

Chukchi Sea Play 7: Rift Sequence-Active Margin

Geological Assessment

GRASP UAI: AAAAA DAH

Play Area: 8,204 square miles

Play Water Depth Range: 90-170 feet

Play Depth Range: 2,600-12,000 feet

Play Exploration Chance: 0.384

Play 7, Rift Sequence-Active Margin, 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)	1,953	6,251	12,902
Total Gas (Tcfg)	4.153	13.243	27.712
Total Liquids (Mmbo)	1,214	3,895	7,971
Free Gas** (Tcfg)	3.145	10.034	21.216
Solution Gas (Tcfg)	1.008	3.209	6.496
Oil (Mmbo)	1,052	3,354	6,799
Condensate (Mmbc)	162	541	1,172
<i>* Risked, Technically-Recoverable</i> <i>** Free Gas Includes Gas Cap and Non-Associated Gas</i> <i>F95 = 95% chance that resources will equal or exceed the given quantity</i> <i>F05 = 5% chance that resources will equal or exceed the given quantity</i> <i>BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas</i> <i>Mmb = millions of barrels</i> <i>Tcf = trillions of cubic feet</i>			

Table 1

The 2006 assessment of play 7, the “Rift Sequence-Active Margin” (without exclusion of discovered resources at Burger prospect¹) forecast mean, risked,

¹ *Exclusion of discovered resources at Burger prospect by using the “MATCHR” module within the GRASP assessment program forecasts resources of 5,799*

undiscovered, technically recoverable resources of 3,895 million barrels of petroleum liquids (oil and condensate from gas) and 13.243 trillion cubic feet of natural gas (solution gas and free gas). Play 7 is the top play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 21.5% (6,251 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). The overall assessment results for play 7 are shown in [table 1](#). Oil and gas-condensate liquids form 62% of the hydrocarbon energy endowment of play 7. [Table 5](#) reports the detailed assessment results by commodity for play 7.

[Table 3](#) summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi Sea play 7. [Table 4](#) reports the risk model used for play 7. The location of play 7 is shown in [figure 1](#).

The reservoirs of play 7 are primarily Upper Jurassic to Lower Cretaceous sandstones (equivalent to the Kuparuk Formation) that were deposited in a zone of active faulting and flexural subsidence near an active rift that lay beneath what is now North Chukchi basin. This tectonic environment produced a pattern of abrupt thickness changes among component stratigraphic units. During Rift sequence deposition, tectonic depressions evidently accommodated greater thicknesses of strata. Areas where great thicknesses of the Rift sequence were preserved may correspond to great (and possibly commercial) thicknesses of sandstone

Mmboe, 3,573 million barrels of oil and condensate, and 12.506 trillion cubic feet of gas (F95 to F05 ranges, 4,087 to 7,774 Mmboe, 575 to 4,790 million barrels, and 8.876 to 16.767 trillion cubic feet, respectively) for play 7.

reservoirs within the sequence. This inferred correspondence draws upon analogy to the abrupt expansion in thickness of Kuparuk sandstones that is observed in fault-bounded depressions in the Prudhoe Bay area.

Kuparuk sandstones are 50 to 100 feet thick in most areas, including Kuparuk field, but expand to 450 gross feet in the fault-bounded depression hosting Point McIntyre field near Prudhoe Bay. 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. Play 7 is charged by the Hanna trough play charging system. Three offshore wells (Burger, Crackerjack, Popcorn) penetrated play 7. Burger and Popcorn wells encountered gas (with condensate) in sandstones ranging up to 107 feet in thickness at Burger. Burger prospect is estimated (most likely case) to house discovered resources of 14.038 trillion cubic feet of gas and 724 million barrels of condensate. At Crackerjack well, no sandstones are preserved within the Rift sequence because most of the sequence is truncated at the Lower Cretaceous unconformity.

A maximum of 103 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 7. These 103 pools range in mean conditional (un-risked) recoverable volumes from 2 Mmboe (pool rank 103) to 2,183 Mmboe (pool rank 1). Pool rank 1² ranges in

² The largest pool in play 7 is alternatively considered to have been discovered at Burger prospect, with 3,222 million barrels

possible conditional recoverable volumes from 475 Mmboe (F95) to 5,940 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 7.

