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Title: PIMS Workshop on Advances in Seismic Imaging and Inversion

Event Type: Industrial-Activity

Location:

University of Alberta

Dates:

May 20-22, 2015

Topic:

Seismic imaging plays an important role in prospecting for resources and understanding the Earth's interior. This is an example of a mathematical inverse problem, in which data are used to estimate subsurface parameters. Traditionally, this has been done using only part of the recorded seismic wavefield (primary reflections); this is seismic migration. Modern analytical techniques are being developed that involve a greater part of the seismic wavefield, incorporate more complete physical models, and utilize advanced mathematical methods. In this workshop, we will bring together researchers from academia and industry to discuss ways to improve upon, and best utilize these new techniques, as well as new types of models that attempt to better characterize the data.

Methodology:

With a high participation from graduate students in both geophysics and applied mathematics, we chose to run one day of short courses specifically on wave propagation and full waveform inversion for seismic imaging. The remaining two days were dedicated to one-hour talks by our 5 invited speakers from industry and academia, and 30-minute contributed talks. There was ample time set aside for interaction between all participants.

Objectives Achieved:

A key objective was to train our graduate students in current methods of full waveform inversion, including the latest mathematical approaches and robust numerical techniques. The overwhelming feedback is that the students did learn a lot, fulfilling this main objective. The format of one day of short courses was very successful for this. The interaction between industry researchers and academicians was very successful as well, connecting the work that is done in oil and gas exploration companies (Shell, CGG, Russell-Hampton) with the scientists at universities. We had an excellent series of talks, both invited and contributed, with robust participation from the conference attendees.

Scientific Highlights:

The one day of short courses on wave propagation, full waveform inversion and related mathematical methods was very well received by the students, with excellent feedback received

from this audience. Andreas Fichtner's talk on global seismic imaging was very much talked about, and definitely a highlight with the broad audience. It enriched the series of talks that went from small scale exploration seismic to full earth imaging, as exemplified by the enlightening overview talk of Dr. Sam Gray from CGG. ///

Dr. Gary Margrave's talk on merging migration with inversion was brilliant and highlighted an effective research path to leverage the successes of seismic migration as practiced in industry with recent mathematical developments in solving inverse problems. An excellent illustration of coupling current technology with past intuitions, expressed in a way that made a solid impression with the participants. Dr. Eldad Haber's short course brought together in a concrete way the various approaches to demystify Full Waveform Inversion and present hands-on numerical implementations for the participants. ///

It was very revealing to see that many of the industrial participants, as practicing geophysicists, come from a background with formal training in applied mathematics.

Organizers:

Sacchi, Mauricio, Physics, University of Alberta //
Innanen, Kris, Geoscience, University of Calgary //
Malcolm, Alison, Earth Sciences, Memorial University //
Lamoureux, Michael, Mathematics, University of Calgary

Speakers:

Invited Speakers: //

Peter Bakker (Shell) "Developments in wave path tomography" //
Andreas Fichtner (ETH Zurich) "Imaging the Earth from sedimentary basins to the deep mantle" //
Sam Gray (CGG) "BIG imaging, little imaging: convergent paths" //
Brian Russell (Hampson-Russell Software & Services) /cancelled/ //
Bill Symes (Rice University) "Asymptotic least squares offset gathers and applications" ///

Short courses: //

Michael Lamoureux (University of Calgary) "Wave equations and propagators: theory and numerics" //
Mauricio D Sacchi (University of Alberta) "Seismic imaging as a linear inverse problem" //
Kris Innanen (University of Calgary) "Theory of FWI from a perturbation approach and the generalized AVO problem" //
Eldad Haber (UBC) "FWI from scratch" //
Alison Malcolm (Memorial University) "Theory of FWI from an adjoint state approach and applications to 4D monitoring" ///

Contributed talks: //

Ning Tu (UBC) "Sparse least-squares seismic imaging with source estimation utilizing multiples" //
Gary Margrave (University of Calgary) "Iterated modeling migration and inversion" //
Aaron Stanton (University of Alberta) "Elastic LS migration" //
Eran Treister (UBC) "Joint FWI and travel time tomography" //
Wenyong Pan (University of Calgary) "Gauss-Newton and Full Newton FWI for elastic constants in fractured HTI media" //
Shahpoor Moradi (University of Calgary) "FWI sensitivities and scattering potentials associated with

homogeneous and inhomogeneous viscoelastic waves" //

Pratap Sahay (CICESE) "Seismic Attenuation and Poroelasticity Theory" //

Kai Rothauge (UBC) "Computation of the adjoint for time dependent wave equation" //

German Rubino (University Lausanne) "Effects of fracture network connectivity on the anisotropic seismic properties of low-permeability formations" //

Richard Bale (Key Seismic) "Offshore east coast: model-based water-layer demultiple breathes new life into old data" //

Jeff Gu (University of Alberta) "Imaging the crust and mantle beneath the Western Canada Sedimentary Basin" //

Babatunde Arenrin (University of Calgary) "Incorporating well information into FWI" //

Felix Oghenekohwo (UBC) "A new take on compressive time-lapse seismic acquisition, imaging and inversion" //

Nasser Kazemi (University of Alberta) "Divide and conquer (D&C) algorithms for least squares migration"

Links:

Event announcement: <https://www.pims.math.ca/industrial-event/150520-pwasii> //

U of A announcement: <https://uofa.ualberta.ca/physics/research/pims2015> //

Short Courses Notes: <https://www.ualberta.ca/~msacchi/PIMS-2015/>

File Uploads:

Additional Upload 1: http://www.pims.math.ca/files/final_report/ASII.pdf
