

Chukchi Sea Play 18: Nanushuk Topset Sandstones (Lower Brookian)-Arctic Platform

Geological Assessment

GRASP UAI: AAAAA DAS

Play Area: 15,837 square miles

Play Water Depth Range: 150-170 feet

Play Depth Range: 1,000-8,000 feet

Play Exploration Chance: 0.1092

Play 18, Nanushuk Topset Sandstones (Lower Brookian)-Arctic Platform, 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)	33	510	1,436
Total Gas (Tcfg)	0.063	0.747	2.071
Total Liquids (Mmbo)	22	377	1,068
Free Gas** (Tcfg)	0.050	0.505	1.388
Solution Gas (Tcfg)	0.013	0.242	0.684
Oil (Mmbo)	19	350	992
Condensate (Mmbc)	3	27	76
<p>* Risked, Technically-Recoverable</p> <p>** Free Gas Includes Gas Cap and Non-Associated Gas</p> <p>F95 = 95% chance that resources will equal or exceed the given quantity</p> <p>F05 = 5% chance that resources will equal or exceed the given quantity</p> <p>BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas</p> <p>Mmb = millions of barrels</p> <p>Tcf = trillions of cubic feet</p>			

Table 1

Play 18, the “Nanushuk Topset-Arctic Platform” play, is the 11th-ranking play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 1.8% (510 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). The overall assessment results for play 18 are shown in [table 1](#). Oil and gas-condensate liquids form 74% of the

hydrocarbon energy endowment of play 18.

[Table 5](#) reports the detailed assessment results by commodity for play 18.

[Table 3](#) summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi play 18. [Table 4](#) reports the risk model used for play 18. The location of play 18 is shown in [figure 1](#).

Like play 17, play 18 comprises the unstructured area of the Arctic platform that lies south of Barrow arch, east of the wrench fault province of western Chukchi shelf (equivalent play 13), and north of the fold-belt (play 11). Reservoir objectives include delta-plain and nearshore sandstones of the Lower Cretaceous Nanushuk Group. Low-relief anticlines possibly related to differential compaction and stratigraphic terminations of homoclinally south-dipping sandstones form the primary trap types. Like play 17, the play is modeled as predominately charged by the Hanna trough play charging system, although some contribution from the gas-rich Colville basin system on the south is possible. 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. The play was tested at Diamond and Burger wells. A gas-charged (logs) sandstone 36 feet thick was encountered at Burger well, which is located within several miles of a fault that passes 3,500 feet below into the 14

trillion cubic feet Burger gas pool (Craig and Sherwood, 2004). This fault may have formed a migration conduit for gas escaping upward from the pool in the Rift sequence sandstone.

Play 18, Nanushuk Topset Sandstones (Lower Brookian)-Arctic Platform, 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	20	213	715
2	8	86	231
3	5	55	147
4	3.4	40	116
5	2.7	32	89
6	2.2	26	76
7	2.0	22	64
8	1.8	20	57
9	1.6	18	51
10	1.5	16	46
* 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 188 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 18. These 188 pools range in mean conditional (un-risked) recoverable volumes from 0.4 Mmboe (pool rank 188) to 213 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 20 Mmboe (F95) to 715 Mmboe (F05). [Table 2](#) shows the conditional sizes of the 10 largest pools in play 18.

In the computer simulation for play 18 a total of 134,554 "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 9 contains the largest share (25,056, or 19%) of simulation pools (conditional, technically recoverable BOE resources) for play 18. Pool size class 9 ranges from 8 to 16 Mmboe. The largest 2 simulation pools for play 18 fall within pool size class 18, which ranges in size from 4,096 to 8,192 Mmboe. [Table 6](#) reports statistics for the simulation pools developed in the GRASP computer model for play 18.

