Chukchi Sea Play 14: Brookian Sandstones-North Chukchi High

Geological Assessment

GRASP UAI: AAAAA DAO
Play Area: 8,603 square miles
Play Water Depth Range: 100-180 feet
Play Depth Range: 1,650-15,500 feet
Play Exploration Chance: 0.03264

Play 14, Brookian Sandstones-North Chukchi High, 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)	0	1,455	5,309
Total Gas (Tcfg)	0.000	4.474	16.056
Total Liquids (Mmbo)	0	659	2,452
Free Gas** (Tcfg)	0.000	3.206	11.058
Solution Gas (Tcfg)	0.000	1.268	4.998
Oil (Mmbo)	0	485	1,840
Condensate (Mmbc)	0	174	612

** 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 14, the "Brookian Sandstones-North Chukchi High" play, is the 7th-ranking play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 5.0% (1,455 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). The overall assessment results for play 14 are shown in table 1. Oil and gas-condensate liquids form 45% of the hydrocarbon energy endowment of play 14. Table 5 reports the detailed assessment results by commodity for play 14.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi Sea play 14. Table 4 reports the risk model used for play 14. The location of play 14 is shown in figure 1.

Potential reservoirs of play 14 are inferred to consist primarily of shallow marine to fluvial sandstones of Early Cretaceous to Tertiary age that are hypothesized to have been deposited in littoral systems that fringed North Chukchi high, an area of recurrent uplift throughout Albian-Aptian (post-Brookian unconformity) and later time. Play 14 therefore includes both Lower and Upper Brookian sequences. The play may be charged by a combination of the North Chukchi basin, Nuwuk basin, and Hanna trough play charging systems, which originate in the deep parts of basins that surround North Chukchi high. Play 14 was not tested by any well.

A maximum of 23 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 14. These 23 pools range in mean conditional (un-risked) recoverable volumes from 9 Mmboe (pool rank 23) to 1,694 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 186 Mmboe (F95) to 5,787 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 14.

Play 14, Brookian Sandstones-North Chukchi High, 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	115	1694	5787
2	41	453	1337
3	20	233	682
4	12	144	422
5	9	98	291
6	7	72	215
7	6	55	165
8	5.3	45	131
9	4.8	37	108
10	4.4	32	91

** 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 14 a total of 36,627 “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 13 contains the largest share (6,267, or 17%) of simulation pools (conditional, technically recoverable BOE resources) for play 14. Pool size class 13 ranges from 128 to 256 Mmboe. The largest 33 simulation pools for play 14 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 14.

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

Basin: Chukchi Sea Planning Area
Play Number: 14
Play UAI Number: AAAAA DAO

Assessor: K.W. Sherwood
Play Name: Brookian Sandstones - North Chukchi High

Date: January 2005

Play Area: mi² (million acres) 8,603 (5.506)
Reservoir Thermal Maturity: % Ro 0.48 - 1.85

Play Depth Range: feet 1,650 - 15,500 (mean = 7,024)
Expected Oil Gravity: ° API 35
Play Water Depth Range: feet 100 - 180 (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*	450		1345		8594	24485/65320			54902				696412
Prospect Area (acres)-Model Output**	450	1020	1601	3517	9032	23514/47085	23295	39565	55030	90146			694669
Fill Fraction (Fraction of Area Filled)	0.05	0.10	0.11	0.14	0.16	0.17/0.05	0.20	0.22	0.23	0.26			0.50
Productive Area of Pool (acres)***	47	163	250	567	1470	3969/8544	3889	6356	9076	15083	22000	29000	161020
Pay Thickness (feet)	60	122	136	163	200	209/64	245	273	294	327	370	401	650

* 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	0.64
Output Play Level Chance*	0.6368

Prospect Level Chance	0.051

Exploration Chance	0.03264

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

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
	0.8	Trap Integrity (shallow, sandy section, no known regional seal)	0.1
		Chance Porosity > 10%	0.85
		Migration (diversion up bounding shallow, young faults)	0.6
	0.8	Preservation (risk of biodegradation)	

