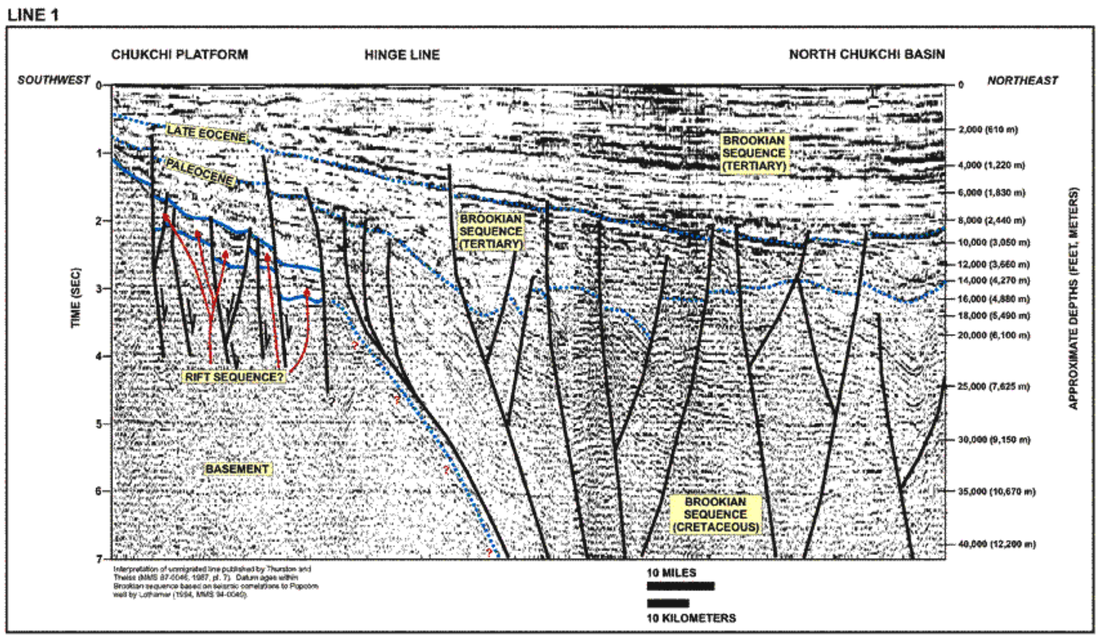
REPRESENTATIVE SEISMIC PROFILES, CHUKCHI SHELF, BEAUFORT SHELF, AND HOPE BASIN

LINE 1



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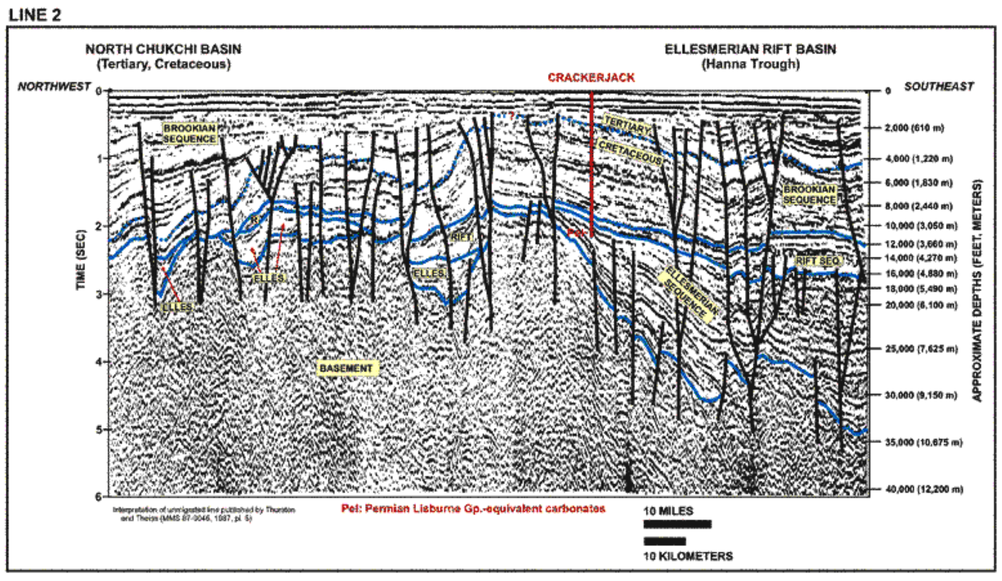

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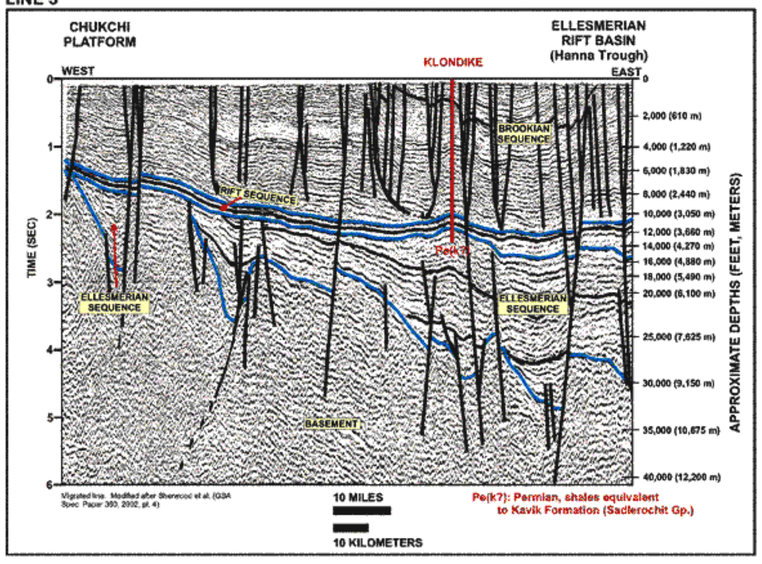
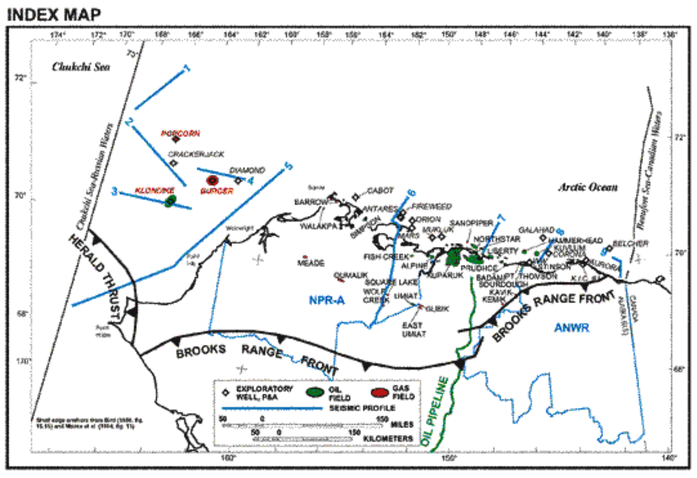


INDEX MAP



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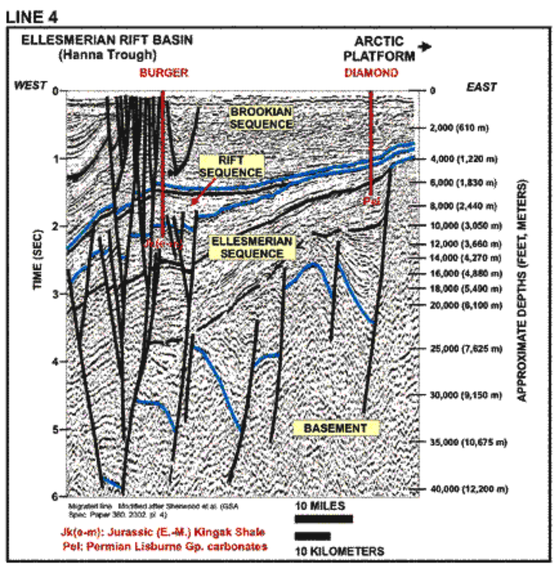

