Chukchi Sea Play 8: Rift Sequence-Stable Shelf

Geological Assessment

GRASP UAI: AAAAA DAI
Play Area: 21,319 square miles
Play Water Depth Range: 90-170 feet
Play Depth Range: 3,500-13,140 feet
Play Exploration Chance: 0.16

Play 8, Rift Sequence-Stable Shelf, 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)	521	3,787	10,841
Total Gas (Tcfg)	1.421	9.993	28.681
Total Liquids (Mmbo)	268	2,009	5,737
Free Gas** (Tcfg)	0.983	6.609	18.856
Solution Gas (Tcfg)	0.437	3.384	9.825
Oil (Mmbo)	217	1,654	4,716
Condensate (Mmbc)	51	356	1,021

** 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 8, the "Rift Sequence-Stable Shelf" play, is the third-ranking play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 13% (3,787 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). The overall assessment results for play 8 are shown in table 1. Oil and gas-condensate liquids form 53% of the hydrocarbon energy endowment of play 8. Table 5 reports the detailed assessment results by commodity for play 8.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi Sea play 8. Table 4 reports the risk model used for play 8. The location of play 8 is shown in figure 1.

The reservoirs objectives of play 8 are primarily Late Jurassic to Early Cretaceous sandstones equivalent to the Kuparuk Formation of northern Alaska. Unlike the Rift sequence in the tectonically active rift zone (play 7) to the north, the Rift sequence in play 8 was instead deposited on a tectonically stable shelf and slope that rimmed a deep water "basin plain" area in southernmost Hanna trough. On the stable shelf and slope, we anticipate fine-grained marine shelf sandstones that are probably thinner than their counterparts in tectonic depressions in play 7. This play is charged by the Hanna trough play charging system. All of the "unidentified" prospects used to construct the prospect numbers distribution for this play were estimated using a prospect density (area basis) that was devised from mapping "geobodies" imaged by seismic attributes in three-dimensional seismic data within the correlative sequence in the National Petroleum Reserve-Alaska (NPRA). The size range of these "geobodies" also helped define the prospect area distribution. A prospect within the play was incidentally tested while drilling to a deeper target by Klondike well, encountering pooled oil (inferred from logs) in a sandstone 80 feet thick. Diamond well encountered no sandstones in the Rift sequence (only the Pebble Shale was present) and was barren of hydrocarbons.

The Rift sequence was associated with minor gas shows at Peard No. 1 well onshore. At Barrow, gas production is occurring from Lower Jurassic ("Barrow") sandstones that are apparently unique to the Barrow area.[1] The sequence hosts a gas field at Walakpa that is produced for use by the community of Barrow.

Play 8, Rift Sequence-Stable Shelf, 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	202	1862	7670
2	98	633	1516
3	54	376	941
4	33	263	712
5	22	198	510
6	16	156	419
7	12	127	343
8	10	106	293
9	8	91	254
10	7	79	225
** 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

A maximum of 114 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 8.

These 114 pools range in mean conditional (un-risked) recoverable volumes from 2 Mmboe (pool rank 114) to 1,862 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 202 Mmboe (F95) to 7,670 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 8.

In the computer simulation for play 8 a total of 157,254 "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 (27,192, or 17%) of simulation pools (conditional, technically recoverable BOE resources) for play 8. Pool size class 12 ranges from 64 to 128 Mmboe. The largest 17 simulation pools for play 8 fall within pool size class 20, which ranges in size from 16,384 to 32,768 Mmboe. Table 6 reports statistics for the simulation pools developed in the GRASP computer model for play 8.

[1] *Within the stratigraphic convention used here, the "Barrow" sandstones at the base of the Lower Kingak Formation would be grouped with the Upper Ellesmerian play sequence. In the Beaufort Sea and northern Alaska, the "Barrow" sandstones are grouped with the Rift or "Beaufortian" sequence*

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

Basin: Chukchi Sea Planning Area
Play Number: 08
Play UAI Number: AAAAA DAI

Assessor: K.W. Sherwood
Play Name: Rift Sequence - Stable Shelf

Date: January 2005

Play Area: mi² (million acres) 21,319 (13.644)
Reservoir Thermal Maturity: % Ro 0.80 - 1.73

Play Depth Range: feet 3,500 - 13,140 (mean = 6,943)
Expected Oil Gravity: ° API 30
Play Water Depth Range: feet 90 - 170 (mean = 160)

