

Norton Basin Play 3: Mid-Tertiary West Subbasin Fill

Geological Assessment

GRASP UAI: AAAAAIAD

Play Area: 5,411 square miles

Play Water Depth Range: 30 – 135 feet

Play Depth Range: 4,600 – 12,500 feet

Play Exploration Chance: 0.063

Play 3, Mid-Tertiary West Subbasin Fill, Norton 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	382	1,551
Total Gas (Tcfg)	0.000	1.944	7.896
Total Liquids (Mmbo)	0	36	146
Free Gas** (Tcfg)	0.000	1.944	7.896
Solution Gas (Tcfg)	0.000	0.000	0.000
Oil (Mmbo)	0	0	0
Condensate (Mmbc)	0	36	146
<i>* Risked, Technically-Recoverable</i> <i>** Free Gas Includes Gas Cap and Non-Associated Gas</i> <i>F95 = 95% chance that resources will equal or exceed the given quantity</i> <i>F05 = 5% chance that resources will equal or exceed the given quantity</i> <i>BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas</i> <i>Mmb = millions of barrels</i> <i>Tcf = trillions of cubic feet</i>			

Table 1

Play 3, the Mid-Tertiary West Subbasin Fill play, is the 1st-ranking play (of 4 plays) in the Norton Basin OCS Planning Area, with 64% (382 Mmboe) of the planning area energy

endowment (601 Mmboe). The overall assessment results for Play 3 are shown in [table 1](#). Liquid hydrocarbons consisting of gas-condensate form 9% of the hydrocarbon energy endowment of this play. [Table 2](#) shows the conditional sizes of the 10 largest pools calculated in the *GRASP* computer model of the play. [Table 3](#) summarizes the volumetric input data developed for use in the Play 3 *GRASP* computer model. [Table 4](#) reports the risk model used for the play. [Table 5](#) reports the detailed Play 3 assessment results by commodity.

Norton Basin Play 3 is confined to the Saint Lawrence Subbasin in the western Norton Basin area. Its location is shown in [figure 1](#). Also shown are the Norton Basin COST #1 well and the 1 exploratory well (Arco Y-0436) that penetrated Play 3. The Exxon Y-0430 well on the Yukon horst did not encounter any Play 3 sediments preserved beneath the younger play 1 sequence.

Norton Basin Play 3 consists of Eocene through lower Oligocene clastic sediments deposited in predominantly neritic to upper bathyal environments in the St. Lawrence Subbasin. The most likely reservoir rocks within the play interval are intervals of neritic sands in the lower Oligocene section, except along the Yukon Horst and the basin margins where alluvial fan and deltaic sand deposits may occur. Porosities are in the 10% range, but can locally approach 30% in the shallower areas of the play. Thick sequences of probable turbidite sands were encountered in the COST # 1 well, but showed marginal porosity and permeability.

Potential hydrocarbon charge for the play

derives primarily from thermally mature gas-prone source rocks in the deeper parts of the play interval and in underlying Early Tertiary subbasin strata. The COST wells encountered numerous shales and coaly intervals with humic type III gas-prone kerogen in these rocks. COST #1 well data indicate these intervals may be somewhat leaner than in equivalent sediments in the Stuart Subbasin, but they may also be present in greater volume across the greater Play 3 area. Hydrocarbon migration is expected to be mainly along horst and graben faulting systems within the basin. The most likely hydrocarbon trapping mechanisms include anticlines, faulted anticlines, fault traps, and stratigraphic traps formed by onlap against basement. Common shale intervals provide adequate seals.

Play 3, Mid-Tertiary West Subbasin Fill, Norton 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	71	421	1513
2	42	163	387
3	28	97	213
4	20	67	153
5	15	49	107
6	11	37	80
7	8	29	62
8	6	23	50
9	4	18	41
10	3	15	34
* 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 37 hypothetical pools is forecast by the aggregation of the risk model (tbl. 4) and the prospect numbers model for Play 3. These pools range in mean conditional (un-risked) recoverable volumes from 0.8 Mmboe (pool rank 37) to 421 Mmboe (pool rank 1, tbl. 2). Possible conditional recoverable volumes for pool rank 1 range from 41 Mmboe (F95) to 1.513 Mmboe (F05).

