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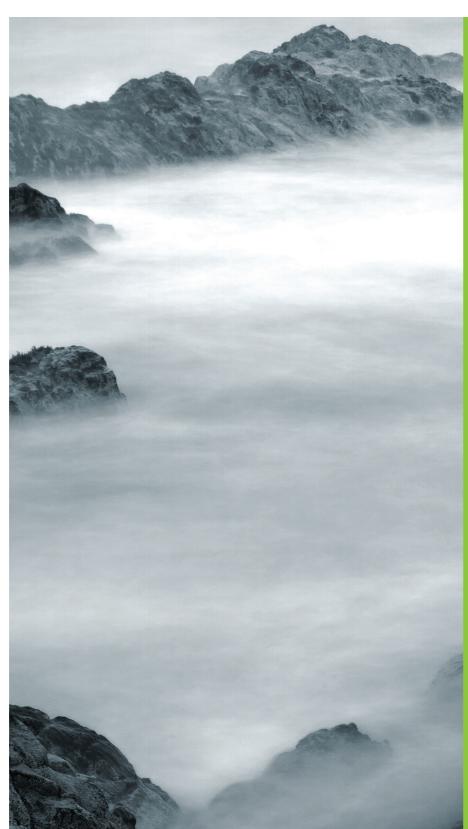
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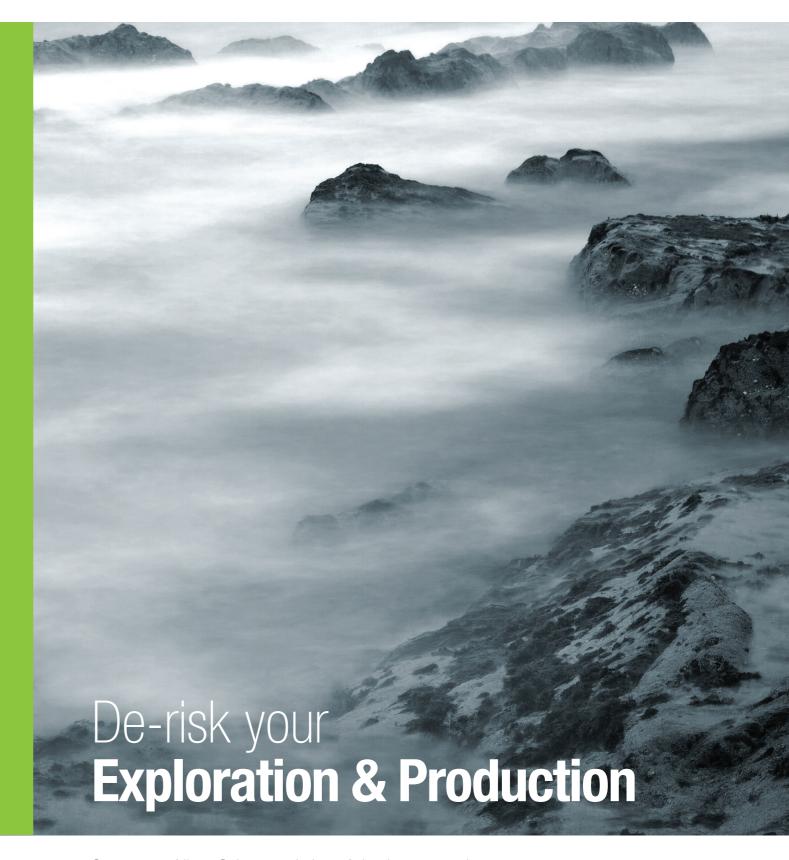
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in Ikon Science













## A word from the CEO

Ikon Science is 'The Present and Future of GeoPrediction'. GeoPrediction combines the sciences of quantitative geology, geopressure and geomechanics. In short, our GeoPrediction software and services

- predict reservoir properties
- ► understand the behaviours of fluids in reservoirs and surrounding rock
- ensure safer drilling

Our mantra for 2016 is 'do much, much more with much, much less', and we are sure you are all in the same boat. As the 'froth and bubble' of the past few years fades, we believe that only genuinely innovative technologies remain; adding value, by providing improved quantification of reserves, opportunities, risks and reducing associated costs.

