

June 2017



*The Epicenter of
Geophysical Excellence*

GSH Journal

GEOPHYSICAL SOCIETY OF HOUSTON

Volume 7 • Number 10



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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.

GSH JOURNAL DEADLINES

Sept 2017	Jul 7
Oct 2017	Aug 9
Nov 2017	Sept 8

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GEOPHYSICAL SOCIETY OF HOUSTON ORGANIZATION CONTACTS

Karen Blakeman, Office Director • Kathy Sanvido, Webmaster/Membership Manager

14811 St. Mary's Lane, Suite 204, Houston, TX 77079 • Office Hours 8 a.m. - 5 p.m.

Phone: (281) 741-1624 • Fax: (281) 741-9364 • Email: office@gshtx.org • Website: <http://www.gshtx.org>

GSH Board of Directors = GSH Executive Committee + SEG Section Representatives

PRESIDENT	Amy Rhodes		281-206-5826	amy.l.rhodes@cop.com
Sponsorship	Haynie Stringer	281-491-2045	832-606-3993	hayniestringer47@yahoo.com
Doodlebugger Fund	Paul Schatz	713-975-7434	713-829-5254	Paul.Schatz@int.com
Editorial Board	Lee Lawyer	281-531-5347		llawyer@prodigy.net
Advertising Committee	Gary Crouse		713-818-2080	gary@iahcrouse.com
Historian	Art Ross	281-360-9331		artross@airmail.net
Office	Dave Agarwal	281-920-4450		dave0836@aol.com
	Glenn Bear	832-624-9950	281-250-4013	glenn.w.bear@exxonmobil.com
Outreach	Lisa Buckner	713-496-4256	713-252-9665	lbuckner@hess.com
Scholarship Liaison	Jim Schuelke	713-296-6801		Jim.schuelke@apachecorp.com
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MEMBERSHIP				
PRESIDENT ELECT	Tommie Rape		713-829-5480	tommiedr@aol.com
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Volunteer Coordinator	Nicola Maitland	713-972-6209	281-507-6552	nmaitland@resolvegeo.com
Career Directions & Progressions	Whitney Blanchard		713-380-7255	wcharris26@gmail.com
	Fernando Enrique Zeigler		832-413-1258	fernando.ziegler@gmail.com
Diversity & Women's Networking	Sofia Campbell	713-668-5406	713-443-4436	sofia.campbell@comcast.net
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Tech Luncheons	Lisa Buckner	713-496-4256	713-252-9665	lbuckner@hess.com
Tech Breakfasts Northside	Glenn Bear	832-624-9950	281-250-4013	glenn.w.bear@exxonmobil.com
Tech Breakfasts Westside	Michael Obriain	713-689-6913	713-829-5238	obriain1@slb.com
	John Gilbert	713-689-7803	832-655-4197	JGilbert@exchange.slb.com
Spring Symposium	Lisa Buckner	713-496-4256	713-252-9665	lbuckner@hess.com
Geoscience Day	Haynie Stringer	281-491-2045	832-606-3993	hayniestringer47@yahoo.com
Continuing Education	Mike Graul	713-465-3181	713-248-3562	mgraul@texseis.com
Webinars	Haynie Stringer	281-491-2045	832-606-3993	hayniestringer47@yahoo.com
SEG DISC	Xianhuai Zhu	832-850-7680	832-492-2298	xzhu@forlandus.com
SPECIAL INTEREST GROUPS (SIGS)	Xianhuai Zhu	832-850-7680	832-492-2298	xzhu@forlandus.com
Data Processing and Acquisition	Clement Kostov	713-689-5752	832-506-6026	kostov1@slb.com
Geoscience Computing	Gary Crouse		713-818-2080	gary@iahcrouse.com
Potential Fields	Rao Yalamanchili	832-351-4824	713-818-3046	rao.yalamanchili@cgg.com
Rock Physics	Ratna Sain	832-624-8716		ratnanabha.sain@exxonmobil.com
Microseismic	Gary Jones		281-924-2210	gljones@sbcglobal.net
SEG Wavelets	Wenyuan Zheng			wyzhang120@gmail.com
SOCIAL / FUNDRAISING EVENTS				
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Icebreaker	Tony LaPierre	713-482-3845	281-733-5281	Tony.Lapierre@rpsgroup.com
Salt Water Fishing Tournament	Bobby Perez	832-554-4301	281-787-2106	r_perez@seismicventures.com
Social at TopGolf - North	TBD			
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Tennis Tournament	Russell Jones	832-295-8350		rjones@Seitel.com
Annual Meeting & Awards Banquet	Katherine Pittman	713-972-6206		kpittman@resolvegeo.com
Golf Tournament	John Naranjo	713-909-8207	281-677-7404	john.naranjo@bp.com
SECRETARY	Nicola Maitland	713-972-6209	281-507-6552	nmaitland@resolvegeo.com
TREASURER	Edith Miller		832-854-7679	edithjmiller@gmail.com
Finance Committee	Rita Creasy-Reed	281-509-8128	281-793-2808	rita.creasyreed@gmail.com
COMMUNICATIONS				
EDITOR	David Watts	713-689-6040		DWatts1@slb.com
Assistant Editor	Courtney Anzalone		713-689-5741	canzalone@slb.com
Assistant Editor	Chirag Parekh		713-689-2388	cparekh@slb.com
Assistant Editor	Kara Shiflett		713-689-6226	kdetro@slb.com
Technical Article Coordinator	Scott Singleton		832-524-8382	Scott.Singleton@comcast.net
Website Coordinator	Tommie Rape		713-829-5480	tommiedr@aol.com
Social Media Coordinator	Liza Yellott	713-881-2894	713-204-0998	lyellott@Seitel.com
SEG SECTION REPRESENTATIVES	Scott Singleton		832-524-8382	Scott.Singleton@comcast.net
	Lisa Buckner	713-496-4256	713-252-9665	lbuckner@hess.com
	Glenn Bear	832-624-9950	281-250-4013	president@gshtx.org
	Mike Graul	713-465-3181	713-248-3562	mgraul@texseis.com
	Sofia Campbell	713-668-5406	713-443-4436	sofia.campbell@comcast.net
	Paul Schatz	713-975-7434	713-829-5254	Paul.Schatz@int.com
SEG ALTERNATE REPS	Bill Gafford	281-370-3264		geogaf@hal-pc.org
	Haynie Stringer	281-491-2045	832-606-3993	hayniestringer47@yahoo.com
	Tad Smith	713-296-6251	832-474-7825	tad.smith@apachecorp.com
	Rita Creasy-Reed	281-509-8128	281-793-2808	rita.creasyreed@gmail.com
GEOSCIENCE CENTER	Bill Gafford	281-370-3264		geogaf@hal-pc.org
SPG-NA Rep.	Dave Agarwal	281-920-4450		dave0836@aol.com
ECH liaison	Bill Gafford	281-370-3264		geogaf@hal-pc.org
OTC Rep.	Roy Clark	281-723-8672		reclark48@aol.com
HPAC	Susan Graul	713-462-1552		srg02@comcast.net
NeosGeos	Sean Kimiagar		817-727-6424	seankimiagar@gmail.com

A Word from the Board

GSH: A Solid Home

By Amy L. Rhodes, GSH President

It has been a challenging year in a volatile business environment and I am very proud of how our office staff and volunteers have successfully navigated the volatility. I believe our society has not only weathered the downturn, but has continued to develop and expand currently being stronger than we have ever been. I had two main focuses this year during my presidency: fiscal discipline and championing new events that would increase the diversity of our members who actively participate in them. I am very happy with what we achieved on both fronts.

As far as fiscal discipline is concerned, we were forced to make some difficult decisions to effectively manage our budgets. We chose to move from a printed to an electronic journal that is only available online. We made this change in the span of a couple of months and it put a huge strain on both our office staff and Editorial Board. In the end, we succeeded in quickly turning around a product that the society can be proud of. We appreciate the patience of our membership as we worked out some initial kinks, but if you visit our most recent journal online, I think you will find the quality to be highly satisfactory.

All our board members and chairs were asked to closely track budgets and look for cost savings where possible. Every single board member and chair delivered on this commitment. One highlight came from our webinar committee who worked hard to schedule several high-quality speakers. Our GSH-SEG Webinar series has proved to be extremely popular with both local and international membership. These events have provided a great benefit to our members and have helped to keep our finances afloat during these challenging times. I believe the webinars will continue to provide a great deal of value to our members in the future years.

We also championed new events that got members actively involved in our society who may not have previously participated. Whitney Blanchard volunteered to coordinate our first Education and Career Development for Unemployed Professionals event. The event was free to attend and provided participants an opportunity to attend talks that discussed the resources available to job

seekers and tips and tricks on how to market their skill set in a challenging market. The event was held at our Geoscience Center and Museum with very encouraging turnaround. It was so well received by our membership that we had a follow up event on May 17th and another coming in August. Stay tuned for more details.



Amy L. Rhodes

Our Inaugural Diversity and Women's Networking Event was held in May of 2016 and the event sold out. A distinguished panel including Ken Tubman, VP Subsurface Technology at ConocoPhillips, Xiaojun Huang, Manager of Subsurface Interpretation and Geophysical Applications at ExxonMobil, Thaimar Ramirez, Manager Performance Analysis and Interpretation at Occidental, and Cecilia Rose, Executive Career Strategist, spoke about how to optimize your career in geophysics. We hosted a second sold out Diversity and Women's Networking Event in November of 2016 where Nancy House, 2016-17 SEG President Elect, and Dr. Scott Tinker, Director of Bureau of Economic Geology, spoke about key global trends in the geophysics profession and future opportunities in our industry and profession. Our members have expressed that these types of professional development events are in high demand in the current business environment.

The Geophysical Society of Houston strives to provide our membership with good value for their time and money. I hope you have been able to attend one of these new events or will consider attending an upcoming event and give us your feedback on what you would like to see at future events. It has been a pleasure leading such a talented group of volunteers and dedicated office staff. I am proud that we will finish the fiscal year in a strong financial position which our next board can leverage into continued success for the future. I believe the new events we have developed add additional value for a broader cross section of our local geophysical community. I plan to stay involved as Past President and I welcome your feedback. Thank you for all that you do for our society.

Correction

In the GSH May Journal Word of the Board article from Edith Miller, her title was incorrectly stated. Edith is the GSH Treasurer for 2016-2017. We apologize for the mistake and any inconvenience.

David Watts
Editor

April 14, 2017

To: GSH Editor



The "Geophysically Speaking" page in the April GSH Journal is completely absurd. It's quite fitting that it contains a photo of the geoscientist/climatologist Leonardo DiCaprio. Perhaps he was lecturing the audience on the Milankovitch Cycles that brought ice sheets to Kansas in the Pleistocene and raised sea level 300 ft. in the last 18,000 years. The anonymous writer, or was it one of our editors, laments that we are perceived "as being complicit in the damaging policies of our major employers". Maybe it's time for a career change, especially since Al Gore compared us to Nazis working in death camps in "Earth in the Balance." What's really

absurd is that now members of a scientific society can "speak out" and criticize the views of others anonymously. You can do that as a blogger on any message board. Do we want the GSH Journal to be an anonymous message board? Can we not stand on our hind legs and tell the world who we are and what we think?

The anonymous writer tells us global warming is truly anthropogenic and cites the IPCC. Their Nobel Prize winning report from 2007 told us that the Himalayan glaciers would be gone by 2035. That bogus claim was later retracted. The "proof" for anthropogenic global warming is based on computer models. Temperature is a scalar quantity, not a vector or a chemical compound. Temperature measurements cannot determine the source of the heat, and the computer models must make thousands of assumptions using a temperature curves based on measurements and inferred measurements that have been edited and spliced together. The AGW camp tells us that the rate of temperature change is increasing. In other words they are taking the second derivative of a noisy function over a (geologically) short time window and predicting disaster. What could possible go wrong with that kind of prediction? Many researchers have recently reported a hiatus of more than 15 years in global warming. However, the AGW camp responds that there has been no hiatus after the data has been carefully edited. The AGW camp repeatedly tells us that 97% of scientists agree that global warming is a man-made danger. There was an excellent article in the Wall Street Journal on May, 26, 2014 by Bast and Spencer entitled "The Myth of the Climate Chance '97%'". It debunks the widely cited Zimmerman/Doran survey published in 2009 in "Eos, Transactions of the American Geophysical Union." Their 97% consensus was based on 77 out of 79 responses to a survey that actually had 3,146 responses. The article also debunks several other widely quoted surveys.

Our anonymous writer also urges us to "throw off the shackles of industrial bias". Perhaps we should start by removing the global sea level charts from the walls of our offices and tell ourselves that climate change is something new. The AGW camp likes to tell us of the threat of rising sea level to people living on coral islands. Of course they neglect to tell us that the corals grew to their present height or greater when sea level was higher and the earth was warmer. We all learned in Geology 101 that corals only grow underwater. Unfortunately most of our fellow citizens have very little background in earth science.

Our anonymous writer warns us about being labelled as "Deniers". Apparently being an AGW denier is as bad as being a Holocaust denier. So now we have members of scientific societies using such ad hominem attacks on those that do not share their opinions. It's quite fitting that the writer uses the phrase "the factitious nature of Global Warming and Climate Change" since the word factitious can mean artificial, man-made or a sham.

I prefer that this letter be published in the Letters to the Editor column with my name attached, instead of the anonymous Geophysically Speaking page.

Sincerely,

Richard C. Burnett

Geophysically Speaking is an article written by an unknown and badly mis-guided author. My personal opinion on anthropogenic climate change differs with his completely. I am embarrassed for The Guru that the errant article was published in close proximity to the Tutorial Nuggets, thus giving certain conspiracy theorists the idea that either I or the Guru were some kind of liberal nuts. Just yesterday, I got a call from a guy in Amsterdam who associated me with the article to which I stated that the Geophysically Speaking is not the view of the GSH Editor nor the GSH BoD as a whole.

We can be reached at Editor@gshtx.org.

Editor

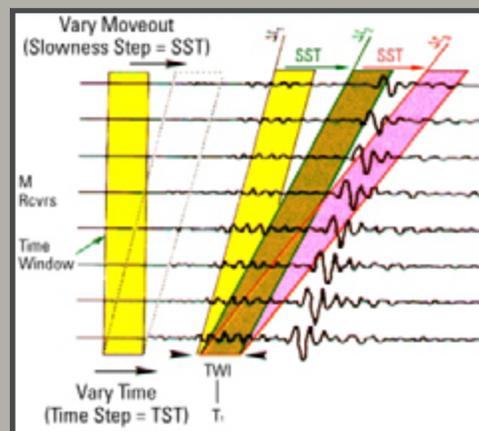
A Live Webinar

An Introduction to Borehole Acoustics - Theory, Measurement, Processing and Applications

Matthew Blyth

LWD Geophysics, Acoustics & Geomechanics Domain Head

Schlumberger Drilling and Measurements



July 25-28, 2017

10:00 am - 2:00 pm Central Time (USA)

This course is intended to provide an overview of the physics of common borehole acoustic modes, the challenges and techniques of their measurement, processing and quality control along with the applications of the answers across a wide range of problems from input to seismic and petrophysical models through to understanding rock mechanics and stress. It will also cover the history of borehole acoustic logging and an overview of modern tool design, both logging-while-drilling and wireline, including the unique concerns of each type of tool. This course will build from first principles and is applicable to all those with an interest in borehole acoustic measurements and their applications or who commonly incorporate this kind of data into their daily work.



