Kodiak Shelf Play 1: Neogene Structural Play

Geological Assessment

GRASP UAI: AAAAA MAB
Play Area: 55,200 square miles
Play Water Depth Range: 100 - 600 feet; Mean: 255 feet
Play Depth Range: 3,000 - 12,000 feet; Mean: 5200 feet
Play Exploration Chance: 0.08

Play 1, Neogene-Structural, Kodiak 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	375	1,551
Total Gas (Tcfg)	0.000	1.840	7.618
Total Liquids (Mmbo)	0	48	196
Free Gas** (Tcfg)	0.000	1.840	7.618
Solution Gas (Tcfg)	0.000	0.000	0.000
Oil (Mmbo)	0	0	0
Condensate (Mmbc)	0	48	196

** 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 1, the Kodiak Shelf "Neogene Structural" play, is the only play in the Kodiak Shelf OCS Planning Area, and thus contains all of the Kodiak Shelf Planning Area energy endowment (375 Mmboe, or 2.1 Tcf gas equivalent). Rocks underlying the Neogene section are too altered or too structurally deformed to be considered as prospective oil and gas reservoirs.

The extent of play 1, which occupies nearly the entire Kodiak shelf, is shown in figure 1. The play encompasses the shelf and most of the upper slope, but the most prospective areas are structurally controlled Neogene depocenters on the shelf where Miocene and younger strata reach maximum thicknesses. A seismically mapped rock sequence offshore, referred to as seismic sequence C, is analogous to the Neogene stratigraphic section onshore on Kodiak Island and is the basis for the definition of prospects in play 1. A generalized illustration of the onshore stratigraphic section and corresponding offshore seismic sequences of the play area is shown in figure 2.

The overall assessment results for play 1 are shown in table 1. The principal resource is predicted to be dry gas, with minor amounts of condensate. Gas constitutes 87% of the resource (1.84 Tcf), while gas condensate constitutes 13% (48 Mmboe, or 0.27 Tcfge). Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of play 1. Table 4 reports the risk analysis model used for the play. Table 5 reports the detailed assessment results by commodity for play 1.

The primary reservoir objectives for the play are shallow marine turbidite-related sandstone units in the Neogene section (Turner and others, 1987), sealed by alternating Neogene shale intervals. Traps primarily include thrust-faulted and normal-faulted anticlines formed by Neogene tectonism, along with possible turbidite channel sands and stratigraphic pinchouts. Relatively quartz-rich sandstones of mostly middle Miocene age form the potential

reservoir rocks for the play.

Play 1 is charged by Eocene source rocks of seismic sequence B that have reached maturity deeply buried beneath the Kodiak shelf Neogene depocenters. The woody-herbaceous nature of the organic material in samples collected from this source interval in the Kodiak KSSD COST wells (fig. 1) suggests that it is markedly gas-prone and that the hydrocarbon endowment is largely thermogenic dry gas. R_o values from the Eocene interval in the COST wells are 0.4 to 0.5, and TAI's are 2 ½ to 3 + (Turner and others, 1987). A secondary potential gas source for the play is biogenic gas formed within woody-herbaceous, organic-bearing intervals in the less-deeply buried parts of the Neogene sequence itself. This would be similar to the sourcing of the gas that is produced in upper Cook Inlet. Gas shows were present in two separate intervals in the early to middle Miocene section of the KSSD-2 COST well (Turner and others, 1987).

The three major risk factors identified for play 1 (tbl. 4) relate to:
1) Probability of effective expulsion - Eocene source rocks appear to be somewhat indurated, with relatively low porosity and core permeabilities, generally averaging under 0.1 millidarcies;
2) Probability of an efficient source rock - The TOC of Kodiak COST well Eocene source rock samples is low to moderate, generally averaging between 0.5 and 0.6 %);
3) Reservoir Quality - Well log permeability of reservoir sands is low to moderate, averaging 1.8 millidarcies in the Miocene section and 6.3 millidarcies in the Pliocene section of the KSSD-3 well (Turner and others, 1987).

