

The Playbook

Haynesville Shale



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Haynesville Shale: *The Playbook*

From the editors of *Oil and Gas Investor*, *E&P*, and *Pipeline and Gas Technology*

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Haynesville Shale Continues To Impress E&Ps

East Texas and North Louisiana have served another tantalizing reservoir – the superb Haynesville shale.

Haynesville Recovery Techniques

Development in any play tends to follow the most efficient and most governmentally acceptable plan over time. In the Haynesville shale, Chesapeake seems to provide that leadership.

Haynesville Financial Aspects

Financial rewards from a Haynesville investment vary according to a number of variable factors, including early-entry versus late-entry land costs, efficiency of operations, economies of scale, and position on the learning curve for drilling and completion.

Companies Operating in the Haynesville Shale

All key players profiled with contact information.

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Why the Haynesville Is Really That Good.

Speakers:

Peggy Williams, Senior Exploration Editor, *Oil and Gas Investor*

Robert C. Turnham, President and COO of Goodrich Petroleum Corp.

Ken L. Kenworthy, Co-founder and President, GMX Resources

Gary Kolstad, President and CEO, Carbo Ceramics

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Haynesville 101

The Haynesville shale play has erupted as the hot new US gas target.

By Nissa Darbonne
Executive Editor
Oil and Gas Investor

Investors and E&P executives poured into the US \$1 billion-market-cap, Houston-based Goodrich Petroleum Corp. presentation at IPAA's 2008 Oil & Gas Investment Symposium in New York to hear about its Haynesville shale potential in Northwestern Louisiana.

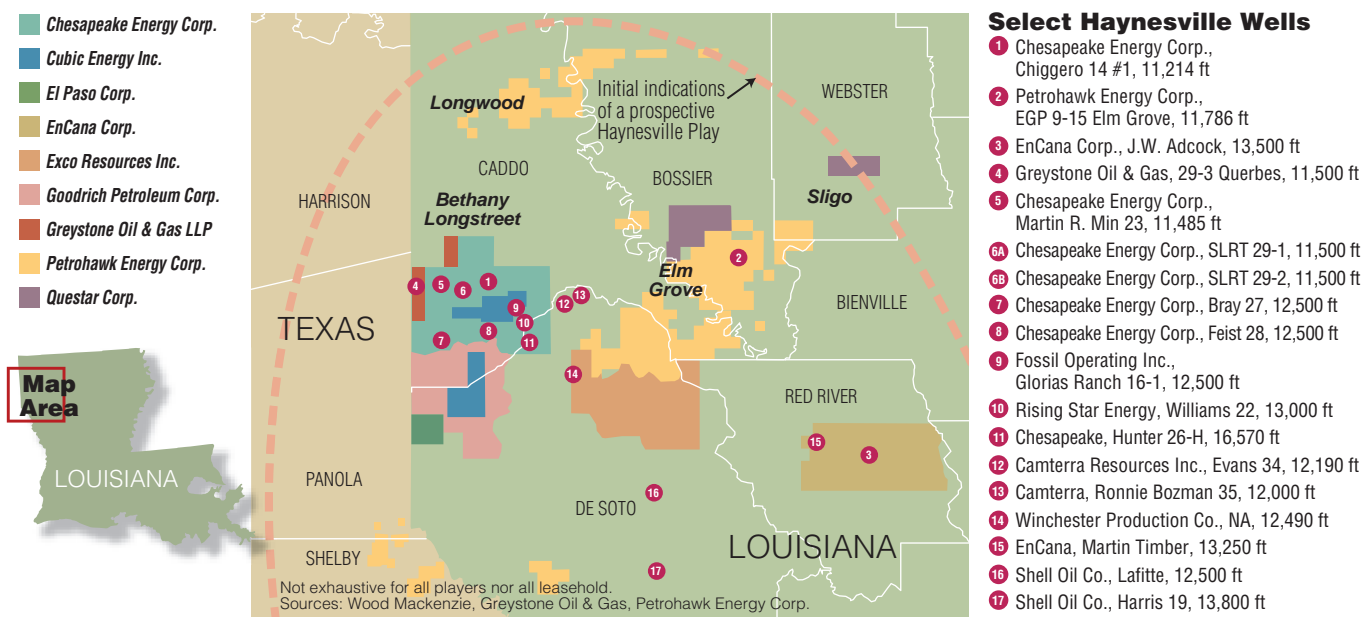
"Clearly the Haynesville is a meaningful piece of business, if it pans out like some of us think it is doing," Rob Turnham, president and chief operating officer, said. The Goodrich break-out room for more discussion attracted more than two dozen investors and analysts. An investor-relations manager for a competing producer attended the presentation. He quipped, "No, you're mistaken. That wasn't me."

The scene was repeated in the Petrohawk Energy Corp., Questar Corp., and other Haynesville-prospective presenters' break-out rooms in New York and the same week at Howard Weil's annual energy conference in New Orleans.

Haynesville acreage-holders' responses to media and investor questions have ranged from not wanting to talk about it to issuing press releases and holding analyst meetings. Dave Pursell, analyst with Tudor, Pickering, Holt & Co. Securities Inc., has written "Bat Out of Haynesville" to the tune of Meat Loaf's "Bat Out of Hell." Pursell opens it: "The landmen are screaming and the clerks are howling, way down in the (Shreveport, Louisiana) courthouse tonight."

Chuck Stanley, president and chief executive of Salt Lake City-based Questar Market Resources, which operates the E&P business of Questar Corp., said simply in New York, "Yes, the Haynesville is present under (some of) our acreage, and we do own it."

He said in a break-out room later, "We're going to watch the Haynesville for a while. It's early. We want to see more data. It's still new." There is a ver-



tical test well to Haynesville in the middle of Woodardville Field, in which Questar operates, but he wouldn't talk about the results.

"We do have the log," he grinned. Besides in Elm Grove Field, the company also has interests to the south, in Thorn Lake Field. "Yes, the Haynesville is under Thorn Lake too," he said.

He added, "Many of our leases are still in the primary term." The company is now doing a lease-by-lease analysis. "We're scrubbing individual lease files now." Questar holds at least 10,000 acres prospective for Haynesville.

Before the Haynesville news erupted, Questar Exploration & Production Co. bought a 97%-plus average working interest in 22,000 net acres in Red River and Bienville parishes in Northwestern Louisiana, sitting on top of the Haynesville, for some \$655 million, the largest portion of it from Will-Drill Resources Inc. Total reserves from the purchase are some 600 Bcfe.

Stanley said in New York, "A deal's a deal. Timing's everything ... We knew about the Haynesville because there's been a lot of noise. Shreveport's a fairly small town." But Questar bought the package primarily for Cotton Valley and Hosston potential, he added.

The operator with the largest Haynesville leasehold is Chesapeake Energy Corp., and controversy surrounds its claim that the Haynesville play could be the next Barnett. Chairman and Chief Executive Aubrey McClendon said, "The Barnett remains No. 1 in Chesapeake's portfolio, but the Haynesville shale could be even bigger some day." McClendon also discussed the play in New York and New Orleans.

Larry Nichols, chairman and chief executive of Devon Energy Corp., said a week earlier at the Developing Unconventional Gas conference, sponsored by *Oil and Gas Investor* and *E&P* in Fort Worth, "You don't drill a couple of wells and say anything is the next Barnett shale."

McClendon said the Haynesville may be bigger than the Barnett — at least for Oklahoma City-based Chesapeake. The company is No. 2 to Devon in the Barnett, and No. 2 to Southwestern Energy Co. in the Fayetteville shale.

"Chesapeake has a big head start in the Haynes-

ville shale," McClendon said. Based on two years of study and three horizontal and four vertical wells, Chesapeake believes the Haynesville may have a

Unconventional Uncertainty

Not much is known so far about economic performance of vertical Haynesville shale wells; even less is known about horizontal ones. "We don't have any confirmed initial production rates; we don't have any decline curves," said Robert Clarke, Houston-based lead analyst, Gulf Coast upstream, for energy consulting firm Wood Mackenzie.

"But if we put hypothetical Haynesville horizontal wells on typical shale-gas decline curves, with costs extrapolated from vertical Haynesville wells and horizontal Cotton Valley wells drilled in the area, and put them under Louisiana fiscal terms, they would need to come online at close to 7 million cf/d to be economically comparable to Barnett shale wells."

That's going to be a stretch, since currently no shale play in the US features wells that average initial potentials (IPs) of even 4 million a day. If Haynesville wells can really average almost twice that much gas, the shale will be the most prolific such play in the nation.

Notably, a Haynesville well needs to recover a good bit more gas than a Barnett or Fayetteville well to be economic, due to higher drilling costs.

That said, Chesapeake Energy Corp. has been unusually bullish

on the Haynesville. "As quietly as it could, Chesapeake assembled 200,000 net acres in the Haynesville, as compared with the 260,000 net acres it holds in the Barnett," said Hill Vaden, analyst, Gulf Coast upstream. "That's a huge statement."

What could transpire is that the Haynesville will demonstrate a decline profile not yet seen in the Barnett, Fayetteville, or Woodford plays. Perhaps initial production (IP) of 3 million a day will work, if rates just gently slide down from there.

"We don't have evidence yet to make a call on economics," said Clarke. "The Haynesville could have production requirements that differ from existing plays. But, ultimately, the reserve requirement will be large."

In WoodMac's view, shale gas is a paradigm shift, and the Haynesville is just one in a whole series of new shale-gas targets companies are unearthing. "These rocks have good original gas-in-place, and it's absolutely no surprise that companies are going to try to get that gas out."

It all comes back to the basic question: How quickly can Haynesville reserves be produced, and what will cash flow look like?

— Peggy Williams

Exposure to the Haynesville*

	Fields	Net Acres (M)	Value (\$MM)	Value/Share	% of Share Price
Goodrich Petroleum	Bethany-Longstreet	20	200	\$8.00	30.9%
Petrohawk Energy	Elm Grove	30	300	\$1.56	8.5%
Chesapeake Energy	Various	50-100	750	\$1.58	3.4%

* At an estimated \$10,000/acre. Acreage is as of early March 2008. Source: Brian Kuzma/JP Morgan

larger impact on the company than any other play in which it has participated to date. Chesapeake has four rigs running in the Haynesville and plans to increase this to approximately 10 by year-end and potentially more in 2009.

It owns or has commitments for more than 200,000 net acres of leases in the Haynesville and has a leasing effort under way with a goal of owning up to 500,000 net acres. The shale is young — some 150 million years old, compared with the more than 325-million-year-old Barnett, Fayetteville, Woodford, and Marcellus.

Chesapeake began drilling the Haynesville in third-quarter 2006 and evaluated cores in early 2007. The results of drilling are confidential but “very encouraging,” he said. He estimates Chesapeake’s 200,000 net acres may have ultimate reserve recovery of 7.5 trillion cubic feet equivalent (Tcfe) net. A 500,000-net-acre position may hold 20 Tcfe net.

Meanwhile, he said Chesapeake’s 250,000 net acres in the Barnett play host at least 8 Tcfe of net ultimate-recovery potential.

If 250,000 net Barnett acres may hold 8 Tcfe, and 500,000 net Haynesville acres may hold 20 Tcfe, McClendon’s numbers suggest the Haynesville’s ultimate-recovery potential is greater than that of the Barnett.

Another leading Haynesville acreage-holder, Houston-based Petrohawk Energy Corp. Chairman, Chief Executive, and President Floyd Wilson said, “All in, we’re in the play for \$2,000 an acre.” Now, lease costs have grown.

“Everybody we talk to now has an advisor and an attorney. (The lease cost is) not going back down.” Some 700 to 800 brokers are working in the play now. “We’re tripping over each other.” Some landowners are getting \$1 million bonuses for a few hundred acres.

The Haynesville is at 11,000 ft to 13,000 ft in

Petrohawk’s leasehold and a bit deeper to the south. He estimated total reserves of 150 Bcfe to 200 Bcfe per sq mile and a 20% recovery rate. “It could be a 5 Bcfe play for \$5 million. We hope to turn it into a typical statistical model ... a whole bunch of average wells.”

Even at higher lease costs, “it’s dimes on finding costs; it’s not dollars.” And, Wilson said, “We’re in an area where you just don’t drill dry holes.”

Approximately half of Petrohawk’s Haynesville-prospective acreage is held by production, and the rest can be held with one well per section, he said. The company is ramping up to at least five rigs in the play by year-end. “(Our) Elm Grove Field is right in the middle of the play. It’s an early-stage play but it has most of the parameters we look for in this kind of play.”

The company’s net Haynesville leasehold is now more than 100,000 acres and estimated resource potential is several Tcfe. Well costs are estimated at \$6 million to \$8 million each. Estimated ultimate recovery is 4 Bcfe per well, Petrohawk estimates for planning purposes.

The shale sits between the Bossier and Smackover at 10,500 ft to 13,000 ft in Elm Grove Field, is over-pressured and often more than 200 ft thick. A private operator says there is an Upper Haynesville but the leading target is Lower Haynesville, which has higher porosity, more net feet of pay and more gas content.

Dick Stoneburner, Petrohawk chief operating officer, said, “We don’t know how far south it extends (economically). We think we’ve seen the geologic limits to the north, east, and west.” Petrohawk has data on more than 30 Haynesville penetrations and logs. Wilson said, “We’re well-positioned to be a major player in this.”

Petrohawk would like to hold 250,000 net acres. Its \$800 million, 2008 capex budget includes \$450 million for wells in North Louisiana, excluding lease-acquisition costs. “The Haynesville shale

prospective area is more than 3,000 sq miles,” Wilson believes.

Brian Kuzma, E&P analyst for JPMorgan Securities Inc., said 5 Bcfe wells suggest Haynesville leasehold is worth \$40,000-plus per acre. “These wells only cost \$5 million to \$6 million each, which would mean that these reserves would be worth some \$1.25 per thousand cubic feet in the ground, using \$7.50 gas prices. Given a 5 Bcf well — 4 Bcf after royalties — on 120 acres, this equates to \$42,000 an acre in value.”

Goodrich’s Turnham said in New York that, if applying the metrics other producers such as Petrohawk and Chesapeake are using for the Haynesville play’s potential, Goodrich’s 28,000 net acres may

contain between 900 Bcfe and more than 1 Tcfe. The impact to Goodrich? The entire company’s proved, probable, and possible reserves total just under twice that (1.7 Tcfe), without figuring in the Haynesville potential.

Still, “we feel it is an emerging play. It’s still a bit early,” he warned. Goodrich’s Haynesville potential is in its acreage in the Bethany-Longstreet Field, primarily, and may also be producible in its Longwood Field holdings to the north. The former “is obviously the hot spot for the Haynesville discussion.”

It drilled a sample vertical well into the Haynesville and “we certainly saw what we hoped to see.” It showed 10% to 15% porosity and other economic

The Players

Here are more facts on the Haynesville shale.

Who revealed the play first? One source says, “The industry has been aware of the Haynesville, and just waiting for someone else to spend the money to test it.” In terms of going public about the play, Cabot Oil & Gas Corp. made a small reference to it in a Feb. 13, 2008, press release.

Petrohawk Energy Corp. met with analysts in early March 2008 and discussed the play. It didn’t put out a press release, but there were analyst reports. The shale was out of the bag when Chesapeake Energy Corp. issued a press release on its test results on March 24. But, micro-cap Cubic Energy Inc. appears to have publicized the play first, issuing a press release in November 2007 on a well targeting the Haynesville, and it revealed more definitive results in January.

What is believed to be the center of the play, and what are the play’s boundaries? The sweet spot of the play is initially believed to be just south of Shreveport in and around Elm Grove Field. Its northern boundary is believed to

be in the area of Longwood Field. Its eastern, western, and southern boundaries are not fully tested; however, the play is believed to extend slightly into East Texas and to begin just south of Sligo Field in Louisiana.

What are some of the publicly held players? Chesapeake Energy Corp. (NYSE: CHK), Petrohawk Energy Corp. (NYSE: HK), Goodrich Petroleum Corp. (NYSE: GDP), Exco Resources Inc. (NYSE: XCO), EnCana Corp. (NYSE: ECA), Questar Corp. (NYSE: STR), El Paso Corp. (NYSE: EP), Forest Oil Corp. (NYSE: FST), Cabot Oil & Gas Corp. (NYSE: COG), The Meridian Resource Corp. (NYSE: TMR) and Cubic Energy Inc. (OTCBB: QBIK). A private producer, Greystone Oil & Gas LLP, Houston, has some 6,000 Haynesville-prospective net acres in Caddo Parish.

What does the acreage cost? Acreage costs have risen from US \$500 to \$5,000 in a matter of weeks.

What have been some of the well results? In southwestern Caddo Parish, a Chesapeake well, Chiggero 14 #1, found 195 net ft of Haynesville pay. Petrohawk’s

EGP 9-15 in Elm Grove Field in southeastern Caddo Parish found 220 net ft. Southeast of that, in Red River Parish, EnCana’s J.W. Adcock found 148 net ft.

Goodrich Petroleum reports its vertical test, GDP 1-J Cook, found 220 net ft of shale, Chesapeake’s 1-29 found 200, and the private Fossil 16-1 found 210 net ft.

Dallas-based Cubic Energy reports its Hudson 10 #1, drilled to total depth of 11,650 ft, found 1,100 ft of shale in Johnson Branch in Caddo Parish. The company also has interests in Bethany-Longstreet.

Can Haynesville shale production be commingled with Cotton Valley and Hosston production? The Haynesville is higher-pressured and will need its own horizontal wells, although the state permits comingling production from vertical Cotton Valley and Hosston wells.

What are the lease terms in North-western Louisiana? There is a vintaging of leases in the area, based on a clause in which, in the three-year primary term, an operator has to drill to the deepest formation it plans to drill. Other leases are ordinary.

features. The James Cook No. 1 was drilled and completed vertically through the Haynesville for approximately \$2.5 million. “It’s still early, again, but we’re excited about it.”

Goodrich’s acreage in the Haynesville is adjacent to a portion of Chesapeake’s 250,000 net acres, noted David Heikkinen and Stacy Nieuwoudt, analysts with Tudor, Pickering, Holt. “Given current well costs of \$6 million to \$7 million, we believe Goodrich will wait for the play to come to them. Don’t be surprised if Goodrich enters a joint venture on a portion of its acreage with a more experienced operator in the play.”

They expect Goodrich will recover 4 Bcfe per well. They are risking drilling results at a 33% success rate. “It’s still super-early in the play – Chesapeake has seven wells to date – but we’re peering over the leasehold for any chatter on Chesapeake or Petrohawk wells.”

Meanwhile, Denver-based Forest Oil Corp. has dropped the Haynesville bomb, announcing a deal for Northwestern Louisiana properties prospective for shale production. Its \$285 million pending purchase from a private seller targets Cotton Valley.

“Additionally, we may have opportunities in the Bossier/Haynesville shale ...” said Forest President and Chief Executive Craig Clark.

Forest had little activity in the Ark-La-Tex area two years ago, “but it has been the fastest-growing area within the company recently.”

The potential on the stock-price meter pops. Carin Kehne Kiley, E&P analyst for Calyon Securities (USA) Inc., raised her 2008 estimates for Chesapeake’s earnings per share to \$3.50 from \$3.40, and cash flow per share to \$9.05 from \$8.85, based on its new Haynesville potential. For 2009, she forecasts \$3.40 and \$10.30, respectively, each up 5% to 10% from her previous forecasts.

Other analysts suggest the needle-moving potential for smaller-cap players is larger.

The hot word at investment conferences in 2007 was “MLP,” an upstream business model focused on harvesting reserves, rather than exploring for them. Today, it’s “Haynesville,” a new US gas-exploration play. ■

Adapted from “Haynesville 101,” Oil and Gas Investor, May 2008

Caddo Parish, La., one of the hottest areas in the Haynesville shale play, hosts this NOMAC rig for Chesapeake Energy.

Photo courtesy of Chesapeake Energy Corp.



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Northwestern Louisiana is tall-tree country. Southern yellow pines surround a Haynesville superpad location in Caddo Parish.

*Photos
by Lowell
Georgia*



The Harty Haynesville

East Texas and North Louisiana have served another tantalizing reservoir – the superb Haynesville shale.

By Peggy Williams
Senior Exploration Editor
Oil and Gas Investor

Gone are the days of expansion and buoyant expectations. The industry has turned on a dime and, in the midst of world tumult and economic crises, companies are sorting through their prospects. In 2009’s dour reality, one play that remains at the head of most lists is the Haynesville shale.

The Jurassic Haynesville is prodigious and truly remarkable. It has every characteristic desirable in a shale reservoir: rich total organic carbon (TOC) content, excellent thickness, strong geopressures, wide areal extent, tough bottom seal, and incredible homogeneity.

As rigs idle across the country, the Haynesville will be a bright spot of investment. Operators fortunate enough to hold swaths of Haynesville acreage are reallocating their capital to concentrate on development of this uncommon shale.

It’s that good.

Shale pioneer

The company that ushered the Haynesville onto the industry stage was Chesapeake Energy Corp. The Oklahoma City-based firm unveiled its Haynesville program with typical panache last spring. It made some bold statements about the potential of the shale, and sent people throughout the country scrambling for maps to figure out what exactly it was talking about.

Of course, Chesapeake was not the first to see the possibilities in the unique shale reservoir, but it was certainly the first to bring widespread attention to it.

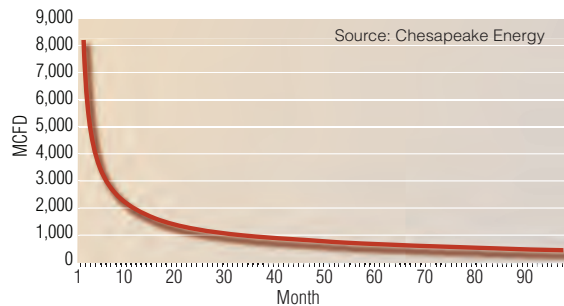
At present, Chesapeake has 14 rigs working in the play, spread through Louisiana’s Caddo, DeSoto, and Sabine parishes. Mid-summer 2008, it entered a joint venture with Plains Exploration & Production Co. Chesapeake assigned Plains 20% of 550,000

net acres for US \$1.65 billion in cash and \$1.65 billion in carried working interests. Going forward, Plains pays 50% of Chesapeake’s 80% working-interest costs until the carry is spent.

The company currently holds nearly 500,000 net acres in the play, exclusive of Plains, and produces 65 million gross cf/d of gas from 16 horizontal wells.

For Chesapeake, the Haynesville proffers unbelievable potential. Its massive acreage position could allow it to develop 14 Tcf in recoverable reserves, based on a 50% risk factor on 29 Tcf of unrisksed reserve potential.

Haynesville Shale Decline Curve



At the close of 2009, the company plans to have 35 rigs at work in the Haynesville, an average of 25 to 26 rigs across the year. Conceivably, Chesapeake could be producing more than 600 million cf/d net from Haynesville wells by the end of 2010.

“What makes the Haynesville so robust is the over-pressured nature of the reservoir,” said John Sharp, Chesapeake geoscience manager, Louisiana district. Throughout the Haynesville, reservoir pressures range from 9,000 to 12,000 psi, and most of Chesapeake’s wells run around 9,800 psi. Pressure gradients of 0.85 to 0.9 psi per ft allow Haynesville wells to produce at far higher rates than wells in such shales as the Barnett or Fayetteville, where pressure gradients run in the range of 0.42 to 0.5 psi per ft.

Early Haynesville horizontals were excellent wells, and today’s completions are even better. Chesapeake’s last four wells have posted production rates in excess of 10 million a day. Estimates of ultimate per-well recoveries have climbed from 4.5 Bcf recoverable to 6.5 Bcf, and some wells are now close to 8.5 Bcf apiece.

And, the play is epic: It spans an area 100 by 100 miles, from Harrison County, Texas, to Bienville Parish, La.

Clearly, the Haynesville has the flow rates, reserves, and repeatability to deliver solid returns even at low-end gas prices. At Nymex prices of \$5 per thousand cubic feet and assumed capex of \$7 million per well, the Haynesville can deliver a 20% rate of return. Indeed, according to Chesapeake’s calculations, prices have to be below \$3.88 per thousand before returns on a 6.5 Bcfe well, even given an 80% first-year decline, drop below 10%.

Haynesville Shale Characteristics
True vertical depth: 10,000 to 13,000 ft
Measured depth: 14,000 to 17,000 ft
Net thickness: 200 to 300 ft
Total organic content: 4%
Thermal maturity (vitrinite reflectance): 2.2% to 3% Ro
Average log porosity: 10%
Pressure: 0.9 psi/ft
Water saturation: 15% to 20%
Gas-in-place: 150 to 225 Bcfe per section
Anticipated recovery factor: 25% to 30%
Average EUR per horizontal well: 4.5 to 8.5 Bcfe
Source: Chesapeake Energy

“The economics are obviously very attractive,” Sharp said.

Chesapeake has drilled and completed more horizontal wells than any other operator in this new play. It has already improved its costs and sees potential for more efficiencies.

“With the use of oil-based mud and by paying close attention to geosteering operations, we are drilling our laterals in fewer days and with fewer problems than before,” said Sharp. In less than a year, average drilling times for horizontal Haynesville wells have dropped from between 50 and 60 days to between 40 and 50.

Also, Chesapeake is using superpads wherever possible, a strategy that lowers costs and reduces its footprint.

In the superpad approach, two 640-acre units are developed via two pads built along the section line. Four wells with 4,500-ft laterals are drilled to the north on each pad, 660 ft apart, at 80-acre spacing. Each pad also has four wells directed south. Per-section recovery is estimated at 52 Bcf, so each two-pad development accesses 104 Bcf of gas. Superpad drilling also allows such efficiencies as running gathering lines down section lines.

Nonetheless, the Haynesville can be recalcitrant. Big issues are mud-motor and measurement-while-drilling (MWD) tool failures, due to reservoir temperatures that range from 300°F to 350°F. Naturally, the failure rates of these directional tools bear heavily on costs and drilling times in the lateral holes. The availability of specialty proppant for completions is another trouble spot; on each well, Chesapeake typically fracs eight to 10 slickwater stages, with some 2.6 million lbs of proppant.

Furthermore, as remarkably regular as the Haynesville is, its depth, thickness, and permeability do vary. Structural elements, such as faulting and higher dip rates in some areas, can offer added complications.

“Generally speaking, initial well quality is more a function of matrix permeability, rather than thickness or depth,” said Sharp.

“But we are very early in this play in terms of drilling.”

Elm Grove monsters

A firm that is enjoying a run of fabulous Haynesville



A technician stands atop a sand/proppant transport vehicle during preparations to frac a well in Caddo Parish.

wells is Petrohawk Energy Corp. The Houston-based company had a hefty position in North Louisiana's Elm Grove and Caspiana fields before the Haynesville burst forth.

On its leases on the superlative Elm Grove structure, Petrohawk had been drilling horizontal Cotton Valley wells in the Taylor sand for several months and encountering fabulous rates and pressures. Intriguingly, the overpressured Haynesville lay 1,000 ft deeper. As data on the reservoir properties of the Haynesville were revealed, the company recognized that the shale was a legitimate target.

Petrohawk had previously studied one Elm Grove well that had penetrated Haynesville, and it engineered its initial shale test in the vicinity of this well with a long lateral and multiple frac stages. The techniques were similar to those used in its Fayetteville shale wells.

It completed its first Haynesville well in June 2008.

Essentially, it had no learning curve: Petrohawk's first batch of wells tops the list of high-flowing Haynesville powerhouses, coming in at initial-potential rates between 15 million and 28 million per day apiece.

"We have been working our own area, and it's not small," said Dick Stoneburner, Petrohawk executive vice president and chief operating officer. "There are 30 miles between our farthest wells, and we have seen results improve with each well." This is supported by the most recent completions that Petrohawk announced in early December, with initial production rates between 21 million and 28 million per day.

Petrohawk holds 300,000 net acres in the play. It currently runs 11 horizontal rigs and completes approximately four to five Haynesville wells a month. At year-end 2008, it expected to have 12 to 13 Haynesville wells on production.

The company figures that its acreage contains some 12 Tcf in potential resources. It recently upped

Weatherford International personnel stimulate a shallow Cotton Valley well in Bethany-Longstreet Field in Caddo Parish. Goodrich Petroleum acquired acreage in the field for Cotton Valley potential, and later found it was in the heart of Haynesville country.



its reserve estimates to 6.5 Bcf per well, and recovery potential to 50 Bcf to 60 Bcf per section.

“Both production performance and volumetric data support these estimates. The amount of gas in place is astonishing,” said Stoneburner. The notably homogenous Haynesville has a net-to-gross ratio of nearly 100% across more than 4,500 sq miles.

Certain Petrohawk strategies differentiate it from other operators. In advance of its horizontal rigs, the company drills the vertical sections of its Haynesville wells with pre-drill rigs. These “spudder” rigs drill to 500 ft to 600 ft above the Haynesville, set casing and move off. “The program is cost beneficial — our dayrates are less, and the mobilization and demobilization charges are more than offset.”

One drilling concern is bottomhole temperature, which rises to the southeast as the reservoir deepens. “In deeper portions of the play, the indus-

try is approaching limitations with the temperatures associated with getting MWD tools to work,” said Stoneburner. “We’re fortunate in our area that we’re not at temperatures above the specifications of the tools.”

On completions, Petrohawk likes short stages. It has not fractured a well with fewer than nine stages, and most of its wells feature 12-stage fracs. Each stage covers approximately 325 ft to 350 ft, and takes about 80,000 lbs of 100-mesh and 200,000 lbs of 40/70 premium proppant in slick water. “We pump as little gelled fluid as possible; we don’t go to gel until we have to.” Additionally, the company runs both resin-coated and ceramic proppant.

“We’re quite anxious to get out of our own little comfort area around Elm Grove and Caspiana and prove that we can drill the same kind of wells throughout the play,” he said. “I’m hopeful and optimistic that will be the case.”

In that light, one of the three recently completed wells, which had an initial rate of 28 million per day, was drilled 12 miles south of Elm Grove, and Petrohawk has started wells in Harrison and Shelby counties, Texas. The Harrison County well is a Haynesville test, while the Shelby well is actually a horizontal test in the Bossier shale that lies above the Haynesville. “It appears to have petrophysical properties similar to the Haynesville’s.”

That would be something, if it works. It would add yet another broad target to a region already brimming with opportunity.

Established player

Some companies with enviable Haynesville positions had the good fortune to hold Ark-La-Tex leases acquired for shallower objectives. That was the case with Houston-based Goodrich Petroleum Corp.

“I would like to tell you that we had a vision the Haynesville was coming, but that would not be accurate,” said Robert Turnham, Goodrich president and chief operating officer. “We liked the area because of its multiple objectives and the repeatability of the plays.”

Goodrich began assembling its position in East Texas and North Louisiana in late 2003. It gathered a package of properties that targeted Cotton Valley and other standard-issue shallow zones.



“We were fortunate enough to get in early and put our acreage together,” he said. Indeed, Goodrich’s position in Bethany-Longstreet and Longwood fields, in DeSoto and Caddo parishes, Louisiana, is in the heart of the Haynesville.

Early last year, Chesapeake came calling. The two firms struck a joint-venture deal, in which Chesapeake paid Goodrich \$173 million for deep rights on 10,200 net acres in North Louisiana, spread across Bethany-Longstreet and Longwood. Chesapeake, operator of the JV, has two rigs running at present and will add two more by the second quarter.

