# HARTENERGY

LONDON

2019 EAGE Conference & Exhibition

PREVIEW

OFFICIAL SHOW DAILY OF THE 81ST EAGE CONFERENCE AND EXHIBITION

# **Embracing Change for a Better Future**

EAGE 2019 to address challenges and opportunities.

### BY FAIZA RIZVI, HART ENERGY ASSOCIATE EDITOR

s the demand for global energy increases, the indus $oldsymbol{\Lambda}$ try is witnessing a revolution. The 81st EAGE Annual Conference and Exhibition will focus on the theme "Embracing Change-Creativity for the Future."

"The Local Advisory Committee [LAC] is working closely with the EAGE to help shape the conference to be relevant to today's opportunities and challenges," said Howard Leach, BP head of Exploration and EAGE 2019 LAC chairman, in a statement. "[Our theme reflects] the changes that are occurring in the world and our role as geoscientists and engineers in helping to solve some of the big questions of our time."

EAGE 2019 has an engaging lineup of events that will provide educational and networking opportunities for professionals at all stages of their careers.



**EAGE Chairman** 

The opening ceremony will kick off with a welcome address by Jean-Jacques Biteau, president of EAGE. The event also will feature a debate in line with the conference theme on the topic "Getting Fit for the Future— What Will the Oil and Gas Industry Look Like in 2030?" The debate will be followed by the awards ceremony and the icebreaker reception.

Big Data Challenges Facing Seismic Data and Exploration Geophysics

Optimized content management strategies maximize data's value.

### CONTRIBUTED BY KATALYST DATA MANAGEMENT

 $\mathbf{S}$  eismic data is Big Data exemplified. With many companies doubling their data every two years, short-term, narrowly focused strategies for data storage can quickly become obsolete. New content management architectures and strategies will be needed to accommodate the Big Data explosion. The Holy Grail for today's companies is an enterprisewide content management strategy to handle increasing volumes of data in an agile, efficient and controlled manner. This is especially true in the world of subsurface data, where digital transformation is crucial to optimizing today's production and tomorrow's discoveries.

"EAGE 2019 will, as ever, showcase a world class technical program," Leach said in the statement. "A rich student program is being planned where participants will be challenged to 'think outside the screen.' Events will include interview coaching and a virtual reality experience. The Laurie Dake Challenge will return-teams can test their skills developing (virtually) a U.K. oil field."

The technical program will include workshops, field trips, oral and e-poster presentations, short courses and dedicated sessions covering a diverse range of topics. EAGE has partnered with SPE Europec to create an extensive program

that reflects the diversity of scientific research disciplines.

Conference sessions will address topics such as geological visualization of reservoirs, key seismic innovation, recent exploration discoveries and the role of geosciences in a safe and sustainable world.

Approximately 19 interactive workshops will be held on Sunday, Monday and Friday during EAGE week. Field trips include visits to Jurassic Coast World Heritage Site and Urban Geology of Piccadilly.

> See BETTER FUTURE continued on page 4



**HODAILY NEWS** 

# Get a more complete picture of your reservoir. We are the largest multi-client subsurface data provider in the world.

From geoscience to engineering, TGS has the most complete data libraries to help E&Ps make smarter onshore and offshore investment and drilling decisions.

But production optimization doesn't come easy. Oil and gas companies must first tackle the Big Data challenges facing subsurface data management, including establishing a company-wide, global approach to resolving those issues, such as

• Maintaining data sovereignty worldwide;

• Managing petabytes of seismic data; and

• Implementing Big Data analytics.

Taking a comprehensive content management approach to managing Big Data can increase discipline and availability; solve challenges related to architecture, global regulatory compliance and data ownership; and provide big benefits such as optimized production.

