Gulf of Alaska Planning Area (Alaska) – Province Summary

2006 Oil and Gas Assessment

Location

The Gulf of Alaska Planning Area is located offshore southern Alaska, as shown in figure 1. The Gulf of Alaska shelf assessment province includes an 850-mile-long segment of the Alaska continental margin from near the southwest tip of the Kenai Peninsula on the west to Dixon Entrance at the U.S.-Canadian border on the southeast (fig. 2). It encompasses the outer continental shelf (OCS) and extends from the three-mile limit seaward to approximately the 1000-meter isobath. The continental shelf ranges in width from less than 15 miles adjacent to Baranof Island in the southeast to more than 60 miles near Middleton Island in the west.

Leasing and Exploration

Exploration in the Gulf of Alaska province began northwest of Kayak Island in 1901, with 44 wells eventually drilled in the Katalla oil field and nearby areas by 1932. The shallow wells were drilled around surface oil seeps. They produced high-quality oil at low flow-rates from a fractured-rock reservoir. Production in the Katalla district yielded only about 154,000 barrels of oil before production stopped in l933. Over the next 30 years, 23 additional exploratory wells were drilled onshore in the area extending from north of Kayak Island to about 60 miles southeast of Yakutat Bay (fig. 3). One well was drilled in 1927 and 22 others between 1954 and 1963. None yielded producible quantities of hydrocarbons.

Tenneco Oil Company drilled the first offshore exploratory well in State of Alaska waters near Middleton Island in 1969 (fig. 3). An industry consortium drilled a stratigraphic test (COST[1]) well in the Gulf of Alaska province midway between Kayak Island and Icy Bay in 1975. The first offshore lease sale in Federal waters anywhere in Alaska, Gulf of Alaska Lease Sale 39, was held in April of 1976. That sale resulted in 76 leases being awarded for a total of $559,836,587. In October of 1980, Lease Sale 55 resulted in 35 leases being awarded for a total of $109,571,073. In June of 1981, a reoffering sale, RS-1, resulted in one lease awarded for $170,496.

Eleven exploratory wells were drilled in Federal waters following the OCS lease sales. Ten of the wells were completed between Kayak Island and Icy Bay (fig. 3) in 1977 and 1978. Exploration of the Gulf of Alaska shelf finally concluded with the drilling of the ARCO Y-0211 Yakutat No.1 well offshore south of Yakutat Bay in 1983. None of the offshore wells encountered significant quantities of pooled hydrocarbons. There are no leases currently active or lease sales scheduled for the Gulf of Alaska Planning Area.

Geologic Setting of the Gulf of Alaska

The Gulf of Alaska shelf assessment province includes three major tectonostratigraphic terranes or composite terranes (Jones and others, 1987; Nokleberg and others, 1994; Plafker and others, 1989). From northwest to southeast, these are the Chugach/Prince William composite terrane, the Yakutat terrane, and the Wrangellia/Alexander composite terrane

[1] *Continental Offshore Stratigraphic Test*

(fig. 2). The terranes all lie adjacent to the northwestwardly-moving Pacific plate and are separated from it on their seaward margins by the Aleutian subduction zone, the Transition fault, and the Fairweather-Queen Charlotte fault. The tectonic style of the Gulf of Alaska continental margin ranges from convergent in the northwest, to oblique subduction in the central area, and to transform in the southeast.

The Chugach/Prince William composite terrane is a large accretionary complex that extends northwestward from the modern Aleutian subduction zone (fig. 2). The northwestern part of the Gulf of Alaska Planning Area overlies the accretionary complex and the Cenozoic strata there are deformed by convergent tectonics. The Kayak zone is a northeastward extension of this subduction zone from the deep-water Aleutian Trench onto the continental shelf. The Kayak zone is a crustal suture between the accretionary complex of the Chugach/Prince William composite terrane and the recently arrived Yakutat terrane. It is a zone of intense structural deformation and crustal foreshortening.

TheYakutat terrane is underthrusting the Chugach/Prince William composite terrane in an oblique manner along its northern and western margins (Plafker, 1987). The strata of the Yakutat terrane are deformed by northeast-trending thrust faults and tightly-folded anticlines from the Kayak zone to the Pamplona zone (fig. 2). Eastward from the Pamplona zone, Cenozoic rocks of the Yakutat terrane are much less deformed by crustal shortening. Folds in the eastern part of the Yakutat terrane are broad and gently dipping.

The southeastern segment of the Gulf of Alaska shelf is a transform margin landward of the Fairweather-Queen Charlotte fault, which is an active, right-lateral strike-slip fault (fig. 2). The shelf is very narrow in the southeast and Cenozoic strata there overlie the Wrangellia/Alexander composite terrane.

