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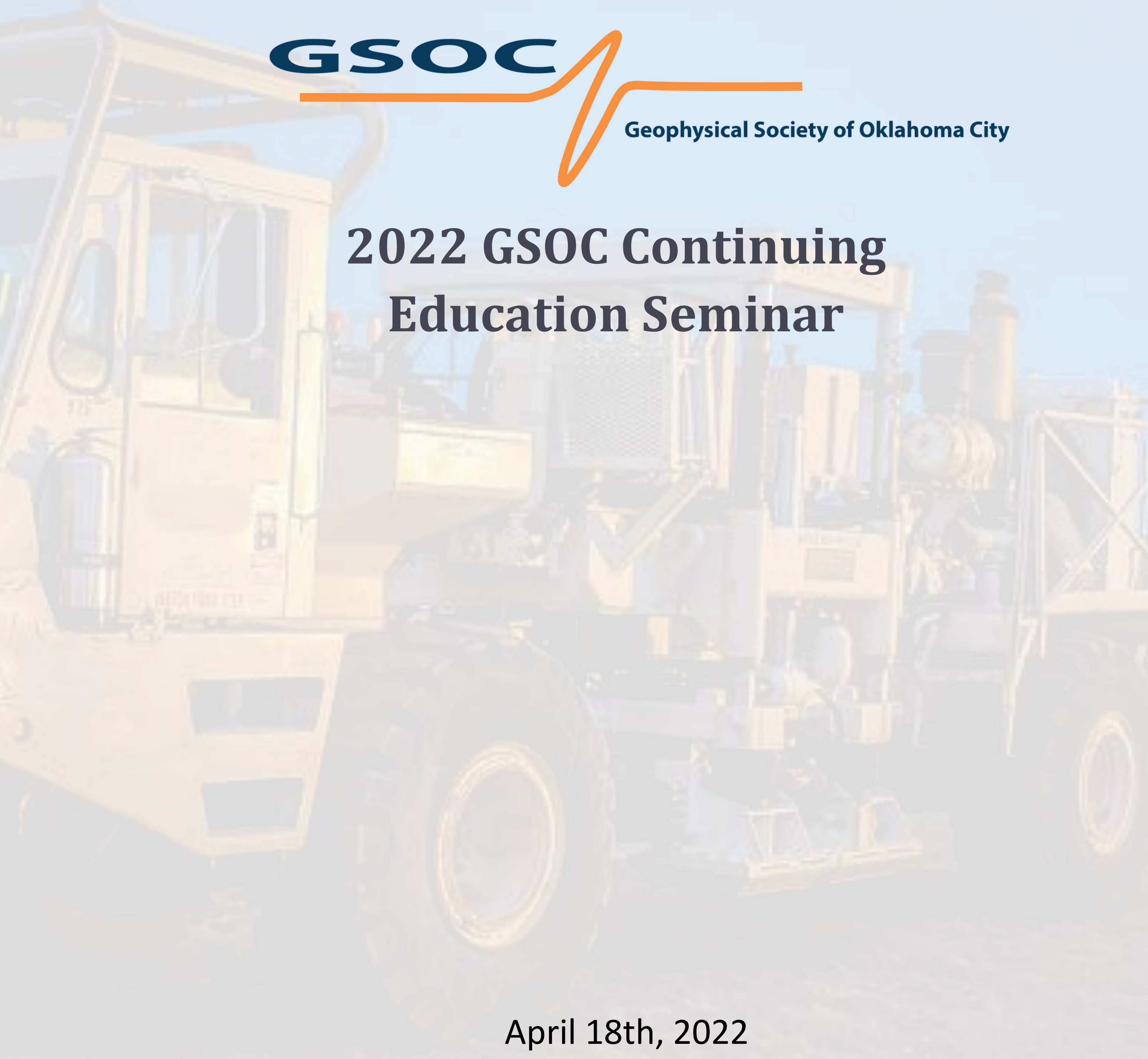
Geophysical Society of Oklahoma City



2022 GSOC Continuing Education Seminar

April 18th, 2022

11:00 am – 5:30 pm

http://gsoc.seg.org

2022 Continuing Education Seminar

Schedule of Events

11:00 am	**Check in Begins**	
11:30 am	**Lunch**	
12:00pm - 12:50pm	**Bruce Karr** *Fairfield Geotechnologies*	"Permian Basin Reflections: Past, present and future, a look at high trace density (HTD) data over the Fasken C-Ranch and Mud City surveys"
12:50pm -1:40pm	**Alan Bai** *CGG*	"Imaging the Complex Geology in the Central Basin Platform using Land FWI"
1:40pm - 2:30pm	**Bob Springman** *GTSeis*	"Correct Reservoir Size Estimation with Depth imaging: more than just a single process"
2:30pm - 3:00pm	**Break**	
3:00pm - 3:50pm	**Ge Jin** *Colorado School of*	"New DAS Applications in Unconventional Reservoir Characterization"
3:50pm - 4:30pm	**Jackson Haffener** *Devon*	"Did We Break New Rock? Utilizing Diagnostics to Differentiate New Fracture Creation vs Old Fracture Reactivation: A Meramec and Wolfcamp Study"
4:40 pm - 5:30pm	**Ali Tura** *Colorado School of*	"The CCUS Landscape and Vital Role of Geophysics

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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	Kenton Shaw
Past President	Stephanie Cook
Vice President	Bob Springman
Secretary and Webmaster	John McKnight Oluseun Sanuade
Treasurer	Jay Gully

