HGS Bulletin

Volume 67, Number 4

Houston Geological Society

DECEMBER 2024

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The Houston Geological Society Bulletin (ISSN-018-6686) is published monthly except for July and August by the Houston Geological Society, 14811 St. Mary's Lane, Suite 250, Houston, Texas 77079-2916. Phone: 713-463-9476.
Editorial correspondence and material submitted for publication should be addressed to the Editor, Houston Geological Society Bulletin, 14811 St. Mary's Lane, Suite 250, Houston, Texas 77079-2916 or to office@hgs.org.
Subscriptions: Subscription to a digital version of this publication is included in the membership dues ($30.00 annually). The subscription price for non-members is $160.00.

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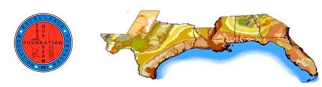
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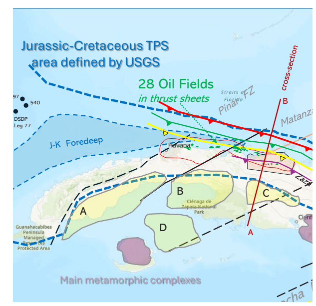

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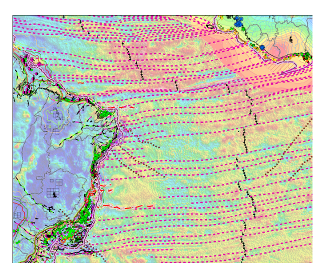
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Penny Patterson, HGS President 2024-25
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December is a Time for Gathering Together and Giving

December is a time for gathering with family, friends, co-workers, and many, many more acquaintances to enjoy everyone's company, catch up with old colleagues, regale about fun-filled events of the year, and, most of all, join and imbue in much merriment. In addition, it is a time of exchanging gifts and giving one another holiday cheers and warm wishes. It is also a time of giving thanks and support to our community and integral organizations.

What better place is there than the Houston Geological Society to celebrate the holiday season? HGS is hosting the Third Annual Holiday Party on December 16, 2024, from 5:30 to 8:00 pm at the Cadillac Bar in Houston, Texas. This is a perfect time to bring your spouse, significant other, and a friend or two or more to celebrate the holiday season and network with fellow geoscientists and their family and friends. Please join me, my husband, the HGS Board Members and their spouses, our geoscience community, and, of course, Santa T-Rex, aka the holiday party decoration dinosaur, for a fun-filled evening!

Third Annual HGS Holiday Party on December 16, 2024, from 5:30 to 8:00 pm at the Cadillac Bar in Houston, Texas

December is also a time of giving thanks and reflecting on the contributions our communities and organizations have provided us with over the past year. I sincerely thank everyone for their support of HGS over your many years. I ask that you please continue to consider HGS in your thoughts for giving back and supporting HGS in its mission to promote and advance our diverse disciplines in geoscience and to provide networking opportunities for the exchange of informative and innovative technologies and training for our geoscience community. HGS is committed to being our geoscience community's "go-to" resource organization. To accomplish this mission, HGS needs everyone to work together as a team to assist in guiding HGS forward to achieve its mission.

From the President *continued on page 7*

Ted Godo, HGS editor 2024-25
editor@hgs.org

Reflections and Blessings

I am writing this letter just before the Thanksgiving holiday and want to express my heartfelt thanks not only for the blessings in my life but also to all the people who have helped me and helped this *Bulletin* improve. We are trying hard to improve an organization that allows its members to grow and network. The *Bulletin* is just one aspect of this, delivering interesting and hopefully insightful articles.

A great example of networking happened a few days ago at the Norris Center, where the HGS and GHS held a one-day "Case Study Academy." This event featured a panel of "well-seasoned" geoscientists with over 30 years of experience, many of whom discussed case studies of successful and failed exploration wells telling what they had learned from each. These disclosures led to frank discussions of how problems were worked through to find answers and the needed resources. This a key concept, simple in theory, really, but we (even and maybe especially the "seasoned person") should be able to actively listen to every team member, including any new observation-based ideas, to see their merits.

We all, even the "seasoned person", should actively listen to every team member

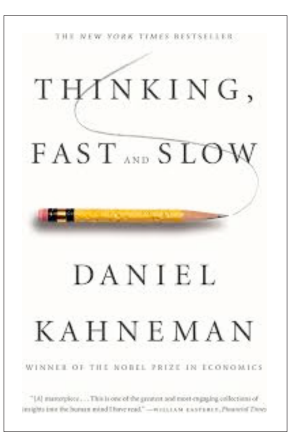
Interestingly, one of the many themes brought out in the case studies was how we humans think. When either identifying a new prospect or risking the prospects we have, do we have any inherent biases based on our experience or knowledge that were actually "blind spots" in our thinking? The answer, of course, is yes; we all have these blind spots, and discussions arose on how they might be better identified. There were three books on this subject that three different speakers recommended (and this was not coordinated). The books are:

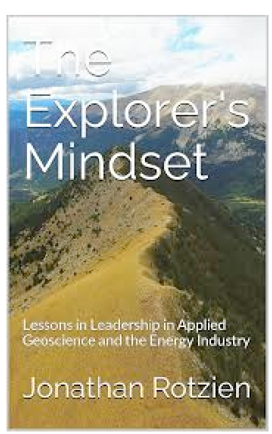
- *Thinking, Fast and Slow* by Daniel Kahneman
- *The Explorers Mindset* by Jonathan Rozien
- *Blind Spots* by Dr. Marty Makary

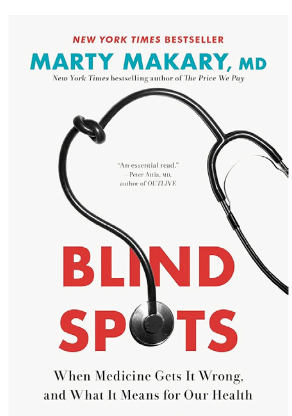
One practical solution for addressing whether we as a team are aware of things that could lead to blind spots was to seek the opinion of someone who comes fresh to the presentation. We all likely had such an experience when, for example, taking along a non-geologist to help while measuring a rock section. While the geologist is busy climbing uphill with head down, the non-geologist, taking in all the surrounding beauty, interrupts the geologist by pointing out the precariously perched rock overhead about to fall. An obvious blind spot, but what about when blind spots are an outcome of cognitive dissonance – saying one thing while having a belief in another? Why? Well, we do. Anyway, check out any of the books and reflect.

This *Bulletin* includes quite a few technical articles on the theme of more global exploration examples (to help our thinking broaden). Thank you to all the authors for this contribution. Remember, if you want to share something in the *Bulletin*, please get in touch with the board or me. ■

Wishing you all a harvest of blessings, good health, and good times.
Ted Godo







From the President continued from page 5

Two fundamental **gift-giving opportunities** make a significant difference in helping HGS reach its mission goal of being the "go-to" resource organization. These opportunities are volunteer work and financial contributions through sponsorships and donations to HGS's programs.

Volunteer work for HGS is crucial for organizing and hosting our events and a wonderful opportunity to give back to HGS and our geoscience community. There are three upcoming events/programs that HGS could greatly use your help as a volunteer. The **Science and Engineering Fair of Houston (SEFH)** will be held on February 15, 2025 at the Fort Bend Epicenter, in Rosenberg, Texas. At the SEFH fair, junior and senior high school students from across the greater Houston area compete in 25 categories of STEM topics. HGS supports the fair in a variety of ways. HGS members volunteer to work as judges for the fair to assist with reviewing the geoscience student projects. Additionally, HGS awards summer internships to three outstanding high school senior students to study at the Houston Museum of Natural Science each year. This is an outstanding opportunity to nurture our budding geoscientists!

A second volunteer opportunity is working with the **Continuing Education Committee** and teaching courses for our geoscientists. For example, this month, on December 2, 3, 4, 8, and 10, 2024, Angel Callejon will teach an HGS Short Course: "Fundamentals of Basin Modeling in Oil Exploration." I attended Angel's course last year, and I can personally say it is an intensive course that teaches geoscientists the fundamentals and procedures for basin modeling.

Finally, the latest volunteer opportunity at HGS is to participate in the newly formed **Mentorship Program**. This program will focus on helping fellow geoscientists at any stage of their career to assist with technical or personal challenges that may arise. Plans are underway to begin the Mentorship Program this spring, so stay tuned for more information!

Sponsorships for HGS's events, such as conferences, symposiums, and social gatherings, are vital to organizing and hosting these events and programs. This fall, HGS hosted the 2024 Student Expo, the 2024 Africa Conference, the HGS/University of Houston Sheriff's Lecture Dinner, the GSH/HGS Case Studies Symposium, the HGS Golf Tournament, and the HGS Sporting Clays Tournament. All these events were made possible by generous sponsorships. So, whether you are an employee of a large corporation or an employee or partner in a small independent company, please consider sponsoring one or more of HGS's events so that we will be able to continue to promote excellence and camaraderie in our geoscience community.

Donations to HGS are also immensely important to us. For example, they help fund HGS's undergraduate scholarships, which are awarded each February during the HGS Scholarship Dinner, and the HGS high school senior student internships at the HMNS. Finally, donations to HGS help us keep "HGS's doors open, the lights on, and the computers running" for our day-to-day business.

Your support of the Houston Geological Society matters to us. We sincerely appreciate every hour of volunteer work and every dollar of sponsorship and donation to HGS. To show our appreciation, each month in the HGS Bulletin, we publish a list of sponsorships and donations to recognize everyone's contributions to HGS's events and programs.

Your commitment to HGS helps us build and strengthen our geoscience community and brings us closer together. ■

Looking forward to seeing you at the HGS Holiday Party,
Penny Patterson

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We Are The HGS

Gwladys Gaillot, HGS member since August 2024

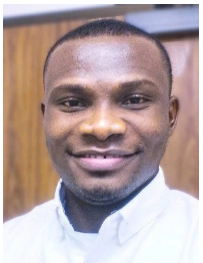
Gwladys Gaillot is a new member of HGS, but she has spent nearly 18 years at Exxon and Apache, primarily as a deep-water sedimentologist and stratigrapher. Born and raised in Dunkerque, France, a harbor city close to the Belgium border, she spent weekends and vacations with her family in forested countryside greenspaces. Gwladys childhood memories are filled with outdoor experiences involving building shelters in the woods and observing wild fauna and flora. Of course, when she was very young, she imagined being a flight attendant traveling around the world and being a meteorologist. When it was time for college, she had another passion. She was gifted in STEMS (Math, Physics, Biology/Geology), and probably due to her childhood experience of the outdoors, she decided to use these skills to pursue an engineering degree in forest management. After about a year, the engineering component didn't fit her, so she transitioned to studying Biology first at the University of Lille. She then completed her studies in southern France at the University of Montpellier. In this second phase of her undergraduate program in Montpellier, she took a Geology requirement and studied with a professor, which changed her life career direction.

she is interested in attending some of the lectures offered around dinner by HGS

It was when this professor drew 3D block diagrams on the board. The drawings depicted very elegant successions of steps from ocean spreading and subduction to continental collisions, volcanism, and erosion. This intrigue moved her to change her course to geology instead of biology. She did not have a specific career in mind then, but her parents continued to encourage her to follow her heart and that love was the key to success, together with hard work and dedication. While in her twenties, after a childhood of multiple dancing types, her focus turned to flamenco dancing, where she could express herself further while practicing sports and making good friends.

In her last year in geology at Montpellier, a few months of research was included in her program. Her interest in geology narrowed to wanting to combine sedimentology with geophysics, and two professors there worked together to make it happen using outcrop and seismic. Gwladys stayed on at Montpellier for her graduate program. She was one of the top two of her equivalent master's degree program. She was offered funding for a three-year PhD research study funded by TotalFinaElf (now

We Are The HGS *continued on page 10*



Daniel Owodunnit HGS member since August 2024

Daniel Owodunni grew up in SW Nigeria. He characterized the area where he grew up as "living amidst landscapes that told stories of times well before humanity." The scattered Precambrian-aged rocks stood out across the terrain "shaped in the forms of animal and human faces." His grandparents and other locals "gave explanations-myths of petrified humans who were turned to stone by divine forces." However, even as a child, Daniel was unsatisfied with mythical answers as he wanted to know "how natural forces had shaped these magical formations." This curiosity led him to pursue a bachelor's degree in Geology in 2014 at the Federal University of Technology, Akure (FUTA) in Nigeria. Daniel is a very expressive and outgoing individual. During his undergraduate studies, he discovered that he had a passion for leadership and collaboration. He also served during this time as the student body president of the Nigerian AAPG student chapter for three years and the president of the FUTA NAPE conference. Daniel also led a school team on an independent mapping exercise with petrographic descriptions of rocks along the Aye-Obe River in Osun State, Nigeria. If these activities weren't enough during his undergraduate studies, Daniel also participated in Oil Rig Training at the Petroleum Institute of Warri, Delta State. He also interned as a geoscientist with Shell Nigeria and at Degeconek Nigeria Limited. In Daniel's senior year, he was awarded a research assistantship and worked on his senior thesis, where he looked at the physio-chemical properties of the groundwater in the shallow coastal plain aquifer of Abesan, Lagos. As Daniel said, "this connected my passion for geology with solutions to real-world problems."

Education holds in it the power to rewrite the narratives, bridge socio-economic gaps, and uplift an entire community. This has influenced my personal goals and my passion for teaching and mentorship.

We Are The HGS *continued on page 10*

We Are The HGS is a series that highlights the careers and contributions of HGS members with the intention of building community. Would you like to be featured in We Are The HGS? Send a note to editor@hgs.org.

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TotalEnergies) studying the growth and evolution of submarine channels based on data recently acquired over the modern Congo Fan (or Zaire). Specifically, her study used 3D seismic on the Gabon shelf as it related to the study of the modern Congo fan. Upon graduation, she was offered a post-doc position by Total. However, her future husband was moving to Japan to work for IODP (International Drilling Program). "We both love traveling, so I applied for a post-doc with Jamstec in Japan to study the heat flow and gas hydrate potential in the Nankai Trough."

After 3.5 years in Japan, it was time to think about the next step for both her and her now husband and two-year-old child. Gwladys and her husband both had a background of interest in oil companies, deep water sedimentology (her), and petrophysics for her husband. Both sent their resumes to ExxonMobil and were invited to Houston for an interview, and both were offered positions. I asked what her favorite assignment in Exxon was, and she answered that she had experience in Equatorial Guinea. It was this assignment that she integrated into the stratigraphy core team and performed research on process sedimentology to develop better stratigraphic models for deep water reservoirs. While there, she also worked with the development/production departments as she used 4D seismic to pair with a modeler and reservoir engineer to find new opportunities in mature fields. Gwladys process sedimentology work used very high-resolution seismic, field studies, and experiments (flume and tank) to develop a numerical model for the deposition of turbidites. Her experience in this integrated multi-disciplinary team established much of the groundwork for understanding stratigraphic traps that became very useful at the time of Liza's discovery in Guyana. This brings us up to date as Gwladys has been working for Apache for the past 4 years following the Guyana discoveries into Suriname's block 58 appraisal.

When asked what motivated her to join HGS, she responded that she is interested in attending some of the lectures offered around dinner by HGS. She also wants to support the efforts of the local HGS society, which is dedicated to promoting knowledge sharing in geology with the community. ■

After graduation, Nigeria has a mandatory one-year service program called the National Youth Service Corps (NYSC). As a corps member during his national service, Daniel worked to ensure that resources were transparently and efficiently distributed to less privileged communities, where he also helped with vaccinations and other public health initiatives. Daniel also served as a council member for the United Nations Major Group for Children and Youth (UNMGCY). UNMGCY is the formal mechanism for young people to engage in the United Nations. Daniel also contributed to the UN's environment program (UNEP), which focused on environmental sustainability. During this work as a corps member, the pandemic occurred, and Daniel still had time to work virtually as a geography instructor with UK Enrydvyne.

In June 2022, he enrolled at the University of Ilorin, an affiliate with the National Teachers' Institute (NTI), for a Postgraduate Diploma in Education (Geography), completing this at the end of 2023. In 2024, he enrolled at LSU, Baton Rouge, working in stratigraphy, sedimentology, and geochemistry to study the carbon cycle in the terrestrial environment. Specifically, Daniel's dissertation is titled "Reconstructing pCO_2 in Modern Terrestrial Environments: Source Characterization of Phytane and Pristane Biomarkers and Their Role in Carbon Cycle Dynamics." At his short time at LSU, he also became president of the LSU/AAPG student chapter.

When I asked Daniel which internships or other projects significantly impacted his career path, he answered that his experience with Degeconek Nigeria Limited stands out as the pivotal experience. Daniel said it gave him transferable skills that helped him in his other roles. In addition, he applied advanced analytical techniques to petroleum system simulation, sedimentary petrology analysis, and seismic data interpretation. Working in multidisciplinary teams enhanced his technical skills and communication while leading intern projects gave him leadership experience. "Degeconek sealed my interest in the field of resource exploration and data-driven decisions."

I asked if there were any last words he would like to leave with, and he answered, "Education holds in it the power to rewrite the narratives, bridge socio-economic gaps, and uplift an entire community. This has influenced my personal goals and my passion for teaching and mentorship." ■

Old Rocks, New Energies The Energy Transition the Gulf Coast

PROGRAM

GCSSEPM 40th Annual Perkins-Rosen Research Conference 2–4 December 2024, Houston, Texas

Monday, 2 December

Session I: Plenary Special Session—Chairs: Clare Falcon (LSU), Cindy Yeilding (The Center for Houston's Future)

8.30–9.00am Keynote: Equinor in the energy transition—Sarah Delille* (Equinor)
9.00–9.30 Keynote: TBA—Mark Dean* (Chevron)
9.30–9.55 Gulf of Mexico stratigraphic and structural foundation for the energy transition—John Snedden*

Session IIA: CCUS Regional & Site Evaluation—Chairs: J. Helmich (Equinor), A. İbrahimbaş (Shell)
10.30–11.00 Keynote: From legacy to the future—how vintage seismic is being used to characterize CCS sites with machine learning—Jeni Masi*, Mike Powney, Dan Austin, Theresia Citraningtyas, Monika Dyrendahl, Behzad Alaei, Anastasiia Jacobsen, Sharon Cornelius, Felix Dias, Pete Emmet
11.00–11.25 New energy perspectives for carbon storage along Texas Gulf Coast—A. Fick*, S. Halder,
11.25–11.50 Time-lapse microgravity screening for CCS—Dominik A. Kardell*
1.00–1.25pm CO_2 storage resources of offshore Gulf of Mexico continental shelf—Alex Bump*, I. Faruqi
1.25–1.50 Faulting within and above CO_2 storage interval across the northern Gulf of Mexico shelf—Bryan P. Stephens*, Liepin He, Kevin Trosclair, Cheri Cruz, Erin Elliott
1.50–2.15 Effect of fault geometry and top seal stratigraphy on fault migration of sequestered CO_2 in the Miocene section, offshore Texas—L. Salo-Salgado*, J. Silva, L. Lun, C. Rogers, R. Juanes
2.15–2.40 Enhanced seismic imaging and pore pressure prediction for CCUS in the Gulf of Mexico—Ravi Kumar*, Minshen Wang, Shengda Ding, Mothi Sabaresan, Daniel Carruthers, Paola Fonseca

Session IIb: Modeling and Risking of Carbon Storage & Containment—Chairs: H. Ni (UT), T. Sun (Chevron)
3.15–3.45pm Keynote: Evaluating CO_2 retention risk for geological sequestration sites—J. Steven Davis, Rene Jonk, Kevin Bohacs*
3.45–4.10 Calibrating performance predictions for large-scale injection—C. Okezie, A. Bump*, A. Hovorka
4.10–4.35 Controls on pore-scale properties of mudrocks and their sealing capacity—Hugh Daigle*
4.35–5.00 Modeling CO_2 plume migration and retention with physical analogs—Hailun Ni*
5.00–5.25 Capturing geologically realistic high-resolution reservoir heterogeneity with computational stratigraphy in modeling CO_2 geological storage—Boxiao Li*
5.25–5.50 The impact of capillary heterogeneity trapping on field-scale CO_2 geologic storage simulations—Jose Eduardo Ubillus*, Hailun Ni, Sahar Bahkshian, David DiCarlo, Tip Meckel
6.00–8.00 Icebreaker

Tuesday, 3 December

Session III: Geothermal Energy—Chairs: M. Wright (Rohmtek), M. Ross (UT-Austin, Eavor Technologies)
8.30–9.00am Keynote: Is geothermal energy a viable option for campus/community decarbonization of heating and cooling in the Gulf Coast?—Malcolm Ross*, Andrew Parker
9.00–9.25 Geothermal Play Fairway Analysis (GPFA)—Texas/Gulf Coast mechanisms of heat generation—Kevin McCarthy*, Will Pettitt, Rich Priem
9.25–9.50 Applied petrophysics in geothermal reservoirs: leveraging oil and gas evaluation techniques for energy transition—Katerina Yared*
9.50–10.15 Implications for geothermal energy in the context of a global energy outlook—Richard Chuchla*

Session IV: Critical Minerals—Chairs: Bianca Kennedy (LSU), Rob Bruant (BP)
10.40–11.10 Keynote: Critical mineral potential of the Gulf Coast region—Brent A. Elliott* and J. Richard Kyle
11.10–11.35 Understanding the lithium content trends in the Smackover Formation: potential influencing factors in the Ark-La-Tex region—Julie Bloxson*
11.35–12.00 Data analytics and machine learning workflows for optimization of lithium-rich brine assets. Case study: Smackover Formation, Arkansas—J. Ochoa*, S. Sahoo, S. O'Leary, M . Z

PROGRAM

12.45–1.10pm Exploring for critical metals in Louisiana—Bianca Kennedy*, Matthew Loocke, Clare Falcon

1.10–1.35 Estimating the mass of lithium in Smackover Formation brines using machine learning— Katherine Knierim*, Andrew Masterson, Philip Freeman, Amanda Herzberg, Aaron Jubb, Bonnie McDevitt, Colin Doolan, Jessica Chenault

1.35–2.00 Lithium: a developing industry in ranches of NE Texas and Arkansas—P. Mullin*, D. Daudin, S. Pokrovsky

2.00–2.25 Opportunities for the energy transition in further exploration and exploitation of Gulf Coast salt domes—Matthew Loocke*, Bianca Kennedy, Clare Falcon

Session IIa (continued): CCUS Regional and Site Evaluation—Chairs: Matt Croy (Equinor), Alex Bump (UT-BEG)

2.25–2.50pm Geological characterization of the Chandeleur Sound 3D seismic survey area, offshore Louisiana, and the potential for anthropogenic carbon sequestration within a newly discovered Middle Miocene submarine canyon—Marcie Phillips*, Annie Walker, Dallas Dunlap, John W. Snedden, Michael L. Sweet, Shuvajit Bhattacharya

2.50–3.15 CO_2 storage site screening for depleted fields on the Texas Gulf Coast—an integrated approach—Yijie Zhu*, Sophie Boulter, Tianyu Chen, Marie McKechnie

3.45–4.15 Keynote: CO_2 residence time and geothermal resource potential of the Hosston and Travis Peak Formations, onshore US Gulf Coast region—Laurie A. Burke*

4.15–4.40 Sleipner, Snohvit, Smeaheia, northern lights, and Kalundberg, Norway and Denmark—Michael Schoemann*, Janine Helmich

4.40–5.05 Wedges, bridges, and hockey sticks: exploring the energy transition—Cindy Yeilding

Wednesday, 4 December

Session V: Hydrogen—Chairs: Barry Katz (HGS), Lorena Moscardelli (UT-Austin BEG)

8.30–9.00am Keynote: An overview of hydrogen in the subsurface—Barry J. Katz*

9.00–9.25 The role of salt tectonics in the energy transition: an overview and future challenges—Ol. Duffy, Mi. Hudec, F. Peel, G. Apps, A. Bump, Lorena Moscardelli*, T. Dooley, N, Fernandez, S. Bhattacharya, K. Wisian, M. Shuster

9.25-9.50 The new gold rush—gold hydrogen: why is it important, what do we know and where could it be?—Mike Powney*, Ian Hutchinson, Owain Jackson, Andrew E. Stocks, Andrew C. Barnicoat, Stephen R. Lawrence

9.50–10.15 Keynote: Emerging hydrogen economy in Texas: the role of the subsurface in geological storage—Lorena Moscardelli*, L. Ruiz-Maraggi, N. Lin, N. Schuba, A. Martinez- Doñate, L. Melani, L. Ko, E. R. Calzado, M. Shuster

10.50–11.15 Mississippi salt basin diapirs: considerations for geological hydrogen storage—C. Nur Schuba, Lorena Moscardelli*, L.

