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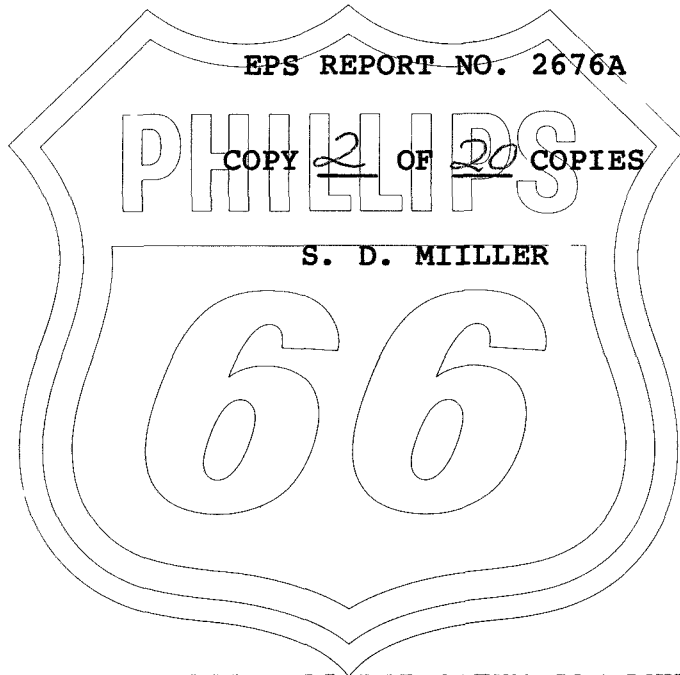
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SOURCE ROCK POTENTIAL OF SELECTED
SAMPLES FROM THE ESSO 9/8-1 WELL,
GROUP LICENSE AREA
NORWEGIAN SECTOR, NORTH SEA
JOB NO. RE0210



PHILLIPS PETROLEUM COMPANY
EXPLORATION PROJECTS SECTION
BARTLESVILLE, OKLAHOMA
SEPTEMBER, 1984

Source Rock Potential of Selected Samples
 from the Esso 9/8-1 Well, Group License Area,
 Norwegian North Sea
 EPS Report 2676A

SUMMARY AND CONCLUSIONS

Based on visual, TOC and pyrolysis measurements of seven selected cuttings samples from the Esso 9/8-1 well, the following conclusions are established:

<u>DEPTH (FT.)</u>	<u>HYDROCARBON POTENTIAL</u>	<u>HYDROCARBON TYPE</u>
6200-6300	Very Good	Oil
6340-6390	Very Good/Excellent	Oil
5900-6200	Good	Oil/Gas
6390-6500	Good	Oil/Gas

The studied intervals have reached the early stage of the main oil generation phase. The sediments probably have not generated or expelled much of their hydrocarbons at their present thermal regime.

The best source potential is exhibited by shales selected from the interval 6340-6390 ft.

DISCUSSION

Seven selected cuttings samples from the Esso 9/8-1 well in the Norwegian Sector of the North Sea were examined. The samples were chosen by the EPS geochemists as part of a larger source rock study of the Group License Area (GLA) in the North Sea.

Vitrinite reflectance, thermal alteration index, fluorescence microscopy, kerogen typing, total organic carbon and pyrolysis measurements were completed (Figs. 1-3). The following is a discussion of source rock type and hydrocarbon generating potential of the studied intervals.

Interval: 6200-6300 ft.; 6340-6390 ft.

Hydrocarbon Potential: Very Good/Excellent

Hydrocarbon Type: Oil

Sediments in the intervals 6200-6300 ft. and 6340-6390 ft. possess very good potential to produce a significant quantity of liquid hydrocarbons. Vitrinite reflectance measurements indicate that the intervals have reached the early stage of the oil generating phase ($R_o = 0.55$). Thermal alteration indices (TAI = 2+) support this conclusion. Both intervals contain abundant amorphous sapropel (50-60%) exhibiting intense orange fluorescence; this fluorescence property indicates that the amorphous kerogen is oil-prone and of high quality. Both intervals exhibit high TEI values (52-93). These elevated TEI values indicate the probable presence of non-indigenous oil. This oil may have been expelled from local shale lithologies and migrated into the sandy units of both intervals, or expelled and migrated from more distant source rocks.

Both intervals exhibit high TOC (2.47-3.96) and high HI (243-322) values, suggesting a very good source rock potential. At a higher thermal regime, or if located downdip, these sediments should produce significant quantities of liquid hydrocarbons.

