ROBERTSON RESEARCH INTERNATIONAL LIMITED

NORWEGIAN OFFSHORE AREA - PRELIMINARY REPORT NO.1.

Project No. RRI/789/IIB/2676

PRELIMINARY RESULTS OF BIOSTRATIGRAPHIC AND PETROLEUM GEOCHEMICAL STUDIES OF THE AMOCO NORWAY 2/11-1 WELL.

9th MAY, 1978

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I

GENERAL INTRODUCTION

As anticipated the initial six to eight weeks of the study have proved rather difficult, due to Robertson Research receiving material from a number of wells which proved to be unsuitable for petroleum geochemistry but quite suitable for biostratigraphy.

Therefore our main problem in the last six weeks has been to locate unwashed sample material and to establish whether there is sufficient material of good quality for both petroleum geochemical and biostratigraphic analysis. Initially this was a slow process but is now gaining momentum and, due to valuable assistance by various companies, we now have quite a considerable number of well sections available to us. Overall we see no significant problems in getting access to samples as outlined in the brochure describing the project. Although the amount of material is, at times, rather limited.

We have provisionally selected ten key wells for detailed analyses. These wells are 1/3-1, 2/7-1, 2/11-1, 7/3-1, 9/4-1, 10/8-1, 11/10-1, 17/4-1, 25/1-1 and 25/10-2. They were selected on the basis of their distribution, client interest, the stratigraphic sequence involved, and to incorporate as many type lithostratigraphic sections as possible. Of these ten wells we now have access to the following five wells: 1/3-1, 2/7-1, 2/11-1, 7/3-1 and 9/4-1, and we anticipate access within the next two to three weeks to the others with the exception of the 10/8-1.

At the moment work is being carried out in one form or another on the following wells: 2/3-1, 2/3-3, 2/5-1, 2/7-1, 2/11-1, 7/3-1, 9/4-1 and 16/11-1.

II

BIOSTRATIGRAPHIC BREAKDOWN

The stratigraphic breakdown for the Amoco Norway 2/11-1 well as it stands at present is as follows :

Tops in feet

1320		Pleistocene
1890		Pliocene - Upper Miocene
3060		Middle - Lower Miocene
5910		Oligocene
6750		Eocene
7260		Lower Eocene
8460	2578	Palaeocene
8530	2600	Danian, Lower Palaeocene

Tops in feet

8600	7621	Maastrichtian	30.5
8700	[illegible]	Coniacian	30.5
8800	[illegible]	early Coniacian - Turonian	24.4
8880	2736	Turonian	152.5
9380	[illegible]	Cenomanian	6.1
9400	[illegible]	Albian - Aptian	73.2
9640	2938	Barremian	67.1
9860	[illegible]	early Barremian - late Hauterivian	79.3
10120	[illegible]	Hauterivian	97.6
10440	[illegible]	Valanginian	109.8 m.
10800	[illegible]	early Valanginian	60
11000	[illegible]	Ryazanian	128.1
*11420	[illegible]	late - middle Volgian	414.8
12780' to 15392'(T. D.)		Volgian	796.6

414.8
796.6
1211.4

* The top of the Jurassic is based on palynological evidence alone. The lithological, micropalaeontological and geochemical data tend to suggest that the Lower Cretaceous - Upper Jurassic boundary is in fact at approximately 11630'.

This breakdown is subject to revision as this project proceeds.

III

LITHOLOGICAL COMMENTS

The Tertiary above the Palaeocene is a standard clay and shale sequence. Tuffs marking the top of the Balder Formation were first noted at 8490' but the Balder

and Sele Formations seem to be consist mainly of very fine argillaceous sandstone.

The Chalk Group is normal for the area. Of note is the presence of the thin Plenus Marl horizon at 9360'.

The Cromer Knoll Group is relatively thick and almost wholly argillaceous. Where it passes into the Jurassic Bream Formation the shales become darker with higher gamma ray readings. The Bream Formation as a whole is an unusually thick and uniform shale sequence with occasional thin carbonate beds.

IV

MICROPALAEONTOLOGICAL COMMENTS

The Tertiary microfaunas from this well are often poorer than is usual in this area although sufficient fossils are present to provide an adequate basis for stratigraphic dating.

The Upper Cretaceous microfaunas are rich but the Lower Cretaceous assemblages are generally sparse with palynology providing the data for the dating of the older intervals.

Microfaunal assemblages from the Upper Jurassic are generally poor with few foraminifera being recovered. Other microfossils such as radiolaria and sponge spicules do, however, provide some help in dating this part of the section.

V

PALYNOLOGICAL COMMENTS

The Lower Cretaceous cuttings examined yielded rich and diverse palynofloral assemblages of Ryazanian - ?Aptian age. Caved elements do, however, figure prominently as do reworked Neocomian and Upper Jurassic elements. Although a complete Lower Cretaceous sequence appears to be present it is accordingly difficult to delimit a number of stage and substage boundaries.

Sedimentation appears to have been continuous across the Jurassic-Cretaceous boundary in the earliest Cretaceous and uppermost Jurassic dinocyst assemblages. They are, however, broadly similar and it difficult with the available material to define the boundary, a situation which is further complicated by massive caving and reworking.

The samples analysed below 11380' are contaminated by oil (drilling mud additive) and processing of these materials has proved to be very difficult. Recovery was poor to moderate from the majority of these samples and few stratigraphic conclusions can be drawn. The majority of the dinocysts recovered are, however, Volgian (middle?) in character, an age which is confirmed by the rich dinocyst assemblages recovered from the cored interval 12670' - 12710'.

