A special publication from the publisher of Petroleum News.

OPPORTUNITIES FOR PROFITS IN ALASKA'S NEW OIL BOOM

A EXPLORATION

		W	H A T ' S	INSID	Е?		
Welcome to Inside Alaska Exploration	Hendrix: Open O&G dialog from state	Indie paves way to North Slope oil	ConocoPhillips' march west from Kuparuk	North Slope multi- million barrel leftovers	Hilcorp's measured steps in Far North	Brooks Range, ASRC push developments	Mapmakers Northern Alaska highlights

Big new North Slope play

Independent Armstrong to develop Nanushuk reservoir, oil from unanticipated source to the north

BY KAY CASHMAN

Petroleum News

R eferring to Armstrong and Repsol's huge North Slope discovery, Mark Myers told Petroleum News on Feb. 14, 2016, "the proven contingent oil reserve number makes the discovery the largest since the Alpine field, the probable contingent reserve number the largest since the Kuparuk field, and the possible contingent number makes the discovery the largest since

Prudhoe," with one caveat: Armstrong and partner Repsol's "discovery" was in "multiple different reservoirs, not just one major reservoir as in the case of the original Kuparuk and Alpine discoveries."

MARK MYERS

Myers, who at the time was commissioner of the Alaska Department of Natural Resources, called the Armstrongoperated Pikka unit find "amazing" and was "very excited" to see the development moving forward.

The Nanushuk pool had a 650-foot-plus oil column, good porosity and 150-foot thick net pay, he said.

More than 15 years earlier Myers had worked in the area as an exploration geologist for ARCO Alaska (today ConocoPhillips), and had come across the Nanushuk play. "We saw very good evidence for the Nanushuk oil that Armstrong and Repsol have identified and delineated. At that time we had no idea of the size of the accumulation." Shortly later ARCO Alaska exited the area. Myers remained intrigued by what he'd seen, but did not suspect that the Nanushuk reservoir was sourced from the north, from under the Barrow Arch, unlike the North



The leases ARCO dropped were eventually picked up by independent oil man Bill Armstrong of Denver who had entered Alaska in late 2001 (see Armstrong's Alaska story on page 12) with a small staff of experts and a determination to pick up a

BILL ARMSTRONG

chunk of the millions of barrels of North Slope reserves largely ignored by the majors operating there.

Armstrong had a reputation for identifying promising oil deposits, then planning and permitting exploration before bringing in a larger partner to finance and operate them. The independent had already had several successes in Alaska, before acquiring the leases that would one day be in the 65,000-plus acre Pikka unit.

Drilled less than 10% leasehold

In 2011, Armstrong brought in mega-major Repsol and embarked on an aggressive \$1 billion exploration program that put down 16 wells in four scant winter exploration seasons, drilling less than 10 percent of the total 750,000 leasehold acres it held with Repsol and a smaller partner.

First oil 2021

By February 2016, Bill Armstrong had formally announced his intention of moving forward with development of the 120,000 barrel-a-day Pikka project, hoping to be in production by 2021 due to a twoyear delay instigated by requesting an environmental impact statement be done by the U.S. Corps of Army Engineers.

The project is also referred to as Nanushuk because that reservoir was the largest of those discovered and represented a new play in northern Alaska.

Armstrong's partners include mega-major Repsol and Denver independent GMT Exploration.

Armstrong had brought in Repsol in 2011, largely to finance a \$1 billion-plus, 16-well exploration and appraisal program and operate their shared 750,000 acres, but by early 2016 had convinced Repsol to relinquish operatorship in favor of Armstrong taking over to move the project into development and production.

State Commissioner of Natural Resources Mark Myers said of Pikka in a Feb. 14, 2016, email to Petroleum News, "a production rate of 120,000 barrels of oil per day is not unreasonable under the probable contingent reserves reported, with a peak

see 2021 page 22

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Another big find

ConocoPhillips announces Willow oil discovery west of Mooses Tooth 2, in Nanushuk horizon

> **BY ALAN BAILEY** Petroleum News

showed a flow rate of 3,200 barrels per day of light 44 degree API oil over a 12-hour

\$36.6 million in bids

State of Alaska, BLM, attract bids on more than 1 million acres across North Slope, Beaufort Sea

BY KRISTEN NELSON Petroleum News Apparent high bids totaled \$16.9 million for the state's North Slope sale and



C onocoPhillips has announced a new Nanushuk oil find in the Greater Mooses Tooth unit in

Mooses Tooth unit in the northeastern National Petroleum Reserve-Alaska. Discovered by the Tinmiaq Nos. 2 and 6 exploration wells drilled in early 2016, the find, called the Willow discovery,

We've got running room now to test that new play on state lands and onto federal lands."

-ConocoPhillips Alaska President Joe Marushack

could hold 300 million barrels of recoverable oil, the company said in a Jan. 13 press release. Depending on the results of further appraisal drilling and the chosen development scenario, the field could produce at a rate of up to 100,000 barrels per day, the company said. ConocoPhillips has a 78 percent interest and Anadarko Petroleum a 22 percent interest in the find.

A test using the Tinmiaq No. 2 well

period, ConocoPhillips said. The company said that it will further appraise the discovery through a 3-D seismic survey com-

mencing in January 2017. The find lies west and slightly north of the company's Mooses Tooth 2 development.

"This discovery is tremendously exciting not only for ConocoPhillips, but

also for the state of Alaska," said Joe Marushack, president of ConocoPhillips Alaska. "Willow's proximity to existing infrastructure improves the economic viability of the discovery. Development of Willow, a potential multibillion-dollar investment, could provide thousands of jobs during construction and could gener-

see FIND page 20

- ----

The state of Alaska had one of the largest lease sales on Dec. 14, 2016, since it went to the areawide sale system in the late 1990s, with offerings received both for the North Slope and the Beaufort Sea sales. On the same day the federal Bureau of Land Management, in its 13th National Petroleum Reserve-Alaska sale since 1999, brought in almost as much as the state in apparent high bids, some \$36.6 million between state and federal sales.

The state received no bids for the areawide North Slope Foothills sale, but received 402 bids on 384 tracts from six bidder groups in the North Slope areawide sale and eight bids on seven tracts from three bidder groups in the Beaufort Sea sale.

BLM received 92 bids on 67 tracts, with five companies or bidding groups participating and all but one having at least one apparent high bid. \$870,431 in the Beaufort Sea sale. BLM apparent high bids totaled \$18.8 million.

The division said that by acreage the 2016 North Slope sale was the second largest of its kind since 1998, when areawide oil and gas leasing began, while by dollar amount the sale was the third largest since 1998.

North Slope

The state received the most bids, 402 on 384 tracts, in the North Slope areawide lease sale, with almost 600,000 acres receiving bids and \$16,900,490 in apparent high bids.

Initial bidder group data from the division lists acreage on which bidders or bidder groups bid: Alliance Exploration Inc., 12,800 acres; Accumulate Energy Alaska Inc. and Burgundy Xploration LLC, 142,560 acres; Armstrong Energy LLC

see BIDS page 19



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Welcome to Inside Alaska Exploration

BY KAY CASHMAN

Publisher & Executive Editor of Petroleum News

The purpose of this publication is to introduce you to company projects on Alaska's North Slope that were moving forward at \$40 oil and continue to move ahead with planning and development at \$50 to \$55 per barrel oil, with the express purpose of identifying opportunities for profit in Alaska's new oil boom.

That prerequisite keeps the projects onshore or in near-shore state waters, not in federal waters, which begin about three miles offshore.

Thus, I have included contact information for the five companies I see as most likely to sanction oil fields at current oil prices.

Although few northern Alaska oil fields become a reality without partners, none of these companies appear to be actively seeking investors or partners for their projects, although ConocoPhillips Alaska's parent always has shares of stock available on the New York Stock Exchange.

My advice: Approach the following people at these companies to determine their level of interest.

And by all means, subscribe to Petroleum News, a weekly oil and gas newspaper based in Anchorage, by signing up here: http://bit.ly/2jAxSWP or email our circulation director Renee Garbutt at rgarbutt@petroleumnews.com or call 281-978-2771 (Houston) or 907 522-9469 (Anchorage).

I hope you enjoy this special publication from Petroleum News. Please feel free to contact me with questions or comments.

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February 8, 2017

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Hendrix: Open dialog on Alaska O&G

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Inside Alaska Exploration

BOOKKEEPER

Heather Yates

Released Feb. 14, 2017 A special publication owned by Petroleum News, which is owned by Petroleum Newspapers of Alaska LLC.

MAILING ADDRESS PO Box 231647 Anchorage, AK 99523-1647 Phone: (907) 522-9469 Email: circulation@PetroleumNews.com Webpage: www.PetroleumNews.com

Printed by DFW Printing Co., Inc.

Petroleum News and its supple ment, Petroleum Directory, are owned by Petroleum Newspapers of Alaska LLC. The newspaper is published weekly. Several of the individuals listed above work for independent companies that contract services to Petroleum Newspapers of Alaska LLC or are freelance writers.

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OWNER: Petroleum Newspapers of Alaska LLC (PNA) Petroleum News (ISSN 1544-3612) Published weekly. Address: 5441 Old Seward, #3, Anchorage, AK 99518 (Please mail ALL correspondence to: P.O. Box 231647 Anchorage, AK 99523-1647) Subscription prices in U.S. — \$118.00 1 year, \$216.00 2 years Canada — \$206.00 1 year, \$375.00 2 years Overseas (sent air mail) — \$240.00 1 year, \$436.00 2 years "Periodicals postage paid at Anchorage, AK 99502-9986." POSTMASTER: Send address changes to Petroleum News, P.O. Box 231647 Anchorage, AK 99523-1647.

ConocoPhillips: The march west

Stepping out incrementally from existing infrastructure and the road system reduces risk, increases returns on Alaska North Slope, most profitable area in North America for major

BY STEVE SUTHERLIN

Petroleum News

n January 2017, when ConocoPhillips Alaska announced the Willow discovery at its Greater Mooses Tooth unit in the National Petroleum Reserve-Alaska, it was a large dose of validation for the company's strategy to step out incrementally westward from its North Slope infrastructure, which has made Alaska the most profitable place the major does business in North America.

Rather than casting about to the far horizons in search of mammoth fields, the company is exploring closer to existing infrastructure so that discoveries like Willow can be produced quickly and economically. A decade ago ConocoPhillips was on a different course, drilling wildcat exploration wells in distant corners of NPR-A and assembling an expensive portfolio of leases in the Beaufort Sea and Chukchi Sea.

The roots of the stepping-out strategy in Alaska reach back to 2000, when ConocoPhillips utilized a staged development scheme for developing the Alpine field in the Colville River unit. The program allowed the company to bring satellites into production every few years without expanding pipeline and processing capacity.

The strategy led most recently to production from the CD-5 pad in the Colville River unit. From CD-5, ConocoPhillips is stepping out farther west with a gravel road and pipelines into the NPR-A with the Greater Mooses Tooth 1 development project. The company is permitting Greater Mooses Tooth 2, which will be linked to GMT-1. Production from all three of the pads will flow to the central processing facility of the Alpine field, then onward through the company's Kuparuk River unit lines to the Trans Alaska Pipeline System.

Willow is big

The Willow find was discovered by the Tinmiaq 2 and Tinmiaq 6 wells, drilled some 4 miles apart to vertical depths of just over 4,200 feet in early 2016. The Tinmiaq wells - the westernmost wells in the Greater Mooses Tooth unit - encountered a Brookian Nanushuk accumulation which could be in excess of 300 million barrels of recoverable resource. The Brookian is the youngest and shallowest of the major petroleum bearing rock systems on the North Slope.

The size of the Willow discovery presents ConocoPhillips with a tantalizing decision which could result in a deviation from its strategy to feed existing processing facilities directly from satellites.

If the new field is developed as a satellite of the Alpine field, production would probably be limited to some 40,000 or 50,000 barrels per day. If the field is developed with its own standalone production facilities, a level of 100,000 bpd could likely be reached, said Joe Marushack, president of ConocoPhillips Alaska in January 2017.

ConocoPhillips has a 78 percent interest and Anadarko Petroleum a 22 percent interest in the Willow discovery.

Marushack said Willow would be a major step out from GMT-2. From there, ConocoPhillips could easily head First phase of girder placement for Nigliq Channel bridge work for ConocoPhillips Alaska's CD5 project; photo taken in late October 2014. north to develop its Bear Tooth unit. The company said commercial production from Willow completed.

is possible as early as 2023.

New exploration

ConocoPhillips plans to explore this winter (2016-17) near the village of Nuiqsut on newly acquired leases previously associated with the Tofkat unit.

The company plans to drill one well and one sidetrack in the area south of the Colville River unit. According to permitting filings, the proposed Putu exploration project Putu No. 1 would be a directional well on ADL 390674 targeting a bottomhole location on ADL 391015. Putu No. 1A would be a vertical sidetrack from the same starting location.

"The Putu 1 well will provide additional reservoir information in the area and narrow uncertainty around reservoir description parameters including oil-water contact, sand quality and thickness, and oil viscosity," the company wrote in filings.

The proposed surface location of the wells is on Kuukpik Corp. land. ConocoPhillips said it intends to work closely with the Native corporation throughout the project. The relevant subsurface lands are jointly owned by the state and Arctic Slope Regional Corp.

ConocoPhillips believes that construction of a 1-mile ice road originating at the Alpine Resupply Road at the Colville River unit and an 800-foot-square ice pad accompanying the project should be included under previously acquired permits. The ice pad would hold a 60-man drilling camp for mobilization, demobilization and support and a

> Alaska spending represented 17 percent of the total 2016-2017 Putu Exploration Project \$7.7 billion budget in 2016, versus \$2.6 billion in the Lower Pikk 35 31 Ownership / Leases 48, \$1.4 billion in the Asia Pacific and the Middle East Unit Exploration Activity regions, \$1.3 billion in Europe and \$800 million in Canada.

second 60-man testing camp for activities after drilling is

Less risk; more importance

For now, ConocoPhillips has abandoned offshore programs and is avoiding risky exploration ventures. The stepping-out strategy is central to operations.

The strategy is responsible for increasing the importance of the Alaska segment as the global company struggles to respond to declining oil prices. The plan is to more or less offset production declines from aging fields

> through improved technologies and conservative exploration.

> "Over the past couple of years, we've been able to change the profile of our Alaska business," ConocoPhillips Chief Executive Officer Ryan Lance said at the end of 2015. "We've transformed the declining production base into one that can deliver stable production for a decade."

