

Beaufort Sea Play 16: Brookian Foldbelt

Geological Assessment

GRASP UAI: (AAAAABBA)

Play Area: 4,521 square miles

Play Water Depth Range: 5 – 1600 feet

Play Depth Range: 14000 – 25000 feet

Play Exploration Chance: 0.258

Play 16, Brookian Foldbelt, Beaufort 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	3,645	9,647
Total Gas (Tcfg)	0.000	4.161	11.348
Total Liquids (Mmbo)	0	2,905	7,628
Free Gas** (Tcfg)	0.000	3.552	9.743
Solution Gas (Tcfg)	0.000	0.609	1.605
Oil (Mmbo)	0	2,748	7,228
Condensate (Mmbc)	0	157	401

** 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 16, the Brookian Foldbelt, is the Beaufort Sea province's richest play containing 28% of the province's hydrocarbon endowment (3645 Mmbl mean BOE). The overall assessment results for play 16 are shown in [table 1](#). Liquid hydrocarbons likely make up 80% of these resources. [Table 5](#) reports the detailed

assessment results by commodity for play 16.

[Table 3](#) summarizes the volumetric input data developed for the *GRASP* computer model of Beaufort Sea play 16. [Table 4](#) reports the risk model used for play 16. The location of play 16 is shown in [figure 1](#).

Play 16 includes Tertiary Sagavanirktok Formation topset sequences and Cretaceous to Tertiary Canning Formation topset and prodelta sequences complexly structured by both Brooks Range folding and coeval faulting along the hinge line fault system. The hinge line fault zone obliquely intersects the foldbelt within the Brookian Foldbelt play. The large number of mapped closures among these structures accounts in large part to the size of this play. Major offshore structural features in the play include Herschel high, Demarcation subbasin, and Camden anticline. Onshore, the corollary play includes the Marsh Creek anticline and other shallow structures in the coastal plain of the Arctic National Wildlife Refuge (ANWR). Reservoir sandstones are very sparse in the three offshore wells (Belcher, Corona, and Aurora) that tested prospects in this play. However, in Canadian waters, the Natsek well, at the southeast end of the Herschel high encountered reservoir-quality sandstones in Upper Cretaceous and Paleocene rocks. Potential oil sources include the Hue Shale and Canning Formation, which probably underlie many offshore structures in the Foldbelt play. However, wells testing the play penetrated only Tertiary shales with gas-prone kerogen. The dominant recognized trap types include anticlines, faulted anticlines and fault closures. Also

likely are stratigraphic traps occurring in syn- and post-tectonic sediments that fill basins developed between folded uplifts. Late stage structuring may have disrupted some earlier-formed hydrocarbon pools.

Three offshore wells tested the play but failed to find pooled hydrocarbons. Belcher well was drilled on an anticline on the Herschel high and encountered neither sandstones nor hydrocarbon shows. Corona was drilled on the crest of Camden anticline, and encountered only sparse thin sandstones with no hydrocarbon shows. Aurora was drilled on an anticlinal feature adjacent to ANWR. It encountered primarily shales with no hydrocarbon shows in the Brookian sequence.

There is a high level of uncertainty in this play due to the complex structuring of the sequence and the lack of success of wells testing this play. Accordingly risk has been applied to the seal, timing, source, migration, presence of formation, and adequacy of reservoir facies.

A maximum of 49 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 16. These pools range in mean conditional (un-risked) recoverable volumes from 1.6 Mmboe (pool rank 49) to 2,144 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 289 Mmboe (F95) to 6,044 Mmboe (F05). [Table 2](#) shows the conditional sizes of the 10 largest pools in play 16.

Play 16, Brookian Foldbelt, Beaufort 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	289	2144	6044
2	178	795	2287
3	129	437	1106
4	99	289	644
5	79	211	478
6	65	164	317
7	53	132	259
8	44	109	207
9	37	92	175
10	31	78	148

* 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

[Table 6](#) reports statistics for the simulation pools developed in the GRASP computer model for play 16. In the computer simulation, a total of 204,262 “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 (37,191 or 18%) of simulation pools (conditional, technically recoverable BOE resources) for play 16. Pool size class 11 ranges from 32 to 64 Mmboe. The largest pool among the 204,262 simulation pools falls within pool size class 20, which ranges in size from 16,384 to 32,768 Mmboe.