The Gulf of Alaska shelf assessment province is dominated by a very thick wedge of Tertiary-age rocks deposited on the Gulf of Alaska continental margin. The Tertiary strata overlie “basement” complexes composed of older rocks of the various terranes identified in figure 2. All of the undiscovered oil and gas resources of the Gulf of Alaska assessment province are associated with the Tertiary strata. Regional stratigraphic relationships of the Tertiary rocks are schematically illustrated in the stratigraphic panel of figure 4. Additional information for the geology of the Gulf of Alaska shelf may be found in Plafker and others (1978), Bruns and Carlson (1987), Plafker (1987), and Risley and others (1992).

Potential Traps

The structural fabric in the northwestern part of the Gulf of Alaska assessment province is dominated by convergent tectonics. Potential hydrocarbon traps are anticlines associated with thrust faults and high-angle reverse faults. On the Middleton Island shelf area, west of the Kayak zone (fig. 2), the structures trend west to southwest and the closures are on the northern, upthrown sides of the faults.

The structural fabric of the Yakutat shelf from the Kayak zone eastward to the Pamplona zone is dominated by oblique subduction. The area is intensely folded and faulted and the structures generally trend northeast-southwest. The closures are on the northwestern, upthrown sides of the reverse faults. Combination structural-stratigraphic traps may be present on the flanks of many of the structures.

East of the Pamplona zone, the Yakutat shelf is much less deformed than to the west, and the structures tend to be broad, low-relief anticlines. The closures are more likely to be associated with drape over

Paleogene basement highs rather than with Neogene faulting. Stratigraphic pinch-out traps are probably present, but their locations are difficult to predict with existing data.

The southeastern Gulf of Alaska shelf is a transform margin and potential traps are most likely associated with wrench faults. Transpressional folds along wrench-fault zones are probably the dominant trapping mechanism.

Reservoir Formations

Potential reservoir rocks throughout the Gulf of Alaska are confined to the Tertiary section. Figure 4 is a schematic cross-section across the northern Gulf of Alaska that illustrates the stratigraphic relationship of the potential reservoir units, both in a lateral and vertical sense. Sandstones in the basal part of the Yakataga Formation had marginal reservoir-rock quality properties in the Middleton Island well. Porosity and permeability values in Yakataga Formation sandstones were better in wells to the east between the Kayak zone and the Pamplona zone (Risley and others, 1992).

The Poul Creek Formation of Late Eocene to Middle Miocene age may have sandstones with adequate reservoir qualities` in local areas. The underlying Kulthieth Formation of Eocene age had sandstones with better reservoir-rock properties present in the ARCO Y-0211 (Yakutat No. 1) well. Sandstones were present in this well in the Kulthieth section, with thicknesses of 50 to 150 feet, porosities greater than 20 percent, and permeabilities of 10 to 20 millidarcies (Risley and others, 1992).

Petroleum Source Rock Potential

The source rock potential of the Gulf of Alaska Continental Shelf varies from the northwest to the southeast. The northwestern Middleton Island shelf area overlies the accretionary rocks of the Prince William terrane. Potential source rocks in that area appear to be gas prone, low in total organic carbon (TOC), and thermally immature to marginally mature for the most part. That assessment is based on data from the Tenneco Middleton Island State No. 1 well and correlation to six COST wells on the Kodiak shelf to the south (Turner and others, 1987). Two potential source rock sequences occur in this area: 1) thermally-immature to marginally-mature Oligocene to Miocene strata equivalent to the Sitkinak Formation of Kodiak Island; and 2) thermally mature Eocene strata equivalent to the Sitkalidak Formation of Kodiak Island (fig. 4).

The area east of the Kayak zone for approximately 135 miles along the northern Gulf of Alaska overlies the Yakutat terrane, where oil-prone source rocks are known to be present (Plafker, 1987). About 70 oil seeps occur onshore, including those at the abandoned Katalla oil field north of Kayak Island (fig. 2). According to Van Kooten and Short (2006), the seeps along the westernmost part of this area are sourced by marine organic shale of the Poul Creek Formation. The seeps along the easternmost part of this area are sourced by oil-prone coals of the Kulthieth Formation. Minor oil-shows were reported offshore in the ARCO Y-0211 (Yakutat No. 1) well.

The source rock potential in the southeastern Gulf of Alaska shelf area is unknown as there are no well data. The nearest outcrops on Prince of Wales Island (fig. 2) are crystalline rocks of the Alexander terrane, which have no source-rock potential. The nearest stratigraphic analog to the Tertiary age basin on the shelf is in the Queen Charlotte basin of British Columbia, where Miocene age, gas-prone siltstones occur (Bustin, 1997). Based on well and outcrop data there, the best source rocks in the southeastern Gulf of Alaska shelf are assumed to generate biogenic

methane, analogous to the Cook Inlet Tertiary province.

