February 2018

The Epicenter of Geophysical Excellence

GSH Journal

GEOPHYSICAL SOCIETY OF HOUSTON
Volume 8 • Number 6

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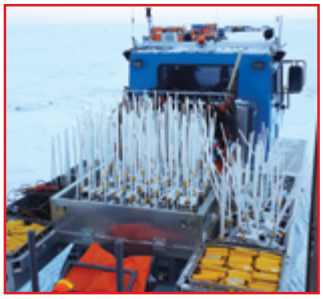
On The Cover...

Wireless Seismic operations in Alaska.

Photo courtesy of Wireless Seismic."



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

Apr 2018.....**Feb 8**
May 2018.....**Mar 9**
June 2018.....**Apr 13**

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A Word from the Board

Houston Strong.

By Kat Pittman, 2nd VP

After the devastation that Hurricane Harvey left in its wake, our city and its people came together like never before. It was heartbreaking to watch as the pouring rain and the release of the reservoirs flooded our city, and then heartwarming to watch Houstonians respond and band together as neighbors. People gave of themselves in many fashions - clothing, diapers, funding, time, labor... the list goes on. In a day and age when everyone is consistently "too busy," the city paused and people pitched in without hesitation for the greater good. Although the hurricane itself is behind us, I know that many of our members are still dealing with its aftermath.

"Houston Strong" became our city's war hymn. I love this because it was not merely a slogan; it was a true representation of the city's response in the wake of disaster. Our city has bounced back in a way that seems improbable on paper. Cleanup crews and contractors hit the ground running on homes across the city. We were able to host the SEG annual meeting downtown only a few short weeks after the hurricane. The Houston Astros even went from having the worst record in baseball a few years ago to winning the World Series for their city! Go Astros!

Strength manifests in many forms. There is strength within us, and there is strength that we give others when they are in need. Strength can come in short bursts, and it can also endure. In this vein, I can't help but think of all the ways that Houston has remained strong over the last few years, both before and after Harvey. As the oil and gas capital of the world, we have felt the industry downturn in every facet of our lives. Our great city and its people have withstood immense lows, with thousands of layoffs and too many people left asking "what's next?" The geophysical industry itself has felt shaken.

Amid all this turmoil, I am pleased at how our society has responded. The board has focused on being a good steward of society funds by keeping a close eye on the budget. We have kept events on the calendar and even added events dedicated to helping members navigate this season, such as the unemployment forums and additional networking events. We have increased our communication with the SEG and our joint networking/icebreaker event during the annual meeting had record-breaking attendance. Members have stepped up to volunteer their time and their ideas, two valuable resources. Companies who may not have the funds to sponsor events have come up with creative ways to be a part of the society through volunteering and in-kind sponsorships. I truly feel like the Board of Directors, the office staff, and our members have operated like a team. Between the strong technical events and social networking events, we have created a culture in which every member can find their place if they are looking for one.

Kat Pittman

We are grateful for the members who have shown strength by volunteering their time, attending events, and remaining involved. The GSH is strong. We have endured. Thanks for being a part of something great within our industry.

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Dear GSH Journal reader,

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

editor@gshtx.org

Sincerely,

Dmitry Kulakov, Editor

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From the Other Side

By Lee Lawyer

The Living Legends met at the GeoScience center in early November, last year. At that meeting, Dick Baile and Lee Lawyer (me) announced a Matching gift in the amount of $5,000 to cover costs at the GeoScience center. Scott Petty soon added $2,500 to the match, bringing it up to $7,500. The match was scheduled for December, January and February. Since this column is published close to February 1, you have one month left on the available matching funds. If you donated in December, you were able to include it on your 2017 tax return. (Tax return?? Since when?) This announcement is a virtual, "Pass the Hat" request. Your contribution need not be huge or even large. A lot of us are putting our money into the house "Rebuilding phase". I understand that! But it would be nice if a lot of us could give something to show our support for our local Society. AND it will be matched, doubled in value.

I have an anecdote for this subject: Quite a few years ago the AAPG scheduled their Annual convention in Houston. Several Universities hosted receptions. I am a member of the AAPG and an alumnus of University of Oklahoma. I was asked to set up a fund raising effort to pay for the OU Reception. The normal way to do that was to contact the 'fat cats' and get several substantial contributions. Two or three gifts would be enough to cover costs. I chose not to do that. I sent a short note to the OU members of the AAPG living in Houston. I asked each them to give no more than $20.00 and that I would return any gift larger than that. Amazingly, I collected more than double the amount needed to cover the reception. AND a lot of people got to participate and were part of the OU reception. It broke attendance records.

We can easily match the amount set up by Baile, Petty and Lawyer using a similar approach. Think about that. If 150 of us gave $50 each, we would match the grant. How easy is that? We can do more but instead of increasing the amount given, let's increase the number of contributors. If only 500 of us contribute $50, we have paid for the GeoScience Center for an entire year plus the $7,500 matching grant. We have a month left. Call the staff. Inundate them with calls. Use the post office. Give online (I am not sure how to do that but it will be available online).

Elwood P. has a friend called Harvey. Elwood carries on a conversation with him. All seems normal, but no one else can see nor hear his friend. That is strange since Harvey is a six-foot, three-and-one-half-inch tall rabbit, I think I have seen that anthropomorphic rabbit. At least I have witnessed the consequences of having Harvey as a guest.

In early August, 2017, I lived in a moderately large house in a quiet neighborhood. Since my wife passed away six years earlier, I vowed to stay in that moderately large house as long as possible, thinking of health issues. I am not a spring chicken (where did that come from?). Never once did I consider that outside forces could change things so drastically. There is a note on the survey plat of my moderately large house, "This house is outside the 100-year flood plain and doesn't need flood insurance." Wow! Fortunately, I hadn't read that note and took out flood insurance in spite of the surveyor's note. Many others did not. The first thing people ask is, "Did you get any flood water?" It is a routine question. About half of the people I asked said "yes".

There are three stages that follows the retreat of the flood waters. First is the demolition stage. That doesn't really mean demolition but it does mean taking all of the wall board down that has encountered any flood water plus a couple of feet more to accommodate the upward growing mold spores. Also, all lower level counters and cabinetry are removed plus furniture and the like that was affected by the flood.

Next comes the remediation phase, 'drying out'. Large fans are set up and run for days until all of the sodden studs and the foundation are thoroughly dry. A light spray is used to kill the growing mold. When timely, a certificate is issued stating that all is well, i.e., no mold.

The final phase is called the "Rebuild Phase". Put the house back in shape, wall board, counters, cabinetry, carpet, etc.. The entire process takes several months. There is competition for contractors. Florida was hit by a hurricane, which diverted a lot of man power from Harvey. I had no reason to refit my house, select new furniture, paint colors, counter tops, buy kitchen paraphernalia, re-stock the bar and the list goes on and on. So, I sold the house "as is". I probably lost money but I saved a lot of work and worry.

For many of us, this hurricane was a life changer. I had insurance. Many did not. As of this writing I am still waiting for the FEMA Insurance to make a settlement. Insurance companies are wonderful institutions. They make money, statistically speaking, from reducing the payment of insurance losses. They are the sole arbiters. I hope to have a settlement by the anniversary of Harvey.

Technical Luncheons

Practicing S-Wave Reflection Seismology with P Sources

Register for Tech Lunch Westside

Register for Tech Lunch Downtown

Speaker(s): Bob A. Hardage

Bob A. Hardage

Westside

Tuesday, Feb. 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 garage off Sam Houston Tollway/Beltway-8 northbound feeder or Town & Country Blvd)

Downtown

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

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

Abstract:

Two concepts form the physics of practicing S-wave reflection seismology with P sources. The first concept is that all land-based, vertical-displacement sources (i.e. traditional P sources) produce two downgoing illuminating wavefields. The first illuminating wavefield is the traditional direct-P wavefield, and the second is a direct-SV wavefield. This fundamental principle that two illuminating wavefields are produced by P sources has been ignored for decades. Instead, only reflection wavefields produced by illuminating direct-P modes generated by P sources have been used in reflection seismology. This presentation will stress that important seismic images and valuable seismic attributes have been overlooked because geophysicists have not utilized the downgoing direct-SV illuminating wavefields produced by land-based P sources.

The second concept that needs to be emphasized is that the direct-P and direct-SV wavefields produced by onshore P sources cause vertical geophones to record two independent and interlaced reflection wavefields (a P-P wavefield and a SV-P, or converted-P, wavefield). Similarly, horizontal geophones also record two independent and interlaced wavefields (a SV-SV wavefield and a P-SV, or converted-SV, wavefield). In this presentation, I will focus only on data recorded by vertical geophones, with emphasis on the SV-P (converted-P) mode.

There are, no doubt, some earth-surface conditions where it will be difficult to create acceptable quality SV-P data with P sources. Only expanded use of the concept of utilizing the direct-SV wavefields produced by P sources will help seismic data users understand what earth-surface conditions and what data-acquisition parameters are not favorable for practicing SV-P reflection imaging with P sources. It should be emphasized that the objective of this industry education effort is not to push for abandonment of traditional S-wave sources (horizontal vibrators and inclined impacts). The intent is to show that these traditional S-wave sources are not required for illuminating geology with direct-S modes unless a person prefers to use them. The speaker intends to continue to use traditional S sources at any opportunity that is presented.

Biography:

Bob A. Hardage received a PhD in physics from Oklahoma State University. He worked at Phillips Petroleum for 23 years where he advanced to the office of Exploration Manager for Asia and Latin America. His next assignment was a vice-president position at WesternAtlas. He then established a multicomponent seismic research laboratory at the Bureau of Economic Geology where he is now Senior Research Scientist. He has been a member of SEG for 50 years and an AAPG member for 46 years. SEG has awarded Bob a Special Commendation, Life Membership, and Honorary Membership. He wrote the monthly Geophysical Corner column for AAPG's Explorer magazine for six years. AAPG has honored Bob with a Distinguished Service Award for promoting geophysics among the geological community.

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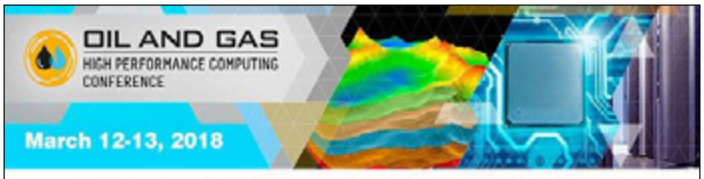

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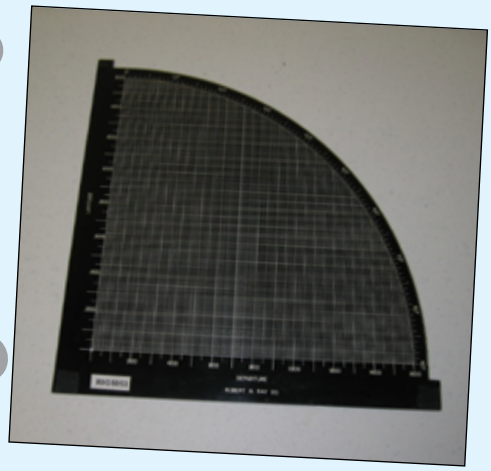

Do you know what it is?

This month's answer on page 38.

