Wave Inversion Technology Consortium

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Preface

This is the 13th issue of the Annual WIT report. In some cultures, the number 13 is considered to be a harbinger of misfortune. Well, as everyone else, WIT experienced the economic effects of the current crisis. We lost sponsors but not to an extent that we need to be concerned. Currently, fifteen companies are sponsoring the consortium and new potential sponsors are preparing to join. In conclusion, the 13th year of WIT was a difficult year, but it was certainly not a year of misfortune for us.

Research-wise, once again, WIT was recognised by the international exploration community. The paper *A work flow for the processing of reflection seismic data with CRS attributes* by Baykulov, Dümmong and Gajewski, presented at the 2009 SEG meeting in Houston, was ranked among the top thirty of the almost 700 papers of this meeting. During the 2009 annual EAGE conference, the workshop on *Locally Coherent Events – A New Perspective for Seismic Imaging* had a strong WIT impact. All WIT research teams were invited to give presentations in this workshop. The number of papers with CRS related issues from groups outside WIT is constantly increasing at the EAGE and SEG meetings. CRS related topics like multi-parameter stacking, slope and curvature applications, traveltime interpolation, event tracking and picking were at an all time high at these meetings. The increased interest in these topics by other research groups will certainly influence the work of WIT in the near future and new research alliances seem likely. Last but not least, we hope that this will help to consolidate the number of WIT sponsors and may be even attract new supporters to continue on our mission to provide leading edge solutions for the exploration industry.

Since summer 2009, Thomas Bohlen, formerly University of Freiberg, occupies the Chair of Applied Geophysics at the University of Karlsruhe. This concludes the search for a successor of WIT founding member and former WIT director Peter Hubral. We very much welcome Thomas in the WIT research team and we are confident that his research on wave form inversion will complement the WIT portfolio in a positive way. The combination of model building approaches based on kinematic wave field attributes and waveforms can be nicely cascaded into a powerful work flow for reflection seismic data processing. This is a current research topic in the consortium. The capability of partial CRS stacks to regularise data in an amplitude-preserving fashion is valuable for any wave equation-based processing step.

In September 2009, we launched the new WIT web site. The appearance and structure has not been basically kept so that you still find the familiar buttons and topics. The whole system is operated by the TYPO3 content management system, which is much more appropriate for an international research team distributed over two continents than the previous system. The web site can be maintained from any location by the WIT research teams and all teams have access to pertinent areas of the site. A news section was introduced, where we post actual events and information relevant to WIT researchers and sponsors. There, you can read about visits of WIT researchers to sponsors, internships of students, WIT conference contributions, visits of scientists to WIT teams and other announcements. You may check the news section once in a while to see what was going on in WIT as we do not send email notifications about changes in this section in order to keep the WIT related traffic in your mail box on the lowest possible level. The WIT mailing list is kept as a medium to forward information that should be noticed by all WIT sponsors. The traffic on this list usually does not exceed 10-15 mails per year.

As in previous years, there were many exchange visits between sponsors and WIT researchers. WIT research teams were pleased to host the visits of Evgeny Landa, Boris Kashtan, Denis Anikiev, Paolo Marchetti, Alex Möller, Andreas Hölker, Hervé Perroud, and Einar Iversen. Martin Tygel spent his Sabbatical in Norway and paid several visits to Hamburg, discussing issues related to time migration, data mapping, and image ray tomography. Mikhail Baykulov spent the summer of 2009 with Addax Petroleum to work on a 3-D data set and to implement the 3-D partial CRS stacks. M.Sc. student Benjamin Schwarz spent an internship at Fugro in London, UK. Dirk Gajewski visited Ecopetrol and EAFIT University in Columbia. Ecopetrol has a strong commitment to education and supports several M.Sc. students of EAFIT and other Columbian universities. It is planned to provide short term visits of these students to WIT research teams and to host graduate students for potential Ph.D. studies at WIT teams.

A new IBM Power6 System super computer was acquired at the German Climate Computing Centre (DKRZ) in Hamburg. The city of Hamburg through its University is a 27% shareholder of the DKRZ. This allows the WIT team in Hamburg to access the new 264 nodes, 8448 cores, 158 TeraFlops system for complex imaging, modeling, and inversion tasks. The 3-D CRS processing and the NIP-tomography software currently runs on a 256 nodes, 2048 core SUN LINUX cluster of the DKRZ. With the installation of the new system, the already favourable computing conditions have been further improved.