“Our basis in the acreage is extremely favorable; prior to the JV, our land costs were \$350 per acre,” said Turnham. “When we apply Chesapeake’s payment, we actually have a credit of \$2,500 per acre.”

In total, Goodrich currently owns 22,000 net Haynesville acres in North Louisiana. It also has a Haynesville venture with Matador Resources on its Central Pine Island project in Caddo Parish, adjacent to Longwood Field. A Haynesville well, operated by Matador, is drilling on that property.

Furthermore, Goodrich expects to spend \$75 million to \$100 million this year in capex on its East Texas holdings — 38,500 net acres prospective for Haynesville in Minden and Beckville fields in Panola and Rusk counties.

Goodrich has high hopes: “Of the 10 vertical pilot wells we’ve drilled to date, the best production rates have come from our East Texas wells,” Turnham said. Reasons for this are not straightforward, as the Haynesville is a bit thinner and shallower in East Texas than in Louisiana. Porosities are alike, from 9% to 15%, and gas-in-place calculations also conform. From its western-most vertical well at Minden, across East Texas and into North Louisiana’s Longwood Field, the Haynesville is strikingly similar.

“Yet, we’ve seen rates as high as 2.6 million cf/d from a vertical well in Minden Field. The highest rate we recorded in North Louisiana was a million a day from a vertical completion,” he said.

“Until we can find out differently, we feel just as good about our East Texas acreage as we do about North Louisiana,” Turnham added.

And, the company is pushing down into the Angelina River trend to see if the Haynesville is prospective there. Goodrich recently added a 50%

interest in 6,000 acres in Nacogdoches County, and is currently drilling a vertical well to test Haynesville at 14,500 ft on that property. It’s targeting the shale as seen in Trawick Field, where a strong vertical Haynesville completion came in at 3.3 million a day.

“We have almost 42,000 net acres in the Angelina Trend that’s not included in our 60,500 net Haynesville acres,” said Turnham. “It will be a huge addition for us if this area works.”

Vertical wells in the Haynesville run \$2.7 million. At mid-year 2008, Goodrich posted average reserve size of 300 million cubic feet for an incremental Haynesville completion below the Cotton Valley sand. Costs for adding the Haynesville tail run \$500,000.

“If horizontal wells don’t work in certain areas in the Haynesville, Cotton Valley wells can be deepened to capture Haynesville on 20-acre spacing,” he said. “This offers us the ultimate downside protection.”

It’s a fallback option, certainly, but one that may never need to be taken. “The Haynesville reservoir looks so superior. The big question we — and most others — have is the decline rate on the wells.”

East Texas expansion

Radnor, Pennsylvania-based Penn Virginia Corp. exhilarated Haynesville players when it announced sterling results on its #5-H Fogle in Harrison County, Texas. The stout well was the first to jump the play from North Louisiana into East Texas; it was completed for 8 million cf/d, a rate restricted by the surface facilities.

Penn Virginia had been looking at the Haynesville play (which it prefers to call the Lower Bossier shale) for several years. It had an active Cotton Valley drilling program in East Texas, and drilled ratholes into the top of the overall Bossier section.

“We kept picking up quite a bit of gas on mud logs as we drilled this part of the hole,” said Baird Whitehead, president of Penn Virginia Oil & Gas, the company’s E&P unit. In 2006, as part of its Cotton Valley program, Penn Virginia took 17 vertical Cotton Valley wells down through the Smackover.

It encountered gas shows in most of the Upper and Lower Bossier shales, Haynesville Lime and Smackover in the holes. It started completing, and

it tested the Lower Bossier shale in most of the wells in the group. Completion rates on a sustained basis, after fracturing the vertical section, ranged from 100,000 to 300,000 cf/d per well from the Lower Bossier shale.

Based on sidewall-core and advanced-log data and its vertical well results, the company decided the shale would make a good horizontal candidate.

The Fogle absolutely exceeded expectations. “The well has already made half a Bcf, and is at least a 6 Bcfe to 8 Bcfe well, based on history to date.”

Penn Virginia did not have drilling issues in its first well, which required 16 lb/gal mud in the shale section. But, subsequent tests have been more difficult. “This is a technically challenging play: It’s deep, with high temperatures and high pressures, and well control can be an issue. It can be a bear to drill, although we have made some solid improvements with recent wells.”

The company holds approximately 62,000

acres in the play. Of that total, about 12,000 acres reside in an area of mutual interest that it formed in 2003 with GMX Resources Inc. for Cotton Valley drilling. That AMI extends to the Haynesville, and Penn Virginia plans to drill shale wells within the agreement this year.

To date, it has focused on its 100% acreage. During the past several months, it has drilled wells across its position to test potential. “As of the beginning of December, we had completed five wells and were waiting on completions with a small number of recently drilled wells.”

Results have been announced on three tests, all of which are producing. It currently has three rigs drilling Haynesville wells; the play will command 40% of Penn Virginia’s 2009 budget.

The Lower Bossier wells run \$7 million apiece; as costs decline in the service sector, Penn Virginia expects a well could be drilled and completed for less than \$6.5 million.

“The Lower Bossier play is huge. There is going



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to be variability – we think estimated ultimate recoveries may range from 4 Bcfe to 10 Bcfe per well, depending on area – but, in general, the economics are strong. We think it's the most prospective domestic shale play.”

Across its acreage position, based on a conservative 20% recovery of gas in place, Penn Virginia could have net recoveries of 1.5 Tcf or more.

Furthermore, potential exists in the Upper Bossier. “We will drill a horizontal Upper Bossier shale well this year. It's also overpressured, and appears to have excellent reservoir qualities. And, the Upper Bossier generally overlays the same area as its lower cousin.

“East Texas is just amazing: There's also potential associated with the Haynesville Lime and Smackover, and deeper ideas yet.”

Right place, right time

A regional firm that has found itself well positioned in the burgeoning shale play is GMX Resources. The Oklahoma City-based company plans to spend 85% of its 2009 and 2010 budgets drilling and completing Haynesville/ Bossier shale horizontals, said Ken L. Kenworthy Jr., president, chief executive and chairman.

GMX was initially a Cotton Valley sand player, but in 2006 it drilled 19 vertical penetrations below the sand into the Bossier/Haynesville shale and into the Smackover. It encountered abundant gas in most of those layers, and was particularly interested in the Lower Bossier/Haynesville that exhibited the most gas and carried the best porosities.

The firm experimented with different types of completions on its vertical wells, and reached rates as high as 1 million to 2 million a day, with steep declines. It took cores and did extensive analysis, including collection of advanced-logging suites. It joined Core Laboratories' proprietary Haynesville shale-gas study.

“At the time, we didn't know how best to develop the reservoir horizontally, so we waited for other, large-cap shale developers to show us the way,” said Kenworthy. GMX eventually turned its focus back to drilling the Cotton Valley sand.

That all changed when Penn Virginia announced

results from its nearby Fogle well, immediately next to GMX's leasehold.

“The horizontal play in Caddo Parish was turning up success after success and, when Penn Virginia verified it in Harrison County, Texas – right next to us – that was the confirmation we needed to go in head-first,” says Kenworthy.

GMX's quick reaction allowed it to double its acreage position in short order. It now holds 38,455 net Haynesville/Bossier shale acres, and operates 81% of that.

“It looks like the Haynesville will be two to three times as lucrative as the Cotton Valley,” he said. “Payouts in the Haynesville are measured in months; Cotton Valley sand wells take three years to pay out.”

Additionally, the Haynesville holds twice as much recoverable gas as the Cotton Valley. GMX estimates it has resource potential of 2 Tcf in the Haynesville/Bossier shales, compared with 1 Tcf in the Cotton Valley sand.

The company just completed its first Haynesville well, #9-H Callison, in which it holds a 100% interest. It is making 7.7 million cf/d from a 2,200 ft lateral that was stimulated with an eight-stage frac.

GMX, which owns Diamond Blue Drilling, is also scheduled to receive five new FlexRigs this year. For 2009, the company will have five to nine at work in Haynesville, the precise level depending on gas prices, production results and credit markets. “We see the floor price for economic Haynesville development at less than \$3 per thousand cubic feet,” says Kenworthy.

“The Haynesville absolutely has the ability to withstand a low-price environment. It will be the last field standing because the reservoir is that superior.”

Northern side

Southern Star Energy Inc. is a small firm working the northern side of the play in Louisiana. “We've now drilled two wells into the Haynesville and, the more I learn, the more tickled I am with what I see,” said David Gibbs, Southern Star president and chief executive officer.

The company was formed two years ago to chase North Louisiana projects. Initially, it targeted Cot-

ton Valley; to date Southern Star has drilled seven such wells. It holds 5,400 contiguous net acres in Louisiana's Bossier Parish, with partners Ramshorn Investment and Dynamic Resources. Southern Star holds 40% of the venture and operates.

Its first Haynesville well, #17-2 Atkins-Lincoln, was designed as a vertical hole set up for resource assessment. "We are very happy with the section we encountered in the #17-2 well," said Gibbs. "We had strong gas shows and very good porosities throughout the interval."

Moreover, reservoir thickness is outstanding: The well encountered some 390 ft of prospective section. "This well confirmed the presence of porous Haynesville shale on our acreage. It's changed our perception of the play's extent, and the potential of our position."

Southern Star has temporarily suspended the well; pending the results of its evaluation, it will either complete it as a vertical producer or drill a lateral into the shale. To enhance its understanding of the play, the company also joined Core Labs' proprietary Haynesville study. Southern Star took 180 feet of whole core in the upper shale zone and sidewall core in the lower interval.

"We had a lot of gas coming out of the well, but we were able to keep it under control, and we had excellent hole stability."

A second Haynesville well, #20-1 A.S. Burt, about 1.5 miles southwest of the initial test, has further confirmed the presence of Haynesville potential on the company's acreage. The Burt well encountered a slightly thinner gross interval (312 feet) but improved porosity and resistivity. In its current 10-well program, Southern Star expects to devote five to six wells to test the shale; the remainder will develop Cotton Valley targets.

"At this stage of the game, we are drilling vertical holes and leaving wellbore geometry that allows us to drill horizontals. If we go horizontal, we'll bring in a different rig for the lateral portions."

The cost difference between horizontal and vertical Haynesville wells is considerable. In its area, a massively fractured vertical Haynesville can be completed for \$3.9 million; a horizontal runs \$8 million.

"We're working to decide the best approach going forward. We're poised for some real growth."

Robust economics

So that's the Haynesville: Good news abounds. It offers strong wells, huge extent, and onshore operations in an established corner of The Patch.

Enormous amounts of capital continue to pour into the Haynesville, and a growing number of companies have taken stakes. In addition to companies mentioned above, Berry Petroleum Co., Bidas Energy, Cabot Oil & Gas, Camterra Resources, Clayton Williams, Comstock Oil & Gas, Cubic Energy Inc., Devon Energy Corp., EnCana Corp., Exco Resources Inc., Fossil Operating, J-W Operating, Nadel & Gussman, Questar Corp., and Shell Oil work the play.

In these difficult times, even if smaller players or distressed companies are bought out, the buyers will remain committed to Haynesville development.

The leases are expected to be drilled — as the economics are robust. "In our estimate, returns on a midpoint Haynesville well are on par with returns from a core-area Barnett well," said Robert Clarke, Houston-based lead analyst, U.S. Lower 48, and Hill Vaden, Gulf Coast analyst, for energy-research and -consulting group Wood Mackenzie. Midpoint Haynesville returns do not top the nation's premier onshore play — the Deep Bossier in East Texas' Amoroso Field — but are superior to returns from Cotton Valley and Wilcox.

Breakeven prices — those that deliver a 10% rate of return — for the Haynesville fall around \$5 per thousand cubic feet (at Henry Hub). The range is between \$4 and \$6.50.

And, that range is fluid. As gas prices drop, it's anticipated that costs will drop. "We're already seeing costs come down, and that will subsequently drive down the breakeven point."

In other, more-established shale plays, returns improved over time as operators became more efficient and tailored drilling and completion techniques to the specifics of each reservoir. "What's striking is the relative immaturity of the Haynesville. There's significant upside, should wells improve," said Clarke. "Returns are now very good, and are likely to get even better." ■

Adapted from "Haynesville Shale," Oil and Gas Investor, January 2009

Unraveling the Haynesville

The extraordinary Haynesville shale play has rejuvenated activity in one of the nation's vintage producing provinces.

By Peggy Williams
Senior Exploration Editor
Oil and Gas Investor

The Upper Jurassic Haynesville shale is a unique and complicated beast. It's a remarkably consistent shale that occurs at depths from 10,000 ft to 13,000 ft across a swath of East Texas and North Louisiana.

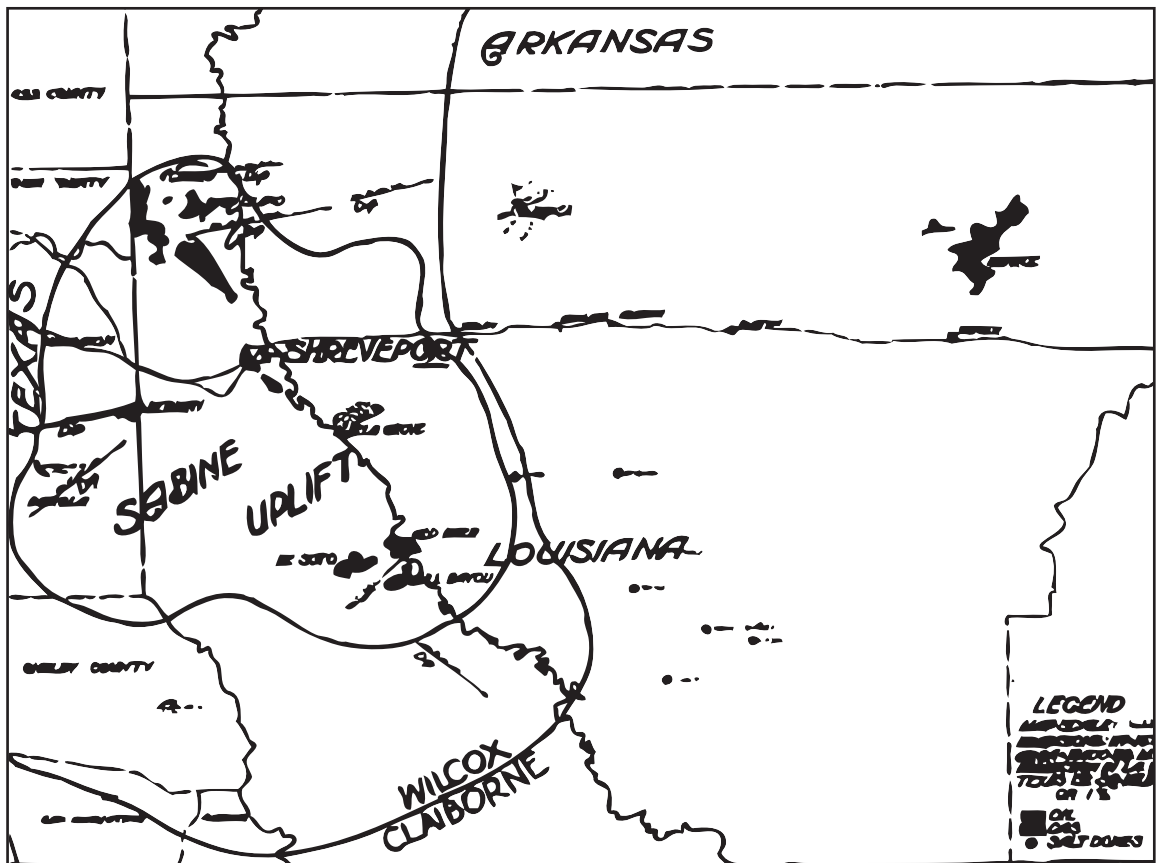
A notable feature of the Haynesville is its discovery in an area that has hosted oil and gas pro-

duction for more than a century. The shale play lies on the Sabine Uplift, a huge regional structure that rolls from Louisiana's Caddo, Bossier, De Soto, and Red River parishes into Texas' Harrison, Panola, and Shelby counties. The feature separates the North Louisiana and East Texas salt basins.

The Sabine Uplift was the site of Louisiana's first

The Sabine Uplift has been recognized as a feature important to oil and gas explorers since the industry's earliest days. This map was drawn in 1920 by Sidney Powers, an eminent petroleum geologist.

Source:
American Association
of Petroleum Geologists



natural-gas discovery. In March 1905, the #1 Offenhauer struck oil at 1,556 ft in Caddo Parish. In May, the #2 well hit the shallower Nacatoch gas reservoir at such pressures that a crater blew out and swallowed the derrick, a steam engine, two pumps, and 3,500 ft of pipe. It was a spectacular find.

Caddo Field extended across 180 sq miles on the northern end of the Sabine Uplift, and its Upper Cretaceous reservoirs yielded tremendous volumes of oil and gas at depths from 800 ft to nearly 4,000 ft.

After its discovery, a boom enveloped the area. Massive gas fields were found at Shreveport, Cedar Grove, and Elm Grove a few years later, near the center of the flat-topped uplift. Oil pools were developed at Red River, DeSoto, and Bull Bayou on the uplift’s southern side and at Pine Island on its northern edge, all before 1920.

Now, the Haynesville shale play has ignited a 21st century boom in this classic region.

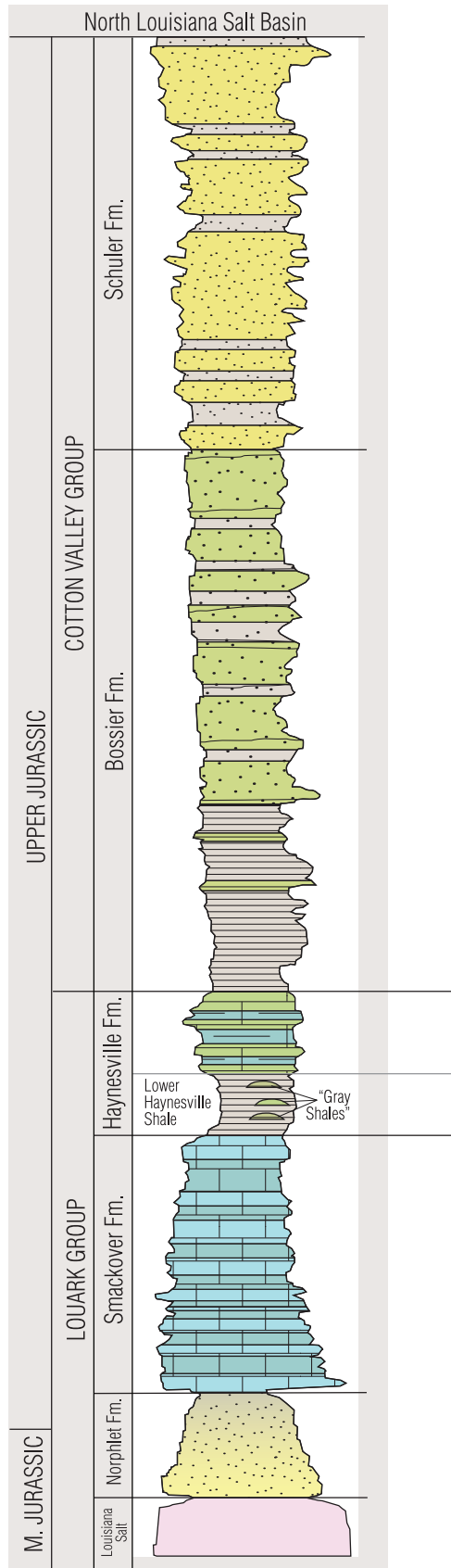
Haynesville deposition

At Haynesville time, the Sabine area was stable, both structurally and stratigraphically. The uplift rose during Cretaceous and later times, well after the Haynesville was deposited.

Like other black shales, the Haynesville shale was laid down in a restricted basin. These environments, deprived of oxygen, are most amenable to the preservation of organic materials, the building blocks of fossil fuels. The Haynesville basin was ringed by carbonate shoals to the north, west, and south.

But the shale is just part of a larger descriptive unit called the “Haynesville formation” that spreads across portions of Louisiana, Alabama, Arkansas, Mississippi, and Texas. It’s an Upper Jurassic mixture of sands, shales, and anhydrites. Like most formations, its particular composition varies with locality.

Formations are fundamental geological units; they are combined into groups, or subdivided into members. Usually, they are considered to be distinct, mappable bodies of rocks. The Haynesville formation takes its name from Haynesville Field, developed near the town of Haynesville in Louisiana’s Claiborne Parish. Here, wells penetrated the formation where it consisted mainly of sandstones and siltstones.

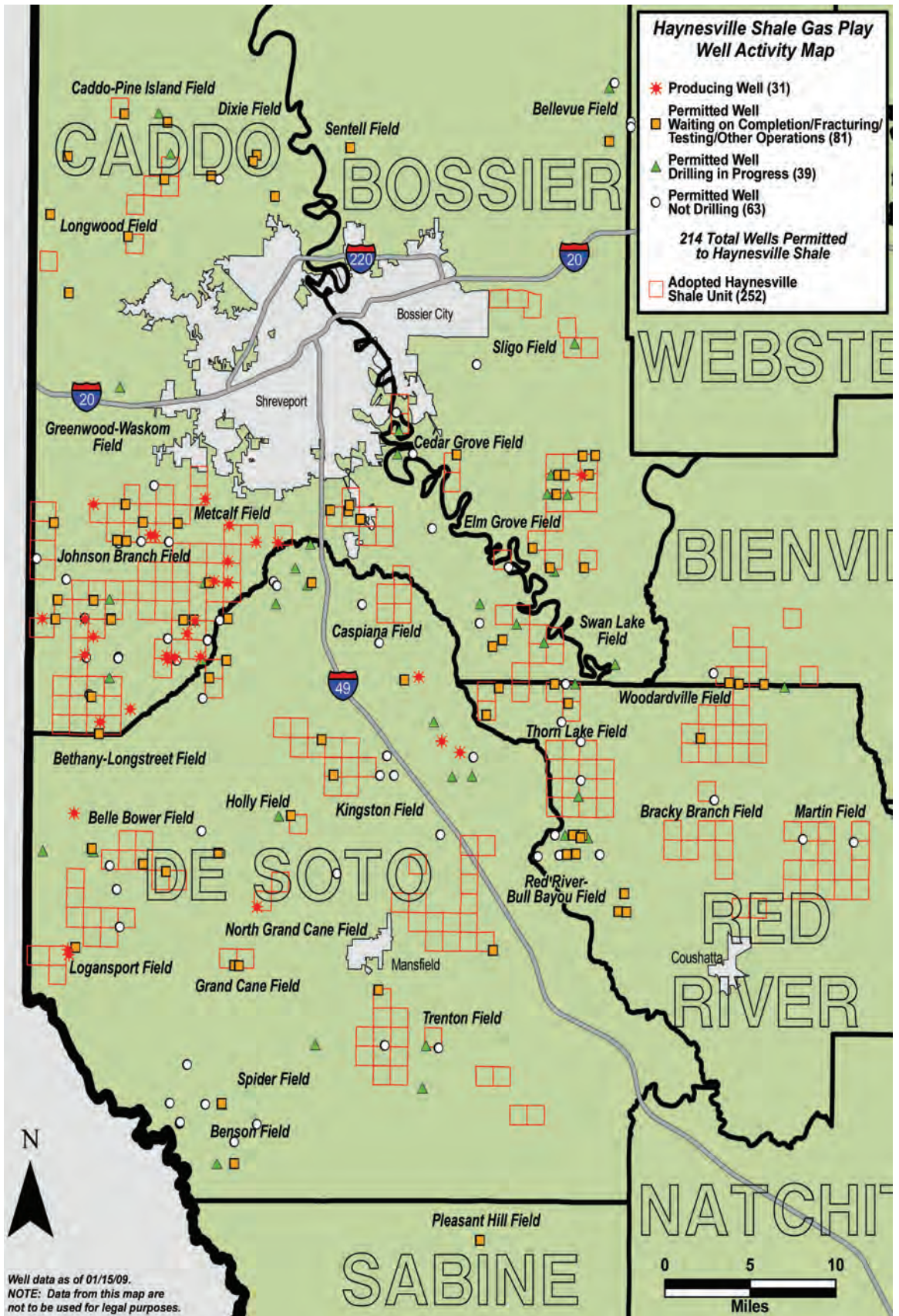


A log from a North Louisiana well shows the typical Middle and Upper Jurassic sequence in the region.

Adapted from Chesapeake Energy Corp.

Activity is brisk in the Louisiana portion of the Haynesville shale play.

Source: Louisiana Department of Natural Resources



Initially, the Haynesville was considered the basal part of the Cotton Valley formation. In the late 1940s, as understanding of the subsurface grew, geologists in the Shreveport Geological Society advocated a separation of the Haynesville formation from the overlying Cotton Valley formation. Workers recognized a major unconformity that separated the gray sands, silts, and shales of the Cotton Valley from lower Haynesville beds that consisted of red sands, silts, and red shales.

Today, geologists consider the Bossier and Schuler formations to be part of the Cotton Valley Group, and the Haynesville, Smackover, and a couple of deeper formations to be part of the Louark Group.

Changes across locales

The zone of interest in the Haynesville shale play is a “hot” shale that can reach some 350 ft in thickness. This shale is easily recognizable on gamma-ray logs, because the radioactive minerals in the organic material register high intensities on the logs.

However, various operators talk about Upper Haynesville and Lower Haynesville, or even Bossier shales. There’s considerable confusion around the shale sequence, although hundreds of wells have penetrated the section in this old producing area.

That’s because of facies changes within the formations. On the flank of the East Texas salt basin, the Haynesville produces from carbonate reservoirs. Here, the Cotton Valley (or Haynesville) Lime is present, and the hot portion of the Haynesville shale is developed below that carbonate. In this region, the lime separates the overlying Bossier from the Haynesville shales.

In East Texas the Bossier contains sands and shales. Tight sands are productive in both the shallow, shelf play in the Freestone Trend and in the Deep Bossier play in Leon and Robertson counties. As the Bossier heads eastward into Louisiana, it loses its clastics and becomes almost all shale.

Additionally, in North Louisiana the carbonate wedge that is the Cotton Valley Lime/Haynesville Lime grades into shale. That means the Bossier and Haynesville shales sit atop one another in the eastern portions of the shale play, and together form a

SYSTEM	SERIES	Stratigraphic Unit	
		East Texas	N. Louisiana
CRETACEOUS	Upper	Nacatosh	Nacatoch
		Taylor	Ozan/Annona
		Austin	Austin/Tokio
		Eagleford	Eagleford
		Woodbine	Tuscaloosa
	Lower	Buda Limestone	
		Georgetown	
		Frederickburg	
		Paluxy	Paluxy
		Glen Rose	Glen Rose
		James Limestone	James Limestone
		Pettet	Sligo
		Travis Peak	Hosston
	JURASSIC	Upper	Cotton Valley
Gilmer Ls.			Bossier
Haynesville			Haynesville
Buckner			Buckner
Smackover			Smackover
Norphlet			Norphlet
Middle		Louann Salt	Louann Salt
	Werner	Werner	
TRIASSIC		Eagle Mills	Eagle Mills

The Haynesville is just one of many oil- and gas-producing intervals present in East Texas and North Louisiana.

Source: U.S. Geological Survey

very thick shale sequence.

A similar change is seen moving to the south and southwest from the town of Haynesville: the eponymous formation grades from sandstone into shale.

At present, the heart of the Haynesville shale play appears to reside in Louisiana’s southern Bossier, northern DeSoto, and southern Caddo parishes. Operators are active across the area, and are drilling and completing shale wells in East Texas, particularly in Harrison County, on the west side of the play, and in Bienville and Red River parishes on its eastern side. Shreveport sits smack in the center of the prospective area, and rigs are working along its northern side as well. ■

Haynesville Squeeze-out

The prize form this deep Northwestern Louisiana shale is great. Resources for surfacing its natural gas reward are the greatest challenge now.

By Nissa Darbonne
Executive Editor
Oil and Gas Investor

Got ceramic proppant? You'll need it in the Haynesville. Dave Pursell, managing director and head of macro-research for Tudor, Pickering, Holt & Co. Securities Inc. in Houston, said sand is too risky for the deep, high-temperature, high-pressure Haynesville wells in Northwestern Louisiana.

And, there are only two US suppliers of the manufactured material. Brazil has a bit of additional ceramic proppant; otherwise, "it's probably going to coming from China," he said.

"Uh, oh. So now we have quality issues to worry about. If anyone has been in the fracturing business, quality matters a lot when these little beads are holding the fracture open, and that's what's defining a good well and a not-so-good well."

Pursell was among speakers at the 7th annual A&D Strategies and Opportunities Conference in Dallas, presented by *Oil and Gas Investor* and *A&D Watch*.

The Haynesville play isn't as simple as drilling a Gulf of Mexico bright spot, he said. "This is a time when completion engineering really matters. Drilling engineering really matters. This isn't the Gulf of Mexico, where it's a geoscience-driven play, where all you have to do is drill the bright spot and you have a really good well.

"This (Haynesville play) is very complicated, so I would want to partner with a guy who has smarter guys than me, and I think you're seeing that (in the play)."

Proppant will particularly be an issue. Currently, the two US suppliers of specialty, ceramic proppant — material that literally props open the fractured rock — are Irving, Texas-based Carbo Ceramics Inc. and Saint-Gobain NorPro, the Norton Proppants Inc. division of Arkansas-based Norton.

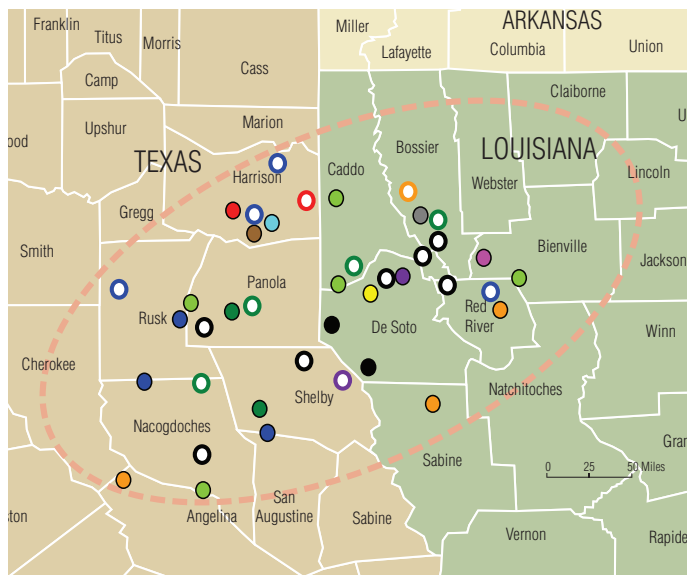
"Let's assume we're pumping a Barnett shale-style completion with 3 million lbs of proppant per well —

and I think that number is higher, not lower, over time. That's 1.5 billion lbs of ceramic proppant needed for Haynesville development, and that's just for 500 wells, per year," said Pursell.

"If you talk to your ceramic-proppant suppliers, most are very near capacity currently, so where are we going to get 1.5 billion lbs of ceramic proppant? Carbo Ceramics has less than a half-billion lbs per year of roofline-expansion capacity. Saint-Gobain, the old Norton proppants, maybe has 200 million lbs per year (of extra capacity). The Brazilians can probably produce a little more.

