

Deep Learning: A Step toward Automatic Prestack Interpretation

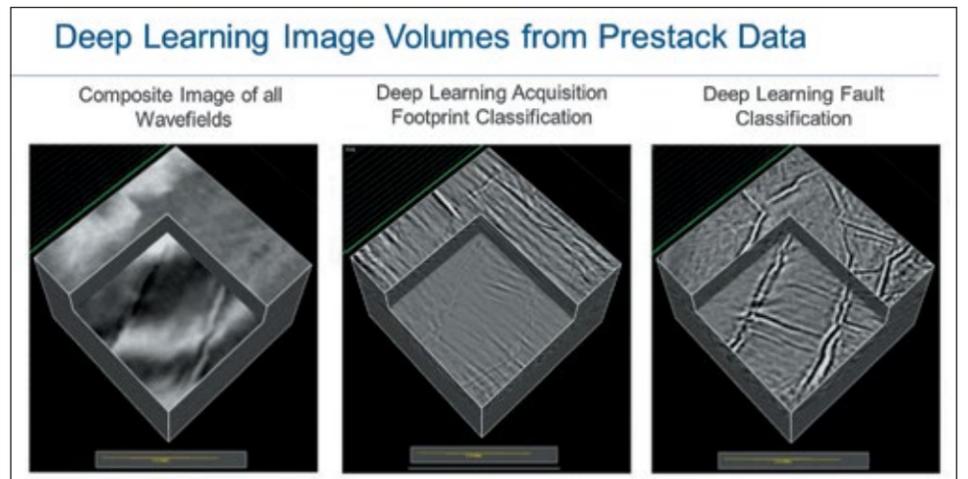
Deep learning will play a strategic role in the industry's digital transformation.

BY DUANE DOPKIN, EMERSON AUTOMATION SOLUTIONS

Machine learning methods have been applied to geoscience data for more than 25 years, with commercial applications emerging in the early 1990s. These applications were largely focused on the automation of tedious tasks and the classification of digital data. Once considered as nice-to-have technologies, machine learning solutions are rapidly gaining acceptance through a surge in R&D, application experience and the availability of technology as open source offerings. Sizes and diversities of subsurface and surface data are motivating the industry to find alternative methods to analyze data in time frames that are not possible with current methods. Deep learning, a specific type of machine learning, is one such alternative that holds strong promise for solving several challenges with the seismic method.

The industry has been advantaged by a wealth of high-density and rich azimuth seismic data, acquired over the past 10 years. These data-rich surface acquisitions sample an equally rich set of subsurface information resulting in different wave-

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This comparison shows image volume (all wavefields) versus deep learning classification of acquisition footprint energy and fault energy. The separation of wavefields is enabled by the creation of FAZ direction angle gathers, principal component analysis and deep learning. (Image courtesy of Emerson Automation Solutions)

Method Changes the Way Marine Seismic Data are Acquired, Processed

A seismic field trial confirmed potential for reduced environmental impact and demonstrated higher sampling and acquisition efficiency.

