7/12-2 W.25

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A MATURATION AND SOURCE ROCK STUDY OF THE SECTION 1,500 - 3,676 METRES OF THE CONOCO NORWAY 7/12-2 WELL, NORWEGIAN NORTH SEA

by

B. S. COOPER

C. DARLINGTON

M. J. FISHER

J. S. BUTTERWORTH

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Robertson Research International Limited,
Ty'n-y-Coed,
Llanrhos,
Llandudno, Gwynedd,
North Wales, LL30 1SA.

Prepared for:

Conoco Norway Inc.,
P.O. Box 488,
4001 Stavanger,
Norway.

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I

INTRODUCTION

A maturation study and source rock evaluation have been carried out on the section 1,500 to 3,676 metres of the Conoco Norway 7/12-2 Well drilled in the Norwegian North Sea.

Sidewall cores were received over the section 1,633 to 3,617 metres and canned ditch cuttings from 1,500 to 3,676 metres. Source rock qualities, spore colouration indices and vitrinite reflectivities were determined on sidewall cores of sufficient size and the analyses supplemented where necessary using ditch cuttings. All the canned samples were analysed for headspace gas content, the cuttings then being washed and described. In view of the good quality and extensive coverage offered by the sidewall core samples, organic carbon content and occasional source rock analyses were necessary only on ditch cuttings from below 3,190 metres. Gas chromatography of the C_{15+} saturate, (alkane), fraction was carried out on those samples from which hydrocarbon abundances of greater than 100 ppm were recorded. The sidewall core samples were of good quality for geochemical analysis as were the ditch cutting after removal of suspected caved material. The age of the section is believed to be Tertiary to Jurassic.

II

RESULTS AND INTERPRETATION

A. MATURITY EVALUATION

Spore colouration and vitrinite reflectivity analyses have been used to determine the maturity profile of this well section. These analyses have been supplemented by analysis of the C_1 to C_4 headspace gases in the canned ditch cuttings samples.

1. Headspace Gas Analysis (Table 1 and Figure 1)

A very well defined series of trends is seen in headspace gas compositions, figure 1. Samples from depths between 1,500 and 2,600 metres all display high concentrations of headspace gas exceeding 11,000 ppm, over 91% of which is methane. One exception is the sample from 2,500 metres with a 66.4% methane content. Between 2,700 and 3,040 metres total headspace gas concentrations are lower, ranging from 500 ppm to 3000 ppm, and the wet gas content, (ethane, propane and the butanes), increases to between 38% and 54% of the total gas. Two samples with over 86% methane occur at depths of 3040-70 and 3070-100 metres and have headspace gas concentrations of 3000 ppm and 800 ppm respectively. From 3,160 metres to the base of the section the C_1 to C_4 gas content generally increases from 400 ppm to 20,000 ppm the richest samples at 3,520-50 and 3,610-40 metres having contents of 20,000 ppm and 12,000 ppm respectively. There is a well defined depletion in methane such that wet gas abundance increases from 54% to over 90% at the base of the section. A gas lean sample of higher methane content is noted at 3,370-400 metres and this result is considered valid, the sample being of organically lean shale and sand.

The results of this analysis show that significant changes in relative hydrocarbon contents take place between 2,300 and 2,500 metres. It is believed that the section is immature for significant hydrocarbon generation to a depth of approximately 2,500 metres, transitional mature between this depth and 2,750 metres as characterised by the increasing abundance of the C_2 to C_4 gases.

The very large contents of methane rich gas in the section above 2,400 metres are anomalous and unexpected. Even if the actual headspace volumes were very small for the cans from this section, the concentrations would still be unusually high. We must suggest then that infiltration of gas is occurring into this mostly argillaceous section and a possible source could be in a fault with associated increased fracture porosity. Minor faults or fractures may also occur at 2,400-500, 2,600-700 and 3,040-100 metres where compositions appear to be enriched in methane.

Recent experimental work has shown that very large volumes of methane are released from argillaceous sediments when they are in contact with potassium hydroxide. Hence if KOH was used in the drilling mud this might also explain the anomalously high methane concentration in the topmost part of the section.

2. Spore Colouration Analysis (Table 2 and Figure 2)

An effect of maturation processes on sporopollenin is to increase the visible colour density from pale yellow, through orange and brown to black. The determinative procedures of Staplin (1969) have been largely followed in this analysis, except that a ten-point scale of colour indices has been utilised rather than the five-point scale adopted by Staplin. Detailed kerogen descriptions have not been made, but dominant kerogen types are noted in Table 2.

Within the interval 1,633 to 2,148 metres spore colour indices of 2 to 2.5-3, indicative of organically immature sediments, were found. The actual range in spore colours for the assemblages is very narrow, spores being moderately abundant to abundant in all the analysed samples. Vitrinite is the dominant kerogen in the upper part of this interval, but below 1,685 metres, sapropelic debris is also a major component.

Between 2,23? and 2,528 metres spore colour indices from 3 to 3-3.5

were noted and are indicative of transitionally mature sediments. Within this interval the kerogen consists mainly of sapropel with subordinate amounts of vitrinite and inertinite.

In the interval 2,723 to 3,561.5 metres spore colour indices of 3.5 to 5-5.5 were recorded and are indicative of mature sediments. Inertinite is the dominant component in this interval, although sapropel is also common, as at 3075, 3243, 3267, 3301 and 3319 metres. Below 3561.5 metres the organic residues were too impoverished for spore colour measurements to be made, although inertinite could be seen as the dominant kerogen. ?

3. Vitrinite Reflectivity Analysis (Figure 3 and Enclosures 1 and 2)

Measurement of vitrinite reflectivity was carried out on a total of thirty-five samples using kerogen concentrates mainly above 2,500 metres and kerogen concentrates and mounted rock chips below. All the data obtained during this analysis is included in the vitrinite reflectivity summary charts to be found as enclosures at the end of this report.

Plotting of the data figure 3, suggests that vitrinite reflectivity increases from about 0.30% at 1,600 metres to 0.38% at 2,445 metres. Within this interval, and particularly in the upper half, much of the vitrinite is considered to be reworked this assumption being reinforced by the observation of reworked palynomorphs, (during spore colouration studies). Below 2,500 metres and to 3,000 metres little or no vitrinite has been observed and the vitrinite reflectivity gradient extrapolated. From 3,000 to 3,500 metres only rare vitrinite particles could be distinguished, with reflectivities of 0.47% at 3,040-70 metres, 0.53% at 3,319 metres and 0.50% at 3,490-520 metres. Below 3,500 metres small numbers of vitrinite particles occur in most samples with reflectivities in the range 0.46% to 0.54%. At 3,600 metres a vitrinite reflectivity of 0.50% is interpreted from the data. The material recorded with a reflectivity of about 0.30% particularly between 2,100 and 2,400 metres is probably of sapropelic origin, not caved vitrinite.

On investigation of the samples in incident blue light, dispersed yellow or yellow-orange fluorescing phytoclasts were seen between 1,633 and 1,904 metres with large quantities of yellow-orange fluorescing exinitic material at 1,930 metres. Within this interval orange-brown fluorescing organic particles were noted at several horizons. Between 1,980 and 2,358 metres little or no organic fluorescence was seen. From 2,427 to 2,723 metres yellow fluorescence is exhibited from the small amounts of organic particles present, though orange fluorescing spores were noted at 2,427 metres. In the deepest interval 3,040 to 3,670 metres golden-yellow and orange spores are evident in most samples, rich exinite contents occuring at depths of 3,267, 3,573 and 3,580-610 metres.

The data obtained from incident light microscopy suggest that oil-prone types of organic matter are likely to become mature at about 2,500 metres where reflectivities of between 0.35% and 0.40% are predicted. It is probable that humic, gas-prone types of organic matter only become mature for significant gas generation towards total depth or at least 3,600 metres.

4. Comparison of Maturation Indices

Spore colouration and vitrinite reflectivity studies are in good agreement in their estimation of the maturity profile of this well section and are further supported by evidence from headspace gas analysis.

The data suggest that the section is immature for hydrocarbon generation above 2,200 metres. Between this depth and about 2,700 metres a transitional or early stage of maturity exists which is consistent with spore colour indices of 3-3.5, vitrinite reflectivities of 0.38% and 0.39% and the presence of about 40% wet gas in the headspace gases. Below 2,700 metres the section is considered to be mature for the generation of oil from any oil-prone types of organic matter contained by the sediments. Towards the base of the analysed section the sediments are mature for medium to low specific gravity oils, high concentrations of wet gas, spore colour indices of up to 5.5 and vitrinite reflectivities of 0.54% having been recorded. Humic, gas-prone types of organic matter are likely to be mature only close to total depth in this section where vitrinite reflectivities exceed 0.50%.

B. <u>SOURCE ROCK EVALUATION (Table 3 and Figures 4, 5 and 6)</u>

The source rock evaluation of this well section is discussed in six parts on the basis of lithological variations and geochemical changes.

i. <u>Interval 1,633 to 2,055 metres, Samples 1 to 10</u>

This interval is characterised by brown-grey and olive-grey calcareous shales with organic carbon contents of 3.1% to 7.0% which are above average for argillaceous sediments. The extractability of the organic matter in solvents is fairly constant ranging from 6.8% to 9.3%. Hydrocarbon abundances closely reflect the variation in organic carbon content of the samples in all but one case and vary from 40 ppm to 445 ppm.

From figures 4 and 5 it can be seen that the likely present product from this immature section is gas. Only small quantities of hydrocarbons have so far been generated in relation to the large amounts of organic matter present. In a mature situation these sediments would be likely hydrocarbon sources for gas in view of their high contents of humic organic matter, but with associated liquid hydrocarbons where sapropelic oil-prone types of organic matter have been detected during spore colouration analysis particularly below 1,750 metres, table 2. In the section, however, some values of extractability and hydrocarbon content are higher than would be expected for an immature sequence and the possibility of contamination or oil staining cannot be precluded.

ii. <u>Interval 2,104 to 2,575 metres. Samples 11 to 20</u>

Light grey and olive-grey calcareous shales dominate this interval. Organic carbon contents range from 0.29% to 2.02% and the majority of shale samples have contents with the 1%-2% range. The extractability of the samples shows a narrow range, 4.4% to 7.9%, and increases slightly with depth. A higher extractability of 13.9% was recorded on sample 20,2575 metres. Hydrocarbon concentrations are low to average in relation to organic carbon content and sediment type and range from 30 ppm to 260 ppm.

The hydrocarbon product predicted from these shale samples is gas, figure 4. However, as with the interval discussed above the sediments are considered generally immature for significant hydrocarbon generation to have occurred as yet and it is this factor that controls the source potential of the interval rather than a lack of suitable types and quantities of organic matter. Sapropelic, oil-prone organic matter has been observed as the major kerogen component between 2,148 and 2,528 metres and appreciable quantities of liquid hydrocarbons might be sourced by corresponding sediments should they be encountered in a more mature situation. Samples 19 and 20, from 2,445 and 2,528 metres respectively are identified as hydrocarbon sources with a fair potential for oil, figure 5, and they are believed to be from depths near to the immature - mature boundary. It is possible that very minor amounts of liquid hydrocarbons could be generated from these latter mentioned sediments. There is also a possibility of minor oil staining in the section.

iii. <u>Interval 2,663 to 3,035 metres, Samples 21 to 22</u>

White chalk and grey calcareous shale and siltstone comprised the samples from this interval. The chalk samples have very low organic carbon contents of 0.07% and 0.10% and no further analyses were carried out on them. Organic carbon contents are low at 0.29% and 0.31% in the shale and siltstone samples respectively. Extractabilities of 5.9% and 3.1% were recorded on these samples and hydrocarbon abundances are low at not more than 20 ppm.