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9th MAY, 1978

I

INTRODUCTION

Petroleum geochemical studies have been carried out on samples received from the Amoco Norway 2/11-1 well. The samples were received below the 20" casing shoe at 1290 feet as dried but unwashed cuttings at 30 and 20 feet intervals reducing to 10 feet intervals below 11160 feet. Samples were selected for analysis by compositing mostly at 60 feet intervals but dependent on lithological and log data. After compositing, samples were washed with cold water as necessary to remove drilling mud.

Relevant drilling information for this well is as follows :-

20"	Casing	-	1197 feet below K. B.
$13^{3}/_{8}$"	Casing	-	5641 feet below K. B.

$9^5/_8$"	Casing	-	11261 feet below K. B.
T. D.		-	15392 feet below K. B.

The well was drilled with a normal water based mud to 11261 feet but was replaced by an invert oil emulsion mud (Vertoil) for drilling below the $9^5/_8$" casing shoe. Caliper logs show the hole to be reasonably coherent down to 7800 feet but considerably enlarged from 7850 feet in the Palaeocene until into the top of the chalk at about 8750 feet. This is reflected as shale caving into the chalk and possibly into the Lower Cretaceous. The hole as measured by the caliper log was of very good quality below the $9^5/_8$" casing but cuttings were of poor quality for extractive source rock evaluation in this interval because of the use of oil based mud. For this latter reason it was also difficult to wash the samples effectively in this interval or to obtain good kerogen concentrates because of both the difficulty of aqueous acid attack and the type of organic matter present. It is also of note that diamond bits were used in two intervals from about 11875 to 12125 and 12225 to 12677 feet.

The samples, with the exceptions noted above, were of good quality for geochemical analysis. The analytical procedures used include organic carbon analysis on all the bulk cuttings samples at 60 feet intervals and organic carbon analysis on individual lithologies where observed. Where extractive source rock analysis has been carried out, organic carbon analysis has been carried out on samples both before and after extraction. This latter procedure has been particularly important in the case of the Lower Cretaceous/Upper Jurassic interval where invert oil based mud was used. Although extractability data were obtained in this interval they are not reported because of the contamination problem. Selection of samples for geochemical analysis in this study is intended to start at the Middle Miocene so

in most wells where the Tertiary is being studied analyses are starting at the Middle Miocene.

Source rock quality has been assessed in this study using first the organic carbon screening data, followed in detail by extractive source rock and pyrolysis analysis on bulk composite samples using the Rock-Eval technique for the pyrolysis analysis. Kerogen composition has also been assessed on a semiquantitative basis using visual estimation of kerogen components in unsieved, unoxidised palynological preparations. It has also proved necessary in the Upper Jurassic to repeat the pyrolysis analysis on the solvent extracted rock powders to more accurately assess hydrocarbon potential of these sediments. Gas chromatographic data is not presently available.

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

II

RESULTS AND INTERPRETATION

The results of the various analyses carried out on the 2/11-1 well are presented in Tables 1 to 3 and graphically in Figures 1 to 3.

Table 1 lists data on maturation level in the section 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). Table 2 lists the

organic carbon and source rock evaluation data obtained using conventional solvent extraction procedures. Table 3 is a compilation of the pyrolysis data for the well and was obtained using the same samples as were selected for source rock evaluation by extraction. The pyrolysis data are plotted against depth in Figure 3.

It is to be noted that pyrolysis analysis has been carried out on the samples below 11000 feet both before and after solvent extraction. The results obtained after extraction are the ones plotted for this interval of the well. It is notable that there is a distinct trend to apparently poorer source potential in both Hydrogen Index and in Potential Yield with depth and particularly below about 13000 feet.

MATURITY DATA

Our assessment of the spore colouration data indicates that the interval down to about 6500 feet is immature and that the Lower Tertiary sediments below this depth are at an early stage of maturity for oil generation given the presence of oil-prone organic matter. The Lower Cretaceous and Jurassic sediments are in the middle range of maturity for oil generation. It is notable that sporomorphs were very rare in the Jurassic interval but that the kerogen which was judged to be sapropelic undergoes a noticeable change in colour with depth to dark brown/black within this interval.

Vitrinite reflectivity data give a trend rising from about 0.3% at 5000 feet to about 0.65% at T.D. 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 6500 feet while the whole of the Jurassic section is probably at a reflectivity level of 0.55% to 0.65% where very significant oil generation would be anticipated.

HYDROCARBON SOURCE POTENTIAL DATA

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

Interval 4890 to 6270 feet	-	Above average carbon content but immature on structure. Kerogen is dominantly humic and particularly vitrinitic rather than inertinitic. No source potential. Minor oil stain.
Interval 6270 to 7140 feet	-	About average carbon content, immature to early state of maturity. Kerogen predominantly humic and particularly vitrinitic. No source potential. Minor oil-stain.
Interval 7140 to 8550 feet	-	Mostly well below average carbon content with a few exceptions. Kerogen is predominantly humic and vitrinitic. No source potential on - structure but oil-stain is present and particularly in the Palaeocene interval.
Interval 8550 to 9470 feet	-	Chalk - organically lean. Substantial amount of caving. Oil-staining significant down to 8780 feet. No source potential.
Interval 9470 to 11645 feet	-	Shales and marls - average to slightly above average carbon content. Kerogen

is predominantly humic and particularly is inertinitic. No source potential. Oil-stain is frequent however.

