

ROBERTSON RESEARCH INTERNATIONAL LIMITED

NORWEGIAN OFFSHORE AREA - PRELIMINARY REPORT NO. 4A

Project No. RRI/789/IIB/2676

PRELIMINARY RESULTS OF PETROLEUM GEOCHEMICAL STUDIES

OF THE PHILLIPS NORWAY 2/7-1 WELL

21st July, 1978

I

INTRODUCTION

Petroleum geochemical studies have been carried out on samples received from the Phillips Norway 2/7-1 well. The samples were received at varying intervals and were selected for analysis by compositing at 60 or 80 feet intervals dependent on lithological and log data. After compositing, samples were washed with cold water as necessary to remove drilling mud, and air dried at 50°C. No core samples were available from this well section.

The well is believed to have been drilled with a water based drilling mud throughout.

The samples were of good quality for geochemical analysis. Compositing was started at 3500 feet so that representative material of Middle Miocene and older ages has been analysed with the exception of the interval 9025 to 10200 feet where no sample material was available. The analytical procedures used

include organic carbon analysis on all the bulk cuttings samples at 60 to 80 feet intervals and also on individual lithologies where bulk samples consisted of more than one lithotype. Extractive source rock analysis has been carried out on samples containing more than 0.5% organic carbon at approximately 250 feet intervals. Gas chromatographic analysis has been carried out on alkane fractions from samples containing greater than 100ppm of hydrocarbon. Pyrolysis source rock evaluation using the IFP/Fina ROCK-EVAL apparatus has been carried out on the same samples as used for extractive analysis, on samples where insufficient material was available for extractive analysis, on samples of picked lithologies where composite samples contained more than one significant lithotype and in the Jurassic interval on samples after they have been solvent extracted for source rock analysis. Kerogen composition has been assessed on a semiquantitative basis by visual estimation of the kerogen components in unsieved, unoxidised, palynological preparations.

Maturity levels have been assessed in this study using principally spore colouration analysis on sieved, unoxidised, palynological preparations and vitrinite reflectivity on kerogen concentrates. In assessing maturity level, reference may also be made to the temperatures of maximum pyrolysis rate which give useful indications of maturity level when used in conjunction with the kerogen type.

II

RESULTS AND INTERPRETATION

The results of the various analyses carried out on the 2/7-1 well are presented in Tables 1 to 3 and are represented graphically in Figures 1 to 4. Table 1 lists data on maturity level in the sections along with the kerogen composition data for the same samples. The spore colouration and vitrinite

reflectivity trends with depth are shown in Figures 1 and 2 respectively. Table 2 lists the organic carbon and extractive source rock evaluation data while pyrolysis data are presented in Table 3. Pyrolysis data are represented graphically against depth in Figures 3 and 4. A detailed graphic presentation of all the data will be presented later in the compilation report.

MATURITY DATA

Our assessment of the spore colouration data is that the Lower Tertiary sediments in the analysed interval below 5000 feet are at an early stage of maturity for oil generation given the presence of oil-prone organic matter (see source rock evaluation). No reliable spore colour data have been obtained in the Lower Cretaceous interval but spore colour values in the Upper Jurassic seem to indicate a maturity gradient which is a continuation of that in the Tertiary. The Upper Jurassic Kimmeridgian rocks have spore colours which indicate that the section is well mature and at colour indices of 7 rising to 8.5 little residual hydrocarbon generating potential can remain. An estimation of the remaining hydrocarbon potential can be made from the pyrolysis data. At present maturity levels fairly high gravity oil would have been sourced from sapropelic organic matter.

Vitrinite reflectivity data give a trend rising from about 0.30% at 4000 feet to about 0.55% at the base of the Tertiary. A value of 0.35%, which we consider can indicate the onset of maturity for oil generation in a Tertiary basin, is reached at about 6000 feet in the analysed interval of the Tertiary. The reflectivity level in the Lower Cretaceous is not defined as no clearly identified vitrinite was seen in this interval.

The Upper Jurassic interval of the well has provided vitrinite reflectivity results which indicate a marked discontinuity in the Kimmeridgian shale sequence. The organic matter appears to be largely sapropelic in origin and has been heated to the extent that near the base of the section it has become reflective at

approximately the same level as the in situ vitrinite. Vitrinite is scarce in the samples from 12180 to about 13500 feet but is considerably more abundant and occurs as coaly fragments below 14000 feet. There is a very marked change in reflectivity values between 13600 and 13960 feet with values above 13600 feet of around 0.6% but values below 13960 feet are around 1.0%.

HYDROCARBON SOURCE POTENTIAL DATA

On the basis of the geochemical data obtained, the following breakdown of the analysed interval of the 2/7-1 well is made:

- Interval 3000 to 9025 feet - Interval is represented by variously coloured green-grey, medium grey and brown-grey shales and mudstones with above average to well above average organic carbon contents (typically 2% to 3% but in excess of 4% between about 6000 and 7000 feet). The organic matter is predominantly humic and in particular is vitrinitic and present maturity levels no significant hydrocarbon generating potential is anticipated. It is noted that solvent extraction has recorded anomalous amounts of extractable organic matter, particularly hydrocarbons throughout the analysed Lower Tertiary interval. Gas chromatography has indicated an oil-like alkane distribution and contamination by migrant oil is suspected.
- Interval 10200 to 11220 feet - Chalk - organically lean with no hydrocarbon source potential. Influx of grey calcareous

shales in the lower part of the interval.

Interval 11240 to 12160 feet - Lower Cretaceous marls. Variable but generally low content of organic matter which is predominantly inertinitic. No source potential.

