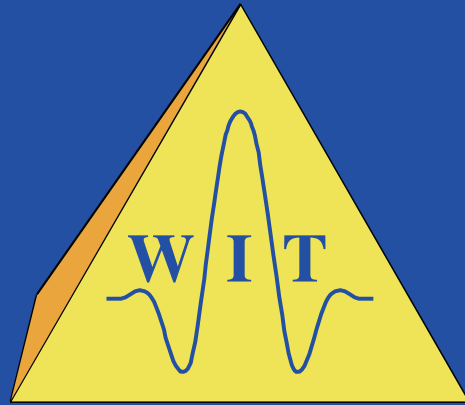


Wave Inversion Technology



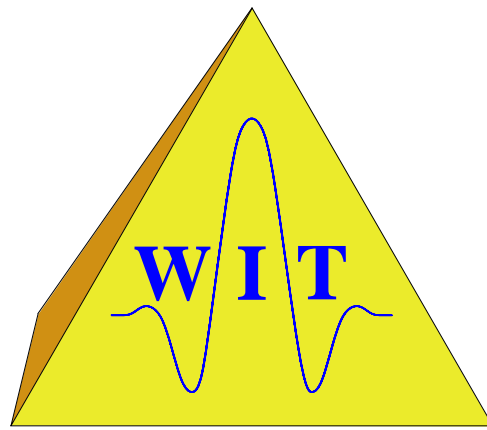
Wave Inversion Technology
established 1997 in Karlsruhe

Annual Report

1997

- **Table of Contents**
- **Preface**
- **WIT Working groups**
- **Research personnel**
- **WIT Sponsors**

Wave Inversion Technology



Wave Inversion Technology
Geophysical Institute, Uni Karlsruhe

Annual Report No. 1

1997

Karlsruhe, February 16, 1998

with contributions
from the WIT Groups:

Geophysical Institute
Karlsruhe University
Hertzstr. 16
76187 Karlsruhe
Germany

Tel.: (+49) 721/608-4443
Fax: (+49) 721/71173
e-mail: peter.hubral@physik.uni-karlsruhe.de

Dept. of Applied Math.
IMECC - UNICAMP
C.P. 6065
13081-970 Campinas (SP)
Brazil

Tel.: (+55) 19/788-7900 or -7915
Fax: (+55) 19/239-5808
e-mail: js@ime.unicamp.br

Institute of Geophysics
Hamburg University
Bundesstr. 55
20146 Hamburg
Germany

Tel.: (+49) 40/4123-2975
Fax: (+49) 40/4123-5441
e-mail: gajewski@dkrz.de

Department of Geophysics
Geosciences Center - UFPA
C.P. 1611
66075-970 Belm (PA)
Brazil

Tel.: (+55) 91/211-1671 or -7915
Fax: (+55) 91/211-1609
e-mail: soellner@ufpa.br

WIT Web Page:
<http://www-gpi.physik.uni-karlsruhe.de/pub/wit/wit.html>

Copyright © 1997

by Karlsruhe University

Karlsruhe, Germany

*Copying permitted for all internal purposes of the Sponsors of
Wave Inversion Technology Consortium*

TABLE OF CONTENTS

Preface	IV
----------------------	----

Imaging A: True Amplitude Image Transformations

<i>Hubral P., Schleicher J., and Mueller T.,</i> – Review – Seismic Reflection Imaging ..	3
<i>Martins J., Schleicher J., Tygel M., and Santos L.,</i> 2.5D true-amplitude Kirchhoff migration and demigration	5
<i>Novais A., Santos L., Tygel M., and Ursin B.,</i> A unified Born–Kirchhoff representation for acoustic media	9
<i>Oliveira A., Tygel M., and Filpo E.,</i> On the application of true-amplitude DMO. . . .	13
<i>Santos, L.T., Schleicher, J., Tygel, and M.,</i> 2.5D true-amplitude offset continuation .	17
<i>Santos L., Schleicher J., Tygel M., and Hubral P.,</i> Modeling by demigration	21
<i>Schleicher, J., Hubral, P., Tygel, M., Jaya, and M.S.,</i> Minimum Apertures and Fresnel zones in migration and demigration	27
<i>Tygel, M., Schleicher, J., Hubral, P., Santos, and L.T.,</i> 2.5-D True-Amplitude Kirchhoff Migration to Zero Offset in Laterally Inhomogeneous Media	33
<i>Ursin B. and Tygel M.,</i> Reciprocal volume and surface scattering integrals for anisotropic elastic media	41

