Wave Inversion Technology Consortium

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Preface

On behalf of the members of the Wave Inversion Technology (WIT) Consortium in the different groups in Belém, Berlin, Campinas, Hamburg, and Karlsruhe I want to thank the WIT sponsors for their continued support. In the previous years much of our scientific research efforts went into the development of new theories, algorithms and workflows for seismic imaging, tomographic inversion, characterisation of rock properties and passive monitoring. The past year—the 8th year of the WIT Consortium—distinguishes itself from the previous years by the fact that the collaboration with various sponsors was significantly intensified. Some sponsors have provided us with real seismic data and their experience in processing seismic data with our algorithms in industrial environments. This has helped us to adjust our activities and the development of our methods more to the needs of the WIT sponsors. The fact that former WIT members have found employment in the industry also confirms our success. We look forward to intensifying the close cooperation from which our researchers and WIT sponsors should benefit equally. It is a great pleasure for us to congratulate Alexander Goertz, Christof Mueller, Stefan Buske, and Stefan Lueth from the WIT-Group Berlin for winning the EAGE's Cagniard Award 2004. They have received the award for their poster on "Fresnel-volume multicomponent migration", presented at the 2003 EAGE meeting in Stavanger.

For 2004 we have gained one more sponsor: Fugro Seismic Imaging Ltd. Welcome to WIT! We hope that our supporters will maintain confidence in our research activities for years to come and look forward to a further extensive exchange of ideas.

Peter Hubral

Summary: WIT report 2004

IMAGING

Garabito et al. present a short review of the two well stablished 2D-CRS parameters search strategies and present a comparison between the results of the application of both CRS stack implementations to the marmousi data set.

Salvatierra et al. presents a global optimization scheme applied to the CRS problem in the 2-D situation. Numerical experiments illustrate the potential of the method.

Koglin and Ewig briefly present how CRS atributes are used to obtain CRS moveout corrected CRS super gather which are necessary for the subsequent residual static correction. The theoretical background, some recent extensions of the implementation, and a real data example are discussed.

Heilmann and von Steht present a recent extention of the CRS-stack-based imaging workflow able to support arbitrary top-surface topography. The implementation combines two different approaches of topography handling to a cascaded processing strategy demanding very little additional effort. Finally, the CRS stack and also CRS-stack-based residual static corrections can be applied to the original prestack data without the need of any elevation statics. The CRS-stacked ZO section, the kinematic wavefield attribute sections and the quality control sections can be related to a chosen planar measurement level by a redatuming procedure. Due to this redatuming procedure, the influence of the rough measurement surface can be entirely removed from the output sections of the CRS stack. Thus, an ideal input for the subsequent CRS-stack-based processing steps is provided.

Boelsen presents new hyperbolic traveltime formulas for the 2D CO CRS stack that are able to take top-surface topography into account. Two types of topography are considered, namely a rugged topography and a smooth one. Moreover, a stacking operator for a vertical seismic profile (VSP) acquisition geometry is derived. In addition, an approach to redatum the CO CRS stack section is proposed and tested with a synthetic data example.

Boelsen and Mann discuss the application of the 2D CO CRS stack to ocean bottom seismics and show a simple synthetic data example with a comparison of model- and data-derived wavefield attributes. Moreover, a new approach to stack multi-component data in order to obtain PP and PS CO CRS stacked sections is presented.

Kluever reviews the event-consistent smoothing algorithm for the 2D case and introduces its extension to the 3D case. The effect of the smoothing on CRS results is demonstrated using a small 2D real dataset.

Biloti and Schleicher suggest a dip correction for coherence-based migration velocity analysis. They demonstrate how the velocity update can be improved when the reflector dip is taken into account. As an additional search parameter, the reflector dip is also determined. A simple synthetic example demonstrate the feasibility of the method.

Vanelle suggests a simple technique to fill gaps in ray traveltime maps.

Jäger shows how CRS attributes can be used to determine optimum stacking apertures for Kirchhoff (true-amplitude) migration. In this way, the efficiency of the migration algorithm as well as the quality of the resulting images can be improved.

Lüth et al. present a method for imaging sparse three-component seismic reflection data in a heterogeneous 3D velocity model. The location of a reflection point is derived using the polarisation direction of the multicomponent data and the Fresnel volume of the respective wave path is then derived by paraxial ray tracing. The imaging condition is finally restricted to the Fresnel volume of the reflection wave path.