Interval 12180 to 15000 feet - Dark grey to black shales of Upper Jurassic Volgian age. On geochemical evidence the interval may be divided into two parts. The upper part from 12180 to 13660 feet is organically richer than average with carbon contents of 3% to 5%. The organic matter is predominantly sapropelic but well advanced in maturity so that little hydrocarbon generating potential remains.

The interval from 13680 to 15000 feet is considerably richer with organic carbon contents up to 10% or more. The level of maturity is very significantly higher than in the overlying interval and there is a marked change in kerogen composition with significantly greater amounts of humic vitrinitic organic matter being present. There appears to be virtually no remaining potential for generating liquid hydrocarbons and dry gas only is anticipated.

It is notable that in this Jurassic interval there are relatively large amounts of

extractable hydrocarbons. These hydrocarbons are oil-like in alkane distribution and are believed to be indigenous to the formation. They presumably represent hydrocarbons which have been sourced in situ but which have been unable to migrate out of the formation in which they are found.

TABLE 1A MATURITY EVALUATION DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH FEET	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R _{av} %	KEROGEN COMPOSITION (%)		
					INERTINITE	VITRINITE	SAPROPEL
3500- 580	Ctgs	Lt ol-gy mdst	3.5		30	30	40?
3860- 940	"	Ditto	3	0.30(28)	40	40	20
4100- 150	"	Ditto	3.5		45	45	10
4540- 620	"	Ditto	3-3.5	0.31(3)	30	20	50?
4952- 5041	"	Ol-gy mdst	3.5	0.30(1)	60	20	20
5270- 350	"	Lt ol-gy sh	2.5	0.29(1)	40	*	60?
5520- 580	"	Ol-gy/brn-gy sh	2.5?	0.31(5)	10	5	85
5840- 910	"	Ditto	3.5	0.35(11)	20	70	10
6110- 170	"	Lt ol-gy sh	3.5-4	0.30(11)	20	80	*
6360- 430	"	Ditto	4	0.32(5); 0.39(4)	40	40	20
6550- 610	"	Lt ol-gy/brn-gy sh	4.5-5?	0.40(21)	50	50	*
6800- 870	"	Ditto	4	0.42(31)	15	80	5
7000- 080	"	Ditto	4.5-5	0.40(28)	30	70	*
7400- 470	"	Ditto	4.5	0.40(25)	30	70	*
7860- 900	"	Ditto	4.5	0.41(15)	25	70	5
8040- 090	"	Ditto	4.5	0.45(15)	40	60	*
8250- 310	"	Lt ol-gy sh	*	0.32(13); 0.45(3)	20	80	*
8510- 590	"	Ditto	5	0.40(1)	20	80	*
8850- 910	"	Ditto	5	0.52(10)	5	90	5
10200- 260	"	Chalk	*	*	50?	50?	*
10540- 600	"	Ditto	*	0.64(4); 0.86(4)	20	*	80?
10780- 840	"	Ditto	*	*	90	*	10?
11020- 080	"	Ditto + mnr sh	*	1.07(2)?	60	*	40?
11240- 300	"	Ditto + Ditto	*	0.86(2)?	60	*	40?
11480- 520	"	Med gy calc sh	6?	0.55(2)	50	20	30?
11780- 840	"	Lt ol-gy calc sh	*	*	50	*	50?
12020- 080	"	Ditto	6?	*	70	*	30?
12180- 240	"	Dk gy calc sh	6-6.5	1.11(7)?	50	5	45
12420- 480	"	Ditto	7	0.62(2)	30	10	60
12720- 785	"	Ditto	7	0.71(4)	10	5	85
13000-060	"	Ditto	7.5	0.64(2)	30	5	65

TABLE 1B MATURITY EVALUATION DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH FEET	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R _{av} %	KEROGEN COMPOSITION (%)		
					INERTINITE	VITRINITE	SAPROPEL
13270- 330	Ctgs	Dk gy calc sh	7.5	0.64(1)	30	5	65
13540- 600	"	Ditto	8	0.66(10)	30	5	65
13750- 810	"	Ditto	7.5	0.63(10); 0.86(12)	30	5	65?
13960-14005	"	Ditto	8	0.97(26)	30	5	65?
14280- 340	"	Ditto	8	1.05(22)	35	*	65?
14530- 590	"	Ditto	8-8.5	1.05(9)	20	*	80
14725- 790	"	Ditto	8.5	1.04(11)	30	5	65?
14940-15000	"	Ditto	8.5	1.10(17)	25	25	50?