Imaging B: Macromodel-independent Zero-offset Simulations

<i>Cruz J., Hubral P., Tygel M., and Schleicher J.,</i> The common-reflecting-element (CRE) method revisited	47
<i>Höcht G., Jäger R., and Hubral P.,</i> A new look at subsurface illumination in seismic imaging	55
<i>Müller T., Tygel M., Hubral P., and Schleicher J.,</i> Eigenwave based multiparameter traveltimes expansions	61
<i>Müller T.,</i> Common Reflection Surface Stacking	69

<i>Perroud H., Hubral P., and Höcht G.,</i> Common-reflection-point stacking in laterally inhomogeneous media	77
---	----

Imaging C: Imaging in General

<i>Jaya M. S., Hubral P., and Botelho M.,</i> Constructing migrated image scans by post-stack remigration	85
<i>Mann J. and Jaya M. S.,</i> 3D finite difference post-stack time and depth remigration	93
<i>Pasasa L., Wenzel F., and Zhao P.,</i> Imaging complex 2D structure with non-Fermat arrival Kirchhoff depth migration	97
<i>Schleicher J., Hubral P., Höcht G., and Liptow F.,</i> Seismic constant-velocity remigration	105

Rock Physics

<i>Shapiro S. A.,</i> – Review – Rock Physics and Waves in Random Media	111
<i>Bojinski S., Shapiro S., Gold N., and Stanullo J.,</i> Seismic characterization of statistical properties of fractured composite materials	113
<i>Gold N. and Shapiro S.,</i> Upscaling in elastic random media	121
<i>Shapiro S. A., Royer J., and Audigane P.,</i> Estimating the Permeability from Fluid-Injection Induced Seismic Emission	127
<i>Shapiro S. A. and Mueller T. M.,</i> Seismic signatures of permeability	137
<i>Weiss A.,</i> What Higher Order Statistics can reveal on the Seismogram	143
<i>Werner U. and Shapiro S. A.,</i> Frequency-dependent shear-wave splitting in finely layered media with intrinsic anisotropy	147

Modeling A: Asymptotic Methods

<i>Gajewski D.,</i> – Review – Modeling: Asymptotic Methods	153
<i>Ettrich N.,</i> Finite-difference traveltimes computations for anisotropic media	155
<i>Ettrich N.,</i> A hybrid method for traveltimes computation	159
<i>Falk J. and Tessmer E.,</i> Numerical Studies of Realistic Single Well Monitoring and Walkaway VSP Configurations	165
<i>Kosłowski O. and Ettrich N.,</i> Computation of frequency-dependent traveltimes	169

<i>Leidenfrost A. and Gajewski D.,</i>	Strategies for 3D travel time computation	173
--	---	-----

Modeling B: Full Wave Form Modeling

<i>Karrenbach M.,</i>	– Review – Full Wave Form Modeling	179
<i>Karrenbach M.,</i>	Modeling of Physical Systems	181
<i>Laux S.,</i>	Calculation of selected wavefields with the reflectivity method	187
<i>Pohl M. and Karrenbach M.,</i>	Reflectivity modelling: a tool for testing processing algorithms	193

Computer Science and Artificial Intelligence

<i>Karrenbach M.,</i>	– Review– Computer Science and Artificial Intelligence	203
<i>Karrenbach M. and Jacob M.,</i>	Large-Scale Parallel Geophysical Algorithms in Java: A Feasibility Study	205
<i>Essenreiter R. and Karrenbach M.,</i>	Multiple Reflection Attenuation in Marine Seismograms using Backpropagation Neural Networks	211

Anisotropy

<i>Gajewski D.,</i>	– Review – Anisotropy	217
<i>Gajewski D., Kashtan B., and Zillmer M.,</i>	Normal moveout velocities in 3D arbitrary anisotropic media	219
<i>Ruedas T. and Teßmer E.,</i>	2D seismic modeling in transversely isotropic media with a Chebyshev-Fourier method in consideration of the free surface and the surface/grid interface topography	227
<i>Zillmer M., Gajewski D., and Kashtan B. M.,</i>	P-wave AVOA for vertically fractured media	235
WIT Working Groups	239
Software List	243
List of WIT Sponsors	249
Research personnel	252