Shales collected and examined from the 6340-6390 ft. interval yielded the highest TOC (6.67) and HI (442) values obtained in this study (based on whole rock pyrolysis measurements). These high values coupled with the presence of abundant (70%), intensely fluorescent amorphous sapropel indicate that the shale units have excellent potential for the generation of liquid hydrocarbons.

Interval: 5900-6200 ft.; 6390-6500 ft.

Hydrocarbon Potential: Good

Hydrocarbon Type: Oil/Gas

Sediments from the 5900-6200 ft. and 6390-6500 ft. intervals exhibit good potential to generate liquid hydrocarbons and gas. They have reached the early stage of the oil generating phase according to vitrinite reflectance measurements ($R_o = 0.54-0.58$). Thermal alteration indices ($TAI = 2+$) support this conclusion. Both intervals possess nearly equal amounts of liquid and gas-prone kerogen, indicating a potential for both oil and gas generation at higher thermal regimes.

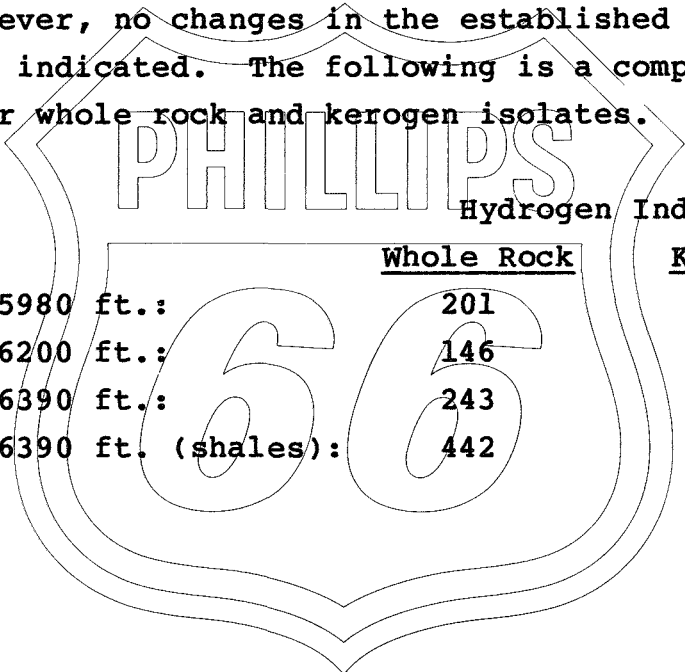
The intervals 5900-6200 ft. and 6390-6500 ft. possess good TOC values (1.42-2.02 and 1.82, respectively) and fair HI values (143-201 and 153, respectively). Visual examination of the kerogen slides reveals the presence of abundant, intensely fluorescent bitumen in the interval 5900-6200 ft. This bitumen, together with very high TEI values (119-122) indicate the presence of non-indigenous migrated oil in these sediments. The interval 6390-6500 ft. also contains common bitumens and these together with elevated TEI values likewise indicate the probable presence of non-indigenous oil.

High percentages of inertinite (30%) were observed in the interval 5900-6200 ft.; the abundance of these particles may have overwhelmed the in situ vitrinite populations of these sediments. In a previous Phillips Petroleum Company study of the Esso 9/8-1 well in 1975 by L. L. Urban, a vitrinite reversal trend was described with R_o values going from 0.75 at 5900 ft. to 0.48 at 6500 ft. This observation was thought to be related to "recycled organics that have been subjected to a previous high thermal history and/or oxidation during deposition or subsequent reworking." This interpretation may be correct in light of the presence of large inertinite populations (30%) noted for the

interval in this current study. The recording of only the least mature vitrinite populations yielded consistent Ro values (0.54-0.58) reflecting an early "oil window" maturity. Other, highly mature vitrinite populations (Ro = 0.88) observed between 5900 and 6300 ft. are considered to be recycled.

GENERAL OBSERVATIONS

Whole rock pyrolysis and kerogen isolate pyrolysis measurements yield somewhat different results for the same sample intervals. The hydrocarbon potentials were initially established using the whole rock pyrolysis results. When kerogen isolate results were made available, somewhat higher hydrogen index values were noted; however, no changes in the established hydrocarbon potentials were indicated. The following is a comparison of hydrogen indices for whole rock and kerogen isolates.



