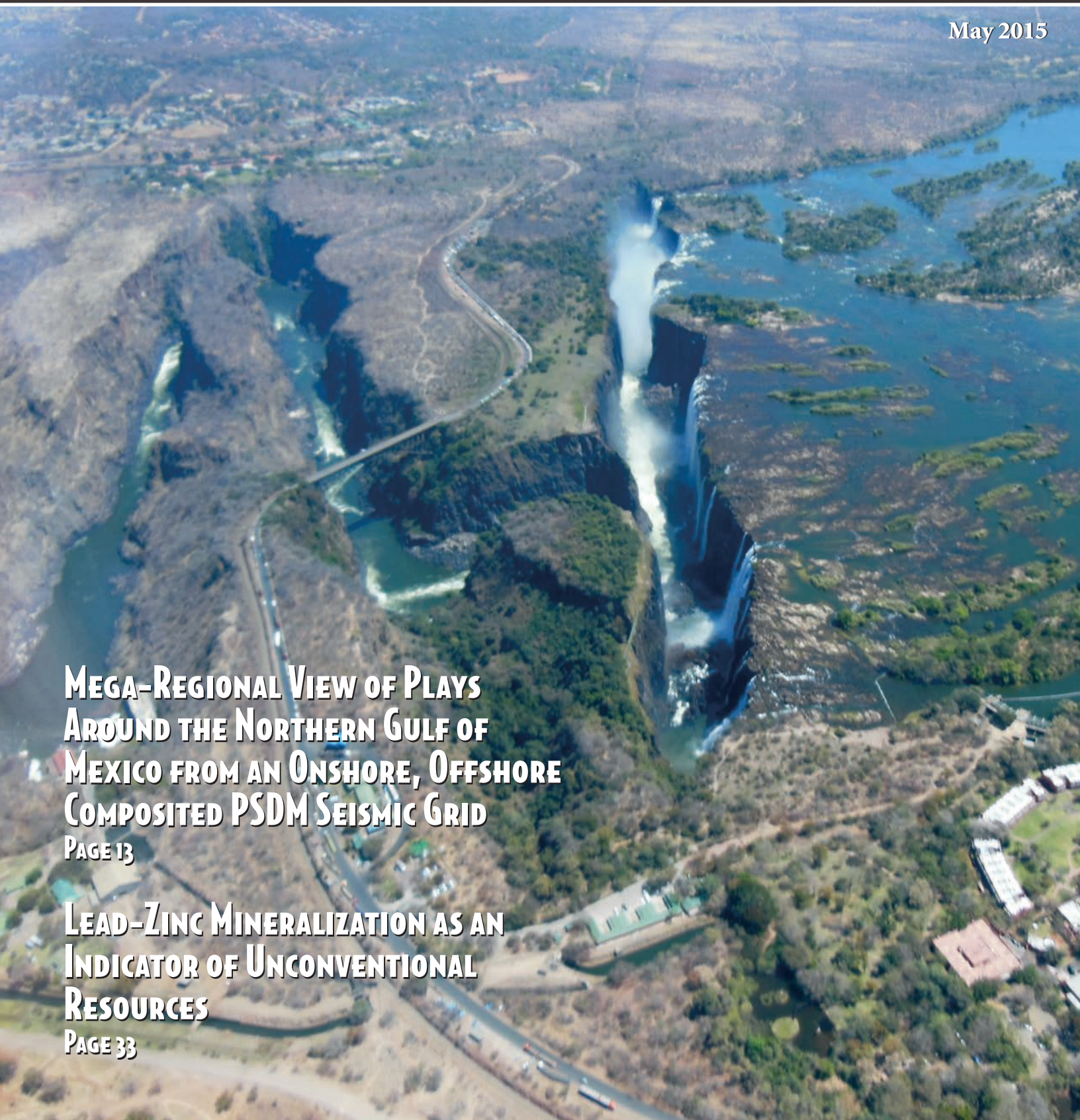
HGS Bulletin
Houston Geological Society
Volume 57, Number 9
May 2015



Mega-Regional View of Plays Around the Northern Gulf of Mexico from an Onshore, Offshore Composited PSDM Seismic Grid

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Lead-Zinc Mineralization as an Indicator of Unconventional Resources

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SEE THE ENERGY

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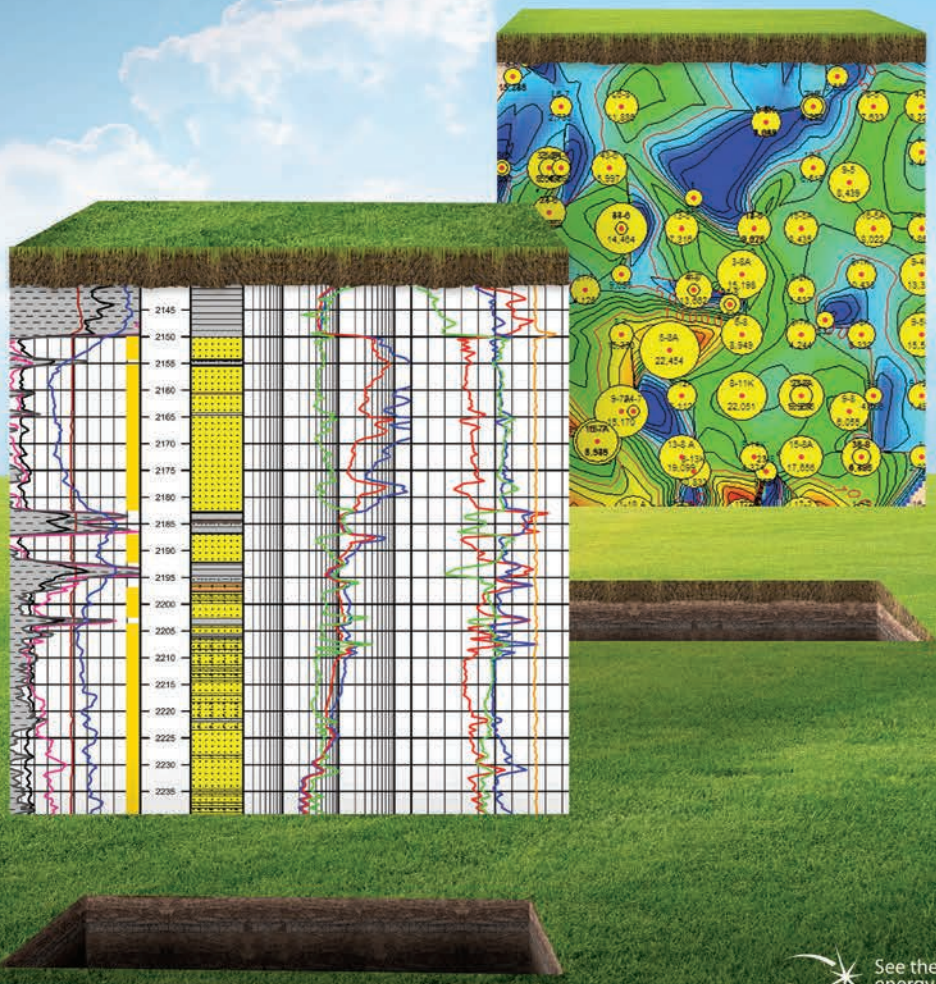

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The Bulletin
Houston Geological Society

Volume 57, Number 9 May 2015

In Every Issue

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Technical Meetings

Other Features

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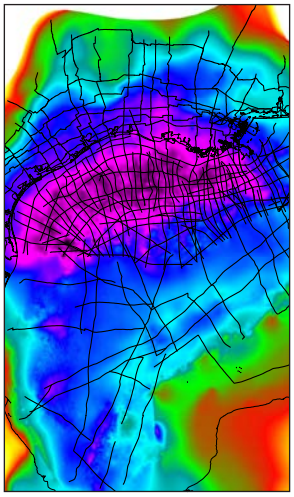

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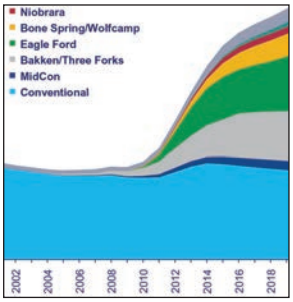

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About the Cover: Victoria Falls in southern Africa on the Zambezi River at the border of Zambia and Zimbabwe. The Zambezi River flows into eroded fractures or joints in massive basalt flows forming one of the largest water falls on earth, over 300 feet vertical height. Earlier falls eroded some of the down-river meanders. Photo by Jeff Lund

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Museum of Natural Science	Inda Immega	713-661-3494	immega@swbell.net	D2
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Nominations	Barry J. Katz	832-854-6989	BarryKatz@chevron.com	P
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The Houston Geological Society Continuing Education Committee Presents

Resume Review and Interview Advice Seminar

Speaker: Elizabeth Nelson, ConocoPhillips U.S. Experienced Hire Recruiting Team
May 12, 2015

The Resume Doctor is IN

Whether you are a mid-level professional back in the job market or a fresh grad, everyone could use a refresher on how to write a resume that gets noticed, and tips for when you are selected for the interview.

In this half-day seminar we will cover composing the Resume and Cover Letter, Interview Dos and Don'ts, and Dressing for Success; plus a review of typical interview questions. Afterwards we will have one-on-one sessions with recruiting professionals who will review your resume personally and offer advice. Registrants should bring TWO (2), double-spaced copies of their current resume for review during the one-on-one sessions.

Since the focus of this seminar is experienced members who have found themselves back in the job market, students can register for the waiting list by calling the HGS office: 713-463-9476

Pricing

Pre-Registration closes 11:45 pm, Sunday May 10, 2015.

HGS/GSH Member:	$40.00
Non-Member:	$50.00
Student Member	$25.00

Continental Breakfast, Coffee and Break refreshments are included in the Registration price.

There is room for 45 attendees.

Date: Wednesday, May 12, 2014 • 8 a.m. – 12 noon (Doors open at 7:30 a.m.)

Location: Schlumberger South Dairy Ashford iCenter • 1325 Dairy Ashford Houston Texas 77077 (Just north of Briar Forest Dr.)

Note: PRE-REGISTRANTS ONLY. Due to venue facility security requirements, there will be NO WALK-IN attendees.

Please make your reservations on-line through the Houston Geological Society website www.hgs.org

For more information about this event, contact HGS Office • 713-463-9476 • office @hgs.org

Biographical Sketch

Elizabeth Nelson is currently the Talent Market Advisor for ConocoPhillips U.S. Experienced Hire Recruiting team.

- A former scientist who brings over fourteen years of recruiting and career counseling experience in the technical and scientific arena.
- Specialized focus in recruiting geologists, geophysicists, petrophysicists, reservoir engineers, petroleum engineers and upstream research laboratory personnel.
- National Recruiter of the Years 2007 and 2008 for the scientific arm of Fortune 500 staffing giant, Kelly Services.
- "Resume Doctor" for the AAPG Student Expo.

Joining Elizabeth in the effort to provide attendees with the one-on-one resume review sessions experience will be two dynamic recruiting professionals with the Lucas Group:

Leah Cordoncillo, Senior Partner, Oil & Gas, joined Lucas Group in 2014 as Senior Partner and has more than 13 years of recruiting experience in the oil & gas industry. She specializes in placing top oil & gas professionals in the exploration and production sector throughout Houston, Dallas, Denver, Bakersfield as well as internationally.

Kasia Maartens, Senior Executive Search Consultant, joined Lucas Group in January of 2014; and has been an executive recruiter since 2012, following a previous career as a tradeshow marketing partner. She has a Social Sciences Bachelor's Degree from Baylor University and Master's Degree in Industrial and Organizational Psychology (scientific study of the workplace).

Ken Nemeth
ken.prez.hgs@gmail.com

Presidential Ponderings

It's nearly the end; one more column to ponder after this and much of it usually thanks the numerous members and sponsors who have had an impact on HGS activities throughout the fiscal year. This has led me to review some of my ponderings and look back at whether I was successful or not. Fortunately, the momentum of HGS is such that I didn't break anything, although there was a lot of bending.

It didn't take long in my term to realize that my hopes and plans were subject to employer demands, family obligations, and hours in a day. You really get an appreciation for what long-serving HGS members have meant to the Society in terms of effort, sacrifice, service, and success. As these members age, HGS really needs our young professionals to step up and learn from them before they "retire" from HGS. In that regard my term was not as successful as I had hoped it to be. HGS has some young professionals stepping up for local office as well as AAPG delegates. It is not the numbers that I had hoped for, but I appreciate those young members who have stepped forward to participate in HGS activities.

Unfortunately, our educational outreach efforts have fallen off. We have been without chairpersons for several committees and thus our programs have suffered. At a time when STEM programs are receiving more attention, HGS has not been able to contribute as it has in the past because of the dearth of volunteers. HGS has maps (some in frames), bones, and other materials that are waiting to be distributed through the Maps in Schools and Bones in Schools programs. Since SIPES is also active in these endeavors, perhaps our members are participating in these programs through that organization. As I have mentioned in other ponderings, if you have an inclination towards service in education, consider participating on or chairing one of these committees: Academic Liaison, Educational Outreach, Earth Science Week, or Science and Engineering Fair. Some of these committees do have chairpersons, but more members are always welcome.

Two popular social events have also fallen by the wayside. The Shrimp Peel Committee has lacked a leader for several years. The Tennis Tournament has not been held for the last two years for lack of an organizer. GSH is going to invite HGS members to play in its tournament next fall.

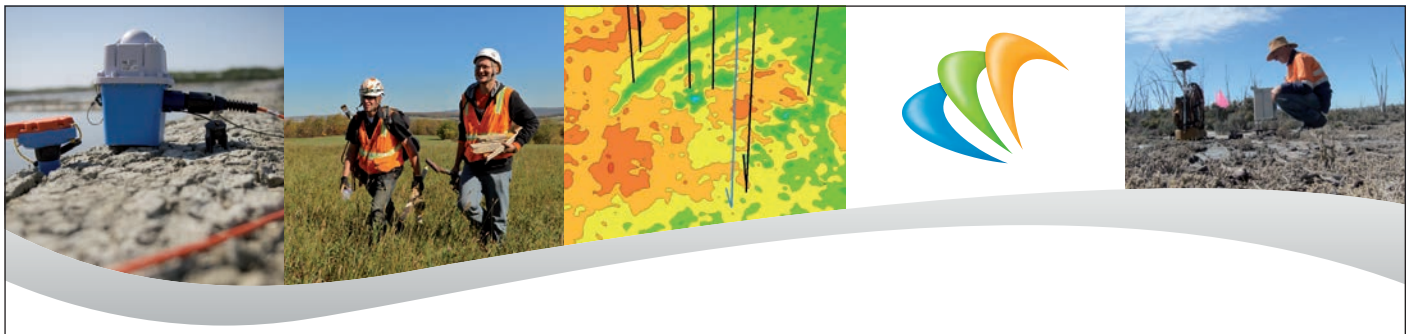
I had great plans for writing columns, but they didn't always work out. Fortunately, some others have succeeded where I did not. I want to mention two articles that stand out for me:

- If Not Me… Who? If Not Now… When?
- Building a Legacy

If you aren't willing to take those steps to be active, there are geologists who will. If you don't do it now, there may not be a when. I urge the employed, the unemployed, and the underemployed to actively participate in the HGS events. I urge you to take advantage of the educational opportunities that HGS provides.

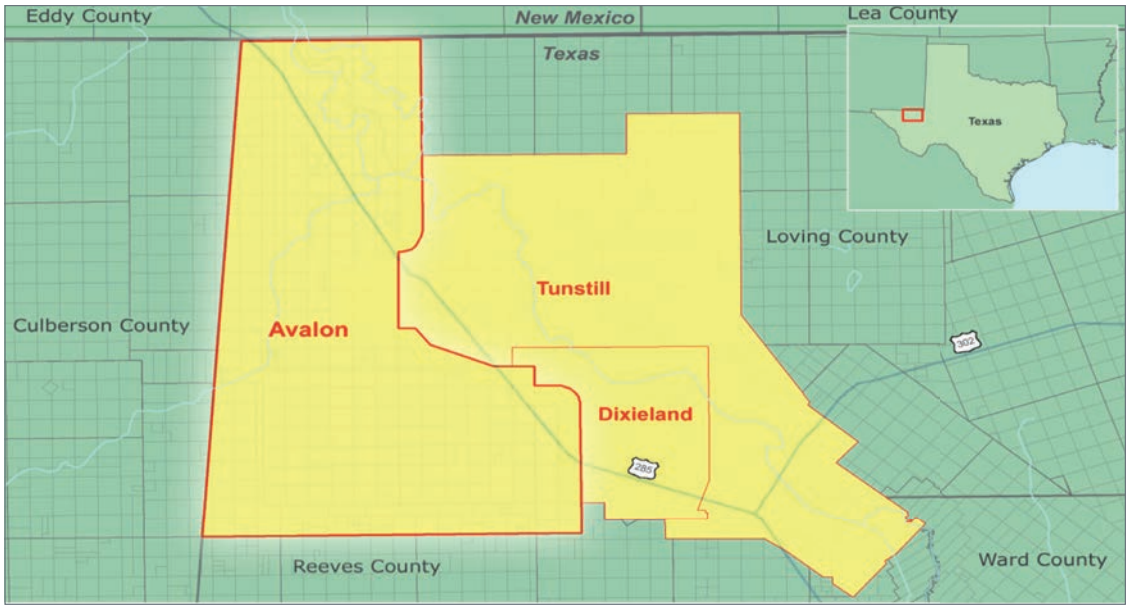
I have written that geologists in Houston should make HGS part of their career development plan. As the uncertainties for many members become realities, this action is more important than ever. Where else can a geologist have the opportunity to mix and mingle with peers if not in local professional organizations (HGS, SIPES, GSH, and SPWLA)? If you aren't willing to take those steps to be active, there are geologists who will. If you don't do it now, there may not be a when. I urge the employed, the unemployed, and the underemployed to actively participate in the HGS events. I urge you to take advantage of the educational opportunities that HGS provides. I urge you to participate in the available educational outreach opportunities that will promote interest in science for our youth of today. Dan Billman, a past AAPG Delegates Voice Secretary/Editor asked those questions in one of his columns in 2013-14. You can read Dan's words here: http://archives.aapg.org/business/hod/2013/10oct/index.cfm.

From the President *continued on page 9*



Avalon 3D Seismic Survey

A new state-of-the-art multi-client solution in the prolific Delaware Basin



Located in one of North America's most prolific basins, the newly acquired 282 square mile high-end 3D seismic survey offers four hundred fold broadband data. Setting a new standard, Avalon will allow better imaging to address the noise and statics challenges in the area.

Targeting the Bone Springs, Wolfcamp and Avalon formations, the complete solution ties the geophysical data to the geology enabling enhanced sweet spot detection and improved hazard avoidance for optimal well placement. The project uses a multi-disciplinary approach comprising advanced imaging, orthorhombic pre-stack time migration, simultaneous inversion, reservoir characterization and **RoqScan**™ mineral evaluation.

