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GEOCHEMICAL OPERATIONS AND DEVELOPMENT GROUP

PETROLEUM GEOCHEMISTRY OF THE WELL 35/3-2, NORWEGIAN SECTOR, NORTH SEA

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CONTENTS

SUMMARY

Cuttings and sidewall core sediment samples of Cretaceous and Jurassic ages from the well 35/3-2 were examined for this geochemical study. The interval analysed was from 2410m to ∿ 4160m. Sandstones or metamorphic rocks were encountered below this depth to TD.

The Oil Generation Threshold is tentatively placed in the range 3300 - 3700m on the basis of vitrinite reflectance measurements. Spore colours suggest the OGT may be somewhat shallower ca. 3100m. The results also suggest the Middle and Lower Jurassic below the unconformity ca. 3829m are at least sufficiently mature for onset of gas generation.

Pyrolysis studies indicated the Jurassic kerogens were likely to source gas and possibly some (minor amounts of) condensate. Total hydrocarbon source potentials however, were at best, only moderate. The source quality of the Cretaceous sediments examined was generally poor or insignificant.

The results were compared to those for the well 35/3-1.

1. INTRODUCTION

The Statoil/BP/Saga well 35/3-2 was drilled at location 61° 51' 05.98"N, 03° 46' 28.22"E in the Norwegian Sector of the North Sea. The well was spudded on 19th May 1980 and reached a total depth of 4400m on 19th September 1980.

The primary objective was to test some Lower Jurassic sandstones on a Westerly dipping fault block 2 Km updip and east of the well 35/3-1. Gas was found in Cretaceous levels.

Cans of wet cuttings material were available from 3500m to TD as was a suite of sidewall core samples. Cuttings samples from intervals that had been turbo-drilled were not examined in detail nor were samples below ∿4160m to TD which appeared to be oxidised or metamorphic in nature and thus not suitable for geochemical analyses. After work had commenced a request from Norway was received not to use the sidewall core material provided, thus in some instances full sets of analyses were not completed.

For this study twenty-seven samples of cuttings or sidewall core material from the interval 2410m to 4160m were examined. The stratigraphic interval covered is Campanian to ?Late Pliensbachian. Although detailed geochemistry was requested only on samples below 3500m it was necessary to examine a larger interval to better establish the maturity of the sediments. The biostratigraphic information (shown in Table 7) was provided by BP Sunbury (Crux, 1980).

2. ANALYTICAL TECHNIQUES

The objectives of the geochemical analyses undertaken were to establish the maturity and hydrocarbon source potential of the sediment samples. The following techniques were used to determine these parameters.

2.1 Sample Preparation

Prior to any of the analyses, cuttings samples were washed, dried and picked to remove cavings and any obvious contaminants, to provide a uniform lithology of geochemical interest. Sidewall-core samples were cleaned as far as possible by removal of surface contamination. Apart from the Vitrinite Reflectance and Visual Kerogen Analyses, samples were ground and then sieved to achieve a uniform mixture for analysis. The cuttings samples used were 30m composites and in such cases the depth quoted is the top of the interval.

2.2 Vitrinite Reflectance

Vitrinite Reflectance measurements were made on coarsely ground cuttings or sidewall core samples contained in polished resin blocks. Reflectances (% Ro) were determined using oil immersion objectives on $\sim 5\mu$ particle widths at a light wavelength of 546 mm. A reflectance value of Ro = 0.55% is considered to characterise the Oil Generation Threshold for an average oil-prone kerogen.

2.3 Visual Kerogen and Spore Colour Descriptions

Visual Kerogen and sporomorph colour studies were carried out using transmitted light microscopy on samples previously demineralised by hydrochloric/hydrofluoric acid treatment. A colour rating of 3/4 on a scale of 1-7 is considered representative of the generation threshold for liquid hydrocarbons from an average oil prone kerogen.

2.4 Pyrolysis Studies

Total hydrocarbon source potential yields (kg/tonne) of the samples were assessed by the Rock-Eval apparatus. A pyrolysis-gas chromatography technique developed at BP Sunbury (Dungworth, 1979) was also employed to determine the Gas/Oil Generation Index (GOGI) of the samples. Analysis of the GOGI value and total hydrocarbon potential yield makes possible a relative estimation of the amount of oil and gas likely to be sourced from a Kerogen.

2.5 Soluble Extract Studies and Organic Richness

Finely ground and sieved sediment samples (5g) were extracted with dichloromethane (100ml) using a Chemcol high speed mixer for 20 minutes. After filtration and evaporation of the solvent, the Total Soluble Extract (TSE) was obtained. The TSE was de-asphaltened by addition of hexane and separated into its constituent saturate (SAC), aromatic and residual fractions by High Performance Liquid Chromatography (HPLC). The SAC fraction was analysed by glass capillary gas chromatography (GC) to obtain the n-alkane distribution used to calculate the Carbon Preference Index (CPI) over the range C_{18} - C_{32}.

The organic richness of the sediments was assessed by Total Organic Carbon (TOC) determinations on decarbonated samples. This was accomplished by decarbonating ground and sieved samples with hydrochloric acid, drying under vacuum at 50^{o}C and analysing for carbon with a Leco Carbon Analyser.

The Generation Indices TSE/TOC (o/oo) and SAC/TOC (o/oo) were calculated from these results.

Pyrolysis, HPLC and GC data were collected and analysed by a Hewlett-Packard HP 3354 Laboratory Automation System.

3. RESULTS AND DISCUSSION

3.1 Vitrinite Reflectance

These results are summarised in Table 1 and the full data set collected is presented in Appendix 1.

Samples were examined from 2410m to 4247m to obtain a maturity trend over as large an interval as possible. However, the amount of reliable autochthonous vitrinite in the Cretaceous and Middle Jurassic was rather low, with gnarled particles of inertinite and reworked material generally dominant. As a result of this, the results were not considered sufficiently reliable to make a statistically valid projection of the various maturity thresholds.

The results tentatively suggest the Oil Generation Threshold (OGT) is in the range 3300 - 3700m, within the Albian/Cenomanian interval although reliable reflectance values are few. Below the Lower Cretaceous-Middle Jurassic unconformity at ca. 3829m, the reflectances in the Toarcian-Middle Bajocian interval suggest the maturity is about equivalent to the Gas Generation Threshold (GGT) (R_o = 0.7%). In the Pliensbachian section ∿ 100m deeper, several sets of vitrinite reflectances were somewhat lower. These samples, however, were characterised by the presence of bitumen staining, and the spore fluorescence colours under ultra-violet light suggest a slightly higher maturity than is indicated by vitrinite reflectance. Thus source rock sediments of Jurassic or older age in this well are probably at least at the GGT stage of maturity.

The small interval between the OGT and the GGT suggests a high geothermal gradient but is more plausibly explained by the absence of the Upper Jurassic as a result of erosion.

3.2 Kerogen Studies

3.2.1 Spore Colour Descriptions

These results are summarised in Table 2.