One sign of our value add is that RokDoc usage worldwide has continued to stay incredibly strong, as demonstrated by our M&S (maintenance and support) renewal figures. We are doing our best to earn and keep this confidence that you have shown in us, by delivering increasing value to our customers. We are continuing to actively invest in, and develop, our RokDoc suite, and constantly improving the quality and service of our M&S. We pride ourselves on faster than ever response times, top drawer on-site support and an ever growing online video resource library.

Thank you for picking up our literature and for your interest in Ikon Science.

Martyn Millwood Hargrave Ikon Science CEO





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## Work with Ikon Science to:

- ldentify and add new reserves without needing to drill new wells
- ► Rigorously qualify exploration prospects, improving the probability of future exploration success
- Identify and target bypassed pay within mature fields
- ► Reliably predict commercial hydrocarbons in outstep locations
- Identify and target sweet spots within unconventional plays
- Fully integrate available data to build geomechanical models and optimise completion strategy and design
- Safe and cost effective abandonment planning with our optimised "plug plan" product and studies
- Leverage limited capital with participation in multi-client projects to obtain technical results that would otherwise be beyond current budgetary capacity
- Optimise IT spend by providing superior functionality and usability at an equivalent cost point to incumbent technology

For Ikon Science, value is all about delivering relevant answers to our customers with all the necessary information to fully understand how conclusions were reached and what may be the uncertainties affecting the results. These answers help our customers make business-critical decisions with confidence.



Cover photo by Phill Clegg - Ikon Science Pressure Tutor Other photography by Rob Dudley - Ikon Science Manager Canada





## Making high-stakes exploration decisions?

## You need quantitative information that GeoPrediction delivers

Exploration is full of unknowns. Ikon Science brings you modern scientific methods that help mitigate exploration risks. We make maximum use of available data and knowledge to support critical decisions such as; what acreage to license, what data to purchase, how to rank drilling prospects, and where to drill exploratory wells.

### Invest with confidence

Gain valuable insights before you commit to licensing exploration acreage.

Ikon Science can help you uncover vital clues about a viable hydrocarbon system and potential trap mechanisms. Understanding the regional stress regime can provide insight into probable faults and fractured zones. The regional pressure regime will alert you to potential drilling risks and make reservoir pressure predictions more accurate. We can also deliver a rapid analysis of regional seismic data, including direct hydrocarbon indicators, depositional history, and the probability of reservoir-quality porosity and permeability.

Invest with confidence by taking advantage of our expertise and integrated solutions to make the most effective acreage evaluation.

### Purchasing the right data

High-quality, high-resolution data is vital for reliably imaging today's complex hydrocarbon plays. Using our industry-leading workflows, Ikon Science can help you purchase data with confidence, knowing that it is up to the task of imaging your targeted formations. Non-exclusive seismic surveys provide rapid, cost-effective access to data for exploration purposes.

Our Ji-Fi (Joint Impedance and Facies Inversion) workflow can be run on a small area inside the survey, using regional geological knowledge to obtain a meaningful classification of facies within the seismic data. The results will give you a definitive assessment of whether the data can deliver the answers you need.

Ikon Science has completed a wide range of regional studies covering rock physics trends, pressure regimes, and geomechanical stress regimes. These can be used to inform local analyses – such as the Ji-Fi test described above – even if there are no well data available within the target area.



Whether it's onshore, offshore, or anywhere in between, lkon Science has the experience, knowledge and technology to guide you in the right direction.

# Find the sweet spot

Ikon Science has been helping companies find the right targets since 2001. Our people, workflows and technologies are highly refined for understanding best rock, fluid, pressure and stress combinations.