A new-found optimism surrounding the company's Alaska segment and several years of profitable operations spared Alaska capital **Chief Executive Officer** spending from the budget ax in 2016.

While ConocoPhillips slashed its 2016 budget by 25 percent over 2015 levels, the company cut Alaska spending by only 5 percent to \$1.3 billion. Given that the company completed two major capital projects in Alaska in 2015, those cuts were negligible.

of years, we've been

able to change the profile of our Alaska

ConocoPhillips

business.

Ryan Lance

Robust activity

Over the past four years, ConocoPhillips has drilled nine exploration or appraisal wells at its four North Slope units - the Cassin No. 1 and No. 6 wells in the Bear Tooth unit in 2013; the Rendezvous No. 3 and Flattop No. 1 wells in the Greater Mooses Tooth unit in 2014; the Moraine No. 1 and DS3S-620 Moraine wells in the Kuparuk River unit in 2015; and the Tinmiaq No. 2 and No. 6 wells in the Greater Mooses Tooth unit and the CD5-21 (or "Hyperion") well from the new CD-5 pad at the Colville River unit in 2016.

In addition to the CD-5 pad at the Colville River unit and the GMT-1/GMT-2 development in the Greater Mooses Tooth unit, ConocoPhillips sanctioned the Drill Site 2S and the Drill Site 1H NEWS project at Kuparuk.

While the NEWS project is an expansion of existing infrastructure to target heavier oil deposits in the West Sak

see MARCH page 6

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ABOUT ALASKA'S OIL PATCH

continued from page 3 MARCH

formation at the Kuparuk River unit, the other three projects represent a similar type of strategic advance.

ConocoPhillips, based on its successes and continued capital commitment, appears to be poised to retain its status as Alaska's largest oil producer for the foreseeable future.

Mooses Tooth

In May 2001, before forming the Mooses Tooth unit, Phillips Alaska Inc. announced oil discoveries from the Spark No. 1, Spark No. 1A, Moose's Tooth C, Lookout No. 1, Rendezvous A and Rendezvous No. 2 wells. Except for the Lookout well in the northeast corner of the unit, all of those wells were clustered in the center of the unit. In subsequent years, the company drilled exploration wells in the east and south of the unit, including Pioneer No. 1 and Grandview No. 1 in early 2009 and Rendezvous No. 3 and Flat Top No. 1 in early 2014.

The recently sanctioned \$900 million GMT-1 development is on the eastern end of the unit, at lease AA 81798. The project includes construction of a drilling pad, a 7.7-mile road and associated facilities and pipelines and an initial nine-well drilling program with the capacity for 33 wells. Production from GMT-1 is expected to come online in late 2018 with approximately 30,000 barrels of oil per day, gross, at peak production, according to ConocoPhillips. ConocoPhillips also is permitting the GMT-2 development in the south-central portion of the unit, near lease AA 81781. In August 2015, the company applied for a federal permit to drill the GMT2-R112 oil well on lease AA 81800. ConocoPhillips has outlined the GMT-2 project with a base plan of 10 wells and the potential for 19 wells.

Alpine has more than 429 million barrels in recoverable reserves surrounded by satellites, most holding more than 50 million barrels of oil.

Since first oil at Alpine in late 2000, ConocoPhillips stepped out production of satellites as the Alpine field naturally declined, to make use of existing production facilities. The latest, CD-5, produced the first oil from NPR-A in 2015.

To develop a major field in the ecologically sensitive area, ConocoPhillips installed a gravel airstrip and gravel pads, but no permanent connection to the North Slope road system. Each winter more than 1,500 truckloads of modules, pipeline and equipment are moved to Alpine by ice road.

The Colville River unit was the first significant oil production on Native land allotments in Alaska, and as a result required negotiations with Native corporations in addition to state and federal permits.

In 2004 and 2005, ConocoPhillips prepared for increased satellite production by expanding capacity at Alpine to produce 35,000 more barrels of crude oil each day and 100,000 barrels of produced water each day.

In 2004, ConocoPhillips sanctioned the development of the first two Alpine satellites: the Fiord field discovered in 1999 and the Nanuq field three miles to the south of Alpine discovered in 2001.

The Kuparuk River unit

The ConocoPhillips-operated Kuparuk River field, 40 miles west of Prudhoe Bay, is North America's second-largest oil field. Kuparuk, discovered in 1969 by Sinclair Oil Corp. with the Ugnu No. 1 well, was acquired that year by ARCO Alaska. It took another decade before ARCO sanctioned development.

The delay gave the industry time to build the trans-Alaska oil pipeline and to bring the Prudhoe Bay unit into production.

The ARCO development program called for bringing 20 square miles of the field online by 1982, but also working with nearby leaseholders on a longer-term plan 200 for square

miles. ARCO started work on Central Processing Facility 1 in 1979 and after three sealifts the company brought the Kuparuk River field online in late 1981. At the same time, ARCO was working with the other interest owners on the agreements needed to unitize the field.

Conservation Commission.

In the decades since, activities at Kuparuk River have been dedicated to expanding the field through infill drilling, satellite development and enhanced oil recovery.

ConocoPhillips as operator

Through mergers and acquisitions between 1999 and 2002, ConocoPhillips became the operator of the Kuparuk River unit. ConocoPhillips now owns a 55.3 percent interest in the unit.

In recent years ConocoPhillips has used coiled tubing drilling to access smaller accumulations missed by conventional drilling equipment.

At both the Kuparuk River and Colville River units, the company employs a combination of technologies to improve the economics of smaller pockets of oil.

Time-lapse 3-D seismic (also known as "4-D" seismic) allows ConocoPhillips to "illuminate pockets of oil that are in separate fault blocks or for whatever reason are not producing into an existing well bore," Executive Vice President of Technology and Projects Alan Hirshberg said in a February 2013 analyst update.

Coiled-tubing drilling can "twist and turn through the rock" to reach these pockets.

The coiled tubing is a continuous length of flexible, small-diameter steel tubing rather than lengths of rigid steel drill-pipe. A tool at the end of the drilling equipment can turn more than 60 degrees over a 100foot stretch of well, which "allows us to go right to these pockets that we found with the 4-D," Hirshberg said.

ConocoPhillips thus can use existing well bores to target pockets of oil too small to justify drilling a separate vertical well. When seismic information uncovered eight different zones near a single wellbore at Kuparuk, the company used coil-tubing equipment to drill the first "octolateral" on the North Slope. "That's a very cost effective way to get at those zones that weren't producing before," Hirshberg said.

Uber rig commissioned

ConocoPhillips Alaska announced Oct. 6, 2016, that it had commissioned Doyon

While ConocoPhillips slashed its 2016 budget by 25 percent over 2015 levels, the company cut Alaska spending by only 5 percent to \$1.3 billion. Given that the company completed two major capital projects in Alaska

in 2015, those cuts

Drilling Inc. to build a new extended reach drilling rig for the North Slope. The rig will increase the surface area that can be accessed from a single drill site from 55 square miles to 125 square miles, the company said.

The company said that the rig will initially target Fiord

Step out at Alpine

ConocoPhillips honed its stepping-out strategy at the Colville River unit, with primary production from the Alpine field, some 80 miles west of Prudhoe Bay.

ConocoPhillips built the CD-3 pad for Fiord and CD-4 for Nanuq. Both satellites came online in 2006.

Alpine production averaged 123,000 bpd in fiscal year 2006, according to Alaska Department of Revenue figures - the fiscal year peak of annual production for the original Alpine field. In fiscal year 2007, overall production through the Colville River unit facilities averaged 124,000 bpd, with 103,000 bpd from Alpine, 11,000 bpd from Fiord and 10,000 bpd from Nanuq.

In 2008, the company sanctioned a third satellite, Qannik, located in a shallower accumulation above Alpine, by expanding the existing pad at CD-2.

All production is through the main facilities at Alpine. A pad and landing strip were built at Fiord — which is a roadless development — and a pad and a short gravel road to the main Alpine facilities at Nanuq.

Kuparuk The

River field produced 32.4 million barrels in 1982 and 39.9 million barrels in 1983, when ARCO started building Central Processing Facility 2 and the Seawater Treatment Plant, and the additional facilities accommodated additional production. The field produced 46.1 million barrels in 1984, 79.7 million barrels in 1985 and 95 million barrels in 1986, when ARCO began construction on Central Processing Facility 3.

Those early years saw two secondary recovery projects, a CPF-1 waterflood launched in 1983 and a small-scale enhanced oil recovery project in 1988. ARCO also began infill drilling in 1988.

Originally, engineers had expected production to peak at 250,000 bpd, but in December 1992, total Kuparuk River unit production peaked at 339,386 barrels per day, according to the Alaska Oil and Gas

were negligible.

West, an undeveloped satellite oil

field adjacent to the Beaufort Sea, in the extreme northwest of the Colville River unit.

The rig will be able drill to distances of more than 33,000 feet, versus 22,000 feet for current rigs. ConocoPhillips spokeswoman Natalie Lowman told Petroleum News that the rig would allow Fiord West to be developed from existing drilling pads, probably CD-2 and CD-5.

"Adding the ERD rig to our rig fleet on the North Slope is a potential breakthrough event," Marushack said. "It could enable increased oil production by reducing the cost of developing economically chalpreviously unreachable lenged or resources."

The rig features a muscular top drive to deliver torque to the huge length of subsur-

see MARCH page 9

Hendrix: Open dialog on Alaska O&G

Walker's cabinet-level oil and gas adviser to governor and former Apache head in Alaska, says robust communication with industry, feds and stakeholders can boost production

The 800-mile trans-Alaska oil pipeline stretches from Prudhoe Bay in the north to the Port of Valdez in the south.

BY STEVE SUTHERLIN

Petroleum News

A laska has a new strategy to attract and retain oil and gas explorers and producers. In July 2016, Gov. Bill Walker appointed former oil company executive John Hendrix to a new cabinet-level position as chief oil and gas adviser.

Hendrix believes that communication is the key to establishing better relations between the industry and government.

"My job is trying to increase oil and gas production," Hendrix told Petroleum News in a December interview.

As someone who speaks the language of the industry, Hendrix has moved to open a dialog with all of the companies operating in Alaska, he said.

Hendrix, who has nearly four decades of oil and gas experience, 18 years of which were engineering and managerial positions on the North Slope and in Anchorage for BP, most recently served

engine."

New realities

The recent downturn in oil prices savaged Alaska's oil and gas production tax revenue collections, exposing state spending levels as unsustainable on a long term basis and creating a multibillion dollar budget deficit in the short term.

While state lawmakers explore spending cuts and potential new sources of revenue, Hendrix seeks to find ways to make the state more competitive as an oil province in the current price environment.

"We want to structure ourselves so that we can be competitive in a \$50 a barrel world and if we focus around that, anything above \$50 a barrel is cream," he said.

Hendrix was pleased with the results of the state's record-setting Dec. 14 North Slope and Beaufort Sea lease sales which produced a combined \$17.77 million in apparent high bids.

"It was a very popular lease sale," he said.

With the lease sale completed, Hendrix said he is looking forward to the upcoming legislative session which he hopes will provide the fiscal clarity the governor's office will need to determine what it can to do help companies succeed in exploration and development. cally.

"Wouldn't it be nice if we had a master plan — and we're talking about this right now on the North Slope — to pre-permit leases so you could go out and drill and develop?" Hendrix said. "Then it's no longer this probability and possibility, it's a reality that when we sell leases ... people can drill."

Hendrix is optimistic that the Trump administration, working with Alaska's Republican Sen. Lisa Murkowski, Sen. Dan Sullivan and Rep. Don Young, will move to eliminate permitting barriers that block development Alaska.

Alaska competes with states like Texas, which holds a lot of private property and doesn't have to go through BP Exploration (Alaska) at the Resource Development Council's annual conference in Anchorage.

Weiss said the Prudhoe Bay field laid the foundation for the development of other North Slope fields, including Kuparuk River, Alpine, Northstar, various satellite fields and Point Thomson.

On the horizon, she said, are potential further significant developments at Greater Mooses Tooth, Nuna and Liberty, and exciting major recent oil finds in Armstrong's Nanushuk prospect and Caelus Energy's Smith Bay find.

"Those are the pearls that are strung on the string of Prudhoe Bay and TAPS," Weiss said.

"That's what we have on the North Slope right now, and we need to basically see how we can get those in," Hendrix said. "We've got a lot of discoveries to the east with Armstrong, and Conoco doing a great job in the west.

"Caelus is farther out with their discovery," Hendrix said, adding that he is meeting with the company to determine how to get to the point where its discovery represents proven or possible reserves.

'We need to continue to help them get to the point where they can start talking about a pipeline and road," he said. "First what you have to have is a good solid well test that you can get SEC verification on the reserves and then you've got bankable reserves and you can move forward.

"We need to make any news that we hear a reality and if we can, that's great for Alaska and great for jobs," Hendrix said.

Opportunity set

"One thing I've been doing since I've

Hendrix said the state is actively looking for ways to help companies succeed in Alaska. He said that when

he — along with the Division of Oil and Gas and the Department of Natural Resources — meets with oil

and gas companies, discussions center around how Alaska as a state can do things to help with infrastructure, roads, pads and permitting. been doing since I've been here is talking to DOG and DNR about building an opportunity set," Hendrix said. "Where are all of our oil and gas possibilities; what's the timing; what's keeping them from happening?

"We work them all in concert with each other and understand when we pull the lever for that, and is there a common thread, like what technology will unlock what — like all the tens of bil-

most recently served as Apache Corp.'s general manager in Alaska from 2011 to 2016.

"I've met with all the oil and gas companies in Alaska since I've been here (in the cabinet), and continue to meet with them on how to be competitive," he said. "It's very important for the governor and Alaska to have a vibrant oil and gas business and to demonstrate to the world that we're open for business; we're going to continue to reach out to every oil and gas company that's here working."

Hendrix said the governor's office also plans to reach out beyond the state to promote Alaska oil and gas prospects, joining the Alaska Department of Revenue delegation at the annual NAPE Summit, Feb. 15-17 in Houston.

"It's just being competitive," he said. "We understand that the Alaska oil and gas industry is vital to Alaskans; it's our

How can we help?

Hendrix said the state is actively looking for ways to help companies succeed in Alaska. He said that when he — along with the Division of Oil and Gas and the Department of Natural Resources meets with oil and gas companies, discussions center around how Alaska as a state can do things to help with infrastructure, roads, pads and permitting.