Haynesville shale activity: 2008 players

- Berry (4,500 Net)
- Cabot (135,000 Gross)
- Chesapeake (440,000 Net) & Plains E&P (110,000 Net)
- Comstock (53,000 Net)
- Devon (483,000 Net)
- Ellora (70,600 Net)
- El Paso (42,500 Net)
- EnCana/Shell (370,000 Net)
- Encore (21,200 Net)
- EXCO (107,000 Net)
- Forest (91,000 Net)
- GMX Resources (38,500 Net)
- Goodrich (60,500 Net)
- J-W Operating (Acreage n/a)
- Penn Virginia (60,000 Net)
- Petrohawk (300,000 Net)
- Questar (28,000 Net)
- XTO (100,000 Net)



Source: Tudor Pickering Holt & Co. Securities Inc.

“The problem is you can’t find 1.5 billion lbs of incremental capacity for at least several years, so where is that incremental supply going to come from in a few years? It’s probably going to come from China.”

Cozy up with Halliburton, Schlumberger, and other frac-job vendors that have the largest dubs on proppant supply? “If your company is drilling a lot of wells, you may be able to go to Halliburton or Schlumberger and lock up ceramic volumes. That’s where drilling 140 wells a year (like Petrohawk Energy Corp. plans in the Haynesville) matters a lot, compared with the guy who is going to drill five or 10. I think proppant is a big deal, and this is, again, where size may matter.”

The Haynesville play is not the Barnett. “Think about where we are. We’re in deep, high-pressure, high-temperature reservoirs.” The Haynesville is at 10,000 ft to 12,000 ft. “Let’s assume ceramic proppants are required, because sand crushes and doesn’t have temperature stability at 300 degrees, so we’re going to have to run a ceramic of some sort.”

Play consolidation

This issue and others will lead to consolidation in the play, he forecasts.

Steve Herod, executive vice president, corporate development, and a co-founder of Haynesville developer Petrohawk, expects consolidation in the play.

“(Leasing) is certainly not finished, but it definitely has slowed,” he said. “A great deal of acreage has been leased or acquired in the past six to eight months. There will continue to be activity, and there are people who haven’t leased yet, but companies are looking for quality and adding to concentrations of acreage. That tends to happen at a slower pace.”

He expects more joint-venture deals, such as that between Chesapeake Energy Corp. and Goodrich Petroleum Corp., and Chesapeake and Plains Exploration & Production Co. “And, you’ll see some of the private operators that haven’t sold yet sell their production, which may include Haynesville rights, but I think the bulk of the on-the-ground mineral leasing is probably over,” he said.

Petrohawk, which has amassed some 300,000 acres in the play, held a 58,000-acre position before the leasing frenzy that began to make headlines ear-

lier this year, mainly due to its Elm Grove Field stake. “The Haynesville is really perfect for us. We have a unique situation in that we had ... a great competitive advantage from our years of operating in the core of the play,” Herod said.

“We believe we can secure rigs, tubulars and frac dates by leveraging long-standing relationships with suppliers to the area. The majority of large landowners in northwestern Louisiana know Petrohawk, and our track record is solid; many of them have been getting royalty checks from us for years.

“So that has been a key advantage, and we have great partnerships with other operators in the area, which we can look to leverage and expand as the play evolves.”

Pursell said developing the Haynesville has several challenges, in addition to proppant supply. Haynesville wells from just 25% of the sweet spot may make a combined 8 Bcf of gas a day by 2015. “What are the risks to that 8 Bcf a day?” It isn’t so much a matter of reservoir risk.

“(Instead), I think there is more project risk — execution risk and timing risk. There are any number of issues. How do I get 150 rigs capable of drilling the kind of wells we need to drill in North Louisiana?”

Rig owners and operators have shown a willingness to build more rigs, but the type needed in the Haynesville will come largely from high-pressure, high-temperature South Texas, and will put pressure on onshore-rig dayrates overall. The pressure pumping that is needed in the Haynesville is also that used in South Texas, as well as 15,000-lb-rated fracturing equipment, and qualified personnel.

“More important is fracture proppant,” Pursell said.

These factors and others will squeeze out some Haynesville players. “Who are the sellers here? It’s typically the small guy who woke up one morning and found out he had scratched off the Haynesville lottery ticket and had 20,000 acres and said, ‘You know what? I don’t have the appetite to drill a \$7 million well that, if I don’t do it right, is probably a \$12 million well.’ These are the sellers.

“I’m not sure that, if you’re small, you have to sell. But, if you don’t have the capital appetite, then (to sell is) the right answer.”

IN TERMS OF JOINT VENTURES, the most likely partners are companies with shale horizontal-drilling experience, such as from the Barnett and Fayetteville plays.

In terms of joint ventures, the most likely partners are companies with shale horizontal-drilling experience, such as from the Barnett and Fayetteville plays, Pursell added.

Forward market

Natural gas prices are taking notice. “This play is real, and that has implications for why natural gas prices have come down from \$13.50 to \$7,” Pursell said.

The recent softening in gas prices is due in part to expectations of large new supply coming online from the Haynesville. The current-month Nymex price for natural gas was below \$8 at press time.

Herod said, “There are wide ranges of expectations out there for new Haynesville production, but most don’t fully take into account the challenges to bringing large amounts of gas to market in a new play. This play is evolving quickly, but it’s not a magic trick.

“We’ve been planning for all possible obstacles to execution, but we can’t lose sleep over short-term volatility in product prices. If we see long-term trends develop, we’ll adjust, but we’re very well suited to execute a long-term program here through our low-cost structure, active hedging, strong capitalization, a concentrated asset base and higher-than-average price realizations.”

Pursell sees the Haynesville rig count peaking at 150 in 2015. “Assuming 5 Bcf gross recovery per well, which I think will prove conservative the next couple of years, this play produces 8 Bcf a day by 2015.

“That’s why the market is nervous. That’s 8 Bcf a day from effectively 25% of the sweet spot, because these companies (as assessed in one forecast) represent half of the acreage in the sweet spot, and we’re only giving them credit (in this forecast) for half of the acreage.

“So the potential is there, and that’s why the

market is nervous.”

He added, “We didn’t even talk about pipelines – off-take capacity – and getting this gas to market. Pipeline numbers right now, with compression for 42-in. pipe, based on our math, are about \$6 million per mile, so there is a capital cost there that isn’t trivial.”

Herod said, “Take-away can be an issue and probably will be in the Haynesville in the next couple of years. A lot of numbers are being thrown around about what is available, and we’re working all of that very hard.

“We feel like we have secured what we need. We take a very pro-active approach to gathering: We would rather build our own line and control the timing ourselves than wait on someone else.”

He added that the “Haynesville is the biggest gas play of our generation, and we (at Petrohawk) are fortunate to get ourselves right in the middle of it. It’s ideally suited for us.”

At sub-\$8 natural gas? Petrohawk’s leasehold was acquired at an average of \$5,000 an acre. “At \$6, \$7, \$8, or \$9 (Nymex gas), it has great IRRs (internal rates of return). Even at a higher per-acre cost, it’s still an economic play,” Herod said.

Water disposal in the Haynesville is also an issue.

“That’s going to be a challenge too,” he said. “We feel we have addressed that, but all the service-related items are going to be a challenge. Water, proppant, people, access – everything. With the ramp-up that’s coming, it’s going to be a challenge.

“It was a big challenge in the Barnett, but it was dealt with. In the Fayetteville, it was a challenge, but it was dealt with. The industry is really good at figuring out a way to get things done when the economics are there.”

Pursell said, “Particularly in the better plays, if there’s a will, there’s a way.” ■

Adapted from “Haynesville Squeeze-out,” Oil and Gas Investor, October 2008.



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Haynesville Vies for Top Gas Shale

Operators tie down land positions and tune wells for high production.

By Don Lyle
Contributing Editor

Northwestern Louisiana and East Texas may return to international prominence as they springboard off the Haynesville shale to reach for the title of the top gas province in the US and the fourth-largest gas province in the world.

Anadarko Petroleum has Haynesville potential under its extensive East Texas properties.

Photo courtesy of Anadarko Petroleum Corp.

According to Chesapeake Energy Corp., the company that opened the Haynesville land rush in March 2008, the play could contain more than 200 Tcf of natural gas and 20 Tcf in gas reserves on its property alone. Chesapeake also reported initial production rates as high as 15 MMcfge/d from horizontal Haynesville shale wells. In addition, Cubic Energy Inc. and Petrohawk Energy had announced potential from the Haynesville by that time, but neither with the impact of Chesapeake. Petrohawk, for example, estimated a possible 6 Tcf in reserves on its properties.

Plains Exploration & Production Co., using

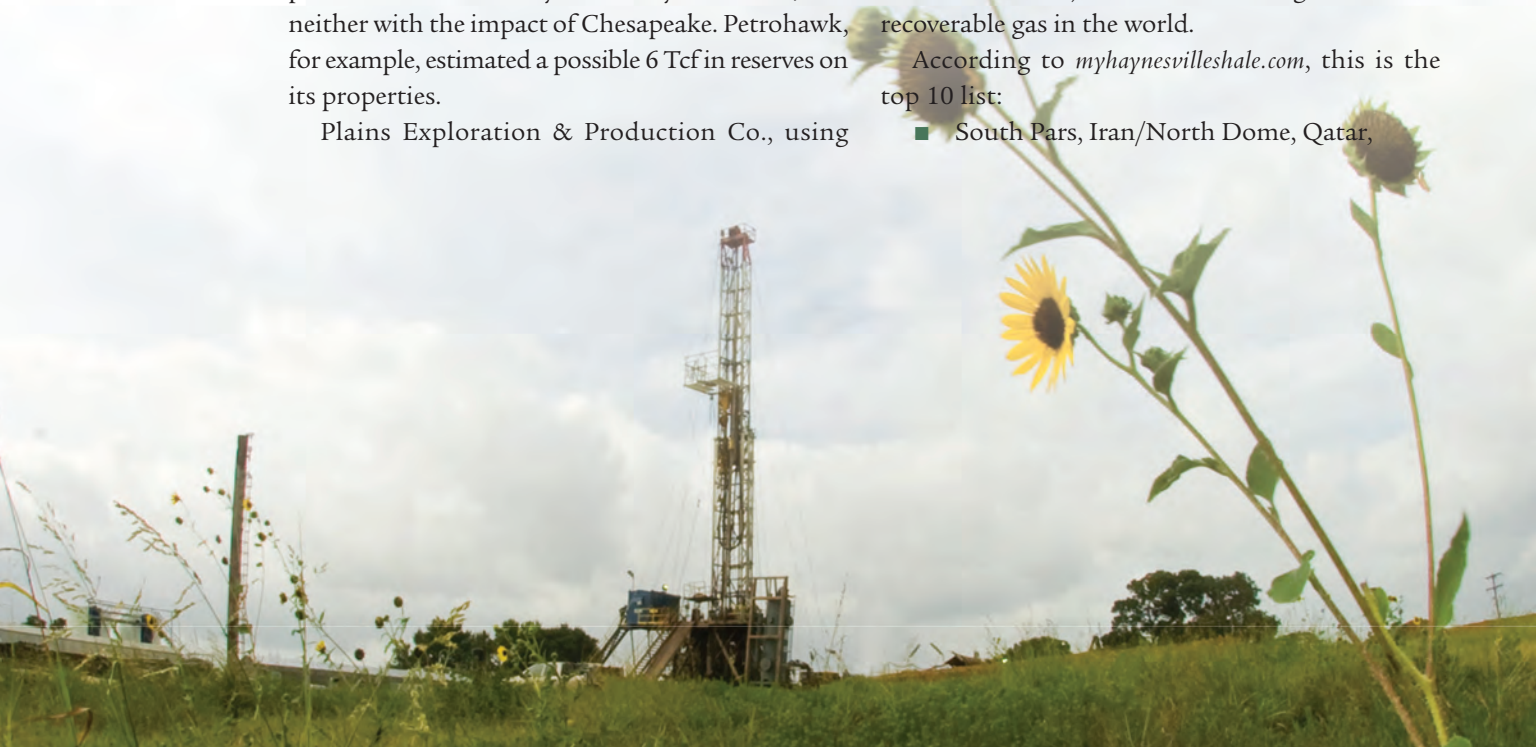
Chesapeake figures, said the play covered 3 million acres with recoverable resources of 4.5 Bcfge to 8.5 Bcfge per well with a median number of 6.5 Bcfge per well on the 550,000 acres of leases it shares with Chesapeake. Assuming the current 80-acre spacing in the play, the median number of that range amounts to nearly 44.7 Tcfge of recoverable gas on that property alone.

If the lower end of the Chesapeake range applies across the whole 3 million acres, recoverable resources jump to 167 Tcfge.

If that number is accurate, that amount of recoverable gas would make the Haynesville (also called the Lower Bossier) shale the fourth-largest source of recoverable gas in the world.

According to *myhaynesvilleshale.com*, this is the top 10 list:

- South Pars, Iran/North Dome, Qatar,



- Urengoy, Russia,
- Yamburg, Russia,
- Haynesville shale, USA (Louisiana and Texas),
- Hass R'Mel, Algeria,
- Shtokman, Russia,
- Zapolyarnoye, Russia,
- Hugoton, US (Texas/Oklahoma/Kansas),
- Groningen, Netherlands, and
- Bonavenko, Russia.

For comparison, North Dome/South Pars contains an estimated 1,180 Tcf of gas and Shtokman an estimated 135 Tcf.

Those positions are a moving target. In October 2008, Turkmenistan said Gaffney, Cline & Associates estimated recoverable resources between 141 Tcf and 494 Tcf of gas at its South Yolantan-Osman complex.

At one time, the Ark-La-Tex region topped the gas charts. That action started in April 1905 when the Producers No. 2 well in Caddo County, La., hit a shallow Nacatoch formation gas pocket that created a mud pit large enough to swallow the rig and everything else on the well site.

By 1907, the region exported gas to Shreveport, La., in Louisiana's first gas pipeline. By 1911, Gulf Refining drilled the world's first offshore well, the Ferry No. 1, in Caddo Lake (not counting Southern California's offshore wells drilled from piers).

By 1925, Louisiana Power and Light Co. built a power plant at Sterlington, fed by gas from giant Monroe field. That plant used 30 MMcf/d of gas to supply power to 610,000 people in 442 cities. Gas from the region traveled by pipeline to St. Louis, Mo.; Memphis, Tenn.; Atlanta, Ga.; Birmingham, Ala.; Dallas and Houston, Texas, and New Orleans, La.

At its peak, some people called the Northwestern Louisiana-East Texas gas play the biggest in the world, and Monroe field alone ranked among the world's biggest gas fields in the world. It was big at the time, but the field has produced less than 7.5 Tcf of gas since its discovery.

Oilfield legends Mike Benedum and Joe Trees ranked among the pioneers in the area's early development with headquarters in northwestern Caddo Parish in Trees City, now simply Trees. In the current Haynesville shale development, the pioneer is

Aubrey C. McClendon, chief executive officer, and his research team at Chesapeake Energy Corp.

According to an October 2008 presentation by John Kapchinske, vice president of geosciences in Chesapeake's southern division, and John Sharp, geoscience manager in Louisiana for the company, "Chesapeake's latest discovery could become the largest US gas field and one of the top five gas fields in the world," covering 3.5 million acres in northern Louisiana and east Texas.

Louisiana Mineral Board Secretary Marjorie McKeithen had this to say about its June 2008 lease sale: "This is an extraordinary time for Louisiana, particularly in North Louisiana, where we are experiencing something akin to a modern day gold rush due to excitement about the Haynesville shale discovery. To put the magnitude of this sale into perspective, this month's lease sale surpassed by more than double the bonus collections for the previous 11 months of FY 2007-08 combined, almost entirely because of activity in North Louisiana ... 25 of the 38 leases awarded were from Caddo, Red River, and Bienville parishes, totaling approximately US \$34 million in cash payments, and the average bonus per acre for these leases was over \$13,400 per acre, while more typical prices in the past for North Louisiana have been around \$400 per acre."

In the heart of the Haynesville shale area, lease bonuses up to \$30,000 an acre set the high standard with royalty payments of 25% or more. Lease terms have dropped to as low as three years, forcing operators to build fast-track drilling plans into their programs to secure Haynesville leases by production.

Hot spots in Louisiana are in Bienville, Bossier, Caddo, DeSoto, Red River, and Webster parishes, but operators consider nearly all of Northwestern Louisiana prospective. In Texas, Panola, Rusk, and Harrison counties get most of the Haynesville action. Activity also exists in Sabine; Lincoln parishes in Louisiana; and Shelby, Limestone, Marion, Upshur and Gregg counties in Texas. One company is looking as far east as Northwestern Mississippi.

Some leasing has crept over the border into Columbia County, Ark., but that isn't considered highly prospective, yet.

Tough lease terms, tight timetables, and natural

Comparison of Chesapeake Shales

Source: Chesapeake Energy Corp.

	Barnett	Haynesville	Fayetteville	Marcellus
Vertical depth (ft)	5,400-9,600	10,000-13,000	1,200-7,500	1,500-8,000
Thickness (ft)	250-500	200-300	50-200	75-300
Gas in place (Bcf/sq mile)	100 avg.	200 avg.	48 avg.	100 avg.
Recovery factor (%/spacing)	34/60	26/80	37/80	30/80
Porosity (avg.)	7%	10%	6.5%	6%
Total organic content (avg)	5%	4%	4%	6%
Reserves/horizontal well	2.65 Bcf	6.5 Bcf	2.2 Bcf	3.75 Bcf
Dominant lithology	Siliceous Mudstone	Argillaceous Calcareous Mudstone	Siliceous Mudstone	Argillaceous Mudstone
Age (millions of years)	Mississippian	Jurassic	Mississippian	Devonian
	320-345	152-156	320-345	385-390
Initial production (MMcf/d)	2.5	10	1.9	4.3
First-year decline	70%	81%	68%	75%
Well cost (\$ US million)	2.8	7.0	3.0	3.5
Finding cost (\$/Mcfge)	1.39	1.44	1.64	1.12
NYMEX req'd price (\$/Mcf)	4.98	3.88	5.12	2.69

gas prices hovering below \$4.50/MMBtu on the New York Mercantile Exchange may have taken some of the shine out of the play.

An October 2008 report from station KTBS in Shreveport said the city of Shreveport got no bids on mineral rights under 2,500 acres of parks and rights-of-way and Bossier City got no bids on 3,000 acres of city property up for mineral rights leases.

The station said, "Two or three months ago, when there was a bidding frenzy to lock up mineral rights to property over the Haynesville shale, Shreveport might have gotten \$50 million or more." Of course, at least on the Bossier City portion of the lease sale, the city's enthusiasm about taking advantage of the play may have had an impact. The city fathers passed a resolution that they would accept no lease bonus bid for less than \$27,500 an acre.

The Haynesville also is following the trend of the Barnett and the Marcellus. As activity climbs, pipeline takeaway capacity tightens. According to Chesapeake, current pipeline capacity, including a backhaul to Carthage, Texas, totals more than 3 Bcf/d. That includes the CenterPoint 42-in. Line, the Boardwalk 42-in. Line, the Texas Gas Transmission 20-in. Line, the Tennessee Gas Transmission 20-in.

Line, and the Crosstex LIG and Regency lines.

Chesapeake is evaluating seven different proposals for transmission lines from 36 in. to 42 in. in size from Carthage to Perryville. It also said there is potential for capacity between 8 Bcfge/d and 10 Bcfge/d to Henry Hub and/or Perryville.

Characteristics

Elements for the organically rich shale were deposited some 170 million years ago during the Upper Jurassic age when the area was a shallow off-shore basin.

The tight Jurassic Smackover lies immediately below and provides a fracture-treatment barrier from above and a water incursion barrier from below.

The shale feeds gas to the rich Cotton Valley formation above. The Haynesville itself was commonly considered a source rock, but most operators thought it was too tight to act as a reservoir until the Barnett and other shales paved the way.

With data from some 450 wells that have penetrated the Haynesville shale, the play's largest leaseholder and most prolific developer has a good idea by now about the makeup of the shale and the play,



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and it's confident about its estimate of 4.5 Bcfe to 8.5 Bcfe per well as an ultimate recovery estimate.

The formation lies between 10,000 ft and 13,000 ft, and the company will drill its horizontal wells to 14,000 ft to 17,000 ft in the shale, which ranges in thickness from 200 ft to 300 ft. The shale deepens to the south.

Toward the north, around the Louisiana-Arkansas border, the shale mixes with interbedded sands, but the sands don't hold the same value as the shale. The sand-shale mix also occurs as the play moves into East Texas.

Total organic content runs about 4% with a thermal maturity between 2.2% and 3%. The play's average porosity is about 10% and the pressure gradient is about .9 psi/ft, according to Chesapeake's Kapchinske and Sharp.

Water saturation ranges from 15% to 20%, and Chesapeake's prime territory holds 150 Bcfe to 225 Bcfe per section. Chesapeake anticipates recovering 25% to 30% of the gas in place, they added.

Haynesville operators get additional advantages they don't find with most other shales. The over-pressured reservoir contains higher pressure than other shales; it has a high gas-in-place factor and high initial recoveries.

The area is geologically stable and structurally uncomplicated with a good fracture barrier below the shale and no apparent water problems.

Adding to the plus side of the ledger, the shale lies in an area near major pipelines and infrastructure and the area is mostly rural, according to the geoscientists.

By October 2008, Chesapeake had drilled 16 horizontal wells and one vertical well to produce a gross 65 MMcfge/d (net 50 MMcfge/d), and other operators combined had drilled some 11 horizontal wells and 81 vertical wells in an area measuring approximately 90 miles by 100 miles.

Recovery techniques

Development in any play tends to follow the most efficient and most governmentally acceptable plan over time. In the Haynesville shale, Chesapeake seems to provide that leadership.

Chesapeake plans to drill in 1-mile-by-1-mile superpads, one superpad per section, with eight wells per pad.

The technique offers a shared surface imprint for the wells and fewer rig moves. The company will drill horizontals north and south on 80-acre spacing with single 4,500-ft laterals. That factory-type development allows the company to place gathering lines east and west along section lines between superpads.

Chesapeake's Kapchinske and Sharp said the company drills 13 1/2-in. holes with 10 3/4-in. casing at the surface, then drops to a 9 7/8-in. hole at about 4,000 ft and sets 7 5/8-in. casing at around 12,000 ft. It kicks off to a 6 3/4-in. hole in the horizontal section and sets 5 1/2-in. casing at around 16,000 ft.

Chesapeake's latest four horizontal wells at the time of the presentation in October took 41 to 47 days to drill and complete. The first four horizontal wells took 48 to 61 days to drill and complete.

The company uses water-based mud in the laterals, and one of its active programs works to reduce mud motor and measurement-while-drilling inefficiencies. Chesapeake wants to use learning curve efficiency and economies of scale to perfect a repeatable program that reduces days and costs to drill and complete its wells.

For the completion, Chesapeake is increasing its frac stages in the horizontal section to 10, up from five in October 2008. It is increasing sand concentrations with an October rate of 500 lb to 750 lb per lateral foot and it's using varying mesh sizes and percentages for best results.

It also is increasing use of slickwater fluids and decreasing the perforation clusters to 60 ft, down from 100 ft, and it is improving its drill-out and clean-out operations.

In recent wells, Chesapeake has increased its laterals to 4,100 ft from 3,500 ft, increased proppant to 2.6 million lb from 2 million lb and increased average frac stages to 8.5 from 5.5.

Those changes helped increase average estimated ultimate recoveries to 6.8 Bcfe per well from 4.1 Bcfe per well.

With those learning-curve improvements in hand, the two geoscientists said the company has compiled pro forma expectations for a horizontal well with a 6.5 Bcfe estimated ultimate recovery.

That well should produce 10 MMcfge/d initially and 8.3 MMcfge/d for the first month. One-year

Economics at Gas Price and Completed Well Costs

Source: Goodrich Petroleum Corp..

3 Bcfge EUR	\$6 million	\$7 million	\$8 million
\$7/Mcfge	14%	9%	6%
\$8/Mcfge	19%	14%	10%
\$9/Mcfge	24%	18%	14%
\$10/Mcfge	30%	23%	17%
6 Bcfge EUR			
\$7/Mcfge	52%	40%	32%
\$8/Mcfge	67%	52%	41%
\$9/Mcfge	84%	65%	52%
\$10/Mcfge	101%	79%	64%
8 Bcfge EUR			
\$7/Mcfge	113%	89%	72%
\$8/Mcfge	143%	113%	92%
\$9/Mcfge	174%	138%	113%
\$10/Mcfge	206%	165%	135%

cumulative production should offer 1.3 Bcfge, rise to 2.8 Bcfge in five years and 3.8 Bcfge in 10 years. The well should cost \$7 million to drill for a finding cost of \$1.44/Mcfge. Even at \$6/Mcf, the drilling and completion cost should pay out in less than a year.

For comparison, a Barnett shale well will have cumulative production of about 1.45 Bcfge in the first 10 years, and a Fayetteville shale well would produce a cumulative 1.2 Bcfge in the same period.

That pro forma Haynesville well production will decline 81% in the first year, 34% in the second year, 22% in the third year, 17% in the fourth year, 13% in the fifth year, 11% in the sixth year, 9% in the seventh year, 8% in the eighth year, 7% in the ninth year, and 6% in the tenth year with shallower declines thereafter.

The company's initial production rate on a well with an estimated ultimate recovery of 8.5 Bcfge starts at about 13 MMcfge/d, and a well with a 4.5 Bcfge ultimate recovery will initially produce some 7 MMcfge/d.

Financial aspects

Financial rewards from a Haynesville investment

vary according to a number of variable factors, including early-entry versus late-entry land costs, efficiency of operations, economies of scale, and position on the learning curve for drilling and completion.

It might be useful to compare numbers from more than one company.

At or near the top of the heap sits Chesapeake. According to Kapchinske and Sharp, the company's rate of return looks like this:

- On a 4.5 Bcfge well: 10% at \$5/Mcf gas, 13% at \$6, 24% at \$7, 27% at \$8, and 49% at \$9;
- On a 6.5 Bcfge well: 20% at \$5, 26% at \$6, 50% at \$7, 74% at \$8 and 105% at \$9; and
- On a 8.5 Bcfge well: 35% at \$5, 62%, at \$6, 98% at \$7, 150% at \$8 and 220% at \$9.

Another point of view comes from Plains Exploration & Production Co.'s 1.65 billion purchase of 20% of Chesapeake's interest in 550,000 prime acres of Haynesville shale properties.

According to a Seeking Alpha report, that amounts to 110,000 net acres for Plains at a surface acreage cost of \$15,000 an acre, but there's more to the deal.

Plains also agreed to carry half of Chesapeake's

drilling and completion costs, up to another \$1.65 billion, and that increases the cost per acre to \$30,000, a nice bonus for Chesapeake, which has an estimated average land cost around \$10,000 an acre.

No wonder McClendon said the Haynesville would be one of the most important projects in the company's history.

Goodrich Petroleum, another major leaseholder in the play, offered additional numbers. It assumed gas prices higher than the current rate around \$6/Mcf, but the play still should eke out a minor profit, even with an \$8 million to-completion cost and a 3 Bcfge well.

According to J.P. Morgan Market Research: "... the Haynesville is likely capable of producing 5+ Bcfge (per well) for \$5 million to \$6 million, which would mean its economics would rival the Barnett and that acreage could be worth over \$40,000/acre."

A June 2008 report by Deutsche Bank said the Haynesville should provide a 69% internal rate of return with 150 Bcf to 250 Bcf of gas in place per section, a \$6 million to \$7 million drilling and completion cost, 4.5 Bcf to 8.5 Bcf of ultimate recovery, a 25% royalty rate and a \$9/Mcf gas price. The only shale play in the US that beats those numbers is the Marcellus shale with an 86% internal rate of return.

Southern Star Energy, one of the smaller players in the Haynesville, estimated a net well cost of \$2.4 million

(\$6 million gross), to reach net reserves of 1.4 Bcfge.

The company has a 40% net working interest and a 6% net revenue interest. It has a lease operating cost of \$1/Mcfge and received \$11.59/Mcfge at the end of June 2008.

It paid a production tax of 29 cents/Mcfge. One well with an initial gross production rate of 5 MMcfge/d had a 46.7% internal rate of return.

Its breakeven point with gas at \$6/Mcf was 5 MMcfge/d.

A substantial operator in the play, Petrohawk, presented another set of numbers. It assumed 80-acre spacing, a 75% net revenue interest, 5 Bcfge per well, an 8 MMcfge/d gross initial production potential, and \$7.5 million to drill and complete a well.

With those basic numbers, the company figured returns at different gas prices for its leasehold costs. The potential looked good, even at high acreage costs:

- At a \$30,000/acre leasehold cost, a 20% return at \$6 gas going to a 150% return at \$12 gas;
- At \$20,000/acre, about a 30% return at \$6 and a 165% return at \$12;
- At \$10,000/acre, about a 35% return at \$6 and a 230% return at \$12; and
- At \$5,000/acre, a 37% return at \$6, a 60% return at \$7, an 82% return at \$8, a 120% return at \$9, a 160% return at \$10, a 200% return at \$11, and a 260% return at \$12. ||

Operating Companies

Anadarko Petroleum Corp.
Berry Petroleum Co.
BP America Inc.
Bridas Energy USA Inc.
Cabot Oil & Gas Corp.
Camterra Resources Inc.
Chesapeake Energy Corp.
Comstock Resources Inc.
Continental Resources Inc.
Cubic Energy Inc.
Delta Petroleum Corp.
Devon Energy Corp.
Dynamic Resources Corp.
El Paso Corp.
EnCana Corp.

Encore Exploration Co.
EXCO Resources Inc.
Forest Oil Corp.
Fossil Operating Inc.
GMX Resources Inc.
Goodrich Petroleum Corp.
Indigo Minerals LLC
J-W Operating Co.
Mainland Resources Inc.
Marathon Oil Co.
Matador Production Co.
Nadel & Gussman Ltd.
Noble Energy Inc.
Penn Virginia Corp.
Petro Resources Corp.

Petrohawk Energy
Pinnacle Operating Co. Inc.
Plains Exploration & Production Co.
Questar Corp.
Ramshorn Investments Inc.
Rising Star Energy Development Co.
Samson Contour Energy E&P
Shell Exploration & Production
Southern Star Energy Inc.
Southwestern Energy Production Co.
St. Mary Land & Exploration Co.
Stroud Petroleum
Unit Corp.
Will-Drill Production Co.
XTO Energy Inc.

Key Players

Anadarko

Anadarko Petroleum Corp. just started drilling in the Haynesville shale; not because it doesn't like the play, but the Houston-based company is busy these days.

Worldwide operations brought in net income of US \$16 billion in the third quarter of 2008 with cash flow of \$3.5 billion and discretionary cash flow of \$1.13 billion.

It reached a record 600,000 boe in production at one point during the quarter with average sales of 552,000 boe, including almost 2 Bcf/d of gas.

It has production in Algeria, China and in Brazil, where it hit Wahoo in Block BM-C-30 in the Campos Basin, its first operated pre-salt well. It also is exploring offshore Ghana and Liberia.

It's developing the Tonga West field, where it has 700 ft of net pay in the Gulf of Mexico with potential for 200 million to 400 million boe.

Among unconventional resources, it hit a record 800 MMcf/d of coalbed methane gas in the Powder River Basin of Wyoming, and enhanced oil recovery of 10,000 b/d in the same area. It's drilling tight-gas wells in Pinedale in the Green River Basin of Wyoming.

In shales, it's working the Marcellus in Appalachia, the Pearsall/Eagleford in the Maverick Basin of Texas, and the Haynesville in Texas and Louisiana. It also has properties in the Floyd shale in Alabama.

