Hope Basin Planning Area (Alaska) – Province Summary

2006 Oil and Gas Assessment

Location

The Hope Basin Planning Area (and assessment province) lies in the southern Chukchi Sea south of Point Hope (68°20' N. Lat.) between the northwest coast of Alaska and the U.S. - Russia maritime boundary, as shown in figure 1. It includes portions of both Hope and Kotzebue basins, separated within the planning area by Kotzebue arch (fig. 2A). The planning area includes the easternmost part of the larger Hope basin that extends 300 miles west into Russian waters. The planning area includes offshore parts of Kotzebue basin, which extends eastward beneath State of Alaska lands.

Leasing and Exploration

The Hope Basin Planning Area was offered as part of a "special interest" leasing program in the 2002-2007 Five Year OCS Program. The special interest program invited industry selection of specific lands that would subsequently be "licensed" through a competitive bidding process. Industry did not express any interest in obtaining exploration rights in the Hope Basin Planning Area. The special interest program was terminated in 2005. Separately, the part of Hope basin north of Pt. Hope (fig. 2A) was offered in Chukchi Sea Planning Area lease sales in 1988 and 1991, but attracted no bids.

Exploratory drilling within Hope and Kotzebue basins consists of two onshore wells, Cape Espenberg 1 and Nimiuk Point 1, drilled on State of Alaska lands on the south and north flanks, respectively, of Kotzebue basin in 1975 (located in fig. 2A). These wells penetrated Tertiary sediments with no oil or gas shows. Seismic data has been collected over most of the Hope basin assessment province, ranging from an approximate 3X5 mile grid north of Pt. Hope to an irregular web of lines 5 to 15 miles apart in Kotzebue basin (Zerwick, 1998). Seismic sequences analogous to the major stratigraphic sequences penetrated by the Kotzebue basin wells were correlated across Kotzebue arch and into Hope basin on the basis of seismic character and position. Our model for the age, lithology and hydrocarbon potential of Hope basin is therefore drawn from speculative correlations through seismic data to the Kotzebue basin wells. We have also utilized stratigraphic information from drilling in the entirely separate but analogous Norton basin 200 miles to the south.

Geological Setting of Hope Basin

Both Hope and Kotzebue basins are Tertiary-aged transtensional pull-apart basins that may be related to right-lateral movement along the Kobuk fault zone (fig. 2A). Basin extension and subsidence probably began in the early Tertiary. Strata penetrated by the Cape Espenberg 1 and Nimiuk Point 1 wells in Kotzebue basin range from Eocene through Quaternary in age (fig. 3). Two stages of faulting, during the Eocene and Miocene, caused extensive structural deformation in Hope basin (Tolson, 1987a).

The northern parts of Hope basin apparently lie on deformed Mesozoic and Paleozoic rocks of the Brookian-Chukotkan orogenic belt exposed on Wrangel Island (Russia) and on Cape Lisburne (Alaska). Eastern Kotzebue basin probably overlies sedimentary and igneous Cretaceous rocks

like those exposed to the east in the northern Yukon-Koyukuk province of Alaska. Sediments in the Kotzebue basin wells overlie Paleozoic(?) schists and carbonates like those widely exposed on the Seward Peninsula. These latter rocks probably form basement beneath western Kotzebue basin, and the southernmost parts of Hope basin.

The sedimentary fill reaches approximately 18,000 feet in maximum thickness in both Hope and Kotzebue basins. Outcrops surrounding Hope basin (summarized by Grantz and others, 1975, and Tolson, 1987a) and the Kotzebue basin wells (Cape Espenberg and Nimiuk Point wells; fig. 2A) indicate that basin fill consists of two main tectonostratigraphic sequences: 1) Eocene(?) volcanics, volcaniclastics, conglomerates and sandstones; overlain by 2) Oligocene(?) and younger shallow-marine to nonmarine sandstones, siltstones and conglomerates (fig. 2B). In Kotzebue basin, the seismic sequence correlated to the Eocene(?) sequence reaches 10,500 feet in thickness and the seismic sequence correlated to the Oligocene(?) and younger sequence reaches 8,500 feet in thickness. In Hope basin, the correlative seismic sequences each reach 11,500 feet in maximum thickness.

In Russian waters, Hope basin strata are underlain by up to 2 km of seismically-stratified rocks inferred to be Cretaceous in age (Shipilov, 1989; Pol'kin, 1984). The petroleum source and reservoir potential of these inferred Cretaceous rocks are unknown. Whether these rocks extend eastward into the deepest parts of U.S. Hope basin is not known, although analyses of seismic reflection and refraction data have not identified any pre-Tertiary stratified rocks beneath Hope basin in U.S. waters (Grantz and others, 1975; Tolson, 1987a, 1987b).

