at each successive stage – incorporating additional information on non-foraging behaviours and prey distribution. Predictive distribution maps will be produced for key seabird species found on the west coast of Ireland. These will be incorporated into an online GIS platform with functionality to overlay maps to identify areas with high densities of the most vulnerable species. The potential risks to the most vulnerable species or in the most bio-diverse hotspots can then be explored further in future research.

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

## **Reservoir Connectivity, Compartmentalisation, and Overpressure Conditions in the Sable Sub-basin (Nova Scotia, Canada) and Porcupine Basin (Ireland)**

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Overpressure is abnormally high subsurface pressure exceeding hydrostatic pressure at a given depth, and occurs when fluids become trapped in the pores of sedimentary rocks. Overpressure has been identified as a risk element in the Sable Sub-basin of Nova Scotia, and has been identified as a poorly understood risk element in the Porcupine Basin of Ireland. The Sable Sub-basin and Porcupine Basin formed as a result of the formation of the North Atlantic Ocean, therefore represent diverse tectonic styles and depositional environments. The Sable Sub-basin is southwest-northeast trending and is part of the Scotian Basin; it comprises Mesozoic-Cenozoic sediments (up to 18,000 m) overlying a Palaeozoic basement. The Porcupine Basin is a north-south trending basin located on the Irish continental margin, and comprises sediments from the Carboniferous to Holocene.

Previous work has established overpressure in the Sable Sub-basin is variable in magnitude and unpredictable, with faults assumed to be either dynamic (allow communication) or static (does not allow communication), which is inaccurate. Utilising 3D seismic datasets, with wireline log and pressure data, we are completing a reservoir connectivity analysis of the Sable Sub-basin to determine the effect of fault behaviour on connectivity and pressure migration. This study uses 3D geometric models to demonstrate the location and magnitude of overpressured reservoir compartments, integrating reservoir architecture, fault behaviour, and pressure data to generate a preliminary map for de-risking future exploration.

Abnormal pressure and pressure distribution has received limited study in the Porcupine Basin. Pressure measurements have been collected (repeat formation tests, formation leak off tests, and drill stem tests) in several wells, providing a preliminary dataset to begin investigating pressure behaviour in the basin. A petrophysical analysis of the wells will be completed to determine if there is overpressure present and potential lateral pressure connectivity across the basin.

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

## **Downtime Assessment for Facilities Offshore of Ireland – DAFOIL**

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<sup>2</sup> *School of Engineering, The University of Edinburgh.*

Ireland lies on the continental shelf, and faces the most extreme weather and ocean wave conditions experienced by the eastern Atlantic Ocean. The aim of the present work is to characterise the extreme wave behaviour in the seas off Ireland in order to inform offshore engineers and designers of extreme and operating conditions.

To exploit the offshore oil and gas reserves off the west coast of Ireland, the offshore industry must have confidence that its facilities can operate safely in deep water. Wave climate statistics have to be accurately estimated, especially the likelihood of extreme water crest elevations and also the distribution of weather windows. Such statistics will provide the offshore oil and gas industry with valuable insight into expected temporal changes to sea states and facility responses over different time windows, allowing



downtime periods to be predicted. The outputs will also contribute to the design methodology for maritime facilities offshore of Ireland.

A coherent database of validated wave data will also result from this work.

Work to date has focused on methods to identify and replace the so-called “wild points”, which are spurious values of free surface elevation. A data filter was decided on after various trials. To identify errors, a ratio of the median free surface elevation to the  $H_{\max}$  for each interval was used. This filter identifies spikes and removes values either side of a spurious spike which was calculated to be approximately five times the largest expected wave period, this allows sufficient time for transient errors to decay, (Cahill, B. 2011). This filtered high frequency wave data has allowed preliminary estimates of return periods of extreme wave heights to be made at the AMETS buoy locations. Other areas which will be investigated include spectral analysis of the wave climate in the NW Atlantic, spatial interpolation mapping and ocean simulation in the wave tank.

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

## References

Cahill, B. 2011. Characteristics of the Wave Energy Resource at the Atlantic Marine Energy Test Site. PhD Thesis, University College Cork, Ireland.

## Sedimentary provenance of the Devonian Munster Basin and the Mesozoic North Celtic Sea Basin: evidence from detrital zircons

Fairey, B.<sup>1</sup>, Kerrison, A.<sup>1</sup>, Meere, P.<sup>1</sup>, Mulchrone, K.<sup>2</sup>, Linnemann, U.<sup>3</sup>, Hofmann, M.<sup>3</sup>, Gärtner, A.<sup>3</sup>, Sonntag, B.<sup>3</sup>, Byrne, K.<sup>4</sup>

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Palaeogeographic reconstructions are fundamentally important to hydrocarbon exploration as they can provide useful information about sediment pathways and basin development. This study uses over a thousand concordant detrital zircon ages to assess the provenance of the eastern part of the Devonian Munster Basin and the Mesozoic North Celtic Sea Basin (NCSB) as well as, to a lesser extent, the South Celtic Sea Basin. The research forms part of a wider project that aims to clarify source to sink sediment movements during the Upper Devonian but especially during Triassic to Cretaceous times in the onshore and offshore basins of southern Ireland. Kernel Density Estimation (KDE) plots are used to display the large U-Pb and Pb-Pb age datasets. Onshore samples, particularly those of the upper Old Red Sandstone (ORS), show strong Palaeozoic to late Neoproterozoic peaks whereas KDE plots from Devonian-Carboniferous transitional samples show more complex profiles. Cretaceous and Jurassic samples from the North Celtic Sea Basin also show peaks in the Palaeozoic. However, greater sediment input seems to be from an ultimate source that is Neoproterozoic in age. A number of potential sediment sources of Palaeozoic age are presently exposed on the island of Ireland. The most obvious and geographically proximal sources are the Leinster Granite as well as the Ordovician volcanics of the Rosslare Complex. These rocks could well have acted as detrital zircon sources for the Munster Basin. The Palaeozoic zircons in the NCSB may have been sourced directly from these rocks or may have also been recycled from Munster Basin sediments. The Neoproterozoic zircons would have been sourced

from further afield with potential sources being the Welsh Massif, the oldest gabbros of the Rosslare Complex and the metavolcanics of the Dalradian Supergroup in Ireland. The data acquired in the present study will add great value to the broader understanding of regional tectono-stratigraphy before opening of the Atlantic Ocean. The southern Irish Mesozoic basins continue to maintain interest in the hydrocarbon exploration industry and projects like this one can act as catalysts for future investment.

