

# EAGE DAILY NEWS

## 2019 EAGE Conference & Exhibition

OFFICIAL SHOW DAILY OF THE 81ST EAGE CONFERENCE AND EXHIBITION

## Industry Ready to Accept the Challenges of a Low Carbon Future

The Tuesday morning forum featured insights and opinions.

BY MARK VENABLES, CONTRIBUTING EDITOR

The oil and gas sector faces a challenging dichotomy with the drive to provide more energy to alleviate poverty in the developing world, while at the same time reducing carbon emissions to meet the very real threat of climate change. That was the contradiction addressed at the 2019 EAGE in Tuesday morning's debate on delivering the world's low carbon energy needs.

The first challenge highlighted was the geographic disparity when it comes to ambitions. Neal Anderson, CEO of Wood Mackenzie, worked in the U.S. for almost a decade until he returned to the U.K. six months ago.

## CCS Provides a Path to the Future

Technical session addresses the need for implementing a commercial model.

BY MARK VENABLES, CONTRIBUTING EDITOR

The basic idea of carbon capture and storage (CCS)—capturing CO<sub>2</sub> and preventing it from being released into the atmosphere—was first suggested in 1977. It was initially envisaged as a technology for reducing the carbon emissions from the generation of electricity from fossil fuels, but it has now moved far beyond that original goal and increased in scope to include utilization.

Speaking at EAGE 2019, Luke Warren, CEO of the Carbon Capture and Storage Association, explained that it is difficult to see a future for the oil and gas industry that does not include carbon capture, utilization and storage (CCUS) in one form or another. “The future of the oil and gas sector is intimately tied very closely to the development of carbon capture, utilization and storage, particularly in a world where the ultimate political objective is net zero emissions,” he said. “To achieve our ambitions, any CO<sub>2</sub> that is emitted needs to be balanced by an equal amount that is captured.”

The basic idea of carbon capture and storage (CCS)—capturing CO<sub>2</sub> and preventing it from being released into the atmosphere—was first suggested in 1977. It was initially envisaged as a technology for reducing the carbon emissions from the generation of electricity from fossil fuels, but it has now moved far beyond that original goal and increased in scope to include utilization.

Following his line of reasoning, one industry cannot succeed without the other. “The size and scope of the oil and gas industry moving forward will depend on the development of a CCUS industry to balance it out,” Warren said. “Fortunately, it is moving forward quickly.”

It is a view echoed by the Intergovernmental Panel on Climate Change. Every scenario that they have developed shows that CCUS has a significant role to play over the course of this century. But despite this awareness, Warren still witnesses some adverse sentiments toward the technology. “One of the more frustrating elements is that there is still a negative narrative around this technology,” he said. “People are saying that the technology is difficult, and we haven't made as much progress.”

“But I think there is a lot to be positive about. I have had the pleasure of working in this area for over 10 years, and we have come a long way. When I started in the sector all those years ago there were three or four projects that were recognized around the world;

See **PATH TO THE FUTURE**  
continued on page 4

“I had been continuously talking to clients in the United States about the energy transition but could gain no traction from anyone until about six months ago, and even then the response was lukewarm,” he said. “Since I have been back in Europe, it is the first point of discussion; everyone is talking about this. There is a real difference between the agenda in the United States and Europe, and this is not helped by President Trump's attitude toward climate change.”

There are also varying priorities in different regions when it comes to the importance of energy supply. “The level of debate around carbon capture is different in each geographic location,” Luca Bertelli, chief exploration officer at ENI added. “When I go to developing countries, the greatest concern is to improve the quality of life of their citizens, and a prime mover there is to ensure that they all have access to energy.”

See **CARBON FUTURE**  
continued on page 7



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## DAILY NEWS

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# SCHEDULE OF EVENTS

### Wednesday, June 5

07:30 – 18:00	Registration <i>Registration area</i>
08:30 – 10:30	EAGE Forum Sessions III: “New Technologies for Geoscience and Engineering.” <i>Capital Suite Room 12</i>
08:30 – 17:10	Technical Program (oral presentations) <i>Conference area</i>
09:00 – 10:30	Decarbonization and Energy Transition – Special Session <i>South Gallery Room 20/22</i>
09:30 – 13:00	Career Advice Centre <i>EAGE Community Hub #1400</i>
09:00 – 17:30	Exhibition <i>Exhibition floor</i>
09:00 – 17:30	IGLOO VR Experience <i>Exhibition floor</i>
09:00 – 17:30	Exhibition Theatre <i>Exhibition #540</i>
09:00 – 17:30	International Prospect Center Program <i>Exhibition #1440</i>
12:10 – 13:30	Annual General Meeting for Members and Meet the Committees <i>South Gallery Room 20/22</i>
13:00 – 14:00	How to Get Published <i>EAGE Community Hub #1400</i>
13:30 – 14:30	EAGE Student Exhibition Tour <i>Starting point: EAGE Community Hub #1400</i>
15:00 – 17:00	EAGE Geo-Quiz <i>EAGE Community Hub #1400</i>
15:00 – 17:00	Women in Geoscience and Engineering – Special Session <i>South Gallery Room 20/22</i>
16:00 – 18:00	Young Professionals – Special Session <i>South Gallery Room 20/22</i>
19:00 – 23:30	Conference Evening <i>Natural History Museum</i>

## Conference Highlights–Wednesday, June 5

### Launch: Decarbonization and Energy Transition Special Interest Community

09:00 – 10:30, *South Gallery Room 20/22*

Philip Ringrose (Geoscience Specialist, Equinor)

Ingrid Paola Tello Guerrero (Core Analyst, ALS Petrophysics)

Karin de Borst (Geomechanicist, Shell)

Iain Stewart (Director, Plymouth University Sustainable Earth Institute)

### Annual General Meeting for Members

12:10 – 13:30 hrs, *South Gallery Room 20/22*

Is there anything you ever wanted to know about EAGE but haven't had the chance to ask? Curious to meet the EAGE board and discuss the association's strategy? If so, the Annual General Meeting for Members (AGMM) is where you should be! Members are encouraged to engage with the Board and share ideas and thoughts on EAGE and its future.

The mission and activities of the EAGE are supported by two divisions as well as by a number of permanent committees. Would you like to get to know more about them and how you could possibly participate in their activities? Come meet committee representatives in an informal atmosphere and chat about committees' mission, work and possibilities for engagement.

