

Norton Basin Play 1: Upper Tertiary Basin Fill (upper Oligocene-Miocene)

Geological Assessment

GRASP UAI: AAAAA IAB

Play Area: 10,644 square miles

Play Water Depth Range: 20-135 feet

Play Depth Range: 500-8,600 feet

Play Exploration Chance: 0.048

Play 1, Upper Tertiary Basin 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	139	626
Total Gas (Tcfg)	0.000	0.709	3.192
Total Liquids (Mmbo)	0	13	58
Free Gas** (Tcfg)	0.000	0.709	3.192
Solution Gas (Tcfg)	0.000	0.000	0.000
Oil (Mmbo)	0	0	0
Condensate (Mmbc)	0	13	58
<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 1, the “Upper Tertiary Basin Fill” play, is the 2nd-ranking play (of 4 plays) in the Norton Basin OCS Planning Area, with 23% (139 Mmboe) of the planning area energy endowment (601 Mmboe). The overall assessment results for Play 1 are shown in [table](#)

1. Liquid hydrocarbons consisting of gas-condensates 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 1 *GRASP* computer model. [Table 4](#) reports the risk model used for the play. [Table 5](#) reports the detailed Play 1 assessment results by commodity.

Play 1 (shown in [fig. 1](#)) includes all of the late Oligocene and younger age clastic sediments deposited across Norton Basin, and effectively occupies the entire Norton Basin prospective area. All six exploratory wells and the 2 COST wells that were drilled in the play area ([fig.1](#)) penetrated Play 1 sediments. Depositional environments include transitional to outer neritic deltaic and shallow marine settings, with environments possibly as deep as upper bathyal occurring deeper in the more western portion. Porosities in the Play 1 sands can range from 10 to 36% and permeabilities can range as high as 1 darcy or better. Upper Oligocene sand intervals are thicker, while sands of the Miocene are generally thinner but less compacted. All sediments in the play are thermally immature, and the potential hydrocarbon sources principally occur in older sediments contained in the underlying subbasins. Proposed hydrocarbon migration routes would be predominantly along faults. The potential trapping mechanisms are anticlines, faults, and stratigraphic traps. Shale intervals are common and provide adequate seals.

Potential hydrocarbon charge for the play derives primarily from gas-prone thermally mature sedimentary rocks of the Early Tertiary

subbasin strata underlying Play 1. These rocks include numerous shales and coaly intervals and were shown to contain primarily humic type III organic matter in samples recovered from the COST wells. Hydrocarbon migration would be expected to take place predominantly along horst and graben faulting systems within the basin. The potential trapping mechanisms are anticlines, faulted anticlines, fault traps, and stratigraphic traps.

Play 1, Upper Tertiary Basin 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	26	206	782
2	12	70	178
3	7	39	98
4	4	25	64
5	2.4	17	44
6	1.7	13	33
7	1.31	10	25
8	1.06	8	20
9	0.90	6	17
10	0.78	5	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-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas			

Table 2

A maximum of 23 hypothetical pools is forecast by the aggregation of the risk model (tbl. 4) and the prospect numbers model for Play 1 (tbl. 3). These 23 pools range in mean conditional (un-risked) recoverable volumes from 1.5 Mmboe (pool rank 23) to 206 Mmboe (pool rank 1, tbl. 2). Possible conditional recoverable volumes for pool rank 1 range

from 26 Mmboe (F95) to 782 Mmboe (F05).

In the computer simulation for Play 1 a total of 30,862 "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 1. Pool size class 10 contains the largest share (6118, or 19.8%) of simulation pools for the play. Pool size class 10 ranges from 16 to 32 Mmboe. The largest simulation pool for Play 1 falls within pool size class 17, which ranges in size from 2048 to 4096 Mmboe.

No producible hydrocarbons were encountered in any of the wells (fig. 1) that penetrated Play 1.

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

Basin: Norton
Play Number: 1
Play UAI Number: AAAAAIAB

Assessor: S. Banet
Play Name: Upper Tertiary Basin Fill Play

Date: March, 2006

Play Area: mi² (million acres) 10644 mi²; 6.812 million acres
Reservoir Thermal Maturity: % Ro 0.25 - 0.4 - 0.5

Play Depth Range: feet 500 - 3,500 - 8,600
Expected Oil Gravity: ° API 45
Play Water Depth Range: feet 20 - 135
Prospect Distance from shore: miles 27 - 77 - 144

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*	30	529.3327	829.3327	1758.2236	4050.007	10097 / 16628	3329.0509	14598.1613	19769.3452	30987.2343	51388.8765	71999.2202	185000
Prospect Area (acres)-Model Output**													
Fill Fraction (Fraction of Area Filled)*	0.1	0.2005	0.2223	0.2642	0.32	.33461 / .10474	0.3876	0.4297	0.4607	0.5108	0.5738	0.62	1
Productive Area of Pool (acres)***	5	178.893	284.429	617.271	1460	3382.493 / 624.511	3453.264	5480.995	7494.304	11915.53	20080.2	28436.29	80270
Pay Thickness (feet)	20	57.924	66.739	84.562	110	118.827 / 48.751	143.09	164.778	181.303	208.894	245	272.476	380

