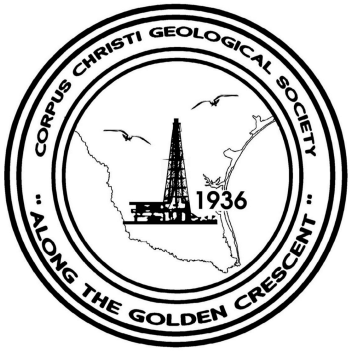
# BULLETIN

## Corpus Christi Geological Society




**and**

## Coastal Bend Geophysical Society


**May**
**2020**
**ISSN 0739 5620**

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# Table of Contents

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**P.O. BOX 1068* C.C.TX. 78403**
**2019-2020**
**www.ccgeo.org**

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**2017-2018**

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# Visit the geological web site at www.ccgeo.org

# CCGS/CBGS JOINT MEETING SCHEDULE 2019-2020

**September 2019**

| S | M | T | W | Th | F | S |
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**October 2019**

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**November 2019**

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Thursday, Sept. 26th at 5:30-8:00p.m. Kickoff at Hoegemeyer's Barbeque Barn.

12-1:00pm
Speakers: Richard Parker Geophysicist w/Schlumberger
Edgar Velez geomechanics domain champion for the western hemisphere

11:30-l:00 pm
Speaker: Dr. Neil Bockoven "Early Human Interactions & Migrations—Three Mysteries"

**December 2019**

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**January 2020**

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**February 2020**

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12-1:00pm
Speaker: Peter M. Duncan President & CEO of Micro-Seismic, Inc. "Frac-Driven Interactions & Well Spacing: A Microseismic Perspective

11:30am-1:00pm
Speaker: SEG Distinguished Lecturer, Sergey Fomel—University Texas, Austin. "Automating Seismic data analysis and interpretation.

# CCGS/CBGS Joint Meeting Schedule 2019-2020

| March 2020 | | | | | | |
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| April 2020 | | | | | | |
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| May 2020 | | | | | | |
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| 31 | | | | | | |

Dr. Charles Puryear-Senior Research Geophysicist at Multi-Physics Technologies. "Spectral Extrapolation & Acoustic Inversion for the Characterization of an Ultra-thin Reservoir."
**MARCH 26: MEMBERS MEETING NUECES BREWING 6:30PM**

Canceled due to Coronavirus

Canceled due to Coronavirus

# Calendar of Meetings and Events

## Calendar of Area Monthly Meetings

Corpus Christi Geological/Geophysical Society..... Third Wed.—11:30a.m.
SIPES Corpus Christi Luncheons..... Last Tues.—11:30a.m.
South Texas Geological Society Luncheons..... Second Wed—noon San Antonio
San Antonio Geophysical Society Meetings..... Fourth Tuesday
Austin Geological Society..... First Monday
Houston Geological Society Luncheons..... Last Wednesday
Central Texas Section of Society of Mining, Metalllurgy & Exp..... 2nd Tues every other month in San Antonio


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# SPONSORS

President's Letter – COVID19 Edition (May 2020)
By Randy Bissell
April 7, 2020

From a bunker somewhere in Corpus Christi, Texas

First, to let everyone know Austin Nye is fine – we spoke recently, and I offered to pen this month's President's Letter. No worries, there has been no ascension to the throne, hostile takeover, or coup – but if YOU really want that President job, we can arrange something.

COVID19 or Coronavirus Pandemic is certainly changing everything we thought we'd expect from 2020. By the time this is published in late April, it will have been a 5-week pause in American society.

At this writing in early April 2020, 1000 people a day are dying in the US. Remember those families.

The oil business is wrecked at $21.50 a barrel. Funny is the day when $1.70 natura1 gas seems a good price. But gas is getting shut in because of the oil glut – you see, nobody wants the condensate.

It should be no surprise that the May Luncheon Meeting is canceled. Darn near everything else is! We will just have that wonderful speaker in November at our first luncheon of the next season.

**Next season.** The Board Officers have requested that everyone stay in their positions into next year just to keep things going. Of course, what 2020-21 looks like will be determined by the trajectory of COVID19 and our country, state, county, and city. We can be hopeful that normalcy will return, but all of that seems so uncertain today.

To speak with any certainty is fraught with peril, but there are some ideas about what next year's calendar will look like.

The 2020-21 (Planned) CCGS Calendar

| | |
|---|---|
| Late Sept-Early October | KICKOFF MTG./BBQ |
| November Luncheon | Technical Talk on Geology |
| January Luncheon | Technical Talk on Geophysics |
| February Lunch-n-Learn | Technology B.Y.O.L. |
| March | Called Members Meeting |
| April Luncheon | Collegiate Month |
| May Luncheon (Tentative) | Special Speaker if Available |

In summary, that means:

- One evening BBQ to kick things off
- Three or four luncheons at Water Street
- One B.Y.O.L. Presentation (bring your own lunch) somewhere.
- One evening's gathering of members to discuss plans for next Society year.

For years we have been soliciting volunteers to help us run the Society through our summer dues mailouts, bulletin ads, and emails. To those who have answered the call, thank you for making the Society work.

As I have said before, we have a solid roll of members, regular meetings, money in the bank, funded foundations to do good, and a general friendliness amongst us. Our guest speakers always mention how great it is to come to Corpus Christi – I am proud to be a part of this Society (and since 1985!)

Times are a'changing. Your Board talks about right-sizing the management and activities of the Society. We want what we do to fit within a niche of value to our members.

Remembering that we are not the CBGS, which exists as a chapter of the SEG to advocate for the education and utility of geophysics.

We are not SIPES. As SIPES is multi-disciplined and oriented towards established independent professional businesses.

We are not the Exploration Managers which meet to facilitate closer networking of independent geologists.

We ARE the **Corpus Christi Geological Society**, shaped by an *inclusive* mission to all practicing professionals, earth science educators, interested individuals, and students.

Many in the CCGS are members of SIPES, the CBGS, and attend Exploration Managers lunches. The best role of the CCGS is to compliment the aims of our fellow groups, not to compete with them or overlap missions. To the degree that we can combine meetings, tech talks, and socials, we need to be innovative. Alignment of our efforts is a practical necessity, perhaps post-COVID19 more than ever.

Before I close, a few more important things come to mind.

1) You've noticed we now use Constant Contact for emailing Society news. And I've noticed that only 50% of you *actually* open those emails. Fewer than half open the Bulletin.
2) Bulletins will only be available ONLINE for May. Those who have a printed Bulletin subscription might notice that little icon on Adobe PDF Viewer that looks like a printer. Press that and one gets delivered to your home instantly. Because of COVID19, we are just NOT handling bulk mail at the Post Office. If you demand some kind of refund, just talk to me.
3) Printed Bulletins *may* not get offered in 2020-21.
4) The Directory Issue of the Bulletin will be done in December – we need help to spearhead that if anyone is interested.
5) Dues will be solicited *normally* this summer with a package for you to return with dues OR you can pay dues online.
6) For 2021-22, we will likely go to a postcard reminder for you to pay CCGS/CBGS dues online only and provide updated info via an email address.
7) Dues remain $25 for each organization.

Quite the letter and I am not even the President!

If you know me well, hopefully you know me as a person of enthusiasm about Earth Science and a strong conviction to conduct it with excellence. But I want to share that I am also a person of faith. I have faith in America's foundation of

Liberty – faith in science's ability to contribute to our good – faith in the pluck of our people to endure and thrive – and faith in God to see us through this test.

What I believe will emerge is a better America, better science, better people, stronger families, and a better CCGS.

That, my friends, is my personal hope for all of us.

God Bless,

Randy Bissell
CCGS Board & Membership Chairman

# Scholarship Awards April 2020

The Corpus Christi Geological Society awarded $6,500 in scholarships to 8 local students from TAMU-CC and TAMU-K in April 2020. These scholarships are to be used for the Summer and Fall 2020 semesters. Congratulations to:

TAMU-K
Christiano Irving, BS Geology
Taylor Palmer, BS Geology

TAMUCC
Hunter Gomez, BS Geology
Loren Walker, BS Geology
Lauren Williams, BS Environmental Science
Michael Haley, MS Environmental Science
Ryan Turner, MS Geochemistry
Derry Xu, MS Chemistry

Normally, awards would be presented during the regularly scheduled April meeting. Since the April and May meetings have been cancelled, we do not have the honor of meeting these students in person. Given the unusual times of social distancing and work from home orders, these students have had to be innovative in finishing their course work and finding acceptable alternatives for field camps that were cancelled due to the CoVid-19 pandemic. I congratulate them.