This event follows the EAGE Recognition Program Drink (by exclusive invitation for Silver-, Gold- and Platinum-level members).

### Women in Geoscience and Engineering Special Session

15:00 – 17:00, *South Gallery Room 20/22*

London 2019 will once again offer a special session for women in the geoscience and engineering community. This session is dedicated to women who are or aim to be professionals in geoscience and engineering fields and to all delegates interested in a talk tackling gender-related issues for the industry and academia. The program will feature inspiring speakers representing different experiences of career and personal life management, followed by a panel discussion. Participants will have time for informal networking at the end of the session. This will allow the opportunity to mingle with fellow participants and to share experiences and new ideas.

*Keynote Speaker:*

Robbie Gries (Founder and President, Priority Oil & Gas LCC)

*Panel Speakers:*

Julie Vonnet (Senior Strategic Marketing Planner, Emerson)

Antonio Gallego Mingo (Senior Exploration Geologist, CEPISA)

Alicia Newton (Director of Science & Communications, The Geological Society)

Gill Gordon (UK HR Director, Schlumberger)

Julie Branston (Schlumberger)

Severine Pannetier Lescoffit (Statoil)

Kristin Gjertsen (Aker BP)

Although tailored for the female members of EAGE, we invite all full delegates and all conference delegates to join.



# Solving Efficiency Fragmentation with an End-to-End OBS Technology Suite

New system spans initial survey planning and design through field execution to maximize operational performance.

CONTRIBUTED BY ION GEOPHYSICAL

Ocean-bottom seismic (OBS) acquisition techniques are an effective means of building high-quality seismic datasets, but operational inefficiencies have made scaling OBS for large exploration projects difficult.

“Seabed operations are still inefficient relative to towed streamer,” said Chris Usher, ION Geophysical CEO. “Challenges exist in source control, in receiver management, in the number of vessels required to carry out the OBS operation, and in QA/QC management. This operational fragmentation creates a high number of opportunities for delay, which can cascade through every phase of the OBS operation.

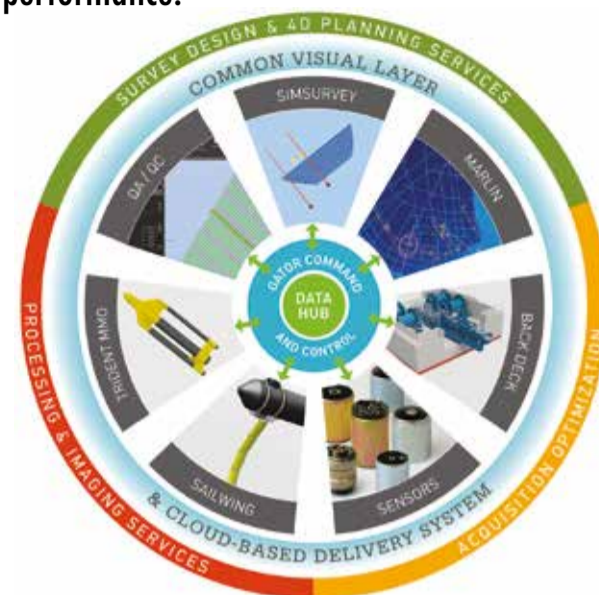
“Our goal is to bring OBS operations to a new level of performance, increasing the value of the data by enabling better geophysics and delivering it to E&P geoscientists faster,” Usher said.

ION leveraged best practices and technology envisioned during the firm’s time operating its own seabed acquisition business to develop an end-to-end OBS offering called 4Sea. The objective of the 4Sea technology is to dovetail each step

of the acquisition operation, compounding performance benefits at each phase for a more cost- and time-effective result. The key is a data-centric approach, with cutting-edge software orchestrating novel, “smart” hardware.

“4Sea is truly a transformational architecture, unifying data with proven command and control, allowing all stakeholders to share data in real time,” Usher said. “We are applying unique capabilities across the offering, from time and motion simulations through SIMOPS, back deck management and in-water systems to control the source more efficiently, all tied together with a built-for-purpose QA/QC system.”

The 4Sea system spans initial survey planning and design through field execution to maximize operational performance. MESA SimSurvey software is an operations’ digital twin that simulates multiple acquisition scenarios, constrained by the geophysical objectives and the available equipment, allowing optimal plan selection. Marlin software provides a unique digital platform that enables multiple stakeholders to share and visualize vessel route plans, foresee and avoid conflicts between vessels and fixed assets, optimize schedules safely within a rules-based environment, and



The 4Sea technology is transforming seabed seismic. (Image courtesy of ION Geophysical)

## BGP – Beyond the Belt and Road

BGP is a leading geophysical contractor, providing geophysical services to our clients worldwide. BGP currently has 57 branches and offices, 6 vessels and 19 data processing and interpretation centers overseas. The key business activities of BGP include:

- \* Onshore, offshore, TZ seismic data acquisition;
- \* Seismic data processing and interpretation;
- \* Reservoir geophysics;
- \* Borehole seismic surveys and micro-seismic;
- \* IT services.
- \* Geophysical research and software development;
- \* GME and geo-chemical surveys;
- \* Geophysical equipment manufacturing;
- \* Multi-client services;



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measure and improve asset performance. In the field, Gator software drives real-time command and control across multi-vessel crews for highly flexible source configuration and deployment/retrieval scenarios, and it provides the orchestration across 4Sea’s smart hardware.

These unique hardware solutions further improve OBS operational performance. ION’s automated Back Deck system accelerates receiver deployment, enabling node-handling vessels to operate at higher speeds. Deployment and retrieval at up to five knots can markedly reduce total vessel time over the course of a project. The 4Sea Back Deck system also reduces the crew size necessary to handle nodes, minimizing HSE exposure and risk. SailWing active source steering improves source vessel operations, enabling tighter turning radii for faster line changes, less drag for fuel efficiency, and more consistent array stability for better geophysics. 4Sea’s hardware and software components are seamlessly linked to an integrated QA/QC protocol that ties vessel telemetry with acquired seismic data for higher quality survey results.

“This new acquisition architecture provides a step change for OBS operations,” Usher said. “We deliberately made 4Sea a modular system from the outset, so that contractors can use as much of the system as they want. For example, our automated Back Deck is compatible with virtually any seabed node, and our SailWing system can be deployed on any source vessel. These are both compatible with Gator software they may already have invested in, significantly improving any contractor’s performance.”

These improvements will benefit projects in congested producing fields, but also bring the benefit of OBS surveys to new market applications.