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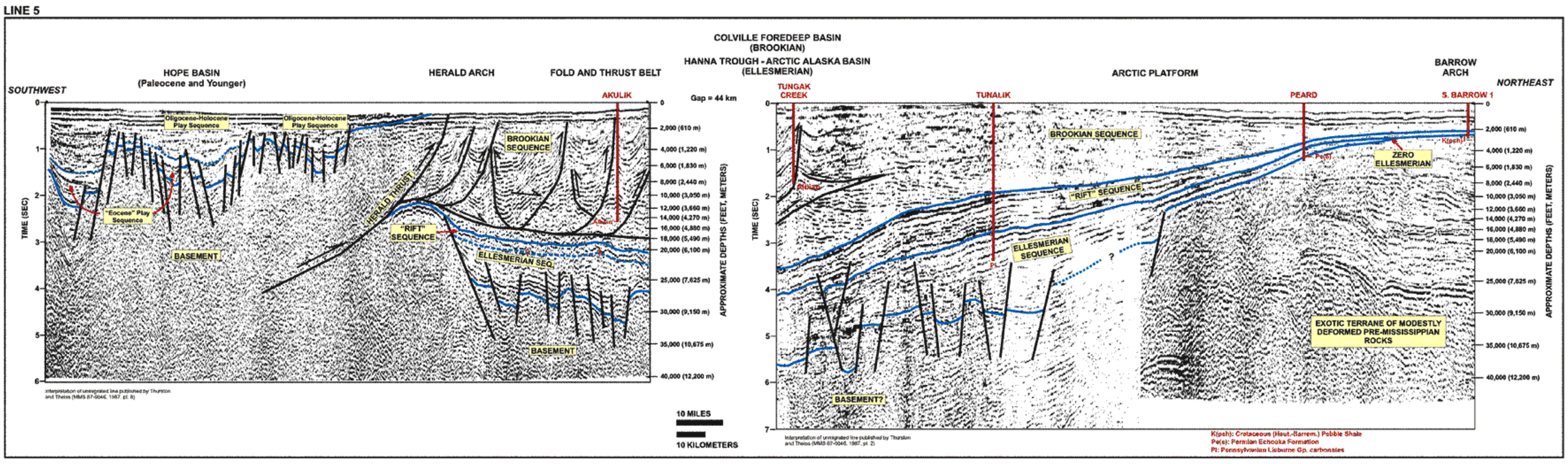

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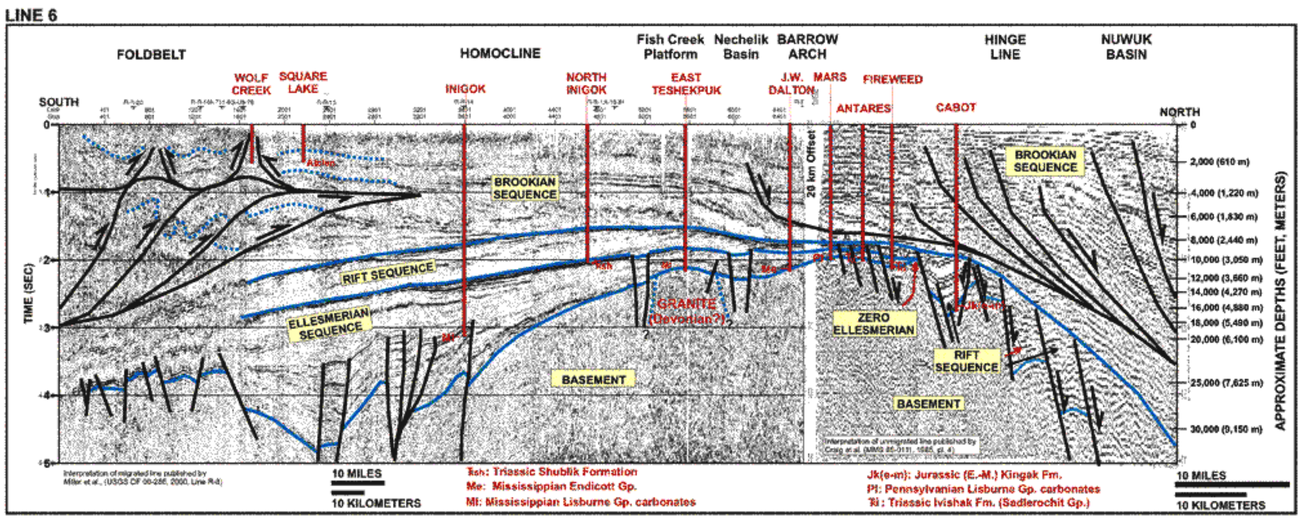

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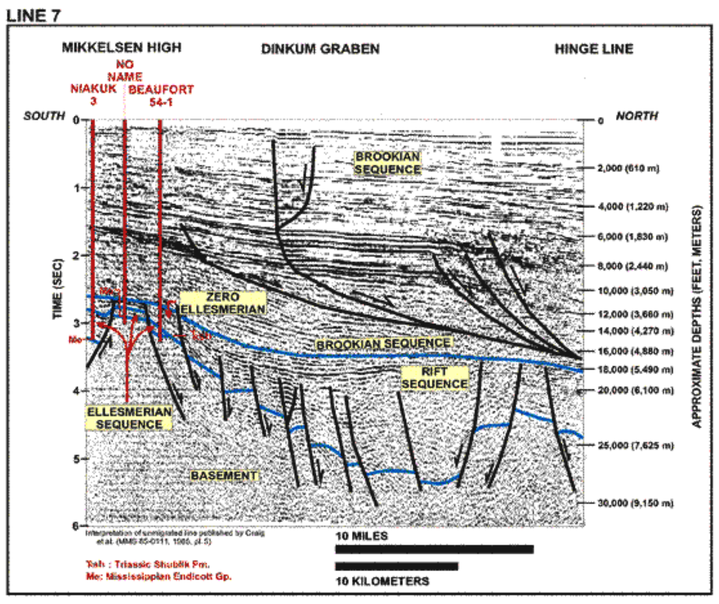

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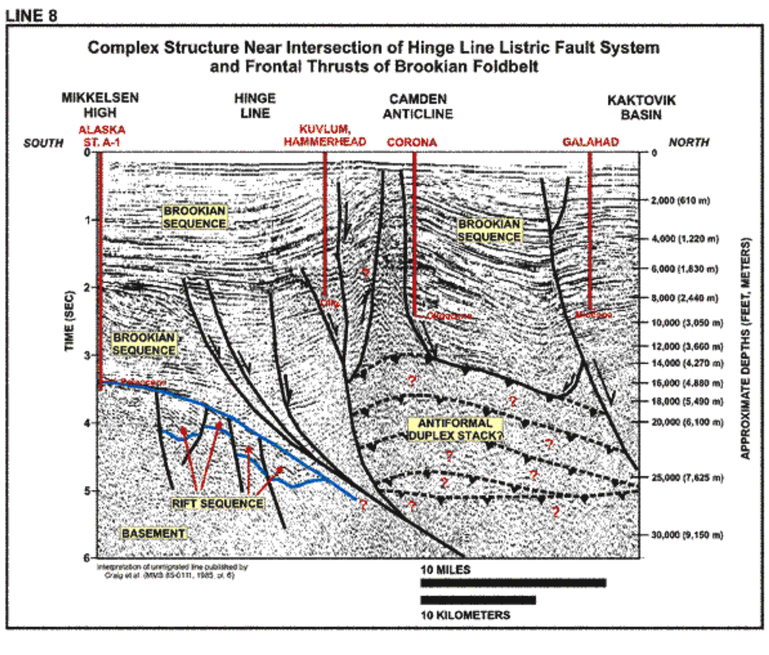

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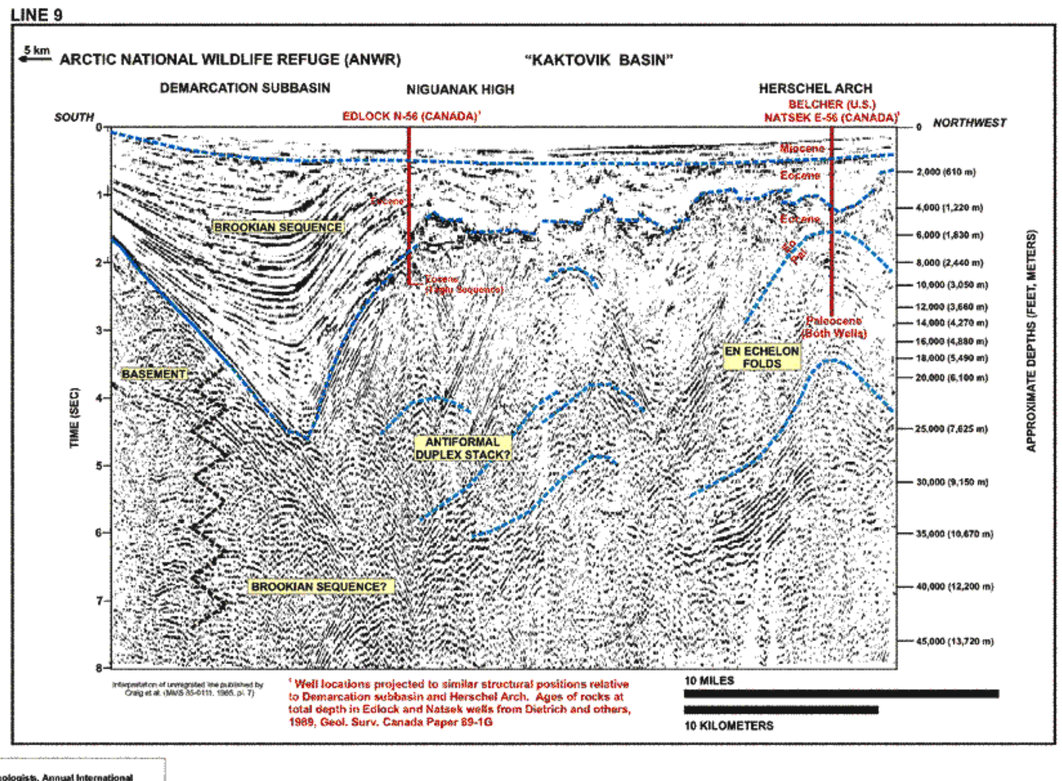