The company controls more than 80,000 net acres, up from 70,000 net acres at the end of the second quarter, in an area prospective for Haynesville. It holds most of that territory by production under the Carthage area in Texas and the Elm Grove field area in Louisiana.

In September 2008, it had accumulated 75,000 net acres in the Haynesville at an average cost of \$30,000 an acre, according to a company presentation.

Anadarko drilled its first operated well in Haynesville during the third quarter of 2008 and completed it in the fourth quarter. It plans to drill three or four exploratory wells to Haynesville, including one horizontal well, during 2008.

Talking about the company's Marcellus and Haynesville shale plays, Chairman and Chief Executive Officer James T. Hackett said, "People tend to overestimate how much infrastructure the industry can put in place and how fast it can do the work ... so that when we talk

about Haynesville going out, where it's ... obviously looking like a fabulous reservoir — same with Marcellus; it looks like a fabulous reservoir, so far — but these things take time to put in place and the service industry isn't equipped yet to be there in a big way. Parts of the pipeline infrastructure are in place, but it must be enhanced significantly, and I just don't think it happens as quickly as everybody is fearing it might from the standpoint of being bearish about gas prices." ■

BP

BP keeps a tight grip on information about many of its operations, including the Haynesville shale, but East Texas was a core area for Amoco Production Co. before BP bought that company, and BP still has a major acreage position with potential Haynesville production held by production from shallower zones.

During a 2008 strategy presentation, Andy Inglis, BP

A drilling crew works the rig floor on an Anadarko Petroleum well in East Texas where the company has properties with Haynesville potential.



Photo courtesy of Anadarko Petroleum Corp.

chief executive of exploration and production, listed 10 areas, each with the potential to produce 1 billion boe. In North America, that included unconventional gas where BP planned to prove up 12 Tcf in tight gas resources by identifying sweet spots for fracturing and technical-limit drilling and completions.

This year, the company purchased Chesapeake Energy's 90,000 acres of property in the Woodford shale play in the Arkoma Basin in Oklahoma for US \$1.75 billion.

BP also formed a joint venture under which it will get a 25% interest in Chesapeake's Fayetteville shale properties in Arkansas for \$1.9 billion. Of the 540,000 acres that Chesapeake held, BP will have 135,000 net acres. Part of that money will fund 100% of Chesapeake's 75% share of drilling and completion expenditures, up to \$800 million.

"This transaction, when combined with our recent Woodford acquisition, establishes a material position in the two attractive shale plays in the Arkoma Basin. Together with our substantial position in the emerging Haynesville shale play in East Texas, we have established a position in three key emerging shale basins. Combined, these shale positions represent around 1 billion boe of resources which could contribute up to 100,000 boe/d (600 MMcfge/d) of production by 2015," Inglis said.

He added, "We are now in a position to grow our North America gas business beyond today's current production level of 470,000 boe/d." At a 6 Mcf equivalent of 1 bbl of oil, that puts gas production at 2.8 Bcf/d. The Woodford acquisition would add more than 200 MMcfge/d to that number, which means another 400 MMcfge/d would come from the Haynesville and Fayetteville shales.

Although BP hasn't announced any Haynesville shale acquisitions, East Texas was one of Amoco's core areas when BP bought the company, and BP undoubtedly has producing properties over the Haynesville formation.

BP offered a clue to its Haynesville plans as it posted a job offer for a Haynesville operations geologist. It said, "The Haynesville operations geologist will work with a multidisciplinary development team to support the Haynesville shale multi-rig horizontal drilling program. The operations geologist will lead the team's well-planning process and support the team's efforts to optimize well locations. They will be responsible for the evaluation of all geologic-related services supplied at the well site and

will be the focal point between subsurface and D&C (drilling and completion) during the execution of any operation."

Initial assessment work, supported by offset wells, seismic data, and industry activity has demonstrated that the emerging Haynesville Shale of East Texas has the potential to deliver in excess of 500 MMboe net BP resources. Appraisal drilling coupled with the acquisition of proprietary state of the art 3-D appraisal seismic, will commence in 2009, with the first development drilling commencing in 2010. If the play is proven successful, BP's incumbent acreage position has the potential to support an eight rig level loaded multiyear development program.

Referring to the Woodford shale acquisition in BP's *Horizons* magazine in October 2008, Andy Hopwood, BP's North American (NA) Gas strategic performance unit leader, said, "This is an important move for NA Gas. As natural gas prices rise in North America, BP has determined that investment in shale gas development aligns with our plans for growth.

"This is our first major investment in shale gas. Not only will its production put NA Gas on a path to exceed output of 500 boe/d, it will also serve to bring great lessons in the appraisal and development of our Haynesville shale gas play," he added.

BP started seriously investigating shale gas in 2006 as the Barnett play in north Texas exploded. The company put a multidisciplinary team together to locate and appraise shale basins. They devised a ranking system for shales, and the deals for Woodford and Lafayette shales, along with existing holdings with Haynesville potential, obviously ranked high on that list.

"If we didn't go forward and brave the new challenges of shale gas, BP would be missing out on a major new direction for gas supplies that will highlight the next two decades," Hopwood said. ■

Berry Petroleum Corp.

Berry Petroleum Corp. entered the Haynesville shale play earlier in 2008 as it purchased producing properties in two gas fields in East Texas. The Haynesville is a bonus in this transaction, since the company didn't include the Haynesville and Bossier shales in the transaction value. Those plays offer the company substantial upside potential in both existing stacked zones and the shales.

The purchase included Freestone Consolidated field

in Limestone County and Darco field in Harrison County.

Darco field in Harrison County covers 2,112 acres with 36 wells producing 7.6 MMcfge/d gross, 5.9 MMcfge/d net. Average estimated ultimate recovery is 1.5 Bcfge from Cotton Valley and Travis Peak on 40-acre infill spacing with vertical wells. During 2008, four vertical wells completed in Haynesville tested at an average initial production rate of more than 1.2 MMcfge/d per well. The field lies some three miles northwest of Penn Virginia's Fogle #5H horizontal well, a well that tested at more than 8 MMcfge/d from Haynesville. Berry has one rig running, drilling on 40-acres spacing and recompleting additional zones in existing wells.

Berry plans a Haynesville horizontal test in Darco field during 2009.

Freestone field in Limestone County covers 2,641 acres with 97 wells producing 34.7 MMcfge/d gross, 27.1 MMcfge/d net, with an estimated ultimate recovery of 3.3 Bcfge per well from the conventional zones. Currently, the company is drilling 20-acre infill wells to develop the Cotton Valley lime, Bossier sand, and upper and lower Cotton Valley sand. It's also working on shallower Travis Peak and Pettit formation wells. The company has test gas from several Bossier shale completions and sees upside potential in the Cotton Valley lime and the Bossier shale. ■

Bridas Energy USA Inc.

Bridas Energy USA Inc. (BEUSA) landed a spot in Bethany-Longstreet field in De Soto Parish in the North Louisiana oilpatch in 2003, started drilling immediately, maintained a leadership position in the stacked pay zones and carried that lead into the Haynesville shale.

It bought into the area with a joint venture agreement with Cadence Resources Inc. on some 3,200 acres of properties in the field and earned interests by drilling wells.

Two years later, after Aurora Oil & Gas Corp. acquired Cadence, BEUSA bought out Aurora's share of the play for US \$4.75 million. Shares ranged from 22.5% to 45%. At that time, the sale involved 1,657 acres with 14 wells. Twelve of those wells produced 400 MMcfge/d net and contained an estimated 1.46 Bcfge in net proven reserves.

The properties included the east half of sections 29 and 32 and all of sections 27, 28, 33, and 34 of township 13n-15w.

Since that time, it expanded its operations into township

12n-15w and 13n-14w still in Bethany-Longstreet field.

Primary targets were the Hosston and Cotton Valley formations with some production from Pettet, but the company recently started investigating the Haynesville.

In June 2008, the company completed the Billy Joe Andrews 33-1 in Section 33-13n-14w from Haynesville perforations between 11,909 ft and 12,012 ft in the 12,450-ft vertical well. The Bethany-Longstreet field well tested at 452 Mcf/d of gas on a 12/64-in. choke with 923 pounds of pressure.

In late November, the US affiliate of Bridas Corp. of Buenos Aires, Argentina, had 14 wells permitted, drilling, or being completed in the field, all scheduled to Cotton Valley or Haynesville.

The company specifically designated the Christal Holmes 20, in Sec. 20-13n-15w as a Haynesville well. It drilled the vertical well to 12,296 ft and was waiting on completion tools.

It also designated the Mary Belle Smith 28 as a Haynesville well in Sec. 20 of the same township. That well was projected to 15,790 ft, including a 4,550-ft horizontal leg aimed due south.

It also completed the Martin Timber Co. LLC 20 to Cotton Valley at 10,500 ft and tested the well for 3.18 MMcf/d of gas. It then went back into the well, drilled to 12,331 ft, and was testing the well, probably in the Haynesville formation.

In addition, it permitted the Eloise Christian 30 with a target depth at 12,500 in Sec. 30. That depth also is consistent with the Haynesville formation. ■

Cabot Oil & Gas Corp.

Cabot Oil & Gas Corp. leaped off a US \$602.8-million acquisition in mid-2008 to land in the Haynesville shale as one of its core areas.

That acquisition ramped the company's Haynesville-prospective area to more than 135,000 acres, up from nothing a year earlier. It included leases and existing infrastructure. With that acquisition, Cabot added the Haynesville to its existing core in the Marcellus shale in Pennsylvania and West Virginia.

Together, they account for \$2.4 billion of the company's \$5 billion valuation.

One of the bonuses associated with the Haynesville play is the stacked pay in the area, and Cabot has that potential in its Minden, Trawick, and County Line fields in East Texas.

Minden field splits the border of Panola and Rusk

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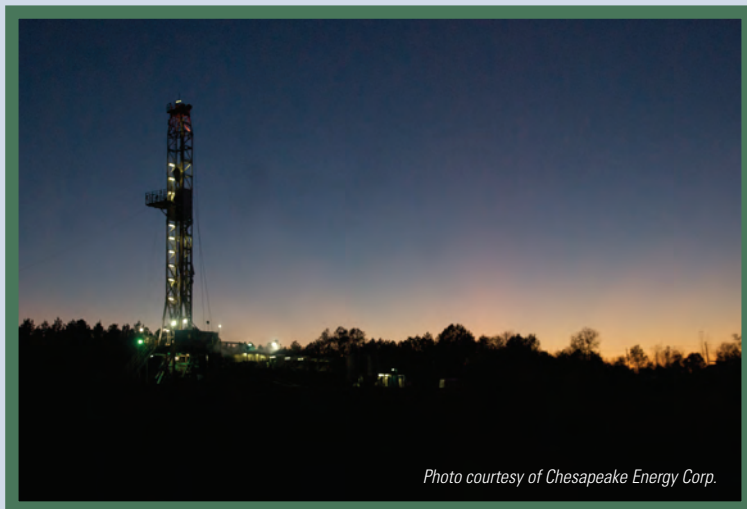


Photo courtesy of Chesapeake Energy Corp.

Caddo Parish, La., one of the hottest areas in the Haynesville shale play, hosts NOMAC rig #46 as it drills the Muslow Land and Timber No. 21 H-1 horizontal well to Haynesville for Chesapeake Energy.

counties. The company had 12,700 acres and added another 25,000 gross acres during 2008. It has drilled 13 wells into the Haynesville lime and drilled its first horizontal well into the Haynesville shale, at a vertical depth of 10,700 ft, immediately above the lime. It hasn't released results from the shale test yet, but its lime wells at 11,300 ft, have shown initial potential between 650 Mcf/d and 2.3 MMcf/d.

In that field, Cabot has drilled 80 wells and acquired another 63 wells in the Travis Peak, Cotton Valley and Haynesville. It also has potential production from the shallower Rodessa and James and Pettet limes.

The Haynesville shale horizontal well, with a 4,000-ft lateral, has a potential estimated ultimate recovery of 3 Bcfge to 6 Bcfge for a completed cost of \$5 million to \$6 million.

It already drilled a vertical Haynesville shale well in the field for 1.6 MMcfge/d.

Goodrich Petroleum Co. also brought in Haynesville shale production from vertical wells immediately north of Minden field.

A similar vertical Haynesville shale well in the company's Trawick field, the TGU 1-101, tested for 3.3 MMcfge/d with 1,800 psi of flowing casing pressure. That field is on the border of Rusk and Nacagdoches counties.

Trawick has produced 1.2 Tcfge of gas from the James, Pettet and Travis Peak formations, and another 5.3 Bcfge came from two Cotton Valley, two Haynesville lime and one Haynesville shale wells.

Cabot is running one rig in the field to drill at least eight wells to earn working interests from 50% to 100%. It is drilling horizontal wells to both the Hay-

nesville shale and the James lime.

According to Cabot, Trawick has between 180 and 220 Haynesville shale locations with potential of 360 Bcfge to 880 Bcfge in reserves.

It also is drilling a Haynesville shale well in County Line field, which straddles the borders of Nacagdoches, St. Augustine, and Shelby counties. Current production from that field comes from James lime and Pettet.

According to Dan O. Dinges, president and chief executive officer, "We are in the largest land grab in decades, particularly in the East and East Texas."

That grab and subsequent drilling has put a strain on materials. "We continue to work with vendors to secure the frac sand for our completion operations," Dinges said in early December. "Currently we expect the horizontal Haynesville/Bossier shale at Minden and the deep vertical test at County Line both to be fraced in mid-December."

Cabot faces a situation common to companies working this area. It was testing its Pinkerton 12H horizontal Haynesville lime well in December after drilling the 3,100-ft horizontal section for a total depth of 14,407 ft. It fractured that well in eight stages with 1.6 million lb of proppant.

That completion and other company wells were delayed because of a lack of proppant available in the area, he said. ■

Camterra Resources Inc.

While other companies are starting to look seriously at the working in Northwest Louisiana and the Haynesville, Camterra Resources Inc. has an established program with several wells drilled, waiting on tools, or permitted in the play.

The subsidiary of The Carlisle Cos. is no newcomer to the business. As far back as 1993, it acquired the US assets of Norway's Neste Oy, and it has operations in six states.

The company is testing the Hosston at 11,000 ft in Bryceland field in Bienville Parish, La., and has another nine Lower Cotton Valley wells permitted, testing, or waiting on state permits in Elm Grove field in Caddo Parish.

The company's Haynesville operations currently lie in Caspiana field in De Soto Parish where it has six wells either planning or working at depths from 11,935 ft to 15,469 ft. All the wells are in township 15n-14w.

Camterra is cleaning the hole in its Hall 9 horizontal

well in Section 6, and it set casing at 11,935 ft as waiting on completion tools at the Newport Development LLC well in Section 1.

It has permitted the Otto Turner 2 in Section 2, the Brown et al 10 in Section 10, the Dalton 4 in Section 4, and the Slattery Co. 25 in Section 25.

It also has drilled the Evans 34 No. 1 well in Sec. 34-16n-14w where it found the Haynesville between 11,255 and 11,830 ft.

No test or completion information has been made public on any of the wells.

Chesapeake Energy Corp.

Chesapeake Energy Corp. entered the Haynesville shale play early, put its reservoir experts to work learning the shale's secrets, gathered a massive chunk of land in the sweet spot, and has started an aggressive program to earn payback for its investment.

That's Chesapeake's style. It's the technique and commitment that made it the top natural gas producer in the US by the end of the third quarter of 2008 with an average daily production of 2.138 Bcf/d, or 3.5% of total US production. By the end of 2009, the company plans to reach 2.475 Bcf/d and climb to an average 2.88 Bcf/d the following year.

It was on track to hit those numbers in early November. Company production rose 23% in 2007, targeted another 17% in 2008, and Chesapeake had activity in place to grow 17% in 2009 and 16% in 2010 as it transferred gas from its 12.1 Tcfge in proved reserves. It also planned to raise that number to as much as 15 Tcfge by the end of 2009.

It's also the top driller in the country with a peak 158 operated rigs in August 2008 to less than 130 in November and an anticipated drop to as low as 110 rigs in 2009.

Chesapeake lowered its drilling capital expenditure budget by 31%, or US \$2.9 billion combined, for 2009 and 2010, and cut its acquisition budget by \$2.2 billion over the same period. Between the end of July 2008, and the end of the same year, it had trimmed those combined budgets by \$9.8 billion, or 58%, to \$7.2 billion in response to an economy that shows lower demand and offers lower prices.

In spite of the cutbacks, the company anticipates 5% to 10% higher production by the end of 2009 and 10% to 15% production growth in 2010 to finish the decade with production at 2.7 Bcfge/d.

Chesapeake specializes in resource plays, like the Haynesville and Marcellus, where it is number one or two in most plays. It has lined up some 60 Tcfge of risked, unproved reserve potential and 190 Tcfge of unrisked unproved reserves in those plays with a drilling inventory of 37,300 net drilling sites on 15.6 million net acres.

POSITION

Chesapeake calls the Haynesville its largest discovery and expects it to become the biggest natural gas field in the US.

The company accumulated some 700,000 gross, 480,000 net, acres in the 3.5 million acres covered by the play in Northwestern Louisiana and East Texas. Those acreage numbers are effective after it sold a 20% interest in 550,000 gross acres to Plains Exploration and Production Co. in mid-2008.

That acreage give Chesapeake around 3,000 risked, net undrilled well sites with average reserves of 6.5 Bcfge per well. That's the mean number in a range between 4.5 Bcfge and 8.5 Bcfge for the core area.

At the end of the third quarter of 2008, it had 200 Bcfge of proved reserves in the Haynesville with 14.4 Tcfge of risked unproved reserves and 29 Tcfge of unrisked unproved reserves.

Production at that time had reached 65 MMcfge/d gross, 50 MMcfge/d net, from 16 horizontal and one vertical well.

That number will grow rapidly. Chesapeake had 14 operated rigs working the play in late 2008, but it will add another 21 by the end of 2009. That growing rig count should boost Haynesville production to 80 MMcfge/d by the end of 2008, 325 MMcfge/d by the end of 2009, and 615 MMcfge/d by the end of 2010, according to a company presentation.

The sweet spot makes good wells. The company's initial production from its first eight horizontal wells ranged from 5 MMcfge/d to 15 MMcfge/d on a restricted choke with flowing casing pressures as high as 6,500 psi.

Chesapeake started its work on the Haynesville on a block of acreage it held in southern Caddo and Bossier parishes in Louisiana. Between January and September 2007, it drilled five vertical wells to the formation and cored four of them. It analyzed that information and data from 100 additional wells at its Chesapeake Reservoir Technology Center, and then it put an army of landmen to work getting leases in an

area internally called “the Blob.”

Figuring 3 million acres, or 4,700 sq miles, in the Blob and 52 Bcfge of gas in place per square mile, the gas-in-place number works out to 244.4 Tcfge.

FINE TUNING

One way Chesapeake added value to its Haynesville holdings was by selling a big piece. Big production requires a big investment, and Chesapeake has put \$4 billion into the play. But its deal with Plains gave it back 80% of that investment at a cost of 20% of its potential.

Chesapeake sold 20% of 550,000 net acres for \$3.3 billion. Half of that came in as an upfront payment. The other half eases in as Plains carries Chesapeake on drilling and completion costs.

The deal lowered Chesapeake’s risk as well as its costs, and, with Plains bearing much of the future drilling, it also moved production from the play forward.

It lowered Chesapeake’s average land costs by 77%, to \$1,600 per acre from \$7,100 per acre. As the play reaches its peak, an average acre could be worth \$50,000. Prices already have climbed past the \$30,000 mark.

According to Chief Executive Office Aubrey K. McClendon, “This transaction establishes a \$16.5 billion valuation for our Haynesville shale leasehold, all of which is located in the core area of this very significant discovery.”

Plains’ carrying contribution on wells, he added, offers “exceptional finding costs from this play of less than \$1 per Mcfge.”

- Chesapeake’s early wells averaged about \$6.5 million to drill and complete, “and we anticipate that we will be able to reduce these costs by at least 10% once full-scale development of the play is under way based on other shale play experience,” McClendon added.
- Section-sized superpads also will lower costs. It can drill eight horizontal wells — north and south — per pad on 80-acre spacing. Laterals currently are about 4,500 ft long. They system also offers a shared surface imprint, fewer rig moves and allows the company to run gathering lines east and west along section lines between pads.
- In October 2008, the company had added more sand — 650 to 750 lb per lateral foot — to its completions and increased its use of slickwater

systems. It was working on improved drill-out and clean-out operations, decreased perforation clusters to 60 ft from 100 ft, and increased frac stages to 10 from five, according to John Kapchinske, vice president of geosciences for the company’s southern division and John Sharp, geoscience manager for Louisiana.

- Chesapeake also takes advantage of economics of scale for services and materials on its massive operation.

In early January 2009, on property shared with Goodrich Petroleum and Plains, Chesapeake completed the Holland 17H-1 for 14.5 MMcfge/d on a ²⁴/₆₄-in. choke after drilling to 16,200 ft, including a 4,400-ft horizontal lateral. That well is in the Bethany-Longstreet field area of Caddo County, La.

Comstock Resources Corp.

Comstock Resources Corp. has a solid grip on properties in North Louisiana and East Texas and runs an active drilling program. Most of its production comes from wells shallower than the Haynesville shale, but the company is digging deeper.

During the first nine months of 2008, it drilled 96 gross, 49.5 net, successful wells in the territory. Successful means they tested at an average rate of 2.7 MMcfge/d. That drilling included 35 gross wells in the Hico Knowles-Terryville area in Louisiana for an average 3.7 MMcfge/d and 33 gross wells in Logansport field in Louisiana for an average 1.5 MMcfge/d initial potential. It also drilled four successful horizontal Cotton Valley wells in Waskom and Blocker fields in Harrison County, Texas, for an average 7.5 MMcfge/d.


The company’s activity also includes active Haynesville shale activity where it had four horizontal wells drilled and being completed. Its BSMC LA 7 #1 H well in Toledo Bend North field went to a vertical depth of 11,750 ft with a 4,300-ft lateral. The company completed the well with a 10-stage frac job and, in early December, produced at an initial rate of 9 MMcfge/d. Comstock has an 88% working interest in that well.

Its second horizontal Haynesville well, the Collins LA #15 H in Logansport field, went to 10,350 ft with a 4,200-ft lateral. The company was completing a 10-stage frac job in December. It has a 100% interest in that well and a 22% interest in the Gamble 24 #1 H well in the same field. That well reached a vertical depth of 11,800 ft before extending a 3,950-ft lateral.

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Photo courtesy of Cubic Energy Inc.

Dozens of rigs explore for vast gas potential in the Haynesville shale.

It drilled the Bogue A#6 H well in Waskom field to 11,400 ft vertically, and Comstock plans a 4,000-ft lateral. It also drilled the vertical portion of the Green #13 H in Blocker field to 11,650 ft and plans a 3,700-ft lateral.

Comstock also planned to complete the vertical portions of three wells by the end of the year. They were the Headrick #1 H and Hart #1 in Logansport field and the Moneyham #7 H in Longwood field. It plans 4,000-ft laterals on each of the wells.

In all, the company has 82,796 gross, 67,918 net, acres with Haynesville potential. On 80-acre spacing with 3.5 Bcfge to 4 Bcfge per well, the resource potential could reach 2.2 Tcfge to 2.5 Tcf from properties in Harrison, Panola, and Rusk counties in Texas and Bossier, Caddo, De Soto, and Sabine parishes in Louisiana.

For 2009, Comstock will drill some 76 gross, 55.9 net, wells. That's fewer wells than it drilled in 2008. It will concentrate its drilling program in 2009 of higher-return properties, including the Haynesville shale, where it will spend some \$399 million.

Comstock's Haynesville program will consist of 43 gross, 32 net, horizontal Haynesville wells and includes two wells in Longwood field, seven wells in Waskom field, six wells in Blocker field, and one well each in Beckville and Darco fields, all in East Texas. In Louisiana, the program includes 12 wells in Logansport field, eight wells in North Toledo Bend field, and another three wells in South Toledo Bend field. ■

Continental Resources Inc.

Continental Resources Inc., one of the biggest fish in the Bakken shale play in North Dakota and a good catch

in other shale basins entered the Haynesville shale in Louisiana as a minnow.

In addition to some 577,000 net acres in the Bakken, the company holds 46,000 net acres in the Woodford shale in Arkoma Basin of Oklahoma; 88,000 acres in the Marcellus, Rhinestreet and Huron in Appalachia; 46,000 acres in the New Albany; 27,000 acres with Lewis potential in Wyoming, 110,000 acres in the Woodford shale play in the Anadarko Basin, and 67,000 acres in the Barnett-Woodford play in the Marfa Basin of West Texas. In all, that's about a million acres in resource plays.

During the first quarter of 2008, the company allocated US \$27 million to fund property acquisitions in the emerging plays such as the Haynesville in Louisiana, the Marcellus in Pennsylvania, and the Huron on Ohio and West Virginia. Operations went so well, directors raised the capital budget by \$167 million and allocated \$51 million of that to the emerging plays. "We clearly have tremendous growth opportunities ahead of us. We are focused on growing production, reserves and our lease position, particularly in resource plays, which we believe will create significant additional value for our shareholders for many years," said Chairman and Chief Executive Officer Harold Hamm at the time.

By the second quarter, the company had 17,000 acres in Louisiana and planned to spud its first well in the fourth quarter of 2008. That property position grew to 20,000 acres in the third quarter, 26,000 acres in the fourth quarter and the company began preliminary work for a well in De Soto Parish in Louisiana.

As oil and gas prices fell in the fourth quarter, the company reduced its rig count to reflect lower prices, but it apparently planned to continue its Haynesville work. ■

Cubic Energy Inc.

Cubic Energy Inc., working off its existing Cotton Valley properties in Caddo and De Soto parishes in Louisiana, is one of the more active smaller operators in the Haynesville shale play as it works through a venture with operator Fossil Operating Inc.

The company holds 12,000 gross, 6,326 net, acres, of a majority position in 12 sections in two parcels on the southeastern flank of the Sabine uplift. The parcels are parts of Johnson Branch and Bethany Longstreet fields and property held by Chesapeake Energy and Goodrich Petroleum surround Cubic's holdings.

In mid-January 2009, Cubic said it elected to partici-

pate in the Chesapeake HA RA SUM S Mitchell 12-15-16H1 horizontal well. Chesapeake plans to drill the well to 16,500 ft with a completion in Haynesville in Section 12-15n-16w in Johnson Branch field in Caddo Parish, La. Cubic will have a 2.5% working interest in the well.

"Participating in the S Mitchell well will give Cubic's technical personnel valuable insights in the methods and technology that Chesapeake has been developing. Their expertise in this area and the Haynesville is cutting edge. This well will give Cubic valuable resources to use in our own operated acreage," said Calvin Wallen, president and chief executive officer.

An analysis estimates Cubic's land contains between 217 Bcfge and 245 Bcfge of gas in place per section.

By September 2008, the company's fifth well, the Red Oak Timber 5 No. 1, to the Haynesville formation reached total vertical depth at 11,950 ft. It was the second well on its southern Bethany Longstreet property. The other three vertical wells were in Johnson Branch field.

Both this well and the Estes 7 No. 1 in the same field encountered comparable thickness and quality to producing wells in Johnson Branch and Caspiana fields, according to Richard Sepulvado, vice president of exploration and production. Cubic has a 35% interest in wells in this field with Fossil Operating as operator and a 49% interest in wells in Johnson Branch field.

By the end of 2008, it had participated in 12 producing wells in Johnson Branch field and another 10 wells in the Bethany Longstreet field in De Soto Parish, La.

It hasn't released production details on any of its Haynesville wells.

Delta Petroleum Corp.

Delta Petroleum Corp. entered the Haynesville shale play with a formula that has proven successful for decades in the oilpatch.

According to the company's Web site, "We believe that our ongoing development of reserves in our core area should be supplemented with exploratory efforts that may lead to new discoveries in the future. At Dec. 31, 2007, we had significant undeveloped, unproved acreage positions in both the Columbia River Basin (in Washington) and the Central Utah Hingeline plays, each of which has gained substantial interest within the exploration and production sector due to their relatively unexplored nature and the potential for meaningful hydrocarbon recoveries."

The company also lists oilpatch veterans with proven track records of success on the board of directors.

During the second and third quarters of 2008, the company expanded its exploratory efforts with the acquisition of 16,000 net acres in the Haynesville shale play in Caddo Parish, La., and Harrison, Shelby, and Stagecoaches counties in Texas.

It paid approximately US \$35 million from the properties and plans to use existing staff members in its Southeast Texas operations to line up a site for initial drilling early in 2009.

To keep drilling expenditures within corporate cash flow, Delta planned to spend \$150 million to \$175 million in 2009, but that budget will include properties in the Piceance Basin, the Utah Hingeline, the Columbia River Basin, and one well in the Haynesville shale. Delta has taken a good look at current prices. It dropped its drilling budget to about \$85 million in 2009 with 88% of that budget aimed at its core Rocky Mountain properties.

Devon Energy Corp.

Devon Energy Corp., the biggest producer in the Barnett shale play in North Texas, zeroed in on the Haynesville shale during 2008 to become one of the largest leaseholders in the play.

In a May 2008 presentation, Devon didn't even mention the Haynesville among its solid development areas, although it mentioned East Texas among its emerging plays.

The company did have existing production in East Texas with an average 83% interest in 137,000 net acres in the Groesbeck area and Carthage, Waskom, Bethany, Stockman, and Appleby fields in Shelby, Panola, and Harrison counties. All three counties are prospective for Haynesville shale, but production came from Cotton Valley, Travis Peak, Pettet, and Bossier sands.

Devon already had some 2,000 wells in those fields, including horizontal wells.

By early August, the company revealed that it had assembled 483,000 net acres with Haynesville shale potential, and that it was one of the largest leaseholders in the properties, according to a Seeking Alpha report. Much of that property was held by production from shallower zones in fields it already operated in the area. For comparison, Devon had 727,000 acres in the Barnett shale at that time.

At that time, Devon said its average royalty was less than 25%. It also said it anticipated drilling its first Haynesville horizontal well in the third quarter of 2008. It already had 14 vertical shale wells.

With the announcement of the added acreage during a conference call, Devon estimated its Haynesville potential reserves at 73 Tcfge.

Asked about drilling plans and potential production, Darryl Smette, senior vice president of marketing and midstream operations, said, "Other parties have suggested it will be a very robust area, but there's still a lot of work to do. Assuming the work is successful, we'll probably need greenfield projects two or three years down the road."

By November, the company raised its Haynesville position to some 580,000 net acres with a royalty exposure of less than 20%. It planned to drill two Haynesville horizontal wells in the fourth quarter.

The company had no reason to push the Haynesville play. It still was busy developing its Barnett holdings with promises of faster returns, and it was ramping up its Woodford shale activity where it had gotten initial potential production of 7.1 MMcf/d and 6.7 MMcf/d on two horizontal wells.

In the third quarter, it had collected \$3.8 billion for its sales of gas, natural gas liquids, and oil during the second quarter as higher prices raised revenues 65% from the same quarter a year earlier. Net income came in at a record \$2.6 billion in spite of curtailed production from BP's 400,000-b/d Azeri-Chirag-Guneshli field in the Caspian Sea offshore Azerbaijan. Devon has a minority interest in that field.

The record also includes some 1.5 million boe of Gulf of Mexico production lost to hurricanes Gustav and Ike.

