Chukchi Sea Play 25: Upper Brookian—Nuwuk Basin

Geological Assessment
GRASP UAI: AAAAA DAZ
Play Area: 3,280 square miles
Play Water Depth Range: 130-1,500 feet
Play Depth Range: 1,000-25,000 feet
Play Exploration Chance: 0.09996

Play 25, Upper Brookian-Nuwuk Basin, 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	1,000	3,644
Total Gas (Tcfg)	0.000	3.135	11.639
Total Liquids (Mmbo)	0	442	1,573
Free Gas** (Tcfg)	0.000	2.665	10.064
Solution Gas (Tcfg)	0.000	0.470	1.575
Oil (Mmbo)	0	299	1,002
Condensate (Mmbc)	0	144	570
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 25, the "Upper Brookian—Nuwuk Basin" play, is the 9th-ranking play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 3.4% (1,000 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). The overall assessment results for play 25 are shown in table 1. Oil and gas-condensate liquids form 44% of the hydrocarbon energy endowment of play 25.

Table 5 reports the detailed assessment results by commodity for play 25.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi Sea play 25. Table 4 reports the risk model for play 25. The location of play 25 is shown in figure 1.

Play 25 includes Tertiary deltaic-topset facies of the Sagavanirktok Group extending northward from the hinge line fault zone to the 500 m isobath. The maximum thickness of the sequence in the play area is about 12,000 feet. Reservoir quality is likely to be poor due to the distance from the sediment source and the sand-poor nature of the Lower Brookian strata from which some sediment was cannibalized on the Arctic platform to the south. Sandstones may thicken abruptly in wedges along the downthrown sides of listric growth faults that dissect Nuwuk basin. Only a reconnaissance seismic grid exists over most of the area of this play. For this reason, probability distributions for prospect areas and prospect numbers in this play are based on seismic mapping in a structurally-analogous area on the west flank of North Chukchi high. Ellesmerian rocks are not known to be present beneath Nuwuk basin. Therefore, source rocks for oil or gas would have to be associated with shales of the underlying Torok Formation-equivalent Lower Brookian sequence. Torok Formation shales are gas-prone where sampled in well bores onshore. In Nuwuk basin, many thousands of feet of these shales have passed through the oil window and into the gas window. Rotated blocks along listric growth faults are the main types of traps. No wells have penetrated the Nuwuk basin

fill.

Play 25, Upper Brookian-Nuwuk Basin, 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	178	794	2217
2	89	395	873
3	50	258	595
4	31	185	430
5	22	140	333
6	17	111	269
7	14	91	224
8	12	76	192
9	10	66	167
10	9	58	149
* 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 47 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 25. These 47 pools range in mean conditional (un-risked) recoverable volumes from 8 Mmboe (pool rank 47) to 794 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 178 Mmboe (F95) to 2,217 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 25.

In the computer simulation for play 25 a total of 44,613 "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 (9,417, or 21%) of

simulation pools (conditional, technically recoverable BOE resources) for play 25. Pool size class 12 ranges from 64 to 128 Mmboe. The largest 12 simulation pools for play 25 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 25.

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

Basin: Chukchi Sea Planning Area
Play Number: 25
Play UAI Number: AAAAA DAZ
Assessor: K.W. Sherwood
Play Name: Upper Brookian - Nuwuk Basin
Date: January 2005

Play Area: mi² (million acres) 3,280 (2.099)
Reservoir Thermal Maturity: % Ro 0.30 - 2.00
Play Depth Range: feet 1,000 - 25,000 (mean = 8,000)
Expected Oil Gravity: ° API 35
Play Water Depth Range: feet 130 - 1,500 (mean = 300)

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		1249		4643	7845/10686			17253				34444
Prospect Area (acres)-Model Output**	455	927	1269	2303	4620	6874/6498	9028	13011	15983	21222			34378
Fill Fraction (Fraction of Area Filled)	0.10	0.20	0.22	0.26	0.32	0.33/0.10	0.39	0.43	0.46	0.51			1.00
Productive Area of Pool (acres)***	100	276	393	714	1465	2289/2344	2967	4220	5386	7392	9000	10000	20326
Pay Thickness (feet)	45	114	132	168	220	238/99	288	333	367	425	500	558	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	0.5	Prospect Level Chance	0.19992	Exploration Chance	0.09996
Output Play Level Chance*	0.4994				