## Ready to optimise drilling and completion operations?

Predict, plan, and monitor in real-time to reduce risk and decrease cost

Non-productive time is the enemy of cost-effective drilling and completion operations. Ikon Science applies proven workflows to accurately predict formation properties, over-pressure, and well stability risk. Armed with accurate predictions, you can plan and execute well programs with confidence.

### Best practice well design

The complexity and diversity of geological conditions, rock properties, and fluid dynamics make it impossible to precisely predict what will happen when we drill a new well. The key to reducing uncertainty and avoiding unplanned events is thorough planning that incorporates and respects all of the available data.

Best practice well design starts with an integrated team of technical specialists, and a high level of effective communication. Ikon Science applies standard, consistent techniques to each well we analyse, from pre-drill to the final well report.

Our proven workflows improve the prediction of formation properties through which the well will be drilled. We analyse regional and local pressure trends to accurately predict over-pressured zones and potential wellbore stability risks. All of these elements contribute to a lower-risk drilling program.

### Hitting the target

An accurate understanding of the subsurface is the key to placing and completing wells effectively. Whether you are targeting bypassed oil in a mature field, drilling an untested outstep away from proven reservoir, or trying to find sweet spots within an unconventional resource play, Ikon Science can help.

Our industry-leading GeoPrediction software and services reduce uncertainty and provide insights into your reservoir architecture at unprecedented resolution. By integrating data, technology, and expertise across rock physics, geomechanics, and geopressure prediction, we help you reliably predict rock properties, stresses and pressures.

Before you decide where to drill and how to complete, ask your Ikon Science representative how we can help you hit all of your targets – in the reservoir, production, and cost.

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## Apply GeoPrediction to produce more efficient development plans and optimise production

Detailed quantitative knowledge of your reservoir is vital for designing a development drilling program that delivers maximum ultimate recovery while keeping down costs and mitigating risk. During field life, monitoring processes provide advanced notice of possible production issues, and help you develop and implement strategies for enhanced recovery.

### Get development drilling right

Once a viable field has been discovered and confirmed through appraisal drilling, development planning begins. Production wells should ideally be located where they can optimally drain the reservoir. Correctly predicting connectivity within a complex reservoir is critical to achieving optimal drainage with as few wells as possible.

Rapid analysis of regional seismic data can reveal decision-critical information. This may include direct

hydrocarbon indicators and clues from depositional history that might influence the probability of finding reservoir-quality porosity and permeability.

Factors that might compromise drilling - such as proximity to salt domes, pore pressure anomalies, or abnormal stress regimes - must also be taken into consideration. Ikon Science can help you mitigate these risks and plan wells with confidence. Our multi-disciplinary team of experts completes comprehensive drilling risk studies using our RokDoc suite of integrated tools.

To learn more, please ask us for an example risk assessment study.

### Keep an eye on the reservoir

Stay alert to unexpected changes during the producing life of your field. Deviations from modelled flow rates and water saturation values may indicate that the reservoir is not behaving as predicted.

Ikon Science provides 4D (time-lapse) seismic analysis tools that offer unprecedented insight into water contact

movements and can help identify areas where flow is not occurring as expected. We can also assist with 4D forward modelling that will show whether a 4D survey has the potential to resolve changes in pore fill or water contact depth.

Geomechanical and pressure studies can shed further light on the reasons for unexpected changes in reservoir performance, and help you plan remedial actions.

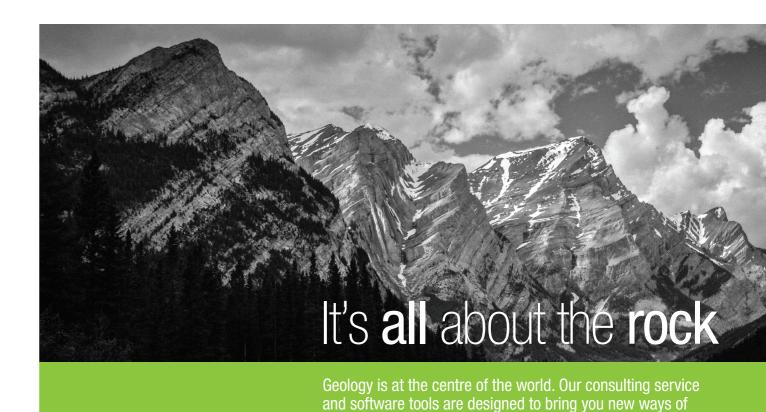
Call us today to discuss field-scale reservoir management.