Lesser risk factors (tbl. 4) include:
Probable presence of effective reservoir - Neogene reservoir sand intervals appear to be largely turbidite related; reservoir turbidite sand packages may be distal, thin, or discontinuous;
Trap - Possibility of insufficient size or volume.

Play 1, Neogene Structural Play, Kodiak 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	72	387	1218
2	41	164	376
3	28	102	227
4	19	72	168
5	14	54	119
6	10	42	94
7	7	34	76
8	5	27	62
9	4	23	52
10	3	19	45

** 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 50 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 1. These 50 pools range in mean conditional (un-risked) recoverable volumes from 0.8 Mmboe, or .0044 Tcfge (pool rank 50) to 387 Mmboe, or 2.2 Tcfge (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 72 Mmboe, or 0.4 Tcfge (F95) to 1218 Mmboe, or 6.8 Tcfge (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 1.

In the computer simulation for play 1, a total

of 70,485 “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 (12,781, or 18%) 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 17, which ranges in size from 2,048 to 4,096 Mmboe. Table 6 reports statistics for the simulation pools developed in the *GRASP* computer model for play 1.

REFERENCES CITED

Turner, R.F. (ed.), Lynch, M.B., Conner, T.A., Hallin, P.J., Hoose, P.J., Martin, G.C., Olson, D.L., Larson, J.A., Flett, T.O., Sherwood, K.W., and Adams, A.J., 1987, Geological and operational summary, Kodiak shelf stratigraphic test wells, Alaska: U.S. Minerals Management Service OCS Report MMS 87-0109, 341 p.

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

Basin: Kodiak Shelf
Play Number: 1
Play UAI Number: AAAAAMAB

Assessor: J. Larson
Play Name: Neogene Structural Play

Date: 31 March, 2005

Play Area (mi^2, millions of acres): 55,200 mi^2, 35.382 million acres
Reservoir Thermal Maturity, % Ro: 0.3 - 0.7

Play Depth Range, feet: 3,000 - 5,200 - 12,000
Expected Oil Gravity, ^{o} API: Gas Play / Condensate
Play Water Depth Range, feet: 105 - 255 - 600 +
Prospect Distance from Shore, miles: 10 - 36 - 110

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	288				5470	~~~							63360
Prospect Area (acres)-Model Output	288	1485	1981	3205	5470	7489 / 7003	9336	12439	15106	20148	27860	34580	63360
Fill Fraction (Fraction of Area Filled)	0.1	0.144	0.169	0.222	0.3	0.33139 / 0.15552	0.405	0.476	0.531	0.625	0.75	0.847	1
Productive Area of Pool (acres)	115	468	720	1478	3290	6422.66 / 8999.00	7321	11247	15041	23142	37585	51930	63360
Pay Thickness (feet)	9	32	40	59	90	109.508 / 73.792	138	173	202	255	330	392	480

MPRO Module (Numbers of Pools)

Play Level Chance	0.4

Prospect Level Chance	0.2

Exploration Chance	0.08

Risk Model

Play Chance	Petroleum System Factors	Prospect Chance
0.5	Probability of effective source rock expulsion (indurated source rock)	
	Probability of an efficient source rock (low TOC)	0.4
	Presence of reservoir (cores show limited permeability)	0.55
0.8	Effective reservoir (Turbidite sands - irreg. distribution, thickness, etc.)	
	Trap definition (Possibility of limited size, volume)	0.9

Fractile	F100	F95	F90	F75	F50	Mean / Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	38	56	62	72	85	88.11 / 22.16	101	110	117	129	143	153	156
Numbers of Pools in Play				(F40=0)	(F35=11)	7.05 / 9.38	15	19	21	24	28	31	50