Potential Traps

Hope and Kotzebue basins offer mostly low-side fault-seal traps, but faulted anticlines, simple anticlines, and stratigraphic traps are also observed and mapped in seismic data. Hope basin prospects are areally quite large; a few range up to 80,000 acres in size (Zerwick, 1998). Median values of prospect area distributions (for plays) range from 10,000 to 12,000 acres, nearly double those mapped in other Alaska basins outside the Arctic.

Reservoir Formations

Density log porosities averaging 29 percent over approximately 700 net (aggregate over interval) feet of sandstone in each of the two Kotzebue basin wells indicate good reservoir potential for the Oligocene(?) and younger sequence. The underlying Eocene(?) sequence has a high proportion of volcaniclastics rich in chemically unstable grains that promoted cementation or collapse of internal pore spaces of sandstones. Density log porosities of the Eocene(?) sequence average 15 percent over 110 net feet of sandstone (Larson and Olson, 1984).

Although not observed in the Kotzebue basins wells, sandstones are inferred to have been deposited near the base of basin fill across broad areas of Hope and Kotzebue basins. The inference of the widespread existence of these basal sandstones is based upon analogy to eastern Norton basin, where sandstones are common within Paleocene(?) and Eocene rocks overlying basement and have conventional core porosities ranging up to 12.8 percent (Norton Basin COST No. 2 well; Turner et al., 1983). Porosity of sandstones is generally less than 10 percent at burial depths exceeding 10,000 ft (Zerwick, 1998).

Petroleum Source Rock Potential

Organic materials in samples from Tertiary strata of both Kotzebue basin wells are predominately Type III or gas prone (Mobil E&P, 1981). These Tertiary rocks appear to overlie a basement consisting of varied metamorphic rocks in U.S. waters. Paleozoic basement rocks are thermally overmature with no petroleum source potential in the Kotzebue basin wells.

In contrast to the U.S. Hope basin, Tertiary rocks in the Russian Hope basin are underlain by up to 2 km of rocks observed only in seismic data but inferred to be Cretaceous in age (Shipilov, 1989; Pol'kin, 1984). The petroleum source potential of these inferred Cretaceous rocks is unknown. Although thermally immature Cretaceous rocks are exposed north and west of Kotzebue basin (Tolson, 1987b), Cretaceous strata do not appear to floor Hope basin in U.S. waters.

Because available data fail to identify any credible oil source rocks, we view Hope and Kotzebue basins as fundamentally gas prone. Coal beds within the Hope basin fill form the most likely sources for methane or either biogenic (bacterial) or thermogenic origins. We acknowledge two highly speculative potential sources for liquid petroleum: 1) Cretaceous(?) or Paleozoic(?) rocks (observed in seismic data in Russian Hope basin) beneath western parts of U.S. Hope basin; or 2) resinite in coals in the shallower sequences in Hope basin. However, there are no data from outcrops or wells to support the presence of credible Cretaceous or Paleozoic oil sources or oil sources related to coal resinite.

Tertiary sediments in the Cape Espenberg 1 and Nimiuk Point 1 wells (located in fig. 2A) are thermally immature (vitrinite reflectance values are mostly less than 0.5% Ro). However, extrapolation of vitrinite reflectance data from the two wells projects a depth of -7,300 ft subsea for the 0.6% Ro isograd, as shown in figure 4. Assuming a -7,300 ft depth for the top of the oil generation zone across the entire Hope basin, we observe that only the central parts of Hope and Kotzebue basins reach thermal maturities sufficient to have generated oil or gas (area mapped in gray in fig. 2A).

Petroleum Migration Patterns

Shale formations sufficiently thick and laterally continuous to form regional seals have not been identified at the Kotzebue basin wells or in surrounding outcrops. Extensive north- to northwest-trending faults in the Hope basin (shown in fig. 2A) offer mainly vertical avenues for migration of hydrocarbons rising out of thermally mature rocks in the central part of the basin. The lack of regional seals and the extensive faulting suggests that migration of thermogenic petroleum (or biogenic methane) is primarily vertical, rather than laterally along dip in porous carrier beds beneath regional seals. Vertical migration typically dominates petroleum movement patterns in highly-faulted rift or wrench basins (Demaison and Huizinga, 1991). Figure 5 identifies two charge areas within northern Hope basin, including a central (red) area where prospects might be charged by thermogenic petroleum (most likely methane), and a larger (pink) area where the basin fill is thin and where biogenic methane is the most probable resource.

Oil and Gas Resources of Hope Basin

The 2006 oil and gas assessment of Hope basin identified 4 plays. Three plays (1-3) were quantitatively assessed using the *GRASP* computer model. A fourth play (4) was assessed as offering negligible potential based on high risk and small prospect numbers. As reported in tables 1, 3 and 4 and in figure 6, Hope basin is forecast to offer resources of 150 Mmb of oil and condensate and 3.769 Tcf of gas (mean,

risked, technically recoverable resources). At mean values, gas comprises 82 percent of the resource endowment of Hope basin. Oil and condensate resources range up to 603 Mmb and gas resources range up to 14.980 Tcf at fractile F05 (5% chance).

