Mission-Oriented Seismic Research Program

2017 Annual Technical Review and Meeting

Tuesday, May 23 and Wednesday, May 24

UH HSC Room 102
(please see the nearby map for meeting and parking location- parking will be validated at the meeting)

AGENDA

Tuesday, May 23, 2017

8:00 AM Welcome, breakfast/reception

8:30 AM Technical Program begins: Meeting Overview—IDENTIFYING AND RESPONDING TO PRIORITIZED AND PRESSING SEISMIC EXPLORATION CHALLENGES- Modeling and Direct and Indirect Inversion: How a direct inversion method communicates whether our chosen 'problem of interest' is 'the problem we need to be interested in'. (Below please find the Abstract of a recently accepted paper to the Interpretation Journal of the SEG).

Direct inverse methods assure that we have solved the problem of interest, and in addition they communicate whether the problem of interest is the problem that we (the seismic industry) need to be interested in. When a direct solution doesn't result in an improved drill success rate, we know that the problem we have chosen to solve is not the right problem --- since the solution is direct and cannot be the issue. On the other hand with an indirect method, if the result is not an improved drill success rate, then the issue can be either the chosen problem, or the particular choice within the plethora of indirect solution methods, or both. The inverse scattering series (ISS) is the only direct inversion method for a multidimensional subsurface. Solving a forward problem in an inverse sense is not equivalent to a direct inverse solution. All current methods for parameter estimation, e.g., AVO and FWI, are solving a forward problem in an inverse sense and are indirect inversion methods. The direct ISS method for determining earth material properties, defines both the precise data required and the algorithms that directly output earth mechanical properties. For a 3D elastic earth model of the subsurface the required data is a 3x3 matrix of multi-component data, PP, PSH, PSV,SH SH… and a complete set of shot records, with only primaries. Each mechanical earth property is a distinct series, order by order in that 3x3 data matrix of primaries.

With indirect methods any data can be matched and updated: one trace, one or several shot records, one component, multi-component, with primaries only or primaries and multiples.

Added to that are the innumerable choices of cost functions, generalized inverses, and local and global search engines. Direct and indirect parameter inversion are compared. For a simple normal incident plane wave on a single horizontal reflector, and an acoustic model, the direct ISS method has more rapid convergence and a broader region of convergence. The difference in effectiveness increases as subsurface circumstances become more realistic and complex and in particular with band-limited noisy data.

*Arthur B. Weglein**

PREPROCESSING WITH A NON-HORIZONTAL ACQUISITION SURFACE: Impact on multiple removal and imaging, PREPROCESSING FOR ONSHORE, OBS, and TOWED STREAMER ACQUISTION. Developing and delivering new and more effective methods for the essential preprocessing steps that in addition to their intrinsic value are necessary prerequisites for the new high-end and most effective methods that eliminate free surface and internal multiples, and that subsequently depth image and invert primaries. Those prerequisites include: **removing ground roll** and **preserving reflection data at all offsets**, and **source and receiver de-ghosting for towed streamer, on-shore and ocean bottom acquisition, accommodating both flat horizontal and non-flat acquisition surfaces.**

8:40 AM Green's theorem tutorial Part I: for wave field separation (separation of reference and scattered wave-fields, and for de-ghosting)

*Arthur B. Weglein**

9:40 AM A new method for deghosting data collected on a depth-variable acquisition surface by combining Green's theorem wave separation followed by a Stolt extended Claerbout III wave prediction for oneway propagating waves

Jing Wu and Arthur Weglein*

10:10 AM Morning break

10:20 AM Impact of the topography of the acquisition surface on the effectiveness of the ISS internal multiple attenuation and elimination algorithms: analyzing the problem and providing and delivering a response to the challenge

Yuchang Shen and Arthur Weglein*

10:50 AM Impact of the topography of the acquisition surface on preprocessing and subsequent free surface multiple elimination and depth migration: describing the challenge and providing an effective response

Zhen Zhang and Arthur Weglein*

11:30 AM Lunch

MULTI-DIMENSIONAL INTERNAL-MULTIPLE ELIMINATION WHEN PRIMARIES AND INTERNAL MULTIPLES ARE PROXIMAL OR INTERFERE AND WITHOUT DAMAGING THE TARGET PRIMARIES

1:00 PM A tutorial on the inverse scattering series: distinct isolated task subseries for removing free surface and internal multiples

*Arthur B. Weglein**

MULTIPLE ELIMINATION FOR SURGICALLY REMOVING MULTIPLES THAT INTERFERE WITH TARGET AND RESERVOIR PRIMARIES Developing and delivering the next generation of **urgently needed multiple removal capability**, with the **elimination** of **free surface and internal multiples,** without depending on energy minimization adaptive subtraction and thereby **accurately predicting and surgically removing a multiple that interferes with a target or reservoir primary, and with the unique ability to not damage the target or reservoir primary**. The latter interference between a multiple and target primary can frequently occur both on shore and off-shore, as well. That next generation of capability will only be delivered by M-OSRP and for many sponsors that project and delivery is the business driver and ROI.

2:00 PM Afternoon break

2:10 PM A multidimensional method that eliminates internal multiples: a new toolbox option for removing multiples that interfere with primaries, without damaging the primary, and without any knowledge of subsurface properties.