Oil and Gas Resources of the Gulf of Alaska

The Gulf of Alaska assessment province is divided into six geologic plays that reflect the tectonic and stratigraphic histories of the diverse tectonic terranes that underlie the Gulf of Alaska shelf. These plays are: (1) the Middleton fold and thrust belt; (2) the Yakataga fold and thrust belt; (3) the Yakutat shelf - basal Yakataga Formation; (4) the Yakutat shelf - Kulthieth sands; (5) the Southeast Alaska shelf subbasin; and (6) the Subducting terrane. All of the known potential source rocks and reservoir rocks in these plays are Tertiary in age. Data used to characterize and model the Gulf of Alaska shelf plays are tabulated in the play summaries.

All six plays were quantitatively assessed using the *GRASP* computer model. Table 1 summarizes the 2006 assessment results by commodity for the Gulf of Alaska, with detailed results by commodity reported in table 4. Table 3 lists the risked, undiscovered technically recoverable oil and gas resources by commodity for the 4 individual plays. Table 2 shows the conditional sizes of the 10 largest pools in the Gulf of Alaska assessment province. Gulf of Alaska assessment results are shown graphically in figure 5.

The 2006 oil and gas assessment of the Gulf of Alaska forecast resources of 627 Mmb of oil and condensate and 4.65 Tcf of gas (mean, risked, technically recoverable resources). At mean values, gas comprises 57 percent of the resource endowment of the Gulf of Alaska. Oil and condensate resources range up to 2,040 Mmb and gas resources range up to 16.003 Tcf at fractile F05 (5% chance).

Gulf of Alaska 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	1,454	4,887
Total Gas (Tcfg)	0.000	4.650	16.003
Total Liquids (Mmbo)	0	627	2,040
Free Gas** (Tcfg)	0.000	4.167	14.442
Solution Gas (Tcfg)	0.000	0.483	1.560
Oil (Mmbo)	0	449	1,440
Condensate (Mmbc)	0	178	600

** 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

The six plays in the Gulf of Alaska are estimated to contain a maximum of 139 pools. The majority of these are mixed pools (oil and gas). The exceptions are in play 1, which has 90 percent gas pools, and play 5, which contains all gas pools. The largest pool in the Gulf of Alaska, which is in play 4, contains a mean conditional resource of 612 Mmboe, with a maximum (F05) conditional resource of 2,072 Mmboe. The largest gas pool, which is in play 1, contains a mean conditional resource of 0.832 Tcfg (148 Mmboe), with a maximum (F05) conditional resource of 2.956 Tcfg (526 Mmboe). Only six of the pools in the Gulf of Alaska have mean conditional resources exceeding 100 Mmboe (or 0.562 Tcfge).

Gulf of Alaska OCS Planning Area, Alaska, 2006 Assessment, Conditional BOE Sizes of Ten Largest Pools				
Assessment Results as of November 2005				
Pool Rank	Play Number	BOE Resources * (Mmboe)		
		F95	Mean	F05
1	4	54	612	2072
2	2	26	282	929
3	3	24	211	806
4	4	25	155	405
5	1	9	148	526
6	6	9	137	402
7	2	10	88	257
8	5	19	87	215
9	4	13	84	227
10	3	11	66	168
** 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

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Links to Summaries for Individual Plays and Appended Items

2006 Assessment Results for Gulf of Alaska OCS Planning Area

Risked, Undiscovered, Technically Recoverable Oil and Gas Resources, as of November 2005

		BOE Resources (Mmbo)			Oil Resources (Mmbo)			Gas-Condensate Liquid Resources (Mmbo)			Free* Gas Resources (Tcfg)			Solution Gas Resources (Tcfg)			Total Liquid Resources (Mmbo)			Total Gas Resources (Tcfg)		
Play Number	Play Name	F95	Mean	F05	F95	Mean	F05	F95	Mean	F05	F95	Mean	F05	F95	Mean	F05	F95	Mean	F05	F95	Mean	F05
1	Middleton Fold and Thrust Belt	0	87	367	0	1	6	0	12	50	0.000	0.411	1.743	0.000	0.002	0.007	0	13	55	0.000	0.412	1.750
2	Yakataga Fold and Thrust Belt	0	258	961	0	88	317	0	34	129	0.000	0.651	2.496	0.000	0.109	0.398	0	122	446	0.000	0.760	2.894
3	Yakutat Shelf-Basal Yakataga Formation	0	221	752	0	86	287	0	27	92	0.000	0.513	1.786	0.000	0.093	0.311	0	113	379	0.000	0.606	2.097
4	Yakutat Shelf-Kulthieth Sands	0	646	1,956	0	209	599	0	91	283	0.000	1.729	5.424	0.000	0.214	0.610	0	300	882	0.000	1.943	6.035
5	Southeast Alaska Shelf Subbasin	0	109	379	0	0	0	0	0	0	0.000	0.614	2.128	0.000	0.000	0.000	0	0	0	0.000	0.614	2.128
6	Subducting Terrane	0	134	473	0	64	231	0	13	46	0.000	0.250	0.865	0.000	0.066	0.233	0	78	277	0.000	0.315	1.098
Sum of All Plays**		**0**	**1,454**	**4,887**	**0**	**449**	**1,440**	**0**	**178**	**600**	**0.000**	**4.167**	**14.442**	**0.000**	**0.483**	**1.560**	**0**	**627**	**2,040**	**0.000**	**4.650**	**16.003**

