BULLETIN

Corpus Christi
Geological Society

and

Coastal Bend
Geophysical Society

October
2017

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TABLE OF CONTENTS

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2017-2018
www.ccgeo.org

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P.O. BOX 2741*C.C. TX. 78403
2017-2018

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Visit the geological web site at www.ccgeo.org

CCGS/CBGS JOINT MEETING SCHEDULE 2017-2018

September 2017

S	M	T	W	Th	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

October 2017

S	M	T	W	Th	F	S
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8	9	10	11	12	13	14
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22	23	24	25	26	27	28
29	30	31				

November 2017

S	M	T	W	Th	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Monday, Oct. 2, 2017 6:00 pm BBQ Kickoff at Hoegemeyers & Presentation by Carl Tape, Ph.D., Associate Professor of Geophysics, Geophysical Institute, University of Alaska Fairbanks "*Seismology in Alaska: Earthquakes, Bears, & High-Performance Computing.*"

Oct., 18, 2017 11:30am-1:00pm Speaker: David Mittlefehldt, PhD., Planetary scientists, Astromaterials Research & Exploration Science (ARES), Johnson Space Center, National Aeronautics & Space Administration (NASA) "Mars Exploration Rover Opportunity: Exploring the Rim of Endeavour Crater on Mars, Day-4,841+of a 90-Day Mission."

11:30 am – 1:00 pm
Speaker: Eugene L. Ames, Jr. "The History of Discovery: The Largest Oil Field in the World & Other Musing by a Geologist & Wildcatter."

December 2017

S	M	T	W	Th	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

January 2018

S	M	T	W	Th	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

February 2018

S	M	T	W	Th	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

Combined November/December for the Holidays.

11:30 am – 1:00 pm
Speaker: To be determined

11:30 am – 1:00 pm
Speaker: Peter Wang, Geophysical Technical Advisor, Paradigm "A New Technique of Lithology and Fluid Content Prediction from Prestack Data: An Application to a Carbonate Reservoir"

CCGS/CBGS Joint Meeting Schedule 2017-2018

March 2018

S	M	T	W	Th	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

11:30 am – 1:00 pm
Speaker: To be determined

April 2018

S	M	T	W	Th	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

11:30 am – 1:00 pm
Speaker: To be determined

May 2018

S	M	T	W	Th	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

11:30 am-1:00 pm
Speaker: To be determined

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
Austin Chapter of SIPES………… First Thursday
Houston Geological Society Luncheons………… Last Wednesday
Central Texas Section of Society of Mining, Metalllurgy & Exp………… 2nd Tues every other month in San Antonio

CCGS PESIDENT'S LETTER

It is very difficult not to think of the recent storm and those affected. I hope this letter finds the membership, their friends and families as well as can be post Harvey. We would like to attempt to organize those in our ranks who feel compelled to do something for those in need across the bay. We will discuss this endeavor in more detail during the next board meeting and hopefully come up with a plan of action that involves enough members to assist with the numerous jobs needed in Port Aransas, Aransas Pass, Rockport, and other small communities within reach. Keep in mind that no matter your state of physical ability there is a job small or big enough for you to make a difference. Please contact me directly via email at Austin@nyexp.us to volunteer, as I am sure the help will be needed for many months to come.

Austin Nye
CCGS President

The Corpus Christi Geological Society
The Coastal Bend Geophysical Society

Invite you to the

Society Kickoff Bar-B-Q

Monday, October 2, 2017

5:30 to 8:00 p.m.

Hoegemeyer's Barbeque Barn

711 Concrete Street (Located across from Concrete Street Amphitheater).
From downtown, take Chaparral St. north, then left on Belden St.

$25 per member/guest

$15 students*

Complimentary Bar Courtesy of

GISLER BROTHERS LOGGING CO., INC.

South Texas Operations
P.O. BOX 485 RUNGE, TEXAS 78151
Office : (830) 239-4651 Cell : 361-676-1369

West Texas Operations
P.O. BOX 1759 STANTON, TEXAS 79782
Office : (432) 270-7730 Cell: 361-676-1369

This year during the Kickoff, we will be hosting a slide presentation: Dr. Carl Tape: Associate Professor, Geophysical Institute at the University of Alaska Fairbanks on earthquakes and seismicity in Alaska.

RSVP (required) by Friday, Sept. 29

Dorothy Jordan, Dorothy@headingtonenergy.com, 361-885-0113

Wes Gisler, wes@gislerbrotherslogging.com, 1-830-239-4651

***Special thanks to the 2017 Fiery Ice Conference at TAMUCC, Dec. 6-8, for supporting the reduced student costs for this year's Kickoff. Find out more about the conference at www.fieryice2017.com**

CBGS President's Letter

CBGS Scholarships

The board decided to give 2017-2018 scholarships of $2,000 each for Texas A&M University-Kingsville, Texas A&M University-College Station, and the University of Houston to promote geophysics. The following criteria is followed in awarding the scholarships.

1. Must be a citizen of the USA

2. Must have declared Major Geophysics at the main campus of the receiving university

3. Must have GPA 3.0

4. Must 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.

Dr. Subbarao Yelisetti- President
Lonnie Blake- Vice President
Matt Hammer- Secretary/ Treasurer
Dr. Robert Schneider- Continuing Education
Lonnie Blake- Golf Chair
Ed Egger- Scholarship Chair

News

- According to the U.S. government, the U.S. shale production is set to rise for the 10th consecutive month in October, spurred by U.S. oil prices rising above the $50 a barrel threshold.

- The U.S. Energy Information Administration (EIA) reports that the Eagle Ford oil output in Texas is set to fall by 9,000 barrels per day (bpd) to 1.27 million bpd, the first monthly decline since April.
- Permian production is forecast to rise by nearly 55,000 bpd to 2.6 million bpd, the highest level in records dating back to 2007 as reported by Catherine Ngai and Scott DiSavino on reuters.com.
- U.S. natural gas production was projected to increase to a record 59.7 billion cubic feet per day (bcfd) in October. That would be up almost 0.8 bcfd from September and also the seventh monthly increase in a row as reported by Catherine Ngai and Scott DiSavino on reuters.com.
- The EIA projected gas output would increase in all of the big shale basins in October, except for the Eagle Ford as reported on reuters.com.

CBGS Business

CBGS currently has 49 members.

CBGS offered Basic Seismic Attributes course on 28th April, 2017 in EOG conference center in Corpus Christi and is looking forward to offer many such courses. Topic suggestions are welcome. Email your suggestions to Subbarao.Yelisetti@tamuk.edu or Lonnie_Blake@eogresources.com

CBGS will hold its annual **Golf Tournament** to fund its scholarship program on October 6, 2017 at Northshore Country Club
To participate or sponsor, please contact Lonnie Blake, 361 887 2665, Lonnie_Blake@eogresources.com
Anyone who wants to help, contact Lonnie Blake

BS degree in Geophysics, Minor in Geophysics and Certification in Geophysics offered at Texas A&M University-Kingsville from Fall 2017.
Please contact Dr. Subbarao Yelisetti (Subbarao.Yelisetti@tamuk.edu) or
Dr. Robert Schneider (Robert.Schneider@tamuk.edu) for additional information.

TAMUK will offer GEOL 4375/PHYS 5385-Seismology grad/undergrad stacked class on Tuesday and Thursday from 5:00-6:15 pm in Spring 2018. This is available for the professional community as well as our students. You can sign up as a “transient” student in order to take classes without actually enrolling in the school. If anyone in the professional community wishes

to sign up for this, please contact the instructor, Dr. Subbarao Yelisetti
Subbarao.Yelisetti@tamuk.edu

Education/Events

-SEG

SEG annual meeting in Houston, September 24th-29th.

Technical program can be found at http://seg.org/Annual-Meeting-2017/Schedule/Sessions.

See http://seg.org/Annual-Meeting-2017/Schedule/Courses for continuing education courses.

Visit http://seg.org/Annual-Meeting-2017/Schedule/Workshops for workshops.

See http://seg.org/Education/Lectures/Honorary-Lectures/2017-HL-van-der-Baan for SEG honorary lecture locations in Texas. Topic is human-induced seismicity.

See http://seg.org/Education/Lectures/Distinguished-Lectures/2017-DL-Abma for information about upcoming SEG distinguished lecture in Houston and other locations.

-SPE

SPE convention in San Antonio, October 9th-11th.

-AGU

AGU fall meeting in New Orleans, December 11th-15th.

See https://agu.confex.com/agu/fm17/preliminaryview.cgi/programs.html for sessions and program information.

Monthly Saying

"Prospecting for oil is a dynamic art... The greatest single element in all prospecting, past, present and future, is the man willing to take a chance." - Everett DeGolyer

Monthly Summary

Texas Oil and Gas Info	Current Month	Last Month	Difference	
Texas Production	**MMBO/BCF**	**MMBO/BCF**	**MMBO/BCF**	
Oil	87.8	94.8	-7.0	June
Condensate	9.2	9.7	-0.5	June
Gas	616.7	648.1	-31.4	June
	Current Month	**Yr to date - 2017**	**Yr to date - 2016**	
Texas Drilling Permits	1125	8628	4830	August
Oil wells	298	2199	1412	August
Gas wells	74	479	250	August
Oil and Gas wells	666	5419	2848	August
Other	21	123	88	August
Total Completions	557	4945	8107	August
Oil Completions	401	3917	6166	August
Gas Completions	115	676	1527	August
New Field Discoveries	2	22	16	August
Other	3	10	42	August

Subbarao Yelisetti
President, CBGS

Seismology in Alaska: earthquakes, bears and high-performance computing

Alaska is one of the world's prolific producers of earthquakes, including the 2002 magnitude 7.9 strike-slip earthquake on the Denali fault and the 1964 magnitude 9.2 subduction earthquake on the Alaskan megathrust. Earthquakes occur throughout the state and are a reminder of the active subduction, collision, and faulting that have shaped the highest mountains in North America. Over the past five years, seismic stations have been deployed in some of Alaska's most inaccessible regions. New seismic data provide opportunities to characterize new fault zones and to image complex subsurface structures, from the underlying Pacific slab to sedimentary basins within the crust. Complex structures produce complex earthquake ground motion that can be modeled using high-performance computational resources. I will discuss new seismic deployments, discoveries, and scientific frontiers in Alaska.

