BULLETIN

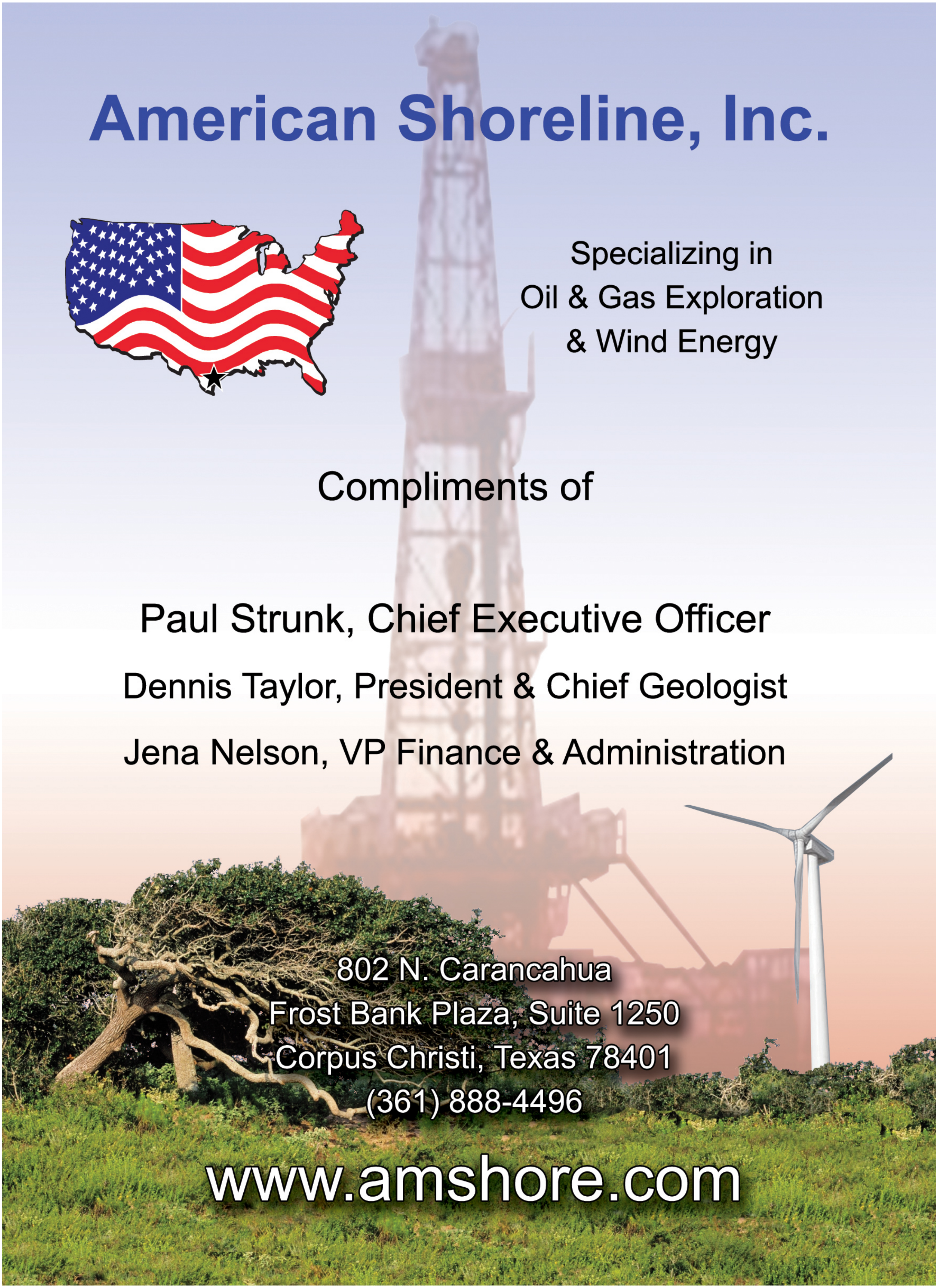
Corpus Christi Geological Society

and

Coastal Bend Geophysical Society

February
2016

ISSN 0739 5620



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2015-2016
www.ccgeo.org

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2015-2016

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Visit the geological Web site at www.ccgeo.org

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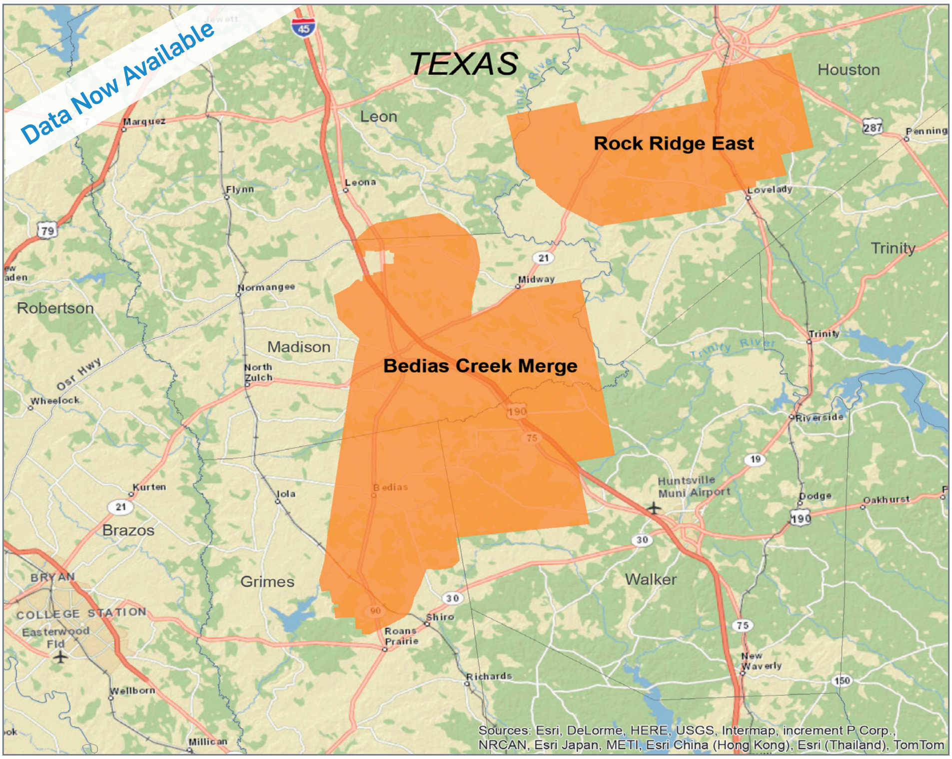
YOU'VE ARRIVED

Bedias Creek Merge
Madison, Grimes, Walker, and Leon Countires, Texas



Sources: Esri, DeLorme, HERE, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom

CGG offers the industry's most recent and technologically advanced multi-client data library in the world's key locations. Here is what Bedias Creek has in store:

- 110-fold data acquired using cableless **Sercel UNITE** crews and a dynamite source
- State-of-the-art processing, including 5D Interpolation and Orthorhombic Pre-Stack Time Migration

The best data, the right location, the right time!

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☎ +1 832 351 8463
✉ cheryl.oxsheer@cgg.com

CGG
Passion for Geoscience

cgg.com/multi-client

CCGS/CBGS JOINT MEETING SCHEDULE 2015-2016

September
2015

S	M	T	W	Th	F	S
		1	2	3	2	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			

Sept. 10, 2015
5:30p.m.—8:30p.m.
Kickoff BBQ
Hoegemeyer's Barbeque Barn

October
2015

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

Oct. 28—11:30a.m.—1:00p.m. Speaker: Neil Peake, CCG Geo Consulting Seismic Reservoir Characterization. "Unconventional Reservoirs: An Integated Workflow Incorporating Surface Seismic, Mineralogy, & rock Properties in the Haynesville Shale."

November
2015

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					

Nov. 18—11:30a.m.—1:00p.m. Speaker: Lorenzo Garza & Joe Stasulli, Railroad Commission of Texas. "Horizontal Drilling in Texas: A Tale That Begins in the Austin Chalk, but Whose Ending Has Yet To be Written."

December
2015

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		

Dec. 9—11:30a.m.--1:00p.m. Speaker: Dmitri Bevc,Ph.D., Chevron, SEG Distinguished Lecturer "Full Wave-Form Inversion: Challenges, Opportunities and impact"

January
2016

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						

Jan. 20--11:30a.m.—1:00p.m. Speaker: Charles Sicking, VP of R&D/Chief Geophysicist, Global Geophysical Services, Inc. "Predicting Frac Performance and Active Producing Volumes Using Microseismic Data"

February
2016

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					

Feb. 17—11:30a.m.—1:00p.m. Speaker: Richard Coffin, Ph.D., Dept. Chair, Physical & Envir. Sciences, Texas A&M Univ.—Corpus Christi. "Integration of Geochemistry & Geophysics Applied to Coastal Gas Hydrate Assessment"

CCGS/CBGS JOINT MEETING SCHEDULE 2015-2016

March							April							May						
S	**M**	**T**	**W**	**Th**	**F**	**S**	**S**	**M**	**T**	**W**	**Th**	**F**	**S**	**S**	**M**	**T**	**W**	**Th**	**F**	**S**
			2016							**2016**							**2016**			
		1	2	3	4	5						1	2	1	2	3	4	5	6	7
6	7	8	9	10	11	12	3	4	5	6	7	8	9	8	9	10	11	12	13	14
13	14	15	***16***	17	18	19	10	11	12	13	14	15	16	15	16	17	***18***	19	20	21
20	21	22	23	24	25	26	17	18	19	***20***	21	22	23	22	23	24	25	26	27	28
27	28	29	30	31			24	25	26	27	28	29	30	29	30	31				

March 16—11:30a.m.—1:00p.m.
Speaker: Thomas Ewing, Ph.D., Texas Bureau of Economics Geology & Frontera Expl. Consultants, Inc. “Building Texas: Insights from the “Texas Through Time Project”

April 20—11:30a.m.—1:00p.m.
Speaker:

May 18—11:30.m.—1:00p.m.
Distinguished Speaker:

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 Tuesday—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, Metallurgy & Exp	2nd Tues every other month In San Antonio

PRESIDENT’S LETTER

GCAGS Convention hosted by CCGS in September, 2016

WHY SPONSORS SHOULD PLEDGE THEIR SUPPORT NOW.

The CCGS will be publishing the Convention Announcement Brochure for the GCAGS 2016 to be sent out to over 9000 Gulf Coast members in May. Become a sponsor before February 29, 2016 to be recognized in the Convention Announcement Brochure. You will also be recognized on our website, at the convention by signage, and in the Convention Program Guides as well.

GCAGS is a non-profit professional organization whose purposes are to foster education and the communication of ideas, and to provide financial support to geoscience students and faculty conducting research in the Gulf Coast region.

The annual GCAGS Convention serves as a forum for the discussion and publication of papers on subjects concerning the geological profession as they relate to Gulf Coast area geology.

The registration fees alone do not cover convention costs. The GCAGS convention strives to be the most economical technical convention offered amongst many. Our full registration fees have traditionally been $300 or less. Student rates are usually $35. The field trips and short courses are led by industry leaders who are experts in their fields. Again the costs are very reasonable. This allows the maximum numbers of students, professors, retired scientists, and independents to attend.

WHY DO YOU WANT TO HELP SPONSOR THIS CONVENTION?

Thirty-five percent of any proceeds above the cost of the convention stay with the Corpus Christi Geological Society. The CCGS is very active in the local community:

- Teacher workshops for local K-12 science teachers will be offered during the convention at no cost, including handouts for the classroom.
- Rocks and Minerals presentations are made to schools, boy and girl scouts.
- USGS terrain maps, South Texas Ice Age Murals, and Bones are provided to schools.
- The CCGS is trying to display large beautiful boulders at each area middle school with display signs. They show igneous, metamorphic and sedimentary rocks. These are expensive, but are in high demand.

- The CCGS is also collecting ice age mammoth bones to not only display in schools, but all local libraries.
- Geology tables at Earth Day/Bay Day are manned with minerals and ice age bones.
- CCGS members are Science fair judges and display ice age bones at “science day” in schools.
- The CCGS scholarship committee provides scholarships to local TAMUCC, Del Mar College, and TAMUK earth science students, averaging $15,000 per year.

With all the good that is done by the GCAGS and the CCGS, I encourage you to consider a sponsorship now to this 66th Annual GCAGS Convention. Look for the sponsorship form in this bulletin or go to www.gcags2016.com.

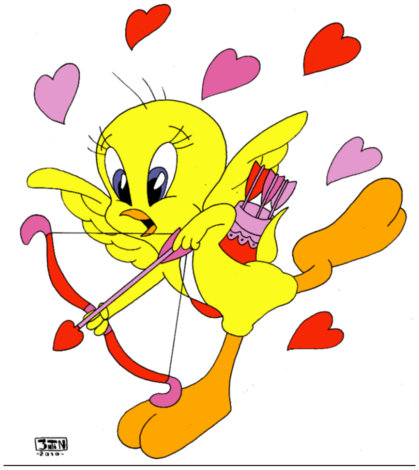
Mike Lucente—CCGS President

BLOOD DRIVE

THE BLOODMOBILE – IN **FEBRUARY, 2016**
WILL BE AT SOME CONVENIENT LOCATIONS
PLEASE CALL 855-4943 for those locations or see below

Happy Valentine's Day!!

Before you eat too much chocolate – go out & donate some blood! Tweety would be happy too!



ATTENTION!!!

When you give blood: They have us listed as C.C. Geological Society. Our number with them is 4254 & it would be helpful if you can give them that number also.

FOR CURRENT SCHEDULES & LOCATIONS OF THE BLOODMOBILES YOU CAN LOG ON TO:

www.coastalbendbloodcenter.com

This message approved by Mike Lucente….

