BULLETIN

Corpus Christi Geological Society

and

Coastal Bend Geophysical Society

February
2020

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2019-2020
www.ccgeo.org

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COASTAL BEND GEOPHYSICAL SOCIETY
P.O. BOX 2741*C.C. TX. 78403
2017-2018

OFFICERS

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Scholarship Chairman	Matt Hammer	361-888-4792 361-563-6137	mhammer@royalcctx.com

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Visit the geological web site at www.ccgeo.org

CCGS/CBGS JOINT MEETING SCHEDULE 2019-2020

September 2019

S	M	T	W	Th	F	S
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 2019

S	M	T	W	Th	F	S
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27	28	29	30	31		

November 2019

S	M	T	W	Th	F	S
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10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

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

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

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

December 2019

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
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29	30	31				

January 2020

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
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February 2020

S	M	T	W	Th	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
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23	24	25	26	27	28	29

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

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

CCGS/CBGS Joint Meeting Schedule 2019-2020

March 2020							April 2020							May 2020						
S	M	T	W	Th	F	S	S	M	T	W	Th	F	S	S	M	T	W	Th	F	S
1	2	3	4	5	6	7				1	2	3	4						1	2
8	9	10	11	12	13	14	5	6	7	8	9	10	11	3	4	5	6	7	8	9
15	16	17	18	19	20	21	12	13	14	15	16	17	18	10	11	12	13	14	15	16
22	23	24	25	26	27	28	19	20	21	22	23	24	25	17	18	19	20	21	22	23
29	30	31					26	27	28	29	30			24	25	26	27	28	29	30
														31						

Dr. Charles Puryear-Senior Research Geophysicist at Multi-Physics Technologies. “Spectral Extrapolation & Acoustic Inversion for the Characterization of an Ultra-thin Reservoir.”

Calendar of Meetings and Events

Calendar of Area Monthly Meetings

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

CCGS PRESIDENT'S LETTER

Happy New Year to everyone! Hope you all had safe and enjoyable holidays. The January luncheon was fantastic, and Peter Duncan's talk on Frac Driven Interactions from a Microseismic Perspective enthralled me.

When I went to college the first time in Austin, Texas, my dad asked me to tag along at a geologic convention that was being held in Austin. I was standing in a circle with a small group of his peers, and one of them asked me what I wanted to be. A geologist! I replied. Another gentleman in the group warned me, with emphasis, that Gulf Coast petroleum geology exploration was dying and there would not be an industry for me to work in by the time I got my degree…which was fair as it was nearly a decade later that I received my paper. Over that decade oil went from $15.00 to $130.00, the shale play was born, new quiescent continental shelves were explored and developed, and America became an exporter of oil and gas. There is a quote I found way back that goes like this "no mineral, including oil, will ever be exhausted. How much oil is still in the ground when extraction stops, and how much was there before extraction began, are unknown and unknowable. The amount extracted from first to last depends on the cost and price." I'm sure many of you have seen or regularly noticed the LNG ships that are coming and going with more frequency. The industry is exciting, though, with the highest of highs and the lower than lowest of lows. Our industry is like baseball, you can be a hero with a three hundred batting average. How many other industries tolerate six, seven, eight plus figure losses annually? You know you are going to have some losses, and those losses are not going to be small. So how euphoric it must be to stay in the game long enough for the hits, the runs, the grand slams?! The oil industry can be a game, a ride, a wave. It is Something like your first bicycle ride without the training wheels, you know it is going to hurt. Growing up surfing, wiping out in Corpus Christi did not entail much beyond the washing machine sensation. Do not panic, and you will make it. The volatility of our industry is much like the sea. What looms over the horizon?

Up Coming Events: CCGS Golf Tournament April 17, 2020—12:30pm at NorthShore Country Club

CCGS 3rd Annual Brew Pub Crawl April 18, 2020—starts 1:00 at the Railroad Seafood Station & Brewing Co.

Austin Nye
CCGS President

SPONSORS

CBGS President's Letter

CBGS Board 2019-2020

Dr. Subbarao Yelisetti- President
Samara Omar- Vice President
Erik Scott- Secretary/ Treasurer
Matt Hammer - Scholarship Chair
Mark Wiley - Golf Chair
Education – Robert Schneider

CBGS Scholarships

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

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

Scholarship Requirements

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

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

News

- According to the U.S. Energy Information Administration (EIA) projections, U.S. crude output would rise to 13.3 million bpd in 2020 from a record 12.2 million bpd in 2019.
- At the time of writing this report, U.S. crude futures were trading around $57 a barrel and expected to remain so for the balance of 2020, and $53 in calendar 2021, respectively. This compares to $64.90 in 2018 and $57.04 in 2019 as reported by Scott DiSavino on reuters.com.
- According to Baker Hughes, U.S. oil drillers added 14 rigs in the week of Jan 13. The current rig count is 673. There were 852 active rigs in the same week a year ago.

CBGS Business

CBGS currently has 42 active members, 4 honorary members, and 40 student members. Raised $1,200 towards student scholarships through membership revenue.

CBGS workshops/talks

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

CBGS is also planning to host another lecture featuring Charles Puryear on March 4th, 12-1 pm. Contact Samara Omar at Samara_Omar@eogresources.com for additional details about these talks.

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

Golf Tournament

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

New Degree Tracks at TAMUK

- Texas A&M University-Kingsville (TAMUK) started its first cohort of MS Petrophysics program in Fall 2018. If you are interested in joining this program in Fall 2020, please contact the graduate coordinator for MS in Petrophysics, Dr. Subbarao Yelisetti at Subbarao.Yelisetti@tamuk.edu.
- **BS degree in Geophysics, Minor in Geophysics and Certification in Geophysics** offered at Texas A&M University-Kingsville since Fall 2017. Interested students can contact Dr. Subbarao Yelisetti (Subbarao.Yelisetti@tamuk.edu) for additional information.

Education/Events

-SEG

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

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

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

-AGU

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

Monthly Saying

"Horses create 772 grams of pollution per kilometre traveled, modern cars only 72.4 grams per kilometre"
"The wellsite footprint for wells drilled at Prudhoe Bay has been reduced from 60 acres to 6 acres since 1970" - Quotes from Lee Gerhard, AAPG Explorer, February 2001.

