BULLETIN

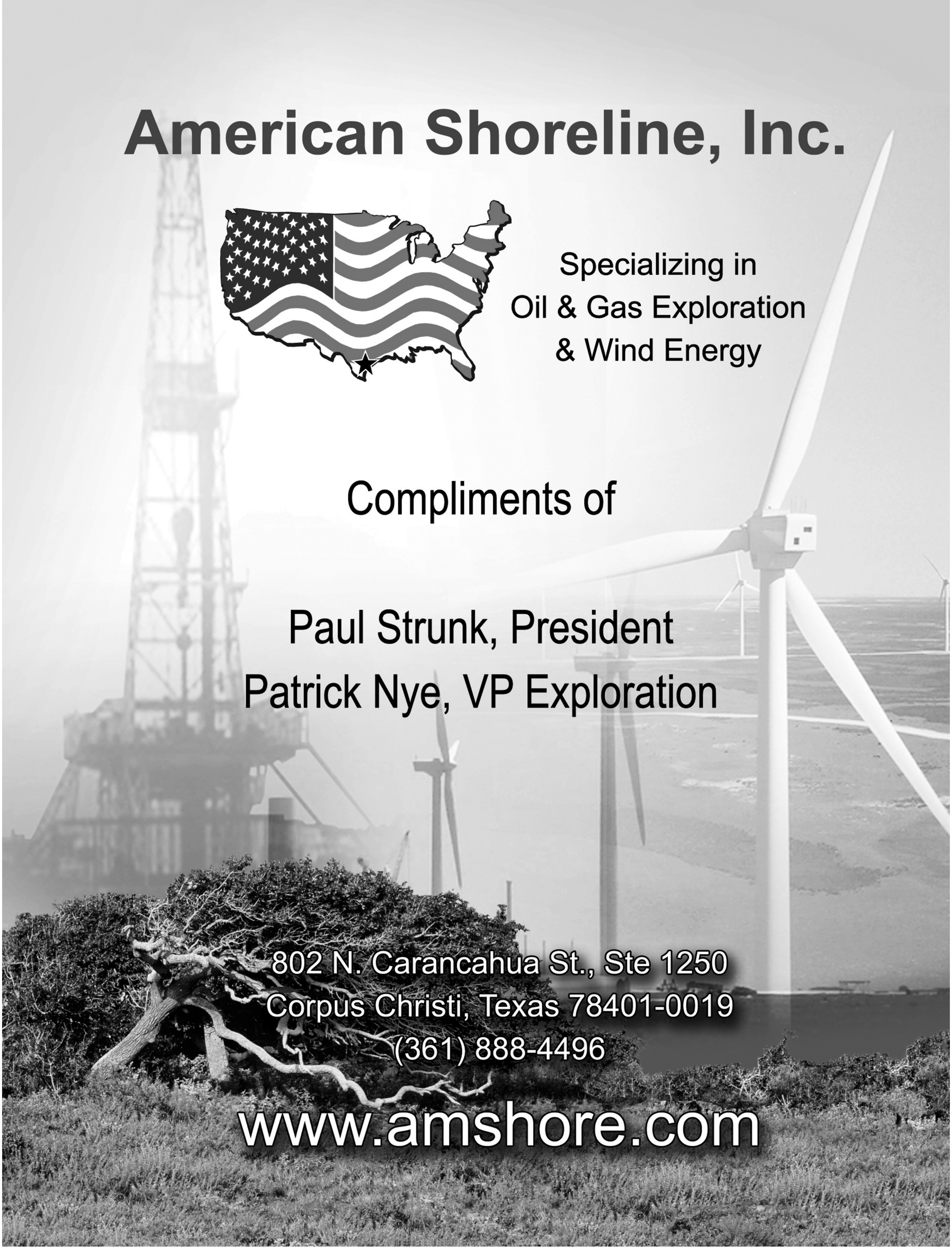
CORPUS CHRISTI
GEOLOGICAL SOCIETY

and

COASTAL BEND
GEOPHYSICAL SOCIETY

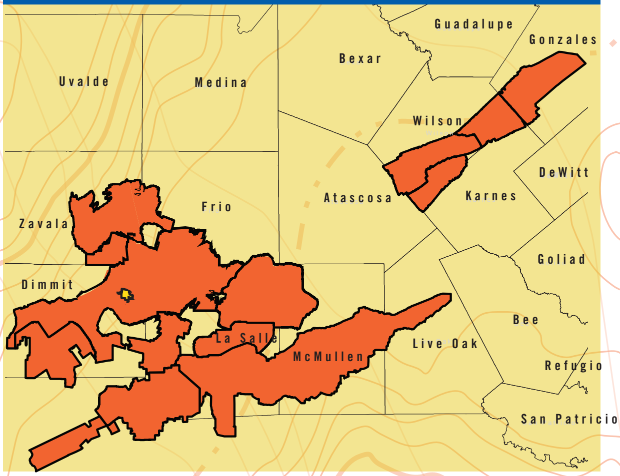
March
2013

ISSN 0739-5620

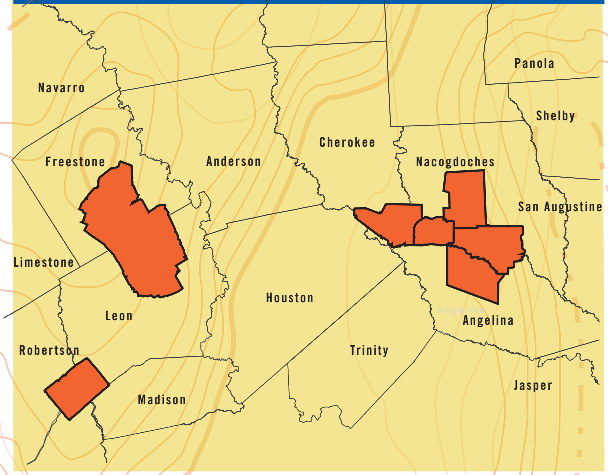


Texas Is Hot... AGAIN!

SOUTH TEXAS



EAST TEXAS



You might think this is old news, but you'd be wrong. Our Texas Multi Client datasets are heating up! Olmos, Escondido, Pearsall, Austin Chalk, Buda, Woodbine - this data gets you so much more than just Eagle Ford. Licensing our seismic provides a multitude of opportunities for successful prospectivity and production.

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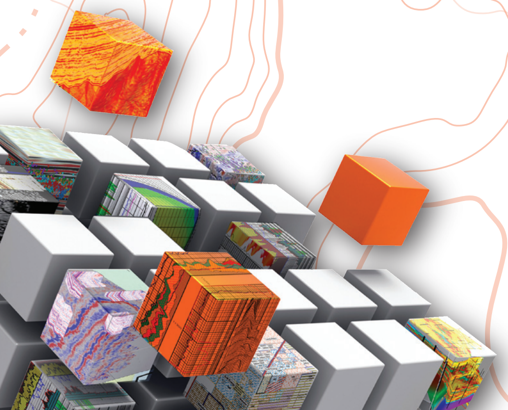

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2012-2013
www.ccgeo.org

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Sept. 13, 2012
5:30p.m.--8:00p.m.
Kickoff BBQ--The Bar-B-Q Man Patio Cantina

Oct. 18--11:30a.m.-1:00p.m.
Speaker: Mark Gregg--Kiwi Energy "Developing an Exploration Tool in a Mature Trend: A3-D AVO case study in South Texas"

Nov. 15--11:30a.m.--1:00p.m.
Speaker: Ray Govett "River Basins of Texas"

December 2012

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Dec. 19--11:30a.m.--1:00p.m.
Speaker: Chuck Segrest GeoSystems " Reservoir Characterization by Rock/Log Modeling"

Jan. 16--11:30a.m.-1:00p.m.
Speaker: Rocky Roden--Rocky Ridge Resources "Lessons Learned from a 10 year Industry-wide DHI Consortium"

March 2013

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March 20--11:30a.m.-1:00p.m.
Speaker: Jeffery Dravis
“Paleotrade winds & structural controls on Mesozoic carbonate plays around the Gulf rim”

April 17--11:30a.m.-1:00p.m.
Speaker: Frank Cornish
Do Upper Wilcox Incised Valleys Support Paleogene Gulf of Mexico (GOM) Isolation?

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 TX. Section of Society of Mining, Metallurgy & Exp.	2nd. Tues. every other month San Antonio

Meetings and Area Seminars

CCGS PRESIDENT'S LETTER

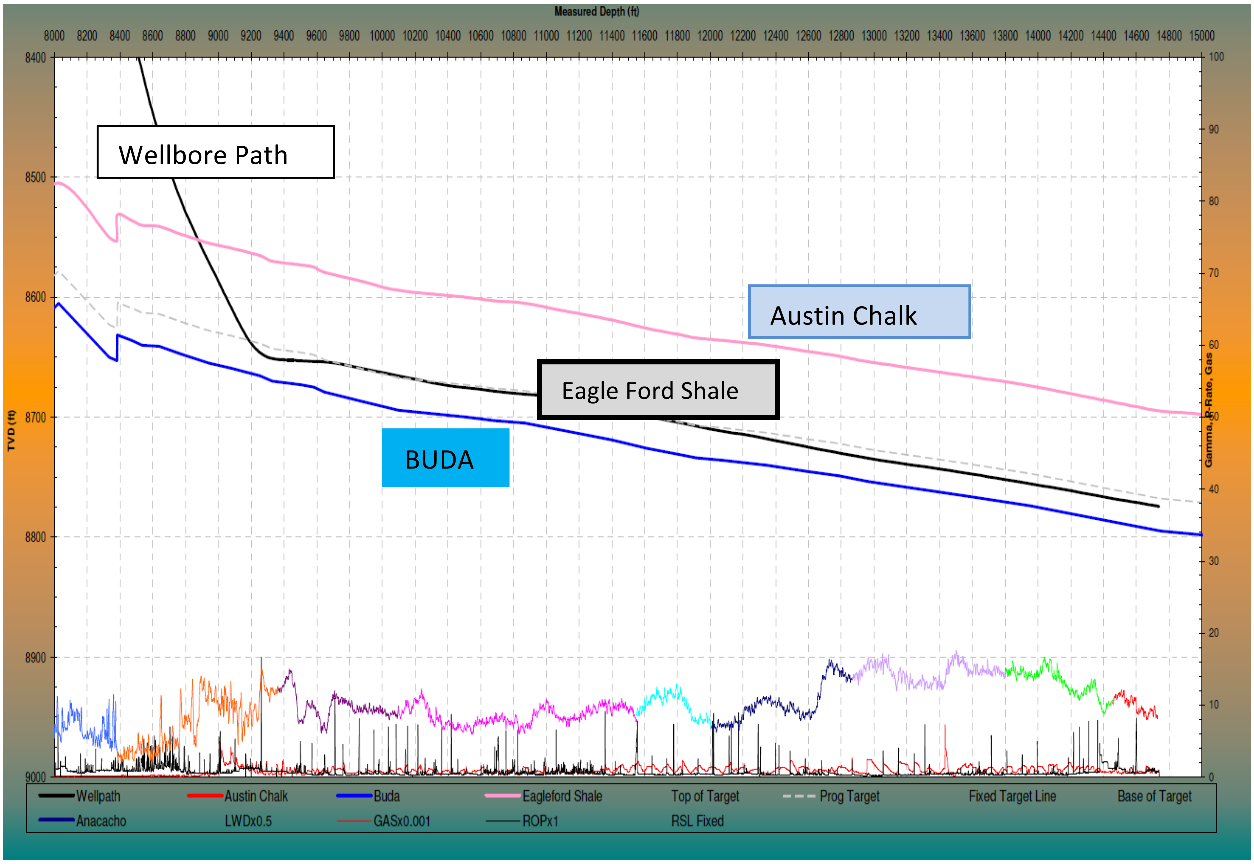
Spring is rapidly approaching our part of the World. Winter in the United States has been skewed toward the North Eastern 1/3 of our Country this year due to the predominant position of the steering jet stream. The South Western United States has literally been on the warm side of that steering jet stream and in South Texas we have had a very mild winter which is not atypical for our part of the World. As a result the use of Natural Gas has not been as rampant as normal and natural gas prices have not escalated during this winter. As the return of summer approaches the "air conditioning season" will demand huge amounts of electricity in South Texas that are derived from natural resources like Oil, Gas, Coal, and Uranium plus augmentation by Wind Energy, Geothermal, Tidal, Solar, etc. Again I state that hopefully you are looking for Oil and Gas and other minerals that can provide Energy to keep this planet running. We are charged with this as our main endeavor as Geologists. The Critical search for these raw materials is the bottom line for the continued "technological existence" of humans. What I am trying to impart this month in a simple bottom-line statement to all the people and governments of the Earth is "**Support your Worldwide Oil and Gas and Natural Resource Businesses**". Do not hinder the hunt for energy; only support it. This "hunt" is critical to our existence and to support of our standards of living around the World! Your support should start right here at home on the Texas Riviera in South Texas.