Bruce Karr

Principal Technical Adviser for Fairfield Geotechnologies

Biography

Bruce Karr, Principal Technical Adviser for Fairfield Geotechnologies, Worked for Fairfield since 1994 as a Senior Geophysicist, Technical Manager, Processing Center Manager and Technical Sales Manager and not the Principal Technical Adviser. Mr. Karr's expertise includes 3D and 4D multi-component land data, with particular focus on geophysical problems including long wavelength statics, spectral enhancement, noise attenuation and signal enhancement, depthtime issues, land seismic acquisition design and land field technology. Mr. Karr received a BS in Geophysical Engineering and a minor in Geology from the Colorado School of Mines in 1988 and began his career with GSI shortly after graduation in Saudi Arabia. Mr. Karr was then transferred to Midland, Texas, where he began processing seismic data. By the early 1990s, West Texas was a prolific region for 3D surveys being acquired in the Midland and Delaware basins. Mr. Karr has worked with students and professors in partnership with the Colorado School of Mines Reservoir Characterization Project (RCP), Golden, Colorado; the Bureau of Economic Geology Consortium (EGL), Austin, Texas; and the Kansas Geological Survey (KGS), Lawrence, Kansas. Mr. Karr has produced or coproduced a number of papers and presentations concentrating on his areas of expertise in solving geophysical, geologic and reservoir problems. As a member of the Fairfield Geotechnologies team, Mr. Karr uses his knowledge to help clients resolve complex land project challenges in integrated geophysics with geology and reservoir characterization

Permian Basin Reflections: Past, present and future, a look at high trace density (HTD) data over the Fasken C-Ranch and Mud City surveys

*Bruce Karr and Andrew Lewis, Fairfield Geotechnologies; Ron Bianco, Fasken Oil and Ranch

Abstract

Summary The Permian has been a prolific hydrocarbon producing basin for over a century, with over 500,000 wells drilled. Current production defies the theory of "peak oil." Proven reserves in the Permian are at an all-time high. While US oil production declined steadily for approximately 40 years, production changed direction starting in 2007. By 2018, production surpassed 1970 peaks and continued to climb substantially until early 2020. The worldwide pandemic only paused the production in the Permian basin. Increases in production are projected to surpass 2019 highs by as early as 2023. Seismic data began to play a role in oil and gas exploration in the Permian Basin in the late 1960s and 1970s. In the 1980s, regional 2D seismic data sought to define regional geology and larger drillable structures. 3D seismic data only started to contribute significantly in the early 1990s. Unsurprisingly, onshore 3D seismic was quickly adopted in the Midland Basin. From late 1990s through about 2010, land 3D seismic surveys provided the most insightful data for oil and gas exploration in the US and specifically in the Permian Basin. Between 2010 and 2018, tighter station spacings and higher fold incrementally improved the quality of 3D land seismic data for oil and gas exploration. During this same time, companies developing unconventional reservoirs shifted capital expenditures away from geology and geophysics to fund more horizontal drilling and completions. The concept of where to drill was gone and development effectively became a mining operation. The shift from exploration to exploitation treated reservoirs as being homogenous. However, after investing billions of dollars, it turns out that the subsurface is complex and more accurate subsurface predictions are needed to generate dividends on invested capital. High-trace-density (HTD) seismic data is beginning to further define fine-scale geology and produce robust earth models that influence well planning and completions. The evolution of seismic data in the Permian Basin is stunning! 3D seismic began to properly image data that may have been out of plane from 2D seismic surveys. It enabled 3D interpretation of geological bodies and that further advanced by geometric attributes from 3D seismic data. The structure and stratigraphy that these data imaged generated a step change in subsurface interpretation. However, attaining better spatial resolution to illuminate and interpret finer details in the subsurface is needed to drill fewer wells with higher production. This in turn generates the highest return on invested capital. HTD seismic surveys began gaining popularity in the Permian Basin because they provide greater geologic detail to create better well plans. HTD 3D seismic survey designs begin to acquire additional data that previous generations of 3D surveys were missing. These data include finer sampling of both near and far offsets, finer lateral sampling, increased fold, broader frequency spectrums through vibroseis sweep advancements, and fuller azimuthal sampling. By doing so, more detailed reservoir architectures are predicted including faults, fracture networks, rock properties, and geologic heterogeneities. This prediction enables data driven well planning that enables the utilization of capital for the highest possible return.

Permian Basin Reflections: Past, present and future, a look at high trace density (HTD) data over the Fasken C-Ranch and Mud City surveys

*Bruce Karr and Andrew Lewis, Fairfield Geotechnologies; Ron Bianco, Fasken Oil and Ranch

