HGS Bulletin
Houston Geological Society
Volume 63, Number 1
September 2020

Virtual Zoom Meeting
The Martin County Texas Super Stack: Developing the Sweetest Spot in the Midland Basin

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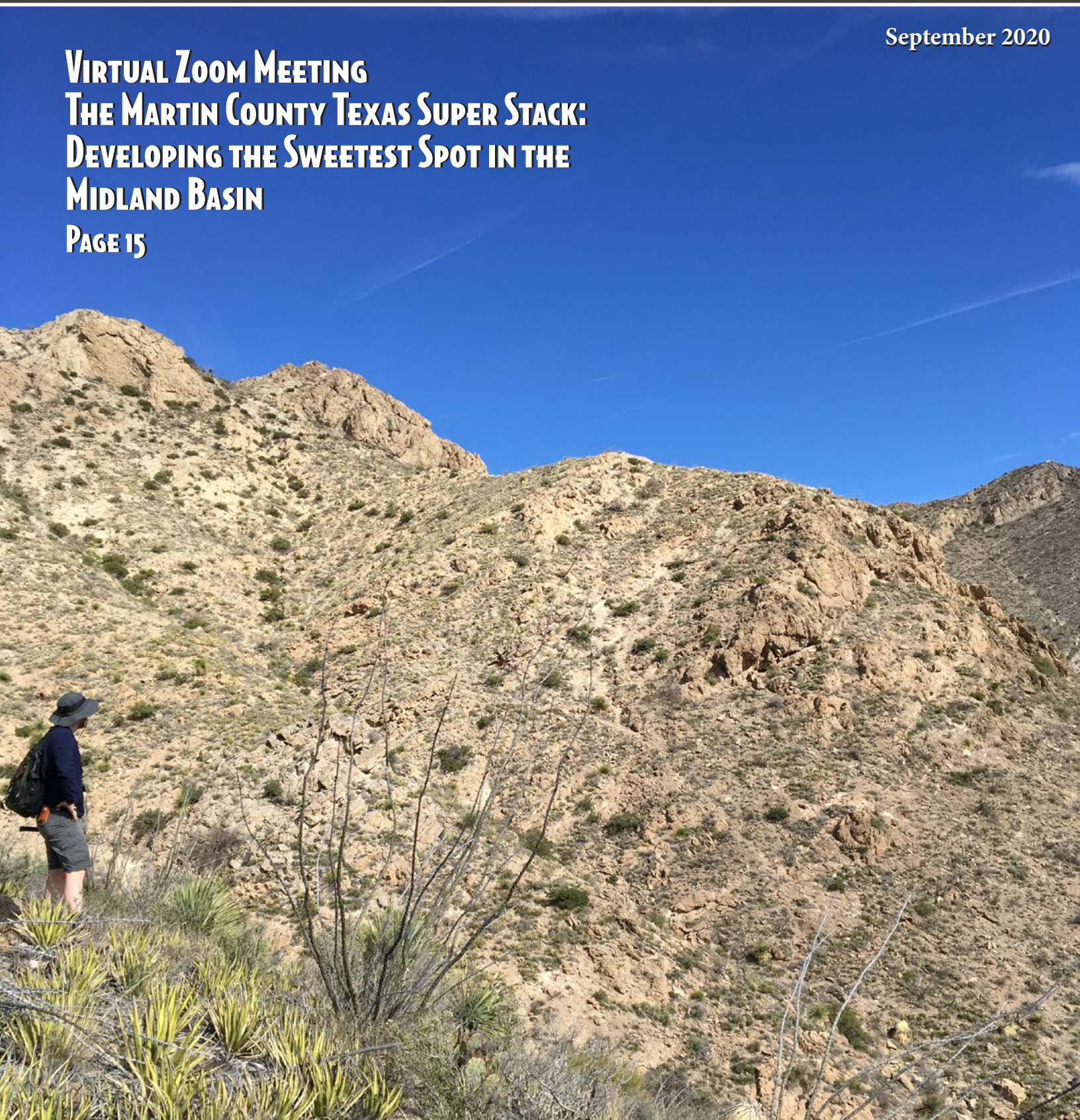

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Houston Geological Society
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In Every Issue

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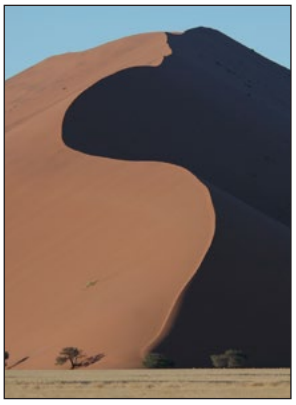
Technical Meetings

Other Features



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About the Cover: Fieldwork in the Franklin Mountains, West Texas in the good old times. Investigating the Lower Ordovician El Paso Group as an analogue for the temporally equivalent Ellenburger of the Permian Basin.
Photo Supplied by Dr. Ceri Davies of CGG.

2020 HGS-PESGB Africa Conference

A Virtual Conference Thursdays in October

Abstract Deadline Extended Through September 1

The conference will be held during the month of October every Thursday from 8:00-10:00 am CST.
It will be a virtual conference with Q&A. Participants may purchase a day session or the entire series.
Day sessions: $50USD • Entire Conference: $175USD

Registration now open https://www.hgs.org/civicrm/event/info?id=2146
For Exhibitor/Sponsorship Information Contact: office@hgs.org

Africa and its Conjugate Margins – New Ideas, Plays, and Innovation

Technical Session Themes

1. **Offshore Africa and its Conjugate Margins – New Ideas in an Old Area, Old Ideas in a New Area**
   - Known Plays to be Tested in New Areas
   - Mapping Known Plays Across Multiple Basins
2. **Applications of New Technology**
   - Adding Reserves in Existing Basins
   - Integration of Multiple Technologies to Unlock Future Potential
3. **North Africa Focus – New Areas and Ideas – Central Atlantic and Mediterranean Margins**
   - Frontier Exploration Plays
   - New Exploration Plays in Under-explored Areas
   - Field Appraisal and Development Case Studies
4. **Africa – A New Approach to Increase Investment**
   - Government Participation and Cooperation
   - Corporate Responsibility, and Ways to Engage Communities

Submit abstracts – Africa2020@hgs.org

2020 HGS-PESGB Africa Conference

A Virtual Seminar Series
Thursdays in October

Sponsorship Opportunities

The conference will be held during the month of October every Thursday from 8:00-10:00 am CST.
It will be a virtual conference with Q&A. Participants can purchase a day session or the entire series.
Day sessions: $50USD • Entire Conference: $175USD

Registration now open https://www.hgs.org/civicrm/event/info?id=2146
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Africa and its Conjugate Margins – New Ideas, Plays, and Innovation

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For more information, please contact office@hgs.org or call 713-463-9476

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Your membership expired June 30, 2020

Annual dues are only $30.00
Emeritus members pay $15.00 • Full-time students $10.00

Check your email for a reminder notice and renew online at www.hgs.org

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Mailing / Billing Address: _____
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Current Employer _____
(required/if unemployed mark 'in transition')
Job Title_____
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(required)

☐ **I do not wish to disclose**
Year Graduated_____
Degree Name & (BS MS or PH.D)_____
(required)

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Would you like to volunteer? ____ (Y/N) Committees of Interest: _____

Annual dues $30.00 Active or Associate: _____
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OPTIONAL DONATION: Scholarship Contributions Calvert & HGS Foundation: $5.00
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The Calvert Memorial Fund *is a scholarship program for U.S. students enrolled in earth science graduate programs in our region. It is managed by a 5 member HGS board of trustees that provides annual support for* **graduate** *studies.*

The HGS Foundation Fund *is a scholarship program designed specifically for* **undergraduate** *geoscience students from area universities.*

Jim Tucker
president@hgs.org

A New Year

We can all agree this is a year we will remember for a long time. So much has changed; some things for a while, and some others likely forever. The Houston Geological Society year runs July-June, and so this year for us began at the depth of the pandemic locally, at least we hope things do not get worse.

If it had to happen, this upsetting of so many things we are used to could not have happened at a better time. We did have to reschedule a couple of events to a virtual format, and had already cancelled the annual Guest Night and shooting event, and the biennial Grand Canyon Raft Trip was delayed a year, since the National Park was closed. But we had the summer to think, prepare and try out strategies, and practice. (And renew our HGS dues, if we had not already.)

It was and is a time for creativity, and our Members got to work with some new ideas. These provided ways to professionally enrich and entertain. There were a series of Field Trip Fridays, where we could take a break at the end of the week to see something away from home, and a Continuing Education course on the business environment and practice as a benefit for renewing Members. This also allowed us chances to improve our skills at conducting meetings with multiple participants and webinars with scores of observers and questions and answers. The Communications Committee and our office staff have been developing skills and establishing protocols for effectively remotely presenting as much of our traditional professional content and activities as we can until in-person meetings are safe to have again. If you would like to learn how to facilitate these meetings, please contact the Communications Committee, as they are having training courses so Members can learn the basics of videoconferencing and webinars.

We are not planning any in-person HGS events through the remainder of 2020, although we have the provision to do so, if conditions in the coming months allow. Our regular technical meetings will continue, as will the biennial Africa Conference which we host in alternation with our sister PESGB society. In June we decided to do it virtually, and creatively, planned on five Thursday mornings in October, allowing virtual attendance from colleagues in Europe and elsewhere in the Eastern hemisphere who are not travelling. The lessons we learn from these remote events may allow us to offer remote attendance as an option for future events is things return to normal, whatever normal is.

The lessons we learn from these remote events may allow us to offer remote attendance as an option for future events as things return to normal, whatever normal is.

I hope everyone is able to take advantage of the professional development opportunities available online, in addition to the HGS events mentioned above. One thing I have tried to do is make one call per day to a colleague who I have not kept up with in a while. The response has been very positive, and it has been refreshing to talk to folks I have not talked to in way too long, and I hope it has been for them as well. I admit that days can still be busy, and if I get in one or two calls per week it's a good week, but I'm glad of having a good excuse to do something I should have kept up with. Maintaining your professional network is like gardening, something to regularly keep up with so it is not neglected.

The news continues to announce some sort of merger, purchase, or reorganization every week. Many Members and colleagues are out of their jobs through no fault of their own, and many early career colleagues are experiencing this for the first time. HGS, along with over two dozen upstream professional organizations, participates in the semi-annual SPE-GCS Midcareer Hiring Event. This is a great, focused event putting professionals and hiring companies together. It will be held virtually on 29 September, and can always use volunteers. See the SPE-GCS website for more details.

Be safe and volunteer for something this month. ■

GeoGulf 2020 Physical and Virtual remains GO for LAUNCH!

Come join us and pass a good time at GeoGulf 2020 (70th GCAGS/AAPG GCS/GCSSEPM) in Lafayette, Louisiana, Sept. 30–Oct. 2, for our full-service restaurant *Chez Gulf Geo* at the Petroleum Club of Lafayette, where we are going to feed you well, with attendees receiving two complimentary lunches and food at our Icebreaker, Happy Hour, and Breaks. As *lagniappe*, you also get a robust technical program, exposition, prospect alley, golf tournament, field trips and short courses, luncheons, special events, and more!

We recognize that personal risk assessment and institutional restrictions may impact your ability to attend in person. We are therefore pleased to announce that GeoGulf 2020 is offering a reduced-fee virtual option, with all technical sessions streamed live over the internet with additional recordings available on-demand.

