

April 2018



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GSH Journal

GEOPHYSICAL SOCIETY OF HOUSTON

Volume 8 • Number 8

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Data Acquisition Operations for a Global Geophysical Crew.

Photo courtesy of Global Geophysical.



EDITOR'S NOTE

To ensure your information reaches the GSH members in a timely manner, please note the following deadlines and plan accordingly. Please submit your articles and any questions to Dmitry Kulakov, editor, at dkulakov@slb.com

GSH JOURNAL DEADLINES

June 2018.....Apr 13
Sept 2018..... July 13
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A Word from the Board

GSH Into The Future

by Maitri Erwin, First Vice President Elect

It is my honor to represent the large and active Geophysical Society of Houston, especially at this time of industry volatility and energy evolution. Over and above hosting high-quality technical talks, social gatherings and community outreach events, the GSH Board meets face-to-face each month without fail. We discuss and make reasonable plans with realistic direction, assign responsibilities to those fit to accomplish them, communicate outcomes and get things done on a lately tight budget. There is very little bureaucracy, and this Society all about offering the most to our membership in the greater Houston area. How? Every Board member is a geoscience professional and our work is aided by a limited number of extremely committed and capable office staff and volunteers.

The Geophysical Society of Houston is, however, an aging organization; our conversations often turn to the future face of the Society, Board succession plans and carrying the current level of enthusiasm forward. What should the modern geoscientific society become to attract a diverse group of students and young professionals? How to convert them into longstanding members who take on leadership responsibilities? Several related questions arise: Coming up on the year 2020, is the scientific society still relevant? If so, what sort of community do young scientists want? My biggest reason for being a GSH and SEG member is to meet physically and virtually, and to share our science and experiences as scientists. But, is that considered scientific community any longer?

To help answer these questions, I borrow the following from a late, great American leader: "Ask not what your Society can do for you, but what you can do for your Society. Ask not what the GSH will do for you, but what together we can do for fellow and future geophysicists." In other words, tomorrow's GSH relies on your active contribution to the conversation today. We, therefore, ask you to engage with us on [Facebook](#) and [Twitter](#) to share your thoughts on these topics:

- What activities make GSH valuable to you?
- How would you measure the success of these activities?
- Finally and most importantly, in my opinion, how are you willing to motivate yourself and attract other busy geophysics professionals to volunteer effectively?

This is also an open invitation to participate in the various GSH gatherings, conduct your own brainstorming sessions, and experiment with ways by which young and diverse geophysics professionals can partake, contribute and lead into the future. Take the initiative.



Maitri Erwin

Once again, I thank everyone who has made the GSH a strong, positive and vibrant organization, and continues to do so during this period of change. Even the weather hasn't cooperated with us since the beginning of my tenure on the Board! My hat is off to the efficiency of our staff and cooperation of our membership for keeping all events on track and not missing a beat through hurricane, flood and ice. I look forward to seeing many of you at the 2018 GSH-SEG Spring Symposium on April 4th and 5th, and hearing your thoughts and ideas on sustaining and growing our Society for the generations to come.



Looking for more ways to participate in the Geophysical Society of Houston?

Consider how you can make a difference by volunteering at one of our events!

Contact Nicola Maitland to learn more about this excellent networking opportunity:

nmaitland@resolvegeo.com - 713-972-6209





Dear GSH Journal reader,
Please, feel free to contact any of us with any
and all questions or suggestions that you can come up with.

editor@gshtx.org

Sincerely,

Dmitry Kulakov, Editor



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From the Other Side

By Lee Lawyer



I attended a tech luncheon given by Tom Smith. The subject was Artificial Intelligence, sort of. The general idea was to allow the computer program to make decisions as new data and information become available. I say, 'sort of Artificial Intelligence' because Tom's discussion was a little deeper than I have just described. IBM has a software product called, Watson. Presumably

this refers to something A. Conan Doyle would write. Namely, Sherlock and Watson, with Watson being the chronicler. "With Watson, you can transform the way you work.", so says IBM. After listening to Tom Smith, I believe them. IBM also has a "Get Started for free" button, I was afraid to click it for fear of being replaced by a computer. Not true, says Tom. One way to use AI is 'supervised' and another is 'non-supervised', it is unclear who is supervising whom.

When I first got to fiddle with a machine, we had no language to talk to the computer. It was all "system" level commands, the very terminology we used irritated me. What is this "talking" to a computer. Ridiculous! And in a few short years we asked computers questions and worse yet, we are getting answers, complicated answers. Oh well, so I am not omniscient, but the dreamers in computer science suggested another step. Why do we need to ask a computer a question? It should give us answers dependent on the data, unsupervised, that is.

Wait, if I hadn't written miles of code, the dumb computer would be worthless. I am still in command. Those same dreamers decided to let the computer devise their own code. Wasn't there a movie or two about computers going wild and threatening the owners? One called, 2002, which was obviously made a number of years ago.

As I recall, the thing we liked about computers of old, was when one inputs data to a computer, one gets the same answer every time. How can we de-bug a computer program that legitimately gives different answers every time? This introduces uncertainty to our world. There is one definition of insanity, "You ask the same question over and over, expecting a different answer"....insane! But not in AI. Perhaps one can statistically analyze the answers and give them a ranking, selecting the

most probable. Sounds a lot like oil/gas exploration, doesn't it?

To be fair, I must discuss the other platforms. Global X, has BOTZ, 'Robotics & Artificial Intelligence EFT'. I will not go into the acronym, EFT. But this company "seeks to invest in companies that potentially stand to benefit from increased adoption and utilization of robotics and artificial intelligence." The point that Tom Smith made several times was that AI and the broader subject is wide spread. One can find many books and technical material covering the subject. Global X is an investment in an EFT (still not going to discuss EFTs and use up the rest of this column).

I attended the February GSH Board meeting, it was veddy, veddy interesting. One of our more successful projects (depending on how one defines, "successful") is sponsoring technical webinars. I am sure you have seen the promotional material for different webinars. The importance of this type of 'live' instruction is there is no need to travel, just sit in front of a computer screen in your office or home. The instructor talks you through a series of slides, questions are asked and answered, and discussions are allowed.

I said that webinars were successful depending on how you define successful. A couple of years ago the SEG ranked their various activities using numerical methods and cost/revenue was given weight. That was easy, but they ran into problems when trying to scale 'value'. One parameter of 'value' was the number of members affected. The 'value' of the Annual Meeting was greater than a small work shop because it made more revenue and because it affected a larger number of members. The workshop only touched a few and it was close to breakeven financially, but there is no way to give a number to the content of a workshop. Back in the 50's, a workshop on CDP was very valuable to the profession of Exploration Geophysics. Given the difficulties of giving a number to the actual value of given activities, the SEG fell back on the considered opinions of members of the Board Directors and we voted.

Frankly, the GSH webinars are valuable to the GSH because they return needed revenue. The registrants vote on the value of the course by registering. Mike Graul "browbeat" the Board to get the ball rolling on technical webinars. Haynie Stringer, Frank Dumanoir, and others have contributed time and effort. We share revenue with the SEG under a Memorandum of Understanding to get wider promotion of each webinar. Please give a big round of applause for the Webinar Committee, numerically they get a grade of 99% (No one is perfect).




**ANNOUNCING THE 2018
 GEOPHYSICAL SOCIETY OF HOUSTON
 HONORS & AWARDS BANQUET**

Thursday, May 3rd, 2018
 Cocktails - 6:00 pm, Dinner - 7:15 pm

Hotel Sorella
 La Scala Ballroom
 800 Sorella Ct
 Houston, TX 77024

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Technical Breakfasts

Extending the Reach of Full-waveform Inversion with Reflection Data: Potential and Challenges

Register
for Tech Breakfast
North

Register
for Tech Breakfast
West

Speaker(s): Adriano Gomes, CGG

North

Tuesday, Apr. 3, 2018

7:00 - 8:30 a.m.

Sponsored by Anadarko Petroleum and Lumina Reservoir Inc.

Location: Anadarko Petroleum
1201 Lake Robbins Drive
The Woodlands, TX 77380

Abstract:

In the last few years, several methods have been proposed to increase the significance of reflection data in the FWI workflow. A common feature in all these methods is the extraction and/or enhancement of the low-wavenumber component of the FWI gradient of reflection data, also known as tomographic term or "rabbit ears", which is generated along the reflection wavepath.

It is clear that despite having the potential to extend the maximum update depth beyond that of diving-wave FWI, Reflection FWI (RFWI) is also subject to additional restrictions, due to the "tomographic" nature of the problem. In fact, RFWI shares many concepts with migration velocity analysis (MVA) methods, such as ray-based reflection tomography. However, since the contributions from many events are calculated simultaneously in RFWI, it is more susceptible to the effects of amplitude imbalance, which can lead to limited vertical resolution and convergence to local minima.

In this talk, the main limitations and requirements of this approach are discussed using synthetic examples. Finally, this method is applied to subsalt datasets in the Gulf of Mexico. The results suggest that, at the current stage, RFWI can be viewed as a complement, rather than a replacement, to established velocity inversion methods. Nonetheless, the significant improvement obtained by RFWI in the real data example shows that this technique is worth understanding and improving further, as it could become a valuable tool for updating the deeper section of velocity models.

West

Wednesday, Apr. 11, 2018

7:00 - 8:30 a.m.

Sponsored by Schlumberger and WesternGeco

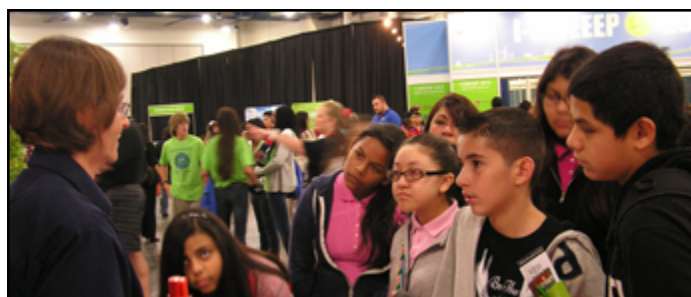
Location: Schlumberger
Q Auditorium
10001 Richmond Ave.
Houston, TX 77042



**Adriano
Gomes**

Biography:

Adriano Gomes currently works for CGG (Houston), where he holds the position of Lead Researcher. He received a BS degree in Computer Science in 2011 and a MS degree in Geophysics in 2013, both from the Federal University of Bahia, Brazil. He then joined CGG in 2013, first in Villahermosa, Mexico and later in Houston since 2015, where he has been working on the research of topics related to imaging and inversion, such as LSRTM and FWI.