Minimum Number of Pools	0

Mean Number of Pools	7.05

Maximum Number of Pools	50

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)	N/A												
Gas Recovery Factor (Mcfg/acre-foot)	32	115	143	206	310	371.216 / 239.131	466	580	673	838	1074	1266	1600
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	N/A												
Condensate Yield ((bbl/Mmcfg)	6	13	14	18	24	25.979 / 10.837	31	36	40	46	54	60	110

Pool Size Distribution Statistics from *POOLS* (1,000 BOE): **μ (mu)** = 9.83222358 **σ^2 (sigma squared) =** 2.16263109

Random Number Generator Seed = 204796

BOE Conversion Factor (cf/bbl)	5620
Probability Any Pool is 100% Oil	0
Probability Any Pool is 100% Gas	1

Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0
Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	N/A

Table 3. Input data for Kodiak play 1, 2006 assessment.

Risk Analysis Form - 2005 National Assessment

Assessment Province:	Kodiak Shelf	**Play Number, Name:**	Play 1 - Neogene Structural Play
Assessor(s):	J Larson	**Play UAI:**	AAAAAMAB
Date:	17 March 2005 / 13 Oct 2005		

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**	***0.5000***	***0.4000***
	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	0.50	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	0.40
	c. Preservation			
	Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	1.00	1.00
2.	**Reservoir component** (2a * 2b)	**2**	***0.8000***	***0.5500***
	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	0.80	1.00
	b.			
	Probability of effectiveness of the reservoir, with respect to minimum effective porosity, and permeability (as specified in the resource assessment).	2b	1.00	0.55
3.	**Trap component** (3a * 3b)	**3**	***1.0000***	***0.9000***
	a. Presence of trap			
	Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	1.00	0.90
	b. Effective seal mechanism			
	Probability of effective seal mechanism for the trap.	3b	1.00	1.00
	Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)		***0.4000***	
	(1 * 2 * 3) *Product of All Subjective Play Chance Factors*			
	Average Conditional Prospect Chance[1]			***0.1980***
	(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		***0.0792***	
	(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 Kodiak shelf 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:	**AAAAAMAB**		**Play No.**		**1**		
World	Level	-	World	Level		Resources	
Country	Level	-	UNITED	STATES		OF	AMERICA
Region	Level	-	MMS	-		ALASKA	REGION
Basin	Level	-	**KODIAK**	**SHELF**			
Play	**Level**	**-**	**Play**		**1**	**Neogene Structural Play (Kodiak)**	
Geologist	Larson						
Remarks	Neogene	Structural	Play		1		
Run Date & Time:		Date	19-Sep-05	Time		14:05:05	

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	375,460	589,100
Oil (Mbo)	0	0
Condensate (Mbc)	48,037	77,304
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	1,840,100	2,886,500
Solution Gas (Mmcfg)	0	0

10000 (Number of Trials in Sample)

0.3999 (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	53,712	0	6,834	263,460	0
35	376,300	0	46,669	1,852,500	0
30	526,960	0	66,546	2,587,500	0
25	668,530	0	84,812	3,280,500	0
20	817,830	0	101,810	4,024,000	0
15	989,770	0	125,880	4,855,100	0
10	1,201,100	0	153,140	5,889,400	0
8	1,303,800	0	168,710	6,379,100	0
6	1,458,400	0	186,180	7,150,100	0
5	1,551,100	0	195,620	7,617,900	0
4	1,662,200	0	212,680	8,146,200	0
2	2,067,200	0	272,810	10,084,000	0
1	2,472,500	0	318,090	12,108,000	0
0.1	3,747,000	0	680,240	17,235,000	0
0.01	4,401,300	0	581,350	21,468,000	0
0.001	4,819,700	0	667,650	23,335,000	0