“The market is moving to a multiclient model for seabed surveys, which means lots of acreage being covered by lots of nodes,” Usher said. “By improving the rate of node deployment and data collection, 4Sea is making full-azimuth, long offset surveys in complex geologies both technically and economically feasible.” ■

### BETTER FUTURE

(continued from page 1)

today we have 23 industrial scale projects that are either operating or under construction.”

Over that decade the conversation has moved on from does this technology work to how can it be implemented at scale? The challenge the industry will face for the next 10 years is how to move CCUS along the path that the renewables sector has followed, reducing the cost and developing a commercial model to drive growth in the market.

“Despite these advances, the CCUS sector has a long way to go. By and large, we don’t have a policy framework in place that can drive this forward,” Warren said. “There is some good work in the U.S. around tax credits and some excellent work in the U.K. around an investment framework for CCUS. But outside of those countries the debate is at a very early stage.

“The other final point I would make is that there is a lack of big champions. We haven’t seen the industry wholeheartedly get behind the technology and push it as an option to be deployed at scale. We also haven’t seen the environmental movement get behind the CCUS story even though it is critical to the future of combating climate change.” ■



# Reducing Geomechanical Risks in Drilling and Reservoir Production

Integrated 1-D to 3-D workflows mitigate production risk in a reduced time frame without compromising reservoir complexity.

BY CAMILLE COSSON AND GAVIN BALDWIN,  
EMERSON AUTOMATION SOLUTIONS

Sustainable field management cannot be performed without a thorough understanding of reservoir mechanics and how it evolves throughout the life of a field. However, performing a comprehensive subsurface geomechanical study in a reasonable time frame is still perceived as a challenging task.

One of the main difficulties is obtaining reliable geomechanical data and accounting for its associated uncertainty. Another challenge is ensuring that geomechanical models honor other data of different scales and types, such as geophysical, geological and petrophysical data. Requiring geologists, reservoir engineers and geomechanical experts to work together as a team also may not be easy, as they all have their own methods and often use different tools.

Over the past few years, Emerson has worked to overcome these challenges and build a platform that enables integration and collaboration. This platform

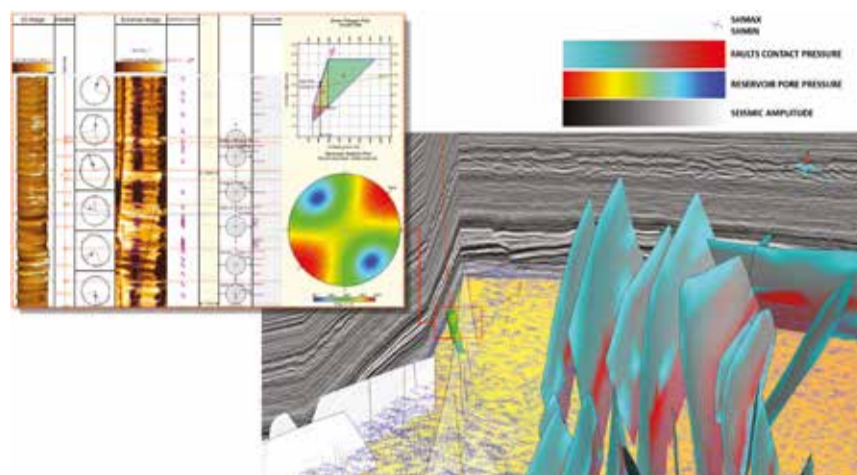
- Delivers a comprehensive toolbox for the analysis of data of different scales and types;
- Offers a unique technology for creating consistent and reliable digital representation of the subsurface. It integrates all available data and associated uncertainties, and shares them across disciplines to support field management decisions; and
- Provides an open environment where geoscientists can access information, collaborate and carry out seamless 1-D to 3-D cross-domain workflows.

Emerson's geomechanics workflow begins with a 1-D geomechanical analysis, aimed at estimating the rock properties and stresses acting on a wellbore. A 1-D mechanical earth model is developed by simulating a post-drilling, geomechanical analysis, based on data acquired from the well. Emerson's petrophysical analysis application Geolog, offers a broad range of tools for handling a wide variety of well data, includ-

ing logs, borehole images, pore pressure, formation test and full waveform sonic. Pore pressure can be predicted, and the mud weight lower limit identified. Dynamic elastic rock properties and rock strength are then calculated down the well, and electrofacies can be defined. Horizontal minimum and maximum stress magnitudes are calculated using either the isotropic poroelastic horizontal strain model or the stress polygon method; these are calibrated with leakoff test results and borehole images.

Following well-scale studies, 3-D analysis must be performed to account for the spatial reality and impact of the subsurface structure. This means comparing high-resolution well results with larger-scale data: 3-D predicted pore pressure from seismic-derived velocity models, rock elastic properties from seismic inversions, and fault and fracture characterization from full-azimuth imaging. In the integrated Emerson environment, data are stored in a common database and can be instantly cross-checked and calibrated. The workflow takes advantage of machine learning methods to gain a better estimate of rock mechanical property distribution in subsurface space, especially when dealing with both seismic and well data. These techniques enable the easy integration of huge amounts of data and the rapid production of results while reducing uncertainties.

Estimating the distribution of initial stresses and the evolution of stress throughout the life of the field cannot be done without flow-coupled geomechanical simulations. Through Emerson's extended solution portfolio and partnerships, it is



Advanced Emerson technologies and an integrated environment enable geoscientists to efficiently create collaborative knowledge about subsurface geomechanics. (Image courtesy of Emerson Automation Solutions)

possible to model strain and stress modifications stemming from changes in reservoir pressure conditions caused by production, identify the best drilling and production plans, and predict events such as subsidence, cap rock integrity, fracture and fault reactivation. A key feature is the ability to automatically generate a 3-D geomechanical model from a high-resolution geologic model. Based on a unique hybrid mesh that is entirely conformable with subsurface structure complexities, this 3-D mechanical earth model is perfectly suited for finite element simulations. Thanks to this technology, unwarranted simplifications are avoided and geomechanical prediction can be confidently used to support drilling decisions. For more information visit booth 830 or [emerson.com/epssoftware](http://emerson.com/epssoftware). ■

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# Revolutionizing North Sea Exploration and Production through OBN Technology

Investment opportunities for multicient projects increase.