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

### **Fluid inclusion Studies and Mineral Liberation Analysis (MLA) of Hydrocarbon Prospective Basins in the Newfoundland and Labrador Offshore Massif**

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<sup>2</sup> *Department of Earth Sciences, Memorial University, St John's NL, Canada.*

This project will use a range of microscopic techniques that facilitate the study of aqueous and hydrocarbon-bearing fluid inclusions and their potential use as temporal markers of palaeo oil migration events. Fluid inclusions are micron scale samples of aqueous and hydrocarbon fluids trapped in annealed microfractures developed during burial, or earlier in authigenic minerals e.g. quartz and/or calcite during cementation. Microscopic studies are carried out on specially prepared doubly polished fluid inclusion wafers (~150 microns thick) of well core, sidewall core and cuttings (a total of ~215 samples). By using a combination of transmitted light and UV light microscopy, cathodoluminescence, laser Raman microscopy and microthermometry, it will be possible to collate and compare textural and compositional data relating to the trapping history of aqueous and hydrocarbon fluid inclusions. Provenance analysis will be performed on the same suite of samples using SEM-MLA techniques. This will include mineral identification and investigation of provenance-sensitive minerals. The samples of core and cuttings are from nine offshore wells located to the east of Labrador and Newfoundland. The wells under investigation are from four basins with significant hydrocarbon potential: Flemish Pass, Hopedale, Saglek and South Whale Basins. The overall result of these combined studies will be a serious de-risking for petroleum exploration in the Newfoundland and Labrador offshore massif.

This project is funded by the Offshore Geoscience Data Program (OGDP) that is jointly administered by Nalcor Energy – Oil and Gas and the Department of Natural Resources, Government of Newfoundland and Labrador.

## **Towards integrated, lithosphere-scale modelling of the thermal structure and evolution of basins**

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The shape and evolution of the geotherm beneath a basin depends on both crustal and mantle-lithosphere structure beneath it: lithospheric thickness and its changes with time (these determine the supply of heat from the deep Earth), crustal thickness and heat production (the supply of heat from within the crust), and the thickness and thermal conductivity of the sedimentary cover (the insulation). Detailed thermal structure of the basins can be modelled by integrating data on crustal structure and heat production with information from crustal and mantle seismic tomography and with other data (topography and bathymetry, gravity, surface heat flow). New methods of computational petrology provide a framework for self-consistent integrated modelling of basin structure and evolution, using the entirety of relevant data. New tomographic models of the North Atlantic - Arctic crust and upper mantle, constrained by unprecedentedly large waveform datasets, provide increasingly high resolution and accuracy of the imaging. Integrated, lithosphere-scale modelling based on the new data and methods can offer significantly improved models of the thermal structure and evolution of basins.

## **Filling the gaps: Using marine observer data from seismic surveys to enhance our understanding of marine mammal distribution in Irish waters.**

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Irish waters are a geologically diverse region and highly productive in terms of natural resources. The region also supports over 20 species of marine mammals. In the last 20 years over 5000 hours of survey effort focused on examining the distribution of marine mammals in Irish waters has been carried out by opportunistic and dedicated surveys. However, the temporal and spatial coverage of these surveys often differ, and large areas such as the Porcupine Basin remain poorly surveyed. This reduces our knowledge of the distribution of rare and vulnerable species of marine mammals and compromises our ability to manage human activities such as Oil and Gas exploration. To begin to fill these knowledge gaps more survey effort is required. We identified a source of high-quality, effort-related sightings data that could be used to supplement existing data and fill gaps in survey coverage. Observations made by marine mammal observers (MMOs) on board seismic vessels are carried out by trained observers, over extensive areas and prolonged periods. Over 4000 hours of MMO survey effort has been conducted, often in waters not frequented by other dedicated surveys, with a high density of survey coverage around the Porcupine Basin. However, a number of factors such as the variation in data collection methodologies and the influence of seismic noise on the behaviour of animals need to be considered before combining data from this source with dedicated survey data. Despite this, these data may be a useful addition to currently available datasets and contribute to filling some of the gaps in our knowledge of cetacean occurrence and distribution. Once these data have been validated and combined with existing data, future studies can be designed to prioritise survey coverage in data deficient or high value areas of Irish waters.

This project was carried out in MaREI (Marine Renewable Energy Ireland), supported by SFI funding under Grant No. SFI/12/RC/2302. The authors would also wish to acknowledge industry partner funding from KOSMOS Energy.

## **Provenance and sediment routing of onshore and offshore southwestern Ireland**

Kerrison, A.<sup>1</sup>, Fairy, B.<sup>1</sup>, Meere, P.<sup>1</sup>, Mulchrone, K.<sup>2</sup>, Linnemann, U.<sup>3</sup>, Hofmann, M.<sup>3</sup>, Gärtner, A.<sup>3</sup>, Sonntag, B.<sup>3</sup>, Byrne, K.<sup>4</sup>

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Provenance studies are powerful tools in determining the nature of sedimentary transport systems. They give valuable information on the geological history of an area and often show that sedimentary pathways can have a greater control on provenance than proximity to a source area. The Mesozoic offshore basins of southwestern Ireland are situated among a complex series of failed-rifts, forming half graben structures geometrically along pre-existing Caledonian, Acadian and Variscan structural lineaments. This study aims to determine source to sink sediment movements within these terranes during Devonian, Triassic, Jurassic and Cretaceous times. Sandstones were sampled across onshore Devonian Dingle, Munster and South Munster basins, and offshore Mesozoic western North Celtic Sea, Fastnet and southern Porcupine basins. U-Pb detrital zircon geochronology analyses were conducted on these samples to determine relationships between basins and assess the likelihood of multiple sedimentary recycling events. The abundance of Neoproterozoic aged zircons within Jurassic sediments of well 62/07-01 suggests there is no evidence for recycling from onshore Ireland into the Porcupine Basin. This dominance indicates broad-scale sedimentary recycling from a Laurentian terrane north of the Iapetus Suture and not from Avalonian basement. This differs to the Fastnet and western North Celtic Sea basins where Triassic recycling off the Irish Massif is most likely responsible for correlating Ordovician, Upper Neoproterozoic and Paleoproterozoic detrital zircon ages. Onshore samples show zircon ages that are consistent throughout the mid to late Devonian. Samples within the Dingle and South Munster basins display late Neoproterozoic to Cambrian ages, typical of peri-Gondwanan basins; a signature not evident within Munster Basin samples. Continued analyses of offshore Triassic, Jurassic and Cretaceous samples within the western North Celtic Sea and Fastnet basins will further constrain exhumation off the Irish Massif.