This report summarises our activities in 2009. Some of the presented studies are mature and reflect the conclusion of several years of research or a refinement of an existing technique. Other papers present research at its infancy and, occasionally, it may even not yet be obvious where it will lead. Ten years ago, CRS started out with a stack and has evolved into a complete processing work flow comprising several tools to go from time to depth. Without your support, such long lasting research concepts could not have been realized. Most public funding is restricted to two or three years, and it would require a long chain of successful project applications to work on a time scale comparable to the WIT project. Although the publicly-funded research is a major part in funding for all research teams, the WIT support is a component of continuity in our scientific work. On behalf of all WIT research teams, I express my sincerest appreciation for providing this opportunity to us.

Dirk Gajewski

Summary: WIT report 2009

IMAGING

Baykulov and Gajewski performed partial 3D CRS stacks to enhance the quality and regularity of prestack 3D seismic data. Results of the automatic CRS parameter search are used to perform a simple and robust weighted summation. The method is verified on 2D and 3D synthetic data and applied to field 3D data. Improved prestack gathers have higher S/N ratio and show better coherence of reflections.

Costa and Schleicher apply the idea of double path-integral migration velocity analysis to a real data set to show that the method yields quantitative information about the migration velocity model. Migrated images using interpolations with different regularisations of the extracted velocities demonstrate the high quality of the resulting velocity information.

Dell and Gajewski demonstrate a new application of the CRS attributes for time migration velocity analysis. They show how the attributes can be used to effectively separate reflected and diffracted energy. Then, they introduce and apply a new technique for poststack time migration velocity analysis on the diffracted wavefield. As a result, they obtain highly-focused time migrated images in addition to the velocities.

Dell et al. propose a new method to map common midpoint (CMP) gathers into common scatterpoint (CSP) gathers. The CSP data mapping is based on the parameterization of the migration operator with the apex time. Then, they apply a migration velocity analysis to CSP gathers and perform an automatic Common Reflection Surface (CRS) stack for this gathers. As a result, they obtain more accurate velocity spectra and highly-focused time migrated images.

Dümmong and Gajewski add geological constraints into the search procedure of CRS attributes. These constraints are linked to the stacking velocity and the geological dip of the structures under investigation. Field data examples illustrate the effect of the constraints on the determined CRS attributes and the final stack.

Kang revisits the fundamentals of the normal-incidence point (NIP) wave tomography. Inverting for picked kinematic wavefield attributes otained from the 3D CRS stack, this approach offers an efficient way to generate a kinematically consistent smooth 3D velocity model along with the reconstructed NIPs in the subsurface.

Köhn et. al. discuss the influence of parametrization in elastic full waveform tomography of synthetic multicomponent reflection seismic data. Starting from a long wavelength model for the elastic material parameters the waveform tomography result can resolve details below the seismic wavelength. The influence of different parameterizations on resolution and ambiguity are investigated using a simple test problem. Afterwards the resolution for a geological realistic model will be discussed.

Lima et al. present results of a consistent workflow for processing and imaging applied to marine seismic data. The data set was collected in the Southern Atlantic offshore Brazil. Searching for techniques to increase the data resolution, fundamental steps of signal processing together with imaging methods based on the data-driven CRS technology, such as CRS-stack-based residual static correction and pre-stack data enhancement, were applied and proved to be successful. The final aim of the data processing and imaging sequence was to obtain sections ready to be submitted to geological interpretation. The latter was conducted on the final stacked and CRS time-migrated sections.

Macedo et al. propose to use smearing instead of stacking when constructing velocity spectra in CMP velocity analysis. They describe, discuss, and test two methodologies in a very simple model. Smearing the total amplitude leads to conventional velocity spectra, with possible advantages because of its potential for parallel computing. Using the amplitude density gives rise to a slightly different coherency measure. Numerical experiments indicate that this measure might be able to improve the focussing of the velocity peaks in the velocity spectra.