Since joining Schlumberger in 1997 Matthew has filled a variety of roles, all within the field of logging while drilling. He is currently involved in the long term technical development plan for LWD acoustic and seismic technology and their applications within Schlumberger. He has authored and coauthored multiple papers on LWD technology and its uses. A graduate in 1996 from Cambridge University with a Bachelors and a Masters in Engineering, he is a member of the SPWLA, SPE, SEG and ASA and has served as both a VP and as President of the Houston SPWLA chapter. He is currently the secretary of the SPWLA Sonic SIG and is a 2016/2017 SPWLA Distinguished Speaker.

Miss part of the sessions? Never fear. All sessions are recorded and available for later viewing by registered users.



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Honors and Awards Banquet 2016 - 2017



Honors and Awards continued on page 8.

Honors and Awards Banquet 2016 - 2017



Congratulations to our Honorary and Life Membership Awardees Honors & Awards Banquet 2017



2017 Honorary Membership Awardee Baishali Roy

Baishali Roy received a BSc and MSc degree in Geophysics from the Indian Institute of Technology, a PhD degree in Geophysics from the University of Western Ontario, Canada and a Post-Doctoral Fellowship from the University of British Columbia, Canada. In

2000, Baishali joined the Subsurface Imaging Technology Center of Conoco in Ponca City embarking on a geophysical career primarily focusing on advanced seismic analysis methods for reservoir characterization and monitoring for a range of petroleum reservoirs (conventional, unconventional, heavy oil) around the globe. She is now a Principal Geophysicist with the Subsurface Technology group in ConocoPhillips in Houston.

During the 17+ years with ConocoPhillips, Baishali has worked on a wide range of

technology projects collaborating closely with both exploration and production business units and has been a technical team lead for various cross-disciplinary projects. At present her work focuses on development and utilization of DAS/DTS for subsurface and near well bore monitoring, collaborating with a multidisciplinary team including completions engineers, reservoir engineers and geologists in order to close the loop towards an integrated understanding.

Baishali is an active member of the SEG, EAGE, SPE and GSH and has been active through these organizations by organizing workshops and serving as Associate Editors for GEOPHYSICS and INTERPRETATION special issues. She has also served as the SEG – DISC Chairperson from (2009-2013) and has been a member of the SEG Continuing Education Committee and the MRPC committee. Currently Baishali is actively serving on the TLE Editorial board.



2017 Life Membership Awardee Sofia Campbell

Sofia Campbell holds degrees in Geology and Geophysics from the University of Melbourne and Curtin University of Technology, Australia. She started her career with SANTOS in Australia in 1991 as an Interpretation Geophysicist

and subsequently moved to Houston in 1998 employed by Schlumberger. In 2007 Sofia branched out yet again and started Energy Professional Search, her own upstream oil and gas industry recruiting business.

Since 2009, Sofia has continued to volunteer and hold various chair positions in the Geophysical Society of Houston (GSH), including a two-year Board of Director position for the GSH as First Vice President. Sofia has also been instrumental in the creation of the GSH's

Inaugural Diversity and Women's Networking Event and the even more successful sponsorship-driven second event, "Alchemy of Success".

An invited speaker at GSH, AWIS, OTC events and the Women's Global Leadership Conference in Energy, Sofia has addressed topics that have included: networking, personal branding, creating a diverse workforce, promoting STEM, negotiating salaries, interview coaching, and building a strong resume.

Sofia is currently serving as a Society of Exploration Geophysicists (SEG) Section Representative for the GSH and Chair of GSH Diversity and Women's events. Sofia's other professional memberships include the SEG, AAPG, HGS, AWG and WEN. When Sofia is not working in some capacity as a creative and innovative leader in the oil and gas industry, she enjoys art, travel, golf, yoga, gastronomy, critiquing tea and smelling the Plumeria.

Congratulations to our Honorary and Life Membership Awardees Honors & Awards Banquet 2017

2017 Honorary Membership Awardee Manika Prasad

Manika Prasad is a Professor of the Petroleum Engineering Department at the Colorado School of Mines. Her research interests are multidisciplinary research on rock, sediment and fluid properties, quantitative nano- and microscale characterizations, flow zone mapping, and nondestructive materials characterization. A large part of Manika's work is on clays, shales, unconsolidated sands, poorly and well consolidated sandstones and chalks, and impedance microstructure in rocks and glasses. Manika is an educator in the most comprehensive sense of the word, from the nanoscale of the micropores in the cores she likes to study (and abuse!) to the basin scale, where her research findings are applied.

While an educator's task is to teach, her goal and purpose are for her students to learn. Perhaps even more, it is to instill in those students an excitement about the subject she is teaching and love of further learning because of that teaching. Manika Prasad, selected to receive the 2015 SEG Outstanding Educator Award, is many times over a model recipient for this honor.

Not unusual for geophysicists, Manika's career spans beyond three continents and several professional disciplines in and related to the earth sciences. Starting with a B.Sc. (honors) at the University of Bombay, India, she went on to obtain a M.Sc. and then Ph.D. (summa cum laude) at Christian-Albrechts Universität in Kiel, Germany. Her study disciplines migrated from geology (chemistry minor) to geology (minors in geophysics and marine geology) and then to geophysics (minors in marine geology and sedimentology).

This brought her to an academic career that included appointments at the University of Hawaii, Stanford University, and Colorado School of Mines.

Remarkably, she was the 2014 SEG Continuing Education Lecturer and 2012 SEG/AAPG Fall Distinguished Lecturer, in a rare example of a woman geophysicist in a leading technical role, of which we need so many more, to inspire the young generations. One of her students told us, "Manika is known not only for excellence in research and education, but for her high moral values and humility as a person.... Manika has been much more than a teacher and an adviser. She has been a role model for many students at CSM."

Beyond teaching in the classroom, as a keynote speaker or invited panelist in international technical events, and through an extensive number of publications, Manika's skills as an educator include advising some 31 graduate and undergraduate students in geophysics, petroleum engineering, and chemical engineering.

In addition, she has served SEG as Associate Editor of Geophysics and as a member of several committees. She also is the technical editor of the Reservoir Evaluation and Engineering Formation Evaluation for SPE. Twice, Manika was named Outstanding Mentor to Native American Students at Stanford.



2017 Life Membership Awardee Paul Schatz

Paul began his career in West Texas as field geophysicist for Geophysical Systems, the company that pioneered 1024 channel digital seismic acquisition, sign-bit recording, and onsite data processing for quality control. He came to Houston in 1980 to establish a new office for the company. In 1984, he joined Professional Geophysics as Houston Area Geophysicist. In 1988, he joined Advance Geophysical as North America Sales Manager. Advance was acquired by Landmark Graphics in 1994, where he became Major Accounts Manager. Paul joined Paradigm Geophysical in 1996 as VP US Sales, and in 2000 moved on to INT as VP Sales, where he remains to this day.

Paul has been an active contributor to the GSH, having managed Icebreaker receptions, and the GSH Annual Meeting and Barbeque events held at the Houston Zoo in 2010 and 2011. He has served as Chair of the Directory committee, Chair of the Web site committee, and as SEG section representative.

Paul was elected GSH Secretary in 2004, 2nd Vice-President in 2010, and President in 2014. He is a committed supporter of the GSH Geoscience Center and Museum. Paul is currently serving as prior past president.

Paul is a member of several professional societies and area organizations including SEG, GSH, HGS, SPE, and the MIT Enterprise Forum. Paul was a registered Boy Scout Leader for ten years and participates in numerous civic activities throughout the Houston area. Paul holds a BSc degree in Geology from UCLA and an MBA from the University of Houston Bauer College of Business. When he is not busy volunteering, Paul enjoys quality time with his wife Susan, children Matthew and Sydney, builds web sites, and collects old science fiction and adventure movies.



Announcing the GSH 2017 - 2018 New Officers



President Elect
Dennis Yanchak



1st VP Elect
Matitri Erwin



2nd VP Elect
Denise Dorsey



Treasurer
Katie Baker



Secretary
Lillian Comegys



Editor
Dmitry Kulakov

Congratulations to our newly elected Officers!

President's Award Winners

**Whitney
Blanchard**

Rookie of the Year!



**Tim
Hall**

Webinar Committee



**Mike
Graul**

Webinar Committee



**Lee
Lawyer**

Webinar Committee



**Haynie
Stringer**

Webinar Committee



**Frank
Dumanoir**

Webinar Committee



25 Year GSH Honorees

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Badachhape
Alistair Brown
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William Cathey

Noel Daly
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Rebecca Olsen
David Purcell
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James Reeves
Brian Russell
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Arville Slaughter
Gene Sparkman

Terrance Stanislav
Kurt Strack
Scott Tiefenthaler

50 Year GSH Honorees

Reid Carter

Shooters & Sponsors Needed!

32nd Annual

GSH Sporting Clays Tournament

Saturday, August 26, 2017

American Shooting Centers

16500 Westheimer Pkwy.

7:00 am – 1:00pm

**To be a sponsor and secure a spot for your team,
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Ryan Marshall ▶ (713) 962-9414
ryan.marshall@dawson3d.com

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Accounting for Bias and Uncertainty in Facies Estimations from Deterministic Inversions

By John V. Pendrel, Henk J. Schouten, Raphaël Bornard, CGG

Summary

Bayesian inference procedures can be used as interpretation tools for seismic inversions. The results are facies and their probabilities of occurrence derived from the native outcomes of inversions or their derivatives. Although deterministic inversions produce a single outcome, they have uncertainties associated with them. Further, due to inappropriate low frequency models or thin bedding, biases in the inversion properties can arise. We use a phenomenological approach to model these effects and separately correct for them in the subsequent Bayesian inference. The results are facies interpretations and pay maps which account for bias and uncertainties and will provide greater confidence in reservoir volume estimates.

Introduction

Bayesian inference can be used to infer the probabilities of occurrence of geologic facies from seismic reflection data and in particular, from full-stack and AVO inversions (Pendrel et al., 2006). It is observed that facies, when displayed in a cross-plot space defined by inversion outcomes, commonly exhibit a clustering behaviour. This clustering can be described by assigning a joint probability density function (fPDF) to each facies. Applying Bayes' rule with optional priors provides the probability of occurrence of each of the facies at every location in 3D space. Volumes of the most-probable facies are then easily computed. The design of the fPDFs comes initially from well log data but can be augmented by rock physics modeling or any other available information. The cross-plot space need not be restricted to the native outcomes of inversions but can be other useful derivatives. For example, in unconventional shale plays, Vqtz and brittleness have been used (Pendrel et al., 2014).

It has been recognized that deterministic seismic inversions, while producing one single set of most-likely reservoir properties, contain inherent uncertainties and possibly, biases. We broadly categorize these effects into two classes – seismic band-based and low frequency band-based. Seismic band uncertainties can arise, for example, from random, and coherent noise in the seismic data and gather misalignment. Biases can be variable from one geologic layer to the next and result from attempts to image thin layers and uncertainties in the estimated angles of incidence and the inversion wavelets. In the low frequency band, bias can be caused by attempts to account for lateral variabilities in facies property trends

by the interpretation of well logs. Extension of the low frequency model (LFM) with ultra-low frequency stacking velocity information and trend replacement from facies identification can cause both bias and uncertainty.

A rigorous approach might be to estimate the uncertainties in each of the inversion inputs and from these, the net uncertainty in the inversion outcomes. Here we take a more phenomenological approach. We use the differences between inversion outcomes at well locations and high-cut-filtered well logs as inputs to the bias-uncertainty analysis procedure. This method is described in greater detail below. However, it is important to ask what types of errors the difference data represent. Certainly they contain information from the seismic band. Should the LFM used for inversion be computed by well log interpolation, then there will always be low frequency agreement. But if the LFM is derived from other information or perhaps an average over the available logs hung on structure, then the difference measure will be a mixture of the two types. Previous works (Pendrel et al., 2016) have used the method to identify bias and uncertainty effects while not attempting to separate the two. Here, we address that and extend the analysis to the probabilistic estimation of pay thicknesses.

Method

The inversion algorithm which we employ makes no use and has no knowledge of any well log information within the seismic band so that we can say that the inversion algorithm is blind to the logs within that band. It then follows that an effective QC is the comparison of the inversions to high-cut-filtered logs at the well locations. A cross-plot of high-cut filtered logs vs inversion outputs should result in a set of data points clustering along a line with a slope of unity. Any deviation from this slope is an indication of bias. The observation that the data points in the QC cross-plot cluster along the best-fit line rather than lie on it is an indication of uncertainty. We measure the distance of each data point from the best-fit line and use these to construct a residual histogram. To this we fit an uncertainty PDF (uPDF).

The contribution of the LFM band to the uncertainty and bias in this QC depends upon how the LFM was constructed. There will be no contribution when it is built by a process involving the interpolation of the logs. When it is constructed from any other method, then the QC described could contain an LFM component.

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After uPDFs are computed for each layer and each of the inversion outputs, they are incorporated into the Bayesian facies analysis. The outcomes of inversion are no longer represented by single points in the inversion cross-plot space on which the facies PDFs are defined but by ellipses. Should a bias correction be necessary, then the ellipses are shifted. The effects of bias alone can be investigated by simply setting the standard deviation of the uncertainty PDF to be small or zero. We recognize the possibility that the uncertainties from associated inversion outputs could be correlated. This would mean that the multi-dimensional uPDFs would be rotated. We have not seen this effect in real data and so do not pursue that notion further here. We also note that the PDFs could be defined through a non-parametric approach which we have also not considered in this writing. The effect of the uPDFs is to add uncertainty to the individual facies probabilities. As the standard deviations of the uPDFs become larger, the probabilities of occurrence of the facies become more similar and the ability to discriminate between them is reduced.

Example

We test the above ideas with a Gulf of Mexico data set. Geologically, there is a set of two vertically-stacked deltaic systems of middle Pliocene age. They average 400 ft. in thickness and are separated by about 500 ft. Within the play area are delta slope deformation,

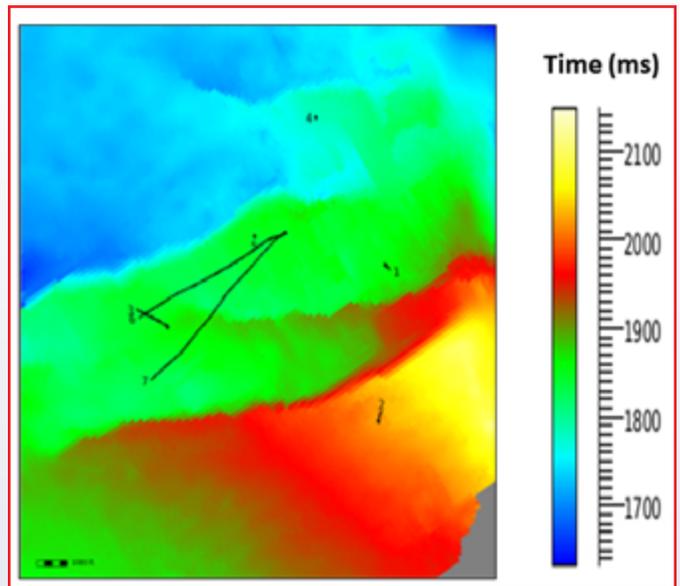


Figure 1: Project map showing the green horizon and well locations.

slump-induced turbidites, thin mouth-bed deposits but without the presence of any delta plain facies. The key horizon is the top of the green sand which is shown in Figure 1. The sharp discontinuities are the results of faulting. Below the green horizon, we recognize both upper and lower sandstones.