By the time of the company's third-quarter report, company president John Richels said the Haynesville could be in the same league as Devon's Barnett shale holdings. At that time, Devon produced 2% of total gas from the country in its Barnett operations at 1.1 Bcfge/d and planned to raise that number to 1.2 Bcfge/d from 3,800 Barnett wells by the end of 2008.

By that time, it also had raised its Woodford shale production to 50 MMcf/d in Eastern Oklahoma.

In East Texas, the company started production on three horizontal gas wells in the third quarter with average initial rates of 17 MMcfge/d.

That's flush production by any standard, but news

from the Haynesville was even better. Devon had drilled two horizontal gas wells in the Carthage area with initial production rates of 26 MMcf/d and 22 MMcf/d. Those wells, however, were in the Haynesville lime, not the shale.

The porous lime lies immediately below the shale, but it covers a much smaller area than the shale. Where the lime exists and contains gas, estimated ultimate recoveries run as high as 8 Bcfge.

As Devon moves into the Haynesville shale, the company will bring with it the refined operations techniques it put to work in the Barnett and in the shallower East Texas zones.

In the Barnett, for example, the company started a recycling program to reclaim the water used in the massive fracture treatments. It heated the recovered frac water and condensed it to manufacture distilled water for other wells. Between 2005 and 2007, it had recycled more than 5 million bbl of water.

During that time, the company's learning curve cut drilling and completion times in half and increased average well production by 15%.

Dynamic Resources Corp.

Dynamic Resources Corp., a 20% partner in 5,300 acres in Sentell field in Bossier Parish, La., participated in its second Haynesville shale test and raised fund to continue activity in the popular play.

Southern Star Energy is the operator with a 40% interest and Ramshorn Investments Inc. holds the remaining 40%.

The companies have been drilling successful Cotton Valley wells in the field and decided to go after the Haynesville shale, as well, in 2008. With one Haynesville well on the books and the follow-up well drilled through Cotton Valley on the way to Haynesville, the company borrowed US \$6 million to finance its share of development costs in the field.

Robert Fedun, president, said, "These funds give Dynamic the ability to pursue our aggressive development of the Sentell field. In our next phase of development, our plan is to drill at least six Cotton Valley wells and two Haynesville wells, and this financing gives Dynamic the capital to fully fund this program and move the company toward capital self-sufficiency."

The operator set intermediate pipe at 9,530 ft in early November and drilled and logged the Haynesville at 11,300 ft on the A.S. Burt 20-1 vertical well in the south-

west portion of the field with “positive results.” This is the second Haynesville well in the program.

The Atkins-Lincoln 17-2, in the center of the field, was the first Haynesville well in the series. That well found rock with “encouraging properties” and the companies sent samples to Core Laboratories for petrophysical analysis before completing the well.

After the Burt well, Fedun said, “This well is also our second test of the Haynesville shale, following our successful initial Haynesville test in the Atkins-Lincoln 17-2 in October. We believe this test will further define the presence and extend of pay in the Lower Bossier/Haynesville within this play, which would represent significant additional value.”

That first well reached 205 ft of highly laminated silty, naturally fractured shale with cross-plot porosities from 9% to 12% characteristic of the Lower Bossier shale. Below that interval, the well encountered 185 ft of black organic, rich shale characteristic of the Haynesville shale.

The Burt 20-1 well reached 11,220 ft in late November 2008 and logged 312 ft of highly laminated, silty, and naturally fractured Haynesville with shale-corrected porosity of more than 12% and resistivity between 20 and 70 ohm-meters. The operator recovered more than 120 ft of core in key intervals of the shale started core analysis.

Combined with core results from the Atkins-Lincoln 17-2, the companies plan to optimized completion designs. ■

El Paso Corp.

El Paso Corp. likes predictability in its operations. That’s one advantage of its pipeline activities that it is carrying over to oil and gas work.

The Peoples Energy Production Co. acquisition for US \$879.1 million last year was part of that plan, and the company also is aiming for more production from plays such as the Haynesville, Pierre, and New Albany shales.

The Haynesville shale and tight Cotton Valley sand fit into the corporate plan, and El Paso is counting on production from its Holly/Logansport and Bethany-Longstreet fields in Northwestern Louisiana and its Minden/Southeast Brachfield area in East Texas, all prospective for Haynesville. The Haynesville shale is thinner in Texas and those fields are less prospective than the prime Louisiana properties.

The company started four horizontal wells in the Cot-

ton Valley by early November 2008, two producing and two drilling. The wells cost between \$6 million and \$7 million to drill and El Paso completed the wells with five or six frac stages.

The Lindy Britton #2H tested with an initial potential of 7 MMcfge/d, and the Sample H #5 tested for 3.2 MMcfge/d, according to state figures. The company planned three more horizontal Cotton Valley wells through the end of 2008.

El Paso also completed its first two wells in the Haynesville shale in the third quarter of 2008. The Miller Land Co. 10H #1 offered an initial potential of 4.5 MMcfge/d, while the Travis Lynch GU #4-H tested for 8 MMcfge/d.

The company had not completed the RF Gamble 24H #1 and still was drilling the Blake 10H #1 horizontal Haynesville wells at the end of 2008.

El Paso learned from its experience on the Miller Land well. It increased the number of frac stages to 10 and increased drilling and completion efficiency on the Travis Lynch well. The improvements showed in nearly doubled production. That doesn’t mean the Miller Land was a bad well. The well came in with an initial production volume of 3 MMcfge/d.

In addition to the wells, El Paso expanded its Tennessee Gas Pipeline subsidiary’s Carthage pipeline system in East Texas with a \$39 million investment to expand takeaway capacity. ■

EnCana Corp.

EnCana Corp. qualifies as an East Texas stalwart with operations dating back to 2004 when it got into the deep Bossier and Cotton Valley plays, and it has grown the territory and the plays into a corporate core.

By the end of the third quarter of 2008, the company produced 400 MMcf/d of gas from the area, up from 143 MMcf/d at the end of 2007. In context, that’s a substantial portion of its 3.9 Bcf/d of total gas production and a strong contributor to the company’s 16% production growth from gas resource plays in the third quarter of 2008. That growth also put its Louisiana-Texas operations ahead — in terms of potential for higher returns — of its substantial assets in Jonah field in Southwestern Wyoming.

EnCana acquired its first Haynesville leases in 2005 and drilled the first three vertical wells on those properties the following year. In 2007, the Canadian producer signed a 50-50 joint exploration agreement with Shell Exploration & Production for the Haynesville play.



Back Then You Didn't Always Follow the
Conventional Wisdom.



David's interests in the 1970s:

1. Dance Steps to "Stayin' Alive"
2. Date on Saturday Night
3. Fast Car
4. Gas Money for Fast Car



And Today You Still Look for *Unconventional* Opportunities
Where Others Only See Obstacles.

So check out this unconventional offer.



David's interests today:

1. Watching "Dancing With the Stars"
2. Latest New Release from Video Store
3. Fast Car and Family Car
4. Unconventional Gas Strategy

Corn isn't the only crop in Haynesville country. This EnCana rig prepares to harvest the deep Haynesville shale.

They drilled three vertical and two horizontal wells in the promising shale. The results from those wells were promising enough that they increased their rig count for the Haynesville from two to seven gross rigs by the end of 2008.

By mid-June 2008, EnCana had accumulated a net

325,000 acres of land with Haynesville potential. In the third quarter, it bought 25,000 net acres of Haynesville land for US \$101 million, and it arranged to buy another 89,500 acres of shale properties from Indigo Minerals LLC for \$457 million.

Those properties were in Northwestern Louisiana. That gave EnCana a position of more than 400,000 net acres plus another 63,000 net acres of mineral rights.

"EnCana, along with our partner, Shell Exploration & Production, has an industry-leading land position in this area of Louisiana. We currently have six rigs running with a focus on cost reduction and completion optimization," said Randy Eresman, EnCana's president and chief executive officer.

EnCana offered some strong reasons for its attachment to the Haynesville play during an October 2008 presentation.

The full-cycle supply cost for Haynesville gas comes in at slightly more than \$4/Mcf. Among shale plays, only the core Barnett area, at \$3.50/Mcf, is better. EnCana's Horn River shales in British Columbia match the Haynesville at a little more than \$4/Mcf.

Among other shales, the first-tier Barnett step-out area costs about \$4.50, the Marcellus shale \$5, the Woodford shale core and the Utica shale \$5.50, the Fayetteville almost \$6, more than \$6 for the Raton Basin Pierre, \$6.75 for the non-core Woodford, slightly more than \$7 for the Pearsall shale in the Maverick Basin, \$7.75 for the tier 3 Barnett step-out area and the Niobrara in Northwestern Colorado, and nearly \$8.25/Mcf for gas from the deep Baxter shale in the Vermillion Basin of Southwestern Wyoming and Northwestern Colorado.

Jeff Wojahn, executive vice president of the company and president of the US division, said the company is excited about the potential of the Haynesville. "It's a tremendous resource with tens of Tcfs of resource for EnCana," he said. By the end of 2008, the company planned to drill five vertical and two horizontal Haynesville wells.

Its first horizontal well, announced in February 2008, came in with an initial potential of 8 MMcfge/d, the rate of some of the largest Barnett shale wells. Its second horizontal well pegged at 15 MMcfge/d in the first couple days of testing.

The attraction of the Haynesville play has its disadvantages. EnCana got its earlier leases with royalty rates of 15 to 20%, but it paid 25% on the later leases



Photo courtesy of EnCana Corp.

Rate of Return

Source: Encore Acquisition Co.

	8 Bcfge well	5 Bcfge well
\$9.50/Mcfge	203%	65%
\$8.00/Mcfge	124%	43%
\$7.00/Mcfge	91%	33%

as the land grab accelerated. Lease terms also dropped from five years to three years.

From EnCana's point of view, the company must find and categorize its properties for production potential quickly to decide which properties it will keep and which it will relinquish. That leaves the company little time to refine its completion techniques.

In contrast, the lease terms in the company's Horn River Basin play, where it holds 220,000 acres, are longer. It can work on completion techniques without rushing to evaluate parcels.

That comparison is particularly good, since both plays represent the same potential for EnCana. "These are very meaningful positions, each with the potential to ultimately achieve production levels approaching 1 Bcf/d (of gas) net to EnCana, which is comparable in size to the potential we have announced in our more-established plays at Montney in Northeast B.C. (British Columbia) and Deep Bossier in East Texas," said Eresman.

As it refined its operations in its 120 MMcf/d Barnett concentration, EnCana ordered a fit-for-purpose rig for its operations there. It undoubtedly will take the same approach in its Haynesville operations.

The rig sits on a set of tracks that will allow it to move and EnCana uses it to drill as many as 20 horizontal wells from a single pad. That allows the company to drill faster with a smaller footprint and less noise.

It also implemented a technique to recycle frac fluids at its Barnett operation. ■

Encore Acquisition Co.

Encore Acquisition Co. increased its position in the Haynesville shale in 2008 and plans to add a drilling rig to begin developing its properties early in 2009.

The company closed an acquisition in mid-July that added 3,200 net acres in Greenwood Waskom/Stateline field at a cost of US \$54 million to its existing 10,000 net acres in the heart of the Haynesville play. It also held some 8,000 net acres in the extension area of the play for a total 21,200 net acres at that time.

As part of the deal, Encore got five units producing from Cotton Valley, and it will take over those operations. Encore holds an average 92% working interest and a 72% net revenue interest in the new properties.

During a November 2008 presentation, the company said it had no Haynesville production, but it did have 32.3 million boe in proved and probable reserves in the Haynesville, assuming 5 Bcfge in reserves in a horizontal well. It also assumed it would take \$8 million to drill and complete a Haynesville horizontal well.

By that time, its land position had grown to more than 40,000 gross, 22,600 net, acres, and it had 213 horizontal locations on 160-acre spacing in the play in East Texas and North Louisiana.

Among its Louisiana holdings were a 100% interest in the Haynesville in Greenwood Waskom field, a 26% interest in the Lower Cotton Valley and Haynesville in giant Elm Grove field, and a 25% interest in the Lower Cotton Valley and Haynesville in Caspiana field.

Of its 22,600 net acres, 16,000 are in the heart of the play.

Encore set aside \$88 million in its 2009 capital expenditure budget to employ one rig to work the stacked Travis Peak, Cotton Valley, and Haynesville formations. ■

EXCO Resources Inc.

EXCO Resources Inc., a heavy hitter in the East Texas-North Louisiana segment of Ark-La-Tex and in the Marcellus and Huron shales in Appalachia, is shifting from exploration and experimentation to development in its two shale plays.

With 119,800 net acres, the company's Haynesville land position stands to make strong contributions to EXCO's largest division, East Texas-North Louisiana. The company has substantial production in that area from upper and lower Cotton Valley, Travis Peak, Pettet, and Hosston zones.

The company raised its 2008 capital budget for the division to US \$481 million with \$90 million of that directed at leasing, drilling, and completing Haynesville assets.

The rate of return on Encore's Haynesville properties remains strong at prices of US \$7/Mcfge and higher.

Net Asset Value Per Well Reserves

Source: Encore Acquisition Co.

	PV 10 Nymex \$9.50	PV10 Nymex \$8	PV10 Nymex \$7
8 Bcfe	\$22.0 million	\$17.2 million	\$14.0 million
5 Bcfe	\$10.6 million	\$7.6 million	\$5.6 million

Encore's Haynesville wells offer a healthy payback on the company's investment.

The company doesn't have to be as frantic about drilling as many other companies. Some 60% of its Haynesville properties already are held by production from shallower zones. In spite of that, all but one of EXCO's eight Haynesville wells in four counties and parishes have been vertical, both to secure land by production and to analyze rock properties for better completions.

Vertical wells drilled to date are in Harrison County, Texas, and Caddo and DeSoto parishes in Louisiana. The wells have disclosed an average Haynesville-Bossier shale interval of 200 ft of net pay with high porosity and organic content that shows significant gas in place. Initial production rates on the verticals wells ranged from 800 Mcf/d to 2.8 MMcf/d of gas with 1,000 to 3,200 psi of flowing casing pressures. Two Haynesville wells in DeSoto Parish tested for 1.3 MMcf/d and 6,100 psi of flowing casing pressure and 1 MMcf/d with 6,600 psi of flowing casing pressure.

"We have plans for increased activity in the Haynesville shale in 2009, and accordingly have signed long-term commitments with drilling contractors for five 1,500 hp, top drive drilling rigs capable of drilling horizontal Haynesville wells," said Douglas H. Miller, chief executive officer.

Those rigs will help drill 20 shale wells and 141 conventional wells in the area with the 11 rigs already working.

It currently has five rigs working in the Shreveport area, which includes Holly/Caspiana and Longwood/Greenwood/Waskom fields, both of which lie in the prospective area for Haynesville. Rigs in that area have been drilling through conventional producing zones for additional potential production from Haynesville.

EXCO completed its first operated horizontal Haynesville well in mid-December 2008 after spudding in August. That well, the Oden 30H #6 in DeSoto Parish, reached a 12,304-ft vertical depth in a pilot hole, and the company took 180 ft of core before plugging back for a

4,481-ft lateral and drilling to a measured depth of 16,083 ft.

The company then conducted a nine-stage stimulation treatment with 3.2 million lb of proppant, completing the well for a five-day average production rate to sales of 22.9 MMcf/d of gas through a ²⁶/₆₄-in. choke with 7,800 psi of flowing casing pressure.

"This well is the largest single well in our company's history and represents the first of many horizontal drilling locations that we have in the Haynesville play," Miller said.

It planned to drill 25 or more Haynesville horizontal wells during 2009.

In addition to its drilling activities, EXCO acquired midstream operations in the area with throughput of 535 MMcf/d of gas. Some 60% of that gas comes from the company's wells. It also is completing a \$37.6 million, 57-mile TGG intrastate pipeline expansion to add another 100 MMcf/d of capacity.

That's a timely expansion as many companies seek to secure land through Haynesville production and EXCO shifts its 2009 focus to development.

Miller described the leasing situation for Haynesville-prospective properties in the Ark-La-Tex area. "Over in East Texas-North Louisiana, we've bid on a small deal that had some production and some Haynesville potential that offset our acreage a week ago. I think we bid \$40 million. The guy laughed at us and traded at double," he said. Acreage in the area sells between \$20,000 and \$30,000 an acre.

He added, "It isn't just Aubrey [McClendon, chief executive officer of Chesapeake Energy Corp.] buying it. There're a lot of players over there and this is not a hyped play. I don't know who pitched it out that Aubrey will hype it, but we're kind of on-board with some of Aubrey's numbers, and in some cases, we think Aubrey might even be low, so there's a legit play. I don't believe that there's going to be 200 rigs running there by the end of January and we're going to be at 2 or 3 Bcf a day, because rigs, 1,500-2,000 hp rigs,

just don't fall from the sky with 50 people (working the play)."

From EXCO's point of view, it has more than 2.7 Tcfge of proved, probable, and possible reserves in the Ark-La-Tex area with more than 3,000 undrilled Cotton Valley-Hosston locations and 1,400 drilling locations with Haynesville potential, assuming 80-acre spacing. ■

Forest Oil Corp.

Forest Oil Corp. plans establish a position as a strong player in high-return shale plays, along with its tight sand and conventional assets, and the Haynesville shale in Texas and Louisiana and the Utica shale in Quebec play a big role in that strategy.

Overall, the company has 4,943 shale locations in its pockets with a net unrisks potential return up to 9.57 Tcfge.

The Utica shale accounts for 3,390 locations and a net unrisks reserve potential of 4.14 Tcfge, while the Haynesville contributes 1,148 locations with 5.07 Tcf in net unrisks potential reserves.

In East Texas and Northern Louisiana, the company holds 193,000 gross, 143,000 net, acres and 140,000 gross, 106,000 net, acres are prospective for the Haynesville-lower Bossier shale. Most of its holdings are in Harrison County, Texas, and Red River, Webster, and Bienville parishes in Louisiana.

To date, Frontier has drilled 10 Haynesville-Bossier shale wells with initial potential production rates from 1.5 MMcfge/d to 4.4 MMcfge/d, and the company has spud its first horizontal well, according to a November corporate presentation.

It put one stand-alone vertical Haynesville-Bossier well on line in the third quarter at a production rate of 4.4 MMcfge/d. That's its best rate for any vertical well in the two-state area.

It drilled three Cotton Valley horizontal wells during the third quarter in the area with 9.9 MMcfge/d of initial potential from the best well and an average 6.6 MMcfge/d from all three wells. Overall, it has drilled 12 horizontal wells to that formation with an average 5.4 MMcfge/d of initial production.

The company already has three rigs working its Cotton Valley play in the area.

Forest planned to finish 2008 with production between 75 MMcfge/d and 80 MMcfge/d from all horizons.

The company plans to either drill or deepen 16 vertical

wells to reach the Haynesville in 2008. It already has started the laboratory work it needed to support the two or three horizontal wells it plans to finish drilling by the end of that year.

Forest will use the same technique in the Haynesville that worked for it in the Cotton Valley. That includes a pilot program in 2008 to analyze the shale and identify horizontal targets. "We will then follow that up with a combined vertical and horizontal program to optimize the economics in the play. Within this plan, Forest intends to commence a 2 - 3 well Haynesville/Bossier Shale horizontal program in the fourth quarter of 2008 based on its pilot program results. We are very excited about our proven results in the Cotton Valley and the potential of the emerging Haynesville/Bossier Shale play," said H. Craig Clark, president and chief executive officer. ■

Fossil Operating Inc.

Fossil Operating Inc. knows what the Haynesville looks like. It has driven drillbits into the field in properties in Louisiana.

At least for the present, the company is drilling vertical wells that could later be re-completed as horizontal holes.

According to the *Shreveport Times*, Fossil's Daniels 3-1 in Sec. 3-15n-15w tested for 253 Mcf/d of gas on a 22/64-in. choke with 20 b/d of water. It perforated Haynesville from 11,40 to 11,602 ft in the 11,750-ft well. That well is in Johnson Branch field in Caddo Parish, La.

Haynesville isn't the company's only target. In the same field, it completed the Wilbanks 31-1 to the Cotton Valley, a well that tested for 756 Mcf/d of gas on a 28/64-in. choke with 1,307 b/d of water from perforations between 9,086 and 9,708 ft in a 10,250-ft well.

That's one of the big attractions of the Haynesville play. The potential for profitable production from stacked zones reduces the chances for failure.

With Cubic as a 49% interest holder, the company has completed three vertical wells in Johnson Branch field.

The companies also worked together with Cubic as a 35% partner in properties in Bethany-Longstreet field, also in Caddo Parish.

Fossil drilled the Estes 7-1 vertically to 11,950 ft in Sec. 7-14n-15w in Bethany-Longstreet field and found a Haynesville thickness comparable to wells in Johnson Branch and Caspiana fields. That was the venture's first Haynesville well in the field.



Photo courtesy of Anadarko Petroleum Corp.

East Texas, one of the fast-emerging areas for the Haynesville shale play, keeps rig crews turning to the right.

Fossil drilled the Red Oak Timber 5-1 vertically to 11,950 ft in Section 5-14,15w in the same field and was waiting on state permits in late November.

The companies also permitted the Red Oak Timber 6-1 in section six of the same township. That well was scheduled to 12,500 ft. ■

GMX Resources Inc.

GMX Resources Inc. grabbed its piece of the oil and gas patch, and it's sticking to it as it zooms in on stacked pay on the Sabine Uplift in East Texas and Northwest Louisiana.

Its main properties lie in Carthage North field in Panola and Harrison counties in East Texas and in Caddo Parish in Louisiana. It has a drilling program in progress down through the Haynesville shale, it has infrastructure in place and it's building more.

It calls itself a pure play company with acreage in the Haynesville sweet spot. Its early entry into the play offers the company low-cost acreage and a high net revenue interest.

It had 434.5 Bcfge in proved reserves and 3.2 Tcfge in proved, probable, and possible reserves at the end of the third quarter of 2008. Those 3P reserves include 597 Bcfge from the Haynesville-Bossier shale.

To help get its gas to market, GMX has invested \$100 million in infrastructure. It will have some 350 MMcf/d of gas takeaway capacity by the end of 2009.

The company's properties include 38 gross, 31 net, Travis Peak, Hosston, and Pettet producers among its 377 gross, 277 net, producing wells. It has 313 gross, 177.38 net, Cotton Valley producers with another 2,657 gross, 1,974 net, undrilled vertical Cotton Valley locations, based on vertical wells on 20-acre spacing.

GMX also has 480 net Haynesville-Bossier locations based on 80-acre horizontal well spacing on its 38,455 net acres of land with Haynesville potential.

The Haynesville in this area is 300-ft to 350-ft thick with 90 Bcfge to 200 Bcfge of in-place resources per section. Potential reserves range from 4.5 Bcfge to 8.5 Bcfge per well.

GMX estimates drilling and completion costs at \$5 million to \$7 million for a horizontal well but admits its early horizontal wells will cost closer to \$7 million.

It has drilled 20 vertical wells to the shale and has proposed another 17 horizontal wells. GMX drilled and completed its first Haynesville well in the fourth quarter and had drilled a second well with completion scheduled for the first quarter of 2009. GMX currently has five rigs working the layered pay zones. It owns three Diamond Blue drilling rigs and is leasing two more rigs.

The company originally planned to spend \$400 million in 2009 and 88% of that was scheduled to develop its Haynesville resources. With the downturn in prices, GMX cut its 2009 capital expenditure budget to \$220 million.

It now plans to drill 27 net Haynesville/Bossier wells in 2009, including five in its joint development area with Penn Virginia Corp. Those wells should offer an average initial potential of 4 MMcfge/d. With that starting

rate, GMX anticipated 2009 production of 24.7 Bcfge.

GMX raised \$134 million in a recent stock offering and increased its borrowing capacity by \$50 million to make sure it can fund those plans.

A testimony to the company's success shows in its production figures. It raised its production from 8.7 Bcfge in 2007, to an estimated 12.5 Bcfge in 2008.

It previously had estimated 13 Bcfge in 2008 production, but its joint development venture with Penn Virginia dropped its rig count from four in the first half of 2008 to none in the second half. Penn Virginia plans to put two rigs to work on the play in 2009

GMX offered its view on Haynesville economics, assuming a horizontal well that costs \$7.5 million to drill and complete, produces 6 MMcfge/d on average over the first month and has an ultimate recovery of 7 Bcfge.

The numbers also assume a 100% working interest, a 79% net revenue interest, a \$7.50/Mcfge selling price, and a 60 cents/Mcf lease operating cost over the life of the well.

In that situation, the cumulative undiscounted net future value of the well would total \$29.87 million and the net present value, discounted at 10% a year, would reach \$12.98 million, net of the well cost. The company's break even point would be \$2.88/Mcfge.

GMX claimed a finding and development cost of 80 cents/Mcfge compared to the median \$2.69/Mcfge for all companies in the play.

Working off those figures, the company switched strategies in the third quarter of 2008 from drilling primarily vertical Cotton Valley wells to drilling horizontal Haynesville wells. It spud its first horizontal well, the Callison 9H, in August 2008 and reached total depth in 48 days with a 2,250-ft lateral. The company fractured 2,200 ft of hole in eight stages, each consisting of 350,000 to 500,000 lb of ceramic proppant and 10,000 to 12,000 bbl of slickwater/gelled water. Stages will be 350 to 500 ft apart and it will perforate the well in 5-ft clusters 85 ft apart.

GMX put the well on production in late November at a stabilized rate of 7.7 MMcfge/d on a 2²/₆₄-in. choke with 5,200 psi of flowing casing pressure.

It started drilling two more horizontal wells and planned to complete the Bosh 11H and Baldwin 17H in the first quarter of 2009. It will spud its fourth horizontal well to the Haynesville in December and plans to drill its next 16 horizontal wells with average 3,800-ft laterals and 11 to 12 stimulation stages. ■

Goodrich Petroleum Co.

Goodrich Petroleum Co. made a home in the Cotton Valley trend in East Texas and Northwest Louisiana, and it parlayed its position there into bonus production from the Haynesville shale.

Overall, it has 422 Bcfge of proved reserves on 201,000 gross, 128,00 net, acres. That number grows to 2 Tcfge in proved, probable and possible reserve potential, and that doesn't include the Haynesville. The Haynesville adds another 2.5 Tcfge to 4.7 Tcfge of net reserve potential on 60,500 net acres. Some 22,000 acres are in Louisiana.

The company operates eight of the 11 drilling rigs on its property.

One of the best aspects of its position involves a joint venture deal with Chesapeake Energy Corp. in Northwest Louisiana.

According to Goodrich, Chesapeake paid \$178 million for deep drilling rights on 10,000 acres. Chesapeake gets a 20% interest in Bethany-Longstreet field acreage and a half interest in Longwood field acreage. Chesapeake later bought another 7,500 acres of deep rights from a third party to give the partners a half interest each in both fields.

That deal puts Goodrich in a partnership with the most technically advanced company in the play, and will allow it to transfer that technology to its properties on the Texas side of the play. It gives the company a jump start on horizontal drilling. With Chesapeake as operator, the venture started its first horizontal well in September 2008.

Chesapeake completed the Holland 17H-1 horizontal well in the Bethany-Longstreet field for 14.5 MMcf/d of gas on a 24/64-in. choke. It drilled the well to 16,200 ft, including a 4,400-ft horizontal leg. Goodrich held a half working interest in the well with Chesapeake controlling 40% and Plains Exploration & Production in for the remaining 10%. ■

Marathon Oil Co.

Marathon Oil Co. boasts production from around the world. It only takes on plays with the potential for high production and large profits and it lists the Haynesville shale among its choices for emerging resource plays.

The company's 25,000 net acres in the Haynesville in Louisiana and Texas hold a place on the to-do list with the company's 260,000 net acres of coal seam gas in the UK, its 40,000 net acres in the Marcellus shale in West

Virginia and Pennsylvania, and its 30,000 net acres in the Woodford shale in Oklahoma.

Although it has no existing Haynesville wells or production, it plans to start action in the play in 2009.

Current production from East Texas come from the Cotton Valley carbonate and deep Bossier sand, and that's the 25,000-acre exploratory position with Haynesville potential the company acquired in 2007. It planned nine gross, five net, wells in the area in 2008, and will begin work on those legacy acres in 2009. The land with Haynesville potential is held by production from shallower zones.

Marathon also holds leases in Haynesville field in Northern Louisiana where it produced 600 b/d of oil, 8 MMcf/d of gas and 600 b/d of natural gas liquids, but that field is named after the town in Northern Louisiana. It doesn't produce from the Haynesville formation and generally is considered outside the Haynesville shale economic window. ■

Indigo Minerals LLC

Indigo Minerals LLC, one of the biggest landholders in Louisiana, is cashing in on the Haynesville play as a royalty owner with producing wells in the area.

Indigo was organized in 2006 out of a partnership of Martin Cos., Yorktown Partners, and Indigo Management to control oil and gas leases and minerals for Roy O. Martin Lumber LLC and Martin Timber Co. LLC, a fee mineral position that covered territory in 30 Louisiana parishes. It also acquired 300,000 net fee minerals royalty and non-operated working interest acres from Calton Petroleum late in 2007 for US \$61.5 million. That land included property in 17 states, primarily Alabama, Mississippi, Louisiana, and Oklahoma.

Overall, Indigo controlled more than 750,000 net acres of land and had interests in more than 900 producing wells. Some 450,000 net mineral acres, including producing property and royalty acreage, were in Louisiana and East Texas.

At mid-year 2008, the company agreed to sell some 89,500 acres of northern Louisiana properties prospective for Haynesville shale to EnCana Corp. for \$457 million in cash.

Indigo kept 22,000 acres of Haynesville properties, including 7,700 acres in Logansport field in Northwestern DeSoto Parish.

During 2008 Indigo set a capital budget of \$60 million. It had drilled or participated in seven wells with a 100%

success rate through mid-year and expected to end the year with five rigs working its Ark-La-Tex interest with the Hosston/Travis Peak, Cotton Valley, and Haynesville shale as primary targets.

J-W Operating Co.

J-W Operating Co. may not be one of the biggest companies in the Northern Louisiana oilpatch, but it's one of the most active with wells targeting Cotton Valley and Haynesville.

In late November 2008, the company had nine wells permitted, drilling, testing, or waiting on tolls or permits in the Lower Cotton Valley on the Bossier Parish side of Elm Grove field. It scheduled the wells from 9,433 ft to 13,338 ft.

It didn't disclose the target for the Broussard 5 in Section 5-16n-12w in the field, but at 15,000 ft, it would fit in the Haynesville horizontal window.

J-W had six more wells on the Caddo Parish side of Elm Grove field, two wells to the Cotton Valley in Sections 3 and 12 of township 16n-13w, and two wells with an undisclosed target, but both the Waters 20 in Section 20 and the JJ Giglio in Section 19 were projected to 11,700 ft.

It also was drilling the Dean 17 well in Haynesville at 10,315 ft in Section 17, and it was testing the Kinsey 21 well in Haynesville at 11,700 ft.

It had another three Cotton Valley wells in Woodardville field in Red River Parish.

J-W was working two additional wells in Sligo field in Bossier Parish, one to 9,598 ft and the other to 11,250 ft, but the state statistics didn't identify the target zone.