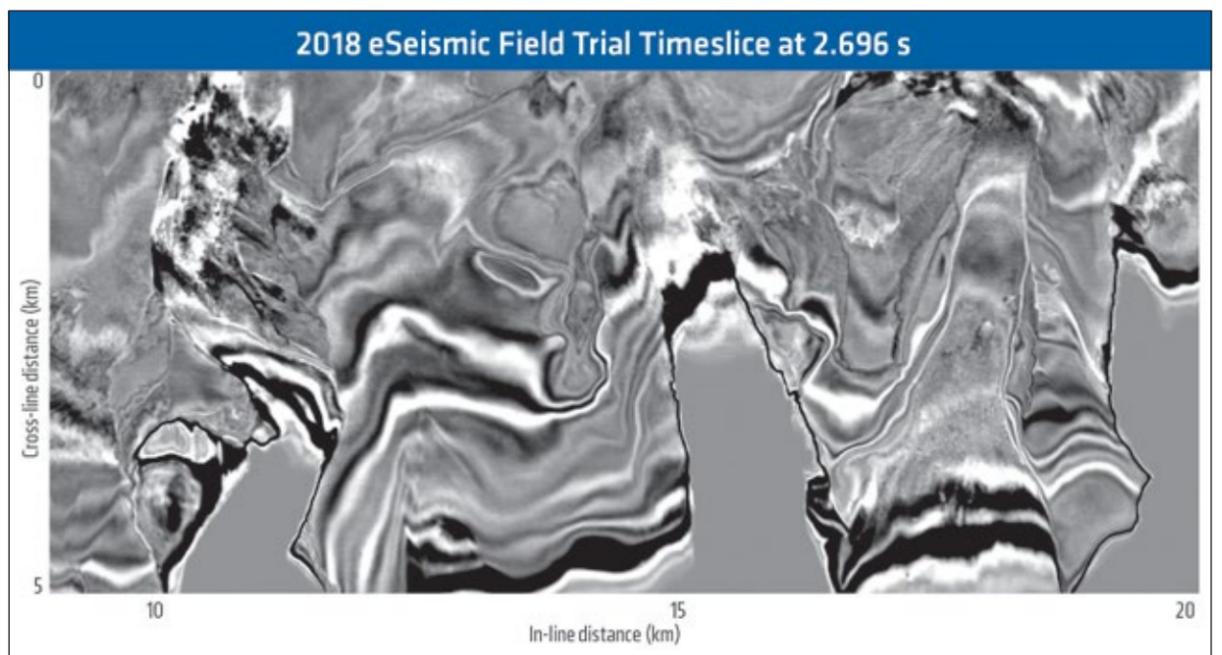
CONTRIBUTED BY PGS

PGS has recently completed a small scale seismic trial using eSeismic offshore Brazil. eSeismic involves the use of continuous source and receiver wavefields to fundamentally change the way that marine seismic data are acquired and processed. The results show a significant decrease in sound pressure levels meaning less environmental impact and sampling is improved without compromising efficiency.

This novel method is currently under development in PGS' R&D unit and involves the continuous recording of seismic data for as long as it takes to acquire the sail lines. The sources also are operated continuously and the field trial confirms the potential benefits of recording of continuous source and receiver wavefields including reduced environmental impact, improved efficiency and better data quality. eSeismic development is funded by The Research Council of Norway, Equinor and PGS.

To use the method with existing equipment, individual airguns are triggered in a near-continuous fashion with short randomized time intervals to generate a continuous wavefield. The emitted signals approach the properties of white noise making it possible to deconvolve the data with the total source wavefield.

The recent eSeismic field trial survey was acquired with 16-by-8, 100-m-long multicomponent streamers with 100-m inter-cable spacing. A constant streamer tow depth of 15 m was used. The source setup consisted of six sub-arrays with airguns, and each sub-array was equipped with six airguns. Individual airguns were triggered with a mean interval between consecutive triggerings of several shots a second. The nominal separation between the sub-arrays of airguns was 16.67 m. Since the source deconvolution using the proposed method can solve for one point source per sub-array of airguns, so six point sources in the cross-line direction, the nominal cross-line bin size for this survey is 8.33 m. In the in-line direction the receiver gathers have a trace spacing of 12.5 m. For comparison, a conventional dual-source acquisition with the same streamer geometry would deliver a cross-line bin size of 25 m.



A timeslice from the 2018 eSeismic 3-D pilot survey in Brazil is shown. Reducing the energy emitted reduces environmental impact while preserving data quality. (Image courtesy of PGS)

Reducing environmental impact

One of the main potential benefits with the proposed method is reduced environmental impact of marine seismic sources. The peak sound pressure levels are significantly reduced by triggering one airgun at a time compared to triggering many airguns in an array simultaneously as in conventional marine seismic sources. Sound exposure levels also are reduced. The peak sound pressure levels are approximately 20 dB to 22 dB lower for the proposed method compared to conventional, whereas the sound exposure levels are 8 dB to 9 dB lower for eSeismic.

Better data quality by increasing sampling by 300%

Dense cross-line common mid points spacing is achieved without compromising the acquisition efficiency. The 800-m-wide sail line is sampled with 96 common mid points compared to 32 with a standard dual-source con-

figuration. The bin size of the 3-D migrated volume is 12.5 m by 12.5 m.

Improving efficiency

From an efficiency standpoint, there are minimal vessel speed limitations because this method does not require the seismic recording or the sources to be triggered with specific spatial intervals. Limitations imposed by shot cycle time and record length are now relaxed.

Imaging continuous wavefields

On the receiver side, all the continuous data are processed at once to maintain the continuity of the data. After receiver motion correction of each measured component, the measured data are in stationary receiver positions and the deconvolution of the emitted source wavefield can be performed. This is done by computing the entire emitted source wavefield that can contribute

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VOTING RIGHTS

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vote of those gathered both in person at the meeting and those joining remotely via an online linkup.

The other two amendments considered by the council on Sunday proved more contentious.

The second amendment brought before the council would have reduced the credential submission requirements for those applying for SEG Active Membership. Currently, applicants are required to give substantial detail on their educational background and professional experience during the application process. The proposed Bylaws change would have eliminated this requirement and made submission of such information voluntary.

District 3 Representative Stuart Wright, speaking in opposition to the proposition, said he believed the proposed amendment constituted a “significant change” to the SEG Bylaws and that he has not heard a substantial call for such a change from the members he represents. Similarly, incoming SEG Board Director at Large David Lumley said he believed that active members should have “some skin in the game” and that he didn’t consider an application process that might take an hour to complete to be overly onerous. He argued that making the application process too easy could lead to negative unintended consequences.

