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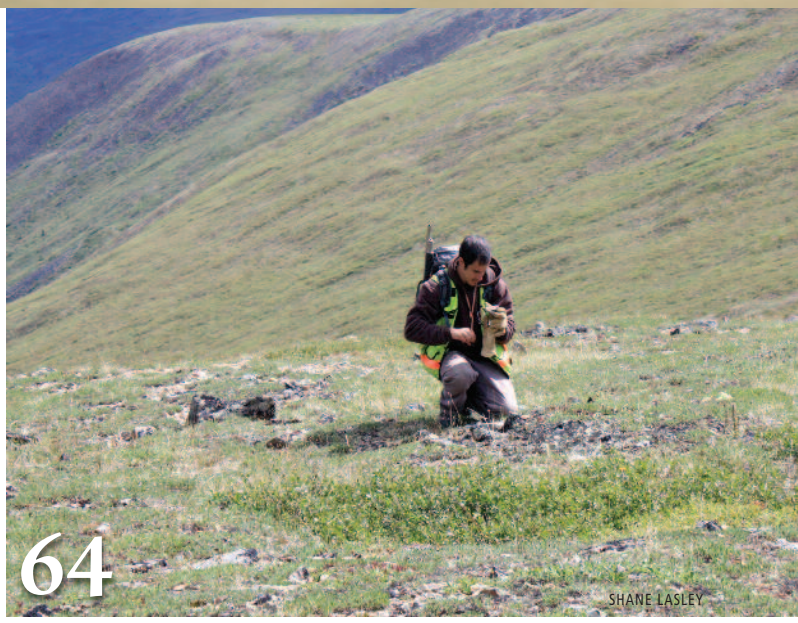

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Saluting Don Lasley, miner and dad

Dedicated to Don Lasley — Fortune Hunt Alaska 2011 is dedicated to Don Lasley, discoverer of the first Crooked Creek diamond and father of our company's general manager, Clint Lasley, and North of Mining News publisher and executive editor, Shane Lasley. Pictured here, from left to right, Shane, Lance, Don, Matt and Clint.

Three diamonds discovered along a two-mile, or three-kilometer, stretch of Crooked Creek in the Circle Mining District during the 1980s sparked the curiosity of geologists hoping to discover the source of the gems. The first of the Crooked Creek diamonds, dubbed Arctic Ice, was a one-third carat stone discovered by Don Lasley at a gold placer operation about seven miles west of the mining town of Central (see article on page 60).

Experts said it was impossible to find quality diamonds in Alaska. Lasley disagreed, watching for them as he worked Interior gold claims. He was certain the state held a virtual bonanza of valuable elements that could contribute to a dynamic economy for the Far North.

Lasley is the father of two of our publishing company's top people: Shane and Clint Lasley.

Shane is publisher and executive editor of North of 60 Mining News and Clint is general manager of our company.

"Dad was commonly at odds with conventional wisdom. It was this kind of outside of the box thinking that allowed him to recognize Arctic Ice as a diamond when others said it was not possible. It may take someone with a similar adventurous spirit to find the source of the Crooked Creek diamonds that have eluded geologists for nearly 30 years," Shane said.

"Being born in Fairbanks in the years leading up to the pipeline and growing up in a rural Alaska mining town has provided me with a unique understanding of the issues surrounding resource development in the state," he said when asked how his upbringing helped him today.

"My parents always instilled in us the importance of family, integrity and work ethic. It is by those examples I live my life and operate our business on a daily basis," Clint said when asked the same question.

This magazine is dedicated to their father, Don Lasley, who has retired from mining in body, but not spirit. He and his wife Carol still own the Lasley home in Central, Alaska, and visit as often as they can from New Mexico, where they moved to be closer to Don's mother, Laurabelle Lasley.

Three of their four sons and all of their grandchildren and great-grandchildren continue to live in Alaska, instilled by Don and Carol with a love for the state and appreciation for the two industries that built it, minerals and oil.

Thank you, Don and Carol, for raising hardworking, intelligent sons. Shane is largely responsible for making North of 60 Mining News the outstanding publication it is today; Clint has made sure our company is a wonderful place to work, remains solvent and provides first-rate services to readers and advertisers.

Cheers to one and all,
Kay Cashman, publisher & executive editor
Petroleum News

The Hunt for PETROLEUM

Exploring off the beaten path

A glimpse into the potential of the future: A review of Alaska's nonproducing oil and gas basins

BY ALAN BAILEY & KAY CASHMAN
Petroleum News

Although this publication focuses on oil and gas opportunities in the proven geologic basins of the North Slope and Cook Inlet, there are other Alaska nonproducing basins with the potential for natural gas, and in some cases oil.

Geologist Robert Swenson, director of Alaska's Division of Geological and Geophysical Surveys, or DGGS, recently gave an overview of some of these less known basins and their resource potential.

A group of companies drilled a well in the Nenana basin in 2009. A barge stationed on the Nenana River was used to carry heavy equipment across the river to the drillsite access road, seen directly behind the barge.

Alaska, Swenson explained, is traversed by several major geologic faults. The relative movement of rocks on either side of these faults has thrown up mountains in some areas, while causing other areas to sink into low-lying basins. Erosion of the mountains has caused sand and gravel to flow as sediment into the basins.

The basins formed in this way are Tertiary in age and generally contain non-marine sediments — sediments consisting of sands, gravels and shales laid down from ancient rivers and lakes. Coal seams interspersed with these sediments have formed from rotting and compressed vegetation. And bacteria feeding on that rotting organic material have created methane, the primary component of natural gas, with that gas becoming adsorbed onto the coal.

If stresses in the Earth's crust cause folding and uplift of the coal seams, the resulting drop in pressure in the coal can release the gas into sandstone reservoir rocks to form gas fields, Swenson said. The Cook Inlet

continued on page 12

basin, with its prolific gas fields, is a Tertiary basin of this type.

For oil and gas to be formed from the cooking of organic material, as distinct from the formation of gas from bacterial action, the organic material needs to be heated to an appropriate temperature.

And, given the rate at which the subsurface temperature increases with depth in Alaska, the organic material would need to be buried to depths of 18,000 to 20,000 feet for the material to become hot enough for oil and gas to be generated. Since there are relatively few places in the Alaska Tertiary basins where these depths are attained, geologists consider the basins to be generally gas-prone.

The oil in Cook Inlet basin has flowed into Tertiary sandstone reservoirs from older, deeper Mesozoic source rocks.

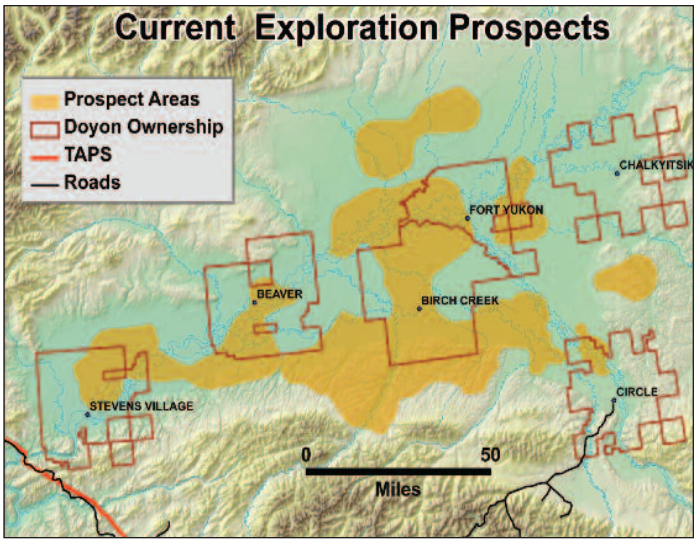
Nenana basin

The 8,500-square-mile Nenana basin, 50 miles southwest of Fairbanks, is a classic Tertiary basin in Interior Alaska. Thick coal seams and sandstone strata exposed at the surface near Healy, on the north side of the Alaska Range, demonstrate the potential for finding gas resources in the basin.

"This is exactly what you want to see from an exploration standpoint," Swenson said. "The coals are what are going to be generating the gas. The sands are what are going to be actually reservoiring that gas."

The basin attains depths of around 18,000 feet in its deepest parts, thus possibly putting some of the deeper rock strata into temperatures where oil might be generated, Swenson said. However, the basin is thought to be primarily gas prone.

A group of companies, including Native regional corporation Doyon Corp., is engaged in exploration of the Nenana basin and drilled one well in the basin in 2009, which did not encounter a commercial gas accumulation, and is currently planning a seismic survey in the northern part of the basin.



Some areas prospective for oil and gas in the Yukon Flats include land owned by Doyon Ltd. The Alaska Native regional corporation is evaluating a subbasin near Stevens Village, about 35 miles from the trans-Alaska oil pipeline (shown in red on the map).

Yukon Flats, Susitna

The relatively large, 15,000-square-mile Yukon Flats basin, north of Fairbanks, is another classic Alaska Tertiary basin. With a typical Tertiary rock sequence of sandstones and coals, and with depths up to 23,000 feet, this basin has a fair amount of oil and gas potential, Swenson said. There is industry interest in the basin, he said (editor's note: Doyon has been spearheading efforts to attract explorers).

The Susitna basin, to the north of Anchorage and separated from the Cook Inlet basin by a major geologic fault actually consists of two smaller basins — a major basin within the main sweep of lowlands around the Susitna River, and a minor basin to the northwest, near the village of Skwentna. With Tertiary strata having a maximum thickness of 15,000 feet in the major basin, the basin lacks sufficient depth for likely oil generation

continued on next page

and probably holds just gas. The older Tertiary strata that host oil in the nearby Cook Inlet basin appear to be missing in the Susitna basin, and no one has yet found evidence of a viable oil source rock in the area, Swenson said.

With two wells drilled some years ago and just some 1960s era seismic data available, exploration of the basin has been very limited.

Cook Inlet Energy LLC currently operates a state exploration license in the Susitna basin. Given the proximity of the basin to the Alaska Railbelt, DGGS is doing a detailed study of the basin's petroleum geology.

The Copper River basin around the town of Glennallen, is large, but relatively shallow, containing only about 3,000 feet of Tertiary strata. But in the western part of the basin these strata are similar to the marine Mesozoic rocks that generated oil in Cook Inlet basin, Swenson said. Some drilling has occurred.

Bering Sea

In addition to onshore basins, there are several large, similar Tertiary basins under the waters of the Bering Sea, on the relatively shallow Bering Sea shelf.

The Bering Sea basins include Norton basin, under the Norton Sound, and Hope basin, to the northwest of Kotzebue.

The existence of complex geologic structures, especially large geologic faults, in Norton basin has given rise to a number of potential plays, producing some exploration interest, Swenson said. The basin contains up to 23,000 feet of Tertiary stratigraphy.

ARCO drilled two stratigraphic test wells there in 1980 and 1982, and the federal government leased 59 tracts in the basin following a March 1983 lease sale. Companies drilled six exploration wells in the mid-1980s, with all of the wells indicating the presence of natural gas; one or two had weak oil shows.

The former U.S. Minerals Management Service, or MMS, assessed the possibility of finding up to 1.6 trillion cubic feet of gas in the basin.

Navarin basin

The largest and most remote of the Bering Sea basins is the 32,000-square-mile, 36,000-foot-deep Navarin basin, 350 miles west of the Yukon-Kuskokwim Delta. One stratigraphic test well and eight exploration wells have been drilled in this basin, finding gas shows and, in the lower part of the Tertiary section, the limited existence of oil-prone source rocks. The wells found seven potential oil and gas reservoir rock units in the Tertiary, Swenson said.

MMS assessed the possibility of 500 million barrels of oil and six trillion cubic feet of natural gas in the basin, but the area would be very expensive to explore and develop, Swenson said.

Another Bering Sea basin, North Aleutian (Bristol Bay), has high oil and gas potential and has been the subject of exploration in the past (editor's note: the basin is now subject to a lease sale moratorium, ordered by President Obama in March 2010).

Hunting for elephants in Cook Inlet

It's good times for Southcentral Alaska explorers as promising geology gets boost from government

BY KAY CASHMAN
Petroleum News

Dwindling oil and gas production and an aging infrastructure are normally the hallmarks of a mature oil and gas province. But despite its collection of declining oil and gas fields, Southcentral Alaska's Cook Inlet basin remains substantially underexplored, as evidenced by the sparse distribution of on- and offshore exploration wells in the region (see satellite image on page 74).

Cook Inlet, a major sea inlet between the Kenai Peninsula and the mainland of Southcentral Alaska, lies over part of a deep sedimentary basin between the Kenai Mountains and the mountains of the Alaska and Aleutian ranges. The basin extends beyond Cook Inlet under the western side of the Kenai Peninsula, under the lower land on the west side of the inlet and under the waters of Shelikof Strait.

Since the late 1950s the Cook Inlet basin has produced about 1.4 billion barrels of oil and 10 trillion cubic feet of natural gas, but U.S. Geological Survey scientists have theorized that only 4 percent of the petroleum that could have been generated by the basin's source rocks has ever been found. And the U.S.

continued on next page

For the first time in more than a decade, a jack-up rig is headed for Cook Inlet. The Spartan 151 left Freeport, Texas, on March 18, under contract to Escopeta Oil, which will use the rig to explore Kitchen Lights, a large offshore unit in the upper Cook Inlet that combines four distinct oil and gas prospects.

Department of Energy's 2004 report on the basin's natural gas hypothesizes that there are missing giants — large oil and gas fields — that remain to be discovered.

Even more surprising is the fact that only a handful of wells have been drilled in the Susitna basin, a northern extension of the Cook Inlet basin.

So, as residents of Southcentral Alaska become increasingly concerned about tightening natural gas supplies, and as the region's main oil refinery has to import more and more of its feedstock, significant oil and gas resources remain to be found in Cook Inlet.

John Bedingfield, Apache's vice president for worldwide exploration and new ventures, said Cook Inlet is intriguing because of its "tremendous" oil potential.

Two sequences

There are two major sequences of hydrocarbon-bearing rocks in the basin: a younger and shallower sequence that is Tertiary in age with sandstone reservoirs, and an older, deeper sequence that is Mesozoic in age.

Upper Cook Inlet basin, the prime focus of oil and gas exploration and the only part of the basin with producing oil and gas fields, attains its greatest depth near the northwest corner of the Kenai Peninsula. In that area about 25,000 feet of Tertiary, coal-bearing, terrestrial sediments overlie a thick sequence of marine Mesozoic sediments. The rocks include an abundance of hydrocarbon sources, reservoirs and traps.

A broadly similar sequence of Tertiary rocks extends across the whole upper Cook Inlet area, but thins toward the edges and toward the lower basin.

Oil exploration initially targeted the Mesozoic strata but the 1957 discovery of the Swanson River oil field in Tertiary sediments shifted the attention of later explorers to the Tertiary. To date there have been 11 significant oil finds and 28 significant gas finds in the upper Cook Inlet area, with all of the finds occurring in the Tertiary.

Basin's challenges

Exploring the Cook Inlet basin can be challenging. Fields typically contain multiple small reservoirs that may be difficult to find. Deposition of the Tertiary sediments from rivers and river fans, spreading from the ancient mountains surrounding the basin, has given rise to rock units that are often discontinuous. River channels and fans can be difficult to differentiate using single rock samples from wells, thus giving rise to issues such as knowing how far a particular reservoir may extend.

"There's been a lot work over the years by the industry to try to predict reservoir continuity," per geologist Paul Decker of Alaska's Division of Oil and Gas.

Also, perhaps because of clay content of the sediments, it is often difficult to recognize pay zones using well logs, said Tim Ryherd, a commercial analyst with the division. It is not always obvious where the gas sands are, even if you drill right through the middle of a gas reservoir, he said.

And, Decker said, acquiring high quality seismic in the basin can be difficult, in part because of the basin's complex structures. The coal seams in the Tertiary sequence also tend to absorb seismic energy.

Nonetheless, Cook Inlet basin explorers have found some sizable fields. The largest oil field, McArthur River, had produced about 628 million barrels of oil by the end of 2008, with recoverable oil reserves of about 646 million barrels.

Stratigraphic traps

A quick inspection of a map of Cook Inlet's discovered fields shows that they follow two main trends on either side of the basin axis — one trend passes up the west side of the Kenai Peninsula and the other trend passes up the west side of Cook Inlet.

The trends lie on either side of the central axis of the basin.

"If you look at a map of the well plots there's very few in the core, along the axis (of the basin)," Ryherd said.

Interestingly, the Kitchen oil and gas prospects, where Escopeta Oil plans to drill this summer from a jack-up rig, is on the axis of the basin.

Decker also said much of the drilling in the Cook Inlet basin has focused on the crests of the major structures in the basin. He thinks there is scope for exploring the flanks of the structures, where fluids will likely have migrated up the structures.

continued on page 74

GEOKINETICS IN ALASKA

Marine vibrator undergoing field trials

onSEIS tests in Alaska

Custom-built TZ/OBC deployment/recovery vessel

Geokinetics completed the acquisition of PGS Onshore on February 10, 2010. This acquisition significantly expanded the scope and scale of the Company in many ways and as such, Geokinetics is the largest provider of onshore seismic data acquisition services based in the Western Hemisphere and the second largest in the world. As an acknowledged industry leader in challenging environments, the Company owns approximately 200,000 channels of recording equipment and has the capacity to operate up to 32 seismic crews worldwide and the ability to process seismic data collected throughout the world.

Research and Development has been and continues to be a focus for the Company. Working closely with Ag Track and Goodyear in 2000 and 2001, the Company participated in the development of arctic grade rubber tracks for geophysical equipment operating in Alaska. The goal was to develop environmentally friendly transportation to protect the sensitive tundra from damage while conducting seismic surveys in the rugged foothills of Alaska's North Slope. More recently, Geokinetics has been involved in helping develop new environmentally friendly seismic energy sources such as "onSEIS" (Synchronized Electronic Impulsive Source) and the marine vibrator. The onSEIS units have all the benefits of traditional impulsive surface sources, but are also lightweight, agile and can be synchronized, which improves operational efficiency. The onSEIS technology is now fully commercialized and is currently deployed and being utilized in various regions, and Geokinetics is the only seismic contractor utilizing this technology. The marine vibrator is intended for shallow water (OBC/TZ) applications where air guns and drilling might be prohibited. The image quality is comparable to that of air guns, but the units contain an automatic noise filter with vibrator technology and emit very low levels of ambient noise to reduce the affect on fish or sea mammals. Geokinetics expects this technology to be fully commercial by the end of the year and the Company has an unrestricted license to use, manufacture and develop marine vibrator technology for all applications with the exception of towed streamer.

In Alaska, operating as PGS Onshore since 2001, Geokinetics has acquired over 2,000 linear miles of 2D and 1,700 square miles of 3D seismic data in various sedimentary basins of the state, including the North Slope, Nenana, Copper River, and the Cook Inlet. The Company has offices located in Anchorage, Fairbanks and on the North Slope to support its activities and meet the needs of its clients. With a fleet of 13 AHV-IV vibrators and the newest mobile arctic grade seismic camps in the state, the Company has the resources locally to field both 3D and/or 2D seismic crews, and house over 150 men at any time during operations on "the slope". In addition, the Alaska management team, which has remained in place since the acquisition last year, have managed and operated crews around the world, and over the past 40 years in Alaska in areas as remote as Kotzebue, Yakutat and the Alaska Peninsula. This stability and experience within the group has been an important aspect in maintaining good working relationships between the Company and federal, state, and local communities in all areas it operates.

Area Manager for Alaska, Chuck Robinson, commented, "While the name may have changed our commitment to provide high quality data and innovative solutions in a safe and environmentally friendly manner to our clients in Alaska and throughout the world remains the same."

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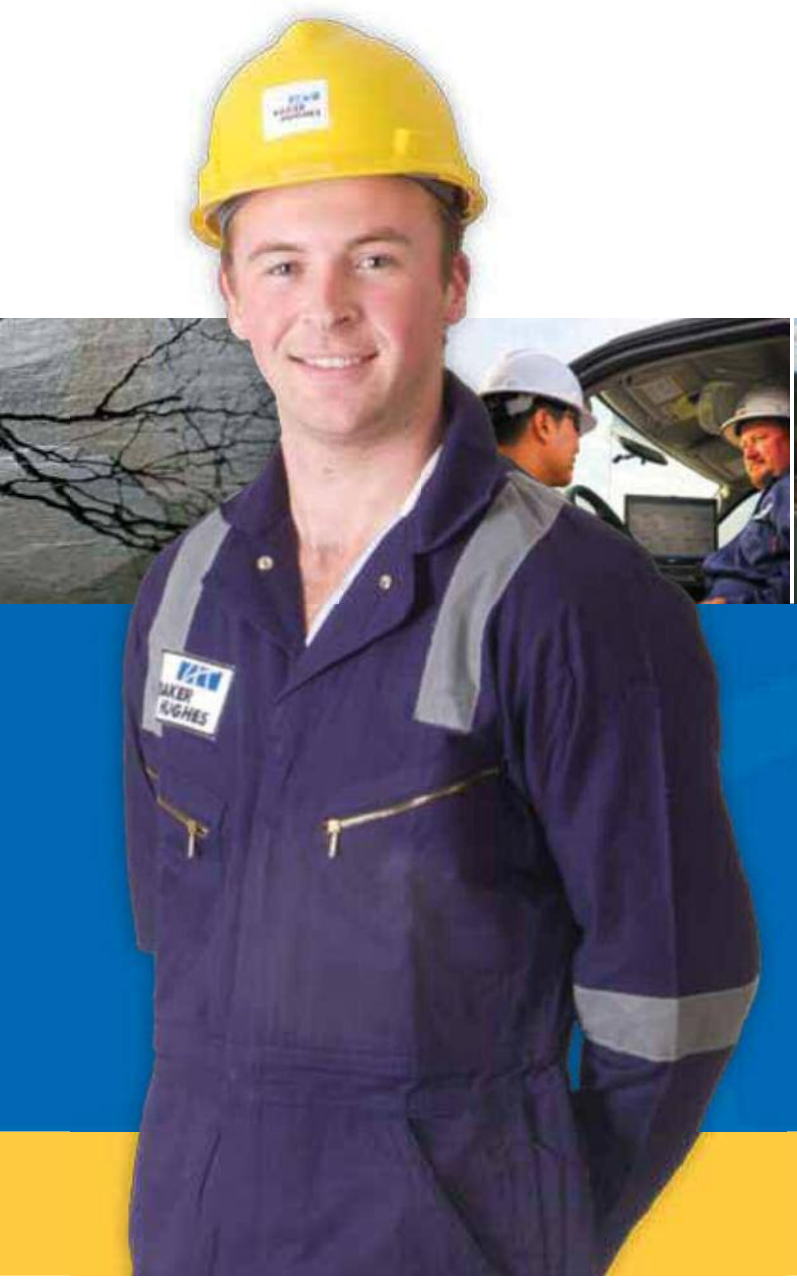

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Hunt for shale oil begins in Alaska

Crude from three stacked, world-class, source rocks migrated into giant Prudhoe Bay, Kuparuk traps

BY RANDY BRUTSCHE
For Petroleum News

At least two oil companies are going after unconventional shale oil plays in Alaska — three of which are world-class source rocks, stacked one on top of the other.

In the State of Alaska's latest North Slope lease sale, Great Bear Petroleum LLC, an independent focused only on Alaska, stepped out boldly and bet $8 million to win some 537,600 acres in the oil maturity window along the Dalton Highway and adjacent to the 800-mile trans-Alaska oil pipeline from Prudhoe Bay to Valdez, Alaska's northernmost ice-free port. Brooks Range Petroleum Corp. joint venture partners already hold a combined 240,000 acres on the North Slope, at least 94,000 acres of which is prospective for shale oil extraction.

These two companies have declared an interest in seeing how well they can repeat the successes reported from Lower 48 states' unconventional shale plays, such as the Bakken formation in North Dakota and Montana and the Eagle Ford formation in South Texas.

The North Slope is home to Prudhoe Bay and other world-class oil fields. Approaching 16 billion barrels of oil have been produced from the North Slope to date — from 100 billion barrels of oil discovered along the Barrow Arch, all of which migrated from source rock farther inland.