Key Figures

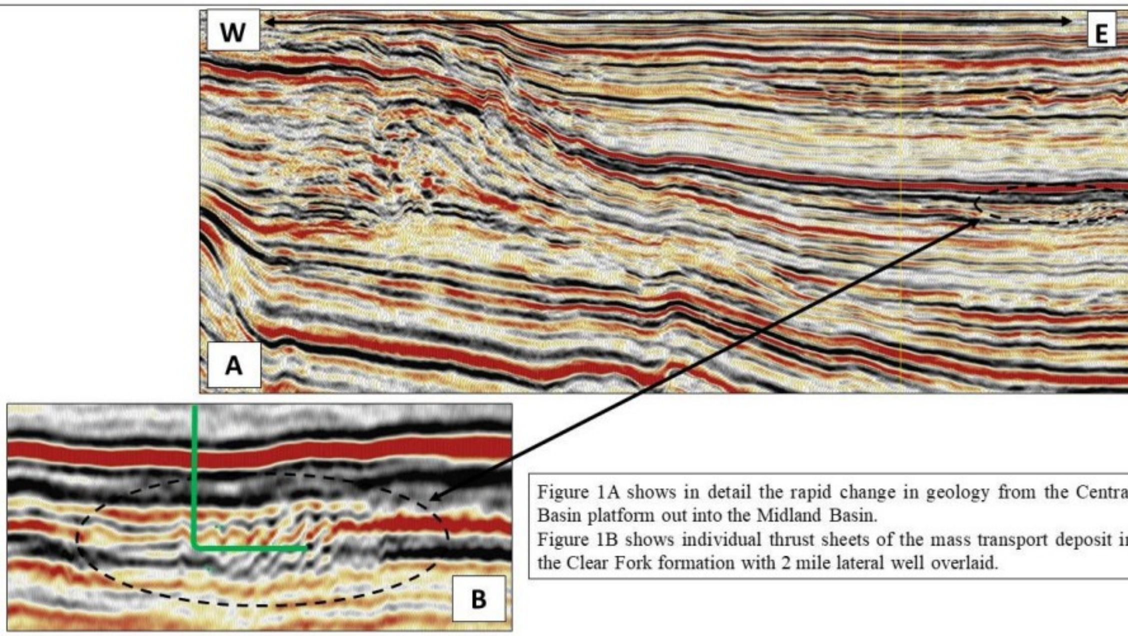
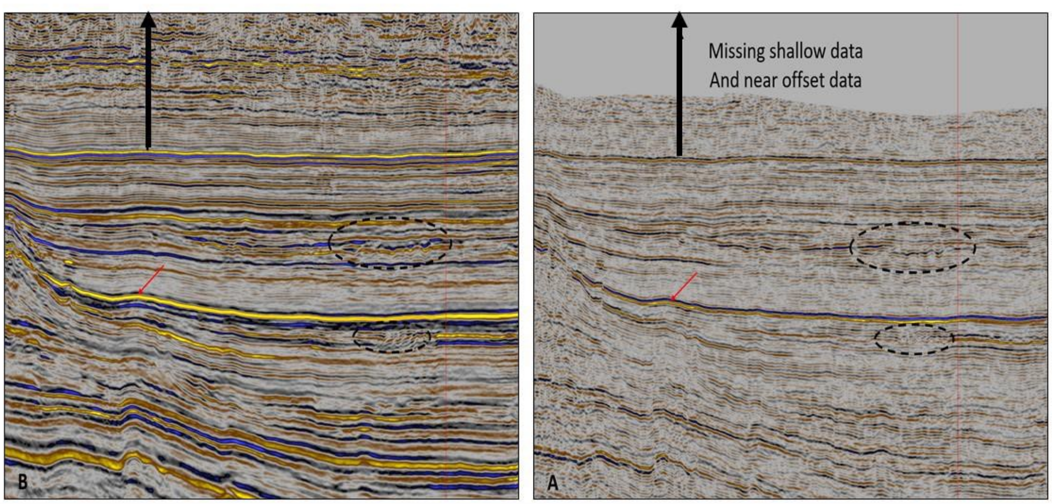


Figure 1A shows in detail the rapid change in geology from the Central Basin platform out into the Midland Basin.
Figure 1B shows individual thrust sheets of the mass transport deposit in the Clear Fork formation with 2 mile lateral well overlaid.

Figure 2: Comparison of the 2009 and HTD 2020 stacks. The red arrow is the BSA, base of the San Andres. The black arrow is a direct relationship to having or not having near offsets. The missing near offsets are why there is missing shallow data. Those near offsets will be used for near angle gathers in elastic property determination and the stack will be used for drilling hazards, freshwater mapping and shallow hydrocarbon potential.



Alan Bai

Seismic Imager at CGG

Biography

Alan Bai received his PhD in Material Chemistry from Queen's University in 2006, and worked as a researcher at University of Calgary. Alan joined CGG in 2014 as a seismic imager. He has worked with data from the East Coast of Canada and offshore Africa with experience in high resolution TTI PSDM velocity model building, 3D SRME and MWD de-multiple as well as 3D de-ghosting. His recent focus involves applying advanced processing technologies to onshore projects in the Permian Basin, including 3D LSRME/IME, FWI and Least Squares Migrations.