This interval is very lean in organic material and, though at an early stage of maturation is unlikely to support any significant hydrocarbon sourcing horizons on the basis of the samples analysed.

iv. <u>Interval 3,075 to 3,255, Samples 23 to 25</u>

Dark grey and olive-grey shale were noted in this interval. The Organic carbon contents of the shales in this interval are quite variable from 0.31% to 7.5% in a dark grey shale from 3,075 metres. Extractabilities of 8.1% and 12.2% have been recorded along with a very low extractability of 0.2%

on the organically rich shale from 3,075 metres. Hydrocarbon abundances are low except in sample 25, 3,243-55 metres with a concentration of 590 ppm.

Apart from sample 25 the remaining samples, possibly with the exception of the shale from 3,201 metres, suggest no hydrocarbon rich horizons to be present. It is doubtful whether the organically rich horizons detected are sufficiently mature for significant gas generation to take place. Sample 25, 3,243-55 metres indicates a hydrocarbon rich horizon with a good potential for the sourcing of liquid hydrocarbons, figures 4 and 5.

v. Interval 3,267 to 3,490 metres. Samples 26 to 31

Olive-black and dark grey shales dominate this part of the section. The darker shales have organic carbon contents of 1.21% to 7.0% and the lighter grey shales 0.31% to 0.56%. Extractabilities ranging from 5.4% to 22.1% have been recorded, the organically rich samples having higher extractabilities. Hydrocarbon abundances are considerably higher in the organically richer samples and range from 485 ppm to 6,060 ppm. The organically leaner shales examined have hydrocarbon concentrations of 30 ppm and 185 ppm.

The likely hydrocarbon product from these sediments is oil or oil and minor gas except in the case of sample 30 for which very minor quantities of gas are predicted, figures 4 and 5. Samples 27, 28 and 29 indicate horizons with a good or very good potential for generating medium to light oil and a similar product is suggested by sample 31, though the low quantity of organic matter included in the sediments will severely limit the sourcing capability.

vi. Interval 3,515 to 3,676 metres, Samples 32 to 39

Light grey and olive grey siltstones and sandstones , pinkish siltstones and sandstones and brown-red calcareous mudstones have been encountered in this interval and some caved? dark grey shale also noted. Organic carbon contents are low in this interval, ranging from 0.08% to 0.68% except in a sandstone with included organic matter and an unusually rich red-brown mudstone. These samples have organic carbon contents of 1.62% and 1.30% respectively. Extractabilities are high in this interval, often exceeding 20%, and range from 12.9% to 44.5%. Hydrocarbon abundances are high in this interval in comparison to the lithologies present and vary from 230 ppm to 1,455 ppm.

The confirmation of high extractability and high hydrocarbon content in these relatively lean sediments suggest that hydrocarbon staining has occured (samples 32, 33 and 34). It is doubtful whether any of the horizons analysed have source rock potential, the grey siltstones being organically lean and the dark grey shales probably being caved.

C. GAS CHROMATOGRAPHIC ANALYSIS (Figures 7 to 11)

Analysis of samples using capillary chromatography has been made where C_{15+} hydrocarbon concentrations of greater than 100 ppm have been detected during source rock analysis.

The distribution of hydrocarbon components displayed by the chromatograms suggests two geochemically distinct units to be present in the section.

i. Interval 1,633 to 2,148 metres. Samples 1 to 12

Within this interval alkane components in the range $\underline{n}$-C_{10} to $\underline{n}$-C_{31} are seen, the presence of abundant alkanes lighter than $\underline{n}$-C_{15} being unexpected. The $\underline{n}$-alkanes (from C_{17} to C_{25}) are present in similar proportions and a strong predominance of odd numbered $\underline{n}$-alkanes is developed between C_{23} and C_{31}. Branched and cyclic alkanes are abundant including high concentrations of triterpane and sterane components from C_{27} to C_{32}. Pristane and phytane are present in all samples as significant or as dominant components. In the cases of samples from 1,717, 1,750 and 1,930 metres there is a suggestion of the presence of a heavy oil residue which has remained after water-washing. In general the chromatograms obtained are characteristic of immature humic, gas-prone types of organic matter. The light components present may be due either to the contribution from sapropelic, (oil-prone), types of organic matter in the sediments or to minor oil-staining.

ii. Sample 19, 2,528 metres and Interval 3,243 to 3,617 metres. Samples 25 to 39

There is a great similarity in the chromatograms obtained from samples in these formations. The normal alkanes are by far the most prominent peaks and pristane and phytane make significant contributions particularly at 3,243 and 3,307 metres. Only traces of polycyclics, steranes and triterpanes are seen. The normal alkanes usually range between C_{16} and C_{28} and maximum concentrations lie from $\underline{n}$-C_{19} to $\underline{n}$-C_{22}. Although oil-staining or hydrocarbon contamination is expected from the source rock data below 3,515 metres no special distinguishing features have been seen.

III

CONCLUSIONS

Integration of the maturation and source rock quality profiles of the section 1,500 to 3,676 metres of the Conoco Norway 7/12-2 Well leads to the following general conclusions.

a) Interval 1,500 to 2,055 metres   Middle Mioc — E. Oligocene.

The argillaceous sediments encountered at these depths have a high content of organic material which, when viewed microscopically, was seen to be of a mainly humic, gas-prone type. However, the interval is immature for the sourcing of substantial quantities of liquid or gaseous hydrocarbons. Certain horizons have shown both liquid and gaseous hydrocarbon concentrations and extractabilities which are higher than would be expected and some oil-staining or contamination is suspected.

b) Interval 2,104 to 2,575 metres   E. Olig — E. Eoc.

The calcareous shales of this interval are of average organic richness and contain mainly sapropelic, oil-prone types of organic matter. The interval is presently immature for appreciable quantities of hydrocarbons to be generated, though these sediments may have a sourcing capability at greater depths of burial. Some oil-staining is also thought to have taken place in this interval.

c) Interval 2,663 to 3,035 metres   Palaeocene — Base Chalk.

A small number of samples, comprising chalk, shale and siltstone, were received from this interval. The sediments are thought to be marginally mature for hydrocarbon generation, though the low content of organic matter and leanness in generated hydrocarbons precludes the analysed horizons from having a significant source potential.

d) Interval 3,075 to 3,255 metres   L. Cret — Top Jurassic

The chiefly argillaceous sediments penetrated in this interval contain widely varying quantities of organic material and, apart from one horizon, only low concentrations of hydrocarbons. The interval is mature for liquid hydrocarbon generation, though the dominant organic matter type to be found is of a gas-prone nature. An horizon with a liquid hydrocarbon source potential is identified by sample 25, 3,243-55 metres. It is doubtful whether at the present level of maturation the organically rich gas-prone horizons are sufficiently mature for the generation of appreciable quantities of gas.

e) <u>Interval 3,267 to 3,490 metres</u> T. Jur — 45m above base Reservoir.

Several organically rich shale horizons have been identified within this interval. The interval is mature for medium to light oil generation and high concentrations of hydrocarbons have been noted in many samples. Oil-prone types of organic matter have been identified by chemical and microscopic methods. The data suggest that liquid hydrocarbon source rocks of high quality are present and that minor gas generation is also likely.

f) <u>Interval 3,575 to 3676 metres</u> ?Triassic – Barren Interval.

Samples from this interval comprise red-brown mudstones, sandstones and siltstones. The sediments contain low contents of organic material which in general is of a gas-prone type. The high extractabilities and relatively large hydrocarbon contents of the samples for their lithology type suggest that considerable quantities of non-indigenous hydrocarbons are present.

TABLE 1

HEADSPACE GAS ANALYSIS DATA

CLIENT: CONOCO NORWAY   **WELL:** 7/12-2   **LOCATION:** NORWEGIAN N. SEA

SAMPLE DEPTH METRES	TOTAL C_1-C_4 GAS PPM	PERCENT C_1	PERCENT C_2	PERCENT C_3	PERCENT iC_4	PERCENT nC_4
1500-600	30100	93.7	2.0	2.7	1.2	0.4
1600-700	49100	95.7	1.4	1.8	0.9	0.2
1700-800	21600	92.8	2.2	3.2	1.4	0.4
1800-900	35000	93.2	2.5	3.0	1.0	0.3
2000-100	29400	91.7	2.9	3.7	1.3	0.4
2100-200	30100	91.8	2.8	3.5	1.5	0.4
2200-300	26400	92.8	3.1	2.6	1.2	0.3
2300-400	11400	93.2	2.5	2.8	1.2	0.3
2400-500	42000	94.8	3.5	0.9	0.6	0.2
2500-600	7000	66.4	3.5	14.9	7.6	7.6
2600-700	37000	95.5	0.5	2.0	1.2	0.8
2700-800	3000	62.0	3.6	17.0	10.3	7.1
2800-130	2100	59.0	4.1	16.6	12.2	8.1
2830- 60	1700	57.1	3.5	15.1	15.9	8.4
2860- 90	2200	57.2	6.5	19.9	10.4	6.0
2890-920	1800	57.6	5.4	19.0	10.8	7.2
2920- 50	1300	45.8	5.2	23.2	14.1	11.7
2950- 80	700	54.9	4.7	19.8	12.4	8.2
3010- 40	500	53.2	4.5	20.0	14.0	8.3
3040- 70	3000	86.9	3.5	5.8	2.3	1.5
3070-100	800	87.8	4.2	5.3	1.8	0.9
3160- 90	500	45.5	24.5	22.3	3.1	4.6
3190-220	400	31.5	35.0	25.6	3.1	4.8
3220- 50	1200	29.4	36.2	27.4	2.6	4.4
L.B.P.						
3250- 80	2800	14.4	21.7	32.7	7.6	23.6
3310- 40	2900	14.4	21.7	34.1	7.5	22.3
3340- 70	2600	19.0	27.5	32.5	5.8	15.2
3370-400	200	33.1	13.0	33.7	2.3	17.9
3460- 90	6900	4.5	4.2	6.0	23.4	61.9
3490-520	9000	5.0	8.4	34.7	17.0	34.9
3520- 50	20000	1.3	10.5	39.0	13.7	35.5
3610- 40	12000	13.3	11.0	36.6	12.9	26.2
K Robres						
3640- 70	6700	8.7	11.1	40.2	17.5	33.5
3640- 70	5800	6.2	8.2	34.8	17.8	33.0
3670- 76	2800	5.1	7.3	34.0	18.0	35.5

