Chukchi Sea Play 16: Brookian (Upper and Lower)-Deep Gas

Geological Assessment

GRASP UAI: AAAAA DAQ
Play Area: 13,873 square miles
Play Water Depth Range: 130-330 feet
Play Depth Range: 7,000-27,500 feet
Play Exploration Chance: 0.0135

Play 16, Brookian (Upper and Lower)-Deep Gas, 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	94	531
Total Gas (Tcfg)	0.000	0.464	2.619
Total Liquids (Mmbo)	0	12	65
Free Gas** (Tcfg)	0.000	0.464	2.619
Solution Gas (Tcfg)	0.000	0.000	0.000
Oil (Mmbo)	0	0	0
Condensate (Mmbc)	0	12	65

** 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 16, the "Brookian-Deep Gas" play, is the 23rd-ranking play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 0.3% (94 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). The overall assessment results for play 16 are shown in table 1. Play 16 is assessed as offering non-associated gas in all pools. Gas-condensate liquids form 13% of the hydrocarbon energy endowment of play 16. Table 5 reports the detailed assessment results by commodity for play 16.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi Sea play 16. Table 4 reports the risk model used for play 16. The location of play 16 is shown in figure 1.

Potential reservoir objectives include mostly Cretaceous and Tertiary sandstones in North Chukchi basin and Early Cretaceous Torok sandstones in Colville basin that lie at depths below the floor for survival of petroleum liquids, at vitrinite reflectances exceeding 2.0 percent. Play 16 includes mostly rocks of the Lower Brookian sequence in both the Colville and North Chukchi basins. Rocks of the Upper Brookian sequence also exceed 2.0 percent vitrinite reflectance in a small, deep graben in North Chukchi basin. All pools within this play are modeled as consisting completely of gas. In Colville basin, the traps are primarily located in the undeformed plate below the regional detachment at the base of the foldbelt play (11). The subthrust plate probably consists of Torok Formation shales and turbiditic sandstones. This play was not tested by any well.

A maximum of 18 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 16. These 18 pools range in mean conditional (un-risked) recoverable volumes from 9 Mmboe (pool rank 18) to 172 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 30

Mmboe (F95) to 449 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 16.

Play 16, Brookian (Upper and Lower)-Deep Gas, 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	30	172	449
2	15	85	208
3	10	55	132
4	8	40	97
5	6	32	76
6	5.6	27	62
7	5.1	23	54
8	4.7	21	47
9	4.4	19	42
10	4.0	17	39

** 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 16 a total of 11,060 “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 11 contains the largest share (2,888, or 26%) of simulation pools (conditional, technically recoverable BOE resources) for play 16. Pool size class 11 ranges from 32 to 64 Mmboe (or 0.2 to 0.4 Tcfge). The largest simulation pool for play 16 falls within pool size class 17, which ranges in size from 2,048 to 4,096 Mmboe (or 12 to 23 Tcfge). Table 6 reports statistics for the simulation pools developed in the GRASP computer model for play 16.

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

Basin: Chukchi Sea Planning Area
Play Number: 16
Play UAI Number: AAAAA DAQ

Assessor: K.W. Sherwood
Play Name: Brookian (Upper and Lower) - Deep Gas

Date: January 2005

Play Area: mi^2 (million acres)	13,873 (8.878)	**Play Depth Range**: feet	7,000 - 27,500 (mean = 18,763)
Reservoir Thermal Maturity: % Ro	2.03 - 6.46	**Expected Oil Gravity**: ^{o} API	60 (No Free Oil)
		Play Water Depth Range: feet	130 - 330 (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*	725		2239		6538	9274/9328			19089				43924
Prospect Area (acres)-Model Output**	726	1592	2162	3668	6440	8832/7484	11388	15639	18922	24726			43537
Fill Fraction (Fraction of Area Filled)	0.18	0.30	0.32	0.37	0.43	0.44/0.10	0.50	0.54	0.57	0.62			1.00
Productive Area of Pool (acres)***	221	653	885	1560	2767	3895/3496	5019	6888	8422	11083	13000	15000	31133
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	0.3	Prospect Level Chance	0.045	Exploration Chance	0.0135
Output Play Level Chance*	0.2904				

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

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
	0.3	Reservoir Presence (generally a distal turbidite facies)	
		Chance Porosity > 10%	0.045

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	47	55	59	69	80	81.96/18.64	91	101	106	111	120	130	188
Numbers of Pools in Play						1.11/2.03	2	3	4	6	7	8	18

Zero Pools at F29.07

Minimum Number of Pools	2 (F25)	Mean Number of Pools	1.11	Maximum Number of Pools	18

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)	No Free Oil												
Gas Recovery Factor (Mcfg/acre-foot)	273	510	579	722	921	1019/440	1207	1410	1582	1869	2100	2350	4101
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	No Free Oil												
Condensate Yield ((bbl/Mmcfg)	13	18	19	22	25	25/5	28	30	31	33	36	38	50

Pool Size Distribution Statistics from *POOLS* (1,000 BOE): **μ (mu)=** 10.869 **σ^2 (sigma squared)=** 1.030 **Random Number Generator Seed=** 996059

BOE Conversion Factor (cf/bbl)	5620	Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0
Probability Any Pool is 100% Oil	0	Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	1
Probability Any Pool is 100% Gas	1		

Table 3. Input data for Chukchi Sea play 16, 2006 assessment.