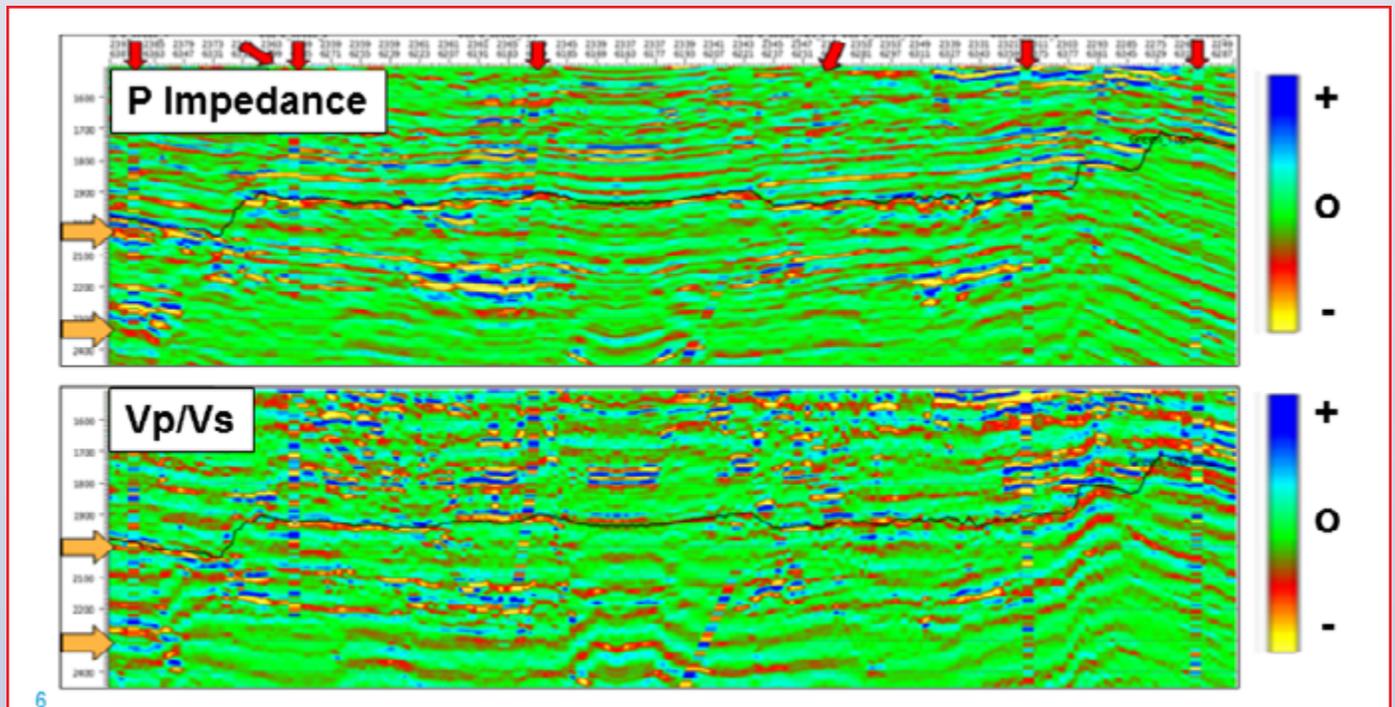


Figure 2: P-impedance and Vp/Vs from a relative inversion (no low frequencies). Band-pass-filtered logs have been overlain at the well locations (red arrows). The inversion algorithm was blind to the wells in the seismic band.

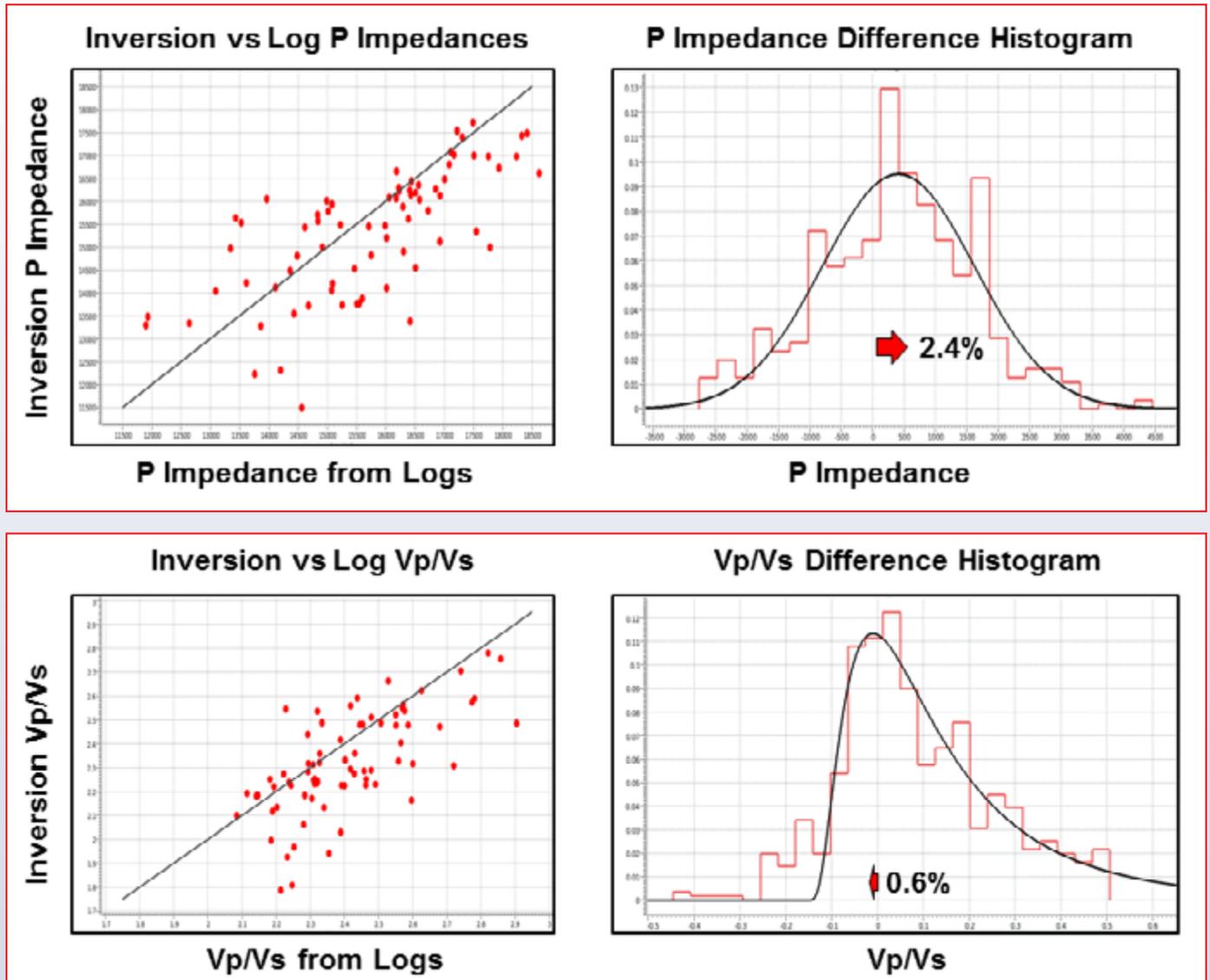


Figure 3: Cross-plots of p-impedance and Vp/Vs from inversion with their high-cut-filtered log counterparts (upper left, lower left) for the upper sandstone indicate deviations from a one-to-one line and therefore, bias. There is also significant scatter representing uncertainty in the inversion results. On the right are the modelled uPDFs for p-impedance and Vp/Vs.

The available seismic consisted of five partial-angle stacks with the maximum angle in the farthest stack being 50 degrees. This was not judged to be sufficient to resolve density with any degree of certainty. A single set of wavelets, one for each partial stack, was obtained by matching elastic synthetics to the seismic at each of the seven available wells. The log sets included full-wave sonic logs over the reservoir interval, facilitating the creation of the AVO wavelets. A simultaneous AVO inversion algorithm (Pendrel et al., 2000) was used to complete the inversions. Low frequency information was supplied to the inversion in the form of facies-based constant trends interactively defined at horizons and hung on structure. The lowest frequencies were further modified using stacking velocity information (Pendrel, 2015).

The results of the relative (no low frequencies) simultaneous inversion are shown in *Figure 2* along an arbitrary line passing through all the wells. Band-pass-filtered logs are overlain. The matches are not perfect since the inversion has no prior knowledge of the high frequency component of the logs. The regions of interest are the sands (between the orange arrows) where there is the possibility of hydrocarbon-bearing sands. The p-impedance agreement to wells is good and the Vp/Vs fair.

Bias QCs for p-impedance and Vp/Vs are shown in *Figure 3* for the upper sandstone. There is considerable scatter (uncertainty) as well as significant bias. These can be seen clearly in the difference histogram plots in *Figure 3*. Biases of 2.4% and 0.6% exist for p-impedance

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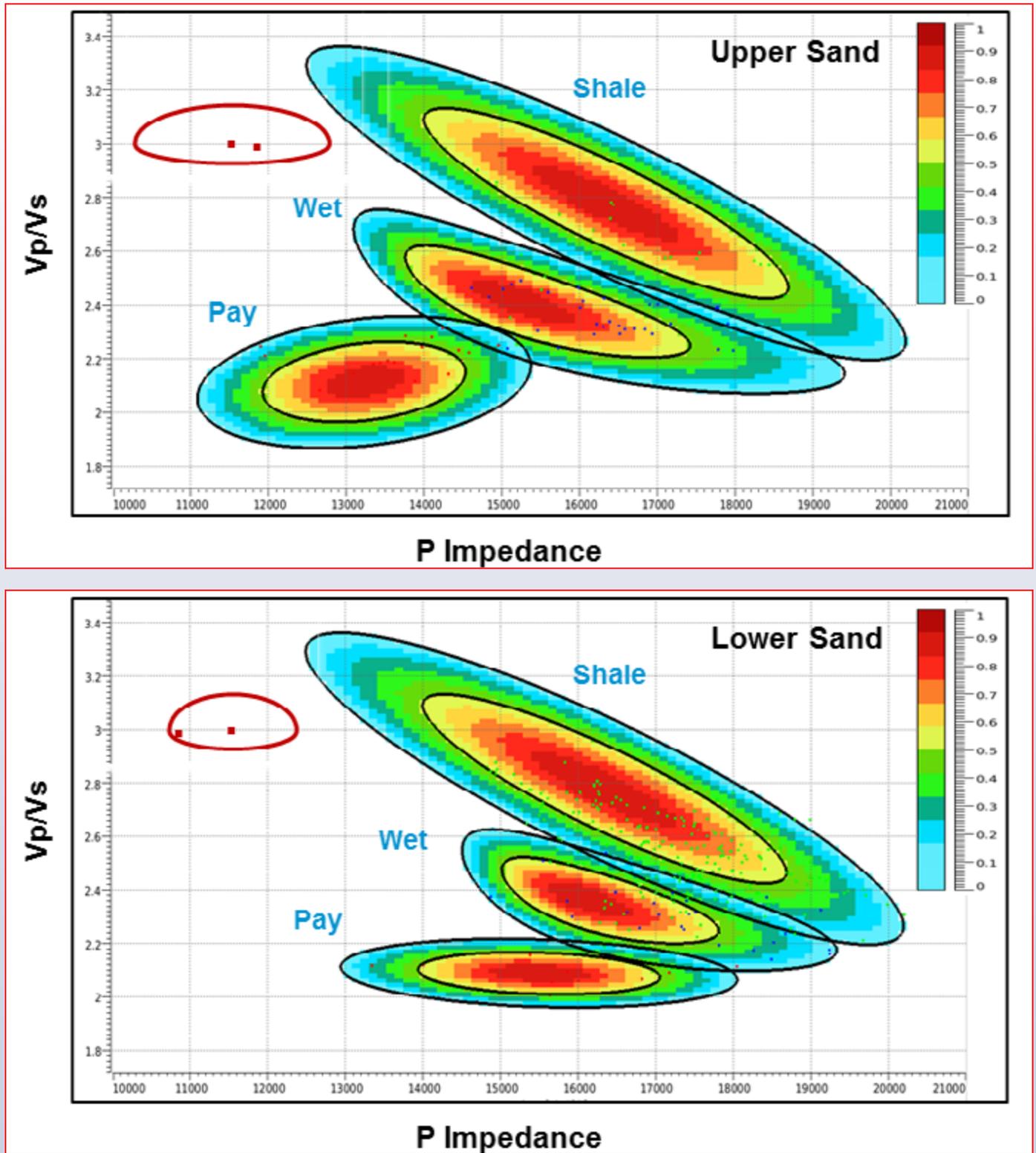


Figure 4: Bayesian facies analysis templates for the upper and lower sandstones. Also shown are the uPDFs (red ellipses). The distance between the centric and non-centric red dots inside the ellipses represent the bias.

and V_p/V_s , respectively. Since the modelled uPDFs in Figure 3 are used in the Bayesian analysis, a bias correction is effectively made.

Figures 4a and 4b show the facies PDF templates used in the Bayesian inference for the upper and lower sandstones. Note how the characteristics of the sandstones change in

Technical Article continued on page 17.

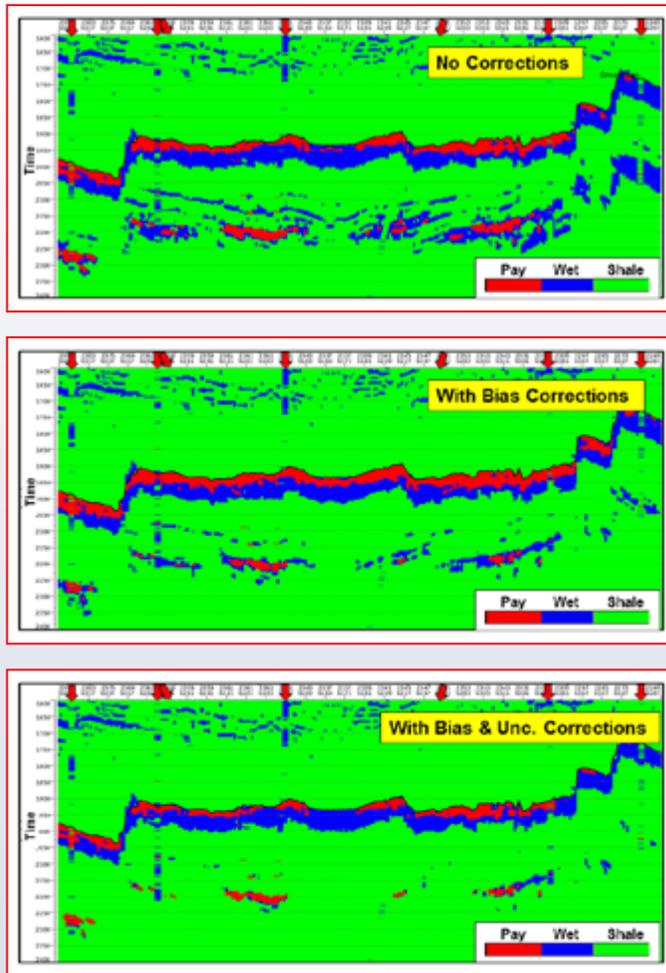


Figure 5: Three versions of the most-probable facies are shown, corresponding to no corrections (upper), bias corrections (middle) and both bias and uncertainty corrections (lower). Bias corrections have increased the pay in the upper sand and reduced it in the lower. Uncertainties reduce probability contrasts generally but have also reduced pay due to the asymmetry in the V_p/V_s component of the uPDFs.

this short time interval. **Figure 5** compares the results of the Bayesian facies classifications when bias is ignored (upper) and when it is incorporated (middle). There is more pay in the upper sandstone in the bias-corrected version. The opposite is true in the lower sandstone. Apparently, the biased inversions had resulted in wrong classifications of some facies. As expected, the pay probabilities in **Figure 5** (lower panel) are reduced when both uncertainty and bias are taken into account. There is increased confidence in the surviving high probability areas however, since imperfections in the inversion have been addressed.