Preface

We are glad to put the first Annual Report of the WIT Consortium into your hands. We hope it will please you as we have made all attempts to be as professional in compiling this report as we have always been in our research. We are glad that in addition to the research contributions from Karlsruhe and Campinas (Brazil) the sponsors can now benefit from contributions from Hamburg University. This demonstrates that the WIT Consortium wants to operate globally, by attracting attractive researchers from wherever they are as long as they are attracted by the WIT philosophy. This is to attract attractive sponsors by providing them the most attractive geophysical research products.

Peter Hubral

Karlsruhe, February 16, 1998

Working groups

Group:	Seismic Imaging and Inversion
Group leaders:	Peter Hubral (University of Karlsruhe, Karlsruhe, Germany) Walter Soellner Joao Carlos Ribeiro Cruz (Federal University of Pará (UFPA), Belem/Brazil) Martin Tygel Jörg Schleicher Lúcio Tunes Santos (State University of Campinas (UNICAMP), Campinas/Brazil)
Ph.D. students:	Luiz Alfredo Montes Vides <i>Determination of Interval Velocities in 3D Inhomogeneous Media -administration of programs (group developments)</i> German Garabito Callapino <i>Zero Offset Imaging - responsible for FOCUS/Disco based processing</i> Isabel Cristina Tavares <i>Determination of the Characteristic Function of Hamilton from Reflection Seismograms</i> Joao Luis Martins (UNICAMP) <i>Migration and Demigration in 2.5 Dimensions</i> Maria Amélia Novais Schleicher (UNICAMP) <i>An Unified Born–Kirchhoff Approximation</i> Ricardo Biloti (UNICAMP) <i>Multiparameter Inversion by Optimization</i> Rodrigo Portugal (UNICAMP) <i>The 2.5D Acoustic Wave Equation</i> Carlos Piedrahita (UNICAMP) <i>Multiparameter Velocity Analysis</i> Makky S. Jaya <i>Construction of migrated image scans by post-stack remigration</i> Thilo Müller <i>Developping the Common Reflection Stacking (CRS) method; Assisting Prof. Hubral in giving lectures; Supervising Master students;</i>

- Master students: Norcirio Pantoja Queiroz
True Amplitude Time Migration without Knowledge of Velocities
- German Höcht
Imaging with the Common Reflection Point and the Common Reflection Surface Stack
- Rainer Jäger
Title of the thesis not yet known
- Jürgen Mann
Derivation and Implementation of the Image Wave Theory and its Application to Seismic Data
- Group: **Analysis and Modeling of Complex Structures**
- Group leader: Martin Karrenbach
scientific leadership, development of modeling and analysis methods
- Ph.D. student: Joerg Mueller
Finite difference modeling in fault zones and complex structure 3D Model building in GOCAD (Skills: Fortran90, SEPlib, Matlab)
- Research Geophysicist: Maren Scheidhauer
Testing of processing algorithms for nonconventional surveys (Processing Packages: FOCUS, SEPlib, SU, GMT)
- Research Student: Baerbel Traub
3D Asymptotic Raytracing with a Wave Front Construction Method (Skills: SEPlib, Moser's recursive raytracing)
- Research Student: Kai-Uwe Vieth
Pre-stack processing of nonconventional seismic surveys (Skills: Fortran, FOCUS, SEPlib, SU, GMT)
- Group: **Multiple Reflection Identification and Suppression**
- Group leader: Martin Karrenbach
scientific leadership
- Ph.D.student: Robert Essenreiter
Development of multiple identification and suppression techniques on the basis of neural networks
- Master students: Susanne Laux