Oliveira et al. discuss the dependence of single-stack redatuming constructed from migration-demigration chainging on the velocity model. For this purpose, they demonstrate the application of single-stack redatuming to synthetic seismic data for media with two or many flat layers and in models with lateral velocity variations. Our examples demonstrate the quality of the redatumed data both kinematically and dynamically.

Silva Neto et al. show that reverse time migration (RTM) in 2.5D offers an alternative to improve resolution and amplitude when imaging 2D seismic data. They implement a truly parallel finite-difference modelling algorithm in the mixed time-space/wavenumber domain. Numerical experiments using synthetic data demonstrate the better resolution and amplitude recovery of 2.5D RTM relative to 2D reverse time migration.

Valente et al. review three time-to-depth conversion techniques, discuss their algorithmic procedures and show their differences by applying them to a 2D synthetic data set. In particular, they demonstrate that the different procedures react differently to different kinds of regularization. Although the image-ray trajectories and the resulting depth velocity models depend on the regularization employed, the final depth images corresponding to these different models are very similar.

MODELING

Gelius et al. provide a simple framework of understanding and analyzing both diffraction-limited imaging as well as super-resolution. By utilizing the null-space solutions of the wave problem, super-resolution is apparently obtained since such solutions can give an extremely well localization of the point-source target.

Kaschwich et al. present a comparison between different ray-based modeling techniques, such as standard ray tracing, Kirchhoff-Helmholtz forward modeling and modeling by demigration. Furthermore, we propose a modified modeling by demigraion approach by using an alternative PSDM simulator.

Tessmer discusses that modelling algorithms based on the so-called pseudo-acoustic wave equations for TTI media are unstable if variations of symmetry axes tilt are present. By numerical examples he shows that an algorithm based on the anisotropic equations of motion yields stable results.

OTHER TOPICS

Aleixo et al. extend Alkhalifah's two-step procedure for extracting the NMO velocity and the nonhyperbolicity from seismic travaltimes. For this purpose, they use a more accurate nonhyperbolicity term in the traveltime approximation, which allows to predict the bias in the NMO velocity estimate, thus providing a means of correcting both the estimated NMO velocity and the resulting anisotropy parameter value. By means of a numerical example, they demonstrate that the estimation of both traveltime parameters is improved considerably.

Coimbra et al. relate offset-continuation (OCO) rays to the kinematic properties of OCO image waves that describe the continuous transformation of the common-offset reflection event from one offset to another. By applying the method of characteristics to the OCO image-wave equation, they obtain a ray-tracing-like procedure that allows to construct OCO trajectories describing the position of the OCO output point under varying offset. The endpoints of these OCO trajectories for a single input point and different values of the RMS velocity form then the OCO rays. A numerical example demonstrates that the developed ray-tracing procedure leads to reliable OCO rays, which in turn provide high-quality RMS velocities.

Freitas presents a case study for a 3D land data from Mexico illustrating how applications of the CRS attributes may contribute to important steps of the conventional workflow of depth processing.

Garabito et al. discuss the results of the application of two CRS stack implementations (multi-step and one-step search strategies) in a low-fold real land dataset, without using any constraints in the determination of the CRS parameters and using the stacking velocity model as an information known “a priori” in the optimization process.

Leite and Vieira investigate the relationship between sensitivity analysis, based on the Miller-Murray model, **S**, of the CRS operator with respect to the parameters v_0, R_{NIP}, R_N and α_0, and compare with the attributes search strategies that is based on physical-mathematical considerations of the stack operator.

Perroud et al. propose an algorithm for an (approximate) Inverse CRS transformation, namely one that (approximately) transforms the CRS attributes back to data space. The CRS transform pair established in this way may find a number of applications in seismic imaging and data processing, in the same way as other well-known transformations, e.g., Fourier, Radon, tau-p, etc.

Santos and Schleicher show that the complete set of CRS parameters can be extracted from seismic data by an application of modern local-slope-extraction techniques. The necessary information about the CRS parameters is contained in the slopes of the common-midpoint and common-offset sections. Here, they improve the previous extraction technique, eliminating the need for slope derivatives.

Tygel et al. provide an interpretation of the CRS coefficients of time-migrated reflections. The interpretation is done in terms of the ability of such coefficients to determine dip and curvature of the reflectors in depth.

