

Welcome to the TCCS Newsletter!

The Texas Consortium for Computational Seismology (TCCS) is a joint initiative of the Bureau of Economic Geology and the Institute for Computational Engineering and Science (ICES) at The University of Texas at Austin. Its mission is to address the most important and challenging research problems in computational geophysics as experienced by the energy industry while educating the next generation of research geophysicists and computational scientists.

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Spring Meeting

The Spring 2016 Research Meeting of the TCCS will take place at the Bureau's Houston Research Center April 10–11, 2017.

Representatives of participating companies are invited to register for the meeting at: <http://www.beg.utexas.edu/tccs/>.



See You in Houston in September

TCCS has submitted 20 expanded abstracts for the 2017 Society of Exploration Geophysicists Annual Meeting in Houston. The papers fall into nine different subject areas: Diffraction Imaging and Modeling, Full Waveform Inversion, Interpretation, Seismic Processing: Migration, Seismic Processing: Interpolation and Regularization, Seismic Theory, Seismic Velocity Estimation, Special Session: Emerging Professionals, and Time Lapse.

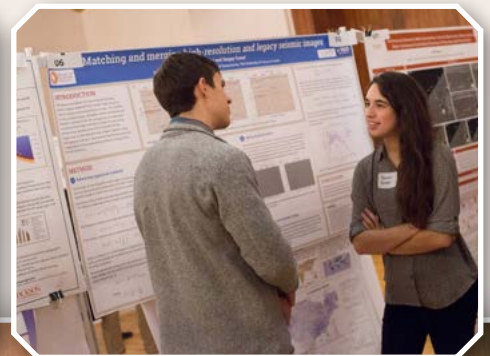


Spring 2017 Jackson School Research Symposium

In February, more than 110 students participated in the 6th Annual Jackson School Research Symposium. Each spring semester, students of the Jackson School of Geosciences at UT Austin present their research in a day-long poster competition evaluated by faculty, research scientists, and industry representatives. The goal of the Symposium, which is sponsored by ConocoPhillips, is to provide cross-disciplinary collaboration among graduate students, undergraduate students, faculty, and research scientists at the Jackson School. This year students from Sergey Fomel's group won the second-place award for the best-represented research group.



Sean Bader discusses his poster "Semiautomatic Seismic to Well Ties" with external judges.



Sarah Greer discusses her poster "Matching and Merging High-Resolution and Legacy Seismic Data" with an industry representative.



Sarah Greer, Yunzhi Shi, Zhiguang Xue, Sean Bader, Mason Phillips, Yanadet Sripanich, and Melody Bechberger (ConocoPhillips representative).

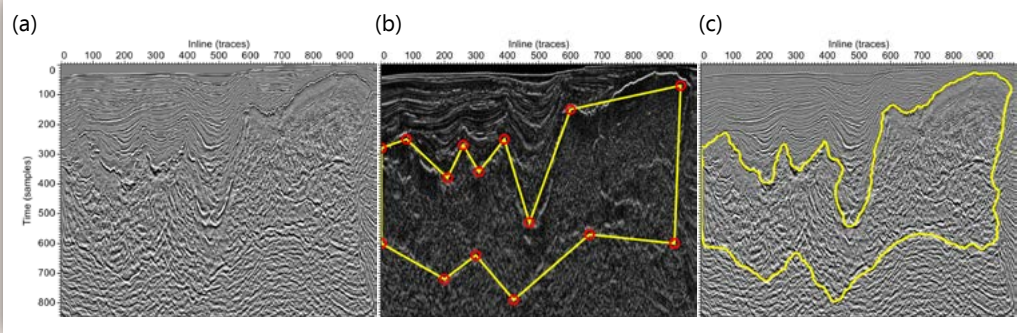
Research Highlights



Xinming Wu has been working on a semiautomatic method to efficiently pick complicated salt boundaries from seismic images.

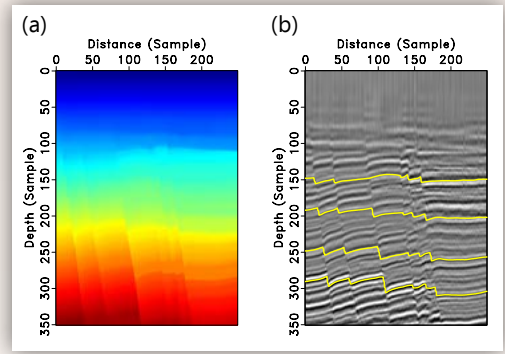
In this method, several control points are first picked near the salt boundary to interpolate an initial curve, which is then updated to the final salt boundary by using an optimal path-picking algorithm.