CONTRIBUTED BY TGS

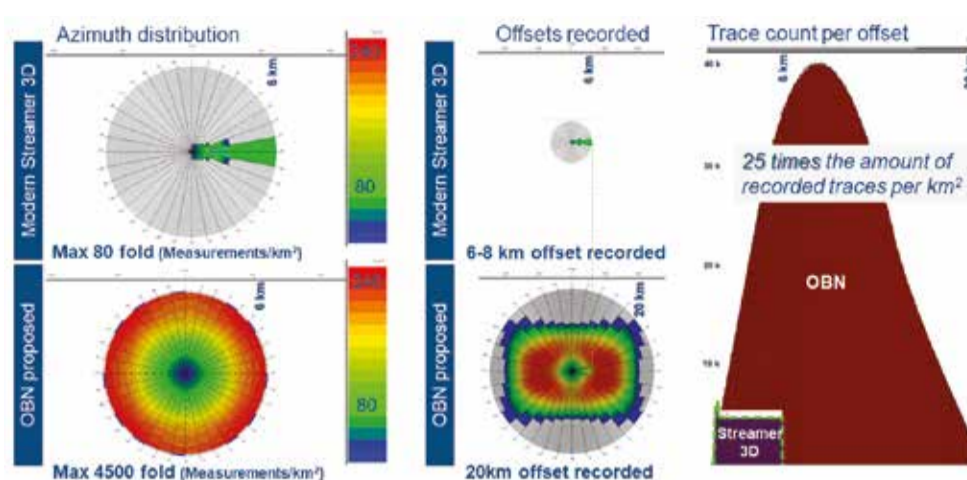
For exploration and production (E&P) companies, a key driver is to maximize the life of producing fields and production facilities. In times of declining reserves, infrastructure-led exploration (ILX) is more important than ever. Ocean-bottom node technology (OBN) is already proving to deliver the highest quality seismic data, and as the cost of acquisition and processing of these data decreases, the technology becomes competitive compared to traditional seismic methods.

By utilizing experienced crews on multiple node and source vessels and deploying the latest hardware and precision positioning systems, operators will ensure high efficiency and the best data quality the industry has yet seen. Survey designs will be optimized to image producing assets and known play models for successful near-field exploration.

OBN is the ultimate imaging tool for complex geological challenges. With full-azimuth acquisition, complex geology can be illuminated in all directions and structures, and attribute variations can be properly un-

derstood. Ten times higher fold significantly improves the signal-to-noise ratio and the ability to distinguish between structure and attribute anomalies the interpreter can and can't believe in. Other advantages include ultralong offsets, measurement of the full wavefield and measurement of both P- and S-waves, e.g., for better characterization of fluids in a reservoir.

Already being applied in a multitude of offshore basins around the world, OBN offers enhanced data quality to help operators overcome imaging challenges. TGS has recently undertaken projects in the Mississippi Canyon and Atwater Valley protraction ar-



OBN 3-D data capture is producing a step change in quality compared to modern streamer 3-D data. (Image courtesy of TGS)

reas of the U.S. Gulf of Mexico (GoM). This year TGS has planned to complete the 602.3 sq mile (1,560 sq km) Utsira OBN in the North Sea in cooperation with AGS and, in the years to come, expects to expand further in selected areas on the Norwegian and U.K. continental shelves. In the North Sea the company plans to capture dense OBN data for improved imagery. A successful and efficient dense OBN multicient project can pave the way for similar initiatives in the GoM, Brazil and other regions.

Recently, there have also been extensive OBN surveys in the Red Sea and the Persian Gulf to absorb capacity. Closer to traditional multicient markets, E&P companies are beginning to combine E&P needs in search of discoveries with shorter time-to-market.

Despite the reduction in the cost of alternative seismic acquisition, OBN has prevailed and grown its presence in the proprietary acquisition domain during and since the downturn. The market is now estimated to be worth \$1 billion today versus a combined streamer market of \$3.5 billion, according to ABGSC.

The recent closing of the price differential between streamers and OBN is opening large multicient OBN investment opportunities in areas with complex geology, a conglomerate of license holders and acreage turnover. The Central North Sea and Viking Graben are examples of such areas. There are several companies, including TGS, that are positioning themselves to take the lead on multicient OBN adaption and grow this market over the next decade. OBN is defining a new baseline for quality subsurface imaging using full-azimuth, ultralong offsets, small bin size and exponentially more measurements per area. Therefore, this technology could well form the cornerstone of the European growth strategy of these companies through the next decade and beyond.

To find out more about OBN offerings from TGS, visit booth 920 or [tgs.com](http://tgs.com). ■

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# Extend Boundaries of Well Exploration

DAS seismic solution provides high-quality data to borehole industry.

CONTRIBUTED BY SERCEL

Last March, Sercel launched its first distributed acoustic sensing (DAS) seismic solution: SigmaWave. Designed in partnership with Fotech Solutions, SigmaWave is the first integrated distributed acoustic solution designed exclusively for borehole seismic applications and reinforces Sercel's advanced range of downhole seismic acquisition systems.

SigmaWave is fully integrated with Sercel's existing downhole seismic tools and enables continuous, real-time seismic measurements along the entire length of a fiber-optic cable. Whether by retrievable or permanent deployment, it is now possible to visualize and monitor the well in real time and instantly generate SEG-Y files. With unique features, such as user-selectable gauge length, acquiring the highest quality seismic data, without compromise, is now possible.

Seamless integration of Fotech's cutting-edge fiber-optic monitoring technology into Sercel's seismic acquisition systems is a natural fit of best-in-class solutions and heralds a significant step change in data quality and productivity levels.

Chris Shannon, Fotech Solutions CEO, said, "SigmaWave represents the best of two industry leaders and demonstrates how, together, we continue to push the boundaries of innovation in upstream applications—with the opportunity to enable the best of DAS technology for the seismic industry."

"Our launch of the SigmaWave integrated DAS solution offers the borehole industry a complete seismic acquisition system that is robust and provides accurate data in a ready-to-use format, for a wide range of applications and at an accessible cost," said Pascal Rouiller, Sercel CEO. "It will enable our clients to improve the description of their reservoirs to enhance recovery." ■



Sercel's DAS solution SigmaWave is designed for borehole seismic applications. (Image courtesy of Sercel)

## CARBON FUTURE

(continued from page 1)

We cannot stop the developing world from making use of their energy resources."