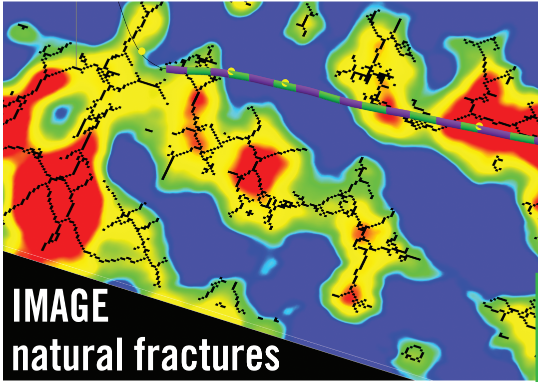
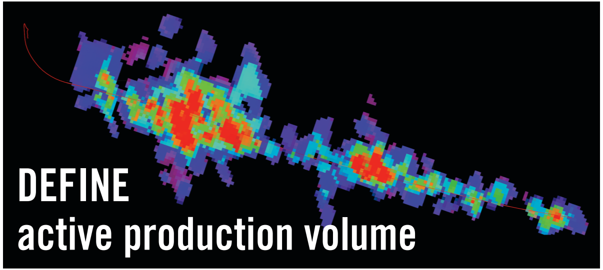
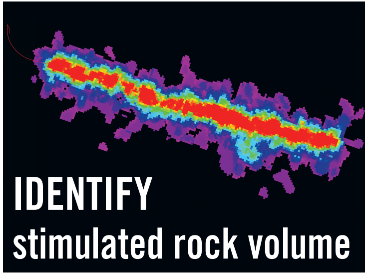
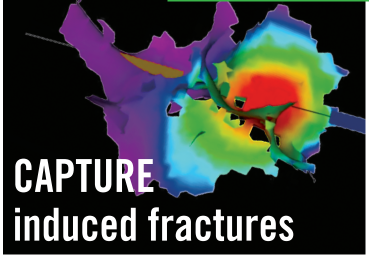


IMAGE
natural fractures


DEFINE
active production volume


IDENTIFY
stimulated rock volume

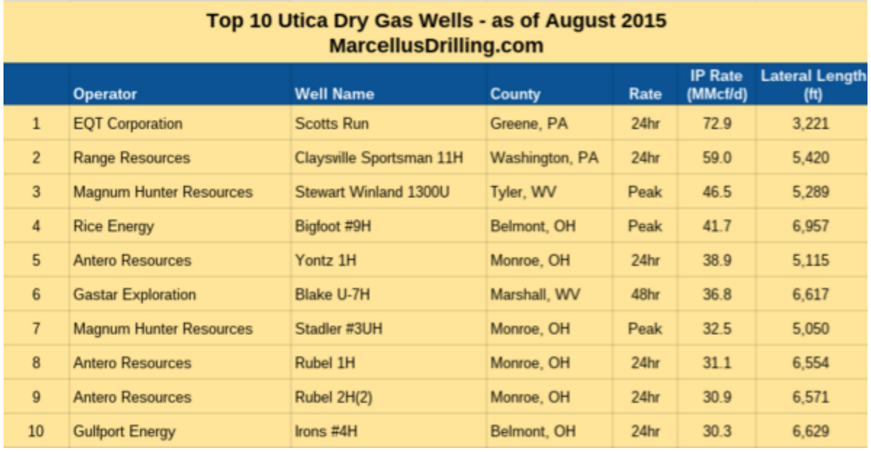

CAPTURE
induced fractures

CBGS PRESIDENT'S LETTER

News -

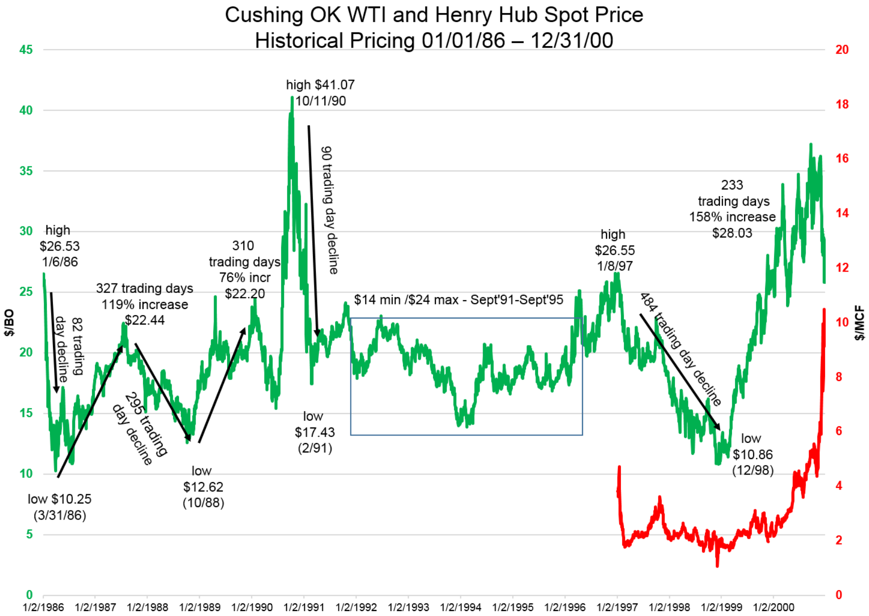
Commodity prices are the news. Read that 40 O&G operators have filed for bankruptcy (per Fuelfix.com).

Following are some interesting graphs.



Top 10 Utica Dry Gas Wells - as of August 2015
MarcellusDrilling.com

	Operator	Well Name	County	Rate	IP Rate (MMcf/d)	Lateral Length (ft)
1	EQT Corporation	Scotts Run	Greene, PA	24hr	72.9	3,221
2	Range Resources	Claysville Sportsman 11H	Washington, PA	24hr	59.0	5,420
3	Magnum Hunter Resources	Stewart Winland 1300U	Tyler, WV	Peak	46.5	5,289
4	Rice Energy	Bigfoot #9H	Belmont, OH	Peak	41.7	6,957
5	Antero Resources	Yontz 1H	Monroe, OH	24hr	38.9	5,115
6	Gastar Exploration	Blake U-7H	Marshall, WV	48hr	36.8	6,617
7	Magnum Hunter Resources	Stadler #3UH	Monroe, OH	Peak	32.5	5,050
8	Antero Resources	Rubel 1H	Monroe, OH	24hr	31.1	6,554
9	Antero Resources	Rubel 2H(2)	Monroe, OH	24hr	30.9	6,571
10	Gulfport Energy	Irons #4H	Belmont, OH	24hr	30.3	6,629



Cushing OK WTI and Henry Hub Spot Price
Historical Pricing 01/01/86 – 12/31/00

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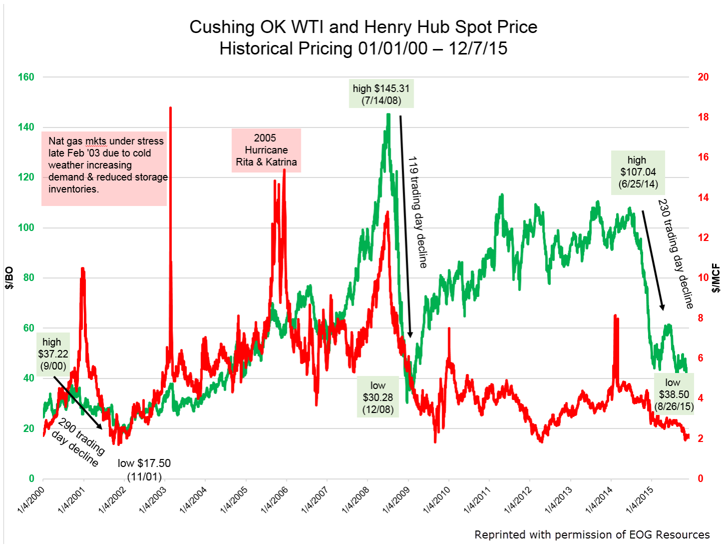

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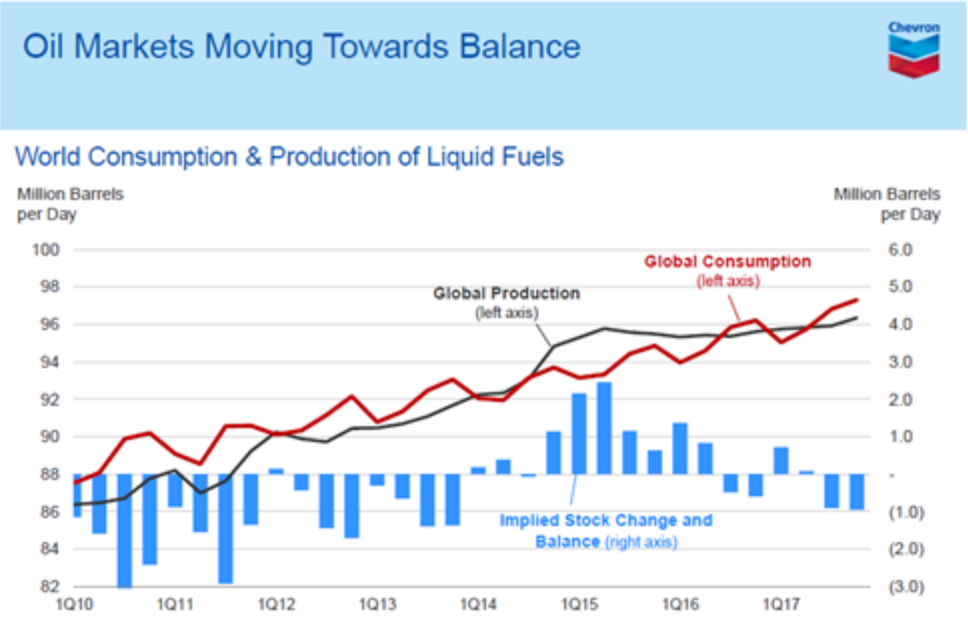
<u>On a positive note, looks like supply/demand is getting closer to balanced</u>.



Oil Markets Moving Towards Balance

World Consumption & Production of Liquid Fuels

<u>Business -</u>

CBGS golf tournament being scheduled. Scholarship applicants solicited.

<u>Education/Events -</u>

- GSH

Applied Azmuthal Anisotropy - Webinar - 4 half days, Feb 4, 5, 6 ,7 – Dr. Heloise Lynn

Interpretation Technology Symposium/Exhibition - April 13-14 Norris Conf Center, Houston City Centre

Numerous technical luncheons if you happen to be in Houston. Check following link.

<u>Geophysical Society of Houston Calendar</u>

CBGS has a revenue sharing agreement with GSH. Please mention CBGS if you register for any GSH events.

- SEG

Understanding and Adapting Rock Physics Principles for Mudrock (Shale) Reservoirs, OK City, Manika Prasad, 29Feb/1Mar

SEG Convention, 16-21 October, Dallas

SEG has 450+ eLearning courses online from $0.99 to $150.00(most expensive I saw) [http: //www.seg.org/professional-development/seg-on-demand](http://www.seg.org/professional-development/seg-on-demand)

- AAPG

Deepwater Reservoirs, 10 February, Houston

AAPG Convention, 19-22 June, Calgary

- HGS

Continental Margin Evolution, 25-25 February, Rice University

Mudrocks Conference, 8-9 March, Woodlands

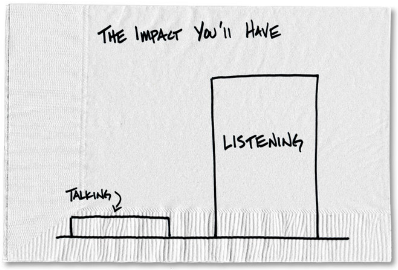
- NAPE

February 10-12, Houston

- OTC

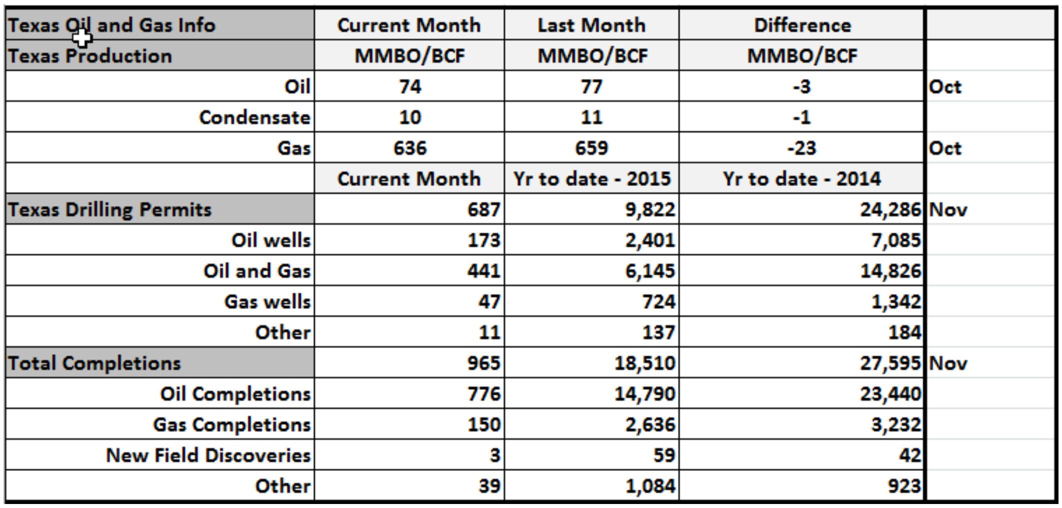
May 2-5, Houston

Thought for the month



A vision without a task is but a dream, a task without a vision is drudgery, a vision with a task is hope of the world. - Inscription on a wall in Sussex England, circa 1730

Monthly O&G Statistics



Texas Oil and Gas Info	Current Month	Last Month	Difference	
Texas Production	MMBO/BCF	MMBO/BCF	MMBO/BCF	
Oil	74	77	-3	Oct
Condensate	10	11	-1	
Gas	636	659	-23	Oct
	Current Month	Yr to date - 2015	Yr to date - 2014	
Texas Drilling Permits	687	9,822	24,286	Nov
Oil wells	173	2,401	7,085	
Oil and Gas	441	6,145	14,826	
Gas wells	47	724	1,342	
Other	11	137	184	
Total Completions	965	18,510	27,595	Nov
Oil Completions	776	14,790	23,440	
Gas Completions	150	2,636	3,232	
New Field Discoveries	3	59	42	
Other	39	1,084	923	

Lonnie Blake—CBGS President

GCAGS 2016
EXPLORE THE FUTURE
LOOKING BACK
THINKING FORWARD...
Corpus Christi Geological Society
1936 2016
Celebrating 80 Years
Corpus Christi, Texas – Sept. 18-20, 2016
www.GCAGS2016.com

Plans for the GCAGS are moving along nicely. Abstracts for presentations are coming in. The deadline has been extended to February 20th so get your submission in soon. Fourteen sessions are now in the making. Check out the sessions on our website: www.gcags2016.com.

We still need help. We need session chairs for the themes of:

- Conventional Carbonates and Clastics
- Enhanced and Secondary Recovery
- Mexico and Latin America
- The Changing Coastal Landscape
- Climate from Multiple Perspectives

Papers have been submitted on these topics. If you are interested in chairing any of these sessions, contact Rick Paige or Bob Critchlow at TechProgramChair@gcags2016.com.

We need local volunteers to coordinate with the convention management company in the areas of transportation (buses/vans for shuttles and field trips) and exhibits. Let me know if you're interested.