Risk Analysis Form - 2006 National Assessment

Assessment Province:	Chukchi Sea OCS Planning Area	**Play Number, Name:**	16. Brookian (Upper and Lower) - Deep Gas
Assessor(s):	K.W. Sherwood	**Play UAI:**	AAAAA DAQ
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**	***0.3000***	***0.0450***
	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	0.30	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	0.05
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)	***0.3000***	
(1 * 2 * 3) *Product of All Subjective Play Chance Factors*		
Average Conditional Prospect Chance[1]		***0.0450***
(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	***0.0135***
(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 16, 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:	**AAAAADAQ**		**Play No.**		**16**		
World	Level	-	World	Level		Resources	
Country	Level	-	UNITED	STATES		OF	AMERICA
Region	Level	-	MMS	-		ALASKA	REGION
Basin	Level	-	**CHUKCHI**	**SEA**		**SHELF**	
Play	**Level**	**-**	**Play**		**16**	**Brookian (Upper and Lower) - Deep Gas**	
Geologist	Kirk	W.	Sherwood				
Remarks	2005	Assessment					
Run Date & Time:		Date	19-Sep-05	Time		13:55:10	

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	94,267	203,710
Oil (Mbo)	0	0
Condensate (Mbc)	11,657	25,355
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	464,270	1,003,500
Solution Gas (Mmcfg)	0	0

10000 (Number of Trials in Sample)
0.2904 (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	0	0	0	0	0
55	0	0	0	0	0
50	0	0	0	0	0
45	0	0	0	0	0
40	0	0	0	0	0
35	0	0	0	0	0
30	0	0	0	0	0
25	82,315	0	10,238	405,070	0
20	167,980	0	20,644	828,050	0
15	255,580	0	31,451	1,259,600	0
10	363,610	0	45,097	1,790,000	0
8	417,170	0	51,979	2,052,300	0
6	489,780	0	60,350	2,413,400	0
5	531,140	0	65,164	2,618,800	0
4	581,040	0	73,535	2,852,200	0
2	726,550	0	88,393	3,586,400	0
1	917,740	0	113,150	4,521,800	0
0.1	1,481,700	0	189,530	7,261,800	0
0.01	2,150,500	0	263,340	10,606,000	0
0.001	2,275,800	0	245,300	11,412,000	0

Table 5. Assessment results by commodity for Chukchi Sea play 16, 2006 assessment.

Basin: CHUKCHI SEA SHELF
Play 16 - Brookian - Deep Gas
UAI Key: AAAAADAQ

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	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
6	1	2	10	0.090416	0.001	0.003442		0	0	10	0	0	0	0	1	1	1	1	1.174022	1.846903	15.986574	1.598657
7	2	4	77	0.696203	0.0077	0.026506		0	0	77	0	0	0	0	1	1	1	1	2.072919	3.991816	238.457544	3.096851
8	4	8	338	3.056058	0.0338	0.116351		0	0	338	0	0	0	0	1	2	1	2	4.008515	7.999246	2093.292000	6.193173
9	8	16	909	8.218806	0.0909	0.312909		0	0	909	0	0	0	0	1	4	1	4	8.009949	15.999352	11103.346000	12.214903
10	16	32	2090	18.896925	0.209	0.719449		0	0	2090	0	0	0	0	1	5	1	5	16.005643	31.994576	49648.515000	23.755270
11	32	64	2888	26.112116	0.2888	0.994148		0	0	2888	0	0	0	0	1	6	1	6	32.004111	63.983234	133864.933000	46.352123
12	64	128	2651	23.969259	0.2651	0.912565		0	0	2651	0	0	0	0	1	8	1	8	64.015151	127.965330	243032.040000	91.675606
13	128	256	1496	13.52622	0.1496	0.514974		0	0	1496	0	0	0	0	1	4	1	4	128.026723	255.993783	263822.864000	176.352188
14	256	512	511	4.620253	0.0511	0.175904		0	0	511	0	0	0	0	1	3	1	3	256.299850	501.123288	172508.406000	337.589844
15	512	1024	81	0.732369	0.0081	0.027883		0	0	81	0	0	0	0	1	2	1	2	514.590611	945.562306	53401.555000	659.278442
16	1024	2048	8	0.072333	0.0008	0.002754		0	0	8	0	0	0	0	1	1	1	1	1056.179000	1912.553000	10834.225000	1.354278
17	2048	4096	1	0.009042	0.0001	0.000344		0	0	1	0	0	0	0	1	1	1	1	2107.034000	2107.034000	2107.034000	2.107034
18	4096	8192	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
19	8192	16384	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
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									0.000000	0.000000	0.000000	0.000000
		Totals	**11060**	**100.000008**	**1.106**	**3.807229**	Above Class	0	0	0									0.000000	0.000000	0.000000	0.000000

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.

