BULLETIN
Corpus Christi Geological Society

and

Coastal Bend Geophysical Society

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2020-2021
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Visit the geological web site at www.ccgeo.org

CCGS/CBGS JOINT MEETING SCHEDULE 2020-2021

September 2020

S	M	T	W	Th	F	S
		1	2.	3	4	5
6	7	8	9	10	11	12
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November 2020

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29	30					

Virtual Meeting Sept 16, 2020
At 11:00 am
Honoring Ray Govett

Oct 21 Virtual Meeting at 11:00 am
Presenter Dr. Osareni Ogiesoba from the BEG

Nov. 18 Virtual Meeting at llam
Presenter: Andrew Munoz Geophysicist for Ensign Natural Resources. "Unlocking Value from Vintage Seismic Processing-Pre-Stack Conditioning & Inversion in the Eagle Ford Shale"

December 2020

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January 2021

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31						

February 2021

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7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28						

Dec 1 Virtual Meeting at 11am
Presenter: Dr. Lisa Tauxe Distinguished Professor of Geophysics, Scripps Inst. Of Oceanography, Univ. of Calif. San Diego. "Hunting The Magnetic Field Through Ocean Drilling"

Jan 20 Virtual Meeting at 11am
Presenter: David M. Abbott, Jr. AIPG Ethics Columnist & Ethics Chairman Emeritus.
"Selected topics in Geoethics"
Jan.6 Virtual Meeting
Integrating Seafloor & Outcrop Data Uncovers Surprising Results

Feb. 17Virtual Meeting at noon
Dr. Shuoshuo Han, Research Associate, University of Texas Institute for Geophysics. "Links Between Sediment Properties & Megathrust Slip Behavior-the Cascadia Example."

CCGS/CBGS Joint Meeting Schedule 2020-2021

March 2021

S	M	T	W	Th	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
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April 2021

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May 2021

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23	24	25	26	27	28	29
30	31					

April 8 Virtual Meeting at 11:00am. Presenter: Michael Hudec "Evolution of the Salina del Bravo, Mexico."

April 21 Virtual Meeting at 11am. Presenter: Ryan Turner. "Investigating fault control on reservoir & spatial distribution of hydrocarbons using 3D seismic data & well logging data."

May 19 Virtual Meeting at 11 am. Presenter: Jory A. Pacht, President, Altair Resources. "Energy 101, A Rational Approach to Our Energy Future." "The Great Texas Freeze Out: What Happened?"

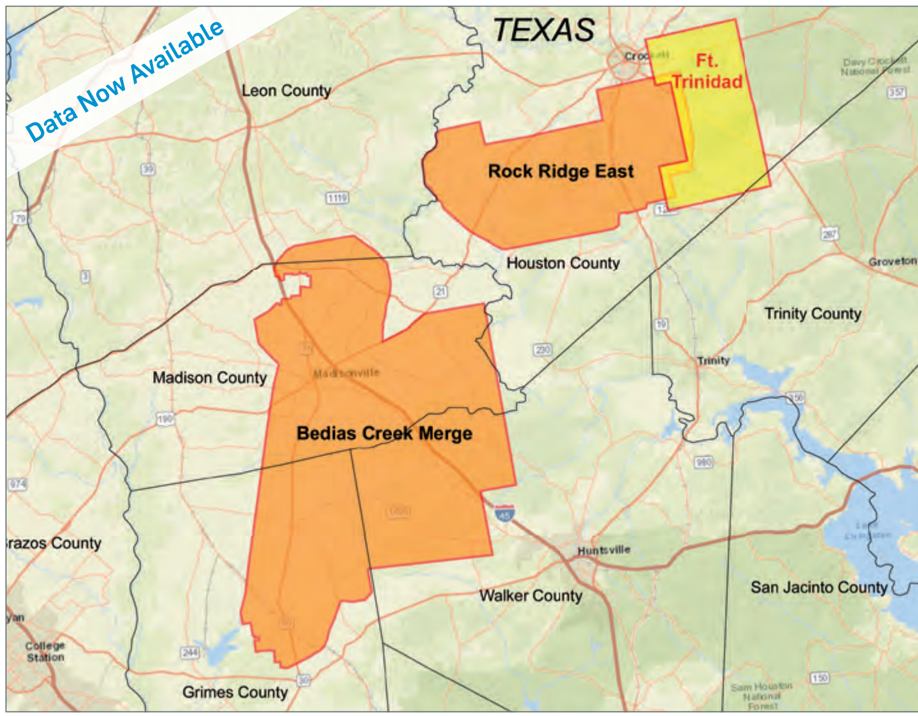
Calendar of Meetings and Events Meetings and Events

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

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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CGG
Passion for Geoscience

From the President's Desk

Rick Paige

Blazing a New Trail

Welcome to the final Bulletin of the 2020-21 season. Unfortunately, the pandemic's tenacious grip on our community continues to force our meetings go virtual. Hopefully, with increasing numbers of vaccinations, in-person gatherings can resume soon, perhaps as early as this summer.

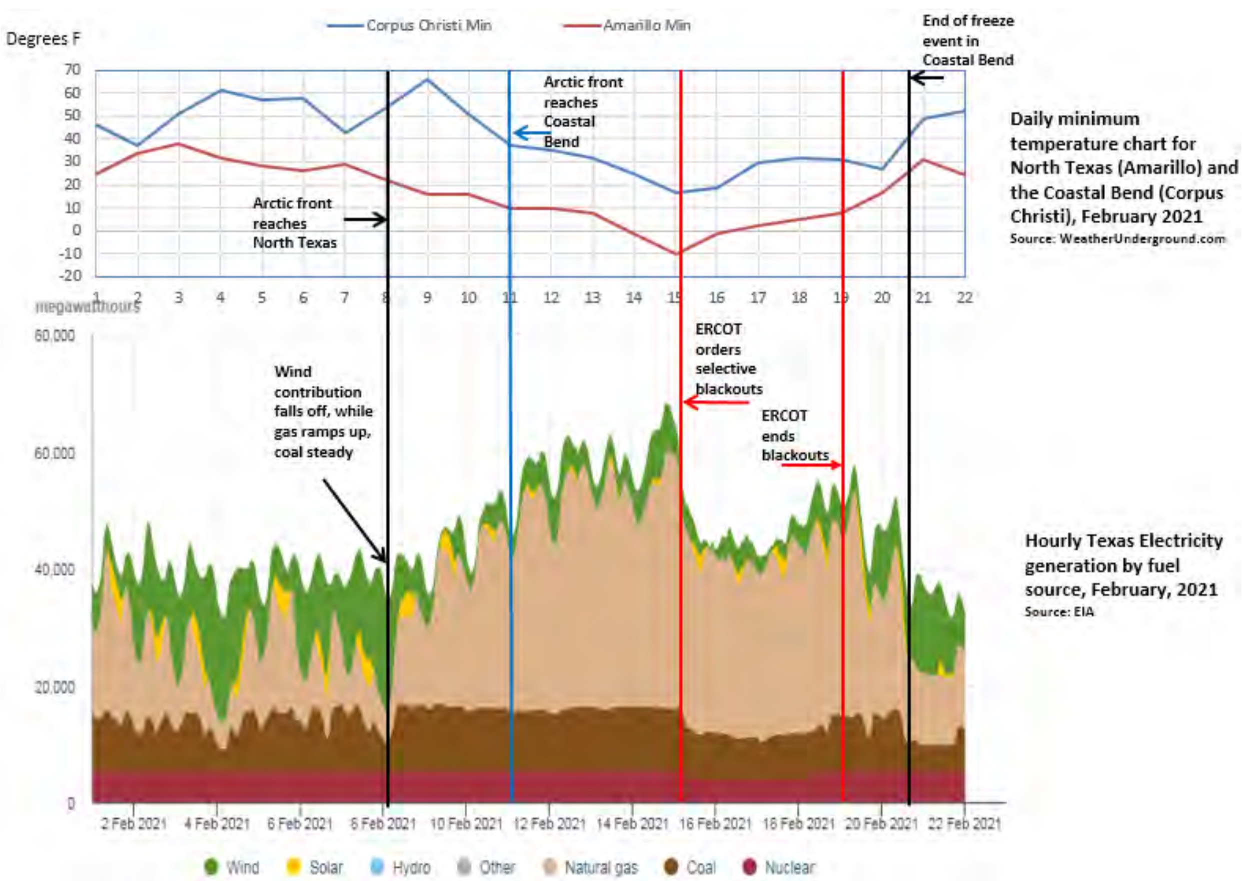
Thursday, April 8th, Dr. Michael Hudec, will present his AAPG Distinguished Lecture on the Salina del Bravo region, including the structural evolution of the Perdido Fold Belt. Our regularly scheduled luncheon meeting, Wednesday, April 21st, features the announcement of this year's scholarship recipients. And in recognition of that special occasion, Ryan Turner, a past scholarship award winner and recent graduate of Texas A&M, Corpus Christi, will speak to us on his thesis topic of determining the role of faults in reservoir compartmentalization and hydrocarbon migration pathways at La Rucia Field, Brooks County. Wednesday, May 19th, Dr. Jory Pacht, will join us to deliver a two topic discussion: the first on global energy realities and challenges, and the second a critical look at what went wrong during the "Great Texas Freeze Out". I hope you can join us for these diverse talks. As always, watch your email for Zoom invitation links.