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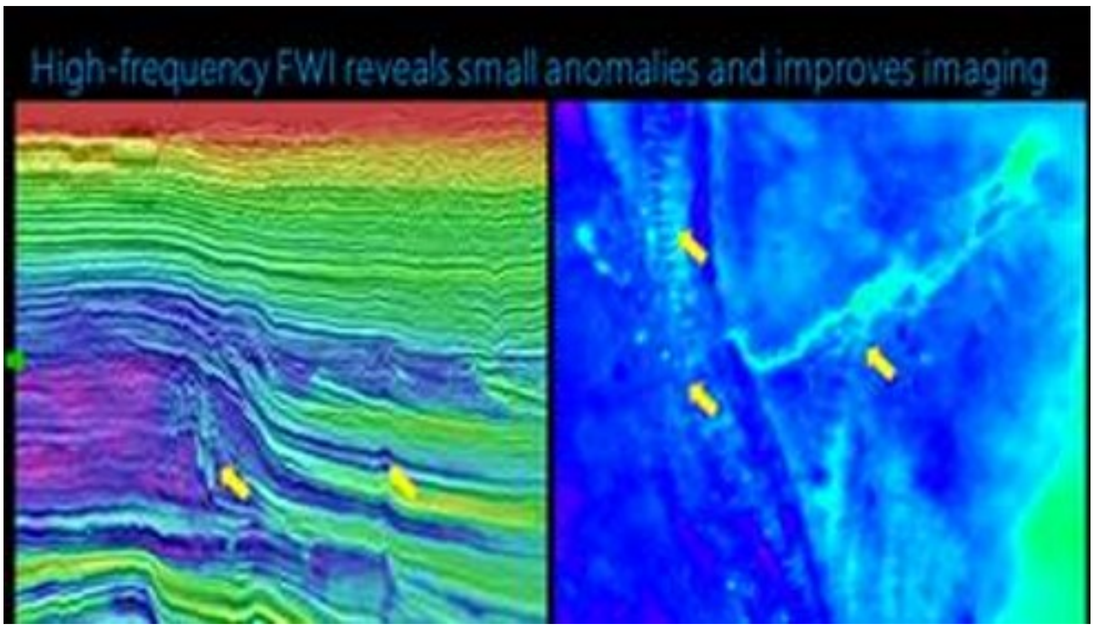
Imaging the Complex Geology in the Central Basin Platform using Land FWI

Alan Bai, CGG

Abstract

Land FWI was successfully applied to a newly acquired dense acquisition in the Central Basin Platform to resolve the complex geology from shallow to deep. The resulting high-resolution velocity model captures fine velocity anomalies and significantly improves the seismic imaging

Key Figures



Bob Springman

GT Seis

Biography

Robert Springman is a geophysical adviser at GTSeis with 49 years of experience in geophysical imaging. His work started in Houston with Geophysical Services, Inc. doing seismic data processing and then interpretation. After leaving GSI he continued his career in seismic interpretation with both large oil and gas companies and small independents in positions as geophysicist, geophysical manager, chief geophysicist and independent geophysical consultant. Areas of experience have been in the G.O.M., Rockies, Mid-Continent, North Texas and various international exploration areas. His work has led to discoveries of many MMBO and hundreds of BCFG. Numerous publications, courses and presentations in geophysical imaging have been made to AAPG conventions, SEG, geophysical society and geological society meetings. He has served five years as the continuing education chair for the GSOC and served in officer positions of the GSOC through president. Presently Vice President of the GSOC and invited instructor of geophysics interpretation at Oklahoma State University. He is a life time member of the GSOC, active member of the DGS and OCGS and emeritus member of the SEG.

Bob earned a B.S. degree in Geology and Mathematics from Oklahoma State University in 1973.

Correct Reservoir Size Estimation with Depth imaging: more than just a single process

Scott Boyer, GT Seis (Presented by Bob Springman, 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, correct geographical location and correct geometry and topology has become paramount for a successful business model that guides drilling, geosteering, completion, fracking and re-fracking, as well as production and EUR estimations.

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 TrueDepth.

The key to being able to produce a high quality image begins with the attention to detail in the pre-processing stages of any project. Employing the right process in the correct manner is a key step to producing the inputs required for the high-end processes that are shown in this presentation.

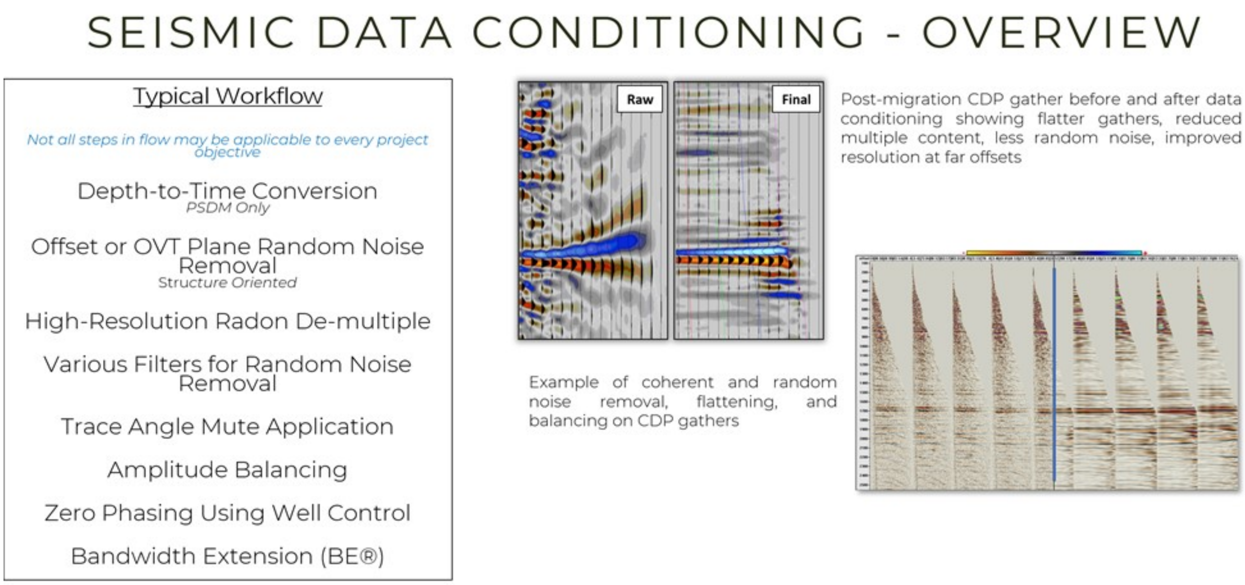
Particularly important has been the development of a new workflow that increases the efficiency and robustness of the techniques. The new workflow incorporates several new pieces of technology making the resulting images more accurate. Some key examples are demonstrated that will help to produce the high quality input that is key to the entire process.