The Wave Inversion Technology (WIT) Consortium

The Wave Inversion Technology Consortium (WIT) was established in 1997 and is organized by the Institute of Geophysics of the University of Hamburg. It consists of three integrated working groups, one at the University of Hamburg and two at other universities, being the Mathematical Geophysics Group at Campinas University (UNICAMP), Brazil, and the Geophysical Institute of the Karlsruhe University. In 2003, members of the Geophysical Department at the Federal University of Pará, Belém, Brazil, have joined WIT as an affiliate working group. In 2007, NORSAR joined WIT as research affiliate. The WIT Consortium offers the following services to its sponsors:

a.) research as described in the topic "Research aims" below;

b.) deliverables;

c.) technology transfer and training.

RESEARCH AIMS

The ultimate goal of the WIT Consortium is a most accurate and efficient target-oriented seismic modelling, imaging, and inversion using elastic and acoustic methods. Within this scientific context it is our aim to educate the next generations of exploration geophysicists.

Exploration and reservoir seismics aims at the delineation of geological structures that constrain and confine reservoirs. It involves true-amplitude imaging and the extrapolation of the coarse structural features of logs into space. The goals on seismic resolution are constantly increasing which requires a complementary use of kinematic and wave equation based techniques in the processing work flow. At WIT we use a cascaded system of kinematic and full wave form model building and imaging techniques. Since our data and inversions are never perfect it is the challenge to find those techniques which produce the best images for erroneous velocities and faulty wave forms.

The WIT consortium has the following main research directions, which aim at characterizing structural and stratigraphic subsurface characteristics:

- Imaging and inversion in 2, 2.5, and 3D
- AVO and inversion
- Macrovelocity model building and updating
- Local event slopes
- CRS real data processing
- CRS and multiparameter processing topics

- Imaging of acoustic emissions (passive seismics)
- True-amplitude migration
- Seismic interferometry
- Full waveform tomography
- Forward modelling
- Migration and tomography

WIT PUBLIC RELATIONS COMMITTEE

Name	University	Area
Dirk Gajewski	Hamburg	Coordination and contact to representatives
Jürgen Mann	Karlsruhe	Contact to representatives
Claudia Vanelle	Hamburg	Administration and contact to representatives, WIT Report

STEERING COMMITTEES

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Martin Widmaier	Petroleum Geo-Services (PGS)
Gerd Rybarczyk	Petrologic Geophysical Services
Matthias Riede	RWE Dea AG
François Audebert	Total E&P RD
Henning Trappe	TEEC

COMPUTING FACILITIES

The Hamburg group has access to a 264 nodes (16 dual core CPUs, 8448 cores in total) IBM p575 "Power6" cluster at the German Computer Center for Climate Research (Deutsches Klimarechenzentrum, DKRZ) for numerically intensive calculations. It is equipped with 20 TeraByte of memory and its performance per core is 18.8 GigaFlops. There is also access to a SUN Linux cluster with 256 nodes (2 quad core Opteron, 32

GB each). A SUN Fire X4600 (8 dual core Opteron, 32 GB) is exclusively available for the group's computing demands. Additional computer facilities consist of several Linux workstations and Linux PCs.

The research activities of the Campinas Group are carried out in the Computational Geophysics Laboratory. The Lab has many PC Linux workstations and Sun Ultra 60/80 workstations connected by a dedicated network, suitable for parallel processing. Educational grants provide seismic packages from leading companies such as Landmark and Paradigm. Besides State Government funds, substantial support both for equipment and also scholarships are provided by the Brazilian Oil Company Petrobras. An extension of the Lab with substantial increase of computer power and space is being built in the new facilities of the Center of Petroleum Studies. The new Lab, expected to be in operation next year, will also have remote access to the computing facilities of the Petrobras Research Center in Rio de Janeiro.

In Karlsruhe, the research project uses computer facilities that consist of mainly Hewlett-Packard, Silicon Graphics, and Linux workstations. These are networked with a local compute server, a Silicon Graphics Origin 3200 (6 processors, 4 GB shared memory) and 8 dual-headed quad-core Xeon workstations with 8 GB RAM and 1.5 TB disk space each. For large-scale computational tasks, a Hewlett-Packard XC 6000 Linux cluster is available on campus. It is currently equipped with 128 nodes (allowing a theoretical peak power of 1.9 Tflops), 2 TB memory, and a 10 TB Lustre file system.

