



*The Epicenter of  
Geophysical Excellence*

February 2017

# JGSH Journal

GEOPHYSICAL SOCIETY OF HOUSTON  
Volume 7 • Number 6



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Data Acquisition, Processing and Inversion,  
with Oz Yilmaz – Page 14**

**Unemployment Professionals:  
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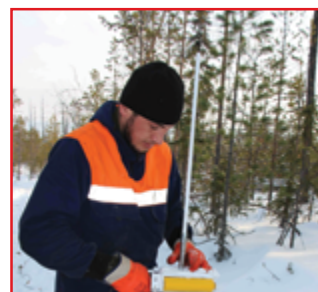
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### On The Cover...

*Deploying a Wireless Seismic system in Russia.*

*Photo courtesy of Wireless Seismic.*



## EDITOR'S NOTE

To ensure your information reaches the GSH members in a timely manner, please note the following deadlines and plan accordingly. Please submit your articles and any questions to David W. Watts, editor, at DWatts1@slb.com.

### 2016 GSH JOURNAL DEADLINES

Apr 2017 .....	Feb 2
May 2017 .....	Mar 3
June 2017 .....	Apr 7

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# A Word from the Board

## *Times are A-changin'... Be a Part of It!*

*By Nicola Maitland, Secretary*

As we have ended 2016 with WTI prices in the consistent 50's, I can't help but to acknowledge the excitement in the air. From all aspects of the upstream segment, things seem to be ramping up. People are excited for what is to come. The NEW age of the oil & gas business is around the corner. Do you want to be a part of it? I know I do! To quote our 2016 Nobel Prize winner in Literature, Bob Dylan:

*'Come senators, congressmen  
Please heed the call  
Don't stand in the doorway  
Don't block up the hall  
For he that gets hurt  
Will be he who has stalled  
There's a battle outside raging  
It'll soon shake your windows and rattle your walls  
For the times they are a-changin'*

Things around us are constantly changing. In this industry, we have no choice but to change with it or get out. I'm excited to see what changes come with a more stable oil price and want to help influence what changes occur within OUR society, the GSH. Be a part of that change by attending the events, both technical and social. Volunteer at an event and meet your fellow members. Work one of the many K-12 outreach events and influence the next generation of scientist. Go to the Geoscience center and engulf yourself in our rich history.

In addition to being the Board of Director's Secretary, I have been the Volunteer Coordinator for the GSH for 3 years now. With all of the changes that have come with the downturn, volunteering has been an ever evolving constant. Giving of your time and sharing your talents will always be rewarding no matter what the situation. The extra benefit of volunteering with the GSH is that you get to influence change. Your voice gets to be heard and you are rewarded in many ways. One precious reward is in the relationships that have been built. The bonds we forge through the GSH can be everlasting. They bring opportunities in good and bad times while creating a camaraderie that only those that have been in the trenches can understand. Our society consists of some of the most interesting people in this city, if I do say so myself. Networking is happening at every event and our volunteers get to be on the front line of that. I want to take the opportunity to thank our many loyal and generous volunteers; you know who you are. Without you, this society could not function and would not be as successful as it is.

My father recently had a quadruple bypass. There were a lot of complications and emotions but, now that we

are almost out of the woods, I am able to see that there really was a huge silver lining. I got to spend some true quality time with my family. We are all busy but, when times are tough, we come together. The last 2 years in O&G have been rough but we have rallied. Our society's infrastructure is designed to be the supportive Geo-Family we all need at some time or another. A great example of this is the newly organized group to support the displaced community. Another example is the Diversity and Women's Networking Events that I was honored to help co-chair in May & October. These events allow us to lift each other up, ask for guidance, mentor or be mentored, and feel supported.

I am excited to see what 2017 brings and am excited that I get to be a part of that change. Don't you want to be a part if it too? Get involved! No matter what your interests are, we have a place for you. With over 100 events a year, there is something for everyone.

Join us!

Nicola

## **Employers Matching and Gifting Programs**

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

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



# GSH 2017 Annual Golf Tournament

April 17, 2017

*Walden Golf Club, Conroe*



**Dennis Sump, 2<sup>nd</sup> VP**      **281-370-1827**

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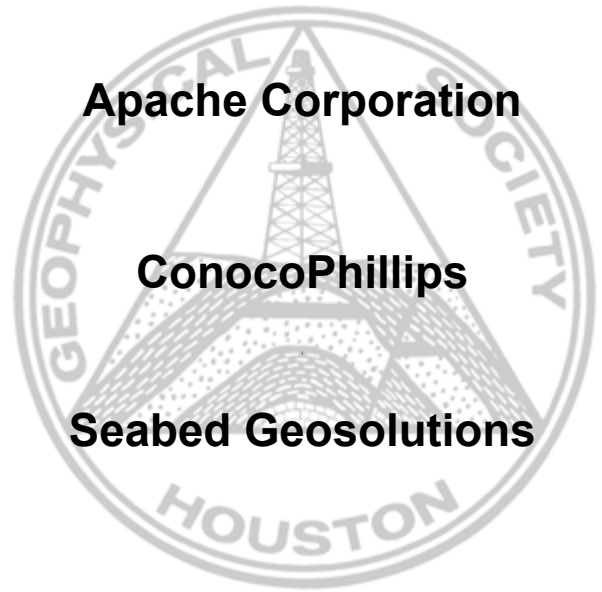
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## Carbonate Essentials

Christopher L. Liner, PhD

*Former SEG President*

*Storm Endowed Chair of Petroleum Geology*

University of Arkansas



### A Live Webinar

**April 25 & 26, 2017**

8:30 am - 11:30 pm Central Time (USA)

This course is an overview of carbonates from geology to seismic interpretation, with particular emphasis on karst topography and seismic expression thereof. To illustrate key concepts, field sites and case histories are presented from global locations.

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## Technical Events - See [gshtx.org](http://gshtx.org) for more details on these events

### ROCK PHYSICS SIG:

#### *Dipole Shear Anisotropy Using Logging While Drilling Tools*

<b>Feb. 1, 2017</b>	<b>Speaker(s):</b>	Matthew Blyth, Schlumberger
	<b>5:15 PM to 6:30 PM</b>	Sponsored by CGG and Ikon Science
	<b>Location:</b>	CGG 10300 Town Park Dr. Houston, TX 77072

### TECH BREAKFASTS

#### *Mapping Reservoir Stress Conditions Using Hydraulic Fracturing Microseismicity*

	<b>Speaker(s):</b>	Orlando J. Teran, PhD, Structural Geologist, MicroSeismic Inc.
<b>Feb. 7, 2017</b>	<b>7:00 AM to 8:30 AM</b>	Sponsored by Anadarko and Lumina Reservoir Inc.
Northside Breakfast	<b>Location:</b>	Anadarko Petroleum 1201 Lake Robbins Drive The Woodlands, TX 77380
<b>Feb. 8, 2017</b>	<b>7:00 AM to 8:30 AM</b>	Sponsored by Schlumberger and WesternGeco
Westside Breakfast	<b>Location:</b>	Schlumberger, Q-Auditorium 10001 Richmond Avenue Houston, TX 77042

### DATA PROCESSING & ACQUISITION SIG

#### *Recent Advances in Separating the Reference Wave and Preserving Reflection Data, and for Deghosting, for Towed Streamer, On-shore and Ocean Bottom Acquisition: Implications for Multiple Removal, Structural Determination and Amplitude Analysis*

<b>Feb. 7, 2017</b>	<b>Speaker(s):</b>	Jing Wu and Arthur B. Weglein, M-OSRP/Physics Dept./University of Houston
	<b>4:30 PM to 6:00 PM</b>	Sponsored by Schlumberger
	<b>Location:</b>	Schlumberger, Q-Auditorium 10001 Richmond Avenue Houston, TX 77042

### GEOSCIENCE COMPUTING SIG

#### *UAS Sensors and Applications*

<b>Feb. 9, 2017</b>	<b>Speaker(s):</b>	Jonathan Kohn, Founder and CEO at UM Inspections, LLC.
	<b>11:30 AM - 1:30 PM</b>	Sponsored by The Society of HPC Professionals and UDI
	<b>Location:</b>	Unique Digital Inc. Conference Center 10595 Westoffice Dr. Houston, TX 77042

### TECH LUNCHEONS

#### *Data Interpretation and Integration from a Seismic Perspective – The Excitement of Innovation*

	<b>Speaker(s):</b>	Laurie Weston Bellman, 2017 CSEG Distinguished Lecturer
<b>Feb. 14, 2017</b>	<b>11:00 AM to 1:00 PM</b>	
Westside Luncheon	<b>Location:</b>	Norris Conference Center 816 Town & Country Blvd. Houston, TX 77024 (Free parking off Beltway-8 northbound feeder or Town & Country Blvd.)
<b>Feb. 15, 2017</b>	<b>11:00 AM to 1:00 PM</b>	
Downtown Luncheon	<b>Location:</b>	Petroleum Club of Houston 1201 Louisiana, 35th Floor (Total Building) Houston, TX 77002 (Valet parking entrance off Milam; UH & Rice students are encouraged to use Metro Rail)
<b>Feb. 16, 2017</b>	<b>11:00 AM to 1:00 PM</b>	Sponsored by Southwestern Energy
Northside Luncheon	<b>Location:</b>	Southwestern Energy Conference Center 10000 Energy Drive Spring, TX 77389 (Free Parking onsite)



# Rock Physics SIG - Dipole Shear Anisotropy Using Logging While Drilling Tools

**Speaker(s):** Matthew Blyth, Schlumberger

**Wednesday, Feb 1, 2017**  
5:15pm - 6:30pm

**Register**  
for Rock Physics

## Technical Breakfasts

### Mapping Reservoir Stress Conditions Using Hydraulic Fracturing Microseismicity

**Speaker(s):** Orlando J. Teran, PhD  
Structural Geologist,  
MicroSeismic Inc.

*Northside*

**Tuesday, February 7, 2017**  
7:00 – 8:30 a.m.

**Sponsored by Anadarko and  
Lumina Reservoir Inc.**

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

**Abstract:** Focal mechanisms, when computed for an entire microseismic catalogue, permit a rapid assessment of the stress states throughout the stimulated reservoir. The premise for this is that the fracturing potential depends on the frictional resistance to slip and ratio of shear to normal stress on the plane (determined by fracture orientation within the stress field). Previous studies using borehole images and laboratory techniques have demonstrated that the most hydraulically conductive fractures have the highest failure potentials.

In this talk, we present a geomechanical analysis workflow using microseismic focal mechanisms to investigate the dynamic response of the reservoir during and after stimulation. Focal mechanisms are derived using full waveform fitting techniques, and the ambiguity in identifying the true fracture plane is resolved by simply choosing the nodal plane that aligns with the developing hydraulic fractures. A global stress inversion of the fracture plane solutions is done to estimate the orientations and relative magnitudes of the principle stresses. Friction laws are then used to constrain for each event a suite of geomechanical parameters (failure potential, dilation tendency, and excess pore pressure) in order to identify fracture populations likely to control fluid flow, those that required different stimulation pressures in order to contribute to flow, and the mechanical conditions that favored out-of-zone growth and reactivation of geohazards. The method is applied and discussed in the case of a microseismic event catalogue obtained during the stimulation of two horizontal wells landed in the Eagle Ford, where large variations in fracture patterns as well as geohazards were observed. We will also show examples from other plays to demonstrate that this workflow is applicable to all plays.

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for Tech Breakfast  
Westside

*Westside*

**Wednesday, February 8, 2017**  
7:00 – 8:30 a.m.

**Sponsored by Schlumberger  
and WesternGeco**

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



**Orlando J.  
Teran, PhD**

**Biography:** Geophysicist/Structural Geologist Surface  
Microseismic Analyst

Orlando's career as a geophysicist began over 2 years ago at MicroSeismic Inc., where his role includes processing and analysis of microseismic data as well as developing tools for advanced microseismic analyses. Prior to joining MicroSeismic, he pursued a graduate degree in structural geology in Baja California, where he studied active faults and a modern earthquake rupture.

Orlando has a Ph.D. in Geology from Centro de Investigacion Cientifica y de Educacion Superior, Ensenada, Baja California, Mexico, and a BA in Geology from Western State Colorado University in Gunnison, Colorado. He has also co-authored articles published in Science and Nature based on his contributions to advancing the understanding of earthquake ruptures.

Daniel C. Huston  
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# Data Processing & Acquisition SIG

*Recent Advances in Separating the Reference Wave and Preserving Reflection Data, and for Deghosting, for Towed Streamer, On-shore and Ocean Bottom Acquisition: Implications for Multiple Removal, Structural Determination and Amplitude Analysis*

**Speaker(s):** Jing Wu and Arthur B. Weglein,  
M-OSRP/Physics Dept./University of Houston

**Tuesday, February 7, 2017**

4:30 p.m. Sign-in, Snacks, Social Time

5:00 p.m. Start of presentation

**Sponsored by Schlumberger**

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

**Abstract:** We begin with a brief overview of objectives, strategy, projects, plans and deliverables in [M-OSRP consortium](#) at University of Houston. We then focus on and describe several recent advances in the initial wave separation steps in the seismic processing chain. First, we extend the Green's theorem based marine towed streamer deghosting method to accommodate non-horizontal and undulating cables. The current industry standard deghosting method, the P-Vz method, assumes that the acquisition surface is horizontal. The P-Vz method can have problems and be less than effective with feathered towed streamer data, and with on-shore and ocean bottom acquisition in the presence of significant variable topography. Secondly, we advance the Green's theorem method to de-ghost both the ocean bottom pressure data and multi-component displacement data.

Thirdly, the marine towed streamer Green's theorem reference wave, reflection data separation method is extended to on-shore acquisition for ground roll removal without damaging the reflection data. That method provides an alternative to the traditional filtering methods for ground roll removal that can damage reflection data. Finally, we simplify the on-shore algorithm with a reduced data requirement, allowing effective application with current land acquisition.

These advances in preprocessing are important for broad band data interests. In addition, they are required prerequisites for all inverse scattering series (ISS) free surface and internal multiple methods to allow the latter capability to deliver their promise and potential. The ISS methods are direct and do not require subsurface information, but are high-graded and benefit

from the preprocessing methods and advances described in this presentation.