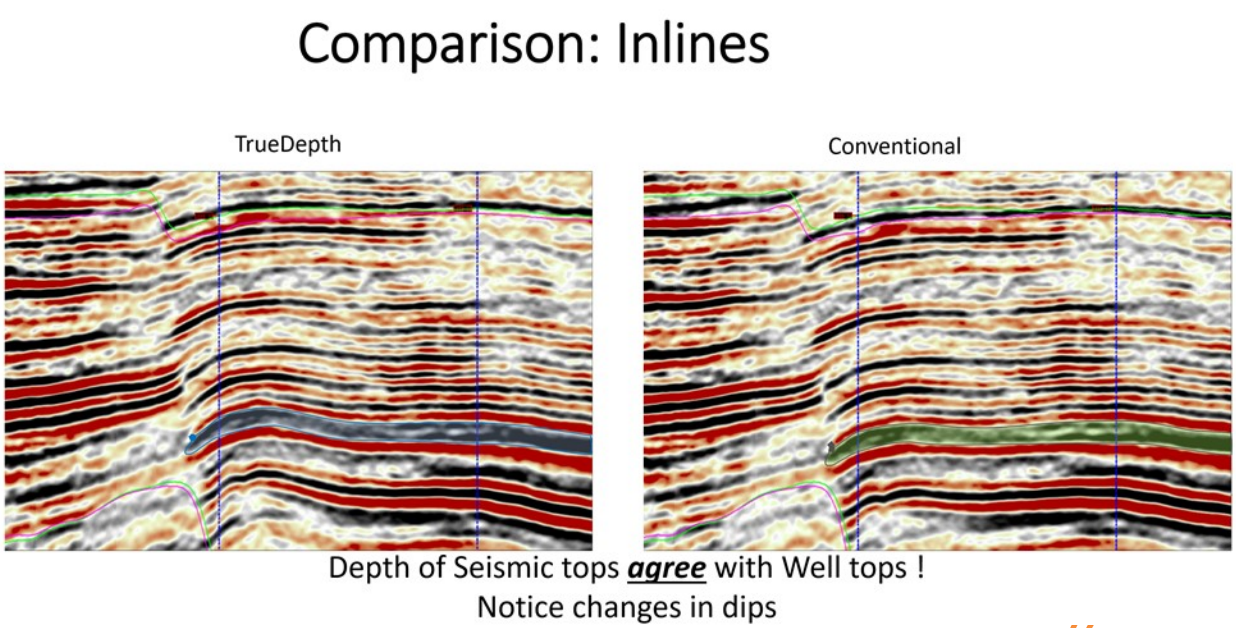
We will finish the article by demonstrating the value of the new workflow and technologies by applying them to real case histories, onshore and offshore.

Correct Reservoir Size Estimation with Depth imaging: more than just a single process

Scott Boyer, GT Seis (Presented by Bob Springman, GTSeis)

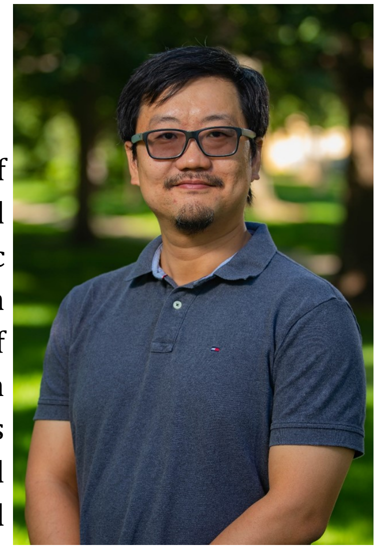
Key Figures





Ge Jin

Colorado School of Mines



Biography

Dr. Ge Jin is Assistant Professor of Geophysics and co-director of Reservoir Characterization Project (rcp.mines.edu) at Colorado School of Mines. His research mainly focuses on Distributed Fiber-Optic Sensing (DFOS) applications in Geophysics. He has been working on DFOS-related research projects since 2014 and has authored dozens of publications and patents in this field. He is also interested in machine-learning applications and seismic imaging. He currently leads a research group focusing on hydraulic fracturing monitoring and reservoir characterization using DFOS measurements. Dr. Jin obtained his Ph.D. in Geophysics from Columbia University in the City of New York, and dual B.S. in Geophysics and Computer Science from Peking University. He worked as a research geophysicist in the oil industry for five years before joining the university in 2019.