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

Basin: Beaufort
 Play Number: 16
 Play UAI Number: AAAAABBA

Assessor: Johnson/Scherr
 Play Name: Foldbelt

Date: 10/17/2005

Play Area: mi² (million acres) 4521 (2893.2)
 Reservoir Thermal Maturity: % Ro

Play Depth Range: feet 1400 6,200 25000
 Expected Oil Gravity: ° API 30
 Play Water Depth Range: feet 5 160 1600

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	108	1107		3286	7000		14911			44259		95023	200000
Prospect Area (acres)-Model Output													
Fill Fraction (Fraction of Area Filled)	0.1	0.14		0.29	0.5		0.76			0.95		0.99	1
Productive Area of Pool (acres)	13	371	607	1365	3365	0829.725/26345.99	8340	13450	19542	29629			195214
Pay Thickness (feet)	7.0	21.9	26.6	36.9	53.0	61.486/36.492	76.2	92.6	105.6	128.4	160.0	185.3	391.9

MPRO Module (Numbers of Pools)

Play Level Chance	0.8	Prospect Level Chance	0.32256	Exploration Chance	0.258048
-------------------	-----	-----------------------	---------	--------------------	----------

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
	0.8	Adequate Reservoir	
		Adequate Seal	0.9
		Adequate timing	0.7
		Adequate migration	0.8
		Adequate formationi	0.8
		Adequate source	0.8

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	67.00	70.50	72.00	75.00	78.00	79.06/5.43	82.00	84.00	86.00	88.00	90.00	92.00	100.50
Numbers of Pools in Play			0@F79.99	19	24	20.43/10.98	28	30	31	33	35	40	49

Minimum Number of Pools	0	Mean Number of Pools	20.43	Maximum Number of Pools	49
-------------------------	---	----------------------	-------	-------------------------	----

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)	61	133	153	192	248	266.779/106.446	320	367	403	462	539	598	1012
Gas Recovery Factor (Mcfg/acre-foot)	51.0	233.5	304.9	476.4	782.0	1029.210/874.273	1283.7	1674.9	2005.5	2619.3	3537.4	4322.0	7577.0
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	38.0	96.0	112.9	148.0	200.0	221.428/105.929	270.2	317.6	354.3	416.6	500.0	564.7	1051.0
Condensate Yield ((bbl/Mmcfg)	7.60	19.21	22.58	29.61	40.00	44.286/21.197	54.04	63.51	70.85	83.31	99.98	112.90	210.20

Pool Size Distribution Statistics from POOLS (1,000 BOE): μ (mu)= 10.7242928 σ^2 (sigma squared)= 2.54337846 Random Number Generator Seed= 753316

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	0.25
Probability Any Pool is 100% Gas	0		

Table 3. Input data for Beaufort Sea play 16, 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: AAAAAABBA **Play No. 16**

World Level - World Level Resources
 Country Level - UNITED STATES OF AMERICA
 Region Level - MMS - ALASKA REGION
 Basin Level - **BEAUFORT SHELF**
Play Level - 16 - Brookian Foldbelt

Geologist Peter Johnson
 Remarks Play 16 2005 Assessment
 Run Date & Time: Date 19-Sep-05 Time 13:50:28

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	3,645,100	3,187,800
Oil (Mbo)	2,747,900	2,404,900
Condensate (Mbc)	156,910	183,700
Free (Gas Cap & Nonassociated) Gas (Mmcf)	3,552,200	3,853,800
Solution Gas (Mmcf)	608,580	572,920

10000 (Number of Trials in Sample)
 0.8006 (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	423,030	323,000	16,963	394,340	72,504
75	1,551,500	1,182,700	64,481	1,455,800	254,080
70	1,901,600	1,442,300	80,185	1,807,900	323,040
65	2,199,700	1,668,200	92,489	2,089,900	377,510
60	2,496,200	1,884,400	109,220	2,412,900	411,630
55	2,780,700	2,097,300	119,850	2,705,000	462,040
50	3,094,600	2,328,200	132,930	3,039,000	520,990
45	3,431,900	2,588,000	149,830	3,322,300	578,770
40	3,761,000	2,847,800	158,420	3,597,300	644,660
35	4,175,800	3,142,200	172,890	4,123,700	713,210
30	4,634,400	3,524,400	191,280	4,374,400	788,790
25	5,174,400	3,972,900	203,680	4,720,000	888,040
20	5,829,700	4,421,700	254,250	5,524,400	959,400
15	6,628,200	5,045,300	292,690	6,145,600	1,105,200
10	7,687,100	5,787,600	338,150	7,474,500	1,300,400
8	8,309,200	6,277,000	349,150	8,000,900	1,457,800
6	9,105,000	6,923,400	356,720	8,677,600	1,578,100
5	9,647,400	7,227,500	400,710	9,742,600	1,605,400
4	10,319,000	7,600,300	470,170	10,862,000	1,776,200
2	11,967,000	9,216,900	462,930	10,712,000	2,141,900
1	14,392,000	10,639,000	718,640	14,792,000	2,258,800
0.1	21,677,000	16,557,000	766,070	19,750,000	4,722,300
0.01	27,611,000	20,569,000	1,014,300	28,223,000	5,651,800
0.001	29,323,000	13,652,000	1,718,600	75,508,000	2,905,700

