March 2018

GSH Journal

GEOPHYSICAL SOCIETY OF HOUSTON
Volume 8 • Number 7

The Epicenter of Geophysical Excellence

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On The Cover...

Surveying landfall location of condensate pipeline, Hainan Island, South China Sea.

See article by Scott Singleton.

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

May 2018	**Mar 9**
June 2018	**Apr 13**
Sept 2018	**July 13**

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A Word from the Board

From Another Side

By Dennis Yanchak, President Elect

It's that time again ... time to compose my thoughts and let you know what is going on in the Geophysical Society of Houston from my viewpoint. Five years ago, I didn't think that GSH would become a focal point of my geophysical life but through the encouragement of my friends and co-workers, I successfully ran for the office of treasurer in 2013. The responsibility of managing the society's financial wellbeing brought a new found admiration of the many activities that GSH sponsors throughout the year: 80+ social and technical events. It's very challenging to balance between providing those social and technical programs while maintaining a strong financial organization. I've been a part of organizations that failed their financial obligation in my corporate career, working for Gulf Oil and Amoco when their financial situations relegated them to the annals of history. But the GSH, having just passed our 70th anniversary, is still going strong.

As I write this, we are beginning the budgeting process, seeing where we can tighten our belts, offer new and inviting social and technical events, and grow our society even in tough times in the oil patch. We have cut costs over the past few years, most notably by moving to an online only publication of the GSH Journal. For some, the move to an online journal is not very satisfying. Some among us, still prefer to open a hardcopy publication, but hopefully we haven't lost too many members because of that. Having said that, I do wonder how many will actually read this column?

Cutting cost helps but we still do need to provide income for all of our activities and office expenses. One source of income for these is through our membership fees. In my role as president-elect, I have the pleasure of working with many enthusiastic volunteers and the dedicated staff of the GSH in this area. A relatively large percentage of our members have now achieved emeritus status, allowing them to continue their membership at half the regular cost (and for those mathematically inclined, reducing our funds from membership fees). To keep the society alive and vibrant, we continue to explore ways to expand our membership and entice a diverse and younger group of geoscientists and those interested in geosciences to join. Income from membership only covers about 20% of the society's expenses so the remaining funding needs to come from corporate and personal donations, technical webinars, social functions and the GSH's annual Spring Symposium.

Dennis Yanchak

This year's symposium, entitled Sharper Images and honoring Dave Hale is right around the temporal corner, so mark your calendars for April 4th and 5th and join us for fun times and stimulating technical discussions at Houston's premier technical event. Halftime entertainment during the first day of the symposium is the SEG Challenge Bowl where you can find out just how much you don't know about geophysics and the SEG. The lunch break of the second day doesn't disappoint either with recognition of this year's honoree, Dave Hale, and maybe some toasting and roasting as well. All of that is surround by outstanding technical presentations and discussions!

I did mention personal donations and there are many donors who help support the GSH. We hope that the trend will continue into the new year and under the new tax code. As a 501(c)(3) non-profit organization, donations to the GSH are still tax deductible when you itemize, but the higher standard deduction may decrease the number of people that continue to itemize. Luckily, many who donate to the GSH do so because of the role we play in the geophysical and technical community in the greater Houston area ... the tax benefit is a secondary consideration.

The fiscal year is quickly passing, with only a few months remaining before the change in the board and officers and I ascend to the office of president. I've learned a lot, and I mean a LOT, from Tommie Rape and the past presidents that continue to stay involved with the GSH. I would like to take this opportunity to publicly thank them for their sincere dedication to the success of the GSH and everything I have learned from them.

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

27 Mar 2018 • Houston, Texas

UPSTREAM OIL & GAS

PROFESSIONALS HIRING EVENT

Trini Mendenhall Community Center 1414 Wirt Rd

*To attend the Hiring Event, you must be a member of at least one of the collaborating organizations listed below: AADE, AAPG, ASME – South TX, GSH, HAPL, HGS, IEEE – Houston, O&G Admins, NSBE – Houston, PinkPetro, SIPES – Houston, SPE, SPEE, SPWLA – Houston, SWE – Houston Area

From the Other Side

By Lee Lawyer

I am *"Enjoying Life as it happens"* or I could say, *"Enjoying the future as it arrives*. These columns should prove both of those homilies. Just because I lost my house and most of my belongings, shouldn't give me license to complain about natural occurrences. C'est La Vie.

I write these columns a full month in advance of publication. That makes it awkward to comment on something occurring concurrently with the column. Have we all contributed a few bucks to the GeoScience Center Challenge grant? Recall, last month. If many of us contribute a pittance to the grant, we can easily meet the challenge. So far (02/22/2018) we have covered 90% percent. If you promise to cough up a shekel or two, I may extend the time limit a smidge or is that a smidgeon. I may have to donate my own smidgeon to my own Challenge Grant! Egad! Don't let that happen. Hopefully, there is a way to make your contribution using our Website. Give it a try and let me know.

I am not sure I can use the term 'The Flood' without identifying it by name. The people down Braeswood way seem to flood every time it rains. That is a relatively recent occurrence. It would be hard to tell that much older neighborhood that they shouldn't have built there. A better question is, *"Why did those two Allen brothers chose a landing so unsuited for human population growth?"* But the people of Houston are stuck with, *"Enjoying Life as it Happens"* and look forward to methods to mitigate general flooding. Is there a geophysical method to address this problem? Yes, an alidade. For those of you who don't know what an alidade is, be happy in your ignorance. It is usually identified with a plane table, thus "Plane table and Alidade". Most of the land seismic acquisition was surveyed using Plane Table and Alidade. Not too accurate but after the drafting room adjusted the line to fit mapped features on ground, one can assume the line is in the right township.

Interesting to see if areas in Houston have subsided. I am talking feet not fractions of an inch. The GPS is accurate enough to measure the difference from one year to the next, I think. Better yet, we can admit that taking ground water out from under Houston may not be smart. Is there an anthropogenic factor in subsidence? I love big words. But be careful how you answer. There may be data around somewhere to give us the correct answer.

I recently signed on to a Huffington Post Site that headlined a technical study authored by Graeme T. Swindles, an associate professor of Earth system dynamics at the University of Leeds, and others, and published last month in the journal' Geology. They found that small changes in glacial ice impacted volcanic activity! This seemed strange to me but upon further reading the data was from 4500 to 5500 years ago on Iceland. Iceland! Iceland sits directly on top of the Mid-Atlantic Spreading Center. You probably are unaware but I am a "Scientific Skeptic". When I read just the headlines or the introduction, I leap to skepticism. Could the data on Iceland indicate the heat from near surface magma is the cause of temporary ice melt or the ice melt causing the approaching magma? In either case, there could be volcanic activity. We need to focus on causality. Of course, the unloading at the surface of the earth can cause interesting responses. There are estimates of 'rebound' on Greenland if all of the ice were to melt there. It is very large and measured in many hundreds of feet.

I seem to be stuck on geomorphology. Anthropogenic geomorphology, for which we need a short hand version. Out in Southern California there are several old oil fields have had subsidence on the order of tens of feet. Don't recall the exact amount but it is anthropogenically caused by the large amounts of oil removed from the subsurface.

Back about 1947, a geophysical company came into being. It was named Dawson Geophysical and had the reputation of being financially conservative. Many of the small geophysical companies formed about that same time would add as many seismic crews as they could sell to clients. Decker Dawson stoutly refused to go in debt to form a seismic crew that had the possibility of lasting only through one cycle of field work. Decker Dawson was also noted as a true 'gentleman'. Anyone who knew him can testify to that. He left us on February 5. We will miss him.

Thought for the day: ***"From the Other Side", it's anthropogenic!***

Technical Luncheons
Advanced Imaging for Practitioners

Register for Tech Lunch West

Register for Tech Lunch Downtown

Register for Tech Lunch North

Speaker(s): 2018 1Q, 2Q Distinguished Lecturer
William W. Symes, Rice University

William W. Symes

West

Tuesday, Mar 20, 2018
11:00 a.m. – 1:00 p.m.

Location: Norris Conference Center (City Centre)
816 Town & Country Blvd.
Houston, TX 77024
(Free parking off Beltway-8 northbound feeder or Town & Country Blvd.)

Downtown

Wednesday, Mar. 21, 2018
11:00 a.m. – 1:00 p.m.

Location: Petroleum Club of Houston
1201 Louisiana St., Floor 35
Houston, TX 77002
($10 valet parking with discount – entrance is off of Milam Street)

North

Wednesday, Mar. 22, 2018
11:00 a.m. – 1:00 p.m.

Location: Southwestern Energy
Conference Center
10000 Energy Drive
Spring, TX 77389
(Free parking)

Abstract:

Seismic migration has been a core geophysical technology for more than 50 years and continues to evolve in its capacity to reveal detailed quantitative information about the sedimentary earth. Integration of ever more accurate and complete seismic wave physics, more precise numerical methods, and rapidly improving computer hardware and software environments have made formerly "advanced" methods such as prestack reverse time migration (RTM) relatively routine.

This lecture will discuss two variants of RTM aimed at enhancing the significance of image amplitudes. Both true amplitude migration and least squares migration (LSM) are being actively researched; singly and in combination, they have many applications, some surprising. I will describe a number of these applications and illustrate them using synthetic and field data examples.

Sharper Imaging, Angle-Dependent Reflectivity: True amplitude migration modifies RTM by filters and scale factors, producing physically significant amplitudes and more accurate event wavelet for negligible incremental cost. Some variants of true amplitude migration also can produce an extended image volume depending on position in the subsurface and on scattering angle/azimuth. Much additional information can be extracted from such extended images, including estimates of various physical parameters.

Accelerated least squares migration: LSM is iterative linear inversion, requiring repeated RTM application to update a physical model of the subsurface so that data traces are fit, wiggle for wiggle. Therefore, its improved account of the subsurface comes at a fairly high computational price. A properly formulated true amplitude migration can be used to accelerate the convergence of the iteration, reducing the required number of RTM applications by an order of magnitude or more with little additional cost per iteration.

Fast LSM Angle-dependent Reflectivity: Extended images represent the earth as a scattering angle/azimuth dependent reflectivity volume. Extended true amplitude migration accelerates an extended version of LSM also, yielding an extended model volume of calibrated precision at relatively low price.

Irregular Sampling / Missing Data: LSM naturally adapts to irregular acquisition geometry. By treating infill data as additional inversion targets to be determined, it is possible to use true amplitude accelerated LSM with incomplete data as well.

Accelerated FWI: Full waveform inversion (FWI) is the full-physics, nonlinear version of LSM, which is itself a single step in an effective FWI iteration. Acceleration (or even replacement) of this Gauss- Newton step by true amplitude migration results in a very substantial speed-up of FWI, coming much closer to convergence even with the small number of iterations used in typical contemporary FWI exercises.

Velocity Estimation: The velocity field is an essential input to most prestack imaging methods. A reasonably accurate initial estimate of velocity also is essential for reliable FWI.

Technical Luncheons continued on page 8.

Technical Luncheoncontinued from page 7

Traveltime tomography is perhaps the most common source of velocity information for these purposes. Wave equation migration velocity analysis (WEMVA) is another. Even though WEMVA is essentially tomographic, aimed at extracting kinematic information from the data, true amplitude migration and accelerated LSM can play a surprisingly constructive role. Use of these inversion methods in constructing image gathers for WEMVA substantially enhances the effectiveness of the WEMVA velocity update, removing some notorious artifacts that can impede convergence, and permitting effective accuracy control.

Things to Come: Much of the theory and practice for both true amplitude migration and LSM rests on the simplest acoustic wave equation. Recent work focuses on incorporating more accurate seismic physics, particularly elastodynamics and attenuation, and on reducing the computational expense of angle- dependent reflectivity estimation.

Biography:

William W. Symes graduated with honors from the University of California--Berkeley in 1971 and received a PhD in mathematics from Harvard University in 1975. After research and teaching positions at University of British Columbia, University of Wisconsin, and Michigan State University, in 1983 he joined the faculty of Rice University, where he currently is Noah G. Harding Professor Emeritus and Research Professor in Computational and Applied Mathematics. He also has been a faculty member in Rice's Department of Earth Science. He has worked in many areas of applied and numerical mathematics, including numerical methods for wave modeling, scientific software engineering, and theory of, and algorithms for, seismic inversion. He has developed grid-based eikonal solvers, data compression and multi parameter inversion algorithms, efficient viscoelastic modeling methods, QC methods for finite difference modeling (as part of the SEG's Phase I SEAM project), optimal check-pointing for RTM and FWI gradient calculation, wave equation based acceleration of iterative least squares migration, and the extended modeling / differential semblance concept for seismic velocity estimation. To better explore these topics in an industrial context, Symes founded a research consortium, The Rice Inversion Project, which has been sponsored for more than 25 years by firms in the oil and computer industries, and has supported the studies of more than 40 MA, PhD, and postdoctoral students. Among other honors and awards, Symes has received the Ralph E. Kleinman and Geoscience Career awards from SIAM and is a SIAM Fellow (inaugural class) and Fellow of the Institute of Physics. In 2015, he received the Desiderius Erasmus prize from the European Association of Geoscientists and Engineers for his "seminal contributions to methods, analysis, algorithms, and software for seismic inversion and wave propagation..."

Technical Breakfasts

Rapid Autonomous Marine 4D (RAM4D) – Unmanned Time-lapse Seismic Acquisition

Register for Tech Breakfast North

Register for Tech Breakfast West

Speaker(s): David Chalenski, Shell International Exploration and Production, Inc.
Co-author: Paul Hatchell, Jorge Lopez, Malcolm Ross, Shell International Exploration and Production, Inc.

David Chalenski

North

Tuesday, Mar. 6, 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

West

Wednesday, Mar. 14, 2018
7:00 – 8:30 a.m.

Sponsored by Schlumberger and WesternGeco

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

Abstract:

We present recent work developing an autonomous, unmanned marine seismic source system for 4D reservoir surveillance, called Rapid Autonomous Marine 4D (RAM4D). The current vision of RAM4D involves a single, small surface vessel towing a small seismic source. The vessel is unmanned and operates autonomously without escort, following pre-charted shotpoints without human intervention. We lay out the benefits of such technology implementation: primarily low-cost, frequent or on-demand, small footprint 4D surveys causing lower environmental exposure, and unmanned operations leading to improved safety. We will show the results of an autonomous 4D survey conducted in an inshore lake using the RAM4D system, and plans to conduct further 4D tests in Deepwater in 2018. A further adaptation to the RAM4D system involves towing short streamers as part of a High-Resolution 4D (HR4D) acquisition system. We present this concept and the results of an integration test.

The source-only RAM4D vessel will target permanent receiver technologies such as Ocean Bottom Cables (OBC), semi-permanent nodes, or Distributed Acoustic Sensing Vertical Seismic Profiles (DAS VSP). These Permanent Reservoir Monitoring (PRM) systems are good candidates for monitoring with lower-output sources due to their low 4D noise and have the potential for high impact from OPEX reductions in the source effort. Endurance will be limited by various factors such as fuel tank capacity and compressor condensate control, but we anticipate ten days continuously at-sea to be feasible. The current implementation of RAM4D utilizes a 250 in3 source, but the flexibility exists to extend the source size up to 500 in3 with minimal impact on shot spacing and survey duration.

The smaller footprint of RAM4D should allow rapid, or on-demand, 4D surveys since no on-vessel crew must be mobilized and the small vessels can be stored locally near ports.

Biography:

David A. Chalenski received his Ph.D. from Cornell University in experimental plasma physics in 2010 and B.S. also from Cornell University in electrical and computer engineering in 2004. He worked at the University of Michigan as a Research Scientist from 2010-2013 continuing his work in the fields of plasma, pulsed power and fusion science. Since joining Shell in 2013 as a Research Geophysicist on the Houston-based Areal Monitoring team, Dave has focused on novel Deepwater 4D seismic applications, including low-cost, low-footprint acquisition and autonomous sources.