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*	318		789		5440	16931/49898			37522				497446
Prospect Area (acres)-Model Output**	319	666	970	2123	5517	15679/33677	14967	24835	36953	61420			488990
Fill Fraction (Fraction of Area Filled)	0.25	0.37	0.40	0.45	0.51	0.51/0.09	0.57	0.61	0.64	0.68			1.00
Productive Area of Pool (acres)***	126	320	487	1072	2792	8096/17775	7583	12783	18320	30935	48000	60000	309801
Pay Thickness (feet)	30	62	69	82	100	104/30	121	135	144	160	180	195	350

* 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*
Output Play Level Chance**	0.9995

Prospect Level Chance	0.16

Exploration Chance	0.16

* (Apparent oil pay [log] at Klondike well)

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

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
		Closure Presence (most prospects inferred from analog geobodies-NPRA 3D seismic amplitude mapping)	0.8
		Reservoir Presence (continuous but thin and subject to stripping at uncconformities)	0.8
		Chance Porosity > 10%	0.25

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	28	39	47	62	83	98.04/55.22	120	140	160	190	230	260	561
Numbers of Pools in Play	3	5	6	9	14	15.69/9.55	20	24	27	32	39	47	114

Zero Pools at F99.98

Minimum Number of Pools	3 (F99)	Mean Number of Pools	15.69	Maximum Number of Pools	114

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)	41	84	96	121	162	187/96	227	271	311	374	440	490	929
Gas Recovery Factor (Mcfg/acre-foot)	263	645	730	895	1128	1236/496	1462	1675	1862	2163	2600	2900	4998
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	520	1450	1600	1800	2050	2044/424	2300	2450	2550	2700	2850	2950	3600
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)= 11.232 σ² (sigma squared)= 2.223

Random Number Generator Seed= 682571

BOE Conversion Factor (cf/bbl)	5620
Probability Any Pool is 100% Oil	0.2
Probability Any Pool is 100% Gas	0.2

Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.6
Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.3

Table 3. Input data for Chukchi Sea play 8, 2006 assessment.

Risk Analysis Form - 2006 National Assessment

Assessment Province:	Chukchi Sea OCS Planning Area	**Play Number, Name:**	8. Rift Sequence - Stable Shelf
Assessor(s):	K.W. Sherwood	**Play UAI:**	AAAAA DAI
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***	***1.0000***
	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	1.00
	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***	***0.2000***
	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	0.80
	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	0.25
3.	**Trap component** (3a * 3b)	**3**	***1.0000***	***0.8000***
	a. Presence of trap			
	Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	1.00	0.80
	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]				***0.1600***
	(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			***0.1600***	
	(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

Oil (apparent log pay) in Rift Sequence sandstone at Klondike 1 well.

Table 4. Risk model for Chukchi Sea play 8, 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:	**AAAAADAI**		**Play No.**		**8**		
World	Level	-	World	Level	Resources		
Country	Level	-	UNITED	STATES	OF	AMERICA	
Region	Level	-	MMS	-	ALASKA	REGION	
Basin	Level	-	**CHUKCHI**	**SEA**	**SHELF**		
Play	**Level**	**-**	**Play**		**8**	**Rift Sequence - Stable Shelf**	
Geologist	Kirk	W.	Sherwood				
Remarks	2005	Assessment					
Run Date & Time:		Date	19-Sep-05	Time	13:53:19		

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	3,787,100	3,694,300
Oil (Mbo)	1,653,500	1,826,500
Condensate (Mbc)	355,610	428,940
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	6,609,100	7,582,800
Solution Gas (Mmcfg)	3,383,500	3,796,300