> See **BIG DATA** continued on page 7

### Data types:

- **3D Seismic:** advanced high-resolution imaging
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- Interpretive products: from seismic interpretation to basin modeling, we cover it all

### Machine learning:

- SaltNet: using AI to guickly detect salt bodies
- ARLAS: using AI to make every wireline log a quad combo

### Advanced imaging solutions:

- OBN: illuminate complex geology targets from all angles
- FWI: build highly detailed and accurate velocity models early in the processing sequence

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# **SigmaWave**

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Ahead of the Curves



# DAILY NEWS

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# SCHEDULE **OF EVENTS**

## **Tuesday, June 4**

07:30 - 18:00	Registration
	Registration area
08:30 - 11:00	EAGE Forum Session I: "Delivering the World's Low Carbon Energy Needs."
	Capital Suite Room 12
08:30 - 17:10	Technical Program (oral presentations)
	Conference area
09:00 - 11:30	Career Advice Centre
	EAGE Community Hub #1400
09:00 - 17:30	Exhibition
	Exhibition floor
09:00 - 17:30	IGLOO VR Experience
	Exhibition floor
09:00 – 17:30	Exhibition Theatre
	Exhibition #540
09:00 – 17:30	International Prospect Center Program
	Exhibition #1440
12:00 - 13:30	Senior Executive Managers Lunch
13:30 – 15:30	EAGE Forum Session II: "The Roles of Geoscientists & Engineers in the
	Changing Energy and Technology Landscape."
	Capital Suite Room 12
14:00 – 14:30	Motivational Speech by Dr Suzie Imber
	EAGE Community Hub #1400
14:30 - 16:00	Student Networking Café
	EAGE Community Hub #1400
16:00 - 18.00	Young Professionals – Special Session
	South Gallery Room 20/22
16:00 - 18.00	Afternoon Drinks at the Exhibition
	Exhibition hall

For a detailed description of the program, use the EAGE 2019 app or refer to the relevant pages of the EAGE program and catalog for full descriptions of the EAGE highlights.

# **Digital Transformation by Geoscientists** for Geoscientists

Using latest advancements improves data management and models.

CONTRIBUTED BY IKON SCIENCE

tions via the iPoint Datastore completing the full cycle of has the ability to provide tangible tools to aid in this digital transformation, thus enabling their clients to make

kon Science will be premiering the newest addition to its Lextensive solutions portfolio, iPoint, at this year's EAGE. This addition follows the December 2018 acquisition of Perigon Solutions, a leader in wellbore data management and visualization.

iPoint is a comprehensive wellbore data management solution focused on ensuring that key data and interpretations are centrally aggregated, easily accessible and appropriately secured to reduce current industry challenges that often lead to significant inefficiencies and underutilization of data. As part of the acquisition, Ikon Science gained a highly experienced team with an extensive consulting background in data aggregation, cleanup and integration. This newly added team is based in Aberdeen, U.K., and Houston.

The iPoint application and suite of data solutions significantly expands Ikon Science's software portfolio allowing users to easily locate, understand and vet their subsurface data before adding further value with key quantitative subsurface workflows. Once the data has been interpreted and enhanced with those workflows, that new information can be aggregated and shared across teams, groups and organizanowledge aggregation and team share.

Ikon Science understands that a digital revolution is underway across the oil and gas industry. Significant advancements in technology along with access to cost-effective and scalable cloud computing are making the ultimate goal of smarter, faster and better decisions with all available information more attainable than it has ever been. Machine learning also offers an opportunity to classify, interpret and predict massive volumes of data, enabling geoscientists to hone in on the subtle anomalies that inform reservoir properties and well performance. And while this digital revolution is promising, it is also forcing operators who want to maximize their subsurface knowledge and insights with these analytical methods and workflows to recognize that the major challenge hindering this goal is that their data aren't ready for the task.

Since its beginning, Ikon Science has been heavily involved with and motivated by the quest to help operators understand subsurface qualities and behaviors with various types of data. With the addition of iPoint and associated technical experience to the Ikon Science technology suite, a company heavily vested in subsurface understanding now

informed subsurface decisions.

In April, Ikon Science announced the launch of a transformational new offering called Deep QI, which is a new and rapidly expanding portfolio of powerful workflows and solutions leveraging modern machine learning and deep neural networks for answering important questions about the subsurface. Deep QI delivers the first in a series of major software updates to the RokDoc platform featuring new functions and data-tuned algorithms that allow users to train both deep neural networks and support-vector machine methods to predict discrete and continuous subsurface properties from 1-D at the well to 3-D from seismic and engineering models with ability to extend into 4-D time-lapse domains.

Ikon Science will be showing iPoint along with case studies of how organizations in the oil and gas industry have used this technology to overcome common data challenges at Ikon Science booth 710. In addition to a schedule of daily booth talks, iPoint will be featured during the Ikon Science booth Lunch & Learn. Please email jsharples@ikon*science.com* to secure your seat and lunch.