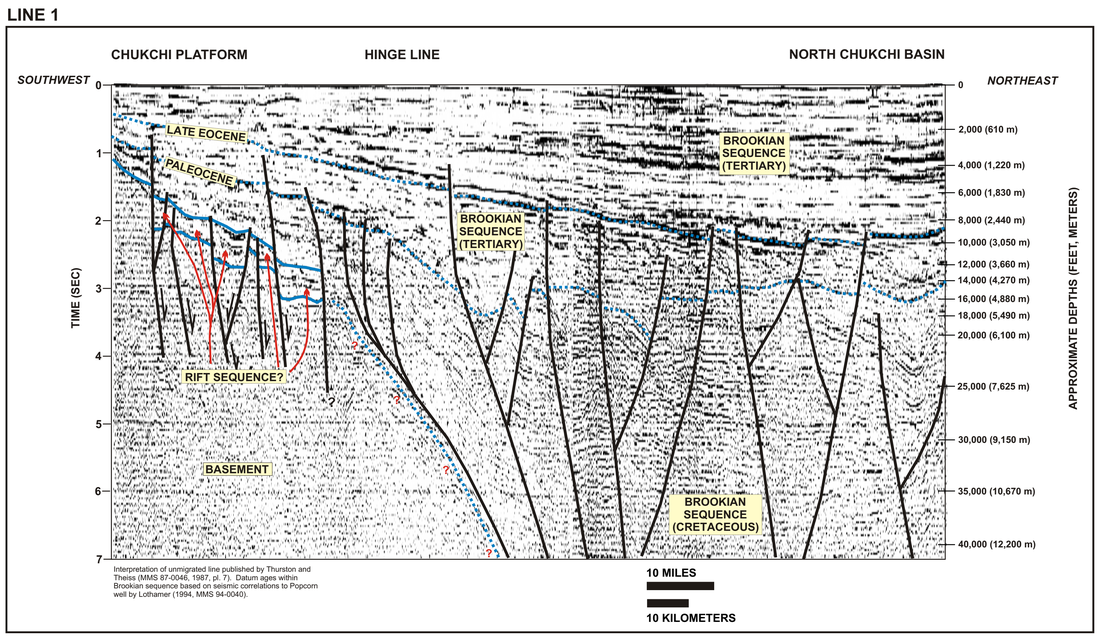
Source:
Sherwood, K.W., Craig, J.D., Scherr, J., Johnson, P.P., and Cooke, L.W., 2001, Undiscovered Oil and Gas Resources of U.S. Arctic Alaska Outer Continental Shelves (abs): American Association of Petroleum Geologists, Annual International Meeting, St. Petersburg, Russia, poster presentation, Abstracts with Programs, July 15-18, 2001, St. Petersburg, Russia.

Sherwood, K.W., Craig, J.D., Scherr, J., Johnson, P.P., and Cooke, L.W., 2002, Undiscovered Oil and Gas Resources of U.S. Arctic Alaska Outer Continental Shelves (abs): Poster presentation at AAPG Pacific Section, Anchorage, Alaska, May 18-23, 2002; American Association of Petroleum Geologists Bulletin, v. 87, no. 6, p. 1159.

Minerals Management Service
Alaska OCSR, Anchorage, AK

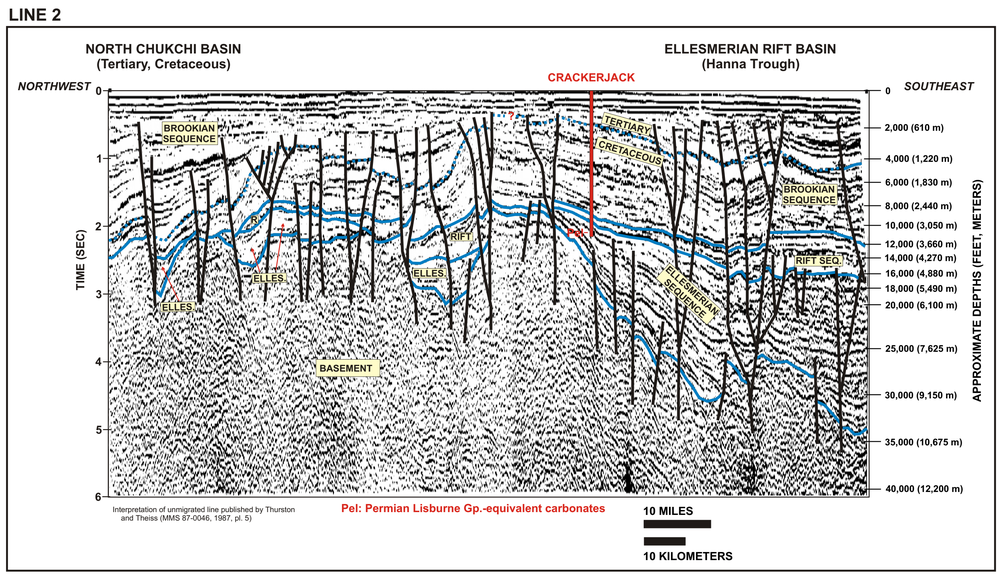
REPRESENTATIVE SEISMIC PROFILES, CHUKCHI SHELF, BEAUFORT SHELF, AND HOPE BASIN

LINE 1



Interpretation of unmigrated line published by Thurston and Theiss (MMS 87-0046, 1987, pl. 7). Datum ages within Brookian sequence based on seismic correlations to Popcorn well by Lothamer (1994, MMS 94-0040).

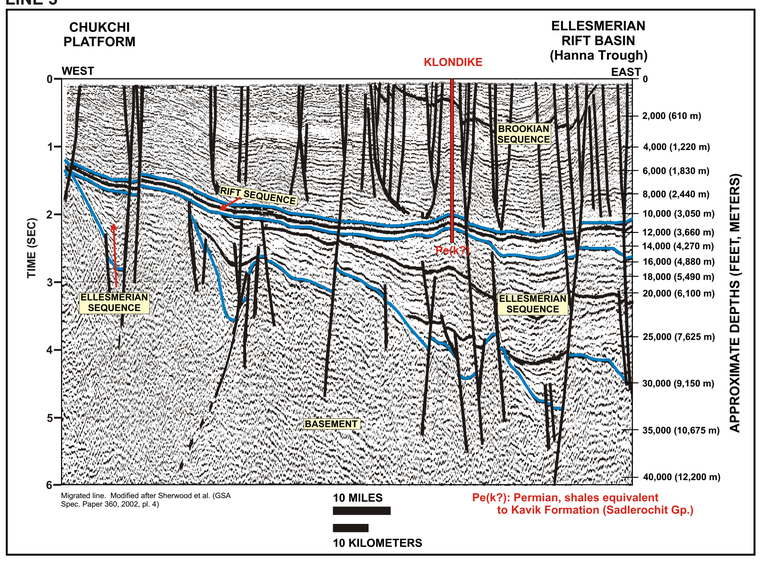
LINE 2



Interpretation of unmigrated line published by Thurston and Theiss (MMS 87-0046, 1987, pl. 5)

Pel: Permian Lisburne Gp.-equivalent carbonates

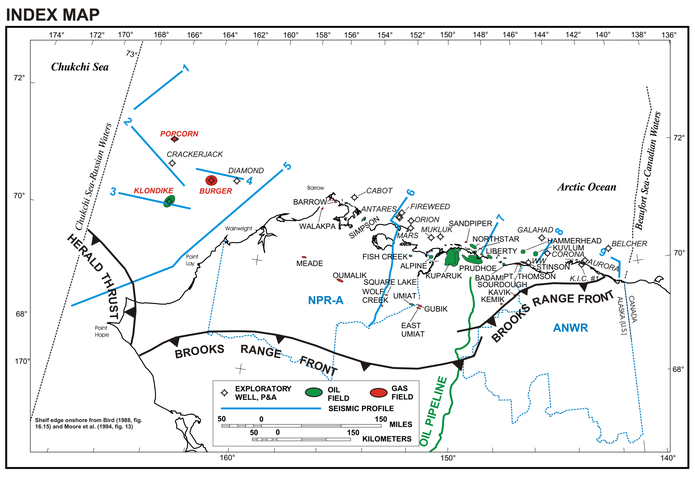
LINE 3



Migrated line. Modified after Sherwood et al. (GSA Spec. Paper 360, 2002, pl. 4)

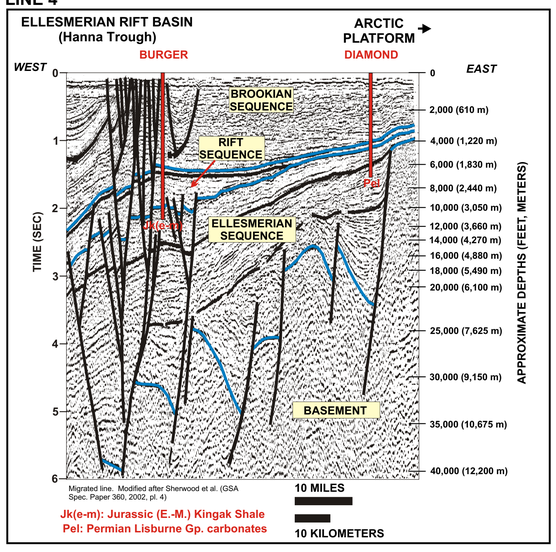
Pe(k?): Permian, shales equivalent to Kavik Formation (Sadlerochit Gp.)

