EXPLORATION PROJECTS SECTION

SOURCE ROCK POTENTIAL OF THE
17/12-3X WELL, BREAM FIELD,
NORWEGIAN SECTOR OF THE NORTH SEA
JOB NO. RE1408

EPS REPORT NO. 2604A
COPY 10 OF 12 COPIES

D. C. BOATWRIGHT
E. B. ROBERTSON

EXPLORATION AND PRODUCTION GROUP

BARTLESVILLE, OKLAHOMA

SOURCE ROCK POTENTIAL OF THE 17/12-3X WELL, BREAM FIELD, NORWEGIAN SECTOR OF THE NORTH SEA

JOB NO. RE1408

EPS REPORT NO. 2604A

COPY 10 OF 12 COPIES

D. C. BOATWRIGHT

E. B. ROBERTSON

PHILLIPS PETROLEUM COMPANY

EXPLORATION PROJECTS SECTION

BARTLESVILLE, OKLAHOMA

APRIL, 1984

Source Rock Potential of the 17/12-3X Well, Bream Field, Norwegian North Sea EPS Report No. 2604A

Summary

This study evaluates the source rock potential of the 6430'-8861' interval of the 17/12-3X well from the Bream Field in the Norwegian sector of the North Sea. Two intervals (6627'-7120' and 7393'-7868') are identified as potential sources of oil.

Introduction

The 6430' to 8861' interval of the 17/12-3X well from the Bream Field in the Norwegian North Sea was evaluated for its source rock potential. The interval studied includes a thin slice of the Neocomian rocks overlying a nearly complete Dogger-Malm sequence. These Middle to Late Jurassic sediments unconformably overlie sediments of questionable Triassic age. Of the 2431' studied, 1402' appear to have limited source rock potential. Two intervals (6627'-7120' and 7393'-7682') within the portion of the well dated as Volgian/Kimmeridgian appear to be potential source rocks for oil. Two other intervals in the well are identified as potential sources of gas or a gas/gas liquids mix. One of these (7120'-7393') is in the Volgian/Kimmeridgian whereas the other (8201'-8299') is in the portion of the well dated as Bathonian. An interval of rocks (8299'-8548') in the Bathonian appears to have potential as a gas source.

Summary of Potential Source Rocks

Age	Interval	Thickness	Probable Product
Volgian/Kimmeridgian	6627'-7120'	393'	Oil
Volgian/Kimmeridgian	7120'-7393'	373'	Gas or a gas/gas liquid mix
Volgian/Kimmeridgian	7393'-7682'	289'	Oil
Bathonian	8201'-8299'	98'	Gas or a gas/gas liquid mix
Bathonian	8299'-8548'	249'	Gas

Discussion

Albian/Berriasian: 6430'-6627'

The portion of the Albian/Berriasian interval that was sampled (6430'-6627') is not a potential source of hydrocarbons because the kerogen is oxidized. An Ro (vitrinite reflectance) value of 0.77 and a TAI (thermal alteration index) value of 2- indicate that the sediments are mature. The TOC (total organic carbon) value (1.0-3.0%) indicates that a rich source of organic carbon is available for catagenesis, but the marginal marine paleoenvironment suggested by the palynoflora (EPS Rept. 1710A) indicates that the organic component was oxidized before it was incorporated into the sediments. The HI (hydrogen index) value is 108.1 and the HC (hydrogen to carbon) ratio is .636.

Volgian/Kimmeridgian: 6627'-7682'

The portion of the well dated as Volgian/Kimmeridgian (6627'-7682') is divided into three units. The first unit (6627'-7120') is considered to be a source of liquid hydrocarbons. The second unit (7120'-7393') is a secondary source for gas or a mixture of gas and gas liquids whereas the third unit (7393'-7682') is a potential source of oil. This latter interval

is second only to the 6627'-7120' interval in its potential for generation of oil.