J-W also completed two Cotton Valley wells in Caspi-ana field in Caddo Parish. The Frierson 6 in Sec. 6-15n-12w tested for 2.19 MMcf/d of gas through a ²⁰/₆₄-in. choke from perforations between 9,042 ft and 9,248 ft. The Hutchinson Heirs 17 in Section 17 of the same township tested for 398 Mcf/d of gas through a ²⁸/₆₄-in. choke from perforations between 7,947 ft and 9,274 ft. About two miles from the Hutchinson Heirs well in the same township, Chesapeake Energy was waiting on completion tools at a 12,180-ft Haynesville well.

J-W also has production from Cotton Valley in Smith County, Texas. ■

Mainland Resources Inc.

Mainland Resources Inc. put together a 2,695-acre blocks of land with Haynesville potential on the east side

of East Holly field in De Soto Parish, La., and plans to use the property as a company maker.

According to Mainland, "The company plans to use this foundation as a platform to grow its assets through drilling initiatives an immediate push to develop production. This is expected to provide a rapidly expanding reserve base and strong operating infrastructure designed to deliver excellent value in this business cycle and beyond."

The prospect, south-southeast of Shreveport, has potential for production from Hosston, Cotton Valley, and Haynesville.

Mainland wasted no time. It made a deal with Petrohawk Energy, a solid Haynesville player, in August 2008, and Petrohawk started drilling on the property in October. Under the agreement, Petrohawk will pay all drilling and completion costs of the Griffith No. 1-H horizontal well on Mainland's property to earn 60% of the first well. Petrohawk will pay 80% of the costs on the second well and 60% of costs on subsequent wells.

In return, Mainland immediately handed over 60% of its lease holdings to Petrohawk, but only for zones below the base of the Cotton Valley.

As a part of the deal, Petrohawk agreed to market any Mainland production above the Haynesville, as well.

"This is a great day for Mainland Resources. With Petrohawk fully on board, we are ready to move ahead with drilling our Haynesville leases immediately," said Mike Newport, Mainland president.

Even before the deal with Petrohawk, Mainland had approved an US \$8.5 million expenditure to drill the Griffith No. 1-H, and it had permitted the well and started negotiating with contractors for a drilling window.

It planned to drill vertically to 13,000 ft. If analysis through Schlumberger's Haynesville shale evaluation software showed economic potential, the company planned to drill a 4,000-ft, 7 7/8-in. lateral.

The Louisiana leases aren't the only piece of Haynesville pie on Mainland's plate. The company signed a letter of agreement in September 2008 to acquire 5,000 net acres with in Mississippi and plans to drill the first well to evaluate Haynesville shale potential in Southwestern Mississippi in the Mississippi Interior Salt Basin.

According to the company, no wells have been drilled to test in Haynesville shale in the area and US Geological Survey and US Department of Energy resource estimates report deep Jurassic gas potential in the

area.

"We have data that suggests the potential Haynesville shale in this region could be similar in nature to the gas-bearing Haynesville shale in Northwest Louisiana. No one knew just how good the deep shale in Northwest Louisiana was until an exploration company stepped up and drilled the Haynesville, Hosston, and Cotton Valley formation. That what we're setting up to do in this potential new Haynesville shale play in Mississippi," Newport said. ■

Matador Production Co.

Matador Production Co. has taken the Haynesville by the horns as it drills its own wells and works with a joint venture partner in North Louisiana.

In June, Goodrich Petroleum, which has its own aggressive Haynesville program, said it had signed a definitive agreement with a private company to acquire a half non-operated interest in 5,800 gross, 2,900 net, acres in Caddo Pine Island field in Caddo Parish, La., for US \$3.3 million. That included both acreage costs for its interest and a drilling promote on the initial well, the Hall 5 No. 1.

Matador is the operator on the Hall 5 well in Sec. 5-19n-15w. State figures say the well was scheduled to 9,140 ft and drilling still was in progress in November 2008. According to Goodrich, the well originally was scheduled as a vertical test, but Matador re-entered the well in mid-October and started drilling a horizontal section. The companies anticipated results around the end of 2008.

The companies also drilled and logged the Lanier 16-1 in Section 16-19n-15w after drilling to 10,660 ft. That well reached 287 ft of pay in the shale. Matador will re-enter the well and planned to drill a horizontal leg in the first quarter of 2009.

The companies also are testing the Hall 9-1 in Sec. 9-19n-15w, the third vertical Haynesville well in the partnership, which was scheduled to 9,300 ft. The well reach 315 ft of pay in the Haynesville shale with excellent gas shows, Goodrich said.

In the same area, Matador drilled the CCMP1 well in Sec. 1-19n-16w to 10,735 and is testing. It also has permitted the Hall 4-1 to 11,999 ft in Section 4-19n-15w. It also planned three tests to Smackover between 10,768 ft and 13,000 ft in the fields, but those wells also could be completed in Haynesville.

In Thorn Lake field in Red River Parish, Matador

applied for a drilling unit that includes Haynesville between 9,930 ft and 11,963 ft immediately south of the Caddo Parish boundary line.

Matador also asked for seven drilling units to Haynesville in Caspiana field in Red River Parish.

The company currently has Cotton Valley wells in both the Caddo and DeSoto Parish sides of Caspiana field. It also is awaiting completion tools at a well drilled to an undisclosed formation below 10,000 ft in Longwood field in Caddo Parish. ■

Nadel & Gussman Ltd.

Nadel & Gussman Ltd. and Jetta Operating Co., a team that successfully worked the stacked pay zones of Northern Louisiana for more than a decade, lowered their sights to the Haynesville shale.

The two companies formed their combination in 1994 to drill for pay in the Hosston and Cotton Valley formations in Northern Louisiana.

Nadel & Gussman has operations in several areas, including the Permian Basin and the Rocky Mountains, as well as Northern Louisiana.

The companies, with Nadel & Gussman as operator, reached total depth at 10,640 ft on Nov. 10, 2008, at their 1 Haynesville Mercantile 36 vertical well in Sec. 36-23n-10w in Shongaloo field in Webster Parish, La. They started drilling the well on Oct. 26.

The venture partners asked the state for two additional drilling and production units for both Cotton Valley and Haynesville in Shongaloo field after drilling the Mercantile 36 well and to force pool the units.

The companies also have five wells in various stages of permitting and completion in Hico-Knowles field in Lincoln Parish. There, the Farley 22 well tested for 262 Mcf/d of gas on a 48/64-in. choke with 12 bbl of condensate and 30 bbl of water a day from the Hall formation from perforations between 8,868 ft and 8,886 ft.

They also filed requests for 11 drilling and production units to produce gas and condensate from Haynesville in Dixie field in Bossier and Caddo parishes. In that area the Haynesville lays between 9,220 ft and 10,800 ft in the companies' Franks 22-1 well in Sec. 22-19n-14w in Caddo Parish.

According to completion information in the *Shreveport Times*, the Franks 22-1 tested at 44 Mcf/d of gas on a 22-in. choke from Cotton Valley perforations from 8,393 ft to 8,401 ft after the company drilled the well to 10,804 ft.

In the same field and township, the Franks 18 in Section 18 was drilled to 10,615 ft and is waiting on order, the Franks 20 was going through tests at 10,793 as the companies prepared to drill horizontally, and the companies suspended drilling on the Franks 17 well.

The companies also completed a Hosston well in Choudrant field in Lincoln Parish. ■

Noble Energy Inc.

Noble Energy Inc. sets its drilling programs around the world. It likes plays with big resources, potential to work the learning curve and the chance of big returns.

In its onshore operations in the US, that formula points to tight sands and shales. Following that strategy, the company put together a big land inventory of low-risk development potential and prospects with high-impact exploration opportunities. Through October 2008, the company added 400,000 net acres to its onshore US inventory at an average cost of US \$160 an acre.

Its largest resources play is Wattenberg field in North-eastern Colorado, where it produces some 280 MMcfge/d net from 3.3 Tcfge in proved and discovered reserves from tight sands. It estimated net unrisks reserves in its properties at 4.4 Tcfge.

The company has interests in the New Albany shale in Indiana and recently joined the rush to East Texas and North Louisiana with the acquisition of almost 20,000 net acres of land. Drilling plans in 2008 called for seven James lime wells; 33 Hosston, Travis Peak, and Cotton Valley wells; and one Haynesville horizontal well on its properties in De Soto Parish, La., and Shelby County, Texas.

The property has more than 1 Tcfge in net unrisks resources and room for up to 600 wells.

Penn Virginia Corp.

Penn Virginia Corp. worked so well in the Haynesville (Lower Bossier) shale in East Texas that it is the company others would like to emulate.

The object of that envy is Penn Virginia's Fogle #5-H, the company's first horizontal well to the Haynesville and a well that tested at 8 MMcfge/d. The well produced 460 MMcfge in the first 143 days of production in spite of pipeline restrictions. When other companies tell shareholders about their Haynesville potential, they often tout their locations by how close they are to the Fogle well. By the end of the third quarter, production

had dropped to 2 MMcfge/d, and the company estimated ultimate production from the well between 6 Bcfge and 8 Bcfge.

The Radnor, Pa., company has more on the positive side of its resume than that single well. "We expect growth in our oil and gas segment from a number of our project areas, including the Lower Bossier (Haynesville) shale in East Texas, the Granite Wash formation in the Midcontinent region, the Selma Chalk in Mississippi, and Appalachian horizontal coalbed methane," said A. James Dearlove, president and chief executive officer. "We are encouraged by all of our initial Lower Bossier shale horizontal wells, Granite Wash horizontal wells, and Selma Chalk horizontal wells for which we have results." Penn Virginia holds 61,000 net acres in East Texas and Northwest Louisiana with 292 Bcfge in proved reserves and 1.49Tcfge in proved, probable, and possible reserves. Production reached 40.9 MMcfge/d and it has 1,567 drilling locations in the area. Production comes primarily from Cotton Valley.

For 2008, the company aimed 55% of its capital expenditures at the area, up from 48% the previous year. That's US \$320 million in 2008, compared to \$150 million a year earlier.

That investment paid for four working rigs by the end of 2008. The company planned 13 gross, 12.8 net, horizontal Haynesville wells in 2008. It planned to spend approximately \$87 million to drill and complete 18 gross, 12 net, Lower Bossier/Haynesville shale wells in 2009. Penn Virginia expects to recover between 4 Bcfge and 10 Bcfge per horizontal well from that zone at a cost between \$7 million and \$7.5 million for each well.

By December 2008, the company lowered its spending plans to \$250 million for 2009 as it anticipated lower demand. Some \$236 million of that will go into development drilling in core areas, including the Haynesville shale. Showing confidence in the Haynesville play, Penn Virginia maintained its \$87 million budget for that area.

During the third quarter of 2008, the company drilled 18 gross, 15.4 net, Cotton Valley vertical wells and four gross, 3.8 net, Haynesville shale horizontal wells. Thirteen gross, 10.9 net, wells were successful, including two Haynesville wells. Nine gross, 8.3 net, wells were awaiting completion.

The company is making a transition from an exclusive vertical Cotton Valley program early in 2008 to an exclu-



Photo courtesy of Chesapeake Energy Corp.

sive horizontal Haynesville campaign by the end of the year.

It is involved in a joint development area agreement with GMX Resources in the Haynesville play, but the venture cut its working rigs in the play from four in the first half of 2008 to none in the second half. It plans to work two rigs on Haynesville horizontal wells in the area in 2009.

Among the company's other Haynesville wells, it completed the Gibson #2-H development well in the Fogle area for 3.5 MMcfge/d with a flowing casing pressure of 2,800 psi from a 2,700-ft lateral. It stimulated the well with 1.1 million lb of sand in seven stages.

Dearlove said the company estimates about 100 Bcfge in place per section in the Bossier with 20% of that recoverable. ■

Petro Resources Corp.

Petro Resources Corp. may be a small company, but it's not too small to get a piece of the action in the East Texas tight sand, lime, and shale play.

The Houston, Texas, company took an initial 5% working interest in an area the operator, Goodrich Petroleum Corp., calls its "Surprise Prospect" in its Angelina River Trend in Nacogdoches County in Texas. Petro Resources later took an additional 5% interest in the prospect about five miles south of Trawick field.

The prospect area could cover 6,000 net acres with primary objectives in the Bossier shale, upper and lower Cotton Valley Taylor sands, and Travis Peak sand. Secondary objectives are the Haynesville shale, Knowles lime, James lime, Pettet sand, and Rodessa shale.

Wells drilled by mid-November 2008 included the

A NOMAC rig reaches for Haynesville in Caddo Parish in Louisiana.

Grigsby No. 1 and the Lilly No. 1. Both wells found pay in the James lime and Travis Peak and were awaiting completion equipment.

A third well, the Tucker No. 1, was drilling toward the Haynesville shale, and the scheduled Hill No. 1 was planned as a James lime and Travis Peak well but could be drilled deeper to the Haynesville.

Goodrich planned to complete the Tucker well in December and the Hill well in January.

Upon completion of the wells and a production evaluation, Petro Resources could elect to participate in as many as six wells in the Surprise Prospect.

By late December, Goodrich was drilling its fourth well on the Surprise Prospect and the three previously drilled vertical wells were either being completed or were awaiting completion. Petro Resources planned to drill two additional Surprise Prospect wells with Goodrich during 2009. ■

Petrohawk Energy Corp.

Everybody likes a role model. If there's a role model in the Haynesville play, a company others want to be like, it's probably Petrohawk Energy Corp.

First, the company has one of the largest land inventories in the play, more than 300,000 net acres that provide over 2,400 net drilling locations and some 11.9 Tcfge of risked resource potential.

Second, by February 2009, it already had 16 horizontal wells flowing 160 MMcfge/d to sales.

Petrohawk's initial position in the play was centered around Elm Grove Field, comprising approximately 32,000 net acres accumulated through three separate acquisitions from 2006-2007. This known structure for prolific Lower Cotton Valley and Hosston production was the location of the first horizontal Lower Cotton Valley well in the area, reported with an initial production rate of 16.5 MMcfge/d in January 2008. After confirming the area prospective for Haynesville shale, and applying completion techniques used in its Lower Cotton Valley horizontal drilling, Petrohawk launched a massive leasing and development effort in early 2008. The effort including financing, contracting rigs and materials, securing large amounts of firm transportation space on regional pipelines, and fine-tuning its completion recipe to deliver some of the best and earliest results in the play.

The company's first Haynesville shale well, the Elm Grove Plantation (EGP) #63, tested at 16.8 MMcfge/d, and subsequent wells in the Elm Grove and surrounding

areas have produced at initial rates of between 15 and 28 MMcfge/d. The wells were all placed on chokes ranging from 24/64 in. to 26/64 in. and had strong flowing casing pressures of between 6,500 psi and 7,500 psi.

A major step-out from the Elm Grove area was reported in early February 2009 with the Griffith 11-#1, a 23.3 MMcfge/d completion in south central DeSoto Parish. The company's 2009 drilling schedule includes plans to test more southern targets in DeSoto Parish, as well as northern reaches of Caddo Parish into Harrison County, Texas.

With drilling and completion costs between US \$8.0 million and \$9.0 million to reach currently estimated ultimate recoveries averaging 6.5 Bcfge per well across the play, it's no wonder Petrohawk has diverted big dollars to the emerging Haynesville play. The company is targeting longer laterals (up to 4,500 ft) with up to 15 frac stages per well, intending to improve the ultimate drainage pattern by drilling fewer wells per section for less overall capital deployed. In addition, the company has an average leasehold cost of \$5,000 an acre, while some of the latecomers have spent as much as \$30,000 an acre to get into the play.

Petrohawk allocated \$218 million of its 2008 capital budget of \$1.1 billion to the Haynesville with the intention of drilling 26 gross wells by the end of the year. Sixteen of those wells were on production by February 2009. It had 11 rigs running in the Haynesville in late 2008.

For 2009, Petrohawk lowered its capital expenditure plans to \$1 billion, but \$690 million of that will go into Haynesville development, and it will raise the rig count in the play to 14.

Twelve of those rigs will continue the company's work in Louisiana. The other two will work the company's East Texas Haynesville properties. Those rigs will help the company finish 2009 with between 75 and 80 gross operated Haynesville wells, putting it firmly on track to drill the number of wells need to retain leases.

Petrohawk planned to have initial results from Haynesville and Bossier shale drilling in Shelby County, Texas, before the end of 2008, as it put two rigs to work in the area on its own properties.

It also started drilling activity on property dedicated to its joint venture with EOG Resources in Nacogdoches County, Texas, in the fourth quarter of 2008.

The company's 2009 wells should provide an even greater economic advantage than its 2008 wells.

Authorities for expenditure set 75 days to drill and complete its Haynesville wells in 2008, and the company plans to drill larger, longer lateral wells in the same time frame in 2009. With only 12 operated wells evaluated in its 2008 reserve reporting, Petrohawk's third-party engineers credited the company with 163 Bcfge of proved reserves, which could increase drastically after executing its full year 2009 program.

In line with higher production rates, Petrohawk also is increasing its gathering system takeaway capacity in the Haynesville, the Fayetteville shale in Arkansas, and its developing Eagle Ford shale play in South Texas. In 2008 the company formed Hawk Field Services LLC, which has a current budget of over \$100 million to construct a large gathering and processing network in the eastern portion of the Haynesville play, geographically located to attract third-party volumes as serve as a new revenue center for the company.

After completing several capital raises in 2008 and the first debt offering of E&P companies of 2009 to position the company to go after a unique opportunity in the Haynesville, Floyd C. Wilson, president, chairman, and chief executive officer, said, "From a balance sheet perspective, we have navigated the recent turmoil in the markets through drilling performance, a conservative financing structure with substantial liquidity, a low operating cost structure, and aggressive exploration, enhancing our capability to deliver growth even when capital conservation is in order. Our ability to decelerate or accelerate our program when desired is an important tool we have used amidst unprecedented volatility. The incredible opportunities within our portfolio provide Petrohawk with a multiyear platform for economic growth." ■■

Pinnacle Operating Co. Inc.

Pinnacle Operating Co. Inc. has been working the shallower zones of Northern Louisiana and East Texas, but it's apparently preparing to reach deeper to the Haynesville.

In July 2008, the company asked the state conservation commission to create a unit for Haynesville and Hosston production in Red River-Bull Bayou field in DeSoto Parish, La., with forced pooling. The Haynesville in that area lies between 10,948 ft and 12,856 ft.

According to late November state records, the company permitted the Tabor well to 8,208 ft in Sec. 20-12n-12w in Red River-Bull Bayou field. The records didn't mention the Haynesville.

At least one organization believes Pinnacle is one of the good guys in the oilpatch when it comes to the Haynesville play.

The East Ridge County Club (ERCC) in Shreveport, La., recently announced the grand opening of the Pinnacle Room in a club renovation.

The club bulletin said, "As most everyone knows, Pinnacle Operating Co. held the mineral lease on our land dating back to 1973, and there has been continuous production under that lease since it was executed. ERCC has received royalty payments every year — about US \$2,800 in royalties in 2007. Our royalty under that lease is one-sixth — which was pretty favorable to ERCC, considering the customary royalty rate in 1973 was one-eighth.

"When all the 'to do' about the Haynesville Shale cropped up this year, Pinnacle very magnanimously agreed to release the rights for 'deep production' back to East Ridge. Had they not done that, we would not be eligible to receive a lease bonus at all, and our royalty interest would have remained at one-sixth.

"Since all this took place, we have been busy negotiating the best mineral lease we can for ERCC. We have not yet executed a lease, but expect to do so shortly. Under the terms of the new lease, ERCC will receive a significant bonus payment, our royalty percentage will go up to one-fourth, and there will be no drilling activity on our land.

"While the lease bonus will certainly be welcome, the increase in our royalty percentage is the thing that will be most beneficial to the club in the long run. The actual amount of royalty payment will depend on the amount of gas produced and the price of natural gas at the time, and both of those will likely fluctuate throughout the production life of the Haynesville shale. There are plenty of scenarios, though, under which ERCC would receive monthly royalty checks in six figures for many years."

Pinnacle also permitted the Delaney well to 10,250 in Sec. 27-23n-7n in Haynesville East field in Claiborne Parish, La. Up near the Arkansas border in Haynesville East field the Haynesville formation turns to sand.

In addition to its shallower work in Louisiana, Pinnacle drilled the Stewart Tischauser No. 1 wildcat in Nacogdoches County, Texas, to 10,405 ft for an initial potential of 1.4 MMcf/d of gas on a $\frac{5}{16}$ -in. choke, according to the *Tyler Morning Telegraph*. It did not disclose the target formation or whether the well was vertical or horizontal. ■■



Photo courtesy of Cubic Energy Inc.

Gas export capacity is developing into a problem for some Haynesville operators.

Plains Exploration & Production Co.

Plains Exploration & Production Co. bought into the Haynesville shale play with one of the larger onshore acquisitions on the oilpatch record books, and it still may have picked up a bargain.

The company bought a 20% working interest, 15% net revenue interest, in 550,000 Chesapeake Energy Corp. acres in the play for US \$1.65 billion. It added another \$1.65 billion on top of that to carry half of Chesapeake's costs to drill and complete wells for several years.

The deal shaved Chesapeake's risk and costs in the wells, and it moved production from Haynesville forward for both companies.

The deal also lowered finding and development costs for Plains. Those costs throughout its operations average \$15/boe. Costs in the Haynesville acquisition average \$10.98/boe, or \$1.98/Mcfge. It also gave Plains exposure to an estimated 50 Tcfge of resource potential.

Chesapeake will operate the wells on the acreage. The companies have some 6,875 drilling locations on

80-acre spacing with Chesapeake's horizontal well plan.

In the third quarter, the companies had six rigs at work in the Haynesville, but they jumped to 14 rigs in November 2008, and planned to employ 26 rigs by the end of 2009 and 60 rigs by the end of 2010. That 2009 rig rate will require some \$460 million, or 40% of its total capital budget for the year, to support the venture's Haynesville drilling plans.

The venture began drilling wells in July 2008, started producing in the third quarter and, by November, had four wells on line producing 36 MMcfge/d gross, 5 MMcfge/d net to Plains. Chesapeake's first eight horizontal wells showed initial potentials between 5 MMcfge/d and 15 MMcfge/d. Most of Chesapeake's early work was in Caddo Parish, La.

The hookup with Chesapeake gives Plains more advantages. Chesapeake has its own rig fleet and can allocate rigs according to opportunities. Chesapeake's early wells averaged about \$6.5 million to drill and complete, but other operators in the play report costs between \$7 million and \$8 million.

Plains anticipates median well costs of \$6.5 million for the first three years of the program with a drop to \$5.5 million thereafter.

Where other operators are drilling a single horizontal well on a 640-acre section, Chesapeake plans eight horizontal wells on section-sized pads.

Under that plan, it will drill wells with 4,500-ft laterals north and south on 80-acre spacing for better drainage, a shared surface footprint and fewer rig moves. The pattern also lets the company run gathering lines east and west along section lines between the pads.

Plains also gets the advantage of Chesapeake's research that calls for more sand and more frac stages for higher production levels and Chesapeake's ability to use economies of scale for services and materials.

The companies expect gross Haynesville production to grow from about 1,000 boe/d in 2008 to 20,000 boe/d in 2010, to 60,000 boe/d in 2013, and to about 80,000 boe/d in 2017.

Plains also agreed to sell its Permian Basin and Piceance Basin oil and gas interests for \$1.25 million to Occidental Petroleum Corp. to help pay for its Haynesville activities.

"This divestment facilitates PXP's [Plains'] rotation from assets with moderate growth and challenging differentials to the unparalleled high growth Haynesville shale play, which is proving to have stronger operating

metrics and growth attributes with higher wellhead realizations," said James C. Flores, chairman, president, and chief executive officer of Plains.

"With an expanding drilling program and production beginning in the fourth quarter of this year, the Haynesville Shale will become a key driver to our production and reserve growth for most of the next decade while bolstering our return on investment," he added. ■

Questar Corp.

Questar Corp. bought its way into the tight gas play in Northwestern Louisiana with traditional zones as its primary target, but the financial attraction of the Haynesville shale led the company to drill deeper into its holdings in the area.

The Salt Lake City-based company holds some 35,600 net acres in the area. That translates to more than 1,500 drilling locations with an average working interest of 62%. Estimated ultimate recoveries from Cotton Valley and Hosston range from 700 MMcfge to more than 3.25 Bcfge with wells that range in cost from \$1.7 million to \$2.5 million.

It already has 341 wells and 168 locations in Elm Grove field, 96 wells and 347 locations in Woodardville field, 12 wells 496 locations in Thorn Lake field, and 485 additional locations in the area, all in the Cotton Valley and Hosston plays.

In all its Northwester Louisiana horizons, it claims probable reserves of 141 Bcfge, possible reserves of 459 Bcfge, and a resource potential of 1.3Tcfge. Within those numbers, it calculates its Haynesville shale resource potential at 865 Bcfge with a 44% average working interest.

Now, it is evaluating Haynesville shale on 30,150 acres in the three fields with 864 potential horizontal well locations in 80-acres spacing. It calculated Haynesville ultimate recoveries at 4.7 Bcfge per well, gross.

It completed its first operated horizontal well, the Waerstad #3 well in Thorn Lake field in Red River Parish, and put it on production at an initial rate of 16 MMcf/d of gas on a ²³/₆₄-in. choke with 6,400 psi of flowing casing pressures after eight frac stages in a 3,234-ft lateral. It also was participating in a non-operated well in Elm Grove field and planned to participate in another well in that field.

It drilled the Wiggins 36H #1 horizontal well in Woodardville field in Bienville Parish and put it on production at an initial rate of 7.4 MMcf/d through a ²²/₆₄-

in. choke with 5,450 psi of flowing casing pressure after nine frac stages on a 3,455-ft lateral. In the same field, it was drilling the Shelby 31H #1 and the Golson 32H #1 wells.

During the company's second quarter 2008 investor presentation, Keith Rattie, chairman and chief executive officer, said the company planned to core and log the full Haynesville zone before plugging back to kick off on the horizontal legs, "so, it will take a while before we have results to report.

"Like other operators in this play, we are going to have to move quickly to evaluate Haynesville potential on some of our acreage," he said. "About a third of our Haynesville rights are not HBP [held by production], and are therefore still under primary lease term. Where this is the case, we have to drill a well to establish production from the Haynesville during the primary term of the lease, or we lose our Haynesville rights. Most of the primary leases don't expire until 2010 or 2011, but a few do expire this year and next, so we are focused on those right now."

Chuck Stanley, president and chief executive officer of market resources, added during the teleconference, "The Haynesville is a play that, frankly, is further up the curve as far as commerciality. I am sure you are familiar with some of the results from offset operators — including a recent field well that was report in the media as IPing over 16 million a day from a horizontal lateral in the Haynesville. And, interestingly, it is offset directly by Questar acreage on three of the four sides."

That was the Petrohawk Elm Grove Plantation 63H well that tested at 16.8 MMcfge/d when it was completed in July in Elm Grove field. ■

Ramshorn Investments Inc.

Ramshorn Investments Inc., a subsidiary of Nabors Drilling, holds a 40% stake in Sentell field where Southern Star Energy Inc. works stacked pay through the Haynesville shale.

Southern Star, the operator, holds another 40% and Dynamic Resources Corp. owns the remaining 20% interest in the venture in Bossier Parish, La. The companies formed their combination in 2006 before the Haynesville looked like a profitable play.

The companies bought a gross 5,300 acres, including 10 wells drilled in the 1950s on 640-acre spacing, and began working the field's deeper zones.

In December 2007, Southern Star was working the

Cotton Valley. Its Atkins-Lincoln 18-2 well in the field bottomed in the formation at 9,950 ft. The company perforated from 8,478 ft to 8,492 ft and used a slickwater frac with 71,770 lb of proppant to complete the well. It flowed to sales at a rate of 703 Mcf/d of gas with 900 psi of flowing tubing pressure.

The second Haynesville test in the field, the Burt 20-1 well, reached 11,220 ft in late November 2008 and logged 312 ft of highly laminated, silty, and naturally fractured Haynesville with shale-corrected porosity of more than 12% and resistivity between 20 and 70 ohm-meters. The operator recovered more than 120 ft of core in key intervals of the shale started core analysis.

Combined with core results from the Atkins-Lincoln 17-2, the companies plan to optimized completion designs.

The first Haynesville well, drilled near the center of the field, was the Atkins-Lincoln 17-2. Like the Burt well, it targeted the Cotton Valley and was deepened to the Haynesville. The companies called the well successful.

The companies are part of the Core Laboratories Integrated Reservoir Solutions regional Haynesville shale study, and they sent cores from both wells to the laboratory for analysis before completing the Haynesville zone.

After the Atkins-Lincoln well was drilled, a Dynamic release said, "Wireline logging and mud log shows indicate the Atkins-Lincoln 17-2 well encountered 205 feet of highly laminated, silty, and naturally fractured shale zone with cross plot porosities ranging from 9% to 12%. Mud logs indicated abundant gas shows throughout the interval, ranging from 400 to 600 units with trip gas as high as 3,000 units. This interval exhibits the characteristics of the Lower Bossier shale. Immediately below this laminated section, the well encountered approximately 185 ft of quality dark black organic rich shale. In this zone, gas shows ranged between 1,100 and 3,000 units. This lower interval exhibits all of the characteristics that the industry classifies as the Haynesville shale. The well bore is suspended with 7-in. intermediate casing through the Cotton Valley formation at 9,500 ft in order to preserve the option to either complete the well as a vertical producer, or to re-enter the well bore for horizontal drilling pending the development of completion techniques."

According to Robert Fedun, president of Dynamic, "The preliminary results from the Atkins-Lincoln 17-2 well represent significant news. We believed that we might be sitting on top of a significant Haynesville position, and now we have evidence that the Sentell Field is right in the middle of the Haynesville play. We have

extensive petrophysical analysis work ahead of us, and another vertical Haynesville test well to drill this year, but the initial results are positive. This new well discovery should be additive to our reserve base." ■

Rising Star Energy Development Co.

Rising Star Energy Development Co. busily worked Northern Louisiana in 2005 and 2006 with six wells drilled to producing formations in Caspiana field in Caddo and DeSoto parishes. Then along came a stranger with an offer the company couldn't refuse.

After working the shallower zones, Rising Star, with Denver Mineral & Royalty Co. and other partners, sold its properties to Chesapeake Energy Co., a company with its eye on the deeper Haynesville.

Now, the companies still carry 1,257 net royalty acres in Chesapeake-operated properties in the field, and it has the properties on the sale block.

Before the sale, Rising Star had drilled and completed 12 wells in the field. After the sale, Chesapeake staked, permitted, started drilling, or completed 15 horizontal wells in the Haynesville.

Rising Star also has variable overriding royalty interests in Longwood field in Caddo Parish on properties in the Chesapeake, Plains Exploration & Production, and Goodrich Resources venture.

Rising Star is a privately held company organized in 1995 for former officers and managers of the Hunt family's Placid Oil Co. ■

Samson Investment Co.

Samson Investment Co. has worked the stacked pay of Southern Louisiana since 2003 when the company acquired Contour Energy Co. for approximately US \$146 million, including debt, and created Samson Contour Energy E&P Co.

At the time, Jack Schanck, co-chief executive officer of Samson, said, "This acquisition is very synergistic with Samson's existing activities in Louisiana and solidifies Samson's position as a significant Ark-La-Tex player. Samson has used a balanced method of growth in this region through both acquisitions and the drillbit."

Samson has worldwide operations, but it has continued its Louisiana operations. Now, with the Haynesville shale play making headlines, the sister company of Samson Resources Co. is expanding its operations to take in that formation.