SOURCE ROCK EVALUATION DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	TOTAL EXTRACT P.P.M.	EXTRACT % OF ORGANIC CARBON	HYDRO- CARBONS P.P.M. OF ROCK	HYDRO- CARBONS % OF EXTRACT	TOTAL ALKANE % HYDRO CARBON:
3500-580	Ctgs	Lt ol-gy sl calc mdst	1.78					
3620-700	"	Ditto	2.34	1080	4.6	160	15	77
3740-820	"	Ditto	2.39					
3860-940	"	Ditto	2.64					
4000-040	"	Ditto	2.81					
4100-150	"	Ditto	2.87					
4200-250	"	Ditto	2.90					
4300-380	"	Ditto	2.19					
4420-500	"	Ditto	2.65	2450	9.2	415	17	75
4540-620	"	Ditto	2.62					
4660-720	"	Ditto	2.65					
4760-840	"	Ditto	1.98					
4880-920	"	Ditto	1.90					
4952-5041	"	Ol-gy sl calc mdst	2.42					
5050-130	"	Ditto	3.15					
5175-260	"	Ditto	2.42	1425	5.8	460	32	78
5270-350	"	Lt ol-gy sl calc sh	2.23					
5360-420	"	Ditto	2.87					
5440-500	"	Ditto	2.59	3255	12.5	550	17	76
5520-580	"	Ol-gy/brn-gy sl calc sh+mnr lt. ol-gy sh	3.50					
5590-660	"	Ditto	3.31					
5680-740	"	Ol-gy/lt ol-gy slty sh	3.15					
5760-820	"	Lt ol-gy/brn-gy sl calc slty sh	3.48	3320	9.6	445	13	77
5840-910	"	Ditto	2.94					
5940-6010	"	Ditto	3.26					
6030-090	"	Lt ol-gy sl calc sl slty sh	3.17					
6110-170	"	Ditto	4.10					
6190-250	"	Ditto	3.79	3915	10.3	350	9	54
6270-340	"	Ditto	4.69					
6360-430	"	Ditto	4.15					
6450-530	"	Ditto	4.75					
6550-610	"	Lt ol-gy/brn-gy sh	4.58					
6650-710	"	Ditto	5.79					

SOURCE ROCK EVALUATION DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	TOTAL EXTRACT P.P.M.	EXTRACT % OF ORGANIC CARBON	HYDRO- CARBONS P.P.M. OF ROCK	HYDRO- CARBONS % OF EXTRACT	TOTAL ALKANE % HYDRO- CARBON
6800-870.	Ctgs	Lt ol-gy/brn-gy sh	3.58					
6900-970	"	Ditto	5.30					
7000-080	"	Ditto	4.96					
7400-470	"	Ditto	2.30					
7570-640	"	Lt ol-gy sh+mnr yel- brn dol	2.15					
7670-750	"	Ditto	1.95					
7780-840	"	Ditto	2.04					
7860-900	"	Lt ol-gy sh+10% brn- gy sh	7.42					
7950-8010	"	Ditto	1.72					
8040-090	"	Ditto+mnr ol-gy sh	2.02					
8110-150	"	Ditto+mnr brn-gy sh	1.95					
8170-230	"	Lt ol-gy sh+mnr brn- gy/dk gy sh	2.62					
8250-310	"	Ditto+ditto	2.17					
8330-390	"	Ditto+mnr brn-gy sh/ yel-brn lst	2.00					
8430-490	"	Ditto+ditto	1.98					
8510-590	"	Ditto+ditto	1.49					
8610-670	"	Ditto+ditto	2.34					
8690-755	"	Ditto+50% brn-gy sh	3.68					
8770-830	"	Ditto+10% ditto	3.05					
8850-910	"	Ditto+ditto	2.80					
8930-9025	"	Ditto+ditto	2.55					
10200-260	"	V lt gy/yel-gy lst	0.34					
10270-330	"	Ditto	0.19	625	32.8	40	7	*
10340-410	"	Ditto	0.17					
10430-500	"	Ditto	0.36					
10540-600	"	Ditto	0.37					
10620-680	"	Ditto	0.38					
10700-760	"	Ditto+mnr med-lt gy calc sh	0.28					
10780-840	"	Ditto+ditto	0.54					
10860-920	"	Ditto+mnr med gy calc sh	0.48					
10940-11000	"	Ditto+ditto	0.60					

SOURCE ROCK EVALUATION DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	TOTAL EXTRACT P.P.M.	EXTRACT % OF ORGANIC CARBON	HYDRO- CARBONIC P.P.M. OF ROCK	HYDRO- CARBONS % OF EXTRACT	TOTAL ALKANES % HYDRO CARBONS
11020-085	Ctgs	V lt gy/yel-gy lst+mnr med gy calc sh	0.65					
11100-160	"	Ditto+ditto	0.44					
11180-220	"	Ditto+ditto	0.52					
11240-300	"	Ditto+ditto	0.70					
11320-380	"	Lt-med gy calc sh	0.98					
11700-760	"	Lt ol-gy calc sh	1.18					
12020-080	"	Lt ol-gy/med gy calc sh	1.36					
12100-160	"	Ditto	2.00					
12180-240	"	Dk gy calc sh+10% lt gy sh	4.65					
12260-320	"	Dk gy sl calc sh+20% med gy sh	2.89					
12340-400	"	Ditto+mnr lt gy sh	3.94					
12420-480	"	Ditto+ditto	3.15					
12490-540	"	Ditto+ditto	2.78					
12580-640	"	Ditto+ditto	2.98					
12655-705	"	Dk gy calc sh+40% lt gy calc sh	2.76					
12720-785	"	Ditto+10% ditto	3.81					
12795-850	"	Ditto+ditto	4.23	6050	14.2	1625	27	78
		Extracted rock	3.73					
12860-920	"	Ditto+ditto	4.38					
12930-990	"	Ditto+ditto	3.94	5965	15.1	2055	34	81
		Extracted rock	3.92					
13000-060	"	Ditto+ditto	2.79					
13070-130	"	Ditto+ditto	2.96					
13140-200	"	Ditto+ditto	3.09	6705	21.6	1075	16	87
		Extracted rock	2.96					
13210-260	"	Ditto+ditto	2.77					
13270-330	"	Ditto+ditto	3.70					
13340-400	"	Ditto+ditto	5.67	6895	12.1	2090	30	81
		Extracted rock	5.54					
13410-460	"	Ditto+5% lt-med gy calc sh	6.92					
13470-530	"	Ditto+ditto	2.87					

