Chukchi Sea Play 11: Foreland Foldbelt (Lower Brookian)

Geological Assessment

GRASP UAI: AAAAA DAL
Play Area: 8,150 square miles
Play Water Depth Range: 50-165 feet
Play Depth Range: 3,160-8,640 feet
Play Exploration Chance: 0.23

Play 11, Foreland Foldbelt (Lower Brookian), Chukchi Sea OCS Planning Area, 2006 Assessment, Undiscovered Technically-Recoverable Oil & Gas

Assessment Results as of November 2005

Resource Commodity (Units)	Resources *		
	F95	Mean	F05
BOE (Mmboe)	1,238	2,853	5,077
Total Gas (Tcfg)	3.464	7.854	13.728
Total Liquids (Mmbo)	621	1,455	2,634
Free Gas** (Tcfg)	3.095	6.992	12.172
Solution Gas (Tcfg)	0.369	0.862	1.556
Oil (Mmbo)	456	1,075	1,928
Condensate (Mmbc)	166	381	707

** Risked, Technically-Recoverable*

*** Free Gas Includes Gas Cap and Non-Associated Gas*

F95 = 95% chance that resources will equal or exceed the given quantity

F05 = 5% chance that resources will equal or exceed the given quantity

BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas

Mmb = millions of barrels

Tcf = trillions of cubic feet

Table 1

Play 11, the "Foreland Foldbelt" play, is the fourth most important play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 9.8% (2,853 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). The overall assessment results for play 11 are shown in table 1. Oil and gas-condensate liquids form 51% of the hydrocarbon energy endowment of play 11. Table 5 reports the detailed assessment results by commodity for play 11.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi Sea play 11. Table 4 reports the risk model used for play 11. The location of play 11 is shown in figure 1.

The reservoir objectives in play 11 are primarily deltaic sandstones of the Nanushuk Group deposited in Colville basin in Early Cretaceous time and subsequently deformed by north-verging Brooks Range deformation in earliest Paleocene time. Structural deformation increases toward the south, and broad un-faulted anticlines in the northern part of the play area grade into steep-limbed, thrust-faulted, and often breached anticlines to the south. Potential reservoir sandstones in the folded sequence are charged by the Colville basin play charging system. Play 11 was not tested offshore. Onshore exploratory drilling of about 30 anticlinal prospects over about 50 years discovered 6 sites of pooled gas (Tungak Creek(tested gas), Wolf Creek (tested gas), Gubik (600 billion cubic feet), Meade (20 billion cubic feet), Square Lake (58 billion cubic feet), and East Umiat (4 billion cubic feet) and one oil field (Umiat), the latter with estimated reserves of 70 million barrels.

A maximum of 42 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 11. These 42 pools range in mean conditional (un-risked) recoverable volumes from 6 Mmboe (pool rank 42) to 856 Mmboe (pool rank 1). Pool rank 1 ranges in possible

conditional recoverable volumes from 268 Mmboe (F95) to 2,100 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 11.

Play 11, Foreland Foldbelt (Lower Brookian), Chukchi Sea OCS Planning Area, 2006 Assessment, Conditional BOE Sizes of Ten Largest Pools			
Assessment Results as of November 2005			
Pool Rank	BOE Resources *		
	F95	Mean	F05
1	268	856	2100
2	182	447	846
3	136	319	584
4	104	246	461
5	82	198	360
6	64	162	293
7	50	135	249
8	39	113	214
9	30	96	184
10	22	81	160

** Conditional, Technically-Recoverable, Millions of Barrels Energy-Equivalent (Mmboe), from "PSRK.out" file*

F95 = 95% chance that resources will equal or exceed the given quantity

F05 = 5% chance that resources will equal or exceed the given quantity

BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas

Table 2

In the computer simulation for play 11 a total of 171,315 "simulation pools" were sampled for size. These simulation pools can be grouped according to the USGS size class system in which sizes double with each successive class. Pool size class 12 contains the largest share (39,020, or 23%) of simulation pools (conditional, technically recoverable BOE resources) for play 11. Pool size class 12 ranges from 64 to 128 Mmboe. The largest 6 simulation pools for play 11 fall within pool size class 19, which ranges in size from 8,192 to 16,384 Mmboe. Table 6 reports statistics for the simulation pools developed in the *GRASP* computer model for play 11.

