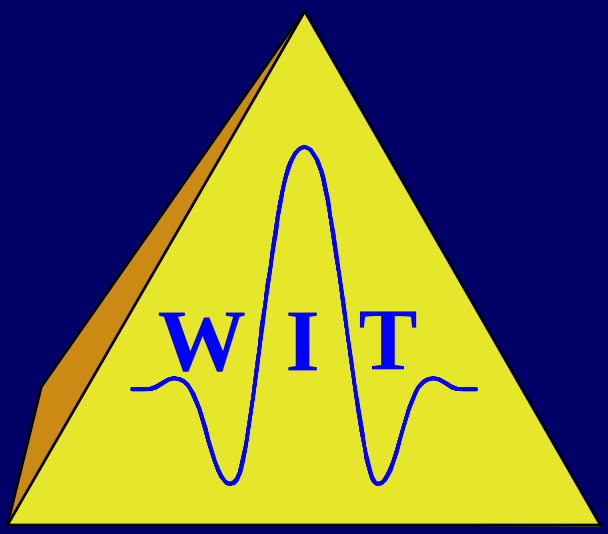
# Wave Inversion Technology Consortium




**Wave Inversion Technology**
**established 1997 in Karlsruhe, Germany**

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**Martin Tygel** from the Campinas WIT group receives the EAGEs "Conrad Schlumberger Award" in Florence on June 30, 2002 for his many contributions to unify the theory of seismic true-amplitude reflection imaging.

**Yonghai Zhang** from the Karlsruhe WIT group receives the EAGEs 2002 "Eötvös Loránd Award" for the best paper published in Geophysical Prospecting in 2001.

(photos by courtesy of Norman Bleistein)


**Claudia Vanelle** from the Hamburg WIT group receives the 2002 “Shell She-Study-Award” in appreciation of her PhD thesis and her results in the final round of the competition. The award is presented to Claudia by Christoph Matschie (right), State Secretary at the Ministry for Education and Research, and Kurt Döhmel, CEO of the German Shell. (photo by courtesy of Shell, Germany)

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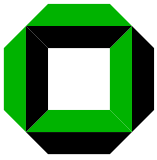


# Contents

# Preface

Through the help and the continuous support of our sponsors, the Wave Inversion Technology (WIT) consortium has been successfully existing for six years now. During this time, many sophisticated imaging and modeling methods were developed, implemented, and tested by the research groups in Berlin, Campinas, Hamburg, and Karlsruhe. While one sponsor unfortunately left the consortium in 2002, we were able to win WesternGeco and Petrobras as new members, thus our technology was available to a total of 12 sponsors in 2002.

The successful work within the WIT consortium was once again noticed and honored in 2002 by the EAGE at their annual international conference and exhibition in Florence (Italy): Martin Tygel received the renowned "Conrad Schlumberger Award" for his many contributions to unify the theory of seismic true-amplitude reflection imaging. Yonghai Zhang and his co-authors received the "Eötvös Loránd Award" for the best paper published in Geophysical Prospecting, entitled "Common-Reflection-Surface (CRS) stack for common offset".

On November 26$^{th}$ 2002, the Shell She-Study-Award was presented to Dr. Claudia Vanelle from the Hamburg WIT team in a ceremonial act at the Hyatt Hotel in Hamburg (Germany). The prize was awarded to Claudia in recognition of her PhD thesis and her results in the final round of the competition. After successfully defending her thesis in April 2002, Dr. Vanelle was awarded a grant by the German Research Foundation (DFG). This grant enables her to continue the research within the WIT consortium as a post-doctoral researcher.

Dr. Tobias Müller from the Berlin WIT group was awarded the "Emmy-Noether Fellowship" of the German Research Foundation (DFG). He continues his research on waves in random media at the Curtin University in Perth (Australia) in close cooperation with the Berlin WIT group. In Perth he works together with Prof. Boris Gurevich, one of the world experts on Rock Physics.

The WIT group from Hamburg has jointly organized the 10$^{th}$ International Workshop on Seismic Anisotropy (10IWSA) in cooperation with Prof. Dr. Klaus Helbig (Hannover, Germany) and Prof. H. Igel (Munich, Germany). The meeting took place from April 14$^{th}$ to April 19$^{th}$ 2002 in Tutzing (Germany). On occasion of this well-attended workshop a special issue of the Journal of Applied Geophysics will appear—the proceedings are currently being compiled by the Hamburg WIT team with some strong support by Dr. Ivan Pšenčík (Prague, Czech Republic). Publication is scheduled for spring 2003. For further details on the workshop including links to the workshop program, abstracts and workshop presentations, please see the brief report on the workshop printed in this volume.

