October 2016

GSH Journal

GEOPHYSICAL SOCIETY OF HOUSTON
Volume 7 • Number 2

The Epicenter of Geophysical Excellence

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SEG SOCIETY OF EXPLORATION GEOPHYSICISTS

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MTG

FEATURES

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LOOK INSIDE

On The Cover...

The CGG Oceanic Sirius on a seismic survey.

Image courtesy of CGG.

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 David W. Watts, editor, at DWatts1@slb.com.

2016 GSH JOURNAL DEADLINES

Dec 2016	**Oct 3**
Jan 2017	**Nov 2**
Feb 2017	**Dec 3**

GSH Digital Journal *Navigating the Downturn*

By David Watts, GSH Editor, editor@gshtx.org

The oil Industry has seen significant upheaval in the last couple of years and it has had to react swiftly through choppy waters that in the past were pleasantly smooth and predictable. These challenges to the industry and the GSH society have made us acknowledge the need to be creative in designing our functions and services to support you as our members and supporters especially regarding our publications. While the GSH wants to be technically savvy and environmentally conscience in all of our publications, we also acknowledge there exists a tremendous cost in creating the Journal publication. This cost has been accentuated these last two fiscal years due to a substantial decrease in advertising revenue with the restrictions in many companies advertising budgets.

In striving to be financially responsible, the GSH has made the difficult decision to provide the society members an online and electronic publication of the Journal for the continued fiscal year of 2016-2017. While we acknowledge that this decision has been a difficult one, the GSH Board of Directors feels that it is within the best interest of the society as a whole to maintain our financial budget and be cognizant of the current business environment. At the end of the year, this decision will be reevaluated.

Moving forward, the GSH will continue to provide the high quality Journal which all of you have come to expect and we are striving to expand our content and material to continue to serve our readers. Looking forward, I am very excited about this electronic version as we will no longer have the limitations which have limited our content, format, and size of the Journal which a printed version must abide by. We will start out small with subtle changes to the Journal to make the online viewing easier and more user friendly with an emphasis in interactivity. Looking into the future, we can envision a broader evolution of the Journal into a truly unique online experience that our members can easily access and absorb the information and material that will be available.

In striving to be financially responsible, the GSH has made the difficult decision to provide the society members an online and electronic publication of the Journal for the continued fiscal year of 2016-2017.

To help each of you with navigating through the online experience, the Editorial committee is supplying the link to the training guide within Adobe to assist you through the tools and features which are currently available to assist with your online experience. Please utilize the link provided below to view the Adobe tutorial guide. Additionally, we have added a brief summary of available quick tools when you open the Journal for the first time in Adobe. We are looking forward to an exciting Journal for 2016-2017.

Please email me with any question or concern that you may have.

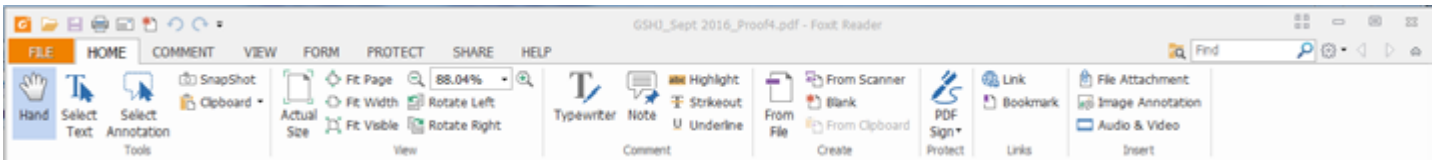
https://helpx.adobe.com/acrobat/tutorials.html

Geophysical Society of Houston
Online Training Guide

The online digital version of the Geophysical Society of Houston's Journal allows the reader to utilize the tools within Adobe to quickly navigate through the online document. The following points of emphasis are to help guide you through the pdf digital version.

Main Tool Bar has tabs including HOME and HELP

- **HOME**



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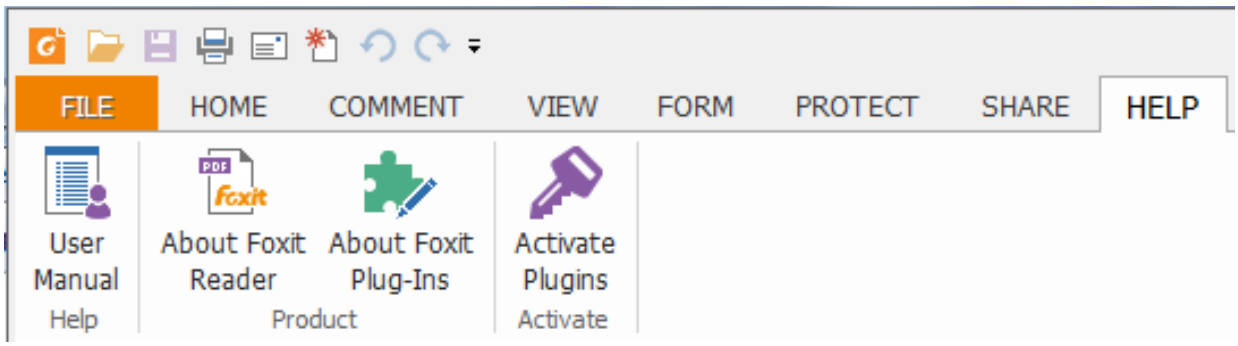

Adobe User manual help icon

Geophysical Society of Houston
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Adobe Tools

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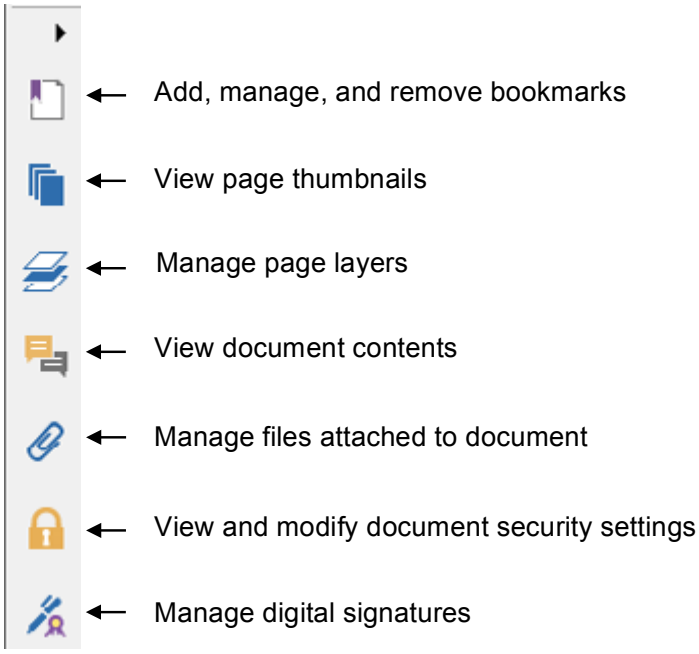

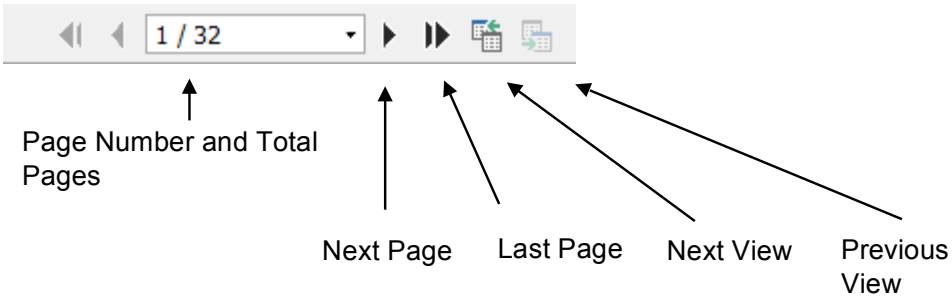

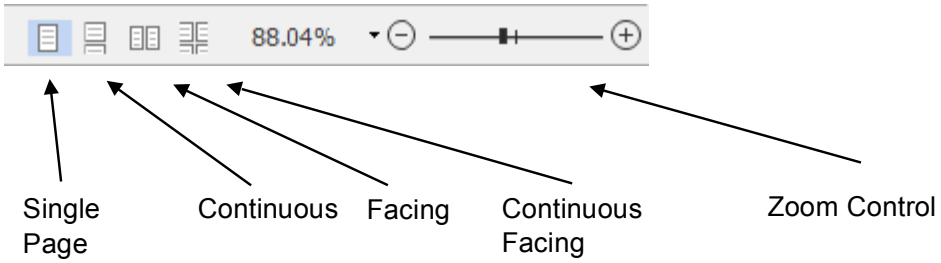

Here the reader can employ a page by page or actual magazine layout or anything in between as desired to allow for individual preferences. The zoom percentage allows for increased magnification.

A Word from the Board

Are You Building for the Future?

By Dennis Sump, 2nd VP

Hello Members,

Greetings from the newly elected Board of Directors of the Geophysical Society of Houston. As we head into the 4th quarter of 2016, it is time we examine the status of our industry. The Oil and Gas industry has continued to step-back and recharge due the lower energy prices. This has been a very painful and stressful time for companies and our professionals and their families. However, since the first of year we are starting to see glimpses of industry recovery. The price of WTI at the end of 2015 was hovering around $30 per barrel. The price on August 12 was just south of $45 per barrel. A 50% increase over 8 months does not constitute a spike, but a gradual positive move in the price of oil. This is great news for all of us and gives us hope and confidence for the rest of 2016 and into 2017.

The 2nd VP of the GSH oversees all the social and networking events for the society. These events not only provide excellent networking opportunities, but provide our supporting companies a chance to meet with and present solutions to industry professionals. These events are a welcome relief from the day to day struggles in our industry. We use these events to give all attendees an opportunity to relax and enjoy the famous camaraderie of this business. The GSH is a non-profit organization and all the monies raised in our social events, through participation and sponsorships, are the largest single source of our funding. These events assure that the GSH continues to provide the continuing education, outreach and historical preservation that it has continued to provide since 1948. Heck that is even longer than I have been born!

In 2015, we held 9 different social and networking events. Golf Tournament, 2 TopGolf events, 2 Icebreakers, Sporting Clays, Tennis Tournament, Fishing Tournament and our Honors and Awards Banquet. Even in such a difficult year, all the events were very successful. All of these events take extensive planning and time for our volunteers and office managers, Kathy Sanvido and Karen Blakeman. Each event is managed by a committee chair and often several sub-chairs. These are all volunteers that take time away from their job to assist the GSH. In these tough times, we are even more grateful for their work and sacrifice. Having been the Golf Tournament chair for the last 5 years, I can attest that these events do not happen without the tireless efforts of our volunteers. In addition to organizing and directing the events, the chairperson(s) are tasked with gathering sponsorships for their particular event. Speaking of our sponsors, they have continued to assist the GSH with our mission. Even with limited sponsorship and marketing budgets, companies and individuals continue to help, whenever possible. If a company cannot allocate sponsorship dollars, many are stepping up and providing sponsorships that help us reduce our costs of the event.

Dennis Sump
2nd VP

2016 brings new challenges and opportunities for the GSH in regards to event preparation and scheduling. We understand that in the present climate we needed to make certain our events provided timely and needed opportunities for the industry to participate. Also, to continue our work in the geophysical industry, we have to assure that these events are economically feasible and not an undue burden on our loyal sponsors. We scaled back the 2016 Golf Tournament in April and have postponed the TopGolf events, Northside Icebreaker, and Tennis Tournament for this year. We are confident that with the uptick in our industry these events will be back very soon. I mentioned opportunities that are available from this consolidation in our events:

1) Our sponsors can now better budget for their limited sponsorship monies, with only a limited number of events to select for sponsorship.

2) There are opportunities for new events and venues and possible combining of events

I would like to welcome Katherine Pittman, the new 2nd VP Elect, who will be assuming the role of 2nd VP after my tenure is complete in July 2017. She has been a huge help to me and will do an incredible job in her position. She is not only very organized, but she also possesses a keen eye for problem solving and has a vision for the GSH and its activities.

In conclusion, this industry will continue to rebound and will come out stronger than ever before. We have the brightest scientific minds and businessmen/women of any industry. We will adapt, invent, explore and discover new efficiencies that will bring all of us back to the top! The Geophysical Society of Houston continues to be *the* source for news, education and historical preservation for our industry. We are very proud of all our members, staff and officers for their support of this great organization.