- Selective and full wave form modeling with the reflectivity method for testing of deconvolution techniques*
(Skills: SEPLib, Reflectivity Modeling)
- Albrecht Haeussermann
Application of neural network multiple suppression on real data
- Research students: Robert Mauch
Coherency analysis of seismic data (Skills: SEPLIB, Fortran90)
- Ingo Koglin
Computation and analysis of seismic attributes (Skills: SEPLIB, Fortran90)
- Group: **Geophysical Characterization of Reservoirs and Stochastic Structures**
- Group leader: Sergei A. Shapiro
Scientific leadership
- Ph.D. students: Andreas Kirchner, Karlsruhe
Stochastic characterization of reservoir properties. Characterization of fault zones in non-destructive testing. Management and administration
- Tobias Mueller, Karlsruhe
Statistical wavefield analysis and further development of Rytov Approximation. Wave propagation in poroelastic media
- Kai-Uwe Vieth, Karlsruhe
Application and development of imaging and inversion techniques. Non-destructive localization of macroscopic cracks in fibre reinforced composite materials
- Erik Saenger, Karlsruhe
Simulation of the Propagation of elastic waves through inhomogeneous media. Application of parallel computing devices
- Pascal Audigane, Nancy/France
3D inversion and modeling of permeability tensor
Affiliation: CRPG-CNRS, Nancy, France
- Master student: Stephan Bojinski, Karlsruhe
Seismic Characterization of fractured composite media by statistical wavefield analysis, thesis to be finished soon.

Group: **Elastic Wavefield Modeling**
Group leader: Friedemann Wenzel
Ph.D. students: Linus Pasasa
High-resolution seismic imaging in waste disposal sites
Melanie Pohl
Modelling of anisotropic features in the earth's crust
Master student: Mechita Schmidt-Aursch
FD-modelling of the elastic wavefields generated by realistic sources

Group: **Applied Geophysics Group (AGG), Hamburg**
Group leader: Dirk Gajewski
Research associates: Norman Ettrich
Ekkehart Tessmer
Ph.D. students: Joachim Falk
Andree Leidenfrost
Master students: Thorsten Graf
Olgierd Koslowski
Other students: Carsten Falck
Maximilian Krueger
Sebastian Barth
(Skills: Seismic Unix (SU), GeoDepth)

Software List

The authors are responsible for their programs and the copyright and ownership remains with the author. Sponsors of WIT can use those programs for all internal purposes. No warranty or suitability for any particular purpose is given, neither expressly nor implied. For access to the software contact the authors at the email addresses given below and arrange transfer modalities (installation) with them directly. The sponsor has to cover possible costs for the transfer.

Program Name: Remnew
Program Description: 3D finite difference post-stack time and depth remigration based on seismic image wave theory
Language: Fortran90
Software Package Requirements: SEPlib
Interactive: no
Author: Juergen Mann
E-mail: jmann@gpirls1.physik.uni-karlsruhe.de

Program Name: MZO90
Program Description: Finite difference migration to zero-offset and finite difference dip moveout based on seismic image wave theory
Language: Fortran90
Software Package Requirements: SEPlib
Interactive: no
Author: Juergen Mann
E-mail: jmann@gpirls1.physik.uni-karlsruhe.de

Program Name: Illu
Program Description: Performs the so called Common Reflection Surface Stack, searching the three stacking parameters at the same time.
Language: Fortran 90
Software Package Requirements: SEPlib
Interactive: no
Author: Thilo Mueller
E-mail: Thilo.Mueller@phys.uni-karlsruhe.de

Program Name: Illu2
Program Description: Performs the so called Common Reflection Surface Stack, searching the three stacking parameters in 2 search steps. Therefore it is faster, but not as accurate as Illu.
Language: Fortran 90
Software Package Requirements: SEPlib
Interactive: no
Author: Thilo Mueller
E-mail: Thilo.Mueller@phys.uni-karlsruhe.de

Program Name: AKU2D
Program Description: 2D finite-difference wave equation modeling of acoustic waves, 6th/10th order approximation in space, 2nd/4th order approximation in time, absorbing boundaries, free surface
Language: Fortran 77
Software Package Requirements: none
Interactive: no
Author: Joachim Falk, University of Hamburg
E-mail: falk@dkrz.de, gajewski@dkrz.de

Program Name: ELA2D
Program Description: 2D finite-difference wave equation modeling of seismic waves (P-SV), 6th order approximation in space on staggered grids, 2nd/4th order approximation in time, absorbing boundaries, free surface
Language: Fortran 77
Software Package Requirements: none
Interactive: no
Author: Joachim Falk, University of Hamburg
E-mail: falk@dkrz.de, gajewski@dkrz.de