** Free gas, occurring as gas caps associated with oil and as oil-free gas pools (non-associated gas).*

*** Values as reported out of Basin Level Analysis-Geologic Scenario aggregation module in GRASP, "Volume Ordered" aggregation option. Total liquids and total gas values were obtained by summing resource values for means and fractiles of component commodities. Play resource values are rounded and may not sum to totals reported from basin aggregation.*

BOE, total energy, in millions of barrels (5,620 cubic feet of gas per barrel of oil, energy-equivalent); Mmbo, millions of barrels of oil or liquids; Tcfg, trillions of cubic feet of natural gas

Table 3. Summary of Gulf of Alaska province summary assessment results for ultimate technically recoverable resources (UTRR), by play, 2006 assessment.

Province Resources - Technically Recoverable, Risked, By Product

Geological Resources Assessment Program-GRASP-Version 8.29.2005

The	Current	UAI	AAAAAE			
	is	for				
World	Level	-	World	Level	Resources	
Country	Level	-	UNITED	STATES	OF	AMERICA
Region	Level	-	MMS	-	ALASKA	REGION
Basin	**Level**	**-**	**GULF**	**OF**	**ALASKA**	

Basin Level Aggregation of Risked, Technically Recoverable Resources By Product (Province Aggregation ".out" file)

Volume Ordered (Play Aggregation Method)
RandomSeed = 347348
Number of Trials = 10000

Greater Than Percentage	BOE (Mboe)	Oil (Mbo)	Condensate (Mbc)	Solution Gas (Mmcfg)	Free (Gas Cap & Nonassociated) Gas (Mmcfg)
99	0	0	0	0	0
98	0	0	0	0	0
97	0	0	0	0	0
96	0	0	0	0	0
95	0	0	0	0	0
90	0	0	0	0	0
85	0	0	0	0	0
80	11,361.12	4,376.98	1,401.02	4,261.23	27,115.88
75	143,508.52	49,533.80	19,367.87	52,328.94	366,961.59
70	232,798.99	83,502.89	30,505.47	84,081.76	583,521.55
65	316,469.99	114,163.52	41,059.67	113,355.40	792,851.59
60	454,913.61	165,115.48	59,225.57	171,317.97	1,124,499.82
55	663,739.09	229,363.77	81,063.76	237,568.52	1,748,042.49
50	836,713.78	286,322.91	98,847.48	304,006.78	2,233,667.09
45	1,033,079.90	336,690.07	123,557.23	362,925.93	2,856,393.30
40	1,238,141.30	394,517.16	146,101.41	426,240.21	3,493,837.58
35	1,458,713.51	460,350.25	172,876.85	498,476.46	4,140,757.18
30	1,704,117.74	532,420.48	200,719.90	561,088.77	4,895,803.95
25	2,006,660.96	630,705.59	236,803.44	666,709.68	5,735,324.17
20	2,369,505.87	732,506.56	279,921.59	800,202.52	6,826,574.25
15	2,847,532.34	854,302.54	344,288.15	930,171.17	8,336,880.87
10	3,568,191.73	1,087,020.96	431,833.97	1,155,660.61	10,361,612.21
5	4,887,131.12	1,439,689.15	600,017.11	1,560,249.15	14,442,278.58
4	5,362,561.58	1,627,241.04	657,482.21	1,741,255.05	15,556,196.37
3	6,107,706.60	1,855,153.05	751,924.59	2,024,435.40	17,649,099.36
2	7,246,543.31	2,150,899.68	905,589.60	2,360,514.16	21,187,589.46
1	9,535,857.63	2,786,793.21	1,223,715.73	3,028,941.35	28,023,518.31
Mean	1,453,979.07	448,968.75	177,674.61	482,833.36	4,166,793.30
Rep	1,453,822.43	443,173.26	182,862.34	485,301.19	4,166,860.80
Min	0	0	0	0	0
Max	42,345,591.04	9,219,634.77	6,481,695.53	9,664,616.76	140,076,128.85

Table 4. Detailed report of ultimate technically recoverable resources (UTRR) by commodity, as reported in province aggregation file by *GRASP* computer model, 2006 assessment.