The CCGS Scholarship fund receives donations from member contributions, the CCGS Golf Tournament, the CCGS Pub Crawl, the CCGS Fishing Tournament, and the Corpus Christi Oilman's Tennis Tournament. These donations are vital to allow the committee to fund the scholarships for our students. Every donation is very much appreciated.

Again, due to the current pandemic, we have cancelled the annual CCGS Golf Tournament and Pub Crawl. If possible, these events will be rescheduled later in the year.

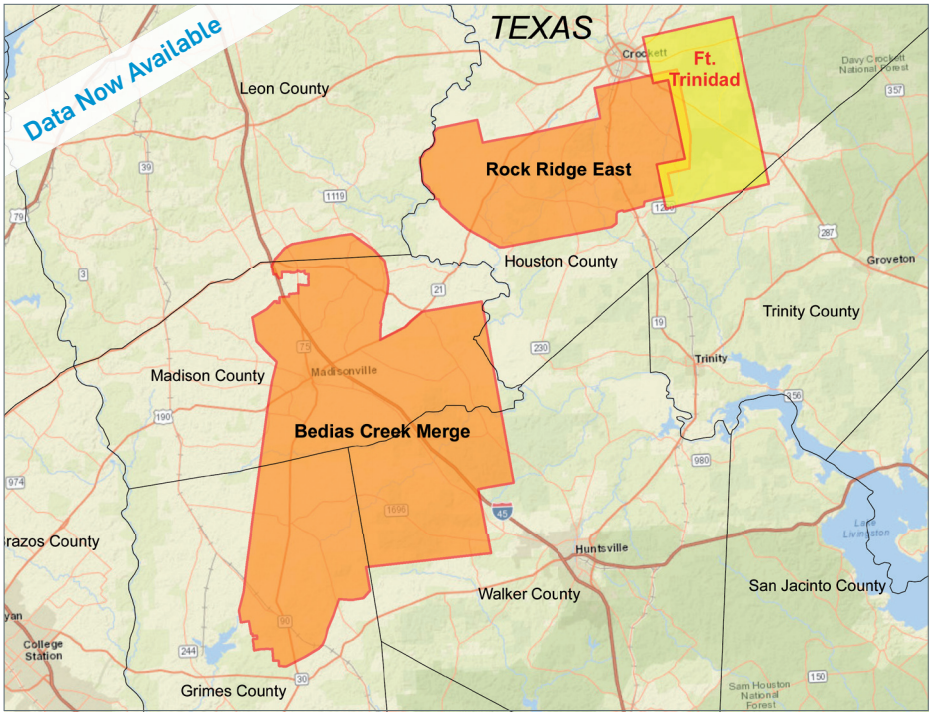
Much appreciation to Nye Exploration and Dawson Recycling of Gregory. These companies had sent in sponsor checks for the golf tournament, but donated their sponsorship to the scholarship fund even though the tournament was cancelled. Many thanks to Fermin Munoz for organizing the golf tournament and to BJ Thompson for organizing the pub crawl! A lot of planning had been done by both of these gentlemen.

The Scholarship Committee members are:
Brent Hopkins, Treasurer; Austin Nye, CCGS President
BJ Thompson, Sebastian Wiedmann, and Casey Mibb, Members

Dawn S. Bissell
Scholarship Committee

YOU'VE ARRIVED

# New Ft. Trinidad 3D Survey
## Houston and Trinity Counties, TX




CGG continues to expand its East Texas footprint with high-quality 3D projects while illuminating the stacked pay formations.

Data is already available from our Bedias Creek Merge and Rock Ridge East projects. Orthorhombic PSTM from our newest project Ft. Trinidad is also now available.

**The right data, in the right place, at the right time**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scott.tinley@cgg.com

Cheryl Oxsheer
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cgg.com/ROP

CGG
Passion for Geoscience

## CBGS President's Letter

**CBGS Board 2019-2020**

Dr. Subbarao Yelisetti- President
Samara Omar- Vice President
Erik Scott- Secretary/ Treasurer
Matt Hammer - Scholarship Chair
Mark Wiley - Golf Chair
Education – Robert Schneider
Monica Estrada – TAMUK student representative
Ryan Turner-TAMUCC student representative

**CBGS Scholarships**

The Coastal Bend Geophysical Society (CBGS) has donated $10,000 to the Department of Physics and Geosciences, Texas A&M University-Kingsville in support of the multidisciplinary Petrophysics Graduate Program that has been requested. These funds will be used as scholarships in attracting quality graduate students.

The board awarded three scholarships of $2,000 each to undergraduate geophysics majors from Texas A&M University-College Station, University of Houston and Texas A&M University-Kingsville. We will be awarding the scholarships again this year.

**Scholarship Requirements**

Criteria for awarding the Scholarship from Coastal Bend Geophysical Society of Corpus Christi, Texas:

1. Scholarships are open to undergraduate or graduate students.
2. Must have declared major in Geophysics, or Geology with a concentration in Geophysics or Petrophysics.
3. Preference is given to students attending Coastal Bend schools (TAMU-K, TAMU-CC and Del Mar College), then to Coastal Bend natives attending other universities.
4. Must have a GPA of at least 3.0 and be in good standing with the school.
5. Must make effort to attend a Coastal Bend Geophysical Society Meeting in Corpus Christi Texas after being awarded a scholarship to be recognized by the society.

**News**

- According to the U.S. Energy Information Administration, U.S. shale oil output is expected to drop by 194,000 barrels per day (bpd) in April as producers reduce drilling activity after oil prices plunged.
- Crude oil prices dropped by more than 65% in the first quarter as demand plummeted due to the coronavirus pandemic and supply ballooned due to a price war between Saudi Arabia and Russia, as reported by Devika Krishna Kumar and Scott DiSavino on reuters.com.
- At the time of writing this report, U.S. natural gas output was projected to drop to 83.2 billion cubic feet per day (bcfd) in May, as reported by Devika Krishna Kumar and Scott DiSavino on reuters.com.

**CBGS Business**

CBGS currently has 43 active members, 4 honorary members, and 40 student members. Raised $1,200 towards student scholarships through membership revenue.

**CBGS workshops/talks**

CBGS organized **2020 SEG Distinguished Lecture** entitled "*Automating seismic data analysis and interpretation*" by Sergey Fomel on February, 11th, 2020, from 11:30 am -12:30 pm. Sergey's biography and abstract can be found at https://seg.org/Education/Lectures/Distinguished-Lectures/2020-DL-Fomel

CBGS has also hosted another lecture entitled *"Spectral Extrapolation and Acoustic Inversion for the Characterization of An Ultra-thin Reservoir"* by Charles Puryear on March 4th, 12-1 pm.

CBGS is looking forward to offer workshops/talks in the future. Topic/speaker suggestions are welcome. Email your suggestions to Samara_Omar@eogresources.com or Subbarao.Yelisetti@tamuk.edu

**Golf Tournament**

CBGS organized its annual **Golf Tournament** to fund its scholarship program in the first week of October, 2019 at Northshore Country Club. Raised ~$1,600 for the scholarship fund.
If you are interested in our next Golf Tournament, please contact Mark Wiley at Mark_Wiley@eogresources.com

**New Degree Tracks at TAMUK and Graduate Scholarships**

- Texas A&M University-Kingsville (TAMUK) started its first cohort of MS Petrophysics program in Fall 2018. If you are interested in joining this program in Fall 2020, please contact the graduate coordinator for MS in Petrophysics, Dr. Subbarao Yelisetti at Subbarao.Yelisetti@tamuk.edu.
- Texas A&M University-Kingsville is offering **$1000 scholarships** to TAMUK graduates who plan to join a graduate program at TAMUK in Fall, 2020, including the M.S. in

Petrophysics in the Department of Physics and Geosciences. It is not just for May graduates but any graduate of TAMUK is eligible for this award if they join the Petrophysics program in the Fall, 2020. It will automatically be applied to the student's account – so you do not need to apply or anything to get it. The Department of Physics and Geosciences also has other scholarships. For additional details about the program and scholarships, please visit the website: https://www.tamuk.edu/artsci/departments/phge/phys/academics/gp.html

- **BS degree in Geophysics, Minor in Geophysics and Certification in Geophysics** offered at Texas A&M University-Kingsville since Fall 2017. Interested students can contact Dr. Subbarao Yelisetti (Subbarao.Yelisetti@tamuk.edu) for additional information.

## Education/Events

### -SEG

SEG 2020 annual meeting will be held in Houston, TX from Oct 11-16th. See https://seg.org/AM/2020/ for additional details.

See https://seg.org/Education/Lectures/Distinguished-Lectures for information about upcoming SEG distinguished lecture in Houston and other locations.