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

Basin: KODIAK SHELF
Play 01 - Neogene Structural Play (Kodiak)
UAI Key: AAAAAMAB

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	1	0.001419	0.0001	0.00025		0	0	1	0	0	0	0	1	1	1	1		0.051231	0.051231	0.051231	51.230546
2	0.0625	0.125	8	0.01135	0.0008	0.002		0	0	8	0	0	0	0	1	1	1	1		0.083859	0.115805	0.836745	104.593180
3	0.125	0.25	78	0.110662	0.0078	0.0195		0	0	78	0	0	0	0	1	2	1	2		0.125480	0.249778	16.149382	207.043365
4	0.25	0.5	380	0.539122	0.038	0.095		0	0	380	0	0	0	0	1	2	1	2		0.250537	0.499766	147.555804	388.304740
5	0.5	1	1242	1.762077	0.1242	0.3105		0	0	1242	0	0	0	0	1	4	1	4		0.501412	0.999441	941.180595	757.794380
6	1	2	2909	4.127119	0.2909	0.72725		0	0	2909	0	0	0	0	1	6	1	6		1.000086	1.999927	4351.117000	1.495743
7	2	4	5945	8.434419	0.5945	1.48625		0	0	5945	0	0	0	0	1	9	1	9		2.000223	3.999429	17678.161000	2.973618
8	4	8	9291	13.181528	0.9291	2.32275		0	0	9291	0	0	0	0	1	10	1	10		4.000392	7.999983	54475.284000	5.863232
9	8	16	12402	17.595234	1.2402	3.1005		0	0	12402	0	0	0	0	1	12	1	12		8.000183	15.999546	144192.854000	11.626581
10	16	32	12781	18.132936	1.2781	3.19525		0	0	12781	0	0	0	0	1	12	1	12		16.000925	31.999137	294145.338000	23.014267
11	32	64	10975	15.570689	1.0975	2.74375		0	0	10975	0	0	0	0	1	13	1	13		32.000001	63.999025	497820.757000	45.359524
12	64	128	7597	10.77818	0.7597	1.89925		0	0	7597	0	0	0	0	1	8	1	8		64.011294	127.995915	681606.554000	89.720490
13	128	256	4239	6.014046	0.4239	1.05975		0	0	4239	0	0	0	0	1	6	1	6		128.005708	255.946526	753551.451000	177.766327
14	256	512	1851	2.626091	0.1851	0.46275		0	0	1851	0	0	0	0	1	4	1	4		256.117067	511.623526	640003.410000	345.760895
15	512	1024	631	0.895226	0.0631	0.15775		0	0	631	0	0	0	0	1	3	1	3		512.451422	1019.027000	436852.661000	692.317993
16	1024	2048	131	0.185855	0.0131	0.03275		0	0	131	0	0	0	0	1	2	1	2		1030.793000	2024.017000	172796.812000	1.319060
17	2048	4096	24	0.03405	0.0024	0.006		0	0	24	0	0	0	0	1	1	1	1		2090.343000	2828.156000	56053.507000	2.335563
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									Below Class	0.000000	0.000000	0.000000	0.000000
		Totals	**70485**	**100**	**7.0485**	**17.621248**	Above Class	0	0	0									Above Class	0.000000	0.000000	0.000000	0.000000

Number of Pools not Classified: 0
Number of Pools below Class 1: 0
Number of Trials with Pools: 4000

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 Kodiak play 1, 2006 assessment.