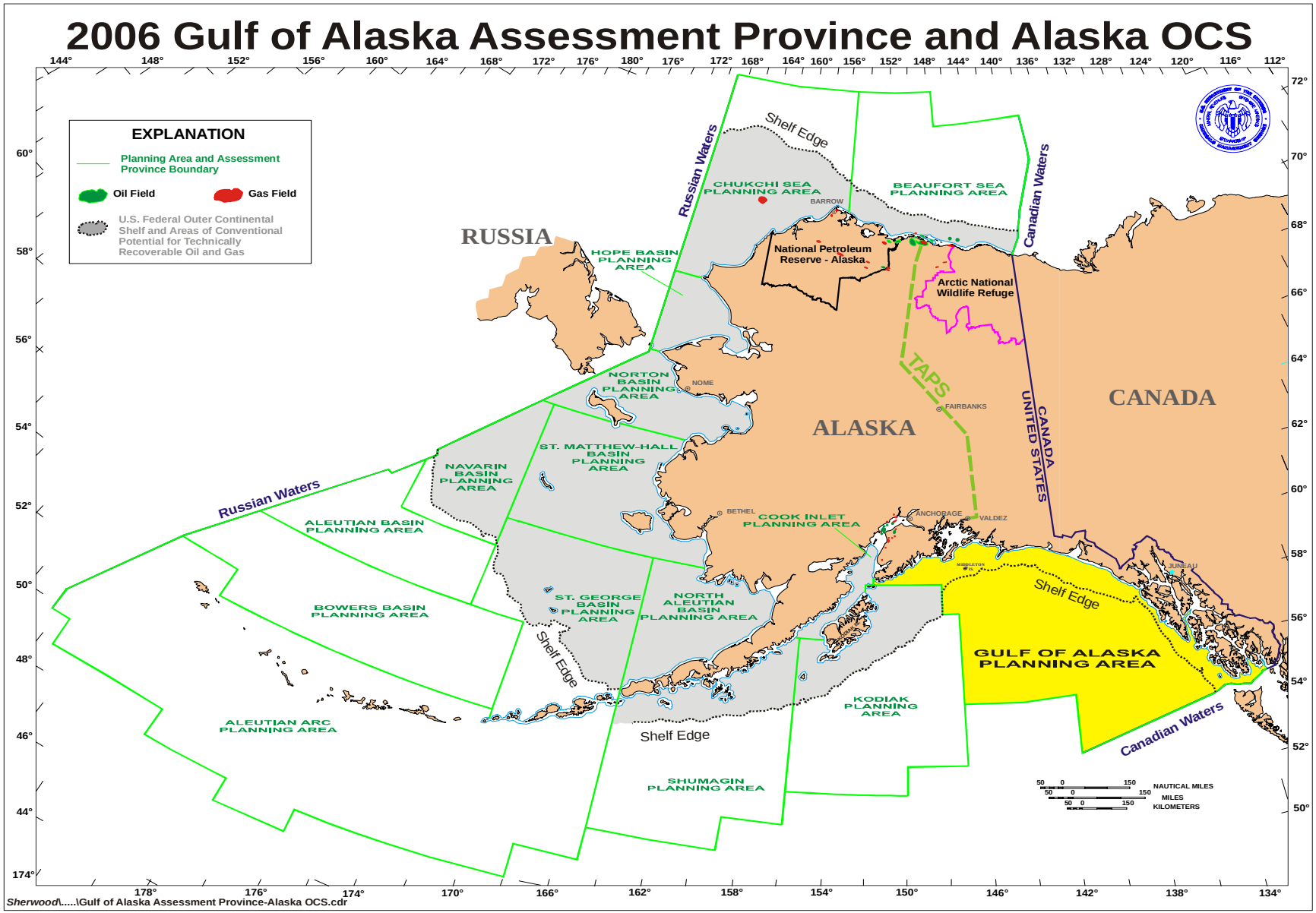

Figure 1. Location of Gulf of Alaska Planning Area and 2006 assessment province.

