

CREWES NEWS

The Consortium for Research in Elastic Wave Exploration Seismology

New students at CREWES

In this issue we continue our introduction of new and returning students.

Marcia Coueslan began her university education in geological engineering at the University of Waterloo. After graduation, she worked for three years with Geco-Prakla in Houston doing advanced demultiple processing and depth imaging. For the last two years she has been with Schlumberger in their borehole seismic processing group. Then, after deciding to return to university, she spent the past summer working as a summer student at Husky interpreting seismic on an East China Sea project. She is now pursuing a master's degree with Dr. Don



Lawton studying multicomponent time lapse monitoring of carbon dioxide injection into coalbed methane reservoirs.

Marcia loves travelling, camping, hiking, and cycling. She and her fiance also plan to do as much skiing as they can this winter, and take a crack at snowshoeing. She also likes photography, reading, cooking and dancing.

Tingge Wang comes to us from China where he received a B.Sc. (1985) in Applied Geophysics from the East China Petroleum Institute, and an M.Sc. (1992) in Exploration Geophysics from Jiangnan Petroleum Institute. From 1985 to 2001, he worked for China National Petroleum Corporation as a field geophysicist, seismic data processor, research geophysicist, and senior geophysicist. Currently he is a 3-D visualization laboratory manager at the University of Calgary. He is now studying with Dr. Larry Lines and is interested in time-lapse seismic analysis, multi-component seismic exploration and application of visualization technology to seismic exploration.



In his spare time he enjoys basketball, table tennis, volleyball and music.

Linping Dong graduated from the University of Petroleum of China in 1982 with a B.Sc. in Geophysics. Since then his extensive experience has included teaching courses in digital signal analysis and principles of seismic exploration, working as a senior processing geophysicist and associate director of a seismic data processing office, and being an associate professor at Xi'an Petroleum Institute.



Linping recently completed an M.Sc. program with CREWES in which his research focused on nonstationary wavelet estimation. He verified that the wavelet estimated from Gabor deconvolution is consistent with the Q-filtered VSP wavelet using both synthetic and real data. He also worked on Q-estimation and error analysis, as well as investigation of the phase property of the Vibroseis wavelet. He is now returning to pursue a Ph.D. with Dr. Gary Margrave. **CN**

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Talisman Donation

Talisman Energy Inc. has recently donated a number of seismic field radios. CREWES



has always maintained an active acquisition program, and this equipment will be most helpful in facilitating our future efforts in that area. We express our appreciation to Scott Verot and his colleagues at Talisman for their assistance. **CN**



New Ph.D. Thesis Available Online

We congratulate Jon Downton on the successful defence of his thesis. The abstract is included below, and the full thesis is available at www.crewes.org/Theses.



Seismic parameter estimation from AVO inversion

Jonathan E. Downton

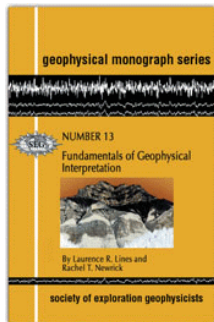
AVO inversion is a well established seismic exploration methodology to predict the earth's elastic parameters and thus rock and fluid properties. This thesis introduces a series of theoretical improvements to the AVO inverse problem. These include, a practical methodology to perform three-term AVO inversion instead of the industry standard of performing two-term AVO inversion. Two-term AVO inversion constrains the inversion either implicitly by truncating a term, or explicitly through some empirical relationship, thus introducing bias into the estimate. Using probabilistic constraints based on local geologic information, the three-term inversion can be constrained so as to give stable estimates, but with minimal bias. To help the explorationist understand the reliability of these estimates, a series of quality controls are developed and verified.

In order to estimate reliable density reflectivity, long offsets are required. NMO stretch and offset-dependent tuning introduce problematic distortions at these offsets. Two methods are investigated to address these issues. First, stretch-free NMO is investigated as a way to precondition the data. Secondly, an AVO waveform inversion which incorporates into the forward model NMO stretch and offset-dependent tuning is considered.

