THEATER PRESENTATION ABSTRACTS AND TECHNICAL PAPERS

Advances in Geophysics - Seismic Processing and Imaging

Monday, 9:15 AM; Tuesday, 2:00 PM; Wednesday, 11:15 AM

The ability to use seismic data continues to improve through a combination of improvements to seismic acquisition, processing, imaging, and inversion methods. High-resolution seismic processing, imaging, and modeling deliverables for prospecting can be achieved using a careful combination of technologies in all these domains, with particularly attention paid to the behavior of seismic waves in the subsurface.

The ability to develop and implement new and improved algorithms that deal with different aspects of the recorded seismic wavefield is facilitated by advances in computing technology. These algorithms become building blocks for comprehensive workflows that contribute to seismic acquisition productivity, improved seismic imaging of the subsurface, higher-resolution subsurface models, and refinements in seismic-based methods for quantitative subsurface property assessment.

In recent years, several advances in geophysical technology have significantly contributed to these improvements. These include: Surface wave modeling and attenuation, innovations in 5D data regularization, vibroseis harmonic noise attenuation, improvements in tomographic inversion, and improvements in the application of machine learning.

This presentation will highlight some of these advances, including:

a. Model-based ground roll attenuation by near surface elastic parameter estimation, surface wave modeling, and adaptive subtraction.
b. The use of radon-based data modeling in 5D data reconstruction, for improved data modeling and handling of aliasing.
c. Vibroseis harmonic noise attenuation, which can also contribute to improved seismic acquisition productivity.
d. Tomography improvements, including optimizations that enable higher-resolution velocity models.

These technologies provide the basis for improved utilization of seismic data from new seismic acquisition programs, while also making seismic data more relevant for legacy seismic acquisitions.

Featured Technologies: Echos™, GeoDepth™

Exploring for Wolfcamp Reservoirs, Eastern Shelf of the Permian Basin, Texas, Using a Machine Learning Approach

Monday, 9:45 AM; Tuesday, 2:30 PM; Wednesday, 1:00 PM

To evaluate the quality of a reservoir and gain a more realistic measure of its behavior, geoscientists are challenged to achieve accurate seismically-calibrated facies distribution mapping. In this presentation, we demonstrate the impact of the full dimensionality of the available seismic data (prestack with or without poststack) and well data to infer facies heterogeneities distribution in a Permian oil-filled carbonate reservoir, using a machine learning method.

The goal is to generate a probabilistic facies model from the seismic data. The strength of this method is the system's ability to integrate data of different types (e.g. core, wireline, seismic) and resolutions. This technology reveals new potential about seismic data reliability for predicting away from wells, especially when referring to prestack data (which carry more information) with any type of seismic attributes.

Featured Technologies: SeisEarth™ + Machine Learning Solutions

From Full-Azimuth Seismic Data to Fracture Network

Monday, 10:15 AM; Tuesday, 3:15 PM

Stress/fracture intensity and orientation are among the factors that govern well placement and stimulation, and affect hydrocarbon production and recovery of an unconventional play. Knowledge of stress/fracture spatial distribution is required in the well planning process.

Seismic data contains information about stress/fracture intensity and azimuth. The major challenge is to extract such information accurately and efficiently. With Emerson E&P Software technologies, we can:

a. Condition the seismic data properly to reflect the nature of anisotropy that represents the in-situ stress/fracture. To do so, seismic velocity/amplitude variation with azimuth must be preserved throughout the seismic processing and imaging process.
b. Extract stress/fracture attributes through technologies such as RMOZ or AVAZ inversion. To understand the target zone(s), the overburden effect must be removed if the overburden HTI or orthorhombic layer(s) is present.
c. Visualize, interpret, and analyze the extracted attributes using a state-of-the-art software platform to understand spatial distribution of stress/fractures.

In this presentation, we will use an Eagle Ford project to focus on technologies and workflows for stress/fracture attribute generation, interpretation and analysis. Attention is given to the interval orthorhombic attributes that minimize the overburden effect. Furthermore, the derived attributes are used to model the fracture network.

Featured Technologies: EarthStudy 360™, SeisEarth™ and SKUA-GOCAD™

Investigating and Ranking Prospects with Advanced Seismic Interpretation and Quantitative Methods

Monday, 10:45 AM; Tuesday, 4:00 PM; Wednesday, 2:30 PM

In order for O&G companies to succeed in today's competitive environment, they need to adopt the most efficient and effective petro-technical solution for interpretation and prospect ranking. With the recognition that the role of the general interpretation geoscientist must expand, software solutions are required that are visually and computationally connected. To accelerate both the learning and application curve, Emerson has engineered its interpretation canvases to accommodate the qualitative with the quantitative, and the supervised with the unsupervised.