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Data Processing & Acquisition SIG

Diffraction Imaging as a Migration Velocity Analysis Tool

Register
for Data
Processing

Speaker(s): Dmitrii Merzlikin,
TCCS consortium, UT Austin

Location: Schlumberger
Q Auditorium
10001 Richmond Ave.
Houston, TX 77042



**Dmitrii
Merzlikin**

Tuesday, Apr. 17, 2018

4:30 p.m. Sign-in, Snacks, Social Time
5:00 p.m. Start of presentation

Sponsored by Schlumberger

Abstract:

Diffraction imaging is a set of methods aiming to boost direct responses of subsurface discontinuities to a seismic wavefield. Subsurface discontinuities include faults, channel edges, fracture swarms and etc. These direct responses have a shape of diffractions and are often weaker than reflections associated with laterally continuous boundaries. Conventional seismic data processing is targeted to enhance the latter events, and, therefore, might decrease diffraction amplitudes with respect to reflections even more. Proper processing of diffracted energy is crucial for highlighting subsurface discontinuities. Diffractions along with reflections carry information about wave-propagation velocity in the subsurface and are the only source of velocity information for single-offset and other narrow-offset distribution acquisition geometries, where conventional normal-moveout velocity analysis is not a viable option.

Author will illustrate diffraction imaging capabilities by field data examples; discuss methods for efficient reflection and diffraction separation to highlight diffracted events. He also will present a method for diffraction-based migration velocity analysis and provide its velocity-model independent formulation based on the double-path summation framework. The ability of the proposed approach to automatically estimate migration velocity from diffractions by synthetic and field data examples will be demonstrated.

Biography:

Dmitrii Merzlikin is a fourth-year PhD student in Texas Consortium for Computational Seismology (TCCS) at The University of Texas at Austin supervised by Dr. Fomel. He holds MSc and BSc degrees in Geophysics from Lomonosov Moscow State University. His research interests

include: Seismic Imaging, Signal Processing, Diffraction Imaging, Path-Summation Imaging and Inverse Theory.

Dmitrii's talks given at the 2017 SEG Houston Annual Meeting were ranked in the "top 39".

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2018 GSH - SEG Spring Symposium & Exhibition



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Sharper Imaging

Case Studies Highlighting Advances in Seismic Acquisition and Processing that Impact Drilling Decisions On & Offshore

4-5 April, 2018

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Technical Program Chairman: Grant Byerley
Technical Committee*

Doug Foster, Dan Whitmore, Dennis Yanchak, John Anderson



**Dave Hale
Honoree**

A banquet toasting and roasting Dave will be held during lunch Thursday, 5 April

SEG Student Challenge Bowl competition will be held during lunch Wednesday, 4 April

Social Gathering on Wednesday Evening

Symposium Topics

Broadband high density land 3D
Compressive Seismic Imaging (CSI) on land
High density marine 3D/4D
Fiber optics DAS VSP
Full Waveform Inversion and Least Squares Migration
Image guided tomography

Time is scheduled after each presentation for an extended open-floor discussion.

Invited speakers and extended discussion

Dave Monk (Apache)	Joe Dellinger (BP)
Paul Hatchell (Shell)	Ke Wang (Chevron)
Albena Mateeva (Shell)	Denes Vigh (WesternGeco)
Antoine Guitton (DUG)	Bin Wang (TGS)
Rob Stewart (U of H)	Sverre Brandsberg-Dahl (PGS)
Ping Wang (CGG)	Chuck Mosher (ConocoPhillips)

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Exhibit booths available. Find information on the website.

For Registration, Sponsorship & Booth Info, call the GSH at 281-741-1624 or visit gshtx.org/symposium2018

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GSH Annual Golf Tournament

@ The Woodlands Palmer Course

MONDAY, APRIL 16, 2018

Mapping Fluid under Complex Salt Structure in the Gulf of Mexico – An Integrated Approach

Shenghui Li*, Kenny Gullette, Tingting Zhang, Arvind Sharma, Robert Marten, BP America

Summary

It is well known that seismic imaging under complex salt is a challenging endeavor and the industry is still struggling despite all the progress that has been achieved. However, it is possible, with high-quality data and careful analysis, to extract reservoir information from subsalt amplitudes. In this paper, we present an example from the deep-water GoM and illustrate the possibility of mapping reservoir fluids under complex salt structures.

Introduction

Salt structures can be complex due to its mobility. Seismic waves passing through complex salt structures will be highly distorted. Without a good understanding of the distortion and its impact on seismic amplitude, correlating seismic amplitudes with reservoir fluids will likely be a fruitless effort.

In the Miocene intervals we are interested in, finding sand from seismic data has been relatively easy, a fact supported by many GoM wells. However, distinguishing oil sand from brine sand has been much more difficult, especially when coupled with changes in sand quality. In many cases, the only difference between them is a subtle change, difficult to recover from noisy data.

Here, we present an example of separating oil sand from brine sand using seismic amplitudes under ~12,000 ft of salt. We attribute the success to favorable reservoir rock, adequate seismic data quality, advanced migration, post-migration data conditioning and data analysis in the optimal impedance domain.

Can we distinguish oil sand from brine sand on seismic data? Rock Property Evaluation

Before we analyze the seismic data, we need to first ask the question of whether it is possible to detect the difference between oil sand and brine sand for noise-free data. To answer this question, we need to model the seismic response of reservoir rocks. While it is possible to predict seismic response using analogue wells, the best scenario is using wells in the data area. Comparing well synthetics to seismic data at the well location offers a way to evaluate the potential for fluid mapping.

In this study, two wells with sonic and density logs were available within our seismic volume. Log quality must be carefully checked and potential problems must be resolved before generating synthetics.

The sand package we investigate lies below ~12000 ft of salt in ~3000 ft of water. (Figure 1). The first well

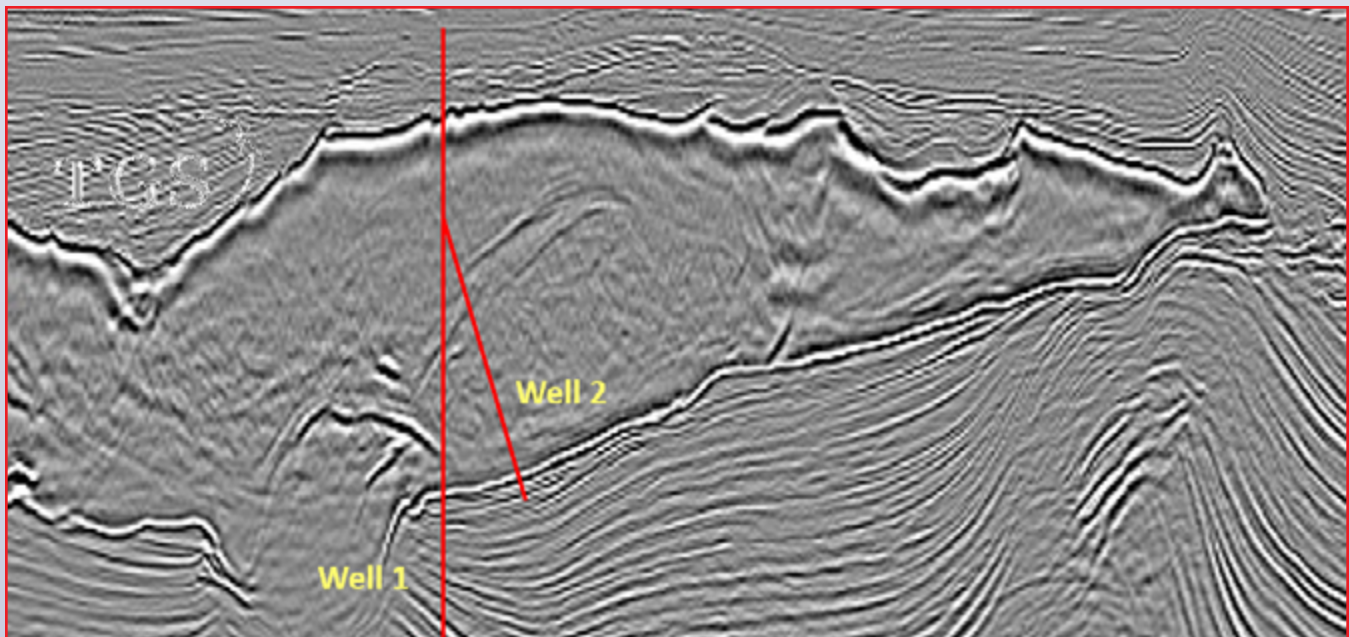


Figure 1: Well location and salt structure

Technical Article continued on page 13.

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targeted a deeper interval but encountered pay sands just below the salt. A subsequent appraisal well was drilled approximately 5000 ft up dip to evaluate the potential of the reservoir. The close proximity of these two wells and available data offer us unique opportunity to investigate the variation of both lithology and fluid variation.

There are three oil sands in the discovery well. The first sand is about 400 ft thick but only the bottom (Figure 2) 70 ft was charged with oil. It is clear from the Volume of Shale (VSH) track that the sand is clean at the base. The second and third sands are not very clean, with an average Net to Gross of 50%. Based on formation resistivity, the oil saturation of these sands varies from 50% to 80%. Less sand was encountered in the appraisal well and the quality of the reservoir also degraded, probably due to a change in depositional environment. Within the 1000 ft interval, only a few thin sands were charged with 50% oil saturation (Figure 3).

With a good understanding of lithology and fluid in these wells, we investigate the change in amplitudes from different fluids. To answer this question, we perform a fluid substitution using Gassmann's equation (Gassmann, 1951). In the process, we derive the dry frame bulk modulus of the reservoir rocks and replace the in-situ fluid.