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Technical Breakfasts

Characterization of Natural Fractures and Fluid Flow Anisotropy Using AVAz Inversion of Wide-Azimuth Seismic Data

Register for Tech Breakfast Northside

Register for Tech Breakfast Westside

Speaker(s): Colin M. Sayers, Schlumberger

Colin M. Sayers

Northside

Tuesday, Feb. 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

Westside

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

Sponsored by Schlumberger and WesternGeco

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

Abstract:

Rock fractures are of great practical importance to petroleum reservoir engineering because they provide pathways for fluid flow, especially in reservoirs with low matrix permeability, where they constitute the primary flow conduits. Rock fractures may also influence the propagation of hydraulic fractures and understanding the spatial distribution of natural fracture networks is key to optimizing production in low permeability reservoirs. Properly processed, imaged and well calibrated surface seismic can be used for obtaining information on the density and orientation of natural fractures and the magnitude and orientation of the in-situ principal stress components which influence the aperture and hydraulic conductance of such fractures. The use of seismic AVOAz (Amplitude Variation with Offset and Azimuth) inversion to determine fracture density and orientation as well as horizontal stress anisotropy and the orientation of the principal stresses is described. A method for constructing a geologically realistic discrete fracture network (DFN), constrained by seismic amplitude variation with offset and azimuth (AVAz) data, will be presented. Upscaling then allows the anisotropic permeability and elastic stiffness tensor of the fractured reservoir to be determined from the DFN realization. The approach is illustrated using examples from the Middle East and North America

Biography:

Colin Sayers is a Scientific Advisor in the Schlumberger Seismics for Unconventionals Group in Houston. He entered the oil industry to join Shell's Exploration and Production Laboratory in Rijswijk, The Netherlands in 1986 and moved to Schlumberger in 1991.

His technical interests include rock physics, exploration seismology, reservoir geomechanics, seismic reservoir characterization, unconventional and fractured reservoirs, seismic anisotropy, borehole/seismic integration, stress-dependent acoustics and advanced sonic logging.

He is a member of the AGU, EAGE, GSH, HGS, SEG, and SPE, a member of the Research Committee of the SEG and has served on the editorial boards of the International Journal of Rock Mechanics and Mining Science, Geophysical Prospecting and The Leading Edge. He has a B.A. in Physics from the University of Lancaster, U. K., a D.I.C. in Mathematical Physics and a Ph.D. in Physics from Imperial College, London, U. K. In 2010 he presented the SEG/EAGE Distinguished Instructor Short Course "Geophysics under stress: Geomechanical applications of seismic and borehole acoustic waves" and was chair of the editorial board of The Leading Edge. In 2013 he was awarded Honorary Membership of the Geophysical Society of Houston "In Recognition and Appreciation of Distinguished Contributions to the Geophysical Profession". He received the award for best paper in The Leading Edge in 2013.

Data Processing & Acquisition SIG

Advances in the Study of Seismic Inverse Problems

Register for Data Processing

Speaker(s): Professor Maarten de Hoop, Rice University

Tuesday, Feb. 6, 2017
4:30 p.m. Sign-in, Snacks, Social Time
5:00 p.m. Start of presentation

Sponsored by Schlumberger

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

Maarten de Hoop

Abstract:

We present an overview of advances in the study of inverse problems in exploration seismology with an emphasis on anisotropic and nonlinear elasticity, and (multiple) scattering. We discuss uniqueness results with geometric data, time-domain or high-frequency waveform data, and finite-frequency or time-harmonic data on the one hand, and novel reconstruction procedures on the other hand. We touch upon the conditional Lipschitz stability estimates (well-posedness) underlying robust iterative regularization, techniques from boundary control and scattering control disentangling internal multiple scattering without knowledge of the wave speeds and interfaces, elasticity in Finsler geometry, and nonlinear interaction of distorted plane waves with discontinuities in the nonlinear material parameters generating quasi-internal sources. We conclude with some emerging directions at the intersection of deep learning and inverse problems.

Biography:

Maarten de Hoop is the Simons Chair in Computational and Applied Mathematics and Earth Science at Rice University, where he leads the Geo-Mathematical Imaging Group research consortium. His research interests are in inverse problems, microlocal analysis and computation, and applications in exploration and global seismology and geodynamics. In addition to appointments at Rice and Purdue, he has been on the faculty of Colorado School of Mines, Massachusetts Institute of Technology, and the Graduate University of the Chinese Academy of Sciences Beijing (visiting faculty). He has served as senior research scientist and program leader with Schlumberger Gould Research Center and is scientific advisor since 2010 with Corporate Science and Technology Projects, Total American Services, Inc. Maarten received his Ph.D. in technical sciences from Delft University of Technology in the Netherlands. In 1996 he was awarded the J. Clarence Karcher Award (Society for Exploration Geophysicists).

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Why I Joined the GSH

By Oscar Eli Vasquez

Initial Contact

I was first made aware of the GSH around the month of August during lunch with two geophysicists. I had recently moved back to Houston, of which I am a native, from Newfoundland, Canada where I was pursuing my Masters. I had decided to return to Houston to find employment, and had reached out to my contacts for advice on my pursuit. It was at this moment where one of my contacts suggested I join the GSH. My first contact with the GSH was at the SEG Annual Meeting 2017 in Houston. I approached the GSH booth and spoke to Kathy Sanvido, the membership manager. She advised I join immediately and look into volunteering for the society, as it would provide me exposure to working professionals so that I could build my network. And that is exactly what I did.

Volunteering

The GSH is always looking for 1-2 volunteers to help with the tech lunches where I received my first taste in volunteering both figuratively and literally, as volunteers can attend the event for free and be well fed while learning of developments in the geophysics field. I also spent time working at the GSH office located on 14811 St Marys Ln # 204, Houston, TX 77079 for those interested! I had the pleasure of helping out Kathy and Karen, the office director, with different items throughout the office (they have a lot on their plate!). Spending time with them was a great way to use my day. Volunteering at the office also granted me the opportunity to take part in the GSH officer meeting that are held monthly, and are open to GSH members for anyone interested in learning the root of how the society functions. Also, you never know who from the geophysics world may come by the office, offering a great networking opportunity.

Benefits

The GSH is a welcoming community willing to lend a hand for any members in need. As I have been unemployed, my main fear had been a decline in my geophysics technical skills, and falling behind on the techniques and technologies constantly evolving in the geophysics field. The GSH does a great job in providing resources for geophysicists to remain educated through the form of webinars, technical lunches/breakfasts, and special interest group presentations. The events occur regularly and are open to anyone interested, but members get the discounts! For students and the unemployed, greater discounts are offered making these resources affordable even for the strictest of budgets. I have also built my network further by speaking with working professionals and retired, where I believe frequent participation with the society can expand one's network and provide opportunity to contribute to the geophysics community. I am grateful to those I have met in the GSH, and I hope to continue being an active participant for the society.

JOIN TODAY!!!

Marine Electromagnetic Methods – Present and Future

By Leonard Srnka and Steven Constable, Institute of Geophysics and Planetary Physics, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA 92039-0225

Summary

Since industry began funding marine electromagnetic (EM) methods in the 1980s, tremendous progress has been made in applying these methods not only to hydrocarbon exploration but also to a wide range of applications. After more than two decades of excitement and investment, many successes and some failures, marine EM use has now greatly diminished due to a combination of factors, including resolution and depth limitations, imaging uncertainties, perceived high costs, difficulties in business integration, and the recent down cycle in hydrocarbon markets. Fortunately, acquisition costs are declining due to the arrival of continuously towed systems, subsurface depths of investigation are increasing, and cooperative seismic-EM inversions are beginning to produce better estimates of lithologies and fluids, including for marine hydrates. Enabled by the technical progress made in deep water for hydrocarbon use, offshore EM is expanding to other applications. Virtually any EM onshore application is now a candidate for the offshore. These include permafrost, geothermal, minerals, contaminant mapping, and groundwater investigations. Offshore EM methods are now firmly installed in the geophysical toolkit, and their uses will grow.

Introduction

Industry embarked decades ago on a journey to remotely measure subsurface electrical properties offshore (see *Figure 1*). Earlier use of marine EM methods focused on understanding tectonics in mid-ocean ridge and other plate boundary systems, work that continues today in the academic groups (see *Figure 2*). Magnetotelluric methods (MT) for industry began in 1996, testing the mapping of Gulf of Mexico salt structures at the Gemini prospect (Hoversten at al., 2000). The primary oil and gas business driver was to determine rock and fluid properties better than could be done with reflection seismology alone. Marine controlled source electromagnetic methods (CSEM) were developed to address that need. CSEM arrived in 2001 offshore Angola, focused on detection of reservoired hydrocarbons (Eidesmo et al, 2002; Srnka et al., 2006; Constable and Srnka, 2007). It was well known previously from first principles that CSEM would only determine subsurface resistivity, and not be a new direct detection tool. There is no maximum water depth limitation to these methods, but shallow water (<50 meters) can be challenging due to background noises and the direct source airwave arrival in CSEM. That need has been met in

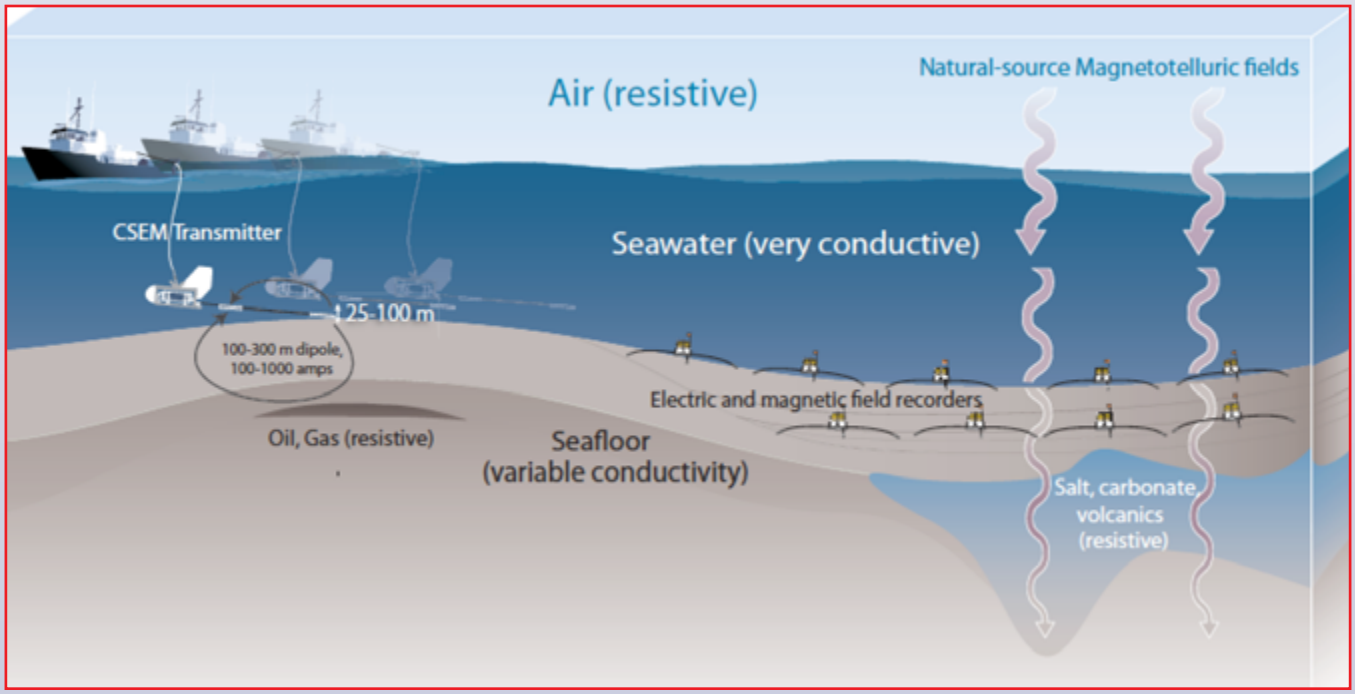

Figure 1: Schematic of marine MT (natural-source) and CSEM (controlled source) EM methods. The multi-component electric and magnetic seafloor receivers are essentially the same for both source types.