Monthly Summary

Texas Oil and Gas Info	Current Month	Last Month	Difference	
Texas Production	**MMBO/BCF**	**MMBO/BCF**	**MMBO/BCF**	
Oil	126.9	136.7	-9.8	September
Condensate	16.8	18.1	-1.3	September
Gas	785.0	825.1	-40.1	September
	Current Month	**Yr to date - 2019**	**Yr to date - 2018**	
Texas Drilling Permits	803	11654	13307	December
Oil wells	162	2801	3356	December
Gas wells	37	668	819	December
Oil and Gas wells	571	7295	8201	December
Other	10	135	123	December
Total Completions	609	9238	10986	December
Oil Completions	491	7046	8588	December
Gas Completions	98	1753	1813	December
New Field Discoveries	0	16	23	December
Other	3	35	40	December

Subbarao Yelisetti
President, CBGS

Winn Exploration Co., Inc.

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Contacts:

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Tom Winn (Geologist)	361-844-6992
Southern Winn (Geologist)	361-844-6998

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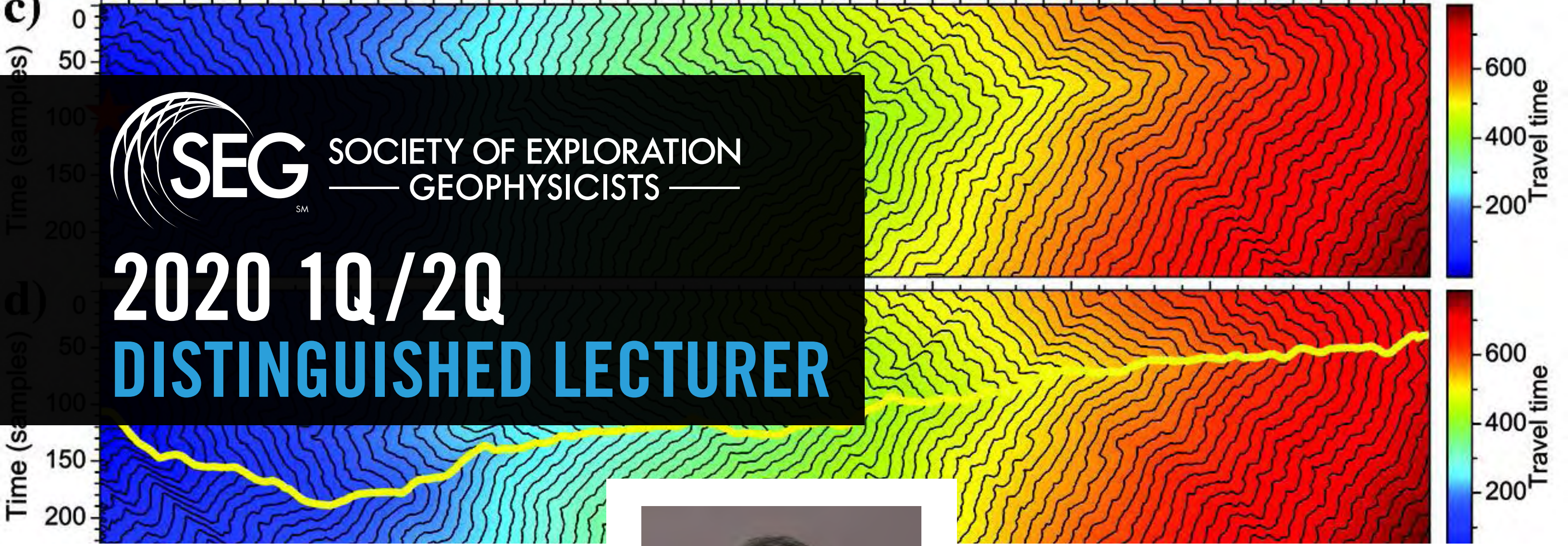


SEG SOCIETY OF EXPLORATION GEOPHYSICISTS

2020 1Q/2Q DISTINGUISHED LECTURER

Automating seismic data analysis and interpretation

Presented by Sergey Fomel, University of Texas, Austin, Texas, USA

Date & Time: February 11th, 11:30am - 1:00pm

Location: Water Street Events (upstairs)

Cost: $30.00/person, students free

WHY ATTEND?

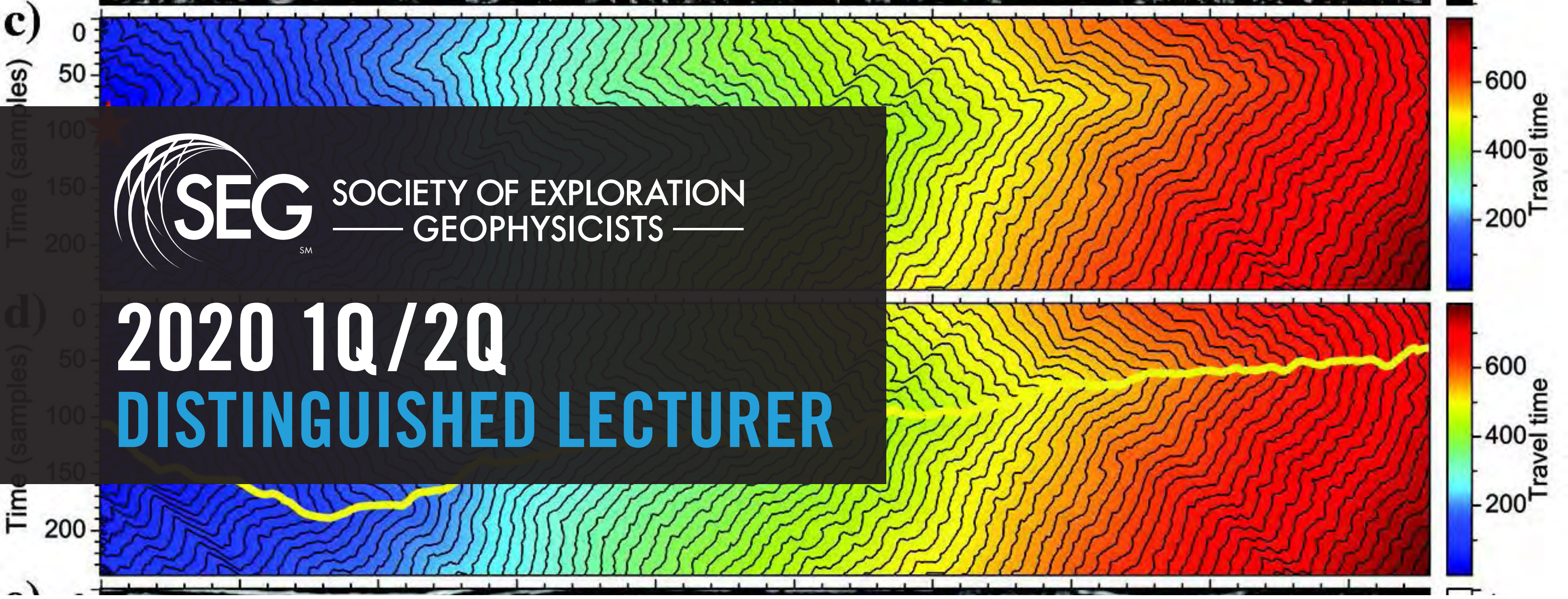
-Keep current with the latest developments in geophysics

