Chukchi Sea Play 9: Rift Sequence-Deep Gas

Geological Assessment

<u>GRASP UAI</u>: AAAAA DAJ Play Area: 7,666 square miles

<u>Play Water Depth Range</u>: 100-150 feet <u>Play Depth Range</u>: 9,000-22,775 feet <u>Play Exploration Chance</u>: 0.042

Play 9, Rift Sequence-Deep Gas, Chukchi Sea OCS Planning Area, 2006 Assessment, Undiscovered Technically-Recoverable Oil & Gas

Assessment Results as of November 2005											
Resource	Resources *										
Commodity (Units)	F95	Mean	F05								
BOE (Mmboe)	0	48	237								
Total Gas (Tcfg)	0.000	0.237	1.168								
Total Liquids (Mmbo)	0	6	29								
Free Gas** (Tcfg)	0.000	0.237	1.168								
Solution Gas (Tcfg)	0.000	0.000	0.000								
Oil (Mmbo)	0	0	0								
Condensate (Mmbc)	0	6	29								

^{*} Risked, Technically-Recoverable

F05 = 5% chance that resources will equal or exceed the given quantity

BOE = total hydrocarbon energy, expressed in barrels-of-oilequivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas

Mmb = millions of barrels
Tcf = trillions of cubic feet

Table 1

Play 9, the "Rift Sequence-Deep Gas" play, is the 26th-ranking play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 0.2% (48 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). Play 9 is assessed as offering non-associated gas in all pools. The overall assessment results for play 9 are shown in table 1. Gas-condensate liquids form 12% of the hydrocarbon energy

endowment of play 9. Table 5 reports the detailed assessment results by commodity for play 9.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi Sea play 9. Table 4 reports the risk model used for play 9. The location of play 9 is shown in figure 1.

Play 9 includes prospects that lie at subsurface depths beneath the petroleum liquids survival "floor" (2.0% vitrinite reflectance) and that would therefore contain only gas. Reservoir objectives would be primarily thin, basin-floor turbidite sandstones deposited in the basin plain area south of the stable shelf sedimentary province of the Rift sequence. However, in western Arctic Alaska, shelf deposits in the play sequence (e.g., at Tunalik well) enter the all-gas window as well. The anticipated hydrocarbon mix is 100 percent nonassociated gas, probably derived from underlying, oil-expended Shubik source beds of the Hanna trough play charging system, or marine shales (upper Kingak Formation, Kuparuk Formation, Pebble Shale) within the Rift sequence. High levels of thermal maturity for prospect reservoirs are expected to have an adverse effect on reservoir properties, which primarily accounts for the small endowment of this play. 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 threedimensional seismic data within the correlative sequence in the National Petroleum Reserve-Alaska (NPRA). The

^{**} Free Gas Includes Gas Cap and Non-Associated Gas F95 = 95% chance that resources will equal or exceed the given quantity

size range of these "geobodies" also helped define the prospect area distribution. Play 9 was penetrated at Tunalik well, which encountered pooled gas (logs) in a Kuparuk-equivalent sandstone at 12,508 feet within the play sequence.

Play 9, Rift Sequence-Deep Gas, Chukchi Sea OCS Planning Area, 2006 Assessment, Conditional BOE Sizes of Ten Largest Pools

Pool Rank	BOE Resources *										
1 OOI Kalik	F95	Mean	F05								
1	7	64	165								
2	3	29	81 50								
3	2	18									
4	1.3	12	36								
5	1.0	9	27								
6	0.9	8	22								
7	0.82	6	19								
8	0.76	5.6	17								
9	0.72	5.1	15								
10	0.69	4.7	14								

^{*} 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-oilequivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas

Table 2

A maximum of 36 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 9. These 36 pools range in mean conditional (un-risked) recoverable volumes from 1 Mmboe or 0.006 Tcfge (pool rank 36) to 64 Mmboe or 0.360 Tcfge (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 7 Mmboe or 0.039 Tcfge (F95) to 165 Mmboe or 0.927 Tcfge (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 9.