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For Information Regarding Technical Article Submissions, Contact GSHJ Coordinator Scott Singleton (Scott.Singleton@comcast.net)

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many instances, fulfilled primarily by new and established geophysical contactors who leveraged research from a few key universities, including the University of California San Diego in the USA and Southampton in the UK, as well as providing advancements of their own. These contractors collectively saw the potential, and then took on considerable technical and business risks.

used in pre-drill predictions that were correct, either wet or dry holes. The best control on false positives is a good understanding of the geology, plus joint interpretation with seismic and other geophysical data. Perhaps most important are the negative (i.e dry hole) results: there have been virtually no false negatives of material size reported (Hesthammer et al. 2012; Hesthammer 2015; see *Figure 3*). This strong CSEM

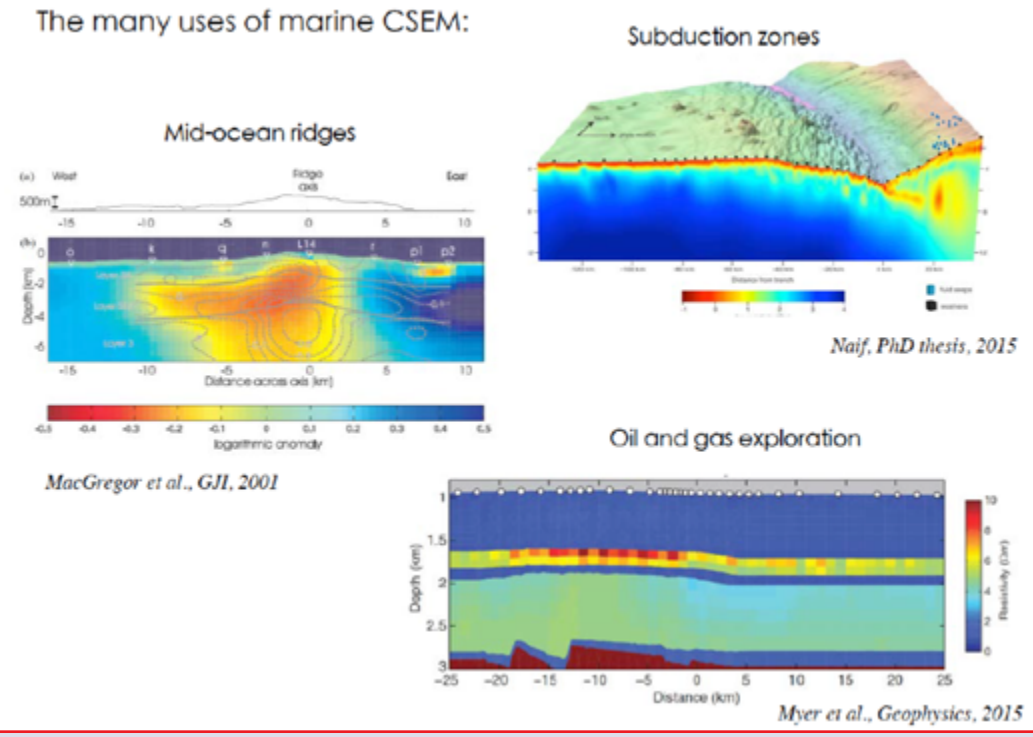

Figure 2: Three established uses of marine EM methods: LEFT, exploring the structure and thermal state of mid-ocean ridges, MacGregor et al 2001; TOP, studying ocean-continent subduction zones, Naif et al 2015; and BOTTOM, exploring for hydrocarbons on the NW Australia shelf.

In the case of CSEM, which is the most appropriate tool for reservoir fluid estimation since it is primarily sensitive to the vertical component of subsurface resistivity, pre-drill prediction accuracy of hydrocarbon presence in siliciclastic settings rivals that of seismic DHIs, within the CSEM depth range of applicability of roughly 2500 meters below the sea floor, depending on the average background vertical resistivity (Constable and Srnka 2007). Effective depth of investigation and resolution both improve as the average resistivity of the section increases, but concomitantly the likely resistivity contrast between hydrocarbon-bearing units and other strata decreases, thus decreasing CSEM sensitivity to resistive targets since to first order the maximum response is proportional to the net thickness-resistivity contrast product of the target.

False positives for hydrocarbon detection are to be expected, since other lithologies (e.g. evaporites, volcanics, coals) are usually very resistive compared with host sediments. Indeed, false positives have been encountered, but less than a dozen have been reported out of the many hundreds of surveys

technical ability for vetting probable dry hole locations seems to have been under-utilized by industry.

An apparent false negative in an early CSEM application over a major Ghana oil discovery has been shown to be due to faulty survey design and inadequate data analysis, which considerably dampened industry interest in the technology.

Business adoption for routine exploration operations has been uneven since CSEM commercialization in 2001, with a group of early adopters such as ExxonMobil, Shell, and Chevron investing heavily and then scaling back. Some independents and national oil companies picked up the technology later, and some have continued its use at various levels of application. CSEM research and development and application expenditures have followed the classic "S curve" characteristic of emerging technologies: rapid growth to a peak after early successes, a long decline after prediction failures, a bottoming-out, and then slow recovery to a sustainable level as the strengths and weaknesses of the technology are better understood and its value proposition becomes clearer.

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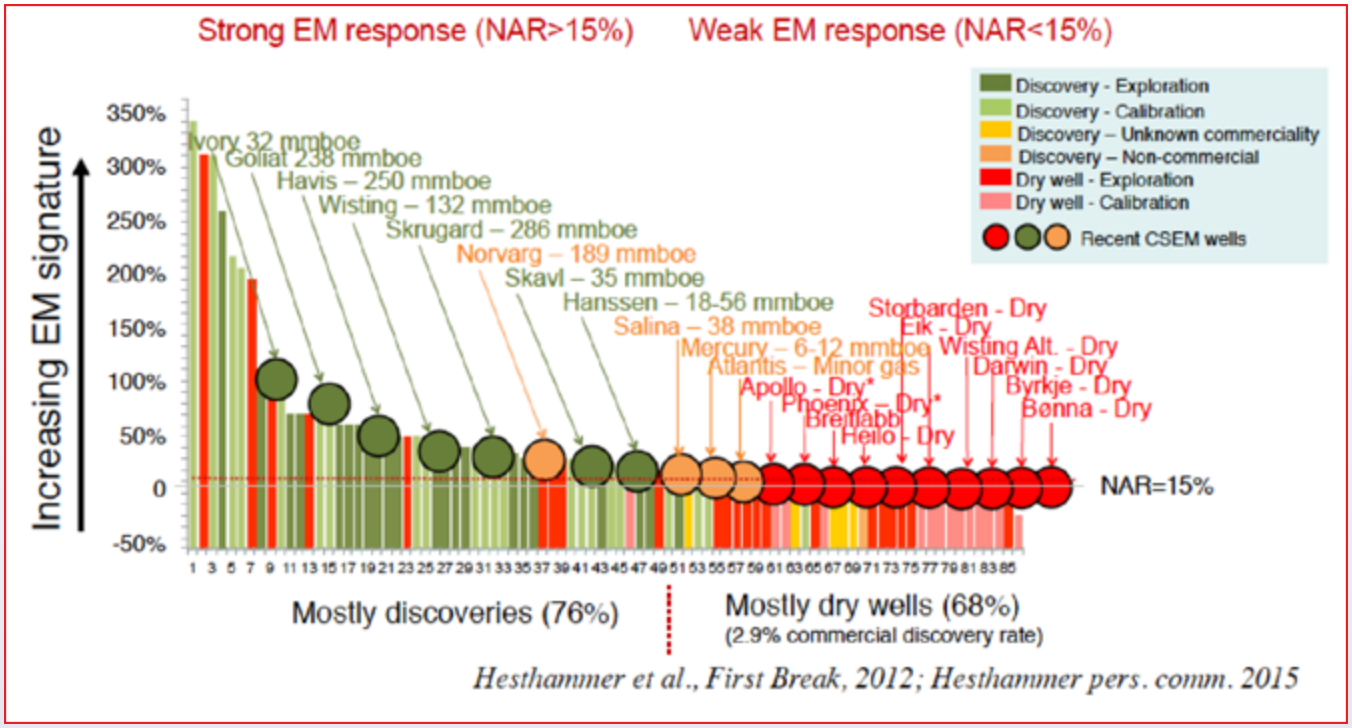

Figure 3: CSEM prediction success rate for wells in the Barents Sea, North Sea, and offshore India. All of the "mostly dry" wells had weak or no CSEM responses (NAR=normalized amplitude response above the so-called "background", a parameter favored by some CSEM contractors; an NAR of 0.15 was assumed to be the minimum reliable signal).

Business Paradigms and Challenges

CSEM users faced a range of business challenges that seem to have been only partly overcome. These challenges were not unexpected for a major new technology appearing in a very large, mature, and fairly conservative industry. This is especially true since CSEM has too often been viewed as a competitor for well-established seismic reflection techniques, rather than as a complementary method. As many authors have said in presentations and publications, integration of CSEM with seismic and other geoscience data is essential for effective use of this relatively new technology. But few geophysical data interpretation packages integrate seismic reflection and CSEM data in an organic way, although progress has been made recently.

Obviously, there are significant business motivations to honor drill well commitments in licenses, in spite of negative CSEM responses, rather than paying a back-out fee. Not the least of these is gaining geological knowledge of the basin by drilling. Another rationale for down-weighting negative CSEM responses is mistrust of the results, perhaps due to the low spatial resolution or uncertainties in determining resistivity values, rather than just the newness of the technology. But because of the much higher sensitivity to a range of hydrocarbon saturations than in the case of reflection seismic (e.g. Archie's law), especially where low gas saturations can give false seismic DHIs or uncertain fluid edges, such mistrust deserves more thought. Perhaps a re-think of exploration business models is also appropriate to better value well avoidance, especially in times of low hydrocarbon prices where controlling exploration costs is paramount.

A global market factor that may be playing a role in CSEM use, as well as for other geophysical exploration tools, is the changing concept of "peak oil". Originally defined as the maximum supply capacity, it has come to mean maximum demand. In this second interpretation, priorities of both commercial and national oil companies may shift to a more measured program of discovery and development, valuing long-term technical strengths, local resources and security of supply over near-term market economics. For example, there is a large and growing EM methods effort in China, including marine EM research, where developing and sustaining a national capability appear to be valued.