See https://seg.org/Education/Lectures/Honorary-Lectures for SEG honorary lecture locations in Texas.

### -AGU

2020 Fall AGU annual meeting will be held in San Francisco, CA from December 7-11th, 2020. https://fallmeeting.agu.org/2018/future-meetings/

## Monthly Saying

"You can fill your gas tank at the Jordan-Iraq border crossing for 10 cents" - not sure whether that's Cdn or US! (Bob Bain, CSPG International Division Presentation, Feb 20th, 2001).

## Monthly Summary

| Texas Oil and Gas Info | Current Month | Last Month | Difference | |
|---|---|---|---|---|
| **Texas Production** | **MMBO/BCF** | **MMBO/BCF** | **MMBO/BCF** | |
| Oil | 135.5 | 135.0 | 0.5 | December |
| Condensate | 18.4 | 18.0 | 0.4 | December |
| Gas | 805.5 | 792.9 | 12.6 | December |
| | **Current Month** | **Yr to date - 2020** | **Yr to date - 2019** | |
| **Texas Drilling Permits** | 744 | 2772 | 3395 | March |
| Oil wells | 189 | 702 | 963 | March |
| Gas wells | 43 | 154 | 241 | March |
| Oil and Gas wells | 468 | 1794 | 1954 | March |
| Other | 4 | 11 | 29 | March |
| **Total Completions** | 2177 | 5407 | 4807 | March |
| Oil Completions | 1699 | 4278 | 3621 | March |
| Gas Completions | 478 | 1129 | 1186 | March |
| New Field Discoveries | 0 | 1 | 9 | March |
| Other | 725 | 1763 | 1765 | March |

Subbarao Yelisetti
President, CBGS


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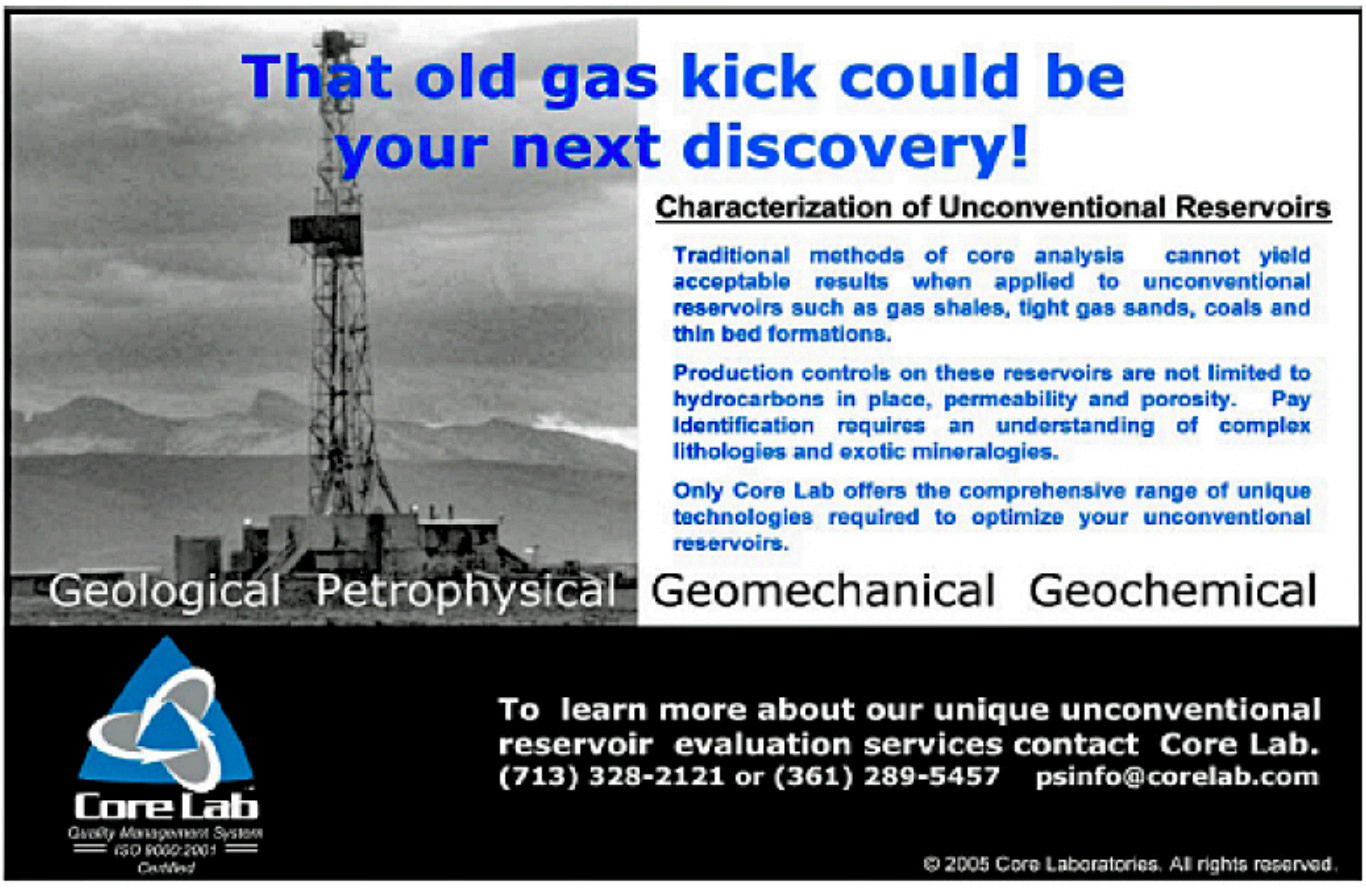

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U.S. Gulf Coast Petroleum Systems Project

# Assessment of Undiscovered Conventional Oil and Gas Resources in the Downdip Paleogene Formations, U.S. Gulf Coast, 2017

Using a geology-based assessment methodology, the U.S. Geological Survey estimated mean undiscovered, technically recoverable conventional resources of 100 million barrels of oil and 16.5 trillion cubic feet of gas in the downdip Paleogene formations in onshore lands and State waters of the U.S. Gulf Coast region.

## Introduction

The U.S. Geological Survey (USGS) assessed undiscovered, technically recoverable oil and gas resources in the conventional sandstone reservoirs of downdip Paleogene formations deposited along an arcuate extent from south Texas through Louisiana (Salvador, 1991). The USGS conducts geology-based assessments of undiscovered petroleum resources by evaluating components of a total petroleum system (TPS), including source and reservoir rocks, seals and traps, and petroleum products geohistory. The interval assessed here is part of the Upper Jurassic–Cretaceous–Tertiary Composite TPS from Warwick and others (2007) in onshore lands and State waters of the U.S. Gulf Coast region (fig. 1). Within a TPS, strata in an assessment unit (AU) share similar stratigraphic, structural, and petroleum-charge histories. In this update of previous assessment work (Schenk and Viger, 1996; Dubiel and others, 2007), the USGS outlined 11 such AUs in the downdip Paleogene formations of the TPS (fig. 1). Eight AUs for conventional resources were quantitatively assessed, and three AUs for continuous (unconventional) resources were not quantitatively assessed.

## Geologic Model for Assessment

Potential reservoirs in downdip Paleogene formations may exist as deep as 30,000 feet and may include paleoslope sandstones deposited as incised channel fills, slope fan channels, and ponded turbidites in intraslope minibasins. A paleoslope depositional environment was modeled for the AUs based on the stratigraphic interpretations of geophysical data, paleontologic picks, and combination of detrital zircon provenance studies with stratigraphic scaling relationships (Sømme and others, 2009). Potential seals consisting of fine-grained strata typical of continental slope deposits were interpreted as condensed sections on well logs and seismic lines. Trapping styles were interpreted to be both stratigraphic (for example, channel fill pinched out under distal overbank mudstones) and structural (for example, growth faulting in an expanded fault zone setting). AUs overlap with terrestrial source rocks interpreted in the west (Texas) of the TPS that transition to marine source rocks interpreted in the east (Lousiana), and thus, multiple Mesozoic–Paleogene source intervals are plausible (Hood and others, 2002), whereas thermal maturities are within the oil window or higher within the study area. Regardless, poor reservoir porosity, permeability, temperature, and pressure estimates may challenge further industry exploration.