Microseismic SIG

Evaluating Stress and Strain by Integrating Microseismicity with Geomechanical Modeling

Register for Microseismic

Speaker(s): Doug Angus, ESG Solutions
Co-Author(s): Francois Tremblay, University of Leeds
Ted Urbancic, Gisela Viegas and
Katie Bosman, ESG Solutions

Thursday, Mar 8, 2018
11:30 a.m. - 1:00 p.m.

Sponsored by MicroSeismic

Location: MicroSeismic
10777 Westheimer,
Suite 110
Houston, TX 77042

Doug Angus

Abstract:

In this paper we integrate hydraulic fracture and geomechanical modelling with microseismic data to quantify deformation and stress field evolution as a predictive tool, as well as calibration and microseismic workflow. Our approach utilizes simulated fractures (i.e., fracture displacement) as well as moment tensor solutions to represent localized discrete rupture zones. The geomechanical algorithm evaluates the Green's functions for each rupture and subsequently calculates the co- and post-seismic deformation using linear superposition. These data are then combined with DPA to define an integrated view of the reservoir. We show that the integration of fracture models with geomechanical simulation forecast stress and strain fields consistent with observed microseismicity for a hydraulic fracture experiment. We compare dynamic parameter analysis from the observed microseismic data with geomechanical predictions from elastic and visco-elastic models and note the sensitivity of the dynamic parameter behavior to the geomechanical Earth model; visco-elastic models better represent the dynamic or collective behavior of the microseismicity whereas the elastic models are sufficient to forecast potential volumes and timing of microseismicity.

Biography:

Advisor, ITG Geomechanics at ESG, has over 10 years of experience developing and applying new technology in the field of seismic geo-mechanics to address reservoir production and injection challenges, specifically to improve reservoir characterization and monitoring. He has pioneered practical approaches to integrate microseismicity, time-lapse seismology, rock physics, surface deformation, and coupled fluid-flow and geo-mechanical modelling. He has published up to 50 journal papers and up to 40 conference abstracts on a diverse range of problems, spanning theoretical, exploration and engineering seismology as well as hydrocarbon, carbon storage and engineering scale problems. He has been heavily involved in R&D efforts that are heavily multi-disciplinary, involving the integration of seismology, rock and petro-physics, hydro-mechanics and geodesy. He was previously Associate Professor of Seismic Geomechanics at the University of Leeds, UK

Data Processing & Acquisition SIG

Image Domain Mute for Post-critical Energy Attenuation in Wave Based Migrations

Register for Data Processing

Cintia Lapilli

Speaker(s): Cintia Lapilli, WesternGeco
Co-author: Dmitry Kulakov, WesternGeco

Sponsored by Schlumberger

Tuesday, Mar. 13, 2018
4:30 p.m. Sign-in, Snacks, Social Time
5:00 p.m. Start of presentation

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

Abstract:

Post critical components of seismic records carry valid information about the subsurface, but due to the complexity of these components they are usually removed for structural imaging by muting them in standard seismic processing. Such mutes, when carried out in the data domain, become rapidly cumbersome and time consuming for complex high-impedance contrast geobodies. In this talk we propose a new method consisting of a mute in the image domain, improving the stacked images and greatly simplifying pre-processing stages and reducing turnaround time.

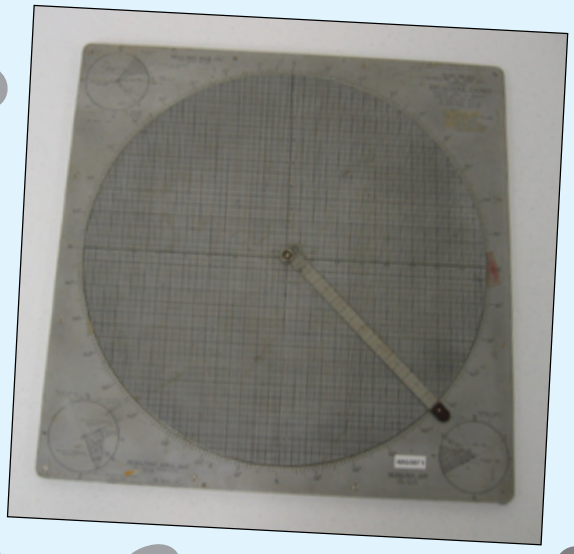
As a result, images of high-impedance-contrasts are more adequate for structural imaging, interpretation and inversion. Applications to a Gulf of Mexico dataset illustrates this newly proposed technique.

Biography:

Cintia Lapilli received her PhD degree in Physics in the field of Condensed Matter Theory from the University of Missouri, Columbia (2006). Cintia then joined WesternGeco, Schlumberger where she is a Research Scientist working in the imaging research group (2006-present). Her work focuses on several imaging and illumination problems including wave-equation migration and propagation, polar-tilted (TI) and orthorhombic anisotropy, wave-equation illumination, and imaging with multiples.

Mystery Item

This is a geophysical item...



Do you know what it is?

This month's answer on page 43.

Potential Fields SIG

En Echelon Magnetic Anomalies in the Western Indian Ocean: A Foundation for Potential Fields Interpretation of the Geological Structure of the East African Continental Margin

Register for Potential Fields

Andrew Long

Speaker(s): Andrew Long, Subterrane Ltd.,

Thursday, Mar. 22, 2018
5:30 p.m. - 8:00 p.m.

Location: HESS Club
(Houston Engr. & Science Society)
5430 Westheimer
Houston, TX 77056

Abstract:

Utilizing two complimentary satellite gravity/magnetic datasets - Sandwell's latest Free Air gravity and the Enhanced Magnetic Model (2015 edition), we present a qualitative interpretation of the East African continental margin. The data are residualized using conventional systematic corrections, yielding signatures respectively of shallow crustal density variation and deep crustal magnetization variation. By making correlations to seismic reflection profiles, onshore outcrop geology, wells and seismicity it is possible to determine structures from gravity and magnetics indicating strike slip tectonics have played a dominant role in the break-up of Gondwana. The earlier Permo-Triassic Karoo extensional rifting across East Africa propagated almost orthogonally to the Jurassic break-up margin of Madagascar and the Lamu Basin, Kenya indicating a major change in the regional stress regime.

We present an overview gravity and magnetics review of the East African margin that highlights present and past structures, commencing onshore within the Anza Basin, and finishing offshore southern Madagascar. Along the tour, evidence is offered to suggest distinct changes in strike slip structural zones along the margin that are clearly imaged in the residualized gravity and magnetic record, and have been well documented and researched in structural geology. Underpinning the interpretation are the presence of four magnetic anomaly highs arranged in an echelon configuration offshore Northern Mozambique and Tanzania. Together with the residual gravity signature and seismic correlations, an elegant present-day duplex system is identified. By extending the curved fault solutions, the duplex system is seen to be bound to the north by transpressional structures, and to the south by a narrow transtensional rifted corridor.

This interpretation is still in development to extend across onshore East Africa towards the western arm of the E.A.R.S. (East African Rift System) and outboard to the Western Indian oceanic spreading centre, and south to the offshore Angoche Basin, southern Mozambique and the Beira High.

Biography:

Andrew Long is a geologist and owner of Subterrane Ltd., graduating from Imperial College, London with BSc Geology-Geophysics and MSc Petroleum Geophysics. HE started his career with PGS Reservoir as a geophysicist and specialized in potential fields methods with Geosoft. Andrew is a Fellow of the Geological Society of London and an active member of the SEG. He has research interests driven by projects in the East African Continental Margin, West African offshore Mauritania-Senegal-Gambia-Guinea-Bissau-Guinea Basin, and the Pacific and Caribbean Margins.

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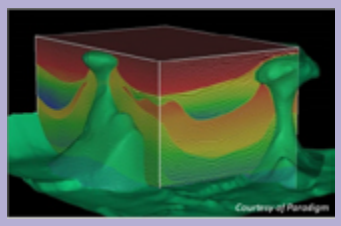
SOCIETY OF EXPLORATION GEOPHYSICISTS

Introduction to Applied Depth Imaging

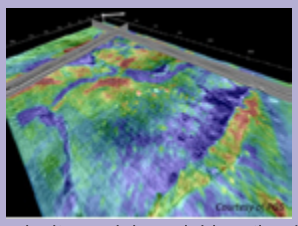
Understanding the basic concepts and practical aspects used in depth velocity model building and depth imaging

Four Half-days (10 AM - 2 PM) March 26-29, 2018

Presented by Dr. Ruben Martinez



Seismic image with velocity model overlaid and interpreted salt bodies (Courtesy of Paradigm).



FWI velocity model overlaid on the depth seismic image (Courtesy of PGS).

The goal of this course is for the participant to gain an understanding of the basic concepts and practical aspects used in depth velocity model building and depth imaging in an intuitive manner. The participant will be exposed to depth imaging practices currently in use through the description of workflows illustrated with synthetic and field data examples for a variety of complex geology scenarios. The theoretical content is kept to a minimum required to emphasize the practical aspects. This course is designed for geophysicists, geoscientists, geologists, time processors, junior depth imagers and seismic and geologic interpretation specialists seeking a practical understanding of depth velocity model building and imaging.

1. Introduction to the course
2. Depth migration fundamentals
3. Understanding seismic velocities
4. Practical understanding of velocity anisotropy
5. Review of velocity estimation methods used for depth imaging
6. Seismic data conditioning for depth imaging
7. Isotropic and anisotropic velocity model building and imaging in practice
8. Optimization of seismic images for a more reliable geologic interpretation
9. Overview of emerging velocity model building and imaging methods

Ruben Martinez is a Petroleum Geoscience Consultant and Instructor with Reservoir Geoscience, LLC. He is author and co-author of more than 70 technical papers published and/or presented at international conferences and 12 patents on seismic data acquisition, processing and imaging. He has taught numerous courses, and conducted seminars and workshops on seismic processing and imaging.

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Seafloor Deformation Monitoring: Past, Present and Future

By Paul Hatchell[1], Robin de Vries[2], Vicki Gee[3], Heather Cousson[1], Jorge Lopez[1], Shaun Dunn[4], Nick Street[4], Adrian Parsons[4], Jami Cheramie[5] and Eric Fischer[5], ([1]Shell International Exploration and Production Inc., [2]Shell Global Solutions International B.V., [3]Shell Exploration and Production Company, [4]Sonardyne International Ltd., [5]Oceaneering Survey Services)*

Summary

Over the past decade or so several disparate sensor technologies have been gainfully employed to detect the very subtle, but measurable, changes at the seafloor. These technologies include measurement of horizontal and vertical deformations.

The ultimate goal of such deformation monitoring systems is to provide continuous and near real time surveillance of seafloor changes using equipment which is highly sensitive, low cost, long life, and most importantly that delivers significant business value by helping to reduce reservoir uncertainty and to identify potential geo-hazards as part of a proactive reservoir management philosophy.

This paper reviews the past, present and future of seafloor deformation monitoring starting with early proving trials of horizontal and vertical deformation measurement, through deployment of equipment at producing reservoirs and finishing with ongoing research activities targeting the amalgamation of seafloor sensors, AUVs and surface drones to provide an integrated real-time deformation monitoring system suitable for even the slowest of subsiding reservoirs.

Introduction

Deformation data are useful to constrain reservoir and geomechanical models and for understanding issues related to the stability of wells and seafloor infrastructure.

In onshore environments, several methods are proven for detecting surface deformations that use techniques such as optical leveling, GPS, and InSar (van der Kooij, 1997; Bourne et al, 2006, Allan et al, 2017). These onshore methods are accurate to better than cm precision and may be closely correlated with dynamic reservoir processes (Didraga and Lopez, 2016). These techniques are not applicable offshore however, and new technologies are required.

Current methods for measuring seafloor deformation in deepwater fields are sorted into three different categories based on the type of measurement used:

- Methods that measure relative vertical displacement using seafloor water pressure. (Eiken et al, 2000, 2008; Bourne et al 2006; Sasagawa and Zumberge, 2013; Dunn et al 2016;)

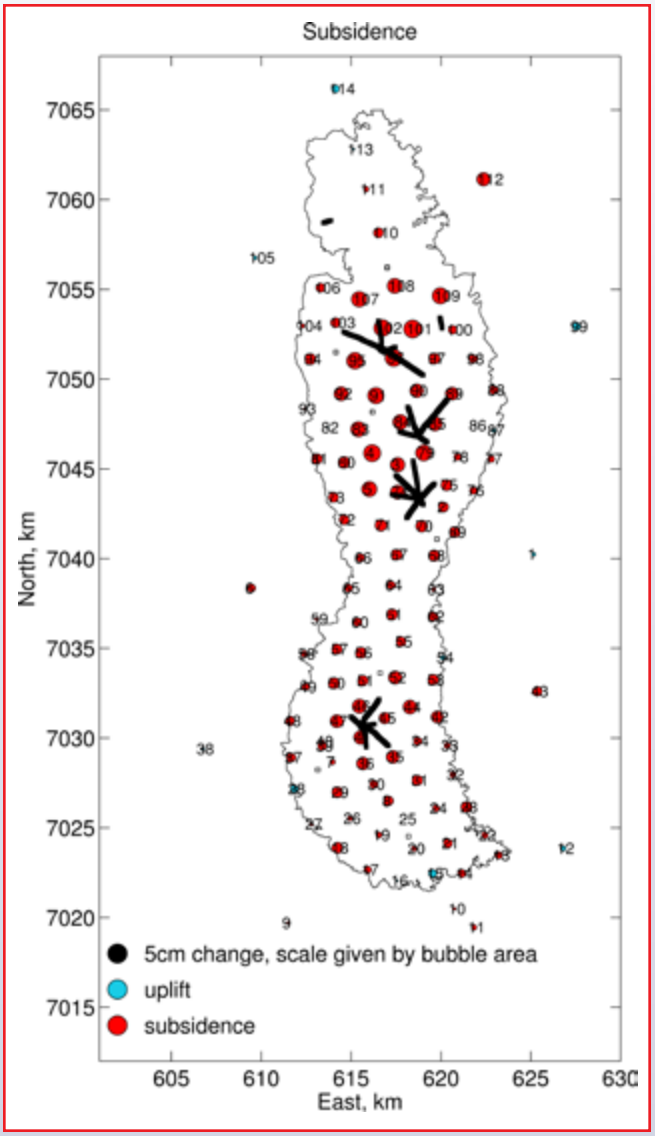

Figure 1: Subsidence observations in the deepwater Ormen Lange field using the method of Eiken et al (2000; 2008).

- Methods that measure relative horizontal displacements using acoustic ranging between stations (Bourne et al, 2006; Dunn et al, 2016)

- Absolute horizontal positioning using acoustic ranging and GPS (Spiess 1985; Sato et al, 2013; Gagnon et al, 2007)

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Examples of applying a variety of these methods in deepwater fields are discussed together with some pros/cons of the different techniques. Following this summary, we discuss some promising ideas for improving this technology in the future.

Methods using pressure

Pressure is the most widely used technique for measuring seafloor subsidence in deep-water environments. Manufacturers of precision pressure sensors quote an absolute accuracy of 0.01% and a resolution of 0.0001% which translates into a 10 cm absolute accuracy and 1 mm resolution at 1000m water depths. In order to take advantage of the high resolution of these sensors, it is important to remove tidal and atmospheric effects from the measurements and this is most easily accomplished by looking at the relative difference of pressures measured at different locations so that common tidal and atmospheric pressure signals subtract away.

Eiken et al (2000; 2008) developed a technique to measure the relative vertical height differences of fixed seafloor monuments by moving high precision pressure sensors between them. By placing reference monuments at locations inside and outside of the expected deformation zone they accurately map small changes in subsidence. Their estimated measurement error is typically a few mm and rivals the precision of methods used onshore.

This method was applied to the Ormen Lange field located offshore Norway where 100+ concrete monuments were placed around the field as shown in *Figure 1* and surveys were acquired in 2012 and 2014. The vertical movement measured between these surveys is displayed in this figure, and the maximum subsidence in this 2-year interval is ~ 5.0 cm.

The advantage of this method is the high precision <1cm that is obtained, but this method is costly because of the extensive use of Remote Operated Vehicles (ROV) required to move the pressure sensors between the monuments. For this reason, such surveys are made infrequently and therefore discriminating between long-term slow movements and short-term sudden movements such as due to fault slip (Ottemöller et al, 2005) is not possible.