SOURCE ROCK EVALUATION DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	TOTAL EXTRACT P.P.M.	EXTRACT % OF ORGANIC CARBON	HYDRO- CARBONS P.P.M. OF ROCK	HYDRO- CARBONS % OF EXTRACT	TOTAL ALKANES % HYDRO CARBONS
13540-600	Ctgs	Dk gy calc sh+5% lt- med gy calc sh	2.99					
13610-660	"	Ditto+ditto	6.45					
13680-740	"	Ditto+ditto	11.30	11595	10.2	2925	25	78
		Extracted rock	8.57					
13750-810	"	Ditto+ditto	5.79					
13820-880	"	Ditto+ditto	12.04	12125	10.0	3955	33	78
		Extracted rock	9.63					
13890-950	"	Ditto+ditto	3.97					
13960-14005	"	Ditto+ditto	2.74					
14280-340	"	Ditto+ditto	8.96	7450	8.3	1880	25	75
		Extracted rock	6.84					
14345-405	"	Ditto	6.23					
14410-460	"	Ditto	17.86	12155	6.8	2015	17	70
		Extracted rock	11.71					
14465-525	"	Ditto	7.39					
14530-590	"	Ditto	9.22	10410	11.2	3460	33	87
		Extracted rock	6.94					
14595-655	"	Ditto	7.28					
14660-720	"	Ditto	7.89	6970	8.8	1950	28	84
		Extracted rock	5.75					
14725-790	"	Ditto	4.87					
14800-860	"	Ditto	5.32					
14870-930	"	Ditto	3.30					
14940-15000	"	Ditto	4.37					
		<u>PICKED LITHOLOGIES</u>						
5175-260	Ctgs	Lt ol-gy calc sh	2.05					
5270-350	"	Ditto	1.41					
5360-420	"	Ditto	2.35					
5440-500	"	Ditto	2.11					
5520-580	"	Ditto	1.84					
5520-580	"	Ol-gy/brn-gy calc sh	4.02					
5590-660	"	Ditto	2.81					
5680-740	"	Ditto	2.04					
7570-640	"	Lt ol-gy sh	1.81					

SOURCE ROCK EVALUATION DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	TOTAL EXTRACT P.P.M.	EXTRACT % OF ORGANIC CARBON	HYDRO- CARBONS P.P.M. OF ROCK	HYDRO- CARBONS % OF EXTRACT	TOTAL ALKANE % HYDRO CARBON
7670-750	Ctgs	Lt ol-gy sh	1.65					
7780-840	"	Ditto	1.65					
7780-840	"	Ol-gy sh	2.30					
7860-900	"	Lt ol-gy sh	1.92					
7860-900	"	Brn-gy sh	5.51					
8110-150	"	Lt ol-gy sh	1.59					
8110-150	"	Brn-gy sh	3.71					
8170-230	"	Lt ol-gy sh	1.94					
8170-230	"	Brn-gy sh	4.36					
8250-310	"	Lt ol-gy sh	1.76					
8330-390	"	Ditto	1.72					
8330-390	"	Brn-gy sh	5.29					
8430-490	"	Lt ol-gy sh	1.59					
8510-590	"	Ditto	1.84					
8610-670	"	Ditto	1.70					
8610-670	"	Brn-gy sh	4.83					
8690-755	"	Ditto	7.04					
8770-830	"	Ol-gy sh	2.23					
8770-830	"	Brn-gy sh	5.29					
8850-910	"	Ditto	4.73					
8930-9025	"	Ditto	3.96					
10780-840	"	Med-lt gy calc sh	1.42					
10860-920	"	Ditto	0.80					
11320-380	"	Ol-gy calc sh	0.42					
11480-520	"	Med gy sh	0.89					
11540-600	"	Ditto	1.17					
11700-760	"	Ditto	0.68					
12180-240	"	Lt gy sh	0.53					
12180-240	"	Dk gy calc sh	5.52					
12580-640	"	Med gy sh	0.63					
12580-640	"	Dk gy sh	2.86					
12720-785	"	Lt gy calc sh	0.56					
12720-785	"	Dk gy sh	3.88					
13070-130	"	Lt gy calc sh	0.59					
13070-130	"	Dk gy sh	3.73					

TABLE 3A

ROCK - EVAL. PYROLYSIS DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	GENERALISED LITHOLOGY	ORGANIC CARBON (%)	TEMPERATURE (°C)	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (PPM)
3620-700	Lt ol-gy mdst	2.49	429	51	183	*	1300
4000-040	Ditto	2.81	423	48	51	*	1400
4420-500	Ditto	2.66	430	54	72	*	1500
4760-840	Ditto	1.98	429	21	67	*	400
5175-260	Ol-gy mdst	2.38	423	33	66	*	800
5440-500	Ditto	2.88	428	129	54	*	3700
5760-820	Lt ol-gy sh	3.00	433	107	54	*	3200
5940-6010	Ditto	3.26	420	89	74	*	2900
6190-250	Ditto	3.93	429	110	59	*	4300
6450-530	Ditto	4.75	429	94	47	*	4500
6800-870	Ditto	3.58	430	224	118	*	8000
7000-080	Ditto	4.96	428	110	49	*	5400
7400-470	Ol-gy sh	2.30	428	66	21	*	1500
7570-640	Lt ol-gy sh	2.15	428	32	63	*	700
7860-900	Ditto	7.42	431	13	10	*	1000
8110-150	Ditto	1.95	438	69	74	*	1300
8430-490	Ditto	1.98	432	20	15	*	400
8690-755	Ditto	3.68	426	79	51	*	2900
8930-9025	Ditto	2.55	428	70	137	*	1800
10200-260	Chk	0.34	430	17	364	0.7	100
10430-500	Chk	0.36	421	43	423	0.2	200
10940-11000	Chk	0.60	429	245	136	0.1	1500
11320-380	Lt-med gy calc sh	0.98	*	*	74	*	*
11700-760	Ditto	1.18	*	*	38	*	*
12100-160	Med gy calc sh	2.00	436	63	72	0.08	1300
12180-240	Dk gy calc sh	4.90	439	123	25	0.2	6000
12260-320	Ditto	2.89	441	94	57	0.2	2700
12580-640	Ditto	2.98	438	60	41	0.2	1800
12795-850	Ditto	3.97	438	56	32	0.3	2200
12930-990	Ditto	3.51	438	60	38	0.2	2100
13140-200	Ditto	3.04	439	74	36	0.2	2200
13340-400	Ditto	3.63	440	182	27	0.2	6600
13540-600	Ditto	2.99	434	404	28	0.3	12100
13680-740	Ditto	9.25	438	17	6	0.4	1600
13820-880	Ditto	11.68	454	105	8	0.3	12300
14280-340	Ditto	6.48	443	65	41	0.4	4200