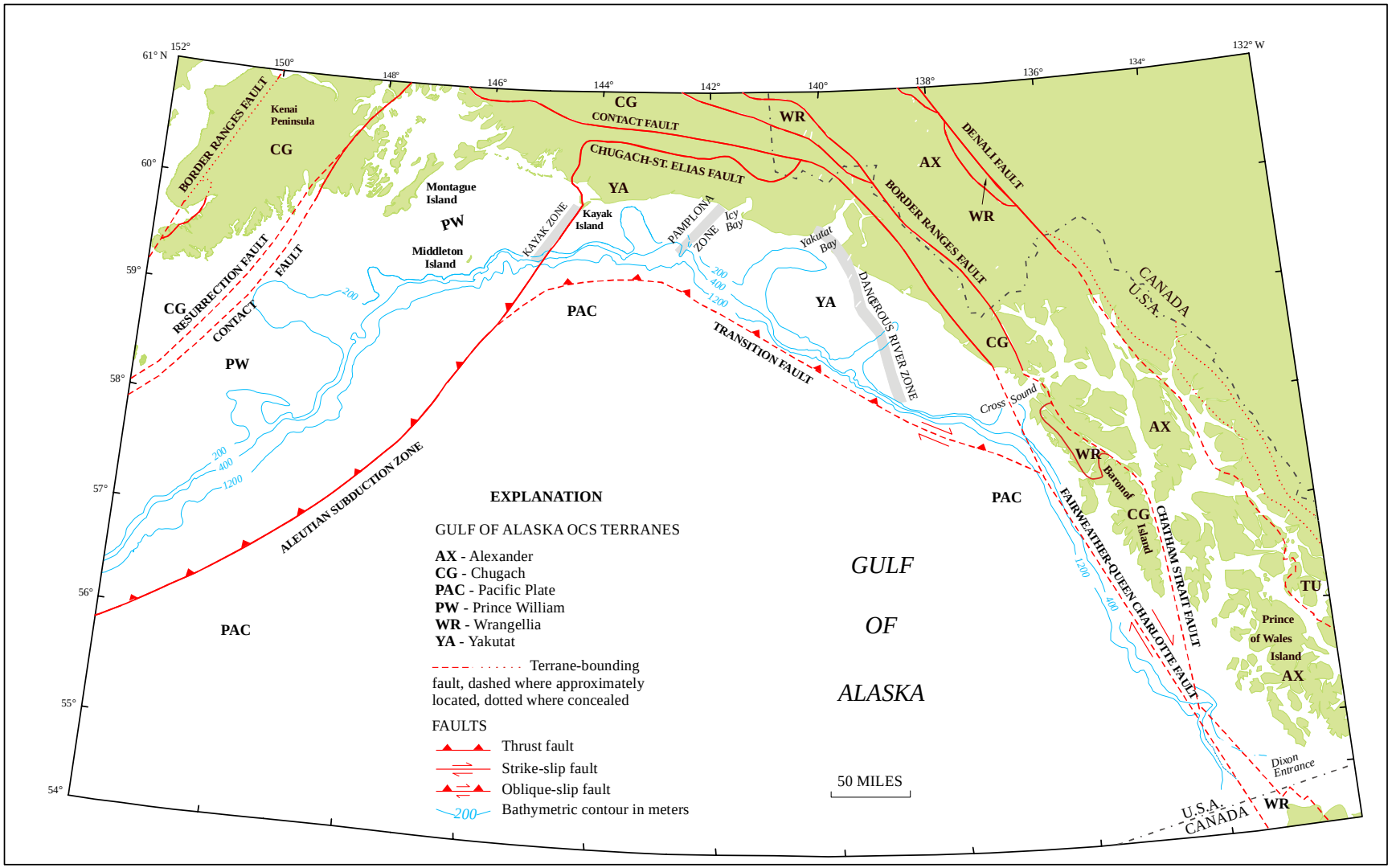

Figure 2. Map showing the geologic framework of the northern Gulf of Alaska region, including major faults, selected physiographic features, and tectonostratigraphic terranes and their boundaries.

