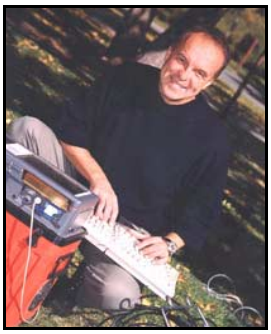
# CREWES NEWS

**The Consortium for Research in Elastic Wave Exploration Seismology**

## First Announcement: Sponsors Meeting

We are pleased to announce that our 16th Annual Sponsors Meeting will be held November 17-19, 2004 at the Banff Centre in Banff, Alberta. We encourage all interested individuals to mark this date in their calendars. We look forward to seeing you there! ***CN***

## CREWES Directors receive CSEG Awards



At the recent CSEG Annual Meeting, two of the directors of CREWES received noteworthy honors.

CREWES Director **Rob Stewart** became only the 25th person to receive an honorary CSEG membership. This is in recognition of "distinguished contributions in the field of geophysics or in service to the CSEG".

Associate Director **Gary Margrave** was selected to receive the award for Best Luncheon Speaker for the year 2003. Gary spoke in December on the topic "Gabor Deconvolution: Extending Wiener's method to nonstationarity". His co-authors were Linping Dong, Peter Gibson, Jeff Grossman, Dave Henley and Michael Lamoureux.

We congratulate both Gary and Rob on these well-deserved awards. ***CN***

## CSEG and EAGE Abstracts available online

Some thirty new abstracts are available on our website for viewing by sponsors. These have been accepted for presentation at either the CSEG or EAGE conventions to be held this spring.

A password is required to access the abstracts. If you require a password, please visit www.crewes.org and follow the "Passwords" link. ***CN***

## In This Issue...



## Student Award

CREWES graduate student Julie Aitken has been selected to receive the award "Outstanding Academic Achievement - MSc" from the Department of Geology and Geophysics at the

University of Calgary. Julie is currently researching the application of GPR to subsurface imaging. Her supervisor is Dr. Rob Stewart. Congratulations, Julie! ***CN***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# Welcome to New CREWES Students

In this issue we continue our introduction of this year's new students. ***CN***

**Natalia Soubotcheva** was born in Moscow, Russia and graduated from Moscow State University in 1995. She then worked as a geophysicist in Russia and Canada for 8 years before joining CREWES in 2003. Under Dr. Stewart's supervision she participated in the Arctic Exploration project. She is currently researching integrated reservoir analysis: time-lapse analysis, PP-PS inversion, and velocity modelling.

In her spare time she enjoys down-hill skiing, weight-training, cycling and yoga. She is married and has two children.

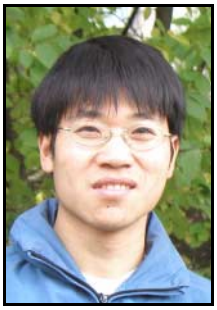
**John Millar** received a bachelors degree in Geophysics at the University of Calgary and an M.Phil. in Applied Mathematics at the BP Institute for Multiphase Flow at Cambridge University. He then worked for a year and a half on potential field modelling of the Chicxulub impact crater.

He is now pursuing a Ph.D. with Dr. John Bancroft at the University of Calgary. His research interests are numerical methods, programming, and modeling.

John plays lacrosse and hockey.

**Carlos Montaña** is from Bucaramanga, Colombia. He received a Bachelors degree in Mechanical Engineering from the Universidad Industrial de Santander. He then worked for five years on contract with the Colombian Petroleum Institute, the research branch of the national oil company. He was processing seismic information and supporting research projects.

He first came to U of C in 2002 as a visiting student, but now is in a Ph.D. program working with Dr. Gary Margrave on attenuation and time-frequency representations. Other topics of interest are pseudospectral modelling of seismic waves, anisotropy, and pseudodifferential operators.



**Xiang Du** is from Beijing, China. He received an M.Sc. in Solid Mechanics from Tsinghua University in 2002. While acquiring his degree he researched wave propagation, processing with multi-resolution wavelets, and genetic algorithms. He then worked at the Peking Foundation to develop fingerprint sampling software. He is interested in modeling and inversion and is now studying with Dr. John Bancroft and working on migration by a joint finite element and finite difference method.

For hobbies he enjoys music, volleyball, and ping pong.