Program Name: GRIMFIDI

Program Description: 2D finite-difference wave equation modeling of seismic waves (P-SV), 6th order approximation in space on staggered grids, 2nd/4th order approximation in time, adjustable grid spacing by grid refinement technique, absorbing boundaries, free surface, manual available
 Language: Fortran 77
 Software Package Requirements: none
 Interactive: no
 Author: Joachim Falk, University of Hamburg
 E-mail: falk@dkrz.de, gajewski@dkrz.de

Program Name: PWC-Stack
 Program Description: velocity independent stacking approach
 Language: Fortran
 Software Package Requirements: DISCO/Focus
 Interactive: No
 Author: W. Soellner and G. Garabito Callapino
 E-mail: soellner@marajo.ufpa.br

Program Name: Fdmod
 Program Description: Finite Difference Modeling Package (time domain, optimized derivative coeff. , elastic, viscoelastic, anisotropic, free surface, absorbing, topography)
 Language: Fortran90 (HPF)
 Software Package Requirements: SEPlib
 Interactive: No
 Author: M. Karrenbach
 E-mail: martin.karrenbach@physik.uni-karlsruhe.de

Program Name: sepref
 Program Description: Reflectivity Modeling (isotropic, wave field selection)
 Language: Fortran77
 Software Package Requirements: SEPlib
 Interactive: No
 Author: S. Laux
 E-mail: martin.karrenbach@physik.uni-karlsruhe.de

Program Name: CHANT

Program Description: 2D elastic pseudospectral Fourier-Chebyshev fullwave modeling with free surface boundary conditions and surface topography. 4th order Taylor expansion in time.
 Language: Fortran 77
 Software Package Requirements: none
 Interactive: no
 Author: Thomas Ruedas, University of Hamburg
 E-mail: ruedas@dkrz.de

Program Name: CT3D
 Program Description: 3D elastic pseudospectral Fourier-Chebyshev fullwave modeling with free surface boundary conditions. 4th order Taylor expansion in time.
 Language: Fortran 77
 Software Package Requirements: none
 Interactive: no
 Author: Ekkehart Tessmer, University of Hamburg
 E-mail: ekkehart.tessmer@dkrz.de, gajewski@dkrz.de

Program Name: CT3DTOPO
 Program Description: 3D elastic pseudospectral Fourier-Chebyshev fullwave modeling with free surface boundary conditions and surface topography. 4th order Taylor expansion in time.
 Language: Fortran 77
 Software Package Requirements: none
 Interactive: no
 Author: Ekkehart Tessmer, University of Hamburg
 E-mail: ekkehart.tessmer@dkrz.de, gajewski@dkrz.de

Program Name: CT3DANX
 Program Description: 3D fully anisotropic elastic pseudospectral Fourier-Chebyshev fullwave modeling with free surface boundary conditions. 4th order Taylor expansion in time.
 Language: Fortran 77
 Software Package Requirements: none
 Interactive: no
 Author: Ekkehart Tessmer, University of Hamburg
 E-mail: ekkehart.tessmer@dkrz.de, gajewski@dkrz.de

Program Name: vid2d
Program Description: 2D finite-difference eikonal solver, expanding squares
Language: Fortran 77
Software Package Requirements: none
Interactive: no
Author: Norman Ettrich, University of Hamburg
E-mail: ettrich@dkrz.de

Program Name: fdpert2d
Program Description: 2D finite-difference eikonal solver, first-order perturbation method included, simultaneous traveltime computation for several isotropic models, traveltime computation for anisotropic models
Language: Fortran 77
Software Package Requirements: none
Interactive: no
Author: Norman Ettrich, University of Hamburg
E-mail: ettrich@dkrz.de

Program Name: qin3d
Program Description: 3D finite-difference eikonal solver, wavefront expansion
Language: Fortran 77
Software Package Requirements: none
Interactive: no
Author: Norman Ettrich, University of Hamburg
E-mail: ettrich@dkrz.de

Program Name: wfc2d
Program Description: 2D wavefront construction, multivalued travel-times, amplitudes, phases, take-off angles
Language: Fortran 77
Software Package Requirements: none
Interactive: no
Author: Norman Ettrich, University of Hamburg
E-mail: ettrich@dkrz.de

Program Name: polfd

Program Description: 2D FD eikonal solver in polar coordinates. Takes a velocity field on a rectangular grid as input and gives the computed travel times on an also rectangular grid.