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



## **Transformative actions towards marine energy futures**

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### *Context*

Ireland is aiming to become an early leader in the full scale commercialisation of Marine Renewable Energy (MRE). Innovations in policy and planning are needed to set up a system for decision-making fit for the purpose to realise full potential of the MRE sector.

A co-evolutional approach is needed addressing not only 'technical innovation' but also 'institutional innovation', an approach that provides enabling conditions to achieve long term plans for marine energy (both offshore and renewable). A major ingredient of this is to address the power to influence decision-making in governments together with civil society.

In this collaboration we are working together with representatives from markets and civil society and leaders from government on policy relevant research at the interface between all sources of Governance. The study supports decision-makers to make better decisions and to enable Ireland to successfully harness Energy from the Ocean. In this context, we are looking into the decision-making process for large scale developments for Marine Energy projects in Ireland and how decisions were made in the past, in cases such as the Corrib Gas or the Shannon Foynes project, and use the lessons to emerge to guide better decisions in the future.

### *The approach*

We are undertaking research analysis on Governance arrangements using the Governance Baseline approach and the 'Orders of Outcome' model developed from scientific peers within Future Earth Coasts (formerly Land-Ocean Interactions in the Coastal Zone (LOICZ)), an international programme of the Earth System Science Partnership.

### *Two major components form the basis of the analysis:*

Based on international case studies the approach aims at taking stock of how decisions were made, identifying the player at multiple levels and where influences lay with regard to institutional arrangements.

Based on collaborations (including workshop and interview facilitation) the research seeks to build trust between relevant stakeholders from government, industry and civil society involved in decision-making for Marine Energy and to build consensus on where stakeholders agree or disagree.

## **Decision Support for Oil-Spills (DSOS)**

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<sup>1</sup> *National Centre for Geocomputation, Maynooth University, Maynooth, Co Kildare*

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. The research objectives include designing, building and assessing a scalable cloud-based Geoinformatics platform architecture using a real-world oil-spill exercise. Particular focus has revolved around role of data inputs from Satellite Remote Sensing, Drones and Mobile Devices e.g. Smartphone App.

The geospatial platform, comprising; ingestion, storage, discovery, fusion, analysis, visualisation and reporting modules, has been completed. These modules are designed around a Common Operational Picture (COP) structure where an Administrator or Emergency Coordinator can input team members, configure response logistics, initiate incidents, mobilise teams, task responders and observers, collate 'live' information from the field, carry out damage assessment, implement response plans and record all activity. The platform, Smartphone app was tested using a live Oil-Spill exercise in April 2015. Technology and work-flow refinements, identified during that exercise, are currently being applied to the systems. A number of organisations have already registered interest in this emergency pollution response platform.

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

## **Ambient noise, seismic survey signals and whale presence from western Irish waters between May and September 2014 using moored acoustic loggers**

McCauley, R.D.<sup>1</sup>

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Six sea noise receivers were set over 18-May-2014 to 20-Sep-2014 west of Ireland on the eastern and northern sides of the Porcupine Basin and on the southwestern flank of the Porcupine Bank. The work was a collaboration between Woodside Energy, Galway-Mayo Institute of Technology, the Irish Marine Institute, RPS Metocean (Western Australia) and CMST. The receivers detected: nearby vessel noise; natural ambient sea noise sources; marine exploration seismic survey signals; fin and blue whale calling; whistling signals from smaller toothed whales; sperm whale clicks; toothed whale echo-location signals; and various other anthropogenic sounds. Ambient noise was dominated by vessels, natural sources and fin whales at all sites up until early July 2014. On average 1.6, 1.1 and 1.8 recognisable vessels / day passed, at a median passage time of 3.1, 3.0 and 4.2 hours and maximum received level of 108, 107 and 112 dB re 1 $\mu$ Pa at the northern and eastern Porcupine sites respectively. Ship tonal signals were present in the deep sound channel frequencies continually. In early July seismic survey signals appeared, dominating frequencies up to 300 Hz for the remaining recording period and present at ~20-30% of the time. Up to three seismic vessels were present. Seismic surveys signals up to 145 dB re 1 $\mu$ Pa<sup>2</sup>.s (SEL) were common. Fin whale signals were common, more prevalent on the northern and eastern Porcupine Bank sites and increasing in number later in the recording period. There was a slight tendency for fin whale calling to be more prevalent just after sunrise and sunset. Fin whale calling was present during seismic surveys. Signals from North Atlantic blue whales were detected at the southwestern Porcupine Bank site in low numbers but not at the eastern sites. Calculated detection ranges for recognisable fin and blue whales signals were similar, varying enormously with heading from receiver and ambient noise, in the range 46-198 km. Large numbers of toothed whale whistles and

echolocation clicks were detected. Whistling and echolocation clicks were more prevalent at eastern Porcupine Basin site (closest to Irish coast), intermediate at southwestern Porcupine Bank site (furthest from coast), least prevalent at the north Porcupine and increased across the sampling period. Most whistling bouts were produced by one or two animals, although it was common to have up to four animals whistling simultaneously with the maximum 17. Sperm whale, possible beaked whale and unattributed echolocation clicks were present. Possible beaked whale detections were rare and sporadic at the northern Porcupine Basin site (~ 1% of the time) and increased in prevalence to the south and later in the sampling, reaching 40-60% of the time post late July. Sperm whale clicking was greatest at the southwestern Porcupine Bank site and generally increased in rate through time to be present 20-50% of the time at the eastern Porcupine Basin site. The presence of sperm whales and dolphins was correlated, present simultaneously in 17% of samples with sperm whales at the northern Porcupine Basin site, 32% at the southwestern Porcupine Bank site and 52% at the eastern Porcupine Basin site. No minke or humpback whales were recorded at any site during the study period.

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

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<sup>1</sup> *School of Civil, Structural & Environmental Engineering, University College Dublin*

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The ever increasing demand for offshore infrastructure in the petroleum industry leads to the desire for new techniques to determine soil properties for foundation design to reduce the time and financial burden associated with such projects.

The multi-channel analysis of surface waves (MASW) technique is widely used in onshore geotechnical investigations. This technique provides the shear wave velocity ( $V_s$ ) which is an important parameter for geotechnical characterisations of sub-bottom materials in marine environments. For engineering purposes the shear wave velocities, using the density of the material, can be converted into small strain shear modulus values ( $G_{max}$ ). These values can then be utilised in foundation design. The objective of this project was to develop the MASW technique for offshore use, replacing the traditional geophone spread with a 24-channel hydrophone cable and using an air gun as the seismic source.