"EMBRACE GEOLOGY"

48 Shale Basins in 38 Countries

“EMBRACE GEOLOGY”

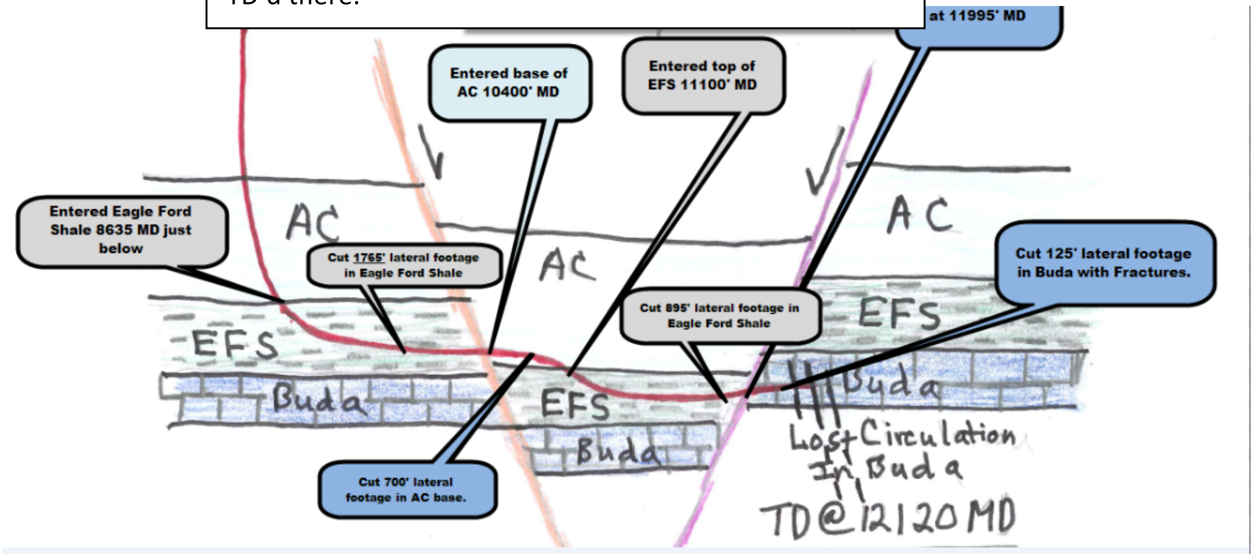
To change is inevitable and to survive is essential. The Horizontal Drilling Paradigm “Tsunami” is rapidly propagating and covering the 48 Shale Basins in 38 Countries of the world in our hunt for Oil and Gas reserves to sustain our technology driven societies. Our Geology students and Geologists will literally be “surfing this wave” of change over the immediate future. The United States Geoscience Teams and Specialty Drilling Teams have pioneered how to do this type and technique of hydrocarbon hunting and producing, and the rest of the world follows our lead. We will continue to drill vertical wells, but more and more wells will start to look like the diagrammatic example below of a wellbore that has been directionally drilled for several thousand feet in a fractured high TOC (total organic carbon) shale unit sandwiched between two fractured carbonate units. This is an example of an Eagle Ford Shale well that has been perfectly drilled “on target” and stayed “in Zone” stratigraphically between the Austin Chalk and the Buda Limestone in a “toe down” configuration. This Geology had to be embraced literally “laying on its side”. Just as Weathermen observe jet stream steering currents, Geologists and Drilling Engineers GeoSteer wells so that they can have a Geosteering Report of the finaled wellbore showing where it is in time and space. This is a diagrammatic example of a well that went as planned and has the best chance of being fracture stimulated and completed as a flowing gas or oil well.



Below is a diagrammatic example of a well that demonstrates a deviated well path where the GeoSteering was very tricky and the well path became tortuous. The well completion scenario would be much more complex for a deviation of this nature that did not stay in zone on target. To embrace this kind of Geology in unconventional lateral shale well requires a team that can understand the data and change the Geosteering plan when needed. Change is inevitable and ability to adapt to the changes means survival.

“EMBRACE GEOLOGY”

Into the Eagle Ford; cut a fault into the Austin Chalk; back down into the Eagle Ford Shale; stayed in zone for a given distance; cut another fault into the Buda and TD’d there.



ASK Yourself: Which Shale basin would I like to work as a Geologist, and in which Country? That opportunity exists for all of you young Geologists! Onward and do not be afraid to “EMBRACE CHANGE”.

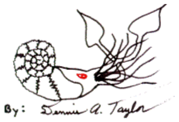
Relative to the recent “Near Miss” of 17.200 Miles for a 150’ Long Asteroid in parting here is an interesting Geological Trivia Fact:

Largest Crater

The largest crater on Earth is over 500km (or 311 miles) wide, partly located beneath Mexico. It was created following an asteroid impact 65 million years ago that may have led to the extinction of the dinosaurs.

Our Guest speaker for March at our noon luncheon meeting at the Town Club will be Jeffery Dravis, and his topic for his presentation is "Paleotrade Winds & Structural Controls on Mesozoic Carbonate Plays Around the Gulf Rim". Please be there to welcome our speaker. See you there!

EMBRACE GEOLOGY;



Dennis A. Taylor *CCGS President 2012-2013*

Boulders in Schools

Boulders in Schools would like to extend a “THANK YOU” to Shell Machine Works. Last fall the boulders program put 20 signs along with the boulders at local schools. Shell Machine Works donated the metal backing plates which hold the ID plaque that describes each boulder. These backing plates were precut to speed up the process of sign building. Once again, THANK YOU, to David Shell and his staff for their donation to the Boulders in Schools program.

Please remember that through the generosity of you and the community the CCGS can make a positive impact on the next generation of geoscientist.

Once again, thank you.

Dennis O. Moore

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361-883-7073

BLOOD DRIVE

THE BLOODMOBILE – IN **MARCH, 2013**
WILL BE AT SOME CONVENIENT LOCATIONS
PLEASE CALL 855-4943 for those locations or see below

Take advantage of those strong March winds - &
Go Fly a Kite! Then - Blow on over to the Bloodmobile!!

Please Donate your Blood!!

……

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 please give them that number also.

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

www.coastalbendbloodcenter.com

Thanks! Mike Lucente

……

CCGS SCHOLARSHIPS

Spring 2013 semester

APPLICATION REQUIREMENTS:

1. Applicant must be majoring in Earth Sciences and currently attending a college in the local area.
2. Minimum overall GPA: 2.5; Minimum Geology GPA: 3.0
3. Fill out the application form completely and sign.
4. Short essay clearly explaining how this scholarship will assist you in achieving your geologic career goals and the reasons your application should be considered by the Committee.
5. Applicant must provide two (2) letters of recommendation- one must be from a geoscience faculty member or from a supervisor with whom applicant has worked with in a geoscientific undertaking.
6. Applicant must provide a school transcript.
7. **Applications must be postmarked by: March 25, 2013**

Mail completed application to: Dawn Bissell, CCGS Scholarship Committee Chairman / 253 Circle Drive/ Corpus Christi, TX 78411

Please send an email to bissells@swbell.net once you've mailed your application so that we know to expect it.

Please read requirements carefully and submit only complete applications. Applicants who have received a CCGS scholarship in the past are eligible to apply again. Scholarships will be awarded based on merit and need. The award amounts may vary with the minimum individual award being $500. Award recipients will be recognized at the monthly luncheon in April and are strongly encouraged to attend.

Board Members:
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Jason Downing - Vice Chairman
Dennis Taylor - CCGS President
Patrick Nye - Secretary
Sebastian Weidman - Member
Frank Cornish - Member
Bill Maxwell - Member

Corpus Christi Geological Society
Scholarship Application Form
Summer – Fall 2013

Last Name: First Name;

Mailing address:
(where award may be mailed if applicant is selected)

City: State: Zip Code:

Email:

Daytime Phone: Best time to call:

Alternate Phone:

University Currently Attending:

Department: Major:

Scholarship is for class level (circle one):

Freshman Sophomore Junior Senior Graduate Student

Total Hours Completed: Overall GPA (Minimum 2.5):

Total Hours - Geology: Geology GPA(Minimum 3.0)

Hours Planned for Scholarship Semester: Geology Hours:

Will this scholarship be used toward field camp? Yes No

Prior recipient of CCGS Scholarship? Yes No

Applicant Signature Date

Mail application, along with essay, two letters of recommendation, and transcript to
Dawn Bissell, CCGS Scholarship Committee Chairman
253 Circle Drive, Corpus Christi, TX 78411
Must be postmarked by March 25, 2013. Email bissells@swbell.net once you've mailed your application, so we know to expect it.

Comment & Request from Your Corpus Christi Geological Society President Elect: *Dennis A. Taylor*

The Corpus Christi Geological Society membership is a great group of people to be associated with over the last 29 years. Even with the ups and downs of the Oil and Gas Industry that we have all witnessed, the CCGS has been a strong Society with Great Luncheons, Great Programs, and Tremendous Interaction with our community and schools through a varied set of Society supported programs over much of its existence. The CCGS is known about in the ranks of Earth Scientists across this fine country that we live in and I want all of you to know that I am proud to be a member of this Geological Society and I look forward to being your President in 2012 Summer-Fall through 2013 Winter -Spring.

I am asking for your help to prepare for my tenure as President. We have numerous Officers, Committees, and Chairpersons involved in making our organization run smoothly with effectiveness. Please continue to serve your Geological Society in your current positions. We need you and your talents to make a difference in the success of Geology throughout Texas, the USA, and the World. Please know that your precious time that is spent volunteering for your Society is greatly appreciated. Thank You. Together we form a strong team and ultimately that is what continues to make us successful.

Over the next few days I will be looking for individuals to continue their current jobs and for volunteers to fill other positions. The process has already been in motion but we need commitments soon. Please feel free to provide suggestions and nomination names for various positions especially for individuals with the talent and the spirit to possibly fill any of the positions but especially positions such as Technical Editor, Vice President / Program Chairman, Treasurer, and Academic Liaison. The normal sequence is for the Vice President / Program Chairman to become President Elect and ultimately President. In my past service I served as Technical Editor for 2 consecutive years and then Vice President / Program Chairman for 1 year and then President Elect for one year. Please remember that we are a dual society and that Coastal Bend Geophysical Society provides for one half of the Luncheon programs. Thank you CGBS for your gracious participation. If you know someone that can fill these positions then by all means please contact me. Self-Nomination is also an avenue for filling positions. Let me know if you have particular interest in filling a given position. I will be talking to many of you this week or contacting you by e-mail. Please remember that you are needed and most definitely wanted! All of the positions are very very important to our continued success as an Effective Geological Society. Let's be the best in the Country.

Sincerely & Highest Regards;
Geologist & CCGS President Elect: *Dennis A. Taylor*

Direct #: 361.844.6722 Main Office #: 361.888.4496 Office Fax #: 361.888.4588

Cell #: 972.672.9916 Home #: 361.767.2803

Office E-mail: **dennis@amshore.com**
Home Office E-mail: **dtaylormetateminerals@msn.com**

CBGS PRESIDENT'S LETTER

Colleagues with the arrival of the March Bulletin, the 2012-2013 year for our societies will be drawing to a close in a few short months. I want to take this opportunity to announce that I will be stepping down as CBGS President. Lonnie Blake has offered his name in nomination for the office of president for the 2013-2014 year. Should anyone else like to serve as president, please contact the current officers so we can place your name in nomination. With Lonnie's decision to accept the office of president, we will need to have someone fill his position as vice-president. Thus, we will be accepting nominations for this position.

The current bulletin was a good read this month, especially the article by Randy and Emily Bissell. The Corpus Christi Marina article was an excellent example of uniformitarianism in action. The history of the CCGS by Ray Govett was an interesting piece for those of us who have not lived and worked in the Corpus Christi area for extended periods of time. How gasoline and tire rationing during World War II was a catalyst for Corpus Christi area geologists to decide on starting their own society was noteworthy.

Upcoming events: The March 20th speaker will be Jeffery Davis. The title of his talk is "Paleotrade winds and structural controls on Mesozoic carbonate plays around the Gulf rim"

Don Walker

CBGS President 2012-2013

Geothermal Energy and Waste Heat to Power:
Utilizing Oil and Gas Plays
March 12 - 14, 2013
SMU Campus in Dallas, Texas

The SMU Geothermal Lab is hosting its 6th Geothermal Energy Utilization Conference in March. We are excited to have **Jon Wellinghoff, Chairman of the Federal Energy Regulatory Commission**, as the keynote speaker and **Doug Hollett, Program Manager of the DOE Geothermal Technologies Program**, as our evening reception speaker.

This conference brings together individuals from all aspects of project development for electrical production from geothermal energy and the captured heat from surface equipment. The same technologies can be used for both of these applications in oil and gas fields. There is one track of talks for attendees, with 30 minute breaks designed for networking and team building. Tours of the pressure equipment demonstration will be available. The end goal is to advance the understanding of energy production so that companies can successfully produce emission-free energy, while extending the life of an oil or gas field.

The pre-conference workshop *A Primer on Geothermal Energy Resources and Waste Heat Technologies* will provide a great introduction for those new to the geothermal and waste-heat communities. Four Continuing Education Credits will be given.

The conference details are as follows:

Name: Geothermal Energy and Waste Heat to Power: Utilizing Oil and Gas Plays
Dates: Workshop –March 12; Conference March 13-14, 2013
Price: $500 by February 15th, $600 by March 8th
Location: SMU James M. Collins Center in the Cox School of Business, Dallas, Texas
Website: http://smu.edu/geothermal/Oil&Gas/GeothermalEnergyUtilization.htm
Contact: Maria Richards, mrichard@smu.edu, 214-768-1975

Check the conference website for registration information, a list of conference presenters, the program itinerary, and a list of previous attendees. **Register by February 15th** to receive the early bird discount.

We look forward to discussing ideas with you at this event!

SMU | GEOTHERMAL LABORATORY

LUNCHEON MEETING ANNOUNCEMENT
CCGS &CBGS—WEDNESDAY, MARCH 20, 2013

Location: Corpus Christi Town Club, One Shoreline Plaza (Downtown)
Bar Sponsor: Schlumberger (Pete Graham)
Student Sponsor: Core Lab (Juan Cabasos)
Time: 11:30a.m., lunch served at 11:45a.m., speaker at noon
Cost: Members $25 ($3 surcharge if no reservation)
Reservations: Please make your reservations by email allison@aaoperating.com

Jeffrey J. Dravis Ph D
Dravis Interests, Inc., Houston, Texas
Web: www.dravisinterests.com

Dr. Dravis is a carbonate geologist who consults for large and small oil companies in the U.S. and Canada. He conducts integrated regional and local field studies for industry, as well as detailed core and thin section studies in order to unravel controls on porosity evolution. Jeff also teaches in-house and field training seminars for industry, having presented nearly 200 applied carbonate seminars, including over 50 field trips to the modern carbonate environments on Caicos Platform, in the southern Bahamas.

Jeff received his B.S. in Geology from St. Mary's University in San Antonio, a Masters of Science in Marine Geology from the University of Miami, Florida, and a Doctorate in Geology from Rice University in Houston. He worked at Exxon's geological research lab in Houston for eight years before becoming a full-time consultant over 25 years ago. He has been an adjunct Professor of Geology at Rice for the past 25 years, where he teaches part-time and mentors students.