To maximize the amplitude difference between brine and oil, we explored Extended Elastic Impedance (EEI Connelly et al, 1999, Whitcombe et al, 2002). From the AI-GI cross plot shown in Figure 4, it is clear that

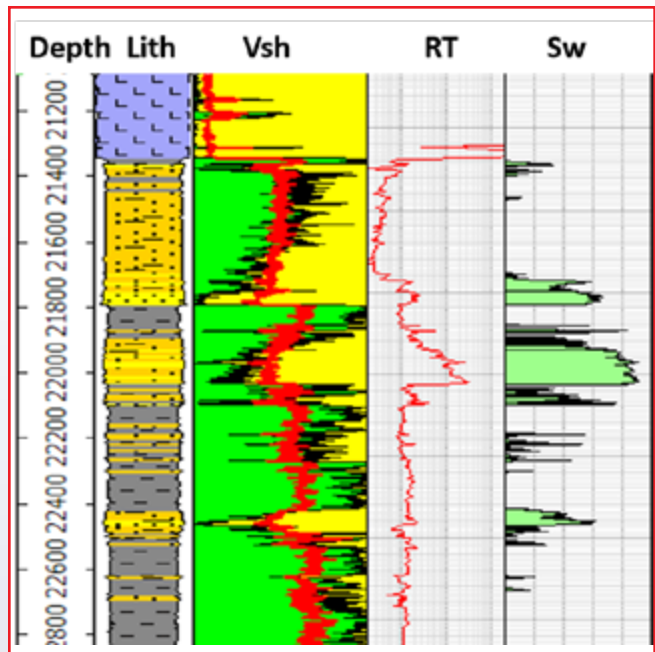


Figure 2: Log data and interpretation on Well 1

a projection along EEI + 30 would provide maximum separation between different fluids. Unfortunately, the seismic gradient data are very noisy and we have to focus our efforts on AI.

Post Migration Data Conditioning

Due to velocity uncertainty and wave field attenuation/dispersion, unwanted energy persists even using the most advanced migration algorithms. Consequently,

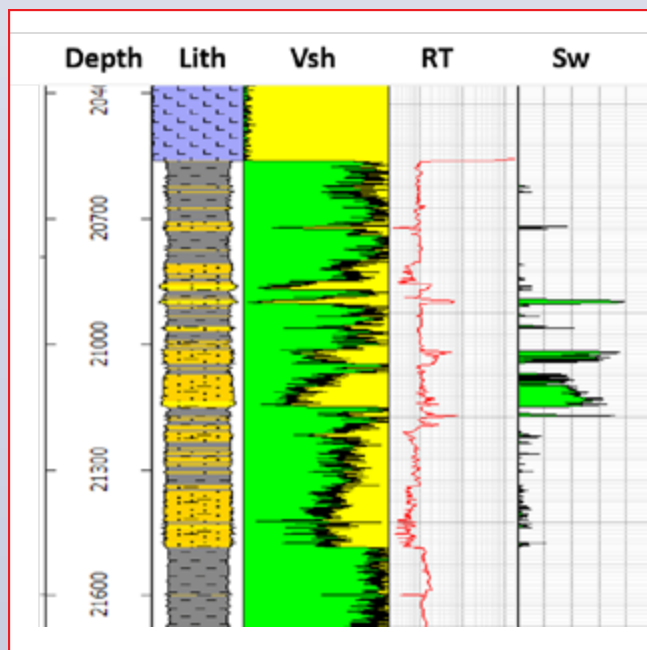


Figure 3: Log data and interpretation in Well 2

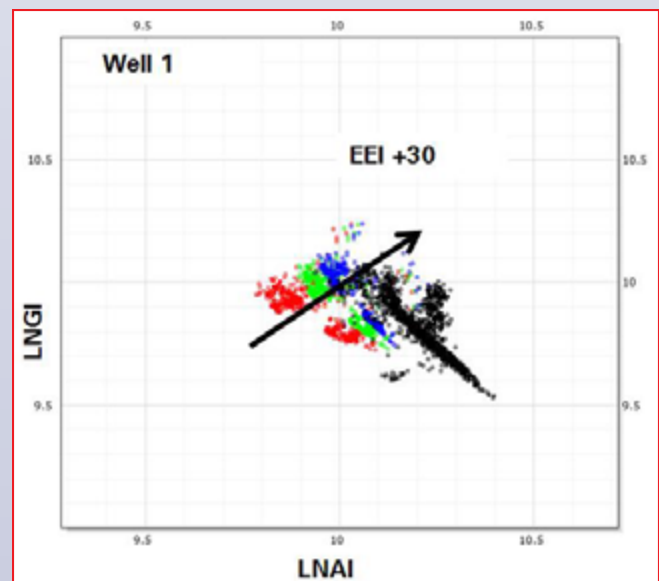


Figure 4: AI-GI crossplot of Well 1. Red/green/blue are the responses of the same sand with different fluid fill (gas/oil/brine) and the black data cloud represents shale.

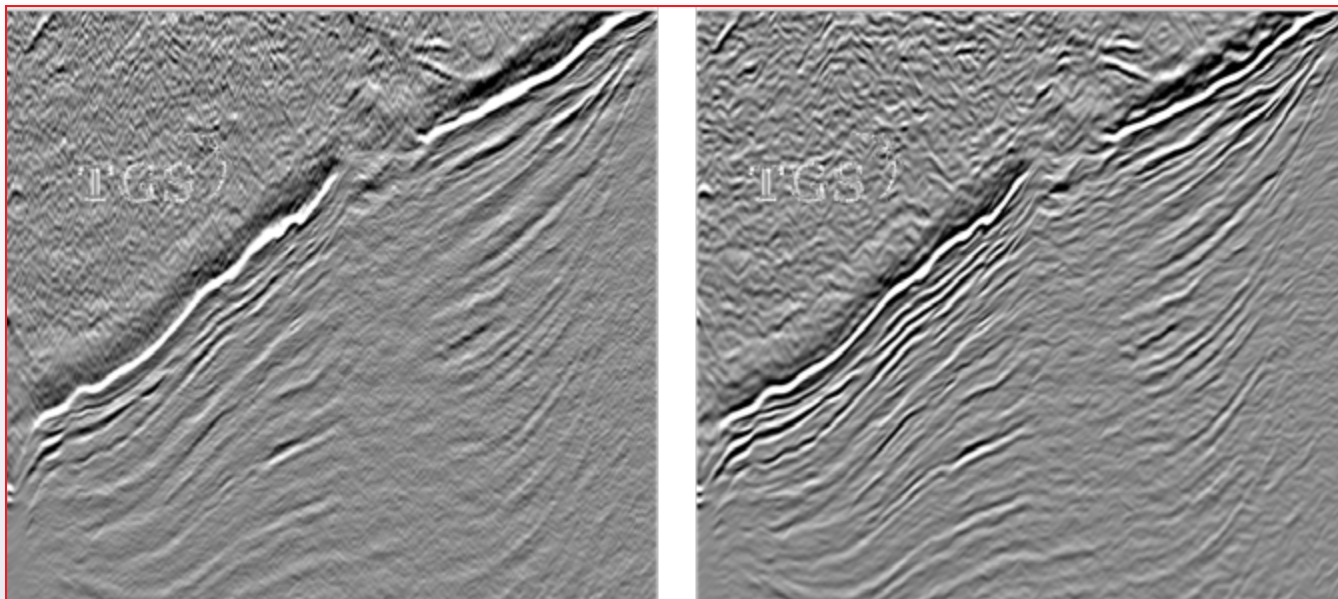


Figure 5: Subsalt image before/after data conditioning

the gathers after migration need to be conditioned before the amplitudes can be reliably correlated to reservoir properties. These problems become even worse in sub-salt areas where velocity and scattering problems are magnified.

To condition seismic data for amplitude extraction, we need to remove noise, flatten events and boost/balance the frequencies. The noise removal part consists of de-noise in the offset domain and Common

Depth Point (CDP) domain. Gather flattening involves Residual Normal Move Out (RMO), statics trimming, and multi-dimensional shifts (Zhang et al, 2016). The gathers from various azimuths are flattened and aligned with each other in the common gathers. To boost the frequencies, we applied inverse Q and then post-stack bluing.

The end result of the post migration data conditioning is a cleaner, better imaged stack with less noise, and

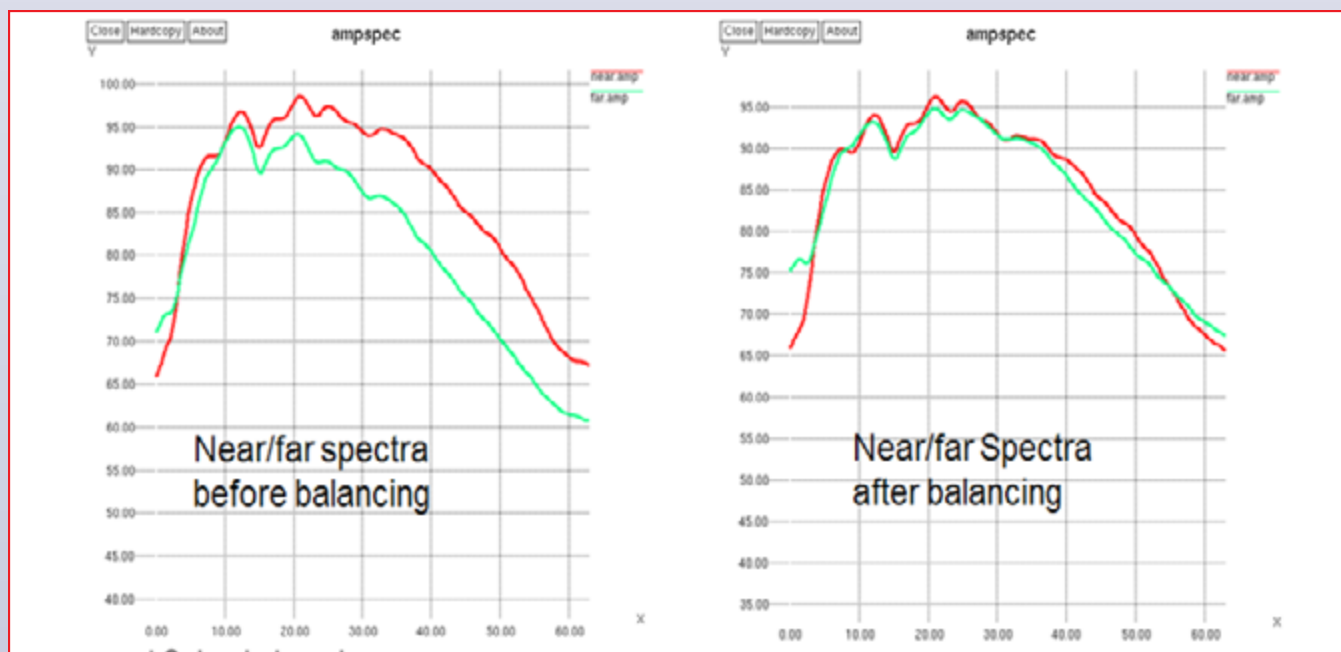


Figure 6: Data spectrum before/after data conditioning. The red curve is for near gathers and green is for far gathers.