Play 7, Rift Sequence-Active Margin, 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	475	2183	5940
2	280	984	2126
3	197	649	1340
4	144	480	991
5	108	374	818
6	82	300	661
7	63	246	531
8	48	205	457
9	36	173	383
10	28	147	338
* Conditional, Technically-Recoverable, Millions of Barrels Energy-Equivalent (Mmboe), from "PSRK.out" file. Burger gas pool (14.038 Tcfg + 724 Mmbc = 3,222 Mmboe; Craig & Sherwood, 2004) was not excluded from the undiscovered resources in this model. If Burger pool is excluded using the MATCHR module ("PSDR.out" file) in GRASP, the largest remaining pool ranges 439-1446-2867 Mmboe (F95-Mean-F05). 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 7 a total

oil-equivalent in resources (14.038 trillion cubic feet gas and 724 million barrels of condensate). The largest hypothetical undiscovered pool remaining in play 7 after exclusion of Burger prospect ranges in F95 to F05 “conditional” (unrisked) sizes from 439 to 2,867 million barrels-equivalent, with a mean size of 1,446 million barrels-equivalent.

of 272,921 “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 (43,973, or 16%) of simulation pools (conditional, technically recoverable BOE resources) for play 7. Pool size class 12 ranges from 64 to 128 Mmboe. The largest 5 simulation pools for play 7 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 7.

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

Basin: Chukchi Sea Planning Area
 Play Number: 07
 Play UAI Number: AAAAA DAH

Assessor: K.W. Sherwood
 Play Name: Rift Sequence - Active Margin

Date: January 2005

Play Area: mi² (million acres) 8,204 (5.251)
 Reservoir Thermal Maturity: % Ro 0.56-1.12

Play Depth Range: feet 2,600 - 12,000 (mean = 8,564)
 Expected Oil Gravity: ° API 30
 Play Water Depth Range: feet 90 - 170 (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*	318		818		5954	19766/62572			43353				236956
Prospect Area (acres)-Model Output**	318	639	983	2242	6326	16733/28990	17282	30184	42805	71453			233415
Fill Fraction (Fraction of Area Filled)	0.25	0.37	0.40	0.45	0.50	0.51/0.09	0.57	0.61	0.64	0.68			1.00
Productive Area of Pool (acres)***	105	333	491	1123	3132	8545/15207	8737	15130	21616	35513	45000	54000	162218
Pay Thickness (feet)	8	40	48	64	90	102/54	126	151	170	204	250	286	700

* 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 **	0.9999

Prospect Level Chance	0.384
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Exploration Chance	0.384
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* Gas-Condensate Discovery at Burger--(14.038 Tcftg + 724 Mmcb = 3,222 Mmboe)

* First Occurrence of Non Zero Pools As Reported in PSUM Module for "Pre-MatchR" Run

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 unconformities)	0.8
		Chance Porosity > 10%	0.6

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	32	40	45	54	67	71.05/23.96	81	92	100	115	130	140	213
Numbers of Pools in Play	11	14	16	20	26	27.28/10.07	32	37	40	46	53	59	103
Two Pools at F100.00													
Minimum Number of Pools	2 (F100)		Mean Number of Pools		27.28		Maximum Number of Pools		103				

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)	50	93	108	140	193	223/118	272	330	375	457	520	580	1006
Gas Recovery Factor (Mcf/acre-foot)	296	552	618	771	989	1085/447	1300	1514	1670	1916	2300	2500	4670
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	330	700	760	860	960	958/178	1070	1130	1160	1230	1300	1330	1600
Condensate Yield (bbl/Mmcf)	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)= 11.171		σ^2 (sigma squared)= 2.502		Random Number Generator Seed= 532059								
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BOE Conversion Factor (cf/bbl)	5620	Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.6
Probability Any Pool is 100% Oil	0.2	Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.3
Probability Any Pool is 100% Gas	0.2		

Table 3. Input data for Chukchi Sea play 7, 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: AAAAADAH	Play No. 7	
World Level -	World Level -	Resources
Country Level -	UNITED STATES	OF AMERICA
Region Level -	MMS -	ALASKA REGION
Basin Level -	CHUKCHI SEA	SHELF
Play Level -	Play	7 Rift Sequence - Active Margin
Geologist Kirk W.	Sherwood	
Remarks 2005 Assessment		
Run Date & Time: Date	19-Sep-05 Time	13:53:07

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	6,251,200	3,578,000
Oil (Mbo)	3,354,000	2,156,500
Condensate (Mbc)	540,920	398,690
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	10,034,000	6,995,200
Solution Gas (Mmcfg)	3,208,600	2,076,000