Influence of Stronger Easterly Paleotrade Winds on Carbonate Play Development – Applications of Caicos Platform Models to Petroleum Exploration

JEFFREY J. DRAVIS
Geological Consultant
Dravis Interests, Inc., Houston, Texas

INTRODUCTION

Models for predicting facies distribution and play potential across subsurface carbonate platforms are based on the classical studies of Edward Purdy in the northern Bahamas (Purdy, 1962, A,B), with later slight modification based on studies of Holocene sediments on other platforms in the north (Dravis, 1979; Harris,

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1979; all summarized in Scholle, et al., 1983; Figs. 1-3). The implications from these studies is that high-energy depositional facies (barrier reefs; oolitic and/or skeletal sands) are confined to platform-margin settings influenced by oceanic swells or strong tidal currents, with much of the platform interior characterized by low-energy, peloidal-micritic facies (Figs. 2 and 3).

Depending on their orientation with respect to the open Atlantic Ocean, and the influence of gentle easterly trade winds, northern Bahamian platform margins today are dominated either by linear reef complexes or oolitic sands, but not the two together. In addition, weak currents set up by these gentle easterly trade winds strip mud and silt-sized carbonate material from the tops of the open platforms and shed it off the leeward (western) edges of these northern platforms, producing thick, basinally-restricted, onlapping highstand wedges (Wilber et al., 1990; Fig. 4). The environmental stress associated with this leeward margin highstand shedding tends to inhibit development of any reef complexes along these margins.

The subsurface exploration connotations from these studies are: (1) drill platform margins for high-energy facies; (2) ignore the platform interior as low-energy, micritic, and nonprospective; (3); do not explore for reefs along leeward margins; and (4) ignore thicker onlapping wedges since they will be mud-prone.

A major problem with the northern Bahamian models, however, is that they often fail to explain many carbonate play relationships in the subsurface. For example, in the Cretaceous around the ancestral Gulf of Mexico, there are productive subsurface plays where reefal and oolitic facies coexisted, or where substantial reef complexes developed along a leeward platform margin. Or, situations where isolated reefs and/or oolitic grainstones occurred well inboard of the platform margin, too far inboard to be influenced by oceanic swells or tidal currents. And, examples exist where onlapping wedges emplaced along leeward margins are grainstone-prone.

Now, Holocene and Pleistocene facies patterns on Caicos Platform in the southern Bahamas (Figs. 1 & 5), related to the influence of stronger easterly trade winds, better explain these subsurface carbonate play relationships (Wanless and Dravis,

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1989; Wanless and Tedesco, 1993; Dravis and Wanless, 2008). Perhaps more excitingly, they offer the potential to explore in areas historically ignored by the northern Bahamian models. These Caicos models have evolved from our more than 25 years of conducting research and training seminars on Caicos Platform. They apply equally to both carbonate platforms and ramps in the rock record.

This paper discusses the effects of stronger easterly trade winds on shallow-marine carbonate deposition on Caicos Platform, and demonstrates its application to the occurrence and distribution of Cretaceous hydrocarbon-bearing carbonate plays around the rim of the ancestral Gulf of Mexico. These models often best explain carbonate play distribution for many other geological time periods around the world, but discussion of those case studies is beyond the scope of this paper.

EASTERLY TRADE WINDS

Easterly trade winds faithfully operate parallel to, and on either side of, the equator, from five degrees north or south of the equator, to 30 degrees, north or south (Fig. 6). From 5 degrees to about 22 degrees north or south of the equator, the trade winds blow stronger and more persistently each year from the eastern quadrant (with northeast, east and southeast components). These are the stronger easterly trade winds. The gentle easterly trade winds blow from 22 degrees to 30 degrees, north or south of the equator, but are much gentler and not as persistent. Five degrees on either side of the equator defines the doldrums, where the trade winds do not blow. Prevailing winds north or south of 30 degrees are from the west (the westerlies).

Published maps, like the one shown in Figure 7, establish the general location of a particular basin or prospect relative to the paleoequator, for a particular time period. If one understands the general physiographic setting of a shallow-water carbonate system, for a given stratigraphic age, then one can use these types of maps to better predict whether that carbonate system was influenced by easterly paleotrade winds, and whether those winds were stronger or more gentle. As this paper will demonstrate, the orientation of certain sand bodies, the distribution of certain types of reefs, or the composition of highstand onlapping wedges can be used to deduce the paleotrade winds influences, and define the windward versus leeward sides of platforms.

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PHYSIOGRAPHIC SETTING OF CAICOS PLATFORM

Caicos Platform is the most southerly of the Bahamian platforms with island development (Figs. 1 & 5). Located at a latitude between 21 and 22 degrees north of the equator, this platform is influenced by stronger easterly trade winds. It is a relatively small platform by northern Bahamian standards, but exhibits the same Holocene carbonate sedimentary environments as documented in the northern Bahamas (Fig. 8). The climate of Caicos Platform is semi-arid, and evaporites form today on several of the islands. Further, world-class outcrops of Pleistocene reef and oolitic sand sequences superbly preserve the sedimentary attributes of their Holocene counterparts. Our outcrop studies, augmented by coring and high-resolution seismic data, demonstrate the key role that stronger easterly trade winds played in controlling late Pleistocene carbonate deposition, just as they do today in the Holocene (Wanless and Dravis, 2008).

CAICOS HOLOCENE DEPOSITIONAL MODELS

This paper summarizes a few of our alternative Holocene Caicos depositional models and discusses their applications with respect to the exploration for subsurface carbonate plays. For a complete discussion of all the models, see Dravis and Wanless (2008).

Occurrence and Distribution of Holocene Oolitic Sands

Wind-wave agitation generated by stronger easterly trade winds promotes widespread development of Holocene shallow-marine, platform margin to platform interior oolitic sands (Figs. 8 & 9). This is in major contrast to the northern Bahamas where ooid sands are generated by tidal currents, but confined to platform-margin settings.

Holocene oolitic sands on Caicos Platform exist as widespread sheets or linear shoals, depending on preexisting topography and water depth. Shallow subtidal ooid sand shoals, like the Ambergris and Mid-Platform shoals, assume an orientation parallel to the prevailing stronger easterly trade winds (Fig. 8). Ooids sands forming along shorelines of older Pleistocene islands, such as West Caicos and Providenciales, created shoreline-parallel sand bodies oriented perpendicular to prevailing easterly trade winds. Ooids at these localities form in the beach and shallow shoreface environments and are delivered to the Holocene beach ridges. The beach ridges on West Caicos range in height from 7 to 20 meters and prograded up to one-half kilometer into the prevailing winds, in about

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3500 years (Lloyd, et al., 1987; Fig. 10). Widespread subtidal sheets of ooid sands also form in platform interior settings, in waters at least 3-5 meters deep (Wanless and Tedesco, 1993; Fig. 9). Tidal currents do not play a role in Holocene ooid sand formation on Caicos Platform.

Evolution of Holocene Reef Systems

Holocene reef deposition in the interior of Caicos Platform, or along leeward margins. is strongly controlled by stronger easterly trade winds.

In the platform interior of Caicos Platform, isolated and coalesced patch reefs occur well over 40 kilometers inboard from the open windward margins (Fig. 11). This is anomalous compared to the northern Bahamas. The more persistent and stronger trade winds affecting Caicos Platform promote water renewal by circulating oceanic, open-marine, waters well up onto the platform, and provide water agitation that permits these isolated reef complexes to develop. These reefs coalesce in seaward directions, some evolving lengths and widths exceeding hundreds of meters (Fig. 12).

Wherever leeward margins change orientation and develop more favorable exposure to prevailing easterly winds, kilometer-scale linear reef complexes develop (Figs. 11 and 13). The subtle change in platform-margin orientation protects these reefs from off-bank sediment stress that normally inhibits reef growth on leeward platform margins. As a result of major storm activity, these Holocene reefs shoaled to mature reef flats, with associated back-reef skeletal grainstone deposits. But, these skeletal sands are being converted into oolitic sand today by persistent wind-wave agitation related to the stronger easterly trade winds.

Coeval Reef and Ooid Sand Deposition

Reefs and oolitic sands coexist in many settings on Caicos Platform because of wind-wave agitation. This is in direct contrast with the northern Bahamas where only one or the other sedimentary facies occurs along a platform margin, but never together.

On Caicos Platform, isolated patch reefs and oolitic sands coexist in platform-interior settings, some in waters deeper than 8 meters, because of wind-wave agitation (Fig. 12), reflecting the persistent wind-wave agitation that converts skeletal grains to ooids.

Isolated patch reefs and ooids coexist off of the northwest side of West Caicos Island as

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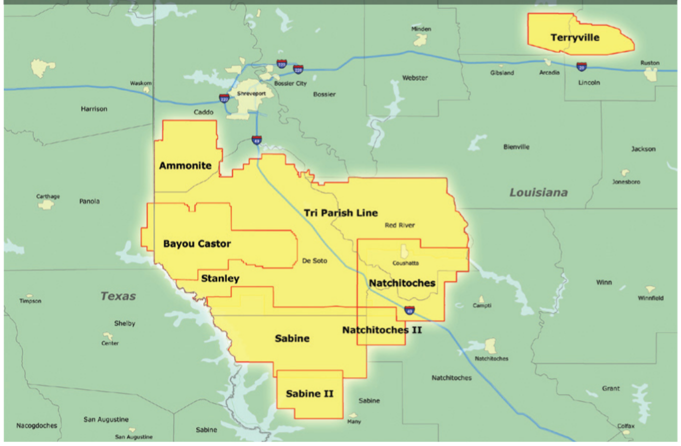

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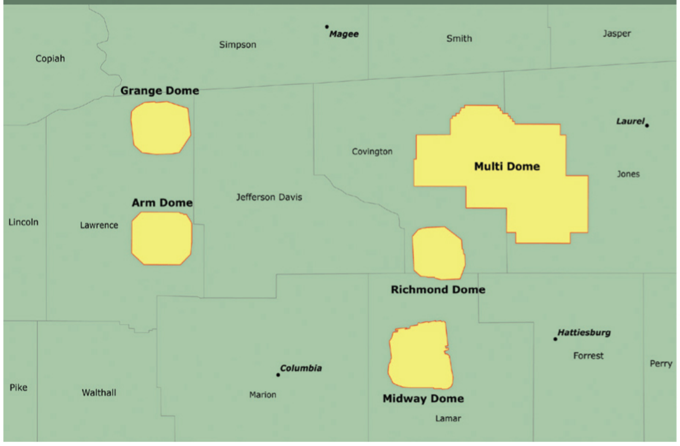

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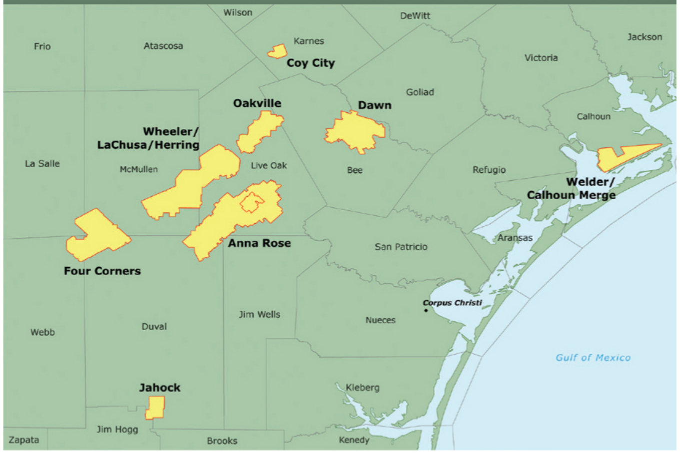

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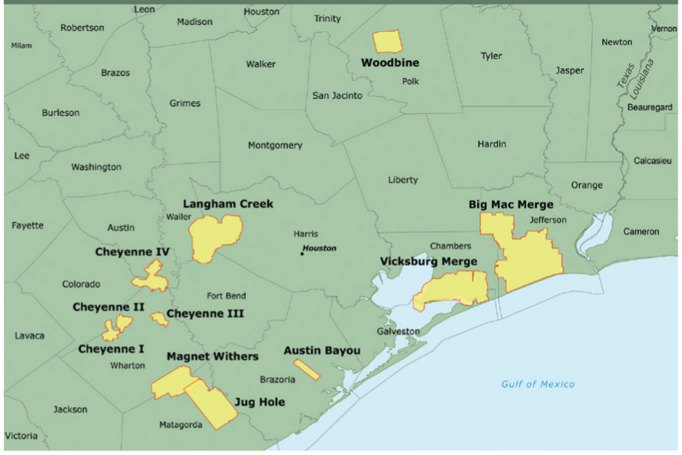

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well (Fig. 9). As noted earlier, this co-occurrence of ooids and reefs is observed in back-reef flat grainstones associated with discontinuous, leeward-margin reef complexes, where skeletal grainstones are converted to oolitic sands (Fig. 13), also by exposure to the wind-wave agitation promoted by the stronger easterly trade winds.

Off-Bank Shedding of Carbonate Sands

Field observations and aerial photography demonstrate that stronger easterly trade winds set up off-bank currents that not only shed mud- and silt-sized sized material from the top of Caicos Platform, but also coarser carbonate sands as well. In the northern Bahamas, gentle easterly trade winds are only capable of shedding carbonate mud- and silt-sized material (Wilber, et al., 1990).

On Caicos Platform, stronger easterly trade winds set up gradual movement of oolitic and other sands from the platform interior to the leeward margin of the platform, creating subtidal levees when major storms throw back some of this sand to create depositional subtidal topography along the platform margin (Fig. 8). But most of these sands are shed off the leeward margins of Caicos Platform. For example, ooid sands at West Spit (Fig. 14), which are derived from the large Ambergris shoal complex to the east (up-wind), cascade over the edge of this leeward platform on windier days. In fact, Hurricane Ike in September of 2008 completely stripped away all of the West Spit oolitic sand and moved it into the adjacent basin. West Spit recovered within six months, proving the efficiency of trade winds in moving ooid sands east to west to the leeward platform margin. Academic seismic shot off the leeward margin of Caicos Platform reveals a prominent onlapping wedge of Holocene material. While never cored, this wedge undoubtedly is sand-prone, given the field observations noted above. These grainstones would have excellent reservoir potential in the rock record.

SUMMARY OF SOME OF THE CAICOS MODELS

The Holocene and Pleistocene sedimentary record on Caicos Platform shows that wind-wave agitation created by stronger easterly trade winds can promote different styles of carbonate sedimentation across a shallow-marine platform, can modify existing environments, and can dictate the composition of sediments shed from its top.