GeoGulf 2020 Registration is Open

www.geogulf.org

GeoGulf 2020 is partnered with AAPG ACE 2020 with significant added value for your GeoGulf sponsorship, exhibition, and in-person attendance.

- **Sponsor GeoGulf 2020 and receive complimentary equivalent cash value sponsorship of AAPG ACE 2020 Online. Join our growing list of sponsors!** Already an AAPG sponsor? Sponsor GeoGulf 2020 and that contribution adds to your AAPG sponsorship which may level you up to the next tier.
- **Exhibit at GeoGulf 2020 and receive a complimentary AAPG ACE 2020 Online exhibitor slot.**
- **Attend GeoGulf 2020 in person and receive complimentary AAPG ACE 2020 Online registration!**

***** GeoGulf 2020 is proud to host the 1st AAPG Gulf Coast Section Student Expo *****

As an integral part of GeoGulf 2020, we are pleased to announce the 1st AAPG Gulf Coast Section Student Exposition, which will include a dedicated student poster session, short courses and workshops, networking opportunities, and other activities. **CALL FOR STUDENT POSTERS:** We are still accepting poster abstracts (visit our website for more details).

Ceri Davies
editor@hgs.org

From Wales to Houston

Fellow Houston Geological Society Members: Thank you for your support of the Houston Geological Society (HGS) and your investment in one of the oldest geological societies in the world. Your continued support and involvement in the society is appreciated not only by the Board but all past, current and future members. As a society, we have experienced almost 100 years of history but the current events are certainly something that we will all acutely remember.

For this first issue of the 2020-21 HGS year, I'd like to take a brief moment to introduce myself if I may. I'm an early mid-career geologist who has worked in the industry for a little over 10 years. I grew up in Pembrokeshire in West Wales. For those of you who have not been lucky enough to visit yet, Pembrokeshire offers some of the most specular outcrops and geology that a geologist could want – from the late Precambrian to the late Carboniferous, charting the Caledonian Orogeny in the North of the county and the Variscan Orogeny in the south.

I studied Geophysics with Geology at the University of Liverpool in the UK before obtaining a PhD in Paleomagnetism, with a focus on the Earth's magnetic field during the Cretaceous. I joined what was then Fugro Robertson (formerly Robertson Research) and continue to enjoy 10+ years at the company, now a part of CGG.

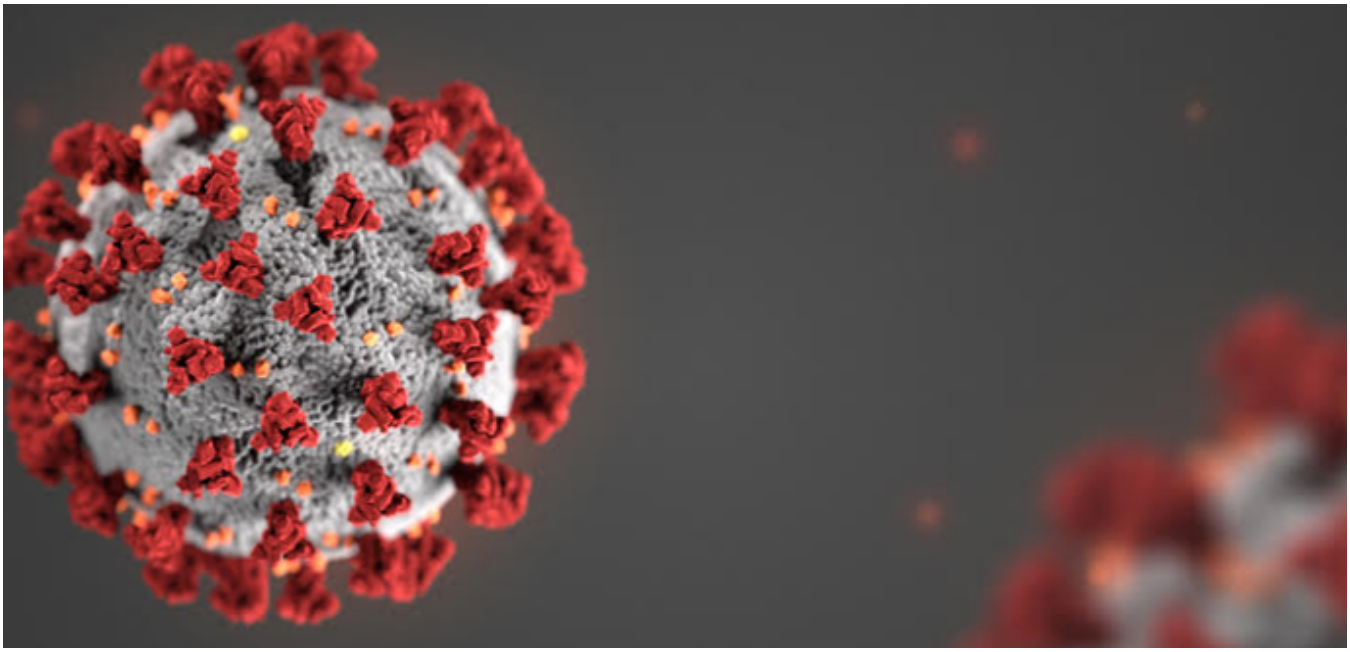
My first experience with the HGS was in October of 2011 at an event co-presented with the Geophysical Society of Houston designed to introduce us early career members to the industry. I vividly remember a comment by one of the guest speakers who insisted we learn all we could about shale because it was about to send shock waves across the industry.

Now, as we enter a new era for the industry where digitalization, coding and pivoting are common place, the HGS continues to support its members in this time of transition for many. Whilst operating remotely and with a new normal being established, if you have any requests for courses or experiences that you would like to share with other HGS members please do get in touch.

I look forward to hearing from you and also meeting up with you in person at a future HGS event.

With best wishes,
Ceri

Cambrian strata along the Pembrokeshire Coast National Park near St. Davids.



Coronavirus (COVID-19) Policy Statement: Updated Friday, August 28, 2020

Because of the ongoing coronavirus (COVID-19) situation, all in-person HGS events through the end of 2020 are cancelled/postponed or will be substituted by online events. Please check the HGS website on a regular basis for all HGS online event opportunities.

The HGS Board will continue to monitor the situation and determine whether to extend the cancellation or postponement of HGS in-person events as we enter the New Year.

Please monitor hgs.org and your email for further communication concerning HGS events.

For more information about how you can help to prevent the illness, visit the CDC website: https://www.cdc.gov/.

2020-2021 HGS Board

Houston Geological Society June 2020 Report

By Jon Blickwede

During the current 1 July 2019 – 30 June 2020 fiscal year, the Executive Board of Houston Geological Society decided to pursue two main objectives aimed at maintaining/improving the overall health of the society. With the petroleum E&P industry downturn of the past few years, now severely exacerbated because of the COVID-19 pandemic, membership growth, attendance at society-sponsored events, and industry support of these events have been adversely affected. **Because of this, the HGS Board has been actively searching for 1) new ways to increase membership, especially of early and mid-career professionals, and 2) reducing the total number of HGS-sponsored events.** Regarding the former objective, the young professionals subgroup of HGS, HGS NeoGeos™, has had new leadership and has significantly increased the number and type of local events tailored for this demographic of professionals and students; indeed, HGS NeoGeos group is the only subgroup that has held at least one event (online) every month since the pandemic began affecting HGS events this past March.

In regard to the latter main objective, early in the fiscal year the Board had decided to "put on hiatus" the two social events specifically for committee chairs (the August "Chair Fest" and Spring "Mid-Fest" events, and the June 2020 HGS "Guest Night," which had suffered a financial loss at the June 2019 event.

Because of restrictions imposed by the pandemic. most in-person HGS events since March 2020 have been cancelled/ postponed or converted to virtual events. Accordingly, the HGS has expanded its Zoom license to allow for online events with participation up to 500 attendees. **HGS events that have been conducted online since March have been successful in terms of attendance. Of note during 2019-2020, HGS has significantly increased the number of subscribers (>1400) and views (>200,000) to its YouTube channel, where many of the presentations at HGS events have been posted.**

Another major effort during 2019-2020, successfully completed as of the elections of 10 May, was to revise the HGS Constitution & By-laws, which had not been modified for a decade and were in need of incorporating more modern business practices such as allowing for a quorum to be established for voting during remote/ online Board meetings. A draft of the new Constitution/By-laws was prepared by the Board during late 2019 (with assistance from an attorney specializing in governing documents of Texas non-profit, professional organizations such as HGS), and approval was obtained via vote of the general membership during the 10 April-10 May election of new Board members.

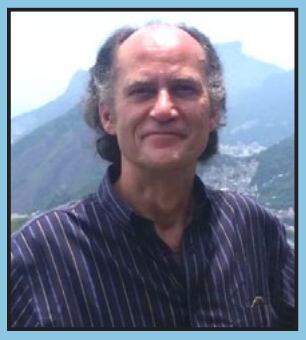
This past year, like all years, HGS served our membership and the Houston geoscience community in many ways to keep our professional skills current and promote cooperation and collaboration among geoscientists in industry, academia, and government:

- **Many HGS members were involved in planning and execution of the 2019 GCAGS Convention (GeoGulf 19) in Houston on 23-25 October 2019.**
- **During the 1 July 2019 - 30 June 2020 fiscal year we will have had 29 presentations at the General Dinner, General Lunch, Northsiders Lunch, Environmental & Engineering Dinner, North American Explorationists Dinner, and International Explorationists Dinner meetings. This is down from a total of 45 such HGS presentations during the 2018-2019 fiscal year, a 35% decrease.** In part this decrease was intentional, as a cost-cutting measure prior to the inception of the COVID-19 pandemic. But obviously a major reason for the significant overall decrease in HGS events in 2019-2020 was directly related to the pandemic—because of official restrictions by the Houston and Harris County governments on the maximum number of attendees at in-person gatherings, and also based on the judgement of the HGS Board regarding the health-related safety of HGS members.
- **During this fiscal year, HGS has sponsored or co-sponsored the following special events** in addition to the regular annual monthly meetings mentioned above:
  - **The first annual HGS/EAGE (European Association of Geoscientists & Engineers) Conference on Latin America was held on 19-20 November 2019.** HGS was the host for this first-ever event and had 165 attendees.
  - The second annual conference will be hosted by EAGE and is scheduled for December 1-3 2020. The third event, in 2021, will return to Houston and be hosted by HGS.
  - The Fall 2019 AGC (Applied Geoscience Conference Series) **Geomechanics Conference was held on 6-7 November 2019** at Southwestern Energy's facilities in Spring, Texas. The theme of the event was "Applied Geomechanics Through the Life Cycle of a Field."
  - The time-honored **HGS/PESGB (Petroleum Exploration Society of Great Britain) Africa Conference was held in London on 1-2 October 2019**, hosted by PESGB. The 2020 edition of the Africa Conference will be hosted by HGS, but because of the pandemic will consist of a series of virtual, online events during October, instead of an in-person event at a venue in Houston.
  - **We held one Continuing Education course** (Introduction to Hydrocarbon and Fluid Analysis, Stratum Reservoir) **during 2019-2020**.
  - **HGS held a new social event during the fiscal year, the "HGS Family & Friends Fall Fun Day" in The Woodlands, Texas on 5 October. In addition, the annual HGS Golf**

Houston Geological Society June 2020 Report *continued on page 11*

A Live Webinar!