TEMPERATURE (°C) = TEMPERATURE AT MAXIMUM RATE OF PYROLYSIS
 PRODUCTION INDEX = AN ESTIMATE OF PRESENT HYDROCARBON GENERATING POTENTIAL
 COMPARED TO THAT AT OPTIMUM MATURITY
 POTENTIAL YIELD = AN ESTIMATE OF HYDROCARBON PRODUCTION AT OPTIMUM MATURITY

ROCK - EVAL. PYROLYSIS DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	GENERALISED LITHOLOGY	ORGANIC CARBON (%)	TEMPERATURE (°C)	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (PPM)
14410-460	Dk gy calc sh	10.09	462	150	1	0.3	15100
14530-590	Ditto	7.51	444	54	18	0.4	4100
14660-720	Ditto	7.83	440	31	21	0.5	2500
14800-860	Ditto	5.32	448	88	55	0.5	4700
14980-15000	Ditto	4.37	438	17	57	0.8	700
<u>PICKED LITHOLOGIES</u>							
5175- 260	Lt ol-gy calc sh	2.05	422	27	109	*	500
5270- 350	Ditto	1.41	425	52	163	*	700
5360- 420	Ditto	2.35	427	156	88	*	3600
5520- 580	Ditto	1.84	424	90	97	*	1600
5520- 580	Ol-gy/brn-gy sh	4.02	423	176	45	*	7100
5680- 740	Ditto	2.04	433	82	160	*	1700
7570- 640	Lt ol-gy sh	1.81	434	24	48	*	400
7780- 840	Ditto	1.65	435	27	53	*	400
7780- 840	Ol-gy sh	2.30	436	59	34	*	1400
7860- 900	Brn-gy sh	5.51	433	105	44	*	5800
8110- 150	Ditto	3.71	436	117	56	*	4400
8170- 230	Ditto	4.36	437	122	40	*	5400
8330- 390	Lt ol-gy sh	1.72	427	34	32	*	600
8330- 390	Brn-gy sh	5.29	433	126	32	*	6700
8510- 590	Lt ol-gy sh	1.84	440	213	55	*	4000
8610- 670	Ditto	1.70	432	58	37	*	1000
8610- 670	Brn-gy sh	4.83	433	147	35	*	7100
8690- 755	Ditto	7.04	427	162	38	*	11500
8770- 830	Ol-gy sh	2.23	429	89	56	*	2000
8770- 830	Brn-gy sh	5.29	433	147	32	*	7800
8930- 9025	Ditto	3.96	430	115	60	*	4600
10780- 840	Med-lt gy calc sh	1.42	436	28	138	*	400
11540- 600	Ol-gy calc sh	1.17	441	29	129	*	300
12180- 240	Lt gy sh	0.53	*	*	139	*	*
12180- 240	Dk gy calc sh	5.52	442	155	25	*	8500
12580- 640	Ditto	2.86	434	117	44	*	3400

TEMPERATURE (°C) = TEMPERATURE AT MAXIMUM RATE OF PYROLYSIS
 PRODUCTION INDEX = AN ESTIMATE OF PRESENT HYDROCARBON GENERATING POTENTIAL
 COMPARED TO THAT AT OPTIMUM MATURITY
 POTENTIAL YIELD = AN ESTIMATE OF HYDROCARBON PRODUCTION AT OPTIMUM MATURITY

ROCK - EVAL. PYROLYSIS DATA

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SE.

SAMPLE DEPTH (FEET) OR NOTATION	GENERALISED LITHOLOGY	ORGANIC CARBON (%)	TEMPERATURE (°C)	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (PPM)
<u>REPEAT ANALYSIS - EXTRACTED RESIDUES</u>							
12795-850	Dk gy calc sh	3.73	436	32	49	*	1200
12930-990	Ditto	3.92	425	32	28	*	1200
13140-200	Ditto	2.96	432	41	36	*	1200
13340-400	Ditto	5.54	441	71	18	*	4000
13680-740	Ditto	8.57	436	109	10	*	9300
13820-880	Ditto	9.63	434	86	10	*	8200
14280-340	Ditto	6.84	448	28	27	*	1900
14410-460	Ditto	11.71	459	59	11	*	6900
14530-590	Ditto	6.94	452	39	11	*	2700
14660-720	Ditto	5.75	449	31	27	*	1800