Both the AVO inversion and AVO waveform inversion are developed using a Bayesian framework. Gaussian and long-tailed distributions are explored for the likelihood and *a priori* probability distributions. The optimization problem results in non-linear solutions. The AVO inversion is solved using Newton-Raphson while the AVO waveform inversion is solved using conjugate gradient. In each case, the methodology is demonstrated on synthetic and real data examples.

The synthetic example shows that the AVO waveform inversion provides the most accurate estimates in the presence of NMO stretch and tuning. Preconditioning the data with stretch-free NMO improves the results of the AVO inversion, but not as much as the AVO waveform inversion results. For real seismic data the AVO waveform inversion also provided the best results of the methods tested. An example is shown where both the AVO inversion and AVO waveform inversion are able to estimate density reflectivity that differentiate commercial from noncommercial gas.

Geophysical Interpretation Handbook



We congratulate CREWES faculty member Dr. Larry Lines and his colleague Dr. Rachel Newrick for having published what is likely to become a classic text in exploration seismology, "Fundamentals of Geophysical Interpretation".

This book was introduced recently at the SEG convention in Denver, and all sponsors were provided with free copies of this excellent text at the CREWES Sponsors Meeting. It is currently a featured product at the SEG Bookmart. **CN**

CREWES Software Update

CREWES has recently produced two software packages, SynGram and QuadDes. SynGram has been available to sponsors for many years as SYNTH, created by Dr. Gary Margrave, while



QuadDes is Dr. Don Lawton's survey design software, also familiar to sponsors. They were distributed in their present form at the recent sponsors meeting in Banff. CREWES plans to market these executables to the geophysical community at large later in 2005. **CN**

Research Report 2004

Below we include the Table of Contents for the Research Report presented at the recent CREWES Sponsor's Meeting. Complete reports are available at www.crewes.org/Reports. A password is required, which can be easily and quickly obtained by members of sponsoring companies. Visit www.crewes.org and click on "Passwords".

Chap.	Authors	Title
1	<i>Li et al.</i>	Well log study and stratigraphic correlation of the Cantuar Formation, southwestern Saskatchewan
2	<i>Haase & Stewart</i>	Estimating seismic attenuation (Q) from VSP data at a heavy-oil field: Ross Lake, Saskatchewan
3	<i>Soubotcheva & Stewart</i>	Predicting porosity logs from seismic attributes using geostatistics
4	<i>Karami et al.</i>	Design of a horizontal well using 3C-3D seismic data at the Ross Lake, Saskatchewan heavy oilfield
5	<i>Xu & Stewart</i>	Delineating a sand channel reservoir using 3C-3D seismic data: Ross Lake, Saskatchewan
6	<i>Bland et al.</i>	Testing the quality of geophone plants for 3-C land acquisition
7	<i>Henry C. Bland</i>	A loss-resistant method of seismic data transmission over wireless data networks
8	<i>Bland et al.</i>	Remote, wireless, permanent seismic stations: A mountain case
9	<i>Chen et al.</i>	Spatial distribution of microseisms at Turtle Mountain
10	<i>Hall & Maier</i>	CREWES computer systems: an update
11	<i>Hogan & Margrave</i>	The new SYNTH/LOGSEC modelling facility
12	<i>Kimberly A. Munro</i>	Automatic event detection and picking of P-wave arrivals
13	<i>Ma et al.</i>	Seismic modelling with the reflectivity method
14	<i>Manning & Margrave</i>	Finite-difference modelling corrections: application in a variable velocity medium
15	<i>Manning & Margrave</i>	AVO responses as modelled with a finite-difference program
16	<i>Matteo Niccoli</i>	Synthetic seismic modelling and imaging of an impact structure
17	<i>Kelter & Bancroft</i>	Characteristics of P, SV, and SH wave propagation in an anisotropic medium
18	<i>Xiao et al.</i>	Estimating anisotropy parameters in layered VTI media
19	<i>Niccoli et al.</i>	Seismic velocity investigation of the Steen River impact structure, northern Alberta
20	<i>Daley & Krebes</i>	Approximate QL phase and group velocities in weakly orthorhombic anisotropic media
21	<i>Daley & Krebes</i>	Alternative linearized expressions for qP , qS_1 and qS_2 phase velocities in a weakly anisotropic orthorhombic medium
22	<i>Daley et al.</i>	Phase velocity approximations in a transversely isotropic medium
23	<i>Elapavuluri & Bancroft</i>	Equivalent offset migration in anisotropic media
24	<i>Elapavuluri & Bancroft</i>	Finite-difference modelling in structurally complex anisotropic media