### Enhanced oil recovery (EOR)

As flow rates decline toward their economic limit, having a clear picture of your reservoir can greatly assist in planning enhanced oil recovery. Artificial lift, water flooding, gas injection, re-completions, and infill drilling can all help to revive flow rates back to profitable levels.

Ikon Science delivers superior reservoir property prediction, reliably locating remaining oil and gas within the system to help you optimise EOR investments.

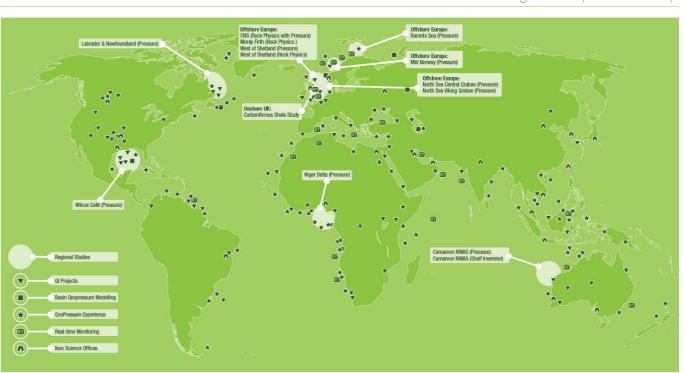
Our latest facies-aware inversion technology, Ji-Fi, can deliver an incredible picture of your reservoir, even with relatively few drainage wells and in deep water environments. This makes Ji-Fi a very valuable EOR tool. Read our North Sea case study. We can also contribute to the long-term viability of your operations. Geomechanical studies, for example, help to mitigate the risk of seal breach caused by excessive injection pressures.



and develop your assets.

### Ikon Science global experience map

understanding and visualising your geology, to better explore



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## RokDoc. Reservoir characterisation underpinned by the best-in-class rock physics

RokDoc is the industry leading GeoPrediction software platform. whose capability spans the whole field life-cycle.

### Reliable subsurface predictions from trusted technology

RokDoc provides a complete 1D to 4D working environment. Seismic data can be integrated with core, log, pressure and simulator data so you can perform simple modelling right through to reservoir characterisation and 4D monitoring.

RokDoc has been developed in collaboration with major oil companies and academic experts since 2001, and it has become synonymous with rock physics in the global market place. As a philosophical client of ours once said 'when it comes to finding oil, you should always starts with the rocks'. The development of the inversion, geopressure and geomechanics technology in RokDoc all found their roots in this unique heritage, and Ikon Science is committed to bringing the next wave of tools to market which deliver reliable subsurface predictions.

### RokDoc is accessible for all interpreters

RokDoc has unparalleled rock physics algorithms and useful workflows in one easy-to-learn package. The tools in RokDoc can be used to identify and quantify geological variations, based on seismic and well data.

A new RokDoc user will easily make geological 'sketches' of a seismic interpretation and then determine if the synthetic matches the seismic. RokDoc makes it simple to perform all the usual fluid substitutions, variable contacts and pressure perturbations, etc. Excellent on-site and online support, documentation and training are available and our Support Team is famed for being the most responsive in the business. We are our own customer, with the Ikon Science services teams using RokDoc around the world to deliver customer projects and regional studies.

RokDoc also has connections to many industry standard applications, including Schlumberger's Petrel\* and TIBCO's OpenSprirt. RokDoc opens up the field of rock physics to the mainstream oil and gas industry.

### A wealth of science at your fingertips

An experienced RokDoc user will have access to a wealth of science at their fingertips.

