

FLY LIKE AN EAGLE FORD

A fresh Cretaceous shale play in South Texas slips into the industry's future.

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The latest shale play to take flight is a streamlined version of the resource plays now familiar to the industry. This newest play is young and chock full of rich gas, and its economics are decidedly positive.

The Eagle Ford shale trends across a great swath of Texas, stretching from Giddings Field in Brazos and Grimes counties down into the Maverick Basin in Maverick County. The Cretaceous Eagle Ford has long been known as a majestic source rock, supplying hydrocarbons to the great Austin Chalk fields and giant East Texas Field. Now it's coming into full plumage as a formidable self-sourced reservoir.

The shale takes its name from Eagle Ford, in Dallas County. From its surface outcrop, it plunges to depths of more than 14,000 feet in South Texas. As its depth varies, so does its hydrocarbon content, ranging from dry gas to oil. These variations, along with internal facies changes, combine to make portions of the Eagle Ford trend particularly attractive to explorers.

Indeed, a couple of areas appear to have all

variables aligned correctly to deliver good resource potential.

"The play exhibits considerable heterogeneity along strike, but specific areas already hold viable, commercial potential," says Robert Clarke, Houston-based lead analyst, Gulf Coast, for international consulting firm Wood Mackenzie.

"This is largely due to a high-Btu production stream and reasonable drilling costs. The Eagle Ford is not likely to grow to be as large as the Woodford or Fayetteville plays, but early analysis suggests it could be very profitable."

Just a handful of wells produce from the Eagle Ford, and these have all been drilled in the past year. Production histories are lacking.

"But results are intriguing, and production from the early wells seems to be holding up quite nicely."

Hatching a play

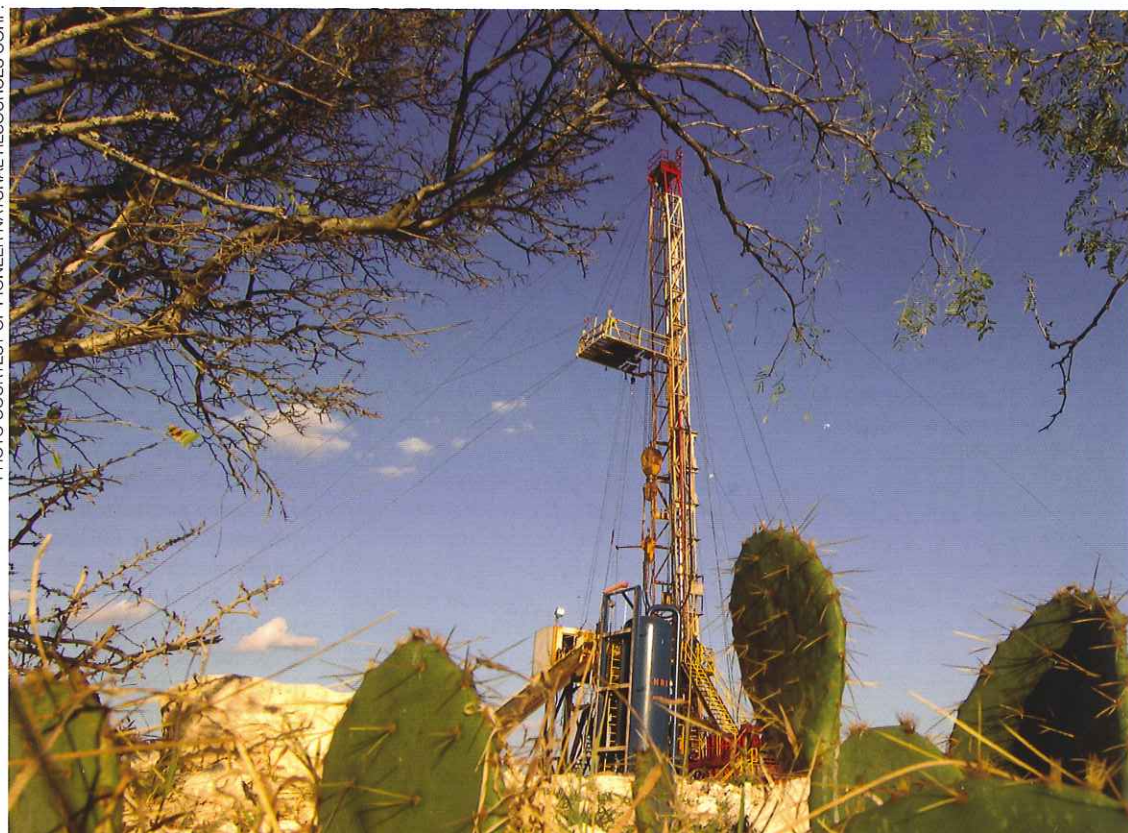
Houston-based Petrohawk Energy Corp. disclosed the Eagle Ford's potential to the public