This method is highly efficient and can be easily implemented to interactively add or move control points, while quickly updating the picked salt boundary. The control points are not required to be exactly on the boundary, which makes the human interactions convenient and efficient. In 3D salt-boundary extraction, the method recursively picks 2D salt boundaries in a sequence of inline or crossline slices and then fits these 2D boundaries to generate a 3D boundary. Human interactions are greatly reduced by using a salt boundary picked in the previous slice as an initial curve for picking in the following slice.



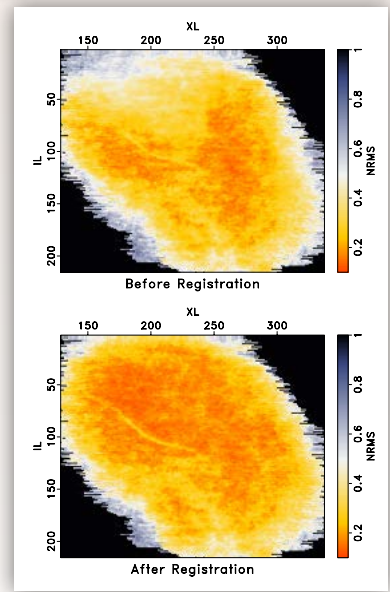
Zhiguang Xue has developed a method to make predictive painting correctly spread information across faults.

Predictive painting is an efficient and accurate algorithm that recursively spreads information from a seed trace to its neighbors by following the local dips. However, it has difficulty spreading information across faults with significant displacement. This problem is addressed by incorporating fault-slip information estimated using local similarity scanning. Figure (a) shows the predictive painting result on a seismic image having six faults, and Figure (b) shows several automatically picked horizons.



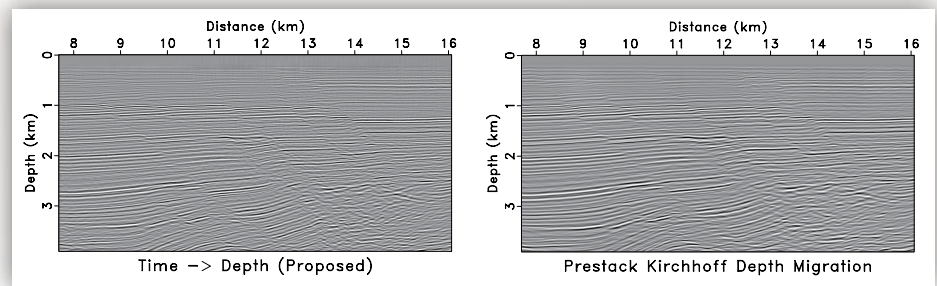
Mason Phillips has been working on applications of modified plane-wave destruction filters for geophysical data analysis. He has developed a method for estimation of time shifts between time lapse seismic images using spectral decomposition.

Time-lapse time shifts are difficult to measure from seismic data in the presence of tuning effects caused by low frequencies or thin beds. They can be measured more accurately by first decomposing time-lapse seismic images into discrete frequency components using the local time-frequency transform. Use of high-frequency components mitigates problems associated with sidelobe interference. Amplitude-adjusted plane-wave destruction filters are used to invert for both time shifts and amplitude changes between time-lapse seismic images at each frequency. Plane-wave destruction filters can accurately and efficiently measure small shifts between seismic traces, making this algorithm particularly effective.



Yanadet Sripanich has been working on a fast approach to time-to-depth conversion and interval velocity estimation in the presence of lateral variations. With an assumption of mild variations, this problem is greatly simplified and implemented in a straightforward manner.

In practice, we observe a speedup by a factor of 10 from this approach compared to previous algorithms, while the results maintain reasonable accuracy.