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CGG
Passion for Geoscience

Dave Miller
dwmiller.hgs@gmail.com

What is Your Job?

At some point in our careers, we have probably heard someone say "That's not my job" — perhaps we've even said it ourselves. Personally I find it to be one of the most frustrating responses you hear commonly in the workplace. I have been thinking about this a lot lately and would like to offer a few thoughts.

Any organization is composed of recommenders and approvers/deciders. The size of the respective groups is normally a function of the size of the organization and, for very small companies, both roles may be filled by the same person. Each group has certain obligations and responsibilities to fulfill in order for an organization to succeed.

Many of us are in the recommender group. It is our job to provide our best technical input and recommendations to help the deciders make the best choice to create value for our company. We express our technically based opinions and endorsements, based on our skills and experience, in an honest, open and appropriate way and present the basis for our position. If we see something we feel is incorrect, it is our obligation to point it out and explain or demonstrate why we feel that way. The fact that a group of colleagues has, perhaps, arrived at another conclusion does not remove our responsibility to express our concerns. Don't expect these to always be welcomed. Science is not based on popular vote – it wasn't that long ago that "everyone knew" that the Earth was flat and that the Sun revolved around it. Once we have had the opportunity to present our case and have been given a "fair hearing", we then have the commitment to respect the decision made and do our best to implement it efficiently.

We work in an industry that expects us to use our technical and business skills to contribute to the success of our companies. For the most part we are well compensated to do this. Our minds are what make us valuable; and our refusal to use them for the benefit of our employer, even if it is a bit uncomfortable, represents a failure to do our job.

The approvers/deciders also have certain obligations. They make sure all technical viewpoints and arguments are considered and are given a "fair hearing". They are then obliged to make the best decision for the company. In a perfect world, the reasoning behind the decision would be explained to all involved, but often it is not possible and we have to accept this.

We work in an industry that expects us to use our technical and business skills to contribute to the success of our companies. For the most part we are well compensated to do this. Our minds are what make us valuable; and our refusal to use them for the benefit of our employer, even if it is a bit uncomfortable, represents a failure to do our job.

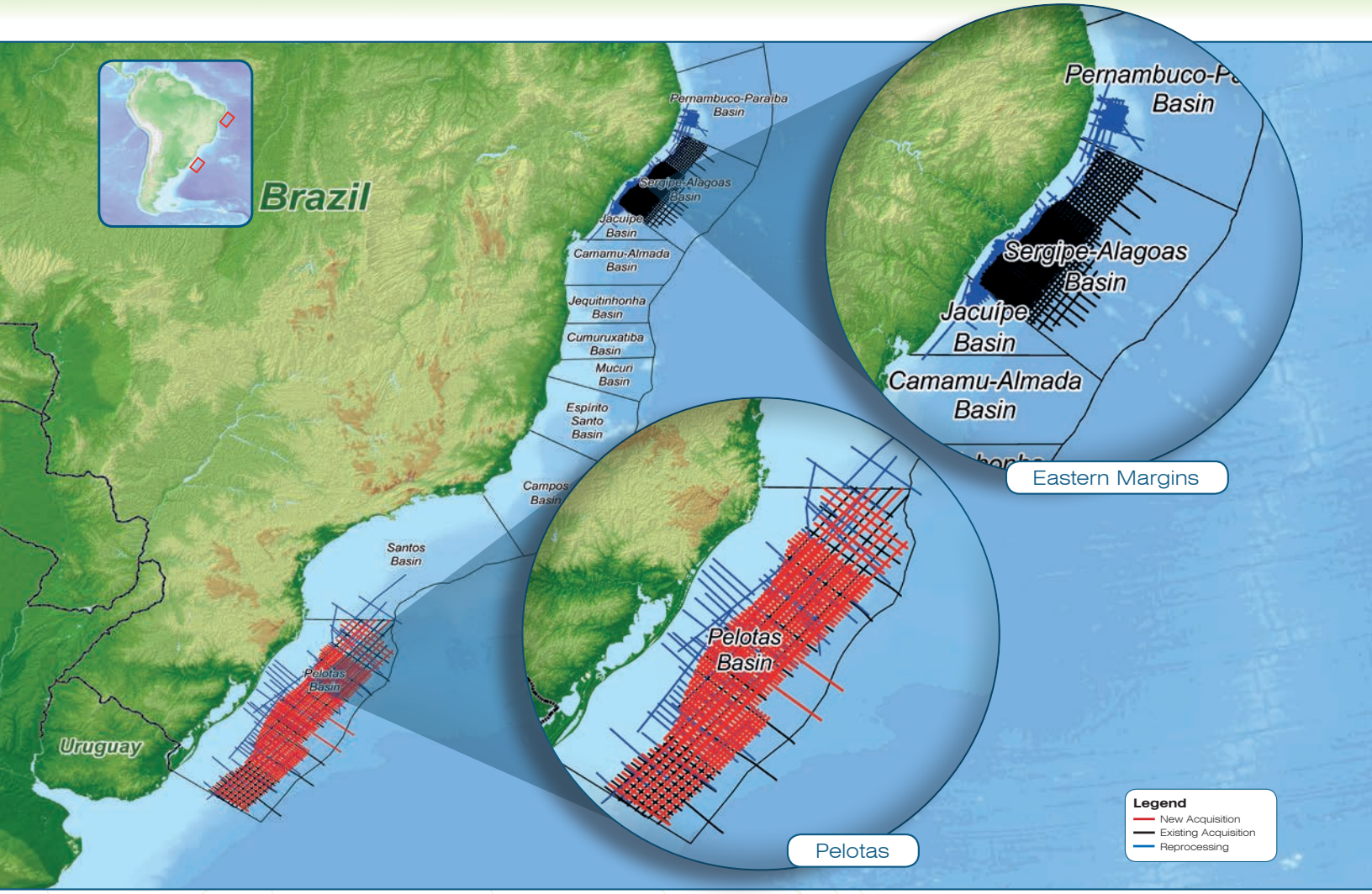
On another note, I came across the following item in a letter to the editor published in a foreign newspaper. It fits in with last month's column. The author of the letter was discussing why it was difficult for some of his fellow citizens to find employment. He proposed a formula which he felt could explain why this was a difficult challenge for some people. His formula is "Success = Attitude x (Skills + Training + Knowledge + …)". Attitude was considered to be binary, with a value of either "0" or "1". Think about this.

This month I have the pleasure of publishing the only unsolicited technical article I received this year. I hope you enjoy Steve Schutter's paper and would like to thank him for submitting this for publication in the HGS *Bulletin*. It would be nice if we received more of these in the future. ■

Until next month, take care.

Brazil: Eastern Margins & Pelotas

Extensive 2D Multi-Client Seismic Data



In anticipation of the 2015 bid round in Brazil, Spectrum offers 45,000 km of seismic data from the Pelotas Basin in the south and the Jacuipe, Sergipe-Alagoas and Pernambuco Basins along the eastern margin of Brazil. Of the 45,000 km, approximately 23,000 km of long offset data was acquired in 2013/2014 and approximately 22,000 km was reprocessed during the same time period. All lines will have both time and depth products, and the Sergipe 2014 new acquisition will have additional broadband and AVO products available.

An infill seismic survey for the Pelotas Basin is expected to commence in Q1 2015.

+1 281 647 0602
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Spectrum

From the President continued from page 5

Building a legacy is something we all want to do, even if only subconsciously. The world recognizes many people for different things, and talks of their legacies. HGS has had many members leave a professional legacy as geologists, scientists, entrepreneurs, and leaders (in industry and professional societies). HGS recognizes professional society legacies through its annual awards. These people have served as mentors in their companies and in the HGS. They have been educators and people of influence. As my term comes to an end, I ponder what my legacy will be, not only what I will have left to HGS, but also what I will have done with my work and in other organizations. I hope that I have served the HGS membership well as your President this fiscal year. The Society has enjoyed a prosperous year, has transitioned to new staff, and continues to serve its members through its programs. As the flat highway of 2014 becomes the roller coaster of 2015, there will be opportunities for older members to help younger members and for younger members to help older members. What will your legacy be? If you want to have some words to ponder, log onto the HGS website and visit the September 2013 *Bulletin* to read Past President Katz's column.

May brings the HGS membership two events. The Geomechanics Conference will take place on May 18th through the efforts of that committee and Vice President John Jordan. It will be a one-day event and registration assistance is available for unemployed members. You need to register through the HGS office for those details. The week before the conference, the Continuing Education Committee will host a half-day seminar on resume writing. *The Resume Doctor is IN* is the working title for a presentation that will be made by Elizabeth A. Nelson. This event will be held at the Schlumberger South Dairy Ashford iCenter.

May is also election month. HGS elects its new Board members this month. I encourage you to vote online or by mailed ballot as soon as you can. Our best election turnout was 16%. I hope we can do better than that this year. By the time you read this, AAPG will have conducted the HGS election for three House of Delegates positions. We have seven candidates; the four not elected will serve as alternates. Information about the candidates was published in the April *Bulletin*.

I began my term citing the HGS Vision, Mission, and Slogan. I can report that the Society is staying true to its vision, especially now. I believe that HGS is the essential organization serving earth science professionals in the Houston community. HGS is working on its mission. This is something that requires additional volunteers and an active membership to succeed. HGS continues to provide earth science enrichment through technical education, networking opportunities, and community service. There is more that can be done for community service. I ask the HGS members to participate actively on those committees. Lastly, there is no question that we are a local society with a global reach. I have seen membership applications from students and professionals living in several foreign countries this past year.

The June *Bulletin* honors our awardees for this year. The Earth Science Fair winners (HMNS Interns) as well as a Teacher of the Year will be recognized at Guest Night. I encourage you to sign up for this popular event.

I have pondered enough for this month. It has been an honor to serve HGS as your President. ■

Applied Geoscience Conference

May 18th, 2015

Geomechanics in Unconventionals

Please join us for the Houston Geological Society's premier one day technical conference, focusing on geomechanical integration and advancement in the assessment of unconventional reservoirs.

The program will highlight field examples of geomechanical workflows, with sessions focusing on Unconventional Geology & Geophysics, and Integrated Workflows & Engineering Design.

AM Session 1: Geological Mechanics of Unconventionals
AM Session 2: Geophysical Geomechanics
PM Session 1: Engineering Geomechanics
PM Session 2: Value of Integration

May 19, 2015: Core Laboratories Rock Mechanics Technical Tour (9 am – 11am, tour limited to 25 people)

Registration Open!

Registration Fees	
HGS Member	$350
Non HGS Member	$395
For those that wish to attend but are experiencing financial hardship as a result of current industry trends please contact Andrea Peoples for further information.	

If you would like to be considered for a non-commercial technical poster presentation please contact Andrea Peoples at HGS.

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945 GESSNER ROAD • HOUSTON, TX 77024

For more information please visit: www.hgs.org or contact Andrea Peoples: andrea@hgs.org

Applied Geoscience Conference

May 18, 2015

Preliminary Oral Presentations – Monday, May 18, 2015

7:00	**Registration and Coffee**	
8:00 - 8:10	Welcome and Opening Remarks	
	Session 1: Geological Mechanics of Unconventionals	
8:10 - 8:45	Geomechanical Modeling of Hydraulic Fracturing: Importance of Mechanical Stratigraphy, Stress State, and Pre-Existing Structures	**Kevin Smart,** *Southwest Research Institute*
8:45 - 9:20	Geomechanical Characterization of Unconventional Plays from Static and Dynamic Measurements.	**Malleswar Yenugu,** *Ikon Sciences*
9:20 - 9:55	Impact of Heterogeneity and Anisotropy on Mechanical Properties and Stresses	**Munir Aldin,** *Metarock*
9:55 - 10:25	**Coffee, Posters, Exhibits**	
	Session 2: Geophysical Geomechanics	
10:25 - 11:00	Acoustics Based Geomechanics – The Opportunities and Pitfalls	**Tom Bratton,** *Independent*
11:00 - 11:35	Integrating Seismic & Microseismic to Understand Fault and Fracture Activity in Unconventional and Fractured Reservoirs	**Ross Peebles,** *Global Geophysical Services*
11:35 - 1:00	**Lunch, Posters, Exhibits**	
	Session 3: Engineering Geomechanics	
1:00 - 1:35	Well Spacing, Fracture Spacing, Sequencing and Fluid Selection in Pad Fracturing of Horizontal Wells	**Mukul Sharma,** *The University of Texas at Austin*
1:35 - 2:10	Targeted Fracing and Refracing – A Discrete Fracture Network Geomechanical and Dynamic Simulation Approach to Reservoir Stimulation Alternatives	**Bill Dershowitz,** *Golder Associates*
2:10 - 2:45	Geomechanics Impact on Shale Reservoir Re-Fracturing	**Ibraham Abou-Sayed,** *i-Stimulation Solutions*
2:45 - 3:15	**Coffee, Posters, Exhibits**	
	Session 4: Value of Integration	
3:15 - 3:50	Horizontal Hydraulic Fractures in Laminated Source Rocks?: Observation and Indicators	**George Walters,** *Schlumberger*
3:50 - 4:25	3-D Integrated Workflow for Understanding the Fracture Interference and Its Impact into the Gas Production of the Woodford Shale	**Eva Paza,** *Devon*
4:25 - 5:00	Realizing the Full Potential of Geomechanics by Adding Geophysics and Geology: Completion Optimization Using a Field Validated 3G Workflow	**Ahmed Ouenes,** *FracGeo*
5:00 - 7:00	**Social Hour –** *Fourth Floor Atrium* **Poster Presentations by Invited Graduate Students**	

Tuesday, May 19, 2015

9 am – 11am Core Laboratories Rock Mechanics Technical Tour
(tour limited to 25 people)

Applied Geoscience Conference

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May 18th, 2015

Geomechanics in Unconventionals

Please join us for the Houston Geological Society's premier one day technical conference, focusing on geomechanical integration and advancement in the assessment of unconventional reservoirs.

The program will highlight field examples of geomechanical workflows, with sessions focusing on:

AM Session 1: Geological Mechanics of Unconventionals
AM Session 2: Geophysical Geomechanics
PM Session 1: Engineering Geomechanics
PM Session 2: Value of Integration

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Monday, May 11, 2015

Westchase Hilton • 9999 Westheimer

Social Hour 5:30–6:30 p.m.
Dinner 6:30–7:30 p.m.

Cost: $45 Preregistered members; $50 non-members/walk-ups

To guarantee a seat, pre-register on the HGS website & pre-pay by credit card.
Pre-registration without payment will not be accepted.
Walk-ups may pay at the door if extra seats are available.

Barbara J. Radovich
ION Geophysical Inc., Houston, TX
Don Howard and Ed Haire
INEXS and ION Geophysical Inc., Houston, TX
Gulce Dinc
ION Geophysical Inc., Houston, TX

Mega-Regional View of Plays Around the Northern Gulf of Mexico from an Onshore, Offshore Composited PSDM Seismic Grid

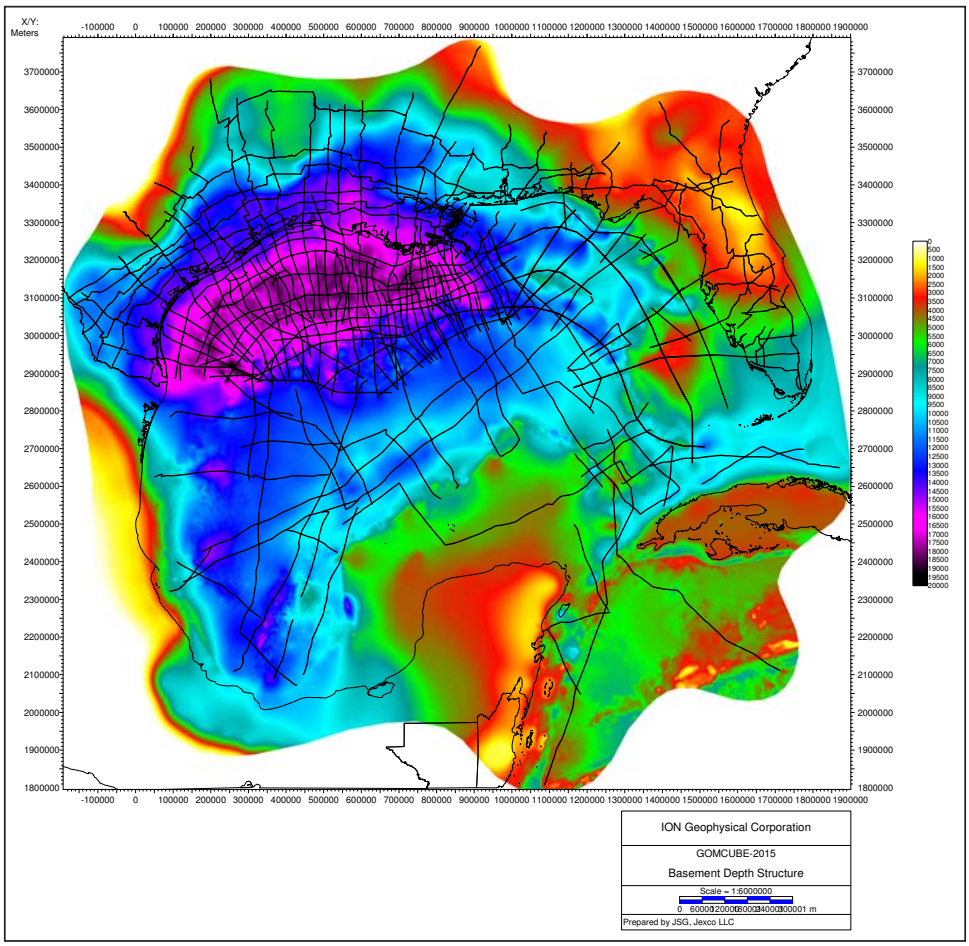
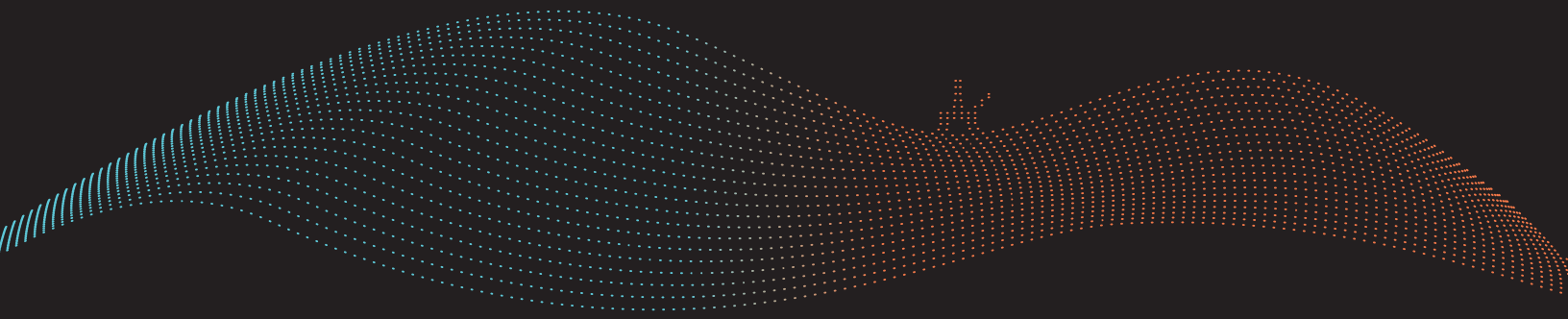


Figure 1. Basement map for Gulf of Mexico from seismic data, bathymetry and mega-regional survey velocity cube. (Courtesy of ION Geophysical, Inc.)