The main computing facility at the Geophysics Graduation Program in Belém is the Seismic Processing Lab (ProSis). The hardware resources include: workstations (RS3600) from IBM and a SUN SparkStation 20, all networked to a local server SUN Enterprise-3500 with 2 processors; several networked Linux-PCs; for large-scale applications, a cluster of PCs with 20 dual-processor nodes. The proprietary software packages available for seismic applications are ProMAX, Disco-Focus, and Gocad.

WIT research personnel

Rafael Aleixo received a B.Sc. (2003) in Mathematics and an M.Sc. (2007) in Applied Mathematics from University of Campinas (UNICAMP), Brazil. Since 2007 he has been a Ph.D. student at UNICAMP. His research interests include seismic imaging methods, seismic modeling, anisotropy, and image-wave propagation. He is a member of SEG, EAGE, SBGf, and SBMAC.

Daniela Amazonas graduated in Mathematics (2004) and received her M.Sc. in Geophysics (2007), both from Federal University of Pará (UFPa), Belém, Brazil, where she is working toward a Ph.D. in seismic methods. Her research interests are concentrated in wave-equation migration methods. She is a member of SEG and SBGf.

Denis Anikiev is studying for a bachelor degree at the Department of Physics of Earth at St.Petersburg State University, Russia. He participated in an exchange program with Hamburg University in 2006,2007 during his work on the "Localization of Seismic Events by Diffraction Stacking". His present research interests include localization of seismic events, inverse problems for acoustic media, and virtual source technology. He is a student member of SEG, EAGE, SPE.

Mikhail Baykulov received his diploma in geophysics in 2004 from Saratov State University, Russia. He confirmed his diploma in 2005 at the University of Hamburg with a thesis on the application of the CRS stack to reflection data from the crystalline crust of Northern Germany. In April 2009 Mikhail defended his PhD thesis with the title Seismic imaging in complex media with the Common Reflection Surface stack. His present research interests include 2D/3D CRS imaging, velocity model building, and depth inversion of seismic data.

Ricardo Biloti received his B.Sc.(1995), M.Sc. (1998) as well as Ph.D. (2001) in Applied Mathematics from the State University of Campinas (UNICAMP), Brazil. He worked at Federal University of Paraná (UFPR), Brazil, as an Adjoint Professor, at the Department of Mathematics, from May 2002 to September 2005, when he joined Unicamp as an Assistant Professor. He has been a collaborator of the Campinas Group since his Ph.D. His research areas are multiparametric imaging methods, like CRS for instance. He has been working on estimating kinematic traveltime attributes and on inverting them to construct velocity models. He is also interested in Numerical Analysis, Numerical Linear Algebra, and Fractals. He is a member of SBMAC (Brazilian Society of Applied Mathematics), SIAM and SEG.

Thomas Bohlen received a Diploma of Geophysics (1994) and a Ph.D. (1998) from the University of Kiel, Germany. From 2006 to 2009 he has been Professor of Geophysics at the Institute of Geophysics at the Technical University Freiberg where he has been the head of the seismics and seismology working groups. Since 2009, he is Professor of Geophyics at the Geophysical Institute of the Karlsruhe Institute of Technology. He is the head of the applied geophysics group. His research interests and experience include: seismic modelling, full waveform inversion, surface wave inversion and tomography, reflection seismic imaging. He is a member of SEG, EAGE, AGU, ASA, and DGG (member of the executive board).

Pedro Chira Oliva, received his diploma in Geological Engineering (UNI-Peru/1996). He received his MSc., in 1997 and PhD., in 2003, both in Geophysics, from Federal University of Pará (UFPA/Brazil). He took part of the scientific research project "3D Zero-Offset Common-Reflection-Surface (CRS) stacking"

(2000-2002) sponsored by Oil Company ENI (AGIP Division - Italy) and the University of Karlsruhe (Germany). Currently he is full Professor at the Institute of Coastal Studies (IECOS) of UFPA. His research interests include seismic stacking and seismic modeling. He is member of GOCAD consortium (France) and SBGf.