Interval 11645 to 15392 feet – Dark grey shales - organically rich. An excellent oil source which may already have sourced much of its oil.

TABLE 1 MATURITY EVALUATION DATA

WELL: 2/11-1 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
12710- 720	Core	Dk gy sh	5.5	*	20	10	70
12860- 920	Ctgs	Dk gy/gy-blk soft sh	*	*	15	5	80
13100- 160	"	Ditto	*	*	15	5	80
13340- 400	"	Ditto	*	0.58(2)	15	5	30
13560- 620	"	Ditto	*	*	15	5	80
13800- 860	"	Ditto	6?	0.64(5)	15	5	80
14040- 100	"	Ditto	6?	*	15	5	80
14280- 340	"	Ditto	*	0.67(5)	15	5	80
14520- 580	"	Ditto	*	0.52(2)	15	5	80

TABLE 1 MATURITY EVALUATION DATA

WELL: 2/11-1 LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, Rav%	KEROGEN COMPOSITION (%)		
					INERTINITE	VITRINITE	SAPROPEL
4830- 890	Ctgs	Lt ol-gy calc sh	2.5	0.32(29)	30	60	10
5130- 190	"	Ditto	2.5	0.30(11)	15	80	5
5430- 490	"	Ditto	2.5	0.30(2)	20	80	*
5730- 790	"	Ditto+30% dk gy sh	3?	0.33(12)	50	50	*
5970- 6030	"	Dk gy/brn-gy sh	3?	0.32(19)	40	60	*
6420- 480	"	Brn-gy sh	3.5?	0.33(4)	30	70	*
6720- 780	"	Ditto	3.5	0.35(12)	35	60	5
6960- 7020	"	Ditto	3.5	0.34(14)	35	60	5
7260- 320	"	Brn-gy/gn-gy sh	3.5	0.40(14)	35	60	5
7500- 560	"	Ditto	3.5-4	0.41(9)	35	60	5
7800- 860	"	Ditto	3.5-4	0.41(13)	35	60	5
8100- 160	"	Ditto	4	0.39(3)	35	60	5
8280- 340	"	Ditto	3.5	0.39(31)	35	60	5
8500- 550	"	Mtl red-brn/gn-gy sh	4	0.43(20)	35	60	5
8620- 670	"	Chk+mmr sh	4.5	*	35	55	10
8780- 840	"	Ditto	*	*	*	*	*
9160- 220	"	Ditto+40% sh	*	*	*	*	*
9460- 520	"	Ditto+30% sh	*	*	50?	50?	*
9760- 820	"	Lt/med gy marl	4.5?	*	70	25	5
10060- 120	"	Ditto	4.5	*	70	25	5
10340- 400	"	Ditto	5?	*	70	25	5
10640- 700	"	Ditto	5	*	60	10	30
10940-11000	"	Lt gy marl+50% med gy sh	*	*	60	10	30
11240- 300	"	Ditto+50% ditto	5	*	80	15	5
11540- 600	"	Med gy calc sh	5	*	40	*	60
11645- 690	"	Med/dk gy sh	5	*	15	15	70
11870- 900	"	Dk gy soft sh	4.5	*	15	15	70
12060- 100	"	Ditto	5.5	0.57(4)	15	15	70
12280- 320	"	Dk gy/gy-blk soft sh	5?	*	15	15	70
12460- 510	"	Ditto	5	*	15	5	80
12600- 640	"	Ditto	*	*	15	5	80
12670- 680	Core	Brn-blk sl slty sh	5.5	*	15	5	80

TABLE 2

SOURCE ROCK EVALUATION DATA

WELL: 2/11-1 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
4830- 890	Ctgs	Lt ol-gy calc cly sh +drilling mud	1.20					
4890- 950	"	Ditto+ditto (Extracted rock)	2.65 2.28	1915	7.2	400	21	68
4980- 5010	"	Ditto+ditto	2.25					
5010- 070	"	Ditto+ditto	2.31					
5070- 130	"	Ditto+ditto (Extracted rock)	2.68 2.98	2150	8.0	460	21	82
5130- 190	"	Ditto+ditto	2.34					
5190- 250	"	Ditto+ditto	2.47					
5250- 310	"	Ditto+ditto	3.05					
5310- 370	"	Ditto+ditto	2.91					
5370- 430	"	Ditto+ditto (Extracted rock)	3.66 2.64	3545	9.7	600	17	87
5430- 490	"	Ditto+ditto	2.35					
5490- 550	"	Ditto+ditto	1.92					
5550- 610	"	Ditto+ditto+mnr dk gy sh	2.26					
5610- 670	"	Lt ol-gy calc sh+30% med-dk gy sh+drilling mud	2.36					
5670- 730	"	Ditto+ditto+ditto (Extracted rock)	4.07 3.23	3365	8.3	580	17	68
5730- 790	"	Ditto+ditto+ditto	3.21					
5790- 850	"	Med-dk gy sl calc sh+ 10% ol-gy cly sh+ drilling mud	3.32					
5850- 910	"	Ditto+ditto+ditto (Extracted rock)	4.17 3.07	2750	6.6	450	16	84
5910- 970	"	Med-dk gy/brn-gy sh (sl slty)+drilling mud	3.44					
5970- 6030	"	Dk. gy/brn-gy sh+mnr pnk-gy lst+drilling mud	3.60					
6030- 060	"	Ditto+ditto+ditto (Extracted rock)	4.71 3.29	2800	5.9	630	23	81
6090- 150	"	Ditto+ditto+ditto	2.39					
6150- 210	"	Ditto+ditto+ditto	2.33					
	"							

TABLE 2 (Cont'd.)