**Biography: Jing Wu** received her B.S. (2009) in geophysics from China University of Geosciences, and an M.S. (2012) in geophysics from Peking University. She is currently a PhD student in seismic physics at the University of Houston, advised by Prof. Arthur B. Weglein. Her research topics include seismic signal processing for the removal of multiples, ground roll and ghosts, and seismic forward modeling. Among Jing Wu's contributions are a method to remove ground roll without damaging reflection data, and showing that the original inverse scattering series internal multiple attenuation algorithm's ability to not only be applied without subsurface information but without any slightest algorithmic change for any earth model type (acoustic, elastic, anisotropic, anelastic...) was explicitly demonstrated for an absorptive/dispersive subsurface.

**Arthur B. Weglein** received his PhD in physics from the City University of New York and then spent two years as a Robert Welch Postdoctoral Fellow at the University of Texas at Dallas. He entered seismic petroleum research in 1978, first at Cities Service Oil Company Research Laboratory in Tulsa (1978-81) and Sohio Petroleum Company Research Laboratory in Dallas (1981-85). Weglein spent the next 15 years as a member of ARCO's research staff. He spent a sabbatical year (1989-90) as visiting professor at the Federal University of Bahia, in Brazil, and three years (1990-94) as scientific advisor at Schlumberger Cambridge Research in Cambridge, England. In 2000, Weglein joined the University of Houston. In 2002, Weglein was promoted to a university-wide chair, the Hugh Roy and Lillie Cranz Cullen Distinguished Professorship in Physics, with a joint professorship in the Department of Physics and the Department of Earth and Atmospheric Sciences. Weglein received the 2008 CCNY Townsend Harris Medal, and in 2010 the SEG Reginald Fessenden Medal for contributions to seismic exploration. In 2016, Weglein was awarded the SEG's highest honor, the Maurice Ewing Medal.

**Register**  
for Data Processing



**Jing Wu**



**Arthur B. Weglein**



# Geoscience Computing Rice University Conference History

In anticipation of an upcoming [2017 High Performance Computing Conference](#), the GSH is pleased to host this article by Jan Erik Odegard, Ph.D., and Associate Vice President, Research Computing & Infrastructure & Executive Director, Ken Kennedy Institute at Rice University. This article is about the history and purpose of the conference, not so much on HPC SIG itself. The conference has grown from 160 attendees to over 500 in 8 years and 2017 will be its 10th anniversary. This article was written shortly after the spring 2016 conference and the GSH will host an upcoming GSH article focusing on the 2017 conference and the history of the series. – GSH Editor

## 2016 Geoscience Computing Rice University Conference

*By Jan Erik Odegard, Ph.D., Rice University*

Price of oil was down but attendance was up at the 2016 Oil & Gas High-Performance Computing (HPC) Conference, 9th annually hosted by Rice University.

Given the tumultuous times in the oil and gas industry, the program committee wasn't sure what to expect in terms of participation for this year's conference. Would registration hit an all-time low after growing for nine straight years? Short of a dramatic oil price rebound, images of Wile E. Coyote in mid-air had been suggested after the 2015 record year with 500 people attending. Surprisingly, all concerns were unfounded and with 520 attending, 2016 was another record year! Equally satisfying, was the fact that sponsors for this year's conference were there in full force. The demographics also remained largely unchanged with 37% attending from the oil and gas industry.

Conference attendees have various reasons for coming back year after year (and telling their colleagues to come, too), but one common theme is the value of the conference. From the caliber of speakers, to the relevance and timeliness of topics covered, to the networking among peers, the conference is seen as a smart investment of time for HPC professionals. Being located in Houston, the energy capital of the world, certainly doesn't hurt either.

Bookended by four pre-conference HPC tutorials, invited keynotes and plenary talks, the two-day conference also included twenty presentations in four parallel sessions, eight disruptive technology lightning-talks, a student poster session and lots of time for networking. The parallel session on data analytics approaches and tools, a first in the conference series, was a huge hit – a trend we expect will continue. Similarly, the parallel session focused on HPC facility operation and visualization that has been part of the series since 2008 continues to be one of the best attended sessions. This speaks to the fact that, while the industry is fiercely competitive, there are opportunities and a willingness to share best practices when it comes to HPC operations. Parallel sessions on imaging, algorithms and accelerators

have become a staple, spanning challenges and developments in seismic imaging, and reservoir modeling and simulation.

In his opening keynote address, *"How Is High-Performance Computing Reshaping O&G Exploration and Production?"* François Alabert, vice president for geo-technology at Total S.A. said the company was responding to the oil crash by investing in the latest generation of high-performance computing. The volume of data resulting from simulations, lab measurements and field measurements is growing exponentially. "We're seeing increasing costs and decreasing returns. The only way to improve performance is to improve technology and know-how," said Alabert. In the second keynote presentation, *"Exploration Seismology and the Return of the Supercomputer,"* Sverre Brandsberg-Dahl, chief geophysicist, data processing and technology at PGS, said, "We are 'Vikings,' and we operate boats and need more computing power. It's a well-kept secret: the driver of our industry is HPC, [now] we must work [even] smarter and do more with less."

The strong attendance and vibrant conversation shows the industry is in it for the long haul and the need for exascale is still front and center. The conference is a unique opportunity for engaging with the IT industry and helps influence the IT roadmap to meet needs of the oil and gas industry. As Alabert said, "...the challenge is incorporating a lot more physics [in our models] with maybe just a little bit more funding for hardware."

Several themes emerged from the conference. Aside from budget challenges, getting better I/O performance is increasingly critical as data volumes continue to grow. Programmability and the expectations of more tightly integrated accelerators continue to be a hot topic, too. Finally, finding and keeping good HPC talent continues to be a recurring theme. Competition for HPC talent is not just between energy companies, it is increasingly with Silicon Valley. The good news is that it appears, for the short term, that HPC groups across the oil & gas industry are somewhat less impacted by the

*Geoscience Computing continued on page 10.*

market than other divisions. This speaks to the increasing importance of using technology, including HPC, to drive return on investment.

It is with a degree of optimism that we reserved **March 15-16, 2017** for the **10th anniversary of the Rice Oil & Gas High-Performance Computing Conference**.

Save the date now and follow us at:

<http://og-hpc.org/>,  
on **twitter #oghpc**,  
**@jeodegard**  
or **@RiceK21**.

I also recommend you save the dates, **October 1-4, for the 2017 EAGE Oil & Gas HPC Workshop in Dubai**. Happy HPC and we look forward to connecting with all of you at the next HPC conference.

## Geoscience Computing SIG

### *UAS Sensors and Applications*

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**Now meeting every month during lunch. A lunch will be served.**

**Speaker(s):** Jonathan Kohn, Founder and CEO at UM Inspections, LLC.

**Thursday, February 9, 2017,**  
11:30 a.m. - 1:30 p.m.

**Sponsored by The Society of HPC Professionals and UDI**

**Abstract:** UAS technology has the potential to bring saving and efficiency and most important 3D real world data to Geoscientists, from aerial imaging for inspections and photogrammetry and LiDAR for mapping. The UAS provides a platform for the collection of spatial data with unprecedented accuracy and precision. Facilities, as well as land and its subsurface can be digitally modeled and studies via VR interface, in order to provide the perspective required by the energy industry. Environmental and economic challenges created by the exploitation of natural resources now require a quantified approach to risk mitigation in often complex areas of high consequence. In this presentation I will discuss some of the hardware and software infrastructure available and deployed by our company such as the surveying drones and complementary tools and processing of the captured data for analysis, prediction and visualization. Allowing for remote viewing through internet portals the end users. I will also present examples of how these components are combined and

**Location:** Unique Digital Inc.  
Conference Center  
10595 Westoffice Dr.  
Houston, TX 77042  
[www.google.com/maps](http://www.google.com/maps)

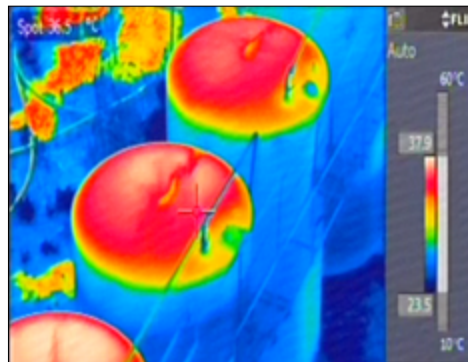
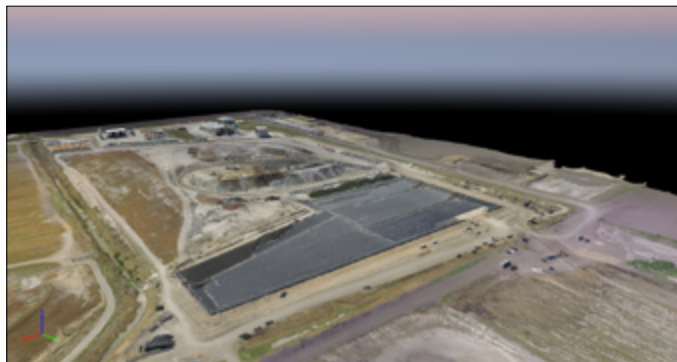


**Jonathan Kohn**

used by groups in the field and the board room to enhance and streamline their efforts in modeling their real world assets for near real time situational awareness.

**Biography:** Jonathan Kohn is the Founder and CEO at UM Inspections, LLC.

UMI is the third entrepreneurial venture for Jonathan Kohn. As an executive with experience in Business Development, Land & Information Systems Management efforts in the Oil and Gas Upstream Industry. Prior to founding UMI, Jonathan served as VP for Balanced Energy LLC and founded Geodex LLC a Title information systems company. Jonathan's strengths are identifying emerging business markets, information systems management and development, business set up and capital raising. He has been directly involved in the for the assemblage, deal structure, and capitalization of over 70 drilling projects. Army Reserve Veteran- 91B.





# Technical Luncheons

## *Data Interpretation and Integration from a Seismic Perspective – The Excitement of Innovation*

**Speaker(s):** Laurie Weston Bellman  
2017 CSEG Distinguished Lecturer

### *Westside*

**Tuesday, February 14, 2017**

11:00 a.m. – 1:00 p.m.

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

### *Downtown*

**Wednesday, February 15, 2017**

11:00 a.m. – 1:00 p.m.

**Location:** Petroleum Club of Houston  
1201 Louisiana, 35th Floor (Total Building)  
Houston TX 77002  
(Valet parking entrance off Milam; UH & Rice students are encouraged to use Metro Rail)

**Abstract:** It's a little cliché to say, but technology is changing so fast that it's difficult to keep up. Computer storage, processing speeds and visualization capabilities continue to grow exponentially; "integration" (however difficult it is to define) is the dream of most geoscience departments and generic "big data" analysis techniques are evolving rapidly – this is indeed an exciting time to be a geophysicist, a scientist, a human being.

Geoscientists are the Google Translate of the oil industry; our job is to translate the coded information in the data we gather to English (or other language of choice). We used to do this with creatively hand drawn and coloured maps and a generous amount of intuition – now we use sophisticated algorithms and powerful visualization, although intuition and creativity are still most definitely required. With all of these new tools, what is the current state of our effectiveness as translators? What are some of the exciting developments? What is the future vision and how do we get there?

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for Tech Lunch  
Northside

### *Northside*

**Sponsored by**  
**Southwestern Energy**

**Thursday, February 16, 2017**

11:00 a.m. – 1:00 p.m.

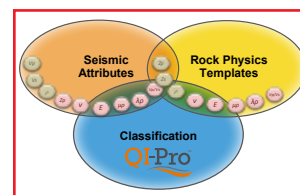
**Location:** Southwestern Energy  
Conference Center  
10000 Energy Drive  
Spring, TX 77389  
(Free Parking onsite)



**Laurie  
Weston  
Bellman**

*Featured in this month's Technical Article on page 19.*

### ***Towards Interactive QI Workflows***



Most companies and research groups are working to some degree to incorporate multiple data types (such as seismic data, well logs, production information, microseismic, etc.) in their interpretations of and predictions from the data they acquire; the more pieces of the puzzle added, the clearer the picture. Integration methods range from simple visual comparisons of maps made from two different data sources to numerical modelling and statistical procedures at a basic data level. Quantitative Interpretation (QI) is a broad approach that encompasses many linked techniques in its aim to extract geological properties from seismic data. These geological properties can then be included in analytical methods to determine the key factors in predicting the future performance of a hypothetical well or field.

QI involves a series of analysis steps that each require input datasets, mathematical functions and parameter selections. Choices are made at each point that affect the outcome to some extent, so the more experienced the practitioner; the more times they have seen a particular situation and learned from the results, the better the choices and the higher the chance of a satisfactory

*Technical Luncheons continued on page 12.*

outcome. By satisfactory, I mean a realistic prediction of geology from seismic data that not only matches the existing wells, but also predicts the geological conditions in an undrilled location that turn out to be correct. This is an accepted and effective process that has been adopted around the world to reduce exploration and development risk.

Much of the credit for the degree of success of the QI outcome can be attributed to factors that are beyond our control, such as the inherent elastic contrasts and intrinsic properties of the rock, the conditions in the near surface (on land or water), the weather on the day the seismic data were acquired. However if we go beyond face value, regardless of quality, the seismic data always contain more information than we think. QI encompasses the best methods currently available to dig deeper and reveal the hidden information. So, how do we make it better?

Aside from improvements in the theory, which is ongoing, we make QI better by increasing the quality of the inputs, ensuring the appropriateness of the assumptions underlying the mathematical functions, testing the correctness of the parameter choices, and doing everything faster than ever. This plan sounds straightforward, but it's almost never obvious how to make these workflow improvements. This kind of challenge is where big data analytical techniques with a corresponding increase in computer processing speeds and capability (eventually even quantum computing) can be introduced. Seismic data has always been big, but seismic analysis is mostly linear: the output from one process is the input to the next. Analytical techniques allow lateral analysis that geoscientists are only just starting to touch on. Statistics and machine learning are much more mathematical than most of us are comfortable with and the approach doesn't necessarily come easily for geoscientists who are used to seeing a direct cause and effect to their analysis. However, as long as we maintain a good balance of objective mathematical process and subjective geological sense, this new direction should reveal new insights and enhanced efficiencies and, perhaps most importantly, be a catalyst for integration.