In this poster the process used at a shallow site in Dublin Bay will be described briefly and some resultant Offshore MASW  $V_s$  profiles will be presented. A comparison of  $G_{max}$  values produced from: these Offshore profiles;  $V_s$  Profiles determined using onshore MASW performed at low tide; and from SPT values from borehole trials previously carried out in this area, is presented.

Further sea trials have just been completed on a second site which are currently being evaluated.

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

## **Goelectrical characterisation of the NW Carboniferous Basin (Ireland) for testing new methodologies and assessing their potential for reservoir characterisation.**

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This study aims at improving our methods of characterizing saline aquifers by integrating new electromagnetic data with existing geophysical and geological data. This kind of characterisation is relevant for studying the potential for onshore carbon sequestration, but is also applicable to the evaluation of geothermal resources in appropriate geological settings. The current project (IRECCSEM, funded by Science Foundation Ireland) is focused on two study areas: the Clare Basin and the NW Carboniferous Basin. In this paper we present first results from a three-dimensional (3D) inversion and modelling of the magnetotelluric (MT) data acquired in the NW Carboniferous Basin in summer 2015. The electrical resistivity distribution beneath the survey area is constrained using a joint inversion of three different types of electromagnetic data: MT impedance tensor responses (Z), geomagnetic transfer functions (GTF) and inter-station horizontal magnetic transfer-functions (HMT). The preliminary 3D resistivity model obtained reveals the goelectrical structure of the subsurface, which still needs to be translated into parameters which are relevant to fluid flow. Since the electromagnetic data are organised along profiles linking four wells drilled in the area, the available well log data will be used to evaluate some of the existing petrophysical relationships and in a further step calibrate them to our study area. This will allow us to interpolate the rock physical properties from one well to another well, using the computed goelectrical model as a reference. The obtained results will be compared to available independent geological and geophysical data in order to analyse the validity of our technique, to characterise the uncertainties inherent to our approach, and to assess the potential of this methodology for reservoir characterisation.

## **Palaeo-canyon development and the interplay between down-slope and along-slope processes in the Donegal-Barra fan area, Rockall Basin.**

Owens, M.<sup>1</sup>, Haughton, P.<sup>1</sup>, Georgiopolou, A.<sup>1</sup>

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Slopes along the eastern margin of the Irish Rockall Trough are characterised by prominent canyons which incise the margin from the shelf edge and mid-slope to the base of slope. These appear to be relict features that were locally reutilised by discharge from the British-Irish Ice Sheet during the Pleistocene. Previous work based on regional 2D seismic lines attributed canyon formation to widespread slope failure associated with a phase of rapid Late Eocene differential subsidence. Trough deepening was accompanied by an intensification of bottom-current circulation and the development of the regional C30 unconformity. Large mounded features above the C30 unconformity at the base of the slope (the Erris Wedge) were attributed to mass-transport processes that excavated the canyons and were modified by later gravity currents.

A re-investigation of the Erris Wedge 'mounds' and related stratigraphy is currently underway using the Midelton and PGS-SRT seismic cubes in the NE sector of the trough (beneath the Donegal-Barra fan). Seismic stratigraphy and surface mapping reveal an erosional seascape with canyons up to 300m deep



that incise into a Lower Eocene drape and turn distally to the south suggesting there may have been a significant axial trough gradient. The mounded features are revealed as inter-canyon ridges that were probably amplified by Oligo-Miocene bottom-current activity and limited canyon spill-out. Amplitude mapping demonstrates the canyons were conduits for gravity currents that helped maintain the canyon morphology and these locally constructed channel networks at the base of slope that were deflected by local topography to flow parallel to slope. The internal structure of the bottom-current amplified 'mounds' is characterised by low to moderate amplitude continuous reflectors which suggest along-slope processes came to dominate over down-slope transport as the basin became increasingly isolated from up-dip sediment supply. Local mound disruption and extensive polygonal faulting indicate instability, however the mounds appear to be constructional features seeded on earlier erosional relief, not mass-transport deposits. This leaves open the possibility of significant downslope sand transport by gravity during and immediately after the development of the C30 surface in this area. The interplay between down and along-slope transport helped maintain an inherited sea floor topography that persists through to the present day, although it has been partly buried by glaciogenic sediment associated with the Pleistocene Donegal-Barra fan.

### 3D Fault zone representation in reservoir modelling

Papanikolaou, V.<sup>1</sup>, Manzocchi, T.<sup>1</sup>

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It is widely known that faults rarely comprise of one single surface; instead, they form complicated zones, including features such as relay zones, fault lenses and regions of normal or reverse drag within the wall rocks. The precise details of this fault zone complexity can have a strong impact on both subsurface flow and reservoir compartmentalisation. Most reservoir modelling techniques adopt a simplified way of including faults, since the majority of the fault-related models represent faults as 2D surfaces rather than 3D volumes. This simplification can have a strong impact on fluid flow, owing to the different across-fault and up-fault juxtapositions that can be present in a low-fidelity reservoir model of a complex fault. The aim of this work is, initially, to create a number of 3D geocellular fault zone models that honour realistic structural complexity and to illustrate the effect of this complexity on flow by comparison with conventional models that exclude it. Ultimately, the study aims to improve available methods for incorporating realistic 3D fault complexity in reservoir modelling.

### Benthic habitat mapping on the Irish Atlantic Margin

Patterson, A.<sup>1</sup>

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The ability to characterise benthic habitats, and the communities which occur therein, is essential for developing sustainable environmental management of the effects of anthropogenic activity in the marine environment. The European Nature Information System (EUNIS) is a comprehensive system for determining benthic habitat types. The system consists of levels which describe where the habitat is found (depth), what the bottom type is (sand, mud, rock etc.) and the characterising species present. The further down the hierarchy one goes, the more information is provided by the classification. The most useful is a level 5 or 6 classifications: (1) environment, (2) biogeographic region, (3) biological zone (depth), (4) substratum and (5/6) biology. Once a habitat has been identified, Geographic Information Systems (GIS) can be used to visualise the distribution of these habitats. These visualisations, called

habitat maps are essential tools in monitoring changes in the extent and community composition of known habitats. The ability to visualise these changes provide environmental managers with a powerful tool to assist in developing objectives and practices for conserving marine habitats. Here we provide an initial broad-scale habitat map for the Irish Atlantic Margin. Habitat maps for both EUNIS levels 4 and 5/6 are illustrated. Further work will employ a measure of ecological status to determine the vulnerability of the derived habitats to environmental stress.