11.15–11.40 Hydrogen storage in salt caverns; evaluating the potential of Permian Basin evaporitic sequences for cavern development (USA)—Ander Martinez-Doñate*, Leandro Melani, Leopoldo Ruiz-Maraggi, Lorena Moscardelli

11.40–12.05 Evaluating depleted gas reservoirs for hydrogen storage: a criteria-driven approach—R, Okoroafor*, L. Kumar Sekar, A. Badejo

12.05–12.25 Hydrogen and ammonia projects at Equinor—Stephanie Curran*

1.15–1.40 Determining the favorability of sedimentary lithium accumulation in the geological record: a global approach—David Lee, Amanda Galsworthy, Bill Heins*, Howard Golden

Session VI: Energy Transition Workforce—Chairs: Bianca Kennedy (LSU), Rob Bruant (BP)

1.40–2.05 SEG EVOLVE carbon solutions internship: preparing students for industry—a mentor's perspective—Ryan Ruppert*

2.05–3.15 Panel Discussion: The energy transition: perspectives from the Gulf Basin and global analogs—Moderator: Ayşe İbrahimbaş (Shell), Panelists: TBD

POSTER PRESENTATIONS (listed in alphabetical order)

Determining the favorability of sedimentary lithium accumulation in the geological record: a global approach—David Lee, Amanda Galsworthy, Bill Heins*, Howard Golden

Exploring for critical metals in Louisiana—Bianca Kennedy*, Matthew Loocke, Clare Falcon

Geology for CO_2 is still geology—borehole images for understanding local capillary trapping in reservoirs—A. Kumar, El. Haddad, Adaobi Elekwachi

Opportunities for the energy transition in further exploration and exploitation of Gulf Coast salt domes—Matthew Loocke*, Bianca Kennedy, Clare Falcon

Analyzing critical metal and fluid interactions of a historic subsurface volcanic core drilled from Door Point, LA, US Gulf Coast—Ashlyn Schneida*, Bianca Kennedy, Matthew Loocke

Identification and analysis of reservoir-seal pairs for sequestration of CO2 in the greater Mississippi Embayment, onshore Gulf of Mexico—Robert Wellner*, Kathryn Denommee, Raed El-Awawdeh, Peter Gold

Cuba's Petroleum System in the Northern Thrust Belt

By Ted Godo

In 1945, at the end of the Second World War, Cuba had only a few small oil fields, and geologists theorized that a similar oil prospectivity found in Venezuela might also exist in Cuba. Although sparsely drilled then, an active petroleum system was evidenced by single oil wells, water wells with oil and gas shows, and oil seeps throughout Cuba (Echevarria-Rodriguez, 1991; Delgado-Lopez, 2019). International companies, including the US, began to study and acquire leases from the government. The Cuban government itself bought a single National 75 drilling rig to stimulate exploration. A few years passed gearing up the exploration campaign with some drilling, but no significant discoveries were made. The Cuban government was encouraging international involvement, so in 1954, a local Cuban company called Grupo-Jarueca made a deal with Kerr-McGee to use the National 75 rig to drill a prospect around an oil seep near Jatibonico, Cuba. Well #1 discovered oil at 1,100 feet and named the resulting field the Jatibonico Field after the town (Silverman, 2016). The Jatibonico discovery further ignited oil exploration in Cuba. Majors and small companies more rapidly acquired acreage and drilled wells in onshore basins until 1959, when the revolution was completed. The new communist government then nationalized all internationally held oil and gas facilities. They were rebranded into a single, state-controlled company, The Cuba Oil Union (Spanish: Unión Cuba-Petróleo), also known as CUPET.

Today, there are 28 oil fields, all located just onshore and offshore, less than five km off the northern Cuban coast (**Figure 1**) (Schenk, 2008). CUPET discovered and currently operates most of the oil fields. The other operator is a Canadian oil company, Sherritt International, which has been an operator for 25 years. Cuba does not have significant fossil resource reserves and mainly relies on imports to meet domestic energy demand. As of 2021, its proven oil resources were 124 million barrels (mmbo) and 2.5 trillion cubic feet of gas (TCf) (EIA, 2024; cubabusiness report, 2016). Cuba produces approximately 45,000 barrels of oil daily and 3 million cubic meters of gas. This supports half the domestic consumption with the balance using imports.

Regarding deepwater exploration since 2004, one well was drilled that year, three more in 2012, and none since (Ananev, 2014; Felipe, 2016). Repsol drilled the 2004 well in block N27, in 1660 meters of water, calling it Yamagua-1, and drilled it to a total depth of 3,400 meters. Newswires reported traces of oil in an excellent carbonate complex. Then, in 2012, three deepwater wells were drilled by Spanish, Norwegian, Indian, Malaysian, Russian, and Venezuelan firms, all being dry holes. The first of the three wells was named Jaguey-1, drilled by Repsol in 1700m of water to 4,666m below the seabed, and reports said it "missed the reservoir". The second well was drilled 100 miles west of Jaguey by Petronas and Gazprom. The findings were said to reveal an active petroleum system, but the reservoir was tight with low porosity (reading through the tea leaves). Lastly, the third well was drilled by the Russian company Zarubezhneft in block L-01X off the north Cuban coast, targeting reservoirs below 6,500 meters. The well is reported as dry, with no other information available.

Cuba's Petroleum System *continued on page 15*

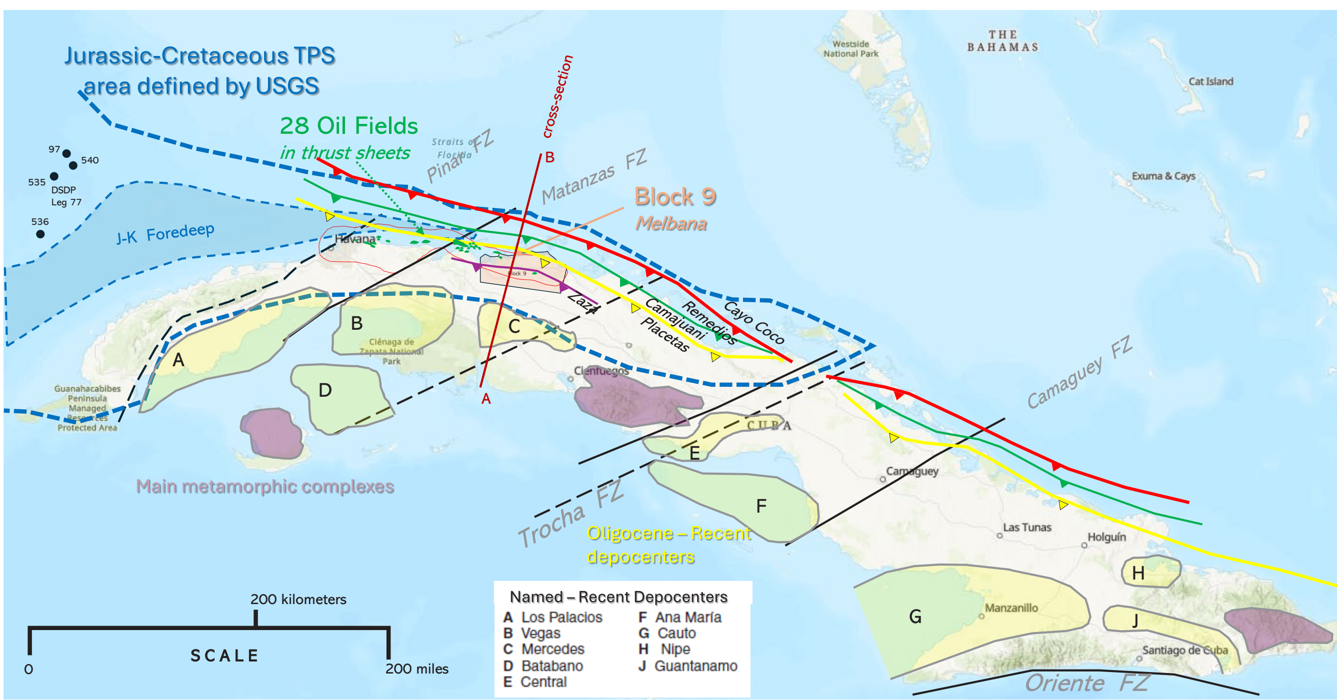

Figure 1. *Geologic features, basins, thrust sheets and oil fields of the Northern Petroleun Province*

There is still perhaps considerable geologic scope for Cuban offshore oil and gas fields, especially if newer technologies were used to develop the heavy oil in fractured carbonates. A second "Feature Article" in this *Bulletin* will show a recent Cuban discovery and appraisal by Melbana Energy Limited, an ASX-listed Australian company.

Also of note, this month (Dec 4th-6th) Cuba is holding the Cuba Energy Summit in Havana. This event is the first of its kind in five years. The event invites energy companies, service providers, and governmental authorities that want to tap into the country's proven resources. Company sponsors of this event include Cupet, Melbana, Sonangol, Davalos, Petro Australis, Arpel, Biba, and Acera (newsinamerica, 2024).

REGIONAL GEOLOGIC SETTING

Tectonics

The geology of Cuba is very different from other Caribbean islands in that there is a wide range of rock ages, from Precambrian metamorphic rocks to outcrops of Jurassic and Cretaceous rocks and a Cenozoic age volcanic arc complex with ophiolites. Western and Central Cuba are orogenic belts with folding and thrusting, while eastern Cuba has the Cenozoic volcanic arc with ophiolites (off-scrapings). Three distinct episodes that made Cuba are 1) A Jurassic breakup of North and South America (Pangea) with rifting and a passive margin through the Cretaceous with the development of oceanic crust of the proto Caribbean, 2)further development of a magmatic and metamorphic evolution of Upper Cretaceous and Paleogene ophiolite-arc complex and 3) a Paleogene "soft collision" and transfer of the NW Caribbean plate forming Cuba to the North American plate (Iturralde, 2016; van Staal, 2020). Soft collisions occur when contractional deformation and associated metamorphism are principally concentrated in rocks of the leading edge of the partially pulled-down buoyant plate and the upper plate forearc terrane (van Staal et al., 2020). Excellent Paleogeographic maps are shown in four references recommended herein for review (Escalona, A., 2021a; Escalona, A., 2021b; Mann, 2021; Pindell, 2020b).

Timing Comparisons with the Opening of the Gulf of Mexico

In the Gulf of Mexico (GOM), at the end of Bathonian time, the (Louann) salt "sag" deposition was nearly completed, differentiating it from the pre-rift stage in the area where Cuba is now positioned (Pindell et al., 2020a—Fig 5). The pole for the Yucatan counterclockwise rotation was located just west of present-day NW Cuba. As a result of this rotation, water in the GOM was blocked from extending any further south by the Sarasota arch, as can be seen by the narrow area (or finger) of salt deposition (Pindell, 2020a; Nguyen, 2016; Fig 1). The overall sag sequence that included the Louann salt deposition is much thicker to the west in the GOM than the easternmost area and was caused by the difference in dynamic elevation (Pindell, 2022a).

While the GOM was forming, the "unzipping" or opening of the North Atlantic margin had been going on, stopping short of separating South America and Africa. The North Atlantic spreading center shifted westward by a transfer fault extending northwestward, offsetting its spreading center that would begin forming the proto-Caribbean crust. The initial rifting for the proto-Caribbean formed half-grabens filling with marine clastics and evaporites of the San Cayetano formation, with water likely entering from the Atlantic.

Cuba's Petroleum System *continued on page 16*

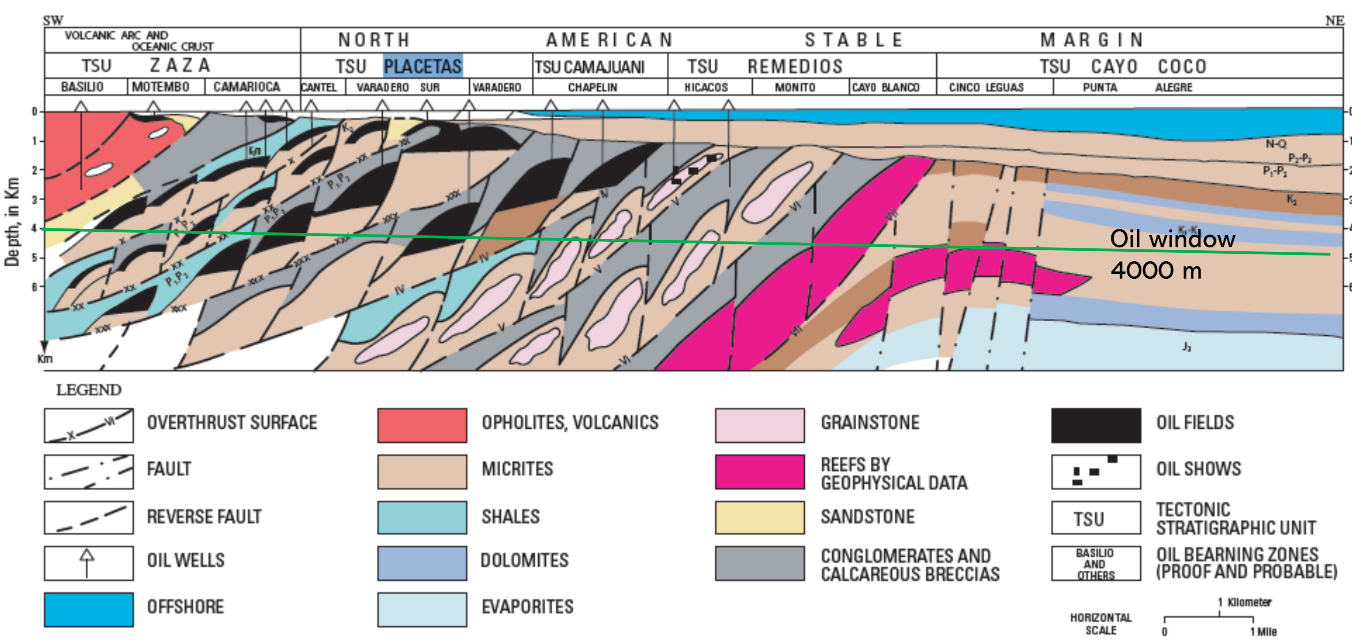

Figure 2. *Schematic geologic cross section over the northwestern Cuba showing the named thrust faults or (TSU's) and their relation to onshore and offshore oil fields (modified after Schenk, 2008; after Echevarria-Rodriguez and others, 1991)*

Cuba's Petroleum System continued from page 15

The North American sedimentary rocks initially deposited on the passive margins of eastern Yucatan in the proto-Caribbean basin, now outcrop as juxtaposed fold and thrust belts in Cuba. They are mapped as terranes called the Guaniguanico terrane, the Northern Foldbelt, and the metamorphic Caribbean terranes (Iturralde-Vincent, 2011).

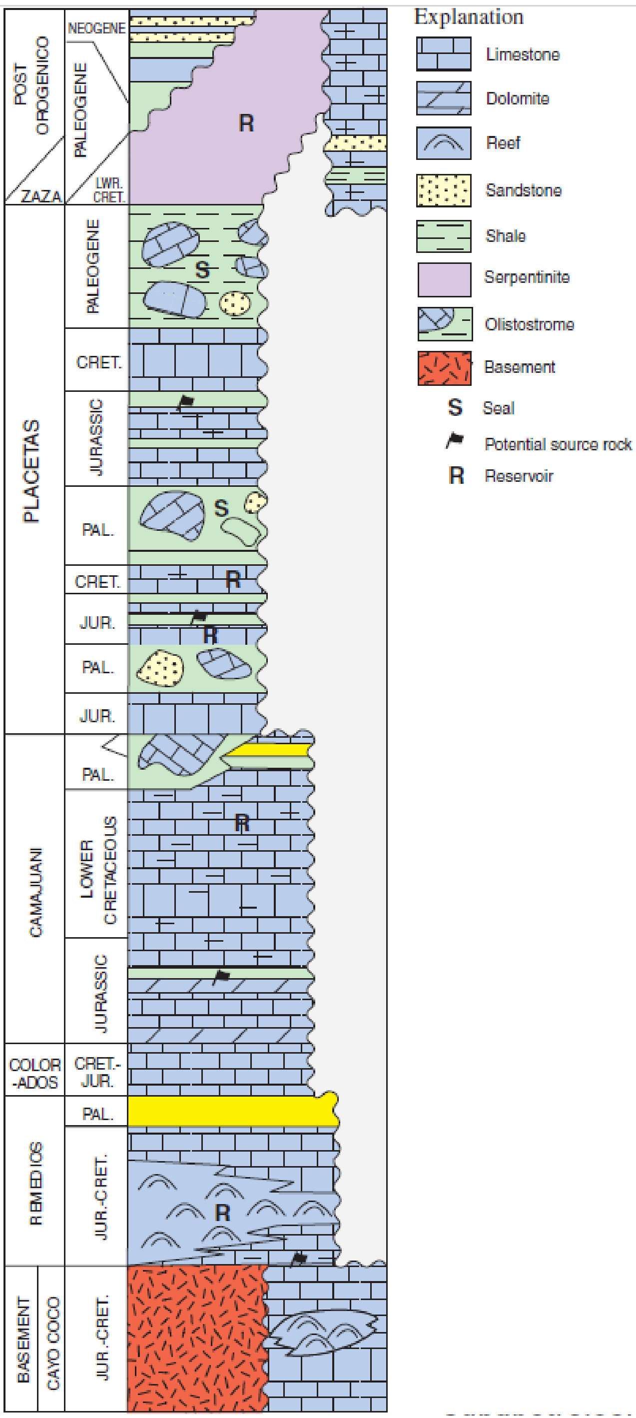

Figure 3. *A stratigraphic column showing thrust repetitions in the Jurassic through Tertiary section in the Cuban fold and thrust belt in northern Cuba Schenk (2008) (modified from Cubapetroleo, 2002).*

PETROLEUM SYSTEMS

Cuba has two distinct petroleum provinces (Lopez,2019-fig1.1). The Northern Province has a string of oil fields found in a fold and thrust belt with source rocks in four intervals in the Jurassic and Cretaceous. The Southern Province comprises nine "piggy-back" basins formed in the Upper Cretaceous-Tertiary, which overlie subsiding extinct volcanic arcs (Echevarria-Rodriguez, 1991). These nine basins practically occupy most of the onshore area but extend to offshore areas in the south (**Figure 1**). This article will focus on the Northern oil province.

The two most significant oil fields in the overthrust belt of the northern province are Varadero and Boco de Jaruco, located on the coast and just offshore. Both fields report over 1 billion barrels in place. Oil is produced from fractured Late Jurassic and Cretaceous limestones. Volumetrically, the most significant source rock in the basin are mudstones of the Kimmeridgian/Tithonian age, known as the Cifuentes member (Gonzalez, 2013).

Varadero field, discovered in 1971, produces heavy oil (220API) in shallow water. The field has recovered 77% of its total recoverable reserves with an expectation to recover 90mmboe by its field life, estimated to be in 2059 (Offshore Technology, 2021). Boco de Jaruco oil field, discovered in 1969, is located on the coast and produces heavy oil (170API). Cumulative production through 1993 had been 23 MMBO (Schenck, 2009) but updated numbers in 2020 suggest the ultimate might be in the 50 MMBO range, given sketchy numbers by the Russian operator Zarubezhneft (Upstream, 2020). The other fields in this productive northern thrust belt have a median size of 5.2 MMBO (Schenck, 2008).

Since the early 1950s, " Tectonostratigraphic Units" (TSU) have been used to name and characterize each major imbricated thrust sheet separated by the leading edges of significant thrust faults in Cuba. Five Tectonostratigraphic Units (TSU) describe the oil-productive area of northwest Cuba. Each unit is represented by an association of rocks of different ages and facies with normal stratigraphic relations or a metamorphic or tectonic overprint (Hatten, 1988). From south to north, these are the Zaza, Placetas, Camajuani, Remedios and Cayo Coco units (**Figure 2**) (Hatten, 1988: Ducloz and Vuagnat, 1962). Most of the rock ages within most TSUs range from Oxfordian to Turonian. A stratigraphic column showing thrust repetitions in the Jurassic through the Tertiary section is shown in **Figure 3**.

CUBA STRATIGRAPHY

The focus of this article is the petroleum province of Northwestern Cuba. This province's stratigraphic column uses outcropping thrust sheets and drilled wells in the frontal thrust zone (**Figures 4 & 5**). Other control points come from several DSDP wells drilled in the Florida Straits. The oldest sediment reached in these wells is Berriasian **Cuba's Petroleum System** *continued on page 17*

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(Lower Cretaceous) (Dallmeyer, 1984; Schlager, 1985). Below the Berriasian, no other wells in the Cuban thrust belt or outboard (north) have penetrated the seismically identified autochthonous half-grabens (Schenk, 2008-fig40; Magnier, 2004-fig 1). *[1] The stratigraphic section in these half grabens above basement rock has been described by what is considered the equivalent age found in exposures of western Cuba.