"When the state comes to a meeting like the Office of Project Management and Permitting, OPMP, they get the feds to the meeting; an individual oil company can't drive that."

Hendrix said federal intervention is the culprit in making many of Alaska's oil and gas leases impossible to develop economiall the federal per-

mitting that Alaska does, he said.

"They don't have sanctuaries and wilderness and monuments as much as we do; 65 percent of our state is owned by the federal government; less than 3 percent is privately held," Hendrix said.

With Trump in office, Alaska may — if it manages the situation smartly — be able to level the playing field and become more competitive with Texas and other oil states, Hendrix said, adding that he expects the Trump administration to be sensitive to the negative impacts of federal overreach.

String of pearls

Alaska's North Slope holds a great deal of potential for the future, Hendrix said.

"We have a great option set."

Hendrix recalled a reference to a muchused "string of pearls" concept from a Nov. 16 speech by Janet Weiss, president of lions of barrels under the ground of heavy oil.

"ANWR is on the radar, just like Smith Bay and everything else but we have to basically be smart about things," he said. "We've got to be prudent about it; we've got to keep it all on the radar."

Hendrix said that he and Natural Resources Commissioner Andy Mack learned that the state's forward planning was conducted only five years into the future.

"We need to be looking 20 years out," he said. "We need to start asking ourselves, what will the North Slope look like in 2050?

Nurturing competition

While Alaska's North Slope traditionally has been dominated by majors BP, ConocoPhillips and ExxonMobil, that own

see HENDRIX page 9

North Slope leftovers aplenty

Alaska still has plenty of crude oil and natural gas: USGS geologist Dave Houseknecht overviews potential hydrocarbons that remain undiscovered and/or undeveloped

ALAN BAILEY

Petroleum News

Editor's note: This overview was provided prior to Armstrong/Repsol announcing their giant Nanushuk discovery that suggested a whole new source of North Slope oil coming from the north, not from the south, which had been the source of almost all the producing North Slope oil fields.

Ith plentiful oil and gas resources but difficult development economics and controversial environmental issues, Alaska presents something of a challenge for oil and gas explorers. But the state and its offshore seas still hold huge potential volumes of undiscovered and undeveloped resources.

On Sept. 15, U.S Geological Survey geologist Dave Houseknecht, an expert on Alaska petroleum geology, spoke to the Alaska-Japan LNG Opportunity Summit about the state's oil and gas potential.

Arctic potential

Commenting that the preponderance of Alaska's hydrocarbon resources lie in the state's Arctic region, Houseknecht referenced a 2008 study that the USGS had

carried out, estimating the volumes of oil and gas that may remain undiscovered across the whole of the Arctic. Based on analyses of the various geologic basins that lie around the Arctic region, the agency's scientists had concluded that northern Alaska presents the most promising Arctic region for oil exploration. Undiscovered natural gas in the Arctic, on the other hand, is likely concentrated in both the Russian

and U.S. sectors of the region, Houseknecht said.

But much of the Alaska Arctic undiscovered oil resource lies offshore, a circumstance that has led to some impediments to Alaska exploration, especially on the outer continental shelf, Houseknecht commented. In addition, some regions, such as the Arctic National Wildlife Refuge, or ANWR, have high oil potential but are off limits to oil exploration, Houseknecht said.

Stranded gas

And, while the discovery of the massive Prudhoe Bay oil field on Alaska's North Slope resulted in the construction of the trans-Alaska oil pipeline for carrying oil to market, the economic disparities between Arctic oil and gas have left the gas as a stranded resource. In the absence of a natural gas market, a major natural gas discovery on the North Slope is tantamount to a dry hole, Houseknecht said.

While cumulative oil production from the North Slope has now reached a level of around 16.5 billion barrels, gas production, used for local consumption on the Slope, has

only amounted to about 7.6 trillion cubic feet - most of the gas produced along with the oil has been re-injected into the field reservoirs and remains part of the gas reserve base in northern Alaska, Houseknecht said. The U.S. Geological Survey and the Bureau of Ocean Energy Management have estimated that there may be about 17 billion barrels of technically recoverable oil remaining undiscovered onshore in northern Alaska; about 15 billion barrels of undiscovered oil on the Chukchi shelf; and about 8 billion barrels of undiscovered oil on the Beaufort shelf. The corresponding figures for undiscovered natural gas are 99 trillion cubic feet onshore, 76 state's other producing oil and gas province, has estimated undiscovered oil resources of 1 billion barrels in state lands and a further 1 billion barrels in the federal part of the basin, Houseknecht said. Estimated undiscovered gas resources amount to 14 trillion cubic feet, he said. To date the basin has produced about 1.4 billion barrels of oil and about 7.8 tcf of gas, with the gas production number reflecting the fact that Cook Inlet gas has enjoyed access to markets, Houseknecht said.

Although there are published estimates of undiscovered oil and gas for various parts of Alaska, commercial confidentiality issues make it difficult to obtain estimates for oil and gas reserves, the volumes of

resource that have been proved to exist and that can be

The U.S. Geological Survey and the Bureau of Ocean **Energy Management have** estimated that there may be about 17 billion barrels of technically recoverable oil remaining undiscovered

onshore in northern Alaska.

North Slope have been starting to develop relatively impermeable sand reservoirs using techniques associated with shale oil development in the Lower 48, such as horizontal drilling and massive "fracking" techniques.

USGS has assessed the possibility of developing shale oil in northern Alaska and has concluded that there may be 1 billion barrels of extractable oil of this type, with perhaps 40 tcf of shale gas. But, but because of difficult economics, development of these resources may come after the development of more conventional hydrocarbons, Houseknecht said.

Houseknecht referenced a 2008 study that the USGS had carried out, estimating the volumes of oil and gas that may remain undiscovered across the whole of the Arctic. Based on analyses of the various geologic basins that lie

around the Arctic region, the

agency's scientists had

presents the most promising

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Issue of Petroleum News.

viably produced. It appears that the reserves volumes for Alaska as a whole lie in the ranges of 3.4 billion to 5 billion barrels of oil and 28 tcf to 36 tcf of gas, with the preponderance of these reserves being in the northern part of the state, Houseknecht said.

Other resources

Houseknecht said that, in addition to the continued production of oil from traditional field reservoirs, companies operating on the

> But northern Alaska, offshore and onshore, with an estimated nearly 40 billion barrels of oil and more than 200 tcf of gas, remains in the Alaska driving seat as a world-class resource. There are few places on Earth where it is possible to find this scale of resource either on land or beneath water as shallow as that of the Chukchi and Beaufort seas. Houseknecht said.

Arctic exploration opportunities

An assessment of the geology of northern Alaska suggests that oil and gas are likely to be found under a broad area of the Chukchi Sea shelf, in a zone along the northern North Slope and under the relatively nearshore waters of the Beaufort Sea. However, the deeper basins onshore to the north of the Brooks Range and further offshore under the Beaufort Sea are more likely to contain just gas.

And there is plenty of opportunity for exploration. The exploration well density in northern Alaska is just three wells per thousand square miles, Houseknecht said. That compares with a well density of 250 per thousand square miles in Wyoming, a state that would fit between Prudhoe Bay and the Burger prospect, a promising

prospect in the Chukchi Sea, he said.

Almost all drilling activity in northern Alaska takes place in and around the area of existing oil development in the central North Slope. This focus of activity reflects the way in which the distance from any existing oil infrastructure has such a huge impact on the economics of oil development in northern Alaska, Houseknecht said.

Cook Inlet is different

The petroleum geology of Cook Inlet is very different from that of the North Slope and is closely related to the fact that the petroleum basin underneath the inlet has formed as the Pacific plate, one of the massive plates that form the Earth's crust, slides under the Alaska continent.

> Oil and associated gas, both formed from the heating of hydrocarbon source rocks, are found in the deeper rock reservoirs of the basin, while shallower reservoirs host only natural gas, formed from the microbial decomposition of coal and other organic material.

Although current oil and gas fields are in state land in and around the upper Cook Inlet, the more northerly part of the inlet, there is also oil and gas potential on the federal outer continental shelf in the more southerly lower Cook Inlet. Renewed interest in the development of the

Cosmopolitan oil and gas prospect, offshore the southern Kenai Peninsula, appears to bode well for interest in the lower Cook Inlet, where the Bureau of Ocean Energy Management will be holding a lease sale in a couple of years, Houseknecht said.

trillion cubic feet on the Chukchi shelf and 27 trillion cubic feet on the Beaufort shelf.

Cook Inlet

The Cook Inlet basin, in Southcentral Alaska, the

nies operating on the North Slope have been trying to find viable ways of developing this resource, but with mixed success, Houseknecht said. However, as technology evolves, and if oil prices remain high or increase, this challenging resource may enter the oil production profile for northern Alaska, he said. concluded that northern Alaska

There is also a massive North

Slope resource in the form of

perhaps 37 billion barrels of

heavy oil, a form of natural bitu-

men. Two of the larger compa-

Coalbed methane, natural gas that can be extracted from coal seams, is common in many parts of Alaska but is likely to be of

value more as a rural energy source rather than as a driver for major gas production, Houseknecht said. Another potential source of gas, sometime out in the future, is gas hydrate, an ice-like material that exists onshore and offshore the North Slope.

Other basins

There are several other basins with hydrocarbon potential in other parts of Alaska, including the Susitna basin that extends north from the Cook Inlet basin and the Nenana basin in the Alaska Interior. The Alaska Department of Natural Resources and USGS have been collaborating on researching the oil and gas potential of the Susitna basin. Doyon Ltd., the Native regional corporation for the Alaska Interior, has been exploring the Nenana basin and has reported positive indications from a couple of wells that it has drilled. Wells in the Kotzebue and Selawik basins in northwest Alaska suggest that these basins are gas prone, with potential gas resources to supply local communities.

But northern Alaska, offshore and onshore, with an estimated nearly 40 billion barrels of oil and more than 200 tcf of gas, remains in the Alaska driving seat as a world-class resource. There are few places on Earth where it is possible to find this scale of resource either on land or beneath water as shallow as that of the Chukchi and Beaufort seas, Houseknecht said.

OPPORTUNITIES FOR PROFITS IN ALASKA'S NEW OIL BOOM INSIDE ALASKA EXPLORATION

July 23, 1957 headline "Richfield Hits Oil" in the Anchorage Daily Times proclaims the discovery of the Swanson River oil field on the Kenai Peninsula that kicked off the Alaska oil boom.

continued from page 6 **MARCH**

face drill pipe, Lowman said. Also, the rig will handle extra long, heavy casing with a surface casing diameter of 16 inches rather than the traditional 12.5 inches.

Fiord West discovery

In a U.S. Corps of Engineers permit application ConocoPhillips mentioned positive results from the Char No. 1 exploration well, drilled in 2008, as confirming a potential satellite development at Fiord West. The Alaska Oil and Gas Conservation Commission published data from the well.

The well penetrated the Nanushuk formation; the Torok formation; the HRZ; the Kuparuk D and C sands; and the Nuiqsut, before bottoming in the Nechelik formation at a vertical depth of 7,647 feet. Reports on production testing in the Kuparuk indicated flow rates of some 3,750 barrels per day of 37 API oil. Flow testing in the Nechelik showed 28 API oil flowing at some 270 barrels per day.

Storied Alaska history

Through a series of acquisitions, ConocoPhillips traces it Alaska roots back to pioneering oil and gas discoveries on the Kenai Peninsula and in Cook Inlet, including the historic Swanson River discovery of 1957 by Richfield Oil Co.

Ten years later on the North Slope, ARCO's Prudhoe Bay State No. 1 well struck oil and gas in April 1967. The completion of the Sag River State No. 1 in March 1968 confirmed the discovery of the Prudhoe Bay field, the largest oil field in North America. Today, ConocoPhillips owns 36.1 percent of the Prudhoe Bay unit. ■

continued from page 7 **HENDRIX**

the Trans Alaska Pipeline System, the playing field is opening for smaller players, Hendrix said, adding, "There are a lot of partnering opportunities that they can have."

Since 2002, small and mid-size oil prospects have been developed by several independents and majors that were new to Alaska. Of special note is when Denver independent oil man Bill Armstrong began partnering with larger companies from outside the state to bring new oil online.

"The larger companies (TAPS, Prudhoe and Kuparuk River owners) need TAPS filled and they can't fill it themselves, so we need to continue to encourage the small independents and the major independents to come to Alaska to drill and explore," he said. "I think you'll see that owners of the pipeline appreciate companies putting oil down the trans-Alaska pipeline — and hopefully gas down the gas pipeline in the future — because we need them all up here."

The state will continue to actively encourage facility sharing, another area where every player benefits, not just in reducing costs but in reducing environmental impact.

"This is talking very openly, but we know that the North Slope is difficult to get permits in," Hendrix said. "It's a fragile, hostile environment at times and the less we can make a footprint like a facility, and that we could share it makes sound sense," which is what several independents are already doing, or plan to do.

"I think you'll see that Armstrong is moving ahead with a well this winter, and that's because they're building a relationship with Conoco and other people on the North Slope, and understanding if you can facility share you lower your lifting costs."

Educate, communicate

Hendrix said the state must educate the incoming U.S. president on the benefits of oil and gas development in

Alaska, while seeking to remove some of the roadblocks the federal government throws in the way.

"We have a resource-rich state that's always developed resources responsibly," Hendrix said. "The cost of doing business up here is expensive not only because of being in the Arctic but also because we have a lot of regulations that are double-dipping and we need to help work on that."

The Walker administration understands that oil and gas is vital to the state, he said.

"We need to partner with the oil and gas industry in a responsible way," he said. "We still have a lot of opportunities out there, and it's putting our heads together on how to make this work at \$50 oil or less prices so we can bring new exploration into development and into production as soon as possible."

"We need people to come to Alaska, drill exploration wells, and get good quality well testing and core data; that helps us," Hendrix said. "We want people to drill wells."

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Hilcorp tackles North Slope challenges

Quest for Arctic profitability focused on costs, workovers, infill wells in recently acquired units; lowers price stings

BY STEVE SUTHERLIN

Petroleum News

ook Inlet producer Hilcorp Alaska LLC expanded to \prime the North Slope in 2014 with a package of four BP Exploration (Alaska) Inc. properties.

In one fell swoop, Hilcorp became owner and operator of the Northstar unit, operator and majority owner of the Duck Island unit, operator and 50 percent working interest owner of the Milne Point unit and a

50 percent working interest owner of the offshore Liberty field.