I am determined to have at least one social event this season, even if it must be virtual. I've never attended a virtual social event, and so have no idea how it might come off. But our Society deserves a social get-together. For many of us it's been over a year without meaningful contact with fellow members, and so we must at least try. More on this at the end of the letter.

The Great Texas Freeze-Out

The "Great Texas Freeze-Out" of February 2021 is old news by now, so forgive me for dredging it up, but this is my first opportunity to comment as the CCGS did not put out a March Bulletin. If it helps, it's February as I write this.

Look at this chart. It neatly summarizes much of what happened. [Note, if viewing a printed B&W edition, I recommend downloading the free color Bulletin online at CCgeo.org]



To enumerate, soon after the arctic front reached Texas, February 8:

1) Wind generation cut back about 2/3.
2) Natural gas-fired electricity generation ramped up more than 2 times above normal.
3) Coal steadied to its normal daily high output. Nuclear remained constant.

Then, during the early hours of February 15, as temperatures plummeted to their ultimate lows:

4) Electricity output dropped about 1/3, following shortfalls from all energy sources.
5) Shortfalls continued to grow from gas and coal through the 16^{th}, then began reversing.
6) Full grid output wasn't restored until February 19.

Throughout this timeline, natural gas provided the greatest compensation to the sudden increase in electricity demand, beginning on Feb 8th. All while it was forced, by law, to prioritize home heating (that priority was, however, rendered partly ineffective where blackouts occurred). It was the only energy source to significantly increase its output during the freeze.

<u>What's not revealed in the chart, and has been the source of much rancor since, is the level to which each energy source fell below maximum capacity.</u> [All reported data is from the EIA, unless otherwise noted] Solar fell below maximum capacity, but is so inconsequential to our state's electricity output that it really had no significant effect. Nuclear fell off 23% for 3 peak days of the crisis (Feb 15-17), but maintained steady output for the rest of the event.

For 7 of the 12-day weather event coal generated at a steady rate equal to its normal diurnal daily peak, which was 16% above its January daily average. But over the 3 day weather crisis peak, when Corpus Christi experienced 65 consecutive hours at, or below, freezing (weatherunderground.com), it fell 26% below its January average.

Wind, at peak crisis, fell 70% below its normal output, and 47% below for the event duration. Most of this was due to turbines icing up. As is happens, ERCOT, which by now I'm sure every Texan knows stands for Electricity Reliability Council of Texas, the agency that monitors and oversees Texas' electrical grid, claims to have expected this and was intending to compensate with more natural gas generation[1].

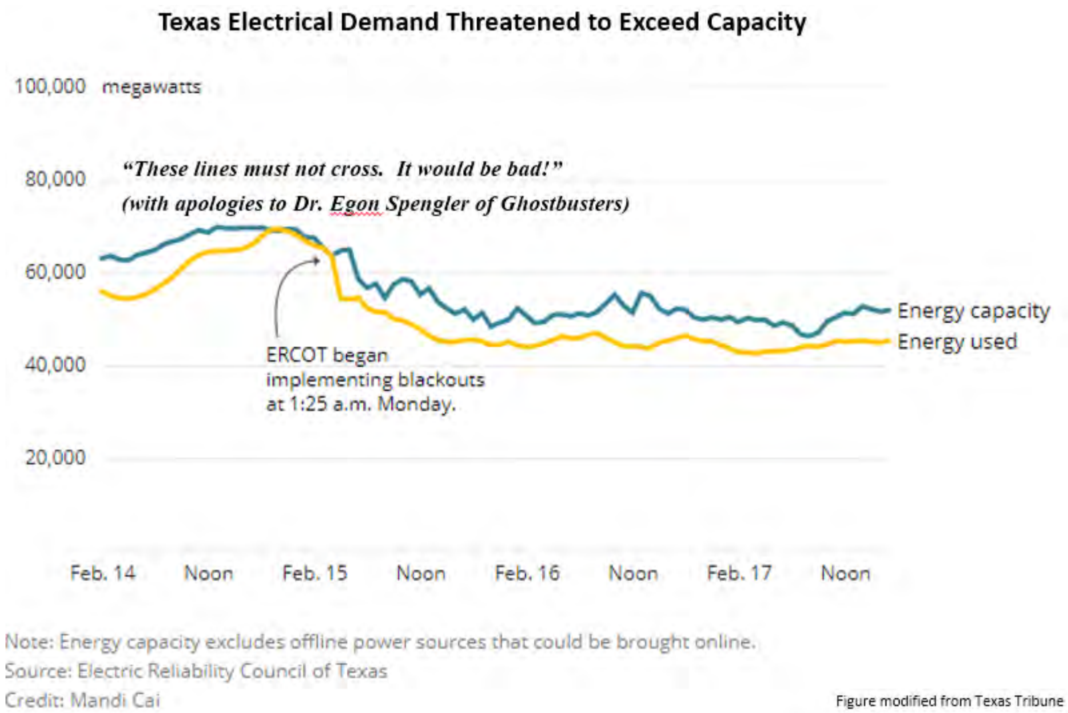
Natural gas generation of electricity, despite ramping up nearly 100%, ultimately fell below its normal output. How much below is difficult to determine because, in wintertime particularly, gas is used in the commercial and residential sector for heating and cooking, in addition to electricity generation. Overall gas delivery (to all Texas consumers) was reported as 30% to 50% below normal[2]. According to IHS Markit, Texas gas production fell to an ultimate low of 11.8 Bcf on February 17[3]. This is 53% below the December 2020 daily average (EIA), and 45% below the prior week average (oilprice.com).

As of this writing, daily Texas gas production numbers are not yet published for the entire weather event, but it's clear natural gas production was seriously impacted by the storm. The causes are multiple[4]: **1)** power station equipment failed, taking generators offline; **2)** gas wells were shut-in due to either entrained water freezing in the lines, pressure regulator freeze-ups, or liquid storage tanks filling to capacity with trucks unable to navigate the roads and empty them; **3)** major gas pipelines operated at reduced capacity due to failed compressors (I haven't been able to find any specific confirmation of this, but it could explain why natural gas in storage wasn't able to bail out the Texas electrical grid).

The Texas grid faced more demand than it could supply and so very early February 15th ERCOT called for selective blackouts (see chart below). [Why they were rolling in some areas, but prolonged in others I have not been able to determine] This led to a secondary crisis: loss of municipal water. This is easier to explain: without heat, pipes freeze and break. In some cases, such as my own, even with uninterrupted

[1] Texastribune.com, 2/16/21
[2] Texasmonthly.com, 2/19/21
[3] Naturalgasintel.com, 2/25/21
[4] Various sources

heat, they freeze and break. And that was even after setting my outside faucets and indoor sinks to slow drips!



Texas, at least Gulf Coast Texas, simply does not build homes and buildings to withstand long stretches of bitter cold. If the consequences hadn't been so dire, it would have been funny that the Corpus Christi water department spent three days searching in vain for a major water main break to explain its sudden drop in water pressure, only to discover it was due to the many homes and buildings with broken water pipes. Death by a thousand breaks.

Houston reported a similar story[5], while San Antonio blamed its loss of water on blackouts knocking out electric pumps at pumping stations[6] (maybe San Antonio homes are better insulated? Furthermore, are there no diesel powered backup generators at the pumping stations?).

[5] Houstonchronicle.com, 2/17/21

You add it all up and I say we experienced a "perfect storm" of system failures. However, it's a perfect storm that could have, and should have been foreseen. The weaknesses of Texas windmills, the natural gas gathering and transmission system, and coal and gas-fired power plants were well known and even expected. In 2011, after a brutal polar vortex caused widespread blackouts in Texas, and 2014, when another harsh freeze forced small cutbacks to the grid, multiple agencies recommended winterization of these weak points[7]. After all, northern cold weather states rarely suffer these types of winter issues because their systems are winterized[8]. But Texas operates a deregulated "energy only" electrical system (power generators only get paid for actual electricity produced)[9], which does offer many advantages. However, spending for rare cold events is not one of them.

When passing electric deregulation in the mid-1990s, Texas legislators expected that the prospect of higher energy prices during extreme weather events would prompt energy operators to spend for their protection[10]. That policy has generally worked for the hot summer months, but clearly not for the more infrequent winter freezes.

