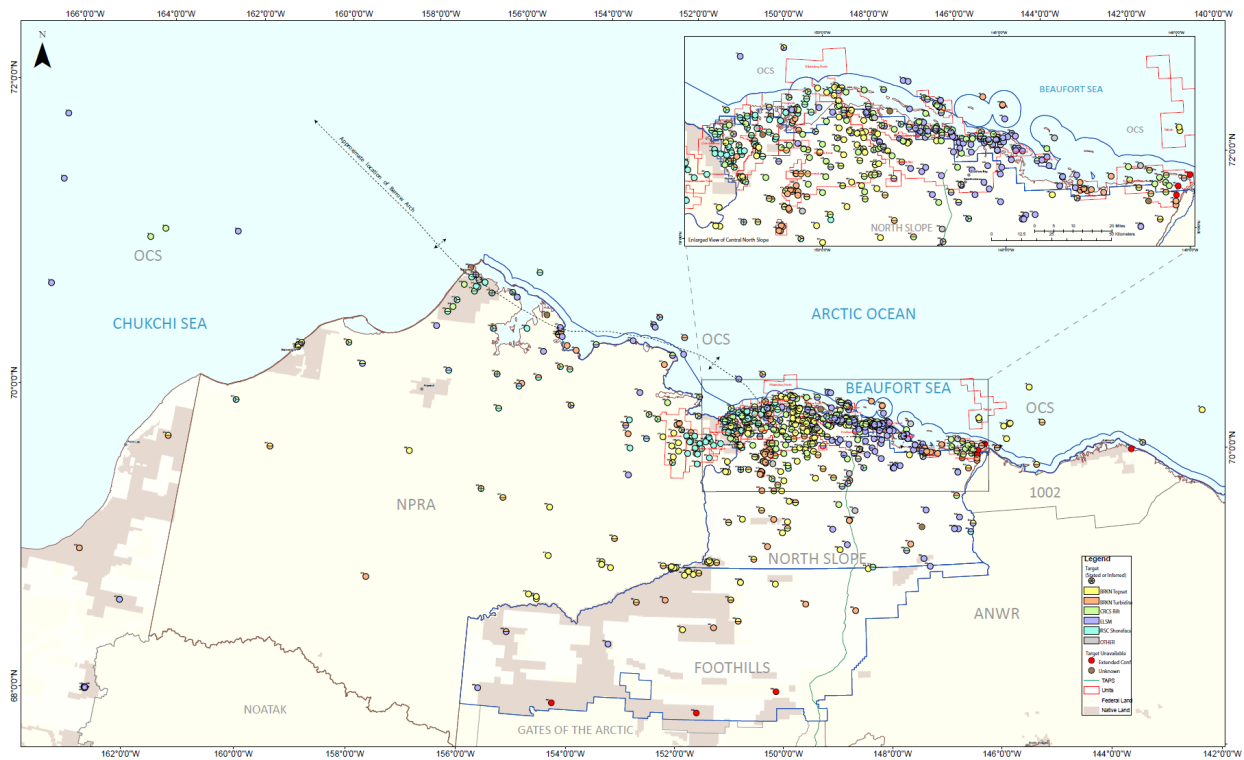


# MAP AND DATABASE OF EXPLORATION DRILLING TARGETS CATEGORIZED BY PLAY TYPE, NORTH SLOPE AND OFFSHORE ARCTIC ALASKA

Laura Gregersen and Garrett Brown

## Miscellaneous Publication 167



Map of exploration drilling targets categorized and colored by play type, North Slope, and Offshore Arctic Alaska with inset map.

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STATE OF ALASKA  
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DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS



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# MAP AND DATABASE OF EXPLORATION DRILLING TARGETS CATEGORIZED BY PLAY TYPE, NORTH SLOPE AND OFFSHORE ARCTIC ALASKA

Laura Gregersen<sup>1</sup> and Garrett Brown<sup>2</sup>

## INTRODUCTION

Since exploration drilling began on the North Slope of Alaska in 1944, numerous oil and gas accumulations have been discovered and 18 billion barrels of liquid hydrocarbons have been produced from North Alaska through 2018 (AOGCC, 2018a). Wells have targeted five main play types: Ellesmerian clastics and carbonates (Kekiktuk, Lisburne, Ivishak, Shublik, and Sag River), Jurassic shoreface sands (Barrow, Simpson, Kugrua, Nechelik, Nuiqsut, and Alpine), Cretaceous rift sands (Walakpa, Kuparuk, Put River, Kemik, and Thomson), Brookian turbidites (Torok, Seabee, and Canning), and Brookian topsets (Nanushuk, Tuluvak, Schrader Bluff, West Sak, Ugnu, Prince Creek, and Sagavanirktok). A sixth category called 'Other' includes the remaining targets (e.g., basement, methane hydrates, and coalbed methane).

This comprehensive study documents the drilling target by play type from public domain sources for 548 exploration wells on the North Slope and adjacent offshore areas in the Beaufort Sea and Chukchi Sea. The discovery well and production data for each producing pool are integrated into the study.