Gary Ingram, vice president of exploration and appraisal at OMV, is adamant that the oil and gas sector is engaged and motivated to deliver the energy transition. "The word 'transition' is important, as it means moving from one phase to another. We have a dominant model now that very much favors oil and gas, but it is going to move to a future paradigm that has many more strands of energy supply to reduce and eventually eliminate carbon. The exact makeup of the new energy mix is unknown. But it will be driven by emissions, affordability and reliability of supply. If any of these are not met it will not be sustainable.

"We are aware of what is needed and are not standing by. We are fully engaged and motivated. If oil and gas companies want to survive, they need to understand the future business landscape and the opportunities that it presents," he said. "We all know that there is no more business as normal; things must change."

Greenhouse gas emissions are categorized into three scopes by the most widely used international accounting tool, the Greenhouse Gas Protocol. Scopes 1 and 2 cover direct emissions sources such as production emissions, fuel used in company transportation and energy used. Oil and gas companies are embracing these two with organizations such as the Oil and Gas Climate Initiative that has many of the world's oil and gas majors as members. But when it comes to scope 3, which is all indirect emissions due to the use of the products they produce, the path ahead is more problematic.

"As a company, we have already taken some practical steps such as reducing flaring and harmful emissions, and reduced travel from both truck movements and flights," Ingram added. "In that area, digitization has been a catalyst allowing for remote operations that mean we need to move people around less."

Bertelli was quick to point out that, despite the need to reduce carbon emissions, the industry needs to up its game when it comes to exploration. "We cannot stop exploring for hydrocarbons or we would soon have energy supply problems," he said. "At present, we are only replacing 30% of the energy we use with new discoveries. By that measure the industry is not doing well. We know that renewables will continue to grow very quickly, but under every scenario oil and gas will still play a major role. As an oil and gas company, it is our job to develop a holistic strategy for a better energy mix." ■

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Booth Number 330

June 5<sup>th</sup> | 3.30 – 5.30 pm



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# Integrated Solution for OBN Data Processing

Software enables superior imaging for OBN data.

CONTRIBUTED BY BGP

In view of the characteristics and difficulties of OBN data processing, BGP has developed an integrated OBN data processing solution, including high-efficiency onboard processing, time domain processing and depth domain processing. The main technologies are as follows.

**Data-driven three-component receiver re-orientation:** Determines and corrects the orientation parameters of the receiver by performing polarization analysis on direct waves. This method is independent of the orientation parameters recorded in the field. Meanwhile it can be used to verify the field orientation.

**Adaptive Vz noise attenuation:** Uses the four-component adaptive matching technique to adaptively recover the signals of the X, Y and Z components into the component to which it belongs. This method can protect the effective signal of the Z component to the greatest extent while effectively suppressing the shear wave noise, so that P component and Z component can be matched better, and the subsequent wavefield separation is improved.

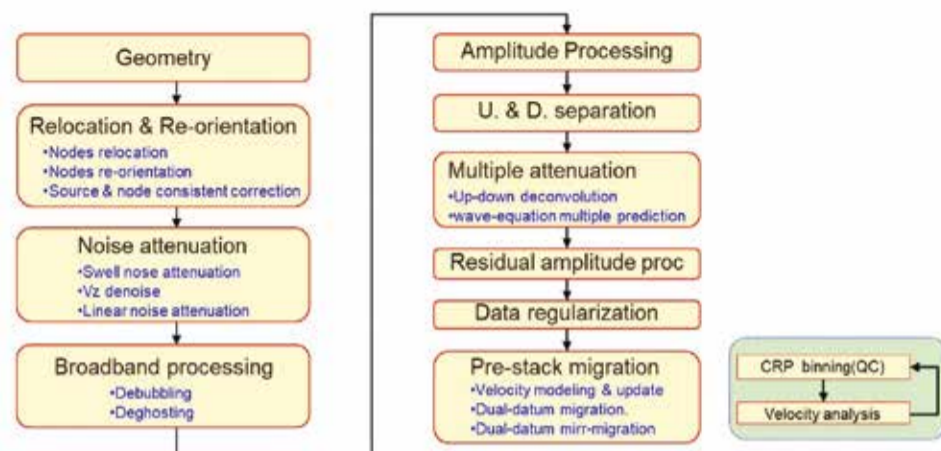
**Common reflection point binning:** The CMP stacking is no longer applicable because the shot and receiver are not at the same depth level for OBN acquisition. It is based on Snell's law to calculate the space-time variable trajectory of the reflection points, and the travel time is calculated by the non-hyperbolic travel time so that the direct processing of the OBN data can be realized, and the structure error exist-

ing in CMP stacking for deep-water OBN processing is solved.

**Up and down wavefield successive separation:** The method establishes the characteristic coefficient equation based on the energy criterion of the cross-correlation function between the up-going wavefield and the down-going wave field, and the optimal up- and down-going wavefield separation coefficient could be obtained iteratively.

**Up-down deconvolution and wave-equation multiple prediction:** The multiples associated with the bottom in the up-going and down-going wave can be respectively suppressed by the combined up-going and down-going wavefield deconvolution and the wave-equation multiple prediction.

**Dual datum PSTM:** In view of the problem of big elevation differences between shots and the receivers in deepwater OBN acquisition, this method deals with the asymmetry by calculating the travel time at different datum and simultaneously performing the conversion of velocity and imaging time of different datum.



BGP provides an integrated solution for OBN data processing. (Image courtesy of BGP)

**Mirror migration:** It uses first order receiver-side ghost to obtain better images, which gives better illumination than that by up-going primary wavefields, especially for the shallow layers, and can effectively solve the imaging error for the seabed and subsurface caused by the sparse distribution of the receiver in the OBN acquisition.

BGP's integrated solution for OBN data processing has been applied in different areas. Visit BGP at booth 1030 for more information. ■

# Northwest of Shetlands Insight with New Generation of Blended Seismic

Step change in source deblending enables bespoke, high-density acquisition designs to address difficult geological scenarios.

