Geophysical Society of Oklahoma City

2021 GSOC Continuing Education Seminar

March 22, 2021

Virtual

9:00 am – 5:00 pm

http://gsoc.seg.org

2021 Continuing Education Seminar

Schedule of Events

8:50	***Log On Opens***	
9:00 — 10:00	**Jake Covault** **Zoltan Sylvester** *UT-Austin Bureau of Economic Geology Quantitative Clastics Lab*	Sandy Building Blocks of Basin-Floor Submarine-Fan Reservoirs: Low-Sinuosity Deepwater Channel Deposits, Permian Basin A Net Methodology for Automated Well-Log Correlation: Examples from the Permian Basin, Texas
10:00 — 11:00	**Pandu Devarakota** *Shell Global Solutions*	Opportunities and Challenges of Deep Learning in E&P: A Sneak Peek on a Couple Applications
11:00 — 1:00	***Lunch***	
1:00 — 2:00	**Ramya Ravindranathan** *Department of Earth and Atmospheric Sciences, University of Houston*	Amplitude of Pair Correlation Function to Understand Heterogeneity from Well-log and Seismic Data
2:00 — 3:00	**Kayla Kroll** *Lawrence Livermore National Laboratory*	Ensemble Forecasts of Induced Seismicity
3:00 — 4:00	**Scott Boyer** *GTSeis*	TrueDepth Prestack Depth Migration: An Essential Tool for Mitigating Drilling Risk
4:00 — 5:00	**Rui Zhang** *University of Louisiana at Lafayette*	Integration of Seismic and InSAR data for CO_2 Sequestration Study at In Salah Project
5:00	***Speaker Appreciation and Closing Remarks***	

GSOC Geophysical Society of Oklahoma City

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About the Geophysical Society of Oklahoma City

The Geophysical Society of Oklahoma City (GSOC) was chartered as the sixth chapter of the Society of Exploration Geophysicists (SEG) in October, 1952. This chapter was largely working geophysicists from Central and Western Oklahoma. By 1970, the Society had grown to nearly one hundred and twenty members, and on June 4, 1971 the GSOC dedicated a granite monument, marking the site of the 1st reflection seismic survey conducted in the USA conducted fifty years earlier by a crew of scientists led by Dr. John C. Karcher. This first seismic data was acquired approximately ½ mile west of Penn Square Mall in Oklahoma City. The monument is currently seeking a new home moving from its original location in the front lawn of Belle Isle Library

Today the society serves nearly two hundred members and is staffed by an annually elected Board of volunteers. The GSOC holds monthly meetings from September-May as well as multiple special events throughout the year. The Board makes a distinct effort to provide members with a series of relevant and beneficial technical seminars to further each member's continuing education in geophysics as well as provide a venue for members to expand and maintain their professional network.

GSOC Officers	2020 - 2021
President	Stephanie Cook
Past President	David Smolkin
Vice President	Cecilia Ramirez
Secretary & Student Volunteer	Clayton Silver
Treasurer	Kenton Shaw

Future Events

Monday, April 19th, 2021

GSOC Virtual Technical Talk :

Randall Hunt, Hunt Petroleum Geophysics

11:30 a.m.

Jake Covault

UT-Austin Bureau of Economic Geology Quantitative Clastics Lab

Biography

Dr. Jacob Covault is a Senior Research Scientist and co-PI of the Quantitative Clastics Laboratory (QCL). His expertise is the sedimentology and stratigraphy of deep-water depositional systems, and source-to-sink sediment dispersal. Jacob aims to address challenges in the exploration and development of natural resources, namely reservoir presence and quality prediction in frontier basins, and reservoir connectivity and heterogeneity. Prior to his present position at the QCL, Jacob was a senior research scientist at Chevron Energy Technology Company, and served the Department of the Interior at the U.S. Geological Survey working on the National Assessment of Carbon Dioxide Storage. He received Ph.D. and B.S. degrees in Geological and Environmental Sciences at Stanford University, where he played football 1999-2003. Jacob has published peer-reviewed research papers and scientific conference abstracts pertaining to petroleum geology, reservoir characterization, sedimentology, stratigraphy, basin analysis, Earth surface processes, and marine geology. Jacob was the recipient of the 2017 SEPM Wilson Award in recognition of “Excellence in Sedimentary Geology by a Young Scientist.”