## WHAT IS IN THIS PUBLICATION?

This publication includes four map sheets and an Excel spreadsheet database of 548 exploration wells on the North Slope, Beaufort Sea, and Chukchi Sea. Sheet one contains a map of all exploration drilling targets categorized by play type and charts of exploration drilling timelines for each of the five main play types. Given the large number of wells in the corridor extending onshore and offshore from the Colville Delta to the Sagavanirktok Delta, this area on sheet one includes many well symbols and map numbers that overprint each other and are difficult to read. This problem is alleviated on sheets 2-4. Sheet two includes four maps of Ellesmerian exploration drilling targets broken out by geologic horizons: Kekiktuk Formation, Lisburne Group, Sadlerochit Group, Shublik Formation, and Sag River Formation. Sheet three includes a map of the Jurassic shoreface exploration drilling targets and a map of Cretaceous rift exploration drilling targets. Sheet four includes a map of Brookian topset exploration drilling targets and a labeled map of Brookian turbidite exploration targets.

The excel spreadsheet database includes the following information for each well:

- Map number used on the *Map of all Exploration Drilling Targets Categorized by Play Type* (sheet 1).
- General well information:
  - API number; well name; current operator; spud date; completion date; and total depth of well in feet.

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- Public availability status and first production:
  - YES indicates the well's target was clearly stated in a public source.
  - NO indicates no target information was found in a public source.
  - INF indicates the target was inferred from public data such as drill stem tests (DST) or core.
  - EC indicates the well is currently tagged as 'indefinite confidentiality' with the Alaska Oil and Gas Conservation Commission (AOGCC, 2018a).
  - WTS indicates a public source states that the well was tested or had significant shows in the target.
  - FP indicates first production of an AOGCC pool. In some pools, multiple wells produced oil during start-up. The authors picked one well to represent the first production of the pool.
  - DevD indicates a development well, instead of an exploration well, discovered a new oil or gas accumulation that is a producing pool tracked by the AOGCC.
- Specified formation name(s) of the exploration target within each play type category.
- Notation if the well was a discovery well of a producing pool or if it contributed to the first production of the pool.
- A link to the public source of the exploration target information and the page number within the source.
- A link to a secondary public source, when applicable, and its corresponding page number within the source.
- An explanation of the formation name abbreviations for each play type (also found in appendix 1).
- An explanation of the AOGCC producing pool abbreviations for each play type (also found in appendix 2).
- The Excel spreadsheet is available from the Alaska Division of Oil & Gas (<http://dog.dnr.alaska.gov/Information/Studies>).

## DATA

All exploration target data integrated into this study are from public sources. The primary sources of public domain data are state and federal well histories, Alaska Division of Oil and Gas unit decisions, Petroleum News articles, Alaska industry news articles, federal well summary reports, and lessee press releases.

The authors used an iterative process to collect and review exploration target data. The first step was to gather exploration target information from any possible public source, document the findings, and record a link and page number(s) of where the exploration target data are stated. Then, the authors verified each exploration target and cited the reference. If the target was directly stated or the inferred target could be deduced from the supporting public data, the target was placed into a play type category. Otherwise, the authors conducted an additional search of public data so a satisfactory drilling target could be identified or inferred.

The availability of the drilling target data varied so a 'public availability status' was designated for each well. The drilling targets are explicitly stated for 346 wells (public availability status = YES). 161 wells are

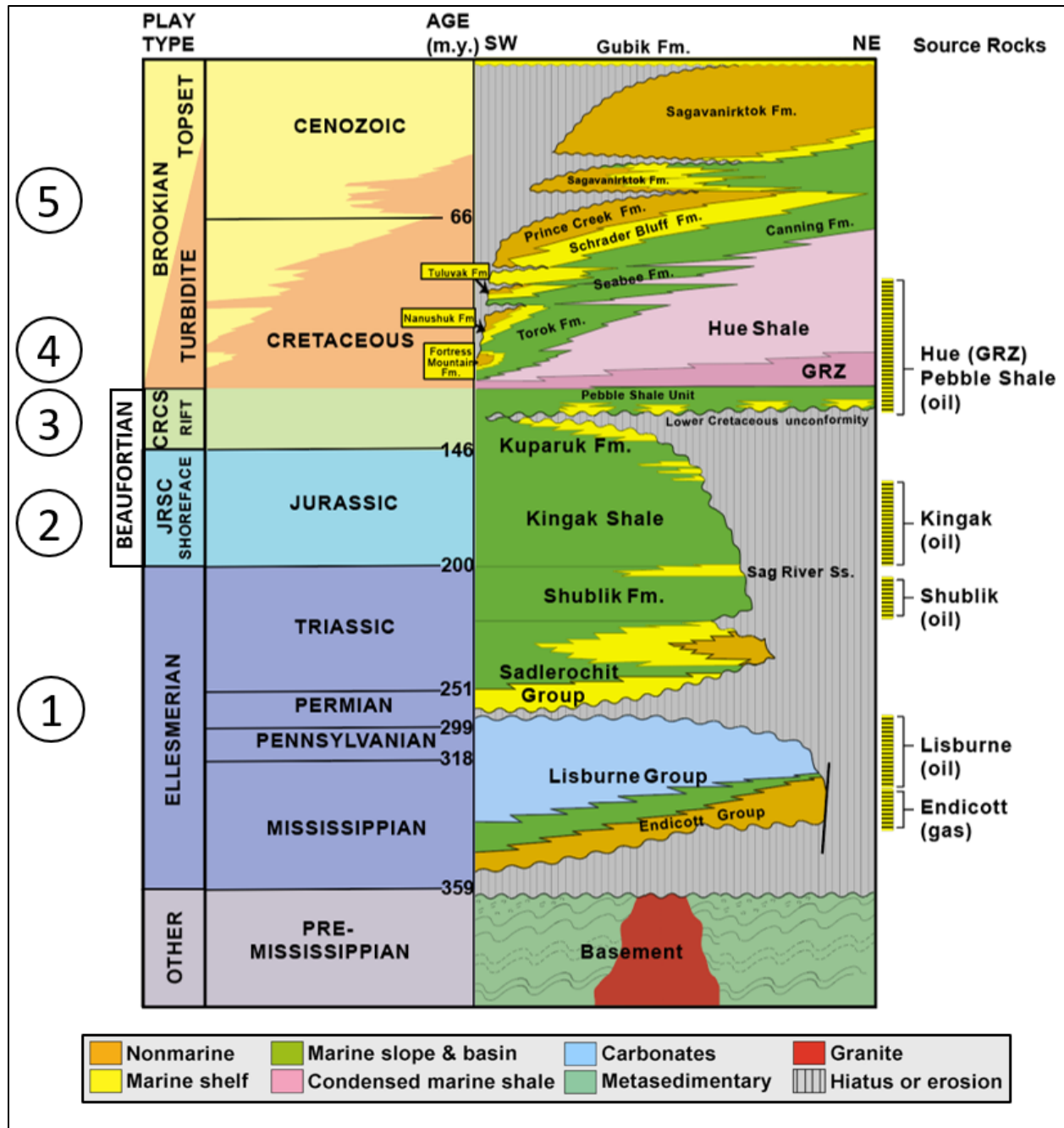
inferred from data such as core and drill stem tests (public availability status = INF). Eight wells are held under extended confidentiality with an unknown release date due to the status of acreage within a three-mile radius of the well (public availability status = EC). Twenty-one wells are explicitly stated as a well test and/or show (public availability status = WTS). Eleven wells were unable to be determined from the publicly available data (public availability status = NO).