<u>TABLE 2</u>

<u>GENERALISED KEROGEN DESCRIPTION AND SPORE COLOUR INDEX</u>

DEPTH METRE	DOMINANT KEROGENS	SPORE COLOUR INDEX
1633	Vitrinite >> Inertinite > Sapropel	2
1651	Ditto	2
1685	Vitrinite > Inertinite > Sapropel	2
1717	Ditto	2
1750	Sapropel > Inertinite > Vitrinite	2-2.5
1784	Ditto	2-2.5
1868	Ditto	2-2.5
1904	Vitrinite > Sapropel	2-2.5
1930	Ditto	2-2.5
1980	Vitrinite and Sapropel	2.5
2104	Ditto	2.5-3
2148	Sapropel and Vitrinite	2.5-3
2233	Sapropel	3 - (3.5)
2272	Sapropel	3 - (3.5)
2358	Sapropel and Inertinite	3 - (3.5)
2427	Ditto	3 - (3.5)
2445	Sapropel, Inertinite and Vitrinite	3 - 3.5
2528	Sapropel and Exinite > Vitrinite > Inertinite	3?
2723	Inertinite > Sapropel	3.5 - 4
3075	Exinite > Inertinite ≥ Sapropel	4 - 4.5
3201	Inertinite >> Sapropel	4.5
3243	Inertinite ≥ Sapropel	4.5 - 5
3267	Sapropel >> Inertinite	4.5 - 5
3301	Sapropel > Inertinite	4.5 - 5
3319 – Fan.	Vitrinite, Inertinite and Sapropel	4.5-5 and pale ±
3489	Ditto	± 5
3517	Inertinite	± 5
3552	Inertinite	5 - 5.5
3561.5	Inertinite > Sapropel	5 - 5.5
3601	Inertinite, no measurable phytoclasts	*
3608.5	Inertinite, no measurable phytoclasts	*

SOURCE ROCK EVALUATION DATA

COMPANY: CONOCO NORWAY WELL: 7/12-2 LOCATION: NORWEGIAN N. SEA

SAMPLE DEPTH (METRES) 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
1. 1633	SWC	Brn-gy sl calc sh	3.1	2175	7.0	130	6	55
2. 1651	"	Ditto	4.0	2710	6.8	180	7	46
3. 1685	"	Ditto	4.9	3460	7.1	40	1	32
4. 1717	"	Brn-gy/ol-gy calc sh	3.2	2495	7.8	145	6	44
5. 1750	"	Ol-gy sh	3.3	3075	9.3	315	10	54
6. 1784	"	Brn-gy calc sh	4.8	3800	7.9	250	7	41
7. 1868	"	Brn-blk sl calc sh	7.0	4850	6.9	445	9	40
8. 1904	"	Brn-blk sh mic sh	5.4	4210	7.8	280	11	41
9. 1930	"	Brn-gy/ol-gy sl mic sl calc sh	5.8	4880	8.4	395	7	41
10. 1980	"	Ol-blk calc sh	5.6	7170	12.8	650	8	32
11. 2104	"	Lt ol-gy calc sh	1.78	855	4.8	140	16	69
12. 2148	"	Ditto	1.57	685	4.4	125	18	48
13. 2180	"	Ditto	2.0[illegible]	1265	6.3	140	11	48
14. 2233	"	Ditto	1.50	790	5.3	95	12	49
15. 2272	"	Ditto	1.30	595	5.4	115	19	39
16. 2358	"	Lt ol-gy sh	1.24	600	4.8	85	14	35
17. 2427	"	Lt ol-gy sl calc sh	0.29	165	5.7	30	18	*
18. 2445	"	Lt ol-gy sh	0.35	205	5.9	40	20	66
19. 2528	"	Lt gy sh	1.70	1345	7.9	260	19	52
20. 2575	"	Lt gy sl slty sh	0.90	1250	13.9	145	12	59
21. 2723	"	Med gy calc sh	0.29	170	5.9	20	12	72
22. 3035	"	Lt gy calc sltst	0.31	95	3.1	<20	-	-
23. 3075	"	Dk gy sh	7.5	175	0.2	20	11	*
24. 3198-220	Ctgs	Dk ol-gy sh+mnr snd	0.42	340	8.1	70	21	55
25. (3243	SWC	Ditto						
(3255	"	Lt ol gy calc sh	1.37	1665	12.2	590	35	62
26. (3267	"	Ol-blk sh						
(3277	"	Ditto	7.0	15485	22.1	6060	39	41
27. 3289	"	Ditto	2.70	5335	19.8	1425	27	43
28. 3301	"	Dk gy mic calc sh	4.1	6450	15.7	2495	39	46
29. 3319	"	Ol-blk calc sh	1.21	1060	8.8	485	46	66
30. 3370-400	Ctgs	Dk gy sh+mnr snd	0.56	300	5.4	30	10	29

TABLE 3 (Cont'd.)

SOURCE ROCK EVALUATION DATA

COMPANY: CONOCO NORWAY WELL: 7/12-2 LOCATION: NORWEGIAN N. SEA

SAMPLE DEPTH METRES 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
3537.5	S.W.C.	V lt gy sltst	0.19					
3550-80	Ctgs	Dk gy calc sh+tr lt gy sltst+tr red mdst	0.67					
3561.5	S.W.C.	Gn/gy calc sltst	0.16					
3569.5	"	Grn/red sl calc mdst	0.25					
3580-610	Ctgs	Dk gy calc sh+pnk calc sltst/sst	0.46					
3597.5	S.W.C.	Pale red calc mdst	0.14					
3601	"	Mtl pnk/gy calc sltst	0.09					
3608.5	"	Pale red sl calc sltst	0.08					
3610-40	Ctgs	Dk gy calc sh+tr pnk calc sltst/sst	0.44					
3640-70 K Rohres	"	Ditto+ditto+tr blk sh	0.46					
3640-70 L.B.P.	"	Ditto+ditto	0.37					
3670-76	"	Ditto+50% pnk calc sltst	0.32					

SOURCE ROCK EVALUATION DATA

COMPANY: CONOCO NORWAY WELL: 7/12-2 LOCATION: NORWEGIAN N. SEA

SAMPLE DEPTH METRES 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
31. 3460-90	Ctgs	Dk gy sh+mnr snd	0.45	540	13.2	185	34	66
32. 3515	S.W.C.	Lt ol-gy sst+bit incl	1.62	5490	33.9	1415	26	72
33. (3517	"	Lt ol-gy sltst						
(3518	"	Lt ol-gy calc sltst + bit incl	0.68	2305	33.9	1455	63	71
34. 3552	"	Med dk gy mic sh	0.46	595	12.9	455	76	72
35. 3573	"	Gn gy sl calc sltst	0.31	1380	44.5	430	31	74
36. 3580.5	"	Dk red/brn sl calc mdst	0.35	640	18.3	360	56	88
37. 3605.2	"	V lt gy sl calc sltst	0.55	1000	18.2	275	28	76
38. 3611.8	"	Pnk/lt gy calc sltst	0.51	1105	21.7	230	21	71
39. 3617	"	Reddish brn mdst	1.30	2450	18.8	950	39	77
		ORGANIC CARBON DETERMINATION ONLY						
2032	S.W.C.	Ol-gy calc sh	6.6					
2055	"	Ditto	5.0					
2663	"	Wht chk	0.07					
2905	"	Ditto	0.10					
3160-90	Ctgs	Dk gy sh+mnr lstn	0.34					
3201	S.W.C.	Gy calc sh	2.64					
3220-50	Ctgs	Ol-gy/dk gy sh+mnr snd	0.31					
3250-80 L.B.P.	"	Ditto	0.31					
3250-80 K Robres	"	Ditto	0.32					
3280-310	"	Ditto	0.38					
3310-40	"	Ditto	0.36					
3340-70	"	Ditto	0.31					
(3489 (3492	S.W.C. "	Yel-gy sl calc sst	0.26					
3490-520	Ctgs	Dk gy sl calc sh	0.34					
3520-50	"	Gy-dk gy calc sh+lt gy sltst/sst	0.54					

C

D

FIGURE 1

HEADSPACE ($C_1 - C_4$) HYDROCARBONS

COMPANY : CONOCO NORWAY WELL : 7/12-2 LOCATION : NORWEGIAN NORTH SEA

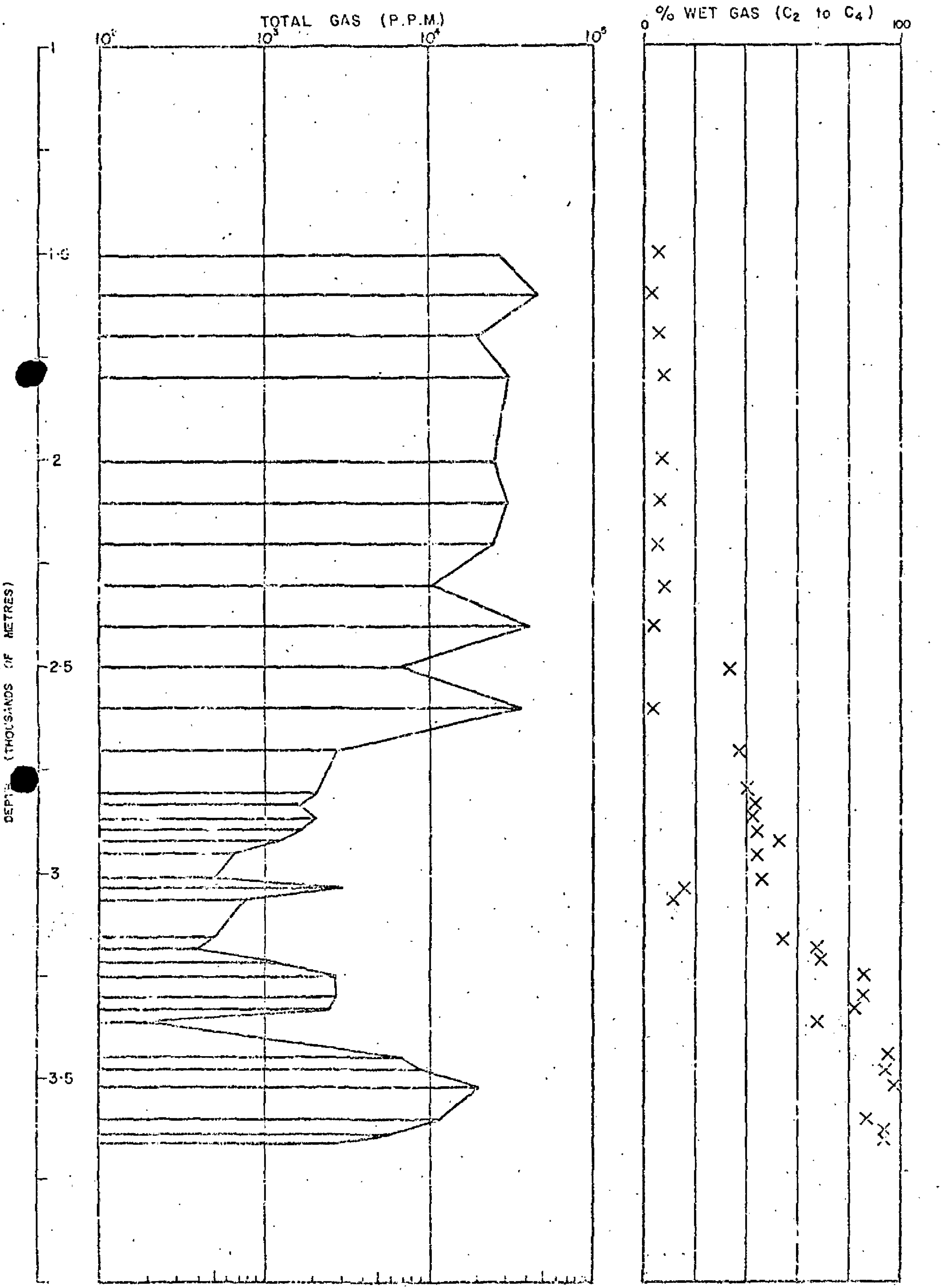
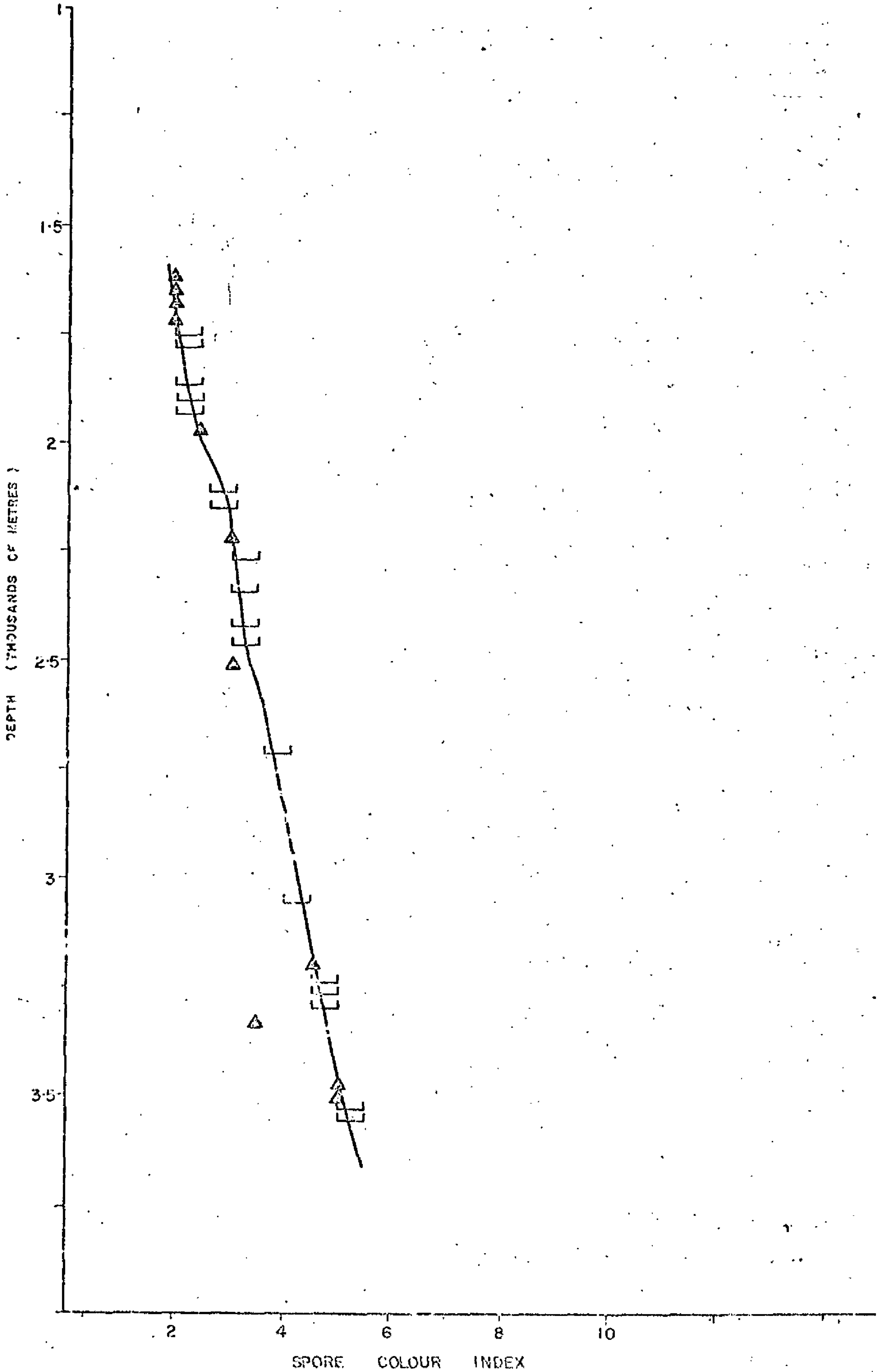