* 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	0.4
Output Play Level Chance*	0.3996

Prospect Level Chance	0.12
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Exploration Chance	0.048
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* First Occurrence of Non Zero Pools As Reported in PSUM Module

Risk Model

Play Chance	Petroleum System Factors	Prospect Chance
0.5	Effective reservoir: minimum porosity, permeability	
0.8	Trap with minimum rock volume	
	Efficient source rock with sufficient volume, maturity, drainage	0.12

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	44	54	56	60	64	64.33 / 6.14	68	70	72	74	77	79	82
Numbers of Pools in Play					0	3.09 / 4.15	7	8	9	11	12	13	23

Minimum Number of Pools	0	Mean Number of Pools	3.09	Maximum Number of Pools	23
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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 (Mcf/acre-foot)	182	337.893	376.13	449.919	549	573.818 / 175.787	669.901	745.409	801.322	892.001	1006.39	1090.689	1650
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	0	constant											
Condensate Yield ((bbl/Mmcf)	7.5	12.96	13.935	15.731	18	18.358 / 3.732	20.596	22.14	23.25	25	27.127	28.645	33

Pool Size Distribution Statistics from *POOLS* (1,000 BOE): μ (mu)= 9.76102837 σ^2 (sigma squared)= 1.91115938 Random Number Generator Seed = 812776

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 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

Play UAI: AAAAAIAB			Play No. 1		Resources	
World	Level	-	World	Level	OF	AMERICA
Country	Level	-	UNITED	STATES	ALASKA	REGION
Region	Level	-	MMS	-		
Basin	Level	-	NORTON	BASIN		
Play	Level	-	Play		1 Upper Tertiary Basin Fill Play	
Geologist	Sue	Banet				
Run Date & Time:	Date	19-Sep-05	Time	14:08:53		

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	139,130	261,680
Oil (Mbo)	0	0
Condensate (Mbc)	13,023	24,765
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	708,700	1,332,900
Solution Gas (Mmcfg)	0	0

10000 (Number of Trials in Sample)

0.3996 (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	8,349	0	767	42,612	0
35	101,950	0	9,320	520,560	0
30	152,870	0	14,136	779,710	0
25	207,210	0	19,351	1,055,800	0
20	265,740	0	24,781	1,354,200	0
15	340,550	0	31,710	1,735,700	0
10	435,680	0	40,427	2,221,300	0
8	492,710	0	46,353	2,508,500	0
6	569,790	0	52,393	2,907,800	0
5	626,270	0	58,347	3,191,800	0
4	689,880	0	64,667	3,513,700	0
2	882,500	0	84,255	4,486,100	0
1	1,189,500	0	111,150	6,060,200	0
0.1	2,412,600	0	207,870	12,391,000	0
0.01	3,994,500	0	402,750	20,185,000	0
0.001	4,130,600	0	386,960	21,039,000	0

Table 5. Assessment results by commodity for Norton basin play 1, 2006 assessment.

Basin: NORTON BASIN Play 01 - Upper Tertiary Basin Fill Play UAI Key: AAAAAIAB				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	3	0.009721	0.0003	0.000751	0	0	3	0	0	0	0	0	1	1	1	0.064334	0.107976	0.239974	79.991281
3	0.125	0.25	31	0.100447	0.0031	0.007756	0	0	31	0	0	0	0	0	1	1	1	0.126488	0.241039	5.999512	193.532646
4	0.25	0.5	149	0.482794	0.0149	0.037278	0	0	149	0	0	0	0	0	1	2	1	0.258330	0.499865	58.312180	391.356915
5	0.5	1	487	1.577992	0.0487	0.121841	0	0	487	0	0	0	0	0	1	3	1	0.500097	0.998989	370.145818	760.053039
6	1	2	1161	3.761908	0.1161	0.290468	0	0	1161	0	0	0	0	0	1	4	1	1.000728	1.999276	1767.725000	1.522588
7	2	4	2535	8.213984	0.2535	0.634226	0	0	2535	0	0	0	0	0	1	7	1	2.000908	3.999270	7628.022000	3.009082
8	4	8	4389	14.221373	0.4389	1.098074	0	0	4389	0	0	0	0	0	1	8	1	4.001145	7.995036	25889.197000	5.898655
9	8	16	5959	19.308535	0.5959	1.490868	0	0	5959	0	0	0	0	0	1	9	1	8.001044	15.998801	69466.853000	11.657468
10	16	32	6118	19.823732	0.6118	1.530648	0	0	6118	0	0	0	0	0	1	8	1	16.001464	31.998886	140813.099000	23.016197
11	32	64	4779	15.485063	0.4779	1.195647	0	0	4779	0	0	0	0	0	1	7	1	32.001709	63.999098	215760.861000	45.147701
12	64	128	3004	9.733653	0.3004	0.751564	0	0	3004	0	0	0	0	0	1	7	1	64.002398	127.960764	265852.793000	88.499596
13	128	256	1459	4.727497	0.1459	0.365024	0	0	1459	0	0	0	0	0	1	4	1	128.056436	255.581903	255436.244000	175.076248
14	256	512	559	1.811289	0.0559	0.139855	0	0	559	0	0	0	0	0	1	3	1	256.223737	511.567416	196714.532000	351.904358
15	512	1024	169	0.547599	0.0169	0.042282	0	0	169	0	0	0	0	0	1	1	1	512.154928	1008.765000	119022.015000	704.272278
16	1024	2048	52	0.168492	0.0052	0.01301	0	0	52	0	0	0	0	0	1	1	1	1024.543000	1911.723000	70087.720000	1.347841
17	2048	4096	8	0.025922	0.0008	0.002002	0	0	8	0	0	0	0	0	1	1	1	2064.972000	3884.713000	22384.588000	2.798073
18	4096	8192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	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	0	0	0	0	0	Below Class			
Totals			30862	100	3.0862	7.721291	Above Class			0	0	0	0	0	0	0	0	Above Class			
Number of Pools not Classified: 0																					
Number of Pools below Class 1: 0																					
Number of Trials with Pools: 3997																					
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 Norton basin play 1, 2006 assessment.