Several areas in the Eagle Ford shale play already hold viable, commercial potential, says Robert Clarke, Houston-based lead analyst, Gulf Coast, for international consulting firm Wood Mackenzie.



Right, the Cretaceous Eagle Ford shale extends across a broad area, but current activity is focused in South Texas.

PHOTO COURTESY OF PIONEER NATURAL RESOURCES CORP.



"The Eagle Ford fracs like a dream." Dick Stoneburner, Petrohawk Energy

last fall when it announced a hefty discovery in La Salle County. Since that revelation, interest in the shale has soared.

The company teamed with an independent geologist from Corpus Christi to generate the play concept. The initial phase was extensive subsurface analysis of the regional Eagle Ford; that was followed by geochemical and petrologic analyses of well samples in the prospective area.

Petrohawk had no previous position in this quiet corner of South Texas, but it liked the prospect's similarities to the Haynesville shale. The Eagle Ford and Haynesville have comparable thickness, gas-in-place volumes per section, and total organic carbon (TOC) values. In the prospect area, the Eagle Ford was some 250 feet thick and occurred at depths between 11,000 and 12,000 feet.

This piece of the Patch had some shallow production, and deep control was sufficient to narrow focus to a particular locality. Immense ranches dominated the land picture, which made it a prime place to quickly put together a sizeable resource play.

Petrohawk began to acquire leases in early 2008, and rapidly pulled together 160,000 net acres. It drilled its first well in Syndicate Field, in La Salle County, near Fowlerton. Last October, it announced its STS-241-#1H as a discovery flowing 7.6 million cubic feet of gas and 250 barrels of condensate per day from a 3,200-foot lateral fractured in 10 stages.

The company confirmed the play with its Dora Martin #1-H, drilled some 14 miles to the west. This well tested 8.3 million cubic feet per day, with no condensate, from a 4,300-foot lateral fractured in 12 stages.

The Eagle Ford took flight. Petrohawk's third well, Donnell #1H, probed the eastern side

of its acreage in McMullen County; this was 18 miles east along strike from the discovery well. It made 3.6 million cubic feet of gas and 395 barrels of condensate per day. That was followed by the Brown Trust #1H, drilled in the vicinity of the STS-241-#1H, which made 8.1 million cubic feet and 200 barrels of condensate per day.

Petrohawk had discovered a field that stretched more than 30 miles along strike, and each of its tests encountered highly prolific reservoir in the Eagle Ford. The company has dubbed its find Hawkville.

"Our field is geologically bounded," says Dick Stoneburner, executive vice president and chief operating officer. "The Eagle Ford is everywhere, but we're in a little mini-basin of high-porosity/high-resistivity facies. It's clearly a local and very mappable deposit."

An unusual feature, given remarkable homogeneity in the shale reservoir itself, is the rapid change from dry gas to rich gas and condensate across Petrohawk's leasehold.

"The variances in condensate yield and maturity are a result of different thermal maturity across our position," he says.

To the southwest, core from Petrohawk's Dora Martin well recorded thermal maturities of 1.4% Ro. At its STS well in the center of its position, Ro is 1.1%. Vertical depth to the reservoir is the same; company geoscientists surmise that the southwestern portion of its leasehold was once buried more deeply but later uplifted by the Chittim Arch, a Tertiary structural feature that trends into the area from the northwest.

