

01 August, 2010

## Frederick Brook Shale Spurs Canadian Exploration

Another Shale Shows Promise

By Susan Eaton

Game changer? Horizontal drilling affirms more than a decade of E&P efforts in Canada's Maritime provinces – the Frederick Brook Shale emerges as a potentially prolific play.



When Apache Canada Ltd.'s Green Road B-41 horizontal well spudded on June 18, the event marked a technological step-change in the hunt for shale gas resources in New Brunswick, one of Canada's Maritime provinces that shares a border with Maine.

The commencement of horizontal drilling operations affirmed more than a decade of exploration and production efforts by Corridor Resources Inc. – a Canadian junior and Apache Canada's joint venture

partner – to characterize the Lower Carboniferous Frederick Brook Shale as a potentially prolific resource play.

In stark contrast to its North American black marine shale counterparts, the Frederick Brook Shale is derived from a continental lacustrine source.

“Fundamentally, the Frederick Brook Shale stacks up very favorably – from a new ventures opportunity – to anything in Canada and the United States,” explained Calgary-based geologist Robert Spitzer, Apache Canada’s vice president of exploration.

“It doesn’t suffer from being over-mature, nor from significant structure,” he continued. “We know we’ve got a basin full of lacustrine shales that should be capable of production – it’s rich, and it’s thick.”

Spitzer recently assumed the management of Apache Corporation’s global unconventional exploration program.

“The Frederick Brook Shale has all the right ingredients for a world class shale: the vitrinite reflectance ranges from 0.6 to 2.4, taking you from the oil window to the dry gas window,” Spitzer said. “The burial history is good, and it’s deep enough. British Columbia’s Horn River Basin is one of our analogs, and the Frederick Brook Shale is comparable or a little bit better than the Horn River Basin shales.

“However,” he added pragmatically, “it’s early days.”

After five years of operation in the Horn River Basin, Apache Canada has jointly drilled 70 horizontal wells with trajectories now averaging 2,000 meters.

Describing Apache Canada’s portion of the Horn River Basin as “in the development stage,” Spitzer said his mandate is to identify and develop new gas shale resources in Canada, the United States and around the world.

Often new opportunities in the Lower 48 are largely unattractive, he said, due to fierce industry competition, high land bonuses and small land blocks. Apache Canada focused, instead, on the Maritimes Basin, which spans eastern Canada and comprises numerous, intercontinental strike-slip sub-basins.

In particular, Apache Canada homed in on the Frederick Brook Shale, an emerging resource play located in New Brunswick, a province with a competitive one-eighth royalty and a history of oil and gas production that dates back to the 1850s.

Leveraging its shale gas success in the Horn River Basin, Apache Canada is applying its E&P expertise to unlock the potential of the Frederick Brook Shale.

## Location, Location, Location

Part of New Brunswick's attractiveness is the existence of the Maritimes & Northeast Pipeline, a 1,400-kilometer transmission system that crosses the province, transporting 400 to 450 mmcf per day of natural gas from offshore Nova Scotia to markets in Eastern Canada and Boston. In its current configuration, the pipeline's capacity is rated at 500 mmcf per day in Canada and 800 mmcf per day in the United States.

Halifax-based Corridor Resources was created in 1995 in direct response to the construction of the Maritimes & Northeast Pipeline – and true to its namesake, Corridor acquired lands along the pipeline route. Today the company holds 321,000 net acres in the Sussex sub-basin and the adjacent Elgin sub-basin.

Corridor's McCully Field, located in the Sussex sub-basin, contains 138 Bcf of proven plus probable reserves and currently produces 18 mmcf per day of natural gas from 30 wells tapping the Hiram Brook tight gas sand reservoir. Ten percent of the sales gas goes to the Potash Corporation of Saskatchewan's nearby industrial facility, and the remainder is transported to Boston via the Maritimes & Northeast Pipeline system.

The Frederick Brook Shale directly underlies the Hiram Brook tight gas sands in both the Sussex and Elgin sub-basins.

"It was important for us to get closer to market," Spitzer said, citing the 20-kilometer tie-in for the Green Road B-41 well to the McCully Field. "If gas prices stay low, it's good to be close to markets and infrastructure."