INDEX MAP



Shelf edge onshore from Bird (1988, fig. 16.15) and Moore et al. (1994, fig. 13)

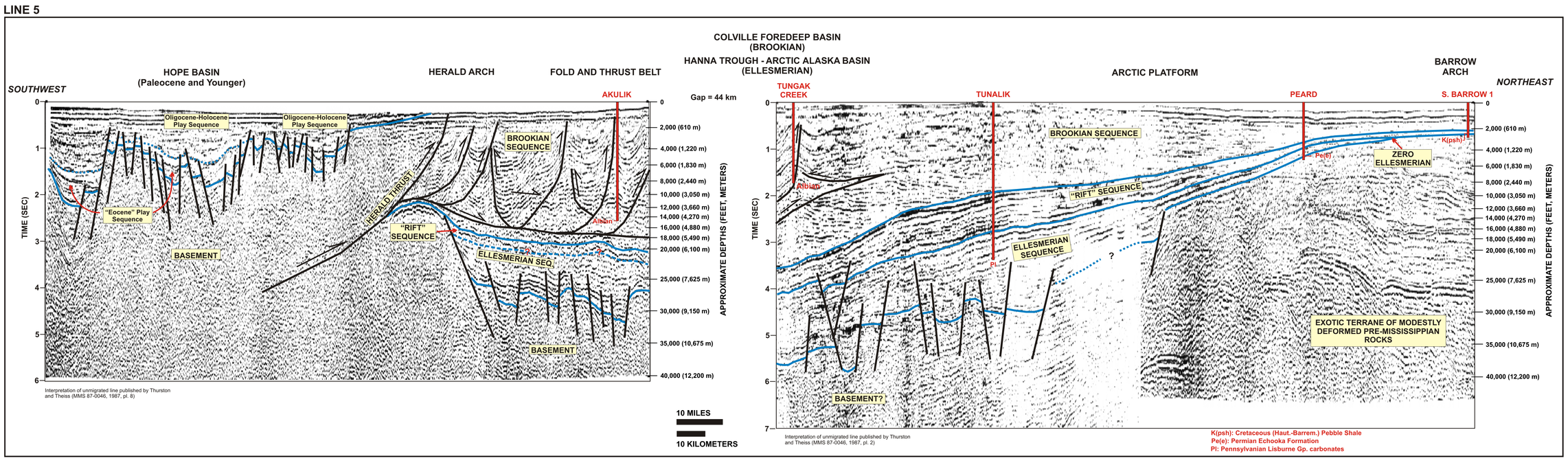
LINE 4



Migrated line. Modified after Sherwood et al. (GSA Spec. Paper 360, 2002, pl. 4)

Jk(e-m): Jurassic (E.-M.) Kingak Shale
Pel: Permian Lisburne Gp. carbonates

LINE 5

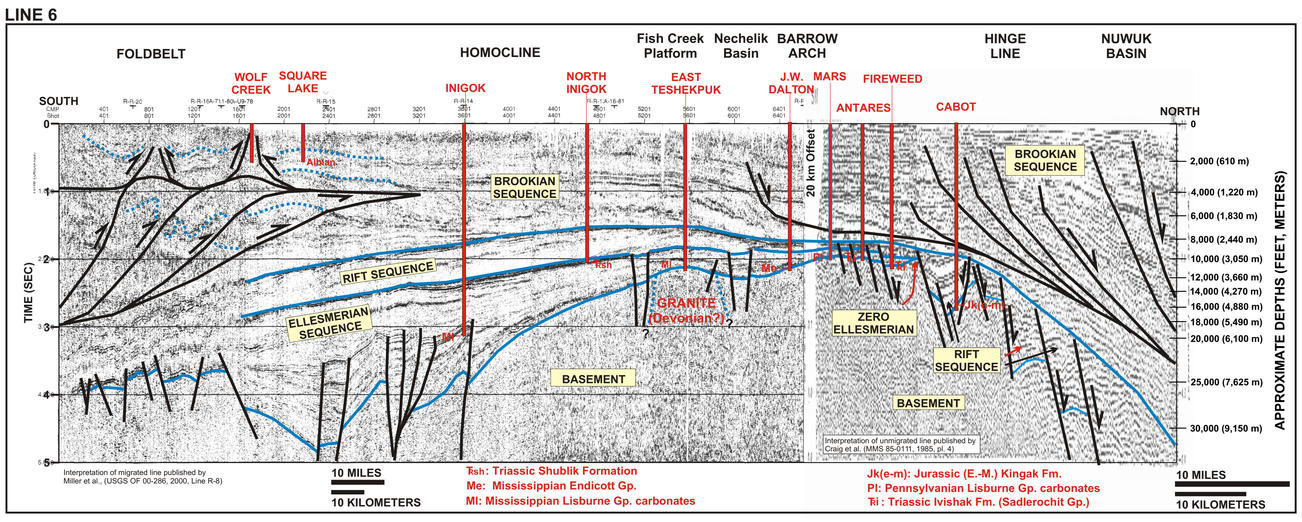


Interpretation of unmigrated line published by Thurston and Theiss (MMS 87-0046, 1987, pl. 8)

Interpretation of unmigrated line published by Thurston and Theiss (MMS 87-0046, 1987, pl. 2)

K(psh): Cretaceous (Haut.-Barrem.) Pebble Shale
Pe(e): Permian Echooka Formation
Pl: Pennsylvanian Lisburne Gp. carbonates

LINE 6

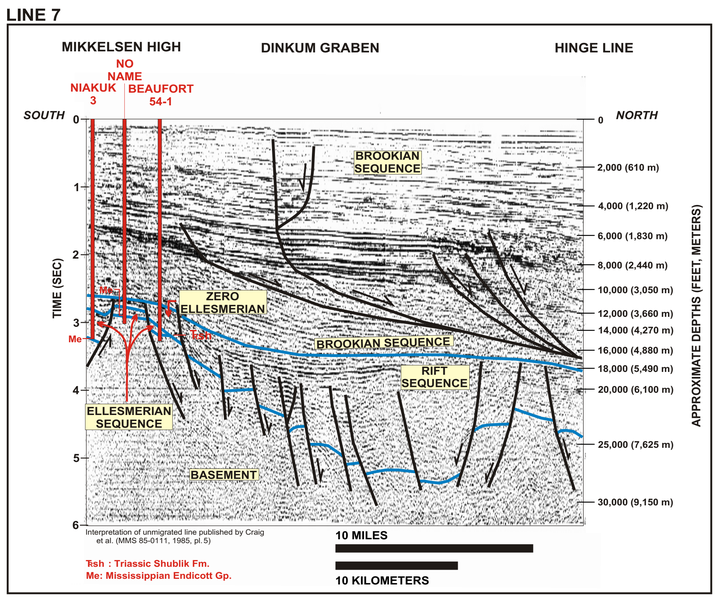


Interpretation of migrated line published by Miller et al., (USGS OF 00-286, 2000, Line R-8)

Interpretation of unmigrated line published by Craig et al. (MMS 85-0111, 1985, pl. 4)

Ꞧsh: Triassic Shublik Formation
Me: Mississippian Endicott Gp.
Ml: Mississippian Lisburne Gp. carbonates
Jk(e-m): Jurassic (E.-M.) Kingak Fm.
Pl: Pennsylvanian Lisburne Gp. carbonates
Ꞧi: Triassic Ivishak Fm. (Sadlerochit Gp.)

