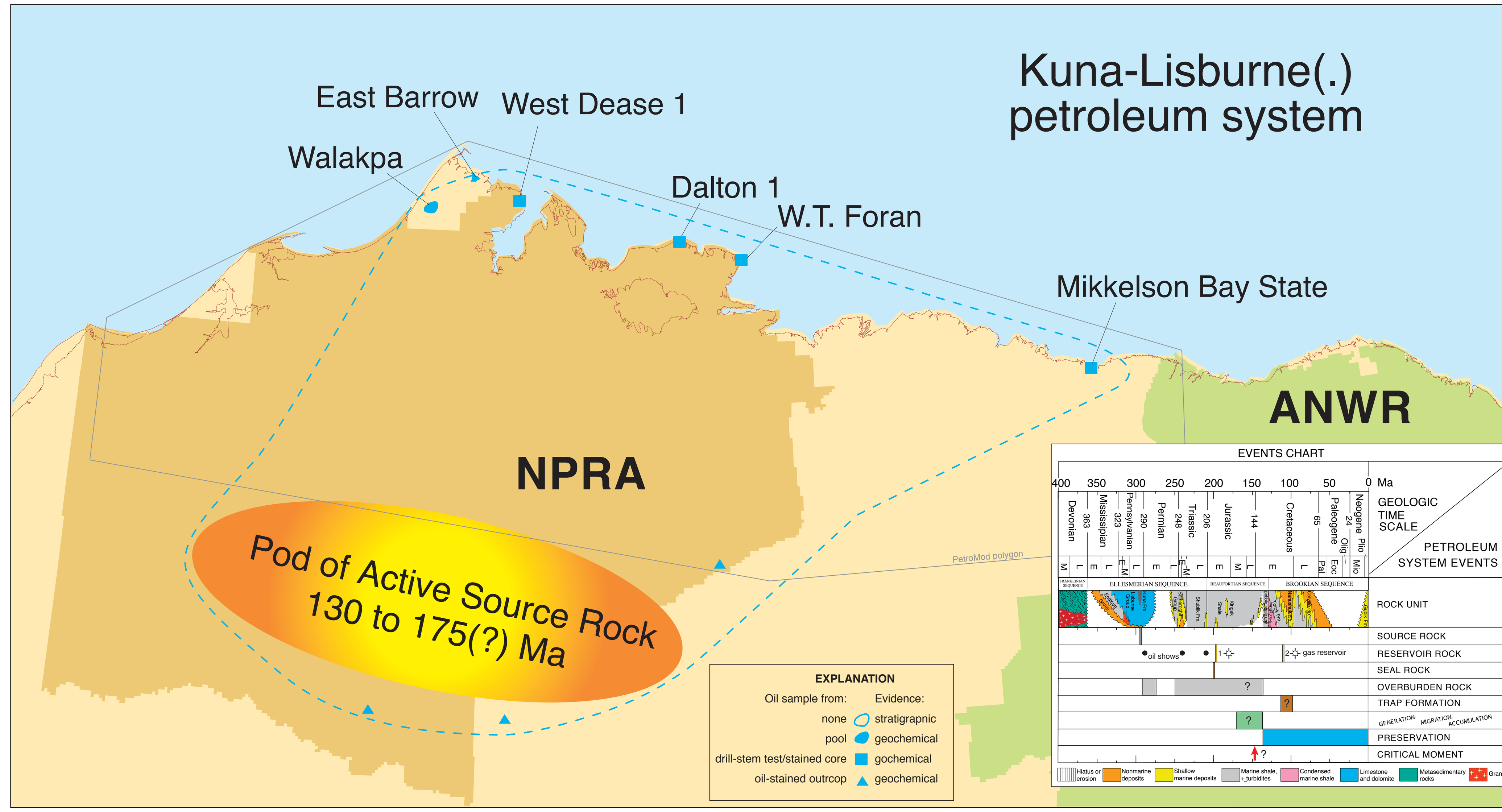
Alaskan North Slope Petroleum Systems

by L.B. Magoon[1], P.G. Lillis[2], K.J. Bird[1], C. Lampe[3], K.E. Peters[1]

1, U.S. Geological Survey, Menlo Park, California 2, U.S. Geological Survey, Denver, Colorado 3, Integrated Exploration Systems, Juelich, Germany


Kuna-Lisburne(.)
petroleum system
East Barrow
West Dease 1
Walakpa
Dalton 1
W.T. Foran
Mikkelson Bay State
ANWR
NPRA
Pod of Active Source Rock
130 to 175(?) Ma
EVENTS CHART
GEOLOGIC TIME SCALE
PETROLEUM SYSTEM EVENTS
ROCK UNIT
SOURCE ROCK
RESERVOIR ROCK
SEAL ROCK
OVERBURDEN ROCK
TRAP FORMATION
PRESERVATION
CRITICAL MOMENT
EXPLANATION
Oil sample from: Evidence:
none stratigraphic
pool geochemical
drill-stem test/stained core geochemical
oil-stained outcrop geochemical

Oil and gas pools charged by the Kuna Formation

Lisburne	NO.	POOL NAME	FIELD NAME	DATE DISCOVERED	RESERVOIR NAME	AGE	OIL or GAS	GAS CAP	RECOVERABLE OIL CUMULATIVE (10^6 BBL)	RECOVERABLE OIL REMAINING (10^6 BBL)	RECOVERABLE OIL ORIGINAL (10^6 BBL)	REC FAC (%)	IN-PLACE OIL (10^6 BBL)	RECOVERABLE GAS CUMULATIVE (10^9 FT^3)	RECOVERABLE GAS REMAINING (10^9 FT^3)	RECOVERABLE GAS ORIGINAL (10^9 FT^3)	REC FAC (%)	IN-PLACE GAS (10^9 FT^3)
x	2	SOUTH BARROW	BARROW FIELD	15-Apr-49	Barrow ss (Kingak Shale)	Jurassic	GAS	na	na	na	na	na	na	22.2	4	26.2	nd	nd
o	23	EAST BARROW	BARROW FIELD	04-May-74	Barrow ss (Kingak Shale)	Jurassic	GAS	na	na	na	na	na	na	7.6	5	12.6	nd	<<1000
x	33	WALAKPA	WALAKPA FIELD	07-Feb-80	Walakpa sandstone	Cretaceous	GAS	na	na	na	na	nd	nd	7.5	25	32.5	nd	nd

