HGS Bulletin
Houston Geological Society
Volume 56, Number 7
March 2014

# Strategic Geology: The Mystery and Allure of Rare Earth Elements

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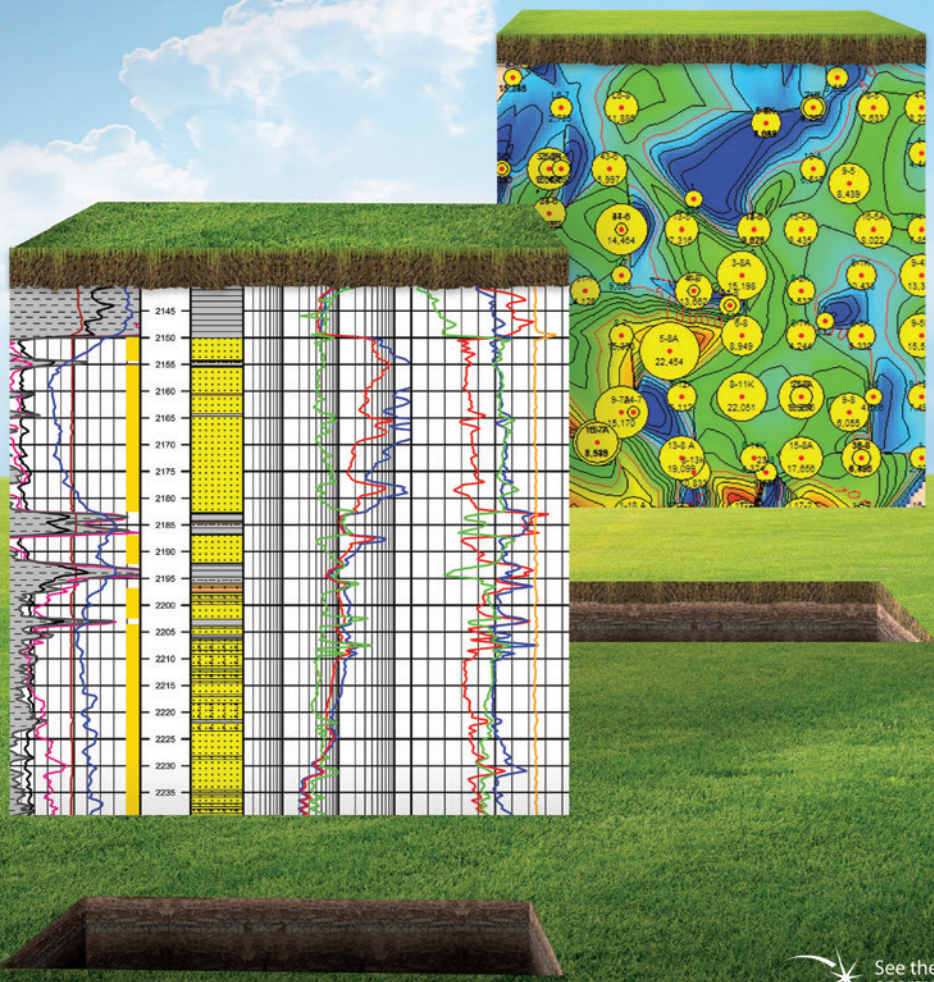


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## In Every Issue





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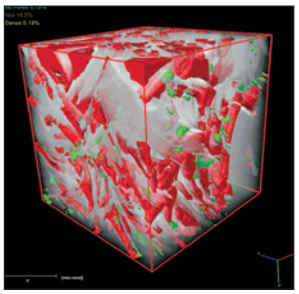
## Technical Meetings



## Other Features





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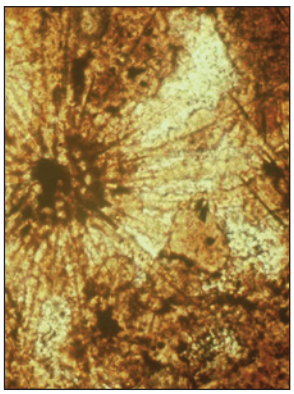

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**About the Cover:** The Lena River, the 11th longest in the world, is the easternmost of three great Siberian rivers that flow north to the Arctic Ocean. The impressive Lena River delta, one of the world's largest, covers more than 11,500 square miles. The delta is the location of the most extensive protected wilderness area in Russia and an important refuge for large concentrations of waterfowl. *Source: United States Geological Survey, Landsat 7 image acquired July 27, 2000.*

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The Houston Geological Society Continuing Education Committee Presents

# Critical Assessment of Shale Plays: Bridging the Gap with Engineers

**Speaker: Gary Citron, Rose & Associates**
**March 5, 2014**

Rose & Associates continues its series of contributions to the HGS with another installment on the critical assessment of shale plays. For 2014, the one day course covers characterization techniques at the handoff interface between geoscientists and engineers. After a brief refresher on using statistics to describe the uncertainty associated with various shale plays, we address play segmentation via compositing techniques and selection of segments with the preferred geologic attributes for future pilot drilling. We then focus on the relationship between program sample size and the probability of achieving drilling pilot goals, uncertainty associated with various aspects of the production type curve, and finish with decision tree structuring and the aggregation techniques to model the development program.

This course is designed for geoscientists and engineers to enhance effective communication and characterization for unbiased profitable investing.

**Pricing**

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| HGS/GSH Member: | $105.00 |
| Non-Member: | $125.00 |
| Emeritus/Life/Honorary | $70.00 |
| Student Member | $70.00 |
| Student Non-Member | $85.00 |

**There is room for 100 attendees.**

**Date:** Wednesday, March 5, 2014 • 8 a.m. – 5 p.m.
**Location:** Noble Energy • 1001 Noble Energy Way • Houston, TX 77070
**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**

**Gary P. Citron** (BS, Geology, State University of New York at Buffalo; MS & PhD in Geology, Cornell University)

After a twenty year career as a geoscientist, manager, and internal consultant for Amoco exploration business, Gary joined Pete Rose's consulting firm, which focuses on the field of prospect and play risk analysis, in February 1999. While at Amoco, Dr. Citron actively mentored younger geoscientists on prospect evaluation.

Gary became Pete's first Partner in Rose & Associates, LLP in 2001 and assumed the role of Managing Partner in 2003, leading R&A to multiple consecutive years of profitable growth. Rose & Associates is a recognized leader in professional instruction and consultation related to the field of play and prospect characterization, leading to more reliable portfolio management.

Dr. Citron has developed expertise in consensus building in prospect risk assessments and performance tracking of operational activity. In addition to his teaching and consulting obligations associated with conventional and unconventional resource opportunities, he coordinates a yearly gathering of risk team coordinators to share and compare best practices. He also helps companies benchmark their predictive performance against companies in their peer group. In 1999 he was selected by the AAPG to serve in their Visiting Geologist Program. In 2001, he received the best paper award from the AAPG's Division of Professional Affairs, and again in 2007 he was honored for delivering a 'Top Ten Oral Presentation' at the AAPG annual convention in Long Beach.

Gary regularly donates his time to the AAPG for for its education curricula, teaching courses on prospect, play and shale analysis. Gary has served in the AAPG House of Delegates and in the SPE as an Associate Editor for Economics and Management journal (SPEEM). He is a Texas State certified and licensed Geologist who has authored or co-authored more than a dozen publications, and has been an invited and honored speaker for the SIPES, Geological Society of London, AAPG, SPE and SEG.

*Barry Katz*

*bjkatz.hgs@gmail.com*

# Reasons to Join the Crowd – Attend AAPG

Thirty five years ago I attended my first the AAPG Annual Convention and Exhibition in Houston. I interviewed with Texaco at that conference and within three months I began my professional career here in Houston. Since then I have attended all but two of the annual meetings. Why have I attended these meetings as well as several of the international conferences? There are several reasons for my continuous attendance at these conventions:

- The technical program provides a means to learn about some of the emerging exploration plays and new developments in the geosciences;
- There are numerous occasions for building and maintaining a professional network;
- Opportunities exist to present my work and have it vetted by peers.

This year, once again, the annual convention will be held in Houston and the Houston Geological Society will be acting as host. The technical program is quite robust and should provide those new to the industry an opportunity to begin building a strong technical foundation.

For those of us that have been around for a few years, there is the opportunity to see what is new and how things have changed. Just consider unconventional resources. A few years ago no one considered fine-grained rocks to be potentially exploitable reservoirs. They were considered source rocks and seals, but not reservoirs. Today, we view these rocks as complete petroleum systems. Concepts in geoscience are rapidly evolving and in a world of low natural gas prices we need to exploit these resources with a scalpel and not a machete. Our work requires a better understanding of where the core producing areas are and the stratigraphic position of the "sweet spot," as well as the controls on both, and where the hydrocarbons are stored and ultimately how we can maximize production. These unconventional resources will be one of the eleven technical themes of this year's convention.

*An effective network requires nurturing, which means occasional face-to-face connections, phone calls, and emails.*

If the past is any guide to the future, this year's meeting will also be an excellent networking opportunity. The last AAPG meeting in Houston was attended by more than 8100 attendees and this number may be exceeded this year. Use time between talks, during coffee breaks and lunch, at the many social events and in the exhibition hall to network. Meet new people working in your field and renew contacts face-to-face. We must all remember that a network is more than a connection on LinkedIn. An effective network requires nurturing, which means occasional face-to-face connections, phone calls, and emails. There is no better time for those face-to-face meetings than this year's convention, and I will be scrambling to touch base with those in my personal network that has developed over the past few decades. A number of the contacts that I have made and nurtured at AAPG have over the years become friends and collaborators. They have provided data, technical reviews, and have helped with an interpretation of a unique dataset every once in a while.

I will also be presenting a paper at this year's meeting. Early in my career, my reason for presenting at AAPG was to help establish my professional standing and to receive external feedback. I wanted to ensure that my thoughts, concepts, and beliefs were not too inwardly focused and limited by corporate needs and wants. Today, I believe that my professional standing has been established, but I still remain interested in having my work vetted. The program for this year has been set, but there will be opportunities to present at next year's meeting in Denver or at the 100th Anniversary Convention in 2017 back here in Houston.

I strongly recommend that you register for this year's convention. If you can't break away from the office for the three days of the meeting, carefully review the program and pick a day to attend. All of us can find at least one day to attend this meeting. Professional conferences and conventions should truly be considered work and be part of one's development. **From The President** *continued on page 9*

## AAPG 2014 Houston Convention Special Event

# HGS "Night at the Paleontology Museum"

## Featuring Dr. Robert T. Bakker

**Tuesday, April 8, 2014**
**6:30pm – 10:30pm**

**Morian Hall of Paleontology, Houston Museum of Natural Science**

$65 per person for adults
$35 per person for students

Tickets sold online at the AAPG convention website www.aapg.org/houston2014/

Admission includes multi-course buffet dinner and IMAX theatre talk. Cash bar.

Free AAPG bus shuttle (leaving and returning) to the George R. Brown Convention Center.
Free museum garage parking for registrants driving personal cars.

**Event Sponsor**

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Join the Houston Geological Society on Tuesday, April 8, and experience the world-class Houston Museum of Natural Science Morian Hall of Paleontology featuring over sixty huge fossil displays and 30 action-posed dinosaurs. Inspect a real T. rex skeleton featuring the best preserved and most complete hands and feet of any T. rex ever found! See a uniquely well-preserved Triceratops — "mummified" with preserved skin, plus fossil dinosaur eggs and a "prehistoric safari" that includes the grand saga of human evolution! There will be guided tours by volunteer experts inside the exhibit hall, plus time to meet Dr. Bakker and ask questions about the dinosaurs.

Your ticket buys you a delicious buffet dinner, drinks and amazement, as you sit next to the huge dinosaur, reptile and fossil displays. The HGS encourages AAPG convention registrants to bring spouses and young guests to this social event. This night at the museum will include a fascinating talk by Dr. Robert T. Bakker, ground breaking science author ("The Dinosaur Heresies") and authority on dinosaur evolution. Dr. Bakker is a world-famous lecturer, consultant and advisor to the movie Jurassic Park.

This event is sure to sell-out and space is limited to the first 400 people. Tickets for AAPG convention participants and guests will be sold online using the AAPG ACE convention website at www.aapg.org/houston2014/.

*Michael F. Forlenza, P.G.*
*hgs.forlenza@gmail.com*

# Strategic Geology: The Mystery and Allure of Rare Earth Elements

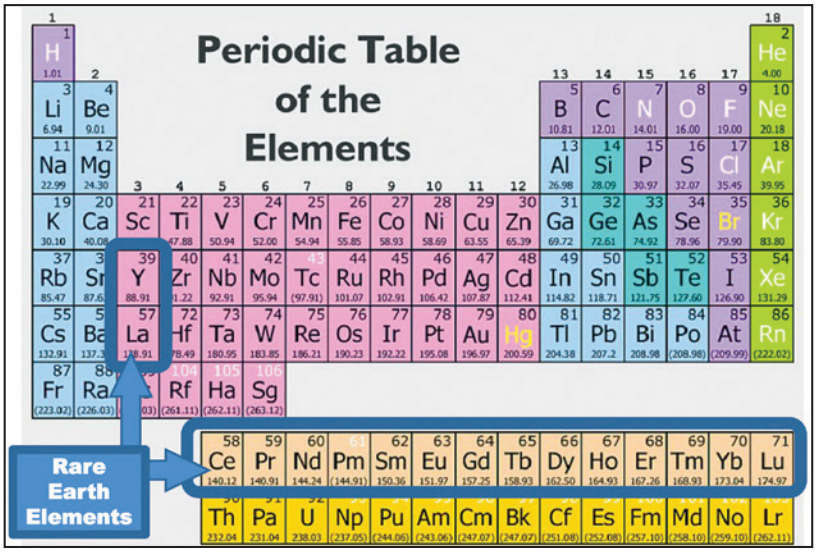
Samarium, Praseodymium, Terbium, Lutetium. These sound odd. Are these break-away republics from the old Soviet Union? Maybe some new wonder drugs for weigh loss or baldness? In fact, these are members of a group of chemicals known as rare earth elements.

The availability and supply of rare earth elements have become critical in the functioning of our modern high-tech economy. Concerned strategists may say the United States faces a crisis in the reliability of this supply due to a lack of domestic production and that the control of the majority of the world's supply of rare earth elements by China puts the United States at risk of a supply disruption.

So, what are rare earth elements? How is their occurrence and abundance influenced by geology? And, why are they important?

## Rare Earth Elements

Rare earth elements (REEs) are a group of seventeen metallic elements that occur together in the periodic table. The group consists of yttrium and the 15 lanthanide elements (lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium). Scandium is found in most REE deposits and is sometimes classified as a REE. The International Union of Pure and Applied Chemistry includes scandium in their definition of REEs.




*Source: United States Geological Survey*

These metals have many similar geochemical properties that often cause them to be found together in geological deposits. These metals are silver, silvery-white, or gray with a high luster and high electrical conductivity. Because these metals all bond strongly to oxygen, they tend to occur together in the structure of various minerals. These bonds also make them hard for refiners to separate.

The REEs are not as rare as their moniker would suggest. According to the United States Geological Survey (USGS) Scientific Investigations Report 2010-5220, titled the "Principal Rare Earth Element Deposits of the United States", by the authors K. R. Long, B. S. Van Gosen, N. K. Foley, and D. Cordier, the estimated average concentration of the REEs in the Earth's crust ranges from around 150 to 220 parts per million. These concentrations exceed that of many other metals that are industrially mined such as copper (55 parts per million) and zinc (70 parts per million). Unlike most commercially-mined base and precious metals, however, REEs are rarely concentrated into mineable ore.

## The Geology of Rare Earth Elements

Economically important occurrences of REEs are associated with several varieties of uncommon alkaline igneous rocks including carbonatite, alkaline intrusive complexes, and peralkaline formations, as well as their weathering products. The United States has recently conducted studies of the occurrence and distribution of REEs. The USGS's Mineral Resources Program's Open-File Report 2011–1256, "Carbonatite and Alkaline Intrusion-Related Rare Earth Element Deposits – A Deposit Model" by Philip L. Verplanck and Bradley S. Van Gosen, presents the findings of some of this recent work.

As described in the USGS report, alkaline rocks form an expansive category of igneous rocks. Using a broad definition, alkaline rocks are

**From The Editor** *continued on page 9*

## From the President continued from page 5

There is more than AAPG for you to consider this month. The HGS Board has started considering awards and honors that will be presented this coming June. We have ideas but would like to hear from you. Are there members of the Society that you believe have contributed to the organization, the science, or the community? Send the Board a brief note letting us know who you believe should be recognized by the organization and why. At our January Board meeting, we decided to explore the idea of new awards so please don't feel constrained by actions of prior boards. Remember, professional recognition is important.

Hoping to see you at the George R. Brown Convention Center in April. ■

Until next time...