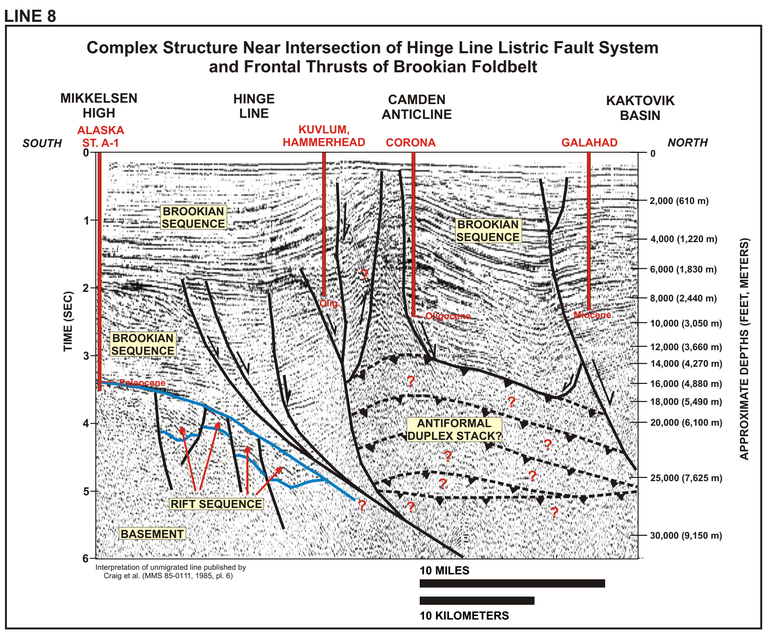
LINE 7



Interpretation of unmigrated line published by Craig et al. (MMS 85-0111, 1985, pl. 5)

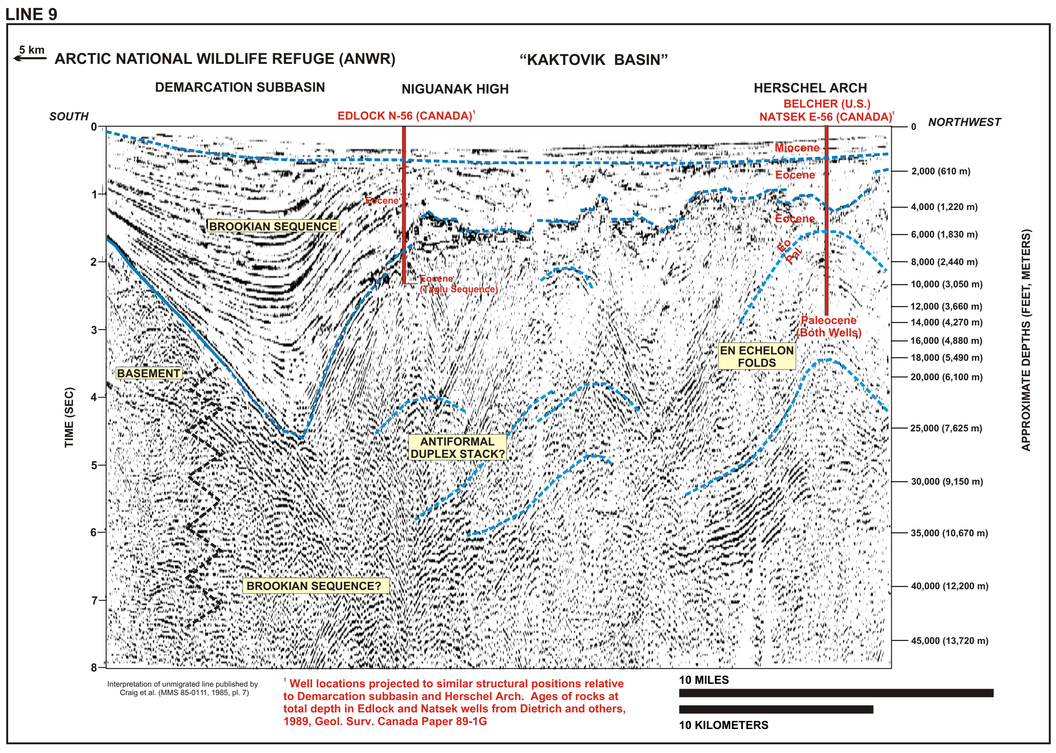
Ꞧsh : Triassic Shublik Fm.
Me: Mississippian Endicott Gp.

LINE 8



Interpretation of unmigrated line published by Craig et al. (MMS 85-0111, 1985, pl. 6)

LINE 9



Interpretation of unmigrated line published by Craig et al. (MMS 85-0111, 1985, pl. 7)

[1] Well locations projected to similar structural positions relative to Demarcation subbasin and Herschel Arch. Ages of rocks at total depth in Edlock and Natsek wells from Dietrich and others, 1989, Geol. Surv. Canada Paper 89-1G

Source:

Sherwood, K.W., Craig, J.D., Scherr, J., Johnson, P.P., and Cooke, L.W., 2001, Undiscovered Oil and Gas Resources of U.S. Arctic Alaska Outer Continental Shelves (abs): American Association of Petroleum Geologists, Annual International Meeting, St. Petersburg, Russia, poster presentation, Abstracts with Programs, July 15-18, 2001, St. Petersburg, Russia.

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Minerals Management Service
Alaska OCSR, Anchorage, AK

UNDISCOVERED OIL AND GAS RESOURCES OF U.S. ARCTIC ALASKA OUTER CONTINENTAL SHELVES

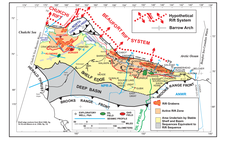
K.W. Sherwood, J.D. Craig, J. Scherr, P.P. Johnson, L.W. Cooke
U.S. Minerals Management Service

GEOLOGICAL MODELING

BASINS AND TECTONIC FEATURES

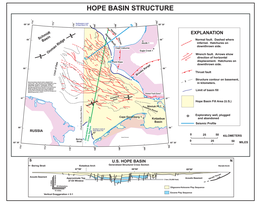
ELLESMERIAN SEQUENCE BASINS

RIFT SEQUENCE TECTONIC FEATURES



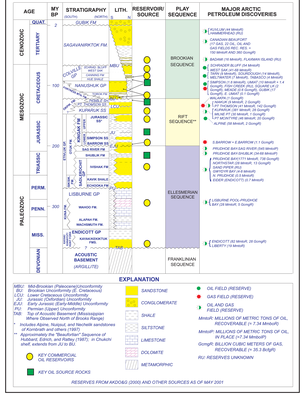
BROOKIAN SEQUENCE BASINS AND PLATFORMS

HOPE BASIN STRUCTURE



STRATIGRAPHIC COLUMNS

Stratigraphic Column
Chukchi Shelf, Beaufort Shelf, and Arctic Alaska



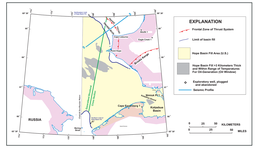
PLAY MAPS

ELLESMERIAN SEQUENCE PLAYS, ARCTIC ALASKA
Total Number of Offshore Plays = 9
Maximum Number of Undiscovered Offshore Oil and Gas Pools = 300
Mean Undiscovered Conventionally Recoverable Oil and Gas at $30/bbl ($5/bboe) and $1.75/Mcf ($.06/Mcfe), 1/1/2000, 95 Bcfe (1.075 bcf)

RIFT SEQUENCE PLAYS, ARCTIC ALASKA
Total Number of Offshore Plays = 4
Maximum Number of Undiscovered Offshore Oil and Gas Pools = 225
Mean Undiscovered Conventionally Recoverable Oil and Gas - 1.06 Bbbl, 2.261 mmbl, 341 Gcfe (12.06 bcf)
Mean Undiscovered Conventionally Recoverable Oil and Gas at $30/bbl ($5/bboe) and $1.75/Mcf ($.06/Mcfe), 1/1/2000, 2.26 Bbbl Oil (12.06 bcf)

BROOKIAN SEQUENCE PLAYS, ARCTIC ALASKA
Total Number of Offshore Plays = 20
Maximum Number of Undiscovered Offshore Oil and Gas Pools = 595
Mean Conventionally Recoverable Oil and Gas - 10.9 Bbbl 21.861 mmbl, 140 Tcfe (20.92 bcf)
Mean Undiscovered Conventionally Recoverable Oil and Gas at $30/bbl ($5/bboe) and $1.75/Mcf ($.06/Mcfe), 1/1/2000, 10.9 Bbbl Oil (20.92 bcf)

U.S. HOPE BASIN PLAYS
Total Number of Offshore Plays = 6
Maximum Number of Undiscovered Offshore Oil and Gas Pools = 150
Mean Undiscovered Conventionally Recoverable Oil and Gas at $30/bbl ($5/bboe) and $1.75/Mcf ($.06/Mcfe), 1/1/2000, 1.7 Bbbl Oil (9.2 bcf)



GEOLOGY OF PLAY SEQUENCES

ELLESMERIAN SEQUENCE: *Mississippian to Early Jurassic*

Ellesmerian rocks in the subsurface north of the Brooks Range are Mississippian to Early Jurassic in age. In the Brooks Range Ellesmerian-equivalent rocks are Devonian to Early Jurassic in age. The Ellesmerian sequence is bounded by the Devonian Antler Orogeny and the Jurassic rift event. The lower part of the basin collapsed. The relationship of the Ellesmerian-equivalent rocks of the Brooks Range to the Ellesmerian rocks in the North Slope subsurface is therefore speculative.