Samples from 3092m to 4133/60m were examined and the sporomorph colours observed suggested, in contrast to vitrinite reflectance results, that the entire section was at least sufficiently mature for the onset of generation of liquid hydrocarbons (spore colour 4). Only a very gradual change of colour was apparent over the interval reaching colour 4-4/5 from 3746m to 4133m. Gas-prone Kerogens in the deeper section of the well would be sufficiently mature for gas generation.

3.2.2 Source Potential from Visual Kerogen Descriptions

These results are summarised in Table 2 and detailed in Table 2A.

Visual Kerogen descriptions of source quality suggested there was no hydrocarbon source potential in the sediments of Albian to Cenomanian/

Santonian age. Open marine environments of deposition were proposed for the samples at 3092m, 3204m and 3468.5m and less well-defined open-marine to near shore marine environments at 3336m and for the samples of Albian age. Poor source potential for gas was indicated for the sediments of Late Toarcian to Middle Bajocian age (3830m,3845/72m) and poor/poor-moderate oil and gas source potential from some sediments of Pliensbachian and Toarcian age.

Some algal detritus with Botrycoccus-like structure was found in the samples at 3945/62m, 4046/72m and 4133/60m which suggested some oil source potential from these kerogens. Environments of deposition suggested for the Lower and Middle Jurassic ranged from near-shore marine (3945/72m, 4046/72m, 4133/60m) to brackish/some marine influence (3845/72m), to brackish or non-marine (3830m,4033.5m).

3.3 Pyrolysis Studies

The results obtained are shown in Table 4.

The hydrocarbon source potential of the Upper and Lower Cretaceous sediments examined was generally poor or insignificant. The best sample was one predominantly gas-prone kerogen at 3483m with a maximum theoretical yield of hydrocarbons = 1.6 kg/tonne.

The Jurassic source sediments contained only poor-to-moderate potential at best, *MAX values reaching 2.2 - 2.5 kg/tonne. Pyrolysis-gas chromatography suggested the kerogens were predominantly gas-prone (GOGI = .49 - .84) although some minor amounts of condensate might also be sourced from these.

The quantitative pyrolysis studies are generally regarded as the more reliable indicator of source quality.

3.4 Soluble Extract Studies and Organic Richness

These results are listed in Tables 4,5 and 6.

N-alkane GC traces are shown in figures 1 to 6 and the normalised n-alkane distributions in figures 7 and 8. The results of soluble extract studies were not of great value in evaluating the maturity of the section. Some odd-over-even predominance of the n-alkanes was apparent in the gas chromatograms of the samples although generally they appear mature in character. Low generation indices were calculated from the data obtained. These results however, are consistent with the presence of gas-prone kerogens and significant amounts of inertinite as noted under Reflected Light Microscopy.

The large n-C21 peak observed in sample 3830m (figure 2) is most probably due to contamination by sidewall core gun grease (see also figure 6).

Total organic carbon determinations were only carried out on a few samples of interest. The organic richness of the Cenomanian section varied from poor, to good at 3483m, TOC = 2.2% wt, although it was mostly moderate, TOC = .56-.98% wt. The five samples of Jurassic age analysed contained good organic richness, TOC = 2 - 2.9% wt. The significance of these however, is downgraded by the presence of inertinite which has no potential to source hydrocarbons, and this is borne out by the low pyrolysis yields observed.

*MAX = maximum theoretical yield of hydrocarbons.

4. CONCLUSIONS

The results obtained therefore suggest the following conclusions may be made.

Although the quality of the vitrinite data is not high, the Oil Generation Threshold is tentatively placed at 3500m ± 200m. The sediments in the Middle and Lower Jurassic below the unconformity ca. 3829m are probably sufficiently mature for gas generation to have occurred.

Although the spore colours observed suggested maturity for generation of liquid hydrocarbons below 3092m, this may be due to the subjectivity of the technique and/or the types of Kerogen present which are gas or gas/condensate prone and the oil generation threshold may be deeper as is suggested by vitrinite reflectance determinations.

The source quality of the Cretaceous is generally poor. Poor to moderate source potential is indicated for some sediments in the Jurassic with gas and minor amounts of condensate likely from the Kerogens present.

These results agree quite well with those from 35/3-1 (Speers, 1977). In that well the OGT was placed ca. 3200m on the basis of vitrinite reflectance measurements and the GGT ca. 4100m based on light hydrocarbon analyses. The interval between the OGT and GGT is smaller in this well but this may be explained by the absence of the Upper Jurassic as a result of erosion.

Visual Kerogen descriptions disagree rather markedly in evaluation of the maturity of the Cretaceous but are basically in agreement for the Jurassic. For 35/3-1 spore colours suggested an OGT ca. 3950m although not supported by other evidence. The best explanation for this disparity is probably the result of these two studies being carried out by two palynologists and serves to emphasize the subjectivity of the technique.

The pyrolysis techniques employed in this study confirm the Kerogen types encountered in 35/3-1 are also present in 35/3-2: predominantly gas-prone with minor condensate source potential.

No evidence was found in this study to suggest any biodegradation of the hydrocarbons deep in the subsurface as was suggested for 35/3-1 and the difficulties encountered in that study were therefore probably introduced in transit/storage or other.

5. REFERENCES

1.	Speers, G.C. and Apps, P.G.	1977	Petroleum Geochemistry of NOCS well 35/3-1. EPR Report 7033
2.	Crux, J.A., Davies, S.C. and Duxbury, S.	1980	The Biostratigraphy of Saga well 35/3-2, Norwegian Sector, North Sea. EPR/TN 3127
3.	Dungworth, G.	1979	Commissioning and use of a New Pyrolysis - Gas Chromatography (PGC) Kerogen Analyser. EPR/R7060, Geochemical Development Group, EPD, Sunbury.