The discovery well for each producing pool and a well that represents the first production for each pool was also incorporated into this study. For each well that discovered a producing pool, the prefix ‘Disc’ is placed before the pool name in the database under the appropriate play type category for that well. Most producing pools were discovered in an exploration well; however, a few producing pools were discovered in a development well. Those development wells are incorporated into the study and given the public availability status of DevD. The well that represents the first production for each pool was also included in this study. The public availability status for the first producers is FP, with the prefix ‘Zz’ is placed before the pool name in the database under the appropriate play type category.

## **INTERPRETATION OF PLAY TYPE CATEGORIES**

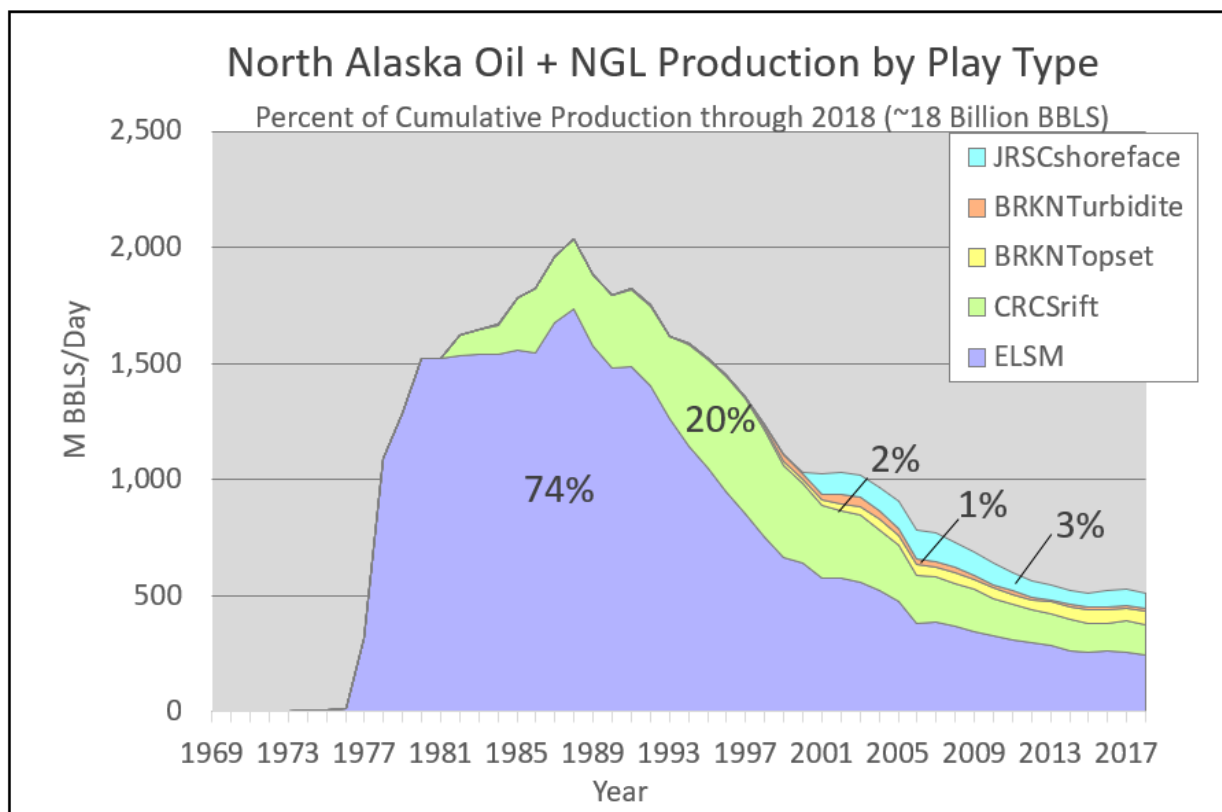
The goal of this project was to provide generalized ‘geologic’ filters to exploration and production data in north Alaska that were in sync with Federal oil and gas resource assessments by the United States Geological Survey (USGS) and the Bureau of Ocean Energy Management (BOEM) (formerly known as the Minerals Management Service [MMS]). In north Alaska, oil and gas exploration wells have targeted five main stratigraphic play type categories: Ellesmerian clastics and carbonates, Jurassic shoreface sands, Cretaceous rift sands, Brookian turbidites, and Brookian topsets. We developed a sixth category called ‘Other’ to encompass everything other than the play types listed above (i.e., basement, methane hydrates, and coalbed methane). The stratigraphic play types are color coded and shown in a generalized stratigraphic column for north Alaska (fig. 1; sheet 1).