In the computer simulation for play 9 a total

of 19,647 "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 (3,724, or 19%) of simulation pools (conditional, technically recoverable BOE resources) for play 9. Pool size class 9 ranges from 8 to 16 Mmboe (or 0.04 to 0.09 Tcfge). The largest 2 simulation pools for play 9 fall within pool size class 15, which ranges in size from 512 to 1,024 Mmboe (or 2.9-5.8 Tcfge). Table 6 reports statistics for the simulation pools developed in the GRASP computer model for play 9.

GRASP Play Data Form (Minerals Management Service-Alaska Regional Office) Basin: Chukchi Sea Planning Area Assessor: K.W. Sherwood Date: January 2005 Play Number: 09 Play Name: Rift Sequence - Deep Gas Play UAI Number: AAAAA DAJ Play Depth Range: feet Play Area: mi² (million acres) 7,666 (4.906) 9,000 - 22,775 (mean = 17,352) Expected Oil Gravity: OAPI Reservoir Thermal Maturity: % Ro 2.03-6.00 60 (No Free Oil) Play Water Depth Range: feet 100 - 150 (mean = 130) POOLS Module (Volumes of Pools, Acre-Feet) F100 F75 F50 Mean/Std. Dev. F25 F15 F10 F05 F02 F01 F00 Prospect Area (acres)-Model Input* 318 4557 12379/31271 27895 52520 Prospect Area (acres)-Model Output** 318 606 880 1889 4525 8522/10151 11018 17004 22186 31955 52374 Fill Fraction (Fraction of Area Filled) 0.25 0.38 0.40 0.45 0.51 0.52/0.10 0.57 0.61 0.64 0.69 1.00 Productive Area of Pool (acres)*** 4398/5385 19000 40022 116 295 441 953 2263 5519 8713 11255 16637 21000 Pay Thickness (feet) 9 12 13 16 20 21/7 25 28 30 33 38 41 70 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 Prospect Level Chance **Exploration Chance** 0.042 0.105 Output Play Level Chance* 0.3906 First Occurrence of Non Zero Pools As Reported in PSUM Module Prospect Chance Risk Model Play Chance **Petroleum System Factors** 0.4 Reservoir Presence (distal facies) 0.03 Chance Porosity > 10% 0.105 Fractile F99 F95 F90 F75 F50 Mean/Std. Dev. F25 F15 F10 F05 F02 F01 F00 Numbers of Prospects in Play 16 21 24 32 41 46.64/22.17 55 65 72 84 100 115 212 1.96/3.11 4 6 11 12 36 Numbers of Pools in Play 5 8 Zero Pools at F39.09 **Minimum Number of Pools** 2 (F35) Mean Number of Pools 1.96 **Maximum Number of Pools** 36 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) 439 728 804 957 1174 1266/449 1475 1672 1836 2113 2500 2700 4603 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)= 9.337 σ^2 (sigma squared)= 1.696 Random Number Generator Seed= 822952 BOE Conversion Factor (cf/bbl) 5620 Probability Any Pool Contains Both Oil and Free Gas (Gas Cap) Probability Any Pool is 100% Oil Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap Ω 1 Probability Any Pool is 100% Gas

Table 3. Input data for Chukchi Sea play 9, 2006 assessment.

Risk Analysis Form - 2006 National Assessment Assessment Province: Chukchi Sea OCS Planning Area Play Number, Name: 9. Rift Sequence - Deep Gas Assessor(s): K.W. Sherwood Play UAI: AAAAA DAJ 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 Averge Conditional **Factors** Prospect Chance¹ 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 1a 1.00 1.00 rock of adequate quality located in the drainage area of the reservoirs b. Effective Expulsion and Migration Probability of effective expulsion and migration of hydrocarbons from the source rock to the 1b 1.00 1.00 reservoirs. c. Preservation Probability of effective retention of hydrocarbons in the prospects after accumulation. 1c 1.00 1.00 2. Reservoir component (2a * 2b) 2 0.4000 0.1050 a. Presence of reservoir facies Probability of presence of reservoir facies with a minimum net thickness and net/gross ratio (as 0.40 1.00 2a specified in the resource assessment). b. Reservoir quality Probability of effectiveness of the reservoir, with respect to minimum effective porosity, and 0.11 2b 1.00 permeability (as specified in the resource assessment). 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 За 1.00 1.00 assessment) b. Effective seal mechanism Probability of effective seal mechanism for the trap. 1.00 1.00 Overall Play Chance (Marginal Probability of hydrocarbons, MPhc) 0.4000 (1 * 2 * 3) Product of All Subjective Play Chance Factors Average Conditional Prospect Chance 0.1050 1 * 2 * 3) Product of All Subjective Conditional Prospect Chance Factors 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 0.0420 (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 9, 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: AAAAADAJ Play No. 9

