

## St. George Basin Play 1: St. George Graben Play

### Geological Assessment

*GRASP UAI: AAAAAJAB*

*Play Area: 4,400 square miles*

*Play Water Depth Range: 300-535 feet*

*Play Depth Range: 5,625-9,375 feet*

*Play Exploration Chance: 0.21*

Play 1, Graben, St. George Basin 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	234	698
Total Gas (Tcfg)	0.000	0.860	2.642
Total Liquids (Mmbo)	0	81	228
Free Gas** (Tcfg)	0.000	0.841	2.590
Solution Gas (Tcfg)	0.000	0.020	0.052
Oil (Mmbo)	0	37	92
Condensate (Mmbc)	0	44	136
<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 1, the “St. George Graben” play, is the most important play (of four plays) in the St. George Basin OCS Planning Area, with 33% (234 Mmboe) of the Planning Area energy endowment (712 Mmboe). The overall assessment results for play 1 are shown in [table 1](#). Oil and gas-condensate liquids form 35% of the hydrocarbon energy endowment of play 1. [Table 5](#) reports the detailed

assessment results by commodity for play 1.

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

The St. George graben trends northwest-southeast for over 200 miles, is 10- to 25-miles wide, and contains as much as 40,000 feet of Cenozoic strata. Potential hydrocarbon traps include faulted anticlines, upthrown fault traps over basement horst blocks, downthrown faults along the border faults of the graben, drape of Tertiary strata over basement fault blocks, stratigraphic onlap onto the basement, and possible pinchout of sands. Five exploratory wells, including one sidetrack hole, were drilled in the graben. All wells were plugged and abandoned with only minor gas shows encountered. The exploratory and stratigraphic test wells are located in [figure 1](#).

The best reservoir rocks encountered in the graben are sandstones of Oligocene age. The Arco Y-0511 well encountered fine-grained Oligocene sandstones in beds ranging from 10- to 40-feet thick for a gross total of 460 feet. Porosities ranged from 20 to 30 percent and permeabilities ranged from 20 to 130 millidarcies. The Exxon Y-0527 well had Oligocene sandstones in beds ranging from 5- to 20-feet thick for a gross total of 185 feet. The Exxon Y-0530 and the Chevron Y-0519 wells,

also located in the graben, had no sandstones of reservoir quality. Porosity loss with depth tends to be very high in the St. George basin province because the rocks have a high content of volcanic rock fragments which are diagenetically altered to zeolite and clay minerals with burial.

The source-rock potential is poorly known for the graben, but the COST No. 2 well, located along its southeastern margin, had relatively low TOC values in the Cenozoic and Mesozoic sections (Turner and others, 1984b). The kerogen types identified were gas-prone and the top of the oil window occurs at approximately 12,000 feet. Other unexplored areas of the graben are much deeper and may have better source-rock potential. The Arco Y-0511 well penetrated the northern boundary fault of the graben and recovered samples of Jurassic shale that had TOC values of 0.5 to 2.0 percent. The visual kerogen examination reported a high percentage of amorphous material. If oil-prone source rocks are present in the St. George basin assessment province, they probably occur in Jurassic strata. The province is underlain by the Mesozoic Peninsular terrane which extends from the Cook Inlet area, where Middle Jurassic strata are known to have generated oil (Magoon and Claypool, 1981; Magoon and Anders, 1992).

A maximum of 29 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 1. These 29 pools range in mean conditional (un-risked) recoverable volumes from 6 Mmboe (pool rank 29) to 153 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 40

Mmboe (F95) to 449 Mmboe (F05), or in a gas case from 0.225 Tcfge (F95) to 2.523 Tcfge (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 1.

Play 1, Graben, St. George Basin 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	40	153	449
2	24	74	155
3	16	50	103
4	11	36	74
5	7	28	57
6	5.4	22	46
7	4.2	18	38
8	3.49	15	33
9	2.99	13	28
10	2.64	11	25
* 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 1 a total of 54,884 "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 10 contains the largest share (14,334, or 26%) of simulation pools (conditional, technically recoverable BOE resources) for play 1. Pool size class 10 ranges from 16 to 32 Mmboe. The largest simulation pool for play 1 falls within pool size class 16, which ranges in size from 1,024 to 2,048 Mmboe (or 5.8 to 11.5 Tcfge). Table 6 reports statistics for the simulation pools

developed in the *GRASP* computer model for play 1.