Accepted	<p>P. Karimi, S. Fomel, and R. Zhang, 2017, Creating detailed subsurface models using predictive image-guided well-log interpolation: Interpretation, accepted.</p> <p>Y. Sripanich, S. Fomel, J. Sun, and J. Cheng, 2016, Elastic wave-vector decomposition in heterogeneous anisotropic media: Geophysical Prospecting, accepted.</p> <p>A. Stovas and S. Fomel, 2016, The modified generalized moveout approximation: a new parameter selection: Geophysical Prospecting, accepted.</p> <p>B. Tong, I. Tsvankin, and X. Wu, 2017, Waveform inversion for attenuation estimation in anisotropic media: Geophysics, accepted.</p> <p>G. Wu, S. Fomel, and Y. Chen, 2017, Data-driven time-frequency analysis of seismic data using nonstationary Prony method: Geophysical Prospecting, accepted.</p> <p>X. Wu, 2017, Structure-, stratigraphy-, and fault-guided regularization in geophysical inversion: Geophysical Journal International, accepted.</p>
Published 2017	<p>H. Chen, H. Zhou, Q. Zhang, and Y. Chen, 2017, Modeling elastic wave propagation using k-space operator-based temporal high-order staggered-grid finite-difference method: IEEE Transactions on Geoscience and Remote Sensing, v. 55, 801–815.</p> <p>L. Decker, D. Merzlikin, and S. Fomel, 2017, Diffraction imaging and time-migration velocity analysis using oriented velocity continuation: Geophysics, v. 82, U25–U35.</p> <p>B. Engquist, C. Frederick, Q. Huynh, and H. Zhou, 2017, Seafloor identification in sonar imagery via simulations of Helmholtz equations and discrete optimization: Journal of Computational Physics, v. 338, 477–492.</p> <p>D. Merzlikin and S. Fomel, 2016, Analytical path-summation imaging of seismic diffractions: Geophysics, v. 82, S51–S59.</p> <p>D. Merzlikin, T. A. Meckel, S. Fomel, and Y. Sripanich, 2017, Diffraction imaging of high-resolution 3D P-cable data from the Gulf of Mexico using azimuthal plane-wave destruction: First Break, v. 35, 35–41.</p> <p>Y. Sripanich, S. Fomel, A. Stovas, and Q. Hao, 2017, 3D generalized nonhyperboloidal moveout approximation: Geophysics, v. 82, C49–C59.</p> <p>X. Wu, 2017, Building 3D subsurface models conforming to seismic structural and stratigraphic features: Geophysics, v. 82, IM21–IM30.</p> <p>X. Wu, 2017, Directional structure-tensor based coherence to detect seismic channels and faults: Geophysics, v. 82, A13–A17.</p> <p>X. Wu and G. Caumon, 2017, Simultaneous multiple well-seismic ties with flattened synthetic and real seismograms: Geophysics, v. 82, IM13–IM20.</p> <p>R. Zhang and S. Fomel, 2017, Time-variant wavelet extraction with a local-attribute-based time-frequency decomposition for seismic inversion: Interpretation, v. 5, SC9–SC16.</p>
Published 2016	<p>M. Bai, X. Chen, J. Wu, G. Liu, Y. Chen, H. Chen, and Q. Li, 2016, Q-compensated migration by Gaussian beam summation method: Journal of Geophysics and Engineering, v. 13, 25–48.</p> <p>Y. Chen, 2016, Dip-separated structural filtering using seislet transform and adaptive empirical mode decomposition based dip filter: Geophysical Journal International, v. 206, 457–469.</p> <p>Y. Chen, W. Huang, D. Zhang, and W. Chen, 2016, An open-source Matlab code package for improved rank-reduction 3D seismic data denoising and reconstruction: Computers & Geosciences, v. 95, 59–66.</p> <p>Y. Chen and Z. Jin, 2016, Simultaneously removing noise and increasing resolution of seismic data using waveform shaping: IEEE Geoscience and Remote Sensing Letters, v. 13, 102–104.</p> <p>Y. Chen, J. Ma, and S. Fomel, 2016, Double sparsity dictionary for seismic noise attenuation: Geophysics, v. 81, V17–V30.</p> <p>Y. Chen, D. Zhang, Z. Jin, X. Chen, S. Zu, W. Huang, and S. Gan, 2016, Simultaneous denoising and reconstruction of 5-D seismic data via damped rank-reduction method: Geophysical Journal International, v. 206, 1695–1717.</p> <p>P. Deng, Y. Chen, Y. Zhang, and H.-W. Zhou, 2016, Weighted stacking of seismic AVO data using hybrid AB semblance and local similarity: Journal of Geophysics and Engineering, v. 13, 152–163.</p> <p>M. Far and B. Hardage, 2016, Fracture characterization using converted waves: Geophysical Prospecting, v. 64, 287–298.</p> <p>S. Gan, S. Wang, Y. Chen, J. Chen, W. Zhong, and C. Zhang, 2016, Improved random noise attenuation using f-x empirical mode decomposition and local similarity: Applied Geophysics, v. 13, 127–134.</p> <p>S. Gan, S. Wang, Y. Chen, and X. Chen, 2016, Simultaneous-source separation using iterative seislet-frame thresholding: IEEE Geoscience and Remote Sensing Letters, v. 13, 197–201.