Professor Yu. Kravtsov (Institute of Space Research, Russian Academy of Sciences), an Alexander von Humboldt-Prizewinner, continues his work with the Berlin WIT group. The Karlsruhe group is pleased to have Professor Mikhail Popov (Steklov Mathematical Institute, St. Petersburg, Russia) as a guest professor. Professor Hervé Perroud from IPRA Géophysique (Pau, France) is visiting the Campinas group at the Computational Geophysics Laboratory at UNICAMP (Brazil). Professor Boris Kashtan (St. Petersburg University, Russia) continued his close cooperation with the WIT group in Hamburg, where he spent four

months in 2002. Peter Hubral and Jürgen Mann were invited to give presentations on CRS stack at the annual meeting of the CNPC (Chinese National Petroleum Corporation) which took place during the start of August in ZhangJiaJie (China). Peter Hubral is currently spending a sabbatical at Universidade Federal do Pará at Belém (Brazil).

It is evident that international cooperation and the exchange of ideas are very important elements of WIT. We will try to continue in the same way and hope that our supporters will keep believing in us, our ideas and our research for the years to come. On behalf of all WIT colleagues we want to thank our sponsors for their support during the past six years.

Claudia Payne, Dr. Jürgen Mann, Thomas Hertweck, and Christoph Jäger

# Summary: WIT report 2002

## IMAGING

**Menyoli** and **Gajewski** present a workflow for estimating velocity/depth model for the DOBREflection 2000 line. We use the CRS software and classical software for processing, such as poststack and prestack depth migration for obtaining an accurate depth model of the inverted Foldbelt structures.

**Bergler et al.** introduce the processing software `cocrs` which provides stacked common-offset sections and wavefield attributes from multi-coverage prestack data in a data-driven manner. The processing parameters are explained in detail to make the use of `cocrs` easier.

**Mann** and **Höcht** revisit the well-known pulse stretch phenomenon usually occuring during normal-moveout correction. In contrast to conventional NMO, data-driven imaging methods based on multi-parameter traveltime approximations like Multifocusing, delayed hyperbola approaches, or Common-Reflection-Surface stack are not subject to such effects. This contribution discusses the adaptation of the stacking operator to the actual reflection response and the behavior of the wavefield attributes along the seismic wavelet.

**Chira-Oliva et al.** discuss first comparisons between a new fourth-order traveltime expansion in terms of the zero-offset CRS parameters and the more classical hyperbolic moveout. The numerical examples suggest that the new fourth-order expression provides a better approximation to true traveltimes than the hyperbolic one.

**Menyoli et al.** present poststack time migrated images of the Donbas Foldbelt data. The unmigrated stacked section was generated after applying the CRS stack method. The results show that in complex geology were CMP stacking and the subsequent poststack time or depth migration fails, the CRS stacking and the subsequent poststack time/depth migration gives high quality results which are easy to interpret.

**Koglin** and **Ewig** give a short introduction to a new approach that uses the moveout corrected super gathers obtained by means of CRS attributes for residual static corrections. The theoretical background and first synthetic results are presented.

**Perroud et al.** describe the use of the Common Reflection Surface (CRS) method to estimate velocities from Ground Penetrating Radar (GPR) data. Combination of the obtained depth-converted velocity map with in situ measurements of electrical resistivity enables to estimate both water content and water conductivity. These quantities are essential to delineate infiltration of contaminants from the surface after industrial or agriculture activities. The method has been applied to a real dataset and compared with the classical NMO approach. The results show that the CRS method provides a much more detailed velocity field, thus improving the potential of GPR as an investigation tool for environmental studies.

**Duveneck** presents a tomographic velocity inversion method based on Common-Reflection-Surface (CRS) attributes. The method constructs smooth laterally heterogeneous velocity models for depth imaging. It is demonstrated on a 2D synthetic example.

**Schleicher et al.** discuss the consistency and stability of a finite-difference scheme for the image wave

equation for remigration. Numerical tests demonstrate that at the boundary of satisfying the strictest stability criterion, the implementational form of the chosen FD scheme is essential to obtain stable result with a limited numerical error.

