SEG19
SAN ANTONIO, TX
15-20 SEP 2019
INTERNATIONAL EXPOSITION
89TH ANNUAL MEETING

DAILY NEWS

WEDNESDAY 18 September 2019

HARTENERGY | THE OFFICIAL SHOW DAILY PUBLISHER OF THE SEG INTERNATIONAL EXPOSITION AND 89TH ANNUAL MEETING

Preparing the Next Generation

Student-centric programs prepare future leaders and reinforce lessons learned in school through the application of skills with real-world data.

BY JENNIFER PRESLEY, EXECUTIVE EDITOR

For many, the 89th Annual Meeting of the Society of Exploration Geophysicists began on Sunday evening with the opening icebreaker on the floor of San Antonio's Henry B. González Convention Center. However, Sunday evening brought to a close this year's SEG/ExxonMobil Student Education Program (SEP) and the SEG/Chevron Student Leadership Symposium (SLS) for the 80 participating students and organizers.

This year's SEP was a 2.5-day short course, beginning on Friday evening, that prepared 30 students from around the world for the challenges of an oil industry career through the use of hands-on exercises and lectures directly related to geoscience/geophysics. Sponsored by ExxonMobil, the students are provided real-world materials to use in team exercises that are led by the company's geoscientists serving as program instructors.

"We start at the beginning where we are looking at a really big scale, and we haven't acquired much data yet. We're working with really sparse data, just a couple of 2-D seismic lines and no well data, and we're looking for structures," said Alana Robinson, a SEP instructor and geophysicist for ExxonMobil.

Building on those observations, the students then bid on a block.

See **PREPARING** continued on page 13

Celebrating the Best

The 2019 SEG Honors and Awards recognize individuals who have made outstanding contributions to geophysics.

BY BILL WALTER, ASSISTANT MANAGING EDITOR

The spirit of exploration geophysics is collaborative, and at the annual SEG Honors and Awards Ceremony on Tuesday evening, it turned celebratory. Of the many individuals awarded, some were students, others were decades-experienced scientists, but all were committed to the advancement of the community. As Don Steeples, former president of SEG and current chair of the Honors and Awards Committee (HAC) told Hart Energy, "attendees who have been paying attention … will recognize many of the awardee names from past SEG service activities and as authors of SEG publications."

Don Steeples

A long-time member of the geophysical community, Robert H. Stolt won the highest honor, the Maurice Ewing Medal, which is periodically awarded by a unanimous vote of both the HAC and the board of directors. Stolt is known for his pioneering contribution to seismic migration in the Fourier domain such that a single number is output at every point in the subsurface. His award citation stated that

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SEG19 SAN ANTONIO, TX 15-20 SEP 2019 INTERNATIONAL EXPOSITION 89TH ANNUAL MEETING

SCHEDULE OF EVENTS

All events in conjunction with SEG 2019 will be held at the Henry B. Gonzalez Convention Center in San Antonio, Texas, unless noted otherwise. For a complete schedule of events visit *seg.org/Annual-Meeting-2019/Schedule*.

Wednesday, Sept. 18

7:30 a.m. to 5:30 p.m. ... Registration and Self-serve Badge Kiosks (Main Lobby)
7:30 a.m. to 6 p.m. ..... SEG Book Mart (Main Lobby)
8 a.m. to 10 a.m. ..... Members-only Breakfast: Meet, Eat and Greet (Room 220)
8:30 a.m. to 10:35 a.m... Plenary Session: Improving the Business Model of Land Seismic and Processing in the U.S.: Technology, Quality, Economics (Stars at Night Ballroom B1)
8:30 a.m. to 5:10 p.m. ... Technical Program Oral Sessions (Rooms 214-305)
9 a.m. to 4:30 p.m. ..... SEG Exhibition (Exhibit Hall 1-3)
9 a.m. to 4:30 p.m. ..... SEG Student Lounge (Exhibit Hall, SEG Avenue)
9:20 a.m. to 4:20 p.m. ... Technical Program Poster Sessions (Exhibit Hall, Hall 1)
12 p.m. to 1 p.m. ..... Delegate Luncheon (Exhibit Hall 1-3)
1:50 p.m. to 3:55 p.m. ... Plenary Session: The Changing Business Climate of Marine Geophysics: Roadmap to the Future (Stars at Night Ballroom B1)
5:30 p.m. to 8:30 p.m. ... Wrap-up Party (Convention Center: The LDR and Grotto)

Thursday, Sept. 19

7:30 a.m. to 4 p.m. ..... Registration and Self-serve Badge Kiosks (Main Lobby)
7:30 a.m. to 6 p.m. ..... SEG Book Mart (Main Lobby)
8:30 a.m. to 5 p.m. ..... SEG Near-surface Summit: Advances in Unmanned Airborne System (UAS) Geophysics (Room 217A)
8:30 a.m. to 5 p.m. ..... Postconvention Workshops (Rooms 221-304)
8:30 a.m. to 5 p.m. ..... SEG Near-surface Summit: Near-Surface Geophysics for Archaeological and Forensic Applications (Room 217D)

Friday, Sept. 20

7:30 a.m. to 1 p.m. ..... SEG Book Mart (Main Lobby)
8:30 a.m. to 12 p.m. ..... Postconvention Workshops (Rooms 221-304)

INDUSTRY NEWS

USGS Estimates Alaska North Slope Holds Nearly 54 Tcf Of Natural Gas Hydrate

The Alaska North Slope could hold an estimated 58.8 trillion cubic feet (Tcf) of undiscovered, technically recoverable natural gas hydrate resources, according to an updated assessment by the U.S. Geological Survey (USGS).

The assessment follows a 2008 study that revealed an estimated 85 Tcf of technically recoverable gas resources could be within Alaska North Slope's gas hydrates. The latest news comes after evaluation of more extensive 3-D seismic mapping, better data collection and more refined analysis.

"To date, there is no known commercial production of natural gas from gas hydrate formation and the commercial viability of gas hydrate reservoirs is not yet known," USGS said in a statement Sept. 10. "This assumption is based on both limited field testing and numerical production models of gas hydrate-bearing reservoirs. No analysis was provided as to whether it would be profitable to produce these resources."

Gas hydrates are crystalline solids that contain gas molecules trapped inside cage-like structures of water molecules. They are naturally occurring, forming in the presence of high pressures and low temperatures. Although gas hydrates can be problematic for oil producers, as they tend to cling to each other and increase in size causing blockages in pipes, they are also seen as another form of unconventional resource that could be developed if challenges are overcome.

"The study of gas hydrate as an energy resource is still an emerging field," USGS scientist Tim Collett, lead author of the assessment, said in the statement. "The USGS has been conducting research on gas hydrates since the 1980s. Every time we conduct these assessments, we incorporate more and higher quality data, and our estimates become more precise."

The USGS' assessment examined technically recoverable resource potential in the North Slope of Alaska covering a 41,089-sq-mile area bounded by the National Petroleum Reserve-Alaska (NPR-A), Arctic National Wildlife Refuge, Brooks Range and the state-federal offshore boundary.

Gas hydrates below the permafrost were assessed, while free gas potentially trapped below the gas hydrate stability zone were not part of the study.

"Geochemical analyses of drill cuttings and core samples from wells drilled in the state of Alaska lands between the Canning and Colville rivers and within NPR-A indicate that the gas within the drilled and well log inferred gas hydrate accumulations is in part from thermogenic sources, with the thermogenic gas migrating from deeper sources, including known conventional oil and gas accumulations," USGS said in the report.

"Thermal conditions conducive to the formation of permafrost and gas hydrates are believed to have persisted in the Arctic since the end of the Pliocene (about 2.58 million years ago)," the agency added. "In addition, most permafrost-associated gas hydrate accumulations probably developed from preexisting free-gas fields that originally formed in conventional hydrocarbon traps and were later converted to gas hydrates upon the onset of glaciation and cold Arctic conditions."

About 27% of the undiscovered gas hydrate resources estimated mean of 53,796 billion cubic feet are within the Sagavanirktok Formation Gas Hydrate assessment unit (AU), 33% in the Tuluvak-Schrader Bluff-Prince Creek Formations Gas Hydrate AU, and 40% (21,511 BCFG) in the Nanushuk Formation Gas Hydrate AU, the report showed.

But the USGS cautioned that "given that relatively few wells have penetrated the expected gas hydrate accumulations in these three AUs, there is significant geologic uncertainty in these estimates."

—Velda Addison

See **INDUSTRY NEWS** continued on page 12

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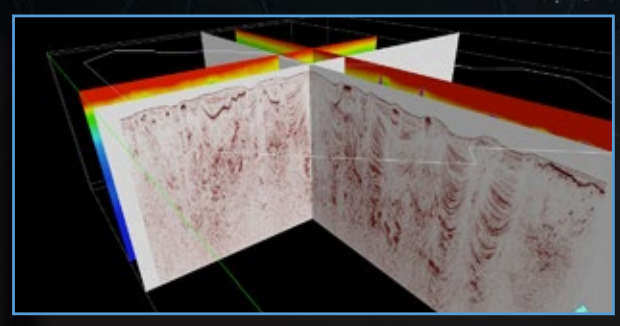
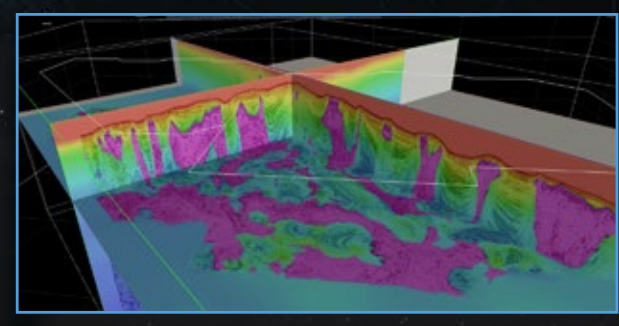


Screen with the **GAIA Viz** workflow.



Evaluate with the **GAIA Pro** workflow.

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Disaster Recovery in a Multicloud Environment

Companies must consider separating backups and maintaining data inventory.