SOURCE ROCK EVALUATION DATA

WELL: 2/11-1 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
6210- 270	Gtgs	Dk gy/brn-gy sh+mnr pnk-gy lst+drilling mud	3.09	1610	5.2	360	22	74
		(Extracted rock)	1.89					
6270- 330	"	Ditto+ditto+ditto	1.66					
6330- 390	"	Brn-gy sh+mnr pnk-gy lst+drilling mud	1.62					
6420- 480	"	Ditto+ditto+ditto	1.57					
6540- 600	"	Ditto+drilling mud	1.57					
6600- 660	"	Ditto+ditto	2.90	1445	5.0	500	35	56
		(Extracted rock)	1.82					
6660- 720	"	Ditto+ditto	1.40					
6720- 780	"	Ditto+ditto	1.32					
6780- 840	"	Ditto+ditto	1.22					
6840- 900	"	Ditto+ditto	1.15					
6900- 960	"	Ditto+ditto	2.12	970	4.6	80	9	56
		(Extracted rock)	1.57					
6960- 7020	"	Ditto+ditto+mnr dk gy sh	1.31					
7020- 080	"	Ditto+ditto+ditto	1.12					
7080- 140	"	Ditto+ditto+ditto	2.04	1045	5.1	180	17	71
		(Extracted rock)	1.25					
7140- 200	"	Ditto+ditto+ditto	0.95					
7200- 260	"	Brn-gy/gn-gy sh+ drilling mud	0.68					
7260- 320	"	Ditto+ditto	0.75					
7320- 380	"	Ditto+ditto	0.70					
7380- 440	"	Ditto+ditto	1.29	635	4.9	120	19	69
		(Extracted rock)	0.96					
7440- 500	"	Ditto+ditto	0.82					
7500- 560	"	Ditto+ditto	0.85					
7560- 620	"	Ditto+ditto	0.72					
7620- 680	"	Ditto+ditto	0.79					
7680- 740	"	Ditto+ditto	1.42	535	3.8	100	18	67
		(Extracted rock)	0.87					
7740- 800	"	Ditto+ditto	0.75					
7800- 860	"	Ditto+mnr drilling mud	0.75					
7860- 920	"	Ditto+ditto	0.77					

SOURCE ROCK EVALUATION DATA

WELL: 2/11-1 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
7920- 980	Ctgs	Brn-gy/gn-gy sh+mnr yel-gy lst	0.73					
7980- 8010	"	Ditto+ditto	0.77					
8040- 100	"	Ditto+ditto (Extracted rock)	1.13 0.92	1770	15.7	480	27	78
8100- 160	"	Ditto+ditto	0.62					
8160- 220	"	Ditto+ditto	0.72					
8220- 280	"	Ditto+ditto	0.72					
8280- 340	"	Ditto+ditto	0.78					
8340- 400	"	Ditto+ditto (Extracted rock)	1.70 1.25	1170	6.8	220	19	>95
8400- 460	"	Red-brn/gn-gy mtl sh +mnr v lt gy lst+ drilling mud	0.78					
8460- 500	"	Ditto+ditto+ditto (Extracted rock)	2.62 2.12	14470	55.2	2030	14	81
8500- 550	"	Ditto+ditto+ditto	0.67					
8560- 620	"	Chk+mnr med-dk gy sh+ mnr red-brn sh+ drilling mud (Extracted rock)	2.55 0.88	14645	57.4	4980	34	79
8620- 670	"	Ditto+mnr brn-gy/gn-gy sh+drilling mud (Extracted rock)	2.57 0.78	17300	67.3	2650	15	65
8670- 700	"	Ditto+drilling mud (Extracted rock)	2.90 0.73	26070	89.9	10160	40	77
8730- 780	"	Ditto+ditto (Extracted rock)	1.73 0.66	10840	62.7	6250	58	73
8780- 840	"	Ditto+ditto	0.40					
8860- 920	"	Ditto+ditto	0.44					
8920- 980	"	Ditto+ditto	0.44					
8980- 9040	"	Ditto+30% ol-gy sh+ drilling mud	0.58					
9040- 100	"	Ditto+ditto+ditto (Extracted rock)	1.47 0.87	3955	26.9	1395	35	79
9100- 120	"	Ditto+ditto+ditto	0.79					
9160- 220	"	Chk+40% ol-gy sh+mnr red-brn/gn-gy sh+ drilling mud	0.65					
9220- 280	"	Ditto+ditto+ditto	0.66					
9280- 340	"	Ditto+20% ditto+ditto	0.64					

TABLE 2 (Cont'd.)