**Faranak Mahmoudian** is from Iran, and was born and raised in Tehran. She received her B.Sc. in physics in 2000 from Khage Nasir Toosi University of Technology in Tehran. She then came to Canada and is now conducting her masters work with Dr. Gary Margrave.

She is currently interested in AVO analysis, migration, seismic data processing, seismic imaging and seismic wave propagation (She loves everything in geophysics!)

She enjoys swimming, cooking, and listening to music. Faranak is married and has one daughter.

**Pavan Elapavuluri** studied physical chemistry as an undergraduate, then graduated in May 2000 from the Indian School Of Mines with an M.Sc. (Technology) in applied geophysics. During this time he gained work experience with the Oil and Natural Gas Corporation of India and also with the National Geophysical Research Institute (NGRI) in Hyderabad, India.

In 2000 he came to U of C to complete an M.Sc. with CREWES. Having accomplished that goal he is now enrolled in a Ph.D. program with Dr. John Bancroft, and is especially interested in working on techniques which account for seismic anisotropy.

# Technical Article: Spherical Wave AVO Modeling of Converted Waves

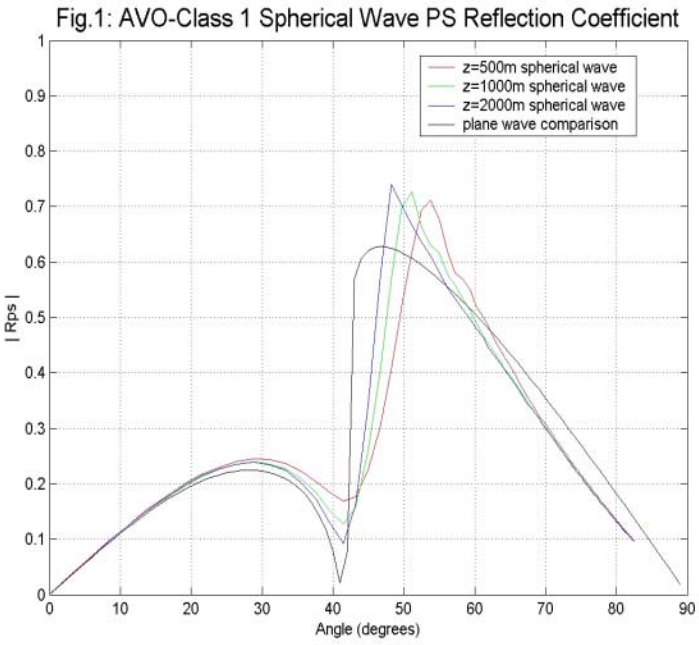
*Arnim B. Haase*

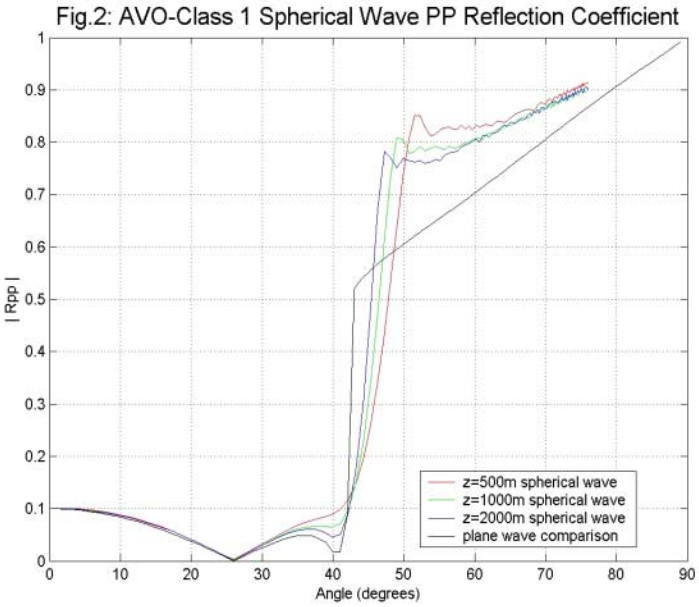
## Introduction

Three parameter AVO-inversion and joint PP-PSv inversion have been investigated recently to increase accuracy and information content of AVO-analysis. The common approach is plane-wave analysis utilizing linear approximations of the Zoeppritz equations. Small incidence angles and small parameter changes are assumed for these approximations. For reasonably accurate density estimates, larger reflection angles and also post-critical events are desirable. Approximations to "Zoeppritz" break down near critical angles and even "exact Zoeppritz" is a plane-wave approximation to the real world. What, then, is the difference between plane-wave and spherical wave responses? The present study attempts to find some answers to this question.