TABLE 1

VITRINITE REFLECTANCE DATA

WELL: 35/3-2
LOCATION: NORWEGIAN SECTOR NORTH SEA

DEPTH (M)	REFLECTANCE VALUES(%RO)	COMMENTS
2410	.47(7).63(3)	L-M/GN PAR I+V/M RM/BW
2410.1	.73(3)	
3092	0(0)	NDP/L GN PAR I+R/NTV
3162	.49(5)	L-M/GN PAR I+R/F V PAR
3207	0(0)	NDP
3336	.34(1).45(5)	L/GN PAR I+R/BW/F V W PAR
3391	.54(4)	M/GN PAR I+R/F PAR V
3468.5	0(0)	NDP/HI RO I+R
3477	.39(1).48(1)	L GN PAR I+R/F V PAR ?
3477.1	.61(1)	
3483	.34(1).62(4)	L/PAR I+R/TR P V W PAR
3593	.42(4).63(12)	M-RICH/M I+R PAR/LOWEST RO MEASURED
3593.1	.96(4)	
3653	.61(1).5(3)	M/M GN PAR I+R/F PAR TRUE V?
3671	.64(2)	M/GN PAR I+R/LOWEST RO MEASURED-POS TRUE
3746	.58(15).81(5)	M-RICH/PL PAR I+RM/F BW+W PAR V
3750	.71(1).54(1)	L/GN PAR I+HIGH RO V+R/NTV/BS
3830	.71(14).57(5)	M-RICH/OBS/PAR I+R DOM/S G PAR+W TRUE V
3830.1	.88(2)	
3898	1.18(3).62(2)	BS+BW/L I+R/LOWEST RO MEASURED-POS TRUE
3922	.69(18).48(3)	L-M/G PAR I+R/S G W PAR V
3965	.35(1).54(20)	OBS/M I+R/W+PAR V/F LGN FR
3980	.55(20)	L/BW/I+R PAR/S G VW+W PAR
4033.5	.66(20)	L-M/G VST += I PAR/BS
4151.5	0(0)	NDP/NO ORGANIC MATERIAL
4196	0(0)	NDP/NO ORGANIC MATERIAL
4247	0(0)	NDP/NO ORGANIC MATERIAL

FIGURES IN PARENTHESES INDICATE NUMBER OF READINGS
SEE LIST OF ABBREVIATIONS OVERLEAF

TABLE 1A

VITRINITE TABLE ABBREVIATIONS

ANS	-	ANISOTROPIC
B	-	BITUMEN
BS	-	BITUMEN STAINING
BW	-	BITUMEN WISPS
BAR	-	VIRTUALLY BARREN
CAV	-	CAVED
CARB	-	CARBARGILITE
COR	-	CORRODED
CTGS	-	CUTTINGS
DD	-	DIFFERENTIATION DIFFICULT
DMA	-	DRILLING MUD ADDITIVE
DOM	-	DOMINANT
F	-	FEW
FR	-	FRAGMENTS
G	-	GOOD
GN	-	GNARLED
GRAN	-	GRANULARITY
I	-	INERTINITE
INST	-	INTERSTITIAL
L	-	LOW ORGANIC CONTENT
LGN	-	LIGNITE
M	-	MOSTLY
MOD	-	MODERATE ORGANIC CONTENT
NDP	-	NO DETERMINATION POSSIBLE
NTV	-	NO TRUE VITRINITE
OBS	-	OVERALL BITUMEN STAINING
OCC	-	OCCASIONAL
OX	-	INDICATIONS OF OXIDATION
P	-	POOR
PAR	-	PARTICLES
PL	-	PLENTY-PLENTIFUL
R	-	REWORKED
RM	-	REWORKED MATERIAL
RO	-	REFLECTANCE MEASUREMENT
RES	-	RESIN
RICH	-	RICH-HIGH ORGANIC CONTENT
S	-	SOME
SC	-	SCRUFFY
SH	-	SHALE
SLT	-	SILTSTONE
SML	-	SMALL
SP	-	SPECKS
SUB	-	SUBORDINATE
STR	-	STRONGLY
TR	-	TRACE-V.LOW ORGANIC CONTENT
TEL	-	TELINITIC
V	-	VITRINITE
VW	-	VITRINITE WISPS
VAR	-	PARTICLES OF VARIABLE(HIGH) RO
VST	-	VITRINITE STRINGERS
W	-	WISPS-WISPY
*	-	ALLOCTHONOUS
=	-	EQUAL PROPORTIONS

TABLE 2

VISUAL KEROGEN DESCRIPTIONS

WELL: 35/3-2
LOCATION: NORWEGIAN SECTOR NORTH SEA

DEPTH(M)	SPORE COLOUR	SOURCE POTENTIAL
3092	4	NONE
3204	4	NONE
3336	4	NONE
3468.5	4	NONE
3593	4	NONE
3683	4	NONE
3746	4-4/5	NONE
3830	4-4/5	POOR GAS
3845	4-4/5	POOR GAS
3965	4-4/5	POOR-MOD OIL/POOR GAS
4033.5	4-4/5	POOR?-MOD GAS
4046	4-4/5	POOR OIL/GAS
4133	4-4/5	POOR-MOD OIL/POOR GAS

TABLE 2A

Number	Depth in metres	Type	Amount of Organic Matter	Miospores (Trace/Rare 1-2, Common 3, Frequent 4, Abundant 5)	Phytoplankton excluding Tasmanitids (1-2, 3, 4, 5)	Tasmanitids (1, 2, 3)	Foram Linings (1, 2, 3)	Megaspores (1, 2, 3)	Other Microfossils (1, 2, 3)	Cuticles (1-2, 3, 4-5)	Other Tissues (1-2, 3, 4-5)	Brown 'Wood': Lignite (1-2, 3, 4-5)	Black 'Wood': Vitrinite + Inertinite (1-2, 3, 4-5)	Black 'Wood': Inertinite only (1-2, 3, 4-5)	Finely Dissemated Particles (1-2, 3, 4-5)	Amorphous Vascular Plant Material (1-2, 3, 4-5)	Amorphous Matter of Marine/Algal Origin (1-2, 3, 4, 5)	Preservation State (good, fair, poor)	Reworking	Environment of Deposition (undiff. mar., open mar., restricted mar., nr. shore mar., some mar. influence/brackish, non-mar./freshwater)	Colour Maturation (1, 2, 3, 4, 5, 6, 7)	Source Potential
	3092	SWC	MOD	1-2	4	1				1-2		1-2	3		1-2			good (○), fair		open mar.	4	NONE
	3204	"	SML	1-2	3								3		1-2			good (○), fair		open mar.	4	NONE
	3336	"	SML	3	3		1			1-2	1-2	1-2	4-5		1-2, 3[6]	1-2		fair, poor		open mar. → nr. shore mar.	4	NONE
	3468.5	"	V.SML	1-2	1-2								3		1-2			fair		open mar.	4	NONE
	3593-20	CTG	SML	3	4				1[7]	1-2	1-2	1-2	4-5		1-2, 3[6]	1-2		fair, poor		open mar. → nr. shore mar.	4	NONE
	3683-10	"	MOD	3	4				1[7]	1-2	1-2	3	4-5		1-2, 3[6]	1-2		fair, poor		open mar. → nr. shore mar.	4	NONE
	3746-76	"	MOD	3	4					1-2	1-2	1-2	4-5		1-2, 3[6]	1-2	1-2	fair		open mar. → nr. shore mar.	4 →	NONE
	3830	SWC	LGE	5	1-2	1[7]				1-2	1-2	1-2	4-5		3, 4-5[6]	1-2		fair (○), poor		some mar. influence/brackish → non-mar./freshwater	4 →	POOR GAS
	3845-72	CTG	LGE	5	1-2	1				1-2	1-2	1-2	4-5		3, 4-5[6]	1-2		fair (○), poor		nr. shore mar. (?) → some mar. influence/brackish	4 →	POOR GAS
	3945-92	"	MOD	5	3				2[9], 3[8]	3	3	3[10]	4-5		3, 4-5[6]	1-2		fair (○), poor		nr. shore mar.	4 →	POOR-MOD O / POOR GAS
	4033.5	SWC	LGE	4						3	3	1-2	4-5		3, 4-5[6]	1-2		poor		non-mar./freshwater	4 →	POOR?-MOD GAS
	4046-72	CTG	SML	5	3		1		1[7], 2[9], 3[8]	1-2	1-2	1-2	4-5		3, 4-5[6]	1-2		poor		nr. shore mar.	4 →	POOR O/G
	4133-60	"	MOD	4		1			3[9,8]	1-2	1-2	1-2	4-5		4-5	1-2		poor		nr. shore mar.	4 →	POOR MOD/ POOR GAS