Hope 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	821	3,268
Total Gas (Tcfg)	0.000	3.769	14.980
Total Liquids (Mmbo)	0	150	603
Free Gas** (Tcfg)	0.000	3.721	14.784
Solution Gas (Tcfg)	0.000	0.048	0.196
Oil (Mmbo)	0	57	231
Condensate (Mmbc)	0	93	371

** 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 3 quantified plays in Hope basin are estimated to contain a maximum of 169 pools. These are predominantly gas pools with a minority fraction of mixed (oil and gas) and oil (no gas cap) pools. The largest pool in Hope basin contains a mean conditional resource of 355 Mmboe, with a maximum (F05) conditional resource of 958 Mmboe. Converting these volumes to an all-gas case, the largest pool in Hope basin contains a mean conditional resource of 1.995 Tcfge, with a maximum (F05) conditional resource of 5.384 Tcfge. Only 6 pools have mean conditional resources exceeding 100 Mmboe (or 0.562 Tcfge). Table 2 shows the conditional sizes of the 10 largest pools in Hope Basin Planning Area.

Hope Basin 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	1	110	355	958
2	1	74	186	359
3	2	42	162	400
4	1	54	132	248
5	3	39	120	312
6	1	40	102	188
7	2	22	87	184
8	1	30	82	152
9	1	23	67	127
10	3	26	66	123

** 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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Zerwick, S.A., 1998, Hope Basin Assessment Province: in: *Undiscovered Oil and Gas Resources, Alaska Federal Offshore (As of January 1995)*, Sherwood K.W. (ed.), Minerals Management Service, OCS Monograph MMS 98-0054, p. 217-225.

Links to Summaries for Individual Plays and Appended Items

Play 1, (Late Sequence), Hope Basin, Assessment Summary
Play 2, (Early Sequence), Hope Basin, Assessment Summary
Play 3, (Shallow [<10,000 ft] Basal Sandstones), Hope Basin, Assessment Summary
Play 4, (Deep [>10,000 ft] Basal Sandstones), Hope Basin, Assessment Summary
Hope Basin Plays-Assessment Results by Commodity (Excel Format)
Hope Basin Plays-Input Data Tables (Excel Format)
Hope Basin Plays-Pool Size Models (Txt Format)
Hope Basin Plays-Simulation Pools-Statistics (Excel Format)
Hope Basin Province-Assessment Results (Excel Format)

2006 Assessment Results for Hope Basin 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	**Late Sequence** (Oligocene-Pliocene)	0	457	1,762	0	37	142	0	51	198	0.000	2.047	7.884	0.000	0.027	0.106	0	88	340	0.000	2.074	7.990
2	**Early Sequence** (Eocene)	0	165	714	0	9	39	0	19	82	0.000	0.762	3.288	0.000	0.010	0.044	0	28	121	0.000	0.772	3.332
3	**Shallow (<10,000 ft) Basal Sandstones**	0	199	792	0	12	50	0	23	91	0.000	0.911	3.612	0.000	0.010	0.046	0	34	142	0.000	0.922	3.658
4	**Deep (>10,000 ft) Basal Sandstones**	Play 4 Assessed with Negligible Resources																				
Sum of All Plays**		0	821	3,268	0	57	231	0	93	371	0.000	3.721	14.784	0.000	0.048	0.196	0	150	603	0.000	3.769	14.980

** 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 Hope basin province assessment results for ultimate technically recoverable resources (UTRR) by play.

Province Resources - Technically Recoverable, Risked, By Product

Geological Resources Assessment Program-GRASP-Version 8.29.2005

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

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

Volume Ordered (Play Aggregation Method)
RandomSeed = 516035
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	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	145,383.11	6,025.56	16,869.25	4,848.73	683,535.52
35	962,886.78	47,024.01	111,724.05	38,605.82	4,480,653.78
30	1,279,750.08	80,076.86	146,843.36	65,675.26	5,851,228.59
25	1,568,772.91	101,228.13	179,191.05	85,674.84	7,154,873.15
20	1,858,435.00	105,932.87	214,841.59	89,415.51	8,552,236.74
15	2,185,662.42	169,664.85	248,115.91	136,341.55	9,799,153.37
10	2,601,016.46	185,893.52	297,526.98	154,925.37	11,745,963.90
5	3,268,344.27	231,326.75	371,473.00	196,037.51	14,784,322.66
4	3,456,675.70	250,691.13	393,659.95	212,905.89	15,592,358.55
3	3,716,474.02	294,387.17	419,553.15	240,476.54	16,633,762.81
2	4,058,581.93	284,960.92	462,114.71	236,658.76	18,374,006.63
1	4,662,558.09	370,452.63	522,382.08	318,225.01	20,867,620.40
Mean	820,874.95	56,777.08	93,492.13	47,889.58	3,720,914.72
Rep	820,883.75	31,085.75	104,381.45	27,651.80	3,824,389.18
Min	0	0	0	0	0
Max	10,228,423.49	490,383.17	1,201,449.62	464,741.58	47,510,898.18