But how do we get there? It's hard to argue with the potential benefits of a more complete and thorough analysis of the range of available data, but there is plenty of debate about appropriate and effective procedures, near term objectives, and in a business

environment, the best use of limited money. Shortcuts are tempting. Instead of saving money; however, shortcuts usually expose large gaps or inaccuracies in our knowledge – which is not always a bad thing. Collaboration, integration, models of all kinds (scientific and business) and a little bit of faith are therefore necessary to understand, effectively communicate and eventually achieve the ultimate benefits of a significant paradigm shift.

My presentation will not necessarily answer all the questions posed in the abstract, but there will be explanations, examples and opinions.

**Biography:** Laurie Weston Bellman's career as a geophysicist in the oil and gas business has spanned almost 30 years so far. During that time, she has seen the science (and the business) from many different perspectives. She has been part of the evolution of exploration objectives and analysis techniques, both as an interested observer and an active contributor. Originally a Physics/Astronomy graduate from the University of Victoria in B.C., Laurie has enjoyed a variety of career challenges in Canada and internationally.

Laurie started her career with Shell Canada in Calgary doing seismic processing and interpretation in the central plains area of Alberta. Looking for adventure and travel, she took a position with LASMO plc in London, to work on various European, North African and Middle East projects. Upon her return to Canada, Laurie began a consulting contract with Nexen Canada Inc. where her main professional interest migrated to the Canadian oil sands. Based on that interest, she founded her own seismic consulting company in 2007 called Oil Sands Imaging, which was later re-branded as Sound QI and sold to Canadian Discovery in 2012.

Drawing on her experience as a seismic interpreter in many basins around the world, Laurie is well aware of the combination of hard data, imagination, creativity and collaboration that is necessary to be an effective and successful member of an exploration or development team, regardless of background. At the same time, Laurie's education in physics and astronomy, and her early career as a seismic processor have given her a respect (and healthy skepticism) of data and data analysis. The integration of all these aspects is her objective in her current role.



# Geoscientists Without Jobs: A Guide to Surviving the Downturn

## Part Six: Consulting Dollars and Sense

By Paul E. Murray ([paulm@fipgeophysical.com](mailto:paulm@fipgeophysical.com))

"Are you STILL interested in geoscience jobs in Houston, Paul?" I get this email once a week from one of many job search sites I frequented over the last year. In that time, the number of open full-time jobs in the oil business has hovered just north of zero. While oil companies are still advertising intern positions (although one wonders who is left to mentor them?), those of us with experience wanting in the game have to do so under the banner of consultancy. If perusing the biographies of geoscientists on LinkedIn is any indication, the old trope about "consultant" being a euphemism for "unemployed" resonates with uncomfortable familiarity.

***It is nearly a truism that first-time consultants do not understand what they should charge for their time.***

There are countless books, seminars and courses on starting your own business and defining your unique value proposition; the reader is encouraged to determine his or her own course as a consultant. On offer here are some practical guidelines for consultants about money; mainly, what to charge, tax implications, and getting paid in a timely fashion. (I'm neither an accountant nor a lawyer, so I disclaim all advice here. These are lessons learned from experience, and you should seek the advice of a professional before putting your skin in the game.)

It is nearly a truism that first-time consultants do not understand what they should charge for their time. If you've never been in charge of budgets and hiring, you may be surprised by what it costs a company to employ someone, and therefore what makes a consultant an attractive option to a potential client. If you're employed in the US and want to know your fully-loaded cost, a good rule of thumb is to double your salary. A full-time US employee works 2,000 hours in a year, so your cost per hour is a simple calculation.

Charging much higher as a consultant reduces your odds of securing a contract unless you have unique skills that command a premium. With over 70,000 oil and gas professionals on the streets in Houston alone, uniqueness is unlikely. Charging much less carries risks, too. Once you find out that actually billing 2,000 hours a year is a bridge too far and you've averaged out the feast-or-famine cycles of consulting, your annual income may not be as impressive as your hourly rate might initially lead you to believe it should be.

Once you set a rate, you have to stick with it. Charging different rates to different customers will cause trouble. Aside from the reputational issue, you create an additional ethical problem for yourself by creating an incentive to bill hours to one client over another. There are exceptions to the rule, though; if someone is willing to engage you for extended periods (a month or more), it is customary to discount your hourly or daily rates.

Taxes are also markedly different, and include such surprises as the so-called "self-employment tax". As of 2016, the IRS codes state a self-employed person will pay an additional 15.3% on your first \$181,000 of gross income in addition to the customary income taxes you pay as someone else's employee. Since you have to pay estimated taxes on a quarterly basis as well, you need to keep enough on hand to cover those payments every 90 days to avoid costly penalties.

Unlike employment where you get a paycheck every 14 or 15 days, you won't get paid until you send your clients an invoice. If you're not familiar with terms like "net-30", be prepared to wait for your money. Payment terms and timelines should be included in any contracts. Keep time sheets, even if the client does not request them from you, so you have an auditable trail of your time and costs for a project. Keep track of all your costs and receipts; if the client is not willing to cover those expenses, you may be able to deduct them on your taxes.

If you contract with companies based in your own country, your path to resolving contract disputes is well-established. If you sign a contract with a foreign entity that dictates legal actions must be filed in their home country's court

*Geoscientists Without Jobs continued on page 14.*

system, you are at a disadvantage. Since the most likely dispute you will encounter is non-payment, one way to mitigate this risk is to ask for a retainer for some portion of the contract. If your client routinely deals with contractors, this will not be an unusual nor unreasonable request. If the client is unwilling to consider this, take that as a red flag. You then have to weigh the risks of waiting months to be paid or possibly not at all.

Remember your consulting contracts are, in fact, legal contracts. Your clients are bound to pay you, but are also bound to deliver on your work. When you're a struggling consultant, it is tempting to take any work offered, even if it exceeds your skills. Remember your reputation is the coin of the geoscience realm. From the last column, readers may recall the reputational benefit of altruism by referring potential clients to more qualified candidates. When one factors in the legal, financial and reputational risks, discretion is also the better part of contract work. Stepping outside your comfort zone is good for growth, but leaping off a cliff in pursuit of your contracting quarry may leave you feeling like Wile E. Coyote in that moment before gravity kicks in.

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Oz Yilmaz, PhD in Geophysics

Director of Anatolian Geophysical & CTO of GeoTomo LLC.

**February 28, March 1, 2, 3, 2017 10:00 am - 2:00 pm**



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*Shot-receiver spatial sampling requirements in land seismic data acquisition, large-offset recording, swath-line recording, the meaning of the near-surface in exploration seismology, seismic wave velocities in the near-surface, factors that influence surface-wave propagation in the near-surface --- source depth, velocity contrast between the near-surface and the subsurface, thickness of the near-surface, near-surface geometry, near-surface velocities, near-surface heterogeneities, wave attenuation in the near-surface, surface topography, and recording geometry --- workflows and case studies for near-surface modeling by traveltime inversion and image-based near-surface modeling for statics corrections, workflow and case studies for subsurface imaging in areas with irregular topography, complex near-surface and complex subsurface.*

Oz Yilmaz received his B.S. in Geology with Geophysics Option from the University of Missouri-Rolla in 1970, M.S. in Geophysics with research in rock physics and earthquake seismology from Stanford University in 1972, and after five years in the industry, a Ph.D. in Geophysics with research in exploration seismology from Stanford University in 1979. Aside from numerous publications on all aspects of seismic data analysis, Oz wrote three books published by SEG --- Seismic Data Processing (1987), Seismic Data Analysis (2001), and Engineering Seismology (2015).



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# Education and Development of Unemployed Professionals

## *What's Your Career Signal-to-Noise Ratio?*

By Sofia Campbell, Energy Professional Search

Examining ourselves at juncture points in our career offers us an opportunity to critically evaluate what is important to employers – and making a concerted effort to develop real value in our work is essential to our success. This process ought to be an ongoing endeavor, yet many of us wait until an industry downturn affects us to ask what went wrong... Learn how to develop strategies for growing your career wherever you are now – and how to reflect upon your role in the greater geoscience community. *Introspection, communication, networking and leadership* are just a handful of the qualities that will be highlighted to demonstrate how to improve your career signal-to-noise ratio.

This article summarizes key points that I made during the January 25<sup>th</sup> **Education & Career Development for Unemployed Professionals** GSH Premier Event at the Geoscience Center. It is a reminder for those who attended and a resource for those who did not – and focuses on the soft skills that can be honed throughout our career to help us stand out from the crowd, regardless of the price of a barrel of oil. *Why, How, When and What* are addressed through an inside to outside approach. Starting with looking closely at ourselves, communicating our value, reaching out to others and finally offering direction within our greater industry community – we can develop an authentic and personal approach to success that will give us a deep sense of accomplishment and simultaneously achieve our employers' objectives.

Good deal so far, right? Let us begin the journey to examine what's your career signal-to-noise ratio...

### *Why bother?*

In modern-day western culture, our personal "identity" is wrapped up intimately with our work, career, and studies and how we earn a living. We've all experienced the question as children, "What are you going to be when you grow up?" I'm certain nobody answered, a geophysicist that spends at least three periods of their entire working life in recession questioning their last big purchase, their college major and career choice. Even during "good" times in our jobs, we may have scratched our heads when management scraps a project we've put months of time into, injected our best technical effort and we "know" will be a successful discovery. Why bother?

Begin with: **Introspection** – the internal barometer that is closest to the bone, is for your eyes only and is essential to develop so that you will maintain a personal signal that positively stands out and above all the noise of life's minutia. With time and attention, introspection is your best strategy against anything that the economy, industry, or weatherman throws at you!

Hmm, sounds like a bit of a stretch for us "techie" geotypes.... Yes – you are right – it is. Which is why you'll see some folks thrive in tough times. They are the ones who have taken the dive into discovering **Who Am I?** Their personal value is not only measured by their college degree or the whims of a fickle and fluctuating economy – but their personal value is established by identifying their core **Values**, creating a **Mission Statement** and making a commitment to live with **Authenticity**. You'll know this person when you meet them. They carry a classy sense of success about them that goes beyond what they do for a living.

**Balance** in our work and personal life is a lofty goal. It is not a destination or status quo. Rather, it ought to be approached as a constant work in progress that addresses our **Mental, Physical, Emotional** and **Spiritual** aspects. Being out of work is a good time to reevaluate what may need some attention. Chances are our stress level is higher, so the **Physical** is a good place to start. Numerous studies have shown a direct correlation between our Physical health and *Lifestyle Choices, Exercise, Diet and Sleep*. We can improve our **Emotional** wellness by practicing *Hobbies, Meditation*, spending time with *Family and Friends* in social activity. **Spiritual** health is a subjective and very personal choice in how it is practiced – the key takeaway being that feeling a strong sense of *Support* by your community in good and especially bad times, is vital. **Mental** wellness is another subjective but powerful way to jumpstart feeling balanced. For some *Organization* is key – office desk, house, contact list, garage or golf bag – ways to feel clearheaded. For others it's time to pursue additional *Education* – filling up one's head – which I'll elaborate on next.

Most companies invest a significant amount of operational budget toward continuing education and training for employees. Although tempting, don't depend only on what your employer can do for you...be proactive and

*Education and Development continued on page 16.*

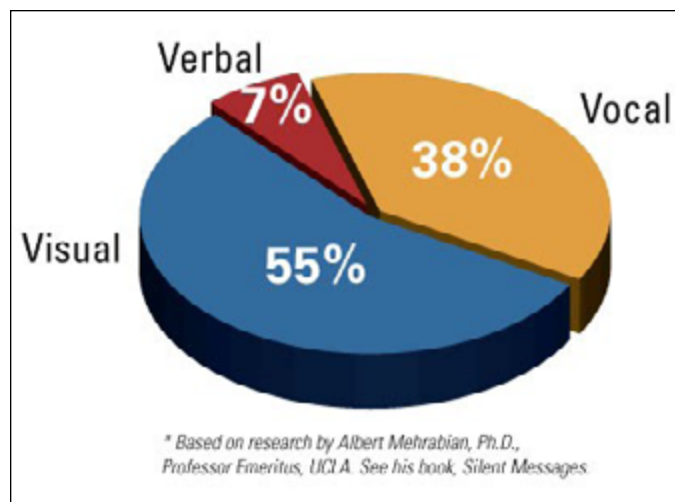
improve your expertise signal-to-noise ratio and make an **Investment** in your own training and education. This ought to be ongoing throughout your career, somewhat dependent on your functional role and most of all, thoughtful. Consider it a **Risk vs Diversification** process. Too much training in subjects too widespread may produce a weak signal, where all those extra courses listed on your resume start to look like noise with no hands-on experience to back it up. On the other hand, allot of training in a narrow subject can be risky, as your skillset could become obsolete if the technology shifts or funding dries up. Striking the perfect balance of breadth and depth is a challenge all of us face in an ever-evolving technical industry; however, this is something you have control over and can take responsibility for. Make it fun – but make it make sense!

It is an ongoing iteration to figure out who we are, create balance in our life and invest in our skillset. So now we've completed a little introspection...

*How do I develop and market my key qualities?*

**Communication** is everything. I've witnessed colleagues who are fantastic at what they do but wonder why they are looked over at times of promotion or team reorganizations. It's one thing to let your work speak for itself – which inherently is a great part of your value to realizing the company objective – but if you have unfulfilled aspirations, it shouldn't be news to you that mindreading doesn't exist. You need to communicate your qualities accurately, convey their value and present a compelling reason why you are important. Put in other words...why your signal-to-noise ratio makes you a valuable employee.

**First Impressions** are key and the initial reason why your audience will either listen to you or switch off – no matter how much of a genius you really are.



Best illustrated by this pie chart: 55% of your message comes across in your body language (visual), 38% by your tone (vocal) and only 7% by the actual words you use (verbal). Improving your first impression is something you can definitely work on and there are a variety of resources to help you develop a way to market yourself that feels both comfortable to you and is also positive. The goal here is to reduce the distracting elements of noise to see the real value you bring.