Recoverable oil and gas by reservoir rock

EVENTS CHART NUMBER	RESERVOIR NAME	AGE	MIXTURE (%)	RECOVERABLE OIL CUMULATIVE (10^6 BBL)	RECOVERABLE OIL REMAINING (10^6 BBL)	RECOVERABLE OIL ORIGINAL (10^6 BBL)	REC FAC (%)	IN-PLACE OIL (10^6 BBL)	RECOVERABLE GAS CUMULATIVE (10^9 FT^3)	RECOVERABLE GAS REMAINING (10^9 FT^3)	RECOVERABLE GAS ORIGINAL (10^9 FT^3)	REC FAC (%)	IN-PLACE GAS (10^9 FT^3)	RECOVERABLE OIL (10^6 BBL)	RECOVERABLE GAS (10^9 FT^3)	RECOVERABLE BOE (10^6 BBL)	RECOVERABLE TOTAL BOE (10^6 BBL)	BOE (%)
1	Barrow ss (Kingak Shale)	Jurassic	100	na	na	na	na	na	29.8	9	38.8	nd	nd	na	38.8	6.5	6.5	54.6
2	Walakpa sandstone	Cretaceous	100	na	na	na	nd	nd	7.5	25	32.5	nd	nd	na	32.5	5.4	5.4	45.4
														na	71.3	11.9	11.9	100

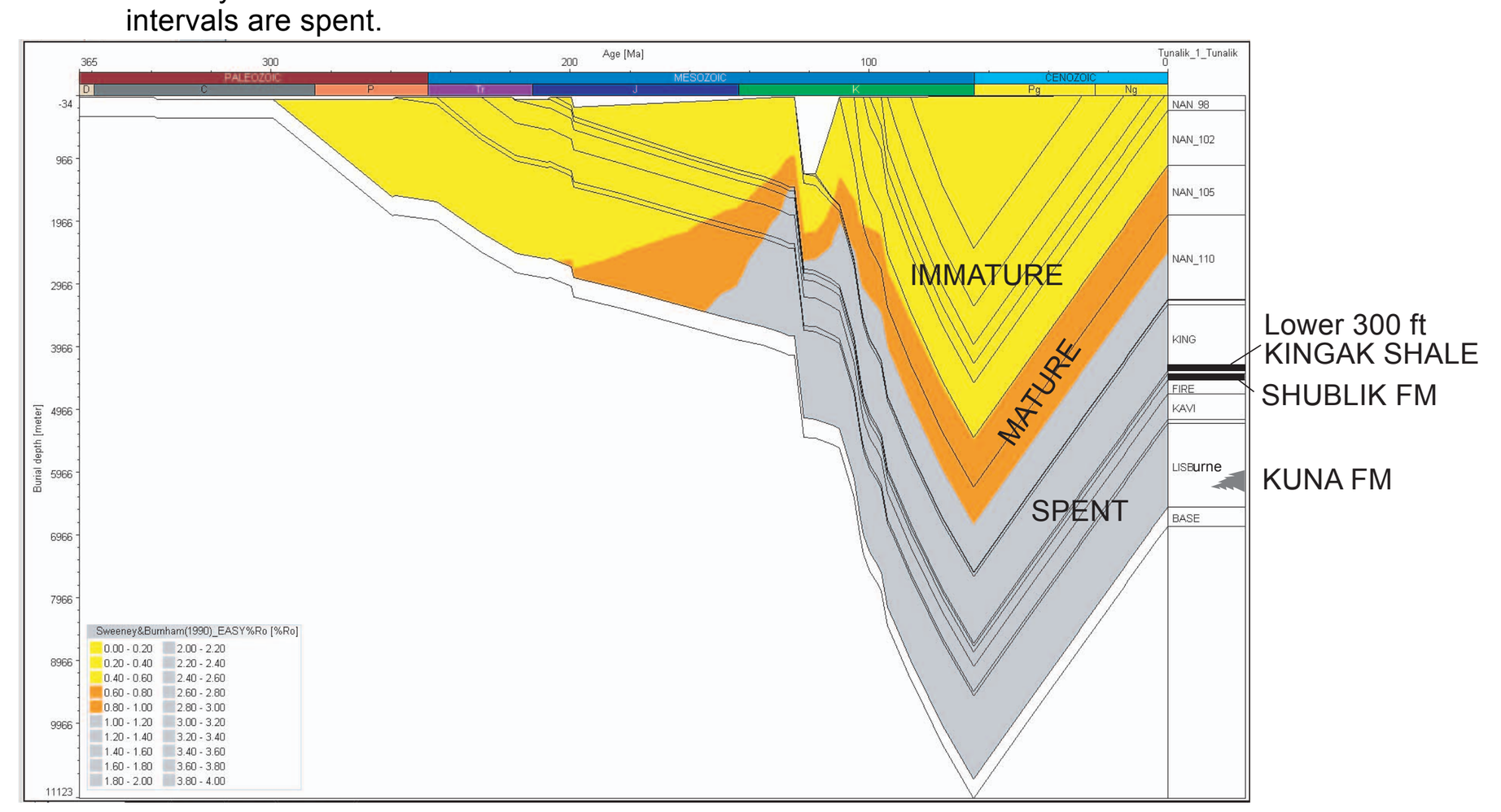
Oil samples from oil-stained cores and drill-stem tests from wells where hydrocarbons were expelled from Kuna Formation or Lisburne Group source rock

