

Chukchi Sea Play 4: Ellesmerian-Deep Gas

Geological Assessment

GRASP UAI: AAAAA DAE

Play Area: 15,707 square miles

Play Water Depth Range: 115-250 feet

Play Depth Range: 10,394-37,160 feet

Play Exploration Chance: 0.018

Play 4, Ellesmerian-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	198	719
Total Gas (Tcfg)	0	1	4
Total Liquids (Mmbo)	0	25	90
Free Gas** (Tcfg)	0.000	0.977	3.539
Solution Gas (Tcfg)	0.000	0.000	0.000
Oil (Mmbo)	0	0	0
Condensate (Mmbc)	0	25	90

* 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 4, the “Ellesmerian-Deep Gas” play, is the 18th-ranking play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 0.7% (198 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). Play 4 is assessed as offering non-associated gas in all pools. The overall assessment results for play 4 are shown in [table 1](#). Gas-condensate liquids form 13% of the hydrocarbon energy

endowment of play 4. [Table 5](#) reports the detailed assessment results by commodity for play 4.

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

The reservoir objectives for play 4 include all potential reservoirs in both Lower Ellesmerian and Upper Ellesmerian sequences (reservoir strata described in plays 1,2,3,5, and 6).

Prospects in play 4 occur at subsurface depths beneath the petroleum liquid survival “floor” (2.0% vitrinite reflectance) and should contain only non-associated gas. High thermal maturities have a detrimental effect on reservoir properties and multi-cycle tectonic history combined with extremely deep burial at present (to 38,000 ft) result in high exploration risks for play 4. Play 4 was penetrated at Tunalik well in northwestern Alaska with minor gas shows in the Shublik Formation.

A maximum of 27 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 4. These 27 pools range in mean conditional (un-risked) recoverable volumes from 3 Mmboe or 0.016 Tcfg (pool rank 27) to 185 Mmboe or 1.040 Tcfg (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 26 Mmboe or 0.146 Tcfg (F95) to 504 Mmboe or 2.832 Tcfg (F05). [Table 2](#) shows the conditional sizes of the 10 largest pools in play 4.

Play 4, Ellesmerian-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	26	185	504
2	11	74	189
3	6	45	113
4	4	32	80
5	3	24	60
6	2.5	19	49
7	2.1	16	41
8	1.9	14	35
9	1.7	12	31
10	1.6	11	27

* 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 4 a total of 31,927 “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 (7,356, or 23%) of simulation pools (conditional, technically recoverable BOE resources) for play 4. Pool size class 11 ranges from 32 to 64 Mmboe (or 0.2-0.4 Tcfge). The largest 3 simulation pools for play 4 fall within pool size class 17, which ranges in size from 2,048 to 4,096 Mmboe (or 12-23 Tcfge). [Table 6](#) reports statistics for the simulation pools developed in the *GRASP* computer model for play 4.

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

Basin: Chukchi Sea Planning Area
 Play Number: 04
 Play UAI Number: AAAAA DAE

Assessor: K.W. Sherwood
 Play Name: Ellesmerian-Deep Gas

Date: January 2005

Play Area: mi² (million acres) 15,707 (10.053)
 Reservoir Thermal Maturity: % Ro 2.11 ->8.00

Play Depth Range: feet 10,394-37,160 (mean = 22, 486)
 Expected Oil Gravity: ° API 60 (condensate--no free oil)
 Play Water Depth Range: feet 115-250 (mean = 130)

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*	500		3259		11225	17882/22178			38665				323676
Prospect Area (acres)-Model Output**	581	2293	3288	5912	11174	17247/19385	20988	30019	37658	52187			287149
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)***	208	919	1367	2451	4777	7634/9099	9109	13315	16862	23470	31000	38000	125296
Pay Thickness (feet)	10	38	44	55	70	75/29	90	103	113	129	150	166	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	0.6	Prospect Level Chance	0.03	Exploration Chance	0.018
Output Play Level Chance*	0.5941				

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

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
	0.6	Reservoir Presence (distal facies)	0.03
		Chance Porosity > 10%	0.01

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	92	105	130	145	170	177.28/47.16	200	220	240	260	280	300	460
Numbers of Pools in Play					3	3.19/3.33	6	7	8	9	11	12	27

Zero Pools at F59.43

Minimum Number of Pools	2 (F55)	Mean Number of Pools	3.19	Maximum Number of Pools	27
-------------------------	---------	----------------------	------	-------------------------	----