10000 (Number of Trials in Sample)
0.9995 (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	0	0	0	0	0
99.99	0	0	0	0	0
99	203,350	89,692	18,593	351,210	183,050
95	520,860	217,450	50,640	983,120	437,460
90	792,410	351,240	70,893	1,376,200	704,700
85	1,039,700	455,090	96,492	1,811,600	931,480
80	1,256,800	539,190	118,760	2,238,600	1,127,200
75	1,481,400	635,420	140,340	2,679,900	1,285,700
70	1,701,100	752,710	158,170	2,941,100	1,500,000
65	1,926,900	814,210	193,110	3,537,200	1,630,800
60	2,169,900	940,370	203,200	3,849,600	1,918,200
55	2,433,000	1,047,600	232,240	4,312,400	2,168,300
50	2,705,300	1,184,700	256,370	4,754,500	2,350,400
45	3,021,500	1,373,500	268,830	4,921,000	2,830,100
40	3,359,400	1,501,100	300,650	5,681,600	3,072,000
35	3,723,900	1,713,700	327,410	6,018,700	3,438,800
30	4,205,800	1,943,000	370,710	6,702,700	3,931,100
25	4,741,100	1,996,000	474,860	8,664,700	4,094,000
20	5,475,700	2,493,400	472,820	9,024,400	5,078,800
15	6,464,700	2,828,000	620,730	11,270,000	5,680,200
10	7,994,400	3,478,200	732,630	14,105,000	7,158,200
8	8,762,900	3,537,300	902,370	17,060,000	7,236,500
6	9,916,200	4,510,100	860,910	16,421,000	9,122,300
5	10,841,000	4,716,100	1,021,200	18,856,000	9,825,300
4	11,995,000	5,084,500	1,165,400	21,504,000	10,783,000
2	15,282,000	6,326,900	1,517,700	28,552,000	13,248,000
1	18,524,000	8,853,900	1,536,800	27,674,000	18,034,000
0.1	31,938,000	15,349,000	2,503,300	47,397,000	31,767,000
0.01	39,124,000	19,665,000	2,790,200	52,417,000	41,266,000
0.001	42,937,000	25,788,000	1,301,900	33,411,000	55,647,000

Table 5. Assessment results by commodity for Chukchi Sea play 8, 2006 assessment.

Basin: CHUKCHI SEA SHELF
Play 08 - Rift - Stable Shelf
UAI Key: AAAAADAI

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	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
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	37	0.023529	0.0037	0.003701		12	18	7	1	1	1	1	1	1	1	2		0.603754	0.988783	30.477555	823.717713
6	1	2	327	0.207944	0.0327	0.032713		163	96	68	1	2	1	2	1	1	1	2		1.013303	1.999470	537.800213	1.644649
7	2	4	2533	1.61077	0.2533	0.253401		1415	654	464	1	4	1	3	1	2	1	5		2.000288	3.999088	7887.362000	3.113842
8	4	8	7531	4.789067	0.7531	0.753401		4449	1716	1366	1	8	1	5	1	3	1	11		4.001388	7.999891	45694.988000	6.067586
9	8	16	14452	9.190228	1.4452	1.445778		8666	3086	2700	1	11	1	6	1	6	1	17		8.000485	15.999937	171504.878000	11.867208
10	16	32	21358	13.581848	2.1358	2.136655		12667	4390	4301	1	17	1	6	1	6	1	28		16.000466	31.998939	501535.339000	23.482317
11	32	64	25854	16.440918	2.5854	2.586435		15567	5154	5133	1	14	1	9	1	7	1	24		32.001918	63.994172	1200509.000000	46.434170
12	64	128	27192	17.291771	2.7192	2.720288		16098	5503	5591	1	15	1	7	1	10	1	22		64.001982	127.995397	2509824.000000	92.300087
13	128	256	24934	15.855877	2.4934	2.494398		14979	4800	5155	1	17	1	6	1	9	1	25		128.021736	255.999943	4551534.000000	182.543274
14	256	512	17178	10.923729	1.7178	1.718487		10398	3176	3604	1	12	1	6	1	5	1	16		256.000509	511.853647	6172346.000000	359.316925
15	512	1024	9578	6.090783	0.9578	0.958183		5642	1916	2020	1	7	1	4	1	4	1	10		512.019023	1023.363000	6853461.000000	715.541992
16	1024	2048	4177	2.656212	0.4177	0.417867		2494	764	919	1	5	1	3	1	3	1	6		1024.817000	2046.183000	5801264.000000	1.388859
17	2048	4096	1187	0.75483	0.1187	0.118748		681	243	263	1	3	1	2	1	2	1	3		2048.760000	4090.440000	3350382.000000	2.822563
18	4096	8192	672	0.427334	0.0672	0.067227		403	126	143	1	2	1	2	1	2	1	3		4101.650000	8177.336000	3905615.000000	5.811926
19	8192	16384	227	0.144352	0.0227	0.022709		125	48	54	1	1	1	1	1	1	1	2		8237.760000	16369.454000	2453470.000000	10.808236
20	16384	32768	17	0.010811	0.0017	0.001701		10	5	2	1	1	1	1	1	1	1	1		16413.273000	29178.212000	345488.773000	20.322869
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	**157254**	**100.000008**	**15.7254**	**15.731693**	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: 9996

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 8, 2006 assessment.