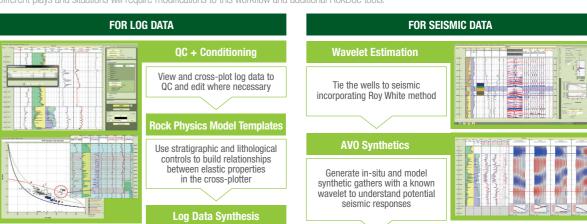
Adding RokDoc 3D to your tool kit brings a range of sophisticated, interactive tools; seismic data conditioning, seismic inversion and techniques to convert impedance volumes into meaningful and accurate geological rock properties for prospect evaluation. RokDoc 3D enables detailed interrogation of volume data, allowing guick and robust analysis of results.

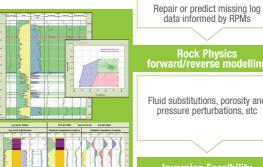
For more information and to arrange demonstrations visit ikonscience.com/rokdoc

RokDoc is the leading rock physics forward modelling software toolkit. Nothing compares with what you can do with RokDoc. Take a tour and learn how RokDoc can bring a splash of colour to your world.

The image below shows a snapshot of RokDoc's capabilities in a generic workflow. It is designed to highlight some of RokDoc's extensive functionality, rather than form an exhaustive list.

Different plays and situations will require modifications to this workflow and additional RokDoc tools.





Fluid substitutions, porosity and pressure perturbations, etc

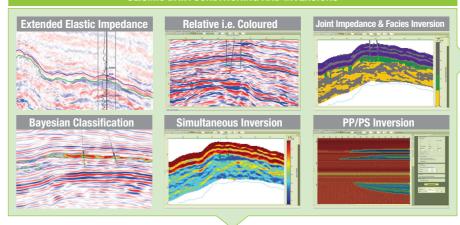
### **Inversion Feasibility**

Cross-plot impedance data to target impedances for inversion

### 2D Modelling

Geophysical 'sketchpad' which allows theoretical situations to be modelled and compared. Wedge models/laver cakes/synthetic seismic

### **SEISMIC DATA CONDITIONING AND INVERSIONS**



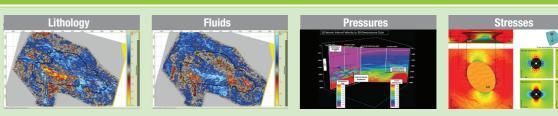
### **GEOMECHANICS**

Robust geomechanical models for stress and stress analysis which incorporate rock physics and geopressure functionality

### **3D GEOPRESSURE**

Tools for geologically-driven processes to asses shale trends overhurden and fracture pressure

### RESERVOIR CHARACTERISATION



We are building an extensive online library of 'how to' videos for our users. This enables our Support Team to focus on your specific problems, ensuring you get the most out of RokDoc.





## Want to get more out of your reservoirs? Ji-Fi is the answer

The ultimate objective for an oil company is to find hydrocarbons and then produce it in the most efficient and profitable manner. To do this the geoscientist must understand the heterogeneity of the reservoir so as to determine where the oil/gas is located and the flow paths within the reservoir; using this information makes drilling, production costs and recovery factors more efficient.

### Rock physics has the answer

In other words this is all about facies; rock physics is a robust and proven quantitative scientific method to determine the properties of rocks, including permeability and fluid fill. Until the development of Ji-Fi there was no robust scientific way to accurately predict facies without wells and of course we would like to know the facies before we drill the wells rather than the other way around.

### Ji-Fi results, North Sea case study

A case study on the Forties field proved that Ji-Fi facies and impedances were consistent with the well data; the Ji-Fi approach accurately predicted the location of the hydrocarbons, water legs and the various facies in

the reservoir without the direct use of the wells or user intervention. Note that whilst the wells were used to determine the rock properties of the area they were not directly used to calibrate the seismic. Thus every well in the study was a blind test and so could be used to verify (or otherwise) the accuracy of the results.