Dr. Carl Tape is a seismologist the University of Alaska Fairbanks. He develops and applies techniques in computational and observational seismology to obtain better images of Earth's internal structure and to obtain better representations of earthquakes. Three-dimensional numerical simulations of the seismic wavefield form the foundation of computational seismology. These simulations produce synthetic seismograms and also volumetric sensitivities that are used within the seismic imaging problem. Improved seismic images of the crust and mantle provide an important snapshot of a dynamic Earth, and they can be used for scenario earthquake simulations that help assess seismic hazard in earthquake-prone regions. Dr. Tape received his B.A. in physics and geology from Carleton College, a M.S. from Oxford University, and a Ph.D. from California Institute of Technology. He did postdoctoral research at Harvard University before starting as faculty at UAF in 2010.

EarthScope

Speaker Series

Monday, October 2nd

The EarthScope Speaker Series is part of the larger EarthScope Education and Outreach program and seeks to present the scientific results of EarthScope researchers to faculty and students in departmental seminars at colleges and universities. Speakers are selected based on their outstanding research accomplishments involving EarthScope as well as their abilities to engage a variety of audiences.

"We'll be talking about his talk for some time"; "Expressing the contribution of EarthScope and its available data is always a great reminder for the faculty and grad students in the department"; "very valuable in terms of collaborative connections and collegial outreach".

Texas A&M University - Kingsville

700 University Blvd, Kingsville, TX 78363 | Time & Bldg TBA | (361) 593-2767

www.earthscope.org

CBGS GOLF TOURNAMENT

Coastal Bend Geophysical Society
NorthShore Country Club
October 6, 2017
12:30 p.m. Shotgun Tee Time
Four-Man Scramble
100 Player Limit * Sign up Early
Contact: Lonnie Blake – Lonnie_blake@eogresources.com
361 876 6614

Name ________________________________

Email ________________________________

Company Name ______________________

Address ______________________________

City, State, Zip ________________________

Phone _______________________________

_____ Yes, Please Place on a Team

_____ I want to be on a Team with: (list below)

Player 2: _____________________________

Player 3: _____________________________

Player 4: _____________________________

_____________ $100 per Golfer

_____________ $400 per Team (4 players)

_____________ Sponsorship Total

_____________ **TOTAL AMOUNT DUE**

PAYMENT INFORMATION

_______ Check Enclosed

Make Checks payable to:
Coastal Bend Geophysical Society
Matt Hammer
500 N. Shoreline Blvd Ste. 807,
Corpus Christi, Texas 78401

Sponsorships

#____ Golf Beverage Cart $700 ea. _______

#____ Golf Holes (18) $200 ea. _________

#____ Longest Drive
(2) $100 ea. __________

____ Closest to the Pin
(2) $100 ea. __________

Door Prize Sponsor __________

Total Sponsorship $___________

NorthShore Country Club

801 E. Broadway St.
Portland, TX 78374
Entry Fee Includes:

- Green Fees
- Range Balls
- Carts
- Beverages on the Golf Course
- Door Prizes
- Dinner Buffet

Energy Auxiliary

Please join us for a Meet and Greet

The Bissells' Otra Casa

249 Circle Drive

Entrance on Third Street

Thursday, October 5, 2017

5:30 pm to 7:30 pm

RSVP by Friday, September 29th to

Dawn at 361-960-2151 or bissells@swbell.net

Events planned for 2016-2017

Wednesday, December 6th – Fall Cocktail Party

Thursday, February 15th – Ladies Night Out

Friday, April 27th – Shrimp Boil

Wednesday, June 6th – Spring Luncheon

Board Members for 2017-2018

President ~ Darlene Murry
VP /Secretary ~ Dawn Bissell
Treasurer ~ Leslie Blake
Social Directors ~ Melody Schnexnayder and Mary Jones
Parliamentarian ~ Rita Graham

We don't hold monthly meetings; we simply have 3-4 social gatherings per year! It's a great way to get to know folks in our industry and a good time is always had by all.

Energy Auxiliary
2017 - 2018 ~ Membership Form
Please enclose your membership dues of $35 payable to EA and return to
Leslie Blake – 409 Santa Monica Pl. - Corpus Christi, TX 7841

Name: ______________________________ Spouse's name: ________________________
Address: ___________________________ Home phone: __________________________
City, Zip: _________________________ Email: ______________________________
Your place of work: ________________ Your work/cell phone: ________________
Spouse's place of work: _____________ Best contact number: _________________

Please indicate on back how you would like to help - from joining the board, serving on a committee, to ideas for events. Suggestions?

sponsors

TEXAS A&M UNIVERSITY CORPUS CHRISTI HOKKAIDO UNIVERSITY UNIVERSITETET I BERGEN HNEI Hawai'i Natural Energy Institute University of Hawai'i at Mānoa AIST NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

FIERY ICE 2017 - *Corpus Christi, Texas, USA, 6-8 December 2017*

The website for the 11th International Workshop on Methane Hydrate Research and Development is now open: http://www.tamucc.edu/pens/fiery-ice-2017 (August 1, 2017). Details of the Workshop and a link to online registration are provided on this website.

Important Dates (North America Central Standard Time [CST]):

- August 1, 2017: Fiery Ice 2017 website opens
- August 1, 2017: Online registration begins
- September 1, 2017: Opening date for abstract submission
- October 15, 2017: Last day to submit abstracts
- November 1, 2017: Notification of acceptance of submitted abstracts
- October 20, 2017: Early registration closes
- December 7, 2017: Online registration closes

Registration Fees:

- Early registration (until October 20, 2017): U.S. $600
- Regular registration (until December 7, 2017): U.S. $700
- Student registration (until November 15, 2017): U.S. $300
- Onsite registration: U.S. $700 (Regular); U.S. $400 (Student)

The registration fee includes:

- *Admission to the workshop on December 6, 7, and 8*
- *Reception on December 6*
- *Banquet Dinner on December 7*
- *Lunch on December 6 and 7*
- *Breakfast on December 6, 7 and 8*
- *Morning and afternoon refreshments during the workshop*

Please note that registration fee does not include accommodations. Participants are responsible for reserving and paying for their hotel accommodations. Hotel registration will be available August 1, 2017.

Call for Abstracts:

The Call for Abstracts will be emailed and posted on the website by August 1, 2017

Tentative Program Schedule:

Time / Date	December 5 (Tue)	December 6 (Wed)	December 7 (Thu)	December 8 (Fri)
Morning	Pre-workshop event	Registration Opening remarks Plenary lecture 1	Registration Breakout session report 1 National reports	Breakout session report 2 Plenary lecture 2 Closing remarks
Afternoon 1		Oral presentations National reports	Oral presentations National reports	
Afternoon 2		Poster presentations Breakout session 1	Poster presentations Breakout session 2	
Evening		Banquet Dinner – Corpus Christi Aquarium	TAMU-CC Campus Dinner and Cocktails	

Changes in this schedule will occur as speakers are organized.

Pre-Workshop Event:

The pre-workshop event on December 5 will be held at the Omni Hotel and will include registration at a reserved location in the lounge where cocktails can be purchased.

Breakout Sessions:

The topics of the 6 breakout sessions that will be held on December 6 and 7 are being finalized by the International Steering Committee. An announcement of the breakout session topics will be posted on the Workshop website in the near future.

Workshop Venue:

The 11th International Workshop on Methane Hydrate Research and Development will be held at the Omni Hotel in downtown Corpus Christi, Texas.

Accommodations:

Blocks of hotel rooms at the Omni Hotel (https://www.omnihotels.com/hotels/corpus-christi) in downtown Corpus Christi at a discounted rate have been reserved for the workshop participants. Please visit the Workshop website and go to the Accommodations section for more information.

Visas:

Detailed information regarding visas is available on the Workshop website. If you are NOT a citizen or permanent resident of the U.S. or its territories, or reside in a U.S. Visa Waiver Program (VWP) designated country, and are planning to apply for a Visitor (B) visa, then please do so as early as possible. Please contact us by email if you have questions or require assistance in obtaining a visa.

International Steering Committee:

Professor Richard Coffin
Texas A&M University Corpus Christi USA

Professor Bjørn Kvamme
University of Bergen NORWAY

Professor Stephen Masutani
University of Hawai‘i USA

Dr. Norio Tenma
National Institute of Advanced Science & Technology JAPAN

Professor Tsutomu Uchida
Hokkaido University JAPAN

Workshop Secretariat:
Email: Alessandra.Garcia@tamucc.edu
Website: http://www.tamucc.edu/pens/fiery-ice-2017


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Field Notes: My Eclipse - A Transcending Experience

What did I expect to experience in the August 21, 2017 Eclipse? I had no idea what it would be like to be in the zone of "totality," but I knew that it was something we had to do -- if it was easy and cheap. Dawn had been talking about the 2017 Eclipse for about 10 months. She genuinely is an inspiring science-lover having provoked me to see *Australopithecus afarensis* (Lucy), the Marfa Lights, and now the Eclipse. All were glorious experiences.

"I simultaneously felt a very small part of the magnanimous universe, but infinitely large in the centrality of my self-awareness and consciousness."

The story: We had discussed the logistics of finding the "right place" to see the eclipse and found several great resources online. Nashville seemed a logical launching point, with family in the region and the advantages of a multi-purpose trip. As we looked at all the options, Paducah, Kentucky, caught my eye but even a few months beforehand all the rooms were booked.

Having traveled to Nashville numerous times to visit family, one of our favorite places to stay is the "Cabin at Cedar Run Farms." This early-1800's log cabin was rebuilt as a guest house and styled as a B&B. When we found out that it was available for the eclipse, we booked it immediately.

Was 99.7% totality was total enough? In the days before the event, having studied the maps, it seemed fairly straightforward to travel north into the shadow of the moon. Actually, totality was only about 15 miles north of the cabin. The small hamlet of Ashland City, Tennessee, was offering free Moon Pies at their city park on the Cumberland River and that location was scheduled to experience almost 2 minutes of totality. But between the cabin and Ashland City, there were a string of lovely Tennessee State Parks along the Harpeth River. The limestone cliffs of the river valley showed promise for a spectacular place to view the eclipse. After driving around and earnestly searching, we settled on the "Narrows of Harpeth" as the right place.

The "Narrows" is a tight meander bend on the Harpeth River where a late 1800's entrepreneur cut a tunnel and channel through the Chattanooga Shale in order to create a waterfall for a mill. In the State park, the soft Devonian Chattanooga Shale underlies cliff forming, Mississippian Fort Payne Limestone. In Texas, the same section is called the Woodford Shale and the Mississippi Lime. Like the Mississippi Lime, the Fort Payne is known for siliceous sponges. The cliff is about 150-200 ft. of escarpment overlooking the river valley and the Harpeth Indian Mounds on the floodplain below. This vantage point was breathtaking.