It would be great to have a social media whiz to help us advertize to all the young geologists or NeoGeos.

Of course we are soliciting sponsorships. See Mike's President's Letter for all the good reasons to sponsor the GCAGS. The sponsorship form can be found in this issue. Contact Lonnie Blake (361-876-6614) or me for more information.

Looking Back *Thinking Forward . . .*

Dawn Bissell
General Chairman
361-960-2151

**2016 GULF COAST ASSOCIATION
OF GEOLOGICAL SOCIETIES
ANNUAL CONVENTION**

CORPUS CHRISTI, TEXAS

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January 2016

Greetings

The Corpus Christi Geological Society is organizing the Gulf Coast Association of Geological Societies annual convention to be held at the American Bank Center, Corpus Christi, Texas from the 18st to the 20th of September, 2016. The deadline to get your organizations sponsorship in the convention packet is Feb 15th. Sponsorships received after that date will be posted on the website and at the convention venue, but not in the packet.

The GCAGS Convention is a great way to put your organization forward:

- GCAGS has 9000 members, the largest AAPG Section
- 600 -1000 geoscientists and their companies attend the convention
- Professionals from 14 states and 2 countries attended in 2015
- Corpus Christi, the “Sparkling City by the Sea”, a popular GCAGS site
- A very cost effective program to attend/publicize your organization

Proceeds from the annual convention fund every program that the GCAGS does, including: Student and Faculty research grants, the Visiting Professor program, Scholarship Fund Matching program, Student Chapter (AAPG) Leadership Summit travel assistance, Gulf Coast Section of Imperial Barrel Award Competition, Professional Honors and Awards, Teacher of the Year Awards, The GCAGS *Transactions*, and the GCAGS *Journal*.

Sponsoring companies will gain added publicity and acknowledgement throughout the entire Convention. In addition, sponsoring companies will gain longer term advertising exposure through acknowledgement pages at the beginning of the *GCAGS Transactions* publication. The following Sponsorship Levels are available:

Double Diamond – Highest Contributing Sponsor

Diamond	$25,000
Emerald	$15,000
Sapphire	$5,000
Topaz	$1,000
Patron	$500

To have your company prominently listed as one of the key sponsors of the upcoming convention please return the attached sponsorship form. If you have any questions, please contact Lonnie Blake at sponsorships@gcags2016.com, or Dawn Bissell at bissells@swbell.net at 361.960-2151 for details.

Lonnie Blake, Sponsorship Chairman
361-876-6614

GCAGS 2016
EXPLORE
THE FUTURE
LOOKING BACK
THINKING FORWARD...
Corpus Christi, Texas – Sept. 18-20, 2016
www.GCAGS2016.com

**2016 GULF COAST ASSOCIATION
OF GEOLOGICAL SOCIETIES
ANNUAL CONVENTION**

CORPUS CHRISTI, TEXAS

CORPUS CHRISTI GEOLOGICAL SOCIETY
1936 2016
CELEBRATING 80 YEARS

The Gulf Coast Association of
Geological Societies and the Gulf
Coast Section of SEPM

Corporate Sponsorship Opportunities

Corpus Christi, the “Sparkling City by the Sea” is always a popular GCAGS venue.

What a great way to put your organization forward:

GCAGS – 9000 members, the largest AAPG Section
- 600 - 1000 geoscientists attend
- 900 Professionals representing 450 companies from 14 states and 2 countries attended in 2015

Benefits of sponsorship

- Reinforce your company’s name and logo
- Visibility in the exhibit hall
- Stand out from your competitors – give your products and services and edge
- Enhance your standing in the industry
- Earn a profile among young geoscientists – your future workforce

Sponsorship packages – designed to maximize your investment

- **Diamond (D) $25,000+**
- **Emerald (E) $15,000+**
- **Sapphire (S) $5,000+**
- **Topaz (T)$1,000+**
- Patron (P)$500+

Sponsor an event or product – for even more visibility

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Integration of Geochemistry and Geophysics Applied to Coastal Gas Hydrate Assessment

Presented by: Richard Coffin, Ph.D. – Department Chair, Physical and Environmental Sciences, Texas A&M University – Corpus Christi

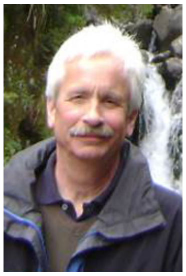
Summary

Methane hydrates are recognized to exist in high concentrations in coastal oceans around the world. The Japanese are exploring the potential for hydrates in the Nankai Trough, off the coast of Tokyo Japan, for development as a dominant national energy source. Exploration of for hydrates is expensive and uncertain with a focus on data from seismic profiling and deep sediment drilling. Recent studies have combined seismic profiles, shallow sediment geochemistry, heatflow and controlled source electromagnetics to predict deep sediment hydrate deposits. This approach provides a more thorough, less expensive, investigation prior to deep sediment drilling.

Faculty at TAMU-CC have been involved in methane hydrate exploration off the coasts of New Zealand, Chile, Canada, Alaska in the Arctic Ocean and in the Gulf of Mexico. Results of these studies show the need to integrate geochemistry and geophysics to assess the coastal hydrate loadings. Some examples include: 1) Strong seismic blanking indicative of high vertical methane migration off the coast of Chile was observed to have a low vertical methane flux through the deep sediment; 2) High vertical methane migration on Atwater Valley in the Gulf of Mexico was observed to be coupled with a high vertical chloride flux in the porewaters, that suggest deep sediment salt diapirs caused unstable sediment methane hydrate deposits; and 3) Recently seismic patterns taken on Chatham Rise east of New Zealand suggested a strong current and past deep sediment hydrate loading. Thorough geochemistry through this region indicates that gas hydrates are not present.

This presentation will provide an overview of predicted methane hydrate deposits in different coastal regions and the advantages of combining different parameters in the evaluation. Work will include brief overviews of expeditions in the Gulf of Mexico at Atwater Valley, west of Concepción on the mid Chilean Margin, and work at two sites east off New Zealand*.* We provide an overview of the benefits and issues with the interpretation of deep sediment hydrate deposits using different approaches for the field survey.

About our Presenter:



Dr. Richard (Rick) Coffin is the chair of Physical and Environmental Sciences, Texas A&M University – Corpus Christi and the founder of Strategic Carbon LLC, an engineering and environmental consulting firm. He is an oceanographer and biologist by training, with a B.S. and M.S. from the University of New Hampshire and his Ph.D. in oceanography from the University of Delaware. He was a NSF Postdoctoral Fellow at Gordon College in Wenham, Mass. He has worked at the Naval Research Laboratory in Washington, D.C., and the EPA in Gulf Breeze, Florida. Rick has served as adjunct faculty at the University of Hawaii, University of Delaware, Florida State, and Texas A&M.

Dr. Coffin’s background is in isotope geochemistry is applied to determine key ecosystem cycles. His work has focused on soil groundwater systems, estuaries, coastal and deep ocean water column and sediment. Field work has been global with recent priorities on Navy harbors through the US, the Arctic Ocean and coastal regions off Chile, New Zealand, Canada, Norway, Japan and the US. During these field efforts contribution has been through working as leader or co-leader of planning, execution and interpretation. Work has addressed environmental assessment, energy exploration and field technology development. Examples of success include providing a 25 million dollar cost savings plan for harbor remediation in Liepaja Latvia and focusing methane hydrate energy exploration sites off the coasts New Zealand, Alaska, Texas and Chile providing 10 – 30 million dollar savings at each potential drill site.

The key issues that have developed through his research include:

- Transition of basic geochemical sciences to cost savings and legal certification on applied environmental topics.
- Development and application of carbon isotope geochemistry to assess natural and anthropogenic carbon cycling. Applied to environmental monitoring and natural carbon cycle modeling.
- Proof of geochemical and seismic data integration for assessment of deep sediment methane hydrate loading.
- Prediction on deep ocean carbon sequestration environmental impact and residence time.

The Corpus Christi Geological Society is pleased and honored to have Dr. Coffin as a member and as our presenter for Collegiate Month in February. Texas A&M University - Corpus Christi is a vital part of the Society and our community.

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Managing Unconventional reservoirs using Streaming Depth Imaging and Passive Recordings

Charles Sicking, Jan Vermilye, Lance Bjerke, Ashley Yaner, Scott Simms, Global Geophysical Services, Inc.

Abstract

The Streaming Depth Imaging (SDI) method images passive emissions that come from the fractures in the subsurface and is used to generate products that allow for reservoir management. It is called streaming depth imaging because all of the recorded time is processed into the same output depth volume. The SDI method uses integration over time to focus and image Long Duration Signals (LDS). LDS occur continuously but episodically in the trace data. The outputs of SDI are seismic emission volumes from which the fracture systems in the subsurface rock volume are extracted.

Products that are computed using SDI provide reservoir management over the life of the reservoir. These products include images of the natural fracture systems, the computed Stimulated Rock Volume (SRV), and the computed producing volumes around a well called the Active Producing Volume (APV). Pre-existing natural fractures computed from ambient data recorded before drilling can predict the performance of the frac treatment and also can predict the rock volumes that have a high potential to produce oil and gas. The ability to different of the reservoir zones that will produce oil and gas from those zones that will not produce before the wells are drilled, provides substantial predictive value for reservoir management.

Introduction

The acquisition, processing, and imaging of the passive trace data area important for the SDI method. The waveforms that are sourced at depth must be preserved because the source signatures are highly variable and cannot be measured from the recorded data. The trace filtering must not change the phase of the signals. The dominate frequency band for LDS signals are between 15 and 55 Hz. This is the same band that is the primary transmission band observed for 3D reflection data. Collecting all of the LDS signal in the imaging computation reveals the natural fractures in the rocks and shows the fracture permeability pathways in the reservoir.

Previous publications describe most of the aspects of the SDI method. The correlation of the passive emission volume to the natural fractures in the subsurface is addressed in Geiser 2012, Lacazette 2013, Lacazette 2015, Sicking 2012, and Sicking 2014. These articles show natural fracture systems in outcrops and fractures in downhole log data that correlate directly to SDI imaged fractures and how the fracture distribution correlates with the amplitudes in the emission volume. SDI products can provide significant value for the life cycle management of unconventional reservoirs. 4D passive recordings should be employed for optimum life cycle management. The recommended acquisition design for 4D passive data is a buried grid.

The SDI method for passive data is analogous to pre-stack depth migration (PSDM) used to image 3D reflection data. The method requires that a single velocity and statics model be developed for use with all of the recorded data. LDS are of fundamental importance to the products computed using the SDI method. All of the signal generated from a single voxel in the subsurface is focused back to that voxel in the final integrated depth volume.

The SDI method – description and synthetic example

SDI can best be described as Pre-stack Depth Migration (PSDM) using one-way travel times where the seismic sources are at depth and the waves travel one way from the sources to the receivers. The SDI method is similar to PSDM used for reflection data regarding the requirements for acquisition, processing

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for noise suppression, velocity model building, and statics. The SDI method departs from the PSDM method in the imaging steps and in the products derived. For 3D reflection data, there are a large number of high amplitude active sources and a large number of receivers on the surface, the traces are on the order of 10 to 25 seconds long, and each trace has the zero time reference of the source trigger for that trace. For passive data the trace length ranges from hours to days. The PSDM method collects the signal for a single voxel by combining all of the recorded traces into one output image. For passive imaging the signal is distributed over hours of time so the signal integration requires two steps. First the traces gather are broken into smaller window and each time window is imaged to create one depth volume. The depth volumes are integrated in order to compute the final seismic emission volume. Figure 1 illustrates the method using synthetics. The SDI method applied to each voxel for the depth volume and for each time window is illustrated using synthetic data in Figure 1. The traces were computed using a wave equation modeling program. An impulse was generated at the reservoir depth and the propagating waveform was recorded at each receiver at the surface of the Earth. The impulse response was modeled at three different X, Y locations at the depth of the reservoir. The time window of each impulse was inserted into background noise that was computed using a random number generator. The random number sequences for each trace were filtered to the band pass of the modeled signal before the impulses were added into the traces. The RMS amplitude of the background traces was computed and compared to the peak waveform amplitude of the signal impulse. The S/N is defined to be the ratio of the peak of the waveform of the signal to the RMS amplitude of the noise. For this synthetic, the S/N ratio was computed such that the signal in the unfocused trace data would not be observed by casual observation but the signal is observed in the focused trace data. The peak signal to RMS noise ratio for this data is approximately 1.0. All four trace panels in the figure show the same traces. When focusing is applied for a voxel that has signal from the voxel, that signal can be observed in the trace display. The trace length for all traces was set to 12 seconds. A total of 14 impulses were summed into these traces such that the impulses overlap in time in the same traces. For this experiment, only one impulse was summed for the top right corner of the image slice shown in Figure 1. The focusing time of this impulse was 4.1 seconds from the start of the traces. For the X, Y, location in the middle of the depth slice, three impulses were summed into the traces. The focusing times for these three impulse were 3.0, 6.2, and 8.8 seconds. For the X, Y, location in the bottom left corner of the depth slice, ten impulses were summed into the traces. The focusing times for these impulses are shown by the blue arrows in the trace display in the bottom left panel of Figure 1. This experiment is presented to illustrate that the SDI method sorts the impulses to their correct location in X, Y, and Z and that signals coming to the receivers from many locations in the subsurface but at the same time are properly located. The SDI method for this experiment broke the trace data into 120 overlapping 200 millisecond windows, computed 120 depth volumes, and integrated all of the depth volumes to get the final volume. The depth slice in Figure 1 is taken from the final integrated volume. From the figure, one can see that the integrated seismic emissions are weakest at the location of the single impulse location and strongest at the location where there are 10 impulses inserted. In addition, the background noise from the random sequences in the traces is suppressed while the signal level is built up.