### Understand the heterogeneity of your reservoir

This technology means that Ji-Fi can be used for both exploration and development; all that is required are a few wells in the same geological regime to determine the regional rock properties. The result gives geoscientists a robust description of oil/gas content and the facies of potential reservoirs - in other words a scientific way to achieve understanding of the heterogeneity of the

Much more information is available at ikonscience.com/jifi

## Multiple inversion workflows available with RokDoc

### Inversion schemes for every workflow

Ikon Science's inversion technology is designed with accuracy and science at its core. We have developed a number of inversion methods that offer detailed impedance understanding for any environment.

- Simultaneous inversion
- PPPS inversion
- Coloured inversion
- Model-based inversion
- Delivery inverter
- Stochastic inversion
- AVO inversion

### ► Band-limited inversion

### Recent enhancements in RokDoc

Ikon Science is committed to bringing the next wave of tools to market which deliver reliable subsurface predictions.

### RokDoc plug-ins for Petrel\*

Our RokDoc plug-ins+ that do not require a RokDoc license

- 1. RokDoc Pore Pressure Calculator
- 2. RokDoc Seismic Data Conditioning
- 3. RokDoc Rock Physics Workflow
- 4. RokDoc Bayesian Classification 5. RokDoc Cross-Plotter
- 6. RokDoc Extended Elastic Impedance

Plus the RokDoc Interconnector for Petrel\*, which is embedded into Petrel\* and allows a user with a RokDoc license to move data from Petrel\* into a RokDoc project, and return results to Petrel\*. The systematic use of RokDoc in conjunction with Petrel\* ensures rigorous quality assurance of interpretation which in turn drives consistently better drilling and reservoir predictions.

\*Mark of Schlumberger

\*Requires additional licensing

### Schlumberger partnership

Since November, the following functionality of Petrel\*'s QI module is powered by RokDoc

- Our industry-leading coloured inversion workflow
- ► An intuitive 2D forwarding modelling workflow (wedge, anticline, and dipping reservoir models)

Schlumberger and Ikon Science have an agreement to continue to develop quantitative seismic interpretation capability in the Petrel\* E&P software platform.

### RokDoc Advanced WellTie module

Ikon's latest technology for tying wells to broadband seismic data, now available in RokDoc.

- Increased value from broadband and conventional seismic data e.g. in particular, the key low frequency information
- ► NEW Bayesian wavelet estimation method
- NEW parametric constant phase method
- NEW option for multi-tapering
- ► Significant improvements in wavelet editing; digitalisation, padding, mixing and blending

Better ties result in better wavelet definition, and ultimately better seismic inversions.

### RokDoc GeoPressure

RokDoc GeoPressure is the complete package for 1D to 3D pressure analysis and prediction. Reservoir engineers, geologists and interpreters are able to integrate and analyse pressure, wireline and lithological data for offset wells and gain greater insight in undrilled prospect areas.

### RokDoc GeoMechanics

Adds geomechanical model building to rock physics and quantitative interpretation package. Understanding the stress state in the earth is of vital importance for well plan design, completions optimisation, cap rock

integrity, and wellbore stability. Finding a prospect is only part of the battle; safely drilling the well and optimising production is the end goal, and RokDoc GeoMechanics makes it easier to predict how a well is going to behave before, during, and after production.

### RokDoc Real-time

Any pore pressure prognosis inherently involves uncertainty; offset well data uncertainty, seismic data uncertainty and geological uncertainty. Estimating and predicting pore pressure in real-time with RokDoc RT reduces this uncertainty as the well is drilled, thus reducing the risk and the cost of the drilling operation.





## Ikon Science service solutions will add value in any environment

We provide an integrated solution to meet any challenge. From AVO reconnaissance, to reservoir characterisation, to well planning, PPwD, borehole stability and more. Our team of experts have the technology and the know-how to offer an exceptional service and deliver a best-in-class project.

