Beaufort Sea Play 14: Brookian Faulted Eastern Turbidite

Geological Assessment:
GRASP UAI: AAAAABAW
Play Area: 3566 square miles
Play Water Depth Range: 100 - 1600 feet
Play Depth Range: 4800 - 25000 feet
Play Exploration Chance: 0.389

Play 14, Brookian Faulted Eastern Turbidites, 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	941	2,354
Total Gas (Tcfg)	0.000	3.938	9.962
Total Liquids (Mmbo)	0	240	581
Free Gas** (Tcfg)	0.000	3.892	9.842
Solution Gas (Tcfg)	0.000	0.046	0.120
Oil (Mmbo)	0	65	144
Condensate (Mmbc)	0	175	438
* 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 14, the "Brookian Faulted Eastern Turbidite" play, contains 7% of the Beaufort Sea province hydrocarbon endowment (941 Mmbl mean BOE). The overall assessment results for play 14 are shown in table 1. This is primarily a gas play with 74% of the endowment coming from natural gas. Table 5 reports the detailed assessment results by

commodity for play 14.

Table 3 summarizes the volumetric input data developed for the GRASP computer model of Beaufort Sea play 14. Table 4 reports the risk model used for play 14. The location of play 14 is shown in figure 1.

The play includes the Upper Cretaceous and Tertiary prodelta shales and turbidites of the Canning Formation where they lie north of the hinge line fault zone and east of the eastern stratigraphic limit of the Torok Formation. Reservoirs are primarily turbidite sandstones in a submarine fan environment. The primary source rocks are expected to be gas-prone shales of the Canning Formation. There is also a potential for hydrocarbon generation from Beaufortian (or "Rift") sequence source rocks that underlie the Brookian play sequence. These Beaufortian sources are likely to be buried to below the base of the oil window and are most likely fully expended with respect to oil. As such, the adequacy of the source is the primary play risk. The presence of closure, adequate seal and presence of reservoir facies are risk factors at the prospect level. Prospects in the play are both stratigraphic traps related to sand mounds within the marine shale sequences, and fault traps against listric growth faults. No wells have tested the play.

A maximum of 40 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 14. These pools range in mean conditional (un-risked) recoverable volumes from 0.7 Mmboe (pool rank 40) to 531 Mmboe (pool rank 1). Pool rank 1 ranges in possible

conditional recoverable volumes from 75 Mmboe (F95) to 1,705 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 14.

Play 14, Brookian Faulted Eastern Turbidites, 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	75	531	1705
2	44	188	486
3	31	107	251
4	22	72	172
5	17	52	112
6	13	40	83
7	10	31	66
8	7	25	53
9	5	20	43
10	4	16	35
* 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 14. In the computer simulation for the play, a total of 160,849 "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 (28,534, or 18%) of simulation pools (conditional, technically recoverable BOE resources) for play 14.   Pool size class 10 ranges from 16 to 32 Mmboe. The largest pool among the 160,849 simulation pools falls within pool size class 18, which ranges in size from 4,096 to 8,192 Mmboe.

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

Basin: Beaufort   **Assessor**:   Johnson/Scherr   **Date**:   10/17/2005
Play Number: 14   **Play Name**:   Brookian Faulted Eastern Turbidite
Play UAI Number: AAAAABAW

Play Area: mi^2 (million acres)   3566 (2282.5)   **Play Depth Range**: feet   4800   14,000   25000
Reservoir Thermal Maturity: % Ro   **Expected Oil Gravity**: ^{O} API   30
                                 Play Water Depth Range: feet   100   500   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	69	676		1972	4150		8734			25477		54034	80000
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)	7	226	368	818	1992	2402.975/10942.08	4907	7812	11156	17025			77576
Pay Thickness (feet)	7	22	27	37	53	61.486/36.492	76	93	106	128	160	185	392

MPRO Module (Numbers of Pools)

Play Level Chance	0.9		Prospect Level Chance	0.432		Exploration Chance	0.3888

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
	0.9	Adequate Source	
		Presence of Closure	0.8
		Adequate Seal	0.9
		Presence of Reservoir Facies	0.6

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	31.0	34.0	36.0	39.5	44.0	41.37/4.88	48.5	51.0	53.0	56.0	59.0	61.0	62.0
Numbers of Pools in Play			0	14	17	16.09/6.47	20	22	23	24	26	31	40