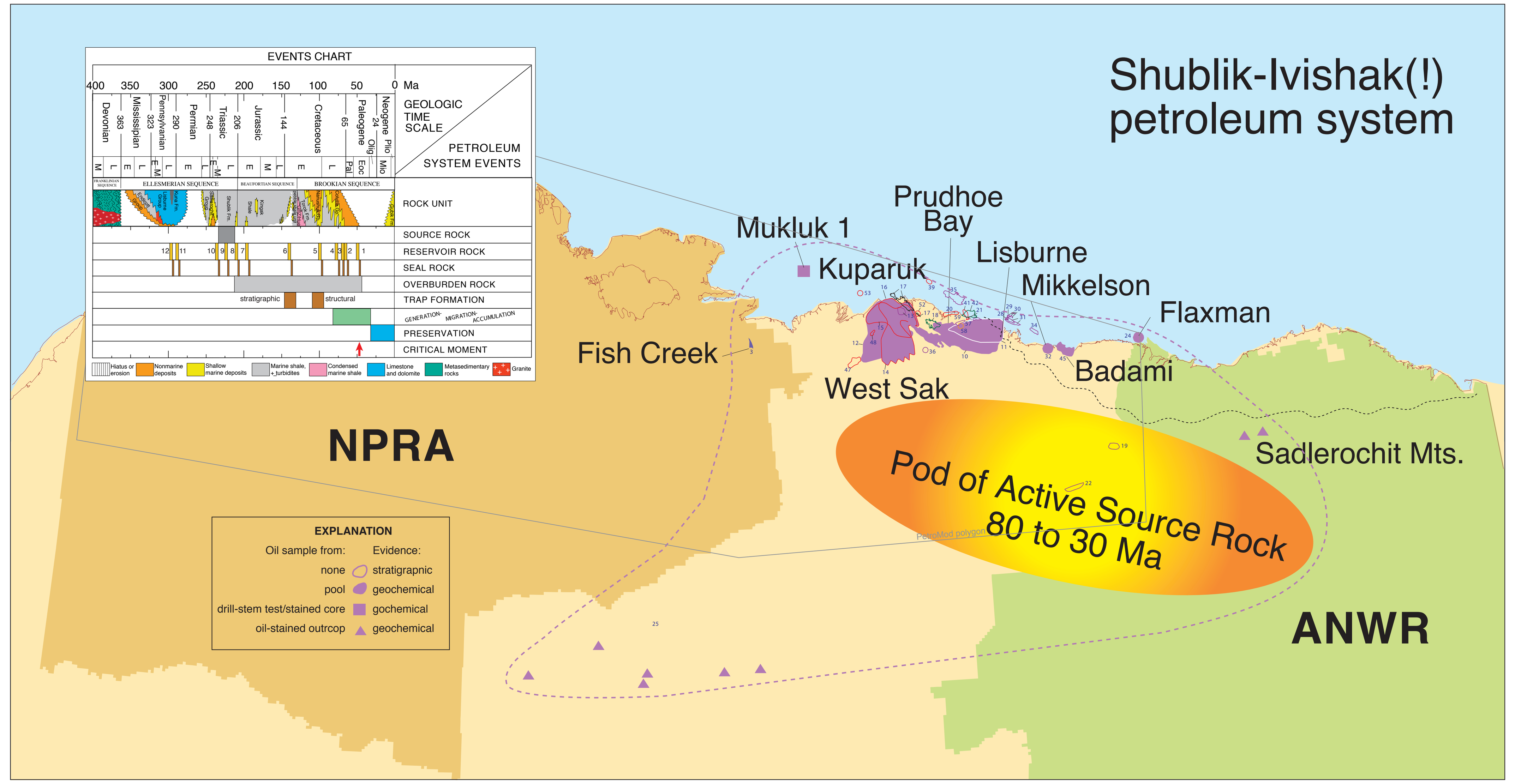
OIL SOURCE ROCK	SAMPLE ID		ADDITIONAL SAMPLE ID	TOP (FT)	BOT (FT)	STY	ROCK UNIT	LAT	LONG	API NUMBER
Lisburne	J. W. DALTON	1	R197-292	7967	7967	CC	LEDGE SD MBR	70.92050	-153.13753	50279200060000
Lisburne	J. W. DALTON	1	R197-357	8333	8333	CC	LISBURNE	70.92050	-153.13753	50279200060000
Lisburne	J. W. DALTON	1	DST 3-DALTON NO.1	8482	8538	OL	LISBURNE	70.92050	-153.13753	50279200060000
Lisburne	J. W. DALTON	1	R197-361-362	8520	8525	CC	LISBURNE	70.92050	-153.13753	50279200060000
Lisburne	J. W. DALTON	1	DALTON WELL	8568	8665	OL	Lisburne	70.92050	-153.13753	50279200060000
Lisburne	SOUTH BARROW	12	S. BARROW NO. 12	2203	2250	OL	SAG RIVER SD	71.23725	-156.33778	50023200060000
Lisburne	SOUTH BARROW	12	R118-012	2248	2248	CC	SAG RIVER SD	71.23725	-156.33778	50023200060000
Lisburne	SOUTH BARROW	17	R175-070	2095	2127	CC	BARROW SD	71.23473	-156.26314	50023200110000
Lisburne	SOUTH BARROW	17	DST 4R	2122	2345	OL	BARROW SD	71.23473	-156.26314	50023200110000
Lisburne	SOUTH BARROW	17	=R175-095	2212	2322	OL	BARROW SD	71.23473	-156.26314	50023200110000
Lisburne	SOUTH BARROW	17	R175-080	2322	2345	CC	SAG RIVER SD	71.23473	-156.26314	50023200110000
Lisburne	SOUTH BARROW	19	R176-066	2039	2069	CC	BARROW SD	71.24151	-156.33352	50023200120000
Lisburne	SOUTH BARROW	19	R176-078	2161	2245	EN	Sag River Sd	71.24151	-156.33352	50023200120000
Lisburne	SOUTH BARROW	19	R176-082	2200	2245	EN	SAG RIVER SD	71.24151	-156.33352	50023200120000
Lisburne	SOUTH BARROW	19	R176-075	2230	2245	CC	SAG RIVER SD	71.24151	-156.33352	50023200120000
Lisburne	W. T. FORAN	1	R109-172	8205	8283	EN	Lisburne	70.83223	-152.30312	50103200100000
mix HRZ Lisburne	SOUTH BARROW	20	DST#3; UP ZN FLOW	1556	1639	EN	Pebble shale	71.23250	-156.33670	50023200150000
mix HRZ Lisburne	SOUTH BARROW	20	R226-017;INTALFLO	1629	1639	EN	PEBBLE SH	71.23250	-156.33670	50023200150000
mix HRZ Lisburne	SOUTH BARROW	20	R226-018;FINALFLO	1629	1639	EN	PEBBLE SH	71.23250	-156.33670	50023200150000
mix HRZ Lisburne	SOUTH BARROW	9	R117-014	2425	2425	CC	BARROW SD	71.26774	-156.61484	50023200030000
mix Lisburne HRZ	WALAKPA	1	SAME AS R221-129	2070	2070	CC	PEBBLE SH	71.09934	-156.88439	50023200130000
mix Lisburne HRZ	WEST DEASE	1	R225-146	3720	3725	CC	BARROW SD	71.15907	-155.62919	50023200140000
mix Lisburne HRZ	WEST DEASE	1	R225-164	3805	3810	CC	SAG RIVER SD	71.15907	-155.62919	50023200140000

The Lower Mississippian to Lower Permian Lisburne Group is widely distributed on the North Slope, and consists mainly of shallow marine carbonate rocks, with local deep marine shale, chert, fine-grained limestone and dolomite. North of the Brooks Range the Lisburne is platform carbonates with sporadic interbeds of organic-rich shale (Masterson, 2001). In the central and western Brooks Range the Lisburne Group consists of the deep marine Kuna Formation (Mull and others, 1982) and is generally organic-rich (Tailleur, 1964; Bird and Jordan, 1977; Magoon and Bird, 1988; Banet and Evans, 2002). The Lisburne has been proposed as an oil source rock (Bird and Jordan, 1977; Anders and others, 1985; Huang and others, 1985; Hughes and others, 1985; Keal and Dow, 1985; Magoon and Bird, 1988; GeoMark, 1997; Lillis and others, 1999; Holba, Wilson, and others, 2000, 2001; Masterson, 2001; Lillis and others, 2002), and work in progress by the USGS (Lillis, unpublished data) shows that the shale facies is likely the primary oil source. The Kuna-Lisburne is here designated a source rock unit because the Kuna Formation and other unnamed thin beds of organic-rich source rocks are within the Lisburne Group.