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	66,990	52,004	1,289	28,698	48,278
99.99	66,990	52,004	1,289	28,698	48,278
99	1,137,900	619,520	92,734	1,795,800	596,350
95	1,952,800	1,052,200	161,640	3,145,100	1,008,000
90	2,542,600	1,342,400	225,630	4,207,300	1,269,500
85	2,971,100	1,593,400	264,660	4,728,300	1,527,200
80	3,375,700	1,775,200	289,780	5,656,500	1,709,800
75	3,736,100	2,019,100	315,730	5,925,100	1,950,000
70	4,070,700	2,186,100	353,650	6,491,200	2,113,000
65	4,437,200	2,367,200	388,010	7,225,500	2,226,900
60	4,791,300	2,496,300	427,580	8,118,700	2,376,500
55	5,136,600	2,743,400	449,510	8,292,000	2,631,900
50	5,509,500	2,970,400	463,390	8,828,600	2,837,000
45	5,930,600	3,233,400	500,720	9,275,100	3,068,900
40	6,346,400	3,356,100	568,260	10,401,000	3,210,500
35	6,804,800	3,626,500	593,260	11,034,000	3,494,100
30	7,331,200	3,978,700	637,390	11,420,000	3,838,700
25	7,930,600	4,258,900	677,450	12,738,000	4,089,800
20	8,668,400	4,626,200	764,720	13,972,000	4,447,300
15	9,595,300	5,242,800	819,120	14,808,000	5,049,100
10	10,842,000	5,887,800	903,930	17,208,000	5,552,900
8	11,454,000	6,043,400	1,006,400	18,985,000	5,767,200
6	12,272,000	6,799,200	1,006,900	18,490,000	6,609,600
5	12,902,000	6,799,100	1,172,100	21,216,000	6,496,300
4	13,674,000	7,350,100	1,163,700	21,954,000	7,045,900
2	16,122,000	9,048,900	1,287,200	23,860,000	8,656,800
1	18,576,000	10,158,000	1,597,400	28,709,000	9,623,100
0.1	25,235,000	11,149,000	2,974,400	50,986,000	11,460,000
0.01	31,963,000	23,088,000	1,119,400	26,260,000	17,329,000
0.001	37,430,000	20,951,000	3,100,400	54,751,000	20,438,000

* The results for Chukchi Sea Play 07 do not exclude the discovered resources (14,038 Tcrg & 724 Mmbc) at Burger structure (Craig and Sherwood, 2004).

Table 5. Assessment results by commodity for Chukchi Sea play 7, 2006 assessment.

Basin: CHUKCHI SEA SHELF Play 07 - Rift - Active Margin UAI Key: AAAAADAH				Model Simulation "Pools" Reported by "Fieldsiz.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	0	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	0	0.000000	0.000000
3	0.125	0.25	13	0.004763	0.0013	0.0013	5	8	0	1	1	1	1	0	0	1	1	1	1	0.193661	0.233998
4	0.25	0.5	67	0.024549	0.0067	0.0067	27	22	18	1	1	1	1	1	1	1	1	1	1	0.260796	0.497924
5	0.5	1	423	0.15499	0.0423	0.0423	212	118	93	1	2	1	1	1	1	2	1	2	2	0.503289	0.998822
6	1	2	1940	0.710828	0.194	0.194	1135	407	398	1	3	1	2	1	2	1	2	1	5	1.004602	1.996806
7	2	4	6491	2.378344	0.6491	0.6491	3784	1370	1337	1	4	1	3	1	4	1	4	1	7	2.004153	3.999915
8	4	8	14904	5.460921	1.4904	1.4904	8953	3019	2932	1	9	1	4	1	5	1	5	1	11	4.000059	7.999733
9	8	16	26338	9.650412	2.6338	2.6338	15756	5253	5329	1	9	1	6	1	6	1	6	1	15	8.001421	15.999774
10	16	32	35876	13.145196	3.5876	3.5876	21402	7012	7462	1	12	1	6	1	8	1	8	1	18	16.000638	31.998912
11	32	64	42780	15.674866	4.278	4.278	26152	8395	8233	1	15	1	7	1	9	1	9	1	21	32.002459	63.994975
12	64	128	43973	16.111988	4.3973	4.3973	26547	8627	8799	1	16	1	8	1	7	1	7	1	20	64.002003	127.988349
13	128	256	40543	14.855214	4.0543	4.0543	24549	7979	8015	1	16	1	8	1	7	1	7	1	22	128.005614	255.993687
14	256	512	29213	10.70383	2.9213	2.9213	17818	5603	5792	1	10	1	5	1	6	1	6	1	16	256.021672	511.947195
15	512	1024	18349	6.723191	1.8349	1.8349	11182	3498	3669	1	7	1	5	1	4	1	4	1	9	512.062198	1023.837000
16	1024	2048	8713	3.192499	0.8713	0.8713	5300	1723	1690	1	6	1	4	1	3	1	3	1	8	1024.139000	2047.893000
17	2048	4096	2463	0.902459	0.2463	0.2463	1452	547	464	1	4	1	3	1	3	1	3	1	5	2048.689000	4095.977000
18	4096	8192	734	0.268942	0.0734	0.0734	375	220	139	1	2	1	2	1	2	1	1	1	3	4101.679000	8113.844000
19	8192	16384	96	0.035175	0.0096	0.0096	61	21	14	1	1	1	1	1	1	1	1	1	2	8288.772000	16314.677000
20	16384	32768	5	0.001832	0.0005	0.0005	4	1	0	1	1	1	1	1	0	0	1	1	1	17289.396000	18182.878000
21	32768	65536	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000
22	65536	131072	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000
23	131072	262144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000
24	262144	524288	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000
25	524288	1048576	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000
Not Classified			0	0	0	0	Below Class											Below Class			0.000000
Totals			272921	99.999992	27.2921	27.292099	Above Class											Above Class			0.000000
Number of Pools not Classified: 0				Min and Max refer to numbers of pools of the relevant size class that occur within any single trial in the simulation.																	
Number of Pools below Class 1: 0																					
Number of Trials with Pools: 10000																					