The Volgian/Kimmeridgian portion (6627'-7682') of the well is thermally mature. The Ro values range between 0.72 and 0.91 and the TAI values are between 2- and 2+. The slightly lower TAI values at the top of this unit are interpreted to be the result of caving from the less mature overlying sediments. The interval is within the prime "window" for generation of hydrocarbons. High TOC values (1.83-7.14%) indicate that a rich source of organic carbon is available for catagenesis.

Three units are delimited on the basis of their kerogen component. The first unit (6627'-7120') contains liquid prone kerogen with HI values ranging between 221.7 and 526.9 and HC ratios falling between 0.709 and 1.164. The unit is an oil source. The second unit (7120'-7395') has a mixed source of kerogen components that produce gas or a mixture of gas and gas condensates. The HI values are between 175.4 and 180.4 and the HC ratios fall between 0.721 and 0.784. A third unit (7393'-7682') has a kerogen component that is oil-prone with its HI values ranging between 225.0 and 408.4 and HC values between 0.759 and 1.015.

Oxfordian/Callovian: 7682'-7836'

The portion of the well dated as Oxfordian/Callovian (7682'-7836') is a poor source of hydrocarbons.

The sediments recovered in the Oxfordian/Callovian portion of the well are representative of the highly oxidative marginal marine depositional environment in which the amorphous alginitic fraction of the kerogen was oxidized prior to preservation. The organic fraction has a higher than usual unoxidized terrestrial component and this kerogen could source gas of a mixture of gas/gas liquids. This section is thermally mature with the Ro values between 0.85 and 0.92 and the TAI values from 2+ to 3-.

Both thermal parameters indicate that the sediments encountered are in the prime thermal "window" favorable for hydrocarbon catagenesis. The TOC values indicate that a rich (2.46 to 5.4%) source of organic carbon is preserved in the sediments. The HI values range between 39.1 and 157.9 and the HC ratios range between 0.558 and 0.607.

Bathonian: 7836'-8548'

Three units are delimited in the Bathonian portion (7836'-8548') of the well. The first unit (7836'-8548') is a poor source of hydrocarbons with the limiting factor being the oxidizing character of its marginal marine depositional environment. A second unit (8201'-8299') is a potential source of gas or a gas/gas liquids mixture, whereas the third unit (8299'-8548') is a potential source of gas.

The Bathonian portion of the well is thermally mature. Ro values are from 0.85 to 0.92 and TAI values range between 2+ and 3-. Both thermal parameters indicate that the sediments are within the prime "window" of hydrocarbon generation. TOC values range between 1.42 and 5.90%. An absence of marine palynomorphs suggests that the two high TOC values (13.87% at 7808'-7907' and 15.91 at 8300'-8399') most likely indicate the presence of paralic coals.

The Bathonian (7836'-8540') is subdivided into three units based on the quality of the kerogen contained in the sediments. The first unit (7836'-8201') is liquid-prone with the limiting factor being the oxidizing character of the depositional environment. The HI values for this unit are from 51.7 to 192.9 and the HC ratios range between 0.565 to 0.716. The second unit (8201'-8299') is a potential source of gas or gas and gas condensate. The HI values range from 178.8 to 288.7 and the HC rations range between 0.725 and 0.864. The third unit (8299'-8548') is liquid-prone. The HI values range between 31.0 and 254.7 and the HC ratios range between 0.539 to 0.826.

?Triassic: 8548'-8949'

The portion of the well that is interpreted as questionable Triassic in age is divided into two units. The first unit (8548' to 8758') is a marginal source for gas or a mixture of gas and gas liquids. A second unit (8758-8971') is, at best, a lean source of gas. The factor limiting the hydrocarbon potential of the upper unit (8548' to 8758') is the oxidizing character of its marginal marine environment of deposition. The limiting factor in the second unit (8650' to 8861') is an absence of readily available organic carbon.