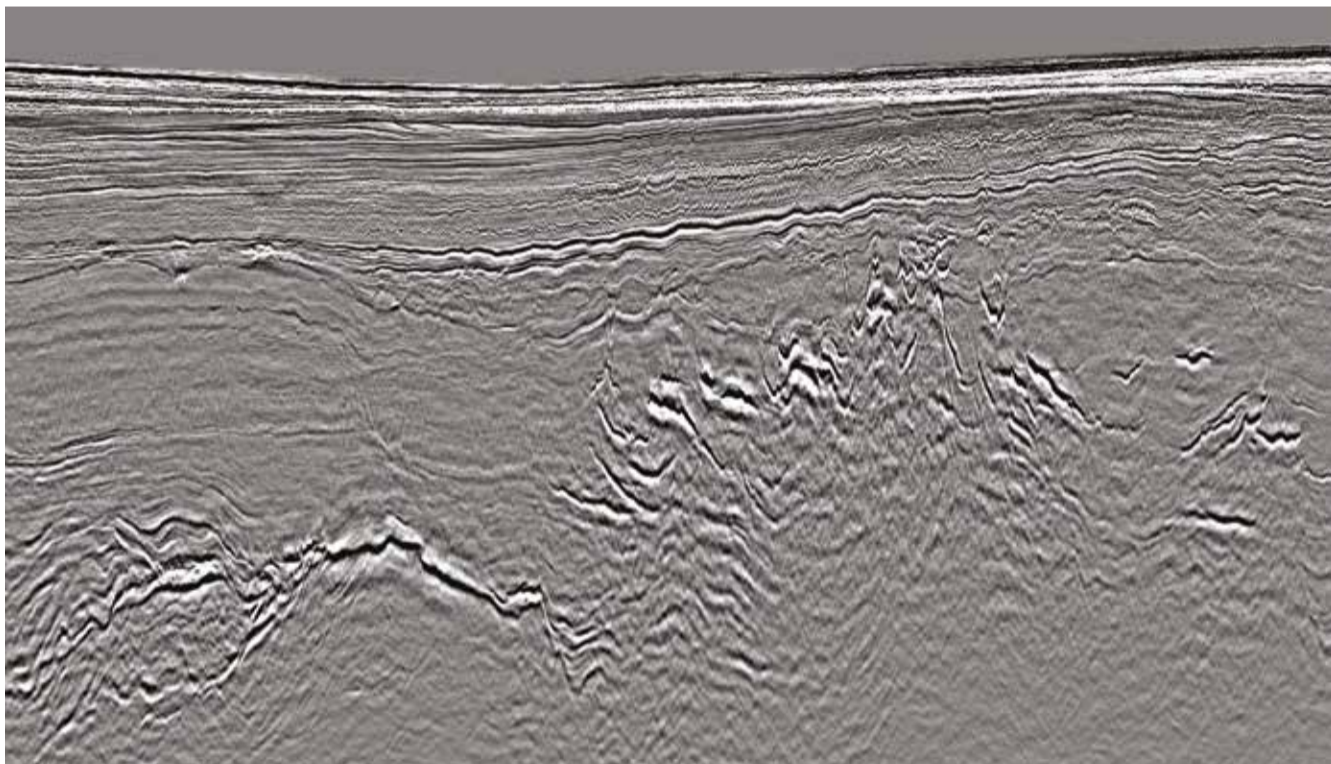
CONTRIBUTED BY CGG

Among many recent seismic technology advances, there has been a step change in source deblending. This has enabled the design of surveys, which use multiple sets of simultaneous sources to provide bespoke imaging solutions for a range of challenging environments. Typically, this includes a dramatic increase in source density and the collection of additional offset-azimuth coverage without losing fold and near offset coverage.

A recent example of this new generation of blended seismic imaging projects was the rich-azimuth, multicient survey acquired over the North Rona Ridge, northwest of Shetlands. The intention was to image multiple targets from shallow Tertiary and Cretaceous plays, through to complex fractured Devonian-Carboniferous reservoirs and Pre-Cambrian fractured basement plays. These are all potentially productive reservoirs along the Rona Ridge with examples including the Clair and Lancaster fields. A key challenge faced in this region is the imaging of targets beneath Tertiary volcanic intrusions.

Taking advantage of the flexibility and versatility offered by deblending, bespoke survey designs were evaluated against the geological imaging objectives and the practical operational constraints for the efficient acquisition of the dataset. A key element of the design was the inclusion of wide-azimuths from a group of sources positioned out to the side of the streamers. This enabled the survey to be acquired efficiently parallel to the coastline, in the strike direction of the main structure, while still providing crossline offsets and dense sampling in the dip direction. This geometry also provided good ray path diversity to image beneath the Tertiary volcanic intrusions known to be present in the area, by increasing the maximum y-offset.

Several rich-azimuth solutions with the source vessel placed at the front, middle and end of the cable were tested. The chosen strategy was determined from analysis by an integrated geoscience group, based on the modeled illumination benefits. It used a dual-vessel, rich-azimuth setup, with each vessel equipped with triple sources, and the source vessel positioned broadside to the streamer vessel, half way along the streamers. As well as maximizing the rich-azimuth contribution to the stack, the source vessel positioning also



Fast-track prestack depth migration from the rich-azimuth volume is shown. (Image courtesy of CGG Multi-Client & New Ventures)

provided a difference in apparent dip between arrivals from both vessels, assisting the deblending.