SOURCE ROCK EVALUATION DATA

WELL: 2/11-1 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
9340- 360	Ctgs	Chk+40% ol-gy sh+ mnr red-brn/gn-gy sh	0.56					
9400- 460	"	Ditto+mnr lt ol-gy/ gy-gn/gy sh+drilling mud	1.46	2190	15.0	240	11	48
		(Extracted rock)	1.05					
9460- 520	"	Ditto+30% ol-gy/gn-gy sh+drilling mud	0.69					
9520- 580	"	Ditto+med gy marl+ drilling mud	0.89					
9580- 640	"	Med gy marl+15% chk+ drilling mud	0.95					
9640- 680	"	Ditto+ditto+ditto	1.42	2025	14.2	220	11	60
		(Extracted rock)	1.04					
9700- 760	"	Med gy/lt ol-gy/brn-red mtl marl	1.33					
9760- 820	"	Ditto+mnr med gy sh	0.81					
9820- 880	"	Ditto+ditto	1.14					
9880- 940	"	Ditto+ditto	1.60	2970	18.6	1050	35	79
		(Extracted rock)	1.30					
9940-10000	"	Ditto+ditto	0.86					
10060- 120	"	Ditto+ditto	1.46	2065	14.2	40	2	>95
		(Extracted rock)	0.94					
10120- 160	"	Ditto+ditto	0.81					
10220- 280	"	Ditto+ditto	2.77	13305	48.0	5560	42	83
		(Extracted rock)	1.62					
10280- 340	"	Ditto+10% ditto	2.53					
10340- 400	"	Ditto+10% med gy sh	2.28					
10400- 460	"	Ditto+ditto	3.19	10785	33.8	4740	44	76
		(Extracted rock)	1.69					
10460- 520	"	Lt-med gy/red-brn marl+mnr med-dk gy sh	1.68					
10520- 580	"	Ditto+ditto	1.69					
10580- 640	"	Ditto+ditto	1.99					
10640- 700	"	Ditto+10% ditto	2.66	7585	28.5	2990	39	86
		(Extracted rock)	1.55					
10700- 760	"	Lt-med gy/pale brn/ red-brn marl+40% med-dk gy sh	1.89					
10760- 820	"	Ditto+ditto	1.75					

SOURCE ROCK EVALUATION DATA

WELL: 2/11-1 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
10820- 880	Ctgs	Lt ol-gy/dk gy sh+ lt gn-gy marl	1.36					
10880- 940	"	Ditto+mnr med gy sh	2.27					
10940- 100	"	Lt ol-gy marl+50% med gy calc sh	2.15					
11000- 060	"	Ditto+ditto	2.59	5665	21.8	*	*	*
		(Extracted rock)	0.89					
11060- 120	"	Ditto+ditto	1.84					
11120- 180	"	Ditto+ditto	1.75					
11180- 240	"	Ditto+ditto	2.21					
		INTERVAL DRILLED WITH INVERT OIL EMULSION MUD						
11240- 300	"	Lt ol-gy marly+50% med gy calc	1.98					
11300- 360	"	Med gy calc sft sh	2.22					
		(Extracted rock)	0.85					
11360- 420	"	Ditto+ditto	2.36					
11420- 480	"	Ditto	2.18					
11480- 540	"	Ditto	2.24					
11540- 600	"	Ditto	2.37					
		(Extracted rock)	0.90					
11600- 645	"	Med-dk gy sft sh	2.78					
11645- 690	"	Ditto	6.54					
11690- 750	"	Ditto	6.99					
		(Extracted rock)	5.20					
11750- 810	"	Ditto	7.92					
11810- 870	"	Dk gy sl calc sft sh	7.11					
11870- 900	"	Ditto	5.43					
11900- 950	"	Ditto	5.50					
		(Extracted rock)	4.36					
11950- 980	"	Ditto	8.77					
11980-12020	"	Ditto	8.33					
12020- 060	"	Ditto	8.00					
12060- 100	"	Ditto	6.08					
		(Extracted rock)	4.04					
12100- 140	"	Ditto	7.20					
12140- 180	"	Ditto	6.13					

TABLE 2 (Cont'd.)

SOURCE ROCK EVALUATION DATA

WELL: 2/11-1 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
12180- 230	Ctgs	Dk gy-blk sft sh+occ pnk-gy lst	6.36					
12230- 280	"	Ditto+ditto	5.75					
12280- 320	"	Ditto+ditto	7.49					
		(Extracted rock)	5.86					
12320- 370	"	Ditto+ditto	7.10					
12370- 410	"	Ditto+ditto	7.37					
12410- 460	"	Ditto+ditto	6.13					
12460- 510	"	Ditto+ditto	8.65					
		(Extracted rock)	6.17					
12510- 550	"	Ditto+ditto	7.57					
12550- 600	"	Ditto+ditto	6.95					
12600- 640	"	Ditto+ditto	7.38					
12640- 660	"	Ditto+ditto	6.94					
		(Extracted rock)	4.19					
12660- 690	"	Ditto+ditto	8.36					
12670- 680	Core	Brn-blk sl slty sh	7.23					
12680- 690	"	Med-dk gy sl slty sh+ mnr pyr	2.10					
12690- 700	"	Med-dk gy lam slty sh	2.62					
12700- 710	"	Lt ol-gy/med-dk gy lam slty sh	3.72					
12710- 720	"	Dk gy sh	7.74	28240	36.5	2110	7	43
		(Extracted rock)	7.14					
12760- 800	Ctgs	Dk gy-blk sft sh+occ pnk-gy lst	7.53					
12800- 860	"	Ditto+ditto	7.82					
12860- 920	"	Ditto+ditto	6.74					
		(Extracted rock)	4.26					
12920- 980	"	Ditto+ditto	6.05					
12980-13010	"	Ditto+ditto	5.20					
13010- 050	"	Ditto+ditto	4.99					
13050- 100	"	Ditto+ditto	4.83					
13100- 160	"	Ditto+ditto	5.31					
		(Extracted rock)	2.68					
13160- 220	"	Ditto+ditto	5.09					
13220- 280	"	Ditto+ditto	4.97					

TABLE 2 (Cont'd.)