Minimum Number of Pools	0		Mean Number of Pools	16.09		Maximum Number of Pools	40

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)	29	73	85	111	149	164.292/76.833	200	234	261	306	366	412	756
Gas Recovery Factor (Mcfg/acre-foot)	128	331	391	517	704	783.779/386.437	959	1132	1266	1495	1803	2043	3867
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	68	229	283	404	600	715.843/ 470.258	891	1102	1272	1574	2000	2347	5309
Condensate Yield ((bbl/Mmcfg)	8	19	23	30	40	44.286/21.197	54	64	71	83	100	113	210

Pool Size Distribution Statistics from *POOLS* (1,000 BOE):	μ (mu)= 9.72306362 σ^2 (sigma squared)= 2.49378207	Random Number Generator Seed= 341020

BOE Conversion Factor (cf/bbl)	5620	Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.1
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	0.9		

Table 3. Input data for Beaufort Sea play 14, 2006 assessment.

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Risk Analysis Form - 2006 National Assessment

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Assessment Province: Beaufort	**Play Number, Name:** 14, Brookian Faulted Eastern Turbidite
Assessor(s): Johnson/Scherr	**Play UAI:** AAAAABAW
Date: 20-Oct-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 Factors	**Averge Conditional Prospect Chance[1]**
1. Hydrocarbon Fill component (1a * 1b * 1c)	**1**	*0.9000*	*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 rock of adequate quality located in the drainage area of the reservoirs.	1a	0.90	1.00
b. Effective Expulsion and Migration			
Probability of effective expulsion and migration of hydrocarbons from the source rock to the reservoirs.	1b	1.00	1.00
c. Preservation			
Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	1.00	1.00
2. Reservoir component (2a * 2b)	**2**	*1.0000*	*0.6000*
a. Presence of reservoir facies			
Probability of presence of reservoir facies with a minimum net thickness and net/gross ratio (as specified in the resource assessment).	2a	1.00	0.60
b. Reservoir quality			
Probability of effectiveness of the reservoir, with respect to minimum effective porosity, and permeability (as specified in the resource assessment).	2b		
3. Trap component (3a * 3b)	**3**	*1.0000*	*0.7200*
a. Presence of trap			
Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	1.00	0.80
b. Effective seal mechanism			
Probability of effective seal mechanism for the trap.	3b	1.00	0.90

Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)	*0.9000*	
(1 * 2 * 3) *Product of All Subjective Play Chance Factors*		
Average Conditional Prospect Chance[1]		*0.4320*
(1 * 2 * 3) *Product of All Subjective Conditional Prospect Chance Factors*		
[1] **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	*0.3888*	
(Product of Overall Play Chance and Average Conditional Prospect Chance)		

Comments: *See guidance document for explanation of the Risk Analysis Form*

Table 4. Risk model for Beaufort Sea play 14, 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: AAAAABAW			**Play No.**		**14**		
World	Level	-	World	Level	Resources		
Country	Level	-	UNITED	STATES	OF	AMERICA	
Region	Level	-	MMS	-	ALASKA	REGION	
Basin	Level	-	**BEAUFORT**	**SHELF**			
Play	**Level**	**-**	**Play**		**14 Brookian**	**Faulted**	
Geologist	Peter	Johnson			**Eastern**	**Turbidite**	
Remarks	Play	14	2005 Assessment				
Run Date & Time:	Date	19-Sep-05	Time	13:50:03			

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	940,700	750,190
Oil (Mbo)	65,278	147,010
Condensate (Mbc)	174,740	159,250
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	3,891,800	3,170,800
Solution Gas (Mmcfg)	45,971	124,990