Velocities, Imaging, and Waveform Inversion



The Evolution of Characterising the Earth's Subsurface

Featuring Dr. Ian F. Jones - ION Geophysical

Duration/Format: **3 half-day interactive webinar sessions**
October 27-29, 2020
9:00 AM - 1:00 PM Central Time (Houston,USA)

The course is designed for practising geoscientists and geoscience students who desire a better understanding of the principles and limitations of both current and emerging technologies involved in subsurface parameter estimation and imaging. The material is designed to help readers better understand how contemporary velocity estimation methods work, and what approximations are involved in obtaining computationally tractable solutions. The evolution of the industry's approaches to building earth models with ray tomography and full waveform inversion is covered, as are some of the emerging possibilities for replacing imaging techniques with direct subsurface parameter inversion methods. The approach will be mostly non-mathematical, concentrating on an intuitive understanding of the principles, demonstrating them via case histories.

Course Outline

Introduction
Near Surface & Topography
Anisotropy
Overview of the principles of migration
  Ray versus wave descriptions
  Creating gathers for WEM methods & least-squares modification
  How various algorithms differ, what their limiting assumptions are, etc.
Ray-based Tomography
  Generic update loop: Hybrid gridded tomography
  Non-parametric picking
Wave-based tomography
Industry comparisons of tomography & FWI
Future directions

Optional topics that may be covered depending on time
Seismic response to strong lateral contrasts: e.g. salt
Seismic response to strong vertical contrasts: e.g. chalk

This **12 hour course** can be taken in the comfort of **your office** or even **your own home**. It works on **PC's, iPads, iPhones**, or even two tin cans with a taut string (not recommended). **No travel costs**. **The Course Fee: $335!** With major discounts for Groups and Students. 1.2 CEU's are awarded.

Sponsored by

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Register now at: gshtx.org and seg.org
All sessions are recorded and available on-demand to attendees.

Houston Geological Society June 2020 Report continued from page 9

Tournament was held on 21 October at the Sterling Country Club & Houston National Golf Club.

– **As a community outreach effort during the COVID-19 pandemic, HGS organized two volunteer events for HGS members at the Houston Food Bank during April and May 2020.**

This year, as always in recent years, HGS promoted the geosciences in a number of ways:

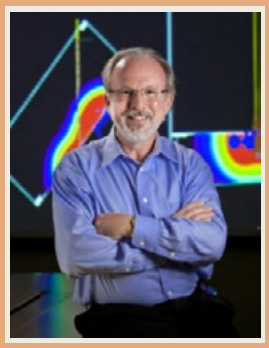
- Through the Calvert Graduate Scholarship Fund and the Undergraduate Scholarship Foundation Fund, HGS **awarded 15 scholarships** (up from 13 in the previous fiscal year) amounting to around $54,000 of geoscience university student support.
- Through participating in the **Energy Science and Technology Council of Houston** umbrella organization, HGS continues to participate in the **Science and Engineering Fair of Houston** by providing judges, as well as sponsoring three student internships at the Houston Museum of Natural Science during the summer - the Richard G. Howe Intern, the Claudia Ludwig Intern and the Barry Katz Intern.
- Our **Educational Outreach Committee** is active during the entire school year going to individual schools. They have a partnership with the IPAA/PESA Extern Program for high school students, but also reach out to middle and elementary schools. They have served more than 2000 students grades 2-12 by presenting Rock Lab, Bones in Schools, Houston Museum of Natural Science Day, Petroleum Academy Career Day, Career Panel, High Island Beach Learning, Map Labs, and geologic field trips to Whiskey Bridge and the Texas Hill Country.
- Both the **Earth Science Week Committee** and the **Museum of Natural Science Committee** annually participate in the multi-day event every year at the Houston Museum of Natural Science (HMNS). Hands-on activities and interactive demonstrations were presented in the Glassell Hall, Wiess Energy Hall and Morian Hall of Paleontology.
- HGS continues to participate in the **Houston Gem and Mineral Show**.

Respectfully Submitted,

Jon Blickwede
HGS President 2019-2020
Tel. (713) 463-9476

A Live Webinar

Microseismic monitoring: what I have learned in the last four years



Peter M. Duncan, PhD
President & CEO, MicroSeismic, Inc.

November 18 & 19, 2020 10:00 am – 2:00 pm

"In 2016 I presented a 2-day overview of microseismic monitoring as I understood it at that time. Over the last four years the application of microseismic data, particularly to the development of unconventional resources through hydraulic fracturing, has made great strides particularly through integration with other reservoir geology and engineering practices. In this course I will try to bring you up to date on what has been accomplished using case histories of recent projects."

This **8 hour course** can be taken in the comfort of **your office** or even **your own home**. It works on **PC's, iPads, iPhones**, or even two tin cans with a taut string (not recommended). **No travel costs**. **The Course Fee: $250!** With major discounts for Groups and Students. 0.8 CEU's are awarded.

Sponsored by

SEG SOCIETY OF EXPLORATION GEOPHYSICISTS

Register now at: gshtx.org and seg.org

All sessions are recorded and available on-demand to attendees.

Wednesday, September 8, 2020

Virtual Meeting via Zoom
7:00–9:00 p.m.
HGS Members $10 Non-Members $30 Students $5
https://www.hgs.org/civicrm/event/info?id=2230
Registered Attendees: A confirmation email will be sent upon registration with meeting links.
Event contact: Matthew Cowan – mrcowan1@hal-pc.org

Rusty Branch
Gehrig, Inc.

Utilizing Applied Geophysics for Rapid Assessment of Subsurface Characteristics and Identification of Areas of Geologic Concern for Engineering Projects

Applied geophysics includes a suite of subsurface exploration methods that complement conventional geotechnical and geological approaches. These methods allow geoscientists and engineers to rapidly assess subsurface conditions and identify areas of geologic concern that can impact project success while simultaneously compressing the timeline for both design and construction.

Integration of geophysical exploration into the pre-design process is becoming common as many geoscientists and engineers have realized its value for site characterization. These methods are especially well-suited to linear projects such as water and wastewater conveyance, transportation and in some cases, electrical transmission. However, the methods are also useful for rapid subsurface characterization of earthen dams and development sites in karst-prone areas. Frequently used methods include seismic, geo-electrical, microgravity, radar, magnetics, and electromagnetics. This presentation provides an introduction to applied geophysics through the review of case studies where geophysics complimented engineering projects. ■

Biographical Sketch

Rusty Branch is a multidisciplinary scientist and has been a member of the Gehrig, Inc. team since March of 2016. He has more than a decade of experience in the field of applied geophysics, including UAV-based geophysics. He has served on boards and committees for several professional organizations on the local, state, and national levels. He is a past chair of the AEG Texas Chapter and the Texas Section of the ASCE Geo-Institute. Rusty has authored/co-authored peer-reviewed publications in the fields of geology, vertebrate paleontology, and botany. His 20+ years of professional experience covers geoscience, bioscience, vertebrate paleontology, information systems, and geographic information systems.

Education

BS Earth Science/Geology from Tarleton State University
MS Biology with post-master's work in terrestrial ecology from Baylor University
MBA from U.T. Arlington

Monday, September 21, 2020

Virtual Meeting via Zoom
6:00–7:00 p.m.
HGS Members $10 Non-Members $30 Students $5
https://www.hgs.org/civicrm/event/info?id=2227
Registered Attendees: A confirmation email will be sent upon registration with meeting links.
Event contact: Bryan Guzman – vice.president@hgs.org

Derek Buster
Guidon Energy

The Martin County Texas Super Stack: Developing the Sweetest Spot in the Midland Basin

The Midland Basin of west Texas is a crown jewel for oil & gas companies operating in the United States. The 2014 downturn and COVID-19 have shown the Midland Basin can continue operating in a lower oil price environment when all other oil producing basins are forced to stack rigs. Even more economically recoverable oil remains in the Midland Basin than critics have previously predicted. This case study reveals the "Martin County Super Stack", a sweet spot like no other.

Exploration methods used by geoscientists and petroleum engineers to predict sweet spots have traditionally relied on sparse physical evidence. Oil-in-place, net pay, clay volume, maturity, these are not the map properties that matter to predicting play economics. The most ideal combination of these geologic properties will still yield poor well results even with a perfectly engineered and executed plan. A primary reason performance in an unconventional oil play seems difficult to predict is that much of the physical evidence we traditionally use to map a basin remains overlooked, and often because most operators don't look very far outside their own acreage position. Basin-wide we have seen an evolution over the past decade in well spacing, well design, and completion methods, driven mostly by interference and poor predictability. Operators are transitioning from proving landing targets that work economically in "standalone" wells, to co-developing stacked targets, with geometrically spaced well patterns to optimize recovering the most oil without compromising future locations. Closer examination of physical properties and primary well performance drivers using the scientific method, proper evaluation technology, and consistent petroleum industry practices highlight additional economic benches most E&P companies won't develop, and once this development begins some of those upside benches left behind are gone forever. ■

Biographical Sketch

Derek Buster is the Petrophysical Advisor at Guidon Energy & Swallowtail Royalties Holdings Corporation located in Irving Texas. Guidon Energy operates approximately ~45,000 gross acres in Martin County Texas. Swallowtail Royalties Holdings manages approximately ~12,000 net royalty mineral acres located in Martin, Howard, Midland and Glasscock counties. He currently advises on subsurface evaluation and development of unconventional resources in the Midland Basin core. Prior to joining Guidon, he was Petrophysicist at Stone Energy Corporation and Apache Corporation working North American shale in the Appalachian Basin, Permian Basin, Alberta Basin, and several frontier exploration projects in lessor known shale basins. He has 12 years operational experience with Schlumberger & Baker Hughes in the Gulf of Mexico and North America land. He has co-authored several SPE and SPWLA publications related to delivering significant cost savings to operators through leveraging technology as a first adopter.

Houston Geological Society President's Night Award Dinner

On June 30th we hosted our annual President's Night Award Dinner remotely via Zoom. Whilst unable to get together in person, we were able to recognize and award those companies and members who have significantly contributed to the society.

Corporate Star Award

The Corporate Star Award honors companies who have made significant contributions to the Houston Geological Society. These contributions can be monetary or "in kind" such as donating a venue, services, materials, or an individual's time. Over the course of the past year, our Corporate Sponsors have donated $45,000 to the HGS!

Gold Level

Baker Hughes • Chevron

Silver Level

Occidental Petroleum • Thunder Exploration

Bronze Level

Black Falcon Energy • Kosmos Energy • Quantico Energy Solutions

Rising Star Award

The Rising Star Award honors individuals who are relatively new to the HGS or have recently made significant and promising contributions to the enhancement and success of the Society.

Tiffani Kennedy
Lanette Marcha
Jake Schultz

Chairman's Award

The Chairman's Award honors members who have made extraordinary efforts or unique contributions to their committee. These members deserve special recognition for all that they have done this year.

Rich Germano
Joe Lynch
Chi Vinh Ly

President's Award

The President's Award honors members whose extraordinary efforts or unique contributions in a fiscal year or over a short period of time deserve special recognition.

Casey Langdon

Distinguished Service Award

The Distinguished Service Award honors members who have given long-term valuable service to the Society.

Tarek Ghazi
Umesh Prasad
Elliot Wall

Honorary Life Membership

The HGS Honorary Life Membership award honors the members who have distinguished themselves in the field of Geological Sciences or have contributed outstanding service to the success and welfare of this organization.