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The key aspect of the Caicos models is that that high-energy carbonate facies are not just confined to platform margin settings but can occur in platform-interior settings historically considered to be low-energy, micritic, and nonprospective. On Caicos Platform, therefore, reservoir potential exists over much of the platform, in contrast to the northern Bahamas, where reservoir potential is confined to platform margins. Observations from Caicos Platform demonstrate that given suitable paleotopography, high-energy reef or oolitic sand complexes, or both, can develop anywhere in the platform interior if the climate was persistently windy (which the stronger easterly trade wind belts are) and water depths were shallow enough to be agitated. In windier settings, leeward margins also could be settings for reef development if off-bank sediment transport was blocked by depositional topography, or the platform interior was sufficiently deep to inhibit shedding. Leeward margins also would be sites for preferential shedding of carbonate sands, creating onlapping wedges with excellent reservoir potential.

CRETACEOUS CARBONATES PLAYS, ANCESTRAL GULF OF MEXICO: HOW THEIR GEOLOGY CONFIRMS THE INFLUENCE OF STRONGER EASTERLY PALEOTRADE WINDS

Published paleogeographic maps (Hofling and Scott, in Kiessling, et al., 2002; Fig. 7) now permit better prediction of paleotrade wind belts for a given basin and geological time period, and help delineate which side of a basin was windward or leeward. Several Cretaceous reefal complexes, all developed in stronger easterly paleotrade wind belts, reflect aspects of the Caicos models discussed above. These case studies are briefly discussed below, along with the geological evidence supporting the overriding influence of stronger easterly paleotrade winds on their development and occurrence.

Black Lake Field, Louisiana

Lower Cretaceous (Sligo-aged) Black Lake Field (156 MMBOIP) in central Louisiana developed on salt-related topography more than 50 miles inboard of the Sligo platform margin (Fig. 15; Hermann, 1971; Sams, 1982; Harbour and Mathis, 1894). Why would such a high-energy complex, surrounded by relatively deeper-marine subtidal facies,

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evolve this far inboard from the open ancestral Gulf of Mexico? Its location is too far inboard from the Sligo platform margin to be influenced by oceanic swells or tidal currents (tidal currents do not promote reef development anyway). The answer is several fold. First, salt tectonics created the paleotopography and relatively shallow water to localize the reef complex. Second, stronger easterly paleotrade winds provided the persistent agitation and water renewal required for this isolated reef to develop.

The geological evidence for this paleotrade wind influence is twofold: first, the back-reef rudist grainstones were converted to oolitic grainstones (Fig. 16; reefs and ooids together – one aspect of the Caicos models); and second, the rudist reef core is limited to southeastern side of this paleotopographic high, and reef-derived skeletal grainstones were preferentially shed in a northwestern direction, leeward of the reef core (Fig. 17). These relationships imply that the prevailing easterly trade winds were not only stronger, but blew mostly from the southeastern quadrant.

Fairway Field, East Texas

Lower Cretaceous (James/Pearsall age) Fairway Field (410 MMBOIP) in East Texas also developed more than 50 miles inboard from the margin of the ancestral Gulf of Mexico (Fig. 18; Achauer, 1985; Webster, et al., 2008). Like Black Lake, it too was developed on a salt-related structure that created the paleotopography and shallow water conditions necessary for reef development (Maione, 2000). A major subtidal sand body comprised of reef-derived skeletal grainstones was shed off of Fairway to the northwest, where these grainstones intersected shoreline parallel oolitic grainstones. At Fairway Field itself, isopach maps of the porous and productive skeletal grainstones exhibit a consistent southeastern-northwestern orientation (Fig. 19).

Drawing on the Caicos Holocene analogs discussed earlier, stronger easterly paleotrade wind influences best explain the geological relationships noted above. Fairway complex is too far inboard for oceanic swell or tidal currents influences. Tidal currents do not drive reef development, nor do they promote ooid sand development along an open shoreline. The various sand body orientations noted above for Fairway are consistent with the sand body orientations noted for Caicos Platform, where the subtidal sand bodies

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orient parallel to the prevailing stronger easterly trade winds, but shoreline parallel sands orient perpendicular to those same winds. Further, development of ooid sands along a beach is consistent with the Caicos trade wind model for making ooids.

Golden Lane and Poza Rica Fields, Mexico

In Mexico, the Middle Cretaceous Golden Lane Field (2.2 BBOIP) produces from a series of rudist reef complexes developed along the western (leeward) margin of Golden Lane Atoll (Fig. 20; Enos, 1985). Nearby, Poza Rica Field (2.7 BBOIP) produces from a thick wedge of rudist grainstones shed off the western margin of the Golden Lane Atoll (Viniegra-O, 1981). What factors controlled the occurrence and distribution of these play types, and are they linked depositionally?

First, both fields are related to an offshore granitic basement high, surrounded by relatively deeper-marine waters, which provided the suitable paleotopography to initiate the development of Golden Lane Atoll (Enos, 1983). Rudist reef complexes developed around the periphery of this feature, including the western margin, but later structural movement and upward tilting to the northwest confined production mostly to the western margin of this atoll structure. Second, paleogeographic reconstruction indicates that the Golden Lane Atoll was located 10-15 degrees north of the paleoequator during Middle Cretaceous time, in the heart of the stronger easterly paleotrade wind belt (Fig. 7). This relationship implied that the western margin was also a leeward margin. Based on the northern Bahamian models discussed earlier, a leeward platform margin is not considered a good location for robust reef development because it faced away from the open ancestral Gulf of Mexico, and would have been subjected to sediment stress related to off-bank sediment movement promoted by the easterly paleotrade winds. Third, Poza Rica field produces from a thick, onlapping wedge of skeletal grainstones sourced from rudist reefs developed along the western (leeward) margin of Golden Lane Atoll (Fig. 21).

So, which model best explains these producing field relationships? The stronger easterly paleotrade wind model does, based on relationships from Caicos Platform. These Golden Lane rudist reefs thrived on a leeward margin because of persistent wind-wave agitation related to the stronger easterly paleotrade winds, but also because a deeper-water lagoon

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to the east inhibited off-bank sediment stress (C. Kerans, personal communication; seismic-based observation). This inference is consistent with the paleogeographic setting (Fig. 7); the conversion of back-reef skeletal sands to ooids along the western margin is further evidence for agitation provided by these winds (Coogan, et al, 1972; Fig. 22). In addition, as was seen on Caicos Platform, these stronger trade winds would have promoted persistent shedding of rudist grainstones from these leeward margin reef complexes, producing the thick wedge of onlapping grainstones that defines Poza Rica Field.

SUMMARY

Holocene and late Pleistocene geology on Caicos Platform teaches us that exploration strategies for subsurface plays should always factor in paleo-wind direction and intensity, since it expands the potential for grainstones (oolitic and other types) and reefal deposits to develop much further inboard on ancient carbonate platforms. Orientation of ancient platforms with respect to easterly paleotrade winds will determine if a platform margin was windward or leeward. The strength of these winds will determine whether onlapping wedges developed off of leeward platform margins were grainstone-prone, or not.

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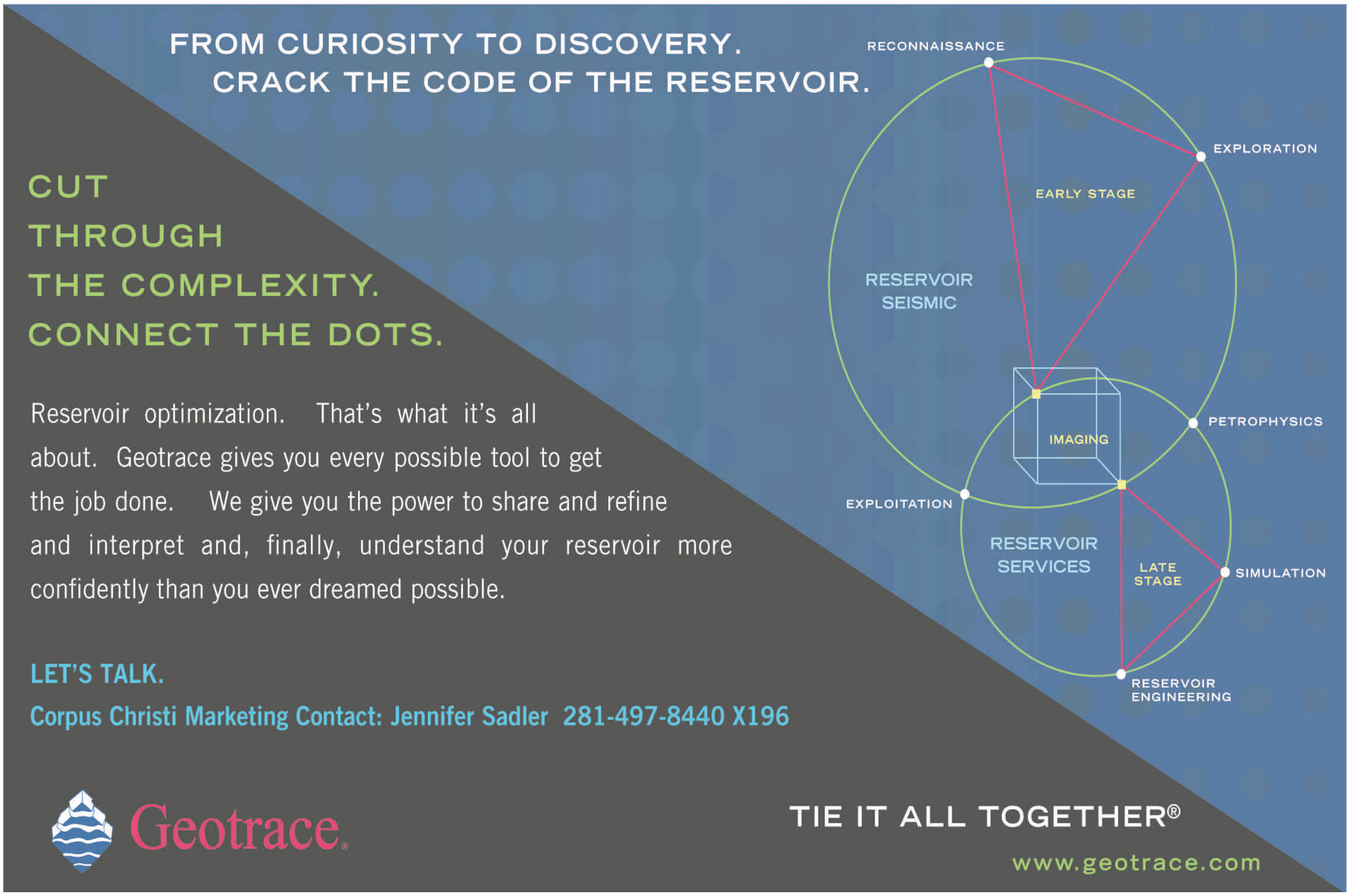
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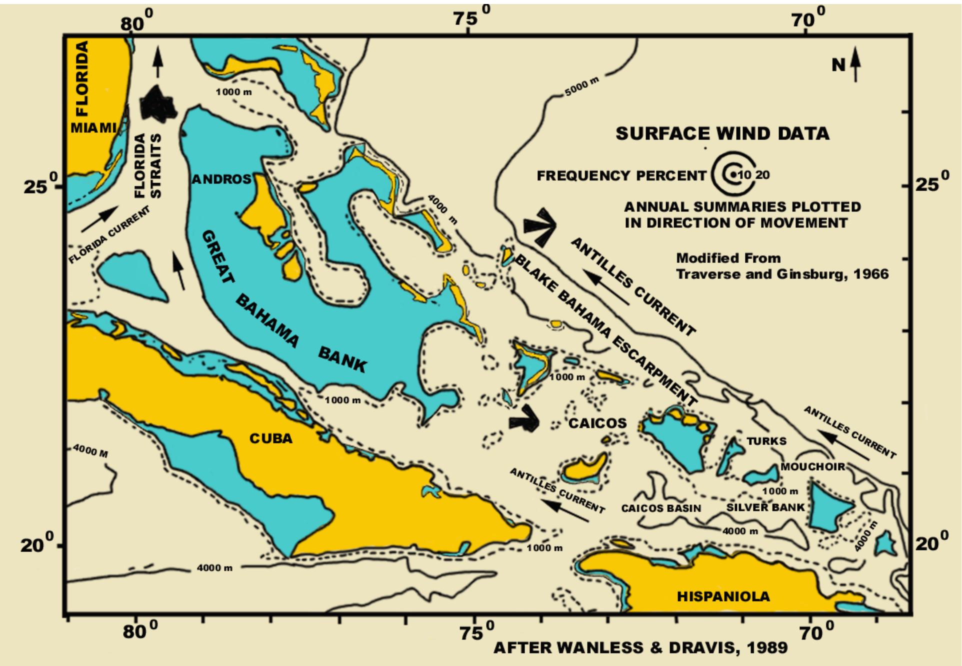

Figure 1. Map of the Bahama Platform Complex showing the geographic location of Great Bahama Bank in the north and Caicos Platform in the south. Note the wind roses. Great Bahama Bank is influenced by gentle easterly trade winds and a rainy climate. Caicos Platform, located south of the 22-degree north latitude, is influenced by stronger easterly trade winds and a semi-arid climate with evaporites forming coevally with carbonates.