From deepest to shallowest, these source rocks are the Triassic-age Shublik, the Jurassic-age Kingak and the Cretaceous-age Hue. (The Hue shale is also referred to as the GRZ, HRZ or Pebble shale. Although the Pebble shale is a different rock unit from the Hue shale/GRZ, it is generally found in the same location as the Hue.)

continued on next page

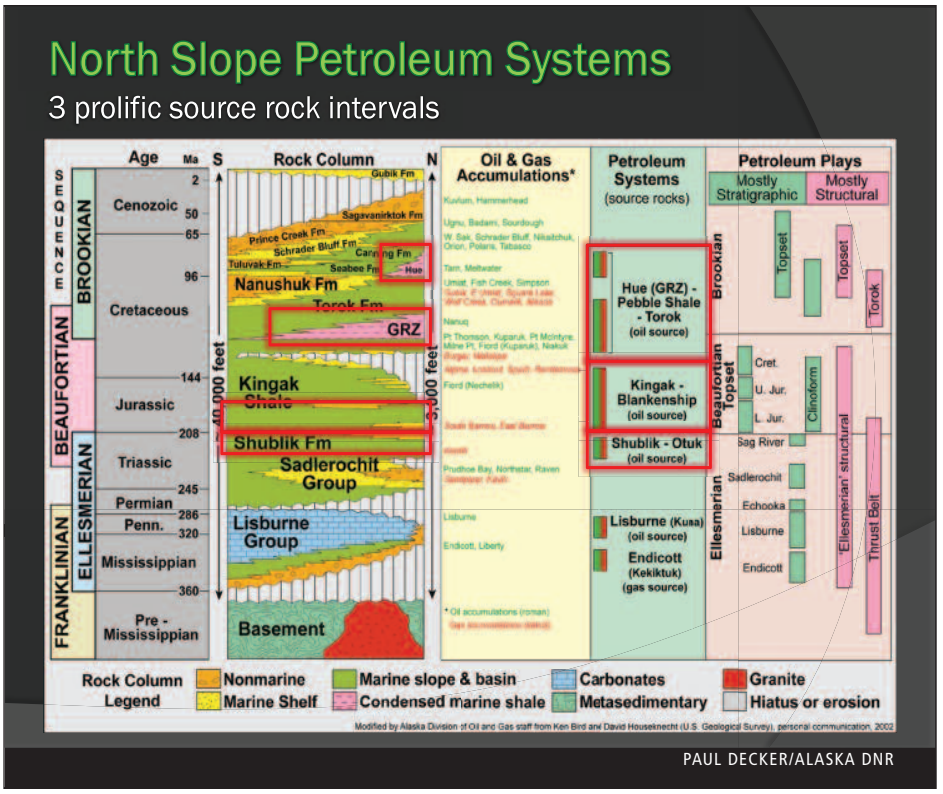

P.L. DECKER, 2005

Great Bear leading charge

Great Bear hopes to begin producing crude oil and natural gas liquids, or NGLs, in 2013, in three 15-year-phases that call for about 200 factory wells a year, once it drills four 11,000-foot core holes in the second half of this year and four production test wells in 2013.

The company's plan, which its executives consider aggressive, has gotten kudos from both Alaska's Republican Gov. Sean Parnell and its legislators, Republicans and Democrats, who invited Great Bear to make several recent presentations to legislative committees.

One of their questions and follow-up comments to Great Bear's President and Chief Operating Officer Ed Duncan encouraged him to consider drilling 1,000 wells a year. He appeared startled by the question, but said it was not impossible: "Two hundred wells a year is a lot, but it's scalable. If the capital is there; if the development infrastructure is there, and the ability to move that produced oil into the pipeline is there — all of those are challenges — but if all of those are there, it can be done. There's nothing that we're waiting for from a technology perspective. The ability to drill and complete these wells is proven. It will be better a year from now than it is today," he noted.



Great Bear is projecting spending $10 million apiece on the factory wells. That alone is $2 billion a year for drilling, Duncan pointed out.

"We can grab the upward incline of our drill out, that point where we hit 9,000 wells, and drag it to the left if we want to accelerate the program," he said, pointing to an overhead used in his presentation. "That tilts the production profile up. … We could conceivably rebuild the production down TAPS to well in excess of a million barrels a day. And we could do that relatively quickly if we accelerate the program. … Also, our program is predicated on adding one more source rock to the mix (all three phases will exploit the Shublik) — either the Kingak or the HRZ," but, he said, Great Bear could increase production by drilling more wells and producing from all three source rocks.

"The richest source rock on the North Slope and one of the richest source rocks in North America — in fact, one of the richest source rocks in the world — is the Shublik formation," Great Bear Petroleum President and COO Ed Duncan told legislators. "Its regional extent, its quality, is extraordinary. And that is our primary target."

If Great Bear can successfully develop the resource as currently planned, exploiting just two of three stacked shale source rocks in its 45-year measured drill-out program with 200 wells a year, it estimates it will produce 200,000 barrels per day by 2020; 350,000 bpd by 2035; 450,000 bpd by 2041; peaking at 600,000 bpd in 2056, with a sustained long-term production of 450,000 barrels per day out as far as 2074.

Duncan told lawmakers that he believes his leases alone contain at least 2 billion barrels of recoverable oil and 12 trillion cubic feet of natural gas.

According to Great Bear, Alaska has three of the most prolific source rocks in the world — a chunk of the geologic "kitchen"

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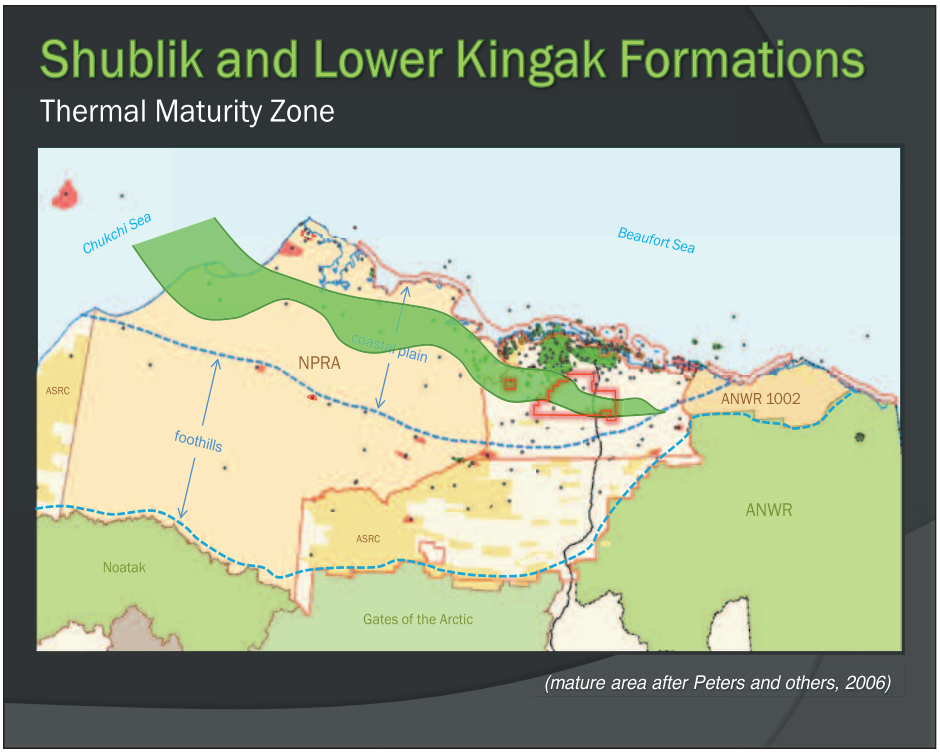
PAUL DECKER/ALASKA DNR



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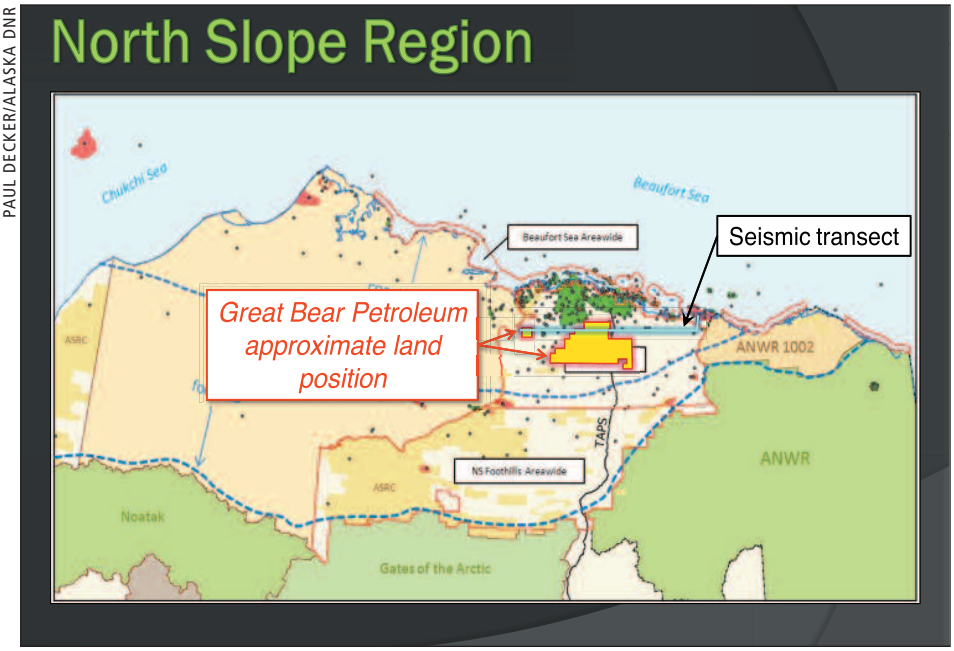

that generated the 100 billion barrels of oil that millions of years ago migrated north into traps along the northern coast.

Recovery percentage getting better

"The percentage of hydrocarbon recovered is a moving target," Duncan said. "Two years ago it was probably 3-4 percent. Now it's 5-6 percent, and it's improving. Technology in this particular field is moving at a spectacular pace, and it's driven by the success of the plays like the Bakken, the Eagle Ford, the Barnett, the Marcellus, and so forth. So the exploitation, reservoir stimulation and production technologies, are improving dramatically, have improved dramatically. We're using 5-6 percent as our base case today. My suspicion is … it will be higher than that by the time we drill our full production test next January."

"The richest source rock on the North Slope and one of the richest source rocks in North America — in fact, one of the richest source rocks in the world — is the Shublik formation," Duncan told legislators. "Its regional extent, its quality, is extraordinary. And that is our primary target."

Duncan said he expects the test and resultant factory wells to be roughly 9,000 to 11,000 feet deep with 4,000 to 6,000 foot laterals.

Great Bear scored, but didn't win it all

But there is still room for other companies to develop shale plays on Alaska's North Slope. "By no means did Great Bear win all of the acreage that would be prospective, that would appear to be in the oil maturation window," Alaska Division of Oil and Gas geologist Paul Decker told Petroleum News.

"I think they are very well-positioned geologically," Decker said. But it's "a question of geology versus 'close-ology.' Based on thermal maturity, the North Slope source rock plays likely extend far beyond Great Bear's acreage position, particularly to the west. However, from the perspective of needing to build out year-round access and infrastructure tie-backs, someplace very close to the Dalton Highway, TAPS, and producing fields would seem a logical place to start," and Great Bear's acreage brackets both the Dalton Highway (Haul Road) and the trans-Alaska oil pipeline, Decker said.

A careful, informed selection; not a land grab

Why is Duncan so certain his company's acreage holds billions of barrels of recoverable oil?

The geology of the North Slope is well known and understood, documented by seismic, numerous field studies and well data, Duncan said. So when his company bid on 537,600 acres in last year's North Slope lease sale, it was not making a blind land grab.

"There are massive amounts of very, very good technical information and studies on this basin. I kept reviewing everything, looking for critical problems, talking to the best geoscientists that I knew of. … We knew where the source rocks were, we knew their thermal maturity. I went over all of it several times alone and with colleagues," Duncan said.

"I am quietly confident … had we not made our move in this lease sale we would have been locked out of it by next. Our timing was fortuitous," Duncan said, echoing the sentiments of the early leaseholders in the shale plays in the Lower 48.

Matching geology with technology for BP

Considering the job Duncan did for Sohio (now BP) in Alaska, from 1982 to the late 1980s, it's not surprising that Great

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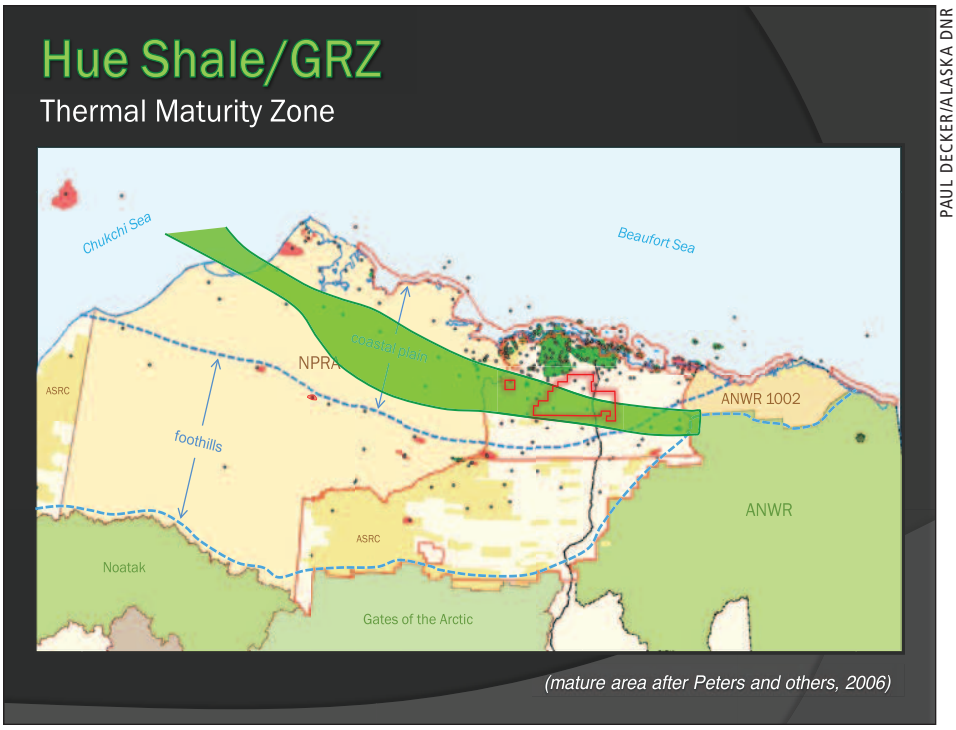

PAUL DECKER/ALASKA DNR

Bear was first to pick up leases targeting an oil shale play in Alaska's Brookian Foredeep, also known as the Colville basin, which lies north of the Brooks Range and south of the North Slope's producing oil and gas fields.

As a project supervisor and geologist with the Sohio exploration group, Duncan was in charge of everything on and offshore between the Colville River and the MacKenzie Delta in Canada. He was tasked with matching the geology of an area or prospect with advances in technology that might make it economically viable.

So not only was he well versed in the North Slope's petroleum systems, but he was trained to watch for the convergence of technology and geology, which he saw initially with Petrohawk Energy's advances in well design at Eagle Ford, involving everything from increased lateral lengths to less restrictive choke sizes, tighter perforation cluster spacing, increased proppant and the use of new vegetable based fracking gels to overcome concerns about the use of toxic chemicals in hydraulic fracturing operations.

Duncan asserts the challenge of producing oil and gas from North Slope source rocks in Great Bear's leases has little to do with the area's geology. "The challenge is not the geology; it's well understood here. The challenge for the play is: Is it operationally doable on the slope."

The answer, he said, is yes. "We got past that issue pretty quickly."

"There's always a chance the rocks just won't perform the way we want them to. We don't expect that. That's way outside our prediction range of outcomes. Also, there's a chance the rocks will perform well beyond what we might imagine from an analog perspective," Duncan said.

"We need to design our fracs. Our first four planned full production test wells have large R&D research element in them. We'll perfect a method very quickly in the first few wells, then we go into factory drilling, and the costs go down at that point.

"That's the operational model that has been developed in the Lower 48," he said.

"We'll drill down to the source rock and then run the laterals along the source rock strata and using state-of-the-art rock fracturing techniques to cause oil to flow direct from the sources."

Brooks Range joins Alaska shale game

Alaska-based Brooks Range Petroleum Corp., or BRPC, is drilling the state's only exploration well on the North Slope this winter.

Brooks Range was formed in 2006 as the Alaska operating entity for the joint venture working interest owners, who are currently Kansas-based Alaska Venture Capital Group, or AVCG, which holds a 50 percent working interest in the JV's 240,000 acres on the North Slope and nearshore Beaufort Sea; TG World Energy, a small Calgary public corporation; and Ramshorn In-

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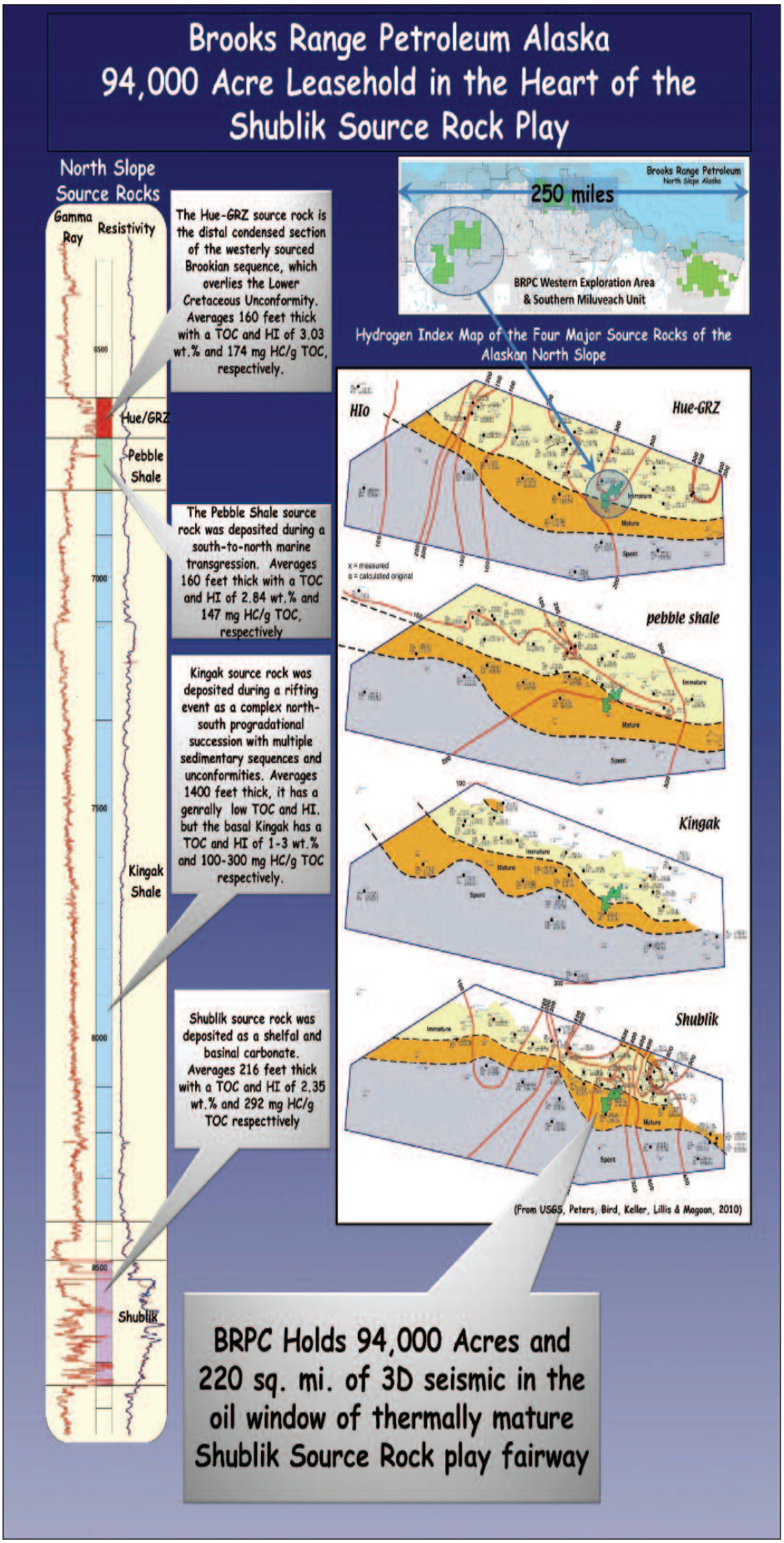

Editor's note: The Shublik map was modified from Peters et al 2006. CREDIT: Alaska Venture Capital Group

vestments, a wholly owned subsidiary of Nabors Drilling USA, out of Houston.

Ken Thompson, managing director of AVCG, recently told state legislators that his "job in the last … nine months has been to pound the pavement, make a lot of contacts and get our … next investor … that can bring capital, as well as expertise, to us." In the same period of time, he said, the partners were assessing their acreage for source rock potential.

"Starting with our working interest owners' meeting in Anchorage on July 20, 2010, we discussed the source rock potential and began some of our geologic assessment on AVCG et al acreage and surrounding areas. We feel our JV's almost 100,000 acres to the west around Tofkat, Big Island and even our Southern Miluveach unit area has source rock potential being in the right maturation and depth window. And we are also studying source rock and low-permeability sands potential in our Beechey Point unit," Thompson said.

Thompson said the JV partners "have made great progress on a comprehensive well log assessment and we plan visual core studies in 2011. Could these source rock shales and/or lower-permeability sands in these areas on the North Slope be the next Bakken or the next Eagle Ford development? AVCG and our JV partners plan to find out!"

JV's focus on next frontiers

Thompson said AVCG and its partners focus "is on what we call the next frontiers for major developments on the North Slope," which "fall into two categories for what we do."

One frontier, he said, is exploration for smaller fields. Smaller being "in the 25-to-50 million-barrel range," noting it was possible they would find something larger, "but for now we're focused on those." Both in his days with ARCO and more recently with AVCG, looking at seismic, he "saw a lot of" 25-50 million barrel fields.

"We believe there's a lot of potential production in low permeability sands; there are a couple of resources, they're more expensive to develop, but on our Southern Miluveach unit to the west … we have identified about 1 billion barrels in place, maybe about only 20 percent of that's recoverable, but it's … more expensive to develop."

The second frontier for major developments that his company and its partners are "excited about" is the "oil-source shales," believing the JV's acreage holds "significant potential" for shale plays.

USGS assesses unconventional resources

BY ALAN BAILEY
Petroleum News

While much oil and gas interest in North America has focused recently on new so-called unconventional oil and gas plays, especially involving the extraction of hydrocarbon resources directly from oil and gas shales, the Alaska oil industry has continued along a route of seeking and developing oil from conventional porous and permeable reservoir rocks.

But with Great Bear Petroleum forging ahead with plans to extract oil directly from source rocks on the North Slope, Alaska looks set to join the unconventional oil and gas bandwagon.

And the U.S. Geological Survey, the federal agency that has for many years conducted assessments of Alaska's conventional onshore oil and gas resources, is now turning its attention to estimating how much unconventional oil and gas might be accessible in northern Alaska and in the Cook Inlet basin.

Dave Houseknecht

The agency hopes to complete its Cook Inlet assessment in the late spring or early summer, and run the numbers for its northern Alaska assessment sometime in the fall, USGS geologist Dave Houseknecht told Petroleum News Feb. 8.

Trapped in the rock

Unlike a conventional oil and gas play, where hydrocarbons migrate into a porous source rock to become trapped under an impervious seal rock, an unconventional play, sometimes referred to as a "continuous" play, involves a rock unit saturated with oil or gas over a broad area, with the fabric of the rock itself, rather than an overlying seal rock, trapping the hydrocarbons in place. The much publicized "fracking" techniques used in this type of play release the hydrocarbons by smashing open the rock fabric.

Estimating the producible volumes of hydrocarbon resources in this type of unconventional play involves assessing three factors: the extent and thickness of the hydrocarbon bearing rock unit; the mechanical and oil production properties of the rock; and the likely success rates for well production from the rock, Houseknecht explained.

Essentially, a geologist conducting the assessment will use the rock properties to estimate the sizes of cells from which individual wells might be able to drain hydrocarbons and will use the hydrocarbon production characteristics of the rock to estimate ultimate production volumes for the wells.