# E&P DAILY NEWS | JUNE 4, 2019 | PREVIEW

# **Modified Workflows Speed Completions of Seismic Processing Projects**

Automated velocity model building approach cuts turnaround from months to days.

### CONTRIBUTED BY PGS

**D**y modifying existing workflows, a velocity model can Dbe generated without manual intervention with results that are comparable to a conventional velocity model building exercise. The time taken to create such a model was reduced from 90 days using traditional model building to only a few days for the automated approach.

The industry expects seismic processing projects to be completed faster, so how do we meet the challenge? While the answer may be complex, modifications and manipulations to established systems could enable reductions in turnaround, an example being in building depth imaging velocity models. A model provides an image of the subsurface, from which a range of probabilities and estimates may be made, drilling campaigns planned and then plans put into action. Seismic data underpins this, and the data's spatial veracity is dependent on the model used to position the data. Although other factors are important, a seismic processing project is all about the earth model.

The cornerstone of reverse engineering is determining

how design features from one process can apply in another way for a different process. PGS generated a usable velocity model using a Monte Carlo simulation, proving that this type of automation without manual intervention can help reduce turnaround. The result is equivalent to a 'conventional" velocity model building exercise.

The starting point for the automation of the velocity model begins by determining how the data support the model prior to creating a randomly generated model population. Once created, the population is tomographically inverted. A statistical analysis is performed on all the resulting models in the population, and the analysis is used to update the starting point prior to reintroducing a pass of random model generation and inversion.

The process is repeated with the goal of producing a model that explains the data, by producing flat Common Image Gathers (CIGs). Move-out metrics are generated after each pass

\* Geophysical research and software development;



The image shows the creation of an automated velocity model (right) from an inaccurate starting model (left). The automated model (right) shows a strong correlation with the model built during a conventional velocity model workflow (center). (Image courtesy of PGS)

> of the simulation, which are used to map the progressive convergence of the solution using these metrics.

> An initial model was created to run the test. The model was modified to incorporate a known and locally varying error of up to 10% in the model. Once randomly perturbed, the starting model was up to 15% too fast or slow. The results were checked against a final tomographic model that was built using the same data and generated in 90 days.

> The figure shows three sets of CIGs and three stacks with their associated velocities co-rendered on the seismic sections. The middle image is the result of the 90-day model building exercise. The left image shows the starting point for the automated Monte Carlo model building process. The starting CIGs show a significant level of move-out as the model was up to 15% wrong. The image on the right shows the product of the automated simulation. Gather flatness is equivalent to the conventional approach (middle image), and the co-rendered velocity model closely resembles the model built in 90 days.

> The automated approach to building a velocity model using a Monte Carlo simulation converges on a solution of equal quality to conventional model building. In this example, the starting point was up to 15% in error but was still resolved. The workflows were initiated by a geophysicist who had no prior knowledge of the data. No well constraints were available to confirm the accuracy of any of the resulting models.

> The implications of this approach are considerable. While the original model building took 90 days, the automated model was built in significantly less than an order of magnitude of that time. With the addition of more nuanced automation steps and simplistic machine learning initiatives we anticipate a further reduction in turnaround and aim to create an automated model in days rather than months.

### **BETTER FUTURE** (continued from page 1)

EAGE also offers forum sessions, which are open to all delegates. Two EAGE forums will be held on Tuesday that will discuss delivering the world's low carbon energy needs and the roles of geoscientists and engineers in the changing industry landscape. Wednesday's EAGE forum will focus on new technologies for the upstream. Special sessions include "Women in Geosciences" and the Young Professionals Session. The EAGE exhibition is expected to attract more than 7,000 industry leaders and energy professionals to explore the newest technologies, products and innovative services. The exhibit will have special areas such as the Digital Transformation Area that seeks to explore and showcase forward-thinking technology. The International Prospect Center will provide vital information about forthcoming licensing rounds. The Startup Area will enable geoscience and engineering startups to exhibit their solutions to attract prospective investors. The EAGE Community Hub will feature a career symposium on Monday. This interactive event aims to guide participants in successfully navigating the early stages of their careers. This year's symposium will focus on digital skills and will feature speakers from the industry and academia. The EAGE bookshop, IGLOO virtual reality experience, career advice center and student area are some key highlights of the EAGE Community Hub.