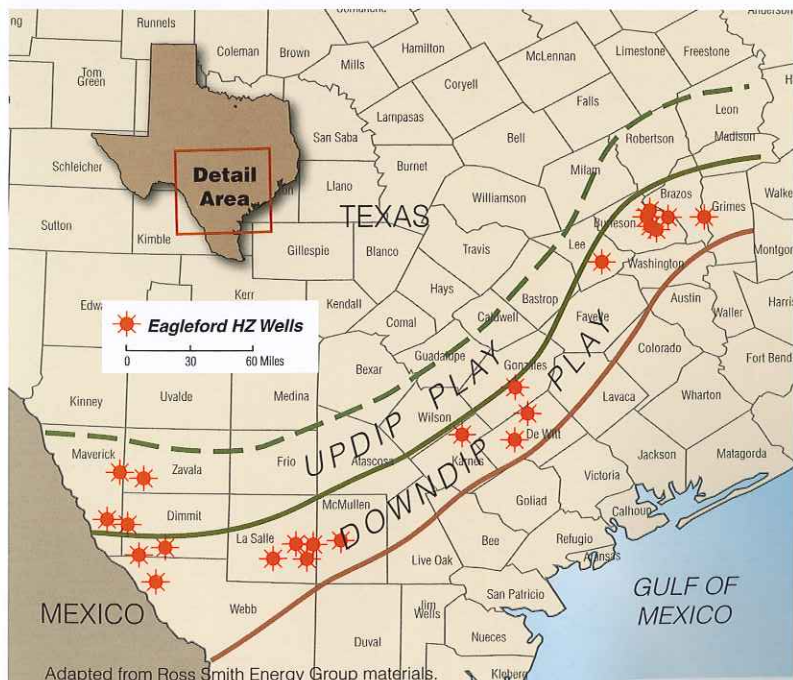
Although the play was predicated on its analogy to the Haynesville, the two shales do exhibit some striking differences. The Eagle Ford, Cretaceous in age, features a pressure gradient of 0.65 psi per foot and contains lots of carbonates; the Jurassic Haynesville has gradients of up to 0.90 psi and minor carbonates.

"The Eagle Ford's carbonate content is 70% in some places, and clay content is very low," says Stoneburner. "It makes completions easier—the Eagle Ford fracs like a dream."

Certainly, the Eagle Ford is far more amenable to drilling and completion work than its pricklier cousin. Unlike the Haynesville, the Eagle Ford does not require large volumes of high-strength proppant. In its Eagle Ford laterals, which are typically 3,500 to 4,000 feet long, Petrohawk runs about 100,000 pounds of 100-mesh and 200,000 pounds of 40/70 proppant in each frac stage. The operator uses mainly white sand, but it does tail in each stage with some premium proppant.

The company believes potential estimated ultimate recoveries of Eagle Ford horizontal wells will likely fall between 4- and 7 billion cubic feet equivalent (Bcfe) apiece. Drilling costs are plummeting: Petrohawk's initial horizontal test cost \$12 million and took more than 75 days to drill, while its latest well was drilled for \$4.5 million in just 22 days. "We have

The Eagle Ford shale trends from the Maverick Basin through South Texas and beyond; it also extends into Louisiana. Two areas of interest have developed: an updip play that is shallower and oil-prone, and a downdip play that is deeper, more highly pressured, and gas- and condensate-prone.



eliminated a host of costs, such as drilling pilot holes and setting intermediate casing," says Stoneburner. "The pressure is not high, and these are not troublesome rocks to drill."

The sharply lower drilling and completion costs have immediate effects on the play's metrics: "We are drilling sub-\$5 million wells for 5 Bcf or more. The economics are off the chart."

Petrohawk's Eagle Ford leases are split by the Frio River. Currently, the company runs one rig on the southwest side of the river and one on the northeast. It is phasing in additional rigs and will raise its count to six. Initially, it planned to spend \$50 million on the play this year; recently it upped that commitment by \$70 million.

Stoneburner says it's likely that other areas in the expansive Eagle Ford trend will be found that hold the same prolific facies identified by Petrohawk. "But so far, I think that we have found the best rock."

Feathering out

Swift Energy Co. is a long-time South Texas operator that has its own noteworthy Eagle Ford potential.

"We see two Eagle Ford play areas: relatively shallow wells in the Maverick Basin, and deeper wells downdip of the Stuart City/Edwards reef trend in South Texas," says Bob Banks, executive vice president and chief operating officer.

Petrohawk is working the downdip trend. Among others, such firms as Anadarko Petroleum, St. Mary Land & Exploration and TXCO Resources are at work in the updip Eagle Ford play, centered in Webb, Dimmit and Maverick counties. This end of the play is shallower, lower pressured, and grades from gas/condensate to oil in the northern portion of Maverick County.