The **Elevator Speech** – oh horror of horrors some will cry... Yes – it can be thought of as a “sales pitch” but it is really just a form of communication that allows you to concisely market your value. It should be short, factual, to the point and memorable. It only improves with practice so start with a simple message and build on it. The good thing is that it's mostly used to introduce you to new people, so even if it feels awkward at first, it will improve, evolve and develop with time. Most importantly your elevator speech ought to pique the listener's interest and leave space for their imagination. Imagination? Yes...just like the part of the iceberg below the surface of the water that engages the listener's interest to want to find out more. Your elevator speech needs to be genuine and passionate – and it is a great form of communication to yourself as a reminder of your true value.

The entire package of visual, vocal and verbal – together with your value and real, verifiable achievements – becomes your unique and authentic **Personal Branding**. This is why a resume is rarely matched to a job description accurately, as the “whole package” is only experienced through an in-person interview – when you get to showcase your personal talent bank account. At that time, your ability to raise your soft-skill signal-to-noise ratio is paramount to landing the position, raise or promotion because your true value exceeds a resume checklist of hard-skills that can be learned on the job.

First impressions, an elevator speech and creating personal branding are essential to communicating one's key qualities. As with introspection, it is an ongoing process to develop your marketing soft skills and it requires practice and patience as you change and evolve throughout your career.

*When should I focus on career development?*

A distinct pattern is emerging: career development is ongoing and begins as a senior or post-graduate level student and continues at every stage of your career: early, mid and late. Career development is not linear but rather, cyclic.

One constant throughout everyone's career and life are our **Relationships**. There are numerous metaphors illustrating that no man is an island. Our careers are unlikely to exist if it were not for the relationships we have: student to teacher; graduate employee to team lead; mid-career peer to peer across disciplines; mid-level manager to CEO. After a while it looks like a spider's web of silken threads that connect us all in this industry as geoscience professionals and underlines the golden rule to never burn bridges!

**Networking** is 101 to career success! It is the direct line to finding out what your connections know that you should know to help you filter out the signal from the noise. Opportunities for networking exist in every interaction that we have with another person at the office, between companies, at professional events, amongst alumni and social gatherings with professional colleagues. Social media networking including but not limited to LinkedIn professional groups, Facebook professional organization group pages and Twitter feeds ought to supplement face-to-face interaction – and be used judiciously.

Another networking tool that is less intimidating for some is to get involved in **Volunteering**. Throughout one's career and life, there are a multitude of choices where to volunteer. Think strategically about where you contribute and get the best rate of investment on your time and energy. The relationships you form in the collaborative efforts of volunteering can enhance your skillset – provided you can highlight valuable signal results from the noise of being involved superficially in too many endeavors. It is OK for it to be a win-win for you too.

Depending on where we happen to be in our career, our experiences and what our current needs are, we can be an **Inspiration** to others – or ourselves seek inspiration, motivation and guidance. Whilst many of our workplace relationships will be transactional with an end in mind, inspiring others or being inspired about our career can take one of the following forms: **Coaching, Mentoring and Sponsoring** – the end goal of each being focused primarily on career development and success. Navigating career landscapes that are both within our consciousness but more importantly, those often-mysterious detours we are not even aware of, begs for the intervention of greater experience. Guides who can see that which we cannot and lead us in the direction of honing our career strengths through self-study and focusing on what is valuable to employers – are priceless.

For you to be more than just successful throughout all the stages of your career, the relationships that you

will nurture through networking, volunteering and inspiration-focused career development are key to lay the foundation for synergistic work that is essential to business success.

*What is important to employers?*

Think like it is your own business! It is easy to slide into the mindset that we work for "other people", or a "big company"; when in fact, we are working for ourselves by simply trading our time and expertise on a daily basis with our employer, who pays us to achieve their core objective. Keep your employer's corporate goal, mission statement or target at a level of consciousness that helps you to prioritize your daily efforts and very quickly, you will establish natural **Leadership** skills.

Leadership in itself is not what is valued the most; however, it typically rides shotgun with being identified as one or more of the following: a **Contributor**, **Influencer** or **Visionary**.

You can become a great leader by being a prolific **Contributor** that is focused on doing valuable work versus busy work. The path to leadership can be one of contributing technical excellence and expertise rather than people, project and budget management. Ideally student interns, new hires and early career folks will be focused on augmenting their education with hands-on experience to build their technical skillset. Being crystal clear about how your work adds value to the company you work for is a high priority and can be achieved through meaningful networking, mentoring and internal company relationships. Your goal is to ensure your contribution is signal and not noise.

About the middle of our careers is where we see differentiation occur where some remain as valuable Contributors and others move to **Influencer** roles. It can be as a project lead, a team lead or as a subject matter expert. This is where the signal-to-noise ratio is under constant scrutiny as your salary most likely represents a big investment by the company in your potential. It is even more imperative if you are in this camp to be very strategic about how you manage your career – as you need to amp up the value quotient. *Think globally but act locally.* It is a powerful way to approach your everyday when your efforts are strongly aligned with the corporate charter and your results equally impressive.

Being a **Visionary** can occur earlier in a career but typically individuals rise out above the crowd about mid or late career, armed with a solid technical



background, corporate experience, credibility and a creative mindset that drives the industry to the next level. This is an elusive quality that is not necessarily developed but is the fortuitous combination of creative leadership and from the corporation's perspective, being in the right time and place – both financially and culturally. Furthermore, not everyone wants to be an entrepreneur within a large – or small – company; however, one thing is sure: the successful visionary leader will keep us all employed in the long term!

Whether you identify as or aspire to become a Contributor, Influencer or Visionary, your primary goal is to be valuable, stay valuable and become more valuable to your employer.

*So – what is your career signal-to-noise ratio?*

Have you taken the time to really explore your true potential and have you taken the time to ascertain what is really important to your employer?

Will you?

Reflecting back on this discussion, I have presented some key development areas that you can and ought to address throughout your career. Tackling all aspects at once is like attempting to climb Mt. Everest never having trained for it; however, identifying one or two areas that resonate with you today that either need signal enhancement – or noise reduction – will give you a strategy to begin and sustain the ongoing process of becoming more successful in your career.

Let the exciting journey begin!

## Geoscience Center News

By Bill Gafford

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

We have added some additional items to our Museum display at the University of Texas, Bureau of Economic Geology, Houston Research Center, or as we call it, the "BEG". This facility, on West Little York, houses a large collection of geologic well core and cuttings and we were recently offered additional space for our display of vintage geophysical artifacts. The space is in one of the core layout rooms and has been enjoyed by the visitors who attend classes or core workshops. Our display includes torsion balances, magnetometers, survey instruments, and a variety of marine

and land seismic detectors or geophones and recording devices from the early days of exploration. A portion of the display can be seen in the picture below. We are going to add some additional items, informational signs, and pictures in the future.

Our next Living Legends Doodlebugger social event will be on Thursday, February 9, from 9:00 until noon. As usual, everyone is invited, including spouses, working or retired doodlebuggers, and anyone who just wants to come by and listen to good conversation about experiences in the oil patch. There will be light snacks, coffee, soft drinks, water, and a chance to see some of our newer additions to the Geoscience Center.

We are also still looking for volunteers to help with some of the projects on our list. Please let me know if you might be interested.

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, please contact me at [geogaf@hal-pc.org](mailto:geogaf@hal-pc.org) or at 281-370-3264.



# Towards Interactive QI Workflows

By Laurie Weston Bellman

Ms. Bellman is the CSEG Distinguished Lecturer. She will be giving her talk at the technical lunches this month (see notices in this issue). This article serves as the basis for her talk.

## Introduction

QI is not new. The general idea has existed since geophysicists first started noticing variations in the wavelet several decades ago. Relatively recently however, the process has incorporated geological templates (Avseth et al., 2005, Weston Bellman, 2009) to directly relate seismically-derived elastic properties to geological

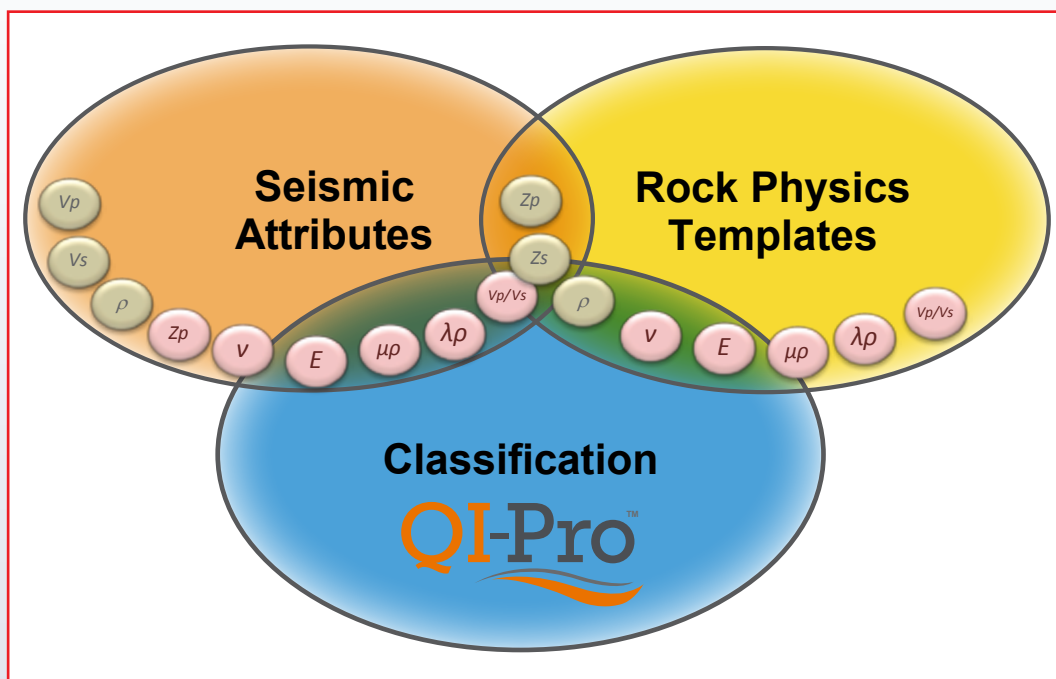


Figure 1: Integrated QI elements

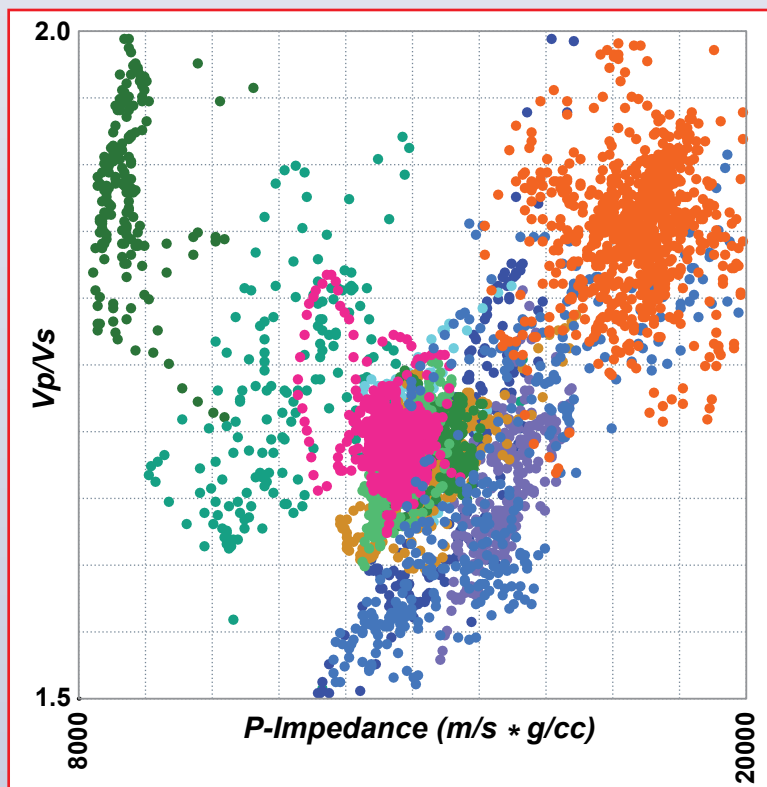


Figure 2: Geological template: Crossplot of Vp/Vs vs P-impedance with points coloured by geological formation.

properties of interest such as porosity, facies type, reservoir quality, geomechanical indicators and reservoir fluids. As such, a modern, integrated QI process consists of three main components: templating, attribute estimation and classification (Figure 1).

## Method

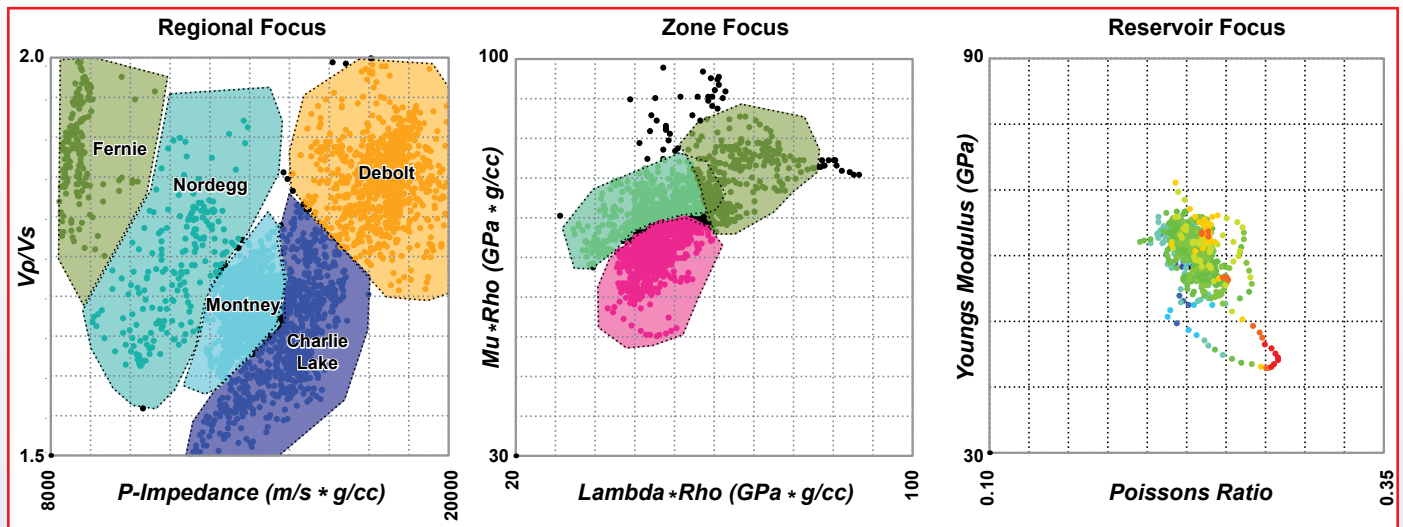
### Templating

Geological templates represent the expression of geological properties of interest relative to elastic rock properties derived either from well log data or theoretical rock types synthesized through modeling (mineral proportions, fluids and porosity type and magnitude). Figure 2 shows a template illustrating the relationship between the elastic properties Vp/Vs ratio (y-axis) and P-impedance (x-axis) and the geological formation (colour). The plot clearly shows a pattern indicating certain ranges of elastic properties that can be associated with several distinct geological units (others are overlapping in this domain).

