Welcome to the fifth *TCCS Newsletter*!

The Texas Consortium for Computational Seismology is a joint initiative of the Bureau of Economic Geology (BEG) and the Institute for Computational Engineering and Sciences (ICES) at UT 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.

In this newsletter, you will find latest updates on our research, professional awards, job opportunities, and staff changes.

## TCCS Sponsors

TCCS appreciates the support of its sponsors: BP, CGG, Chevron, ConocoPhillips, ExxonMobil, Saudi Aramco, Schlumberger, Shell, Statoil, and Total.

For sponsorship opportunities, please contact sergey.fomel@beg.utexas.edu.

## Spring Meeting

The Spring 2014 Research Meeting of the TCCS was held in Houston on March 20–21 at the BEG Houston Research Center. More than 70 people attended the meeting, including representatives from 10 sponsor companies. The meeting's 20 presentations included research presentations by TCCS staff and guest lectures by Jianwei Ma (Harbin Institute of Technology), Tip Meckel (BEG), and Yu Zhang (ConocoPhillips).

The meeting agenda is available at http://www.beg.utexas.edu/tccs/docs/2014_1_Agenda.pdf.

Presentations and report materials from the meeting are available to sponsors at the members area of the website: http://www.beg.utexas.edu/tccs/private/index.php.



## See You in Denver

TCCS submitted 18 expanded abstracts to the 2014 SEG Annual Meeting in Denver. These papers fall into 12 different subject areas: Acquisition, Anisotropy, Full Waveform Inversion, Interpretation, Seismic Modeling, Seismic Processing: Interpolation and Regularization, Seismic Processing: Migration, Seismic Processing: Multiples, Seismic Processing: Noise Attenuation, Seismic Theory, Seismic Velocity Estimation, and RARA (Recent Advances and the Road Ahead).

**Hejun Zhu** is working on two projects associated with frequency-domain full waveform inversion (FWI). The first project is to estimate model uncertainties for FWI by using prior information from depth migration. Figure (a) shows two depth profiles drawn from the prior (left) and posterior (right) distributions through the middle of the classic 2D Marmousi model. Model uncertainties are significantly reduced at shallow depths, while at greater depths the uncertainties are just slightly reduced. The second project is to implement the 3D frequency-domain FWI based on the fast parallel sweeping preconditioner solver. Figure (b) shows a recovered SEG/EAGE overthrust model after 40 nonlinear conjugate gradient iterations.
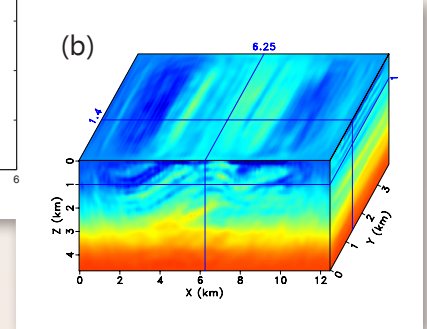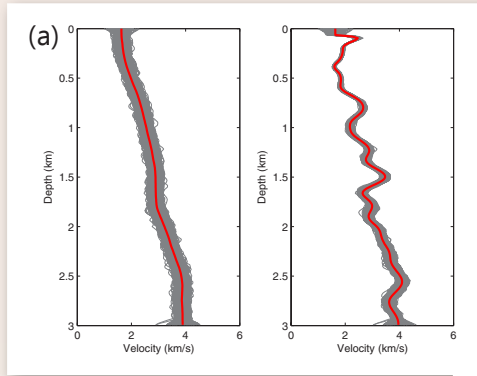


**Luke Decker** has been working with Xavier Janson of the BEG's Reservoir Characterization Research Laboratory and Sergey Fomel to investigate the potential diffractions have for assisting interpreters. Applying diffraction imaging techniques to some of Dr. Janson's synthetic carbonate models allows us to resolve geologically interesting features better than with conventional reflection imaging. The images show a series of voids and a karst interface. Diffraction imaging can enable the interpreter to better resolve void edges and discern where voids are superimposed on each other in the image.