BY RICHARD DAVIS, KATALYST DATA MANAGEMENT

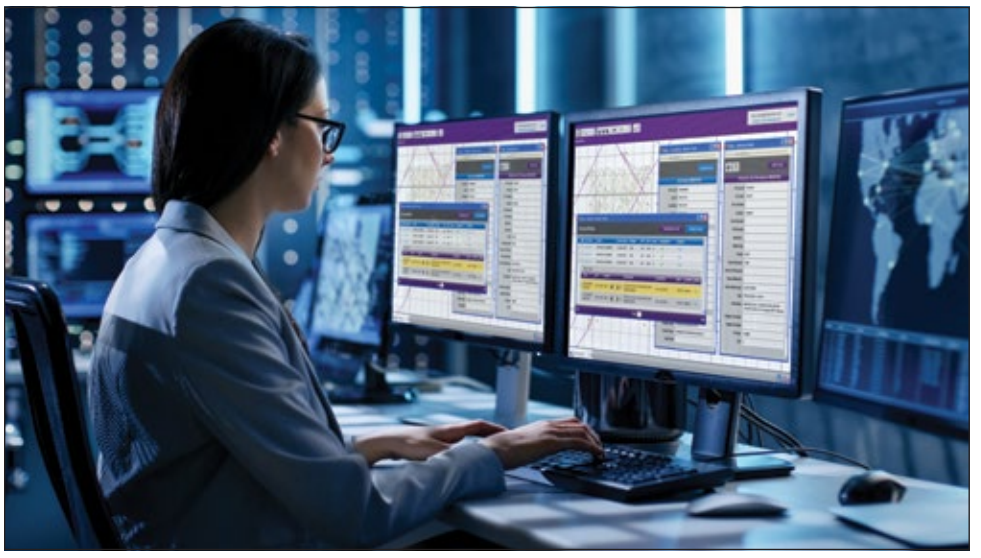
When decision-makers in companies think about disasters they normally take their cues from nature and consider hurricanes, tornadoes, floods, fires, etc. Sometimes they might consider an aircraft crashing into the facility and other extreme scenarios. To mitigate these potential risks, companies draw up business continuity plans and disaster recovery plans.

From a threat to data perspective, the foundation of recovering from one of these disasters has long been the offsite backup—a copy of the data stored at a physically separate and somewhat distant location that is judged unlikely to be subject to the same disaster at the same time.

The cloud allows companies to automatically have redundant storage, either within the same data center or at another data center in the same region at no additional cost. If a natural disaster were to strike the cloud data center being used, the data are safe and remain available from another location.

While adopting a regional redundancy strategy protects against data loss from natural disasters, it does nothing to protect data from the more common consequences caused by the pervasive presence of hackers and their targets.

To guard against this, cloud providers offer soft delete or versioning. These allow companies to recover from a known delete event but if they are not aware within the time period set, then the data becomes unrecoverable. Also, any object that has been soft deleted or archived incurs additional storage cost as it is effectively a copy.



A DR dataset should be physically and logically separated from the primary dataset to prevent interference. (Image courtesy of Katalyst Data Management)

For a more resilient approach, companies might choose an asynchronous geo-redundant copy stored in another part of the world. Again, the delete will eventually catch up and the company has the additional cost of the additional storage and the interregional transfer fees both to send the data out and then bringing it back as part of the recovery.

The most secure method then for isolating a disaster recovery (DR) dataset from interference is to keep that dataset disconnected from the network. Katalyst Data Management stores a companies' data in two separate locations: a primary dataset in an IBM Spectrum Protect TSM environment and an offline backup on tape.

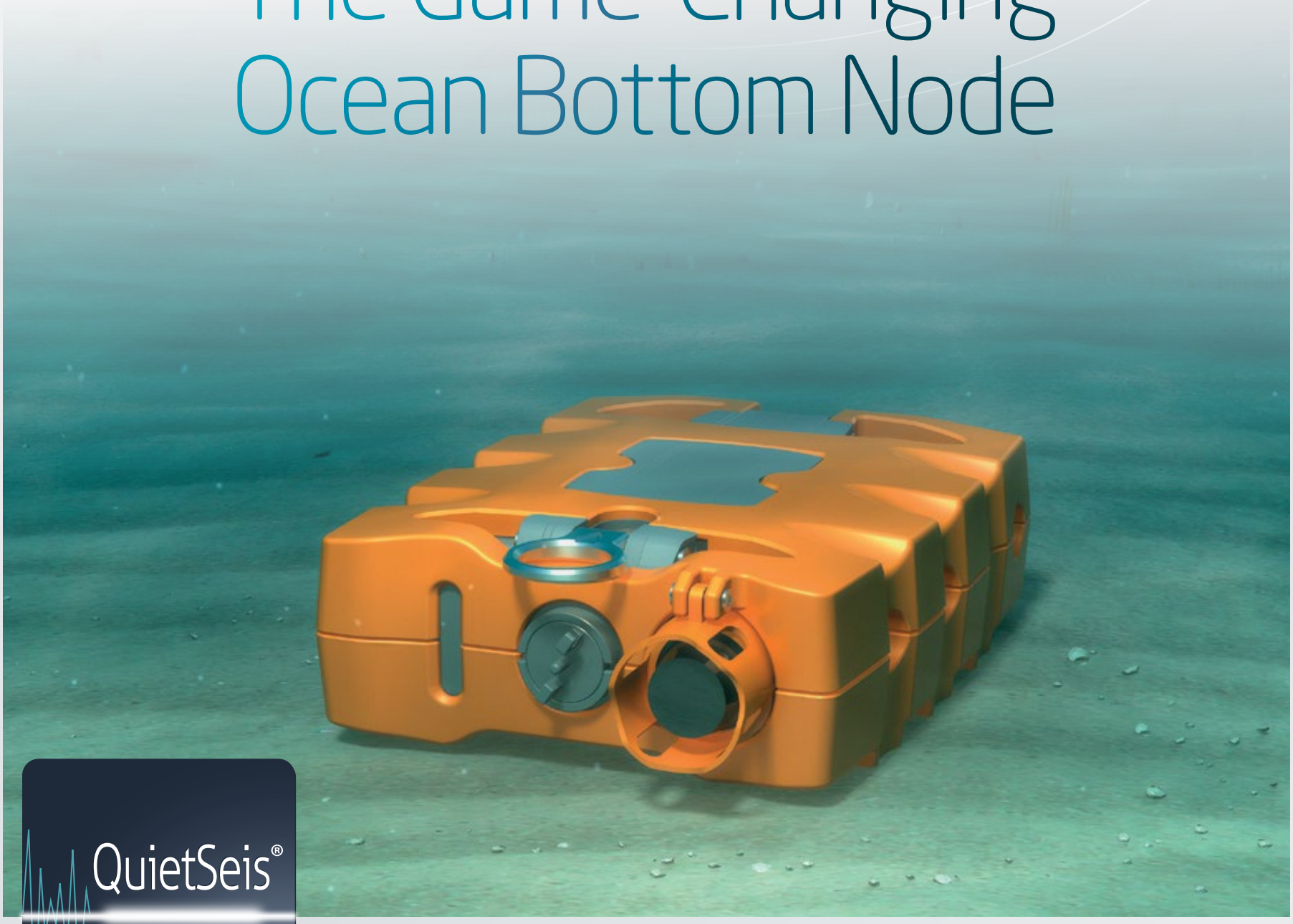
Katalyst also manages data in client-managed public cloud storage environments. For these environments, Katalyst recommends that an offline copy of the data be maintained at Katalyst. Even if a company has configured soft delete or versioning on its cloud data stores, many subsurface data files can sit in storage for years without being viewed. The background processes in the cloud will automatically repair them if they suffer bit rot in storage, but if they are mistakenly deleted or moved, they may be gone by the time someone revisits them.

See **RECOVERY** continued on page 11

NEW

GPR

The Game-Changing Ocean Bottom Node



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Shear-wave Vector Seismic and Application in the Qaidam Basin

Multicomponent seismic decreases uncertainty in Sanhu gas field pilot study.

CONTRIBUTED BY BGP

Multicomponent seismic is an exploration technology that involves the recording and analyzing of multiple modes of seismic waves, such as P- and S-waves as well as their converted modes. As hydrocarbon exploration moves into complex areas, there is an ever-increasing need for improving seismic accuracy and resolution, and reducing the non-uniqueness and uncertainties in seismic inversion. In such cases, multicomponent seismic may offer a complementary solution while conventional single component P-wave-only seismic becomes more and more insufficient.

Since 2000, BGP has made some advances in acquisition, processing and interpretation of PS converted seismic data; the company has also successfully carried out several multicomponent PS-wave seismic projects both at home and abroad, such as the Sichuan, Tarim and Ordos basins. Despite these successes, limitations in PS converted data were also evident as the frequency bandwidth and signal-to-noise ratio of the converted shear-wave data were often lower than their P-wave counterparts. Consequently, in recent years, BGP has focused intensive efforts in the R&D of shear-wave source vector seismic technology as a potential remedy to the shortcomings of PS converted-wave seismic.

In 2017, BGP made a breakthrough in shear-wave vector seismic, consisting of five key technological developments:

1) Based on previous successes, BGP upgraded the shear-wave vibrator from 16,000 lb in the 1980s to 30,000 lb (BV300S, Figure 1);
2) Implemented a small-interval, high-fold and wide-line high-density acquisition geometry; the nominal fold reached 2,000, compared with a nominal fold of a few tens (20 to 40) in the 1980s;
3) Established the technical standard for shear-wave data acquisition with digital seismic crews, accurate navigation, super spread design, shear-wave source polarity control and recording, and three-component Big Data real-time quality control;
4) Developed specific shear-wave processing procedures including shear-source polarity correction, shear-wave statics and shear-wave noise reduction;
5) Established specific P- and S-wave joint interpretation procedures including event registration and joint inversion.

At the same time, a pilot study in the Sanhu gas field of the Qaidam Basin in west China was conducted by BGP. The Sanhu Field is located in eastern Qaidam Basin, and full of shallow bio gas deposits with an unconsolidated sandstone setting. The surface is relatively flat with hard alkalinous soil sand. BGP acquired 497 miles (800 km) of 2-D 6C multicomponent data with both P- and S-wave sources. As shown in Figure 2a, the P-waves are attenuated by the presence of gas, and it is very difficult to interpret the geological structure and identify the fault system. However, as shown in Figure 2b, the internal structures, particularly the fault system within and beneath the gas clouds, are clearly imagined in the shear-wave section. Furthermore, the frequency contents and penetration depths of the shear-wave data are both comparable with the P-wave data; therefore, the resolution of the shear section is almost twice that of the P-wave section.