6- IN FIRST SLIDE ONLY : 7- FUNGAL REMAINS : 8- IRREGULAR MORE OR LESS AMORPHOUS MASSES SHOWING ALGAL (BOTRYCOCCUS)-LIKE STRUCTURES : 9- MIOSPORE MASSES

TABLE 3

ROCK-EVAL AND PYROLYSIS DATA

WELL: 35/3-2
LOCATION: NORWEGIAN SECTOR NORTH SEA

DEPTH (M)	P1 KG/TONNE	P2 KG/TONNE	GOGI	OIL YIELD KG/TONNE	GAS YIELD KG/TONNE
3092	Ø	.1			
3162	.1	.2			
3204	Ø	Ø			
3336	.1	.5			
3391	Ø	.1			
3468	.1	.1			
3477	.2	.6			
3483	.3	1.6	.6	1	.6
3500	.2	.3			
3593	.2	.4			
3630	.1	.3			
3653	.1	.2			
3671	.1	.2			
3683	.2	.4			
3746	.1	.1			
3750	.1	.2			
3781	Ø	.2			
3830	.5	2.2	.49	1.5	.7
3845	.3	1.8	.73	1	.8
3898	.1	.2			
3922	.2	.9			
3965	.2	1.4	.62	.9	.5
3980	.4	.9			
4033	.2	.6			
4046	.3	.7			
4133	.3	2.5	.34	1.4	1.1

TABLE 4

LITHOLOGY AND TOC DATA

WELL: 35/3-2
LOCATION: NORWEGIAN SECTOR NORTH SEA

DEPTH(M)	AGE	PICKED LITHOLOGY	%TOC	%CARBONATE
2410	CAMPANIAN	C-CLAYSTONE	N.D.	N.D.
3092	CENOM./SANT.	S-MUDSTONE	0.56	11.5
3162	CENOM./SANT.	S-MUDSTONE	0.76	31.6
3204	CENOM./SANT.	S-MUDSTONE	0.39	14.7
3336	CENOMANIAN	S-MUDSTONE	0.88	35.3
3391	CENOMANIAN	S-MUDSTONE	0.98	17
3468.5	CENOMANIAN	S-SHALE	0.51	43
3477	CENOMANIAN	S-SHALE	N.D.	N.D.
3483	CENOMANIAN	S-SHALE	2.2	28.3
3500	CENOMANIAN	C-SLTST/SST	N.D.	N.D.
3593	ALBIAN	C-SILTSTONE	N.D.	N.D.
3630	ALBIAN	S-SHALE	N.D.	N.D.
3653	ALBIAN	S-MUDSTONE	N.D.	N.D.
3671	ALBIAN	S-MUDSTONE	N.D.	N.D.
3683	ALBIAN	C-SHALE	N.D.	N.D.
3746	ALBIAN	C-SHALE	N.D.	N.D.
3750	ALBIAN	S-SILTSTONE	N.D.	N.D.
3781	ALBIAN	C-SHALE	N.D.	N.D.
3830	L.TOARC./M.BAJ	S-MUDSTONE	2.2	28.2
3845	L.TOARC./M.BAJ	C-MDST/SHALE	2.7	31
3898	L.TOARC./M.BAJ	S-MUDSTONE	N.D.	N.D.
3922	TOARCIAN	S-MUDSTONE	N.D.	N.D.
3965	TOARCIAN	C-SILTSTONE	2	20
3980	L.PLIENSBACHIAN	S-SILTSTONE	N.D.	N.D.
4033	L.PLIENSBACHIAN	S-SILTSTONE	N.D.	N.D.
4046	?L.PLIENSBACH.	C-SHALE	N.D.	N.D.
4133	?L.PLIENSBACH.	C-SHALE	2.9	17.4

SAMPLE TYPES :-
N-CORE SAMPLE
S-SIDEWALL CORE
O-OUTCROP
C-CUTTINGS

TABLE 5.

SEDIMENTS SOLUELE EXTRACT DATA

WELL: 35/3-2
LOCATION: NORWEGIAN SECTOR NORTH SEA

DEPTH (M)	TOC %WT	TSE/TOC 0/00	SAC/TOC 0/00	CPI	ASPHALTENES %WT
3483	2.2	22	8	1.13	3.2
3830	2.2	39	14	1.1	12.3
3845	2.7	20	7	1.09	3.3
3965	2	29	12	1.09	2.3
4133	2.9	27	9	1.12	7.5