The San Cayetano exposures in western Cuba involve extensive multiple thrust sheets, and its base is unknown, but an estimated thickness of 1500 meters has been given by Haczewski (1976). Together, these numerous thrust sheets are mapped as the Guaniguanico terrane. Zircons taken from the San Cayetano outcrops were analyzed to determine the sediment provenance (Ascanio-Pellon et al., 2024). The results show that the San Cayetano sediments were derived from the Oaxaquia basement and the Chiapas batholith at the southern Yucatan margin. The deposition of San Cayetano was then followed by tectonically displacing it northeastward, forming the western part of Cuba today (Ascanio-Pellon, 2024-figs 13 and 14). In some wells of the frontal thrust zone, polymictic sandstone and marine shale intervals are present, called Cuba's Petroleum System continued on page 18

*[1] *If one expands the search for a well that penetrated the rift grabens to include Chevron's Great Issac#1 well off the southeast Florida coast, it did penetrate a Triassic section with an oil show in the graben (Epstein, 2009).*

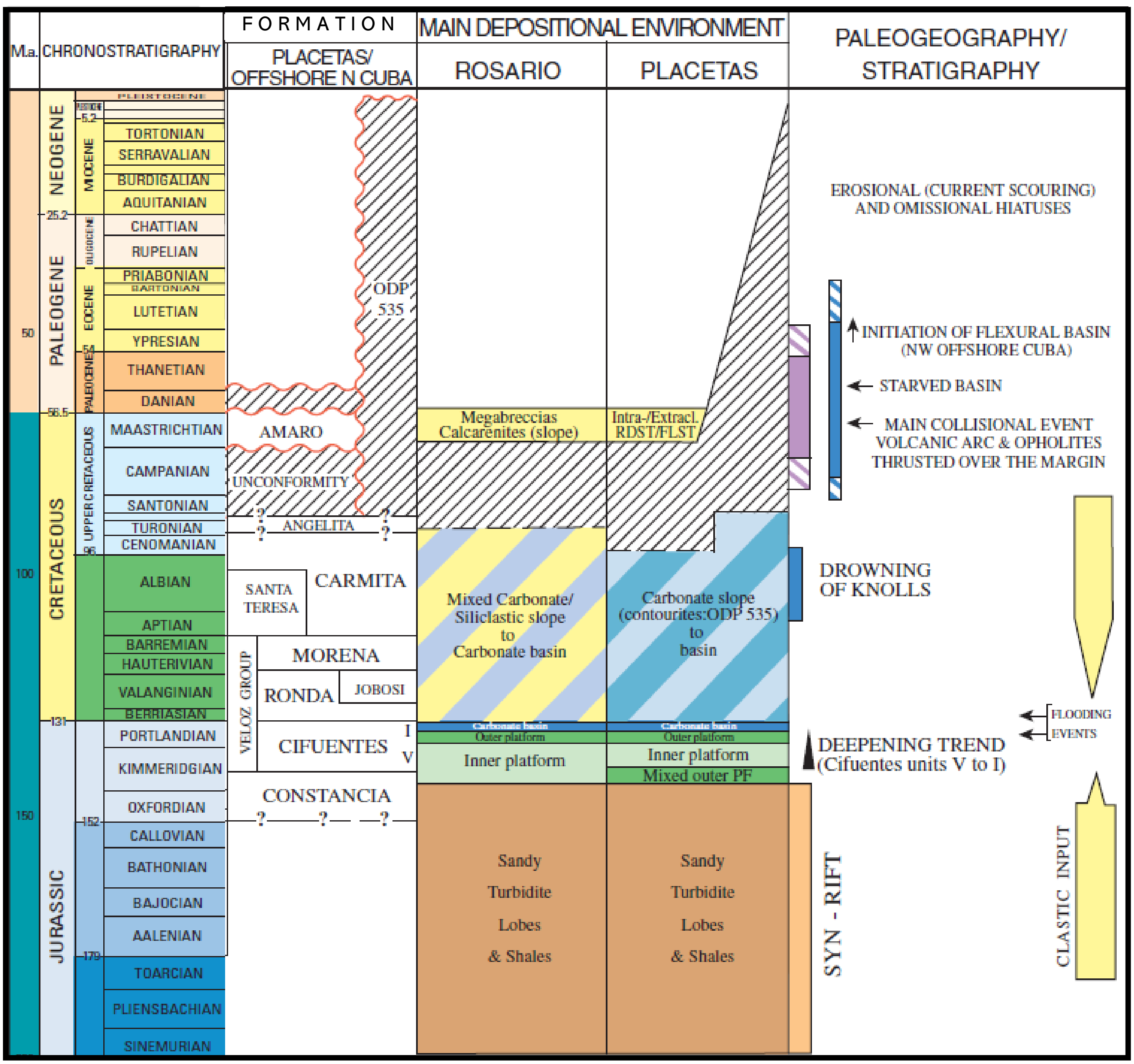

Figure 4. *Lithostratigraphic column for northwestern Cuba showing stratigraphy of the Placetas Tectonostratigraphic unit (modified from Schenk 2008 from Sanchez Arango et al, 2003)*

Cuba's Petroleum System

continued from page 17

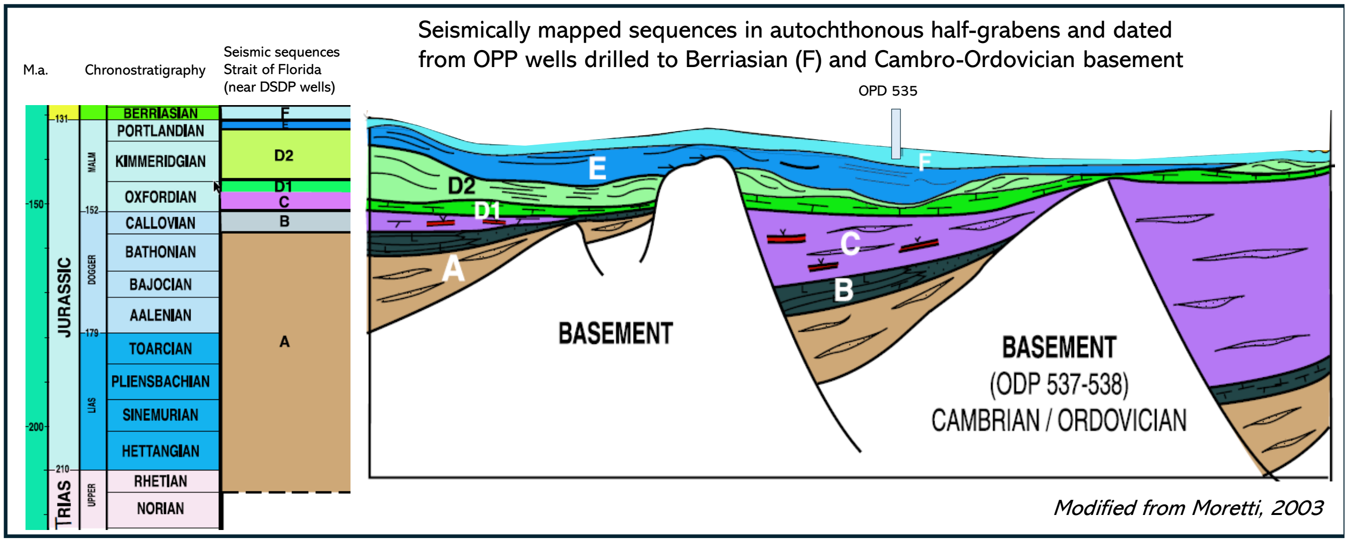

Figure 5. *Schematic cross section showing correlation of the seismic sequences with lithostratigraphic charts (northcentral and western Cuba) modified after Moretti, 2003).*

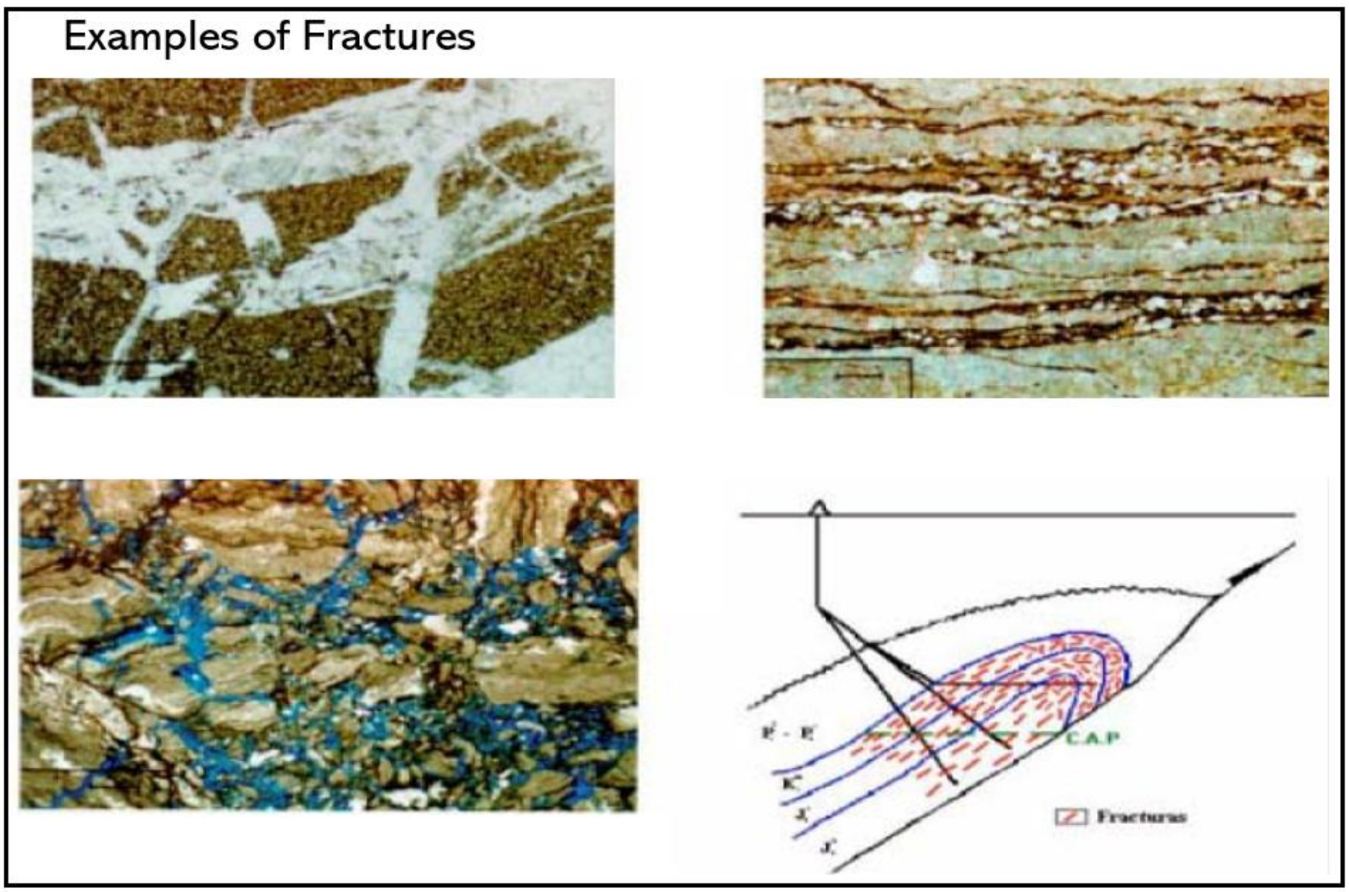

Figure 6. *Fracturing in the Veloz carbonates (after Alvarez-Castro, 2004)*

Cuba's Petroleum System *continued on page 19*

the Constancia sandstone. The Constancia is thought to be perhaps the uppermost (Oxfordian age) equivalent of the San Cayetano outcrops (Schenk, 2008; Gonzalez, 2013). Haczewski (1976) described the San Cayetano outcrops as having coarse red clastic sandstone(subaerial?), marine sandstone, mudstones, and evaporites. The presence of mobilized salt has been penetrated in four salt domes drilled along the northern Cuban coast beneath thrust faults. This salt is possibly sourced from the half-grabens below the frontal thrust zone (Meyerhoff & Hatten, 1968; Wassell,1993; Schenk, 2008; Moretti, 2003; Arango, 2013; Spector, 2014). Carbonate is likely the dominant lithology deposited in the grabens during the Oxfordian and Kimmeridgian with possible reef development at the remnant rift topography edges and overtop.

As the remnant topography healed, carbonate sediment continued to be deposited, connecting a wider aerial distribution of Tithonian through the Berriasian age. The underlying Tithonian is thought to coincide with the first oceanic crust formed in the Proto-Caribbean (Cobiella Reguera 2000, 2008; Pszczolkowski, 2003; Sánchez Arango, 2001, 2007). Onshore, Florida was still the paleo highland that defined the northern edge of the southern dipping passive margin. Moving further south, the rate of subsidence increased toward the oceanic crust. This is particularly highlighted by Aptian, into early Cenomanian sediments which rapidly transitioned to basinal sedimentation (Hempton, 1993). In the Cenomanian, pelagic limestone is deposited with some shale and cherts, suggesting the silica is provided by the closely approaching volcanic Arc complex (Hempton, 1993). This becomes more apparent during the Turonian when volcaniclastic rocks of the Moreno member are deposited. They consist of sandstones, conglomerates, and volcanic "dacite tuffites" (Hempton, 1993; Psyczolkowski, 1978). The Santonian section is virtually missing in Cuba as a sharp angular unconformity truncates the Turonian and is overlain by Maastrichtian orogenic turbidites generated during the arc/margin collision. Hempton (1993-fig14) illustrates that this "forebulge," or a raised section of rocks in front of the leading edge of the colliding tectonic plate, was caused by bending/flexing of the Earth's lithosphere due to the immense loading of the arc/margin. Uplifting the forebulge area and progressively migrating its crest northward resulted in exposure/karstification of the previously deposited limestones (Hempton, 1993; Ananev, 2014; Shipper, 2024). Shipper (2024) compared the burial history of four wells north of the thrusting, illustrating the rapid subsidence/burial on the north side of the forebulge caused by the flexing of the lithosphere.

RESERVOIRS

The fields developed in the overthrust province are from carbonate reservoirs of the Veloz Group (Upper Jurassic—Barremian), sourced from Jurassic clayey carbonate facies and sealed by Tertiary shales. Most Cuban oil is heavy crude with high viscosity and only have a five to seven percent oil recovery factor (Felipe, 2016). Initially, production wells were vertical and produced 100-200 barrels per day. However, since the 1990's, the change to drilling horizontal wells allowed production rates to increase to three to four thousand barrels per day (Alvarez, 2004). Most of the horizontal wells reach a length of over 6,000 meters (Felipe, 2016). Because reservoirs of the Veloz group also contain the major source rocks, migration would appear to be simply a filling of the adjacent fractures, creating pathways for more deliverable oil (permeability). The drawback is that crude is a heavy oil that is only marginally mature in most fields. The fields are often found around the top of the oil window.

The Veloz Group reservoirs are effective mainly due to fracturing, which can be intense with porosity values yielding between 13 – 18% with permeability on the order of darcies (Alvarez, 2004). Alvarez (2004) describes the fracturing developed in three phases: Phase 1 occurred with compaction and often filled with calcite; Phase 2 occurred during the orogenic period with bedding-parallel fractures and filled with bitumen and oil. Phase three is related to a post-orogenic period where fractures are chaotic due to intense brecciation and are filled with oil and bitumen (**Figure 6**). The cutoff depth for good porosity/permeability is 2500-3000 meters (Alvarez, 2004).

SOURCE ROCKS

Source rock presence in the northern Cuban petroleum system is well established. Multiple source rock intervals are found in the 1) synrift (Early to Late Jurassic – San Cayetano FM), 2) late synrift sequence (Oxfordian-Constancia FM), 3) sag to ocean crust formation (Kimmeridgian to Barremian-Veloz group-Cifuentes member), 4) Rapid subsidence of deep water mudstones deposited just prior to arc collision (Aptian-Turonian – Carmita and Angelica FM).

Synrift-age source rocks have not been penetrated in deep water. The equivalent aged San Cayetano outcrops with interbedded black shale and sandstone have been evaluated for source rock characteristics. Outcrop source rock evaluations using Rock-Eval VI, show that the outcrops are mature to overmature. After corrections for maturity, the initial TOC was about 3% with a hydrogen index (HI) of 170 for a sample with a PI of 0.85 (remnant S2=3.1 mgHC/g) (Moretti, 2003).

The late syn-rift Oxfordian rocks have variable outcrop thicknesses, ranging from a few meters to more than 2km (Moretti, 2003). The formation name given to this rock is the Constancia, and 25 core samples from four exploration wells in the Varadero oil field have been analyzed (Gonzalez, 2014). Results indicate that these rocks have an organic carbon content (TOC) ranging from 0.13 wt% to 5.84 wt%. The average hydrocarbon generation potential (S2) is between 0.34-5 mg HC/g for low TOC rocks, and high TOC rocks have an S2

Cuba's Petroleum System *continued on page 20*

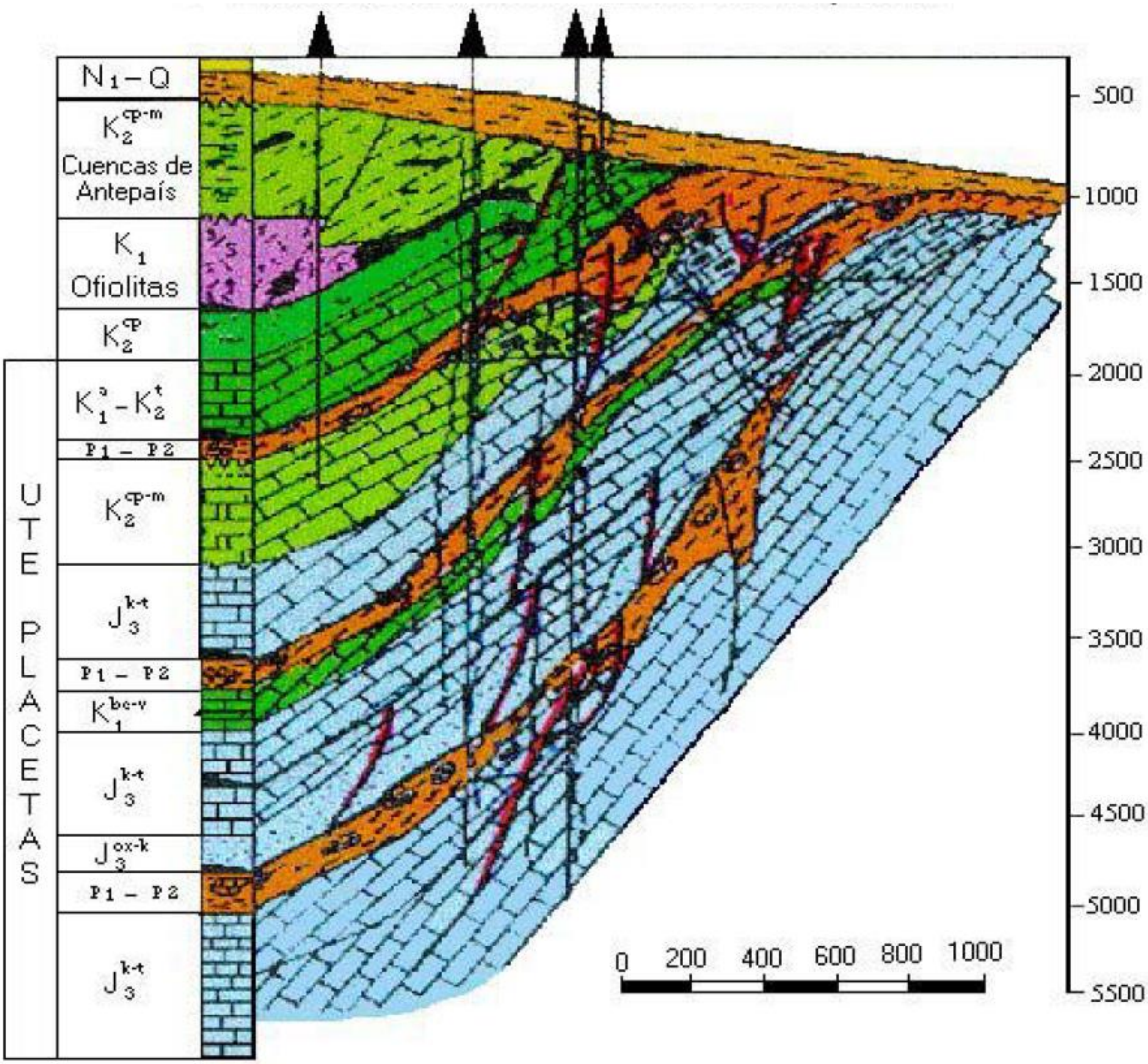

Figure 7. *Cross section of the Boca the Jaruco oil field (taken from Alvarez-Castro, 2004 (fig1))*

from 5-49.9 mg HC/g, suggesting overall, a good to excellent potential. No maturity correction is needed for the richness determination as the Constancia extract rock is immature to early mature (Gonzalez, 2014).

The Kimmeridgian early sag through the widespread Tithonian to Barremian rocks is called the Veloz Group. However, the richest portion of this interval is the Kimmeridgian/Tithonian age, known as the Cifuentes member. This interval, made up of deep-water carbonate mudstones, is volumetrically the most significant source rock in the basin (Gonzalez, 2013). The Cifuentes member has been analyzed in 37 core samples from ten exploration wells in two oil fields (Via Blanca (VB) and Boca de Jaruco (BJ) fields) ranging in depths from 1468 to 4037 meters (Gonzalez, 2013). The TOC content ranges from 0.5 to 9.91 wt%, suggesting a fair to excellent source rock. Overall, this is a wide range in TOC, but if the stratigraphic equivalent from four wells (VB-2, VB-3, BJ-4, and BJ-5) is broken out, then the TOC range tightens from 2.08 to 9.91%. These highlighted samples came from a depth range between 1400 and 2300 meters (Gonzalez, 2013). A cross-section across Boca de Jaruco is shown in **Figure 7** (Alvarez-Castro,2004). Thermal maturity measurement from vitrinite reflectance ranged between 0.52 and 0.59%, which agrees with the spore color index and Tmax calculations supporting an immature to marginally mature level. In another study that sampled Cifuentes outcrop samples where thermal levels are mature to overmature, reported HI values are above 400mg HC/g rock, with some richer levels having up to 600 mg HC/g rock (Magnier, 2004).

Cuba's Petroleum System *continued on page 21*

The Aptian/Albian section has been evaluated both in outcrop and in the DSDP wells with similar values (Magnier, 2004; Moretti, 2003). An outcrop study of the Aptian/Albian is sampled from the Carmita formation. From the outcrops, the best values are S2 = 9 mg HC/g, HI = 280, and TOC = 3.1% for a mature sample (PI = 0.8), which means an initial S2 of more than 30mgHC/g (Magnier, 2004). Delgado Lopez (2019) also identified the same major source rock packages and studied the richness values using outcrop samples. In the two DSDP wells, Rock-Eval analyses also show excellent potential. The highest S2 levels are found in the Valanginian and Hauterivian. In the DSDP 535 well, the S2 was as high as 50 mg HC/g, and HI was up to 700 (Moretti, 2003). In the Turonian period, the Angelica formation was sampled in the La Manuy-1 well over a 74-meter interval, with a consistent potential of 6-8 mg HC/g for S2 and 550/600 for the HI of immature samples taken between 726 and 800 meters deep (Moretti, 2003).

STRUCTURES

Hydrocarbon traps are found in asymmetric folded structures, with mapped sizes that are the smallest in the southern TSUs of between 3-6 km in length (strike) and 1.5 to 2 km in width (dip) (Echevarria-Rodriguez, 1991). Further outboard toward the frontal zone, larger mapped structures increase to 30-40 square kilometers (Echevarria-Rodriguez, 1991). Seismic resolution is difficult but can identify flatter dips <300 on otherwise often incoherent and irregular seismic horizons corresponding to mapped surfaces interpreted either in different or in the same TSU (Echevarria-Rodriguez, 1991).

It was not apparent to me, reviewing the literature, that cross sections could be balanced or restored because it appeared that faults often cut previously folded rocks. This would make balancing or reconstructing difficult or suspect. I do not know if, indeed, there are previous folds cut by later faults, making it impossible to balance, or whether the seismic data is so complex to interpret that only major packages are shown as thrust sheets. Ananev (2014) states, "This geological complexity makes it very difficult to identify, by seismic, the elements that make up the petroleum systems (source rocks, reservoirs, and seals) and the traps where the hydrocarbons are stored."

CRITICAL MOMENT — CHARGE

The Northern Cuba petroleum province requires the vertical stacking of thrust sheets, each carrying the source rock, to bury the source rock to the depth of the oil window. The top of the oil window is 4000 meters (Alvarez, 2004). The Veloz group (Late Kim to Barremian) brackets the gross source rock interval, including the richest Cifuentes member (late Kim and Tithonian). Stacking of the Veloz group is stacked in some places to more than 6000 meters.

Individual thrust sheets have a general equal thickness between 1.5 to 2 km thick (Parnell, 2003). A simplified burial plot is shown in **Figure 8**. The oil windows are shaded in green and are overlain on thrust sheets viewed at different depths (Parnell, 2003). The burial plot shows that the Veloz source rock package entered the oil window in the second and third thrust sheets.

SUMMARY

Cuba's oil potential has much promise if only because of the numerous source rocks present and a tectonic influence to create structures. The problem **Cuba's Petroleum System** *continued on page 22*

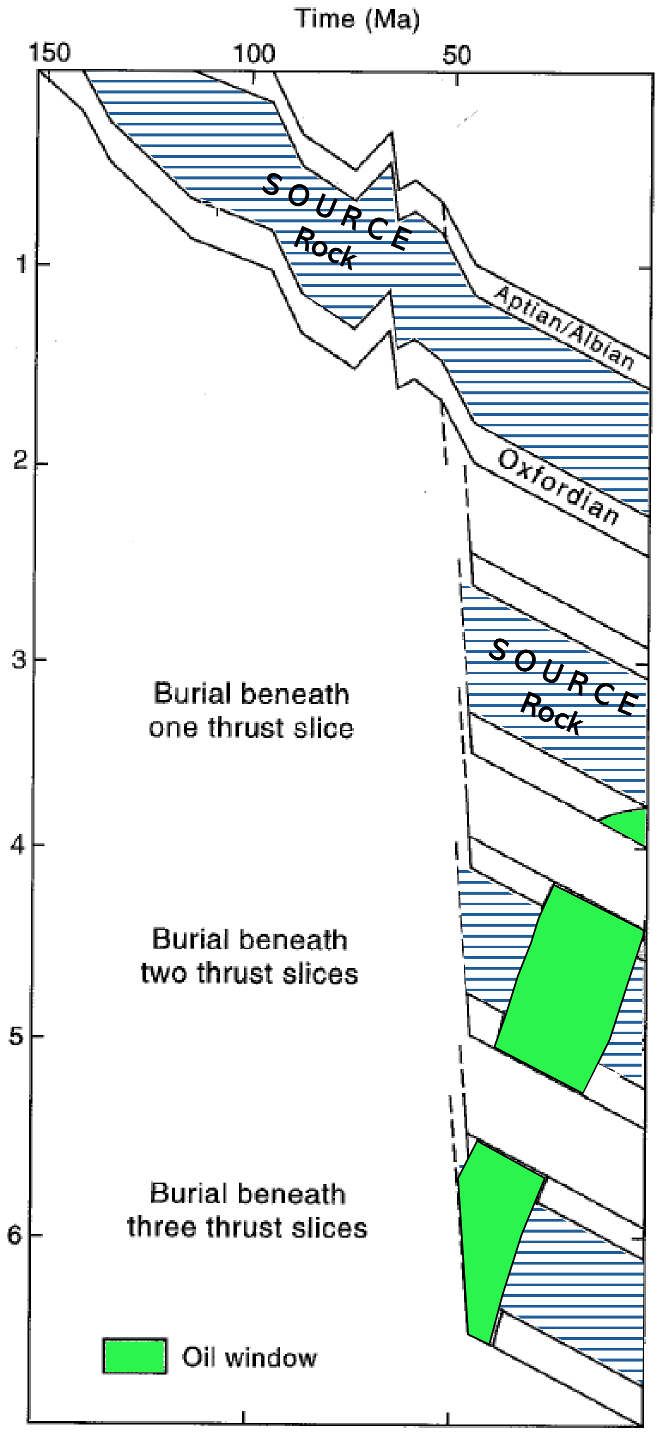

Figure 8 *A semiquantitative burial history model constructed for the north coast region (modified from Parnell, 2003)*

to date is the lack of matrix porosity in carbonates that require fractures to deliver the oil. There are likely facies changes in the carbonates where matrix porosity is developed, but does that area coincide with structures that are commonly the first things drilled? In addition, the question of enough overburden, whether caused by sedimentation or the stacking of thrust sheets, can be even further buried to mature source rocks to a higher API gravity, helping flow rates.