In the computer simulation for Play 3 a total of 71,307 "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. Table 6 reports the size classes and statistics for the simulation pools (conditional, technically recoverable BOE resources) developed in the GRASP computer model for Norton Basin Play 3. Pool size class 10 contains the largest share (12,518, or 18%) of the simulation pools for the play. Pool size class 10 ranges from 16 to 32 Mmboe. The largest simulation pool for Play 3 falls within pool size class 17, which ranges in size from 2,048 to 4,096 Mmboe.

Producible hydrocarbons were not encountered in either of the two wells (Cost # 1, Y-0436) that penetrated the play.

Reservoir Thermal Maturity: % Ro		0.5 - 0.7		Expected Oil Gravity: ° API		45							
				Play Water Depth Range: feet		30 - 135							
				Prospect Distance from shore, miles:		28 - 72 - 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*	40	284.7905	468.0382	1073.4942	2699.9879	8093.3 / 16715	6790.8468	11139.6862	15575.5122	25597.5318	44774.0879	65000.9944	185000
Prospect Area (acres)-Model Output**													
Fill Fraction (Fraction of Area Filled)*	0.1	0.2005	0.2223	0.2642	0.32	.33767 / .10931	0.3876	0.4297	0.4607	0.5108	0.5738	0.62	1
Productive Area of Pool (acres)***	12	78.664	134.328	328.459	887.001	2629.641 / 6009.7	2395.344	4082.148	5857.078	10001.62	18265.15	27289.41	72000
Pay Thickness (feet)	40	102.433	114.56	138.112	170	178.368 / 57.022	209.25	233.926	252.27	282.136	320.001	348.027	490

* model fit to prospect area, fill fraction data from NA95 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	0.42	Prospect Level Chance	0.15	Exploration Chance	0.063
Output Play Level Chance*	0.4201				

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

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
	0.7	Reservoir with minimum thickness, net/gross ratio	
	0.6	Trap with minimum rock volume	
		Efficient source rock: volume, maturity, drainage	0.15

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	102	105	107	110	113	113.21 / 4.57	116	117	118	120	122	124	136
Numbers of Pools in Play					0	7.13 / 8.75	16	18	20	22	24	25	37

Minimum Number of Pools	0	Mean Number of Pools	7.13	Maximum Number of Pools	37
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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)	0	constant											
Gas Recovery Factor (Mcfg/acre-foot)	193	348.519	386.393	459.087	556	579.201 / 170.343	673.373	746.263	800.056	887.001	996.209	1076.386	1590
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	0	constant											
Condensate Yield (bbl/Mmcfg)	7.5	12.96	13.935	15.731	18	18.358 / 3.732	20.295	22.14	23.25	25	27.127	28.645	33

Pool Size Distribution Statistics from <i>POOLS</i> (1,000 BOE):	μ (mu)= 9.71315007	σ ² (sigma squared)= 2.36707951	Random Number Generator Seed = 661588
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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 Norton basin play 3, 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: AAAAAIAD			Play No. 3		
World	Level	-	World	Level	Resources
Country	Level	-	UNITED	STATES	OF AMERICA
Region	Level	-	MMS	-	ALASKA REGION
Basin	Level	-	NORTON	BASIN	
Play	Level	-	Play		3 Mid-Tertiary West Subbasin Fill Play
Geologist	Sue	Banet			
Run Date & Time:	Date		19-Sep-05	Time	14:09:13

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	381,700	591,850
Oil (Mbo)	0	0
Condensate (Mbc)	35,860	56,485
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	1,943,600	3,011,500
Solution Gas (Mmcfg)	0	0

10000 (Number of Trials in Sample)