The company asked the state to authorize 10 drilling and production units with force pooling in sections 4 through 10 and 15 in Township 18n-14w and for sections 1 and 12 in Township 18n-15w in north Caddo Parish, La. Those units would combine Haynesville and Cotton Valley production. Nearby wells find Haynesville between 10,910 ft and 11,487 ft.

The company also asked permission to include three Haynesville drilling and production units in Sligo field in Bossier Parish where it has permission to produce from Hosston and Cotton Valley. Haynesville depth in that field lies between 9,110 ft and 10,968 ft.

In a recent state report, Samson Contour had drilled the Forcap 22 in Section 22-21n-12w in Antrim field in Bossier Parish. The well bottomed at 12,315 ft, but the target formation wasn't revealed. The well was shut in and waiting on orders.

Farther south, in Benton field in Bossier Parish, the company drilled the Brown et al to 2,996 ft in Sec. 12-20n-13w. That well also was waiting on orders. Samson Contour also permitted the Wallace 18 in Sec. 18-20n-12w in the same field to 10,672 ft. That well will have a horizontal leg reaching north-northeast into Section 7. Both wells probably are too shallow for a Haynesville test.

It is waiting on state approval on its Davis Bros. 25 well in Sec. 35-15n-4w in Vernon field in Jackson Parish. That 15,321-ft well probably is outside the Haynesville sweet spot. It has produced from Bossier tight sand.

To the north, in Sec. 23-19n-5w in Terryville field in Lincoln Parish, the company permitted the Woodard 23 to 12,650 ft. ■

Shell Exploration & Production Inc.

Shell Exploration & Production Inc. holds a major land position in the Haynesville shale but it's taking a nearly passive role in the action as its partner, EnCana Corp., works most of the properties.

The two companies signed a joint venture agreement for the area in 2007. Shell hasn't revealed much about its position in the play, but EnCana claims a net 400,000 acres, which should give Shell a similar land position.

According to Randy Eresman, EnCana's president and chief executive officer, "In the third quarter of 2008, we strengthened our position in the Haynesville gas resource play by acquiring 25,000 net acres, increasing our land position to about 400,000 net acres, plus

63,000 net acres of mineral rights. We continue to see great potential in this promising shale play. EnCana, along with our partner, Shell Exploration & Production, has an industry-leading land position in this area of Louisiana. We currently have six rigs running with a focus on cost reduction and completion optimization. We will target drilling and completing the first well in the mid-Bossier shale in the fourth quarter."

The venture hasn't been idle. Fourteen wells were permitted by EnCana in Brachy Branch field in Red River Parish, La., with all but two of the wells reaching below 10,000 ft. Horizontal wells were scheduled to total depths as far as 17,000 ft.

The company permits one horizontal well to 17,200 ft in Gahagan field in Red River Parish, and permitted or started drilling 10 wells in Martin field in the same parish. Two of those wells apparently had problems with stuck pipe, according to state records in late November.

EnCana also permitted or started testing five horizontal wells to depths as far as 17,550 ft on the Red River Parish side of Red River-Bull Bayou field.

All that EnCana work doesn't mean Shell left all the work to its partner.

Shell proposed eight 640-acre drilling and production units in Trenton field, six more in Oxford field, and two additional units in Brushy Bayou field, all in DeSoto Parish. It also proposed 12 units in Grogan field in Sabine Parish.

With EnCana apparently working the Red River Parish side of Red River-Bull Bayou field, Shell permitted the Diocese of Shreveport 21 well on the DeSoto Parish side of the same field in Section 21-13n-12w. It scheduled the well to 16,500 ft.

In late November 2008 Shell was waiting on completion tools at the Harris 19 well at 16,350 ft in Trenton field in DeSoto Parish.

The company also permitted the Blackstone Ivory 15 well in late October 2008 with a scheduled depth of 16,600 ft in Brushy Bayou field in De Soto Parish, according to state records.

Swepi LP permitted Blackstone Ivory 15 in late October in Brushy Bayou field in to 16,600 ft in DeSoto Parish.

Shell was flaring the Murray 31 well in Sec. 31-10n-11w after drilling to 12,900 ft in Grogan field in Sabine Parish.

All the company's efforts haven't been successful. In San Miguel field in Sabine Parish, it shut in the Olympia Minerals 26 well in Section 26-9n-12w and was preparing to plug the well. It was projected to 13,555 ft. ■

Southern Star Energy Inc.

Southern Star Energy Inc. and its partners parlayed a solid Cotton Valley production machine into a test bed for high-potential Haynesville shale wells in Northern Louisiana.

Southern Star operates the companies' position in 5,432 gross, 2,243 net, acres of land in Sentell field in Bossier Parish, La. Its partners are Dynamic Resources with a 20% working interest and Ramshorn Investments, a Nabors Drilling subsidiary, with the remaining 40%.

The companies had five producing wells in the tight Cotton Valley sand with another two awaiting production hookup and 50 locations in the Cotton Valley in the field.

The company drilled the Atkins Lincoln 17-2 vertical well to Haynesville and planned to complete it in

December 2008. It also drilled into the Cotton Valley at the A.S. Burt 20-1 and planned to continue drilling to Haynesville.

In a November presentation, Southern Star said the Atkins Lincoln vertical well cost a gross US \$2.2 million, or \$880,000 net to Southern Star's share. The A.S. Burt 20-1 cost came in at \$3.9 million gross, \$1.56 million net.

During the next nine months, the companies in the venture also plan the Weil 6-2, Weil 5-1, Miciotto 16-1 and Cash Point Plantation 30-1 vertical wells to Haynesville, each at a gross cost of \$4 million, \$1.6 million net.

The company offered its own set of economics for a horizontal Haynesville well. The well would cost \$8 million, or \$3.2 million net, with net reserves of 2 Bcfge per well.

Southern Star assumed a realized price of \$7.94/Mcfge, a net lease operating cost expensive of 36 cents/Mcfge, a net production tax of 56 cents/Mcfge, initial gross production of 10 MMcfge/d. That would give the company an internal rate of return of 73.1% and a net present value, discounted at 10%, of \$6.62 million per well. The company's breakeven realized price would come in around \$2.91/Mcfge and it would see payout in 1.2 years.

"The A.S. Burt 20-1 is our second test of the Haynesville Shale, following on our successful initial Haynesville test in the Atkins-Lincoln 17-2 in October. We believe this test will further define the presence and extent of pay in the Lower Bossier/Haynesville within our Sentell Field leasehold, representing additional valuation upside for our company," said David Gibbs, president and chief executive officer.

The Burt well found 312 ft of silty, highly laminated and naturally fractured Haynesville shale after bottoming at 11,220 ft. Indicated porosity reached 12% with resistivity ranging from 20 to 70 ohm-meters.

The mud logs registered gas shows, and the Southern Star sent some 120 ft of core out for laboratory analysis. ■

Southwestern Energy Production Co.

Southwestern Energy Production Co., the company that put the Fayetteville shale on the map of mouth-watering plays, will take a look to see if the Haynesville shale offers similar opportunities for profit.

Throughout its operations, Southwestern claims 1.45 Tcfge of reserves with 96% of those reserves in natural gas.

It averages 28% production growth a year from 2004

Hands on this EnCana drilling rig don't work bankers' hours. Drilling Haynesville wells is a full-time job.



through 2007 with a 31% annual reserve growth all at a finding and development cost of \$2.26/Mcfge. It won't be easy to find a play that allows the company to continue posting those numbers.

Outside of the Fayetteville shale in Arkansas, which gave the company 600 MMcf/d of gas production on Sept. 30, 2008, up from 260 MMcf/d a year earlier, Southwestern's top asset is its East Texas properties and the James lime play.

It holds 353 Bcfge in reserves and produces 29.9 Bcfge of gas a day from its 118,906 net acres of land.

Some of that land has potential for Haynesville production. The company plans to find out if reality matches potential, Southwestern signed a deal with a private company to drill two Haynesville shale wells on 41,500 acres of land. It won't be easy for those wells to match the company's James lime experience. Those wells have averaged 9 MMcfge/d each in initial potential.

Southwestern's partner will drill Haynesville-Bossier shale wells in Shelby and San Augustine counties in Texas on the company's Angelina River trend. That area also includes leases in Nacogdoches County.

In 2009, Southwestern Energy will maintain its most active operations in the Fayetteville shale, but it also will spend \$121 million in East Texas where it will drill 34 of its planned 40 wells to the James lime. That budget compares with \$150 million in 2008. ■

St. Mary Land & Exploration Co.

St. Mary Land & Exploration Co. likes resource plays so well that it boosted its 2008 capital budget by US \$100 million just so it could work them faster.

The Denver-based company claims nearly 1.1 Tcfge in proved reserves with a proved, probable, and possible 2.79 Tcfge on its potential list. That doesn't include shale prospects in the Haynesville in East Texas and Louisiana, the Bakken in North Dakota, or the Pearsall/Eagleford in South Texas.

The companies growth plays include the Woodford shale, the Bakken shale, the Cotton Valley tight sand, the Wolfcamp-Spraberry tight sand, and the Haynesville shale.

It has some 50,000 acres with Haynesville potential, 30,000 in Shelby County and 10,000 acres in Panola County, in East Texas and another 10,000 in DeSoto Parish in North Louisiana.

The company's Carthage field properties in Panola County may have Haynesville potential, company offi-

cial said in a December 2008 presentation. Several companies are drilling to Haynesville and at last one well is producing from Haynesville shale a short distance to the north in Rusk County.

St. Mary bought into the Panola County properties for \$50 million for their James lime potential.

It has partnered with Petrohawk to develop the Cotton Valley, where horizontal wells are as attractive as Haynesville horizontal wells. In that play St. Mary is operating in Carthage field and Petrohawk is operating in Elm Grove and Terryville fields in Louisiana.

The company considers its 50,000 acres with Haynesville potential a no-cost acquisition, since it paid only for the Cotton Valley potential.

St. Mary started drilling Aug. 25, 2008, at its Johnson Trust 1 with Haynesville as the target in Section 1-11n-14w in DeSoto Parish, La. That Spider field well reached total vertical depth at 12,250 ft on Nov. 7, and St. Mary started logging and coring operations.

After coring and analysis, the company plans to kick off on a 4,500-ft horizontal lateral. It planned to complete the well in January 2009.

It also has a second horizontal Haynesville well in its strategy.

It has permitted the Weyerhaeuser 2 well in Section 2-11n-14w in DeSoto Parish, La., one spacing unit away from its Johnson Trust well. The Weyerhaeuser well is scheduled to 10,200 ft vertically but could kick off to horizontal from that depth. ■

Stroud Petroleum Inc.

Stroud Petroleum Inc. brings veteran horizontal drilling and production skills, picked up during years of activity in Texas and Louisiana layered pay, to the Haynesville shale.

In June 2008, it applied for a Haynesville drilling and production unit in Sec. 4-15n-12w in Caspiana field in Red River and DeSoto parishes in Louisiana.

Two months later, it was on the Louisiana state docket for a hearing for a Haynesville unit in Thorn Lake field in Red River Parish.

By late November, it had completed the Louisiana Wildlife well in Sec. 10-14n-12w in Thorn Lake field in the Haynesville formation at 12,300 ft. The well was shut in and waiting on orders. In Sec. 3 of the same township, the company was testing its Savage well in the Cotton Valley formation at 9,925 ft.

Stroud is an active company. In May 2008, it applied

for state authorization for 14 drilling and production units in Hosston and Cotton Valley in Caspiana field.

It also has asked for Cotton Valley units in D'Arbonne Lake field in Union Parish, Hico-Knowles field in Lincoln Parish, and McKenzie field in Claiborne Parish, but those units generally are considered outside the presently active Haynesville fairway.

It also has drilled to the staple North Louisiana Nacatosh formation in Caddo-Pine Island field in Caddo Parish.

In Texas, the company discovered the Ore City field in Upshur County, which produces from Travis Peak.

It also has wells or drilling plans in Rusk, Panola, Limestone, and Freestone counties in Texas, with production from Travis Peak and Cotton Valley. Currently, Panola and Rusk counties have been mentioned as Haynesville-potential areas.

Stroud has horizontal drilling experience in the Wilcox in Central Texas and the Austin Chalk, the Buda, and the Georgetown formations in Texas.

Unit Corp.

Unit Corp. has a big advantage in these days of frantic drilling and high competition for drilling rigs in the highly competitive shale plays.

It controls the fourth-largest rig fleet in the US with 131 rigs, and it is a substantial operator that likes resource plays including the Marcellus in the Appalachian Basin, the Granite Wash in the Texas Panhandle, the Woodford shale in Oklahoma, and the Cotton Valley sand and Haynesville shale in East Texas.

Overall, it controls 375,000 gross, 105,000 net, acres in five shale plays.

By November 2008 it held 30,300 gross, 15,500 net, prospective Haynesville acres in Shelby and Harrison counties in Texas, up from 27,164 gross, 11,506 net, acres in July.

In July, the company said it participated as a 60% working interest partner in a vertical Haynesville well in Shelby County and found encouraging mud log gas shows.

By the end of the third quarter, testing on a restricted choke on that well revealed a production rate of 700 Mcf/d of gas with 2,350 lb of flowing casing pressure, according to Brad Guidry, senior vice president of exploration, during a conference call reported by *www.seekingalpha.com*. That equates to between 2 MMcf/d and 3 MMcf/d on open flow.

Responding to questions from analysts, he said about 120,000 lb of sand was screened out during completion, and the company was trying to get 300,000 lb into the single-stage frac job.

At that time, the company was near total depth on its second vertical well in the same area.

"After evaluation of these two wells we will formulate a drilling plan for that play that will most likely include horizontal drilling. In addition, we have also acquired leases of approximately 15,000 gross acres and 3,700 net acres in Ross and Cherokee counties, Texas, which is currently unproven but potentially prospective for the Haynesville shale," said Guidry.

The company obviously likes the Cotton Valley-Haynesville combination. Although only 4% of its 514.6 Bcfe in proved reserves are in East Texas and Northwestern Louisiana, it planned to spend US \$105 million of its \$470 million in capital expenditure in that region and \$30 million of that amount in the two states.

Unit estimated the cost of its two vertical Haynesville wells at \$6 million. ■

Will-Drill Production Co. Inc.

Will-Drill Production Co. Inc. knows Northern Louisiana, and it knows how to make money out of its stacked formations.

It marked the Haynesville formation as an asset with potential to fatten its bank account, and it has drilled to that formation.

The company already produces from Woodardville field in Red River Parish in Louisiana. Recently, it completed the Couvillion et al 2 in Sec. 2-14n-10w in the field for 1.3 MMcf/d of gas on an ¹⁸/₆₄-in. choke with 2,000 pounds of pressure from Cotton Valley perforations between 10,058 and 10,260 ft in a well it drilled to 10,400 ft.

In the same field, the Louisiana Conservation Office scheduled a hearing in December 2008 to consider Will-Drill's request for Hosston, Cotton Valley, and Haynesville units in Woodardville field in Bienville and Red River parishes. It asked for six additional drilling units each in Cotton Valley and Hosston and 14 drilling and production units in Haynesville. Haynesville in that area lies between 10,705 ft and 12,620 ft in a nearby Questar Corp. (formerly Will-Drill Sustainable Forests 28-1) well. That Haynesville well is in Sec. 28-15n-9w.

Will-Drill also put Woodardville field acreage up for sale in November 2008 through the Oil & Gas Asset

Clearinghouse. That parcel included 4,189 net acres with Haynesville potential and 4,778 net acres of Hosston/Cotton Valley with two operated and five non-operated units, 11 producing wells, five drilling and completing wells, and net production of 2.3 MMcf/d of gas in October 2008.

Also in October, the company applied for four Hosston and Cotton Valley drilling and production units in Sec. 7-12n-15w in Logansport field in DeSoto Parish. Sec. 6, immediately to the north, already has been designated as a Haynesville unit by another company.

Will-Drill also has permitted wells or is drilling or completing wells in Alabama Bend field in Bienville Parish, Clay field in Lincoln Parish, and Cotton Valley field in Webster Parish, but most of those wells are scheduled to the Cotton Valley and Gray formations. ■

XTO Energy Inc.

XTO Energy Inc. plants a big footprint in most of the major shale plays around the country, and its smallest shale position in the Haynesville still is largest than most companies' largest positions.

The company displayed one reason for those strong positions in its motto for 2008. It was XTO's "Year of Acquisitions." That's no idle boast. It spent US \$10.6 billion in acquisitions to get 2.3 Tcfge of proved reserves with between 6 Tcfge and 8 Tcfge of potential production.

Its biggest addition of the year was its \$4.2 billion bolt-on acquisition of properties with Haynesville potential.

It plans to follow up the year of acquisitions with "The Year of the Drillbit" in 2009. Its proposed \$3.3 billion budget should increase the company's production by 22%, if the plan works out. Some \$1 billion of that capital budget will be directed at the eastern region, which includes its Haynesville shale properties, and \$800 million of the eastern region budget will go into the Barnett shale.

That's just part of plan the company hopes will double reserves to 22 Tcfge and double production to 3.6 Bcfge/d by 2011, and it's counting on its shale properties to contribute substantially toward that goal.

Among its 1.7 million acres of shale holdings, only 100,000 net acres are in the Haynesville shale, but that property can produce between 3 Bcfge and 6 Bcfge per well. It holds 280,000 net acres in the Marcellus shale, 450,000 net acres in the Bakken; 280,000 net

acres in the Barnett; 380,000 net acres in the Lafayette, and 210,000 net acres in the Woodford.

Most of the Haynesville acreage came from its \$4.2 billion acquisition of Hunt Petroleum Co.

At the end of the third quarter of 2008, the company had started drilling its first two horizontal wells in the Haynesville shale, but hadn't completed the wells and had no test results.

Those wells face stiff competition in the XTO portfolio. The company has completed five wells in the Lafayette shales with 4,000-ft lateral sections and an average daily production rate of 2.5 MMcf. It completed the Churchill 1-26 well in the Woodford shale for 4.3 MMcf/d.

In its Freestone Trend play, the Beddingfield 6H horizontal Cotton Valley tight sand well came in at 8 MMcf/d.

"Moving into 2009, XTO Energy is positioned for another record performance, even with the obvious challenges in the global marketplace. Our dominant positions in numerous prolific basins give XTO visible growth with outstanding economic margins," said Bob R. Simpson, chairman and chief executive officer, during the company's third quarter report to shareholders.

"This quarter offered great opportunities for our operational team as we integrated the acquisition properties and began to see exciting field results," added Keith A. Hutton, president.

About the Hunt Petroleum properties in the company's eastern region, Hutton said, "Simply put, the majority of these properties equate to a super-charged bolt-on for XTO. With our knowledge of these assets, we already see the potential to realize more than twice the allocated reserves. Over the past decade, our team has aggressively developed the tight-gas sands and carbonates of our eastern region. The Hunt assets overlap and align with our substantial operated positions."

The company isn't through acquiring for growth. "We will add to the Haynesville, but we will be within what we perceive is the core," Simpson said. He also cautioned against falling for the hype surrounding various plays by emphasizing that XTO will only invest in areas that experience tells it will pan out well.

"It bothers me when I see the hype artists come in and trade off of our reputation with the public. I see that being done very much right now by some of these people. You're going to hear me speaking what I judge to be true," he said. ■

The Haynesville Heats Up

Activity is not the only thing heating up the Haynesville. Bottomhole temperatures near equipment thresholds cause changes in the technology menu.

By Dick Ghiselin
Contributing Editor


FIGURE 1. Properly placed fracture treatments are the key to unlocking Haynesville gas.

Photo courtesy of BJ Services

Operators exploring and developing Haynesville shale prospects face a dual challenge. They are starved for information but lack the ability to get it in the conventional way. Most agree that to build an effective reservoir development plan requires intimate knowledge of the target formations — where they are located and where the “sweet spots” are found. How best to acquire this infor-

mation is the subject of some conjecture, in part because the horizon depth exists at temperatures that challenge the reliability of many logging-while-drilling (LWD) tool systems. LWD, most agree, is the most efficient way to place wells within a reservoir because they can be geosteered, that is, steered using real-time geological data acquired from an instrumented bottomhole assembly (BHA) rather





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than geometrically steered using azimuth and inclinometry sensors. The critical questions that must be addressed include mechanical properties of the shale for fracture width and height prediction, effective porosity for volumetrics, fracture identification and qualification, and internal frac gradient, closure pressure and formation pressure (Figure 1).

All drilling services providers use well planning and drilling efficiency software that helps model and monitor well construction. The value of these programs, like any program, is a function of the quality of the input data. This is one point all service providers agree on regarding the Haynesville — there is not enough quality data available yet on which to build a customized package or an approach to well construction in the play. As a result, service providers are soliciting as much log, core, and drilling data as they can get to help them model the Haynesville and inject some predictability value into their recommendations. Presently, most information is coming from the vertical pilot holes that have been drilled and cored. Little is available from the laterals that have been drilled so far.

Beating the heat

A big advantage of technology is that it is not static. Progress is being made to improve the heat resistance of LWD tool strings. In this vein, Weatherford has just announced the successful drilling of a 60-degree deviated Haynesville hole terminating in a 3,500-ft horizontal lateral at 11,600-ft true vertical depth. Bottomhole temperature averaged 320°F and the BHA, driven by the company's Revolution rotary steerable system (RSS), completed 119 hours continuous operation at this temperature with a total of 193 hours below the rotary table. As temperature reliability becomes commonplace, LWD may evolve as the well construction and formation evaluation technique of choice.

For high-temperature work, Halliburton recommends its Solar GeoPilot RSS. The tools are rated to 350°F, and, when coupled with an extended gauge bit in the FullDrift bit configuration, can drill without hole spiraling or crookedness often encountered when drilling laminated shales with soft ductile layers. In lateral sections, the company recommends its openhole ShaleLog service that com-

bines data from LWD Triple combo with the Dipole acoustic logging tool. Complementing this logging suite is the company's LaserStrat Wellsite Chemostratigraphy Service that provides wellsite mineralogy spectroscopy on retrieved drill cuttings. After casing is set in lateral sections, Halliburton offers its Cased Hole Shalelog Service, consisting of its ChiModeling interpretation of eCoil-conveyed pulsed neutron log data. According to the company, this information helps operators pick perforating intervals for subsequent horizontal frac stages.

Even if more temperature-resistant LWD tools were available, the thick Haynesville may not be the best application for the most popular well-placement devices. Most of these propagation resistivity boundary mapping tools have a radial range of about 20 ft and because the gas sweet spots can be anywhere within the shale body, it would be easy to miss them in a bed where thickness ranges from 150 ft to more than 300 ft.

Earlier chapters have given a detailed description of the Haynesville trend. They have pointed out that the Haynesville shale is thick, hot, and heterogeneous. It doesn't lend itself to traditional prospecting and evaluation methods. The old traditional logs used to describe most formations and the intervening strata don't come close to providing enough information on which to base a reservoir development campaign. Accordingly, many operators are drilling, coring, and evaluating vertical pilot holes, then attempting to project the information they acquire to the lateral drainholes they drill subsequently.

But conventional coring is costly and time consuming. Thorough dissection and evaluation of cores in a laboratory can take weeks. Fortunately, there are some new wireline logging instruments that can take the heat and provide many of the needed key answers.

Downhole detective work

When Sir Arthur Conan Doyle's famous fictional detective, Sherlock Holmes, was asked by his assistant, Dr. Watson, how he used his powers of deduction to develop information, he replied, "Elementary Watson, elementary!" This response is in vogue in

evaluating the Haynesville, where ECS elemental capture spectroscopy logging is providing clues to solve shale heterogeneity issues. The ECS tool bombards the formation with high-energy neutron radiation, then measures and records the energy spectra of the resulting gamma rays of capture that emanate from the neutrons' interaction with elements in the shale. From the elemental volumes present, geoscientists can calculate mineralogy, thus characterizing the rock and providing valuable input to interpretation programs with objectives that include definition of reservoir properties.

According to Dee Grant, SHOC (Schlumberger Horizontal Optimization and Completion) solutions manager, the preferred logging suite includes triple combo (resistivity, plus density/neutron porosity), ECS, and the new Sonic Scanner acoustic scanning platform service. The triple combo/ECS services yield clay volume and type as well as identify and quantify the volume of free gas. The Sonic Scanner tool enables full 3-D anisotropy studies and stress orientation. The information provided by this service helps understand hydraulic fracture orientation and growth which is key to optimal lateral placement.

Helping in the analysis and developing answers that facilitate stimulation design is TerraTek, a recently acquired Schlumberger subsidiary that identifies mechanical parameters such as closure stress and formation competence. TerraTek has analyzed and studied many thousands of feet of Haynesville core, using the data it accumulates to integrate with and calibrate log responses. These results are valuable in helping to select proppant size and type as well as optimum carrier fluid for proppant compatibility. The high closure stress associated with the Haynesville dictates the use of high-strength proppants to resist crushing. The formation competence factor gives an indication of potential embedment of the proppant — meaning that instead of propping the fracture open as intended, the proppant becomes embedded in the fracture face as the fracture tries to close and is essentially rendered ineffectual. This problem can be overcome by pumping treatments that develop a multilayer proppant pack in the fracture.

But long term, most service companies have iden-

tified the development of a systematic well design work flow as their primary objective. "We still do not know all we would like to know about the Haynesville," said Grant, "and our experience in other shale plays leads us to conclude that more knowledge and a robust procedure will pay off in the long run." Grant alluded to work flows his company had developed for successful campaigns in the Barnett, the Bakken, Woodford, and Fayetteville shales.

"These shales are not the same as the Haynesville," he said, "that would be too easy." Accordingly, Schlumberger has developed an iterative model that is enhanced by each new piece of relevant information as it is acquired. It helps move the analysts quickly up the learning curve, Grant said. And it identifies the risks and suggests ways to mitigate them. By employing an iterative approach, the model can grow and improve as it is being used, giving successively better results until a distinct "Haynesville solution" evolves.

Richard Lewis, technical projects leader for Schlumberger Data & Consulting Services (DCS), said, "We are not necessarily looking for an exclusive 'Haynesville solution,' even though the play has some unique characteristics." Lewis pointed out that he and his colleagues have examined well data on more than 1,000 US shale wells and the similarities are far more striking than the differences.

"The goal in most shale wells is firstly to land the laterals in the right place and orient them with the prevailing stress field," he said. "Then we recommend logs that provide total and effective porosity, water saturation, total organic carbon content, volume of adsorbed and free gas in place, and relative gas permeability." Lewis cited the value of mechanical properties logs to provide a good understanding of regional stress profiles and hydraulic fracture closure stress. "We also need to know if there are natural fractures plus their location, orientation, and density," he said. "Unfortunately, if you miss your target level in the shales by only 30 ft, you may miss a commercial pay opportunity altogether." The company runs the ultra-high resolution Fullbore Formation MicroImager tool in the pilot holes to help identify optimum target levels.

Additionally, on most shale wells, Lewis' group recommends the Sonic Scanner service. It gives

FIGURE 2.

Real-time operational data enables service company engineers to optimize treatments as they are pumped.

Photo courtesy of BJ Services



compressional, shear, and Stoneley velocity, formation mechanical properties, and the orientation of maximum horizontal shear velocity. “We have figured out how to use Stoneley waves to determine horizontal shear velocity,” he said. “The shale is like an Oreo cookie with high modulus layers bounding a soft clay-rich layer. We use elemental capture spectroscopy logging to get a handle on clay content and mineralogy.”

Because many Haynesville operators depend on data from vertical pilot holes to help them properly place and drill their laterals, DCS provides a 36-hour turnaround on pilot hole data interpretation and analysis that helps the operator land the lateral. “By placing the lateral landing point in the optimal zone, the initial production increased by a factor of 2 to 3.5 times,” Lewis said.

Halliburton agrees that prior planning is the key to success in any well evaluation. It enters all relevant well data into a well planning and operations management program called Engineer’s Desktop, developed by Landmark and comprising a dozen interlinked programs each intended to optimize a different well-construction parameter. However, the Haynesville presents a particular challenge in the fact that so little prior data exists. Accordingly, the company has developed a comprehensive logging suite it recommends for the vertical pilot holes most operators are drilling. Similar in part to the system described above, the Halliburton plan calls for additional data from its MRIL nuclear magnetic resonance imaging tool and its extended-range micro imager, the XRMI tool. Specific information sought includes T1 longitudinal relaxation time analysis that yields lithology independent measurements of effective porosity, free fluid porosity, clay-bound water, and capillary-bound water. The XMRI measurement helps discriminate open natural fractures that can actually flow gas from marginal class fractures that simply pose leak-off problems. The tool can also identify and orient the drilling induced fractures that are the clue to regional stress fields.

During the drilling phase, Landmark’s OpenWire software enables real-time operations monitoring by transmitting LWD data from the well site to the office using the Wellsite Information Transfer Stan-

dard Markup Language protocol. The software enables real-time decision support from the asset team to effect steering decisions and maintain safe operating conditions. Real-time information can be used to simultaneously update the reservoir model, correlate with information from offset wells and complement the overall reservoir development plan.

In many cases, operators do virtually all their detailed formation evaluation and core analysis in the vertical pilot holes they drill prior to kicking off the production lateral. Most are comfortable drilling the pilot holes with water-based mud, which makes formation evaluation much easier. For the laterals, they reverse-out the water-based system and substitute an oil-based mud. In many cases, this solves the shale imbibition problem and forestalls formation damage in the production zone. Because there is little resistivity contrast in the shale, many wells are geometrically steered through the Haynesville.

However, as pointed out by Schlumberger and Halliburton, geosteering can still be effective using NMR and acoustic logs, and many well placements have been optimized using these techniques while drilling the laterals. In addition, important information that affects the stimulation treatment/completion design and implementation is acquired during the logging phase. Because computer-based work flows and reservoir models are used, updates are almost instantaneous and treatment designs can be improved right up to and during the time they are pumped.