World Level World Resources Level Country Level UNITED **STATES** OF **AMERICA** MMS ALASKA **REGION** Region Level

Basin Level - CHUKCHI SEA SHELF

9 Rift Sequence - Deep Gas

PlayLevel-PlayGeologistKirkW.Sherwood

Remarks 2005 Assessment

Run Date & Time: Date 19-Sep-05 Time 13:53:29

Summary of Play Potential

Product	MEAN	Standard Deviation				
BOE (Mboe)	48,107	90,792				
Oil (Mbo)	0	0				
Condensate (Mbc)	5,946	11,332				
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	236,950	447,040				
Solution Gas (Mmcfg)	0	0				

10000 (Number of Trials in Sample)

0.3906 (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	20,206	0	2,532	99,327	0			
30	42,234	0	5,301	207,570	0			
25	65,593	0	8,144	322,870	0			
20	94,135	0	11,594	463,880	0			
15	123,660	0	15,109	610,030	0			
10	165,460	0	20,649	813,860	0			
8	188,160	0	23,592	924,850	0			
6	218,630	0	27,643	1,073,400	0			
5	236,530	0	28,666	1,168,200	0			
4	259,000	0	32,738	1,271,600	0			
2	327,530	0	40,709	1,611,900	0			
1	402,180	0	49,568	1,981,700	0			
0.1	696,860	0	112,050	3,286,600	0			
0.01	962,250	0	119,720	4,735,000	0			
0.001	1,085,800	0	143,600	5,295,200	0			

Table 5. Assessment results by commodity for Chukchi Sea play 9, 2006 assessment.

	Basin: CHUKCHI SEA SHELF Model Simulation "Pools" Reported by "Fieldsize.out" GRASP Module																						
	Play 09 - Rift - Deep Gas UAI Key: AAAAADAJ																						
6 7 tt 110	y. 70000.	7.10																					
	Classifica	ition and Size	!	Poo	Count Stati	stics	Pool Types Coun		unt	Mixed Pool Range		Oil Poo	Oil Pool Range Gas Pool F		ol Range	lange 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	C) (0	1	0	0	0	0	0	0	0	0	0	0	0	1 1	0.000000	0.000000	0.000000	0.000000
2	0.0625	0.125	0	C) C	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.000000	0.000000	0.000000	0.000000
3	0.125	0.25	5	0.025449	0.0005	0.00128		0	0	5	0	0	0	0	1	1	1	1	1	0.139768	0.219971	0.891705	178.340971
4	0.25	0.5	123	0.62605	0.0123	0.031482	1	0	0	123	0	0	0	0	1	2	1	2	1	0.251988	0.499976	50.441817	410.096079
5	0.5	1	563	2.865577	0.0563	0.1441	1	0	0	563	0	0	0	0	1	3	1	3	1	0.502663	0.999272	433.604618	770.168066
6	1	2	1302	6.626966	0.1302	0.333248		0	0	1302	0	0	0	0	1	5	1	5	1	1.000310	1.999000	1973.266000	1.515566
7	2	4	2447	12.454827	0.2447	0.626312		0	0	2447	0	0	0	0	1	7	1	7]	2.000383	3.999442	7254.913000	2.964819
8	4	8	3287	16.730289	0.3287		1	0	0	3287	0	0	0	0	1	10	1	10	1	4.000235	7.999037	19294.726000	5.870011
9	8	16	3724	18.954548	0.3724	0.953161		0	0	3724	0	0	0	0	1	11	1	11	1	8.001130	15.999079	42925.222000	11.526644
10	16	32	3628	18.465923	0.3628	0.92859	1	0	0	3628	0	0	0	0	1	9	1	9	1	16.001939	31.961684	83124.896000	22.912045
11	32	64	2727	13.879982	0.2727	0.697978	1	0	0	2727	0	0	0	0	1	8	1	8	1	32.007717	63.968386	123553.947000	45.307644
12	64	128	1410	7.176668	0.141	0.360891	1	0	0	1410	0	0	0	0	1	6	1	6	1 1	64.027901	127.958823	122461.235000	86.851936
13	128	256	378	1.923958	0.0378	0.096749	1	0	0	378	0	0	0	0	1	3	1	3	1	128.312627	248.561309	62575.052000	165.542465
14	256	512	51	0.259582	0.0051	0.013053	1	0	0	51	0	0	0	0	1	1	1	1	1 1	257.070903	511.713537	16226.358000	318.163879
15	512	1024	2	0.01018	0.0002	0.000512	1	0	0	2	0	0	0	0	1	1	1	1	1	574.949560	621.477910	1196.427000	598.213745
16	1024	2048	0	C) C	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.000000	0.000000	0.000000	0.000000
17	2048	4096	0	C) C	0		0	0	0	0	0	0	0	0	0	0	0	1	0.000000	0.000000	0.000000	0.000000
18	4096	8192	0	C) C	0	1	0	0	0	0	0	0	0	0	0	0	0	1	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	1 1	0.000000	0.000000	0.000000	0.000000
20	16384	32768	0	C	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1 I	0.000000	0.000000	0.000000	0.000000
21	32768	65536	0	0	0	0	l	0	0	0	0	0	0	0	0	0	0	0	1 1	0.000000	0.000000	0.000000	0.000000
22	65536	131072	0	0	0	0	l	0	0	0	0	0	0	0	0	0	0	0	1 1	0.000000	0.000000	0.000000	0.000000
23	131072	262144	0	C	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1 I	0.000000	0.000000	0.000000	0.000000
24	262144	524288	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1 1	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	1 1	0.000000	0.000000	0.000000	0.000000
Not Clas	sified		0	0	0	0	Below Class	0	0	0									Below Class	0.000000	0.000000	0.000000	0.000000
	Totals 19647 100 1.9647 5.028666 Above Class 0 0							0									Above Class	0.000000	0.000000	0.000000	0.000000		
Numbe	Min and Max refer to numbers of pools of the relevant size class that Number of Pools not Classified: 0 Number of Pools below Class 1: 0 Number of Trials with Pools: 3907																						