GRASP Play Data Form (Minerals Management Service-Alaska Regional Office)

Basin: Chukchi Sea Planning Area
Play Number: 11
Play UAI Number: AAAAA DAL

Assessor: K.W. Sherwood
Play Name: Foreland Foldbelt (Lower Brookian)

Date: January 2005

Play Area: mi² (million acres) 8,150 (5.216)
Reservoir Thermal Maturity: % Ro 1.02 - 1.24

Play Depth Range: feet 3,160 - 8,640 (mean = 6,162)
Expected Oil Gravity: ° API 35
Play Water Depth Range: feet 50 - 165 (mean = 150)

POOLS Module (Volumes of Pools, Acre-Feet)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Prospect Area (acres)-Model Input*	589		3644		13223	21925/28998			47978				135278
Prospect Area (acres)-Model Output**	627	2525	3557	6672	12844	19766/20400	24733	35995	44394	61996			135168
Fill Fraction (Fraction of Area Filled)	0.12	0.19	0.20	0.22	0.25	0.25/0.04	0.28	0.30	0.31	0.33			0.50
Productive Area of Pool (acres)***	146	600	903	1648	3251	5021/5332	6307	9044	11190	15850	17000	20000	44804
Pay Thickness (feet)	20	68	81	109	150	168/85	207	246	277	329	400	456	600

* model fit to prospect area data in *BESTFIT*
** output from *@RISK* after aggregation with fill fraction
*** from *@RISK* aggregation of probability distributions for prospect area and fill fraction

MPRO Module (Numbers of Pools)

Input Play Level Chance *	1 *	Prospect Level Chance	0.23	Exploration Chance	0.23
Output Play Level Chance**	0.9999				

* (30 exploration wells onshore discovered 6 gas fields and 1 oil field; 7/30 = 0.23333)

** First Occurrence of Non Zero Pools As Reported in PSUM Module

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
		Timing (traps [~65 Ma] post-date major migration [~100 Ma])	0.29
		Chance Porosity > 10%	0.8

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	57	61	63	68	73	74.49/8.86	80	82	85	90	93	96	114
Numbers of Pools in Play	8	11	12	14	17	17.13/4.17	20	21	23	24	26	28	42

Two Pools at F100.00

Minimum Number of Pools	2 (F100)	Mean Number of Pools	17.13	Maximum Number of Pools	42

POOLS/PSRK/PSUM Modules (Play Resources)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Oil Recovery Factor (bbl/acre-foot)	42	80	91	116	157	174/81	212	252	282	331	390	430	819
Gas Recovery Factor (Mcfg/acre-foot)	191	425	474	588	767	838/348	1010	1161	1288	1503	1700	1800	3035
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	500	680	710	760	800	803/84	860	880	900	930	960	980	1100
Condensate Yield ((bbl/Mmcfg)	13	29	33	40	50	54/19	64	72	79	90	105	120	200

Pool Size Distribution Statistics from *POOLS* (1,000 BOE): μ (mu)= 11.369 σ² (sigma squared)= 1.418 Random Number Generator Seed= 509823

BOE Conversion Factor (cf/bbl)	5620	Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.3
Probability Any Pool is 100% Oil	0.2	Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.25
Probability Any Pool is 100% Gas	0.5		

Table 3. Input data for Chukchi Sea play 11, 2006 assessment.

Risk Analysis Form - 2006 National Assessment

Assessment Province:	Chukchi Sea OCS Planning Area	**Play Number, Name:**	11. Foreland Foldbelt (Lower Brookian)
Assessor(s):	K.W. Sherwood	**Play UAI:**	AAAAA DAL
Date:	1-Jan-05		

For each component, a *quantitative* probability of success (i.e., between zero and one, where zero indicates no confidence and one indicates absolute certainty) based on consideration of the *qualitative* assessment of **ALL** elements within the component was assigned. This is the assessment of the probability that the minimum geologic parameter assumptions have been met or exceeded.