Mike Deming

Teacher of the Year Award

This award was established to honor educators who have made extraordinary efforts or unique contributions in Earth Science Education.

Astra Zeno

Wednesday, September 23, 2020

Virtual Meeting via Zoom
12:00 –1:00 p.m.
HGS Members $10 Non-Members $30 Students $5
https://www.hgs.org/civicrm/event/info?id=2228
Registered Attendees: A confirmation email will be sent upon registration with meeting links.
Event contact: Bryan Guzman – vice.president@hgs.org

Alfred, Dicman
Scala Energy LLC.
(Now SOTAOG)

A New Methodology to Determine Well Spacing in Unconventional Reservoirs - A Delaware Basin Study

Well spacing and its impact on performance degradation is currently an area of critical concern in unconventional reservoirs. A new methodology to estimate well spacing and optimum completion design based on local geology from readily available data is presented. The significant outcomes of this workflow are the ability to rank well performance, impact of geology/landing target, changes in pressure regimes along the lateral relative to an existing similarly landed producer.

At the core of this methodology is the innovative estimation of additional pressure induced from stimulation treatment long after closure when there is no more fluid leak-off into the matrix. This estimation is achieved through time dependent leak-off data that are usually available after stimulation. Multidisciplinary components like petrophysical properties, PVT, DFITs, geomechanical modeling and their uncertainties are stochastically engaged to realize the most probable stimulated rock volume (SRV).

A Delaware Basin Wolfcamp case study comprising of 10 wells is presented and the results obtained through the methodology are summarized below.

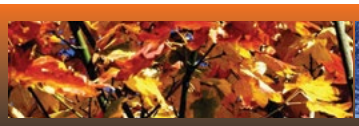
- The would-be relative underperformers were identified immediately after the frac job.
- The local faults/ fractured zones were identified and reaffirmed with seismic and well data.
- Identified the impact of geology on completion variables.
- The evaluated pressure regimes along the horizontal were corroborated by well performance.
- Correlated the landing zone impact to stimulation.
- The appropriate well spacing and optimum completion design to minimize well interactions were determined, specific to local geology and landing targets.

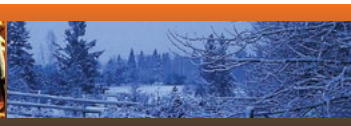
Present industry solutions to well spacing involve expensive geomechanical earth modeling or frac geometry monitoring that are time consuming, data intensive and unfortunately geography specific. The new methodology presented is quicker and requires no new data collection than those that are routinely gathered. ■

Biographical Sketch

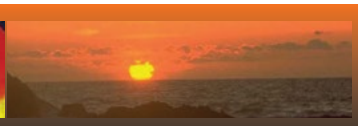
Dicman Alfred is currently the Director of Subsurface for SOTAOG, heading the real-time production optimization and predictive analytics group. He has 18 years of unique expertise in Geoscience and Engineering domains. His areas of focus include business development, petrophysical modeling, inter-discipline integration, geo-cellular modeling, analytical reservoir performance analysis, production optimization, completion design, data analytics and machine learning. Recent experiences include involvement as a Technical Advisor from acreage acquisition to development for Scala Energy, Senior petrophysicist with the Upstream Technology Worldwide Petrophysics group at Marathon Oil, Engineering lead for Eagle Ford field development and Team lead for field studies in Woodford, Eagle Ford and Austin Chalk. Prior to joining Marathon, he worked as a wireline field engineer for Halliburton Energy Services and as a Petroleum Engineer for Schlumberger Information Solutions. He holds a Master's Degree in Petroleum Engineering from Texas A&M and a Bachelor's Degree in Mechanical Engineering from Indian Institute of Technology, Chennai.

September 2020





Sunday	Monday	Tuesday	Wednesday
		1	2
6	7	8 **HGS Board Meeting** *6 p.m.*	9 **HGS E & E Virtual Zoom Meeting** *"Utilizing Applied Geophysics for Rapid Assessment of Subsurface Characteristics and Identification of Areas of Geologic Concern for Engineering Projects,"* *Rusty Branch,* *Page 13*
13	14	15 **HGS NeoGeos Virtual Zoom Event** *Tentative*	16
20	21 **HGS General Dinner Virtual Zoom Meeting** *"The Martin County Texas Super Stack: Developing the Sweetest Spot in the Midland Basin,"* *Derek Buster,* *Page 15*	22	23 **HGS General Luncheon Virtual Zoom Meeting** *"A New Methodology to Determine Well Spacing in Unconventional Reservoirs - A Delaware Basin Study,"* *Dicman Alfred,* *Page 17*
27	28	29 **AAPG Virtual ACE** **SPE-GCS Upstream Oil & Gas Professionals Hiring Event** *Page 12*	30 **GEOGULF 2020 GCAGS Convention** *Page 6*



GeoEvents

Thursday Friday Saturday

3	4 Don't wait, make your reservations online at hgs.org	5
10	11	12
17	18	19
24	25 **Virtual Pre-registered Prices:** Dinner Meetings members..... $10 Emeritus/Honorary members..... $10 Student members ..... $5 Nonmembers $30	26

Reservations:
The HGS prefers that you make your reservations on-line through the HGS website at www.hgs.org. If you have no Internet access, you can e-mail 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, check with the Webmaster@hgs.org. Once the meals are ordered and name tags and lists are prepared, no more reservations can be added even if they are sent. **No-shows will be billed.**

Thursdays in October, 2020
Virtual 2020 HGS-PESGB Africa Conference
Page 2

November 19-20, 2020
Virtul Second EAGE/HGS Conference on Latin America
Page 11

STGS Fall Field Trip - Friday, October 16th, 2020

"Geology, Frontier History, and Oenology of the Texas Hill Country"

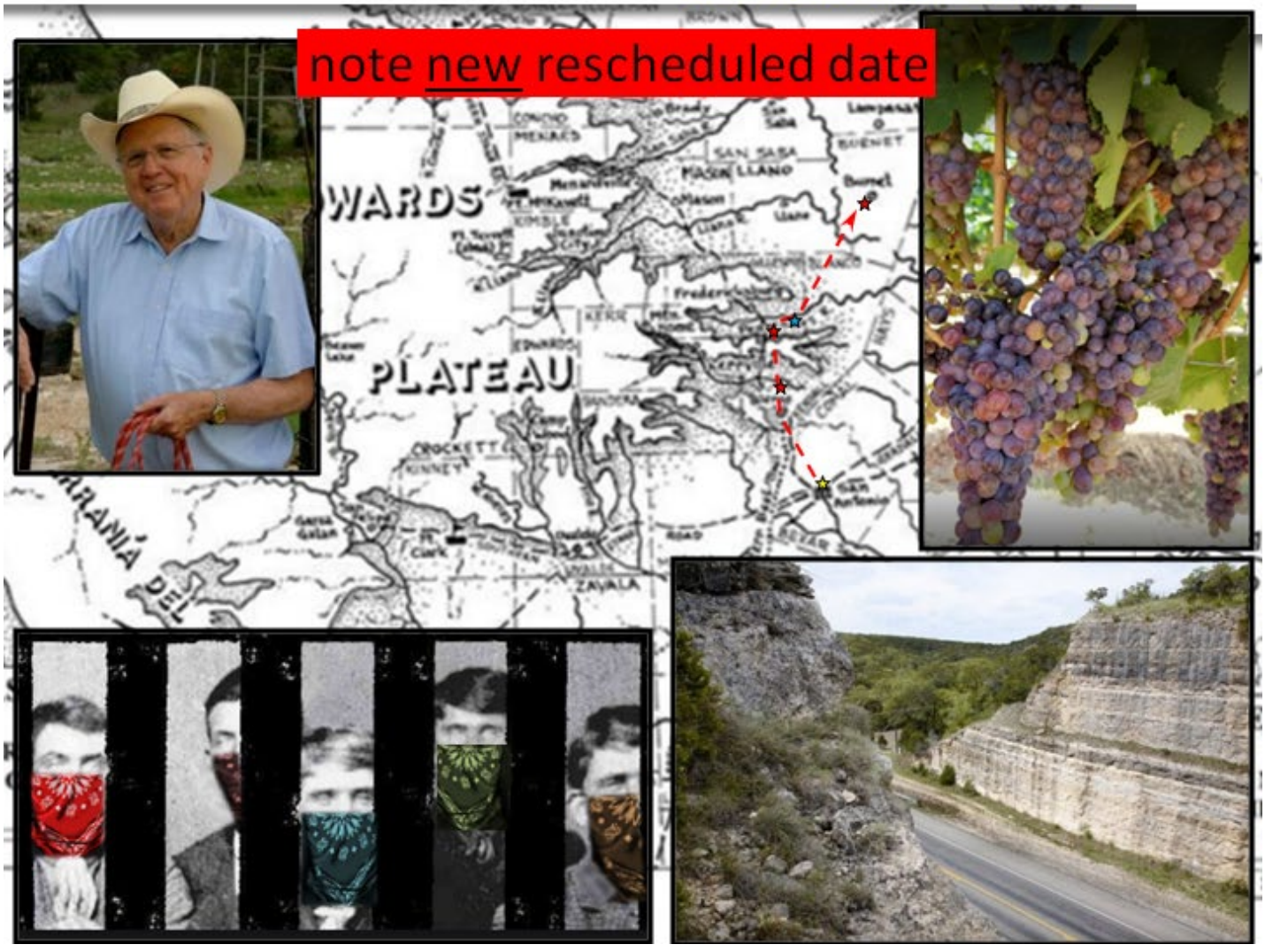
Trip Leader: Pete Rose

Pete will discuss how geology shaped the white man's settlement of the Texas Hill Country beginning with their slim pickings from farming and ranching, their grim encounters with Indian raiding parties and stage coach robbing desperados, to eventual law and order forged by the justice of Texas Rangers. Pete will show that geology creates and controls the extent of the true Hill Country terroir; that is, where actually nurturing vines in Texas soil, to harvest locally raised grapes that yield sustainable and desirable wine, is possible and thriving.