TABLE 6

SEDIMENTS SOLUBLE EXTRACT DATA

WELL: 35/3-2
LOCATION: NORWEGIAN SECTOR NORTH SEA

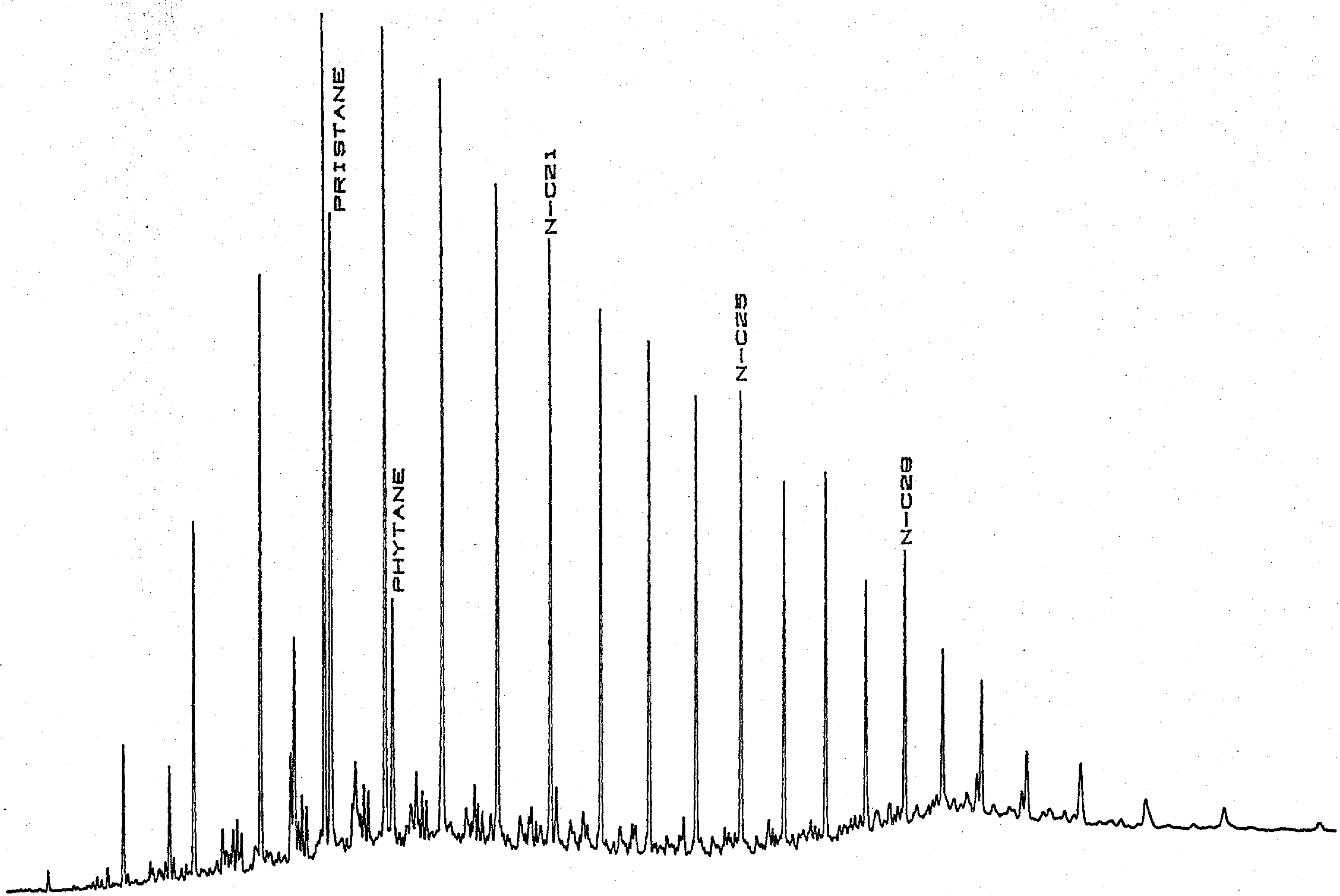
DEPTH(M)	%SAC	%TSE	PRIST/PHYT	PRIST/C-17	PHYT/C-18
3483	36.3	.048	2.63	1.01	.39
3830	35.5	.078	3.1	1.16	.36
3845	37	.055	2.82	.76	.33
3965	42.5	.059	2.61	.43	.19
4133	34.6	.077	1.98	.46	.24

TABLE 7

BIOSTRATIGRAPHICAL SUMMARY

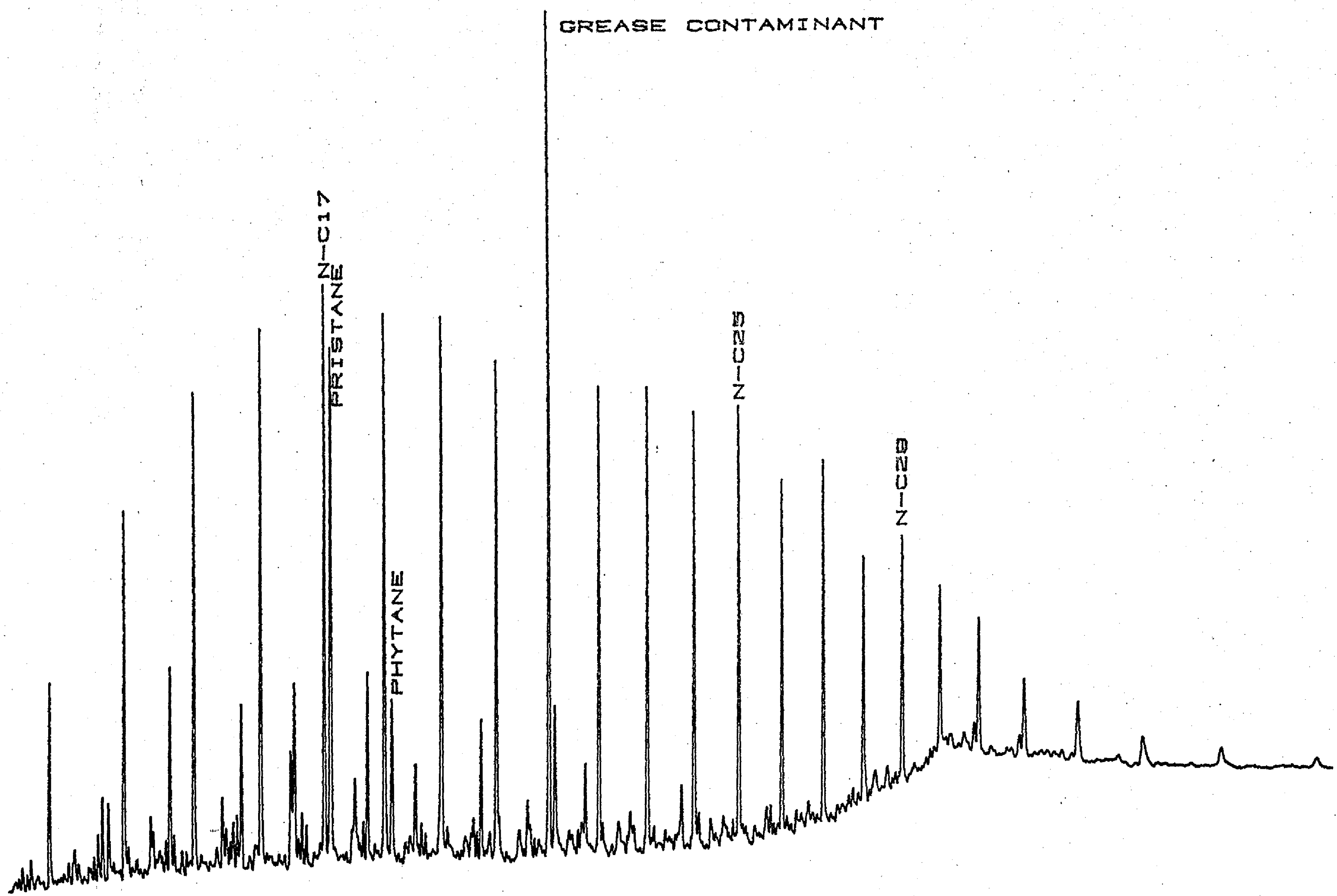
DEPTH (M)	AGE
500 - 720	PLIOCENE
730 - 900	MIOCENE TO PLIOCENE
910 - 990	MIOCENE
1000 - 1070	OLIGOCENE
1080 - 1190	EOCENE TO OLIGOCENE
1200 - 1340	EOCENE
1350 - 1540	PALAEOCENE
1550 - 1700	MAASTRICHTIAN
1710 - 2540	CAMPANIAN
2550 - 3320	CENOMANIAN TO SANTONIAN
3340 - 3515	CENOMANIAN
3530 - 3800	ALBIAN
3816 - 3817.5	LATE APTIAN
3829 - 3922	LATE TOARCIAN TO MIDDLE BAJOCIAN
3947.4 - 3959.75	TOARCIAN
3973.5 - 4007.85	LATE PLIENSBACHIAN
4040 - 4124	? LATE PLIENSBACHIAN
4167 - 4400	INDETERMINATE