With Paradigm 18, geoscientists can easily create workflow-guided volume and interval attributes, access machine learning methods, perform voxel visualization and geobody detection with advanced RGB/HSV visualization, and deploy multi-horizon flattening. These methods are augmented with Quantitative Seismic Interpretation and prestack interpretation to encourage rather than deter investigation.

These capabilities allow geoscientists to quickly sift through their data and confidently identify and rank opportunities for investing through the 2020s. This live demonstration will show how these activities are carried out.

Featured Technology: SeisEarth™

Improving Imaging, Characterization and Interpretation of Seismic Data Using the Paleospace

Monday, 11:15 AM; Tuesday, 10:15 AM

Working in flattened space is a common technique used in geophysical interpretation to better understand deposition sequences and to identify stratigraphic features from seismic. Often, the flattened space is constructed from a simplified 2D displacement model with poor handling of faults. This severely reduces its effectiveness in generating reliable interpretations.

With the SKUA UVT approach, 3D displacements are used rather than a vertical stretch to perform simultaneous flattening of all horizons. This enables generation of a reliable image of the paleospace for both compressional and extensional regimes, regardless of the structural and stratigraphic complexity. This 3D approach allows also data to be moved freely between the current space and the paleospace, unlocking a wide range of applications.

In this presentation, some of the applications that use the paleospace will be demonstrated. These include validating and refining structural interpretations, performing chronostratigraphic interpretations, and de-noising and smoothing seismic data and velocity volumes.

Featured Technology: SKUA-GOCAD™

Automatic Recovery and Classification of Subsurface Features from Prestack Seismic Directivity Data Using Deep Learning

Monday, 1:00 PM; Tuesday, 10:45 AM; Wednesday, 2:00 PM

The recorded seismic dataset is a composite of many wavefields. The standard seismic image volume is dominated by the high energy specular data associated with principle reflectors and faults. Consequently, lower energy wavefields associated with stratigraphic features, reefs, and small faults are often lost in the standard processing and imaging process.

This presentation shows an evolution of Emerson's revolutionary full-azimuth imaging technology, performed in the Local Angle Domain, for characterizing subsurface features from migrated seismic data. This imaging system decomposes the recorded seismic wavefield into full-azimuth directivity components comprised of thousands of dips and azimuths. We will demonstrate the use of Principle Component Analysis (PCA) with its inherent data reduction, to derive the principle directivities. Ultimately, we will use the power of deep learning to classify these directivities into geological features, such as reflectors and faults, plus other identifiable components, such as ambient noise or acquisition footprint. This method presents a reliable method for separating these components and producing targeted images from the composite wavefield. The images reveal superior results over previous diffraction weighted stacks. Additionally, the deep learning approach offers significantly better time-to-results.

Featured Technology: EarthStudy 360™

Emerson E&P Software on the Cloud

Monday, 1:30 PM; Tuesday, 11:15 AM; Wednesday, 9:15 AM

The cloud is a key component of the industry's digital transformation, facilitating access to fit-for-purpose subsurface software solutions and hardware instances. Cloud platforms provide flexible, low-cost access to compute resources, minimizing large upfront investments in hardware and ongoing maintenance. Emerson E&P Software provides a simple yet effective way of allowing users of subsurface geoscience and engineering applications to take advantage of the cloud platform, with multiple implementation models for accessing existing and new web-based technologies.

In this presentation, we will showcase Emerson's cloud platform solution for desktop and high-performance computing (HPC) applications. Interactive applications can be run in a multi-user environment, mimicking the on-premise setup. This allows data and results to be readily shared by different users in the asset team working on the same projects. HPC cloud solutions allow the setup of a virtual cluster with any number of compute nodes (CPUs/GPUS) in minutes, and run Emerson's HPC applications (migrations, tomography, processing, etc.) on the most modern and optimized hardware configurations, consuming the optimal computation capacity for the task.

Featured Technologies: Emerson E&P cloud and application software

Introducing Emerson E&P Software

Monday, 2:00 PM; Tuesday, 1:30 PM

Find out how Emerson's new Exploration and Production (E&P) software business portfolio, comprising Paradigm and Roxar software, can help oil and gas operators increase efficiency, reduce costs, and improve return on investment. The new end-to-end E&P software portfolio enables customers to transform their organizations and E&P workflows, and connect subsurface technology to operational activities, reducing uncertainty and supporting responsible asset management. The combination of Paradigm and Roxar software gives operators the intelligent information and tools they need to increase operational capabilities and achieve Top Quartile Performance on investment in new and established oil and gas reservoirs.

Areas of particular strength for this new offering are advanced digital automation across the reservoir lifecycle, and the increased focus on cloud storage, machine learning, and data analytics. We have a deep understanding of the distinctive data diversity, complexity, storage requirements, and demanding visualization and computational needs of the industry. Today we use machine learning in areas such as seismic interpretation and log interpretation; our goal is to take digitization across the entire reservoir lifecycle.