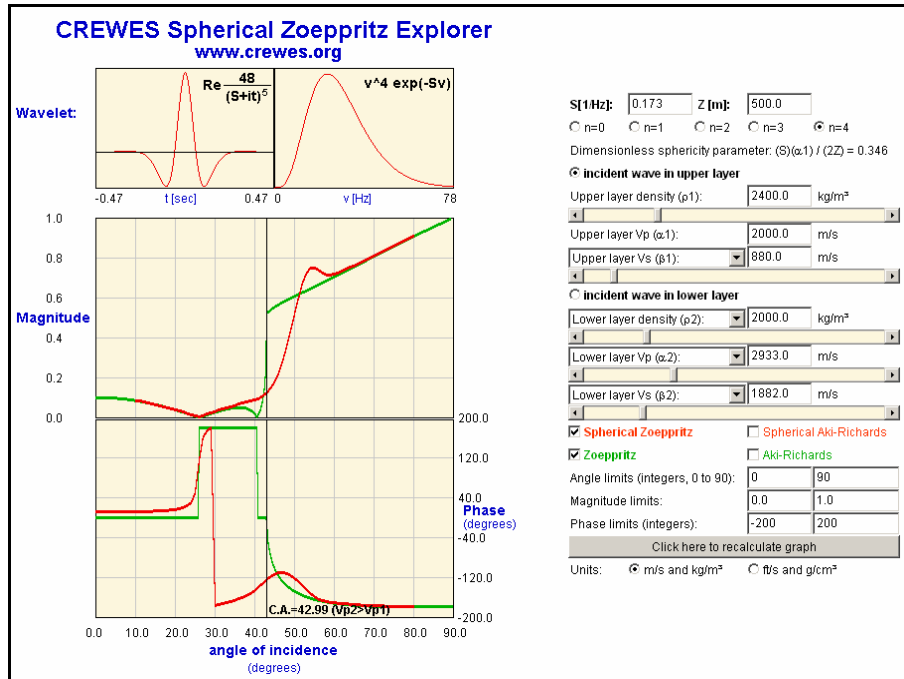
25	<i>Gharibi et al.</i>	The coupled seismoelectric wave propagation in porous media: Theoretical background
26	<i>Dong et al.</i>	Examining the phase property of the nonstationary Vibroseis wavelet
27	<i>Grossman et al.</i>	Minimum-phase revisited
28	<i>Rubak & Lamoureux</i>	Energy-preserving windows for nonstationary filtering
29	<i>Cao & Bancroft</i>	Multiple attenuation by semblance-weighted Radon transform
30	<i>Montana & Margrave</i>	Compensating for attenuation by inverse Q filtering
31	<i>Montana & Margrave</i>	Phase correction in Gabor deconvolution
32	<i>Han-xing Lu</i>	Effect of out-of-plane energy on a 3C-2D seismic line in the Foothills area
33	<i>Lynch & Lines</i>	Dynamic seismic displays
34	<i>David C. Henley</i>	Attenuating the ice flexural wave on arctic seismic data
35	<i>David C. Henley</i>	A statistical approach to residual statics removal
36	<i>David C. Henley</i>	Projection before picking: a statistical approach to tomographic imaging
37	<i>Hugh D. Geiger</i>	Data preparation for prestack depth migration
38	<i>Lamoureux & Adler</i>	Nonstationary image processing via Gabor transforms
39	<i>Millar & Bancroft</i>	Solving surface-consistent statics with multigrid
40	<i>Millar & Bancroft</i>	Multigrid deconvolution of seismic data
41	<i>Christopher B. Harrison</i>	An automatic horizon picker, a window extractor and a node finder for the CREWES MATLAB Library
42	<i>John C. Bancroft</i>	Practical equivalent offset processing
43	<i>Margrave et al.</i>	The FOCI (TM) algorithm for seismic depth migration
44	<i>Al-Saleh et al.</i>	The FOCI method versus other wavefield extrapolation methods
45	<i>Geiger & Margrave</i>	Automatic selection of reference velocities for recursive depth migration
46	<i>Bale & Margrave</i>	Elastic wave-equation migration for laterally varying isotropic and HTI media
47	<i>Bancroft & Al-Saleh</i>	Tutorial on the basics of downward extrapolation operators
48	<i>John C. Bancroft</i>	Continued fraction expansion of the square-root operator
49	<i>Liu et al.</i>	Stability and accuracy analysis of the space-frequency domain wavefield extrapolators
50	<i>Al-Saleh et al.</i>	Poststack and prestack depth migrations using Hale's extrapolator
51	<i>Du & Bancroft</i>	2-D wave modelling and reverse-time migration using a new finite-difference scheme based on the Galerkin method
52	<i>Du & Bancroft</i>	Modelling and migration using a new finite-difference scheme based on the Galerkin method for irregular grids
53	<i>D. A. Zhang & Lines</i>	Seismic methods in heavy-oil reservoir monitoring
54	<i>Xu & Stewart</i>	Estimating impedance from PP and PS seismic data at the Ross Lake oilfield, Saskatchewan