Permanent Seafloor Equipment

Bourne et al (2009) describe a method for monitoring seafloor subsidence using arrays of Pressure Monitoring Transponders (PMTs) permanently installed on the seafloor that measure pressure every hour for several years. The main advantages of this approach are that continuous data can be acquired and expensive ROV vessels are not needed once the devices are deployed. Data from these devices are transmitted back to surface vessels wirelessly using inbuilt acoustic modems.

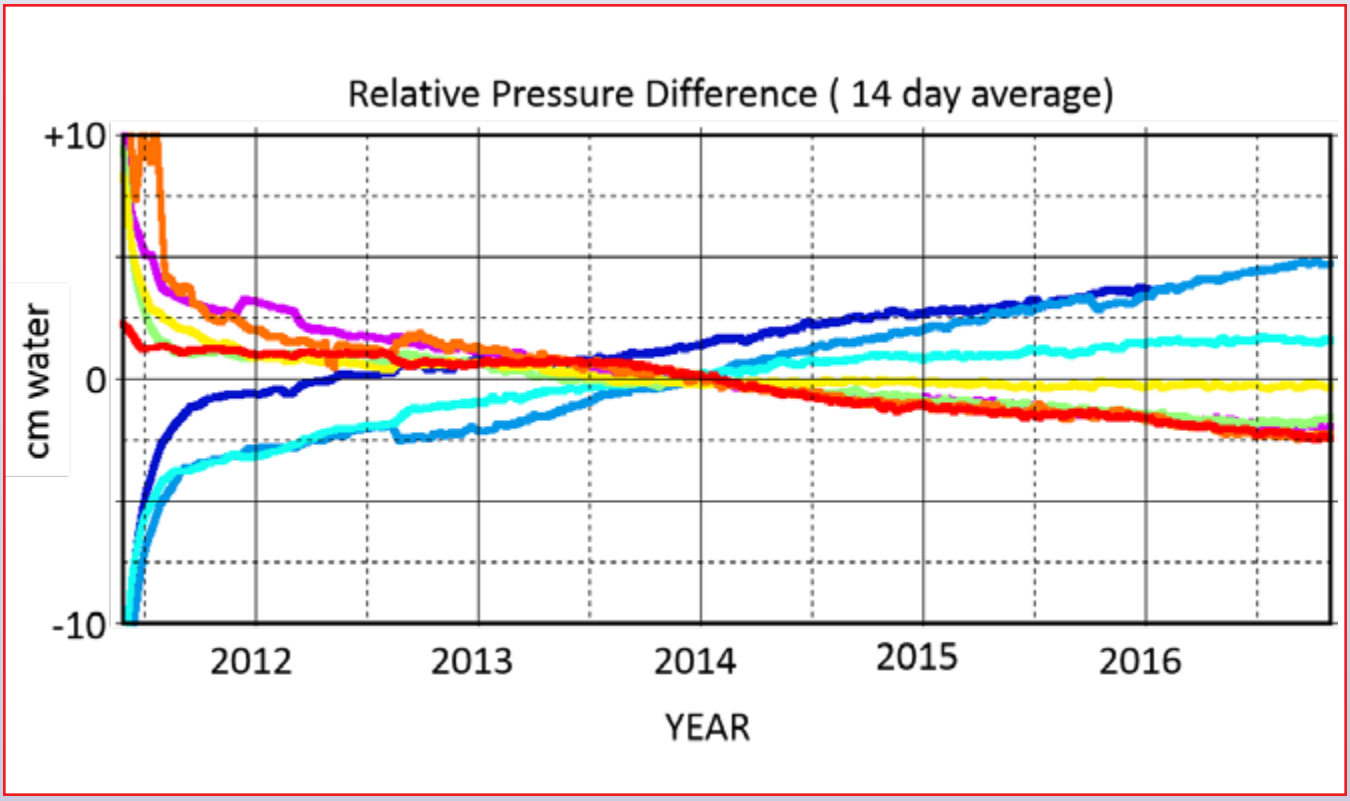

Figure 2: Relative pressure differences (displayed in cm of water) between several pressure sensors deployed for more than 5 years in the GoM.

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The main drawback of employing this method in isolation is that pressure sensors have long-term drifts that can be similar to, or even larger than, the subsidence signal (Chiswell and Lukas, 1989; Chadwick et al, 2006; Sasagawa and Zumberge, 2013).

Dunn et al (2016) show long term monitoring of continuous pressure data also at Ormen Lange using large numbers of pressure sensors that were deployed on the seafloor for more than 5 years. They observe pressure sensor drift rates of ~2 cm/yr. Such a drift rate makes it difficult to detect slowly changing deformations like that in *Figure 1*, but works well in fields with larger subsidence rates.

PMT instruments were deployed in a Gulf of Mexico (GoM) field in water depths ranging from 2500 – 3000 m. *Figure 2* shows the relative pressure differences obtained from a subset of these sensors located within a few kms of each other in a region of the field that is thought to subside very little. The relative pressure difference is determined by taking the difference between DC-adjusted pressures and a reference model created by averaging the pressure data from all the sensors. A 14-day smoothing is applied to the relative pressure difference to suppress random noise. This differencing also removes the effects of atmospheric pressure and ocean current changes.

Long-term stability of the pressure sensors is observed after the initial start-up drift that may last for ~200 days. The linear behavior of the pressure differences could be due either to pressure sensor drift or due to small rates of subsidence. We observe an upper limit of the drift rate of these sensors to be 2 cm of water/year.

Due to concerns related to long-term corrosion we placed weight collars on the PMTs to insure against accidental separation between the upper measurement system (glass sphere) and tripod base as shown in *Figure 3*. The collars were placed after the PMTs had been on the seafloor for more than 1 year. *Figure 4* shows the relative pressure differences of *Figure 2* after de-trending the data in a 200- day interval after the weight collars were place to remove linear subsidence or drift features. We clearly observe the small sudden changes in pressures associated with less than 10 mm movements, or tilts, that occurred when the weight collars were placed. The resolution for detecting these rapid movements is estimated to be ~2.0 mm.

Correcting Pressure Measurements:

Sasagawa and Zumberge (2013) describe a "Self-Calibrating Pressure Recorder" or SCPR that measures the long-term drift of pressure sensors by incorporating a precision Dead Weight Tester (DWT) within the hardware deployed on the seafloor. Periodic calibration of the pressure reading against the DWT allows the sensor drift correction to be estimated and removed from the data. Accuracy of this system is expected to reduce the errors to less than 1.0 cm/year. Shell deployed several of these instruments in two GoM fields and had difficulties with long-term reliability of these complex electromechanical systems

An alternative method for estimating pressure drift correction is to carry out long-term measurements in the laboratory prior to deployment of the instruments on the seafloor (*Figure 5*). Provided that the drifts are largely linear and predictable, this method provides a means to correct them. Prior to a recent deployment of PMT-style devices we placed pressure sensors at temperatures and pressures expected in the field and measured the sensor drift over a period of a few months. This also comprehensively pre-screens the sensors for quality and performance and usefully identifies problematic sensors. This method can also be applied post-retrieval and we are testing this on sensors that were recovered after a 5.5 year deep-water deployment to compare against the long-term drift rates observed on the seafloor.

Figure 3: Weight collar being installed on an PMT device.

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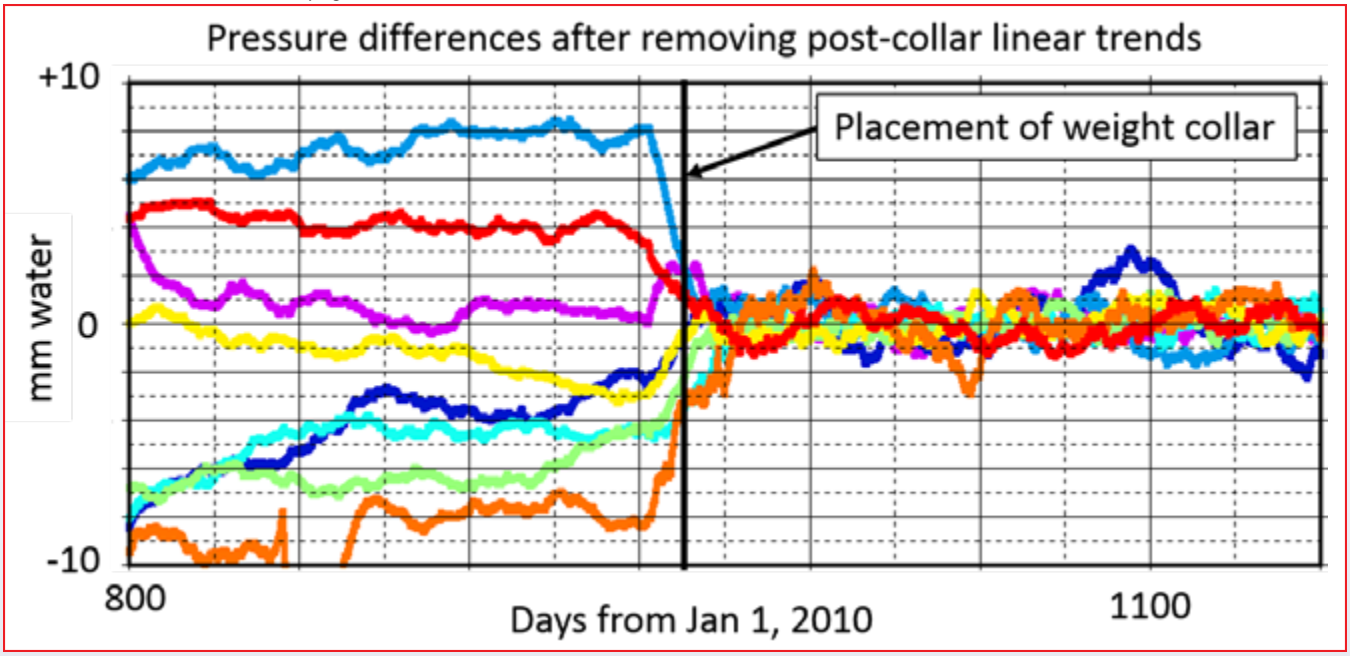

Figure 4: Sudden change in pressures that occurred when weight collars were place on the PMT instruments.

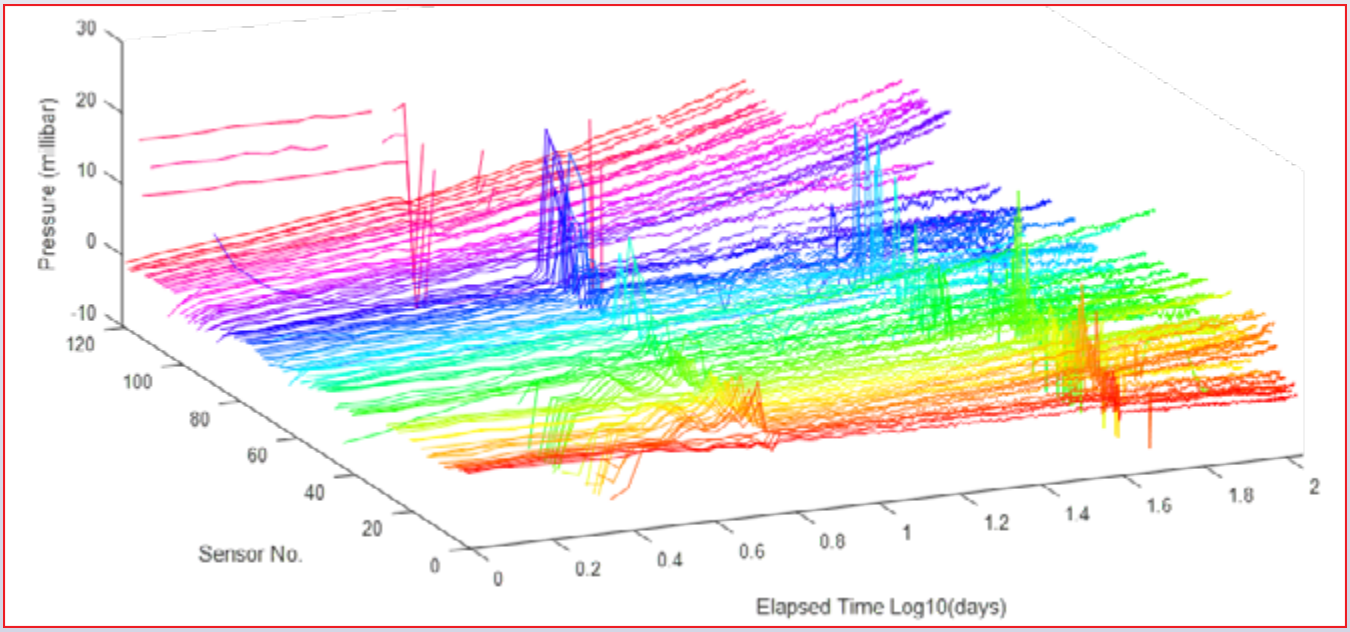

Figure 5: 120 pressure sensors held at the same temperature and pressure for months enabling drift characteristics to be determined and badly behaving sensors to be detected.

Horizontal Deformation Monitoring

The PMT devices described by Bourne et al (2009) are used to measure horizontal seafloor deformations. The devices frequently observe acoustic travel times between pairs of sensors and the sound velocity of the water. These two observables are combined to create a time series of distance variation between every PMT pair.

Geodetic network adjustment is performed to translate time series of distance into time series of station (x,y) positions. Furthermore, this step allows for the rejection of measurement errors, i.e. measurements that do not 'fit' the geometric constraints can be removed.

The errors associated with this method depend on the spatio-temporal variability of the sound velocity, instrument stability, and the spacing of the PMT pairs. To remove gross errors before network adjustment, multivariate statistical testing is performed on travel time reciprocals (i.e. from station A-B and B-A), combined with the sound velocity data, which behave under a multivariate distribution. To

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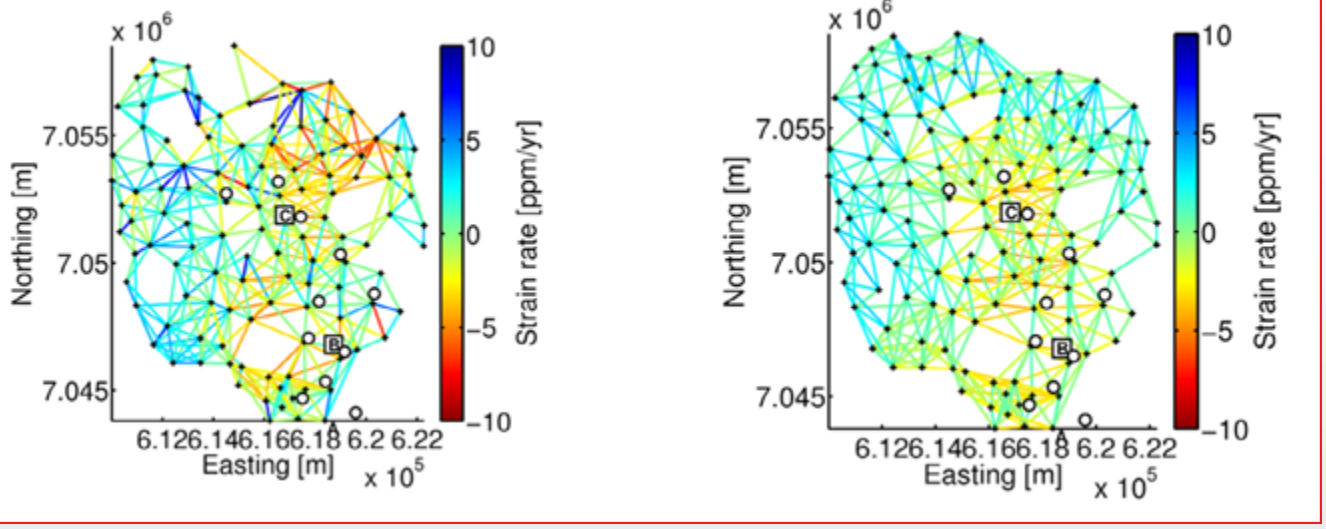

Figure 6: Measured (left) vs. modeled (right) strain rates at Ormen Lange. Each line represents a ranging arc between two PMT's. Green denotes no horizontal displacement, blue shows extension and red shows contraction.

detect and correct instrumental drifts, the individual time series are tested against a sound velocity model based on the entire population of sensors, assuming the network is stable on average (de Vries, 2015).