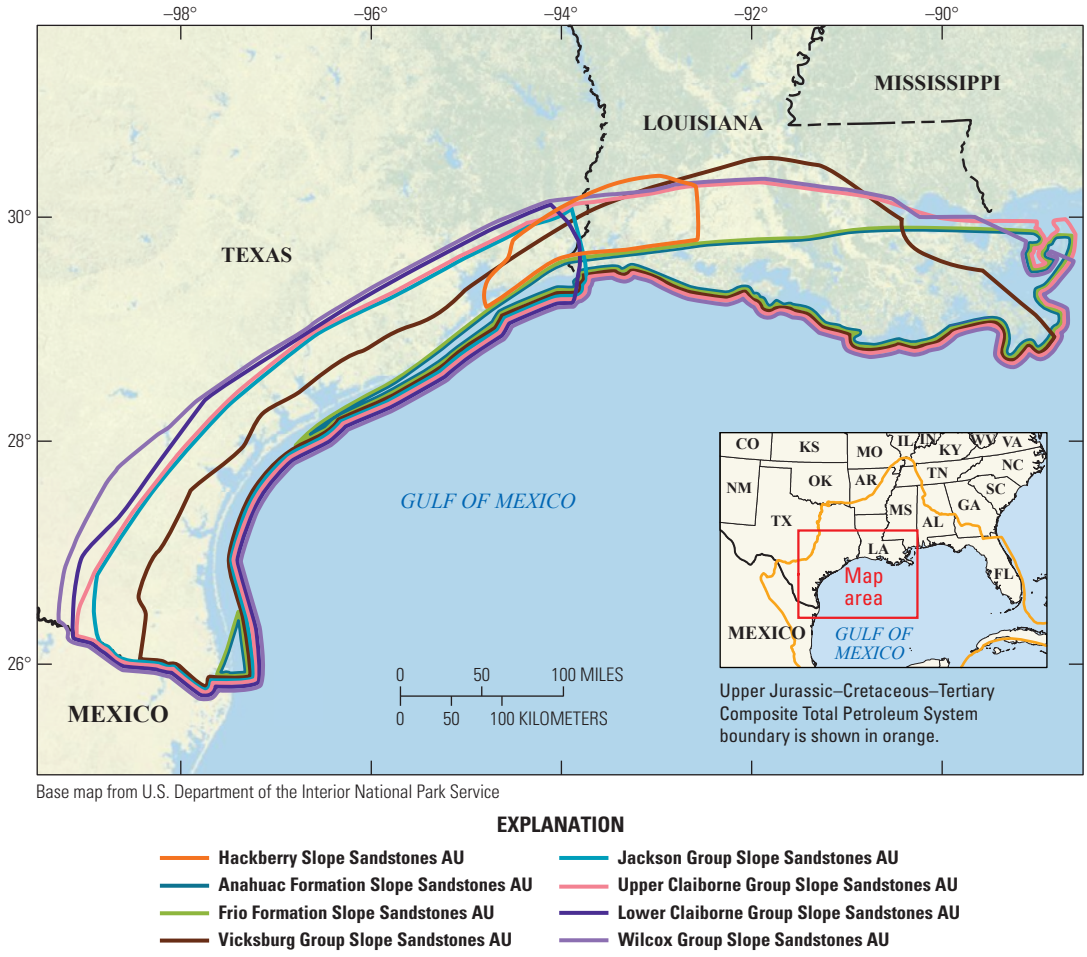


**Figure 1.** Map showing boundaries of the eight assessment units (AUs) in the downdip Paleogene formations along the U.S. Gulf Coast region. AU offshore boundary lines are shown side-by-side for illustration purposes.

## Assessment Units

Eight of 11 downdip Paleogene AUs were quantitatively assessed. These conventional AUs generally stack stratigraphically, and nearly all extend eastward from the United States-Mexico international border and northward from about the State-Federal waters limit. Table 1 lists input data used to calculate undiscovered resources in the eight conventional AUs.

The Hackberry Slope Sandstones AU incorporates upper Oligocene sandstone reservoirs of the middle part of the Frio Hackberry trend of eastern Texas and southwestern Louisiana (fig. 2). AU reservoirs comprise strata within rotated slide blocks and fill sequences in rotational fault accommodation spaces in updip areas and canyon and fan deposits farther downdip. Northern, western, and eastern AU boundaries are the limit of sand deposits in the Hackberry play, defined by Cossey and Jacobs (1992), and thus the limit of historical Hackberry production. The southern AU boundary is coincident with the northern boundary of the Frio Formation Slope Sandstones AU described below.

The Anahuac Formation Slope Sandstones AU comprises reservoirs in the downdip portion of the upper Oligocene Anahuac Formation. Paleodepositional systems of the reservoirs are sparse, shelf-fed channel, fan, and sheet sand deposits with the possibility of carbonate turbidites in eastern Louisiana. The updip AU boundary is the Frio paleoshelf margin, as interpreted by Galloway (2008), where transgressive facies of the Anahuac onlap the shelf.

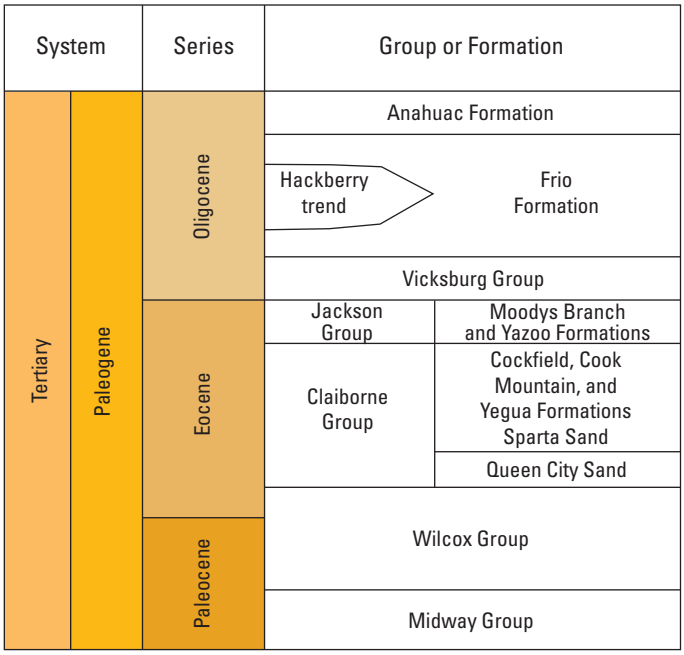


**Figure 2.** Generalized stratigraphic section of the northern Gulf of Mexico coastal plain downdip of the Paleogene shelf margins, modified from Schenk and Viger (1996).

**Table 1.** Key input data for eight conventional assessment units in the Tertiary slope sandstones of the downdip Paleogene formations, U.S. Gulf Coast region.

[AU, assessment unit; MMBO, million barrels of oil; BCFG, billion cubic feet of gas. Shading indicates not applicable]

| Assessment input data—Conventional AUs | Hackberry Slope Sandstones AU | | | | Anahuac Formation Slope Sandstones AU | | | |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Median | Maximum | Calculated mean | Minimum | Median | Maximum | Calculated mean |
| Number of oil fields | 1 | 3 | 6 | 3.1 | 1 | 6 | 30 | 6.8 |
| Number of gas fields | 5 | 12 | 30 | 12.6 | 1 | 25 | 125 | 28.5 |
| Size of oil fields (MMBO) | 0.5 | 0.7 | 20 | 1.1 | 0.5 | 1 | 100 | 2.5 |
| Size of gas fields (BCFG) | 3 | 7 | 300 | 13.1 | 3 | 10 | 1,000 | 26.7 |
| AU probability | 1.0 | | | | 1.0 | | | |
| **Assessment input data—Conventional AUs** | **Frio Formation Slope Sandstones AU** | | | | **Vicksburg Group Slope Sandstones AU** | | | |
| | Minimum | Median | Maximum | Calculated mean | Minimum | Median | Maximum | Calculated mean |
| Number of oil fields | 1 | 6 | 60 | 7.8 | 1 | 3 | 15 | 3.4 |
| Number of gas fields | 2 | 50 | 220 | 55.9 | 3 | 60 | 250 | 66.6 |
| Size of oil fields (MMBO) | 0.5 | 1 | 100 | 2.5 | 0.5 | 1 | 100 | 2.5 |
| Size of gas fields (BCFG) | 3 | 10 | 1,500 | 31.9 | 3 | 8 | 1,500 | 27.5 |
| AU probability | 1.0 | | | | 1.0 | | | |
| **Assessment input data—Conventional AUs** | **Jackson Group Slope Sandstones AU** | | | | **Upper Claiborne Group Slope Sandstones AU** | | | |
| | Minimum | Median | Maximum | Calculated mean | Minimum | Median | Maximum | Calculated mean |
| Number of oil fields | 1 | 3 | 15 | 3.4 | 1 | 7 | 50 | 8.5 |
| Number of gas fields | 1 | 30 | 200 | 36.0 | 8 | 80 | 500 | 94.9 |
| Size of oil fields (MMBO) | 0.5 | 1 | 100 | 2.5 | 0.5 | 1 | 100 | 2.5 |
| Size of gas fields (BCFG) | 3 | 10 | 1,000 | 26.7 | 3 | 10 | 1,000 | 26.7 |
| AU probability | 0.9 | | | | 1.0 | | | |
| **Assessment input data—Conventional AUs** | **Lower Claiborne Group Slope Sandstones AU** | | | | **Wilcox Group Slope Sandstones AU** | | | |
| | Minimum | Median | Maximum | Calculated mean | Minimum | Median | Maximum | Calculated mean |
| Number of oil fields | 1 | 3 | 20 | 3.6 | 1 | 5 | 30 | 5.9 |
| Number of gas fields | 1 | 50 | 250 | 57.0 | 2 | 120 | 1,000 | 150.7 |
| Size of oil fields (MMBO) | 0.5 | 1 | 100 | 2.5 | 0.5 | 1 | 100 | 2.5 |
| Size of gas fields (BCFG) | 3 | 10 | 1,000 | 26.7 | 3 | 12 | 2,500 | 45.4 |
| AU probability | 1.0 | | | | 1.0 | | | |