[FIG. 11]



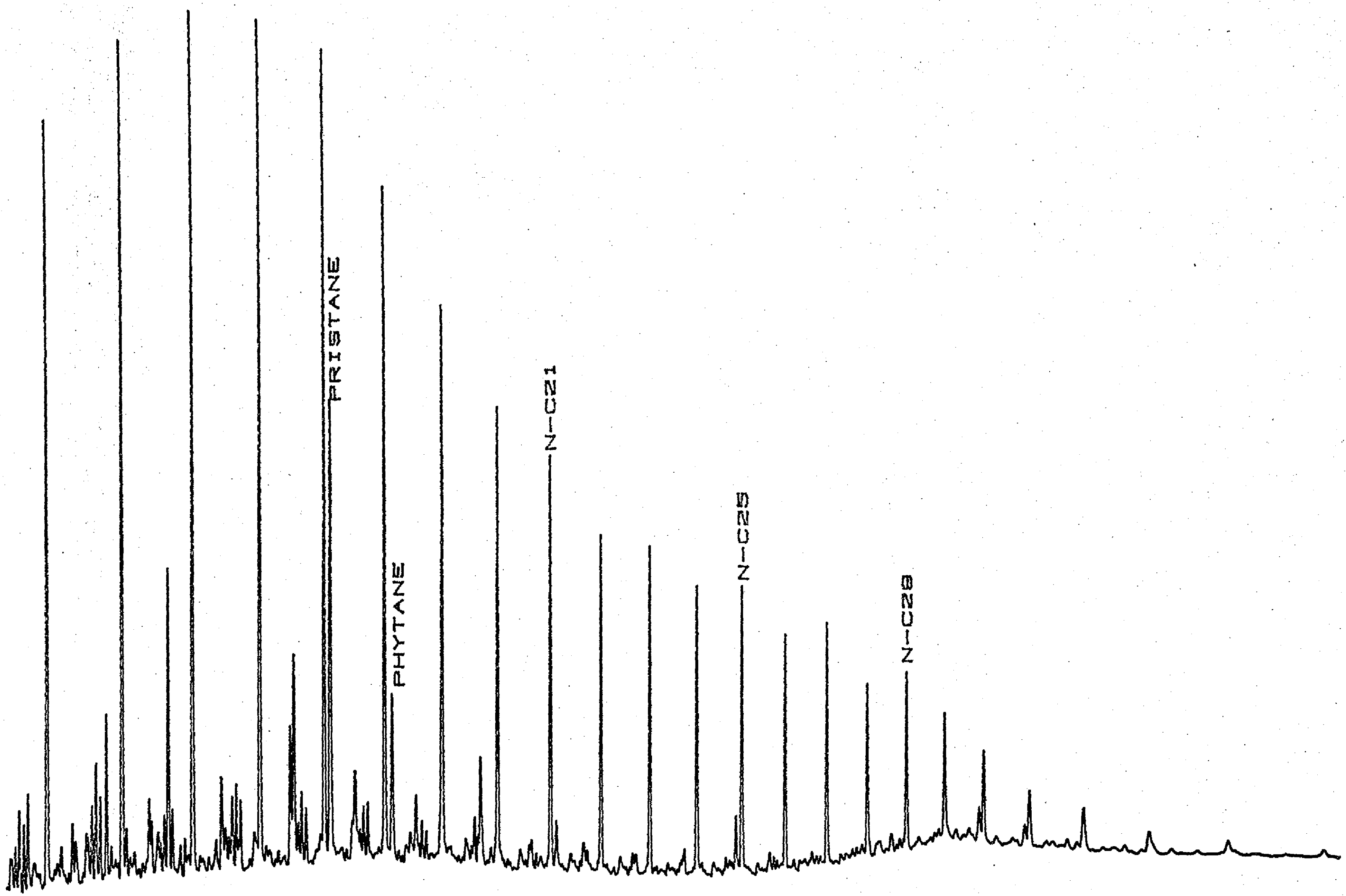
SAMPLE: 35/3-2 3483M SATURATES FRACTION

[FIG. 2]