The geologist will then statistically combine possible ranges of cell sizes and likely production volume ranges, together with ranges in the estimated extent of the complete rock unit, to derive a range of potential, extractable hydrocarbon in the play as a whole.

USGS conducted an assessment of North Slope coalbed methane resources in 2006. And, although there are likely to be substantial unconventional North Slope resources in impermeable, "tight" sands, USGS needs access to appropriate 3-D seismic data to delineate the tight sand bodies, Houseknecht said. There are probably resources in tight sands, even within existing North Slope productions units, but individual sand bodies are probably limited in extent, he said.

Focus on source rock

So, the agency is focusing on potential oil and gas production direct from source rocks, starting with the Cretaceous Gamma Ray Zone and Hue shale, and the Triassic Shublik formation, two prominent source rock intervals that have generated much oil in the North Slope oil fields, Houseknecht said. Could the source rocks in these intervals be tapped directly for oil production, using hydraulic fracking?

Existing seismic data tied into data from existing wells give geologists a good handle on the geographic extent and thicknesses of the source rock units. But, given the total lack of any track record of unconventional oil and gas production on the North Slope, estimating the rock's production characteristics, the parameters needed to estimate the well drainage cell sizes and well productivity, is one of the biggest challenge in conducting an unconventional resource assessment in northern Alaska, Houseknecht said.

Essentially, the geologists have to find analogous rocks from the Lower 48, rocks that have been used for unconventional production and that appear to have somewhat similar characteristics to those on the North Slope, in order to infer the required North Slope production characteristics.

Quite a bit is, however, already known about one key rock property: the distribution of thermal maturity, the measure of the extent to which the rock has been heated to generate oil or natural gas. In general, for example, the thermal maturity is relatively low on the crest of the Barrow arch, a major geologic structure along the Beaufort Sea coast, but increases to the south.

Gamma ray response

For the Cretaceous sources USGS is using the gamma ray response, a hydrocarbon content indicator, from existing well

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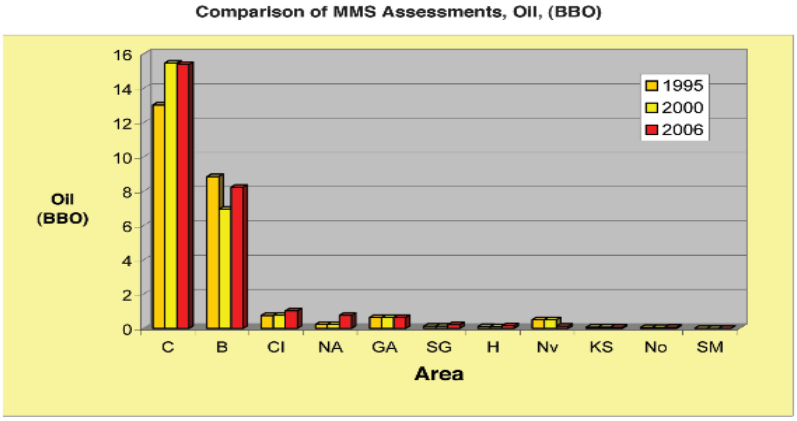
Chukchi star of 2006 OCS assessment

Mean estimate for recoverable oil from Beaufort Sea 8 billion barrels, Chukchi at 15 billion



AREA		1995	2000	2006	% DIFF 2000 to 2006
Chukchi	C	13.02	15.46	15.38	-0.52%
Beaufort	B	8.84	6.94	8.22	18.44%
Cook Inlet	CI	0.74	0.76	1.01	32.89%
N.Aleutian	NA	0.23	0.23	0.75	226.09%
GOA	GA	0.63	0.63	0.63	0.00%
St George	SG	0.13	0.13	0.21	61.54%
Hope	H	0.11	0.09	0.15	66.67%
Navarin	Nv	0.50	0.50	0.13	-74.00%
Kod/Shu	KS	0.07	0.07	0.06	-14.29%
Norton	No	0.05	0.05	0.06	20.00%
St Matt-Hall	SM	< 0.01	< 0.01	NA	NA
Total Alaska		**24.31**	**24.86**	**26.61**	**7.04%**

COURTESY MMS

BY ALAN BAILEY
Petroleum News

In support of planning for its 2007 to 2012 leasing program, the U.S. Minerals Management Service reassessed the petroleum resources in all 15 planning areas in the Alaska outer continental shelf, or OCS. The agency had last assessed all of the planning areas in 1995, although it did reassess the higher potential areas in 2000.

In most instances the oil and gas plays that MMS uses for its assessments had not changed significantly, MMS supervisory geologist Larry Cooke and MMS geologist Kirk Sherwood told Petroleum News in February 2006.

So, although MMS has refined its assessment models, the estimates of technically recoverable resources — resources that could be extracted, regardless of cost, using known technologies — remain broadly similar to those in previous assessments.

Up, on average, 7%

"Just looking at the overall bottom line, it didn't change that much for the conventionally recoverable (resources) in Alaska," Cooke said. "We were up, on average, about 7 percent."

For example, since the 2000 assessment the mean estimate for technically recoverable oil from the Beaufort Sea had increased from 6.94 billion barrels to 8.22 billion barrels, while the corresponding mean estimates for natural gas dropped from 32.07 trillion cubic feet to 27.65 tcf. For the Chukchi Sea, the mean estimate for oil changed from 15.46 billion barrels to 15.38 billion barrels. The mean estimate for Chukchi natural gas went from 60.11 tcf to 76.77 tcf.

As well as calculating estimated mean volumes, MMS estimated possible ranges in resource volume. These ranges increased significantly in the 2006 assessment, suggesting a higher level of uncertainty in the estimates than previously calculated.

The potential range in estimated technically recoverable oil for the Beaufort Sea went from between 3.56 billion barrels and 11.84 billion barrels to a range of between 0.41 billion barrels and 23.24 billion barrels. For natural gas, the range went from between 12.86 tcf and 63.27 tcf to between 0.65 tcf and 72.18 tcf.

The range for technically recoverable oil for the Chukchi Sea went from between 8.6 billion barrels and 25.0 billion barrels to between 2.32 billion barrels and 40.08 billion barrels. The estimated range for natural gas for the Chukchi Sea went from between 13.56 tcf and 60.11 tcf to between 10.32 tcf and 209.53 tcf.

All of the estimates were for conventional resources and do not, for example, include gas hydrates, Cooke said.

Cooke attributed the changes in the assessments to changes in the model that MMS uses for its assessments and to the fact that some new people assessed the plays.

Essentially, geologists evaluate ranges of resources that might be associated with possible oil and gas pools in each oil and gas play in a planning area — possible pools are identified from seismic data. Then the assessment model combines statistically the estimates for individual pools into an overall estimate for the planning area. Changes in both the evaluations of the plays and the method of statistically aggregating the pool estimates can impact the results of the assessment.

"We count those (pools) up and we account for their ranges in sizes … possible ranges in thickness of the pay column," Sherwood said, adding that factors such as estimated reservoir porosities also factor into hydrocarbon volume calculations.

Sherwood said that the statistical method used in the aggregation probably played a role in increasing the range of uncertainty in many of the total resource estimates.

"I think that's partly a model effect, depending on how you aggregate things," Sherwood said. "The aggregation method that is used here would tend to allow the extremes to all add up."

Cooke also pointed out that the latest MMS assessment model allows geologists to use different statistical distributions to describe the uncertainties associated with resource estimates for individual hydrocarbon pools — the previous model only allowed a single type of distribution.

Major changes to Bristol Bay

Sherwood said that MMS made some significant changes to its

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assessment of the North Aleutian basin, also known as the Bristol Bay basin, which lies on the north side of the Alaska Peninsula. In the 1995 assessment the agency only calculated resources for one key play.

"This time we have six plays, five of which we quantified," Sherwood said, commenting that that basin contains tremendous potential petroleum reservoirs.

The 1995 assessment estimated a mean of 0.23 billion barrels of conventionally recoverable oil and 6.79 tcf of conventionally recoverable natural gas for the North Aleutian basin. The new assessment has increased the mean for oil to 0.75 billion barrels and the mean for natural gas is now 8.62 tcf.

The main differences between the new MMS assessment and earlier assessments come to light in the estimates of economically recoverable oil and gas. Calculating economically recoverable volumes involves postulating different development and production scenarios for possible oil and gas fields. Then, by estimating development costs for the scenarios it is possible to estimate how much of the technically recoverable resources could be viably extracted at various resource price levels.

Although MMS analysts have taken into account modern offshore development methods such as subsea completions, an overall increase of development costs over the years has significantly raised the bar on the oil and gas price levels at which offshore developments become viable. MMS economic models hadn't been updated to include cost increases for a number of years, Sherwood said.

For this new assessment the analysts used a new, improved economic model to incorporate costs consistent with known recent costs in the Gulf of Mexico, Cooke said. The analysts also had to allow for specific Alaska cost issues — the oil and gas transportation infrastructure required in Alaska is unique to the state, for example.

Price set at $46 a barrel

Using this approach, MMS analysts determined that there would be minimal recoverable volumes of oil from the Alaska outer continental shelf at oil prices of $18 per barrel, the lowest price level in earlier assessments.

In the 2006 assessment, MMS published detailed estimated economically recoverable volumes of oil at $46 per barrel. And, to test the potential impact of future high prices, the agency also published estimates at $80 per barrel.

For the Beaufort Sea the estimated mean volume of economically recoverable oil at $46 per barrel is 4.12 billion barrels. At $80 per barrel that estimated volume increases to 6.92 billion barrels. The corresponding volumes for the Chukchi Sea are 2.37 billion barrels at $46 and 12.0 billion barrels at $80.

For natural gas, economically recoverable volumes start to appear at a price level of about $4.50 per thousand cubic feet. For the Beaufort Sea the estimated mean volume of economically recoverable gas at $6.96 per thousand cubic feet is 8.79 tcf. That volume increases to 19.97 tcf at $12.10 per thousand cubic feet. The corresponding volumes for the Chukchi Sea are 7.91 tcf at $6.96 per thousand cubic feet and 54.44 tcf at $12.10 per thousand cubic feet.

The natural gas estimates assumed the existence of a gas export pipeline from the North Slope and used estimated tariffs for that pipeline to calculate the economics, Cooke said.

For the North Aleutian basin, the estimated mean economically recoverable oil volumes are 0.63 billion barrels at $46 per barrel and 0.74 billion barrels at $80 per barrel. Estimated mean economically recoverable gas volumes are 5.85 tcf at $6.96 per thousand cubic feet and 8.40 tcf at $12.10 per thousand cubic feet.

The analysts assumed that North Aleutian gas would ship as LNG to Los Angeles or Cook Inlet.

In the 2000 assessment MMS found the possibility of a giant oil accumulation under the Chukchi Sea and estimated pool sizes ranging from less than 1 million barrels to a little more than 1 billion barrels under the Beaufort Sea.

Sherwood said that the 2006 assessment had estimated a maximum gas pool size of about 4.5 tcf in the North Aleutian basin.

"It's that tremendous reservoir sequence out there allowing these big volumes. And there are some big structures too," Sherwood said.

The 2006 MMS assessment can be found at www.mms.gov/alaska/.

Intriguing possibilities in Chukchi

Sherwood reviews geologic features that have lured explorers to North Slope's continental shelf

BY ALAN BAILEY
Petroleum News

When the U.S. Minerals Management Service held its Chukchi Sea lease sale in February 2008, the agency collected about $2.6 billion in high bids on some 488 tracts. In fact, together with the two other Chukchi lease sales that MMS conducted in 1988 and 1991 MMS has raised about $3.1 billion in bonus bids from the Chukchi, MMS geologist Kirk Sherwood told a meeting of the Alaska Geological Society on Nov. 13, 2008.

So what's the big deal when it comes to oil and gas interest in this remote and weather-challenged region?

Essentially, an abundance of large geologic structures combined with a suite of rocks that is similar to those in the prolific petroleum province of Alaska's North Slope, Sherwood said.

Reprint
From Petroleum News
Nov. 23, 2008 issue

"The Chukchi is structurally complex and because of that there are a lot of prospects," Sherwood said. "We've got about 850 that we've mapped out."

Of those prospects that MMS has identified, 83 are larger than 40,000 acres in extent, thus making them comparable in size to some of the North Slope oil fields, Sherwood said. And if any of those prospects hold oil and gas, they may be large enough for viable development.

"Our studies have indicated that for the large pools out there we do see tolerable development economics, despite the high cost of operating in that harsh environment," Sherwood said.

Three sequences

There are three major sequences of rocks in northern Alaska: Each sequence is associated with a major petroleum system and all three occur under the Chukchi Sea.

The first of the sequences, known as the Ellesmerian, involves rocks deposited southwards from an ancient landmass to the north of what is now the Beaufort Sea coast, from late Devonian through Triassic times. The Ellesmerian sequence includes the reservoirs for the Prudhoe Bay, Lisburne

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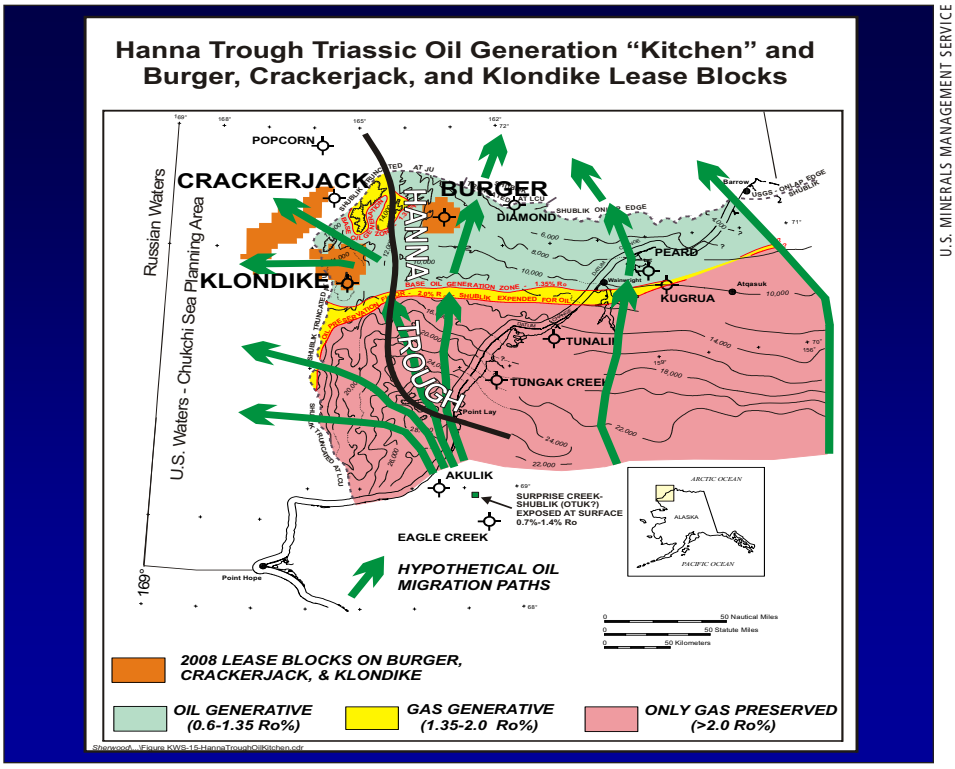


U.S. MINERALS MANAGEMENT SERVICE

and Endicott fields. Sediments of the Ellesmerian sequence accumulated in a basin termed the Arctic Alaska basin that extends east to west under what is now the southern North Slope and Brooks Range Foothills and which extends west under the Chukchi Sea, where it veers northwest into what is known as the Hanna Trough.

The next sequence, known as the Beaufortian or rift sequence, resulted from the breaking apart or rifting of the Canada basin of the Arctic Ocean in Jurassic and early Cretaceous times. The rifting resulted in the formation of fault blocks, with sagging blocks between higher blocks. Deposition of sand into the sags gave rise to reservoir quality sandstones. The Kuparuk River, Alpine, and Milne Point fields, among others, involve Beaufortian reservoirs.

The rift sequence is associated with the formation of the Barrow Arch, a major structural high that extends along the Beaufort Sea coast and that guided the migration of petroleum to major oil fields such as Prudhoe Bay. The Barrow Arch extends west under the Chukchi Sea, where it bifurcates into two arches. One of these arches extends northwest, before veering to the southwest. The other arch veers southwest immediately, to pass near the center of the U.S. sector of the Chukchi.

The third major sequence, known as the Brookian sequence, formed in Cretaceous and Tertiary times as a result of the emergence of the Brooks Range. The emerging mountain range caused sediments to flow into a huge basin, known as the Colville basin, under what is now the North Slope. That basin extends west under the Chukchi. Brookian sediments also spilled out over the Beaufort Sea continental shelf and into the North Chukchi basin in the northern part of the Chukchi Sea.

Fields such as Meltwater, Tarn and West Sak are associated with the Brookian sequence.

Seismic and well data

Much of what is known about the geology under the Chukchi Sea has emanated from the approximately 100,000 line-miles of 2-D seismic that was shot in association with the lease sales of 1988 and 1991, and from the five Chukchi Sea wells that were drilled during that era, Sherwood said. The five wells were called the Popcorn, Crackerjack, Diamond, Burger and Klondike.

To some extent, the 2008 lease sale represented a rerun of the earlier sales, with 172 of the tracts leased in 2008 having been leased previously, Sherwood said. However, companies involved in the 2008 sale did not seem interested in the Brookian plays that had attracted some bids in the previous sales. But Brookian plays in what is referred to as the foreland fold belt, in the southern part of the Chukchi Sea planning area, were excluded from the 2008 sale, he said.

Nor did companies show any interest in plays in older rocks in the northeastern part of the Chukchi.

"What everyone seemed to be going for (in 2008) focused on the plays relating to the Ellesmerian and the Rift sequences," Sherwood said. Almost all of the leases are on extensions of the Barrow Arch, he said.

And 91 percent of the high bids in the 2008 sale clustered around the Burger, Klondike and Crackerjack structures.

"That tells you where the exploration interest is being focused in the Chukchi Sea," Sherwood said. "… They have favorable locations relative to the Chukchi oil generation kitchen and they are large prospects with opportunities that remain untested by existing wells."

And, although the Chukchi wells did not discover any oil pools that people viewed as economic at the time of the drilling, the

continued on next page

wells did encounter hydrocarbons.

So what exactly did the wells find that continues to spark exploration attention? And what might the companies that bought leases in 2008 be looking for?

Burger gas field

The Burger well discovered a major gas field in a 107-foot-thick, rift-sequence sandstone occupying a huge dome-shaped structure, Sherwood said. And part of the Burger structure attracted the highest single bonus bid in the 2008 sale.

"The sandstone was gas saturated with about 86 feet of pay. … Pressure data indicated a possible gas-water contact 415 feet below the depth of penetration of the well," Sherwood said.

The well was abandoned at a depth of 8,202 feet when the drillers lost mud circulation in a tarry rock, he said.

The part of the structure most likely to be productive encompasses an area of 97,000 acres, while the area of the structure delimited by a possible spill point for the reservoir is almost 200,000 acres in extent, Sherwood said. Sherwood said that he and MMS geologist Jim Craig estimated that the Burger structure might contain 14 trillion cubic feet of natural gas, with a possible range from 2 tcf to 63 tcf. The high level of uncertainty in the estimate reflects the fact that only one well has penetrated the structure, he said.

However, if the 14 tcf estimate proved correct, that would represent a substantial increase to the 35 tcf of gas reserves known to exist in the central North Slope, Sherwood said. The Burger reservoir also contains some condensate, he said.

But one intriguing question at Burger is whether there is oil under the gas. The sidewall cores in the well showed a small, residual oil saturation, suggesting that the reservoir may have once contained oil that the gas later displaced, Sherwood said.

"That opens up the possibility of an oil ring or an oil column beneath the gas accumulation at Burger," he said. However, an investigation of the chemical data from the well has failed to either prove or disprove the presence of an oil pool, he said.

"What everyone seemed to be going for (in 2008) focused on the plays relating to the Ellesmerian and the Rift sequences." Almost all of the leases are on extensions of the Barrow Arch, MMS geologist Kirk Sherwood said.

The Klondike prospect

The Klondike well tested a structure on the east flank of the Chukchi Platform, an area on the west side of the Hanna Trough. The well drilled into the lower part of the Sadlerochit Group, the set of Ellesmerian rocks that includes the Ivishak formation; the Ivishak forms the main reservoir in the Prudhoe Bay field. Unfortunately, at Klondike the rocks equivalent to the Ivishak turned out to be barren shales, rather than the sandstone reservoir rocks that are found at Prudhoe Bay.

"This, I think, was very bad news for the concept of exploring for traditional North Slope Ivishak formation reservoirs out here in the Chukchi, on the west side," Sherwood said.

The well did sample some oil and there is further exploration potential around the Klondike structure, Sherwood said. There may be a play where the rocks of the rift sequence thicken around the edge of the structure and there may also be a play in deeper Ellesmerian strata than those tested by the well, he said.

Crackerjack

The Crackerjack well was looking for Ivishak sandstone on the east flank of a huge, 100-mile-long elevated, faulted block, Sherwood said. Unfortunately, the Ivishak turned out to be missing at the well location and the well drilled instead into a lower unit of the Sadlerochit group. And, although Ivishak-equivalent rocks are likely present not too far from the well, experience at the Klondike well suggests that drilling into the local Ivishak would prove futile.

"Probably you don't have a reservoir out there anyway," Sherwood said.

But the well did encounter oil and gas in several sandstones and, as at Klondike, there are some untested exploration possibilities at the prospect. There may be deep Ellesmerian reservoirs below the Sadlerochit Group, and there may also be rift sequence reservoirs on the flanks of the faulted block.

"The well itself penetrated a thin rift sequence but there were no sandstones associated with it," Sherwood said.

But the Burger, Klondike and Crackerjack wells lie right in the area where oil is likely to have flowed into reservoir rocks. And the findings from the Chukchi Sea wells dispelled worries that the rocks might have become overheated as a result of deep burial at some time in the past — that was a big concern during the Chukchi exploration that took place 20 years or so ago, Sherwood said.

"We had a fear, and I think industry to a certain extent shared that fear, that we'd go out there and find a bunch of smoking cinders where our reservoirs ought to be," Sherwood said.

In fact reservoirs like Burger were found to be in pretty good shape, he said.

USGS: *continued from page 25*

logs to infer hydrocarbon-rich rock depths and thicknesses at different locations, Houseknecht said.

And the good news is that the thickest high-gamma-ray concentrations occur along a trend of thermal maturity appropriate for oil generation, he said.

However, a prevalence of carbonate minerals has distorted the gamma ray responses in the Shublik, causing the USGS geologists to resort to a more complex procedure to locate the likely sweet spots in the Shublik source — using data from the Phoenix well, offshore north of the Colville River Delta, USGS is correlating the thickness of the likely prime hydrocarbon-bearing zone of the Shublik across multiple wells.