## From the Editor continued from page 7

deficient in $SiO_2$ relative to $Na_2O$, $K_2O$, and CaO. Carbonatites are defined by the International Union of Geological Sciences (IUGS) system of igneous rock classification as having more than 50% primary carbonate minerals, such as calcite, dolomite, and ankerite, and less than 20% $SiO_2$. Most identified carbonatites are intrusive bodies, but a few extrusive examples are known, most prominently an active carbonatite volcano in northern Tanzania. Peralkaline rocks are one subset of alkaline rocks, defined by $(Na_2O + K_2O)/(Al_2O_3)>1$.

Mineral deposits associated with carbonatites account for the greatest production of REEs. Important deposits are the Bayan Obo deposit in Inner Mongolia in China, and the Sulphide Queen carbonatite of the Mountain Pass district, California. Until the late 1980s, the Mountain Pass mine was the largest global producer of REEs, subsequently supplanted by the Bayan Obo deposit, which is currently the largest producer of REEs. Carbonatite REE deposits are extremely enriched in light REEs, particularly lanthanum, cerium, and neodymium. Although there are no peralkaline alkaline intrusion-related deposits currently being mined for REEs, many are in various stages of exploration because these igneous rocks contain relatively high concentrations of heavy REEs.

Carbonatites and peralkaline igneous rocks tend to occur within stable continental tectonic units, in areas defined as shields, cratons, and crystalline blocks; they are generally associated with intracontinental rift and fault systems. These igneous rocks formed from the cooling of silica-undersaturated, alkaline magmas, which were derived from repeated partial melting in the Earth's upper mantle. The evolution of these initial mantle melts is not well understood. When these magmas ascend through the Earth's crust, their chemical composition undergoes changes in response to variations in pressure, temperature, and composition of surrounding rocks. The result is an astonishing diversity of rock types that are variably enriched in economic elements such as zirconium, niobium, strontium, barium, lithium, and the REEs.

The principal REE-bearing minerals associated with carbonatites are fluocarbonates (bastnäsite, parasite, and synchysite), hydrated carbonates (ancylite), and phosphates (monazite and apatite). Other REE phases are less common, such as britholite and burbankite.

*Rare-earth oxides (clockwise from top center): praseodymium, cerium, lanthanum, neodymium, samarium, and gadolinium. Source: United States Department of Agriculture.*

A common feature of most carbonatite and alkaline intrusion-related deposits is that the surrounding rocks have been hydrothermally altered because of alkali metasomatism. This style of alteration is known as fenitization, so-named because it was first described at the Fen alkaline complex in southern Norway. Alkali-rich fluids are released into the country rock from the crystallizing magma, and reactions convert the host rock minerals to an assemblage of alkali-bearing minerals. Fenites can be classified as sodium or potassium rich. Sodium-rich fenites are characterized by the presence of alkaline feldspar with alkali amphibole or sodic pyroxene, and potassium-rich fenites contain potassium feldspar.

Potentially useful concentrations of REEs can also be found in pegmatites and placer deposits. Among pegmatites, very coarse grained intrusive igneous rocks, the niobium-yttrium-fluorine family comprises a large number of subtypes formed in different geologic environments. These subtypes are granitic in composition and are usually found peripheral to large granitic intrusions. REE-bearing pegmatites have a limited extent and are of economic interest only to mineral collectors. **From The Editor** *continued on page 11*

## From the Editor continued from page 9

Placer deposits are sedimentary accumulations of the REE-bearing minerals, typically monazite and xenotime. Heavy minerals weathered from deeply eroded host rocks are preferentially sorted by hydraulic processes in fluvial or marine environments due to their higher densities. The source rock need not be an alkaline igneous rock. Many common igneous, metamorphic, and even older sedimentary rocks contain enough monazite to make the mineral ubiquitous in placer deposits. Placers types with the greatest concentrations of monazite are typically ilmenite-heavy mineral placers, which have been mined for titanium oxide pigments, and cassiterite placers, which are mined for tin.

### Rare Earths in Texas

REEs have been extracted from at least three locations in Texas. These include the Williams mine in Llano County, the Cornudas Mountains in Hudspeth County, and the Caballo Mountains in Fisher County. Several tons of pegmatite ore were extracted from the Williams mine for the minerals prior to 1909. According to P. Möller in the 1989 paper, "Rare Earth Mineral Deposits and their Industrial Importance," the REE-bearing minerals allanite, gadolinite, and fergusonite were mined along with fluorite from the Middle Proterozoic Town Mountain Granite.

In Hudspeth County, the REE-bearing minerals eudidymite and bastnäsite were extracted from the Victorio Peak Formation on the Diablo Plateau. A 1987 report, Alkaline Rocks and Carbonatites of the World, Part 1, by A.R. Woolley, published by the British Museum of Natural History, indicates that the ore was mined from the nepheline, syenite, and phonolite alkalic igneous host rocks. In the Caballo Mountains, Woolley reports that bastnäsite was mined from quartz monzonite and potassic dikes.

### Expensive Extraction

The extraction of the metallic REEs from ores is difficult and costly. The ores are mineralogically and chemically complex and commonly radioactive. The already difficult metallurgical processes are compounded by the unique composition of each ore. No two are truly alike and there is no standard process for extracting and refining the ore into marketable materials. Before a new mine can be brought on line, extensive and costly testing is required using a variety of known and experimental extraction methods to optimize processing.

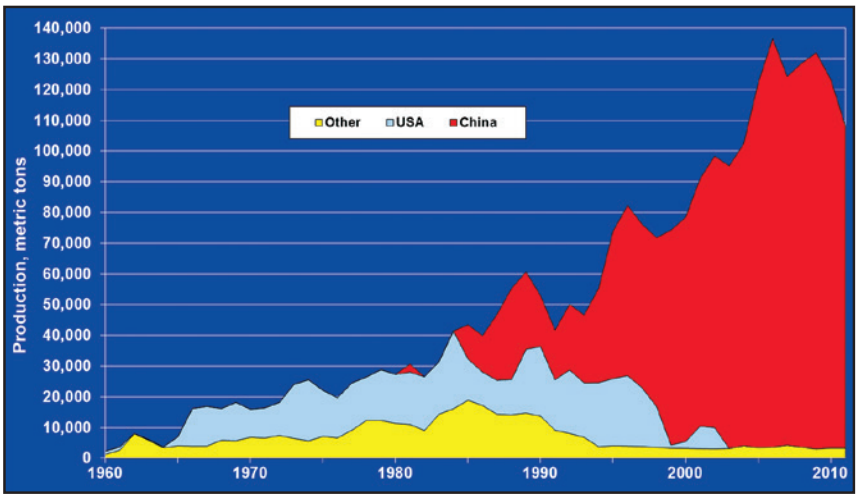
When elements of interest are found in two or more mineral phases within the same host material, each requiring a different extraction technology, the mineral processing is technically challenging. Current mineral-processing practices are capable of sequential separation of multiple mineral phases from one ore, but these methods are often not cost effective. Consequently, deposits where only one REE is concentrated will have a competitive cost advantage over deposits where multi-element extraction is conducted. To date, production has largely come from single-mineral-phase deposits, such as Bayan Obo (bastnäsite) in China, Mountain Pass (bastnäsite) in California, and heavy-mineral placers (monazite).

REE-bearing minerals, once separated, contain as many as 14 individual REEs that must be further separated and refined. The principal deleterious impurity is radioactive thorium. Because radioactive materials are difficult to mine and handle safely, they are heavily regulated. Radioactive mining tailings are often classified as hazardous waste requiring special and expensive disposal methods. The cost of handling and disposing of radioactive material is a serious impediment to the economic extraction of the more highly-radioactive REE-rich minerals. Monazite in particular typically contains considerable amounts of thorium.

### Demand and Production

Before 1950, there was relatively little demand for REEs. At that time, most of the world's supply was produced from placer deposits in India and Brazil and the Mountain Pass Mine in California was producing minor amounts of rare earth oxides from a Precambrian carbonatite. The demand for REEs began to accelerate in the mid-1960s as color televisions were beginning to be manufactured for the mass market. Europium was the essential material for producing the phosphors for the color images. Bastnäsite from the Mountain Pass Mine contained about 0.1% europium. By 1970, this demand made the Mountain Pass Mine the largest REE producer in the world and the United States the leading producer.

**From The Editor** *continued on page 13*




*Global rare earth oxide mine production. Source: United States Geological Survey*

## From the Editor continued from page 11

China began producing rare earth oxides in the early 1980s and became the world's leading producer and exporter by the early 1990s. Through the 1990s and early 2000s, China steadily strengthened its share of the world's rare earth oxide market. The Mountain Pass Mine, and many others throughout the world, were unable to compete with the low cost of production in China and stopped operation.

At the same time, world demand for rare earth metals was burgeoning with their use in materials for a wide variety of defense, aviation, industrial, and consumer electronics products. China capitalized on its dominant position, more than 90% of world production, by restricting exports in 2010 and allowing rare earth oxide prices to rise to historic levels. Due to these rising prices, mining companies in the United States, Australia, Canada and other countries began to reevaluate old REE prospects and explore for new ones. In 2012, the Mountain Pass Mine came back into production and the United States produced about 6% of the world's REEs, with Australia making a little over 3%. Additionally, exploration and development projects have been initiated in Brazil, Finland, Greenland, India, Kyrgyzstan, Madagascar, Malawi, Mozambique, South Africa, Sweden, Tanzania, Turkey, and Vietnam.

Since 2010, prices have dropped sharply as the global economy slowed, new sources have come online, and companies developed methods to use less. Lanthanum oxide is currently around $6 per kilogram, far below its price of $104 in 2011, according to data provided by Australian rare-earth producer Lynas Corp and Mineralprices.com.

### Uses

Although industrial demand for REEs is relatively small in tonnage terms, the materials are essential for a diverse and expanding array of industrial and high-technology applications. The primary uses are for chemical catalysts, metallurgy, and glass polishing. Increasing amounts of REEs are used in magnets, metal alloys for batteries and lightweight structures, and phosphors essential for many current and emerging alternative energy technologies, such as electric vehicles, energy-efficient lighting, and wind power. Several pounds of rare earth compounds are in batteries that power every electric and hybrid-electric vehicle. REEs also play an essential role in our national defense in their use in night-vision goggles, precision-guided weapons, communications equipment, GPS equipment, batteries and other defense electronics.

### Strategic Implications

The global production and supply of REEs comes from only a few sources, with China foremost among them. The USGS Open-File Report 2011-1042, "China's Rare-Earth Industry", 2011, by P. Tse, points out that because of China's earlier decisions to restrict exports, the United States and other developed nations have heightened concerns about future availability.

| Use Category | Share by Volume % | Share by Value % | Growth Rate % |
|---|---|---|---|
| Catalysts | 22 | 5 | 4 – 7 |
| Magnets | 22 | 37 | 10 – 16 |
| Metal alloys | 20 | 14 | 15 – 20 |
| Polishing | 9 | 4 | 6 – 8 |
| Glass | 9 | 2 | negligible |
| Phosphors | 5 | 31 | 7 – 10 |
| Other | 13 | 7 | 5 – 9 |

*Principal use categories for rare earths*

| | |
|---|---|
| Lanthanum | night-vision goggles |
| Neodymium | laser range-finders, guidance systems, communications |
| Europium | fluorescents and phosphors in lamps and monitors |
| Erbium | amplifiers in fiber-optic data transmission |
| Samarium | permanent magnets that are stable at high temperatures<br>precision-guided weapons<br>"white noise" production in stealth technology |

*Defense uses of rare earth elements. Source: Geology.com*

In a December 13, 2013, *Wall Street Journal* article titled, "China Seeking to Trim Exports of Rare-Earth Minerals", author Chuin-Wei Yap reported that China implemented a second round of export quota reductions of REEs despite a shrinking share of the global output. China's Commerce Ministry said it would set its rare-earth export quotas for 2014 at 15,110 metric tons, a 2.5% decline from last year.

China's announcement of lowered export quotas for REEs for 2014 was made despite a ruling against such export quotas by the World Trade Organization. Several recent legislative actions in the United States are aimed at mitigating the possible threat of REE supply disruptions. The National Defense Authorization Act authorizes the Pentagon to stockpile certain critical minerals, including dysprosium and yttrium. Using the National Defense Stockpile Transaction Fund, the Department of Defense may spend up to $41 million to acquire specified materials for each fiscal year from 2014 to 2019. In addition, the Defense

**From The Editor** *continued on page 15*

## From the Editor continued from page 13


*Principal rare earth deposits in the United States. Source: United States Geological Survey.*

Logistics Agency will encourage the domestic supply of strategic and critical minerals.

According to the Congressional Research Report, "Rare Earth Elements in National Defense" released in December 2013, United States policymakers have expressed growing concern that the nation has lost its domestic capacity to produce strategic and critical materials. The Critical Minerals Policy Act of 2013 included directives to develop methods for determining which minerals are critical resources, based on supply restrictions and demand, and to establish a comprehensive national assessment of critical minerals.

Meanwhile, a January 2014 article by Per Liljas in *Time Magazine* says that the British Islands-based private equity firm SRE Minerals Limited has announced that a geological study identified a deposit containing 216 million tons of REEs in North Korea. If verified, the discovery would more than double global known resources and be six times greater than the reserves in China. The report indicates that SRE Minerals Limited entered into a 25-year deal to develop the deposits in Jongju, northwest of the capital, Pyongyang. The USGS said there was insufficient information to comment on the significance of the announcement. SRE acknowledges the estimates are conceptual and not yet proven.

### Summary

Maybe the REEs are not so much rare as undervalued. The geology and occurrence of the REEs is complex and the extraction technically challenging. When the invisible hand market finds the right price, multiple sources become available. So, it is not geology or engineering that makes REEs precious, but economics: supply and demand. ■

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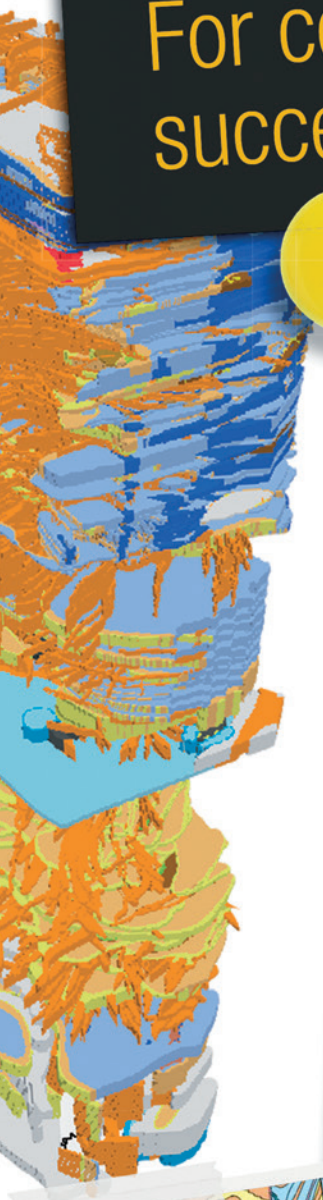


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***James M. Rine,* Erin Smart, William Dorsey, Kultaransingh Hooghan, and Michael Dixon***
*Weatherford Laboratories*
**james.rine@weatherlabs.com*

# Comparison of Porosity Distribution within Selected North American Shale Units by SEM Examination of Argon-Ion Milled Samples

Electron microscopic examination of pores within mudrocks (shales and mudstones) has become much more sophisticated over the last few years, driven not only by the intense economic interest in shale gas and oil, but also by the technological improvements that allow characterization of nanometer-scale features. In the last five years, electron microscopy techniques have evolved sufficiently to allow researchers to identify and quantify nanometer-scale pores. Previous studies characterized mudstone porosity by documenting the frequency distribution of pore sizes. This was done by comparing maximum pore diameters (Loucks et al., 2009) and by analyzing pore volumes (Sondergeld et al., 2010).

*In the last five years, electron microscopy techniques have evolved sufficiently to allow researchers to identify and quantify nanometer-scale pores.*

The objective of this talk is to demonstrate other approaches to porosity analysis by categorizing different pore type distributions and by measuring relative abundances of pore area and volume in four mudrock units: the Mississippian Barnett, Upper Jurassic Haynesville, Middle Devonian Marcellus formations, and the Upper Cretaceous Eagle Ford Group. Although the authors believe the data sets analyzed are insufficient to make broad conclusions concerning the pore systems in these rock units, it is hoped that the approaches demonstrated will assist future researchers with access to more comprehensive data sets.