The sediments found in the ?Triassic portion of the well are thermally mature based on Ro values of 0.85 to 0.91 and TAI values of 2+ to 3-. This interval is well within the prime generation window for hydrocarbons. The depositional environment is interpreted to range from marginal marine at the top of the interval to estuarine at its base with the boundary roughly corresponding to a two part division of the interval. The first unit (8548' to 8758') is liquid-prone with TOC values classified as fair (0.23-0.88%). The HI values range between 31.0 and 134.6 whereas the HC ratios fall between 0.539 and 0.670. The second unit (8650'-8861') is gas or gas/liquid mix prone. This unit has low TOC values (0.32-0.59) and therefore is only a lean source of organic carbon available for catagenesis. The HI values range between 86.4 and 121.5 and the HC ratios range between 0.609 and 0.653.

D. C. Boatwright

E. B. Robertson

Approved:

M. E. Smith

Approved:

E. A. Stanley

SRP APPENDIX
REPORT # 2604A APRIL 84
17/12 3X BREAM
INTERPRETED BY : E. B. ROBERTSON

INTERVAL (FEET) TOP	BSE	TYPE	TAI	(LIQUID) EX.	AM.	(GAS) VI	IN	RO M	SDEV	MD	RANGE MN - MX		#	TOC
6430	6529	C	2-	90	10			0.75	.04	0.73	0.69	0.82	17	
6627	6726	C	2-	80	20			0.77	.04	0.79	0.66	0.81	13	2.25
6824	6922	C	2	80	20			0.77	.05	0.66	0.68	0.87	41	2.30
6922	7021	C	2	80	20			0.77	.05	0.82	0.69	0.84	28	5.84
7021	7120	C	2	60	40			0.72	.04	0.68	0.66	0.79	36	4.32
7120	7218	C	2	60	40			0.77	.04	0.73	0.71	0.85	35	1.83
7218	7316	C	2+	50	50			0.83	.04	0.84	0.76	0.90	33	2.03
7300	7301	S	2	60	40			0.86	.04	0.83	0.81	0.94	31	2.63
7316	7415	C	2+	60	40			0.85	.05	0.82	0.72	0.93	22	5.12
7415	7513	C	2+	70	30			0.91	.04	0.95	0.84	0.97	25	7.14
7480	7481	S	2	60	40			0.83	.03	0.81	0.77	0.89	25	3.76
7513	7611	C	2+	80	20			0.92	.05	0.98	0.83	0.98	29	4.16
7550	7551	S						0.82	.02	0.81	0.79	0.86	18	2.46
7611	7710	C	2+	70	30			0.89	.04	0.94	0.82	0.94	22	3.08
7650	7651	S	2+	70	20	10		0.89	.05	0.85	0.79	0.97	33	5.44
7710	7808	C	2+	60	40			0.85	.04	0.83	0.80	0.93	24	2.99
7740	7741	S	2+	60	40			0.88	.04	0.91	0.82	0.95	17	5.10
7750	7751	S	2+	60	40									
7760	7761	S	2+	60	30	10		0.90	.06	0.84	0.80	1.00	22	5.40
7803	7804	S	2+	60	40			0.93	.24	0.57	0.76	1.10	2	0.48
7808	7907	C	2+	60	40			0.91	.05	0.85	0.85	0.98	22	/3.87
7832	7833	S	3-	60	40			0.88	.08	0.55	0.82	0.93	2	5.30
7845	7846	S	3-	60	40			0.88	.01	0.58	0.87	0.88	2	0.23
7875	7876	S	2+	70	20	10		0.86	.08	0.51	0.79	0.97	5	5.90
7907	8005	C	2+	70	30			0.89	.04	0.87	0.84	0.95	18	5.16
7975	7976	S	2+	80	20									0.21
8005	8104	C	2+	70	30			0.90	.05	0.96	0.82	0.96	18	2.54
8104	8202	C	2+	60	40			0.91	.05	0.85	0.85	0.95	5	2.52
8110	8111	S	2+	60	40									1.42
8202	8300	C	2+	80	20			0.88	.06	0.86	0.76	0.95	20	2.17
8300	8399	C	3-	70	30			0.89	.05	0.83	0.83	0.98	28	/5.91
8365	8366	S	3+	70	30			0.86	.03	0.83	0.82	0.91	8	8.60
8399	8497	C	2+	70	30			0.92	.05	0.94	0.84	0.98	16	9.61
8440	8441	S	2+	70	20	10		0.92	.06	0.98	0.82	0.98	18	0.87
8497	8596	C	2+	60	30	10		0.85	.04	0.82	0.82	0.93	18	4.28
8500	8501	S	3-	70	20	10		0.88	.08	0.81	0.81	0.99	6	1.47
8596	8694	C	2+	70	20	10		0.91	.04	0.82	0.82	0.93	18	0.82