In addition to American markets, there is a small but growing domestic demand in eastern Canada. Natural gas produced in New Brunswick receives a small premium over NYMEX, and netbacks are higher than for other resource plays in western Canada.

"Being first-in to New Brunswick was great," Spitzer said. "Not only do you have to have the right shale, you have to pick the right deal."

The "right deal" was sealed in December 2009 when Apache Canada entered into a joint venture with Corridor – by June 2011, Apache Canada will spend \$25 million CAD to drill, case, multi-stage complete and production test two 2,000-meter wells with 1,000-meter-long horizontal trajectories. The completion of this initial work phase gives Apache Canada an option to invest an additional \$100 million of capital expenditures over a two-year period, earning a 50 percent working interest in 116,000 gross acres in the Elgin sub-basin.

Apache's two horizontal wells in the Elgin Sub-basin will twin Corridor's vertical boreholes which

encountered natural gas in the Frederick Brook Shale -- the Will de Mille H-59 well drilled with air, and the Green Road G-41 well which successfully tested natural gas, in 2009, following propane fracs in two separate intervals.

In the Green Road G-41 well, the lower black shale zone (2,000-2,050 meters), flowed 430 mcf per day at a flowing wellhead pressure of 150 psi over an 83-hour flow period. The upper silty/sandy shale zone (1,850-1,900 meters) produced 42.4 mmscf over 185 hours, peaking at 11.7 mmcf per day and stabilizing at 3 mmcf per day at a flowing wellhead pressure of 700 psi.

## **Get a Bigger Rig**

Oil shales of the Albert Formation (which contains both the Hiram Brook and Frederick Brook members) outcrop in the nearby Moncton sub-basin, demonstrating the existence of an active petroleum system in southern New Brunswick. From the 1850s to 1870s, the shales were mined for bitumen, which was shipped to Boston and Philadelphia where it was distilled to produce kerosene.

Despite Corridor's E&P focus on the Hiram Brook tight gas sands, the deeper Frederick Brook Shale has always been on the company's radar screen – that's according to AAPG member Tom Martel, Corridor's chief geologist. However, during the late 1990s, horizontal drilling and multi-stage fracturing technology didn't exist, Martel explained, nor did the industry believe that shales were capable of production.

Corridor, however, continued to evaluate the Frederick Brook Shale.

One commonly held geological belief – based on outcrop data – was that the Frederick Brook Shale was 200 meters thick. In 1998, however, Corridor rewrote the geological atlas for New Brunswick, when it drilled the Will de Mille H-59 well and penetrated 500 meters of the Frederick Brook Member, an inter-bedded package of kerogenous shale, silty shale and tight gas sands. Martel knew they had a "lively shale" when the Frederick Brook section generated gas shows and strong flares while drilling with air.

Determined to drill and evaluate the entire Frederick Brook Shale section, Corridor's next attempt, the McCully F-58 well, penetrated more than 900 meters of the Frederick Brook Shale – but the well didn't penetrate the entire section, and at 3,700 meters drilling depth, the well was suspended because the double drilling rig was constrained by horsepower.

"We were fighting gas all the way ... with 1,120 weight mud, and there was gas in the shale and a significant flare," Martel said. "Now that was exciting!"

Upgrading to a triple rig, Corridor drilled the McCully E-67 well, finally penetrating the entire Frederick Brook Shale – all 1,164 meters of it – and reaching total depth in the Horton red beds below.

In 2008, Corridor tested the lower zone in the Frederick Brook Shale in the McCully F-58 well, using a nine ton frac, which is small by today's standards for shale gas completions. The zone came on production at 500 mcf per day, and today it produces 175 mcf per day.

## **The Size of the Prize**

Measuring just 15 kilometers across and 40 kilometers long, Martel compares the combined Sussex and Elgin strike-slip sub-basins to California's Ventura Basin.

"When strike-slip basins open, they create very large holes that are deep but not very wide," he said. "You have a highly concentrated packing of gas in a small geographical area."

Yet despite the modest size, there's a lot of gas in the Sussex and Elgin sub-basins.

Based upon a 2009 assessment of Corridor's 10 vertical wells that have penetrated part or all of the Frederick Brook Shale, mapping from 2-D and 3-D seismic surveys, production tests and GLJ Petroleum Consultants, a Calgary-based independent reserve evaluator, assigned 67.3 Tcf of discovered resources to the Frederick Brook Shale. The GLJ report also assigned contingent resources to the Green Road G-41 area of the Elgin, ranging from 395 to 708 Bcf.