This talk, which is derived largely from Rine et al. (2013), compares pore-type character and pore-size distribution between the shales. This comparison is based on the results of two-dimensional field emission environmental scanning electron microscope (FE-ESEM) examinations of ten argon-ion milled (AIM) processed **HGS General Dinner** *continued on page 19*

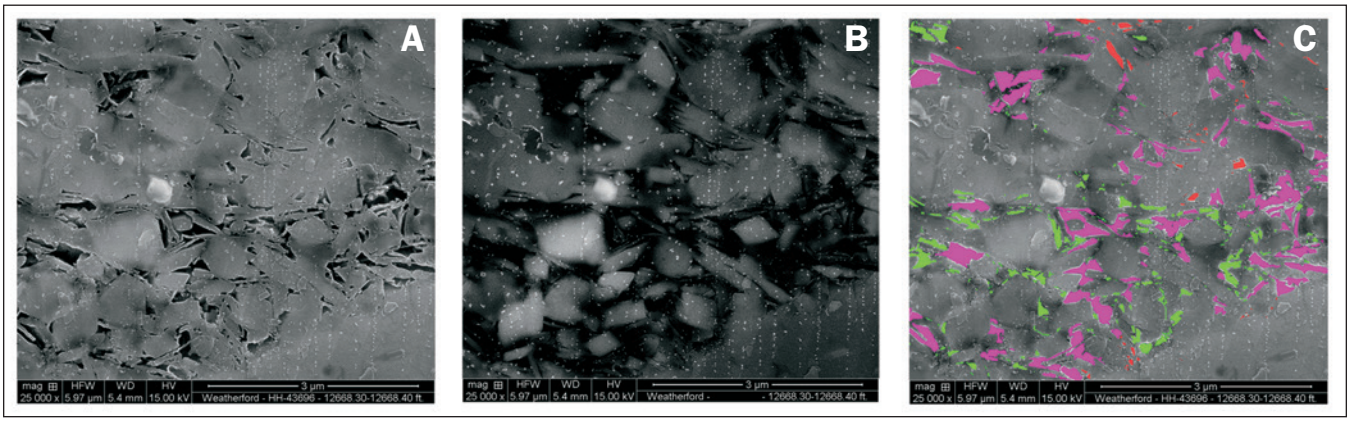


**Figure 1.** *FE-ESEM images of a Haynesville Shale sample. The photomicrographs, which are of the same field of view, include an SE image (A), a BSE image (B), and an analyzed image (C) where pores have been colored and delineated as organic (green), mixed matrix/organic (pink), and matrix (red) pores. Pores were identified with SE images based on their degree of darkness (central portions of pores are generally black) and their generally bright edges. Dark (black) areas within the BSE image depict the presence of pore space or organic material. Note that the majority of the matrix/organic pores have one or more straight borders and may abut inorganic particles. The figure is from Rine et al. (2013).*

## HGS General Dinner continued from page 17

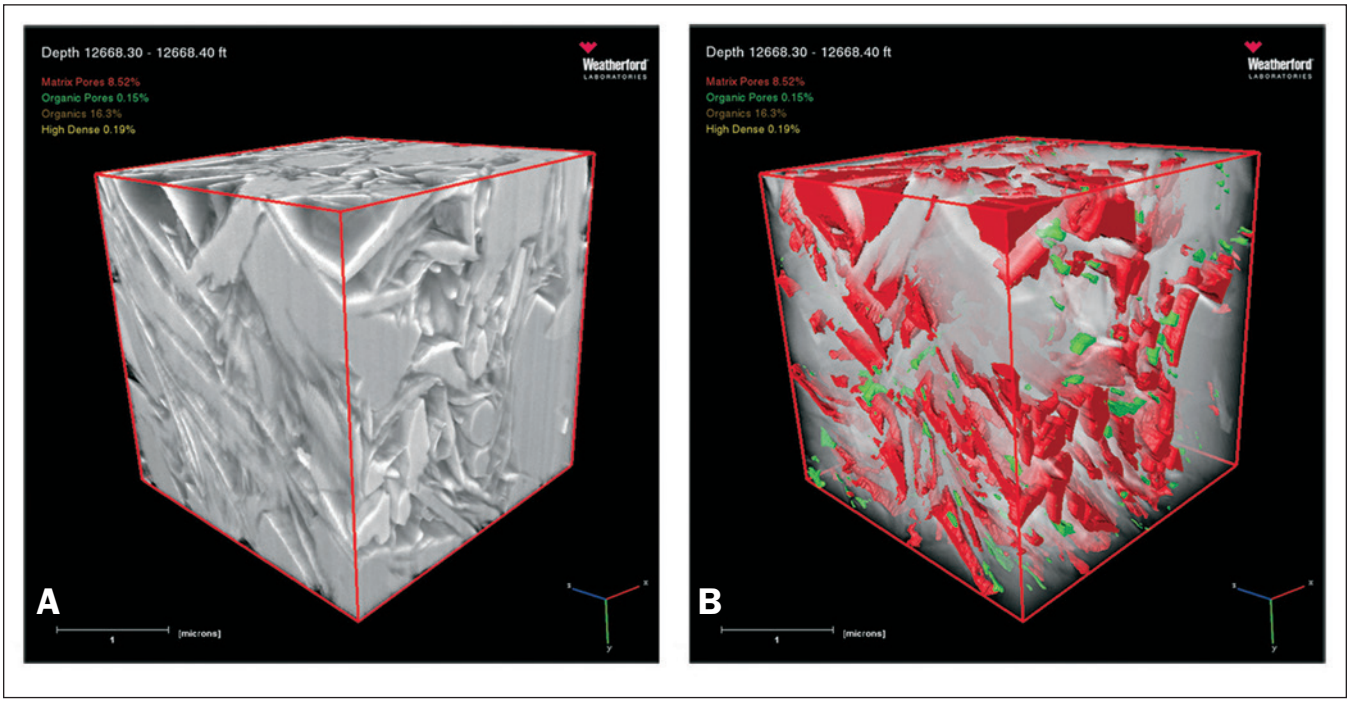


**Figure 2.** *The 3-D blocks depict one focus ion beam scanning electron microscopy (FIB-SEM) analysis done on a portion of a Haynesville Shale sample. Figure A is a grey scale image of the FIB-SEM analyzed sample. Figure B is the sample with interpreted distribution of matrix or nonorganic pores (red) and organic pores (green). The dimensions of the block are 5.30 microns wide by 3.5 microns thick. The total porosity of the FIB-SEM sample is calculated to be 9.0%, whereas the porosity determined by the AIM FE-ESEM survey is 10.8%. The crushed porosity determination for this sample is 8.2%. The figure is from Rine et al. (2013).*

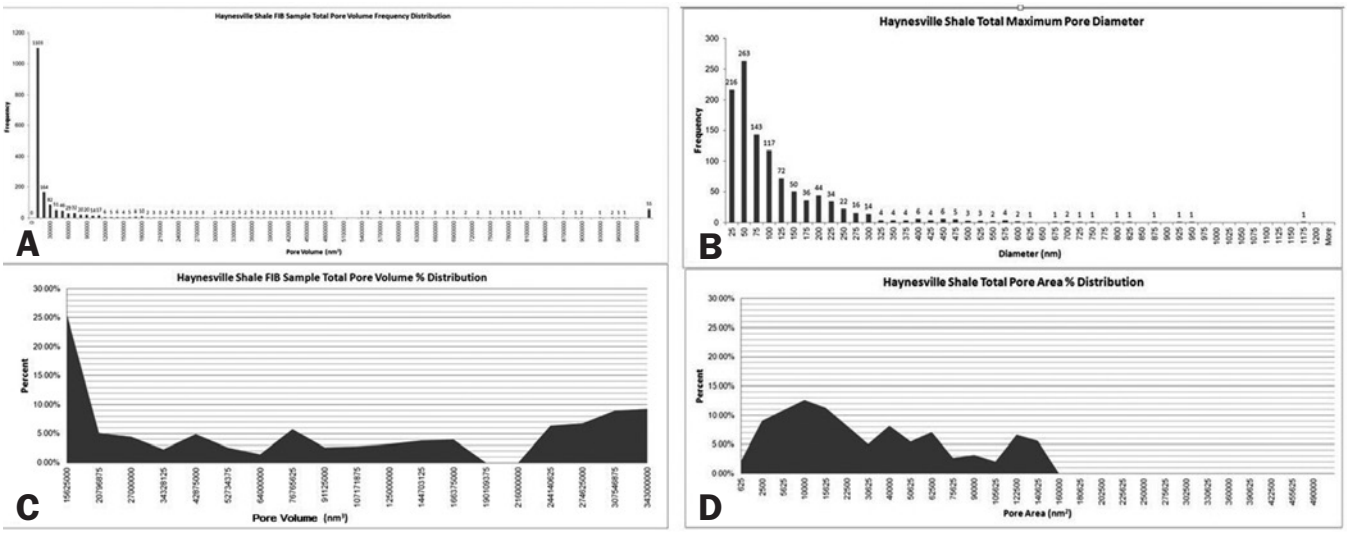


**Figure 3.** *Frequency distribution of total pore volumes within the one Haynesville sample examined by the FIB-SEM (A) is similar to the histogram of Haynesville total pore sizes, based on maximum pore diameters from AIM FE-ESEM examinations (C). The distribution of total porosity (B), or total pore volume between the pores sizes shows a distribution not as skewed to the smaller pore sizes. Relative distribution of pore area values (D) also shows a distribution not as skewed to the smaller pore sizes, as shown in the maximum pore diameter frequency plot C. The figure is modified from Rine et al. (2013).*

samples. This paper also compares results of FE-SEM examination of one AIM Haynesville sample (**Figure 1**) with the three-dimensional focused ion beam scanning electron microscope (FIB-SEM) examination of the same sample (**Figure 2**).

With the AIM samples, pore types are subdivided into three categories: organic pores, mixed matrix/organic pores, and matrix pores based upon the amount and type of material (organic or inorganic) surrounding the pores. This approach differs from the pore-type classification of Loucks et al. (2012) and is less subjective. Organic pores are pores generally associated with kerogen macerals whereas mixed matrix/organic pores are pores that are probably associated with bitumen or pyrobitumen. Matrix

**HGS General Dinner** *continued on page 21*

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## HGS General Dinner continued from page 19

pores are not associated with any organic matter. Within the sample set studied, only the Barnett samples contain pores almost exclusively within organic particles. The majority of the maximum pore diameters are less than 100 nanometers in all the samples examined. Only the Barnett samples, however, had a majority of their pore areas (or porosity) comprised of pores less than 10,000 square nanometers (which is the area of an equidimensional pore with the maximum pore diameter of 100 nanometers).

The major conclusions derived from this study are as follows:

1. Relative distributions of pore areas (or volumes) should be considered when comparing mudrock units, in addition to comparing frequency distribution of maximum pore-diameters.

2. Pore types (organic pores, mixed matrix/organic pores, and matrix pores) show significant distribution differences between mudrock units.

3. For the characterization of nanometer-scale pores, SEM examination of AIM samples is a far superior methodology to thin section petrography and standard (broken sample) SEM examinations. ■

### References Cited

Loucks, R.G., R.M. Reed, S.C. Ruppel, and D.M. Jarvie, 2009, Morphology, genesis, and distribution of nanometer-scale pores in siliceous mudstones of the Mississippian Barnett Shale: *Journal of Sedimentary Research*, v.79, p. 848-861.

*Pictured from left to right: James M. Rine, Erin Smart, William Dorsey, Kultaransingh Hooghan, and Michael Dixon*

Loucks, R.G., R.M. Reed, S.C. Ruppel, and U. Hammes, 2012, Spectrum of pore types and networks in mudrocks and a descriptive classification for matrix-related mudrock pores, *AAPG Bulletin*, v. 96, p. 1071-1098.

Rine, J. M., E. Smart, W. Dorsey, K. Hooghan, and M. Dixon, 2013, Comparison of Porosity Distribution within Selected North American Shale Units by SEM Examination of Argon-Ion Milled Samples, in Camp, W. K., E. Diaz, and B. Wawak, eds., Electron microscopy of shale hydrocarbon reservoirs: *AAPG Memoir 102*, p. 137-152 .

Sondergeld, C.H., R.J. Ambrose, C.S. Rai, and J. Moncrieff, 2010, Micro-structural studies of gas shales (SPE 131771-PP, SPE), Unconventional Gas Conference, Pittsburgh, PA 23-25 February 2010, 17p.



## Letters to the Editor

Letter to the Editor (February 4, 2014):
Michael,
I commend your efforts on compiling the article, Energy – Water Nexus: Texas, Drought, Fracking, and Water, in the February 2014 issue of the HGS *Bulletin*.
Thank you for the effort and time you took to put this together.
Jim
James (Jim) M. Rine, Ph.D.
Principal Geologist / Geologic Advisor
Sedimentology Group
Weatherford Laboratories

.....

Letter to the Editor, February 2, 2014
Sirs:
I am appalled that a magazine purporting to speak for the largest concentration of geologists in America should produce such an impossible statement as appears on page 1 of its February issue.
I am referring to the written explanation of the cover photograph of Iguazu Falls. Sentence #2 in the description, "The falls are located on the border of Argentina and Brazil just downstream of the confluence of the Iguazu and Parana Rivers. IMPOSSIBLE!!
The falls are really UPSTREAM on the Iguazu River! If they were downstream of the confluence with the Parana River, they would be ON the Parana River and thus be between Paraguay and Argentina.
A grade of A on the photo: A grade of F to the author – or at least the proofreader.
William H. Hintze
Certified Professional Geologist

**Editor's Note:** Wow! Someone reads the cover caption.

**Wednesday, Maarch 12, 2014**

Black Lab Pub, Churchill Room • 4100 Montrose Blvd.

Social 5:30 p.m., Dinner 6:30 p.m.

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***Paul Choules, Senior Vice President of Business Development***
*Water Standard*

# Desalination: A Drought Proof Solution for the State of Texas

There is heightened interest in the process of desalination as a proposed drought-proof solution to address the issue of water scarcity with the ultimate goal of mitigating the harsh effects of drought that have affected the state of Texas since 2011. It is also important to note that the attraction of desalination goes beyond alleviating the effects of the drought. Several positive outcomes result from desalination: 1) ensuring water supply to industrial and public sectors, 2) avoiding restrictions on local and international economic activities due to unforeseen water scarcities, and 3) preventing overuse and depletion of the state's natural water resources.

Even more compelling is the fact that Texas has spearheaded several recommendations on seawater desalination as one of the primary water management strategies that would potentially result in 125,514 acre-feet per year of new water supply by 2060 (Texas Water Development Board, 2012). Interest in the use of brackish groundwater as an alternative source of water for desalination also continues to grow as an alternative to the sole use of seawater. Another appealing aspect of the use of brackish groundwater is that its salt content is much less in comparison with seawater. This makes brackish groundwater more cost effective to desalinate than seawater. Nevertheless, other factors such as quantity, demand, economics, and environmental impacts must be considered prior to commencement of any desalination project regardless of water source. ■

## Biographical Sketch

During his over 30 years in the desalination industry, Paul Choules has worked in the areas of business development, permitting, start-up, commissioning, project management, and operating of reverse osmosis and thermal desalination plants around the world with industrial, oil and gas, and municipal clients. Prior to joining Water Standard, Mr. Choules served as vice president with Veolia Water Solutions and Technologies where he led the development and execution of multiple projects in the industrial and municipal markets. Prior to Veolia's acquistion of Weir Techna, Mr. Choules was Techna's regional vice president for the Americas when they contracted and constructed multiple water treatment projects for offshore oil and gas facilities.

His experience also includes 19 years at MECO, where he was responsible for providing support to over 250 desalination installations and developed and executed some of the first successful membrane desalination plants in the Middle East. He was identified as one of 36 global desalination expert "Desalters" in the history of the industry by Global Water Intelligence in August 2011. He is a board member and current president of both the Texas Desalination Association and the Caribbean Desalination Association.