Warm regards,

Dennis

Technical Events - See gshtx.org for more details on these events

TECH BREAKFASTS

Wavelet Denoise for Seismic Noise Attenuation

	Speaker(s):	Zhou Yu
Oct. 4, 2016	***7:00 AM to 8:30 AM***	Sponsored by Anadarko and Lumina
Northside Breakfast	**Location:**	Anadarko Petroleum 1201 Lake Robbins Drive The Woodlands, TX 77380
Oct. 12, 2016	***7:00 AM to 8:30 AM***	Sponsored by Schlumberger
Westside Breakfast	**Location:**	Schlumberger, Q-Auditorium 10001 Richmond Avenue Houston, TX 77042

DATA PROCESSING & ACQUISITION SIG

Isotropic AVO Makes No Sense

Oct. 4, 2016	**Speaker(s):**	Leon Thomsen, Chief Scientist, Delta Geophysics
	4:30 PM to 6:00 PM	Sponsored by Schlumberger
	Location:	Schlumberger, Q-Auditorium 10001 Richmond Avenue Houston, TX 77042

GEOSCIENCE COMPUTING SIG

Visualization Infrastructure at the Campus Scale

Oct. 6, 2016	**Speaker(s):**	Erik Engquist, Visualization Manager, Rice University
	11:30 AM - 1:30 PM	Sponsored by Unique Digital, Inc.
	Location:	UDI Houston Banquet Room 10595 Westoffice Dr. Houston, TX 77042

MICROSEISMIC SIG

Case Examples, QC and Interpretations of Waveform-Based Moment Tensor Solutions

Oct. 6, 2016	**Speaker(s):**	Alexander Droujinine, Shell
	11:30 AM to 1:00 PM	Sponsored by Apache Corporation
	Location:	Apache Corporation 2000 Post Oak Blvd. #100 Houston, TX 77056

TECH LUNCHEONS

New and Not-So-New Applications of Low-Rank Matrix and Tensor Completion to Seismic Data Processing

	Speaker(s):	Mauricio D. Sacchi, 2016 CSEG Distinguished Lecturer
Oct. 11, 2016	***11:00 AM to 1:00 PM***	Sponsored by Anadarko and Lumina
Westside Luncheon	**Location:**	Norris Conference Center 816 Town & Country Blvd. Houston, TX 77024 (Free parking off Beltway-8 northbound feeder or Town & Country Blvd.)
Oct. 12, 2016	***11:00 AM to 1:00 PM***	
Downtown Luncheon	Different Location This Month **Location:**	Hess Corporation 1501 McKinney Houston, TX 77010
Oct. 13, 2016	***11:00 AM to 1:00 PM***	Sponsored by Data Direct Networks
Northside Luncheon	New Location **Location:**	Southwestern Energy Conference Center 10000 Energy Drive Spring, TX 77389 (Free Parking)

ROCK PHYSICS SIG

Dispersion and Attenuation of Seismic Waves in Fractured Reservoirs

Oct. 12, 2016	***5:15 PM to 6:30 PM***	Sponsored by CGG and IKON Science
	Location:	CGG 10300 Town Park Dr. Houston, TX 77072

Technical Breakfasts

Wavelet Denoise for Seismic Noise Attenuation

Speaker(s): Zhou Yu

Northside

Tuesday, October 4, 2016
7:00 – 8:30 a.m.

Sponsored by Anadarko and Lumina

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

Westside

Wednesday, October 12, 2016
7:00 – 8:30 a.m.

Sponsored by Schlumberger

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

Zhou Yu

Abstract: Delivering high-resolution seismic images is an important objective for both land as well as marine data processing. Often, we tend to compromise bandwidth in return for better signal-to-noise ratio, however, this has a direct negative impact on the resolution of the final seismic image. In this abstract, we develop and discuss a new approach using wavelet denoise for noise attenuation that delivers a better signal-to-noise ratio without compromising the bandwidth. Our approach is adaptive, automatic, non-stationary and exploits the signal characteristics in a complete 3D sense. We use forward and inverse normal move-out (NMO) in conjunction with a wavelet transform to effectively distinguish signal from noise and subsequently remove the undesired components. Our approach is well suited for dealing with high amplitude scattered noise such as ground roll and other forms of noise that may be spatially aliased. We demonstrate the effectiveness of our algorithm using multiple examples from various land data-sets acquired around the world in different geological settings.

Biography: Zhou received a B.S. (1983) in marine geophysics from Ocean University of China, an M.S.(1996) in geophysics from MIT, USA and a Ph.D. (2001) in geophysics from University Texas at Dallas, USA. Zhou joined BP in 2001 and has been working in BP's Advanced Seismic Imaging group in the Upstream Technology organization. Zhou's interests are innovative solutions to various signal process and analysis problems. They include Kirchhoff migration operator anti-aliasing, land data process, deconvolution, conditioning data for AVO analysis, ocean bottom seismic data process, inverse-Q process and seismic attribute estimation.

Rock Physics SIG

Dispersion and Attenuation of Seismic Waves in Fractured Reservoirs

Speaker(s): Boris Gurevich

Wednesday, October 12, 2016
5:15 p.m. - 6:30 p.m.

Sponsored by CGG and Ikon Science

Location: CGG
10300 Town Park Dr.
Houston, TX 77072

Boris Gurevich

Abstract: The detection and characterization of domains of intersecting fractures are important goals in several disciplines of current interest, including exploration and production of unconventional reservoirs, nuclear waste storage, CO2 sequestration, and groundwater hydrology, among others. The objective of this study is to quantify the effects of fracture intersections on the frequency-dependent elastic properties of fluid-saturated porous and fractured rocks.

Biography: Boris Gurevich has PhD in Geophysics from Institute of Geosystems, Moscow (1988). His career includes research positions at Institute of Geosystems, Moscow from 1981 to 1994 and at the Geophysical Institute of Israel in 1995-2000. Since 2001, he has been a Professor of Geophysics at Curtin University and advisor to CSIRO Energy (Perth, Western Australia) where he has had both research and management duties as an academic department chair. His main interests are in rock physics, poroelasticity, seismic theory, modelling, imaging and 4D.

Technical Luncheons

New and Not-So-New Applications of Low-Rank Matrix and Tensor Completion to Seismic Data Processing

Speaker(s): Mauricio D. Sacchi,
2016 CSEG Distinguished Lecturer

Mauricio D. Sacchi

Westside

Tuesday, October 11, 2016
11:00 a.m. – 1:00 p.m.

Sponsored by Anadarko and Lumina

Location: Norris Conference Center
816 Town & Country Blvd.
Houston, TX 77024

Downtown

Wednesday, October 12, 2016
11:00 a.m. – 1:00 p.m.

Location: Hess Corporation
1501 McKinney
Houston, TX 77010

Different Location *This Month*

Northside

New Location

Thursday, October 13, 2016
11:00 a.m. – 1:00 p.m

Location: Southwestern Energy
Conference Center
10000 Energy Drive
Spring, TX 77389

Sponsored by Data Direct Networks

Abstract:

In recent years, the development of recommendation systems has become an important area of research for data scientists. A recommendation system (or recommender system) is an algorithm that attempts to predict the rating that a user or costumer will give to an item. Recommendation systems are becoming quite popular in the field of e-commerce for predicting ratings of movies, books, news, research articles etc. Research in the area of data analytics and recommendation systems has led to important efforts toward solving the so-called matrix completion problem. The latter entails estimating the missing elements of a matrix containing customer ratings. The aforementioned problem can be extended to the recovery of the missing elements of a multilinear array or tensor. Prestack seismic data in midpoint-offset domain can be represented by a 5th order tensor. Therefore, tensor completion methods can be applied to the recovery of unrecorded traces. Furthermore, tensor completion methodologies can also be applied to multidimensional signal-to-noise-ratio enhancement, simultaneous source separation, interpretative attribute analysis etc. In this presentation, I will review matrix and tensor completion methods and discuss their implementation to reconstruct, process and enhance seismic volumes. I will also discuss the successful application of tensor completion techniques to the reconstruction of industrial data sets.

The talk is intended for senior undergraduate and graduate students in Geophysics but I expect that it might also be of interest to applied mathematicians, computer and data scientists.

Biography:

Mauricio D. Sacchi received a diploma in geophysics from The National University of La Plata, Argentina, in 1988 and a PhD in geophysics from UBC, Canada, in 1996. He joined the Department of Physics at the University of Alberta (Edmonton, Canada) in 1997. He was promoted to full professor in 2006 and become chairman of the Department of Physics in 2010. His research interests are in the area of signal analysis and imaging methods. He directs the Signal Analysis and Imaging Group, an industry-sponsored initiative for advanced research in signal processing and imaging. He has developed and taught short courses for the industry and for SEG, CSEG, and EAGE in the area of seismic signal theory, transform methods for signal enhancement, seismic inversion, and multidimensional data reconstruction. In collaboration with students, he introduced 5D reconstruction methods, sparse signal representation theory and tensor reconstruction methods to the seismic processing community. With Tad Ulrych he wrote the book Information-based processing and inversion with applications (Elsevier). He is the recipient of the 2012 CSEG Medal, the highest award that the Canadian Society of Exploration Geophysicists bestows. He was also SEG's 2014 Honorary Lecturer for Latin America. He is also the Editor of the journal Geophysics for 2015-2017.

Data Processing & Acquisition SIG

Isotropic AVO Makes No Sense

Speaker(s): Leon Thomsen, Chief Scientist, Delta Geophysics

Tuesday, October 4th, 2016
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

Sponsored by Schlumberger

Leon Thomsen

Abstract:

Does it make any sense to analyze Amplitude Variation with Angle even while ignoring Velocity Variation with Angle (aka anisotropy)? The short answer is No. A longer answer includes an explanation of why we have been able to "succeed" with isotropic AVO anyway, and how we can expect to do better, using a newly available workflow for doing anisotropic AVO.

Biography:

Leon Thomsen holds degrees in geophysics from Caltech (BS, 1964) and Columbia (PhD, 1969). Following academic appointments at CNRS Paris 1969-70), Caltech (1970-72), and SUNY Binghamton (1972-80), his industrial appointments included Amoco (1972-1999) and BP (1999-2008). Following retirement from BP, he serves as Chief Scientist of Delta Geophysics as Research Professor at the University of Houston, and as Visiting Scientist at Lawrence Berkeley National Laboratory.

Thomsen has led technical development in applied geophysics through innovation in vector seismics (polar anisotropy, azimuthal anisotropy, azimuthal AVO, converted waves, and Life-of-Field-Seismics); in pore-pressure prediction; and most recently in ISEM and anisotropic rock physics, through numerous SEG publications and presentations, and many patents.

Thomsen was an early recipient (1960-64) of an SEG Scholarship. He received SEG's Fessenden Award in 1994. He served as SEG Distinguished Lecturer in 1997 and as SEG/EAGE Distinguished Instructor in 2002. He is an Honorary Member of GSH and of EAGE. He is a Foreign Member of the Russian Academy of Natural Sciences and holder of their Kapitsa Medal. He served SEG as Vice President, as President-Elect, and as President (2006-07). He currently serves on the SEAM Board of Directors.

Microseismic SIG

Case Examples, QC and Interpretations of Waveform-Based Moment Tensor Solutions

Speaker(s): Alexander Droujinine, Shell

Tuesday, October 6, 2016
11:30 a.m. - 1:00 p.m.

Location: Apache Corporation
2000 Post Oak Blvd.
#100
Houston, TX 77056

Sponsored by Apache Corporation

Alexander Droujinine

Abstract:

The primary tool for understanding the heterogeneity of reservoirs and the complexity of fracture networks has been microseismic monitoring. It is known that source mechanisms (double-couple or full moment tensors) provide the means to estimate subsurface elastic properties linked to geological, geomechanical and in situ stress conditions. The waveform-based moment tensor inversion method presented here provides both focal mechanisms and tensile failure parameters obtained from full moment tensors. The method has been validated to help optimize the multi-

Microseismic continued on page 12.

Geoscience Computing SIG

Visualization Infrastructure at the Campus Scale

Now meeting every month during lunch.

Speaker(s): Erik Engquist, Visualization Manager, Rice University

Tuesday, October 6th, 2016
11:30 a.m. - 1:30 p.m.

Location: UDI Houston Banquet Room
10595 Westoffice Dr.
Houston, TX 77042

Sponsored by Unique Digital, Inc.

Erik Engquist, Visualization Manager, Rice University

Abstract:

Visualization technology at Rice University shows up everywhere, from undergraduate education to advanced research and international collaboration. The University provides a varied collection of tools and facilities, as well as training, in order to provide the flexibility required by researchers and educators and there, often quite complex, workflows. In this presentation I will discuss some of the hardware and software infrastructure available on campus such as the DAVinCI visualization wall and remote visualization portal. The DAVinCI Visualization Wall is located in the Chevron Visualization Lab. I will also present examples of how these components are combined and used by groups on campus to streamline their efforts in teaching, research, and outreach.

Biography:

Erik Engquist is the Visualization Manager at Rice University. In this role he provides training and support for visualization activities and infrastructure across campus. He joined the university in 2011 having previously supported visualization research at the University of Houston and the San Diego Supercomputer Center. Erik has a M.Sc. from the Royal Institute of Technology, Sweden.

See the article on page 13 for background on the importance of Geoscience Computing and the nature of this SIG.

Microseismic continued from page 11.

Microseismic SIG

Case Examples, QC and Interpretations of Waveform-Based Moment Tensor Solutions

stage hydraulic fracture stimulation (North America) and to monitor the induced seismic activity in a depleting gas reservoir (Oman). Uncertainties in microseismic source solutions have been expressed in terms of relative misfits (variances) between observed and predicted (elastic finite-difference) waveforms. Key deliverables include, but are not limited to 4D distributions of microseismic moment tensor solutions and related geomechanical attributes such as fracture compliances, rupture length, formation pressure drop, and principal stresses.

Biography:

Alexander works in the Shell Projects & Technology team (Rijswijk, The Netherlands) as a senior geophysicist. In the recent years his main focus has been on passive seismic monitoring worldwide. Alexander joined Shell in 2006, after several years of service (as a geophysicist) for the British Geological Survey in Edinburgh, UK. He holds a PhD in geophysics from the Russian Academy of Sciences (1990).

Geoscience Computing

Adoption of Extremely Scalable Compute Architectures is Critical to Keep Pace with Hydrocarbon Demand

By Bert Beals

Tension exists within Exploration & Production (E&P) regarding the adoption of new technologies. This is especially true when these new technologies change work processes. The industry understands that technological advances are crucial to finding and producing hydrocarbons more quickly, efficiently and safely. However, the industry is reluctant to change because of the inherent risk involved in altering proven workflows.