Randy Bissell

Climbing to the top of the ridge, we experienced the initiation of the eclipse with a group of exuberant young locals. As the eclipse progressed towards 50%, we came off the cliff to explore other potential vantage points for totality. Hunger drove us back to the car, where we set up our recently purchased Wal-Mart lawn chairs and enjoyed our pecan chicken salad sandwiches and cold Yuengling beers from the Shell in Pegram, Tennessee.

As the eclipse progressed towards 60%, the shadow effect began to be seen along the roadway where light was filtered through the foliage. Each ray of sunlight became a pinhole telescope for observing the progression towards totality. This produced thousands of little eclipses along the roadway.

What happened towards totality was particularly amazing. When the exact time of the anticipated eclipse was 4 minutes ahead, things began to get pretty weird. As the sun was obscured, the afternoonish light was enchanting. The cicadas began their evening musical ritual as the light dimmed. The serenity of this momentary sunset upon us, the landscape then went dark. In that last moment, I raised my camera to snap the photo above. But then I stared heavenwards, with no camera, no funny glasses, facing the sun to see the black disc of the moon blocking the full glare of our star. Around the moon, the corona of the sun shown hazily into the inky blackness of the darkened sky.

The physical experiences of my other senses were magical. The calm air was cooled in the shadow of the moon crossing the warm August countryside. Stillness. With no exaggeration, there was a peace - a feeling of spiritual integration between my physical existence and nature below and above me. I simultaneously felt a very small part of the magnanimous universe, but infinitely large in the centrality of my self-awareness and consciousness. Others who likewise experienced the eclipse speak to its deep effect on them. It is a difficult articulation but I hear their stories and I relate to the common thread of self-awareness.

Twenty seconds of transcendence and the sun peaked again from the edge of the moon. The eclipse was now in recession...and the earth woke up to its mid-day morning. The anticlimactic seemed to accelerate back to normalcy. People came down from the cliffs. Families loaded up and drove away. We simply sat in our lawn chairs and watched.

So, was it worth it? The planning, the flight, the car rental, the travel stresses? **Yes**, absolutely and completely. As a friend expressed...I think we are now "eclipse chasers!" The next event is on April 8, 2024, and Dawn is making her plans. The 2024 eclipse will sweep across Texas, from Del Rio to Texarkana. We are hooked and excited at the prospect of repeating a "once in a lifetime experience."

Randy Bissell

Technical Editor Note:

The paper in this month's Bulletin is a classic. It was coauthored by two of our very own successful geologist, Don Boyd and Byron Dyer in 1964. The paper is still relevant today in that many of us are back to looking for shallow oil and the Frio Formation is one good place to look.

FRIO BARRIER BAR SYSTEM OF SOUTH TEXAS

DON R. BOYD[1]

BYRON F DYER

ABSTRACT

A study of available subsurface data from wells drilled in the South Texas Counties of Aransas, Nueces, Refugio, and San Patricio discloses the presence of a barrier bar system in the Frio formation (Oligocene in age) which is easily divisible into three distinct depositional environments. With the termination of the major Vicksburg transgression, the seas began their slow withdrawal and deposition of Frio clastics commenced. Within this regressive framework of the Frio, a massive sand bar developed which is analogous to the present day Padre-Mustang-St. Joseph-Matagorda Island complex. These Frio bar sands were transported by longshore currents from an area to the southwest where extensive deltas were being built by the ancestral Rio Grande River Within the Frio bar system continental shelf, bar and lagoonal environments are recognizable. Prolific production has been established in sands occurring in each of these environments. The success of future exploration within the Frio is largely contingent upon a thorough understanding of the depositional framework of this Frio barrier bar system.

INTRODUCTION

The Frio formation, studied downthrown to the Frio-Vicksburg Flexure in Aransas, Nueces, Refugio, and San Patricio Counties, Texas forms an extensive barrier bar system (see Index Map, Figure 1) which is analogous to the present day Padre, Mustang, St. Joseph, and Matagorda Islands of the South Texas Gulf Coast. Frio and Vicksburg formations attain a maximum thickness in the Rio Grande Valley Oligocene depocenter southwest of the subject area in the vicinity of Brooks, Hidalgo, and Kenedy Counties, Texas. For related isopachous maps refer to Williamson 1959 Clastic sediments were deposited to the south by the ancestral Rio Grande River in the form of extensive deltas. Longshore currents transported excess clastic material laterally to form the nucleus of the Frio barrier system in area studied. The Frio barrier system gradually loses its identity further north in Jackson and Wharton Counties where it merges with deltaic sediments of the ancestral Brazos River The proximity to Mesozoic carbonate mountain ranges in adjacent Mexico probably contributed strongly to the high lime cement content of the Rio Grande Valley Frio sands. Sands in the area studied are far enough removed from the lime source so that cementation has not appreciably affected their porosity and permeability

The age of the subsurface Frio has long been in question and this paper will not attempt to resolve such a controversial problem. Most geologists are in agreement that the surface Frio is actually equivalent to a portion of the subsurface Vicksburg which is definitely Oligocene in age. Further agreement is generally found in assigning a Miocene age to the subsurface Anahuac which includes the *Discorbis*, *Heterostegina*, and *Marginulina* zones. The disputed subsurface Frio is probably considered by the majority of geologists to be Oligocene in age. Detailed subsurface correlations in South Texas leave little doubt concerning the rock units being considered and the disagreement over the age of the Frio assumes no practical importance. This paper considers the Frio formation as a "rock" unit which encompasses those sands and shales found between the underlying marine shales of the Vicksburg formation and the lowermost marine shales of the overlying Anahuac formation. The top of the Vicksburg is generally marked by the first occurrence of *Textularia warreni*. The shales of the Anahuac formation comprise the *Heterostegina* zone within the area studied. This means that the Frio barrier bar system in the area of study encompasses the regressive Frio sequence and the transgressive Marg.-Frio (Greta Sand sediments of the *Marginulina* zone. For a more complete discussion of these age problems as well as the stratigraphic relationships both at the surface and in the subsurface, the reader is referred to the Houston Geological Society Study Group Report published in 1954. Other pertinent references are Sellards, et al (1933), Ellisor (1933 and 1944, Cooke 1939, Reedy 1949 and Akers and Drooger 1957

GEOLOGICAL HISTORY

The Vicksburg seas transgressed a vast area of South Texas depositing predominately shales in the area studied, but did not reach as far inland as the underlying Jackson (Eocene) transgression. Shale deposition took place within the subject area in both Jackson and Vicksburg time, but their faunal assemblages are readily discernible. The top of the Jackson formation is considered to mark the top of the Eocene and the base of the Vicksburg formation corresponds to the base of the Oligocene. Vicksburg and Frio sediments were deposited over an existing Jackson continental slope (Burke 1958 and the burden of these sediments is believed by many to have caused a slumping effect which resulted in the Sam Fordyce-Vanderbilt fault system. Common usage by geologists in South Texas has firmly entrenched the term "Frio-Vicksburg Flexure" in South Texas lit-

[1]Texas Eastern Transmission Corporation, Corpus Christi, Texas

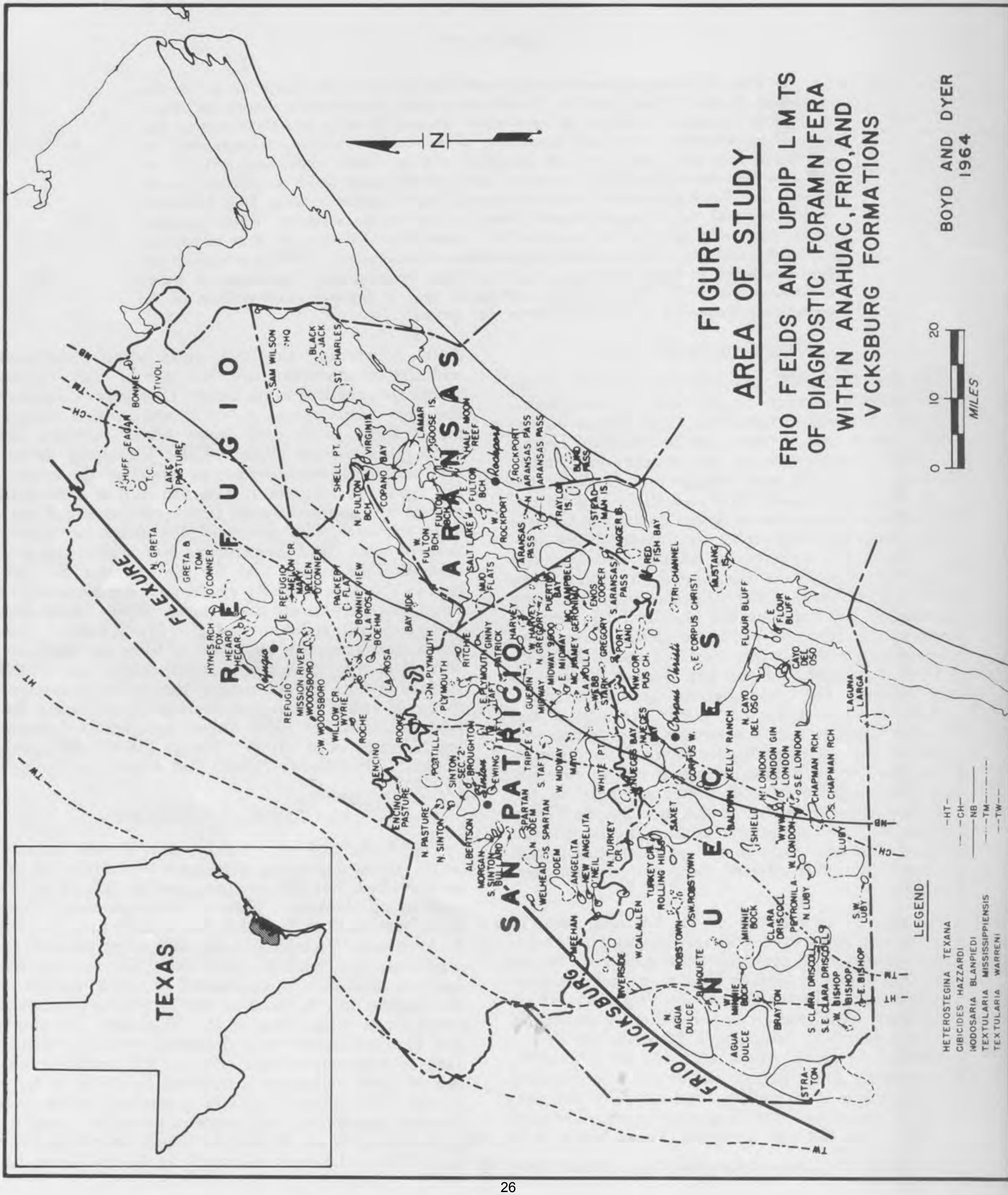

FIGURE I
AREA OF STUDY
FRIO F ELDS AND UPDIP L M TS
OF DIAGNOSTIC FORAM N FERA
WITH N ANAHUAC, FRIO, AND
V CKSBURG FORMATIONS