Aleixo and Schleicher derive the image-wave equation, that is a partial differential equation that describes the dislocation of a reflector image as a function of the velocity model, for elliptically isotropic media. The main objective is to remigrate an isotropic into a medium with a certain degree of anisotropy.

Ferreira & Cruz propose a modified true amplitude (diffraction stack) Kirchhoff prestack depth migration using as Green function a superposition of Gaussian beams (GB's). The process takes in consideration the explicit use of the Fresnel volume elements in order to enhance the resolution of the final imaging.

Vanelle et al. describe the traveltime-based implementation of true-amplitude migration. Application to a highly complex synthetic model and a real data set demonstrates the technique. Whereas the results are equivalent to migration with weight functions obtained from dynamic ray tracing, the efficiency of the traveltime-based implementation is considerably higher.

Kaschwich presents a new stratagy for the migration with angular parametrisation in anisotropic media. The method combines the conventional ray shooting with a hyperbolic traveltime interpolation.

Gajewski and Tessmer introduce a seismic event localization method based on reverse numerical modelling, where event picking can be avoided. The quality of the spatial localization and of the estimation of the excitation time is demonstrated using 2- and 3-dimensional synthetic data sets. Cases with noise contaminated seismograms, macro models with incorrect velocities and the effect of sparse receiver arrays are studied for simple and complex subsurface models.

Leite et al. processed seismic land data of the Takutu basin (Amazonas, Brazil) as an example not for comparison with other processing packages but to demonstrate once more the high potential of the data-driven CRS-stack-based imaging methods. The aim of this ongoing project is to establish a workflow for basin reevaluation for oil play. Based on the CRS attributes obtained during the CRS stacking process, the determination of a smooth macrovelocity model via tomographic inversion was conducted followed by pre- and poststack depth migration.

ROCK PHYSICS AND WAVES IN RANDOM MEDIA

Saenger et al. consider effective elastic properties (i.e. velocities) in three different kinds of dry and fluid-saturated porous media. The synthetic results are compared with the predictions of the Gassmann equation and the tortuosity-dependent high-frequency limit of the Biot velocity relations.

Krüger et al. In this work we estimate the effective reflection coefficients of an interface between a cracked and an uncracked material. The study is based on computer simulations using the rotated staggered grid finite difference method

Kaselow et al. test their hypthesis that the general depth trend of P-wave, S-wave, and formation factor at the KTB test site can be explained as a result of progressive crack closure with increasing depth. They also show a comparison between laboratory and logging derived results of the rocks stress-sensitivity.

Yoon et al. consider deep seismic imaging in the presence of heterogeneous overburden.

Grosfeld and Santos review some different approximations for the P-P reflection coefficient and the associated seismic attributes. To illustrate the ability of the attributes to indicate the presence of oil or gas, numerical examples are also presented. Moreover, a new indicator is introduced, based on an impedance-type approximation for the reflection impedance.

MODELING

Tygel and Santos review and discuss the Taylor expressions of traveltime moveouts for reflection rays around a fixed zero-offset ray. These are referred to as normal parabolic and hyperbolic, or simply quadratic normal moveouts. General 2D/3D expressions, with the inclusion of topographic as well as inhomogeneous velocities are reviewed and discussed.

Costa et al. extend the method of 2.5D FD modeling by out-of-plane Fourier transform to acoustic media with variable density. They demonstrate the quality of the method by a comparison to the analytical solution of the wave equation in homogeneous media and by a comparison to the 3D FD results for two inhomogeneous models, including the Marmousi model.

OTHER TOPICS

Shapiro, Rentsch and Rothert demonstrate that the probability of induced earthquakes occurring is very well described by the relaxation law of pressure perturbation in fluids filling the pore space in rocks. Using this observation they show that the spatial distribution of the density of earthquakes provides a possibility to estimate the hydraulic diffusivity on a kilometer scale with a high precision.

Rentsch, Buske, Lüth and Shapiro propose a new approach for location of seismicity based on principles of wave field back propagation. This concept is characterised by a high degree of automation since time consuming manual picking of arrival times is not required.

Sommer, Gajewski and Patzig present a real data case study and demonstrate the influence of anisotropy on the localization of hydraulically induced seismicity at the continental deep drilling site KTB (Germany). An unrecognized anisotropy affects the localization severely. In the KTB case, if anisotropy is not considered and station corrections are not applied, the center of the event cloud is dislocated 500 m to the south which is about 25% of the total lateral extent of the cloud. The anisotropic model perfectly centers the cloud at the injection well.