-Network with your colleagues

-Lectures are 45 minutes to an hour long

Supported through the SEG Foundation by PGS equinor

For abstract, lecturer bio, and more, visit **seg.org/education/lectures** or email **jwall@seg.org**



SEG SOCIETY OF EXPLORATION GEOPHYSICISTS

2020 1Q/2Q DISTINGUISHED LECTURER

Automating seismic data analysis and interpretation

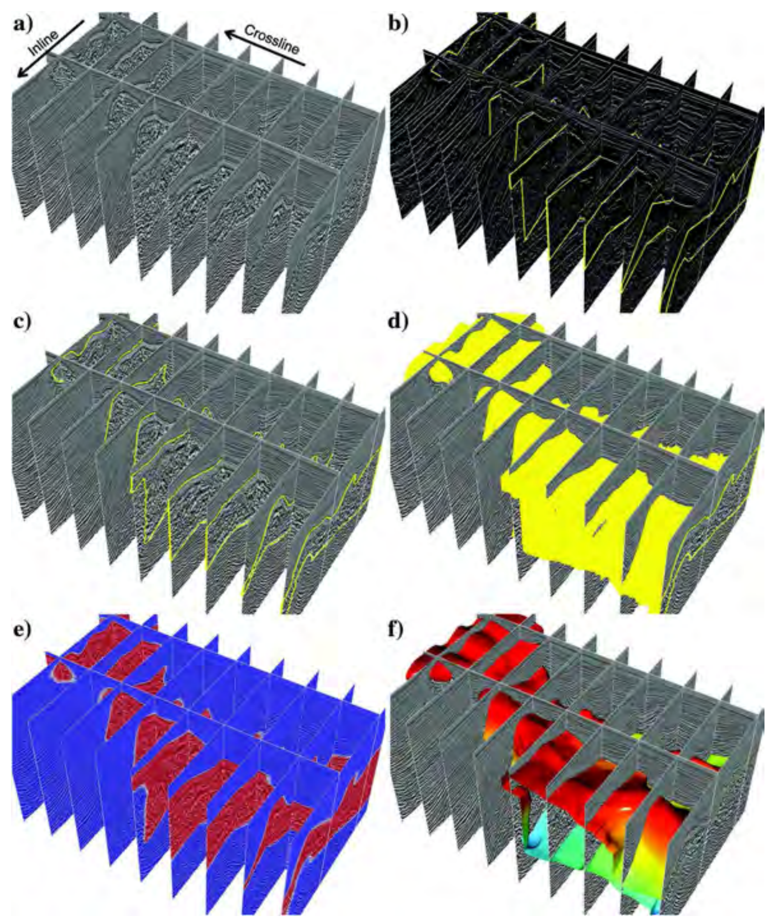
Presented by Sergey Fomel, University of Texas, Austin, Texas, USA

ABSTRACT

Recent developments in artificial intelligence and machine learning can automate different tasks in data analysis. I will discuss the quest for automation by tracking the development of automatic picking algorithms, from velocity picking in seismic processing to horizon picking in seismic interpretation. We will search for the limits of automation to discover the distinguishing qualities that separate human geophysicists from machines.

The automatic picking algorithm follows the analogy between picking trajectories in images with variable intensities and tracking seismic rays in the subsurface with variable velocities. Picking trajectories from local similarity panels generated from time shifts provides an effective means for measuring local shifts between images, with practical applications in time-lapse and multicomponent image registration, matching seismic with well logs, and data compression using the seislet transform. In seismic interpretation, automatic picking finds additional application for tracking fault surfaces, salt boundaries, and other geologic features.

The power of automatic picking is further enhanced by novel deep learning algorithms. The deep learning approach can use a convolutional neural network trained on synthetically generated images to detect geologic features in real images with an unmatched level of performance in both efficiency and accuracy. The lessons to learn from these developments include not only the potential for automation, harvested through artificial neural networks and modern computing resources, but also the potential for human ingenuity, harvested through professional networks.



X. Wu, S. Fomel, and M. Hudec, 2018, Fast salt boundary interpretation with optimal path picking: Geophysics, v. 83, O45–O53.

Supported through the SEG Foundation by PGS equinor

BIOGRAPHY

Sergey Fomel is Wallace E. Pratt Professor of Geophysics at The University of Texas at Austin and the director of the Texas Consortium for Computational Seismology (TCCS). At UT Austin, he is affiliated with the Bureau of Economic Geology, the Department of Geological Sciences, and the Oden Institute for Computational Engineering and Sciences. Sergey received a PhD in geophysics from Stanford University in 2001. For his contributions to exploration geophysics, he has been recognized with a number of professional awards, including SEG's J. Clarence Karcher Award in 2001 and the EAGE Conrad Schlumberger Award in 2011. He has served SEG in different roles, most recently as the Vice President, Publications. Sergey also serves as the project manager for "Madagascar," an open-source software project for geophysical data analysis.

To see Sergey Fomel's full itinerary or to view previous Honorary and Distinguished Lecturer presentations, visit: **seg.org/education/lectures**

"It's up to you to make sure that you remain very well informed, and you will be a valuable employee wherever you choose to work. There's really no other way to do that as effectively as being a member of a professional organization like SEG."

-Klaas Koster,
Chief Geophysicist, Occidental Oil and Gas

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SEG Professional Development provides educational opportunities through courses and lectures taught by recognized geophysical experts from all over the world. The topics are structured to serve industry professionals at all stages of their careers and via a variety of learning channels. These include:

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Honorary Lecture Program (HL)
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The Society of Exploration Geophysicists is a not-for-profit organization committed to connecting the world of applied geophysics. With thousands of members from more than 114 countries, SEG provides educational and technical resources to the global geosciences community through publications, books, events, forums, professional development courses, young professional programs, and more. Founded in 1930, SEG fosters the expert and ethical practice of geophysics in the exploration and development of natural resources, characterization of near surface, and mitigation of earth hazards. For more information visit seg.org.