Schedule	
40 passenger bus departs Petroleum Club parking lot (8620 N New Braunfel SA TX)	8 AM
wine tasting at *Sister Creek Vineyards*	9 AM
wine tasting at *Becker Vineyards*	10:30 AM
box lunch by *My Own Chef* at LBJ Park, Stonewall, Texas	High Noon
wine tasting at *Perissos Vineyard and Winery*	2:30PM
return to Petroleum Club	6 PM

COST: $125 per person

for reservations and payment information email johnlonggeologist@gmail.com



HGS Teacher of the Year
Astra Zeno

Astra Zeno has enjoyed teaching math, science, robotics, aerospace, marine science, technology applications, engineering, and computer science over her eighteen years of teaching. Through guest speakers, field trips, and competitions, Ms. Zeno supplements each lesson with interactive activities. She seeks out opportunities and encourages her students to take risks by participating in numerous district and city-wide competitions and challenges. Astra is especially proud to be the lead teacher for her campus' IPAA/PESA Petroleum Academy (one of only five in the nation), where young women receive multidisciplinary, advanced academic learning experiences in science, mathematics and the emerging technology concepts needed to pursue professional training and degrees in engineering, geology, geophysics and global energy management in the oil & natural gas industry. Ms. Zeno enjoys partnering with HGS to bring the amazing exhibits at the Weiss Energy Hall (Houston Museum of Natural Science) to life for her students. Ms. Zeno also relies on the expertise of HGS volunteers during her campus' biannual STEM Family night. Her students also benefit from an annual hands-on walkthrough of the Tapestry of Time and Terrain map by volunteers from SIPES (Society of Independent Professional Earth Scientists). HGS volunteers are also instrumental in leading amazing interactive rock labs and engaging beach trenching experiences for Ms. Zeno's students. With the help of HGS volunteers and volunteers from sister societies such as SIPES and AAPG (American Association of Petroleum Geologists), Ms. Zeno is able to provide her students with up to date and engaging earth science experiences. ■

South Texas Geological Society Seminar & Field Trip

OVERVIEW OF THE AUSTIN CHALK IN SOUTH TEXAS AND LOUISIANA:

Depositional Setting, Diagenesis, Porosity Evolution, and Play Development

Seminar Lecturer: Jeffrey Dravis

The Upper Cretaceous Austin Chalk trend in south Texas and Louisiana continues its resurgence in interest. Areas like Karnes Trough in south Texas, and central Louisiana, remain the areas of interest right now, but many companies also are exploiting established field areas like Pearsall and Giddings, and expanding into East Texas. Geoscientists who explore in the Austin Chalk, or hope to exploit existing Chalk field trends, should possess a firm understanding of the Austin Chalk's regional depositional and diagenetic framework. This includes appreciating the influence of regional and local paleogeography, preexisting topography, and underlying structural framework. Developing an appreciation of the various diagenetic pathways that affected Austin Chalk porosity and permeability evolution is critical as well, since fractures are only a part of the story.

Field Trip Leaders: Tom Ewing, John Cooper, David Ferrill

Tom Ewing will show and discuss depositional details of Austin Chalk Group outcrops in the San Antonio area pointing out their implications on hydrocarbons exploration. John Cooper will explore the stratigraphy of the Austin Chalk Group in Bexar County from lower to upper contact and integrate geophysical logs to make ties to the subsurface. David Ferrill will discuss faulting and fractures seen in fault zones exposed in the San Antonio area. David's discussion will focus on understanding typical normal fault patterns and using these patterns as an aid in predicting the fracture zone width when planning oil and gas exploration.

NOTE: The field trip will be moderately strenuous, especially in the event of rain

Friday, November 6th, 2020

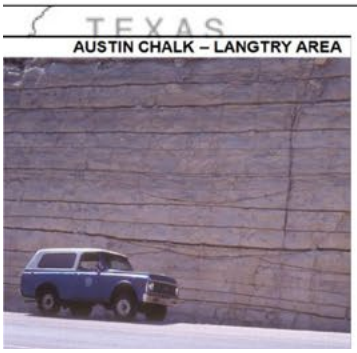
Coffee & pastries at Petroleum Club (7th Floor, 8620 N. New Braunfels, SA TX).....8 AM
Buffet Lunch.....note rescheduled dates.....Noon
Conclusion and *happy hour*.....5 PM

Saturday, November 7th, 2020

Passenger bus departs Petroleum Club (8620 N. New Braunfels, SA Tx) parking lot....8 AM
Box lunch .....Noon
Return to Petroleum Club by.....5 PM

$380 per person (compare to $895 in Houston with no field trip)
(seminar only: $320—field trip only: $100)

for reservations and payment instructions email: johnlonggeologist@gmail.com
or go to https://stgs.org/civicrm/event/info?id=84&reset=1 please register prior to April 16th, 2020



Smart Money: Efficient Investments During Geopolitical Volatility

By Matt Mayer, TGS.

A certain amount of volatility is baked into the oil industry; boom and bust cycles are to be expected when investing in this sector. However, the confluence of events that have occurred in the first quarter of 2020, and the ensuing effect on the markets in general and oil prices specifically, are sure to have shocked even the most conservative market watchers. This downturn is certain to wreak havoc on the US shale sector, but operators who are able to weather the storm and invest wisely through the volatility stand to gain a substantial advantage as we settle into the new economic environment. This analysis will look at the potential hydrocarbon production and costs of development of 4 major Texas oil plays within an economic framework. We will look at wells drilled and produced within the last 5 years from each of these plays using pre-calculated performance statistics, unconventional completions attributes, and allocated well level production volumes including produced water from the TGS Well Performance Database.

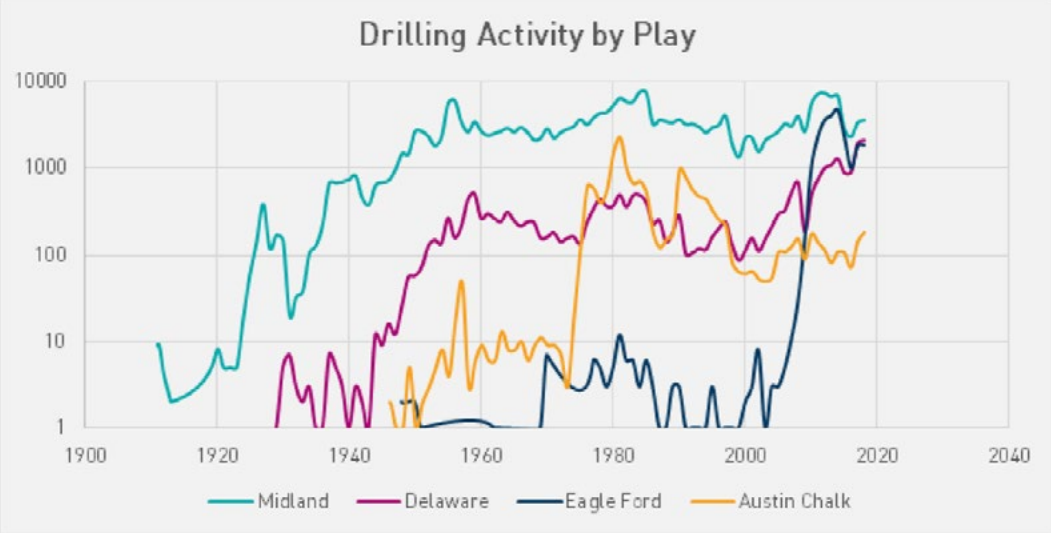


Figure 1: *Drilling and completion activity by play*

Texas has long been the behemoth of oil production in the onshore US. The Permian basin in West Texas, specifically the Delaware and Midland sub-basins, have remained the some of the most active oil plays throughout recent history. But there have also been significant trends towards other Texas hydrocarbon plays during different periods (**Figure 1**). The 1970's and early 80's saw a move towards drilling and producing out of the Austin Chalk, and increases in unconventional completion methods led to the shale boom in the late 2000's and 2010's which paved the way for major exploitation of the Eagle Ford trend.

Various technical and economic conditions have helped shape how and where oil and gas wells have historically been drilled and produced. And now a new environment of technical and economic conditions is forming that will shape the near future of the Texas oil industry. Vast improvements in well planning, drilling, and completion designs have led to highly productive wells and well systems. At the same time, a glut of production and geopolitical price war have cooled prices down to beyond unsustainable lows, paired with the rising capital expenditures of these new and improved drilling and completion techniques. Now, more than ever, the balance between maximizing production and minimizing costs means the difference between success and failure.

This analysis looks at recently drilled wells from the last 5 years in 4 major Texas plays, using criteria to select wells based on the start of production and the basin or formation identifying the play. Wells were restricted to only those that had a calculated first production date of 2015 or later and were then grouped into plays based on either Basin or Formation definition. Then, only the top 20% of wells in each play were selected, using TGS' allocated production and MaxOilPlus2 statistic (90-day oil IP). This final subset of wells was used to calculate type curves and aggregate CAPEX attributes.

The economic analysis was conducted using inputs from the TGS completions attributes to estimate drilling and completion costs, as well as allocated water production and estimated lease operating expenses. This study was forecasted over a 30-year time horizon, calculating NPV and other key economic indicators based on a range of interest rates. Cost estimates were derived from industry publications and operator financial reports, and sales rates were set at pre-slump levels, on the assumption that geopolitical price wars will eventually subside, and market forces will equilibrate.

Figure 2 details the main attributes that were used to derive drilling, completion, and operating estimates, broken down by play. Drilling days, proppant amount, and fracture fluid amounts were

Smart Money: Efficient Investments *continued on page 24*

Smart Money: Efficient Investments During Geopolitical Volatility

continued from page 23

the main drivers of capital expenditures at time 0, while produced water was a main driver of operating costs over the life of the well. As expected, the Permian Basin wells trend towards higher drilling and completions costs, while also producing the highest volume of water. Eagle Ford and Austin Chalk wells tend to be drilled quicker, shallower, and with less hydraulic fracturing costs, while crucially also producing much less water.

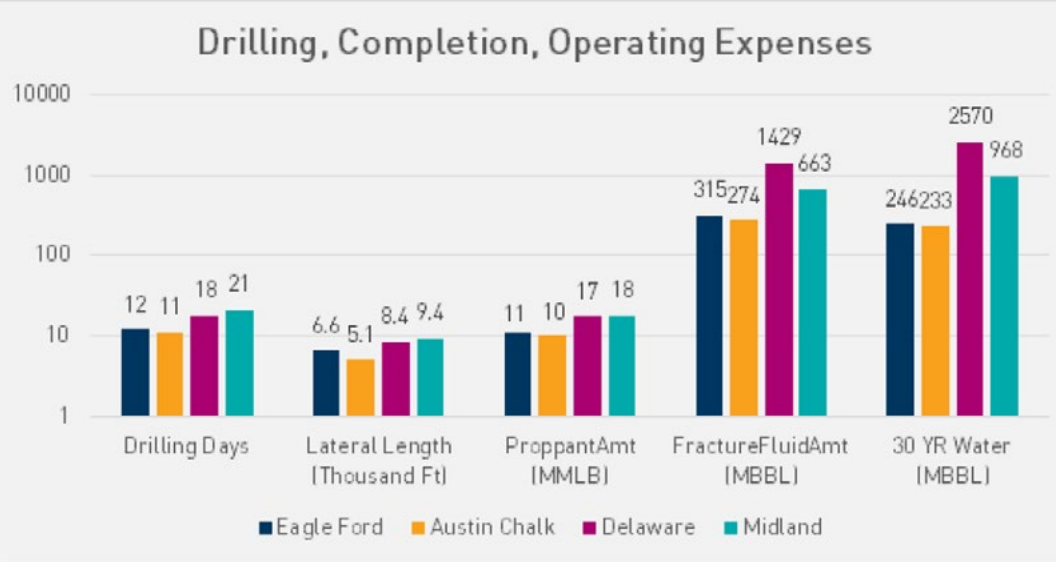


Figure 2: *CAPEX and OPEX drivers by play*

Figure 3 details the oil type curve for each play, calculated using Arps hyperbolic decline curve fit methodology. The B-factors were defined using industry research and public operator reports, while other Arp's coefficients were calculated (within standard boundary constraints) based on observed production histories. In this dataset the Austin Chalk wells tend to produce with the highest IP and initial decline rates, causing them to quickly drop off in production in favor of the Delaware and Midland wells with slightly lower initial declines. Meanwhile, the Eagle Ford wells initially produce with a lower IP but maintain a relatively lower decline throughout the 30-year life of the well.