In the subsurface north of the Brooks Range, Ellesmerian rocks rest unconformably upon deformed Devonian and metamorphosed, that are locally intruded by felsic plutons. Ellesmerian clastic rocks were derived from landmasses exposed to the north (Arctic Alaska Basin) and to the east and west (Nevin Trough). Ellesmerian rocks are as much as 2 km thick in the Nevin Trough, and as much as 1 km thick in the Arctic Alaska Basin. Ellesmerian rocks are absent in the Nevin Trough beneath Colville Basin. The rift event in northern Alaska is thought to be related to the northern Canadian Arch, generally located somewhat north of the Brooks Range. The rift event in northern Alaska is thought to be related to the Canadian Arch, which was active from the Mississippian-Pennsylvanian of widespread orthotectonic Laurentian Sea (Jakobson). Clastic sequences of Late Permian to Early Jurassic age generally reflect erosional unroofing of the Brooks Range. Ellesmerian rocks are absent in the Colville Basin because of Brookian erosional truncation and Brookian rift and post-rift thermal subsidence. Within the rift system, the Ellesmerian and the Brookian Sequences locally exceeds 4 kilometers between northern Alaska but are absent on the Barrow Arch and south of the Barrow Arch.

Important Ellesmerian Sequence reservoir formations include sandstones of the Ivishak Formation (Triassic), carbonates of the Lisburne Group (Mississippian to Permian), and sandstones of the Kuparuk Group (Mississippian). The Kuparuk Formation, which is the Ellesmerian-equivalent of the Prudhoe Bay Unit reservoir, is as much as 100 m thick in the Kuparuk River Unit. The Kuparuk Formation is as much as 30 m thick in the Colville Basin and the Angun Formation (Jurassic) form important oil sources. These oil sources are thermally mature to overmature over large areas beneath Colville Basin. Oil generated in the Colville Basin migrates north in Cretaceous-Tertiary time largely migrated toward the Barrow Arch (Arctic Alaska Basin) on prograding basin floors (Angun, Pebble Trough).

Solaur oil and gas pools have been discovered in the Ellesmerian Sequence with aggregate recoverable discovered resources of 7.08 Bbbl (million metric barrels) of oil, 2.0 Tcf of associated gas, and 0.1 Tcf of non-associated gas. Ellesmerian Sequence undiscovered resources represent 14% of the undiscovered recoverable endowment (1,000 Mmbl-energy-equivalent) of northern Alaska and the Arctic Offshore. The largest undiscovered Ellesmerian Sequence oil and gas pools are 400 Mmbl (56,000 barrels per day) and 2.0 Tcf (57 bcf), respectively.

In a high-price scenario ($30/bbl oil, $1.75/mcf gas), the nine offshore Ellesmerian Sequence plays are assessed with 210 Mmbl and 40 Bcfeq of (mean, risked) undiscovered conventionally recoverable oil and gas, respectively, or a total of 250 Mmbl-energy-equivalent. This represents 25% of the conventionally recoverable energy endowment of the Ellesmerian Sequence plays (1,000 Mmbl-energy-equivalent). The Ellesmerian Sequence locally exceeds 4 kilometers between northern Alaska but the high-price scenario yields 60Mbbl, 1,000 Mmbl-energy-equivalent).

RIFT SEQUENCE: *Early Jurassic to Early Cretaceous*

The rift Sequence* is present from origin from Early Jurassic to Early Cretaceous in age and extrapolate to the "Beaufortian Sequence" defined for the Beaufort margin by Hubbard, Shuster, Grantz, and Houtz (1985). The rift Sequence is bounded by the Jurassic rift event and the Brookian Orogeny. The rift Sequence is as much as 2 km thick in the Colville Basin and Chukchi Shelf and is absent in the Nevin Trough and Arctic Continental Margin Rift System.

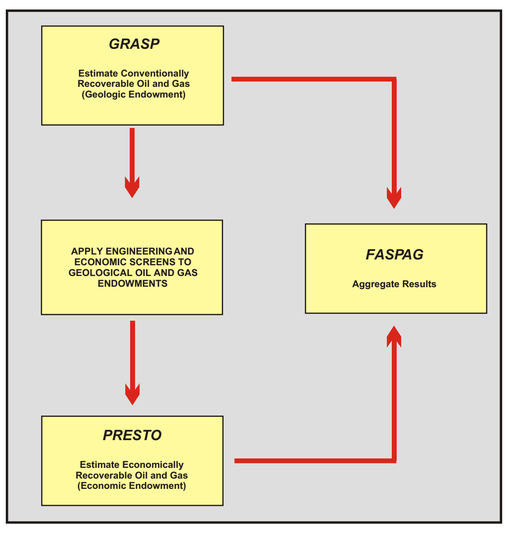
The Rift Sequence was deposited when basins on the south flank of a 1,100-kilometer-long rift system that arbitrarily broke upon a Mesozoic plate and cooled - an overpassive-margin basin. Rift-related sediments were deposited in half grabens and sags. The rift Sequence is thickest in the Colville Basin and Chukchi Shelf and thinnest in the Nevin Trough. Low-relief, rift-related structures are common in the Colville Basin and Chukchi Shelf. The rift system extended northeast along the Beaufort margin to 142° West Longitude then was offset south along a northeasterly transform fault that links to a separate rift segment between the Canadian Arctic Islands and the Alaska North Slope. The Canadian rift segment is thought to be Jurassic to Early Cretaceous in age and to have formed when Greenland broke from Canada and established its modern plate margin along the Alpha Ridge.

Deposition of the Rift Sequence was controlled by a system of grabens, horsts, sags and graffins in a zone of rift-deformed crust that extends up to 200 kilometers south of the Hinge Line. The Hinge Line is the hypothetical boundary between rift-deformed crust and undeformed crust. The Hinge Line is a hypothetical line because the rift-related structures are not well defined south of the Hinge Line. The Hinge Line is as much as 100 kilometers north of the Barrow Arch. The Hinge Line is also the approximate boundary between Ellesmerian-deformed crust and the modern passive-margin basin