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CALL FOR PAPERS

for the

GCAGS JOURNAL

The peer-reviewed journal for Gulf Coast geoscience.

Open Access • Fast Track

The GCAGS Journal, the Journal of the Gulf Coast Association of Geological Societies, is soliciting manuscripts for the 2020 edition (our 9th volume). This peer-reviewed journal is focused on publishing studies of the geology of the onshore and offshore Gulf of Mexico. For the 2020 Journal, although other themes are welcome, we are soliciting manuscripts focused on the conference themes: "All Things Salt," Innovative Use of Technology, Gulf Coast Carbonates (e.g., Smackover), Sustainability, including Carbon Capture, Geomechanics, Temperature and Pressure, and Oil and Gas Field Studies.

Please submit an extended abstract of at least 600 words, including 1–2 representative figures, to the GCAGS Journal Editor, Bob Merrill, at rmerrill@catheart.com by December 16, 2019. Once topic is approved, a full manuscript must be submitted by April 2, 2020. GeoGulf (GCAGS) Convention presentations of Journal submissions are encouraged but not required. GeoGulf 2020 is scheduled for Lafayette, Louisiana, Sept. 30-Oct. 2, 2020.

Please visit www.gcags.org for open access to all of our 8 previous volumes.

INTERESTED IN SERVING AS AN ASSOCIATE EDITOR?

The GCAGS Journal, a peer-reviewed Journal published yearly by the Gulf Coast Association of Geological Societies, is soliciting member societies for associate editors. You would be involved with managing the peer-review process for 1 to 3 manuscripts that are submitted for publication in the GCAGS Journal. Ideally associate editors will contribute their local knowledge and expertise to the editorial process. If you are interested in being an Associate Editor for the GCAGS Journal, please contact Bob Merrill at rmerrill@catheart.com.

GeoGulf 2020 Call for Papers

70th GCAGS/GCSSEPM Convention and Exposition
Sept. 30–Oct. 2, 2020 • Lafayette, Louisiana

Hosted by the Lafayette, Baton Rouge, and New Orleans Geological Societies

GeoGulf 2020 Session Themes

- "All Things Salt"—Tectonics, Oil and Gas, Seismic Acq., Proc., and Interp., Mining, etc.
- Machine Learning and Artificial Intelligence Applications
- GCSSEPM Special Session—Topic to be announced
- Gulf of Mexico Temperature and Pressure
- Smackover Session and Core Workshop
- GIS Technology and Applications
- Gulf Coast Environmental
- The Business Side—Legal, Unitization, Finance, Insurance, etc.
- Geoscience Applications of Drone Technology
- Geomechanics—Conventional and Unconventionals
- Carbon Capture / Underground Storage
- Shallow Hazards
- Success from Failure—Learning from our Mistakes
- And more—We are the place for Gulf Coast Geoactivities! We'll fit you in! Got an idea for a theme session, please let us know!

Professionals and Students: We welcome you to submit an abstract for consideration of oral or poster presentation of 250–300 words by February 3, 2020.

Early abstract submissions will be reviewed within a day or two of receipt with acceptance/ rejection notification. Submit via email, title, author(s) (with full contact information for each, including company or school, full address with zip code, email, and phone number), and abstract (preferably with 1–2 representative illustrations including reference from text and with captions) to General Chair, James J. Willis, james.willis@gcags.org.

All accepted presenters are expected to submit an initial draft of full paper or extended abstract for publication in the *GeoGulf Transactions* by April 1, 2020, to the *GeoGulf Transactions* Editor, James J. Willis, james.willis@gcags.org. Full information, instructions, size limitations, and helpful hints for abstracts, extended abstracts, and full papers will be posted soon at www.geogulf.org.

If you'd like to publish in the *GCAGS Journal*, the peer-reviewed journal of Gulf Coast geoscience, submit an extended abstract of at least 600 words, including 1–2 representative figures, to the *GCAGS Journal* Editor, Robert Merrill (rmerrill@catheart.com) by December 16, 2019. Once accepted for publication, the deadline for submitting a full manuscript is April 2, 2020. Full instructions for manuscript submissions will be posted online at http://www.gcags.org. Convention presentations of *Journal* submissions are encouraged, but not required.


SABALO
ENERGY

Corpus Christi Geological Society

Golf Tournament

4-Person Scramble

April 17, 2020

12:30 p.m. Shotgun Start

At

NorthShore Country Club

Portland, Texas

Golf
Prizes
Door Prizes
Beverages
Dinner

Contact:
Fermin Munoz
Fmunoz04@hotmail.com
361-960-1126

Corpus Christi Geological Society
3rd Annual Brew Pub Crawl
Saturday, April 18, 2020

SCHEDULE

1:00 PM TO 1:45 PM – Meet at Railroad Seafood Station & Brewing Company, 1214 N. Chaparral, CC, TX 78401

1:45 pm – Depart for Lorelei Brewing

2:00 pm to 2:45 pm – at Lorelei Brewing

2:45 pm– Depart for Lazy Beach Brewing

3:00 to 3:45 pm – at Lazy Beach Brewing

3:45 pm – Depart for B & J's Pizza & Brewpub

4:00 to 4:45 pm – at B & J's Pizza & Brewpub

4:45 pm – Depart for Nueces Brewing

5:00 to 5:45 pm – at Nueces Brewing

5:45 pm – Depart for Rebel Toad Brewing

6:00 to 6:45 pm – at Rebel Toad Brewing

7:00 pm – Return to Railroad Seafood Station & Brewing

$75.00 per person, to include transportation and five (5) CCGS Beer Tokens

For RSVP or questions, please contact B.J. Thompson at 361-816-2326

or william.thompson426@gmail.com

Mail checks to "CCGS Brewery Crawl" 8326 Salsa Dr. CC, TX 78415 eog resources

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Pitfalls in the seismic interpretation of fault shadow events — Vicksburg formation of south Texas

Richard C. Bain[1]

Abstract

Reliance on prestack time-migrated seismic data to define structural highs without incorporating all subsurface data and without taking into account the regional and local lateral depositional trends may result in dry holes or poorly positioned production wells due to local velocity changes, which are usually caused by some depositional or structural phenomenon. Tying check-shot control to depositional units may reveal those phenomena and permit assumptions to be made about velocities in areas beyond check-shot control points. We discovered a significant gas accumulation in an area surrounded by dry holes and marginal wells in the Vicksburg Formation in McAllen Ranch Field, Hidalgo County, Texas, by treating a seismic velocity anomaly as a geologic problem and by simple application of arithmetic and geometry to a 3D velocity model. Due to the effects of the anomaly, seismic data displayed in time gave no indication of the existence of a 325 ha (800 ac), 150 BCFG anticlinal structure. A subsurface model that accounted for the velocity anomaly was able to predict its extent and severity by readily identifiable thickness changes in the anomalous units. The resulting discovery yielded a sevenfold increase in field production within a two-year time span.