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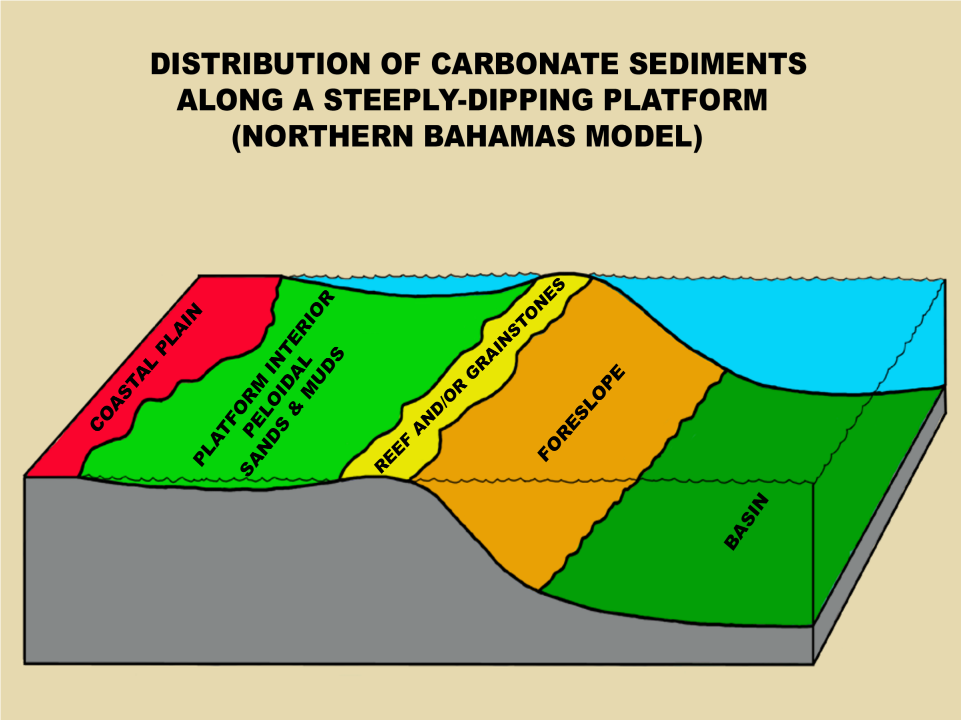
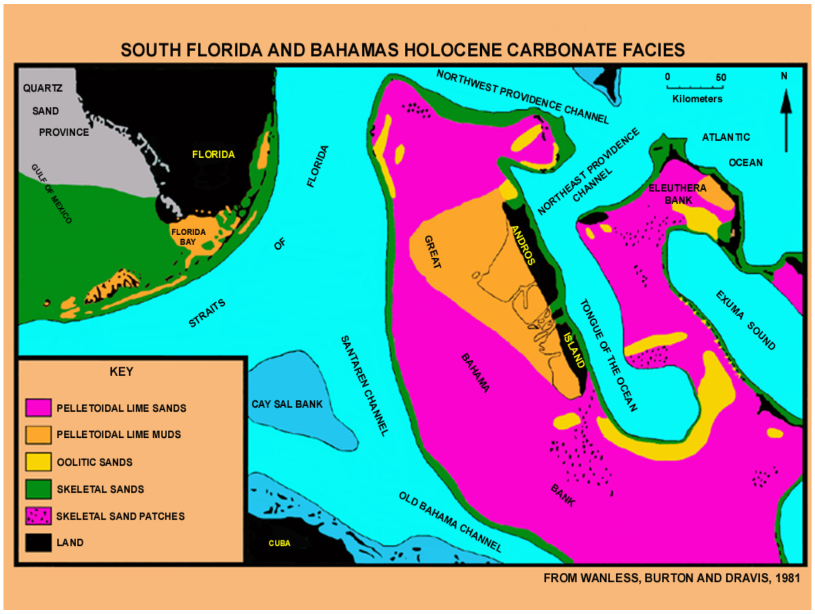


Figure 2. Northern Bahamas model for facies distribution across a carbonate platform with a steeper margin. High-energy facies are confined to the platform margin, either as barrier reefs or grainstones, including oolitic sands. But reefs and oolitic sands do not occur together. The platform interior is low-energy and dominated by micritic-peloidal sediments. The exploration connotation from this model: play the platform margin and ignore the platform interior.



FROM WANLESS, BURTON AND DRAVIS, 1981

Figure 3. Map of part of the Bahama Platform Complex showing Great Bahama Bank. Holocene sedimentary facies patterns delineated on the northwestern part of this Bank define the classical Edward Purdy model. This model changes slightly at the southern and northern ends of Tongue of the Ocean (Harris, 1979) or at the northern end of Exuma Sound (Dravis, 1979) because of the stronger tidal current agitation associated with these deep-water embayments. Low-energy, burrowed, micritic-peloidal sediments dominate open shallower parts of these platforms. Weak currents set up by the gentle easterly trade winds shed mud- and silt-sized sediments from platform tops to the west, producing onlapping wedges of micritic sediment along their western (leeward) margins (see Figure 4).

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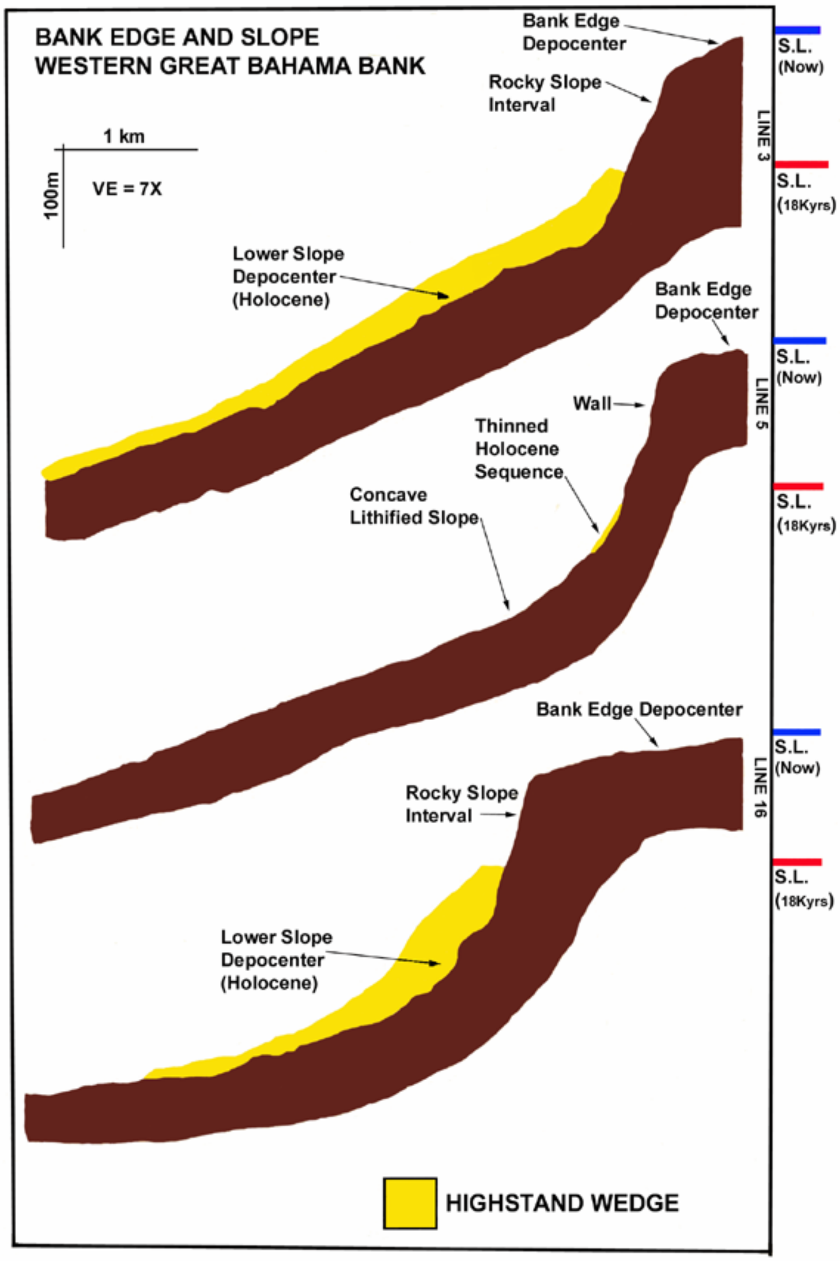

Wilber, et al., 1990

Figure 4. Data from three seismic lines taken across the western (leeward) margin of Great Bahama Bank. These lines show Holocene onlapping highstand wedges of carbonates comprised principally of mud- and silt sized sediments derived from the platform tops. Gentle easterly trade winds are only capable of shedding this type of fine-grained material.

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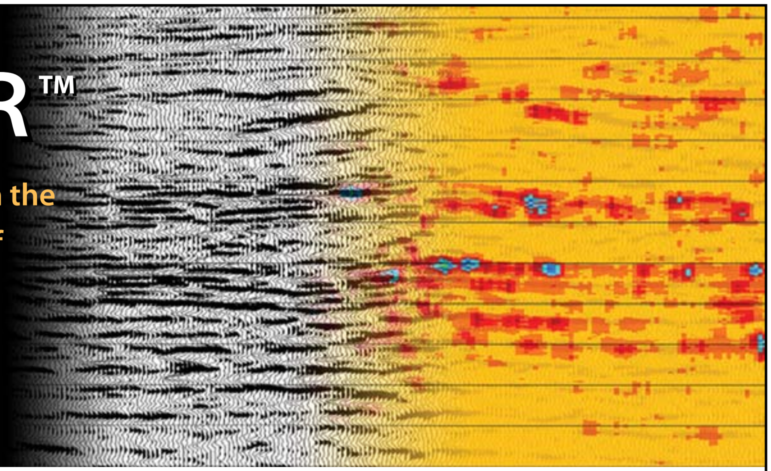

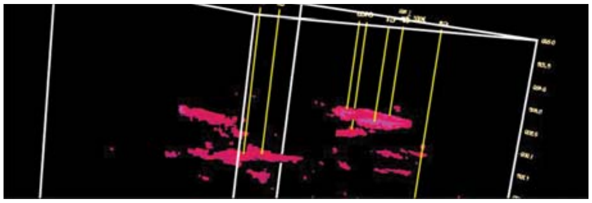

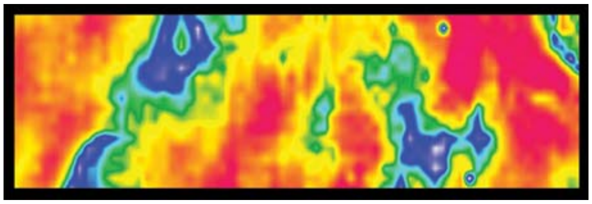

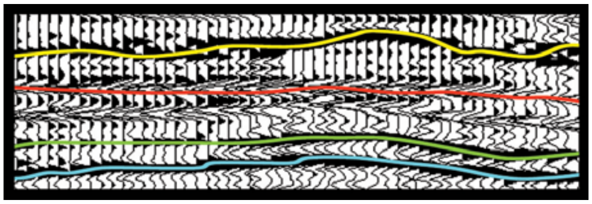

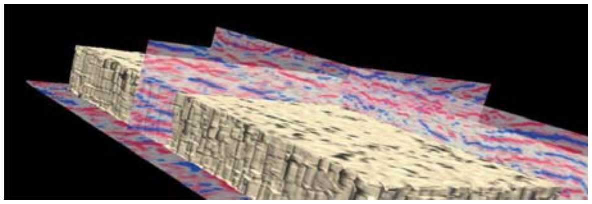

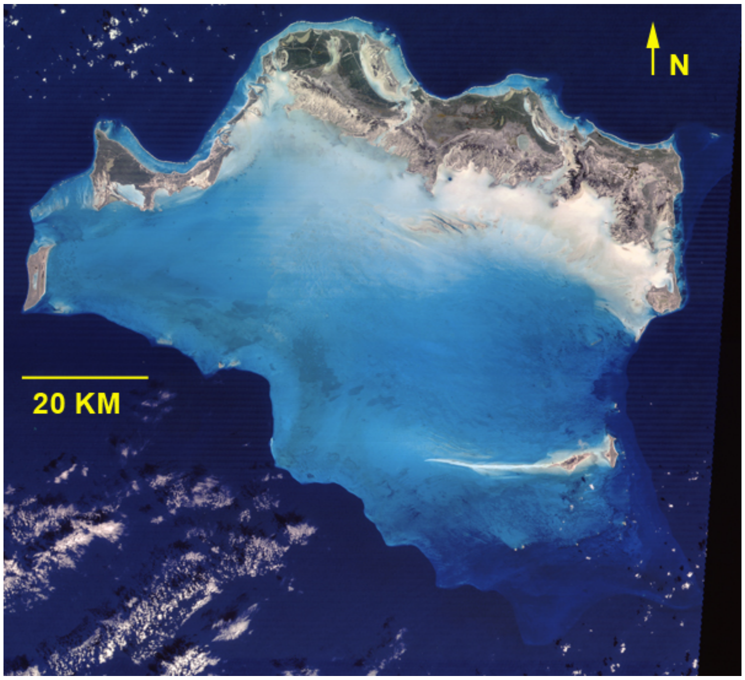

Figure 5. Satellite photograph of Caicos Platform in the southern Bahamas, surrounded by oceanic waters about 2000 meters deep. Most of Caicos Platform is less than 10 meters deep.

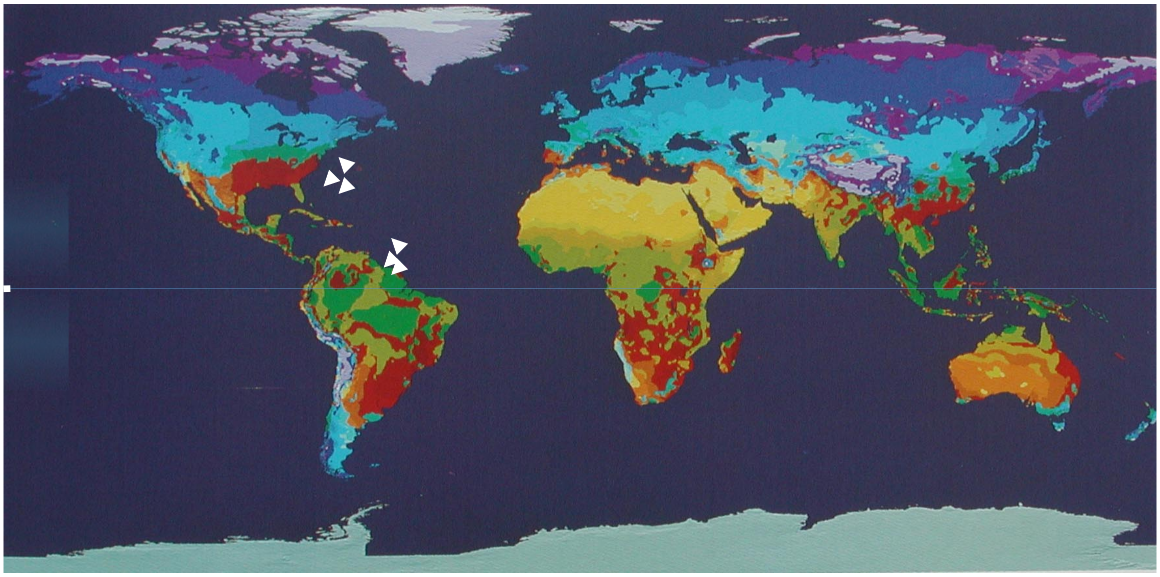

Figure 6. Map of the world showing the distribution of easterly trade wind belts that parallel the equator today. Arrows show the wind direction components. Along the equator are the doldrums, where these winds do not blow. 5-22 degrees on either side of the equator are the stronger easterly trade winds, and from 22-30 degrees the gentle easterly trade winds. The westerlies occur 30 degrees north or south of the equator. Diagram is provided compliments of Harold Wanless.