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 fully integrated 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. In 2003, the Geoscience Center at the University of Pará, Belém, Brazil joined the WIT Consortium as an affiliated working group. 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. data-driven multicoverage zero-offset 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 modeling
8. modeling and imaging in anisotropic media

WIT PUBLIC RELATIONS COMMITTEE

Name	University	Area
Peter Hubral	Karlsruhe	WIT headquarter
Claudia Payne	Karlsruhe	WIT headquarter
Jürgen Mann	Karlsruhe	WIT headquarter & WIT report
Alexander Müller	Karlsruhe	WIT report & WIT CD-R
Ingo Koglin	Karlsruhe	WIT report & WIT CD-R
Christoph Jäger	Karlsruhe	WIT homepage manager
Axel Kaselow	Berlin	WIT homepage manager

STEERING COMMITTEES

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Name	University	Name	Sponsor
Dirk Gajewski	Hamburg	Paolo Marchetti	ENI
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Jörg Schleicher	Campinas	Alfonso Gonzalez	WesternGeco
Sergei Shapiro	Berlin	Thomas Hertweck	Fugro Robertson
Ekkehart Tessmer	Hamburg		

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.

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

Ricardo Biloti received his BSc (1995), MSc (1998) as well as PhD (2001) in Applied Mathematics from the State University of Campinas (UNICAMP), Brazil. Since May 2002, he has been working for Federal University of Paraná (UFPR), Brazil, as an Adjoint Professor at the Department of Mathematics. Nevertheless he is still a collaborator of the Campinas Group. 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, SIAM, and SEG.

Tim Boelsen is currently working on his diploma thesis at the Geophysical Institute, University of Karlsruhe. His field of study focuses on the handling of rugged topography in the CRS stack and the application to synthetic and real data. He is a member of the SEG and EAGE.

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.

Klaus Mairan Laurido do Carmo received his BSc (2001) in Mathematics from the Federal University of Pará (Brazil). Presently, he is finishing his master's thesis entitled "Global Optimization methods applied in the search of the 2-D CRS stack parameters" at Federal University of Pará. His research interest is Applied Mathematics.

Pedro Chira-Oliva received his MSc in 2000 and PhD in 2003 from Federal University of Pará (Brazil), both in Geophysics. His research interests are macro-model independent imaging methods, seismic image wave methods and 3D modeling. He is a member of SBGf and SEG.

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.

João 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. He is a member of SEG, EAGE, and SBGF. Actually, he is the Director of the National Department of the Mineral Production of the Pará Province.

Jaime Fernandes Eiras received his diploma in geology in 1975 from the Pará University, Brazil. He joined Petrobrás in 1976, where he worked as a wellsite geologist until 1983, and as an exploration geologist until 2001. Since March 2002, he has been a visiting professor at the Geophysics Department of the ParÚniversity. As a basin interpreter, he has studied many of Brazil's offshore and onshore areas, such as Atlantic-type, paleozoic, rift, and multicyclic basins. His fields of interest are structural, stratigraphic, and seismic interpretation, especially seismic stratigraphy. He is a member of the Brazilian Geological Society.

Carlos A.S. Ferreira received a BSc (1996) and a MSc (2000), both in physics, at Federal University of Pará. From 1997 to 2001, he spent some time studying geology, where he had the opportunity of working with some geophysical methods, such as vertical electric sounding and well logging, both as a geology graduate student. Presently, he is working towards his PhD in geophysics at Federal University of Pará, where the main topic of his thesis is prestack depth migration using Gaussian beams. His main research interests are quantum description via Ermakov invariants (in physics) and all forward and inverse seismic imaging techniques. He is member of SEG, SBPC and SBGf.

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).

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.

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.

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. Besides the practical application of the CRS stack based imaging workflow in several research projects, he works on the development of the CRS stack software, focusing on the influence of rugged topography and near surface velocity variations. He is a member of EAGE and 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, the SEG's Reginald Fessenden Award in 1979, and the EAGE's Erasmus Award in 2003. He is a regular member of DGG and an honorary member of the EAEG/EAGE and 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 (de)migration 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.

Florian Karpfinger is a diploma student. Presently, he is working at the reservoir characterization group at the Free University Berlin. He is a member of the SEG, DGG, and EAGE.

Tina Kaschwich received her diploma in 2000 in geophysics from Hamburg University. Since 2001 she has been 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.

Tilman Klüver received his diploma (with distinction) in geophysics from Karlsruhe University in February 2004. Since April 2004, he has been a research associate at Karlsruhe University. His research covers the application of kinematic wavefield attributes in 2D and 3D inversion schemes as well as their extraction from seismic datasets. He is a member of the EAGE and the SEG.