FIGURE 2

SPORE COLOUR INDEX AGAINST DEPTH

COMPANY : CONOCO NORWAY WELL : 7/12-2 LOCATION : NORWEGIAN N. SEA



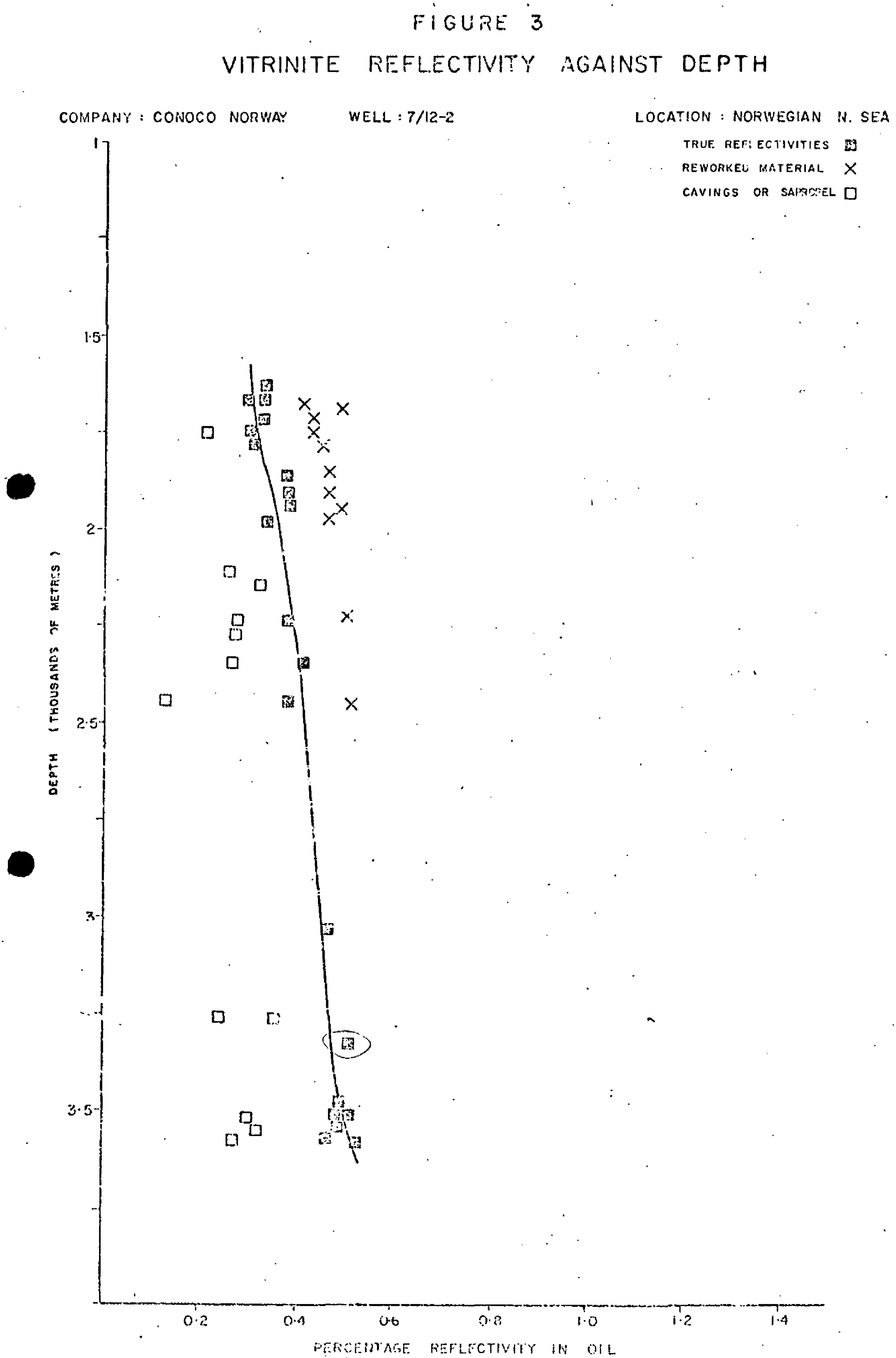


FIGURE 3
VITRINITE REFLECTIVITY AGAINST DEPTH
COMPANY : CONOCO NORWAY
WELL : 7/12-2
LOCATION : NORWEGIAN N. SEA
TRUE REFLECTIVITIES
REWORKED MATERIAL
CAVINGS OR SAPROPEL
DEPTH (THOUSANDS OF METRES)
1
1·5
2
2·5
3
3·5
0·2
0·4
0·6
0·8
1·0
1·2
1·4
PERCENTAGE REFLECTIVITY IN OIL