Table 6. Statistics for simulation pools created in computer sampling run for Chukchi sea play 9, 2006 assessment.

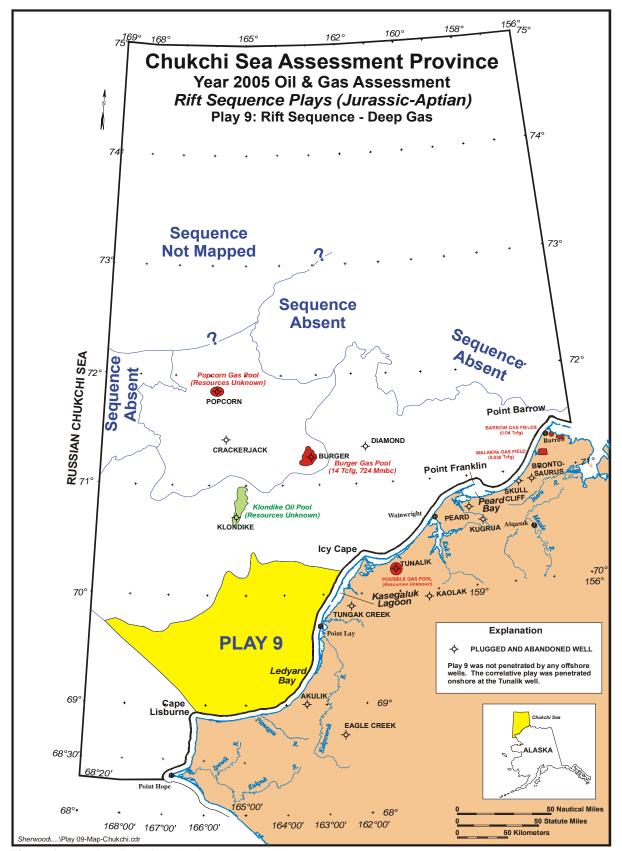


Figure 1. Map location of Chukchi Sea play 9, 2006 assessment.