Number of Pools not Classified: 0
Number of Pools below Class 1: 0
Number of Trials with Pools: 2905

Table 6. Statistics for simulation pools created in computer sampling run for Chukchi Sea play 16, 2006 assessment.

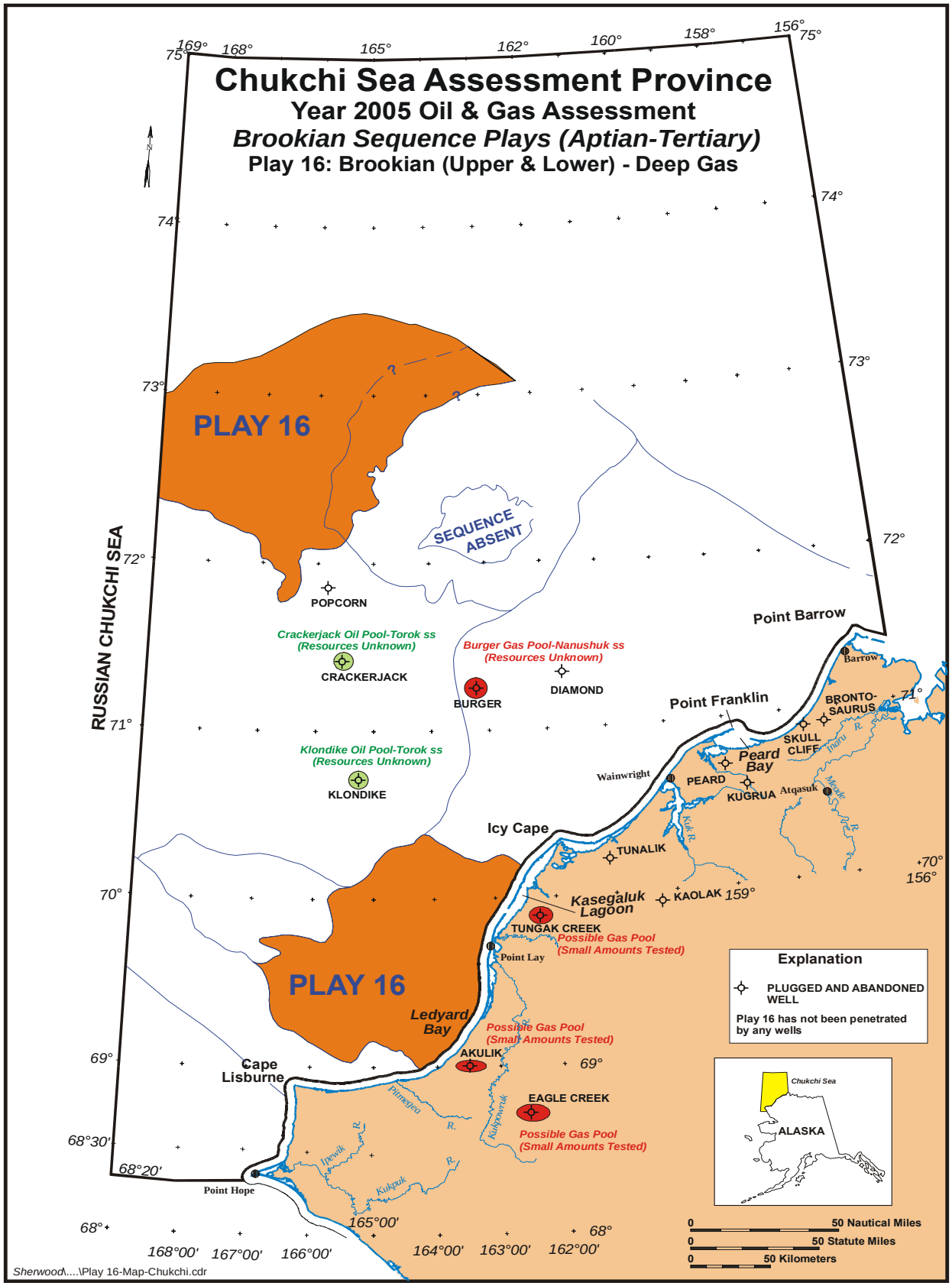

Figure 1. Map location of Chukchi Sea play 16, 2006 assessment.