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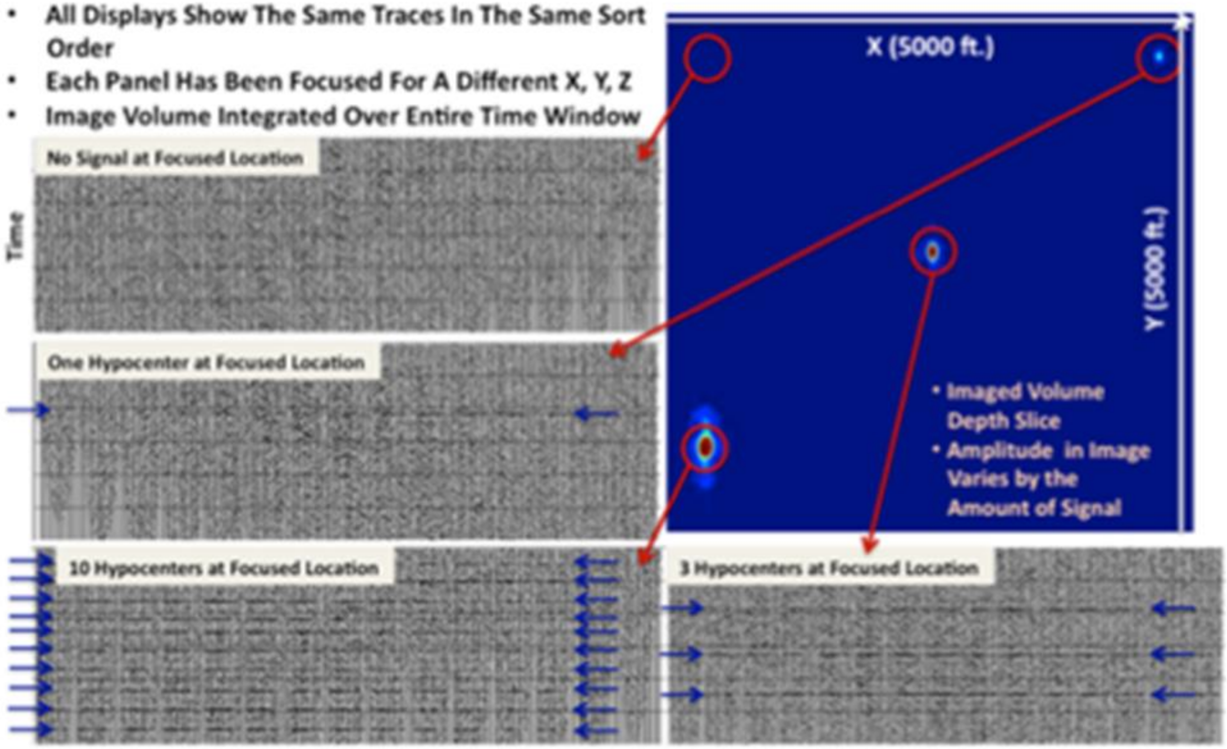


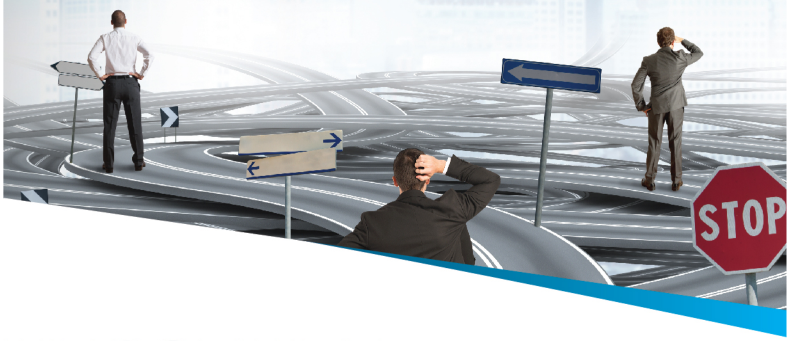
Figure 1: The Streaming Depth Imaging (SDI) method uses Kirchhoff Pre-stack Depth Migration to focus and image the trace data to every voxel in the depth volume. The arrow points to the trace panel focused for that location. The signal energy is integrated over the full time of the recorded traces.

Long Duration Signals (LDS) and SDI

Seismic energy is emitted as rocks release stored elastic strain energy. This energy is not evenly distributed in earth's crust, but is preferentially released on fracture/fault surfaces and in the damage zones surrounding these fractures. Fracture mechanics predicts stress concentrations associated with fractures. Both field studies and laboratory experiments show clear evidence for these stress concentrations, recorded in the damage zones associated with fractures. Damage zones consist of rock volumes with a high density of smaller fractures that display exponentially higher densities with proximity to the main fracture surface.

The brittle crust is in a state of unstable frictional equilibrium and therefore very small changes in stress (<0.01 atmospheres) can cause rock failure. Failure occurs preferentially on small, optimally oriented fractures and in the zones surrounding the fractures where crack-tip stress concentrations amplify the stress magnitudes. During well treatment, the unstable equilibrium is significantly disturbed as additional fluid volumes alter the stress state around the wellbore and reduce the normal stress on preexisting fractures. During production, more subtle movement of fluid produces a similar effect. In both cases, seismic waves are emitted as the rock releases stored elastic strain energy

LDS are continuous seismic waveforms originating in the reservoir and lasting for seconds or minutes and are episodic and pulsating by nature. These waveforms are similar to those documented by Das and Zobach 2013 and discussed by Sicking 2014. Micro-EarthQuake (MEQ) signals are of short duration and have higher amplitudes than LDS waveforms. During pumping, there is a large fluid flow and a large pressure change at the frac stage location. This fluid flow and differential stress causes seismic signals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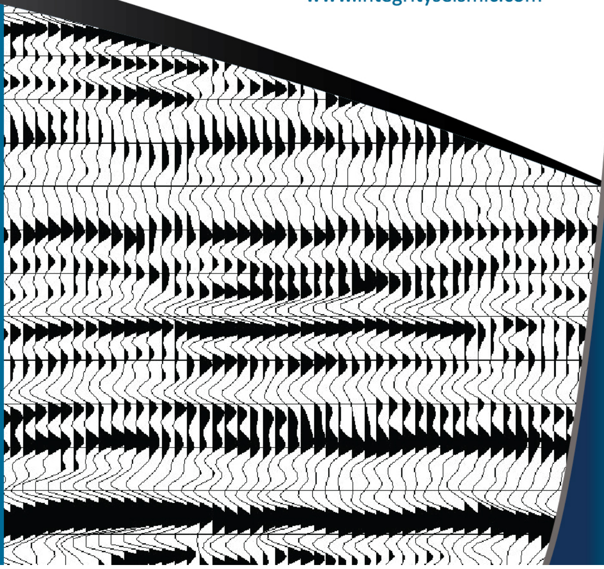

from the frac stage location in the form of LDS waveforms. We have studied the signal for two stages of a frac treatment project. For each of the two stages, LDS were tracked and demonstrated to exist for 60 minutes of the 100 minutes of pump time. Tary 2014 document similar signals recorded in frac data. They appear and disappear on time scales ranging from seconds to many minutes in duration. Signal analyses of the LDS signals shows the frequency range to be positive S/N for LDS is from 15 to 55 Hz. This frequency band is similar to the frequency band observed for surface reflection data. Some rocks generate more MEQs while others generate more LDS and the locations of the MEQ and the locations of the LDS are sometimes co-located and are sometimes separated. These differences are observed in real data but have not been satisfactorily explained.

Stationary surface wave noise

Stationary Surface wave noise: Surface waves are one of the most important sources of noise for the SDI method and must be addressed in order to compute high-quality images. The stationary surface wave noise may cause artifacts in the imaged volumes. Detectability of the passive seismic emissions depends on the S/N ratio of the trace data measured after filtering has been applied to suppress the various types of noise. One of the best methods for suppressing surface wave noise is to use a uniform grid of receivers during the acquisition. Many acquisition systems use cables in the field and cannot distribute the receivers as uniformly as nodal recording systems. Grid designs that use linear distributions of receivers include cables laid out in parallel lines and cables laid out in orthogonal grid. Both of these grid designs approximate the uniform grid and can work quite well if the cables are spaced sufficiently close to each other. A commonly used design for cable systems is the star geometry with nine or more arms radiating outward from the well head. The star design is good for removing surface waves propagating out from the well head. However, normally there are many other stationary surface wave noise sources such that the stationary surface wave noise cannot be removed adequately because the sources are located away from the well head and the noise does not propagate along the cables. The star grid design also suffers from poor sampling toward the ends of the arms where the receivers of adjacent cables are located at large distances.

Figure 2 shows two images of the depth slice computed for the same field data that was recorded simultaneously using two different receiver grids. One is a star grid and the other is an orthogonal grid. This is a good comparison of using a star grid and a uniform grid in the presence of high amplitude stationary surface noise that is not propagating from the well head. A highway cuts through the receiver grid and is the source of significant stationary surface wave noise. The traces for both grids covered the same surface area and had exactly the same processing and noise filtering. The image computed using the star grid shows a large footprint of the highway noise because the noise is hitting the grid perpendicular to the arms in the area of the highway and the other arms are at a distance that prevents them from helping to cancel the noise. The depth slice computed using the orthogonal grid does not show this high level of coherent noise from the highway and the seismic emissions that are generated by the frac treatment at the stage location are much better focused.

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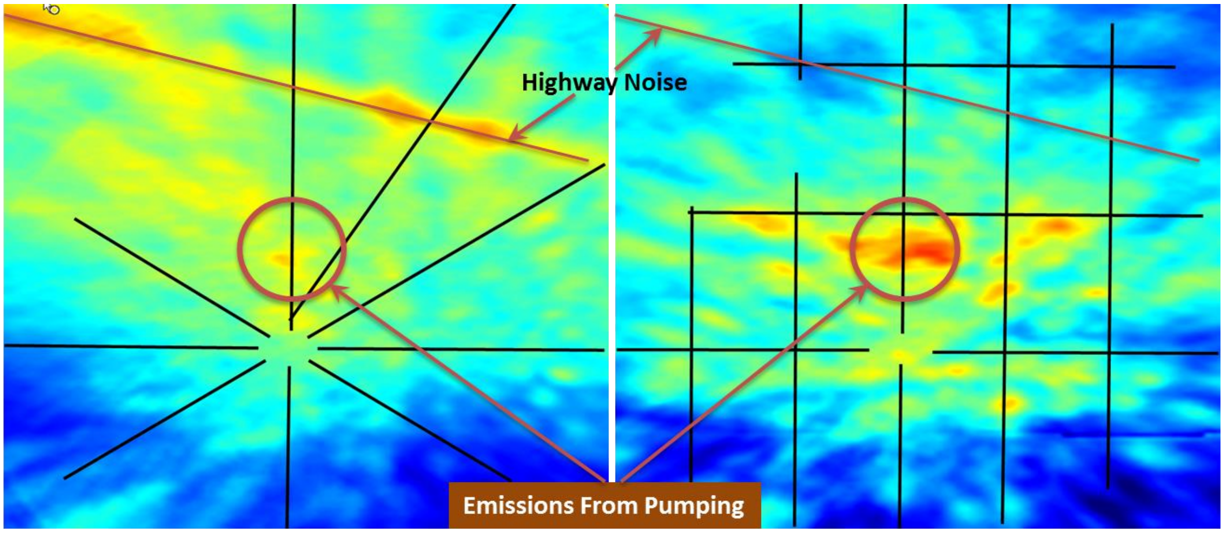

Figure 2: Highway noise footprint in the image volume for recording with a star grid and an orthogonal grid. For the star grid the highway noise hits the arms of the star perpendicular to the linear arrays and the noise is passed into the image volume. The orthogonal grid samples the noise at multiple azimuths and the surface noise from the highway is suppressed in the image volume

Figure 2 shows an example of high amplitude stationary surface wave noise generated by various noise sources that are not located at the wellhead. The star grid design is based on the concept that the most important source of surface wave noise is the well head operations. FK filters applied to each arm of the star grid are used to suppress the noise propagating out from the well head. The well head noise is relatively easy to eliminate from the trace data using FK or FX linear move out filters. Stationary surface wave noise that does not originate at the wellhead cannot be easily suppressed on the star grid arms using the FK filters. When the source of the surface wave noise is not at the well head, the star grid design is inferior to grid designs that have a more uniform distribution of receivers.

Trace Processing for noise suppression

Figure 3 shows an example of the traces recorded in the field and the same traces after each of two filtering steps. The trace data shows the waveforms for a MEQ in order to better visualize the uplift of the trace processing filters. The SDI image volume is computed for the traces at each step. Three slices of the SDI volumes are shown for the map view slice in X and Y, North-South slice in Y and Z, and East-West slice in X and Z. The SDI seismic emission volume is computed from the traces shown for each trace display. The slices taken from the image volume pass through the MEQ focus location. The first pass of processing shows the largest uplift for the trace processing and a very substantial improvement in the image volume. The coherent filter that removes the spikiness in the amplitude spectrum provides most of this uplift. The second pass of trace processing applies the user controlled filtering to remove the background noise and eliminate artifacts caused by surface waves or other noise sources.

Removing the stationary surface wave noise is critically important for good imaging results from a surface recording. This type of noise corrupts the image by imposing artifacts in the final seismic emission volume. The detectability of the weak seismic emissions depends on the S/N ratio of the trace data after filtering has been applied to suppress the various types of noise. The F-X domain linear filter is a high-quality filter that can be used for removal of the surface wave noise propagating from the wellhead. The filters used for removing noise must not change the phase of the desired signal. Note that the phase of the MEQ is the same in all panels which illustrates that the noise filtering did not change the phase of the signal.

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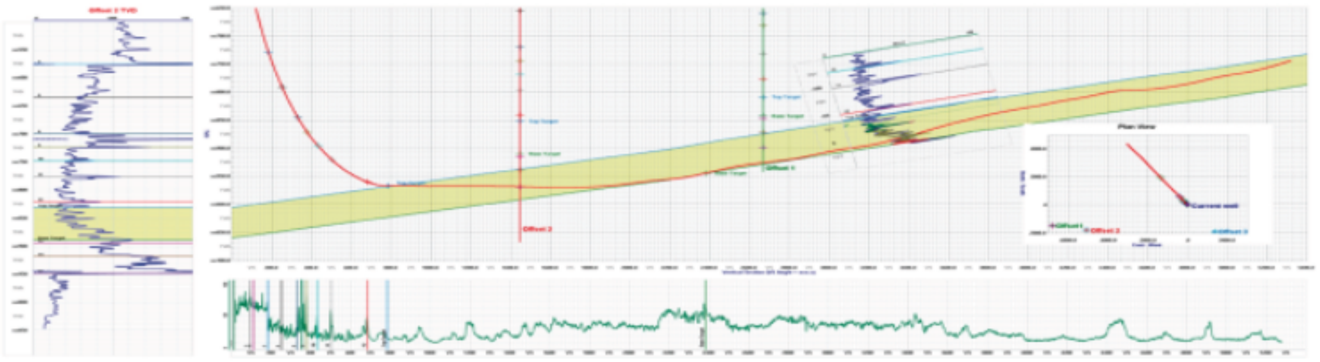

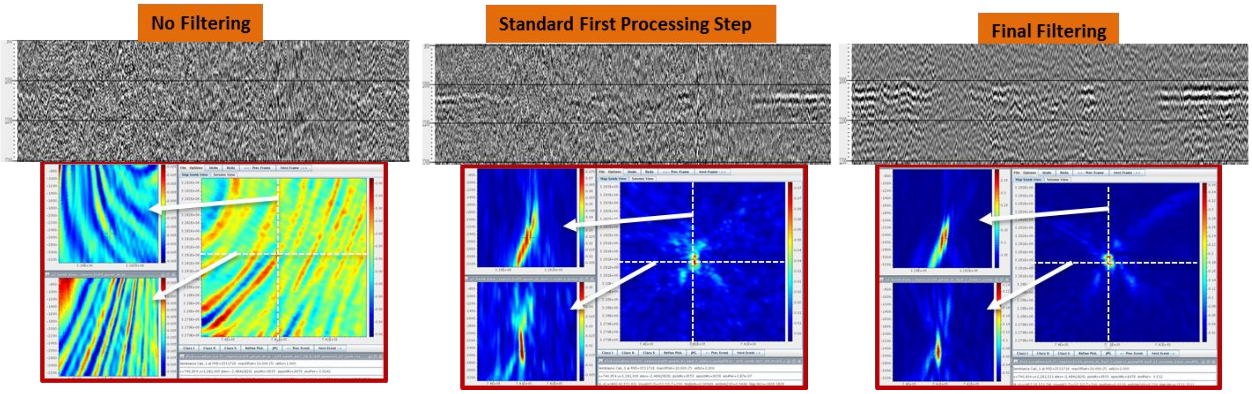

Figure 3: Improvement in the trace data and in the image volume with trace processing steps. Before trace processing the signal is not highly visible in either the traces or the image slices.