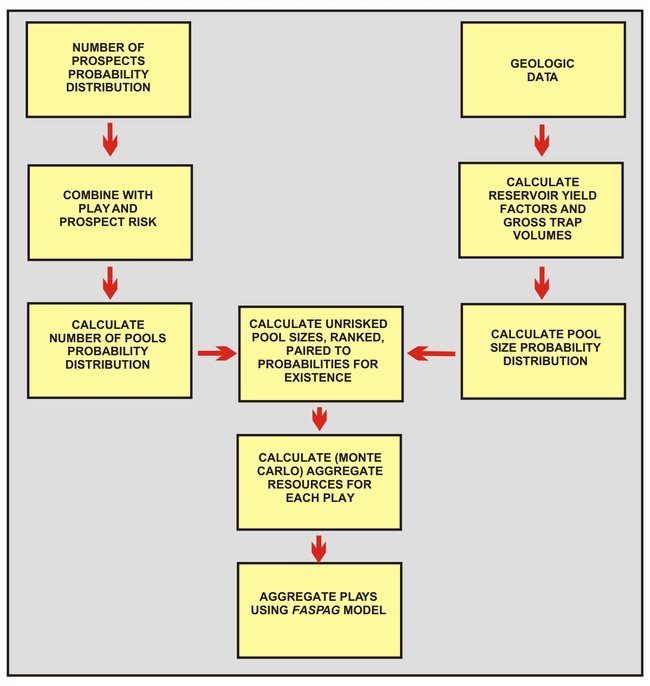
ECONOMIC MODELING

SUMMARY OF ROLES OF COMPUTER MODELS ("*GRASP*", "*PRESTO*", AND "*FASPAG*") IN ASSESSMENT PROCESS

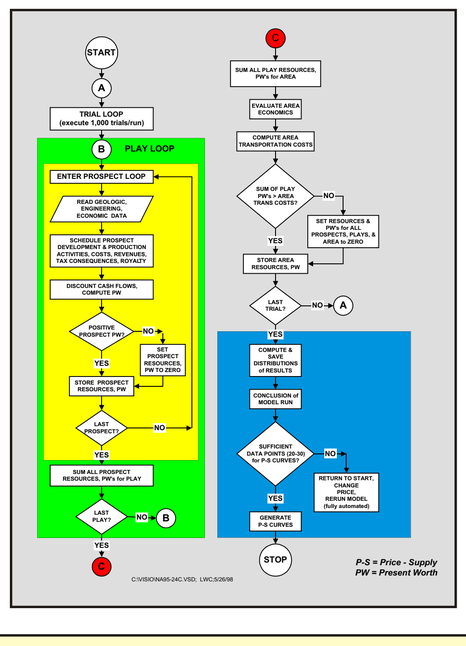
FLOW BETWEEN ASSESSMENT PROGRAMS



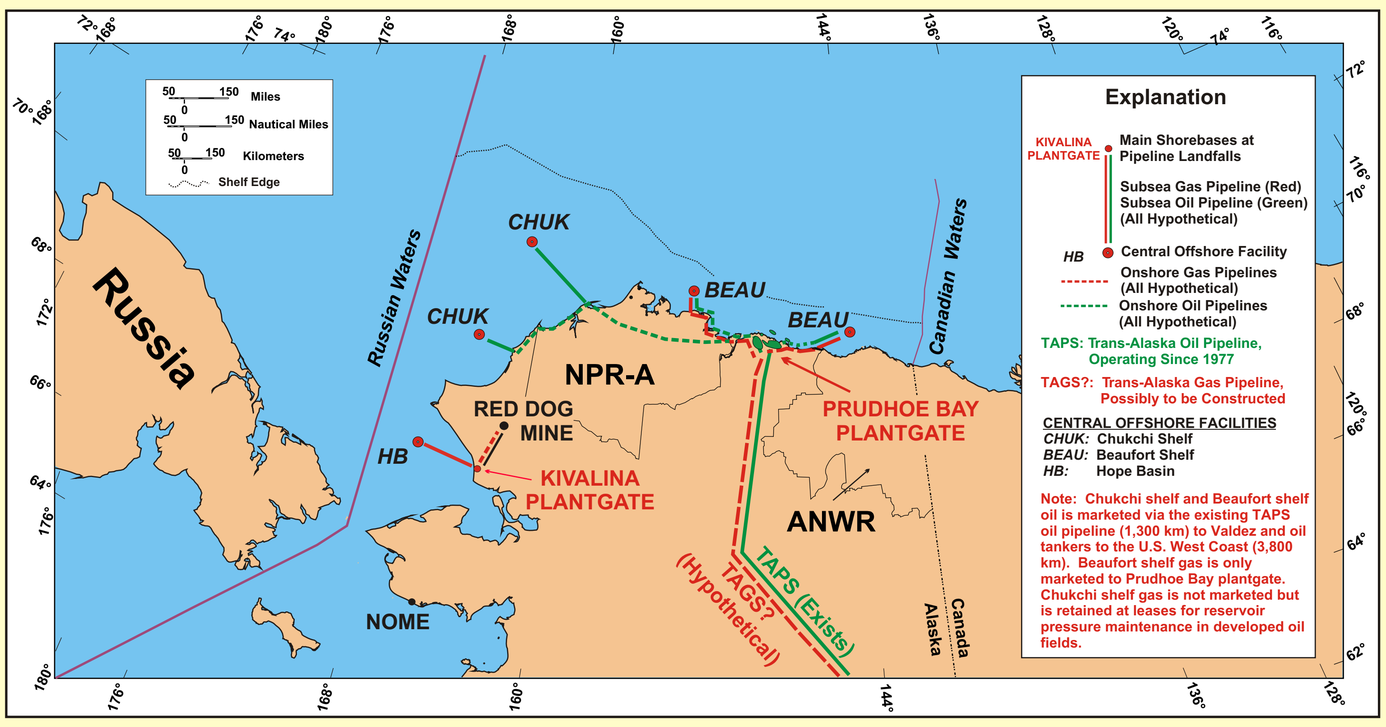
GRASP MODEL: CONCEPTUAL FLOWCHART



PRESTO MODEL: CONCEPTUAL FLOWCHART



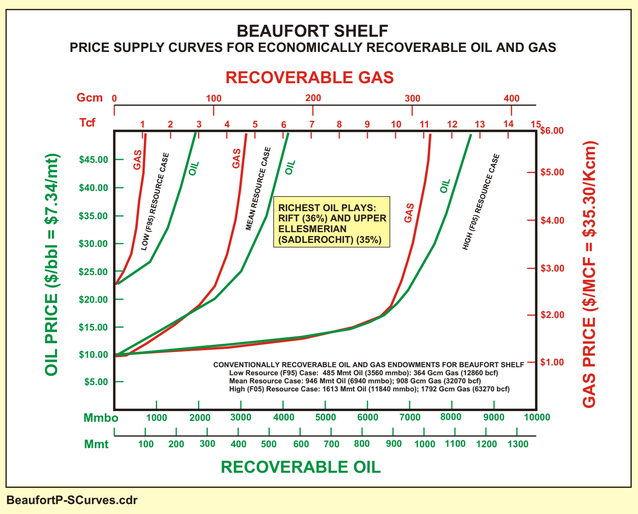
NEW PIPELINES ASSUMED FOR OFFSHORE ECONOMIC ASSESSMENT (2000)



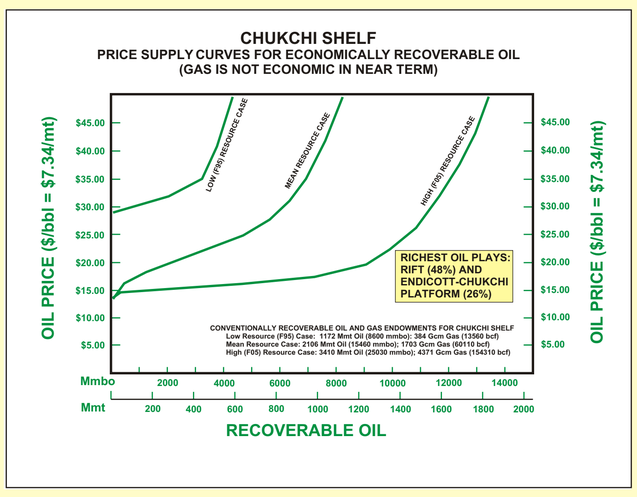
TWO STARTING PRICE MODELS ADOPTED FOR REPORTING RESULTS

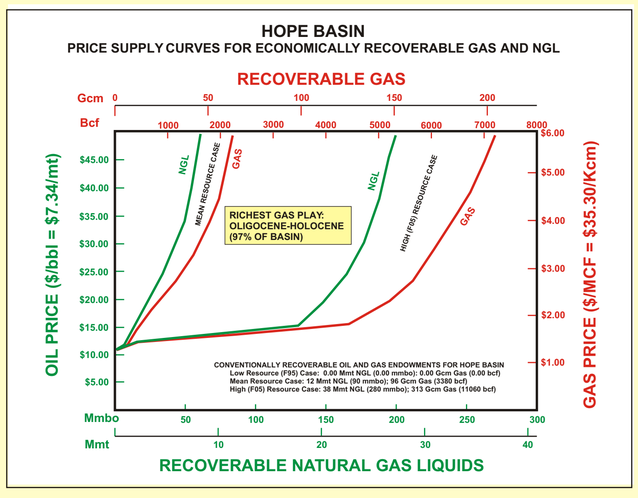
MODEL	STARTING PRICE		GAS/OIL VALUATION/BTU	PRICE GROWTH	INFLATION	BASE YEAR	NPV BASIS/DISCOUNT	FED. CORP. TAX
	Oil	Gas						
Low Price	$18/bbl = $132/mt	$2.11/mcf = $74/Kcm	0.66	Flat	3%	2000	12%	35%
High Price	$30/bbl = $220/mt	$3.52/mcf = $120/Kcm	0.66	Flat	3%	2000	12%	35%

ECONOMIC RESULTS BY PROVINCE (PRICE - SUPPLY CURVES)