Yet change is inherent in the industry and is coming. It always does. The worldwide demand for hydrocarbons is not slowing down. Those of us in the oil & gas and computing industries must take on the challenge of finding ways to integrate new technologies into E&P organizations and day-to-day processes without increasing the risk of missing project deadlines, producing results of questionable quality, or creating systems that are difficulty to use and support. Easier said than done, you say? You're correct, but we have no choice.

This challenge is particularly acute in the realm of seismic data processing and imaging. The size and fidelity of source data in the upstream workflow are rapidly increasing at a rate that conventional system architectures in use today are unable to cope with performance and reliability requirements. Furthermore, modeling and visualization algorithms are growing in complexity. Our ability to support this explosion in algorithmic complexity and data volume has been accommodated – and even driven – for the past 10 to 15 years by regular advances in affordable computing power.

However, as the saying goes, what can't go on forever won't go on forever. It is tempting to take for granted that the regular cadence of processor improvements, memory density increases, network bandwidth growth, latency decreases, storage performance gains, and software development advances will never end. The oil & gas industry has enjoyed this environment for so long that many believe it will continue unabated.

The Capacity Wave

Since about 2000, seismic data processing and imaging have been riding an innovation wave made possible by a high performance computing (HPC) architecture known as capacity computing. Capacity computing systems are built in a lowest cost, fit-for-purpose manner that often leaves little room for scalability beyond the tightly defined architectures of the applications they are designed around.

For the explorationist focused on processing seismic data to enable 3D reservoir simulations, this means the capacity-style compute architecture has been configured, tuned and scheduled to support a specific workflow with certain software applications. While this leads to efficient use of computing, networking and storage resources, this approach does not lend itself to making modifications in the workflow, introducing new algorithms and applications, or inputting varying quantities and varieties of data.

Unfortunately, new workflows, new algorithms, variable data volumes and new processing techniques are precisely what E&P needs today to keep pace with the demand for additional hydrocarbon discovery and production. The petroleum industry has therefore reached a tipping point. More and more, the E&P industry is forced to produce hydrocarbons from reservoirs that are deeper and harder to exploit than those it has tapped before. Producing from these regions can require secondary, tertiary or "beyond" production technologies and require higher fidelity views of the producing area. Additionally, it is critical that the E&P industry improve hydrocarbon recovery rates from known reservoirs.

To accomplish these goals, E&P organizations must continue to adopt new techniques and technologies that will require dramatically increased compute power and data handling resources. The current capacity-style approach to computer architecture, which has contributed so much to innovation in seismic data processing over the past decade and a half, has reached its limit and will not support the advancements needed for future exploration and production.

Capacity computing may have gotten the oil & gas industry where it is today, but this architecture can't take the industry where it needs to go tomorrow.

Geoscience Computing continued on page 14.

Geoscience Computing continued from page 13.

The Benefits of Capability Computing

Fortunately, a solution already exists. It is called 'capability' computing, a design principle used in extremely large HPC architectures. It supports extreme levels of parallelism where a greater number of cores are used than in capacity computing to process massive amounts of data in parallel rather than in sequence. Software applications and associated workflows are written to allow algorithms to take advantage of massive computing core counts at once to solve the problem at hand.

Capability computing systems are architected on a holistic system level, to address troublesome issues like data locality. Storage tiering can be used to reduce the need to move data over slower, more expensive paths without requiring overprovisioning of more expensive, high performance storage. This allows for massive scale at low latencies and provides much higher compute efficiency rates. These characteristics allow for an infrastructure design that reduces the time and cost of running a wide variety of workflows, applications and data types, thus providing maximum system agility. Workflows and workloads can run at any scale required and on whatever parts of the infrastructure that are available when needed.

For the explorationist, the benefits of capability computing are significant and practical. Reservoir simulations that would have taken centuries can now be run in days or weeks, taking into account a greater number and variety of variables. More design changes and parameters can be modeled, tweaked (i.e., parameter sweeps) and tested. Ultimately, the reservoir simulation yields a higher quality, more accurate earth model in less time.

The mathematical algorithms that hold the promise of producing an earth model that most closely reflects the real world have existed for quite some time. However, the limitations of a capacity-style approach within HPC environments will not allow the inclusion of these new algorithms within the time and cost constraints that are inherent in the E&P industry. The broad adoption of capacity computing architectures is the catalyst that will allow the industry to finally reap the benefits of running these algorithms and data at scale and with the economic efficiencies that have been proven by the use of capacity computing in other equally demanding, HPC-intensive markets.

Despite the significant advantages offered by a technology that's already here and would seem ready to implement, the familiar challenge addressed at the outset still remains – how do we transition our capacity-styled HPC architectures to the capability-style approach without creating substantial risk for the E&P organization?

Getting There from Here

The first step is to understand that the design goals of capability computing are different from those of capacity computing. While both styles may use the same basic computational components, capability computing architectures are designed to maximize the efficient use of those components at scale while capacity computing architectures are built from commodity platforms which are designed for general purpose computing across mass markets.

For the past decade or so, HPC architects across all industries have done a good job of creating standardized capacity-style clusters that do what explorationists have needed done. Many of these systems can be purchased "off the shelf," with additional nodes and other components easily added when expansion is needed. Very little communication between the exploration team and the HPC architect has been necessary.

With capability computing, on the other hand, implementations are optimized to work with the hardware, software, and applications already being used in exploration workflows. This means system designers and developers at companies like Cray have to be well acquainted with the explorationists and their computational scientists. Everyone must learn from each other because E&P computing solutions can no longer be built just by ordering and assembling large quantities of various pieces of commodity equipment.

HPC architects have to roll up their sleeves, sit down with the exploration team and figure out how to get the applications and processing workflows up and running on the new architecture. And it's critical for the scientific team to get involved. This involvement will allow E&P scientists to learn how capability computing works and craft how their complex algorithms and massive data sets should be run. This cooperative engagement will help ensure that applications and workflows run correctly from the start with minimal interruption to existing workloads.

Don't pass this responsibility off to the IT staff though. Nobody understands your workflows better than you do, so you have to actively communicate with the teams that will architect, build and manage your new capability computing system.

One of the most important things you can do is get involved with the Society of HPC Professionals (SHPCP). You will be amazed to find that scientists at other oil & gas companies and processing houses are facing the same dilemma regarding the upgrade to more powerful computing systems. Some organizations have already made the transition successfully.

You might also be surprised to learn that many of the challenges you'll face have already been dealt with in industry. Many of these experiences and solutions can be found by speaking to other SHPCP members and attending their conferences and meetings. Get involved now.

Bert Beals is the Global Lead – Energy Industries for Cray Inc. He may be reached at gbeals@cray.com.

16th Annual Saltwater Tournament

Friday, October 7, 2016

TopWater Grill Marina 815 Avenue O, San Leon, TX 77539

We are looking forward to a big event this fall and we encourage full family participation.

Galveston Bay Complex Division

Trophies will be awarded for the heaviest individual Redfish (Non-Tagged), Speckled Trout, and Flounder.

Trophies will also be awarded for the heaviest individual Stringer - 1 Redfish, 3 Speckled Trout, and 1 Flounder.

Galveston Offshore Division

Trophies will be awarded for the heaviest individual Ling, King Mackerel, and Mahi-mahi

Registration fee includes: Launch Fee, and Fish Fry Meal after weigh-in, Refreshments, Trophies, and Door Prizes!

Registration Options include LIMITED SPACES on a BOAT WITH A GUIDE!

Please Register online at: http://www.gshtx.org Or call 281-741-1624

Upon Registration, each participant will be provided by e-mail with a copy of the specific tournament itinerary, rules and disclaimer.

Geoscientists Without Jobs: A Guide to Surviving the Downturn

Part 2: Career Choices and Suffering Minimization

By Paul E. Murray (paulm@fipgeophysical.com)

If you're one of the growing numbers of recently laid-off geophysicists, the question of career change is obvious. If you're gainfully employed watching countless colleagues being shown the door, you may also be pondering the same point: should I stay or should I go? Neither Mick Jones nor I can answer that question, but I can offer a way of thinking about the problem.

I'm a geophysicist by training and a pragmatist by nature, so it seemed natural to frame the complex interplay of costs, limited income, financial obligations and career objectives as an inverse problem. I define the variable to be minimized as my personal suffering (or that of my family, discounting their suffering for having a geophysicist in their midst). Like all inverse problems, there is no unique solution. I assume there are a number of possible "happy valleys" in the dimensions of this space, and the goals of this exercise are to determine what variables drive the path from one local minima to the next, to measure relative costs, and decide how to decrease total suffering.

In Part One, I described the steps of a basic plan for the immediate aftermath of a layoff, summarized as:

1) Determine your burn rate for fixed expenses
2) Estimate the time gap between now and full-time employment
3) Determine the possible scenarios that will cover the gap
4) Define an end goal
5) Work your plan but remain flexible

This gives you a description of the immediate vicinity of your suffering landscape. If you have contingency plans for setbacks such as layoffs, then hopefully you are in a local minimum that will not disappear before you identify the next valley over. If you're already on the slopes, though, your path to the nearest local minimum might be predetermined for you.

Depending upon your position on the landscape, the Lagrange multipliers might negate the effects of every variable except career change. In other parts of the landscape, other variables might increase your well-being just as effectively; for example, maybe you can ride out the downturn as a consultant and have a modest retirement at age 65, but those plans for world travel and a summer home will need rethinking. Perhaps the choice between paying your mortgage and investing in your children's college fund is a no-win situation that forces career change.

There are two useful insights I gained from treating my choices as a "suffering minimization" inverse problem. The first is that moving between any two local minima will temporarily increase one's suffering. The nature and extent of that suffering will vary, but at least you will have some sense of what to expect on that journey. The analogy is imperfect, though, because stresses of different types can feed off one another, and once you're trekking across the landscape, the combination of financial and emotional stresses will make any slope harder to climb.

The second is that the topography of your suffering landscape will vary with time, so take note of the how fast the landscape changes. The safe haven of a local minimum may disappear when financial resources are gone; your hopes of selling your house and moving elsewhere might disappear with a softening real estate market. Steady ground can become quicksand, or a new valley may appear close by. Time can work for or against your depending on your options.

Sticking with a career in geophysics may be an active choice or it may be beyond your control. Of the out-of-work geophysicists to whom I have spoken about this, there are two reasons why they don't change careers: they don't need to change, or they don't think they can. If you're in the former category, you're in an enviable position. If you're in the latter, I have good news.

A well-trained geophysicist possesses a number of highly marketable skills. Computer programming, signal processing, data analysis and mathematical acumen are individually desirable skill sets. If your career has largely been driven by your interest in these skills and their connection to geoscience is only peripheral for you, a career change may be a natural progression. In the exploding world of data science and "Big Data," there is an ever-increasing demand for people who can combine these skills to analyze large, complicated data sets and derive a set of model parameters to make useful forecasts. Call me crazy, but that sounds like an inverse problem. Geophysicists are arguably more prepared for the coming data-driven revolution than any other discipline, so opportunities abound.

It's important to realize a career change is rarely a binary yes-or-no decision. You may explore the other valleys in your vicinity for a time, and later decide that your personal Shire is the world of geoscience. Presently, though, that valley is being scoured. No one will fault you for leaving with all those orcs roaming about.

GSH Outreach
Committee Activities - *By Lisa Buckner*

It's time to celebrate Earth Science Week, Oct. 9-15!

Earth Science Week is the second week in October. The 2016 theme is "Our Shared Geoheritage." If you are involved in the lives of any children in Houston, I encourage you to bring them to one of the events and enjoy a fun day of learning. For more information about the events in Houston, see the flyers in this journal or go to http://www.hgs.org/committee?cmtegrp=sci&committee=Earth%20Science%20Outreach%20Committee. For information about volunteering at the GSH outreach hands-on activity booth at the Earth Science Celebration or Energy Day events, see the "Call for Volunteers" elsewhere in this journal.

I need help! Since I will be serving the GSH as your 1st VP this year, I need to delegate some of the Outreach responsibilities. Please let me know if you would be interested in organizing volunteers for certain events, like Career Days/Career Fairs, Earth Science Celebration at HMNS, Energy Day, etc. Another way someone can help is to serve as the GSH representative to the Engineering, Science and Technology Council of Houston (ECH). The council representative must be available to attend a lunchtime meeting on the first Thursday of every month at the Houston Museum of Natural Science. ECH is involved with the SEFH (Science and Engineering Fair of Houston) and organizes an annual awards banquet for the Grand Prize winners and special award winners of HMNS Research Assistantships. ECH board members include representatives from many societies and the UH. Bill Gafford is the current GSH representative and is looking for a replacement.

On July, 22nd, I spoke about plate tectonics, oil & gas exploration using seismic, frac'ing, microseismic and earthquakes caused by waste water injection to 35 elementary and middle school teachers from public and private Houston area schools. The teachers were attending the Geoscience Institute teacher's workshop run by the Galveston County Regional Science Collaborative. It was held in the former Customs House on The Strand. I also presented the USGS Tapestry of Time and Terrain (Maps in Schools Project) map and gave one to each teacher. A few teachers came up to me afterwards and expressed interest in having a GSH volunteer speak to their class or host a station at their school science night or career day. Thanks go to Sally Wall who invited me to present.