Oil occurrences believed to originate from the Kuna-Lisburne source rock unit are widely scattered. The only oil samples of Kuna-Lisburne with API gravity and sulfur data are from the J.W. Dalton 1, KRU 2F-20, Mikkelsen Bay State 1, South Barrow 12, South Barrow 17, and South Barrow 19 wells. However, there are problems with each of these samples. The oil gravity and sulfur content of the Dalton sample have been altered by biodegradation (Magoon and Claypool, 1988) and the KRU 2F-20 sample was generated at high maturity (Masterson, 2001). The Mikkelsen well is far from NPRA and may have a different oil composition because of possible lateral source facies variations. The South Barrow oil samples were proposed to be Kuna-Lisburne oils (GeoMark, 1997) but more recent geochemical studies suggest that they are derived from the Shublik-Otuk source rock unit (Holba and others, 2000). Consequently, the gravity and sulfur content of Kuna-Lisburne type oil estimated for the assessment has a higher degree of uncertainty than the other oil types. The composition of the South Barrow 12 oil (24 API, 1.6 wt.% S) was selected as representative of Kuna-Lisburne oil. The Kuna-Lisburne(.) lacks commercial oil accumulations but include gas fields in the Barrow area that may have originated from the Lisburne Group.

Burial history for the Tunalik no. 1 well in western NPRA. All three source rock intervals are spent.




Shublik-Ivishak(!)
petroleum system
EVENTS CHART
GEOLOGIC TIME SCALE
PETROLEUM SYSTEM EVENTS
ROCK UNIT
SOURCE ROCK
RESERVOIR ROCK
SEAL ROCK
OVERBURDEN ROCK
TRAP FORMATION
PRESERVATION
CRITICAL MOMENT
Mukluk 1
Prudhoe
Bay
Kuparuk
Lisburne
Mikkelson
Flaxman
Fish Creek
West Sak
Badami
Sadlerochit Mts.
NPRA
ANWR
Pod of Active Source Rock
80 to 30 Ma
EXPLANATION
Oil sample from: Evidence:
none stratigraphic
pool geochemical
drill-stem test/stained core geochemical
oil-stained outcrop geochemical