Velocity model and statics

Velocity. The velocity model must be accurate in order to obtain correct locations for the fractures in the volume. Often, a 1D P-wave velocity model is constructed from a nearby sonic log and the focusing is performed using a 1D velocity model. This works well for the small area around an unconventional reservoir well, especially if the strata are flat layered and relatively homogeneous. When there is a lateral velocity gradient but the velocity model is otherwise simple, the gradient in velocity can be adjusted in the SDI method using beam steering. For a complex structured area, a 3D complex velocity model is required. Figure 4 shows the cross section of a complex 3D velocity model for a thrusted anticline. For this project, the full-volume 3D interval velocity must be used for all aspects of focusing and imaging in order to obtain useful results. The ambient emission volume computed using this 3D interval velocity model in the SDI method is shown on the right in Figure 4. The anticline has high amplitude emissions on the north-east end of the anticline and lower emissions on the south-west end of the anticline. For this project, the passive data was recorded as part of a 3D reflection acquisition. The receivers were rolled along the surface and the passive data was recorded every day during hours when the vibrator sources were not active. For the SDI method, the passive emission volume was computed in pieces that had substantial overlap in space. Each piece of the volume streamed in abut 9 hours of trace data to compute the emission volume under that part of the array. The final emission volumes for each sub-volume were combined to make the full 3D emission volume.

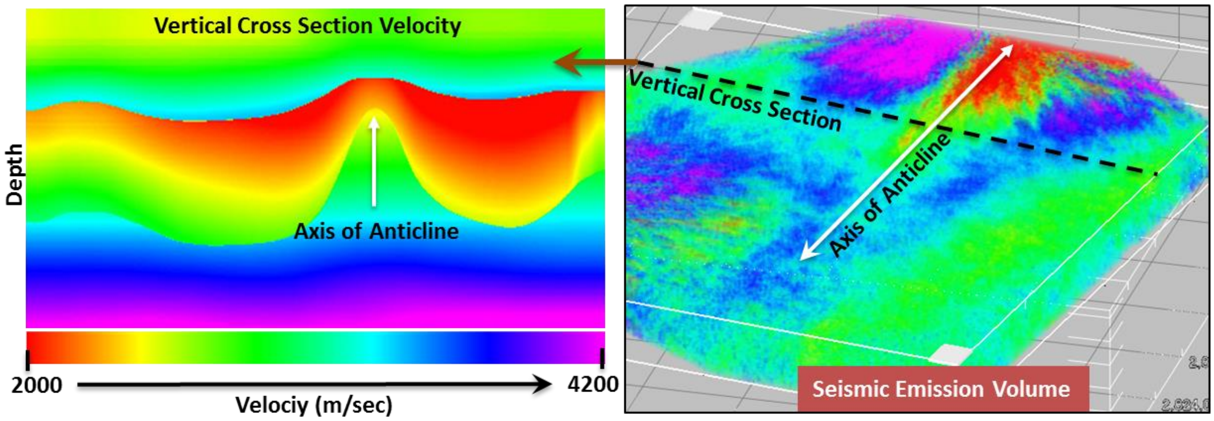

Figure 4: The left panel shows a cross section of the complex 3D velocity model for a thrusted anticline. The right panel shows the seismic emission volume compute using this model. The emissions change along the length of the anticline.

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Statics. For the 3D surface reflection method, every receiver records the signal from many sources and every source in recorded by many receivers. Using the redundancy in the reflection method there are excellent methods available to solve for the surface consistent elevation and residual statics. For the passive recording method this redundancy is not available and, as such, the statics for each receiver must be solved with a different approach. The total statics for passive recording consist of two parts. First, the correction for the receiver elevation is computed from the known elevation of the receivers and the near surface velocity. Quality control of the elevation correction comes from observing the waveform alignment of perf shots with known locations. Second, there are always residual time errors in the flattened perf or MEQ waveforms and these residuals must be corrected in order to obtain the best results from the fracture imaging workflow. Figure 5 shows the waveforms for a perf shot before and after residual statics have been applied. The statics were solved using cross correlation with a pilot waveform.

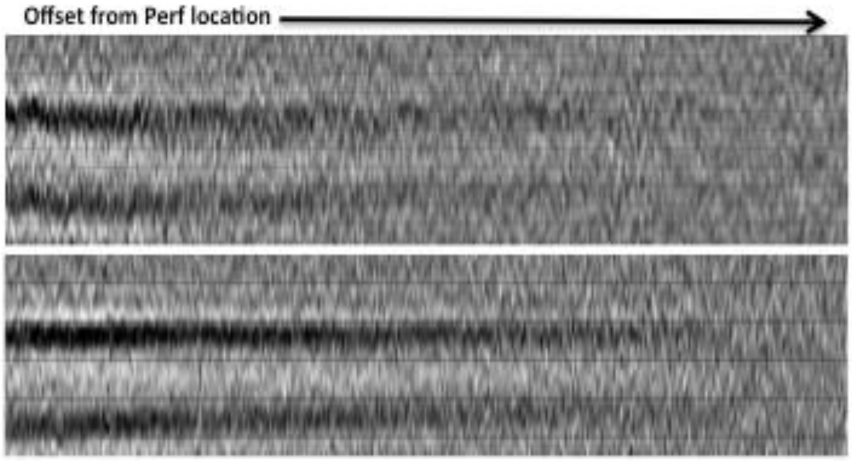

Figure 5. Perf shot, before (top) and after (bottom), the application of residual statics. Applying the residual statics has improved the focusing.

SDI compared to SET

The SET approach to modeling the subsurface would be analogous to recording the data for a 3D reflection method, running the PSDM using all of the traces, and then picking the highest amplitude waveforms in the final volume and replacing the migrated trace volume with the dots of the detected highest amplitude. Figure 6 shows a comparison of the same volume computed using PSDM and the equivalent volume replaced with the detected dots. The waveform volume shows much more information than the same volume that shows only the highest amplitude waveforms.

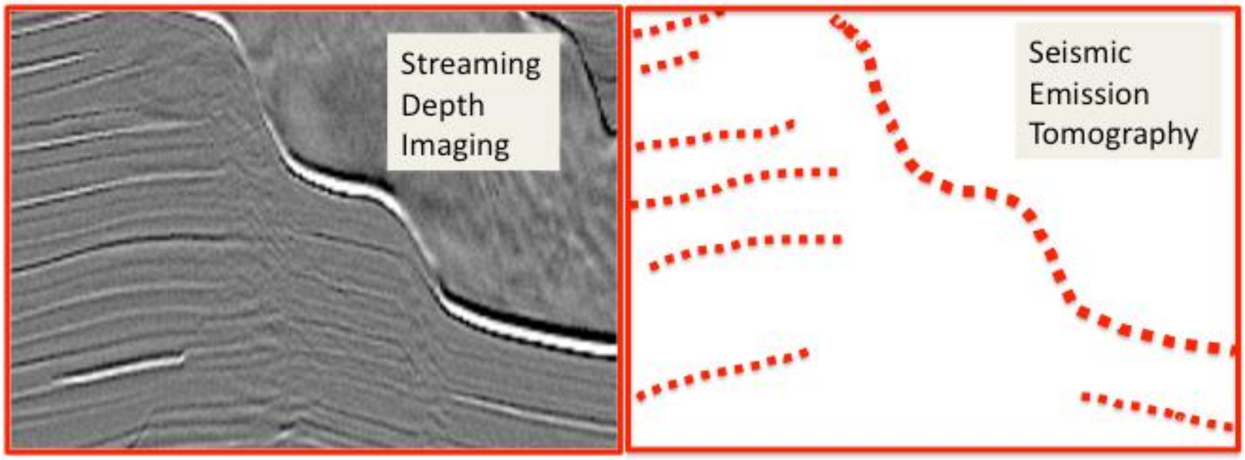

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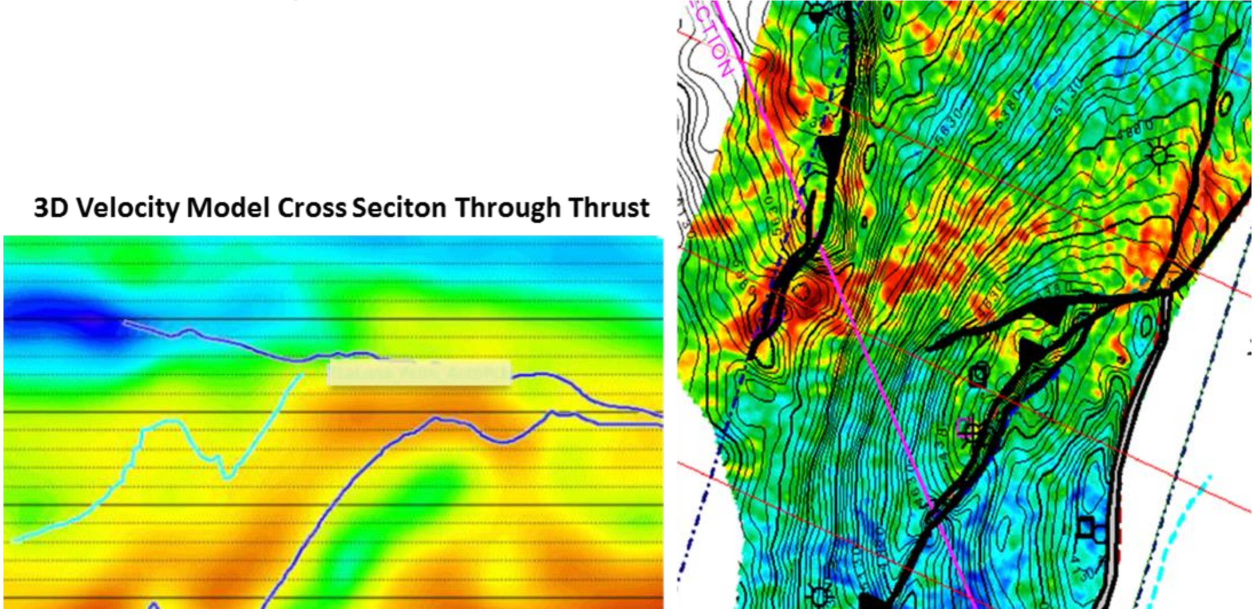
Figure 6. Depth imaging Focuses the traces for all recorded time windows and stacks them to get the full image. SET focuses the trace data for a small time window, stacks the traces, and picks the highest amplitudes.

Pre-drill ambient recordings - Computing natural fracture systems

Recording passive data over the reservoir before the field is developed can predict the zones of natural fracturing that may be most productive. Ambient data can be recorded as an independent acquisition effort or it can be recorded during the acquisition of 3D reflection data. Focusing the passive emissions and imaging them to compute an accumulated emission volume for the reservoir shows the zones in the reservoir that are actively emitting seismic energy. The most important emissions are those that are not located in the larger fault zones that are visible in 3D reflection seismic volumes.

<u>Colombia.</u> The left panel of Figure 7 shows a cross section of the 3D velocity model for a strike-slip fault cutting an anti-cline formed by a pre-existing thrust fault. The right panel of Figure 1 shows the accumulated emissions posted in color for a geologic horizon through the volume. The red zone running East-West through the center shows the highest emissions coming from the rocks in the hanging wall of the thrust fault. This result predicts that the zone of highest natural fracturing is in the hanging wall of the thrust. The production for this reservoir comes from fracture porosity and permeability in the targeted reservoir so that the hanging wall is predicted to have the best production. The data was collected pre-drill. Subsequent drilling of several wells confirms the prediction.



3D Velocity Model Cross Seciton Through Thrust

Figure 7. Example from a Colombian area with a strike-slip thrust fault. The right panel shows a vertical cross section through the velocity model built using iterative pre-stack depth migration. The left panel shows the passive seismic emissions for the reservoir layer. This example predicts that the best production is in the hanging wall of the fault where it has the highest level of active fracturing.

<u>Eagle Ford</u>. The left panel of Figure 8 shows the seismic emissions for the Eagle Ford layer computed from ambient data that was recorded simultaneously with a 3D reflection acquisition. The ambient data was collected at night when the vibrators were shut down. There is a zone of high emissions running East-West through the volume that does not follow the fault systems shown by the 3D reflection data. The currently producing wells in the volume are posted in the figure and show that the best producing wells are in the area of highest passive emissions that show very little visible faulting in the 3D reflection data. In the areas of larger faults that are seen in the reflection seismic data, there are high emissions but lower production. The interpretation is that the larger fault systems allow the pressure from the reservoir

to leak off into the layers above. The best production is where there are fractures shown by the passive emissions but there are not larger faults to carry the pressure to the shallower layers. The right panel of Figure 2 shows an area just northeast of the data in the left panel. The figure shows a vertical slice through the 3D reflection data and the emissions for the Eagle Ford. Also shown are the faults tracks extracted from the reflection volume. There are areas where the emissions are high in the area of fault tracks. The wells in these areas show lower production. The area in the top center of the figure shows high emissions but there are no fault tracks in that area. There is only one well in the area of high emissions and it is the best producer in the volume. This supports the interpretation that the areas of high emissions are areas of high fracture permeability and that the areas of high production are in these areas of high emissions that contain no faults.