The maps of exploration drilling targets highlight the spatial distribution of each play type. Exploration wells targeting the Ellesmerian aged targets, which are the largest contributor to oil production in north Alaska, systematically cover a region that extends from the Chukchi Sea, through northern NPRA, and across the northern portion of the central North Slope. Wells are both onshore and in the Beaufort Sea (sheets 1 and 2). Other Ellesmerian targets are found in the east-central North Slope region and the foothills of the Brooks Range. A small cluster of natural gas wells targeting the Kivalina Member of the Kuna Formation are within the Brooks Range at the Red Dog Mine. The wells targeting the Jurassic cover a region from onshore northwest NPRA to the west-central region of the North Slope (sheets 1 and 3). The wells targeting the Cretaceous rift-related sands are found in the Chukchi Sea and within a seventy-five-mile-wide swath that extends from northwest NPRA to the western border of the Alaska National Wildlife Refuge (ANWR) (sheets 1 and 4). The greatest concentration of Cretaceous rift-related targets is in the north-central North Slope. Wells targeting Brookian turbidites and Brookian topsets cover the northern and central regions of NPRA, the central North Slope, and the foothills of the Brooks Range (sheets 1 and 4). In both Brookian plays north-south trending lines of exploration wells delineate shelf margins. Exploration wells targeting both Brookian play types are found in the Beaufort Sea west and north of ANWR.



**Figure 1.** Generalized stratigraphic column for north Alaska with color code for each exploration target play type. Figure modified from Houseknecht and Bird, 2006; Garrity and others, 2005; Gregersen and Brown, 2019a; and Alaska Division of Oil & Gas.

Each one of the five play types have contributed to oil production on the North Slope. A waterfall chart showing oil and natural gas liquid (NGL) production as categorized by play type highlights the fact that the Ellesmerian reservoirs have been the primary contributors to production (fig. 2; sheet 1). The Cretaceous rift-related reservoirs are secondary followed by the Jurassic shoreface reservoirs, Brookian topsets, and Brookian turbidites.



**Figure 2.** North Alaska oil and natural gas liquid (NGL) production color-coded by play type category. ELSM = Ellesmerian reservoir, JRSCshoreface = Jurassic shoreface reservoir, CRCSrift = Cretaceous rift reservoir, BRKN Turbidite = Brookian turbidite reservoir, BRKN Topset = Brookian topset reservoir. The percentage of each play type's contribution to the 18 billion barrels produced from north Alaska through 2018 is shown in black font. Production data are from AOGCC (AOGCC, 2018a). Figure from Gregersen and Brown, 2019b.

Individual charts for each play type show the annual exploration well count, development well count, discovery date, and annual oil production rate (fig. 3; sheet 1). Oil production is represented by the solid blackline. The number of development wells drilled is represented by the blue solid line; the bars represent the exploration well count that targeted that play type that year. The discoveries that have been put into production are symbolized by closed squares and the undeveloped discoveries are symbolized by open circles. The following historical summaries correspond with the drilling timeline charts presented in figure 3 and summarized by Gregersen and Brown (2019b).

*Ellesmerian Clastics and Carbonates (fig. 3A):* In 1968, the Ellesmerian reservoirs in the supergiant Prudhoe Bay field were discovered. In the following year, 25 exploration wells targeting the Ellesmerian were drilled in an attempt to delineate the discovery and to find other giant or supergiant accumulations. As a result,

numerous oil fields—within the Ellesmerian as well as other play types—were discovered near Prudhoe Bay, and gas was discovered in the foothills. Exploration targeting the Ellesmerian was at its greatest through the mid 1980s. At this same time, oil production from North Alaska was climbing and another giant oil field, Endicott field, was discovered. Smaller in-field oil discoveries were found in the late 1990s and 2000s while other, much larger, oil fields were discovered in different play types. Consequently, the number of exploration wells targeting the Ellesmerian dwindled.

*Jurassic Shoreface (fig. 3B):* The Jurassic shoreface reservoirs were targeted in the 1940s and early 1950s by the US military. The US Navy discovered the South Barrow gas field and produced it to fuel their research stations. Additional gas was discovered in 1974 at the East Barrow gas field. The next wave of exploration came in the mid 1980s and early 1990s. Oil was found in the Colville Delta region, but there was no spare capacity in the Trans-Alaska Pipeline at that time. Following the discovery of oil in the giant Alpine field in 1994, exploration moved westward into the NPRA and wells targeting the Jurassic increased significantly. The latest announced Jurassic shoreface discovery is east of Alpine field.