	Hydrogen Index	
	<u>Whole Rock</u>	<u>Kerogen</u>
5900-5980 ft.:	201	226
6100-6200 ft.:	146	180
6340-6390 ft.:	243	394
6340-6390 ft. (shales):	442	478

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Approved: *E. A. Stanley*
 E. A. Stanley

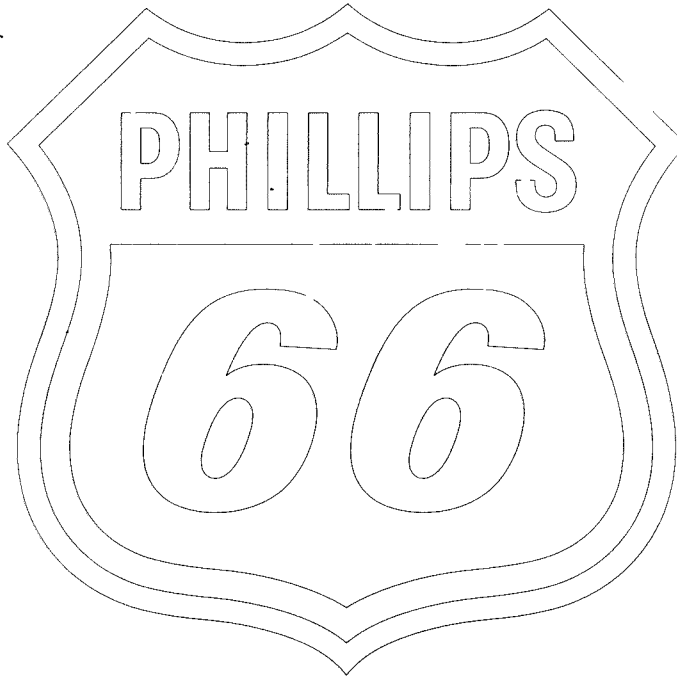
Figures and Tables in this Report:

Figure 1. Source Rock Potential, Thermal Alteration and Whole Rock Pyrolysis Results Plot.

Figure 2. Fluorescence and Oxidation vs. Reduction Plot.

Figure 3. Vitrinite Reflectance Histogram Plot, Unedited Data.

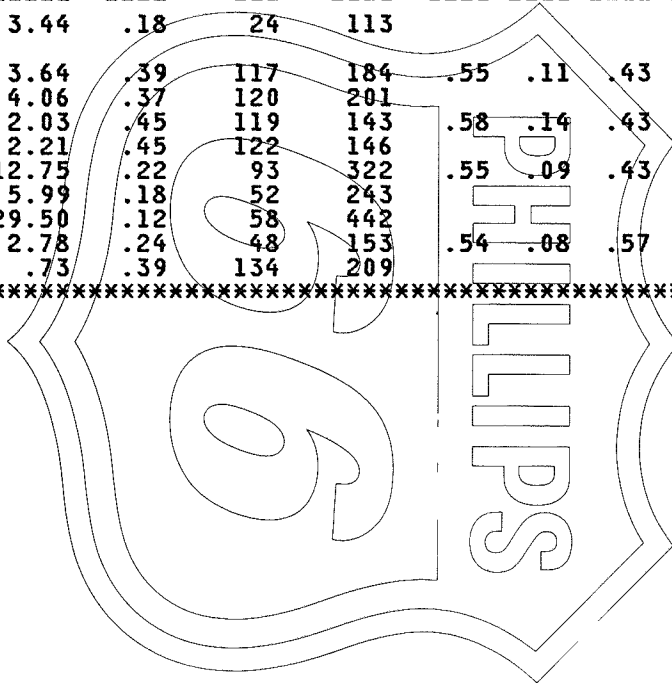
Table 1. Whole Rock Pyrolysis Results, Thermal Alteration, and Source Rock Potential Data.



SOURCE ROCK GEOCHEMICAL AND VISUAL KEROGEN DATA
 ESSO 9/8-1, NORWEGIAN SECTOR, NORTH SEA

Table 1
 EPS Report No. 2676A

SPL TYP	SAMPLE DEPTH FEET	TOTAL ORGANIC CARBON TOC	S1 PEAK (TEH)	S2 PEAK	THERMAL EXTRACTION			VITRINITE REFLECTANCE (RO)					THERMAL ALTERATION INDEX TAI	VISUAL KEROGEN NORMALIZED PERCENT				GEOCHEM SAMPLE CODE		
					INDEX PI	INDEX TEI	INDEX HI	MEAN	STD. DEV.	RO MODE	RO LOW	RO HIGH		PTS	ALG	EXI	VIT		INER	
CUT	2970-3150	3.04	.74	3.44	.18	24	113													EP84CE0
CUT	4300-4410	.32																		EP84CEP
CUT	5900-5980	1.98	2.32	3.64	.39	117	184	.55	.11	.43	.31	.72	22	2+	30	20	20	30	EP84BOD	
CUT	5900-5980	2.02	2.43	4.06	.37	120	201												EP84CEQ	
CUT	5980-6100	1.42	1.69	2.03	.45	119	143	.58	.14	.43	.32	.79	23	2+	30	20	20	30	EP84AZM	
CUT	6100-6200	1.51	1.84	2.21	.45	122	146							2+	30	20	20	30	EP84BOE	
CUT	6200-6300	3.96	3.69	12.75	.22	93	322	.55	.09	.43	.41	.69	29	2+	60	10	15	15	EP84AZN	
CUT	6340-6390	2.47	1.28	5.99	.18	52	243							2+	50	10	25	15	EP84BOI	
CUT	6340-6390	6.67	3.87	29.50	.12	58	442							2+	70	10	10	10	EP84BOG	
CUT	6390-6500	1.82	.88	2.78	.24	48	153	.54	.08	.57	.40	.84	85	2+	40	15	25	20	EP84AZO	
CUT	6800-6900	.35	.47	.73	.39	134	209												EP84AZP	