FIGURE 4

TYPE OF HYDROCARBON PRODUCT FROM SOURCE ROCKS

COMPANY : CONOCO NORWAY WELL : 7/12-2 LOCATION : NORWEGIAN NORTH SEA

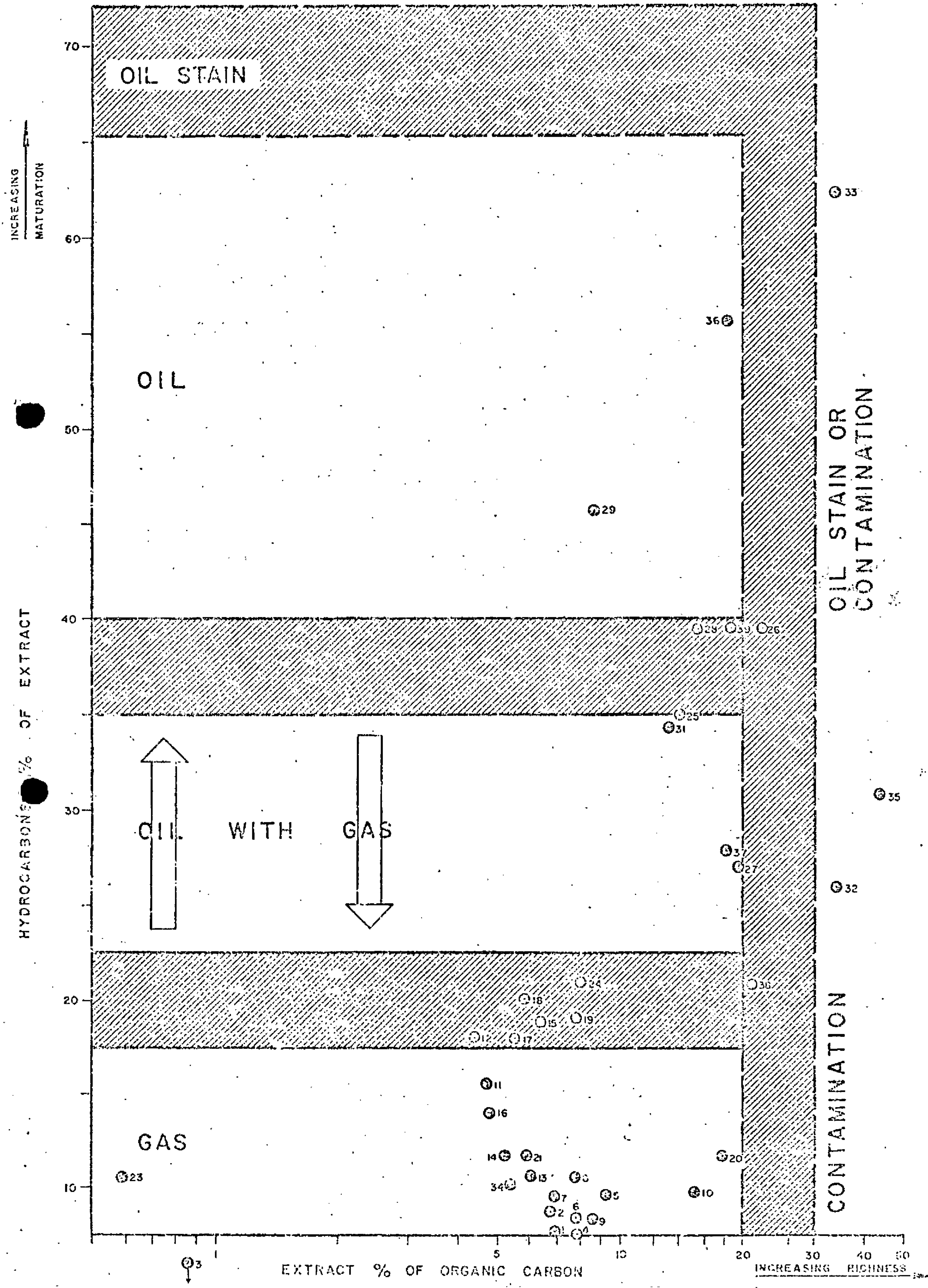


FIGURE 5

MATURE SOURCE ROCK RICHNESS

COMPANY : CONOCO NORWAY   WELL : 7/12-2   LOCATION : NORWEGIAN N. SEA

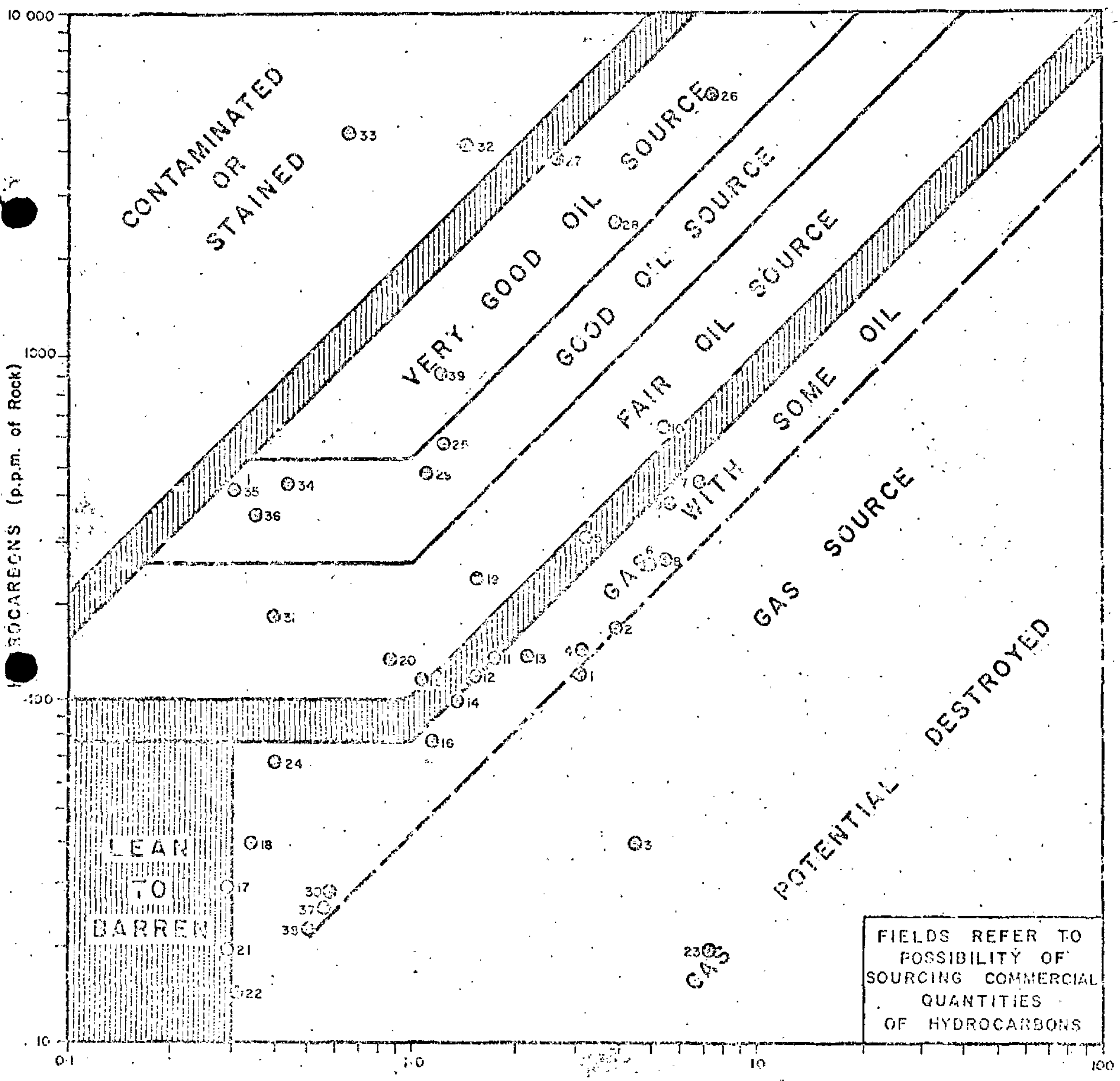


FIGURE . 7

NORMALISED DISTRIBUTIONS OF n – ALKANES

COMPANY : CONOCO NORWAY WELL: 7/12-2 LOCATION: NORWEGIAN NORTH SEA

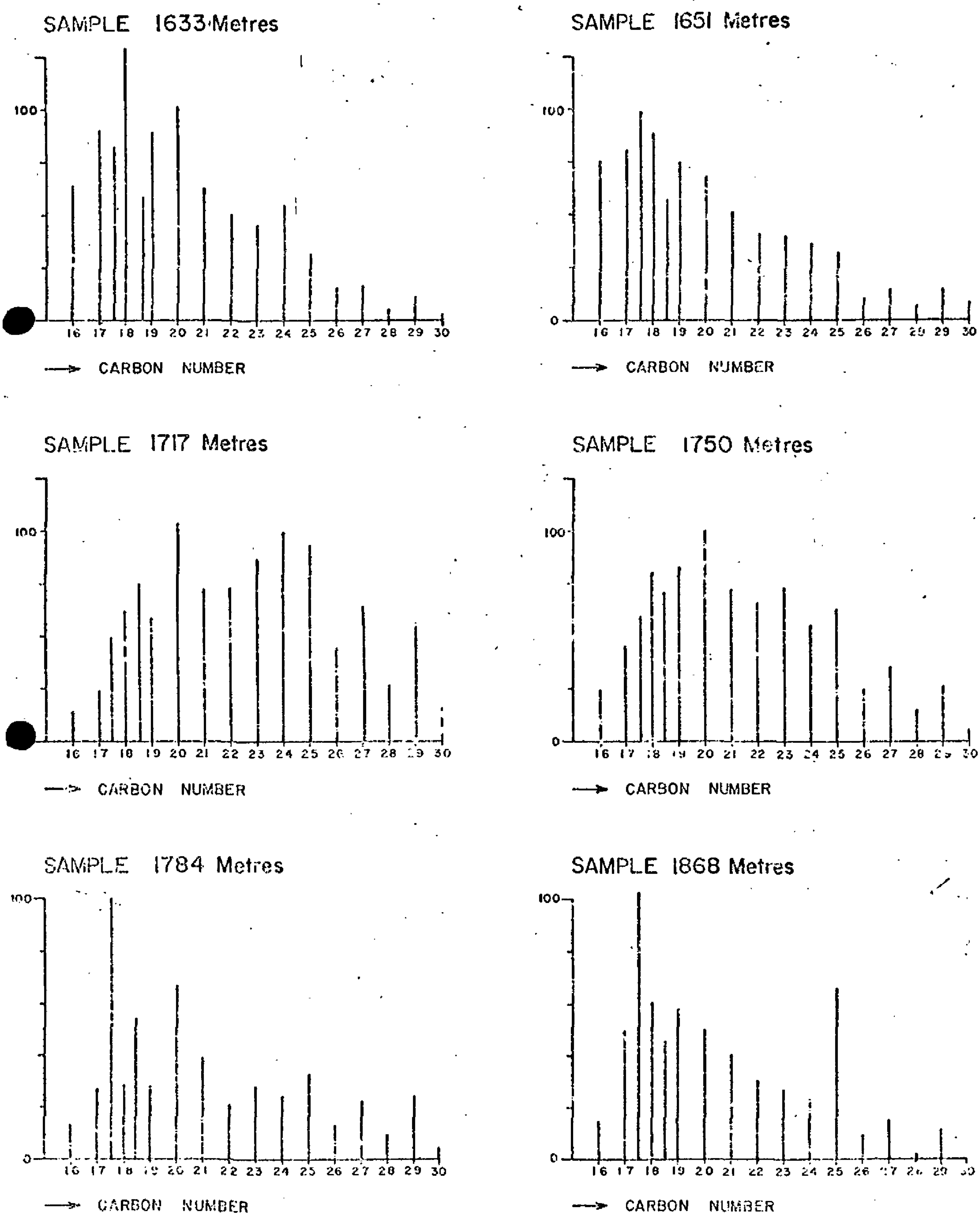


FIGURE 8

NORMALISED DISTRIBUTIONS OF n – ALKANES

COMPANY : CONOCO NORWAY WELL: 7/12-2 LOCATION: NORWEGIAN NORTH SEA

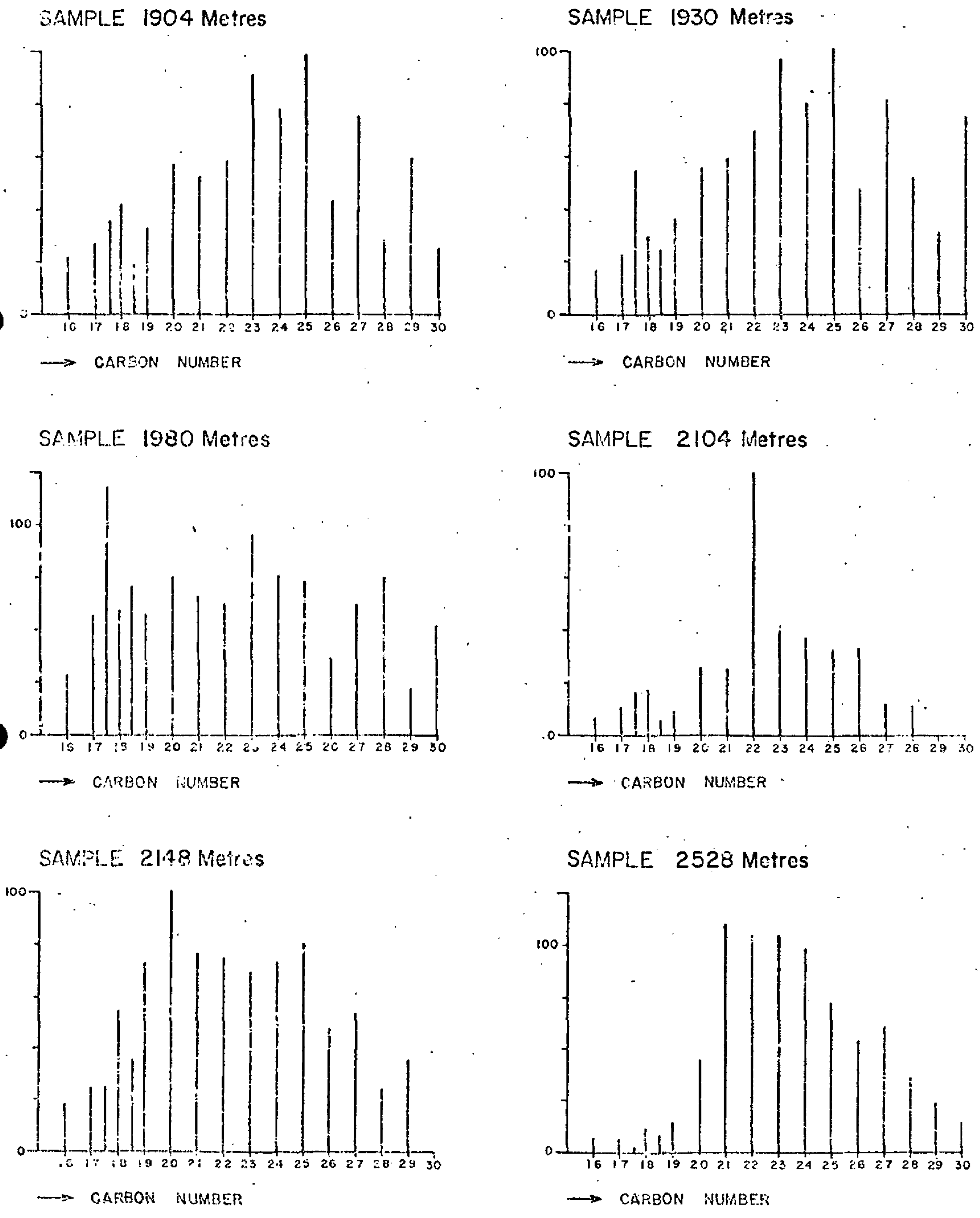
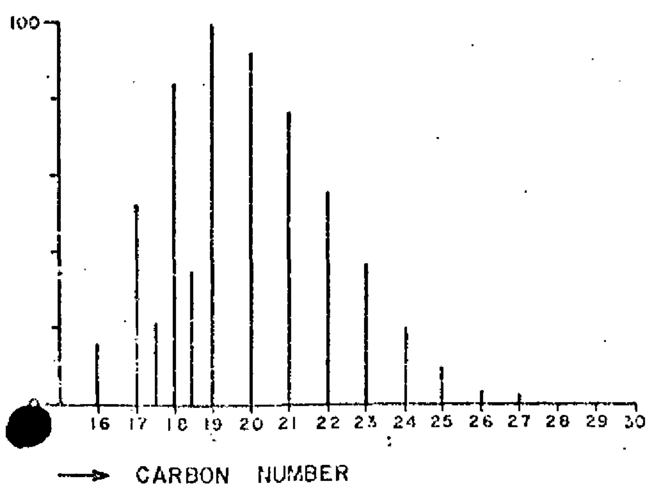