Conventional Image

Diffraction Image
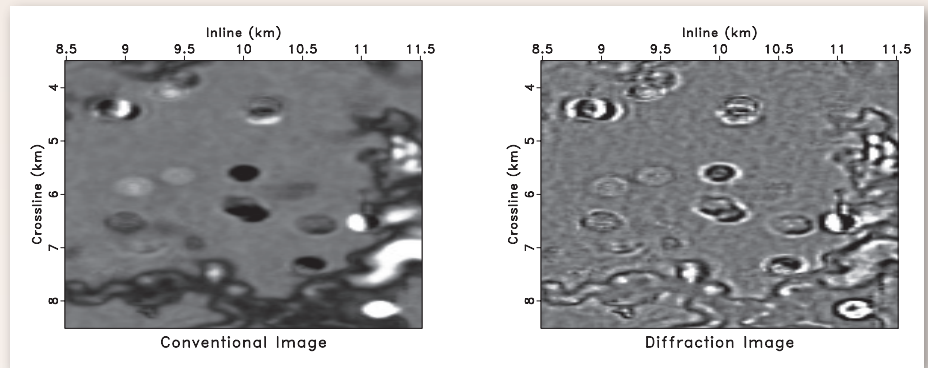
**Yanadet Sripanich** has developed anelliptic approximations for qP phase and group velocities in TTI and orthorhombic media. In TTI media, both phase- and group-velocity approximations represent more accurate alternatives to previously known approximations. The figures show the relative error generated using the parameters of Schoenberg and Helbig's standard model of the new group-velocity approximation in orthorhombic media, which incurs the maximum error of only about 0.5%.
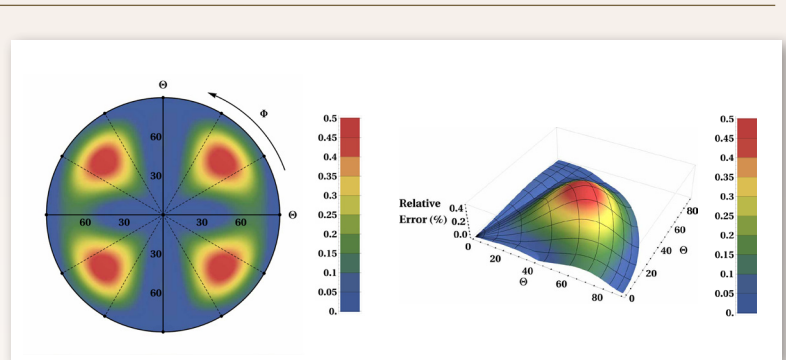


**Junzhe Sun** developed low-rank one-step forward/adjoint wave propagation operators and applied them to attenuation compensation using least-squares reverse-time migration (LSRTM). LSRTM is capable of recovering the true amplitude of subsurface reflectors through conjugate gradient iterations, improving the illumination of conventional visco-acoustic RTM images. An alternative approach is to use Q-compensated RTM, which requires less computation but may suffer from stability issues.



Acoustic

Viscoacoustic

Q−compensated

LSRTM
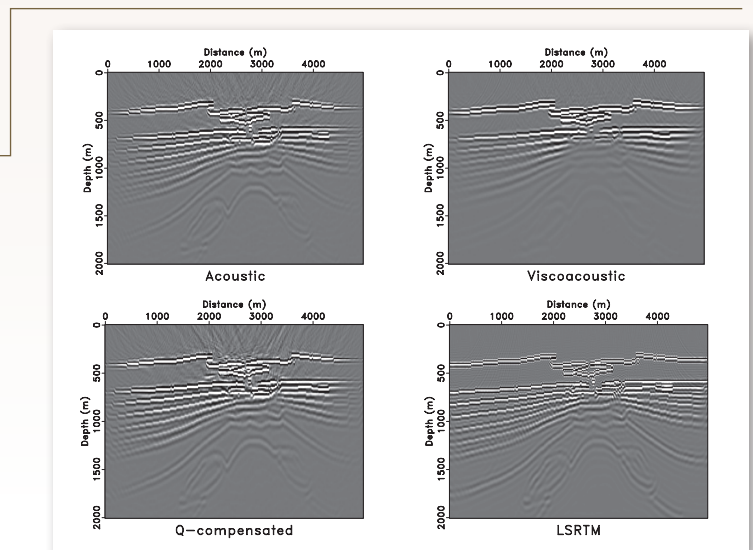
# Professional Awards

▶ **Luke Decker** is the recipient of the 2014 Best SEG Student Poster Award for his poster *Comparison of seismic diffraction imaging techniques: plane wave destruction versus apex destruction* (L. Decker, A. Klokov, and S. Fomel) presented at the 2013 SEG Annual Meeting.