Key onshore to offshore plays across the margin of the northern Gulf of Mexico are investigated on a new and unique mega-regional, PSDM seismic dataset. This, for the first time, illustrates the full scope of play configurations, and offers new approaches for the explorationist. The ION Geophysical dataset is over a decade in the making and is unique, as no other dataset like it exists on any margin in the world today. The seismic data consist of onshore strike and dip lines composited from over 470 segments of legacy onshore data that were reprocessed from field tapes, and seamlessly connect to OBC and offshore long-offset streamer seismic surveys. This grid in turn connects to a newly reprocessed, vintage streamer survey in the southern Gulf of Mexico acquired by the University of Texas from 1974-1984.

HGS General Dinner *continued on page 15*

blueback reservoir
GeoScience Solutions Partner



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AAPG 2015 in Denver, booth #1252

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HGS General Dinner continued from page 13

For the first time, regional maps provide a view of the whole Gulf basin stratigraphy and structure, and basement configuration.

The mega-regional grid illustrates the entire linked extension-to-contraction gravity-driven system, and the resulting salt response that ranged in age from Upper Jurassic through Tertiary. Highlights include an onshore Gulf rim characterized by the foundered Mesozoic margins, trapping significant sediment thicknesses onshore, the development in shelf to deep water of major salt evacuation events of regional extent, including one in Upper Jurassic and one in Early Oligocene, robust Tertiary expansion into extensional features and the resulting formation of the central-eastern and western contractional fold belts in deep water. The fold belts are the site of many discoveries and offer new leads as the folds extend northward under shallow salt canopies. Numerous salt welds are interpreted, often at multiple depth levels, and these offer play ideas including Miocene and older sediments under these welds. The interpretation produces a regional depth map of the Mid-Jurassic unconformity at base Louann Salt. A gradient calculation highlights distinct flexures that separate the historic onshore basins and uplifts. The flexures fan out from southwest to northeast in a pattern consistent with the pull-apart of Africa and Florida, resulting in an improved view of the basement framework that can help guide delineation of deeper plays into the rifted section. There is abundant evidence of old Louann Salt movement in the onshore, offshore and deep water, caused by gravity forces. Onshore growth wedges are numerous in Smackover, Lower Cotton Valley age. Offshore old salt stocks formed in deep water and resulted in thinned Mesozoic section. The stocks were squeezed, salt evacuated and ascended into shallow canopies, and the entrained Mesozoic thinned section has been drilled in supra-salt canopy positions in numerous offshore locations. In deep water, a regional Upper Jurassic/Lower Cretaceous-age salt nappe extruded over layered sediments, fitting in with a more northerly position for the continental/oceanic crustal boundary.

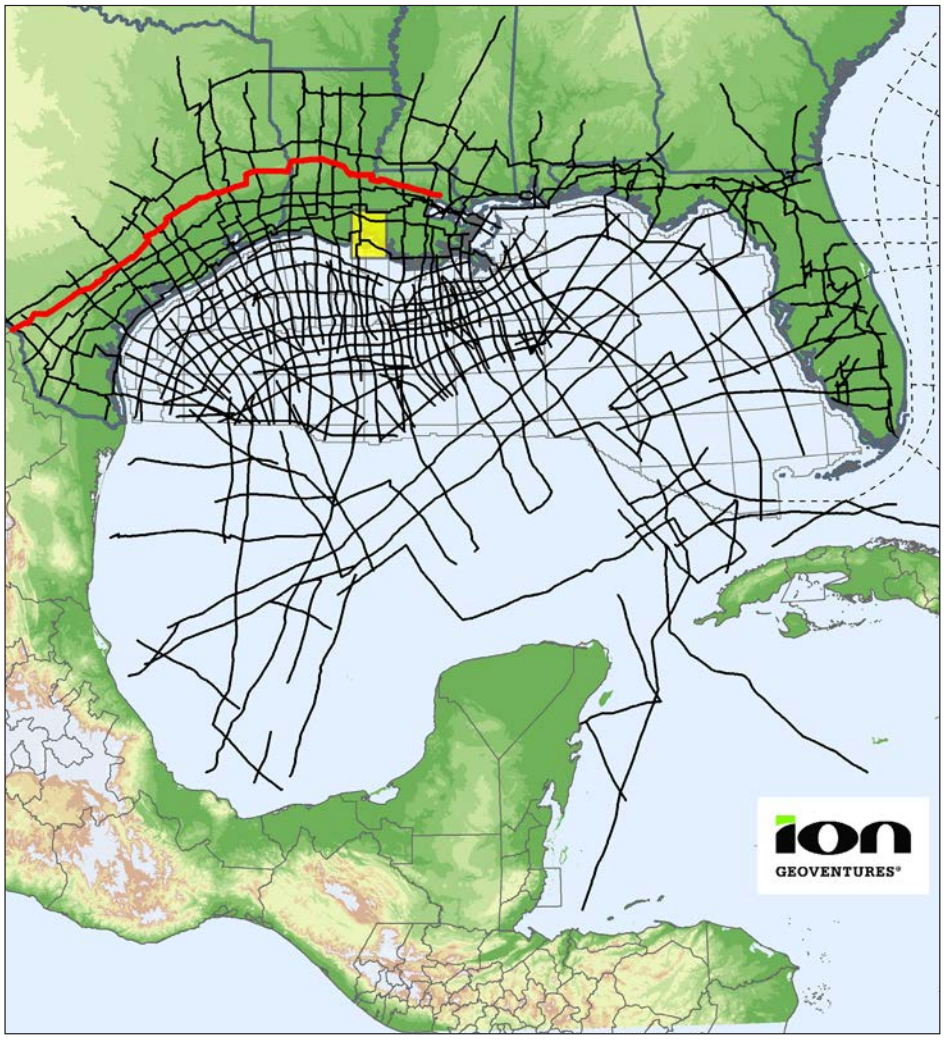

Figure 2. Gulf of Mexico base map of seismic lines for mega-regional seismic survey with key strike composite PSDM seismic line shown highlighted in bold. (Courtesy of ION Geophysical, Inc.)

The widely-spaced onshore seismic grid extends from the updip limit of the Louann Salt to the present-day shoreline, and from the South Texas/Mexico border to the Florida Panhandle. The grid clarifies Mesozoic structuring, the extent of older salt gravity sliding, and paleo-shelf edges in the Cotton Valley. The Mid-to-Upper Jurassic shelf edges are regionally interpreted and assist in reconstruction of the early onshore basins to the Florida shelf. New onshore strike lines show a regional view of the Eagle Ford/Tuscaloosa onlap transgressive wedge and highlight the west-to- east chronostratigraphic relationships. The major foundering of the Mesozoic margins created accommodation space which trapped significant sediment thicknesses onshore, robbing the sediment budget for deposition into deep water. The Cenomanian/Woodbine lowstand edges expanded into the space created by this structuring and formed possible play areas that have been inadequately imaged due to the limited scope of previous datasets. The strike view transecting the foundered margin shows 100-km-

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HGS General Dinner continued from page 15

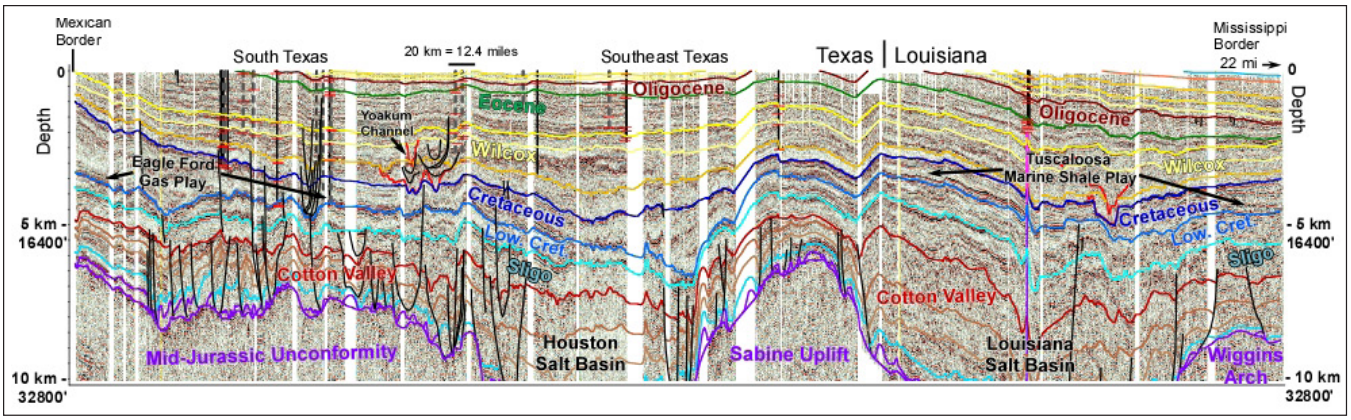

Figure 3. Key strike composite PSDM seismic line showing regional strike view transecting Mesozoic sediments, and highlighting the Eagle Ford and Tuscaloosa wedges. (Courtesy of ION Geophysical, Inc.)

wide fault complexes breaking apart the Mesozoic as the sediment blocks slid basinward on the Louann detachment surface. The mega-regional grid captures the immense size of these features, and provides new insight into Wilcox play opportunities, as these sediments also expanded to fill the complex faulted topography. Nearer to the present-day shoreline, tilted fault blocks involving Wilcox and Mesozoic sediments are numerous under an extensive onshore Eocene to Oligocene allochthonous salt weld and provide prospective leads with overburden thicknesses and drilling depths comparable to the Wilcox deep water fold belt discoveries. Paleocene to Wilcox-age incised canyons occur around the margin and could provide plays against the canyon incisions into older rock. Additional play ideas are proposed as these features formed downdip conduits for lowstand fan sediments. Regional maps of the Wilcox reveal robust Gulf margin fairways in the western and Mexican Gulf, shedding significant thicknesses of these sediments (up to 6 km) into deep water. This Wilcox deluge, however, is confined by the significant barrier to the east from the steeply rising Cretaceous carbonate margins. The Wilcox isopach map shows thinning onto an extensive debris apron that spread out from the Cretaceous shelf; and the Upper to Mid-Wilcox isopach map shows a proportionally greater thickness of sediments trapped onshore, robbing the sediment budget for deposition in deep water. ■

Biographical Sketch

Dr. Radovich has over 37 years of worldwide experience in the interpretation of stratigraphic and structural frameworks using seismic and well log sequence stratigraphy, integrated with modern attribute analysis and risk/reserve evaluations. She has conducted comprehensive assessments of new and emerging deep water exploration areas and given reviews for a prime minister and international energy CEOs. She is a proven oil-finder, having developed new interpretation methods for deep water sheet-form fan reservoirs, leading to major lease acquisition and discoveries in offshore Nigeria for which she received Texaco's highest research award. Recent work includes mega-scale framework interpretation of the Gulf of Mexico, and detailed fan lithofacies delineation and reserve estimation in West Africa. She is a recognized speaker on the integration of 3D seismic attribute and visualization techniques within a framework of sequence stratigraphic architectures, especially in shelf margin to deepwater settings. Her experience covers over 40 areas around the world including West and East Africa, India, South America, Trinidad, Mediterranean, Gulf of Mexico, North Sea and Southeast Asia.

The Houston Geological Society Continuing Education Committee Presents

Resume Review and Interview Advice Seminar

Speaker: Elizabeth Nelson, ConocoPhillips U.S. Experienced Hire Recruiting Team
May 12, 2015

In this half-day seminar we will cover composing the Resume and Cover Letter, Interview Dos and Don'ts, and Dressing for Success; plus a review of typical interview questions. Afterwards we will have one-on-one sessions with recruiting professionals who will review your resume personally and offer advice. **See page 4 for details.**

Wednesday, May 13, 2015

Black Lab Pub, Churchill Room • 4100 Montrose Blvd.
Social 5:30 p.m., Dinner 6:30 p.m.

Cost: $30 Preregistered members; $35 non-members/walk-ups

To guarantee a seat, pre-register on the HGS website & pre-pay by credit card.
Pre-registration without payment will not be accepted.
Walk-ups may pay at the door if extra seats are available.

Amanda E. Miller
Tetra Tech, Inc.

How to Get Product to Market Navigating the Endangered Species Act: A Case Study Using the Lesser Prairie-chicken

One of the challenges facing the petroleum industry is the potential for negative interactions with species protected under the federal Endangered Species Act, and how to successfully avoid, minimize or mitigate the potential effects of development activities. Compounding this challenge is the added pressure of the U.S. Fish and Wildlife Service's deadline of September 2016 by which it must issue final rulings for more than 250 candidate species that are currently under consideration. The resulting issuance of numerous proposed and final rulings has the potential to influence new development, operating assets, and compliance activities across the continental U.S. Using the case study of the lesser prairie-chicken, a newly threatened species found in active areas of development in the southern Great Plains, the presentation will discuss how producers can navigate the process of the Endangered Species Act through agency consultation, field surveys, and appropriate siting measures, resulting in maximized product speed to market. ■

Biographical Sketch

Amanda Miller is a biologist and project manager at Tetra Tech, Inc. with 8 years' experience in energy interactions with wildlife and their habitats. Amanda began her career studying wind energy developments, publishing the first post-construction mortality study on wind energy development in Texas, and has transitioned to petroleum development in recent years, focusing on threatened and endangered species and compliance planning, permitting and implementation. As a biologist, Amanda has experience conducting site evaluation for potential energy developments to determine baseline ecology of sites, including land use/land cover, existing vegetation, fish and wildlife habitat, and occurrence of threatened and endangered species. Amanda utilizes her field experience in representing clients' interests in coordination with state and federal agencies, as well as with non-governmental organizations, in determining the most practical and appropriate pathway to regulatory compliance. Amanda holds a Bachelor of Science degree in Wildlife and Fisheries Management and a Master of Science Degree in Wildlife Science from Texas Tech University.

Monday, May 18, 2015

HGS Joint International and North American Dinner Meeting

Westchase Hilton • 9999 Westheimer
Social Hour 5:30–6:30 p.m.
Dinner 6:30–7:30 p.m.

Cost: $45 Preregistered members; $50 non-members/walk-ups

To guarantee a seat, pre-register on the HGS website & pre-pay by credit card.
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Walk-ups may pay at the door if extra seats are available.

Peter Bartok
University of Houston, Dept. Earth and Atmospheric Sciences
Bartok Inc.
María Carolina Mejía-Hernández and Murad Hasan
University of Houston, Dept. Earth and Atmospheric Sciences

Paleogeographic Constraints on Middle to Late Jurassic Tectonic Reconstruction of the Maya Block of Southern Mexico and Equivalent Strata of Northwestern South America

The paleogeography of the early drift phase along the southern margin of the Gulf of Mexico (Middle to Upper Jurassic) remains problematic. The present study focuses on the relationship between the Maya block of southern Mexico and its Jurassic paleo-neighboring northwestern South America geologic setting. Most published works have relied on paleomagnetic data rather than detailed correlations between the sedimentary rocks of the two regions, their similar age and lineaments of the major Mesozoic rifts. The emphasis of this study is on the Kimmeridgian and Tithonian due to their economic importance. The early rifts of the southern Mexico Maya Block and Guatemala Rubelsanto Trough are most likely related to the Triassic back-arc spreading of central Mexico and genetically related to the back-arc basin of the Magdalena Rift which includes the Cocinas Trough of the Guajira Peninsula, Colombia. As a consequence of the Yucatan rotation during the Early Jurassic the Akal Horst of the Reforma region aligns with the Cocinas Trough, resulting in similar Kimmeridgean paleogeographies for both. Their similar Kimmeridgian ammonites reported by Renz (1960) from the Cocinas Group of the Guajira and the co-eval ammonites of southern Mexico confirm their age equivalence. The role played by the Chiapas Block is discussed and it is considered to have been a later addition to the Maya Block. Previous studies had linked Chiapas to the Maya Block during its Mesozoic translation. The juxtaposition of Chiapas to southern Reforma is most likely post Kimmeridgian and does not appear to have played a role during the late Jurassic depositional setting. The proposed model allows for Kimmeridgian exploration targets to extend beneath the Artesa Mundo Nuevo Platform (southern Reforma Trend) and may be present under more favorable marine conditions in the western part of the Gulf of Venezuela. ■

Biographical Sketch

Peter Bartok is a Petroleum Exploration Consultant with research interests in complex salt tectonics and Regional Gulf of Mexico Tectonics and Williston Basin, as well as in the application of rock physics to exploration. He worked for three years with Pemex in southern Mexico. His experience with BP includes Project Management for Latin America and US Chief Onshore Geologist. He has evaluated prospects in over 40 basins of the world in Latin America, Europe, China and West Africa and was instrumental in defining the exploration technique that led to the discovery of the Pinda carbonates in Angola. Mr. Bartok received his Bachelor's and Master's degrees from the State University of New York. He has worked as a geologist for 20 years and as a geophysicist for another 20 years. Currently he is an Adjunct Professor in Petroleum Geology at the University of Houston, and is an Instructor at Petroskills on Structural Styles, Seismic Interpretation and Development Geology.

Tuesday, May 19, 2015

Hyatt North Houston (former Crowne Plaza Hotel – Greenspoint)
Social 11:15 AM, Luncheon 11:30 AM

Cost: $45 Preregistered members; $50 non-members/walk-ups

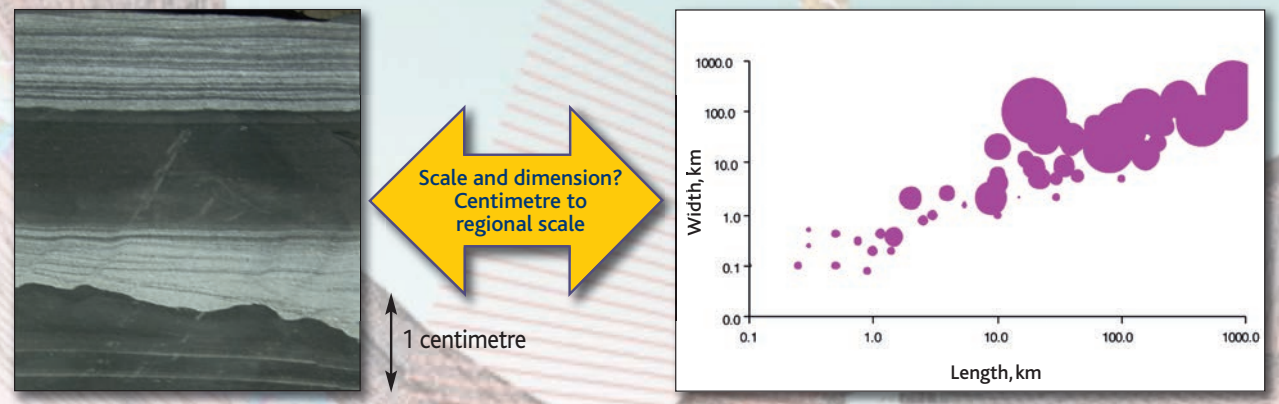
To guarantee a seat, pre-register on the HGS website & pre-pay by credit card.
Pre-registration without payment will not be accepted.
Walk-ups may pay at the door if extra seats are available.