# **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;
- GME and geo-chemical surveys; \* Reservoir geophysics;
- \*Borehole seismic surveys and micro-seismic;
- \* IT services.

4

Geophysical equipment manufacturing;

## Multi-client services;



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# **Geoscience Digitalization Continues Apace**

Rapid expansion in machine learning applications alongside migration to the cloud advances workflows.

### CONTRIBUTED BY CGG

A tindustry events over the last couple of years, digitalization has become a major point of interest with dedicated technical sessions and exhibition feature areas to explore this growing topic. CGG has likewise embraced this technology to transform many areas of its business. Perhaps the biggest area of interest in the industry right now is around machine learning and the opportunities it offers to potentially revolutionize geoscience workflows.

To help geoscientists take advantage of machine learning and deep learning technology, CGG GeoSoftware has developed a machine learning ecosystem. It provides open access to data within its geophysical and petrophysical applications. Python-scripted machine learning lets users get their hands dirty if they like to tinker under the hood, or take advantage of carefully selected pre-built recipes. Many tasks can now be completed more quickly and with more detailed results, such as well log editing and petrophysical analysis, facies classification and reservoir property prediction. Meanwhile, deep neural networks provide benefits for tasks as varied as reservoir quality assessment and near-surface characterization. Learn more about these applications at the daily CGG booth theater presentations.

Even if geoscientists are not using machine learning personally, they'll find it increasingly involved across various aspects of geoscience projects and workflows around them. CGG's Subsurface Imaging experts now benefit from the addition of machine learning to improve tasks such as surface wave inversion, processing QC, job logistics and resource utilization. Their papers on these topics include:

• "Learn to Invert: Surface Wave Inversion with Deep Neural Network" (Workshop 10, Monday, June 3, 9:40 a.m.);

"Near-surface characterization in Southern Oman: Multiwave Inversion Guided by Machine Learning" (Near Surface Technologies I, Tuesday, June 4, 8:30 a.m.);

• "Leveraging a Supervised Machine Learning Toolkit for



This ResPack Fast porosity volume, predicted by HampsonRussell Emerge from seismic data using a neural network trained on well log data, highlights higher porosity targets in the Scoop and Stack plays of Oklahoma. (Image courtesy of CGG Multi-Client and New Ventures)

Better Seismic Processing Quality (Deep Learning and Data Analytics—Seismic Applications I & Methods and Applications II, Thursday, June 6, 3:30 p.m.).

Before the industry gets to the point where it can truly benefit from Big Data analytics and take full advantage of machine learning, there is a need to reach a minimum common denominator in terms of the data itself. Recent efforts have seen the liberation of huge volumes of data from legacy formats, migrating to new data management platforms that include an increasing mix of cloud storage. CGG Smart Data Solutions help to ease this digital transition with end-to-end services from expert upcycling of legacy data into the cloud to the deployment of their modern and flexible GeoTrove data management platform.

Integration and interoperability of geoscience data become important to really take advantage of data analytics and machine learning applications. CGG has spent the last few years gaining valuable experience while taking its geological library into the digital realm, using a proprietary taxonomy and ontology to create a unique framework for its GeoVerse dataset. Meanwhile, its multiclient seismic library is now accessable through its new GeoStore portal, with controlled access to historical client entitlement data. Upload to the cloud is underway for the entire multiclient seismic library.

The cloud offers more than just data storage—cloud computing provides scalable and flexible solutions to computeintensive reservoir characterization workflows and very large projects. Through its technical collaboration with Microsoft, CGG's latest GeoSoftware releases run seamlessly in the Microsoft Azure Cloud Environment. Other major cloud platforms soon will follow.

To find out more about machine learning, visit booth 720 at 3:30 p.m. on Tuesday, June 4, for Happy Hour, or listen to CGG's keynote presentation on Wednesday at 9:30 a.m. in the Digital Transformation Area theater. For information about all of CGG's activity at EAGE visit *cgg.com/eage2019*. ■





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# BOOTH # 1040 - EAGE LONDON 3-6 JUNE

# THE LEADING PROVIDER OF OBN SEISMIC SOLUTIONS







# Improvements in Imaging Through FWI Technology

Hybrid approach provides more accurate velocity models in areas with anomalous features.