Completion technology coalesces

Challenges in fracturing the Haynesville are being identified and quantified every day. There is no final solution yet, but early clues point to three main production-related issues:

- Frac treatments may not achieve optimum results if real-time monitoring and redesign techniques are not used. From the outset, it’s been apparent that treatment specialists need to be able to monitor details of their operations and react on-the-spot to their observations;
- Intrusions of fines and clays as well as diagenetic effects may affect production unless

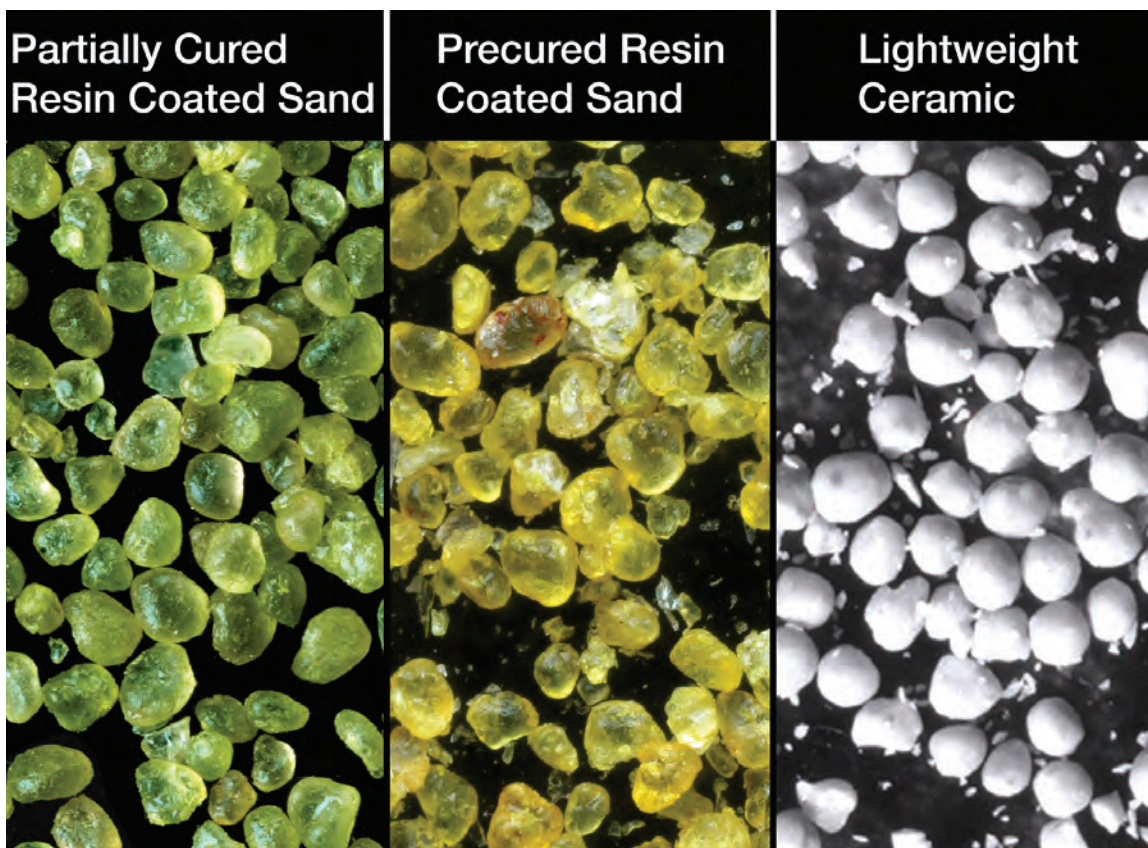


FIGURE 3. Wet-Hot-Crush test fines generation comparison of a partially cured RCP (Prime Plus, with 0.5% fines), precured RCP (3.7% fines), and uncoated lightweight ceramic (8.2% fines) at 8,000 psi (55 MPa) closure stress.

Image courtesy of Hexion

they are quickly identified and controlled; and

- Production can be curtailed by water imbibition into the frac if technology to prevent phase trapping is not employed.

By way of example, Halliburton offers a case relating to intrusions into the fracture, and how they can be detected and mitigated. It has long been known that movement of clays and fines into the fracture and proppant pack can have serious negative effects on production. The effects of diagenesis are not so well known but have now been documented. Even if clays and fines are controlled, diagenetic reactions will still occur between the proppant and the newly exposed fracture face. The result is corrosion much like the corrosion on a battery terminal and can greatly reduce fracture permeability. These effects can occur very quickly under the conditions of heat, pressure, and moisture inside the fracture.

Fortunately, fines, clays, and diagenesis can all be controlled by coating the proppant with a nonre-

active coating before the proppant enters the fracture. An on-the-fly coating system is available that chemically modifies the surface of the proppant grains to provide several important benefits. This proppant coating technology is available from Halliburton as its SandWedge conductivity enhancer.

Performing the treatment

The completion technique of choice appears to be the “plug-and-perf” method. Completion experts from several service companies say this technique gives the greatest flexibility in placing fractures exactly where they should be. The procedure is simple and straightforward in its implementation.

First, a bridge plug is set, usually from a setting tool attached to the bottom end of a hollow carrier perforating gun. Once the plug sets and is sheared off from the setting tool, the perforating gun is pulled up and positioned opposite the interval to be treated. The gun is fired, pulled from the well and the treatment is bullheaded from surface. Subsequently, the next plug-and-perf gun is lowered into

the well. It consists of a composite bridge plug that is set above the previously treated zone to protect it while the next zone is perforated and treated.

The procedure is repeated until all stages have been treated. Then all the composite bridge plugs are drilled up and the well is cleaned up and made ready for the final completion steps. Typically, the lowermost plug is a permanent cast-iron bridge plug, while successive plugs are temporary easy-to-drill composite ones.

The zone-by-zone plug-and-perf technique offers flexibility benefits not found in other techniques. Since each stage is shot and stimulated separately, positioning of subsequent stages can be adjusted as needed based on information acquired during the treatment of the previous stages. The popular new technique is microseismic mapping that tracks the propagation of each hydraulic fracture in real time as it is being pumped. A seismic tool containing an array of sensors is hung off in a nearby offset well. It detects the tiny microseisms that occur as a result of the rocks fracturing and locates them in geospace. By tracking the microseismic events live, as they occur, a 3-D image of the fracture can be visualized. Engineers can make game-changing decisions on the fly as new information is received and processed. Thus, they can position the next treatments to complement those that have been pumped earlier, thereby optimizing reservoir contact. In addition, knowing where a fracture is going allows the stimulation engineer to alter the pumping schedule or introduce diverters to “steer” the fracture away from hazards such as aquifers, leaking faults, or gas caps. Proven effective in the Barnett shale, among others, microseismic fracture mapping is expected to be highly beneficial to Haynesville operators.

In addition to microseismic fracture mapping, Halliburton has found that distributed temperature surveys run in conjunction with treatments are useful to identify treatment distribution problems in the near wellbore area. This information, captured on one treatment, can be used to enhance design and implementation of subsequent treatments, ultimately optimizing treatment techniques. A host of parameters and operating techniques can be adjusted in the design and execution phases of



the next well based on real-time observations from previous wells. Experts can come to understand how the data relates to the geology and geomechanics of the formation, which helps them determine the next steps.

Shooting holes in conventional wisdom

GEODynamics develops and manufactures perforating equipment. “Perforating is often overlooked as an important step in fracture stimulated completions,” said Matt Bell, vice president, Technology. Bell noted that perforating systems became heavily commoditized in the late ‘90s and early ‘00s, and, as a result, today there is insufficient attention paid to potentially differentiating technology. According to Bell, most operators have few, if any, staff with

FIGURE 4. The GC-TRACER equipment provides continuous monitoring of drilling fluid returns to detect minute traces of gas.

Photo courtesy of Weatherford International

CONNEX charges using HNS (hexanitrostilbene), an established high-temperature explosive for oil-field applications. These products were added to the company's catalog specifically for Haynesville applications, although they are now being run in other international markets, Bell explained.

Understand the reservoir first

"The Haynesville is in early days now," said BJ Services' Ed Smith. "There may not be a unique Haynesville 'package,' but there are several solutions, each applying to a different area." Smith's company has trademarked the 'Understand the Reservoir First' process and believes this is the key to optimized completions. "As more wells are drilled and completed, we are gaining the knowledge we need," he said. "We learned in the Barnett play, which has jokingly been characterized as 'the 17-year overnight success,' that there is no substitute for knowledge."

The Barnett experience led BJ Services to create its Shale Technology Team, headed by veteran geologist Randy LaFollette. "Our efforts are not constrained to the Barnett," said LaFollette. "We are developing optimized techniques for each of the current shale plays, because each is different." According to BJ Services, to date no best practices for the Haynesville have emerged — they simply reflect current practice. Shales are highly variable reservoirs with differing source rock quality, varying matrix and bulk permeability, changing geomechanical conditions within the reservoir and its boundary layers, closure stresses, embedment potential, etc., and they do not lend themselves to a standard treatment.

In the Haynesville, while additional information is being gathered, the current consensus seems to be completing wells in horizontal sections averaging 4,000 ft in length. They typically use cemented 4 ½-in to 5 ½-in casing, pumping 2 million lb of proppant in 9 to 12 stages of 40 ft to 60 ft in length, and separated from the next stage by 300 ft to 400 ft. Injection rates vary from 50 bbl/min to as much as 85 bbl/min. Frac designs are focused on 40/70 mesh proppant with a 100 mesh lead-in. BJ Services is presently pumping 30 lb to 35 lb of its Viking and Medallion systems (Figure 2). However, one operator is known to favor a hybrid consisting of slickwater, 25 lb linear, and 25 lb Lightning fluids.

Overall, there is no consensus on fluids, but hybrids seem to be more commonly used of late, as opposed to slickwater fracs or those using crosslinked fluids. LaFollette says that increases in fluid viscosity seem desirable from a proppant transport standpoint. Accordingly, a crosslinked fluid with customized proppant will most likely win in the long run. Today, he said, many operators are pumping what's available, not necessarily what's optimum. This point was acknowledged by an independent operator with several projects ongoing in the area, who mentioned the difficulty of getting the specified proppant on its jobs. Proppant has become so scarce that lately there has been a take-it-or-leave-it attitude among some providers of fracture treatments.

The shortage of quality proppant supply in the Haynesville shale and other areas has not gone unnoticed. "We have opened a new plant in Oklahoma City, Okla., and are very excited about its ability to provide up to 100 lb of proppant annually," said Bill Kemp, sales and marketing manager for Hexion's Oilfield Technology Group.

Extensive research was completed to ensure that Hexion's resin-coated proppants (RCP) will perform under the elevated temperature, high pressure, and wet conditions of the Haynesville. The company developed its Wet-Hot-Crush test to closely model these real-world downhole conditions (Figure 3). RCP are designed to provide maximum fracture flow capacity that increases well production while limiting costly proppant flowback. The resin coating provides additional strength to individual grains, distributes stress throughout the proppant pack, and mitigates fines migration through encapsulation.

Uncoated proppants, such as raw sand and ceramics, generally do not behave as expected under the harsh conditions found in the Haynesville, which can greatly affect well performance. "Hexion recommends a premium, partially cured proppant for water fracs such as Prime Plus to achieve the desired results," said Kemp.

Knowledge of rock properties is highly valuable to better understand the Haynesville. Currently, with depressed gas prices, many operators are drilling merely to hold acreage, and this, in BJ's Ed Smith's opinion, provides an excellent opportunity to

FIGURE 6.
Field-molded
stand-offs help
ensure complete
cement distribution
and bonding.

*Photo courtesy of
Halliburton*



gain knowledge. “We need to understand how it cracks differently from the Barnett or Marcellus,” he said.

There is a dangerous ongoing practice that could limit the potential of a prospect. Some people are satisfied to simply repeat what they did on their last successful job. They want to run the same bits, use the same mud, and specify the same formation treatments. This is a formula for mediocrity. Unless the asset team uses its knowledge to determine with some accuracy the potential of each well, they will not know when they have reached it. The satisfaction with a well that produces 1,000 Mcf/d on completion quickly fades when it is pointed out that the well’s actual potential was 3,000 Mcf/d. With foreknowledge, research and development groups can develop new materials, tools, and techniques to optimize Haynesville completions. “We’re soliciting every shale core our clients will give us,” said Smith. “The rock properties data we derive from these cores is invaluable in helping us design treatments that work.”

Schlumberger’s Grant agrees. “Early involvement with the operators’ asset teams is key,” he said. “We interface with their geoscientists and engineers, not just the completion or production people.”

Solving the puzzle

Each job enhances the next. By recording all pumping parameters when a treatment is pumped a valuable knowledge-base evolves. BJ Services uses this information in its PowerVision System together with Geographic Information System (GIS) analysis to deconvolve the trends. Even so, reservoirs like the Haynesville are extremely complex and very hard to model. Microseismic imaging is about the only

viable technique to understand exactly how the fractures propagate and, thus, to understand the stress patterns that govern their propagation.

Many different services and measurements combine to give the body of knowledge required to thoroughly understand a reservoir, especially shale plays such as the Haynesville. Weatherford has had success with its GC-TRACER Surface Gas Detector (Figure 4). Scanning the mud as it circulates back through the bell-nipple, the GC-TRACER uses a slim probe with a semipermeable membrane to reliably detect the presence of even tiny volumes of gas in the drilling fluid returns and acquire samples for high-speed gas chromatograph analysis. Compact and explosion-proof, the surface equipment is easily installed and delivers timely, more precise results than traditional methods, such as the gas agitator trap, according to the company.

The equipment operates continually while mud is being circulated, and, according to Weatherford, can perform gas composition analysis from C1 to C8 in 60 seconds, and from C1 to C10 in 135 seconds, considerably reducing the chance of missing a pay zone. The unit also analyzes non hydrocarbon gases such as CO₂, N₂, and H₂S as well as aromatics (benzene, toluene, ethylbenzene, and xylene). Of particular note, Weatherford points out, is the GC-TRACER’s ability to detect sweet spots in the shale as it is drilled, providing vital information to completion and stimulation design specialists.

Treatment enhancements

Weatherford cites a variety of its products with application in the Haynesville from a variety of treatment fluids used in slickwater fracs to cleanup enhancers and broad-spectrum biocides that reduce the formation of sulfates and algal slime-forming bacteria. For the production phase, the company touts its many gas-lift solutions. How does one use gas lift in a gas well, one might ask? The answer, Weatherford said, is to help unload liquid that collects in the production zone and lower tubulars impeding the flow of gas. Packaged as the Critical Velocity Reducing System, the service allows operators to choose from a wide variety of solutions to find the one that best fits the well’s specific situation.

The term “specific situation” rings a chord with

Schlumberger as well. The company has developed its SHOC process (Figure 5). They integrate the process with the work of their TerraTek group of shale gas experts, who perform detailed core analysis. From this, drilling mud and frac fluid that are customized to the particular well are recommended to the operator. “In the Haynesville there is a section you want to be in and there are several sections you don’t want to be in,” explained Grant. “Such issues as poor hole stability or a poor place to initiate a fracture make it imperative that we know where we want to be and the places we want to avoid.”

Perhaps the most critical information, Grant continued, is where to land the laterals. The logging suite Schlumberger runs in the pilot hole gives them the information they need to drill the lateral — organic carbon content, clay type, clay volume, and free gas volume. Add to this the stress field information they get from the Sonic Scanner tool, and they are able to orient the laterals so they can pump transverse fractures rather than longitudinal ones. Transverse fractures give the best opportunity to make contact with a greater reservoir area, Grant said.

“We are very confident with the reservoir characterization answers we are getting from that logging suite,” he said, speaking about the triple combo/ECS/Sonic Scanner combination. “The information we get from these logs allows us to put rationale behind each decision. Our top-to-bottom integrated iterative workflow leads us to the best answer and helps rule out inappropriate choices whether we are in the Barnett, the Haynesville, or anyplace else — it points us to the most likely solution and reduces risk,” he concluded.

It goes without saying that shale formations have extremely low permeability, and capillary pressure is well known to be permeability dependent — the lower the permeability the higher the capillary pressure. The increase of capillary pressure as a result of damage (loss of permeability) is responsible for the increase in water saturation in the damaged zone, which ultimately results in low productivity. In other words, high capillary pressure can result in significant imbibition of water into the fracture face where the water can become trapped, blocking the paths required for gas to move to the fracture. A recently developed numerical simulator helps in

understanding the complex relationship among relative permeability to gas, both imbibition and drainage conditions, relative permeability to water, and capillary pressure curves, to name a few.

A new micro-emulsion surfactant, called GasPerm 1000 from Halliburton, provides important benefits to help production from unconventional gas reservoirs be put on on-line faster and at higher rates. This micro-emulsion offers improvements in several areas:

- Helps reduce damage due to phase trapping,
- Enhances mobilization of liquid hydrocarbons including condensate,
- Helps increase regained permeability to gas following treatment,
- Improves load recovery,
- Replaces methanol for water block applications, and
- Improves environmental and safety performance over existing alternatives.

The new surfactant is designed for unconventional reservoirs and modifies the contact angle toward 90°. It is compatible with both acidic and basic fluid systems and can be used as an acidizing additive or fracturing fluid additive. It has been shown to be substantially non-damaging to formation gas permeability, and can be used in place of methanol. When run as an additive at field concentrations, the micro-emulsion reduces flammability risk compared to methanol at concentrations typically used for water block treatment applications.

An innovative new technology from Halliburton called ProTech CRB involves using an injection molding process to pre-bond ceramic carbon fiber stand-offs or centralizers directly to the outer surface of casing before it is run into the hole. The result is excellent cement distribution and bonding even in highly deviated or sidetracked wells or wells with narrow annuli. The technique is easily applied to virtually any casing and offers numerous advantages (Figure 6). ■

Acknowledgements

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Haynesville Drives New Pipeline Development

Plans are under way for getting the new gas to market.

By Bruce Beaubouef, Ph.D.

Editor in Chief

PipeLine and Gas Technology

As upstream operators step up their exploration and production activities in the Haynesville shale, midstream companies and natural gas pipeline operators are making plans to build the transportation infrastructure needed to get this new gas to market. Two key players in this arena are DCP Midstream Partners and M2 Midstream, which recently announced an agreement to develop a new intrastate pipeline designed to serve the needs of the Haynesville shale gas producers.

The project would involve the construction of a new large-diameter pipeline that would move gas from the North Louisiana portion of the emerging Haynesville shale play. The new pipeline, dubbed the “Haynesville Connector,” would be an extension of DCP’s existing Pelico Intrastate Pipeline. Early plans call for the line to originate in western DeSoto Parish and extend over 150 miles to Delhi, La., providing access to existing takeaway systems such as the Southeast Supply Header, and other systems owned by Columbia Gulf Transmission, ANR Pipeline, Trunkline Gas Co., Texas Gas Transmission, Tennessee Gas, Centerpoint Energy, and Gulf South Pipeline. If built, the Haynesville Connector is expected to commence initial deliveries in the third quarter of 2009, and offer an estimated 1.5 Bcf/d of takeaway capacity by early 2010.

“Producers in the Haynesville-Lower Bossier shale area in East Texas and North Louisiana are enthusiastic about results from initial wells which are meeting or exceeding their expectations, and these results are bolstering forecasts for natural gas production in the area,” said Mark Borer, president and chief executive officer of DCP Midstream.

“DCP and Momentum are well positioned to provide critical pipeline infrastructure to serve the near-term needs of Haynesville shale producers by leveraging Pelico’s existing infrastructure, located within the core geography of the shale.” Importantly, Borer noted that this project will insure early capacity availability to help keep pace with anticipated drilling, while also affording additional flexibility in the markets available to producers.

Currently, DCP’s Pelico Intrastate Pipeline serves numerous intrastate and interstate markets, including the Perryville Hub, and it is strategically located to facilitate the transportation of Haynesville shale gas to those markets and to growing markets in the eastern and northeastern areas of the US. The Pelico assets, along with additional gathering assets owned by DCP and Momentum, can help provide an interim solution to producers’ natural gas delivery needs in advance of the Haynesville Connector construction timeline.

“Momentum and DCP have been working on the Haynesville Connector for several months in order to provide Haynesville shale producers with access to a long-term takeaway solution on an accelerated timeline,” said Frank Tsuru, president and chief executive officer of Momentum. “Our complementary skill sets will insure a well-designed pipeline is built on schedule with a focus on customer service. We look forward to working with DCP on this significant opportunity to be part of this emerging natural gas play.” The DCP and Momentum joint venture remains subject to the execution of definitive agreements.

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Fig. 6



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To help move gas from the Haynesville shale, CenterPoint Energy Gas Transmission is considering an expansion of its Carthage-to-Perryville pipeline.

Photo courtesy of CenterPoint Energy



Another notable Haynesville shale gas pipeline project is being planned by Dallas-based Regency Energy Partners, which has announced a US \$1.1 billion plan to expand its North Louisiana pipeline system. “By launching this project to expand our existing midstream infrastructure in the heart of the Haynesville shale, Regency has a ‘first-mover’ advantage in meeting existing and future demand,” said Regency chief executive Byron Kelley. “We expect significant drilling in North Louisiana for many years, and our strategic footprint in the region together with the incremental capacity from this project will position us well to handle this growth.”

Kelley said the expansion of the Regency Intrastate Gas System will provide 1.45 Bcf/d of new capacity to handle expected increases in production from the region. He added that Regency has letters of intent for long-term transportation agreements from anchor shippers covering about 76% of the incremental capacity and is also seeing strong demand for the remaining capacity. The Haynesville expansion project includes looping the existing pipeline, extending the system, and adding new compression.

Construction of the project will be divided into two phases. Phase 1 is expected to be completed during the first half of 2009, adding 300 MMcf/d of capacity once fully operational. Phase one will cost about \$375 million. Phase 2 will add an incre-

mental 1.15 Bcf/d. It is expected to be online by the end of 2009 and fully operational in the first quarter of 2010. Kelley said the project will add 204 miles of pipeline, with diameters ranging from 24 in. to 42 in., and 49,000 hp of compression.

Regency has obtained several commitments from UBS Investment Bank, Morgan Stanley Senior Funding Inc., and RBS Greenwich Capital for approximately \$600 million of debt financing needs associated with this project, which will be utilized to reduce borrowings outstanding under the partnership’s revolving credit facility. Kelley said this funding will allow Regency to utilize its revolving credit facility to finance all of the project costs associated with Phase 1 and a portion of Phase 2 costs.

The company said it intends to finance the remaining costs of Phase 2 by using available capacity under its revolving credit facility and through future equity offerings. The \$1.1 billion in capital needed for the project includes \$121.5 million in commitments approved by Regency’s board last year for longer lead-time items, such as pipe, compression, and rights-of-way.

Kelley said Regency also plans to expand some of its existing interconnections with interstate pipelines and is exploring new intrastate and interstate market options for its shippers. The system reaches across North Louisiana, from Caddo Parish to Franklin Parish, and will be expanded to the southwest into DeSoto Parish to interconnect with Regency’s Logansport gathering system. The project is subject to regulatory approvals, Kelley noted.

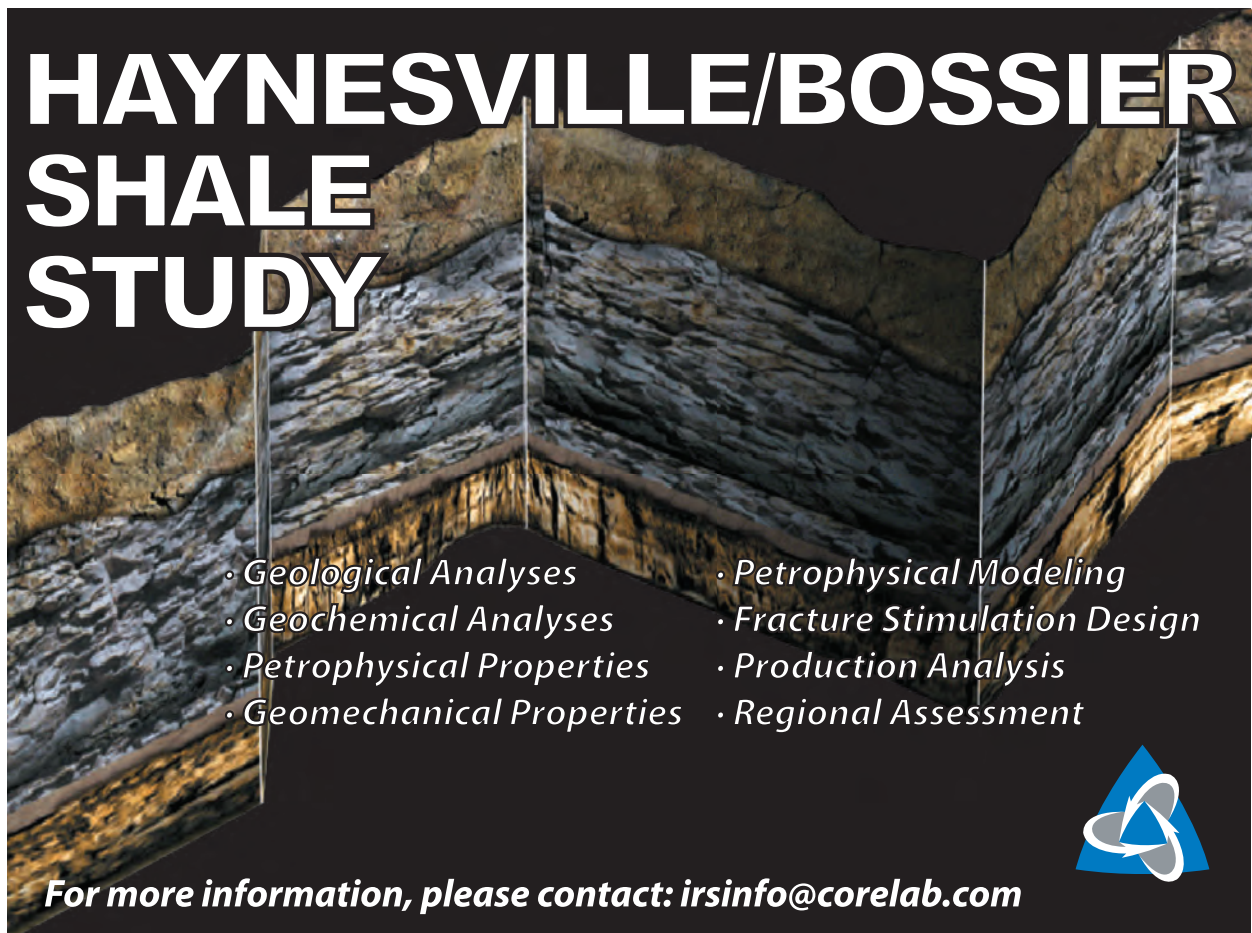
Still other operators hope to be able to expand recently completed pipeline systems to meet the needs of the Haynesville shale gas producers. Perhaps the best example of this is the Carthage-to-Perryville pipeline, placed into service by CenterPoint Energy Gas Transmission Company (CEGT) in 2007. The line, also called “Line CP” by CEGT, runs 172 miles with 42-in. pipe from northeastern Texas to the Perryville Hub in northern Louisiana. In East Texas, it connects to the Carthage Hub, a market center with interconnections with intrastate systems developed by such companies as Atmos Energy, Crosstex Energy

Services, Energy Transfer Partners, and Enbridge Pipelines. The Perryville Hub connects with nine interstate pipelines and two intrastate pipelines. Phase 1 of the 42-in. pipeline originally had a capacity of nearly 1.2 Bcf/d, but CenterPoint has now expanded its capacity to 1.5 Bcf/d. The total cost of the project was approximately \$570 million, according to CenterPoint.

Recently, CEGT announced the start of a non-binding open season to gauge market interest in an additional expansion of its Carthage to Perryville (Line CP) pipeline. CEGT successfully completed the first three phases of Line CP and continues to receive expressions of interest in incremental capacity, according to a company news release. "Natural gas production volumes from the Bossier Sands and Barnett Shale in North and East Texas continue to exceed previous forecasts," observed Cy Zebot, senior vice president and chief commercial officer for CEGT. "As the Haynesville shale further develops,

Line CP is well positioned to expeditiously get these supplies to the marketplace." Assuming adequate expressions of interest are received, Zebot said that CEGT is prepared to execute binding precedent agreements and seek necessary governmental authorizations in order to place the first stages of this project in service as early as the winter of 2009.


Gas production from East Texas remains robust, in addition to the rapidly developing Haynesville shale, according to CEGT. An additional expansion of Line CP would provide these incremental supplies access to the interstate pipelines serving the Midwest and Northeast through CEGT's Perryville Hub, as well as access to markets in the Southeast, through the Southeast Supply Header. Additionally, CEGT's Perryville Hub will provide direct access to the recently announced Perryville Gas Storage project being developed near Delhi. CEGT anticipates that such incremental capacity would be provided with additional compression and line looping of Line CP. ||



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Haynesville Play Exceeds Expectations

While productivity is unmatched, liquidity crunch will slow shale's development.

By Ray Deacon
Senior Research Analyst
Pritchard Capital Partners

The current liquidity crunch may either drive consolidation among the companies exposed or result in delays in the development of a project that could rival the Fayetteville shale in terms of its impact on US supply over the next several years. The Haynesville shale's economics are exceeding all expectations based on results from operators in the core of the play. A good deal of ink has been spilled over the past six months attempting to describe precisely how large of a resource this will be and who will benefit the most.

The noticeable increase in announced production rates from July to December is a first signal that recoverable gas-in-place per-section estimates will continue to creep higher. A number of operators have been reporting initial production rates on horizontal wells in excess of 17 MMcfe/d of late versus July announcements in the 9 to 10 MMcfe/d range, primarily from Chesapeake. Perhaps the only play in North America capable of generating similar types of returns are the deep Bossier shale being spearheaded by Encana and the Marcellus shale play in Southwestern Pennsylvania whose progenitor, Range

Resources, continues to surprise on the upside.

News flow is accelerating, and the next two months will offer a good deal more information for industry and investors to digest. Despite steep well costs at US \$8 million to \$10 million apiece, there is very little doubt that the economics of the play will rival any well drilled in the granddaddy of all the shale plays, the Barnett, where production will exceed 5 Bcf/d this year.



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Payouts on wells are occurring in year one at gas prices approaching \$5/Mcf, excluding the cost of acreage, a relatively similar picture to the Marcellus. The core of the play is proceeding rapidly based on the 37 publicly reported completions to date with a median initial production rate of 9.1 MMcfe/d. Petrohawk's two most recent wells each had initial rates in excess of 17.5 MMcf/d, averaging 20.6 MMcf/d.

nett, although the higher pressures and the uniformity of the shale allow for longer laterals and bigger fracture stimulation treatments that translate into higher EURs and initial production rates than any other shale play. Each fracture stage costs \$300,000 to \$400,000 but the returns for wells with as many as 10 to 15 stages per well look highly economic. Comstock's recently announced well expands the

THE HAYNESVILLE SHALE'S ECONOMICS ARE EXCEEDING all expectations based on results from operators in the core of the play.

The map that is drawn by most players encompasses an area that measures approximately 100 by 105 miles. The Haynesville shale has the potential to drive as much value for the companies involved as the Barnett shale or the Pinedale anticline, the two most significant discoveries of the past 15 years. The core of the play appears to be in northern DeSoto Parish in Louisiana and crosses over into southern Caddo and Bossier as well as Red River Parishes. The field is unlike any other unconventional play currently under development because of the highly pressured nature of the shale. Depth, pressure, and gas-in-place metrics are quite analogous to the Bar-

net into southern DeSoto Parish in Louisiana.

Much news on the play is likely during early 2009. Chesapeake may have as many as 9 new wells on production since its October call. Its production is expected to exceed 100 MMcf/d. Cabot is drilling to the southwest of what looks to be the heart of the trend, a well that could be very important to several producers, including Petrohawk.

Producers are concerned that by 2010 the industry will face difficulties in moving Haynesville gas to consuming markets, especially in light of Petrohawk's first 10 wells in the play having an average initial production rate of 19.4 MMcf/d, including five north of 20 MMcf/d. Regency pipeline has stated publicly that it is moving forward on a scaled-back version of its original plans and hopes to build a 125-mile 1.2 Bcf/d line to tie in its RIGS pipeline originating in the Waskom field at the Texas/ Louisiana border with six interstate pipelines. Despite a fairly reasonable gathering agreement calling for fees of \$0.35/Mcf, producers are balking at 10-year commitments given their unwillingness to put more liabilities on their balance sheet and also because of fear that April bank redeterminations will hurt their ability to utilize lines of credit. Energy Transfer Partners recently reported it is in discussions with several large independent E&P companies regarding the possible construction of a \$1 billion to \$1.2 billion large-diameter interstate natural gas pipeline from East Texas through the Haynesville shale play and terminating at the Perryville Hub in Eastern Louisiana. ■

Drilling to Haynesville below 10,000 ft before making the turn to horizontal uses a lot of drill pipe. This EnCana rig is ready for the job.

Photo courtesy of EnCana Corp.



Haynesville Reference Guide

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