No information available at press time.

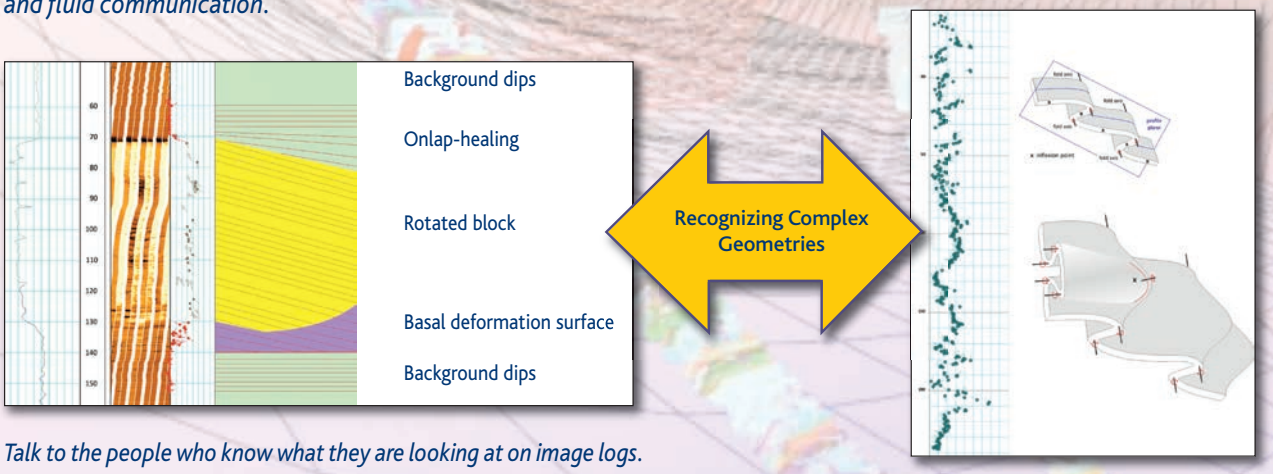
Please check the HGS website (www.hgs.org) for updates.

Getting into **Deep Water**

RECOGNISING MASS TRANSPORT COMPLEXES (MTC) are part and parcel of any exploration or development in continental margin, abrupt margin and submarine canyon plays. Based on hundreds of kilometres of image and cores studies, **TASK FRONTERRA** has determined that at least 12% of deep marine deposits are deformed by creep, failure or rotational slumping. We have conducted numerous studies in the Gulf of Mexico, West Africa, Brazil, West of Shetlands, Nile Delta, Australia: North West Shelf and Malaysia.



Whether you are looking to sequester CO_2 in compartmentalized sediments, or looking at field development strategies – you want to be using the people who can measure and characterize these sediments in terms of geometry, scale, contacts and fluid communication.



Talk to the people who know what they are looking at on image logs.
Talk to the people who have worked on MTC compartmentalization in fields across the globe.

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Wednesday, May 27, 2015

Petroleum Club of Houston • 1201 Louisiana (Total building)
Social Hour 11:30 a.m.
Luncheon 12:00 p.m.

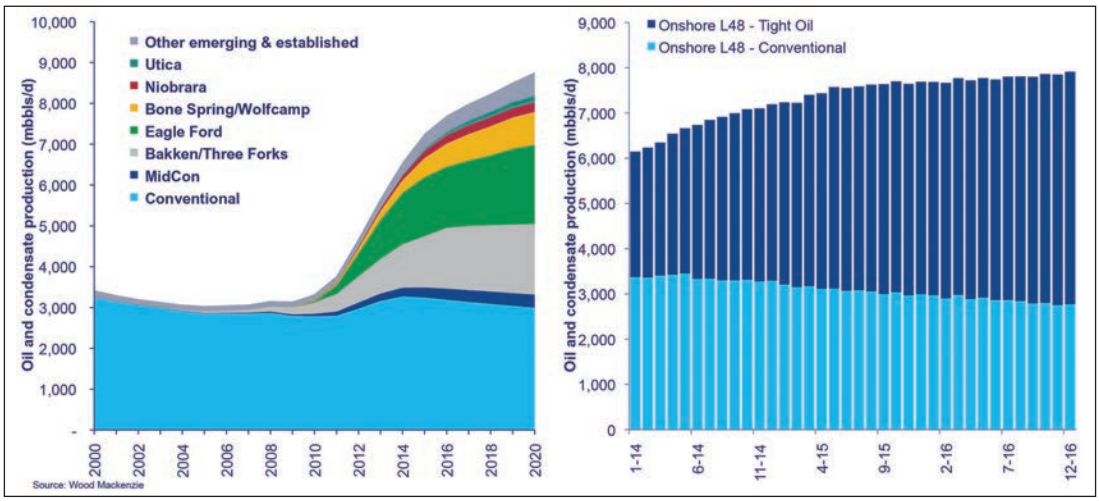
Cost: $45 Preregistered members; $50 non-members/walk-ups

To guarantee a seat, pre-register on the HGS website & pre-pay by credit card.
Pre-registration without payment will not be accepted.
Walk-ups may pay at the door if extra seats are available.

HGS General Luncheon Meeting

Jesse Jones
Wood Mackenzie
jesse.jones@woodmac.com

Oil Prices: Lower 48 Companies and Plays – Break-even Analysis

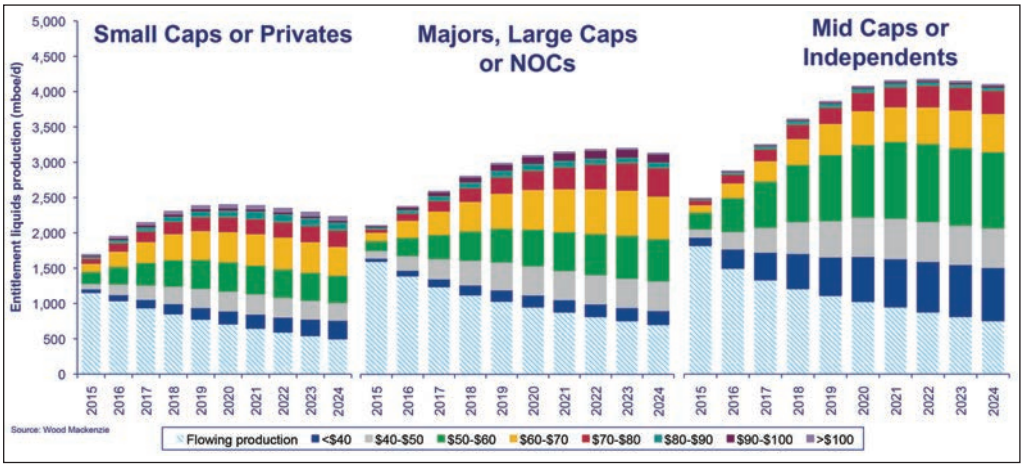


Lower 48 production.

We examined the breakevens of over 800 individual assets in the Lower 48 and see dramatic variations in the viability of company asset bases and sub-plays. Companies with scale and core acreage have the lowest average breakevens, even at a 10% IRR.

Lower 48 oil production will continue to grow in 2015 and 2016. However, the pace of growth will slow considerably starting in the second half of 2015. Tight oil production grew by 1.2 MMbbls/d in 2014, but we expect growth of only 673 mbbls/d in 2015 and 425 mbbls/d in 2016. We forecast tight oil production will reach 7.5 MMbbls/d in 2020.

Three sub-plays (Springer, Karnes Trough and Nesson Anticline) generate at least a 10% IRR at a US$50 flat real WTI price. The 35 remaining oil-weighted sub-plays need an average D&C cost reduction of 30% to be economic at US$50. The most prolific sub-plays (including the Parshall-Sanish and SCOOP Woodford) require the lowest reduction rates.



Lower 48 entitlement liquids supply by break-even

In the Lower 48, North American independents have 20% more of their liquids production break even under US$60 than the majors and NOCs. However, flowing production, important for cash flow, accounts for 75% of the majors' oil production and 83% of their gas production in 2015. In the three marquee

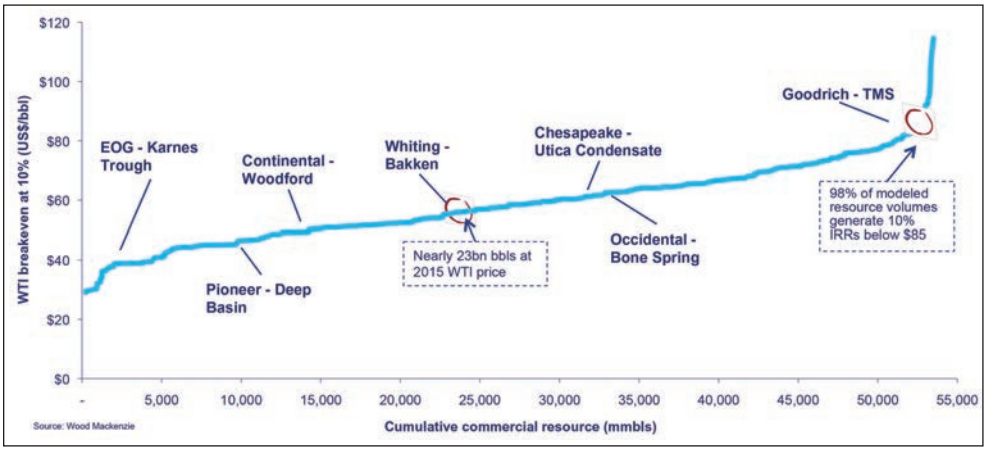
HGS General Luncheon *continued on page 27*

HGS General Luncheon continued from page 25

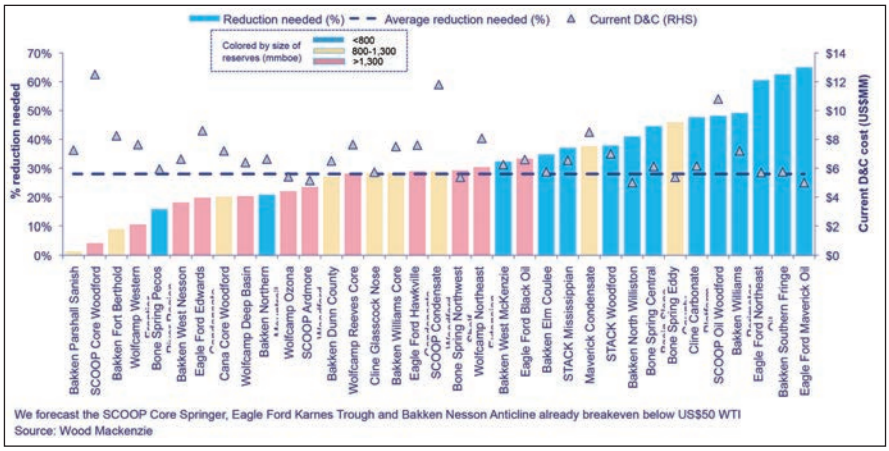
oil plays (the Bakken, Eagle Ford and Wolfcamp) independents dominate remaining resources with 12 Bbbls identified.

Highly levered operators are more likely to have a smaller, narrower resource base, but they do not necessarily hold poorer assets. Several distressed operators hold assets with breakevens below US$60 WTI and US$3.50 HH. Cash flow projections show most operators will be stretched if oil prices drop again.

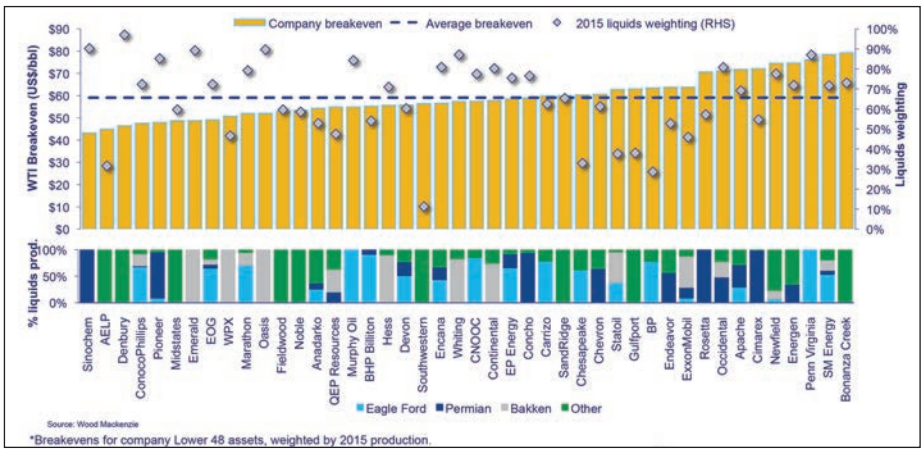
The Lower 48 M&A market will remain depressed until participants approach consensus on the oil price. Activity has declined dramatically, with Q1 2015 spend 85% lower than Q4 2014. We do expect activity to pick up in the second half of 2015 but, given the appetite for the best assets, bargain hunting will be difficult. The early stage Mid-Con (STACK/SCOOP) and Wolfcamp plays may see relatively higher levels of activity, since small caps and independents make up a larger share (93% and 69% respectively) of production. ■



New cumulative liquids resource by breakeven for US assets



Reduction in D&C costs needed to breakeven at US$50 WTI (Q1 2015 cost base)

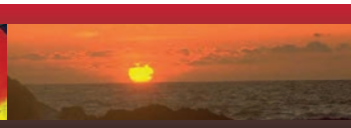


Company weighted average liquids breakevens & portfolio exposure

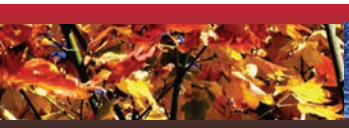
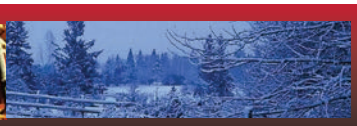
Biographical sketch

Jesse Jones is currently a Research Director on Wood Mackenzie's US Lower 48 Upstream Research team. Prior to this, he worked as the Lead Analyst for the Rocky Mountains, Northeast and West Coast Research team and as an analyst covering the Mid-Continent and Permian regions. Jesse specializes in the analysis of unconventional gas and tight oil plays; and has assisted clients on numerous consulting projects, advising on strategy in L48 unconventionals, competitor benchmarking and asset valuation. Jesse holds a B.S. degree in International Strategic History from West Point and an MBA from Texas A&M University.

May 2015



Sunday	Monday	Tuesday	Wednesday
	Reservations: The HGS prefers that you make your reservations on-line through the HGS website at www.hgs.org. If you have no Internet access, you can e-mail reservations@hgs.org, or call the office at 713-463-9476. **Reservations for HGS meetings must be made or cancelled by the date shown on the HGS Website calendar, normally that is 24 hours before hand or on the last business day before the event.** If you make your reservation on the Website or by email, an email confirmation will be sent to you. If you do not receive a confirmation, check with the Webmaster@hgs.org. Once the meals are ordered and name tags and lists are prepared, no more reservations can be added even if they are sent. **No-shows will be billed.**		
3	4	5 **HGS Board Meeting** *6 p.m.*	6
10	11 **HGS General Dinner Meeting** *"Mega-Regional View of Plays Around the Northern Gulf of Mexico from an Onshore, Offshore Composited PSDM Seismic Grid," Barbara J. Radovich, Page 13*	12 **Continuing Education: Resume Review and Interview Advice Seminar** *"The Resume Doctor is IN," Elizabeth Nelson, ConocoPhillips Page 4*	13 **HGS Environmental & Engineering Dinner Meeting** *"Navigating the Endangered Species Act for Product Speed to Market: A Case Study of the Lesser Prairie-Chicken" Amanda E. Miller, Page 19*
17	18 **Applied Geoscience Conference** *Page 10* **HGS Joint International and North American Dinner Meeting** *Page 21*	19 **HGS Northsiders Luncheon Meeting** *See HGS website (www.hgs.org) for details.*	20
24 31	25	26	27 **HGS General Luncheon Meeting** *"Oil Prices: Lower 48 Companies and Plays – Break-even Analysis" Jesse Jones, Page 25*

GeoEvents

Thursday	Friday	Saturday
Members Pre-registered Prices: Dinner Meetings members..... $45 Emeritus/Honorary members..... $40 Student members..... $10 Nonmembers & walk-ups..... $50 Except - Env. & Eng. ..... $30 Nonmembers & walk-ups..... $35 Emeritus/Honorary members..... $15	1 Don't wait, make your reservations online at ww.hgs.org	2
7	8	9
14	15	16
21	22	23
28	29	30

May 18, 2015
Applied Geoscience Conference – Interdisciplinary Micro to Macro-Scale Geomechanics
Houston, TX

May 31-June 3, 2015
2015 AAPG
Denver, CO

July 20-22, 2015
URTeC 2015
San Antonio Texas

September 13-16, 2015
AAPG/SEG International Conference and Exhibition
Melbourne Australia

September 20-22, 2015
GCAGS Annual Convention
Houston, TX

Explore the Ultra-Deep Ocean
Earth's Last Exploration Frontier

HGS Guest Night
Saturday, June 6, 2015

Houston Museum of Natural Science

Tickets are $50 per person

includes dinner in the HMNS Dinosaur Exhibit
presentation by Dr. Jeff Karson
Giant Screen 3D movie
"Deep Sea Challenge 3D"
directed by James Cameron

Explore the Ultra-Deep Ocean Seafloors of the World Guest Night – June 6, 2015

by Linda Sternbach and Dave Reynolds

What do you know about the Earth's last unexplored frontier? Some scientists say that we know more about nearby planets in the solar system than we know about the ultra-deep world under Earth's oceans. This year's Guest Night will be enlightening, as we learn about deep sea rifts, hydrothermal vents, and unusual rock formations only recently seen by undersea roving vehicles. The HGS welcomes Dr. Jeffrey A. Karson, Earth Science Professor at Syracuse University, as the Guest Night speaker at the Houston Museum of Natural Science, June 6.

Dr. Karson is the lead author of a new book *Discovering the Deep: An Photographic Atlas of the Seafloor and Ocean Crust* just published by Cambridge University Press in May 2015. Jeff Karson has been Chief Scientist and Co-Chief Scientist on multiple deep sea ALVIN DSV-2 missions from 1990-2005. The "ALVIN" is a three person operated deep-ocean research submersible operated by Woods Hole Institute that is accompanied by smaller remote operated vehicles (ROV) which conduct photography and sampling at ocean depths below 10,000 ft. Dr. Karson has been involved with deep ocean research since he was a professor at Duke University 1996-2006, continuing to Syracuse University in New York State, where he was recently Chair of the Earth Sciences Department, until last year.