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

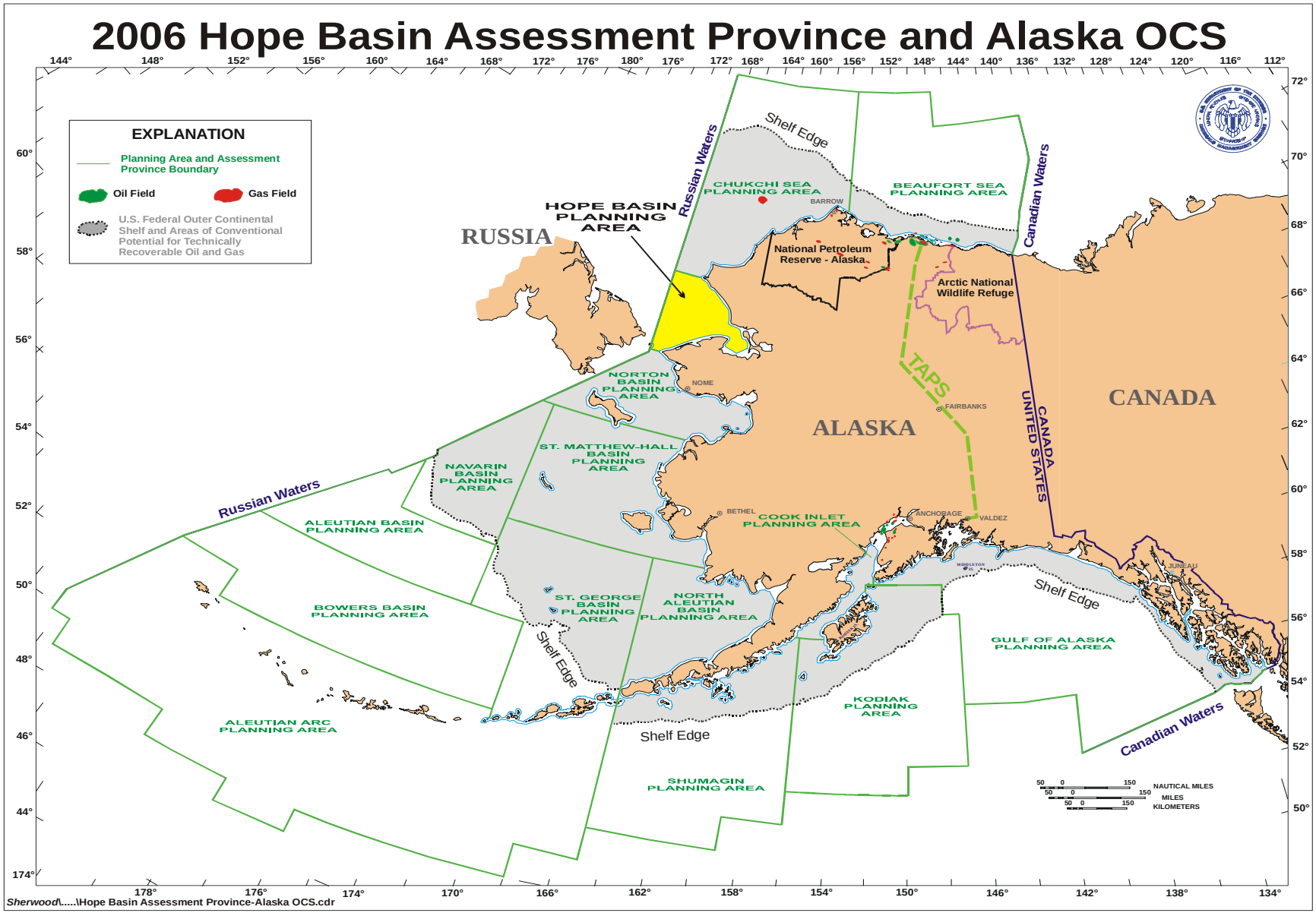

Figure 1. Location map for Hope Basin OCS Planning Area and assessment province.