In an enhancement to a typical comprehensive QI workflow, several templates are investigated and constructed to represent all geological properties of

Technical Article continued on page 20.

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



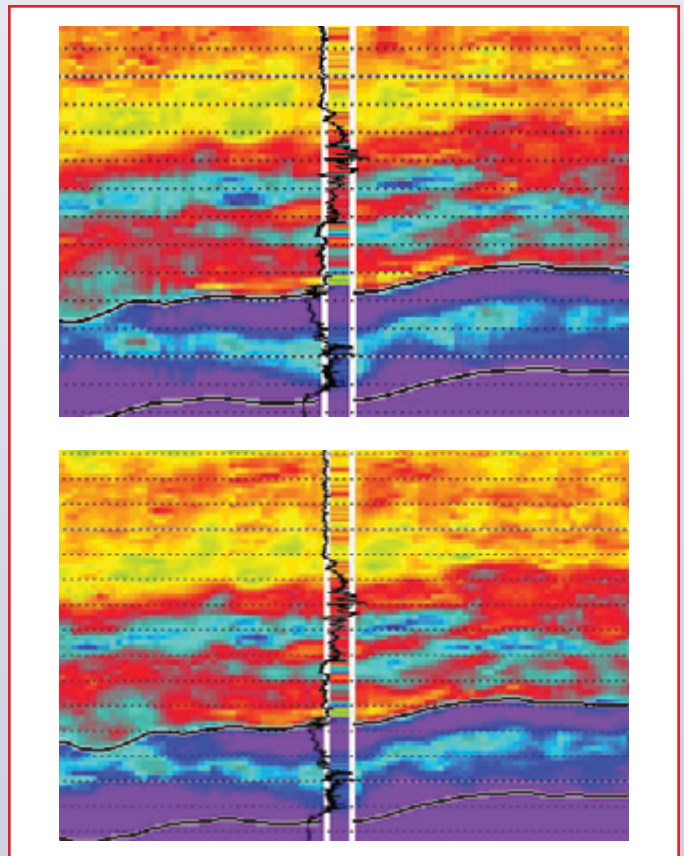
**Figure 3:** Series of templates with increasing reservoir detail. Regional scale (left), zone of interest scale (center) and reservoir scale with the points contoured by porosity (right).

interest. This allows for the contribution of information from multiple elastic properties employed where they are most useful in characterizing specific geological properties. **Figure 3** shows a series of crossplot templates, each able to characterize, in increasing detail, a selected portion of the data segregated by the previous crossplot.

#### Attribute Estimation

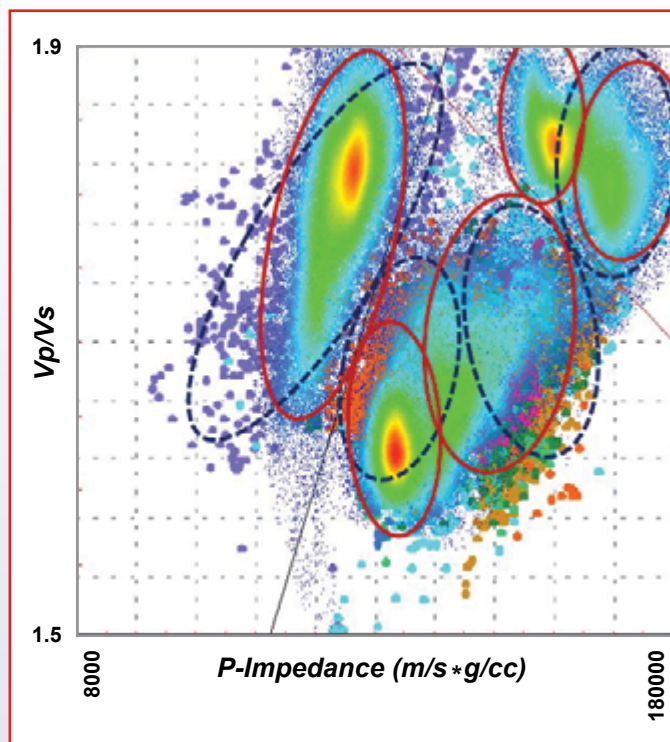
The templating process results in the identification of a set of elastic properties that is useful, either alone or in combination, for representing geological properties of interest. These elastic properties can all be derived from attributes of pre-stack seismic data (Goodway et al., 1997). The detailed geophysical workflow required for this purpose is complex. There are multiple steps with multiple unknowns, each requiring assumptions and educated judgment of intermediate results, all surrounded by varying degrees of uncertainty. The data conditioning and parameter choices at any particular point in the workflow most certainly affect every subsequent step. Indeed, the cumulative effect of these choices could make a significant difference to the ultimate accuracy of the derived elastic properties. Ideally, some process could be devised that would steer the parameter choices to the value that leads to the most accurate geological prediction.

The proposed workflow compares multiple realizations of final outputs that have been derived using a unique set of parameters for each analysis. These are interactively visualized in software designed to give the user 'slider-bar' control over parameter ranges. Thus, both analytical and interpretive assessments at intermediate points in the workflow allow for sensitivity investigation and 'parameter tuning' to ensure the best quality results. **Figure 4** shows



**Figure 4:** Comparison between S-impedance profiles (top and bottom) with only a single AVO parameter difference. S-impedance log displayed in colour with gamma-ray curve overlain. Aside from visually assessing the quality of the match at the well, other detailed features of interest can be compared between different parameter selections.





**Figure 5:** A QI classification view showing geological classification outlines (dashed black ellipses) based on the well log template (large points coloured by formation), and the revised classification outlines (red ellipses) adjusted to fit the actual seismic attribute clusters (small points coloured by cluster density). In the top right corner of the plot, the seismic clustering implies that two clusters would best characterize the data rather than the single one derived from the well data.

an example of two S-Impedance profiles created by varying a single parameter in the previous AVO step. Subtle differences may not seem significant, but if slight improvements are possible at each step, material gains in accuracy and resolution are inevitable in the final results.

### Classification

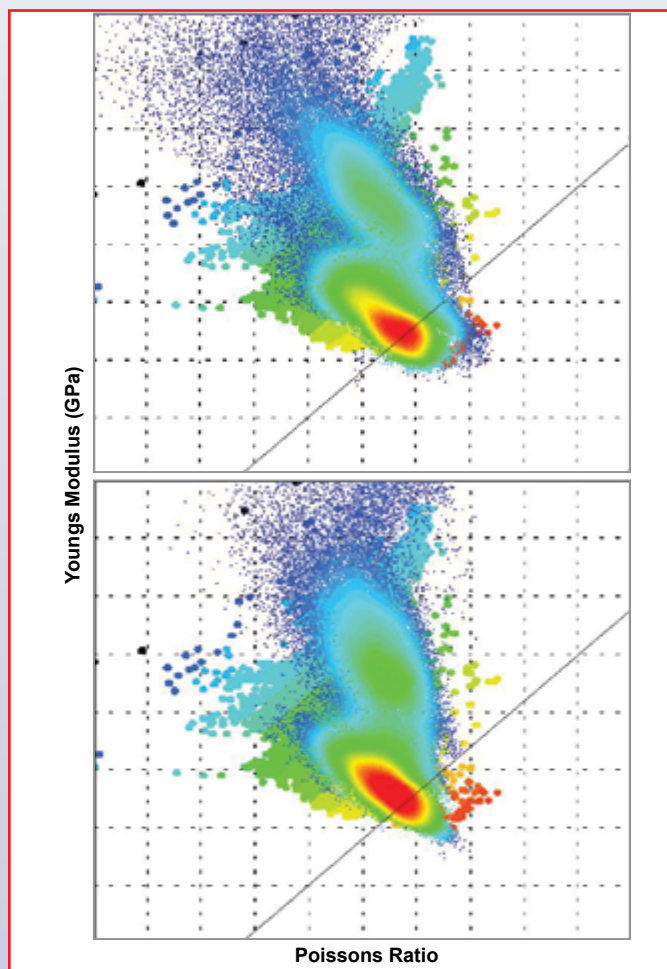
This element of the QI workflow uses the appropriately selected templates to assign geological properties to every sample in the seismic volume based on the associated elastic properties derived from seismic data. Since the templates were designed using elastic properties computed from log data, but applied to elastic properties derived from seismic data, a literal substitution is not always possible. It may be apparent visually that certain clusters in the seismic data do relate to equivalent clusters in the well data, but are not in alignment. In many QI examples, classification is a mathematical process, directly applying the log-data-derived template to the seismic data. In the hypothetical situation just

described, this direct transformation would result in an incorrect characterization and a potential missed opportunity for the seismic data to be utilized effectively.

To overcome this kind of problem, compensation needs to be made for the misalignment of the two data types. QI-Pro, a proprietary application, has been developed to provide an interpretation environment that allows for interactive classification of the seismic data guided by the templates, but not restricted by them. Thus, the classification can be tailored to the best features of the seismic data, ultimately enhancing the validity of the classes defined in the seismic volume.

**Figure 5** shows how this type of creative classification honors the template, but is adjusted to fit the seismic clusters, resulting in a more meaningful geological characterization.

In the ideal interactive QI workflow, seismic attribute data plotted on crossplots would respond to the



**Figure 6:** Comparison between classification views (top and bottom) showing identical templates overlain by seismic attributes derived with different QI parameters. Seismic attribute points are coloured by cluster density.

'slider bar' adjustments in parameters regardless of which particular stage in the QI process the parameter belonged. In this way, sensitivity of the final geological prediction to individual parameter choices at any point in the workflow could be assessed and accommodated. **Figure 6** shows a template overlain with seismic attributes created with different sets of QI parameters, illustrating this concept. **Figure 7** highlights the cumulative effects in the classified volume resulting from the changes in seismic attributes due to the parameter variation.

## Conclusions

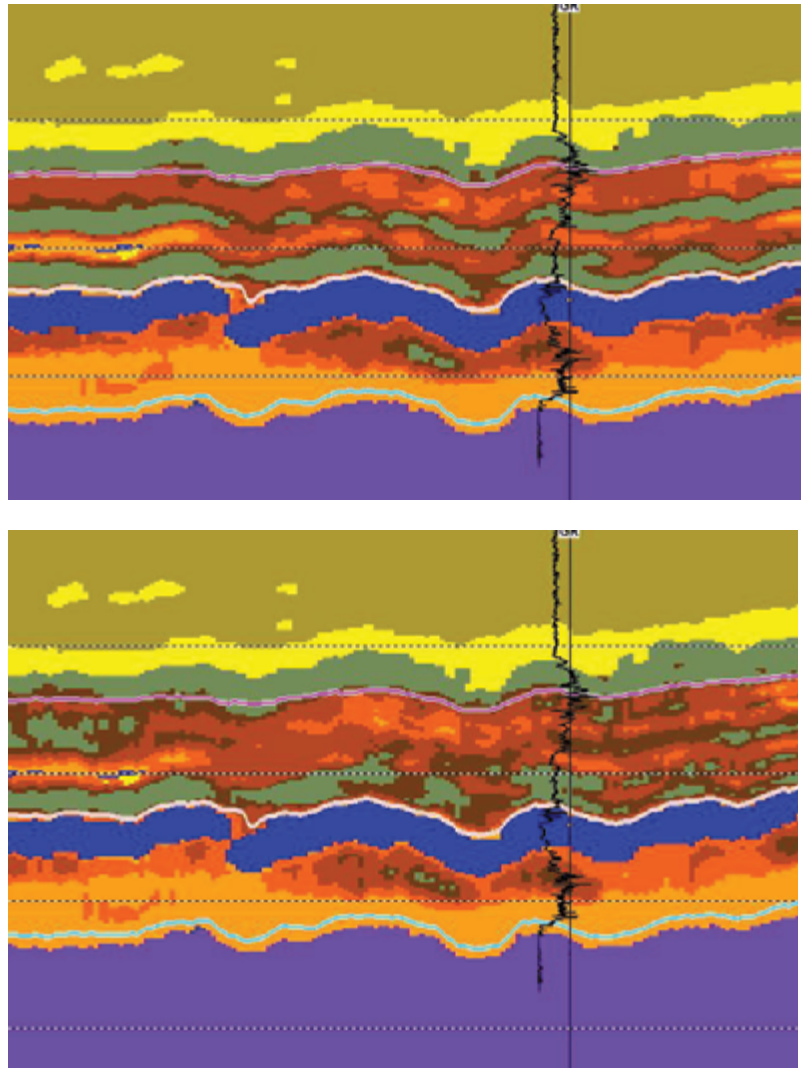
A workflow has been described to link QI processes and allow greater interpretive control over the final results than a simple linear procedure. By interactively tuning the QI process in the ways illustrated in the examples, we are able to bring out the best of the seismic data; we achieve the most accurate attributes possible while at the same time optimizing the accuracy of the geological prediction and determining the parameters that have the most effect on the outcomes.

This workflow provides a solution tailored to seismic resolution and to extracting the most value from any dataset; it allows for the optimum integration between geology and seismic data without losing anything in translation, all within a collaborative integration environment.