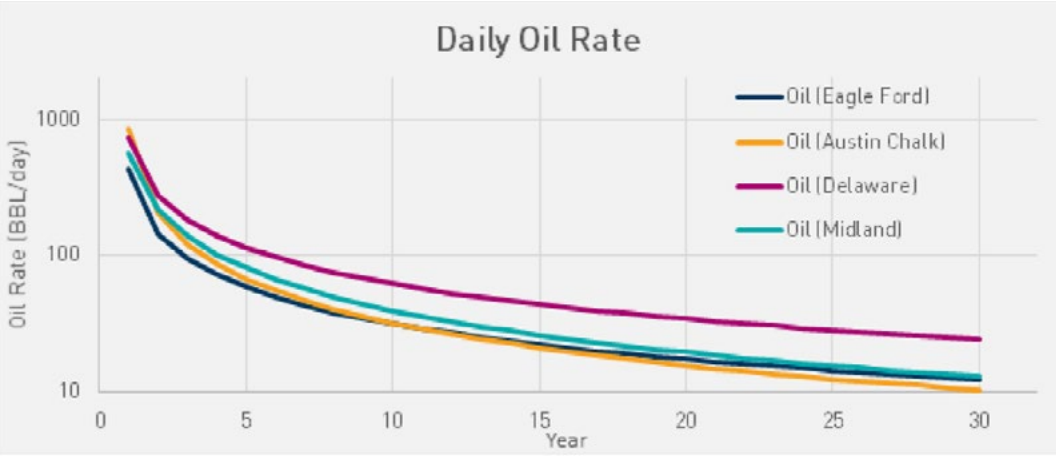


Figure 3: *Forecasted daily oil rates by play*

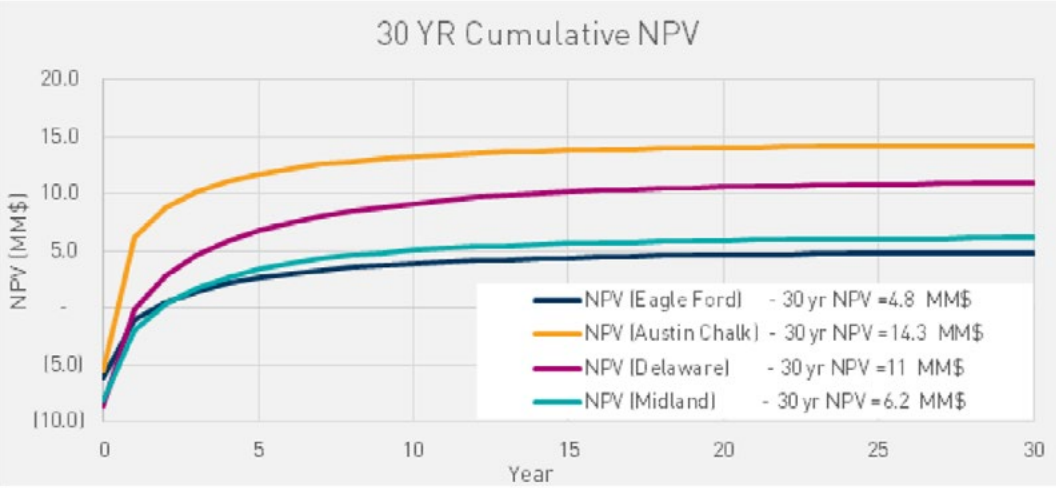


Figure 4: *30 year NVP10 by plat*

Play	PV10 (MM$)	PV15 (MM$)	PV20 (MM$)	PV25 (MM$)	IRR
Eagle Ford	4.8	3.3	2.3	1.5	39%
Austin Chalk	14.3	12.2	10.6	9.4	163%
Delaware	11.0	8.2	6.2	4.8	58%
Midland	6.2	4.2	2.8	1.8	37%

Table 1: *PV economics by play*

Finally, **Figure 4** shows the cumulative NPV10 for each of the 4 play models. The Midland and Delaware models start off with much higher CAPEX, but quickly overtake the less capital-intensive Eagle Ford model with higher production rates. In contrast, the less resource intensive and initially highly productive Austin Chalk model translates into a significantly higher NPV than the other plays, despite the quick drop off in production. As the PV interest rate increases (**Table 1**) this discrepancy only becomes more significant.

Before drawing conclusions from the data there are other facts and assumptions not contained within the model that should be considered. Oil and gas sales prices and water disposal costs were considered static for this analysis, but volatility in the price of oil or the cost of water disposal could lead to significant swings in profitability. As water continues to be produced in high volumes, water disposal costs will continue to rise, leading to much higher long-term operating expenses for plays with higher water production. It's also worth considering the value of investing in stacked target plays versus single target plays. Drilling a well in the Permian with the intent of developing multiple targets, sharing some of the capital expenditures between the targets, could help offset the high initial cost when compared to single target plays like the Eagle Ford and Austin Chalk.

The quantity and quality of acreage available for each of these plays is also worth further consideration. As mentioned earlier, the Permian has been exploited over a long period of time. The highest quality areas of the basin have already been extensively developed, leaving very little quality acreage available for new development, which is reflected both in this study and in consideration for future investment. While prime Eagle Ford acreage is also mostly played out, the Austin Chalk play is spread out over a much wider area, meaning there's potentially still room to identify and develop high quality acreage. Although the selection bias described above does present itself in this analysis, this is the current state of the hydrocarbon environment, and is the framework in which investment decisions should be understood. As the oil price slump drags on, operators will need to consider their asset production profiles in relation to capital and operating costs when determining how to manage current and future assets. ■

Using Time Lapse Geochemistry (TLG) to Understand Fluid Production Changes: A Case Study from the Delaware Basin

By Craig D. Barrie, Catherine M. Donohue, J. Alex Zumberge and John E. Zumberge
GeoMark Research, Houston, TX.

Over the past 5 years there has been a huge increase in the production of crude oil from unconventional shale plays. During this time the major unconventional plays in the USA (e.g. Permian Basin, Anadarko Basin, Eagle Ford) have become some of the world's largest oil producers. However, unlike in 'conventional' exploitation, the target zones in Unconventional systems are generally the source rocks themselves and the wells are horizontal laterals requiring stimulation via hydraulic fracturing. In order to maximize hydrocarbon production operators have developed various well stacking methods, all of which require some form of monitoring to ensure spacing is optimized and fluid production is not being 'stolen' from adjacent formations, thereby reducing production potential in associated wells. This necessity – amongst other geochemical considerations – has resulted in the expansion of 'production allocation' and 'time lapse geochemistry' methods, initially developed for conventional systems, to be applied to these unconventional plays. However, direct applicability of this method to unconventional systems is not straightforward and numerous considerations and limitations need to be taken into account. In this summary paper we will outline the main results and discussion from a case study in the Delaware Basin. The produced oils discussed in this study cover 4 rounds of sampling spread across a 12 month time period and include target zones from the Bone Spring Shale (2) down to the Wolfcamp C Formation with equivalent core to compare against the target zones.

Introduction

Unlike conventional production methods, where vertical wells primarily target migrated fluids in porous reservoir formations, unconventional production involves targeting the source zones directly via horizontal wells which extend laterally, potentially for several miles (*e.g. Ajisafe et al., 2017*). These target zones contain oils locked in tight, low permeability lithologies, and in order to generate economic production the wells need to be stimulated via hydraulic fracturing. The process of hydraulic fracturing creates what is referred to as stimulated rock volume (SRV) across which oil flows, allowing these unconventional systems to be produced. The actual drainage zone is referred to as the drained rock volume (DRV) which is generally smaller than the SRV and is what is being studied via fluid geochemistry. The primary unconventional plays in the USA include multiple unconventional target formations. These formations are generally stratigraphically layered and therefore offer the potential for fluid co-mingling which is geologic in nature but also, and more worrying for operators, a result of the SRV network linking producing formations. Ideally operators attempt to maximize production within individual target zones by assessing the produced fluid from wells post completion, and adjusting completion strategies for new wells based upon this. Therefore, it is important for operators to ask two questions of the data:

1. How is the chemistry of the fluid changing through time and is it trending towards or away from a particular target zone (time lapse geochemistry/production monitoring)?
2. Is there potential for end-member fluid identification and/or quantification (production allocation) of the fluids which are contributing to the production fluid?

Question 1 is straightforward and is the premise behind most of the unconventional time lapse geochemistry studies reported over the last few years (*e.g. Liu et al., 2017; Yang et al., 2019*). Question 2 is much more complicated, and while there are a number of studies which address this capability (*e.g. McCaffery et al., 2010*) it is certainly not a 'one size fits all' strategy. When it comes to allocation, conventional systems have two very crucial items which are generally lacking in unconventionals. Firstly, geochemists have access to end-member produced fluids which are directly equivalent and comparable to the mixed fluids being assessed. Secondly, these systems can be considered largely homogenous and therefore error propagation in mixing models will be low and quantification possible within an acceptable realm of tolerance (usually <5%). Unconventional systems generally lack both of these items. This study aims to address these issues and focuses on the utility of a combination of analytical methods and statistical algorithms to appropriately understand unconventional fluid relationships, mixing and statistically significant changes in production fluid through time.

Geologic Setting

All of the samples discussed are from wells located in Loving, Ward and Winkler Counties of Texas in the Delaware Basin (**Figure 1**).Details on the geological setting and history of the basin can be found in Cook (1966) and others. This study includes

Adapted from: Barrie, C.D., Donohue, C.M. and Zumberge, J.A. 2020. A Statistical Approach to Understanding Fluid Geochemistry Changes in Unconventional Plays. Unconventional Resources Technology Conference held in Austin, Texas, USA, 20-22 July 2020.DOI 10.15530/urtec-2020-2166

oils and core from the Bone Spring 2, Wolfcamp A, B and C formations. It should be noted that operators across the Delaware Basin use variable nomenclature, particularly in the Wolfcamp and associated formations. Therefore, the Wolfcamp A, B and C discussed should be considered equivalent to the Upper, Middle and Lower Wolfcamp (e.g. Schwartz et al., 2015). A total of 74 produced oils from 26 individual wells across 4 separate sampling rounds, within a period of 12 months, were analyzed (September 2018 – September 2019). A total of 15 core samples were selected, based upon target zone information and TOC/Pyrolysis data, from the UL Sugarloaf 20-37 1P pilot well in Winkler County (**Figure 1**).