55	<i>Russell et al.</i>	A case study in the local estimation of shear-wave logs
56	<i>Charles P. Ursenbach</i>	Three new approximations for estimation of R_f from AVO
57	<i>Charles P. Ursenbach</i>	A non-linear, three-parameter AVO method that can be solved non-iteratively
58	<i>Haase & Ursenbach</i>	Spherical-wave AVO modelling in elastic isotropic media
59	<i>Haase & Ursenbach</i>	Anelasticity and spherical-wave AVO modelling in isotropic media
60	<i>Ursenbach & Haase</i>	An efficient method for calculating spherical-wave reflection coefficients
61	<i>Arnim B. Haase</i>	Modelling of linearized Zoeppritz approximations
62	<i>Mahmoudian & Margrave</i>	Three-parameter AVO inversion with PP and PS data using offset binning
63	<i>P.F. Daley</i>	Ray generation and the PS_v primary arrival
64	<i>Jaramillo-Sarasty & Stewart</i>	Interpretation of PP and PS seismic data from the White Rose oilfield, offshore Newfoundland
65	<i>Aitken & Stewart</i>	Shallow GPR and seismic surveying in a carbonate environment: Belize, Central America
66	<i>Moldoveanu & Stewart</i>	3-D ground-penetrating radar surveys on a frozen river lagoon
67	<i>J. Zhang & Bentley</i>	Reservoir characterization in Leming Lake, Alberta
68	<i>J. Zhang et al.</i>	Reservoir simulation and geomechanical modelling in Leming Lake, Alberta
69	<i>Kaprowski & Stewart</i>	3C-3D seismic micro-survey at a Maya plaza ruin in Belize, Central America
70	<i>Ng et al.</i>	Monitoring fluid injection using time-lapse analysis: a Rainbow Lake case study
71	<i>Lawton et al.</i>	Shallow P and S velocity structure, Red Deer, Alberta
72	<i>Robert R. Stewart</i>	Converted-wave seismic exploration: An update
73	<i>Jeff Thurston</i>	Sources of innovation in the upstream oil and gas industry: Demand pull and technology push
74	<i>Stewart et al.</i>	A guide to effective geophysical writing and presentation

Improvements to the Spherical Zoeppritz Explorer

The recently introduced Spherical Zoeppritz Explorer, which displays reflection coefficients for both plane waves and spherical waves, now has two improvements. First, the wavelet is now displayed in time, and not only in frequency. Secondly, it has been compiled with an option which will make it run more robustly on a wider range of systems. Users who may have had difficulty running it from the sponsors meeting CD should try downloading it from the CREWES website, as any former difficulties will likely now be gone.

A full discussion of the theory behind the Spherical Zoeppritz Explorer is contained in the 2004 CREWES Research Report, "An efficient method for calculating spherical-wave reflection coefficients". Anyone with questions or suggestions regarding this or other explorers should contact Chuck Ursenbach (ursenbach@crewes.org). **CN**



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