Language: Fortran 77

Software Package Requirements: none

Interactive: no

Author: Andree Leidenfrost, University of Hamburg

E-mail: leidenfrost@dkrz.de

List of WIT Sponsors

AGIP S.p.A.
RISG Department
20097 San Donato Milanese MI
Italy
Contact:
Mr. Claudio Zenucchini
Tel. 39-2-52047555
Fax: 39-2-52047278

BEB Erdgas und Erdl GmbH
Postfach 51 03 60
D-30633 Hannover
Contact: Dr. Christian Schweitzer
Tel. 49-511-641-2164
Fax: 49-511-641-2403

Chevron Petroleum Technology Co.
1300 Beach Blvd.
La Habra, CA 90631-6374
USA
Contact: Dr. Glyn M. Jones
Tel. 1-562-694-7137
Fax: 1-562-694-7063

Cogniseis Inc.
2401 Portsmouth
Houston, TX 77098
USA
Contact: Mr. Luis Canales
Tel. 1-713-630-3845
Fax: 1-713-630-3968

Geco Prakla UK Ltd.
Schlumberger House,
Buckingham Gate
Gatwick Airport
Gatwick, West Sussex RH6 0NZ
UK
Contact: Dr. Ralf Ferber
Tel: 44-1293-556802
Fax: 44-1293-556800

Mobil Technology Co.
P.O. Box 650232
Dallas, TX 75265-0232
USA
Contact: David L. Hinkley
Tel: 1-214-951-2839
Fax: 1-214-951-2098

Norsk Hydro a.s.
Research Centre
5020 Bergen
Norway
Contact: Hans B. Helle
Tel. 47-55996866
Fax: 47-55996970
e-mail: hans.B.Helle@nho.hydro.com

Preussag Energie GmbH
Waldstr. 39
D-49808 Lingen
Contact: Mr. Paul Krajewski
Tel: 49-591-612-381
Fax: 49-1-591-6127000

PGS Seres AS
P.O. Box 354
Strandveien 4
1324 Lysaker
Norway
Contact: Mr. Thorbjorn Rekdal
Tel. 47-67526643
Fax: 47-67526640

RWE-DEA AG fuer Minerall und Chemie
Postfach 600449
D-22204 Hamburg
Contact: Mr. Wolfgang Apel
Tel: 49-40-6375-2349
Fax: 49-40-6375-3590

Elf Exploration UK plc
30 Buckingham Gate
London SW1E 6NN
UK
Contact: Alan Burns
Tel. +44 171 963 5005
Fax. +44 171 963 5061
E-mail: alan.burns@elfgrc.co.uk

Research Personnel

Robert Essenreiter received his M.Sc. in Geophysics from the University of Karlsruhe, Germany, in August 1996. His master thesis was on Geophysical Deconvolution and Inversion with Neural Networks. Currently he is a Ph.D. Student at the Geophysical Institute, University of Karlsruhe, Germany. His research interests include signal processing and artificial intelligence. In his current project he is working on a new approach for multiple attenuation using neural networks.

Norman Ettrich received his Diploma (1993) in geophysics from the Technical University of Clausthal and a PhD (1997) in geophysics from the University of Hamburg. Since 1996, he has been a research assistant at the University of Hamburg. His interests are ray tracing and seismic migration/inversion. He received EAEG's Van Weelden Award in 1995. He is a member of EAGE.

Joachim Falk received his Diploma (1994) in geophysics from the University of Hamburg. Since 1994 he has been a research associate at the University of Hamburg. He is working on the development of finite difference algorithms using adapted grids for the numerical modeling of acoustic, seismic and electro-magnetic wave propagation problems in complex media. He is a member of the 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 asymptotics, seismic modeling, and processing of seismic data from isotropic and anisotropic media. Together with Ivan Psenck, 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).

Norbert Gold is dealing with the propagation of elastic waves in 2-D and 3-D random media and with finite difference modelling on parallel computers.

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 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.

Makky S. Jaya is working on image animation, i.e., he is trying to solve the problem of obtaining seismic images for a continuous set of parameters using image-wave equations and their solutions.