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

**Basin:** St. George Basin  
**Play Number:** 1  
**Play UAI Number:** AAAAAJAB

**Assessor:** Comer  
**Play Name:** St. George Graben Play

**Date:** March, 2005

**Play Area (mi<sup>2</sup>; millions of acres):** 4,400 (2.816)  
**Reservoir Thermal Maturity, % Ro:**

**Play Depth Range, feet:** 5625 - 7500 - 9375  
**Expected Oil Gravity, ° API:** 35  
**Play Water Depth Range, feet:** 300 - 425 - 535  
**Prospect Distance from shore, miles:** 340

### 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	0				12497	---				39916			~
Prospect Area (acres)-Model Output	976	3913	5057	7762	12497	16034.0 / 12889.0	20119	25977	30885	39916	53275	64581	72000
Fill Fraction (Fraction of Area Filled)	0.06	0.11	0.13	0.16	0.2	0.21192 / 0.074237	0.25	0.28	0.31	0.35	0.4	0.44	0.71
Productive Area of Pool (acres)	101	678	907	1475	2532	3529.17 / 3492.76	4347	5810	7072	9462	13131	16337	54000
Pay Thickness (feet)	48	80	87	101	120	123.848 / 31.888	142	155	165	181	200	215	303

### MPRO Module (Numbers of Pools)

Play Level Chance	0.6	Prospect Level Chance	0.35	Exploration Chance	0.21
-------------------	-----	-----------------------	------	--------------------	------

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
		[ See Risking Sheet ]	

Fractile	F100	F95	F90	F75	F50	Mean / Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	12	18	19	22	25	26.14 / 5.26	29	31	32	35	38	40	57
Numbers of Pools in Play	~	~	F60 = 0	F55 = 5	6	5.49 / 5.07	10	11	12	14	15	16	29

Minimum Number of Pools	0	Mean Number of Pools	5.49	Maximum Number of Pools	29
-------------------------	---	----------------------	------	-------------------------	----

### POOLS/PSRK/PSUM Module (Play Resources)

Fractile	F100	F95	F90	F75	F50	Mean / Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Oil Recovery Factor (bbl/acre-foot)	28	58	66	82	104	110.700 / 40.637	132	150	163	185	213	235	382
Gas Recovery Factor (Mcft/acre-foot)	32	117	148	217	332	407.882 / 294.268	509	640	747	940	1218	1447	3491
Gas Oil Ratio (Sol'n Gas)/(cf/bbl)	89	230	271	357	486	540.402 / 264.579	661	779	871	1028	1238	1402	2644
Condensate Yield ((bbl)/Mmcf)	20	40	42	47	52	52.695 / 8.776	58	62	64	68	73	76	100

Pool Size Distribution Statistics from POOLS (1,000 BOE):  $\mu$  (mu) = 10.1231553  $\sigma^2$  (sigma squared) = 1.09176311 Random Number Generator Seed = 621566

BOE Conversion Factor (cf/bbl)	5620	Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.2
Probability Any Pool is 100% Oil	0	Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.3
Probability Any Pool is 100% Gas	0.8		

Table 3. Input data for St. George basin play 1, 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

<b>Play UAI: AAAAAJAB</b>	<b>Play No. 1</b>	
World Level -	World Level Resources	
Country Level -	UNITED STATES OF AMERICA	
Region Level -	MMS - ALASKA REGION	
Basin Level -	<b>ST. GEORGE BASIN</b>	
<b>Play Level -</b>	<b>1 - Graben Play</b>	
Geologist Comer		
Remarks St.	George	Graben
Run Date & Time: Date	19-Sep-05 Time	14:10:41