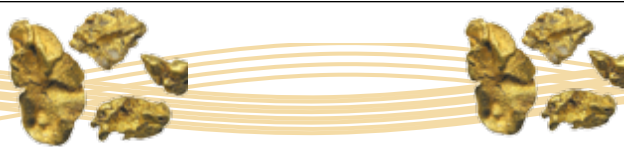
In order to build an interactive process such as this, large data handling and processing capabilities would need to be employed which have not yet been fully implemented to create the examples shown. Customized software is in development and changes are definitely on the horizon.

## Acknowledgements

The author would like to thank colleagues at Canadian Discovery Ltd., for their contributions to the workflows, software development and results presented, in particular, Kevin Lee and Carl Reine.



**Figure 7:** Two equally likely geological property classifications based on two different reasonable sets of QI parameters. Comparison between the final outcomes provides an estimate of uncertainty and sensitivity.



## Missing Page From January Nuggets Found Among Salton Sea Scrolls: Circumstances Labelled “Suspicious”

Houston – In an apparent leak by the Federal Literary Investigation Service, it was revealed that documents related to the January 2017 *Tutorial Nuggets* were found just outside the Torres Martinez Indian Reservation, on State Highway 86, 3 miles west of the Salton Sea.



The esteemed Editorial Board expressed extreme puzzlement over this announcement. “Since there is no hardcopy, only vapor pages, we had no idea such data even existed,” said **David Watts**, Editor of The GSH Journal.

### GSH Editorial Board: Boggled, Baffled and Bewildered

**Watts** continued in a petulant tone, “We print what he sends us. But this is so typical of the Guru; he turns in his article a month over the deadline and then claims misconduct by the beleaguered editorial staff.” The Guru was unavailable for comment, but did say in responding “No Comment”, that, “the ‘deadline’ is draconian. It’s designed to be vindictive and unachievable! They’ve now set it at something like 6 months ahead of the publication date. I spent my summer vacation in the Swiss Alps writing the *January issue*. No comment.”

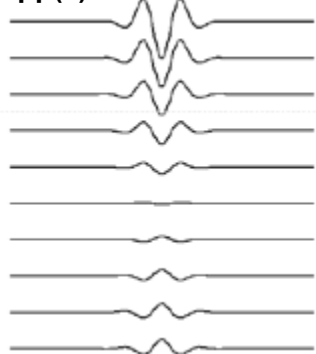
The Board, in its Benevolent Wisdom, will publish extracts from this “missing page” to if nothing else, assuage the delicate sensibilities of The Guru. They appear below.

And now another example **SvP AVO** which can be used to confirm the **P-wave AVO** thus reducing risk.

$\alpha 1 = 8443$	$\beta 1 = 3714$	$\rho 1 = 2.38$	$\sigma 1 = 0.38$
$\alpha 2 = 10074$	$\beta 2 = 6284$	$\rho 2 = 2.10$	$\sigma 2 = 0.14$

The wiggle trace version of the **Gas Sand AVO** gathers appears below.

$R_{pp}(\theta)$



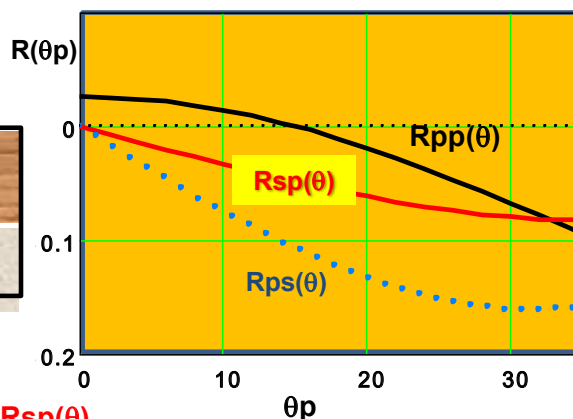
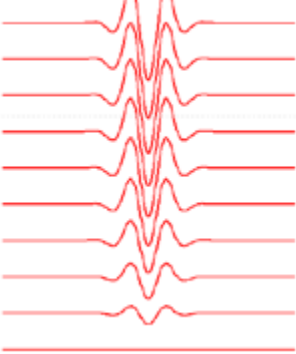
36°



$\theta_p$

0°

$R_{sp}(\theta)$

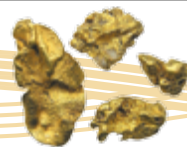


The  $R_{sp}(\theta_p)$  term may be translated to  $R_{ps}(\theta_p)$  amplitude for greater visibility by a simple function related to corresponding **P**- and **S**-wave velocities at the boundary.

$$R_{ps}(\theta_p) = \frac{\cos \theta_p}{\cos \theta_s} \cdot \frac{\alpha}{\beta} \cdot R_{sp}(\theta_p)$$







Once again, keep in mind that the **converted wave information** presented here required **no additional recording**. It is in the **regular P-wave data free of charge**. Just take it to your neighborhood processing shop (skilled and licensed in this type of processing). Dr. Bob Hardage and his Vertishear team deserve much credit for this breakthrough.

**Flash Announcement:** There will be a **Special Session** on this Topic at the SEG Annual Meeting, **September 2017**, in Houston. Be there or be left behind.

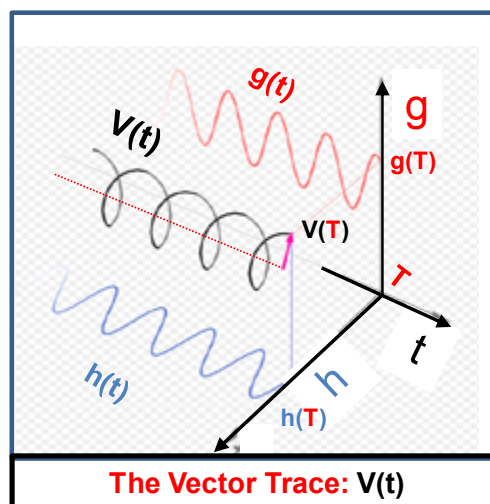
Let's talk about something different for a change.

## Seismic Attributes – A Tutorial Exposé of Some Noté

For the next 6 or 7 years we'll probe the mysteries of **Attributes** – both Trace and Space. We may be forced to beg, borrow and steal from the works of **Art Barnes, Tury Taner, Kurt Marfurt, Nigel Anstey, Satinder Chopra**, and a host of others who have made these attributes part of our everyday interpretation arsenal.

We begin today's pedantic dissertation with a picture familiar to all those with a bluffing acquaintance to the idea of a “**complex trace**” (bear with me, my thirsty friend, this is a tutorial, and the truth will out, along with a healthy dose of technical clarity).

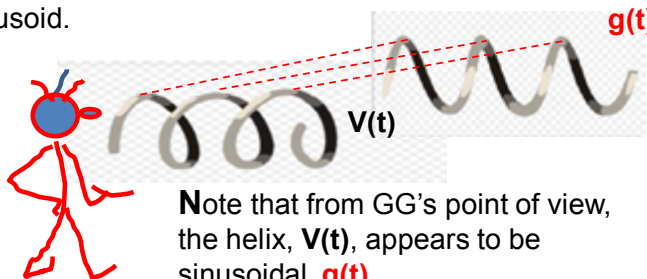
First, *The Guru*, based on his studies dating back to the mid 60's of another millennium, will refer to the phenomenon, depicted at the right, as the **Vector Trace,  $V(t)$** . The keen observer will easily spot the tiny red stick, with an arrow head, at the far right end of the helical curve. This **baton rouge**



is the **Vector** of which we speak. This little guy is moving down the time line and spinning clockwise as it goes. The black helix is the 3-dimensional trace,  **$V(t)$** , formed by the location of the tip of the vector at any time,  **$t$** . In the picture we have captured the vector with a snapshot at  **$t = T$** . Note, if you will, that the projection of the vector tip,  **$V(T)$** , to the vertical plane (formed by the time line,  **$t$** , and the vertical axis,  **$g$** ) strikes with value of  **$g(T)$** . The function formed by a continuous projection is  **$g(t)$** , the red curve, which bears an amazing resemblance to a sinusoid.

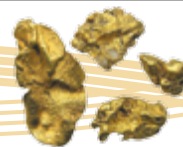
A similar projection to the horizontal plane, ( **$h, t$** ), falls at  **$h(T)$**  with a continuous trace,  **$h(t)$** , the blue curve, also strikingly similar to a sinusoid.

Heuristically, we may grasp the concept of the projections being sinusoidal by considering what **Geoffrey Geofizz** would see if he were to gaze upon  **$V(t)$**  at an angle perpendicular to the vertical plane.

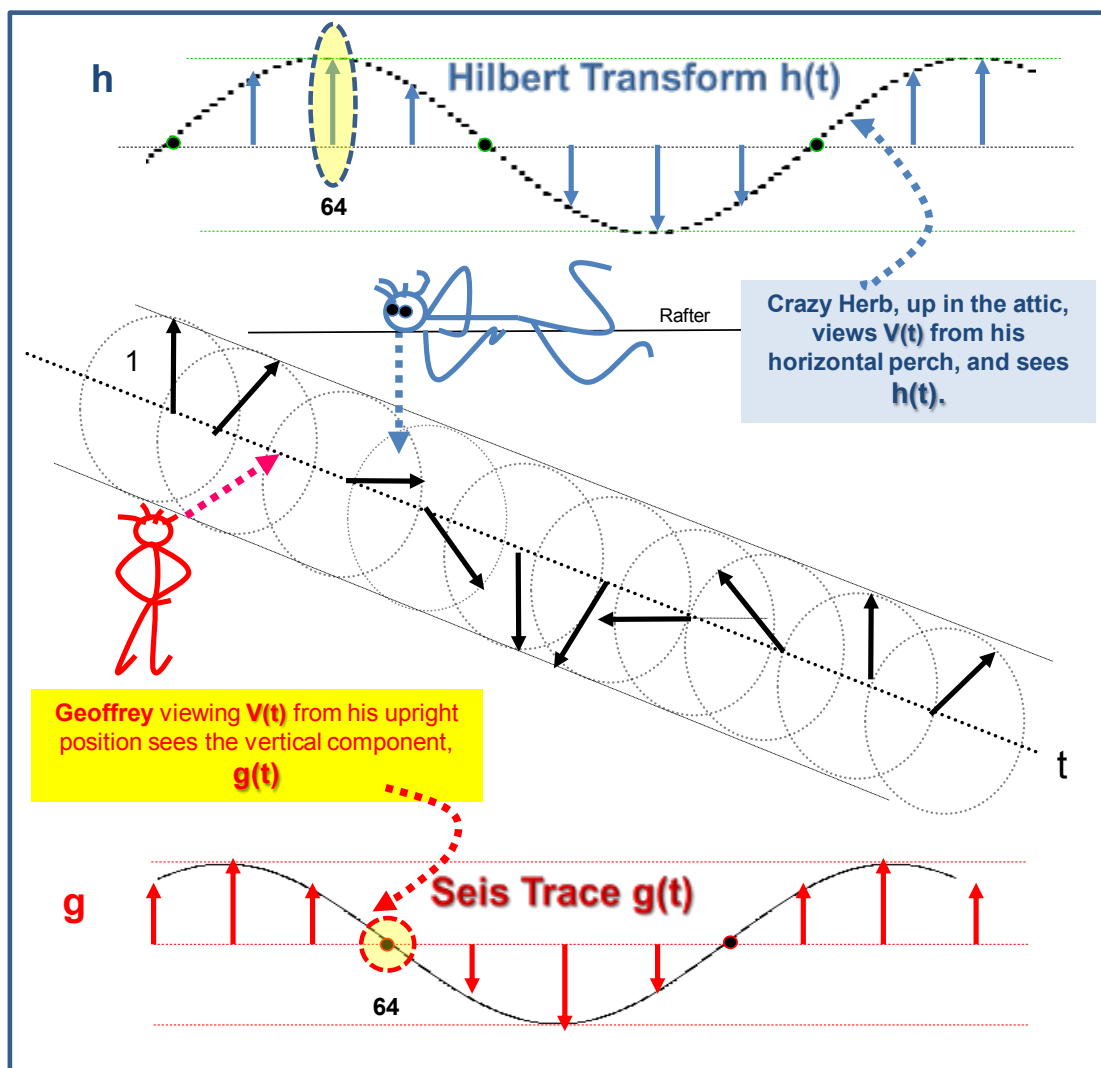


# Tutorial Nuggets

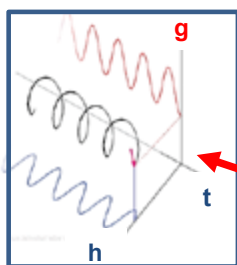
Tutorial Nuggets continued from page 24.



We now introduce you to **Herbert Hilbert**, a somewhat disturbed individual, who spends most of his time in the attic observing the same phenomena that George sees but **90°** out of whack.



We note that when Geoffrey sees the full length of the rotating vector,  $V(t)$ , Herb will see a point. When Geoff sees a point,  $g(64) = 0$ , simultaneously Herb's observation will be  $h(64) = 1$ . The latter situation is highlighted by the dashed enclosures. The projection of the vector onto the horizontal is always  $\pm 90^\circ$  different than the projection onto the vertical plane.



Eventually we'll have to face up to the necessity of describing all these fascinating things with what can only be called *mathematics* (gasp!). We'll face that reality on the next page.

In the meantime, if you'd like to see an animated version of the rotating vector and its projections, use this link:

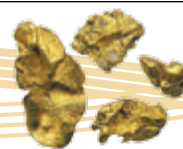
[https://en.wikipedia.org/wiki/File:Rising\\_circular.gif](https://en.wikipedia.org/wiki/File:Rising_circular.gif)



Tutorial Nuggets continued on page 26.

# Tutorial Nuggets

Tutorial Nuggets continued from page 25.