Such deployment and method have been applied at Ormen Lange from 2011 - 2016 (Dunn et al, 2016). Results are displayed in *Figure 6*, which shows modeled (right) versus measured (left) changes in distance for Ormen Lange. Changes of distance of 5 PPM per year (i.e. 5mm change on a 1km distance) can be detected with strong significance. More recently, ranging networks have been deployed at two Gulf of Mexico fields.

Future Trends:

Several ideas are in development that will improve our sensitivity and lower the cost of seafloor monitoring. Laser

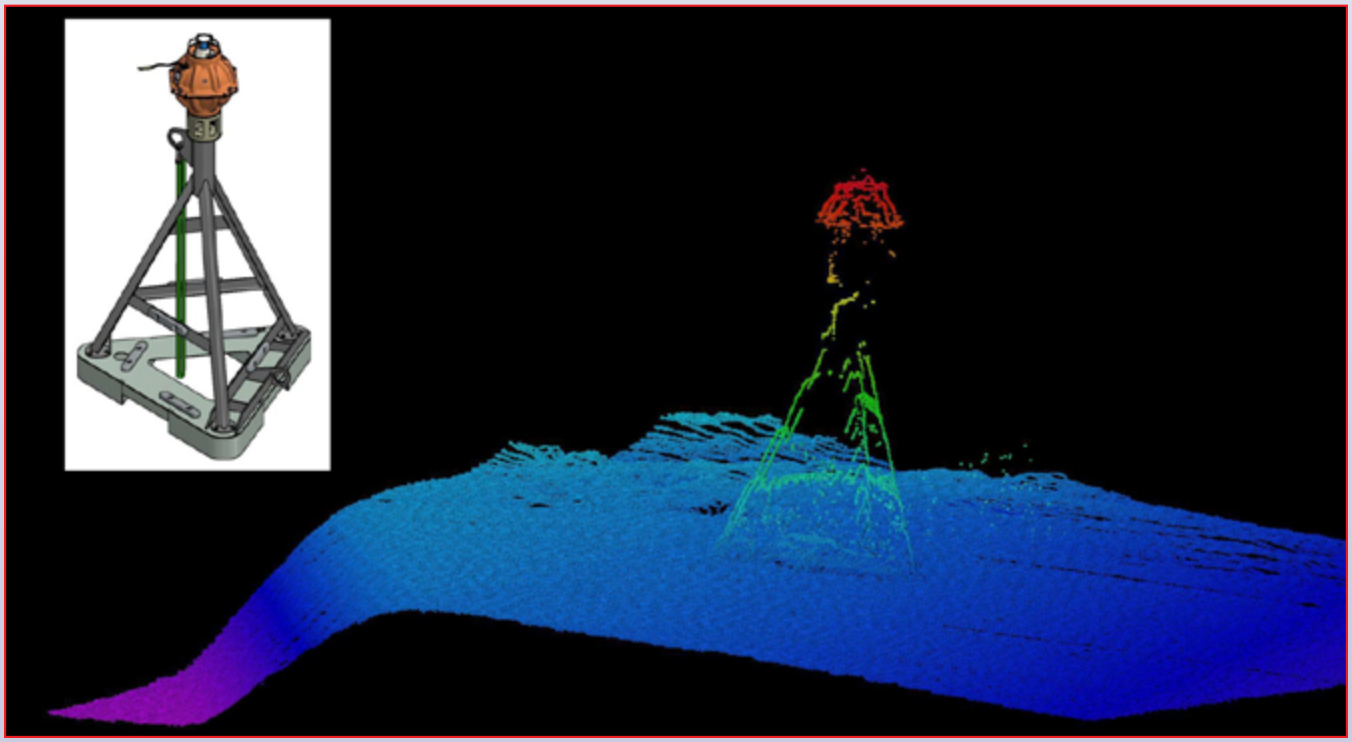

Figure 7: Laser scan of a 3-m high PMT device compared to a drawing of the instrument (inset)

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ranging using Autonomous Underwater Vehicles (AUV) can accurately measure the seafloor bathymetry while also estimating PMT depth using pressure sensors and the laser-determined offset distance from the AUV. Based on current subsea laser technology, sub-centimeter ranging resolution is expected. Surveys of the type carried out by Eiken et al (2000; 2008) could be accomplished using the AUV to move a precision pressure sensor between monuments or simply seafloor features of interest to measure relative depths between these features accurately. Repeating this pressure sensor recalibration survey periodically will permit more accurate subsidence monitoring. *Figure 7* shows an example of the detail that is captured via laser scanning of a PMT on the seafloor.

The use of an AUV will significantly shorten the duration and costs of this survey when compared to using an ROV, and has the added benefit of improved AUV positional accuracy by using the PMT devices as a long-baseline (LBL) acoustic array during bathymetric surveys.

Historically, data from seabed PMTs were extracted using acoustic modems deployed from manned surface vessels with a commensurately high HSE exposure and significant cost implications. It is now standard practice to send unmanned drones, such as the Liquid Robotics WaveGlider, to collect the data and transport it via satellite communications directly to shore.

During future data harvesting missions these drones will also be used to perform GPS-Acoustic measurements (Spiess, 1985; Sato et al, 2013; Gagnon et al, 2007) of the depth (z) and horizontal (x-y) displacement of PMTs in both relative and absolution position terms providing another means to recalibrate the array towards <1cm precision.

Summary

Much has been learned about seafloor deformation monitoring technology from trials and deployments in Norway (Ormen Lange) and the Gulf of Mexico. Campaign-style pressure surveys provide reliable subsidence estimates, but cannot capture nonlinear and discontinuous deformation regimes.

This capability gap is filled by the deployment of continuous pressure and acoustic monitoring networks, which are able to detect rapid changes in depth as precisely as 2mm. Instrumental drift (up to 2cm/yr) poses a problem for precise deformation rates (especially for subtly subsiding fields) and has sparked the development of various remedies: Self-Calibrating Pressure Recorders and lab-calibration of large batches of sensors to select predictably-behaving instruments. Together with improved instrument designs, this has brightened the outlook for performance of continuous monitoring networks.

On the near future's horizon are various novel technologies that have the potential to reduce the cost of campaign-style subsidence surveys and re-calibrate the sensors on continuous monitoring networks. Here, we mention AUV's that can perform laser ranging and pressure surveys, as well as precise GPS-Acoustic positioning of seafloor nodes by a WaveGlider. Improved precision will make these methods appropriate for many more fields across the world.

Acknowledgements

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MEET THE CANDIDATES

A Note From the President

Dear Fellow GSH Members,

An important responsibility of each GSH President is the selection and introduction of candidates for election to the Board of Directors. Beginning in December, a Nominations Committee starts working to identify and attract individuals who are interested in serving the Society and who possess the skills and attributes that will assist the Society in achieving its strategic plan and business objectives.

It is my pleasure to introduce the candidates for the 2018-2019 term. Each candidate offers a unique set of backgrounds, experiences and skills. Take a few minutes to read their biographies. Watch for announcements about the upcoming election.

Please note that our bylaws allow GSH active members to submit write-in candidates for any office. Check the bylaws for specific guidelines.

Dr. Craig J. Beasley

(formerly WesternGeco and Schlumberger)

GSH Candidate for President-Elect 2018-2019

Craig completed B.S., M.S. and Ph.D. degrees in mathematics and then joined Western Geophysical 1981. He has spent his entire career in Schlumberger companies and their antecedents serving in various technical and management positions including VP for R&D and VP, Data Processing. He has received technical and honorary awards from entities such as Litton Industries, Schlumberger and the Society of Exploration Geophysicists. Among them the SEG Award for Best Presentation. He has

Dr. Craig J. Beasley Biography continued on page 22.

Peter Eick

(In-Depth Compressive)

GSH Candidate for President-Elect 2018-2019

Peter Eick is currently a Consultant for In-Depth Compressive, based in Houston, TX. He has over 30 years of industry experience and is a member of the GSH, SEG, and AAPG. His educational background includes an MS in geophysics from University of Utah and a BS degree in Geology from Michigan Technological University.

Peter began his career in 1987 as a consulting geologist doing petrographic work for mining and

Peter Eick Biography continued on page 22.

Gabriel Perez

(Murphy Oil)

GSH Candidate for 1st VP-Elect 2018-2019

Gabriel Perez has been active in seismic imaging and processing, seismic attributes and reservoir characterization for almost 30 years. He is currently a Senior Geophysicist with Murphy Oil in Houston.

Gabriel worked for Ecopetrol, the national oil company of Colombia, from 1989 to 2003, among others as leader of the Geophysics team in ICP, the R&D division of Ecopetrol, and as a senior geophysical advisor in the exploration division. After graduating

Gabriel Perez Biography continued on page 22.

Peter Wang

(Paradigm / Emerson E&P Software)

GSH Candidate for 1st VP-Elect 2018-2019

Peter was recruited into Amoco (now BP) straight out of the MS Geophysics program at the University of Houston in 1986, which were 2D paper section and post-stack time migration days. His BSc Geological Sciences degree was from Brown. He participated in Exploration programs in South Texas, East Texas, Egypt, Gabon, was in a technology group, and had a Quality-focused management consulting role.

In 1994 he went over to the supplier side of the Geophysical industry and

Peter Wang Biography continued on page 24.

Dmitry Kulakov

(Schlumberger)

GSH Candidate for Editor 2018-2019

Dmitry has 9 years of experience in the Oil and Gas industry. He received a BS degree in Exploration Geophysics from Gubkin Russian State University of Oil and Gas in 2009. Then in 2011 he graduated from dual-diploma Reservoir Geoscience and Engineering program holding a MS degree in Geoscience from IFP-School (Paris, France) and MS degree in Reservoir Engineering from Gubkin University (Moscow, Russia). He is an active member of SEG, EAGE and GSH.

Dmitry Kulakov Biography continued on page 24.

MEET THE CANDIDATES

Tony LaPierre
(RPS Group, Inc.)
GSH Candidate for
2nd VP-Elect
2018-2019

Tony LaPierre is the Technical Director of Seismic Operations and Site Investigations with RPS Group, Inc. in Houston with a worldwide business remit. His core area of expertise is the assembling of teams of technical experts to manage geophysical and geotechnical projects. Tony has worked in the geophysical industry since 1986 and founded his own survey QC company in 1994. In 2006 this company was acquired from Tony by RPS. Tony left his native Nova Scotia in 2011 and moved to

Tony LaPierre Biography continued on page 22.

Kenneth Mohn
(MultiClient Geophysical LLC)
GSH Candidate for
2nd VP-Elect
2018-2019

Kenneth Mohn is currently Vice President of North and South America with MultiClient Geophysical LLC (MCG) in Houston. He has a B.S. (1983) and M.S. (1986) degree in Geology from Stephen F. Austin State University.

His oilfield experience started in 1982-1983 working as a Field and Wellsite Geologist drilling shallow oil wells in East Texas. His career in the geophysical industry started in 1987 with TGS Geophysical

Kenneth Mohn Biography continued on page 23.

Whitney Blanchard
(Sigma Cubed Inc.)
GSH Candidate for
Secretary
2018-2019

Whitney Blanchard received her Bachelor of Science degree in Geophysical Engineering from Montana Tech in 2009. She then went on to complete a Master of Science in Geophysics at Montana Tech, and a second M.S. in Geology at the University of Alabama. During this time she interned for Oxy and Chevron doing 3D seismic interpretation, velocity model building, and field level well log interpretation. While completing her thesis at UA, she started working with shallow borehole monitoring

Whitney Blanchard Biography continued on page 24.

Sara Davis (SEIMAX)
GSH Candidate for
Secretary
2018-2019

Sara Davis is Director of Marketing and Business Development for SEIMAX Technologies, a mid-size seismic data processing service company. In her role with SEIMAX, Sara is responsible for the sales of seismic data processing services to the oil and gas exploration companies as well as management of all marketing-related initiatives. After graduating from Loyola University in 1983 with a Bachelor's degree in Communications, she moved to Houston to start her

Sara Davis Biography continued on page 23.

Gabriela Suárez
(PGS)
GSH Candidate for
Treasurer
2018-2019

Gabriela Suárez is currently a Senior Processing Geophysicist for Petroleum GeoServices (PGS) based in Houston, TX. She has over 12 years of industry experience and is a member of the GSH and SEG. Her educational background includes a MSc. in Geophysics from University of Calgary in Canada as well as an undergraduate degree in Geophysical Engineering from Universidad Simón Bolívar, Caracas, Venezuela. Gabriela started her career in 2003 with WesternGeco

Gabriela Suárez Biography continued on page 23.

Fernando Ziegler
(Independent Geophysics Consultant for BHP Billiton)
GSH Candidate for
Treasurer
2018-2019

Fernando Ziegler has been in the oil and gas industry for over ten years. He holds a Bachelor of Science in Physics from The University of Texas at Austin and Master of Science in Geophysics from the University of Houston. Fernando started his career in testing seismic applications for Petroleum Geo-Services and then moved to geophysical migration and processing quality control for GX Technology. Fernando eventually began to specialize in pore pressure, fracture pressure, wellbore stability, seal capacity, hydrocarbon column

Fernando Ziegler Biography continued on page 24.

Dr. Craig J. Beasley *Biography continued from page 20.*

twice received honorable mention for the Best Paper in Geophysics. He is an Honorary Member of the Society of Exploration Geophysics (SEG) and of the Geophysical Society of Houston and is a Foreign Member of the Russian Academy of Natural Sciences. He has presented papers and published widely on a variety of topics ranging from prestack imaging, migration, acquisition and the connections between acquisition, processing and imaging. He pioneered Simultaneous Source technology and has recently worked in broadband seismic techniques and new methods for sparse inversion. He served as the 2001-2002 SEG 1st Vice President and the 2004-2005 President of the SEG. He was the Fall 2009 SEG Distinguished Lecturer as well as the Esso Australia Distinguished Lecturer and 2014 EAGE Distinguished Lecturer. He was the Founding Chair of the SEG Committee for Geoscientists without Borders. He has enjoyed postings in Singapore and Rio de Janeiro and now is in Houston, recently retired as Chief Geophysicist for WesternGeco and Schlumberger Fellow (Emeritus). In retirement, he has served as the General Chair for the 2017 SEG Annual Meeting in Houston and sits on the board of the SEG foundation and is enjoying pursing his passion for underwater photography and video.

Gabriel Perez *Biography continued from page 20.*

from the University of Houston in 2007, Gabriel stayed in Houston. Prior to Murphy, he worked for Oxy as an exploration geophysicist and seismic interpreter, for Geotomo as a seismic processor, for Repsol in seismic attributes and quantitative interpretation, and for BP in seismic imaging and reservoir characterization on land seismic data. He holds a PhD from the University of Houston and an MSc degree from Colorado School of Mines, both in geophysics.

Gabriel has been involved with GSH before: he was the Editor in 2010-2011 and as such the first Editor of the GSH Journal. He highly appreciates the networking and professional development opportunities that come with membership and leadership in GSH and is grateful for the opportunities to give back to a profession from which he has received so much. He has served the SEG as a member of the Translations Committee and of the SEG Foundation's Project Review Committee, and also as a member of the Technical Program Committee for the SEG Annual Meeting Technical Programs. He enjoys reading (mostly geophysics!), jogging and spending time with Bertha Elisa, the love of his life and his wife of 30 years, and his two sons. After the 2014 World Cup he rediscovered a love for soccer and now increasingly finds himself watching games and rooting for Colombia in this year's Cup in Russia.