The few deep-water wells drilled were reported as dry, but there are only four of them. Then there is the seismic quality. There is no doubt that all the innovations used in the GOM could vastly improve the image. We'll see what the future holds, but in the meantime, this summary could provide some insight or basis for more thinking. ■

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Recent Cuba Wells Drilled by Melbana Energy

By Ted Godo

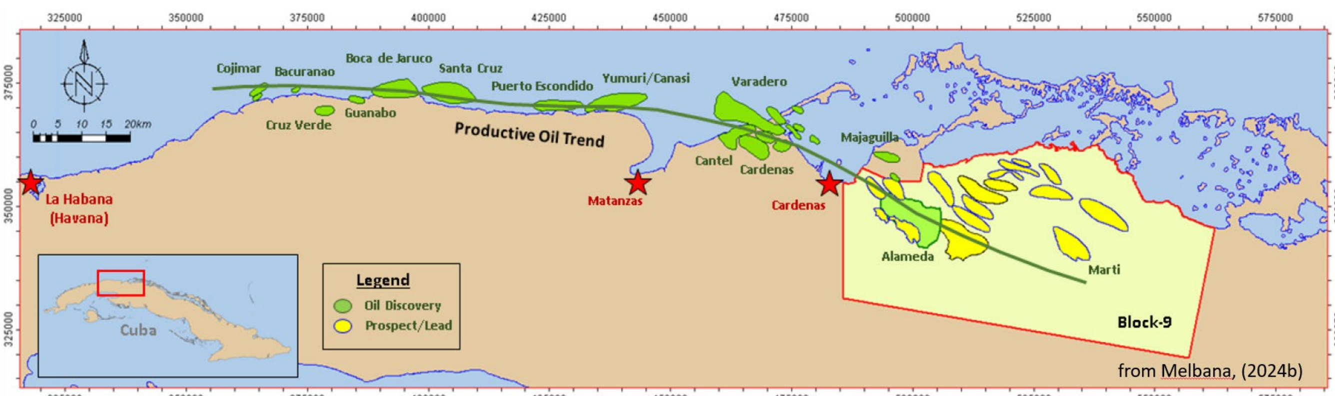

Figure 1 *Map of northern Cuba's Oil Fields extending into Melbana's Block 9 acreage*

This article was written as a follow-up to the other "Feature Article" in this month's *Bulletin* titled "Cuba's Petroleum System in the Northern Thrust Belt." This piece describes the recent operations of an ASX-listed Australian oil company called Melbana, which changed its name from MEO Australia Limited in November 2016 to now MAY. Melbana combines Melbourne and Havana to be more respected when operating in Cuba. I use the word respected because in Cuban slang or local vernacular, Melbana's former name, MEO, has a rather personal degrading meaning. Of course, Spanish is the language of Cuba, but there are differences such that some Spanish speakers call it Cubañol.

In 2013, Melbana identified Block 9, prequalifying as the operator, and was awarded the block in 2015 (**Figure 1**). Block 9 is a large onshore block (2,344 km2) on trend and about 35km from an analogous multibillion-barrel oil field (in place) named Varadero field. Varadero field is an established oil field with infrastructure. Melbana opened the Havana office in 2016 and appointed an experienced ex-Cupet Cuba representative. In 2021, Sonogol (National Oil of Angola), Africa's largest producer, farmed into two exploration wells paying leverage and now has a 70% working interest with Melbana retaining operatorship. Alameda is a large structure located in the western part of Block 9 and is in a similar structural position to the Varadero field, the largest oil field in Cuba. The three wells described below drilled by Melbana are on 2D seismic data. There is a plan for 3D seismic for 2024/2025 to optimize development drilling. In addition to using 2D seismic, Melbana uses magnetic and gravity data to define greater prospectivity in the block which currently has mapped 19 structures.

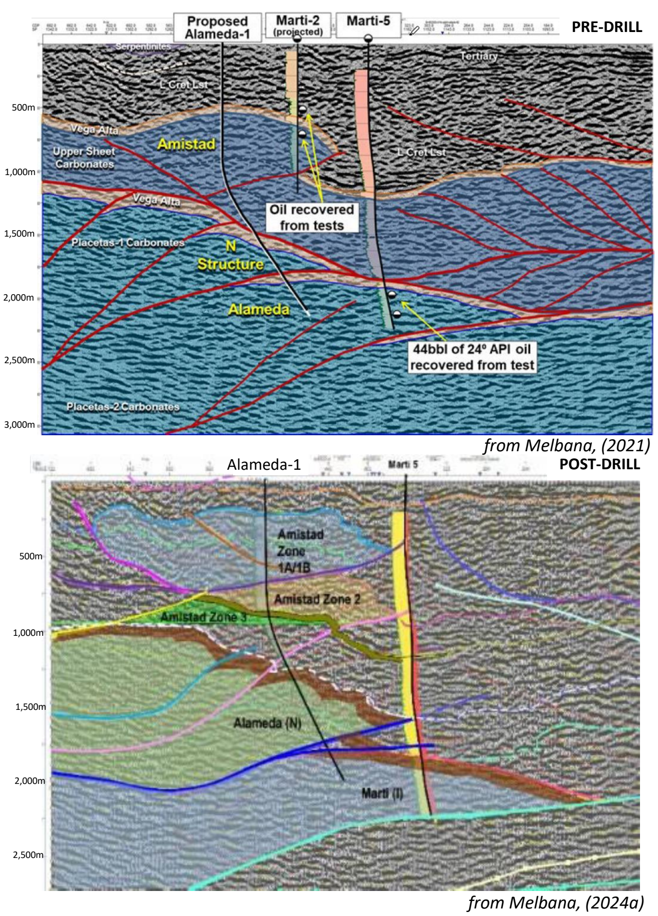

Figure 2 *Pre- and Post-drill seismic*

The Alameda-1 well began drilling and quickly intersected oil starting at 454 meters. The well continued to drill through reservoirs to a total depth of 3,916 meters. The pre-drill interpretation overlies the seismic line in **Figure 2**. That well recovered 240 API oil and had numerous oil shows over an 850-meter gross section from the lower (N) sheet. The well stopped at this depth due to a highly pressured influx of oil and gas into the well bore (fig 2 – post drill). Biostratigraphic analysis taken in the "N" interval indicates a reservoir of similar age to the productive sections in the Varadero oil field (Cuba Business Report, 2022). The "N" interval pressures are significantly higher than in the Varadero field. Also shown on the seismic line is the Marti-5 well drilled 30 years ago located downdip of the Alameda well, which

Recent Cuba Wells Drilled *continued on page 26*

 continued from page 25

recovered 44 barrels of 240 oil (Melbana, 2024a).

Melbana next sidetracked out of the #1 well drilling up-dip in the Amistad Unit (dark blue rock unit in **Figure 3**. This well was drilled during June and July 2023, reaching a total depth of 1975m on July 31st, 2023. The well focused on logging, coring, and flow testing the Amistad Units 1A,1B, 2, and 3 (**Figure 4**). Unit 1B flow tested up to 1900 barrels of oil per day of 190 API crude, resulting in an approved 48mmbo contingent reserve (Melbana, 2024a). Well results also allowed a re-determination of net pay in Units 1A,1B, and 2 from 84 to 243 meters (538m including fractures). Unit 1B is slated for production with the first crude by the end of 2024 (Melbana, 2024a). An additional and substantial resource of heavy 90 API oil was proven in Unit 1A as it flowed to the surface but will require pumping in development (Melbana, 2024b). Finally, in Unit 3, there is also movable oil of a heavy 170 API (on dehydration) currently under assessment (Melbana, 2024b).

The Alemeda #3 well targeted deeper reservoirs, aiming to prove the deeper horizons' potential to produce lighter API crude. The well did reconfirm the presence of oil in the deepest structure. Testing, however, was inconclusive. ■

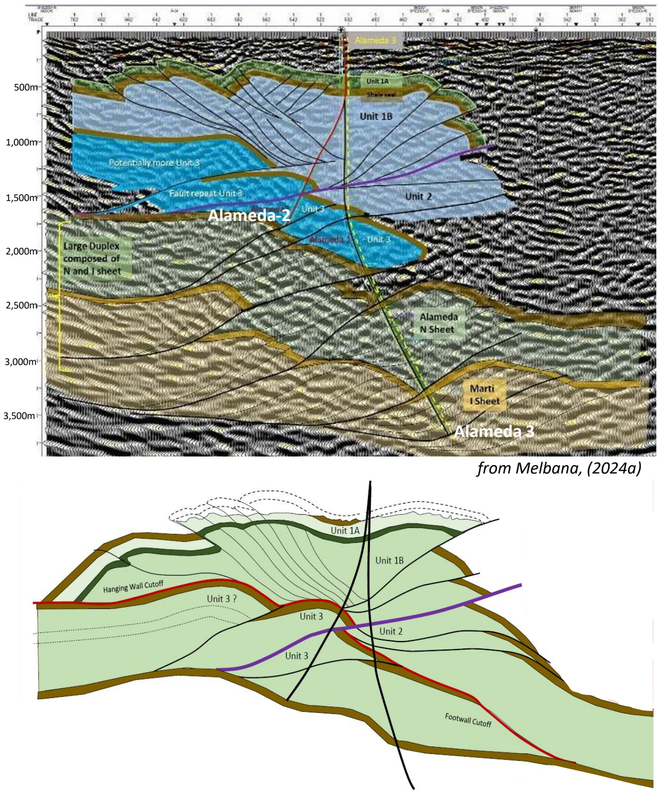

Figure 3 *Post-drill interpreted seismic and corresponding geologic cross-section*

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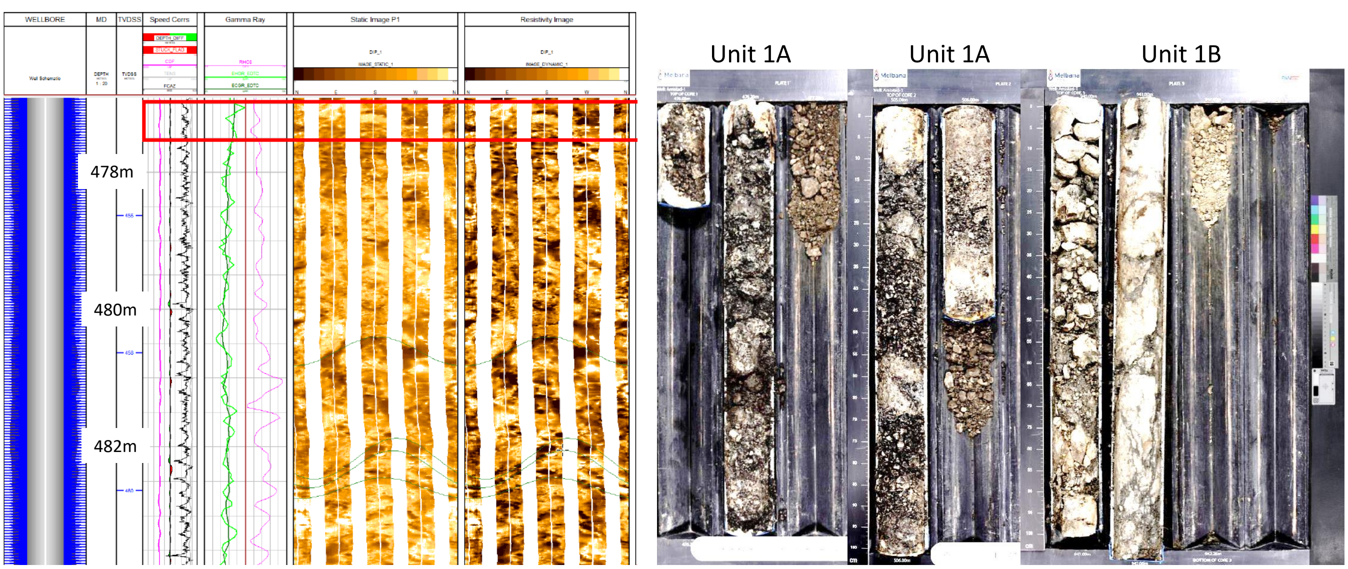
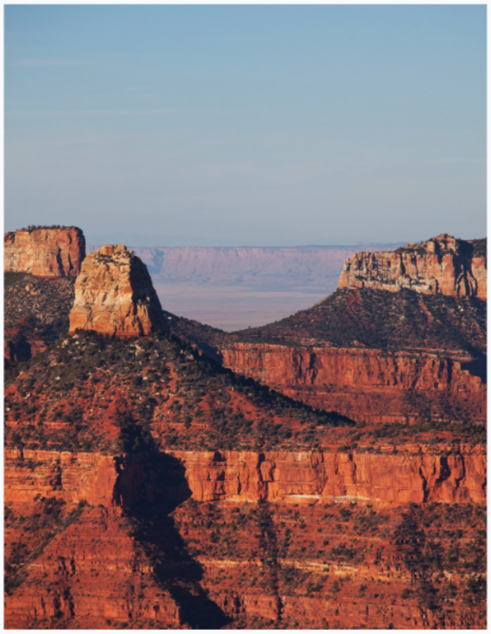


Figure 4 *Cores and FMI from Alameda #2 (updip appraisal) focused on logging, coring and flow testing the reservoir titled Amistad Units 1A,1B,2&3 - from Melbana, (2024a)*

GRAND CANYON FIELD TRIP

June 1-8, 2025



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Angel Callejon
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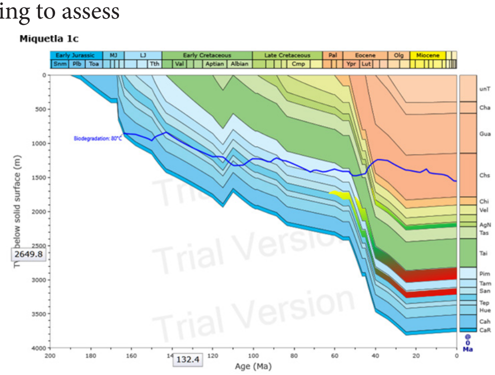
- **Building the Thermal Model:** Learn the principles of thermal modeling to assess the history of temperature changes within the basin, crucial for understanding hydrocarbon maturation.
- **Building the Generative Model:** Explore the mechanisms of hydrocarbon generation, migration, accumulation and preservation, essential for predicting potential reservoirs.

By the end of this course, participants will be well-equipped to apply basin modeling techniques in real-world scenarios, enabling them to make informed decisions in the exploration and development of hydrocarbon resources. Whether you are a seasoned geoscientist or a professional seeking to enhance your skills, this course provides a solid foundation for effective basin analysis.



BIOGRAPHICAL SKETCH

Angel Callejon, Petroleum Systems Assessment Specialist, joined the oil industry in 1988 after teaching geology five and half years at Universidad Central de Venezuela. Since then, has been applying geochemistry and basin modeling for exploration at PDVSA, UH, PRA, ExxonMobil and Equinor within a Basin Genetics framework and most recently for production where he used basin modeling and geochemistry to predict GOR and PVT properties in unconventional plays. Angel also developed a chemo-stratigraphic framework for the Austin Chalk, Eagle Ford, and Buda Formations to characterize and drill sweet spots within the unconventional plays.

Since late 2015 Angel has been an independent consultant in geochemistry and petroleum systems analysis for petroleum exploration and production, and recently accruing expertise in carbon capture, geological storage and monitoring.

Angel is well published, a reviewer for the Journal of Marine and Petroleum Geology, Organic Geochemistry and AAPG journals, and has lectured on the topic of Petroleum Systems at the University of Houston for the past 15 years. Angel joined the Houston Geological Society's Continuing Education Committee early 2023 and is the chairperson of the committee.(callejon@yet2find.com; https://www.linkedin.com/in/callejon)

December 2–4, 9–10, 2024, 7:00am – 8:00am • Zoom meeting
Please make your reservations online https://www.hgs.org/civicrm/event/info?id=2624
For more information about this event, contact HGS Office 713-463-9476 • office@hgs.org

The Houston Geological Society Continuing Education Committee Presents

Prospect Evaluation Methods for Seismic DHIs

Henry Pettingill and Rocky Roden
January 23, 2025, 8:00am – 5:00pm
Core Lab, Building 2, 6323 Windfern, Houston, TX 77040
Attendees will receive a Certificate of Continuing Education for 8 PDH and digital course notes

COURSE DESCRIPTION

This one-day survey course will inform students on all aspects of the use of seismic Direct Hydrocarbon Indicators (DHI's) in evaluating exploration prospects. The class is a synthesis of a longer class given to DHI Consortium Members; proprietary Consortium content is removed.

The course follows the characteristic workflow of evaluating DHI projects, including both theory and application, and integrates the Geological and Geophysical aspects of interpretation. The course also gives the participants a global context of DHI-driven exploration, including analog learnings from the Consortium's 405-well calibration database.

The class has a strong practical orientation. It uses actual prospects and realistic exercises to illustrate the applications of the various concepts and analytical procedures involved in the technical evaluation and investment decision process of DHI-supported prospects.

PRICING

$280 for HGS Members
$140.00 Emeritus
$50 Student/In Transition
$350 Non-Members or
Non-Members can submit an application and pay their dues before registering to get the member price. Please call the HGS office at 713-463-9476 to be registered only AFTER your application and dues are submitted.

After taking this course, participants will have familiarity with all concepts and techniques in the risk and resource evaluation of DHI prospects.

COURSE OUTLINE			
1.		Introduction to DHIs	(45 minutes)
	a.	DHI Definition, Global view of DHIs, Integrated DHI Workflow	
2.		DHI and AVO Technology	(45 minutes)
		BREAK	(15 minutes)
3.		Case Study Introduction: the Glenlivet Prospect	(15 minutes)
4.		Seismic and Rock Physics Data Quality	(30 Minutes)
	a.	Why it is so important	
5.		DHI Characteristics: discussion of the most important ones	(60 minutes)
		LUNCH	(60 minutes)
6.		DHI Volumetrics	(75 minutes)
	a.	Introduction, Setting Area Distribution and Net Pay	
	b.	Glenlivet Example	
7.		Probability of Success (Pg) in DHIs	(60 Minutes)
	a.	Setting a DHI modified Final Pg	
	b.	Glenlivet Example	
8.		Glenlivet Well Results and Learnings	(15 minutes)
		BREAK	(15 minutes)
9.		SAAM Software and Database: Introduction and Live Demo	(45 Minutes)
10.		Selected DHI Database Learnings	(30 Minutes)
11.		Wrap-up: Summary and Course Evaluation	(30 Minutes)

Continuing Education *continued on page 31*

January 23, 2025, 8:00am – 5:00pm • Core Lab, Building 2, 6323 Windfern, Houston, TX 77040
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WHO SHOULD ATTEND

Geoscientists, engineers, and managers involved with evaluating exploration opportunities in seismic DHIs. The course work assumes the participant has a basic working knowledge of subsurface Exploration concepts.

FOR MORE INFORMATION ON THE DHI CONSORTIUM,

This course draws on lessons from the Rose DHI Interpretation and Risk Analysis Consortium, which offers a unique continual training format for participants, as well as 'on the job training' via the flagship activity of our meetings, which is reviewing, evaluating and scoring drilled DHI prospects presented by our members. visit https://www.roseassoc.com/dhi-consortium.

BIOGRAPHICAL SKETCHES

Henry S. Pettingill, Principal Consultant and DHI Consortium Chairman. Henry S. Pettingill is a Petroleum Geologist and Exploration Manager who has been in the oil and gas industry since 1983. He joined Rose Subsurface Assessment in 2018 after 16 years with Noble Energy Inc., where he finished his career as Chief Geoscientist. Prior to that, he served as Director of Business Innovation from 2013-2015, and as Director of Exploration Technology from 2002-2013. His responsibilities included overseeing the Global Exploration Portfolio, Risk Analysis, Geoscience Technology, and Staff Development. Prior to joining Noble, he held various technical and managerial positions within Repsol and Shell. His assignments have focused on Deepwater Exploration and Appraisal, International Exploration/New Ventures, Exploration Risk Analysis, and Portfolio Management. Henry has authored over 100 conference presentations and technical papers, and has taught classes in Exploration Risk Analysis, Creativity and Innovation for E&P Organizations, and a Deep Water Clastics field trip in the Spanish Pyrenees. In 2017, he was recognized by AAPG as one of the industry's "100 Explorationists Who Made a Difference."

Mr. Pettingill holds a BA degree from the University of Rochester and an MSc degree from Virginia Tech (USA). He is an AAPG Certified Petroleum Geologist and an active member of AAPG, SEG, and SPE. He is a Trustee Associate of the SEG and AAPG Foundations. Pettingill is chairman of the Rose DHI Consortium. He serves on the Advisory Board of Virginia Tech Department of Geosciences.

Rocky Roden, Rocky Ridge Resources Inc. Consultant. Rocky has owned his own consulting company, Rocky Ridge Resources, Inc., for the last eighteen years and works with numerous oil companies around the world on interpretation technical issues, prospect generation, risk analysis evaluations, and reserve/resource calculations. He has authored or co-authored over 40 technical publications on various aspects of seismic interpretation, AVO analysis, amplitude risk assessment, and geoscience machine learning. He has over 45 years in the industry as a Geophysicist, Exploration/Development Manager, Director of Applied Technology, and Chief Geophysicist.

He has been a principal in the Rose and Associates DHI Risk Analysis Consortium since 2001. He works with Geophysical Insights on the integration of advanced geophysical technology in machine learning software applications. He is a proven oil finder with extensive knowledge of modern geoscience technical approaches (past Chairman, The Leading Edge Editorial Board). As Chief Geophysicist and Director of Applied Technology for Repsol-YPF (retired 2001), his role comprised advising corporate officers, geoscientists, and managers on interpretation, strategy and technical analysis for exploration and development in offices in U.S., Argentina, Spain, Egypt, Bolivia, Ecuador, Peru, Brazil, Venezuela, Malaysia, and Indonesia.

He has been involved in the technical and economic evaluation of Gulf of Mexico lease sales, farmouts worldwide, and bid rounds in South America, Europe, and the Far East. Previous work experience includes exploration and development at Maxus Energy, Pogo Producing, Decca Survey, and Texaco. He holds a BS in Oceanographic Technology-Geology from Lamar University and a MS in Geological and Geophysical Oceanography from Texas A&M University.

