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EXPLORER

'Big deal' in the Arctic

'Shale Adventure' on Alaska's North Slope

By Heather Saucier



At a time when some operators are slowing production of unconventional resources, and as oil and gas prices continue to fall, three companies have high hopes for producing shale oil north of the Arctic Circle for the first time in petroleum history.

Great Bear Petroleum of Anchorage, Alaska, Royale Energy of San Diego and Burgundy Exploration of Houston hold a total of nearly 800,000 acres in leases on the North Slope of Alaska.

The leases are located south of Prudhoe Bay and stretch about 100 miles from the Colville River on the west to the Sagavanirktok River on the east.

Great Bear has drilled two stratigraphic test wells with its partner, Halliburton Energy Services, and is evaluating three source rocks estimated to contain hydrocarbons by the U.S. Geological Survey (USGS).

"Everyone is watching because this is the first time that shale oil is being tested in the Arctic environment," said AAPG member David Houseknecht, supervisory research geologist and project chief for the USGS' Energy Resources Program in Alaska.

"It is a big deal," he said. "It will be interesting to see what the outcome is."

Three Rocks

Geologists at Great Bear, Royale and Burgundy are eyeing three source rocks: the Triassic Shublik, the Jurassic Lower Kingak and the Cretaceous-Lower Tertiary Brookian (which includes the pebble shale unit and Hue shale).

All have sourced conventional reservoirs on the North Slope, primarily Prudhoe Bay. Broad estimates of oil generated in these source rocks range from 100 billion to one trillion barrels of oil.

Combined, the mean estimate for all three source rocks ranks among the top source-rock systems in the country, placing them just above the Eagle Ford in terms of technically recoverable oil, Houseknecht said.



David Houseknecht

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Specifically, they have the potential to produce up to two billion barrels of retained oil and up to 80 trillion cubic feet of retained gas, according to Houseknecht's report released by the USGS in 2012.

Houseknecht began gathering data on shale oil and gas potential in 2009.

"I decided that considering the level of shale oil and gas development in the Lower 48, we really needed to establish a quantitative perspective on the shale resources on the North Slope," Houseknecht said. "The reaction I got was, 'Why are you doing this?'"

Then, a year later, Great Bear appeared out of nowhere and leased 99 tracts totaling approximately 499,000 acres south of the Prudhoe Bay and Kuparuk fields.

"My phone began ringing off the hook," Houseknecht said. "The state wanted to accelerate the assessment. It's the only time in my life that I anticipated a demand appropriately."

In 2011, Great Bear acquired an additional 45,700 acres and Royale entered the scene and leased 100,000 acres. Burgundy, now in partnership with Tangiers Petroleum, recently popped up acquiring nearly 100,000 acres as well.

Based on Houseknecht's estimates, the Shublik Formation - the oldest of the three - contains the greatest potential per unit area, with a mean of 463 million barrels of technically recoverable oil for the entire play. It is trailed by the Brookian formation with a mean of 449 million barrels, and the Kingak with a mean of 28 million barrels.

The Shublik has diverse rock types - including shale, impure shale, mudstone, siltstone and limestone - and overall is very brittle and ideal for hydraulic fracturing. It also spans an entire range of thermal maturities across both the oil and gas windows.

"There is a wide range of suitable geological conditions that exist," Houseknecht said.

The USGS estimates the likelihood of technically recovering oil as:

- Shublik oil and gas: 95 percent.
- Brookian oil and gas: 90 percent.
- Kingak oil: 40 percent.

From Texas to Alaska

While working as an oil and gas consultant in Houston five years ago, AAPG member Ed Duncan, a petroleum geoscientist and CEO and president of Great Bear, wanted to combine the global basin knowledge he acquired earlier in his career working for BP and his experience with shale plays in Texas, Oklahoma and California to find the next emerging unconventional resource play.

His research serendipitously took him back to Alaska, where he worked in regional exploration plays on the North Slope more than 30 years ago.

"I was stunned to find myself focused pretty quickly on a basin I worked on early in my career," he said. "I dug deeper and realized that not only are there really great source rocks, but some are naturally fractured. Oil that was flow-tested from the Shublik source rock in Prudhoe Bay



Ed Duncan

Eager to get started, Duncan and his wife, Karen Bryan Duncan, who serves as the company's vice president and general counsel, formed Great Bear in 2010 and moved to Anchorage the following year. Although Great Bear operates with just six employees, Duncan describes it as "the world's largest small oil company," touting the expertise of his technical staff - including North Slope consulting geologists Ken Bird, Les Magoon and Allegra Hosford Scheirer, all AAPG members.