Peter Eick *Biography continued from page 20.*

materials testing along with geophysical environmental studies. He then joined Conoco in 1990 in Houston, TX and worked various US exploration projects in Alaska, GOM and Lower-48 until he was transferred to full time seismic acquisitions for Conoco Lower-48 in 1996. He was subsequently transferred to Worldwide Geophysical Operations Group in Houston in 1999, where he worked both domestic and international assignments. He has worked on every continent but Antarctica and has experience in wellbore, land and marine seismic data acquisitions. He is experienced in the full range of geophysical project management from design and tendering through contracting and field operations and quality control. He was steadily promoted at ConocoPhillips to Principal Acquisitions Geophysicist and is a named inventor on 50 US patents. He is the co-inventor of the ZenSeis® high production vibroseis acquisitions technique and also has experience doing microseismic, gravity and magnetics data acquisitions. He left ConocoPhillips in 2015 and started his own company Serenity Geophysical Consultants that continued working both domestic and international projects most recently on the Nevada National Security Site. In 2017 he joined In-Depth Compressive to help advance the practical application of compressive seismic technology in the industry.

He served as GSH Treasurer in 2008-09, and has been a Continuing Education instructor for the SEG since 1999. He has earned multiple Conoco President's awards and ConocoPhillips Technology Awards. He is a Texas licensed Professional Geoscientist, #16 with a specialty in Geophysics. Peter is an active photographer, Eagle Scout, and father.

Tony LaPierre *Biography continued from page 21.*

Houston to take on an expanded role in RPS. Tony's education includes degrees in Geology (BSc Hons, '86) and Civil Engineering (MASc, '99) both from Dalhousie University in Halifax, Nova Scotia. He was encouraged to join the GSH in 2013 during MS150 ride and has been active as Icebreaker Chair since including the 2017 Joint GSH/SEG Early SEG Conference Icebreaker at St Arnold's, 2016 Icebreaker at Texas Bar and Grill, and 2015/2014 Icebreakers at Bowlero in the Woodlands. The 2nd VP elected responsibilities are GSH growth through social events, and Tony is well suited for this given his prior GSH experience. Tony's non business leadership roles include being a founding Chair of the SPE Maritime Section for which he received an outstanding services award in 2016. Tony is a member of the GSH, SEG, EAGE and SPE.

Kenneth Mohn *Biography continued from page 21.*

(TGS-CALIBRE, TGS-NOPEC, TGS) working on multi client projects in the Gulf of Mexico, Canada, Trinidad, and Africa.

In 2003 Kenneth joined FUGRO Multi Client Services as the Vice President for the Americas. He started the office in Houston and developed a group to acquire new and to reprocess existing 2-D and 3-D projects. Projects were primarily in Brazil and the Gulf of Mexico, as well as other regions of South and Central America.

In 2013 he joined MCG and started the office in Houston. MCG has acquired new data in the Caribbean and offshore Mexico as well as reprocessed data offshore Alaska and the East Coast of North America. MCG was acquired by Geoex ltd in 2017, making 2017 a great start with the new company.

Kenneth received a Life Membership Award from the GSH in 2016. He has served the GSH on the Sporting Clays Tournament a few times during the past 10 years as well as a sponsor of several events in the past including the GSH Technical Breakfast and Tennis Tournament (while at FUGRO). Everything at the GSH is a team event, and everyone who contributes to the GSH realizes there is not just one person doing all of the work. There is a great group of volunteers at the GSH. These people, who step forward when needed, or show up at events early and volunteer to help, are what kept Kenneth involved in working on events at the GSH.

Kenneth is a member of the Society of Exploration Geophysicists, the Geophysical Society of Houston, the American Association of Petroleum Geologists, and the Houston Geological Society.

Sara Davis *Biography continued from page 21.*

professional sales career. Her early career was spent in staffing and information technology services. She then joined SEIMAX (formerly Seismic Ventures) in 2002. At that time she became an Associate Member of GSH, and also joined the SEG, AAPG, HGS, and the Houston Chapter of SIPES. Sara was tapped to serve on the board of directors for the Houston Chapter of SIPES from 2011 to 2014. Her role on the SIPES board was that of Sponsorship Coordinator, which carried the responsibility of managing the recognition and publicity extended to event sponsors.

Sara has a long history of community service dating back to the early 80's when she started The Skyliner Club, a volunteer support group for the civic organization, The Downtown Houston Association (DHA). Her role as chairman of The Skyliner Club lead to a three year term on DHA's board and executive committee. In 1990, Ms. Davis moved from civic volunteerism to charity fundraising, and was a founding board member of Hope for ALS, a Houston-based 501.c.3 organization that was established to raise funds in support of research programs to find a cure for Lou Gehrig's Disease. In 1998, she joined the board of Energy2Cure, a team of energy professionals who raised funds for the Leukemia & Lymphoma Society in conjunction with the annual Leukemia Cup Regatta. As a member of the Energy2Cure team, she founded the Leukemia Cup Kickoff, and chaired or co-chaired that event for eight years.

In her spare time, Sara enjoys cooking, sailing, hiking, travel, and attending music and art festivals.

Gabriela Suárez *Biography continued from page 21.*

in Houston,TX, working on time processing for onshore and OBC data. In 2005, she joined the processing team in WesternGeco Denver. In 2006, she started her graduate studies as a Research Assistant for the CREWES Project, University of Calgary. In 2009, she joined Imperial Oil Canada as an Exploration Geophysicist working for Cold Lake Geoscience. In 2010, she got transferred to the ExxonMobil Exploration Company in Houston, TX, to fulfill the role as seismic processing specialist. In 2014, she became a member of the Global Processing Team for Shell International Exploration and Production and served as a Senior Processing Geophysicist with assignments in Houston, TX and Rijswijk, Netherlands. During her career Gabriela has established herself as an expert on processing challenging onshore seismic data and near surface velocity model building using inversion methods for land and marine datasets. For the last year she has been an active volunteer for the GSH office, technical luncheons and diverse GSH activities. Outside of work, Gabriela is an active Master swimmer, swimming coach and love to spend time with her husband and her two dogs Lola and Darla.

Peter Wang *Biography continued from page 20.*

helped develop the depth imaging and AVO software and services business as the sixth US employee of Paradigm. In 1997 he went over to Kelman Seismic Processing and helped grow that office from a four person branch into a regional processing center which was later acquired by CGG. In 2001, he was recruited by Schlumberger, whereupon he started a fourteen-year career which included roles in Customer Support, Onsite Consulting, Technical Sales, Training, Software QA, Team Lead, University Recruiter, Petrel Workflow Champion, Petrel Earth Model Building Product Champion, Seismic for Unconventionals Product Champion, and culminated in attaining the Schlumberger Eureka Technical Careers rank of Principal Geophysicist. The winds of change blew in 2015, but fortunately Peter landed back at Paradigm (now Emerson E&P Software), where he is currently focusing on Machine Learning Facies Classification and Quantitative Seismic Interpretation as a Geophysical Technical Advisor.

Peter has been an SEG member for thirty-five years, and a member of the GSH for an extended period as well, having served as GSH Secretary during 2003-4. He served on the SEG Advanced Modeling Management Committee for seven years and was the modeler who built the SEAM Phase II Arid model. In 2017 he spoke to the Geophysical Societies of Houston, Midland, Oklahoma City, New Orleans, and Lafayette on the topic of Machine Learning.

In his spare time, Peter enjoys personal and quantitative finance topics and in 2016 he wrote the book, "Financial Survival for Oil & Gas Workers". He holds a black belt in the Tomiki style of Aikido and trains at Cy-Fair Aikido.

Fernando Ziegler *Biography continued from page 21.*

height estimates, rock physics, and geomechanics for Marathon Oil and Repsol. During the most recent downturn, he has worked as Chief Operating Officer for a start-up company and as an independent geophysics consultant for various operators and service companies, including QO and Halliburton. Currently, Fernando is an independent geophysics consultant focused on pre-drill and real-time wellbore stability and geomechanics analyses for BHP Billiton.

He is a member of GSH, HGS, SEG, AAPG, and SPE. Presently, Fernando is Vice Chair of Career Directions & Progressions at GSH, Chair of GSH/SEG Membership at GSH (2017 to present), Committee Member and Chair of the AAPG Student Expo Committee (2007 to present, 2015 to present), Executive Committee Member of the Operators' Pore Pressure Forum (2015 to present), Chair of the Challenge Bowl Subcommittee at SEG (2014 to present), and Member of the Committee on University and Student Programs at SEG (2008 to present).

Dmitry Kulakov *Biography continued from page 20.*

During his study Dmitry actively participated in university student science society, presented his works on student conferences and as a team member presented Gubkin University in AAPG IBA competition in 2011. For his contribution to the University he received an honor scholarship in 2009.

Dmitry took several part time and summer positions during his study that exposed him to various activities such as offshore engineering seismic processing on Sakhalin Island with ROMONA, VSP R&E in Schlumberger Moscow Research, microseismic and reservoir data integration in Total E&P (Pau, France) and logistics database design and support in Total E&P Moscow.

After graduation in 2011 Dmitry joined Western Geco (Schlumberger) in Houston Texas, where he is currently holding a position of Earth Modeling Geoscientist. He supports North America production teams with his experience in velocity model building using all up to date technologies such as Full Waveform Inversion, Seismic Guided Drilling, Localized Seismic Imaging, Seismic Tomography and Rock Physics Guided Migrations. Dmitry started active volunteering in 2017 first in a role of GSH Journal assistant editor. He took Editor role starting 2017 Journal year and currently runs GSH Editorial Board and Journal.

In his free time Dmitry enjoys life in Houston with his wife and son. He is keen on reading, photography, playing competitive paintball across Texas and snowboarding.

Whitney Blanchard *Biography continued from page 21.*

arrays and pursued an internship with Schlumberger (SLB) at the Gould Research center in Cambridge, U.K. During this internship she explored SLB's microseismic processing software, and transitioned into a full time role in Houston after completing her degree. At Schlumberger she processed downhole microseismic data on the Petro Technical Services team. In this role she monitored and processed data in key resource plays including the Wolfcamp, Avalon, Utica, and Eagleford formations. She also helped develop SLB's moment tensor inversion tool and processed various Vertical Seismic Profiles (VSPs) before taking on a role with Sigma Cubed Inc, where she has continued processing downhole array microseismic data. Whitney was extensively involved in volunteer work with the Geophysical Society of Houston's main office from 2016-2017 for which she was awarded the President's Award as "Rookie of the Year," and chaired the geophysical unemployment forum in 2017, while also starting a family. Currently, Whitney is a Microseismic processing geophysicist at Sigma Cubed Inc.

From the Far Side

By Dmitry Kulakov

As a thoughtful reader, you may have already noticed that this issue of the GSH Journal is full of articles where authors share their point of view from one side or another. I am very glad that it happened in March, because we have an opportunity to give you an update on the professional life of one of the most outstanding members of the GSH, one whose point of view on the geophysical object of study (the Earth) is unique. Completely different from other geophysicist's, Drew Feustel can provide a view from the "far side", or from space! Furthermore, Drew is going back to space! For those of you who did not see Drew Feustel's talk at the 2015 GSH Spring Symposium, we recommend you check out his interview published in the October and November issues of the GSH Journal of the same year.

Drew was born in Lancaster, Pennsylvania. He grew up in Lake Orion, Michigan, where he graduated from Lake Orion High School in 1983 and received an A.S. degree from Oakland Community College in 1985. He then attended Purdue University, where he received both a B.S. degree in solid earth sciences (1989) and a M.S. degree in geophysics (1991). He then moved to Ontario, Canada to attend Queen's University, where he received his Ph.D. in geological sciences in 1995. For three years, he worked as a geophysicist for the Engineering Seismology Group, Kingston, Ontario, Canada, installing and operating microseismic monitoring equipment in underground mines throughout Eastern Canada and the United States. In 1997, Feustel began working for the ExxonMobil Exploration Company, Houston, Texas, as an exploration geophysicist, designing and providing operational oversight for land, marine, and borehole seismic programs worldwide. After working in the industry for several years, Feustel was selected as astronaut candidate by NASA in July 2000.

Now, Drew is an active NASA astronaut who has already completed two successful missions. His first spaceflight was in May 2009, as a member of STS-125, which was the final space shuttle mission to service the Hubble Space Telescope. As official sources stated, it was a complete success: "...upgraded the Hubble telescope to its most technologically advanced state since its launch nineteen years before and made it more powerful than ever". Drew performed three spacewalks to undertake repairs and accumulated a total ExtraVehicular Activity (EVA) time of twenty hours and thirty-eight minutes. His second spaceflight was STS-134 in May 2011. This was the final flight of the Space Shuttle Endeavour, which delivered the Alpha Magnetic Spectrometer and an ExPRESS Logistics Carrier to the International Space Station (ISS). During this mission, Drew performed three more spacewalks.

Drew's new mission, Expedition 55/56, is scheduled for March 15, 2018. This mission is going to be his third and longest spaceflight so far. He will return to the ISS for six months, serving as a flight engineer on Expedition 55 and then become the ISS commander for Expedition 56.

Drew J. Feustel

The GSH would like to acknowledge the fact that Andrew is the only member of the society who has been so far from Earth, propagating the knowledge of geophysics into outer space. After reading the above-mentioned interview, I see him as one of the most successful geophysicists of all time. He had a dream of becoming an astronaut, but specifically, he has chosen a more complicated path through the geosciences, just because he liked it. Drew stated: "Before I became an astronaut, I never really did anything in my life specific to reaching that goal. I did the things that I liked and the things that I was good at, and that was geoscience". These words

GSH Editors' special Guest, Mole, on behalf of GSH is wishing Drew great luck during the upcoming mission and a safe trip back home.

From the Far Side continued on page 26.

From the Far Side continued from page 25.

Drew testing hammer seismic in Bull Pass, Dry Valleys, Antarctica.

Testing of an elastic weight drop source on a seismic reflection line at Meteor Crater, AZ using a wireless receiver system integrated with a surface exploration vehicle in a next generation space suit.

have motivated me to write this article as an inspiration for continuing our good work. This is what our industry needs right now: people doing what they like and what they are good at. Whether you are demotivated by the longest downturn in history or find yourself in transition, I hope that Drew's impressive biography will be a great reminder that you can be anything and anywhere you want, if you do your best every single day.

We are proud to have such outstanding people like Drew as a part of the geophysics community. I hope that this article will give you the courage and strength to continue playing leading roles in modern geophysics and reach new highs - so I will have more impressive personalities to write about!

To get most recent updates on Drew's journey, follow him on Twitter and Instagram at Astro_Feustel.

Employers Matching and Gifting Programs

Please consider supporting the GSH through your Company Matching or Gifting Program. Volunteer hours are often rewarded with an Outreach Grant / Gift to the organization. Check with your employer now.

The Geophysical Society of Houston is a 501(c)3.

Join us for our end of year party!
The Geophysical Society of Houston's
Annual Meeting and

Honors and Awards Banquet

Thursday, May 3, 2018
New Location!
Hotel Sorella
La Scala Ballroom

Cocktails | 6:00 pm
Dinner | 7:15 pm
Spouses and guests welcome.

GSH Outreach

Committee Activities *By Lisa Buckner*

February was another busy month for the GSH Outreach volunteers. We were invited to participate for the fourth time in two events: **Family Science Night in Bellville, TX** and the **26th Annual Expanding Your Horizons in Science and Mathematics**. The Bellville Engineering Science Technology (BEST) Booster Club sponsored the Family Science Night at the Bellville Junior High School gym on **Monday, February 12** and there were a number of interactive and informational booths at the event. It was a like a mini version of Energy Day. We made a big impression in a small town. Bellville is located between Sealy and Brenham and close enough that a number of parents work in Houston.

On **February 17,** we participated for a second year in the **Girls Exploring Math and Science (GEMS)** event at the Houston Museum of Natural Science. The event targets Girl Scouts but is open to all museum visitors. We hosted a hands-on activity booth and spoke with hundreds of girls eager to learn about possible careers in science and math.