**Goertz** develops an extension to scalar true-amplitude imaging theory. It accounts for the vectorial properties of the elastic wavefield recorded with multicomponent receivers. With this approach, AVO curves for all occurring wave modes can be obtained.

**Hertweck** and **Jäger** investigate various aspects of Kirchhoff migration. They show examples of depth migration with a macrovelocity model obtained by tomographic inversion based on CRS stack attributes, and pre- and poststack migration directly from topography. A brief but general overview of advantages and disadvantages of Kirchhoff migration is presented.

**Jäger** and **Hertweck** give a description of `Uni3D`, an imaging tool for Kirchhoff true-amplitude migration. They concentrate on the technical aspects such as installation, compilation and explanation of all relevant parameters.

## ROCK PHYSICS AND WAVES IN RANDOM MEDIA

**Shapiro** and **Kaselow** give an extension of the piezosensitivty approach towards anisotropic porous rocks and show its application to metamorphic rock samples from the KTB deep drill hole.

**Müller et al.** give an approximate formulation to describe scattering attenuation for plane waves propagating in weakly inhomogeneous and statistically anisotropic random media. Their calculations are based on the well-known Rytov approximation which is able to describe the log-amplitude variance of seismic primaries. This log-amplitude variance is then directly linked with the attenuation coefficient. At last they verified the analytic results by means of numerical experiments

**Saenger et al.** consider 3D isotropic fractured media with ellipsoidal inclusions. They have numerically tested effective velocity predictions of different theoretical approaches: The theory for non-interacting cracks, the Kuster-Toksöz approach, the self-consistent theory, the differential effective medium (DEM) theory and the Gassmann-equation. Additionally, they have studied scattering attenuation of the meanfield predicted by the classical Hudson-approach.

**Rothert et al.** show the application and a new case study of the Seismicity Based Reservoir Characterization method (SBRC). Fluid induced microseismic events at the german KTB location are analysed in terms of a diffusive pore pressure relaxation process in order to estimate hydraulic parameters of the rock. For the first time, it is possible to study the depth-dependency of hydraulic parameters at one drilling site. Hypocenters of the events are compared with results of 3D reflectivity measurements. Good correlation are obtained with structural images which may explain the different spatio-temporal evolution features of the microseismicity. We are able to observe indications of the depth-dependency of hydraulic diffusivity at the KTB. We observe that rock volumes characterized by larger diffusivity also show larger reflectivity.

## MODELING

**Coman** and **Gajewski** present two approaches which increase the efficiency of 3-D wavefront construction (WFC) methods. First, for the estimation of traveltimes within cells, they propose a distance-weighted averaging of extrapolated traveltimes. The extrapolation of traveltimes is performed under consideration of the wavefront curvature. Second, they introduce an insertion criterion for new rays. This criterion uses the difference in wavefront curvature between adjacent rays.

**Kaschwich** and **Gajewski** introduce a new implementation to compute traveltimes for 3D anisotropic media. To demonstrate the method they give several numerical examples.

**Saenger** shows that the rotated staggered grid (RSG) can be applied to the velocity-stress formulation

of the viscoelastic wave equation and to the displacement-stress formulation of the elastic wave equation for anisotropic media. In both cases the implementation of the RSG expands the range of applications.

**Soukina et al.** present a joint inversion of $qP$- and $qS$-waves in homogeneous weakly anisotropic media using a linear formalism for both $qP$- and $qS$-waves. If the observed $qS$-wave polarisation vectors are introduced into the inversion, the tomographic relations for $qS$-waves can be linearised and are thus formally identical to those for $qP$-waves. Numerical results for a homogeneous transversely isotropic model show that the full elastic tensor can be reconstructed.

**Vanelle** and **Gajewski** are currently extending their traveltime based strategy for amplitude preserving migration to anisotropic media. In this paper they describe the determination of geometrical spreading from traveltimes in the anisotropic case. This method is based on a hyperbolic traveltime expansion that also serves for the interpolation of traveltimes. They give several examples to demonstrate the technique.

**Novais** and **Santos** show how the medium symmetry in the 2.5-D situation can be used to accelerate the finite-difference computation of 3-D wave propagation by a repeated 2-D FD modeling in the out-of-plane Fourier domain. They derive a criterion for the wavenumber summation that realizes the inverse Fourier transform and demonstrate the quality of the process by numerical examples.