Results/Discussion

The goal of this project, as is often the goal in these types of studies, was to understand the fluid geochemistry of the wells being analyzed and answer some key questions for the operator:

1. Does the geochemical signature of the fluid differ between the target formations allowing distinct fluid compartments to be defined?
2. Is sub-formation compartmentalization evident indicating multiple potential drainage zones within a single formation?
3. Do the produced oils tie back to the extracted hydrocarbons

Using Time Lapse Geochemistry (TLG) *continued on page 28*

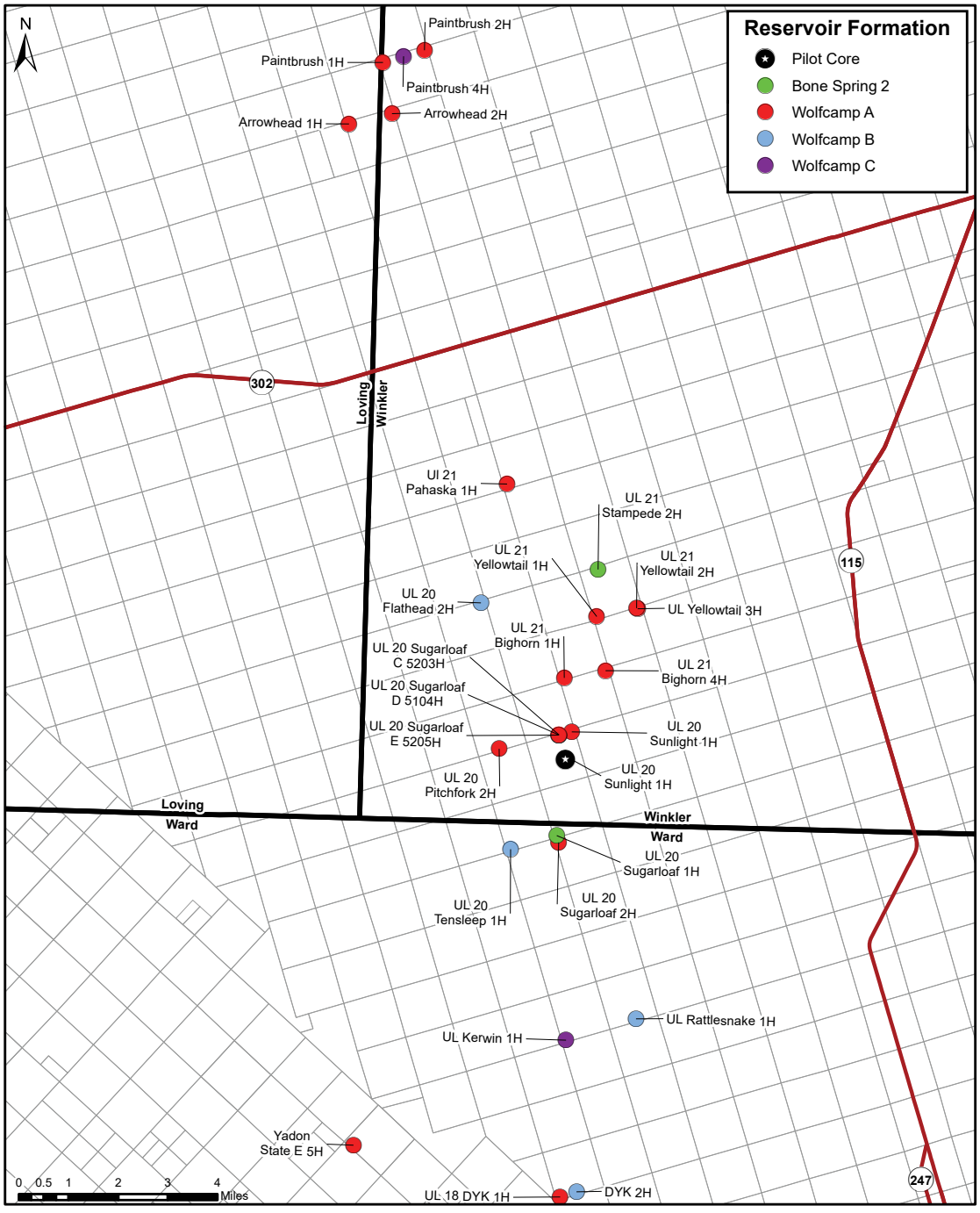


Figure 1: *Location Map for all of the wells/oils analyzed in this case study. The pilot core for the extracted fluids are all from the UL Sugarloaf 20-37 1P well in Winkler County highlighted.*

Using Time Lapse Geochemistry (TLG)

continued from page 27

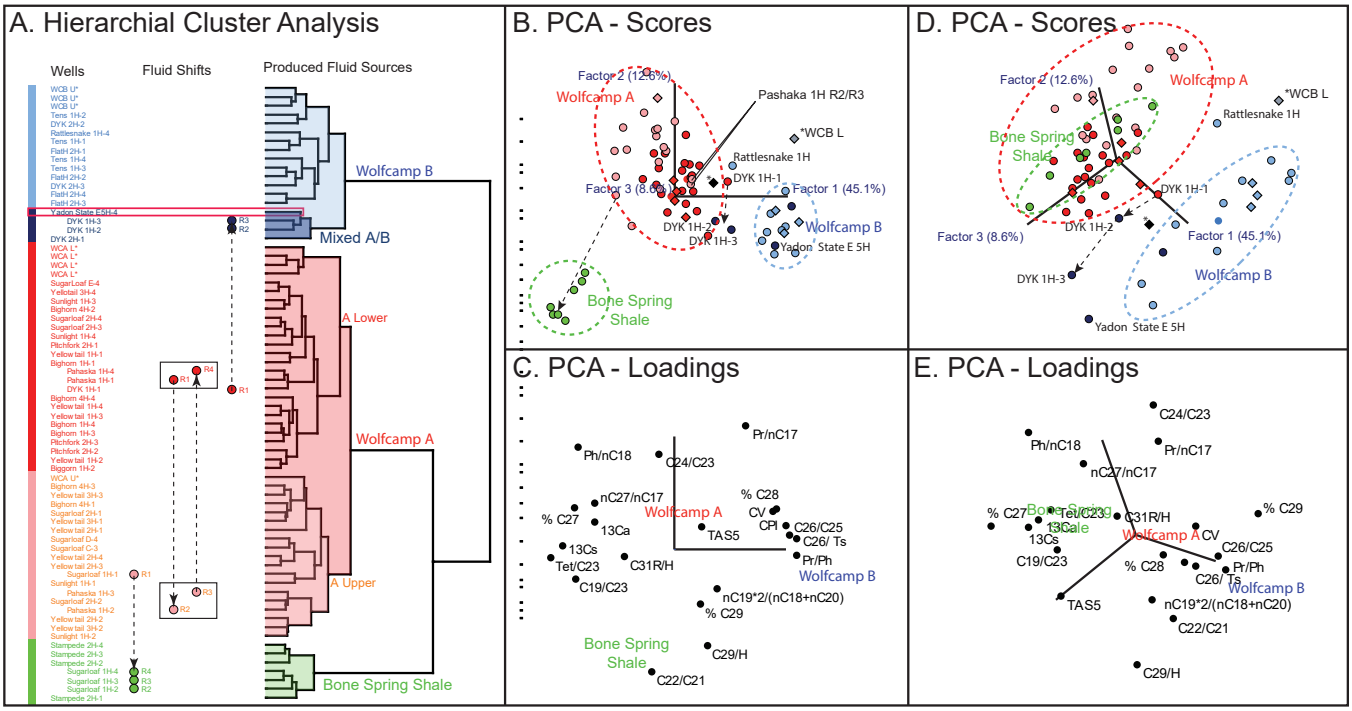


Figure 2: *Statistical diagrams for the core extracts and produced oils analyzed in this study. A. Hierarchical Cluster Analysis (HCA) Dendrogram showing how the oil and extract samples group geochemically. The source of the produced fluids is defined and movement of produced oils between sampling rounds is shown. B. Principal Component Analysis (PCA) scores plots showing the distribution of all of the samples. C. Principal Component Analysis (PCA) loadings plot showing the biomarker ratios which define the scores plots. D. Rotated Principal Component Analysis (PCA) plot. E. Rotated Principal Component Analysis (PCA) loadings plot.*

from the core section and what does that tell us about self-sourcing, migration and potential fluid contributions?

4. Does the fluid signature change through time and if so what does it relate to: (A) geologic pathways, or (B) co-mingling as a result of SRV and therefore DRV connectivity?

All of these questions are designed to help the operator properly define the DRV across target zones in their acreage and determine, in combination with other data, whether they are effectively draining their target zones and therefore how appropriate or otherwise their well spacing design is.

All of the samples in this study were analyzed through a full suite of geochemical techniques (e.g. API gravity, SARA, Isotopes, Gas Chromatography, biomarkers, etc). Assessment of the 1st round of produced oils indicated three distinct geochemical fluid signatures which correlated back to the proposed landing zones (Bone Spring 2, WC A and WC B). The 2nd round of produced oils, covering the same wells revealed the same overall picture, except one of the Bone Spring Shale landed wells showed a shift in its geochemical signature. This shift indicated that during the 1st round of sampling this well (Sugarloaf 1H) was a co-mingled Bone Spring 2/Wolfcamp A well in round 1 but shifted to a dominant Bone Spring 2 oil in round 2. This suggested that the SRV for this well covered both target zones and the DRV in round 1 included WC A input which was cut off some time prior to round 2. All of the other wells showed no change in their fluid signature between the first 2 sampling rounds. The addition of core extracts from these formations helped better define the fluid signatures associated with the landing zones and confirm the initial co-mingled nature of the 1st round Sugarloaf 1H sample.

Additional sampling rounds revealed minimal fluid changes in the existing wells, while the addition of new wells from across the acreage helped to confirm and expand the compartmentalization observations. A number of wells in the southerly section of the study area also did not conform to either the core extract fluid family distributions or the equivalent correlation in the other produced oils. These samples were all Wolfcamp A landed wells, yet were geochemically ambivalent statistically clustering between the two fluid sources. Unlike the Sugarloaf 1H well these wells were stable in their fluid signature rather than showing a trend through time. While co-mingling due to SRV/DRV distribution could explain these signatures, all of the 'mixed' wells were in an area known to contain geologic fracture systems through both the WC A and B formations. It was therefore proposed, particularly given the wells evident geochemical stability, that these wells represented geologic rather than produced induced co-mingled fluids. After four rounds of sampling, 4 distinct fluid groups were evident in this study area, three associated with the defined landing zones: Bone Spring 2, Wolfcamp A and Wolfcamp B and 1 resulting from a geologic mix of Wolfcamp A and B fluids (**Figures 2, 3**). Core

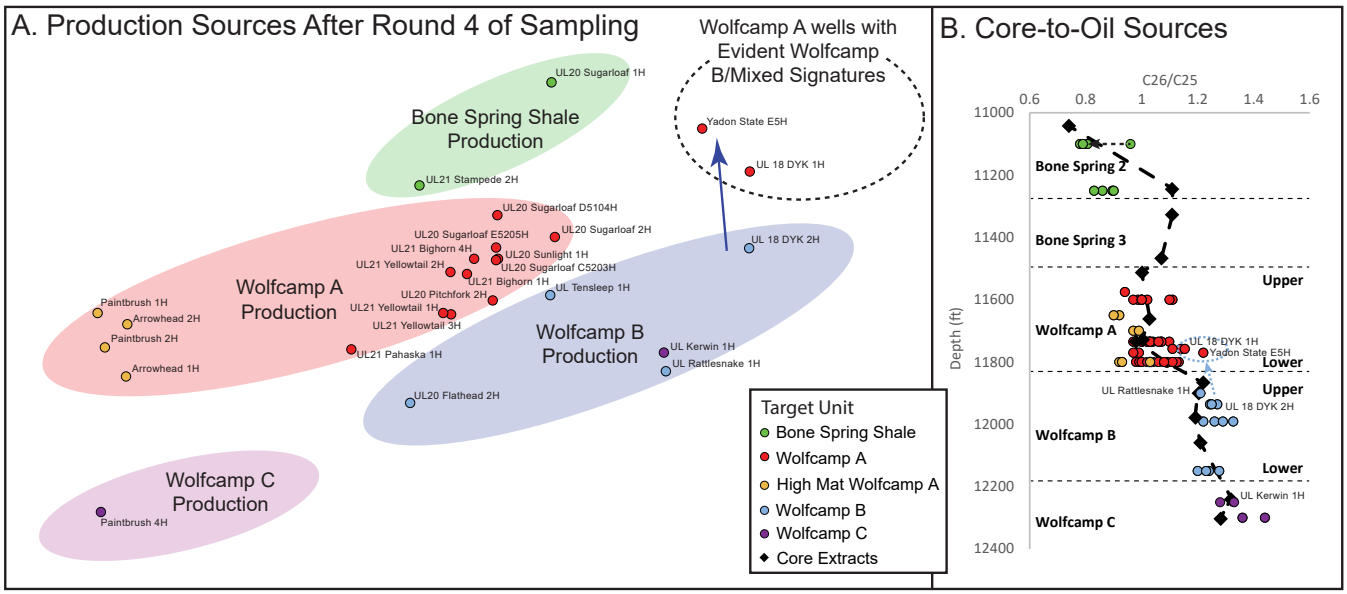


Figure 3: *Summary diagrams highlighting the production sources across all of the wells analyzed after all sampling rounds were completed (A) and fluid distribution, relative to the core, through time (B).*

extracts were used in this study to help correlate produced oils back to the production zones but, that is not the same as allocation, since that terms assumes an 'end-member' relationship in the data. That is not to say that allocation could not have been undertaken, it could, but there is evident and in some cases very significant stratigraphic and lateral variability in the geochemical signatures within individual production zones. Therefore, any quantified assignments would carry significant error bars, potentially larger than the assigned contributions.