## Model Computations

The spherical-wave AVO response of two layer elastic and isotropic models is investigated in phase 1 of this study. Spherical wave responses are computed with the aid of the Weyl integral by numerical integration of plane waves obtained by applying the Zoeppritz equations. A P-wave point source is assumed and free surface effects are not considered. The source signature is chosen to be a 5/15-80/100 Hz Ormsby wavelet. For Classes 1 and 2 of the Rutherford and Williams AVO classification scheme there is an increase of P-wave velocities across the interface, resulting in critical angles and headwaves. Here a Class 1 example with $R_{PP} = 0.1$ is shown.




## Model Results

Figures 1 and 2 display an AVO Class 1 comparison for $R_{PS}$ and $R_{PP}$. The greatest departure from plane wave comparisons is observed in the vicinity of critical angles. The larger the reflector depth, the closer the spherical response to the plane wave comparison; however, even at 2000m depth, there are significant differences. The PP-reflection comparisons in Figure 2 bear striking similarities to their PSv counter parts of Figure 1 in the way they differ from plane wave behaviour near the critical angle. The depth dependence of $R_{PP}$ and $R_{PS}$ is quite similar for spherical wave Class 1 AVO-responses.

*Dr. Haase will present these and other results at the annual CSEG Conference. (The complete abstract is available now to sponsors at the CREWES website.) He also intends to continue with similar modeling experiments of the anelastic case (phase 2).*

## New CREWES Graduates

We are pleased to announce that Sarah Richardson (now Sarah Trend) and Ian Watson have been awarded the Master of Science degree from the University of Calgary. In addition to the thesis abstracts below, their complete theses are available online at our website. Congratulations to both of these scholars! ***CN***

**Integrated geological and geophysical analysis of a heavy-oil reservoir at Pikes Peak, Saskatchewan** *Ian Watson*

Various seismic techniques can be used for monitoring zones of steam injection in heavy-oil recovery. In this integrated case study, post-stack interpretation based analysis techniques are used to delineate steamed and heated reservoir zones at Husky Energy's Pikes Peak heavy-oil field in Saskatchewan. Four methods are compared including reflectivity differencing, impedance differencing, P-wave traveltime ratios, and an isochron method for examining $V_P/V_S$. All methods show promise and consistency for delineating areas of steam injection and temperature increase in the reservoir away from well control.

The integration of well and seismic data reveals methods to further understand the reservoir. The percentage of sand in the reservoir interval is estimated using $V_P/V_S$. The reservoir trap and bottom-water presence are interpreted using isochron measurements of a deeper interval.

A single multicomponent seismic survey is a powerful tool for reservoir surveillance and interpretation at any stage of field development.

**Multicomponent seismic applications in coalbed methane development, Red Deer, Alberta** *Sarah Richardson*

Vertical seismic profiles obtained of Ardley coal zone strata near Red Deer, Alberta demonstrate the effectiveness of multicomponent seismic applications in coalbed methane development. Zero-offset surveys show that a broad-band mini-P vibratory source is ideal for imaging the coal zone, providing a measure of vertical continuity of the coal zone as well as delineating intra-coal events. The extraction of Vp/Vs from P-wave and S-wave seismic data yields a high Vp/Vs value in the near surface (~5), decreasing to approximately 2.5 at 300 m depth. Reflectivity values extracted from walkaway surveys demonstrate that converted-wave data better resolve the upper coal contact than compressional-wave data, as they are less affected by tuning. Numerical modelling demonstrates "proof of concept" that time-lapse seismic imaging will be able to monitor changes in the reservoir resulting from dewatering, allowing producers to optimize enhanced coalbed methane production throughout reservoir life.

## Making Contact...

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Dr. Don Lawton: lawton
Dr. Larry Lines: lines

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**Administrative Manager:**
Louise Forgues: forgues

**Visiting Scholars:**
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**Research Staff:**
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Dr. Pat Daley: pdaley
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Dr. Arnim Haase: haaseab
Kevin Hall: kwhall
Chris Harrison: harrisc
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Steve Lynch: lynch
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