High Impact Exploration in Africa since 2020

By Jamie Collard*, Graeme Bagley, Bryan Gill. *Westwood Global Energy*

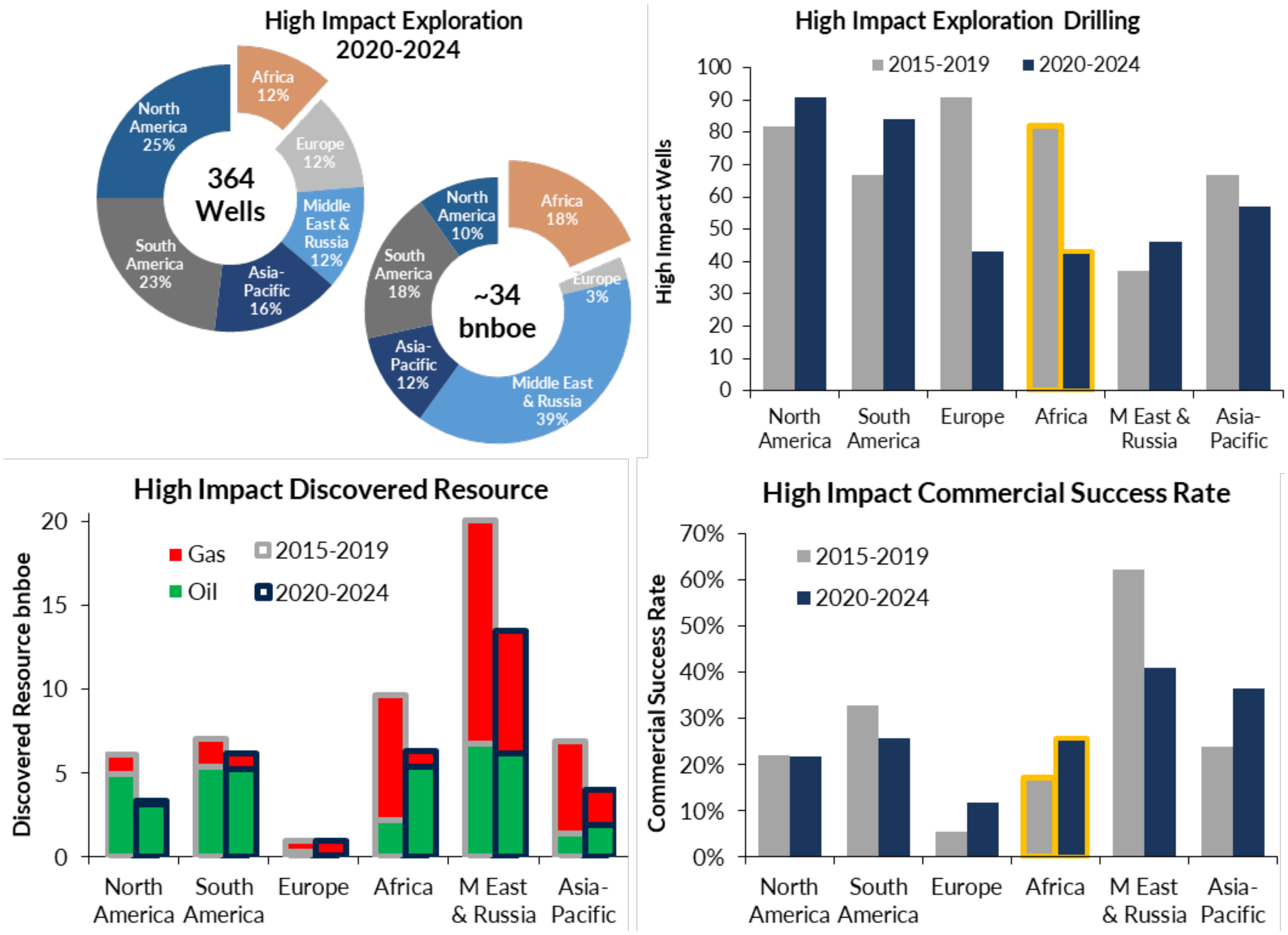

Figure 1. *Top left - High impact exploration drilling and discovered resource by region since 2020. Top right – high impact exploration drilling 2015-2019 and 2020-2024. Bottom left – high impact discovered resource 2015-2019 and 2020-2024. Bottom right – high impact commercial success rates 2015-2019 and 2020-2024.*

As of end-October 2024, 364 high-impact exploration wells have been drilled globally since 2020, discovering ~34bnboe of hydrocarbons split ~22bnbbl of oil and 74tcf of gas. 12% of the high-impact wells were in Africa, finding 18% of the total discovered resource (~6.4bnboe). The 26% commercial success rate achieved in high-impact exploration in Africa was in line with the 27% commercial success rate achieved globally.

Compared to the five-year period 2015-2019, global high-impact exploration drilling has dropped by 15% in the last five years. Despite more wells being drilled in the Americas and in the Middle East, the major decline in Europe (-53%) and Africa (-48%) resulted in overall drilling to decrease. Commercial success rates in Africa, however, improved by nine percentage points to 26%, suggesting that with more opportunities available, companies were able to select higher-quality prospects for drilling. Furthermore, the oil resource discovered since 2020 has increased by 146% in Africa to 5.3bnbbl.

15 high-impact wells are expected to be completed in Africa by the end of 2024. This is a major resurgence compared to 2020, when only four high-impact wells were completed in the region and makes it the busiest year for high-impact exploration in Africa since 2019. At the time of writing, 2024 has delivered a record 46% commercial success rate in Africa. In addition, ~2.7bnbbl of oil has been discovered, representing at least a 10-year high.

Since 2015, high-impact wells have been drilled in 22 countries and 33 different basins in Africa. Drilling hotspots include the Nile Delta, the MSGBC, the Tano, and the Orange basins.

Much of the resurgence in both drilling and success is driven by the Orange Basin, which is currently being drilled out by various companies and is emerging as the largest new oil province since the Suriname-Guyana Basin. The success has the potential to stimulate more frontier basin exploration elsewhere in Africa.

High Impact Exploration in Africa *continued on page 33*

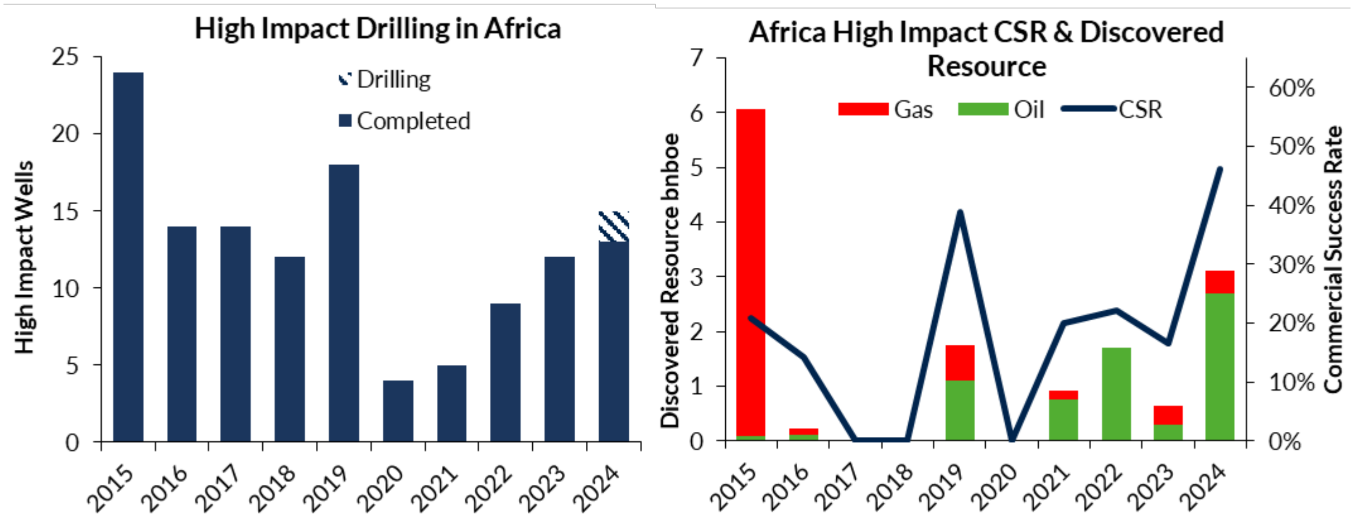

Figure 2. *Left – high impact exploration drilling in Africa since 2015. Right - high impact commercial success rates and discovered resource in Africa since 2015.*

TotalEnergies progressing its 2022 Venus discovery towards potential FID in 2025 and Galp announced a significant discovery in March 2024 at the Mopane complex. The ongoing exploration/appraisal program for Galp at Mopane, as well as upcoming wells at Kapana (Chevron) and Sagittarius/Volans (Rhino Resources) and into the South African part of the Orange Basin will be key for determining the scale of this new petroleum province. It is not all plain sailing, however, with failures drilled in the basin at Cullinan and Nara, as well as Shell highlighting the complexity of its discoveries and commerciality being far from certain.

A key question is whether the Orange Basin can compete with offshore Suriname-Guyana in terms of scale. After 11 wells in the Orange Basin, the answer appears to be potentially yes, with ~5bnboe of potentially commercial resource discovered, compared to ~2.2bnboe after the same number of wells in Suriname-Guyana. However, it should be noted that discoveries in the Orange Basin have had limited appraisal (and are all pre-FID), whilst in Suriname-Guyana there have already been hundreds of million barrels of oil produced, billions of barrels post-FID and several heavily appraised discoveries. Significant challenges remain in the Orange Basin, and more discoveries are needed. More appraisal is required to understand the technical and commercial uncertainties being faced. These uncertainties appear to be greater than those seen in Guyana. If a development at Venus were on the same schedule as ExxonMobil's Liza discovery, FID would have been taken April 2024.

Outside the Orange Basin, Africa has delivered high-impact success offshore Cote d'Ivoire, Egypt, and Angola since 2020. Cote d'Ivoire has seen a revival in exploration, with the 2021 frontier Cretaceous carbonate Baleine discovery coming on stream in 2023 and the 2024 Murene discovery being the first potentially commercial Upper Cretaceous sandstone field in the deepwater of Cote d'Ivoire.

Offshore Egypt remains an active exploration focus area, delivering the 2.8tcf (in-place) Nargis discovery in early 2023, as well as ILX success around West Delta Deep Marine. The key for the region in late 2024/early 2025 will be the upcoming Khendjer-1 (Chevron) and Nefertari-1 (ExxonMobil) wells in the Herodotus basin, which will target frontier Upper Jurassic carbonates and Lower Cretaceous sandstone prospects, respectively. Success in Herodotus could spark yet another phase of exploration within the Eastern Mediterranean. However, recent relinquishments from BP, TotalEnergies, and Shell in licenses further west of the upcoming campaign suggest that the potential plays may be limited in scale.

Exploration in the MSGBC has not been as positive; it is struggling due to a combination of above and below ground factors. This has led to a supermajor exodus from the basin, with BP, Shell and ExxonMobil exiting all exploration acreage in the basin. TotalEnergies is not expected to drill any further wells on its Senegal acreage. Despite three new plays being opened in the basin since 2001, the basin has not emerged as the new oil province the industry was looking for, and the recent Atum-1 well looks to have been unsuccessful, potentially downgrading the Southern MSGBC.

Looking forward to 2025, Westwood has line of sight to ~20 high impact wells in Africa, although exploration plans will firm up through Q1 2025. This would be the busiest year for exploration in Africa since 2015, although it should be noted that Africa is unlikely to see the >50 high impact wells that were drilled annually in 2013-2014.

Key wells expected to complete in 2025 include Akeng Deep, which will be drilled by Kosmos in Equatorial Guinea targeting a frontier ILX Lower Cretaceous prospect with ~180mmboe

High Impact Exploration in Africa *continued on page 34*

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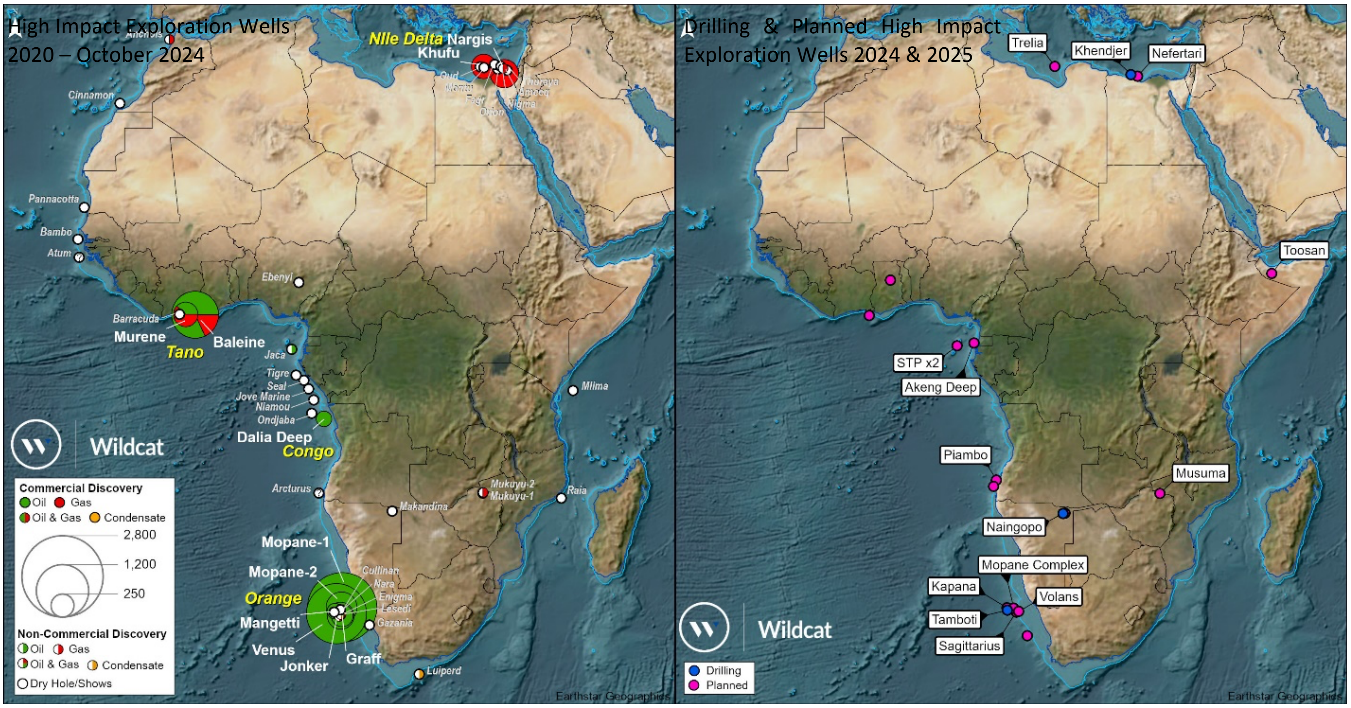

Figure 3. *Left – high impact exploration wells and commercial discoveries since 2020. Right – potential high impact exploration wells expected in 2024-2025.*

potential. Shell and Galp are expected to drill wells over the border offshore Sao Tome and Principe, chasing the frontier Upper Cretaceous play which was proven technically in 2022 by Galp's Jaca well. Azule and TotalEnergies are expected to drill frontier tests in the Namibe Basin, following ExxonMobil's Arcturus-1 well drilled in Q4 2024 (with no results reported at the time of going to press). The Orange Basin will see 4-6 exploration wells in 2025, and it will be a key year to determine whether the basin is giant in scale.

Onshore, there more wells are expected in the Kavango basin onshore Namibia for ReconAfrica; Invictus is planning to drill the Musuma-1 well onshore Zimbabwe in the Cabora Bassa Basin and Genel Energy is hoping to drill the Toosan-1 well onshore Somalia.

In the Eastern Mediterranean, there will be the Herodotus wells discussed previously, and Eni may spud the Trelia well in Area C offshore Libya in the Sirte Basin. The well is understood to be targeting the frontier Upper Cretaceous carbonate play, which was technically proven by Hess' 2009 Arous Al Bahar discovery which encountered 120m net gas (and condensate) pay in Cenomanian & Turonian carbonate reservoirs. The well had been planned in 2014 but was canceled as the licence became under force majeure. Eni farmed into the licence in 2018 and took operatorship, and the force majeure was lifted in 2023.

In terms of exploration, Africa is back. The continent has delivered improved success rates, exciting new basins and plays, and a renewed appetite for future exploration. 2025 is a key year to see whether this excitement will translate into more exploration success. ■

WELCOME TO NEW MEMBERS, EFFECTIVE NOVEMBER 2024

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Sarah Catalina Garcia
Parker Torres
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HongChen Ye

ASSOCIATE

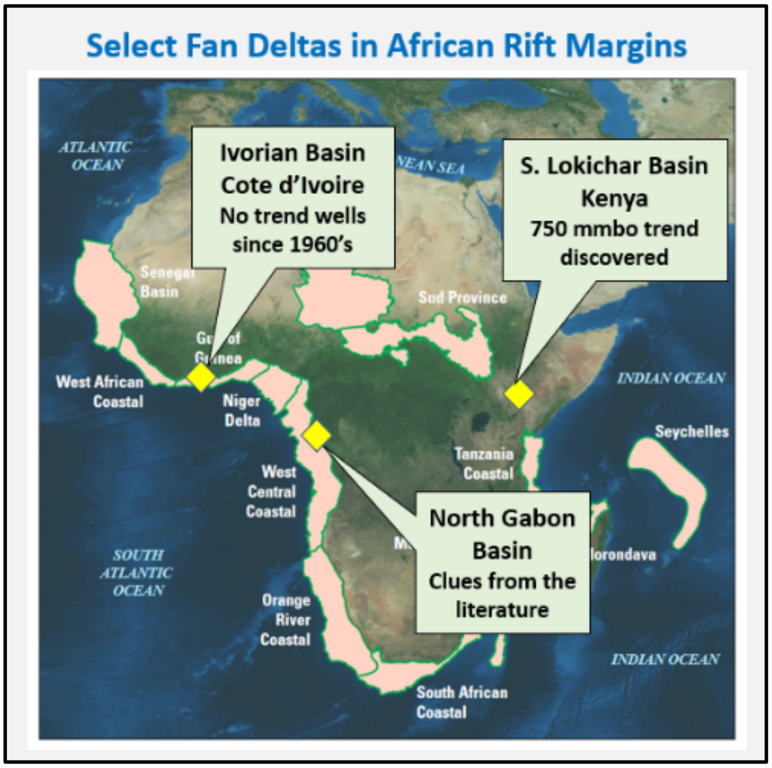
Taylor Galloway
Daniel Baker
Taylor Diehl
Jason Marshall

STUDENT

Richard Caeli
Jumoke Akinpelu
Jigo Mismanos

Fan Deltas and Proximal Fans Underexplored Region Along Rift Margins of Africa

By Karen Carlson, *KC Geoscience Consulting LLC, Houston, Tx*



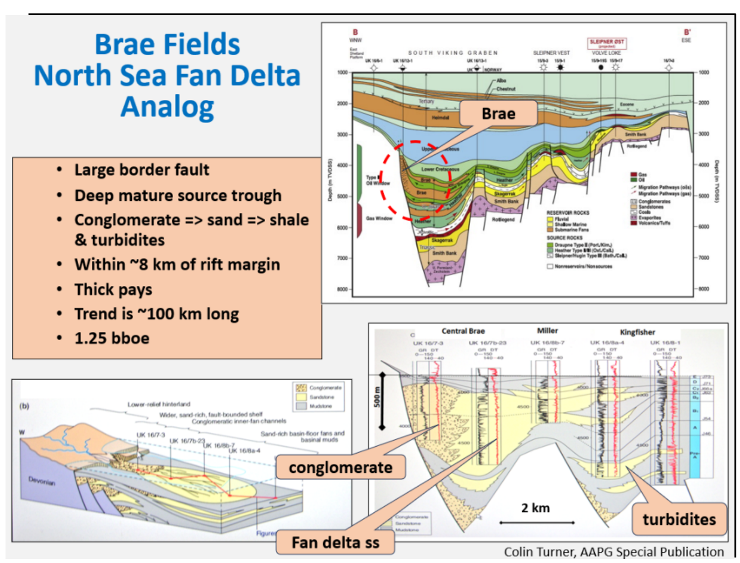
With industry focusing on ever deeper water in search of large potential hydrocarbon resources, rift margins, and proximal deltas remain an underexplored opportunity onshore and in shallow water. Rift margins were mostly explored in the past with older technology. Rift margins (within ~20 km) have been explored predominantly in the late 1950s through the 1970s and consequently have no exploration 3D seismic data, and older wells are often not optimally located. In recent years, some discoveries have been made in this zone helping better understand concepts that can provide revitalization of rift margins.

Two analogs are presented to show the important characteristics of fan deltas and proximal fans. Fan deltas are relatively small depositional systems, often only a few tens of square kilometers in area. An attractive feature of fan deltas is that significant stacked pay is possible. They are typically cored with coarse alluvial material near the rift margin fault with a better-developed reservoirs in adjacent down-dip sands. The prospects are a combination of structural/stratigraphic traps. Almost immediately adjacent to and down-dip of the fan delta sands, lacustrine fans may develop in a rapidly deepening paleoenvironment. These fans are exceptionally underexplored.

Individual fan delta fields range in size from ~20 to 200 mmbo. In some areas multiple fan deltas form a trend of multiple fields totaling up to ~750+ mmbo. Another important feature to this play is a proximal deep source kitchen, about 4-6 km deep. In West Africa, Cretaceous fan deltas and fan reservoirs can be expected to have porosities in the high teens above 3500 meters. The fan delta trend in Cote d'Ivoire is presented to show an opportunity that has been overlooked for six decades.

FAN DELTA PLAY RECIPE

First, we note that this is a rift margin play and consists of alluvial sediments grading from conglomerate to sandstone to shale, with down dip lacustrine fans possible. The play is a combination structural/stratigraphic play with a good understanding of the play model critical to success. The play is within 20 km of the rift margin and typically less than 10 km. The play is more often onshore, but there are cases of the play being in shallow water. A large rift border fault is also key. It provides a proximal deep source kitchen and thick sediment accumulation to provide thick pay. And potential source rock. A general rule of thumb by the author is that economic porosities extend to only about 3500 m but vary according to basin. **Fan Deltas and Proximal Fans** *continued on page 36*



Fan Deltas and Proximal Fans *continued from page 35*

NORTH SEA ANALOG

The Brae Fields are fan deltas. This 100 km long trend has a large border fault creating a deep adjacent source kitchen. The well cross-section shows that within 8 km the facies go from conglomerate to sand to shale and fans/turbidites. A thick section of sand (~400 m) is present. At Brae, both the conglomerate and sand facies are productive, but in most other cases, the conglomeratic facies are not productive.

DISCOVERED FAN DELTA TREND- AFRICAN ANALOG

Discoveries in the Lokichar Basin of Kenya since 2010's are an example of multiple fan deltas along the rift margin with a total resource potential of ~750 mmbo and the largest field, Ngamia, is 200 mmbo. This trend is another clear example of a fit to the play recipe; large border fault, structural/stratigraphic trap, deep proximal source kitchen, onshore, <20 km from rift margin, <3500 m depth. The thick-stacked pay is a key component in success.

Looking at the Twiga Field seismic and well cross-section, one can see that the up-dip Twiga-2 well has conglomeratic facies with only 13 m of pay. In contrast, just a kilometer away in Twiga 2A-ST, a sandstone facies has 115 meters of the productive reservoir. Being in the right facies makes all the difference. The seismic section has a yellow line showing the approximate location of the facies boundary between conglomerate and sand facies.

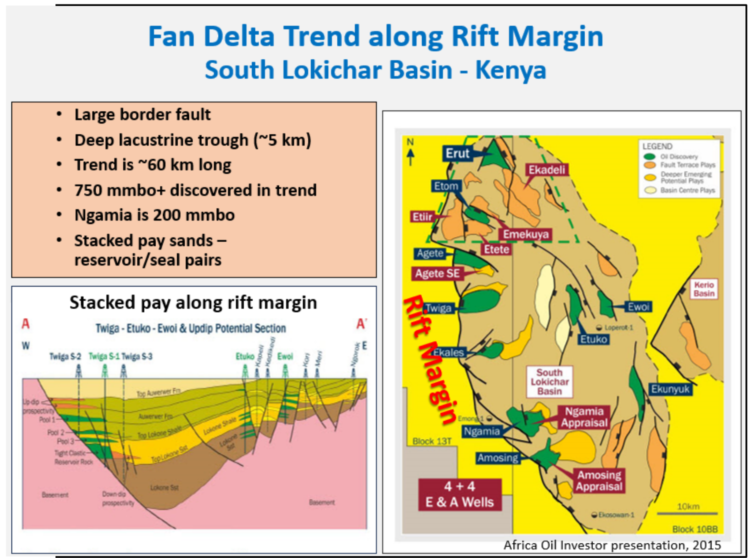
When looking at the rift margin facies in map view, one notices the conglomeratic facies range from 0 to 2 km from the rift margin. Of note is the Ngamia Field which is only about 12 to 15 square kilometers in size, but with thick pays, contains 200 mmbo.