The surprisingly large uncertainty indicated by the QC process, especially for p-impedance (**Figure 3**) has had

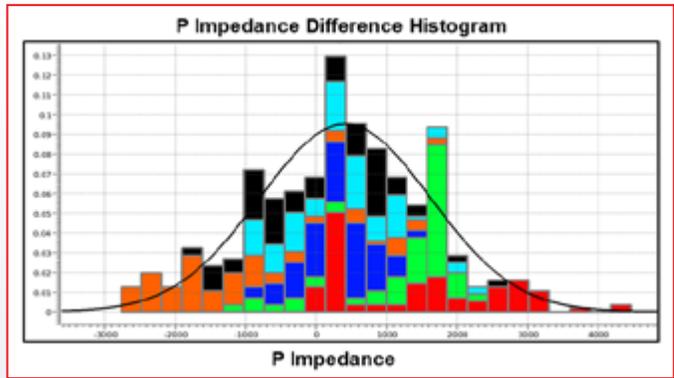


Figure 6: P-impedance residual histogram for the upper sand, colored by wells. The contributions of some wells (red, green, orange) are not centered about zero, indicating that the LFM obtained from the average of all wells will exhibit bias at these locations.

a rather dramatic effect on the probability of pay facies and deserves further investigation. **Figure 6** shows the histogram of p-impedance residuals for the upper sand, but now colored by wells. The contributions of each of the wells are not the same. While some are approximately centered about zero (black, cyan, magenta) other are not (red, green orange). The implication is that the LFM for inversion obtained from an average over all wells was not appropriate for some. In this example, it is known that pressure differences can exist across faults and that fault block-specific LFM's might be more appropriate. We judge that if these were to be undertaken, the p-impedance uncertainty might be reduced by a factor of two.

Finally, we investigate the effects of the above processes on the estimation of net pay thickness for the upper sand. We first mask the pay by probability of occurrence, accepting only those pay facies with probabilities which exceed a particular threshold. Here, the threshold was chosen to be 0.6. The results are shown in **Figure 7** for the same scenarios as in **Figure 5**. We include the additional possibility of an uncertainty reduction by a factor of two according to the alternate LFM approach suggested above. The results are consistent with the most-probable facies sections in **Figure 5**. Bias, in this case, increases the projected net pay while increases in uncertainty reduce pay probability.

Conclusions

We have demonstrated that small biases and uncertainties in seismic inversions of only a few percent can significantly affect critical facies identifications. These can be estimated and input to a Bayesian inference procedure on a layer-by-layer basis to both correct the inversions for bias and produce meaningful facies interpretations which take uncertainty into account.

It has been shown that LFM-building strategies that do not rely on well log interpolation can contribute to inversion bias. Laterally-varying LFM, if they are reasonable, can assist in reducing bias and overall uncertainty. Fault blocked-based LFM were suggested in the example presented. In our future research we will investigate “smart” well log interpolators which will base their interpolation weighting on relevant attributes and further, suggest LFM uncertainties away from well control.

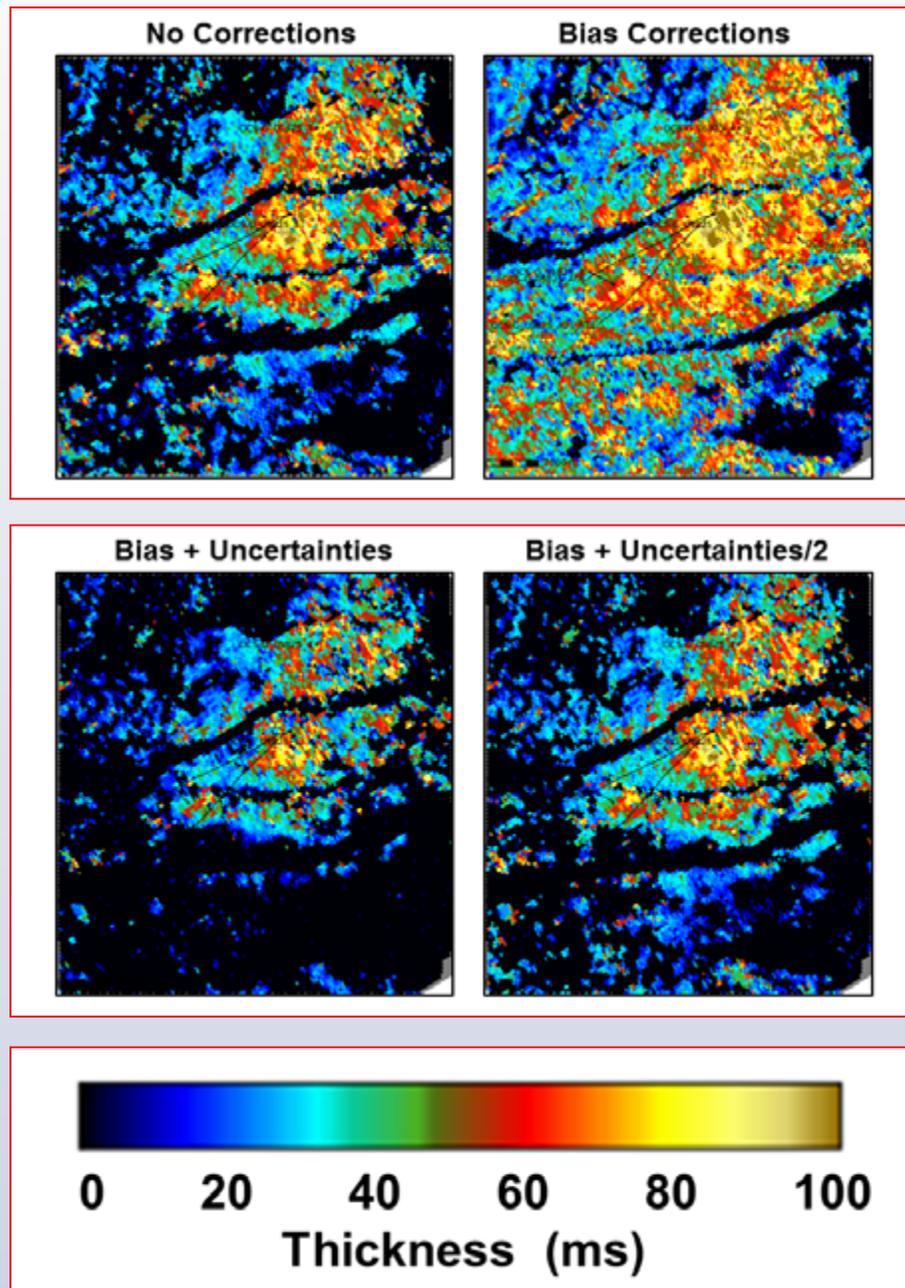


Figure 7: Net pay thickness maps for the upper sandstone wherein it was required that the pay probability meets or exceeds 0.6. The figures show the results for no bias or uncertainty corrections (upper left), bias corrections only (upper right), both bias and uncertainty corrections, (lower left) and bias corrections with a 2X- reduced uncertainty (lower right). The potential benefits of a more appropriate LFM are demonstrated in the lower right figure.

Acknowledgements

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Celebration of Inclusion - A GSH Diversity and Women's Networking Event

by Amy Rhodes

Our third Diversity and Women's Networking Event was a huge success! A diverse group of geophysicists and professionals working in the geophysical industry in Houston, gathered together at the Rogue Wine Bar for a happy hour, which raised over \$2400 for our GSH-sponsored SEG Foundation Carlton-Farren and Hugh Hardy Scholarship fund. In these challenging fiscal times, the Geophysical Society of Houston is committed to continuing our outreach efforts. This event was a great example of our membership supporting outreach efforts and having a wonderful time while doing it.

At our prior Diversity and Women's Networking events, attendees enjoyed high-quality speakers, panels and Q & A's but expressed a desire for more time to catch up with their friends and make new ones! This event provided an informal professional development opportunity, where attendees could discuss ideas, solicit feedback for future projects and career moves, or just catch up on life. This is the true definition of networking and I know that I walked away with new connections and new ideas on how to progress myself both professionally and personally.

As one of the last GSH events of my 2016-17 President term, my husband and I had a wonderful evening spending time with all the people I have met through this event series over the last two years. I have met so many role models at these events who have mentored and inspired me. We look forward to seeing you all at our next GSH Diversity and Women's Networking Event.

Thank you to the planning committee: Sofia Campbell, Nicola Maitland, and Amy Rhodes.



Women's Networking Event continued on page 20.



2017 Diversity & Women's Networking Committee's Happy Hour Celebrating Inclusion

Thank you to our Sponsors!



A Conversation With ...

Laurie Weston Bellman By Lee Lawyer

Laurie Bellman is the Canadian SEG distinguished lecturer for 2016. The GSH was fortunate in getting her to speak here in Houston and giving us the opportunity to talk to her about her professional life that has been quite varied. You will marvel at the many places she has worked, how she got there and how soon she moved on. I would call it the real-life adventures of a doodlebugger. I enjoyed the conversation with Laurie and I am sure you will enjoy reading this story-book adventure. Be warned, when you see the initials QI, know it is a startup venture just now getting underway. To discover what QI stands for, read ahead. (Lee Lawyer)

How did you get involved with geophysics?

Completely by accident. Having read several of your interviews, Lee, it seems that's not so unusual, however I wasn't even thinking university when I left high school. I graduated from high school in a small town in British Columbia called Chilliwack, and university wasn't an option in the minds of many of my friends. My priority was to leave home and experience some adventure, so I left with a friend in my '68 Ford Cortina and drove to Cache Creek in the interior of B.C. Why Cache Creek? It could hardly have been called a town – a collection of gas stations, fast food restaurants and motels at the intersection of three highways; one south to Vancouver, one north to the gold-rush town of 100-Mile House and beyond, and one east to Kamloops and Calgary. Cache Creek desperately needed unskilled workers, so my friend and I got waitressing jobs the day we arrived in town.

Ironically, that first job was with Imperial Oil! At that time, a restaurant called The Voyageur, owned by Imperial, was attached to many Esso gas stations. The recognizable feature of these restaurants was the gigantic red pointy hat on the top of the building. We had to wear a red pointy hat. It went along with the red mini-dress and white apron.

I was ambitious even then. A table of regulars was a group of ladies from the Royal Bank.

They looked so sophisticated to me, so I convinced them to interview me (I took the pointy hat off). I thought I had the best job in town when I started as a bank teller soon after. I learned quickly and was introduced to a much wider world of business, which made me realize that maybe Cache Creek wasn't big enough. I requested a transfer to the small city of Kamloops (60 miles away), and worked my way up to Head Teller at the main branch of the Royal Bank. In those days people used cash, and as head teller, I was responsible for taking all the large deposits from department stores etc. in the 'cash cage', behind bullet-proof glass in the back of the branch. By the end of most busy days, I was wading in money.

Fun as that was, I felt like I was missing some intellectual stimulation – of what kind, I couldn't say. There was a community college in Kamloops and I started taking individual courses to try to figure that out; accounting, philosophy, criminology, psychology, English – nothing quite inspired me. In a moment of self-awareness one day, I realized the only thing I was really interested in was outer space. I hadn't noticed any courses called 'Outer Space', so by process of elimination of all the sciences I knew (not biology, not chemistry), I deduced that it must be physics. I was so sure of my choice, I quit my bank job and registered full time for the Physics program.

This college did not offer degrees, but had a transfer arrangement with the University of Victoria, so after a year, I moved to beautiful Victoria B.C., and by then was knowledgeable enough to know that I was studying Astronomy! UVic was one of the first universities in Canada to have a Cooperative Education (Co-Op) program where job placements in the students' field of study were provided during alternate 4-month terms. My first job after my second year was at the Dominion Radio Astrophysical Observatory, run by the Canadian National Research Council, in Penticton B.C. I was writing programs to analyze radio wave signals collected by the giant array of parabolic dishes right outside my window. I was thrilled. My



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next job, four months later, was with Shell Canada in Calgary. "What use do oil companies have for physics", I wondered.

Shell hired you with what kind of academic background?

I really wasn't much use to anyone with only two years of university Physics/Astronomy, but Shell put me into the processing group with a great supervisor and some very helpful co-workers. I learned a lot about signal analysis for geophysics (which, by the way, is not much different from radio-wave signal analysis), and put my knowledge to practical use processing seismic data.

That sounds like a great program for both the students and the companies hiring them.

It is indeed an amazing program, Lee, especially for people who intend to go into industry. After my first work term at Shell, I had two subsequent work terms at Dome Petroleum and Chevron before graduating with an honors B.Sc. in 1986. When I left the University I already had 20 months of valuable experience and had job offers from all three of the oil companies I had worked for. I eventually chose Shell, but it was a really tough decision between Shell and Chevron.

Did you get an advanced degree?

I didn't get an advanced degree. As you can imagine, given my convoluted route to this point, I was already a 'mature' student. Also, the Co-Op program extended the Bachelor degree from four to five years, and when tempted with lucrative job offers for interesting careers, it was a no-brainer for me to leave school and start the next adventure.

Shell is a great company. Did you get the full year of Shell training?

Shortly after joining Shell, I was fortunate enough to get the opportunity to go to The Hague for Shell's new-hire training program. The Shell training center was near a town called Noordwikerhout, on the coast just north of The Hague – a beautiful rural setting, surrounded by tulip fields. Along with intensive 8-hour classroom training days, there were outings. We went on geology field trips to the northeast coast of England near Whitby and the south of France, and to a castle in England for a week of intercultural communications training (that's why I get along so well with Americans).

Be happy you didn't go with Chevron. We didn't have that level of training. Instead of The Hague, Chevron has Houston. Same elevation but different somehow.



Laurie dressed for the rig in Fort McMurray

Was all the training in Europe?

After the 'basic' training in The Hague, there were a few other trips to Europe for conferences and short courses. There were also several opportunities for training in Houston at Shell's Bellaire Research Center. All of Shell's training courses were taught by experts in the subject matter and extremely valuable.

What kind of job did you have with Shell?

After returning from my training in The Hague, I started in the seismic processing group. This was pretty standard for new geophysicists in Shell – the company strongly believed that interpreters needed to understand seismic data at a fundamental level. Many people also spent time in acquisition for an even more thorough exposure to the basic (and complex) concepts. I completely agree with Shell on that point and believe that assignment made me a better interpreter and contributed to my ultimate passion for quantitative interpretation.

After two years in processing, I moved into carbonate interpretation, following up on the excitement of a recent 2-tcf gas discovery in the Devonian at Caroline.

At that time, in the US Shell was known as Shell Oil Company and wasn't an integral part of Royal Dutch. Royal Dutch Shell was the organization in The Hague. A few years later, Royal Dutch bought Shell Oil Company.

You're right, Lee. There was even a bit of a rivalry between the two organizations. We, in Canada, had strong links to Shell Oil and Royal Dutch, and people like me benefitted from getting both perspectives.

How long did you work for Shell?

Five years. Two years in processing, followed by three years of interpretation in the Caroline exploration group. Knowing me as well as you do, Lee, you can probably guess by now that I started getting restless. I began looking around for another adventure.

Poor seismic data?