Show your pride at industry conferences and outreach events. Pick-up your FREE "I'm a Geoscientist" lapel pin at a GSH meeting or order a free one from the American Geosciences Institute (AGI). The SEG is a member society of AGI.

http://www.americangeosciences.org//be-a-part

Are you interested in volunteering? Do you know of a school that has a career day, seeking speakers or a career fair at which GSH might be able to host an exhibit booth? Or have you been invited to give a classroom presentation at your child's school? We can work together to bring awareness to the students & their educators of the many rewarding and fun careers in the geosciences. Please contact Lisa Buckner at lbuckner@hess.com or 713-496-4256.

K-12 Outreach Volunteers Needed

Earth Science Week 2016 Theme: "Our Shared Geoheritage"

Please help GSH educate children & families about geophysics and geology through fun and easy hands-on activities at our exhibit booths.

Saturday, October 8, 2016 11:00 AM – 3:00 PM
Earth Science Celebration at Houston Museum of Natural Science
http://www.hmns.org or http://www.hgs.org
Shifts: 10:45 am – 1:15 pm, 12:45 pm - 3:15 pm or All Day

Saturday, October 15, 2016 11:00 AM – 4:00 PM
Energy Day Festival at Sam Houston Park (downtown)
http://energydayfestival.org/
Shifts: 10:45 am – 1:45 pm, 1:15 pm – 4:15 pm or All Day

Easy instructions and lunch will be provided for all volunteers.

Contact Lisa Buckner at lbuckner@hess.com or 713-496-4256 to volunteer for a shift or all day at any event.

Come play with us!

GSH Outreach

Earth and Moon Science for Three to Six Year Olds

By Ken Green

I volunteered to fulfill a request from the Montessori Country Day School for a program explaining tides. When I contacted Blanca Rodriguez at the school she explained they had three classes of 30 to 50 kids each, ranging in age from three to six years old. She wanted information concerning any earth science programs about tides to be presented.

My first thought was that there was no way that over 30 kids would sit still for any discussion, nor would they learn anything. However, undaunted, I decided to press on. I decided to simply illustrate the phases of the moon and talk about how gravity keeps the moon in orbit about the earth. I set the stage by having the lights off in the class room, with a Christmas lighting box I have that projects a zillion stars on the ceiling to put us all in space!

I brought a 24 inch physiographic globe showing the topography of both the land and seafloor. I also brought a playground ball with a pair of sunglasses painted on to act as the moon. Fortunately, NASA placed the Juno satellite in orbit around Jupiter on Monday, July 4th, before my Wednesday morning shows. And so I brought a rainbow hued ball to discuss Jupiter at the end if I had time.

I had 28 children sit in a ring on the rug surrounding the globe on its stand. The remaining children sat with the teachers on the outside. Montessori training is remarkably effective at producing well behaved, attentive students. I was shocked to find the students quiet and alert from beginning to end of a thirty minute exercise!

I stood on one end of the rug with a flashlight shining on the globe and the moon. The moon started in the hands of a child at the far side of the ring from me. I explained that one child would spin the earth to represent a day, and the moon (ball) would pass to the next child. I emphasized that the moon was held in tidal lock to the earth so that the same side always faced the earth. This task seemed beyond the abilities of the 3 and 4 year olds but the 5 and 6 year old kids were better at keeping the glasses pointed at the globe. The extra kids outside the circle came in to rotate the earth for a day or two each, depending on how many extra kids I had to involve.

I paused the moon at each of the main phases, starting with Full Moon to begin, Half Moon after 7 days, New Moon at 14 days, Half Moon again (but the other half lit), then back to Full Moon. I taught the children new vocabulary: Waxing moon when increasingly lit, Waning moon as less and less was lit, Crescent moon when less than half full, and Gibbous moon when more than full.

The exercise took about twenty minutes to get through one lunar orbit. I then discussed the way a moon or planet looks as it spins on its axis. I took the moon through another orbit just holding it myself and walking around the globe, keeping the face of the moon toward the globe. One or two children noted that they saw the moon rotate on the axis once in going around the earth, so they got the sense of proper versus relative motion.

Opening the floor to questions was illuminating: I had explained that I was an oceanographer at the start of the exercise, and that the globe showed the mid ocean ridge at the bottom of the sea. The kids in the first class wanted to talk about visiting the aquarium and touching shark eggs! At that point I brought out the Jupiter ball, and found most of the kids immediately knew it was Jupiter and that the Juno satellite had arrived just days before. We talked about the planets and stars and just generally had a good time playing with the balls.

All in all it was a fun experience for the classes and for me! I left the children with one final bit of science: Remember that Gravity is not just a good idea, it's the Law!

Go STEM outreach! – Ken Green

The Road Ahead for the Seismic Value Chain Offshore

By Shuki Ronen, Totum Geophysical Solutions

Summary

Recent advances point to a road ahead with sources that will be based on much lower pressures and much larger volumes than today's airguns. Low pressure sources will be broader band and emit less noise at frequencies that are too high to be useful; with rotation sensors that will provide complete recording of all degrees of freedom and will measure the full wavefield—not done by today's four component nodes; with motorized unmanned surface vessels towing streamers that compared to today's methods will provide more affordable wide-azimuth and long-offset data; and with practical joint multi-mode imaging data analysis methods replacing today's uni-mode methods and producing earth models that best explain all wave modes.

Sources

Seismic sources are pretty much the same airguns that we used decades ago when streamers were solitary, nasty, brutish, and short (adapted from Hobbes, 1651). They are very inefficient; only a few percent of the energy that they release generate acoustic waves at useful frequencies. We need sources with more low frequency signal and less high frequency noise. Chelminski in 2014 proposed and has now tested a new type of source, an evolution of the airgun with significant mutation; radically reducing the pressure, radically increasing the volume, and new design of the ports and the shuttle that will increase the rise time of the released air, generate a near toroidal bubble with larger initial air-water contact area that will reduce cavitation and couple better to the water to generate lower frequency acoustic waves.

These low pressure sources have the advantage that they are broader band and reduce the analog low-cut frequency by a full octave which will have added benefit for sub-salt imaging, velocity modeling, and blocky inversions. Environmentally they reduce ocean noise, eliminating cavitation and reducing 12 dB from 250 Hz to 1 KHz. These sources have pressures under 1000 psi, whereas a conventional air gun is 2000 psi. They have larger volumes – up to 10,000 cubic inches, whereas conventional air guns are only up to 2000 cubic inches. They have ports up to almost 360° (air guns only up to 180°) and can be larger than 60 sq. in. (air guns only up to 20 sq. in.). There is almost no acceleration distance – the port starts opening as soon as the shuttle starts moving (air guns accelerate for 0.5-1" before the ports start opening).

Modeling these two types of sources demonstrates the benefits of a low pressure source. The bubble has half the radius but the same period *(Figure 1)*. This translates to a normalized frequency spectra that has the same primary low frequency peak at 6 Hz but a flatter high frequency spectra *(Figure 2)*.

Receivers

The industry has invested in receivers much more than in sources. Some advances take years or even decades to propagate through the value chain. For example, 24 bit digitizers are the foundation of today's broadband imaging, but the time when we replaced 16 bit with 24 bit recorders, it was not clear why. Similarly, it is not yet completely clear today why we have multi-component

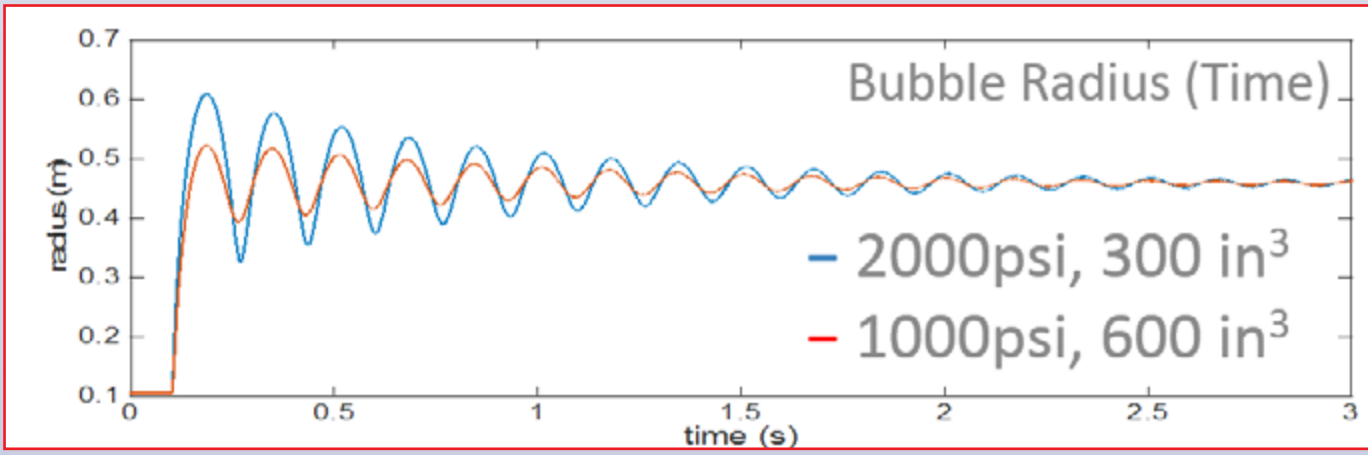

Figure 1: Thermodynamic acoustic numerical modeling of low pressure sources. The blue curve represents a 2000 psi, 300 in^3 source and the red curve represents a 2000 psi, 300 in^3 source. The low pressure source has a smaller diameter bubble than the high pressure source.

Technical Article continued on page 20.

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

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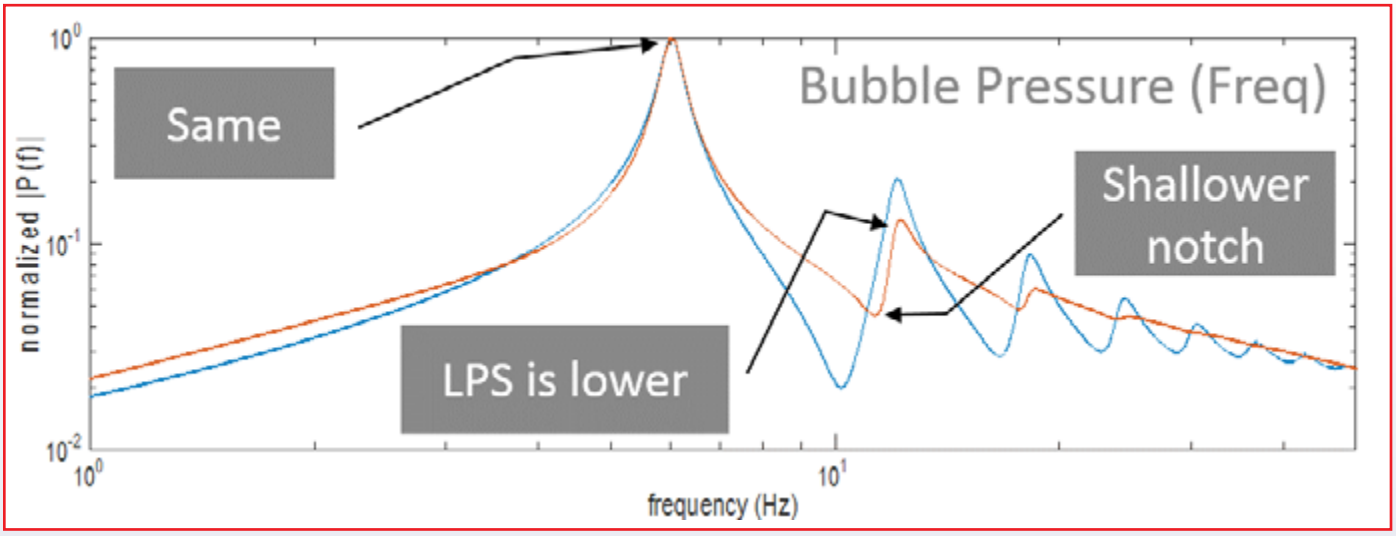

Figure 2: Frequency spectra of data shown in Figure 1. The low pressure source has a shallower notch and lower amplitude rebound pulse than a high pressure source.

receivers – are we doing it for the shear waves? For deghosting? To interpolate? I believe the value of 3C and 4C multi-sensor receivers is becoming practical, but in this paper I choose to not discuss (again) my aforementioned belief but to turn the attention to another type of sensor that I say will take seabed nodes from 4C to 7C or 8C. What I find most interesting is rotation sensors, and in particular measuring rotations with magnetometers.

A stiff rigid body in three dimensions has 6 degrees of freedom—three linear motions and three rotations. An elastic body has another degree of freedom—it can change its volume. The rotations and the volume changes are spatial derivatives of the linear motions. However, to calculate them from linear motions, we would need sensors everywhere. For this reason we need hydrophones to measure volume changes. Similarly we need special sensors to measure rotations. Hydrophones, geophones and rotations sensors are data components. P-wave, shear waves and surface waves are wave modes.

It is important to identify and separate multi-component data to wave-modes. Combination of hydrophone and geophone data to Up and Down modes, and taking the radial as shear waves are just the beginning. Barak et al. (2014) showed that rotation data are useful to better separate wave-modes including shear-waves and surface-waves. I believe that the value of rotation data will be proven to be significant enough to justify adding them to ocean bottom nodes, but we need rotation data to develop the analysis methods. Chicken and egg: we need motivation to spend money to acquire such data. Seabed deployable rotation sensors are not yet available. Or are they?