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 wavefield 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 EAGE and SEG.

Oliver Krüger received his diploma in geophysics in 2002 from Freie Universität Berlin and is currently a PhD student at Freie Universität Berlin. His research interests focus on finite difference modeling, imaging and property prediction of fractured materials.

L.W.B. Leite is a 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.

Rômulo Correa Lima received his diploma in geophysics in 2002 from Geophysical Department of the Federal University of Pará, Brazil, with a thesis on Seismic Migration. In 2002 and 2003, he was a researcher in the seismic group of that university. Currently he is working on 3D modeling.

Stefan Lüth received his diploma in geophysics from the Technical University Clausthal in August 1996. His thesis was on numerical and methodical investigations on diving wave tomography. He then moved to Free University Berlin in order to work on a PhD project within the SFB 267 (Deformation Processes in the Andes). He processed and interpreted Wide-Angle and Seismic Refraction Data from the Andes. He defended his thesis at the FU Berlin in February 2000. Currently, he is a post-doc researcher working on imaging three-component seismic recordings along a tunnel or a VSP-configuration using 3D prestack migration. He is a member of DGG, AGU, and EAGE.

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.

Alex Müller received his diploma in geophysics in December 2003 from Karlsruhe University, Germany. His thesis dealt with the implementation of the 3D CRS stack. Since 2004 he has been a research associate at the Geophysical Institute in Karlsruhe. His research covers the 3D CRS stack and the application of the kinematic wavefield attributes in 3D inversion algorithms. Alex is also responsible for the WIT report. He is a member of the SEG.

Tobias M. Müller received a diploma in geophysics in 1998 from Karlsruhe University and his PhD in 2001 from Free University Berlin. Since 2002 he has been a post-doctoral fellow of the Deutsche Forschungsgemeinschaft at Curtin University of Technology in Perth. His research interests include seismic waves in random media and rock physics. He is a member of DGG, EAGE, and SEG.

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.

Miltiadis Parotidis received his diploma in geodesy and geophysics (Diplom-Ingenieur) in January 1997, and his PhD (Doctor techn.) in June 2001, both from the Vienna University of Technology, Austria. Since November 2002 he has been a post-doc researcher at the Geophysics Department of the Freie Universität Berlin. His main research interests are hydraulic characterization of reservoirs, triggered seismicity by fluid injections, earthquake triggering mechanisms and signatures. He is a member of AGU, DGG, EAGE, EGU, and SEG.

Claudia Payne has been Peter Hubral's secretary since 1990. She is in charge of all WIT administrative tasks, including advertising, arranging meetings, etc. Email: Claudia.Payne@gpi.uka.de; phone: +49-721-608-4443, fax: +49-721-71173

Rodrigo Portugal received his B.Sc. (1995), M.Sc. (1998), and PhD (2002) in Applied Mathematics from the State University of Campinas (UNICAMP), Brasil. In his thesis he studied wavefront construction in the 2.5D situation and its application to the four Kirchhoff operations, namely: modeling, migration, demigration and demodeling. Currently he is an associate researcher of the Department of Geology and Natural Resources (DGRN) at UNICAMP. His research interests include wavefront propagation, numerical analysis, seismic imaging and inversion.

Lasse Rabenstein is a diploma student. He is currently working as a teaching assistant for the department of Geophysics at the FU Berlin. His interests are seismic imaging and wave phenomena in random media.

Susanne Rentsch received her diploma in geophysics from the Free University Berlin in July 2003. Her diploma thesis was about "Hydraulic characterization of rocks using density of microseismicity". Since August 2003 she has been working as a PhD student on location of seismic events using imaging techniques.

Elmar Rothert received his diploma in Geophysics in 1999 from the University of Göttingen. In his diploma thesis he studied the scattering of teleseismic waves at small-scale heterogeneities in the crust and lithosphere below the seismic receiver array GRF in Germany. Since January 2000 he is a Ph.D. student of Prof. Shapiro at the Freie Universität Berlin. Currently, he focuses on the reconstruction of permeability in heterogeneous, anisotropic, fluid-saturated media from induced microseismicity. He is a member of AGU, EAGE, and SEG.

Erik Saenger received his diploma in Physics in March 1998 and his Ph.D. in November 2000 from the University of Karlsruhe. Since January 2001 he has been a research associate at the Freie Universität Berlin. Currently, he focuses on Finite Difference modeling of fractured materials at the Geophysical Institute, Free University Berlin. He is member of the DGG, DPG, SEG, and EAGE.

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