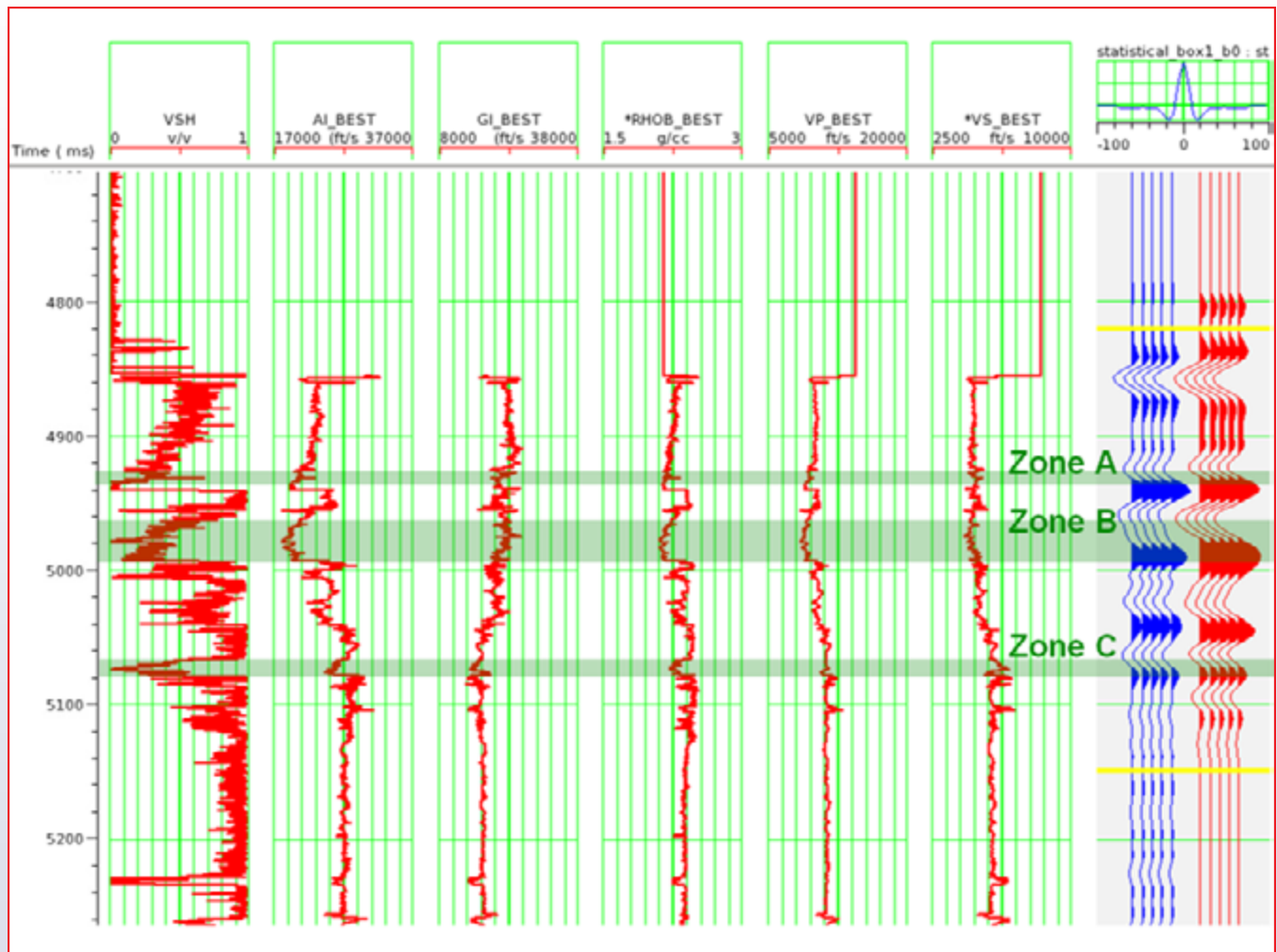


Figure 7: Well tie for Well 1. Blue wiggles are well synthetics with similar bandwidth and red wiggles are seismic data extracted at the well location

an expanded and balanced frequency bandwidth. The before/after images are shown in Figure 5 and the enhancement of the spectrum is shown in Figure 6.

Fluid Identification in the Impedance Domain

The amplitude fidelity and the absence of high angle reflectivity have always been problems for sub-salt seismic analysis. Fortunately, we were able to tie these two wells reasonably well and gained confidence on the seismic data (Figures 7 and 8).

The wavelet used is extracted from the seismic and has a dominant frequency range of 8 to 40 Hz. Well 1 has three oil zones (highlighted by the green shadow in Figure 7). Interestingly, even though zones A and C are thin, ~ 10 ms thick, both synthetic and seismic can resolve them. Deviated Well 2 has only one oil zone, which is marked as Zone B' in Figure 8. The top of Zone B' is also well resolved with a trough on both synthetics and seismic. The inverted acoustic impedances from

these two wells are shown in Figure 9 and it is clear that very good ties are also achieved in impedance domain.

While getting a good tie is encouraging, separating reservoir fluids requires prediction from modeling of the reservoir rock. Figure 10 shows the predicted fluid responses of Well 1. The blue curve is the response of brine-filled sand and the green curve is the oil response. While it is subtle, an amplitude difference of about 25% is observed for Zone B.

We extracted the amplitude along the horizon at the top of Zone B (both wells) to highlight fluid distribution (Figure 11). Interestingly, the 25% amplitude cutoff is not connected between the two wells. One explanation is that the wells have penetrated two unconnected reservoirs. We also varied the cutoff from 20% to 30% and the cutoff amplitude is still not connected.

While highly uncertain, formation tests from these two wells offer some evidence for the interpretation.

Technical Article continued on page 16.

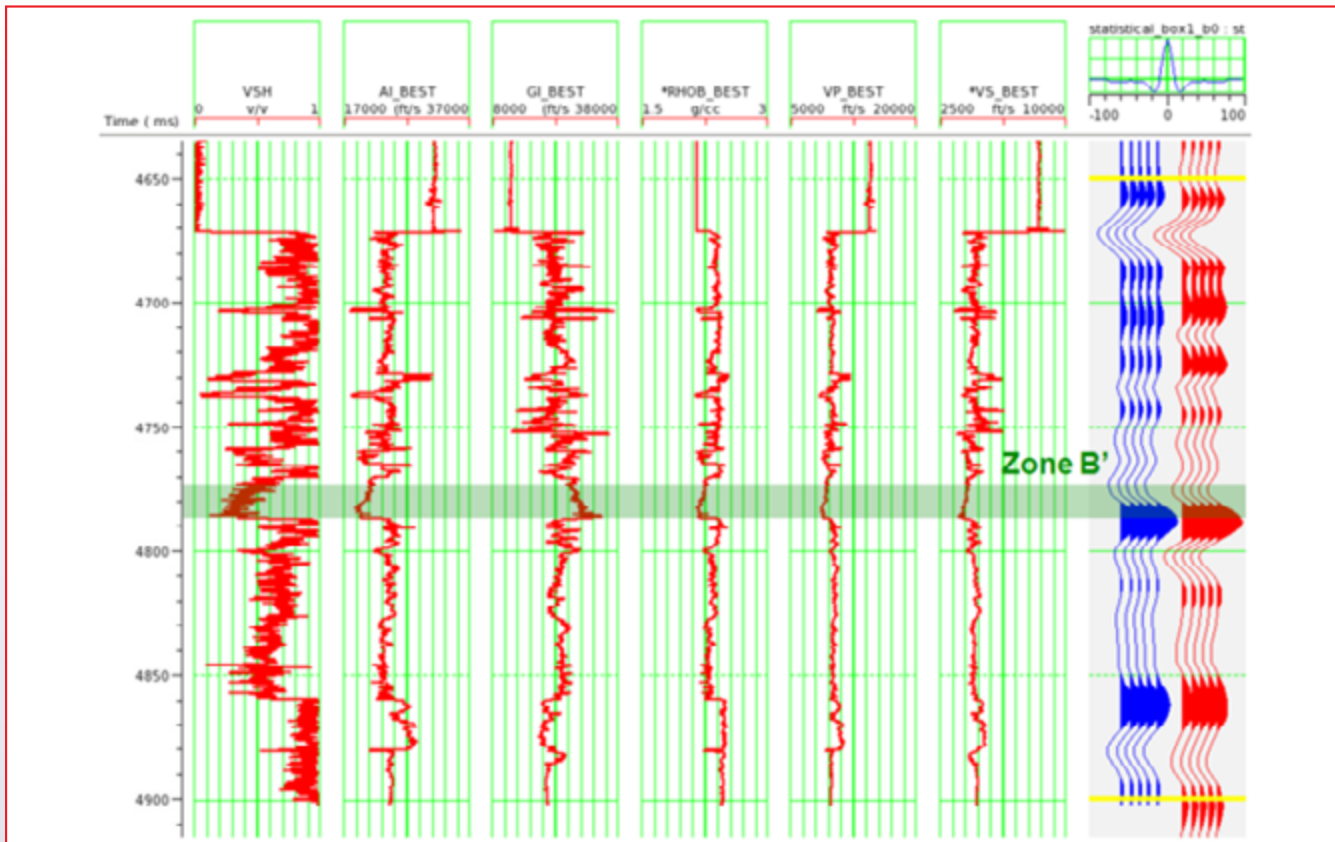


Figure 8: Well tie for Well 2. Blue wiggles are well synthetics with similar bandwidth and red wiggles are seismic data extracted at the well location