BOYD AND DYER
1964

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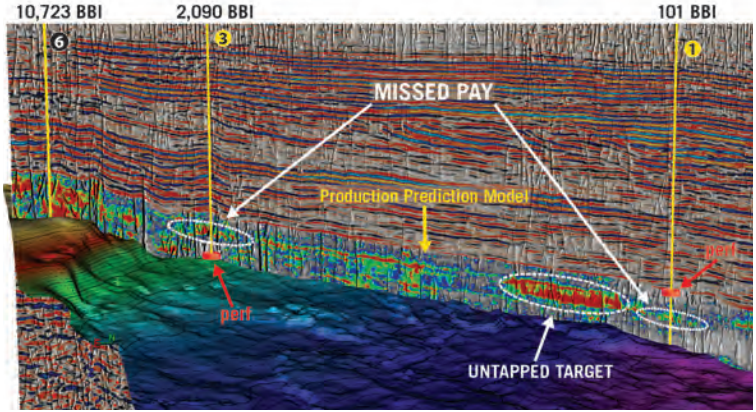

An arbitrary line through 3 vertical wells in the West Texas Permian Basin shows the lateral variations of the Production Prediction Model and reveals refrac potential for Wells 1 and 3 where the red disks indicate the actual completion intervals and the white circles highlight the missed pay. Note the untapped target near Well 1.

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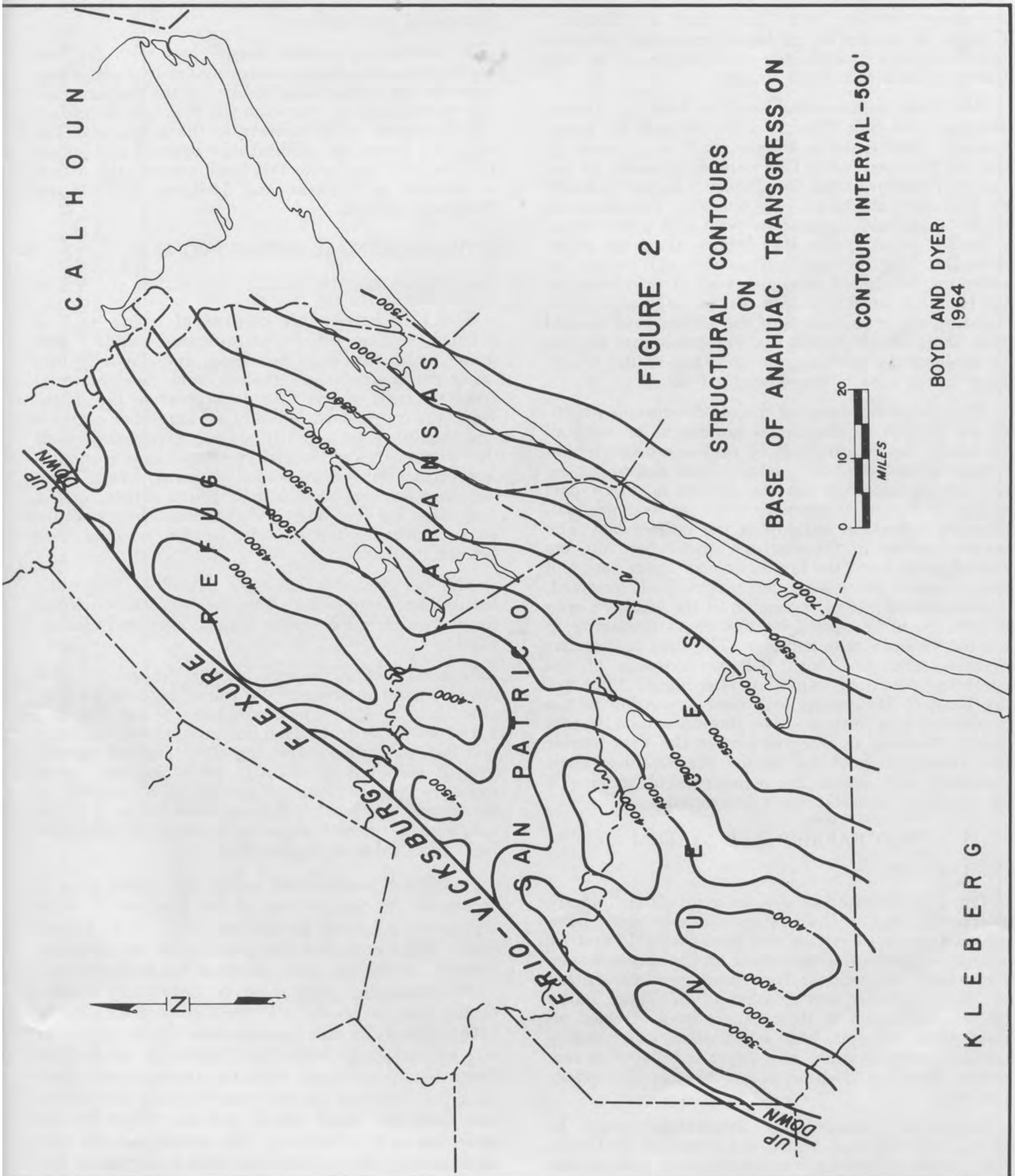

FIGURE 2
STRUCTURAL CONTOURS ON BASE OF ANAHUAC TRANSGRESS ON
CONTOUR INTERVAL-500'
BOYD AND DYER 1964

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erature. The Frio-Vicksburg Flexure is used in this paper to correspond to that area where large down-to-the-coast faults rapidly expand both the Frio and Vicksburg formations forming what was believed for many years to be a "hinge-line" or "flexure" Flexure, in its correct geological meaning, refers to the folds found immediately downthrown to the Sam Fordyce-Vanderbilt fault system.

Vicksburg shales encountered in Aransas, Nueces, Refugio, and San Patricio Counties can be traced laterally into massive deltaic sands and shales in the Rio Grande Valley Oligocene depocenter At the end of Vicksburg time see Figure 1 for updip limits of *Textularia warreni* , this extensive Vicksburg sea began to recede. Coincident with this withdrawal, a barrier island system was formed along the paleo-shoreline. This gradual retreat, with only minor occillations, continued throughout all of Frio time. As the bar built vertically with respect to geologic time, the deep water sediments of the Lower Frio merged with those of the Vicksburg. Paleontologists are not in agreement regarding the true top of the Vicksburg in the area of the downdip Frio.

The rate of regression of the sea determines whether the growth of the bar is horizontal or vertical. Certainly the relative supply of bar sediments and subsidence are the basic factors which determine the rate of regression of the sea. In the northern part of the area studied, retreat of the sea was gradual, allowing a vertical buildup of the barrier bar The reverse is true in the southern area where the sea moved away from the landmass at a faster rate and bar sediments were deposited progressively seaward. The increased rate of regression in the southern area is believed to be caused by this area s proximity to the Rio Grande delta complex. The Frio barrier bar system terminated with the transgression of the overlying Anahuac formation see Figure 1 for updip limit of *Heterostegina texana* resulting in the deposition of a transgressive shoreline sand Greta Sand which is an integral part of the Frio barrier bar Overlapping of the bar by the Anahuac shale preserved and sealed the sequence thus making it an excellent reservoir for hydrocarbons.

FRIO BARRIER BAR SYSTEM

DEFINITION

The Frio barrier bar system is an elongate body of laterally deposited shoreline sands bounded by a lagoonal environment on the landward side and by a continental shelf environment on the seaward side. The above depositional framework was recognized by both Johnson and Mathy 1957 and Burke (1958 Inasmuch as their papers were directed toward other concepts, little explanation was given to the barrier bar system. This paper is believed to represent the first documentation of this subsurface feature.

Diagnostic foraminiferal assemblages may be grouped as lagoonal, which are restricted in lateral extent and are not good index markers, and marine or continental shelf, which can be traced for long distances both in strike and dip directions. The shoreline sands of the bar acted as a barrier separating the lagoonal and shelf facies. Lateral or time equivalents are therefore present within each of the three recognized environments.

In contrasting modern barrier bars with the Frio barrier bar one must visualize that only a small segment of the depositional history of the modern barrier system can be related to the Frio barrier system which is seen in its entirety in the subsurface. For excellent papers on modern day barriers and shoreline features similar to this fossil system, the reader is referred to LeBlanc and Hodgson (1959 and Shephard 1960

ENVIRONMENTAL SUBDIVISIONS

Frio Barrier Bar

The Frio barrier bar consists of coarse to fine grained, well sorted, porous quartzose sands which grade updip into lagoonal shales and downdip into inner continental shelf shales. Sand sized material from the area of the Frio depocenter to the southwest was transported laterally by longshore currents and deposited on a gently sloping continental shelf due to energy loss. Small rivers and streams doubtless influenced sedimentation in local areas. These bar deposits were reworked by eolian action, oscillatory wave motion, and tidal currents. Storms resulted in washover fan deposits in the lagoonal area behind the bar

The bar facies is basically devoid of diagnostic fossils, but sometimes contains reworked marine forams which are normally fragmentary and unidentifiable.

In cross section the Frio barrier bar appears as a massive sand interrupted by minor lagoonal or marine shale wedges. The main body of the Frio bar varies in width from 25 miles in Aransas, Calhoun, and Refugio counties Section A-A , where vertical growth was due to a slowly retreating sea, to 40 miles in Nueces County Section D-D') where, as mentioned previously, the sea retreated at a faster rate and bar growth regressed seaward through geologic time also see Figure 8

Production encountered in the bar proper usually occurs in the top because of the absence of shale separation to hinder upward migration of hydrocarbons. Continuous sands deposited during minor transgressions of the bar also contain substantial reserves. These sands are believed to be genetically related to the bar as shown on the dip sections. Burke (1958 observed that transgressive sands appear to trap hydrocarbons better than regressive sands. The Greta Sand, associated with the transgressive Anahuac Sea, contains greater reserves than the regressive Catahoula Sand which was laid down by the same sea as it withdrew This would indicate that rapid sealing of potential reservoirs is extremely important.