FIGURE 9

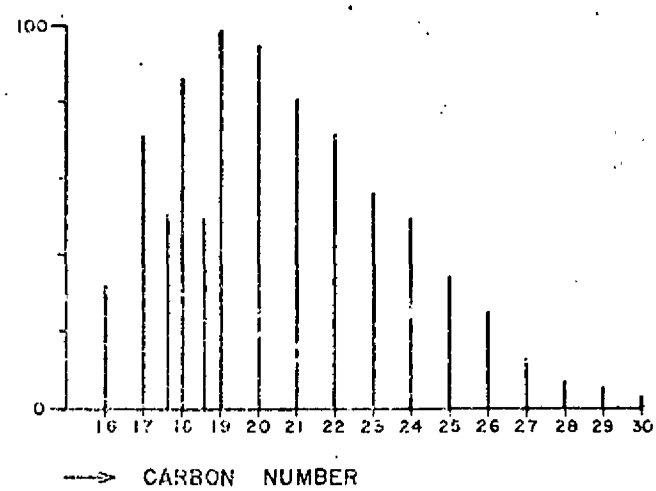
NORMALISED DISTRIBUTIONS OF n – ALKANES

COMPANY : CONOCO NORWAY | WELL: 7/12-2 | LOCATION: NORWEGIAN NORTH SEA

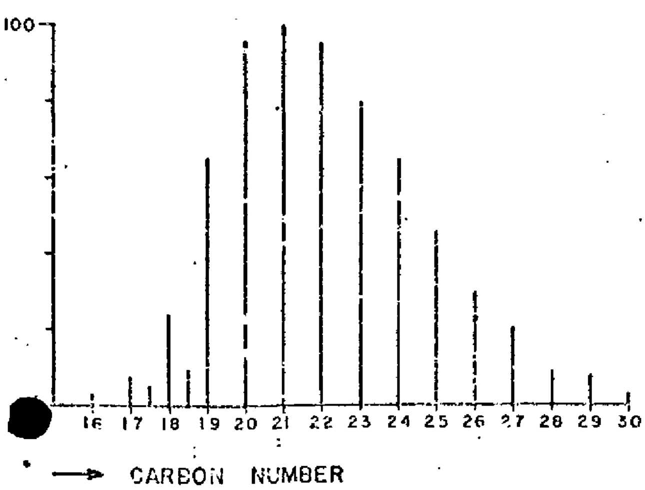
SAMPLE 3243-255 Metres



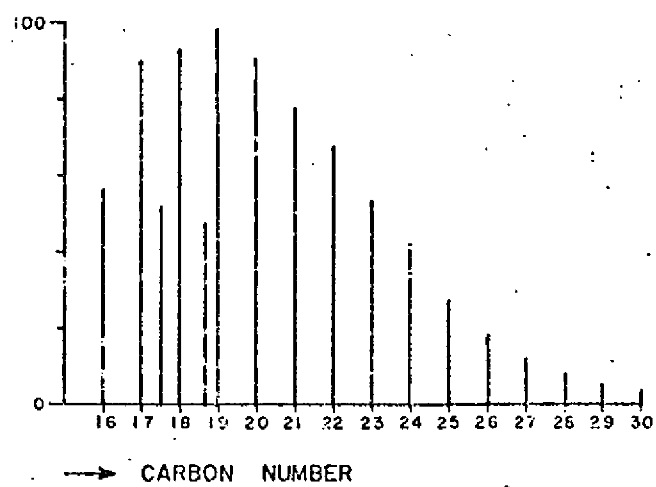
SAMPLE 3267-277 Metres



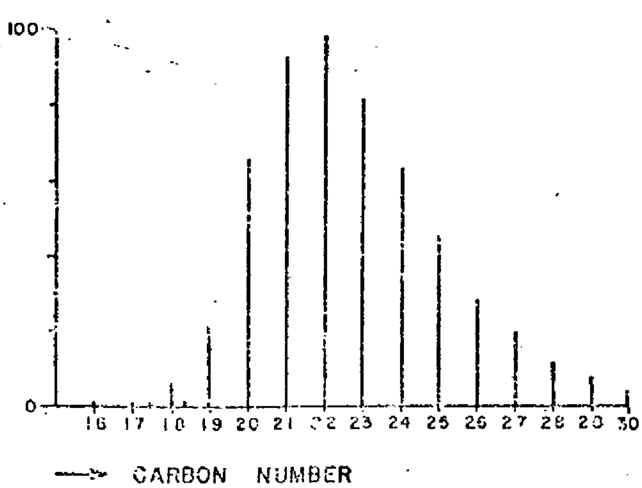
SAMPLE 3289 Metres



SAMPLE 3301 Metres



SAMPLE 3319 Metres



SAMPLE 3515 Metres

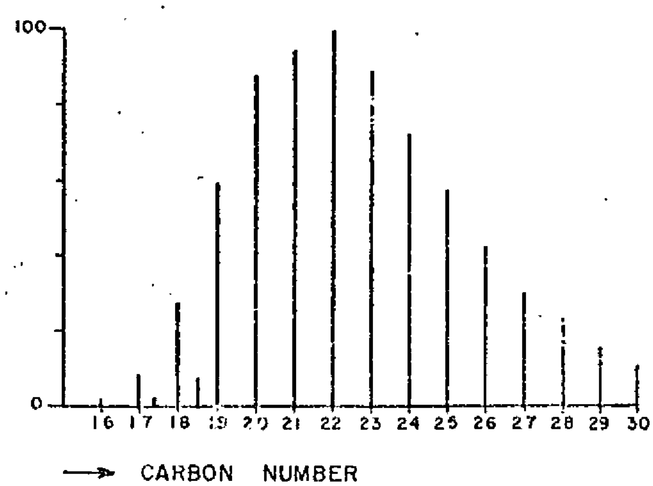


FIGURE 10

NORMALISED DISTRIBUTIONS OF n – ALKANES

COMPANY : CONOCO NORWAY   WELL: 7/12-2   LOCATION: NORWEGIAN NORTH SEA

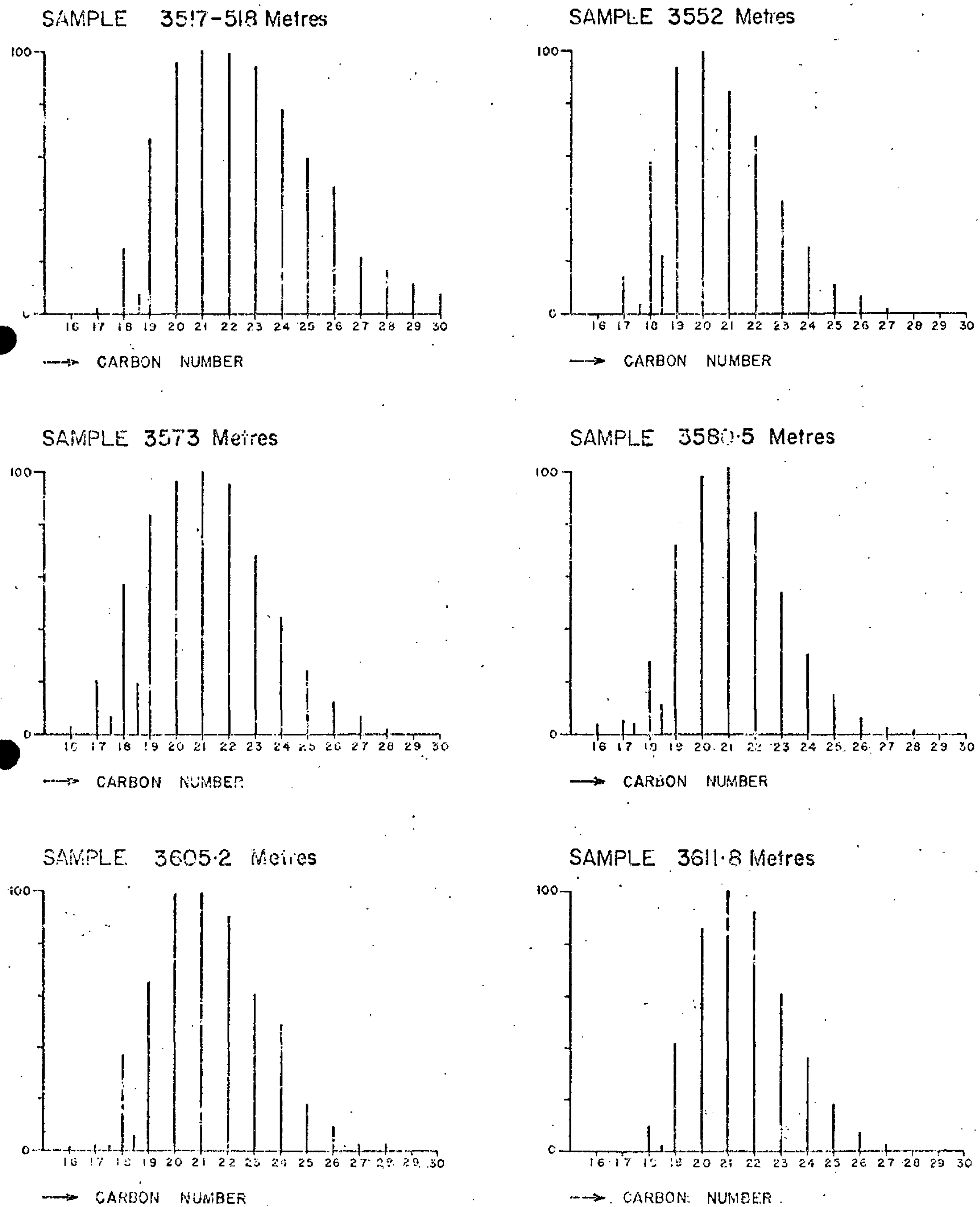
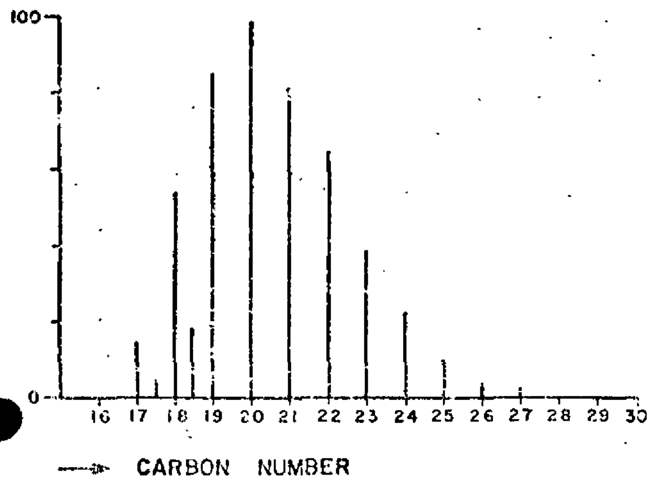