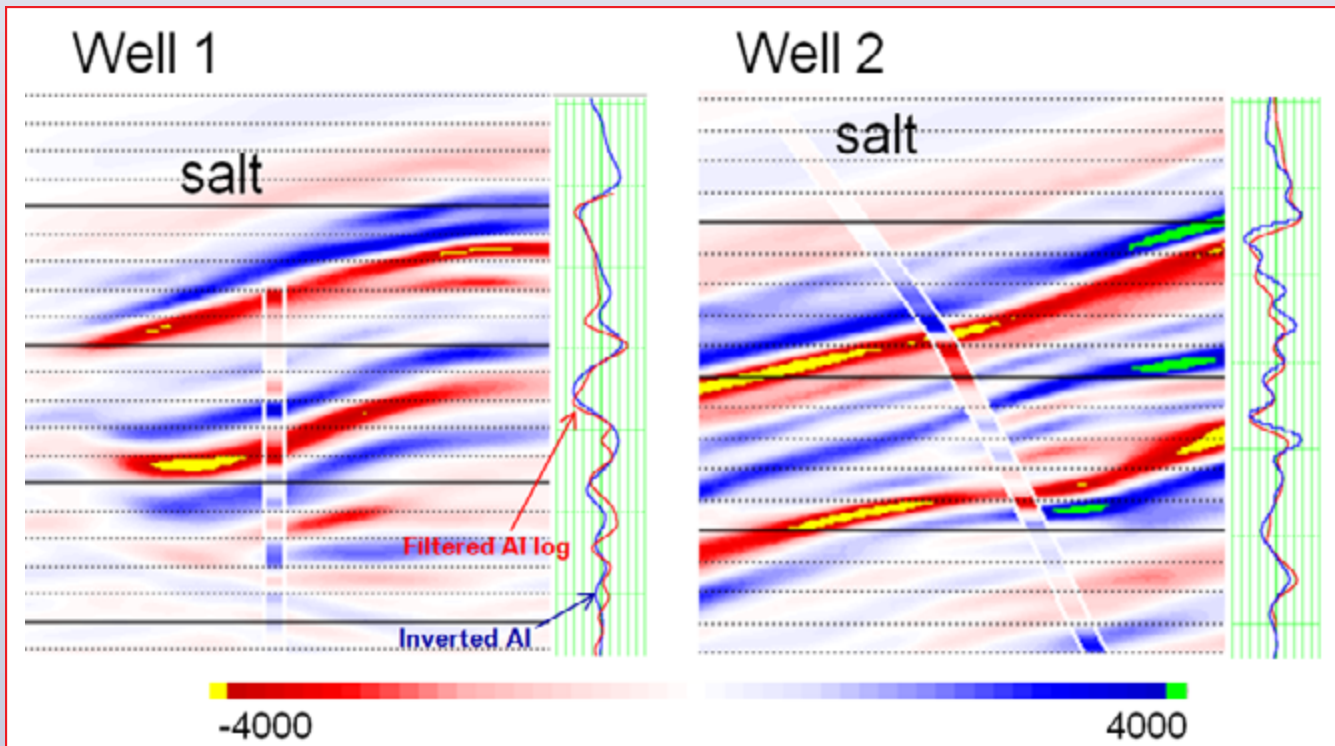


Figure 9: Acoustic impedance inversion QC at Well 1 and Well 2. Red curve is filtered AI from log and blue curve is from seismic.

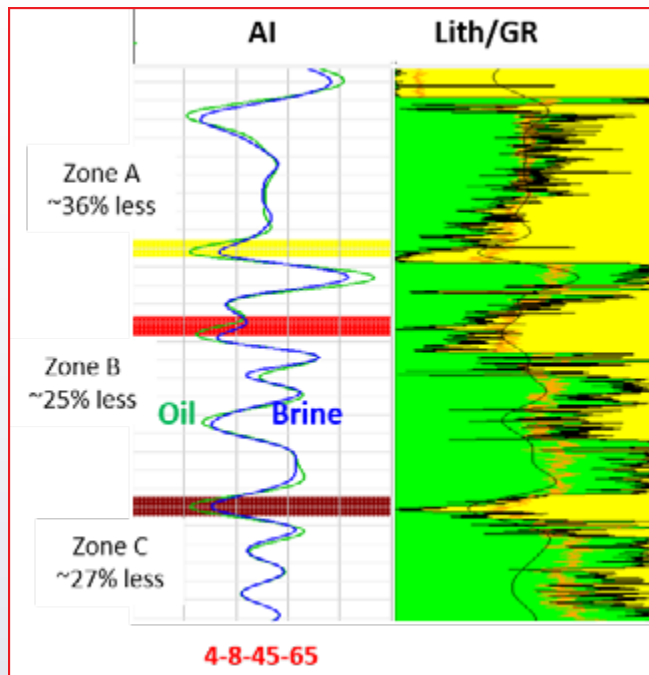


Figure 10: Synthetics of reservoir rock with different fluids. Blue curve is AI of brine filled sand and red curve is for oil filled sand. A wavelet with frequency band of 4-8-45-65 was used for the synthetics.

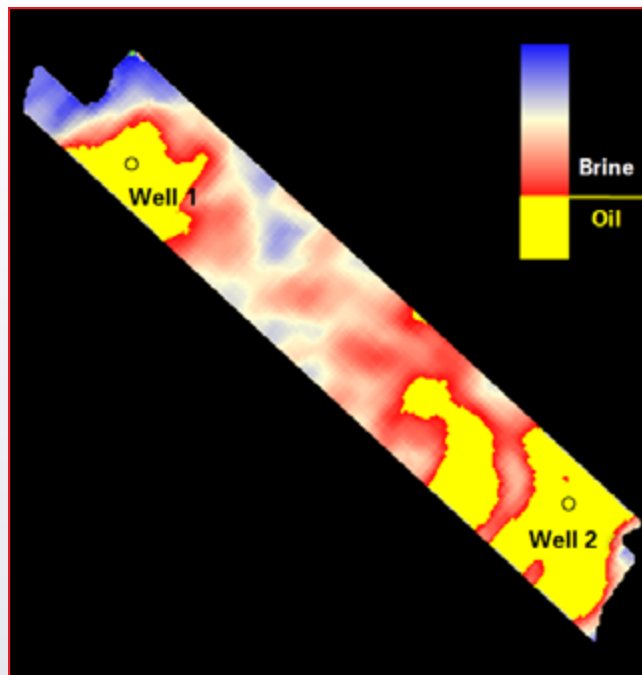


Figure 11: Fluid map extracted over a small test volume. The oil/brine contact was contoured at 25% down from the max amplitude.

The pore pressures in these two wells are different enough that they support the fluid interpretation of unconnected reservoirs.

Conclusions

In this paper, we present an example of mapping reservoir fluid under a complex salt structure. We believe that a few key elements contributed to the success. In the studied area, the seismic properties of reservoir rock are favorable for fluid mapping. If the impedance difference between different fluids fell below achievable seismic resolution, mapping fluids would be impossible. Given favorable rock properties, the

seismic data quality also needs to be good enough for mapping fluid. Normally, raw seismic data from migration are not suitable for fluid mapping and must be conditioned to reduce noise, enhance the frequency response and flatten events. With conditioned data, we can then exploit the amplitude difference between different fluids.

Acknowledgments

The authors would like to thank BP America for permission to publish this work and many other colleagues who have contributed to this work. Special thanks to TGS for allowing us to show the seismic data.

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Permalink: <https://doi.org/10.1190/segam2017-17680788.1>

GSH Outreach

Committee Activities *By Lisa Buckner*

The GSH was invited back for the **10th Annual First Colony Middle School Career Day in Sugar Land** on Friday, January 19, 2018 to host a career exhibit booth. GSH Outreach volunteers, Peter Lanzarone, Mac Hooton and Eddie Eid educated the 8th grade students about geophysical careers in the oil & gas industry, educational requirements and starting salaries. Interested students picked up the "Earth is Calling ... will you answer?" brochure and told them to go to <http://www.beageo.com> printed on the brochure to watch a four minute video about geoscience careers. They gave about 200 GSH logo coiled toy springs to those who watched them demonstrate P-wave and S-wave motion and/or listened to their presentation.



On Saturday, January 20, GSH Outreach volunteers Elena Ermolaeva, Mac Hooton, Huw James and I manned the **GSH booth at The Educator Event @ HMNS**. We spoke with hundreds of K-12 educators from all around the Houston region about the GSH Outreach Program and about how we can help them expose their students to geophysics. The teachers picked up a flyer with a list of the types of events in which GSH can participate on the front and a list of website resources on the back. This year I taught one of the workshops for a *GSH Outreach continued on page 20.*

GSH Outreach continued from page 19.

dozen middle school teachers. They learned how to do the "Exploring for Petroleum" activity with their students by doing it themselves. They worked in teams filling shoe boxes with sand and gravel and buried a water balloon filled with black food coloring and water. They sealed the box lid with tape and exchanged it with another team. Then they



tapped on the lid (source), listened with their ears (receivers) and processed with their brain to determine where the water balloon "oil reserve" was located. Then they drilled using a bamboo skewer. Everyone had fun trying and they learned why it is so important to completely fill the box with sand. Any air gap under the lid causes an acoustics issue. While the teachers were attending four workshop periods, our GSH volunteers spoke to Houston Museum of Science visitors and gave them GSH coiled toy springs.

The annual **Young Women Energized event**, organized by the Women's Energy Network (WEN), was held Tuesday evening from 6 pm - 9 pm on January 23rd (rescheduled due to Harvey) on the campus of Houston Baptist University. WEN and GSH members, Jennifer Holley and I, volunteered as Jr/Sr Table Hosts along with sixteen other WEN members. We participated in three fifteen minute rounds of speed mentoring of high school girls about our careers. The four geoscience table hosts gave their girls the "Earth is Calling ... will you answer?" brochure and told them to go to <http://www.beageo.com> printed on the brochure to watch a four minute video about geoscience careers.

On Thursday evening of January 25th, the GSH hosted an outreach booth at **Felix Morales Elementary School Family Night** from 6 pm to 7 pm in Pasadena, TX. This event was a lot of fun for all involved and the children were very well behaved despite there being a large crowd most of the time. The main feature was a "drilling for oil" game which was very popular with the students and their siblings. We had a real oil sample there which along with the activity helped the children make the connection of where oil actually comes from, and just how difficult it can be to find and extract. GSH logo coiled toy springs were distributed as prizes for participation, successfully finding the "oil" was its own reward. The oil field (can of black shoe polish) was re-arranged once the oil location became known. It was interesting to see that even though the children are generation iPad, there was still great enthusiasm and a need for hands-on activities and experiences. The game and toy springs were very popular. We distributed 150 in the hour so the booth was very busy, and GSH volunteers Huw James and UH SEG Wavelet Matthew Sexton were kept busy too.