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	74	82	86	98	110	112.24/20.96	120	136	143	151	155	160	210
Numbers of Pools in Play					4	3.66/3.43	6	7	8	10	11	12	23

Zero Pools at F63.71

Minimum Number of Pools	2 (F60)	Mean Number of Pools	3.66	Maximum Number of Pools	23

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)	56	121	145	203	297	330/170	424	495	549	658	700	760	1276
Gas Recovery Factor (Mcfg/acre-foot)	241	757	889	1199	1686	1846/861	2318	2713	3007	3478	3900	4100	6335
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	230	1675	1875	2225	2650	2612/667	3000	3250	3400	3650	3850	4050	5000
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)= 11.745 σ² (sigma squared)= 2.293

Random Number Generator Seed= 797285

BOE Conversion Factor (cf/bbl)	5620
Probability Any Pool is 100% Oil	0.34
Probability Any Pool is 100% Gas	0.34

Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.23
Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.5

Table 3. Input data for Chukchi Sea play 14, 2006 assessment.

Risk Analysis Form - 2006 National Assessment

Assessment Province:	Chukchi Sea OCS Planning Area	**Play Number, Name:**	14. Brookian Sandstones - North Chukchi High
Assessor(s):	K.W. Sherwood	**Play UAI:**	AAAAA DAO
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**	***0.8000***	***0.6000***
	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	0.60
	c. Preservation			
	Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	0.80	1.00
2.	**Reservoir component** (2a * 2b)	**2**	***1.0000***	***0.8500***
	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	0.85
3.	**Trap component** (3a * 3b)	**3**	***0.8000***	***0.1000***
	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	0.80	0.10
Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)			***0.6400***	
	(1 * 2 * 3) *Product of All Subjective Play Chance Factors*			
Average Conditional Prospect Chance[1]				***0.0510***
	(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			***0.0326***	
	(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

Table 4. Risk model for Chukchi Sea play 14, 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:	**AAAAADAO**		**Play No.**		**14**		
World	Level	-	World	Level		Resources	
Country	Level	-	UNITED	STATES		OF	AMERICA
Region	Level	-	MMS	-		ALASKA	REGION
Basin	Level	-	**CHUKCHI**	**SEA**		**SHELF**	
Play	**Level**	**-**	**Play**		**14**	**Brookian Sandstones - North Chukchi High**	
Geologist	Kirk	W.	Sherwood				
Remarks	2005	Assessment					
Run Date & Time:		Date	19-Sep-05	Time		13:54:43	

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	1,455,200	2,526,900
Oil (Mbo)	485,210	1,155,100
Condensate (Mbc)	173,880	405,670
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	3,205,900	6,748,900
Solution Gas (Mmcfg)	1,268,100	3,113,500

10000 (Number of Trials in Sample)

0.6368 (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	0	0	0	0	0
95	0	0	0	0	0
90	0	0	0	0	0
85	0	0	0	0	0
80	0	0	0	0	0
75	0	0	0	0	0
70	0	0	0	0	0
65	0	0	0	0	0
60	223,850	60,813	28,675	590,140	164,950
55	450,020	131,290	60,157	1,112,500	340,670
50	653,430	218,190	78,172	1,459,500	547,200
45	847,180	291,750	98,355	1,833,900	734,890
40	1,068,600	311,360	139,670	2,638,700	832,290
35	1,302,800	408,690	169,570	3,032,000	1,039,600
30	1,601,800	560,630	180,960	3,389,000	1,445,300
25	1,924,500	619,670	233,890	4,389,500	1,629,300
20	2,329,400	788,630	263,120	5,092,500	2,088,000
15	2,868,100	1,006,600	316,070	6,104,900	2,580,500
10	3,634,700	1,317,000	403,320	7,481,300	3,277,800
8	4,148,000	1,123,300	590,230	10,807,000	2,874,300
6	4,778,700	1,583,700	569,930	10,687,000	4,066,300
5	5,308,900	1,840,200	611,780	11,058,000	4,997,500
4	6,070,400	1,877,500	779,410	14,261,000	4,923,400
2	8,911,000	2,748,100	1,189,600	20,841,000	7,109,100
1	13,044,000	4,366,600	1,545,900	28,545,000	11,532,000
0.1	26,109,000	9,050,900	4,430,600	43,752,000	27,213,000
0.01	31,892,000	20,503,000	6,514	166,840	63,800,000
0.001	34,137,000	21,988,000	339,130	7,342,500	59,031,000