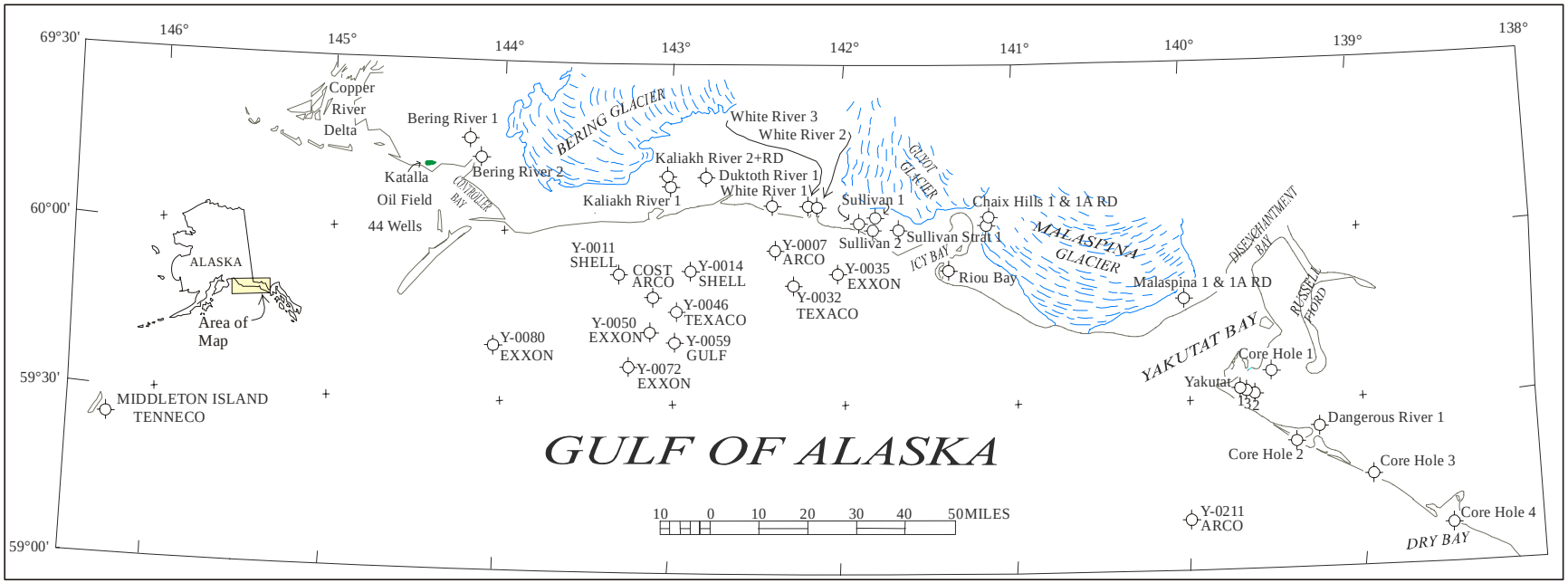

Figure 3. Map showing the location of exploratory wells in the northern Gulf of Alaska and the adjacent coastal plain.