Part 1: Sandy Building Blocks of Basin-Floor Submarine-Fan Reservoirs: Low-Sinuosity Deepwater Channel Deposits, Permian Basin

Jake Covault, UT-Austin Bureau of Economic Geology Quantitative Clastics Lab

Abstract

Submarine fans are deepwater depositional systems that received terrigenous sediment from canyons and channels that extend across continental margins. Sandy channelized architectural elements of submarine fans are important deepwater reservoirs. Outcrops of the Permian (Guadalupian) Brushy Canyon Formation were used to develop one of the first predictive models of deep water slope to basin-floor-fan reservoir architecture, which informed exploration and development of the West African continental margin, among other petroliferous basins. However, how do outcrop-based interpretations of the Brushy Canyon Formation compare to the subsurface? Where is the Brushy Canyon Formation useful as a deepwater reservoir analog? More broadly, do sandy channel deposits maintain the same facies, geometry, and stacking from slope to basin floor?

We used 3D seismic data from Fairfield Geotechnologies and log data of Brushy Canyon Formation deepwater channel deposits, northern Delaware basin, to address these questions. We interpret an overall back step of depositional environments, from large, low sinuosity, confined, proximal basin-floor channel complexes to smaller, more laterally extensive, distal distributary channel deposits organized in lobate patterns; this evolution is consistent with some interpretations of Brushy Canyon Formation outcrops. Basin-floor channels are much lower sinuosity than those on continental slopes, which reflect short-lived channels on the basin floor. A stratigraphic forward model of channel meandering illustrates the evolution of channels from low-sinuosity, short-lived channels to more sinuous, longer-lived ones. Potential controls on channel longevity include 1) over spilling sediment-gravity flows escaping low-relief basin-floor channels promoting avulsions, and 2) external changes in sediment supply to the system promoting depositional-system shutdown and channel abandonment. The subsurface character of sandy channelized architectural elements of the Brushy Canyon Formation in the northern Delaware basin is similar to outcrop-based interpretations; the Brushy Canyon Formation is potentially a useful analog to constrain the facies, geometry, and stacking patterns of basin-floor submarine fans, such as other prospective units in the Permian basin. However, these channels are poor analogs for many slope reservoirs that consist of longer-lived channels with higher sinuosity and more complicated stratigraphic architecture.

Zoltan Sylvester

UT-Austin Bureau of Economic Geology Quantitative Clastics Lab

Biography

Jake Covault and Zoltan Sylvester are the co-PIs of the UT-Austin Bureau of Economic Geology Quantitative Clastics Lab. They develop predictive models and tools for reservoir characterization, modeling, correlation, and source-to-sink predictions for exploration and development. They also develop and test software and offer training in geoscience, software, data analytics and AI algorithms for correlation and mapping of rock properties in the subsurface. Before working at UT-Austin, Jake and Zoltan earned PhDs from Stanford University and worked as research scientists for the energy industry and US Geological Survey.

Part 2: A New Mehodology for Automated Well-Log Correlation: Examples from the Permian Basin, Texas

Zoltan Sylvester, UT-Austin Bureau of Economic Geology Quantitative Clastics Lab

Abstract

Correlation of geophysical well logs is one of the most important - and most time-consuming-tasks that applied geoscientists perform on a daily basis. In many onshore- and shallow-water settings, it is common that hundreds or thousands of wells have to be correlated. Doing this manually is time consuming and strenuous; and humans are unable to take advantage of all the stratigraphic information that a dense set of well logs holds. Using the dynamic time warping (DTW) algorithm, automated correlation of two wells is a fairly simple task. This approach can also be used to correlate a large number of wells along a single path. However, errors accumulate along a single path and loops cannot be easily closed.