Also on the evening of January 25th, I hosted a career exhibit booth at the **6th Annual Goose Creek CISD Career Night** held from 6 pm - 8 pm at Sterling A. Ross High School in Baytown, Texas. I talked to over 100 students of all ages and their parents about geoscience careers. The most common initial question was: "What is geophysics?" About a dozen students said they collected rocks, were really interested in either geology or geophysics and asked lots of questions. Interested students picked up the "Earth is Calling ... will you answer?" brochure. I gave away 63 GSH logo coiled toy springs.

Upcoming outreach events where you can volunteer

(contact Lisa Buckner at lbuckner@hess.com):

April 14, 2018 (10:00 AM - 2:00 PM) -

HISD When I Grow Up Career Expo at HISD Administration Building

April 14, 2018 (10:00 AM - 3:00 PM) -

Scout Fair at NRG Arena (thousands of Scouts)

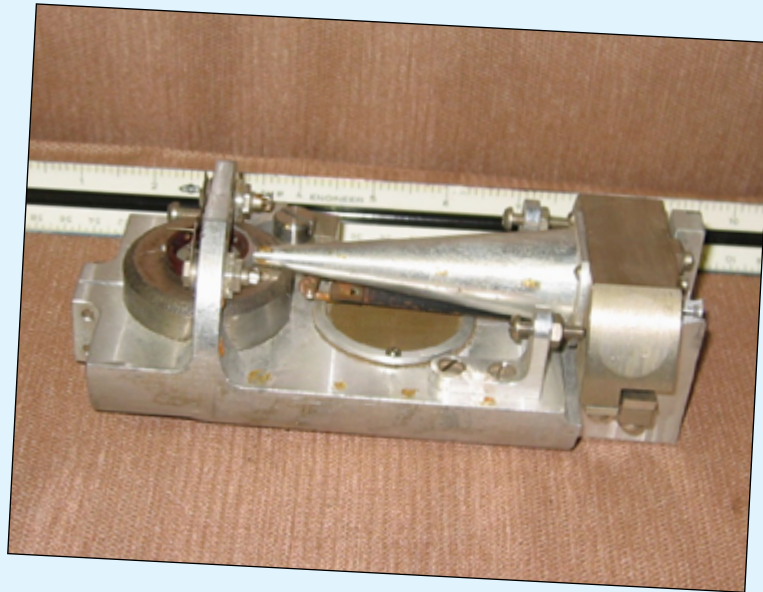
April 21, 2018 (11:00 AM - 1:00 PM) -

Reach for the Stars! STEM Festival for Girls at Rice University (1000 middle school girls)

Do you know of a school that has a career day seeking speakers, career fair or science night at which GSH might be able to host an exhibit booth? If so, please contact Lisa Buckner at lbuckner@hess.com and we can work together to bring awareness to the students of the many high paying and fun careers in the geosciences.

Mystery Item

This is a geophysical item...



Do you know what it is?

This month's answer on page 25.

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Friday, October 5, 2018
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Galveston Bay Complex and Offshore



TOP STORY

Directional Sources LLC receives major Contract from Texas Pseudo Fossil Inc.

Spin-A-Long-3D[®] has been selected as the preferred source for the massive 3D survey planned for late 2018, in East Texas, targeting the long thought dead Devonian Agujero Seco prospect. The 1185 mi² acquisition project has been designed to minimize cost while recording a variety of wave types for the most comprehensive Joint-Simultaneous-Full-Waveform-Inversion for Acoustic-Elastic Parameters and Associated Rocks Properties using Bayesian statistics ever attempted. Otro Estafador, CEO of TPF, indicated that major cost savings in acquisition will result from the use of Compressive Sensing with Neidellsian Sampling Protocol. The latter technique recently made famous when N.S. Neidell was declared "Right" by no less an expert than the legendary Enders Robinson (*TLE* January 2018). Conventional Geophysics, Inc., Houston has been selected to do the processing. Estafador said that their reputation for processing is unparalleled in handling the sparse-but-information-laden data containing a full spectrum of PP, SvP, PSv, ShP, PSh, SvSv, SvSh, ShSp, and ShSh waves recorded by Spin-A-Long-3D[®]'s companion 4D Helix Quad-Phone[®]. This is thought to be its first commercial and public use of these devices as synergistic seismic tools.

GEOPHYSICAL TECHNOLOGY NEWS

LCL Corporation to launch field test of Gravity Wave Transponder this week

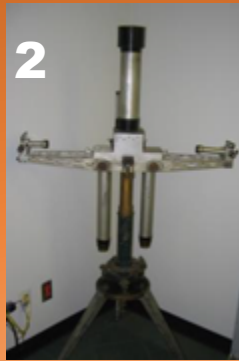
With the incredibly difficult task of harnessing the newest and heaviest element, Oganesson (Og), solved, the LCL Geophysical subdivision will test this high resolution **Gravitas Wave Unit** on an undisclosed target in East Texas. Reports will be published as the device proves it worth, said Dmitry Kulakov, Chief Geophysicist, and coincidentally, brother-in-law of Yuri Oganessian, after whom the element is named.

INSTITUTES AND ACADEMIA

Tree on Southern Ocean island marks start of Anthropocene, scientists say

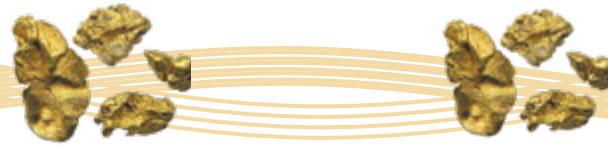
The acceptance by the International Committee on Nomenclature (ICON) of the GSA proposal to add Anthropocene as a new geological epoch has added luster to the tree which sits alone on Campbell Island in the Southern Ocean. Formerly known as "The Loneliest Tree in the World" (nearest neighbor 200 km away in New Zealand), this tree, which marks the beginning of humans' dominant influence on the earth and its environment in the 1950s and 1960s, is now being called, "The Beginning of The End Tree". The GSA and ICON issued a joint statement that with the rapidly increasing man-made environmental damage to the planet. "We can expect the Anthropocene to be the last of the aeoloaic epochs on earth". A sad note.

Vintage Geophysical Equipment on Display



This plaque, titled "The Geophysical Society of Houston Displays of Vintage Geophysical Equipment" hangs in the GSH museum

Relics of the past. (1) Never missed a Presidents' Luncheon; (2) Unidentified – Ask Bill Gafford; (3) Early recording vehicles; man at left believed to be J.H. Stringer, first observer for GSH Gas & Oil; (4) Ditto picture (2) ; (5) Bar flies attending first Presidents' Luncheon; (6) All Presidents' Reception 1953. The two gentlemen are former SEG presidents, the lady a former president of DAR, UDC, PTA, the Parish Council, and several non-subversive organizations; (7) Apparently an early mobile vending machine associated with (3); (8) FEEF scare survivor, Pres. Tommie.

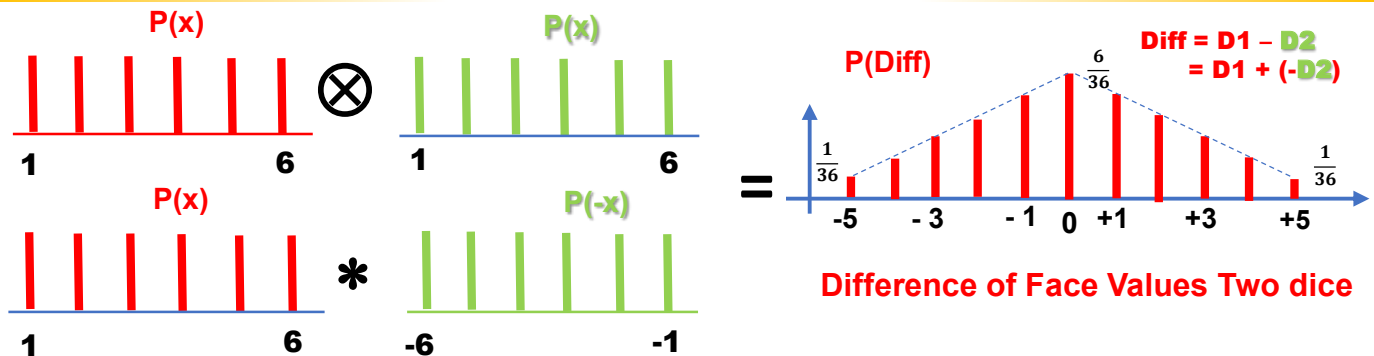


A Tragically Stunted Nuggets

Once again, the GSH Editorial Board has selflessly acted to serve their own evil purposes and sacrificing the intellectual enhancement of the members by cutting the *Tutorial Nuggets* to a single page! The Guru will use the meager allotment to answers the Puzzles of March.

(1) If convolution can be used to calculate the probability of the Sum of random variables, what is the process that would yield the Difference in two random variables? Use this method to determine the difference PDF of face values on two dice. Too avoid ambiguity, consider the two dice to have different colors, one Red, one Green. Difference is defined to be Red – Green. Sketch the Difference PDF.

A principle from our Early Years of The Age of Convolution, was that Correlation (\otimes) is nothing more than Convolution ($*$) with the second named function reversed: $a(x) \otimes b(x) = a(x) * b(-x)$. Rather than time or depth, the variable x , in this case, represents the face value of a die.



(2) Lee Lawyer has involved himself in an GSH power struggle which will be decided by a **Truel**. In a Truel, the three contestants, **A**, **B**, and **C**, in this deadly game, participate in the following way. The three are ranked by accuracy with dueling pistols. The lowest, **A**, having probability of hitting his target, $P_a(H) = 1/3$, firing **first** at either of the other two, **B** or **C**. B has a probability of hitting his man, $P_b(H) = 2/3$, while **C** is **deadly accurate** with probability of $P_c(H) = 1$ – he always hits what he aiming at. After **A** does his thing, **B** takes his turn, firing at either **A** or, if he's still standing, **C**. Then, assuming he's still breathing, it is **C's** turn with the same options. The game continues in the same order until only man remains above room temperature. Unfortunately for Lee, he is **A**. Hoping to maintain his status on this side of the grass, he is asking for our help. What is Lee's best strategy?

Lee should shoot the ground (good probability he'll hit it). Why? Try any other scenarios. A more formal answer (with arithmetic) in May.