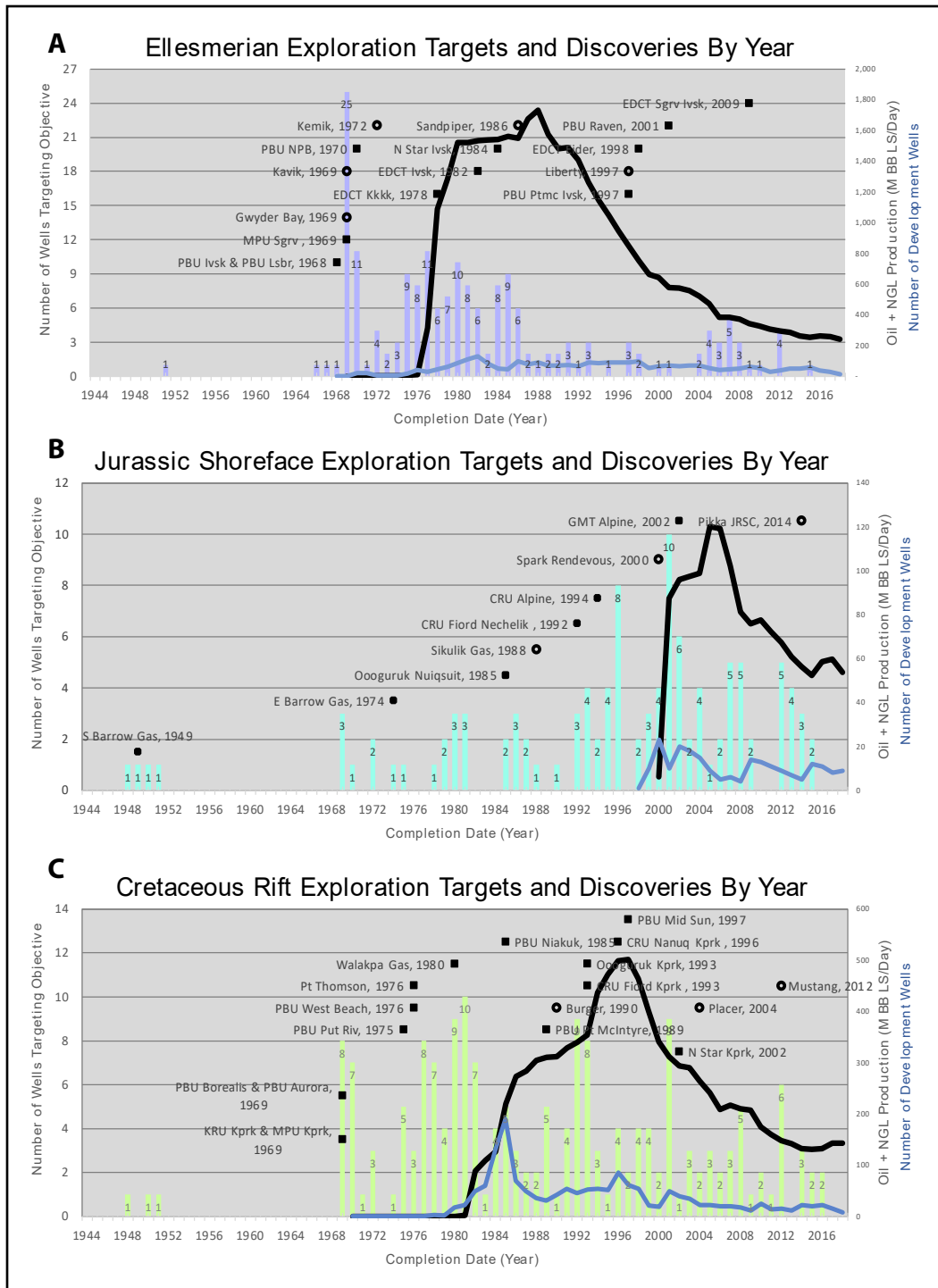
*Cretaceous Rift (fig. 3C):* The Cretaceous rift reservoirs have regularly been a target since the discovery of oil in the Kuparuk Formation at Kuparuk River Field and Milney Point in 1969. Development at the Kuparuk River Field began in 1981. The greatest number of exploration wells drilled were from 1969 through the early 1980s. The discoveries cover a large region along the Barrow Arch from the NPRA to the western border of ANWR. The late 1980s and 1990s found multiple Cretaceous rift-related accumulations along the Barrow Arch, and the most notable oil find was Point McIntyre. Burger gas field was discovered in the Chukchi Sea. The exploration in the early 2000s discovered oil within the North Star Unit and west of Kuparuk River Field.

*Brookian Turbidites (fig. 3D):* The Brookian turbidite reservoirs were targeted the most in the early 1950s along structural anticlinal trends that were expressed in the surface geology. There has been continued interest in Brookian turbidite targets from the 1960s to the present day. Discoveries in the 1990s led to development of Badami and Tarn in 1997.