To create a three-dimensionally consistent correlation framework, we use a Python implementation of the Wheeler and Hale (2014) approach, which is based on the idea of stretching-and-squeezing all logs into a chronostratigraphic diagram that has relative geologic time (RGT) on its y-axis. The depth shifts needed for the RGT transformation are computed by translating the outputs of a large number of pairwise DTW correlations into a least-squares optimization problem that is solved through the conjugate gradient method. The resulting chronostratigraphic diagram provides an overview of the overall stratigraphy and its variability. To create geologically intuitive well-log cross sections, we use a multi-scale blocking method that relies on the continuous wavelet transform to identify stratigraphic units of a certain scale in one well and then propagate these boundaries to all the other wells.

We demonstrate the usefulness of this approach on two datasets with hundreds of wells from the Permian Basin, West Texas. Single-panel correlations that rely on a small number of well pairs show significant differences when compared to the global correlation result; and, despite their geologically reasonable appearance, they are likely to be wrong. In contrast, the RGT approach is not a simple lithologic correlation, as the global optimization often places different lithologies into the same time-stratigraphic unit. Once the correlation framework is in place, linear channel bodies in the deepwater Spraberry Formation are easily detected and clearly highlighted in maps and cross sections. These results suggest that our methodology is robust enough for mapping subtle stratigraphic details, previously considered feasible only through manual interpretation.

Pandu Devarakota

Shell Global Solutions

Biography

Pandu Devarakota is a Team Lead Subsurface and Wells at Shell Global Solutions USA. Pandu and his team are developing a range of technologies from machine learning to deep learning that are focusing on making advancements in AI adoption under Shell's artificial intelligence (Shell.ai) initiative. Pandu is currently acting as a Chair of Data Standards subcommittee in the SEG SEAM AI project. Pandu had a PhD in Signal Processing from the Royal Institute of Technology (KTH), Stockholm, Sweden in 2008 and is practitioner of machine learning techniques in solving many real-world problems. Earlier in his career, he worked for Siemens as a Research Scientist and contributed to the development of various computer aided diagnosis products for detecting early stage of cancer. He led a team in Canon, developing GPU-accelerated next generation of healthcare IT products.

Opportunities and Challenges of Deep Learning in E&P: A Sneak Peek on a Couple Applications

Pandu Devarakota, Shell Global Solutions

Abstract

Applications of deep learning techniques in image analysis have recently increased in the domain of geoscience and seismic imaging. Dozens of papers have been published in this domain, most of which use the now well-established supervised learning paradigm. Majority of these approaches focus on solving one task at a time and ignore the richness of presence of many other structures in the vicinity and their correlation with the task of interest at hand. As a result of this, these approaches work best in solving the identification of simple structures in the shallow areas of the survey where the signal-to-noise ratio is high and struggle in deeper areas as the signal becomes weaker. In addition, it is a challenge to acquire the right data and quality labels to train the deep learning models for some of the fundamental yet persistent challenges in geoscience. In this talk, we present two recent applications of deep learning in seismic processing that are targeted to reduce the cycle time of seismic processing projects.

In the first example, we present the concept of learning multiple related tasks and demonstrate on a use case that the multi-task learning (MTL) learns common representations of related tasks (salt body and salt boundary) and improves the accuracy of identifying and segmenting salt boundary structures even in those areas where the signal is dim and fuzzy. In the second example, we reconstruct the regularly and irregularly missing in narrow-azimuth (NAZ) data using an encoder-decoder style convolutional neural network. One key challenge in NAZ is the sparsity of densely sampled data. Unlike prior approaches, we focus on using real NAZ field data for this study that pose an additional challenge with the presence of random and coherent noise in the data. Field data is manipulated to generate several missing seismic trace scenarios (e.g. regular and irregular with small to large number of missing traces). This data together with the original complete data is used to train an auto-encoder network. The results on unseen ("blind") field data show the effectiveness and generalization ability of the proposed approaches for accurately reconstructing the missing seismic data.