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

Basin: Chukchi Sea Planning Area
Play Number: 18
Play UAI Number: AAAAA DAS

Assessor: K.W. Sherwood
Play Name: Nanushuk Topset Sandstones (Lower Brookian) - Arctic Platform
Date: January 2005

Play Area: mi² (million acres) 15,837 (10.136)
Reservoir Thermal Maturity: % Ro 0.55 - 0.60

Play Depth Range: feet 1,000 - 8,000 (mean = 5,438)
Expected Oil Gravity: ° API 30
Play Water Depth Range: feet 150 - 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*	267		476		2525	5889/12409			13384				62990
Prospect Area (acres)-Model Output**	268	437	614	1184	2707	5584/8007	6215	10055	13662	21447			62227
Fill Fraction (Fraction of Area Filled)	0.18	0.30	0.33	0.37	0.43	0.44/0.10	0.50	0.54	0.57	0.62			1.00
Productive Area of Pool (acres)***	78	186	250	505	1173	2472/3713	2774	4372	5994	9461	13000	15000	40840
Pay Thickness (feet)	14	38	44	55	70	75/29	90	103	113	129	150	166	300

* 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**	0.9941

Prospect Level Chance	0.1092
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Exploration Chance	0.1092
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* (Gas pay [log-inferred] encountered in Burger well)

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

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
		Trap Presence (inferred from geobody sizes and densities in NPRA 3D seismic amplitude mapping)	0.4
		Reservoir Presence (Nanushuk sandstones sparse in .Chukchi shelf wells)	0.5
		Chance Porosity > 10%	0.91
		Migration (Nanushuk underlain by thick sequence of impermeable shales that isolate the play reservoir from deeper known source rocks)	0.6

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	19	29	36	56	89	119.63/116.33	145	180	220	280	370	450	1447
Numbers of Pools in Play	1	2	3	6	10	13.06/13.15	16	21	25	32	43	55	188

Zero Pools at F99.43

Minimum Number of Pools	1 (F99)	Mean Number of Pools	13.06	Maximum Number of Pools	188
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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)	24	63	79	120	184	214/134	274	339	387	468	560	630	1382
Gas Recovery Factor (Mcfg/acre-foot)	76	205	251	348	491	513/219	646	741	812	921	1006	1100	1442
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	290	535	570	630	700	694/112	760	800	830	870	900	930	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)= 9.588 σ^2 (sigma squared)= 1.942 Random Number Generator Seed= 038486

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 18, 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: AAAAADAS		Play No. 18		
World	Level -	World	Level	Resources
Country	Level -	UNITED	STATES	OF AMERICA
Region	Level -	MMS	-	ALASKA REGION
Basin	Level -	CHUKCHI	SEA	SHELF
Play	Level -	Play		18 Nanushuk Topset (Lower Brookian)
Geologist	Kirk W.	Sherwood		- Arctic Platform
Remarks	2005 Assessment			
Run Date & Time:	Date	19-Sep-05	Time	13:55:38

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	510,380	668,610
Oil (Mbo)	349,940	475,620
Condensate (Mbc)	27,479	38,840
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	504,790	690,340
Solution Gas (Mmcfg)	242,480	329,500

10000 (Number of Trials in Sample)

0.9941 (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	4,224	2,121	425	7,994	1,438
95	33,367	19,413	2,685	50,142	13,192
90	64,575	40,342	4,539	82,701	27,983
85	94,047	61,019	5,833	110,920	41,918
80	123,600	79,967	8,096	144,290	55,431
75	152,500	95,887	10,312	192,500	67,712
70	185,070	123,160	10,557	203,910	84,690
65	220,840	144,240	13,210	255,860	100,390
60	254,540	168,490	14,744	284,770	116,000
55	294,520	190,750	18,095	352,600	128,840
50	337,200	230,030	18,230	342,090	157,750
45	380,850	250,610	24,973	417,760	173,860
40	435,260	289,040	25,474	477,410	201,200
35	491,490	339,140	25,064	476,260	239,100
30	562,200	385,390	30,908	550,850	269,070
25	640,150	434,400	36,128	656,650	296,620
20	744,300	496,610	42,826	802,090	349,230
15	872,270	609,190	44,306	809,960	419,560
10	1,060,200	747,620	50,149	955,350	519,650
8	1,172,100	808,360	61,076	1,134,100	566,700
6	1,338,000	960,040	60,113	1,118,500	667,940
5	1,436,100	992,030	75,592	1,387,500	683,580
4	1,566,700	1,116,500	75,128	1,341,200	766,900
2	2,074,100	1,492,900	92,921	1,707,000	1,037,000
1	3,553,600	2,508,200	174,170	3,160,200	1,736,000
0.1	7,388,200	4,971,500	430,300	7,812,600	3,351,300
0.01	8,376,900	6,094,400	361,290	6,663,700	4,133,200
0.001	8,416,100	6,413,600	266,950	5,353,300	4,400,300

Table 5. Assessment results by commodity for Chukchi Sea play 18, 2006 assessment.