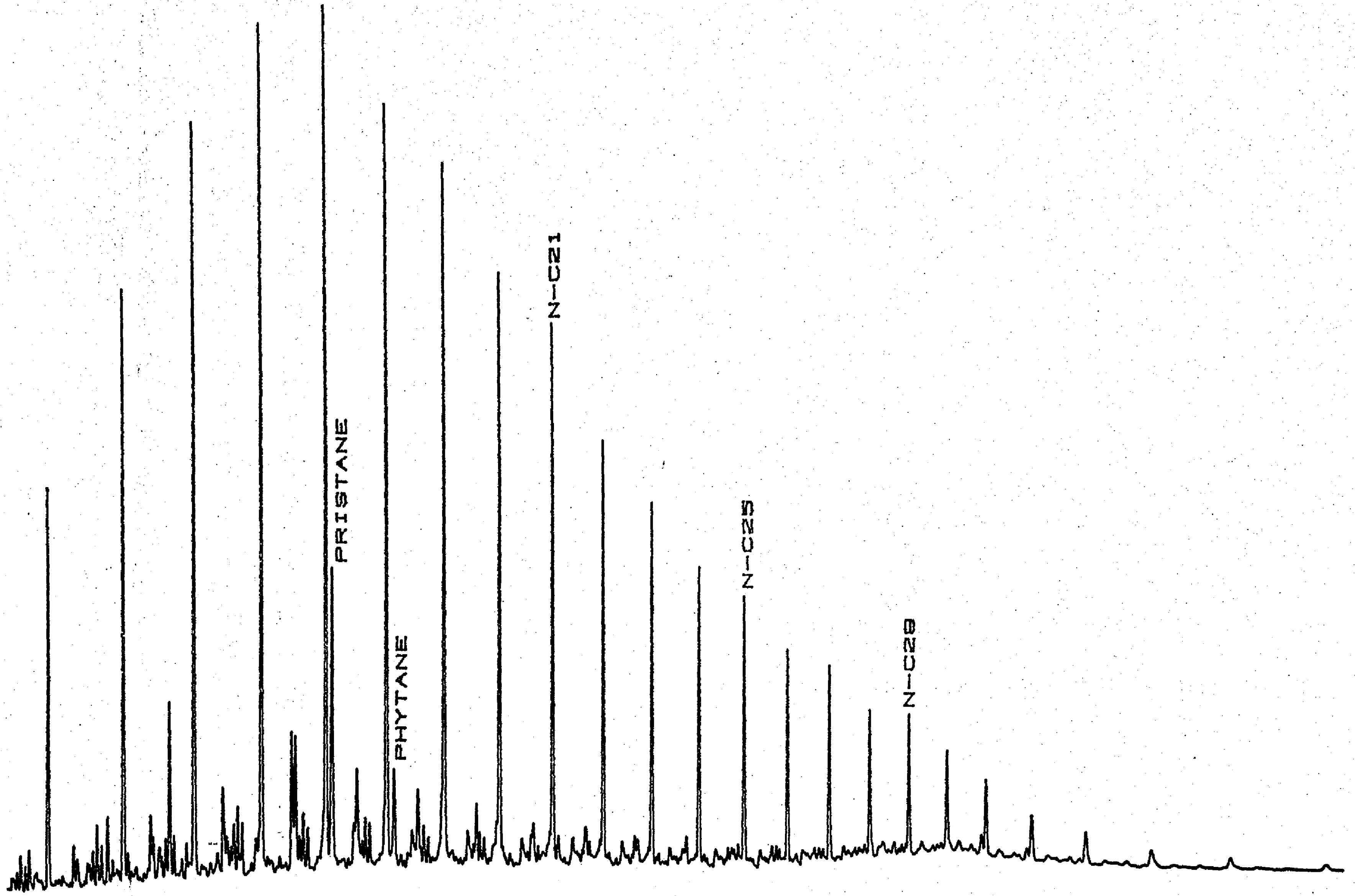
SAMPLE: 35/3-2 3830M SATURATES FRACTION

[FIG. 3]



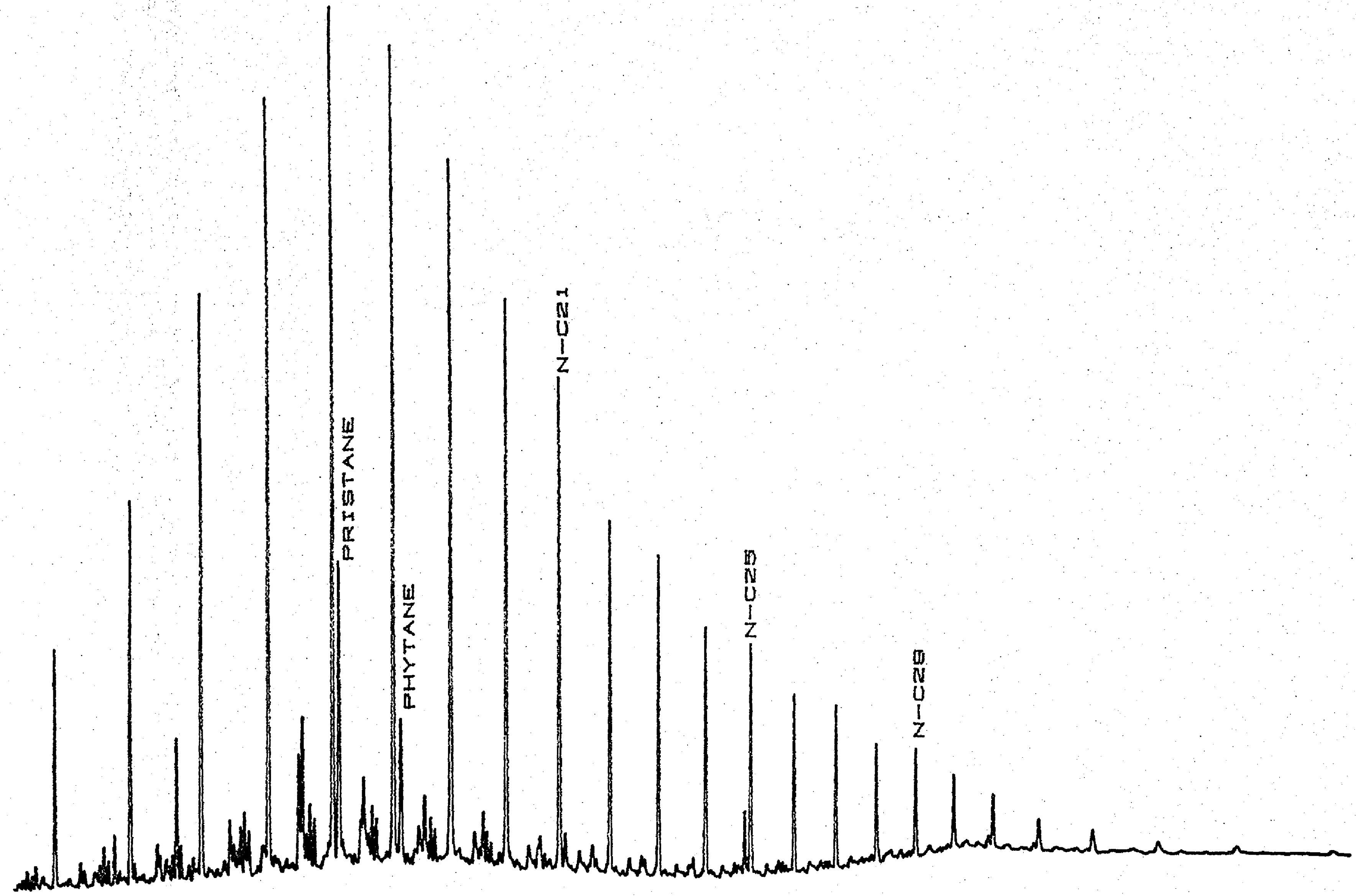
SAMPLE: 35/3-2 3845M SATURATES FRACTION

[FIG. 4]