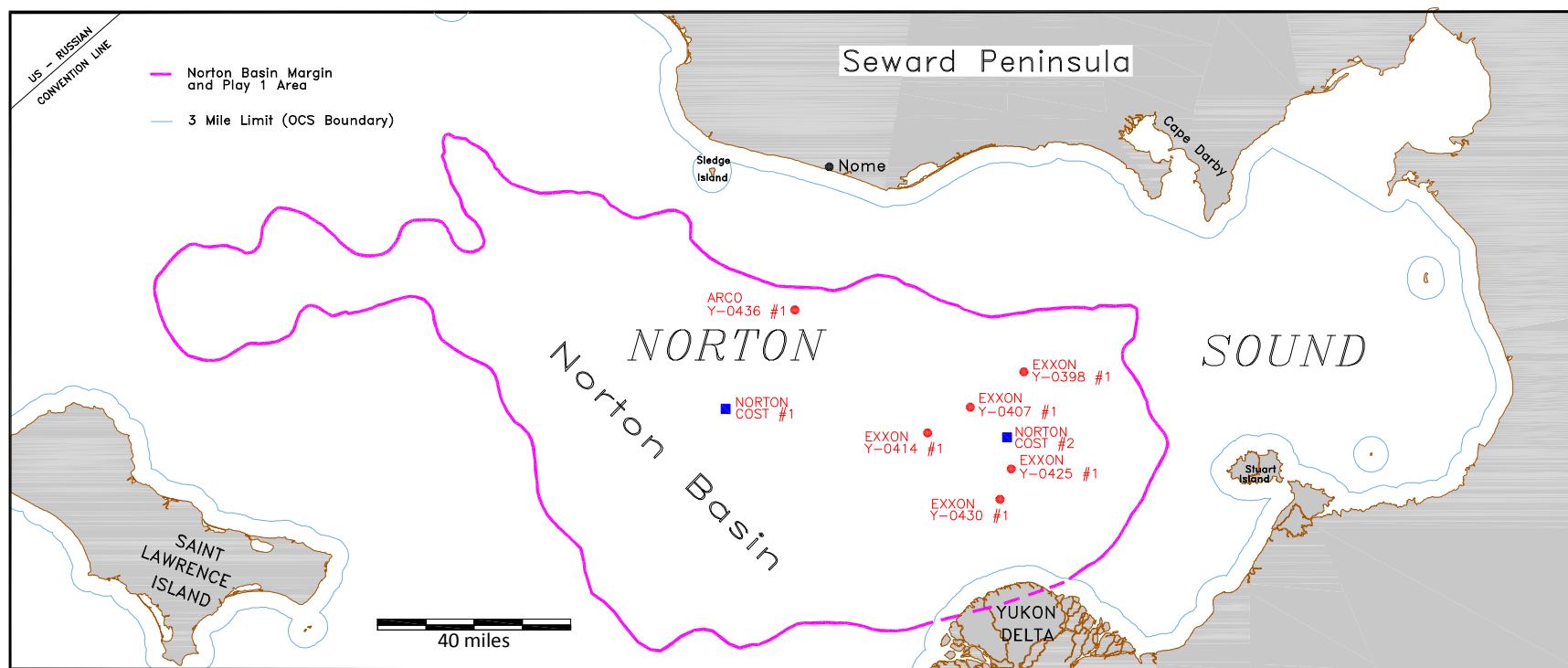


Figure 1. Map of Norton Basin Play 1, the Upper Tertiary Basin Fill play, 2006 assessment, showing the locations of the two COST wells and six exploration wells that penetrated the play. The play occupies the entire Norton basin prospective area. The dashed section in the Yukon delta vicinity lies shoreward of the 3-mile OCS limit and is not included in the Norton basin OCS evaluation.