## OTHER TOPICS

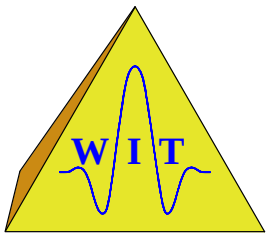
**Gajewski** and **Vanelle** were co-organisers of the Tenth International Workshop on Seismic Anisotropy (10IWSA) sponsored by the WIT consortium. They give a brief report on the workshop.

**Vanelle** summarises analytic expressions for properties of anisotropic media with elliptical symmetry. Based on these formulae, computer codes for the calculation of traveltimes and geometrical spreading in homogeneous elliptically anisotropic media, as well as for reflection and transmission coefficients between two half-spaces with elliptical anisotropy are available. These codes can be used for the evaluation and verification of the results from other programs, e.g., for the computation of traveltimes or AVO curves.

**Santos** and **Tygel** introduce the new concept of Reflection Impedance for elastic media, which generalizes the Acoustic Impedance function, and show how to use it for approximate the P-P reflection coefficient and AVO inversion purposes.

**Biloti et al.** present a new strategy to smooth plane curves, filtering out white noise as well as suppressing outliers. The key idea is to optimally adjust a cubic spline to the data in a least-squares sense. Some examples are provided to illustrate the wide applicability of the method to geophysical problems.

# The Wave Inversion Technology (WIT) Consortium




The Wave Inversion Technology (WIT) Consortium was established in 1997 and is organized by the Geophysical Institute, Karlsruhe University, Germany. It consists of four working groups, one at Karlsruhe University and three at other universities, being the Mathematical Geophysics Group at Campinas University (UNICAMP), Brazil, the Seismics / Seismology Group at the Free University (FU) in Berlin, Germany, and the Applied Geophysics Group (AGG) of the Hamburg University, Germany. 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 modeling, imaging, and inversion using elastic and acustic methods.
Traditionally, 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 onto space. Today, an understanding is emerging on how sub-wavelength features such as small-scale disorder, porosity, permeability, fluid saturation, etc. influence elastic wave propagation and how these properties can be recovered in the sense of true-amplitude imaging, inversion, and effective media.
The WIT Consortium has the following main research directions which aim at characterizing structural and stratigraphic subsurface characteristics and extrapolating fine grained properties of targets:

1. Macromodel-independent multicoverage zero and finite offset simulations.
2. Macromodel determination.
3. Seismic image and configuration transformations (data mapping).
4. True-amplitude imaging, migration, and inversion.
5. Seismic and acoustic methods in porous media.
6. Passive monitoring of fluid injection.
7. Fast and accurate seismic forward moelding.
8. Modeling and imaging in anisotropic media.

## COMPUTING FACILITIES

In Karlsruhe, the research project uses computer facilities that consist of mainly Hewlett-Packard (HP), Silicon Graphics (SGI), and Linux workstations. These are networked with a local compute server, a SGI

Origin 3200 (6 processors, 4GB shared memory). For large-scale computational tasks, an IBM RS/6000 SP-SMP (256 nodes + 52 nodes) and a Fujitsu VPP 5000 are available on campus. If there is still a request for more computing power, a Cray T3e (512 nodes), a NEC SX-4/32, and a Hitachi SR8000 (16 nodes) can be used via ATM networks at the nearby German National Supercomputing Center (HLRS) in Stuttgart.

The Hamburg group has access to a 16 nodes (8 CPUs and 8 GB each) NEC SX-6 supercomputer at the German Computer Center for Climate Research (Deutsches Klimarechenzentrum, DKRZ) for numerically intensive calculations. Additional computer facilities consist of several SUN workstations and Linux PCs.

The Geophysical Department of the Free University of Berlin has excellent computer facilities based on Sun- and DEC-Alpha workstations and Linux PCs. Moreover, there exists access to the parallel supercomputer Cray T3m (256 proc.) of ZIB, Berlin.

The research activities of the Campinas Group are carried out in the Mathematical Geophysics Laboratory. The Lab has many PC Linux workstations and Sun Ultra 60/80 workstations connected by a dedicated network, suitable for parallel processing. For large-scale applications, the Lab has full access to the National Center for High Performance Computing of São Paulo, that maintains, among other machines, an IBM RS/6000 9076-308 SP (43 nodes) with 120GB of RAM. Also available are seismic processing software packages from Paradigm and CGG.