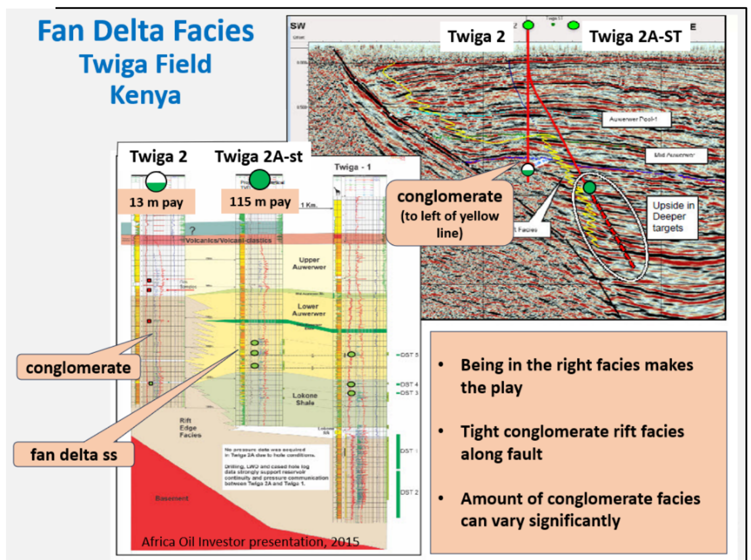
The smaller maps show the Twiga Field area with the boundary between conglomerate and sand facies first shown on a structure map and then shown with a seismic coherency section which highlights the difference between the two facies.

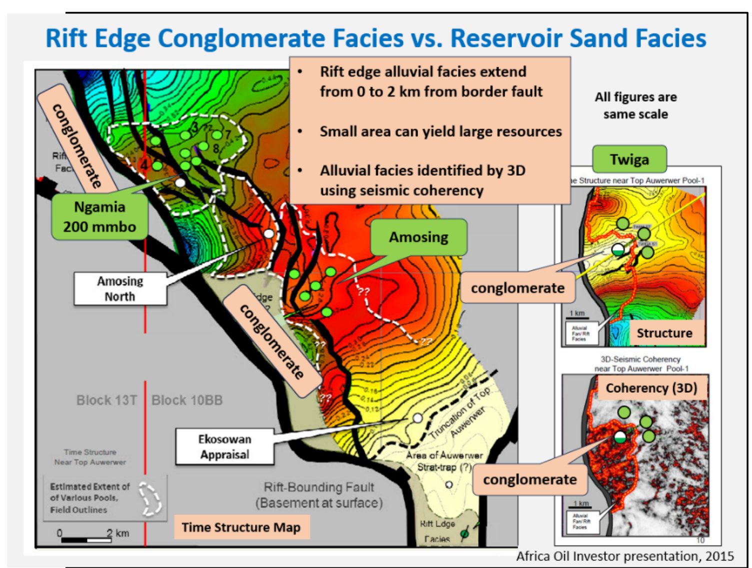
TWO 60-YEAR-OLD WELLS DEFINE A FAN DELTA TREND IN COTE D'IVOIRE

In Cote d'Ivoire there are onshore wells drilled in the early 1960's on single fold seismic data that penetrated fan deltas and proximal fans that were not drilled in auspicious locations. Opportunities for multiple targets abound if one applies the correct concepts. The cross section shows the well-known plays of the Ivoirian Basin. The successful shelf play was mainly on structural highs, mostly since the 1980's. With the discovery of the deep-water fan play in

Fan Deltas and Proximal Fans *continued on page 37*







Fan Deltas and Proximal Fans *continued from page 36*

neighboring Ghana in 2007, this trend became an industry focus. However, the onshore rift margin which has proven reservoir and source rocks has not been pursued. Back in the early 1960's when the Berou and Port Bouet wells drilled, there was little understanding of fan delta concepts and well location decisions made at the time, used older concepts according to 1962 reports.

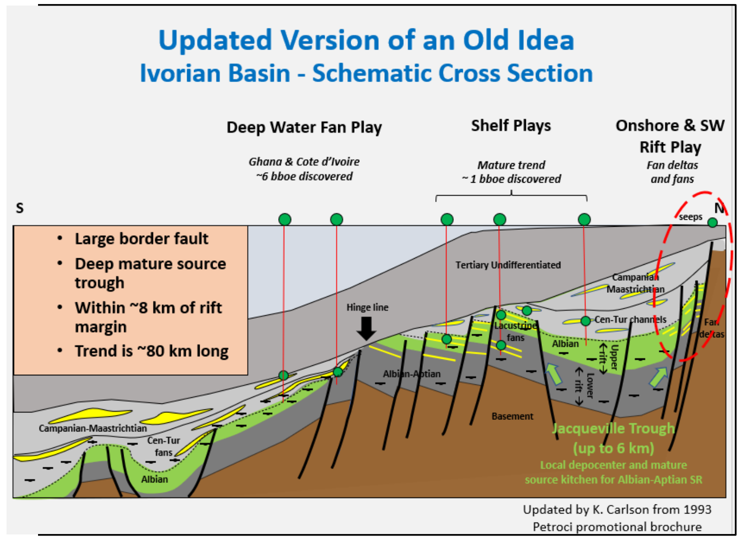
The schematic cross-section shows four wells, drilled from 1957 through 1960. With so few wells in the fan delta trend, the cross section is constructed by placing the wells according to their distance from the rift border fault. Wells are projected into the section from about 45 km. There are two separate known fan delta fan sequences, the upper one is Albian and corresponds in age to the Lion facies. The deeper trend is Albian/Aptian and corresponds in age to the Foxtrot facies. Using the concepts cited earlier, there is over 400 meters of prospective reservoir sand between the Port Bouet well and the up-dip stratigraphic trap against the tight alluvial conglomerates (Objective "A" on Exploration Objectives slide). It should be noted that the target is less than five kilometers from the rift border with a large bounding fault.

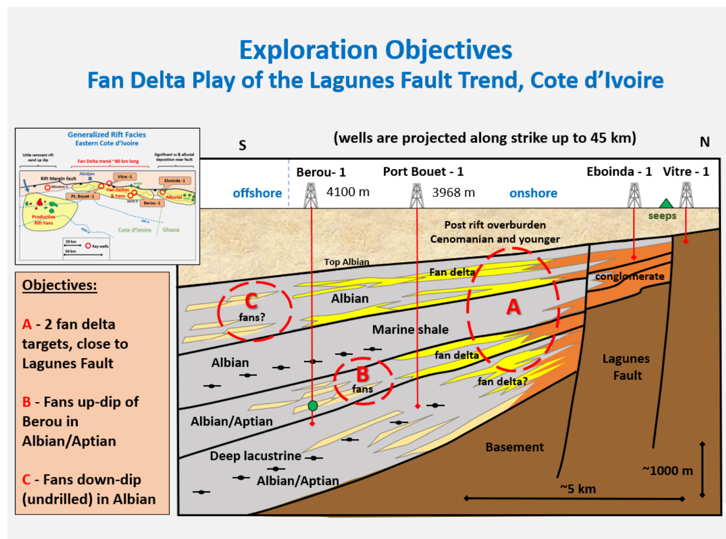
The Berou well penetrated the upper sand interval, and like the Port Bouet well, both are in the fan delta facies. However, in the lower Albian/Aptian, the Berou penetrates down-dip fans. Like Brae Field, these fans are within 8 km of the rift margin. Objective "B" would be a stratigraphic trap in the up-dip fan facies. A thick sand in the Berou well has good oil shows and possible pay.

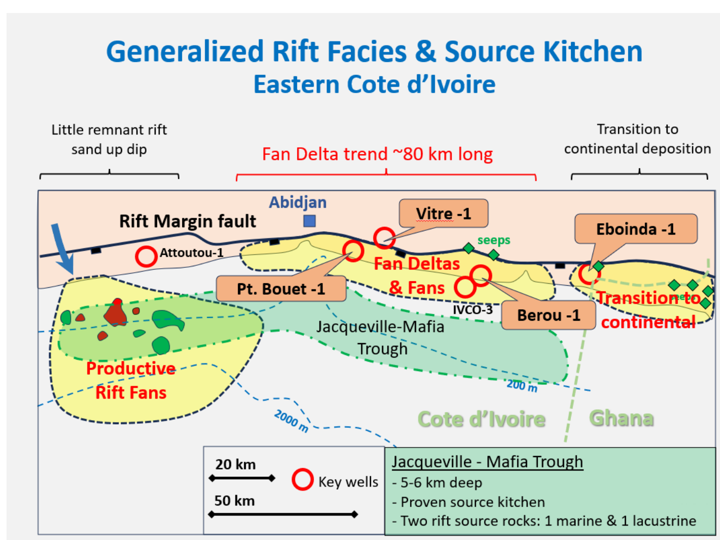
The author has observed that about 3500 m depth is the limit of economic porosities in most fan deltas. That porosity here is about 15% at 3500 m. This porosity level is economic because the sands are thick and play is onshore and in shallow water. This porosity cuy-off will vary by sediment age and other particular basin characteristics elsewhere. The excellent oil show in the Berou well is between 3700 & 3800 meters and is only 13% porosity, but up-dip this fan may be economic. Also note that the Port-Bouet well is 45 km from the Berou well, leaving a significant opportunity for a significant up-dip accumulation.

In Objective "C," there are no wells that penetrate the fans associated with the upper fan delta interval. However, given the Berou location along the coast, it will certainly be in the shallow offshore. For this target, it is expected that ocean bottom cable acquisition will be required to connect the existing onshore and offshore seismic data.

Fan Deltas and Proximal Fans *continued on page 38*

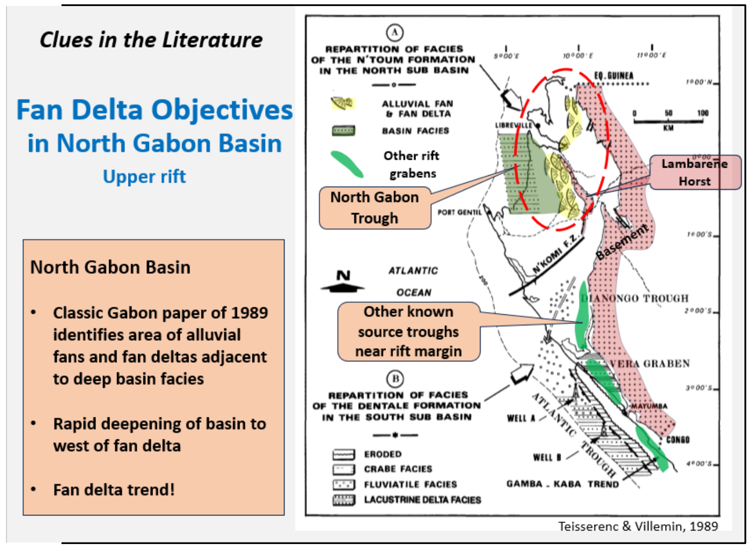






Fan Deltas and Proximal Fans continued from page 37

The generalized rift facies show two main trends. The productive rift fans to the west extend to 40 km from the rift margin. There are well over a hundred wells in this area. Evidence shows that the fans are associated with an up-dip delta, most of which has been eroded. The fan delta trend does not go beyond 20 km from the rift margin, typically much less. It can be seen that there are only 3 wells that penetrate this trend. The Eboinda well may be in trend but it is belived that it may also be part of a highly conglomeratic trend which becomes continental to the east in Ghana.



The Cote d'Ivoire cross-section shows that each fan delta interval has an associated source interval beneath it. The Albian/Aptian interval is lacustrine, while the upper Albian interval is marine. Both source intervals are mature, with the lower interval having expelled a greater amount of hydrocarbons. The adjacent Jacqueville-Mafia Trough is up to about 6 km deep and is proximal to the fan delta reservoirs.

This play in Cote d'Ivoire follows the play recipe. The fan delta trend is estimated to be 80 m long, while the analog South Lokichar trend is 60 km long and has 750 mmbo discovered. This leads one to realistically hypothesize up to ~1 bbo potential. Decades-old thinking about extensive amounts of conglomerates along the rift margin led to drilling wells too far down-dip of the rift margin. Utilizing the fan delta model compared to 1950s and 1960s thinking creates a significant resource opportunity.

CLUES IN LITERATURE

The literature contains clues that, when read with the fan delta model in mind, can lead to uncovering potential new objectives overlooked for many decades. A literature reference from the classic Gabon paper, "Sedimentary Basin of the Gabon," by Teisserenc and Villemin, is shown and indicates possible areas to investigate with new data and new thinking. Also, there is an adjacent deep trough capable of providing a significant source kitchen.

CONCLUSIONS

Numerous countries in sub-Sahara Africa have conditions conducive to productive fan deltas and fit the play recipe. Few are as robust as the example in Cote d'Ivoire, but the clues abound. The play recipe is simple and there are sometimes minor variations, but the play has good juxtaposition of source, reservoir, and seal to make significant fields. Rift margin objectives occur onshore and in shallow water, an ideal location for near-term low-cost developments with higher rates of return. These are ideal conditions for small to mid-sized companies to explore. ■

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WORD BRECCIA – A GEOLOGY WORD JUMBLE

Unscramble the words below using the hint below.

ANROGE ______

ONIVIRA _______

ABGNO _____

WAZKNA ______

UCNAYAT _______

Hint: Basin names mentioned in articles from this issue of the *Bulletin*

Helping "Oddball Oils" Find their Nearest Neighbor(s)

By Craig Schiefelbein, *Geochemical Solutions International (craigs@geochemsol.com);*
William Dickson*, Dickson International Geosciences; and* ***John Zumberge****, Geomark Research*

Continuing research has clarified the tectono-structural history of the Atlantic conjugate margins. This includes the creation and segmentation of source rock depocenters. Since crude oils possess biological clues to their genetic history and evolution from source to trap and beyond, source ages could be assigned that correspond to paleogeographic reconstructions of the South Atlantic conjugate margins associated with five sedimentary mega-sequences: Continental, Transitional/Evaporitic, Carbonate Platform, Marine Transgressive and Marine Regressive with corresponding source rock depocenters. Within the Eastern Brazilian Rift Systems (EBRIS), these depocenters, as formed and segmented, correspond to Syn Rift I (Upper Jurassic), Syn Rift II (Neocomian), Syn Rift III (Barremian), Transitional/Evaporitic (Aptian) and Shallow Carbonate Platforms (Albian) (Chang et al., 1992). While present around the conjugate margins, these source types are supplemented locally by volumetrically dominant Upper Cretaceous Marine and Tertiary Deltaic intervals. The strongest genetic conjugate relationships are observed between oils from central Brazil and West Africa that originated from Barremian (Lower Rift/SynRift I) source rocks deposited in deep, freshwater lacustrine environments. Lacustrine oils in general showed strong correlations of age and location between conjugate salt basins although Great Campos (Southeast Brazil/Syn Rift III) oils stand apart with a unique chemistry.

Oils derived from Transitional/Evaporitic source rocks are limited to offshore northeast Brazil (Sergipe-Potiguar-Ceará). Most crude oils examined from the Niger Delta have unique chemistries associated with an origin from source rocks influenced by higher land plants (angiosperms; Tertiary Deltaic).

Marine oils often demonstrate age correlations related to global ocean anoxic events, independent of conjugate structuration. Several oils from Foz do Amazonas and Para Maranhão have chemistries that are unique relative to oils from all other Brazilian basins, but oils with similar chemistries can be identified when the sample coverage is expanded. Within the limited context of South America these Foz/Para oils are compositionally similar to oils from Suriname/Guyana to the west and Austral/Malvinas basins to the extreme south. When coverage is expanded to include the entire South Atlantic margin, these oils are broadly similar to oils from offshore Gabon, Angola, and the Kwanza Basin but have the strongest affinity to many oils from the conjugate Equatorial Margin (Cote d'Ivoire), where at least two different sources are active.

APPROACH

Our interpretive work began with the assembly of a data set and development of data intimacy through detailed inspection (e.g.,

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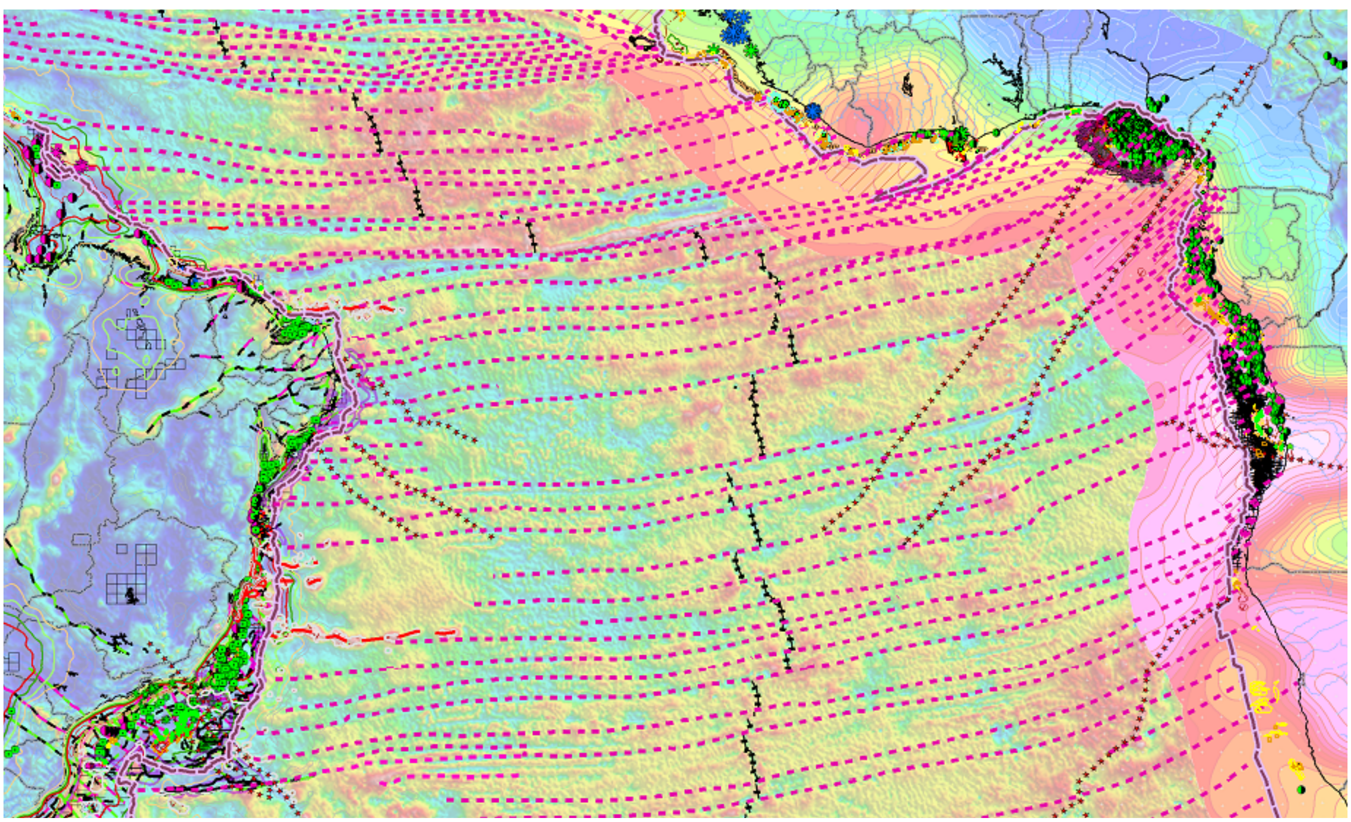

Figure 1. *Distribution of more than 1700 crude oils. (Gravity image compliments of GrizGeo)*

see Dickson et al., 2016). Values from different laboratories that employed different analytical schemes required determining which measurements were common to all samples (the Lowest Common Denominator). Missing parameters from specific samples were supplied from analogs, sample averaging, and standard relationships from other geochemical parameters based on the physical proximity of sample sites and the author’s experience. First-pass cross-plotting of key oil constituents and ratios showed main “anchor” clusters within a broad scatter of points on two- and three-axis plots. Outliers were then examined for causes of scatter, typically unique chemistries (e.g., Paleozoic source) or oils that experienced advanced maturity or extensive bio-degradation, resulting in compromised biomarker distributions.

Recognition and characterization of compositionally distinct oil types or families infers paleo-environmental conditions of source rock deposition and possible age. The clearest results are obtained from pure end-member oils from a single lithology, single paleo-environment source, but this is uncommon to the South Atlantic margin with its compound basins, usually with drift-age marine fans overlying multi-stage rifts. Depositional environments may grade episodically from lacustrine to marine so that in late rift to sag phases, source rocks composed of mixed kerogens are deposited. Oils from such sources in similar phases of maturity may mimic mixed oils from discrete sources co-mingled in a common reservoir.

Key geochemical indicators of source-rock paleo-environments and age in the South Atlantic Margin (Mello, et al., 1988; Schiefelbein et al., 1999, 2001, 2017) have developed along with increasing numbers of samples and a broadening range of data (ie, deuterium isotopes, diamondoids) extracted from each sample. Our multi-parameter approach relied on a combination of parameters corresponding to the ‘black oil’ (>C15) component that are primarily influenced by source, but can also be affected by maturity and/or other alteration processes such as biodegradation. Genetic relationships are established based on compositional similarity.

Geochemical data utilized in this study are entirely non-exclusive and provided by Geochemical Solutions International and Geomark Research. Sample locations in **Figure 1**.

Multivariate statistical analyses [principal component analysis (PCA) and cluster analysis; PirouetteTM , Infometrix, Seattle, WA.] are used to more clearly distinguish the different types of oils present throughout the South Atlantic Margin. Briefly, in PCA, new independent variables (i.e., principal components) are created, which are linear combinations of the original variables (i.e., geochemical parameters). The primary objective of PCA is to reduce the dimensionality of the data to a few important components that best explain the variation in the data. Prior to PCA, the original geochemical variables are auto-scaled (the mean value for each variable is subtracted and divided by the standard deviation) so that stable carbon isotope values (e.g., -30 o/oo) can be meaningfully compared to sterane/hopane ratios, for example. The geochemical variables responsible for the PC axes can be viewed as a Loadings plot and the oil samples can be plotted in principal component space, PC1 versus PC2, as a Scores plot.

Hierarchal Cluster analysis (HCA) is an ancillary technique to PCA whereby a distance matrix is created from the scaled data; the distance between any two samples is a measure of their similarity (this distance is similar to a linear correlation coefficient; perfect correlation would have a value of 1.0 while poor correlation would have values < 0.5). The dendrogram is the output of a cluster analysis and shows groupings or clusters of oils.

Input variables are primarily source dependent and based on information obtained from the detailed analysis of the C15+ saturate and aromatic hydrocarbon fractions (‘black oil’). The fifteen (15) source dependent variables used in the multivariate statistical analyses describe 75% of the variance and include the pristane/phytane ratio, the stable carbon isotopic compositions of the C15+ saturate and aromatic hydrocarbon fractions, and thirteen biomarker ratios, including the distribution of the 14β, 17β-C27, -C28 and –C29 steranes (from m/z 218), C27 Ts/Tm hopanes, C31-35 hopanes/C30 hopane, gammacerane/C30-hopane, C29-demethylated norhopane/C30-hopane, and oleanane/C30-hopane. Ratios based on the distribution of tricyclic and tetracyclic terpanes were also used: C21-Tri/C23-Tri, C26-Tri/C25-Tri, and C24-Tetra/C26-Tri.