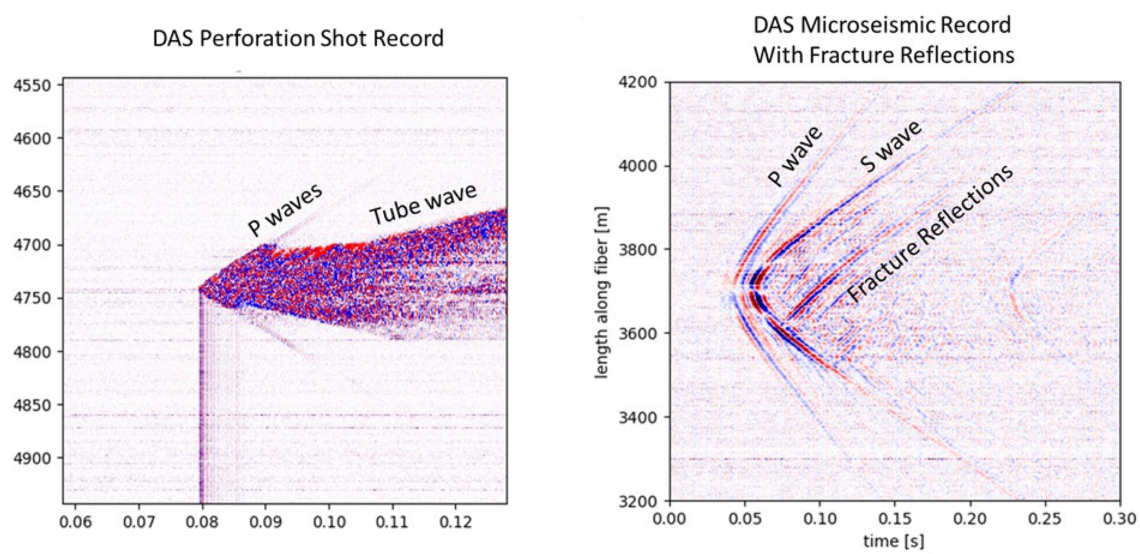
New DAS Applications in Unconventional Reservoir Characterization

Ge Jin, Colorado School of Mines

Abstract

Distributed Acoustic Sensing (DAS) can measure seismic wavefields in unconventional reservoirs with high spatial resolution and large aperture coverage. It can capture highfrequency seismic energies during stimulation operations due to the close proximity to sources. High-resolution seismic signals enable geophysicists to characterize the reservoirs in great detail. This study showcases several recent developments on unconventional reservoir characterization using DAS data. We argue that the seismic energies required for these analyses can be naturally generated during stimulation operations. We first demonstrate that microseismic waveforms can be used to evaluate reservoir thickness and shear velocities using guided wave analysis. We also showcase microseismic based fracture imaging using a workflow modified from standard vertical seismic profiling processing. We then discuss the cases that use perforation shots as seismic sources. DAS data from the same well of the shots can record both P-wave and tube-wave energies. The tube waves are sensitive to near-wellbore fracture connectivity and can be used to evaluate the completion efficiency of individual stages. DAS recorded P waves are sensitive to reservoir lateral heterogeneities. The body wave can appear dispersive if wellbore is approximate to a bedding plane with sharp velocity contrast. With these examples, we hope to convince the geophysicist community that DAS is a promising tool with high potential in unconventional reservoir development. Further research and development can significantly increase the geophysicists' contribution to the field

Key Figure



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Jackson Haffener

Devon

Biography

Jackson attended the University of Oklahoma, getting his bachelors in geophysics in 2015 and masters in 2017. Jackson joined Devon as a geophysical interpreter in the Anadarko basin, before moving to a role focusing on subsurface integration in 2019. Jackson specializes in multivariate analytics, microseismic, optical fiber, and co-visualization with an emphasis on integrating geophysics, geology, completions, and reservoir data.

Did We Break New Rock? Utilizing Diagnostics to Differentiate New Fracture Creation vs Old Fracture Reactivation: A Meramec

Jackson Haffener, Devon

Abstract

Microseismic and cross well strain are both high-end diagnostic tools that provide insight into hydraulic fracture geometry and stimulation effectiveness. However, both datasets have limitations: for example microseismic can over or underestimate the true fracture geometry, while cross well strain is restricted to describing a portion of the fracture geometry it is situated to measure. Furthermore, both datasets can show not only the creation of new hydraulic fractures, but also the reactivation of previously created hydraulic fractures. The focus of this study is two projects where both cross well strain and microseismic were collected and interpreted together to characterize the geometry of new hydraulic fractures and understand the interaction with pre-existing fractures during well stimulation.

The first project is a multi-well development in the Meramec formation of the Anadarko Basin. The second project is Hydraulic Fracturing Test Site 2 (HFTS2) in the Wolfcamp formation of the Delaware Basin. Both projects had low-frequency DAS collected on permanent fibers in offset wells and were monitored with borehole microseismic arrays during stimulations. Organizing the data relative to distance from the active stage and time since stage start, i.e. spatiotemporally, was a key step in understanding what the diagnostics measured during stimulation.