Recent Technical Advances

Continuously towed CSEM systems have appeared that promise to substantially reduce cost and to expand the applications envelope. EM streamers containing single-component (inline E-field) sensors can now be towed separately or together with 2D seismic streamers from dedicated vessels at 4 to 6 knots, rather than at the 1 to 2 knots characteristic of deep-towed CSEM (*Figure 4*). It is reported that cross-talk between the coterminous seismic and EM data is minimal in this system. Much larger electric source dipole moments are becoming available, giving considerably greater geological

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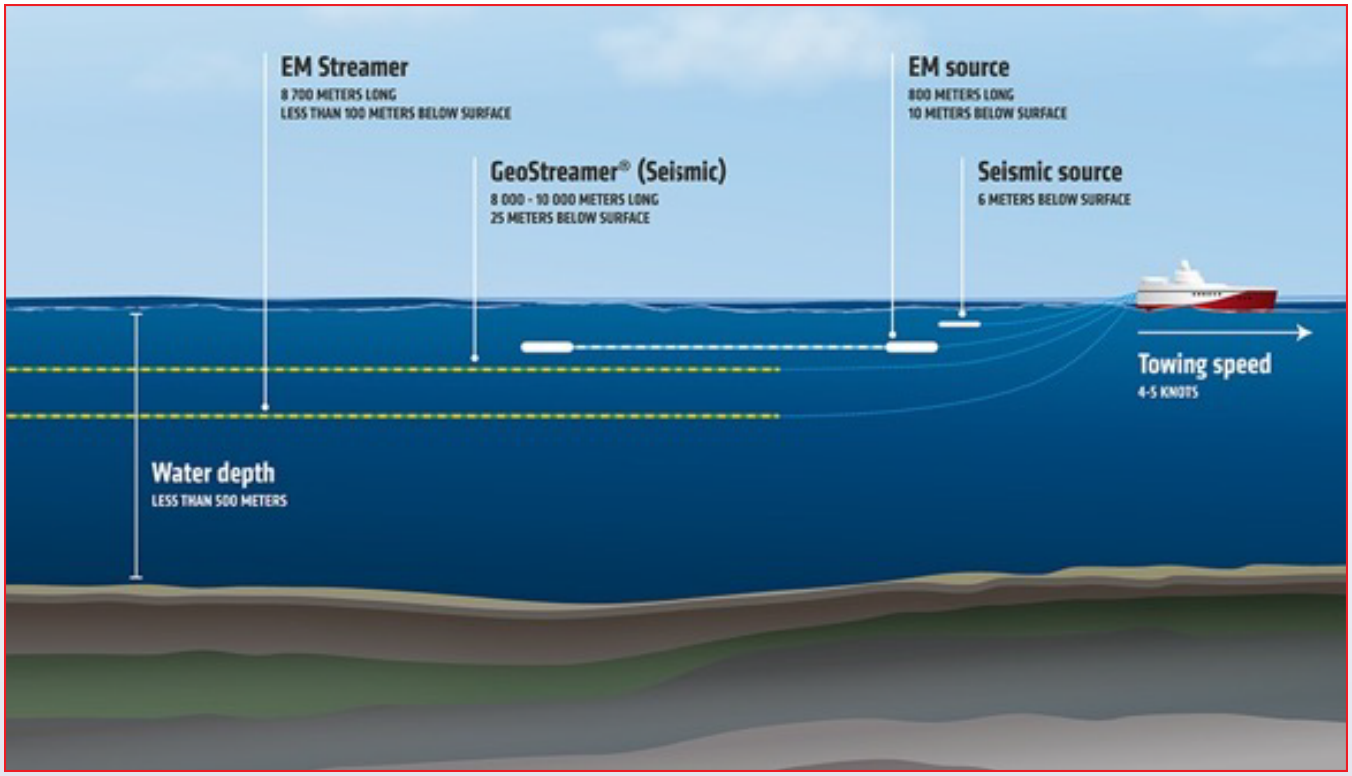

Figure 4: Simultaneous EM and seismic streamer acquisition (image courtesy of PGS)

depth of investigation, although it needs to be noted that the spatial resolution of EM methods decreases strongly with increasing depth. In addition, three component EM-only receiver systems now exist that can be towed at any depth using small vessels of opportunity, such as the UCSD "Vulcan II" system (*Figure 5*), adding cross-line and vertical E-field data that are valuable in edge detection and in data inversions especially when electrical anisotropy is present.

practical. The best results can be achieved when there is well control and calibrated rock physics models for the area (Alvarez et al., 2017). Indeed, while the "holy grail" of joint CSEM/seismic inversion will continue to be pursued, it may be that the rock physics models necessary to relate conductivity to velocity are so prospect-dependent that this approach will have limited application.

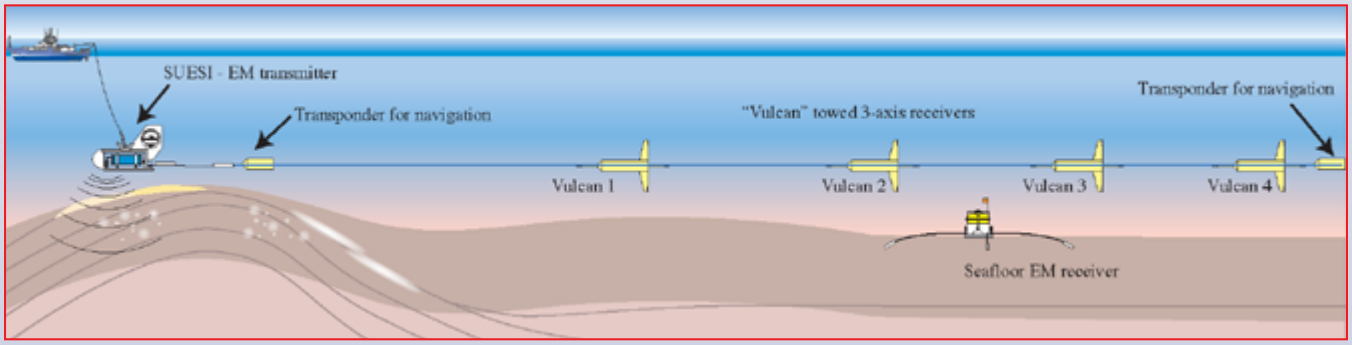

Figure 5. UCSD Scripps Vulcan II marine EM system. Streamer lengths up to 1 km have been achieved.

In addition to advances in acquisition, much progress has been made in EM data interpretation and imaging. Although true joint nonlinear inversion of EM and seismic data has not been successfully accomplished, due to the very different scale lengths of the two types of data, the much larger non-uniqueness of EM imaging, and the large amount of required computation, seismically guided EM inversion is now

Opportunities for New Kinds of Exploration

As mainstream oil and gas exploration applications have waned, other types of offshore resources are coming into play as viable marine EM method targets. These include: marine hydrates for possible gas supplies, for marine geotechnical use such as drilling and infrastructure hazard assessment; and also for studies of ancient and current climate change.

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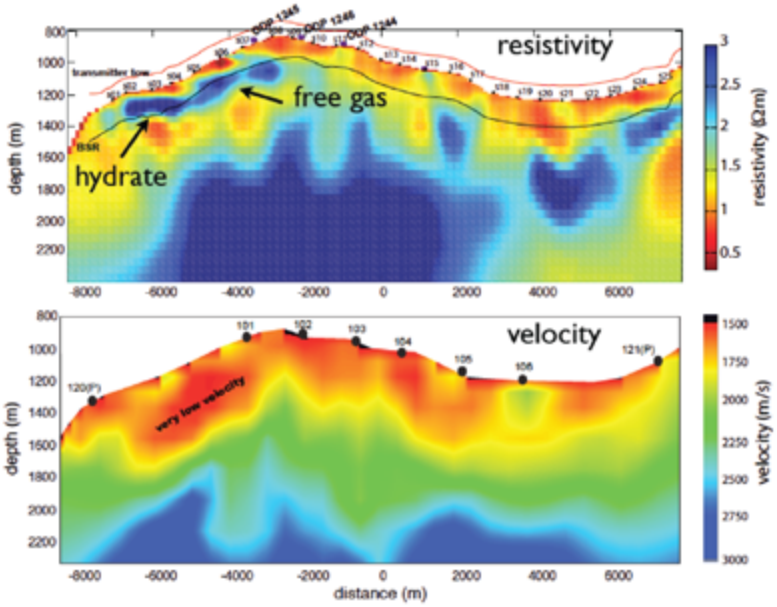

Weitemeyer, Constable and Trehu, 2011

Figure 6: Inverted 2D resistivity from CSEM (top), and seismic tomography P-wave velocity (bottom) at Hydrate Ridge, Oregon (Weitemeyer et al, 2011). Not all low velocity zones correspond to hydrates. Free gas shows as highly resistive areas, indicating high gas saturation.

Pioneering marine EM research by Weitemeyer et al. (2011) at Hydrate Ridge, Oregon (*Figure 6*), located on the accretionary complex of the Cascadia subduction zone, demonstrated the ability of CSEM and MT to image hydrates and free gas offshore, and paved the way for further hydrate applications. For example, exploration for hydrates as a hydrocarbon resource is active in Sea of Japan (*Figure 7*) and in other areas of the Far East.

Emerging marine EM exploration applications also include permafrost (Sherman et al., 2016), geothermal, and minerals work using both conventional and newly developed low-power EM seafloor sources. Environmental applications for mapping contaminants and for fresh ground water supplies are now viable offshore, and research surveys are progressing. Whether a CSEM method in any of its modes is a useful technology) for time-lapse (4D) studies, either for hydrocarbon depletion work or for monitoring gas storage (hydrocarbons or sequestered CO2) continues to be a subject for research (Orange et al, 2009). In all of these cases, modern computing is a major enabler, without which today's applications would be largely impossible.

Conclusions

Although the origin of marine electromagnetic geophysical methods can be traced to DC surveys offshore Cornwall in the

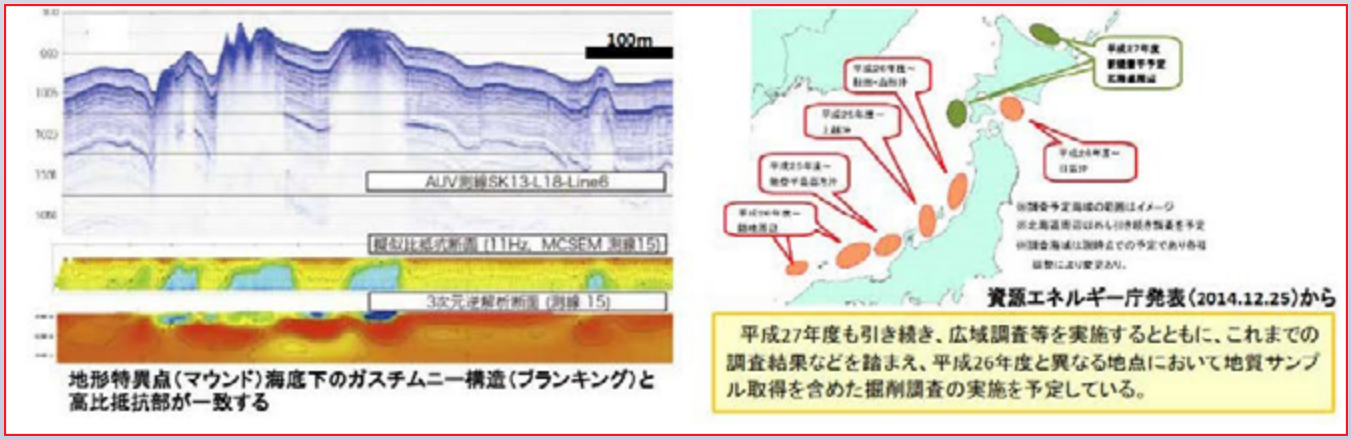

Figure 7: Seismic multi-beam (top left) and CSEM resistivity (bottom left), Sea of Japan. Several basins are prospective for hydrate exploration (right). Images courtesy of the Japan Research Consortium for Methane Hydrate Resources.

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early 1920s, the marine methods we know today in industry are newcomers compared to seismic, gravity, and magnetic methods. A great deal of progress has been made in less than three decades, especially considering the relatively small investment in EM compared to seismic. Enabled by progress made in deep water, offshore EM technology is expanding to other uses. Virtually any onshore EM application is now a candidate for the offshore. Despite the current downturn, marine EM methods will move ahead technically and commercially, and will continue to offer viable geophysical options for geoscience applications.