▶ **Sergey Fomel**'s paper, *Wave-equation time migration*, presented at the 2013 SEG Annual Meeting, was included on the Top 30 SEG Presentations list. This was the 12th of Sergey's SEG presentations to appear on the list.

▶ The paper *Seismic wave extrapolation using lowrank symbol approximation* (S. Fomel, L. Ying, and X. Song), published last year by *Geophysical Prospecting*, was recognized with the 2014 Tinker Family BEG Publication Award from the Bureau of Economic Geology, given to **Sergey Fomel** "for his exemplary publication record in exploration geophysics and his dedication to the development of the open-source software Madagascar." The BEG publication award was established to recognize exemplary publications of demonstrated or expected scientific or economic impact, or those that otherwise increase the visibility of the BEG scientific community. It was renamed in 2014 in recognition of Scott and Allyson Tinker's generous financial contribution toward a permanent fund to endow this award in perpetuity.

▶ **Siwei Li** was awarded the second-place Best Student Paper by the Energy Theme of the Jackson School of Geosciences at UT Austin for *First-break traveltime tomography with the double-square root eikonal equation* (S. Li, A. Vladimirsky, and S. Fomel), published last year by *Geophysics*. The award came with a cash prize thanks to a generous donation from Occidental Petroleum.

# Job Opportunities at UT Austin

Several job opportunities in exploration geophysics and computational sciences are currently open at The University of Texas at Austin.

## ▶ UTIG Shell Chair in Geophysics

The UT Institute for Geophysics, an organized research unit in the Jackson School of Geosciences, is seeking applicants for the Shell Chair in Geophysics. Appointment will be at the most senior level within the Institute, and applicants with significant research experience in industry and academia are encouraged to apply.

The successful applicant will be expected to establish an externally funded research program that addresses today's most relevant problems in applied geophysics. Among the areas of research interests are reflection seismology with an emphasis on 3D imaging and/or time lapse (4D) observations, inversion of geophysical data, and geomechanics and geodynamics.

A joint appointment with the Department of Geological Sciences, the teaching and degree-granting unit of the Jackson School, may be possible depending on the applicant's professional experience, interests, and the teaching needs of the department. http://www.ig.utexas.edu/jobs/ShellChair.htm.

## ▶ ICES Moncrief Endowed Faculty Positions

The Institute for Computational Engineering and Sciences is engaged in a comprehensive initiative to bring advances in computer modeling and simulation to bear on the scientific and engineering challenges that affect our nation's well-being and competitiveness. In support of this goal, the ICES Initiative for Simulation-Based Engineering and Sciences is searching for outstanding researchers in computational science and engineering to fill endowed faculty positions at the Associate Professor level and higher. Searches are underway to find world-leading researchers in three areas: 1) computational geophysical fluid dynamics, with particular interest in ocean modeling; 2) structural bioinformatics, the computational modeling of structure and function of biological macromolecules; and 3) the broad area of predictive science and uncertainty quantification in computational science and engineering. These endowed positions will provide the successful candidates with the resources and environment needed to tackle frontier problems in science and engineering via advanced modeling and simulation. The initiative builds on the world-leading program at ICES in Computational Science, Engineering, and Mathematics (CSEM), which features 16 research centers and groups as well as a graduate degree program in CSEM.

Candidates for these new positions are expected to have an exceptional track record in interdisciplinary research at the intersection of advanced mathematical and computational techniques and target scientific and engineering problems. http://www.ices.utexas.edu/moncrief-endowed-positions-app/.

## ▶ Department of Geological Sciences Assistant Professor in Geophysics

The Department of Geological Sciences in the Jackson School of Geosciences seeks to hire two tenure-track faculty members in the field of geophysics at the Assistant Professor level. We are looking for outstanding scientists who will establish an innovative, externally-funded research program and will be committed to education, including both teaching and mentoring at the undergraduate and graduate levels. A Ph.D. is required by the expected start date.