The local subsidiary of the Texasbased independent intended to develop the Arctic as it had been developing Cook Inlet: reducing operating costs, revitalizing fields on a nearly well-by-well basis and opportunistic drilling of wells in and around existing units.

Hilcorp expected Arctic opera-

tions to be costlier and more difficult, but it hadn't anticipated a sharp decline in oil prices that began just as it was taking possession of its North Slope properties.

"We have a long ways to go before we're coming anywhere close to making the money that we hoped to make when we originally made that investment a year and a half ago," Hilcorp Energy Co. President Greg Lalicker said at the Resource Development Council's annual conference November 2015 in Anchorage.

Lalicker said Hilcorp didn't expect higher oil prices to rescue the investment; instead, the company was addressing the problem.

Hot property: Milne Point

At the 2016 Resource Development Council conference, David Wilkins, senior vice president for Alaska for Hilcorp, said the company is making investments to increase production and efficiency at Milne Point.

He said Hilcorp was permitting the Moose Pad at Milne Point to accommodate 76 wells and up to 15,000 barrels per day of production. First drilling is expected in 2018 and first production in 2019.

Mature field tactics

The company is commissioning the Innovation rig at Milne Point, the lightest modular rig on the North Slope capable of drilling wells on 10-foot spacing, allowing it to work in the tight quarters at Endicott and Northstar.

Most of Hilcorp's resources on the Slope since the acquisition have gone toward the Milne Point unit. Hilcorp has expanded infrastructure, proposed administrative changes, repaired existing wells and begun drilling new wells.

Hilcorp believes Milne Point contains considerable resources, from light oil in deep reservoir rocks to heavy oil in the shallower Ugnu formation. Accessing those resources is a slow and steady process, according to Lalicker.

"It isn't one big project that makes this happen," he told Alaska lawmakers at an informal meeting in February 2016. "It's lots of little things all the time. That's what you do with properties late in their life."

Endicott, Alaska's first artificial island for offshore oil production, operating since 1986.

from one Kuparuk well at K pad and one Sag River well at C Pad). BP drilled mostly laterals and sidetracks of existing wells while Hilcorp drilled exclusively single wells.

Hilcorp concentrates on maintenance

Finally, while BP employed new technological applications to improve production, Hilcorp favored maintenance activities. Hilcorp completed three wells at Milne Point in 2015 but conducted workover operations on 54 existing been working over existing wells. The company drilled no new wells or sidetracks at either unit.

Between July 2015 and April 2016 Hilcorp conducted 11 workover projects at Duck Island and five workover projects at Northstar, while proposing five projects at Duck Island and three at North Star.

According to the AOGCC, Duck Island produced 2.7 million barrels of oil in 2014. Production declined in 2015, to 2.5 million barrels for the year and a cumulative total of

In 2015, working under an existing BP plan of development, Hilcorp brought five wells back into operation but saw a slight decline in total unit production, which it blamed on a large backlog of workovers to complete.

Under a plan of development which runs through July 2017, Hilcorp proposed drilling eight new wells on five pads targeting three of the four formations present at the unit, conducting workover operations on up to 16 existing wells, and expanding infrastructure to accommodate increased oil production. BP drilled seven wells at Milne Point in 2014 — including multilateral wells, accounting for 14 penetrations altogether. Hilcorp drilled three wells there in 2015, and eight wells through the first nine months of 2016.

Working on several pads

Aside from a well at L pad, the BP drilling program in 2014 occurred exclusively at F pad. Hilcorp in 2015 and 2016 drilled 11 wells including four at L pad, three at J pad, two at B pad, one at K pad and one at C pad. While BP exclusively targeted the Kuparuk formation, Hilcorp was primarily targeting the Schrader Bluff formation (aside wells — 29 in the Kuparuk formation, 23 in the Schrader Bluff formation and two in the Ugnu formation.

Much Milne Point effort in 2016 focused on administrative and infrastructure programs such as permitting projects to improve injection at the unit by expanding the physical boundary of the unit, modifying an existing underground injection control Class I permit, building a grind-and-inject facility and expanding the associated Milne Point B pad.

In 2016, Hilcorp asked the state for permission to add some 1.66 acres to the existing L pad for a proposed fivewell development program and to add some 1.59 acres to E pad for a proposed eight-well development program.

In 2014, Milne Point production was 7.1 million barrels, for a cumulative total of 321.9 million by the start of 2015, according to the Alaska Oil and Gas Conservation Commission.

With Hilcorp as operator, production declined to 6.8 million barrels in 2015. In the first six months of 2016, the unit produced 3.5 million barrels.

Duck Island, Northstar

At the Duck Island and Northstar units, Hilcorp has

481.6 million by the start of 2016. In the first six months of 2016, the unit produced 1.3 million barrels.

The Northstar unit produced 3.2 million barrels in 2014, according to the AOGCC, for a total of 162.8 million by the start of 2015. Annual production declined to 2.2 million barrels in 2015, and 1 million barrels in the first six half of 2016, suggesting a slowdown in the decline rate.

Liberty

Hilcorp is permitting development at Liberty, which could add 60-70,000 bpd to the trans-Alaska oil pipeline over a 15-20 year life. Hilcorp filed a new development proposal with regulators in late 2014, to develop the Liberty field from a new gravel island in the Beaufort Sea.

The U.S. Bureau of Ocean Energy Management officially began reviewing the new proposal in mid-September 2015 and twice extended a public commenting deadline on the initial scoping portion of the environmental review.

Currently, BP is Hilcorp's partner at Liberty, but the company has not said it is adverse to adding other partners.

See project details on Hilcorp's special website for Liberty at http://libertyprojectak.com/

BRPC aims for late 2017

JV looks to bring Mustang oil project online as anchor facility between Kuparuk and Colville units

BY KAY CASHMAN

Petroleum News

In early 2016, Brooks Range Petroleum Corp. said it expected to begin oil production from the Mustang field at the Southern Miluveach unit in late 2017. The company saw the project as a potential anchor for future development between the Kuparuk River unit and the Colville River unit, a region that ARCO Alaska (currently ConocoPhillips Alaska) once evocatively labeled the "billion-dollar fairway."

Although BRPC originally considered building a 7,500 barrel per day facility, the company eventually doubled the capacity to 15,000 bpd to accommodate potential third-party shippers in the region.

BRPC, the operating arm of a multicompany joint venture, had initially planned to bring the field online in April 2016, but a combination of low oil prices, technical challenges and the challenge of capital investment delayed the start date. Late 2017 put start-up seven years after the first exploration wells were drilled, which was when Alaska North Slope crude was selling for more than \$120 a barrel.

"We're off to a new start now," Brooks Range Petroleum Operations and Strategy Manager Jack Laasch told the Alaska Support Industry Alliance in May 2016. He was referring to both the resumption of development work and to new ownership.

JK E&P Group Pte. Ltd., Thyssen Petroleum North Slope Development LLC and MEP Alaska LLC acquired BRPC and a package of North Slope properties from Alaska Venture Capital Group and Ramshorn Investments Inc. for \$450 million in mid-2014.

In return for using the Alaska Industrial Development and Export Authority as a financier for two major infrastructure proj-

Tofkat deal

In a Nov. 3, 2016, decision the state Department of Natural Resources gave ConocoPhillips Alaska permission to acquire a package of leases from the former Tofkat unit and add them to the Colville River unit, allowing a joint venture operated by Brooks Range Petroleum Corp. to transfer 15 Tofkat leases to the Colville River unit.

In a pair of decisions, Commissioner Andrew T. Mack asked ConocoPhillips to resubmit an application to add those 15 leases and seven related leases to the Colville River unit —.a request previously turned down by DNR.

ConocoPhillips leased the acreage during the 1990s, as the Titania prospect, but failed to explore the area and eventually relinquished the acreage back to the state.

ConocoPhillips plans to drill the Putu No. 1 well and Putu No. 1A sidetrack on the package of Tofkat leases in the first quarter of 2017 and said it could launch an environmental review for a potential development later in 2017, if drilling results warrant it. —Kay Cashman

ects at the Mustang project, the consortium handed over some working interest in the leases to a pair of public private joint ventures. After all the dust had settled from those deals, BRPC was operating the Southern Miluveach unit on behalf of seven working interest owners: JK E&P subsidiary Caracol Petroleum LLC (36.28 percent), TP North Slope Development LLC (22.46 percent), Mustang Operations Center 1 LLC (20 percent), MEP Alaska LLC percent), Ramshorn (10.37)Investment Inc. (6.08 percent), AVCG LLC (3.82 percent) and Mustang Road LLC (1 percent).

Technical challenges

BRPC completed an initial three-well drilling program in early 2015. All three wells faced complications, making them unusable for production without additional work. A subsequent "root cause analysis" determined that the company needed to acquire a new rig or significantly modify its existing rig to accommodate high pressure in the reservoir.

Analyzing and addressing the problem

occupied the remainder of 2015 and the first half of 2016. Laasch said the company would be ready to resume its drilling program at Mustang with a modified rig sometime in the second quarter of 2017.

The Alaska Department of Natural Resources extended the term of the Southern Miluveach unit agreement until December 2017 to accommodate the new schedule.

In the most recent plan of development, released in late September 2016, BRPC presented a timeline for bringing Mustang online between October and December 2017. The company described its current timeline as a "very high level" assessment based on its current understanding of the field and current economic conditions within Alaska.

Prior to the expected arrival of the first Alaska-fabricated modules in April 2017, the company plans to complete pipeline installation and interconnection and some remaining pad work. The last Alaska-fabricated modules are expected in September 2017, with the Canadian-fabricated modules arriving in August 2017 and installed by October 2017, providing two to three months for conducting the final systemwide review of facilities.

BRPC expects Mustang to initially produce approximately 6,000 barrels per day and gradually increase to a peak of 12,000 bpd by late 2018 and into 2019. A thirdparty evaluation suggests 24.7 million barrels of proved oil reserves, almost 44 million barrels of probable reserves and 51 million barrels of possible reserves.

Economics

Speaking to the Commonwealth North Energy Action Coalition in June 2014, top executive of BRPC Bart Armfield said that the project would be "viable" between \$80 and \$120 per barrel. In his presentation to the Alaska Support Industry Alliance in May 2016, when oil prices were approximately \$46 per barrel, Laasch said the company was committed to bringing the project online at any price but was looking for \$50 per barrel or higher.

The Southern Miluveach unit benefits from its location. It sits along the southwestern border of the Kuparuk River unit, and the Mustang development is less than 1,000 feet from the Alpine common carrier oil pipeline, which follows a series of pipelines to the trans-Alaska oil pipeline and outside markets. The ASRC Exploration LLC-operated Placer unit is immediately to the north, providing a potential future customer for facilities.

As of May 2016, Laasch said the company expected to spend another \$8 million on field engineering, \$25 million on fabrication and \$33 million on the installation of facilities on the field pad, in addition to \$145 million already spent between December 2014 and November 2015 — \$85 million for surface facilities and \$60 million for drilling wells. ■

ASRC advancing Placer

Independent and subsidiary of Native regional corporation move North Slope unit to production

BY KAY CASHMAN

Petroleum News

Hinting at promising results from its first exploration well, ASRC Exploration LLC asked the state Department of Natural Resources for breathing room as it proceeds with work at its North Slope Placer unit — a request DNR granted in September 2016, giving

the company until Sept. 8, 2021, to complete a work plan for the unit. Without the extension, the unit would have expired five years after it was formed on Sept. 9, 2016.

In a letter to state officials, the subsidiary of Arctic Slope Regional Corp. suggested that the Placer No. 3 well expands the known size of the reservoir and appears to be capable of producing economically.

According to the letter and an associated plan of development, the well "confirmed extension of the Placer reservoir beyond the central Placer No. 1 location."

The Placer No. 3 well only identifies one productive interval at the unit, but ASRC told the state it intends to determine, at a later date, whether other zones at the unit also have the capability to be productive.

A two-year program proposed by the

see PLACER page 17 Kuukpik Rig. No. 5 drilling at ASRC Exploration's Placer No. 3 well last winter.

In March 2003, less than

with Armstrong, operator

barrel-a-day oil discovery at

the lvik well.

Indie paves way to North Slope oil

Denver's Bill Armstrong leads independents, majors to North Slope oil discoveries and production

BY KAY CASHMAN

Petroleum News

f you think you don't have what it takes to make a fortune on Alaska's North Slope, you can take lessons from Bill Armstrong, the founder and president of several related oil companies doing business in the Far North.

Because the Denver-based Armstrong was a small concern that preferred to operate without debt, it had taken a novel approach to exploring the complex and expensive world of northern Alaska, pursuing "small prospects" (20 million to 500 million barrels) overlooked by BP and ConocoPhillips, the only producer-operators on the North Slope at the time.

Armed with a team of 15 people some of them former employees of North Slope majors — and a reputation for finding oil and attracting solid partners to operate Lower 48 fields, the independent oilman saved the day for North Slope exploration when he bought his first North Slope leases in October 2001, winning 10 tracts in the state's Beaufort Sea areawide oil and gas lease sale. The acreage, which cost Armstrong \$4.2 million, was in the shallow waters of Harrison Bay between ConocoPhillips Alaska-operated the

an area where Exxon Corp. had made a promising discovery in the mid-1990s, but

> never pursued development.

When first interviewed by Petroleum News in 2001 and asked about his plans for the leases, Bill Armstrong said, "Just print what I do, not what I say." following The

story does just that, leading up to the company's most recent and extraordinary discovery (see top of page 1 story) that taps into an entirely new source of North Slope oil coming from the north, versus the south, the source of the great Prudhoe and Kuparuk fields.

Mark Myers, then the commissioner of the Alaska Department of Natural Resources, referred to the discovery as "amazing."

In a Feb. 14, 2016, email to Petroleum News, Myers said, "the proven contingent oil reserve number makes the discovery the largest since the Alpine field, the probable contingent reserve number the largest since the Kuparuk field, and the possible contingent number makes the discovery the largest since Prudhoe," with one caveat: The "discovery" is "multiple different reservoirs, not just one major reservoir as in the case of the original Kuparuk and Alpine discoveries."

Only time and more development drilling will tell.

In the meantime, here is Armstrong's remarkable (and profitable) adventure in Alaska's oil and gas fields.

Three oil finds in three years

In July 2002, Armstrong filed permit applications for what it dubbed the Northwest Kuparuk prospect. The independent planned to drill three wells in the coming winter exploration season, the only time explorers were able to get on roadless areas of the tundra to drill in northern Alaska.