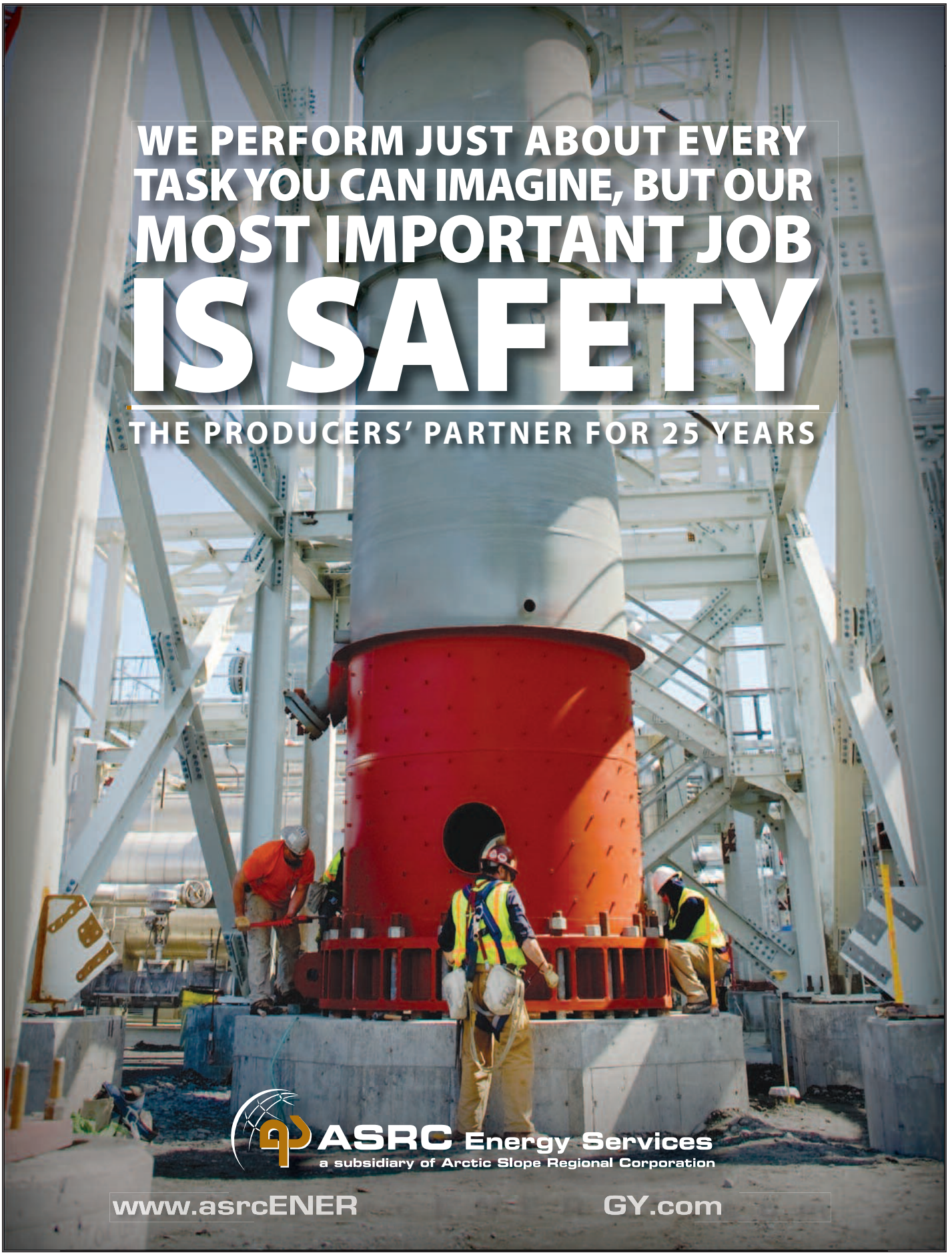
And there is evidence from existing well penetrations on the North Slope that the Shublik is fractured and is brittle enough for fracture stimulation, Houseknecht said.

There's encouragement but quite a bit of uncertainty, he said.

Cook Inlet basin

In the Cook Inlet basin, USGS has already committed to an assessment of conventional resources but is now also assessing coalbed methane resources and potential gas production from impermeable or "tight" gas sands.

Direct gas production from source rocks, in particular from rocks in the Jurassic Tuxedni group, the main oil source for the Cook Inlet oil fields, is also a possibility, although the paucity of well penetrations into this deeply buried rock unit make it impossible at present to make a quantitative assessment of this play, Houseknecht said.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Billions in North Slope leftovers

BY KAY CASHMAN
Petroleum News

There's a common misconception that, with production from major oil fields in northern Alaska declining, the North Slope has become a mature oil and gas province.

While it's true that most of the larger and easier structural plays, particularly onshore, have been drilled, it's also true that many stratigraphic, and some structural, plays have yet to be discovered or tapped, as evidenced by recent exploration and development activities, especially those close to existing oil and gas infrastructure.

Success in the Tarn and Alpine fields in the late 1990s moved exploration attention away from the big Prudhoe Bay-style structures toward stratigraphic traps on- and nearshore the North Slope. At the same time, the Northstar field, largely in state waters and the first Arctic project with a subsea oil pipeline, demonstrated continued success with structural reservoirs.

In general terms, people widely recognize the petroleum systems of northern Alaska as hydrocarbon-rich but reservoir-poor. So, with an abundance of excellent source rocks and a relative shortage of reservoir-quality rock formations, any isolated stratigraphic trap — a hydrocarbon trap formed by the juxtaposition of reservoir and seal rocks in the rock strata — stands a good chance of containing oil or gas.

Thanks to sustained high oil prices, new found capabilities of high-end 3-D seismic techniques to find stratigraphic traps, the use of horizontal drilling, including the latest advancements in hydraulic fracturing, improved the ability to produce from low permeability reservoirs, so more North Slope accumulation became economic to produce.

"Finding new oil with conventional ideas is good (nothing wrong with a nice Sadlerochit play like, say, Northstar)," former Division of Oil and Gas Director Ken Boyd told Petroleum News in an April 2011 e-mail.

But, he said, "Finding new oil with new ideas is even better. The reason

continued on next page

JUDY PATRICK

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

being that new ideas open up new areas to exploration. Badami led to all the new exploration just west of Kuparuk. The lease sales we held after the Badami discovery prove that; lots of new leases on old shelf edges (which is where you find turbidites). Same with Alpine. The discovery of the Alpine sand (not a turbidite but a new play) is what enabled me to go to Shively and Knowles (at the time John Shively was commissioner of the Alaska Department of Natural Resources, of which the division is a part, and Tony Knowles, a Democrat, was governor) to push getting NPR-A open again. To their credit they did it (and that was a tough sell during the Clinton administration)."

Mark Myers

Classic North Slope plays

The classic North Slope oil and gas plays occur along a structural high known as the Barrow Arch under the Beaufort Sea coast of the North Slope. These plays originated from the discoveries of oil fields like Prudhoe Bay and Kuparuk River many years ago.

The Prudhoe Bay field consists of a giant combined structural and stratigraphic trap involving Triassic sandstone reservoirs in a Mississippian to lower Cretaceous sequence of sediments known as the Ellesmerian sequence.

Companies are still looking for opportunities in the Ellesmerian, especially near existing oil and gas infrastructure, where there are numerous such structural plays.

The reservoirs for the Kuparuk River field involve sandstones in what's called the Beaufortian or Rift sequence of Jurassic or lower Cretaceous age — the deposition of the sandstones is associated with rifting or pulling apart of the Earth's crust that occurred during the opening of the Canada basin of the Arctic Ocean.

Although some of the Beaufortian sands can be thin and discontinuous, other areas of more continuous sands give rise to large reservoirs.

Basically, you get a huge range of potential sizes in the same rift breakup sequence but there are a lot of plays in the 20 million to 70 million or 80 million barrels size.

"There are still plays in the 300 million, 400 million or 500 million to a billion-plus size — they're still out there, but they're almost all stratigraphic," Mark Myers, former director of Alaska's Division of Oil and Gas and the U.S. Geological Survey, recently told Petroleum News.

Success with Alpine, the main field in the Colville River unit that came online in 2001, and its Beaufortian Jurassic sandstone reservoir, spurred interest in similar Jurassic plays. There is a series of upper Jurassic sands just below the Alpine sands: "There's at least a billion barrels in place, we think, in that trend," Myers said.

Companies are still looking for opportunities in the Ellesmerian, especially near existing oil and gas infrastructure, where there are numerous such structural plays.

Because of the low permeability of the reservoirs in the Alpine play the gravity of the oil really impacts the ease of oil production. And the oil gravity depends on which of the multiple source rocks in the area generated the oil.

"The source rock's critical and often you get multiple source rocks in a given area," Myers said. "If you look at the Tarn play on the west side of Kuparuk you've got 38-to-37 API gravity in close proximity of 26-to-22 gravity in Kuparuk, because of changes in the sourcing."

Brookian stratigraphic plays

There is a major Cretaceous and Tertiary sequence of petro-

continued on next page

leum bearing sedimentary rocks above the Ellesmerian and Beaufortian sequences in northern Alaska. Known as the Brookian sequence, this younger rock sequence extends all the way from the northern edge of the Brooks Range out over the North Slope and across the continental shelves of the Beaufort and Chukchi seas.

Stratigraphic plays involving topset or turbidite strata in submarine fans typify this Brookian sequence.

"Some of the … submarine fans are very large," Myers said: "If you had reservoir quality and if you had closure you could approach the billion-barrel mark in some these if you had structural fill."

Then there are other situations where you may find smaller fans with as little as 20 million barrels of oil and where several smaller fans stack together the combined volume of oil could reach around 100 million barrels.

However, production problems in the eastern North Slope Badami field (see page 42) have shown that the Brookian plays aren't without risk. And compaction of reservoir rocks at depth may prove problematic.

"But there are some good looking fans as well," Myers said. Some of the younger Brookian sandstones contain particularly clean sand because they've reworked older sediments.

Because the Brookian sequence tends to overlie Beaufortian or Ellesmerian rocks, there are opportunities to explore for situations where there is more than one play at the same location. Brookian plays may dominate the coastal plain of the Arctic National Wildlife Refuge's 1002 area, at the eastern end of the North Slope — Myers concurs with a USGS assessment that the Brookian sequence probably contains the preponderance of oil in that area. However, a couple of intriguing structural trends in the northeast of the ANWR 1002 area include potential Kuparuk-style plays. And Ellesmerian plays occur in thrust sheets along the front of the Brooks Range.

Brooks Range Foothills

Geologists have long considered the Brooks Range foothills, in the southern part of the National Petroleum Reserve-Alaska and extending east to the Dalton Highway, to be a gas prone province.

Myers thinks that reservoir quality will prove critical in locating gas fields in this area: "When you look at it there's a lot of oil-stained rock in outcrop, so the question is 'can you find enough effective porosity and permeability to make good gas reservoirs?'"

Rock units such as the Cretaceous Fortress Mountain formation and the Lisburne dolomites that outcrop in the foothills probably have enough porosity for gas. However, other rock formations that have been buried to relatively shallow depths exhibit better reservoir characteristics.

Ken Boyd

And in the foothills some rocks, probably from less deeply buried strata, provide evidence of reasonable thermal maturity for oil, Myers said. There is, in fact, a known oil field being evaluated by Renaissance Alaska at Umiat, about halfway down the eastern side of NPR-A on the northern side of the foothills, which might see five appraisal wells drilled in the winter of 2011-12, if the company can find funding.

The prospect has 37 degree gravity oil, and targets formations between 200 feet and 1,500 feet, with the upper portion of reservoir in permafrost. Development, which is chal-

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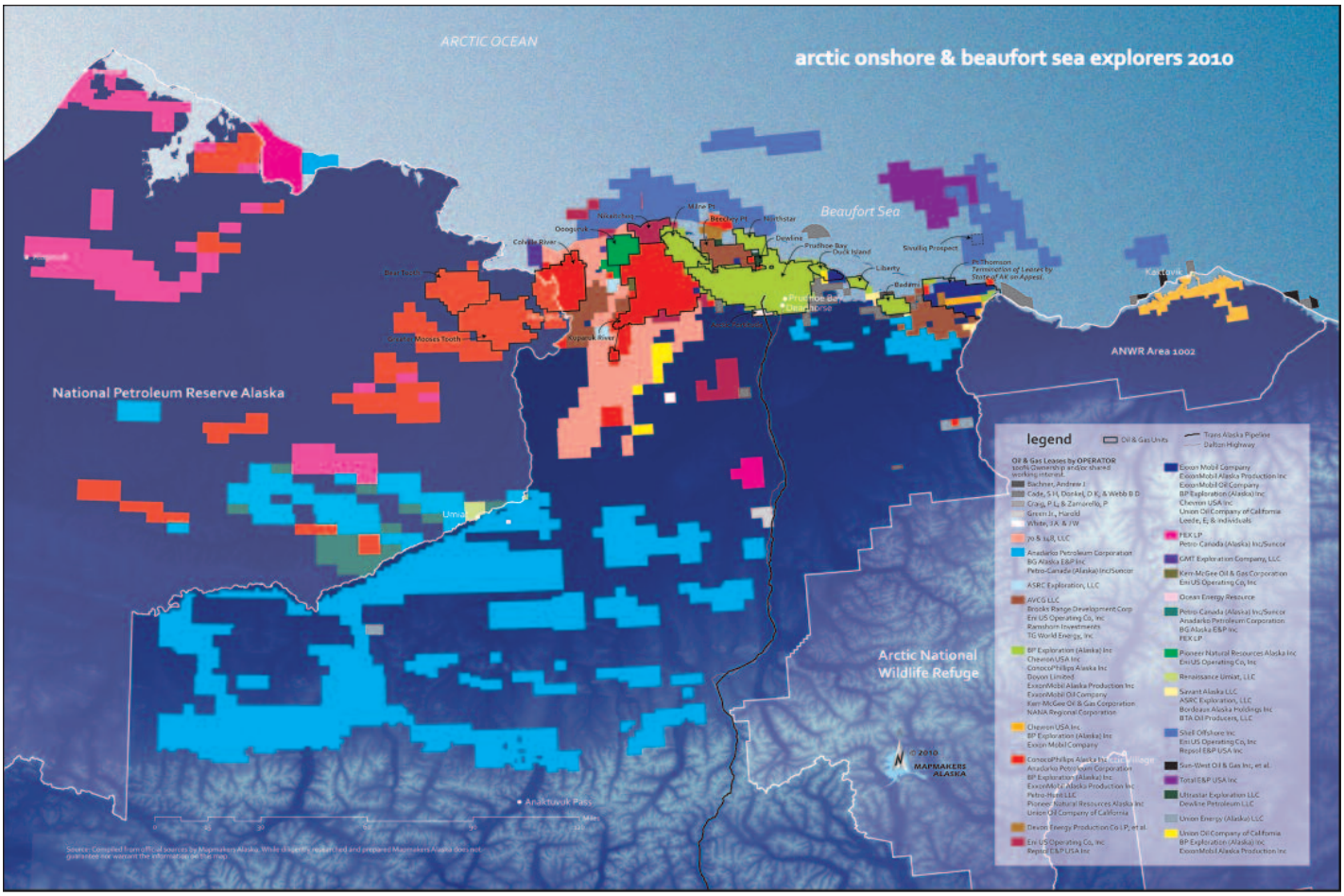

lenged by lack of year-round access, will likely require a 110 mile buried pipeline to the trans-Alaska oil pipeline.

Good news for the area: The State of Alaska has been moving ahead with the permitting of a road west from the Dalton Highway to Umiat.

National Petroleum Reserve-Alaska

ConocoPhillips with its partner Anadarko Petroleum has been spearheading exploration and development west from the Colville River Delta, at the western extremity of existing North Slope oil infrastructure, into the northeastern part of NPR-A.

A series of wells drilled in the area by the partners since the renewal of leasing in NPR-A in 1999 have tested Alpine-equivalent prospects and have yielded discoveries of light oil, conden-

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The North Slope is home to nine fields with production facilities: Alpine, Badami, Endicott, Kuparuk (pictured here), Milne Point, Nikaitchuq, Northstar, Point McIntyre/Lisburne and Prudhoe Bay. Third-party explorers want to be able to lease space in that infrastructure at a reasonable price to keep from having to build new facilities that might make small prospects uneconomic. Some explorers are turning to BP and ConocoPhillips, operators of all but one of northern Alaska's production facilities, but others such as Brooks Range Petroleum Corp., or BRPC, are looking for less expensive options, such as smaller-scale, skid-mounted production systems — what BRPC calls "micro-processing units," that can handle in the neighborhood of 5,000 barrels of oil a day. For larger groups of prospects in an area, BRPC is looking at building new regional processing facilities. Read Petroleum News online at www.petroleumnews.com for more information. The latest comprehensive article about facility access can be found at http://www.petroleumnews.com/pnads/75073419.shtml.

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sate and gas in stratigraphic traps, overlooked before the advent of 3-D seismic imaging.

The accumulations can be viably developed by extending the oil pipeline infrastructure west from their Colville River unit, which contains the first North Slope fields developed exclusively with horizontal well technology.

The unexpectedly prolific sands at Alpine, discovered in 1994 and put online in 2000, opened the door to extending a new Beaufortian play beyond the Prudhoe-Kuparuk infrastructure. The concept is to progressively move farther and farther west into NPR-A, opening up new oil pools as access to the pipeline infrastructure becomes available.

But progress has currently come to a halt because the U.S. Army Corps of Engineers has refused to permit the construction of an access bridge across the Nigliq Channel of the Colville River. Operator ConocoPhillips says that it needs this bridge to develop the NPR-A fields, the first being the Alpine West satellite, from its CD-5 drilling pad.

ConocoPhillips, Anadarko and others have also explored much farther west in NPR-A, but viable oil and gas development at such large distances from existing oil infrastructure would require a major oil find of at least 1 billion barrels.

If Shell, ConocoPhillips, Statoil and others develop their Chukchi Sea leases 100 miles offshore NPR-A, about 150 miles west of Barrow, a subsea oil pipeline would likely be brought to shore at the village of Wainwright in the remote Northwest Planning Area of NPR-A, and then run through the petroleum reserve and on to Pump Station 1 at the central North Slope's Prudhoe Bay field.

A pipeline across NPR-A would open up the petroleum reserve, making it economically viable to drill a number of the larger accumulations there.

Ice road construction in northern Alaska.

Sea change for two majors

Back near the core area of the central North Slope, the high-performance Beaufortian reservoir of the ConocoPhillips Palm discovery on the western edge of the Kuparuk field led to the construction of a new drill site and expansion of the Kuparuk River unit in 2003. A number of satellites were also being developed at Prudhoe by unit operator BP.

By 2002, both BP and the newly merged ConocoPhillips, which had picked up ARCO's Alaska assets two years earlier through Phillips, had begun concentrating on finding "new" oil in their legacy assets in the state.

BP sold or dropped all its exploration leases, starting in 2001, except its leases in the 1002 area of ANWR, where it and Chevron had drilled the KIC well but were not allowed to continue drilling because the region was subsequently closed to development by the feds.

ConocoPhillips was still exploring, but on federal acreage onshore and offshore, looking for big fields and dropping its state exploration acreage. Over the next decade it dropped even its Beaufort Sea federal

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Pioneer's Oooguruk field, the first independent-operated oil field in northern Alaska.

ENS pearls about to be strung

Leaseholders prepare to explore, develop eastern North Slope as Badami, Thomson plans solidify

Badami, the easternmost developed field on the North Slope, has been restarted, thanks to the combined efforts of partners Savant Alaska and ASRC. Photo taken summer 2008.

BY KAY CASHMAN
Petroleum News

It has been more than 20 years since Division of Oil and Gas officials coined the phrase "string of pearls" for the infrastructure-led exploration of Alaska's eastern North Slope. It has taken two more decades for the "string" — a metaphor for new pipelines — to come close to making its way from Pump Station 1 of the trans-Alaska oil pipeline at Prudhoe Bay to the Sourdough discovery on the border of ANWR's 1002 area, some 70 miles east as a goose flies.

The 1002 area is a narrow strip of the coastline of the Arctic National Wildlife Refuge that was set aside for development by Congress because of its hydrocarbon-rich geology. Between it and Endicott are numerous on- and offshore discoveries, several of which are thought to hold upwards of 100 million barrels of oil.

First 'pearl' problematic

The first "pearl" on the string, BP's Badami oil field, came online in 1998, its 22-mile pipeline, or "string," connecting it to the Endicott field in the Duck Island unit, until then the farthest east development along Alaska's northern coast.

Although the 35,000-barrel-per-day line was supposed to be nearly filled by 30,000 bpd from Badami at its peak, the line was expandable, and its corridor would allow for a second and larger pipeline if needed.

Within a year of starting production at Badami, BP with several partners was drilling the Red Dog prospect, its next pearl to the east, between Badami and the undeveloped Point Thomson unit, which was operated by ExxonMobil, and of which BP was a sizable owner.

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This photo, taken in 2009, shows ExxonMobil's Point Thomson unit which has several leases that run along the Staines River, across from the 1002 area of ANWR.

Unfortunately, BP was unable to finish the Red Dog well before the winter drilling season ended.

It was also experiencing serious problems at Badami. While early production had ramped up, as expected, to 18,000 bpd, by early 1999 it had dropped to a mere 3,000 bpd.

One of the challenges in developing the field — a known risk going in and part of the reason the capacity of Badami's pipeline was reduced from 70,000 to 35,000 bpd — was the question of whether its pockets of oil-bearing sands, or channels, would "communicate" so that oil would move from one to the next and into the vertical wellbores.

Published descriptions of Badami's Brookian accumulation suggest its reservoirs are complex, consisting of 61 identified fans laid down during seven depositional events, with thin and discontinuous reservoir-quality sands.

Following a series of startups and stops, and a great deal of effort to get the reservoir to perform, BP shut down Badami and its pipeline for the last time in 2007, with production at 900 bpd.

Savant steps in

In 2008, BP entered into an agreement with Savant Alaska, a subsidiary of Denver-based Savant, to bring Badami back into production using horizontal well technology and possibly advanced hydraulic fracturing techniques. Savant and its minority partner ASRC Exploration, agreed to drill two wells in the unit as part of a deal that would eventually give them working interest in key leases and leave BP with an overriding royalty interest. One of the wells was an exploration well in the untested Red Wolf satellite, and the other a new horizontal sidetrack to one of the original vertical producing wells in the unit.

Both wells were drilled and Badami went back online in November 2010. In early April production from five of six wells was at about 1,600 bpd with the last well expected to go online before the end of April.

Savant's goal is to bring production to 4,000 bpd with those six wells. Its plans include hydraulically fracturing the Killian formation in the vertically drilled Red Wolf well in mid-2011 and improving oil flow in the Brookian by hydraulic fracturing its new horizontal well in 2011 or 2012. (Hydraulic fracturing has been tried before at Badami, but only on vertical wells.)

The powers that be at BP are obviously willing to bet Savant Alaska is going to be successful at keeping the Badami unit in continuous production because last fall BP Transportation (Alaska) filed a tariff revision for the unit's pipeline with the Regulatory Commission of Alaska that drops the rate from $26.09 to $7.26 per barrel of oil — a rate RCA approved.

Still, $7.26 per barrel is more than the combined cost of shipping oil from Endicott to Pump Station 1 and then down the 800-mile trans-Alaska oil pipeline to Valdez, where it's loaded on tankers for delivery to the U.S. West Coast. According to Greg Vigil, executive vice president of Savant Alaska, BP's Badami tariff needs "to be at a level that provides the pipeline owners with enough revenue to cover their expenses, amortize their investment and make a profit."

That said, the last time BP tried to find farm-in partners for Badami satellites (pre-Savant and minority partner ASRC), it

continued on next page

promised to drop the rate to $1 per barrel once throughput reached 18,000 bpd.

Close to settling

Even if Savant is not successful at keeping the Badami unit online, the Badami pipeline would likely be available to transport 10,000 barrels of oil and natural gas condensate starting in 2015-16 from the Point Thomson unit, which has several leases that run along the Staines River, across from the 1002 area.

Too long of a story to tell here, basically the Point Thomson unit was formed in 1977 and is currently bound up in a court fight with the State of Alaska, which is trying to break up the unit and reclaim the acreage.

But even as the legal struggle continues, lawyers for the state and the leaseholders are reportedly drawing close to a settlement — a settlement that will require operator ExxonMobil to finish developing phase one of its 10,000 bpd oil and condensate development, which includes a common carrier 70,000 bpd liquids pipeline to Badami. (A recent Petroleum News story is online at www.petroleumnews.com/pnads/77062310.shtml and a brief history of the unit can be found at www.petroleumnews.com/pnads/12414258.shtml.)

A possible hold up: As of April 10, the U.S. Corps of Engineers was about eight months behind schedule for its record of decision on the environmental impact statement for Point Thomson, which caused the Exxon to change its production start date from 2014 to 2015. Once the decision has been signed — estimated by the agency to occur in March 2012 if there are no other delays — other critical permits should follow within short order.

New unit proposed

In anticipation of all the stars aligning for Point Thomson, one major leaseholder in the area has put together a 200,179-acre unit, Greater Bullen, that includes 68 leases between and south of both Point Thomson and Badami.

A map of the proposed unit, which was filed with Alaska's Division of Oil and Gas by independent Brooks Range Petroleum Corp. on March 29, can be found online at www.petroleumnews.com/pnfm/GBUExhibitG.pdf.

Greater Bullen working interest owners include Anadarko Petroleum, Arctic Slope Regional Corp., BG Alaska, TG World Energy, Ramshorn Investments and Alaska Venture Capital Group, or AVCG. Brooks Range Petroleum Corp., or BRPC, is the operating arm of the last three companies, a subsidiary of AVCG.