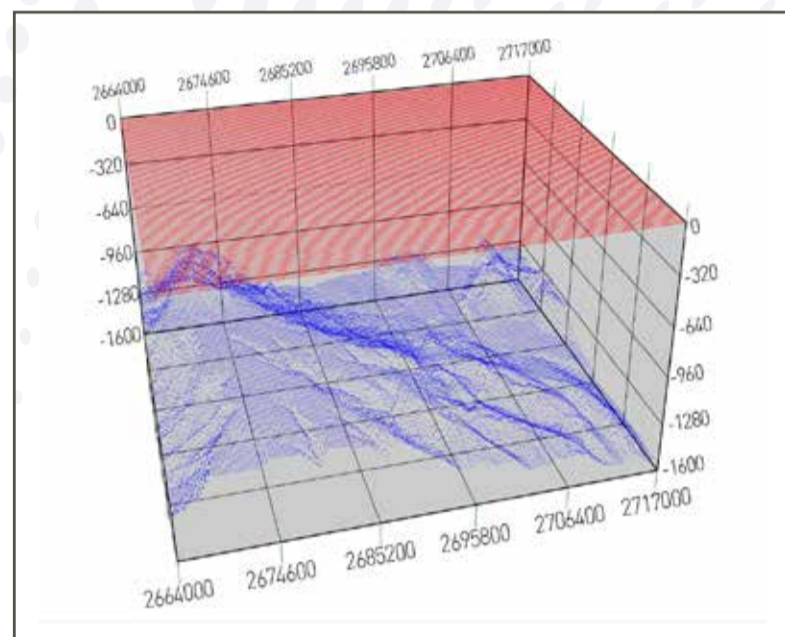
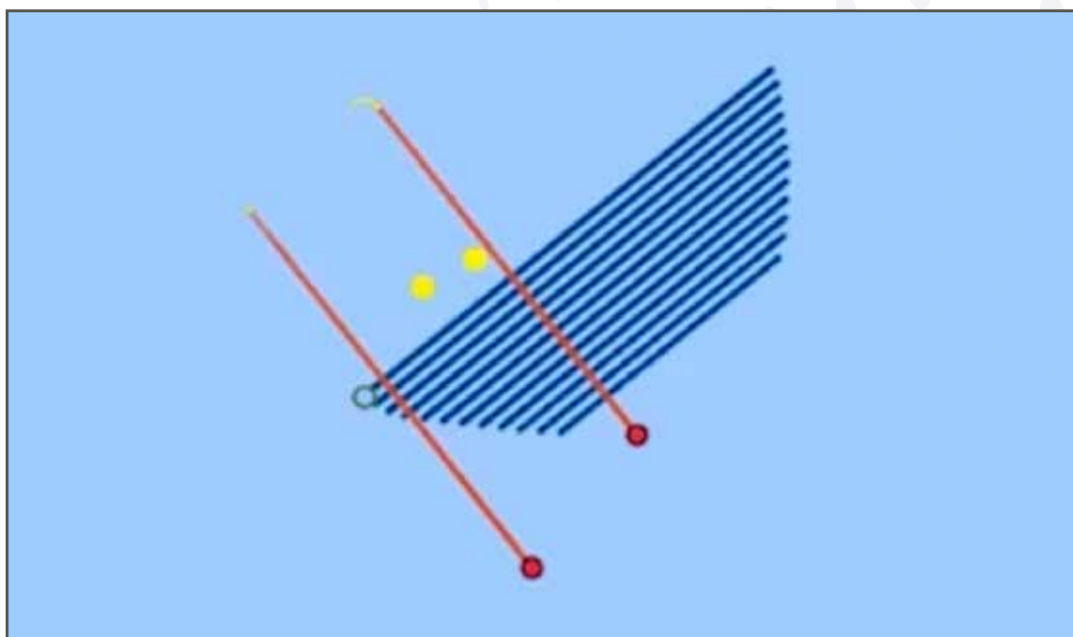
Deblending technology provided the freedom to have multiple sources on the streamer vessel to acquire dense data in the inline direction, while simultaneously acquiring dense data in the crossline direction without compromising the delivery timescale. Deploying six sources sequentially would result in a low-fold, poorly sampled dataset. Therefore, the shooting strategy was adapted to fire the sources more frequently in order to preserve seismic fold for all offset/azimuth classes, as well as increasing operational efficiency. Such an acquisition strategy required an up-to-date system, relying on continuous recording technology to guarantee the integrity of the seismic data, combined with an advanced deblending routine, modified so that all six sources were deblended in one step.

An advanced sail-line-based sequence allowed data to be processed as quickly as possible. The pre-processing sequence included deblending, 3-D simultaneous source and receiver deghosting, model-based water-layer demultiple and Radon demultiple. An initial prestack depth migration velocity model supplied the input to low-frequency full-waveform inversion. A one-way wave equation migration algorithm migrated each shot as soon as it had completed pre-processing, with initial results available 10 days after the last shot.

The figure shows the new simultaneous-source rich-azimuth data set with an uplift in the continuity of deep reflectors and potential reservoirs below the volcanics. This survey provides a great example of how CGG's advanced deblending algorithms and expertise are enabling a new generation of bespoke, high-density acquisition designs, which together can address difficult geological scenarios. ■



# Maximize Survey Efficiencies, Before the Project Begins



MESA® SimSurvey™ software ensures geophysical integrity, risk mitigation and efficiencies of operational planning and survey design. The latest MESA module provides a reliable time & motion and cost analysis functionality to the survey design and planning workflow. The software enables users to transfer survey designs from MESA to compare time and cost estimates for different design scenarios.

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# Exhibition area



## Exhibitors in alphabetical order

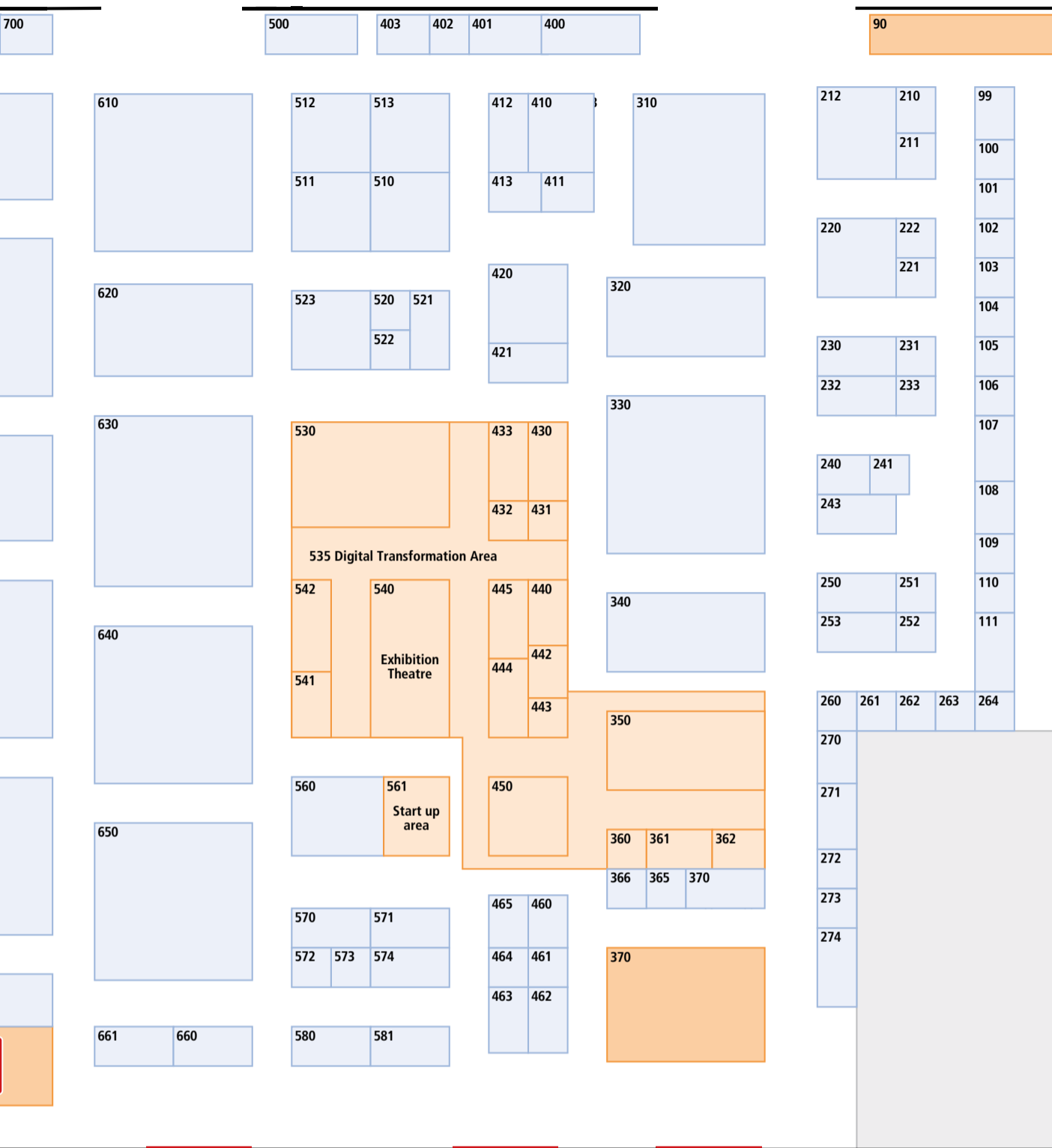
AAPG Datapages	1158	Eliis	1050	Geotek Ltd	222
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Entrance