FIGURE II

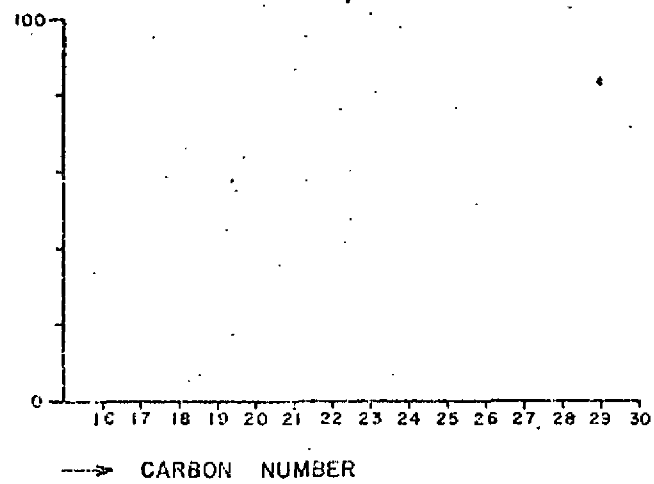
NORMALISED DISTRIBUTIONS OF n – ALKANES

COMPANY : CONOCO NORWAY WELL: 7/12-2 LOCATION: NORWEGIAN NORTH SEA

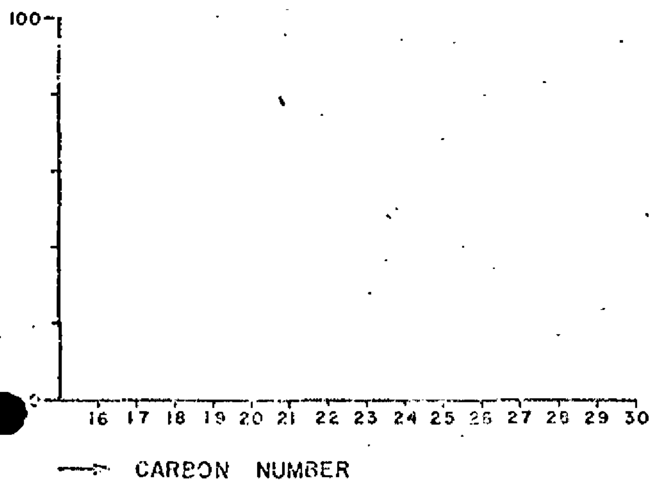
SAMPLE 3617 Metres



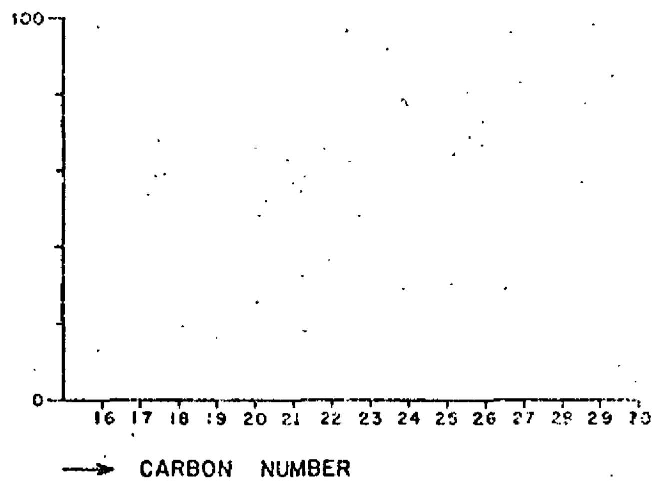
SAMPLE



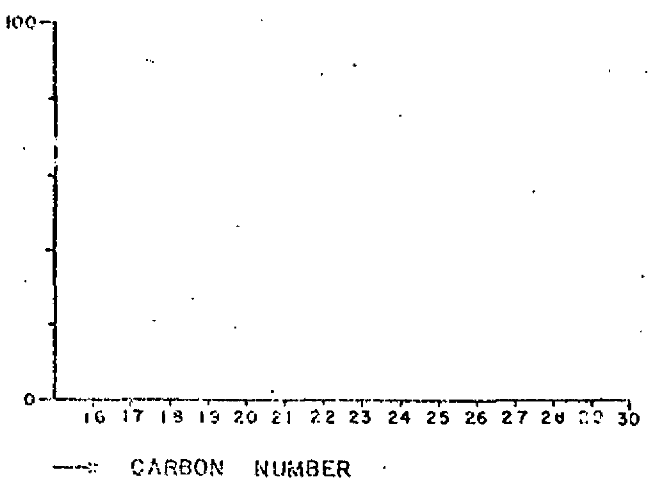
SAMPLE



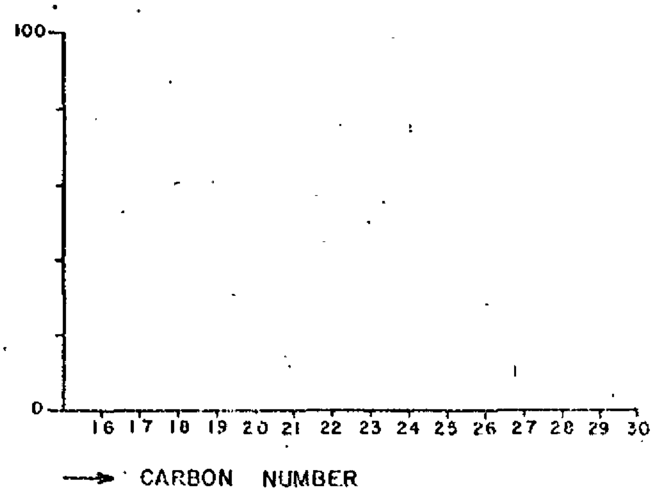
SAMPLE



SAMPLE



SAMPLE



APPENDIX I

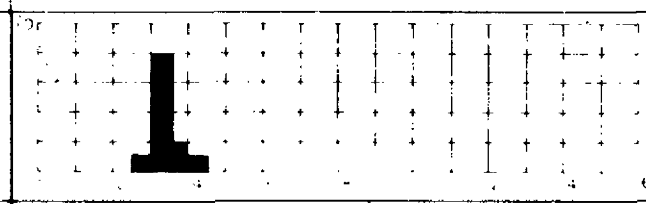
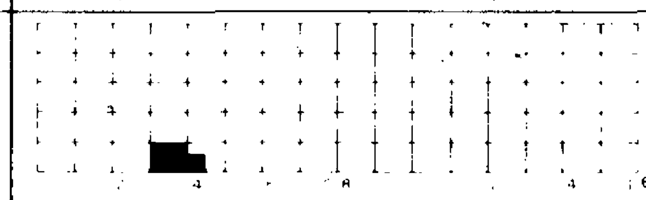
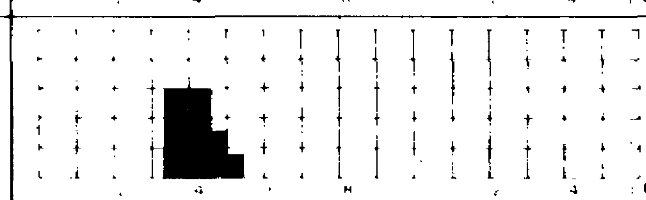
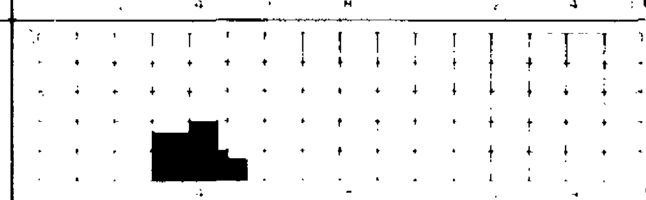
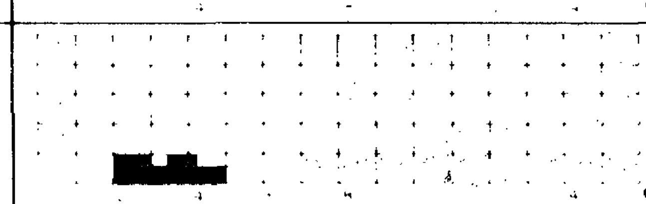
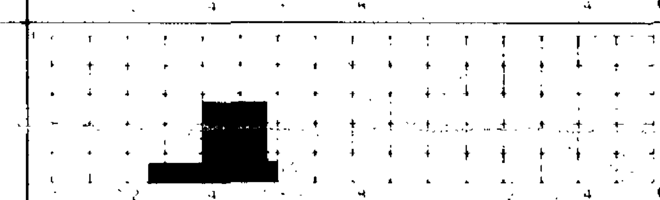
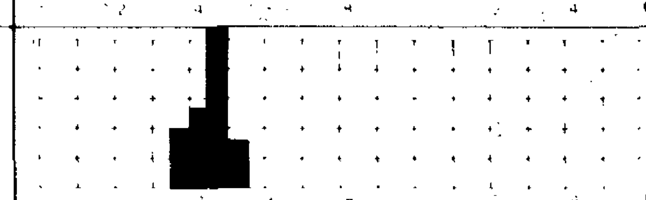
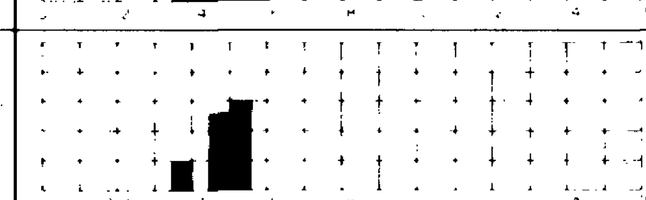
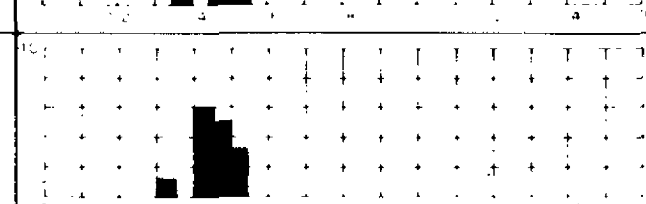
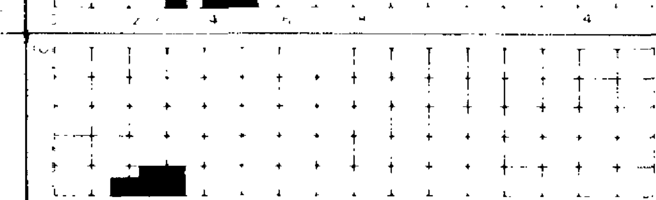
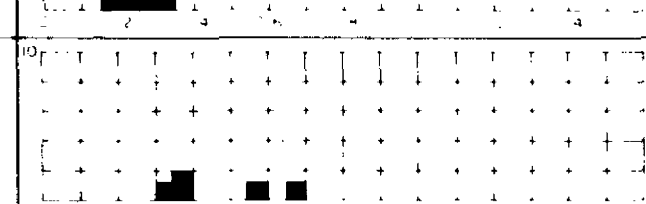
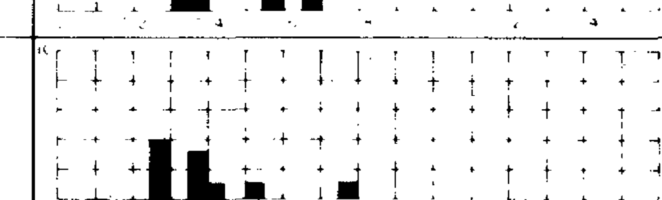
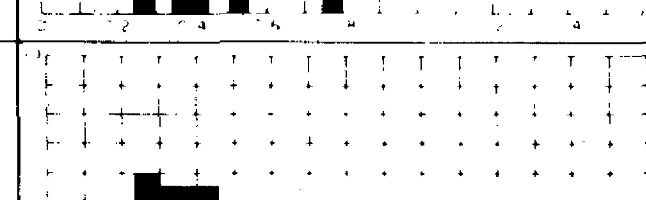
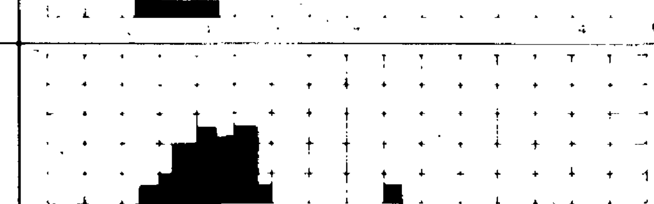
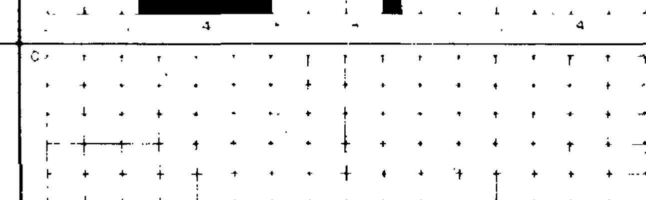
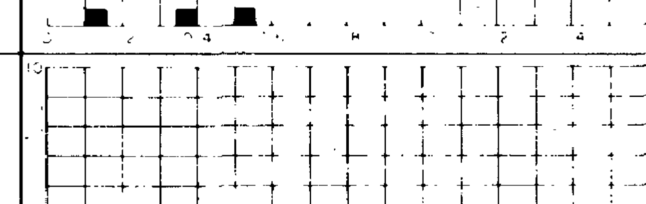
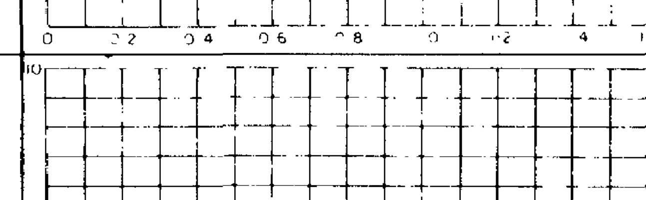
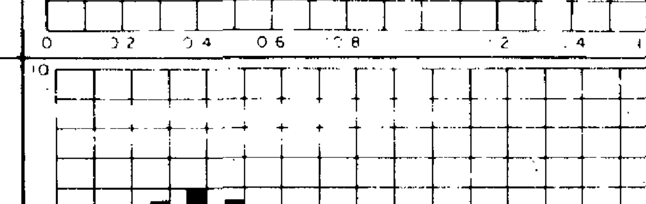
ABBREVIATIONS USED IN ANALYTICAL DATA SHEETS

Alg	-	Algae
Aren	-	Arenaceous
Arg	-	Argillaceous
Bit	-	Bitumen/bituminous
Bl	-	Blue
Blk	-	Black
Brn	-	Brown
Calc	-	Calcareous
Carb	-	Carbonaceous
Chk	-	Chalk
Cht	-	Chert
Cgl	-	Conglomerate
Cly	-	Clay
CMT	-	Cement
Crs	-	Coarse
Ctgs	-	Ditch cuttings
Dk	-	Dark
Dol	-	Dolomite
F	-	Fine
Fer	-	Ferruginous
Flu	-	Fluorescence
Fm	-	Formation
Foram	-	Foraminifera
Fr	-	Friable
Frags	-	Fragments
Glc	-	Glauconite
Gn	-	Green
Gy	-	Grey
Gyp	-	Gypsum
Hd	-	Hard
Inert	-	Inertinite
Lam	-	Laminae/laminated
LCM	-	Lost circulation material
Lig	-	Lignite/lignitic
Lst	-	Limestone
Lt	-	Light
Mdst	-	Mudstone
Med	-	Medium
Mic	-	Micaceous
Mnl	-	Mineral
Mnr	-	Minor

Mtl	-	Mottled
Musc	-	Muscovite
NS	-	No sample
Occ	-	Occasional
Ol	-	Olive
Ool	-	Oolite/oolitic
Orng	-	Orange
Pnk	-	Pink
Pop	-	Population
Pp	-	Purple
Pyr	-	Pyrite/pyritic
Qtz	-	Quartz
Ref	-	Reflectivity
Sap	-	Sapropel
Sft	-	Soft
Sh	-	Shale
Shly	-	Shaly
Sil	-	Siliceous
Slt	-	Silt
Sltst	-	Siltstone
Slty	-	Silty
Snd	-	Sand
Sndy	-	Sandy
Sst	-	Sandstone
SWC	-	Sidewall core
Tr	-	Trace
V	-	Very
Vgt	-	Variegated
Vit	-	Vitrinite
Wht	-	White
Yel	-	Yellow
-	-	Sample not analysed
*	-	No results obtained
Gy-gn	-	Greyish green
Gn/gy	-	Green to/and grey
Gn-gy	-	Greenish grey

VITRINITE REFLECTIVITY DATA SUMMARY CHART

CLIENT CONOCO [illegible] WELL 7/12-2 LOCATION NORWEGIAN NORTH SEA

DEPTH (METRES)	LITHOLOGY & MINERALOGY	TYPE OF ORGANIC MATTER	HISTOGRAM SHOWING REFLECTIVITY VALUES NO. OF MEASUREMENTS	R (av)	NO OF PARTICLES	FLUORESCENCE
1655	Brn gy calc s[illegible] with pyrite	Small vitrinite grains and inertinite. Organic matter intimately mixed with mineral matter in kerogen conc.		0.33	12	Faint yellow and yellow-orange spores.
1651	Ditto	Very small vitrinite grains, no good surfaces due to intermixing with mineral matter.		0.31 0.33 0.30	2 12 [illegible]	Orange-brown fluorescence