In its unit application BRPC said it has identified "many potential hydrocarbon accumulations and additional prospects" within the unit. The two most notable are Friezen (main prospect in the former 14-lease, 79,508-acre BP Slugger unit) and Red Dog. (Note: BP stopped exploring in Alaska in 2001.)

Depending on the source, Red Dog was estimated to contain 45-85 million (P-50) barrels of recoverable oil. BP estimated Slugger contained some 280 million barrels of oil, but did not quote a number for recoverable reserves.

Initially, BRPC is looking at two 3-D seismic surveys over Greater Bullen, and then, beginning in 2017, drilling a well in each of the unit's four exploration blocks — north, south, east, west.

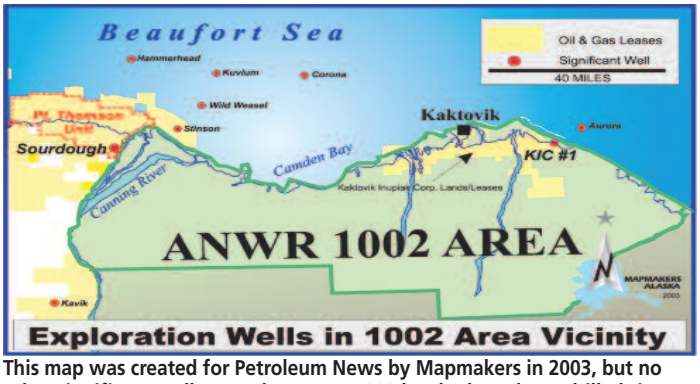
Eastern North Slope prospects

A few other eastern North Slope prospects that are likely to be drilled if the Point Thomson development moves forward include the following:

- Kuvlum-Lonestar, actual Kuvlum leases not held. Shell's 2005 bid for the two Kuvlum discovery leases (with three ARCO wells) just east of Sivulliq was rejected by the feds because the bid was too low. Shell did not bid on Kuvlum leases again, but its undrilled Lonestar prospect is adjacent to Kuvlum leases. Per feds Kuvlum reserves range from 160-300 million barrels of oil.
- Stinson, operated by Donkel Oil & Gas, directly east of Point Thomson, north of ANWR 1002 area in Camden Bay surrounding ARCO Stinson No. 1 discovery well. Per the operator, the Tertiary horizon contains 150 million barrels of oil (probable recoverable reserves) within a single 100-foot thick sand (P90: 80 MMBO; P10: 420 MMBO). Reserves for the basement are currently under assessment.
- Yukon Gold, operated by Savant, and adjacent to ANWR's 1002 area. Per State of Alaska, recoverable reserves are120 million barrels of oil. Discovery well: 1993 BP's Yukon Gold No. 1.

Shell is planning to drill up to two Beaufort wells in the open water season of 2012, with or without the Point Thomson pipeline, including its most well known prospect, Sivulliq, formerly named Hammerhead. One of those two wells might be at its nearby Torpedo prospect.

Tapping ANWR from Pt. Thomson



This map was created for Petroleum News by Mapmakers in 2003, but no other significant wells near the ANWR 1002 border have been drilled since that time.

BY KAY CASHMAN
Petroleum News

Although the settlement between the State of Alaska and the Point Thomson unit leaseholders is not expected to include a commitment to produce the Sourdough oil discovery in the unit, a new plan of development will likely do so because there are 100 million barrels of recoverable oil at Sourdough, which sits across the Staines River from the 1002 area of the Arctic National Wildlife Refuge.

Geologists think Sourdough's reservoir stretches under ANWR's 1002 area and, if produced, could drain federal oil from the other side of the river. (The Sourdough discovery well is roughly a half mile from the 1002 boundary.)

Legal experts say the feds would have no claim to the oil because they are not allowing development of their adjacent acreage in ANWR.

Hence, since the Sourdough discovery announcement in 1997, state officials have been saying developing the prospect could be the first step to opening the 1002 area to oil and gas exploration and development.

Putting Sourdough into production might prompt Congress to permit a subsurface lease sale in the ANWR 1002 area that would allow directional drilling from adjacent state lands and waters.

Rule of capture prevails

In 1997, Petroleum News asked the chairman of the Alaska Oil and Gas Conservation Commission if the federal government would be able to claim correlative rights if Sourdough was developed — correlative rights would give the feds taxes and royalties on ANWR 1002 oil pumped from Sourdough.

The answer was no. Correlative rights, which AOGCC enforces, do "not protect against drainage," the chairman said. The rule of capture would prevail.

What correlative rights do is ensure adjacent landowners have "the opportunity to extract their fair share of the resource," he said. If a landowner does not wish to drill on his side of the property line, that's his choice.

"The federal government does not have to lease this land. Nobody is compelling them to lease it." But if the feds do not lease the 1002 acreage that is adjacent to Sourdough, then the "rule of capture applies," the chairman said.

The rule of capture is the same federal law that applies to the ownership of a wild horse that roams across several property lines — whoever captures it, owns it, he said.

Attorneys interviewed by Petroleum News agreed, as did a 2003 article in Duke University School of Law's Alaska Law Review, which said, "The owner of the drained land has no legal remedy, but may protect his rights by drilling a well of his own in order to capture the same resource."

But the commission chairman and Robert Corbisier, author of the law review article, said there was also a possibility of AOGCC forcing unitization of Sourdough, and including ANWR acreage in the unit — something the agency might have to do under its legal mandate to prevent the waste of oil and gas resources.

NORTH SLOPE LEFTOVERS: *continued from page 40*

leases and pulled back from wildcat exploration in NPR-A, concentrating on its step-out development of the Colville River unit into NPR-A and pulling more oil out of its existing fields. It looked to its federal leases in the Chukchi Sea for its next major oil discovery in Alaska.

This shift in strategy left northern Alaska wide open to independents and majors alike looking for new opportunities in the state.

Anadarko Petroleum was one of the first, beginning major acquisitions the late 1990s, and already a partner with ConocoPhillips in the Alpine field. Canada's Alberta Energy (AEC Oil & Gas), now EnCana, was another.

Kevin Banks

The November 2000 state areawide lease sales for the North Slope and Beaufort Sea saw the first significant influx of independents, with numerous winning bids from Anadarko, AEC and newcomer AVCG LLC of Kansas, which had already entered the state with the acquisition of two of Alfred James III's leases.

AVCG eventually formed an operating arm, Brooks Range Petroleum Corp., or BRPC, and brought in former ARCO Alaska President Ken Thompson, who returned to live in Alaska in 2000.

Long-time senior vice president of ARCO Alaska, Jim Weeks, joined Winstar Petroleum that same year. Alaska-based Winstar had already acquired 12,000 acres on the North Slope as Petersburg Energy LLC. The leases were close to infrastructure and processing facilities, as were those of AVCG.

Eventually impediments to North Slope development by companies other than BP and ConocoPhillips, which operated all the infrastructure on the North Slope, began to disappear — some through litigation, such as the eventual lowering of the tariff through the 800-mile trans-Alaska oil line — and some because BP's and ConocoPhillips' interests were elsewhere.

And then comes Armstrong

In October 2001, Armstrong Oil and Gas, a Denver independent, bought its first leases in the state's areawide North Slope and Beaufort Sea lease sales, leading to the development of the first independent-operated oil field in northern Alaska, Oooguruk, and the first processing facilities not operated by BP or ConocoPhillips, the Eni Petroleum-operated Nikaitchuq field, which came online this year. (Oooguruk's crude is processed at the nearby Kuparuk River unit, which has spare capacity.)

Sean Parnell

Armstrong sold its northern Alaska assets to Eni, and turned to developing a gas field on the Kenai Peninsula, which also just came online.

But it returned to the North Slope and just recently brought Spanish mega-major Repsol in as a 70 percent partner to help it explore and develop nearly 500,000 acres on state leases on- and nearshore. Repsol paid $768 million for the privilege, with about $750,000, Petroleum News sources say, going to be used for exploration, starting with next winter's off-road drilling season, 2011-12.

Lots of room for newcomers

There is still lots of room for newcomers, per Kevin Banks, the current director of the Division of Oil and Gas — and some incredible exploration and development credits available.

"The State of Alaska takes seriously our responsibilities to our leaseholders. We encourage exploration through innovative new programs, paying as much as 40 percent of exploration costs for qualified applicants, and we share our insight into how state and federal agencies interact to help companies navigate smoothly through exploration and development activities. Alaska is a resource development state. We view the people and companies exploring and developing our natural resources as our partners," Banks said in a recent editorial aimed at oil and gas companies interested in entering Alaska, or investing in those that are already here.

The division has a staff of 95 "highly specialized technical experts" who work in asset teams, one of which is the Resource Evaluation section, which Banks said works with "potential investors to give technical briefings and share their knowledge and non-confidential public domain data. …

"The Division of Oil and Gas mission statement says we manage 'oil and gas lands in a manner that assures both responsible oil and gas exploration and development and maximum revenues to the state.'"

"Our goal is to support any responsible company that shares this mission," Banks said. "We want to see you succeed, because when you're successful, so are we."

Governor's goal: 1 million barrels a day

Industry thinks the state's progressive production tax regime has some problems, especially for the legacy field owners. But the tax, commonly referred to as ACES, also takes a lion's share of net profits when oil prices are high, in the $100-plus range. It's very competitive when prices are low, which is where they were when the new production tax was established in 2007.

Alaska's Republican governor, Sean Parnell, is determined to get northern Alaska production back up to 1 million barrels a day from its current 600,000-plus barrels. He sees lowering the progressivity tax rate and adding even more incentives for explorers and developers as key to that effort. Industry agrees and has wholeheartedly backed him.

The Parnell administration is currently championing a tax change bill, which recently passed the House of Representatives, but is still facing challenges in the Senate; challenges that likely won't be resolved until the Alaska Legislature reconvenes in January 2012.

Optimistic about the long term

Myers feels optimistic about the long-term future of the oil industry in northern Alaska.

"I think we'll see just a tremendous amount more oil produced, especially from the stratigraphic plays over time," he said. "I think someone will stumble into that 500 million to a billion barrel field size."

And where is that next big find on state acreage?

In 2005, Myers said, "In the long term if I were to bet on a big prospect, the Brookian stratigraphic plays are where I'd put my money."

In 2011, he also included shale oil (see shale section).

Editor's note: Learn more about the division from its website at http://www.dog.dnr.state.ak.us/oil/ Or contact its office: 550 W. 7th Avenue, Suite 800 & 1100; Anchorage, Alaska 99504. Phone: 907-269-8800.

The Hunt for MINERALS

Following in the steps of early gold seekers, such as this sourdough taking a pause from feeding gravels into his sluice, provides a glimpse of Alaska's vast mineral wealth.
Courtesy of Alaska State Library, Skinner Foundation photograph collection

Fortune awaits 21st Century explorers

Following the steps of early gold seekers provides a glimpse of Alaska's vast mineral wealth

BY SHANE LASLEY
Mining News

At the close of the 19th Century gold enticed fortune hunters from around the world to Alaska, a rugged and sometimes harsh land at the forefront of western expansion. Today, this Far North state, considered by many as the most mineralized province on Earth, continues to attract explorers seeking the yet to be discovered mineral riches of America's Last Frontier.

The Arctic weather, rugged terrain, limited infrastructure and high exploration costs that challenged Alaska's early gold seekers are still in – a situation that has helped keep the state's vast mineral potential at the edge of exploratory expansion.

"It is the same sort of geology as far as we know right now. It is one of those unusual type granites that tend to have these types of elements in them – uranium, thorium and the rare earths," explained Alaska Department of Natural Resources Division of Geological & Geophysical Surveys Senior Minerals Geologist Dave Szumigala.

"Alaska hasn't experienced near the amount of exploration that has taken place in British Columbia and the Yukon (Territory)," according to Millrock Resources Ltd. Vice President of Exploration Phil St. George.

Though the Far North state is regarded as largely unexplored, it has given up several world-class deposits over the past 20 years. Among these recent finds are two world-class deposits St. George was involved early on; Pebble, which is estimated to contain 80.6 billion pounds of copper, 107.4 million ounces of gold and 5.6 billion pounds of molybdenum, and the 40 million-ounce Donlin Creek gold project.

Geologists familiar with Alaska expect that more outstanding deposits lay hidden just below the surface of the vast and underexplored state.

"The thing about Alaska is there are a lot of low-lying areas out there that are covered with vegetation, glacial gravels and things that haven't been explored thoroughly, or at all," St. George explained. "I, and others, think there is a lot of potential to find other Pebbles, other Donlins, other huge gold systems."

These huge systems are not just found in remote and logistically challenging regions of the state. A stone's throw away from the road running north from Fairbanks to the oil fields of Alaska's North Slope, International Tower Hill Mines Ltd.'s nearly 20-million-ounce gold deposit at Livengood is one such find.

First gold in Southeast

Alaska's mineral potential was recognized in 1880 when Auk Chief Kowee, a Tlingit from Admiralty Island, led prospectors Joe Juneau and Richard Harris to the headwaters of the appropriately named Gold Creek. This find near what would later become the state's capital brought a surge of gold seekers, who, over the following two decades, would make gold strikes over

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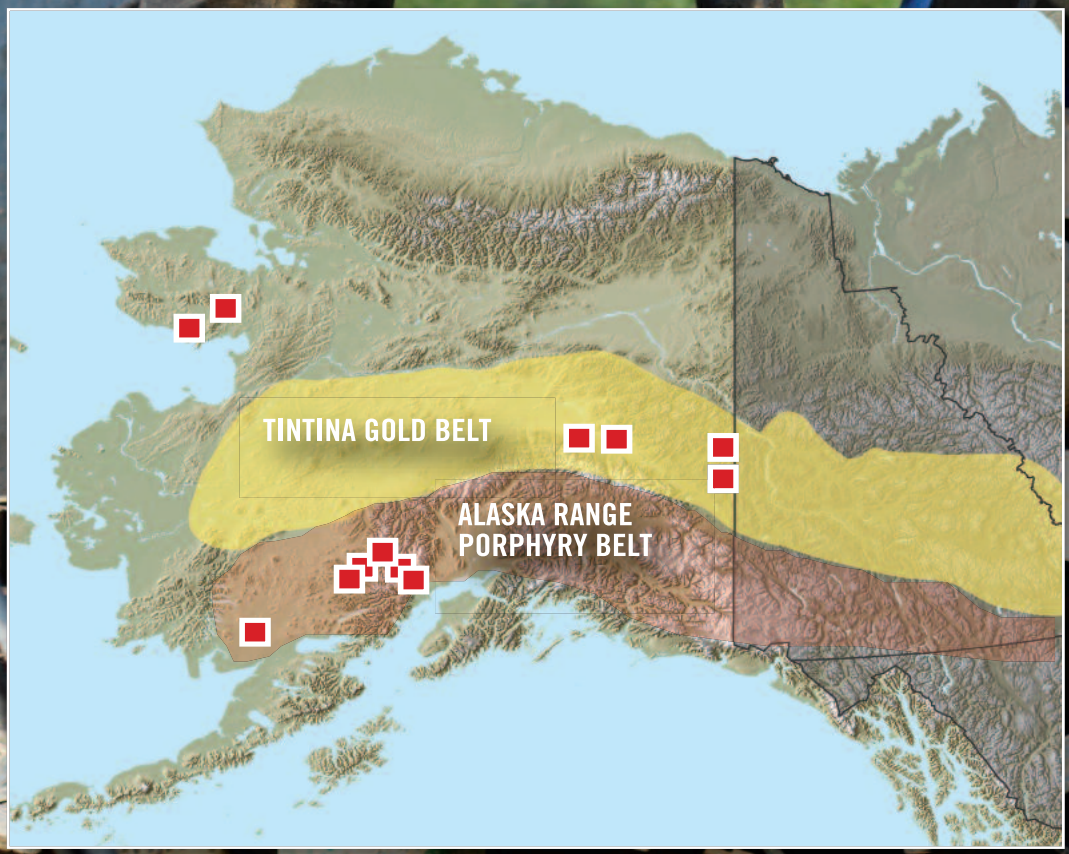

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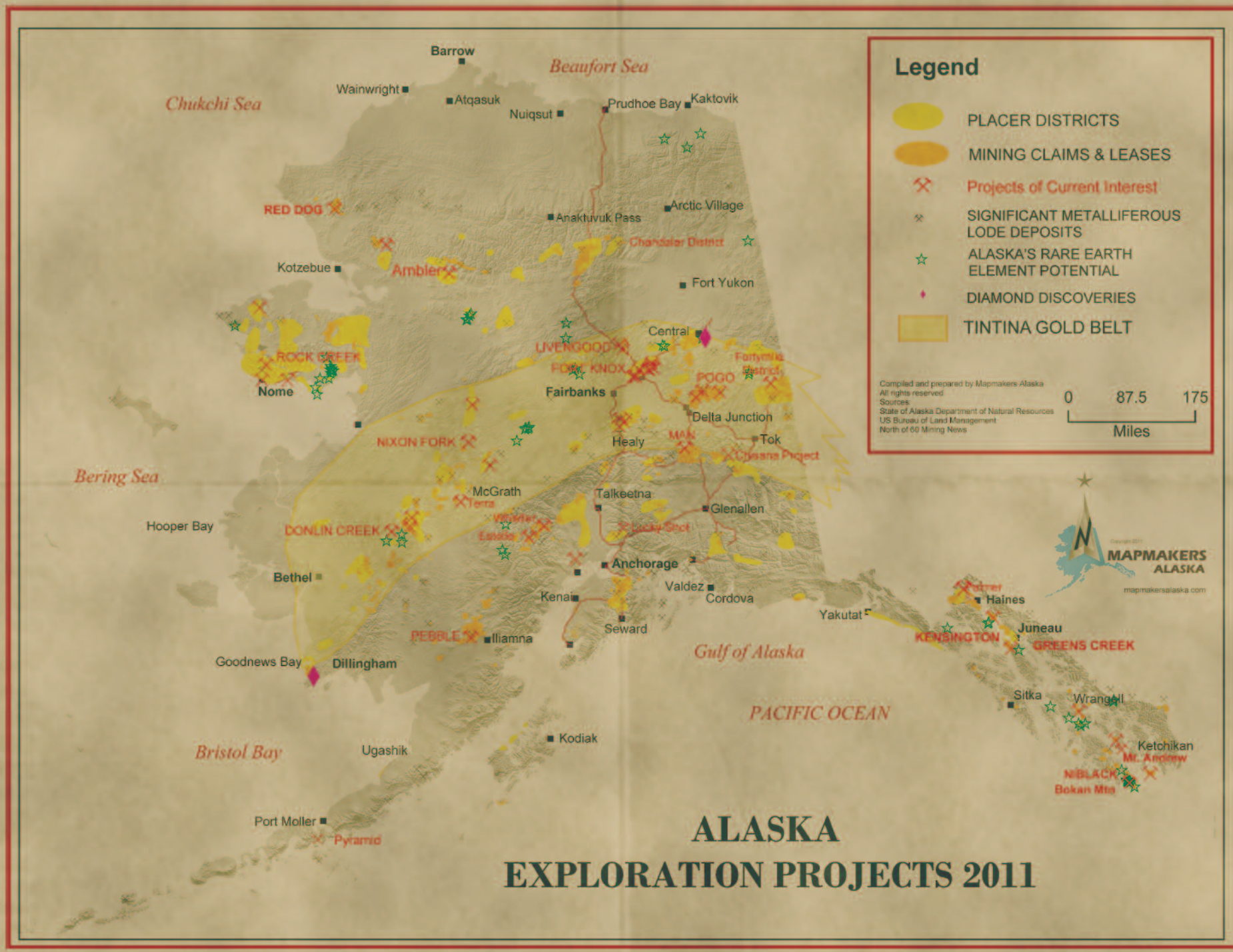

ALASKA
EXPLORATION PROJECTS 2011

the entire state.

A year after the find by Juneau and Harris operations began at the Treadwell gold mine located southeast of Juneau. At its peak, Treadwell employed 2,000 Juneau residents and was the largest gold mine in the world. From 1881 to 1922, more than 3 million troy ounces of gold were extracted from the mine.

Following this initial discovery near Juneau, prospectors spread out over the entire length of the Southeast panhandle, finding not only rich deposits of gold, but also palladium, silver and copper. This heavily mineralized region of Alaska continues to give up significant deposits.

A 450-mile-, or 725-kilometer-, long belt of late-Triassic volcanogenic massive sulfide deposits stretches along the panhandle encompasses such metals-rich deposits as Niblack, Greens Creek, Palmer and, as the belt continues into British Columbia, Windy Craggy.

Anchored by Bokan Mountain to the south, 350-mile-, or 560-kilometer-, trend of more than two dozen rare earth element prospects covers much of the same area of Southeast Alaska.

Explorers find Tintina

Trekking into Alaska's interior fortune hunters made the next big gold strike in the Fortymile District at the eastern extent of Alaska's 109-million-acre portion of the Tintina Gold Belt, a rich gold province that arcs across the breadth of the state.

Two of the three operating gold mines in Alaska (Kinross Gold Corp.'s Fort Knox Mine and Sumitomo Metal Mining's Pogo Mine) as well as International Tower Hill Mines' Livengood project are all found in this eastern region of Interior Alaska.

Since the vastly rich deposits of placer gold were discovered

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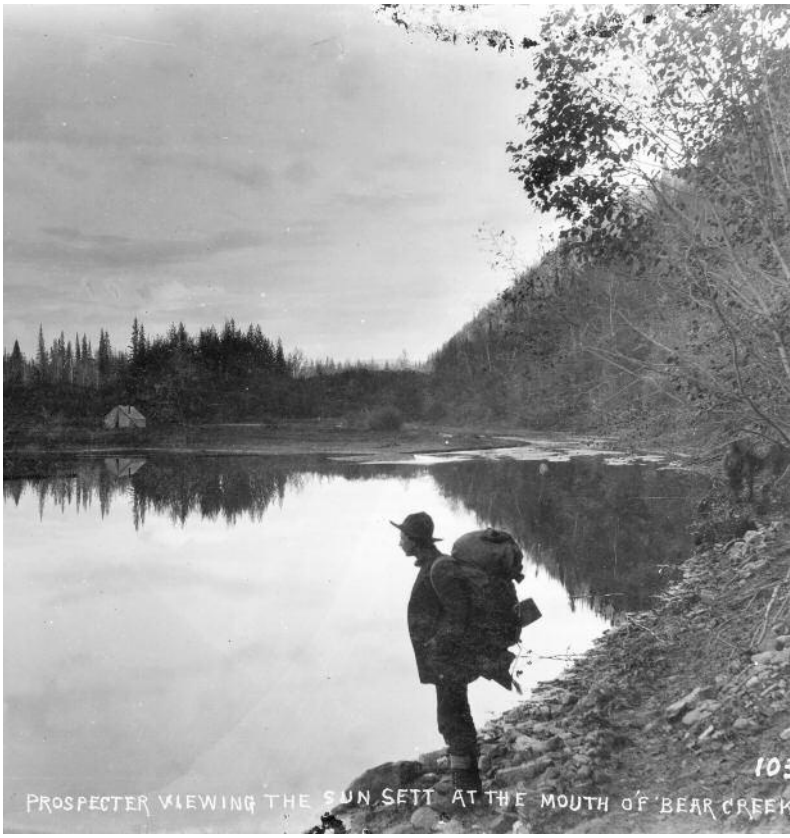


This prospector gazing at the mouth of Bear Creek in Interior Alaska is one of tens of thousands of fortune hunters that canvassed Alaska in search of gold at the turn of the 20th Century. Photo by Eric A. Hegg, courtesy of Alaska State Library, P. E. Larss Photograph Collection

on the gravel bars of the Fortymile River in 1886, more than 12 million ounces of alluvial gold have been recovered from the eastern half of the Tintina Belt, but the lode source of many of the historic mining districts has yet to be found.

Beyond Livengood, the Tintina Gold Belt arcs to the southwest. A 400-mile- or 645-kilometer-long belt of gold-rich terrain known as the Kuskokwim Gold Belt dominates this western extent of the Golden Arch.

Donlin Creek — being developed by Barrick Gold Corp. and NovaGold Resources Inc. — is the crown jewel of the Kuskokwim. Over the past several years, majors and junior explorers alike have scoured this region in search of other large intrusive-related gold deposits, uncovering several promising prospects.