Basin: CHUKCHI SEA SHELF				Model Simulation "Pools" Reported by "Fieldsize.out" GRASP Module																		
Play 18 - L. Brookian - Nanushuk Arctic Platform																						
UAI Key: AAAAADAS																						
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	2	0.001486	0.0002	0.000201	0	2	0	0	0	1	1	0	0	1	1	0.058065	0.058065	0.116131	58.065277	
2	0.0625	0.125	8	0.005946	0.0008	0.000805	0	0	8	0	0	0	0	0	1	1	1	1	0.078360	0.114737	0.778898	97.362250
3	0.125	0.25	128	0.095129	0.0128	0.012875	20	25	83	1	1	1	1	1	1	1	1	1	0.127361	0.249667	25.419540	198.590159
4	0.25	0.5	573	0.425851	0.0573	0.057634	181	104	288	1	2	1	2	1	2	1	3	0.250625	0.499713	222.571413	388.431787	
5	0.5	1	2470	1.835694	0.247	0.248441	1087	434	949	1	3	1	3	1	4	1	6	0.500539	0.999960	1909.647000	773.136437	
6	1	2	7497	5.571741	0.7497	0.754074	3950	1239	2308	1	11	1	5	1	6	1	14	1.000062	1.999544	11341.845000	1.512851	
7	2	4	14110	10.486496	1.411	1.419232	7891	2487	3732	1	18	1	7	1	9	1	29	2.000108	3.999478	41881.342000	2.968203	
8	4	8	20799	15.457734	2.0799	2.092034	12338	3606	4855	1	22	1	8	1	15	1	36	4.000329	7.999703	121888.450000	5.860303	
9	8	16	25056	18.621519	2.5056	2.520217	15200	4738	5118	1	27	1	13	1	13	1	43	8.001385	15.998877	290048.923000	11.576027	
10	16	32	24342	18.090878	2.4342	2.448401	15152	4776	4414	1	33	1	11	1	10	1	40	16.000196	31.998413	558665.439000	22.950680	
11	32	64	19378	14.401653	1.9378	1.949105	12380	4154	2844	1	22	1	14	1	10	1	33	32.001671	63.999331	874337.451000	45.120110	
12	64	128	11959	8.887881	1.1959	1.202877	7780	2664	1515	1	17	1	7	1	5	1	26	64.008091	127.970550	1069070.000000	89.394592	
13	128	256	5686	4.225813	0.5686	0.571917	3815	1369	502	1	11	1	5	1	3	1	13	128.016064	255.951479	991337.294000	174.347046	
14	256	512	1976	1.468555	0.1976	0.198753	1264	579	133	1	6	1	3	1	1	1	7	256.067635	511.543295	680330.575000	344.296844	
15	512	1024	477	0.354505	0.0477	0.047978	274	184	19	1	2	1	2	1	1	1	3	512.144993	1019.248000	322790.816000	676.710327	
16	1024	2048	82	0.060942	0.0082	0.008248	56	26	0	1	1	1	1	0	0	1	2	1024.843000	1841.908000	109062.487000	1.330030	
17	2048	4096	9	0.006689	0.0009	0.000905	6	3	0	1	1	1	1	0	0	1	1	2076.877000	3049.861000	22571.649000	2.507961	
18	4096	8192	2	0.001486	0.0002	0.000201	0	2	0	0	0	1	1	0	0	1	1	4161.619000	4161.619000	8323.237000	4.161619	
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			Below Class		Below Class		Below Class		Below Class		Below Class		0.000000	0.000000	
Totals			134554	100	13.4554	13.533896	Above Class			Above Class		Above Class		Above Class		Above Class		Above Class		0.000000	0.000000	
							0	0	0													