And a quickie for next month: Using the 8 digits 1, 2, ..., 7, 8, make two 4 digit numbers from all 8, such that their sum is a minimum.

**Available Now: The All New Tutorial Nuggets
- The Book II in Real Print!**



U of H Wavelets

Photo Contest



Photo contest winner Julian Chenin in Norway

On December 5, 2017, The Wavelets cohosted a geoscience holiday party alongside the University of Houston's AAPG's student chapter, The Wildcatters, EAS student graduate committee, and Geosociety. The event took place in downtown Houston Art Nouveau Antique Bar, where Mediterranean appetizers and craft cocktails were served under an array of Tiffany lamps. The gathering of faculty, alumni, and students enjoyed a holiday themed photo booth and ugly sweater contest. The Wavelets hosted a photo contest consisting of four themes: field research, people/culture, outdoors/nature, and school spirit. Photos were viewed and voted upon on Facebook, and top five were chosen by attendees of the party. The holiday mixture was a successful way for the Wavelets to end the year alongside fellow student body committees and colleagues.

Mystery Item



The Mystery Item on
page 21
is a
geophone from 1940
called the Merten
Cone geophone.



A Conversation With...

John P. Castagna, Ph.D. - Reimagining the Future

by Azie Aziz

I am fortunate to have spent some time talking with John P. Castagna, and I am interested in his view of the future of geophysics and what geoscientists' focus should be.

John received degrees in geology from Brooklyn College and a PhD from the University of Texas at Austin in geophysics. He is a Professor of Geophysics and the Sheriff Chair at the Department of Earth and Atmospheric Science at the University of Houston. He is well known for his work in AVO analysis, spectral decomposition/inversion and rock physics. His "mudrock" equation is highly cited in literature and commonly used in practice as are the Greenberg and Castagna method and relations. John has co-authored two books on AVO analysis and has numerous publications on spectral decomposition and seismic inversion. After 16 years of working for Atlantic-Richfield, he joined the University of Oklahoma as a chaired professor and institute director in 1996. John later joined the University of Houston in 2003. He founded Fusion Geophysical in 2000 and after "retiring" formed Lumina Geophysical in 2010.

At his core, John Castagna is not only a scientist, educator, and researcher, but he is also an inventor, technologist, businessman, and futurist. I picked John's brain to share what he sees in the future of geophysics.

We have many ambitious young students and early career geophysicists who are eager to take the next challenges. As a start, could you tell us, the most critical problems that you believe they will face?

It is critical to geophysicists that they demonstrate the value of their profession in general, and particularly in unconventional reservoirs. It is incumbent on us to show decision makers that we can impact their business decisions. To do this, we need to understand that geophysical practice "as usual" is not sufficient. We must change what we do and how we do it to align ourselves better with the decision-making process. All too frequently, the "ship has sailed" by the time we have finished our work and presented the results. Also, we tend to throw our outputs over the fence, with the idea that someone else will pick up the ball and run with it. This won't cut it. We must educate ourselves beyond geophysics and learn how our results can be applied, so that we can teach others how to do it. We must understand the problems engineers are challenged with, so we can learn how we can help to



solve those problems and impact those decisions. We should not just do our thing and separate ourselves from other functions. As a bare minimum, our results need to be provided in depth, tied to a well to the fourth decimal place (only slightly exaggerating), and structured and formatted so the results can be readily integrated into other work flows. To use an overused expression: We need cross-disciplinary integration and, if we don't do it, nobody else will.

On another aspect, I would advise students and researchers to learn everything they can about machine learning. In geophysics, we have massive data to begin with, and we multiply this into N-dimensions by what we do with the data. Machine learning is useful because it can help to solve big data challenges and produce results much faster than current practice. We must learn how geophysical data can be incorporated into machine learning algorithms. Critical

Interview continued on page 27.



issues are how the data are compiled and prepared for input, and we must be very careful about the questions we ask, so that the answers make sense and are useful. AI has been with us a long time, but our compute power/technology and algorithms have progressed to the point that we are on the threshold of a revolution.

The question here is do we have enough capability to deal with the large data? We should leverage the rise of cloud computing that can help us to easily access and process big and complex data anywhere and anytime. If our financial data can be on the cloud, it is time to recognize that geophysical data also belongs there. Again, we need to drop old thinking. There are indeed issues to be dealt with. Let's deal with them and get on with it.

What made you to pick geophysics as your career choice, what are the things that set you up that have a massive impact in what you do today?

I chose geophysics because I have always loved geology and physics, and it combines the two subjects together. My father was an electrical and acoustic engineer, and as a child I could play in his laboratory and see the wondrous things he was doing. As a city boy, I always loved to go out into the country and "commune with nature". It was just natural for me to combine these disciplines, and I have never regretted it.

Next to family, geophysics occupies all my remaining waking moments. My ambition has always been to advance the field of geophysics; not to make money.

Money for me is a means to that end and has always been a secondary consideration for me. Others have made a lot more money in this profession than I have, but I have had so much fun and satisfaction doing what I do that I don't worry about it, and the money comes anyway. Regardless of what you choose in your career, you must love what you do. That is probably the key ingredient in success.

Who is your role model or mentor that you want people to know about?

My two most important role models would be my dissertation advisor, Milo Backus, and my father, John Frank Castagna. I also consider myself fortunate to have been able to spend more time with Leon Thomsen and Fred Hilterman than I probably deserve. I love to be in the vicinity of greatness and people I admire.

In your career, you were awarded with the 2005 Reginal Fessenden Award with Matthew Greenberg for the work in shear-wave velocity estimation in porous rocks. One common statement I hear is "I want to be the next John Castagna". How can geophysicists do that?

I always enjoy making discoveries and exploring new things. I love being a researcher. Love what you do. Believe in yourself. Be positive. Work hard. It is that simple.

How can someone figure out how they can be the most useful and successful?

Interview continued on page 28.

Interview continued from page 27.

Be focused on the problems to be solved. Take your time to understand a problem fully, before throwing the kitchen sink at it. Have faith, be confident, immerse yourself, and work very hard. Always look for what can be done and not what cannot be done. It is easy to find fault and to see why things won't work. It is harder to see why they will work. Be positive and you will be successful.

Can you talk about what the future of geophysical research will look like and how we get there?

Geophysicists have the necessary background in geology and physics to be an integrative force in oil and gas exploration and development. There is great opportunity for integrators and communicators. Devote a lot of attention to your writing and your presentations. Lousy communicators are at a disadvantage in advancing their careers. Historically, geophysical researchers are good at incremental improvement in our technology. In this market environment, we need to focus more on disruptive advances. It needs to be an order of magnitude cheaper, faster, or more accurate. We need quantum leaps. Early birds get the worm.

What would be the most important skills to have as a future geophysicist apart from the geophysics knowledge?

Thinking and communicating clearly.

The most memorable time in your career?

It would be watching 500 feet of pay unexpectedly coming off the fax machine, 10 feet at a time. The other one was my first discovery.

What would be the lowest point in your career?

(Laughing) I had too many to list. Well, I had to lay off people. That was not pretty. I pledge to myself not to screw up next time. I keep reminding myself to be careful when forecasting.

Do you have life motto?

On business, it would be Win-Win. On life, "Life is short". On education, you are at the university to learn and not to just collect credentials.

The industry has changed dramatically. What have you seen from inside the company? What keeps you afloat during the tough times in the oil and gas industry?

In my experience, the important attribute is to react quickly when you are presented with unexpected challenges. Despite the terrible industry conditions over the last few years, Lumina has been able to



avoid massive lay-offs. Quickly adapting and leveraging our technical assets have been the most important elements in our success.

What is Lumina corporate culture and brand?

It is a perfect avenue to bring new technology to the industry. We have made our share of mistakes, but we are always focused on delivering quality, keeping promises, and telling the truth. That is always more important to me than profit. My wife suggested that our logo should say "minimal bullshit". The idea has been well received. We may make that official.

If you were not a geophysicist, what would you be?

I would be a novelist or a musician. I was rejected by my college music advisor when I was trying to major in music. I am very thankful to him. I was terrible. I still write when I have time.

What keeps you going?

Family and fun. I love my life and remind myself every day how lucky and thankful I am.

Geoscience Center News

By Bill Gafford

1790 W. Sam Houston Pkwy. N. (Right on Shadow Wood)



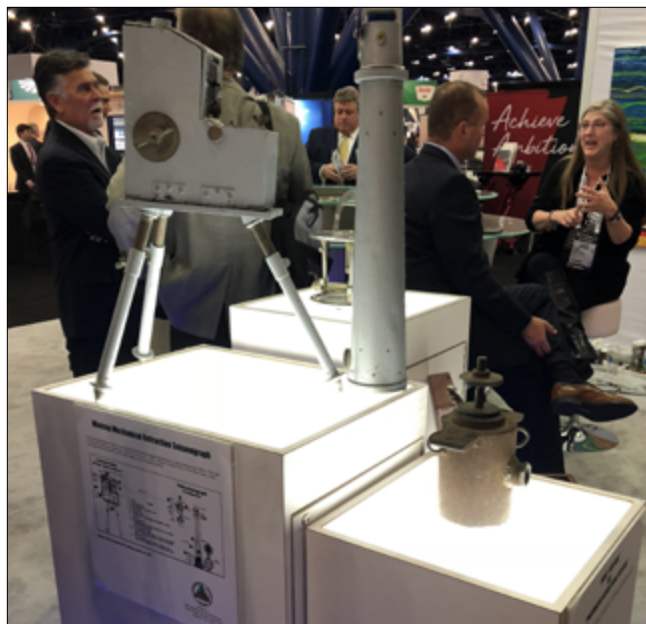
Picture 1: Gene Womack, Art Ross and George Parker.

Our latest Living Legends Doodlebugger social event was held on Thursday, February 8. These events enable visitors to see some of the mystery items that are pictured in the monthly GSH Journal as well as other interesting items in our museum collection. It is also a time for visiting with other oil patch veterans and share stories of their travels and experiences. We usually have some first time visitors also who enjoy seeing instruments and equipment that bring back memories of their careers in the geoscience field. In Picture 1, Gene Womack is showing a vintage seismic field crew desk and the contents to Art Ross and George Parker.