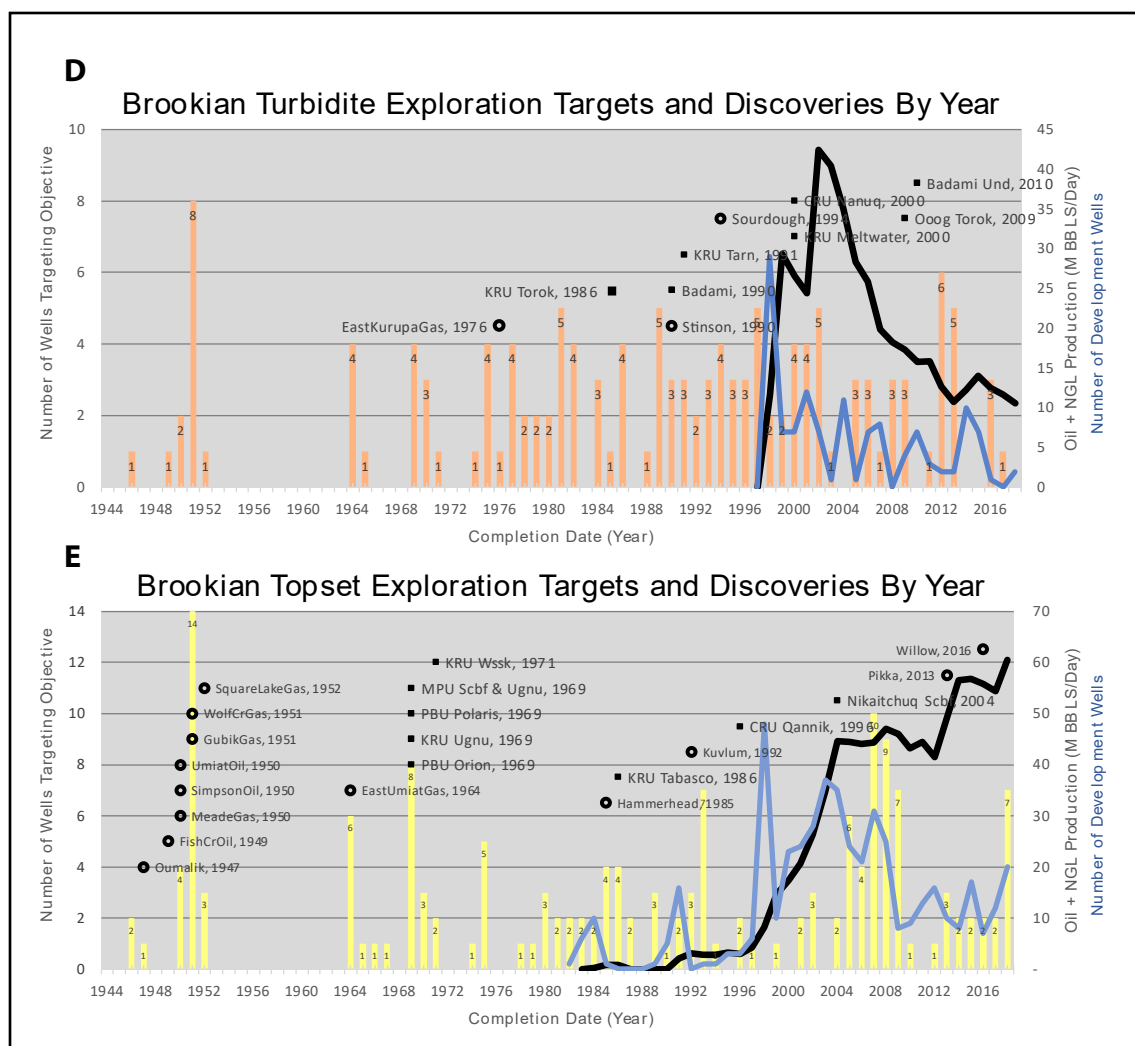
*Brookian Topsets (fig. 3E):* In the late 1940s and early 1950s several Brookian topset reservoirs were discovered by the US Navy along structural anticlinal trends in NPRA and the foothills. Discoveries were mainly gas in small accumulations. There was one notable oil accumulation, Umiat field, which is estimated to contain approximately 70 million barrels of recoverable oil (Kumar and others, 2002). The second round of exploration targeting the topset reservoirs occurred in the late 1960s and early 1970s.

The 1971 discovery of the West Sak viscous oil sands set off a flurry of delineation drilling in the mid 1970s and an early West Sak pilot program in 1983. The mid-1980s to 1990s found multiple 200-million- to 400-million-barrel oil fields in OCS waters (BOEM, 2006). Exploration at Milney Point took off in the early 1990s; extensive development of West Sak sands and the reservoir in the Schrader Bluff Formation started in 1998 and continues today. The Nikaitchuq discovery in 2004 set off a new wave of delineation and exploration drilling targeting topsets in the Schrader Bluff Formation. The most recent oil discoveries within the Nanushuk Formation, in the Pikka-Horseshoe trend, announced in 2013, and at Willow field, announced in 2016, have triggered the most recent exploration and delineation drilling. In 2018, seven exploration wells targeted Brookian topset reservoirs; more than any other play type that year.





**Figure 3.** Individual charts for each play type (from top to bottom: **(A)** Ellesmerian; **(B)** Jurassic Shoreface; **(C)** Cretaceous Rift; **(D)** Brookian Turbidites, and; **(E)** Brookian Topsets showing the annual exploration well count, development well count, discovery date, and annual oil production rate. Oil production is represented by the solid black line. The number of development wells drilled in that year is the solid blue line, and the bars represent the exploration well count that targeted that play type that year. The discoveries that have been put into production are symbolized by closed squares and the undeveloped discoveries are symbolized by open circles.



**Figure 3, continued.** Individual charts for each play type (from top to bottom: (A) Ellesmerian; (B) Jurassic Shoreface; (C) Cretaceous Rift; (D) Brookian Turbidites, and; (E) Brookian Topsets showing the annual exploration well count, development well count, discovery date, and annual oil production rate. Oil production is represented by the solid black line. The number of development wells drilled in that year is the solid blue line, and the bars represent the exploration well count that targeted that play type that year. The discoveries that have been put into production are symbolized by closed squares and the undeveloped discoveries are symbolized by open circles. Figures from Gregersen and Brown, 2019a.