Jessé Carvalho Costa received his diploma in Physics in 1983 from the Physics Department, Federal University of Pará (UFPA) and a Doctor degree in Geophysics in 1993 from the Geophysics Department at the same University. He was a Summer Student at Schlumberger Cambridge Research in 1991 and 1992. He spent 1994 and 1995 as a post-doc in the Stanford Tomography Project at Stanford University. He held a faculty position the Physics Department at UFPA from 1989 to 2003. Currently his is Associate Professor in the Geophysics Department, UFPA. His fields of interest include seismic anisotropy, traveltime tomography and seismic modeling.

Joõ Carlos Ribeiro Cruz received a BSc (1986) in geology, a MSc (1989), and a PhD (1994) in geophysics from the Federal University of Pará (UFPA), Brazil. From 1991 to 1993 he was with the reflection seismic research group of the University of Karlsruhe, Germany, while developing his PhD thesis. Since 1996 he has been full professor at the geophysical department of the UFPA. His current research interests include velocity estimation, seismic imaging, and application of inverse theory to seismic problems.

Sergius Dell received a diploma in Physics from the University of Yekaterinburg (Russia) in 1997. He received his diploma in Geophysics in 2009 from the University of Hamburg. Since 2009 he has been a Ph.D. student at the University of Hamburg. His present research interests include CSP data mapping and time migration velocity analysis on CSP gathers, CRS imaging of the time-migrated reflections and velocity model building by Image Incident Point Tomography, extraction of diffraction events using the CRS stack and poststack time migration velocity analysis.

Denise De Nil received a diploma in geophysics from Ruhr-Universität Bochum in 2001 with a theoretical and numerical thesis on surface wave progation. From 2001 to 2006 she has been a research associate at Christian-Albrechts-Universität zu Kiel, where she has been involved with the development of new analyzing techniques for low quality data in ocean bottom, tunnel and borehole seismics. From 2006 to 2009 she has been a research associate at Technische Universität Bergakademie Freiberg. Her present research focusses on tunnel seismics and numerical modeling of seismic wave propagation. She is a member of Deutsche Geophysikalische Gesellschaft.

Stefan Dümmong received his diploma in Geophysics in 2006 from the University of Hamburg. Since 2006 he is PhD student in the Institute of Geophysics at the University of Hamburg. His research interests are imaging procedures and multiple removal techniques. He is a member of EAGE.

Dirk Gajewski received a diploma in geophysics in 1981 from Clausthal Technical University and a PhD from Karlsruhe University in 1987. Since 1993, he has been associate Professor (Applied Geophysics) at Hamburg University. After his PhD, he spent two years at Stanford University and at the Center for Computational Seismology at the Lawrence Berkeley Lab in Berkeley, California. From 1990 until 1992, he worked as an assistant professor at Clausthal Technical University. His research interests include high-frequency assymptotics, seismic modeling, and processing of seismic data from isotropic and anisotropic media. Together with Ivan Psencîk, he developed the ANRAY program package. He is a member of AGU, DGG, EAGE, and SEG, and served as an Associate Editor for Geophysical Prospecting (section anisotropy) from 1997 to 2002.

German Garabito received his BSc (1986) in Geology from University Tomás Frias (UTF), Bolivia, his MSc in 1997 and PhD in 2001 both in Geophysics from the Federal University of Pará (UFPA), Brazil. Since 2002 he has been full professor at the geophysical department of UFPA. His research interests are data-driven seismic imaging methods such as the Common-Refection-Surface (CRS) method and velocity model inversion. He is a member of SEG, EAGE and SBGF.

Tobias Geib is a diploma student at the KIT in Karlsruhe. He is a member of the Applied Geophysics group since November 2009.He works on the calibration of our superconductive gravimeter located in the Black Forest Observatory. He is a member of DGG.

Håvar Gjøystdal is Research Manager of Seismic Modelling at NORSAR in Kjeller, near Oslo. He also holds an adjunct position of Professor of Geophysics at the Department of Earth Science, University of Bergen. In 1977 he joined NORSAR and started building up research activities within the field of seismic modelling, which to-day include both R&D projects and services and software products for the petroleum industry. Key topics are ray tracing, seismic tomography, and time lapse seismic modelling. He is a member of SEG and OSEG.