SRP APPENDIX
REPORT # 2604A APRIL 84
17/12 3X BREAM
INTERPRETED BY : E. B. ROBERTSON

INTERVAL (FEET) TOP	BSE	TYPE	TAI	(LIQUID) EX.	AM.	(GAS) VI	IN	RO M	SDEV	MD	RANGE MN	- MX	#	TOC
8600	8601	S	2+	70	30			0.89	.05	0.86	0.81	0.97	11	0.27
8615	8616	S	2+	60	40			0.86	.25	0.64	0.68	1.03	2	0.23
8650	8651	S	3-	70	30			0.91	.06	0.82	0.82	0.99	21	0.32
8694	8792	C	3-	60	30		10	0.91	.04	0.87	0.84	0.98	27	0.79
8740	8741	S	3-	70	30									0.52
8792	8889	C	2+	60	40			0.91	.06	0.98	0.82	0.98	18	0.59
8860	8861	S	2+	80	20									0.20

PYROLYSIS RESULTS FOR SAMPLES FROM THE BREAM 17/12-3X, NORTH SEA, NORWAY

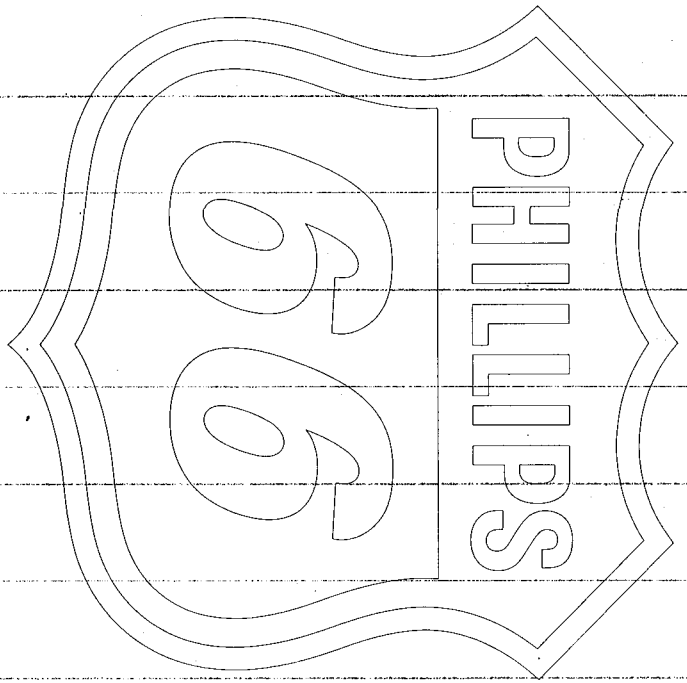
EPS REPORT #2604A

STRAT. INTERVAL	SPL TYP	SAMPLE DEPTH FEET	TOTAL ORGANIC CARBON WT.%	S1 MG.HC/ G.ROCK	S2 MG.HC/ G.ROCK	PRODUCTION INDEX S1/(S1+S2)	THERMAL EXTRACTION INDEX MG/G.	HYDROGEN INDEX MG/G.	HYDROGEN TO CARBON ATOMIC RATIO	GEOCHEM SAMPLE CODE
	CUT	6529-6627	1.11	.11	1.20	.084	9.91	108.1	.636	EP83BSY
	CUT	6627-6726	2.25	.29	3.74	.072	12.89	166.2	.709	EP83BSZ
	CUT	6726-6824	2.06	.22	4.72	.045	10.68	229.1	.789	EP83BTA
	CUT	6824-6922	2.30	.22	5.10	.041	9.57	221.7	.779	EP83BTB
	CUT	6922-7021	5.84	.73	30.77	.023	12.50	526.9	1.164	EP83BTC
	CUT	7021-7120	4.32	.40	19.84	.020	9.26	459.3	1.079	EP83BTD
	CUT	7120-7218	1.83	.15	3.30	.043	8.20	180.3	.727	EP83BTE
	CUT	7218-7316	2.03	.17	3.56	.046	8.37	175.4	.721	EP83BTF
	SWC	7300	2.63	.22	5.40	.039	8.37	205.3	.759	EP84APE
	CUT	7316-7415	5.12	.26	11.55	.022	5.08	225.6	.784	EP83BTG
	CUT	7415-7513	7.14	.74	29.16	.025	10.36	408.4	1.015	EP83BTH
	SWC	7480	3.76	.32	10.76	.029	8.51	286.2	.861	EP84APF