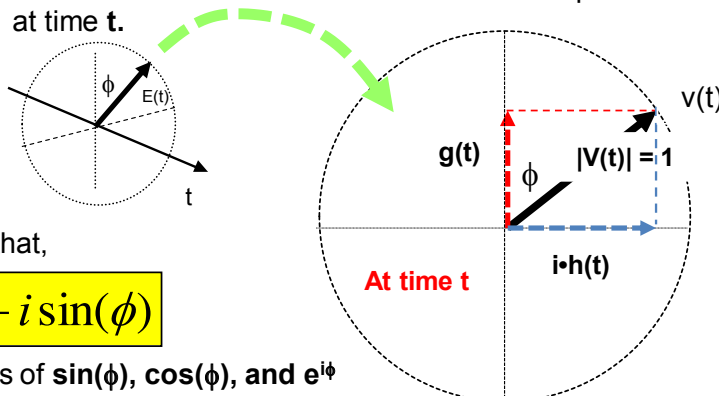


Back in the early days of the **Tutorial Nuggets** (October 2011 *GSH Journal*), your Guru invoked the spirit of Leonhard Euler to explain the mystical “*i*”, “*e*”, and their coupling to produce sinusoids (sine and cosine) differing by **90°**. If I’m not mistaken, that’s just what we now need to help complicate the visually apparent Hilbert Transform. Thanks Lenny.



Euler -  
messing with  
the minds of  
young  
geophysicists  
for centuries

Consider a **spinning vector** of length **1** and its projection onto the vertical and horizontal lines in the plane of rotation at time *t*.



Euler took great joy in telling us that,

$$e^{i\phi} = \cos(\phi) + i \sin(\phi)$$

He based this on the relationships of **sin(φ)**, **cos(φ)**, and **e<sup>iφ</sup>** along with their expressions as power series.

What he has unwittingly described here is a vector, **e<sup>iφ</sup>**, of length **1**, at the angle **φ**. It has been resolved into **component vectors**, **cos(φ)** and **i·sin(φ)**. It’s the “*i*” that usually causes the unwarranted disdain for arithmetic among otherwise rational geophysicists. As was explained in these very *Nuggets*, the “*i*” is merely an operator which rotates a vector **+90°**.

$$\begin{aligned} 1 \cdot e^{i\phi(t)} &= \cos \phi(t) + i \cdot \sin \phi(t) \\ V(t) &= g(t) + i \cdot h(t) \\ V(t) &= |V(t)|e^{i\phi(t)} = |V(t)| \cdot \cos \phi(t) + i \cdot |V(t)| \cdot \sin \phi(t) \end{aligned}$$

Above we have translated Euler into the terminology of our rotating vector, **V(t)**. We note that **g(t) = |V(t)|cos[φ(t)]**. This is simply a description of the **seismic trace** we or our avatar, **Geoffrey**, normally see in the data (unaware of its vectorial nature). The projection onto the horizontal produces **i·h(t) = i·|V(t)|·sin[φ(t)]**. He “*i*” rotated a vector **|V(t)|·sin[φ(t)] 90°**.



Baffled Kumquat

What does it all mean??

Fear Not, Little One. All will be clarified and made useful. You will learn about **Instantaneous phase**, **instantaneous frequency**, the **trace envelope**, and much, much more!

## The February Puzzle

In honor of the rapidly approaching **baseball season**, we offer the following for your consideration. Ace pitcher, **K. K. Casey**, faced **only 4 batters** in the top of the 9<sup>th</sup>. He registered four strikeouts (**K K K K**), yet allowed **one run to be scored**. Is this a misprint? How is it possible, if true? (Would The Guru lie?) Tune in on March 1 for the answer.



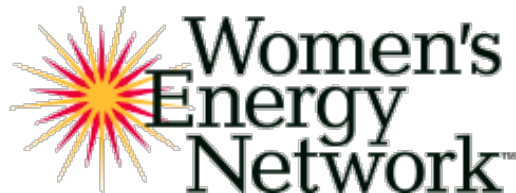
K.K. Casey





# GSH Outreach

## Committee Activities - By Lisa Buckner and David Tett



I volunteered on November 15, 2016 as a Jr/Sr dinner table host (mentor) for the 12th Annual Young Women Energized Event hosted by the Women's Energy Network. Approximately 200 high school girls attended the event held at the Houston Baptist University. Participants are divided into small groups where they are led by a table host who shares her experiences in the energy industry and explains the steps she took to attain her chosen career. Girls are also given the opportunity to ask questions and share concerns. The objective of the program is to demonstrate the vast opportunities that exist in the energy industry for women that can fit a variety of skills and interests and to let them learn from and give them role models of women working in the field and show them that women are making a difference in energy. Please visit their website at <http://www.womensenergynetwork.org/houston> for more information about the event for 9th-12th grade girls, parents, teachers and counselors and their scholarship program. More female mentors are needed and you do not need to be a member of the WEN to volunteer, so please consider participating next year. I was the only geoscientist table host this year. It is a lot of fun and the girls eagerly ask great questions.

There are two events this month that only need one or two volunteers and a third event which needs many. If someone would like to accompany me on a little road trip to Bellville, they are having a Science Night on Monday, February 13 from 6:30 – 8:00 PM. Approximately 500 eager students and family members attended. Some were familiar with seismic crews working in the area. The AAUW Expanding Your Horizons in Science & Mathematics workshop event for middle school girls is on Saturday, February 25. One or two volunteers could assist the girls with the Exploring for Oil activity and the presentation.

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



The **58th Annual Science and Engineering Fair of Houston** will need many volunteers. At least six Special Awards Judges will be needed on Saturday, February 25 at the University of Houston Main Campus Alumni Center to select winners for GSH Awards. We work in teams and no previous judging experience is necessary. The SEFH is also in need of **800** Place Award Judges. Information regarding both types of judging can be found at <http://www.sefhouston.org> in the Judges and Special Awarding Agencies section. We may also have a geophysics career exhibit booth to talk to the parents & teachers during the judging sessions and to the students during their long lunch & dinner breaks. The awards ceremony will be held on Sunday, February 26. Science fairs are not only important for our students to learn more about Science, Technology, Engineering and Math (STEM) but also for Houston's future.

### 2016 Science and Engineering Fair of Houston Results

**In 2016**, SEFH awarded 360 "Place Awards" and 41 businesses, industries, technical societies, government agencies, and educational institutions presented more than 250 "Special Awards," fellowships, and scholarships. SEFH also provided five Melinda Mills Teacher of the Year Awards. Junior Division Place Award winners (72) were eligible to enter the BROADCOM Masters Competition. One hundred and twenty Place Award winning projects were eligible to enter the State SEF in San Antonio. **Ten Senior Division Grand Award winners represented SEFH at the annual INTEL International Science and Engineering Fair (ISEF) in Phoenix, Arizona. These SEFH students were successful with awards being granted. Additionally, one of our SEFH students, Symantak Payra, won the Intel ISEF Young Scientist Award (one of two \$50,000 scholarship awards gifted to students out of 1700 international students).**

*GSH Outreach continued on page 28.*

## GSH K-12 Outreach Volunteers Needed!



### SCIENCE FAIR JUDGES NEEDED

SATURDAY, FEBRUARY 25, 2017

What: 58th Annual Science and Engineering Fair of Houston

Where: University of Houston Main Campus Alumni Center

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

- 1) At least 6 Special Award Judges will be needed to select winners for GSH Awards. We work in teams and no previous judging experience is necessary. We will be looking specifically for projects related to geophysics. Judging will be during the afternoon session 1:30 pm – 5:00 pm. Contact Gokay Bozkurt at [gbozkurt2002@yahoo.com](mailto:gbozkurt2002@yahoo.com) to volunteer.
- 2) SEFH is also in need of 800 Place Award Judges, especially during the first round morning session 8:30 am – 12 Noon and also during the second round afternoon session 1:30 pm – 5:00 pm. No previous judging experience is required and you will not be expected to judge an unfamiliar category. To volunteer, fill out the Online Place Award Judge Application form at <https://www.sefhouston.org/judge-application>

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

## Mystery Item

*This is a geophysical item...*



*Do you know what it is?*

*This month's answer on page 31.*

# Wavelets 1

## *Reflections on Guest Lecturer Jon Rotzien*

*By Claire Ong*

The University of Houston's SEG chapter, SEG Wavelets, hosts a guest speaker at least once a month. The events are usually casual and lunch is provided. On November 4th, 2016, we hosted Dr. Jon Rotzien, the founder and president of Basin Dynamics, LLC, to give a talk titled "Deep water petroleum reservoirs and their outcrop analogues". Dr. Rotzien's expertise includes basin analysis, stratigraphy and sedimentology of deep-water depositional systems, and source to sink sediment transfer.

The talk started off with a few broad questions regarding deep-channel sandstones and outcrops in France and Ireland. It then narrowed into very specific and technical details, such as on lithofacies and on margins in the Annot Sandstone that relate to answering the questions posed at the beginning of the talk, as well as details that were related to reservoirs and reservoir quality. At the end of the talk, students and faculty asked questions that related some of the aspects in the talk with their interests, whether research related or general.

We are grateful toward Dr. Rotzien for giving such an insightful talk. We host guest speakers so that our Earth and Atmospheric Sciences department, as well as anyone who is simply interested in the guest speaker's topic, can perhaps develop or further an interest and or knowledge in that specific topic.





# Wavelets 2

## *The Direct Arriving Wavelets Reflect on the SEG Meeting in Dallas*

By Michael McClimans

A short trip up I-45 brought the University of Houston SEG student society, The Wavelets, to proudly participate in the 86th Annual SEG Meeting in Dallas, Texas. With thirty-six students and faculty delivering fifty-eight presentations, an Award of Merit, a pair of graduate students placing third in the World Finals SEG Challenge Bowl, and Wavelets recognized as one of the top 10 SEG student chapters, the University of Houston (UH) was a very well represented school.

The Wavelets president, Wenyan Zhang, had this to say about the meeting, "I had a great experience at the SEG Meeting. Most of the time I was attending FWI talks. I found many of them very informative, intriguing and inspiring. We were also thrilled that the Wavelets group was awarded a top-10 ranking of student chapters around the world."

UH students presented on a diverse range of topics ranging from ground water exploration with "Near-surface geophysical imaging for groundwater exploration: La Marque, Texas" by Abigail Ross, to reservoir characterization with "Reservoir quality indicators from well logs and 3D-3C seismic in the Marcellus Shale" by Fabiola Ruiz.

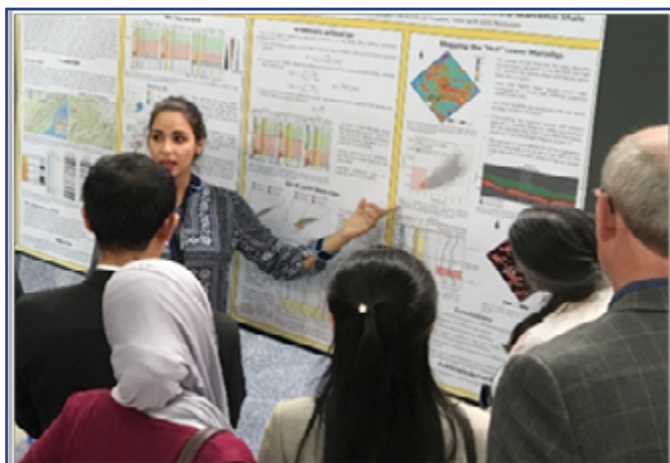
The annual meeting is also where ExxonMobil sponsors the Student Education Program (SEP) for students in the Americas. From many applications, UH students Elita de Abreu and Jing Hua were selected to participate in the two-day learning event. Attending lectures and discussions followed by practical, hands-on exercises, the group of forty graduate students were led by professional

geoscientists focused on preparing them for the challenges of a career in the oil industry.

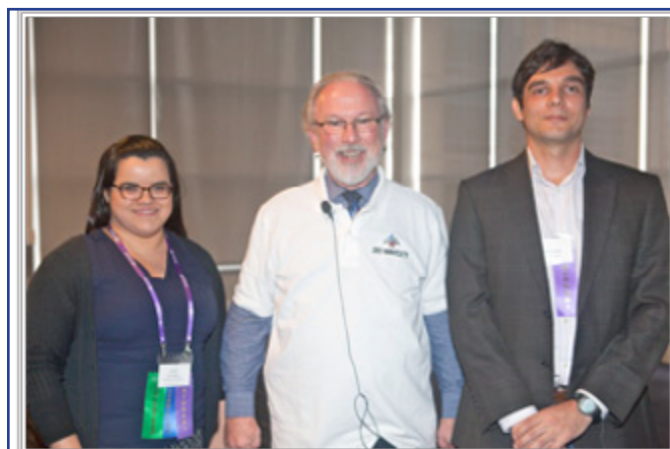
Recently graduated UH student, Dr. Azie Aziz, rejoined the Wavelets group and received The Award of Merit for the Best Student paper at the 2015 meeting titled "3D GPR characterization of sandy mouth bars in an outcrop reservoir analog: Cretaceous Ferron sandstone, southeast Utah."

Wavelets students Alexandre Silva and Joan Marie proudly represented UH by placing third in the 11th Annual SEG Challenge Bowl. With many individual donations and a generous gift from Noble Energy, the Challenge Bowl 2016 exceeded the \$15,000 fundraising goal for the SEG Foundation. The competition began with seventeen student teams from 16 countries. Defeating their regional opponents, six teams advanced to the World Finals. Quizmaster extraordinaire Peter Duncan challenged their geoscience knowledge with questions spanning a difficulty range of the first-year undergraduate to first-year graduate level. Following a quiz-show format teammates chimed in with buzzers to give their responses. The first and second place teams were from Brigham Young University and the University of Calgary, respectively.

As students, we were amazed and inspired by the range of science and technology on display at the SEG Convention. The camaraderie was wonderful with friendships made and minds expanded. We look forward to taking our participation in the next SEG Meeting, in Houston, to new heights (or depths)!



Fabiola Ruiz presenting her research "Reservoir quality indicators from well logs and 3D-3C seismic in the Marcellus Shale."



The Wavelets Challenge Bowl team Joan Marie Blanco (left), and Alexandre Silva (right) with MC Peter Duncan (center).