Introduction

Seismic velocity anomalies, also referred to as *fault shadows* when associated with velocity differences on opposite sides of a fault, have frequently been documented in the literature. Recent examples from the Texas Gulf Coast (Allen and Bruso, 1989; Lowry et al., 1995; Fagin, 1996; Meyerhoff and Braddock, 1998) demonstrate that fault shadows can mask the presence of structural accumulations of hydrocarbons. These examples, from the Wilcox and Frio trends of south Texas, demonstrate the successful positioning of one or two additional wells. These well locations would have been off structure and wet using only time data without appropriate depth correction.

The example presented in this study, from McAllen Ranch Field in the Vicksburg trend in Hidalgo County, Texas, resulted in the identification of 25 well locations on a 325 ha (800 ac) structure that has produced more than 150 billion cubic feet (BCF) of gas. The method used to predict the size and orientation of the structure did not involve reprocessing of seismic data or complex modeling, but instead used computer-based implementation of a simple mathematical process and an understanding of the 3D geometry of the unit that was causing the velocity anomaly.

McAllen Ranch Field is located in northwestern Hidalgo County, Texas (Figure 1), and it produces from the Oligocene-aged Vicksburg Formation from approximately 4250 m (14,000 ft) true vertical depth (TVD). The field is overlain by sands and shales of the Frio Formation and various Miocene-age sediments (Figure 2). The Vicksburg Formation at McAllen Ranch Field developed as a series of coarsening-upward shelf delta wedges downthrown to a major expansion fault (Figure 3). The basinward-thinning sedimentary wedges form traps when draped across an east–west-oriented, deep-seated high.

The part of McAllen Ranch Field examined in this study lies at the distal end of the zone of Vicksburg expansion (Figure 3), on a lease operated by Chevron USA Inc. The reservoir referenced in this study is the Guerra Sand, a 150–300-m (500–1000-ft)-thick sand that was deposited in a proximal delta-front environment. Overlying the Guerra Sand is a series of thinner lower Vicksburg sands which in turn are overlain by approximately 900 m (3000 ft) of upper Vicksburg shale.

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Overlying the Vicksburg are sands and shales of the Frio Formation (1800-m [6000-ft] thick) and Miocene formations (900-m [3000-ft] thick). Basinward, the Vicksburg section is cut off by a major fault, locally known as the *Monte Christo Fault*, which expands the Frio section (Figure 3).

The Guerra Sand produces from a southwest–northeast-oriented anticline. The structural configuration as interpreted prior to 2005 is shown in Figure 4a. At that time, the reservoir was believed to be fully delineated due to the presence of several dry holes and marginal wells along the southern edge of the structure. Wells developed in the Guerra Sand exhibit a common subsea gas-water contact of −4330 m (−14,200 ft), and in general, any well that encountered the sand top below a subsea depth of −4270 m (−14,000 ft) did not have sufficient pay thickness to be considered economic.

Methodology

It is not unusual to use time mapping of seismic data followed by depth conversion for structural positioning of a well location. This generally results in the well encountering the objective reservoir at or near the expected subsurface elevation relative to nearby wells unless there are strong lateral velocity variations. An example of a potential strong velocity variation would be in an area of growth faulting. Care should be taken to understand the differences in average interval velocity that occurs due to thickening of the section on the downthrown side of the fault and the effect those differences have on the dip of seismic reflectors in the footwall of the fault. Examples cited in the literature demonstrate wells that were drilled on apparent structural highs on time data that turned out to be structurally low due to those velocity differences.

Pitfall

An interpreter may incorrectly believe that using prestack time-migrated data with a nearby seismic check-shot survey available for depth control will reduce any uncertainties due to lateral velocity variations. Such an example is shown in Figure 5a, in which a proposed development well location (#99) appears to lie more than 30 m (approximately 100 ft) updip in the same reservoir from a well (#72) in which a seismic check-shot survey was recorded.

The original proposed location of the #99 well in Figure 5a was based solely on the apparent northwest dip observed on the prestack time-migrated data that