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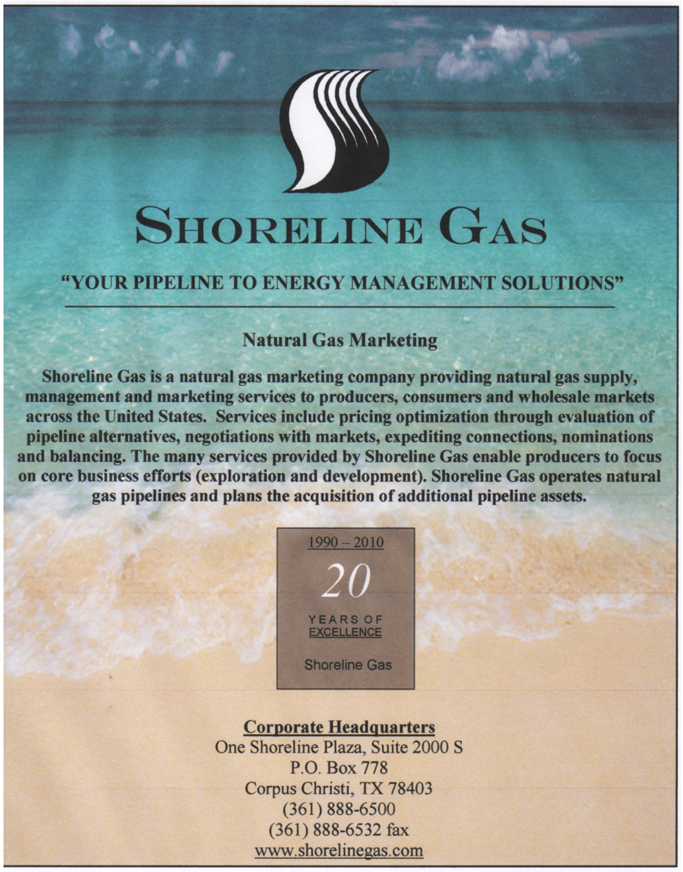

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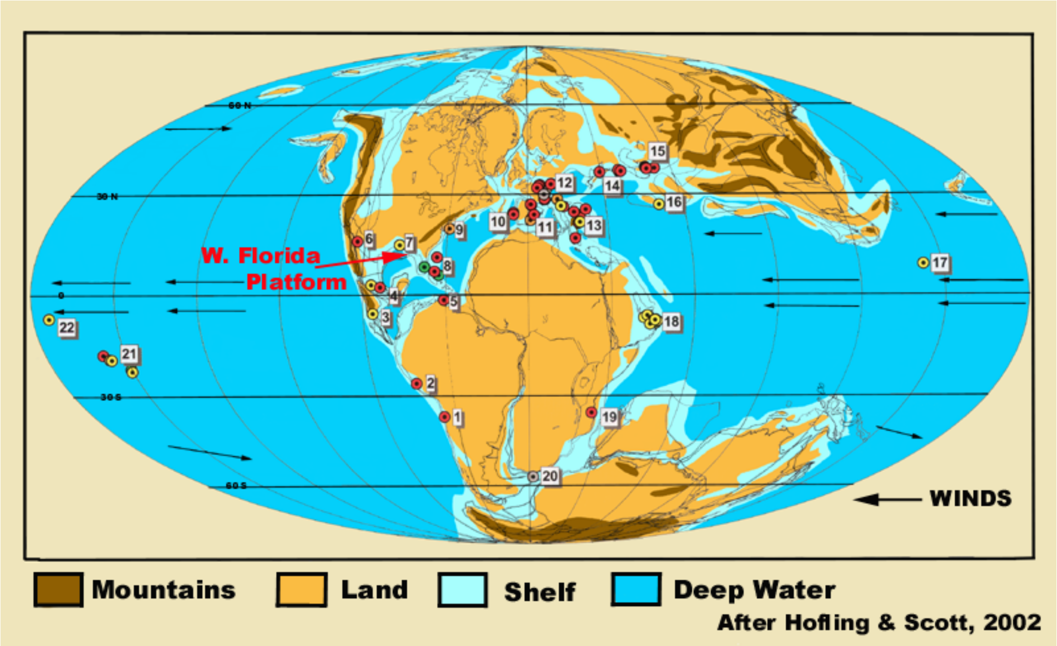
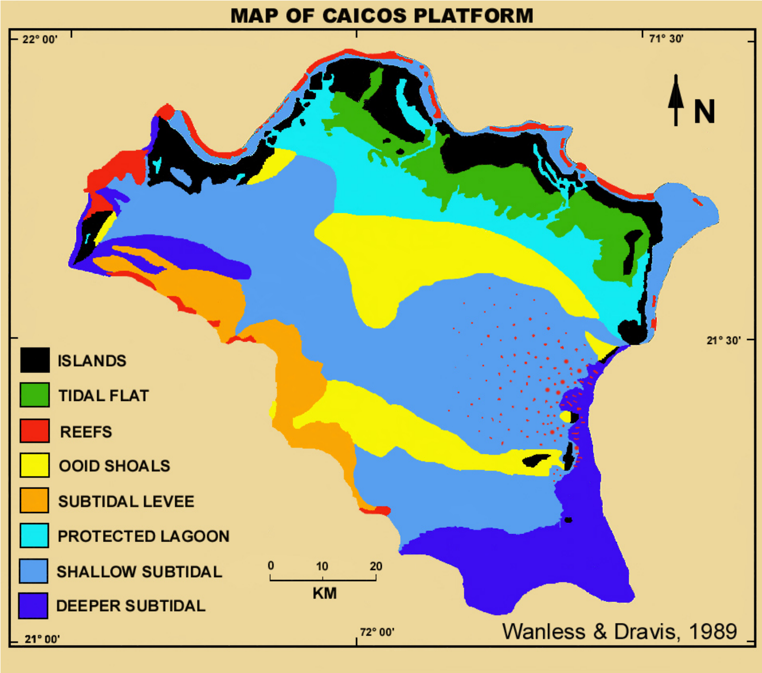


After Hofling & Scott, 2002

Figure 7. Paleogeographic map for the lower Cretaceous showing the location of various land masses and associated basins with respect to the paleoequator. Based on the relationships observed today, one can use a map such as this one to predict the influence of regional winds systems. Using the West Florida Platform as an example, one would predict, because this area is located about 15 degrees north of the paleoequator, that it would have been influenced by stronger easterly trade winds. The wind patterns are those of the authors of this diagram and show the expected wind directions relative to the paleoequator during the lower Cretaceous.



Wanless & Dravis, 1989

Figure 8. Physiographic map of Caicos Platform showing the prominent yellow oolitic sand bodies across the central part of the platform. Subtidal ooid shoals line up parallel to the stronger easterly trade winds, but smaller ooid sand bodies adjacent to older black Pleistocene islands are shoreline parallel and orient perpendicular to the stronger easterly trade winds.

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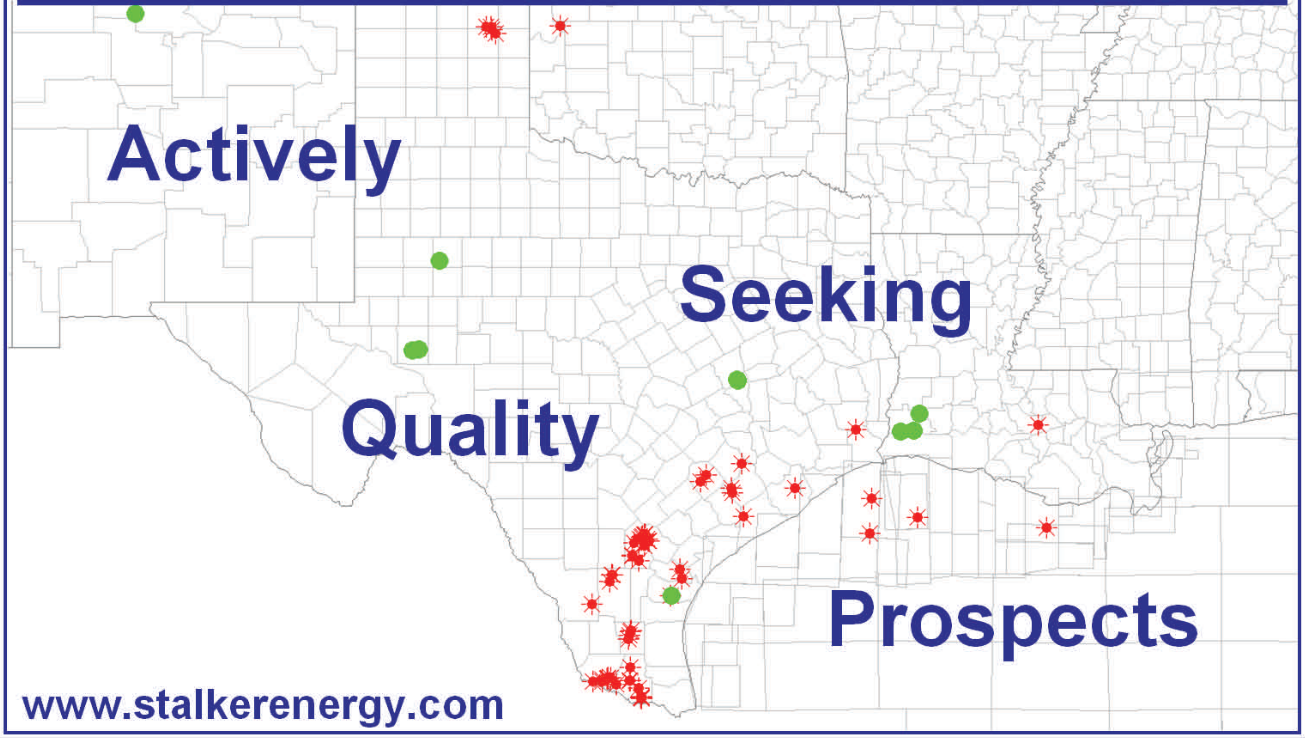

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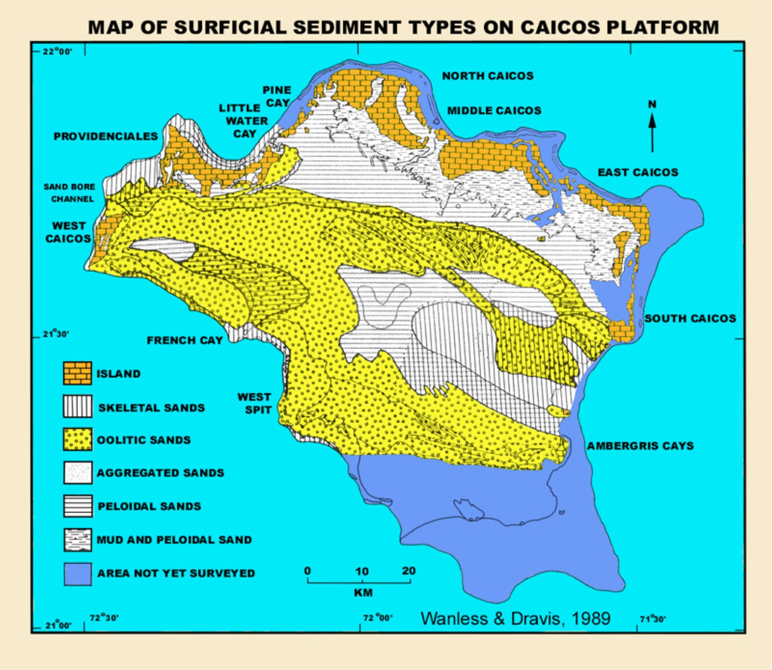

Figure 9. Map of Caicos Platform showing the distribution of Holocene high-energy oolitic sands (yellow). Broad areas of the platform interior, in waters up to 3-5 meters deep, are sites for widespread ooid sand development because of water renewal and wind-wave agitation provided by the stronger easterly trade winds. Tidal currents have little effect on these ooid sands. Ooid sand occurrence and distribution directly contrast with the northern Bahamas, where those oolitic sands are limited to platform margins. On Caicos, any shallow-marine environment persistently agitated by trade winds can become grainstone, along with the development of ooids.

Figure 10. Aerial photograph of West Caicos island looking to the north and showing a Holocene wedge (yellow arrow) comprised of prograding oolitic beach ridges, developed along the western (windward) side of the island. The factory for making ooids is the beach and shallow shoreface (orange arrow). Persistent and stronger easterly trade winds provide the agitation for making ooids. This wedge of oolitic sand has prograded into these winds at rates as high 500 meters in about 3500 years. Most beach ridges are about 25 feet high, except the youngest one along the shoreline, parts of which are 60 feet high.