Amplitude of Pair Correlation Function to Understand Heterogeneity from Well-log and Seismic Data

Ramya Ravindranathan, Department of Earth and Atmospheric Sciences, University of Houston

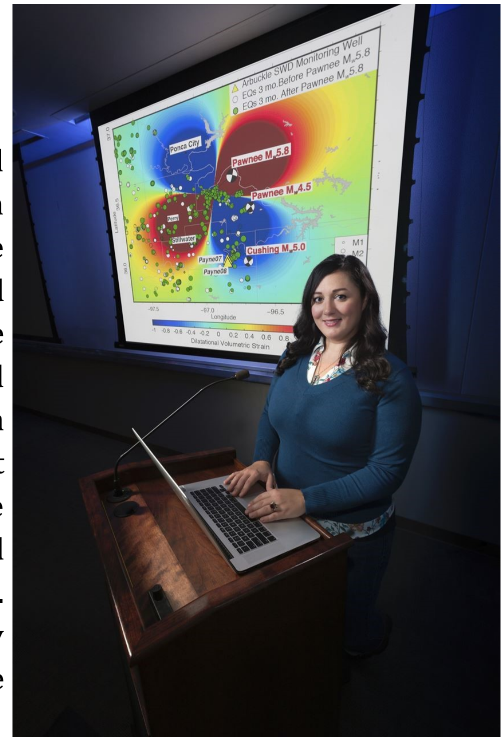
Abstract

The elastic properties of the medium are scale-dependent and therefore it would be ideal to make the best possible use of the seismic data by integrating it with the available well-log data. Effective medium theory (EMT) uses homogeneous physical properties to calculate the effective properties of a heterogeneous medium thereby bridging the gap between the macro- and micro- physical properties. Depending upon the complexity of the medium, different effective medium theories are used. Pair Correlation Function (PCF) approximation method that takes into account the effect of scattering is a very effective tool in understanding the heterogeneity of the medium. It considers the interactions between any two points of a heterogeneous medium. The maximum heterogeneity is recorded when there are fluid filled inclusions in the matrix. The study has previously been successfully carried out mostly on well-log data to distinguish the productive zones from the non- productive zones. The correlation function has two parts: amplitude and correlation radius. This work deals mainly with the amplitude part of the PCF that tends to be higher if the properties of the medium are drastically different in composition from its surroundings. The amplitudes of PCF are calculated for elastic stiffness tensors, density and porosity. The seismic and well-log data are from northern part of South Marsh Island in the Gulf of Mexico. The Tertiary sediments of interest are generally interbedded sands and shales. Apart from distinguishing the productive layer, an interesting correlation between the gamma ray-log and the amplitude of PCF has been observed through this study. This could help in quantifying the net to gross sands in a reservoir.

Kayla Kroll

Lawrence Livermore National Laboratory

Biography



Dr. Kayla Kroll received a BSc in geological sciences from Cal Poly Pomona in 2008 and her MSc and Ph.D. from in Earthquake Physics from the University of California, Riverside in 2012 and 2015, respectively. At UCR Kayla applied observational seismology and numerical earthquake simulation methods to understand earthquake nucleation and triggering, fault interaction, and induced seismicity. Kayla completed a postdoc and converted to Research Scientist at Lawrence Livermore National Laboratory in 2018, where she focuses her efforts on understanding induced seismicity and developing mitigation methods related to energy applications. Kayla serves as the Deputy Group Leader of the Seismology Group and to serve on the LLNL management team for the DOE's SMART Initiative for Carbon Storage.

Ensemble Forecasts of Induced Seismicity

Kayla Kroll, Lawrence Livermore National Laboratory

Abstract

The possibility inducing earthquakes has been recognized as a significant risk faced by carbon storage operations which, in extreme cases, may lead to property damage and complete cessation of storage at a site. Efforts to mitigate this risk first require an understanding of the current and short-term future seismic hazard. Therefore, we have developed an Operational Forecasting of Induced Seismicity toolkit "ORION", an open-source, observation-based ensemble forecasting toolkit which is geared towards helping operators understand the seismic hazard at a site. ORION analyzes how the seismic hazard evolves during injection, and suggests possible mitigation strategies to employ, if an earthquake that exceeds certain threshold is observed. Through its ensemble modeling approach, Orion leverages the benefits of both statistical- and physics-based forecasting methodologies, while reducing the impact of each model's respective limitations. The Orion toolkit consists of an easy-to-use web-based GUI interface that affords a user as much or as little interaction as desired. Advanced capabilities allow the user to upload local, high-precision earthquake catalogs, projected injection profiles and/or spatiotemporal estimates of pressure/stress, and to tune various model parameters. Orion will then provide a spatial and temporal ensemble forecast of seismicity defined as the probability of exceedance of a given earthquake magnitude over a forecast period. Additionally, Orion will provide probability distribution of the statistically derived maximum possible earthquake magnitude that may be expected. Finally, Orion will provide suggested operational management strategies (e.g. reduce injection volumes at specific wells) based on the level of hazard.