# Memorial Tribute

## Elwin Peacock 1928-2016

*It is with great sadness that the GSH provide the following note of Elwin Peacock's passing. Elwin was a central figure in the history of the GSH and was the GSH President from 1970-1971 and was made a Lifetime Member in 1982. The following article describes his life, his work, and his contributions and involvement in the geophysical profession. – Karen Blakeman, Glenn Bear and David Watts*

### Elwin Peacock 1928-2016

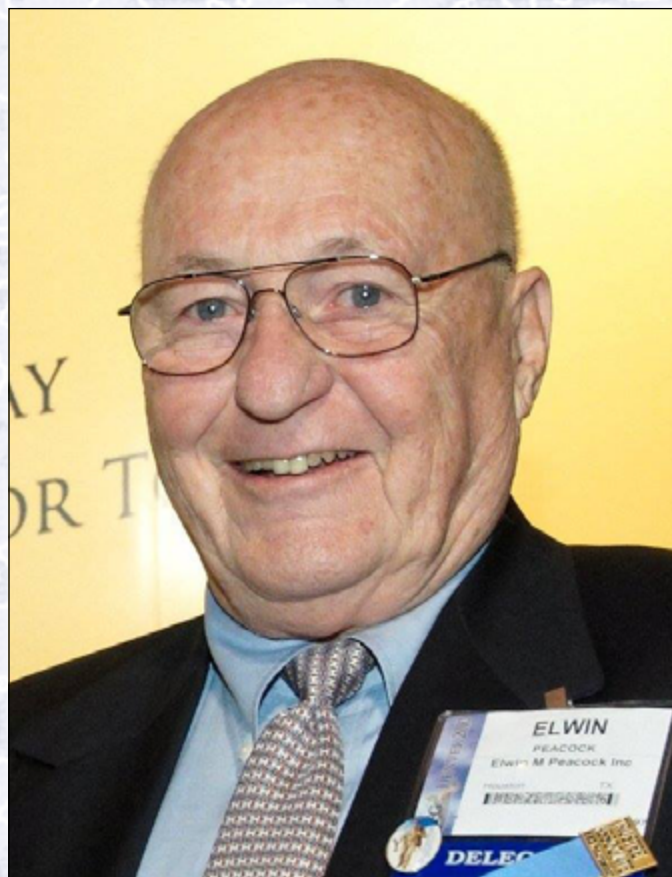
Elwin Merrill Peacock was born the 5th of February 1928, in Dallas, Texas to Helen Wainscott Peacock and Henry Bates Peacock. He passed away peacefully in his sleep on Saturday night, the 10th of December 2016.

Elwin was raised in Houston where he graduated from The Kinkaid School. He then attended Rice Institute and graduated from the University of Colorado in Boulder in 1949 with a degree in Geology. He was a member of the Sigma Chi Fraternity. Elwin earned his Eagle Scout badge in 1943 which he considered one of his most memorable accomplishments. Scouting values, especially the Scout Laws, served him as guides for living throughout his life.

Elwin's employment included Sohio Petroleum Company, Signal Oil and Gas, Seiscom-Delta Corporation until he became an independent consulting geophysicist in 1972 until his retirement.

Elwin was active with his career and professional interests. He served in several capacities with many organizations including: Advisory Board for the Department of Geological Sciences at the University of Colorado, President of the Houston Petroleum Club, Honorary Life Member and Secretary-Treasurer of the Society of Exploration Geophysicists, Trustee of SEG Foundation and founding member of SEG Trustee Associates, Honorary Life Member and President of the Geophysical Society of Houston, member of American Association of Petroleum Geologists, Society of Independent Professional Earth Scientists, European Association of Geoscientists and Engineers, and the Houston Geological Society.

Outside of his professional interests, he served as a member of the Hunters Creek Village City Council, Chairman of Hunters Creek Planning and Zoning



Commission, and the Board of Commissioners of the Village Fire Department. He was also a member of The Houston Racquet Club where he played the game of tennis and enjoyed socializing with friends.

Elwin was an active member of the Methodist church while growing up in Houston. He served as Chairman of the Official Board for Village Methodist Church in Oklahoma City and Southwest Methodist Church in west Houston. Chapelwood United Methodist became his church for over forty years where he was Honorary Member of the Board of Stewards and Trustee.

He is survived by Jane Breitenstein Peacock, his wife of sixty seven years; daughters Julie Peacock, Houston, Texas, Helen Peacock, Atlanta, Georgia and sons David Peacock and fiancé Jennifer Boudreaux of Dallas, Texas and Paul Peacock from Houston, Texas. Other survivors include his brother, Robert B. Peacock and his wife Sidge, of Dallas, Texas; Nieces and nephews include Robert Peacock and wife Becky of Libertyville, Illinois, Kathy Peacock, Plano, Texas, Cathy and Don Beazley of Alachua, Florida, Doug and Lucy McCausland of Arlington, Virginia, and Suzie.

The Mystery Item for the February GSHJ is a Timing motor from the 1930's.

Mystery Item on page 28.





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# 2016 GSH Annual Tennis Tournament



by Russell Jones, Tennis Tournament Chair

The annual GSH Tennis Tournament was held on November 18, 2016. The venue this year was changed to be at the Chancellors Family Center. The facility afforded us the chance to beat the torrential rain storm that came through by having indoor courts. As the heavens opened, heavenly tennis was being played!

The event was well attended with lots of familiar faces from differing parts of the oil and gas industry. Thanks to catering from Eatwell Bakery, a light lunch was available, so there could be no excuses for sluggish play!

The tournament is run like, per Liza Yellott, "speed dating for tennis", where partners and opponents are switched at regular intervals to ensure balanced play. The players with the highest total games at the end of regular play then face each other in the Championship match, while those remaining swill beer.

Four hours of tennis later, along with tired legs and sore feet, the champions were crowned!!!

Many thanks to those who participated and who volunteered their time, and special thanks to our sponsors, who all worked together to make the event such a success.



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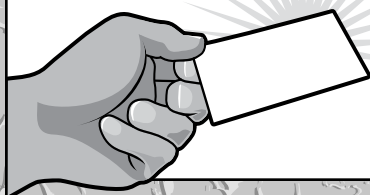


Group A winners: John Robinson, Warren Miller



Group B winners: Brian Taylor, Sean Siegfried





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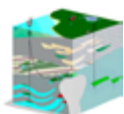
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# Doodlebugger Diary

## *The Odyssey of a Doodlebugger*

### *(The life and times of Ed Lengel) Part 2 of 4*

*As told to Lee Lawyer (Serialized to prevent total fatigue)*

#### **Episode 2: Doodlebugging**

My background in the oil business is varied and encompasses most jobs in the geophysical industry. I applied for a job at French Petroleum as a Computer Operator (Jr. Seismologist), and with a bit of "prevarication" I got it. I worked for over a year picking records and hand drawing sections such as Isochron and Isopach time sections. We had a consulting geophysicist who liked my work and talked me into working for Velocity Surveys as an Analog Playback Operator. I used a single trace Techno Tape to FM tape (hand built) machine, and a TI-9000 to plot sections, both in variable area and variable density. Carl Fredriks who was from Velocity was nicknamed the Submarine Commander because he was a German prisoner of war in a prison in Strathmore near Calgary. He piloted a two-passenger submarine to torpedo ships on the coast but wasn't successful and was captured. He was a tough task master and kept referring to the Hitler Youth Manual as a guide.

After a year or so, I quit Velocity and went to work for Pan American Oil as a Playback Operator. I used an analog machine called the PB-1, a single trace unit with a plastic cam for NMO corrections and the C-100 which was a 24 trace unit with 24 delay lines and matching NMO inputs. Statics were input to a Techno tape by an aluminum card with notches cut in it to offset the write heads that required milliseconds, to match the picked statics. This unit took up almost an entire floor in the Bental building. We progressed to digital playback using a CDC-3300 (an octal machine) to the CDC-3600. I was sent to Minneapolis-Saint Paul to attend school for 3 weeks at Control Data Corp. I learned the operation and maintenance of the CDC-3600.

Later I went to work for Digitech as Operations Manager of their Data Center in Calgary. We used an EMR-30 (Electro-Magnetic Research) system and I went to school in Minneapolis again. EMR was started by some people from Control Data Corp. I was fired from Digitech for.... (Editor: Reason deleted)... I then went to the field with Canwest Geophysical. I worked all positions from Jug Hound, Line Boss, Field OB, Jr. Observer, Party Manager, and Surveyor, to Blaster/Powder-man ending as Observer. Canwest was first purchased by Olympic and then by Dresser Industries. This is where I first ran into Pat Lochrane and Bill Laws. There are legendary episodes of them

having fights in hotel rooms. They used all types of aircraft to travel to the oilfields, from a Gulf Stream Jet to a BAC-111 for international flights. Larger aircraft were used during the Geosource period.

At Dresser/Olympic, my marine career started with a trip to Halifax to board a "tub" called the Clara Beth R, later renamed the M/V Canadian Olympic. This was a Marine Vibroseis Crew! Vibroseis in the water! I thought they were kidding when they said Vibroseis! The vibrator electronics were vacuum tube type. The vibrators hung over the ship at a depth 30 feet and vibrated on top of a tractor tire. The M/V Clara Beth R was a Seismic ship made out of a flat-bottom rig 'drilling mud' supply boat. It would travel at a maximum speed of six knots. The tide coming in on the St. Lawrence River was 7 knots! We could only shoot when the tide was going out! Eventually, bigger engines were installed which gave us 12 knots. We had lines in the North Sea around Anticosti Island and surrounding area. Our survey locations were done by Shoran and Loran Location services.

A base station was located in town, a sister station was on Anticosti Island, and a unit was on the ship. We got our location via triangulation. We worked with pre-plots and a World War II bombing instrument. When a shot point was reached, we hit a fire button on the Sum-It System, which triggered the vibrators and recorder. We had a Technician doing maintenance on the Sum-It recording system. He re-wired the "Fire" switch but hooked up the 110 volts to the vibrators and the 5 volts to the recorder backwards. When we hit "Fire", 110 volts hit the logic bay and fried most of the cards. (Causing one week downtime while a new logic bay was ordered).

The ship had only 18 inches of freeboard on the stern where the cable reel was. We had to back the ship into the cable when picking up. During storms, I was washed under the reel several times when hauling in the cable. During one Atlantic storm, we were facing into the swells and as the ship passed over the crest of a wave, it would bend in the middle. You could hear the steel hull cracking. The mechanic was below decks welding up cracks as they appeared. I was in the wheelhouse watching, when the Captain said we were in serious trouble. We survived but spent a week in port for repairs. Clearly, this was not a ship designed for the North Atlantic.

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

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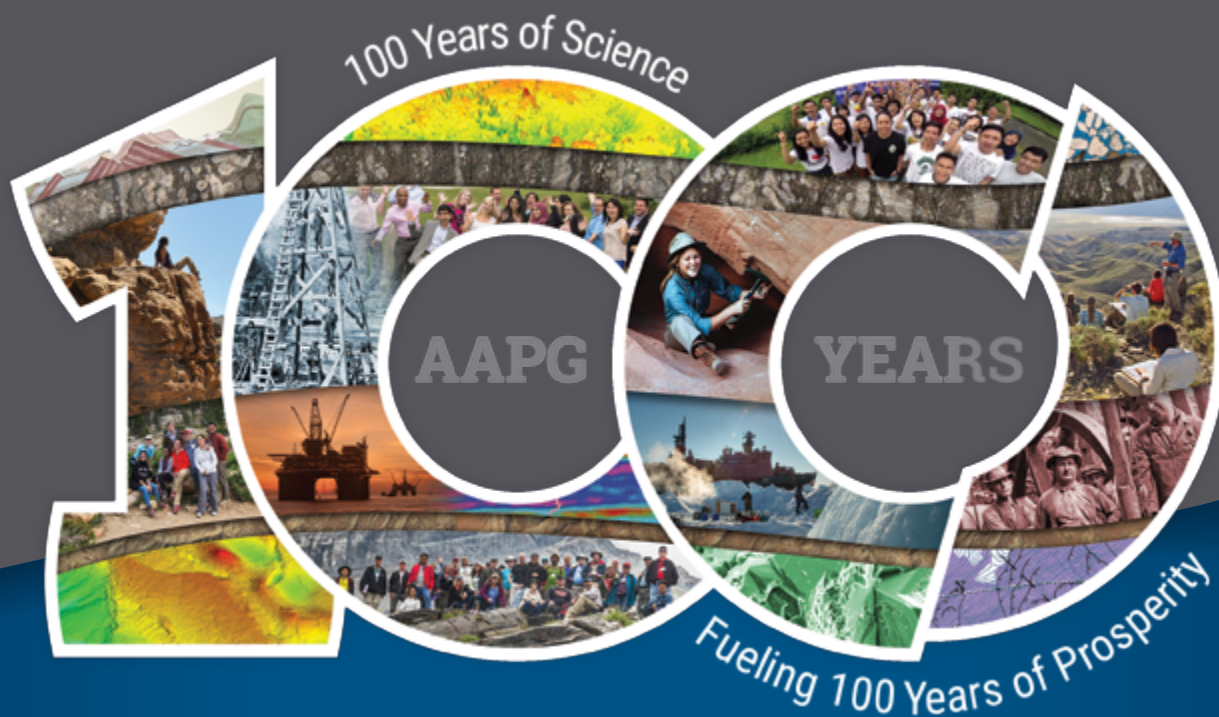
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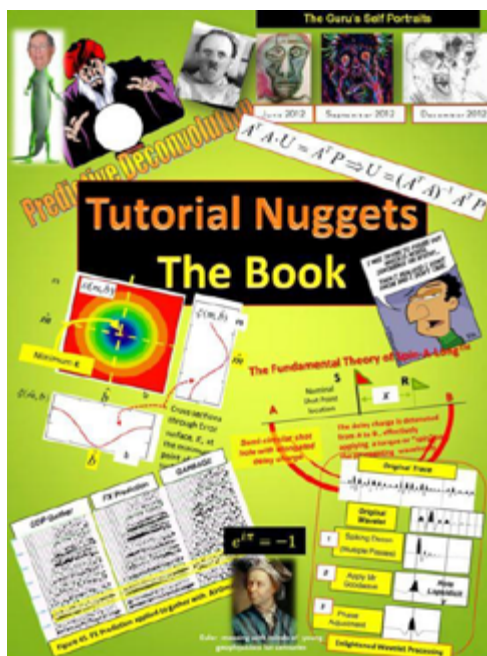
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