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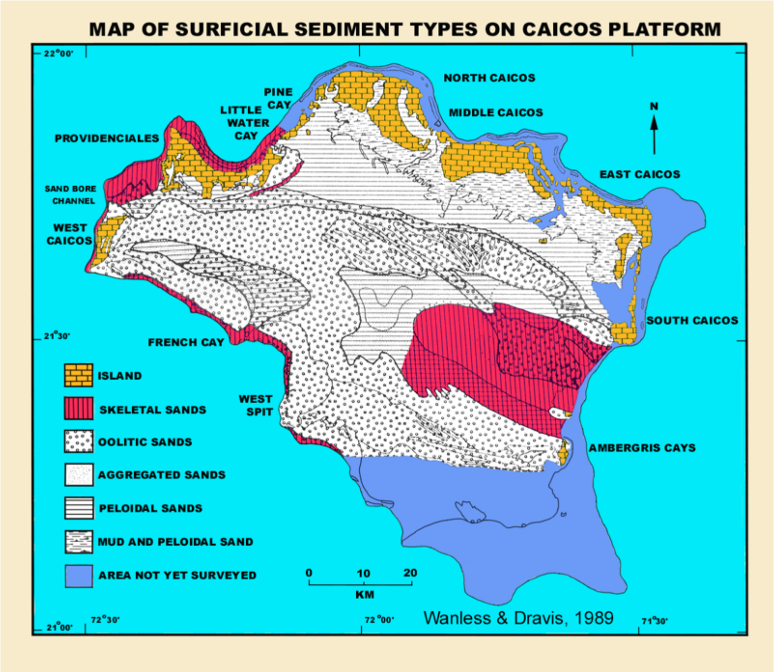

Figure 11. Map of Caicos Platform showing the distribution of Holocene reefs (in red). Not unexpectedly, barrier reefs exist along the northern margin of the platform adjacent to the open Atlantic Ocean. But unexpectedly, reefs also develop as numerous, isolated circular patches over 40 kilometers inboard of the eastern margin (large area of red on platform), and occur as smaller linear reefs along the western (leeward) platform margin as well.

Figure 12. Satellite photograph of several smaller circular isolated patch reefs developed several kilometers inboard from the eastern margin of Caicos Platform. The reef (yellow arrow) in the lower center of this image is Ike Reef, which was decimated by Hurricane Ike in 2008. For scale, Ike Reef is about 100 meters long in a NW-SE direction. Note coalescence of these reefs into much larger scale buildups. Trade winds provide the agitation for these reefs, which are surrounded by 25-30 feet of water. Some reef-derived skeletal sands are oolitically-coated.

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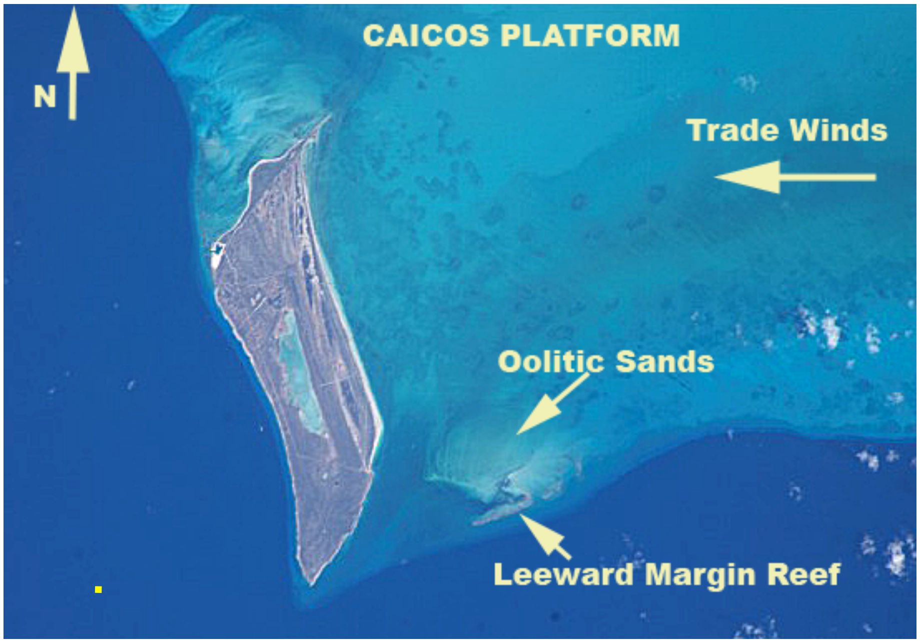

Figure 13. Satellite photograph of the southern part of Caicos Platform showing development of an isolated, leeward platform-margin reef. This reefs exists because the platform margin kinks out and catches the influence of the stronger easterly trade winds. The storm-derived, back-reef skeletal sands are then persistently agitated by the trade winds, converting them to oolitic sands. Here, ooids and reefs exist together. The large island is West Caicos.

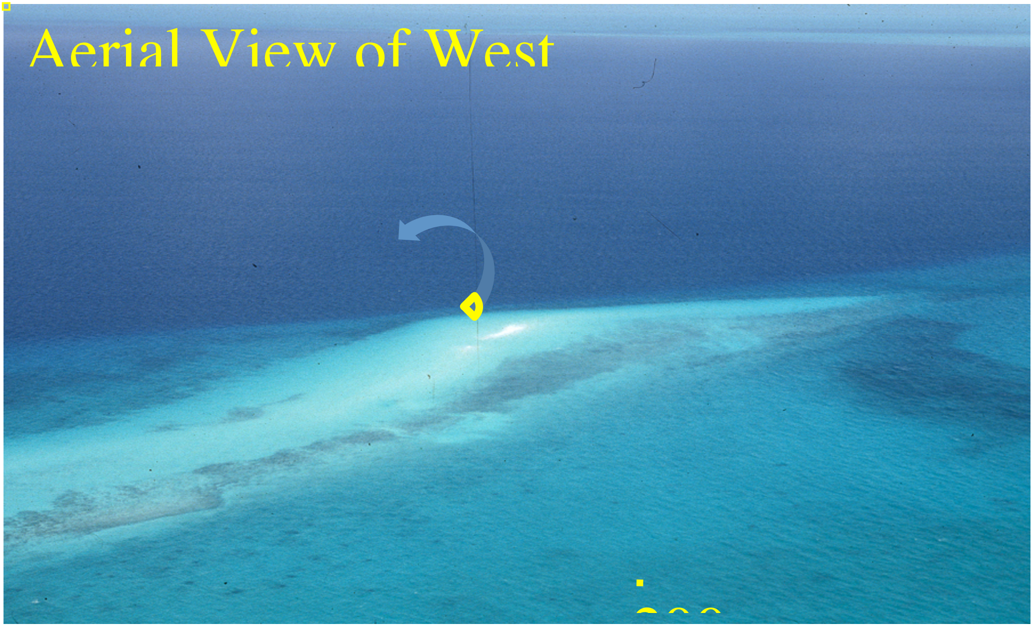

Figure 14. Aerial photograph of West Spit along the western (leeward) margin of Caicos Platform, looking west. These oolitic sands were derived from the major subtidal oolitic sand shoal, Ambergris Shoal, to the east and were gradually moved downwind to the west by stronger easterly trade wind agitation and occasional storms. On very wind days, these sands cascade into the deeper water basin (Harold Wanless, personal communication). In September of 2008, the eye of Hurricane Ike passed over the southern part of Caicos Platform and moved all of these oolitic sands from West Spit into the deeper basin. Six months later, West Spit looked just like it does in this photograph.

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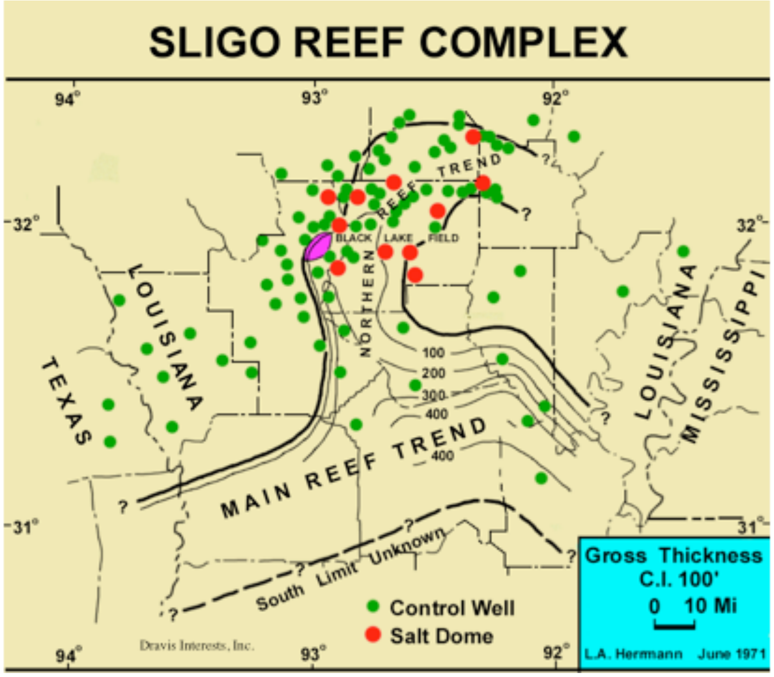

Figure 15. Map of central Louisiana showing location of Black Lake Field about 50 miles inboard from the Sligo platform margin ("Main Reef Trend"). This field developed atop structural topography related to salt movement. The ancestral Gulf of Mexico was off the bottom of this map.

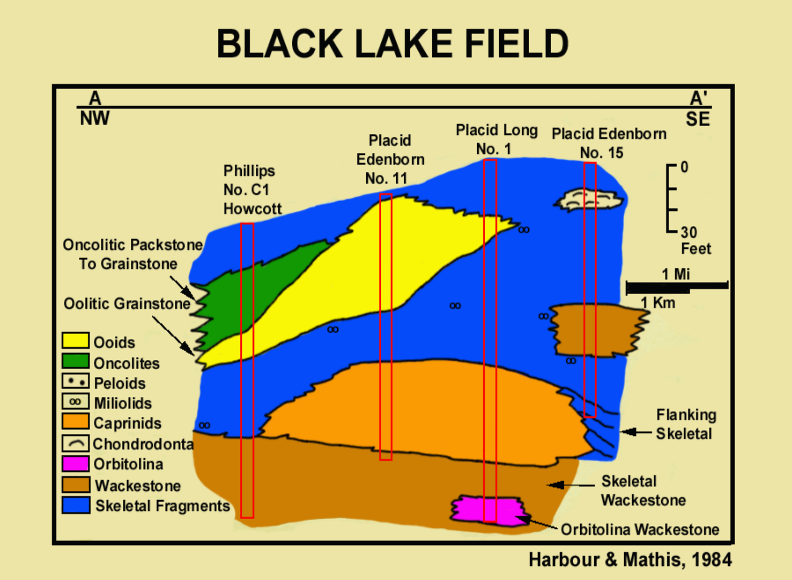

Figure 16. Cross section from Black Lake Field showing the depositional facies associated with this rudist reef complex. The major question is why such a complex would develop this far inboard from the open ancestral Gulf of Mexico (what mechanism would provide for water renewal and agitation, as this setting is too far inboard, based on northern Bahamian models of deposition?). The answer is persistent wind-wave agitation created by stronger easterly paleotrade winds. Paleogeographic models show this is the right setting for such winds; however, the fact that rudist grainstones were converted to oolitic sands at Black Lake, this far inboard, is the geological evidence for these paleotrade wind influences.

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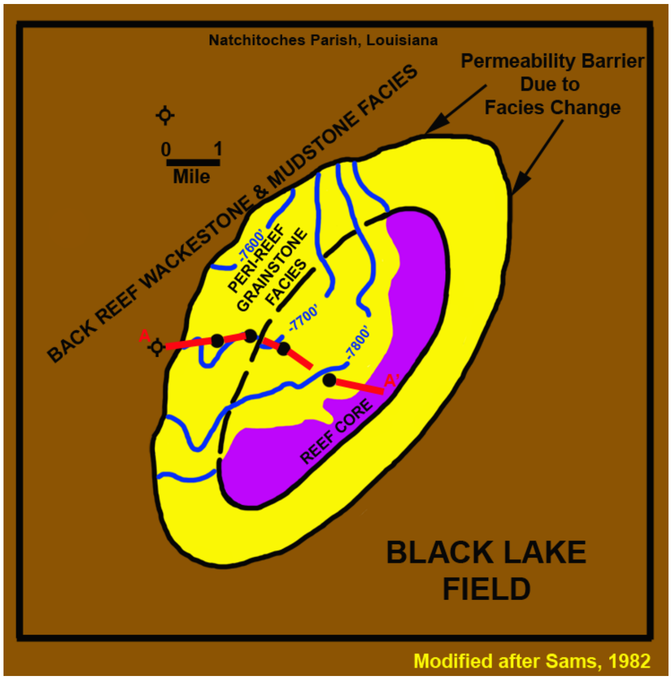
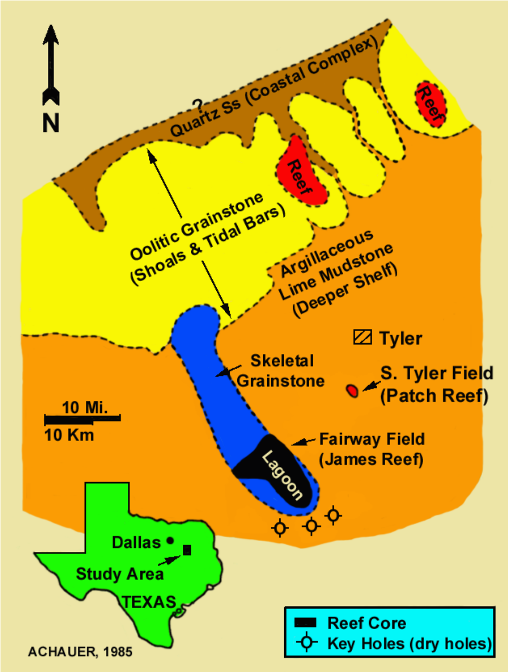


Modified after Sams, 1982

Figure 17. Map of Black Lake Field depositional facies showing development of the rudist reef core along the southeastern side of this complex, with preferential shedding of peri-reef grainstones (recall that some grainstones were converted to oolitic sand) in a northwest direction. This pattern implies that the prevailing paleotrade influence was out of the southeast quadrant, and that the grainstones were moved downwind.



ACHAUER, 1985

Figure 18. Map of Fairway Field, located over 50 miles inboard of the margin of the ancestral Gulf of Mexico. Skeletal sands were shed off of Fairway and extended updip to the northwest, where they intersected with shoreline-parallel oolitic grainstones. Production occurs mainly from these skeletal sands at Fairway, as well as those shed off. This map was published before ooid sand generation related to stronger easterly trade winds had been documented, so all oolitic sands were attributed to tidal current agitation. But such agitation does not occur this far inboard along an open shoreline. Wind-wave agitation related to stronger easterly paleotrade winds is a better explanation.