## WIT PUBLIC RELATIONS COMMITTEE

| Name | University | Area |
|---|---|---|
| Peter Hubral | Karlsruhe | WIT headquarter |
| Claudia Payne | Karlsruhe | WIT headquarter |
| Thomas Hertweck | Karlsruhe | WIT report & WIT CD-R |
| Ingo Koglin | Karlsruhe | WIT report & WIT CD-R |
| Christoph Jäger | Karlsruhe | WIT homepage manager |
| Yonghai Zhang | Karlsruhe | WIT seminar organizer |
| Jürgen Mann | Karlsruhe | WIT poster organizer |

## STEERING COMMITTEES

| Internal | | External | |
|---|---|---|---|
| Name | University | Name | Sponsor |
| Steffen Bergler | Karlsruhe | Jürgen Meister | BEB |
| Dirk Gajewski | Hamburg | Glyn M. Jones | Chevron |
| Thomas Hertweck | Karlsruhe | Paolo Marchetti | ENI/AGIP |
| Peter Hubral | Karlsruhe | Buzz Davis | Landmark |
| Christoph Jäger | Karlsruhe | Jurandyr Schmidt | Petrobras |
| Axel Kaselow | Berlin | Paul Krajewski | Preussag |
| Jürgen Mann | Karlsruhe | Walter Soellner | PGS Geophysical |
| Claudia Payne | Karlsruhe | Christian Henke | RWE-DEA |
| Jörg Schleicher | Campinas | Leon Hu | Saudi Aramco |
| Sergei Shapiro | Berlin | Paul Williamson | TotalFinaElf |
| Ekkehart Tessmer | Hamburg | Henning Trappe | TEEC |
| Martin Tygel | Campinas | Alfonso Gonzalez | WesternGeco |

# WIT research personnel

**Steffen Bergler** received his diploma in geophysics from Karlsruhe University in February 2001. Currently, he is working as a research associate at Karlsruhe University on the the implementation of the CRS stack for finite offset and the 3D CRS stack. He is a member of DGG, EAGE, and SEG.

**Ricardo Biloti** received his B.Sc. (1995) and M.Sc. (1998) in Applied Mathematics from the State University of Campinas (UNICAMP), Brazil, where he is a PhD student since 1998. In his PhD thesis he has been developing a macro-model velocity independent inversion method. He has worked with CRS (Common Reflection Surface) type methods and developed a technique to estimate some seismic attributes without the knowledge of macro-model velocity. He is also interested in fractals. He is a member of SIAM and SEG.

**Stefan Buske** received his diploma in geophysics (1994) from Frankfurt University. From 1994 until 1998, he worked as research associate at Frankfurt University, and from 1998 until 1999 he was with Ensign Geophysics Ltd. (Depth Imaging Department) in London. Since 1999 he is a university staff member at the Free University of Berlin. His research interests include seismic modeling and inversion, deep seismic sounding and parallel programming. He is a member of DGG and EAGE.

**Pedro Chira-Oliva** obtained a master degree of Geophysics in Seismic Methods from Federal University of Pará (Belem, Brazil). He started his PhD studies at the Geophysical Institute, Karlsruhe University. Currently, he is working on 3D CRS stack. His interests are macro velocity model independent imaging and seismic image wave methods.

**Radu-Aurel Coman** (now with TEEC) received his Diploma (1995) in geophysics from the University of Bucharest. From 1995 until 1996, he worked as research assistant at Geoecomar Bucharest and also specialized in geology at the University of Bucharest. After this, he spent two years at the Westfälische Wilhelms-Universität Münster. Since 1999 he is a Ph.D. student at the University of Hamburg. His interests are traveltime computation and Kirchhoff migration. He is a member of EAGE and SEG.

**Erik Ewig** is currently writing his diploma thesis at the Gephysical Institute, Karlsruhe University. He works on the improvement of the CRS stack by means of residual static corrections.

**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 serves as an Associate Editor for Geophysical Prospecting (section anisotropy).

**Alexander Goertz** received his diploma in Geophysics in 1998 and his Ph.D. in 2002 from Karlsruhe University. His research interests include true-amplitude seismic imaging of multicomponent data and AVO

inversion. He is currently a research fellow with Free University Berlin where he focuses on predictive imaging in large-diameter long-distance tunneling. He is a member of SEG and AGU.