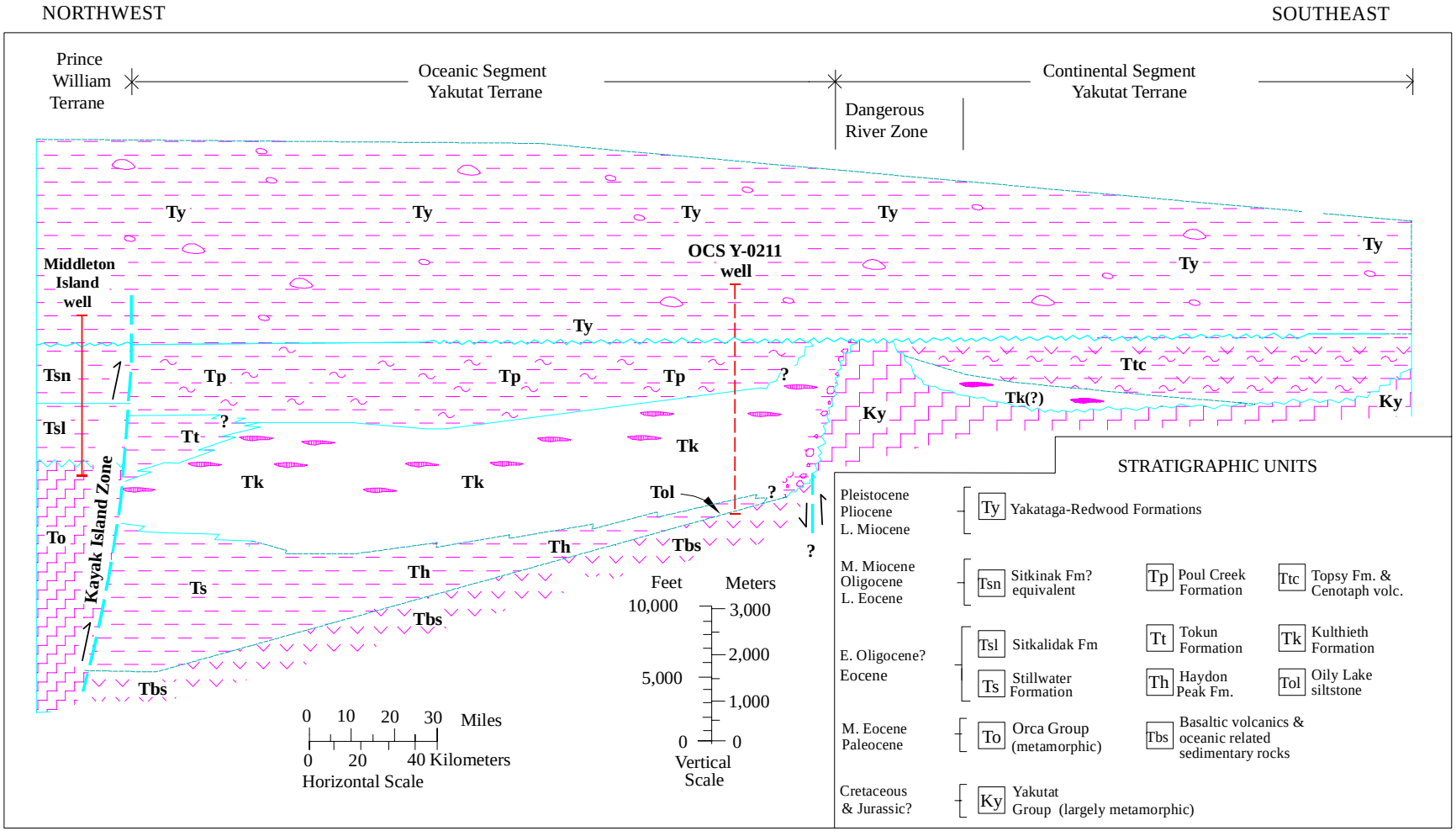

Figure 4. Diagrammatic stratigraphic section of the northern Gulf of Alaska coastal margin. The Yakutat terrane is divided along the Dangerous River zone into areas of oceanic basement on the northwest and areas of continental basement on the southeast. Vertical exaggeration is approximately 17. Diagram modified from Plafker and others (1978).

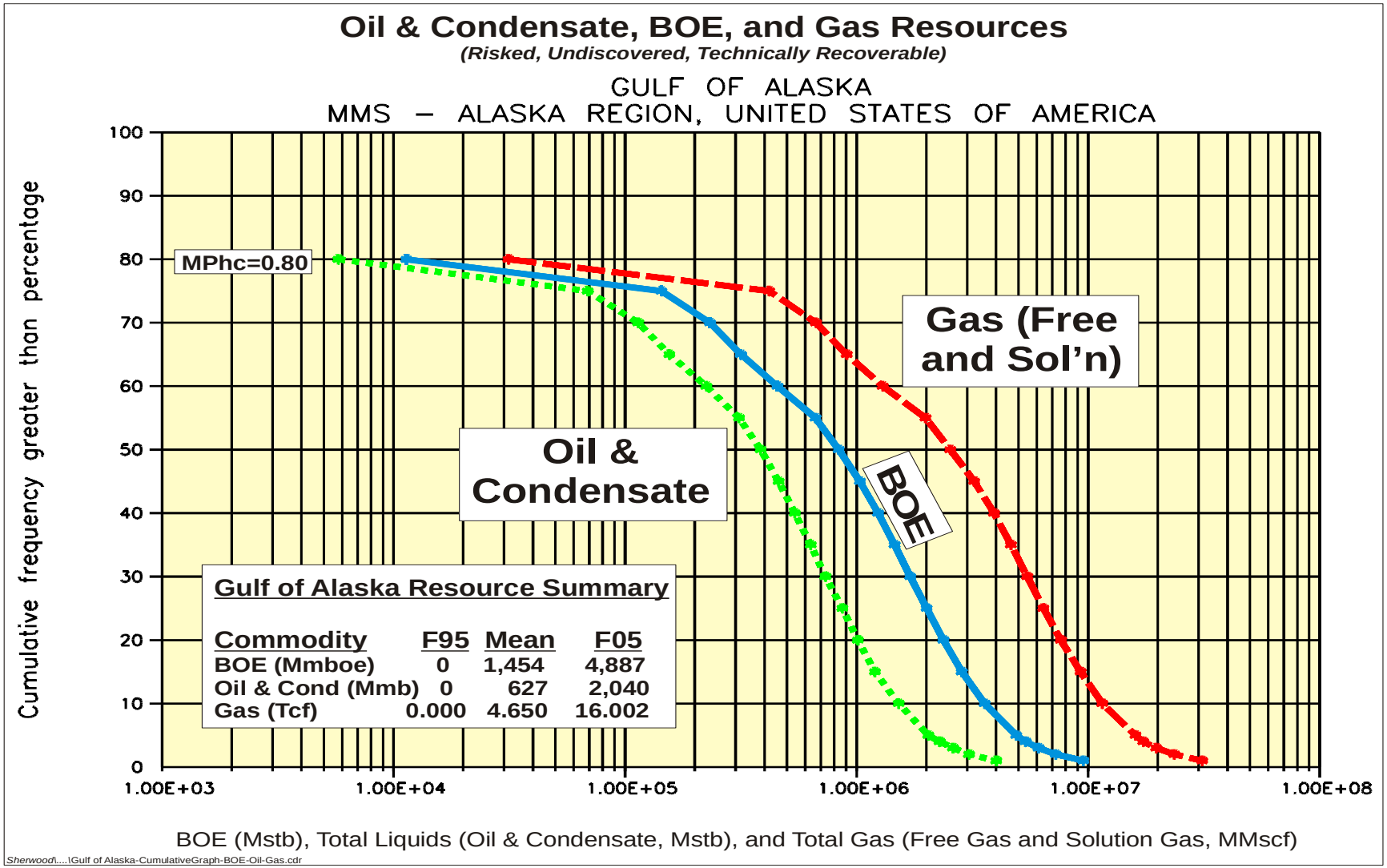

Figure 5. Cumulative probability plot for undiscovered, technically recoverable oil and gas resources for the Gulf of Alaska Planning Area and assessment province, 2006 assessment.