TEMPERATURE (°C) = TEMPERATURE AT MAXIMUM RATE OF PYROLYSIS
 PRODUCTION INDEX = AN ESTIMATE OF PRESENT HYDROCARBON GENERATING POTENTIAL
 COMPARED TO THAT AT OPTIMUM MATURITY
 POTENTIAL YIELD = AN ESTIMATE OF HYDROCARBON PRODUCTION AT OPTIMUM MATURITY

FIGURE 1

SPORE COLOURATION INDICES AGAINST DEPTH

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

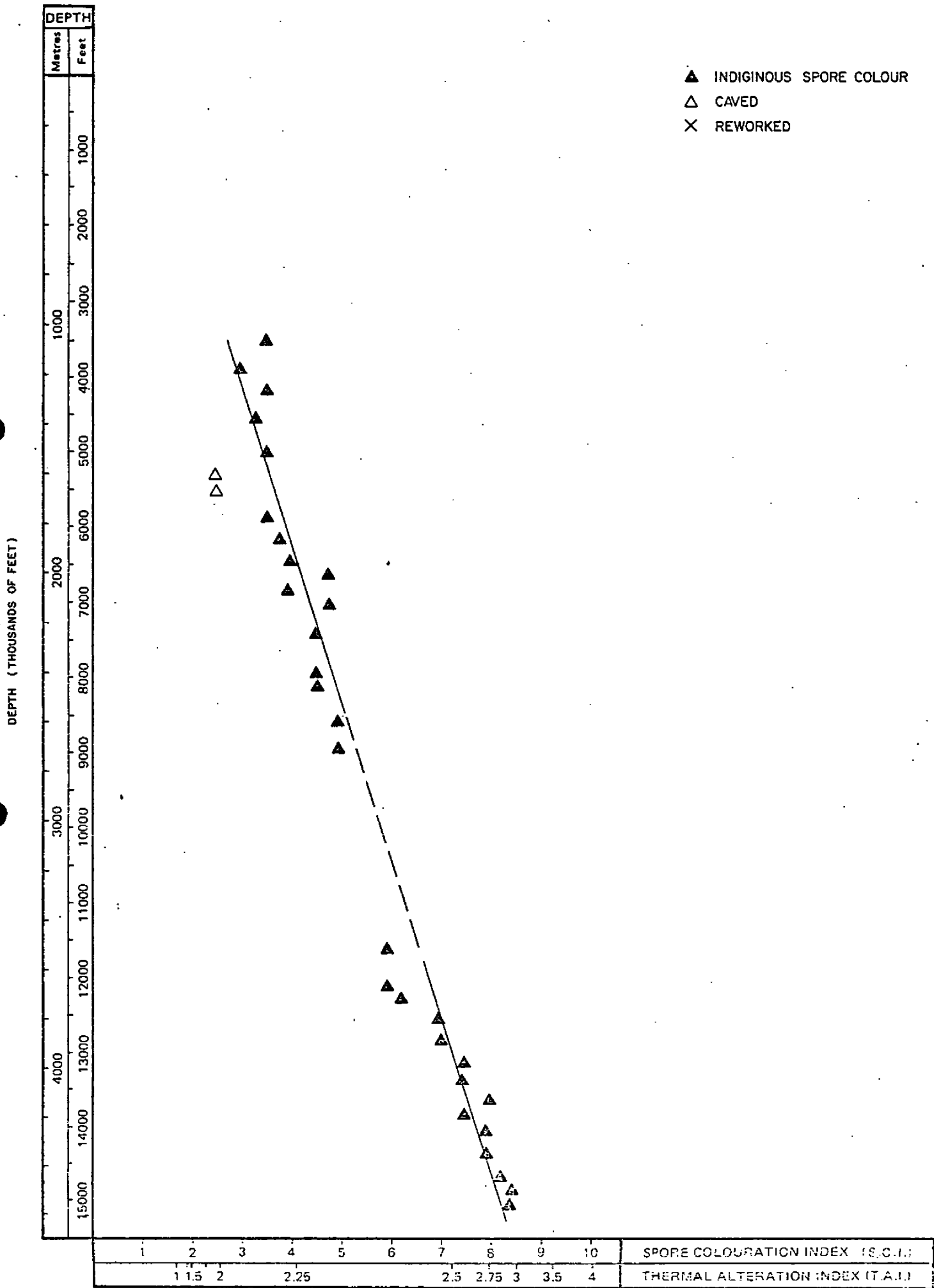


FIGURE 2 VITRINITE REFLECTIVITY AGAINST DEPTH

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA

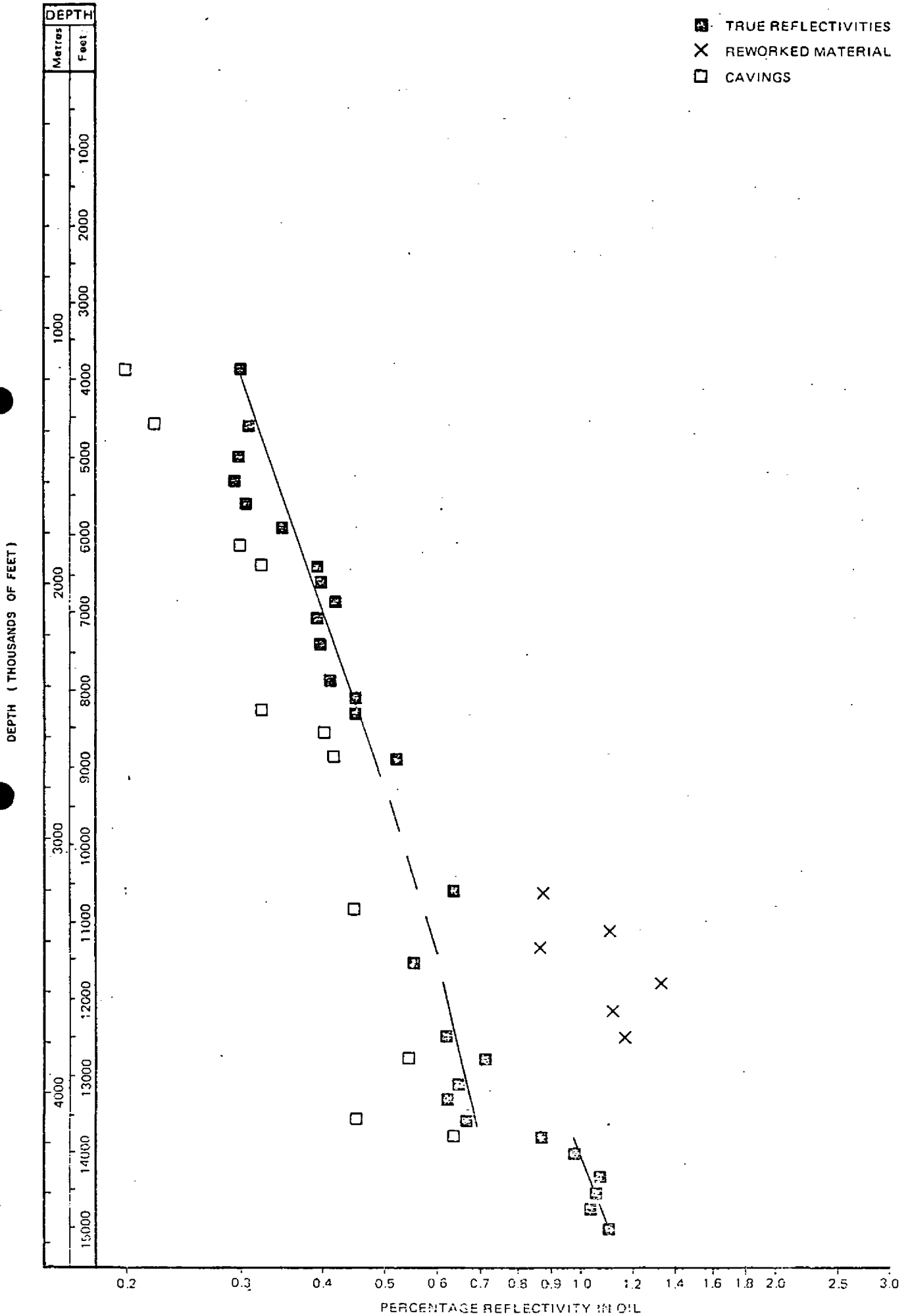


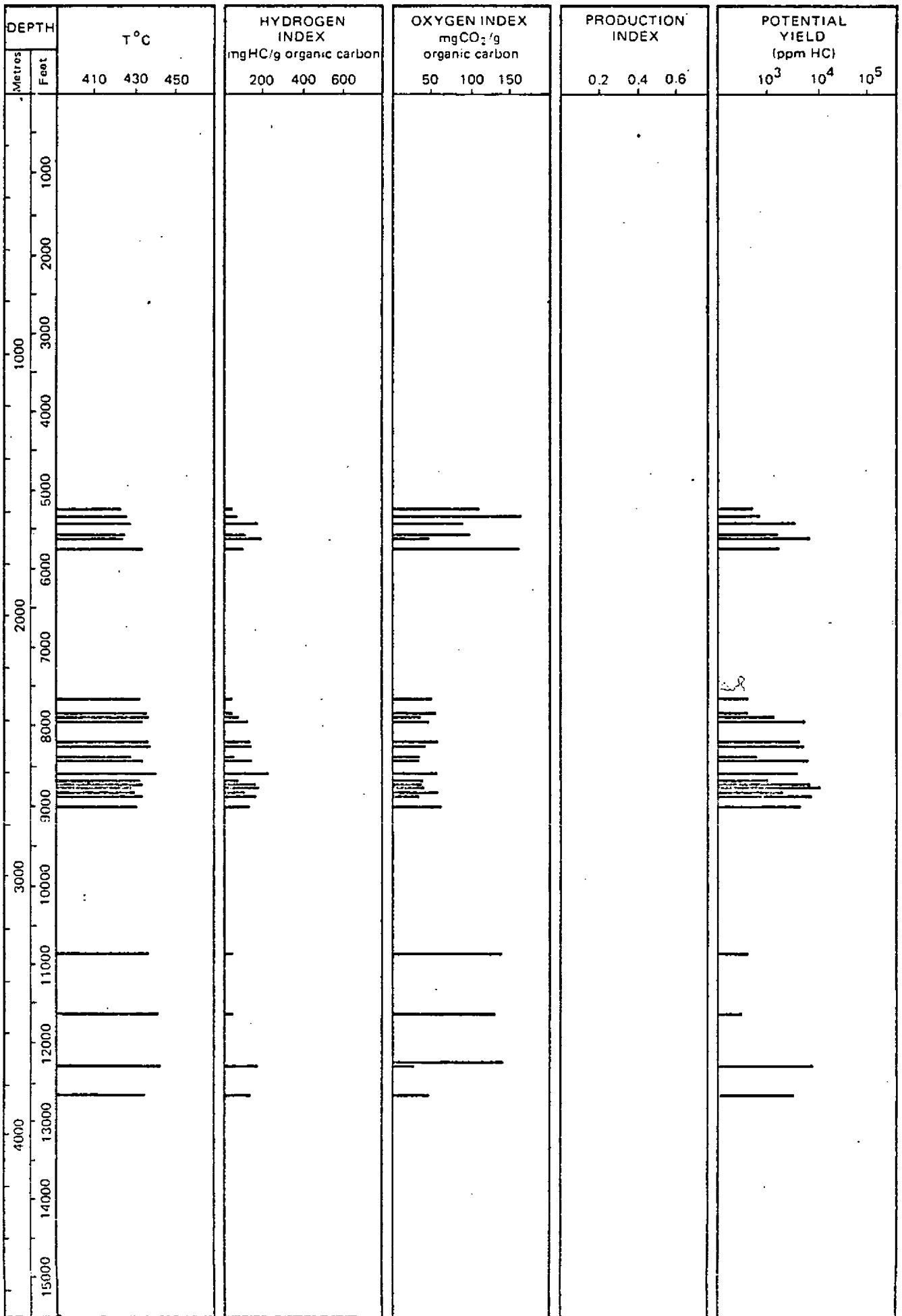
FIGURE 4

PYROLYSIS DATA SUMMARY CHART

PICKED LITHOLOGIES

WELL: 2/7-1

LOCATION: NORWEGIAN NORTH SEA



J.M. H.
P.K.

ROBERTSON RESEARCH INTERNATIONAL LIMITED

NORWEGIAN OFFSHORE AREA - PRELIMINARY REPORT NO. 3

Project No. RRI/789/IIB/2676

PRELIMINARY RESULTS OF BIOSTRATIGRAPHIC
STUDIES OF THE PHILLIPS NORWAY 2/7-1 WELL

4th July 1978.

I

BIOSTRATIGRAPHIC BREAKDOWN

Our breakdown of this well as it now stands is as follows:

Tops in feet

2000	Pliocene
2580	Upper Miocene
3100	Middle Miocene
5260	Lower Miocene
5780	Oligocene
8590	Eocene

Tops in feet

8725	Lower Eocene
9265	Palaeocene
9615	Danian
9854	Maastrichtian
9940	?Campanian
9965	Coniacian - Turonian
10860	Cenomanian
11200	Albian
11230	early Albian-Aptian
11440	Barremian
11700	early Barremian - late Hauterivian
11860	early Hauterivian - Valanginian
12000	early Valanginian - ?Ryazanian
12170	late Volgian (n)
12240	middle Volgian (o)
14000 to 15000 TD	?middle Volgian (?o)

II

LITHOLOGICAL COMMENTS