It had nothing to do with the quality of the data, which was actually extremely good (Shell acquisition and processing, of course). It was simply a matter of: What next? One day, fortuitously, a colleague brought me an ad in the Calgary newspaper for a geophysicist position available at a company called LASMO (London and Scottish Marine

Oil) in their London office. They only required five years' experience. London. That was for me. I applied for the job; got the job. I sold my car, gave Joe (the cat) away to a good home, packed up everything in my apartment and moved to London.

My first five years with Chevron were on Seismic crews. I wandered around a bit but it was all in Oklahoma, Texas and New Mexico. But you had already moved here and there with the Shell Training program. So this move may not have been as drastic as it sounds.

How long were you with LASMO?

In spite of the exciting new environment and challenging new work, I was only with LASMO for three years. My assignment there was in the EAME (Europe, Africa, Middle East) group, focusing initially on two non-operated exploration blocks in Syria. One of the operators was Enron; the other was Total. I was lucky to have been invited by the operators to visit our seismic acquisition in one block and one of the exploration drilling rigs in the other, so I flew to Damascus from Paris with the geophysicist from Total. When we arrived in Damascus, we visited Total's local office and the next day drove across Syria to the Euphrates Graben. We travelled through the town of Palmyra where all the beautiful Roman ruins are (not now unfortunately – because of the unrest in that area). It was spectacular to drive through the desert, through those towns, unbelievable. This was a long way from Cache Creek.



Shell Oil had some production in the south Syria. Chevron was also there but we didn't seem to be able to negotiate with the government and gave up our licenses. I forget the exact reason.

We don't have a LASMO today. What happened?

While I was there, LASMO was the subject of a hostile takeover bid from another similar-sized independent company in London, Enterprise Oil. LASMO successfully fought off this bid, only to be taken over a few years later by the Italian company, Agip. The day that the hostile bid was

Interview continued on page 24.

Laurie dressed for the rig in Syria (near Roman ruins in Palmyra)

announced, however, I got a call from a head hunter who said, "You want to get out of there." She represented a Canadian company called Wascana Energy, which was the overseas office of SaskOil, headquartered in Regina, Saskatchewan. They had a very small office near Leicester Square in the heart of London. Their one geophysicist was moving back to Canada and I replaced him. After a year with Wascana, during which time I managed all geophysical aspects of their operated acreage in Algeria, they decided to close their London office (something about the cost of the rent relative to office space in Regina). They offered me a job in Calgary continuing on the Algeria project, so I ended up coming back to Canada.

That closed the big loop. I hope you took a lot of pictures.

I did.

Who are you with right now?

That's a good question. Be patient Lee – I'm getting there.

I moved back to Calgary with Wascana Energy. Soon after, SaskOil was taken over by Canadian Occidental who subsequently split from Occidental, their parent, and became Nexen.

How long did you work for Nexen?

Well, then I became pregnant with my first child.

Wait a minute. We skipped an important step!

Yes, I suppose so! I met my husband in England. He came back to Canada with me.

You took time off to have the baby?

I took time off when my first daughter was born, then returned part-time to Nexen. My husband (an operations geologist), was offered a contract in Rome (by none other than LASMO) a year later. Not one to turn down this kind



Laurie with members of the 'Dalhousie University Women in Geoscience Group, during her CSEG Distinguished Lecture tour in Halifax, Nova Scotia.

of opportunity, we sold the car, gave away the cat, packed up the house and the baby and moved to Rome. By this time, I was 6-months pregnant with my second daughter so I took early maternity leave from Nexen, and with two babies in the stroller on the cobblestone streets of Rome, became 'Madonna' (that's what the Italians called me). A few months later, I sent my resignation letter to Nexen: "Not coming back because I live in Rome".

LASMO closed their Rome office soon after, so, experiencing a bit of 'déjà vu', we packed again for the return trip to Canada. This was 1999. Oil was \$12/barrel and neither one of us had a job. At 5-months pregnant with baby number three, I went looking for work. My husband signed on with a wellsite company but drilling had dropped to almost nothing. I managed to find an interpretation contract with Alberta Energy (AEC). The contract was for four months or until the day the baby was born, whichever came first.

Those are unusual contract terms.

I worked my four months finishing at 5:00pm on the final day of the contract. The next morning at 8:30 my third daughter was born.

That was amazing timing. You now had three children and they were all at home. What was next?

After about eight months, I got a contract with my former company, Nexen. They were looking for a geophysicist for some short term work to interpret a few 2D lines over a remote area in northern Alberta in a non-core area.

That 2-month contract was my introduction to oil sands.

Seven years later, the oil sands team at Nexen had grown from a part-time geophysicist (me), a geologist and an engineer to thousands of geoscientists, engineers, support staff and field staff in both Calgary and Fort MacMurray. I was still part of the team, having evolved the geophysical workflow into an integrated quantitative interpretation process to predict rock properties, including lithology and fluids, in the reservoir zone.

Were you still on a contract basis or did they really hire you?

All contract. I only wanted to work two or three days a week because of my young family. Due to my schedule, the team mostly ignored me, so I was free to experiment with ideas and work on interesting quantitative interpretation (QI) all by myself. It was, ironically, a fertile environment for me to get creative and innovative. However, because I was 'sidelined' I didn't always get the best attention when it came to computer equipment. It was in a moment of frustration one day when my computer crashed for the umpteenth time, that I considered buying my own high-end hardware. And then it occurred to me that since I was using commercial software, I could buy that too. In fact, I could start my own company! While watching my crashing computer go through its disc-checking on the blue screen, I came up with the name of the company, doodled the logo and by the time the computer came back with its final exasperating message – 'disc unrecoverable', Oil Sands Imaging Inc. was hatched.

I was going to say that that was amazing but it seems in keeping with your background and experience.

I do like a good adventure and this was a different kind altogether. Oil Sands Imaging came into existence in 2007. I was offered some free shared office space from a friend of mine to get started. After the first year, with several QI projects completed, I moved into my own office space and hired a technologist and a business manager. Soon after, once again out of frustration, an idea for interactive quantitative interpretation software formed in my mind. So, I hired a coder and gave him all the specs. Because we had already increased our staff with a few more geophysicists, we were out of office space. He sat at a desk in the lobby and doubled as the receptionist.

He didn't mind multi-tasking, but we had to move again.

Is "Oil Sands Imaging" still in existence?

Not today. We knew we were doing something very unusual with this oil sands data but we came to realize that this process would apply everywhere, not just to a particular play. Our name was holding us back, so we

changed it to 'Sound QI'.

About that time, Canadian Discovery, which is primarily a geological data and consulting company, talked to us about merging. Three months after we changed our name to Sound QI, in August, 2012, we were taken over by Canadian Discovery.

I remained with Canadian Discovery until January 31st of this year as the 'Director of Quantitative Interpretation and Geophysics' of the merged company. We had a lot of success within Canadian Discovery and worked with some great people. However, with an asset sale and subsequent rationalization going on at Canadian Discovery, productive discussions with management resulted in the amicable spin-off the QI department into a separate company. Sound QI "2.0" (actually, Sound QI Solutions Ltd.) was formed. It is an exciting time for me and the other people involved in this new beginning.

Do you have any regrets along the way? There was a lot of change in your life. A lot of stress with moving.

Certainly, there were stressful times. Moving internationally and changing jobs can be extremely challenging. You pack everything and dismantle your life – precious things get sold, lost or broken. You are going where you might not speak the language; moving your family into an unfamiliar house. You have to get a new doctor, a new dentist, a new accountant, new babysitters and house-cleaners, adjust your shopping and eating habits. Learn to drive!

If you could drive in London, you could drive in Rome.

Rome is different. There are no lines on the road. Italian drivers don't like boundaries – they like to keep their options open. This is renegade and dangerous for us North Americans, but delightfully liberating when you get used to it!

But all of that is an aside. Your question was, "Do I have any regrets?". There is stress but that doesn't equate to regret. Stress is a natural consequence of looking forward and doing something unknown and exciting. Some people plan everything – they need to analyze every decision with pros, cons, likely outcomes, weighted options, goals, milestones, spreadsheets! That gives them comfort and works for them. But if you have listened to my story, you'll have noticed that virtually none of it was planned much in advance. The unknown has a certain appeal for me. Sell everything, go to a new country; start a business; take the risk. The answer is no. I have no regrets.

Were you extremely fortunate in doing it this way or did you just cast the dice and hope it worked out?

Interview continued on page 26.



Laurie's 'fan club' in Syria

Were there any disasters along the way. Say you are out in the desert with no water and a bunch of guys on camels show up?

It depends how you define disaster, Lee. I think of disasters as completely random. A fire or an earthquake is a disaster. I think situations only become disasters if you're afraid of them. If I am out in the desert and a bunch of guys show up on camels, I could be super scared at that point or I could say, "Oh, good. They must have water."

You are right of course. When I used the term, disaster, I exaggerated what I was referring to. I was referring to bad things.

I understand. Luckily, seriously bad things didn't happen. Part of that is preparation once a decision is made, but had I systematically planned everything, I probably wouldn't have acted on most of it – I would still be a bank teller.

Why are you making these presentations? Why are you the Distinguished Lecture from the CSEG?

It was an honor to be chosen and they flattered me, to start with. That works on me every time. But I saw another adventure – another opportunity to try something new,

meet new people, experience my field, my industry, my country from a different perspective. You must know by now Lee how much that would appeal to me!

Next question: If you had to advise others interested in earth-science, what would you tell them?

I have completed the Canadian part of the tour. It was about twenty presentations at several Universities across Canada. Many people came and chatted during the social times. Students are uncertain about their own futures and were asking questions like: "What can I do to stand out while I am looking for a job?" or "What can I do during my next two years in school to be employable?" I tell them to be open-minded to not-necessarily-linear career options and take a statistics course. We are being buried with data these days. The old way of looking at one line or one well at a time is not going to get you very far in the 'Big Data' future. By the way, that is the topic of my talk.

That is great, Laurie. I have truly enjoyed our conversation and wish you well with your newly formed company.

Thank you, Lee. My pleasure.

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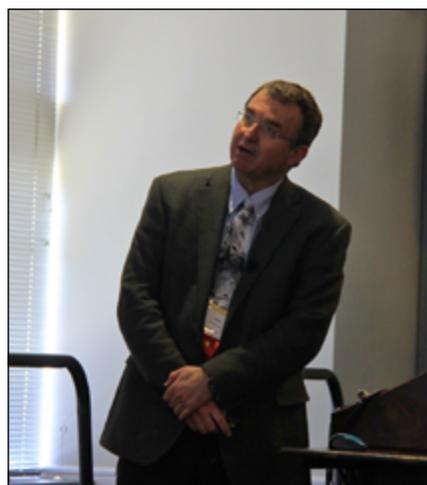
GSH Spring Symposium

Geophysical Acquisition: Advanced Techniques Revealing Challenging Targets

By Lisa Buckner



The GSH-SEG Spring Symposium is a great value at any point in the industry cycle and this year was no exception. The technical presentations, invited speakers, exhibitors, sponsors, fellow attendees and honorees were all of exceptional quality. Planning and executing an event like this would not have been possible without the advice, support, hard work and dedication of the committee members, volunteers and GSH staff. The first steps in planning this event are choosing the honoree(s) and the theme; we always strive to make the theme of the Symposium related to the honorees' field of expertise. After looking over the list of past honorees and topics, our nominations committee realized that no honoree had been recognized from the field of seismic data acquisition. This is a field that is undergoing rapid and significant transformation, and two of the pioneers in this discipline have been Dave Monk and Malcolm Lansley. In order to maximize our chances for success in attracting sponsors, exhibitors and attendees in this continued low oil price environment we decided to honor both of them. Dave and Malcolm were co-workers at GSI, remain close friends to this day, and both were excited to be recognized and share in this honor. The next step was to choose a Technical Program Chair, Tad Smith, who in turn chose sub-committee members Dennis Yanchak, Ken Tubman and Laurence Williams. The rest of the organizing committee included Lisa Buckner (General Chair), Xianhuai Zhu (General Support & Challenge Bowl Teams), Haynie Stringer (Sponsorships & Advertising), Frank Dumanoir (Simulcast Lead & Sponsorship Support), Denise Dorsey (Venue Arrangements), Nicola Maitland (Volunteers & Advertising Design), Peter Duncan (Gulf Coast Challenge Bowl and Roast & Toast MC) and UH PhD candidate Joan Marie Blanco (Program Book & Student Volunteers).



SESSION 1

Everyone was thrilled with the slate of eleven invited speakers, who are some of the best communicators and subject matter experts in the business. Nikki Martin (IAGC President)

Spring Symposium continued on page 30.



started us off with an enlightening analysis of how the shifting political landscape influences environmental public policy, and outlined some of the global political and environmental challenges for the geophysical industry during a time when the oil and gas industry itself is undergoing rapid transformation. One of the key take-aways was that the industry needs to stop using the term “airgun” and replace it with an alternative term like “air source”. Next, honoree Malcolm Lansley gave a historical perspective of 45 years of evolution, innovation and progress in 3D seismic acquisition. He showed us how technological advances in computers, GPS, and telecommunications have resulted in a number of paradigm shifts in our understanding of the optimum ways to acquire seismic data. Not everything can be “fixed” in processing. John Etgen shared some thoughts and reflections on the interplay between seismic acquisition, processing, analysis and interpretation. The four sub-disciplines of geophysics have become so compartmentalized that there is a need for some generalists to look at problems and solutions in a more holistic way in order to make better progress.

SESSION 2

Session 2 was the afternoon of the first day, and focused primarily on case studies. Sarah Cooke shared a marine technology case study of Chevron’s ten year experience with 19 ocean bottom node (OBN) 3D and 4D surveys. Chengbo Li (Conoco Phillips) concluded day one’s technical program with a description of compressive sensing principles for efficient seismic acquisition.



Sandwiched between Sarah’s and Chengbo’s talk was an hour dedicated to visit with our sponsoring vendors and networking with colleagues.

SESSION 3

Eivind Fromyr (PGS) kicked off day two with a discussion about the use of source and receiver diversity for geophysical flexibility and operational efficiency. The industry demand for increased bandwidth at both the lower and higher frequencies for FWI, inversion, etc. can be accomplished in several different ways. Next, Nick Moldoveanu (WesternGeco) gave us a status update on the broadband seismic technology. John Archer (Geokinetics) covered the importance of low frequency seismic, and the concept of dispersed sources and receivers, and showed real world results from the application of Geokinetics’ Symphony technique. One of his key examples was a recent 3D seismic survey Geokinetics shot for Apache.

SESSION 4

The theme for the afternoon talks was The Road Ahead. Shuki Ronen (Low Impact Seismic Sources) described the future of marine seismic sources including low pressure airguns and marine vibrators. Next, John Wei (INOVA) shared his engineering knowledge of new low frequency vibroseis design and control system design. Honoree Dave Monk (Apache) concluded the Symposium with a much anticipated presentation about future seismic technology. He pointed out trends of higher density sampling by means of increasing the number of sources and receivers which may be deployed more efficiently using automation (nodes, drones and motes) and continuous recording with simultaneous shooting. This will require advances in communication, massive data storage and computation capability.

The SEG Gulf Coast Challenge Bowl sponsored by Hess and Microseismic Inc. was held during lunch on the first day of the Symposium under the energetic leadership of Peter Duncan. Five teams of Symposium attendees, three teams from the University of Houston, and two teams from the University of Tulsa competed in the first round of geophysical trivia knowledge. It was a quite humorous



and lively competition. During the second round, only the student teams competed for the prize of an all-expense paid trip to the SEG Annual Meeting in Houston to compete in the global finals. The winning team was Zhencong Zhao and Tianbi Ma from the University of Tulsa Hurricane A Team.