For More Information

Some of the material presented here, plus considerable additional material, is contained in Steve Constable's three different Fall 2016 SEG Distinguished Lectures available at http://seg.org/Education/Lectures/Distinguished-Lectures/2016-DL-Constable.

The SEG 2017 Recent Advances and the Road Ahead session presentation, and the EM Workshop W6 presentation on 4D CSEM, are available at

http://marineemlab.ucsd.edu/resources/presentations/.

Acknowledgements

Many thanks to our fellow members of the global marine EM methods community for their discussions, suggestions, and contribution for this talk, including M Vest Exploration and the members of the UCSD Scripps Seafloor Electromagnetics Consortium, especially RSI, PGS, EMGS, and Statoil.

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GSH Outreach

Committee Activities *By Lisa Buckner*

On Tuesday, December 5 (5:30 PM – 7:00 PM) Mark Niles and I hosted a table at the **I.W. and Eleanor Hyde Elementary School Science Night & Science Fair Awards in League City**. We were one of sixteen invited exhibitors including the NASA and Johnson Space Center, Texas A&M University at Galveston, National Weather Service, FBI, Lunar & Planetary Institute, San Jacinto College of Biology Department and The Health Museum. Some of the parents work for ExxonMobil Pipeline and to my surprise one works on my floor at Hess. He said his sons liked drilling for oil at the GSH table the best. Several students returned to drill again. During the 1.5 hour period we had a steady line of students and gave away 150 GSH coiled toy springs whether they struck oil or not. Since this was our first time visiting this school, we gave one of our Maps in Schools project USGS Tapestry of Time and Terrain maps to one of the teachers who said the 5th grade science students and teacher would really enjoy. Thanks again to GSH Outreach volunteer Mark Niles who lives in nearby San Leon for helping out at such a busy event.

There are four events this month in need of volunteers. If someone would like to accompany me on a little road trip to **Bellville**, they are having their **4th Annual Science Night on Monday, February 12 from 6:30 – 8:00 PM**, dinner provided. Approximately 500 eager students and family members attend. Some are familiar with seismic crews working in the area.

We will host a Community Booth at the **Girls Exploring Math and Science (GEMS) event for Girl Scouts on Saturday, February 17 at the Houston Museum of Natural Science**. Four volunteers are needed from 7:30 AM – 1:30 PM to setup, teardown and staff the booth. Benefits include admission to the museum until the museum closes at 5 pm, access to a snack room for volunteers during the event and the chance to make new friends, network with colleagues and have a lot of fun!

The **AAUW Expanding Your Horizons in Science & Mathematics workshop event for middle school girls is on Saturday, February 24**. One or two volunteers are needed to assist the girls with the hands-on activity and me with the presentation, AAUW membership is not required. We'll be hosting two student hands-on workshops either in the morning or in the afternoon. Lunch will be provided by the American Association of University Women (AAUW) West Harris County Branch.

The **59th Annual Science and Engineering Fair of Houston** will need many volunteers. At least six Special Awards Judges will be needed on **Saturday, February 24 at the University of Houston Main Campus Alumni Center** to select winners for GSH Awards. We work in teams and no previous judging experience is necessary. The SEFH is also in need of 600 Place Award Judges. Information regarding both types of judging can be found at http://www.sefhouston.org in the Judges and Special Awarding Agencies section. The general public is invited to view all of the science fair projects during the Public Day Open House from 5:30 PM – 7:30 PM on Saturday, February 24. The awards ceremony will be held on Sunday, March 4. Science fairs are not only important for our students to learn more about Science, Technology, Engineering and Math (STEM) but also for Houston's future.

2017 Science and Engineering Fair of Houston Results

In 2017, SEFH awarded 360 "Place Awards" and 41 businesses, industries, technical societies, government agencies, and educational institutions presented more than 250 "Special Awards," fellowships, and scholarships. SEFH also provided five Melinda Mills Teacher of the Year Awards. Junior Division Place Award winners (72) were eligible to enter the BROADCOM Masters Competition. One hundred and twenty Place Award winning projects were eligible to enter the State SEF in San Antonio. Thirteen Senior Division Grand Award winners represented SEFH at the annual INTEL International Science and Engineering Fair (ISEF) in Los Angeles, California. These SEFH students were successful with awards being granted.

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

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GSH K-12 Outreach Volunteers Needed!

Science and Engineering Fair of Houston

SCIENCE FAIR JUDGES NEEDED – SATURDAY, FEBRUARY 24, 2018

What: **59th Annual Science and Engineering Fair of Houston**
Where: **University of Houston Main Campus Alumni Center**

Two different types of judges are needed to evaluate the projects by 1,100 Junior and Senior High School students:

1) At least **6 Special Award Judges** will be needed to select winners for GSH Awards. We work in teams and no previous judging experience is necessary. We will be looking specifically for projects related to geophysics. Judging will be during the morning session 9:00 am – 12:00 Noon. Contact Gokay Bozkurt at gbozkurt2002@yahoo.com to volunteer.

2) SEFH is also in need of **800 Place Award Judges**, especially during the first round morning session 9:00 am – 12 Noon and also during the second round afternoon session 1:30 pm – 4:00 pm. No previous judging experience is required and you will not be expected to judge an unfamiliar category. To volunteer, fill out the Online Place Award Judge Application form at https://www.sefhouston.org/judge-application.

Information regarding both types of judging (procedures, criteria, expectations and dress code) and the Online Place Award Application form can be found at http://www.sefhouston.org in the Judges and Special Awarding Agencies section.

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A Conversation With...

Gene Sparkman

by Azie Aziz

"Perseverance and hard work are the key to stay afloat in the world of geophysics" Gene Sparkman

Gene Sparkman is holding a geophone, the crux of the 3-D seismic data collection.

Born in "The Sooner State", Oklahoma, and educated at Texas Western College and the University of Texas at Arlington, Gene Sparkman has been enjoying the roller coaster ride of his career in the oil and gas industry. Having the opportunity to work with two of the industry's legendary icons, T. Boone Pickens and George Mitchell, he cannot be thankful enough for being in the oil and gas industry.

Gene began his career with Pan American Petroleum Corporation (later Amoco) as an Office Computer. He also worked with El Paso Natural Gas, Tenneco Oil Company, Mesa Petroleum, and then as the District Exploration Manager and Vice President of Geophysics with Mitchell Energy Corporation (MEC). Later he joined the Energy Research Clearing House (ERCH) serving as Director. He worked for FusionGeo Inc., and now he has been with Lumina for five years. During his career, he has seen seismic interpretation evolve from mapping three horizons and accompanying iso-times on paper copies to the currently computer generated attributes predicting reservoir rock properties. Early in his career he realized that computers could greatly help seismic interpreters. He expanded the use of workstations while he was with MEC

Gene is committed to his profession as shown by his many contributions to the professional Societies. He was the chairman of the SEG Foundation Trustee Associates, Unconventional Resource Technology Conference (URTEC) Program Co-chairman for two years, Treasurer on the SEG Foundation Board of Directors, SEG Secretary-Treasurer, SEG Executive Committee, Chair of the TLE Editorial Board, Chair of the SEG Finance Committee, and Chair of the SEG Foundation Scholarship Committee. He also served as President of the Geophysical Society of Oklahoma City.

He currently resides in The Woodlands with his wife, Carlene.

Gene Sparkman on the early days of oil and gas industry

"I have been able to survive the ups and downs and maintain my career in the industry. The key is to persevere."

Tell me about the early days of oil and gas; What was it like?

The oil and gas industry has had its ups and downs ever since I first joined the workforce. Prior to completing my senior year at Texas Western College I was hired as an Office Computer by Pan American Petroleum in 1962. The oil and gas industry was in a down cycle period at that time. A number of my college classmates were unable to get jobs with petroleum related jobs so I jumped at the opportunity.

It has been very rewarding to watch the rapid technology changes. When I started my career, we were recording seismic data on big analog tapes, and plotting the data using "Playback Machines." I was on one of the first crews applying the newly developing Analog Vibroseis source.

Interview continued on page 22.

Interview continued from page 21.

We went through a transition in the mid to late 1960s to digital recording and processing. I was involved in the conversion to digital processing before I obtained my degree in Physics from the University of Texas at Arlington and became an interpreter. When I was at Mitchell, I was able to get the first GeoQuest workstation and Oklahoma Seismic's first MIRA system. MIRA was able to generate synthetics to display on paper copies.

What are the low points in your career?

In 1986, while I was with Mitchell Energy, I had to make a difficult decision to let go 10 of the employees, and that left only three of us in the Oklahoma City office.

What are the highlights of your career?

During my tenure as Vice President of Geophysics with Mitchell Energy, I suggested the company make the transition to geophysical work stations instead of the mainframe computing systems that MEC had elected to favor. We built tools for the interpreter.

In 1980, the Mesa Tipton 2-29 well drilled by Northeast Mayfield was the deepest (24,969 ft.) production in the world at the time it was drilled. The most exciting thing is that the well was on the map that I produced. I was remapping in the Anadarko Basin at that time.

When I started at the Energy Research Clearing House (ERCH) at the Houston Advanced Research Center (HARC) in The Woodlands I had an office next to John Castagna while he was working there on assignment from Arco. I helped to organize collaborative research and identified gaps in the technology that needed to be worked on. I organized a workshop to discuss a new technology which was 4-D seismic. I later introduced a workshop on the gaps in deepwater technologies. The ERCH directed the Teal South Time Lapse survey deploying permanently protected OBC recording systems was another major accomplishment.

I also had opportunities working with geophysical icons Doctors Moe Widess, Sven Treitel, and John Castagna. That is a very rare experience.

Gene Sparkman on the future of geophysics

"No one said it would be easy." – Gene Sparkman

What is your advice to the future geophysicist?

Geophysicists need to understand the fundamentals of earth sciences and physical sciences. It is more than just knowing the computer skills and manipulating codes. They need to know the fundamentals of the exploration cycle from the acquisition to the development. Of course, on top of all that, hard work and perseverance are very important if you want to succeed.

I also encourage the younger generation to be actively involved and engaged with the local professional societies like the Geophysical Society of Houston (GSH) as well as the Society of Exploration Geophysicists. I cannot stress more the value of connections and networking.

What would you be if you were not a geophysicist?

I would be a city planner. I worked for the El Paso City Planning Department during the time I was attending Texas Western College full-time and part-time.

What keeps your going?

My family. They keep me going, and I enjoy spending time with them either having a weekend gathering or going on a cruise. All of our family celebrations are at Nana and Papa's house.

Gene Sparkman with his exploration team at Mitchell Energy Corporation office in Oklahoma City.

Gene and his wife Carlene, 4 daughters and the 3 sons-in-law at their 60th wedding anniversary celebration.

Note: Pictures and quotes are taken from Mitchell Energy Corporation's in-house publication, "TERRA-SOL".

A Live Webinar

Sponsored Jointly by the SEG and GSH

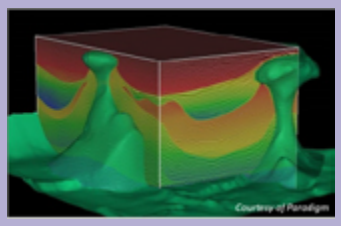
SOCIETY OF EXPLORATION GEOPHYSICISTS

Introduction to Applied Depth Imaging

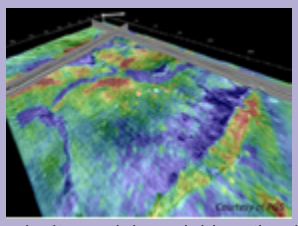
Understanding the basic concepts and practical aspects used in depth velocity model building and depth imaging

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.