In March 1999, Jeff Karson took a ride inside ALVIN to 10,800 ft. to investigate oceanic crust exposed in the walls of a Pacific rift called "Hess Deep." In an interview he said, "Hess Deep is especially valuable to science because it slices through a slowly-moving treadmill of recently created crust produced at one of the planet's fastest-spreading mid ocean ridges, the East Pacific Rise. The rift exposes spots where lava up welled only in the last million years, a mere heartbeat on the geological time scale."

An important part of Dr. Karson's research since 2000 has been on the deep water Mid-Atlantic Ridge. While on the submarine Alvin, he took ROV pictures and samples of what scientists have named the "Lost City," in thousands of feet of water. The "Lost City "has towers of calcium carbonate and underwater vents yielding black "smoke" from hot lava extruding into the Mid Atlantic Rift. The vents have yielded evidence of microbial life forms created in the dark depths of the ocean, demonstrating that life can exist in and evolve from chemosynthetic systems, not just photosynthetic ones. These springs host organisms that live under some of the most extreme conditions on Earth. Black smokers, as the springs came to be called, have now been found throughout the mid-ocean ridge spreading system. Since their discovery, the billowing 360°C jets of metal sulfide- and gas-laden fluids were believed to typify submarine hot spring systems. At extreme depths, tubeworms, giant clams, and spider crabs depend on volcanic gases such as carbon dioxide (CO_2) for survival.

Don't miss HGS Guest Night on June 6! It's incredible opportunity see stunning photos of the deep ocean rifts and imagine what it would be like to visit 10,000 feet under the sea. Guest Night will include a dinner buffet in the Morian Hall of Paleontology. What a Night at the Museum! ■

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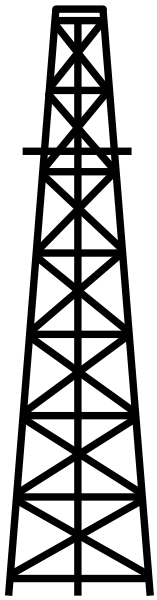

Thursday, June 11, 2015
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Lead-Zinc Mineralization as an Indicator of Unconventional Resources

by Stephen R. Schutter, steveschutter10@gmail.com

If organic-rich mudstones (aka black shales) follow a normal resource distribution, there should be many economically exploitable resources still to be identified; the handful of shales exploited to date may be the most important, but they scarcely constitute the entire population. Thus the challenge to industry is to identify more exploitable resources efficiently. Even in this time of lower oil prices, the economic benefits of more efficient exploration, and being the first to find new resources, should be substantial.

While there are many criteria available for identifying promising areas, one first-pass indicator may be the presence of Mississippi Valley Type (MVT) PbZn deposits, which have associated mature hydrocarbons and typically occur on the margins of sedimentary basins. The mining industry has historically treated the presence of hydrocarbons as a minor issue; the converse concepts of what we can learn about the hydrocarbon system have been ignored. The evidence suggests that various metals, particularly Zn, are widespread in black shales, and are mobilized as the shales undergo burial and maturation. The presence of MVT deposits is not only a direct indicator of a source rock with sufficient volume and maturation to expel hydrocarbons (and thus be a potential unconventional resource), but the details of the deposits can also provide information on basin evolution.

Previously, MVT deposits have been studied from the perspective of the ore bodies, and observations based on data gathered there. Since the emplacement models were subject to debate, the co-occurrence of hydrocarbons was not the focus, and generally it was not considered to be significant.

Organic-rich mudstones (aka black shales) are hydrocarbon source rocks. They are also often enriched in metals, including Ag, Au, Ba, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Re, Se, U, V, Zn and platinum group elements (PGE) (Heckel, 1977; Coveney, 1981, 2003), sometimes to the point of becoming ores. In the past, because the exploitation of conventional migrated hydrocarbons and the mining of ores were so different, the relationship has been largely ignored. In the age of unconventional resources, it may be time to revisit this relationship.

Mississippi Valley Type (MVT) base metal sulfide deposits are characterized by lead and zinc minerals, accompanied by pyrite and often copper, barium minerals and fluorite. They are also marked by the "ubiquitous" presence of hydrocarbons, often heavy oil or bitumen. Much of the mineralization appears to be void-filling (often associated with unconformities and/or karst). Large-scale dissolution and brecciation of host carbonates, precipitation of large volumes of dolomite and calcite cements, and recrystallization of pre-existing dolomite are also characteristic (Gregg and Shelton, 2012). The ore deposits are commonly localized by faults or fractures.

MVT deposits are part of the development of sedimentary basins, and are not clearly related to a crustal (igneous) source for the metals (Macqueen, 1986). They usually occur in small to large deposits in carbonates around the margins of basins, often near the boundary between platform carbonates and basinal shales. They also occur in the earliest phases of rift formation and foreland thrust belts (Anderson and Macqueen, 1988; Evans, 1993). Gregg and Shelton (2012) stated such mineralization is found in sedimentary basins around the world, in rocks ranging in age from Archean to Cenozoic. Carbonate platforms are often strongly dolomitized in the regions where MVT deposits occur; evaporites may be present in the adjacent basins. Black shales are present in the basins and as transgressive/early highstand tongues on the adjacent carbonate platforms.

By some definitions, MVT deposits are confined to carbonates, but metal-rich black shales are clearly linked, especially those that are interbedded with carbonates. The Kupferschiefer of Central Europe is the most extensive metal-rich shale known, and has been mined in enriched zones for centuries. Some classification schemes for ore deposits include it with siliciclastic hosts. However, it has carbonate affinities. It is the transgressive/early highstand deposit associated with the Werra carbonates (the first cycle of the Upper Permian Zechstein), and it unconformably overlies the siliciclastic Upper Carboniferous/Lower Permian Rotliegende. The Kupferschiefer has been described as a dolomitic shale or marl (Maynard, 1983; Leventhal, 1998).

Usually Pb and/or Zn are the mined metals. Most deposits have a high Zn/Pb ratio; Pb-dominated fields are rare. Fluorite and barite may be important byproducts; Cd, Ag, Cu and Ge may also be byproducts. MVT ores typically have high trace amounts of Ni. Individual ore bodies are usually relatively small (generally <10 M t), but ore district totals may be in the 50-500 M t range and be distributed over hundreds of km^2; the Upper Mississippi

Pb-Zn Mineralization *continued on page 35*

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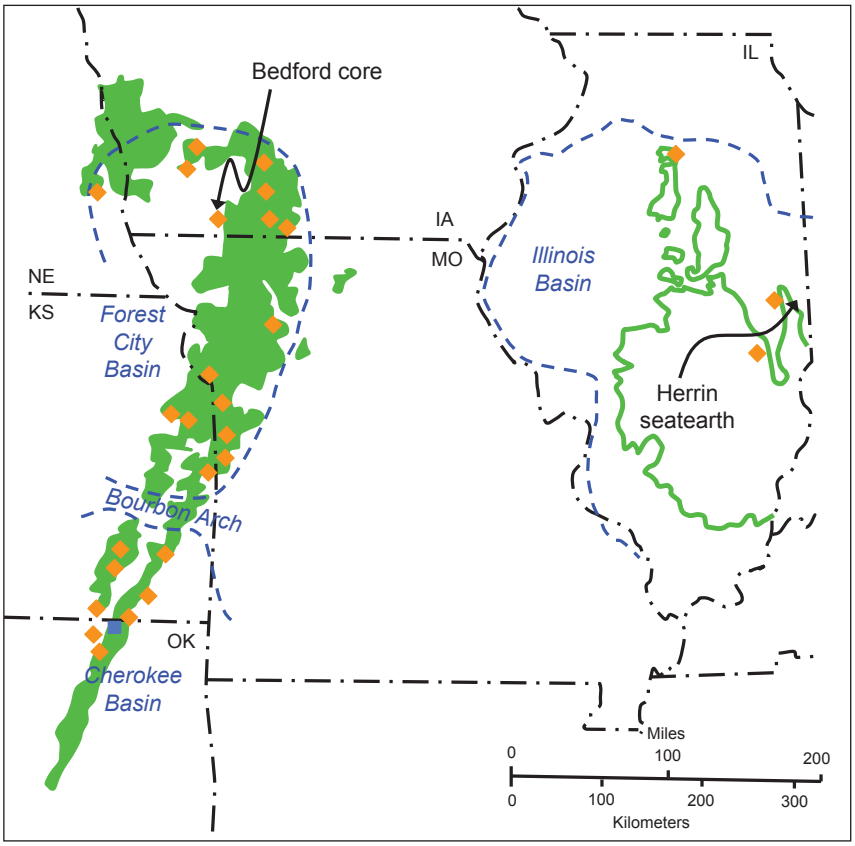

Figure 1. Occurrences of sphalerite and galena in the studied sediments. (sphalerite = orange diamonds; galena = blue square). The green line is the outcrop pattern of the Shoal Creek cyclothem in Illinois; the solid green pattern denotes the Missourian Stage in Nebraska, Iowa, and Missouri; and the Dennis and Stanton cyclothems in Kansas and Oklahoma (from Schutter, 1983, Figure 39). The location of the Bedford core (mentioned in the text) is indicated near the center of the Forest City Basin. The location of the sphalerite-bearing Seatearth limestone is also shown (see Figure 2). Note that the relative sparseness of sphalerite in the Illinois Basin is probably just a sampling artifact.

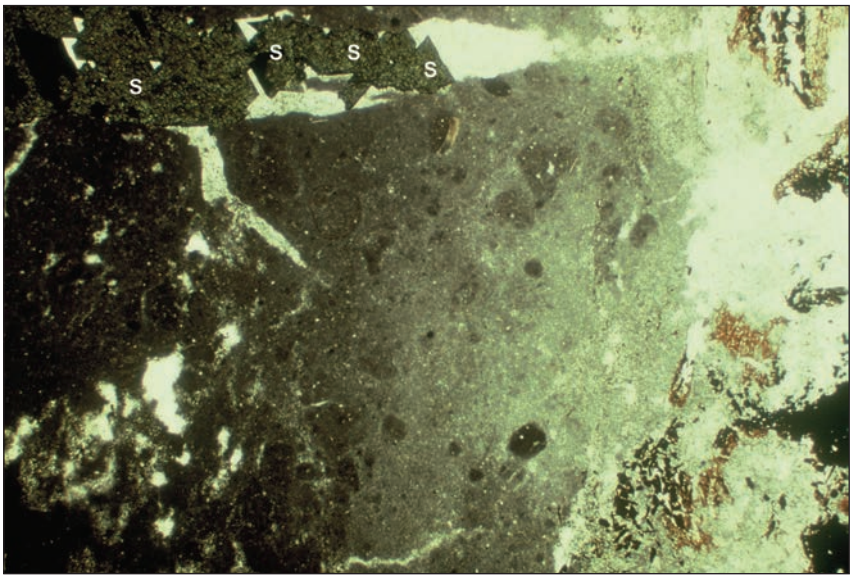

Figure 2. Seatearth limestone (caliche) horizon beneath the Herrin No. 6 coal, Danville, Illinois. Note soilstone texture and cellular root texture at right. The angular crystals in the fracture at upper left (indicated by "S") are idiomorphic yellow sphalerite crystals.

Valley PbZn district has more than 300 ore bodies (Evans, 1993). Anderson and Macqueen (1988, p. 80) state that "MVT ore deposits are simply unusually large representatives of a ubiquitous phenomenon: occurrences of sphalerite and galena are commonplace in carbonate successions."

During the study of the depositional environments of several Upper Pennsylvanian shales of the Midcontinent (Schutter, 1983), the widespread occurrence of sphalerite (ZnS) was noted. Specifically, the black shales involved were the Stark Shale of the Dennis cyclothem of the Kansas City Group and the Eudora Shale of the Stanton cyclothem of the Lansing Group. The shales were not selected for their metal content, knowledge of which emerged from concurrent studies (Martin and Coveney, 1981). Coveney (2003) noted some of these shales exceeded 2000 ppm/t Zn. Nor were the shales unique in this regard, as sphalerite had been noted in other shales and adjacent beds (e. g., Toomey, 1964, Coveney, 1979). In this study, not only were the shales directly analyzed, but the adjacent beds were also examined. Outcrops and cores were sampled over a large area, from northern Oklahoma to southeastern Nebraska and southwestern Iowa, as well as correlative and comparative samples from Illinois (**Figure 1**). Coveney (2003) observed that the associated black shales usually contained 5-35% TOC.

Notably, in terms of their stratigraphic position within the transgressive-regressive cycle, these shales are analogous to the somewhat younger Kupferschiefer. Leventhal (1998) concluded that metal-rich black shales needed to be deposited very slowly (so that the metal could precipitate without dilution) and in anoxic conditions, below 30-50 m minimum depth. He noted that one Midcontinent black shale had Zn, V, Cu, Cr, and Pb enriched by a factor of about 5x105 over sea water; Ni was enriched by 3x106.

The sample procedure included examination of the coarse-mesh (>125 micron) fraction of shales and insoluble residues from carbonates.

Pb-Zn Mineralization *continued on page 37*

Pb-Zn Mineralization continued from page 35

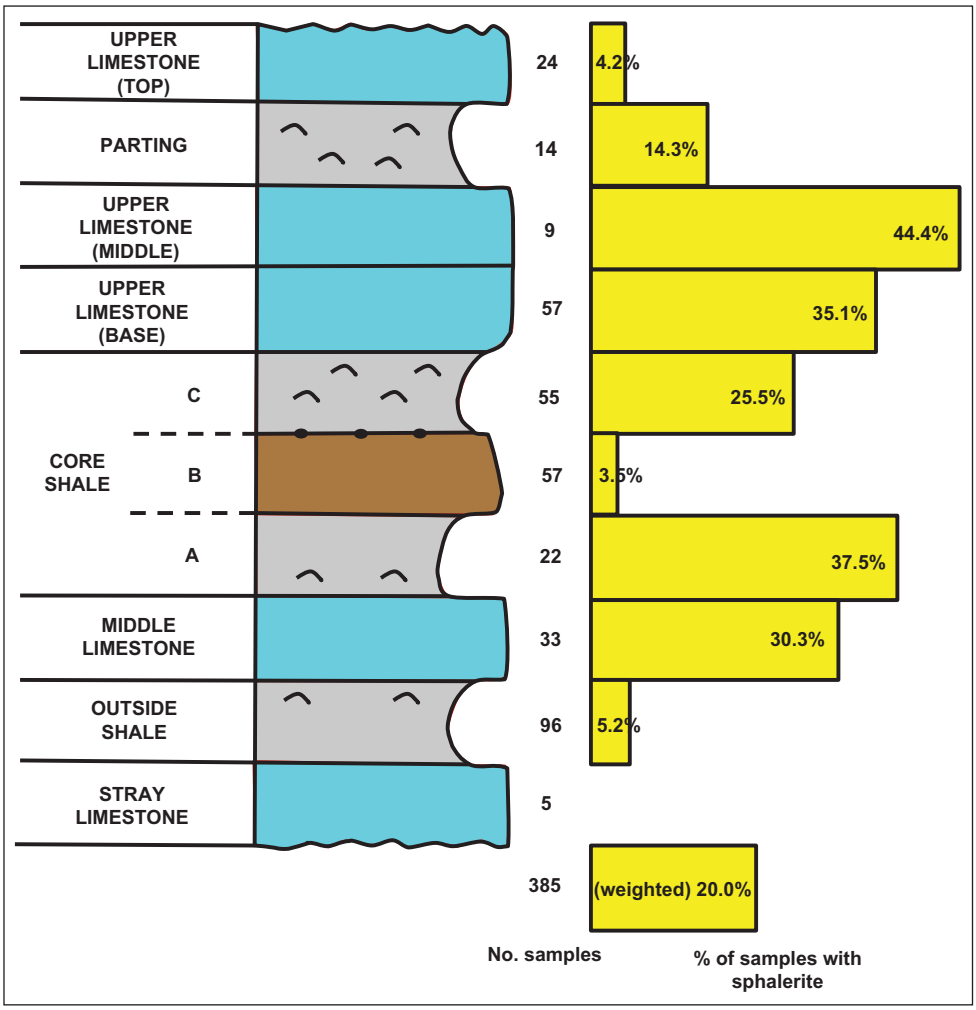

Figure 3. Stratigraphic distribution of sphalerite greater than 125 microns in the Dennis and Stanton cyclothems. The stratigraphic units relate to the standard cyclothem notation. The Zn in the sphalerite probably originates from the middle (B) facies of the core shale, but is expressed in the nearest units with fossils suitable for replacement. Modified from Schutter, 1983, Figure 40.

Of 385 samples examined, about 20 percent contained sphalerite (**Figure 3**). Generally, it took the form of idiomorphic pale yellow resinous material replacing ramose (twig-like) bryozoans and the base of productid brachiopod spines; less frequently, gastropods and ostracodes were replaced. Crystal faces and cleavage planes were frequently visible (**Figure 2**). On some occasions, the sphalerite was zoned with pyrite, or darker red or brown sphalerite. The initial assumption had been that the insoluble residue was due to silicification, but the identification of sphalerite was confirmed by XRD.

The observed sphalerite was surprising because of its widespread distribution and its pale yellow color. The color of sphalerite is principally dependent on the amount of Fe in the structure; pale yellow indicates a very low Fe content. Its observed occurrence was also strongly dependent on grain type – specific fossil groups were preferentially replaced. In one case, in a core from southwestern Iowa, bryozoans were sufficiently abundant that they were 0.6% of the whole rock, which would yield 0.4% Zn. Leventhal (1998) noted that black shales with very high levels of TOC could deplete the supply of reactive Fe, and thus limit pyrite formation.

Conversely, even though the black shales were known to have high Zn content, there was rarely anything in the coarse fraction where it could be directly observed. Martin and Coveney (1981) reported sphalerite in the black shales in phosphate nodules, replacing sponge spicules, and as occasional euhedral crystals. The highest observed sphalerite content was in the argillaceous limestones and gray shales adjacent to the black shales, where favorable carbonate grains occurred (and which would also be the interface between the oxidized and the reduced parts of the cyclothem) (**Figure 3**). Notably, these shales and argillaceous limestones were probably the least porous and permeable intervals.

In MVT deposits, Pb frequently occurs with Zn. In this study, galena was observed replacing bryozoans, but in a much more restricted area than sphalerite, suggesting a different range of conditions. It was observed in northeastern Oklahoma, essentially within the area of the Tri-State lead-zinc district, centered on Joplin, Missouri. Martin and Coveney (1981) reported the identification of claushalite (PbSe) in the Midcontinent black shales. Leventhal (1998) stated that only pyrite and rarely sphalerite were directly observable in metal-rich shales, and other metals do not occur as discrete mineral phases. In this study, not only were pyrite and sphalerite observed in the argillaceous strata associated with the black shales, but galena, barite, and possibly chalcopyrite were also noted.