Martin Karrenbach received his "Vordiplom" in physics in 1985 from the University of Karlsruhe, West Germany, and his M.S. in geophysics from the University of Houston in 1988. He was with SEP from September 1988 through February 1995 when he received his Ph.D. in geophysics from Stanford University. He had summer employment with Siemens, BEB, Cogniseis and most recently with Chevron Oilfield Research Co. He is currently an Assistant Professor at Karlsruhe University, Germany. He is a member of the AGU and SEG.

Andree Leidenfrost received his Diploma (1995) in geophysics from the University of Hamburg. Since 1995 he has been a research associate at the University of Hamburg. His interests are

travel time computation and seismic migration. He is a member of EAGE.

Joao L. Martins is occupied with the development of fast and efficient Kirchhoff-type true-amplitude imaging methods for several different simpler types of media.

Tijmen Jan Moser received his Ph.D. in Geophysics from the University of Utrecht in 1992, on a thesis concerned with the shortest path calculation of seismic ray paths. Thereafter, he held research positions at Amoco (Tulsa, summer 1992), IFP (Paris, 1992-1993), IPG (Paris, 1993-1994), ISEP/Norsk Hydro (Bergen, 1995-1996). He was an Alexander-von-Humboldt fellow at the Geophysical Institute in Karlsruhe (1996-1997). He is currently a consultant at Norsk Hydro (Bergen). His main research interests include applied mathematics, computational seismology, and ray-based imaging. He is a member of SEG, EAGE and MAA. His main area of interest is ray-based imaging. As such, he is involved in developing cost- and memory-effective techniques for wavefront construction, in 2D and 3D smooth and non-smooth media. These techniques have found applications in forward modeling and VSP in complicated structures. Also, he is interested in applications in true-amplitude imaging in presence of realistic, possibly non-smooth, macro-velocity models.

Thilo Müller is working on imaging techniques. He is particularly involved in the so called CRS (Common Reflection Surface) Stack Technique. This is an imaging process that stacks data along the optimum stacking surface, using much more traces than standard techniques and needing no velocity information.

M. Amélia Novais investigates the different aspects of Born and Kirchhoff forward modeling schemes, in particular with respect to amplitudes. She is also working on a combined scheme that incorporates the advantages of both methods.

Melanie Pohl is dealing with wave propagation in generally anisotropic 3D media. She is applying these schemes in lower crustal structure studies and in reservoir simulations.

Thomas Ruedas began studying geophysics at Hamburg university in 1991 and received his Diploma in 1997.

Lúcio Tunes Santos received his BS (1982) and MS (1985) in Applied Mathematics from the State University of Campinas (UNICAMP), Brazil. In 1991 he earned his Ph.D. in Electrical Engineering also from UNICAMP. From 1985 to 1988 he was employed as a Teaching Assistant at the University of So Paulo (USP). Since 1988 he has been working for UNICAMP, first as a Teaching Assistant and since 1991 as an Assistant Professor. Between August 1994 and August 1995, he visited Rice University as a post-doc researcher. His professional interests include seismic modeling and imaging as well as nonlinear optimization. He is a member of SIAM and SBMAC (Brazilian Society of Applied Mathematics). His main areas of research are seismic modeling and true-amplitude imaging. He's also interested in nonlinear optimization algorithms and fractals. His present activities include MZO for variable velocity and modeling by demigration. Moreover, he's also working on exact penalty methods in nonlinear programming.

Jörg Schleicher received his "Diplom" (MSc equivalent) in Physics in 1990 and his "Dr. rer. nat." (Ph.D. equivalent) in Geophysics in 1993 from Karlsruhe University, Germany. After employment as a research fellow at the Geophysical Institute from February 1990 to September 1995, he became a visiting scientist at the Institute for Mathematics, Statistics, and Scientific Computing of the State University of Campinas (IMECC/UNICAMP), Brazil, with a joint grant from the Brazilian National Council for Scientific and Technological Development (CNPq) and Alexander von Humboldt foundation. Since October 1996, he has been employed as an Associate Professor for Applied Mathematics at IMECC/UNICAMP. His research interests include almost all forward and inverse seismic methods. He is a member of SEG, EAGE, DGG, SBGf, and SBMAC. His main areas of research include true-amplitude imaging and ray tracing. He's also interested in any kind of seismic modeling or imaging theories and algorithms. His present activities include research on how to control amplitudes in different kinds of seismic imaging methods and on how to efficiently perform the true-amplitude imaging. Moreover, part of his research is directed towards the extraction of more useful image attributes from seismic data.