The Tertiary is very thick, consisting mainly of clays and shales. The Balder Formation tuffs are well developed, particularly between 9280' and 9300'. The Sele and Lista Formations are essentially shaly with minor glauconitic sandstones.

White to light grey chalk or chalky limestone extends from 9627' to 10540'. An interval of grainy glauconitic limestones and minor shales between 10560' and 10600' is possibly part of the Plenus Marl Formation but the dark grey shales appearing at 10820' definitely belong to this formation. White chalk of the Hidra Formation occurs below this.

The Lower Cretaceous Rødby Formation of Albian age consists of highly calcareous shales which are brown and green in colour rather than the more typical red. The underlying Valhall Formation consists of grey and brown pyritic calcareous shales and argillaceous limestones.

The Jurassic which is at least 3000' thick is made up mainly of dark grey to black shales but with minor intervals of dolomite and calcareous sandstone.

III

MICROPALAEONTOLOGICAL COMMENTS

Microfaunas in the Tertiary of this well are generally abundant and diverse.

Despite the great thickness of sediments, and some localised oxidisation and pyritisation of assemblages, preservational characteristics throughout the Tertiary are quite good.

Accurate determinations of some boundaries, notably the Mio-Oligocene and Oligo-Eocene, has been made difficult by the necessity to relate open marine faunas with faunas from near shore facies of onshore sections. In addition it seems likely that there is a significant amount of reworked Eocene occurring in the Oligocene.

Further refinement of the Tertiary should be possible as correlation studies progress.