### Service solutions

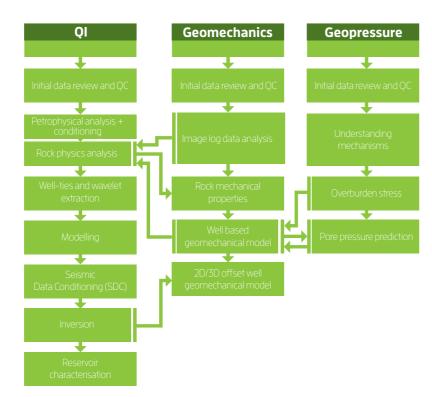
Our goal is not just to deliver data or property volumes, but to provide our customers with robust analysis and interpretation that will be used to assess drilling risks, rank prospects or plan their reservoir appraisal and development strategies.

Our service solutions are fit for purpose proprietary projects designed to tackle even your most complex E&P assets. Our quality control methods, streamlined, integrated workflows and rigorous science deliver successful rock, fluid and pressure predictions for a worldwide client base.

### Signature phased workflows

We work in collaboration with the client operating a phased workflow that enables us to pause and assess progress at key decision points during a project. The result of each stage is discussed and the next steps are agreed on before proceeding. This process is important because data quality and geology are hugely variable, and can lead to surprising results, which is why customisation is key for every project.

Below is an example of a phased, integrated workflow. An interactive version of this chart is available at ikonscience.com/workflows





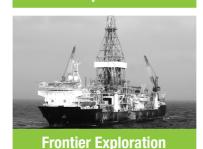
### Environments and challenges

We optimise reservoir understanding in clastics, unconventionals, carbonates, deep water and heavy oil,

and also have extensive experience in under explored areas. We can develop bespoke workflows for any environment. An interactive experience map with case studies can be found at ikonscience.com/expertise.

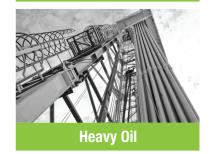


Unconventional





Carbonates



2 13



## Our regional studies. Over 6,000 wells analysed for rock physics, geopressure and geomechanics

The basis of our studies is to generate a regional geological pressure, geomechanics or rock physics model that can inform decisions made on a local scale - the regional informs the local is our motto. Knowing what is happening across the region is invaluable because it gives context to local conditions.

What may seem anomalous in local terms, can make perfect sense when it is viewed in light of regional trends. Our geopressure and rock physics regional studies provide an integrated regional understanding across these disciplines. They offer key data and analysis to enhance exploration and production success, as well as providing information that can lead to increased drilling safety. Regional studies can also be utilised as a powerful and cost effective insight into analogous basins in other parts of the world, for example, the Labrador Basin and Mid Norway, Offshore Brazil and Offshore Niger Delta.

### Labrador and Newfoundland

### The Wilcox and Lower Miocene" \* Geopressure study

- Deep-Water Gulf of Mexico
   149 wells studied
   St Malo, Mad Dog, Jack, Knotty Head, Great White and Neptune fields included

### Perdido Fold Belt Analogy study Rock physics and geopressure study

- 15 wells from the Alaminos Canyon American Gulf of Mexico
- such as Great White, Tobago and Silvertip

### **Equatorial Margin Basins**<sup>^</sup> Geopressure study

Conducted in a phased approach, basin by basin

### Sergipe-Alagoas basins

Ji-Fi and analogue basin study

### Campos and Santos basins<sup>^</sup>

Geopressure and geomechanical study of the pre-salt play



### Carnarvon Basin 0 Geopressure study



· Continental shelf · 578 wells analysed (46% E&A wells)

### Barents Sea" #

- 82 E&A wells studied Regional examination of overpressure distribution, expansion during uplift, seal breach and unexplained dry holes

### West of Shetland<sup>o</sup>

Comprehensive petrophysics, rock and fluid property analysis of 6 wells from UKCS quads 204, 208, 213 and Faroese quad 6004