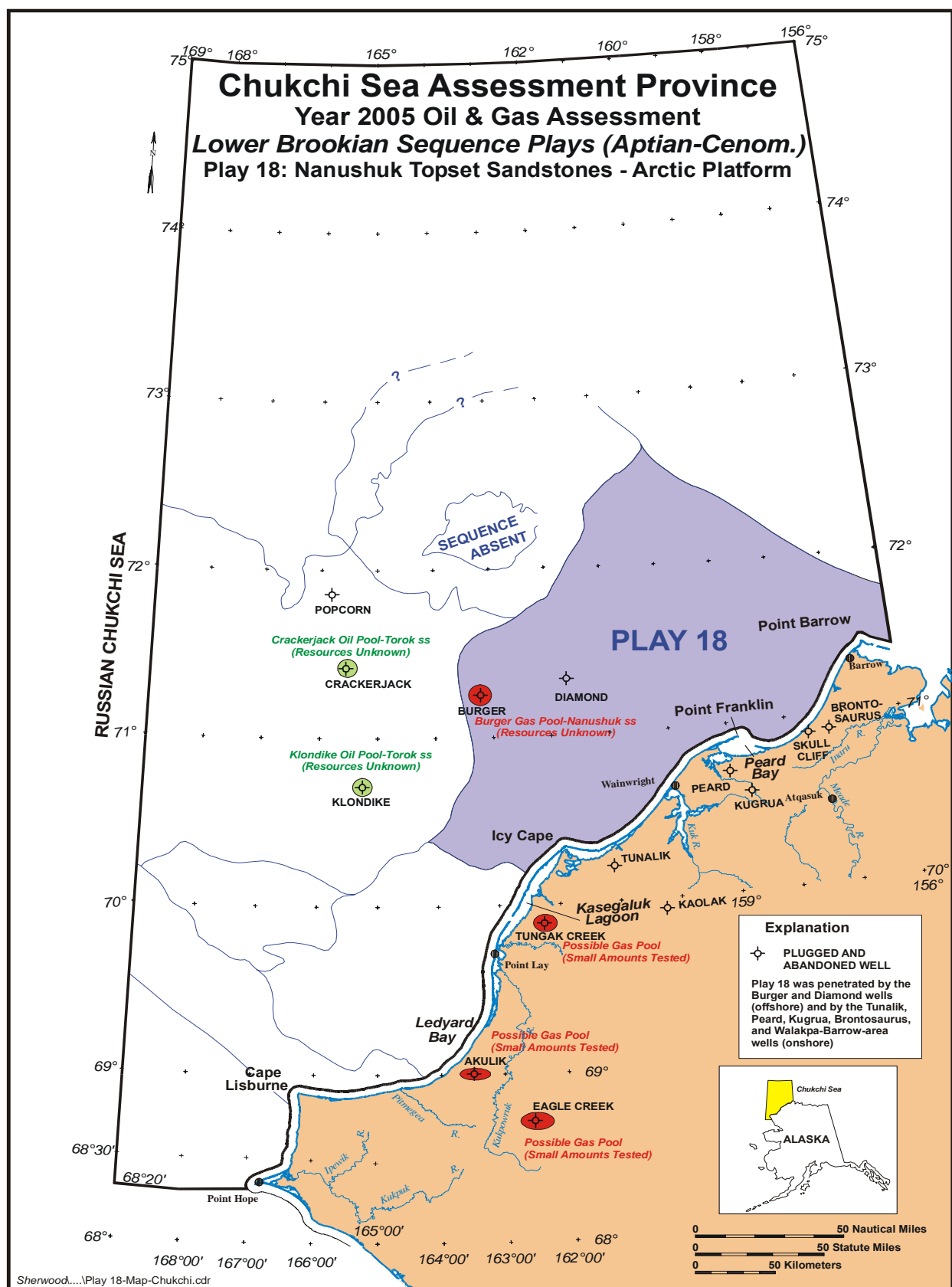


Figure 1. Map location of Chukchi sea play 18, 2006 assessment.