Armstrong asked Jacob Adams, president of Arctic Slope Regional Corp., which represented the Inupiat Eskimo people of the Slope, to name the three wells.

Adams named them Ivik, meaning walrus in the Native language of the six months after partnering region; Oooguruk, meaning bearded Pioneer announced a 1,300seal; and Natchiq, meaning seal.

The prospect name was eventually changed from

Northwest Kuparuk to Oooguruk.

Armstrong said the three wells, which would be drilled to true vertical depths in the 6,700 to 6,900 foot range, would target "multiple horizons down to and through the Jurassic."

The exploration program looked at a

range of intervals, the Division of Oil and Gas, part of the Alaska Department of Natural Resources, or DNR, later said, including "the Cretaceous Middle Brookian, Cretaceous Torok, Kuparuk A, Kuparuk С and Jurassic Nuiqsut/Nechelik.'

Attracts Pioneer as first partner

Eleven months after buying its first leases in Alaska, Armstrong brought in Texasbased independent Pioneer Natural Resources as a 70 percent operating partner to drill the three wells, which represented half the exploration wells put down on the North Slope in the 2002-03 exploration season.

In March 2003, less than six months after partnering with Armstrong, operator

Pioneer announced a 1,300-barrel-a-day oil discovery at the Ivik well.

While it was drilling the Oooguruk well, Pioneer filed a unit plan of operations with the state of Alaska, saying engi-

neering work was underway for possible development and production.

The big independent estimated the reserve potential at Oooguruk to be between 70 million and 90 million barrels

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Mobile, lightweight drilling rigs, such as Nabors 105E, have reduced North Slope exploration drilling costs.

The three ice islands at Pioneer Natural Resources' Kuparuk Northwest prospect are about 700' in diameter and sit 21-22' above sea level. Referred to as "Masterson's Mountains" on the North Slope, they were designed by Dan Masterson of Sandwell Engineering in Calgary. Pictured above is the Ivik well drill site. In the foreground, left to right, is Stu Gustafson, at-the-time vice president of operations for Armstrong Oil & Gas and a consultant to Pioneer on the project, and Bill Van Dyke, at-the-time petroleum manager for the Alaska Division of Oil and Gas. The ice road to the left stands 22' tall.

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of oil equivalent in two main pools, the Kuparuk and the deeper and larger Nuiqsut.

Once Pioneer began drilling it said recoverable reserves at Oooguruk could be as much as 40 percent more than expected: between 120 million and 150 million boe. Prior to that, the company had only booked 10 million barrels of oil from its Alaska operations.

In addition to the increased resource potential, Pioneer said that Oooguruk wells were performing better than expected.

Identifying more North Slope prospects

In the meantime, Armstrong was work

the wells would target multiple objectives, one of the primary targets an attempt to extend the favorable productive Jurassic sand fairway in the Ivik well, partner Armstrong said at the time, noting other objectives were extensions to established production at the Milne field.

When asked whether the company would drill Northwest Milne or bring in a partner to do so, Bill Armstrong said, "Very few wells have ever been drilled without multiple partners on the North Slope and we don't anticipate changing that this year."

Mark Myers, then Division of Oil and Gas director and a well-respected geologist who had worked for ARCO Alaska prior to joining state government, said the key to success in the area was understanding the Jurassic, which, he said, Armstrong clearly

Nabors Alaska roughnecks on the floor of Nabors Rig 27E in early March. The rig just finished drilling Pioneer's lvik well and is expected to spud the second well, Oooguruk, March 14. At right, Nabors driller at drilling control station, Rig 27E, lvik well site.

Wildcat this winter

Bill Armstrong is drilling a wildcat this winter (early 2017) on Alaska's North Slope to "test a new idea" gleaned from a recent Horseshoe 3-D seismic program in the area.

The Denver independent began drilling the Horseshoe No. 1 exploration well in late January 2017 at the southern tip of the Pikka unit, some 20 miles south of the unit, near a horseshoe bend in the Colville River.

According to paperwork filed with the state of Alaska's Department of Natural Resources, the 9,000-foot nearly vertical well is being drilled from a 4.5-acre ice pad that is connected to a 200-foot square staging pad at the existing Drill Site 2P at the Meltwater satellite of the Kuparuk River unit by a 17.5-mile road across Great Bear Petroleum and ConocoPhillips Alaska leases. The drilling pad includes space for the drilling rig, maintenance buildings and a 60- to 90-man camp.

According to permitting documents, Armstrong is drilling the Horseshoe well on ADL 392048, which is part of a package of leases in the area that the company acquired from Royale Energy Inc. in late 2015. In early 2016, Armstrong transferred a 25 percent working interest in the lease — and two neighboring leases — to Repsol E&P USA Inc.

Along with its partner Rampart Energy Inc., Royale had commissioned the Big Bend 3-D seismic program. In a report released in June 2014, Netherland Sewell and Associates Inc. estimated that two prospects identified through the seismic program might contain between 17.8 million and 325.3 million barrels of oil in place, with a best case scenario of 77.5 million barrels.

ing more North Slope prospects.

In July 2003, BP announced the independent was one of the successful bidders for its North Slope exploration acreage. Armstrong won nearly 10,000 acres in the shallow waters of the Beaufort Sea northwest of the BP-operated Milne Point production unit.

In August 2003, Armstrong said it would drill one to three wells at its new Northwest Milne prospect in the 2003-04 exploration season, depending on rig availability.

The proposed wells — the Nikaitchuq No. 1, No. 2 and No. 3 — got their name from an Inupiaq word meaning "to persevere." They would be drilled from two ice pads in about eight feet of water, necessitating a four-mile ice road from the existing, year-round, gravel North Slope road system.

Looking to find stacked accumulations,

did at Northwest Kuparuk.

"The Jurassic ... has significant volume potential to it, but typically produces at slower rates. ... Other horizons — smaller accumulation — like the Brookian and Kuparuk could add significantly faster flow rates to the project," Myers said. The result would be "long-term productivity at reasonable flow rates if you can stack them up and that's something Armstrong is looking to do in that area" — an area Myers had worked for ARCO a decade earlier.

Depending on what they found, he said, production could be handled at a standalone facility or other nearby existing facilities at Milne Point or the Kuparuk River unit, which had spare capacity.

Next up: Kerr-McGee

In early January 2004, as Armstrong moved forward with Northwest Milne drilling, Oklahoma City-based mega-independent Kerr-McGee announced a 70-30 A lawsuit between partners prevented an exploration program from advancing. As part of the resolution of the dispute, Royale acquired Rampart's interest in September 2015 and assumed 100 percent interest over the western block. By the end of the year, Royale had sold the western block to an unnamed buyer, which turned out to be Armstrong.

—Kay Cashman & Eric Lidji

partnership with the Denver independent for operatorship of the prospect.

At the same time, Armstrong filed a unit application with the state of Alaska on behalf of itself and its proposed unit operator, Kerr-McGee, naming the new unit Nikaitchug.

In March 2004, Kerr-McGee said it had encountered high-quality oil at its first Nikaitchuq well in the Spy Island area, the second such discovery announcement in an Armstrong-identified prospect in 13 months on the North Slope.

At the time, Kerr-McGee was a week away from finishing its second exploration well in the unit, which at the time covered almost 13,000 acres in eight oil and gas leases.

In April 2004, Kerr-McGee formally announced that the Nikaitchuq No. 1 well tested at more than 960 barrels per day of 38 degree American Petroleum Institute, or API, crude oil. The company also said that if the prospect was developed "horizontal wells would most likely be utilized, which

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could be expected to produce at higher flow rates than the vertical well."

Another Armstrong/Kerr-McGee deal

In the last half of 2004, Kerr-McGee and Armstrong crafted an agreement on yet another prospect, which Armstrong unitized as the Tuvaaq unit.

The 14,561-acre Tuvaaq unit was in the nearshore waters of the Beaufort Sea between the Oooguruk and Nikaitchuq units, and north of the Milne Point and Kuparuk River units. It would eventually be developed as part of the Nikaitchuq unit.

Success: Two for two

Kerr-McGee was two for two in Alaska by March 2005, announcing another successful drilling season.

The company said it had tested the Schrader Bluff reservoir at its Nikaitchuq No. 4 horizontal appraisal well that winter and it came in at rates of up to 1,200 barrels per day during periods of the initial test, with the crude at 16 to 17 degrees API.

The viscous Schrader Bluff formation, called West Sak at the Kuparuk unit, was under production at three fields onshore: the ConocoPhillips Alaska-operated Kuparuk River unit and the BP Exploration (Alaska)-operated Milne Point and Prudhoe Bay units. Both BP and ConocoPhillips had recently begun largescale Schrader Bluff-West Sak developments using horizontal wells.

Kerr-McGee had also encountered the same Schrader Bluff interval at the Tuvaaq exploration well, some three miles to the west of Nikaitchuq No. 4.

Based on the results of drilling, Kerr-McGee said it was drilling a sidetrack, the Kigun well.

The Kigun target was in the

ConocoPhillips Kuparuk River unit, a farm-out arranged between Kerr-McGee and the major oil company.

"We are encouraged with the results we've seen thus far in Alaska," Dave Hager, Kerr-McGee's senior vice president responsible for oil and gas exploration and production, said. "Although we still need to complete the appraisal program, based on initial evaluation it appears the Schrader Bluff interval might be developed throughout much of our 36,000 acres."

Hager, speaking at the A.G. Edwards' Energy Conference in Boston March 15, 2005, said the company was targeting both reservoirs, the shallower Schrader Bluff and the deeper Sag River. The second horizontal appraisal well that winter, the Nikaitchuq No. 3, tested the Sag River formation; slides accompanying Hager's remarks described the well as drilling a new fault block. "We did test the Sag River at one of our vertical wells last drilling season (Nikaitchuq No. 1) at a rate of 960 barrels a day, 38 degree API," he said. What the company wanted to find out in the 2004-05 season was what the well would do from a horizontal wellbore.

Nikaitchuq No. 2 had been drilled 9,000 feet southeast of the discovery well and successfully extended the accumulation down dip, Hager said.

Onshore, he said, the Schrader Bluff was being developed on 160-acre spacing, and with "approximately 36,000 acres gross ... I think you can see the potential that

exists with this particular program." One of the slides accompanying Hager's remarks showed a resource of 30 million to 60 million barrels for the company's Alaska discoveries being appraised at the time.

Set permitting record

The Denver independent's team was still working very closely with Kerr-McGee: Armstrong's understanding of the area, and its contacts with the Natives, proved valuable to the larger company, Kerr-McGee officials told Petroleum News at the time.

By May 2005, Armstrong had been an active partner in drilling 11 North Slope

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Processing oil at Nikaitchuq

exploration wells in three years and had just finished permitting a shared standalone production facility for the Nikaitchuq and Tuvaaq units on behalf of Kerr-McGee in less than 100 days, which appeared to be a new record for the North Slope.

State of Alaska officials were saying "Alaska is open for business" to oil companies.

One of the main criticisms of the state and federal government in Alaska from long-time producers in the state was about the difficulty of permitting oil and gas activities.

But an executive with Armstrong at the time disagreed — and proved it by securing permissions to explore in and develop in record-time.

He told Petroleum News the "exploration and production regulatory process" in Alaska was "seamless," compared to how it had been seven years earlier when he worked on the North Slope.

Pioneer, Conoco talk facility-sharing

At the Pioneer-operated Oooguruk unit in the shallow waters of the Beaufort Sea, Pioneer was assessing the economics of development and working on a facility sharing agreement with ConocoPhillips, operator of the nearby Kuparuk River unit.

Rapidly coming to a close was the 2004-05 winter drilling season, in which Kerr-McGee led the pack for the number of exploration wells drilled on the North Slope in a single season — six out of 11 wells.

\$500,000 'permitting fee' obstacle

Removing a significant obstacle for drilling in state waters, Armstrong was key in getting a second oil spill response contractor, Alaska Chadux, to set up business on the North Slope. At about the same time the only existing North Slope spill contractor, Alaska Clean Seas, changed its policies, dropping what many newcomers to the state referred to as "Alaska's \$500,000 permitting fee" because state officials demanded participation in a spill response group and the sign-up fee with Alaska Clean Seas had been \$500,000.

Alaska Clean Seas began offering an associate membership, allowing companies interested in drilling to get around the group's \$200 million net worth stipulation for full members and pay a fee for an associate membership for the duration of an exploration season which was far less expensive.

Eni buys Armstrong's ANS assets

In August 2005, the playing field on Alaska's North Slope changed again with Armstrong attracting yet another larger oil company; this one a subsidiary of an Italian mega-major.

Eni Petroleum Exploration Co. purchased Armstrong's Alaska assets, which included 104 oil and gas leases where the Houston-affiliate of Eni SpA said "reserves are expected to exceed 170 million barrels."

The leases encompassed 341,500 gross (273,000 net) acres onshore and offshore in state and federal waters. As part of the deal Eni received Armstrong's minority working interests with Pioneer and Kerr-McGee, including the proposed Oooguruk and Nikaitchuq/Tuvaaq developments.

Although the terms of the deal were not disclosed, Armstrong retained a royalty interest in all the leases it sold to Eni.

A staple of winter exploration: the rolligon.

It's a great place to be and it's a great petroleum system. There are certain things we're pursuing. We're really looking forward to continuing our relationship with all the players on the North Slope and the state of Alaska," he said.

Track record of success

Armstrong's track record to date had been three out of four — i.e. in three out of four North Slope prospects drilled by its first two partners, oil discoveries had already been announced — first at Oooguruk by Pioneer in 2003 and then by Kerr-McGee at Nikaitchuq in 2004 and again by Kerr-McGee in 2005 at Tuvaaq and nearby Kigun, a well in the Kuparuk unit that essentially confirmed the pendent, Armstrong Cook Inlet, announced it had taken over as operator of the onshore North Fork gas unit from Gas-Pro. Leases in, and near, the southern Kenai Peninsula unit were transferred to Armstrong CI.

The natural gas field had been discovered in the 1960s but never developed. After assembling a joint venture of small independent companies, re-entering the discovery well and drilling several new wells and building a pipeline, Armstrong brought the unit into sustained production and in 2013 sold it to Cook Inlet Energy LLC for nearly \$65 million.

Anchorage-based Cook Inlet Energy was a subsidiary of publicly traded Miller Energy Resources of Tennessee.

Tuvaaq discovery.