The physical problems are obvious, the solutions are not. Deregulation is a good thing, until it's not. Adding wind generation to our grid seems innocent (setting aside taxpayer subsidies and large acreage requirements for the moment), except when it fails, or the wind stops blowing, and natural gas and coal must bail it out. In a laissez-faire marketplace, how can we ask thermal power plants to create and maintain excess capacity to cover freeze events when it only gets paid for it every 10 -15 years, and only for a few days? The same can be said of winterizing natural gas well pads and pipelines.

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[6] Bizjournals.com, 2/16/21
[7] Multiple sources
[8] Scientificamerican.com, 2/18/21; texastribune.com, 2/16/21
[9] Wallstjournal.com, 2/20/21
[10] Wallstjournal.com, 2/20/21; Propublica.org, 2/22/21

These are far-reaching policy issues for which I don't have the wisdom to propose the best solution. But I agree with several of my colleagues that say the main culprit in our "Great Texas Freeze Out" was poor policy, not the failure of any single energy producer.

I do, however, have some thoughts on simple, low cost solutions for the next freeze event. They won't prevent all the setbacks, but may help reduce the severity. **1)** Treat major freeze events similar to the way we do hurricane threats. Namely, encourage the public to fill bathtubs, buckets, pots and pans with water, and then as the freeze arrives, ask homeowners and businesses to shut off their water and drain their pipes. We prepare for the loss of water when hurricanes are approaching, before knowing if we will get hit or not. Let's do the same for freezes. I know that's what I will do during the next hard freeze.

2) Wrap pressure regulators all along the natural gas supply chain. I was discussing the gas delivery problem with a good friend of mine, who happens to be a petroleum engineer. He said that quite likely the "frozen equipment" frequently mentioned as causing gas shortfalls are pressure regulators. They are present all along the gas supply chain, from well pads to compressor stations to power plants, and are prone to freezing. He further said they are generally readily accessible, and wrapping them in insulation would be quick and inexpensive. It might not resolve all the gas delivery issues, but might be enough to prevent the next "Great Texas Freeze Out".

In the meantime, let's ask our state legislators what they propose to do, if anything.

Energy Reality in America, Revisited, Final Entry.

Nuclear – the one electricity energy source that could replace all others.

I had planned on offering a fairly comprehensive review of nuclear energy's role in U.S. electricity generation, its past performance, and future potential. However, my unexpected opinion piece on "The Great Texas Freeze Out", forces me to limit this last entry in the Energy Reality series. So, I'll keep it simple: enormous energy density, zero greenhouse emissions, over 90 % capacity factor.

Look at the table below.

Energy Density by Fuel Source

Energy Source	Joules/Cubic Meter
Solar	0.0000015
Wind at 10mph	7
Natural Gas (@STP)	36,400,000
wood	9,000,000,000
Coal, lignite	12,015,000,000
Gasoline	34,200,000,000
Coal, anthracite	36,450,000,000
Crude Oil	37,000,000,000
U-235	1,500,000,000,000,000

From Layton, Intl Journal of Green Energy; Neutrium.net; Wikipedia

Putting it simply, nuclear power is able to generate more power per unit volume than any other available source, by far. In a real-world example, the Indian Point nuclear power plant supplies New York City with 16.4 TerraWatt-hrs/year, while occupying an area of 0.4 square miles.[11] That represents 30% of the city's total consumption. [12] Replacing that with gas-fired electricity would require 20 new

[11] A Question of Power, Robert Bryce, 2020

[12] Statista.com

plants, covering a cumulative 1.25 square miles.[13] But get this – replacing with wind would require 2277 turbines covering 569 square miles![14] That's 47% of the land area of Rhode Island, to replace the output of one nuclear plant, and 30% of NYC's electricity needs!

Regarding greenhouse emissions, there's steam, and that's it. The fissionable material traps its own waste, and so there are no other emissions except water vapor.

Finally, nuclear power plants have ultra-reliable output. Their historical 90% capacity factor is higher than all other electricity producing energy sources.[15]

So, if we REALLY want to cut greenhouse gas emissions, reduce our land footprint, and still produce cheap, reliable electricity, nuclear energy must be a big part of the answer. Realistically I think natural gas and nuclear are a great combination, providing cheap electricity with low emissions, but that's thinking logically, and not politically. Sadly, it seems those two attributes rarely merge.

By the way, the Indian Point nuclear power station is scheduled to be shut down this year, not for age or mechanical reasons, but for politics.[16] Further, Governor Cuomo has set a goal that 50% of New York State's 143 TWh[17] annual electricity consumption be renewable by 2030.[18] It's only feasible if its citizens are willing to cut down their forests, and plant windmills. Based solely on the numbers above, I can confidently predict that's not going to happen.

Finally, in 2019, the total U.S. electrical utility output from all energy sources was 4,234 TWh. The average U.S. light water reactor (LWR) puts out 7.3 TWh/year. So, theoretically 580 nuke plants could replace every other source of electricity we use in this country! Another option, breeder reactors,

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[13] Based on avg U.S.gas plant output of 0.8TWh/yr, (EIA). Also, avg gas power plant occupies 40 ac., (Strata.org).
[14] Assumes national average 160 ac spacing, (Strata.org). Output calculations use national average wind capacity values of recently installed turbines (2.43 MW, energy.gov, 2018). These assumptions may be overly optimistic when applied to New York state. Hilly topography, large tracts of forested land, may require larger capture areas.
[15] Energy.gov
[16] A Question of Power, Robert Bryce, 2020
[17] Energy .gov
[18] Nrdc.org

require less fissile material, and produce less radioactive waste, while extracting more energy from its fuel.

It's completely illogical that nuclear energy isn't in the discussion to supply our rapidly growing appetite for electricity.

What a Long, Strange Trip it's Been

In a season that began during the height of pandemic anxiety, our prospects for a worthwhile season seemed bleak. But by adapting to virtual meetings, and sharing with the South Texas Geological Society, I believe we put forth valuable content. We are still adding to our speaker list, but by season's end the CCGS/CBGS will have presented at least eleven virtual technical "luncheon" meetings, including 2 AAPG Distinguished Lecturers, linked to other presentations from our shared organizations, and distributed a full slate of scholarships. And, at the risk of being premature, we may also host a virtual social event before this season ends, or possibly during the summer. I don't want to spoil the surprise until it's a firm go, but watch your email for announcements.

I regret we never could have an in-person social gathering, but the Covid risk was just too stubborn. Another thing to hope for this summer…

In this, the final Bulletin of the 2020-2021 season, I wish to thank the board and committee chairs for their inspired efforts during this difficult and unprecedented year. Also I want to thank our volunteers who selflessly do their part to keep this organization running. Lastly I want to thank you, our members, for continuing to support one of the best local professional geological societies in the region. For our size, I will go so far as to say the CCGS is one of the best in the nation.

Together we have survived treacherous times with our mission, finances, and future intact.

Bravo!

SPONSORS

To CCGS/CBGS members,

This year's GeoGulf2021 is being held in Austin, **September 19 – 21**.

The organizing committee has extended the abstract submission deadline to April 16, 2021. Here's your chance to get that research paper you've been working on during the pandemic published!

For more information follow the link:

http://www.geogulf2021.org/

Note: if the link above does not work, copy and paste the address into a browser. Often, links are replaced with safer "mimecast" addresses to prevent the download of malware in emails.

Rick Paige
CCGS President, 2020-2021

The Society of Petroleum Engineers – Gulf Coast Section is organizing the 8th semi-annual **Energy Professionals Virtual Hiring Event** for professionals of energy and upstream oil & gas disciplines. The Hiring Event will be held online and will take place on April 7, 2021. As a collaborating society, **Corpus Christi Geological Society members are entitled to participate as employers or job seekers.**

The Hiring Event is one of the most remarkable happenings that bring together experienced & talented professionals with employers and recruiters from various sectors “virtually under one roof”, thereby serving as the platform for open and vast-ranging employment opportunities.

The SPE-GCS will be partnering with Texas Workforce Solutions and over 30 other professional organizations to make this event inclusive and representative of the industry segment. Registration is currently open for Employers, Sponsors, and Government Agencies. Experienced oil and gas professionals who are members of one of the collaborating organizations can participate in the event as jobseekers. For the first time ever, the Hiring Event will be free for both employers and job seekers. For more information about the event, location, time, registration, participants, visit our website: https://www.spegcs.org/hiring-event/.

Employer registration is open here: https://www.spegcs.org/events/6000/

Job seeker registration opens on March 5. Details here: https://www.spegcs.org/events/6015/

For more information, contact C. Susan Howes, PE, PHR c.susan.howes@gmail.com 713.429.5740 or Cell: 713.553.5020

Rick Paige, President CCGS

CBGS President's Letter

CBGS Board 2020-2021

President- Dr. Subbarao Yelisetti
Vice President- Dr. Mohammed Ahmed
Secretary/ Treasurer-Charles Benson
TAMUCC student representative- Ryan Turner

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

- At the time of writing this report, the U.S. crude futures soared to ~$68 a barrel, the highest since 2018.
- According to data from Baker Hughes, the U.S. oil and gas rig count fell to 402 in the week of March 12th, which is about 49% below this time last year.