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

### **Understanding hydrocarbon generation in the Irish Atlantic Margin using inorganic geochemistry**

Porter, S.<sup>1</sup>, Roach, C.<sup>1</sup>, Barry, L.<sup>1</sup>, Simmons, R.<sup>1</sup>

<sup>1</sup> *Chemostrat Ltd., 1 Ravenscroft Court, Buttington Cross Enterprise Park, Welshpool, Powys, UK.*

In order to produce a model for hydrocarbon generation in the Irish Atlantic Margin (IAM), it is imperative that we are able to attain a thorough understanding of the two key components: the hydrocarbon-generating source rock and the associated hydrocarbons. Prior to this study, understanding of the timing of oil generation in the Porcupine and North Celtic Sea basins has been limited. However, the application of rhenium-osmium (Re-Os) geochronology and trace element geochemistry to oil and cuttings samples has provided critical information regarding the temporal and spatial controls on the formation of hydrocarbon deposits in these basins, thus enabling the construction of a new model for oil generation.

Rhenium-osmium and trace element geochemistry has been applied to a suite of oil samples from 11 wells from the Porcupine and North Celtic Sea basins (spanning blocks 26, 35, 48, 49 and 50), in order to investigate hydrocarbon generation in the IAM. Utilisation of the Re-Os technique not only shows that there is a strong possibility of oil mixing in the Porcupine and North Celtic Sea basins, but it enables us to resolve out these mixing events and provide a temporal constraint for them. Rhenium-osmium oil geochronology provides ages of  $129 \pm 23$  Ma and  $169.1 \pm 7$  Ma, indicating that at least two phases of oil generation have occurred in the IAM (in the Early Cretaceous and Middle Jurassic). The latter date for oil generation implies that at least one of the source rocks in the Porcupine Basin petroleum system is likely to be older than Early Jurassic, and potentially points to a source unit from the Late Carboniferous or earlier.

In addition, analysis of trace element distributions and relationships within the oils has demonstrated considerable compositional variation, indicating the presence of several distinct oil populations in the IAM. In support of the Re-Os dataset, these compositional differences indicate the occurrence of oil mixing within these basins. The observed distinction between oil populations also suggests that multiple source rocks have generated the accumulations present in the Porcupine and North Celtic Sea basins. The trace element dataset shows that there are oil families that are specific to each of these individual basins, indicating isolation of several of these petroleum systems within each basin. However, strong compositional similarity is noted between oils in several wells within blocks 26 and 49 suggesting that some connectivity may exist between these two basins.

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

## **Deep structure of the northern Porcupine Basin from wide angle seismic and multichannel seismic data**

Prada, M.<sup>1</sup>, Watremez, L.<sup>2</sup>, Chen, C.<sup>2</sup>, O'Reilly, B.<sup>1</sup>, Minshull, T.<sup>2</sup>, Reston, T.<sup>4</sup>, Wagner, G.<sup>5</sup>, Gaw, V.<sup>5</sup>, Kläschen, D.<sup>5</sup>, Shannon, P.<sup>6</sup>

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The Porcupine Basin is a tongue-shaped basin SW of Ireland formed during the opening of the North Atlantic Ocean. Its history of sedimentation reveals several rifting and subsidence phases during the Late Palaeozoic and Cenozoic, with a particular major rift phase occurring in Late Jurassic–Early Cretaceous times. Previous work, focused on seismic and gravity data, suggest the presence of major crustal faulting and uppermost mantle serpentinisation in the central part of the basin. However, the northward progression of this process is poorly constrained. In the framework of the Porcupine Basin project, we present the northern deep structure of the Porcupine Basin from wide-angle seismic (WAS) data. This particular data set was acquired in 2004 along a 300 km long transect that crosses the basin axis at 52.2 N. WAS data were recorded by 22 Ocean bottom seismometers (OBS) and three land stations installed in Dingle Peninsula. We have used a joint refraction and wide angle reflections travel time inversion method to obtain the 2D P-wave velocity ( $V_p$ ) model of the crust and uppermost mantle, together with the geometry of major geological interfaces. These results combined with coincident seismic reflection data and borehole information shows that the post-rift sedimentary package thickens basinwards up to 8 km and that  $V_p$  vary from 1.5 to 4.5–5 km s<sup>-1</sup> from top to bottom. The underlying  $V_p$  structure up to the Moho shows  $V_p$  between 5.5–7.0 km s<sup>-1</sup> and includes from top to bottom the syn-rift sequence and the crystalline crust. The Moho shallows from the margins towards the basin axis from ~25–30 km to ~15 km deep, which implies a maximum stretching factor of ~5–6. These values are well within the range of crustal extension at which the crust becomes entirely brittle allowing the formation of major crustal faulting and serpentinisation of the mantle.  $V_p$  in the mantle is slightly slower than 8 km s<sup>-1</sup> although further assessment of its uncertainty needs to be done as it is not so well constrained due to the sparse ray density.

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

## Ice sheet - ocean interaction in the eastern North Atlantic: searching for millennial-scale climate events at the western Porcupine Bank

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The North Atlantic region is a key site for understanding the role of oceanographic and climatic changes. Since the Greenland Ice Sheet exhibits ice sheet collapses over the last decade, concerns about the potential contribution to alterations in temperature, sea level and the Atlantic Meridional Overturning Circulation (AMOC) configuration and strength are reinforced.

The British Irish Ice Sheet (BIIS) is a useful past analogue for the behaviour of a marine-based ice sheet in a warming world. Sediments accumulating along the Porcupine Bank and in the adjacent Rockall Trough have provided potential insights into the evolution and demise of the former BIIS. Sediment grain size analyses and X-ray images confirm the appearance of ice rafted debris (IRD) throughout the last glacial within sediment cores taken from the lower slope of the Porcupine Bank (>2700 m water depth). The IRD can be well differentiated from Heinrich Events (HE) which appear as distinct grey bands with a dense presence of IRD and accompanied high magnetic susceptibility. Accordingly, the Porcupine Bank region west of Ireland is clearly influenced by the BIIS and by imprints coming from Laurentide Ice Sheet (LIS) triggered HE.