The microfaunas of the Upper Cretaceous are relatively poor and poorly preserved. It is apparent, from the assemblages, that a stratigraphical hiatus occurs at approximately 9965' and this appears to mark the junction of the Tor with the Hod Formation. In the Lower Cretaceous quite rich and well preserved assemblages facilitate a subdivision of this

interval. In the basal part of the Cretaceous however the microfaunas are relatively poor in numbers.

In the Jurassic only rare foraminifera occur throughout and in the interval 11960' - 12690' only rare microfossils occur. However from 12700' and until the base of the well radiolaria and the sponge spicule Rhaxella perforata occur in significant numbers. In general radiolaria predominate down to 13520' but below this Rhaxella perforata becomes dominant.

IV

PALYNOLOGICAL COMMENTS

Rich and diverse palynofloral assemblages were recovered from the Lower Cretaceous section below 11480'. Assemblages and datums characteristic of Barremian, Hauterivian and Valanginian sediments were encountered. The thin early Valanginian interval may also include sediments of Ryazanian age and be a reflection of sedimentary condensing around the Cretaceous - Jurassic boundary. A distinct palynofacies and palynofloral break characterizes the top of the Jurassic. A thin interval of late Volgian sediments is recognised and the underlying sediments are considered to represent a thick middle Volgian section. There is a gap in the samples below 13980' and the deepest samples examined (below 14300') yielded few structured palynomorphs. It is noted, however, that no pre-Volgian indices were recovered during the course of this study.