- The expected decline in crude production is 160,000 bpd in 2021 to 11.15 million bpd, as reported by Scott DiSavino on reuters.com.

CBGS Business

CBGS currently has 43 active members, 4 honorary members, and 40 student members. Raised $1,450 towards student scholarships through membership revenue.

CBGS workshops/talks

CBGS recently co-hosted the Ocean Discovery Lecture entitled "*Hunting the Magnetic Field through Ocean Drilling"* by Dr. Lisa Tauxe on Dec 1, 11 am-12:30 pm.

CBGS recently co-hosted a talk entitled "*Links Between Sediment Properties and Megathrust Slip Behavior – the Cascadia Example*" by Dr. Shuoshuo Han on March 1st at noon.

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

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 Spring 2021, please contact the graduate coordinator for MS in Petrophysics, Dr. Subbarao Yelisetti at Subbarao.Yelisetti@tamuk.edu.
- The Department of Physics and Geosciences at TAMUK is offering competitive scholarships for MS Petrophysics students. 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 2021 annual meeting will be held in Denver, CO from 26th Sep- 1st Oct. See https://seg.org/AM/ 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

2021 Fall AGU annual meeting will be held in New Orleans, LA from December 13-17th, 2021.
https://www.agu.org/Fall-Meeting

Monthly Saying

"All my life I have been hearing that the oil was going to run out. It never happens. They keep discovering new oil fields. The world is apparently floating in oil fields" - Jane Jacobs

Monthly Summary

Texas Oil and Gas Info	Current Month	Last Month	Difference	
Texas Production	**MMBO/BCF**	**MMBO/BCF**	**MMBO/BCF**	
Oil	133.1	138.5	-5.4	November
Condensate	18.8	20.1	-1.3	November
Gas	810.1	843.1	-33.0	November
	Current Month	**Yr to date - 2021**	**Yr to date - 2020**	
Texas Drilling Permits	606	1416	6376	February
Oil wells	152	333	1566	February
Gas wells	49	106	439	February
Oil and Gas wells	386	931	3998	February
Other	9	20	125	February
Total Completions	959	2448	20149	February
Oil Completions	709	1728	15838	February
Gas Completions	250	720	4311	February
New Field Discoveries	1	1	13	February
Other	340	870	7317	February

Subbarao Yelisetti
President, CBGS

ZOOM

VIRTUAL MEETING

Thursday, APRIL 8TH, 2021

11:00AM

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Evolution of the Salina del Bravo, Mexico: The Bravo Trough, Sigsbee Canopy and Perdido Fold Belt.

Michael Hudec

Senior Research Scientist, Bureau of Economic Geology

Abstract

The Salina del Bravo region, on the continental slope just south of the Texas border, is dominated by four structures. From landward to seaward: the Bravo trough, Sigsbee Canopy, Perdido fold belt, and BAHA high. The Bravo trough lies beneath the updip part of the slope, and is characterized by a thick, intensely folded Tertiary section beneath which the Mesozoic section is thin or absent. The Bravo trough runs for roughly 400 km along strike, and is at least 40 km wide, with the west edge lying beyond the limits of our dataset. The downdip end of the Bravo trough is connected to the Sigsbee canopy by a feeder or weld. The Sigsbee canopy lies almost entirely seaward of the Bravo trough, and in most places overlies the Perdido fold belt. In many places the Perdido fold belt folds the base of the Sigsbee canopy. Elsewhere, Perdido folds are truncated beneath an unconformity on which the canopy is emplaced. At the seaward end of the system is the BAHA high, named for the first well drilled in it. The BAHA high is a structural high in the base of salt, with 1-2 km of relief in most places. Like the Bravo trough, it runs over 400 km along strike. The Perdido fold belt lies on top of or updip of the BAHA high.

We interpret the Bravo trough as a former salt wall (the Bravo diapir) that was loaded by sediments during a major depositional phase in the early Cenozoic. These sediments expelled salt from the Bravo diapir into the Sigsbee canopy. This depositional phase also destabilized the margin, leading to extension beneath the present onshore (Burgos basin) detached near the top of the Cretaceous. This extension was accommodated partly in the Bravo trough, where the detachment ramped down to the base of salt, and in the Perdido fold belt. The Perdido fold belt was buttressed against the BAHA high, which formed the downdip end of the system. We constructed a physical model to test the viability of our hypothesis. This model was able to reproduce all of the major features of the Salina del Bravo region.

Biography

Mike Hudec is a senior research scientist at the Bureau of Economic Geology and directs the Applied Geodynamics Laboratory, an industry-sponsored research consortium studying salt tectonics. He received his doctorate from the University of Wyoming in 1990, and spent the next eight years at Exxon Production Research, where he specialized in salt tectonics, extensional tectonics and seismic interpretation. His current research interests include palinspastic restoration of salt structures, deepwater structural styles and evolution of the Gulf of Mexico Basin.

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Investigating fault control on reservoir and spatial distribution of hydrocarbons using 3D seismic data and well logging data: A case study from the Oligocene Vicksburg Formation, Brooks County, Texas

Ryan Turner

Coastal Geomorphologist, Conrad Blucher Institute

Abstract

In southern Brooks County, Texas, the Lower Oligocene Vicksburg Formation (LOVF, Rupelian stage, approximately 33.9-27. 82 million years ago), is being influenced by the Vicksburg Fault Zone (VFZ). The VFZ is characterized by listric-normal faults that have formed highly faulted rollover anticlines that are sought-after structural traps for hydrocarbon exploration. This research explored how secondary synthetic (dipping East), antithetic (dipping West), and how perpendicular to the coast faults are affecting the accumulation and spatial distribution of hydrocarbons within the La Rucias Field. Results indicate that synthetic, antithetic, and coast-perpendicular faults affecting the V-102, V-17, and V-19 horizons provide conduits for hydrocarbon migration. Antithetic faults and coast perpendicular faults within the rollover anticline are terminating beneath the overlying unconformity shale seal layer between the V -16 and V-17, creating natural gas accumulation. While synthetic faults affect the overlying seal

layer migrating gas out of the V-102, V-17, and V-19. Bidirectional faulting linking antithetic and perpendicular to the coast faults are acting as additional pathways for enhanced hydrocarbon accumulation. Spatial distribution of hydrocarbons within the La Rucias Field varies with the horizon being targeted. Productive V-102 reservoirs are located on the western flank of the rollover anticline , the V-17 and V-19 reservoirs are located on structural highs where antithetic faults are not affecting the overlying shale seal layer, and the most productive V-17 and V-19 reservoirs are being affected by bidirectional faulting terminating beneath the shale seal layer allowing accumulation and spatial distribution within the rollover anticline. Investigating the control of these fault systems enhances our understanding on subsurface fluid migrations and accumulations (oil, gas, groundwater, and contaminants) in the expanded Vicksburg productivity trends.

Biography

After earning his Associates of Science from Alamo Colleges in 2016, Ryan transferred to Texas A&M Corpus Christi earning his Bachelors of Science in geology in 2018. His master's degree from TAMUCC in Coastal and Marine System Sciences was earned in 2020. Ryan is a multi-awardee (4 years) of the Corpus Christi Geological Society's scholarships. Ryan was instrumental as a student volunteer in 2016 for the Gulf Coast Associations of Geological Societies (GCAGS) that CCGS hosted in 2016. During his time at TAMU-CC he was elected Vice president of the Geology club and elected as the President of the TAMU-CC SEG student chapter. During the last semester in his master program, Ryan was selected as the Outstanding Graduate for the College of Science and Engineering Fall 2020.

Upon graduating with his masters in 2020, Ryan is employed as a Coastal Geomorphologist at the Conrad Blucher Institute in Corpus Christi.