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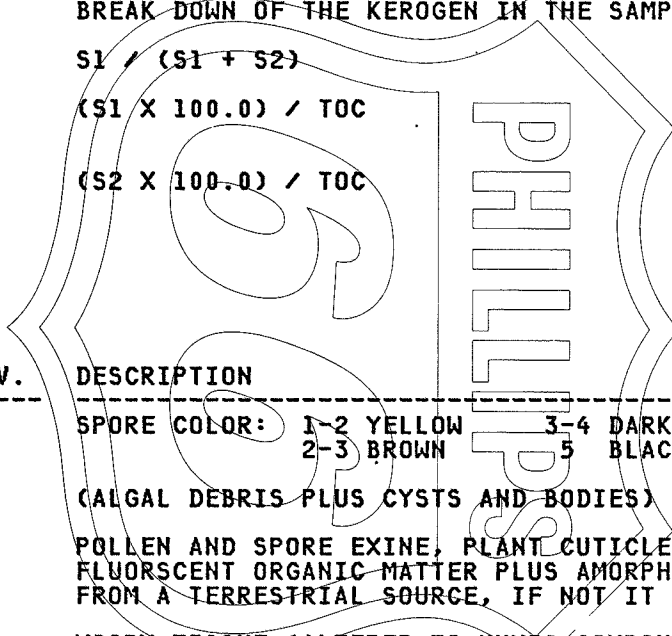
SOURCE ROCK REPORT/PLOT TERMINOLOGY

TOC/PYROLYSIS GEOCHEMICAL DATA:

TERM	ABBREV.	DESCRIPTION
TOTAL ORGANIC CARBON	TOC	THE AMOUNT OF ORGANIC CARBON IN A ROCK SAMPLE, EXPRESSED AS WEIGHT PERCENT OF THE ROCK SAMPLE
THERMALLY EXTRACTABLE HYDROCARBONS	S1 (TEH)	THE AMOUNT OF THERMALLY EXTRACTABLE HYDROCARBONS (HC) CURRENTLY IN THE ROCK SAMPLE, EXPRESSED AS MG.HC/G.ROCK
	S2	THE AMOUNT OF THERMALLY EXTRACTABLE HYDROCARBONS GENERATED FROM THE THERMAL BREAK-DOWN OF THE KEROGEN IN THE SAMPLE (MG.HC/G.ROCK)
PRODUCTION INDEX	PI	$S1 / (S1 + S2)$
THERMAL EXTRACTION INDEX	TEI	$(S1 \times 100.0) / TOC$
HYDROGEN INDEX	HI	$(S2 \times 100.0) / TOC$

VISUAL KEROGEN DATA:

TERM	ABBREV.	DESCRIPTION
THERMAL ALTERATION INDEX	TAI	SPORE COLOR: 1-2 YELLOW 3-4 DARK BROWN 2-3 BROWN 5 BLACK
ALGINITE	ALG	(ALGAL DEBRIS PLUS CYSTS AND BODIES) PLUS AMORPHOUS SAPROPEL
EXINITE	EXI	POLLEN AND SPORE EXINE, PLANT CUTICLES, RESINS, AND OTHER STRONGLY FLUORSCENT ORGANIC MATTER PLUS AMORPHOUS HERBACEOUS (IF RECOGNIZABLE AS FROM A TERRESTRIAL SOURCE, IF NOT IT IS RECORDED UNDER ALGINITE)
VITRINITE	VIT	WOODY TISSUE (ALTERED TO HUMIC COMPOUNDS) PLUS NONFLUORESCENT STRUCTURED TRANSLUCENT MATERIAL PLUS AMORPHOUS VITRINITE
INERTINITE	INER	COALY MATERIAL INCLUDING FUSINITE, SEMIFUSINITE, PSEUDOVITRINITE, MACRINITE, AND INERTODETRINITE



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