### CONTRIBUTED BY TGS

With exploration and production (E&P) activities in-creasing in the North Sea, full-waveform inversion (FWI) technology is providing improved seismic imaging and high-resolution seismic attributes for E&P companies. TGS' multistage FWI workflow—which includes dynamic warping, image-guided FWI, wavepath FWI and phase-only reflection FWI-is currently being applied to multiple projects in the northwest Europe region. Data from the Moray Firth in the U.K. showed improved imaging beneath shallow channels made up of sediments with a highly variable velocity, while data from the Porcupine Basin in Ireland as well as the Norwegian Barents Sea showed the same enhancements beneath shallow channels but also improved imaging from accurately modeling shallow gas anomalies. By applying an FWI workflow and technology, operators are now able to build highly detailed and accurate velocity models relatively early in the processing sequence.

Geologically reasonable, data-driven velocity model building is one of the most critical processes for a seismic



The image shows zoomed inline slices of initial imaging and velocity (left), final imaging and velocity (center), and final imaging and total velocity update (right). (Image courtesy of TGS)

imaging project. Often this depends on ensuring that the model is tied structurally to the underlying geology, with



model features following the large-scale imaging trends. This assumption breaks down in situations where the velocity is strongly heterogeneous within particular layers or structures, which is especially noticeable when large gas pockets disrupt the imaging with anomalously low velocities and high signal attenuation. When these features are prominent in shallow imaging, the disruption of the signal due to an inaccurate velocity model may propagate down through a significant portion of the imaged depth, despite the true anomalies being located in shallow sediments.

In a paper written by TGS, the company presents a successful workflow for an imaging project that shows strong velocity and attenuation anomalies in otherwise orderly shallow sediment. The signal in these regions is distorted heavily, leaving little useful kinematic information for reflection tomography. In this case, refraction and reflection-based FWI model updates are able to provide details of the highresolution velocity contrasts within this region, and alternating iterations of image-guided tomography (Hilburn et al., 2014a) are then able to resolve the larger scale velocity updates needed to correct for bulk travel time errors. This approach leads to a velocity model that is geologically constrained in most areas, with very high-contrast features corresponding well with the imaged anomalous regions. Observed structure below the features is greatly improved, with obvious uplift more than 1.2 miles (2 km) deeper than the velocity anomalies.

This hybrid high-resolution FWI and tomography model building approach is set out by TGS, and the associated case study is then discussed to demonstrate the effectiveness of this job flow.

TGS will be presenting this paper at the EAGE under the title: "High-resolution Velocity Model Building Through Multistage FWI and Image-guided Tomography to Resolve Ultraslow Velocity, High-attenuation Seismic Features." The presentation will be from 8:30 a.m to 12:10 p.m. on Thursday, June 6, in Room 8.

To find out more about FWI offerings from TGS, visit booth 920 or *tgs.com*. ■

# Download the



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# Vibrator Auto-Guidance Optimizes Vibroseis Productivity

New solution reduces travel time and dead time while ensuring data quality.

### CONTRIBUTED BY SERCEL

Last March, Sercel launched the world's first Vibrator Auto-Guidance solution, designed to increase vibroseis productivity by up to 10%. The solution can be fitted to all Sercel Nomad seismic vibrator trucks and works by optimizing a truck's travel time to the next vibrating point (VP) and reducing baseplate dead time. This provides an increase in source efficiency and consequently a cost saving for acquisition.

Deployed on seismic survey projects around the world, Sercel Nomad vibrators deliver high-performance broadband vibroseis in the harshest environments. Boasting the latest innovations in shaker and hydraulic circuitry design, they are recognized for their environmental credentials based on low-emission engines and an Intelligent Power Management system, which optimizes engine efficiency to reduce fuel consumption by up to 15%.

The addition of Vibrator Auto-Guidance improves vibroseis productivity in two ways. During operations, the truck's deceleration is adjusted and controlled automatically, reduc-

# BIG DATA

(continued from page 1)

### Keeping data sovereign to its source

Data sovereignty is the concept that subsurface data and information are subject to the laws of the country in which they are located. Concerns underlying data sovereignty include enforcing privacy regulations and preventing exploration and production (E&P) data stored in a foreign country from being subpoenaed by the host country's government.

But data sovereignty became more complicated with the U.K.'s General Data Protection Regulation (GDPR). Data ownership rights across national boundaries have always been enforced but the passage of the GDPR in 2018 made data sovereignty a top-of-mind issue.