Oil and gas pools charged by the Shublik Formation

SHUBLIK SOURCE ROCK	MIXTURE (%)	MAP NO.	POOL NAME	FIELD NAME	DATE DISCOVERED	RESERVOIR NAME	AGE	OIL or GAS	GAS CAP	RECOVERABLE OIL CUMULATIVE (10^6 BBL)	RECOVERABLE OIL REMAINING (10^6 BBL)	RECOVERABLE OIL ORIGINAL (10^6 BBL)	REC FAC (%)	IN-PLACE OIL (10^6 BBL)	RECOVERABLE GAS CUMULATIVE (10^9 FT^3)	RECOVERABLE GAS REMAINING (10^9 FT^3)	RECOVERABLE GAS ORIGINAL (10^9 FT^3)	REC FAC (%)	IN-PLACE GAS (10^9 FT^3)
x	50S	24	FLAXMAN	POINT THOMSON UNIT	06-Sep-75	Flaxman sandstone	Tertiary	OIL	nd	nd	nd	nd	nd	nd	na	nd	nd	nd	nd
x	100S	32	MIKKELSON	MIKKELSON	11-Nov-78	Flaxman sandstone	Tertiary	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
o	100S	15	UGNU	UGNU	09-Aug-69	Ugnu sand (Sagavanirktok Fm)	Cretaceous-Tertiary	OIL	nd	nd	nd	nd	nd	19000	na	nd	nd	nd	nd
o	100S	13	SCHRADER BLUFF	MILNE POINT FIELD	09-Aug-69	Lower Ugnu sands (Schrader Bluff Fm)	Cretaceous	OIL	nd	11.9	nd	nd	nd	nd	5.8	nd	nd	nd	nd
x	100S	14	WEST SAK	KUPARUK RIVER FIELD	09-Aug-69	West Sak sands (Schrader Bluff Fm)	Cretaceous	OIL	nd	2.5	nd	nd	nd	15000	1	nd	nd	nd	nd
o	100S	48	TABASCO	KUPARUK RIVER FIELD	01-Jan-92	Tabasco sand (Schrader Bluff Fm)	0	OIL	nd	2.4	nd	nd	21-30	85	0.4	nd	nd	nd	0.1
o	100S	41	STUMP ISLAND	POINT MCINTYRE FIELD	22-Mar-88	Seabee Fm	Cretaceous	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
x	100S	3	FISH CREEK	FISH CREEK	04-Sep-49	Nanushuk Gp	Cretaceous	OIL	no	na	nd	nd	nd	<<1000	na	nd	nd	nd	8
x	100S	12	KUPARUK	KUPARUK RIVER FIELD	07-Apr-69	Kuparuk Fm	Cretaceous	OIL	nd	1661.5	nd	2000	33	6000	1861	nd	nd	nd	2800
o	100S	42	POINT MCINTYRE	POINT MCINTYRE FIELD	22-Mar-88	Kuparuk Fm	Cretaceous	OIL	nd	297.9	nd	nd	nd	nd	350.8	nd	nd	nd	nd
o	100S	52	CASCADE	MILNE POINT FIELD	14-Mar-93	Kuparuk Fm	Cretaceous	OIL	nd	nd	50	50	nd	nd	nd	nd	nd	nd	nd
o	100S	16	KUPARUK	MILNE POINT FIELD	09-Aug-69	Kuparuk Fm	Cretaceous	OIL	nd	112.5	nd	nd	nd	nd	55.9	nd	nd	nd	nd
o	100S	18	AURORA	PRUDHOE BAY FIELD	24-Aug-69	Kuparuk Fm	Cretaceous	OIL	nd	na	nd	20-35	nd	100	na	nd	nd	nd	100
o	59S	26	WEST BEACH	PRUDHOE BAY FIELD	22-Jul-76	Kuparuk Fm	Cretaceous	OIL	nd	1.77	nd	1.77	nd	nd	7.43	nd	7.43	nd	nd
o	100S	36	HEMI SPRINGS	HEMI SPRINGS	03-Apr-84	Kuparuk Fm	Cretaceous	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
o	100S	58	MIDNIGHT SUN	PRUDHOE BAY FIELD	20-Dec-97	Kuparuk Fm	Cretaceous	OIL	nd	na	nd	nd	nd	60	na	nd	nd	nd	100
o	100S	53	THETIS ISLAND	THETIS ISLAND	28-Apr-93	Nuiqsut sandstone	Jurassic	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
o	100S	17	SAG RIVER	MILNE POINT FIELD	09-Aug-69	Sag River Fm	Triassic	OIL	nd	1.1	nd	nd	nd	nd	1	nd	nd	nd	nd
o	100S	19	KAVIK	KAVIK	05-Nov-69	Ivishak/Sag River Fms	Triassic	GAS	na	na	na	na	na	na	na	na	nd	nd	330
o	100S	22	KEMIK	KEMIK	17-Jun-72	Shublik Fm	Triassic	GAS	na	na	na	na	na	na	na	na	nd	nd	500
o	100S	35	NORTHSTAR	NORTHSTAR FIELD	30-Jan-84	Ivishak Fm	Triassic	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
o	100S	39	SANDPIPER	SANDPIPER UNIT	25-Jan-86	Ivishak Fm	Triassic	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
o	59S	57	SAMBUCCA	PRUDHOE BAY FIELD	20-Dec-97	Ivishak/Sag River Fms	Triassic	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
x	59S	10	PRUDHOE BAY	PRUDHOE BAY FIELD	19-Dec-67	Ivishak/Shublik/Sag River Fms	Triassic	OIL	yes	6038.8	1631.2	7670.0	52.0	14750.0	20075.8	?	16815.0	62	27140.0
o	59S	28	EIDER	ENDICOTT FIELD	29-May-98	Ivishak Fm	Triassic	OIL	yes	0.6	nd	0.6	27-38	7.8	4.1	nd	4.1	nd	30.7
o	59S	20	GWYDYR BAY	GWYDYR BAY	25-Nov-69	Ivishak Fm	Triassic	OIL	nd	na	nd	nd	nd	28.3	na	nd	nd	nd	590.0
o	59S	21	NORTH PRUDHOE BAY	PRUDHOE BAY FIELD	31-Mar-70	Ivishak Fm	Triassic	OIL	nd	1.3	nd	1.3	nd	nd	3.9	nd	3.9	nd	nd
o	59S	29	SAG DELTA NORTH IVISHAK	ENDICOTT FIELD	14-Feb-78	Ivishak Fm	Triassic	OIL	no	4.4	nd	4.4	nd	8.3	3.6	nd	3.6	nd	nd
x	59S	11	LISBURNE	PRUDHOE BAY FIELD	19-Dec-67	Wahoo/Alapah/Lisburne Gp	Mississippian-Pennsylvanian	OIL	yes	79.7	nd	79.7	nd	1062.0	677.6	nd	677.6	nd	1770.0
o	59S	30	SAG DELTA NORTH ALAPAH	ENDICOTT FIELD	14-Feb-78	Lisburne Gp	Mississippian	OIL	no	nd	nd	nd	nd	2.2	na	nd	nd	nd	nd
o	59S	31	ENDICOTT	ENDICOTT FIELD	14-Feb-78	Kekiktuk Cgl (Endicott Group)	Mississippian	OIL	yes	233.2	120.8	354.0	nd	nd	674.5	nd	472.0	nd	nd
o	100S	34	TERN ISLAND	LIBERTY UNIT	03-Mar-83	Kekiktuk Cgl (Endicott Group)	Mississippian	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd

Recoverable oil and gas by reservoir rock

EVENTS CHART NUMBER	RESERVOIR NAME	AGE	MIXTURE (%)	RECOVERABLE OIL CUMULATIVE	RECOVERABLE OIL REMAINING	RECOVERABLE OIL ORIGINAL	IN-PLACE OIL	RECOVERABLE GAS CUMULATIVE	RECOVERABLE GAS REMAINING	RECOVERABLE GAS ORIGINAL	IN-PLACE GAS	RECOVERABLE OIL	RECOVERABLE GAS	RECOVERABLE BOE	RECOVERABLE TOTAL BOE	BOE
1	Flaxman sandstone	Tertiary	100S	na	nd	nd	nd	na	nd	nd	nd	na	nd	nd	nd	nd
2	Ugnu sand (Sagavanirktok Fm)	Cretaceous-Tertiary	100S	nd	nd	nd	19000	na	nd	nd	nd	nd	nd	nd	nd	nd
3	Schrader Bluff Fm	Cretaceous	100S	16.8	nd	16.8	15085	6.3	nd	6.3	nd	16.8	6.3	1.1	17.9	0.1
4	Seabee Fm	Cretaceous	100S	na	nd	nd	nd	na	nd	nd	nd	na	nd	nd	nd	nd
5	Nanushuk Gp	Cretaceous	100S	na	nd	nd	<<1000	na	nd	nd	8	na	nd	nd	nd	nd
6	Kuparuk Fm	Cretaceous	100S	2074.9	50	2075	6160	2280.3	nd	2280.3	3000	2075	2280.3	380.1	2455.1	18.1
7	Nuiqsut sandstone	Jurassic	100S	na	nd	nd	nd	na	nd	nd	nd	na	nd	nd	nd	nd
8	Sag River Fm	Triassic	100S	1.1	nd	1.1	nd	1	nd	1	nd	1.1	1	0.2	1.3	0.0
9																
10																
11	Lisburne Gp	Mississippian	59S	79.7	nd	79.7	1064.2	677.6	nd	677.6	1770.0	79.7	677.6	112.9	192.6	1.4
12	Kekiktuk Cgl (Endicott Group)	Mississippian	59S	233.2	120.8	354.0	nd	674.5	nd	472.0	nd	354	472.0	78.7	432.7	3.2
		TOTAL:				10202.9				20263.8		10202.9	20263.8	3377.3	13580.2	100

Oil samples from oil-stained cores and drill-stem tests from wells where hydrocarbons were expelled from the Shublik Formation