This **16 hour course** can be taken in the comfort of **your office** or even **your own home**. It works on **PC's, iPads, iPhones**, or even two tin cans with a taut string (not recommended). **No travel costs**. **The Course Fee: $390!** With major discounts for Groups and Students.

What if I have to miss a session?

Worry Not, All sessions are recorded and available to registrants.

Register Now! **GSH Website: gshtx.org Events Tab**

PDFs and More 9-1-1 Calls to Bayes

At our last meeting, we left GSH President **Tommie Rape** in a despondent, bordering on suicidal, state. He had just taken a test for **FEEF**, which his doctor told him was **positive** for this dreaded malady (Flesh Eating Explosive Flatulence) which, if it doesn't kill its victims and anyone within a 30-foot circle, leaves them without friends, living out a life of lonely desperation on a desert island with only monthly deliveries (by 10000-foot airdrop) of canned lima beans and garlic to sustain a pitiful existence. Medieval leper colonies were a lot more fun. No wonder Tommie is a wreck. We left it up to the readers to calculate the probability that Tommie actually had **FEEF** as the **80% accurate test** indicated. The chances looked bleak, but now we'll find out what Rev. **Bayes** has to say about that. The Guru hopes you've done your homework and have already called Tommie with probability that he is FEEF-ridden, ghoulish as that might be.

Here is how the problem was posed in the January Nuggets.

The FEEF affliction is enjoyed by some 0.**1%** of the world population**: P(F) = .001**. The **test** for it is credited with being **80% accurate**, meaning if you have it, the test will be **positive** (settle your affairs), with probability **P(POS|F) = 0.80**. It also means that the **False Negative** (missed it, when you've got it) is **P(NEG|F) = 0.20.**

On the other hand, those folks who **don't have FEEF**, **P(NO-F) = 0.999**, when tested, have a **False Alarm** rate of **9.6%**, that is, **P(POS|NO-F) = .096**. This means that if you're FEEF-free, the test will be correctly **negative (NEG) 90.4%** of the time: **P(NEG|NO-F) = 0.904**.

So, Tommie, your Chances of actually having FEEF are given by **P(F|POS)** = ? Let's let the readers solve this for you. They will call with the good news. **This is the February Puzzle**

Here's how we'll solve it using the Bayer Theorem:

$$P(F|POS) = \frac{P(POS|F)\cdot P(F)}{P(POS)} = \frac{P(POS|F)\cdot P(F)}{P(POS\,|F)\cdot P(F) + P(POS|NO-F)\cdot P(NO-F)}$$

The dreaded probability Tommie has FEEF given the positive test

The probability of having a POS test result under any conditions

Using the various probabilities, defined above, we can plug and crank to obtain -

$$\mathbf{P(F|POS)} = \frac{(.80)\cdot(.001)}{[(.80)(.001) + (.096)\cdot(.999)]}$$

The Probability Tommie's a Goner

P(F|POS) = .00827 = 0.83%

Now you can smile, Tommie

The chances the president has **FEEF** are under 1% in spite of the positive test result. Anti-intuitive, but now we can all breath easy (if you'll pardon the levity).

Tutorial Nuggets continued on page 25.

Tutorial Nuggets continued from page 24.

The paradoxical result, which gave Tommie new life, and the right to return to polite society, can be made slightly more intuitively appealing with two enlightening clues. First, note that any probability can normally be expressed as the **event being evaluated** (here the probability of **FEEF**, given a **positive** test result **normalized by all ways the event (positive test)** could occur, which is a relatively large number given the high fraction of false positives.

Secondly, it's often useful to look at the numbers by assuming a **large sample population**, say **10000 people**. From that size group, the most likely number of **FEEF** victims is **10** (0.1% of the population). You know who are. On the other side are usually some **9990 folks** (99.9%) with whom you are safe riding an elevator. Put the bloodless probability fractions in terms of the **number of peeps**. That way may give you a better feeling for **the reality of the probability**, or not.

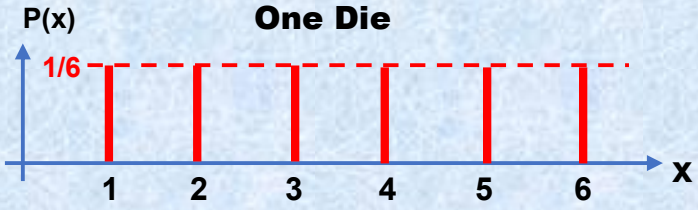
The Committee

Professor Guru, would it be OK if we move on to something less stressful now? Perhaps something related to **elastic inversion** for **rock properties**? (Wasn't that the intended topic back in November 2017 *GSH Journal?)*

Yes, Oh Cherubic Choir of The **Topic Change Committee**, we should move on now, if only you will appreciate that these topics, on which we dwell, are important building blocks essential to understanding **Enlightened Inversion**.

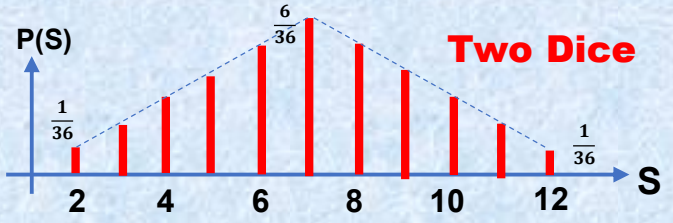
PDF – Not the Format variety, the Statistical Type

Probability Distribution Functions, PDFs, are usually presented as graphs. Let's start with something familiar and simple, the **PDF of dice** – that is, what comes up on the throw of one, two, or more dice..



The variable, **x**, represents the value that comes up with the roll of **1 die** with **6** faces of a cube. We can obtain **P(x)**, the probability or any particular face value, **x**, showing up by either simple logic (assuming this is an "honest" die, or by empirical / statistical methods, that is rolling, say, **60000** times and counting the number of times each of the 6 possibilities shows up. We expect about **10000** each (with a reasonable tolerance for small variation around that). Either way, we will conclude that the **P(x) = 1/6**, (if the die hasn't been subjected to some hanky panky.

Now let's stir the pot and roll **2 dice** and calculate P(S), where S is the sum of the 2 dice which can range from **2** (snake eyes) to **12** (box cars). There are **36** possible **combinations** of the two dice with **6** of those



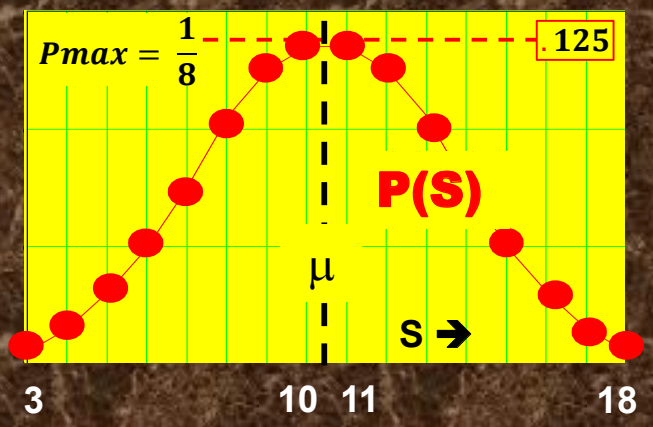
Tutorial Nuggets continued on page 26.

Tutorial Nuggets continued from page 25.

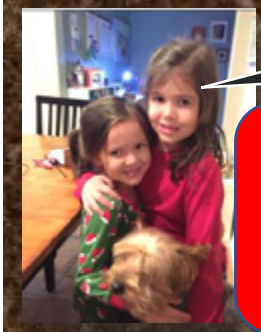
producing a sum of **7**, giving it the highest probability: **P(7) = 6/36 = 1/6**. The lowest (2) and (12) have the fewest combinations, one each, with **P(2) = P(12) = 1/36**.

Consider now the sum of **3 Dice**. There will be, in case you're too lazy to count, 216k combinations of dice faces that sum to 16 different possibilities THE **PDF** of the possible outcomes is depicted in the diagram, **P(S)**, at the right, **S** is the possible sum values. In this case, **10** and **11** are the most probable values with **P(10) = P11) = 27/216 =1/8**.

P(S) – The PDF of 3 Dice



A curious phenomenon is being revealed before our very eyes. Note that the shape of the **PDF** is rapidly approaching a **bell-shape**, also known as a "**Gaussian**" curve (from the ancient Gaelic, meaning **Bell-shaped,** or in modern parlance, a **Normal distribution curve**). It happens in all **convolutional sequences** regardless of the mix of odd shapes (those typified by members of the GSH Board of Directors), being convolved together.



Dr Guru, you're scaring my sister and Murphy! What's this "convolutional sequence" you're babbling about?

A good question – if somewhat irreverently phrased. Well, little Kumquat and Murphy, consider this: how was I able to quickly determine from the uniform (equal probability) single die PDF, the probability of the sum of 2 dice? And then, without hesitation, the PDF of the sum of 3 dice?

This leads us to the **March brain stretchers.**

(1) **D**emonstrate that you can construct the 3 PDFs I've shown you, using convolution.

(2) **W**hat we have looked at, in the way of PDFs, so far have been **DISCRETE**, but not necessarily discreet. The **P(10.5) = 0** on the 3 dice problem, in spite of the fact that **10.5** is the mean or average value, **μ**, of the PDF. It is the "expected" value even though it can't happen. Here's an interesting and useful concept: Many of the statistics used in Inversion involve "continuous" variables such as the reservoir porosity, Φ, expressed as a volumetric fraction. If you attempt to compute the probability of any particular Φ, e.g., 18.0, you will find that P(18.0) = 0. Using the nomenclature of the merciful, we learn that PDF is often called **Probability Density function**, this may allow you to understand how we are able to create and use PDFs in Inversion and modeling. Do so, and be ready to discuss in front of your Peer Group at our March encounter.

GSH Annual Tennis Tournament

by Russell Jones, Tennis Tournament Chair

Once again, the end of a long season of tennis came to its climatic finale when the annual tennis tournament was held at the Chancellors Tennis Center on November 17th.

This year the field was wide open and the trophies up for grabs as some of the regular attendees were unable to attend. We missed their tennis prowess and camaraderie!

Undaunted by the competition to come, the gallant warriors marched towards the arena with a belly full of sandwiches. Spirits were high after the door prizes were awarded. Many thanks to those who had donated wonderful gifts: Paradigm, Mark Tinne (Tubular Products) and Erin Chang (personal gift of Rockets tickets!!!)

The splendid facilities of Chancellors along with the luxury and convenience of an indoor venue allowed for exciting and competitive tennis. After six rounds of "speed dating" tennis, there were four clear winners who would go on to compete in the deciding championship set. They competed while the rest of us sat and recuperated, and in order to help soothe away the muscle soreness, partook in some medicinal drinking.

David Dietz, John Robinson, Robert Sorley and Mark Tinne battled it out with Robert and Mark prevailing.

Once again, a huge thanks to all those helped, donated and generally supported our efforts. Special thanks to Eve and Liza from Seitel and Kathy from the GSH for their help before and during the event and an even bigger thank you to Strasburger for their generous sponsorship which helps keep the tournament viable.

See you all next time!

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ATTORNEYS AT LAW

U of H Wavelets

SEG Wavelets Distinguished Lecturer, Dr. Raymond Abma, on Simultaneous and Coded Seismic Sources: Present and Current Technologies.