**Zeno Heilmann** received his diploma in Geophysics from the University of Karlsruhe (TH) in October 2002. Since November 2002 he has been a research associate at the Geophysical Institute, Karlsruhe University. Currently he works on the development of the common-reflection-surface (CRS) stack, focusing on the influence of the top surface topography.

**Thomas Hertweck** received his diploma in Geophysics in May 2000 from Karlsruhe University, Germany, where he passed the exams with distinction. His thesis dealt with true-amplitude migration, demigration, and modeling by demigration. Since August 2000, he has been a research associate and teaching assistant at the Geophysical Institute, Karlsruhe University. Since 2001, he is jointly responsible for the administration of the computer systems at the Geophysical Institute. His fields of interest are numerical analyses, development of seismic software (especially on Linux systems and parallel shared-memory machines), seismic ray theory, and seismic (true-amplitude) imaging. Currently, he focuses on the implementation of true-amplitude (de)migration software and the application on real data with rugged topography. He is a member of EAGE and SEG.

**German Höcht** received his diploma in geophysics in 1998 from Karlsruhe University. Since 1998 he has been a research associate at Karlsruhe University. His interests are macro velocity model independent imaging methods. He is member of the SEG.

**Peter Hubral** received an M.Sc. in 1967 in geophysics from Clausthal Technical University and a Ph.D. in 1969 from Imperial College, London University. Since 1986, he has been a full Professor of Applied Geophysics at Karlsruhe University specialising in Seismic Wave Field Inversion. During 1970-73 he was with Burmah Oil of Australia and from 1974 to 1985 he was with the German Geological Survey in Hannover. He was a consultant in 1979 with AMOCO Research and, during 1983-1984, a PETROBRAS-sponsored visiting professor in the PPPG project at the Universidade Federal da Bahia in Brazil. In 1995-1996 he was an ELF- and IFP-sponsored visiting professor at the University of Pau, France. He received EAEG's Conrad Schlumberger Award in 1978 and SEG's Reginald Fessenden Award in 1979. He is a member of DGG, EAEG and an honorary member of the SEG. Peter Hubral is involved in most of WIT's activities, in particular those including research on image resolution, image refinement, image attributes, multiple suppression, incoherent noise suppression, true-amplitude imaging, interpretative processing, and image animation.

**Christoph Jäger** received his diploma (with distinction) in Geophysics in February 2002 from Karlsruhe University. His thesis was about true-amplitude migration and demigration and its implementation. Since March 2002, he has been a research associate at the Geophysical Institute in Karlsruhe. He is currently working on the efficient implementation and the application of true-amplitude (de)migration software. Christoph is also responsible for the maintenance of the WIT homepage. He is a member of EAGE and SEG.

**Tina Kaschwich** received her diploma in 2000 in geophysics from Hamburg University. Since 2001 she is a Ph.D. student at the University of Hamburg. Her research interests are ray method and migration in anisotropic media. She is a member of EAGE.

**Axel Kaselow** received his diploma (M.Sc. equivalent) in Geology from Karlsruhe University in April 1999. Since then, he has been a research associate at the Geophysical Institute, Karlsruhe University, and became a member of WIT's internal steering committee. In January 2002 he joined WIT's rock physics group in Berlin. His research interests are 4D modeling and rock physics, and the development of rock physical software. He is currently working on seismic properties of porous and fractured rocks under stress, especially on the dependence of seismic velocities on pore fluid pressure. He is a member of the SEG and EAGE.

**Ingo Koglin** received his diploma in geophysics in 2002 from Karlsruhe University. Since 2002 he has been a research associate at Karlsruhe University. His research interests include preparation and application of seismic wave field attributes obtained by the CRS stack. He uses the attributes for inversion and to improve imaging. A second field of interest is the improvement of the CRS stack by means of residual static correction. He is a member of SEG.

**Oliver Krüger** is a diploma student. Presently, he is working in the modeling group at the Freie Universität Berlin. His thesis is about accuracy of numerical modeling methods.

**L.W.B. Leite**: Professor of Geophysics at the Graduate Course in Geophysics, and member of the Department of Geophysics of the Federal University of Pará (Belem, Brazil). His main emphasis at the present time is seismic wave propagation in thin layers for deconvolution and inversion problems.