The GLJ report quotes a resource of 370 to 625 Bcf per square mile (upper and lower zones combined), which is based upon free gas-in-place, with no contribution from adsorbed gas within existing kerogen.

"In the shale gas world, I'm not aware of anything that comes remotely close to the Frederick Brook Shale, and that's because of its thickness," Martel said.

## **Southwestern Looks Northeast**

Less than four months after Apache Canada announced its entry into the Frederick Brook Shale play, Houston-based Southwestern Energy announced it was the successful bidder on exclusive licenses totaling 2.52 million acres in New Brunswick. The architect of the Fayetteville Shale play, Southwestern Energy will invest \$49 million CAD of capital expenditures during the next three years, culminating with the drilling one well by 2012.

"We (Apache and Southwestern) were both surprised, I think, with each other's appearance in New Brunswick," said AAPG member Randy Ponder, vice president of Southwestern Energy's new venture group. "Our challenge is to be a first mover in an area, and to find large, contiguous blocks with opportunity."

"It's a natural extension to the expertise that we've gained in the Fayetteville and the Marcellus," explained Ponder, a geologist. "The Frederick Brook Shale compares quite favorably to some of the shales that we've worked, including the Fayetteville, the Marcellus, and the Haynesville.

"In fact," he added, "the Frederick Brook Shale's TOCs are richer in places than any of those shales."

Southwestern Energy's acreage is situated north of the Corridor acreage, in an area that's essentially unexplored. Before bidding, the company reviewed analogous sub-basins to the south and assembled all publicly available aeromagnetic data. It reprocessed these data, creating a depth-to-basement map that revealed the existence of several sub-basins beneath the Carboniferous cover at surface.

"We were rather surprised," Ponder said of the discovery of these narrow, strike-slip sub-basins. "The more we tried to determine what else they could be, the more they looked legitimate."

Southwestern Energy also compared the onshore interpretation to the offshore seismic data – the shales also exist in the offshore – obtaining a stronger regional structural interpretation.

Within four short months of obtaining the licenses, Southwestern Energy has flown an airborne magnetic and gradiometer survey, and is currently permitting a surface geochemistry sampling program to be conducted later this summer. All of these back-to-the-basics exploration tools will be integrated to further evaluate the new sub-basins, optimizing the positioning of a 1,000- to 1,300-kilometer 2-D seismic survey to be acquired next summer.

"Although we've just started the exploration phase, if successful, New Brunswick is going to be a significant part of Southwestern Energy's business," Ponder said.

"We're hopeful," he added. "Like the shale gas, there should be more McCully fields (tight gas sands) if the petroleum system is working."

## **By the Sea**

During the next few years, the future of the Frederick Brook Shale as a world class resource play could be determined as these two industry leaders – and by a Canadian junior quickly moving up the shale gas learning curve – apply their expertise in the development of North American shale gas plays.

"These two horizontal wells will go a long way to answering our questions about the Frederick Brook Shale (and silt)," Spitzer said. "At the end of the day, it all comes down to producibility."

Given commercial success, Apache Canada's full-scale development phase contemplates the annual drilling of one to two pads over a 10- to 30-year time frame. Each well pad would have eight to 16

horizontals with trajectories on the order of 2,000 meters.

"We're cutting to the chase here, faster than we did in the Horn River Basin, and we've made use of the learning curve in the Horn River Basin," Spitzer added. "You need scale to make this work. And, if it works, we've got a lot to do."

Apache Canada conducted stakeholder consultations and open house meetings before commencing drilling operations.

"People have concerns, whether in the Horn River or New Brunswick," Spitzer said with respect to water usage in multi-stage slick water fracs.

Apache Canada is investigating tapping the largest source of nearby water, the ocean.

"Why wouldn't we look at the potential of using sea water, and reducing the amount of fresh water?" he said, adding that the salinity of sea water is similar to that of Devonian carbonate formation water that will be used by Apache Canada and its partner EnCana in multi-stage fracs in the Horn River.

"Using sea water is an elegant solution – if it can be done," he said, "and we've been innovative in mitigating impacts, whether in British Columbia or New Brunswick."