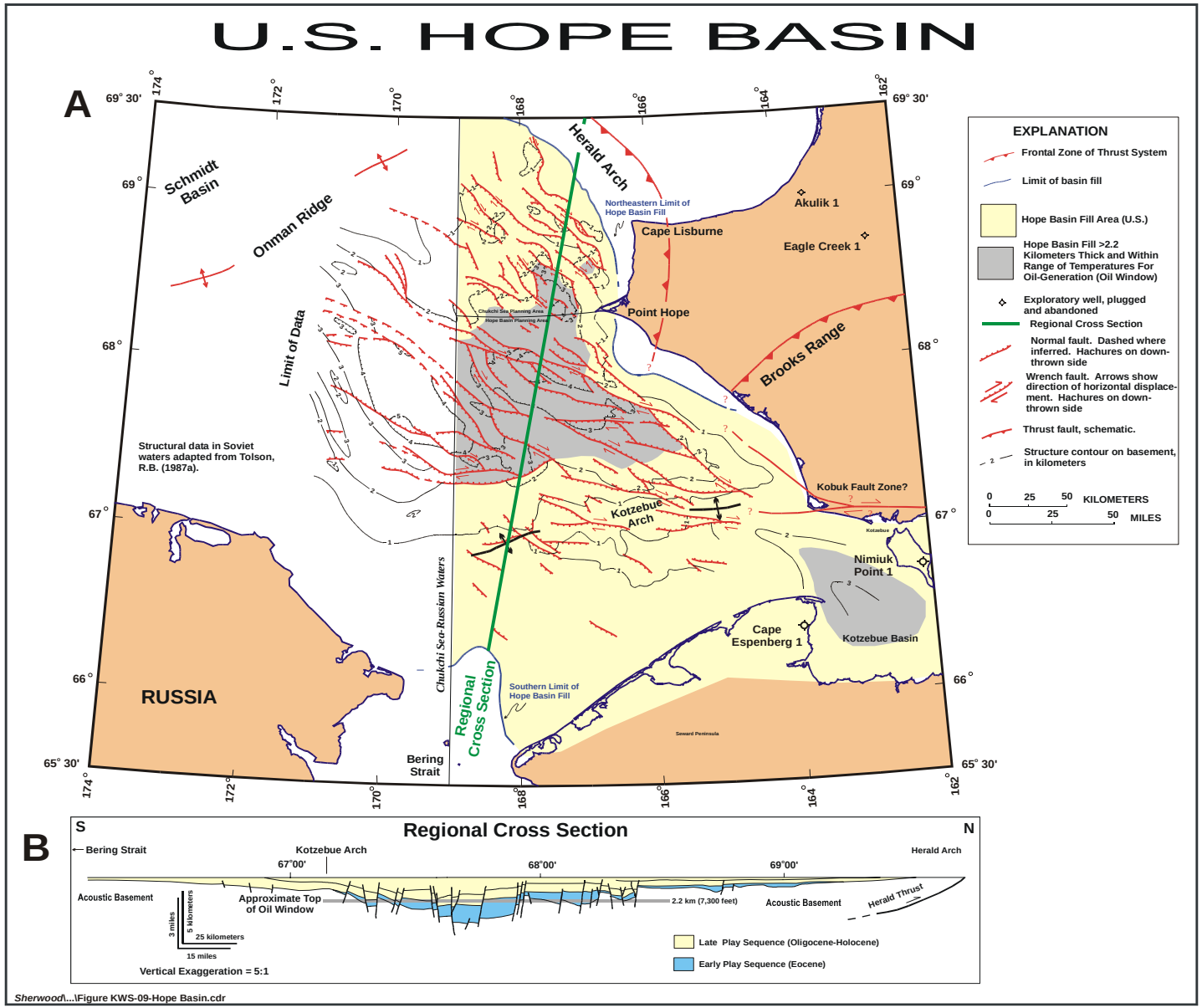

Figure 2. (A) generalized structure map of Hope basin; (B) regional cross section across Hope basin.