"Alaska hasn't experienced near the amount of exploration that has taken place in British Columbia and the Yukon (Territory) –Millrock Resources Ltd. Vice President of Exploration Phil St. George

Golden beaches of Nome

By the turn of the 20th Century fortune seekers had reached the gold-rich beaches of the Seward Peninsula of western Alaska, touching off Alaska's best known gold rush. Over the ensuing century, some 10 million ounces of placer gold has been recovered there, while only 30,000 ounces of lode gold has been mined, making the region a prime target for modern explorers.

Though made famous by gold, the 20,600-square-mile, or 53,350-square-kilometer, Seward Peninsula is host to tungsten-enriched tin deposits at its western tip and rare earth element prospects to the east.

The tin-tungsten potential of the western Alaska isthmus is highlighted by the Lost River Mine, located on Cassiterite Creek about 6 miles, or 10 kilometers from the Bering Sea. Lode production from a historical mine here is said to include 5.6 tons of concentrate containing 3.5 tons of tin and 0.6 tons of tungsten in 1913 and 309 tons of tin in concentrate produced between 1952 and 1955.

In the 1960s two resources were calculated for the Lost River property; 200,500 tons grading 1.3 percent tin and 0.125 percent tungsten oxide (WO3) and 105,000 tons grading 0.76 percent tin and 0.6 percent WO3. Cape Mountain and Potato Mountain are two similar prospects in the region.

The Seward Peninsula's rare earth potential is highlighted by a 50-mile-, or 80-kilometer- long trend of REE occurrences found were the isthmus connects to the rest of Alaska. In addition to REEs turning up in samples, this area hosts the right geology for deposits of these increasingly important metals.

"It is the same sort of geology as far as we know right now. It is one of those unusual type granites that tend to have these types of elements in them – uranium, thorium and the rare earths," explained Alaska Department of Natural Resources Division of Geological & Geophysical Surveys Senior Minerals Geologist Dave Szumigala.

This is a high priority target for state geologists charged with assessing Alaska's REE potential.

Bold explorers explore Brooks

At the height of the Nome Gold Rush adventurous prospectors were seeking gold along the southern slopes of the Brooks Range, a 600-mile-long chain of mountains dividing the oil-rich

continued on next page

North Slope from the rest of Alaska.

By 1901 these bold explorers were finding gold in the cold streams of the Chandalar and Koyukuk-Nolan districts, north of the Arctic Circle. High-grade orogenic veins are the suspected source of the rich alluvial deposits and large gold nuggets found by the early fortune hunters of this region.

The western reaches of the Brooks Range is home to several high-grade sedimentary exhalative deposits. The most notable of these SEDEX deposits is Red Dog, being mined by partners Teck Resources Ltd. and NANA Regional Corp.

While extremely high zinc grades give Red Dog its distinction, the mine produced more than 6 million ounces of silver as a byproduct in 2010.

"Red Dog is one of the greater lead-zinc deposits in the world and there is more potential for those in Northwest Alaska, as well as other places there are Paleozoic rocks that are similar to Red Dog," St. George said.

Anarraaq and Lik, located 7 miles, or 9 kilometers, and 14 miles, or 17.5 kilometers, respectively, from Red Dog, are two other known high-grade SEDEX deposits in the area.

The western half of the Brooks Range is also home to a belt of precious metals-enriched volcanogenic massive sulfide deposits. Arctic, being advanced by NovaGold Resources Inc., is the best known of these 400-million-year-old deposits.

Arctic is located in the Ambler District, a belt of VMS deposits that stretches at least 70 miles, or 115 kilometers, east-west. Similar Devonian-age VMS mineralization has been discovered as far as 140 miles, or 230 kilometers, east of the deposit. Hints of this Devonian age mineralization have also been found on the Seward Peninsula, about 200 miles, or 320 kilometers, to the southwest.

Since the vastly rich deposits of placer gold were discovered on the gravel bars of the Fortymile River in 1886, more than 12 million ounces of alluvial gold have been recovered from the eastern half of the Tintina Belt, but the lode source of many of the historic mining districts has yet to be found.

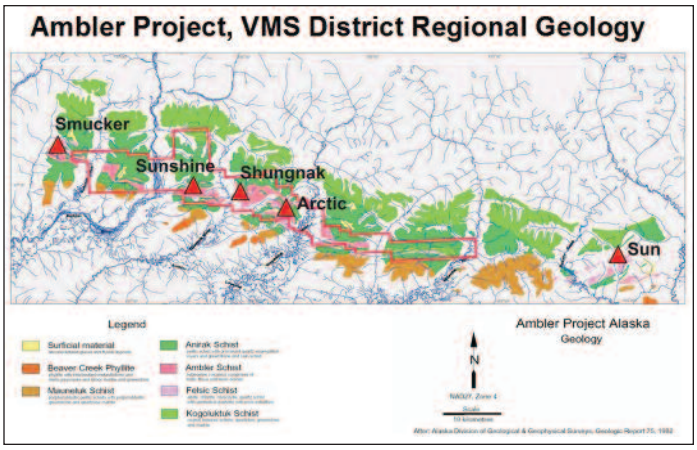
Though much of the VMS mineralization discovered in northern Alaska is very high grade, explorers have only scratched the surface due to its remoteness.

"It hasn't been drilled off very well because it is so remote. People have just worked on the very near-surface mineralization, so there is a lot of potential at depth. There is potential for other Arctics. If there was some infrastructure or development starting to occur at Arctic, the (Ambler) district would probably get another generation of deeper, more thorough drilling," St. George observed.

Building infrastructure to access Alaska's natural resources is a priority for Alaska Gov. Sean Parnell and a road to the Ambler district is high on his to-do list.

"Another roads-to-resources goal is to complete environmental permitting, public process, and ultimately access the Ambler Mining District and its rich mineral deposits within five years. The Legislature and I joined forces on this piece with US$4 million during the 2010 session, and I've included US$1.25 million more in this proposed budget," Parnell said.

Utilizing these funds, State of Alaska Department of Transportation & Public Facilities is studying potential transportation corridors connecting Ambler to Alaska's contiguous infrastructure.



Courtesy of NovaGold Resources Inc.

Though an exact route has yet to be determined, it would likely follow the footsteps of Alaska's early gold seekers, taking off from the Dalton Highway about 200 miles, or 320 kilometers, north of Fairbanks and heading west along the southern slopes of the Brooks Range.

Hints of rare earth elements have also been found along the southern slopes of this mountain chain north of the Arctic Circle.

Porphyry belt, more

South of the Tintina Belt lies a band of mineral-rich terranes, or series of related rock formations, drawing the attention of modern day fortune hunters. This arc consists of the Wrangellia Composite and Kahiltna terranes, two interrelated but distinct

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Geologists Joey Wilkins and Maarten de Moor canvas Full Metals Minerals Ltd.'s Pyramid copper-gold property on the Alaska Peninsula. This geologically active region of the "Ring of Fire" hosts a belt of young porphyries and epithermal gold deposits. Full Metals Minerals Ltd.

assemblages.

The Kahiltna assemblage was formed when the Wrangellia Composite Terrane — which consists of three related terranes (Wrangellia, Peninsular and Alexander) — thrust up the ocean floor as it collided with Alaska.

Pumped with copper and gold-bearing fluids at least twice, the more than 400-mile-, or 650-kilometer-, long Kahiltna Terrane in Southwest Alaska is home to the Pebble deposit and is highly prospective for other world-class porphyry copper-gold and intrusive gold deposits. This region

"There are great indications of mineralization all around this Kahiltna Terrane, and I think an area play could really break out here," Millrock President and CEO Greg Beischer told Mining News.

Though the Kahiltna assemblage is best known for its porphyry and other intrusive related copper and gold projects, the region also is highly prospective for other styles of mineralization.

"All over the Kahiltna Terrane keep your mind open to any style of mineralization — it could be VMS (volcanic massive sulfide), a skarn or a great big vein," Beischer advised.

The Kemuk iron-titanium property, located about 100 miles, or 160 kilometers, west of the Pebble project, is one such project.

The U.S. Geological Survey estimated reserves on the project at 2.2 billion tons grading 15 percent to 17 percent iron and 2 percent to 3 percent titanium. The deposit, hosted in magnetite-bearing ultramafic rocks, also is prospective for platinum group elements.

The Wrangellia Terrane, a subset of the larger composite terrane, stretches east from Southcentral Alaska through southern Yukon Territory and along the coast of British Columbia. This island arc is prospective for nickel, platinum group elements and copper-gold porphyries.

A 175-mile, or 280-kilometer, long area of rare earth element soil anomalies has also been outlined in this region along the southern slopes of the Alaska Range.

Yet another belt of young porphyries runs the length of the nearly 1,000-mile- or 1,600-kilometer-long Alaska Peninsula southwest of the Pebble deposit. The mineralization in this geologically active section of the "Ring of Fire" is much younger than the others, ranging from 10 million years to current.

Full Metal's Pyramid project, on this island arc formed by the Pacific Ocean plate diving under the North American plate, hosts 125 million tons of near-surface copper mineralization grading 0.403 percent copper and 0.025 percent molybdenum. Exploration in the late 1980s identified associated gold values that have greatly improved the potential at the project.

Terrane wreck

Alaska can attribute its mineral wealth to multiple terranes dumping their payloads over its landscape. Geologists are still sifting through the wreckage of this terrane wreck — a task not always easily accomplished as pileups have resulted, in many cases, from multiple mineralization events intertangled in the same geographical regions over time.

"We have got all these mineral deposits and mining districts because the geology of Alaska is composed of rocks of multiple ages, formed by a wide variety of geological processes, arranged in these various terranes that slammed into each other in what is present-day Alaska," explains Alaska Division of Geological & Geophysical Surveys geologist David Szumigala.

Coal, rare earth elements, tungsten, uranium, niobium and diamonds have been found amongst the gold, zinc, copper and other commodities that have spilled across the Far North landscape.

As economic deposits in other politically-stable parts of the world become harder to come by, fortune hunters will continue to follow the footsteps of Alaska's early gold seekers in order to discover the unfound riches hidden in the terrane wreckage that makes up the Last Frontier.

North to the Future for vital REEs

Dysprosium, terbium-enriched Bokan highlights Alaska as potential source of critical metals

BY SHANE LASLEY
Mining News

Rare earth elements are not as scarce as their name implies, but a mine producing these strategic minerals outside of China is uncommon. So, when the Far East country dramatically cut its REE exports, the rest of the world scrambled to discover alternative sources of these much needed metals. With dozens of REE prospects scattered across its expanse, Alaska may help supply the United States' growing need of these strategic elements.

"We cannot afford to be dependent on foreign sources of rare earth elements — and we believe Alaska's subsurface contains vast quantities," Alaska Gov. Sean Parnell said when rolling out his proposed Fiscal Year 2012 budget.

Gov. Parnell has asked the Alaska Legislature to approve funding for a comprehensive 3-year project to determine the potential of REEs deposits on state lands. This project will include conducting geologic field work and developing Alaska specific REE mineral-deposit models.

Parnell has also urged President Obama to consider directing the U.S. Geological Survey to conduct a similar inventory and geological program on federal lands in the Far North state.

"Alaska has already identified some of the most promising REE sites in the nation and we should be working to find more," Parnell informed Obama.

Due to the growing focus on these technological metals, Alaska Department of Natural Resources Division of Geological & Geophysical Surveys (DGGS) has already begun compiling information on the state's rare earth element potential.

In their initial assessment, DGGS has identified 71 known REE occurrences in the state and millions of acres of Alaska real estate prospective for these minerals.

"Our nation can look 'North to the Future,' to Alaska, for solutions on REEs," Parnell touted in his letter to Obama.

Over recent years nearly 97 percent of the world's supply of rare earth elements has come from China. So, when the Far East country dramatically cut its REE exports, the rest of the world scrambled to discover alternative sources of these critical metals. Courtesy of U.S. Department of Agriculture

Bokan highlights SE potential

Alaska's REE potential is underscored by the discoveries made by Ucore Rare Metals Inc. at its Bokan Mountain property on Prince of Wales Island in Southeast Alaska.

An inaugural NI 43-101-compliant resource calculated for Bokan earlier this year estimates the deposit hosts an inferred mineral resource of 3.7 million metric tons grading 0.75 percent total rare earth oxides.

Though not particularly large or high-grade, 39 percent of the TREO found at Bokan are the more valuable heavy rare earth oxides.

Technology Metals Research co-founder Jack Lifton – consid-

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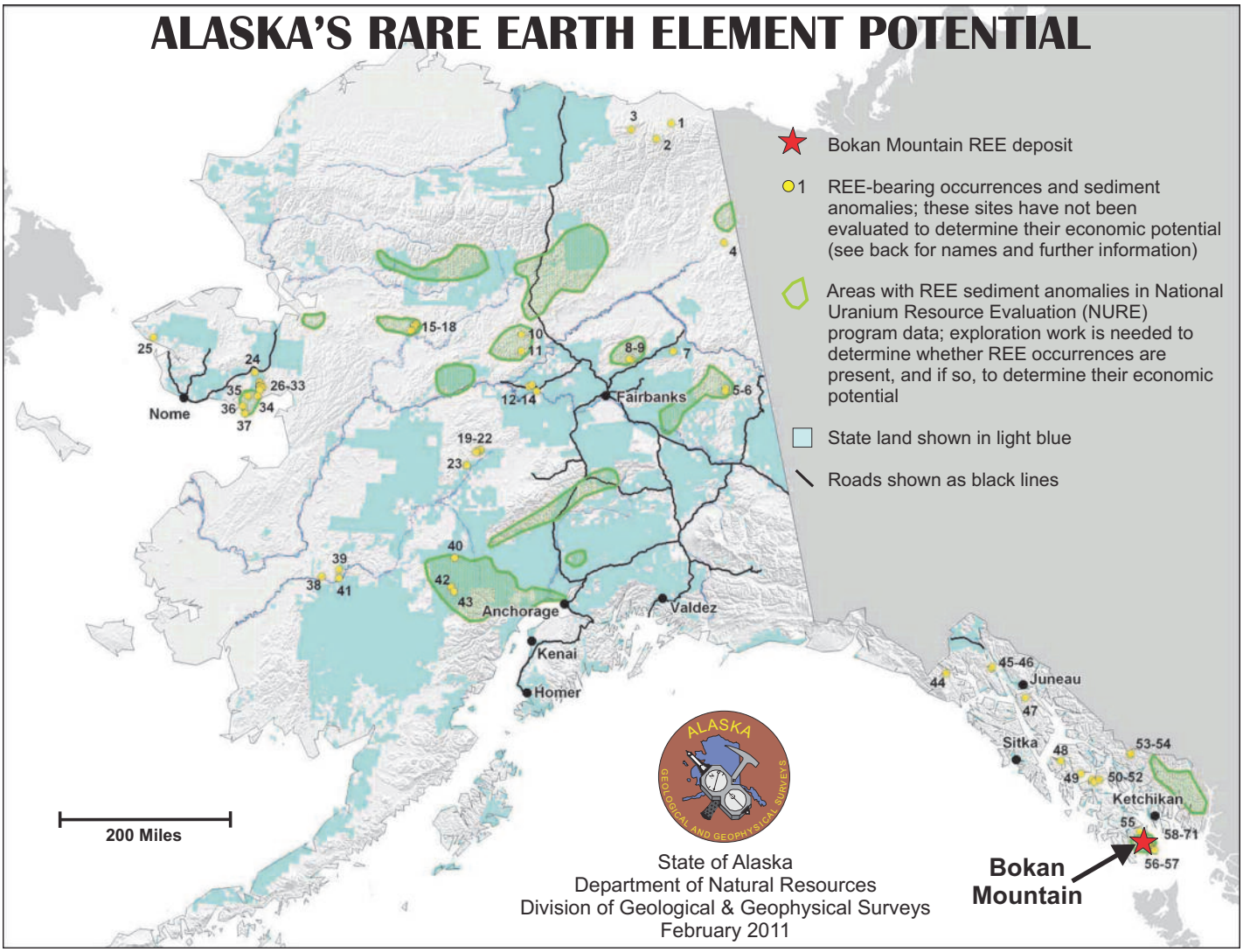

ered to be the leading authority on the sourcing and end-use trends of rare and strategic metals – said Bokan Mountain is key to securing a domestic supply of the critical heavy REEs.

"Because of its proportion of heavy rare earths, (Bokan) is the most desirable deposit to be developed in the United States," Lifton said. "For the future of this country, this development in Alaska is very important. I am hoping it comes to the attention of the national government."

Amongst the HREEs found in the deposit at Bokan are dysprosium and terbium; two metals considered to be especially vital to the high-tech and green industries.

Dysprosium has been ranked by the U.S. Department of Energy as the number one most critical strategic metal to the United States. In 2004, dysprosium was valued at US$30/kg, compared to current values of more than US$450/kg.

The mineral resource at Bokan Mountain contains an estimated 0.29 kilograms of dysprosium per metric ton. Of the remaining four rare earth metals DOE deemed critical, Bokan contains an estimated 1.08 kilograms per metric ton neodymium, 0.05 kilograms per metric ton terbium, 0.03 kilograms per ton europium and 1.88 kilograms per metric ton yttrium.

In its initial assessment, DGGS has identified a trend of REE prospects stretching along the entire 135-mile-, or 220-kilometer-, length of Prince of Wales Island; many of which display characteristics similar to Bokan.

Based upon preliminary work carried out by the United States Geological Survey and subsequently reviewed by Fairbanks-based Avalon Development Corp., Contango Ore Inc. snatched up Salmon Bay and Stone Rock Bay — two of the island's REE prospects.

"Alaska has already identified some of the most promising REE sites in the nation and we should be working to find more." –Alaska Gov. Sean Parnell

The 980-acre Stone Rock Bay property is located about 12 miles, or 19 kilometers, south of Bokan Mountain project and the 2,540-acre Salmon Bay is located on the northern shores of the island.

Dora Lake, located some 20 miles, or 30 kilometers, north of Bokan Mountain is another interesting REE prospect unveiled in the initial DGGS assessment. Geological investigations in 1990 discovered REE-bearing pegmatites along a two-mile trend from the head of Dora Bay to Dora Lake. The geologists that conducted the survey estimate a 1-meter-thick vein dike near Dora Lake contains an inferred resource of about 500,000 tons of material with 442 parts per million niobium, 71 ppm uranium, 1,775 ppm yttrium, 1.53 percent zirconium, and 2,816 ppm REE. And, like Bokan, nearly half of the REE content of this prospect is estimated to be the highly sought after HREEs.

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The REE-trend on Prince of Wales Island is a subset of a 350-mile-, or 560-kilometer-, belt prospective for these strategic metals that spans Southeast Alaska. All told, more than two dozen prospects have been identified along the panhandle.

"Those things like Bokan Mountain, those alkaline granitic complexes, occur in groups and there are a number of those in Southeast Alaska," explains DGGS Senior Minerals Geologist Dave Szumigala.

"Those things like Bokan Mountain, those alkaline granitic complexes, occur in groups and there are a number of those in Southeast Alaska." –Alaska Department of Natural Resources Division of Geological & Geophysical Surveys Senior Minerals Geologist Dave Szumigala

Beyond Bokan

REEs have been discovered in anomalous amounts all across the state, but most of these prospects have not been investigated.

"In Southeast they (REE prospects) are better explored because there is better access overall," Szumigala explains.

A band of prospects about 90 miles, or 135 kilometers, east of Nome is strikingly similar to the geology that hosts the REE deposits on Prince of Wales Island.

"It is the same sort of geology as far as we know right now. It is one of those unusual type granites that tend to have these types of elements in them – uranium, thorium and the rare earths.

Not only is the geology right, but a dozen REE-bearing occurrences have been identified along a 50-mile-, or 80-kilometer-, long trend of this prospective area.

Mount Prindle in Interior Alaska is a particularly exciting prospect due to the high concentrations of REEs discovered there.

The property — Located about 60 miles, or 90 kilometers, north of Fairbanks — was staked for uranium by MAPCO Inc. in 1978. Subsequent exploration identified several small deposits with extremely high concentrations of REEs and thorium. Rock samples taken from Mount Prindle returned grades of 15 percent REE and 0.1 percent uranium oxide.

The downside to this high-grade REE prospect is it lies within the White Mountain National Recreation Area. Though it is located in a region off limits to mining, a further understanding of this high-grade deposit could lead geologists to other similar prospects in Interior Alaska.

Other Interior Alaska occurrences include Hot Springs Creek, about 50 miles, or 80 kilometers, east of Mount Prindle; and Spooky Valley, about 100 miles, or 160 kilometers west of the high-grade prospect.

Core, the company that staked two of the REE prospects on Prince of Wales Island, has also laid claim to Spooky Valley and three other Interior Alaska REE properties.

Avalon Development — which has compiled its own database of Alaska REE prospects — will deploy a geological team to conduct mapping, geochemical sampling and other tasks designed to determine the presence and magnitude of rare earth element mineralization at Spooky and Core's five other REE properties in Alaska.

Characterized by DGGS as a slightly different type of occurrence, REEs discovered near Manley Hot Springs in Interior Alaska have particularly high concentrations of niobium, a metal used in high-grade structural steel, super alloys and superconducting magnets.

A reserve of about 100,000 pounds of niobium is estimated to be present in placer tailings at Idaho Gulch. Known as Tofty Ridge, this niobium prospect is near a 12-mile-, or 19-kilometer-, long group of cassiterite- and gold-bearing placer deposits known as the tin belt, and the area is underlain by Cretaceous and Tertiary granitic plutons.

NURE outlines prospects

The National Uranium Resource Evaluation (NURE) program was originally charged with evaluating domestic uranium potential when initiated by the U.S. Atomic Energy Commission in 1973. Later NURE was expanded to test for REEs and other strategic metals, which led to the identification of a number of large REE prospective areas across Alaska.

Between 1975 through 1979 this extensive geological initiative blanketed about 80 percent of Alaska with stream sediment, soil and rock samples.

Though little work has been done to follow-up on the discoveries made under NURE, several large swaths of REE anomalies were discerned by the program. Areas of note are a 175-mile-, or 280-kilometer-, long trend stretching along the southern slope of the Alaska Range and a region stretching about the same distance west from the Cook Inlet.

As long as the Western World could depend on China as a low cost REE-supplier there was little incentive to investigate Alaska's potential as a source of these metals important to high-tech and green technologies. With the Far East nation restricting global supply and prices skyrocketing, exploration companies and government agencies will surely look "North to the Future" to secure a domestic source of these vital metals.

Solving the Alaska diamond enigma

New geological models speculate on potential source; Tintina Fault aids, complicates search

BY SHANE LASLEY
Mining News

Setting aside the textbooks and adopting a new geological model may be the first requirement for the adventurous explorer seeking the source of alluvial diamonds found in Alaska. Though the precious gems have been found in the workings of placer gold mines in Interior Alaska and rumors of similar discoveries swirl in other regions of the state and neighboring Yukon Territory, according to the conventional model neither of these Far North jurisdictions host the geological conditions to produce the glimmering stones.

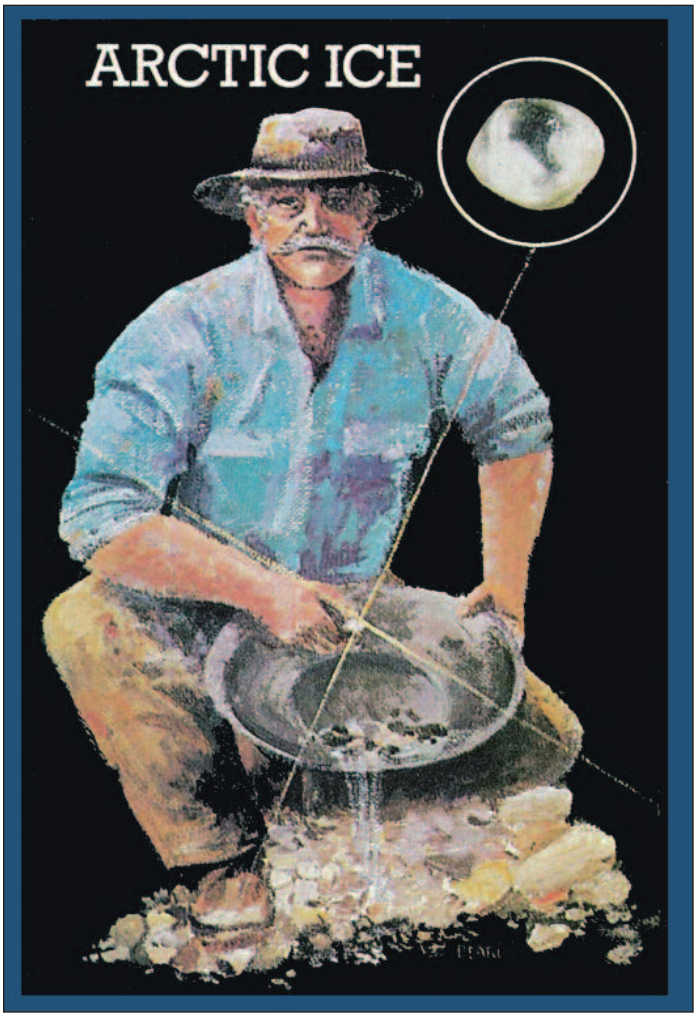
Three diamonds discovered along a two-mile, or three-kilometer, stretch of Crooked Creek in the Circle Mining District during the 1980s sparked the curiosity of geologists hoping to discover the source of the gems.