## Summary of Play Potential

Product	MEAN	Standard Deviation
<b>BOE (Mboe)</b>	234,020	254,710
<b>Oil (Mbo)</b>	36,631	60,089
<b>Condensate (Mbc)</b>	44,286	50,350
<b>Free (Gas Cap &amp; Nonassociated) Gas (Mmcfg)</b>	840,920	953,580
<b>Solution Gas (Mmcfg)</b>	19,512	34,668

10000 (Number of Trials in Sample)

0.5997 (MPhc [Probability] of First Occurrence of Non-Zero Resource)

Windowing Feature: used

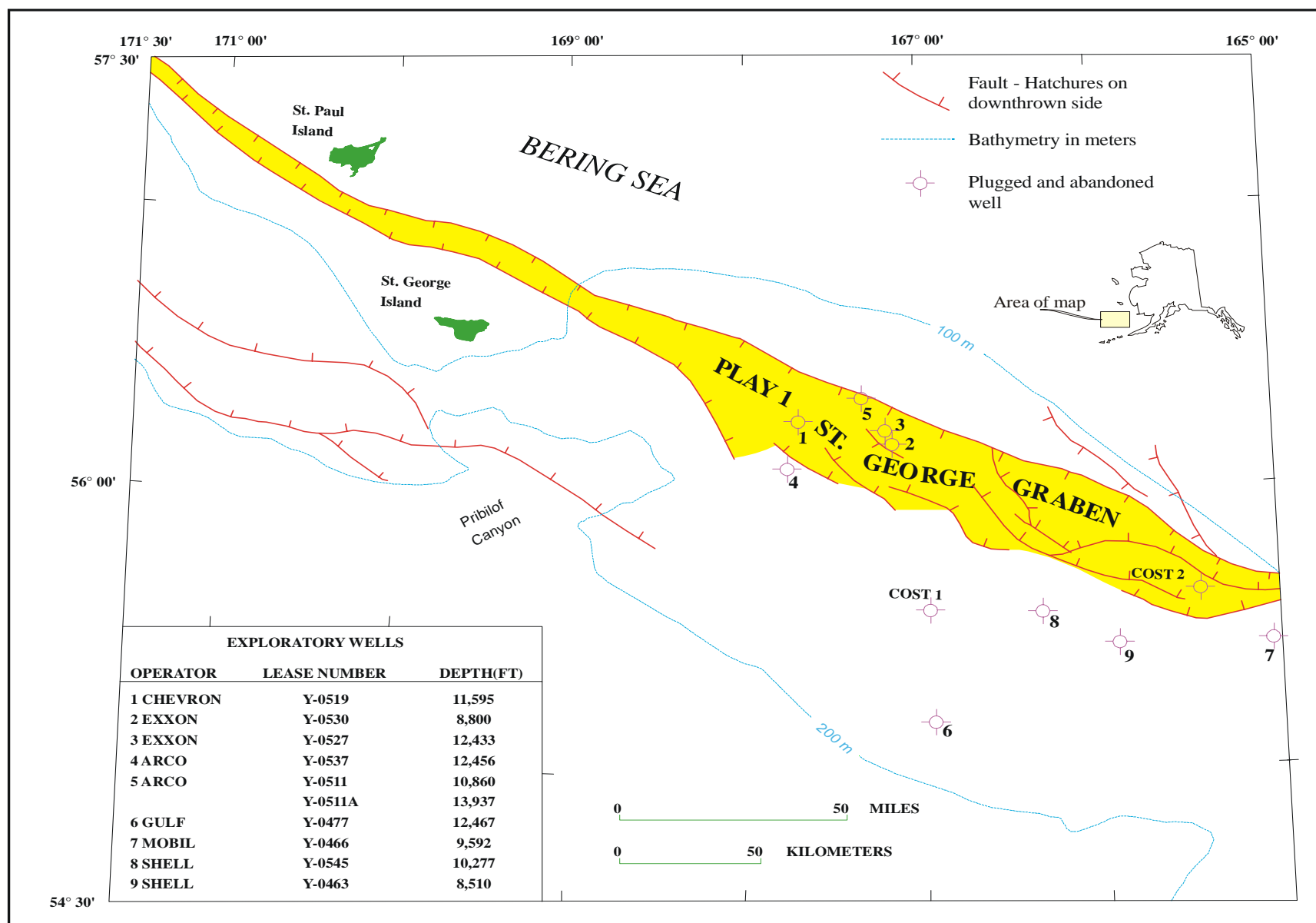
## Empirical Probability Distributions of the Products