OIL SOURCE ROCK	SAMPLE ID		ADDITIONAL SAMPLE ID	TOP (FT)	BOT (FT)	STY	ROCK UNIT	LAT	LONG	API NUMBER
mix Shublik Hue	PRUDHOE BAY UNIT	R-1	R215-357	9169	9169	CC		70.34528	-148.90511	50029203530000
mix Shublik Hue	PRUDHOE BAY UNIT	R-1	R215-378	9332	9332	CC		70.34528	-148.90511	50029203530000
mix Shublik Hue Kingak	PRUDHOE BAY NO. 1		PRUDHOE BAY NO. 1	6875	7000	OL	CRETACEOUS UPR	70.32333	-148.54222	50029200010000
mix Shublik Hue Kingak	PUT RIVER NO. D-3		PUT RIVER(23-14-1	10417	10535	OL	Sadlerochit	70.29583	-148.74917	50029200570000
mix Shublik Hue Kingak	SAG RIVER STATE	1	R202-001	8483	8483	CC	SAG RIVER SD	70.25488	-148.34228	50029200020000
mix Shublik Hue Kingak	SAG RIVER STATE	1	SAG RIVER NO. 1	8649	8649	OL	Sadlerochit Group	70.25488	-148.34228	50029200020000
mix Shublik Hue Kingak	SAG RIVER STATE	1	SAG RIVER NO. 1	8895	8905	OL	Sadlerochit Group	70.25488	-148.34228	50029200020000
mix Shublik Hue Kingak(?)	PRUDHOE BAY NO. 1		PRUDHOE BAY NO. 1	9505	9825	OL	LISBURNE	70.32333	-148.54222	50029200010000
Shublik	FISH CREEK	1	FISH CREEK NO.1	2925	3060	OL	NANUSHUK	70.31194	-151.87222	50103100010000
Shublik	KUPARUK 25647 NO. A-7		KUP NO 1A-7	5875	6188	OL		70.33048	-149.67290	50029206580000
Shublik	KUPARUK 25649 NO. C-4			7575	7575	OL		70.32497	-149.49492	50029205470000
Shublik	KUPARUK RIVER UNIT	3A-9	WEST SAC NO.23	5975	6191	OL		70.40303	-149.93795	50029206990000
Shublik	NORTHWEST EILEEN ST NO. 1		N.W.EILEEN NO. 1	6565	6646	OL	Kuparuk River ss	70.36528	-149.35874	50029200130000
Shublik	OCS Y-0334 NO. 1 (MUKLUK)			7360	7385	OL		70.68334	-150.91997	55231000010000
Shublik	PUT RIVER STATE	1	R204-002	9049	9049	CC	SADLEROCHIT	70.23626	-148.67977	50029200170000

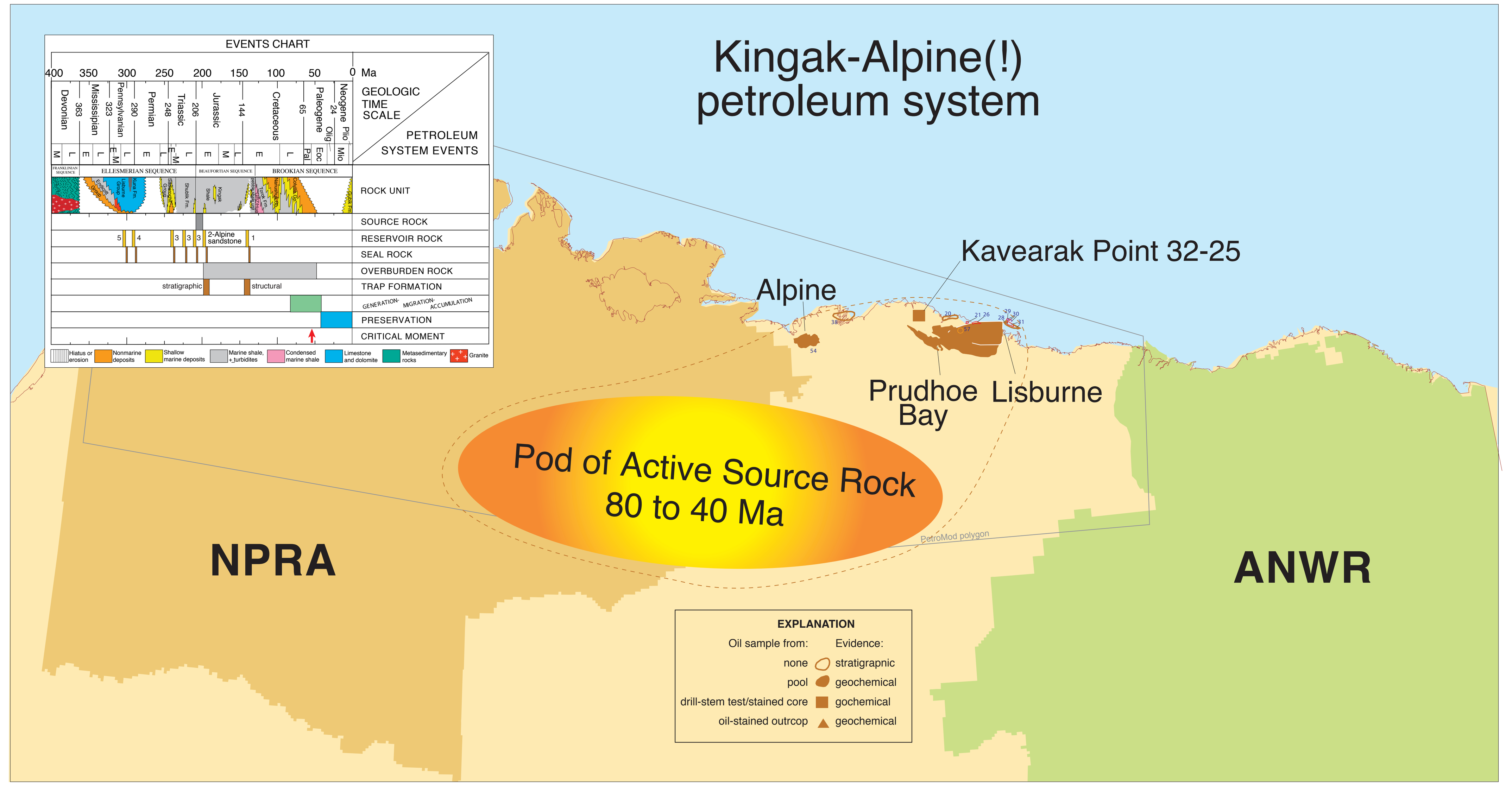
The Shublik-Ivishak(!) is the largest petroleum system on the North Slope with 13.58 GBOE of recoverable hydrocarbons. The twelve reservoir rocks range in age from Mississippian through Tertiary indicating a complicated migration. The accumulations in the Prudhoe Bay area contain oil and gas from the Kingak Shale and Hue Shale, however, most of the petroleum originated from the Shublik Formation or 59% (Masterson, 2001). The heavy oil layer in the Ivishak Formation in Prudhoe Bay field indicates that there were two periods of hydrocarbon charge.