MVT deposits are usually found around the margins of sedimentary basins, where the metal-bearing fluids coming out of the basin are focused by structural or stratigraphic changes. The basins are also frequently known hydrocarbon-producing

Pb-Zn Mineralization *continued on page 39*

Volunteers Needed for GCAGS Annual Convention

SEPTEMBER 20-22, 2015
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The Gulf Coast Association of Geological Societies Annual Convention will be held in Houston, Texas from September 20th through the 22nd, 2015. In order to make this all come together we will need a number of volunteers. They will be needed beginning Friday, September 18th through the 22nd. The duties will include helping prepare convention material, working the registration desk, and working in the speakers' and judges' rooms. Volunteer positons are open to students, geoscientists and others.

Please contact me at 713-591-1155 or by e-mail at jamesmgrubb@yahoo.com and provide me with your e-mail address, phone number and the days you are available to volunteer. Additional announcements will follow in the *Bulletin*.
Thank you, Jim Grubb, Volunteer Chair

Pb-Zn Mineralization continued from page 37

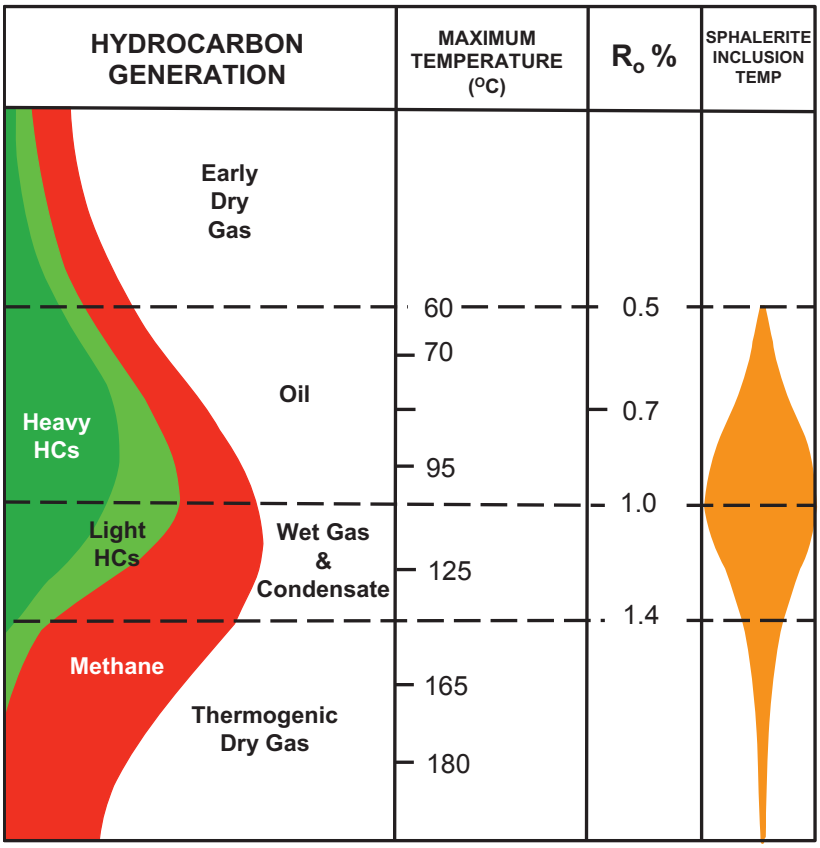

Figure 4. Relationships between hydrocarbon maturity, temperature, and vitrinite reflectance. From Etminan et al., 1984, Figure 2 and Masterlarz et al., 2013, Figure 17. Temperature range in MVT deposits, indicated by sphalerite inclusion temperatures, is typically about 60° to 160°C, occasionally as high as 250°C (as per Hatch et al., 1986; Spirakis, 1986; Anderson and Macqueen, 1988; Evans, 1993; Gregg and Shelton, 2012) and effectively the same range as the oil window.

basins, and, by extension, contain hydrocarbon source rocks. For example, the Upper Mississippi Valley Tri-State PbZn area (NW Illinois, SW Wisconsin, NE Iowa) is updip from the Illinois Basin; the Tri-State district of SE Kansas-NE Oklahoma-SW Missouri is updip from the Arkoma Basin and the Devonian-Mississippian Woodford Shale; and the Pine Point MVT deposit near the border of the Northwest Territories and Alberta, one of the largest in the world, is in Middle Devonian carbonates updip from the Devonian source rocks in the Western Canada Basin. All of these deposits have associated mature bitumens, even though the host rocks are not themselves mature.

Previously, MVT deposits have been studied from the perspective of the ore bodies, and observations based on data gathered there. Since the emplacement models were subject to debate, the co-occurrence of hydrocarbons was not the focus, and generally it was not considered to be significant. The primary issues were the source of the metal ions, and the source of the sulfate; hydrocarbons (or local organic matter) were called upon to reduce the sulfate to sulfide. Gize and others (1991) discussed whether mineralization took place before, during, or after hydrocarbon migration — they concluded that the hydrocarbon source involved Type I or Type II kerogen. Leventhal (1998) similarly found that RockEval analysis of organics with MVT deposits exhibited very high hydrogen indices. Parnell (1991) concluded that while bitumens were often spatially associated with metal ores or enriched in metals, they were not from the same source; paragenesis indicated the metals and bitumen moved at different times. Thus, the recognition in Schutter (1983) of widespread sphalerite mineralization, associated with the distribution of Zn-rich, organic-rich shale, provides a different perspective, indicating a strong relationship with MVT mineralization and hydrocarbon source rocks.

Indeed, the link and its details may be even stronger. Fluid inclusion studies in MVT deposits indicate the ore-bearing fluids were typically about 60°C to 160°C, occasionally as high as 250°C (**Figure 4**), in the mature oil window, and may have ranged up into the wet gas window. The mineralizing fluids coming up out of the basin effectively were also those associated with the maturation and migration of hydrocarbons. In many cases, the host rock and its contained organics are thermally immature (Hatch et al., 1986; Macqueen, 1986); the hot fluids from the basin account for higher temperatures observed and presumably for local maturation. The included fluids also have very high chloride levels (often 15-25% NaCl by weight, according to Evans, 1993), similar to oil-field brines, permitting the transport of large volumes of metal ions (according to many models). Eisenlohr and others (1989) linked the maturation and migration of hydrocarbons in the Canning

Pb-Zn Mineralization *continued on page 41*

Business Design Centre, Islington

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PESGB Conference on African E&P

Always Something New Coming Out of Africa

This annual conference, alternating between London and Houston has established itself as the primary technical E & P conference on Africa, with attendances in recent years reaching over 600, including operators, consultants, governments and academia.

The main conference committee for the 2015 London event will include Ray Bate (Chairman), Duncan Macgregor, Richard Dixon, Kevin Dale, Sean Akinwale and Ian Poyntz.

Thursday 3 September		
8.30	**Registration & Coffee**	
9.20	**Welcome and Introduction**	H. Wilson, PESGB President
Session 1: New Exploration Hotspots, Discoveries and Prospects *Session Chairs : Harry Davis (Delonex), Raymond Komori (Sasol)*		
9.30	**Keynote : Exploration in Africa in a Low Oil Price Environment – Does it make sense?**	J. Austin, OMV
9.55	**Keynote : Frontier Exploration in Africa – title tba**	A. Milne, Shell
10.20	**Keynote : East Africa Rift Exploration: What worked; What didn't and Future Challenges**	I. Cloke, Tullow Oil
10.45	**Coffee & Poster Presentations**	
11.15	**Keynote : Major new discoveries off Senegal: the opening of an unexplored deepwater margin and the discovery of two new play types**	J. Clayburn et al, Cairn Energy
11.40	**Exploration History of the Kwanza Basin**	N. Adams, BP
12.05	**The Aptian Potential of the South Atlantic Margins**	P. Birch et al, Impact Oil and Gas
12.30	**Lunch & Poster Presentations**	
Session 2: New Kitchens : Geodynamics and Heat Flow Modelling *Session Chairs : Helen Doran (Ophir), Julian Moore (BP)*		
13.45	**Keynote : Seismic Imaging of African Crust and Mantle and the Driving Forces for Basins and Plateau Topography : Results from Africa Array**	A, Nyblade, PennState University
14.10	**Thermal History and hydrocarbon charge in the East African Rift System: the South Lokichar Basin, Kenya**	G. Kuper, Tullow Oil
14.35	**New Constraints on the Early Evolution of the South Atlantic Basin As Revealed By Recently Acquired Magnetic, Gravity and Seismic Reflection Data**	P. Towle et al., Anadarko
15.00	**Coffee & Poster Presentations**	
15.30	**Keynote : Key factors controlling the thermal history of transform margins**	M. Nemcok et al, EGI
15.55	**3D seismic stratigraphic analysis of sedimentation and fluid flow on the Nigeria Transform Margin**	O. Olobayo et al, Univ. of Manchester
16.20	**New Gravity Data Helps Define the Indian Ocean Spreading Ridge and Crustal Boundaries Offshore East Africa**	I. Davison et al, Geo International
16.45	**Kenya Ultra Deep Water : COB definition with an inverse modelling methodology**	M. Biancone et al, ENI
17.10	**Insight into the East Coast of Africa from a new tectonic model of the Indian Ocean**	C. Reeves et al, Earthworks
17.40	**Evening Reception**	

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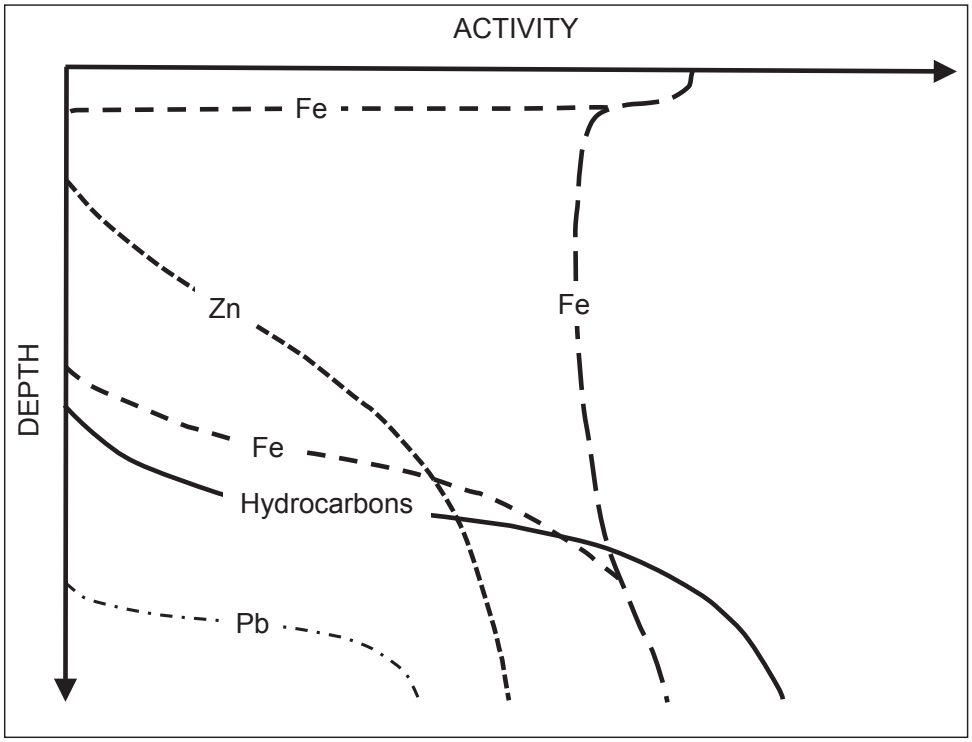

Figure 5. Conceptual diagram of increasing chemical activity with depth/temperature. The various chemical groups may be at least semi-independent, but there may also be a degree of dependency, as cation activity may rely partially on the destruction of hydrocarbon molecules and the release of the various metals. The two tracks for iron (Fe) (short dash dropping to zero, and long dash) indicate that with very high levels of available organic material in the sediment (short dash), the available mobile iron may be depleted (Leventhal, 1988), and may not become available again until released diagenetically. This appears to be the case in the studied cyclothems, with Fe-poor sphalerite formed at low temperatures.

Basin to the expulsion of metal-bearing brines to produce the MVT deposits of that basin, but they did not specifically identify the hydrocarbon source rock as the metal source. Etminan and Hoffmann (1989) noted that fluid inclusions in the Canning Basin examples contained virtually mature oil-like hydrocarbons, while the local organic matter was less mature and did not match the hydrocarbons in the inclusions.

The widespread pale yellow sphalerite observed in association with the Pennsylvanian shales was Fe-poor and was not observed to have associated hydrocarbons. Other indications (such as spore and conodont colors) were that the rocks were generally immature to marginally mature for hydrocarbon generation. The Zn for the sphalerite came from the shale, possibly with connate

Pb-Zn Mineralization continued on page 43

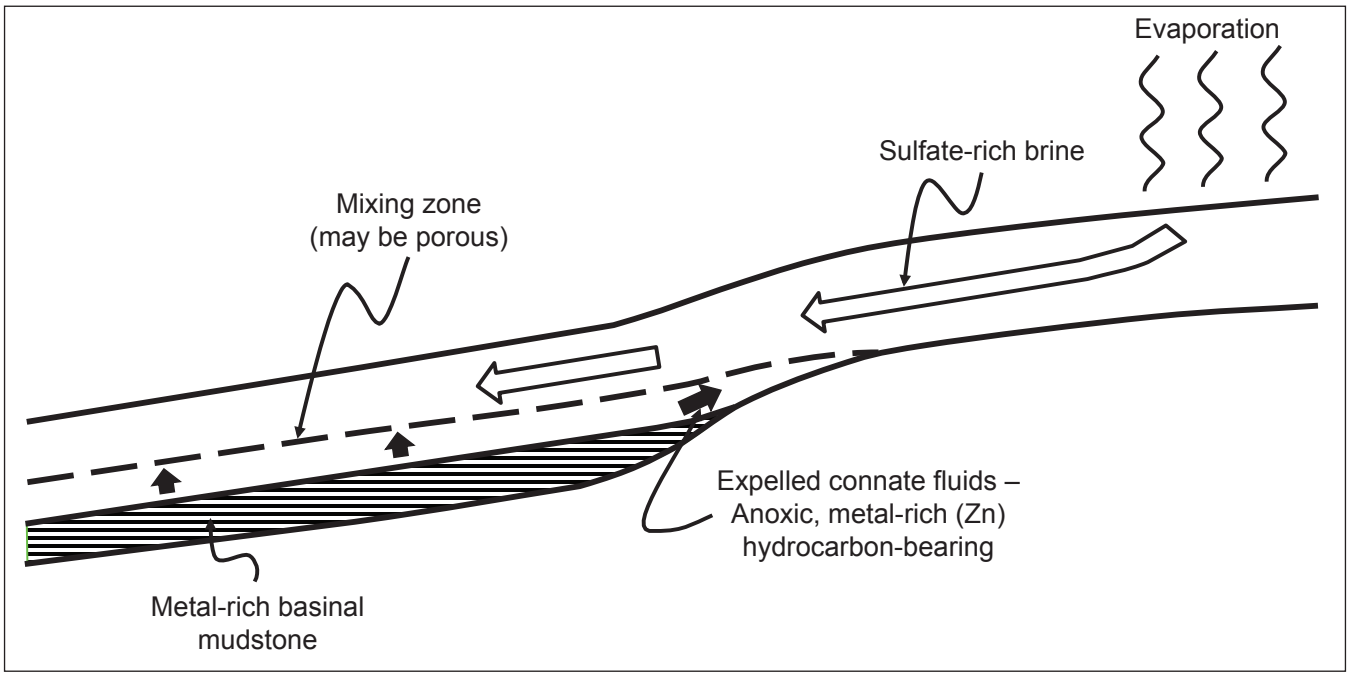

Figure 6. Diagram showing relationships of metal-rich basinal mudstone to refluxing brine with sulfate. The location of the mixing zone may be more strongly controlled by stratigraphy than by distance from the sources of the fluids. Note that this would be expected to be in a largely carbonate environment; a siliciclastic setting, associated with a delta, would probably not result in refluxing brine.

Wednesday 2 September
The conference will be proceeded by a day course led by D. Macgregor, MacGeology entitled Petroleum Basins of Sub-Saharan Africa (separate registration).
The PESGB Evening Lecture, open to all members and registrants, will be given by K. Myers, Richmond Energy Partners on the subject of 'A review of frontier exploration in Africa since the discovery of the Jubilee Field' from 18.30.

Interactive Session: Seismic Workshop
Session Chair : Patrick Coole (PGS)
In collaboration with PGS, PESGB is offering seismic service companies the opportunity to present on a geological topic of their choice, and the ability to run through the dataset afterwards. Presentations and data shows can run for a total of 50 minutes with a short break for setting up in between. Participants are asked to bring a laptop to display their data, projection facilities will be provided on the day.

Poster Programme
There will also be around 30 technical posters on display throughout the conference. The listing of these will be in the next issue of this magazine. New posters are now being accepted only for student presenters.

Preliminary Oral Programme

Friday 4 September		
8.30	**Registration & Coffee**	
Session 3: New Insights on Trap Types and Reservoir Geometries *Session Chairs; Jerry Jarvis (Tullow), Vincent Mashasha (Sasol)*		
9.00	**Understanding the Pressure Regimes along the West Africa Margin and their Implications for Prospectivity**	S. O'Connor, Ikon Geopressure
9.25	**The importance of inherited structural fabrics on the evolution of the MSGBC Basin and its implications for an underachieving petroleum province.**	R. Cowan, Tullow Oil
9.50	**Reservoir Consequences of Deposition Near a Large Igneous Province: A comparison of the Senegal-Guinea Bissau Margin with Volcanically-Influenced Equatorial and South Atlantic Basins**	A McAfee, Core Labs
10.15	**Ntomme Field, offshore Ghana-unravelling puzzling geometries**	C McFerran, Tullow Oil
10.40	**Coffee & Poster Presentations**	
11.10	**The Pande Gas Fields Complex in the South Mozambique Basin, a history**	K. Dale et al., Sasol
11.35	**Mzia: A Different Kettle of Fish - Finding, Appraising and Developing a Shy Giant**	N. Pike et al, BG Group
12.00	**The Meleiha concession in the Western Desert - from Emry Deep oil discovery to innovative exploration concepts**	G. Serafini et al., ENI
12.25	**Lunch & Poster Presentations**	
Session 4: New Reservoirs: African Carbonates in Time and Space *Session Chairs : Fabio Lottaroli, ENI, Ian Poyntz*		
13.45	**Keynote : Depositional geometry and facies variability of non-marine carbonates in rift basins**	G. Della Porta, University of Milan
14.10	**Pre and Post Salt Tectono-stratigraphic evolution of the onshore Namibe-Benguela-Kwanza basins, Angola**	I. Sharp, Statoil
14.35	**Depositional Models & Reservoir Quality Variation in Cretaceous Travertines, Onshore Namibe Basin, Angola**	R. Dixon et al, BP
15.00	**Coffee & Poster Presentations**	
15.30	**The evolution of the South Atlantic lacustrine deposits in response to Early Cretaceous rifting, subsidence and lake hydrology**	T. Sabato Ceraldi et al, BP
15.55	**Neocomian Carbonates in Mauritania : Play opening potential and regional implications**	A. Jamil et al, Tullow Oil
16.20	**Kenya Carbonate Study**	tbc
16.45	**Awards Ceremony**	
17.00	**Closing Address and Invitation to Houston, 2016**	I. Poyntz, HGS

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Member £300 Non Member £355

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fluid expelled by compaction (Leventhal, 1998, noted that black oozes, the precursors to metal-rich black shales, are often >90% connate water), released by adsorbed hydroxides by reduction or from organic compounds as they began to undergo maturation (Angino, 1964; Gibbs, 1976). The release and movement of Zn and other metals is apparently a function of basin evolution, closely associated with hydrocarbon maturation and migration. Understanding the details can greatly enhance basin modeling (**Figure 5**). Notably, Hatch and others (1986) found that Fe-rich sphalerite was emplaced at higher temperatures than Fe-poor sphalerite.