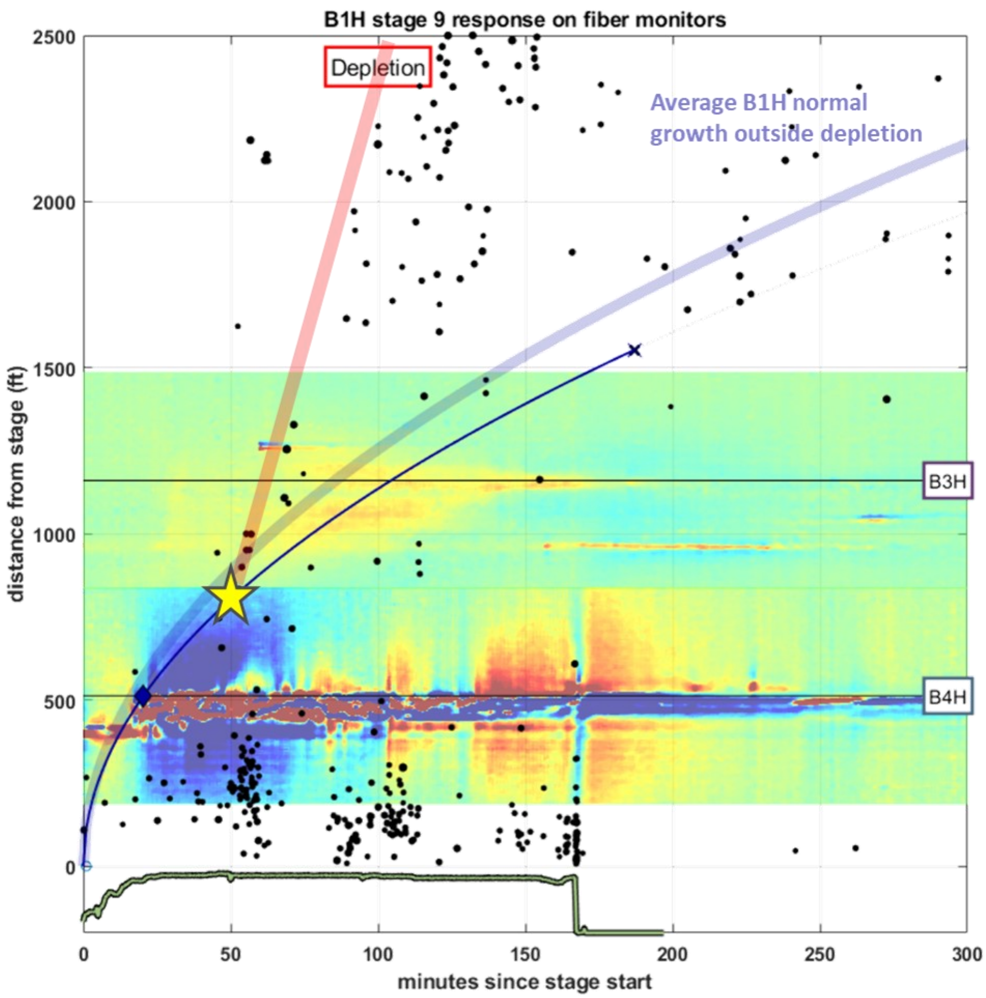
Both projects tell a similar story, where wells have extensive interactions with previously created fractures originating from both parent wells and recently completed child wells. This interaction manifests as a quicker arrival and muted strain response in cross well strain and a more rapid and linear move-out of the triggering front over time in the microseismic. We interpret these signatures to be showing re-dilation of pre-existing fractures. Also visible in the diagnostics are arrivals with slower growth, generating microseismicity with a parabolic move-out of the triggering front over time, and typical strain response with heart shaped tensional front leading the arrival. This signature is interpreted to be new hydraulic fracture creation and growth. Once this reactivation mechanism is understood for a basin it can also be noted and described using lower-cost techniques, such as Sealed-Wellbore Pressure Monitoring (SWPM).

The main motivation for most microseismic and cross well strain studies are understanding hydraulic fracture geometry, however interactions with failed media and analysis of either datatype in isolation can cause misinterpretations extremely far from reality. Understanding the range of possible mechanisms measured by these advanced diagnostics is key in not just accurately characterizing fracture stimulation, but also in understanding the impact of failed media on hydraulic fracture growth. Once understood, these observations can also be used as a baseline to measure success or failure of mitigation trials.

Did We Break New Rock? Utilizing Diagnostics to Differentiate New Fracture Creation vs Old Fracture Reactivation: A Meramec