[illegible]	Ditto	[illegible] vitrinite particles and inertinite.		0.4[illegible]		Little or no organic fluorescence.
[illegible]	[illegible]-gy ol-gy calc sn	Spong [illegible] [illegible] vitrinite could be reworked.		0.33 [illegible]	1 [illegible]	Ditto
[illegible]	Ol-gy sh with framboidal pyrite.	[illegible] reflecting granular [illegible] masses. Some resin. Vitrinite particles, some reworked.		[illegible] [illegible] [illegible]	1	Mainly yellow and golden-yellow fluorescence. Also faint orange [illegible] fluorescence.
[illegible]	Brn-gy calc sn	[illegible] quantity of vitrinite, rather spongey		[illegible]	[illegible] 1	Rare yellow and golden fro[illegible] very small phytoclasts.
1868	Brn-blk sl calc sn	Much vitrinite th[illegible] with embedded mineral matter		[illegible]	1 1[illegible]	Rare yellow organic fluorescence
1904	Brn-blk sl mic sh. Fair quantity of pyrite.	Fair quantity of vitrinite often embedded with mineral matter and especially pyrite.		[illegible] 0.47 [illegible]	[illegible]	[illegible]re golden-yellow fluorescing spores.
1930	Brn-gy ol-gy sl mic sl calc sh	Vitrinite often with embedded mineral matter, especially pyrite		[illegible] 0.45	2 11	No organic fluorescence
1980	Ol-blk calc sh	Ditto		0.[illegible] .47	1 14	Major yellow fluorescence and minor orange fluorescence.
2104	Lt ol-gy calc sh	Rare organic matter poor vitrinite particles		0.21 0.[illegible]	4	No organic fluorescence
2148	Ditto	Rare very small vitrinite grains and semifusinite		0.[illegible] 0.57 0.[illegible]	[illegible]	No organic fluorescence
2233	Ditto	Poor sample with mineral matter, [illegible] pyrite, in vitrinite. Also semifusinite and fusinite		0.28 0.38 0.51 0.77	4 1 1 1	Rare dull yellow organic fluorescence
2272	Ditto	Very sparse organic material often with mineral matter. Occasionally vitrinite and resin? Some inertinite		0.28 0.[illegible]	[illegible]	No organic fluorescence
2358	Lt ol-gy sh	Vitrinite often with embedded mineral matter. Clear areas of vitrinite not abundant		0.[illegible] 0.4[illegible] 0.[illegible]1	1 21 1	Faint yellow organic fluorescence
[illegible]	Lt ol-gy sl calc sn	[illegible] vitrinite particles		*	*	Orange fluorescing spores
2415	Lt ol-gy sh	Lean in organic matter. When present organic matter embedded with mineral.		0.14 0.38 0.52	1 1 1	Occasional yellow organic fluorescence
2528	Lt gy sh with much pyrite	No vitrinite seen. Occasional inertinite and faint exinites. No particles measured		*	*	Rare yellow and yellow orange fluorescence
2723	Med gy calc sh much pyrite	Occasional inertinite, no vitrinite seen. No particles measured.		*	*	Faint yellow ?organic fluorescence
3040-70	Lt gy calc sltst	Vitrinite particle at Ro 0.47% Remainder of material of questionable origin probably sapropel ?		0.47 0.36 0.27	1 2 1	Rare orange spore fluorescence

REF: DRAWING NO. 032P/2386/3653a DATE DECEMBER 1976