The Frio Formation Slope Sandstones AU incorporates paleoslope sandstone reservoirs within lower to upper Oligocene Frio Formation strata. Paleodepositional systems of the reservoirs are both sand aprons in south Texas fed by the Norma and Norias Deltas and shelf-fed submarine channel and fan deposits throughout the AU. The updip AU boundary is the Frio shelf margin from Galloway (2008).

The Vicksburg Group Slope Sandstones AU consists of lower Oligocene Vicksburg Group sandstone reservoirs found downdip of the Vicksburg paleoshelf margin. Reservoirs are delta-fed aprons along the paleoshelf margin in Texas and sparsely distributed turbidite deposits throughout the AU, which therefore has a decreased probability. The updip AU boundary in south Texas is the Vicksburg shelf margin as defined by Coleman (1990), and the updip boundary in eastern Texas and southern Louisiana is the reinterpreted Vicksburg shelf margin and downdip limit of post-Vicksburg erosion.

The Jackson Group Slope Sandstones AU reservoirs comprise downdip equivalents of the upper Eocene and lower Oligocene Moodys Branch and Yazoo Formations. With a major paleodeposition center located downdip of the Rio Grande embayment, the AU only extends eastward to a facies change to primarily clay in the vicinity of the Texas-Louisiana State line. The Jackson paleoshelf margin from Galloway (2008) defines the northern AU limit.

The Upper Claiborne Group Slope Sandstones AU comprises downdip reservoirs of the middle Eocene Cockfield, Cook Mountain, and Yegua Formations and Sparta Sand (fig. 2). Paleodepositional systems included progradational shelf-fed and delta-fed aprons. The Yegua paleoshelf margin from Galloway (2008) defines the northern AU limit.

The Lower Claiborne Group Slope Sandstones AU comprises downdip reservoirs of the middle Eocene Queen City Sand. Sands of the Queen City were likely transported from the south Texas Rio Grande embayment to the paleoshelf edge and beyond, though they are not interpreted to extend east past the Texas-Louisiana State line. The Queen City paleoshelf margin from Galloway (2008) defined the northern AU limit.

The Wilcox Group Slope Sandstones AU comprises paleoslope sandstone reservoirs of the Paleocene–Eocene Wilcox Group strata. Paleodepositional systems of the reservoir strata are sandy delta-fed aprons and shelf-fed aprons in onshore Texas and Louisiana (McDonnell and others, 2008). The upper Wilcox Group shelf margin from Galloway (2008) defined the northern AU limit.

The continuous AUs reflect the extent of potentially self-sourcing shale oil and (or) gas resources. The Lower Claiborne Group Continuous AU, the Wilcox Group Continuous AU, and the Midway Group Continuous AU were defined where there is evidence of organic-rich, marine kerogen-rich mudstones in the oil-window or higher thermal maturity zone. There is no known development of continuous resources in this TPS from these three groups, and the source rock potential of these formations is not well known. Therefore, these three AUs were not quantitatively assessed.

## Undiscovered Resources Summary

The USGS assessed undiscovered, technically recoverable resources for eight conventional oil and gas AUs in the downdip Paleogene formations (table 2). The estimated mean totals are 100 million barrels of oil (MMBO) with an F95–F5 range from 13 to 310 MMBO; 16,500 billion cubic feet of gas (BCFG), or 16.5 trillion cubic feet of gas, with an F95–F5 range from 4,033 to 38,851 BCFG; and 409 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 91 to 1,001 MMBNGL.

**Table 2.** Results for eight conventional assessment units in the Tertiary slope sandstones of the downdip Paleogene formations, U.S. Gulf Coast region.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included in the NGL category. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. Shading indicates not applicable]

| Total petroleum system and assessment units (AUs) | AU probability | Accumulation type | Total undiscovered resources | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Oil (MMBO) | | | | Gas (BCFG) | | | | NGL (MMBNGL) | | | |
| | | | F95 | F50 | F5 | Mean | F95 | F50 | F5 | Mean | F95 | F50 | F5 | Mean |
| Upper Jurassic–Cretaceous–Tertiary Composite Total Petroleum System | | | | | | | | | | | | | | |
| Hackberry Slope Sandstones AU | 1.0 | Oil | 1 | 3 | 7 | 3 | 3 | 8 | 25 | 10 | 0 | 0 | 1 | 0 |
| | | Gas | | | | | 71 | 146 | 321 | 164 | 4 | 10 | 24 | 11 |
| Anahuac Formation Slope Sandstones AU | 1.0 | Oil | 3 | 12 | 50 | 17 | 3 | 16 | 85 | 30 | 0 | 1 | 3 | 1 |
| | | Gas | | | | | 187 | 635 | 1,759 | 759 | 6 | 23 | 77 | 30 |
| Frio Formation Slope Sandstones AU | 1.0 | Oil | 2 | 12 | 62 | 19 | 2 | 17 | 104 | 30 | 0 | 1 | 5 | 2 |
| | | Gas | | | | | 528 | 1,548 | 3,828 | 1,780 | 17 | 57 | 167 | 70 |
| Vicksburg Group Slope Sandstones AU | 1.0 | Oil | 1 | 5 | 27 | 8 | 1 | 7 | 45 | 13 | 0 | 0 | 2 | 1 |
| | | Gas | | | | | 571 | 1,609 | 3,853 | 1,833 | 19 | 59 | 169 | 72 |
| Jackson Group Slope Sandstones AU | 0.9 | Oil | 0 | 4 | 26 | 8 | 0 | 10 | 70 | 20 | 0 | 1 | 3 | 1 |
| | | Gas | | | | | 0 | 695 | 2,291 | 866 | 0 | 15 | 51 | 19 |
| Upper Claiborne Group Slope Sandstones AU | 1.0 | Oil | 3 | 14 | 64 | 21 | 7 | 35 | 170 | 55 | 0 | 2 | 9 | 3 |
| | | Gas | | | | | 739 | 2,121 | 5,664 | 2,517 | 16 | 47 | 126 | 56 |
| Lower Claiborne Group Slope Sandstones AU | 1.0 | Oil | 1 | 5 | 29 | 9 | 2 | 12 | 79 | 23 | 0 | 1 | 4 | 1 |
| | | Gas | | | | | 443 | 1,313 | 3,307 | 1,521 | 9 | 29 | 75 | 34 |
| Wilcox Group Slope Sandstones AU | 1.0 | Oil | 2 | 10 | 45 | 15 | 5 | 23 | 120 | 38 | 0 | 1 | 4 | 1 |
| | | Gas | | | | | 1,471 | 5,420 | 17,130 | 6,841 | 20 | 82 | 281 | 107 |
| **Total undiscovered conventional resources** | | | **13** | **65** | **310** | **100** | **4,033** | **13,615** | **38,851** | **16,500** | **91** | **329** | **1,001** | **409** |