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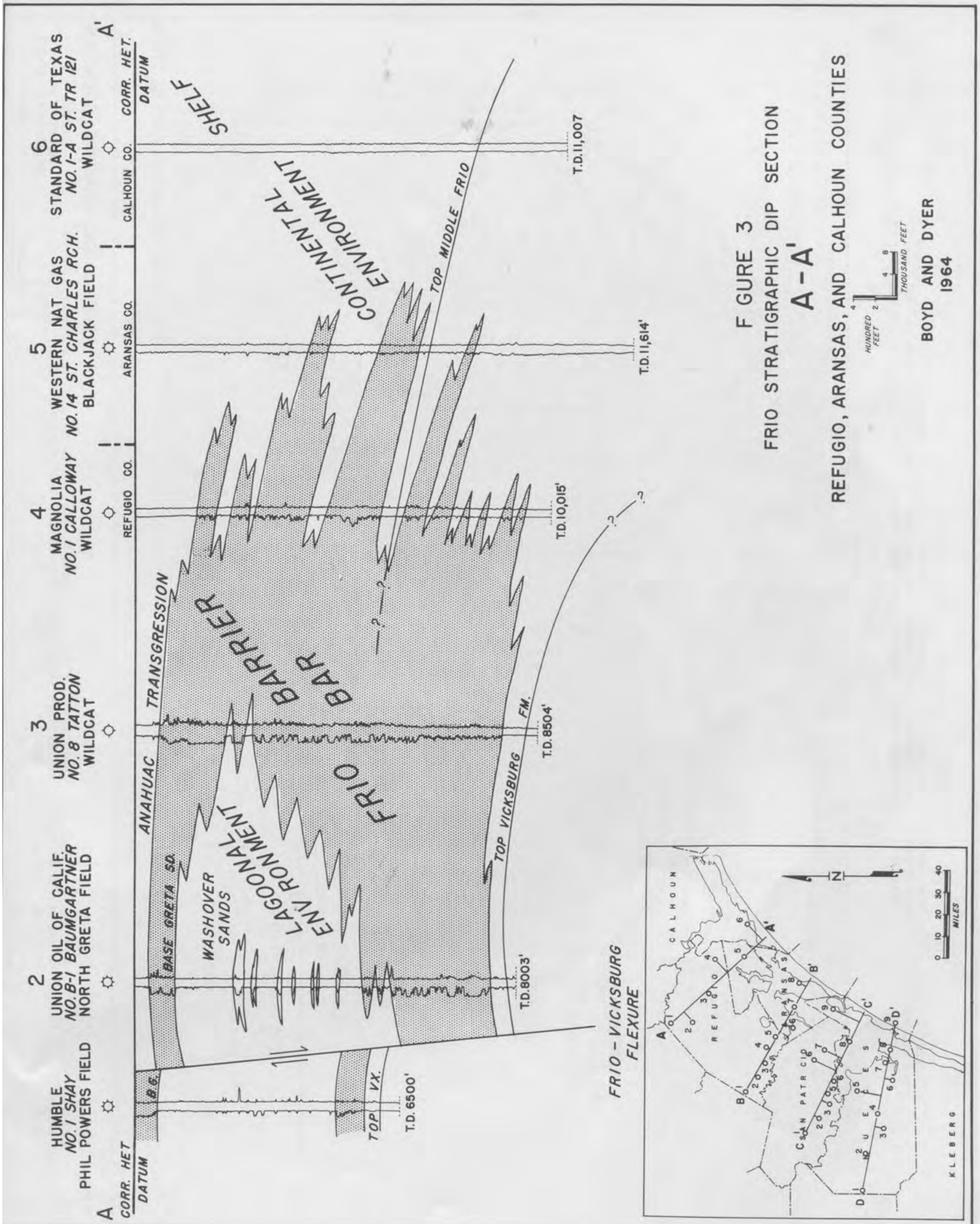

FIGURE 3
FRIO STRATIGRAPHIC DIP SECTION
A-A'
REFUGIO, ARANSAS, AND CALHOUN COUNTIES
BOYD AND DYER
1964

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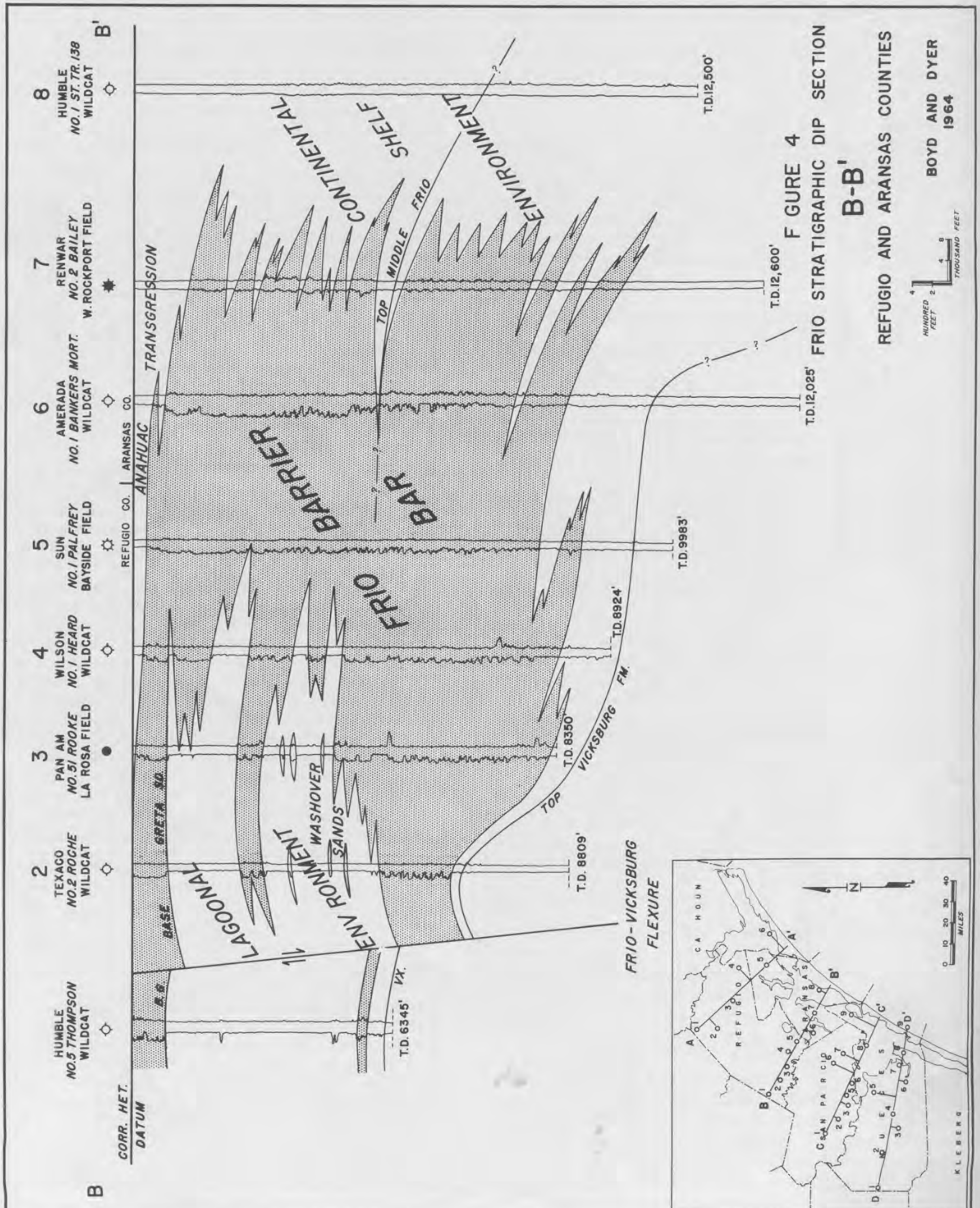

F GURE 4
FRIO STRATIGRAPHIC DIP SECTION
B-B'
REFUGIO AND ARANSAS COUNTIES

BOYD AND DYER
1964

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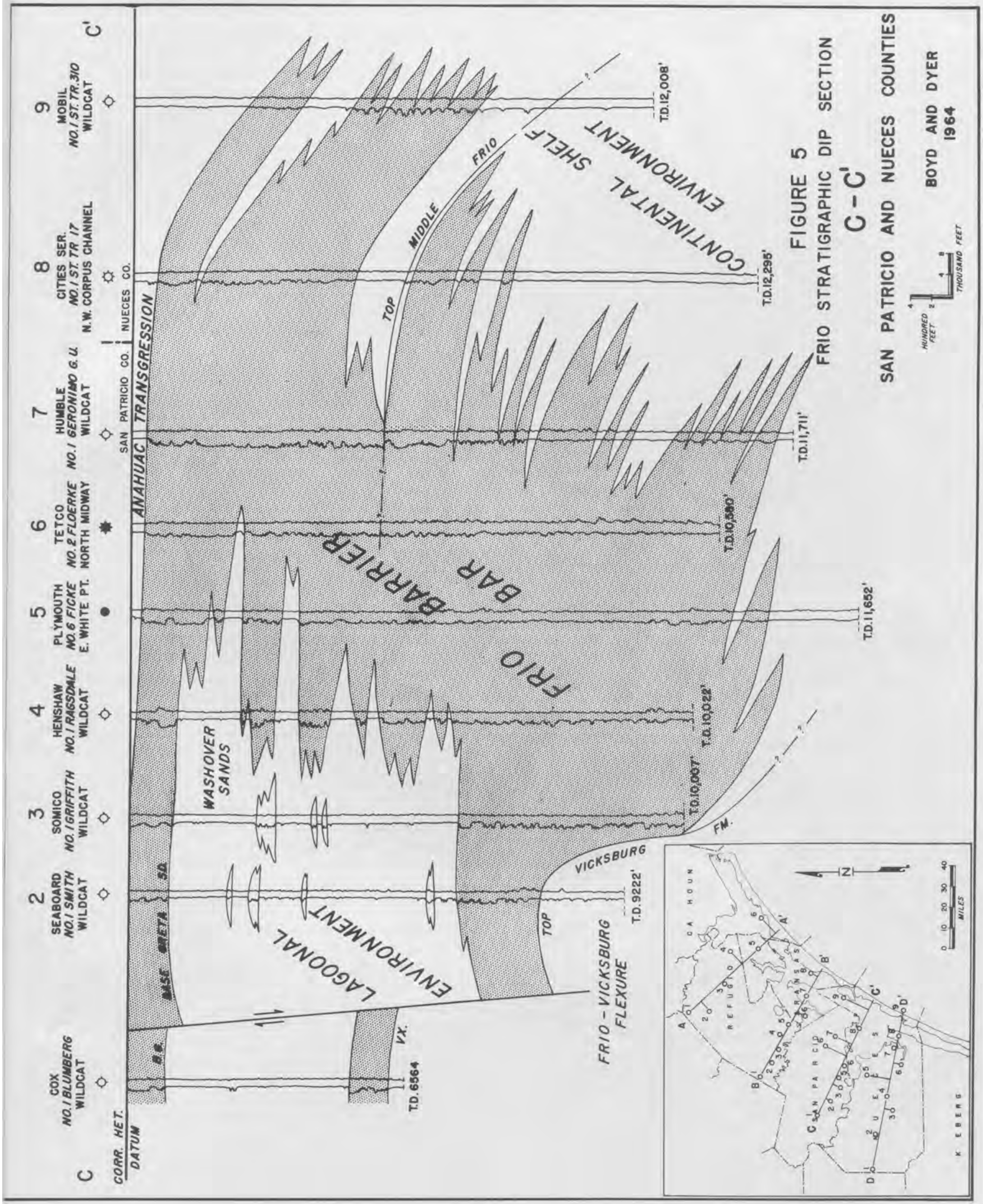