Table 5. Assessment results by commodity for Beaufort Sea play 16, 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	9	0.004406	0.0009	0.001124	9	0	0	1	1	0	0	0	0	1	1	0.044175	0.050408	0.440721	48.969034
2	0.0625	0.125	62	0.030353	0.0062	0.007743	62	0	0	1	1	0	0	0	0	1	1	0.069204	0.123969	6.272360	101.167090
3	0.125	0.25	232	0.11358	0.0232	0.028975	232	0	0	1	2	0	0	0	0	1	2	0.128132	0.249921	44.681317	192.591891
4	0.25	0.5	726	0.355426	0.0726	0.090671	726	0	0	1	2	0	0	0	0	1	2	0.250302	0.499632	277.661839	382.454336
5	0.5	1	1279	0.626157	0.1279	0.159735	1279	0	0	1	3	0	0	0	0	1	3	0.503047	0.999797	968.470166	757.208884
6	1	2	2912	1.42562	0.2912	0.363682	2912	0	0	1	4	0	0	0	0	1	4	1.000106	1.999409	4329.656000	1.486832
7	2	4	6593	3.227717	0.6593	0.823405	6593	0	0	1	5	0	0	0	0	1	5	2.002680	3.999896	19958.324000	3.027199
8	4	8	14070	6.888212	1.407	1.757212	14070	0	0	1	8	0	0	0	0	1	8	4.000141	7.999426	84270.582000	5.989380
9	8	16	24498	11.993421	2.4498	3.059573	24498	0	0	1	11	0	0	0	0	1	11	8.001054	15.999746	289031.758000	11.798178
10	16	32	33886	16.589478	3.3886	4.232047	33886	0	0	1	13	0	0	0	0	1	13	16.000549	31.996232	790293.506000	23.322125
11	32	64	37191	18.207499	3.7191	4.644811	37191	0	0	1	16	0	0	0	0	1	16	32.001240	63.998889	1706041.000000	45.872402
12	64	128	33216	16.261469	3.3216	4.14837	33216	0	0	1	12	0	0	0	0	1	12	64.003585	127.998715	3029869.000000	91.217171
13	128	256	23493	11.501405	2.3493	2.934058	23493	0	0	1	11	0	0	0	0	1	11	128.000317	255.944476	4219034.000000	179.586853
14	256	512	12861	6.296325	1.2861	1.60622	12861	0	0	1	8	0	0	0	0	1	8	256.000509	511.757464	4546014.000000	353.472839
15	512	1024	6123	2.997621	0.6123	0.764706	6123	0	0	1	5	0	0	0	0	1	5	512.266397	1023.911000	4350875.000000	710.579041
16	1024	2048	3930	1.924	0.393	0.490821	3930	0	0	1	6	0	0	0	0	1	6	1024.056000	2047.535000	5677951.000000	1.444771
17	2048	4096	2314	1.132859	0.2314	0.288997	2314	0	0	1	4	0	0	0	0	1	4	2050.613000	4094.833000	6552541.000000	2.831695
18	4096	8192	772	0.377946	0.0772	0.096416	772	0	0	1	2	0	0	0	0	1	2	4097.431000	8184.770000	4176552.000000	5.410042
19	8192	16384	89	0.043571	0.0089	0.011115	89	0	0	1	2	0	0	0	0	1	2	8253.772000	14454.114000	887773.353000	9.974981
20	16384	32768	6	0.002937	0.0006	0.000749	6	0	0	1	1	0	0	0	0	1	1	17641.106000	20027.997000	115394.198000	19.232367
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						Below Class	0.000000	0.000000	0.000000	0.000000	
			0	0	0	0	Above Class	0	0	0						Above Class	0.000000	0.000000	0.000000	0.000000	
Totals			204262	99.999992	20.4262	25.510429															

Number of Pools not Classified: 0
Number of Pools below Class 1: 0
Number of Trials with Pools: 8007

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 Beaufort Sea play 16, 2006 assessment.