Conclusions

The geochemical results from the produced oils and extracted core fluids forming this study suggest the following points should be borne in mind when attempting such a project:

1. The dynamic and heterogenic nature of unconventional formations means a simple, one size fits all approach, and direct adaption of methodologies developed for conventional systems, is not the best approach to further understanding of production fluids.
2. Core fluid extracts provide valuable information on general correlations between fluid production and landed target formations. However, as is evident, these relationships are limited in scope and should not be the lynch pin upon which these studies are based. Produced oils are the key.
3. Identification of co-mingled production fluids, due to hydraulic fracturing and well spacing, is crucial. However, accurate contribution quantification is extremely complicated in unconventional systems. The mathematics forming the basis of un-mixing algorithms are relatively simple, it is the dynamics of the systems themselves which are complicated.
4. The geologically and geochemically robust approach to understanding these systems through time is to statistically assess the fluids and look for statistically significant shifts in fluid geochemistry. ■

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William Goldsby
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Scott McDonough
James Rine
Jack Schneider

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Nicholas Dusak

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David Hoyt
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Ramiro Pierin
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Geoffrey Davis
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Rao Yalamanchili

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Alexis Carrillo
Mackenzie Flynn
Patrick Wagner

Welcome New Members

Remembrance

Bruce L. Byrd, Jr.

Bruce L. Byrd, Jr. passed away at age 73 on June 11, 2020 after a battle with pancreatic cancer. He was a scientist and an entrepreneur, a patriot, a teller of some good ghost stories, and a reasonably good cook. His office was sometimes messy but he always knew where to find things.

Bruce was born in Detroit Michigan on a cold icy morning on January 16,1947. In 1953 a family move took him to Richmond, Virginia where he was a 1965 graduate of Hermitage High School.

Bruce was a US Air Force veteran and flew 141 combat missions on Special Operations gunships in Southeast Asia – he was awarded four Distinguished Flying Crosses, nine Air Medals, and the Vietnam Cross of Gallantry.

He graduated with a BS degree in Geology from Virginia Tech in 1974 and worked as a Geophysicist and Geologist for several oil and gas companies in Texas, West Virginia, and Colorado. In 1981 he earned an MBA degree from the University of Denver and later opened his own petroleum exploration consulting company – Dune International. He was an Emeritus member of the American Association of Petroleum Geologists and the Society of Exploration Geophysicists, as well as several other professional petroleum organizations.

Bruce played guitar since his teens and loved bluegrass music, salt water fishing out in the Gulf, hiking and camping in the Rockies, anything to do with Einstein and astronomy, and a cold beer or a good single malt Scotch whisky. Maybe not in that exact order.

He loved to travel and his work often took him on trips to Europe, Africa, Asia, Australia, and the Middle East. At last count he had set foot in some 66 countries – some exotic, some dangerous, but all interesting and full of new things to experience. Bruce worked on a number of U.S. and worldwide exploration and development projects for public and private companies, and foreign government agencies.

Bruce is survived by his wonderful loving wife Jo Anna, 3 daughters – (Rhonda, Columbus OH; Jennie, New Orleans and Ashley, Houston) and 4 grandchildren (Michael, Conrad, Macallan and Reese). Also surviving are his loving mother Mildred, sister Gail, brother Greg and niece Gina Cannella Romer. His father Bruce Byrd Sr. predeceased him in 1982.

"I've had a really good and full life – so no flowers and no tears, please. Instead just have a sip of a nice cold beer on a warm sunny afternoon and think about the good times we shared", Bruce Byrd Jr. ■

Remembrance

Donald Booth Clutterbuck
1929-2020

Donald Booth Clutterbuck, 91, was born on March 3, 1929 in Beaumont, Texas to Donald James and Catherine Booth Clutterbuck. Don spent his formative years in Beaumont, Texas and Tulsa, Oklahoma. He graduated from Marquette High School in Tulsa in 1947, where he was class president for three years and was remembered for his ready smile and friendliness. In 1951, Don graduated from Marquette University in Milwaukee, Wisconsin.

Following several months as a roustabout in the oil fields of West Texas, he then reported to the Navy Officer Candidate School in Newport, Rhode Island. Don served 3½ years in the Navy aboard the Destroyer Escort *USS LeRay Wilson*, based out of San Diego. Early on in San Diego, Don met LaDonna Marie Bicknese, "a spirited and beautiful young lady from Minnesota" he once wrote, who had moved to California to teach elementary school. They soon engaged and married in July 1954 on the Naval Air Station in Coronado, California.

Following his discharge from the Navy, the couple moved to Austin, Texas, where Don earned a M.A. in Geology at the University of Texas. He then went to work for Shell Oil Company for 10 years, living with LaDonna in Midland, Del Rio, and Corpus Christi, Texas; and Santa Fe, New Mexico. He later enjoyed a long career working for several independent oil & gas companies, ultimately serving in Senior VP, President, and COO roles with Inexco, McCormick, Tipperary, OXOCO, RPI and AFG Energy. After moving to Houston in 1965, Don and LaDonna would live there (with a one-year sojourn in Denver, Colorado) for 55 years.

Don retired in 1999 and spent much of his free time volunteering at the Houston Museum of Natural Science. Don was an enthusiastic docent, sharing his love of geology at his much-loved Weiss Energy Hall and in the Cullen Hall of Gems and Minerals, and educating himself and the public about special exhibits as diverse as the Titanic, the Vikings and the world's largest Russian Faberge Egg collection. His 15 years of volunteer service there won him many accolades and friends with whom he had engaging lunches.

Don was a longtime member of both the Houston Geological Society and the Petroleum Club, where he served on the Board for many years as well as a term as President. Don joined HGS in 1/1/58.

Don was preceded in death by his wife LaDonna, He is survived by his sons John Clutterbuck (wife Anne) and Jim Clutterbuck, and his beloved grandchildren, Caroline, William, Miles and Zoe. A private memorial service will be held later in Houston, Texas. In lieu of flowers, the family suggests that donations be made to the Houston Museum of Natural Science.

Remembrance

Richard Dale "Ricky" Cook
1952-2020

Richard "Ricky" Cook was a longtime resident of Houston, Texas. He lived a full and purposeful life from 7/17/52 to 8/11/2020. Ricky graduated from the University of Texas with a degree in Geology in1976. He settled in Houston and started his first and last job as a geologist at Pennzoil, later becoming Devon Energy. Ricky joined the Houston Geological Society on 03/01/1987.

He was a loving and devoted father and recent grandfather who always made spending time with them a priority. Ricky made friends wherever he went and had many interests including live music, the Hill Country, happy hours with friends, music cruises, walking his dogs, spending time in prayer, and playing his trumpet. One of his greatest joys was playing trumpet in several bands including the Lone Star Symphonic band.

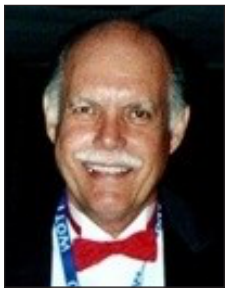
He is survived by his son Cody Cook, brothers David and Brian Cook, grandson Jackson Cook, and girlfriend Kaydee Cooper. ■

Summarized from Life Tributes section of the *Houston Chronicle* on 08/13/2020

Remembrance

Remembrance

Harry Max Jr.
1936-2020



On Saturday, July 25, 2020, **Harry Max Jr.,** loving husband and father of three children, passed away at the age of 84.

Harry was born December 30, 1936, in Tifton, Georgia to Harry Max Sr. and Beatrice Max. He received his geology degree from Texas A&M University in 1959, and worked in the oil industry for 61 years in Houston and numerous countries overseas. In August, 1957 he married Mary Katherine Kester. They raised three daughters, Kathy, Marlene and Beth.

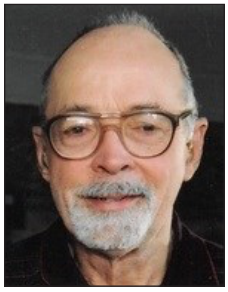
He is survived by his wife of 62 years, Katherine, his three daughters, his brother Larry, seven grandchildren and two great grandchildren.

He enjoyed tennis, racket ball, golf, poker, ranching and spending time with family and friends. He was loved and will be greatly missed. ■

Summarized from the Life Tributes section of the *Houston Chronicle* on July 30, 2020.

Remembrance

Raymond Wallace Knapp
1935-2020



Raymond Wallace Knapp beloved only child of teacher/first-day cover artist Dorothy Apt Knapp and teacher/ornithologist Maxwell Knapp, passed away peacefully in his sleep on Monday, August 10th, 2020. He was born in Rhinebeck, New York in November of 1935.

Wally's love of nature and rock collecting inspired him to study geology at Rensselaer Polytechnic Institute in Troy, New York. Upon graduation he was recruited by Shell Oil, completing their training in locations throughout the American West. During the heyday of the oil boom Wally moved to Houston to work as a petroleum geologist for Amoco and met his wife Mary. They settled in West University Place where they raised two daughters.

A long-time member of the Houston Gem and Mineral Society and supporter of the acquisition of The Perkins and Ann Sams Mineral Collection at the Houston Museum of Natural Science, Wally also acquired and maintained an impressive personal collection, which he happily shared with others. A lover of poetry, he wrote and published two collections of poems. Wally was a loving and generous father who enjoyed travels with his family throughout the United States and abroad. Despite a disabling early loss of hearing, he retained his love of people, an indefatigable spirit, and a wonderful sense of humor.

Wally is survived by his wife, Mary Knapp, daughters Anne-Marie Knapp Hoyle (Jonathan) and Lillie Knapp Hebert (Todd) and three grandchildren: Isaac Hoyle, who inherited his gregarious nature; Oliver Hebert, who inherited his love of collecting; and Dottie Hebert, who inherited his "punny" sense of humor. He also leaves behind many dear relations and lifelong friends. The family is grateful to Wally's long-time caregiver Bobbie Rochelle. ■

"The memory turns back –
Of romps through morning meadow's dew;
A seed of spirit that would always be.
So naturally I thought of you,
Who held my hand – and taught me to be free."

Wally Knapp, *The Seedlings Gather Gold*

Reported in the August 22, 2020 Life Tributes section of the *Houston Chronicle*

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

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

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