McHargue and Price (1982) noted the widespread occurrence of generally ferroan late-stage dolomite in the Midcontinent cyclothems. While not pervasive, it was most common as dispersed dolomites in the argillaceous limestones directly above the core shales, where they attributed it to Mg+2-rich fluids moving out of the shales; some void-filling ferroan dolomite was also observed. This would not be the massive, pervasive dolomitization associated with classic MVT deposits, but would be consistent with a marginal, widespread phenomenon indicating the system is generally present in the basin. The relationship to sphalerite mineralization is unclear; most likely it is a parallel process beginning at low temperatures, but the ferroan nature suggests a somewhat higher temperature zone.

Saddle dolomite often occurs with MVT mineralization (Machel, 2004). Fluid inclusion work indicates temperatures of 80°-150°C, consistent with other data and within the oil generation window. Features of the saddle dolomite crystals indicate rapidly changing conditions and possible mixing of different fluids.

There are other aspects of MVT deposits that relate to basin evolution. One is that the sulfur isotopes in the sulfides are relatively heavy. Bacterially reduced sulfur tends to be isotopically lighter. The included hydrocarbons or organics could be the source of the sulfur, but again they are isotopically lighter than the sulfide sulfur (Spirakis, 1986). The sulfur in MVT deposits is isotopically in the same range as Phanerozoic sea water and evaporites; in some cases it may also be in the range found with igneous rocks (Evans, 1993). The mineralization frequently takes place in voids, often attributed to karst. The sulfide minerals themselves are often zoned, suggesting episodic pulses of fluid movement from the basin. Bethke (1986) noted that the higher temperatures at the basin margins indicated in the MVT deposits (as opposed to the disseminated yellow sphalerite) indicate efficient movement of hot fluids from the basin which could not be sustained by compaction.

A comprehensive model (**Figure 6**) could be that the sulfate is brought in by reflux of evaporative brines from the basin margins. Such sulfate would be isotopically heavy. Cavernous porosity and dolomite precipitation frequently occur in mixing zones (Machel, 2004), where the evaporite brines mix with other water masses. The changing concentrations of many different ions results in selective dissolution and precipitation. For instance, the specific mineral composition and structure may lead to preferential dissolution of specific grains, as apparently has occurred with the bryozoans and productid spines in the Pennsylvanian shales, which were then filled with Fe-poor sphalerite. Removal of sulfate (by sulfate reduction) from a gypsum-equilibrium brine might result in a cascade of local reactions. The hydrocarbon fuel for sulfate reduction could be either transported with the basin-derived metals, or in situ in the case of the immature Pennsylvanian black shales (mixing zone selective dissolution may account for the preferred grain replacement). Notably, Long and Angino (1977) found that a Ca+2-rich brine, close to gypsum precipitation, was particularly effective at releasing Zn and Pb from argillaceous sediments. Evaporitic brine generation would be consistent with the carbonate environments (siliciclastic deltaic environments are less likely to develop evaporitic brines). In the Upper Pennsylvanian, evaporites are known from the Williston Basin and West Texas. The evaporitic brines could be developed locally during the lowstand portion of the Pennsylvanian cycles, or more regionally with the progressive offlap and increasing aridity during the Late Pennsylvanian and Early Permian. Notably, the brine compositions could change with increasing restriction due to falling sea level.

The updip setting of the black shales of Pennsylvanian cyclothems can be viewed as an incipient MVT basin, with only marginal conditions. The observed Fe-poor sphalerite is widespread and associated with the organic-rich black shales. The disseminated dolomite associated with the shales may also represent the earliest phases of maturation and fluid expulsion. Coveney and Goebel (1981) reported temperatures in "minor" occurrences of sphalerite in eastern Nebraska of about 60°C. This may not require a heating event and/or long-distance migration of hydrothermal fluids. Given that the Permian climate was arid tropical, an elevated surface temperature (25°-30°C) would be likely, and the Permian would be the time of maximum burial in the area. Even with a modest continental geothermal gradient (of 25°-30°C/km, following Anderson and Macqueen, 1988), 60°C doesn't require extraordinary conditions, but since the area was moderately active tectonically in the Pennsylvanian, local thermal anomalies might be expected. The widely dispersed sphalerite (and possibly dolomite) associated with the organic-rich black shales in the shallow parts of a basin indicate that more intensive, focused fluid flow from the basin center may be capable of producing MVT deposits. Notably, karst aquifers permit fluid flow to be focused and transported with little interaction

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AAPG Education

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or temperature loss. MVT deposits are frequently described as associated with karst (although cavernous porosity from fluid mixing may also be a possibility). Thus MVT deposits are the result of the burial of an organic-rich, metal-bearing source in a basin, and not a special event related to deep-seated igneous intrusions or basement faulting.

A curious aspect of the MVT deposits in the Mississippi Valley is that they are strongly enriched in radiogenic Pb, termed J-type lead after Joplin, MO, in the Tri-State District, where it was first recognized (Evans, 1993). This would be consistent with the Pb being derived from black shales that were strongly enriched in U. Humic organics (Type III and Type IV) have a much stronger affinity for U than do marine organics (Type I and Type II) (Swanson, 1960). The Pennsylvanian Chattanooga/New Albany/Woodford black shales of the Midcontinent and Illinois basins have high levels of humic organics, in at least some areas, and consequently high U content. Thus, they could be expected to be the source of relatively abundant radiogenic Pb. In contrast, Pine Point in Canada, presumably sourced from the downdip Devonian shales, does not have high levels of radiogenic Pb, consistent with low levels of terrestrial organic input.

Fluid movement and emplacement of MVT deposits in the Mississippi Valley have been dated as late Pennsylvanian and Permian, based on paleomagnetic dating (citations in Evans, 1993). However, many of the MVT deposits are in stratigraphically older units. Since the mobilized metals are carried by very dense basinal brines, they might be expected to move down stratigraphically, even as they moved laterally and structurally up out of the basin.

Dravis and Muir (2014) recently described the dolomitization they found at the top of the Ordovician Ellenburger Group on the Eastern Shelf of Texas. The Ellenburger has been described as karstified; it directly underlies Pennsylvanian black shale (Dravis and Muir, op. cit., Fig. 15). In addition to having a complex history of dolomitization (including saddle dolomite formation), the rocks also contain bitumen and common sphalerite. The sphalerite is broadly attributed to basement-derived hydrothermal fluids; no consideration was given to the overlying shales. Notably, Dravis and Muir compared the Ellenburger features to those observed in the Middle Devonian of the Western Canada Basin.

Thus, there are three aspects of MVT deposits that are directly applicable to hydrocarbon exploration and development. One is that they are direct indicators of sufficient mature hydrocarbon-rich source rock downdip to expel hydrocarbons (often oil or bitumen) along with metal-rich fluids. And so they are also direct indicators of downdip unconventional resources.

Second, the mechanism for MVT deposits may be very similar to that for hydrothermal dolomite reservoirs [an excellent example is the Lennard Shelf of the Canning Basin, where both processes occur (Eisenlohr et al., 1994)]. The basinal fluids that result in MVT deposits may also be responsible for the porosity and dolomite recrystallization in conventional hydrothermal dolomite reservoirs.

Third, they provide a valuable tool for basin modeling. The mineralization provides evidence of where fluids originated and from whence they migrated, and, in a paragenetic sense, when it happened. Details of the fluid migration may be obtained from the details of the mineralogy, particularly mineral zonation. The fluid inclusion work indicates a minimum temperature for the source of the fluid. Basinwide fluid movement is apparently tied to tectonic events (Gregg and Shelton, 2012), and pulses of exceptionally warm fluid may be the result of fracturing events. Knowledge of when those events took place, and under what tectonic stress regime, may provide valuable information on the fracture sets of the source shale. If high levels of radiogenic Pb are an indication of the type of organics present in the source rock, it will have a bearing on the type of hydrocarbons likely to be found.

MVT deposits primarily involve Pb, Zn, Cu, Ba and fluorite. Other metals, notably Au, are sometimes concentrated in black shales; notably, the Carlin-type Au deposits, where Au in auriferous pyrite in black shale is released and concentrated by oxidation (Gize, 1986; Hausen and Park, 1986; Morton, 2014) or it may be released by recrystallization during amphibolite metamorphism to produce orogenic gold deposits (Gaboury, 2013). Coveney (2003) suggested secondary processes may concentrate some metals; for example, in the Kupferschiefer Zn is widespread, but Cu is locally concentrated, perhaps by oxidizing fluids. In these cases, it is not yet clear whether the black shale environment is responsible for the original concentration, or if the organic-rich sediments are simply responsible for precipitation from migrating fluids. The range of metals found in black shales responds to different conditions, but they provide information on the original sediment and how it responds to changing conditions during burial. Unraveling these relationships may provide not only better exploration methods for unconventional hydrocarbons, but also exploration techniques for valuable metal resources.

There are also broader lessons for the exploration of unconventional resources. One is that a broad-based integrated approach, utilizing many lines of evidence about the development of the resources is most effective as it is more likely to capture pertinent (but unexpected) evidence. Such a broad-based initial approach permits the identification of the most relevant variables (which are not always the same), allowing a more targeted exploration strategy going forward. **Pb-Zn Mineralization** *continued on page 47*

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Another lesson is that not all sources of information come from the oil and gas industry. In the case of black shales, large amounts of information have been generated by the mining industry. There have also been contributions from the exploration for uranium, particularly during the Cold War era. Broadly, black shales have been targets of interest for a very long time; the unconventional resource phase is only the most recent episode. ■

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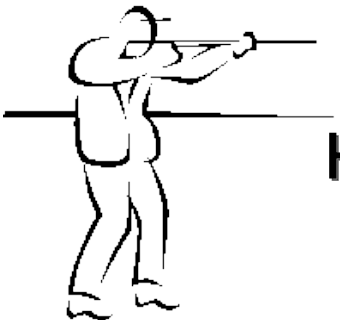

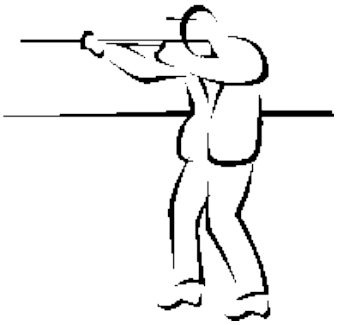

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Government Update

*by **Henry M. Wise, P.G.** and **Arlin Howles, P.G.***

If you'd like the most up-to-date Texas rules, regulations, and governmental meeting information we direct you to the HGS website to review The Wise Report. This report, which comes out as needed but not more often than once a week, offers the most up-to-date information that may be of interest to Texas geologists.

AGI Geoscience Policy Monthly Review (February 2015)

Bureau Of Ocean Energy Management Moves Forward on Arctic Leasing

On February 12, 2015 the Bureau of Ocean Energy Management (BOEM) released their final environmental review for oil and gas leases in the Chukchi Sea off the coast of Alaska. This release of the final supplemental environmental impact statement resolved deficiencies found in the 2007 environmental review, conducted under the Bush Administration that had prevented lease holders from moving forward on drilling in the Chukchi Sea. This keeps leaseholder Royal Dutch Shell plc on track to pursue their proposed drilling this summer.

The new BOEM assessment is based on a scenario projecting that 4.3 billion barrels of oil and 2.2 trillion cubic feet of natural gas could be produced from the Chukchi Sea leases. BOEM's review suggests extracting this oil would require eight new platforms of Arctic-class design and 589 wells drilled for exploration, delineation, production and service.

Obama Administration Proposes New Arctic Offshore Drilling Rules

On February 20, 2015 the Bureau of Safety and Environmental Enforcement (BSEE) in conjunction with BOEM proposed rules for future oil and gas drilling on 128 million acres in the Beaufort and Chukchi seas as allocated in the BOEM's 2017-2022 Outer Continental Shelf Oil and Gas Leasing Plan. The proposed rules require region-specific oil spill response plans and immediately-accessible spill control and containment equipment. Additionally, the rules mandate that each Arctic drill site have a second, back-up oil rig available in case of a blow out, a requirement that was opposed by oil company representatives last fall.

National Academy's Reports Urge Geoengineering to Counter Climate Change

A National Academy of Sciences (NAS) panel called for more research into geoengineering as a method to combat climate change in two reports released on February 10, 2015. Geoengineering describes "deliberate, large-scale manipulations of Earth's environment that might be used potentially to offset some of the consequences of climate change." These methods include injecting compounds into the atmosphere to increase cloud reflectivity, a higher risk option with quicker results, or capturing carbon from the atmosphere and injecting it into oceans, soil, or underground, which projects lower risk but is slower to make an impact on global CO2 levels.

The panel proposed a series of small-scale, closely-monitored experiments to explore ways that scientists can counter recent warming. The recommendations focus on developing baseline knowledge of whether and how various geoengineering methods work. Geoengineering opponents argue that these experiments present a "moral hazard" and that they may have unintended, adverse, worldwide impacts. The panel disagreed, stating that society has "reached a point where the severity of the potential risks from climate change appears to outweigh the potential risks from the moral hazard" of conducting geoengineering experiments.

Marcia McNutt, former Director of the U.S. Geological Survey and current Editor of Science, chaired the 16-member panel. The reports were sponsored by the U.S. intelligence community, the National Oceanic and Atmospheric Administration (NOAA), NASA, the Department of Energy (DOE), and the NAS.

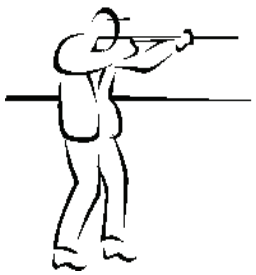
DOI Distributes $50 Million for Western Drought Response

On February 6, 2015 Interior Secretary Sally Jewell announced that $50 million allocated by Congress for Western drought relief will be used by the Bureau of Reclamation, water districts, and other water users to increase efficiency and conserve water in drought-stricken areas. The California Central Valley Project will receive $20 million, which will help with scientific monitoring and managing limited water supplies. Colorado will receive aid for the Colorado River system and declining Lake Mead. The funds will also support drought response and comprehensive drought plans and WaterSMART's reclamation and reuse work with farmers and municipalities in conserving water.

USGS Releases Report on 60 Years of Hydraulic Fracturing

The United States Geological Survey (USGS) released a report on February 17, 2015 that examines trends in the spatial distribution, treatment fluids, additives, proppants, and water volumes for nearly 1 million hydraulically fractured wells and 1.8 million fracturing treatments during the period 1947 through 2010. The report notes the recent increase in horizontal, or directional, drilling, which has grown from six percent of new wells drilled in 2000 to 42 percent of new wells drilled in 2010.

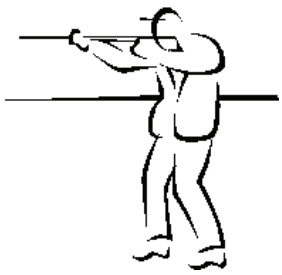
Government Update *continued on page 53*



ANNUAL HGS SKEET SHOOT

Saturday, June 27, 2015

Greater Houston Gun Club
6702 McHard Road, Missouri City



SPONSORSHIP APPLICATION

Ammo Sponsor - $750.00
- Paid squad of 5 Shooters
- Signage at the Club During Event
- Recognition at Awards
- Logo on HGS Website

Cigar Sponsor - SOLD
- Paid squad of 5 Shooters
- Signage at the Club During Event
- Recognition at Awards
- Logo on HGS Website

Flurry Sponsor - $750.00
- Paid squad of 5 Shooters
- Signage at the Club During Event
- Recognition at Awards
- Logo on HGS Website

Field Sponsor - $750.00
- Paid squad of 5 Shooters
- Signage at the Club During Event
- Recognition at Awards
- Logo on HGS Website

Beverage Sponsor - $750.00
- Paid squad of 5 Shooters
- Signage at the Club During Event
- Recognition at Awards
- Logo on HGS Website

Cap Sponsor - $1000
- Sponsor Logo on Event Caps
- Paid squad of 5 Shooters
- Signage at the Club During Event
- Recognition at Awards
- Logo on HGS Website

To sponsor, please indicate your sponsorship level _____ with payment (payable to HGS) to:

HGS - 14811 St. Mary's Lane, Ste. #250 - Houston, Texas 77079 - Attn: Andrea peoples

Or you can email your sponsorship form to andrea@hgs.org

Name _____ Phone _____ Amt. Enclosed_____

Company _____ Email _____

Billing Address _____

Credit Card # _____ Exp. Date _____ Sec. Code# _____

Approved by_____ Date_____

If you would like HGS to invoice your sponsorship please complete the section below:

Invoicing Address _____

Accounting Contact Name _____ Contact Email Address _____

Special Billing Codes _____

Approved by_____ Date _____

Please email your company logo to office@hgs.org. Note: Company logos (300+ dpi) must be received no later than May 1, 2015.

If there are any questions, please contact Tom McCarroll—713-419-9414 or tom_mccarroll@yahoo.com.

To register online, please go to http://www.hgs.org/eventskeetshoot

Government Update continued from page 51

Obama Renominates Kimball as USGS Director

President Obama renominated Dr. Suzette Kimball as Director of the U.S. Geological Survey (USGS) on February 26, 2015 following the lapse of her nomination at the beginning of the 114th Congress in January. Dr. Kimball, who has been with USGS for 16 years, was first nominated to the post in January 2014. The Senate Energy and Natural Resources Committee (ENRC) approved Kimball by unanimous consent, but her nomination stalled on the Senate floor. Dr. Kimball has served as Acting Director of the agency for the past two years following the retirement of the previous director, Marcia McNutt.