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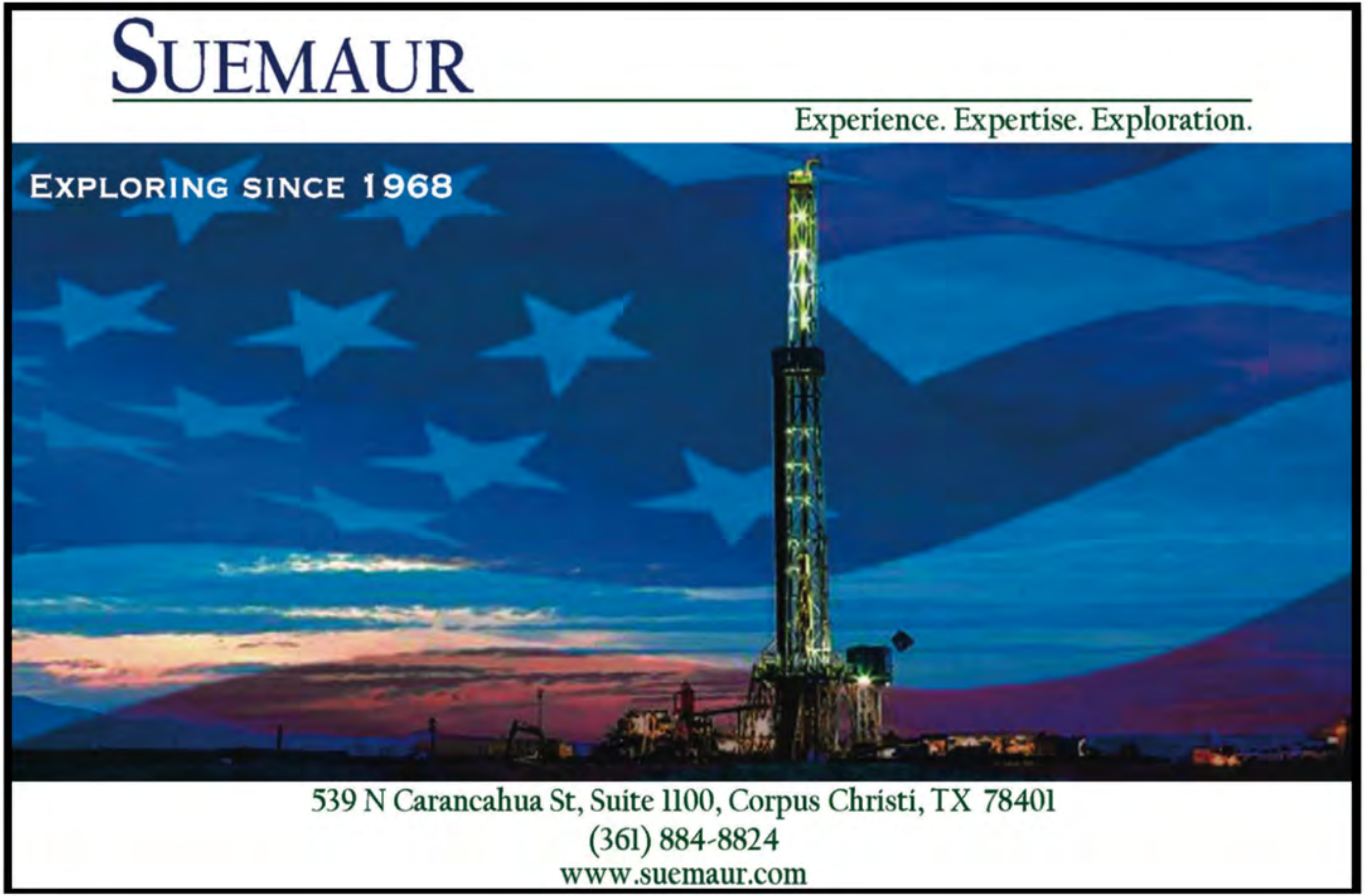

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This meeting is presented in two parts:

1) Energy 101, A Rational Approach to Our Energy Future.

2) The Great Texas Freeze Out: What Happened?

Jory A. Pacht, President, Altair Resources

1) Energy 101 Abstract

Perhaps the most important thing to understand about energy is just how much of it we use. Every man, woman and child in the world uses 20 million watt-hours of energy per year. In developed countries, the number is far higher. The reason energy use is so high is that energy is in everything we do. For example, food for a family of four for a week takes the energy equivalent of 22 gallons of gas to grow, ship, process and sell. If energy is in everything we do, then the cost of energy is in everything we do and worldwide, most decisions on energy sources are made based on cost. This is particularly true for undeveloped and developing countries, whose per capita GDP is far below the U.S. However, it is also true for industrial powerhouses like China, that have prioritized economic growth.

So, as we hear various pundits and politicians are calling for a carbon-free world in 30, 20 and now 15 years, we must ask if this is realistic? Can we accomplish this without devastating our economies? And if the U.S. takes this step, will the rest of the world, including economic competitors like China, follow suit? Currently ~89% of all energy in the world is produced using fossil fuels. Solar and wind comprise only 4%. Are the world's citizens ready to accept the increased economic and land use costs that come with a switch to renewable sources of energy? In countries that are desperately poor, is it moral to insist that they forgo the benefits of cheap energy that we enjoy?

Anthropogenic global warming is an inconvenient truth. But so are the huge benefits that every country in the world has enjoyed and is enjoying as a function of cheap fossil fuel energy. Managing global CO_2 will therefore require rational market-based solutions that may be different for different countries. Political invective on both sides is counter-productive and only creates division.

Biography

Dr. Pacht began his career at ARCO in the exploration research department in 1980. ARCO recognized his contribution in its 1987 Annual Report where his team was credited with adding $350 million of reserves. His work continued at TGS-NOPEC as a Senior Scientist working in the Gulf of Mexico and offshore Africa. In 1992, he founded Seis-Strat Services, Inc., a geological and geophysical service company employing up to 35 geo-scientists in seven countries. He sold Seis-Strat in 2008. From 2004 to 2016, Dr. Pacht founded (with partners) and sold several oil and gas production companies, one of which was producing over 5600 BOEPD at time of sale. He is presently the President of Altair Resources. Dr. Pacht has won five best paper awards and has published over 80 papers and abstracts. He serves on the Alumni Advisory Board of the School of Earth Sciences at Ohio State, where he received his Ph.D.

Constructing a geophysical test site for a coastal community's research and education activities

Mohamed Ahmed[1], Ryan Turner[1], Michael Haley[1], Samantha Shyrigh[1], Dionel Colmenero[1], and Tejaswini Penchala[1]

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Abstract

A geophysical test site (GTS) contains subsurface targets of known materials, orientations, and depths. GTSs offer unique opportunities for geophysical research, training, and educational activities. They provide platforms to investigate the penetration and resolution of different geophysical techniques for characterizing the shallow subsurface. GTS-based field exercises represent an interesting, motivating, rewarding, and enjoyable experience for students and instructors. We have constructed a GTS at Texas A&M University–Corpus Christi that contains several objects (e.g., steel drums, plastic drums, plastic buckets, steel pipes, and well covers) buried at depths ranging from 0.5 to 3 m to simulate real-life situations. In this article, we provide a thorough description of the site location, subsurface geology, surface topography, and construction methodology, as well as the types, locations, orientations, and depths of the subsurface targets. Research and education significance and implications of the GTS are also described. This article could serve as a reference for the construction of new GTSs worldwide.

Introduction

More than 30% of the world's population lives in coastal areas, and 50% are likely to do so by 2030 (Small and Nicholls, 2003). Coastal communities, however, are vulnerable to natural forces such as flooding, hurricanes, and tsunamis (Wu et al., 2002; Dolan and Walker, 2006; Felsenstein and Lichter, 2014). Hurricanes and flooding are associated with loss of life, livestock, crops, and natural habitat; contamination of surface and groundwater resources; and property and infrastructure damage (Grineski et al., 2019; Venkataramanan et al., 2019). Floods alone account for more than one-third of economic losses resulting from natural forces (Kourgialas and Karatzas, 2013). These natural forces also have significant damaging effects on buried subsurface utilities (water/sewer pipes, power/phone cables, etc.) around homes, farms, industrial sites, and urban areas (Canto-Perello and Curiel-Esparza, 2003; Kourgialas and Karatzas, 2013; Essam et al., 2020).

Geophysical techniques provide a comprehensive and reliable set of nondestructive and cost-effective tools that could be used to detect and map subsurface utilities and to investigate and characterize the shallow subsurface (Benson, 1993; Allred et al., 2004; Jaw and Hashim, 2013; Morsy and Rashed, 2013; Rashed and Atef, 2015). By mapping and characterizing spatial variations in the physical properties of the earth, geophysical techniques enhance the reliability and speed of any subsequent geotechnical and engineering investigations. Information extracted from geophysical data (e.g., subsurface object type, depth, and geometry) can be a significant factor in saving money, time, and lives prior to conducting drilling or excavation activities.

Geophysical techniques, however, cannot always detect all subsurface targets. In some cases, the subsurface targets are too small or deep to resolve (Telford et al., 1990). Some targets are impossible to image because their physical properties are similar to those of the surrounding materials. Moreover, interpretation of any geophysical data could be challenging due to the uncertainty in the subsurface targets, also called nonuniqueness. This term refers to the fact that a measured physical effect cannot always be interpreted in terms of a unique source occurring at a particular depth inside the earth because a variety of sources with various parameters and different depths could theoretically produce the same physical effect. Trial pits are used to constrain the collected geophysical data. However, these pits are expensive and time consuming to construct. Another way to minimize nonuniqueness and assist in interpreting geophysical data is to understand the geophysical responses of subsurface targets with known materials, depths, and geometries. We then can use these responses to detect similar, but unknown, targets. To better understand these responses, we needed to construct a geophysical test site (GTS).