Yanglei Zou, Chao Ma and Arthur Weglein*

2: 40 PM Comparing the new Inverse Scattering Series (ISS) internal-multiple-elimination algorithm and the industry-standard ISS internal-multiple-attenuation algorithm plus adaptive subtraction when primaries and internal multiples interfere and where we can evaluate the efficacy using wave-theoretical data consisting of only primaries

Chao Ma, Yanglei Zou, and Arthur Weglein*

Invited Guest Presentations: to share complementary, collaborative and cooperative initiatives and activities

3: 10 PM A new research consortium to advance low frequency active seismology: reaching one hertz and beyond
Professor Mark A. Meier, Physics Dept./University of Houston

3: 50 PM The physics of porous media and seismoelectric wave propagation: A new model and opportunity
Dr. Niels Grobbe, MIT, Math Dept. and Earth Resources Laboratory

Wednesday, May 24, 2017

A FIRST MIGRATION THAT IS EQUALLY EFFECTIVE AT ALL FREQUENCIES AT THE TARGET AND RESERVOIR - RESOLUTION COMPARISON WITH RTM FOR A SINGLE REFLECTOR AND A WEDGE

MORE EFFECTIVE MIGRATION AND DIRECT INVERSION VELOCITY ANALYSIS Progressing and delivering the first **migration method for heterogeneous media that is equally effective at all frequencies at the target and reservoir. It provides improved structural resolution and amplitude, compared to all current migration methods including RTM.** The documented codes for a 2D and 3D heterogeneous subsurface will be delivered in 2017. **This new and more effective migration will require a velocity model and we will link with a direct non-linear inverse scattering series method for velocity analysis as an alternative to all current indirect velocity analysis methods, for example, CIG flatness and FWI.**

Key–note address, Abu Dhabi, March 31st , 2015 presented at the SEG FWI, Workshop Filling the gaps in Abu-Dhabi

8:30 AM Green's theorem tutorial Part II: for wave field prediction: imaging conditions, one-way and two-way wave equation migration for a more effective and fundamentally more capable and interpretable migration for improved resolution and amplitude analysis at the target and reservoir (Stolt extended C III imaging for migrating in a heterogeneous media).

*Arthur B. Weglein**

(Glossary of imaging conditions: in our usage, Claerbout imaging I is the exploding reflector model, Claerbout II imaging, is the space and time coincidence of up and downgoing waves, and Claerbout III (CIII) refers to predicting a coincident source and receiver experiment at depth at time equals zero. Stolt extended CIII to allow structure and amplitude analysis for specular and non-specular reflectors. M-OSRP has extended the Stolt CIII for heterogeneous media, without high frequency approximations in the imaging principle or in the wave propagation model-hence a migration method that's equally effective at all frequencies at the reservoir.) This new migration method requires a velocity model.

The Claerbout II imaging principle resides behind all current leading edge RTM methods used in industry. Claerbout II and all RTM methods are intrinsically high frequency approximations independent of how they are extended or implemented. Benefits of the new Stolt extended C III imaging for two-way propagating waves: (1) provides a new and first migration method that's equally effective at all recorded frequencies at the target and reservoir and hence added-value and advantages for both structural determination and amplitude analysis in migration and (2) provides clarity on the role of primaries and multiples in imaging and migration.

Stolt extended C III imaging for two way propagating waves provides a clear and definitive response to the role of primaries and multiples in imaging and inversion: Multiples: signal or noise?

Arthur B. Weglein

9:30 AM An initial study to quantify the resolution difference between an industry leading-edge migration, RTM, and the first migration method that is equally effective at all frequencies at the target

Qiang Fu, Yanglei Zou, and Arthur Weglein*

10:00 AM A wedge resolution comparison between RTM and the first migration method that is equally effective at all frequencies at the target: tests and analysis with both conventional and broadband data

Yanglei Zou, Qiang Fu and Arthur Weglein*

10:30 AM Morning Break

11:00 PM A method that guides and assures that when computing the Green's function it will achieve and deliver equal effectiveness for all frequencies at the target and reservoir in Stolt extended C III migration for heterogeneous media

Fang Liu, Qiang Fu and Arthur Weglein*

12:00 PM Lunch

1:00 PM **GAME CHANGING MIGRATION, DIRECT AND WITHOUT A VELOCITY MODEL** The direct inverse scattering series (ISS) depth imaging without a velocity model will be progressed and delivered as a tool box option. In contrast to other new approaches to migration, for example, Interferometry and Marchenko imaging, that require a velocity model, the ISS direct imaging method is the only imaging method that is direct and doesn't require a macro-velocity model or any other subsurface information.
The ISS direct depth imaging (without a velocity) subseries derives from the same exact set of equations, the inverse scattering series, that earlier derived, e.g., the distinct ISS free surface and internal multiple subseries, and the subseries that performs Q compensation without knowing or needing to estimate Q. The ISS depth imaging subseries will once again have the same GAME-CHANGING delivery and impact and will play the same role, on processing primaries for structural determination and amplitude analysis, as ISS free surface and internal multiple removal has already delivered for effectively eliminating multiples. M-OSRP has the potential and opportunity to deliver that game changing next generation imaging effectiveness and capability- providing a new tool box option for the most complex, inaccessible and daunting imaging challenges- arranging for currently inaccessible targets and reservoirs to become accessible and delivered.

An executive summary review, ISS depth imaging from synthetic data to viability on field data and update

*Arthur B. Weglein**

2:15 PM The strategy and recent progress in taking the ISS direct depth imaging without a velocity model from a demonstrated field data viability to an option in the seismic imaging tool box

Chao Ma and Arthur B. Weglein*

3:15 PM-4:00PM Meeting summary, overview of progress and plans, and meeting adjournment

*Arthur B. Weglein**

7:30 PM Dinner

M-OSRP Annual Technical Review and Meeting Dinner at **Fogo de Chao,** (spouse or significant other are invited) (8250 Westheimer Rd. Houston Texas, 77063)