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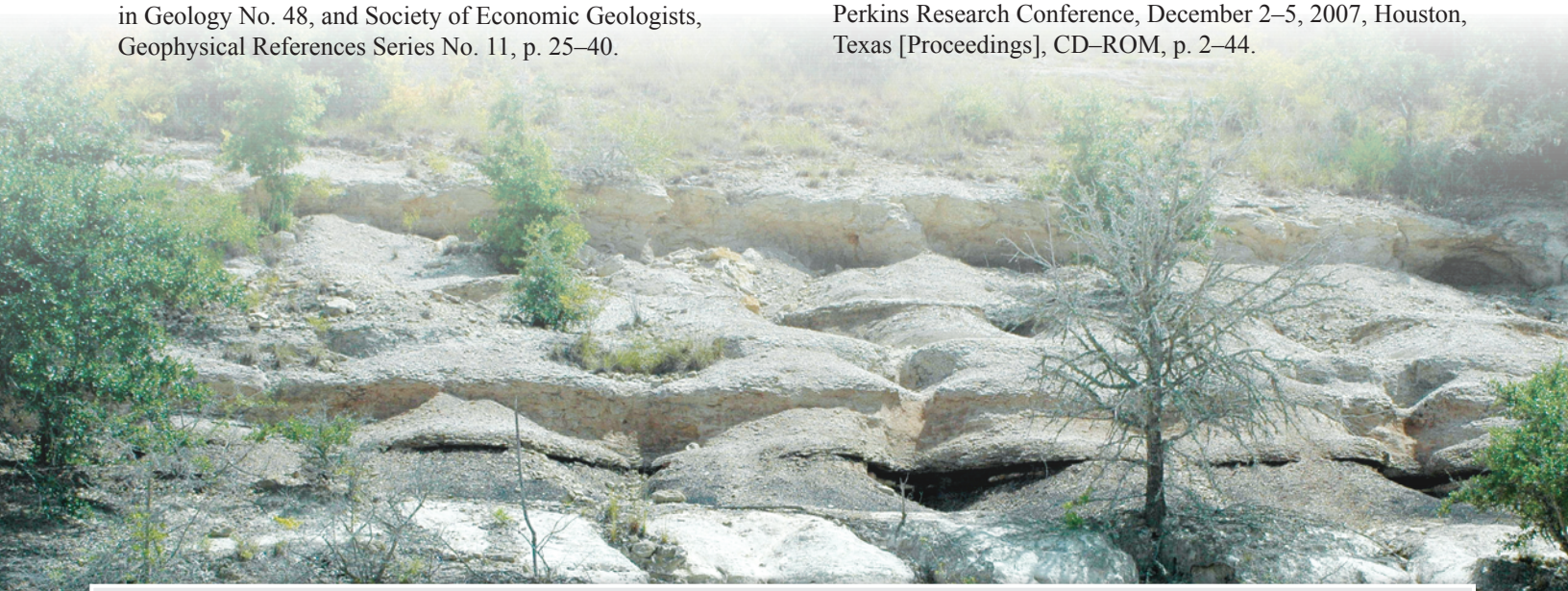

## Downdip Paleogene Formations Assessment Team


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## For More Information

Assessment results are also available at the USGS Energy Resources Program website at https://energy.usgs.gov.

Photograph of an outcropping of Eocene Jackson Group rocks at Lake Somerville, Texas. These sandstones may be considered general shallow-water equivalents to the slope sandstones investigated in this Paleogene assessment. Photograph by James L. Coleman, Jr., is also used as banner image.

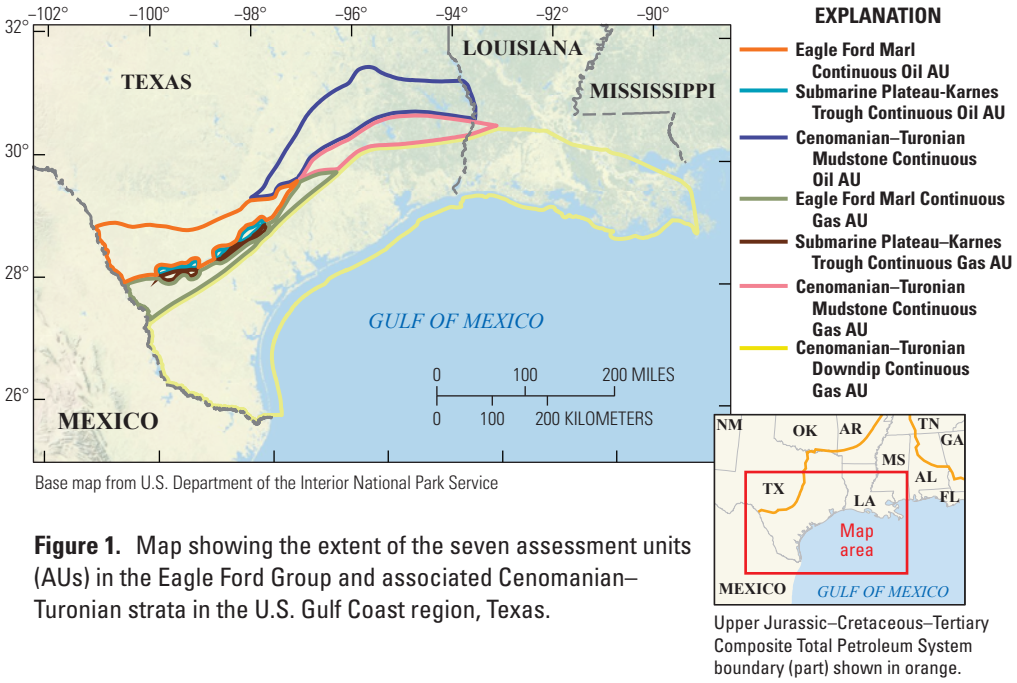
U.S. Gulf Coast Petroleum Systems Project

# Assessment of Undiscovered Oil and Gas Resources in the Eagle Ford Group and Associated Cenomanian–Turonian Strata, U.S. Gulf Coast, Texas, 2018

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 8.5 billion barrels of oil and 66 trillion cubic feet of gas in continuous accumulations in the Upper Cretaceous Eagle Ford Group and associated Cenomanian–Turonian strata in onshore lands of the U.S. Gulf Coast region, Texas.

## Introduction

The U.S. Geological Survey (USGS) assessed undiscovered, technically recoverable hydrocarbon resources in self-sourced continuous reservoirs of the Upper Cretaceous Eagle Ford Group and associated Cenomanian–Turonian strata, which are present in the subsurface across the U.S. Gulf Coast region, Texas (fig. 1). The USGS completes geology-based assessments using the elements of the total petroleum system (TPS), which include source rock thickness, organic richness, and thermal maturity for self-sourced continuous accumulations. Assessment units (AUs) within a TPS are defined by strata that share similar structural and petroleum-charge histories along with lithology and stratigraphy.




Base map from U.S. Department of the Interior National Park Service

**Figure 1.** Map showing the extent of the seven assessment units (AUs) in the Eagle Ford Group and associated Cenomanian–Turonian strata in the U.S. Gulf Coast region, Texas.

Upper Jurassic–Cretaceous–Tertiary Composite Total Petroleum System boundary (part) shown in orange.

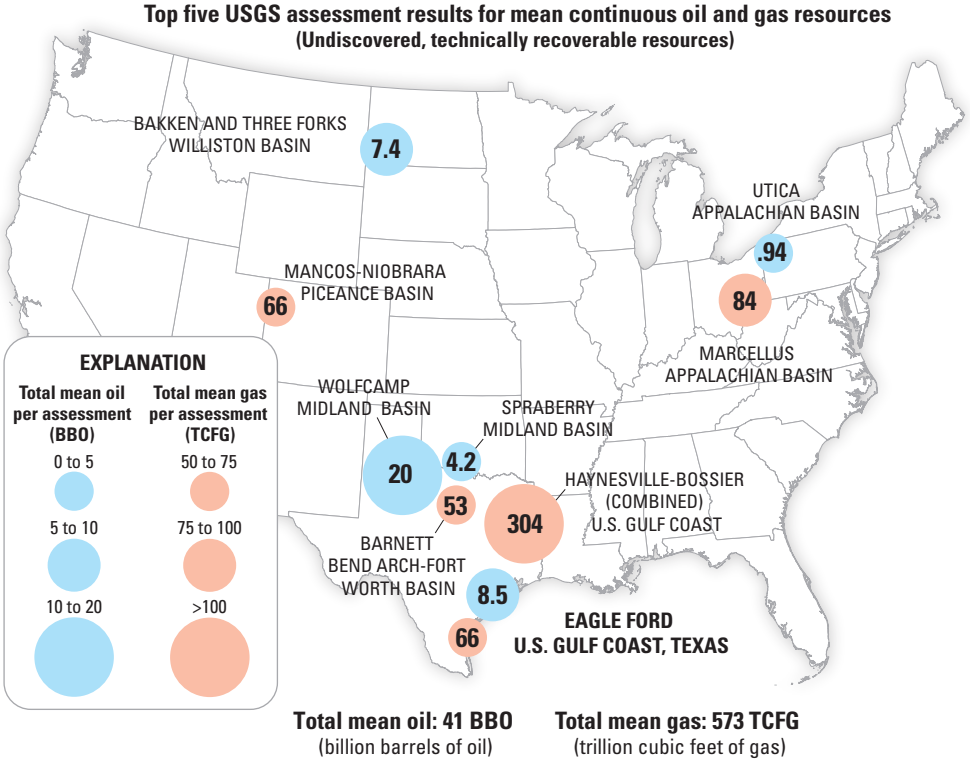



**Figure 2.** Bubble map showing the relative sizes of the top five U.S. Geological Survey assessment results through 2018 for continuous oil and gas resources in the United States. Quantitative assessment results are from Coleman and others (2011), Kirschbaum and others (2012), Gaswirth and others (2013, 2016), Marra and others (2015, 2017), Hawkins and others (2016), and Paxton and others (2017a, b).