During the Roast and Toast on day two, Peter Duncan shared the many similarities and differences in the lives of our two honorees. Both of them were born, raised and schooled in the UK and worked on field crews. Their careers eventually brought them to Dallas to participate together in GSI's Area Geophysicist University.

One innovation this year was the inclusion of a vendor hour so attendees would have time to visit with our exhibitors (Polarcus, Dawson3D, WesternGeco, ACTeQ, SEAM, GSH and Geoscience Center) to learn about their technology and services. It was also the perfect opportunity to thank them for supporting the Symposium. Without them and our generous sponsors (Anadarko, Apache, ExxonMobil, Wireless Seismic, Effdee Consulting) and in-kind sponsors (Paradigm, Geo Interiors, Katalyst Data Management, Resolve Geosciences) the event would not have been possible. Another innovation was the addition of Toast & Roast messages to the honorees in the program book which makes it a nice keepsake for them.

The 2017 GSH-SEG Spring Symposium was a great value as a continuing education and networking experience.



This event is designed for the express benefit of our membership. Great thanks go to our UH student volunteers (Ezzedeen Alfataierge, Nan Sun, Andrea Paris, Jiannan Wang, Jingjing Zong, Somaria Sammy, Wenyuan Zhang, Yinshuai Ding, Li Chang) who helped during the event with registration, running microphones during Q&A, dimming the lights so we could all see the presentations better and then restoring them for Q&A, taking candid and requested photos and monitoring the simulcast attendees for questions. Mike Graul helped Peter Duncan with humorous quips on the Roast & Toast slides and also made the simulcast possible with onsite assistance from Tim Hall and Chris Hall. Thank you to Scott Singleton for stepping up to moderate one of the technical sessions. Most of all, we greatly appreciate the hard work and dedication of our great GSH staff members, Kathy Sanvido and Karen Blakeman. Without them, GSH events would not be successfully planned, funded, advertised or executed and attendees would not be registered. They provide advice, encouragement, suggestions for improvement and make everything happen. The organizing committee and chairpersons are open to listening to your comments, critiques, constructive criticism, suggestions for improving the event and nominations for future honorees to consider. We look forward to better times for our industry, celebrating the awesome achievements of future honorees and seeing you at the next GSH-SEG Spring Symposium.





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Exploring Houston Through Geocaching

by Rochelle J. Herbst & Britain Willingham

In the heart of the fourth-largest city in the U.S., on a sweltering day in the middle of June, we approached a concrete enclosure along a narrow path of the Green Trail within Houston's own Memorial Park. Away from the hordes of bikers, and immersed in the sounds of nature, this remnant of the WWI-era Camp Logan¹ rose four feet above the ground, with a twenty-foot drop inside its walls and no visible exit. While surrounded by birds, thick brush, trees and the insects that call them home, it was easy to forget the city for a while and focus on the real reason we were there that day.

While enjoying the solitude of the scenery and debating what purpose the ruins had served within the military training camp², we proceeded to an overlook above a shallow pond and began our search of the area. Though we had yet to find what we were looking for, we were assured by our GPS device that our location was at the correct coordinates. By chance, one of us climbed up a tree situated above the pond, beside another ruin covered in graffiti. There, tied to a branch in a rope-and-pulley like fashion, was an army-green plastic tube hanging from the tree. After lowering it down, we unscrewed the lid and pulled out a piece of paper, adding the date and our team name to the list. After a quick high-five and a good-luck kiss, we continued down the path in search of the next cache.

Our quest was part of an activity called geocaching.³ In its most basic form, this global scavenger hunt involves hiding physical objects, or "caches", and posting the GPS coordinates of the location publicly for other people to find. While similar to letterboxing (which involves the use of clues and landmarks to locate hidden objects), the current form of geocaching was enabled by former President Clinton's removal of the Selective Availability (SA) from the Global Positioning System worldwide on May 2, 2000.⁴ With the removal of the SA, which had been implemented originally for national security reasons, the error of GPS receivers went from about 45 meters down to a circular error of 2.8 meters and a spherical error of 4.6 meters, as recorded on a Trimble SV6 receiver within hours of the removal.⁵

The very next day after the removal of the SA, the first geocache was created by Dave Ulmer, who posted the coordinates, 45°17.460'N 122°24.800'W, on the Usenet newsgroup sci.geo.satellite-nav.⁶ Within four days, the cache had been found and logged twice, and a new activity for GPS enthusiasts was born. Originally termed "GPS stash hunt" or "gpsstashing", the name was changed to its current form, "geocaching," to avoid any negative connotation.

While there are multiple sites using a variant of geocaching, Geocaching.com, run by Groundspeak, Inc.,



Off the Green Trail at Memorial Park: The friendly trail and lush environment hide the fact that the photo was taken downtown Houston. Bikers beware! Despite its size, Memorial Park offers great geocaching adventures, some rather challenging.

boasts approximately 3 million active users worldwide, about 830,000 of which are in the U.S.⁷ The only tools necessary to begin geocaching are a GPS device, a pen, and a love of exploring. Geocaching.com has a downloadable app for both Android and iPhone users, and also enable the exporting of .gpx files⁸ to many models of GPS devices, such as Garmin, Magellan, DeLorme, Falk, and Rand McNally. We started out using the Android app, but after some issues with GPS sensitivity (which can be affected by cloud cover, trees, or tall buildings), we bought a dedicated GPS device, which comes in handy for slogging through the mud or wandering around in the Houston humidity without fear of damaging your smartphone.

Caches can be hidden anywhere on public property, so there is a wide variety of locations to suit anyone's tastes. While the more difficult terrains can involve mountain climbing (not in Texas, of course) or even scuba diving for underwater caches, there are many finds to be made in urban environments. The cache containers themselves can take the form of anything from an ammo can, a magnetic key holder, or even a false rock. Cache descriptions often include riddles and hints about the surroundings to help you uncover the final location of the container (in the case of our Camp Logan cache, you can guess what sort of clue we had). Whether you are looking for an activity to enrich your hiking experience, or you would rather stay in an urban environment, there's a cache for you.

Geocaching continued on page 35.



A common geocache container is an ammo can. Other caches, particularly more urban varieties, take the form of test tube like containers, pharmaceutical capsules, or magnetic containers no bigger than a penny. Every size to accommodate family members with better vision than you have.



The remains of the Hillendahl-Egging Cemetery in Addicks Reservoir. This small family size cemetery is situated in Bear Creek off of N. Eldridge Pkwy, 15 miles west of the 610 loop on I-10 in the Energy Corridor.

However, geocaching is not without its share of controversy. Since so much of the activity involves searching an area for a strange object in non-obvious locations, it can attract the attention of “muggles”, the term used by geocachers to describe non-cachers. For example, Peter Loftus of the Wall Street Journal reported that a groundskeeper at Dover, Delaware Park placed a call to authorities after discovering a suspicious object attached to the side of an electrical box.⁹ A bomb squad was called in, and with the use of a robot, it was determined that the package was harmless, though not before causing alarm and wasting the local police’s time and resources. To help prevent such incidents from happening, the geocaching community advises using discretion when searching for caches so as to avoid attracting too much attention and leading to false alarms. Walking one’s dog when out caching, or bringing your children along can help cachers to search without looking too out of place. In our experience, the recent Pokemon GO craze has also come in handy. If all else fails, just swipe at your phone’s screen and pretend you’re catching digital monsters.

In the year since we started caching, we have discovered places we never knew were here in all our years living in Houston. Some of our most memorable finds involve overgrown trails no longer included on maps, or places that are a footnote to history, such as Camp Logan in Memorial Park. One cache had us explore the area around an abandoned cemetery on the outskirts of Bear Creek Park, one of the last remnants of a formerly-thriving 19th century German settlement whose last occupants were forcibly removed in the 1940s for the development of the Addicks Reservoir.¹⁰ Another cache sent us just west of downtown Houston to the once-abandoned Founders Memorial Cemetery where John Kirby Allen, one of the co-founders of Houston, was buried in 1838.¹¹

Whether driving through the city or backpacking through remote wilderness, geocaching enables you to explore the world outside your front door. Every cache is a new location to explore, and with each additional find you make, you discover a little more about the world we live in.

(Endnotes)

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How Things Have Changed...Not Really

By David Watts, Editor 2015-2017

In my past articles on How things have changed, I have written and noted how the GSH has evolved over the years since its inception in 1947. However, this past month of April, 2017, the GSH held its board of director elections and rather than something changing, something continued again in showcasing the strength of the GSH.

Every year, the GSH holds its board of director elections in April to allow you, the society members, to vote on and elect the incoming Board of Directors to allow them the opportunity to guide the GSH community in the upcoming year. This year we have had a wonderful group of people who wanted to volunteer their time and expertise in representing the GSH on the board and this brief article is written to say thank you for their volunteerism. As noted in the March journal, 11 of your colleagues put their names into the hat for election positions of President, 1st VP, 2nd VP, Secretary, Treasurer, and Editor.

The results of your election has provide the incoming board and the elect board to be:

President Elect: Dennis Yanchak
 1st VP Elect: Maitri Erwin
 2nd VP Elect: Denise Dorsey
 Treasurer: Katie Baker
 Secretary: Lillian Comegys
 Editor: Dmitry Kulakov

In doing some research this past month at the Geoscience center, I came across a list of all our past GSH presidents and while I cannot list all the officer positions, I felt that a list of past our incoming and elect presidents would showcase how things have really not changed at the GSH. Therefore, it pleases me to provide to you a historical list of all the GSH presidents including this year's election results:

Year	President	Year	President	Year	President
1947	Walter J. Osterhoudt	1948	Roy L. Lay	1949	Jack C. Pollard
1950	Roy F. Bennett	1951	E.W. Johnson	1952	E. Joe Shimek
1953	John E. McGee	1954	Y. O. Hall	1955	W. Harlan Taylor
1956	Walter B. Lee	1957	George P. Montgomery	1958	John F. Anderson
1959	Dave P. Carlton	1960	Paul Farren	1961	W.H. Gibson
1962	C.H. Broussard	1963	Otis T. Halliday	1964	James M. Wilson
1965	Woodson M. Tottenham	1966	James D. Divelbiss	1967	Ben R. Howard
1968	A.A. Hunzicker	1969	Jack D. Wallner	1970	Elwin M. Peacock
1971	Bird G. Swan	1972	Jack C. Weyand	1973	Curtis C. Bratt
1974	George E. Parker	1975	Ray E. Faudry	1976	F. Burke Calhoon
1977	Bob J. Martin and Norman S. Neidell	1978	Kevin M. Barry	1979	A.M. Olander
1980	James K. Grigsby	1981	Kay N. Burns	1982	Raymond C. Farrell
1983	Don W. Frye	1984	Charles H. Andrews	1985	Harold L. Landers
1986	Joe H. Smith	1987	John L. DeVault	1988	Alf Klaveness
1989	Bob C. Jones	1990	William H. Gilchrist	1991	Mike Schoenberger
1992	Hugh W. Hardy	1993	Thomas K. Fulton	1994	Arthur H. Ross
1995	Cheryl S. Stevens	1996	Wulf F. Massell	1997	William T. Gafford
1998	Robert H. Tatham	1999	Patrick S. Starich	2000	John Sumner
2001	Dave Agarwal	2002	Dan Ebrom	2003	Roy E. Clark, Jr.
2004	Steve DanBom	2005	Pat Peck	2006	Kathy Hardy
2007	George Marion	2008	Frank Dumanior	2009	Mike Graul
2010	Bob Wegner	2011	Jim Schuelke	2012	Scott Singleton
2013	Tad Smith	2014	Paul Schatz	2015	Glenn Bear
2016	Fred Hilterman and Amy Rhodes	2017	Tommie Rape	2018	Dennis Yanchak

It is interesting to note that Amy, Tommie and Dennis have been and will be serving as President and President-Elect for the overlapping fiscal year of 2017. 2017 is the 70th year of the GSH. It just goes to show that the GSH is strong and enduring and all of those who volunteer their time, energy, and expertise to the GSH keeps the GSH going and going. So while things do change, it is obvious that the GSH really isn't changing.....it is like the Energizer Bunny.....it keeps on going and going. It is something that I feel we all should be very proud of.



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 Charles Angerman
 Christian Strand
 Dan Maguire
 David Shope
 Donald Koglin, Jr.
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 Julianne Schneider
 Ken Smith
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 Maria Carla Diaz
 Mark Roberts
 Marty Davis
 Mehmet Mataracioglu
 Michael Clark
 Nebojsa Pralica
 Norm Pedersen
 Peter Aaron
 Philip Schearer
 Ratnanabha Sain
 Rebecca Boon
 Rob Holt
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 Sneha Biswas
 Steve McIntosh
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 Timothy Watson
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Thank You to our Volunteers

As the fiscal year of 2016-2017 comes to a close, I would like to reach out to all of our GSH volunteers and provide a huge THANK YOU for all your effort, time, and dedication this year. Without you as volunteers, the GSH, Newsletter, Journal and the GSH hosted events would not have been successful. We are blessed that so many of you offer your time and energy to support the GSH and the Geoscience Center. Without you, we wouldn't be where we are today. On behalf of the entire GSH Board of Directors, members, sponsors and supporters, I wanted to personally thank you very much for all that you have done this past year. We hope that you have a great summer break.

Best Regards,
 David Watts
 Editor

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GSH Outreach

Committee Activities - by Lisa Buckner, Ashok K. Ghosh and Art Ross



Huw James



James Cowell

Hargrave High School in Huffman, TX invited GSH to participate their Career and College Expo on April 6, 2017. Outreach volunteers Art Ross and Ashok Ghosh hosted the GSH career exhibit booth. Booths were located indoors on the Hargrave HS basketball court, which was big enough to house about 60 tables by various entities that were offering career choices ranging from Air Force and Marine Recruiters, Hair cutting and styling, Office management skills, Modeling, fashion design, accounting, etc. The GSH table was third from the first row near the entrance and there were groups of students that stopped by to take a look at the geophones, seismic sections, paper records, etc. In addition, we gave away 150 coiled toy springs with the GSH logo and webpage address and

also the 'Earth is Calling' brochures. We also explained to the students our the role of Geosciences in general and Geophysics in particular for finding the 'petroleum' and many other valuable natural resources hidden deep underneath the earth's surface.

The high school was very accommodating. They served the exhibitors a mid-morning snack and at noon time a box lunch from Jason's Deli and offered cold drinks all through the morning. The students' interest was quite high and different groups were rotated through to avoid overcrowding. The High School principal was very appreciative and personally thanked all the exhibitors upon our arrival and departure and offered help from the students to carry out our supplies.

Art Ross wrote: I believe we were able to generate interest in both Geophysics and Geology and we both felt it was a very worth-while effort.

On Saturday, April 22 James Cowell, Huw James and Lisa Buckner hosted a career exhibit booth at the annual HISD 'When I Grow Up Career Expo' and College Readiness event. There were 95 booths at the admission free event which was open to all HISD students and their families. The younger students played the Drilling for Oil game. We explained geophysics to the older students using a coiled toy spring to demo wave motion and an interpreted seismic section. We also had crude oil samples, one black and the other orange (sulfur). Huw brought some HGS rock samples and water to demo how sandstone and carbonate rock absorb liquids while shale does not. He also amazed people with a floating rock (pumice) since Houstonians are not familiar with lava rocks. He asked people if they ate rocks.



James Cowell speaking to family at 2017 HISD 'When I Grow Up Career Expo'

Outreach continued on page 39.



Lisa Buckner and James Cowell and student.

Then broke off small bits of a halite rock sample from Hockley and had them taste them (salt). He told them tell their friends that their parents make them eat rocks every day!