Featured Technologies: Emerson E&P software suite combining Roxar and Paradigm

Unconventional Field Development in the Cloud

Monday, 2:30 PM; Tuesday, 12:00 PM; Wednesday, 1:30 PM

Pervasive inefficiencies are weighing down unconventional field development operations. In 2017, well completion was still the second largest overall cost, accounting for over 25% of the total services expenditure.

This presentation explains how you can accelerate your organization's digital transformation to eliminate remaining inefficiencies. We will demonstrate use cases of unconventional field development that leverage the digital shift enabled by cloud computing. At the core of this transformation is Emerson's secure, independent, open ecosystem with decision-driven cloud native applications. Some are custom written for well placement and completion optimization.

The presentation will include alternative non-siloed approaches that incorporate seismic, microseismic, well, and diverse reservoir data for rapid and inclusive decision making. Combining reservoir intelligence such as modeling aided by machine learning, with the power of IIoT, makes it possible to improve performance by making remedy, maintenance and optimization decisions predictively.

Cloud applications are enabling a new digital operations model where accessibility, mobility and real-time decisions are placed at the core of field development, resulting in unparalleled operational performance.

Featured Technologies: Paradigm™ k, Harvest, SKUA-GOCAD™

The Impact of Uncertainties in Velocity Modeling on Production Forecasts

Monday, 3:15 PM; Tuesday, 1:00 PM; Wednesday, 10:45 AM

The O&G industry faces two major challenges related to subsurface modeling workflows. The first is geologic risk assessment – the industry requires enhanced solutions for quantifying geologic risk as it moves into more complex tectonic settings and more (economically) marginal prospects. The second challenge is productivity – the industry requires solutions that allow domain experts to quickly integrate and share knowledge across the prospect lifecycle.

In this presentation, we describe a unique approach to subsurface interpretation and modeling, that shows how the addressed uncertainties impact future production estimates. We focus on the development and quantification of velocity uncertainty, associate with it seismic interpretation, and integrate it into subsurface modeling workflows. With uncertainty collected at the important stage of time-to-depth conversion, the interpretation becomes not a single configuration, but a means of generating an ensemble of reservoir models that can be used to reduce risk and improve decision making.

This presentation features a tomographic approach for assessing and quantifying the impact of velocity errors (perturbations) on subsurface structural errors, which leads to the generation of multiple 3D grids. For each of these grids a geomodel can be constructed with further simulation and production forecast. The measured impact of key uncertainties on production is used to manage project risks and follow the optimal development or reservoir management strategy.

We will demonstrate powerful and automated workflows that integrate tomography, static and dynamic modeling with production prediction solutions.

Featured Technologies: GeoDepth™, SKUA-GOCAD™, RMS™, Tempest™

Model-based Tomography for Assessing Subsurface Structural Uncertainty: Integration of Geophysical and Geological Models

Monday, 4:00 PM; Tuesday, 9:15 AM; Wednesday, 10:15 AM

Subsurface structural uncertainty can be sourced to errors in migration velocity models. These errors directly affect the position of migrated events. One of the reasons for these errors is limitations in the resolution of seismic data. These limitations result in non-unique velocity models, where multiple models can equally flatten the events in common image gathers. The resultant subsurface structural uncertainty can have a direct impact on reservoir reserves estimation, spill point and closures, and well planning across fault zones.

This presentation features a tomographic approach for assessing and quantifying the impact of velocity model errors (perturbations) on subsurface fault zones and horizon-position errors. Key results of the technology are newly positioned target horizons/faults from the perturbed models that are kinematically equivalent and honor geophysical assumptions of gather flatness. For each horizon and fault, this leads to a set of possible (x, y, depth) locations of the structure that are directly fed into a subsurface modeling system (SKUA-GOCAD) for geologic validation and analysis.

We will demonstrate powerful and easy-to-use tools and automated workflows that integrate the tomography (GeoDepth) and geologic modeling (SKUA-GOCAD) systems.

Featured Technologies: GeoDepth™, SKUA-GOCAD™

Quantitative Seismic Interpretation (QSI) in a Multi-data Interpretation Environment

Monday, 4:45 PM; Tuesday, 9:45 AM; Wednesday, 9:45 AM

Modern Quantitative Seismic Interpretation (QSI) requires the simultaneous analysis of many datasets. Emerson E&P Software's interactive platform makes these workflows available to the innovative interpreter in an easy-to-use way. Seismic, impedance, and various other attributes are analyzed simultaneously, as they are being integrated with well data and Rock Physics models. The multi-data approach which involves, for example, multi-data view, multi-attribute well ties, multi-attribute model perturbations, and/or multi-attribute crossplots, provides a holistic view of the various aspects of the subsurface and the reservoir.