			Play Chance Factors	Averge Conditional Prospect Chance[1]
1.	**Hydrocarbon Fill component** (1a * 1b * 1c)	**1**	***1.0000***	***0.2875***
	a. Presence of a Quality, Effective, Mature Source Rock			
	Probability of efficient source rock in terms of the existence of sufficient volume of mature source rock of adequate quality located in the drainage area of the reservoirs.	1a	1.00	1.00
	b. Effective Expulsion and Migration			
	Probability of effective expulsion and migration of hydrocarbons from the source rock to the reservoirs.	1b	1.00	0.29
	c. Preservation			
	Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	1.00	1.00
2.	**Reservoir component** (2a * 2b)	**2**	***1.0000***	***0.8000***
	a. Presence of reservoir facies			
	Probability of presence of reservoir facies with a minimum net thickness and net/gross ratio (as specified in the resource assessment).	2a	1.00	1.00
	b. Reservoir quality			
	Probability of effectiveness of the reservoir, with respect to minimum effective porosity, and permeability (as specified in the resource assessment).	2b	1.00	0.80
3.	**Trap component** (3a * 3b)	**3**	***1.0000***	***1.0000***
	a. Presence of trap			
	Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	1.00	1.00
	b. Effective seal mechanism			
	Probability of effective seal mechanism for the trap.	3b	1.00	1.00
	Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)		***1.0000***	
	(1 * 2 * 3) *Product of All Subjective Play Chance Factors*			
	Average Conditional Prospect Chance[1]			***0.2300***
	(1 * 2 * 3) *Product of All Subjective Conditional Prospect Chance Factors*			
	[1] Assumes that the Play exists (where all play chance factors = 1.0)			
	Must be consistent with play chance and prospect distribution -- See discussion on Page 3 of Guide			
	Exploration Chance		***0.2300***	
	(Product of Overall Play Chance and Average Conditional Prospect Chance)			

Comments: *See guidance document for explanation of the Risk Analysis Form*

2b: Chance That Porosity >10%, Based on Regional Model for Porosity vs Reservoir Thermal Maturity

7 discoveries within the onshore extension of this play: Gubik, Wolf Crrek, Meade, Umiat, East Umiat, Square Lake, and Tungak Creek. 7 discoveries out of ~30 exploration wells = 0.233 exploration success rate.

Table 4. Risk model for Chukchi Sea play 11, 2006 assessment.

GRASP - Geologic and Economic Resource Assessment Model - PSUM Module Results

Minerals Management Service - Alaska OCS Region
GRASP Model Version: 8.29.2005)
Computes the Geologic Resource Potential of the Play

Play UAI:	**AAAAADAL**		**Play No.**		**11**		
World	Level	-	World	Level		Resources	
Country	Level	-	UNITED	STATES		OF	AMERICA
Region	Level	-	MMS	-		ALASKA	REGION
Basin	Level	-	**CHUKCHI**	**SEA**		**SHELF**	
Play	**Level**	**-**	**Play**		**11**	**Foreland Foldbelt (Lower Brookian)**	
Geologist	Kirk	W.	Sherwood				
Remarks	2005	Assessment					
Run Date & Time:		Date	19-Sep-05	Time		13:54:09	

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	2,852,900	1,222,300
Oil (Mbo)	1,074,800	668,640
Condensate (Mbc)	380,520	228,260
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	6,991,900	3,771,800
Solution Gas (Mmcfg)	862,090	536,600

10000 (Number of Trials in Sample)
0.9999 (MPhc [Probability] of First Occurrence of Non-Zero Resource)
Windowing Feature: used

Empirical Probability Distributions of the Products

Greater Than Percentage	BOE (Mboe)	Oil (Mbo)	Condensate (Mbc)	Free (Gas Cap & Nonassociated) Gas (Mmcfg)	Solution Gas (Mmcfg)
100	136,890	13,570	33,437	492,910	12,244
99.99	136,890	13,570	33,437	492,910	12,244
99	814,850	302,490	106,370	2,041,500	240,130
95	1,237,500	455,590	165,500	3,095,100	369,040
90	1,494,300	535,520	201,590	3,825,100	430,340
85	1,682,000	669,000	210,900	3,972,300	535,320
80	1,840,100	685,980	237,830	4,597,000	552,520
75	1,985,600	704,300	272,960	5,102,800	563,900
70	2,122,400	810,790	273,750	5,179,900	652,720
65	2,255,000	860,950	300,440	5,452,400	693,960
60	2,390,500	913,160	309,720	5,831,400	730,750
55	2,535,600	939,600	335,430	6,317,900	766,600
50	2,674,800	1,047,300	338,710	6,393,200	849,680
45	2,808,700	996,100	381,840	7,231,800	809,040
40	2,958,000	1,132,300	389,620	7,177,800	892,790
35	3,127,900	1,226,500	402,360	7,451,200	973,680
30	3,313,900	1,250,400	435,510	8,145,600	1,004,200
25	3,523,200	1,208,900	507,510	9,193,700	960,110
20	3,759,200	1,373,500	514,350	9,414,500	1,102,500
15	4,029,500	1,474,000	541,390	10,135,000	1,183,900
10	4,426,500	1,728,700	568,420	10,583,000	1,384,300
8	4,633,800	1,750,800	638,940	11,207,000	1,405,100
6	4,902,000	1,968,900	620,610	11,426,000	1,570,200
5	5,076,600	1,927,500	706,510	12,172,000	1,555,600
4	5,277,000	2,000,300	706,390	12,838,000	1,607,600
2	5,923,900	2,407,400	739,700	13,667,000	1,938,400
1	6,583,000	2,598,100	880,260	15,379,000	2,069,000
0.1	9,804,000	2,811,200	1,245,800	30,014,000	2,284,400
0.01	12,732,000	10,342,000	259,660	4,930,700	7,037,700
0.001	13,346,000	2,187,900	3,423,200	41,861,000	1,607,400

Table 5. Assessment results by commodity for Chukchi Sea play 11, 2006 assessment.