The extent to which the oceanographic conditions at the Porcupine Bank were influenced by the BIIS or how the conditions change during HE is distinguished by foraminifera-based analyses. Planktonic foraminifera assemblage data reveal slightly increased temperatures during HE, whereas no linkages are visible during the other IRD peak events. Therefore, a higher resolution approach, also combining stable isotopes ( $\delta^{18}\text{O}$ ) and trace elements (Mg/Ca) of planktonic foraminifera will be performed to explore changes in sea surface temperatures (SST), sea surface salinities (SSS) and water mass characteristics.

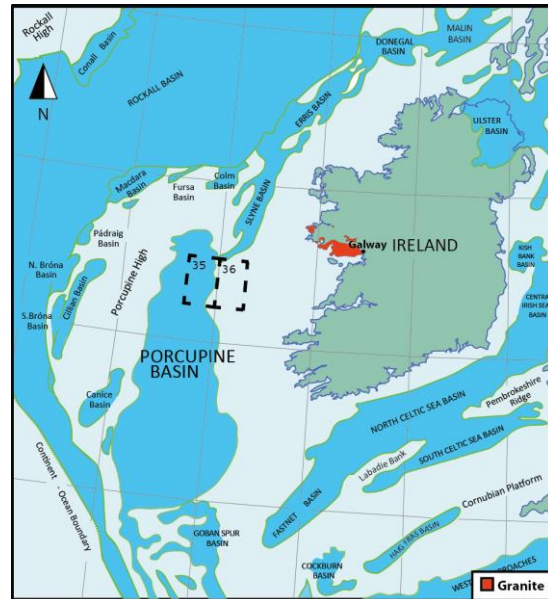


Figure 1. Map location of study area (quadrants 35, 36) in the northeast Porcupine Basin and the Galway granites, onshore Ireland (modified from Naylor and Shannon 2011).



## **Integrated Chemostratigraphic and Biostratigraphic evaluation of the Lower Cretaceous and Jurassic successions encountered in the Irish Atlantic Margin**

Roach, C.<sup>1</sup>, Butler, N.<sup>2</sup>, Ortiz, S.<sup>2</sup>, Joachim, C.<sup>2</sup>, Lees, B.<sup>1</sup>, Simmons, R.<sup>1</sup>, Pearce, T.<sup>1</sup>

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Thirteen wells from across the Irish Atlantic Margin (IAM) were subjected to a multi-disciplinary investigation, with a view to establishing an integrated correlation framework for the Upper Mesozoic successions encountered. Of the thirteen wells, four were selected as key wells (43/13-1- South Porcupine Basin; 26/28-1 – Connemara; 35/8-1 - Burren and 35/8-2 - Spanish Point) for both their geographic and stratigraphic coverage. These were targeted for a high resolution chemostratigraphic evaluation (using geochemical data acquired via ICP-OES and ICP-MS analyses) and full biostratigraphic analysis, including micropalaeontology, palynology and nannopalaeontology techniques. In addition, a sub-set of samples from these wells were subjected to XRD and petrographic analysis, with the main objective of identifying element – mineral associations across the study intervals. The integrated datasets from these four wells produced type sections from which the remaining nine study wells could be compared. These subsequent wells were added into the overall zonation scheme through the addition of new geochemical data (ICP) and re-evaluated legacy biostratigraphic data.

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

## **Raman spectroscopy as a measure of thermal maturity in Irish coal and shale samples**

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<sup>3</sup> *Trinity College, University of Dublin*

Raman spectroscopy uses the inelastic scattering of monochromatic light to chemically fingerprint a material. Recent work on the Raman spectra of coal samples has led to the derivation of thermal maturation indices which correlate with vitrinite reflectance (Liu *et al.*, 2012). This technique is mainly applicable to carbonised samples of solid organics that are thermally mature to overmature (samples of low maturity have high fluorescence making peak determination difficult). Two indices were proposed by Liu *et al.* (2012), the first utilising the change in the interpeak distance between the 'G' (C-C stretching in graphitic materials) and 'D' (measure of disorder) peaks (G-D). This index was proposed to measure thermally mature to highly mature samples. The second index utilises the change in peak height ratio (D/G) to determine the equivalent vitrinite reflectance value for thermally overmature samples.

Our research focused on exploring this technique further, through the analysis of Irish coal samples. Raman spectral analysis was carried out using two different laser wavelengths (532 nm, 785 nm) for comparative studies. Multiple peak fitting was performed in order to determine hidden peaks and assess further potential correlation options. Initial data indicate inconsistencies between the measured vitrinite reflectance values and the indices proposed by Liu *et al.* (2012).

## **Cenozoic deformation and faulting in Ireland's Offshore Basins**

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<sup>1</sup> *Fault Analysis Group, School of Earth Sciences, University College Dublin*

Previous work suggests that the three principal controls on Cenozoic deformation in offshore and onshore Ireland are: (i) the Icelandic plume, causing widespread uplift and denudation, (ii) Alpine compression and (iii) Atlantic spreading, generating both extensional and compressional structures. The predominance of any one factor on the nature and spatial distribution of Cenozoic structures is uncertain and likely to vary both spatially and temporally. In this project, we are defining improved constraints on the nature, evolution and spatial distribution of Cenozoic structures which have the potential not only to provide for up-fault leakage of pre-existing traps, potentially to traps at higher structural levels, but could also form anticlinal or fault-related traps.

Whether or not Cenozoic faults arise from later compression or extension they can play an important role in hydrocarbon leakage and trapping. Central to determining their effects on trap integrity or formation is an understanding of the mechanisms of fault reactivation and the generation of potential traps (such as inversion folds). Factors identified as strongly influencing fault reactivation and associated deformation include fault type, size, orientation, dip direction and displacement distribution. For example, Cenozoic normal faulting in the Porcupine Basin most often arises from the reactivation of major N-S trending basin bounding faults, rather than smaller intra-basinal faults. Pre-existing NE-trending normal faults within the Irish Sea can now be shown to accommodate very large Cenozoic sinistral strike-slip faults in addition to the well-established inversion-related folding and reverse displacements arising from N-S Alpine compression. Associated NNW-trending strike-slip faults, such as the Codling fault, are linked to hydrocarbon leakages (indicated by HC sniffer data) and attest to the importance of Cenozoic deformation on hydrocarbon leakage. By contrast the formation of anticlinal traps associated with Alpine compression in the Celtic Sea basins demonstrates the ability of Cenozoic deformation to form traps. These varied effects will be investigated in further detail in this project, to provide a better understanding of the Cenozoic deformation in Ireland's offshore basin and an improved basis for assessing the impact of this deformation on associated hydrocarbon potential.