"No one has done the amount and quality of work we have done," Duncan said. "We are much more heavy on the petroleum systems science from what I have read."

In 2012, Great Bear completed drilling the Alcor No.1 and Merak No. 1 test wells off the Dalton Highway,

with good results.

"The thermal maturity of the rocks were exactly spot on with our pre-drill predictions, and the geomechanics of the Shublik exceeded our expectations," Duncan said.

Combining his findings with data on source rocks his team gathered from existing wells on the North Slope, Duncan found that the Shublik Formation is carbonate rich, contains high silica content and has little clay - ideal for a hydraulic fracturing operation.

He believes both the Shublik and lower Kingak formations contain "world class" source rocks with the potential to produce light oil and condensate.

"We have proven that with the results of our own wells," Duncan said, adding that all three source rocks are present in the oil window.

Great Bear had hoped to drill several lateral wells off of the Alcor and Merak wells in 2012 to test oil production from the shale. However, it was forced to delay those plans, primarily because of the pending expiration of its rig contract.

Possible Bumps in the Road

Despite the Shublik's potential for an unconventional play, finding sweet spots may be difficult, Houseknecht said. In a basin like the North Slope, thermal maturities do not always reflect the current temperature, as the entire North Slope has been uplifted, and rocks on the top have eroded.

The maximum temperature in the Shublik most likely occurred 40 million years ago, he said, and since then the rocks have cooled.

"One of the uncertainties is whether or not there would have been pressure reduction in the formation over those millions of years that would be detrimental to the drive mechanics," he said. "When you go from one unconventional play to another, some are currently at maximum temperature but many have decreased in temperature since the time the kinetic reactions occurred that generated the oil and gas."

Houseknecht noted that the Shublik overall generates heavier oil, so ideal geomechanics must be present for the oil to move through the rocks.

While the Kingak and Brookian generate lighter oil, Paul Decker, AAPG member and petroleum geologist at the Alaska Division of Oil and Gas, remains uncertain of their ability to produce. He says:

- The Kingak Formation may not be brittle enough to hydraulically fracture.
- In the Brookian Formation, which contains very thin volcanic ash beds that could alter mechanical properties in the rocks, it is unclear whether it will be possible to create fractures and keep them open.
- "The Shublik Formation is likely to be the most exploitable, at least initially," Decker said. "It has created most of the oil on the North Slope. And the USGS has made a tentative interpretation for one high gravity field sourced from the Shublik."

If that is correct, parts of the Shublik could produce light oil.

Three More Wells

Great Bear's permitted well sites sit in a 15-mile strip just west of the Dalton Highway near the Trans-Alaska Pipeline. This area is between Deadhorse and the Franklin Bluffs pad.

Having mapped all three source rocks with a "retained phase fairway approach," targeting areas likely to contain lighter oil and condensate saturated reservoirs, Great Bear will begin drilling the Alkaid No. 1, the first of three additional wells planned this winter season, weather permitting.

Duncan's eyes are on the Talitha No. 2 well, however, which he expects to drill in March on a tract Great Bear picked up just two months ago. Located at the southern end of Great Bear's leasehold roughly three miles west of the Dalton Highway, Talitha, because of its location, will be key in further delineating retained phase fairways of the Shublik Formation, Duncan said.

The third planned well is the Phecda No. 1.

All three are specifically targeting conventional reservoir zones with plans to obtain data relevant to

unconventional plays in each stage of drilling.

"We are focusing 100 percent of our source rock evaluation time on predicting or understanding how much oil is retained in the source rocks and what is remaining in place," Duncan said.

The conventional reservoirs on Great Bear's leasehold have been regionally proven through 3-D seismic data the company acquired over the last few years covering 420 square miles, Duncan said. In addition, Great Bear will be shooting an additional 170 square miles of seismic this winter.

To date, Great Bear is the only company to have systematically used modern method 3-D seismic south of the Prudhoe Bay and Kuparuk fields, Duncan said, adding that the seismic data, which has identified both conventional traps, small displacement fault patterns and natural fractures in the shale, has been key in pinpointing well locations.

"We have the benefit of being able to image details in the subsurface with our 3-D that our predecessors did not have," Duncan said. "We have this great collection of interwoven strata that have a lot of conventional and unconventional potential to the south of Prudhoe Bay and Kuparuk that is basically untested."