Senate Commerce, Science, and Transportation Committee (CSTC) Advances Tsunami Warning Bill

The Senate Commerce, Science, and Transportation Committee marked up and passed the Tsunami Warning, Education, and Research (TWER) Act of 2015 (H.R.34) on February 26, 2015. The legislation reauthorizes programs that support tsunami forecasting and coastal mitigation efforts and includes a new authorization for tsunami detection research. This research involves developing a test near-field warning system for the Northwest U.S., where tsunami waves generated by an offshore earthquake could reach the coast in as little as 15 to 30 minutes. Senator Maria Cantwell (D-WA) supported the bill, stating "we want a preparedness plan, and we want to do everything we can to make sure people are ready. Twenty minutes is not enough time to evacuate everyone from coastal communities."

The bill, which passed the House in January, may move to the Senate floor for consideration.

Grijalva Introduces Legislation to Reform Hardrock Mining Industry

Representative Raul Grijalva (D-AZ), Ranking Member of the House Natural Resources Committee, introduced legislation this February that would overhaul the non-coal mining industry. The Hardrock Mining Reform and Reclamation Act (H.R. 963) builds upon a bill previously introduced by Rep. Peter DeFazio (D-OR) in the 113th Congress. If enacted, the bill would increase industry royalties and implement new fees that would help clean up abandoned mine sites.

The new legislation was introduced concurrently with the release of a Government Accountability Office study that shows at least 20,401 potentially contaminated abandoned mine sites exist.

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HGS Welcomes New Members

New Members Effective March 2015

ACTIVE MEMBERS

Andy Benson
Summer Brown
Marcel Chin-A-Lien
Frelynn Cohrs
Michael Cornyn
David Higginbotham
Joseph Hill
Simon Kattenhorn
Umer Khan
Andrey Klimushin
Kendra Kruse
Justin Palmer
Anthony Shaw
Peter Shimer
Stefan Stahl
Mark Steele
Charles Terhune

ASSOCIATE MEMBER

Teresa Sonnier

EMERITUS MEMBER

Robert Vicars

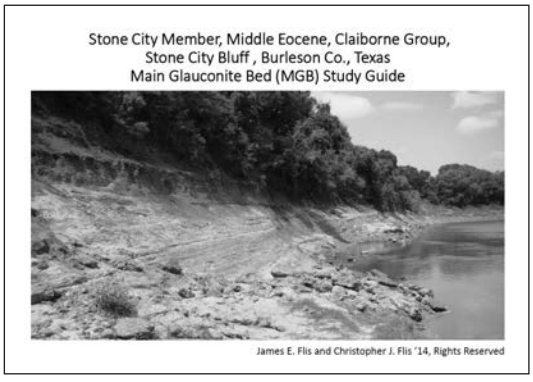
STUDENT MEMBERS

Wey Foo
Luchen Li
Saro Ntagha
Tim Shane

Welcome New Members

New to the HGS Website!
Stone City Member: Main Glauconite Bed Study Guide

Courtesy of Jim and Chris Flis



The Stone City Bluff is a special location on the Texas Gulf Coast Plain. It is the best of relatively few places where marine rocks of Paleogene age are exposed and available for public access. This access provides a window into Middle Eocene rocks that were deposited in the Gulf of Mexico approximately 41.8 million years ago. Geologists study outcrops such as these to understand the environments of deposition and the processes controlling sediment deposition. Information gleaned from an outcrop can help in oil exploration, paleontology, understanding of ancient climate and groundwater hydrology. The objective of this study guide is to present a comprehensive summary of the Main Glauconite Bed (MGB) found at Stone City Bluff. This bed contains a rich fossil fauna and lithology that has attracted explorers and researchers since the mid 1800's and research continues on this bed. It is hoped that with this guide you, as an interested student, teacher or hobbyist can be part of that research. A bibliography of subject matter pertinent to the Stone City Bluff is attached with this guide. The guide can be found on the HGS website using the following link: http://www.hgs.org/node/5639.

Government Update continued from page 53

While there has yet to be outright opposition to the legislation, the National Mining Association refutes the suggestion that companies do not pay their fare share towards clean up citing other regulations associated with the Clean Water, Clean Air, and National Environmental Protection Acts.

Hardrock mining currently falls under the jurisdiction of the General Mining Act of 1872, which does not require non-coal mining firms to pay royalties on federal lands.

DSCOVR Begins its Journey to Monitor Solar Wind

NASA's Deep Space Climate Observatory (DSCOVR) satellite launched February 12, 2015 beginning its nearly million mile journey to Lagrange Point L1, 932,000 miles from Earth between the Earth and the Sun. From there DSCOVR will monitor solar wind, a plasma stream of particles that flows from the upper atmosphere of the Sun at speeds 1 million miles per hour and greater, providing vital information and warnings on potentially damaging space weather. Space weather such as x-ray solar flares, coronal mass ejections, and interplanetary magnetic fields can impact GPS systems, radio, and power grids among other vital technology.

DSCOVR will take over solar wind monitoring from the 17-year-old Advance Composition Explorer (ACE) satellite and is also equipped with instruments to monitor ozone and aerosols in the atmosphere. Allowing for view of an entire hemisphere, DSCOVR will provide more data at almost 10 times the speed ACE operates. DSCOVR is expected to reach its final destination in 110 days.

House, Senate Question Gaps in Satellite Weather Data

Concerns stemming from a recent Government Accountability Office (GAO) report on weather satellites have caught the attention of the House Science, Space, and Technology (SST) Committee and Senate appropriators. The report suggests a potential gap in weather satellite data could last between 11 months and 5 years from when current satellites become nonfunctional to when new satellites are able to transmit calibrated data. The House SST Committee held a hearing to discuss the potential gaps in satellite data on February 12, 2015. Shortly thereafter, Senate appropriators expressed disappointment that the National Oceanic and Atmospheric Administration (NOAA) does not have a plan to mitigate the potential data gap.

In the House hearing, representatives from NOAA and NASA remained optimistic that the current satellite, Suomi-NPP, will remain functional longer than the GAO estimates and that the JPSS satellites will launch on schedule. Subcommittee Chairman Jim Bridenstine (R-OK) suggested that NOAA and NASA purchase verifiable data from commercial weather satellite data providers in the future, which would avoid potential gaps caused by relying on data from only one source. During the Senate budget hearing, Senator Richard Shelby (R-AL) criticized the agencies for their mixed messages about the gap and reinforced the concerns expressed by other members of Congress: "It is clear that loss of this data would negatively impact the capability of our nation's weather forecasters—potentially putting lives and property in harm's way." ■

HGS Golf Tournament

Monday – October 19, 2015
Kingwood Country Club

Dust Off The Clubs, Polish The Shoes, And Pad The Handicaps, It's Time For Golf!

Come out and join us for golf, food, friends and fun at the annual HGS Golf Tournament at Kingwood Country Club. This year's format will be a four man scramble, with three flights determined by handicap. First, second, and third place awards (blind draw for 3rd place) will be awarded for each flight. There will be prizes awarded for closest to the pin and long drive as well as many great door prizes and raffle prizes for participants.

The entry fee is $150.00 per person or $600.00 per team on entries received on or before October 9th. Entries will be accepted after October 9th, but a $25.00 late fee will be applied per golfer. Individual entries will be grouped with other individual golfers to make a foursome. Entries are limited and will be accepted on a first-in basis.

Companies or individuals interested in sponsoring the event should contact Mark Dennis at 281-494-2522 (office), 281-705-4346 (cell) or by email at mdennis@petrolog.com.

To enter, please fill out the entry form and email, fax or mail along with your entry fee (payable to HGS Entertainment Fund) to:

Petro Log International, Inc.
One Sugar Creek Center Blvd., Suite 945
Sugar Land, TX 77478
Office: 281-494-2522 Fax: 281-494-2526
Email: mdennis@petrolog.com & mlange@petrolog.com

SCHEDULE OF EVENTS

8:00 – 9:45 a.m.	Registration and free use of driving range (Breakfast will be provided by **Petro Log International, Inc.**)
10:00 a.m.	Shotgun start
3:00 p.m.	Cash bar, open buffet
3:30 p.m.	Door prizes and awards presentation

Team Captain _____ Phone _____ Amount Enclosed _____

Company _____ Email _____

Billing Address _____

Credit card # _____ Exp. Date _____ Code# _____

Please Provide Email Addresses For All Team Members. All Communications Will Be Done Via Email.

Foursome Members *(Please Print)*	**Company**	**Phone Number/Email**	**Hdcp/ Avg. Score**
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____

*Please provide email addresses for **all** team members. All communications will be done via email.*

HGS Golf Tournament

Monday – October 19, 2015
Kingwood Country Club

Sponsorship Application

Trevino Sponsorship $500.00

- Hole signs on all three courses.
- **Company name** displayed on sponsor recognition board at registration and awards banquet.

Hogan Sponsorship $750.00

- Hole signs on all three courses.
- **Company logo** displayed on sponsor recognition board at registration and awards banquet.

Nicklaus Sponsorship $1,000.00

- Hole signs on all three courses.
- **Company logo prominently** displayed on sponsor recognition board at registration and awards banquet.
- **Company logo** displayed on driving range and practice putting green.

Title Sponsorship $2,000.00

- Hole signs on all three courses.
- **Company logo prominently** displayed on sponsor recognition board at registration and awards banquet.
- **Company logo** displayed on driving range and practice putting green.
- **Company logo** displayed on beverage carts.
- **Sponsorship includes tournament entry for one team (4 people).**

To sponsor, please indicate your sponsorship level _____
and mail, fax or email sponsor application form along with payment (payable to HGS Entertainment Fund) to: Petro Log International, Inc. • One Sugar Creek Center Blvd., Suite 945 • Sugar Land, TX 77478
281-494-2526 (fax), 281-494-2522 (office), Email: mdennis@petrolog.com

Name _____ Phone _____ Amount Enclosed _____

Company _____ Email _____

Billing Address _____

Credit card # _____

Exp. Date _____ Security Code# _____

Please email your company logo to Mark Dennis at mdennis@petrolog.com.
Note: Company logos (high resolution file) must be received no later than October 9th.
If there are any questions, I can be reached at 281-705-4346 (cell) or 281-494-2522 (office).

HGS *Bulletin* Instructions to Authors

All materials are due by the 15th of the month, 6 weeks before issue publication. Abstracts should be 500 words or less; extended abstracts up to 1000 words; articles can be any length but brevity is preferred as we have a physical page limit within our current publishing contract. All submissions are subject to editorial review and revision.

Text should be submitted by email as an attached text or Word file or on a clearly labeled CD in Word format with a hardcopy printout to the Editor.

Figures, maps, diagrams, etc., should be digital files using Adobe Illustrator or Adobe Photoshop. Files should be saved and submitted in .ai, .eps, .tif or .jpg format. Send them as separate attachments via email or CD if they are larger than 5 MEGs each, accompanied by figure captions that include the file name of the desired image. DO NOT EMBED them into your text document; they must be sent as separate files from the text. DO NOT USE POWERPOINT, CLIP ART or Internet images (72-DPI resolution) as these do not have adequate resolution for the printed page and cannot be accepted. All digital files must have 300-DPI resolution or greater at the approximate size the figure will be printed.

Photographs may be digital or hard copy. Hard copies must be printed on glossy paper with the author's name, photo or figure number and caption on the back. Digital files must be submitted in .tif, .jpg or .eps format with 300-DPI or greater resolution at the printing size and be accompanied by figure captions that are linked by the file name of the image. The images should be submitted as individual email attachments (if less than 5 MB) or on CD or DVD.

Advertising

The *Bulletin* is printed digitally using InDesign. Call the HGS office for availability of ad space and for digital guidelines and necessary forms or email jill@hgs.org. Advertising is accepted on a space-available basis. **Deadline for submitting material is 6 weeks prior to the first of the month in which the ad appears.**

Random Inside Ad Placement Black & White Prices Shown Color add 30% to prices shown below					Specific Page Color Ad Placement					
No. of Issues	Random Eighth Page	Random Quarter Page	Random Half Page	Random Full Page	Inside Front Cover Full Page	Inside Back Cover Full Page	Page 2 Full Page	Outside Back Cover Half Page	Back of Calendar Full Page	Calendar Quarter Page
10	$823	$1,387	$2,488	$4,734	$7,830	$7,560	$7,384	$6,858	$6,750	$2,700
9	$823	$1,387	$2,488	$4,734						
8	$750	$1,260	$2,242	$4,307						
7	$665	$1,123	$2,014	$3,834						
6	$590	$990	$1,782	$3,392						$1,890
5	$497	$837	$1,503	$2,860	$4,698	$4,536	$4,466	$4,104		
4	$405	$683	$1,223	$2,326						
3	$327	$550	$990	$1,886						$1,080
2	$232	$392	$704	$1,339						
1	$146	$246	$443	$842	$1,404	$1,296	$1,313	$1,080	$1,296	$810
Professional Directory Section Business Card Ad 10 Issues – $160 ($30 for each additional name on same card)										

Website Advertising Opportunities

HGS has multiple website advertising opportunities for your company! We've expanded our offerings to include a 275 x 800 pixel, rotating banner ad on the front page of the website. We have kept the popular Event Calendar and Geo-Job Postings advertisement locations!

	Home page Banner	Home Page (200 x 400 pixels)	Event Calendar (200 x 400 pixels)	Geo-Jobs (120 x 90 pixels)	Website Business Card (Members Only)	Personal Resumes (Members Only)
One year	$3,000.00	$2,800.00	$2,500.00	$1,400.00	Free	Free
6 months	$2,000.00	$1,800.00	$1,500.00	$750.00	Free	Free
3 months	$1,500.00	$1,300.00	$1,000.00	$450.00	Free	Free
Monthly	$ 700.00	$500.00	$ 400.00	$200.00	Free	Free

We still offer Geo-Jobs - where your company can post job openings for 14 days at $50.00 or 30 days at $100.00.

For more information regarding website advertising visit HGS.org or email jill@hgs.org.

Application to Become a Member of the Houston Geological Society

Qualifications for Active Membership

1) Have a degree in geology or an allied geoscience from an accredited college or university; or
2) Have a degree in science or engineering from an accredited college or university and have been engaged in the professional study or practice of earth science for at least five (5) years.

Qualifications for Associate Membership (including students)

1) Be involved in the application of the earth or allied sciences.
2) Be a full-time student enrolled in geology or in the related sciences.

Apply online at www.hgs.org and click on Join HGS

Annual Dues Expire Each June 30. (Late renewals – $5 re-instatement fee)
Annual dues are $28.00; emeritus members pay $14.00; students are free.

Mail this application and payment to:
Houston Geological Society
14811 St. Mary's Lane, Suite 250 • Houston, TX 77079-2916
Telephone: 713-463-9476 Fax: 281-679-5504

Payment method:

☐ Check, ☐ VISA, ☐ MasterCard, ☐ American Express, ☐ Discover

Card # _____

Expiration Date: _____ Card I.D. _____

(Card I.D. – 3 or 4 digit number on front or back of card)

To the Executive Board: I hereby apply for ❑ Active or ❑ Associate membership in the Houston Geological Society and pledge to abide by its Constitution and Bylaws. ❑ Check here if a full-time student.

Name: _____

Address: _____

_____

Home Phone: _____ *Spouse's Name:* _____

Email: _____

Job Title: _____

Company: _____

Company Address: _____

_____

Work Phone: _____ *Fax Number:* _____

Circle Preferred Mailing Address: Home Office

Professional Affiliations: _____

❑ AAPG member No.: _____

Professional Interest:

❑ Environmental Geology
❑ International E&P
❑ North American E&P (other than Gulf Coast)
❑ Gulf Coast E&P (onshore & offshore)

School _____

Degree _____ *Major* _____ *Year* _____

_____

School _____

Degree _____ *Major* _____ *Year* _____

Earth Science Work Experience _____

_____

_____

_____

Applicant's Signature _____ *Date* _____

Endorsement by HGS member (not required if active AAPG member)

Name: _____

Signature _____ *Date* _____

Membership Chairman _____ *HGS Secretary* _____

revised 7/30/14

Houston Petroleum Auxiliary Council News

Janet Steinmetz, *281-531-7204*

ATTENTION ALL HGS MEMBERS! Please share this article with your spouse. Spouses of geologists, geophysicists, landmen and engineers are invited to join HPAC, an organization designed especially for you.

On Monday, May 4 the Book Club will kick off the month with their discussion of Donna Tartt's novel, *The Goldfinch*, led by Georgeann Massell. The next meeting will be held on August 3. **Edie Bishop** will guide us through the moving novel, *The Invention of Wings*, by Sue Monk Kidd. Joanne Lane will host. Everyone is welcome.

It is hard to believe that our current officers of HPAC will soon be passing the torch to their successors. The new officers will be installed at the Spring Luncheon and Style Show on Thursday, May 14 at Maggiano's Little Italy Restaurant. In addition to a delicious luncheon, we will enjoy seeing our members model the latest fashions from "It's All About You" boutique. Be sure to make your reservation.

The *Bridge Groups* will continue to meet during the summer. For information on the *Petroleum Club group*, call **Daisy Wood**, 832-581-3231. Call **Audrey Tompkins** about the *Cinco Màs group* at 713-686-0005. It's great fun for everyone. This leads me to introduce you to **Audrey Tompkins** and her autobiography:

"A true *HOUSTONIAN*, I was born in Houston and lived here all my life except for the little time we lived in Austin. Keith continued his studies to complete his degree in Science in Geology and to continue his athletic achievements on the University of Texas track team. As a pole vaulter, he received his UT sweater, leather jacket, and blanket. Keith was hired by Gulf Oil right out of college. He worked the Gulf Coast and Offshore. When he retired in the 80's, he was with Mesa Petroleum. I attended Business College and University of Houston.

While still in Austin we were surprised to find we were to have an addition to our family with not one but two — twin boys. With more additions to our family we were very involved with little league, school and neighborhood activities. I was very busy at my church — teaching children's classes and leadership positions. We have truly enjoyed doing things with our family including water skiing, snow skiing, trips to South Padre Island, Disney World, Six Flags (which was the fad in the fifties), and all points in between.

I received the honor of being elected as the last President of The Houston Geological Auxiliary before our merger to become part of HPAC (I have to admit some of us were a little skeptical). It has turned out well, and we have truly enjoyed the merger and all the new friends.

I now coordinate the "Cinco Màs" bridge group, a group which began in the fifties. We love our bridge group and welcome everyone. Our ladies are so cordial to new members; it doesn't matter if their bridge talents are excellent or mediocre. We have a wonderful group. Come join us."

Thank you, Audrey for sharing your story. Our organization is blessed to have many interesting members who have arrived here by many different paths. ■

You are invited to become a member of

HPAC

2014–2015 dues are $20.00 Mail dues payment along with the completed information

to **Susan Bell** • 11431 Legend Manor • Houston, Texas 77082

YEARBOOK INFORMATION

Last Name	First Name	Name Tag
Spouse Name	Company	
Street Address	City State	Zip
Email Address	Home Fax	
Home Phone	Cell Phone (Optional)	Home Email Address

Please choose a committee assignment if you are interested.

☐ Fall Event ☐ Yearbook ☐ Bridge ☐ Membership

☐ Christmas Event ☐ Spring Event ☐ Notification ☐ Book Club

☐ Exploring Houston ☐ Courtesy

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