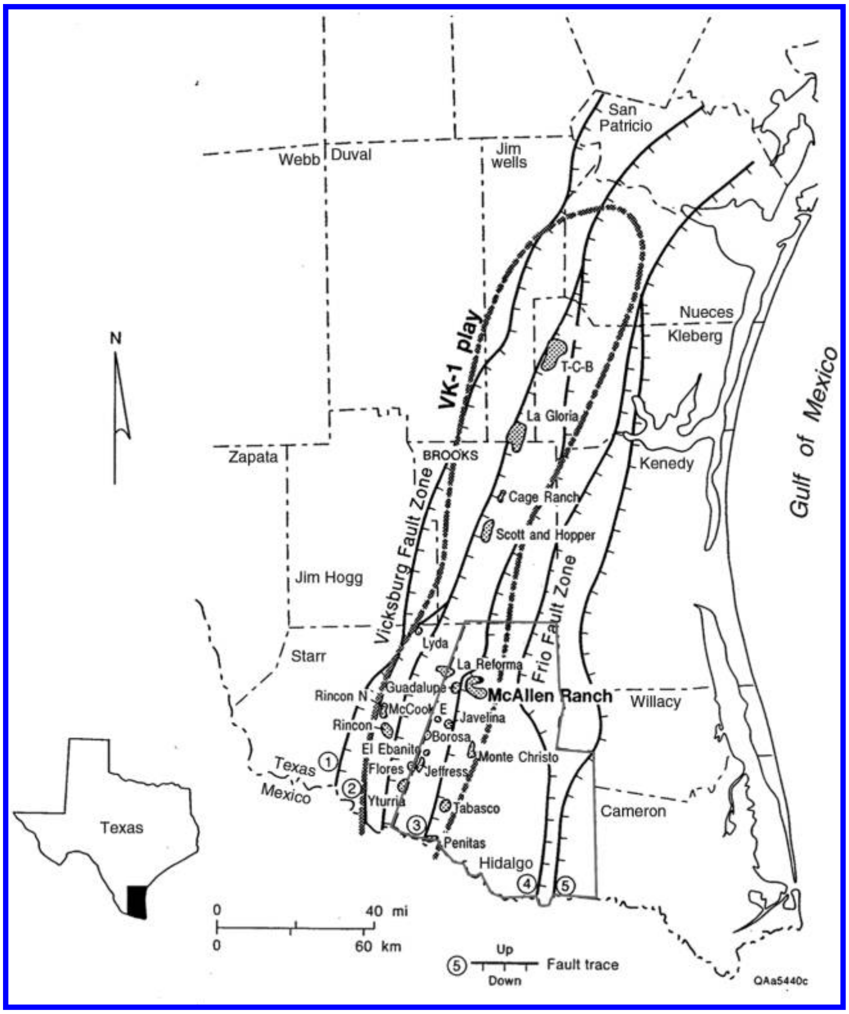

Figure 1. Map of the Texas Gulf Coastal Plain showing the McAllen Ranch Field in Hidalgo County, South Texas (modified after Langford et al., 1994).

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appeared to place it updip from the #72 well. The check-shot survey provided only a single point of depth control and was not sufficient to address the issue of lateral velocity changes. The pitfall of relying only upon the appearance of the seismic data and not taking into consideration any subsurface data that could have added to the structural understanding of the area of interest resulted in a proposed location that would have been a dry hole. Fortunately, the pitfall was recognized during the planning process for the well, and an alternate location was selected. Had the well actually been drilled in such a position, it would have encountered the reservoir low to the #72, at a location below a known gas-water contact, as shown in Figure 5b.

Mitigation

The pitfall was resolved just prior to the well staking by a thorough search for subsurface well data that revealed a dipmeter from the #72 (Figure 5b) that was not known to exist at the time the #99 was originally proposed. The dipmeter indicated 20° southeast dip at the sand top, in direct conflict with the seismic data. Fortunately, the team that proposed the well chose to honor the well data, specifically the dipmeter, over the seismic data, even though a reasonable explanation for the apparent northwest dip on the seismic data could not be provided at the time.

One should assume that a seismic interpretation in time accurately portrays geometry in depth unless one has an understanding of the local seismic velocities. In this example, a fault shadow effect was suspected as the cause of the anomaly because of the presence of the Monte Christo fault that expanded the Frio section in the area. The method used to quantify the effect of the fault shadow began with creation of arbitrary 2D lines through the 3D seismic volume to tie all wells with check-shot surveys to each other. It quickly became clear that a 450-m (1500-ft)-thick interval in the lower Frio Formation known locally as the *Massive Frio* had interval velocities that were as much as 50% faster than the overlying or underlying units. The Massive Frio is the zone that was involved in the expansion across the Monte Christo Fault, reaching a thickness of greater than 2100 m (7000 ft) on the downthrown side. This had the effect of a giant lens that distorted all of the data beneath the fault plane (Figure 6; see also Figure 5a and 5b).

The average measured log value of bulk density of the shale units within the Massive Frio is 2.5 g/cc, compared to 2.4 g/cc for the shale units in the overlying Upper Frio or the underlying Upper Vicksburg sections. The higher shale density in the Massive Frio may be the cause of the faster velocity within the unit. A determination of the depositional source of the difference in densities is beyond the scope of this study.

The top and base of the Massive Frio are readily correlated on well logs and can be easily tied to strong, continuous events on the 3D seismic data. This permitted a 3D velocity model to be created involving four simple steps (Figure 7):

1) Using the 3D volume, map the time surfaces bounding the top and base of the three units with distinct velocity differences: (1) ground surface to top of Massive Frio (average interval velocity of 2600 m/s [8500 ft/s] to 2750 m/s [9000 ft/s]),

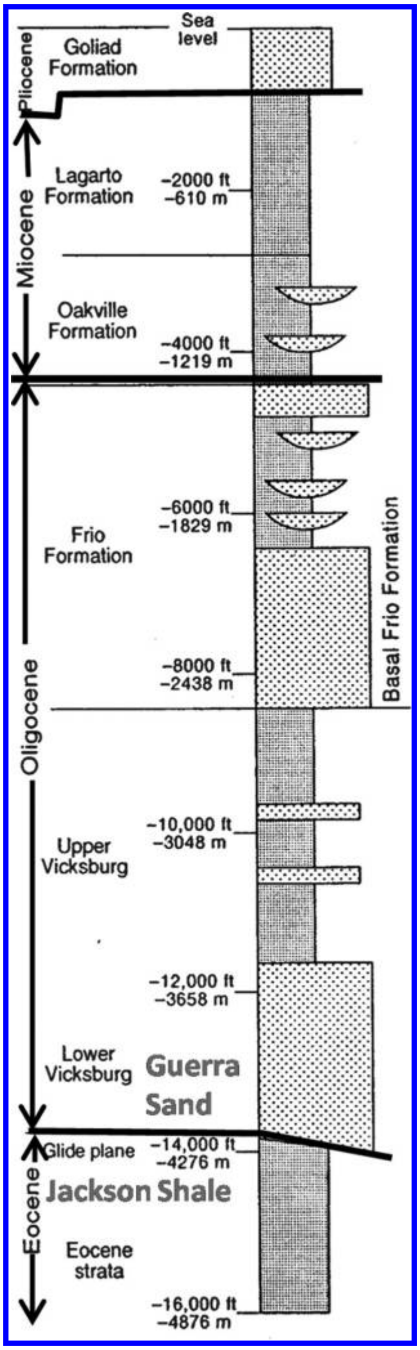

Figure 2. Tertiary stratigraphy in the McAllen Ranch Field area. General depths for McAllen Ranch Field are shown (from Langford et al., 1994). Actual producing depth in the study area is approximately 4250 m (14,000 ft).

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(2) top of Massive Frio to base of Massive Frio (3800 m/s [12,500 ft/s] to 4100 m/s [13,500 ft/s]), and (3) base of Massive Frio to top of Guerra Sand (2750 m/s [9000 ft/s] to 3000 m/s [10,000 ft/s]).
2) Using the 3D volume, create isochron volumes between these surfaces.
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4) The surfaces, interval thicknesses, and velocity maps were exported to GOCAD for efficiency in performing the following calculations. For each unit, the isochron value was multiplied by the contoured average interval velocity to yield a predicted thickness for the unit. Next, the units were summed and the result was a prediction of the shape and orientation of the top of the objective Guerra Sand (Figure 4c).