A GTS contains subsurface targets with known physical properties, geometries, and depths (Porsani et al., 2010; Poluha et al., 2017). Sites like these are used to record typical, standard geophysical responses of each technique above each subsurface target. These responses then can be used to identify subsurface targets in areas where there is little or no available information about the subsurface. The subsurface targets of the GTS are usually selected to simulate real-life environments in engineering, geotechnical, environmental, and archaeological applications. In addition, GTSs provide a facility for teaching, training, demonstrations, and research supporting many aspects of geophysical surveys. Examples of GTSs include those established at Stanford University, USA; University of Waterloo, Canada; Western Michigan University, USA; Waterways Experiment Station, USA; University of Leicester, UK; University of Sao Paulo, Brazil; and Asian Institute of Technology, Thailand.

Recently, we constructed a GTS at Texas A&M University–Corpus Christi (TAMU-CC) in Corpus Christi, Texas, USA. We followed the same model advanced by Western Michigan University (Sauck, n.d.). In this article, we provide a thorough description of the TAMU-CC site location, subsurface geology, surface elevation, and construction methodology, as well as the types, locations, attitudes, and depths of the subsurface targets

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buried there. We also discuss the research and educational significance and implications of our GTS.

GTS at TAMU-CC

The GTS is a 2500 m² area (50 × 50 m) located in the Momentum Campus of TAMU-CC (Figure 1). This site is about 60 m from a parking lot, 30 m from the Thomas J. Henry Tennis Center, and about 350 m from the intersection of Nile Drive and Ennis Joslin Road. On a larger scale, the GTS is located in southern Texas close to the confluence of Corpus Christi Bay and Oso Bay. The GTS is oriented 20°W to avoid intersecting with a pre-existing cross-country athletic track. The magnetic declination and inclination within the GTS are reported to be 3.4489°E and 56.5023° down, respectively.

The Late Pleistocene Beaumont Formation represents the dominant subsurface lithology where the GTS is installed. The Beaumont is composed of clay-rich sediments transected in some locations by sandy fluvial and deltaic-distributary channels (DuBar et al., 1991). Under the GTS, the Beaumont Formation ranges in thickness from 45 to 100 m (Young et al., 2010). Along the Texas coast, the Beaumont Formation thickens and dips coastward (Solis, 1981).

A topographic survey using a differential global positioning system (GPS) was carried out before the construction of the GTS and installation of the subsurface targets. Using a Trimble GPS unit, 108 surveying points were collected inside and outside the GTS (Figure 2). The collected elevations were interpolated to generate a surface elevation map for the GTS (Figure 3). Figure 3 indicates that the GTS is in a flat region. The ground elevation ranges from 4.08 to 4.19 m over the entire site, with a mean surface elevation of 4.12 m (Figure 3).

Before installing subsurface objects within the GTS, we conducted preliminary complete magnetic and electromagnetic surveys. The main objectives of these surveys were to document the background responses, without the interference of subsurface targets, and to locate and remove man-dumped objects (old cans,

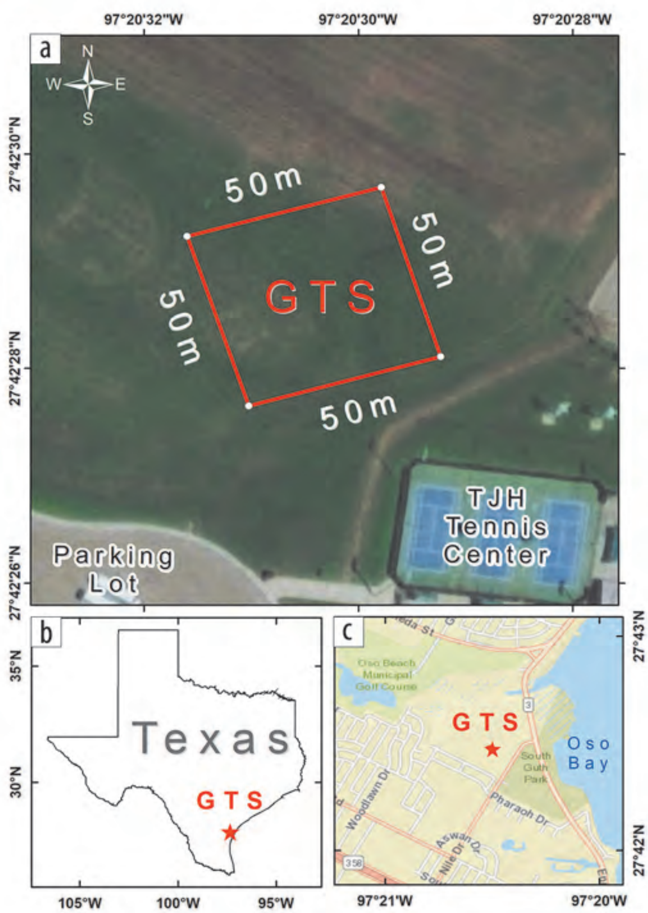

Figure 1. (a) Map showing the 50 × 50 m location of the GTS. (b) The GTS location in Texas and (c) in Corpus Christi.

Figure 2. Topographic survey using GPS before the GTS construction.

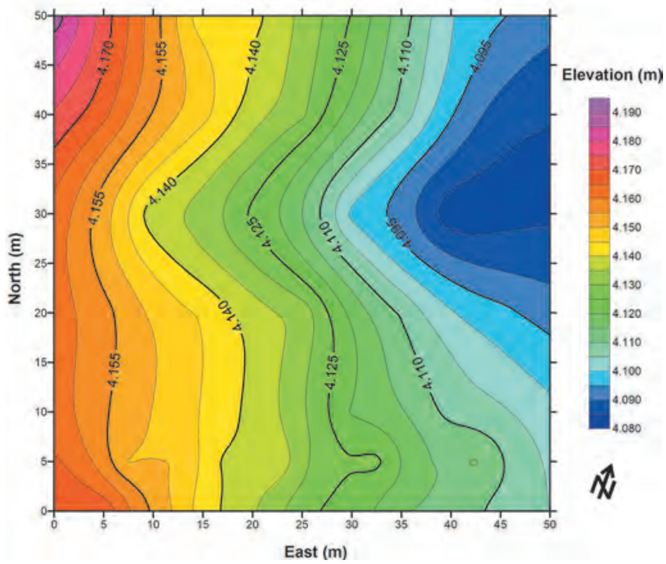

Figure 3. Surface elevation of the GTS.

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wires, etc.). The magnetic survey was carried out in September 2019 using our Geometrics G-858 magnetometer and gradiometer. The electromagnetic survey was conducted in October 2019 using our Geonics EM-31 system. Our results indicate no significant variations in earth's total magnetic field within the GTS (average: 45,566 nT). Similarly, no significant conductivity anomalies were reported within the GTS; the average apparent conductivity is reported as 204.50 mS/m.

The GTS targets were distributed along seven lines and grouped by material type (Figure 4). GTS targets were selected to have magnetic, electric, and electromagnetic responses. We installed steel drums, plastic drums, plastic buckets, steel pipes, and well covers. The depth from ground surface to the top of the GTS targets ranges from 0.5 to 3 m. These targets were chosen to simulate real-life situations. For example, the steel and plastic drums could represent chemical waste contamination, the steel pipes might represent part of a utility network (e.g., water, gas, electricity, telephone), and the well covers represent the heads of regular and/or abandoned wells. Table 1 lists target types, locations, depths, and attitudes.

A Brunton compass was used to orient the target lines along the northeast direction. A backhoe was used to excavate the holes (Figure 5), and a small shovel was used for final refinement and adjustment of each hole. The GTS construction started on 17 February 2020 and was complete by 4 March 2020. After the excavation, we measured the dimensions of each hole and the depth to the bottom of each hole. A soil sample was collected every 0.5 m from each hole. These samples will be used later for lithologic and petrophysical analysis. The targets were then placed in their designated holes. Each target was horizontally leveled with a bubble level. During target installation, while the holes were still open, the depth from the ground surface to the top of each target was measured. We report these depths in Table 1. The targets were then buried, and the holes were filled using the excavation materials that originally came out of the hole. These procedures were repeated for each target installed on the GTS.

Four hidden reference markers (Figure 6) were installed in the four corners of the GTS. To create these, we used PVC pipe (length: 8 in. [0.2 m]; diameter: 2 in. [0.05 m]) filled with steel nails (length: 3 in. [0.07 m]) and closed on both ends. These reference markers were buried at a depth of 0.15 m around the GTS perimeter to prevent them from being vandalized or accidentally destroyed by lawn mowers. These reference markers will be used to define the GTS corners each time field data are collected.