By Monica Guerrero

The University of Houston SEG student chapter, The Wavelets, had the honor of hosting the SEG 2017 North American Distinguished Lecturer, Dr. Raymond Abma, senior research geophysicist at the Upstream Technology group in BP on October 20, 2017. Dr. Abma lectured on simultaneous and coded seismic sources, a technology that has gained interest in industry in the past decade. Simultaneous source surveys use more than one seismic source at a time to reduce the cost of acquisition by reducing the time necessary to acquire the full shot geometry. He gave examples of simultaneous source surveys in marine cases, which typically use airguns as the source. The talk primarily focused on advances in the acquisition technique, its financial effect, and the comparison of the final product of both simultaneous source surveys and conventional surveys.

Figure 1 Dr. Abma discussing individual shot records.

Figure 2 Graduate student Ezzedeen Alfataierge introducing Dr. Raymond Abma.

Professors and students, both graduates and undergraduates were in attendance. The SEG Wavelets introduced the lecturer to the audience then began the hour-long talk, which kept the audience engaged by Dr. Abma's obvious desire for his research and relatable examples. Following the talk, Dr. Abma graciously answered the audience's questions, casually talked to students and professors, and posed for a group photo.

Figure 3 Q & A panel with Dr. Abma following talk.

The SEG Wavelets host at least one speaker per month, for members, faculty, graduate and undergraduate students. They select the speaker such that his/her lecture provides information to the audience that helps broaden their understanding of current research topics and engage the audience in thinking about solutions for common problems faced in industry. The Wavelets were honored to have Dr. Abma accept their invitation to speak at the University of Houston, and are thankful for Mr. Alfataierge for coordinating the event.

Figure 4 Group photo of Dr. Abma and talk attendees.

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)
Jon Cocker (DUG)
Rob Stewart (U of H)
Ping Wang (CGG)
Joe Dellinger (BP)
Sergey Fomel (UT)
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 ...

J. Haynie Stringer

by Tommie Rape

The many social and technical opportunities offered by the Geophysical Society of Houston (GSH) for the geophysical profession of Houston and beyond are due largely to many dedicated volunteers. The GSH wants to recognize some of these contributors 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 person'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

J. Haynie Stringer, born and raised in Mississippi, graduated from Mississippi State University with a Bachelors of Science degree in mathematics. Haynie then began work with Western Geophysical as a computer programmer. For the first few years of his career he traveled the world while installing new computer systems on field seismic crews in both marine and land operations. Haynie then returned to Houston where, over the next few decades he progressed through various management positions with WesternGeco and various legacy companies. He managed various software development functions for Western Geophysical that developed and supported many different operational and processing software packages for seismic and magnetic operations. Haynie was the Product Champion of Seismic Data Management for Schlumberger Information Solutions. For eleven years Haynie was Vice President of Aero Service Division, Western Geophysical Data Processing/Software Services that was responsible for all aspects of multiclient product lines in gravity and magnetics, seismic navigation, aerial photography, and geophysical data processing. While working at Western Geophysical he also met his wife, Barbara, who was also working there. They have two grown children. He retired in 2004, holding several patents after helping develop many of the geophysical industry's leading geophysical operation and processing systems. Then, Haynie started his next important job.

After retiring from Western Geophysical, Haynie quickly got involved with the Geophysical Society of Houston (GSH) by accepting a request to work with the Outreach and Geoscience Museum Committees. He said that he had not wanted to lie around in retirement, but instead wanted to make good use of his time and keep in touch with the geophysical community. Soon after getting involved with the GSH, Haynie saw a shortcoming in the technical training in the geophysical arena, and he worked to develop the GSH/HGS Geoscience Day in 2006. Over the years this has been a very successful one day event for new hires to learn about many aspects of the petroleum industry. While developing this event, the GSH discovered a remarkable talent of Haynie's, and that was in his ability to solicit sponsorship from the petroleum industry in support of GSH sponsored events. Haynie then became chair of the Sponsorship Committee (known within the GSH as Haynie's Angels), where for years he has championed the support of GSH social and technical events by industry. He quickly became involved in many of the GSH social events (e.g. Salt Water Fishing Tournament, Sporting Clays event, Tennis Tournament, the annual Icebreaker, etc.) where he led efforts in getting financial support for the events. These events have for years successfully raised money the society has parlayed into outreach and scholarships for our future generations of geophysicists. Similarly, Haynie has supported many of our technical events by attracting support for our Spring Symposium, Technical Breakfasts, and Technical Lunches. Somehow, amongst all these efforts, Haynie found time to serve as the 2nd VP for the GSH in 2007-08. His leadership in the GSH continued to grow as he then became involved in the Financial Committee and the Editorial Committee. In the Financial Committee he has provided a very valuable historical perspective that aids incoming Treasurers as they grow into their new job. In the Editorial Committee Haynie (and Lee Lawyer) helped develop the idea, design, and generation of the GSH Journal and continues to help in the proofing of the monthly issues and the oversight of its content. He also provides images that make up the beautiful and exciting

Interview continued on page 31.

Interview continued from page 30.

covers of every issue of the Journal. The last few years, Haynie has chaired the highly successful Webinars Committee that has provided invaluable technical training for geophysicists worldwide and has funded the GSH outreach, scholarship efforts, and the GSH in general. Haynie has continued in his leadership roles by serving as the SEG Representative and on the GSH Board of Directors for many years. He has rarely missed a Board meeting in the many years he has served the GSH. Haynie has also served on the Nominations Committee for many years where he has helped select nominees for the future leadership of the GSH; he has also helped this committee select Honorary and Lifetime GSH awardees that are honored by the society for their very valuable service to the GSH. Haynie's presence throughout the years has been invaluable in providing support to succeeding GSH officer administrations.

Though his greatest efforts go to the GSH, Haynie also supports other organizations through his volunteer efforts. For 12 years he has volunteered for the Houston rodeo by working in the Support Committee doing computer work. At his church he has worked many years on the Finance Committee and on the committees for four building campaigns. He has served on his home owners board for 15 years. Where all of you may have benefitted from his services is when Haynie served as the Volunteer Coordinator for two different SEG International Conventions here in Houston. The Conventions would not be able to function without the many volunteers recruited and organized by Haynie.

With Haynie being such a model volunteer, I asked him why he has continued his extensive volunteer efforts with the GSH. He said that his efforts have no exalting purpose; his efforts are just to keep him interacting with the geophysical community that he enjoys.

Being such a volunteer role model, I also asked him how to advise some to start volunteering for the GSH today. He said a person should find something that they have a passion for and then get involved; they should not say that they just want to be on the volunteer list and then wait for something to happen. They should get involved by going to events and talking to GSH leaders. **Potential volunteers, particularly students and young professionals should recognize the valuable experience and lifelong contacts that they would gain in volunteering for the GSH that would help them in their professional jobs.**

Haynie's value to the GSH has been recognized many times by the GSH. He has been honored with Lifetime membership and has won the President's Award twice. Haynie has provided tremendous leadership through the years in the GSH. But with his fondness for the GSH, he is also a "behind the scenes guy". He provides the graphics for many ads that you may have seen, but never knew that they were prepared by him. He drops by the GSH office often just to see how he can help and he often provides the GSH staff with lunch. Haynie provides all of his services to the GSH because (as mentioned earlier) he enjoys being involved with the geophysical community, but also because he wants to **"help make the GSH very relevant to the geophysical community"**. I hope that all of you out there appreciate that relevance and the extremely valuable part that Haynie Stringer has played in achieving that relevance.

Thank you, Haynie.

GEOSCIENCE CENTER 2017 – 2018 CHALLENGE

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

Matching: John & Amy Aubrey, Frank Dumanoir, Cheryl Mifflin, Roshan & Dave Agarwal, Bob Johnson, Lisa Buckner, Jerry Coggins, Sidney Conger, Peter Duncan, D W Frye, Tommie Rape, Art Ross, John Sherwood, Haynie Stringer, Neil and Sharon Zimmerman, Bill Albers, Brian & Julie Burgess, Alan Foley, Taylor Galloway, Tony LaPierre, George Parker, Zachery Van Orman

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)

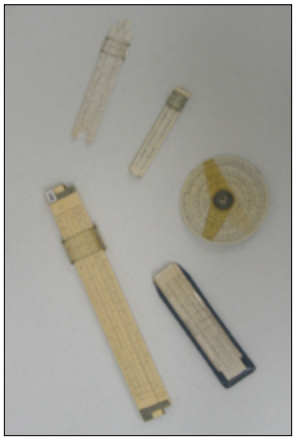


Figure 1

Figure 2

This month I would like to give a little background on some of the "computers" we have at the Geoscience Center. In the early days of petroleum exploration, a "computer" was the person who computed the various corrections for the field records. This was done by hand, or with the help of mathematical tables, such as a "CRC Standard Mathematical Tables" book, and maybe a slide rule. A picture of some of our slide rules (*Figure 1*) is included with this article. As you can see, they came in various sizes and shapes. Another "computer" was a Monroe calculator, shown in *Figure 2*, which was totally mechanical until electrical ones were developed. They were a mainstay in field offices and were also used for expense reports and bookkeeping. Later came the small battery powered hand held calculators, such as the one shown in *Figure 3*.

One of our more interesting computers dates to the 1950's and is a Dip Logging Computer. It had been in our inventory for many years and its purpose and use had been a mystery. A few years ago, a volunteer researched the item and discovered that it was described in the early 1950's in the AAPG Bulletin. Carter Oil Company personnel invented the device, and it was used to compute and display dip amount and direction in drilled wells from well logging tools. Humble Oil later acquired Carter Oil and made the version which we have. This device is also pictured in *Figure 4*.

Another product of the 1950's is the CGC 5000 Optical Analog Gravity Computer. This desk mounted computer was used in the interpretation of gravity anomalies. It was designed to semi-automate the graticule or dot chart calculations previously done by hand, and this device sped up the process of gravity modeling and interpretation. Our desk mounted model is shown in *Figure 5*.

We have a display of the pictures of past GSH presidents on one wall at the Geoscience Center. However, one picture is missing and that is of Earl W. Johnson, who was GSH President in 1951. He helped Henry Salvatori start Western Geophysical in 1933 and he also started General Geophysical Company in 1935. Pictures of the other Presidents were taken from GSH photo directories or newsletters. If anyone can help find a picture of Mr. Johnson, please let me know.

Another item that we are searching for is an SGR seismic recording unit. This cableless system was developed by Amoco in the 1970's, and although thousands were produced and eventually used by various seismic contractors, we have not been able to find one to preserve in our museum collection. We would like to have a control box as well as a recording box. Please let me know if you have any contacts that might be able to help.

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.