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Westchase Hilton • 9999 Westheimer
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***William Sager***
*Earth and Atmospheric Sciences*
*University of Houston*
*wwsager@central.uh.edu*
*www.geosc.uh.edu*

# Seismic Imaging of the Largest Single Volcano in the World: the Story of Tamu Massif

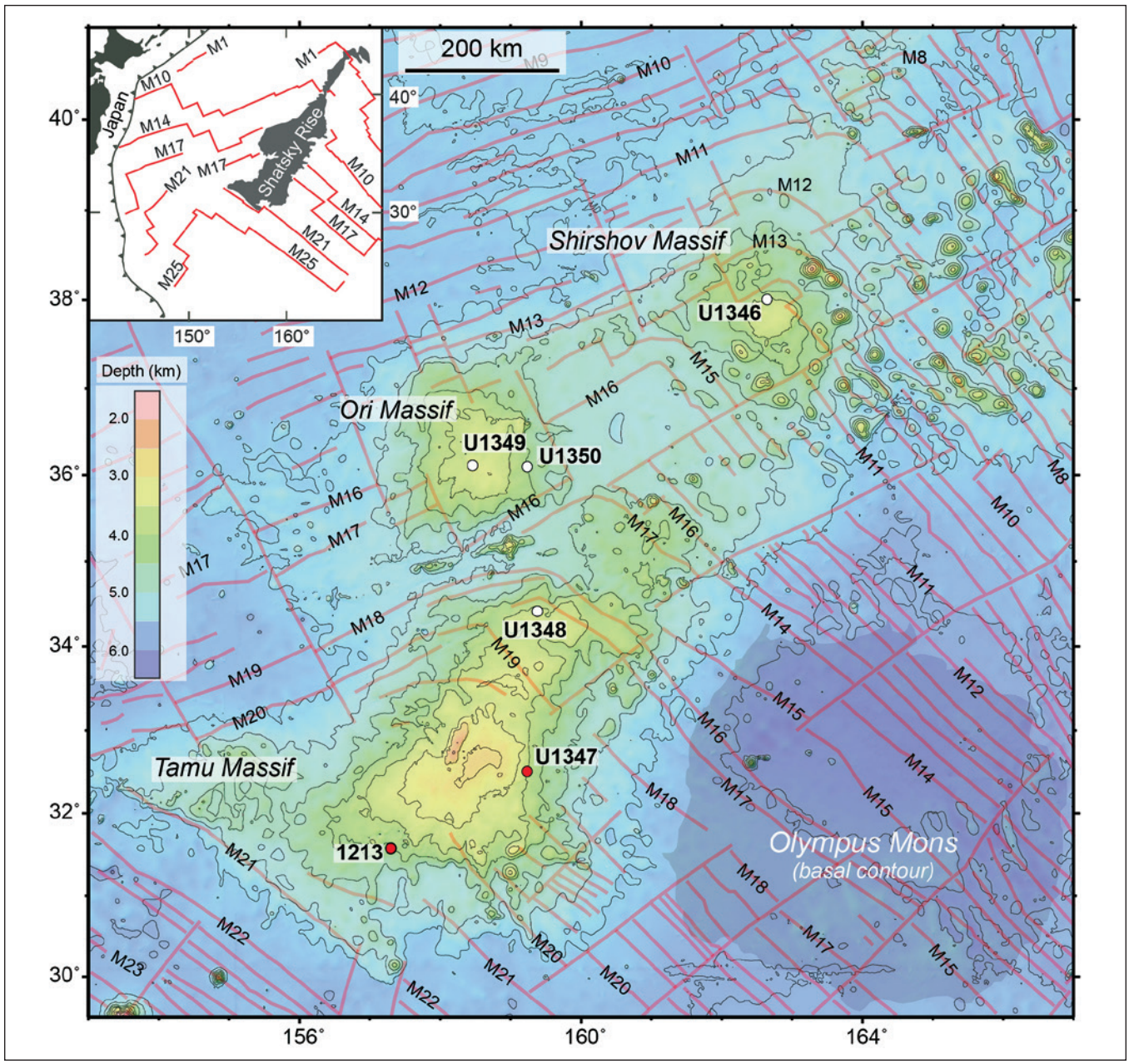


**Figure 1.** *Bathymetry map of Shatsky Rise, showing the morphology of Tamu Massif and other volcanic edifices. Contours are shown at 500-m intervals. Red lines show magnetic anomalies (of the Mesosoic M-series) and fracture zones. Numbered and white dots denote Ocean Drilling Program and Integrated Ocean Drilling Program drill sites. The gray area in the lower right shows the basal contour of Olympus Mons volcano on Mars for size comparison. The inset at upper left gives the location of Shatsky Rise relative to Japan.*

**HGS International Dinner** *continued on page 27*

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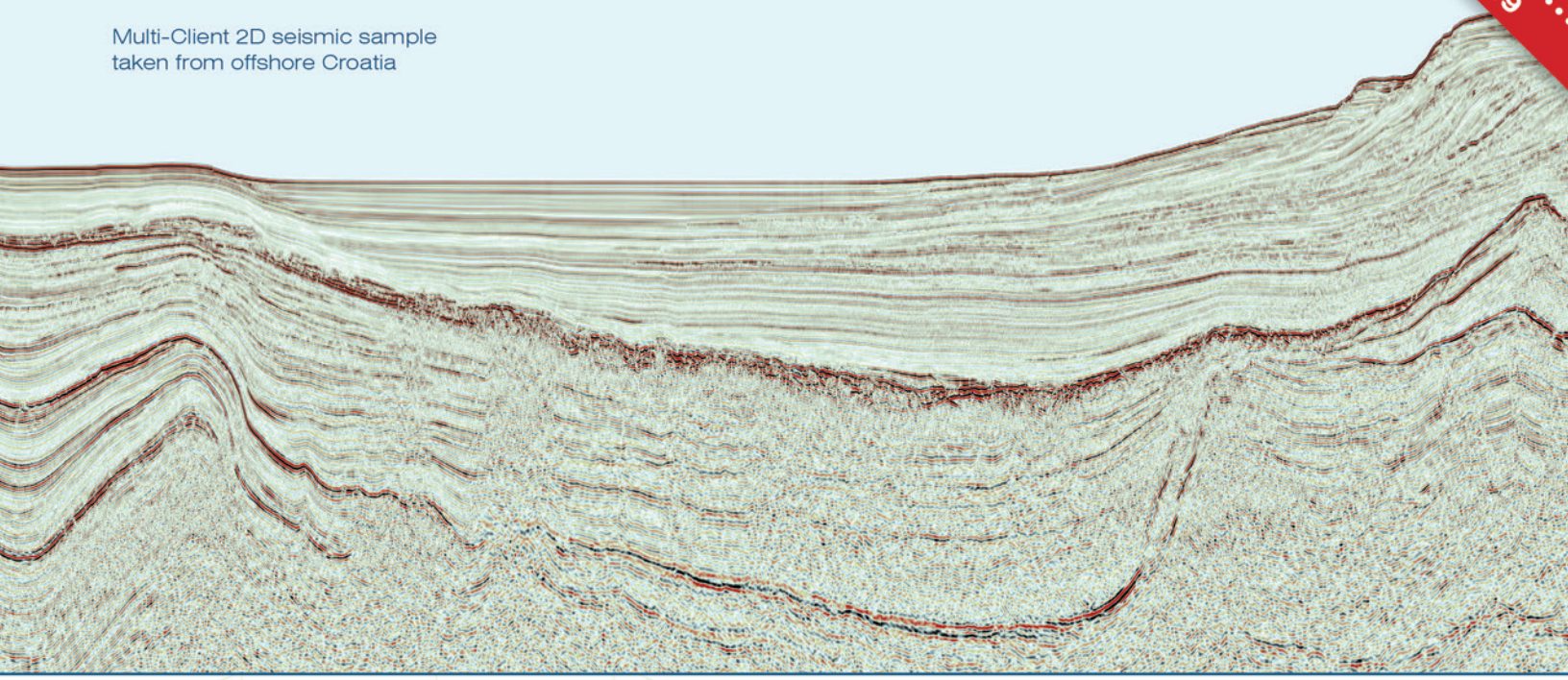
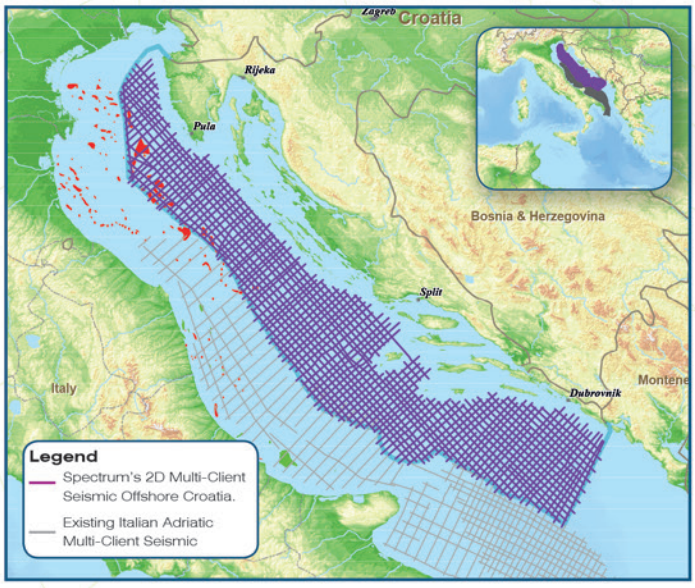
# Offshore Croatia

## A New Oil Province at the Heart of Europe

Multi-Client 2D seismic sample taken from offshore Croatia






Spectrum has acquired a truly unique Multi-Client seismic survey offshore Croatia. This is the only seismic data available to license in this hugely underexplored region which expects to see its first offshore licensing round this year.

The survey, acquired under contract to the Ministry of the Economy in Croatia, covers approximately 15,000 kilometres of long offset seismic data with a 5 km x 5 km grid. It extends across most of the Croatian Adriatic Sea and connects with Spectrum's reprocessed seismic data covering the Italian Adriatic Sea.

Final PSTM data will be delivered at the beginning of February with all processed data available in early April. The Government of Croatia plans to hold a licensing round over the country's offshore continental shelf in Q2 2014.

Spectrum

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## HGS International Dinner continued from page 25

Many sub-oceanic plateaus are massive basaltic volcanoes. Their structures, and how they erupt and evolve, are not well understood because they are submerged beneath the oceans in remote locations. Multichannel seismic profiles and rock samples taken from Integrated Ocean Drilling Program core sites were used to interpret the structure of the Tamu Massif, the oldest and largest structure of the Shatsky Rise oceanic plateau in the northwestern Pacific Ocean. Tamu Massif is seen to be a single, immense volcano, constructed from massive lava flows that emanated from the volcano center to form a broad, shield-like shape. The volcano has anomalously low slopes, probably due to the high effusion rates of the erupting lavas. Tamu Massif could be the largest single volcano on Earth and is comparable in size to the largest known volcano in the Solar System, Olympus Mons on Mars. Data from Tamu Massif document a class of oceanic volcanoes that is distinguished by its size and morphology from the thousands of common seamounts found throughout the oceans. ■

### Biographical Sketch

**William W. Sager** is a professor in the Department of Earth and Atmospheric Sciences at the University of Houston. He graduated from Duke University in 1976 with a B.S. degree in physics and earned M.S. and Ph.D. degrees in geology and geophysics from the University of Hawaii in 1979 and 1983, respectively. After 29 years at Texas A&M University, Professor Sager began teaching at the University of Houston in 2013. His areas of research expertise are marine geophysics, paleomagnetism, and plate tectonics. Although his studies are all over the globe, two primary research focus areas are the Gulf of Mexico and Pacific Ocean. His publication record includes 111 refereed articles in books and journals and 130 abstracts. He has sailed on 41 major research cruises since 1977, totaling more than four years at sea, in all of the world's oceans. During his 30-year academic career, he has mentored over 100 graduate students, who now hold positions in industry, academe, and government laboratories.

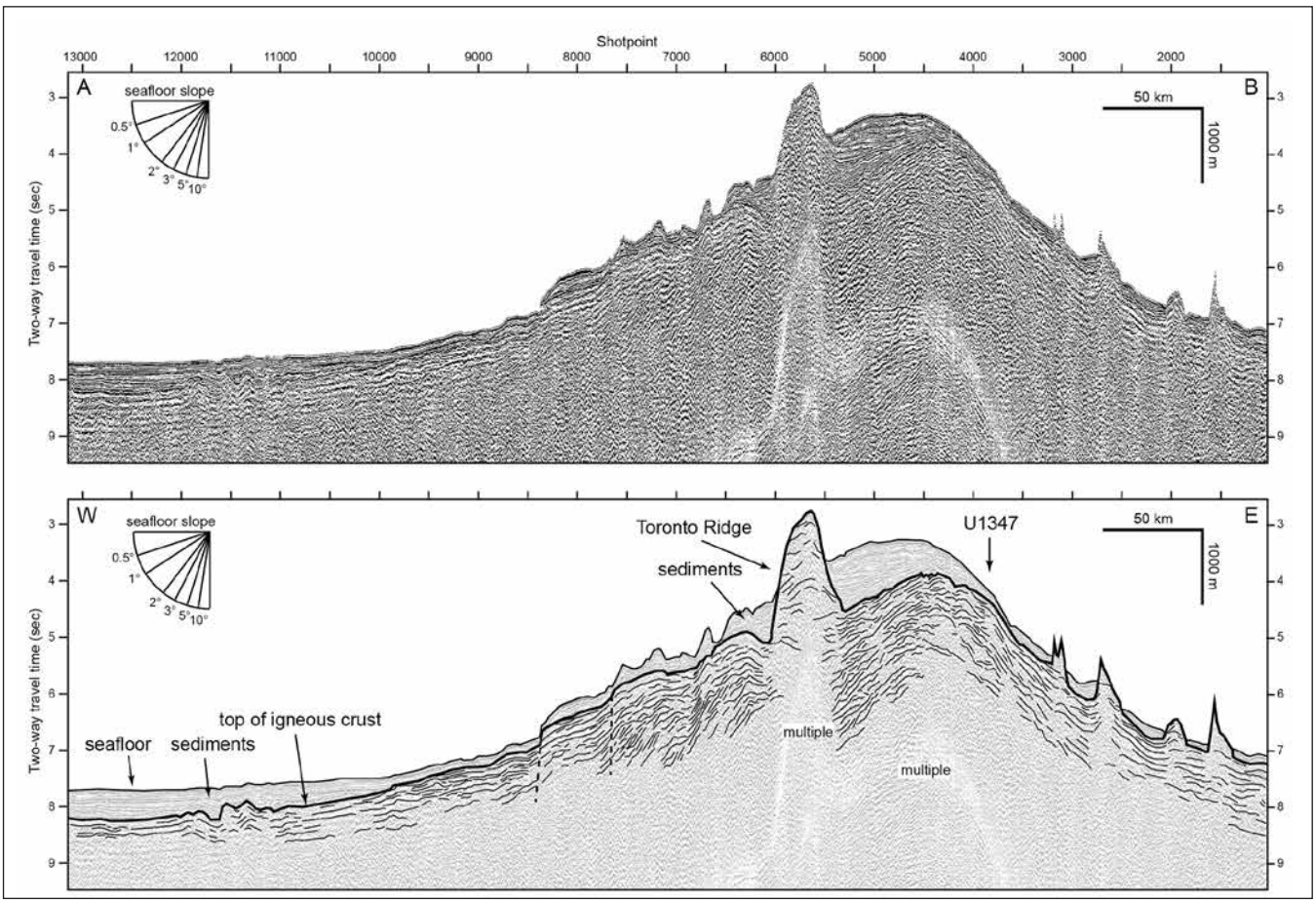


**Figure 2.** *Multichannel seismic line across Tamu Massif. Upper panel shows uninterpreted data and bottom panel shows a structural interpretation. Vertical exaggeration 30:1.*

**HGS International Dinner** *continued on page 29*


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5:25PM
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## HGS International Dinner continued from page 27