RESULTS AND DISCUSSION: STATISTICAL ANALYSES

Starting from a collection of 1740 samples, 329 oils were excluded due to either high maturity, biodegradation, contamination, and /or other post-generative processes. The remaining 1411 samples were statistically separated into five major families: Early SynRift; Late SynRift/Sag; Marine/Mixed; Marine; Tertiary Deltaic (**Figure 2**). Incorporation of additional geologic constraints from tectono-structural mapping suggest that oil family and sub-family distributions often relate to sediment thickness and basin to sub-basin structure; lacustrine oils show strong correlations of age and location between conjugate salt basins; and marine oils demonstrate age correlations related to global ocean anoxic events. Source paleoenvironment and age are inferred, often using key biomarkers such as n-propyl C30 steranes that only have marine precursors (Moldowan, et al., 1990) or oleanane, a specific biomarker associated with higher land plants and, in this study, a Tertiary source (Moldowan, et al., 1994). The relative abundance of nuclear demethylated hopanes or the C27 Ts/Tm ratio help identify areas where extensive paleodegradation or advanced

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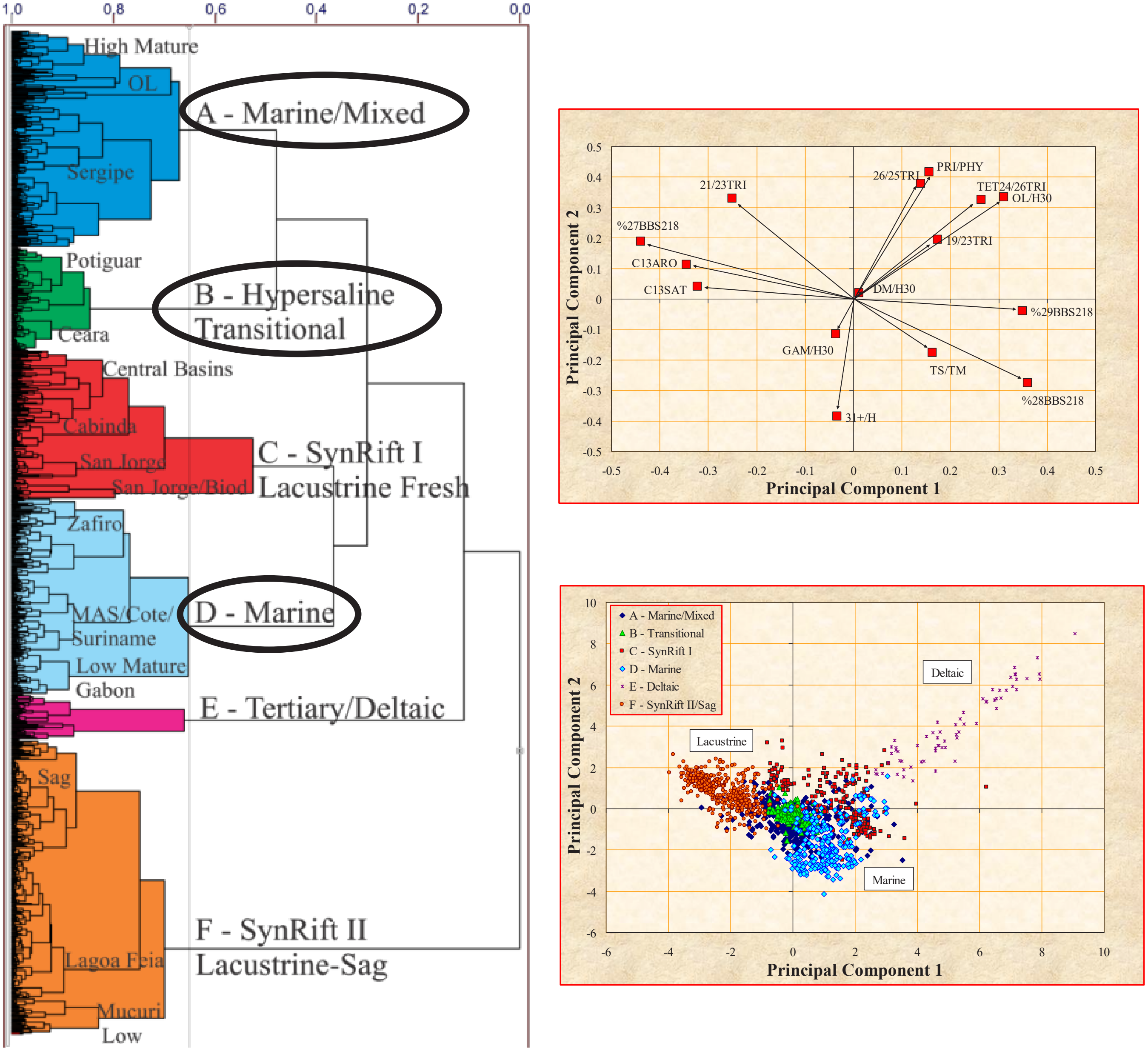

Figure 2. *Hierarchal Cluster Analysis (HCA) Dendrogram (left) and Principal Cluster Analysis (PCA) loadings and scores for all South Atlantic Margin oils.*

maturity has occurred. In other words, chemical composition data and multivariate were utilized to separate oils into compositionally similar groups according to source depositional environment and likely age/rifting event.

The strongest genetic relationships are observed between oils from central Brazil and West Africa that originated from Barremian source rocks deposited in similar deep, freshwater lacustrine environments (Family C; Lower Rift/SynRift I). Family F oils have a unique source chemistry related to SynRift II and/or sag depositional environments and are mainly from the Great Campos sub-basins. Family E oils are all from the Niger Delta area and are distinguished by the presence of oleanane, a specific biomarker associated with deltaic environments and a probable Tertiary origin.

To better understand the origin and distribution of oils derived from middle to upper Cretaceous source rocks deposited in different marine environments (Families A, B and D), a second statistical analysis was performed. Oils from Families C, E and F were excluded and PCA loadings were modified to include the proportion of C30 tetracyclic terpanes relative to C27 diasteranes (TTP Index; from m/z 259; Holba et al., 2000; 2003). Two other parameters (C29-demethylated norhopane/C30-hopane, and oleanane/C30-hopane) were omitted. Two major groups and

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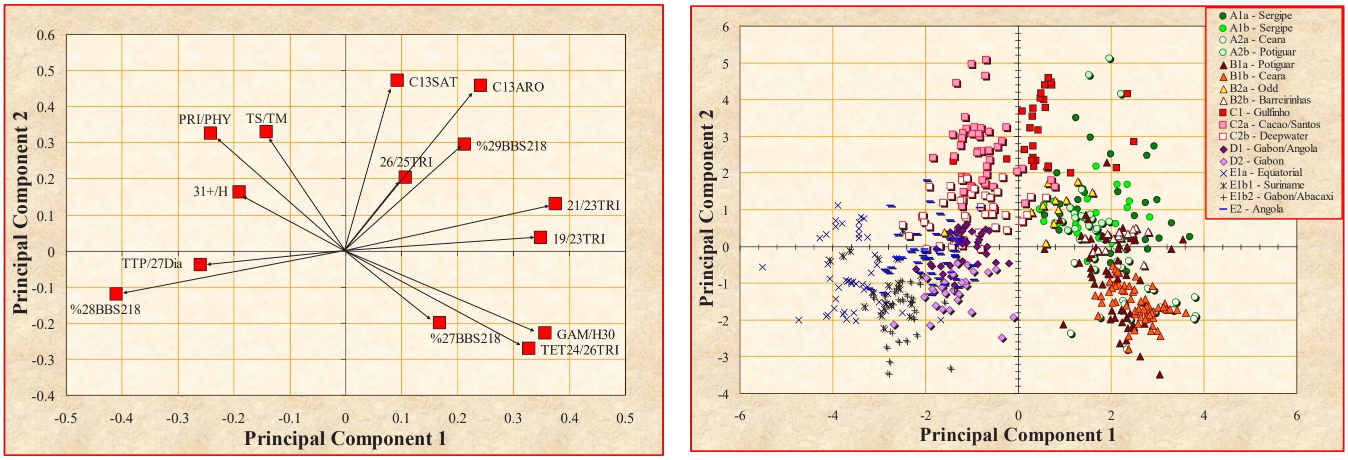

Figure 3a. *Principal Cluster Analysis (PCA) loadings and scores for marine oils from the South Atlantic Margin.*

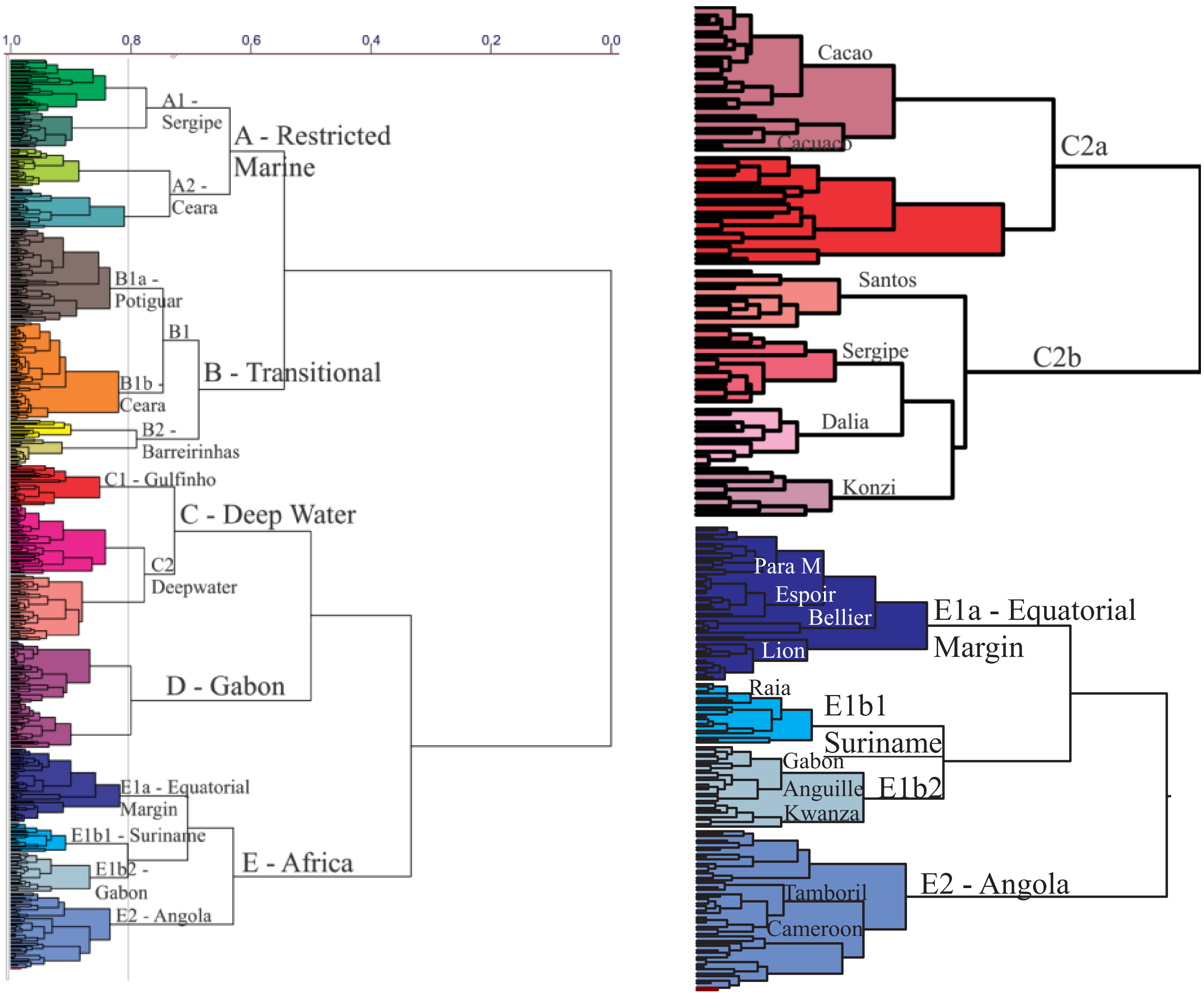

Figure 3b. *Hierarchal Cluster Analysis (HCA) Dendrograms for marine oils from the South Atlantic Margin.*

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five sub-families of oils are distinguished and can be associated with different environments including Transitional/Evaporitic, Carbonate Platform, Marine Transgressive and Marine Regressive (**Figure 3**). Correlations between oils in the seventeen marine oil sub-families may be considered as age correlations possibly related to global ocean anoxic events.

Oils in Families A and B originated from Aptian source rocks deposited in restricted marine or hypersaline transitional environments. These oils mainly occur in the Barreirinhas, Ceará, Potiguar and Sergipe-Alagoas basins located in northeastern Brazil. Oils in Family D originated from Albian to Senonian source rocks deposited in a different marine environments. These oils are limited in distribution and are from mainly onshore and offshore northern Gabon. Oils in Families C and E are more widely distributed and therefore considered as 'odd' in the sense that they are found on both sides of the margin.

The strongest genetic relationships are observed between oils from central Brazil and West Africa that originated from Barremian source rocks deposited in similar deep, freshwater lacustrine environments (Family C; Lower Rift/SynRift I). Family F oils have a unique source chemistry related to SynRift II and/or sag depositional environments and are mainly from the Great Campos sub-basins. Family E oils are all from the Niger Delta area and are distinguished by the presence of oleanane, a specific biomarker associated with deltaic environments and a probable Tertiary origin.

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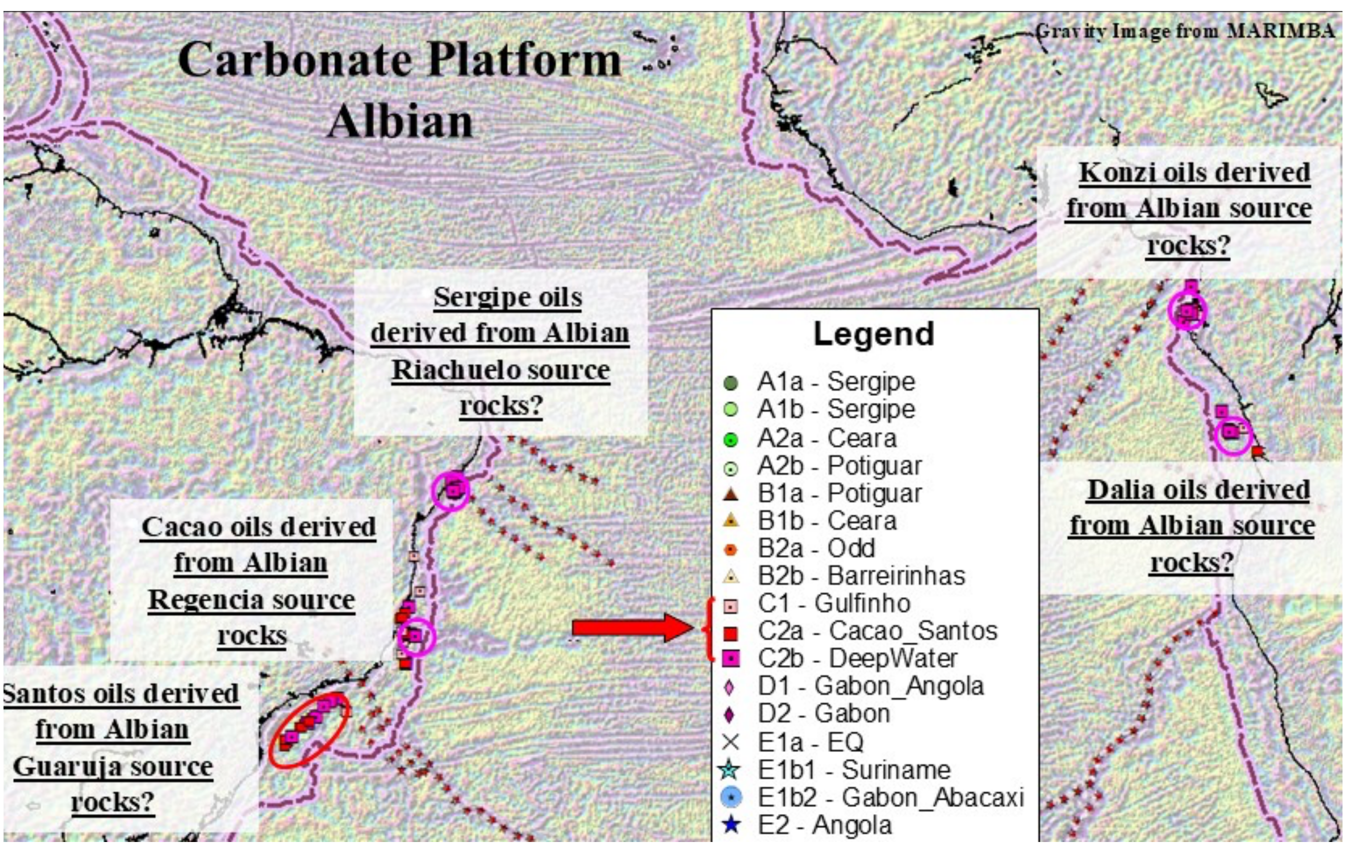

Figure 4. *Distribution of Marine-Derived oils from Family C.*

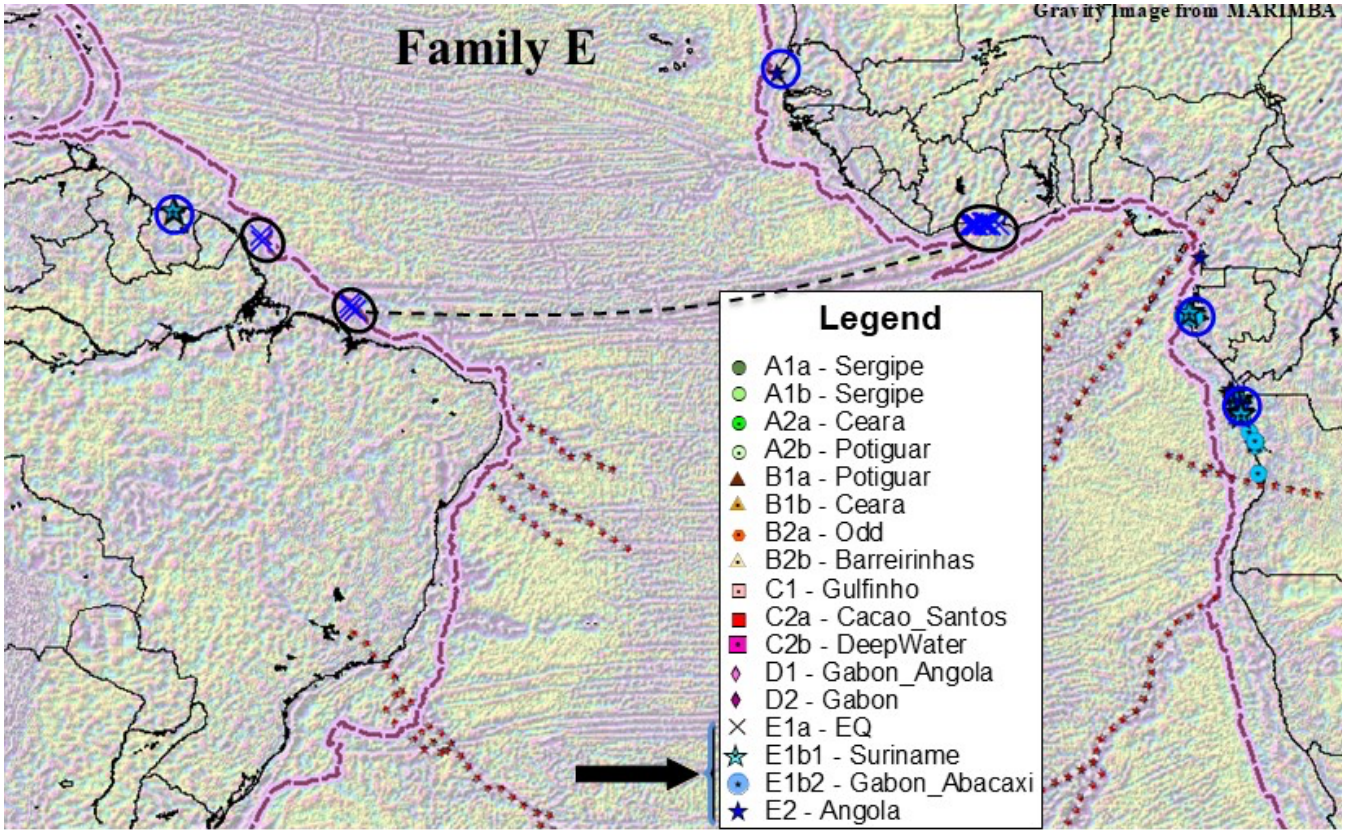

Figure 5. *Distribution of Marine-Derived oils from Family E.*

oils are limited in distribution and are from mainly onshore and offshore northern Gabon. Oils in Families C and E are more widely distributed and therefore considered as 'odd' in the sense that they are found on both sides of the margin.

Family C oils can be separated into six subgroups and many of these oils have been positively correlated to Albian source rocks in multiple different basins (GSI and Core Lab non-exclusive studies). As can be seen from **Figure 4**, these oils are located in Santos (Itajai Acu and Guaruja formations), Espírito Santo (Regencia Formation) and Sergipe (Riachuelo and Continguiba formations?) basins offshore Brazil and offshore northern Gabon (Konzie Field) and central Angola on the African side. Previous investigations (Dickson, et. al. 2012) utilizing piston core and remote sensing data suggest that several oils from the Dalia/Girassol area offshore central Angola have a complex history and may also contain a pre-salt oil component. Similar observations can be made for Espírito Santo oils from the Gulfinho area. Two oils from offshore Sergipe contain anonymously high concentrations of oleanane that may be related to a local Eocene thermal volcanic event (Schiefelbein, et. al., 2016) which is supported by source rock maturity data.

Family E can be separated into four broad sub-groups that include oils from Suriname, Senegal, Cameroon, Gabon, Angola and both sides of the equatorial margin (**Figure 5**). Observations based on the strong correlation between oils along Equatorial Margin Basins (Dickson et. al., 2016) suggest that the Equatorial Atlantic opening was structurally asymmetric with deep monoclinal basins forming along the African margin between the St Paul and Chain Fracture Zones (FZ) while the Brazilian-Guyanan conjugate margin appears to have retained much or all of the early syn-rift architecture. This opening asymmetry a) biased the location of lacustrine (early to mid-Cretaceous pre-rift to early syn-rift) source rocks and b) locally narrowed the width of the optimal marine (well-known Mid to Late Cretaceous post-rift) source kitchens. The latter, where rapidly buried offshore Ivory Coast and Ghana, contribute to a risk of late charge from light (condensate and gas) hydrocarbons. Although multiple lacustrine-sourced oil families are seen all along the NE Brazil margin, none have been identified along the West African Transform (WAT) Margin.

CONCLUSIONS

Marine oils often demonstrate age correlations related to global ocean anoxic events, independent of conjugate structuration. Several oils from Foz do Amazonas and Para Maranhão have chemistries that are unique relative to oils from all other Brazilian basins, but oils with similar chemistries can be identified when the sample coverage is expanded. Within the limited context of South America these Foz/Para oils are compositionally similar to oils from Suriname/Guyana to the west and Austral/Malvinas basins to the extreme south. When coverage is expanded to

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include the entire South Atlantic margin these oils are broadly similar to oils from offshore Gabon, Angola (Dalia/Girassol) and the Kwanza Basin but have the strongest affinity to many oils from the conjugate Equatorial Margin (Cote d'Ivoire) where at least two different sources are active.

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Monday, December 9, 2024

5:30 – 8:00 p.m.

HGS Members/Emeritus/Honorary Life $65
Students $25 • Non-Members & Walkups $75
Norris Conference Center, Citycentre
816 Town and Country Blvd #210 • Houston, TX 77024
https://www.hgs.org/civicrm/event/info?id=2577
Event Contact: Catie Donohue

Bill DeMis, Pablo Eisner,
Dave Martens, and Ken Tubman

Gone but Not Forgotten: Navigating the Impact of Industry Consolidation on Geoscience Careers and Innovation

The oil and gas industry is no stranger to cycles of boom and bust. Today, we are still working through our most recent bust, just as we moved through these cycles in the 50s, 60s, 80s, and 90s. As part of this process, we've learned to expect phases of consolidation and workforce changes. Recently, we've witnessed the absorption of long-established companies such as Pioneer, Hess, and Marathon—organizations that made substantial contributions to geoscience innovation. While market and business dynamics drive these transitions, their effects extend beyond immediate job shifts, raising critical questions about the preservation and dissemination of technical knowledge. Common concerns are that technical projects may be cut short, and valuable insights could be lost in the shuffle. However, these transitions also create opportunities for collaboration, new research avenues, and industry-wide knowledge sharing. This duality presents challenges and openings for geoscientists navigating their careers in a consolidating industry.

This discussion panel will explore the opportunities and challenges posed by corporate mergers and acquisitions on geoscience work and career development. Panelists will offer strategies to pursue technical and business opportunities during periods of transition, share advice for staying aligned with professional goals, and reflect on lessons learned from their own experiences.

KEY TOPICS WILL INCLUDE:

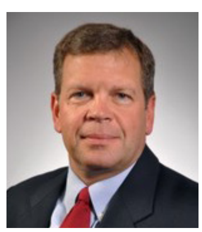
- How to ensure technical interests and innovations survive company transitions.
- Strategies for leveraging mergers as opportunities for career growth and innovation.
- Balancing personal professional development with industry shifts.