Jackson Haffener, Devon

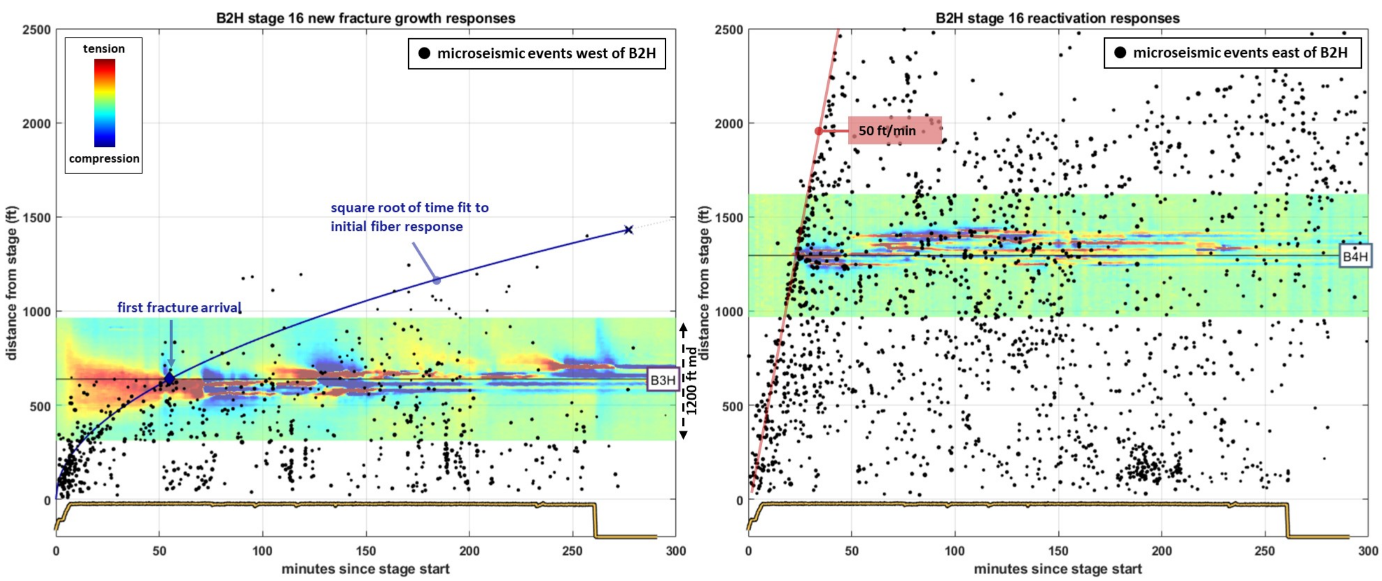
Key Figures



Did We Break New Rock? Utilizing Diagnostics to Differentiate New Fracture Creation vs Old Fracture Reactivation: A Meramec

Jackson Haffener, Devon

Key Figures continued



Ali Tura

Colorado School of Mines

Biography

Ali Tura is Professor of Geophysics and Co-director of Reservoir Characterization Project at Colorado School of Mines. His expertise is in the areas of petroleum systems, reservoir characterization and monitoring, seismic methods, CO2 and sequestration, fiber optic technology and data analytics. He is also Chief Scientist at Tulip Geosciences, a geosciences consulting and training company. Prior to this, he was Geophysical Senior Fellow at ConocoPhillips, Geophysical Advisor at Chevron and 4D subject matter expert at Shell. He has over 30 years of industry and teaching experience. Dr. Tura was the 2021 SEG Distinguished Lecturer.

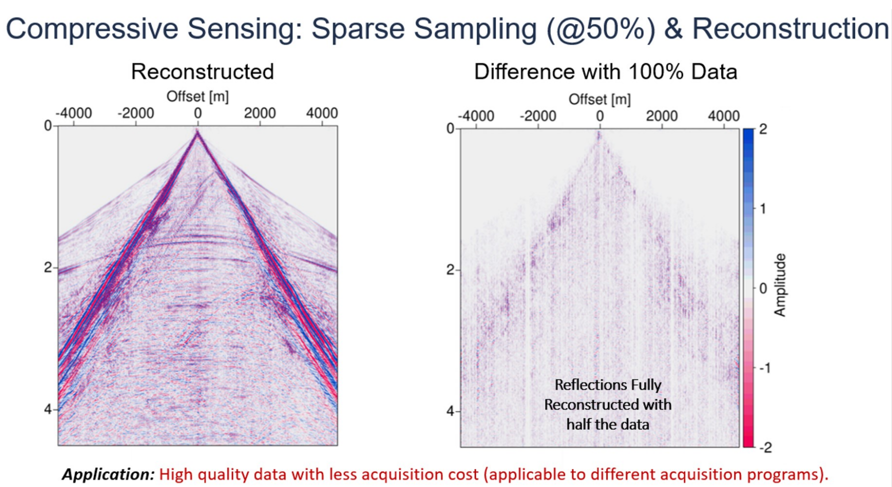
The CCUS Landscape and Vital Role of Geophysics

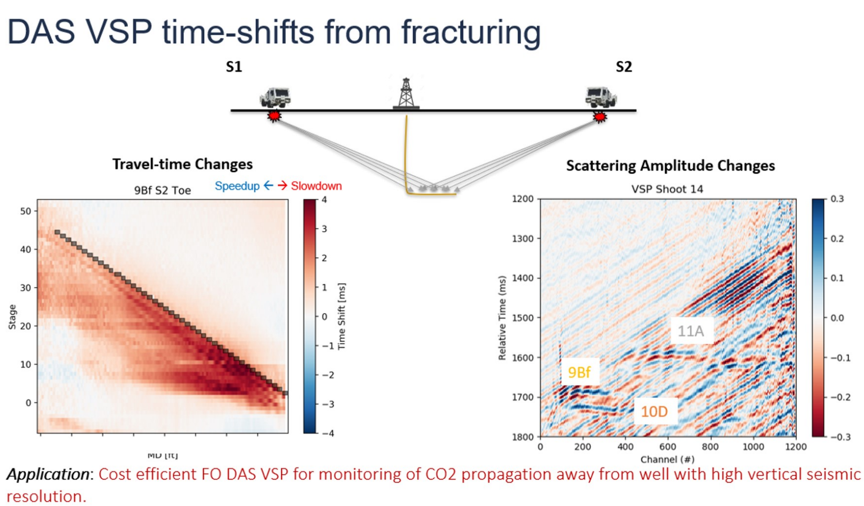
Ali Tura, Colorado School of Mines

Abstract

For this presentation, I will start with going over the important role of geophysics in CCUS requirements and projects. I will discuss the economics of different carbon capture and sequestration options and show why enhanced oil recovery (EOR) related sequestration can be an optimal solution. This can potentially form the best initial path for the energy industry and a reasonably well posed problem for geological and geophysical long-term storage and monitoring. Next I will discuss several research topics: CO2 for EOR in unconventional reservoirs, the risks associated with CO2 leakage in orphan or older wells, and several new geophysical technologies (fiber optics and compressive sensing) for CCUS applications

Key Figures





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