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

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
		Seal Integrity (mostly fault traps)	0.6
	0.5	Timing (migration preceded Tertiary-age trap formation?)	
		Reservoir Presence (unknown)	0.7
		Chance Porosity > 10%	0.85
		Migration (diversion by numerous faults)	0.8
		Preservation (shallow reservoirs subject to biodegradation)	0.7

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	20	25	28	33	42	44.55/15.59	51	58	62	70	80	86	160
Numbers of Pools in Play						4.45/5.32	8	10	12	14	17	19	47

Zero Pools at F49.96

Minimum Number of Pools	4 (F45)	Mean Number of Pools	4.45	Maximum Number of Pools	47

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)	39	90	111	156	229	259/138	333	395	445	525	600	650	1077
Gas Recovery Factor (Mcfg/acre-foot)	236	844	1013	1353	1858	1984/845	2482	2836	3106	3534	3900	4100	6305
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	400	1100	1200	1400	1600	1579/328	1780	1890	1950	2070	2200	2260	2700
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)= 11.648	σ² (sigma squared)= 1.455	Random Number Generator Seed= 298076

BOE Conversion Factor (cf/bbl)	5620	Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.23
Probability Any Pool is 100% Oil	0.34	Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.5
Probability Any Pool is 100% Gas	0.43		

Table 3. Input data for Chukchi Sea play 25, 2006 assessment.

Risk Analysis Form - 2006 National Assessment

Assessment Province: Chukchi Sea OCS Planning Area	**Play Number, Name:** 25. Upper Brookian - Nuwuk Basin
Assessor(s): K.W. Sherwood	**Play UAI:** AAAAA DAZ
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*	*0.5600*
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	0.80
c. Preservation			
Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	1.00	0.70
2. Reservoir component (2a * 2b)	**2**	*1.0000*	*0.5950*
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	0.70
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**	*0.5000*	*0.6000*
a. Presence of trap			
Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	0.50	1.00
b. Effective seal mechanism			
Probability of effective seal mechanism for the trap.	3b	1.00	0.60

Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)	**0.5000**	
(1 * 2 * 3) *Product of All Subjective Play Chance Factors*		

Average Conditional Prospect Chance[1]		*0.1999*
(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	*0.1000*
(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 25, 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: AAAAADAZ			**Play No.**		**25**	
World	Level	-	World	Level	Resources	
Country	Level	-	UNITED	STATES	OF	AMERICA
Region	Level	-	MMS	-	ALASKA	REGION
Basin	Level	-	**CHUKCHI**	**SEA**	**SHELF**	
Play	**Level**	**-**	**Play**		**25 Upper Brookian - Nuwuk Basin**	
Geologist	Kirk	W.	Sherwood			
Remarks		2005 Assessment				
Run Date & Time:		Date	19-Sep-05 Time		13:57:11	

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	1,000,100	1,367,700
Oil (Mbo)	298,570	475,870
Condensate (Mbc)	143,790	226,000
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	2,664,700	4,043,800
Solution Gas (Mmcfg)	470,150	753,290

    10000 (Number of Trials in Sample)
    0.4994 (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	41,813	13,682	5,765	105,740	19,962
45	625,870	223,970	78,965	1,460,400	354,490
40	933,580	293,280	132,610	2,400,900	452,430
35	1,177,500	405,610	146,980	2,880,900	631,330
30	1,456,400	453,480	201,290	3,792,300	712,620
25	1,747,300	505,590	250,930	4,804,000	764,080
20	2,073,400	575,290	316,040	5,708,800	934,240
15	2,416,900	743,040	329,330	6,393,200	1,163,000
10	2,882,700	812,870	419,340	7,967,000	1,308,500
8	3,141,200	970,140	437,150	8,235,700	1,509,000
6	3,450,600	1,001,900	509,770	9,317,600	1,579,400
5	3,643,700	1,002,300	570,430	10,064,000	1,575,300
4	3,894,800	1,108,300	572,640	10,716,000	1,725,400
2	4,753,800	1,258,900	750,270	13,379,000	2,045,800
1	5,539,900	1,595,500	830,850	14,920,000	2,578,100
0.1	8,884,000	370,240	2,616,400	32,634,000	509,240
0.01	10,538,000	2,165,000	1,657,700	34,318,000	3,422,600
0.001	10,871,000	1,846,400	1,955,100	36,682,000	3,048,900

Table 5. Assessment results by commodity for Chukchi Sea play 25, 2006 assessment.