Key et al. (2012) recorded EM data with OBNs and noticed that they can "see" earthquakes on the magnetometer data *(Figure 3)*. How can magnetometers record seismic waves? The analysis by Barak et al (submitted to 2015 SEG) shows that the recorded variation of the magnetic components is due to rotation of the seabed in the earth

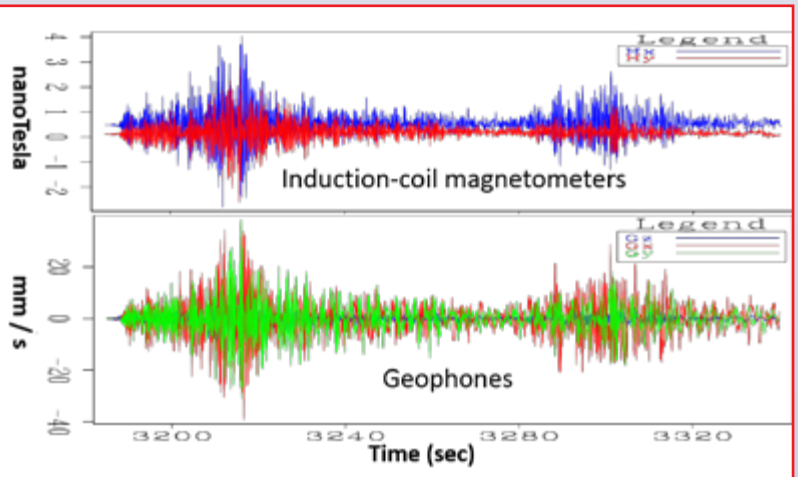

Figure 3: Data from the SERPENT EM survey off the coast of Nicaragua. This survey was active during a magnitude 5.4 offshore earthquake with a focal depth of 62 km on April 17, 2010. This node had both EM and seismic sensors. The induction-coil magnetometer clearly records the same motions as the geophone.

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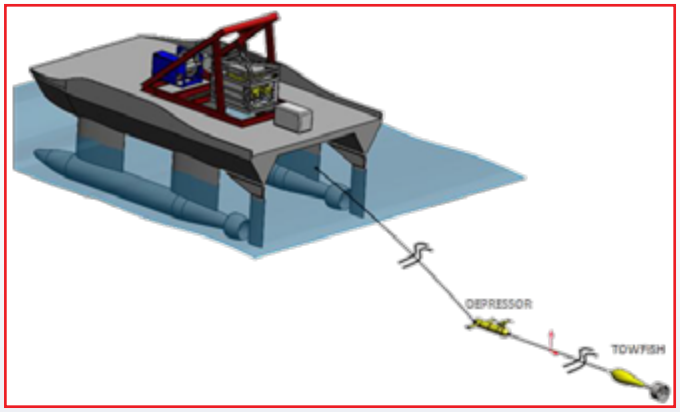

Figure 4: Conceptual drawing of an unmanned surface vehicle towing a streamer.

magnetic field. Until and unless we have affordable high-quality industrial-strength rotation sensors, we can use magnetometers!

Geometry

To image below complex overburden such as subsalt and sub-basalt we need wide azimuth data. To build velocity models, with tomographic and full waveform inversion methods we need far offset data. Wide azimuth and long offset data have significant added value, but so far at a significantly higher cost—often too high to justify.

I would like to turn attention to an alternative solution that has a new value-cost position: Swarms of streamer-towing unmanned motorized surface vessels (Blacquiere and Berkhout, 2013). The motorized USVs *(Figure 4)* keep up with the main streamer vessel which has the source. They record data continuously and go back to the mother ship to download data and upload diesel. Their endurance is a few weeks. This method is based on naval technology (US Navy Research, 2014). The swarm alternative will acquire far-offset wide azimuth data with less shooting, without spreading the sources over a large area, and with less simultaneous data to deblend.

Data Analysis

The road ahead in data analysis leads to joint imaging: of primary reflections and multiples; of reflections and refractions; of surface-, seabed-, and borehole-data; PP and PS as well as various PSS modes; seismic and non-seismic. The recent advance that I would like to cover is joint primaries and multiples, which is a start. In the not so distant past multiples were no more than "source generated noise" to be attenuated. We then found that they could provide better images than primaries. We found that the definition of noise is something that we do not account for, but that it can become useful signal when we account for it. We became pretty good in uni-mode imaging of one special multiple—the mirror image (Dash

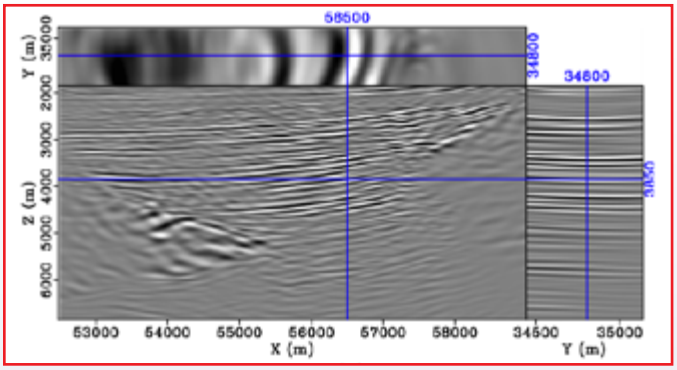

Figure 5: Primary reflection reverse time migration image.

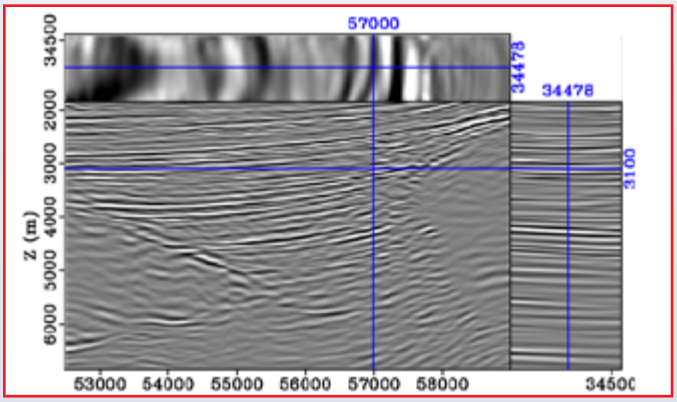

Figure 6: Mirror image RTM of the same data as in Figure 5.

et al, 2009). The next step is multi-mode imaging (Wong et al 2010; Berkhout and Verschuur, 2011; Weglein, 2014).

The basic idea is simple: Nature is multi-mode. If we pretend it is single mode then we are leaving a lot of value behind, even if we use all our beloved uni-mode programs one by one. We have understood the basic idea for some time (Claerbout, 1971). The reason it is taking so long to implement is the practical difficulties and the limited computing power. People have been able to show fantastic results with synthetic data, but when they applied joint imaging to field data, the results were often disappointing. *Figures 5-7* show somewhat encouraging results (Wong et al, 2014) of joint imaging of OBN data from the Gulf of Mexico (Courtesy of Shell).

Joint imaging of primaries and multiples is the beginning. The road ahead is leading to major improvements in delivery of information. We are now dumping on the interpreter multi-mode cubes—alternative 3D images each produced by uni-mode processing: Up image, down image, Radial image, PS1 and PS2 images, and so on. Worse, acquisition-modes include surface towed streamers, ocean bottom nodes, and borehole data. Too often

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interpreters choose one mode and discard the others. The road ahead leads to delivery of a multi-parameter 3D earth model.

Conclusions

Low-pressure sources will produce broader band data thanks to enhanced low frequency content. Yet less ocean noise thanks to reduced high frequency content.

Rotation sensors are a new types of measurements that we can and will acquire.

Swarms of motorized unmanned autonomous vessels towing streamers will provide more affordable wide azimuth far offset data with minimal ocean noise.

Data analysis will be based on multi-mode imaging rather than today's uni-mode imaging. The modes are primaries and multiples, surface-seabed- and borehole-data, and in the farther future joint P- and shear waves imaging.

Acknowledgements

Many people have provided me guidance and material. Steve Chelminski, Stuart Denny, and Rob Telling helped me with the source section. Bob Brune and Ohad Barak with the receivers. Stuart Denny, John Young, Don Darling, and Seibert Murphy with the survey geometry. Mandy Wong and Biondo Biondi with the data analysis.

Special data are not easily released with permission to study and publish. Much obliged to Scripps Institution of Oceanography who released the magnetic nodes data, and to Shell who released the seismic nodes data.

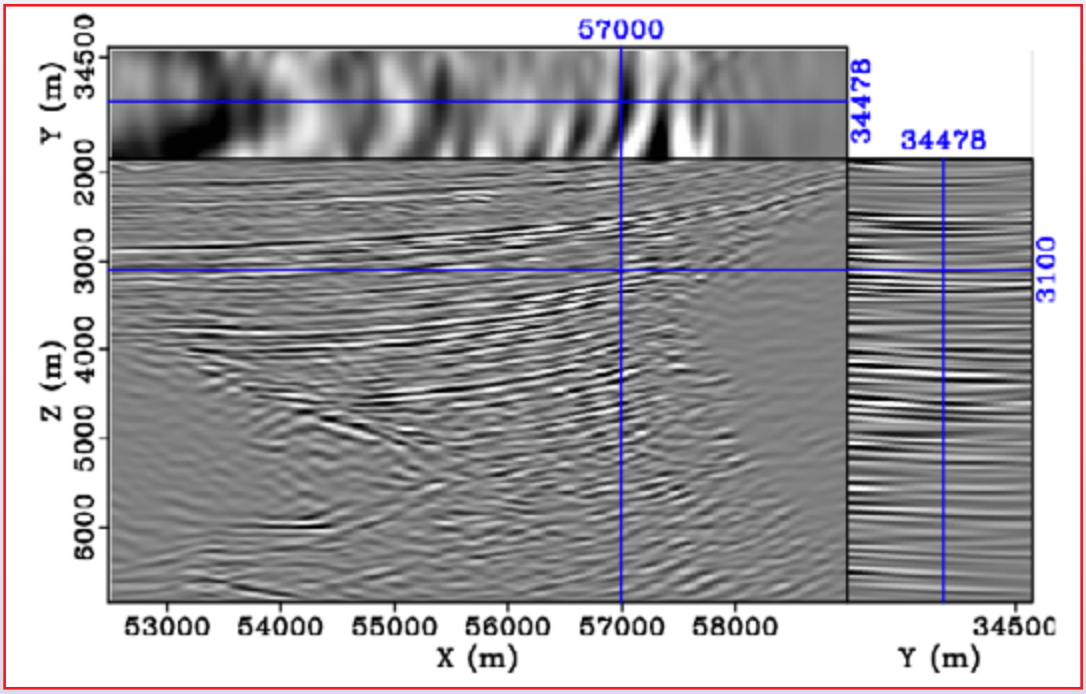

Figure 7: Joint least squares RTM of primary and mirror of same data as in Figure 5.

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International Committee on Nomenclature Sanctions Guru

Oslo -- In a rare move, **ICON** has issued a firm scolding and six month probation to The Guru, along with a stern warning to the *Journal* Editorial Board and a Print Ban Order for fiscal 2016-2017.

Board spokesman Tommie Rape argued that the Guru has a terminal case of **Grecian Symbolosis**, a condition which presents as chaotic and random use of the Greek alphabet in order to obfuscate the meaning of otherwise simple mathematical concepts. The September issue of *Tutorial Nuggets* was cited as a typical of this pathological behavior.

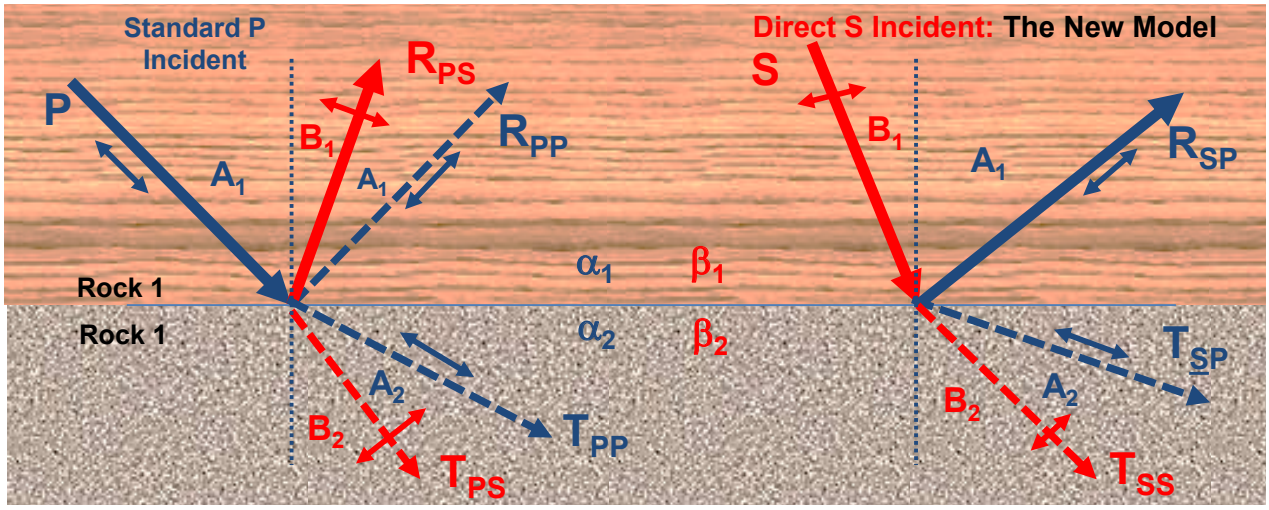

ICON

In spite of these compelling arguments, ICON saw fit to issue an order for a 9 month suspension of printed publishing privileges (which is why you're reading this on the Internet). They added that unless The Guru started using coherent and consistent notation, the suspension would be extended indefinitely. A humbled and vengeful Guru promised remedial action, sort of.