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 Se play 7, 2006 assessment.

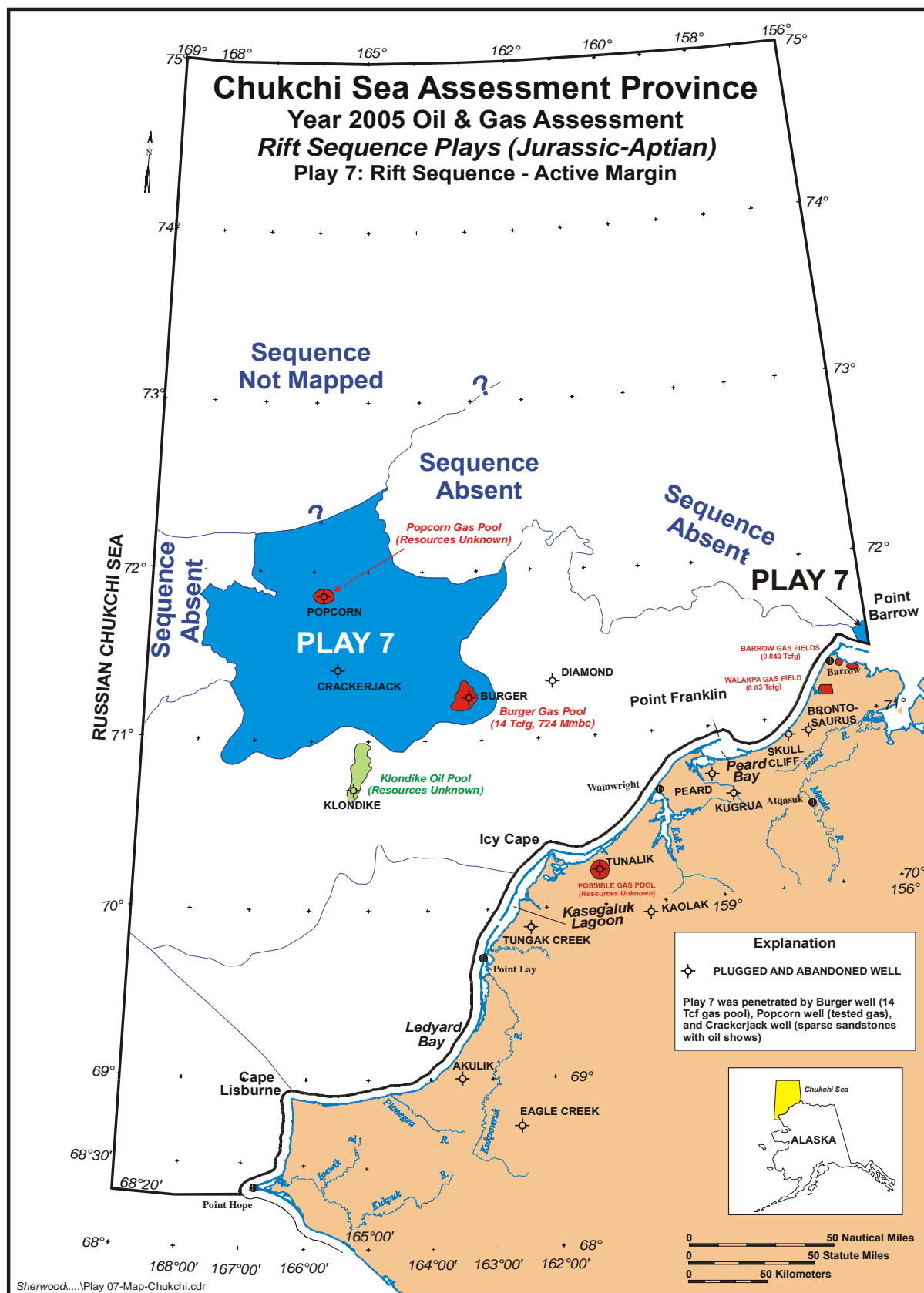


Figure 1. Map location of Chukchi Sea play 7, 2006 assessment.