Basin: CHUKCHI SEA SHELF
Play 11 - L. Brookian Foldbelt
UAI Key: AAAAADAL

Model Simulation "Pools" Reported by "Fieldsize.out" *GRASP* Module

Classification and Size				Pool Count Statistics				Pool Types Count			Mixed Pool Range		Oil Pool Range		Gas Pool Range		Total Pool Range			Pool Resource Statistics (MMBOE)			
Class	Min (MMBOE)	Max (MMBOE)	Pool Count	Percentage	Trial Average	Trials w/Pool Avg		Mixed Pool	Oil Pool	Gas Pool	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Total Resource	Average Resource
1	0.0312	0.0625	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
2	0.0625	0.125	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
3	0.125	0.25	2	0.001167	0.0002	0.0002		0	0	2	0	0	0	0	1	1	1	1		0.196696	0.196696	0.393392	196.696192
4	0.25	0.5	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
5	0.5	1	27	0.01576	0.0027	0.0027		11	1	15	1	1	1	1	1	1	1	1		0.506839	0.996285	22.047713	816.581964
6	1	2	202	0.117911	0.0202	0.0202		43	65	94	1	1	1	2	1	2	1	2		1.031222	1.990146	319.148604	1.579944
7	2	4	1129	0.65902	0.1129	0.1129		310	212	607	1	2	1	2	1	3	1	3		2.003187	3.998030	3527.680000	3.124606
8	4	8	3645	2.12766	0.3645	0.3645		935	827	1883	1	2	1	2	1	3	1	4		4.001590	7.999226	22237.719000	6.100883
9	8	16	9089	5.305431	0.9089	0.9089		2633	1845	4611	1	4	1	3	1	5	1	7		8.005903	15.999304	110208.973000	12.125533
10	16	32	19762	11.535476	1.9762	1.9762		5906	3760	10096	1	5	1	4	1	7	1	8		16.000785	31.993679	470505.154000	23.808580
11	32	64	32650	19.05846	3.265	3.265		9594	6512	16544	1	6	1	5	1	7	1	11		32.000905	63.998263	1534594.000000	47.001339
12	64	128	39020	22.776756	3.902	3.902		11814	7511	19695	1	7	1	5	1	8	1	16		64.003336	127.994118	3603795.000000	92.357643
13	128	256	34305	20.024517	3.4305	3.4305		10726	6767	16812	1	7	1	5	1	8	1	13		128.003793	255.996189	6229526.000000	181.592377
14	256	512	20917	12.209672	2.0917	2.0917		6511	4008	10398	1	5	1	4	1	7	1	11		256.017266	511.958594	7396687.000000	353.620850
15	512	1024	8352	4.87523	0.8352	0.8352		2582	1694	4076	1	3	1	3	1	4	1	5		512.029180	1023.223000	5715894.000000	684.374329
16	1024	2048	1919	1.120159	0.1919	0.1919		566	430	923	1	3	1	2	1	3	1	3		1024.172000	2047.706000	2577384.000000	1.343087
17	2048	4096	267	0.155853	0.0267	0.0267		77	66	124	1	1	1	1	1	2	1	3		2059.146000	3991.248000	693293.831000	2.596606
18	4096	8192	23	0.013426	0.0023	0.0023		1	6	16	1	1	1	1	1	1	1	1		4172.909000	6703.494000	117152.027000	5.093566
19	8192	16384	6	0.003502	0.0006	0.0006		0	1	5	0	0	1	1	1	1	1	1		8771.481000	9534.670000	53392.074000	8.898679
20	16384	32768	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
21	32768	65536	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
22	65536	131072	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
23	131072	262144	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
24	262144	524288	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
25	524288	1048576	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
Not Classified			0	0	0	0	Below Class	0	0	0									Below Class	0.000000	0.000000	0.000000	0.000000
		Totals	**171315**	**100**	**17.1315**	**17.1315**	Above Class	0	0	0									Above Class	0.000000	0.000000	0.000000	0.000000

Number of Pools not Classified: 0
Number of Pools below Class 1: 0
Number of Trials with Pools: 10000

Min and Max refer to numbers of pools of the relevant size class that occur within any single trial in the simulation.