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

## **The basement geology of the Porcupine High; new samples, new relationships and new sources for sediment?**

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The geology, age and affinity of basement highs in the western Irish offshore is poorly constrained yet these uplifted crustal blocks (e.g. the Porcupine High) likely supplied sand into adjacent basins during the Mesozoic. Understanding the nature of these highs could provide a first-order control on the quality and distribution of potential reservoir sandstones within the Porcupine and Rockall basins. In addition, knowledge of these highs aids in constraining the pre-rift configuration of the conjugate margins, by highlighting potential correlative crustal blocks across the Atlantic. Direct sampling of the Porcupine High has been limited, with just one sample, a 1.3Ga orthogneiss, retrieved from the northern part of the high through seabed drilling (Daly *et al.*, 2008). This study aims to better characterise the broader basement geology of the Porcupine High through the multi-proxy analysis (U-Pb zircon geochronology; U-Pb apatite

geochronology; Pb isotopic composition of K-feldspar; petrography) of samples dredged from the NW flank of the high.

The retrieved samples, believed to represent near *in-situ* material, are largely metamorphic in origin, mostly gneisses. To date, eight orthogneisses of syenitic to syeno-granitic composition have been chosen for detailed analysis. Three main age groupings emerge from U-Pb apatite geochronology; there are some Caledonian ages, another group exhibiting a Grenvillian affinity (~1000 Ma) and an older grouping ranging in age between 1690-1800 Ma. The presence of Paleoproterozoic U-Pb apatite ages demonstrate that Grenvillian and Caledonian tectonothermal age resetting was absent in these samples. Two main Pb isotopic populations also emerge and correlate with the age data, one showing a broad Lewisian affinity and another plotting in a similar domain to the Annagh Gneiss Complex (onshore western Ireland) and Rhinns Complex of Inishtrahull.

These new data indicate the presence of a previously unrecognised and complex geological terrane on the Porcupine High, with potential correlatives onshore Ireland, NW Scotland and on the conjugate margin. Future work will expand the dataset by interrogating 1) core/cuttings samples from the base of exploration wells; and 2) large clast samples from cored Mesozoic sandstones, with the ultimate aim of constructing a basement geology map of the region.

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

### **U-Pb zircon ages of the Flemish Cap: Potential sources of detritus to Mesozoic sedimentary basins of the North Atlantic conjugate margin**

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Petroleum exploration of the offshore deep-water basins of the Ireland – Newfoundland conjugate margin is expensive and risky. Improved knowledge of the regional geology of the offshore allows more effective evaluation of the hydrocarbon potential of the region. An aspect of the offshore geology that is particularly poorly known is the nature and geological history of basement uplifts and their contributions to the supply of sedimentary detritus to source and reservoir units in the basins. Recent work has suggested that basement highs in the North Atlantic may have been important sources of sediment to offshore basins during the Mesozoic.

The Flemish Cap is a large, 150 km-wide, circular, isolated submarine knoll 600 km east of Newfoundland. Drill core samples from the central and southern edge of the knoll suggest that the major basement lithology is granodiorite with chemical affinities similar to the ca. 600 Ma subduction-related plutons of the Avalon terrane of Newfoundland and Nova Scotia. U-Pb zircon ages for a granodiorite from a core taken from the central part of the Flemish Cap are strongly discordant, however, so that the correlation with Avalon granitoids has remained speculative.

We determined the U-Pb zircon ages of three granodiorite samples collected from the southern edge of the Flemish Cap by the Canadian scientific vessel CCGS Hudson using the remotely operated submersible vehicle ROPOS in 2010. Laser ablation-ICPMS measurements for U-Pb isotopes were made on inclusion- and fracture-free regions of the zircon grains, which had been imaged by BSE-SEM. The three samples give ages of ca. 300 Ma, ca. 1860 Ma and ca. 2700 Ma. Subsurface images from the submersible vehicle indicate that the Carboniferous sample site represents in-place bedrock and the Paleoproterozoic sample probably does as well. The Archean sample is most probably ice-rafted debris as it was sampled from a flat area on the knoll covered in sediment. The results indicate that the Flemish Cap granodiorites could have provided a local source of detritus with at least Carboniferous and

Paleoproterozoic ages to nearby sedimentary basins during the Mesozoic. Long-distance paleodrainage routes from distal, Carboniferous Variscan and Paleoproterozoic Makkovik/Ketilidian terranes were not required.

This project was funded by the Research & Development Corporation of Newfoundland & Labrador, Nalcor Energy Oil & Gas and the Irish Petroleum Infrastructure Programme (PIP).

## **Quantitative analysis of populations of sedimentary grain morphologies in the basins of Southern Ireland**

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<sup>1</sup>*School of BEES, UCC, Distillery Fields, North Mall, Cork*

<sup>2</sup>*Department of Applied Mathematics, UCC, Western Gateway Building, Western Road, Cork*

Textural analysis helps determine the formation, transportation and deposition processes of sedimentary rocks. Grain size analysis has been traditionally performed in a quantitative way, whereas grain shape analysis is largely subjected to qualitative analysis. We present software to quantitatively analyse shape and size of sand sized sedimentary grains. For consolidated samples, manual tracing of grain boundaries in thin section microphotographs is followed by automatic analysis using image analysis techniques for feature extraction. The method is fully automatic for unconsolidated sediments. Along with the size of grain, shape parameters such as roundness, angularity, circularity and irregularity are measured. More complicated shape parameters such as fractal dimension and Fourier descriptors are also calculated.

To test the software theoretical examples were analysed and produce high quality results supporting the accuracy of the approach. Increasing order of roundness, irregularity and circularity in shapes are matched by calculated values. Samples collected from both the Dingle and Munster onshore basins have been analysed using the software. A graphical summary of the data is presented and allows for quantitative comparisons.

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

## **Hydrocarbon-related research at the Irish Centre for Research in Applied Geosciences (iCRAG)**

Walsh, J.<sup>1</sup>

<sup>1</sup> *Irish Centre for Research in Applied Geosciences, UCD School of Geological Sciences, University College Dublin*

iCRAG is a newly formed national centre for applied geoscience research in Ireland, performing research which is linked to a broad range of application areas and industries. The Centre's research programme consists of four cohesive topics or 'spokes' in the areas of groundwater, hydrocarbons, marine geoscience and raw materials, which are built around four enabling technology and equipment based 'platforms' which focus on geophysical sensing and imaging, geochemistry, 3D geological modelling and public perception and understanding. This poster focuses on our hydrocarbons research 'spoke', outlining a variety of recently initiated and planned PhD and Post-Doc projects on the broad range of topics linked to offshore hydrocarbons. Whilst the research will be conducted in several so-called Targeted Projects, the research programme will be multi-disciplinary in nature, promoting the development of across-spoke and inter-project technical linkages.