The panel will feature geoscientists with diverse experiences across eras and company sizes, known for their technical expertise and engaging perspectives. Join us for an interactive discussion, audience Q&A, and practical advice to turn industry disruptions into personal and professional growth opportunities. ■

PANELISTS

Bill DeMis; President of Rochelle Court, LLC, a geoscience consultancy. Bill has over thirty years of experience in the petroleum industry. Mr. DeMis has held positions of exploration manager for Marathon Oil Company, exploration vice president for Roxanna Oil Company, and chief geologist for Goldman Sachs.

Pablo Eisner; Founder of Pecos Bill Oil and Gas. Pablo has had an impactful career in his 35 years of experience, including positions with Anadarko, Apache, Nexen and CNOOC. Pablo started as an operations geologist and geoscientist interpreter, then progressed to be the team leader, manager, and mentor, and up to the co-founder of an Oil and Gas Operator in Mexico.



Dave Martens; Subsurface Manager, Osborn Oil and Gas. Dave started work with Unocal, spending 12 years in Bangkok followed by working as Chief Geologist for the Gulf of Mexico and post the merger with Chevron, worked in the North American Reservoir Management Team. In 2006 moved on to Marathon Oil, holding the position of Chief Geoscientist and Resource Exploration Manager.

Ken Tubman; Chairman, SAExploration. Ken Tubman has spent more than 40 years in the energy industry, starting with ARCO. He has held senior positions within ConocoPhillips (including Vice President Geoscience and Reservoir Engineering, Vice President Subsurface), Veritas DGC Senior Vice President Veritas Hampson Russell, Vice President Geoservices), and Marathon Oil (Vice President Technical Innovation.)

Wednesday December 11, 2024

Social 5:30 p.m., Dinner 6:30 p.m., Presentation 7:30- 9:00 p.m.

Pre-registered HGS Members $35
Non-Members & ALL Walkups $40
To guarantee a seat, pre-register on the HGS website and pay with a credit card. You may walk up and pay at the door if extra seats are available. Please cancel by phone or email within 24 hours before the event for a refund. Online & pre-registration closes Wednesday, at 5:00 a.m.
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https://www.hgs.org/civicrm/event/info?id=2610
Event Contact: Troy Meinen • troymeinen@gmail.com

Dr. Kenneth Tramm

Risk Assessment: Understanding Ambient Metals

Dr. Tramm will update us on recent research to help us understand what "background" really means in the risk assessment process. This includes a review of physiographic influence on occurrence, flexibility offered within the Texas Risk Reduction Program, and the status of the "Back the BTV" effort that was started to address regulatory concerns voiced by multiple Texas municipalities. This information will be valuable to any staff involved with due diligence, regulatory submissions, site investigations, or waste management. ■

BIOGRAPHICAL SKETCH

Dr. Kenneth Tramm has over 25 years of experience working on environmental assessment and remediation projects across the United States. He served as a national environmental practice leader for two international engineering firms before founding Modern Geosciences in 2011. He holds a master's and doctorate in Environmental Science and Engineering from the University of Texas at Arlington and a bachelor's in Bioenvironmental Sciences from Texas A&M University. He is a licensed Professional Engineer, licensed Professional Geoscientist, and Certified Hazardous Materials Manager. In addition to leading the environmental practice at Modern, Dr. Tramm is an adjunct professor teaching in UTA's Engineering and Geoscience Departments. Dr. Tramm is also the author of Environmental Due Diligence: A Professional Handbook, has served on a number of academic advisory boards, and has served as a subject matter expert for the Texas Board of Professional Geoscientists.

Photo of Gamba sands taken at a road cut outside Libreville, Gabon in Feb 1987 — after a serious rainstorm. A process called "armoring" left small columns of sand protected by a rock. Courtesy of Craig Schiefelbein

December 2024

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1 **GeoGulf 2025 Deadline for Abstracts** *https://www.hgs.org/civicrm/event/info?id=2626*	2 **HGS Short Course** *Fundamentals of Basin Modeling in Oil Exploration* *Page 29* *https://www.hgs.org/civicrm/event/info?id=2624*	3	4	5	6	7 **Make your reservations online at hgs.org**
8	9 **HGS General Dinner Meeting** *Gone but Not Forgotten: Navigating the Impact of Industry Consolidation* *Page 46* *https://www.hgs.org/civicrm/event/info?id=2577*	10 **AAPG Generative AI and Machine Learning Workshop** *https://www.hgs.org/civicrm/event/info?id=2628*	11 **HGS E&E Dinner Meeting** *Risk Assessment: Understanding Ambient Metals* *Page 47* *https://www.hgs.org/civicrm/event/info?id=2610*	12	13	14
15	16 **HGS Third Annual Holiday Party** *https://www.hgs.org/civicrm/event/info?id=2627*	17	18	19	20	21
22	23	24	25 HGS office closed	26	27	28
29	30	31				

RESERVATIONS The HGS prefers that you make your reservations online through the HGS website at WWW.HGS.ORG. If you have no internet access, you can e-mail OFFICE@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, contact the HGS office at OFFICE@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.**

INSTRUCTIONS TO AUTHORS

Materials are due by the first of the month for consideration to appear in the next month's publication. Submissions should be emailed to editor@hgs.org. The Editor reserves the right to reject submissions or defer submissions for future editions.

Text should be submitted as a Word file. Figures or photos may be embedded in the document or submitted separately. The following image formats are accepted: tif, .jpg, .png, .psd, .pdf.

Feature submissions, e.g., Rock Record, should be approximately 600 words. Technical papers should be approximately 2000 words or less (excluding references).

HGS/GESGB 2024 Africa Conference
The Future in Energy, Skills, and Diversity

***By Penny Patterson,** HGS President; **Lucia Torrado,** HGS Editor-Elect; **Linda Sternbach,** Past HGS President; and **Gbenga Olumurewa,** Africa 2024 Committee Chair*

On September 24 and 25, 2024, the Houston Geological Society (HGS) and the Geoscience Energy Society of Great Britian (GESGB) held its 23rd annual HGS/GESGB Africa Conference in Houston, Texas. HGS/GESGB are excited to announce that the conference made an outstanding comeback from "COVID days" with over 80 attendees, 22 exceptional talks, and four vendor booths. This pivotal event brought together leading experts, industry professionals, and graduate students to explore the latest advancements in geology, natural resource management, and sustainable development across the African continent.

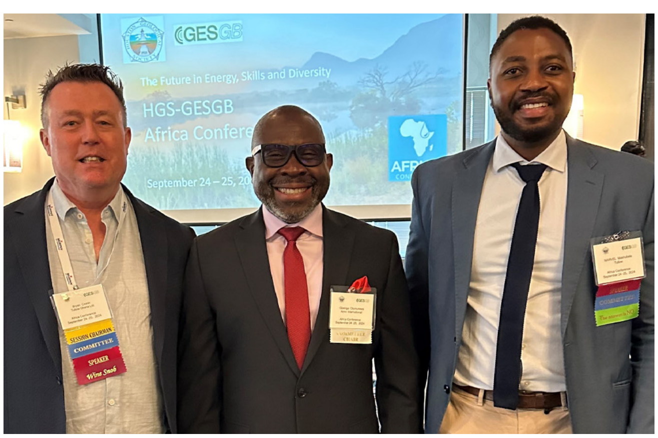
This year's theme was "Africa 2024: The Future in Energy, Skills, and Diversity". The conference was comprised of six sessions including 1) New Techniques and Technologies, 2) New Discoveries, 3) Growing Value, 4) Keeping the Focus on the Future, 5) Petroleum Systems: New Concepts for an Old Paradigm, 5) Switch Energy Alliance's Competition Winners Presentations, and 6) Challenging Thinking. These six sessions provided a diverse array of topics including Active Exploration Areas, Development and Commercialization of Gas, Goals for Energy Transformation, and Solutions for Reducing Carbon Emissions.

The technical program for the Africa 2024 Conference featured a variety of presentations focused on new techniques and discoveries in geological exploration and hydrocarbon prospectivity. Day one began with insights into machine learning for seismic interpretation and the analysis of AVO anomalies in Equatorial West Africa,

HGS/GESGB 2024 Africa Conference *continued on page 50*

Gbenga Olumurewa and Abdul Fattah Bakhiet, organizers

Presentor Jumoke Akinpelu, University of Houston Graduate Student and Bill Dickerson



Africa Conference 2024 Committee Members, (from left to right) Bryan Cronin, Gbenga Olumurewa, Marvel Makhubele

Bryan Cronin accepting the People's Choice Award from Bill Dickson.

HGS/GESGB 2024 Africa Conference continued from page 49

followed by discussions on complex structures in the Niger Delta and de-risking deep-water basins like offshore Somalia. New discoveries highlighted hydrocarbon potential in various regions, including the southern Orange Basin and offshore Equatorial Guinea, while sessions on growing value addressed production from suspended wells and high-impact exploration since 2019 in the whole African continent.

The second day of the conference focused on innovative concepts in petroleum systems, featuring presentations on thermal modeling of source rocks in the Moroccan basin, the identification of unconventional oil types, and expanding hydrocarbon play fairways in the Niger Delta. Discussions also highlighted sustainable energy transitions in Sub-Saharan Africa. The afternoon sessions challenged existing beliefs in hydrocarbon exploration, covering topics like the impact of geological transitions on prospectivity and the significance of sediment waves as reservoirs, concluding with insights into optimizing petroleum systems modeling.

Anne Ekern, President of Switch Energy Alliance, was the keynote speaker who presented Switch Energy's vision on transformative decisions for our global energy future. Following Anne's presentation, Chinaza Peach Arukwe-Moses of Uppsala University, presented her team's winning Switch Energy Alliance Project. Chinaza's team's name was "Green Energy" and her team's project was entitled "Integrated Sustainable Energy Transition in Sub-Sahara Africa: A Case Study of LightUP Kenya project for Universal Electrification and Clean Cooking." Their project focused on mitigating energy poverty in Kenya and emphasized the importance of youth involvement in energy initiatives, as highlighted in the LightUP Kenya project. Next, Promise Nwogu, gave a presentation on "Youth: The Missing Link in Energy Transition" that was followed by an online survey with the conference attendees.

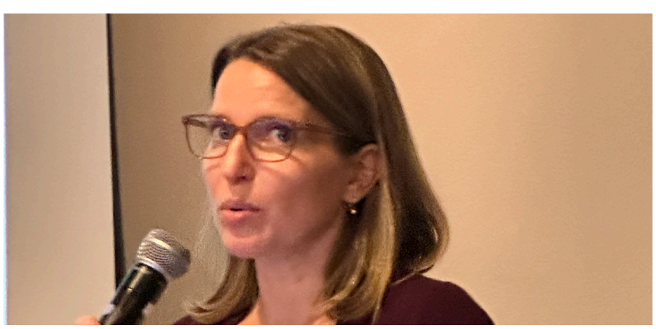
The close of the HGS/GESGB Africa 2024 Conference culminated with the announcement of establishing two inaugural Best Speaker Awards. The first newly established award is the "People's Choice" Award, which recognizes the speaker who received the highest marks from an in-person survey of all the conference attendees. Each speaker was reviewed based on the clarity of their presentation, the presentation's technical merit, and the speaker's engagement of the audience. This year's People's Choice Award was presented to Bryan Cornin, Tullow Oil, for his presentation "Innovations in Deep-Water Sedimentology and Their Impact on Field Development on the Cote D'Ivoire-Ghana Margin".

The Danforth-Bate Award is the second newly established award presented at this year's Africa 2024 conference. This award honors both Al Danforth and Ray Bate, who co-founded the Africa Conference in 2002 and who were long-term contributors to the success of the Africa Conference. The Danforth-Bate Award recognizes the most outstanding speaker at the conference as recognized by the 2024 Africa Conference Committee. This year's Danforth-Bate recipient is Craig Shiefelbain, GSI, inc. who presented "Helping 'Oddball Oils' find their Nearest Neighbors".

HGS/GESGB 2024 Africa Conference *continued on page 51*

Bryan Cronin and Graham Spence session chairs

Casey Donohue and Roy Fitzsimmons session chairs



Catie Donohue HGS Vice President

Craig Shiefelbain receiving the Danforth-Bate Award with Al Danforth's son, Al Danforth's widow Carlota, and Bill Dickson

HGS/GESGB 2024 Africa Conference continued from page 50

Carlota Danforth, Al Danforth's widow, and Jonathan Danforth, Al Danforth's son presented the Danforth-Bate award to Craig Shiefelbain. Carlota and Jonathan both thanked the conference organizers and the attendees for their thoughtful recognition and lasting memory of Al through the establishment of this award.

HGS/GESGB would like to thank the 2024 Africa Conference abstract authors and speakers for their insightful and informative presentations. In addition, HGS/GESGB extends their sincere thanks to the sponsors of the 2024 Africa Conference.

Finally, the 2024 Africa Conference was truly a team event, and we would like to thank our HGS/GESGB committee members and staff and especially Bill Dickson and Catie Donohue, who were instrumental in developing and organizing the conference program.

Next year, the HGS/GESGB 2025 Africa Conference will be held in London, England. We highly recommend making a note in your calendar for fall 2025 to attend this informative networking opportunity. To learn more about the 2025, the website is https://www.ges-gb.org.uk

Jamie Collard dinner speaker

Karen Carlson speaker

Pablo Eisner dinner speaker

Patty Walker and Paul Mann session chairs

Roy Fitzsimmons meeting organizer

HGS/GESGB Africa 2024 Conference Committee Members and HGS Staff

The 26th Annual UH Sheriff Lecture
An Evening Focused on Deep Time and Deep Potential

By Catie Donohue

On November 11th, the HGS cohosted the 26th annual Sheriff Lecture night with the University of Houston. This evening celebrates research conducted by students and faculty from the UH Department of Earth and Atmospheric Science. The event started in 1999 and is held in honor of Robert E. Sheriff, a significant practitioner, scholar, mentor, and advocate for geoscience.

Building off the momentum from last year, 150 people attended. Among the participants were 39 student poster presenters and 30 judges from our Houston geology and atmospheric science community participated as judges.

Dr. Rob Stewart was the host for the evening. He kicked things off with student poster presentations during a social hour. Next, Tom Lapen, the Chair of the Department, provided an overview of department activities, and Dr. Bill Sager introduced a new course focused on applied training for marine survey careers – a skill much in demand. Dave Hume represented the UH-DGH Center for Hydrocarbon Exploration, highlighting exploration opportunities in India and UH's role in helping the industry work through the data. Finishing out the department short talks, Paul Mann summarized current work from the Conjugate Basin Tectonics and Hydrocarbons Consortium, specifically, basin modeling work from the Campos-Santos Basin and additional projects ongoing through the Atlantic Margin.

The capstone of the evening was a presentation by the invited speaker, Lesli Wood, the Robert J Weimer Chair of the Department of Geology and Geological Engineering at Colorado School of Mines. The keynote talk was titled "Seismic Geomorphology of Ancient Earthscapes – Strengthening our Perspective of Deep Time and Clarifying

The 26th Annual UH Sheriff Lecture *continued on page 53*

UH Earth and Atmospheric Science Alumni Club members and Dr. Rob Stewart. From left to right: Julian Chenin, Sarah Giles, David Lankford-Bravo, and Dr. Rob Stewart.

Catie Donohue from HGS and Dr. Rob Stewart from UH presenting the Speaker Awards to Dr. Lesli Wood.

UH Student Poster Award winners.

UH Student Poster Award winners.

The 26th Annual UH Sheriff Lecture *continued from page 52*

our Role in the World's Future". Recognizing that geology is unique in its perspective on time, Dr. Wood showed examples from high-resolution seismic images that recreate regional ancient geomorphology, allowing geoscientists to wander through submarine canyon systems and ancient carbonate environments. While the images were fascinating, the implications for a better understanding of past processes are truly inspiring. Students and professionals alike enjoyed the talk and the chance to reflect on the powerful skills and technology our science creates.

The evening finished with the announcement of students who won prizes based on their poster presentations. Students were judged in five categories: Senior PhD in atmospheric Science, Senior PhD in geology, Senior PhD in geophysics, Senior MS/Junior PhD in any science, and Undergrad/Junior MS. Award winners are listed in the table below. These awards recognize the current and potential contributions of individuals and demonstrate the continued pipeline of geoscience practitioners.

The HGS would like to extend our thanks to the planning committee, including UH committee members Dr. Rob Stewert, Dr. Paul Mann, Dr. Tom Lapen, Dr. Julia Wellner, Ms. Antonius Douglas, Mr. Kay Krishnan, and HGS members Catie Donohue, Andi Peoples, Penny Patterson, Linda Sternbach, and all our judges, for an overall delightful and successful meeting. See you next year! ■

Place	Senior PhD Atmospheric Science	Senior PhD Geology	Senior PhD Geophysics	M.S./1st yr PhD in any science	Undergrad/ 1st yr MS Geology	Undergrad Geophysics
First	Nima Khorshidian	Lucille Baker-Stahl	Jake Parsons	Daniel Ragusa	Estefani Ruiz Toro	Juan Cruz
Second	Rijul Dimri	Ana Vielma	Kenneth Shipper	—	Makenna Harris tie Kennedy Potter tie	—
Third	—	Jumoke Akinpelu	—	—		—

Case Study Academy One Day Seminar Features Exploration Success Stories and Comebacks from Dry Holes

By Linda Sternbach, Charles Sternbach, and Katya Casey, with photos by Crista Lynn Lovelady and others.

Houston Geological Society and the Geophysical Society of Houston collaborated on "Case Study Academy: Lessons from Missed Opportunities and Surprise Successes," presented on November 14th. This unique event was designed to demonstrate the value of integration and to share industry learning experiences over the last three decades. Speakers shared their trial-and-error paths, perseverance, and navigation of the corporate decision-making process for sound investment in the uncertain world of subsurface characterization.

This collaborative event was originally envisioned by the co-hosts Katya Casey (GSH Honorary Member) and Charles Sternbach (HGS and AAPG Honorary Member) and enthusiastically supported by all technical committee members and the leadership of the GSH and HGS societies.

This one-day event was designed as an interactive training experience to immerse the participants into integrated case studies and to stimulate professional discussions, geologic model testing, and networking for geoscientists of all ages and backgrounds.

Early career professionals, particularly graduate students and recent graduates with an MS or PhD in seismic theory or geoscience, were at the heart of this event. 140 participants, including 17 geoscience students, participated in panel discussions, asked questions, and made valuable professional connections.

The one-day seminar featured twelve selected speakers with stories to share that before were hidden behind corporate doors. Talks of Jeff Lund, Steve Cossey, Ted Godo, and Brian Frost opened the event in the morning program. Speakers covered international offshore stories of oil and gas exploration, and Ted Godo shared Shell's drilling program success in the Gulf of Mexico after years of failures in the exploration of deepwater Mesozoic. The seminar luncheon speaker, Jeff Nealon, geophysical manager at Chevron, demonstrated an evolution of seismic imaging technology and showed impressive subsalt imaging in the GOM that helps to derisk drilling targets and more accurately assess the size of the HC accumulation.

Katya Casey, Catie Donohue, Karyna Rodriguez, Kevin Schofield, Mark Shann, Rocky Roden, Denes Vigh, and Young Ho Cha gave afternoon talks challenging the established models. They offered examples of the practical use of Plate tectonics integrated with organic geochemistry, described the evolution of the statistical analysis methods of oil and gas company portfolio, and discussed a recent paradigm shift in the approach to seismic acquisition and processing.

The Case Study Seminar was endorsed by the President of GSH, Mihai Popovici, and the President of HGS, Penny Patterson. Mike Forrest and Joe Reilly of GSH helped moderate the Q&A for an audience of 140 attendees with backgrounds in seismic acquisition, processing, and interpretation, explorers for oil and gas with major oil companies, large independents, and specialized technology companies.

The Case Study Academy welcomed sponsorship from Thunder Exploration, Houston Energy, Murphy Oil Corporation, Mike Forrest, Star Creek Energy, PSI, and U3 Explore. Sustaining sponsors were Z-Terra and Patterson Geoscience Group. Cristalynn Lovelady took event photos.

The event was very well received, and all participants have expressed the desire to attend it in 2025 to continue developing critical and collaborative thinking, which helps accelerate project delivery and build stamina to challenge dogmas and stand out among industry leaders.

Case Study Academy One Day Seminar *continued on page 55*

HGS/GSH presidents and organizers.

Charles Sternbach, Mihai Popovichi, Jeff Lund and Mike Forrest, conference organizers.

Case Study Academy One Day Seminar continued from page 54

Case study morning speakers: Katya Casey, Charles Sternbach, Jeff Lund, Ted Godo, Juan Francisco Arminio, Brian Frost, Steve Cossey and Mike Forrest

Morning panel discussion Charles Sternback, Jeff Lund, Ted Godo, Steve Cossey, Brian Frost, Mike Forest

Graduate students attending on a sponsored ticket from Stephen F Austin University, Rice, and University of Houston.

Afternoon speakers Denes Vigh, Young Ho Cha, Mark Shann, Karyna Rodrigues, Kevin Schofield, and Katya Casey

HGS Membership Application

Houston Geological Society
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Phone: (713) 463-9476
Email: office@hgs.org

Active Membership

In order to qualify for Active Membership you must have a degree in geology or an allied geoscience from an accredited college or university or, 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 5 years. Active Members shall be entitled to vote, stand for election, and serve as an officer in the Society. Active Members pay $36.00 in dues.

Associate Membership

Associate Members do not have a degree in geology or allied geoscience, but are engaged in the application of the earth sciences. Associate Members are not entitled to vote, stand for elections or serve as an officer in the Society. Associate Members pay $36.00 in dues.

Student Membership

Student membership is for full-time students enrolled in geology or an allied geoscience. Student Members are not entitled to vote, stand for elections or serve as an officer in the Society. Student Member dues are currently waived (free) but applications must be filled out to its entirety. Student applicants must provide University Dean or Advisor Name to be approved for membership.

Membership Benefits

Digital HGS Bulletin

The HGS Bulletin is a high-quality journal digitally published monthly by the HGS (with the exception of July and August). The journal provides feature articles, meeting abstracts, and information about upcoming and past events. As a member of the HGS, you'll receive a digital copy of the journal on the HGS website. Membership also comes with access to the online archives,with records dating back to 1958.

Discount prices for meetings and short courses

Throughout the year, the various committees of the HGS organize lunch/dinner meetings centered around technical topics of interest to the diverse membership of the organization. An average of 6 meetings a month is common for the HGS (with the exception of July and August). Short courses on a variety of topics are also planned throughout the year by the Continuing Education Committee. These meetings and courses are fantastic opportunities to keep up with technology, network, and expand your education beyond your own specialty. Prices for these events fluctuate depending on the venue and type of event; however, with membership in the HGS you ensure you will always have the opportunity to get the lowest registration fee available.

Networking

The HGS is a dynamic organization, with a membership diverse in experience, education, and career specialties. As the largest local geological society, the HGS offers unprecedented opportunities to network and grow within the Gulf Coast geological community.

Please fill out this application in its entirety to expedite the approval process to become an Active/Associate member of Houston Geological Society.

Full Name ____ Type *(Choose one)*: Active Associate Student

Current Email *(for digital Bulletin & email newsletter)*______________________

Phone _______________

Preferred Address for HGS mail____

This is my home address ______ business address _____

Employer *(required)*___________________________ Job Title *(required)*____________________ Will you volunteer? ____ (Y/N) Committee choice: ____________________

Annual dues Active & Assoc. for the one year *(July 1st-June 30th)* **$36.00**_______

Student **$0.00**_______

OPTIONAL Scholarship Contributions- Calvert/HGS Foundation-Undergraduate **$5.00**_______

Total remittance______

Payment:

Check #____________

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Signature: __________________________ Date: __________

To the Executive Board: I hereby apply for membership in the Houston Geological Society and pledge to abide by its Constitution & Bylaws.

Company*(required, mark 'in transition' if unemployed)*____

Company Address ______________________

City *(Work)* _________________ **State** *(Work)* __________________ **Postal Code** *(Work)* ______________

School *(required)*____

Major *(required)*____________________________________ **Degree** *(required)*_________________________

Year Graduated __________________

School *(optional)*____

Major *(optional)*____________________________________ **Degree** *(optional)*_________________________

Year Graduated ____________________

Years Work Experience *(required)*_________________

Please submit a brief statement regarding your work experience in the practice or application of earth science or an allied science.

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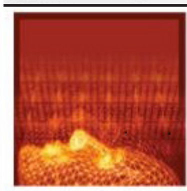

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The pink and orange fluvial and lacustrine deposits of the Claron Formation (Eocene 56-38Ma) are exposed in Bryce Canyon, Utah. Photo taken in 2004 courtesy of Ted Godo