Min and Max refer to aggregate resources of the relevant size class that occur within any single trial in the simulation.

Table 6. Statistics for simulation pools created in computer sampling run for Chukchi Sea play 11, 2006 assessment.

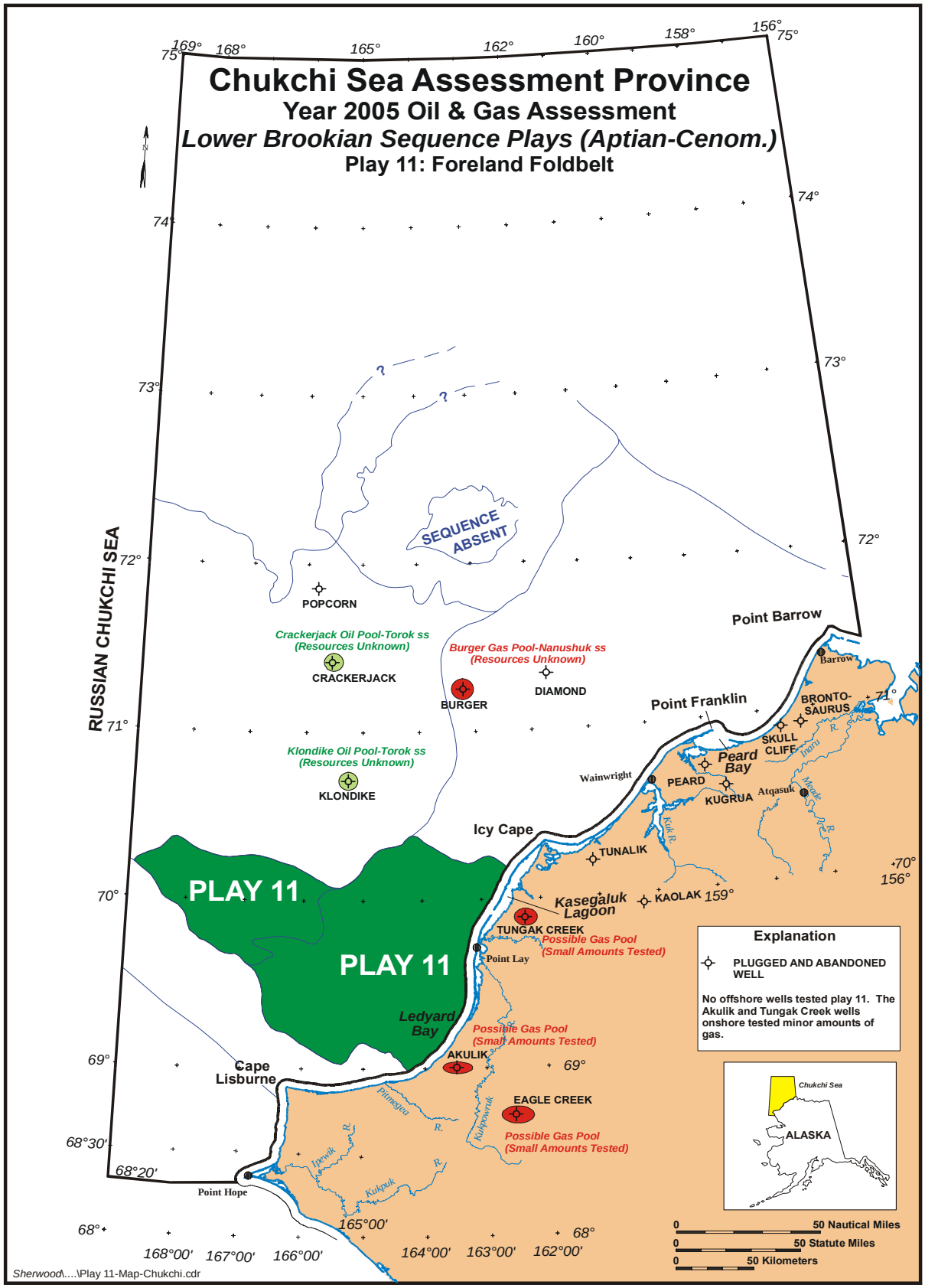

Figure 1. Map location of Chukchi Sea play 11, 2006 assessment.