In response, Maitri Erwin, representing the Geophysical Society of Houston on the Council, said she considered SEG’s membership fee to be adequate skin in the game and that SEG should strive to make its membership application process more broadly accessible.

Nonetheless, the proposed amendment to Article III, Section 1A of the SEG Bylaws failed to achieve the two-thirds majority approval necessary to continue on to a vote of the full SEG Active Membership.

The final proposed amendment considered by the council would grant voting rights and the right of petition to SEG associate members. Under the proposed

change, associate members still would be prohibited from holding elective office or serving on the council, but associate members would be included in the member count to determine the number of representatives from Sections and Associated Societies on the Council.

During discussion, District 1 Representative Allen Bertagne said that the case for such a proposed Bylaws change, both pro and con, should be made further in advance of a Council vote. Aldo Vesnaver, representing the Emirates Society of Geoscience, noted that information about the proposed amendments had been printed in *The Leading Edge*, in accordance with SEG Bylaws. Vesnaver also argued that measures should be taken to improve the level of participation among SEG’s members and that granting voting rights to associate members was a step in that direction.

Erwin said she speaks often to young professionals within SEG who question the value proposition of membership. She said SEG is losing young people and that those young professionals need to be engaged and given the right to vote. “If we don’t,” she said, “we won’t have anyone sitting in this room [in the future].”

SEG Director at Large Ken Tubman said he didn’t understand putting restrictions on an individual’s ability to be active within SEG and agreed with extending voting rights to associate members to encourage involvement from young professionals.

After discussion ended, Council Chair Lee Lawyer called for a vote, and the amendment passed with 37 in favor and 9 opposed, thus achieving the two-thirds majority approval necessary to move forward.

Both the proposed amendment to grant voting rights to associate members and the proposed amendment to expand the pool of candidates for council chair will be submitted by ballot within 60 days to the entire SEG Active Membership.

The meeting included a brief speech by SEG President Nancy House and a discussion about challenges facing district representatives that was led by District 2 Representative Gerald Beaudoin. Lawyer chaired the final council meeting of his three-year term and at the end of the meeting passed the gavel to new Council Chair Gustavo Carstens. ■

SEG Entrepreneurs’ Session

Tuesday, Oct. 16
1:50 p.m. to 5:10 p.m., Level 3,
Ballroom A

Do you dream of being your own boss? Do you have an invention that will revolutionize the oil field? How do you start a company? How do you raise money? How do you navigate the Valley of Death? And how do you recognize and pull out of a bad plan? New this year, the SEG Entrepreneurs’ Session will help address these questions and more with a panel of business experts within the venture capital, finance and marketing sectors and entrepreneurs who have succeeded and ones who have failed. The session will culminate in a “Shark Tank” inspired contest in which teams of hopeful entrepreneurs will present their ideas to the panel and compete for glory and exposure to the SEG community. ■

Industry News

TGS and Schlumberger Announce Project in US Gulf of Mexico

TGS and Schlumberger have announced a new multienterprise nodal seismic project in the U.S. Gulf of Mexico.

The project, named “Amendment,” will comprise acquisition of a 2,350-sq-km multienterprise seismic survey in the Mississippi Canyon and Atwater Valley protraction areas of the U.S. Gulf of Mexico. This prolific area includes open acreage, existing producing assets and new discoveries. Seismic data will be acquired using Fairfield Geotechnologies 4C nodal acquisition technology with operations expected to commence in fourth-quarter 2018. TGS and Schlumberger will apply their full azimuth processing expertise and expect to deliver final data to customers in the first quarter of 2020.

“The Amendment project will enhance our current data coverage in the Central U.S. Gulf of Mexico,” said Kristian Johansen, CEO of TGS. “E&P companies are showing increased interest in the benefits of nodal seismic data to overcome imaging challenges in this region. In the Amend-

ment project, TGS and Schlumberger will reimage underlying WAZ seismic data to provide modern, high-quality nodal seismic data to our clients.”

“Schlumberger and TGS have built up extensive geophysical and geological knowledge in this prolific part of the U.S. Gulf of Mexico,” said Maurice Nessim, president, WesternGeco, Schlumberger. “The application of nodal seismic technology and state-of-the-art imaging techniques will help to accelerate hydrocarbon discovery, development and production for our clients. This unique dataset will provide a step change in illuminating complex subsurface structures and help E&P companies to maximize the value of their producing assets and rejuvenate their exploration portfolios. This highly integrated project will combine well log data, high-quality orthogonal WAZ and new nodal measurements to provide foundations for the first industry-funded regional nodal survey in the deepwater Gulf of Mexico.” ■

METHOD

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to each stationary receiver location. To enable a stable deconvolution of the source wavefield, the source wavefield needs to be as white as possible without deep notches in the spectrum.

In addition to continuous seismic

recording, near-field hydrophone data need to be recorded continuously to be able to determine the wavefield emitted by the individual source elements.

For additional information, visit booth 1841 or pgs.com/eSeismic. ■



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