Enjoy the summer. I may be educating middle school students about geoscience careers at San Jacinto College EnergyVenture Camps and the GSH Geoscience Center plans to host another teacher workshop. I will need volunteers to help at the Earth Science Week event at the Houston Museum of Natural Science on Saturday, October 14 and Energy Day the following Saturday, October 21 at Sam Houston Park (downtown). I will need to delegate more outreach event organization to others. Let me know if you are interested in developing some leadership skills.

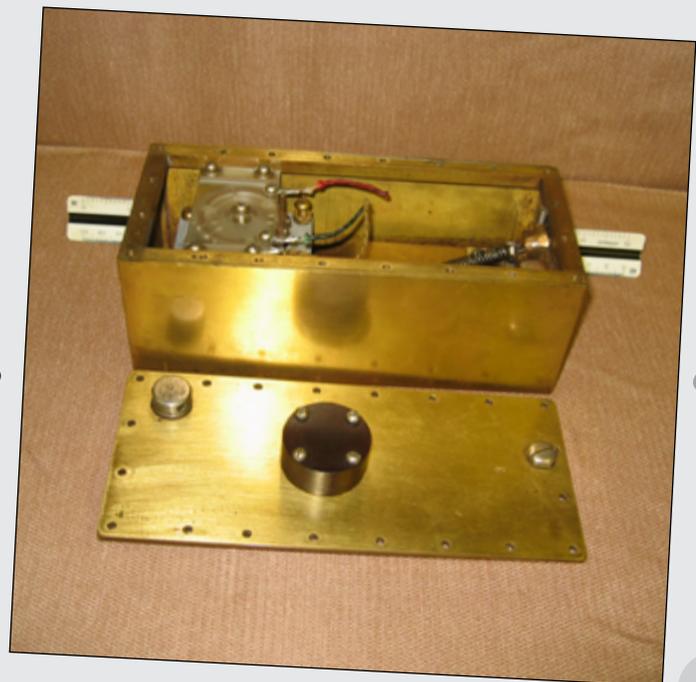
Do you know of a school that has a career day seeking speakers, career fair or science night at which GSH might be able to host an exhibit booth? We can work together to bring awareness to the students of the many high paying and fun careers in the geosciences.

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

Mystery Item

This is a geophysical item...

Do you know what it is?



This month's answer on page 51.

Geoscience Center News

By Bill Gafford

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

We have had a pretty busy year: our inventory of geoscience artifacts is continuously increasing and Bob Sheriff's Library is expanding also.

Our Living Legends Doodlebugger social event on May 11 was again well attended and attracted a few new faces as well. We are always glad to greet first time visitors and give them a tour of our facility. The next such event will be on Thursday August 10.

On May 17, we again hosted an Education and Career Development Event for Unemployed Professionals. Our facility seems to be well suited for meetings or events such as this.

At the recent GSH Spring Symposium, we had a display of some seismic acquisition instruments from our museum collection which supported the theme of the event. The display, which included some old and new seismic acquisition items, is pictured below. In the other picture Gene Womack is shown with a Remote Seismic Recorder unit or RSR, from GP Hyare of Dawson Geophysical Company, who donated the unit to the Geoscience Center. This will add to our collection of cableless seismic recording systems.

The success of the Geoscience Center would not be possible without the dedication of our volunteers. Gene Womack has added greatly to our facility with his woodworking skills and suggestions for organizing our storage area, as well as lending his knowledge of seismic acquisition. Ed Lengel has kept our inventory up to date and helped research some of our more unusual items so that we can understand how they were used in the petroleum industry. This has included geophysical and geological instruments. He has also kept us entertained with stories from his travels around the world while working in many different environments. Our Bob Sheriff Library has been kept very well organized and the inventory kept up to date by Don Townsend and Les Denham, who have kept up with the donations of materials that we get from time to time. They also bring our attention to some of the more significant and interesting books that are donated. Frank Dumanoir has helped put the finishing touches to some of Gene's woodcraft projects and helped gather background information on some of our artifacts. He also has kept us up to date with our audio,



visual and technology needs. George Parker has helped to identify and label some of our artifacts and provided stories of his many years in the seismic industry. We always welcome any new volunteers who may be able to come by and work on any of our list of short term or long term projects.

If you would like to visit the Geoscience Center, and see Mystery Items from the GSH Journal, see some of the items previously mentioned in the Geoscience Center News, or volunteer to help with some of our projects, please contact me at geogaf@hal-pc.org or at 281-370-3264.

U of H Wavelets

Reflections on a Panel Event Hosted by SEG Wavelets

WNC By Claire Ong



On April 7th, 2017, SEG Wavelets WNC hosted a panel discussion with one graduate student, Jingjing Zong, and two professors, Dr. Aibing Li and Dr. Heather Bedle. Dr. Li spoke on the difficulties that professionals can face. Dr. Bedle spoke on transitioning from academia to industry. Ms. Zong spoke on overcoming stress through diet and planning. The topics were aimed at aiding undergraduate and graduate students with important issues and worries concerning academics and going into the industry after graduation.



Overcoming Challenges Professionals Face

A few of the challenges Dr. Li covered included losing passion or becoming too stressed. If you start to become disinterested in your job and may be thinking of switching to a more “challenging” position, it may be due to a lack of stimulation. If you continue studying and updating your knowledge on the new technologies and discoveries, that may continue to fuel your passion.

As for stress, the best solution would be to decrease your load and create a plan. If you need help, such as for house matters, reach out to family rather than taking on the tasks along with all your other present tasks by yourself. Time management can reduce the stress and pressure that these tasks can push onto you. Try to finish one task at a time, rather than a few at the same time. This can help to manage time and deadlines better since it is quite difficult to multi-task, and keeping your mind focused on one task the whole time can both produce better results and save the time that you may take remembering where you left off in between tasks.



Transitioning from Academia to Industry

Dr. Bedle started her talk by going over her background. She worked as an engineer after she received her Bachelor’s degree in Physics and returned to academia to complete a Masters and PhD. As someone who went from educational institutions to industry twice, Dr. Bedle gave advice to the audience regarding such a transition, such as finding a mentor and standing out.

When Dr. Bedle first started working, she found a mentor that could give her pointers. As professionals with more experience and perhaps from the same background, mentors can give advice regarding the industry and adapting.

In a company, there may be hundreds of employees and you may have to work in teams, especially for geoscience. You need to be able to explain what you need to be done in words that can be understood by coworkers that are not familiar with your field. You can garner positive attention by interpreting and comprehending what your coworkers need you to do, even if at first it is not familiar

Wavelets continued on page 42.

Wavelets continued from page 41.

to you, and translating your own part to your coworkers from another field in a way that is fully understandable without losing meaning.



The Keys to Overcoming Stress

The last speaker was Ms. Zong, who spoke on stress and overcoming it. As a graduate student, as well as an undergraduate student, there are times when you can find yourself awake at 2am trying to make a deadline. The stress and pressure that you undergo in the meantime can cause you to have a lack of sleep and bad eating habits. For an overall healthier and happier lifestyle, you need to combat stress with improved exercise, diet, and conversation with others in the same position as you.

Although many deadlines can be close together, a timetable can help to better organize how much time you need to finish everything with minimum stress. This timetable should include time for exercise and adequate time for sleep. Exercise can help to clear one's mind and to alleviate overall lethargy. Three to five exercise sessions a week and 30 minutes to an hour a day would be sufficient and will show fast results in both body and mind health.

However, if you do not change your diet your body will still be under stress and you will still feel lethargic. A balanced diet is key. If you are not used to three meals a day, you can have multiple small meals or nutritious snacks throughout the day to fill your body's requirements.

Talking to others that are in the same situation as you can also relieve the stress that you have internally kept. You can converse about how you are handling your situation and see how others are handling their own situations. This will allow you to openly speak about your worries and burdens in a sharing of thoughts, and try the methods that others are practicing.

Afterthoughts

Although there was no time for discussion on these topics afterward, the audience left with a better understanding regarding how to adapt to working in the industry, how to overcome common challenges, and how to combat stress. SEG Wavelets WNC is looking forward to more successful events that are useful to the students at the University of Houston.



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GSH / HGS 17th ANNUAL SALTWATER TOURNAMENT

Friday, October 6, 2017

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This year's Saltwater Fishing Tournament will include an Offshore Division. We are looking forward to a big event this fall and we encourage full family participation.

Galveston Bay Complex Division

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

Galveston Offshore Division

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

REGISTRATION OPTIONS

- **Registration** fee of \$75 includes: Launch Fee, GSH Fishing Cap, Seafood Dinner after weigh-in, Refreshments, Trophies, and Door Prizes.
- **Registration on a Guided Boat** for 4 hours in the morning or mid-day is \$200. Bait & tackle is included. Check with the GSH Office, 281-741-1624, for times and availability.
- Non-fishing friends and family enjoy a **Seafood Dinner** for \$20

For more information, please contact:

Bobby Perez (GSH)	832-554-4301	Office	281-787-2106	Cell
	832-554-4315	Direct	281-495-8695	Home

E-mail addresses: rdphtx@gmail.com or rperez@seimaxtech.com

GSH / HGS SALTWATER TOURNAMENT

CLICK HERE
to go to the Event Page
for more information and
to download a
Registration Form.

The Geophysical Society of Houston and the Houston Geological Society are non-profit and not-for-profit organizations serving the Geosciences Community. Corporate and individual contributions are appreciated and will be acknowledged on several sponsor boards and banners at the Weigh-In Station and Marina. All contributors will be recognized in the GSH Journal following the tournament. This is a great way to entertain friends, family, business associates, and clients. So spread the word!

GSH Golf Tournament

By Dennis Sump, 2nd VP Geophysical Society of Houston

On April 17th we held the annual GSH golf tournament at the prestigious Walden golf club in Conroe. We had a full field of 140 players on a beautiful day with great food, drinks and lots of fun. This was a new venue for the tournament and everybody enjoyed the change and especially the fried chicken at dinner. In addition to the breakfast tacos, we also had Bloody Marys and cigars for the participants and many door prizes for the lucky winners. With the help of all our participants and generous sponsors we were able to raise over \$12,000 to benefit the GSH Programs and Outreach.

We could not have done this without the hard work of Kathy Sanvido and Karen Blakeman in the GSH office. A special thank you goes out to all the volunteers and the volunteer coordinator Denise Dorsey, and Wes Tyrell, our tournament chairperson.

WINNERS

1st Place Low Net

Dennis Sump
Dennis Clark
Jason Clark
Jay Peyton

2nd Place Low Net

Jason Marshall
Alex Obvinsteve
Mike Albertson
James Small

3rd Place Low Net

Kelly Bentley
Tom Shakleton
Pat Donais
Ben Workman

1st Place Low Gross

Bill Skinner
Jim Ward
Hector Sepulveda
Scott Koza

Long Drive

Russ Neuschaefer

Closest to the Pin

Garrett Sprott

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Diamonds in the Rough

Finally it was refreshing to see such a fabulous turnout and response from our generous sponsors. It is an indication of a great turn around in our business!

Golf Tournament continued on page 45.





2017 GSH Annual Golf Tournament

Thanks to our sponsors for a successful event!

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Silver Sponsor



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In-Kind Sponsor

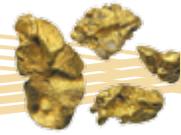






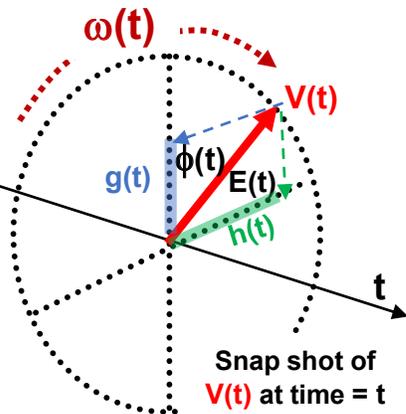




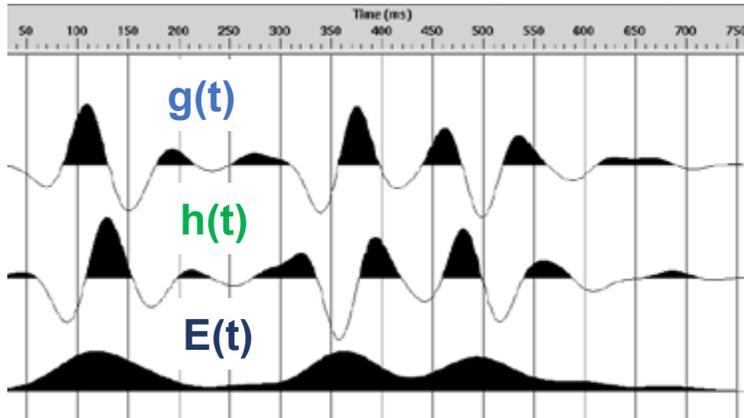



Seismic Attributes to Contemplate over the Long, Hot Summer

During the deep freezes and heavy snows of February in Houston, The Guru began his learned discussion of trace attributes with the concept of the Vector Trace, $V(t)$. We learned that this noble and complex player rotated continuously at a speed of $\omega(t)$, where $\omega = 2\pi \cdot f$ rad/s (or $360 \cdot f$ deg/s for English speaking geophysicists). A multi-tasking wonder, this vector also manages to change its length, $E(t)$, as it moves, carefree, down the timeline, t , of life. The projection of $V(t)$ onto the vertical (“real”) axis gives us $g(t)$, the familiar, everyday seismic trace.



Not so familiar or mundane is the projection of $V(t)$ onto the horizontal (“imaginary”) axis, forming yet another trace, $h(t)$, the **Hilbert Transform**. This guy looks amazingly like a regular citizen trace, and, in fact, is nothing more than $g(t)$ with a -90° phase rotation.

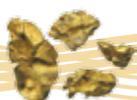
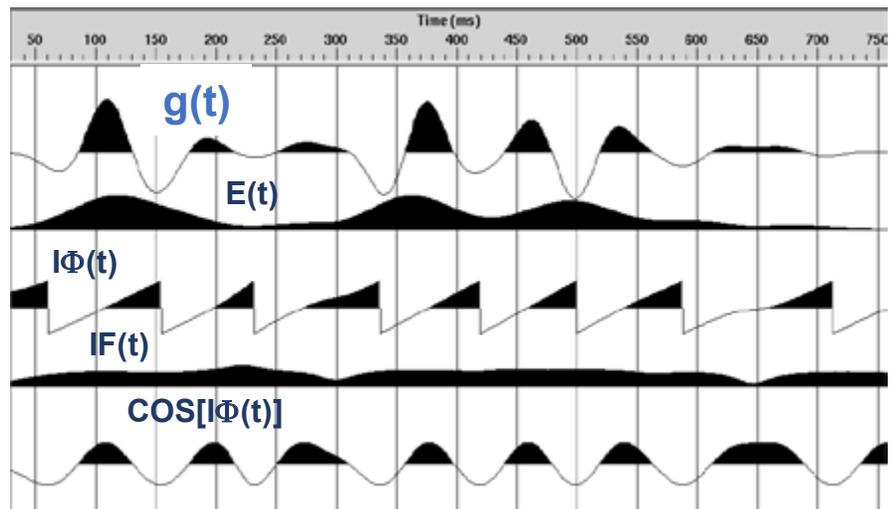


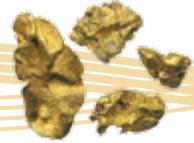
At the left, we see the ever popular and classic trace, $g(t)$, from just outside Wibaux, MT. Below, we see $h(t)$, the Hilbert Transform (a look alike except for a -90° (C) phase rotation). At the bottom is $E(t)$, the envelope or Reflection Strength. It has been computed by,

$$E(t) = \sqrt{g(t)^2 + h(t)^2} .$$

Note that this results from the vector resolution of $g(t)$ and $h(t)$.