The resulting prediction of the structural configuration of the Guerra Sand top showed a structural high extending almost 2 mi southwest of the successful

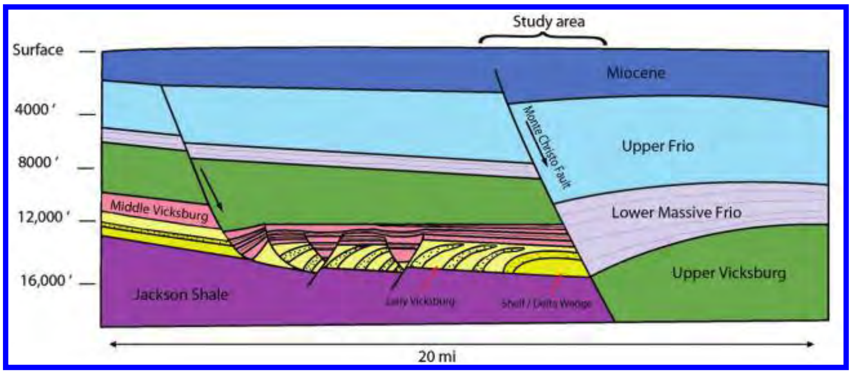

Figure 3. Schematic cross section showing the Vicksburg sequences in the McAllen Ranch Field and vicinity (modified from Whitbread et al., 2000).

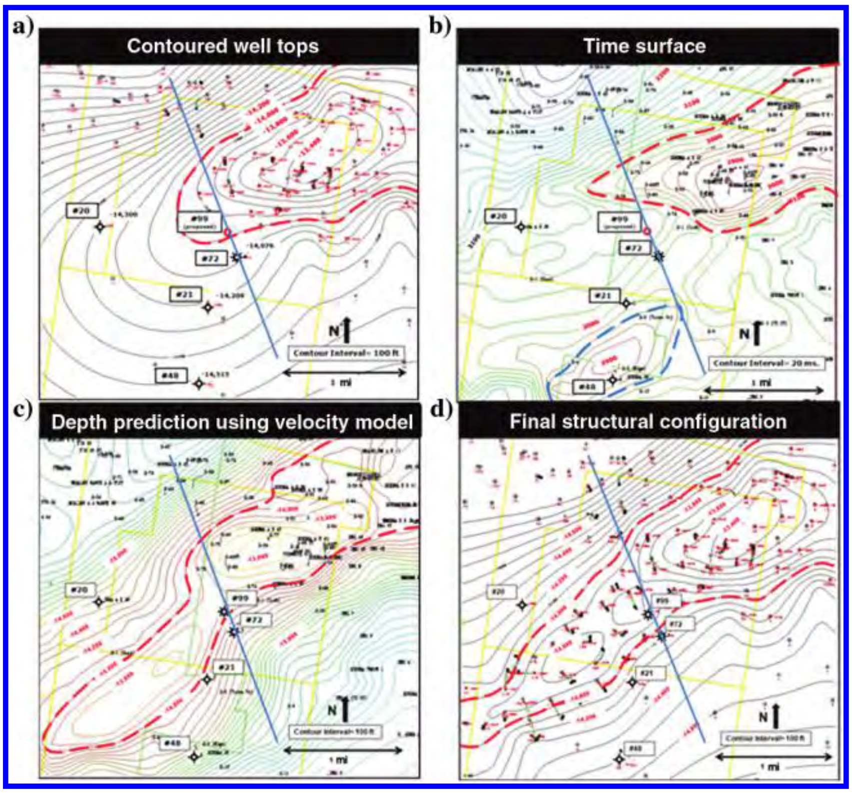

Figure 4. Evolution of the structural configuration of the Guerra Sand in a portion of McAllen Ranch Field (the location of seismic line from Figures 5a, 5b, and 6 is displayed). (a) Pre-2005 structural interpretation of Guerra Sand from subsurface picks. (b) Structure from interpretation of Guerra Sand time surface. (c) Depth prediction for Guerra Sand using the velocity model. (d) 2009 interpretation of Guerra Sand structure from subsurface picks.

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#99 well (Figure 4c). Based on this interpretation and the favorable results of the #99, Chevron undertook a two-year development drilling program in the newly identified structural field extension, named the South Block.

The final structural configuration after 25 wells were drilled very closely matched the model's prediction of the size and shape of the structure (Figure 4d). More than 150 BCF of new gas reserves were discovered, and field production increased from 22 million cubic

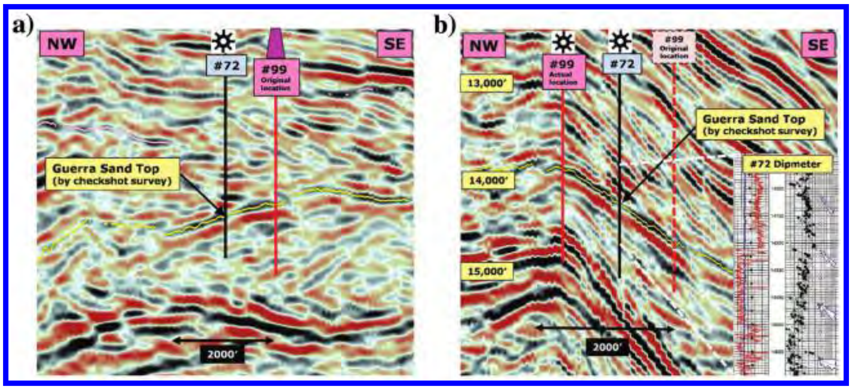

Figure 5. (a) Seismic tie displayed in time, between original proposed #99 location and established Guerra Sand production in #72 well. Note apparent northwest dip of seismic reflectors at the Guerra Sand top. Prestack time-migrated seismic data owned or controlled by Seismic Exchange Inc.; interpretation is that of Chevron USA Inc. (b) Seismic data from Figure 5a stretched to depth based on results of drilling of 25 new wells shown in Figure 4d. Note agreement between dipmeter data and seismic reflectors at Guerra Sand top. Prestack time-migrated seismic data owned or controlled by Seismic Exchange Inc.; interpretation is that of Chevron USA Inc.