"A Needless and Meaningless Restatement"

Reluctantly, the Guru presents a substitute graphic with the new and perhaps semi-permanent notation as mandated by **ICON.** The Guru peevishly announced that, "Cookies will *NOT* be served."

Converted Wave Geometry and Notation



Snell's Law Governs Angles

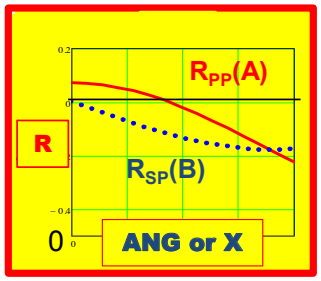
$$\frac{\sin A_1}{\alpha_1} = \frac{\sin B_1}{\beta_1} = \frac{\sin B_2}{\beta_2} = \frac{\sin A_2}{\alpha_2} = p \text{ the Ray Parameter}$$

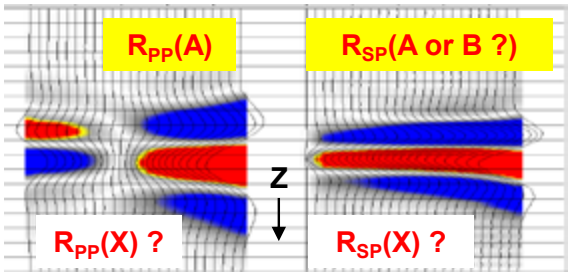
Ultimately, we will want to compare P-wave **AVO** reflectivity, $\mathbf{R_{PP}(A)}$, with the converted wave **Sv – P**, $\mathbf{R_{SP}(B)}$. The latter could be displayed as $\mathbf{R_{SP}}$ **vs B** (the incident angle) or $\mathbf{R_{SP}}$ **vs A** (the reflection angle). The Guru has declared the reference angle shall be the incident angle, **B.** However, note that placing the two reflectivities on the same graph presents some difficulties inasmuch as the angles are not comparable. This may require some thought and industrial strength arm waving. Stay tuned.

Tutorial Nuggets continued on page 24.

Tutorial Nuggets continued from page 23.

The use of Offset, **X**, for the abscissa has some appeal since it represents a common offset at a common image point (after migration) for both the PP and Sv-P reflections. However, with **X** the astute reader will note, the **A** and **B** angles vary with depth and would not be on a uniform scale.





We note also that the depth scale is necessary for proper registration of the **Sv-P** and **PP** reflections.

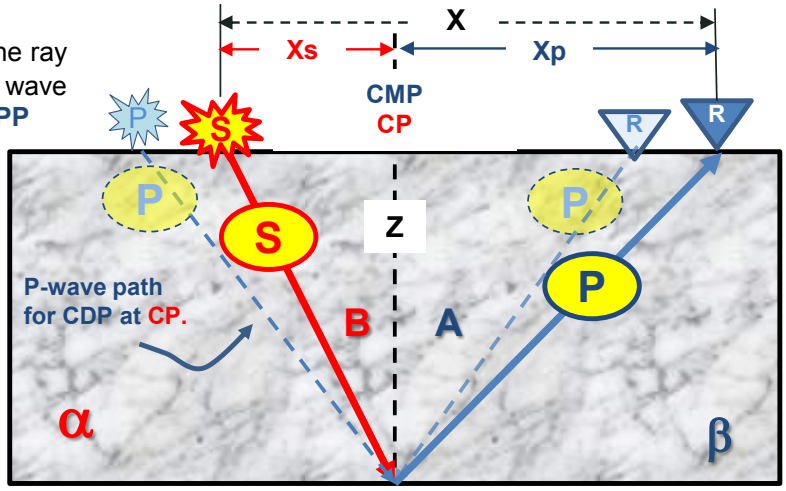
With vatic insight and great consistency, the Guru issues orders for the universal use of angle **A** for both **PP** and **SvP** comparative use at a common image point at any depth. So be it.

Rpp(A, Z) vs Rsp(A, Z)

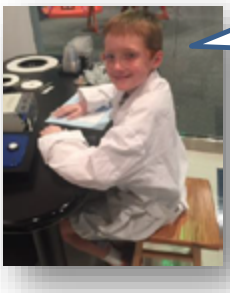
OK, Mr Guru, just how do you plan to get the **PP** reflection at the same place as the **Sv-P?**

You, my little genius, have touched upon the essence of the problem. Let's look.

At the right is a diagram depicting the ray paths for (1) the **Sv-P** converted wave (solid red and blue rays; and (2) the **PP** path with the same offset (X). The two events will appear at the **CMP** for **PP** path which is vertically above the conversion point (**CP**) for the **Sv-P** reflection on the flat reflector at depth, **Z.** Note that other reflectors with different depths will not have the same **CP.** Only after **Sv-P** migration will we have a collection (gather) of traces which can be called a **CCP** – common conversion point.



CIP = CDP = CP



Young Scientist

Does Sv-P migration properly handle PP reflections?

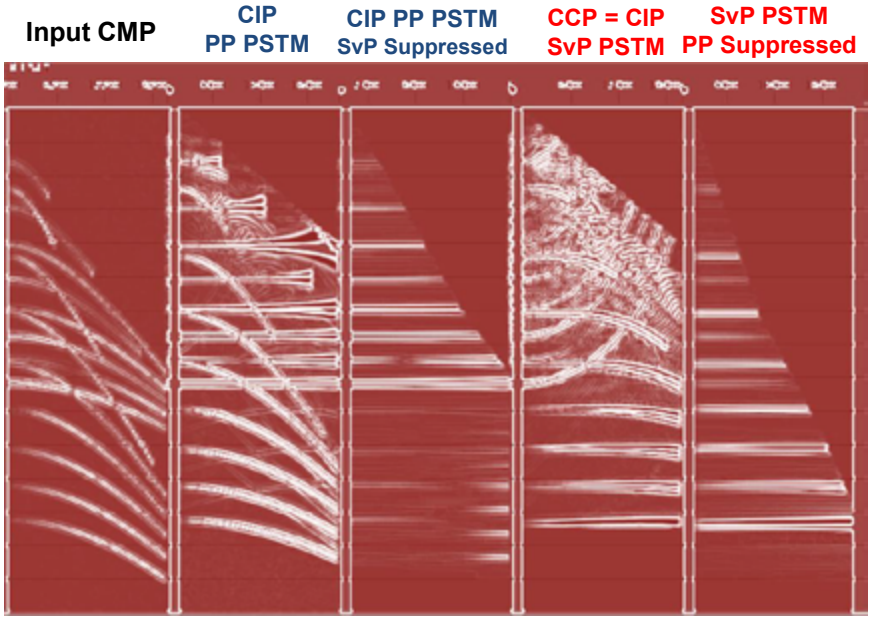
No, Young Scientist, we have to do separate **Sv-P PSDM** and **PP PSDM** to get the proper information for **AVO** comparisons.

And to answer the pre-emptive heckling from aging academicians, let me say we are fully aware of the consequences of ignoring **anisotropy** in analyzing **AVO**, but this is a hand crafted isotropic model for tutorial purposes only.

Tutorial Nuggets continued on page 25.

Tutorial Nuggets continued from page 24.

Below we observe some results from pre-stack migration on a simple cartoon model with 8 **PP** events and 8 corresponding **Sv-P** events. Since the model is **flat**, the input CMPs and migrated data have the proper appearance even though the wiglets are improperly placed. For example, the **SV-P** events on the 2nd panel do not belong on the **CIP** gather of the **PP PSTM.** They are identical to the ones that do belong there. (Shakespeare's plays weren't written by Shakespeare, but by a man of the same name.)



Because these are time migration the events are not lined up, i.e., registered.

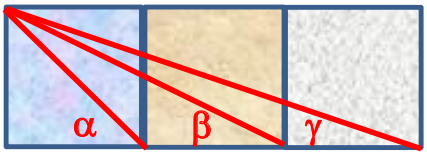
For AVO comparisons we'll have to use depth conversion. The best method would be PSDM or **APSDM** or perhaps an **Azimuthal PSDM.**

In any case, that's where we're heading: direct comparison of the **AVO** of **PP** reflections with the **SvP** counterpart

At our next encounter, we will discuss **Sv-P** and **PP** registration and the lithologic information which may be independently extracted by **AVO** analysis (anisotropically, of course).

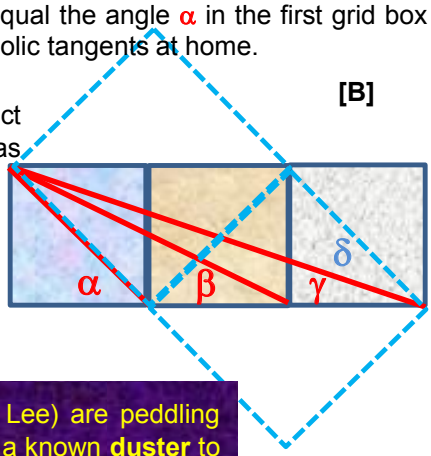
September Puzzle: Barney's Tavern & Tomographic Research Emporium Challenge: Prove in the 3-Grid Tomographic model [A] that the sum of the angles β and γ equal the angle α in the first grid box Use ONLY **Geometry**, and leave those sines, cosines, and hyperbolic tangents at home.

[A]



Solution. Construct the blue grid boxes as shown in **[B]**. Observe that angle β = δ since both are angles which cut similar (2-grid) rectangles in half along the diagonal. Note also that γ + δ = α since they both cut a square (original grid box) in half along the diagonal.

[B]

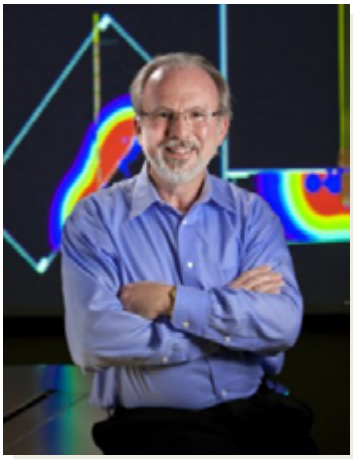


October Nugget Puzzle. Three brothers (Tad, Tommie, and Lee) are peddling two prospects at NAPE, in Houston. One of the two prospects is a known **duster** to the boys, but the other is known (by them) to be gushingly **productive**. The catch is that while **two** of the brothers are scrupulously honest truth tellers, the other is a pathologic liar.. What one question can you ask of one brother that will guide you to the productive prospect unerringly?

As one of the precious and vanishingly few readers of the *Tutorial Nuggets* on the GSH website, you'll find the answer on this same website November 1.

Everything You Always Wanted to Know About Microseismic

Peter M. Duncan, PhD
President & CEO, MicroSeismic, Inc.



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November 9 & 10, 2016

10:00 am — 2:00 pm

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SESSION 01
The History & Background of Frac Monitoring
A historical perspective

SESSION 02
Data Acquisition
How data are acquired

SESSION 03
Imaging Methods
How data are processed and analyzed

SESSION 04
Advanced Interpretation
Analytical frac disciplines

SESSION 05
Predicting Productivity
From dots in the box to EUR

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A Conversation With ...

Alistair and Mary Brown, Part 2

By Lee Lawyer

The following is the continuation of our interview with Alistair Brown. We hope that you enjoy the rest of his story.

How do you explain that anomaly?

When we came in 1978, we didn't know whether we were going to like it or not and the company didn't know how things were going to develop. It was a short term arrangement. In 1980 at the end of two years, it seemed to be working alright so the contract was renewed for another two years. That took us to 1982. By then 3D was beginning to be accepted around the world. There was lots of interest in the subject. I was the one with experience in interpreting 3D. I was a valuable person and they didn't want me to go away. We stayed. I went on local payroll in 1982. Then we could stay as long as we liked. We hadn't planned to stay forever but it worked well. GSI was at its crest and I was very much involved in the early development phase of 3D workstations. I refer to the period 1980 to 1985 as my "golden years." This is the period when I had the greatest impact on the technology. It was exciting, plus our children had grown into the American school system and that happened to suit them. There were all sorts of reasons for us to stay. And then the oil price crash came in 1986.

I think it came a little earlier than that. But no matter. We are going through the same phase now. Is that about the time you left GSI?

GSI had significant involvement in interpretation in the 1980's but it wasn't their core business. You know that, in bad times, companies contract to their core business. And the core business of GSI was data collection and data processing. I was not as valuable as I had been, and they were less interested in me. Therefore, I was less interested in them. It seemed appropriate to head off on my own.

They didn't terminate me because they foresaw that oil prices would turn around in a couple of years. I took a leave of absence. It was 1987 when I took off on my own. I started consulting and teaching courses. But I didn't actually terminate from GSI until a couple of years later. I have continued doing consulting and teaching around the World up to the present day.

This started your teaching career in a sense?

Absolutely. But first of all I didn't think I would do as much teaching as I have done. But actually my teaching started in GSI. They wanted their client oil companies to use their data in the GSI way, so that they would realize it was good stuff and come back for more. GSI had a marketing budget in those days which covered my activities. That's how I started. When I left Bob Graebner was kind enough

to let me take my teaching slides with me. I already had launched myself into teaching 3D interpretation. Remember I had already published the first edition of my book. It came out in 1986.