The Shublik-Otuk source rock unit includes the widespread Shublik Formation and the chert and limestone members of the Otuk Formation in the central and western Brooks Range. Many of the oil fields, including the giant Prudhoe Bay field, contain a mixture of Shublik and other oil types (Seifert and others, 1980; Claypool and Magoon, 1985; Sedivy and others, 1987; GeoMark, 1997; Masterson, 2001), so the oil composition of these fields is partially representative of the Shublik-Otuk oil type. However, oil in the Kuparuk field is derived from the Shublik Formation (Masterson and others, 1997, 2001; Masterson, 2001). Accordingly, representative gravity and sulfur values are 23 API and 1.6 wt.% S, respectively, based on the average composition of Kuparuk field.

Age-equivalent strata mapped as the Shublik Formation in the central and western Brooks Range were renamed the Otuk Formation (Mull and others, 1982) and identified as the source rock for oil in outcrops in the central Brooks Range Foothills (Lillis and others, 2002). Bird (1994) considered the chert and limestone members of the Otuk to be lateral time-stratigraphic equivalents to the Shublik. Similarly, the Shublik and Otuk are considered here as a single source rock unit, although there are noted differences in biomarker composition (Lillis and others, 2002) and lithology (Mull and others, 1982) between the two formations.

Source rock characteristics and thermal maturity of the Shublik Formation are mapped in the poster by Peters and others (this session). The pod of active source rock highlights that area where the source rock is of sufficient richness (TOC), quality (HI), and thermal maturity to be a viable source of hydrocarbons.

The geographic extent of this petroleum system includes the pod of active source rock, the country rock through which the petroleum migrated, and the location of the discovered petroleum from the pod. The reservoir rocks and type of hydrocarbons, either oil or gas, are shown by pool in one table and by reservoir rock in another. Important shows of oil that were analyzed to show the distribution of this system are in a third table. The name of this petroleum system is based on the Shublik Formation as the source rock and the Ivishak Fromation as the reservoir rock that contains over 60% of the oil and gas.


Kingak-Alpine(!)
petroleum system
EVENTS CHART
GEOLOGIC TIME SCALE
PETROLEUM SYSTEM EVENTS
ROCK UNIT
SOURCE ROCK
RESERVOIR ROCK
SEAL ROCK
OVERBURDEN ROCK
TRAP FORMATION
PRESERVATION
CRITICAL MOMENT
Kavearak Point 32-25
Alpine
Prudhoe Lisburne
Bay
NPRA
ANWR
Pod of Active Source Rock
80 to 40 Ma
EXPLANATION
Oil sample from: Evidence:
none stratigraphic
pool geochemical
drill-stem test/stained core geochemical
oil-stained outcrop geochemical

Oil and gas pools charged by the Kingak Shale

KINGAK SOURCE ROCK	MATURE (%)	MAP NO.	POOL NAME	FIELD NAME	DATE DISCOVERED	RESERVOIR NAME	AGE	OIL or GAS	GAS CAP	RECOVERABLE OIL CUMULATIVE (10^6 BBL)	RECOVERABLE OIL REMAINING (10^6 BBL)	RECOVERABLE OIL ORIGINAL (10^6 BBL)	REC FAC (%)	IN-PLACE OIL (10^6 BBL)	RECOVERABLE GAS CUMULATIVE (10^9 FT^3)	RECOVERABLE GAS REMAINING (10^9 FT^3)	RECOVERABLE GAS ORIGINAL (10^9 FT^3)	REC FAC (%)	IN-PLACE GAS (10^9 FT^3)
o	13K	26	WEST BEACH	PRUDHOE BAY FIELD	22-Jul-76	Kuparuk Fm	Cretaceous	OIL	nd	0.4	nd	0.4	nd	nd	1.6	nd	1.6	nd	nd
x	100K	54	ALPINE	COLVILLE RIVER FIELD	27-Mar-94	Alpine ss (Kingak Shale)	Jurassic	OIL	nd	na	429	429	nd	800-1000	na	nd	nd	nd	nd
o	100K	38	COLVILLE DELTA	KUUKPIK UNIT	26-Apr-85	Jurassic sandstone	Jurassic	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
o	13K	57	SAMBUCCA	PRUDHOE BAY FIELD	20-Dec-97	Sag River/Ivishak Fms	Triassic	OIL	nd	na	nd	nd	nd	nd	na	nd	nd	nd	nd
x	13K	10	PRUDHOE BAY	PRUDHOE BAY FIELD	19-Dec-67	Ivishak Fm/Shublik/Sag River Fms	Triassic	OIL	yes	1330.6	359.4	1690.0	52	3250.0	4423.5	?	3705.0	62	5980.0
o	13K	28	EIDER	ENDICOTT FIELD	29-May-98	Ivishak Fm	Triassic	OIL	yes	0.1	nd	0.1	27-38	1.7	0.9	nd	0.9	nd	6.8
o	13K	20	GWYDYR BAY	GWYDYR BAY	25-Nov-69	Ivishak Fm	Triassic	OIL	nd	na	nd	nd	nd	6.2	na	nd	nd	nd	130.0
o	13K	21	NORTH PRUDHOE BAY	PRUDHOE BAY FIELD	31-Mar-70	Ivishak Fm	Triassic	OIL	nd	0.3	nd	0.3	nd	nd	0.9	nd	0.9	nd	nd
o	13K	29	SAG DELTA NORTH IVISHAK	ENDICOTT FIELD	14-Feb-78	Ivishak Fm	Triassic	OIL	no	1.0	nd	1.0	nd	1.8	0.8	nd	0.8	nd	nd
x	13K	11	LISBURNE	PRUDHOE BAY FIELD	19-Dec-67	Wahoo/Alapah/Lisburne Gp	Mississippian-Pennsylvanian	OIL	yes	17.6	nd	17.6	nd	234.0	149.3	nd	149.3	nd	390.0
o	13K	30	SAG DELTA NORTH ALAPAH	ENDICOTT FIELD	14-Feb-78	Lisburne Gp	Mississippian	OIL	no	nd	nd	nd	nd	0.5	na	nd	nd	nd	nd
o	13K	31	ENDICOTT	ENDICOTT FIELD	14-Feb-78	Kekiktuk Cgl. (Endicott Group)	Mississippian	OIL	yes	51.4	26.6	78.0	nd	nd	148.6	nd	104.0	nd	nd