Line 1 (0 m N; Figure 4) contains five subsurface objects. The distance between each of these objects is 10 m. Each location contains a single 55 gal (208.19 liter; length: 0.87 m; width: 0.58 m) empty steel drum. All steel drums were buried empty to avoid corrosion problems. Each of the five drums was buried at a depth between 0.5 and 2 m. Some of the drums were installed in a vertical orientation (e.g., long axis upright), and some were

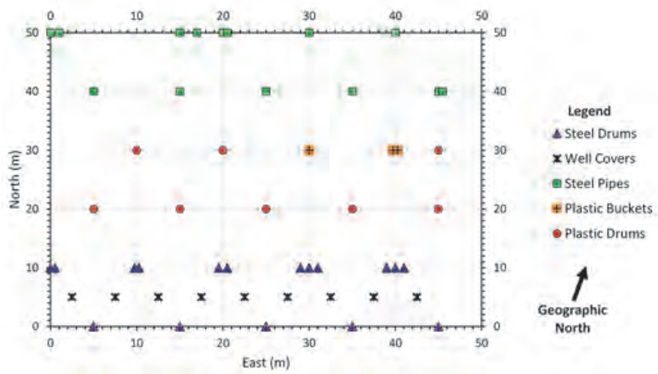

Figure 4. Spatial distribution of the GTS targets (e.g., steel drums, plastic drums, plastic buckets, steel pipes, and well covers).

Figure 5. A backhoe was used to excavate holes for GTS target placement.

Figure 6. Four reference markers filled with steel nails were installed in the four corners of the GTS.

installed in a horizontal orientation (long axis oriented either east–west or north–south) (Figure 7).

Line 2 (5 m N; Figure 4) contains nine manhole well covers, each separated by 2.5 m. Two sets of well covers were installed (Figure 8). The first five locations contain 8 in. (0.20 m; outer diameter) well covers, and the remaining four contain 12 in. (0.30 m) well covers. These well covers are bolt-down style with a ductile iron lid, a steel skirt, and an overall height of 12.7 in.

Table 1. GTS targets types, locations, depths, and orientations.

Line no.	North (m)	East (m)	Target/object	Depth to top (m)	Orientation/remarks
1	0	5	55 gal steel drum, empty	0.5	Axis E-W
1	0	15	55 gal steel drum, empty	0.5	Axis N-S
1	0	25	55 gal steel drum, empty	0.5	Axis vertical
1	0	35	55 gal steel drum, empty	1.0	Axis E-W
1	0	45	55 gal steel drum, empty	2.0	Axis E-W
2	5	2.5	8" well cover	2.5	Iron lid, 12.7", steel skirt, 13.7 lb
2	5	7.5	8" well cover	1.5	Iron lid, 12.7", steel skirt, 13.7 lb
2	5	12.5	8" well cover	0.5	Iron lid, 12.7", steel skirt, 13.7 lb
2	5	17.5	8" well cover	2.5	Iron lid, 12.7", steel skirt, 13.7 lb
2	5	22.5	8" well cover	1.5	Iron lid, 12.7", steel skirt, 13.7 lb
2	5	27.5	12" well cover	0.5	Iron lid, 12", steel skirt, 28.8 lb
2	5	32.5	12" well cover	2.5	Iron lid, 12", steel skirt, 28.8 lb
2	5	37.5	12" well cover	1.5	Iron lid, 12", steel skirt, 28.8 lb
2	5	42.5	12" well cover	0.5	Iron lid, 12", steel skirt, 28.8 lb
3	10	0	55 gal steel × 2, empty	2.0	Axes E-W, parallel, adjacent
3	10	10	55 gal steel × 2, empty	3.0	Axis vertical, adjacent E-W alignment
3	10	20	55 gal steel × 2, empty	3.0	Axes N-S, parallel, 1 m separation
3	10	30	55 gal × 3	3.0	Axes N-S, parallel, adjacent
3	10	40	55 gal × 3, empty	3.0	Axes horizontal, triangle contact
4	20	5	30 gal plastic, empty	0.5	Axis E-W
4	20	15	30 gal plastic, empty	0.5	Axis vertical
4	20	25	30 gal plastic, filled, tap water	0.5	Axis E-W
4	20	35	30 gal plastic, filled, tap water	0.5	Axis vertical
4	20	45	30 gal plastic, empty	1.0	Axis E-W
5	30	45	30 gal plastic, filled, water + 2% salt	1.0	Axis vertical
5	30	10	30 gal plastic, filled, water + 2% salt	1.0	Axis E-W
5	30	20	30 gal plastic, half full, water + 2% salt	1.0	Axis E-W
5	30	30	6 gal plastic pail, empty	0.5	Axis vertical
5	30	40	6 gal plastic pail × 2, 1 filled tap water, 1 empty	1.0	Axis vertical
6	40	5	10' long, 2" inner diameter (ID) steel pipe	0.5	Axis N-S
6	40	15	10' long, 2" ID steel pipe	0.5	Axis N45E
6	40	25	10' long, 2" ID steel pipe	0.5	Axis N90E
6	40	35	20' long, 2" ID, steel pipe	1.0	Axis N90E
6	40	45	10' long, 2" ID steel pipe × 2	1.0	Axes N90E, 0.5 m horizontal separation
7	50	0	10' long, 2" ID, steel pipe × 2	1.0	Axes N90E, 1.0 m horizontal separation
7	50	15	10' long, 2" ID steel pipe × 2	1.0	Axes N90E, 2.0 m horizontal separation
7	50	20	10' long, 2" ID steel pipe × 2	0.5	Axes N90E, 0.5 m horizontal separation
7	50	30	10' long, 2" ID steel pipe	0.5	Axis vertical, 0.6 m to top
7	50	40	10' long, 2" ID steel pipe	0.5	Axis vertical, 0.6 m to top

(0.32 m) and 12 in. (0.30 m), for the 8 in. and 12 in. covers, respectively.

Line 3 (10 m N; Figure 4) contains five spots with double and triple 55 gal empty steel drums buried at depths ranging between 2 and 3 m. The distance between each of these objects is 10 m. Double drums were installed parallel to each other in horizonal (long axis east–west) or vertical (e.g., long axis upright) positions. One set of triple drums was oriented with a triangular contact, and the other set was oriented in a horizontal (long axis north–south) position (Figures 7d–7f).

Line 4 (20 m N; Figure 4) contains five single 30 gal (113.56 liter; length: 0.76 m; width: 0.48 m) plastic drums buried at depths of either 0.5 or 1 m and distributed at a 10 m interval. Three drums are empty and two are filled with tap water. Two of these drums were oriented vertically (e.g., long axis upright) and three horizontally (e.g., long axis east–west) (Figure 9).

Line 5 (30 m N; Figure 4) contains five targets. We installed 30 gal plastic drums in three spots (10 m apart), and 6 gal (22.71 liter; length: 0.36 m; width: 0.30 m) plastic buckets in the other two spots (10 m apart). The distance between the fourth (plastic bucket) and fifth (plastic drum) objects is 5 m. Two plastic drums were filled with 2% salt water; the third was half-filled with 2% salt water. The 2% salt concentration was obtained by adding 2.27 kg of table salt to 30 gal of water. One plastic drum was oriented vertically (e.g., long axis upright) and two drums are oriented horizontally (e.g., long axis east–west). The plastic buckets were installed upright; one spot contains an empty bucket and the other spot contains a bucket filled with tap water and an empty bucket (Figure 9).

Figure 7. (a) Installation and dimensions of steel drums within the GTS. Also shown are the (b) horizontal, (c) vertical, (d) double adjacent, (e) triple adjacent, and (f) triple triangle contact alignments.

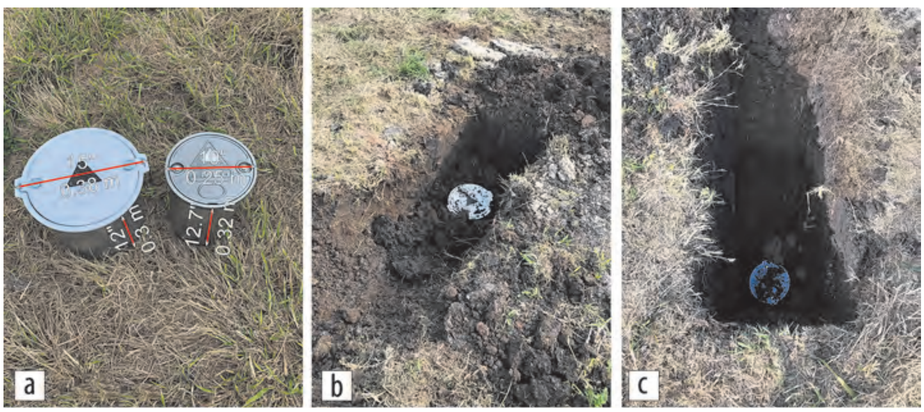

Figure 8. Well covers within the GTS showing (a) types and dimensions, (b) shallow placement (0.5 m), and (c) deep placement (1.5 m).