Sergei Shapiro received his M.Sc. in 1982 from Moscow University and the Ph.D. in 1987 from All Union Research Institute of Geoinformsystem (AURIG) in Moscow, both in Geophysics. During 1982-90 he worked for AURIG as a research geophysicist. Since 1991 he has been a senior research scientist at the Geophysical Institute of Karlsruhe University, Germany, the first two years as an Alexander von Humboldt fellow. From January to August 1997, he was a Heisenberg associate-research professor in Karlsruhe. Since September 1997, he has been a full professor in Applied Geophysics at the Nancy School of Geology, France, where he is cooperating with GOCAD consortium. His interests include exploration seismology, rock physics, and forward and inverse scattering problems. He is a member of SEG, EAGE, AGU, and DGG.

Walter Söllner received a diploma (1983) in geophysics from Clausthal Technical University and his Ph.D. (1990) in geophysics from Clausthal Technical University. Since 1995, he has been a visiting professor in applied seismics at the Federal University of Para (UFPA), Brazil. From 1989 until 1994 he worked as research scientist at the Geophysical Institute at Karlsruhe University. His research interests are seismic processing, imaging and inversion. He is a member of SEG and SBGf.

Ekkehart Tessmer received an MSc in 1983 in geophysics from Hamburg University and a PhD in 1990 from Hamburg university. Since 1990, he has been senior research scientist at the Institute of Geophysics at Hamburg university. Since 1994, he has a university staff position. His research interests include exploration seismology, seismic and electromagnetic wave propagation simulation, and migration. He is a member of DGG, EAGE, and SEG.

Marc Tittgemeyer is focussing on elastic wave propagation through random media. In particular he's interested in an explanation for prominent seismic refraction phases being efficiently propagated most likely within a sub-Moho waveguide.

Martin Tygel received his BSc in physics from Rio de Janeiro State University in 1969, his M.Sc. in 1976 and Ph.D. in 1979

from Stanford University, both in Mathematics. He was a visiting professor at the Federal University of Bahia (PPPG/UFBa), Brazil, from 1981 to 1983 and at the Geophysical Institute of Karlsruhe University, Germany, in 1990. In 1984, he joined Campinas State University (UNICAMP) as an associate professor and since 1992 as a full professor in Applied Mathematics. Professor Tygel has been an Alexander von Humboldt fellow from 1985 to 1987. In that period, he conducted research at the German Geological Survey (BGR) in Hannover. Since 1995, he has been president of the Brazilian Society of Applied Mathematics (SBMAC). His research interests are in seismic wave propagation and processing, including imaging, migration and inversion. He is a member of SEG, SBGf, and SBMAC. His research combines wave propagation and seismic processing. This includes the development of imaging, migration and inversion algorithms, that possess a sound wave theoretical 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.

Wolfgang Velten deals with the development of ray tracing algorithms in 3D blocked media with triangulated surfaces.

Friedemann Wenzel received a Ph.D. in geophysics from Karlsruhe University in 1985. Until 1988 he worked as research scientist in Karlsruhe and at Columbia University (U.S.), until 1990 as Associate Professor in Karlsruhe, until 1992 as Principal Research Scientist of CSIRO Division of Exploration Geosciences in Sydney (Australia), until 1994 as Director of the department 'Structure of the Earth' at GeoForschungs Zentrum Potsdam, and Professor of Geophysics at Potsdam University, since 1994 as Professor at the Geophysical Institute, Karlsruhe University. He is currently head of the Collaborative Research Center 461 (Sonderforschungsbereich) 'Strong Earthquakes - A Challenge for Geosciences and Civil Engineering' at Karlsruhe University. His research interests are in seismology, modeling of wave propagation, and seismic hazard assessment. He is a member of AGU, SEG, EGS, EUG, and SSA.

Ulrich Werner is working on an expansion of the generalized O'Doherty/Anstey theory that, in addition to the frequency-dependent anisotropy due to thin multilayering, also takes frequency-independent intrinsic anisotropy of each layer into account.

Matthias Zillmer Diploma in Physics at the University of Hamburg (1995). Since 1995 PhD research associate at the Institute for Geophysics. Interests in anisotropy, ray theory, reflection coefficients. SEG member.