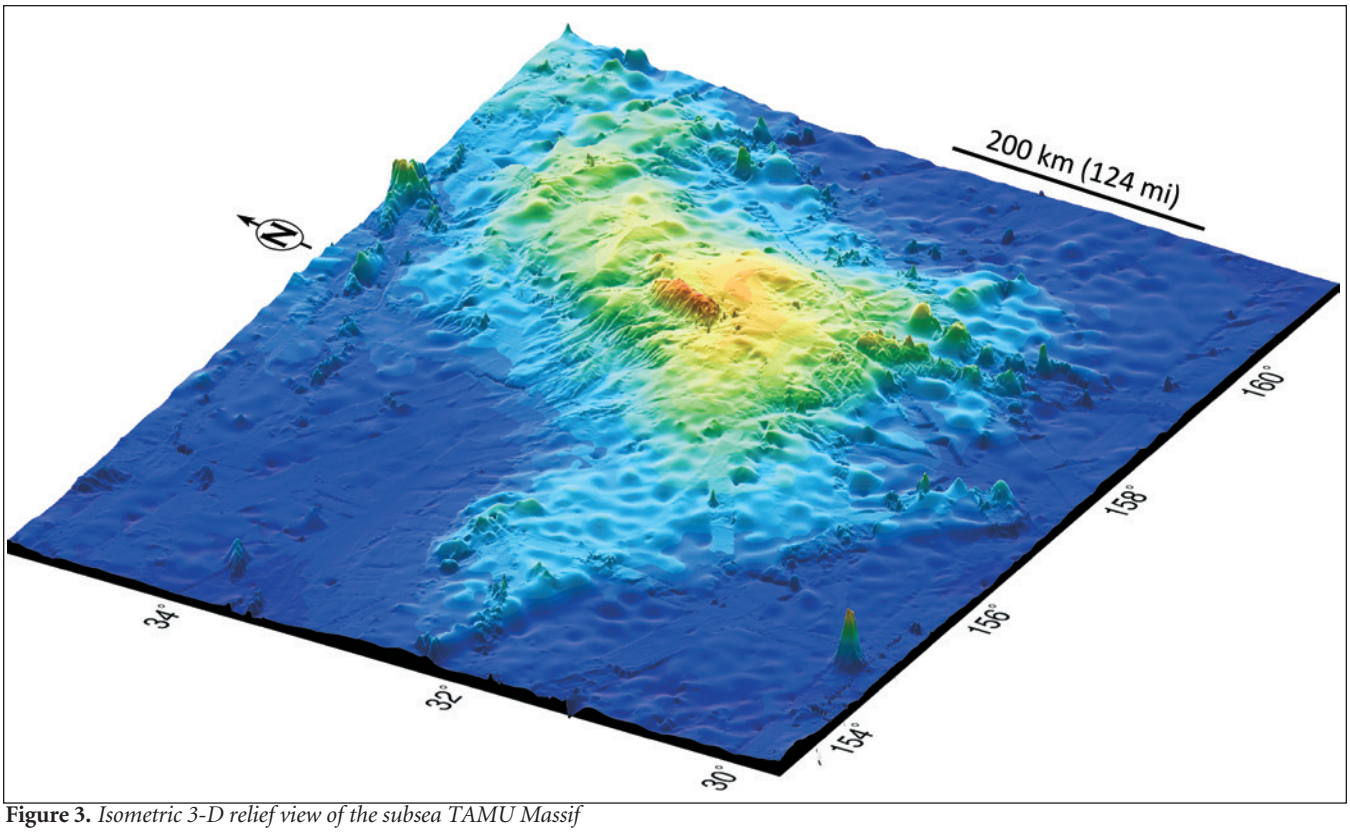


**Figure 3.** *Isometric 3-D relief view of the subsea TAMU Massif*


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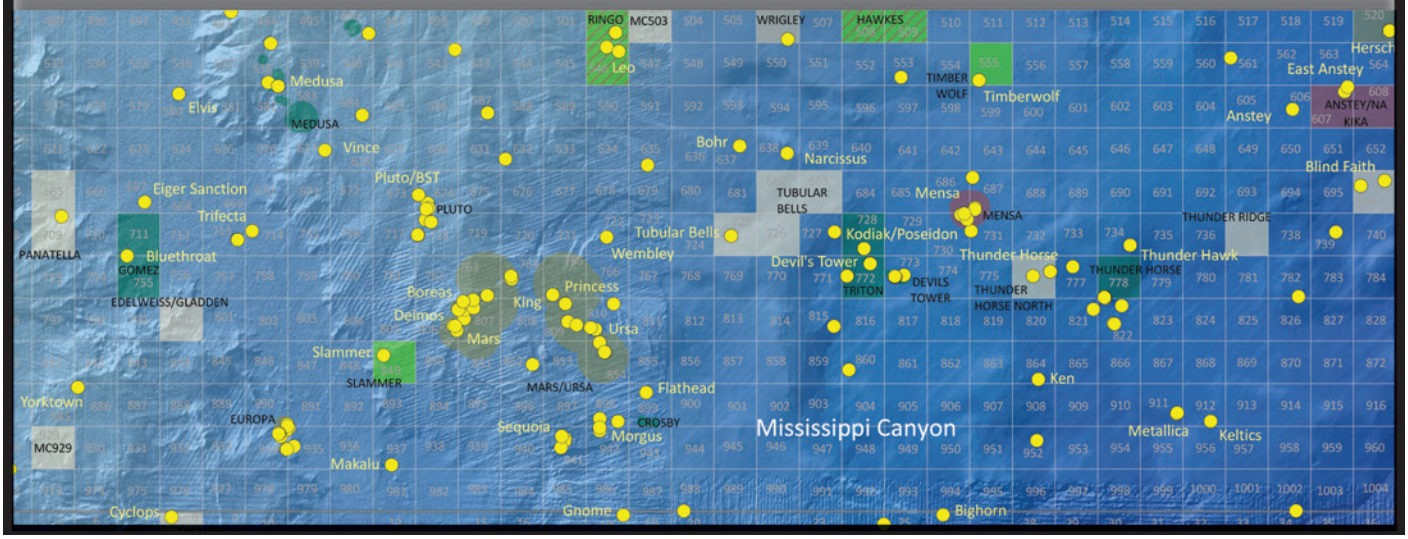

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Petroleum Club • 800 Bell (downtown)
Social 11:15 AM, Luncheon 11:30 AM

**Cost: $30 pre-registered members; $35 for non-members/walk-ups; Emeritus/Life/Honorary: $15; Students: FREE**

**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

*Dee Ann Cooper, P.G. and Roger W. Cooper, P.G.*
*rogerwcooper@yahoo.com*

# Chronocorrelation of the Turonian-Coniacian Stage Boundary in the Boquillas Formation, Big Bend Region, Texas – the *Allocrioceras hazzardi* Zone

In and near Big Bend National Park (BBNP), a thin regionally significant set of isochronous, iron-bearing marker beds at the top of the Ernst Member of the Boquillas Formation identify the Turonian-Coniacian Stage Boundary (~88.6 million years before present). These beds are laterally equivalent to the contact of the Eagle Ford and Austin formations in central and south Texas.

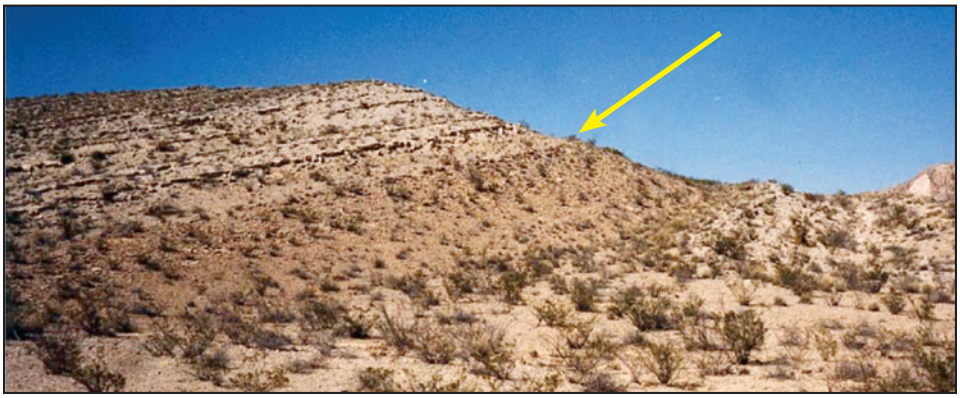


**Figure 1.** *The iron-bearing interval that includes the* Allocrioceras hazzardi *Zone as exposed at Nine Point Draw, Big Bend National Park (N29° 36.585' W103° 08.372'). The base of the interval also marks the Turonian-Coniacian Stage Boundary and yellow arrow indicates the top of the Ernst Member of the Boquillas Formation as well as the top of the iron-bearing interval that forms a distinctive ledge.*

The approximately 3.16 meter thick iron-bearing interval is bounded by disconformities at the base and top and contains a unique fossil assemblage. The fossil assemblage occurs in an approximately 1.29 meter thick interval designated the *Allocrioceras hazzardi* Zone (AHZ). In the eastern part of BBNP, the AHZ is remarkably uniform consisting of four indurated units with three interbedded carbonate mud units. The indurated units have an average thickness of approximately 1.29 meters based on 19 measured sections over a north-south distance of 72 kilometers (45 miles). The indurated beds are calcarenites with graded beds about 1 – 2 centimeters thick. Syndepositional features and structures suggest accumulation in a shallow water environment about 76 meters (250 feet) deep. The sediment accumulation rate is estimated to have been about 1.2 centimeters per thousand years. A similar sequence has been identified in the Lajitas/Buena Suerte area 80 kilometers (50 miles) to the west.

**HGS General Luncheon** *continued on page 33*

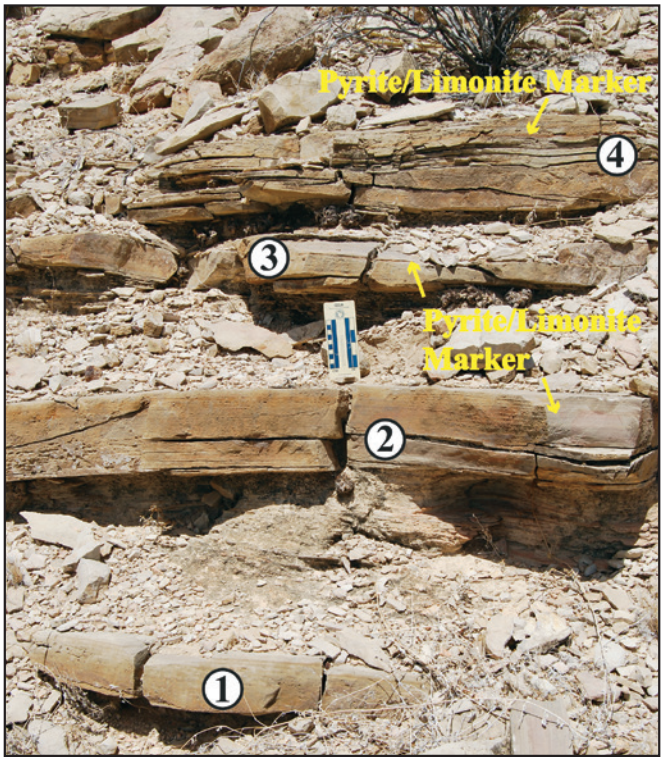



**Figure 2.** Allocrioceras hazzardi *zone at the type locality (N29° 11.777' W102° 59.805') in Big Bend National Park showing the four indurated layers and three intervening mud/shale units. Note the typical brown/tan weathering color of the layers and reddish color of the intervening laminated much shale. The distinctive pyrite/limonite markers present in three of the indurated layers are also identified.*

PESGB

# HGS - PESGB
# 13th Conference on African E&P
# Africa: A World of Opportunities

September 9-10, 2014

The Westin Houston, Memorial City, 945 Gessner Road, Houston, Texas

## Call For Papers, Posters, Sponsors and Exhibitors

**In twelve years this conference has become established as a leading technical E&P forum on Africa, with attendance that can exceed 400. Participants include operators, service companies, consultants, governments and academia. The two day program of talks, technical posters and vendors' exhibits will be held on September 9-10, 2014 in Houston, Texas.**

**The conference, which alternates annually between London and Houston, is organized by the Houston Geological Society (HGS) and Petroleum Exploration Society of Great Britain (PESGB). The HGS-PESGB African Conference covers all aspects of African E&P, with particular emphasis on new ideas for plays and prospects, the geology of the continent and its conjugate margins, and application of emerging technologies.**

**Abstracts (~200 words) should be submitted as soon as possible but no later than March 15, 2014 to the technical committee, Africa2014@hgs.org. The program will be finalized by the end of April.**

**Currently, volunteers are being sought to be proactive Session Chairs and anyone interested should contact the Technical Committee as soon as possible.**

**Details of sponsorship opportunities and display booths are available from the HGS office. To become a sponsor or inquire about exhibit space, contact sandra@hgs.org**

**Registration will be available from April 2014and Early Bird benefits will apply for a few weeks.**

**Further details will appear in the HGS and PESGB bulletins and on their websites, www.hgs.org and www.pesgb.org.uk.**

Conference Committee for 2014:
Martin Cassidy (chair), Al Danforth, Ian Poyntz, Donna Davis and Sandra Babcock (HGS)
Ray Bate and Duncan Macgregor (PESGB).

## HGS General Luncheon continued from page 31

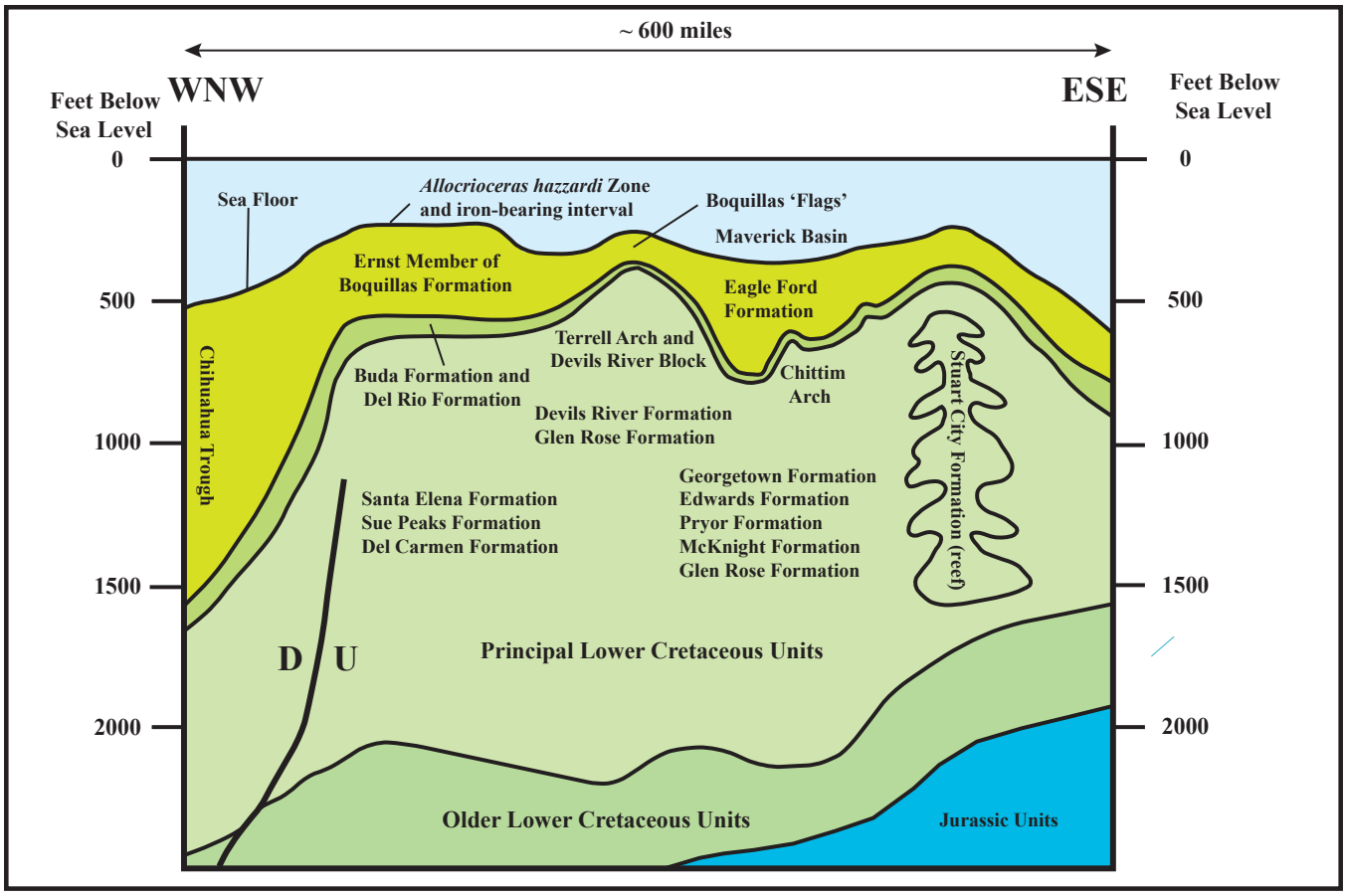



**Figure 3.** *Schematic cross-section showing paleoenvironment at the Turonian-Coniacian State Boundary (~88.6 Ma) during deposition of the* Allocrioceras hazzardi *Zone and enclosing iron-bearing interval in the Big Bend Region as well as possible related units in the Maverick Basin area.*

Preserved fauna in the AHZ are dominated by various nektonic heteromophic ammonite species including *Baculites* sp., *Allocrioceras hazzardi, Scaphites semicostatus, Belemnite* sp., and *Cremnoceramus deformis erectus* (index inoceramid that defines the lowermost Coniacian). Other fauna identified include *Didymotis variabilis, Foresteria* sp., *Cerithiid* sp., and *Laminospondylus transversus.* It is noteworthy that no evidence of large predatory fauna (sharks, etc.) has been discovered to date.

The iron-bearing interval and the AHZ were deposited on a bathymetric high in the Western Interior Seaway at the end of a significant Late Turonian regression following Oceanic Anoxic Event (OAE) 2. These marker beds formed immediately prior to the deposition of the overlying transgressive limestone/chalk/marl sequences of the upper San Vicente Member of the Boquillas Formation (lateral equivalent of the Austin Chalk). The AHZ has been mapped over an area of more than 10,500 square kilometers (4,100 square miles) in the southern Big Bend Region and suggests a somewhat isolated ecosystem. The predominantly nektonic fauna indicates a nutrient-rich environment enhanced by iron derived from subaerial areas to the northeast and possible upwelling from the Maverick Basin area to the southeast and the Chihuahua Trough to the west.

The AHZ and the iron-bearing interval were the basis for a long-term (1994 to the present) classical mapping project of the Boquillas Formation which includes field mapping, measured sections, X-ray diffraction analyses, scanning electron microscope analyses, thin-section analysis, and specimen identification. The research resulted in the publication of five new 7.5-minute geological quadrangles (Texas Bureau of Economic Geology Misc. Map No. 50) and was included in the USGS remap of Big Bend National Park (USGS SI Map 3142). This study also revealed a number of instances where units, mapped by previous workers on the basis of interpretation of aerial photographs and Landsat imagery, were incorrectly identified. This significantly changed the stratigraphic relations and the structural and tectonic interpretation of the Laramide and Basin and Range events in the region. Laramide-related structures are dominantly north-south trending, gently plunging (less than 10°) symmetric and asymmetric folds. Basin and Range structures are north-south and northwest-southeast trending high angle (greater than 70°) normal faults with significant drag-related deformation adjacent to some faults.

Additional information, field descriptions, and maps can be

**HGS General Luncheon** *continued on page 35*

## HGS General Luncheon continued from page 33

found in *Field Guide to Late Cretaceous Geology of the Big Bend Region* written by the authors and published by the Houston Geological Society.