Anderson B. Gomes obtained his Bachelor Degree in Mathematics in 2004, and his Masters Degree in Geophysics in 2006, both in the University of Pará (UFPA), Brazil. Presently, he is a doctor student in the Graduate Course in Geophysics of UFPA in the area of seismic methods applied to oil and gas exploration. He is member of SEG and of SBGF.

Ellen de Nazaré Souza Gomes received her diploma in Mathematics in 1990 from University of Amazônia. She received her Master degree in Applied Mathematics in 1999 from the Mathematics Departament, Federal University of Pará. In 2003, she received her Doctor degree in Geophysics from Geophysics Department at the same University. Her fields of interest are anisotropy and seismic modeling. She has been professor at the Federal University of Pará since 1997.

Sven Heider is a diploma student at the KIT in Karlsruhe. He is a member of the Applied Geophysics group since November 2009.He works on the advancement of field technology for near-surface exploration. The tentative title of his diploma thesis is Interpretation of impact noise measurements. He is a member of DGG.

Olaf Hellwig studied geophysics at TU Bergakademie Freiberg, Germany. Between 2004 and 2005 he spent one year at NTNU Trondheim, Norway. He received his diploma in geophysics in 2007. Since 2008 he is Ph.D. student in the Institute of Geophysics at TU Bergakademie Freiberg. His research interests focus on modeling of seismic wave propagation in boreholes and imaging of reflectors ahead of the drill.

Einar Iversen received Cand.scient. (1984) and Dr. philos. (2002) degrees in geophysics, both from the University of Oslo, Norway. He has worked for NORSAR since 1984 and is currently a senior research geophysicist within NORSAR's Seismic Modeling Research Programme. He received the Best Paper Award in Geophysical Prospecting in 1996. His professional interests are seismic ray theory and its application to modeling, imaging, and parameter estimation. He is a member of SEG and EAGE.

Stefan Jetschny received a Bachelor in Geophysics in 2003 at the TU Bergakademie Freiberg. After finishing internships at RWE Dea, Hamburg, Baker Hughes Inteq, Celle and Eastern Atlas, Berlin, he continued his studies in 2004 at the Institute of Geophysics, TU Bergakademie Freiberg. In 2005 he wrote his Diploma thesis at Baker Hughes Inteq in Houston, USA and received a Diploma (Master) in Geophysics in 2006 at the TU Bergakademie Freiberg. His research interests focus on LWD and wireline imaging tools, processing of borehole imaging data, 2D/3D seismic modelling of full elastic wavefields and the propagation of tunnel surface-waves. He is a member of DGG, SEG, AGU, EAGE and IAMG.

Shin Duck Kang received a Bachelor degree in Applied Mathematics in 1994 in South Korea. He has studied the symbolic program analysis for a cross section of two Fermion particle scattering until 2005 in a Ph.D course on particle physics at the University of Konkuk, South Korea. He received his M.Sc. degree (2008) in Computational Science from the Dept. of Physics, J.W. Goethe University Frankfurt am Main, Germany. After graduating Computational science, he has joined the WIT group at the Karlsruhe Institute of Technology (KIT). His current interest is the implementation and application of 3D NIP tomography based on CRS-Stack attributes and a B-spline velocity model. He is a member of EAGE and SEG.

Tina Kaschwich received her diploma in geophysics (2001) and a Ph.D. in geophysics (2006), both from the University of Hamburg. Since 2005 she has been a research fellow at the seismic modelling group at NORSAR, Norway. Her research interests are ray tracing and wavefront construction methods, imaging and illumination studies for survey planning and quality control for different model and wave types. She is a member of EAGE, OSEG and SEG.

Boris Kashtan obtained his MSc in theoretical physics from Lenigrad State University, USSR, in 1977. A PhD (1981) and a Habilitation (1989) were granted to Boris by the same University. He is Professor at St. Petersburg State University, Russia, and since 1996 Boris is head of the Laboratory for the Dynamics of Elastic Media. His research interests are in high frequency methods, seismic modeling, inversion, anisotropy, and imaging. He regularily visits Germany and spends from weeks to several month at the University of Hamburg every year.

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