SOURCE ROCK EVALUATION DATA

WELL: 2/11-1 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
13280- 340	Ctgs	Dk gy-blk sft sh+occ pnk-gy lst	5.01					
13340- 400	"	Ditto+ditto	5.40					
		(Extracted rock)	3.64					
13410- 460	"	Ditto+ditto	5.21					
13460- 500	"	Ditto+ditto	5.10					
13500- 560	"	Ditto+ditto	5.01					
13560- 620	"	Ditto+ditto	5.11					
13620- 680	"	Ditto+ditto	5.10					
13680- 740	"	Ditto+ditto	4.52					
		(Extracted rock)	2.68					
13740- 800	"	Ditto+ditto	4.60					
13800- 860	"	Ditto+ditto	4.95					
13860- 920	"	Ditto+ditto	4.86					
13920- 980	"	Ditto+ditto	4.70					
13980-14040	"	Ditto+ditto	4.55					
		(Extracted rock)	2.38					
14040- 100	"	Ditto+ditto	4.17					
14100- 160	"	Ditto+ditto	4.54					
14160- 220	"	Ditto+ditto	4.61					
14220- 280	"	Ditto+ditto	4.57					
14280- 340	"	Ditto+ditto	3.37					
		(Extracted rock)	2.14					
14340- 400	"	Ditto+ditto	5.08					
14400- 460	"	Ditto+ditto	4.50					
14460- 520	"	Ditto+ditto	5.08					
14520- 580	"	Ditto+ditto	3.77					
		(Extracted rock)	1.90					
		PICKED LITHOLOGIES						
8500- 550	"	Lt ol-gy sh	0.75					
8500- 550	"	Lt gn-gy sh	0.15					
8560- 620	"	Dk gy sh	1.83					
8560- 620	"	Wht chk, iron stained	1.11					
8620- 670	"	Med brn sh	0.74					
8620- 670	"	Wht chk, iron stained	1.60					
8670- 700	"	Lt ol-gy/gn-gy sh	2.26					
8670- 700	"	Wht chk, iron stained	1.88					

TABLE 2 (Cont'd.)

SOURCE ROCK EVALUATION DATA

WELL: 2/11-1 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
9100- 120	Ctgs	Red-brn sh	0.30					
9100- 120	"	Gn-gy/ol-gy sh	0.73					
9100- 120	"	Wht chk, iron stained	0.52					
9160- 220	"	Dk gy sh	2.33					
9160- 220	"	Lt ol-gy sh,	0.71					
9220- 280	"	Dk gn sh	1.65					
9460- 520	"	Ditto	0.49					
9700- 760	"	Med gy sh	1.72					
9700- 760	"	Gn-gy sh	0.59					
10280- 340	"	Ditto	0.96					
10940-11000	"	Lt-med gy sh	0.88					
11000- 040	"	Ditto	1.34					
11060- 120	"	Ditto	1.81					
11060- 120	"	Gy-red sh	0.54					
11240- 300	"	Lt-med gy sh	1.01					

TABLE 3

ROCK - EVAL. PYROLYSIS DATA

WELL: 2/11-1 LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	GENERALISED LITHOLOGY	ORGANIC CARBON (%)	TEMPERATURE (°C)	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (PPM)
4890- 950	Lt ol-gy calc sh	2.65	426	148	69	*	3900
5070- 130	Ditto	2.68	423	136	132	*	3600
5370- 430	Ditto	3.48	437	58	120	*	2000
5670- 730	Ditto	4.07	*	89	129	*	3600
5850- 910	Med-dk gy sh	4.17	420	99	98	*	4100
6030- 060	Dk gy/brn-gy sh	4.71	423	101	105	*	4700
6210- 270	Ditto	3.09	430	77	107	*	2400
6600- 720	Brn-gy sh	2.90	430	81	112	0.03	2400
6900- 960	Ditto	2.12	426	73	93	0.03	1600
7080- 140	Ditto	2.04	423	47	126	0.02	1000
7380- 440	Brn-gy/gn-gy sh	1.30	429	52	146	0.02	700
7680- 740	Ditto	1.42	428	42	222	0.02	600
8040- 100	Ditto	1.13	421	17	346	0.56	200
8340- 400	Ditto	1.70	429	83	140	0.06	1400
8560- 620	Ditto+chk	2.55	414	80	133	0.52	2000
8620- 670	Chk+mnr sh	2.57	424	199	193	0.68	5100
8730- 780	Chk	1.73	420	188	263	0.55	3300
9040- 100	Ditto+30% ol-gy sh	1.47	426	103	268	0.61	1500
9400- 460	Ditto+mnr sh	1.46	426	70	274	0.53	1000
9640- 680	Med gy marl	1.42	424	55	466	0.47	800
9880- 940	Ditto	1.60	426	23	159	0.49	400
10060- 120	Ditto	1.46	427	20	83	0.57	300
10220- 280	Ditto	2.77	*	*	45	*	*
10400- 460	Ditto	3.19	*	*	34	*	*
10640- 700	Ditto	2.66	*	*	26	*	*
11000- 060	Lt gy marl+med gy sh	2.59	430	30	191	*	800
11300- 360	Med gy calc sh	2.22	430	90	157	*	2000
11540- 600	Ditto	2.37	436	223	147	*	5300
11690- 750	Med-dk gy sh	7.00	431	421	48	*	29400
11900- 950	Dk gy sh	5.50	429	352	74	*	19400
12060- 100	Ditto	6.08	431	367	87	*	22300
12280- 320	Ditto	5.86	437	360	78	*	21100
12460- 510	Ditto	6.17	437	407	69	*	25100

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

TABLE 3 (Cont'd.)