## ERROR AND UNCERTAINTY

All sources of data for this study are found in the public domain. No exploration drilling target information from confidential sources was incorporated. For this reason, the database may be missing exploration drilling targets that the operator had as an objective but did not report in publicly available records. Drilling target inferences made from core or drill stem tests relied upon publicly available formation tops within publicly available well histories as well as the formation picks available at the Alaska Division of Geological & Geophysical Surveys' Geologic Materials Center. One of the most challenging targets to put into

a play type category was labeled 'Cretaceous.' Multiple play type categories are Cretaceous in age. The authors used their best judgment from the well history data and understanding of the regional geology when placing a Cretaceous drilling target into a play type category.

The discovery date for each producing field is sourced from the AOGCC pool rules (AOGCC, 2018b). Most of the discovery dates for the undeveloped accumulations come from Thomas and others, 2007, and Petroleum News articles. The authors recognize that there was a judgment call made by the public source as to which well actually discovered the undeveloped accumulations. There may also be many more accumulations that have been found by exploration wells that have not been announced publicly. These are not included in this study.

The companion database provides a link and a page number for each public source an exploration target is based upon. Because the AOGCC updates its online well history files (AOGCC, 2018c), the page number within the well history file may change. For this reason, when looking up more recent wells, the page number may be incorrect. Most of the older exploration wells were will not be receiving updates to the well files and page numbers are unlikely to change.

## **ACKNOWLEDGEMENTS**

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**APPENDIX 1: EXPLANATION OF DRILLING TARGET FORMATION NAME ABBREVIATIONS**

<b>Exploration Drilling Target Abbreviations</b>	
HYDRATE	Gas Hydrate Stability Zone
CBM	Coal Bed Methane
MARINEClastics	Marine Clastic Rocks
TURB	Turbidite
<b>SVKK</b>	<b>Sagavanirktok Formation</b>
<b>CNNG</b>	<b>Canning Formation</b>
FLAX	Flaxman Sandstone
BDAM	Badami Sandstone
KILLIAN	Killian Sandstone
<b>PCCK</b>	<b>Prince Creek Formation</b>
KGKK	Kogosukruk tongue of Prince Creek abandoned
<b>UGNU</b>	<b>Ugnu Sandstone</b>
UGNUB	Ugnu B Sandstone
<b>SCBF</b>	<b>Schrader Bluff Formation</b>
SCBFN	Schrader Bluff N Sandstone
SCBFO	Schrader Bluff O Sandstone
SCBFOa	Schrader Bluff Oa Sandstone
SLHL	Sentinel Hill Mbr of Schrader Bluff abandoned
BRTL	Barrow Trail Mbr of Schrader Bluff abandoned
WSSK	West Sak Sandstone
WSSKD	West Sak D Sandstone
WSSKB	West Sak B Sandstone
TABSCO	Tabasco Sandstone
<b>TLVK</b>	<b>Tuluvak Formation</b>
<b>SEBE</b>	<b>Seabee Formation</b>
AYYK	Ayyiak Mbr of Seabee Formation abandoned
TARN	Tarn Sandstone
ICEBERG	Iceberg Sandstone
ARETE	Arete Sandstone
CAIRN	Cairn Sandstone
BRMA	Bermuda Sandstone
<b>NNSK</b>	<b>Nanushuk Formation</b>
NNLK	Ninuluk Formation abandoned
CDLR	Chandler Formation abandoned
GRDD	Grandstand Formation abandoned
TUKT	Tuktu Formation abandoned
WILLOW	Willow Sandstone
QNNK	Qannik Sandstone
K2	Brookian K2 Marker

<b>Exploration Drilling Target Abbreviations</b>	
<b>TOROK</b>	<b>Torok Formation</b>
MORAINÉ	Moraine Sandstone
NUNA	Nuna Sandstone
NANUQ	Nanuq Sandstone
CASSIN	Cassin Sandstone
BLACKBURN	Blackburn Sandstone
SANFORD	Sandford Sandstone
OMLK	Oumalik Formation abandoned
TPGK	Topogoruk Formation abandoned
<b>FRTR</b>	<b>Fortress Mountain Formation</b>
<b>HUE</b>	<b>Hue Shale</b>
<b>HRZ</b>	<b>HRZ</b>
<b>PBLS</b>	<b>Pebble Shale</b>
KLBK	Kalubik Formation
PTRR	Put River Sandstone
THOM	Thomson Sandstone
KEMIK	Kemik Sandstone
<b>KPRK</b>	<b>Kuparuk Formation</b>
KPRKC	Kuparuk C Sandstone
KPRKB	Kuparuk B Sandstone
KPRKA	Kuparuk A Sandstone
WLKP	Walakpa Sandstone
BURGER	Burger Sandstone
<b>KNGK</b>	<b>Kingak Shale</b>
ALPN	Alpine Sandstone
ALPNC	Alpine C Sandstone
NUIQ	Nuiqsut Sandstone
NECH	Nechelik Sandstone
SIMP	Simpson Sandstone
KUGRA	Kugrua Sandstone
BRRW	Barrow Sandstone
J5	Jurassic J5 Marker
J4	Jurassic J4 Marker
<b>SGRV</b>	<b>Sag River Formation</b>
<b>SBLK</b>	<b>Shublik Formation</b>
EILN	Eileen Formation
<b>SDLC</b>	<b>Sadlerochit Group</b>
IVSK	Ivishak Formation
KAVIK	Kavik Shale
ECHK	Echooka Formation