Swift's position sprawls across both the updip and downdip Eagle Ford plays. It has been active in South Texas for decades, and holds more than 140,000 acres of leases and makes approximately 50 million cubic feet equivalent a day from 860 wells. Its undeveloped net position prospective for Eagle Ford comprises 85,000 of those acres, spread through Dimmit, Webb, La Salle and McMullen counties.

At present, Swift is engaged in a horizontal Olmos drilling program at AWP Field in McMullen County, a property it has owned for 20 years. Its first such test was recently gauged at an initial production rate of 10 million cubic feet per day. AWP has produced more than 400 Bcf of gas and 40 million barrels of oil; now it holds Eagle Ford potential as well. The property lies on trend with and adjacent to Petrohawk's Hawkville property.

"We've long been interested in the deeper horizons," says Banks. The company even tested the Eagle Ford back in 1998, in a vertical La Salle County well. It flowed at noncommercial rates. "The completion technology back

then was not sufficient to exploit these types of gas shales," he says.

For the remainder of 2009, Swift plans three new horizontal Olmos wells in AWP Field, along with several horizontal Eagle Ford tests. It sees the Eagle Ford as complementary to its primary Olmos development.

It will concentrate its initial Eagle Ford effort at AWP for a couple of reasons: this slice of the play has a higher pressure regime than some other areas, which could result in better recoveries, and Swift has a gathering system serving 600 wells that can be modified to take Eagle Ford gas. It also has considerable infrastructure—offices, roads, processing facilities, access to export pipeline systems and field operators with decades of experience.

Most importantly, Swift likes where AWP lines up in the downdip part of the Edwards reef trend.

"The two key factors in the economic success of the play will be the capital costs of wells, and the volumes they produce in the first two to three years," says Banks.

Industry estimates for in-place gas in the downdip Eagle Ford shale are 200 Bcf per 640-acre section. If the reservoir allows for 20% recovery, Swift could grow its South Texas asset base by several-fold during the next few years on the wings of the shale.

Going forward, the biggest challenge for the company is the sheer amount of dollars the Eagle Ford will require, in addition to the considerable capital needed for an aggressive Olmos horizontal program.

"There are many hundreds of potential locations to drill on our acreage. Because of that, we're looking to the industry to find a like-minded partner to appraise and develop the Eagle Ford."

Maneuvering room

Houston-based Rosetta Resources Inc. is an up-and-coming firm that sees the Eagle Ford as a potential growth dynamo.

"At the time of Petrohawk's announcement, we were already working the play from a technical perspective," says John Clayton, vice president, asset development. "We were encouraged enough by regional work to have started accumulating positions, and we had roughly 5,000 net acres under lease and brokers in the field."

Rosetta got its start in 2005 when it purchased the domestic assets of Calpine Corp.; for a couple of years afterward, it was caught up in litigation over the transfer of those assets during Calpine's bankruptcy. In 2007, Rosetta named Randy Limbacher as its president and chief executive, and adopted a new strategy. In 2008, it prevailed in court. From a company founded to drill conventional prospects with heavy emphasis on 3-D seismic technology, Rosetta transformed itself into an unconventional-resource player.

The new Rosetta holds more than 100,000



Dick Stoneburner, executive vice president and COO of Petrohawk Energy, top, says the company is working in La Salle and McMullen counties, Texas, in a minibasin of high-porosity/high-resistivity Eagle Ford shale facies. Bob Banks, executive vice president and COO of Swift Energy Co., bottom, says Swift's prospective position for Eagle Ford comprises 85,000 net undeveloped acres spread through Dimmit, Webb, La Salle and McMullen counties, Texas.



Rosetta Resources has drilled two Eagle Ford vertical wells, one in northern Webb County and one in La Salle County, Texas. It plans a horizontal test later this year, says John Clayton, top, vice president, asset development. At least a third of Pioneer Natural Resources' 310,000 acres in its Edwards shelf-margin play are prospective for the Eagle Ford shale, and 30,000-plus acres of that appear to fall in a sweet spot, says Chris Cheatwood, bottom, executive vice president, geoscience.

net acres in South Texas, primarily in the Lobo trend. Geoscientists at the company were mapping regional source rocks for the Wilcox, and that work led them to identify the Eagle Ford as a target.

By mid-2008, Rosetta realized that the potential commercial fairway of the Eagle Ford was most likely northwest of its Wilcox play. It began a leasing program. Today, Rosetta has nearly 30,000 net acres prospective for the Eagle Ford and continues to enhance that position.