ROCK - EVAL. PYROLYSIS DATA

WELL: 2/11-1 LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (FEET) OR NOTATION	GENERALISED LITHOLOGY	ORGANIC CARBON (%)	TEMPERATURE (°C)	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (PPM)
12640- 660	Dk gy sh	6.94	439	500	55	*	34700
12710- 720	Ditto	7.74	441	272	27	*	21000
12860- 920	Ditto	6.74	436	463	52	*	31200
13100- 160	Ditto	5.31	433	430	67	*	22800
13340- 400	Ditto	5.40	438	477	58	*	25800
13680- 740	Ditto	4.52	444	431	75	*	19500
13980-14040	Ditto	4.55	436	386	78	*	17600
14280- 340	Ditto	3.37	437	499	94	*	16800
14520- 580	Ditto	3.77	410	333	56	*	12600
	REPEAT ANALYSIS - EXTRACTED RESIDUES						
11000- 060	Lt gy marl+med gy sh	0.88	421	40	245	*	300
11300- 360	Med gy calc sh	0.84	431	200	465	*	1700
11540- 600	Ditto	0.90	430	164	202	*	1500
11690- 750	Med-dk gy sh	5.19	427	506	40	*	26300
11900- 950	Dk gy sh	4.30	434	429	76	*	18400
12060- 100	Ditto	4.04	417	377	130	*	15200
12280- 320	Ditto	3.13	434	349	155	*	11000
12460- 510	Ditto	3.28	435	312	137	*	10200
12640- 660	Ditto	4.19	433	253	84	*	10600
12710- 720	Ditto	7.14	434	229	115	*	16300
12860- 920	Ditto	4.26	435	365	40	*	15600
13100- 160	Ditto	2.62	435	245	55	*	6600
13340- 400	Ditto	3.64	434	284	42	*	10300
13680- 740	Ditto	2.68	433	245	51	*	6600
13980-14040	Ditto	2.38	433	229	77	*	5400
14280- 340	Ditto	2.14	433	204	61	*	4400
14520- 580	Ditto	1.90	419	190	68	*	3600