0.4201 (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	276,570	0	26,055	1,407,900	0
35	422,080	0	39,461	2,150,300	0
30	537,080	0	50,022	2,737,300	0
25	652,710	0	60,556	3,327,900	0
20	781,860	0	73,220	3,982,600	0
15	938,530	0	87,455	4,783,000	0
10	1,166,000	0	108,340	5,944,300	0
8	1,287,700	0	120,990	6,556,700	0
6	1,452,800	0	134,700	7,407,800	0
5	1,550,800	0	145,820	7,895,900	0
4	1,684,300	0	158,220	8,576,500	0
2	2,152,500	0	205,790	10,941,000	0
1	2,565,900	0	247,810	13,028,000	0
0.1	3,758,600	0	326,080	19,291,000	0
0.01	4,972,900	0	486,460	25,214,000	0
0.001	6,290,400	0	665,420	31,612,000	0

Table 5. Assessment results by commodity for Norton basin play 3, 2006 assessment.

Basin: NORTON BASIN Play 03 - Mid-Tertiary West Subbasin Fill Play UAI Key: AAAAAIAD				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	19	0.026645	0.0019	0.004522	0	0	19	0	0	0	0	1	1	1	1	1	1	0.063164	0.124949		
3	0.125	0.25	160	0.224382	0.016	0.038077	0	0	160	0	0	0	0	1	2	1	2	1	2	0.127047	0.249618		
4	0.25	0.5	680	0.953623	0.068	0.161828	0	0	680	0	0	0	0	1	3	1	3	1	3	0.250716	0.499812		
5	0.5	1	1641	2.301317	0.1641	0.390528	0	0	1641	0	0	0	0	1	4	1	4	1	4	0.500008	0.999667		
6	1	2	3505	4.915366	0.3505	0.834127	0	0	3505	0	0	0	0	1	6	1	6	1	6	1.000235	1.999824		
7	2	4	6580	9.227706	0.658	1.565921	0	0	6580	0	0	0	0	1	8	1	8	1	8	2.000724	3.999828		
8	4	8	10004	14.029478	1.0004	2.380771	0	0	10004	0	0	0	0	1	10	1	10	1	10	4.000338	7.999023		
9	8	16	12446	17.454107	1.2446	2.961923	0	0	12446	0	0	0	0	1	10	1	10	1	10	8.000684	15.999424		
10	16	32	12518	17.555079	1.2518	2.979058	0	0	12518	0	0	0	0	1	11	1	11	1	11	16.000611	31.999325		
11	32	64	10099	14.162704	1.0099	2.403379	0	0	10099	0	0	0	0	1	9	1	9	1	9	32.003286	63.995366		
12	64	128	7028	9.855975	0.7028	1.672537	0	0	7028	0	0	0	0	1	9	1	9	1	9	64.012014	127.983857		
13	128	256	3932	5.514185	0.3932	0.935745	0	0	3932	0	0	0	0	1	6	1	6	1	6	128.013001	255.890844		
14	256	512	1741	2.441556	0.1741	0.414327	0	0	1741	0	0	0	0	1	5	1	5	1	5	256.203495	511.587768		
15	512	1024	660	0.925575	0.066	0.157068	0	0	660	0	0	0	0	1	2	1	2	1	2	512.445133	1021.092000		
16	1024	2048	260	0.364621	0.026	0.061875	0	0	260	0	0	0	0	1	2	1	2	1	2	1028.029000	2039.792000		
17	2048	4096	34	0.047681	0.0034	0.008091	0	0	34	0	0	0	0	1	1	1	1	1	1	2054.388000	3260.742000		
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							Below Class	0.000000	0.000000	0.000000	0.000000		
Totals			71307	100.000008	7.1307	16.969774	Above Class	0	0	0							Above Class	0.000000	0.000000	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.																			
Number of Pools below Class 1: 0				Min and Max refer to aggregate resources of the relevant size class that occur within any single trial in the simulation.																			
Number of Trials with Pools: 4202																							

Table 6. Statistics for simulation pools created in computer sampling run for Norton basin play 3, 2006 assessment.