The first of the Crooked Creek diamonds, dubbed Arctic Ice, was a one-third carat stone discovered by Don Lasley during clean-up operations at Jim Regan's gold placer-mining operations on the Diamond No. 1 claim about seven miles, or 11 kilometers, west of the mining town of Central.

The carboniferous gem was first shown to former Alaska Department of Commerce and Economic Development, Office of Mineral Development Director John Sims, who forwarded the stone to a DeBeers subsidiary, which authenticated the diamond.

Following Lasley's discovery, two additional finds were found at Crooked Creek. The Warren Diamond, a 1.4 carat gem was discovered by Mary Warren about 2.5 miles, or 4 kilometers, downstream from the Regan claims. And, just downstream from the Warren Diamond, Paul Manual found a third 0.84 carat gem in the stream. All three stones were independently verified.

Though the State of Alaska, De Beers and other explorers have scoured the gently rolling hills surrounding the discovery, their investigations failed to turn up kimberlites or lamporites that host these gems in the major diamond producing regions of the world. This lack of evidence caused experts to suspect the Crooked Creek diamonds had traveled far from their source and interest in the stones waned.



Arctic Ice, Alaska's first independently verified macro-diamond, was found by Don Lasley during clean-up operations at Jim Regan's placer gold mine near the mining town of Central in Interior Alaska.

New models

A clue to the Crooked Creek diamond riddle may be found in Australia, where a similar and even more compelling enigma lies.

According to the generally accepted geological model, only the thickest portions of ancient crustal regions, or cratons, provide the unique conditions for diamonds to form. This thick continental crust — extending deep enough into the mantle to create the sweet spot known as the diamond stability field — is not existent in eastern Australia, where more than 500,000 carats of placer diamonds have been recovered, or Interior Alaska.

This has led geologists to theorize that some other geological event must have occurred to cause the conditions needed for diamond formation. One such idea is the subduction model.

Geologists have surmised that as one plate dives under another it could create diamond forming conditions. If the subducting plate is thick enough, according to the scientists, it would remain much cooler than the surrounding mantle it is plummeting into. This could create a situation that mimics the diamond forming conditions of cratons.

It is suggested that under optimal conditions this subducting slab carrying a carbon-rich payload could continually create diamonds that would be carried deeper and ultimately be destroyed by the diving plate. But, at the end of subduction, according to the model, an opportunity arises for the glittery stones to be transported to the surface in a fashion similar to classic diamond forming eruptions.

The deep crustal structure model, another postulate with principles similar to the subduction zone model, may better fit the conditions surrounding the Crooked Creek diamonds and

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other reported discoveries in Alaska, Yukon Territory and British Columbia. This theory deduces that massive structures such as large-scale fault systems could create the diamond stability field.

The confirmed diamond finds on Crooked Creek and most of the unverified diamond discoveries in neighboring Yukon Territory are found along the Kaltag-Tintina Fault, and several other rumored finds have been made along the Farewell-Denali Fault. These are the major intra-continental strike-slip faults that form the boundaries of the Tintina Gold Belt.

"You have to have a deep crustal feature that could tap deep into the earth," Alaska Department of Natural Resources Division of Geological & Geophysical Surveys Senior Minerals Geologist Dave Szumigala said, "The best postulation now for what is working for the diamonds found in Central is that you have the Tintina Fault, and that is a deep regional structure, and maybe that has provided a conduit for tapping things below the crustal level."

Daunting feat

Although these geological models provide explorers with new ideas of what to look for when seeking diamonds in Alaska, the search for the source of these gems may still be a daunting feat.

Classic diamond-bearing kimberlite or lamporite pipes are very small, typically ranging from 100 meters to 1,000 meters across. This small surface size coupled with the lack of glaciations and large permafrost-bound low lying areas of Interior Alaska compromise the effectiveness of airborne geophysical and remote-sensing prospecting techniques in this region.

Movement along the Tintina Fault — which passes within about a mile, or 1.6 kilometers, of the Crooked Creek diamond discoveries — adds to the complexity of finding the source of these placer diamonds. Evidence shows that the region south of this strike-slip fault has traveled some 300 miles, or 490 kilometers, to the west — greatly extending the prospective area.

Old fashioned geological investigating coupled with a mind open to new ideas may be what it takes to solve the riddle and discover the source of Alaska's placer diamonds.

According to the generally accepted geological model, only the thickest portions of ancient crustal regions provide the unique conditions for diamonds to form. This thick continental crust exist under Canada's Northwest Territories, where these diamonds were recovered, but is not found in Interior Alaska.

Wrangellia, prime PGM hunting ground

A belt spanning Alaska hosts promising platinum prospects; intriguing sniffs around state

The community of Platinum was founded in 1926 shortly after Yup'ik residents Walter Smith and Henry Wuya discovered the rare metal that inspired the town's name in the streams of the Goodnews Bay region of Southwest Alaska. Courtesy of Calista Corp.

This dredge, put into operation by Goodnews Mining Co. in 1937, recovered the majority of the 650,000 of platinum extracted from the Salmon River area of Southwest Alaska. Courtesy of Calista Corp.

BY SHANE LASLEY
Mining News

For the explorer seeking platinum group metals — platinum, palladium, rhodium, iridium, osmium, and ruthenium — starting at a community that bears the name of the elusive element seems a good choice.

Platinum was founded shortly after the 1926 discovery of the rare metal that inspired the towns name by Yup'ik residents Walter Smith and Henry Wuya in the streams of the Goodnews Bay region of Southwest Alaska.

Anchored by Platinum in the west a 1,250-mile-, or 2,000-kilometer-, long series of associated terranes — dubbed the Wrangellia Composite Terrane — is prime hunting ground for platinum group metals.

"You have Goodnews Bay sitting there, and from Salt Chuck through Goodnews Bay there is a whole belt of those Ural-Alaska types that could be explored," explains Alaska Department of Natural Resources Division of Geological & Geophysical Surveys Senior Minerals Geologist Dave Szumigala.

Though an economic PGM lode-source has yet to be discovered in the Goodnews Bay region, about 650,000 ounces of the extremely rare metals were recovered from the placers of the Salmon River drainage. An Ural-Alaska type ultramafic complex is believed to be the lode source of this alluvial platinum.

Rock samples taken from an outcrop on Red Mountain at the head of a stream feeding the Salmon River returned assay results up to 2.27 grams per metric ton platinum. Geologists also discovered platinum and palladium enriched magnetite clinopyroxene veins in the area.

A hole drilled in 2003 cut 2.7 meters of a little more than 1.1 g/t platinum and 1 g/t palladium. The significance of this intercept was fully recognized on the back of the results of the 2010 season when the company realized it shared characteristics with PGE-bearing reef environments elsewhere in the world. Courtesy of Pure Nickel Inc.

Following up on these finds, Pacific North West Capital and Stillwater Mining Co. undertook a 3,000-meter drill program in the uplands of the placer producing streams in 2008, but failed to pierce the platinum-bearing ultramafic body they were seeking.

Other Wrangellia discoveries

Some 600 miles, or 1,000 kilometers, northwest of Platinum is Pure Nickel Inc.'s Man project, a prospect that is showing promise as a primary source of PGMs.

Though nickel was previously the primary target at Man, platinum and palladium grabbed the spotlight during Pure Nickel's 2010 exploration of the Interior Alaska project.

The final hole of the 2010 season cut 165.9 meters averaging 253 parts per billion (0.253 grams per metric ton) platinum plus palladium. Horizon 2, included in this intercept, returned assays of 318 parts per billion (0.318 g/t) platinum and palladium over 24 meters.

A hole drilled in 2003 cut 2.7 meters of a little more than 1.1 g/t platinum and 1 g/t palladium. The significance of this intercept was fully recognized on the back of the 2010 results when the company realized these layers of PGM-enrichment share characteristics with Western Bushveld, a region of South Africa that produces some 70 percent of the world's platinum and palladium.

Pure Nickel Chief Consulting Geologist Larry Hulbert, who studied in the Bushveld complex for five years, said, "The geochemistry of the drill core is starting to reveal that PGE mineralized horizons are

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present and that they are remarkably similar to that of the PGE-bearing reef environments seen elsewhere in the world,"

About 200 miles, or 320 kilometers, southwest of Man explorers are also finding platinum in the Wrangellia Terrane as it crosses into the Yukon Territory, adding to the potential of this belt.

Salt Chuck, another property owned by Pure Nickel, marks the southeast extent of Alaska's PGM-prospective belt. This Prince of Wales Island property is adjacent to the historical Salt Chuck palladium-copper mine and covers a northwest-trending mafic-ultramafic igneous complex.

Salt Chuck palladium-copper mine is reported to have recovered 290,000 ounces of palladium and 6.2 million pounds of copper from 296,000 tons of ore mined between 1916 and 1941. The mine also produced significant credits of gold and silver.

More recently rare earth elements have also been discovered at Pure Nickel's Salt Chuck property.

"What's intriguing is there are sniffs in a number of places. All it takes is for someone to come up with a model that makes sense, which could lead to a lot of exploration and/or discoveries." –Alaska Department of Natural Resources Division of Geological & Geophysical Surveys Senior Minerals Geologist Dave Szumigala

Intriguing sniffs

While the Wrangellia Composite Terrane is considered the best place in Alaska to hunt for platinum, a number of prospects exist beyond this belt.

According to a report by U.S. Geological Survey geologist Robert Kelley, late Triassic flood basalts characteristic of the Wrangellia Terrane have been found at least 50 miles, or 80 kilometers, southwest from the southern Alaska Range through the Talkeetna Mountains.

No ultramafic rocks have been mapped to date in this possible extension of the Wrangellia, but field geophysical data suggest the possibility of buried ultramafic bodies, and nickel-copper-PGM stream sediment geochemical anomalies occur in close proximity to the basalts.

The Kemuk iron-titanium property is another PGM prospect beyond the bounds of Wrangellia.

The U.S. Geological Survey estimated reserves on the project at 2.2 billion tons grading 15 percent to 17 percent iron and 2 percent to 3 percent titanium. Hints of the platinum metals have also been found in the magnetite-bearing ultramafic rocks at Kemuk.

From the Seward Peninsula in far west Alaska to the Fortymile district at the state's eastern border, small amounts of placer platinum have been recovered as a byproduct of gold mining. These anomalous occurrences underscore the potential of discovering PGMs across the Last Frontier's vast gold producing districts.

Linux Gold Corp. reports that soils samples collected near Dime Creek on the Seward Peninsula contain up to 174 ppb platinum, 144 ppb palladium and 160 parts per billion gold.

"What's intriguing is there are sniffs in a number of places. All it takes is for someone to come up with a model that makes sense, which could lead to a lot of exploration and/or discoveries," Szumigala explained. "But, with the conventional models, these little hits here and there have not evoked an exploration target looking totally at platinum."

Gold's allure draws fortune hunters

Source of much of the placer gold that beckoned Alaska's early prospectors remains unfound

BY SHANE LASLEY
Mining News

Gold's allure has beckoned fortune hunters to Alaska since the 1880 discovery of the yellow metal in the streams near what would later become Alaska's capital of Juneau. Over the ensuing 130 years the glimmering commodity has been recovered in nearly every corner of the Far North state, leaving only the oil-rich plains of the North Slope without a discovery.

Most of the some 42 million ounces of gold found in Alaska has been in the form of placer, leaving the lode source of many of these alluvial producing streams yet unfound.

Over the past two decades enormous gold finds such as Pebble, Donlin Creek and Livengood have been unveiled in Alaska and geologists familiar with the state expect that more world-class deposits lay hidden just below the surface of the vast and underexplored state.

"The thing about Alaska is there are a lot of low-lying areas out there that are covered with vegetation, glacial gravels and things that haven't been explored thoroughly, or at all," Millrock Vice President of Exploration Phil St. George, who played a key role in the discovery of Pebble and expansion of Donlin. "I, and others, think there is a lot of potential to find other Pebbles, other Donlins, other huge gold systems."

"The discovery potential is very high for porphyry deposits generally in this arc environment, but I would also say that Pebble-look-alikes are probably not likely. However, this does not preclude the potential to find other large porphyry deposits with their own unique sets of characteristics." –Pebble Chief Geologist James Lang

Tintina Gold Belt

The Tintina Gold Belt is a particularly rich and vast aurum province that hosts such large Alaskan gold deposits as Fort Knox, Pogo, Donlin Creek and Livengood. These world-class discoveries only begin to account for the source of more than 17 million ounces of placer gold recovered from the streams of the Golden Arc, as the gold belt is sometimes referred.

Bound on the north by the Tintina fault and on the south by the Denali fault, the Golden Arc cuts a swath about 850 miles, or 1,350 kilometers, long across the middle of the state, averaging more than 200 miles, or 320 kilometers, wide.

The gold mineralization of the Tintina Gold Belt in Alaska can be divided into two distinct groups: the eastern portion of the

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The Rolling Thunder project, led by Full Metal Minerals Ltd. geologist Chris Siron, is a staking and exploration initiative aimed at targeting the source of more than half a million ounces of placer gold recovered from streams draining the rolling hills of the Fortymile Mining District in eastern Alaska.
Shane Lasley

Recognizing that the belt of Cretaceous-age deposits, prospects, and placer gold mines of Yukon Territory's White Gold District trends northwest into Alaska, Full Metal Minerals Ltd. geologists surmised that similar mineralization might be the undiscovered lode of the gold-producing streams in the neighboring Fortymile district. Shane Lasley

belt, running from the Alaska-Yukon border about 300 miles, or 484 kilometers, into the state; and the 74,000-square-mile, or 190,000-square-kilometer, Kuskokwim Gold Belt of Southwest Alaska.

In addition to hosting two of Alaska's three operating gold mines, the eastern half of Alaska's Golden Arch is home to International Tower Hill Mines Ltd.'s nearly 20-million-ounce Livengood gold project. The intrusion-related gold mineralization in all three deposits is estimated to be about 90 million to 100 million years old.

Over the past 125 years more than 12 million ounces of placer gold have been recovered from the eastern extent of the Tintina Gold Belt in Alaska, but the lode source of the alluvial deposits of prolific mining districts such as Fortymile and Circle have yet to be found.

Rolling Thunder, an intriguing program launched in 2010 by junior explorer Full Metal Minerals Ltd., is a staking and exploration initiative targeting the source of more than half a million ounces of placer gold recovered from the streams draining the rolling hills of the Fortymile Mining District.

Recognizing that the belt of Cretaceous-age deposits, prospects, and placer gold mines of Yukon Territory's White Gold District trends northwest into Alaska – Full Metal geologists sur-

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In the summer of 1906 this stack of gold bullion at the Miner's and Merchant's Bank in Nome, Alaska was valued at US$1,250,000 by the photographer. Around 10 million ounces of placer gold has been recovered from the Seward Peninsula since gold was discovered there in 1898. Courtesy of Alaska State Library, B. B. Dobbs. Photographs

mised that similar mineralization could be the undiscovered lode of the alluvial gold producing streams in the neighboring Fortymile district on the stateside of the border.

Applying a firsthand understanding of the geologic controls, geochemistry and targeting methods that led to discoveries at White Gold some 60 miles, or 100 kilometers, to the southeast Full Metal geologists canvassed Alaska's Fortymile gold district.

This reconnaissance sampling and mapping has identified multiple areas of strong alteration and quartz veining reminiscent of White Gold. Discoveries made with Rolling Thunder may lead to the source of the Fortymile alluvial gold, and aid the search for the lodes that fed placer streams across Alaska's Eastern Interior.

Further west, more than one million ounce of placer gold found in the streams of the Circle Mining District, but the hardrock sources have eluded explorers. Located about 100 miles, or 160 kilometers, northeast of Fairbanks — this historical district has been mined continuously since 1894.

Kinross Gold Corp.-subsidiary Fairbanks Gold Mining Inc. recently staked a group of claims over a placer producing area in the district.

At the western end of the Golden Arc lies the Kuskokwim Mineral Belt, a 400-mile- or 645-kilometer-long gold-rich terrain that runs northeast from the Goodnews Bay region of Southwest Alaska. The gold mineralization found in this province was deposited by a widespread pulse of magmatism and mineralization about 70 million years ago, making it about 20 million years younger than the Fort Knox-type mineralization to the northeast.

The nearly 40 million-ounce Donlin Creek gold deposit — being developed by Barrick Gold Corp. and NovaGold Resources — highlights the potential of this Southwest Alaska province.

Over the past several years, majors and junior explorers alike have scoured the region in search of other large intrusive-related gold deposits, uncovering several promising prospects.

With more than 1.5 million ounces of alluvial gold recovered from its streams, Iditarod is the most productive placer producing district in the Kuskokwim Mineral Belt, yet only about 3,000 ounce of hard rock gold has been found here.

Famed for its enormous gold nuggets – including the 5th- and 13th-largest found in Alaska, at 122 and 62.5 troy ounces respectively – Ganes Creek is another example of the potential of this mineralized region of the Tintina Gold Belt.

> *"I, and others, think there is a lot of potential to find other Pebbles, other Donlins, other huge gold systems." –Millrock Vice President of Exploration Phil St. George*

Found in the Ophir Mining District about 25 miles, or 40 kilometers, west of McGrath, some 250,000 ounces of placer gold has been mined from Ganes Creek and an estimated 734,000 ounces of the alluvial aurum still remains. The coarse nature of the gold eludes to a nearby lode source.

Besides Donlin Creek-style mineralization, the Kuskokwim belt also hosts Nixon Fork, a carbonate skarn deposit rich in copper, silver and high-grade gold; several mercury-antimony deposits; and a large past-producing placer platinum deposit.

10-million-ounce peninsula

Since the 1898 gold strike made by the "Three Lucky Swedes" on Anvil Creek, just a few miles from present day Nome, an estimated 10 million ounces of gold has been recovered from the Seward Peninsula in Northwest Alaska. Though this 20,600-square-mile, or 53,350-square-kilometer, isthmus is one of the world's most prolific placer producing regions, only about 30,000 ounces of lode gold has been mined there.

The rivers and beaches of the Nome Mining District itself produced more than half of the placer gold that lured tens of thousands of fortune hunters to this far western region of Alaska at the turn of the 20th Century.

"The (Nome) district has produced some 5 million ounces of alluvial gold. We certainly see the potential for additional targets there," NovaGold Resources Inc. President Rick Van Nieuwenhuyse said.

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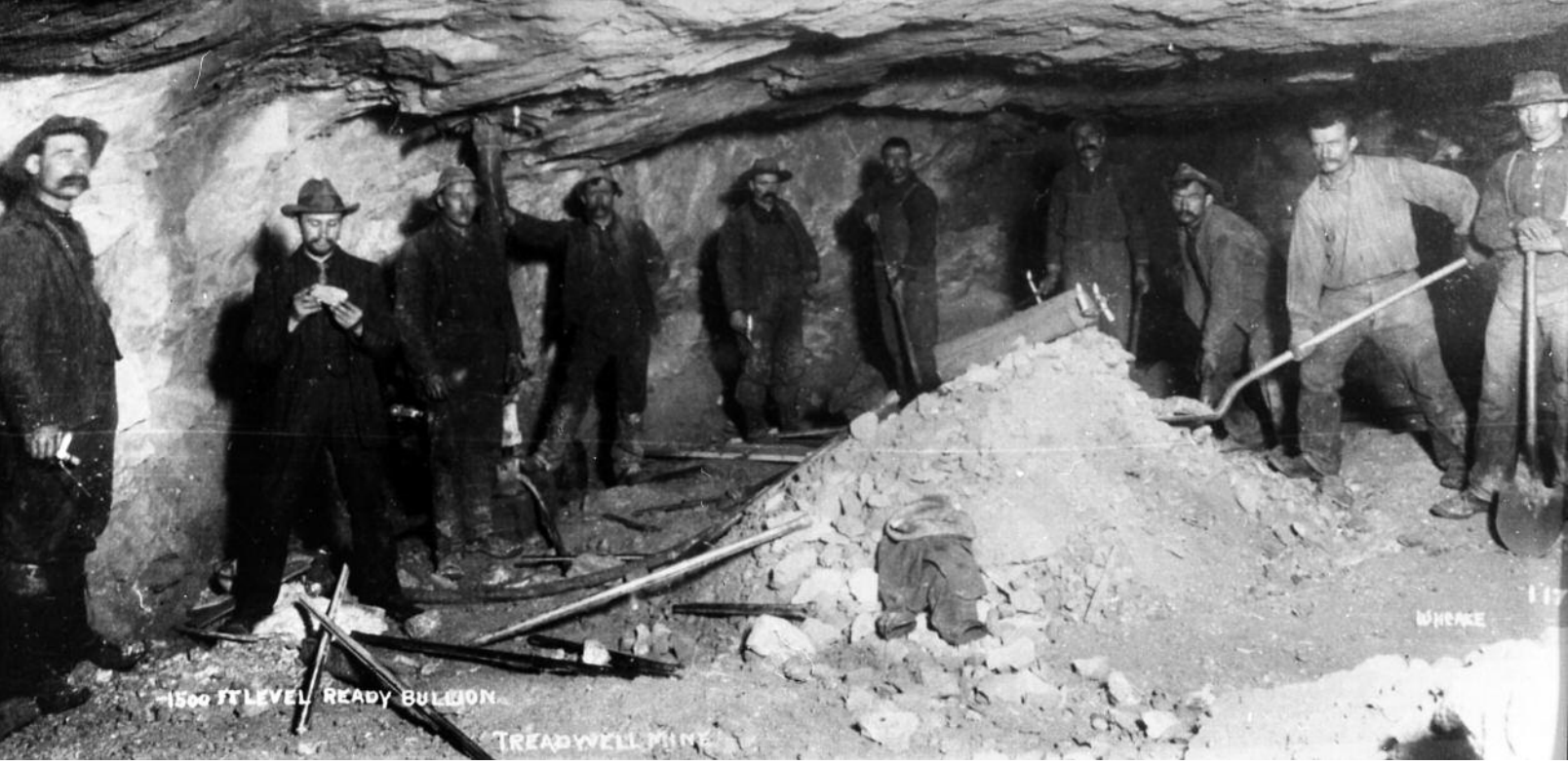

Miners in the 1,500-foot level of the Treadwell gold mine in Southeast Alaska. From 1881 to 1922, more than 3 million troy ounces of gold were extracted from this mine. Courtesy of Alaska State Library, Case and Draper photograph collection

NovaGold's Rock Creek Mine, which was put on care and maintenance before reaching commercial production, is the only modern hardrock mine on the peninsula. The company has put the mine and the nearby Big Hurrah gold deposit up for sale.

With drills turning on two Seward Peninsula gold properties, Millrock Resources Inc. is amongst the most tenacious of the contemporary explorers in the region. This junior, in partnership with Kinross, completed around 2,500 meters of reverse circulation drilling at the Council project northeast of Nome last year. Following the Council program, Ryan Gold Corp., a Toronto-based junior then known as Valdez Gold Corp., funded a 5,000-meter drill program at Millrock's Bluff property east of the famous mining town.