For these positions, we seek individuals in two broad areas of geophysics: Exploration Geophysics and Solid Earth Geophysics. Candidates with specializations in reflection seismic processing, imaging, interpretation, and inversion are encouraged to apply. High-performance computational facilities are available, and candidates would be encouraged to use them to image, visualize, and interpret 3D and 4D geophysical data. Applicants with specializations in near-surface geophysics are also encouraged to apply. Successful candidates will engage with other geophysics faculty, staff, and students to continue to grow a highly competitive energy research portfolio.

The Department of Geological Sciences is part of the Jackson School of Geosciences (JSG), which also includes two research units, the Institute for Geophysics and the Bureau of Economic Geology. With over 190 research scientists and faculty, the JSG is one of the largest academic earth science schools in the country. The University of Texas is also home to the Texas Advanced Computing Center (TACC), an NSF XSEDE facility for high-performance computing. http://www.seg.org/careers/employees/view-jobs/joblist/2013/utexas-121213.

## TCCS Staff

The TCCS group consists of people from six different countries who have come together to move science forward. Our research staff includes Principal Investigators, Postdocs, Ph.D. students, M.S. students, B.S. Honors students, and a Senior Research Fellow:

Yangkang Chen (Ph.D. 2nd year)
Luke Decker (M.S. 2nd year)
Björn Engquist (PI)
Mehdi Far (Postdoc)
Sergey Fomel (PI)
Brittany Froese (Postdoc)
Jingwei Hu (Postdoc)
Parvaneh Karimi (Ph.D. 4th year)
Siwei Li (Ph.D. 5th year)

Karl Schleicher (Senior Research Fellow)
Yanadet Sripanich (Ph.D. 1st year)
Junzhe Sun (Ph.D. 2nd year)
Rian Swindeman (M.S. 1st year)
Zhiguang Xue (Ph.D. 1st year)
Hejun Zhu (Postdoc)

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

## New Face

**Jianwei Ma** is the J. T. Oden Faculty Fellow from March to September, 2014. He received his Ph.D. in solid mechanics from Tsinghua University, China, in 2002. He was an Assistant Professor and Associate Professor at Tsinghua University from 2006 to 2010. He has been a Professor and Vice Dean at the Department of Mathematics, Harbin Institute of Technology, China, since July 2011. He was a Postdoctoral Researcher and since 2002 has been a visiting scholar at the University of Cambridge, University of Grenoble I, EPFL, Ecole des Mines de Paris, and Florida State University. His research interests include sparse transforms, compressed sensing, and geophysics.

### Ph.D. Dissertations

| Name | Year | Title | Current Employer |
|---|---|---|---|
| Vladimir Bashkardin | 2014 | Phase-Space Imaging of Reflection Seismic Data | BP |
| 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 | Georgia Institute of Technology |
| 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

| Name | Year | Title | Current Employer |
|---|---|---|---|
| Luke Decker | 2014 | Seismic Diffraction Imaging Methods and Applications | Chevron |
| 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

| Name | Year | Title | Current Employer |
|---|---|---|---|
| Lubna Barghouty | 2013 | Surface-Related Multiple Elimination and Velocity-Independent Imaging of a 2D Seismic Line from the Viking Graben Dataset | Saudi Aramco |
| Yanadet Sripanich | 2013 | An Efficient Algorithm for Two-Point Seismic Ray Tracing | University of Texas at Austin |

## Testimonials

### Luke Decker
(M.S. 2014)

*I am amazed by the education and professional development I enjoyed at TCCS. Being surrounded by intelligent, engaged, and supportive people helped me easily find collaborators and mentors. The incredible resources provided by the Bureau of Economic Geology meant that I always had the materials and support I needed to do my research as well as I could.*

### Siwei Li
(Ph.D. 2014)

*I feel lucky to have been with TCCS since its birth. The consortium promotes closer relationships between our individual researches and the frontier of industry challenges. One unique feature of TCCS in my opinion is its encouragement of broad vision and active collaboration. I learn a lot from my colleagues, who are always willing to share with me their "a-ha" moments. Most importantly, TCCS cultivates in me a rewarding way of problem solving, data analysis, and time management.*

### Shaunak Ghosh
(M.S. 2013)

*My time at TCCS was professionally very fruitful. Professor Fomel conducts research on a wide range of topics, starting from preprocessing through migration to some aspects of interpretation. Much of his research is very versatile and can find scope for application for practical purposes. I hope being exposed to such a wide variety of problems (and ways of tackling them) will benefit me in the long run.*