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 I SPORE COLOURATION INDICES AGAINST DEPTH

WELL: 2/11-1 LOCATION: NORWEGIAN NORTH SEA

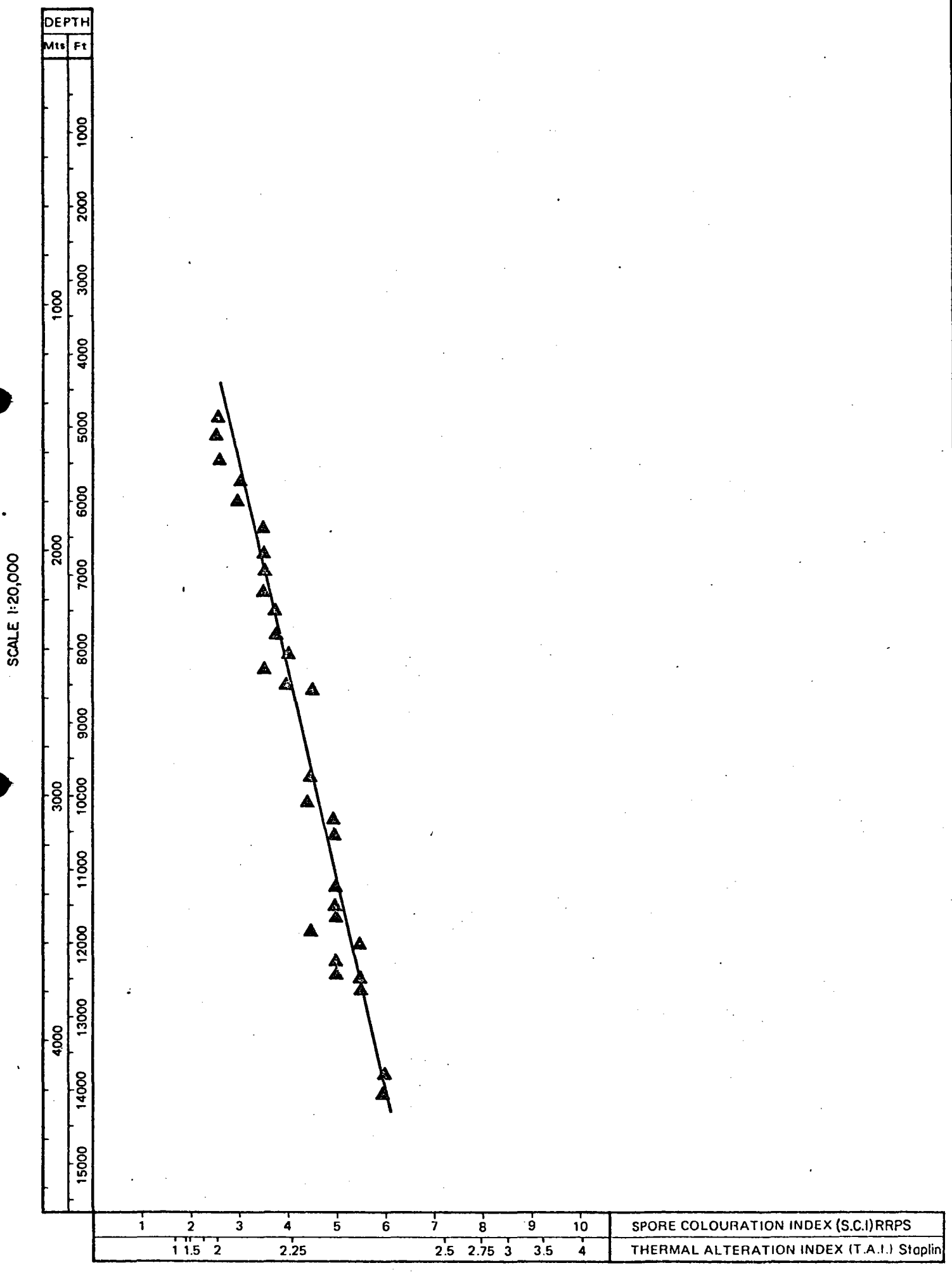

FIGURE 2 VITRINITE REFLECTIVITY AGAINST DEPTH

WELL: 2/11-1

LOCATION: NORWEGIAN NORTH SEA

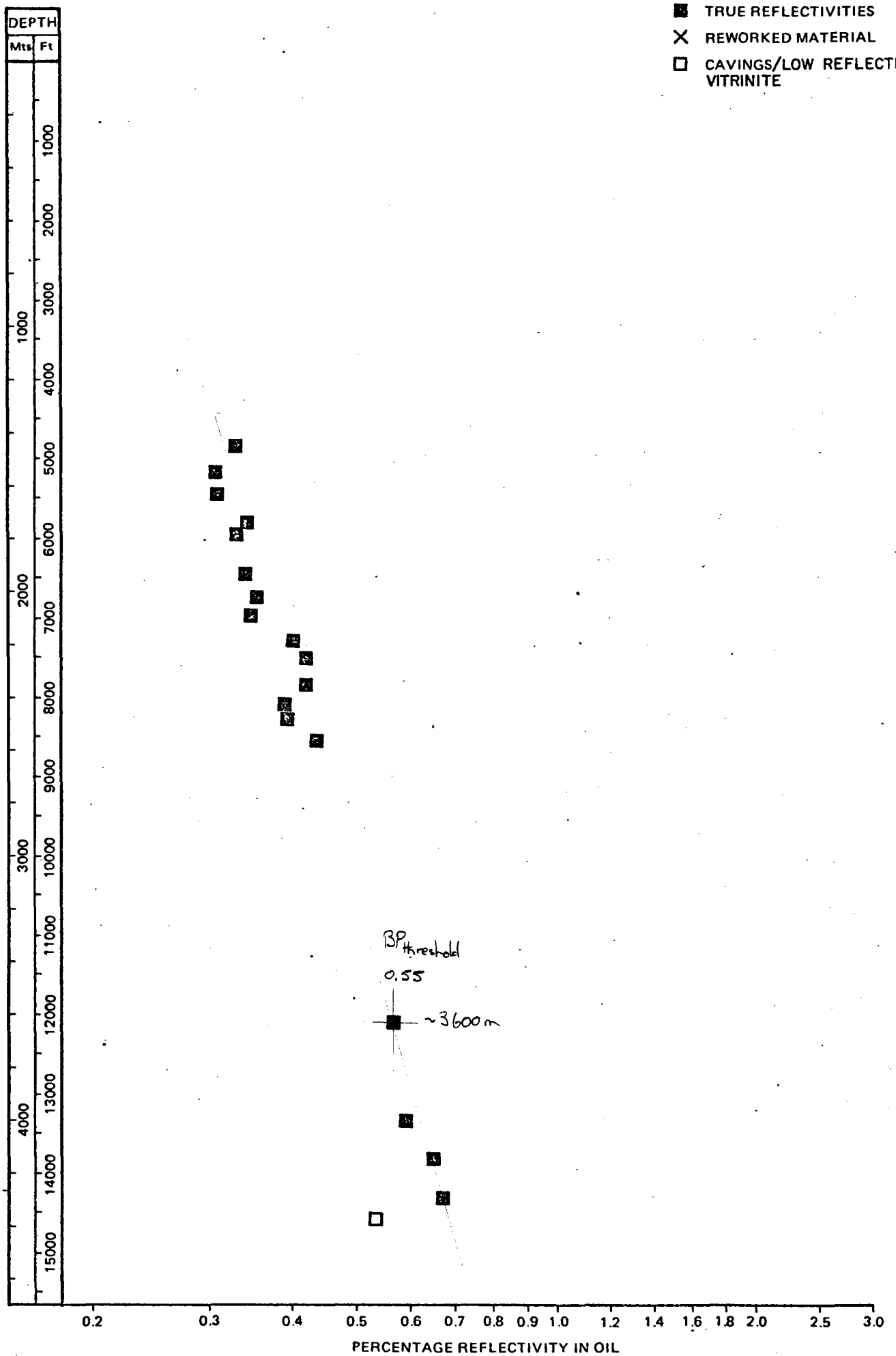

FIGURE 3

PYROLYSIS DATA SUMMARY CHART

WELL: 2/11-1 LOCATION: NORWEGIAN NORTH SEA