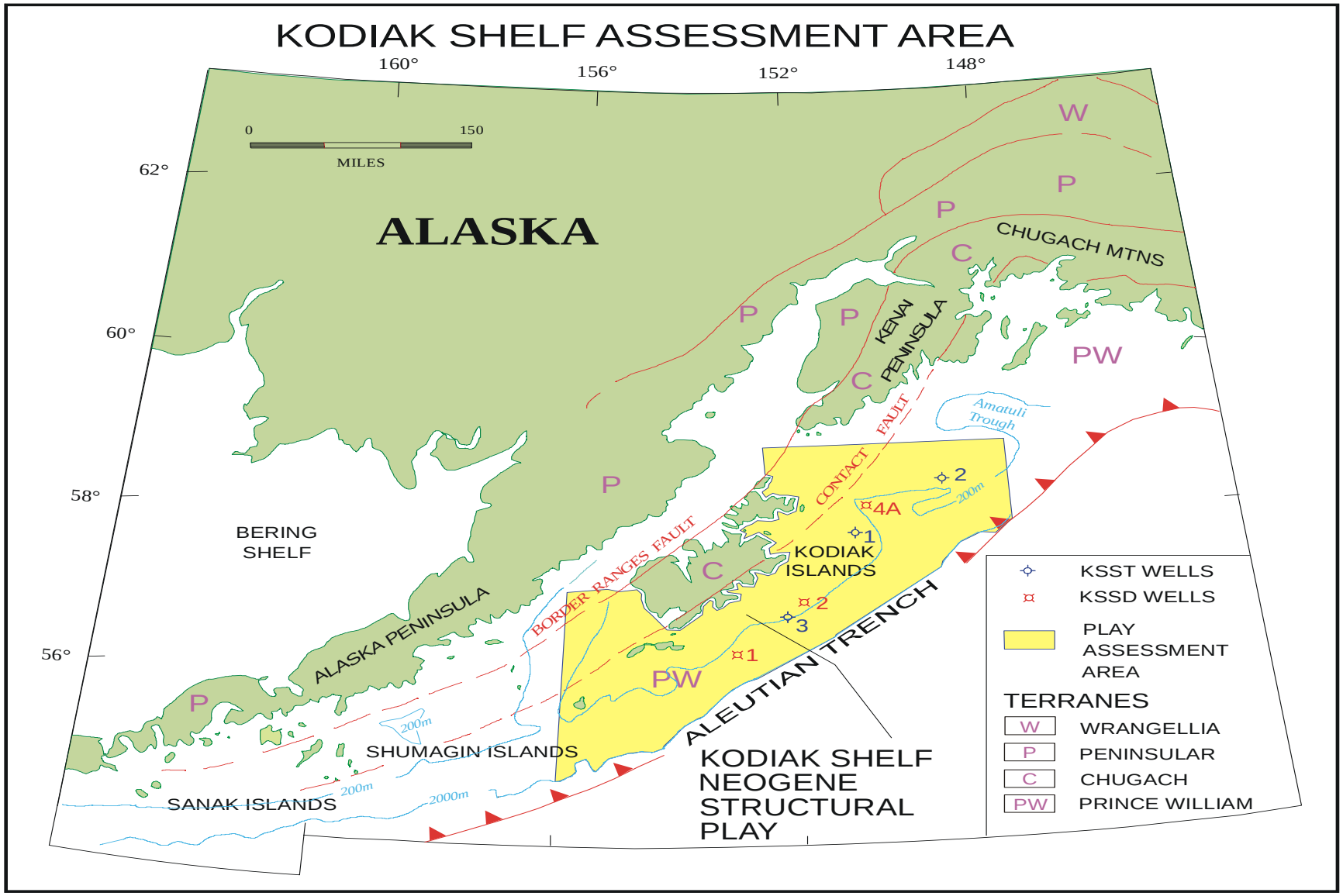

Figure 1. Map showing the location of Shumagin shelf play 1, the Neogene Structural play. Assessment of the area is based largely on onshore geologic data, data from 6 COST wells (3 KSST wells and 3 KSSD wells) drilled offshore of Kodiak Island in 1975 and 1976, and the delineation of three major seismic stratigraphic intervals in the Kodiak and Shumagin Shelf offshore areas.