### Biographical Sketches

**Roger W. Cooper** has over 35 years of professional experience and is currently a Professor of Geology, Department of Earth and Space Science, Lamar University, Beaumont, Texas (1978-1980 and 1985-2014). Dr. Cooper received his Ph.D. from the University of Minnesota-Minneapolis in 1978. He worked as an exploration geologist for Anaconda Minerals Company (1980-1985) focusing on precious and base metal (Pt, Pd, Au, Ag, Cu, Ni) exploration in Precambrian and Paleozoic mafic and ultramafic layered intrusions as well as greenstone belts in North America and Australia.

Since 2004, Dr. Cooper has focused on the Late Cretaceous Boquillas Formation in the Big Bend Region of Texas. His most recent work includes publication of five 1:24,000 geologic quadrangle maps for the eastern part of Big Bend National Park (BBNP) and co-authorship of the United States Geological Survey Geologic Map of BBNP. He is a licensed geologist (P.G. 3603) by the Texas Board of Professional Geoscientists.

**Dee Ann Cooper** is currently Research Fellow at the Non-Vertebrate Paleontology Laboratory, Jackson School of Geosciences, the University of Texas at Austin. She is a licensed Professional Geoscientist in Texas. After a career in journalism (primarily print and radio), Ms. Cooper received her M.S. from the University of Louisiana-Lafayette in 2000. She was the secretary of the 9th International Platinum Symposium in 2002. Her focus, from 1994 to the present, has been on changes in paleoenvironmental conditions during the deposition of the Boquillas Formation. She has authored and co-authored articles and abstracts related to her research since 1995. Beginning in 2001, Ms. Cooper developed a series of field courses for students at Lamar University for both the Ouachita Mountains of eastern Oklahoma and the Trans-Pecos in Texas. These student field courses evolved into a series of field trips for professional geologists for the Geological Society of America, Houston Geological Society, and private industry that were co-led by Roger W. Cooper and others.

**Monday, March 31, 2014**

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

***Stephen Schutter***
*steveschutter10@gmail.com*

# Organic-Rich Mudstones: Asking the Right Questions

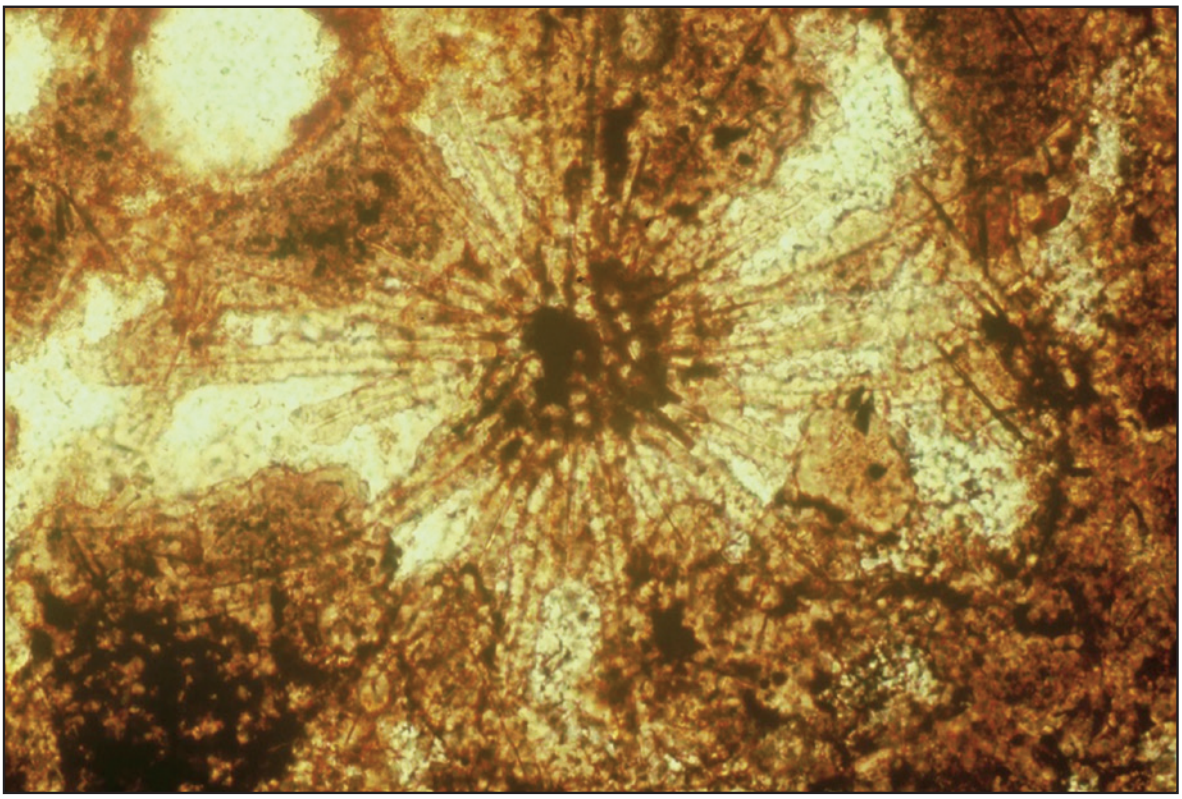


**Figure 1.** *Radiolarian from phosphate nodule, Upper Pennsylvanian Stark Shale, Dennis, Kansas. Radiolarians may be common in the organic-rich shales of the craton, but are rarely this well preserved. Significantly, this example is completely replaced by phosphate, liberating the silica to go elsewhere. Such diagenesis can be a major factor in the silicification of black shales.*

The development of hydrocarbon production from organic-rich mudstone has been a matter of first approximations. Prior to modern hydraulic fracturing technology, mudstones had been largely ignored by hydrocarbon experts. There is a strong tendency today to go with simple models for these complex formations. There are few reliable estimates of the true size of the resource and development still has a large element of luck. (If development success directly correlates to the number of wells drilled, success rates are not being improved by conceptual winnowing.) Resolving play complexity – finding and mapping "sweet spots" – is still the principal challenge. Understanding the details of deposition and diagenesis is not an abstract exercise, but directly impacts petrophysical and engineering properties of the mudstones. Generalizations fall short – the right questions need to be asked.

On an exploration scale, the paleogeographic setting, tectonic environment, eustatic state, and age of the sediments need to be considered. All of these characteristics are important in determining the location, extent, and quality of potential organic-rich mudstones. They are also important in selecting relevant analogs. However, this is just the first step — to successfully locate "sweet spots," more complete understanding of the local mudstones is required. **HGS North American Dinner** *continued on page 39*

## HGS North American Dinner continued from page 37

**Figure 2.** *Oil shale below Deicke K-bentonite (orangish-wite layer at top of recess), Middle Ordovician Platteville Formation, Faribault, Minnesota. The oil shale is sufficiently high grade to produce oil films on water wells in the area. The carbonate deposition rate was very low in the Platteville, with frequent corrosion zones. The expression of the oil shale and the K-bentonite (which is one of the most widespread known) may be the result of failure of carbonate deposition, rather than enhanced deposition of organic material and/or volcanic ash.*

Mesoscale factors determine the structure, relationships, and properties of units within the organic-rich mudstone, and thus affect development. Source and reservoir characteristics may vary with changing depositional environments. Quality of input organics and sediments, diagenesis, frequency, thickness, lateral continuity, and nature of contacts are all functions of the timing and intensity of depositional and post-depositional processes. Oversimplification of organic matter type, clay mineralogy, and fissility may lead to incorrect conclusions, as well as missed opportunities. Integrated studies of all aspects of organic-rich mudstones (paleontology, geochemistry, mineralogy, sedimentology, and stratigraphy) offer a more reliable route to depositional/diagenetic models and predictability in petrophysical parameters. Rate of deposition matters, so organic matter quality is partially a function of eustasy. Deposition of organic-rich mudstones may be punctuated by infrequent events. The effects of these events on organic matter accumulation and preservation, as well as on the resulting rock properties, may be in contrast to deposition (or lack thereof) between events. In such environments, probability and statistics may also play a role in modeling the type of organics and sediments preserved.

Because of the complex interactions of many variables in organic-rich mudstones, an integrated multidimensional approach to their study is best for avoiding pitfalls and oversimplifications. Almost all mudstones can be broken down with sufficient determination; often the process of breaking them down yields useful information. While the fossils in most mudstones are mainly microfossils, they are usually easy to recover and analyze. Beyond the environmental requirements of the organisms, observations regarding their abundance and condition can yield valuable information, and as a bonus, some provide evidence for maturation modeling. Detailed examination of the mineralogy can also provide important information on why, what, and how. Study of the sedimentologic and stratigraphic patterns, both vertically and laterally, can show how the depositional systems worked. Without such analysis, you are left with ambiguities, which lead to unfortunate wells.

Such core- and outcrop-based study provides an important bridge between the nano- scale and the seismic scale, and may be the most directly applicable to well-scale petrophysical properties. While detailed examination of every well and outcrop may be

**HGS North American Dinner** *continued on page 41*

 continued from page 39



impractical, application of statistical analysis and calibration can bridge the gap. Statistical analysis is necessary when deposition is episodic and may be locally incomplete. Leveraging with pre-existing data is also important. Familiarity with the techniques and the goals of the study will also greatly expedite the analysis. Consideration of the megascale parameters permits targeting of specific areas. Combining multiple lines of evidence permits the high-grading of the most favorable areas. This yields a better understanding of the parameters of the organic-rich mudstones, thus contributing to predictability and successful exploration and development. ■

### Biographical Sketch

Stephen Schutter completed graduate work at the University of Iowa, first on the depositional environment of the Middle Ordovician Glenwood Shale, then on the depositional environments of several Upper Pennsylvanian shales, including the Stark and Eudora deeper-water black shales. This work involved integrating multiple lines of evidence to interpret how the shales were deposited and to explain regional variations.

Following school, he worked at Exxon Production Research conducting studies to revise the Paleozoic sea-level curve. Working with sequence stratigraphy, he was able to see how the curve was expressed in shale deposition, particularly in the deposition of organic-rich mudstones. This also involved working with data from basins around the world with the goal of finding the global eustatic signal.

Since then, Mr. Schutter has worked in international exploration with exposure to stratigraphy and depositional systems in a broad range of basins including the Gulf of Mexico, Australia, Indonesia, Brazil, Venezuela, the Caspian region, Poland, the United Arab Emirates, Morocco, and East and West Africa.

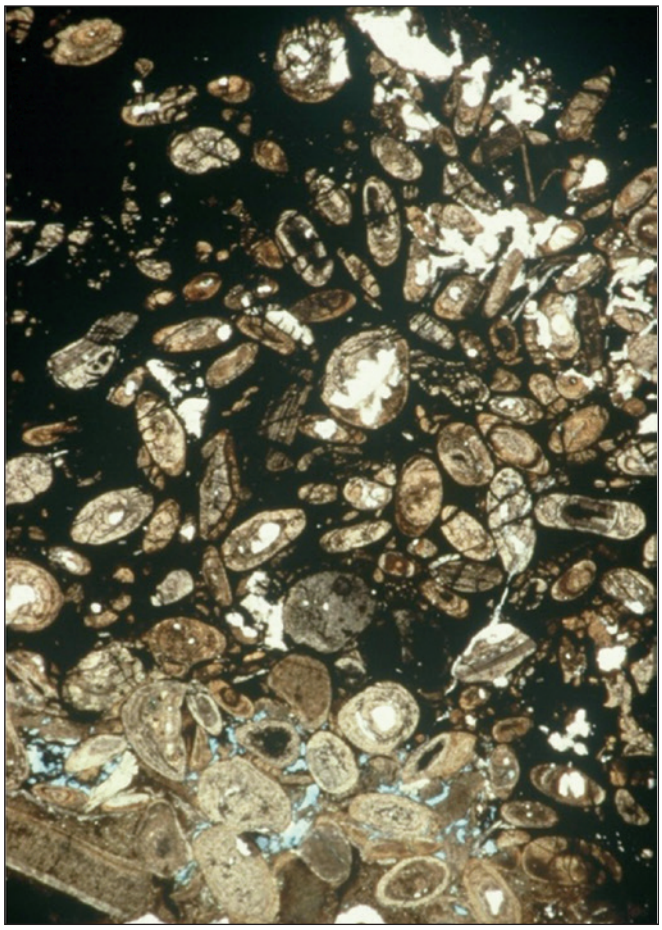
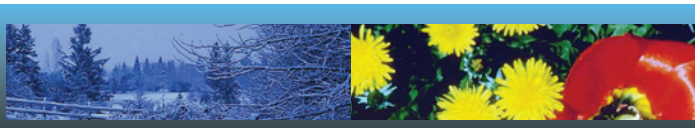
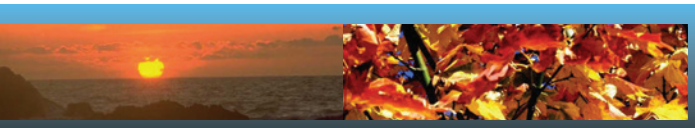


**Figure 3.** *Phosphatic ooids at a hard ground surface within the Upper Ordovician Maquoketa Formation in northeastern Iowa. The black material is pyrite and organic matter. This is a hyper-condensed interval within an organic-rich shale; the event which produced it should have a correlative within the Utica Shale.*

# March 2014



| 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.** | | |
| 2 | 3 | 4 | 5<br>**HGS Continuing Education**<br>*Critical Assessment of Shale Plays: Bridging the Gap with Engineers*<br>*Page 4* |
| 9 | 10 **HGS General Dinner Meeting**<br>*"Comparison of Porosity Distribution within Selected North American Shale Units by SEM Examination of Argon-Ion Milled Samples," James M. Rine, Weatherford Laboratories*<br>*Page 17* | 11 | 12 **HGS Environmental & Engineering Dinner Meeting**<br>*"Desalination: A Drought Proof Solution for the State of Texas," Paul Choules, Water Standard*<br>*Page 23* |
| 16 | 17<br>**HGS International Dinner**<br>*"Seismic Imaging of the Largest Single Volcano in the World: The Story of Tamu Massif" William Sager, University of Houston*<br>*Page 25* | 18<br>**HGS Northsiders Luncheon Meeting**<br>*Tentative* | 19 |
| 23 → 30 | 24<br>**HGS North American Dinner**<br>*"Organic-Rich Mudstones: Asking The Right Questions," Stephen Schutter*<br>*Page 37* 31 | 25 | 26 **HGS General Luncheon Meeting**<br>*"Chronocorrelation of the Turonian-Coniacian Stage Boundary in the Boquillas Formation, Big Bend Region, Texas – the* Allocrioceras hazzardi *Zone," Dee Ann Cooper, P.G. and Roger W. Cooper, P.G* |



# GeoEvents

Thursday Friday Saturday

| | | |
|---|---|---|
| | **Members Pre-registered Prices:**<br>General Dinner Meeting..... $30<br>Nonmembers & walk-ups..... $35<br>Env. & Eng. ..... $30<br>Luncheon Meeting ..... $30<br>Nonmembers & walk-ups ..... $35<br>International Explorationists ..... $30<br>North American Explorationists ..... $30 | **1** |
| **6** | **7** | **8** |
| **13** | **14** | **15** |
| **20** | **21** | **22**<br>**Natural Gas Hydrate Systems – Occurrence and Dynamic Behavior**<br>*Gordon Research Seminar, Galveston, TX* |
| **27** | **28** | **29**<br>**You can make your reservations NOW online at ww.hgs.org** |

**April 6-9, 2014**
AAPG Annual Convention & Exhibition
*Houston, TX*

**April 8, 2014**
HGS Night at the Houston Museum of Natural Science
*Houston, Texas*

**April 16-17**
AIPG 5th Annual Symposium: *Marcellus, Utica, and Point Pleasant Shale: Energy Development and Enhancement*
*Columbus, OH*

**April 26-27 April**
USA Science & Engineering Festival,
*Washington, D.C, USA*

**April 30-May 4**
Seismological Society of America 2014 Annual Meeting
*Anchorage, Alaska*

**May 5-8, 2014**
2014 Offshore Technology Conference
*Houston, Texas*

**May 6 – 7**
TCEQ Environmental Trade Fair and Conference
*Austin Convention Center, Austin, Texas*

**May 12-16, 2013**
GeoConvention 2014: Focus Calgary
*Alberta, Canada*

**June 7**
HGS Guest Night

**June 9-14**
Society of Independent Professional Earth Scientists (SIPES) Annual Meeting
*New Orleans, LA*

**June 15-23**
HGS Grand Canyon Field Trip

# HGS "Night at the Paleontology Museum"

## April 8, 2014- Tuesday Night Social Event - 6:30pm

## AAPG 2014 Houston Convention

## SPONSOR FORM

**Sponsor this special event and benefit the HGS Scholarship Fund.**

### T-Rex Sponsor – $5,000

- 8 complimentary event registrations
- Formal recognition at event
- Company name & logo listed as sponsor on online registration page and in related HGS *Bulletin* articles

### Triceratops Sponsor – $2,500

- 4 complimentary event registrations
- Formal recognition at event
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### Trilobite Sponsor – $1,000

- 2 complimentary event registrations
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**Sponsorship deadline is April 1, 2014**

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Contact Sandra Babcock • Email: sandra@hgs.org

Company Name: _____

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Please submit company logo along with form and payment. Payment by credit card or check.
Please make checks payable to Houston Geological Society.