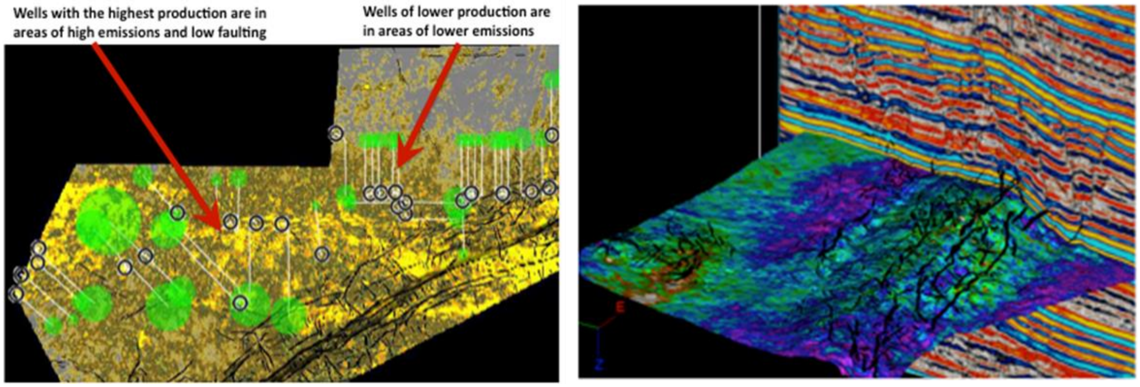


Figure 8. Examples from the Eagle Ford show that the areas of highest passive emissions but located in areas of less faulting have the best production.

Pre-drill ambient, frac monitoring, and permeability pathways

The SDI and fracture mapping system can use ambient recordings to predict the fractures that will be activated by the treatment before the treatment is performed. An example of predicting the frac performance using ambient recording is shown in Figure 9. The left panel shows the accumulated emissions for the volume around the well before the frac treatment and this emission volume was used in planning the frac treatment. The middle panel shows the ambient emission overlaid with the fractures activated by the treatment. The SRV for this well shows a large SRV at the toe, a small SRV in the middle of the well, and a moderate SRV at the head of the well. The panels show that the rock volume activated during the treatment closely matches the natural fracture systems mapped before the treatment. This phenomenon has been observed in other projects.

Permeability pathways. The pathways that carry the pressure from the well being treated to the part of the reservoir away from the well are called the permeability pathways. A separate emission volume that encompasses the entire well is computed for each stage of the frac treatment. These volumes are each computed using independent data so that there is no common data used between in the computations. The final volume is computed from all of the volumes for each stage by counting the number of live values across all volumes for each voxel. This final volume shows the activity level at each voxel for all of the stages combined. The result shows the pathways in the volume that have the highest permeability and are responsible for carrying the pressure from the treatment at the well out into the nearby reservoir. Knowledge of the fracture systems and the highest permeability pathways shows how the reservoir is connected and this knowledge is used for planning adjacent well locations and treatment plans. The right panel in Figure 9 shows the fracture permeability for the reservoir

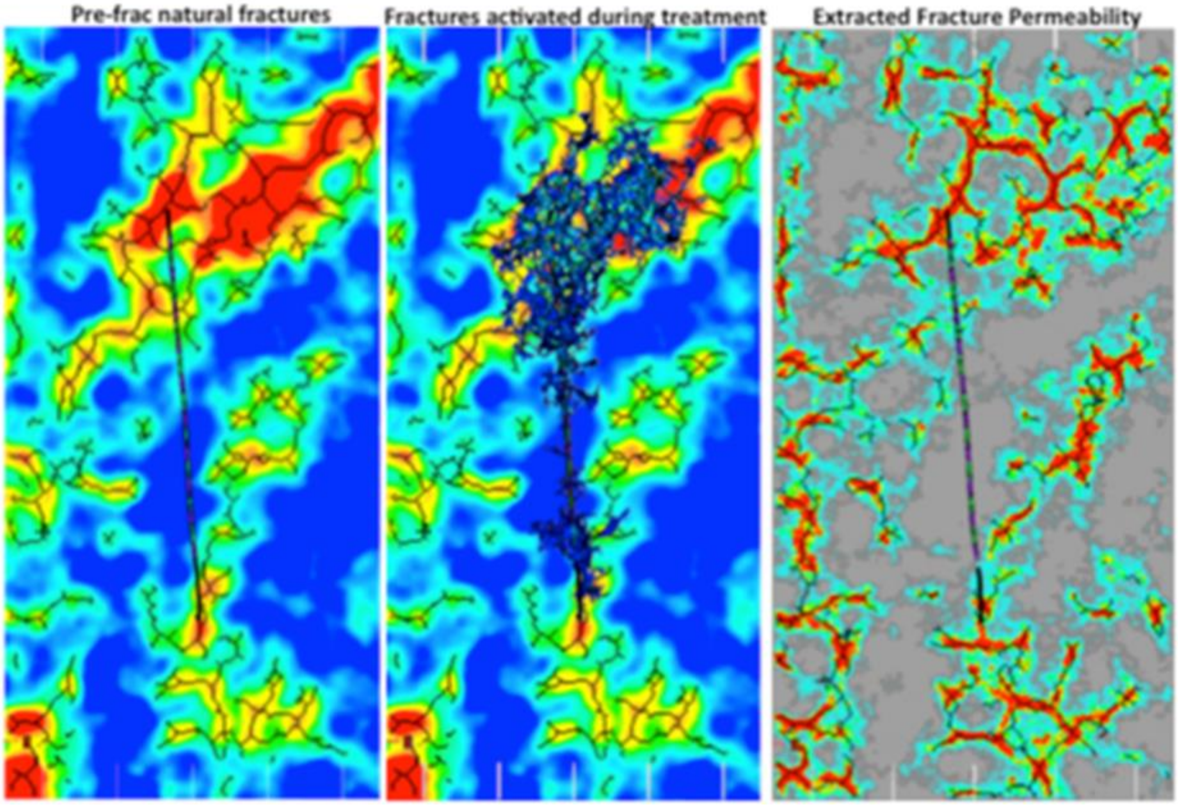


Figure 9. Left panel shows the accumulated emissions for the reservoir around the well for ambient data recorded before the frac treatment. The middle panel show the activated fractures overlaid on the emissions mapped from the ambient data. Note that the activated fractures during treatment closely follow the emissions mapped from the ambient. The permeability pathways for this well volume are shown in the right panel.

Fracture propagation timing

As part of the SDI method for a single stage, a record is kept of the clock time at which each voxel is activated. This clock time of fracture activation is called Fracture Propagation time (FPT) and provides the time sequence of fracture failure for each stage. This allows for the tracking of the fracture formation over time through the volume and adds detailed knowledge of the fracture failure procgression that can be used in treatment design. Figure 10 shows the total stimulated fracture system near the frac stage location for the entire pumping time. The left panel is colored with the amplitude of the integrated seismic emissions and shows the highest level of activity at the perf locations and decreasing activity at locations with increased distance from the stage location at the well. The right panel is colored with the first time of activation for each part of the fracture. Notice that the first time of activation goes to the north side of the perfs early in the pumping and then progresses systematically to the south during the remaining time of pumping. The activation to the north happens in a very short time interval while the activation to the right side is incremental and spaced over the total pump time.

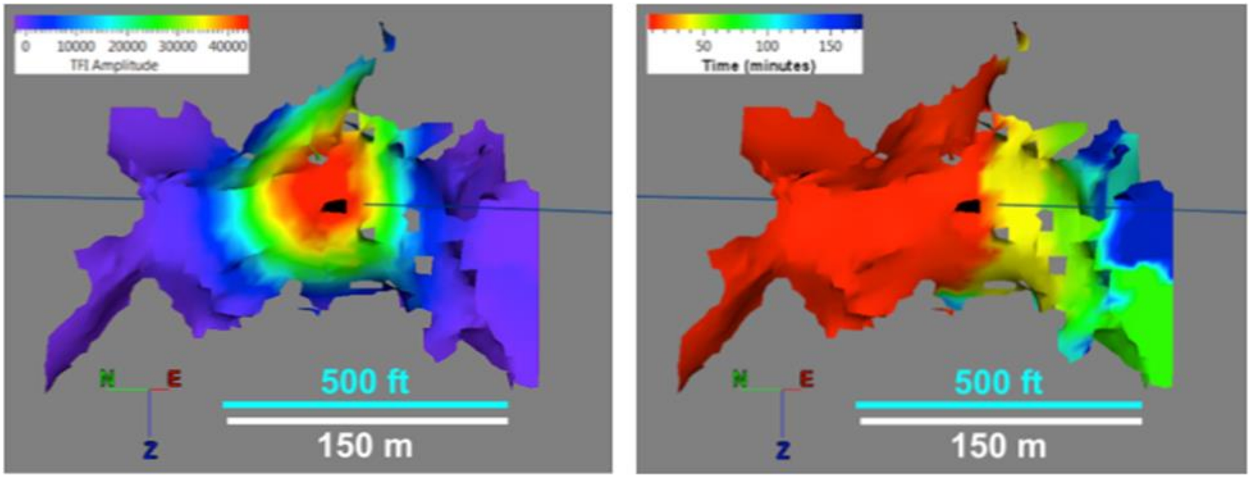


Figure 10: The extracted fractures for one stage are shown with two color scales. The left panel shows the total accumulated emissions for the entire pump time. The highest accumulated activity is at the pref locations. The right panel shows the first time of opening for the fractures (FPT). The FPT data shows that the fractures to the left of the perf locations opened early in the pumping while the fractures to the right opened sequentially over the pump time.

Active Producing Volume (APV)

Computing APV

Producing volumes are best computed from data recorded with a permanent, shallow buried array. This allows for repeated observations throughout the lifetime of the reservoir. For each observation interval, several hours of field data are processed. In general, three hours of high-quality data are required for a stable, stacked depth volume. This volume is further processed to map the volume-wide natural fracture network. APVs for all wells under the array are also extracted from this volume. While there are high-activity locations throughout the entire volume under the array, only those with connectivity to the wellbore contribute to the producing volume. The well deviation path is required in order to extract the predicted or computed producing volumes.

Pre-drill prediction of production volumes

Potential production volumes for a well path can be computed from ambient data collected before a well is drilled. The volumes computed show activity associated with the pre-existing fracture network. The left panel in Figure 11 shows a prospective production volume generated from data recorded two months before the well was drilled. The seismic emission volume was computed from the ambient data recorded at that time and the prospective production volume was extracted along the well path from this pre-drill emission volume. The middle panel shows the APV extracted for the same well during production for 2.5 years. There is a gap of approximately three years between the left panel pre-drill extraction and the right panel extraction during production. There is good correlation between the predicted APV before drilling and for the APV computed after 2.5 years of production. The right panel shows the predicted APV in dark grey and the computed APV from combined observations over 2.5 years. This example shows that planned, regular monitoring of wells should give a comprehensive image of production changes over time and provide significant value to reservoir management.

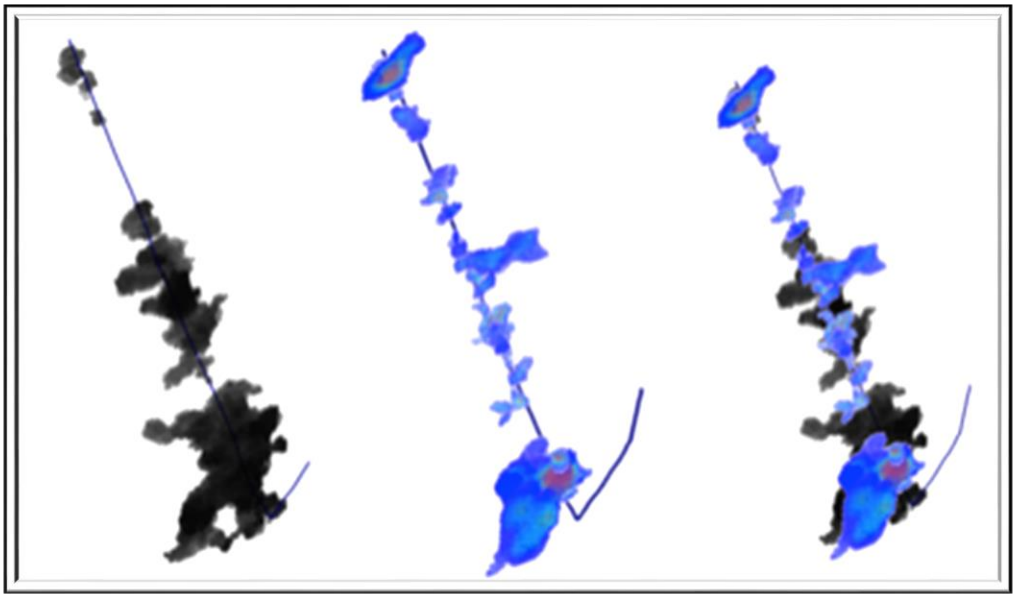


Figure 11: The left panel shows the predicted producing rock volume. The middle panel shows the computed producing volume after the well was producing for 2.5 years. The right panel shows an overlay of the two volumes.

SRV versus APV volumes

The SRV was discussed previously and shows the seismic emission volume that is stimulated during the frac treatment. The APV and the SRV are computed using the same workflow. The SRV is always much larger than the APV because after the stimulation is completed and fluid pressures decline, some of the fractures will close and become inactive. Figure 12 shows the SRV computed during well stimulation and the APV for the same well during production, one year after the frac treatment. The APV is about 40% smaller than the SRV. Both volumes are shown along with the natural fracture network. The fracture network was computed using ambient recordings made while the well was producing. The most active locations along the wellbore in the APV are where active natural fractures intersect the wellbore.