STRATIGRAPHIC COLUMNS

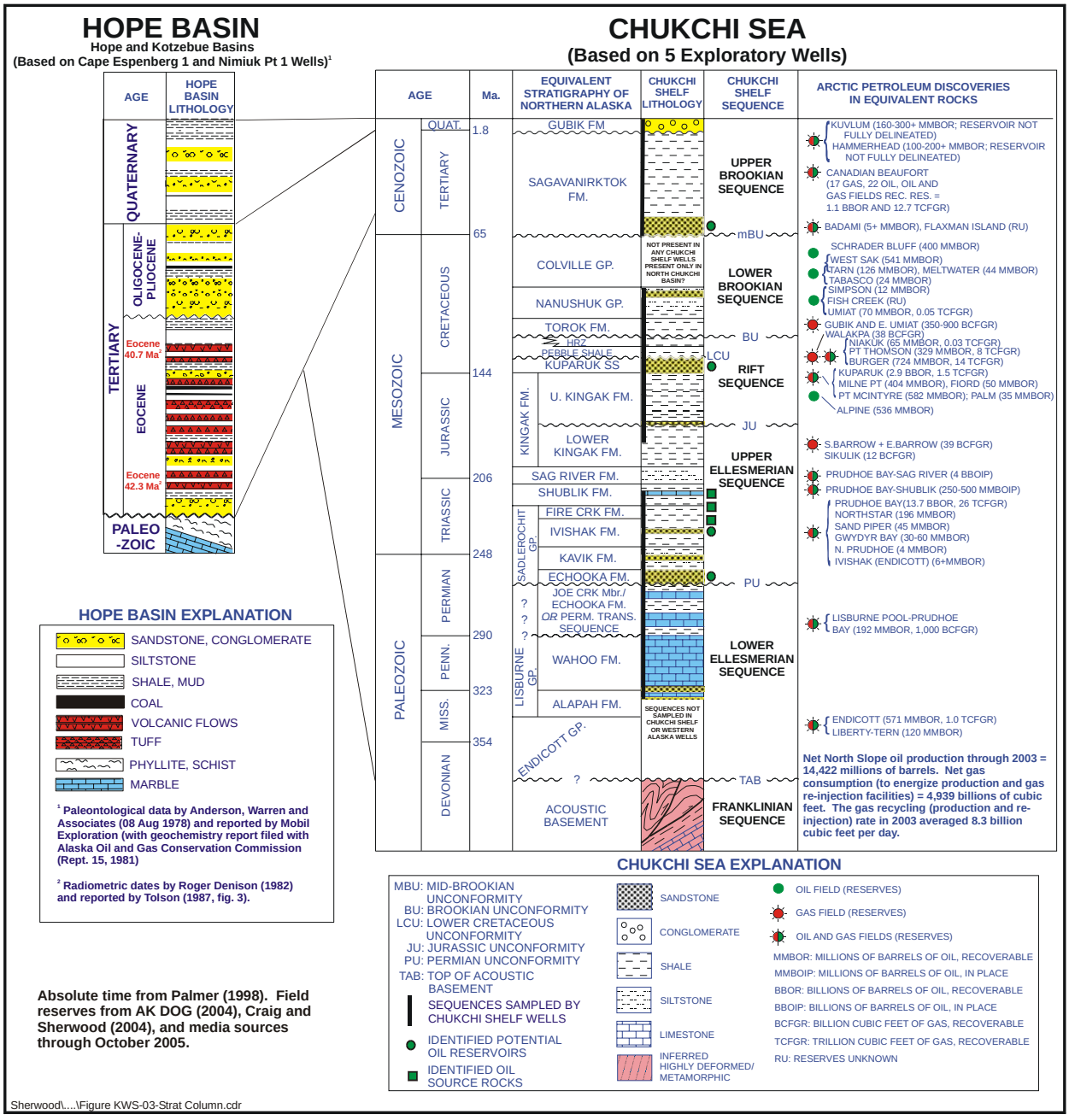

Figure 3. Stratigraphic columns for Hope basin and Chukchi shelf basins north of Herald arch.