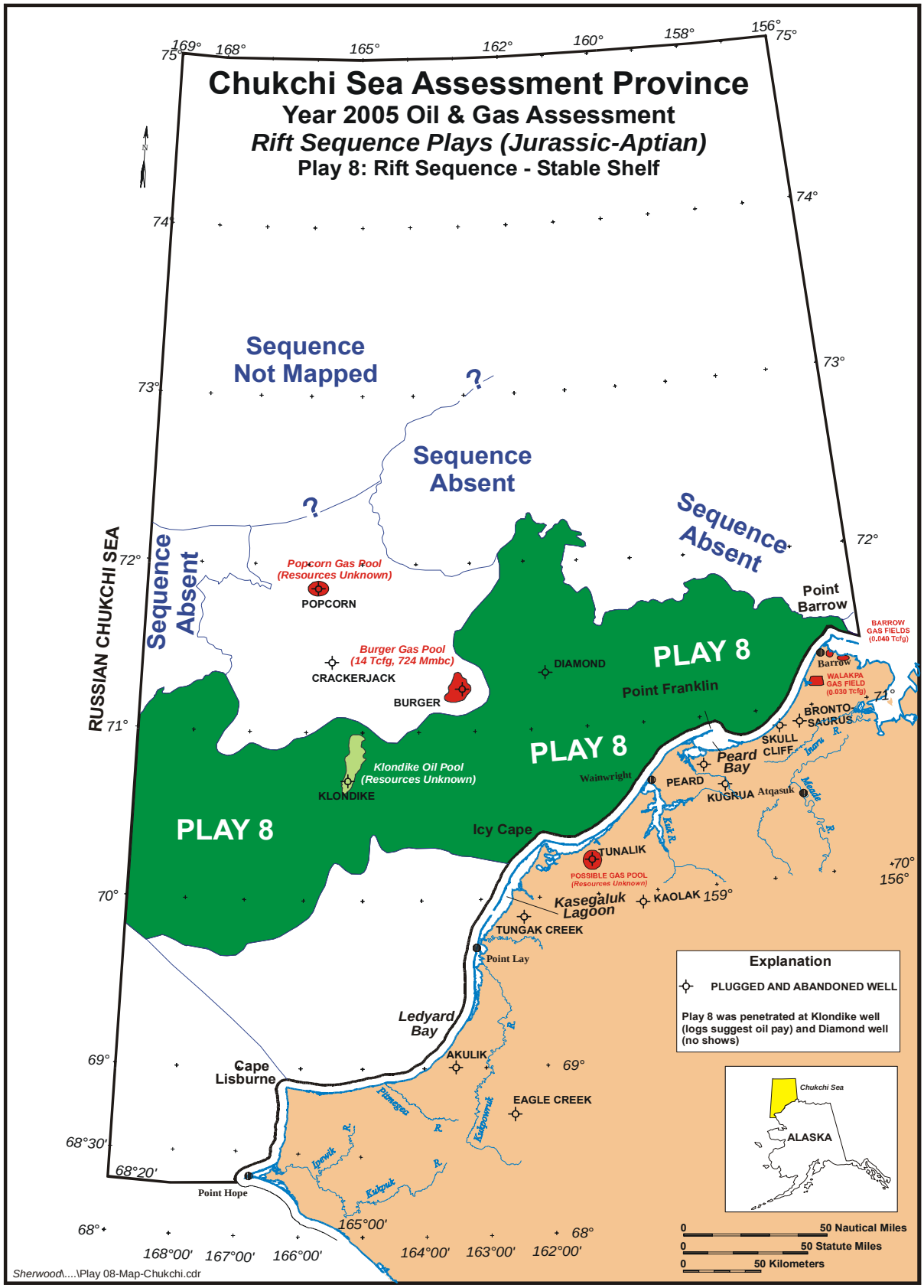

Figure 1. Map location of Chukchi Sea play 8, 2006 assessment.