Name of Cardholder: _____ Card Type: _____

Number: _____ Expiration Date: _____

# HGS Night at the Paleontology Museum — April 8 Includes Scholarship Donations

*by Linda and Charles Sternbach*

*Dr. Robert Bakker in the HMNS IMAX theatre*


*Rusty Walter of Walter Oil and Gas has donated funds to the April 8 Night at the Museum and also has funded the Paula and Rusty Walter Late Jurassic Mesozoic Hall exhibit.*

HGS is hosting a fantastic "Night at the Paleontology Museum" on Tuesday night, April 8, at 6:30 pm at the Houston Museum of Natural Science. This is the featured local society social event of the 2014 AAPG Annual Convention and Exposition in Houston at the George R. Brown convention center. Your ticket buys you a delicious buffet dinner, drinks, and amazement, as you sit right next to the huge dinosaur and reptile fossil displays inside the Hall of Paleontology. Dr Robert T. Bakker, famous paleontologist, dinosaur and reptile expert, and HMNS Museum curator, will give a entertaining presentation at 8 pm in the IMAX theatre. Dr. Bakker and HMNS curator David Temple will have just returned from a recent excavation fossil dig in North Texas with news about the latest discoveries of Permian reptiles and amphibians.

The HGS encourages AAPG convention registrants to bring spouses and guests to this social event. Registration is online at the AAPG 2014 convention website at www.aapg.org/houston2014/. AAPG registrants can buy one or more tickets as they register for the convention. As you register for the AAPG convention, look for the tab called Guest/Social Events. Adult tickets are $65, students are $35. Buses will take ticketed registrants to and from the convention center and the HMNS Museum at 5555 Hermann Park Drive, Houston. There will also be free garage parking available for private cars. If you have already registered for the AAPG convention, but need to add or buy tickets to the HGS Night at the Museum, call the AAPG Registration Center, c/o The Pulse Network 781-821-6732. Get tickets now, as the event may be sold out by the time the convention opens on April 5. The event attendance limit is 400 people.

Walter Oil and Gas has generously donated $25,000 to this HGS Night at the Museum event. Rusty Walter, CEO of Walter Oil and Gas, is an important financial sponsor of the HMNS Morian Hall of Paleontology. The Walter family donated funds to create the Paula and Rusty Walter Jurassic Mesozoic Gallery, opened in 2012, which features action- posed dinosaurs including a Triceratops, three Tyrannosaurus Rexs, a Diplodocus, and a Stegosaurus. Charles Sternbach, event chair, would like to thank CEO Rusty Walter and geologist Mike Jobe for their support of this joint HGS-AAPG convention event.

WALTER OIL & GAS CORPORATION

Additional fund raising is also taking place as a result of the Night at the Museum Event. The HGS Scholarship Fund is looking for several corporate sponsors for this event to increase the funding of the graduate and undergraduate scholarship program. John Adamick, Vice President of TGS-Nopec, former HGS Board member, and chair of the HGS Foundation Scholarship fund (with Carl Norman) has volunteered to round up corporate sponsors. John Adamick is seeking T-Rex sponsors at the $5,000 level, Triceratops sponsors at the $2,500 level, and Trilobite sponsors at $1,000 level.

Sponsorship includes some free tickets and logo recognition. Interested companies can use the form included in the Bulletin, or online at the HGS webpage event site calendar on April 8. Sandra Babcock, the HGS office manager can take checks and credit cards and assist in sponsorship organization. Contact John Adamick at 713-860-2114 john.adamick@tgs.com, and Sandra @hgs.org. ■

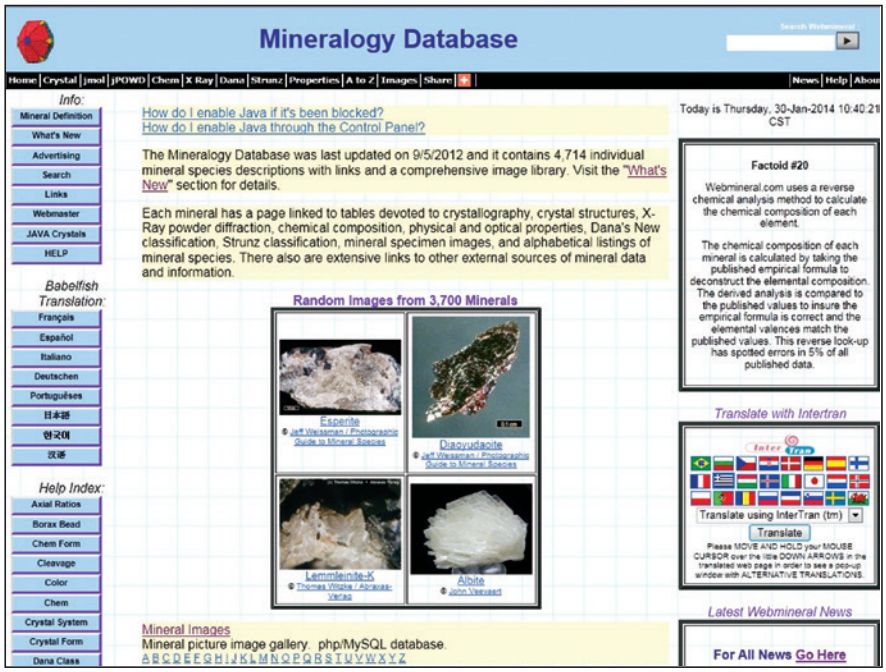
# Geological Website of the Month

## Mineralogy Database

webmineral.com

***By Michael F. Forlenza, P.G.***

What is the chemical formula for stibnite? Name two minerals with three or more cleavages. What is the difference between pyrite and chalcopyrite? Which mineral is number eight on the Mohs hardness scale? Name the seven crystal systems. Anyone? I don't see many hands.

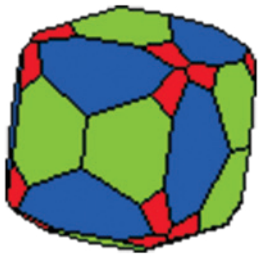



What is the difference between pyrite and chalcopyrite? Which mineral is number eight on the Mohs hardness scale? Name the seven crystal systems. Anyone? I don't see many hands.

For many geologists, mineralogy was a rough sledding. Determining the difference between tetragonal and trigonal crystal systems was not always a simple task. Fortunately, we can now consult the Mineralogy Database website to obtain in-depth knowledge regarding 4,714 individual mineral species without cracking open your old text of Dana's *Manual of Mineralogy*. The Mineralogy Database in presents an extensive catalogue of mineral chemistry, properties, images, and related information.

The website's pages have a plain white graph paper background and various sizes of standard Arial font throughout. The look of the webpages is not the most polished you will find on the Internet, but the extensive record of cross-indexed information is impressive. The homepage has dozens of active buttons and links to various areas on the website where a broad collection of mineralogical data is offered. Most of these buttons connect to sub-pages where minerals and data are grouped by the selected category. Some of these categories are straightforward mineral characteristics: Color, Hardness, Luster, Streak, or Density. Some categories are more exotic: Diaphaneity, Pleochroism, Bireflectance, and Diochroism. Some are just fun to browse: Environments, Name Origins, Pronunciation, and Synonyms. And some are just incomprehensible: jmol Applet, Stunz, Fermion, and jPOWD Applet. The applet links are related to the JAVA™ software needed to run the webpages. If you do not have JAVA, you can still view most of the website, but some functionality may be limited.

*Pyrope*

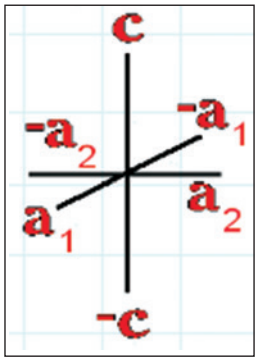


*Diploidal*

The buttons across the top of the homepage link to the best areas for browsing, particularly: Properties, A to Z, and Images.

*Helidor*

The A to Z listing of minerals and the index of Images is really the meat of the database. With detailed links to reference material, these pages contain a vast trove of catalogued mineralogical data presented in alphabetical order. You can browse through the listings or you can focus in on a particular mineral species or group. Drill down to your favorite mineral to review a detailed listing of its vital statistics. My two favorite minerals are pyrope and beryl.




*Tetragonal Crystal System*

**Pyrope** ($Mg_3Al_2(SiO_4)_3$), a dark red garnet (nesosilicate) with an isometric-hexoctahedral crystal form, a hardness of 7.5, and a white streak, has a Dana classification of 51.04.031.01. Found in ultra basic igneous rocks, pyrope has isotropic (n=1.73-1.76) optical properties and cell dimensions of a = 11.459, Z = 8, V = 1,504.67 Den (Calc) = 3.56. The

**Geological Website of the Month** *continued on page 49*

## Geological Website of the Month continued from page

name comes from the Greek, pyropos, "fire-eyed," an allusion to the striking red hue.

**Beryl** ($Be_3Al_2Si_6O_{18}$), occurring in a wide variety of colors including green, blue, yellow, colorless, and pink, has a brittle – conchoidal fracture, a density of 2.63 to 2.9, displays an axial ratio of a:c = 1:0.9975, and is formed mainly within granitic pegmatities. Beryl takes its name from the ancient Greek, beryllos, signifying the "precious blue-green color of sea water." Beryl is known by several synonyms such as Aquamarine (blue variety), Emerald (green), Goshenite (colorless), Helidor (yellow), and Morganite (pink).

**Factoid #12**
**At last count, Webmineral has identified at least 85 minerals named after women.**

The Mineralogy database is the creation of David Barthelmy, P.G. a Houston Geological Society member since 1984 and was on the HGS computer committee in the early 1990s. While a graduate student at San Diego State University, Mr. Barthelmy was a mineralogy teaching assistant. A mineral collector and enthusiast, he used his computer knowledge to develop the mineralogy database and publish it on-line in 1995. He compiled the website using a Microsoft Access database and SAS software to create the webpages.

Based on a January 2014 email conversation, Mr. Barthelmy reports that he works on the website himself and plans to upgrade the supporting software in the near future. Advertisers on the website help to defray the costs of bandwidth, storage, and hardware. Mr. Barthelmy states that the traffic on the website varies between 100,000 to 200,000 unique visitors with about 1,000,000 to 2,000,000 total page views per month. The traffic is highest during the fall months after school starts. He notes that Webmineral "…is a hobby that I do when I am not out doing consulting for petroleum geology."

The Mineralogy Database is not the slickest geological website you will see on the Internet, but the pages do contain an impressive amount of detailed and indexed information. Clearly, this is a well-researched labor of love by a motivated geologist. So, if you're interested in crystallography or just like to see nice photographs of colorful minerals, you should visit the Mineralogy Database. It will take you back to mineralogy lab and that musty set of drawers where the specimens were stored. ■

# AAPG Education

# UPCOMING EDUCATION SCHEDULE

## Last Chance

| | |
|---|---|
| NEW - Virtual Field Trip: Geology of the Grand Canyon, Bryce Canyon, and Zion National Parks -- An AAPG E-Symposium | March 5, 2014 |
| NEW - Technical Writing Triage -- an AAPG E-Symposium | March 13, 2014 |
| Field Safety Course for Field Trip Leaders<br>Houston, TX | March 26-27, 2014 |
| Basinal to Local Scale Stratigraphy and Facies Architecture of the Jackfork Group Turbidites, Arkansas<br>Little Rock, AR | April 3-5, 2014 |
| Getting Started in Fluvial Stratigraphy<br>Houston (with AAPG Annual Convention) | April 5, 2014 |
| Applied Concepts in Naturally Fractured Reservoirs<br>Houston (with AAPG Annual Convention) | April 5-6, 2014 |
| Concepts, Models and Case Studies of Dolomitization<br>Houston (with AAPG Annual Convention) | April 5-6, 2014 |
| Deepwater Siliciclastic Reservoirs Field Seminar<br>California | April 11-16, 2014 |

## Short Courses

| | |
|---|---|
| Basic Well Log Analysis<br>Austin, TX | April 28-May 2, 2014 |
| Petrophysical Analysis and Integrated Approaches to the Study of Carbonate Reservoirs<br>Austin, TX | April 29-May 1, 2014 |
| Summer Education Conference<br>Denver, CO | June 16-20, 2014 |

## Field Seminars

| | |
|---|---|
| Clastic Reservoir Facies and Sequence Stratigraphic Analysis of Alluvial-Plain, Shoreface, Deltaic, and Shelf Depositional Systems<br>Utah | May 3-9, 2014 |
| Geology of Grand Canyon, Bryce Canyon and Zion National Park<br>Nevada | May 31-June 6, 2014 |
| Play Concepts and Controls on Porosity in Carbonate Reservoir Analogs<br>Spain | June 1-6, 2014 |
| Northern Appalachian Basin Faults, Fractures and Tectonics and Their Effects on the Utica, Geneseo and Marcellus Black Shales<br>New York | June 23-27, 2014 |

## Online Courses

| | |
|---|---|
| NEW - Strategic Decision-Making: Current Issues in the Oil Industry | Ongoing |
| Leadership and Strategic Thinking in the Oil & Gas Industry | Ongoing |
| Professional English | Ongoing |
| Technical Writing | Ongoing |
| Petroleum Exploration & Production: An Online Overview | Ongoing |

## Registration and Information:

Toll-free (U.S. and Canada) (888) 338.3387, or (918) 560.2650 • Fax: (918) 560.2678 • email: educate@aapg.org
Download a registration form at http://www.aapg.org/education/index.cfm

# 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.*



### NGWA Industry Newsline, (January 10, 2014)

**U.S. House of Representatives Passes Bill to Cut Federal Superfund Cleanup Powers**

On January 9, 2014 the U.S. House of Representatives defied a veto threat from the White House and passed a bill that would reform Superfund cleanups by limiting the federal government's power to impose solid waste regulations and requiring closer consultation with states before imposing remediation provisions.

The Reducing Excessive Deadline Obligations Act, H.R. 2279, was approved 225-188 on a largely party line vote, with all but four Republicans voting for the measure and all but five Democrats voting against it.

The bill rolls together three pieces of legislation dealing with (1) financial responsibility at contaminated sites, (2) increasing the state role at Superfund sites, including determining site cleanup and listing, as well as providing additional credit for state contribution to site management, and (3) the state role related to federal contaminated sites in the state.

Besides comments raised by Representative Henry Waxman (D-California), others have voiced concern over the potential for increased litigation and slowing of the Superfund process if these bills pass.

**Texas Town Closes Toilet-to-Tap Loop**

Marketplace reports a town's drinking water supply in west Texas includes treated raw sewage effluent.

In the town of Big Spring, Texas, which has a population of about 27,000 people, raw sewage effluent is treated at a brand-new, $1.4 million "raw water production facility." Water arrives there after initial treatment at Big Spring's old sewage treatment plant.

The new facility treats that water with reverse osmosis, plus two stages of disinfection and multiple stages of testing. Any water failing to meet the tests gets sent back to the town's sewage treatment plant to start the process again.

The town's name-sake spring dried up almost 90 years ago at about the same time oil was discovered in west Texas. Big Spring gets fewer than 20 inches of rain a year. Because of the drought, Texas voters recently approved $6 billion in new water projects.

The current five-year plan does not include much reuse of sewage effluent. But when that plan was created, the Big Spring facility was not yet online. No one had gone first.

"It takes somebody—some local entity—brave enough to try it out," said Robert Mace, Ph.D., PG, of the Texas Water Development Board who is a member of NGWA's Scientists and Engineers Division. "Then everyone else is looking over their shoulder. And then once they see it works: Boom. Off everyone goes."

### AIPG eNews (December 2013)

**Landrieu Expected to Assume Senate Energy Chairmanship**

Capitol Hill is about to experience a massive shuffle. Senator Max Baucus (D-MT), current Chairman of the Senate Finance Committee, was recently nominated by President Obama to serve as the next U.S. Ambassador to China. Baucus is expected to accept and be confirmed, and Senators Ron Wyden (D-OR) and Mary Landrieu (D-LA) are expected to fill the subsequent openings.

Senator Wyden, current Chairman of the Senate Energy and Natural Resources Committee, is expected to take over for Senator Baucus, and Senator Landrieu for Senator Wyden. Although changes to the Finance Committee are anticipated, the changes to the Energy and Natural Resources Committee could have broad and lasting impacts on energy in the geosciences.

The Senate Energy and Natural Resources Committee has jurisdiction over the National Energy Policy, Department of Energy National Labs, Federal energy conservation programs and much more. During his tenure, which began in 2013 after the retirement of Senator Bingaman (D-NM), Senator Wyden has focused on many non-traditional energy sources. Landrieu, however, is an outspoken proponent of oil and gas development, especially on the outer continental shelf off the coast of her home state, Louisiana.

The new changes could occur as early as this spring.