### West of Shetland" # Geopressure study

- Forward predict pore pressures in shales for future drilling programs

**UK Onshore Carboniferous Shale** 

Identify and build a predictive model of overpressure within the Carboniferous Shales of the UK

Geopressure study

Geopressure with rock physics study

Atlantic Ireland

### Mid Norway" # Geopressure study

### Studies in development. We welcome input from prospective sponsors.

- # Studies available for monthly lease
- Well data available for purchase



Ikon Science regional studies created using IHS data

### Viking Graben<sup>\*</sup>

Rock physics study

Comprehensive cross border petrophysics, rock and fluid property analysis

### Viking Graben" # Geopressure study

### North Sea Central Graben" # Geopressure study

### Phase 1

### Phase 2

### North Sea Central Graben salinity database<sup>+</sup>

- 358 wells studied
 - Most extensive set of salinity data for Central North Sea ever published

### Central North Seao

Cretaceous.

Moray Firth"

- Analysis of rock and fluid properties from 50 wells
- Covering major plays from three sub basins; Inner Moray Firth, Outer Moray Firth and Witch Ground Graben
- 38 recognised fields, 108 reservoir intervals and with measured shear data available for 32 wells

**Moray Firth Fields** 

and Fairways<sup>^</sup> Rock Physics with

Geopressure Study

- Focussed on the intervals of deeper prospectivity within the Moray Firth

region, specifically formations in the

Zechstein, Triassic, Jurassic and

- Covering quads 11-15, 19-21

Rock physics with geopressure study

35 wells from across quads 21-23 and 28-31 Integrated rock physics and geopressure study to identify hidden potential within the Eocene, Palaeocene, Cretaceous, Jurassic and Triassic intervals

### Southern North Sea<sup>^</sup>

600+ wells studied across: - UK Quads 36-39, 41-44, 47-49, and 53-54





## Ikon Science technical leadership

### Key technical people and expertise

Ikon Science's technical leadership team provides global expertise and an advanced research edge to our products and services.



Denis Saussus Chief Technology Officer



Michel Kemper Director, Research & Innovation



Kester Waters VP Global QI - Products and Solutions



Steve O'Connor Global Technical Lead GeoPressure



Mark Sams *QI Manager (AP)* 



Simon Payne QI Manager (Americas)



Ehsan Naeini *Senior Research Advisor* 



Jeremy Neep Principal Geoscientist

### Our 2016 papers

So far in 2016, the Ikon Science team has published five technical papers in the industry's leading publications, not to mention making a significant number of poster

and paper presentations at conventions - GEO 2016, OTC 2016, DEVEX 2016, EAGE SBGf, and six at the EAGE 2016. Visit the Ikon Science library to find out more.

Here are some recent examples:

"Real-time Monitoring, Using All Available Data, Plays A Vital Role In Successful Drilling Operations" - OTC 2016 by Cory Moore<sup>1</sup>, Eamonn Doyle<sup>1</sup>, Karol Jewula<sup>1</sup>, Lukasz Karda<sup>1</sup>, Tim Sheehy<sup>1</sup>, Stephen O'Connor<sup>1</sup>, and Obren Djordjevic (Murphy Exploration & Production Company)

"The influence of pore pressure in assessing hydrocarbon prospectivity: a review" - May First Break, by Dr Sam Green', Stephen O'Connor and Dr Alexander Edwards

**"Willem 3D: Reprocessed, inverted, revitalized"** - January Leading Edge by Dr Mark Sams', Shane Westlake (Finder Exploration Pty. Ltd), Josh Thorp (Searcher Seismic Pty. Ltd) and Ebrahim Zadeh<sup>i</sup>

<sup>1</sup>Ikon Science at time of publication

### Michel Kemper - SEG Europe Honorary Lecturer 2016



Ikon Science's Michel Kemper was selected as an SEG Europe Honorary Lecturer 2016. Michel lectured on "Infusing rock physics into seismic inversion", and toured across Europe between January-June 2016.