My, my. I didn't realize the timing of that. It came out earlier than I recall.

I prepared the first edition while I was still under the employment of GSI. That helped launch me into teaching and helped oil companies understand their data better. And although I never contemplated doing as much teaching as I have done, my teaching became very popular. As you know, when someone knocks on the door, you try to say "yes." I ended up saying yes to more teaching than I ever intended. Even to this day, that is still the case. It is not my sole business but it has been my principal business for 29 years. People seem to like it.

How about the consulting business? It started out with more consulting than teaching but it changed to more teaching?

I developed an offering to companies that was a combination of teaching and looking at data, which was project assessment, project appraisal, and advice on interpretation methodology. I actually did very little on a project by myself. I did do a lot of looking at your data. We would teach a bunch of people, and then at the end of the week we would go with them to their office and look at their project. In this way I could show them how they could take ideas out of the course and incorporate it into their methodology to get more out of their data. This helped them apply what they learned to their project, but it also gave me the opportunity to see their data and learn from it. Now and then if I would see a piece of data that illustrated something I taught. I would try to get it released. So a significant part of my activity in those days was getting data released so it could go into my

Interview continued on page 28.

Interview continued from page 27.

book and into my slide sequences. As you well know, getting data released from oil companies is not always straightforward. They tend toward being possessive of their data. So getting data released has been a continuing part of my life's work.

It has changed a little bit. Much of the data acquired belongs to the contractor that acquired it, in spec shoots and so forth. But that is neither here nor there. Who published your first book?

It was at the EAGE convention in 1979 that the Geoscience Editor of Elsevier came to me and suggested that I write a book on the 3D. I was a young guy and I was impressed that anyone would suggest that I might write a book. I said I would look into it. The suggestion was that it would cover three areas, 3D data collection, 3D data processing and 3D interpretation. I told the Geoscience Editor of Elsevier that I would only write on interpretation but if he wanted the book on all three things, I would see if I could find other people to do the collection and processing parts. The next couple of years were spent trying to find people who would work on the other two components. I failed. In about 1982 I went to the Elsevier and said, "Look, this isn't going to work but, if you are still interested, we will make the book just on 3D interpretation and the author will be just me." He said, "OK." Then I started a new phase of gathering data and doing my own thing. I spent 1982 to 1984 gathering a manuscript and typing things up. I had an old data processor and Mary typed the copy of the first edition.

You know that color has been a focus of mine and it was important to me that color be properly represented in the book. So now we get to the turning point and it occurred at the SEG convention in Atlanta in 1984. I presented the manuscript with all of colored pictures to the Geoscience Editor of Elsevier and he didn't like it. He said they couldn't publish all of that color. He didn't like that one, "chuck it out," "that one can be black and white," "we don't need that one, chuck it out." And at the end of this meeting with him, I felt bruised and battered. I went away with my tail between my legs, with the question, "What am I going to do now? I have been working for years on this book and he won't do it the right way." So I went to my confidant and mentor, Bob Sheriff. He was not only a good friend but he had a lot of experience in publishing books. He said to me, "Stick to your convictions. If you believe that full color is the right way to publish it, do it that way. Go find a different publisher." So I did as he recommended. I started talking to other publishers and one was SEG. In 1985, SEG was also not prepared to publish in full color. They might have done one signature in color. The only publisher who was prepared to publish in full color in 1985 was AAPG. They already had a record of publishing many volumes in full color, particularly their memoir series. They were prepared to do it the way I wanted. I wrote a letter to Elsevier saying, "I am not going to publish with you because you won't do it the right way." I gave the manuscript to the AAPG. They ran with it and it was published in 1986. It was popular. The first edition sold out in a couple of years. The second edition came out in 1989. It continued selling very well. So the book had some momentum to it. That was also the peak of my teaching activity. Of course, I always used the book as my text in teaching.

I wanted the book to involve SEG because SEG was my society. I tried to get joint publication but failed because of antipathy that then existed between the two societies. I wanted to solve this problem, so I elicited help from Brian Russell who was the President of the SEG at that time. The fifth edition was published in 1999 as a joint publication of the SEG and AAPG. The sixth and seventh editions were likewise published jointly.

We've gone through your school, your move to Australia, your acquiring experience in acquisition, and so forth. It is an excellent background for a geophysicist or a physicist. You have had great career. If you had to do it over again, would you change any aspect of it?

I wouldn't change a thing. I feel that the choice of geophysics, although a little accidental, had served me very well, served my family very well. It has brought us into a wonderful community of people. It permitted us to travel to all sorts of places around the world. I think it is a great profession and I would recommend it to others.

Interview continued on page 29.

Interview continued from page 28.

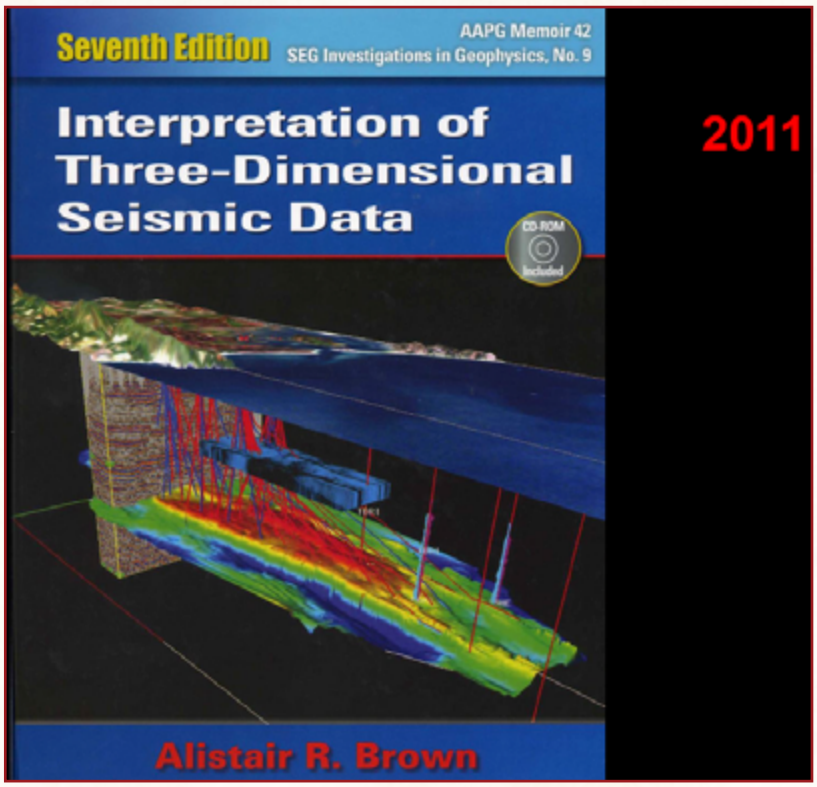
If you had to give advice about career paths to young people, what would you tell them?

I would recommend getting broad experience in the early days, do some different things. It's not as easy to go out in the field today as it was back then. I did find that time extremely useful. But it is a cyclical business, which brings difficulties. Therefore, one has to be tenacious. If you want to stay in our fascinating business, you have to make sure you are good and that takes an effort.

My advice has always been, when you are offered opportunities, accept them. That goes along with your comment on broad experience.

I agree with that. One could phrase it in a slightly different way. Make sure you align your objectives with your company's objectives.

On behalf of the GSH, thank you and Mary for telling us how your life journey has gone so far. I am sure the readers of the Journal will enjoy reading the saga.



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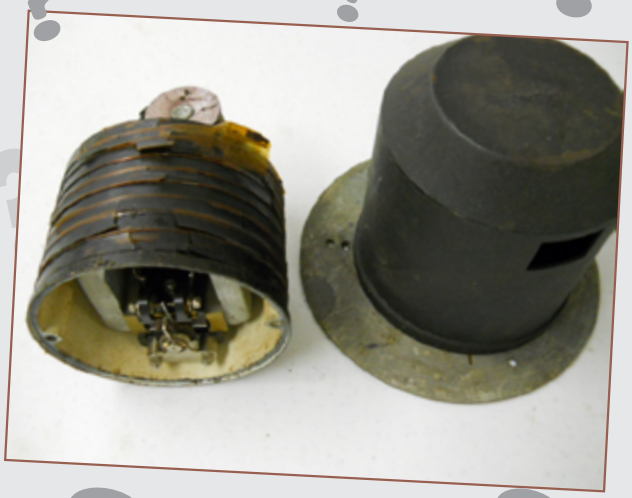
SEG SOCIETY OF EXPLORATION GEOPHYSICISTS WOMEN'S NETWORK COMMITTEE

PGS

Mystery Item

This is a geophysical item...



Do you know what it is?

This month's answer on page 32.

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Wavelets

Acquiring Data, Acquiring an Education: A Student's Reflections on UH Geophysical Field Camp 2016

By Somaria Sammy

The 2016 University of Houston (UH) Geophysical Field Camp took place from May 18-26 at Texas A&M's Galveston Campus. Undergraduate Geophysics students from UH, along with a few from other schools, attended the camp to gain hands-on geophysical experience. The days were long, the students worked hard, and the instructors covered a large amount of information. While the immersion in a week of various geophysical surveys was intense, it was not overwhelming and there were three main factors responsible for the camp's success: the scope, the equipment, and the people.

The Scope

As students, our main focus at the camp was practice, practice, practice. We practiced teamwork, practiced using geophysical equipment, and practiced presenting data to our peers. We were divided into six teams and rotated through six "stations" that each covered a different geophysical technique. The camp consisted of a four day pattern repeated over the eight days at the camp. Three days were spent acquiring data, each day at a new station. The fourth day consisted of student presentations. The six stations covered a wide range of techniques consisting of:

- Marine Geophysics
- Global Positioning Systems (GPS) and Light Detection and Ranging (LiDAR)
- Well-Logging and Vertical Seismic Profiles
- Ground Penetrating Radar (GPR)
- Seismic Refraction
- Gravity and Magnetism

The hands-on experience renewed our enthusiasm for geophysics. Ailea Dingman, field camp attendee, explained, "Taking Marine Geophysics as a class gave me a deeper understanding of the theories and terminology surrounding seismic and sonar bathymetry profiling. Applying marine geophysics as a technique turned out to be way more exciting than I would have thought. The equipment we had access to and the instruction we were given gave me a new interest and excitement, in regards to marine geophysics that I didn't have before."

The Equipment

We had the most fun learning how to use the equipment. At the end of each day we felt accomplished having learnt how to use a new tool. We had just as much fun learning the names of the tools: Boomer, Chirp Sonar Submersible, Vibroseis, Whacker, Total Station, and Magnetometer just to name a few.

Figure 1: Dr. Robert Stewart (back row middle) and Dr. William Sager (back row right) with students on marine geophysics research vessel, Galveston Bay, TX.

Photo by Dr. Robert Stewart.

We were also interested in the actual mechanisms by which the equipment made measurements. We were fascinated by the way the theory we learnt in Physics class was applied to design the tools. And although learning about dual induction and proton precession was a little confusing at first, we developed a new appreciation for the equipment we were using.

For some students this was their first time working with tools. In

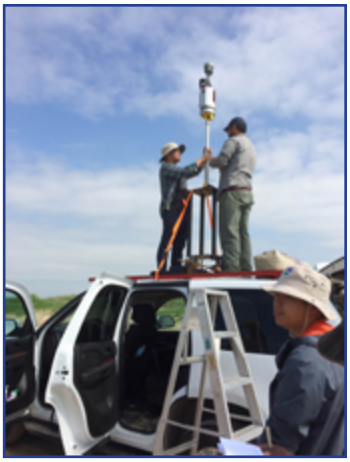


Figure 2: Teaching assistants mounting Lidar scanner on custom-built vehicle rack built by graduate student, Vasilios Tsibanos, Freeport, TX.

Photo by Somaria Sammy.

Wavelets continued on page 32.

Wavelets continued from page 31.

Figure 3: Dr. Shuhab Khan (far left) and students conducting GPR survey, San Luis Pass, TX.
Photo by Fiona Gunawan.

Figure 4: Jeff Sposato explaining the layout and function of cables for seismic survey, La Marque, TX.
Photo by Li Chang.

addition to learning how to operate the equipment, they developed other skills such as untangling cables, swinging a sledgehammer, communicating on a walkie-talkie, safely driving an ATV, and keeping their balance on a boat.

The People

During the eight days that we were at camp we built camaraderie within our teams. Each day we worked together and developed a rhythm to make measurements accurately and efficiently. Each evening we supported each other by sharing notes, clarifying concepts, and offering constructive feedback as we prepared our presentations.

The teachers and teaching assistants at the camp were a great source of information and support. Our teachers were: Dr. Stuart Hall, Dr. Shuhab Khan, Dr. William Sager, Jeff Sposato, Dr. Robert Stewart, Dr. Guoquan Wang, and Dr. Robert Wiley. We benefitted from their expertise as they taught us about surveying, patiently corrected us when we made mistakes, and shared their stories from the field. They worked alongside us every day, teaching us about all aspects of fieldwork—from avoiding dehydration and sunburn, to designing a survey grid.

The activities that they planned for us each day were meaningful and we never felt like we were simply doing busywork. We collected real data and tackled real geophysical questions: How deep is the aquifer? Where is the edge of the salt dome? What is the velocity of this rock?

Geophysical Field Camp was a whirlwind. But in the midst of the whirlwind we were growing as geophysicists. Field camp helped us make connections between the abstract theory we were learning in the classroom and real life applications. Field camp was the most important experience in our undergraduate studies and our geophysics education would be incomplete without it.