	CUT	7513-7611	4.16	.42	12.63	.032	10.10	303.6	.883	EP83BTI
	SWC	7550	2.46	.08	1.13	.066	3.25	45.9	.558	EP84APG
	CUT	7611-7710	3.08	.21	4.86	.041	6.82	157.8	.699	EP83BTJ
	SWC	7650	3.44	.17	4.52	.036	3.12	83.1	.605	EP84APH
	CUT	7710-7808	2.99	.11	2.53	.042	3.68	84.6	.607	EP83BTK
	SWC	7740	5.10	3.30	5.65	.332	64.71	130.4	.664	EP84API
	SWC	7760	5.40	.12	2.11	.054	2.22	39.1	.549	EP84APJ
	SWC	7803	.48	.11	.37	.229	22.92	77.1	.597	EP84APK
	CUT	7808-7907	13.87	.88	14.00	.059	6.34	100.9	.627	EP83BTL
	SWC	7832	5.30	.32	2.33	.121	6.04	44.0	.555	EP84APL
	SWC	7845	.23							EP84APM
	SWC	7875	5.90	.29	3.05	.087	4.92	51.7	.565	EP84APN
	CUT	7907-8005	5.16	.43	8.83	.046	8.33	171.1	.716	EP83BTM
	SWC	7975	.21							EP84APO
	CUT	8005-8104	2.54	.20	2.51	.074	7.87	98.8	.625	EP83BTN
	CUT	8104-8202	2.52	.35	4.86	.067	13.89	192.9	.743	EP83BTO
	SWC	8110	1.42	.41	4.10	.091	28.87	288.7	.864	EP84APP
	CUT	8202-8300	2.17	.31	3.88	.074	14.29	178.8	.725	EP83BTP
	CUT	8300-8399	15.91	1.03	17.08	.057	6.47	107.4	.635	EP83BTQ
	SWC	8365	8.60	.50	21.90	.022	5.81	254.7	.821	EP84APQ
	CUT	8399-8497	9.61	.65	9.87	.062	6.76	102.7	.629	EP83BTR
	SWC	8440	.87	.06	.27	.182	6.90	31.0	.539	EP84APR
	CUT	8497-8596	4.28	.48	5.76	.077	11.21	134.6	.670	EP83BTS
	SWC	8500	1.47	.12	1.69	.066	8.16	115.0	.645	EP84APS
	CUT	8596-8694	.82	.12	.70	.146	14.63	85.4	.608	EP83BTT
	SWC	8600	.27							EP84APT
	SWC	8615	.23							EP84APU
	SWC	8650	.32							EP84APV
	CUT	8694-8792	.79	.11	.96	.103	13.92	121.5	.653	EP83BTU
	SWC	8740	.52	.06	.45	.118	11.54	86.5	.609	EP84APW
	CUT	8792-8891	.59	.10	.51	.164	16.95	86.4	.609	EP83BTV
	SWC	8860	< .20							EP84APX