The Sanhu pilot study reveals great potential for the applications of shear-wave vector seismic exploration. For more details, visit BGP booth 2432. ■

FIGURE 1. BGP upgraded a high tonnage shear-wave vibrator (DV300S). (Images courtesy of BGP)

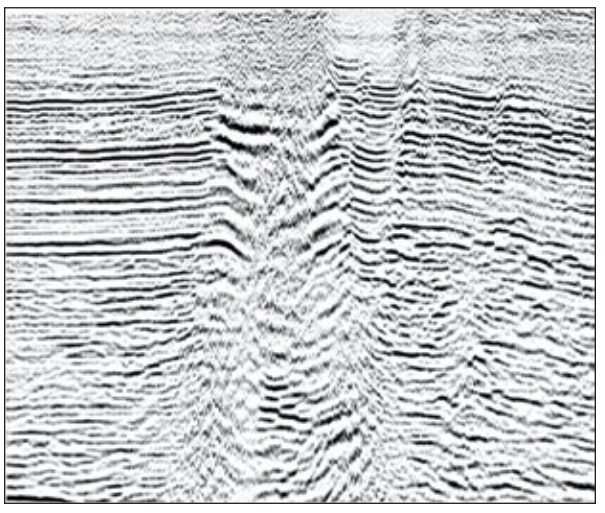


FIGURE 2a. P-wave seismic section from Sanhua shows P-waves are attenuated with gas.

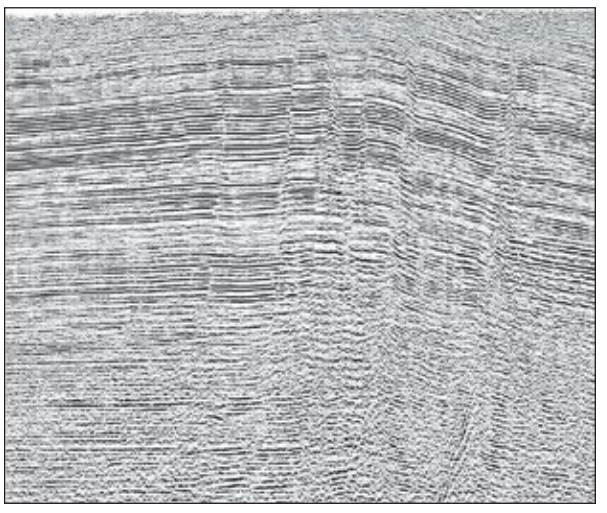


FIGURE 2b. S-wave seismic section from Sanhua shows internal structures more clearly.

Correction of Mis-ties in Seismic Datasets

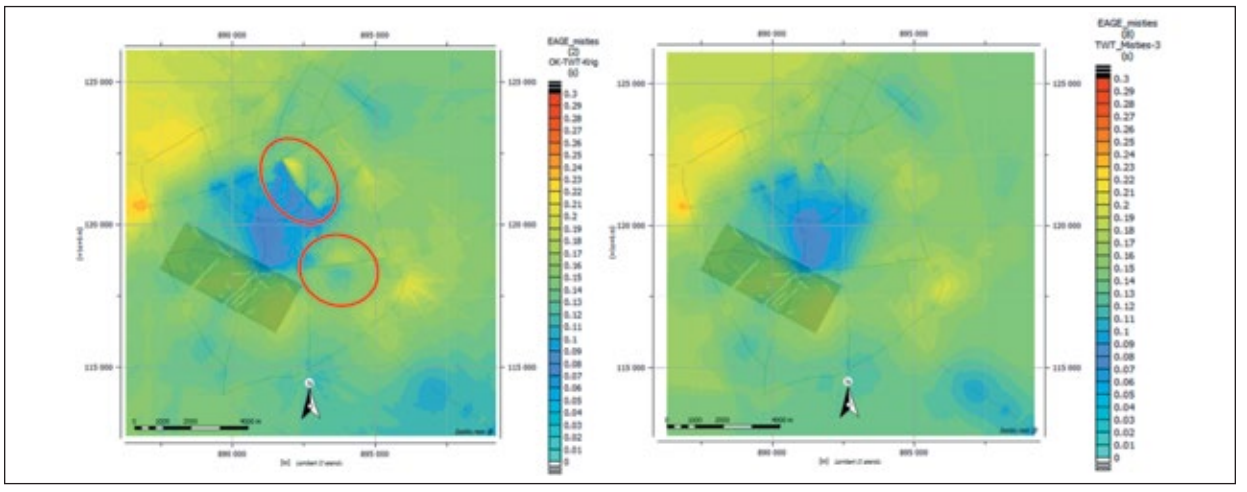
Method uses a geostatistical approach based on kriging with variance of measurement error to filter out random errors.

BY HÉLÈNE BINET, GEOVARIANCES

Geophysical surveys are often composed of several different datasets, typically with multiple crossover points, and generally contaminated by unknown and systematic error. Mis-ties are those intersections where two or more different measures are available at the same location.

Minimizing mis-ties is an old problem that has different solutions. Geovariances has developed a specific geostatistics-based method in which kriging with per-profile measurement error is used to address the issue and to get an estimation and its associated uncertainty simultaneously.

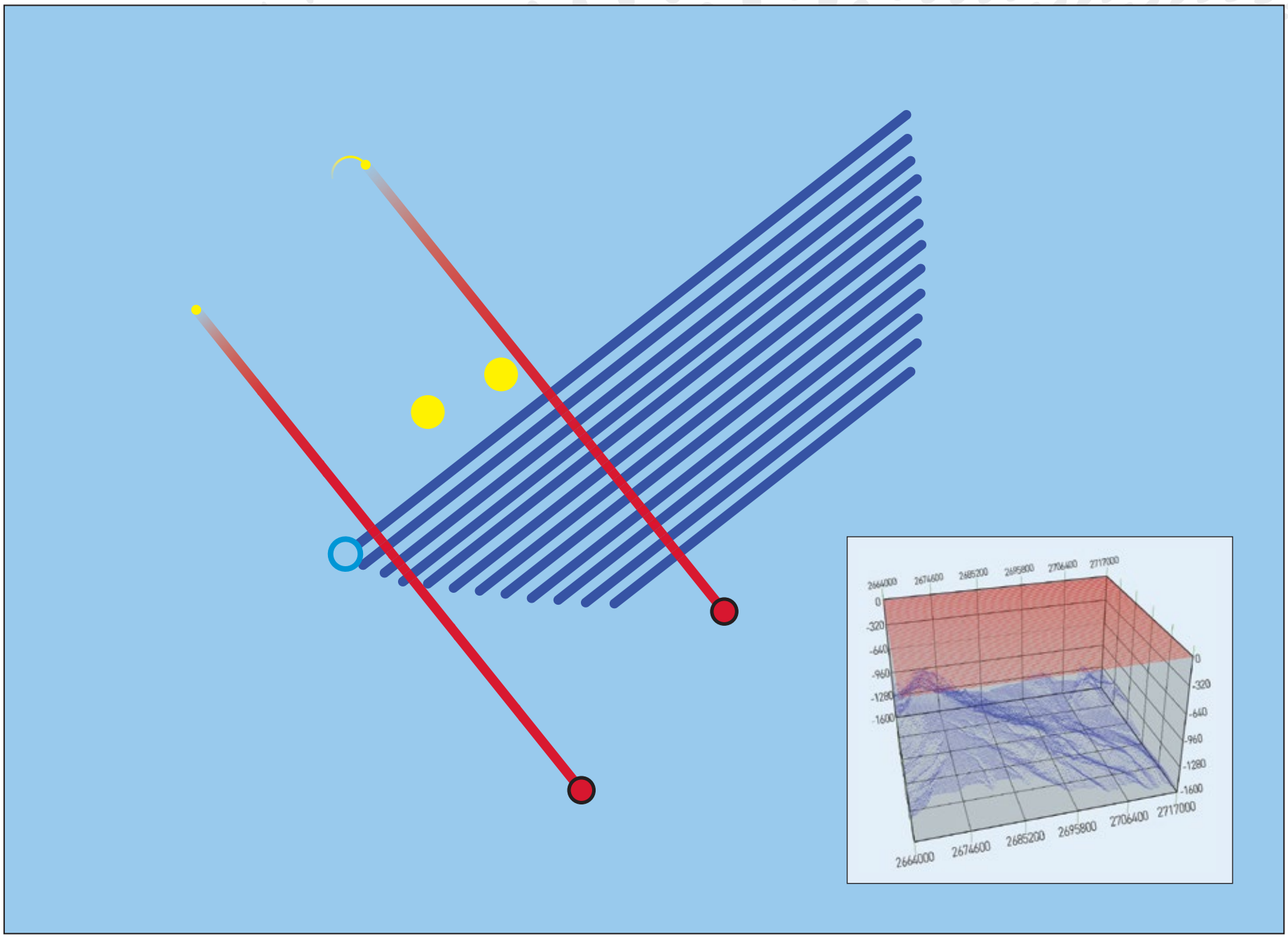
Usually, in kriging with measurement error, a variance of this error is assigned to each datapoint, which characterizes the uncertainty of the measurement at the point location. In Geovariances' approach, a specific model is defined, in which one measurement error is assigned per profile. All the points belonging to a profile are affected by the same uncertainty. It allows one to characterize the error between two samples differently according to whether these samples belong to the same line or not. This approach consists in generating a time map corresponding to a given horizon directly, instead of shifting one by one the different seismic sections. It is faster than the usual workflow, but it is designed and optimized for horizons mapping and time-to-depth conversion operations. The generated time maps are significantly enhanced and can be used as reliable drift maps in time-to-depth conversion operations.



On the left: Two-way time (TWT) mapping without handling mis-ties is seen on the top; the main problematic areas are circled in red. On the right: TWT mapping by kriging with a variance assigned to each profile is shown. It fixes mis-tie issues and preserves accuracy. (Image courtesy of Geovariances)

To learn more about the technique attend Geovariances' poster presentation on Wednesday, Sept. 18, at 11 a.m. Poster Station 3. For more information vist booth 1045. ■

Maximize Survey Efficiencies, Before the Project Begins



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Seismic, Existing Infrastructure Improve Exploration Economics Offshore

Talos, BP and Kosmos Energy are among the companies using seismic technology to help drive infrastructure-led exploration in the Gulf of Mexico.

BY VELDA ADDISON

When faced with the decision of whether to spend about $30 million to shoot new seismic across Block 7 offshore Mexico or a couple of million dollars to reprocess data provided by the government, Talos Energy CEO Tim Duncan chose the latter.