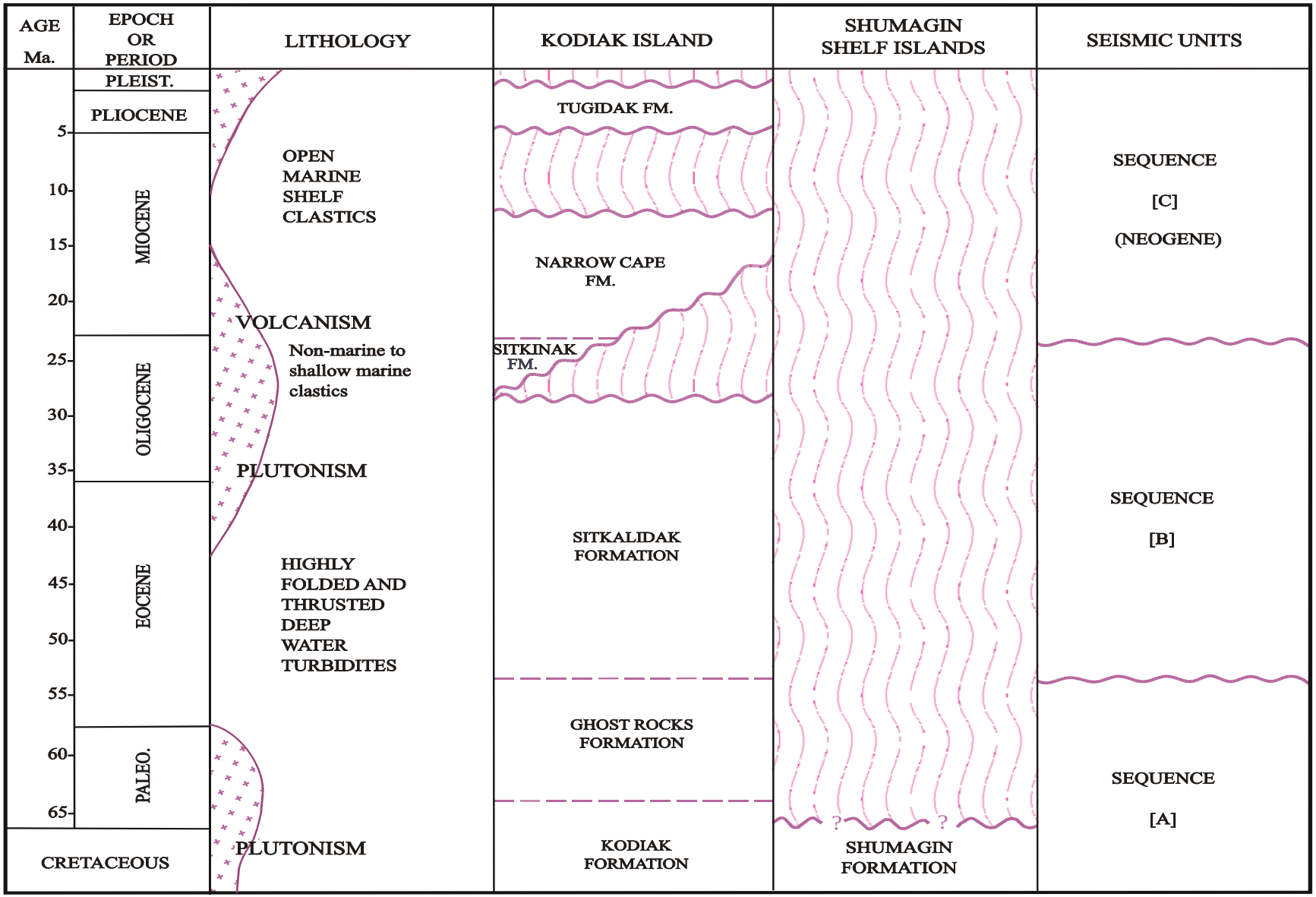

Figure 2. Diagram correlating onshore geologic events and stratigraphy with correlative offshore seismic sequences. All the estimated technically recoverable OCS hydrocarbon resource in the Shumagin shelf area is expected to be found in Neogene sandstone units of seismic sequence C.