FIGURE 5
FRIO STRATIGRAPHIC DIP SECTION
C-C'
SAN PATRICIO AND NUECES COUNTIES
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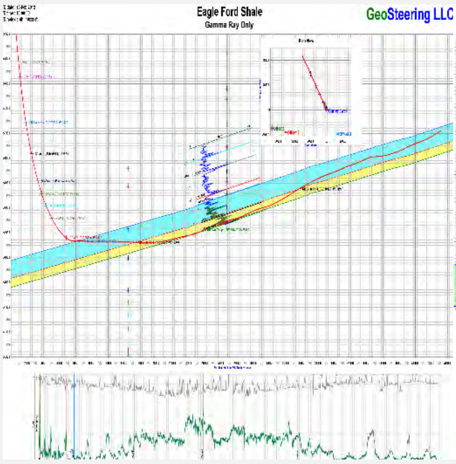

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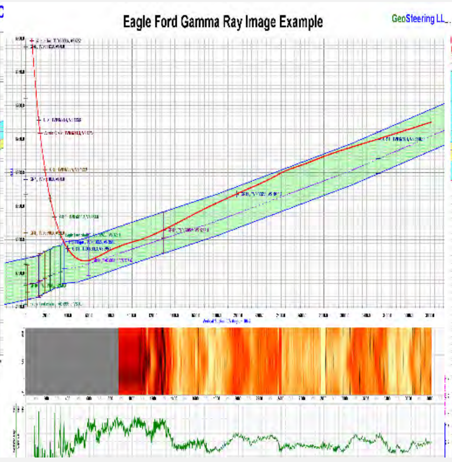

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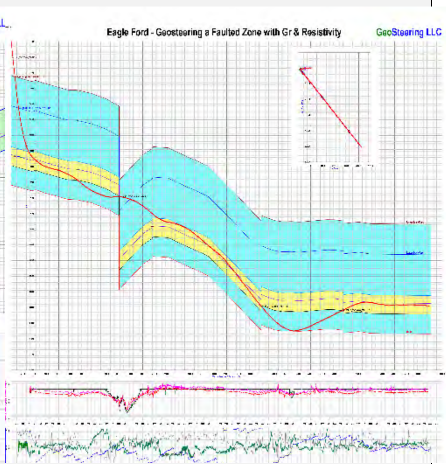

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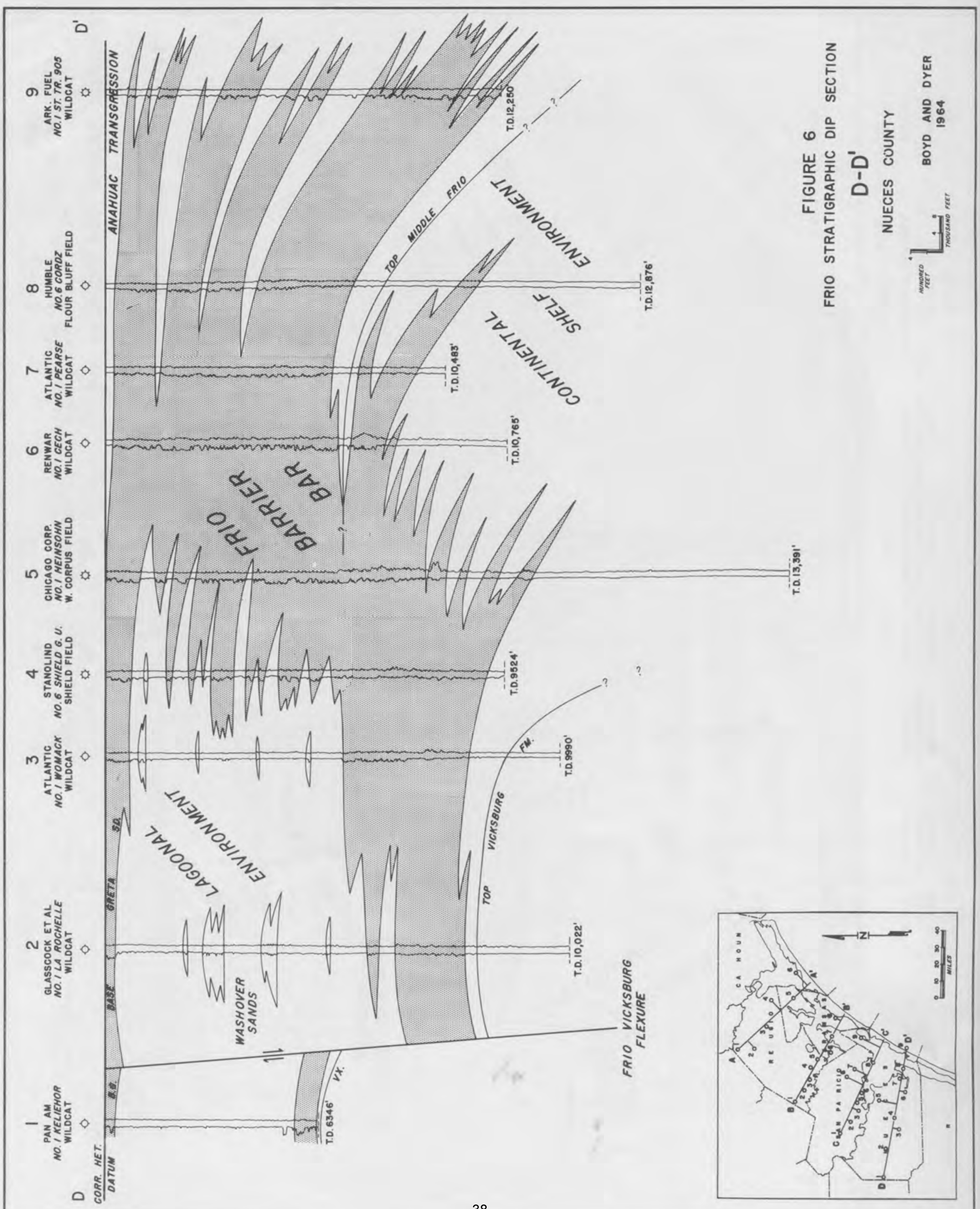

FIGURE 6
FRIO STRATIGRAPHIC DIP SECTION
D-D'
NUECES COUNTY
BOYD AND DYER 1964


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Lagoonal Environment

The lagoonal environment of the Frio barrier bar system is comprised of shales, siltstones, and wash over sands deposited behind the barrier bar in lagoons, bays, and drowned river valleys. For the purpose of this paper washover sands are meant to include that group of sands which were deposited by storm tides, stream channels, or small cuspate spits associated with estuaries. Within the subsurface it is impossible to accurately identify the forming mechanism. Burke 1958) has described this environment as having 5-15% sand.

Shales occurring in this environment often exhibit red and green colors indicating oxidation in the shallow bays and marshes during Frio time. Brackish water faunal assemblages are present, but varying water salinities prevent widespread occurrence with consistency

Production occurring in this environment is primarily from washover sands. Structural and stratigraphic trapping of hydrocarbons common to this facies of the system is found mainly on large anticlinal closures immediately downthrown to and associated with the Sam Fordyce-Vanderbilt fault system. Smaller accumulations occur on faulted anticlines and fault closures which lie east of the "giant" flexure fields.

Continental Shelf Environment

The continental shelf environment of the Frio barrier bar system is comprised primarily of marine shales. Some shelf sands were deposited in this deeper water by mechanisms such as turbidity currents. Shales occurring in this environment are black, gray, and green and are characterized by distinct foraminiferal assemblages which may be traced both laterally and downdip. Additionally, certain of these marine forams have limited vertical extent and therefore are excellent index fossils. *Cibicides hazzardi*, *Nosdosaria blanpiedi*, and *Textularia mississippiensis* may be used to subdivide the marine Frio into Upper, Middle, and Lower respectively The updip limits for diagnostic foraminifera shown on Figure 1 are largely from a paper given by Lohse and Middour at the Biloxi GCAGS Con vention in 1955. These updip limits have been somewhat revised and expanded for use in this paper

Probably the best Frio electric log correlations are found in this facies since the widespread occurrence of marine shale deposition results in resistivity markers which can be carried great distances. Once the relative age of a given marine "wedge" has been established by micropaleontology, this same interval can be readily correlated by electric logs into adjacent wells within the continental shelf environment. These transgressive marine wedges can be carried updip until they terminate against the front side of the barrier bar

Between the interfingering regressions of the bar and the transgressive continental shelf environment contemporaneous faulting is common and has a marked influence on sand development. Contemporaneous faults are those that are active during the period of deposition of their surrounding sediments. This term is synonymous with depositional fault. The more desirable sand conditions are normally encountered immediately downthrown to major contemporaneous or depositional faults while wells drilled near the upthrown side are quite often comparatively shaly An interesting structural phenomenon involving reverse or northwest dip of the Middle and Lower Frio sediments is also present in this environment. This reverse dip is believed to be related to the contemporaneous nature of the faulting. For varying concepts the reader is referred to Walters 1959 and Hardin and Hardin 1960

Excellent production has been established in this facies and a substantial amount of the South Texas Frio exploration effort is presently directed to this area in search of sizeable reverses. It has been proven that appreciable reserves can be found within this environment from thin sands or thinly laminated sand and shale sequences. This is probably due to the large percentage of marine shale available both as source material and as an effective seal for these thin sands. Accumulations of hydrocarbons occur in traps afforded by anticlinal structures and in fault closures and stratigraphic pinchouts against the upthrown sides of down-to-the-coast faults.