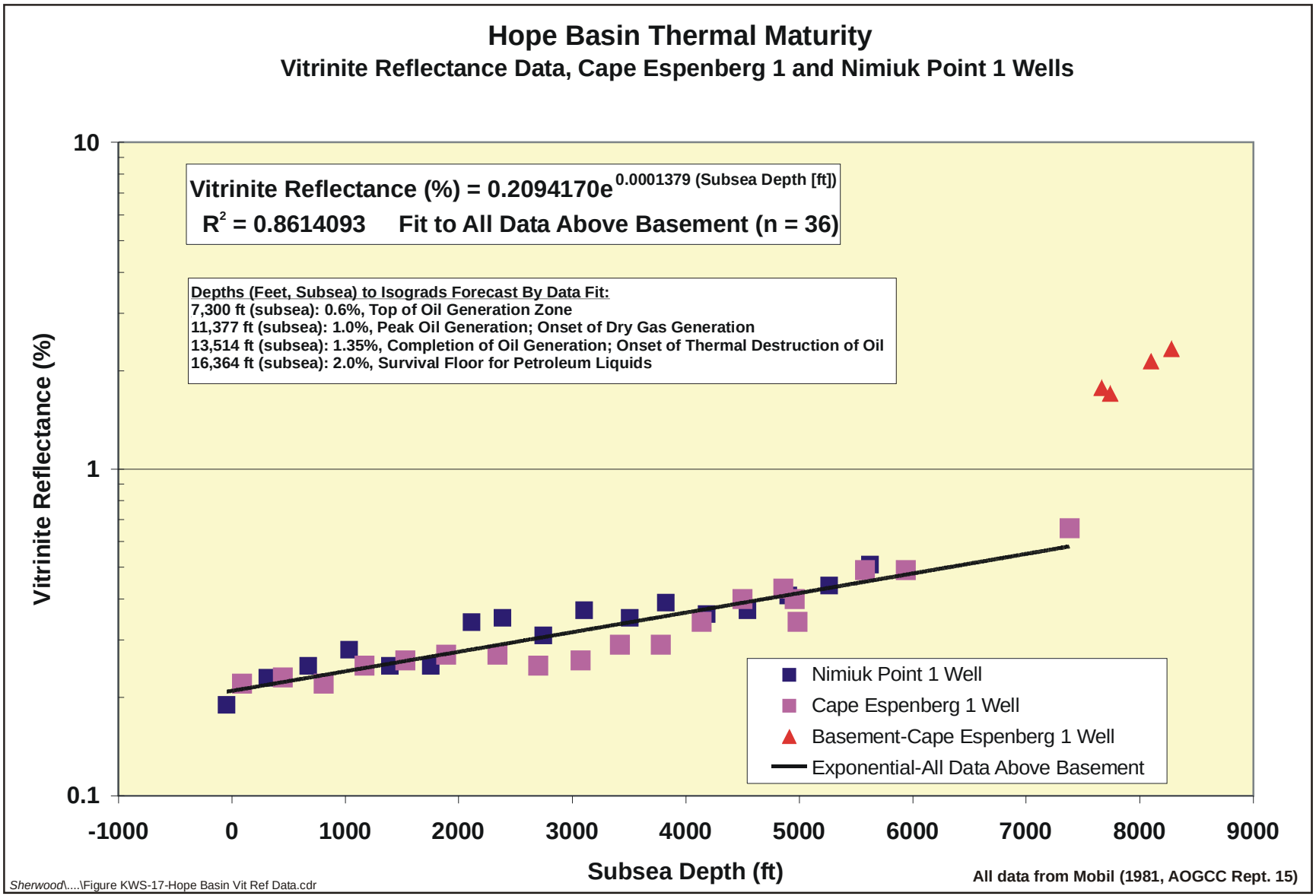

Figure 4. Graph of vitrinite reflectance data for Cape Espenberg 1 and Nimiuk Point 1 wells of Kotzebue basin, with forecasts for isograd depths for Hope and Kotzebue basins.