Hydrocarbon-related research is conducted within 5 main Targeted Projects:

(i) Sediment tracking: investigating provenance tracers, modern sand dispersal and mixing, sediment volumes, partitioning and recycling, and implications for reservoir quality. (ii) Basin evolution and petroleum systems: involving the investigation of early rift architecture, structural evolution and traps, stratigraphic onlaps and traps, hyperextended basins and their fills, stratigraphic evolution at continental-oceanic transition and thermal history/migration modelling. (iii) Reservoir modelling and software development: involving reservoir modelling and imaging, including stratigraphic modelling, well/seismic conditioning and reservoir monitoring, (iv) Unconventional hydrocarbons and (v) Global Subsurface Training Centre in Clare.

## **Irish Centre for Research in Applied Geosciences (iCRAG)**

Walsh, J.<sup>1</sup>

<sup>1</sup> *Irish Centre for Research in Applied Geosciences, UCD School of Geological Sciences, University College Dublin*

iCRAG is a newly formed national research centre which will transform applied geoscience research in Ireland, performing research which is designed to deliver economic impact for a broad range of application areas and industries. The Centre brings together Ireland's leading geoscience experts focusing on a range of issues all of which underpin economic development - from safe and secure groundwater supplies through to the discovery of mineral/aggregate deposits, and from the de-risking of oil and gas exploration to ensuring that the Irish public is educated and informed on these issues. Supported by Science Foundation Ireland and industry partners for the next six years, iCRAG is one of only 12 SFI Research centres, and the first national geosciences initiative to be supported by SFI's flagship funding scheme. iCRAG is a collaboration between 150 researchers within UCD, TCD, NUIG, UCC, NUIM and DIAS and more than 50 industry partners who will work in partnership with government agencies involved in the geosciences sector.

iCRAG's research programme consists of four cohesive topics or 'spokes' in the areas of raw materials, marine geoscience, groundwater and hydrocarbons which are built around four enabling technology and equipment based 'platforms' which focus on geophysical sensing and imaging, geochemistry, 3D geological modelling and public perception and understanding. It will capitalise on Ireland's unique geological resources, including its world-class base metal deposits, its unusually extensive and highly prospective offshore basins and its world-class lowland karst and fractured bedrock aquifers. The principal goal is to embed the outcomes of high quality research within industry practice in Ireland and overseas.

Instead of outlining the full range of iCRAG research, this poster describes some of the research conducted outside of the hydrocarbons spoke which is pertinent to technical issues confronted by the petroleum industry. This includes our marine-related research involving three main Targeted Projects: (i) Marine Acoustics, (ii) Enhancing knowledge and understanding of Ireland's seabed and (iii) Marine remote sensing applications. The broad range of research topics linked to offshore hydrocarbons is the subject of a separate poster.

## **Deep structure of the southern Porcupine Basin and the Porcupine Median Ridge from seismic refraction modelling**

Watremez, L.<sup>1</sup>, Prada, M.<sup>2</sup>, Chen, C.<sup>1,3</sup>, Minshull, T.<sup>1</sup>, O'Reilly, B.<sup>2</sup>, Reston, T.<sup>4</sup>, Wagner, G.<sup>5</sup>, Gaw, V.<sup>5</sup>, Kläschen, D.<sup>5</sup>, Shannon, P.<sup>6</sup>

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The Porcupine Basin is a narrow V-shaped failed rift basin of Permo-Triassic to Cenozoic age, with the main rifting phase in the Late Jurassic to Early Cretaceous. It is located offshore SW Ireland. A previous study shows increasing stretching factors from less than 1.5 to the north to more than 6 to the south using basin subsidence analysis. A ridge feature, the Porcupine Median Ridge (PMR), has been identified in the middle of the southernmost part of the basin. During the last three decades, this ridge has been successively interpreted as a volcanic structure, a diapir of partially serpentinised mantle, or a block of continental crust. Its nature still remains debated today. In this study we use a seismic refraction profile acquired across the Southern Porcupine Basin to derive a P-wave velocity model across the basin, and in particular across the PMR, using tomography modelling following a layer-stripping strategy. We use the data from a 300 km long shot line recorded by 29 ocean-bottom seismic receivers. This profile is oriented west-east and crosses the entire basin in its southernmost part. Thus, we image the deep structure of the basin, the geometry of the continental thinning from margin to margin, and the PMR. Our main results are (1) an asymmetric crustal thinning, implying some simple shear during the extension, (2) a low velocity mantle, with velocities < 7.5 km/s, together with a wide zone of ultra-thinned crust (2-6 km), implying upper-mantle serpentinisation, and (3) velocities of 5-5.7 km/s in the PMR, associated to a high velocity zone in the sedimentary sequence, which may imply a volcanic nature of the ridge and associated feature.

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

## **List of Delegates**

## ATLANTIC IRELAND 2015

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Name	Organisation
Ian Burdis	AGR Petroleum Services
Laurie Phillips	AGR Petroleum Services
Nick Chilcott	AGR Petroleum Services
Peter O'Carroll	Ampere Advisers
Molly DeCoster	Amplified Geochemical Imaging
Marcus Jenkins	Anadarko
Helen Kerr	APT (UK) Ltd
Patrick Barnard	APT (UK) Ltd
Cathal Jones	Ardilaun Energy Ltd
Eoin Ryan	Ardilaun Energy Ltd
John McKeon	Ardilaun Energy Ltd
Karl Prenderville	Ardilaun Energy Ltd
Mark Pearson	Ardilaun Energy Ltd
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John Boyle	Baker B Company Ltd
Sarah Parker	Barnwell Parker Geoscience
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Samuel Piriou	BeicipFranlab
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Donal O'Driscoll	Bluestack Energy Ltd
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Jonathon Watson	Bridgeporth Ltd
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Vanessa Starcher	British Geological Survey
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Paul Gannon	Cairn Energy Plc
Richard Ember	Cairn Energy Plc
Steve Laux	Cairn Energy Plc
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Alex Fowler	CGG Robertson
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Catherine Caulfield	Hannon-Westwood
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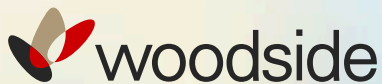
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