</p> <p>S. Gan, S. Wang, Y. Chen, X. Chen, W. Huang, and H. Chen, 2016, Compressive sensing for seismic data reconstruction via fast projection onto convex sets based on seislet transform: Journal of Applied Geophysics, v. 130, 194–208.</p> <p>S. Gan, S. Wang, Y. Chen, X. Chen, and K. Xian, 2016, Separation of simultaneous sources using a structural-oriented median filter in the flattened dimension: Computers & Geosciences, v. 86, 46–54.</p> <p>S. Gan, S. Wang, Y. Chen, S. Qu, and S. Zu, 2016, Velocity analysis of simultaneous-source data using high-resolution semblance—coping with the strong noise: Geophysical Journal International, v. 204, 768–779.</p> <p>W. Huang, R. Wang, Y. Chen, H. Li, and S. Gan, 2016, Damped multichannel singular spectrum analysis for 3D random noise attenuation: Geophysics, v. 81, V261–V270.</p> <p>Y. Lee and B. Engquist, 2016, Multiscale numerical methods for passive advection–diffusion in incompressible turbulent flow fields: Journal of Computational Physics, v. 317, 33–46.</p> <p>H. Li, R. Wang, S. Cao, Y. Chen, and W. Huang, 2016, A method for low-frequency noise suppression based on mathematical morphology in microseismic monitoring: Geophysics, v. 81, V159–V167.</p> <p>H. Li, R. Wang, S. Cao, Y. Chen, N. Tian, and X. Chen, 2016, Weak signal detection using multiscale morphology in microseismic monitoring: Journal of Applied Geophysics, v. 133, 39–49.</p> <p>W. Liu, S. Cao, Y. Chen, and S. Zu, 2016, An effective approach to attenuate random noise based on compressive sensing and curvelet transform: Journal of Geophysics and Engineering, v. 13, 135–145.</p> <p>W. Liu, S. Gao, and Y. Chen, 2016, Seismic time–frequency analysis via empirical wavelet transform: IEEE Geoscience and Remote Sensing Letters, v. 13, 28–32.</p> <p>W. Liu, S. Gao, Y. Liu, and Y. Chen, 2016, Synchrosqueezing transform and its application in seismic data analysis: Journal of Seismic Exploration, v. 25, 27–44.</p> <p>S. Qu, H. Zhou, R. Liu, Y. Chen, S. Zu, S. Yu, J. Yuan, and Y. Yang, 2016, Deblending of simultaneous-source seismic data using fast iterative shrinkage-thresholding algorithm with firm-thresholding: Acta Geophysica, v. 64, 1064–1092.</p> <p>Y. Sripanich and S. Fomel, 2016, Theory of interval traveltimes parameter estimation in layered anisotropic media: Geophysics, v. 81, C253–C263.</p> <p>A. Stovas and S. Fomel, 2016, Mapping of moveout attributes using local slopes: Geophysical Prospecting, v. 64, 31–37.</p> <p>J. Sun, S. Fomel, and L. Ying, 2016, Lowrank one-step wave extrapolation for reverse-time migration: Geophysics, v. 81, S39–S54.</p> <p>J. Sun, S. Fomel, T. Zhu, and J. Hu, 2016, Q-compensated least-squares reverse-time migration using lowrank one-step wave extrapolation: Geophysics, v. 81, S271–S279.</p> <p>J. Wu, R. Wang, Y. Chen, Y. Zhang, S. Gan, and C. Zhou, 2016, Multiple attenuation using shaping regularization with seislet domain sparsity constraint: Journal of Seismic Exploration, v. 25, 1–9.</p> <p>Z. Xue, Y. Chen, S. Fomel, and J. Sun, 2016, Imaging incomplete data and simultaneous-source data using least-squares reverse-time migration with shaping regularization: Geophysics, v. 81, S11–S20.</p> <p>Y. Xue, J. Yang, J. Ma, and Y. Chen, 2016, Amplitude-preserving nonlinear adaptive multiple attenuation using the high-order sparse Radon transform: Journal of Geophysics and Engineering, v. 13, 207–219.</p> <p>D. Zhang, Y. Chen, W. Huang, and S. Gan, 2016, Multi-step damped multichannel singular spectrum analysis for simultaneous reconstruction and denoising of 3D seismic data: Journal of Geophysics and Engineering, v. 13, 704–720.</p> <p>H. Zhu and S. Fomel, 2016, Building good starting models for full waveform inversion using adaptive matching filter: Geophysics, v. 81, U61–U72.</p> <p>H. Zhu, S. Li, S. Fomel, G. Stadler, and O. Ghattas, 2016, A Bayesian approach to estimate uncertainty for full-waveform inversion using a priori information from depth migration: Geophysics, v. 81, R307–R323.</p> <p>T. Zhu, 2016, Implementation aspects of attenuation compensation in reverse-time migration: Geophysical Prospecting, v. 64, 657–670.</p> <p>T. Zhu, J. Carcione, and M. Botelho, 2016, Reverse-time imaging of ground-penetrating radar and SH-seismic data including the effects of wave loss: Geophysics, v. 81, H21–H32.</p> <p>T. Zhu and J. Sun, 2016, Viscoelastic reverse-time migration with attenuation compensation: Geophysics, v. 82, S61–S73.</p> <p>S. Zu, H. Zhou, Y. Chen, S. Qu, X. Zou, H. Chen, and R. Liu, 2016, A periodically varying code for improving deblending of simultaneous sources in marine acquisition: Geophysics, v. 81, V213–V225.</p>