Comparing two seismic images—one of old data shot by state-owned Pemex and Talos' reprocessed data—Duncan pointed out an interesting flat spot typically indicative, he said, of a difference between oil and water on the older image.

"We also knew there was a well 40 miles away that was filled with wet sand. Our view was that if those sands were resident in those locations and it had hydrocarbons this should light up," he told attendees of the AIPN International Petroleum Summit. After reprocessing what the government provided and seeing a clearer image, a well was drilled. The result, as the industry knows it today, is Zama—a discovery believed to hold between 400 and 800 million barrels of oil equivalent (boe) in resources. If the appraisal program, expected to end by mid-year with a 2020 target for a financial investment decision, confirms the resource range, production could be between 150,000 and 175,000 boe/d.

"That's the type of business we want to engage in. What's the smartest dollar we can spend?" Duncan said.

Having plenty of seismic data, including reprocessed data, has proven beneficial for companies like Talos Energy. But independent E&Ps and majors alike are relying heavily on seismic, whether it's reprocessed or the latest advanced technology, to uncover hydrocarbon resources. Such technologies are also playing a crucial role in infrastructure-led exploration underway in the Gulf of Mexico (GoM).

"We can't go on an elephant hunt and expect that to be sustainable through the cycles of … a commodities-based business," Duncan said. "Our model is to have a lot of seismic, use that seismic and go do M&A," eyeing infrastructure and exploration opportunities around it.

Having that infrastructure helps uplift exploration economics, he added. Using reimaged seismic data, the company has been able to uncover opportunities others have passed.

Although U.S. shale is still holding the world's attention, Duncan said opportunities offshore may be more interesting now than the industry has ever seen it. He called the GoM "a whole minion of M&A opportunities," including stranded discoveries, mature assets and assets of private equity-backed companies looking to exit.

When Talos, which completed a reverse merger with Stone Energy last year, bought the Phoenix Field (formerly Typhoon) in 2013 it was flowing about 10,000 bbl/d. But production has since risen to about 40,000 bbl/d, thanks to reprocessing data, which led to new discoveries, redeveloping the asset and exploring to the south with new leases.

"If we can do this one out of three times in our transaction efforts, it's a homerun for us," Duncan said.

Talos, which is a Miocene and Pliocene geologic trend player in the GoM with some interest in the Norphlet play, is using the same reprocessing seismic strategy offshore Mexico.

But the independent is not alone in uncovering new barrels in the GoM.

Technology, specifically breakthroughs in advanced seismic imaging, is having a big impact for BP.

"We can now see below geologic salt layers better than ever before," said Starlee Sykes, BP's regional president of GoM and Canada.

In January, BP said seismic imaging uncovered 1 billion more barrels of oil in place near the Thunder Horse

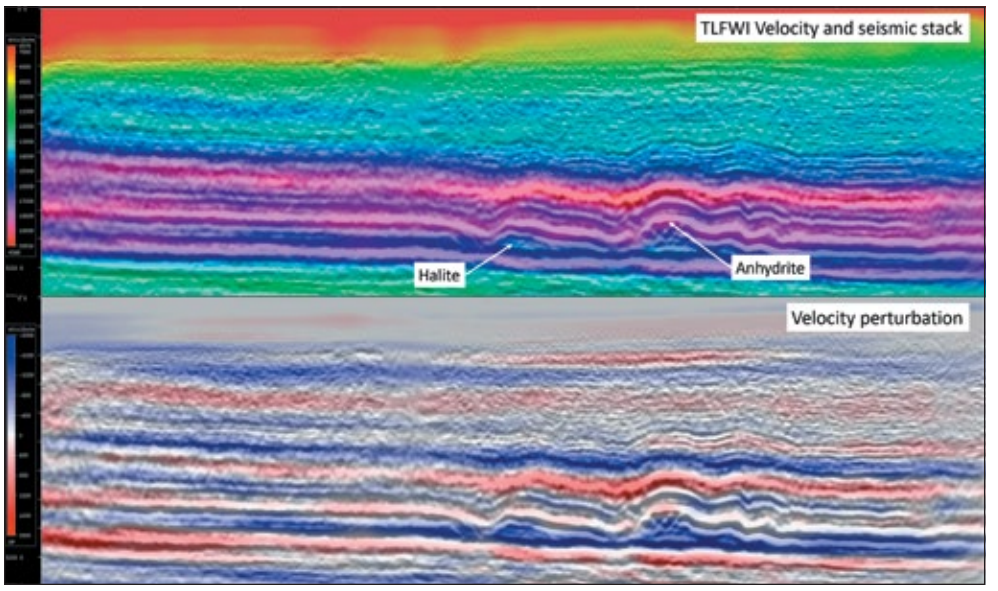
See **INFRASTRUCTURE** continued on page 11

Delaware Basin: Lifting the Cenozoic Veil

The latest seismic technology and multiclient products provide a new perspective on northwest Texas plays.

CONTRIBUTED BY CGG

Booming hydrocarbon production in the Permian Basin over the last few years allowed the U.S. to become once again one of the world's top exporters. However, persistent fluctuations in oil prices are challenging operators to reduce drilling and completion costs. State-of-the-art seismic is one tool that can help operators to de-risk well planning and meet production target. These days, the Paleozoic play in the Delaware Basin is getting the most attention, but it is a very challenging area to image seismically due to the presence of a near-surface evaporite formation. This Cenozoic fill was later partially dissolved by groundwater leaving a highly heterogeneous accumulation, which scatters seismic energy and obscures the reservoir intervals. CGG Multi-Client & New Ventures have been applying the latest seismic technology in the Delaware Basin to overcome this challenge and "lift the veil" on reservoirs in this region.



TLFWI results from CGG's Gini 3-D survey in the Delaware Basin. *Top panel:* 22 Hz TLFWI output velocity model. *Bottom panel:* Velocity perturbation showing how TLFWI has updated the initial smooth input model. Final migrated seismic is overlain on both sections for reference. (Image courtesy of CGG)

High-resolution FWI resolves near-surface heterogeneities

A very accurate near-surface model is key to ensuring a good starting point for depth model building and accurate imaging of the deeper layers. Full waveform inversion (FWI) is a powerful tool to achieve this objective, but has traditionally been very difficult to apply on land data due to inherent near-surface complexity and non-acoustic wave propagation. Nonetheless, previous trials in the area (Roy et al., 2017) showed that iterative refraction FWI used in conjunction with thorough pre-processing and anisotropic prestack depth migration can help better resolve late Permian salt structures, even when using legacy data with limited bandwidth.

CGG took this a step further by designing the Gini 3-D survey, which would provide a better dataset for FWI with higher density sampling and a broadband "low dwell" vibroseis sweep, ensuring good data quality down to 3 Hz. Survey design also included full-azimuth distribution and offsets long enough to record refracted energy down to the non-weathered zone (up to 23,000 ft or 7,010 m in this case). This project benefitted from the latest advances in salt FWI borrowed from offshore applications. CGG has pioneered the application of FWI technology and their proprietary time-lag FWI (TLFWI, Zhang et al, 2018) was able to provide higher quality velocity models in these challenging conditions than conventional FWI. Salt is made primarily of halite and anhydrite in this part of the basin and this high-resolution TLFWI (22 Hz) was able to clearly differentiate between the two, both in structure and elastic properties.

Autonomous vibroseis for efficient acquisition of high-density data

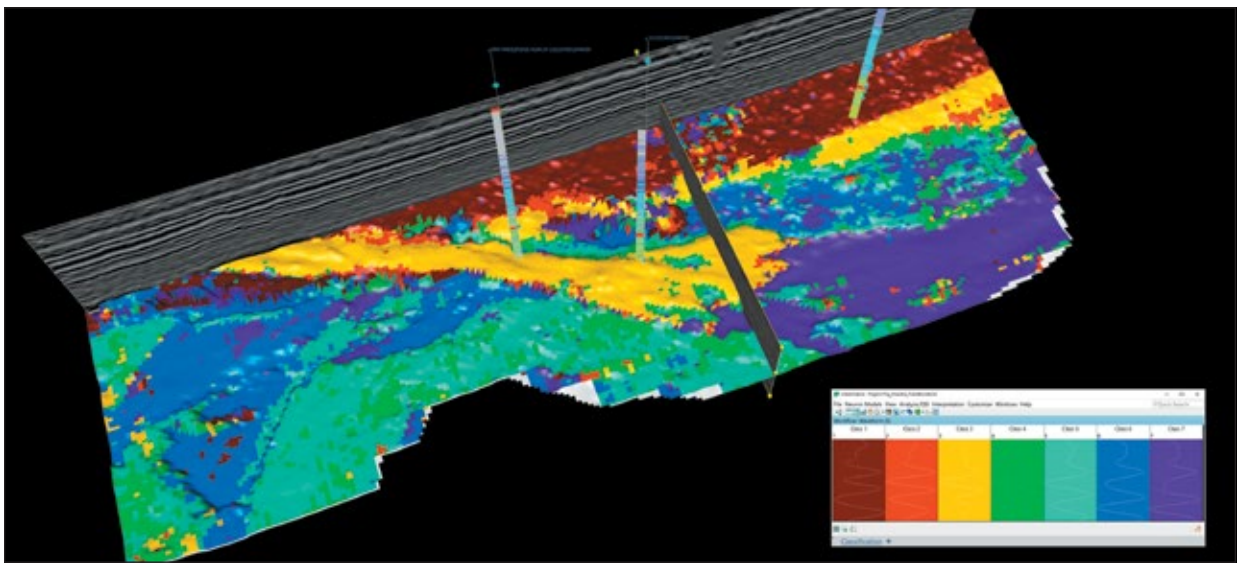
It is widely accepted that image quality for onshore seismic is strongly driven by trace density (e.g., Saleh et al, 2017). Drastically decreasing shot and receiver line spacing comes at a cost, but this can be partly offset by using more efficient acquisition practices, which increase the productivity of the crew. A high-density autonomous, blended vibroseis test was performed in the same area to explore the imaging benefits and economics of such type of surveys in the Delaware Basin (Leslie et al., 2019). Five times the trace density was achieved compared to the equivalent conventional slip sweep baseline survey without a significant increase in cost. Based on the preliminary processing results of the test, this opens the door to a new generation of onshore seismic, which will provide even better reservoir imaging in the tough conditions of the Permian Basin.

To learn more about Permian Basin multiclient data library and imaging solutions, see the presentation at 1 p.m. Wednesday at CGG booth 3347. Also, be sure to attend the post-convention Thursday workshop on the value of high-frequency FWI models. ■

Machine Learning Establishes a Strong Foothold in Exploration and Development Geophysics

Evolving artificial intelligence applications promise benefits to geophysicists.