<b>Exploration Drilling Target Abbreviations</b>	
<b>LSBR</b>	<b>Lisburne Group</b>
WHOO	Wahoo Limestone
ALPH	Alapah Limestone
<b>EDCT</b>	<b>Endicott Group</b>
KAYAK	Kayak Shale
KKKK	Kekiktuk Sandstone
KVLA	Kivalina Mbr of Kuna Formation Red Dog Mine
<b>BSMN</b>	<b>BASEMENT</b>
ARGL	Argillite Basement

BRKN	Brookian Aged Target
TRTR	Tertiary Aged Target
MIOCENE	Miocene Aged Target
PLCN	Paleocene Aged Target
OLIG	Oligocene Aged Target
CCTR	Cretaceous Tertiary Aged Target
PreMSCZ	Pre Mesozoic Aged Target
CRCS	Cretaceous Aged Target
CRCSLower	Lower Cretaceous Aged Target
CRCSUpper	Upper Cretaceous Aged Target
ALBN	Albian Aged Target
JRSC	Jurassic Aged Target
ELSM	Ellesmerian Aged Target
TRSC	Triassic Aged Target
PMTC	Permian Triassic Aged Target
MSSP	Mississippian Aged Target
PREMISS	Pre Mississippian
DVNN	Devonian Aged Target

**APPENDIX 2: EXPLANATION OF AOGCC POOL NAME ABBREVIATIONS**

<b>AOGCC Producing Pools on Alaska's North Slope</b>	
<b>Brookian Topset Pools</b>	
ZzMpuUGNU	Milne Point Unit, Ugnu Ss
ZzKruUgnuUnd	Kuparuk River Unit, Ugnu Ss Undefined
ZzPbuPolaris	Prudhoe Bay Unit, Polaris
ZzPbuOrion	Prudhoe Bay Unit, Orion
ZzKruTabasco	Kuparuk River Unit, Tabasco
ZzNikaScbf	Nikaitchuq Schrader, Bluff Fm
ZzKruWssk	Kuparuk River Unit, West Sak Ss
ZzMpuSCBF	Milne Point Unit, Ugnu Ss
ZzCRUQANNIK	Colville River Unit, Qannik Ss
<b>Brookian Turbidite Pools</b>	
ZzBadmBadm	Badami Unit, Badami Ss
ZzBadmUndOil	Badami Unit, Undefined
ZzKruTarn	Kuparuk River Unit, Tarn Ss
ZzKruMelt	Kuparuk River Unit, Meltwater
ZzOoogTorokOil	Oooguruk Unit, Torok Fm
ZzKruTorok	Kuparuk River Unit, Torok Fm
ZzCRUNANUQ	Colville River Unit, Nanuq Ss
<b>Cretaceous Rift Pools</b>	
ZzKruKprk	Kuparuk River Unit, Kuparuk Fm
ZzMpuKPRK	Milne Point Unit, Kuparuk Fm
ZzPbuWB	Prudhoe Bay Unit, West Beach
ZzPbuPtmc	Prudhoe Bay Unit, Pt. MacIntyre
ZzPbuNiakuk	Prudhoe Bay Unit, Niakiuk
ZzPbuMidSun	Prudhoe Bay Unit, Midnight Sun
ZzWalakpaGas	Walakapa Gas
ZzPbuAuro	Prudhoe Bay Unit, Aurora
ZzPbuBore	Prudhoe Bay Unit, Borealis
ZzNstarKprk	North Star Unit, Kuparuk Fm
ZzCRUALPINENK	Colville River Unit, Nanuq PA, Kuparuk Fm
ZzCRUFIORDKPRK	Colville River Unit, Fiord PA, Kuparuk Fm
ZzOoogKprk	Oooguruk Unit, Kuparuk Fm
ZzPtThomUndOil	Point Thomson Unit, Undefined Oil



<b>Jurassic Pools</b>	
ZzBrrwSouthGas	Barrow South Gas
ZzBrrwEastGas	Barrow East Gas
ZzCRUALPN	Colville River Unit, Alpine Ss
ZzOoogNuiq	Oooguruk Unit, Nuiqsut Ss
ZzCRUFIORDNECH	Colville River Unit, Nechelik Ss
ZzGMTAlpine	Greater Mooses Tooth Unit, Alpine Ss
<b>Ellesmerian Pools</b>	
ZzPbuPrudhoe	Prudhoe Bay Unit, Prudhoe
ZzPbuLsbr	Prudhoe Bay Unit, Lisburne Group
ZzEdctKkkk	Endicott Unit, Kekiktuk Ss
ZzEdctlvsk	Endicott Unit, Ivishak Fm
ZzPbuNPB	Prudhoe Bay Unit, North Prudhoe Bay
ZzMpuSAGRIV	Milne Point Unit, Sag River Ss
ZzPbuPtmclvsk	Prudhoe Bay Unit, Pt McIntyre Ivishak Fm
ZzEdctEider	Endicott Unit, Eider
ZzPbuRaven	Prudhoe Bay Unit, Aurora
ZzNstarlvsk	North Star Unit, Ivishak Fm
ZzEdctSagRivlvsk	Endicott Unit, Sag River Ss & Ivishak Fm

\*\*Zz designates an AOGCC pool