Figure 3

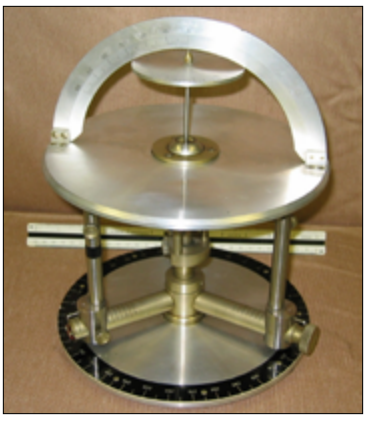
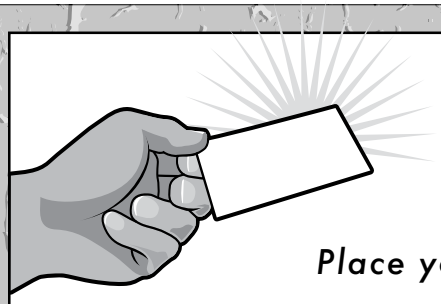


Figure 4

Figure 5



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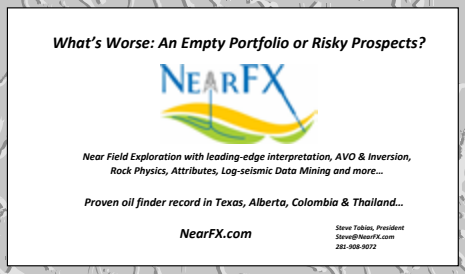

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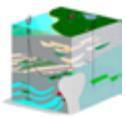
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Doodlebugger Diary

Shipwrecked in the South China Sea

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

This Doddlebugger Diary by Lee Lawyer first appeared in the September 2013 issue of the Journal. If you have an item for the Doodlebugger Diary, send it to llawyer@prodigy.net or to editor@GSH.org

Part 1: Surveying the Yacheng 13 Gas pipeline route

In early 1992 I had found myself laid off from Fugro-McClelland Marine Geosciences where I was a significantly underpaid hazard survey interpretation geoscientist (I had taken the job in 1988 after getting an MS in Geophysics at Texas A&M, at a time when almost nobody was being hired and as a result agreed to a salary that was perhaps half what it should have been). Fortunately, my hi-res acquisition, processing, and interpretation skills were very marketable. I hired on with the acquisition and processing QC company Energy Innovations, which in industry parlance was known as a 'birddog' company because we represented the client company's interests. They immediately handed me what I considered to be a plumb overseas project – surveying the 780 km-long pipeline route from Hong Kong to the Arco Yacheng 13 Gas Condensate Field south of Hainan Island in the South China Sea. And thus our story begins in May, 1992.

After a pleasant business-class flight to Hong Kong and several days seeing the city (my favorite is Kowloon and all the carved jade shops), I went across the border (at the time it was a border) to Shenzhen and the port of Shekou where Arco had their offices. After a day or two of meetings with Arco and the Fugro party chiefs (who were doing the surveying) going over the route, we had a chance to go to the dock to see the boat. When we arrived there, much to our surprise, in place of a survey ship was an erstwhile drillship, the Nanhai 503. It was out of work and had been

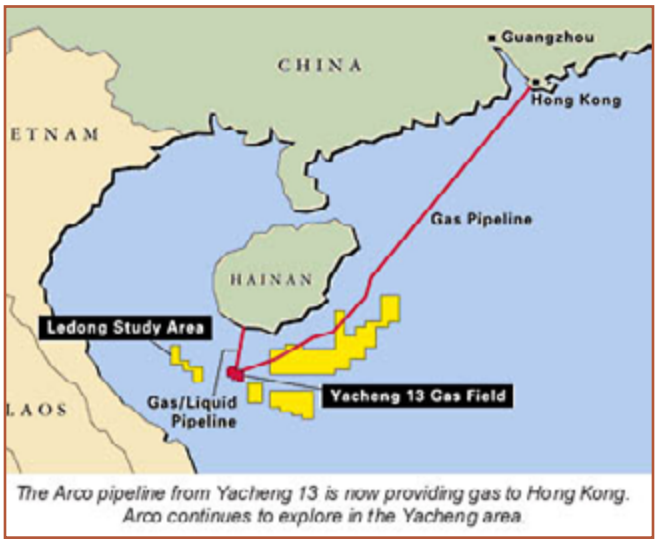


Figure 1: Arco pipeline route from the Yacheng 13 gas field to Hong Kong. From Oil & Gas Online, March 6, 2000 (https://www.oilandgasonline.com/doc/modest-advances-in-chinas-south-china-sea-0002).

hired by Arco to do hi-res surveying. The party chiefs and I exchanged sideways glances that clearly conveyed our discomfort and doubt about what we had signed on for.

Regardless, we outfitted the ship with a normal complement of hi-res gear – fathometer, 3.5 kHz sub-bottom profiler, side-scan sonar and magnetometer. With all equipment and recorders set up and checked out, we were on our way. Our plan was simple enough – survey the route down to the Yacheng 13 platform location, survey a corridor from the platform to the southern shore of Hainan Island where China Offshore Nanhai West (the division of CNOOC responsible for this field) would build a condensate processing facility, then survey an adjacent corridor for the pipeline back to Hong Kong (the idea being to have a wide corridor mapped with side-scan sonar for the pipeline laying crew to have plenty of visibility of potential hazards). Work time would be perhaps a month (I forget the exact preplan time length).

The first leg went smoothly and was completed well ahead of plan. As we approached the east side of Hainan Island the seafloor became quite rocky and we spent an inordinate amount time surveying an increasingly wider area in search of a path that would be acceptable for a pipeline. We

Doodlebugger continued on page 38.

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 37.

Figure 2: Nanhai 503 at dock in Shekou, Shenzhen, China, May 1992.

ended up moving away from the shoreline a considerable distance from the preplan route but in the end found an acceptable route.

As we traversed down the east side of Hainan Island we had to continually be watching for rocky outcrops on the seafloor that might interfere with pipeline laying but eventually reached the location of the future Yacheng 13 platform. At this point we laid in a new route straight to the shore for the condensate pipeline and started surveying. We were about half way to shore on the morning of June 18. I was in the bridge checking out progress overnight. We had taken a deviation around a structure on the bathymetry charts and we were headed back offshore to image the other side of it. We assumed this would be one more in a growing list of deviations to the preplan. All of a sudden, shattering our otherwise peaceful morning, the vessel was jolted to a sudden halt from 5 knots. Everyone went flying forward. When we all lifted ourselves off the deck, sirens were going off everywhere – the engine room, ballast tanks, the drill rig on the back deck. I didn't know a ship had that many alarms.

In seconds, but which seemed like lifetimes, everyone was running in all directions. Anyone who was off shift was instantly on shift. Everyone flew to their respective stations to check out damage. My understanding was that the engine room was intact with no water but engines were put in neutral anyway because the ship was not moving. The ballast and holding tanks were not so lucky. All sorts of fluids were being ejected from vents on the deck as they collapsed in response to hitting the reef. Running around the deck became quite hazardous as oil and water and who knows what else flowed everywhere. The drill rig moon pool was frothing and seawater was flying upwards in all directions.

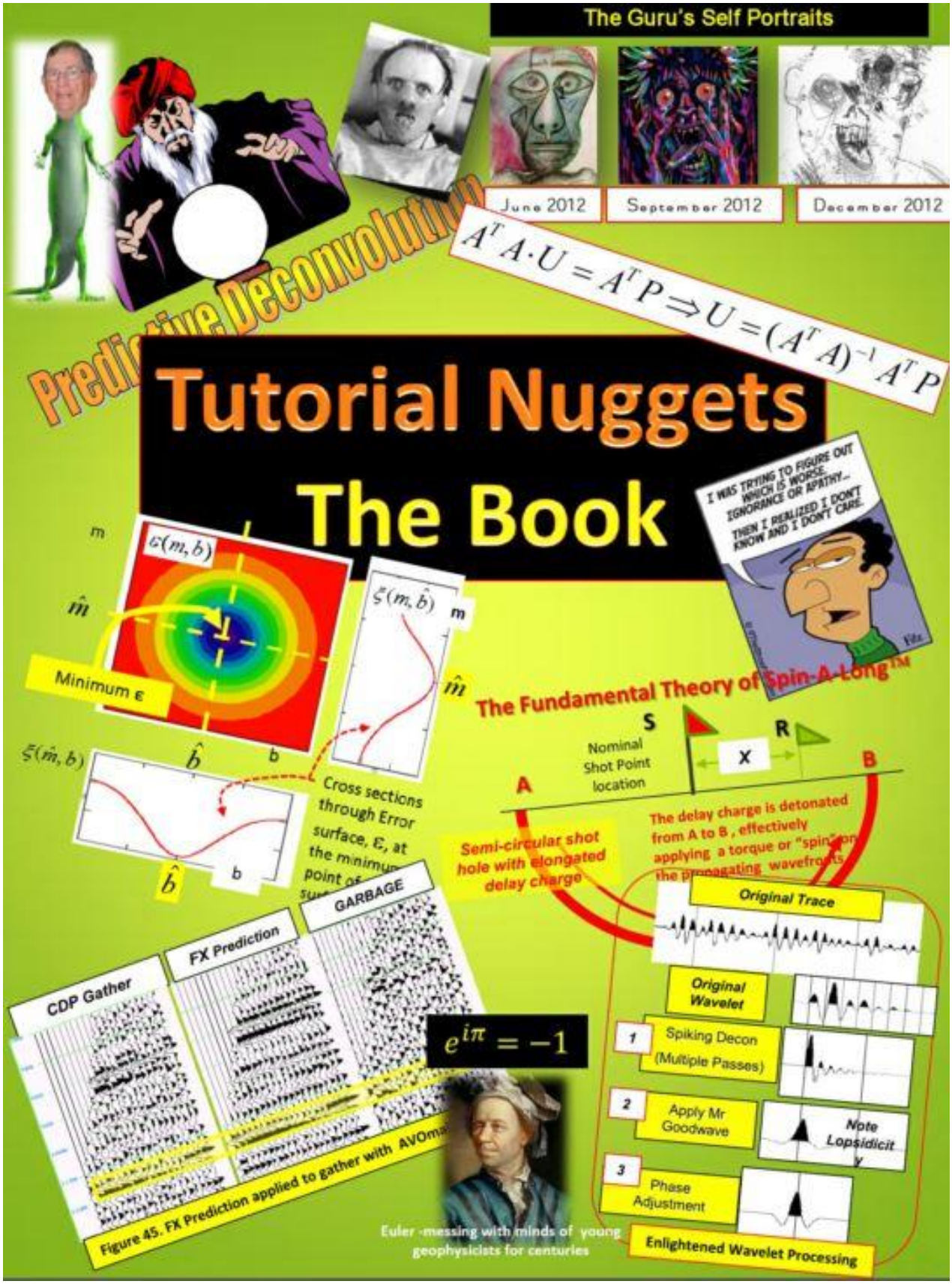
I ran out to the instrument room and then to the back deck as soon as I could. When underway our gear maintained stationary heights above the seafloor. However, when the ship stopped everything fell to the bottom. The Fugro guys managed to retrieve the 3.5 kHz profiler but the magnetometer was hung on the rocks. One of the guys took a fire ax to the cable and cut it away. The party chief and I agreed we needed to collect all the hardcopy and digital data records and stash them because an emergency evacuation was now a certainty and we did not want to lose a month's worth of survey data. We stuffed rolls of records and disks wherever we had space, which meant in our personal bags, throwing out clothes if necessary to make space.

Meanwhile, the ship was slowly bashing itself to pieces on the rocks. We were far enough offshore that we just had long-period swells that were not more than a few feet high. However, what that meant was that the ship would rise up on top of a swell and then slam down onto the rocks at the base of a swell. As long as I live I will never get over the sound of a metal hull crunching on rocks, but that was what was happening every 10-15 seconds. Back on the bridge, I found out that the tide was somewhere around the maximum. What that meant was that in perhaps 6-8 hours the tides would be at a low point which would expose the reef high above the waterline and this would mean a capsized vessel. We needed to get off this ship, and the sooner the better. I never in my life imagined I would end up needing to be rescued by the Chinese navy, but that now seemed to be our only hope.

Next month: Part 2 – The Chinese Navy Mobilizes

Mystery Item

The Mystery Item on page 8 is a A survey scale used for plotting transit lines.



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