BY LORENA GUERRA AND ROB BOND, EMERSON



This waveform classification for seismic facies analysis uses an advanced artificial intelligence process that excels at pattern recognition. (Image courtesy of Emerson)

Machine learning technology is creating significant excitement in the oil and gas industry, with its promise of delivering new functionalities and workflows that will, among other things

- Automate repetitive, tedious and labor-intensive tasks and workflows;
- Extract key information from large amounts of multifactorial data;
- Capture uncertainty;
- Classify and transform digital subsurface data to more diagnostic deliverables; and
- Reduce cycle time, project costs and time to decision.

Machine learning is an application of artificial intelligence in which applications learn specific rules or tasks by themselves, without being explicitly programmed. It is particularly useful when working with large datasets as it detects patterns, makes predictions and may even recommend outcomes that may not be intuitively obvious to human observers.

Artificial Neural Networks (ANNs) are the machine learning technology used most in the oil and gas industry. Inspired by biological neural networks, ANNs can process large amounts of data and extract patterns and information that the human brain cannot see.

Emerson has a 25-year history of adapting and commercializing neural network technology to aid geoscientists in many ways, delivering a broad range of benefits over many disciplinary domains, from automation (first break picking, pioneered in 1991) to classification (electro facies, seismic facies and multiple seismic attributes) and transformation (well log prediction, AVA, 4-D equalization and offset cross equalization).

More recent advances in machine learning have resulted in a new generation of "decision-supporting" solutions, including self-growing and multi-input, multi-output neural networks (rock type prediction and classification), which can train neural network algorithms on input as diverse as prestack data and lithology logs, and provide users with qualified "most probable" seismic classification volumes.

While machine learning is most often used for classification tasks, the rapidly evolving field of deep learning is increasingly being applied to image analysis and object recognition. Encouraging results are being observed in the application of neural networks trained by experienced interpreters for the purposes of horizon, fault and geobody picking.

Deep learning is also showing huge promise in locating target subsurface features using the wavefields recorded and available in prestack seismic data. However, the identification of wavefields associated with targeted subsurface features cannot be solved with deep learning methods alone. A sophisticated data preparation must be run to allow the image capture of wavefields prior to the generation and application of deep learning filters. This problem is solved by using a full-azimuth prestack depth imaging procedure carried out in the local angle domain (EarthStudy 360) where full-azimuth direction angle gathers are created. Each directional angle gather consists of thousands of traces (directions) illuminating each subsurface point from a rich spectrum of angles. Deep learning filters can be designed to recognize all types of subsurface features (e.g., salts, reefs, channels, faults, diffractions) including those associated with low energy that are often missed in traditional seismic processing and imaging workflows.

The promise for the not-so-distant future is that all of these existing, evolving and new technologies, when combined in a chain of processes, will result in consistent, rapid, repeatable automation of mechanical day-to-day activities, providing processing geophysicists, geologists, interpreters, modelers and engineers with more time to focus on the all-important knowledge-based quantitative analysis (and intuition) that lies behind the development of new plays, with quantified uncertainty as a key component.

With a rich history of pioneering the application of machine learning technologies and with proven commercialized technologies and advanced platforms, Emerson continues to lead the way in the development and adoption of innovative technologies, which are rapidly changing our industry and, indeed, the entire world.

Most of these machine learning applications are available in commercial solutions and are being presented in this year's program at Emerson booth 1433. ■

Unlock Data's Potential

Latest data solution improves data access for better subsurface insights.

CONTRIBUTED BY IKON SCIENCE

Continuous improvements are being developed for a knowledge management system to unlock the potential of all subsurface intelligence. (Image courtesy of Ikon Science)

Ikon Science will be showcasing the latest developments in iPoint at this year's SEG. The newest member of an expansive technology portfolio, iPoint is a state-of-the-art data aggregation and knowledge management system that is used by large and small forward-thinking oil and gas companies to aggregate, cultivate and share knowledge between subsurface teams, managers and other key staff within an organization. As the emphasis in the industry shifts from production to long-term profitability, many companies are looking to gain more subsurface insights from their data and in order to do so, they must have easy and confident access to that data; that is the primary purpose of the iPoint solution.

Since acquiring the product and team, Ikon Science has begun transforming the iPoint solution from the wellbore to the full subsurface. iPoint 2019.3, released on Monday, Sept. 16, features new support and handling of absolute time-based data, which will open up capabilities for drilling, production and other key parts of the oil and gas lifecycle. In addition, the iPoint framework has been updated to handle seismic as a new data type, which will allow the development teams to expand with SEG-Y reading capabilities very quickly.

Ikon Science is also introducing direct two-way connectivity to Petrel, allowing users to easily transfer wellbore data between Petrel and the iPoint management platform, in addition to the existent and similar in-built connector for RokDoc.

Further improvements include a redesigned user-interface providing an improved user experience, in addition to the ongoing upgrades to the back-end architecture that promote ever-increasing flexibility, scalability and custom configuration for bulk data handling.

Outside of the core Ikon Science offering for the oil and gas industry, one of the most significant development highlights is a result of collaboration with Seequent, which has enabled a decline curve analysis tool in the iPoint package in addition to connectivity to and from Seequent's flagship product Leapfrog Geothermal. This allows data to be aggregated and easily accessed by geothermal scientists for critical workflows using Seequent's technology enabling digital transformation in other key industries focused on the subsurface.

To hear more more about iPoint visit Ikon Science booth 2829 to see a scheduled talk or arrange a personal demo. ■

INFRASTRUCTURE
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Field and an additional 400 million barrels at the Atlantis Field in the U.S. GoM. The full-waveform inversion (FWI) technology, combined with supercomputing power and a proprietary algorithm, led to the discovery of the additional resources.

At the Mad Dog Field, Sykes said BP deployed its proprietary low-frequency seismic Wolfspar to help the company see additional potential.

Deepwater GoM remains competitive for investment dollars, she added.

"When we drilled the first exploration well at Thunder Horse, oil price was in the range of $8 to $10 per barrel," Sykes said. "If we could make it work then, imagine what we can do now."

Using technology, planning ways to get the most out of existing assets and discoveries, and infrastructure-led exploration are part of BP's exploration strategy, Sykes told media after her presentation. When oil price dropped, it was all about returns, she recalled.

"For us we had a lot of opportunity around our hubs that was really good. To go out and find new stuff wasn't necessary," Sykes said. "Quite frankly the best thing for us to spend money on was filling our hubs. We now have a strategy in place around all four of our hubs to fill them."

BP's four hubs in the U.S. GoM are Thunder Horse, Atlantis, Mad Dog and Na Kika.

But the company still has core exploration opportunities on its radar as it remains active in lease sales, adding to a portfolio of drilling options.

Infrastructure-led exploration is also part of Talos' strategy. Duncan used an asset acquired from Exxon Mobil Corp. in the 1980s as an example.

"After we closed that transaction 10 miles to the east we picked up a stranded prospect that didn't look like it would get drilled by its operator," he said. "We picked up a stranded discovery about 25 miles away and we picked about three or four leases in a lease sale averaging about $100 an acres. Suddenly I have a whole portfolio of ideas to fill up that 30,000 bbl/d facility where all that fixed cost is paid for by that transaction."

It's a formula the company hopes to replicate when feasible. "If we just go hunting for these prospects without access to this infrastructure it changes the dynamics," he said.

It's something to which frontier explorer Kosmos Energy can relate. The company entered the GoM in August 2018 with its $1.225 billion acquisition of Deep Gulf Energy.

"We're now going in and looking for the smaller opportunities that either were too small initially to drill for, too risky or folks didn't even see them," said John Shinol, vice president of geoscience for Kosmos Energy. Nearby infrastructure makes for attractive returns and short timelines from discovery to first oil. "In the Gulf of Mexico, our business has been doing this on average in less than 18 months."

Enhanced seismic data is among the main drivers. Shinol described the GoM as a testing ground for the offshore industry. Technologies such as wide-azimuth surveys, nodal surveys, FWIs and depth imaging were carried out in the basin over the last decade or so, he said. "Not only has it helped to find the big deep fields, but it is also something that can help us find smaller fields near infrastructure. We're leveraging that data and utilizing that to help us find new discoveries." ■

Ocean-bottom Seismic

New partnership makes exploration OBS a reality.

CONTRIBUTED BY iSEISMIC AS

Capitalizing on the recent growth in demand for higher quality 3-D images to aid improved oil recovery and better images in geologically complex areas, ION Geophysical Corp. and iSEISMIC AS plan to accelerate the transition from tradition towed streamer marine seismic to the advanced technique of using ocean-bottom nodes (OBN).

To do this iSEISMIC will utilize the full suite of ION's next generation 4Sea ocean-bottom acquisition and imaging technology to deliver a step-change in the safety, efficiency, quality and turnaround time of seabed surveys.

At the heart of the system is the OBN handling system. The fully automated system takes nodes from the onboard storage unit, attaches them at any specified interval to a passive deployment cable and accurately deploys them on to the ocean floor from the moving handling vessel.

This deployment method, widely known as "node-on-a-rope," is not new in itself but the deployment speed achievable with the ION system is. Another key factor in the complete systems efficiency and quality deliverables is the integrated cutting-edge software that orchestrates the entire operation from initial acquisition simulations, through SIMPOS, deployment management, positioning, source control and QA/QC. ■

RECOVERY
(continued from page 4)

Without a DR backup strategy that physically or logically separates a backup from the primary data, a company's only recourse in this event is to reacquire the data that has been lost. The challenge is in identifying what has been lost, which requires an accurate inventory.

When using a data asset management system, such as Katalyst's PPDM-certified iGlass solution, companies have peace of mind that they have an accurate inventory of their data assets that is physically and logically separate from their cloud data store.