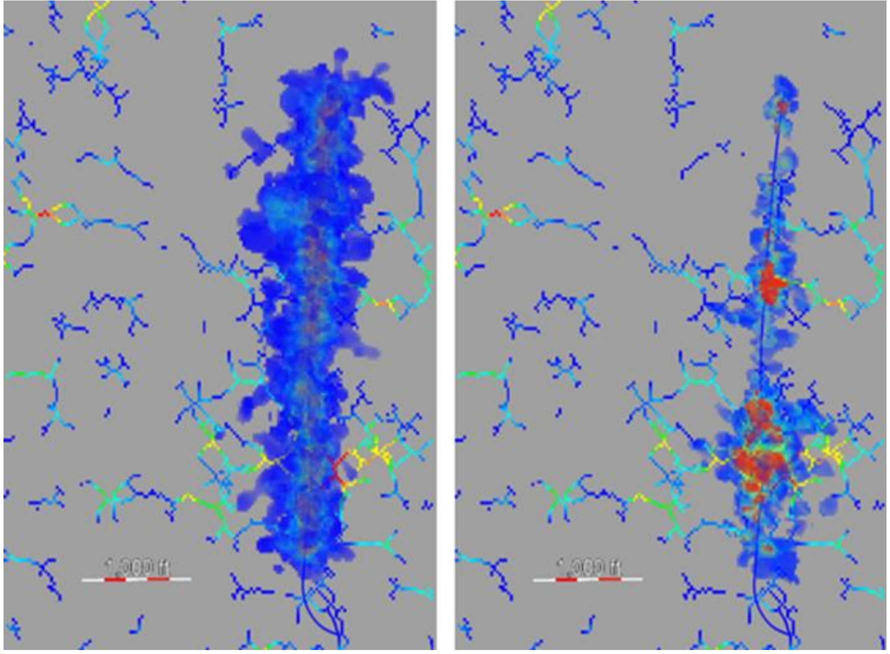


Figure 12. SRV is shown on the left and the APV is shown on the right. The APV is much smaller than the SRV volume because many of the activated fractures do not have proppant and do not produce.

APV before and after

The left panel in the Figure 13 shows the APV for well A prior to the treatment of well B. The producing volume closely follows the areas of the natural fracture systems mapped before the treatment. The fractures mapped in the ambient data are providing most of the production for the well. The right panel in the figure shows the APV for well A after the treatment for well B. The APV after the well B treatment is smaller by approximately 25%. The measured production decline for well A in on the same order as the measured APV volume reduction. The production decline resulting from this frac is explained in the discussion for Figure 3.

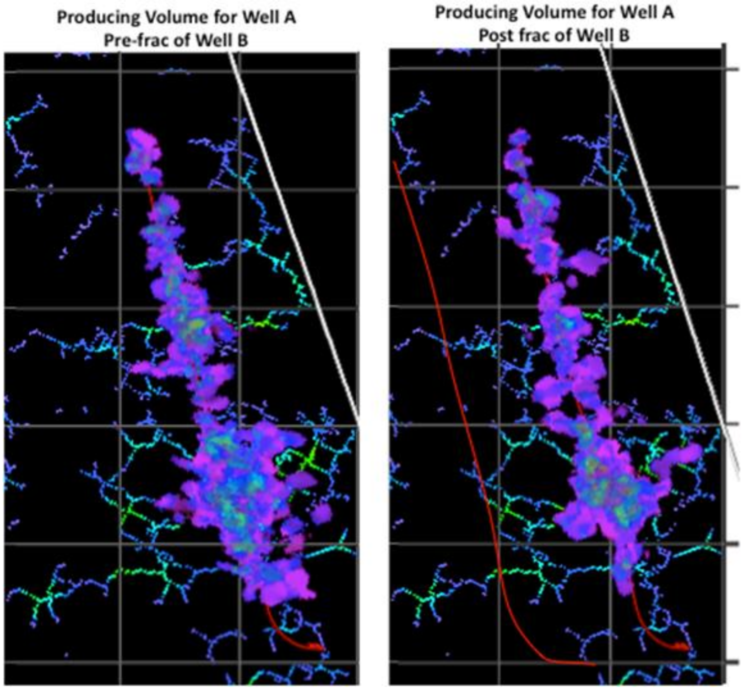


Figure 13. : Fractures connecting well A and well B before the frac of well B. Well A was hit during the pumping for well B. APV before well B frac and after well B frac shows the reduced APV caused by the hit on A during the frac of B. APV volume is proportional to the reduction of production.

Changes in APV over time

Monitoring APV over years of production shows that the size of the volume and the active locations along the wellbore change over time. Though the characteristics of these changes appear to vary among reservoirs, and between wells in the same reservoir, the example shown in Figure 14 shows typical results for the wells in one unconventional reservoir. Shown are the SRV and two APV. The first APV was measured after two years of production and the second after three years of production. For this example there is a decrease in the size of the volume of rock activated by production over time.

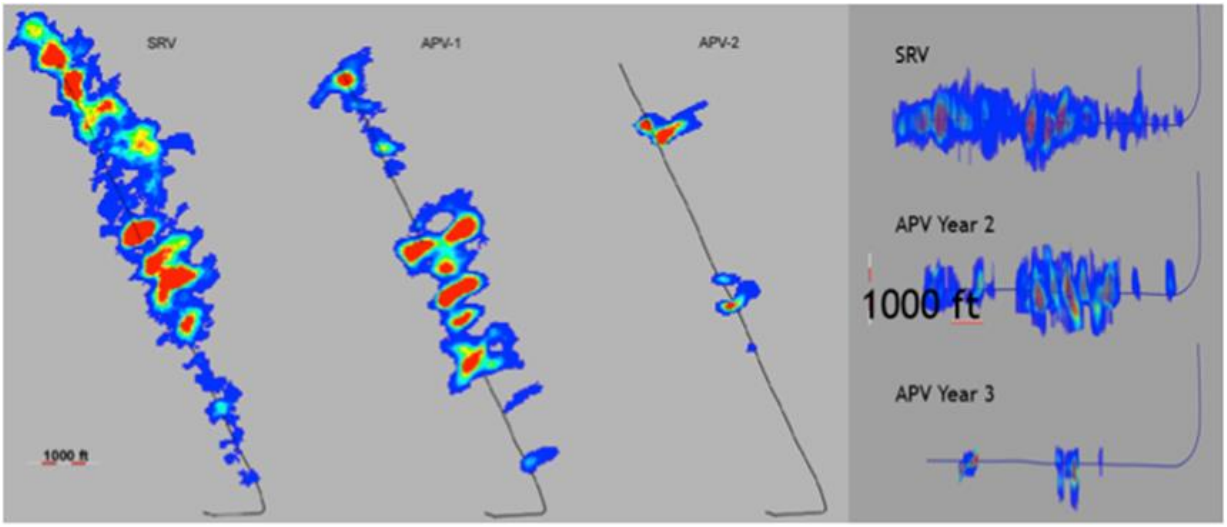


Figure 14: The activated fractures during treatment are shown in the left panel of the map view and the top panel of the cross section view. The middle panel of the map view and the middle panel of the cross section view show the producing (APV) volume after 2 years of production. The right panel in map view and the bottom panel in cross section view show the APV after 3 years of production.

SDI workflow for reservoir management (4D passive recording)

The workflow sequence for reservoir management is to record ambient data before drilling and map the natural fractures in the reservoir using the SDI method. From the map of the natural fractures, plan the drilling location and the frac treatment. Monitor the frac treatment and compare the activated rock volume to the natural fractures. After the well is on production, record ambient again to map the production volume. Experience shows that the pre-existing natural fractures in the rocks impact the fractures that are opened during the treatment and the volume of rock that produces. By mapping the natural fractures before drilling, the performance of the well can be estimated before it is drilled.

Conclusions

Streaming Depth Imaging integrates Long Duration Signals (LDS) over the recorded time interval. By focusing and imaging all of the trace data over the recorded time interval, SDI collects the LDS into a single depth volume from which the fracture systems are extracted. The SDI method requires good field acquisition, high quality trace processing for noise suppression, and pre-stack depth migration. The velocity model and the statics must be accurate because they control the location accuracy and resolution of the fracture systems computed. Stationary surface wave noise must be filtered out in the trace processing because these waves create artifacts in the final image.

The SDI method generates products that contribute to the management of unconventional reservoirs. Ambient passive data recorded pre-drill are used to map the natural fractures and predict production performance in the reservoir. This information before drill and frac has the advantage that the wells locations can be optimized. In addition, the frac hazards that may be encountered in the reservoir are known before the well is drilled. Passive data recorded during the frac treatment are used to compute the fracture volumes that are activated by the treatment and map the zones of highest fracture permeability around the well. The extracted timing of the fracture propagation allows for the analysis of the changing stress state as the rocks are fracturing. Ambient data recorded while the well is in production is used to compute the rock volume that is producing oil and gas and how this active volume changes over the years of production.

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Geiser P, Lacazette A, Vermilye J. Beyond ‘dots in a box’: an empirical view of reservoir permeability with tomographic fracture imaging. First Break 2012; 30 (July):63–69.

Lacazette A, Vermilye J, Fereja S, Sicking C. Ambient fracture imaging: a new passive seismic method. Unconventional Resources Technology Conference, Denver, CO, SPE 168849/URTeC 1582380; 2013. 10p.

Lacazette A., Sicking C., Tibi, R., Yaner A., Fundamentals of Gas Shale Reservoirs, Passive Seismic Methods for Unconventional Resource Development, 2015, John Wiley & Sons, Hoboken, New Jersey

Sicking C, Vermilye J, Geiser P, Lacazette A, Thompson L., Permeability field imaging from microseismic, SEG 1383; 2012. 5 p.

Sicking C, Vermilye J, Lacazette A, Yaner A, Klaus A, and Bjerke L., Case study comparing microearthquakes, fracture volumes, and seismic attributes. URTeC 1934623; 2014. 7 p.

BLOOD DRIVE!

DATE: Thursday, February 25, 2016

TIME: 1:00 pm to 4:00 pm

LOCATION: Railroad Commission of Texas
Corpus Christi District Office
10320 Interstate 37, Corpus Christi, TX 78410

The ***Railroad Commission of Texas*** is hosting the ***Coastal Bend Blood Center's*** Bloodmobile for a blood drive on Thursday, February 25th, from 1:00 pm until 4:00 pm. We are located off the northbound frontage road of Interstate 37, between Carbon Plant Road/Joe Fulton International Trade Corridor and McKinzie Road, across the street from the Texas Department of Public Safety's new licensing office.

Every three seconds someone needs blood!

"The fact is, blood donors save lives. It's that simple and that important. More than four million Americans would die each year if not for blood donors. In the Coastal Bend, more than 150 people a day must donate in order to maintain the blood supply for our community. You may not be able to change the world, but when you become a blood donor, you are giving patients in our community a second chance at life. Blood donation is a convenient and meaningful way for people to make a significant difference in the lives of residents across the Coastal Bend.

We are in need of ALL blood types! By donating blood, you are giving the greatest gift - the gift of life!"

http://www.coastalbendbloodcenter.org

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Giving so that others may live

RAILROAD COMMISSION OF TEXAS

Corpus Christi Geological Society

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Corpus Christi Geological Society Papers available for purchase at the Texas Bureau of Economic Geology

Note: Publication codes are hyperlinked to their online listing in The Bureau Store (http://begstore.beg.utexas.edu/store/).

Cretaceous-Wilcox-Frio Symposia, D. B. Clutterbuck, Editor, 41 p., 1962.
CCGS 002S $15.00

Type Logs of South Texas Fields, Vol. I, Frio Trend. Compiled by Don Kling. Includes 134 fields. 158 p., 1972. Ring binder.
CCGS 015TL $25.00

Type Logs of South Texas Fields, Vol. II, Wilcox (Eocene) Trend. Compiled by M. A. Wolbrink. 98 p., 1979. Ring binder.
CCGS 016TL $25.00

Field Trip Guidebooks

South Texas Uranium. J. L. Cowdrey, Editor. 62 p., 1968.
CCGS 102G $12.00

Hidalgo Canyon and La Popa Valley, Nuevo Leon, Mexico. CCGS 1970 Spring Field Conference. 78 p., 1970.
CCGS 103G $8.00

Padre Island National Seashore Field Guide. R. N. Tench and W. D. Hodgson, Editors. 61 p., 1972.
CCGS 104G $5.00

Triple Energy Field Trip, Uranium, Coal, Gas—Duval, Webb & Zapata Counties, Texas. George Faga, Editor. 24 p., 1975.
CCGS 105G $10.00

Minas de Golondrinas and Minas Rancherias, Mexico. Robert Manson and Barbara Beynon, Editors. 48 p. plus illus., 1978.
CCGS 106G $15.00

Portrero Garcia and Huasteca Canyon, Northeastern Mexico. Barbara Beynon and J. L. Russell, Editors. 46 p., 1979.
CCGS 107G $15.00

Modern Depositional Environments of Sands in South Texas. C. E. Stelting and J. L. Russell, Editors. 64 p., 1981.
CCGS 108G $15.00

Geology of Peregrina & Novillo Canyons, Ciudad Victoria, Mexico, J. L. Russell, Ed., 23 p. plus geologic map and cross section, 1981.
CCGS 109G $10.00

Geology of the Llano Uplift, Central Texas, and Geological Features in the Uvalde Area. Corpus Christi Geological Society Annual Spring Field Conference, May 7-9, 1982. Variously paginated. 115 p., 53 p.
CCGS 110G $15.00

Structure and Mesozoic Stratigraphy of Northeast Mexico, prepared by numerous authors, variously paginated. 76 p., 38 p., 1984.
CCGS 111G $15.00

Geology of the Big Bend National Park, Texas, by C. A. Berkebile. 26 p., 1984.
CCGS 112G $12.00

GEO LINK POST

http://www.lib.utexas.edu/books/landsapes/index.php Free service. Rare, fragile, hard-to-find, public domain documents covering various topics about the landscape of Texas. Includes the Texas Geological Survey from 1887 until 1894.

USGS TAPESTRY OF TIME AND TERRAIN http://tapestry.usgs.gov The CCGS is donating to all of the 5th and 6th grade schools in the Coastal Bend. Check it out--it is a spectacular map. You might want to frame one for your own office. The one in my office has glass and a metal frame, and It cost $400 and it does not look as good as the ones we are giving to the schools.

FREE TEXAS TOPOS'S http://www.tnris.state.tx.us/digital.htm these are TIFF files from your state government that can be downloaded and printed. You can ad them to SMT by converting them first in Globalmapper. Other digital data as well.

FREE NATIONAL TOPO'S http://store.usgs.gov/b2c_usgs/b2c/start/(xcm=r3standardpitrex_prd)/.do go to this webpage and look on the extreme right side to the box titled TOPO MAPS DOWNLOAD TOPO MAPS FREE.

http://www.geographynetwork.com/ Go here and try their top 5 map services. My favorite is 'USGS Elevation Date.' Zoom in on your favorite places and see great shaded relief images. One of my favorites is the Great Sand Dunes National Park in south central Colorado. Nice Dunes.

http://antwrp.gsfc.nasa.gov/apod/asropix.html Astronomy picture of the day--awesome. I click this page everyday.

http://www.spacimaging.com/gallery/ioweek/iow.htm Amazing satellite images. Check out the gallery.

http://www.ngdc.noaa.gov/seg/topo/globegal.shtml More great maps to share with kids and students.

www.ccgeo.org Don't forget we have our own we page.

http://terra.nasa.gov/gallery/ Great satellite images of Earth.

www.ermaper.com They have a great free downloadable viewer for TIFF and other graphic files called ER Viewer.

http://terrasrver.com Go here to download free aerial photo images that can be plotted under your digital land and well data. Images down to 1 meter resolution, searchable by Lat Long coordinate. Useful for resolving well location questions.