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	19,427	1,715	4,130	75,565	766
55	146,450	23,507	28,039	521,540	11,820
50	197,840	27,297	38,374	727,780	15,031
45	235,680	41,006	43,788	827,160	20,828
40	273,860	44,863	51,351	974,130	24,247
35	311,820	48,575	58,267	1,124,700	27,249
30	350,820	64,230	64,040	1,217,900	32,799
25	393,240	54,841	75,906	1,446,100	29,122
20	438,770	72,930	82,254	1,554,000	39,731
15	496,040	69,527	95,161	1,824,500	37,657
10	574,700	109,080	103,640	1,979,300	55,076
8	616,570	77,526	121,300	2,304,500	43,222
6	665,380	97,049	127,870	2,425,200	50,202
5	697,950	92,153	135,770	2,589,600	51,977
4	739,070	115,360	139,260	2,658,700	63,939
2	872,930	132,660	166,890	3,150,900	71,512
1	1,019,400	140,200	200,640	3,733,100	80,132
0.1	1,400,700	19,512	303,660	6,048,400	7,188
0.01	1,875,200	29,812	401,280	8,104,800	11,210
0.001	1,960,900	124,340	393,210	8,060,000	51,630

**Table 5.** Assessment results by commodity for St. George basin play 1, 2006 assessment.

Basin: ST. GEORGE BASIN Play 01 - Graben Play UAI Key: AAAAAJAB				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	0	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	0	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	0	0.000000	0.000000		
4	0.25	0.5	11	0.020042	0.0011	0.001834	0	0	11	0	0	0	0	0	1	1	1	1	1	0.286300	0.499000		
5	0.5	1	73	0.133008	0.0073	0.012171	2	0	71	1	1	0	0	1	2	1	2	1	2	0.507333	0.987900		
6	1	2	418	0.761606	0.0418	0.06969	19	0	399	1	1	0	0	1	2	1	2	1	2	1.005514	1.997770		
7	2	4	1737	3.164857	0.1737	0.289597	92	0	1645	1	1	0	0	1	4	1	4	1	4	2.000389	3.998800		
8	4	8	5225	9.520079	0.5225	0.871124	562	0	4663	1	2	0	0	1	5	1	6	1	6	4.000051	7.998060		
9	8	16	10743	19.574011	1.0743	1.791097	1757	0	8986	1	4	0	0	1	7	1	8	1	8	8.000852	15.998732		
10	16	32	14334	26.116901	1.4334	2.389796	3100	0	11234	1	5	0	0	1	8	1	10	1	10	16.000358	31.993844		
11	32	64	12443	22.671452	1.2443	2.074525	3027	0	9416	1	5	0	0	1	8	1	9	1	9	32.006492	63.998417		
12	64	128	6804	12.397056	0.6804	1.134378	1777	0	5027	1	4	0	0	1	5	1	6	1	6	64.014142	127.982691		
13	128	256	2379	4.334597	0.2379	0.396632	575	0	1804	1	3	0	0	1	4	1	4	1	4	128.044236	255.682368		
14	256	512	619	1.127833	0.0619	0.103201	116	0	503	1	2	0	0	1	2	1	2	1	2	256.353702	502.138893		
15	512	1024	89	0.16216	0.0089	0.014838	9	0	80	1	1	0	0	1	1	1	1	1	1	515.452720	981.274876		
16	1024	2048	9	0.016398	0.0009	0.001501	0	0	9	0	0	0	0	1	1	1	1	1	1	1068.681000	1427.816000		
17	2048	4096	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000		
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			Below Class								Below Class			0.000000		
Totals			54884	100	5.4884	9.150383	Above Class			Above Class								Above Class			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: 5998																							

**Table 6.** Statistics for simulation pools created in computer sampling run for St. George basin play 1, 2006 assessment.



**Figure 1.** Map of St. George basin play 1, 2006 assessment.