Table 5. Assessment results by commodity for Chukchi Sea play 14, 2006 assessment.

Basin: CHUKCHI SEA SHELF
Play 14 - Brookian North Chukchi High - Sand Apron
UAI Key: AAAAADAO

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	1	0.00273	0.0001	0.000157		0	1	0	0	0	1	1	0	0	1	1		0.298978	0.298978	0.298978	298.978090
5	0.5	1	8	0.021842	0.0008	0.001256		0	2	6	0	0	1	1	1	1	1	1		0.683154	0.976963	6.786082	848.260224
6	1	2	54	0.147432	0.0054	0.008479		3	15	36	1	1	1	1	1	1	1	1		1.042645	1.964344	85.707419	1.587174
7	2	4	238	0.649794	0.0238	0.037369		36	80	122	1	1	1	1	1	2	1	2		2.001416	3.982748	755.277444	3.173435
8	4	8	924	2.522729	0.0924	0.145078		186	311	427	1	2	1	3	1	3	1	3		4.008476	7.995821	5593.123000	6.053164
9	8	16	2037	5.561471	0.2037	0.31983		450	680	907	1	3	1	2	1	3	1	4		8.000067	15.995784	24580.836000	12.067175
10	16	32	3678	10.041773	0.3678	0.577485		789	1201	1688	1	3	1	3	1	4	1	6		16.015627	31.982770	87205.853000	23.710129
11	32	64	5141	14.036094	0.5141	0.807191		1129	1695	2317	1	3	1	4	1	5	1	6		32.003117	63.994653	242876.773000	47.243099
12	64	128	6274	17.12944	0.6274	0.985084		1419	2137	2718	1	4	1	4	1	4	1	6		64.006428	127.970393	585343.433000	93.296692
13	128	256	6267	17.110329	0.6267	0.983985		1426	2140	2701	1	3	1	4	1	4	1	7		128.025412	255.998972	1150340.000000	183.555130
14	256	512	5498	15.010784	0.5498	0.863244		1317	1901	2280	1	3	1	4	1	4	1	6		256.012266	511.925421	1997092.000000	363.239685
15	512	1024	3546	9.681382	0.3546	0.556759		858	1253	1435	1	2	1	3	1	4	1	5		512.128203	1023.951000	2538706.000000	715.935242
16	1024	2048	1857	5.07003	0.1857	0.291569		439	661	757	1	2	1	2	1	3	1	4		1024.017000	2046.922000	2620027.000000	1.410892
17	2048	4096	754	2.058591	0.0754	0.118386		166	301	287	1	2	1	2	1	2	1	3		2049.184000	4089.107000	2072551.000000	2.748741
18	4096	8192	195	0.532394	0.0195	0.030617		43	74	78	1	1	1	1	1	1	1	2		4099.307000	8167.408000	1127469.000000	5.781892
19	8192	16384	122	0.333088	0.0122	0.019155		23	45	54	1	2	1	1	1	2	1	2		8208.254000	16356.679000	1386416.000000	11.364065
20	16384	32768	33	0.090097	0.0033	0.005181		4	17	12	1	1	1	1	1	1	1	1		16767.000000	31821.650000	712639.602000	21.595139
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	**36627**	**100**	**3.6627**	**5.750825**	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: 6369

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 14, 2006 assessment.