"We are fortunate to have been involved in the play early on, and feel we have accumulated a very attractive acreage position, especially for a company our size," says Clayton.

To date, Rosetta has drilled and cored two vertical stratigraphic tests on its 13,000-acre Encinal property. One well is in northern Webb County, on the border of La Salle and Webb counties, and the other is eight miles to the north in La Salle County. That location is 14 miles on strike from Petrohawk's Dora Martin.

Rosetta's wells are set up to go horizontal in the future. Additionally, the company plans its first operated horizontal Eagle Ford test this summer.

"Our goal on these plays is to quantify the resource contained in the rock," says Clayton. "We like what we see in both our wells."

Today's technology is such that horizontal holes can be easily drilled with compatible fluids. The challenges lie in completions, in the unique twists presented by each local area. "There have been too many plays where people have walked away because they thought they had poor resource; what they really had were poor completion techniques."

Going forward, Rosetta has joined a consortium of companies involved in an Eagle Ford core study. "We're not primarily working on the commercial aspects of the play yet; we're working on the resource potential. Once we have that, we'll turn to improving recoveries."

Capture acreage; quantify the resource under it; and prudently try to figure out how to increase recovery of the gas in place. That's the new Rosetta mantra, and that's how it is approaching the Eagle Ford.

"We will take our time to do it right."

Long-range potential

A couple of counties away from Petrohawk's inceptive project, there's another area of high interest. Dallas-based Pioneer Natural Resources is completing the horizontal portion of an Eagle Ford well in DeWitt County, more than 100 miles north and east of Hawkville's discovery well.

Pioneer has been working the Eagle Ford for more than a year. It holds 310,000 acres prospective for the shale, coincident with its Edwards shelf-margin play.

In the mid-1990s, one of Pioneer's predecessor companies acquired operations at Pawnee Field, in Live Oak and Bee counties. That accumulation is in the Edwards limestone, directly

below the Eagle Ford shale. Thanks to an 80-well horizontal drilling campaign, Pioneer rapidly grew production from the field.

The company also expanded the Edwards play along strike. "We saw the Edwards as a very long stratigraphic trap," says Chris Cheatwood, executive vice president, geoscience. The operator bought leases and drilled another 75 horizontal wells on a 150-mile-long ribbon that traced the Edwards carbonate ramp.

Layering its well control with extensive 3-D seismic, Pioneer built a detailed picture of the Edwards reef trend. As a byproduct, it grew its knowledge on the Eagle Ford. "Frequently we had to flare gas when we drilled through the Eagle Ford," says Cheatwood.

A few years ago, the company began to model the shale and collect Eagle Ford rock data in its Edwards wells. In 2008, it spudded its first well, Friedrichs #1, specifically targeting Eagle Ford.

"We were really excited about the Eagle Ford," says Cheatwood.

"We were already drilling our well when Petrohawk's announcement hit the press." Pioneer encountered more than 250 feet of Eagle Ford at 14,000 feet, cored 180 feet and drilled a 3,000-foot lateral that was completed in early June at an initial rate of 3.7 million cubic feet of gas per day. The well encountered mechanical problems and was only partially completed in five zones, out of a planned eight-stage frac.

"The completion was cut short because we were only able to get a small portion of the lateral's toe in the more brittle shale," says Cheatwood. "We estimate that probably only two stages are actually giving us gas production." In the third quarter, Pioneer plans to follow the Friedrichs #1 with another well, located 40 miles to the southwest.

At least a third of Pioneer's leasehold has Eagle Ford potential, and more than 30,000 acres of that appears to fall in a sweet spot, says Cheatwood. Most of its acreage is held-by-production or carries lease-renewal options. As a bonus, the company's Edwards infrastructure includes a processing plant and gas pipeline, so it will have a leg up in handling Eagle Ford gas.

In DeWitt County, the Eagle Ford interval occurs some 2,000 feet deeper than in La Salle County, and it's hotter. "Those factors aside, there are a lot of similarities between our area and Petrohawk's area," he says.

Short-term, the company will drill the wells necessary to protect acreage and continue up its learning curve. "We are hunkered down to get through this downturn, so our approach is cautious." That said, Pioneer anticipates a great future for the play. "Rock parameters in the Eagle Ford compare very favorably to other commercial shales, and we have an extensive position. This could be a significant play for us."

Serendipity is a beautiful thing indeed. And the fledgling Eagle Ford is off to a soaring start. □