Eni told Petroleum News Aug. 26, 2005, that it considered the "North Slope and Beaufort Sea as areas with exploration potential for new finds" and said Eni had "decided to establish a position in the area with an emphasis of consistent growth."

Armstrong staying in game

"We're definitely not leaving Alaska," Bill Armstrong told Petroleum News after the announcement of its asset sale.

"We were not capitalized enough to do the things our North Slope partners Pioneer Natural Resources and Kerr-McGee wanted to do. They've both been incredibly great partners for us. It was important to me not to slow them down and be a drag on development at Oooguruk and Nikaitchuq, so we sold our assets to Eni," he said.

Bill Armstrong said his company would stay in the state and continue to put together exploration prospects in northern Alaska.

"We still see huge opportunities on the North Slope. ...

"We still see huge

opportunities on the North Slope. ... It's a great place to

be and it's a great petroleum system." —Bill Armstrong

Bill Armstrong's mantra in Alaska? "Smoother, faster, better, cheaper: everyday that's what we try to do."

By mid-August 2005, well results were still being evaluated from Kerr-McGee's drilling of an exploration well at the fourth prospect, Two Bits (also called

Ataruq), but Armstrong eventually said it was not commercial, a small blip in an otherwise amazing record of success.

Armstrong heads south

Keeping a close eye on his investments in the north, Bill Armstrong returned to Alaska to actively work an oil and gas prospect in another underexplored part of the state this time in Southcentral's Cook Inlet basin, in which exploration had nearly ground to a halt when the Prudhoe Bay discovery had been announced in 1968.

Although activity eventually picked up in the basin, it never reached its earlier intensity.

In September 2007, a local affiliate of the Denver inde-

Armstrong back on North Slope

Still bullish on North Slope oil, but continuing to commercialize natural gas over a thousand miles to the south in the Cook Inlet basin, on Oct. 22, 2008, an Armstrong affiliate accounted for 77 percent of the high bids in the state's areawide North Slope lease sale and 71 percent of the high bids in the areawide Beaufort Sea sale.

The affiliate of the Denver independent, 70 & 148 LLC, picked up more than 200,000 acres in leases, its unusual name the latitude and longitude coordinates for the Prudhoe Bay discovery well.

Why that name?

"It's got good karma," Bill Armstrong told Petroleum News in an interview the day of the sale.

Why was the company back in northern Alaska?

"We're much more bullish on oil than gas, so that's one of the reasons we are coming back to the Slope," Bill Armstrong said. "It's a very forgiving petroleum system so we like it. We're glad to be back."

Armstrong said he was also "bullish on oil prices," which he pointed out are "much better than when we first

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Tundra winter road (ice road) near Mile Post 10.

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went to the North Slope" in late 2001. "Oil was at \$15 a barrel back then, so even if the prices have dropped some recently, they're still much higher than when we first went up there" (\$62.80 a barrel for ANS crude on U.S. West Coast on Oct. 21, 2008, the day before the lease sale). Armstrong said he and his staff, which had grown "substantially" since 2005 when the company sold its oil and gas assets in northern Alaska, are "real excited" to be back "on the North Slope" and "looking forward to working with other leaseholders and operators in the Kuparuk River unit area," such as "ConocoPhillips, Pioneer Natural Resources, Eni Petroleum, Chevron and BP."

He said it would take "cooperation between all of us" to get the leases from the Oct. 22 sale explored and developed.

Plan to be just as active as last time

When asked if 70 & 148 planned any exploration work during the upcoming winter season, Armstrong said no.

"This winter would be too quick for us. We have got to get leases issued, which takes seven to eight months," he explained.

"But we don't go into an area NOT to create activity. Our game plan is some variation of what we did before,

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PLACER

Alaska independent would "re-evaluate and incorporate new seismic into our model to complete geological mapping of the area; perform reservoir engineering for reserves estimates; perform facilities engineering for a development plan; and perform economic evaluations with the goal to sanction the project development." which is to create a lot of exploration activity. That is good for everybody, including the state of Alaska," he said.

First oil from the Oooguruk unit flowed to ConocoPhillips facilities in June 2008, with Pioneer being the first independent to operate an oil field on the North Slope.

In the meantime, Eni was building a standalone production facility for Nikaitchuq and Tuvaaq.

Top bidder at 2009 North Slope sale

Once again it was déjà vu as the Division of Oil and Gas director read 93 bids for 80 tracts in the state's 2009 areawide North Slope oil and gas lease sale on Oct. 28, 2009.

Armstrong's 70 & 148 dominated the sale, with high bids of \$7.8 million on 68 tracts and 91.3 percent of the dollar value of all high bids.

70 & 148 took substantial acreage on the west and southwest side of the North Slope, extending a position the company established in 2008 to the west and south of the Kuparuk River unit.

Kerr told Petroleum News that with the acreage from the sale, the company's Alaska oil and gas lease acreage now totaled some 475,000 acres, topping the list of state oil and gas lease acreage holders.

Kevin Banks, Division of Oil and Gas director at the time, told Petroleum News after the sale that Armstrong had historically done more than just acquire land. "Historically they're more than just somebody picking up a piece of ground. Obviously the exploration work they did at Oooguruk and Nikaitchuq led to producing oil fields," he said.

A new approach to development

With Oooguruk development moving ahead as planned, Pioneer announced a new approach to developing the field in June 2009, a year after bringing it into production.

Pioneer planned to drill horizontal lateral wells in the second and third quarters of 2009 to fracture and stimulate the Nuiqsut formation, the deeper of the two Oooguruk pools.

Scott Sheffield, chairman and chief executive office of the parent company, said Pioneer wanted to expand Oooguruk vertically by developing shallower oil deposits and horizontally by reaching out farther from the island. Pioneer expected to drill extended reach wells that went out about 18,000 feet to a depth of about 8,000 feet.

Eni's approach different

It wasn't long before Eni bought out all of Kerr-McGee's interest in Nikaitchuq, owning 100 percent of the field.

The differences between Eni and Pioneer, partners at Oooguruk, were important.

Pioneer was among the largest independents in the country, but still a small company by oil industry standards. Eni, on the other hand, was one of the biggest companies in the world.

In 2008, Eni produced some 1.8 million barrels of oil equivalent every day from projects on six continents, earning the company some \$12.6 billion (8.83 billion euro).

Eni operated fields in Norway, giving it some Arctic experience, enough to make the company cautious about how it approached Nikaitchuq.

For one, it and former partner Kerr-McGee asked the state to expand the Nikaitchuq unit to include the neighboring Tuvaaq unit, nearly doubling the size of the prospect, and also asked for royalty modification during periods of lower oil prices.

The state said yes.

The expanded Nikaitchuq unit protected more of the resource by unitization. Eni estimated that Nikaitchuq contained 180 million barrels of recoverable reserves from two formations, including one with heavier, and therefore more costly, oil.

Under the agreement, the royalty rate on oil produced from several leases rose and fell on a sliding scale connected to the delivered price of Alaska North Slope crude oil.

Up to an inflation-adjusted price of \$42.54 per barrel, Eni paid 5 percent royalties to the state. As oil prices increased, so did the royalty rate, topping out at 16.667 percent, the original royalty rate attached to most leases in the

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telling ASRC told the state.

A major point of contention between ASRC and DNR's Division of Oil and Gas in previous years was how much acreage the company needed to explore the region.

When the company initially requested the unit in early 2011, it wanted to include four state leases covering some 8,769 acres. But later that year, the state approved a 1,480-acre unit covering portions of those leases — restricting the unit boundaries to the area immediately around Placer No. 1. After reprocessing some seismic information over the region, ASRC asked the state to expand to unit to the original boundaries, arguing that any well drilled within the smaller boundaries would be a "twin" of Placer No. 1.

Placer No. 1 and No. 2 wells ultimately did not justify development.

ASRC acquired the prospect through a state lease sale in 2006, after the leases were contracted from the Kuparuk River unit. By the time the company officially acquired the Placer No. 1 well in mid-2010, the leases were only a year from expiring. The original unitization request was an attempt to preserve the leases for exploration work.

'Billion-dollar fairway'

Between September 2016 and September 2017, ASRC said it would conduct early development activities, using information from all three existing Placer wells to estimate the "extent, size and continuity of all producible reservoirs." It would obtain information from the "CGG Tabasco 3D seismic" and merge the findings into other seismic surveys to better map the geologic structure. It would develop a high-level cost estimate for infrastructure. And it would start discussions with Brooks Range Petroleum Corp. and ConocoPhillips Alaska Inc. about sharing existing facilities.

Between September 2017 and September 2018, the company told the state it intends to use the results of its reservoir mapping to plan future development wells, begin engineering work for drilling pads, roads and pipelines, and propose the first participating area for the unit.

A five-year extension would have allowed ASRC to complete this two-year program and prepare a new work plan in 2018 without the threat of losing the unit or its leases.

Hunch confirmed?

Although well results were scarce, the results were

After several rounds of administrative decisions and appeals, the state ultimately approved the larger unit boundaries in late 2014. In early 2016, ASRC finally drilled and completed the Placer No. 3 well.

By saying the well "confirmed extension of the Placer reservoir beyond the central Placer No. 1 location," the company was suggesting that it was justified in its request to include more acreage in the unit.

In addition to hinting about the reservoir size, ASRC provided another glimpse into its results by telling the state it intended to apply for the well to be certified as capable of producing hydrocarbons in paying quantities, which can be used to extend certain leases.

When ASRC first took an interest in Placer, as part of an "apprenticeship" to learn more about Arctic oil and gas operations, the prospect was included in the Kuparuk River unit. ConocoPhillips operated a two-well exploration program in early 2004 on behalf of a consortium of companies, including a 35.7 percent interest for ASRC. But the

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The Placer unit is nestled between the Kuparuk River unit to the east and the Colville River unit to the west. ARCO Alaska (now ConocoPhillips Alaska) referred to the region as the "billion-dollar fairway" because of the presumed quantities of oil contained between the giant fields.

In recent years, independent operators Armstrong Oil & Gas and BRPC have been pursuing the opportunities in that fairway. With Armstrong in the early development process at the Pikka unit to the northwest of Placer and BRPC nearing startup at the Southern Miluveach unit to the south, an opportunity was created for ASRC.

The Alaska Industrial Development and Export Authority partially financed much of the initial infrastructure investments at the South Miluveach unit, including its processing facilities. One reason the public corporation was interested in the project was the opportunity to improve the economics of other projects in the fairway, including Placer. ■

Editor's note: Articles by Eric Lidji in Petroleum News were used to research this article.

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unit. The scale was based on a U.S. Minerals Management Service program for deepwater federal leases in the Gulf of Mexico.

Once oil was flowing, Eni's Nikaitchuq facilities would be the first producing unit on the North Slope not operated by major leaseholders BP and ConocoPhillips.

Lesson learned? Build modules in Alaska

In January 2008, Eni sanctioned a \$1.45 billion development plan for Nikaitchuq. Plans included a 3.8-mile subsea pipeline connecting the island to a processing facil-

ity at Oliktok Point capable of treating as much as 40,000 barrels of fluid per day, and a 14-mile pipeline connecting that facility to the ConocoPhillips-owned Kuparuk network, which would in turn deliver the fluids to the trans-Alaska oil pipeline. the Kuparuk pipeline. Eni also drilled its first production well, which was awaiting pre-built facilities from Louisiana.

As a result, Eni expected to start producing oil from Nikaitchuq by the end of 2010, early 2011.

Production began from Oliktok Point on Jan. 31, 2011, just four days shy of three years after Eni sanctioned development.

Armstrong brings Repsol to Alaska

In early 2011, Armstrong snagged its biggest deal yet: Spanish mega-major Repsol as a 70 percent partner in 494,211 acres on and near-shore the North Slope, with the companies looking at a possibility of 12 separate developments.

Production began from Oliktok Point on Jan. 31, 2011, just four days shy of three years after Eni

Per a March 7, 2011, press release from Repsol, which said it had agreed to "a broad-reaching exploration and development program," with Repsol and Armstrong's 70 & 148 "collaborat-

More detailed results

In mid-2015, the partners provided more detailed results for the first time. According to Armstrong, two wells from the winter exploration season of 2014-15 and two wells from previous seasons targeted the "East Alpine" field and "encountered oil productive Alpine sand in excess of 95 feet thick at a depth of 6,500 feet with porosities ranging from 15 percent to 25 percent. Well control and seismic data indicates the oil pool covers an area in excess of 15,000 acres."

Another seven wells in the "Nanushuk reservoir" had "proven an oil pool that covers more than 25,000 acres, at a depth of 4,100 feet, with an oil column of 650-plus feet, and up to 150 feet of net pay with an average porosity of 22 percent."

While the companies said they needed more wells to "confirm the ultimate size of some discoveries, this season's (winter 2014-15) results justify moving forward with development," according to Armstrong, which said the companies were permitting developments in the Nanushuk and Alpine.

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Eni ultimately asked for more

time to develop Nikaitchuq. The state approved the request, but noted in its ruling that the company missed the window to barge "processing and operations modules" to the North Slope.

Eni was building those facilities in Louisiana, not Alaska, and according to the state, hurricane-like conditions caused a "work stoppage" at the Louisiana fabrication yard where construction was taking place. Because of Alaska's seasonal restrictions, companies have a brief window each summer to sealift material to the North Slope.

"A variety of factors, including but not limited to schedule delays, not meeting sealift deadlines, capital constraints and fabrication delays have caused Eni to change the pace of development for the Nikaitchuq unit from an accelerated pace of development to a more normal pace," the company said in a plan of development filed in July 2009.

Eni had already built several gravel pads, a subsea pipeline connecting the offshore and onshore facilities and part of an overland pipe to feed Nikaitchuq oil into

sanctioned development.

ing on all aspects of the program," Madrid-based Repsol had committed to supplying "the investment

necessary to explore and evaluate the economic viability of the resources contained in these blocks," which it noted were close to producing fields.

The "minimum exposure" for Repsol, "including amounts to be paid to its partners and the cost of exploration to be carried out over several years, amounted to \$768 million," the release said.

The actual spend was nearly \$1 billion.

The program, focused primarily within the "billion-dollar" fairway between the Kuparuk River and Colville River units, was the most extensive campaign on the North Slope over the next four years — 16 wells or sidetracks, two 3-D seismic surveys and the formation of the offshore Qugruk unit and the Pikka unit along the Colville River Delta.

In November 2014, as preliminary results of the program were becoming clear, Armstrong Director Ed Kerr said, "In 10 or 15 years people will talk about Repsol the same way they talk about BP and ConocoPhillips today, in terms of ... contributing to Alaska's economy."