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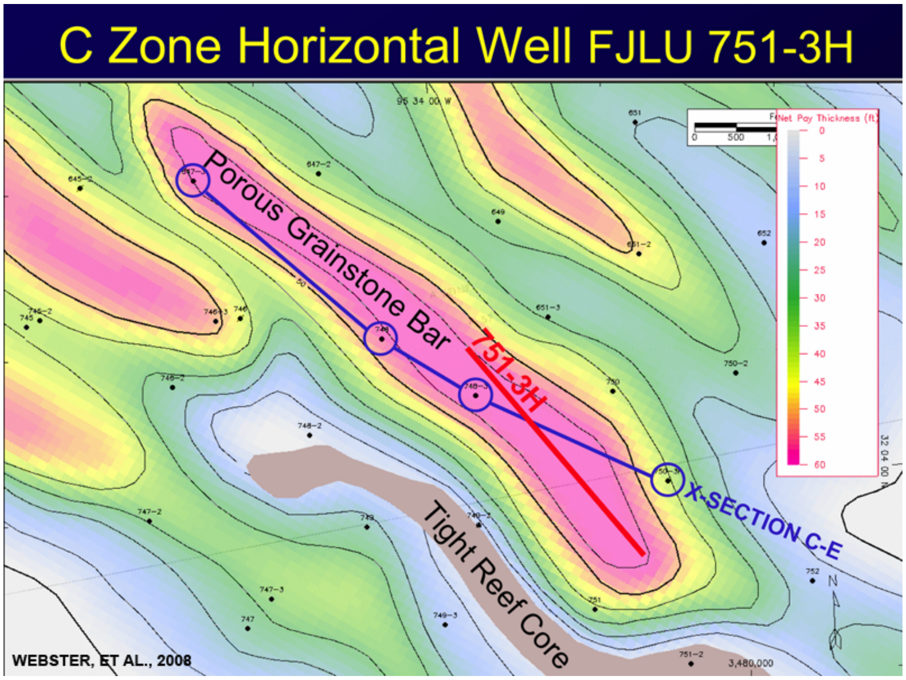

Figure 19. Isopach map for a stratigraphic unit at Fairway Field showing the southeastern-northwestern orientation of porous and productive subtidal skeletal grainstones. This orientation is part of the geological evidence for the influence of stronger easterly paleotrade winds, along with the general shedding of sediment to the northwest, and the presence of shoreline-parallel oolitic grainstones. Collectively, these sand body orientations proved that the prevailing paleotrade winds were from the southeastern quadrant.

Figure 20. Map of Golden Lane Atoll showing the Golden Lane Field (string of small purple-colored fields developed along the western (leeward) margin of this offshore paleohigh. Poza Rica Field is the largest field comprised of allochthonous skeletal (mostly rudist) grainstones shed from the Golden Lane rudist reef complexes.

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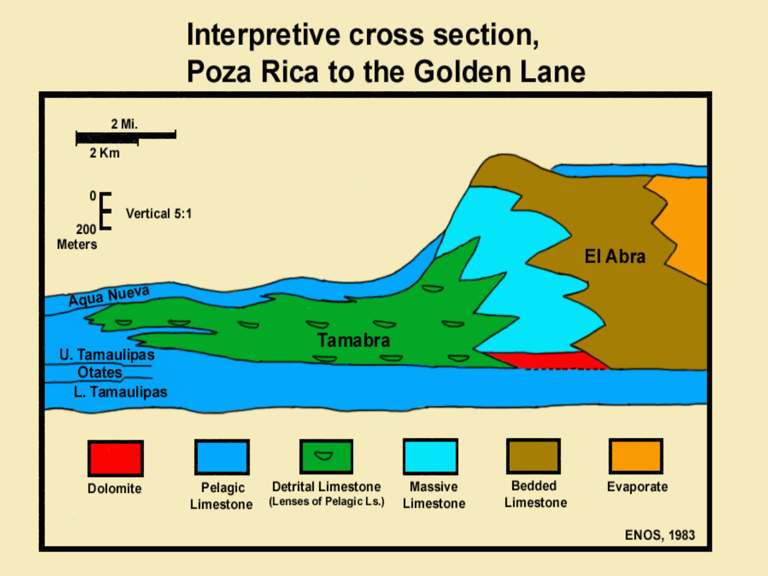

Figure 21. Cross section of depositional lithologies across the western margin of Golden Lane Atoll. The massive El Abra limestones (light blue color) produce from rudist reef complexes, modified by karst processes. The onlapping green-colored Tamabra limestone wedge, over 400 meters thick along the margin of Golden Lane Platform, is comprised of rudist grainstones that are the principal reservoir facies. These grainstones were preferentially shed from this leeward margin into the deeper basin, where they were admixed with basinal pelagic sediments

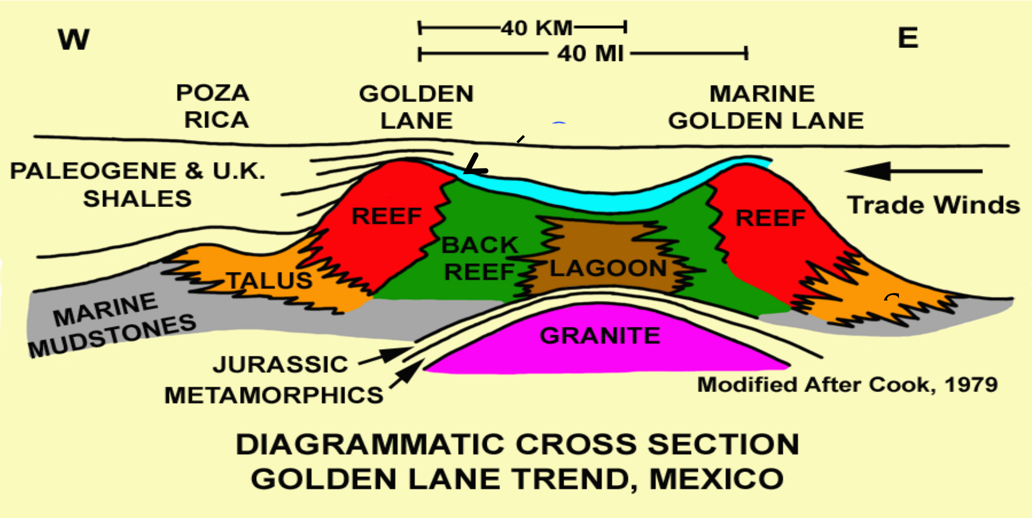

Figure 22. Schematic cartoon showing the generalized facies relationships across the Golden Lane Trend. Production occurs from the rudist reefs complexes along the western edge, in part developed because of agitation provided by the stronger easterly paleotrade winds, and because the deeper lagoon to the east inhibited off-bank transport of sediments. The presence of ooids in the back-reef grainstones (Coogan, et al., 1972) confirms the trade wind influence (again, reefs and ooids coexist). Poza Rica Field is associated with the talus shed off the western margin, again mostly driven by the stronger trade winds moving reef-derived carbonate sand over the leeward margin. Windward-facing reefs, developed along carbonate platform margins that also face the open ocean, do not shed much material into the adjacent basin, as is well documented in other basins (Eberli and Ginsburg, 1987; Wendte, et al., 1990).

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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

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Garcia
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Rincon
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VICTORIA COUNTY
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WHARTON COUNTY
Black Owl

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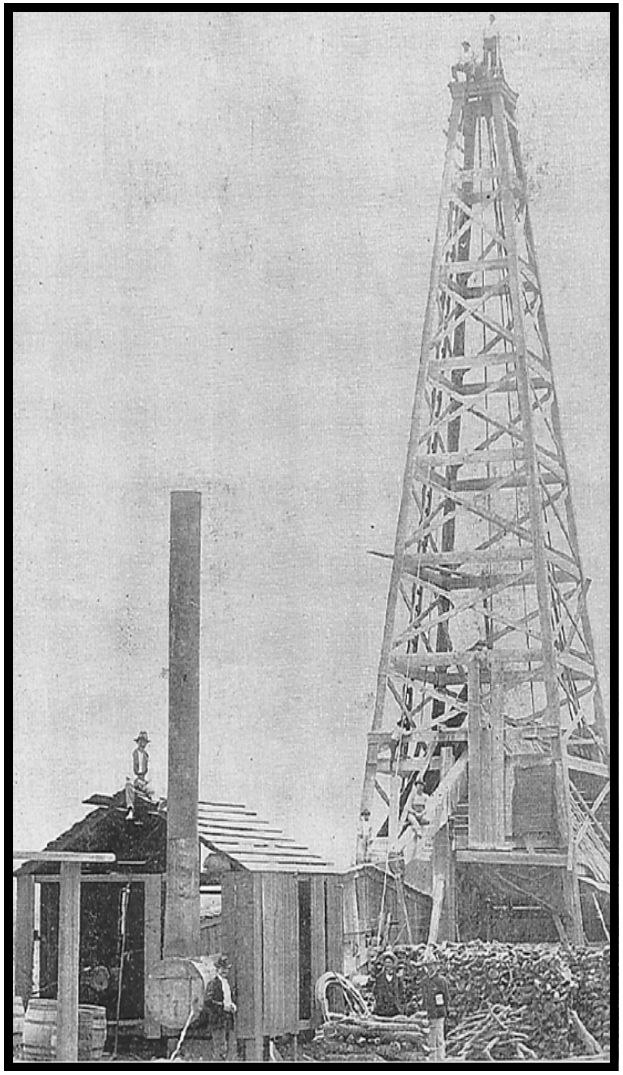

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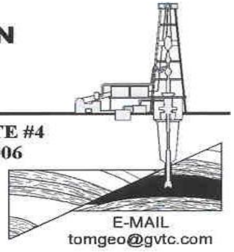

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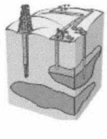

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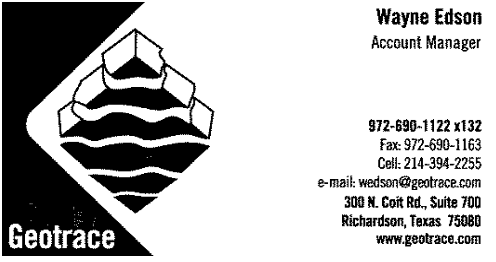
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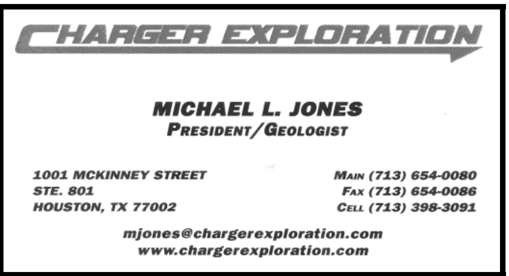
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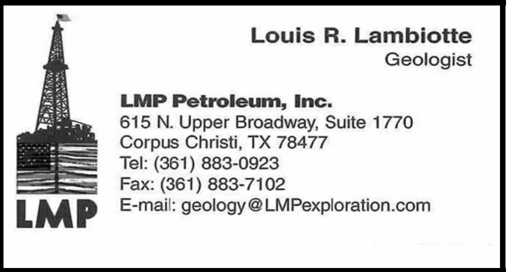
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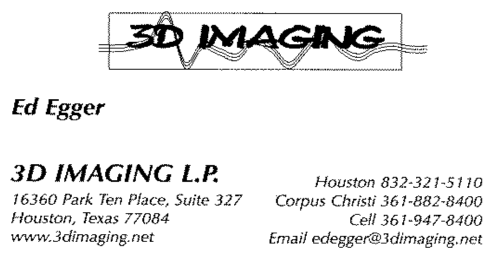
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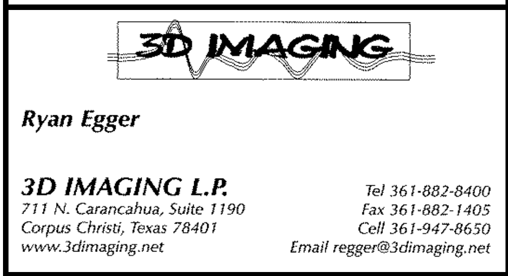
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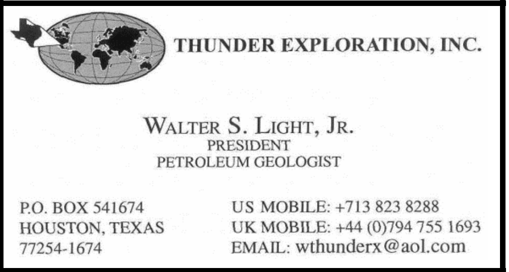
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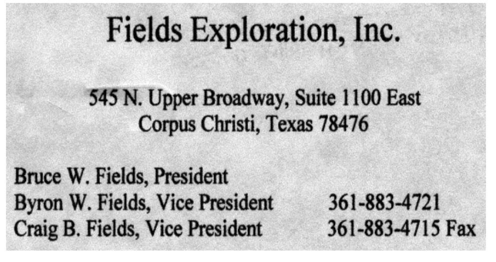
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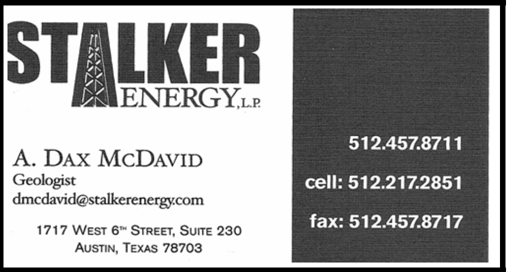
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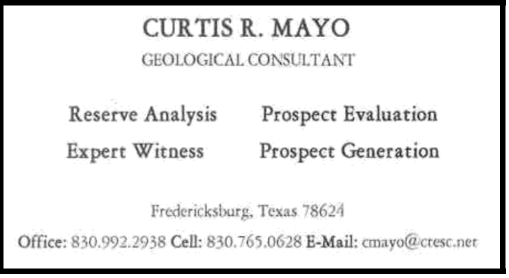
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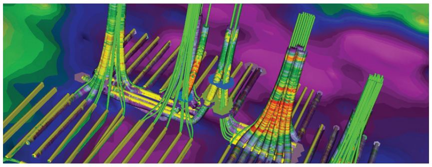
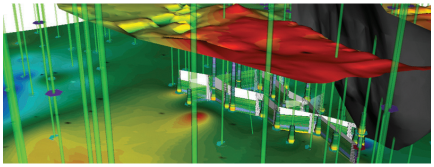


Directional Well Module



3D Visualization Module