To learn more about iGlass and how to implement a disaster recovery strategy for subsurface data, visit Katalyst Data Management at booth 1838. ■

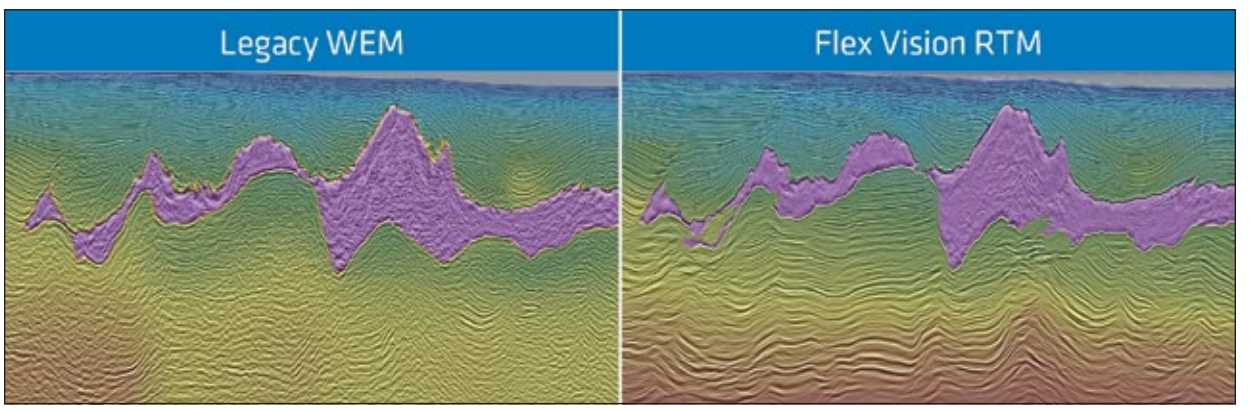
Rejuvenated Seismic Data Available to Boost Exploration in the Flex Trend

Dataset improves knowledge in GoM subsalt.

CONTRIBUTED BY PGS

Newly reprocessed 3-D streamer and OBC data covering 1,158 sq miles (3,000 sq km) have been added to PGS' Flex Vision dataset in the Gulf of Mexico (GoM), now covering 2,703 sq miles (7,000 sq km). Industry interest in these high-resolution depth images has stimulated processing of a further 3,861 sq miles (10,000 sq km) across the Flex Trend. South Timbalier, Ship Shoal, Grand Isle, Ewing Bank and the northern part of Green Canyon are now reprocessed, providing clearer images of existing fields and proven undeveloped reserves.

Flex Vision provides tailored images using Kirchhoff for shallower targets, delivering broad frequency content and reliable amplitudes, and reverse time migration (RTM) for regional understanding and to unlock deeper plays. Due to oilfield infrastructure, new seismic acquisition in the area is difficult and expensive, so rejuvenation of legacy seismic data is a cost-effective solution. To exploit near-field suprasalt reserves, high-resolution seismic images are needed to accurately position existing and new plays. Prolonging the life of subsalt fields, such as Mahogany and Hickory, is only possible by improving models and discovering deeper prospects from superior seismic images, such as those offered by Flex Vision.



A comparison of legacy WEM with Flex Vision RTM illustrates how Flex Vision allows mapping of Paleogene and older systems down to 40,000 ft. (Image courtesy of PGS)

Salt model building for better understanding of salt geometry

The data, re-mastered from field tape with full source and receiver deghosting applied, create a broadband dataset. PGS' unique dual convolutional and wavefield-modeled surface related demultiple flow uses Separated Wavefield Imaging (SWIM) to both attenuate the complex multiples associated with the Flex Trend and accurately image the shallow-water bottom.

A full-waveform inversion (FWI) approach was used to build the sediment velocity model. The salt velocity model was built using innovative salt modeling concepts based on a geological understanding of the salt tectonics associated with the extensional-compressional regime characterized by the Roho basins. Based on this concept, salt scenario testing used a lean salt approach, which dramatically improves the subsalt imaging. Following tomography, the subsalt sediment velocities were calibrated using well information. Roho basins kinematically balance updip extension and downdip compression along low angle detachments. Individual Roho systems may have different kinematic directions while interfering with neighboring basins and result in complex salt geometries along their fringes. The complexity of salt bodies results from multiple deformation events between salt flow and extensional/compressional movement in the basins. This interpretation revises the role of salt keels replacing massive salt feeders with welded salt delivery systems.

The complex salt geometry was competently handled using an accurate velocity model and RTM to reveal structures in the subsalt. Mode converted waves interfere with the imaged subsalt producing sands and were attenuated by modeling and migrating the mode conversions and adaptively subtracting them from the image. A structural version of the RTM is available for mapping and understanding the deep structures.

One contiguous flex trend dataset

Flex Vision delivers a comprehensive and geologically conformable dataset in complex salt architecture. The accurate velocity model was used in the migration to produce broadband Kirchhoff prestack depth domain images and a 35 Hz RTM volume. The Kirchhoff data provide a high-resolution shallow section revealing subtle shallow stratigraphic and structural traps as well as shallow gas hazards. The imaging is amplitude versus offset compliant with available angle stacks and migrated gathers for reservoir characterization. The 35 Hz RTM volume images the Miocene play fairways and potential in the Lower Tertiary. The structural RTM is ideal for mapping sediments terminating against salt walls and determining the structure of the section below 39,370 ft (12,000 m), giving regional context and a broad understanding of the structural and depositional framework. Depositional systems transit this 3-D volume from north to south, into the prolific hydrocarbon province of the deepwater GoM. Flex Vision will cover 11,583 sq miles (30,000 sq km) and will therefore be instrumental in improving understanding of these systems, giving explorers an edge over their competitors. ■

INDUSTRY NEWS
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GeoTomo Announces Partnerships

GeoTomo LLC, a provider of advanced land near-surface and subsurface seismic processing and imaging software products and services, and Z-Terra, a provider of interactive depth imaging and velocity model building software products and services, have announced the availability of an integration between seismic data processing software products and services to advance land time and depth processing workflows.

The direct connection between GeoTomo's GeoThrust and TomoPlus software and Z-Terra's full depth imaging system, which includes RTM, WEM, Gaussian and fast beam migration and beam tomography along with conventional Kirchhoff and ray-based tomography, allows companies to quickly optimize and apply advanced anisotropic processing workflows. The workflow begins with raw field data continuing through final images and deliverables. The complete interactive processing workflow consists of geometry building and QC, travel time tomography, signal enhancement and anisotropic prestack time migration to near-surface, subsurface velocity model building and updating and prestack anisotropic depth migration.

In addition, GeoTomo and HSB Geophysical, a provider of comprehensive well log modeling software tools and services, have announced the availability of seismic data processing software products and services to easily leverage knowledge garnered from well logs into time processing and interpretation workflows.

The direct connection between GeoTomo GeoThrust and TomoPlus software and HSB geophysical toolkits greatly enhances the processing and interpretation workflow of the GeoTomo user. TIPS is a software tool used throughout the industry that delivers an interactive integration of seismic and well log data for comprehensive AVO analysis and for performing seismic well ties. The comprehensive integration of these tools with TIPS, enables companies to verify their time processing workflows with well logs to ensure the images are compatible with the geologic response.

INOVA Geophysical Announces Deals

INOVA Geophysical Equipment Ltd. has announced the sale of 5,000 channels of G3i HD, INOVA's cable-based land recording system to India based, Mahaabala Geo Pvt Ltd. The deal also includes six of the new INOVA ShotPro HD for use alongside the G3i HD acquisition system. The system will be used for providing 3-D seismic data acquisition services to the logistically difficult terrain in the state of Tripura, India. INOVA's G3i HD cable acquisition system is designed to maximize return on investment by reducing equipment related downtime and minimizing the impact of harsh environmental and operational conditions. It supports high channel count, advanced vibroseis acquisition for all 2-D, 3-D or time-lapse 4-D seismic programs.

INOVA Geophysical also has announced the strengthening of its partnership with Mitcham Industries by agreeing to deliver 20,000 Quantum nodes during the current fiscal year. This large purchase is initially slated to be part of a vast nodal based seismic acquisition project to be undertaken in Europe and will become available to Mitcham's rental clientele immediately following.

SAExploration Completes Milestone Project

SAExploration Holdings Inc. has announced it has successfully completed the largest shallow- water ocean-bottom marine project in the company's history. Contracted to SAExploration by a major national oil company, the project, located in the Arabian Sea off the coast of India, utilized more than 20 vessels. These included three ocean-bottom node (OBN) deployment vessels and two seismic source vessels operating in dual source/simultaneous source mode. A total of 5,400 ocean-bottom nodes and in excess of 1,300 km of rope were deployed on the project to acquire approximately 1,200 sq km of full fold seismic data.

Fugro Succeeds with New Seep Survey License Sales Offshore Newfoundland

Fugro and partner Amplified Geochemical Imaging (AGI), are reporting recent success selling multiple licenses for data from frontier regions offshore east coast Canada. The data were acquired during two separate hydrocarbon seep surveys in the Orphan Basin (2017) and Carson Basin (2018), both situated on the continental margin of Newfoundland.

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LEADERS
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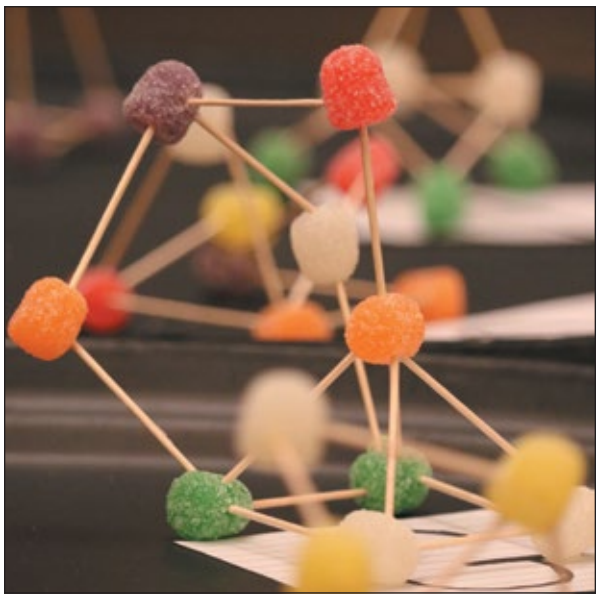
"We're simulating the whole process, from exploration to production," Robinson said. "Once securing their block, the students get more data, like 2-D seismic data and a denser grid. They're able to start making maps of what the structure looks like."

The process continues with the students picking the location of their first well, with each subsequent step securing more data to better determine next steps.



The SEG/Chevron Student Leadership Symposium included a gumdrop structure-building exercise to sharpen teamwork and communication skills. (Photo by Jennifer Presley)

"For example, we'll give the well data so they can tie that into the seismic and begin to look at how that might influence where they want to drill follow-up wells," she said. "The program gives the students a good taste of what it would be like to be a professional geoscientist. One of the really nice things about the program is that it is exercise heavy. They're working in groups of five, so it is emphasizing how important teamwork and communication is to the process."