Featured Technologies: QSI

LUNCH & LEARN PRESENTATIONS

Seismic Geomorphology - Mitigating Lithology Prediction Risk and Providing Context for Further Investigation: Applications and Workflows

Monday, 12:00 PM

As high-quality 3D seismic data has become widely available, our ability to predict the subsurface distribution of lithologies has significantly improved. Stratigraphic interpretation of seismic data involves the integration of stratigraphy and geomorphology, with integrated section and plan view images yielding robust interpretations of stratigraphic architecture and associated lithologies.

Geologically-meaningful seismic patterns can be recognized in multiple domains, including section views, plan views, 3D perspective views, and animated (i.e. movie) views. Once such patterns have been identified, interpreters can populate these patterns with appropriate

lithologies. Seismically-derived geologic interpretations can have significant impact on exploration and production in the following ways:

Geology: 1) prediction of lithology, 2) prediction of compartmentalization, 3) development of depositional analogs, 4) enhanced understanding of geologic processes.

Geophysics: 1) provides depositional context for geophysical analyses (e.g., DHI analysis, reservoir properties from seismic). Understanding geologic context can provide a "reality check" when evaluating geophysical data for rock and fluid properties. 2) Quality control for geophysical processing. Evaluating the quality of seismic images, especially in the plan view domain, of known geologic features can help determine the value of a given processing step. Ensuring that meaningful geologic features are not processed out of the data is critical to maximizing the value of seismic data.

Examples will be given from deep marine as well as shallow marine and non-marine environments, illustrating how patterns observed from multiple seismic domains can lead to robust geologic interpretations and predictions of lithology. Critical workflows designed to efficiently "mine" 3D seismic data will also be illustrated.

Unconventional Field Development in the Cloud

Tuesday, 12:00 PM

See relevant Abstract above.

Holographic Processing and Imaging Yield Highest Possible Seismic Resolution

Wednesday, 12:00 PM

Images representing the subsurface formed from exploration seismic data are an essential element of many, if not most exploration and production activities. For the last 40 or more years, such images have used the technology of signal processing, both implicitly as in acquisition design, and explicitly in forming the displays. This approach has proved quite effective, but also embodies many recognized limitations. For example, the Nyquist limit as applied affects attainable resolution, and the propagating wavelet loses frequencies with time or distance, and hence reduces resolution even more rapidly with recording time.

However, other technologies for forming images from the same data are available. One of these methods, Holographic Imaging, offers significant advantages for most seismic data applications. Holography seeks to image the subsurface in terms of reflectivity, rather than only imaging reflections from the subsurface. Resolution increases approach factors of 5, while also employing novel Extended Visibility Dynamic Range (EVDR) color displays scaled in interval velocity, increases interpretive perception by factors approaching 30. This methodology is available from Emerson E&P Software as a geoscience service.

A number of illustrative examples will be presented as the methodology is described. Both conventional and unconventional objectives are addressed as well as carbonates and clastics. The method also can offer reduced acquisition costs approaching 50%, by employing survey designs which take better advantage of survey data multiplicity, and inherent sampling properties of the Holographic method.

EMERSON E&P SOFTWARE PAPERS IN THE SEG TECHNICAL PROGRAM

Using a Deep Convolutional Neural Network to Enhance the Accuracy of First Break Picking

Yaniv Hollander, Amin Merouane and Orhan Yilmaz

Session: Recent Advances and the Road Ahead

Date and Time: Monday, October 15, 1:50 - 2:15 PM

Location: 204B

Eigenray Tracing in 3D-Heterogeneous Media Using Spectral Element Method

Igor Ravve and Zvi Koren

Date and Time: Monday, October 15, 2:40 - 3:05 PM

Location: Exposition Hall C, Poster Station 15

Slowness-domain Kinematical Characteristics for Horizontally Layered Orthorhombic Media

Zvi Koren and Igor Ravve

Tuesday, October 16, 1:50 - 2:15 PM

Location: Exposition Hall C, Poster Station 18

Modeling Intrasalt Layers when Building Velocity Models for Depth Migration: Examples of the Santos Basins, Brazilian Offshore

Alexandre Maul, Josué Fonseca, Leonardo Teixeira, Pablo Barros, João Boechat, João Paulo Nunes & Thiago Yamamoto (Petrobras); María González and Gerardo González (Emerson E&P Software)

Session: Southern Gulf of Mexico and Latin America

Date and Time: Tuesday, October 16, 3:55 - 4:20 PM

Location: 210C

Azimuthally Anisotropic Effective Parameters from Full-azimuth Reflection Angle Gathers

Liron Korkidi, Raz Litvak, Cindy Ayache, Ronit Strachilevitz, Zvi Koren

Session: Migration and Traveltimes

Date and Time: Wednesday, October 17, 2:40 - 3:05 PM

Location: 205A