To consistently control, manage and access proprietary data that are scattered across geographic borders, the geospatial metadata needs to be extracted from the data sources into something contextual and structured. Once captured in context, secure web content storage management can examine this metadata within the data and verify its proprietary ownership before allowing access to it.

### Managing terabytes and petabytes of seismic data

To handle massive amounts of seismic data, subsurface data management teams and consultants should be familiar with the Professional Petroleum Data Management Association's Master Data Management model and routinely maintain data with a program of content management maintenance services to maximize data's value and accessibility.

Global access to seismic data opens the door to Big Data analytics and production optimization. Subsurface data management and consulting service providers can guide E&P companies through the workflows specific to their data domains to make sure their data management programs are optimized for analytics and artificial intelligence.

Complex oil and gas companies also need flexibility when it comes to data access. Each business unit must be able to locate its subsurface data, with a central administration to ing both its travel time between VPs and any operator-induced delays. The solution also minimizes dead time spent on deploying and recovering the baseplate. The system anticipates descent of the baseplate and commences the action before the truck has come to a complete standstill.

By positioning the Nomad vibrator with the highest degree of accuracy—within 3.3 ft (1 m) of the surveyed position—the Vibrator Auto-Guidance also ensures that the data collected are of the highest possible quality.

"The launch of our new Auto-Guidance system brings additional value to our Nomad vibrator truck users. As well as boosting productivity and data quality, there are related HSE benefits, such as reduced operator fatigue, improved comfort and ergonomics," said Pascal Rouiller, CEO of Sercel. ■



Sercel's Vibrator Auto-Guidance improves trucks' travel time and decreases dead time related to deploying and recovering the baseplate. (Image courtesy of Sercel)



according to the established framework.

### Implementing Big Data analytics

Big Data analytics involve complex and large datasets such that it is difficult to capture, process, store, search and analyze using a conventional database system. Doing so would be like trying to juggle a million data sources, in different formats, and often with little or no context as to where and when the data were captured and cataloged.

To ensure the use of all the relevant data and to make better decisions means first placing data in a centralized repository within the data management system that stores both structured and unstructured E&P data at any scale. At that point, the good solution will bring structure and context to the unstructured data—making it accessible for the data science team for detailed analysis.

To help oil and gas companies with the challenges of Big Data, Katalyst Data Management provides an integrated, end-to-end data and information management solution and a subsurface consulting service that are specifically designed to maximize data access and value.

**BOOTH NUMBER 330** 

# MINDS OF ENGINEERS. PIONEERS AT HEART.

### E&P DAILY NEWS | JUNE 4, 2019 | PREVIEW

# **Efficient Logistics**

The ability to build strong logistics networks creates a competitive advantage.

### CONTRIBUTED BY MAGSEIS FAIRFIELD

Competitors in the seismic industry are always looking for ways to make their operations more efficient through technological innovations, new techniques or geometries, or in logistics. In the race to better serve clients and move quickly between projects separated by oceans, Magseis Fairfield has made significant improvements in the development and manufacturing of modular systems and streamlining transportation of these systems.

There is often little time between acquisition projects, and logistics teams are challenged to turn systems around from final retrieval on one job to first deployment on the next, maximizing utilization of nodes. The ability to move these systems between projects over great distances, or even within the same region, is further limited by the reliance on land and sea freight. With more companies relying on vessels of opportunity, it is imperative that systems are flexible and quickly mobilized for the task at hand. To satisfy this need, more companies are pursuing modular and containerized technologies.

Magseis Fairfield has outpaced the field in realizing the successful implementation of modular systems. The latest in MASS technology can be fully containerized and can be delivered by cargo plane in a matter of hours, instead of days or weeks. Cooperation and coordination between Magseis Fairfield logistical department, local contractors, warehouses and airfreight providers—a cooperation built on trust and good working relationships—create the operational network of logistics teams to help ensure the equipment arrives where it needs to be, when it needs to be there, safely and efficiently.