In its 12th year, this year's SLS was a 2-day program focused on leadership, teamwork and communication skills-building for 50 student leaders who are all active officers of their SEG student chapters. The program focuses on developing leadership skills, the presentation of best practices from selected student chapters, professional leadership coaching, team-building exercises, and a strategic problem solving session with the SEG Executive Committee.

"Our goal is to develop the next generation of leaders within geophysics from around the world," said David Bartel, symposium leader and geophysicists for Chevron. "In doing so, we gain diversity of thought and in experiences. It is important to understand how to be a leader. So we bring these leaders in their student chapters here to the SLS to learn more about being a leader and the importance of communicating as a leader."

Those skills are reinforced through projects like the gumdrop structure exercise.

"It is a communication activity where the students are trying to build gumdrop structures where only one person can see it, and only one person can build it without having any feedback," Bartel said. "And so it is sort of like the old telephone game in that you see how the instructions get down the line to the builder. One of the teams came up and said, 'we actually gave them the same instruction twice in a row. So we tried to make sure the message was delivered right.' It was interesting to hear that, and it was something I don't recall any other team doing in the past because we've done this particular one for three or four years now."

The SLS also provides participants to share and discuss the business culture in their countries, Bartel noted.

"It is important to understand how to communicate properly when in a different country," he said. "For example, knowing what certain hand gestures or words mean or how to greet people and what the business etiquette is very important when working in a multinational, international arena to ensure that you are doing things the right way."

SEP and SLS participants are selected by the SEG through a competitive application process. Travel grants are provided to cover the cost of transportation, lodging and registration. ■

INDUSTRY NEWS
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The comprehensive data packages are being licensed by Fugro and include multibeam echo sounder data (bathymetry, backscatter intensity and water column); sub-bottom profiler data, heat flow measurements and shipboard geochemical screening analyses; advanced geochemical analyses, including biomarkers on select samples, are also included.

The Orphan Basin package covers an area of 11,070 sq km and the Carson Basin package covers an area of 18,880 sq km. Each survey was followed by heat flow and geochemical sampling and analysis. Both programs were planned so that purchasing clients would have the data in advance of the upcoming lease rounds, so data could be used in derisking their potential investment. Purchase post lease round is also advantageous from numerous perspectives including guiding–and potentially reducing the scope of–expensive 3-D seismic surveys. Geochemical datasets (shipboard, conventional shore-based and AGI adsorbent-based analyses) all suggest the presence of thermogenic hydrocarbons.

"With the keen interest in these licenses to international E&P companies, and recent record-breaking bids in the Orphan Basin, it is clear to us there is much excitement surrounding Canada's growing offshore industry and Newfoundland and Labrador's licensing rounds," said Keith Kneale, Fugro's business development director for the Americas.

These data will continue to be useful throughout the life of the field. A variety of further investigations, such as establishing environmental baselines, evaluating seafloor geohazards and preliminary planning for field development, ensures the data will deliver long-term value to any client purchasing a license. Nalcor Energy Oil and Gas was a partner in these work programs. ■

Emerging Tech: Seismic in the Cloud

Technology targets geologists' frustration with seismic, subsurface workflows.

BY MARY HOLCOMB

Seismic portfolios in the industry are taking a new direction—up, to be specific—with Osokey Stream. The cloud-native data management solution leverages storage from the public cloud.

Osokey Ltd.'s seismic in the cloud technology was cultivated as a means to resolve geologists' frustration with seismic and subsurface workflows, according to the company's head of operations Joseph Nicholson. Osokey aimed to break down siloed seismic data to ultimately manage its abundance more effectively.

"The goal really is to enhance the existing subsurface workflows to get people connected to data faster so they can analyze more data, which improves business decisions and frees them up to do more analysis rather than boring tasks," Nicholson said. "Also, to automate a lot of the workflow with machine learning to enable geoscientists and subsurface data managers to focus on value-added workflows rather than workflows that tie up resources unnecessarily."

Working in collaboration with Chevron Corp. and the Oil & Gas Technology Centre (OGTC), the live project traffics Chevron's 2-D and 3-D and pre-stack seismic—currently from the North Sea—into a "highly scalable" repository to be utilized globally on cloud hosted workstations. The project is expected to finish summer 2019, Nicholson said.

Osokey's "serverless" approach eliminates traditional storage routes for seismic data and has been able to improve access to prestack data.

"Historically, seismic data is very big in terms of its volume and the memory it requires, so it is siloed. Often a lot of the data is archived on magnetic tapes so it's no longer online," he said. "By utilizing public clouds you enable far greater levels of data accessibility, and in the same way we use Netflix or Google Docs, we can start accessing data from anywhere through a web browser whereas traditionally we would need siloed applications."

Further challenging traditional methods, Nicholson said seismic in the cloud advances and expedites seismic data discovery. The serverless architecture offers pay-as-you-use cloud and storage costs as opposed to the standard "lift and shift" of data to workstations, where a company would pay for what they were not using.

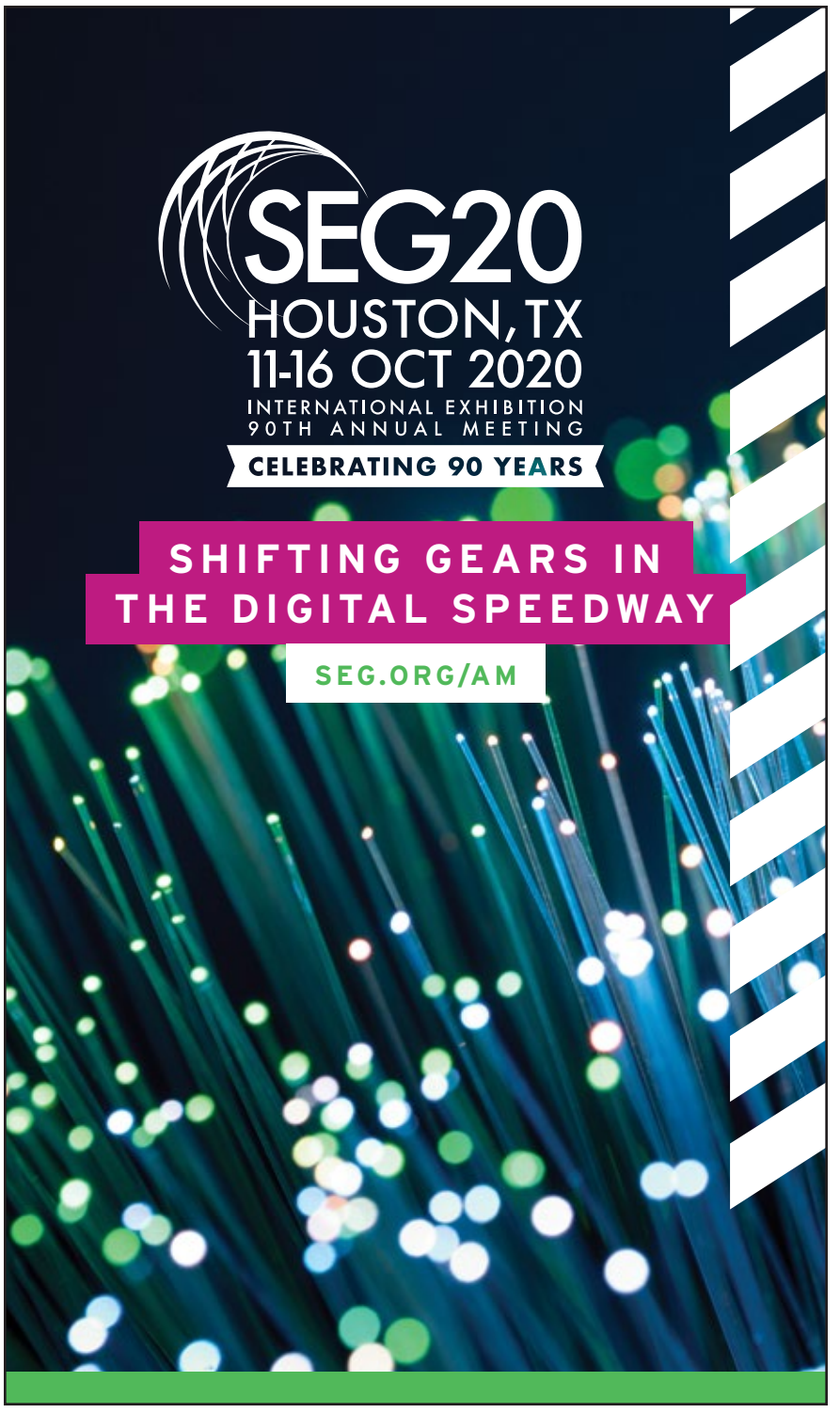
Taking into consideration common security concerns surrounding the cloud, Nicholson said his company's approach to the technology is safe.

"One of the pieces that we are very keen on is that companies can actually store their data in their own cloud account and provision their own data security services and that enables companies to really take control of their data," he said. "The data is encrypted at rest and in transit, and we're using a lot of the same technology that government agencies use.

"It is an important conversation to have, but it is resolved quite quickly," he added.

Drawing benefits from its collaboration with Chevron and OGTC, Nicholson said the project has been a fantastic opportunity to test the technology in other venues. ■

SEG attendees have enjoyed the attractions of San Antonio during the 2019 International Exposition and 89th Annual Meeting. (Photo by Jennifer Presley)



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Stolt has been and remains the main engine of direct seismic migration and inversion methods and a leader in synthesizing two previously unconnected activities into one framework with migration-inversion.

Mauricio D. Sacchi was awarded the Virgil Kauffman Gold Medal, which honors outstanding scientific contributions in the previous five years, for his efforts regarding seismic analysis and imaging, with an emphasis on sparsity. Sacchi's work has had direct application and commercialization for the oil and gas industry. He has served SEG in a number of ways, including as editor-in-chief of Geophysics and as Honorary Lecturer.

Another community veteran, Rock Solid Images (RSI) won the Distinguished Achievement Award for its role as a creative technological innovator over its roughly 20-year existence. Cited by the HAC for its well-respected products and for the ability of its leaders and founders, Richard Cooper and Lucy Macgregor, to deliver science rather than opinion, RSI delivered a unique product at the heart of exploration and production: quantitative rock properties.