10000 (Number of Trials in Sample)
0.9002 (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	73,382	5,946	13,125	301,020	4,208
85	321,610	21,501	58,053	1,347,000	13,370
80	401,630	27,493	70,862	1,685,100	19,313
75	468,700	34,307	86,059	1,936,900	20,751
70	528,370	36,131	98,439	2,190,400	22,809
65	585,610	30,163	108,000	2,494,700	19,981
60	653,300	54,077	116,000	2,680,400	35,281
55	717,880	43,687	135,350	2,997,400	30,915
50	787,110	52,667	143,290	3,284,300	37,993
45	857,840	51,393	159,390	3,600,800	35,644
40	934,680	65,957	172,760	3,858,000	53,352
35	1,022,700	70,744	190,140	4,226,500	54,990
30	1,129,600	83,048	209,750	4,647,500	55,390
25	1,248,900	107,160	225,960	5,076,100	70,722
20	1,398,400	83,553	261,010	5,836,600	86,037
15	1,580,500	115,870	286,430	6,541,900	79,608
10	1,850,300	119,930	342,730	7,710,100	88,461
8	2,019,300	120,590	369,140	8,520,300	75,912
6	2,235,500	127,650	450,600	9,216,500	97,452
5	2,353,800	143,660	437,580	9,841,500	120,320
4	2,505,400	176,820	480,210	10,278,000	109,810
2	3,028,500	168,600	608,560	12,531,000	121,560
1	3,578,700	151,130	780,390	14,775,000	102,550
0.1	5,578,200	67,419	1,091,900	24,799,000	34,944
0.01	8,680,200	4,472	1,240,600	41,781,000	4,059
0.001	9,359,600	41,792	1,310,700	44,975,000	24,963

Table 5. Assessment results by commodity for Beaufort Sea play 14, 2006 assessment.

Basin: BEAUFORT SHELF
Play 14 - Brookian Faulted Eastern Turbidite
UAI Key: AAAAABAW

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	151	0.093877	0.0151	0.016772	10	0	141	1	1	0	0	1	2	1	2	0.032468	0.061680	7.252698	48.031114
2	0.0625	0.125	286	0.177807	0.0286	0.031767	23	0	263	1	1	0	0	1	2	1	2	0.062509	0.124727	26.835340	93.829863
3	0.125	0.25	752	0.467519	0.0752	0.083528	48	0	704	1	1	0	0	1	3	1	4	0.125670	0.249479	142.984752	190.139294
4	0.25	0.5	1483	0.921983	0.1483	0.164723	103	0	1380	1	2	0	0	1	3	1	4	0.250474	0.499881	557.277685	375.777274
5	0.5	1	3293	2.047262	0.3293	0.365767	290	0	3003	1	2	0	0	1	4	1	4	0.500258	0.999739	2493.059000	757.078469
6	1	2	7202	4.477491	0.7202	0.799956	585	0	6617	1	2	0	0	1	6	1	6	1.000175	1.999990	10800.812000	1.499696
7	2	4	14432	8.97239	1.4432	1.603021	1417	0	13015	1	3	0	0	1	8	1	8	2.000060	3.999325	42875.324000	2.970851
8	4	8	22927	14.253741	2.2927	2.546596	2075	0	20852	1	4	0	0	1	9	1	11	4.000080	7.999219	135245.198000	5.898949
9	8	16	28261	17.569895	2.8261	3.139065	2880	0	25381	1	3	0	0	1	12	1	13	8.000295	15.998715	327593.728000	11.591724
10	16	32	28534	17.739618	2.8534	3.169388	2947	0	25587	1	4	0	0	1	11	1	11	16.000131	31.997966	653922.659000	22.917315
11	32	64	23416	14.557753	2.3416	2.600911	2482	0	20934	1	4	0	0	1	9	1	10	32.001224	63.996367	1059628.000000	45.252285
12	64	128	14808	9.20615	1.4808	1.644785	1508	0	13300	1	4	0	0	1	7	1	8	64.000501	127.996417	1326106.000000	89.553322
13	128	256	8040	4.998477	0.804	0.893036	819	0	7221	1	2	0	0	1	7	1	7	128.005629	255.911981	1431960.000000	178.104416
14	256	512	4229	2.629174	0.4229	0.469732	416	0	3813	1	2	0	0	1	4	1	4	256.030659	511.712402	1497629.000000	354.133240
15	512	1024	2149	1.336036	0.2149	0.238698	270	0	1879	1	2	0	0	1	4	1	4	512.256965	1023.379000	1520281.000000	707.436401
16	1024	2048	715	0.444516	0.0715	0.079418	72	0	643	1	1	0	0	1	3	1	3	1024.187000	2041.486000	977124.595000	1.366608
17	2048	4096	146	0.090768	0.0146	0.016217	8	0	138	1	1	0	0	1	1	1	1	2048.878000	4065.404000	386322.309000	2.646043
18	4096	8192	5	0.003109	0.0005	0.000555	0	0	5	0	0	0	0	1	1	1	1	5577.908000	7696.148000	34244.260000	6.848852
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			20	0.012434	0.002	0.002221	Below Class → 0	0	20									Below Class → 0.011742	0.030683	0.500157	25.007863
Totals			160849	100	16.0849	17.866158	Above Class → 0	0	0									Above Class → 0.000000	0.000000	0.000000	0.000000