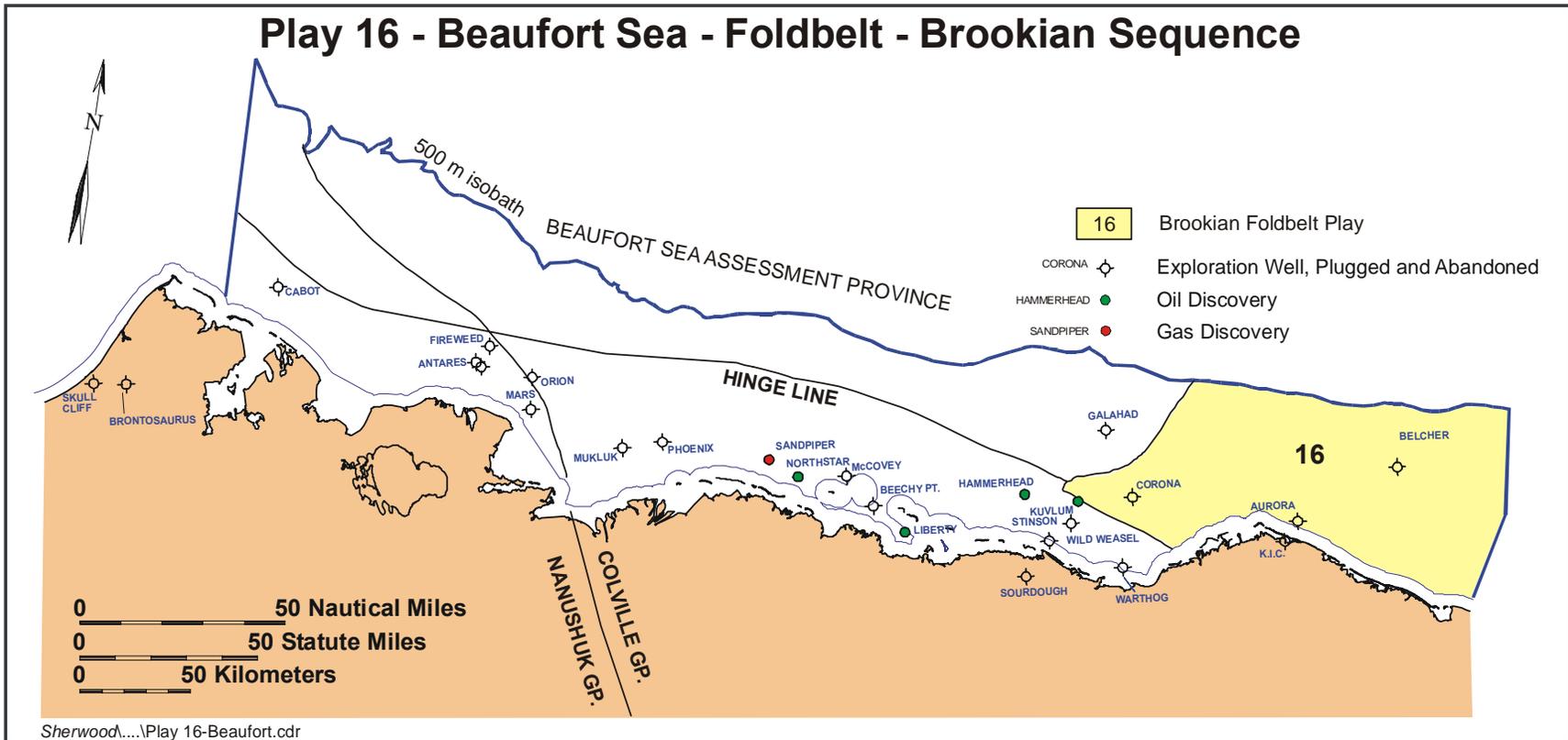


Figure 1. Map location of Beaufort Sea play 16, 2006 assessment.