TintinaGold Resources Inc., a company formed as a spin-out vehicle for NovaGold's exploration properties, completed 1,750 meters of drilling at Kugruk, a property about 70 miles north of Nome that hosts copper-iron skarns, silver-lead-zinc prospects and placer gold rich drainages. This program is the first drilling completed on the project since the late 1970s.

Further north still, Cedar Mountain Exploration Inc. is focused on seeking a near-surface, bulk tonnage sedimentary gold deposit at its Kelly Creek gold project.

Pebble Chief Geologist James Lang says other porphyry deposits are likely hidden under the glacial gravels that cover much of the Southwest Alaska region that hosts the enormous Pebble copper-gold project.

Northern nugget country

Placer deposits in the Chandalar and Koyukuk-Nolan districts along the southern Brooks Range also drew fortune seekers at the turn of the 20th Century. High-grade orogenic veins are the suspected source of the rich alluvial deposits and large gold nuggets found in these placer districts located above the Arctic Circle about 200 miles, or 320 kilometers, north of Fairbanks.

An estimated 84,000 ounces of gold has been recovered from the Chandalar district. About 76,000 ounces of the yellow metal, or about 90 percent of the total, was alluvial gold found in the stream beds and frozen bench gravels. Most of the remaining 10 percent of the total was recovered from the Mikado Lode.

Goldrich Mining Co., a junior mining company that has claims over most of the Chandalar district, said Mikado is one of about 30 auriferous quartz-sulfide veins that are now documented on the property. Very little modern exploration work has been completed at Chandalar.

The Koyukuk-Nolan district, which lies directly west of Chandalar, has produced about 350,000 ounces of placer gold. The region is well-known for producing large nuggets. The third (146 troy ounces), fourth (137 troy ounces), 14th (61 troy ounces) and 17th (55 troy ounces) largest gold nuggets in Alaska were found on the Hammond River, a tributary to the Koyukuk River.

A lode source for these big nugget producing placers has yet to be discovered. Silverado Gold Mines Ltd., though, is drilling what it believes to be the source of the placer gold found in Nolan Creek, another large nugget producing drainage in the district.

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World-class porphyries

At the largest known gold deposit in Alaska, the precious metal is actually a byproduct in a porphyry copper-gold-molybdenum system. The latest resource released by joint venture partners Anglo American plc and Northern Dynasty Minerals Ltd. estimates the Pebble deposit contains more than 107 million ounces of gold, along with its 80 billion pounds of copper and 5.6 billion pounds of molybdenum.

Knowing that porphyry deposits like Pebble are seldom an isolated occurrence, explorers are wondering if another enormous copper-gold deposit of this type lies hidden under the glacial gravels that cover much of Southwest Alaska.

"The discovery potential is very high for porphyry deposits generally in this arc environment, but I would also say that Pebble-look-alikes are probably not likely. However, this does not preclude the potential to find other large porphyry deposits with their own unique sets of characteristics. So, we should not overfocus on the Pebble model, but we should focus more on the favorable environment that Pebble represents," Pebble Chief Geologist James Lang expounded.

The copper-gold-molybdenum was being deposited at Pebble during the same time period as much of the gold of Alaska's Eastern Interior.

"At about the time Pebble was being formed (around 90 million years ago) there was an oceanic plate being subducted under Alaska called the Kula Plate, and that seems to have been a fairly productive time period where Pebble, Fort Knox, Livengood and Pogo were created from the oceanic plate and the current Pacific Plate that is subducting Alaska," St. George explained. "The Kula Plate was still being subducted during the Donlin age."

A belt of porphyry deposits that stretches from Southwest Alaska along the Alaska Range and into the Yukon Territory dates to the time Donlin age, or 65 million to 70 million years ago.

A belt of much younger porphyries can be found further southwest on the Alaska Peninsula and Aleutian Islands.

This island arc, formed as the Pacific Ocean plate dives under the North American plate, has received limited modern exploration and is prospective for both epithermal gold, and porphyry copper-gold mineralizing systems.

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Most of the some 42 million ounces of gold found in Alaska has been in the form of placer, leaving the lode source of many of these alluvial producing streams yet unfound. Courtesy of Judy Patrick Photography

Several prospects have been identified along the nearly 1,000-mile- or 1,600-kilometer-long peninsula and island chain.

Full Metal has an agreement to explore around 1.4 million acres of prospective Native-owned land on the Alaska Peninsula. The Pyramid copper-molybdenum porphyry and Unga-Popov epithermal gold project highlight the potential of the region.

The Pyramid copper-molybdenum porphyry deposit hosts 125 million tons of copper mineralization grading 0.403 percent copper and 0.025 percent molybdenum near-surface. More recent exploration by Battle Mountain Gold in the late 1980s identified associated gold values that have greatly improved the potential at Pyramid.

Unga-Popov — which lies on an island about 20 miles, or 32 kilometers, south of Pyramid — hosts two historical resources; Apollo with 280,000 metric tons averaging 27.7 g/t gold and 92.6 g/t silver and Centennial, which has about 6 million metric tons at 1.5 g/t, or 290,000 ounces of gold.

Tomes to be written

Precious metals-enriched volcanogenic massive sulfide deposits, such as the Arctic deposit in Northwest Alaska and the Niblack deposit in Southeast Alaska, are another target for gold seekers looking to the Far North state.

An estimate completed in 2008 for NovaGold's Arctic deposit outlined an indicated resource of 16.8 million metric tons containing 4.1 percent copper, 6 percent zinc, 0.83 grams per metric ton gold, 59.6 grams per metric ton silver and 0.94 percent lead.The estimate includes an additional inferred resource of 11.9 million metric tons with an average of 3.6 percent copper, 5.0 percent zinc, 0.67 g/t gold, 48.4 g/t silver, and 0.80 percent lead.

Even richer in gold, the Lookout deposit at Heatherdale Resources Inc.'s Niblack project contains an indicated resource of 4.14 million metric tons averaging 1.13 percent copper, 2.32 grams per metric ton gold, 2.27 percent zinc and 38.7 g/t silver. Lookout has an additional inferred resource of 1.74 million metric tons grading 1.09 percent copper, 1.77 g/t gold, 2.02 percent zinc and 25.52 g/t silver. The Trio deposit has an inferred resource of 756,000 metric tons averaging 1.5 percent copper, 1.75 g/t gold 2.91 percent zinc and 26.65 g/t silver.

Located in the eastern Alaska Range, Heatherdale's Delta property represents an emerging VMS region in Interior Alaska. An inferred resource of 15.4 million metric tons grading 0.6 percent copper, 1.7 percent lead, 3.8 percent zinc, 62 g/t silver, and 1.7 g/t gold has been calculated for this property.

Explorers are also finding high-grade orogenic gold in Southcentral and Southeast Alaska, two regions notable for historical high-grade gold mines. Coeur d'Alene Mines Corp.'s Kensington gold mine in Southeast, the historical Independence and Lucky Shot gold mines in Southcentral are just a few examples of historical high-grade gold regions that hold promise for the contemporary fortune hunter.

Tomes can be, and have been, written about Alaska's gold potential, and more chapters are sure to be added as fortune hunters continue to make new discoveries in this vast aurum producing state.

Some 7 million ounces of silver was contained in Red Dog's lead and zinc concentrates in 2010, making the Northwest Alaska mine the state's second largest producer of the white metal. Shane Lasley

Silver enhances luster of Alaska projects

Soaring price makes white metal an important contributor to deposit, prospects across state

BY SHANE LASLEY
Mining News

Silver prices have doubled over the past year and interest in discovering deposits rich in the white metal is pacing its soaring value; and Alaska, the United States top silver producing-state, is an obvious place to search.

Though 14 million ounces were recovered in Alaska last year, accounting for about one-third of the U.S. production, the Far North state has only two mines extracting poor man's gold, as the metal is sometimes irreverently referred.

Hecla Mining Company's Greens Creek mine near Juneau is Alaska's lone primary silver mine and at 7.2 million ounces takes the title of Alaska's largest silver producer in 2010. At the zinc-rich Red Dog mine in Northwest Alaska the white metal is a by-product. Teck representatives informed Mining News that some 7 million ounces of silver was captured in the mine's lead and zinc concentrates last year, though the amounts retained in the refining process is unclear.

Between these two silver producers at opposite corners of Alaska lies a vast area of silver potential.


Greens Creek, the United States' top producing silver mine, has 8 million tons of reserves averaging 426 grams per metric ton silver, 3.4 g/t gold, 10.5 percent zinc and 3.8 percent lead. Hecla Mining Co.

Promising VMS deposits

Volcanogenic massive sulfide deposits similar to Greens Creek hold great promise for explorers seeking silver in Alaska.

The United States' top silver producing mine lies in the midst of a 450-mile-, or 725-kilometer-, long belt of late-Triassic VMS deposits that spans the Southeast Alaska panhandle and carries northward, encompassing the Windy Craggy deposit in British Columbia.

At some 8 million metric tons of reserves averaging 426 grams per metric ton silver, 3.4 g/t gold, 10.5 percent zinc and 3.8 percent lead; Greens Creek is by far the most silver-enriched of the known deposits along this trend.

The ore at Constantine Metal Resources Ltd.'s Palmer project at the north end of Alaska's portion of the VMS belt contains about 31 g/t silver — along with 2 percent copper, 4.8 percent zinc, 0.30 grams per metric ton gold. At the southern end of the VMS trend, Heatherdale Resources Ltd. has defined 4.14 metric tons of ore averaging 38.7 g/t silver, 1.13 percent copper, 2.32 grams per metric ton gold, 2.27 percent zinc in the Lookout zone of its Niblack project.

Woewodski Island is one Southeast Alaska prospect that demonstrates promise to be a Greens Creek contemporary. A hole drilled by Bravo Ventures Group Inc. in 2003 — which cut 1.8 meters grading 222 g/t silver, 6.34 percent lead and 16.15 percent zinc — underscores the potential of the prospect, but the limited drilling conducted here has yet to find thick zones of high-grade massive sulfides.

The Brooks Range, a chain of mountains that spans the more than 600-mile-width of Alaska north of the Arctic Circle also hosts VMS deposits enriched with silver.

Andover Ventures Inc.'s Sun deposit in the Ambler Mining District is one such example. A resource calculated for the project in

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1977 estimates Sun has a resource of 20.3 million tons averaging 74 g/t silver, 1.9 percent copper, 4.5 percent zinc and 1.2 percent lead.

Similar VMS deposits and prospects, including NovaGold Resources Inc.'s Arctic project, span this northern mountain chain.

Heatherdale Resources Inc.'s silver-enriched Delta property – located in the eastern Alaska Range about 36 miles, or 58 kilometers, southwest of Tok – represents an emerging VMS district in Interior Alaska.

An inferred resource of 15.4 million metric tons grading 62 g/t silver, 0.6 percent copper, 1.7 percent lead, 3.8 percent zinc and 1.7 g/t gold has been calculated for Delta. Large massive sulfide boulders averaging 113 g/t silver 7.3 percent lead, 5.6 percent zinc, 113 g/t silver and 0.7 g/t gold have also been found at the 39,840-acre property

"Delta is an early-stage project, but it also represents an emerging massive sulfide district with the potential to be in the top tier of global districts of its type," Heatherdale President and CEO Patrick Smith lauded.

Northwest SEDEX

The silver enriched ore at Red Dog is found in a high-grade sedimentary exhalative, or SEDEX, body.

Exhalative deposits are formed when mineral-rich brine is "exhaled" into the ocean creating layers of sulfide ore. This process continues today in the form of black smokers on the ocean floor.

Northwest Alaska is home to several other SEDEX deposits and is prospective for others.

"Red Dog is one of the greater lead-zinc deposits in the world and there is more potential for those in Northwest Alaska, as well as other places there are Paleozoic rocks that are similar to Red Dog," explains Millrock Resources Inc. Vice President of Exploration Phil St. George.

According to a 2004 report written for the Society of Economic Geologists, the Anarraaq deposit consists of a barite body, estimated to be as much as 1 billion metric tons, and a zinc-lead-silver zone with an estimated resource of about 18 million tons at 18 percent zinc, 5.4 percent lead, and 85 g/t silver.

Lik is estimated to contain about 4.6 billion pounds of zinc, 1.5 billion pounds of lead and 41 million troy ounces of silver. Lik runs about 8 percent zinc, 2.6 percent lead and 1.5 ounces per ton silver; or about half the concentrates found at Anarraaq and Red Dog.

Statewide potential

In addition to the SEDEX- and VMS-style deposits that host Alaska's two producing silver mines, several styles of mineralization spanning the state are known to host rich stores of the shimmery metal.

When mineral-rich brine is not exhaled, but instead is trapped in the ocean floor sediments, it forms replacement-style deposits. Full Metal Minerals Ltd. is exploring one such deposit at its Fortymile project in eastern Alaska.

Hole LWM10-64 drilled at Fortymile last year cut 5.89 meters averaging 198 g/t silver, 7.4 percent zinc, 13.8 percent lead. LWM10-68 intersected 4.4 meters averaging 314 g/t silver, 23.7 percent zinc and 23.6 percent lead

Epithermal gold prospects found along the Alaska Peninsula and the Aleutian Islands are typically contain high concentrations of silver, but are relatively unexplored.

Shumagin and Apollo, two such epithermal gold deposits being explored by Full Metal on Unga Island, contain a combined historical resource of 280,000 metric tons averaging 27.7 g/t gold and 92.6 g/t silver.

Silver Chalice – found on the banks of the Yukon River about 330 miles, or 530 miles, west of Fairbanks – reflects Interior Alaska's potential for silver-enriched epithermal deposits. . Rock chip samples returned assay up to 462 g/t silver. Average silver-gold ratio of sample taken from Silver Chalice is about 40:1, making silver predominant metal at current prices of the two precious metals.

Alaska Department of Natural Resources Division of Geological & Geophysical Surveys Senior Minerals Geologist Dave Szumigala told Mining News that most of Alaska's tin prospects such as Kougarok, Sleitat, Win, Won and Coal Creek contain silver and the white metal is typically a significant byproduct in porphyry copper deposits such as Pebble.

As silver prices soar, poor man's gold will increasingly enhance the luster of mining projects across Alaska.

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There is also scope to explore for stratigraphic traps.

"So far the basin has only really been explored for structural, not for stratigraphic traps," he said.

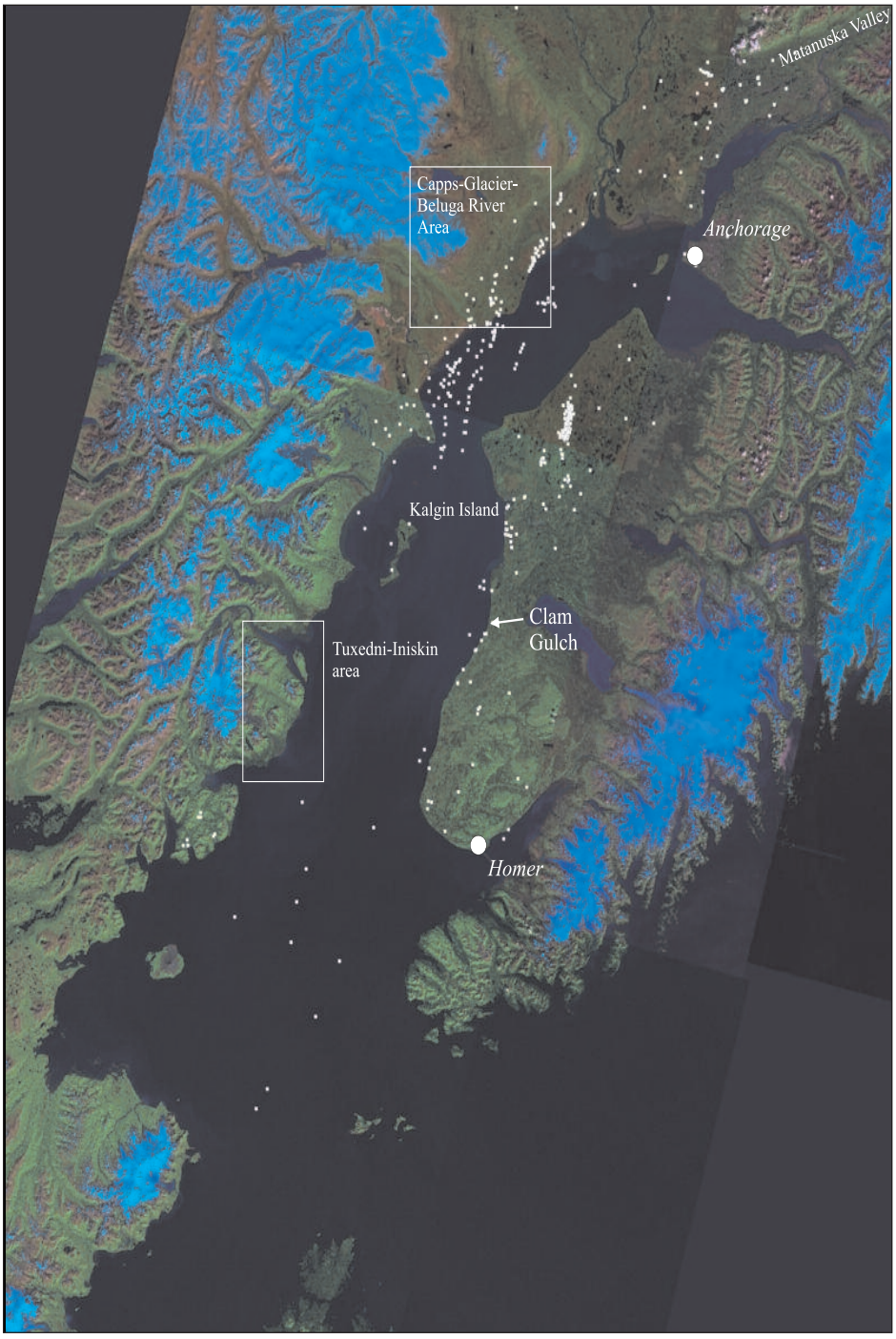
Mesozoic possibilities

The possibility of finding oil and gas in the Mesozoic, beneath the Tertiary basin, intrigues geologists, especially since Cook Inlet oil originated from the Jurassic Tuxedni group within the Mesozoic sequence, having presumably percolated upwards.

Cretaceous rocks in the Mesozoic exposed at either end of the basin show evidence of oil formation, Ryherd said.

However, geologists have also been concerned about the potential for minerals called zeolites to clog the pores of potential reservoir rocks — the chemistry of the Mesozoic rocks tends to be conducive to zeolite formation.

But Decker thinks that the nature of the Mesozoic under the basin is not well understood. In fact the Mesozoic oil and gas potential has become one of several focuses of a multiyear Cook Inlet research program begun in 2006 by Alaska's Division of Geological and Geophysical Survey, or DGGS.



ALASKA DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

The thin scattering of Cook Inlet oil and gas wells, shown as white dots on this 2010 satellite image of the inlet, indicates to many geologists that the Cook Inlet basin is underexplored. A team of geoscientists, led by Alaska's Division of Geological and Geophysical Surveys, is inves- tigating the petroleum geology of the region. The team has been doing fieldwork in the area of the two boxes marked on the west side of the inlet, and along the coast between Homer and Clam Gulch.

It's almost free

Drilling into the deeper Mesozoic is very costly. To encourage exploration and development, the State of Alaska offers Cook Inlet oil and gas producers one of the most favorable tax and royalty environments in the United States, with total rates at or below every other major producing state: Cook Inlet oil is assessed no production tax, and a 12.5 percent royalty rate; natural gas' royalty rate is the same but its gross production tax rate varies, depending on gas prices — at $5 per mcf it's 3.6 percent, which assumes no capital credit-write-off.

Plus, the state pays up to 40 percent of exploration costs. And production tax increases and decreases with oil prices and the level of investment; in other words, the more you invest, the less tax you pay.

And there is a credit for capital investments, plus a 25 percent credit for net losses

On top of that, in 2010 Alaska lawmakers passed a bill with a $25 million tax incentive for the first offshore Cook Inlet well drilled by a jack-up into the Mesozoic. Subsequent wells get $22.5 million and $20 million if they are drilled with the same jack-up.

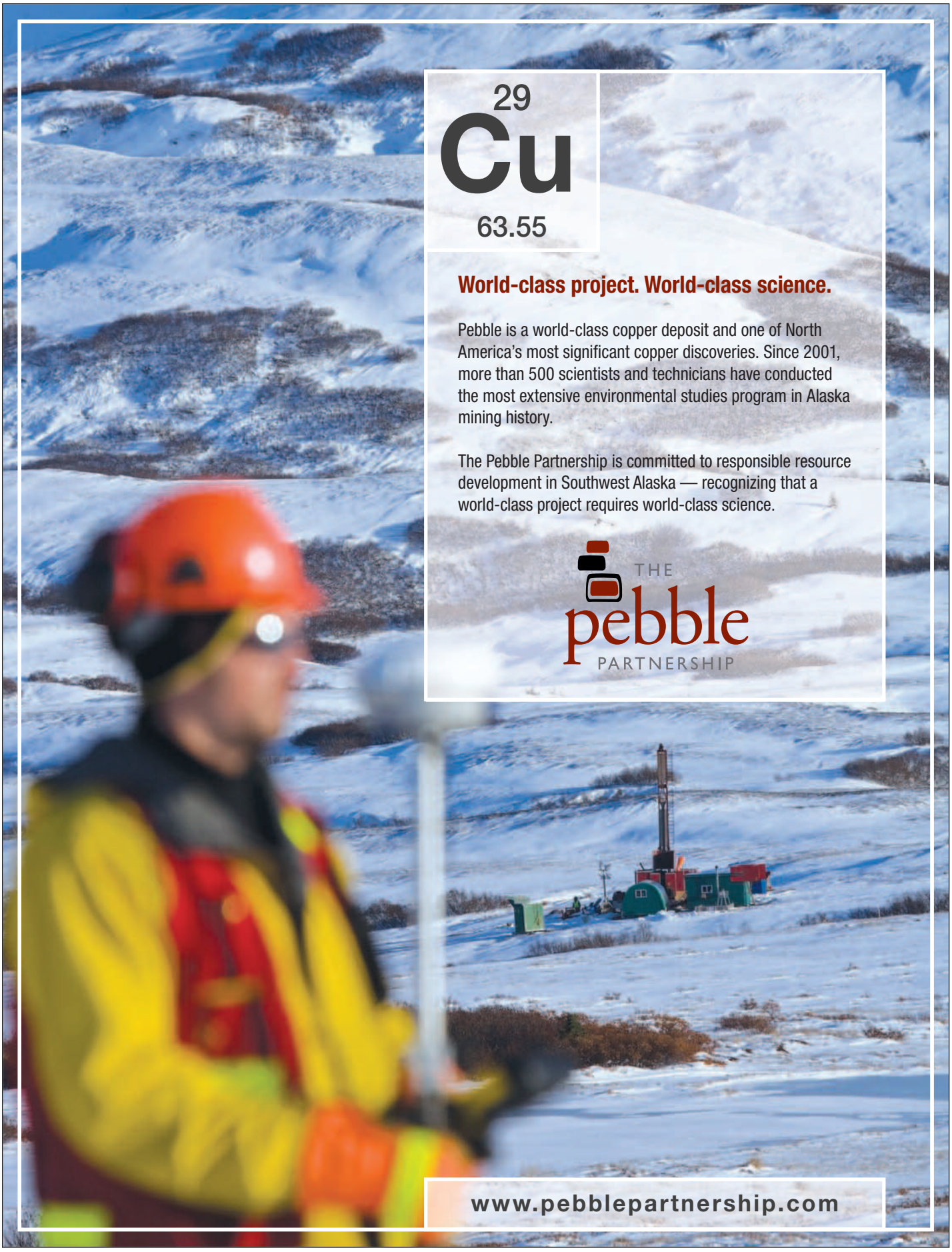
Apache impressed

A few new explorers have entered the Cook Inlet basin since the state's incentives have increased, the most notable Apache Corp., which acquired its initial 200,000 acres in 2010.

John Bedingfield, Apache's vice president for worldwide exploration and new ventures, said Cook Inlet is intriguing because of its "tremendous" oil potential.

In a way, he said, Cook Inlet was a victim of the enormous Prudhoe Bay discovery in 1968, which drew investment and attention away from what had been an impressive oil and gas province in its own right.

Although Apache's main interest is oil, it's mindful of the ready local market for natural gas, Bedingfield said.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