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 not Classified: 20
Number of Pools below Class 1: 20
Number of Trials with Pools: 9003

Table 6. Statistics for simulation pools created in computer sampling run for Beaufort Sea play 14, 2006 assessment.
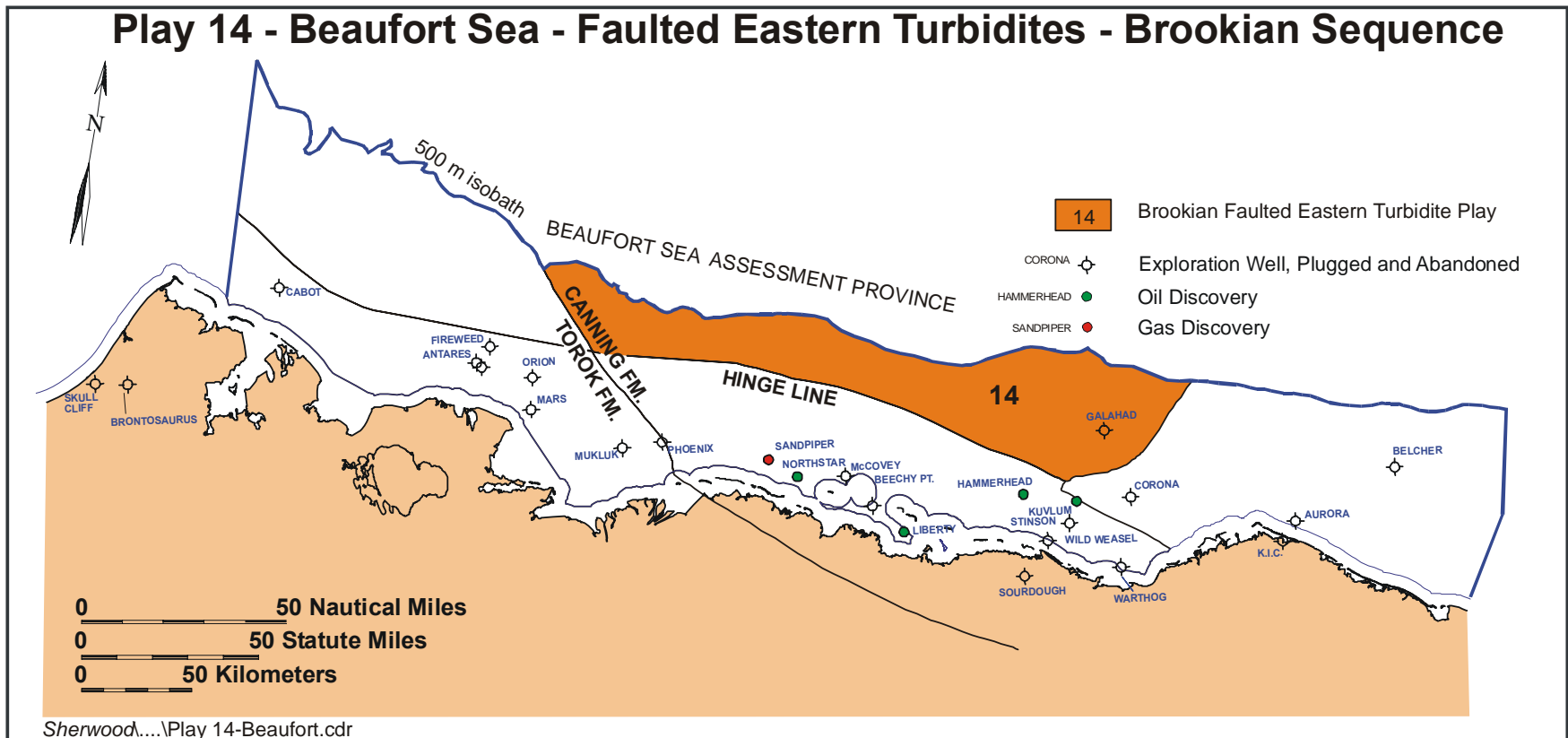
Figure 1. Map location of Beaufort Sea play 14, 2006 assessment.