Entrance



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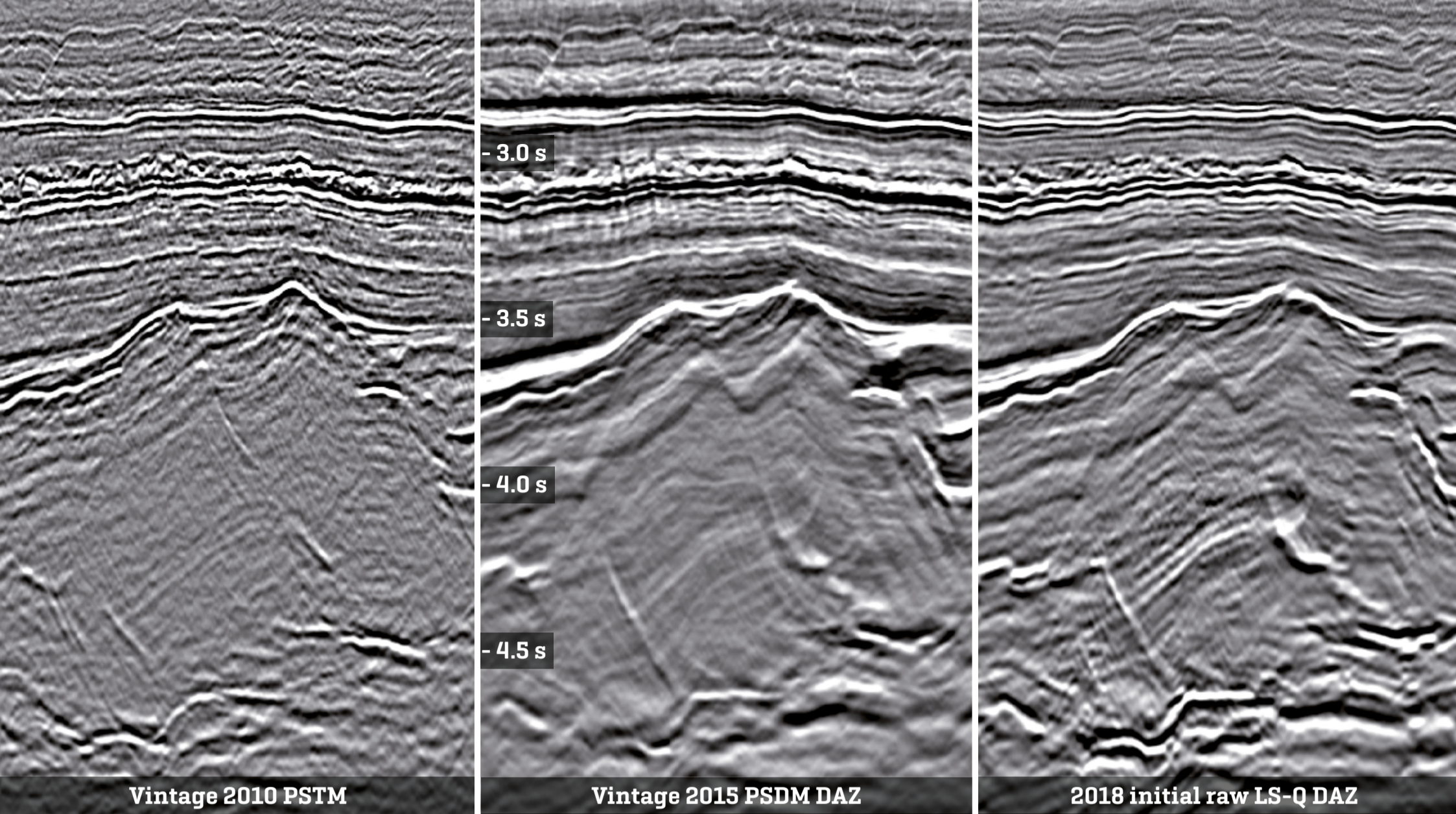
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Vintage 2010 PSTM

Vintage 2015 PSDM DAZ

2018 initial raw LS-Q DAZ

# CORNERSTONE EVOLUTION



## Enhanced imaging increases resolution

CGG Geoscience is currently reprocessing the 35,000+ km<sup>2</sup> Cornerstone multi-client survey in the Central North Sea using the latest cutting-edge imaging technology. The program merges a number of conventional long-offset and **BroadSeis**<sup>™</sup> surveys, acquired at two different azimuths, to create a single contiguous volume with a dual-azimuth area. Early-out products will be available in Q3 2019.

Our Subsurface Imaging experts are tailoring the processing to address the geological complexities, with model building benefitting from advanced Q-Tomo, Q-FWI and Q-RTM. Final PSDM data sets will include least-squares Q-Kirchhoff and wave-equation migrations.

Join us today for Happy Hour on CGG booth #720 at 4pm to learn more!