SAND DISTRIBUTION AND FACIES VARIATIONS

Maximum sand deposition during Upper, Middle, and Lower Frio time within the area studied is shown on Figure 8. This maximum deposition is not based on the total footage of sand drilled or anticipated in a given area, but rather on the relative percentage of sand versus shale.

Each of the stratigraphic sections substantiating the Frio barrier bar system was constructed using a correlative *Heterostegina* electric log datum. With the exception of the Frio-Vicksburg Flexure, no faulting or other structural features were incorporated into the sections. A structural map (Figure 2 contoured on the base of the Anahuac transgression represents the present attitude of the Upper Frio surface after deposition, compaction, formation of local structures, and regional tilting. The 500′ contour interval reflects only the larger structures found near the Frio-Vicksburg Flexure.

The more coastward wells used on the dip sections encountered only a part of the Middle and Upper Frio sediments. On sections A-A , B-B', and C-C' the most downdip well contains little or no sand. However, a good percentage of Upper Frio sand is still present at the most coastward well in Dip Section D-D' (Figure 6) This is attributable to the proximity to the area southwest of this well where sediments of the Frio barrier bar system interfinger and merge with deltaic sediments. The nearness of the Rio Grande Valley depocenter is further documented by strike section Z-Z' (Figure 7), which displays a pronounced thickening to the southwest. In sections D-D' and to some extent C-C', it is obvious that the barrier

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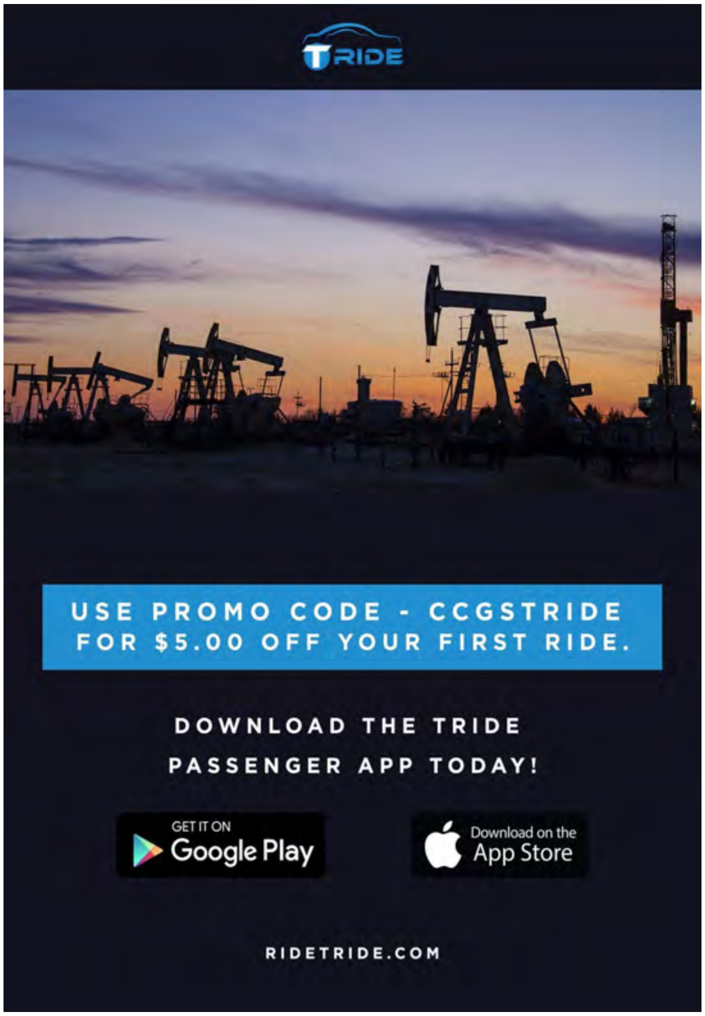

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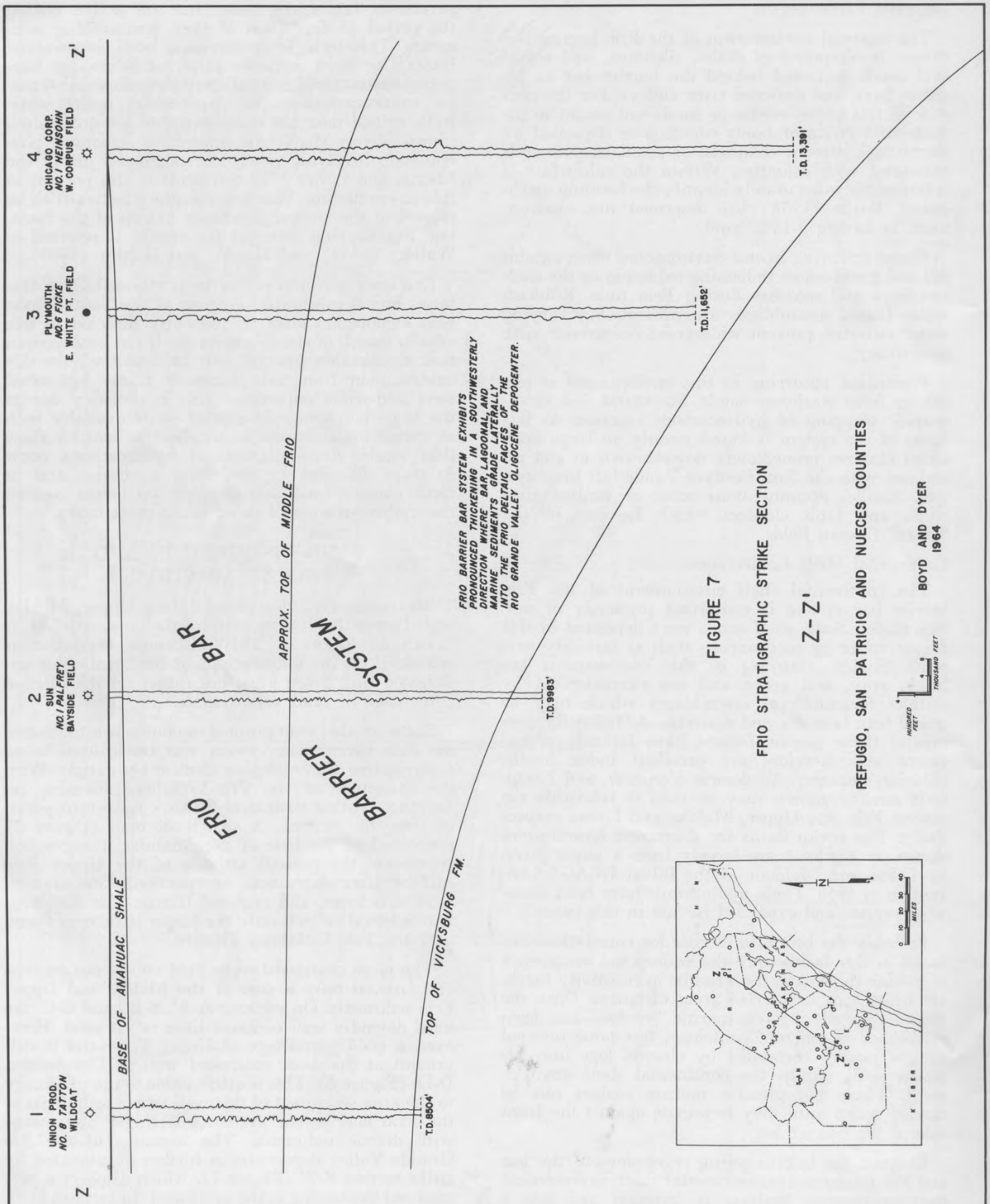

FIGURE 7

Z-Z'

FRIO STRATIGRAPHIC STRIKE SECTION

REFUGIO, SAN PATRICIO AND NUECES COUNTIES

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The Desk & Derrick Club of Corpus Christi is a proud affiliate of the Association of Desk And Derrick Clubs, www.addc.org bar moved progressively seaward with respect to geologic time as the Rio Grande deltaic complex built seaward.

The barrier bar observed in Sections A-A and B-B was remote from the deltaic source area, consequently, a more vertical buildup of the bar occurred. These concepts are substantiated in plan view on the Maximum Sand Deposition Map (Figure 8

Detailed studies of available subsurface data within this four county area leave little doubt as to the bar's existence. The sections presented utilized the deepest unfaulted wells that were typical of their specific geographic area. It is the writers conviction that these sections accurately depict the Frio formation as a barrier bar system with lagoonal shales terminating seaward into bar sands and conversely marine shale wedges terminating against the bar, marking updip transgressions of the continental shelf environment.

DEVELOPMENT AND FUTURE EXPLORATION

Production in this trend was first discovered at Refugio Field, Refugio County, in 1928 from *Discorbis* Anahuac sands. Deeper drilling in this same field later extended production into sands of the Frio formation. This success initiated exploration efforts which utilized surface geology, torsion balance and the magnetometer These methods of exploration were highly effective in locating large, shallow anticlinal structures downthrown to the Sam Fordyce-Vanderbilt fault system. By 1930, discoveries had been made in neighboring San Patricio and Nueces Counties. Because of the more subtle nature of the shallow structures, discovery of oil in Aransas County did not occur until 1936.

During the following highly successful thirty-five years these four counties produced a cumulative total in excess of 1,000,000,000 barrels of oil to January 1, 1963) from sands within the Frio barrier bar system. Within this area there are nine fields Agua Dulce, Stratton, Saxet, East White Point, Plymouth, Portilla, Refugio, Greta, and Tom O'Connor) that will each eventually produce over 100 million barrels of crude oil and condensate. All but three Saxet, East White Point, and Plymouth are closely associated with the Frio-Vicksburg Flexure. Each of these fields exhibits strong structural closure at the top of the Frio see Figure 2 Still of further significance is the fact that within the area studied a total of twenty-four fields will each eventually produce over 25 million barrels of liquid hydrocarbons.