The American Association of University Women (AAUW) West Harris County Branch sponsors the annual **Expanding Your Horizons (EYH) in Science and Mathematics event** which provides career information and role models for Houston area middle school girls. It was held on **Saturday, February 24** at Spring Forest Middle School SBISD. Professional women shared their enthusiasm, education requirements and remuneration working in scientific, technical and financial careers with more than 400 girls, their parents and teachers. Larkin Spires and I presented two geophysics hands-on workshops. The purpose of the event is to inspire young women to pursue STEM related courses in high school and college to ultimately lead to STEM careers.

Project judging for the **59th Annual Science and Engineering Fair of Houston** was also conducted on **Saturday, February 24** at the University of Houston Main Campus Alumni Center. GSH volunteers coordinated by Gokay Bozkurt selected four winners for GSH Special Awards. GSH volunteers also served as Place Award Judges to help select winners in the Earth Science, Physics and other categories. Top students will compete at the Texas State Science Fair or the INTEL International Science Fair. The awards ceremony will be held on March 3 where the GSH awards are presented to the students in attendance.

If you are interested in joining the Outreach Committee or volunteering at a future event, please contact Lisa Buckner at lbuckner@hess.com or 713-496-4256.

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!

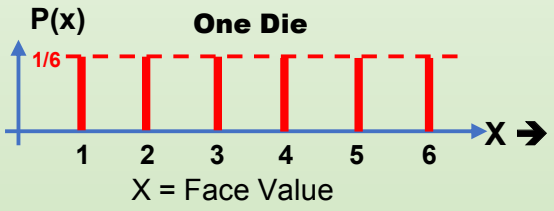
Contact Nicola Maitland to learn more about this excellent networking opportunity:

nmaitland@resolvegeo.com - 713-972-6209

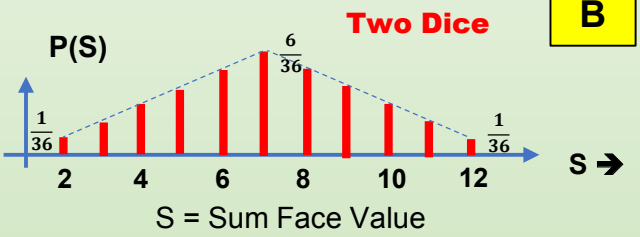
Improbable Relationships Among Probabilities

In last month's Inspirational Tutorial on **PDFs**, we first showed you that the **(A)** probability of any given face value showing up on **a single 6-sided die** to be **1/6**, there being 6 possibilities all equal (on a fair die). We then posed the problem about **(B)** two such dice being rolled and the probabilities of their **sum.** And then the (how does he do it?) probabilities of the **sums** of **(C) three such dice**.

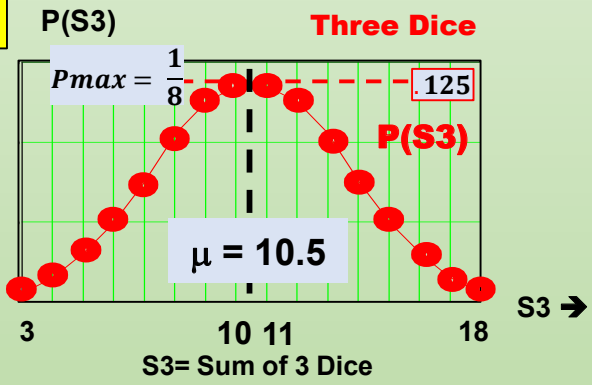
A



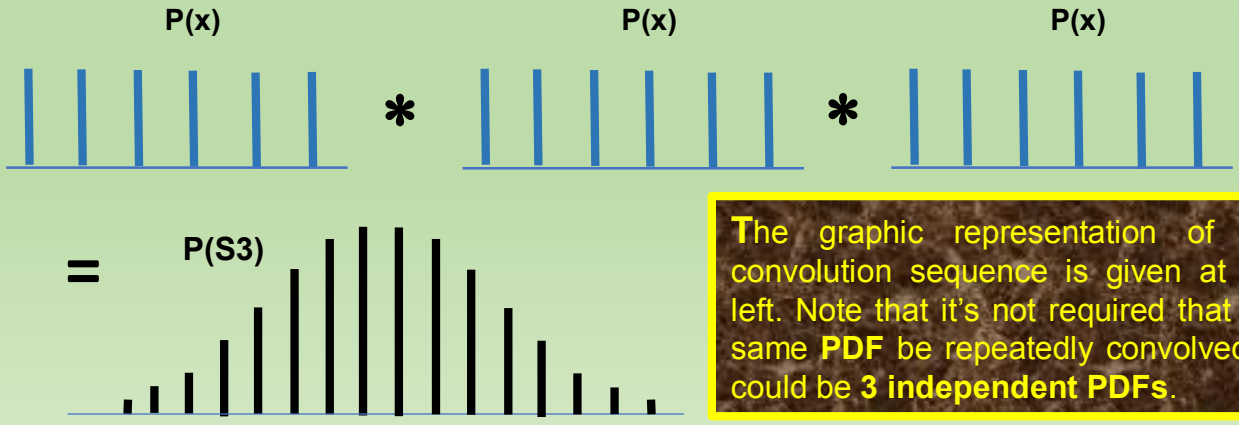
B



C



It was during a heated discussion that the Guru made a startling assertion. *The sleight-of-hand necessary to accomplish this mind-numbing trick was nothing more than (or less) than* ***Convolution.*** Yes, our old friend from the early years of the ***Tutorial Nuggets***. Recall that the Guru said then (and many times since) that **Convolution was Everything.**

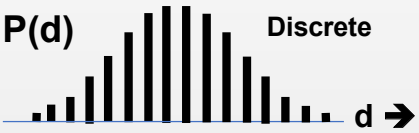


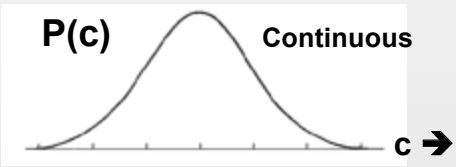
The graphic representation of the convolution sequence is given at the left. Note that it's not required that the same **PDF** be repeatedly convolved. It could be **3 independent PDFs**.

Tutorial Nuggets continued on page 29.

Tutorial Nuggets continued from page 28.

The shape or envelope of the 3rd PDF, **P(S3)**, is rapidly and obviously becoming **Bell-Shaped,** as pointed out to pattern-blind readers in February. This leads inexorably to the **Gaussian** or (special case department) **Normal Distribution Curve** representing the **PDF** of the variable in question. It is well for newcomers to note that in geophysics we are not always limited to **dice** values for PDFs. Occasionally we have things like, say, acoustic impedance (AI) as the variable of interest.





Note that there are fundamental differences between Dice and Impedances, among which one stands out: Dice take on discrete values (usually integers), whereas impedances (ρ·Vp) are free to take on any positive real value, e.g., **33067.763**(ft/s)(g/cc) comes to mind.

Curiously, the **probability** of **c = 33067.763** or any particular value is **0: P(c = r) = 0**, where **r** is any positive **R**eal number. Yet, if we gaze upon the curve, **P(c)**, it is clear some numbers are more probable than others, therefore, not all **P(c) = 0**. Here's the trick that distinguishes the PDF's **P(d)** from **P(c)**. For the continuous variable, **c**, the thing we're measuring around any particular value, **c**, is the density of occurrences in the arbitrarily small zone from **(c-ε) to (c+ε)**, where **ε** is math slang for a **smidgeon**. This is why such curves are often referred to as Probability **Density** Functions. The constraint on these functions (and their discrete cousins) that assures these are valid probability distributions, is that area under the curve must equal one (1). As you know, that area is the integral of the **P(c)** which may be considered the sum of the whole bunch of very skinny rectangles with height = **P(c)** and width = **dc** (roughly, **2ε**).

Bell Shaped PDF

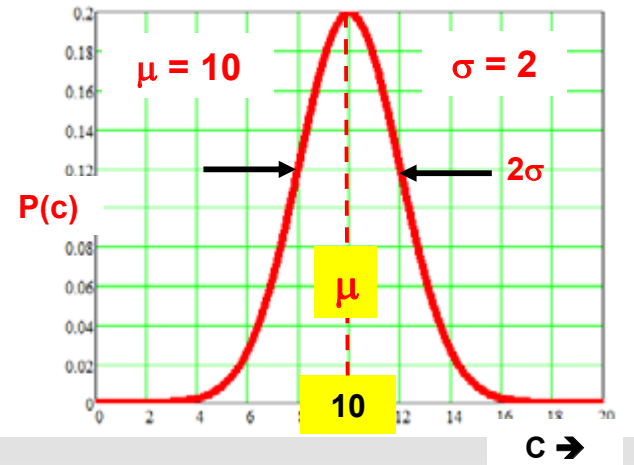
$$P(c) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(c-\mu)^2}{2\sigma^2}}$$

The curve will peak at **μ**, the Buzz-Greek for the **Mean** (weighted average) or "Expected" value of **c**. It is also known as the **Median** and **Mode** (the peak value and most probable for this kind of **PDF**).

The width (spread) of the **PDF** depends on **σ**, which is Greek-Speak for Standard Deviation. Its square, **σ²**, is called the "Variance", as in how much variation is there around the mean. The stuff besides the **σ²** in the denominator assures that the area under the curve is unity:

$$\int P(c)dc = 1.$$

This means all the relative probabilities sum to 1



Tutorial Nuggets continued on page 30.

Tutorial Nuggets

Tutorial Nuggets continued from page 29.

Gaussian PDFs are often assumed to be the best representation for certain **rock properties** and their **physical** allies, for example, **Porosity** and **Impedance (ρVp).** Samplings from related well log values may be used to estimate the parameters, μ and σ of the Gaussian or Normal distribution curves. We try not to fall in love with these parameters because they tend to be fickle, in that 2 miles down the road the mean and standard deviation may have taken on entirely different values. This will be an important consideration for **Inversion from AVO** to actual **rock properties.**

In the meantime, let's ponder these puzzling issues:

(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.

(2) It has been rumored for months around the nooks, crannies and back rooms at the GSH International HQ, that there was an-going power struggle among three of the prominent members of the secretive Board of Elders. Those rumors were confirmed this morning by one of three, Lee C. Lawyer (recently hired – some say stolen – from *TLE* to write *From The Other Side* (FTOS) exclusively for the *GSH Journal*.)

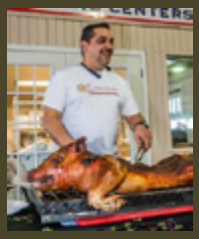
Lawyer revealed that indeed there was a active competition for the Top Spot that has now turned violent. Gloomily, he pronounced that the three Elders had agreed to let a 3- Way Duel (a "Truel") decide who would control the group of elite decisionists.

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, with the lowest, A, having long term statistical probability of hitting his target of 1/3, firing first at either of the other two, B or C. B has a probability of hitting his man = 2/3, while C is deadly accurate with probability of 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.

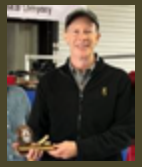
Unfortunately for Lee, he is A in this scenario. Hoping to maintain his status on this side of the grass, he is asking for our help. What is Lee's best strategy – the one with the highest probability of FTOS being in the next issue of the Journal?

32nd Annual Sporting Clays

Even though we had to postpone the shoot 5 months, the hurricane couldn't stop us!! The 32nd GSH Sporting Clay's tournament had a great turnout, with yet another year of great sponsorship! We were also fortunate enough to have the heavy rain hold off until everyone was able to return to the Pavilion for lunch. And speaking of lunch… How great were Chef Martinez and Essentials Catering?!? Between breakfast, fresh juice and that fantastic lunch, they knocked it out of the park. Not to mention the roast pig that the Chef put on at 5am.



Congratulations go out to our winners. Ryan McReynolds won our C Class with a score of 52. Paul Chandler won Class B with a 58. Our AA Class went to Jim Trimble with a 66. And we rounded out the top three with Steve Mitchell – 78, John Foley – 79 & Karen Ward - 80. THAT'S RIGHT! Karen beat out all the boys for the highest overall score of an 80! Great shooting Karen!! Also, big thanks go out to Craig Scantlin. This year's high bidder of the Pointer Wingshooter's Argentina dove hunt.



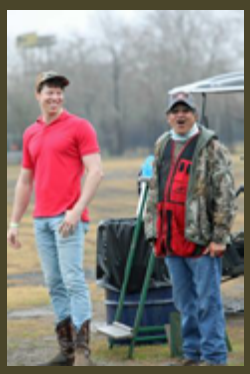
Sporting Clays continued on page 32.

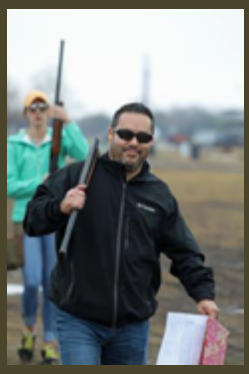
By Ryan Marshall, GSH Sporting Clays Chair

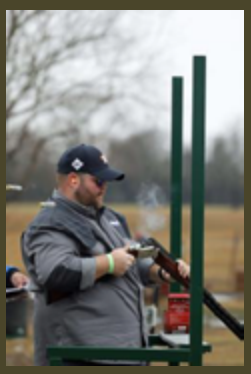
32nd Annual Sporting Clays

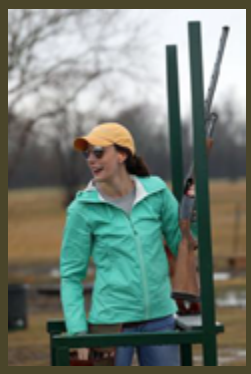
Sporting Clays continued from page 31.

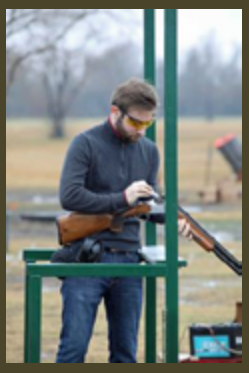
MANY thanks go out to our gracious sponsors! Starting with our two course sponsors, Rill Energy and Dawson Geophysical, we couldn't have the numerous door prizes without you all. No matter your sponsorship level. Due to the much cooler weather, we will look at moving the shoot to March of 2019, but that is yet to be determined. Thanks again for your continued support of the GSH shoot, as it is greatly appreciated.

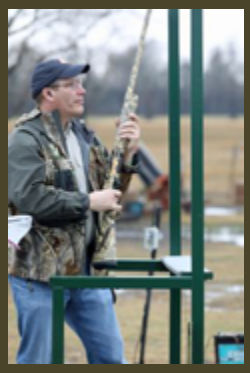


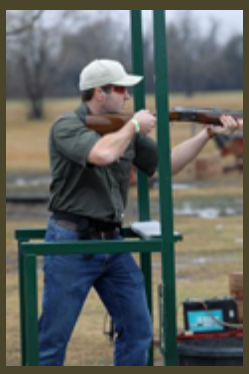


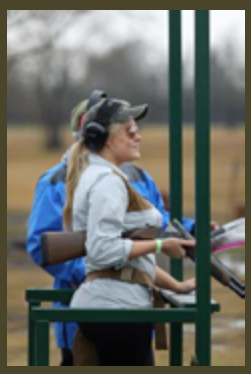












Photos courtesy of Bruce Lindsey Photography

U of H Wavelets

Brian Russell on Extended Poroelastic Impedance at the University of Houston

By Walter Reed

On Friday, November 17th, at the University of Houston, the Society of Exploration Geophysicist chapter, the SEG Wavelets, had the opportunity to host Dr. Brian Russel for a seminar on Extended Poroelastic Impedance. The SEG Wavelets were thankful that Dr. Russell had time to stop by during his visit to Houston and not only provide a technical talk regarding current research, but also give practical advice for careers as young geophysicists.

Dr. Russell is well known in the geophysics community as he was the co-founders of the popular software Hampson-Russell which is now owned by CGG. He is a Past-President of both the SEG and the Canadian SEG (CSEG) and the joint recipient of the Cecil Green Enterprise Award from the SEG. Dr. Russell is currently Adjunct Professor in the Department of Geoscience at the University of Calgary and the University of Wyoming. His current areas of research include AVO, rock physics, inversion, and attribute techniques.