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)	22	227	273	357	474	515/231	623	733	811	948	1100	1250	2034
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 <i>POOLS</i> (1,000 BOE):	μ (mu)= 10.346						σ^2 (sigma squared)= 1.474			Random Number Generator Seed= 631747			
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 4, 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: AAAAADAE **Play No. 4**
 World Level - World Level Resources
 Country Level - UNITED STATES OF AMERICA
 Region Level - MMS - ALASKA REGION
 Basin Level - **CHUKCHI SEA SHELF**
Play Level - Play 4 Ellesmerian Deep Gas
 Geologist Kirk W. Sherwood
 Remarks 2005 Assessment
 Run Date & Time: Date 19-Sep-05 Time 13:52:25

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	198,440	277,070
Oil (Mbo)	0	0
Condensate (Mbc)	24,631	34,836
Free (Gas Cap & Nonassociated) Gas (Mmcf)	976,810	1,363,300
Solution Gas (Mmcf)	0	0

10000 (Number of Trials in Sample)
 0.5941 (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 (Mmcf)	Solution Gas (Mmcf)
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	55,514	0	6,736	274,140	0
50	99,507	0	11,994	491,820	0
45	137,720	0	17,150	677,630	0
40	175,250	0	21,235	865,550	0
35	215,930	0	26,654	1,063,700	0
30	258,120	0	31,696	1,272,500	0
25	309,080	0	37,865	1,524,200	0
20	366,410	0	45,740	1,802,200	0
15	436,520	0	54,479	2,147,100	0
10	532,970	0	67,223	2,617,500	0
8	585,980	0	72,999	2,882,900	0
6	660,330	0	81,416	3,253,500	0
5	719,240	0	89,586	3,538,700	0
4	783,820	0	99,346	3,846,800	0
2	992,490	0	124,300	4,879,200	0
1	1,270,000	0	162,430	6,224,300	0
0.1	2,031,000	0	238,190	10,076,000	0
0.01	2,791,400	0	359,850	13,665,000	0
0.001	3,324,900	0	413,780	16,360,000	0

Table 5. Assessment results by commodity for Chukchi Sea play 4, 2006 assessment.

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	1	0.003132	0.0001	0.000168	0	0	1	0	0	0	0	1	1	1	1	1	1	0.090449	90.449110	
3	0.125	0.25	8	0.025057	0.0008	0.001346	0	0	8	0	0	0	0	1	1	1	1	1	1	0.177738	214.700386	
4	0.25	0.5	33	0.103361	0.0033	0.005554	0	0	33	0	0	0	0	1	1	1	1	1	1	0.252272	392.372996	
5	0.5	1	127	0.397782	0.0127	0.021373	0	0	127	0	0	0	0	1	2	1	2	1	2	0.507585	785.013258	
6	1	2	423	1.324897	0.0423	0.071188	0	0	423	0	0	0	0	1	2	1	2	1	2	1.006770	1.563967	
7	2	4	1108	3.470417	0.1108	0.186469	0	0	1108	0	0	0	0	1	3	1	3	1	3	2.000925	3.031190	
8	4	8	2479	7.764588	0.2479	0.4172	0	0	2479	0	0	0	0	1	5	1	5	1	5	4.004084	6.060404	
9	8	16	4736	14.833839	0.4736	0.797038	0	0	4736	0	0	0	0	1	7	1	7	1	7	8.004209	11.904638	
10	16	32	6744	21.123188	0.6744	1.134971	0	0	6744	0	0	0	0	1	8	1	8	1	8	16.004296	23.313107	
11	32	64	7356	23.04006	0.7356	1.237967	0	0	7356	0	0	0	0	1	9	1	9	1	9	32.008574	45.790882	
12	64	128	5285	16.553387	0.5285	0.889431	0	0	5285	0	0	0	0	1	6	1	6	1	6	64.004531	89.777718	
13	128	256	2559	8.01516	0.2559	0.430663	0	0	2559	0	0	0	0	1	4	1	4	1	4	128.009804	174.297379	
14	256	512	802	2.511981	0.0802	0.134971	0	0	802	0	0	0	0	1	4	1	4	1	4	256.305742	339.918427	
15	512	1024	208	0.651486	0.0208	0.035005	0	0	208	0	0	0	0	1	2	1	2	1	2	513.144484	680.455078	
16	1024	2048	55	0.172268	0.0055	0.009256	0	0	55	0	0	0	0	1	1	1	1	1	1	1026.989000	1.313908	
17	2048	4096	3	0.009396	0.0003	0.000505	0	0	3	0	0	0	0	1	1	1	1	1	1	2416.112000	2.633327	
18	4096	8192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	
19	8192	16384	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	
20	16384	32768	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	
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	0	0	0	0	0	0	0	0	0	0	0	0	Below Class	0.000000	0.000000
Totals			31927	100.000008	3.1927	5.373107	Above Class	0	0	0	0	0	0	0	0	0	0	0	0	Above Class	0.000000	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.	Min and Max refer to aggregate resources 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: 5942		

Table 6. Statistics for simulation pools created in computer sampling run for Chukchi Sea play 4, 2006 assessment.