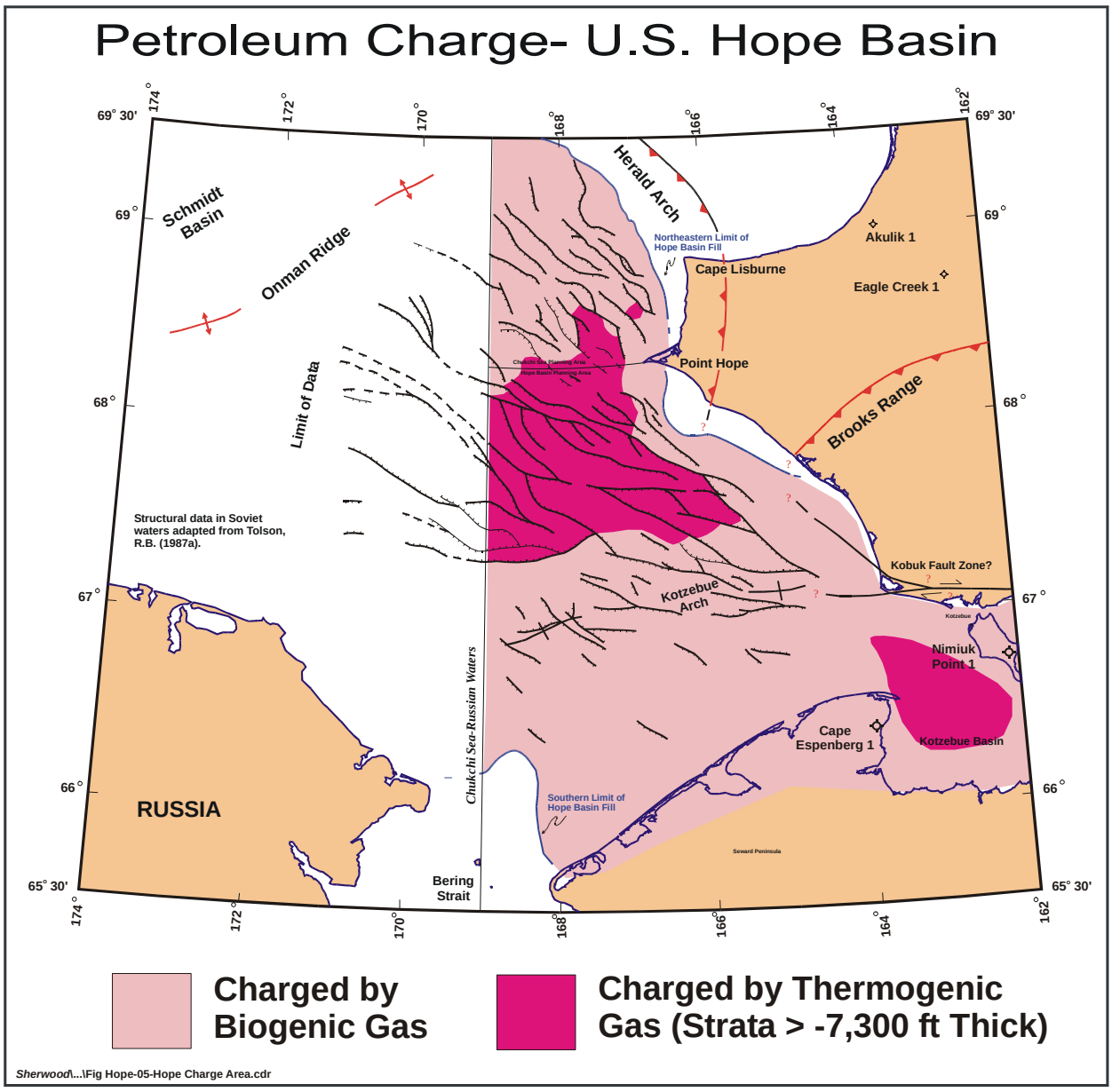

Figure 5. Gas charge systems for Hope basin.

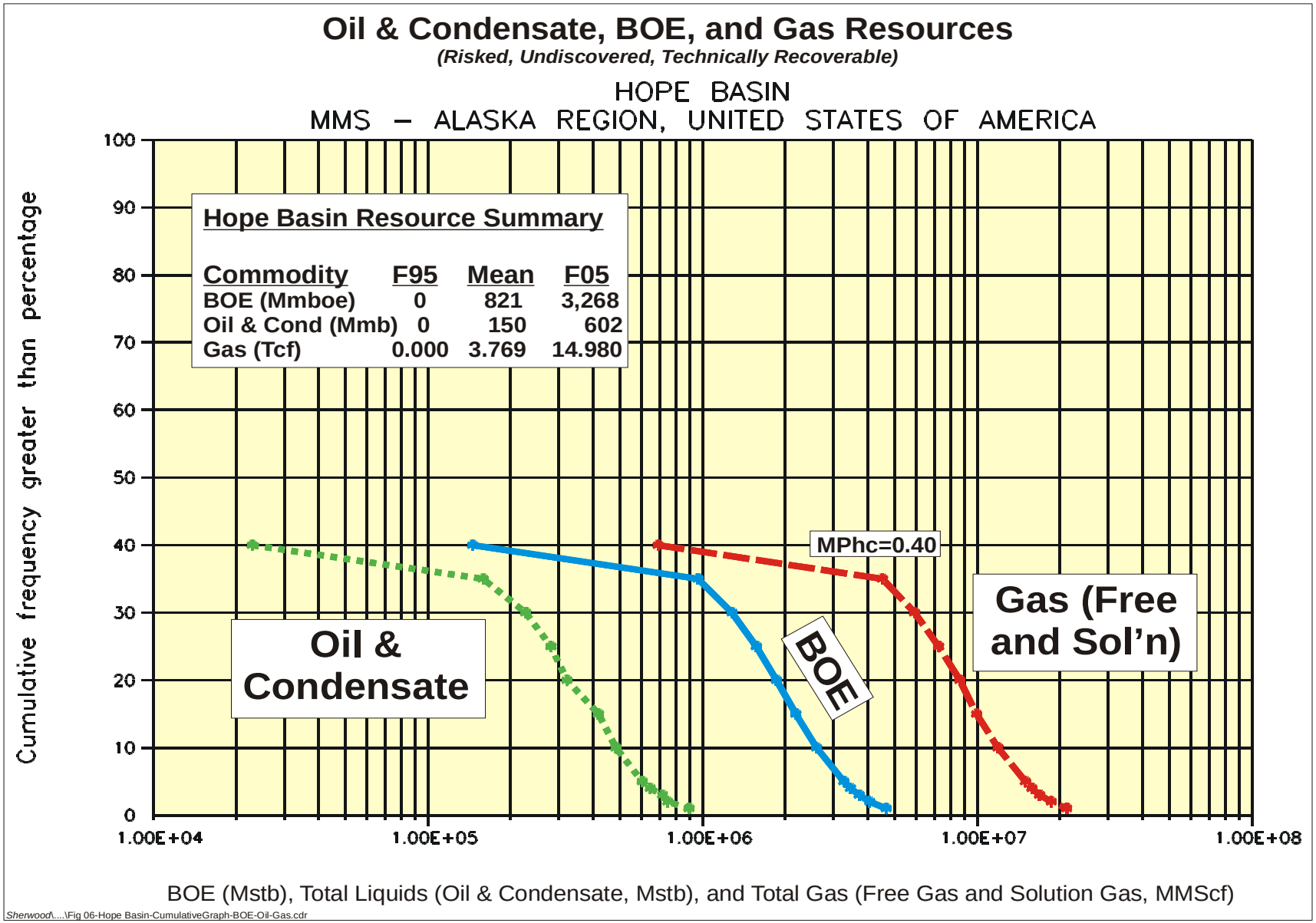

Figure 6. Cumulative probability plot for undiscovered, technically recoverable oil and gas resources for Hope Basin Planning Area, 2006 assessment.