Mystery Item

The Mystery Item for the October GSHJ is a Base Plate Geophone, used in Vibroseis seismic acquisition.

Mystery Item on page 30.

Geoscience Center News

By Bill Gafford

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

Most of the items in our collection of geoscience instruments and documents are from the earlier years of petroleum exploration, but we sometimes receive donated items that are examples of current technology. We recently received a donation from FairfieldNodal of one of their Z700 marine nodes, which is pictured below in a display case, which they also provided. This node is part of a cableless, four component marine seismic acquisition system. It will be added to one of our displays of marine acquisition components, which includes a portion of a marine cable, an air gun, and cable control devices or birds, as well as a model of a marine acquisition vessel.

As we continue to receive donations of books, reports, and periodicals, we have had to rearrange some of our space. We have added more bookcases and expanded the Bob Sheriff Library into some previous storage space. The library now includes over 900 items.

On August 11, our quarterly Living Legends Doodlebugger social event was again quite popular with some new visitors as well as some of our regular attendees. There was some good discussion about some of our newer items on display as well as some of the older items. These events are popular with some of our retired doodlebuggers, but everyone is welcome, including spouses.

The Geoscience Center is listed this year in the HISD Community Resource Guide under STEM Enrichment Opportunities. Hopefully, we will have some visitors interested in geoscience history and career opportunities.

Anyone interested in volunteering at the Geoscience Center is always welcome. If you would like to visit the Geoscience Center, and see some of the Mystery Items from the GSH Journal, or see some of the items previously mentioned in the Geoscience Center News, or for more information, please contact me at geogaf@hal-pc.org or at 281-370-3264.

GSH 2016 Scholarship Recipients

GSH/Hugh Hardy Scholarship

Adam Mattson, Geophysics major at Texas A&M University

Here's an excerpt from Adam's introduction: "My future career plan is to become a petrophysicist focused on thinly-bedded, low resistivity overbank formations. After sitting in on the graduate-level Formation Evaluation class in the fall of 2014, I became interested in formation evaluation. In the spring of 2015, I was able to take the undergraduate equivalent formation evaluation course along with Sedimentology and Stratigraphy. Since then, I have been reading formation evaluation papers, and last December, I was able to obtain well logs and seismic data from the deepwater Gulf of Mexico. Because I was able to obtain quality well data from the Gulf, I started researching deepwater formations and their associated depositional environments.

After I graduate with my degree in Geophysics, I want to pursue a masters in either Geology, Geophysics or Petroleum Engineering with my thesis topic on formation evaluation. My plan is to work on Gulf of Mexico assets once I graduate, and hopefully later in my career, I can work with projects in Angola, Brazil, and Indonesia. I would also like to try carbonate and organic-rich mudrock petrophysics once I have a solid foundation in thinly bedded analysis."

GSH/Carlton-Farren Award

Nathan Seago, Junior Geophysics major at Texas A&M University

Nathan is from Bryan, TX. Here's an excerpt from Nathan's own introduction: "I am eager to start upper level courses and learn about possible research opportunities with professors. Outside the classroom, I am challenged every day to develop my academics, fitness, and leadership through membership in the Corps of Cadets. In addition to the Corps, I volunteer with MSC OPAS (Memorial Student Center Opera and Performing Arts Society) which is a student organization that works to bring thrilling performances and entertainment to campus. Future aspirations include pursuing a career in mining engineering and developing a lifestyle with elements of outdoor adventure and world travel."

The GSH funds the 2 endowed Scholarships above and continues to add to the principle. The generous donations of Individuals and Corporations to the GSH make this possible.

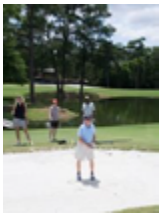
2016 Annual Golf Tournament

This year's tournament was a double challenge. The state of the industry affected Sponsorship and participation. We truly appreciate those who are still active and supportive of GSH goals. In addition, it was originally scheduled for April, but the event was rained out and the courses flooded, taking several weeks to restore courses. The event was held May 23, 2016, at Kingwood Country Club where everyone had a great time. There was a breakfast to start the day along with a preview of the Diamonds in the Rough Silent Auction. We had 150 players plus beverage carts circling each course. After play we had a great lunch and beverages, Door Prizes, Silent Auction, and Tournament Winner Awards.

Denise Dorsey from Katalyst Data Management returned as the volunteer coordinator. Thanks to Denise and all the volunteers. Kathy Sanvido and Karen Blakeman, at the GSH office, also supported this event. – Dennis Sump, Chair

CONGRATULATIONS TO THE WINNERS!

Lake	Island
1st Place	1st Place
Ray Mays	Brad Jones
Trey Barnes	Terry Stanislav
Dan Grobert	Dennis Sump
Janus Rosborough	
2nd Place	2nd Place
Kenny Baucum	Kelly Bentley
Pearl Benson	John Tacket
Danny Backer	Terry Thibodeaux
David Backer	Ben Workman
Closest To Pin:	
Tony Sandoval	Paul Pearce
Longest Drive:	
"Demontrond McRib"	David Rohlins



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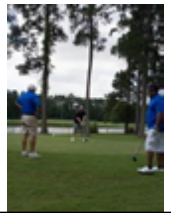



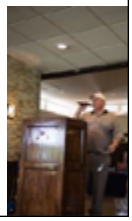

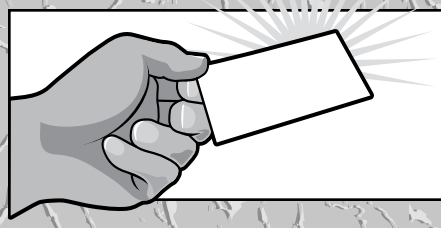

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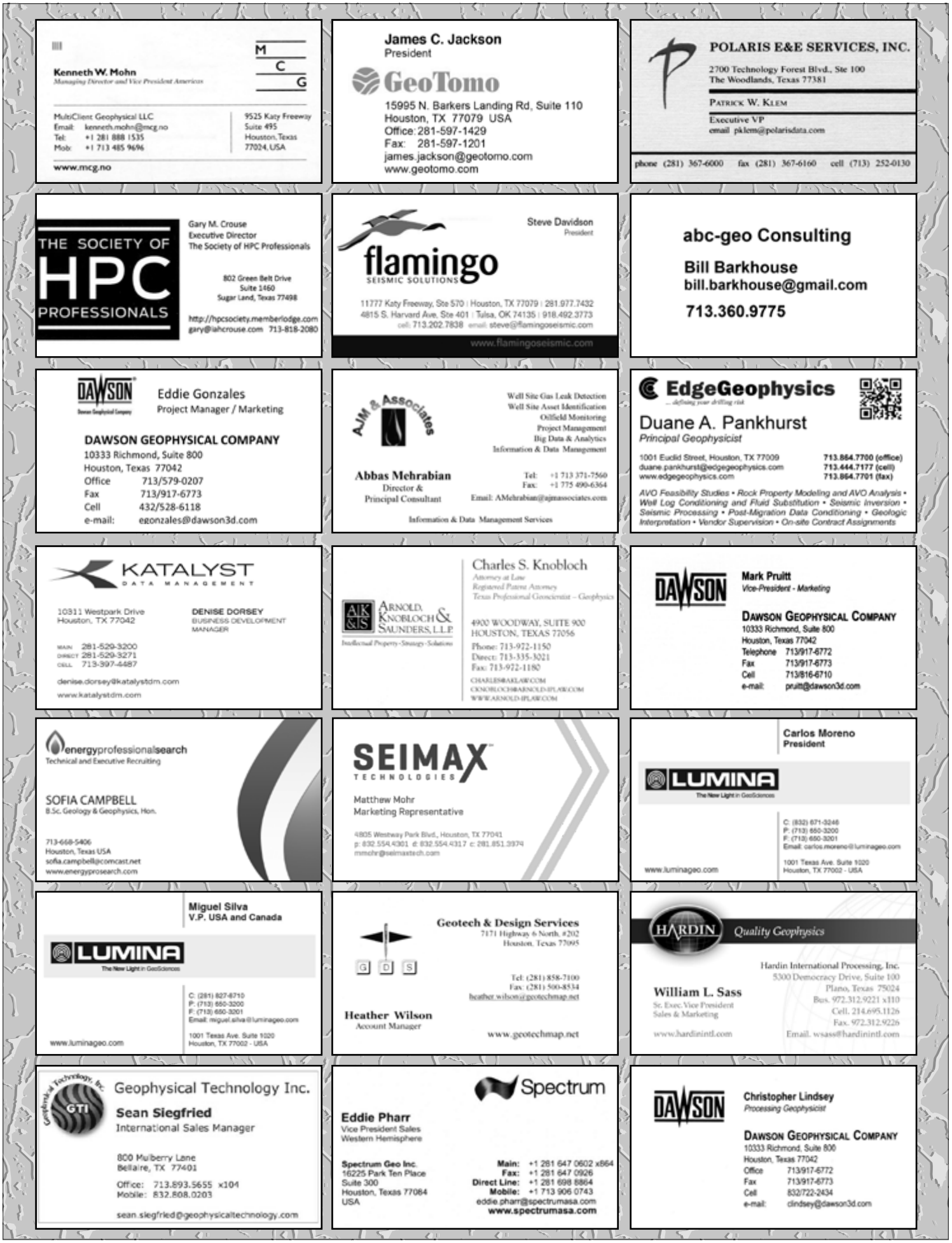
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Doodlebugger Diary

A Trip to a Vessel: 25 Years Later

By Courtney Anzalone

After my experience from my visit to a marine vessel, one of our GSH assistant editors, Courtney Anzalone, has embarked on a new and exciting experience as an InField Geophysicist. This is the second part of a three part series to allow our audience the ability to see how the times have changed in regard to safety and technique. We are always welcoming others to use the Diary to tell us of their start in the industry or of some anecdote that happened along the way. Email to Lee Lawyer, llawyer@prodigy.net or David Watts, dwatts1@slb.com.

When I agreed to go on a temporary assignment offshore on a seismic vessel I didn't realize the training that would be required just to allow me on board the ship. I spent six days doing extensive training at a facility in North Houston and it covered everything from how to use a rope swing to how to put out a fire in a confined space. All I could think was why are they making me do this? I am just a scientist, I couldn't possibly be expected to do anything in crisis.

My first training course was the helicopter survival class and that was the moment I realized that I could possibly die, although it was very unlikely it was still a very quick reality check that made me pay more attention. They strapped me into a helicopter that had been stripped of its parts and told me that they would be flipping me upside down. I don't know if you remember what it feels like to get water up your nose but getting chlorine up your nose might be one of the most unpleasant things I've ever experienced. With every simulation they would add a new task such as popping out the window or putting in a breathing apparatus. I actually had fun doing the course, but I could tell that some of my classmates were not enjoying it and were having moments of anxiety.

The next training course I took concerned personal survival techniques, and I wasn't sure what the class was going to be about. This course focused on water survival training, and it required class participants to stay in the water for roughly three hours. We learned how to flip life rafts, swing from a rope, jump off a platform, and my favorite, how to turn coveralls or jeans into a life jacket. After these two classes, all I could smell was chlorine for days.

The next two classes were about maritime security and social responsibility which consisted mostly of lectures of how to deal with pirates and other shipmates, which seemed like common sense but probably needed to be stated. After completing the maritime safety class, the firefighting class was two days of cramming in knowledge and pure exhaustion.

We were taught how to fight various fires and expected to be able to put them out ourselves. I donned the gear and the firefighters immediately laughed at me because of my small stature. Fellow classmates asked my instructor if he wanted to film me while I tried to handle the fire hose, which spurred me to prove that someone as small as me, could do anything that the boys could do. The sheer pressure behind the hose made it the most difficult thing we did all day and wearing fifty pounds of gear in Houston in July did not help. We also did a search and rescue mission in a blacked out house where we had to pull out a thirty pound dummy, and I am proud to say that I got the fastest time in the class (take that!).

The last day of class was about first aid and CPR, which was a much needed break from the strenuous activities of the week. After all was said and done I felt more

Doodlebugger continued on page 40.

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 39.

secure in my abilities to save myself and my fellow crew members if something were to happen offshore. I have been given enough vaccines, physicals, and training to last me a lifetime, but I am grateful that my company has invested so much into making sure I'm prepared for whatever I may encounter out there. My next diary will be about my first rotation offshore which will be five weeks in the Gulf of Mexico on a seismic vessel.

HPAC Auxiliary News

The Houston Petroleum Auxiliary Council

By Susan Graul, GSH - HPAC Liaison, Srg02@comcast.net

Our HPAC Mission Statement is "to promote and foster social relationships among its members and to assist the Engineering, Geological, Geophysical, and Land Societies in their various requests."

HPAC leadership for this year is

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2nd Vice Pres.: **Wanda Shaw**
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Parliamentarian: **Norma Jean Jones**.

The next year will prove to be as or more exciting and interesting as this year.

The Style Show was great fun. See our lovely ladies in clothes from Soft Surroundings.

The August Book Club met to discuss "A Spool of Blue Thread," a Pulitzer Prize Winner, by Ann Tyler in the Wine Room at Carmelo's Restaurant.

HPAC kicked off the New Year with a Trunk Show of Convention and Holiday Fashions, by Scruples Boutique at a wonderful new venue, Ashton West, on Clay Road. There was magnificent ambiance and lots of free parking.

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