A given interval of time is necessary for a newly discovered field to produce and prove reserves in the magnitude of millions of barrels. However, Portilla, the last field discovered which will ultimately produce 100 million barrels, was first drilled in 1950. Only four fields with an anticipated ultimate production in excess of 25 million barrels have been found since Portilla.

Sources giving crude oil production and estimated reserves for fields in these counties were the 1963 Annual Report of the Texas Railroad Commission Oil and Gas Division, and the Oil and Gas Journal's 1964 Forecast and Review issue.

There are no available statistics for gas and gas condensate cumulative production or estimated reserves. Production records for the first few years that gas was marketed are quite incomplete. Of more consequence is the large unguaged volume of gas which was flared during the years prior to the enforcement of effective conservation practices. It is believed that a conservative estimate of total Frio gas produced for this four county area to January 1, 1963 would be in excess of 10 trillion cubic feet. Condensate produced in association with this gas probably totals more than 100 million barrels.

In excess of 1,200 million barrels of oil and condensate and 10 trillion cubic feet of gas have been produced from sands of the Frio barrier bar system. The majority of this production is found in the larger fields associated with the Frio-Vicksburg Flexure where accumulation is caused primarily by structural trapping. It is clear to most geologists familiar with this area of the Frio that all of the "giant" Frio structures have been explored seismically, drilled, and are producing. Future exploration will undoubtedly uncover many more 25 million barrel fields, but the easily found 100 million barrel fields have been discovered.

Present and future exploration techniques in this bar and lagoonal area will of necessity consist of (1 tracing pinchout of sands across and on the flanks of the large producing anticlines, 2 drilling on much smaller structures for bar sands separated by lagoonal shales or deeper basal bar sands separated by marine shales, and 3 prospecting for stratigraphic continental traps in washover sands.

Much of the exploration effort is now directed toward the inner continental shelf area where bar sands interfinger and merge with marine shales. Within this down-dip province lie the best possibilities for discovering substantial reserves since past exploration has been more concentrated in the lagoonal and bar facies. New seismic methods, an expanding knowledge of solutions to the previously discussed structural and stratigraphic enigmas, and a thorough understanding of the depositional framework of the barrier bar system make this inner continental shelf environment an excellent target for future drilling. Discoveries within this area have been primarily gas and gas condensate. Some of the richest reserves uncovered in the past ten years have been found where bar sands interfinger with marine shales immediately in front of the barrier bar

It is interesting to note that the occurrence of oil in the Frio barrier bar system can generally be related to the lagoonal facies and to the top of the massive bar and therefore to shallower depths. Significant gas and gas condensate reserves are more generally found at greater depths and in sands of

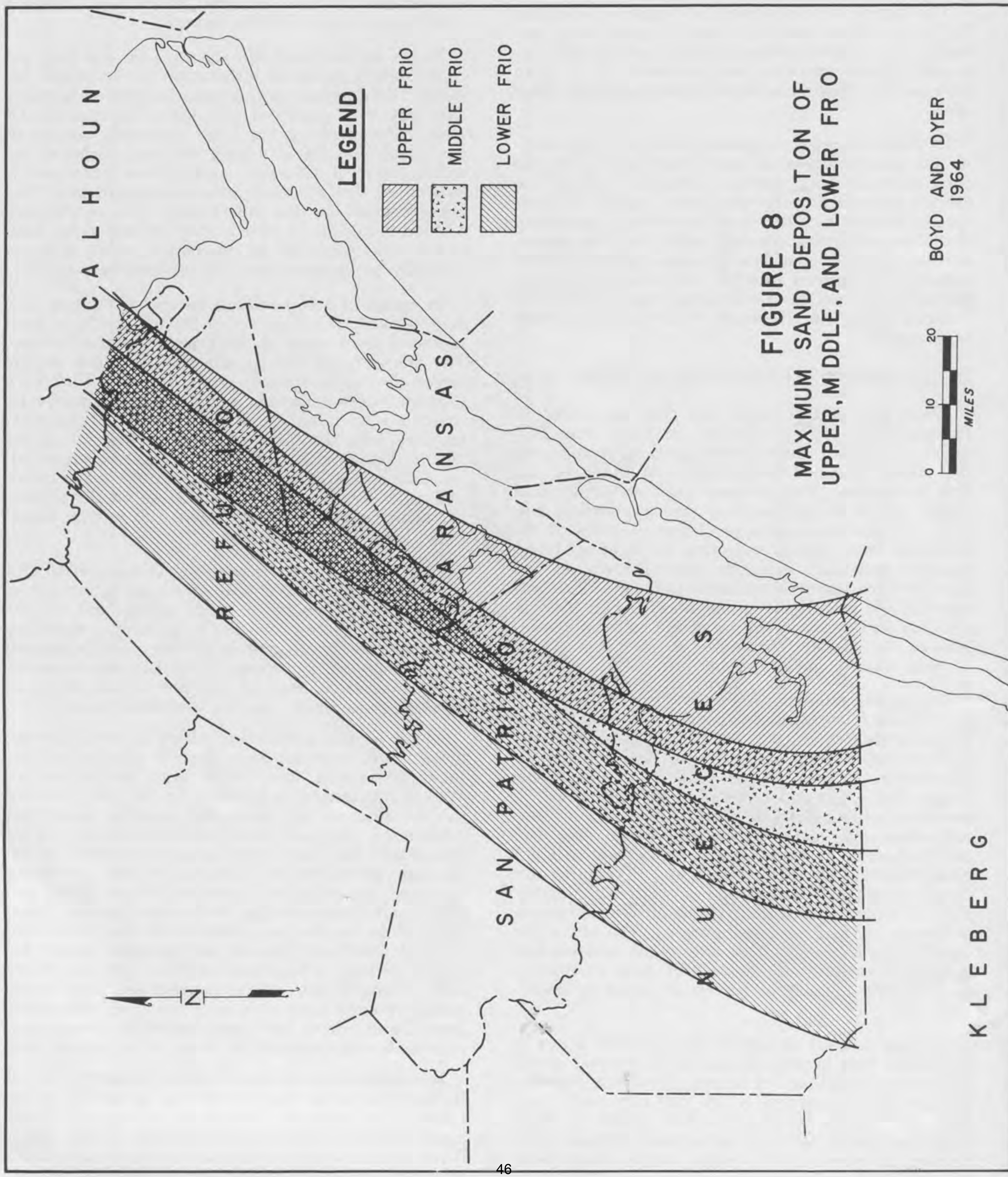

FIGURE 8
MAX MUM SAND DEPOS T ON OF
UPPER, M DDLE, AND LOWER FR O

the inner continental shelf facies. Haeberle (1951 related the occurrence of higher gravity hydrocarbons in the Gulf Coast to more marine conditions. Inasmuch as depth has also been postulated to be a factor in determining whether oil or gas is en countered, it is impossible to predict whether depth of burial or environmental habitat is more important in the above situation.

CONCLUSIONS

The Frio formation of Aransas, Nueces, Refugio, and San Patricio Counties consists of an elongate body of laterally deposited shoreline sands bounded by lagoonal sediments on the landward side and by marine sediments on the seaward side. The following conclusions may be reached from data presented in this paper·

A. Distinctive lithology within the bar proper and diagnostic foraminiferal assemblages within the two bracketing environments enable geologists to make use of both samples and electrical logs in studying the depositional sequence of the Frio in a specific geographic area.

B. Deposition of shoreline sands comprising the bar was primarily by longshore currents coming from the southwest. A greater thickness of the Frio bar sequence in the vicinity of Nueces County is caused by its proximity to the deltas of the ancestral Rio Grande River These deltas are the depocenter for both the Frio and Vicksburg formations of the Gulf Coast.

C. In the past thirty-five years prolific oil and gas production has been established in each environment of the Frio barrier bar system. Much of this success has been the result of drilling easily mapped structural closures. Continued success within the Frio depends not only on basic structural methods, but on the working geologists thorough understanding and utilization of stratigraphy Future Frio exploration within the area studied can be greatly augmented through a study and knowledge of the depositional framework of the Frio barrier bar system.

D. Similar conditions may exist in other formations of the Gulf Coast where deposition was influenced by deltas and longshore currents.

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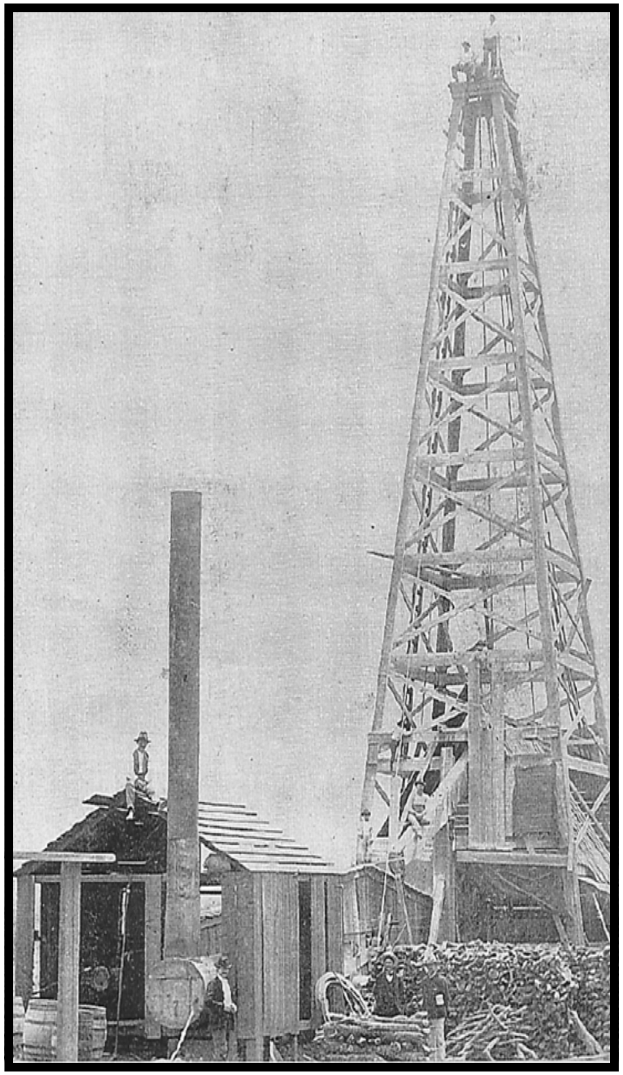

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