Basin: CHUKCHI SEA SHELF
Play 25 - U.Brookian - Nuwuk Basin
UAI Key: AAAAADAZ

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	0.002241	0.0001	0.0002		0	1	0	0	0	1	1	0	0	1	1		0.347527	0.347527	0.347527	347.526699
5	0.5	1	1	0.002241	0.0001	0.0002		0	1	0	0	0	1	1	0	0	1	1		0.777652	0.777652	0.777652	777.651787
6	1	2	19	0.042588	0.0019	0.003804		0	14	5	0	0	1	1	1	1	1	1		1.076274	1.949053	30.036351	1.580861
7	2	4	128	0.286912	0.0128	0.025626		10	86	32	1	1	1	1	1	1	1	1		2.026813	3.975653	385.437212	3.011228
8	4	8	554	1.241791	0.0554	0.110911		90	294	170	1	1	1	2	1	2	1	3		4.013845	7.999123	3404.009000	6.144421
9	8	16	1873	4.198328	0.1873	0.374975		337	916	620	1	2	1	4	1	2	1	4		8.006382	15.996504	22916.262000	12.235057
10	16	32	4232	9.486024	0.4232	0.847247		957	1665	1610	1	3	1	4	1	4	1	6		16.001010	31.976583	101820.851000	24.059748
11	32	64	7072	15.851882	0.7072	1.415816		1643	2759	2670	1	5	1	5	1	5	1	10		32.001239	63.985201	333420.611000	47.146580
12	64	128	9417	21.108196	0.9417	1.885285		2201	3284	3932	1	7	1	9	1	6	1	16		64.040098	127.997670	876207.299000	93.045273
13	128	256	9361	20.982674	0.9361	1.874074		2232	2957	4172	1	5	1	6	1	8	1	14		128.018681	255.984089	1715072.000000	183.214569
14	256	512	7174	16.080515	0.7174	1.436236		1756	2089	3329	1	5	1	4	1	6	1	11		256.010777	511.978956	2584248.000000	360.224121
15	512	1024	3595	8.058189	0.3595	0.71972		829	944	1822	1	3	1	3	1	5	1	6		512.260160	1022.782000	2508777.000000	697.851624
16	1024	2048	1013	2.270639	0.1013	0.202803		229	216	568	1	2	1	2	1	2	1	3		1024.326000	2044.350000	1370191.000000	1.352607
17	2048	4096	161	0.360881	0.0161	0.032232		30	36	95	1	1	1	1	1	2	1	2		2050.428000	4008.656000	415645.600000	2.581650
18	4096	8192	12	0.026898	0.0012	0.002402		0	5	7	0	0	1	1	1	1	1	1		4158.103000	7858.013000	69356.260000	5.779688
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									Below Class	0.000000	0.000000	0.000000	0.000000
	Totals		44613	100	4.4613	8.931531	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: 4995

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 25, 2006 assessment.
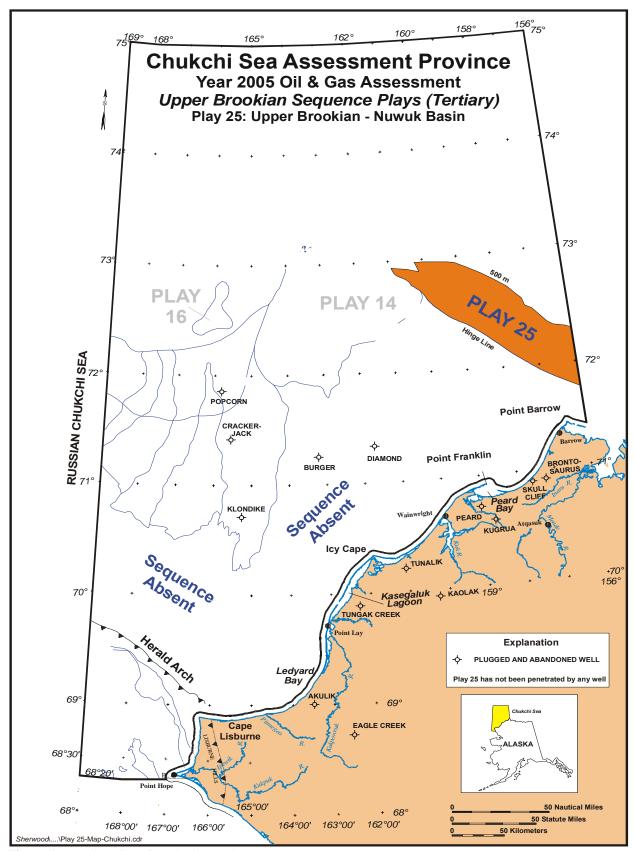
Figure 1. Map location of Chukchi Sea play 25, 2006 assessment.