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NEW (2009-2010)TYPE LOGS IN RED; *****2011; **lost now found**

ARANSAS COUNTY
- Aransas Pass/McCampbell Deep
- Bartell Pass
- Blackjack
- Burgentine Lake
- Copano Bay, South
- Estes Cove
- Fulton Beach
- Goose Island
- Half Moon Reef
- Nine Mile Point
- Rockport, West
- St. Charles
- Tally Island
- Tract 831-G.O.M. (offshore)
- Virginia

BEE COUNTY
- Caesar
- Mosca
- Nomanna
- Orangedale(2)
- Ray-Wilcox
- San Domingo
- **Tulsita Wilcox**
- Strauch_Wilcox

BROOKS COUNTY
- Ann Mag
- Boedecker
- Cage Ranch
- Encintas
- ERF
- Gyp Hill
- **Gyp Hill West**
- Loma Blanca
- Mariposa
- Mills Bennett
- Pita
- Tio Ayola
- Tres Encinos

CALHOUN COUNTY
- Appling
- Coloma Creek, North
- Heyser
- Lavaca Bay
- Long Mott
- Magnolia Beach
- Mosquito Point
- Olivia
- Panther Reef
- Powderhorn
- Seadrift, N.W.
- Steamboat Pass
- Webb Point
- S.E. Zoller

CAMERON COUNTY
- Holly Beach
- Luttes
- San Martin (2)
- Three Islands, East
- Vista Del Mar

COLORADO COUNTY
- E. Ramsey
- **Graceland N. Fault Blk**
- **Graceland S. Fault Blk**

DEWITT COUNTY
- **Anna Barre**
- Cook
- *****Nordheim**
- Smith Creek
- Warmsley
- Yorktown, South

DUVAL COUNTY
- DCR-49
- Four Seasons
- Good Friday
- Hagist Ranch
- Herbst
- Loma Novia
- Petrox
- Seven Sisters
- Seventy Six, South
- Starr Bright, West

GOLIAD COUNTY
- Berclair
- North Blanconia
- Bombs
- Boyce
- Cabeza Creek, South
- Goliad, West
- **St Armo**
- Terrell Point

HIDALGO COUNTY
- Alamo/Donna
- Donna
- Edinburg, West
- Flores-Jeffress
- **Foy**
- **Hidalgo**
- LA Blanca
- McAllen& Pharr
- McAllen Ranch
- Mercedes
- Monte Christo, North
- Penitas
- San Fordyce
- San Carlos
- San Salvador
- S. Santallana
- Shary
- Tabasco
- Weslaco, North
- Weslaco, South

JACKSON COUNTY
- Carancahua Creek
- Francitas
- Ganado & Ganado Deep
- LaWard, North
- Little Kentucky
- Maurbro
- StewartSwan Lake
- Swan Lake, East
- Texana, North
- West Ranch

JIM HOGG COUNTY
- Chaparosa
- Thompsonville,N.E.

JIM WELLS COUNTY
- Freebom
- Hoelsher
- Palito Blanco
- Wade City

KARNES COUNTY
- Burnell
- Coy City
- Person
- Runge

KENEDY COUNTY
- Candelaria
- Julian
- Julian, North
- Laguna Madre
- Rita
- Stillman

KLEBERG COUNTY
- Alazan
- Alazan, North
- Big Caesar
- Borregos
- Chevron (offshore)
- Laguna Larga
- Seeligson
- Sprint (offshore)

LA SALLE COUNTY
- ****Pearsall**

LAVACA COUNTY
- Halletsville
- Hope
- Southwest Speaks
- **Southwest Speaks Deep**

LIVE OAK COUNTY
- Atkinson
- Braslau
- Chapa
- Clayton
- Dunn
- Harris
- Houdman
- Kittie West-Salt Creek
- Lucille
- Sierra Vista
- Tom Lyne
- White Creek
- White Creek, East

MATAGORDA COUNTY
- Collegeport

MCMULLEN COUNTY
- Arnold-Weldon
- Brazil
- Devil's Waterhole
- Hostetter
- Hostetter, North

NUECES COUNTY
- Agua Dulce (3)
- Arnold-David
- Arnold-David, North
- Baldwin Deep
- Calallen
- Chapman Ranch
- Corpus Christi, N.W.
- Corpus Christi West C.C.
- Encinal Channel
- Flour Bluff/Flour Bluff, East
- GOM St 9045(offshore)
- Indian Point
- Mustang Island
- Mustang Island, West
- Mustang Island St. 889S(offshore)
- Nueces Bay/Nueces Bay West
- **Perro Rojo**
- Pita Island
- Ramada
- Redfish Bay
- Riverside
- Riverside, South
- Saxet
- Shield
- Stedman Island
- Turkey Creek

REFUGIO COUNTY
- Bonnieview/Packery Flats
- Greta
- La Rosa
- Lake Pasture
- Refugio, New
- Tom O'Connor

SAN PATRICIO COUNTY
- **Angelita East**
- Commonwealth
- Encino
- Enos Cooper
- Geronimo
- Harvey
- Hiberia
- Hodges
- Mathis, East
- McCampbell Deep/Aransas Pass
- Midway
- Midway, North
- Odem
- Plymouth
- Portilla (2)
- Taft
- Taft, East
- White Point, East

STARR COUNTY
- El Tanque
- Garcia
- Hinde
- La Reforma, S.W.
- **Lyda**
- Ricaby
- Rincon
- Rincon, North
- Ross
- San Roman
- Sun
- Yturria

VICTORIA COUNTY
- Helen Gohike, S.W.
- Keeran, North
- Marcado Creek
- McFaddin
- Meyersville
- Placedo

WEBB COUNTY
- Aquilares/Glen Martin
- Big Cowboy
- Bruni, S.E.
- Cabezon
- Carr Lobo
- Davis
- Hirsch
- Juanita
- Las Tiendas
- Nicholson
- O'Hem
- Olmitos
- Tom Walsh

WHARTON COUNTY
- Black Owl

WILLACY COUNTY
- **Chile Vieja**
- La Sal Vieja
- Paso Real
- Tenerias
- Willamar

ZAPATA COUNTY
- Benavides
- Davis, South
- Jennings/Jennings, West
- Lopeno
- M&F
- Pok-A-Dot

ZAVALA COUNTY
- El Bano

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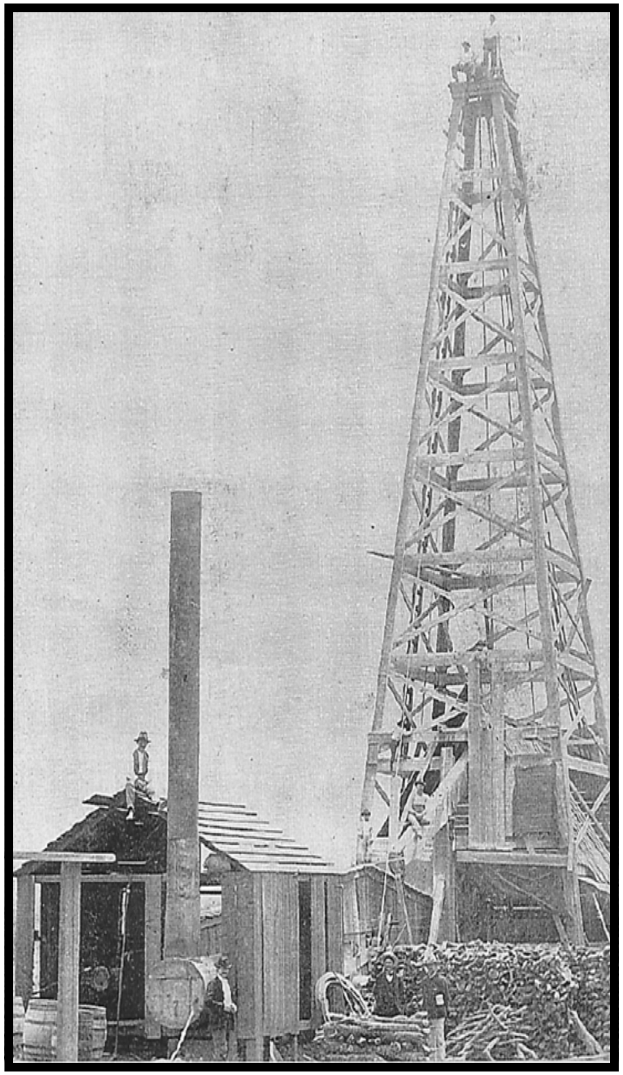
I log -- $10 each, 5-10 logs $9 each and 10 + logs $8.00 each – plus postage



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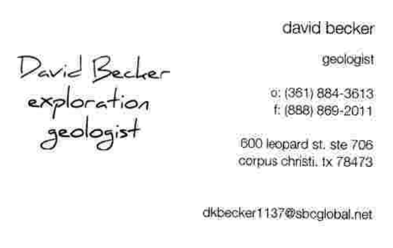

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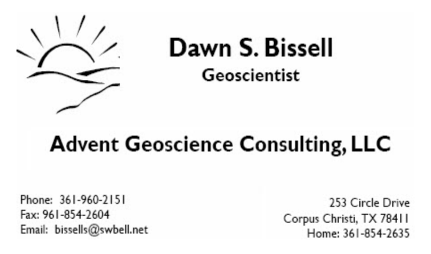

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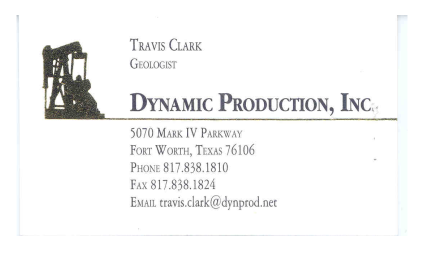

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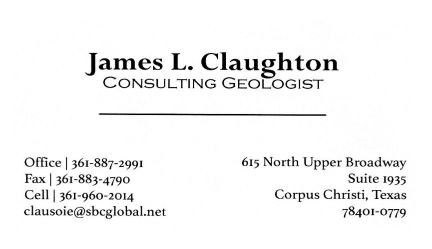

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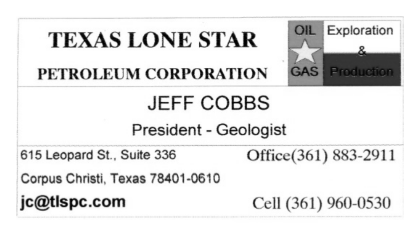

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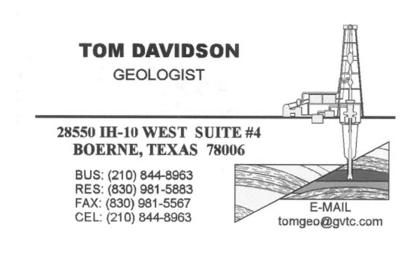

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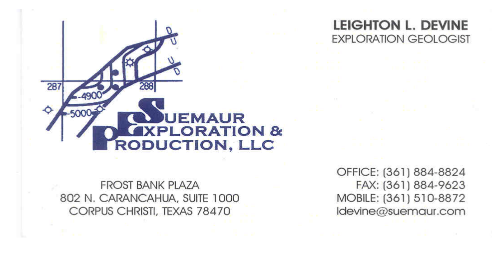

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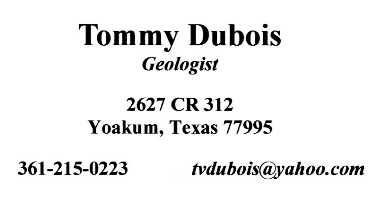

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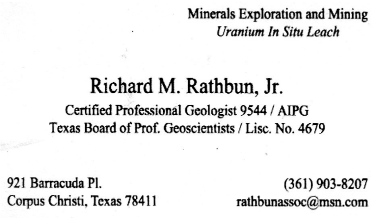

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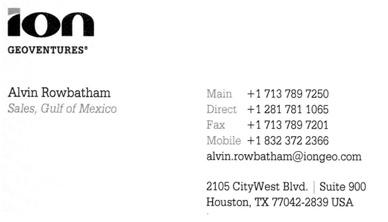

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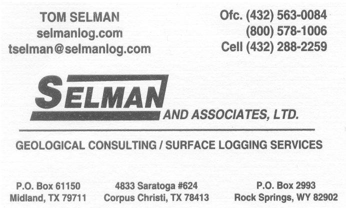

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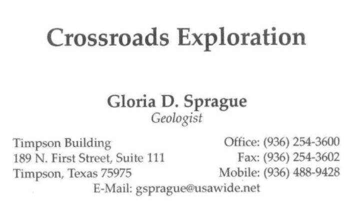

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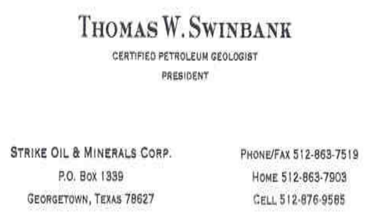

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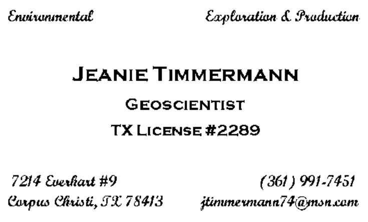

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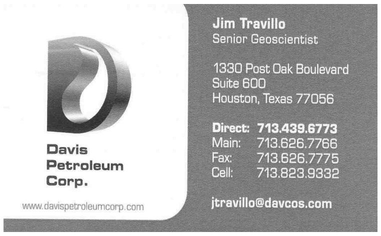

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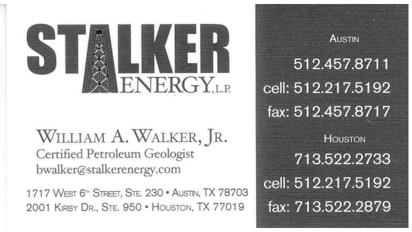

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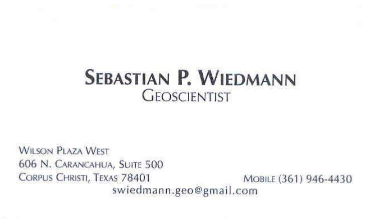

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