The Antonov An-124 Ruslan, a strategic heavy transport aircraft, can carry up to 150 tons of cargo. (Image courtesy of Magseis Fairfield)

In December 2018, Magseis Fairfield transported its first full MASS-Modular system between Stavanger, Norway, and Abu Dhabi, United Arab Emirates, by airfreight—a total of 106 tons of seismic equipment—in a matter of hours. In March 2019, Magseis Fairfield transported its second full MASS-Modular system from Stavanger to Abu Dhabi. Loading of the Antonov An-124 Ruslan was completed within four to five hours due to good logistics planning and an efficient crew. After arrival, the MASS-Modular system was operational in less than a week. The ability to reliably

transport complete systems for quick startup helps cut down on time between projects and improves utilization of vessels and crews. In comparison, sea freight between Norway and UAE would have taken some 33 days. From an operational point of view, it is not difficult to see the enormous benefit.

Improvements in logistics efficiencies will be the next differentiator when evaluating seismic acquisition providers. Companies with the capabilities to build strong and reliable logistics networks will have the competitive edge in reliable, safe, efficient transportation and mobilization.

# Ultra-sensitivity Distributed Acoustic Sensing System

High-efficiency, low-cost borehole seismic survey and simultaneously surface and borehole seismic data acquisition uses the uDAS system.

### CONTRIBUTED BY BGP

Vertical seismic profiling (VSP) plays an important role in bridging the gap between surface seismic and acoustic logging. However, conventional VSP technique is subject to the limitations of downhole geophones array (about 100 levels). It is common that such geophone array cannot cover the full depth of deep wells without moving the tool a few times, due to their limited survivability in HT/HP environments. In order to realize high-efficiency, low-cost VSP data acquisition and permanent monitoring for the whole well, BGP developed a novel ultra-sensitivity distributed acoustic sensing seismograph (uDAS).

The uDAS system is based on phase-sensitive optical time domain reflectometry (p-OTDR). When high-coherent optical pulses are injected into the fiber, the propagating light will cause the internal electric charges to resonate, thereby the Rayleigh backscattering light is generated with the same frequency. When the seismic waves reach the fiber, a slight change in fiber length and refractive index will be induced, thus the optical phase of Rayleigh backscattering light will have the corresponding change. By extracting the optical phase change within interference signal along the fiber at different times, uDAS systems can demodulate continuous time-variant seismic signals. Due to the advantages such as ultra-high sensitivity, much lower cost and passive sensing, the DAS technique has attracted extensive attention in the borehole seismic survey applications in recent years. However, most existing DAS systems have relatively low sensitivity and cannot meet the requirements of high quality borehole seismic survey, thus the performance enhancement of the DAS system is urgently needed. After continuous efforts over the last three years, the uDAS system with ultra-high strain sensitivity has been successfully developed. The uDAS system employs four key techniques, which are highly coherent probe pulses with large optical extinction ratio, low noise optical amplifications based on long period fiber gratings, Rayleigh fading suppression based on multi-frequency modulation, and anti-interference technique based on stabilization of local interrogator. Calibrated by a standard PZT fiber-optic strain generator, the uDAS system achieves the strain sensitivity of  $0.018 \text{ nE}/\sqrt{\text{Hz}}$ Moreover, through precise comparison, the steady re-







On the left, raw geophone recorded VSP data (10 m depth interval); on the right, raw uDAS recorded VSP data (0.83 m depth interval). (Image courtesy of BGP)

sponses of uDAS and conventional geophones are consistent. Furthermore, since the optical fiber is more suitable for transient vibration measurement, while harmonic distortion is unlikely to be induced, uDAS system is more suitable for VSP survey.

We conducted a comparative test using uDAS and conventional geophones in Northeast China. The optical fiber was cemented outside the casing in a vertical well, and the cementing depth was 0 m to 1,000 m. A total of 50 levels 3-C geophone array were deployed at the same depth inside the casing, but the geophone interval was 20 m. The vibrator sources were used with three folds. Both vertical and lateral resolutions of the uDAS data were significantly improved in comparison with the conventional borehole geophone data. The spatial aliasing was obviously sup-

pressed while the shear wave information was much clearer. The VSP imaging results showed that the imaging quality was significantly better than that of the surface seismic, and more details could be seen.

Therefore, it can be anticipated that the uDAS system could replace the downhole geophone arrays in the future, resulting in a new generation of full-well-depth, high-resolution VSP technique. After a certain density of cemented fibers are set in many boreholes of the oilfield, it can implement multiwell simultaneous surface and borehole seismic data acquisition. The uDAS system will play an important role in the evaluation and development of the oil field in the near future.

Please visit BGP at EAGE 2019 at booth 1030 for more information.  $\blacksquare$ 

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