Accelerating development

Toward the end of 2015, Armstrong acquired a majority stake in it and Repsol's North Slope holdings, totaling some 750,000 gross acres.

In that partnership, Armstrong had held a 45 percent interest in the exploration acreage and a 30 percent interest in the development acreage. Following restructuring, Armstrong had a 75 percent interest and operatorship in the exploration acreage and a 45 percent interest in the development acreage with an option to acquire another 6 percent and operatorship, which Armstrong quickly elected to take.

All 16 wells drilled found oil and most found oil in multiple zones, according to Armstrong. A third-party report from the engineering firm DeGolyer and MacNaughton provided reserve numbers.

In February 2016, Bill Armstrong told Petroleum News that the partners would accelerate development of their Pikka unit, with production by 2021. An early description calls for three gravel pads with standalone processing facilities and as many as 76 production and injection wells, in addition to associated infrastructure.

continued from page 1 **BIDS**

39,080 acres; Burgundy Xploration LLC, 279,360 acres; Caracol Petroleum LLC and TP North Slope Development LLC, 12,800 acres; and ConocoPhillips Alaska Inc., 146,600 acres.

Alliance, based in Nevada, is newly formed; Caracol and TP North Slope have small acreage positions.

Accumulate and Burgundy are in the exploration stage on

acreage south of current production; Armstrong is in the process of developing its Pikka unit and has extensive North Slope acreage; tracts are taken, is now more than 400,000 acres, with a joint venture position, with Burgundy Xploration, of more than 690,000 acres. The company said the upcoming Icewine No. 2 well will test the flow potential of the HRZ.

statement from 88 Energy said the net land

position for Accumulate, assuming all of the

ConocoPhillips

While ConocoPhillips Alaska had fewer apparent high bids, it bid on 146,600 acres,

parts.

woman

more than Burgundy

Xploration because

fewer of Conoco's

bids were in the area

where the state has

broken traditional

lease blocks into four

provided by spokes-

Lowman, the compa-

In a statement

Natalie

The division said that by acreage the 2016 North Slope sale was the second largest of its kind since 1998, when areawide oil and gas leasing began, while by dollar amount the sale was the third largest since 1998. bonus bid of \$159,940.80, the division said.

Beaufort Sea

The state received eight bids on seven tracts, a total of 33,460 acres, in the Beaufort Sea areawide sale, with the highest bid, \$50 per acre, submitted by Eni Petroleum US LLC for a tract on the northern edge of the Eni-operated Nikaitchuq field, a 1,280-acre tract with a total bid of \$64,000.

The sum of apparent high bids for this sale was \$870,430.80.

The minimum bid per acre for the sale was \$25.

Narwhal LLC, a new entrant, bid \$25.06 an acre on six tracts on the northern and southeastern edges of a large block of existing Shell leases at Harrison Bay. According to state corporation records Narwhal was formed in early December. The company's 134 existing leases in NPR-A.

The NPR-A sale was dominated by ConocoPhillips Alaska Inc. ConocoPhillips bid on four tracts by itself but the majority of its bids, 61, were in partnership with Anadarko E&P Onshore, its partner at the Colville River unit.

Armstrong Energy took a single tract on the eastern edge of the sale and was apparent low bidder in four leases taken by ConocoPhillips and the ConocoPhillips-Anadarko bidding partnership, all on the eastern edge of the sale in an area formerly held by Repsol. ConocoPhillips and Anadarko appeared to be filling in a large block of available acreage between existing lease positions, moving west.

NordAq took a single tract adjacent to its existing acreage in mid-NPR-A.

BLM did not break out the per-acre bid amount at the sale.

ConocoPhillips has extensive North Slope production and operates the Kuparuk River and Colville River units.

A Division of Oil and Gas map of tracts receiving bids shows small areas of acquisition in or near developed areas of the Slope, but the majority of activity is in the acquisition of three large blocks south of existing leased acreage.

Burgundy Xploration was the most active bidder by tract, with apparent high bids on some 190 tracts. The company also bid in conjunction with Accumulate Energy Alaska on almost 100 tracts, with the companies filling in large block positions to the southwest and southeast of acreage they already hold south of Great Bear Petroleum's position.

Accumulate Energy is a subsidiary of Australian-based 88 Energy Ltd. A Dec. 15

ny said it was pleased with the results of the lease sales and with the acreage it picked up. In addition to bidding on state acreage, ConocoPhillips dominated BLM's NPR-A sale.

"We'll be evaluating our plans for this new acreage," she said. "There are a number of factors that go into decisions on exploration, and we don't discuss our exploration plans until they are confirmed."

ConocoPhillips bid heavily in the area adjacent to NPR-A south of existing acreage positions, as did Armstrong Energy, with the two often bidding on the same tracts. ConocoPhillips was most often the apparent high bidder, but Armstrong did place the highest per-acre bid in the sale, \$111.07 per acre, on tract 529B, a total agent is Jesse Mohrbacher, president and CEO of SolstenXP, an Anchorage-based project management company whose services, as listed on its website, include exploration project management.

The six tracts on which Narwhal bid totaled 32,180 acres for which the company bid a total of \$806,430.80.

One other bidder, Alaska LLC, an existing small leaseholder, was a competing bidder on the tract which Eni took, bidding \$25.39 per acre.

NPR-A

The federal Bureau of Land Management received \$18,813,588.93 in apparent high bids at its 2016 National Petroleum Reserve-Alaska lease sale, the 13th sale BLM has held since 1999. Ted Murphy, BLM associate state director, said the agency received 92 bids on 67 tracts, with a total of \$22,578,611.78 bid. There are NordAq bid \$61,158.93 on the tract; there were no competing bids.

Armstrong Energy bid \$216,229 on the single tract; there were no competing bids. ConocoPhillips bid \$1,295,665 for four tracts, and the bidding partnership of ConocoPhillips and Anadarko bid \$17,240,536 on 61 tracts, 92 percent of the apparent high bids in the sale.

The minimum bids for the sale were \$25 per acre for tracts designated as high potential and \$5 per acre for tracts designated low potential.

By comparison, BLM drew six bids for its 2015 sale, all from ConocoPhillips, with a total bid of \$788,680 and an average bid per acre of \$31.91 for the 28,589 acres in those tracts.

Murphy noted that the state receives half of the revenues from NPA-A lease sales. —A copyrighted oil and gas lease map from Mapmakers Alaska was a research tool used in preparing this story.

FIND

ate substantial revenue for the federal government, state, North Slope Borough, and communities in the NPR-A."

Gov. Bill Walker commended ConocoPhillips on its discovery.

"I congratulate ConocoPhillips on its exciting and promising Willow discovery in NPR-A," Walker said. "This is just one more piece of good news we've received from Alaska's oil and gas explorers in recent months, and it demonstrates that Alaska remains an attractive place to do business and look for oil."

Nanushuk play

ConocoPhillips said that the discovery is in the Nanushuk formation, a part of the Brookian sequence, the youngest and shallowest of the major petroleum bearing rock systems on the North Slope. The two wells were each drilled to vertical depths of just over 4,200 feet.

During a talk at the Alaska Support Industry Alliance's Meet Alaska conference on Jan. 13, 2017, Marushack said that the Willow discovery represents a new oil play for ConocoPhillips. As a follow-up to the discovery and as an avenue to pursuing the play, the company purchased neighboring acreage in the December 2016 state and federal lease sales: 65 tracts amounting to 594,972 acres in the federal sale, and 74 tracts amounting to 142,280 acres in the state sale. The federal tracts were purchased jointly with Anadarko Petroleum,

"We've got running room now to test that new play on state lands and onto federal lands," Marushack said, also commenting that, although the play probably extends west from Willow, the play is blocked in that direction by land within NPR-A that has been withdrawn from oil and gas leasing by the federal government.

Major NPR-A step-out

Marushack said that Willow represents a major step-out from the company's developments at Greater Mooses Tooth 1 and Greater Mooses Tooth 2. ConocoPhillips has teams working on figuring out the most appropriate development scenario for Willow, with a key decision revolving around whether the new field is developed as a satellite of the Alpine field, or whether the field will have its own standalone production facilities.

As a satellite field, production would

probably be limited to some 40,000 or 50,000 barrels per day, while standalone facilities could enable that higher level of 100,000 barrels per day to be reached, Marushack said. Following the

ck drop in the price of

oil in the past couple of years, ConocoPhillips has an annual capital budget of about \$5 billion, with some \$1 billion of that being allocated to Alaska, Marushack said. That Alaska spend supports developments such as the GMT-1 and GMT-2 projects, as well as supporting the company's North Slope exploration efforts. But, if Alaska projects are delayed, the capital allocated to those projects will be diverted to projects elsewhere. In particular, Alaska, with its relatively high cost environment, now competes for investment dollars with shale oil developments elsewhere in North America, Marushack said, although Alaska remains the most profitable place that the company does business according to quarterly reports.

He said that ConocoPhillips had drilled 29 exploration wells in Alaska since 2000, about three-quarters of the exploration wells drilled in the state during that time period. However, the company did not drill any exploration wells between 2009 and 2013 because of the very high taxes in those years, he commented.

When it comes to developing Willow, Marushack said that the state provides much help with project permitting, including federal permitting. The company also works with the Alaska congressional delegation and with the Native communities.

"We've got this four or five pronged approach on how we are working these developments, and that's what we need to do," Marushack said.

see FIND page 22

More fields to come

ConocoPhillips's newly announced Willow oil discovery in the National Petroleum Reserve-Alaska is the third recent major oil find in Brookian rocks near and to the west of the Colville River delta, near the Beaufort Sea coast, to the west of the central North Slope. The Brookian is the youngest and shallowest sequence of rocks in the petroleum systems

of the North Slope.

Armstrong Energy partnered by Repsol E&P USA is planning an oil development involving a major find in the Nanushuk formation in the Pikka unit, to the east of the Colville River delta. And Caelus Energy has announced a huge oil find in the Torok formation, immediately below the Nanushuk formation, at Smith Bay, about 90 miles west of the delta. The Torok and Nanushuk are formations, Houseknecht has suggested that the oil in the Brookian play has come from a source to the north, deep under the Beaufort Sea, with the oil flowing up the northern flank of the Barrow Arch.

Cretaceous in age, within the Brookian sequence.

Willow has its oil reservoir in the Nanushuk and seems closely analogous to Armstrong's Nanushuk discovery.

Significant new play

Geologist David Houseknecht from the U.S. Geological Survey has seen these finds as part of a significant Brookian oil play that exists along the northern side of the North Slope, west from the Colville River delta area and particularly associated with the Nanushuk and Torok formations. The play is also associated with the Barrow Arch, a major, regional geologic structure that runs along the Beaufort Sea coast and is associated with most of the producing oil fields on the North Slope.

Houseknecht has suggested that the oil in the Brookian play has come from a source to the north, deep under the Beaufort Sea, with the oil flowing up the northern flank of the Barrow Arch. That contrasts with the oil in the currently producing fields, which appears to have flowed from the south.

However, Houseknecht has told Petroleum News that, with the Willow discovery lying well south of the coastline, on the south side of the Barrow Arch, the Willow oil might have originated from a source under the discovery. The light character of the oil suggests a Brookian origin such as the HRZ, a prolific North Slope oil source rock. However, the older and deeper Kingak source rock is also a possible origin for the oil.

Stratigraphic traps

Seismic data from the region suggest that the Willow oil lies in a stratigraphic trap, probably toward the base of the Nanushuk, rather than being trapped in a geologic structure, Houseknecht said. Oil flowing up the flanks of the Barrow Arch, either from the south or from the north, would tend to become caught in traps of this type in the Brookian, he said. That concept leads to the conclusion that there is likely to be a prolific oil play running east to west along this region of the northern North Slope and Beaufort Sea coast.

see FIELDS page 22

"Given the need to maximize the trans-Alaska pipeline throughput and to maintain a thriving contractor community, the legacy producers on the North Slope are happy to see more companies operating on the Slope, Marushack said.

PLAY

In late 2015, anxious to get on a fast track to development at Pikka, Bill Armstrong convinced Repsol to sell back partial interest in their shared North Slope leases, giving his company majority ownership and operatorship. Repsol retained the right to take a minority percentage in any North Slope leases picked up by Armstrong in the future, which the company has exercised since that date.

Nobody has seen before

The most exciting news about the Nanushuk discovery was the fact it appeared to be a new play for the region west of the Kuparuk unit

"The Nanushuk is a new and different play for the North Slope, notable for even thicker pay than that discovered in the Alpine reservoir and at such a shallow depth (4,100 feet as compared to 6,500 feet)," Bill Armstrong said.

"That's what makes it so exciting. Nobody has seen this formation productive in this depositional environment before. You look at how thick it is, how good the oil is, how good the reservoir is — it all bodes really well for the play," he said.

The huge Nanushuk oil development being planned by Armstrong marks a significant bright spot amid the current gloom of low oil prices and declining Alaska oil production. But could this particular discovery point the way to a new, unanticipated oil exploration play in Arctic Alaska, with the potential to bring many more barrels of oil to the northern end of the trans-

Alaska pipeline? In a talk at the Alaska Geological Society's annual technical conference on April 22, 2016, U.S. Geological Survey geologist Dave Houseknecht, an established expert on

Arctic Alaska petrole-

DAVE HOUSEKNECHT

um systems, presented compelling evidence for looking into this new play possibility. Essentially, while rocks of middle Cretaceous age, including the Nanushuk formation, along the Beaufort Sea coast west of the central North Slope, have tended to play second fiddle to plays involving some of the older rocks of the region, the new discovery has revealed the possibility of major undiscovered oil resources along a fairway extending perhaps 100 miles west from that recent Armstrong/Repsol discovery, Houseknecht suggested.

Houseknecht characterized from the recent Armstrong/Repsol discovery, with up to 150 feet of net pay sandstone in a 650-foot oil column covering more than 25,000 acres, in reservoir rocks with a porosity of 22 percent, as "pretty astound-ing."

The yellow area on the map depicts the region of massive middle Cretaceous sediment deposition across the Colville basin, with an ancient marine shelf margin running south to north in the Colville River area, before swinging to a more west-northwest direction to the north of the present Beaufort Sea coast. Several middle Cretaceous oil (green dot) and gas (red dot) discoveries appear associated with this shelf margin. Few well penetrations (black dots) have tested a potential middle Cretaceous oil play to the west of the central North Slope.