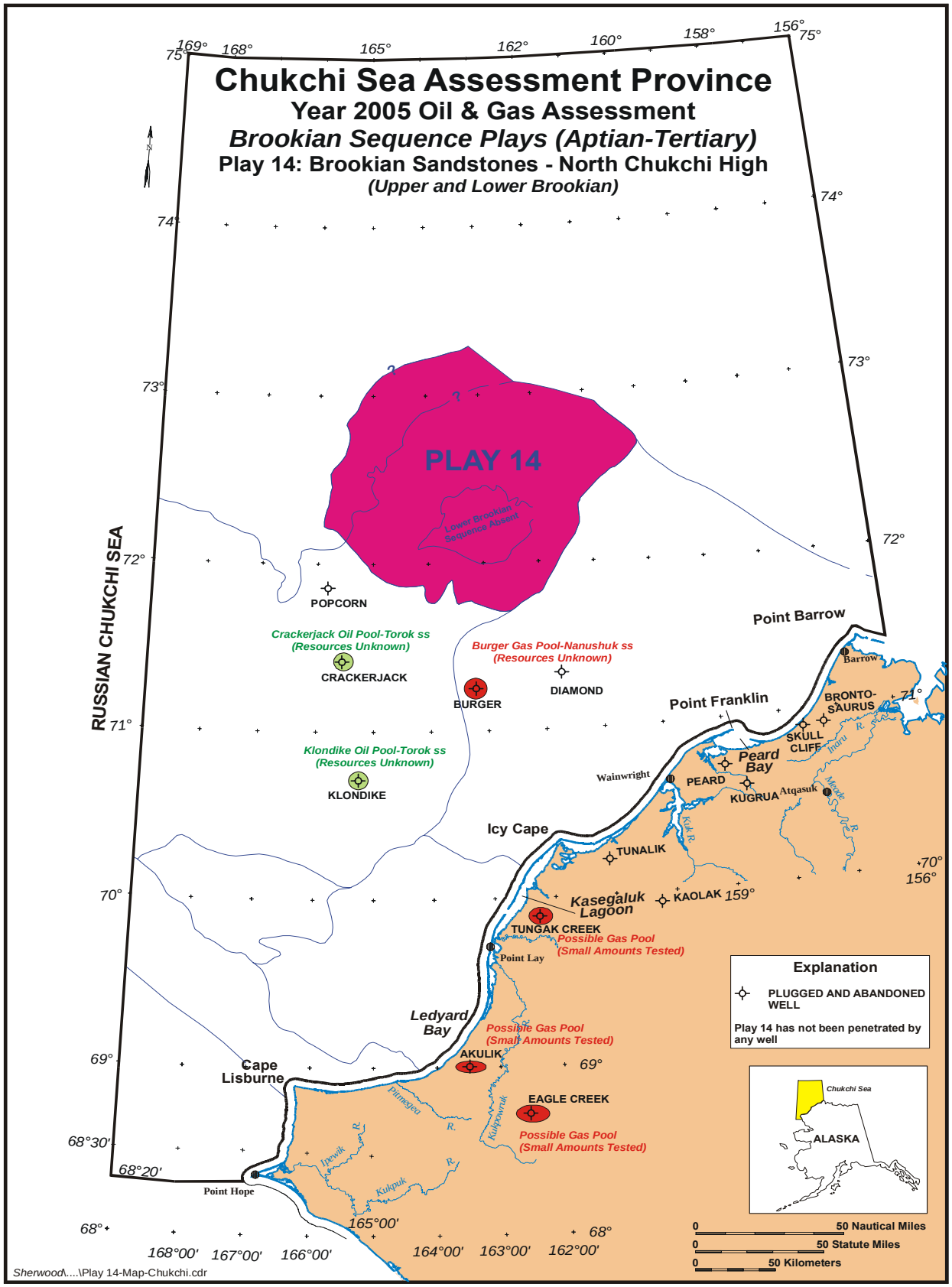

Figure 1. Map location of Chukchi Sea play 14, 2006 assessment.