Extended Poroelastic Impedance (EPI) is used for estimating fluid and lithology effects in rocks just like other methods such as AVO, inversion, elastic and extended elastic impedance (EEI). Dr. Russel points out that it is assumed the estimated elastic parameters represent fluid-saturated values of these parameter, but these elastic parameters are actually poroelastic. In his talk, Dr. Russel extends the use of poroelasticity to generalize the theory of EEI using Biot-Gassmann poroelastic theory.

After the presentation had concluded, Dr. Russell stuck around to answer questions from students such as "tips for getting a job in industry", "should graduates know how to code", 'what coding languages are best to learn". Dr. Russell's presentation and time spent answering questions with the SEG Wavelets was well received and very beneficial. We hope to have him back to speak to us again in the future.

2018 GSH - SEG Spring Symposium & Exhibition

SOCIETY OF EXPLORATION GEOPHYSICISTS

Sharper Imaging

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

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

4-5 April, 2018
Norris Conference Center
Houston CityCentre

General Chairman: Xianhuai Zhu, GSH 1st VP
Technical Program Chairman: Grant Byerley
Technical Committee
Doug Foster, Dan Whitmore, Dennis Yanchak, John Anderson

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

A great opportunity for knowledge sharing!

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

Recognizing Outstanding GSH Volunteers ...

Lisa Buckner

by Tommie Rape

The many social and technical opportunities offered by the Geophysical Society of Houston (GSH) for the geophysical professionals of Houston and beyond are due largely to many dedicated volunteers. The GSH wants to recognize some of these dedicated volunteers and will do so through this series of articles where we will present a monthly selected volunteer and provide our readers with some of the volunteer's professional and volunteer background. Hopefully this will increase our readers' appreciation of these volunteers and maybe encourage them to join the GSH volunteer ranks where they can partake of the many benefits that this work provides. --- Tommie Rape

Lisa Buckner was born and raised in Dallas, Texas. She is a third-generation Aggie, graduating from Texas A&M with a Bachelor of Science degree in geophysics. Then she went to work for Western Geophysical in Houston where she performed land data processing and AVO processing. While working at Western Geophysical, she completed a Master of Science degree in geophysics at the University of Houston. After completing her master's degree, she went to work for Chevron where she was involved in leading edge 3D processing techniques, including depth migration and other techniques. Lisa moved to New Orleans where she was a Petroleum Geophysicist with Chevron. While in New Orleans, after leaving ChevronTexaco, she was a seismic data processor on contract through Collarini Energy Staffing for Shell. An event called Hurricane Katrina brought Lisa back to her roots in Texas, where she went to work for Hess Corporation. Lisa is still with Hess and is currently an IT Subsurface Computing Advisor on the Central Data Management Team in seismic data loading, but she still occasionally returns to her passion of seismic data processing. Lisa is married to T.J. Bronsberg-Adas and has a stepson, Andrew Bronsberg.

Lisa has another interest, and that is working with professional geophysical societies. While in New Orleans, she was a member of the Southeastern Geophysical Society (SGS) where she served terms as Secretary, Second Vice President, and Chair of the Outreach Committee. Lisa's work with the SGS Outreach was the beginning of a second major passion in her life, and that was introducing geophysics to our youth.

During her years in New Orleans, Lisa never ceased her membership in the Geophysical Society of Houston (GSH). Lisa maintained her GSH membership because she "liked reading the GSH newsletter, technical abstracts, and the GSH museum article". Upon her return to Houston, she acted upon that interest and soon got involved with the GSH, where she joined the Museum Committee. Lisa also served several years on the GSH-HGS Geoscience Day Committee and the GSH-SEG Spring Symposium Committee. Recently, Lisa completed a term as the First Vice President of the GSH, where she oversaw the many technical events held by the GSH. While working on the Museum Committee, Lisa nurtured her passion of working with our youth, by proposing to the GSH Board of Directors that we start an outreach program. The Board agreed, and even while carrying out her other GSH duties, Lisa started the GSH Outreach Program and has led that effort ever since as the Outreach Committee Chair.

The GSH Outreach Committee's mission is to educate K-12 students, parents, educators, and the general public by demonstrating geological and geophysical concepts and scientific methods. This mission, in serving our community, has become an important objective of the GSH and is a critical component of its 501(c)(3) status. The initiation, growth, and success of this program is due to Lisa and her leadership, and her effort has been recognized by

Interview continued on page 36.

Interview continued from page 35.

the GSH by honoring Lisa with Life Membership in 2012 and the President's Award in 2016, both in recognition of her exceptional meritorious services to the Society.

The GSH participates in about 20 - 25 outreach events each year. These events target primarily junior high students, but some events are for elementary and also high school students. Valuable information is provided for teachers and families. The events include science fairs, career days, STEM and other events, with the purpose of spurring the youths' interest in science. Lisa and other volunteers usually occupy booths that may be attended by hundreds of youth, teachers, and family members. In the booths, a variety of things are shown to demonstrate how geophysics is applied to tackle scientific tasks. Some of these demonstrations include maps, geophones, and other instruments supplied by the GSH Geoscience Center. A plastic tub with different layers of sediment painted on the outside which is filled with cat litter and a submerged can of black shoe polish is used to demonstrate the difficult task of drilling for a hidden submerged objective. But the most popular booth activities include the use of a coiled toy spring (plastic generic Slinky) to demonstrate energy waves. The GSH gives away about 3,500 GSH logo coiled toy springs a year, "making kids happy (and a few adults too)" while attracting them to scientific phenomena. Lisa attends almost all of the events along with numerous volunteers. This past year over 30 volunteers joined in with Lisa to reach out to thousands of community youth. Some of the events that the GSH outreach participated in include the Celebration of Earth Science @HMNS, Energy Day, Young Women Energized, Houston STEM Education Day, Science & Engineering Fair of Houston, Scout Fair, Energy Venture Camps, Maps in School Project, and many individual school career or science days. Finding events in which to participate is easy, because now Lisa has become very well known and is sought out by teachers and events.

Lisa has demonstrable passion for working with community youth in these outreach efforts. When asked what started this interest and passion, she said that it was probably in her genes, because her mother was a teacher. She continues these efforts because "it is fun". But the biggest reward, she said, is "seeing the light bulb going off in students' eyes" when she incites their interest in science. Lisa spoke at the Energy Venture Camps sponsored by Hess that exposes youth to awareness of careers in the energy industry. After giving a presentation, a mother and daughter came up to Lisa, and said that the daughter had decided to be a geophysicist after hearing Lisa at a previous year's event. Who could not have a passion for this type of activity after hearing that?

Lisa is always looking for volunteers to assist with this outreach. Contact Lisa if you are interested in participating (lbuckner@hess.com). Lisa says and demonstrates that volunteering can be fun, but also beneficial to your

professional career. The GSH Outreach Program is always in the need of younger volunteers, because students relate better to younger people. Young professionals can gain experience in administrative and presentation skills that will benefit their advancement in the professional ranks. The networking opportunities of participating with many other professionals can also be of benefit in the near and long term. It is also fun for many retired geophysicists. If you want to find out more about the outreach activities of the GSH, check out the GSH website (https://www.gshtx.org/Public/Outreach/public/Outreach/Outreach.aspx?hkey=e890ce87-6ae0-4b1b-872a-bdaa8afcca1a) or the GSH Journal where there is an article almost every month describing completed and upcoming outreach activities.

These outreach activities are appreciated not only by the GSH and the recipients of the outreach, but also by many companies that demonstrate their appreciation by supporting the GSH with sponsorship. Lisa and the GSH are grateful to these sponsors for their financial support that enable this outreach to our community.

Naturally, Lisa is not a volunteer exclusively for the GSH. Her employer, Hess, has its own outreach programs and supports her volunteer efforts for the GSH and other organizations. Lisa also is a core member of the Houston A&M Club's Caring Aggies Mentoring Program that mentors underprivileged students. Lisa served on the 2009 SEG Houston Annual Meeting Steering Committee and was a member of the SEG Youth Education Committee for several years. Lisa was a recent co-guest editor of The Leading Edge Special Section: Education in the Geosciences. The University of Houston (UH) recognized her with an award for Outstanding Alumnus by the student societies in 2013 and the UH Earth and Atmospheric Sciences Department in 2015. Lisa is a member of the SEG, GSH, and HGS.

Thank you, Lisa, for championing the GSH Outreach Program. Keep lighting up the eyes of our youth.

GEOSCIENCE CENTER 2017 – 2018 CHALLENGE

Challengers: Dick Baile, Lee Lawyer, Scott Petty, Jr.

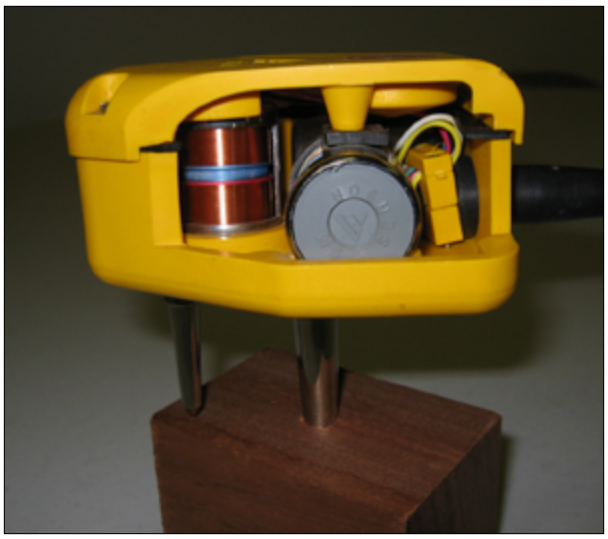
Matching: John & Amy Aubrey, Frank Dumanoir, Michael Forrest, Cheryl Mifflin, Dave Agarwal, Michael Abrams, Bruce Blake, Raymond Abma, Lisa Buckner, Emile Bussemey, Jerry Coggins, Sidney Conger, Peter Duncan, D W Frye, Bob Johnson, Jim Medlin, Tommie Rape, Art Ross, John Sherwood, J. Haynie Stringer, Robert Wyckoff, Neil and Sharon Zimmerman, Bill Albers, Brian & Julie Burgess, Alan Foley, Taylor Galloway, Ashok Ghosh, Pramod Kumar, Tony LaPierre, George Parker, Paul Schatz, Michael Schoenberger, Don Singleton, Dave Smith, Zachery Van Ornam

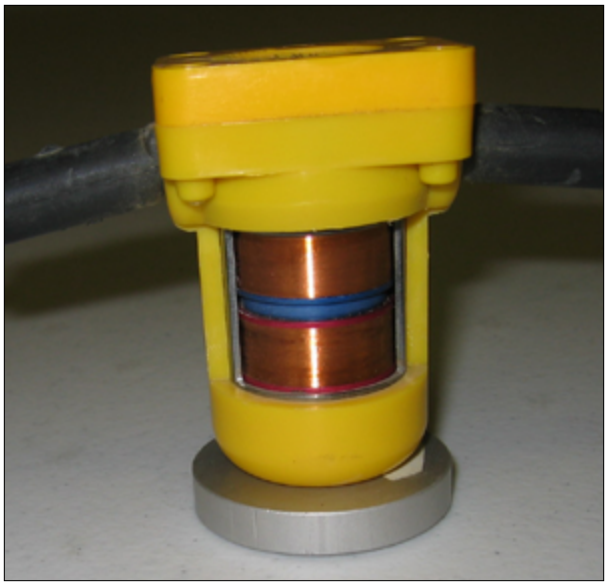
Donations support Programs and Activities of the GSH Geoscience Center including Artifact cataloging and storage, Loans to Universities for display, Bob Sheriff Library, Instruction space and Living Legends. The GSH is a 501(c)3

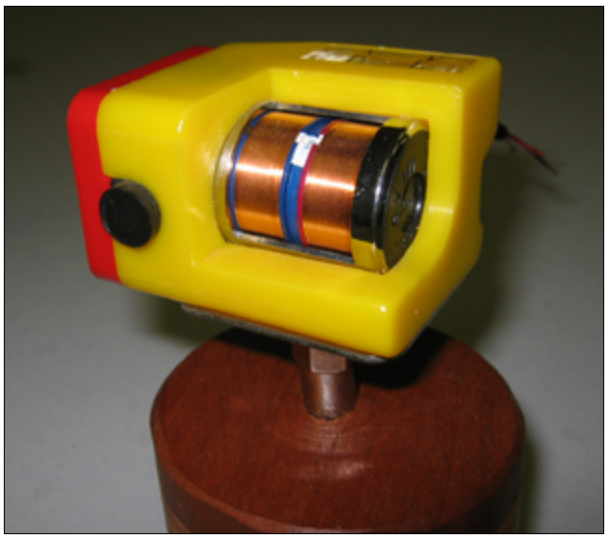
Geoscience Center News

By Bill Gafford

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





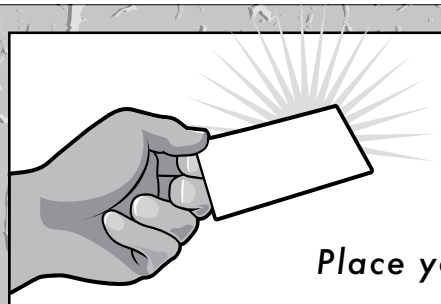


Some of our more interesting items at the Geoscience Center are the cut-a-ways of some of our geophones. They show the moving coil or other moving parts and are very useful when explaining how they are used to record seismic energy to students or the public in general. We have a good number of older geophones that haven't been taken apart to determine exactly how they functioned. Those that are different from the newer models would be good candidates for display along with our existing cut-a-way models. We would like to find someone who has the metalworking tools to properly create some of these cut-a-way display models from some of our older geophones. Please let me know if there are any suggestions, I have included some pictures of our existing models in this article as examples.

We had a good response to our Geoscience Center Challenge and as this article is being written we are well on our way to meeting our goal. The donations will allow us to continue with our Geoscience Center projects including the preservation of geoscience artifacts from the past and using these items to help educate students and the public about geology and geophysics.

We continue to receive donations of books, periodicals, and other items to our Bob Sheriff Library. These additions include workbooks from a variety of seminars and training courses from different companies, and all of these are available to be checked out. The inventory can be viewed on the GSH website under the Outreach tab, then Geoscience Center and Museum. Thanks to Don Townsend, Les Denham, and Ed Lengel for maintaining the inventory and keeping it up to date.

The Geoscience center is open on Wednesday mornings from 9:00 until noon or by appointment. If you would like to visit the Geoscience Center, and see some of the Mystery Items from the GSH Journal, see some of the items previously mentioned in the Geoscience Center News, or volunteer to help with some of our projects, please contact me at geogaf@hal-pc.org or at 281-370-3264.