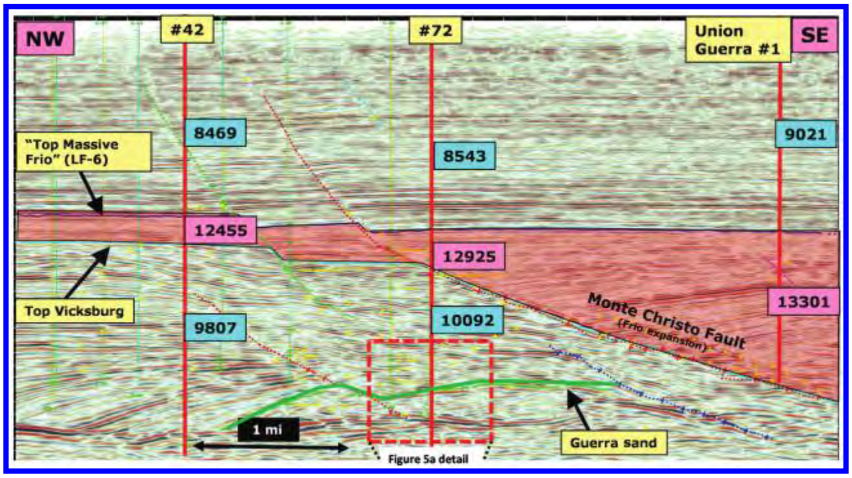

Figure 6. Vertical velocity contrasts in study area. Displayed wells show average interval velocities in feet per second of the units used to construct the velocity model. Note the southeastward thickening of the higher velocity Lower Frio unit on the downthrown side of the expansion fault. Prestack time-migrated seismic data owned or controlled by Seismic Exchange Inc.; interpretation is that of Chevron USA Inc.

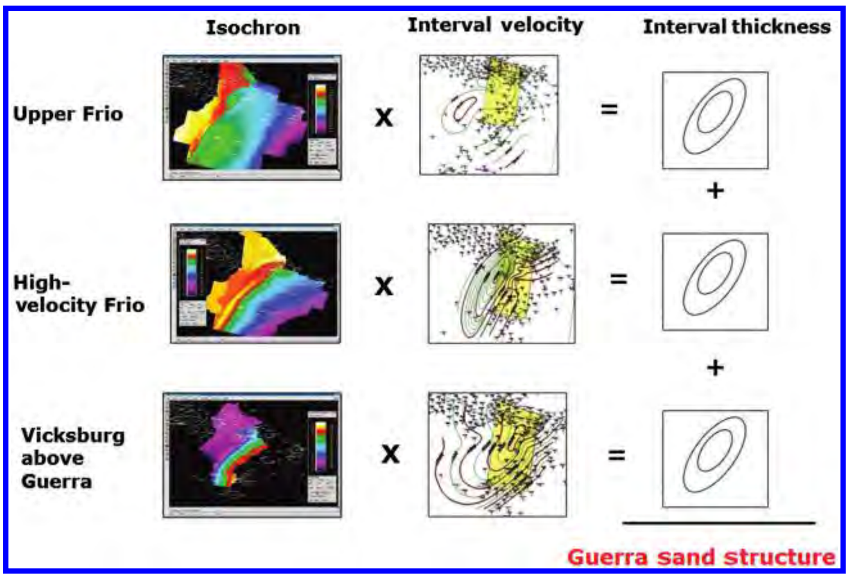

Figure 7. Schematic of method used to predict the depth to the Guerra Sand top in the study area.

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feet (MMCF) per day to more than 170 MMCF per day.

Conclusions

Several valuable lessons can be learned from the success shown in this example. The most important is that one should always honor well data, even if it directly conflicts with what the seismic data are suggesting. In the example presented, a dipmeter provided a more accurate resolution of the subsurface than did the seismic data. Second, simple solutions can work quite well. The velocity model used in this study did not require any seismic reprocessing but only involved simple mathematical calculations. The postdrilling result closely matched the model's prediction. Finally, the success of this project shows that there are still substantial reserves to be found in a seemingly mature province. McAllen Ranch Field is now 50 years old and has been thought to have been fully delineated for the last 25 years, but new discoveries can still be made.

Acknowledgments

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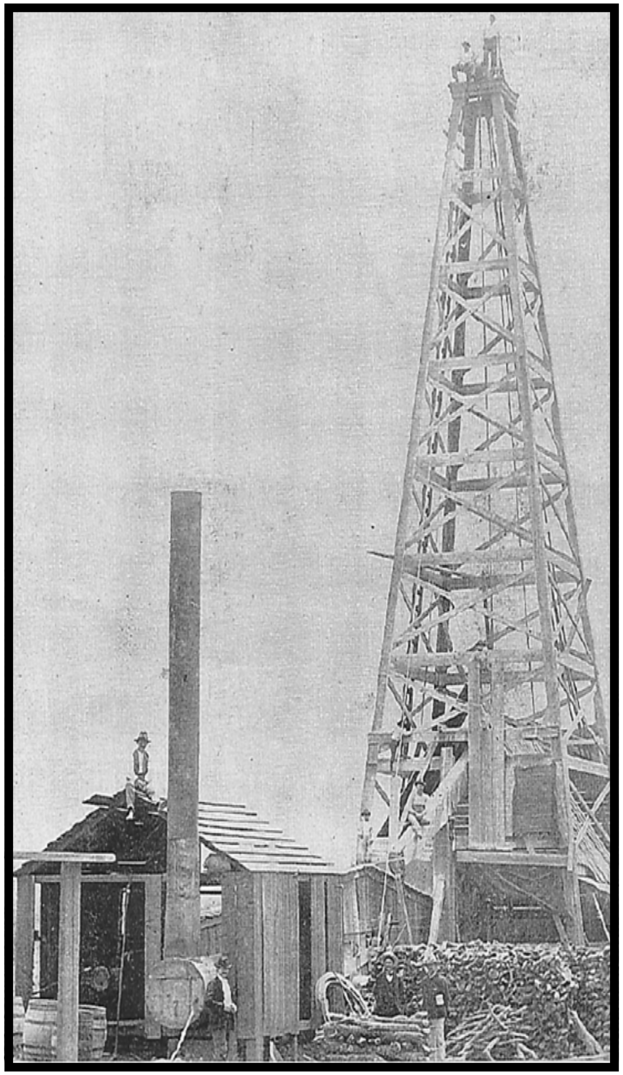

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