Scott Boyer

GTSeis

Biography

Scott Boyer has 24 years of experience with applications and development with seismic data processing software and depth imaging. Scott started in the geophysical industry as a geophysical processing analyst and soon became processing project leader. Scott then joined Geotrace Technologies, Houston in 1997 as geophysical processing analyst, became time and depth imaging specialist, then worldwide support for Geotrace Diamond software processing and development. He has many publications in the SEG societies, some are listed below.

TrueDepth Prestack Depth Migration: An Essential Tool for Mitigating Drilling Risk

Scott Boyer, GTSeis

Abstract

The utilization of non-seismic data in the structural imaging arena has been shifting its importance from an afterthought to an essentially a priori ingredient. The necessity to image complex subsurface structures that are at the right depth, at the correct geographical location and with the correct geometry and topology has become paramount for a successful business model that combines drilling, geosteering, completion, fracking and re-fracking, as well as production and EOR efforts. This article can be thought of as an update and continuation on our 2013 First Break publication (Stein et al 2013) that introduced the concept of True Depth.

Here we will describe the new developments in the technology suite, primarily spawned by our experiences processing many several surveys around the world that pointed to some shortcomings in the original ideas and implementation. Particularly important has been the development of a new workflow that increases the efficiency and robustness of the techniques. The new workflow incorporates several new pieces of technology making the resulting images more accurate. The new technologies include a global delta anisotropy tool, a tomography capable of inverting for velocity and anisotropy, and 3D QC visualization techniques.

Rui Zhang

University of Louisiana at Lafayette

Biography

Dr. Rui Zhang is an associate professor at University of Louisiana at Lafayette (UL Lafayette) with joint appointment of School of Geosciences and Department of Physics from 2014. Dr. Zhang obtained his PhD from the University of Houston in 2010 in Geophysics. After that, he had worked as postdoc fellow at the University of Texas at Austin and Lawrence Berkeley National Laboratory. Dr. Zhang's research area is focusing on the exploration geophysics with application on various energy issues, including O&G industry, CO2 sequestration and geothermal energy enhancement. Dr. Zhang has published 30 peer-review journal papers and about 40 conference papers. In 2018, Dr. Zhang has won the Best paper award in the journal Interpretation.

Integration of Seismic and InSAR data for CO2 Sequestration Study at In Salah Project

Rui Zhang, University of Louisiana at Lafayette

Abstract

The In Salah carbon dioxide storage project in Algeria has injected more than 3 million tons of carbon dioxide into a water-filled tight-sand formation. During injection, interferometric synthetic aperture radar (InSAR) reveals a double-lobed pattern of up to a 20-mm surface uplift above the horizontal leg of an injection well. Interpretation of 3D seismic data reveals the presence of a subtle linear push-down feature located along the InSAR determined surface depression between the two lobes, which we interpreted to have to be caused by anomalously lower velocity from the fracture zone and the presence of CO2 displacing brine in this feature. To enhance the seismic interpretation, we calculated many poststack seismic attributes, including positive and negative curvatures as well as ant track, from the 3D seismic data. The maximum positive curvature attributes and ant track found the clearest linear features, with two parallel trends, which agreed well with the ant-track volume and the InSAR observations of the depression zone. The seismic attributes provided a plausible characterization of the fracture zone extent, including height, width, and length (80, 350, and 3500 m, respectively), providing important information for further study of fracture behavior due to the CO2 injection at In Salah. We interpreted the pattern of depression between two surface-deformation lobes as caused by the opening of a subvertical fracture or damage zone at depth above the injection interval, which allowed injected CO2 to migrate upward. Our analysis corroborated previous interpretation of surface uplift as due to the injection of CO2 in this well.