PYROLYSIS RESULTS FOR SAMPLES FROM THE BREAM 17/12-3X, NORTH SEA, NORWAY

EPS REPORT #2604A

STRAT. INTERVAL	SPL TYP	SAMPLE DEPTH FEET	TOTAL ORGANIC CARBON WT.%	S1 MG.HC/ G.ROCK	S2 MG.HC/ G.ROCK	PRODUCTION INDEX S1/(S1+S2)	THERMAL EXTRACTION INDEX MG/G.	HYDROGEN INDEX MG/G.	HYDROGEN TO CARBON ATOMIC RATIO	GEOCHEM SAMPLE CODE
	CUT	8891-8950	.32							EP83BTW



THERMAL ALTERATION AND SOURCE ROCK POTENTIAL OF PHILLIPS 17/12 3X NORWAY

COPY 10 OF 12 COPIES

DEPTH IN FEET

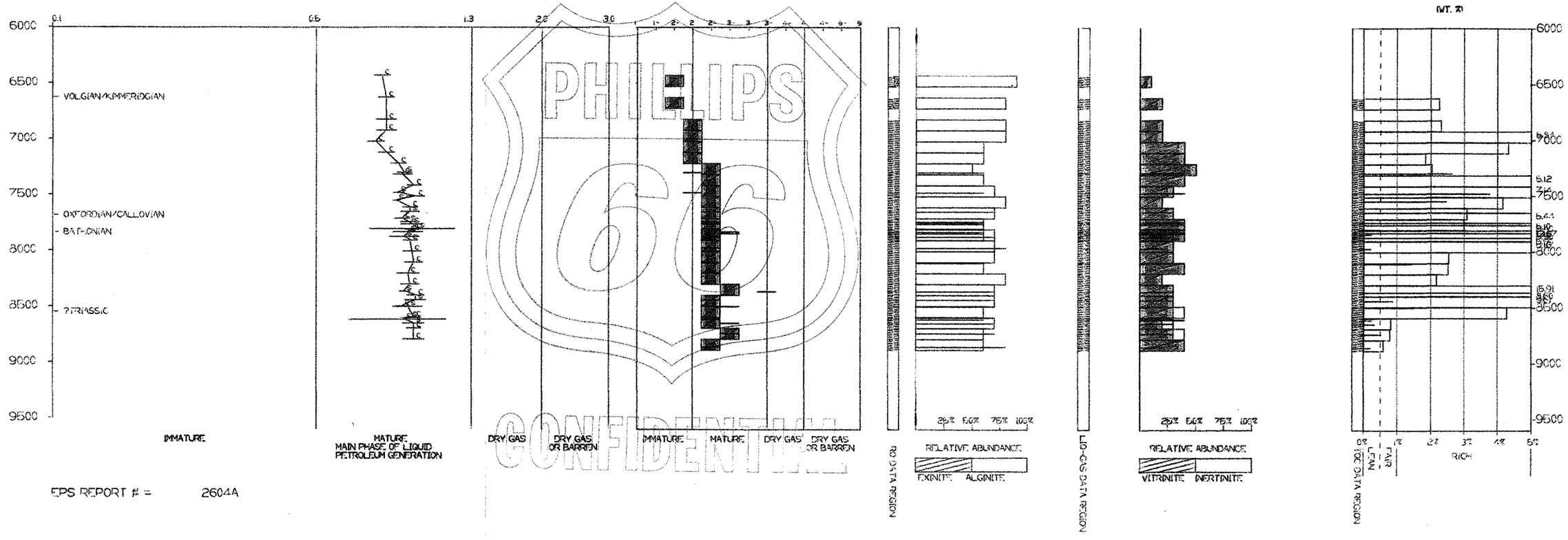
LOG PERCENT REFLECTANCE

THERMAL ALTERATION INDEX/TAD

LIQUID PRONE

GAS PRONE

TOTAL ORGANIC CARBON (TOC) (WT. %)



EPS REPORT # = 2604A

EPS REPORT #2604A

COPY 1 OF 6 COPIES

CORE
CUTTINGS

BREAM 17/12-3X, NORTH SEA, NORWAY

PYROLYSIS RESULTS