## Total Petroleum System and Geologic Models for Assessment

The Eagle Ford Group contains one of the most prolific continuous accumulations of oil and gas in the United States (fig. 2); its composition is predominantly mudstone and calcareous mudstone (marl) with organic-rich intervals. These marine strata were deposited in outer shelf and upper slope environments during the Cenomanian–Turonian ages (Denne and Breyer, 2016). The assessed rock interval

includes mudstone strata that may be slightly older than Eagle Ford Group strata but are not well understood in terms of age or distribution. Therefore, these units are referred to as "associated Cenomanian–Turonian strata." To better capture the resource heterogeneity of this interval, Eagle Ford Group marl strata are defined as having less than 25 percent clay, and Cenomanian–Turonian mudstone strata are defined as having more than 25 percent clay, based on work by Donovan and others (2017). The Eagle Ford Group and associated Cenomanian–Turonian strata are part of the Upper Jurassic–Cretaceous–Tertiary Composite TPS in onshore lands of the U.S. Gulf Coast region, Texas (Dubiel and others, 2012).

## Assessment Units

Seven continuous AUs (fig. 1) were defined for the Eagle Ford Group and associated Cenomanian–Turonian strata across the study area, based on lithology, stratal thickness, thermal maturity, regional geologic features, and spatial distribution of productive fairways.

The Eagle Ford Marl Continuous Oil AU is defined by the United States-Mexico border, the 25-percent-clay line, and the thermal maturity window for oil (0.6–1.3 percent modeled vitrinite reflectance) (fig. 1). Within this AU is the Submarine Plateau-Karnes Trough Continuous Oil AU, which is an area of thicker Eagle Ford Group strata (greater than 120 feet), as mapped by Hammes and others (2016) (fig. 1). The thicker interval is interpreted to have provided additional source rock and reservoir potential. The Cenomanian–Turonian Mudstone Continuous Oil AU is bounded by the 25-percent-clay line, the eastern extent of production of Cenomanian–Turonian oil (at about the Texas-Louisiana State line), and the thermal maturity window for oil (0.6–1.3 percent modeled vitrinite reflectance) (fig. 1).

The Eagle Ford Marl Continuous Gas AU is defined by the United States-Mexico border, the 25-percent-clay line, the updip limit of gas generation (1.3 percent modeled vitrinite reflectance), and the Lower Cretaceous shelf margin as illustrated by Donovan and others (2015) (fig. 1). The Submarine Plateau-Karnes Trough Continuous Gas AU is defined as the area within the Eagle Ford Marl Continuous Gas AU that has Eagle Ford Group strata greater than 120 feet thick, which is interpreted to have additional source rock and reservoir potential. The Cenomanian–Turonian Mudstone Continuous Gas AU is defined by the 25-percent-clay line, the updip limit of gas generation (1.3 percent modeled vitrinite reflectance), and the outboard expression of the Upper Cretaceous shelf margin as illustrated by Galloway (2008) (fig. 1). The Cenomanian–Turonian Downdip Continuous Gas AU (fig. 1), which extends to the State-Federal waters boundary, was not quantitatively assessed because of a lack of data.

Table 1 lists input data used to calculate undiscovered resources in the six quantitatively assessed AUs.

**Table 1.** Key input data for six assessment units in the Eagle Ford Group and associated Cenomanian–Turonian strata in the U.S. Gulf Coast region, Texas.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; MMBO, million barrels of oil; BCFG, billion barrels of gas. The average EUR input is the minimum, median, maximum, and calculated mean. Shading indicates not applicable]

| Assessment input data—Continuous AUs | Eagle Ford Marl Continuous Oil AU | | | | Submarine Plateau-Karnes Trough Continuous Oil AU | | | |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Mode | Maximum | Calculated mean | Minimum | Mode | Maximum | Calculated mean |
| Potential production area of AU (acres) | 3,783,000 | 5,021,000 | 5,661,000 | 4,821,667 | 320,000 | 406,000 | 497,000 | 407,667 |
| Average drainage area of wells (acres) | 60 | 100 | 120 | 93.3 | 60 | 100 | 120 | 93.3 |
| Percentage of area untested in AU | 63 | 73 | 76 | 70.7 | 4 | 22 | 36 | 20.7 |
| Success ratio (%) | 85 | 90 | 95 | 90 | 95 | 97 | 99 | 97 |
| Average EUR (MMBO) | 0.05 | 0.15 | 0.3 | 0.156 | 0.11 | 0.2 | 0.35 | 0.207 |
| AU probability | 1.0 | | | | 1.0 | | | |
| **Assessment input data—Continuous AUs** | **Cenomanian–Turonian Mudstone Continuous Oil AU** | | | | **Eagle Ford Marl Continuous Gas AU** | | | |
| | Minimum | Mode | Maximum | Calculated mean | Minimum | Mode | Maximum | Calculated mean |
| Potential production area of AU (acres) | 2,600,000 | 4,210,000 | 7,270,000 | 4,693,333 | 1,100,000 | 2,000,000 | 2,850,000 | 1,983,333 |
| Average drainage area of wells (acres) | 80 | 120 | 140 | 113.3 | 80 | 120 | 140 | 113.3 |
| Percentage of area untested in AU | 97 | 98 | 99 | 98 | 88 | 93 | 95 | 92 |
| Success ratio (%) | 50 | 70 | 90 | 70 | 80 | 85 | 90 | 85 |
| Average EUR (MMBO, oil; BCFG, gas) | 0.01 | 0.11 | 0.2 | 0.113 | 1 | 2.5 | 4.5 | 2.579 |
| AU probability | 1.0 | | | | 1.0 | | | |
| **Assessment input data—Continuous AUs** | **Submarine Plateau-Karnes Trough Continuous Gas AU** | | | | **Cenomanian–Turonian Mudstone Continuous Gas AU** | | | |
| | Minimum | Mode | Maximum | Calculated mean | Minimum | Mode | Maximum | Calculated mean |
| Potential production area of AU (acres) | 270,000 | 372,000 | 436,000 | 359,333 | 1,000 | 1,500,000 | 3,000,000 | 1,500,333 |
| Average drainage area of wells (acres) | 80 | 120 | 140 | 113.3 | 120 | 140 | 160 | 140 |
| Percentage of area untested in AU | 84 | 88 | 90 | 87.3 | 100 | 100 | 100 | 100 |
| Success ratio (%) | 90 | 95 | 99 | 94.7 | 10 | 50 | 90 | 50 |
| Average EUR (BCFG) | 1.5 | 3 | 5 | 3.079 | 0.3 | 0.9 | 3 | 1.012 |
| AU probability | 1.0 | | | | 1.0 | | | |

## Undiscovered Resources Summary

The USGS assessed undiscovered, technically recoverable oil and gas resources for six continuous AUs in the Eagle Ford Group and associated Cenomanian–Turonian strata, U.S. Gulf Coast region, Texas (table 2). The estimated mean totals for oil and gas resources in the Eagle Ford Marl, Submarine Plateau-Karnes Trough, and Cenomanian–Turonian Mudstone Continuous Oil and Gas AUs are 8,515 million barrels of oil (MMBO), or 8.5 billion barrels of oil, with an F95–F5 range from 5,266 to 12,846 MMBO; 65,981 billion cubic feet of gas (BCFG), or 66 trillion cubic feet of gas, with an F95–F5 range from 37,984 to 104,048 BCFG; and 1,891 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 1,032 to 3,093 MMBNGL (table 2). These assessment results for the Eagle Ford Group and associated Cenomanian–Turonian strata are among the top five largest continuous resources for both oil and gas assessed by the USGS in the United States (fig. 2).