Line 6 (40 m N; Figure 4) contains five targets distributed at an interval of 10 m. These targets are steel pipes (diameter: 2 in. [0.05 m], length: 10 ft [3.04 m]) that were buried at depths of 0.5 and 1 m. These pipes are oriented north–south, N45E, and east. The last spot has two parallel pipes that are trending east and separated by 0.5 m (Figure 10).

Line 7 (50 m N; Figure 4) contains steel pipes (five spots) buried at depths of 0.5 and 1 m. These were distributed at a 10 m interval, except spots 1 and 2 (15 m interval) and spots 2 and 3 (5 m interval) to avoid intersecting with the pre-existing cross-country athletic track. Three spots each had two pipes oriented horizontally (e.g., axis east–west) separated by 0.5, 1, and 2 m horizontally. Two spots had pipes installed vertically, 0.6 m below the ground surface (Figure 10).

Research and educational significance and implications

The GTS provides an ideal platform to enhance teaching and research activities in southern Texas. The GTS will be open for local and regional institutions to use for research and educational purposes. Field-based exercises enhance student engagement and performance by allowing them to learn through active exploration and interaction (James et al., 2003; Li and Liu, 2003; Day-Lewis et al., 2006). Students often are more responsive to concepts when

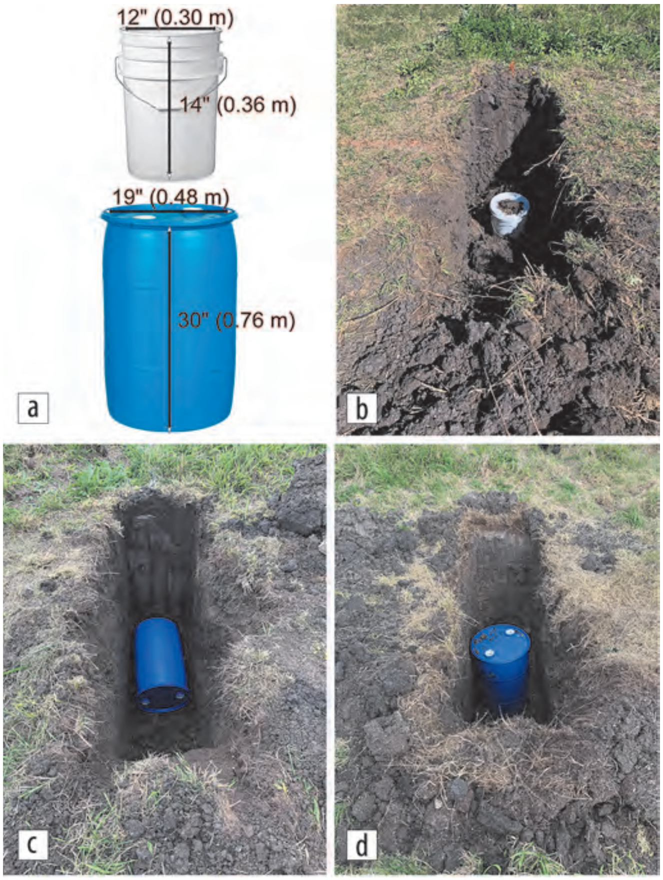

Figure 9. Plastic drums and buckets within the GTS. (a) Types and dimensions of plastic drums and buckets, (b) vertical plastic bucket, (c) horizontal plastic drum, and (d) vertical plastic drum.

Figure 10. (a) Types and dimensions of steel pipes installed within the GTS. Also shown are (b) single horizontal, (c) double 1 m apart, and (d) vertical steel pipes.

they are presented in settings away from regular classrooms or assigned reading methodologies (O'Neal, 2003; Pringle et al., 2010). Generally, field exercises are interesting, motivating, rewarding, and enjoyable for both students and instructors (Fuller et al., 2003).

The GTS is currently serving as a field laboratory for TAMU-CC geophysics and field geology classes. We plan to add GTS-based exercises to current and future hydrogeology, environmental geology, engineering geology, and environmental and engineering geophysics classes. By adding GTS-based field exercises to our course syllabi, we are:

- providing students with the opportunity to practically learn principles behind geophysical methods, geophysical responses over known subsurface targets, and how geophysical techniques are integrated and used for different environmental and geotechnical applications
- increasing students' knowledge about modern environmental and engineering problems that could be solved using geophysical techniques
- helping students recognize which geophysical methods are appropriate to use to address a specific environmental or engineering situation/application
- effectively teaching students how to define typical pitfalls in acquisition, processing, and interpretation of geophysical data
- facilitating interpretation of different geophysical data collected at sites with unknown subsurface features/objects, which will increase the students' confidence in themselves and their ability to analyze and interpret geophysical data
- attracting students with different backgrounds (e.g., environmental sciences, geology, geophysics, engineering, physics), which will foster interaction between future scientists and technicians who work together in investigating environmental, geotechnical, and engineering issues
- promoting undergrad and graduate research in environmental problems
- enhancing the employment prospects for our graduating geology, environmental sciences, and engineering majors by providing practical experience related to their future professional development as well as facilitating students' interaction with industry representatives who use the GTS for equipment calibration

The GTS will be used for research activities as well. The currently established GTSs have been used successfully for various research (Bailey and Sauck, 2000; Giao and Vichalai, 2006; Porsani and Sauck, 2007; Sauck, 2009; Porsani et al., 2010). The TAMU-CC GTS will be used to:

- check the penetration and resolution of different geophysical methods for detection and characterization of shallow subsurface targets buried in clay-rich sediments, an environment that provides challenges and limitations to several geophysical techniques

- compare and investigate differences between modeled and measured responses of geophysical techniques over known subsurface objects
- investigate seasonal changes in geophysical signatures over targets of known materials and depths
- compare responses of different geophysical equipment measuring the same physical parameters
- explore temporal changes in remnant and induced magnetizations of buried metal objects (e.g., drums, pipes, well covers)
- investigate changes in polarity of geophysical anomalies associated with progressive depth increment

The GTS will also serve as a validation site for various geophysical techniques that are routinely used in geologic, geotechnical, and environmental investigations. It could be used to calibrate geophysical equipment over objects with known materials and depths. In addition, the GTS will be used to validate inversion software packages used for geophysical investigations. TLE

Acknowledgments

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Data and materials availability

Data associated with this research are available and can be obtained by contacting the corresponding author.

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Gyp Hill West
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Heyser
Lavaca Bay
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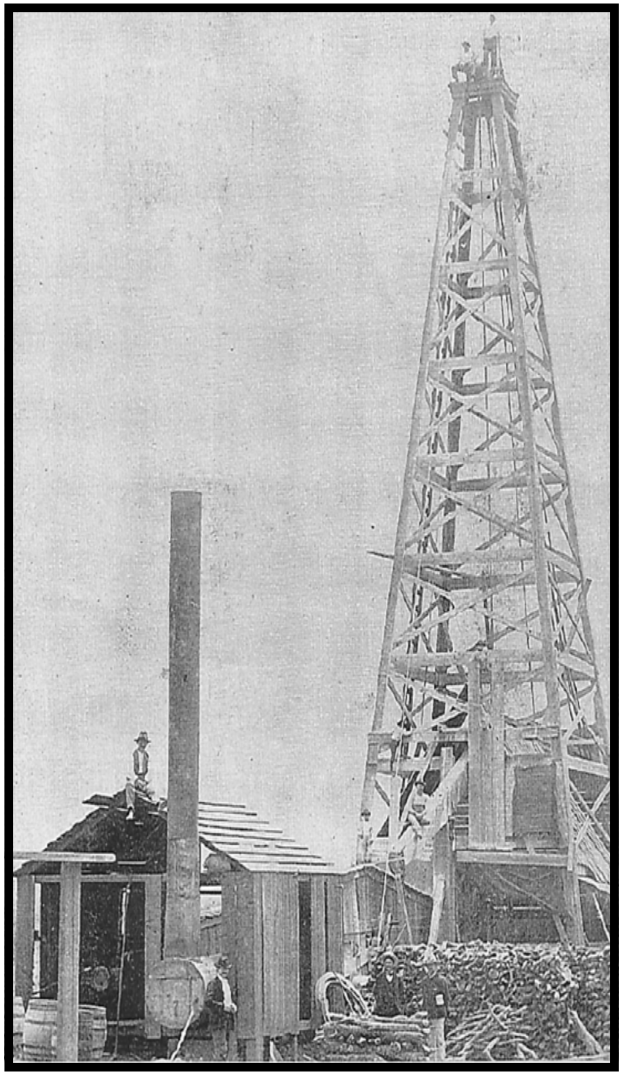

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