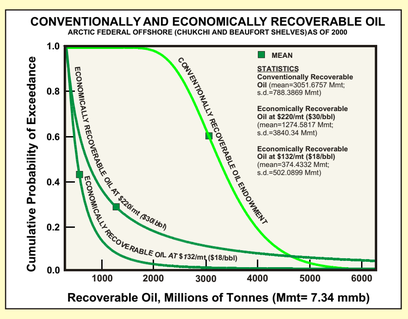


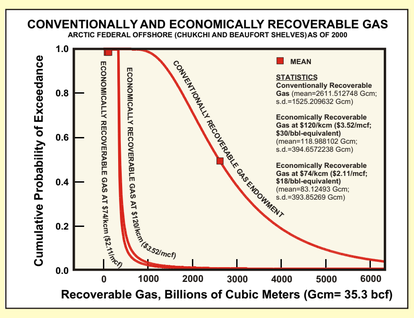
BeaufortP-SCurves.cdr

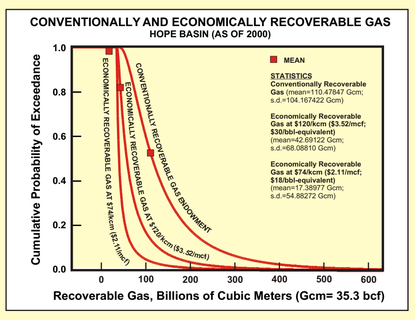


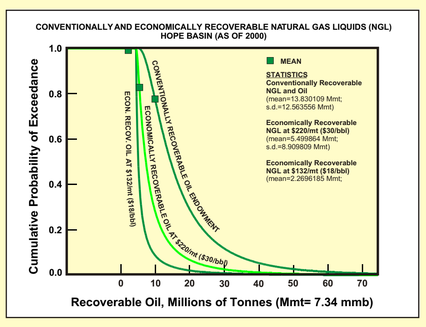


CUMULATIVE PROBABILITY CURVES AND SUMMARY OF ASSESSMENT RESULTS









ECONOMIC RESULTS FOR PLAY SEQUENCES BY PLAY

ELLESMERIAN SEQUENCE, ECONOMIC OIL AND GAS BY PLAY

PROVINCE	YEAR	PLAY NO.	PLAY NAME (CODE NO.)	OIL (BBO)		GAS (TCFG)		OIL (Mmt)		GAS (Gcm)	
				$18/bbl	$30/bbl	$2.11/mcf	$3.52/mcf	$132/mt	$220/mt	$74/Kcm	$120/Kcm
Beaufort Shelf	2000	401	Endicott (UABS0401)	0	0.002	0.008	0.015	0	0.3	0.2	0.4
Beaufort Shelf	2000	501	Lisburne (UABS0501)	0.009	0.042	0.028	0.106	1.2	5.7	0.8	3.0
Beaufort Shelf	2000	603	Upper Ellesmerian-Sadlerochit (UABS0603)	0.615	0.824	1.15	1.451	83.8	112.3	32.6	41.1
Chukchi Shelf	2000	1	Endicott-Chukchi Platform (UACS0100)	0.162	1.603	0	0	22.1	218.4	0.0	0.0
Chukchi Shelf	2000	2	Endicott-Arctic Platform (UACS0200)	0	0	0	0	0	0.0	0.0	0.0
Chukchi Shelf	2000	3	Lisburne Carbonates (UACS0300)	0	0	0	0	0	0.0	0.0	0.0
Chukchi Shelf	2000	4	Ellesmerian Deep Gas (UACS0400)	0	0	0	0	0	0.0	0.0	0.0
Chukchi Shelf	2000	5	Sadlerochit-Chukchi Platform (UACS0500)	0	0.008	0	0	0	1.1	0.0	0.0
Chukchi Shelf	2000	6	Sadlerochit-Arctic Platform (UACS0600)	0.062	0.528	0	0	8.4	71.9	0.0	0.0
			Totals	***0.848***	***3.007***	***1.186***	***1.572***	***115.5***	***409.7***	***33.6***	***44.5***

Mean, Risked, Economically Recoverable Oil and Gas at Indicated Starting Prices

RIFT SEQUENCE, ECONOMIC OIL AND GAS BY PLAY

PROVINCE	YEAR	PLAY NO.	PLAY NAME (CODE NO.)	OIL (BBO)		GAS (TCFG)		OIL (Mmt)		GAS (Gcm)	
				$18/bbl	$30/bbl	$2.11/mcf	$3.52/mcf	$132/mt	$220/mt	$74/Kcm	$120/Kcm
Beaufort Shelf	2000	702	Rift (UABS0702)	0.639	1.127	1.632	2.342	87.1	153.5	46.2	66.3
Chukchi Shelf	2000	7	Rift - Active Margin (UACS0700)	0.421	2.286	0	0	57.4	311.4	0.0	0.0
Chukchi Shelf	2000	8	Rift - Stable Shelf (UACS0800)	0.058	0.679	0	0	7.9	92.5	0.0	0.0
Chukchi Shelf	2000	9	Rift - Deep Gas (UACS0900)	0	0	0	0	0.0	0.0	0.0	0.0
			Totals	***1.118***	***4.092***	***1.632***	***2.342***	***152.3***	***557.5***	***46.2***	***66.3***

Mean, Risked, Economically Recoverable Oil and Gas at Indicated Starting Prices

BROOKIAN SEQUENCE, ECONOMIC OIL AND GAS BY PLAY

PROVINCE	YEAR	PLAY NO.	PLAY NAME (CODE NO.)	OIL (BBO)		GAS (TCFG)		OIL (Mmt)		GAS (Gcm)	
				$18/bbl	$30/bbl	$2.11/mcf	$3.52/mcf	$132/mt	$220/mt	$74/Kcm	$120/Kcm
Beaufort Shelf	2000	803	Brookian Faulted Western Topset (UABS0803)	0	0	0	0	0	0	0	0
Beaufort Shelf	2000	903	Brookian Unstructured Western Topset (UABS0903)	0	0	0	0	0	0	0	0
Beaufort Shelf	2000	1003	Brookian Faulted Western Turbidites (UABS1003)	0	0	0	0	0	0	0	0
Beaufort Shelf	2000	1103	Brookian Unstructured Western Turbidites (UABS1103)	0	0	0	0	0	0	0	0
Beaufort Shelf	2000	1201	Brookian Faulted Eastern Topset (UABS1201)	0.003	0.04	0.001	0.009	0.4	5.4	0.0	0.3
Beaufort Shelf	2000	1303	Brookian Unstructured Eastern Topset (UABS1303)	0.006	0.261	0.013	0.06	0.8	35.6	0.4	1.7
Beaufort Shelf	2000	1400	Brookian Faulted Eastern Turbidites (UABS1400)	0	0	0	0	0	0	0.0	0.0
Beaufort Shelf	2000	1503	Brookian Unstructured Eastern Turbidites (UABS1503)	0.001	0.006	0.001	0.005	0.1	0.8	0.0	0.1
Beaufort Shelf	2000	1602	Brookian Foldbelt (UABS1602)	0.454	0.938	0.102	0.212	61.9	127.8	2.9	6.0
Chukchi Shelf	2000	10	Herald Arch (UACS1000)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	11	L. Brook. Foldbelt (UACS1100)	0.001	0.011	0	0	0.1	1.5	0	0
Chukchi Shelf	2000	12	L. Brook. Turbidites/Wrench Zn (UACS1200)	0	0.002	0	0	0.0	0.3	0	0
Chukchi Shelf	2000	13	L. Brook. Topset/Wrench Zn (UACS1300)	0.001	0.02	0	0	0.1	2.7	0	0
Chukchi Shelf	2000	14	N. Chukchi High/Sand Apron (UACS1400)	0.123	0.731	0	0	16.8	99.6	0	0
Chukchi Shelf	2000	15	L. Brook. Topset/N. Chukchi Basin (UACS1500)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	16	Brookian Deep Gas (UACS1600)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	17	L. Brookian/Turbidites/Arct. Plat. (UACS1700)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	18	L. Brookian/Topset/Arctic Platform (UACS1800)	0	0.016	0	0	0	2.2	0	0
Chukchi Shelf	2000	19	U. Brookian/Sag Phase/N. Chuk. Bsn. (UACS1900)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	20	U. Brookian/Turbidites/N.Chuk.Bsn. (UACS2000)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	21	U. Brookian/Paleovalleys (UACS2100)	0.137	0.701	0	0	18.7	95.5	0	0
Chukchi Shelf	2000	22	U. Brookian/Intervalley Highs (UACS2200)	0.004	0.069	0	0	0.5	9.4	0	0
Chukchi Shelf	2000	24	L.Brookian/Turbidites/Nuwuk basin (UACS2400)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	25	L.Brookian/Topset/Nuwuk basin (UACS2500)	0	0	0	0	0	0	0	0
			Totals	***0.73***	***2.795***	***0.117***	***0.286***	***99.5***	***380.8***	***3.3***	***8.1***

Mean, Risked, Economically Recoverable Oil and Gas at Indicated Starting Prices

HOPE BASIN, ECONOMIC OIL AND GAS BY PLAY

PROVINCE	YEAR	PLAY NO.	PLAY NAME (CODE NO.)	OIL (BBO)		GAS (TCFG)		OIL (Mmt)		GAS (Gcm)	
				$18/bbl	$30/bbl	$2.11/mcf	$3.52/mcf	$132/mt	$220/mt	$74/Kcm	$120/Kcm
Hope Basin	2000	1	Oligocene-Holocene Sequence (UAHB0101)	0.016	0.039	0.612	1.468	2.2	5.3	17.3	41.6
Hope Basin	2000	2	Eocene Sequence (UAHB0201)	0	0	0	0.018	0.0	0.0	0.0	0.5
Hope Basin	2000	3	Shallow Basal Sands (UAHB0301)	0.002	0.001	0.002	0.02	0.3	0.1	0.1	0.6
Hope Basin	2000	4	Deep Basal Sands (UAHB0401)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	26	Oligocene-Holocene Sequence/Hope Basin (UACS2600)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	27	Eocene Sequence/Hope Basin (UACS2700)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	28	Shallow Basal Sands/Hope Basin (UACS2800)	0	0	0	0	0	0	0	0
Chukchi Shelf	2000	29	Deep Basal Sands/Hope Basin (UACS2900)	0	0	0	0	0	0	0	0
			Totals	***0.018***	***0.04***	***0.614***	***1.506***	***2.5***	***5.4***	***17.4***	***42.7***

Mean, Risked, Economically Recoverable Oil and Gas at Indicated Starting Prices

Source:

Sherwood, K.W., Craig, J.D., Scherr, J., Johnson, P.P., and Cooke, L.W., 2001, Undiscovered Oil and Gas Resources of U.S. Arctic Alaska Outer Continental Shelves (abs): American Association of Petroleum Geologists, Annual International Meeting, St. Petersburg, Russia, poster presentation, Abstracts with Programs, July 15-18, 2001, St. Petersburg, Russia.

Sherwood, K.W., Craig, J.D., Scherr, J., Johnson, P.P., and Cooke, L.W., 2002, Undiscovered Oil and Gas Resources of U.S. Arctic Alaska Outer Continental Shelves (abs): Poster presentation at AAPG Pacific Section, Anchorage, Alaska, May 18-23, 2002; American Association of Petroleum Geologists Bulletin, v. 87, no. 6, p. 1159.

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