Recoverable oil and gas by reservoir rock

EVENTS CHART NUMBER	RESERVOIR NAME	AGE	MIXTURE (%)	RECOVERABLE OIL CUMULATIVE (10^6 BBL)	RECOVERABLE OIL REMAINING (10^6 BBL)	RECOVERABLE OIL ORIGINAL (10^6 BBL)	IN-PLACE OIL (10^6 BBL)	RECOVERABLE GAS CUMULATIVE (10^9 FT^3)	RECOVERABLE GAS REMAINING (10^9 FT^3)	RECOVERABLE GAS ORIGINAL (10^9 FT^3)	IN-PLACE GAS (10^9 FT^3)	RECOVERABLE OIL (10^6 BBL)	RECOVERABLE GAS (10^9 FT^3)	RECOVERABLE BOE (10^6 BBL)	RECOVERABLE TOTAL BOE (10^6 BBL)	BOE (%)
1	Kuparuk Fm	Cretaceous	13K	0.4	nd	0.4	nd	1.6	nd	1.6	nd	0.4	1.6	0.3	0.7	0.02
2	Alpine ss (Kingak Shale)	Jurassic	100K	na	429	429	800-1000	na	nd	nd	nd	429	nd	0	429.0	14.91
3	Ivishak Fm/Shublik/Sag River Fms	Triassic	13K	1332.0	359.4	1691.4	3259.8	4426.0	nd	3707.6	6116.8	1691.4	3707.6	617.9	2309.3	80.27
4	Lisburne Gp	Mississippian	13K	17.6	nd	17.6	234.5	149.3	nd	149.3	390.0	17.6	149.3	24.9	42.4	1.48
5	Kekiktuk Cgl. (Endicott Group)	Mississippian	13K	51.4	26.6	78.0	nd	148.6	nd	104.0	nd	78.0	104.0	17.3	95.3	3.31
						2216.3				3962.5		2216.3	3962.5	660.4	2876.8	100.00

Oil samples from oil-stained cores and drill-stem tests from wells where hydrocarbons were expelled from Kingak Shale

OIL SOURCE ROCK	SAMPLE ID		ADDITIONAL SAMPLE ID	TOP (FT)	BOT (FT)	STY	ROCK UNIT	LAT	LONG	API NUMBER
mix Shublik Hue Kingak	PRUDHOE BAY NO. 1		PRUDHOE BAY NO. 1	6875	7000	OL	CRETACEOUS UPR	70.32333	-148.54222	50029200010000
mix Shublik Hue Kingak	PUT RIVER NO. D-3		PUT RIVER(23-14-1	10417	10535	OL	Sadlerochit	70.29583	-148.74917	50029200570000
mix Shublik Hue Kingak	SAG RIVER STATE	1	R202-001	8483	8483	CC	SAG RIVER SD	70.25488	-148.34228	50029200020000
mix Shublik Hue Kingak	SAG RIVER STATE	1	SAG RIVER NO. 1	8649	8649	OL	Sadlerochit Group	70.25488	-148.34228	50029200020000
mix Shublik Hue Kingak	SAG RIVER STATE	1	SAG RIVER NO. 1	8895	8905	OL	Sadlerochit Group	70.25488	-148.34228	50029200020000
mix Shublik Hue Kingak(?)	PRUDHOE BAY NO. 1		PRUDHOE BAY NO. 1	9505	9825	OL	LISBURNE	70.32333	-148.54222	50029200010000
Kingak	KAVEARAK POINT NO. 32-25			7702	7710	OL	Kingak	70.45528	-149.43556	50029200280000
mix Hue? Kingak ?	PRUDHOE BAY NO. 1		PRUDHOE BAY NO. 1	8202	8500	OL	SADLEROCHIT	70.32333	-148.54222	50029200010000

The Kingak-Alpine(!) contains about 2.9 GBOE of recoverable hydrocarbons. The five reservoir rocks range from Mississippian to Cretaceous. Except for the Alpine field, all other fields contain oil and gas that are mixtures of hydrocarbons from other source rocks. Oil recovered from a drill-stem test in the Kavearak well is a non-commercial show generated solely from the Kingak Shale.

The Kingak-Blankenship source rock unit includes the widespread Kingak Shale and the partly age-equivalent Blankenship Member of the Otuk Formation in the Brooks Range. Jurassic marine shales (Kingak Shale) were first proposed by Morgridge and Smith (1972) as a possible source of oil on the North Slope. Seifert and others (1980) presented geochemical evidence that the Kingak Shale is the source rock for oil recovered from a drill-stem test from the Kavearak 32-25 well (Milne Point field) and that the Kingak is a significant oil contributor to Prudhoe Bay field. This interpretation was supported by later studies (Claypool and Magoon, 1985; Premuzac and others, 1986; Sedivy and others, 1987; GeoMark, 1997; Holba, Wilson, and others, 2000, Masterson, 2001). Until Alpine field was discovered, only a few small oil accumulations with pure Kingak oil had been identified (GeoMark, 1997). Because Alpine field is the largest known accumulation of Kingak oil (Masterson, 2001) and is located adjacent to NPRA, the gravity and sulfur content (39°API, 0.3 wt.% S) of the oil from the discovery well (ARCO Bergschrund 1) is representative of Kingak-Blankenship oil.

The Blankenship Member of the Otuk Formation (Mull and others, 1982) is the southern, distal stratigraphic equivalent of the Kingak Shale. Bird (1994) combined the Blankenship with the Kingak in his calculations of the Ellesmerian petroleum system. Work in progress at the USGS (Lillis, unpublished data) shows that Blankenship extract composition is very similar to the oil derived from the Kingak Shale. Therefore, the Blankenship is combined with the Kingak as a single source rock unit.

The source rock characteristics and thermal maturity of the Shublik Formation are mapped in the poster by Peters and others (this session). The pod of active source rock in this poster highlights the area where the basal 300 feet of the Kingak source rock is of sufficient richness (TOC), quality (HI), and thermal maturity to be a viable source of hydrocarbons.

The geographic extent of this petroleum system includes the pod of active source rock, the country rock through which the petroleum migrated, and the location of the discovered petroleum from the pod. The reservoir rocks and type of hydrocarbons, either oil or gas, are shown by pool in one table and by reservoir rock in another. Important shows of oil that were analyzed to show the distribution of this system are in a third table. The name of this petroleum system is based on the Kingak Shale as the source rock and the Alpine sandstone in the Alpine pool within the Kingak Shale as the reservoir rock for the only commercial oil field that contains petroleum solely from the Kingak shale.