Blair Benson Schneider has been honored with the Special Commendation, granted for meritorious services to the public, the scientific community, or to the profession. Though still at a very early stage in her career, Schneider has already served as president of the Association for Women Geoscientists. It was noted in Schneider's award citation that the work she is doing will make applied geophysics better for young women, as well as members of under-represented groups, who will add to the science and society.

Clarified guidelines

Despite the remarkable achievements recognized at the ceremony, Steeples noted that the most difficult part of this year's selection process was "the unevenness in quality of the nominee pool for different awards."

This unevenness is reflected in the fact that some awards, such as the Honorary Membership, which has been granted to at least one individual every year since 1964, were not bestowed at all. Steeples sees a reason for this: "The Honors and Awards Committee has become more discerning," he noted. "Over the years, the awards committee has evolved. … The nomination process wasn't always as thorough or well defined."

The 2018-2019 Honors and Awards Committee has clarified the nomination guidelines for honors and awards. According to the SEG website, "The guidelines are not necessarily rigid nor all-inclusive, but the committee hopes they will be helpful to those wanting to nominate deserving SEG members for awards." The complete guidelines can be found at *seg.org/About-SEG/Honors-and-Awards/Honors-and-Awards-Guidelines*.

With clarity, more opportunities

The committee's clarified standards are anticipated to help SEG adapt to changing times. SEG now represents over 100 countries and more than 10,000 members; this growth brings the potential for more people to make connections and grow in recognition through service. As Steeples said, "I think now there are more opportunities for people to interact with people with similar interests, and those groups of similar interests have become very intimate."

Mike Graul, who was awarded Life Membership, has helped smooth this global transition. His efforts have set the precedent for SEG communication and representation practices worldwide, providing dialogue with subject matter experts and education that would be inaccessible any other way in many parts of the world.

These efforts have clearly paid off, as shown by the widely varied research interests of the three young scientists, Yangkang Chen, Xinding Fang and Hejun Zhu, who received the J. Clarence Karcher Award, a recognition of significant contributions to the science and technology of exploration geophysics by individuals younger than 35.

The fact that educators such as Laura Valentina Socco, recipient of the Outstanding Educator Award, continue to serve students across the globe means that more and more bold scientists will rise to recognition. A professor at the Politecnico di Torino, Socco bases her instructional style on discovery and thought, the very things on which the SEG community thrives.

Getting started

Still, some may ask: "How can I get started?" Steeples has an answer: "Get a hold of an editor and say, 'I'd like to be a reviewer.' It all starts there. I remember when I started as a volunteer to review a little thing called *Careers in Geophysics*. Then I spent five years as associate editor … eventually was chairman of the Publications Committee … and gave lectures all across the world."

More community-driven success stories will come. Luis Alonso Gallardo and Max A. Meju, the joint-recipients of the Reginald Fessenden Award, share one of their own. They received the award, given to those who make a specific technical contribution (e.g., an invention or theoretical advancement) to exploration geophysics, for their development of the current method of cross-gradient joint inversion. The method has had substantial impact on geophysical structure, electromagnetics, near-surface analysis, engineering and hydrogeology applications, and the field of medicine. Gallardo and Meju's accomplishment has created fresh opportunities across the geophysical community. In fact, there are now SEG workshops dedicated to the method with the goal of building new relationships and new ideas.

Other awards and recognitions include:

• Best Paper in Geophysics
2018 "First application of the marine differential electric dipole for groundwater investigations: A case study from Bat Yam, Israel," Amir Haroon, Klaus Lippert, Vladimir Mogilatov, and Bülent Tezkan

• Honorable Mentions, Geophysics
2018 "Time reversal for wave refocusing and scatterer detection using machine learning," Matan Shustak and Evgeny Landa

2018 "Three-term amplitude-variation-with-offset projections," Vaughn Ball, Luis Tenorio, Christian Schiøtt, Michelle Thomas, and J. P. Blangy

2018 "Near-surface velocity estimation using source-domain full traveltime inversion and early arrival waveform inversion," Lu Liu, Yan Wu, Bowen Guo, Song Han and Yi Luo

2018 "High-resolution gravity measurement aboard an autonomous underwater vehicle," Takemi Ishihara, Masanao Shinohara, Hiromi Fujimoto, Toshihiko Kanazawa, Akito Araya, Tomoaki Yamada, Kokichi Iizasa, Satoshi Tsukioka, Shinobu Omika, Takeshi Yoshiume, Masashi Mochizuki and Kenji Uehira

• Best Paper in *The Leading Edge*
2018 "State of stress in the Permian Basin, Texas and New Mexico: Implications for induced seismicity," Jens-Erik Lund Snee and Mark D. Zoback

• Honorable Mention, *The Leading Edge*
2018 "Time-lapse seismic monitoring of individual hydraulic frac stages using a downhole DAS array," Grant Byerley, Dave Monk, Peter Aaron, and Mike Yates

• Best Paper in *Interpretation*
2018 "Pore characteristics and dominant controlling factors of overmature shales: A case study of the Wangyinpu and Guanyintang Formations in the Jiangxi Xiuwu Basin," Fenglin Gao, Yan Song, Zhuo Li, Zhenxue Jiang, Zhiye Gao, Xinxin Zhang, Lei Chen and Qingxin Liu

• Best Paper Presented at Annual Meeting
2018 "Frac-hits mapped by tube waves: A diagnostic tool to complement microseismic monitoring," Zhao Zheng, Henry C. Bland, and Sean R. Machovoe

• Honorable Mention, Best Paper Annual Meeting
2018 "Least-squares seismic horizons with local slopes and multigrid correlations," Xinming Wu and Sergey Fomel

• Best Poster Paper Presented at Annual Meeting
2018 "Magnetoseismic resistivity mapping: Fundamentals and challenges," Qiuzi Li, Harry W. Deckman, and Deniz Ertaş

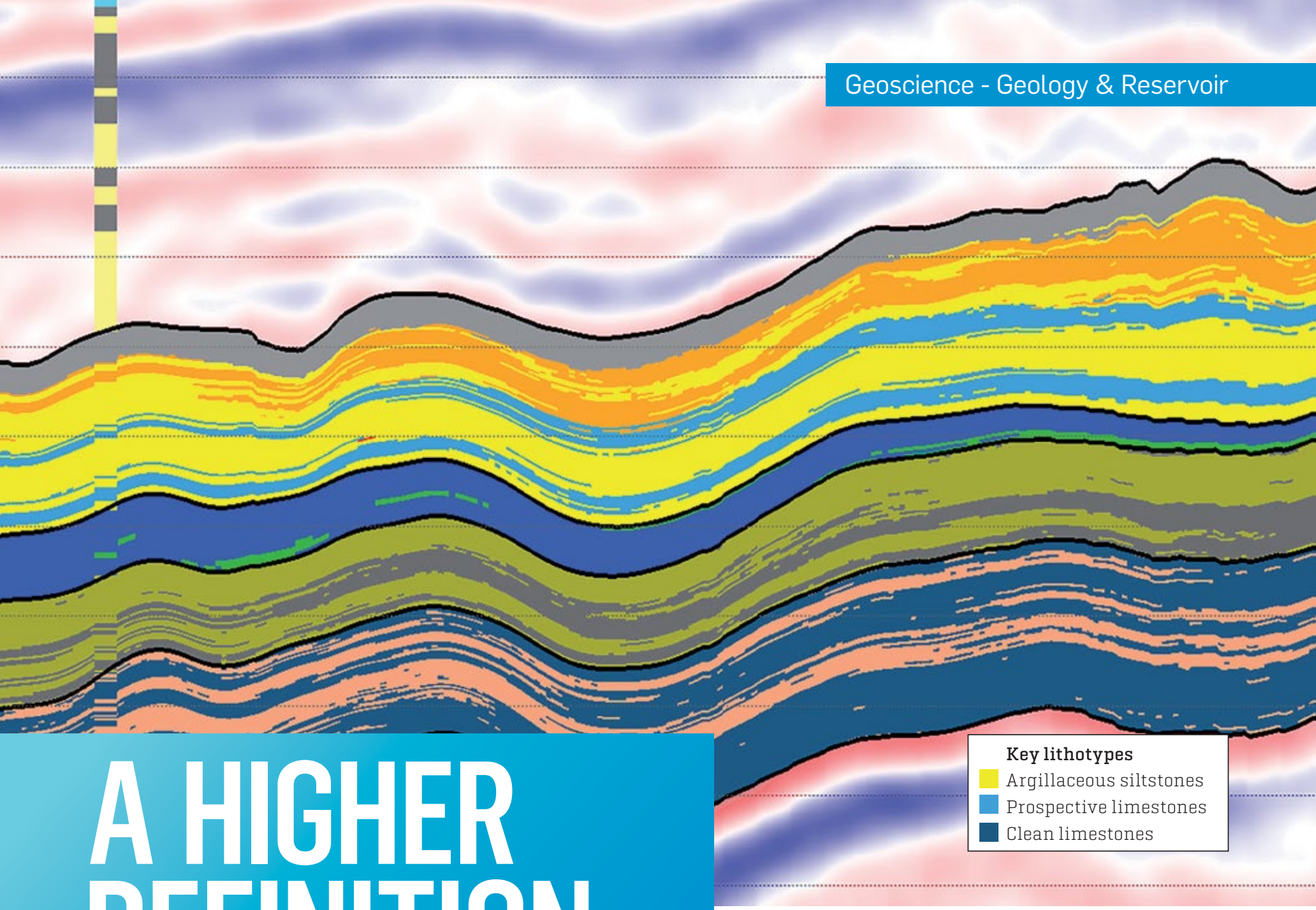
• Honorable Mention, Best Poster Paper Annual Meeting
2018 "Flexible high-performance multiphysics waveform modeling on unstructured spectral-element meshes," Michael Afanasiev, Christian Boehm, Martin van Driel, Lion Krischer, and Andreas Fichtner

• Best Paper Presented by a Student at Annual Meeting
2018 "Q-interface imaging based on data-domain attenuation estimation," Bei Li

• Award of Merit, Best Paper Presented by a Student at Annual Meeting
2018 "Accurate estimates of simultaneous seismic velocity changes and interfracture-source distances from coda wave interferometry," Jonathan Singh

• Best Poster Paper Presented by a Student at Annual Meeting
2018 "Amplitude variation with offset (AVO) inversion modeling with a local elastic solver," Elena Jaimes

• Award of Merit, Best Student Poster Paper at Annual Meeting
2018 "Jump-starting neural network training for seismic problems," Fantine Huot ■



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