Inoceramid shells on a bedding plane in the U.S. Geological Survey Gulf Coast #1 West Woodway research core through the Eagle Ford Group; core was taken near Waco, Texas. Photograph by Stanley T. Paxton, U.S. Geological Survey.

**Table 2.** Results for six assessment units in the Eagle Ford Group and associated Cenomanian–Turonian strata in the U.S. Gulf Coast region, Texas.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. Shading indicates not applicable]

| Total petroleum system and assessment units (AUs) | AU probability | Accumulation type | Total undiscovered resources | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Oil (MMBO) | | | | Gas (BCFG) | | | | NGL (MMBNGL) | | | |
| | | | F95 | F50 | F5 | Mean | F95 | F50 | F5 | Mean | F95 | F50 | F5 | Mean |
| Upper Jurassic–Cretaceous–Tertiary Composite Total Petroleum System | | | | | | | | | | | | | | |
| Eagle Ford Marl Continuous Oil AU | 1.0 | Oil | 3,397 | 4,962 | 7,443 | 5,129 | 5,689 | 9,810 | 16,328 | 10,240 | 100 | 192 | 354 | 205 |
| Submarine Plateau-Karnes Trough Continuous Oil AU | 1.0 | Oil | 77 | 178 | 302 | 182 | 223 | 526 | 941 | 546 | 6 | 15 | 30 | 16 |
| Cenomanian–Turonian Mudstone Continuous Oil AU | 1.0 | Oil | 1,792 | 3,064 | 5,101 | 3,204 | 3,134 | 6,008 | 11,037 | 6,412 | 56 | 118 | 236 | 128 |
| **Total undiscovered continuous oil resources** | | | **5,266** | **8,204** | **12,846** | **8,515** | **9,046** | **16,344** | **28,306** | **17,198** | **162** | **325** | **620** | **349** |
| Eagle Ford Marl Continuous Gas AU | 1.0 | Gas | | | | | 21,922 | 34,303 | 52,061 | 35,304 | 614 | 1,019 | 1,634 | 1,057 |
| Submarine Plateau-Karnes Trough Continuous Gas AU | 1.0 | Gas | | | | | 5,908 | 7,943 | 10,843 | 8,100 | 224 | 316 | 449 | 324 |
| Cenomanian–Turonian Mudstone Continuous Gas AU | 1.0 | Gas | | | | | 1,108 | 4,464 | 12,838 | 5,379 | 32 | 132 | 390 | 161 |
| Cenomanian–Turonian Downdip Continuous Gas AU | | Gas | Not quantitatively assessed | | | | | | | | | | | |
| **Total undiscovered continuous gas resources** | | | | | | | **28,938** | **46,710** | **75,742** | **48,783** | **870** | **1,467** | **2,473** | **1,542** |
| **Total undiscovered continuous resources** | | | **5,266** | **8,204** | **12,846** | **8,515** | **37,984** | **63,054** | **104,048** | **65,981** | **1,032** | **1,792** | **3,093** | **1,891** |

Upper Eagle Ford Group at Lozier Canyon, near Del Rio, Texas. Photograph by Stanley T. Paxton, U.S. Geological Survey.

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Banner image shows organic-rich (darker) interval in the lower Eagle Ford Group at Lozier Canyon, near Del Rio, Texas. Photograph by Stanley T. Paxton, U.S. Geological Survey.

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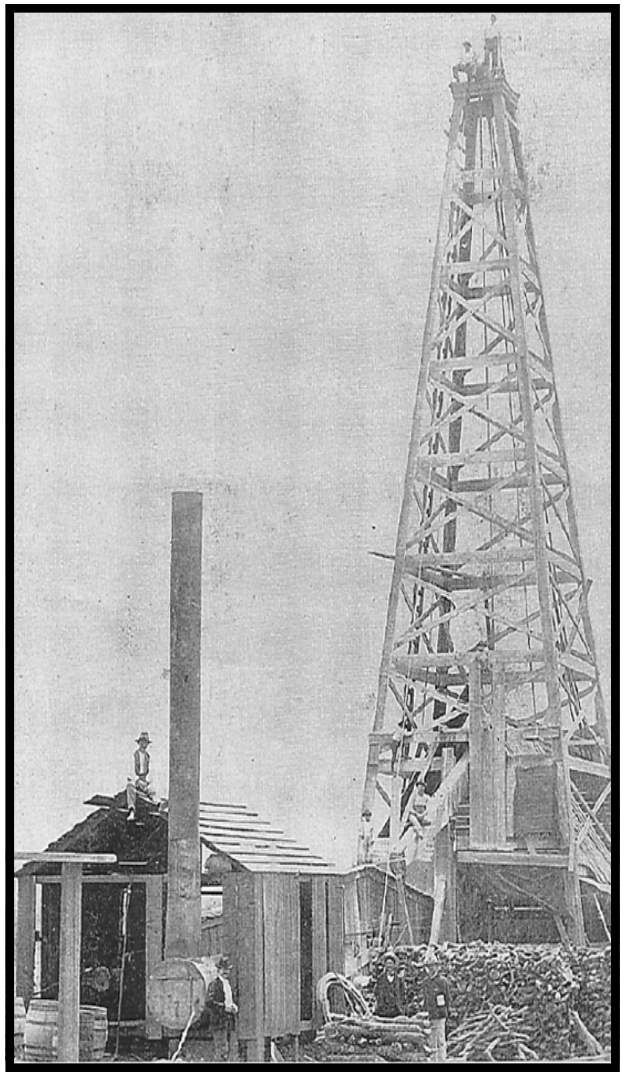

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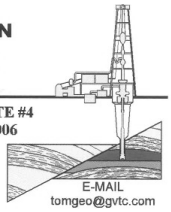

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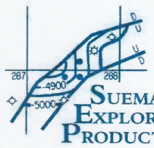


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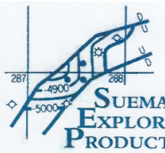

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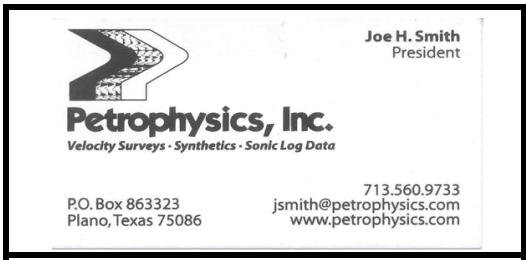


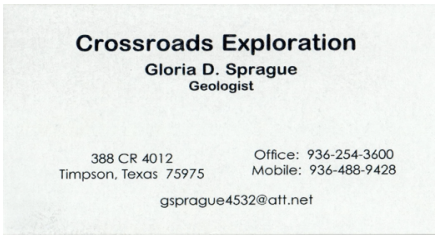


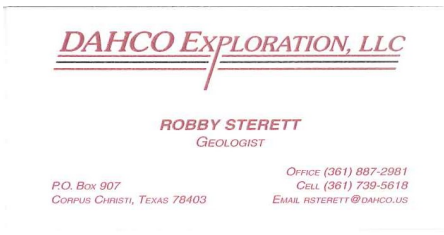



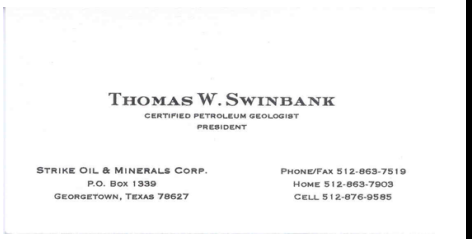




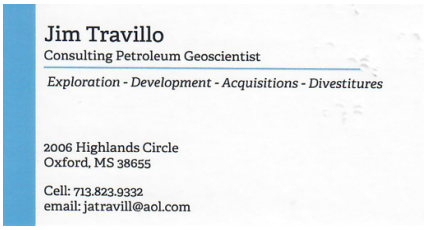


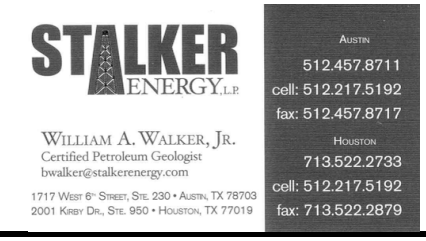




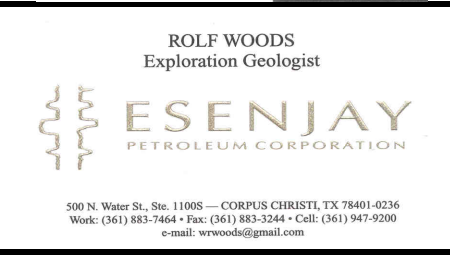


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