TCCS Staff

The TCCS group consists of scholars from five countries who have come together to move science forward. Our research staff includes two principal investigators, six Ph.D. students, two M.S. students, a postdoc, a B.S. student, and a senior research fellow:

Sean Bader (M.S. 1st year)
 Luke Decker (Ph.D. 1st year)
 Björn Engquist (PI)
 Sergey Fomel (PI)
 Sarah Greer (B.S. 3rd year)
 Dmitrii Merzlikin (Ph.D. 3rd year)
 Mason Phillips (M.S. 2nd year)
 Karl Schleicher (Senior Research Fellow)
 Yunzhi Shi (Ph.D. 2nd year)

Yanadet Sripanich (Ph.D. 4th year)
 Zhiguang Xue (Ph.D. 4th year)
 Yunan Yang (Ph.D. 4th year)
 Xinming Wu (Postdoc)

For more information, see
<http://www.beg.utexas.edu/tccs/staff>.

Testimonial



Junzhe Sun

I made one of the best decisions in my life to join TCCS and pursue a Ph.D. degree under the supervision of Dr. Sergey Fomel. TCCS is a multidisciplinary collaboration between Geophysics and Computational Science, and it provides abundant opportunities to interact with world-leading geoscientists and mathematicians, and unparalleled resources in supercomputing. In TCCS, Dr. Fomel cultivates independent thinking and problem-solving, while encouraging collaboration across different disciplines. I am fortunate to have known and worked with some of the brightest minds during my four-and-a-half years in the group, and will continue to benefit from what I learned from them.

Ph.D. Dissertations

Name	Year	Title	Current Employer
Junzhe Sun	2016	Seismic Modeling and Imaging in Complex Media Using Low-Rank Approximation	ExxonMobil
Yangkang Chen	2015	Noise Attenuation in Seismic Data from the Simultaneous-Source Acquisition	Oak Ridge National Laboratory
Parvaneh Karimi	2015	Seismic Interpretation Using Predictive Painting	PGS
Vladimir Bashkardin	2014	Phase-Space Imaging of Reflection Seismic Data	BP
Christina Frederick	2014	Numerical Methods for Multiscale Inverse Problems	Georgia Institute of Technology
Siwei Li	2014	Imaging and Velocity Model Building with Linearized Eikonal Equation and Upwind Finite-Differences	Chevron
Jack Poulson	2012	Fast Parallel Solution of Heterogeneous 3D Time-Harmonic Wave Equations	Google
Xiaolei Song	2012	Application of Fourier Finite Differences and Lowrank Approximation Method for Seismic Modeling and Subsalt Imaging	BP
Paul Tsuji	2012	Fast Algorithms for Frequency-Domain Wave Propagation	Sandia National Laboratory
William Burnett	2011	Multiazimuth Velocity Analysis Using Velocity-Independent Seismic Imaging	ExxonMobil

M.S. Theses

Kelly Regimbal	2016	Improving Resolution of NMO Stack Using Shaping Regularization	ExxonMobil
Ryan Swindeman	2015	Iterative Seismic Data Interpolation Using Plane-Wave Shaping	BHP Billiton
Luke Decker	2014	Seismic Diffraction Imaging Methods and Applications	The University of Texas at Austin
Shaunak Ghosh	2013	Multiple Suppression in the t-x-p Domain	CGG
Salah Alhadab	2012	Diffraction Imaging of Sediment Drifts in Canterbury Basin	Saudi Aramco
Yihua Cai	2012	Spectral Recomposition and Multicomponent Seismic Image Registration	Shell

B.S. Honors Theses

Lubna Barghouty	2013	Surface-Related Multiple Elimination and Velocity-Independent Imaging of a 2D Seismic Line from the Viking Graben Dataset	MIT
Yanadet Sripanich	2013	An Efficient Algorithm for Two-Point Seismic Ray Tracing	The University of Texas at Austin