Pictured at the right are 3 of the attributes discussed above [$g(t)$, $E(t)$, and $I\Phi(t)$]. We have added an “I” at the front of the phase angle to emphasize that it is the **Instantaneous Phase** of $V(t)$, not to be confused with $\phi(f)$, the Fourier term specifying the phase shift of the frequency f . There are two new traces shown, the Instantaneous Frequency, $IF(t)$, and the $COS[I\Phi(t)]$.





A few observations about these traces (previous page). First note the peculiar nature of the $I\Phi$ curve. This is called a “wrapped” phase plot. It goes from -180 to $+180^\circ$ (C), then drops back to -180° and starts again. This is only a plotting convenience – so we don’t have to plot **I**Phase on Jumbo Rolls of toilet paper. In actuality, the phase angle, $I\Phi(t)$, grows larger *continuously* without any abrupt reversals, as depicted in most phase plots. The process of obtaining such a curve is called “unwrapping” the phase. It can be done for both $I\Phi(t)$ and $\phi(f)$.

By invoking the unwrapping process, it makes the next observation easier to swallow. The fourth plot on the multi-attribute diagram, $IF(t)$, is related to $I\Phi(t)$ by describing the rate at which the vector is spinning, which is the angular velocity, $\omega(t) = 2\pi f(t)$. Analogous to **distance = (linear velocity)·(time)**, **angle = (angular velocity)(time)**. The rate of change of either distance or angle is given by taking its derivative with respect to time:

$$I\Phi(t) = 2\pi \cdot IF(t) \cdot t$$

$$\frac{d[I\Phi(t)]}{dt} = 2\pi \cdot IF(t)$$


$$IF(t) = \left(\frac{1}{2\pi} \right) \frac{dI\Phi(t)}{dt}$$

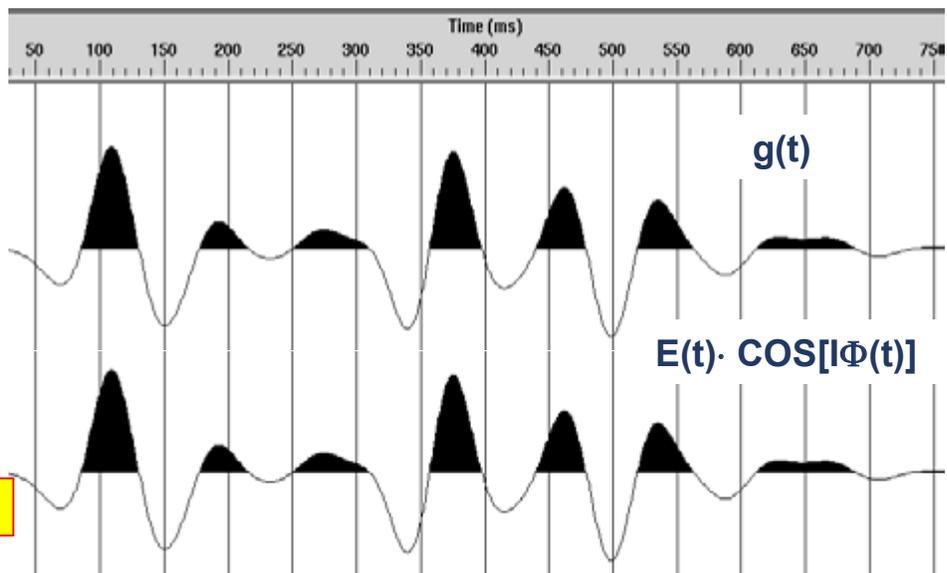
Like the envelope, the Instantaneous Frequency is a positive smooth function. Later, once your security clearance has been verified, you will be allowed to discover what properties of rocks would influence this interesting attribute. Stay tuned this Fall.

Now one more intriguing and fascinating tidbit before we retire for the Summer filled with frolic and contemplation.

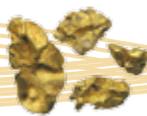
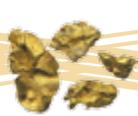
Gaze upon the vector diagram on the previous page and realize that the $g(t)$ may be described geometrically as

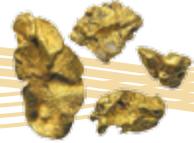
$$g(t) = E(t) \cdot \text{COS}[I\Phi(t)]$$

This was the motivation for introducing the 5th curve on the diagram.



Closing The Loop on The Trace Attributes





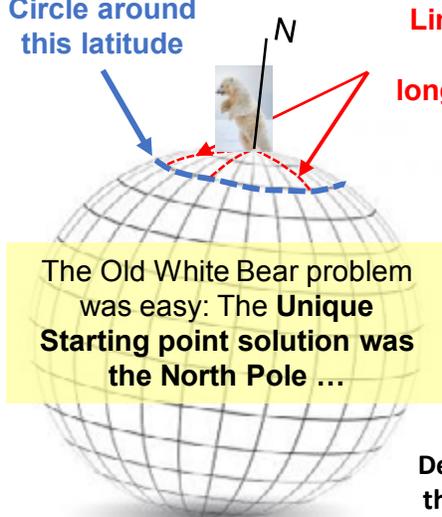
In the May Nuggets, this geographic wonder was presented:

An old brain teaser asks, "If you walk a mile south, then a mile east, followed by a mile north, end up where you started, and shoot a bear; what color is the bear?" Did you ever wonder why it was necessary to have a bear in the problem? Just to be cute, maybe? Or is there a more profound meaning, such as uniqueness? **Incidentally, where did you start?**

Consider the PETA version of the Puzzle: Same path distances and directions (1 mile S, 1 mile E, 1 mile N, end up at starting point), you meet and make friends with a walking bird. What color is the bird? **Does the bird or its color make the answer unique?**

The GSH Geographical Survey and Odd Facts Team has been dispatched to determine the answer. Can you beat them to it? **If it's not unique, name a few points on the earth where this could happen, so as to prove its non-uniqueness.** Good luck, and don't get lost.

Circle around this latitude



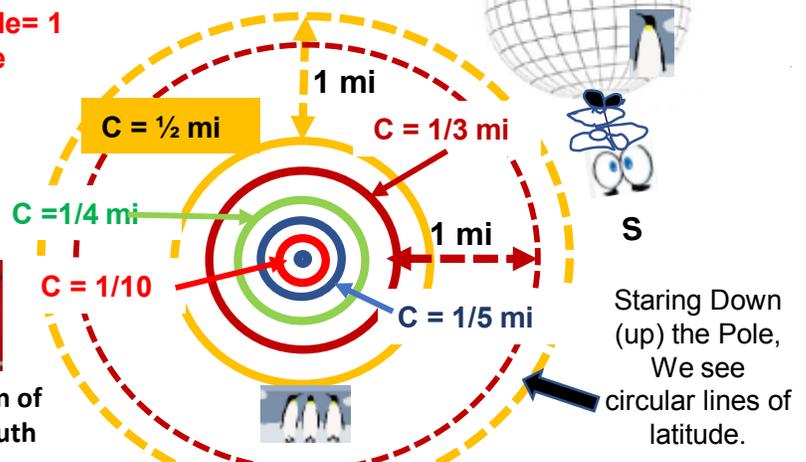
The Old White Bear problem was easy: The **Unique Starting point solution** was the North Pole ...

Line along any longitude = 1 mile



Denizen of the South

...But for the May Puzzle, let's view life from the South Pole



Staring Down (up) the Pole, We see circular lines of latitude.

When the problem includes a **bear**, it has a unique answer (the **North Pole**). Excluding a **bear**, but throwing in a **bird**, now expands the answer to an **infinity** of points around the South Pole. Consider an infinity of circles of latitude each of which has a circumference, C , of $1/N$ mi, where N is an **integer** ≥ 1 . $C = 1, 1/2, 1/3, 1/4, \dots$ In the limit, a very, very small circle at the South Pole. On any of these circles, if you walk a mile east, you'll end up where you started. This means the answer for your **original starting point** is **1 mile north** of this point.

Examples: Start any place on the yellow or maroon dashed lines, walk a mile south to the yellow or red solid circles, respectively. The walking a mile east on either, followed by a stroll north, for a mile, will put you back where you started. **QED.**

Now for your **Summer Puzzle:** The ages of Jane and Mary, when added together, make 60 years. Now Jane is twice as old as Mary was when Jane was half as old as Mary will be when Mary is five times as old as Jane was when Jane was five times as old as Mary. How old, then, is Jane? [Clue: Ages are integers.]



GSH Premier Event

“Education & Development for Unemployed Professionals”

By Fernando E. Ziegler



The GSH recently hosted a second event focused on developing unemployed professionals, continuing on the momentum from our first event. The event took place on May 17, 2017 at the GSH Geoscience Center at 1790 W. Sam Houston Parkway North.

As previously stated by Whitney Harris, chair of the Career Directions & Progressions group: “the target audiences were those looking to gain knowledge in geotechnical and personal development for upcoming career opportunities”.

Guest speakers for this event included Dr. Rob Stewart, Cullen Chair in Exploration Geophysics and Director of the Allied Geophysical Lab at the University of Houston and Paul Murray, geophysical consultant at FIP Geophysical Services and author of a series of articles in our journal over the past many months.

The event began and ended with some time for networking. Guests began the afternoon with a bit of meeting and networking with fellow professionals. To those who have never visited the GSH Geoscience Center, it also gave them an opportunity to see geophysical artifacts in its museum collection. After the talks, guests were able to continue networking, exchange ideas, discuss some of the lessons learned from their own experiences and discuss what the information gathered from the evening’s talks.

The first talk, presented by Dr. Rob Stewart, first focused on current industry trends which have affected all geoscientists; starting with how the price of oil has affected the current workforce, followed by numbers showing participation of



geoscientists at industry events, and looking at current hiring trends observed by various types of newly-graduated university students. The second half of his presentation focused on current research at the University of Houston, expanding a bit onto current programs available for those seeking to further their education.



Career Directions & Progressions continued on page 50.



The second talk, presented by Paul Murray, was derived from an excellent series of articles, *Geoscientists without Jobs: A Guide to Surviving the Downturn*, written for the GSH Journal from September 2016 to April 2017. The talk focused on his perspective on job searching and consulting, with an emphasis on networking. The talk began with an overview of Paul's first year as an unemployed professional, the trials and tribulations he encountered the first year, and how he has managed to become a geophysical consultant with various projects. The latter part of the talk focused on being able to increase

your visibility as a professional by creating goals for networking, using "intelligence gathering" to one's advantage, and achieving this goals by stepping outside of your comfort zone in an intelligent way. The series of articles can be found in previous issues of the GSH Journal, or on his website at: <http://www.fipgeophysical.com/exterra-blog/>

We appreciate the sponsorship of effdee Consulting for this event and we look forward to having members join us at the next unemployed professionals event.



Daniel C. Huston
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Mystery Item

The Mystery Item for the June GSHJ is
single arm, oil damped geophone..

Mystery Item on page 39.

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INTEGRITY

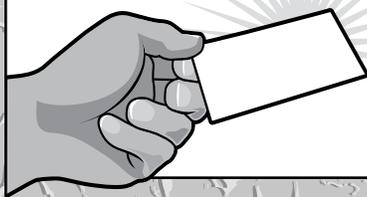
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Jerome L. Coggins
Principal Geophysicist

Katy, Texas USA
281-717-4011
JLC@CogginsGeosciences.com




Sue Pritchett
Business Development Manager

D +1 713 914 0300 - Ext 219 • C +1 281 451 6522
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Katherine Pittman
Vice President of Sales & Marketing

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Tony LaPierre
Technical Director
Seismic Operations
and Site Investigations

411 N. Sam Houston Parkway E.
Suite 400
Houston, Texas 77060, USA

T +1 281 448 6188
F +1 281 448 6189
D +1 713 482 3945
M +1 281 733 5281

E Tony.Lapierre@rpsgroup.com
W rpsgroup.com



Frank Dumanoir
Business Development Consultant

Z-Terra Inc.
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Nicola Maitland
Client Training & Support Manager

431 Mason Park, Suite B
Katy, Texas 77450

Cell: 281-507-6552
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Brian G. Adams
Business Development Manager

281-497-8440
Direct: 281-249-5031
Fax: 281-558-8096
Cell: 832-221-6546

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E-mail: twood@bgrdc.com

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DAVE WILLIAMS
VICE PRESIDENT OF BUSINESS DEVELOPMENT

PHONE: 713-532-5006 10111 RICHMOND AVENUE, SUITE 230
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Robert D. Perez
Senior Marketing Representative

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rperez@seimaxtech.com



Bill Thomas
BUSINESS DEVELOPMENT
MANAGER
M +1 281 804 9435
E billt@dug.com

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Houston, Texas
77024, USA

James C. Jackson
President

GeoTomo

15995 N. Barkers Landing Rd, Suite 110
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Office: 281-597-1429
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james.jackson@geotomo.com
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bill.barkhouse@gmail.com
713.360.9775

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BUSINESS DEVELOPMENT MANAGER

10311 Westpark Dr.
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1001 Euclid Street, Houston, TX 77009-7136

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B.Sc. Geology & Geophysics, Hon.

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Charles S. Knobloch
Attorney at Law
Regional Patent Attorney
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CKNOBLOCH@ARNOLDKSLAW.COM
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JOHN ASMA
Sales Account Executive

T +1 832 327 5400
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john.asma@cegal.com

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Marketing Representative

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President

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Geophysical Technology Inc.

Sean Siegfried
Global Sales Manager

800 Mulberry Lane
Bellaire, TX 77401
Office: 713.893.5655 x104
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Elias Mendoza
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Ryan Marshall
Marketing Representative

DAWSON GEOPHYSICAL COMPANY
10333 Richmond Ave., Suite 800
Houston, Texas 77042
Telephone 713/917-6772
Cell 713/962-9414
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Mark Walker
VP Americas

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Data Management Services

10300 Town Park Drive
Houston, TX 77072
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Alexander Mihai Popovici, Ph.D.
CEO and Chairman

Z-Terra Inc.
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E-mail: mihai@z-terra.com
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Fred Hiltnerman
Chief Scientist
Processing & Integrated
Reservoir Geosciences

1500 CityWest Blvd.
Suite 800
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Dr. Kurt M. Strack
President

KMS Technologies - KJT Enterprises Inc.
11999 Katy Freeway, Suite 200
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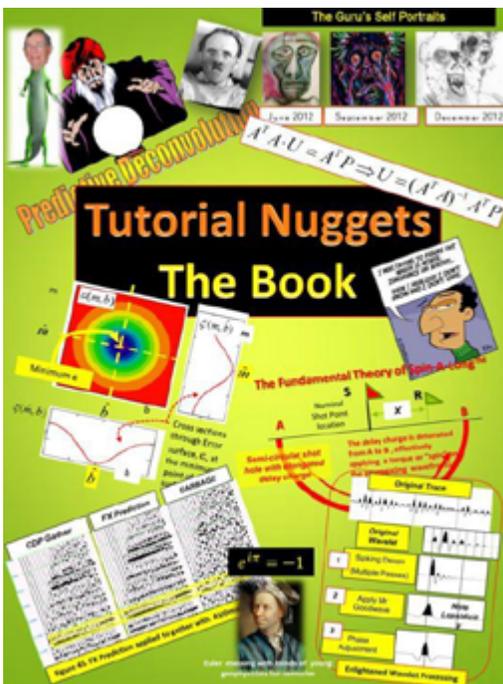


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