During its current winter exploration program, Great Bear is allowing for the possibility of drilling lateral wells and hydraulic fracturing to test oil production if targeted zones of interest exhibit ideal properties.

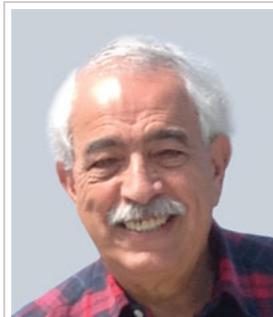
"We are letting the rocks determine our next step," he said.

Great Bear will continue to collect data as it drills, targeting the deepest wells to 150 feet below the base of the Shublik Formation.

Its exploration program now covers 375,000 acres.

Royale has plans to begin drilling in 2016 with four well locations currently in the permitting process. It already has acquired and processed 3-D seismic data over 80 square miles of its acreage and has identified two locations for wells east of the big bend in the Colville River known as Ocean Point.

Calling his work the "shale adventure on the North Slope," AAPG member Mohamed Abdel-Rahman, senior vice president of exploration and production at Royale, said his company is targeting light oil in its conventional plays and relying on core samples to lead them to the right source rocks.



Mohamed Abdel-Rahman

"With the shale, we are going to take anything we can get. We will find which formation has the best characteristics to determine where to drill," he said. "It's a matter of putting the technical story together ourselves."

Burgundy and Tangiers are targeting the Brookian Formation, a choice most likely dictated by the thermal maturities of the rocks on its leasehold.

Making It Economical

As all three companies move full steam ahead, no doubt they are aware of others in the industry quietly asking the - literally - million dollar question:

How can they pull this off?

"Regardless of what shale analog you use in terms of productivity per well, the cost of drilling a single well, especially if it's a horizontal well with massive fracs on the North Slope, will make it a very challenging situation for a pure shale play to be economically viable," Houseknecht said.

With oil and gas hitting their lowest prices since 2009, Decker said, "I can't see that helping. I think there's already a significant challenge in making a source rock play on the North Slope."

Decker said much potential still exists in many conventional plays in Alaska - both onshore and in the federal waters, namely the central North Slope, state lands and onshore in the National Petroleum

Reserve-Alaska.

The area where Royale and partner Rampart Energy plans to drill is just a few miles east of the Spark-Rendezvous conventional field (also known as the Greater Moose's Tooth) targeted for development by Conoco-Philips - an important fact considering that Royale, like Great Bear, is relying on profits from conventional discoveries to fund unconventional plays, Abdel-Rahman said.

The Spark-Rendezvous field will be peaking at 30,000 barrels per day, Rahman said, reiterating reports from Petroleum News.

"In this market, we must devise a way in which we can still explore for the shale while we are producing from conventional accumulations," Abdel-Rahman said. "We hope that the oil found in conventional plays will be lucrative enough to help us finance a costly shale development."

The company plans to drill its first well to the Shublik Formation and take side wall cores, which are smaller than traditional cores and cost less to acquire. They also are more beneficial in calibrating and sampling the variations in petrophysical properties of the shales, Abdel-Rahman said.

Just as the earlier Eagle Ford and Bakken conventional plays led to the development of much-needed infrastructure to support shale development, Duncan said the same needs to happen in Alaska. Aside from the Dalton Highway and Trans-Alaska Pipeline, no other infrastructure exists in the Great Bear project area. If more infrastructure were in place from conventional production, it would help to reduce costs for a North Slope shale play, he said.

Great Bear is currently constructing approximately six-seven miles of ice roads for exploration drilling purposes. To date the company has spent more than \$150 million on leasing, exploration and drilling.

"The market right now is a bear for everybody," Duncan said. "The fact that we have the will to crawl out of bed every morning is pretty good."

In the eyes of Duncan, it is reasonable for a company with Great Bear's potential to build eight development pads a year, with up to 24 wells per pad. If Great Bear's shale play proves successful, and the state supports drilling activities, 200 wells a year is a reasonable expectation, he added.

In such a scenario, Great Bear could produce 200,000 barrels of crude per day by 2020 and peak in 2056 at 600,000 barrels per day, he said.

An uptick in production could give a tremendous boost to the North Slope and the Trans-Alaska Pipeline, whose operations have been threatened by a throughput decline averaging 5.1 percent a year since 1988, Houseknecht said.

If Duncan is correct, Houseknecht said, "This is going to be significant not only here but globally."

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