Beaufort Sea. The rocks appear to have reached depths where, again, the subsurface temperatures could have driven oil formation, Houseknecht said. And with middle Cretaceous sands also dipping northward toward that oil generating kitchen, Houseknecht thinks oil could have migrated into the relatively shallow Nanushuk reservoir from the north, rather than from the south. That being the case, there is a strong possibility of finding more oil, generated and trapped under similar circumstances, along a zone running many miles to the west.

Middle Cretaceous strata

The middle Cretaceous rock sequence at the heart of this play consists of, from older to younger, the Torok and Nanushuk formations. The rocks were formed as part of what geologists call the Brookian sequence, a massive rock sequence mainly deposited in an ancient marine basin called the Colville basin between what is now the Brooks Range and a structural high called the Barrow Arch along the present-day Beaufort Sea coast.

Houseknecht said the sediments which formed the Torok and Nanushuk primarily flowed west to east across the Colville basin, eroded from

an ancient mountain belt that had formed in what is now eastern Russia. The massive pile of sediments, rather like the leading edge of a gigantic sand and mud slide that lasted several million years, spread to the east, toward what is now the central North Slope, while also tipping north over the of the sedimentation changing quite abruptly and a marine shelf margin forming. A similar situation arose on the north side of the Barrow Arch, so that the shelf margin which runs south to north in the Colville River area

swings sharply counterclockwise to run in a more westnorthwest direction to the north of the present day Beaufort Sea coast.

Houseknecht sees this relict shelf margin as a key to a middle Cretaceous oil play.

In fact, one of

the intriguing aspects of this rock system is a condensed shale, deposited on top of the Nanushuk formation as a consequence of a rise in sea level that resulted in water flooding back toward the west across the massive pile of middle Cretaceous sediments. That shale can form a seal for trapping oil and is also a potential oil source, Houseknecht said.

A history of discoveries

Toward the northwest end of the shelf margin the U.S. Navy made a small oil discovery more than 60 years ago near a known oil seep at Simpson Bay. Then, toward the southeastern end of the margin, at Umiat, there is a known oil field with a reservoir in the Nanushuk. There have been natural gas discoveries in the Nanushuk in the Brooks Range Foothills. And near

Nanushuk 6 and Nanushuk 7.)

Moving into the younger Seabee formation, of upper Cretaceous age, there have been two producing discoveries: Meltwater and Tarn. Although the Meltwater produc-

tion has been a little

disappointing, Tarn

has proved particu-

larly successful, with

cumulative produc-

tion of more than

100 million barrels of

oil through 2013,

all lie in proximity to

that Cretaceous relict

Houseknecht point-

margin,

These discoveries

Houseknecht said.

"The Nanushuk is a new and different play for the North Slope, notable for even thicker pay than that discovered in the Alpine reservoir and at such a shallow depth (4,100 feet as compared to 6,500 feet)." —Bill Armstrong

> ed out. And sand-filled geologic systems associated with estuary-like conditions on the ancient landscape seem to exhibit particularly favorable oil reservoir characteristics in the Nanushuk, he said. In the Torok there are potential reservoir sands in deeper water sediments called turbidites, formed from submarine sediment flows.

shelf

The structural setting

In the area of the Colville basin a major geologic discontinuity called the lower Cretaceous unconformity, below the middle Cretaceous strata, slopes markedly upward from south to north toward the Barrow Arch. But the infilling of the basin by the sediment deposited from the west has resulted in the Nanushuk strata lying very flat from a north-south perspective. To the north of the Barrow Arch, on the other hand, the Nanushuk dips steeply northward into another basin, referred to as the Canada basin. The three major North Slope source rock intervals follow this same structural geometry, dipping steeply north to the north of the Barrow Arch and becoming buried to depths where oil might form. That oil should tend to flow back up dip into the Torok and Nanushuk. In fact, unless trapped somewhere along the way, the oil could flow all the way to where the strata outcrop at the surface, a phenomenon that could explain the oil seeps that have been observed along the Beaufort Sea coast, Houseknecht suggested.

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Oil sources

Geologists have long considered the oil in the producing North Slope oil fields in Prudhoe Bay and Kuparuk, for example — to have migrated primarily from the south, where the oil source rocks have been buried relatively deeply and have reached temperatures conducive to oil formation. The three major source rocks are the Triassic Shublik formation, the lower Jurassic Kingak shale and the lower Cretaceous Pebble shale/gamma ray zone (or GRZ).

But seismic data from surveys that cross the Beaufort Sea coast show those same source rock intervals dipping steeply to the north, under the nearshore waters of the Barrow Arch. The result was one of the world's largest clino-

form systems, Houseknecht said. A clinoform is a sloping depositional surface such as might be found within the sediments deposited in a river delta.

But around the area of the current Colville Delta the ancient flow of sediment started to run out of steam, with the nature

intrigued by what he'd seen, but did not suspect that the Nanushuk reservoir was sourced from the north, from under the Barrow Arch, unlike the North Slope's producing fields such as Prudhoe Bay, Kuparuk and others, which had been sourced from the south.

Myers remained

the coast there have been several oil discoveries in the Torok and the Nanushuk: the Cassin, Nanuq, Nuna and Moraine pools in the Torok, and the Qannik and Qugruk discoveries in the Nanushuk. (Within the Nanushuk group the sands are the Nanushuk 3, Nanushuk 2 or Qannik sand,

see **PLAY** page 22

FIND

Cost cutting

ConocoPhillips has driven down its costs in Alaska over the past couple of years. However, when compared with the flexibility of ramping shale oil developments up and down, projects in Alaska face the challenges of having to conduct development work during the winter, typically from ice roads, and of incurring the cost of transporting oil down the trans-Alaska pipeline to market.

And given the need to maximize trans-Alaska pipeline throughput and to maintain a thriving contractor community, the legacy producers on the North Slope are happy to see more companies operating on the Slope, Marushack said. Stories about the three big producers wanting to lock up the North Slope oil industry for themselves "could not be further from the truth," he said.

Marushack said that he is particularly worried about there being enough investment in Alaska this year to "We've got running room

retain a capable workforce in the state. "We need our workforce. We need our contractors to be successful. We all need to come through this together," he said.

But after what he characterized as one of the most difficult times that people in the oil industry can recall, Marushack expressed hope that a recovery is beginning to emerge.

GMT-1 and GMT-2

Currently ConocoPhillips has its GMT-1 project fully permitted and is moving ahead with development. First oil is expected around late 2018. The project, employing about 700 people, involves the construction of an eight-mile gravel road with two bridges. At its peak, it should produce about 30,000 barrels per day of oil.

"It's a great project for us, a great project for the state, a great project for the Native communities," Marushack said.

GMT-2, which lies about eight miles farther into the NPR-A, is still at the permitting stage. But slow progress with the federal permitting is putting the project schedule at risk. The plan has been to have the permits in place in time to start construction in 2018, with a view to seeing first oil in 2020. Construction will require about 700 people and, as with GMT-1, oil production should peak at some 30,000 barrels per day.

Each of these step-out projects in the NPR-A will cost about \$1 billion, a cost figure consistent with ConocoPhillips' Alaska capital expenditure program, Marushack commented.

Oil infrastructure

Recounting his company's long history in Alaska, Marushack also emphasized the importance of keeping the existing oil infrastructure in good condition, to provide a basis for new developments. And, over the years, the state has been a proving ground for a number of new technologies, including the use of multi-lateral wells, coiled tubing drilling and state-of-the-art seismic surveying.

> Marushack expressed particular excitement with the new extended reach drilling rig that Doyon Ltd. is building for ConocoPhillips' use. That rig, an around \$1 billion investment, will enable access to about 125 square miles of the subsurface from a single 12-acre drilling pad. That compares with the five square miles of access from the original 65 acre pads on the North Slope and 55 square miles of access

with existing rigs on 12-acre pads, Marushack said. The new rig has about 10 years of work ahead of it, starting with a Fiord West development in the Colville River unit.

Through all of this, ConocoPhillips sees safety as foundational to its success. In 2016 the company had its safest year ever in Alaska, and one of its best years for environmental performance. "Safety is our license to operate," Marushack said.

—A Mapmakers Alaska map was used to research this article

continued from page 20 FIELDS

During a presentation to the Alaska Support Industry Alliance's Meet Alaska conference on Jan. 13, Joe Marushack, president of ConocoPhillips Alaska, indicated that his company also believes that Willow forms part of a new oil play running east to west through the company's leases in the northeastern NPR-A and adjacent state lands.

By contrast, the nearby Alpine oil field and its attendant satellite fields have oil reservoirs in the older and deeper Beaufortian rock sequence.

Armstrong 'excited'

The first to announce a major Nanushuk discovery and subsequent development plans, Bill Armstrong was pleased by ConocoPhillips's Willow announcement.

"We are really excited about what we have found at Pikka and for what CP has found at Willow. Both discoveries are big and may get a lot bigger. Pikka and Willow could be the first of many as they have revealed a new play type for the North Slope that should have lots of running room."

-ALAN BAILEY & KAY CASHMAN

continued from page 21

PLAY

The likely timing of oil generation also matches the possibility of oil migration into traps of Cretaceous age, he said.

In terms of the petroleum geology of the region, a series of steeply dipping geologic faults associated with the formation of the Canada basin could have impacted the preservation of oil source rocks and the ability of oil to flow from these rocks into the Torok and Nanushuk. But, while faults may play a role in trapping oil, some oil traps would be stratigraphic, caused by subsurface pinch outs of reservoir rocks, while other traps would involve a combination of structural and stratigraphic features, Houseknecht suggested.

continued from page 1 2021

production rate as high as 250,000 bop/d under the possible contingent reserve."

According to Armstrong, he and his partners have "multiple horizons" in the Pikka unit, and plan to "develop the Nanushuk and Alpine horizons, the

Almost untested

now to test that new play

on state lands and

onto federal lands."

-ConocoPhillips Alaska

President Joe Marushack

But, although the oil play along the middle Cretaceous shelf margin may extend nearly 100 miles west of the Colville Delta area, the play remains almost untested, with only a handful of exploration wells penetrating it offshore. Wells drilled far to the west have demonstrated the presence of the Shublik and lower Kingak source rocks in the region, and have found abundant oil shows in Brookian and older rocks. But none of these wells were drilled in areas where potential traps in the middle Cretaceous rocks could best be evaluated, Houseknecht said.

With Brookian reservoir sands becoming compressed at depth and hence losing some of their porosity, the depths to which the potential reservoir rocks have been buried during their history is important in assessing current reservoir quality. It turns out that, while the middle Cretaceous rocks in the area of the Brooks Range Foothills appear to have been buried to depths of 7,000 to 8,000 feet at some time, the equivalent strata in the Simpson Bay area, for example, seem to have only been buried to some 2,000 to 4,000 feet. And, so, the reservoir quality of potential reservoir sands along the suggested Torok-Nanushuk oil play area should be very good, Houseknecht said.

Key uncertainties associated with the play include forecasting the presence of reservoir-quality sandstone along the play fairway, delineation of subtle traps that may involve both stratigraphic and fault components, and -farther to the west offshore - understanding a complex pattern of erosional truncation of the Nanushuk reservoir.

-Petroleum News senior staff writer and geologist Alan Bailey contributed to this article.

of the wells specified in a plan of develop-According to Armstrong, he and his partners have "multiple horizons" in the ment filed in a permit application to the Pikka unit, and plan to "develop at least six 2015. different zones," with the Nanushuk and Alpine horizons the "biggest at this time,"

That expansion was approved in January 2017 by the state. "With construc-

tral processing facility that will process 120,000 bpd. The development is on U.S. Army Corps of Engineers in June Kuukpik Corp. land, and the company is

> Sealift and civil and pipeline work is scheduled for 2019-21, drilling and sealift delivery in

working toward a surface use agreement, he said. The state and Arctic Slope Regional Corp. own the subsurface.

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biggest, at this time."

Armstrong made "a major oil discovery in the Cretaceous Nanushuk formation, which they have encountered in seven wells," Myers said, unit, and plan to "develop calling the discovery "amazing," and "they have reported a very significant oil discovery in the Jurassic Alpine sandstone,

which ... was encountered in four of their wells."

The Nanushuk pool has a 650-foot-plus oil column and good porosity, he said.

Bill Armstrong told Petroleum News that the Nanushuk pool contained oil across a 25,000-acre area at a depth of about 4,100 feet, with 225 feet of net pay in the 650 vertical feet of reservoir rock.

billion barrels, and possible contingent reserves of 3.7 billion barrels, Myers said.

Armstrong and Repsol reported contin-

gent oil reserves of proven 497 million bar-

rels, probable contingent reserves of 1.4

and to be developed first.

According to (Bill)

Armstrong, he and his

partners have "multiple

horizons" in the Pikka

the Nanushuk and Alpine

horizons, the biggest, at

this time."

Unit expansion approved

Pikka, which sits between the Colville River unit (Alpine and its satellites) to the west, the Oooguruk unit to the northeast and the Kuparuk River unit to the east, at that

time included 33 state and joint state and Arctic Slope Regional Corp. leases. But later in 2016, Armstrong applied for 24 state leases to be added to the southern part of the unit the unit — 17 on the west side of the unit and seven on the east side. In its application Armstrong said that the expansion was needed to accommodate all

tion slated to begin with the completion of the ongoing EIS, Pikka oil should start

flowing in 2021,

assuming no large delays," Bill Armstrong confirmed in early 2017.

Several forecasts put crude above \$50~abarrel by 2021, which was what the Department of Revenue estimated it costs to produce oil on the North Slope, be it on land or in the near-shore, shallow state waters of the Beaufort Sea. That is not the case when an oil pool is in federal waters, however. Depending on how far out they are, \$70 oil would likely be the lowest break-even point, Petroleum News sources say.

Three gravel pads

In late 2016, Armstrong Vice President Ed Kerr said three gravel pads are planned for the Pikka unit development, and a cen-

2020-21 and first

production in late 2021.

was needed for the project and that is

An environmen-

tal impact statement

underway, which the Corps of Engineers recently told Petroleum News would be out in draft form by mid-2017.

An estimated 750 million barrels of oil are recoverable from the three planned pads with a total of 76 production and injection wells, Kerr said.

Sealift and civil and pipeline work is scheduled for 2019-21, drilling and sealift delivery in 2020-21 and first production in late 2021.

Sales quality oil will be transported through a new export pipeline to the Kuparuk oil sales pipeline, and then to the trans-Alaska oil pipeline.

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