**Government Update** *continued on page 53*

## Government Update continued from page 51

**Senate Bill to Move NOAA to Department of the Interior**

Senator Richard Burr (R-NC) introduced a bill this December that will transfer the National Oceanic and Atmospheric Administration (NOAA) from the Department of Commerce to the Department of the Interior. The bill aims to cut spending and reduce duplication by consolidating the Department of Labor and the Department of Commerce into a new agency called the Department of Commerce and the Workforce. The bill is co-sponsored by Senators Dan Coats (R-IN) and James Inhofe (R-OK). The bill has been referred to the Senate Homeland Security and Governmental Affairs Committee.

**Senate Finance Committee Proposes New Reforms to Energy Tax Incentives**

The Senate Finance Committee recently released a new proposal to overhaul some energy provisions in the tax code in the United States. The staff discussion draft, introduced by Finance Committee Chairman Senator Max Baucus (D-MT), aims to streamline regulations imposed on energy companies and discontinue a number of key tax credits available to them. The proposal is one of a series of discussion papers prepared by committee staff incorporating ideas from both Republican and Democratic members of the committee and is intended to stimulate discussions on reforming America's tax code.

There are currently 42 energy tax incentives written into the U.S. tax code. Under the proposed regulations, that number would be significantly reduced. The new regulations make four main proposals. First, the new code would consolidate almost all of the preexisting energy tax credits into two new credits. Next, it would make the timelines for the two new incentives longer, thereby instilling confidence in potential investors and businesses. And finally, the new rules would establish a new, technology-neutral tax credit for domestic production of clean energy and for domestic production of clean transportation fuel.

The proposal can be found at: http://www.finance.senate.gov/imo/media/doc/121813%20Energy%20Tax%20Reform%20Discussion%20Draft%20Summary1.pdf

**CRS Report on Energy Tax Credit**

The production tax credit (PTC) for renewable energy, a corporate tax credit available to businesses producing renewable energy through a number of green technologies, expired at the end of 2013. The PTC provided a per-kilowatt-hour tax credit to businesses based on the amount of electricity generated through qualified energy resources, such as wind.

Although the tax credit has expired and been reinstated multiple times over the years (most recently in 2009 by the American Recovery and Reinvestment Act), Congress is still divided whether to reinstate it or not. Therefore, the Congressional Research Service (CRS) was asked to create a report outlining the pros and cons of the production tax credit for renewable energy sources as lawmakers consider whether to reinstate it once more.

The report analyzes the spectrum of outcomes: eliminating the tax credit, making it permanent, and various phase-out options for renewal. Opponents of the PTC view it as the federal government "picking winners," whereas proponents view the PTC as an important tool to help kickstart the fledgling renewable energy industry. For more information and to read the full report go to: http://www.eenews.net/assets/2014/01/08/document_daily_02.pdf.

### USGS Develops County-scale Temperature and Precipitation Maps

The U.S. Geological Survey (USGS) recently released a new website featuring maps and summaries of historical and projected temperatures and rainfall for counties inside the contiguous United States. The effort is a collaborative project with the College of Earth, Oceanic and Atmospheric Sciences at Oregon State University. The maps and summaries are based on 33 climate models used in the 5th Climate Model Intercomparison Project and the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report. The website provides useful tools to characterize climate change through climographs, histograms, and tables that summarize changes in temperature and precipitation from a series spanning from 1950-2099. The website can be found at: http://www.usgs.gov/climate_landuse/clu_rd/nex-dcp30.asp

### National Academies Report on the Impacts of Climate Change

The National Academies Press released a new report, "Abrupt Impacts of Climate Change: Anticipating Surprises," (http://www.nap.edu/download.php?record_id=18373) which provides an updated overview of the potential effects of climate change. The report focuses on high impact events, identifies key vulnerabilities, and advocates for the development of an Abrupt Change Early Warning System in order to effectively anticipate and respond to these disasters when, the report argues, they occur.

### Interior Awards $7M for Climate Science Research

The Department of the Interior announced that it will award an additional $7 million in funding for climate change research. The grants, which are managed by eight regional Climate Science Centers, will fund 50 new research projects at universities and other partners for research. Projects include: determining species, habitats and ecosystems most vulnerable to climate change and ways to make them more resilient; projecting climate change effects on stream flow and fish in different parts of the country;

**Government Update** continued on page 55

# HGS Welcomes New Members

**New Members Effective January 2014**

**ACTIVE MEMBERS**

Philip Bergeron
Patrick Brennan
Trevor Brooks
Derek Buster
Christina Calvin
Gareth Cross
Kanchan Dasgupta
William Drake
Larianna Dunn
Aaron Fisher
Pamela Flowers
Rusty Gilbert
Carrie Hatcher
Dan Herrington
Barbara Hill
Thomas Lenney
Christopher Lipinski
Peter Lippert
Simon McMahon
Sandro Mercio
Tom Miller
Jason Mintz
Shilpa Misra
Cory Moore
Jasmeen Moubarak
Katrina Rabien
Daniel Ramirez
Hugo Rodriguez
Jon Rotzien
Adriana del Pino Sanchez
Jens Schmieder
Russell Stands Over Bull
Stephen Sturm
Ron Tingook
Dibyajyoti Tripathy
Clark Weaver
Joshua Woodworth
Nathan Zimmerman

**ASSOCIATE MEMBERS**

Santiago Diaz III
Scott McWhirter
Jacqueline Morris
Joseph (Nick) Scott

**EMERITUS MEMBERS**

Rosemary Laidacker

**STUDENT MEMBERS**

Oya Ak
William Bailey
Alexandre Cardoso da Silva
Mark Ferguson
Hank Fuselier
David Haddad
Atif Hariz
Waleed Jehangiri
Vern Mills
Mahmud Muhammad
Dung Ngo
Adam Walker
Jiuyuan Wang

*Welcome New Members*

## Government Update continued from page 53

building science-based models to help land managers in different regions better focus their efforts; informing coastal conservation and restoration in the northern Gulf of Mexico; and studying issues such as fire and climate change, sea-level rise, coastal change, and effects of drought on fish and wildlife. This effort is part of President Obama's Climate Action Plan to mitigate and prepare for climate change impacts.

### Weather Forecasting Improvement Act of 2013

The Weather Forecasting Improvement Act of 2013 (H.R. 2413) was passed in December by the House Science, Space and Technology Committee. The bipartisan forecasting bill makes weather-related activities that concern public safety and the economy a top priority for the National Oceanic and Atmospheric Administration (NOAA). The bill aims to better align weather modeling, prediction, and forecasting at NOAA's Office of Oceanic and Atmospheric Research. The bill prioritizes efforts to extend and improve lead time for tornadoes and hurricanes. Language and information for the bill was provided by the weather community, including University Corporation for Atmospheric Research (UCAR), the American Meteorological Society, the Weather Coalition, and the National Academy of Sciences. The bill is in response to recent billion-dollar weather events, including Superstorm Sandy and a number of destructive tornadoes. The bill awaits House and Senate approval.

### 2014 NDAA Includes Critical Mineral Provisions

On December 27, 2013 President Obama signed into law the 2014 National Defense Authorization Act. Although primarily responsible for the direction and authorization of military activities, the bill included provisions relating to the earth science community. Under the new bill the Defense Logistics Agency, a support agency that provides supplies and services to the U.S. military and manages the National Defense Stockpile, is directed to recycle and conserve minerals critical for defense purposes. The bill also permits the Pentagon to stockpile certain strategic materials, including ferroniobium, dysprosium, yttrium oxide, cadmium zinc tellurium substrate materials, lithium ion precursors, and other materials.

### New NASA/JAXA Global Precipitation Satellite

The National Aeronautics and Space Administration (NASA) and the Japanese Aerospace Exploration Agency (JAXA) recently announced the launch date for a new joint-venture satellite. The new satellite, set to launch on February 27, 2014, is equipped with a Global Precipitation Measurement Core Observatory which will provide advanced observations for rain and snowfall around the world. The satellite will greatly enhance weather forecasting and contribute to environmental data and research. The satellite is so advanced that it will be able to detect light versus heavy rainfall, and measure the size and distribution of raindrops, snowflakes, and ice particles.

### USDA & EPA Partner to Support Water Quality Trading

The U.S. Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) announced a partnership to implement and coordinate policies that support water quality trading programs for nutrients, sediments, and other pollutants for economic and environmental benefit. Water quality trading allows regulated entities to purchase and use pollutant reduction credits. Proponents argue the program is a cost-effective way to comply with the Clean Water Act while also improving air quality and ecosystems. The USDA and EPA will coordinate and enhance communications and share information with states, agricultural producers, and third-party members to support water quality trading. ■

Full Color Ads Now Available!

# 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, Canvas or CorelDraw. Files should be saved and submitted in .ai (Adobe Illustrator) format. Send them as separate attachments via email or CD if they are larger than 1 MEG 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 1 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 (Black & White) | | | | | Page 2 (B&W) | Inside Front Cover (Full Color) | Inside Back Cover (Full Color) | Outside Back Cover (Full Color) | Calendar Back (Full Color) | Calendar Page (Full Color) |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of Issues | Random* Eighth | Random* Quarter | Random* Half | Random* Full | Full | Full | Full | Half | Full | Quarter |
| 10 | $823 | $1,387 | $2,488 | $4,734 | $5,680 | $7,830 | $7,560 | $6,858 | $6,750 | $2,700 |
| 9 | $823 | $1,387 | $2,488 | $4,734 | $5,680 | | | | | |
| 8 | $750 | $1,260 | $2,242 | $4,307 | $5,169 | | | | | |
| 7 | $665 | $1,123 | $2,014 | $3,834 | $4,600 | | | | | |
| 6 | $590 | $990 | $1,782 | $3,392 | $4,069 | | | | | $1,890 |
| 5 | $497 | $837 | $1,503 | $2,860 | $3,432 | $4,698 | $4,536 | $4,104 | | |
| 4 | $405 | $683 | $1,223 | $2,326 | $2,792 | | | | | |
| 3 | $327 | $550 | $990 | $1,886 | $2,262 | | | | | $1,080 |
| 2 | $232 | $392 | $704 | $1,339 | $1,607 | | | | | |
| 1 | $146 | $246 | $443 | $842 | $1,010 | $1,404 | $1,296 | $1,080 | | $810 |

**FULL COLOR AD**
* add 30% to B&W charge for full (4) color ad

**BUSINESS CARD**
$160 per 10 Issues – Send two cards
($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 $24.00; emeritus members pay $12.00; 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 ❑ North American E&P (other than Gulf Coast)
❑ International E&P ❑ 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 8/6/10

# Houston Petroleum Auxiliary Council News

***Edie Bishop,*** *HGS Liaison* 713-467-8706 or ewbishop@bishorb.com

As Houston gets ready to host the AAPG Convention in April for the thirteenth time, it offers an occasion for reflection. I am always amazed how much the histories of the several professional organizations are intertwined. It feels as if the birth and changes of one creates and changes another. Perfect examples are the stories of the American Association of Petroleum Geologists (AAPG), Houston Geological Society (HGS), Houston Geological Auxiliary (HGA), and Houston Petroleum Auxiliary Council.

In August 1923, the AAPG extended an invitation asking Houston to host its ninth annual meeting in 1924. According to HGS historical records "…a viable professional organization was necessary to prepare for this meeting, The HGS was formally chartered on August 8, 1923 with **John R. Suman** as President and **David Donoghue** as Secretary. At that time, there were 75 geologists in and near Houston and all were elected as Charter Members." According to **Vern Stefanic**, Managing Editor of *AAPG Explorer*, the chair for that convention was **Alexander Deussen** who was also a founding member of AAPG, its second president and recipient of the Sidney Powers award in 1947. With leadership such as that, it was assured that the convention would be a success. Indeed, it was such a success that Mr. Deussen served as General Chair for the next two Houston hosted conventions.

Later, as the HGS prepared for the 1953 meeting, the leaders recognized how much conventions had changed and expanded to meet the needs of AAPG members and the HGS Board decided a more vibrant spouses' involvement was needed. Being really smart guys, board members **Ralph Cantrell**, and **Jack Colle** turned to their spouses **Charlie Cantrell, Olga Colle**, and their friends **Catherine Marr, Gen Behrman, Merle White, Betty Gahagen, Bea Henson, Polly Turner, Anita Weiner** and **Gladys Selig** for help with this change. The spouses also recognized that many things fell outside the normal activities of HGS and that a viable organization was necessary to fill the role. HGS contributed $50 for the group to cover the cost of the first mailing which resulted in 75 charter members. The first organizational meeting of HGA was held on May 4, 1950 with **Catherine Marr** as President. Like the industry itself, membership in the Auxiliary fluctuated with high membership approaching eight hundred but declining in recent years.

*HGA Board Members 1987. Front - Abba Nae Thompson, Marion Hawkins, Millie Tonn, Elinor Macmillian, Edie Bishop, Tina Hoffman, Suzie Allen. Back - Teeta Udden, Janice Haye, Francis Burk, Katherin Bennett, Marie Hunt, Theresa Barker, Mary Walters, Gina Gilstrap, Hanne Harris, Edie Frick, Suzanne Howell, Pat Hefner, Terry Pooser.*

*HGA members join HGS members in celebrating their 75th Anniversary. L to R: Gerry Cooley, Sandi Barber, Matt Daura, Debra Sacrey, Greg Greggson, Winona LaBrant & Marvin Smith, Marti & Jeff Lund, and Mary Kae & Craig Dingler. (HGA members)*

In 2006, recognizing this demographic of declining membership was parallel with other auxiliaries in the area, HGA President **Norma Jean Jones** and her Board voted to initiate a study to determine whether a merger with the Petroleum Auxiliaries in the Houston area was a possibility. **Winona LaBrant Smith** was asked to begin this investigation. The result of Winona's leadership and hard work was the merger of the Engineering, Geological, Geophysical, and Landmen Auxiliaries into the Houston Petroleum Auxiliary Council (HPAC). This has proved to be a successful venture combining the abundance of talents and interests of the four collective groups. Together, the members have offered a variety of programs and several special interest groups under great leadership!

Looking to the future, the fun will continue because the AAPG has scheduled its 2017 annual convention and exposition (ACE) in Houston at which time it will celebrate its one-hundredth year as an organization.

The geological community has seen many highs and lows associated with the changing fortunes of the oil business, but it is still a great business!!!

An appreciation is extended to all our special interest groups leaders: *Bridge:* **Audrey Tompkins**, 713-868-0005 or **Daisy Wood,** 832-581-3231, *Book Club*: **Phyllis Carter**, 281-397-9888 or A**nita Weiner**, 713-572-9874, and *HPAC Exploring Houston*: **Martha Lou Broussard**, 713-665-4428 or **Linnie Edwards**, 713-785-7115. Spouses and guests are also always welcome and encouraged to attend all events.

Geologists, please encourage your spouses to join HPAC, where they will have an opportunity to meet other spouses of geologists, geophysicists, engineers, and landmen. They will participate in informative and entertaining programs, delicious lunches and welcoming fellowship. The HPAC membership form is included in the HGS *Bulletin*. Contact **Edie Bishop** at 713-467-8707 or ewbishop@bishorb.com for more information.

*You are invited to become a member of*

# HPAC

**2013–2014 dues are $20.00** Mail dues payment along with the completed information

to **Nancy Giffhorn** • 16107 Hidden Lakes Drive • Kingwood, Texas 77345

**YEARBOOK INFORMATION**

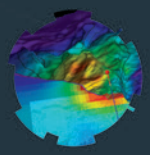
| Last Name | First Name | Name Tag |
|---|---|---|
| Spouse Name | Company | |
| Street Address | City State | Zip |
| Email Address | Home Fax | |
| Home Phone | Cell Phone (Optional) | Home Email Address |

**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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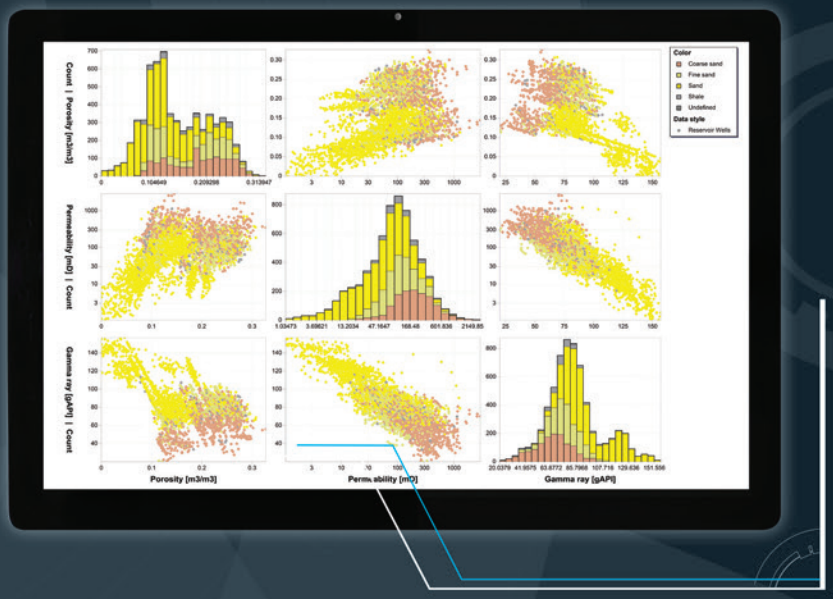


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