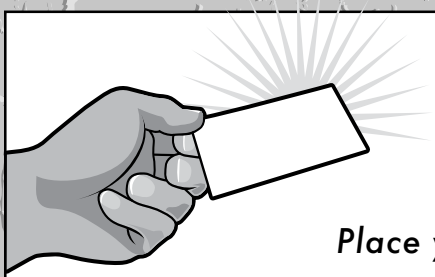
The desk contains the items used on a field crew when computations and interpretations were made in the field and include slide rules and drafting supplies.

We have many items from our museum collection on display at various locations in Houston or in Austin and we are interested in other possible locations. We loaned a few of our more interesting artifacts to Seitel to display in their NAPE booth in early February. They made good conversation pieces and helped expose a large number of people to some of our collection. A portion of the display is shown in Picture 2. If your company might be interested in borrowing some items from our collection for a display just let me know. The inventory can be viewed on the GSH website under the Outreach tab, then Geoscience Center and Museum. There are pictures and a brief description of most of the items in our collection.

Visitors are welcome at the Geoscience Center on Wednesday mornings from 9:00 until noon or by appointment. Volunteers are also needed to help with some of our ongoing projects. Please contact me at geogaf@hal-pc.org or at 281-370-3264 for more information.



Picture 2: Interesting artifacts loaned to Seitel for display in their NAPE booth



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Doodlebugger Diary

Shipwrecked in the South China Sea

Part 3: Stranded in Sanya, Hainan Island

By Scott Singleton

Doodlebugger Diary are the experiences of geophysicists during their working lives. Usually these are not recent events, but more recent ones are just as welcome. Think back to an earlier time when you were on a seismic crew, operating a magnetometer survey, gravity stations, or whatever. I included one that involved a data processing center. Seriously consider contributing a story or two. Scott Singleton recalls a few interesting stories. We are going to run them over several issues of the Journal. Scott is a past President of the GSH and still very active in professional affairs. I know you will enjoy his adventures as a truly certified doodlebugger. Lee Lawyer

If you have an item for the Doodlebugger Diary, send it to llawyer@prodigy.net or to editor@gsh.org.

When we last saw our intrepid doodlebuggers, they were being transferred to a Chinese Navy coastal patrol ship. This ship stayed a short distance away from the Nanhai 503 until a Navy shuttle boat transferred the entire expat crew, after which the Navy ship transported us to the main dock in Sanya. During the trip we all stayed on the back deck, which was quite interesting for anyone who, like me, was an avid student of WWII history as a youth. This vessel was fairly long and narrow, (i.e. streamlined) and on its back deck were two long pairs of rails surrounded by a cage that was open at the front and back of the rails, one end of which led to the water at the stern of the ship. It was apparent to me they were for depth charges. I was amazed. It was very much like standing on the back



Figure 1: Surveying the coastline in vicinity of the landing point of the condensate pipeline from the Yacheng 13 gas field.

Doodlebugger continued on page 34.

If you would like to add stories to the Doodlebugger Diary, send them to: Lee Lawyer at llawyer@prodigy.net or mail them to Box 441449, Houston, TX 77244-1449



Figure 2: The damaged Nanhai 503 enroute to Sanya harbor, as seen while we were surveying the condensate pipeline landing point.



Figure 3: The Nanhai 503 anchored in Sanya harbor awaiting a dry dock to take it in for repairs. Note the new paint on the hull.

deck of the WWII destroyer escort USS Stewart on Galveston Island's Seawolf Park. It was like a time-warp and I was thoroughly enjoying it.

In Sanya, we checked into the main hotel where the party chief and I had a major conundrum on our hands - how to secure our project data. We really had no good options because none were completely secure. In the end we chose the hotel's main safe under the theory that at least this would keep it reasonably secure (if the government had wanted it there would be nothing we could do anyway). Then we set about communicating with the Nanhai 503 to get all of our equipment off the boat, which we eventually succeeded in doing, and then put it in storage at the Sanya dock. After that we all looked at each other and collectively said, 'what next?'

Well, obviously the answer to that question would be to find another vessel. But this was a quest that was a little larger than we could handle. So while Arco and Nanhai West (the Chinese oil company partner in the project) were searching and making all the necessary contractual arrangements, we did our part by looking locally (more on our search and its results in the next part of this series). One of the things we could do locally was to survey the landfall location for the condensate pipeline, which we did (Figure 1). Given that this whole affair had gone completely 'off script', it seemed like a dream and I was continuing to thoroughly enjoy it.

During our surveying we saw the unmistakable 'ship with the derrick' (i.e. the Nanhai 503) making the journey from the reef to Sanya harbor (Figure 2). It stayed anchored in the middle of the harbor for a number of weeks (Figure 3). Apparently, the story we

heard was that Arco and Nanhai West were having a very difficult time finding a shipyard to take on the job of fixing the ship's hull. The report from divers was that the ship struck the reef amidships on its keel, cracking and bending it. This was a major problem because the keel is one of the main structural components of any ship and it was not certain if it could be economically repaired. Eventually the ship made its way back to Hong Kong where it underwent many months of repair in a dry dock. I'd hate to see what that bill was or be the person who had to sign off on it.

Our Sanya time stretched on and on. I forget how long we were stranded there before we found another ship but it must have been more than a month. The town was quite friendly, as might be expected since foreigners were undoubtedly an unusual sight and we had cash to burn (although we were forced to use the official exchange rate of 5 Yuan to 1 dollar and to use 'foreigner money', Figures 4 and 5). The local taverns quickly curried our favor so as to be the place we stopped each day (Figure 6). It was one of the highlights and made our stranding a little easier to bear. What we found out from the locals was that Hainan Island was considered the Florida of China. Apparently Communist party officials from Beijing would come down there, specifically to Sanya and surrounding area, for a little tropical vacationing and thus quite a bit of the local economy revolved around entertainment.

In what must be one of the oddest coincidences of the trip, while we were there we ran into a troop of Russian dancers from Khabarovsk, which is a large city in far eastern Russia north of Vladivostok, actually fairly close to Sakhalin Island. They were on a Russian/



Figures 4 and 5: Front and back of Yuan 'foreigner money'. Note the English on this Chinese bill.

Chinese cultural exchange program and were traveling through China with a performance consisting of traditional Russian dance. Needless to say, we saw their dance routine a number of times, traveling wherever we had to on the island, and did not waste any opportunities to take them out to dinner or show



Figure 6: One of our favorite taverns in downtown Sanya. Two of the crew are on the right.

them around Sanya during their free time (as if we were the experts by then). As you can well imagine, the few weeks they were in the area were a welcome respite and will definitely be remembered by the entire crew for a number of reasons...

Next month: Part 4 – Our First Two Survey Vessel Replacements – The Huang May and Lingshiu



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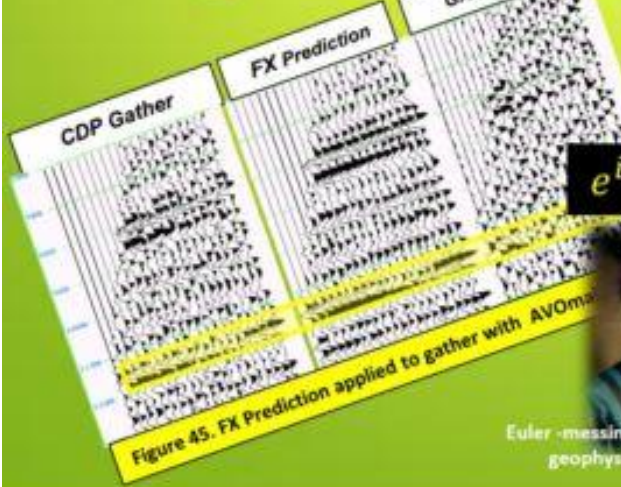
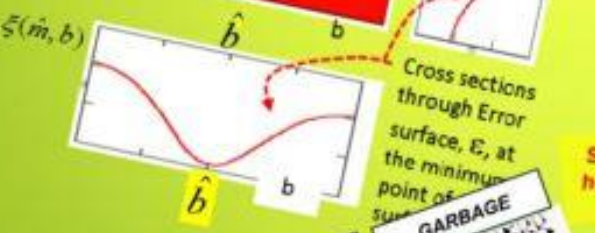
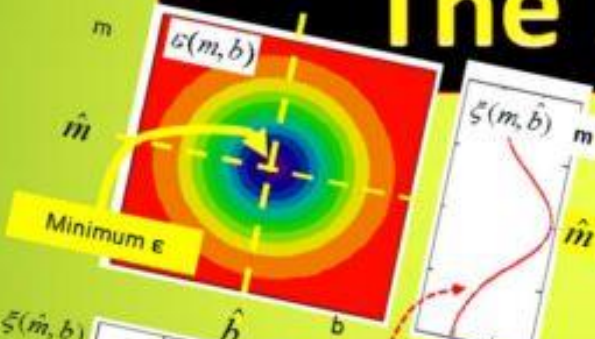
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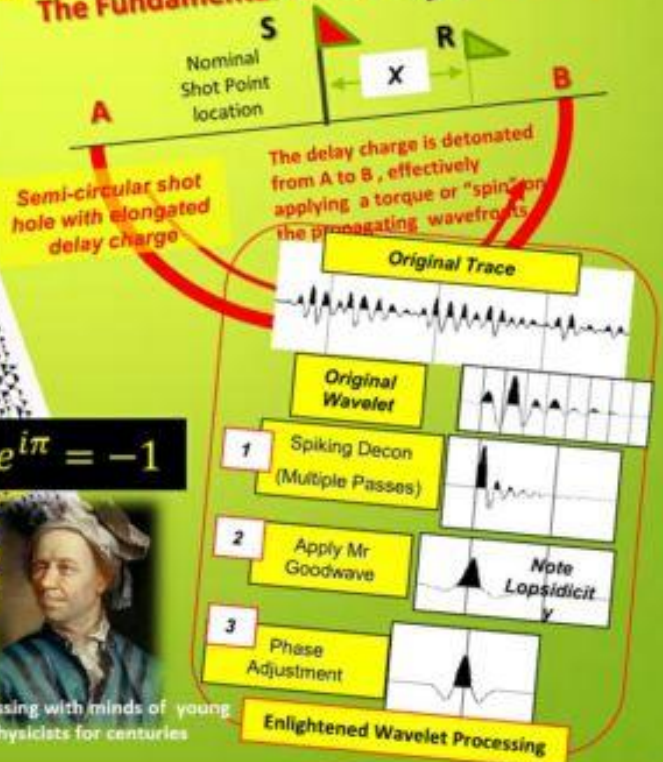
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