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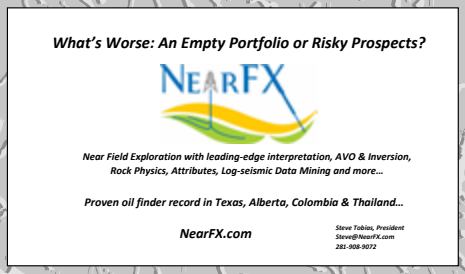


Doodlebugger Diary

Shipwrecked in the South China Sea, Part 2

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

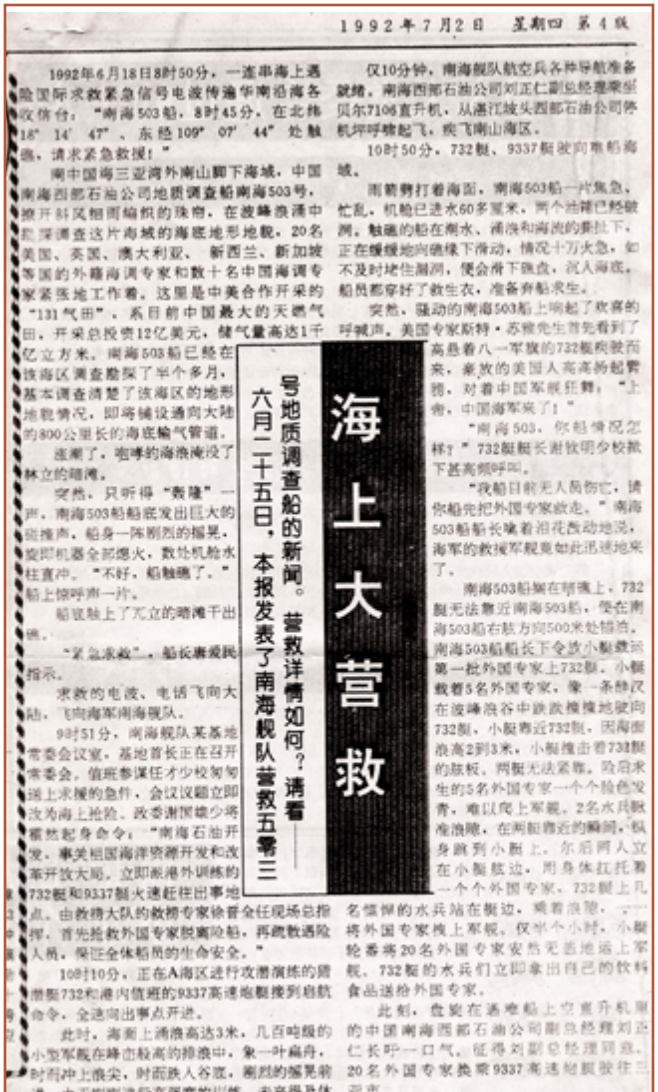
If you have an item for the Doodlebugger Diary, send it to llawyer@prodigy.net or to editor@gshtx.org.

To describe the events following the grounding of the Nanhai 503 on a reef south of Hainan Island in the South China Sea, I think it best to follow along with the official version, at least as told by a Sanya newspaper article on July 2, 1992:

RESCUE IN THE SOUTH CHINA SEA

It is 8:50am on June 18th, 1992, when every radio station along the coast of the South China Sea received an 'emergency help requested' message from the Nanhai 503 – "the ship has collided with a submerged reef at 8:45am at latitude 18° 14′ 47″ N, longitude 109° 17′ 44″ E. The ship needs emergency help."

It was in the South China Sea near the three-bay area where a geological prospecting ship Nanhai 503 from the China Offshore Nanhai West oil company were surveying the topography of this sea area. About 20 foreign prospecting experts who are from the USA, Britian, Australia, New Zealand, Singapore, and other foreign countries and more than 10 Chinese prospecting experts were on board the ship. This is where the #131 Gas Field is located. The #131 Gas Field is one of the biggest natural gas fields in China. It has 100 billion cubic meters of natural gas storage, and the company plans to invest $1.2 billion US dollars in the gas field. The Nanhai 503 has been there for more than half a month. The prospecting experts have finished most of the survey of the seafloor topography in this area, and they are going to install an 800-km seafloor gas pipeline extending to the Chinese coast.



1992年7月2日 星期四 第4版

海上大营救

六月二十五日，本报发表了南海舰队营救五零三号地质调查船的新闻。营救详情如何？请看——

1992年6月18日8时50分，一连串海上遇险国际求救紧急信号电波传遍华南沿海各收信台："南海503船，8时45分，在北纬18° 14′ 47″、东经109° 07′ 44″处触礁，请求紧急救援！"

南中国海三亚湾外南山脚下海域，中国南海西部石油公司地质调查船南海503号，按开斗风钻司编织的珠帘，在波峰浪谷中紧张调查这片海域的海底地形地貌。20名美国、英国、澳大利亚、新西兰、新加坡等国的外籍海洋专家和数十名中国海洋专家紧张地工作着。这里是中美合作开采的"131气田"，系目前中国最大的天然气田，开采总投资12亿美元，储气量高达1千亿立方米。南海503船已经在该海区调查勘探了半个多月，基本调查清楚了该海区的地形地貌情况，即将铺设通向大陆的800公里长的海底输气管道。

涨潮了，咆哮的海浪淹没了林立的暗滩。

突然，只听得"轰隆"一声，南海503船船底发出巨大的撞击声，船身一阵剧烈的摇晃，旋即机器全部熄火，数处机舱水柱直冲。"不好，船触礁了。"船上惊呼声一片。

船底触上了无边的暗滩千出礁。

"紧急求救"，船长唐爱民指示。

求救的电波、电话飞向大陆，飞向海军南海舰队。

9时51分，南海舰队某基地常委会议室，基地首长正在召开常委会，值班参谋任才少校匆匆送上求援的急件，会议议题立即改为南上抢险。政委谢国瑞少将霍然起身命令："南海石油开发，事关祖国海洋资源开发和改革开放大局。立即派港外训练的732艇和9337艇火速赶往出事地点。由教练大队的教授专家徐晋全任现场总指挥，首先抢救外国专家脱离险船，再疏散遇险人员，保证全体船员的生命安全。"

10时10分，正在A海区进行攻潜演练的潜艇732和港内值班的9337高速炮艇接到启航命令，全速向出事点开进。

此时，海面上涌浪高达3米，几百吨级的小型军舰在峰巅较高的排浪中，象一叶扁舟，时而冲上浪尖，时而跌入谷底，剧烈的摇晃前进。由于刚刚进行高强度的训练，未来得及休息，许多水兵吐了，但仍然坚守岗位，一边呕吐，一边操艇。

10时40分，南海舰队航空兵飞行管制室接到南海西部石油公司请求导航的救援电。"南海503船在三亚湾外南山附近触礁，船员准备弃船。我们已派直升机去海上救人，请你们搜索、机场起降保障。"

仅10分钟，南海舰队航空兵各种导航准备就绪。南海西部石油公司刘正仁副总经理乘坐贝尔7106直升机，从港江坡头西部石油公司停机坪呼啸起飞，疾飞南山海区。

10时50分，732艇、9337艇被向南船海域。

雨箭劈打着海面，南海503船一片焦急、忙乱。机舱已进水60多厘米，两个油罐已经破洞，触礁的船在涌水、涌浪和海流的裹挟下，正在缓缓地向礁体下滑动，情况十万火急，如不及时堵住漏洞，便会骨下跌盘，沉入海底，船员都穿好了救生衣，准备弃船求生。

突然，骚动的南海503船上响起了欢喜的呼喊声。美国专家斯特·苏雅先生首先看到了高悬着八一军旗的732艇疾驶而来，乘坐的美国人高高挥起臂膀，对着中国军舰狂舞："上帝，中国海军来了！"

"南海503，你船情况怎样？"732艇艇长谢钦明少校放下甚高频呼叫。

"我船目前无人员伤亡，请你船先把外国专家疏走。"南海503船船长唯着泪花轰动地说，海军的救援军舰竟如此迅速地来了。

南海503船搁在暗礁上，732艇无法靠近南海503船，便在南海503船右舷方向500米处锚泊。南海503船船长下令放小艇载运第一批外国专家上732艇。小艇载着5名外国专家，象一条肿汉在波峰浪谷中跌跌撞撞地驶向732艇，小艇靠近732艇，因海面浪高2到3米，小艇撞击着732艇的肢板，两艇无法紧靠。险些将生的5名外国专家一个个脸色发青，难以爬上军舰。2名水兵艇准跳艇，在两艇靠近的瞬间，纵身跳到小艇上。尔后两人立在小艇肢边，用身体扛托着一个个外国专家，732艇上几名惊悍的水兵站在艇边，顺着浪势，一一将外国专家拽上军舰。仅半个小时，小艇轮番将20名外国专家安然无恙地运上军舰。732艇的水兵们立即拿出自己的饮料食品送给外国专家。

此刻，危难在遇难船上空直升机里的中国南海西部石油公司副总经理刘正仁长吁一口气，征得刘副总经理同意，20名外国专家换乘9337高速艇艇往三亚市。

外国专家感动不已，"中国人民伟大的国际人道主义，在危险时刻，先离后主。"

新闻报道

Figure 1: Newspaper article on the grounding and rescue of the Nanhai 503 from (presumably) the Sanya newspaper on July 2, 1992

The tide is at the flood. The sea water is like a water sheet covering the submerged reef. Suddenly, "Ho-Lo", the whole ship shook with the thunder. Then, the energy

Doodlebugger continued on page 43.

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

Doodlebugger continued from page 42.

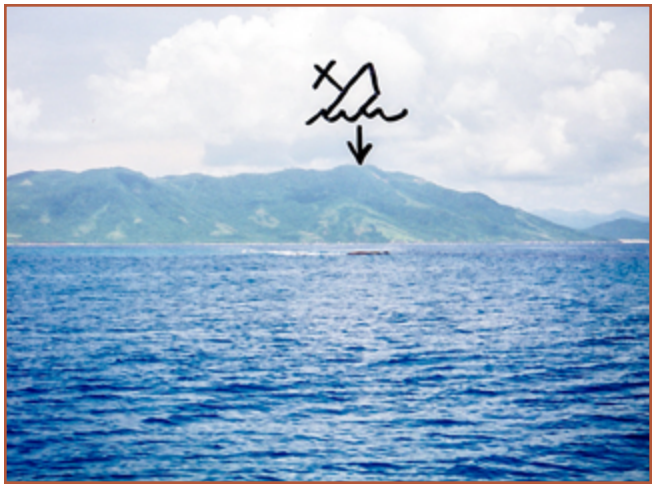


Figure 2: The exposed reef (at low tide) that grounded the Nanhai 503, looking from the south with Hainan Island in the distance to the north.

stops running, and there are several places starting to leak water. Someone started yelling "the ship has collided with the submerged reef!"

"Emergency help signal!" the captain said. The rescue signal goes over the South China Sea coast and the Chinese Navy base at the South China Sea. It is 9:51 that the navy receives the rescue message. The navy senior officers are in a meeting at the base when they receive the message, and they immediately change the subject to how to form a rescue team. General Huo Ran and political advisor, Gun-Xun Xie, order that the naval ship #732 and naval vessel #9337 perform the rescue. Pu-Quan Xun is the captain of the team. First, they plan to rescue the foreign experts out of the damaged ship, then they will try to save the crew with the ship's lifeboat.

It is 10:10am that the naval ship #732 and naval vessel #9337 are at full speed to the location. The sea swell is 3m high. Because the navy just finished sea training exercises many of the sailors were tired and sick, but everyone stayed on their post, so they are ready.

It is 10:40am, and the navy air force gets an order to help the rescue effort. After 10 minutes, everybody was in position.

At 10:50am, the naval ship #732 and naval vessel #9337 are getting close to the accident site. At this moment, the Nanhai 503 was in a very bad shape. There was about 60cm of water in the engine room. Two gasoline tanks were broken. The damaged ship went up and down with the tide. The ship started to slide down the side of the reef and get lower in the water. It was a very dangerous situation. Everyone on board had their life vest on and was ready to evacuate the ship. Suddenly, one of the American experts saw a Chinese naval ship moving to their location at full speed and exclaimed, "God, the Chinese navy is here!"

The captain of the naval ship #732 using a microphone asked, "Nanhai 503, how is your situation?" The captain of the Nanhai 503 answered with a tear, "None is wounded on the ship. Please rescue the foreign experts first."

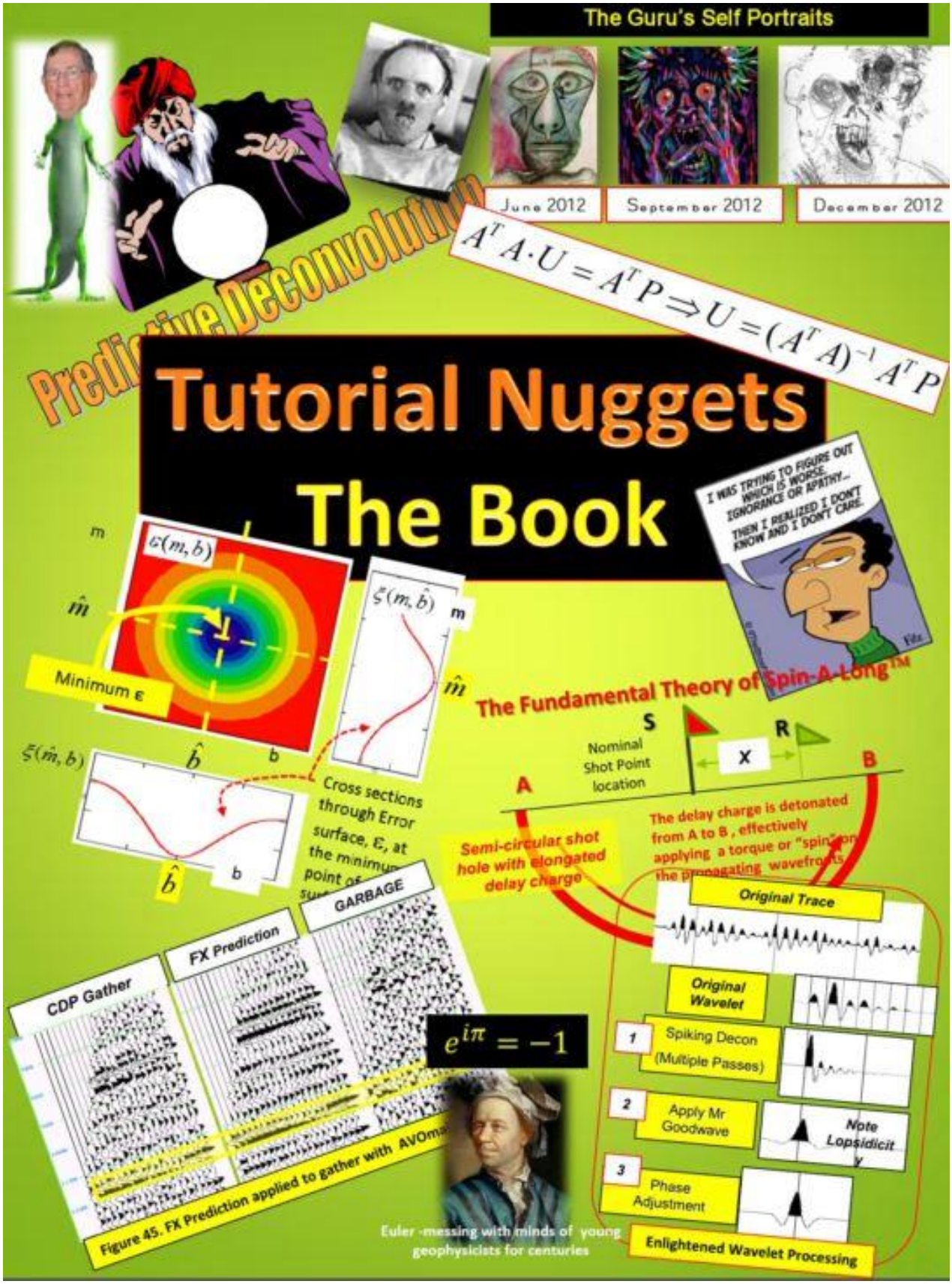
The Nanhai 503 was grounded on top of the reef. The naval ship #732 was not able to get close to it. They got to about 500m from the port side of the ship and sent a rescue craft. The captain of the Nanhai 503 ordered the first five foreigners to get onboard the small rescue vessel. But the rescue craft could not get closer than 2-3m from the naval ship #732 due to the risk of collision, and this meant the five foreign experts were still in danger. At that moment, two Chinese sailors jumped into the rescue craft. Then, the sailors stood at the edge of the vessel using their bodies to support the five foreign prospecting experts and helped them get aboard the naval ship #732. In a half hour, they had rescued all the foreign experts from the Nanhai 503. The sailors aboard the naval ship #732 took out their food and drink and give them to the foreign experts.

The foreign experts are deeply touched by the Chinese people's international spirit. They said, "Chinese people have great international humanitarian spirit. In emergency situations, the Chinese always help the guest first."

Next month: Part 3 – Stranded in Sanya, Hainan Island, China

Mystery Item

The Mystery Item on page 11 is a Dip-Strike Chart from the 1950's.



$75 Member Price