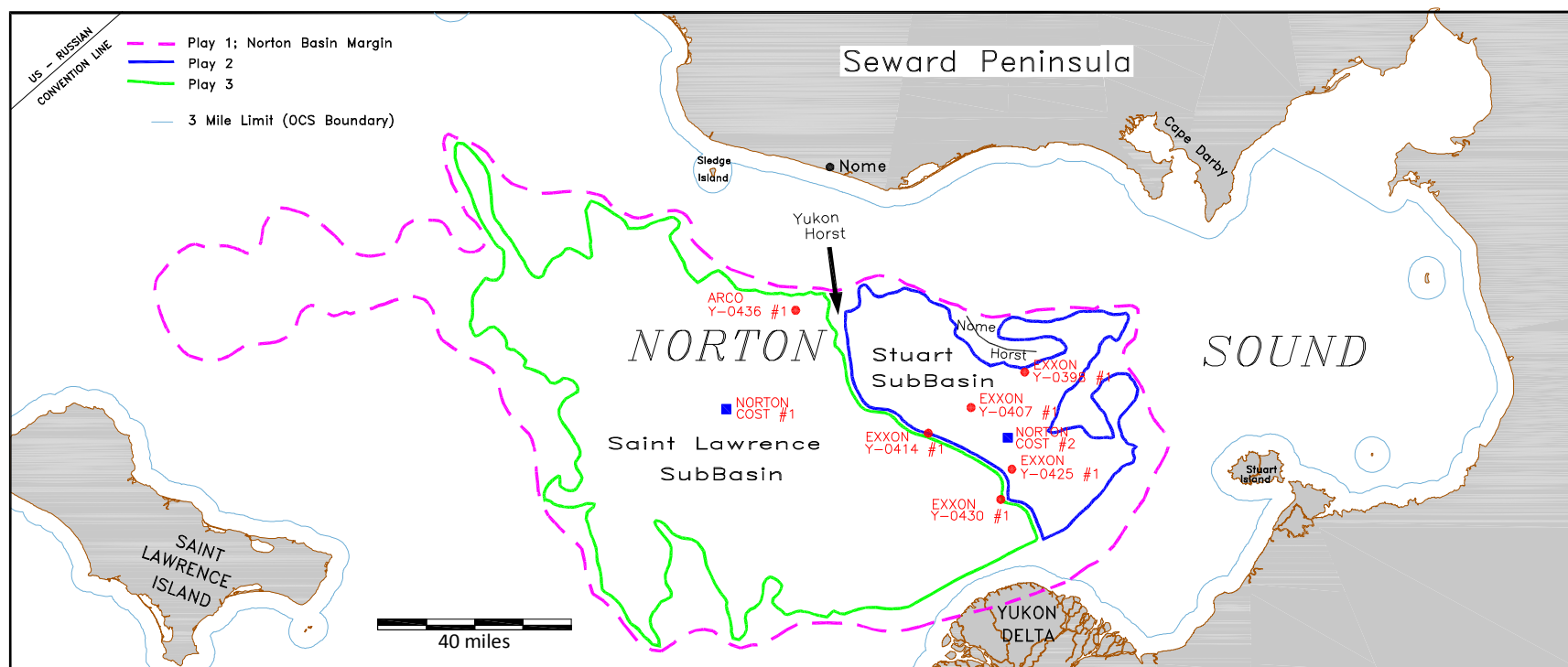


Figure 1. Norton Basin Play 3, the Mid-Tertiary West Subbasin Fill play (2006 assessment), occupying the Saint Lawrence Subbasin in the western portion of the Norton Basin. Two wells (the Norton Basin COST #1 and the Arco Y-0436) were drilled into the Play 3 sequence. Play 3 sediments are absent from the section at the Exxon Y-0430 location.