**Stefan Lueth** received his Diploma in geophysics from the TU Clausthal in August 1996. His thesis was on numerical and methodical investigations on diving wave tomography. In 2000 he received his Ph.D. from the FU Berlin. His research interests include refraction seismic data interpretation, seismic processing and integration of geophysical and geodynamic data.

**Jürgen Mann** received his diploma in geophysics in 1998 from the Faculty of Physics, Karlsruhe University, with a thesis on Seismic Image Waves. In 2002, he received a doctorate in natural sciences (with distinction), again from the Faculty of Physics in Karlsruhe, with a thesis on the Common-Reflection-Surface Stack method. Since 1998 he has been a research associate at Karlsruhe University, since 2001 he is assistant to Prof. Peter Hubral. His fields of interest are seismic reflection imaging methods, especially data-driven approaches based on kinematic wavefield attributes. He is member of the EAGE and the SEG.

**Elive M. Menyoli** received his diploma in Physics with specialization in Geophysics in 1998 at the University of Göttingen. From April 1998 until November 1998, he was with the German Geological Survey in Hannover. Since December 1998 he is a Ph.D. student at the University of Hamburg. His research interest is in Kirchhoff migration of P-SV converted waves.

**Alex Müller** is a graduate student currently working on the implementation of the 3D CRS stack. His main task is the development of efficient search strategies for the eight-parameter moveout surface used in the 3D CRS stack.

**Tobias M. Müller** received a diploma in geophysics in 1998 from Karlsruhe University and his Ph.D. in 2001 from Freie Universität Berlin. His research interests include the theoretical and numerical description of seismic wave fields in randomly inhomogeneous (poro-)elastic media.

**M. Amélia Novais** received her M.Sc. in Mathematics from the Brazilian Institute of Pure and Applied Mathematics (IMPA) in 1993 and her PhD in Applied Mathematics from State University of Campinas (Unicamp) in 1998. Since 1996, she has been a professor for Mathematics at the Federal University of Sao Carlos (UFSCar), Brasil. She has joined Unicamp in April 2002. Her research interests focus on partial differential equations and include seismic forward imaging. In particular, she works with finite differences to obtain the solution of the acoustic and elastic wave equation, as well as with the Born and Kirchhoff approximations. Presently, she also studies image-wave equations. She is a member of SEG, EAGE, SBGf, SBMAC, and SBM.

**Robert Patzig** received his diploma in geophysics from Braunschweig. In the dipoma thesis he developed a digital filter for the detection of the Stoneley-wave (borehole seismics) by combination of a prediction filter and the envelope of the wave. 1999 he received his Ph.D. for "Local earthquake tomography in the region of Antofagasta (Chile)". Next he applied CRS stacking to a seismic profile from the northern Chilean coast. His actual research interest is localizing acoustic emissions with respect to the influence of seismic anisotropy and poor recording conditions (i.e., only on string of receivers in a single borehole).

**Claudia Payne** has been Peter Hubral's secretary for 11 years. She is in charge of all WIT administrative tasks, including advertising, arranging meetings, etc. Phone: ++49-(0)721-608-4443, email: Claudia.Payne@gpi.uni-karlsruhe.de

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verse seismic methods, in particular Kirchhoff modeling and imaging, amplitude-preserving imaging methods, ray tracing, and model-independent stacking. Detailed aspects lay in questions like, for example, how to control amplitudes and boundary effects in different kinds of seismic imaging methods and on how to efficiently perform true-amplitude imaging. Moreover, part of his research interests are directed towards the extraction of additional useful image attributes from seismic data. His most recent activities include research on the resolving power of Kirchhoff migration and on how to make the image wave equation a practical imaging tool. He is a member of SEG, EAGE, DGG, SBGf, and SBMAC.

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oretical basis and can as well be applied to practical problems. His recent publications have been in the study of amplitude aspects of seismic data, namely true-amplitude depth migration and migration to zero offset (MZO). He is also working in kinematical imaging by stacking multi-coverage data, as for example by the common reflection element (CRE) method. He is a member of SEG, SBGf, and SBMAC.

**Claudia Vanelle** received her diploma in physics in 1997 and her Ph.D. in 2002, both from the University of Hamburg. Since 1997 she has been a research associate at the University of Hamburg and since 1998 at the Institute of Geophysics in Hamburg. In 2002 the Shell She-Study-Award was bestowed upon her in appreciation of her Ph.D. thesis. Her scientific interests focus on true-amplitude migration and anisotropy. She is a member of EAGE and SEG.

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