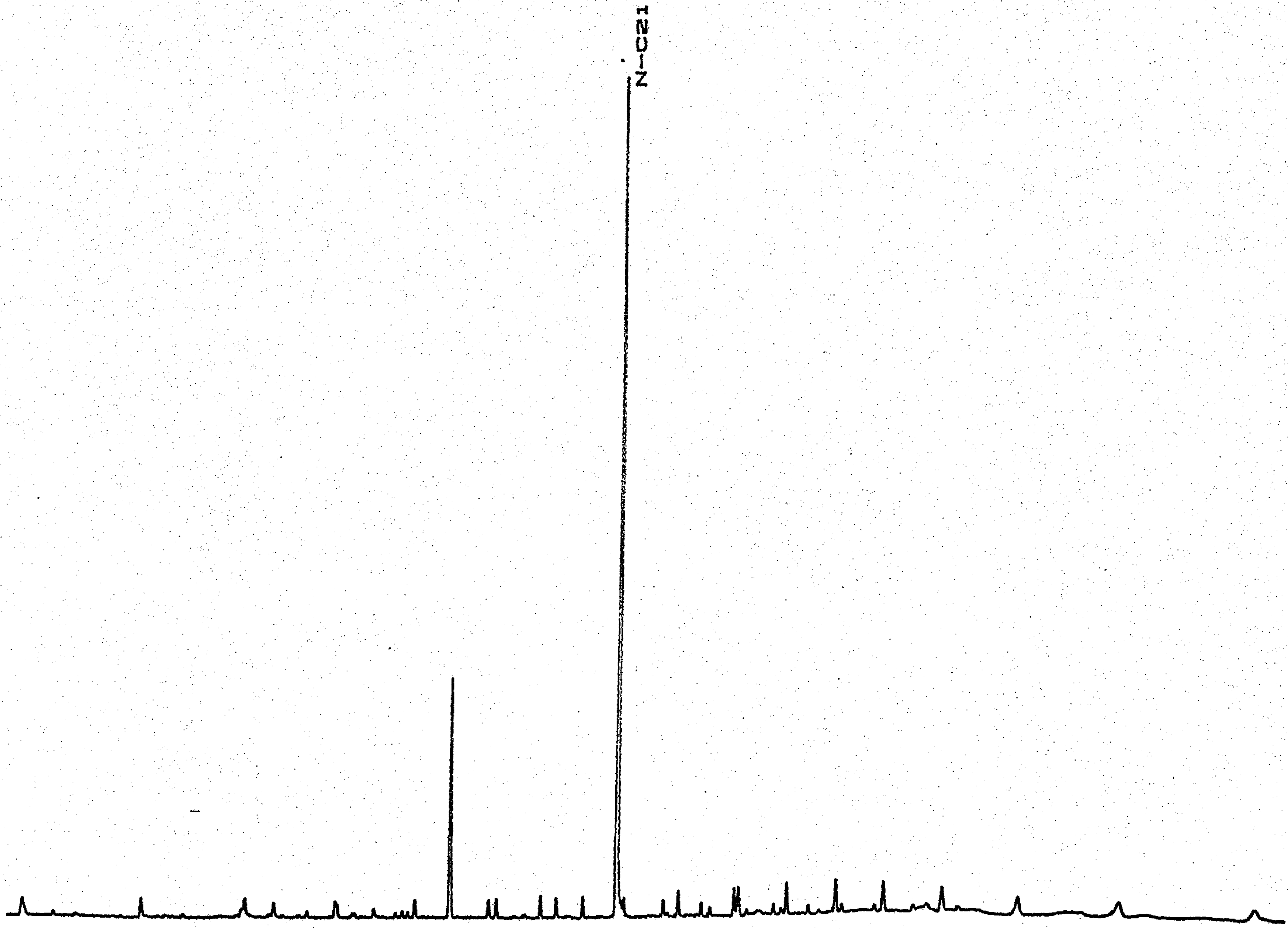
SAMPLE: 35/3-2 3965M SATURATES FRACTION

[FIG. 5]



SAMPLE: 35/3-2 4133M SATURATES FRACTION

[FIG. 6]



SAMPLE: SWC GREASE SATURATES FRACTION

n-ALKANE DISTRIBUTIONS

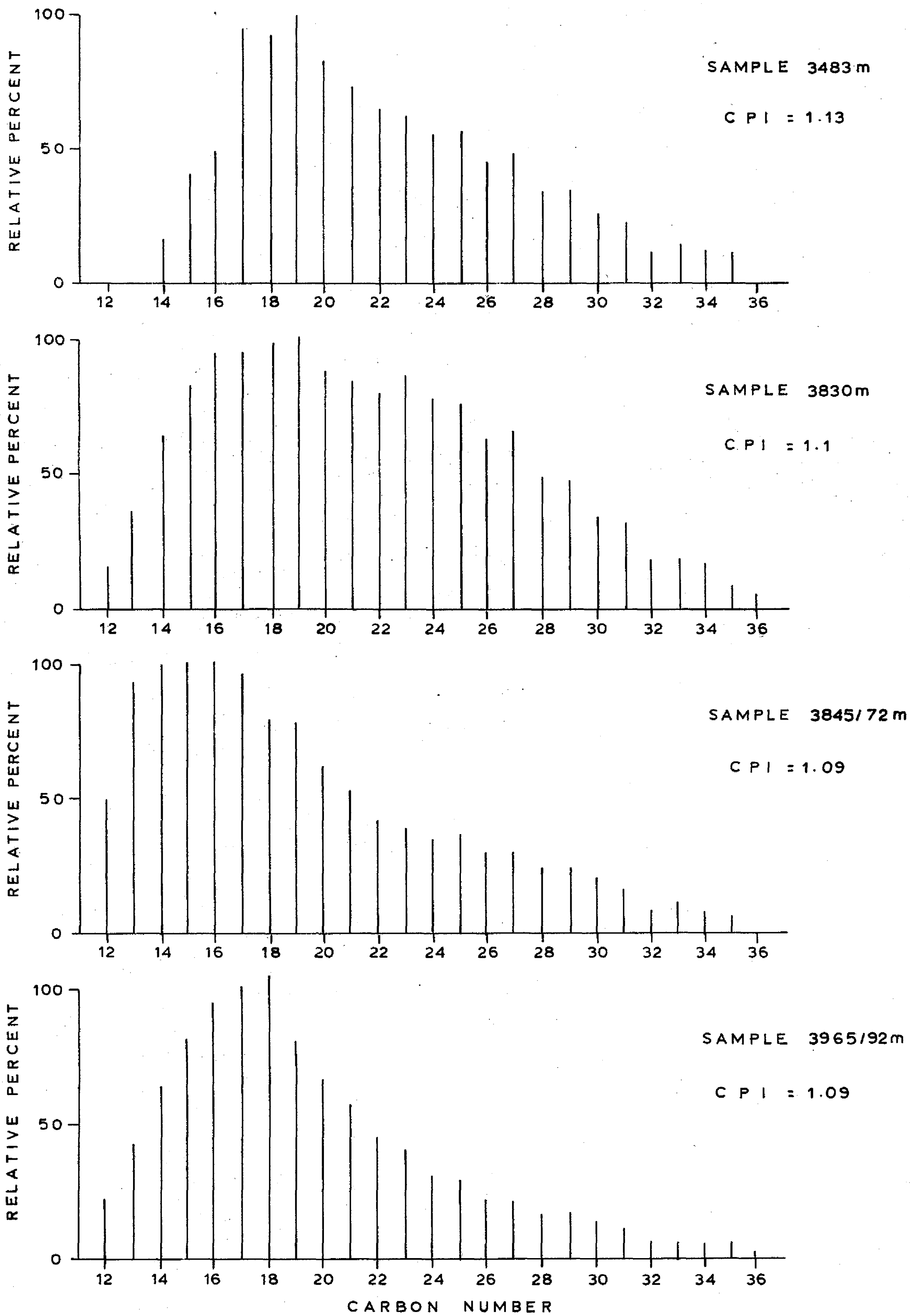


FIG. 7

n-ALKANE DISTRIBUTIONS

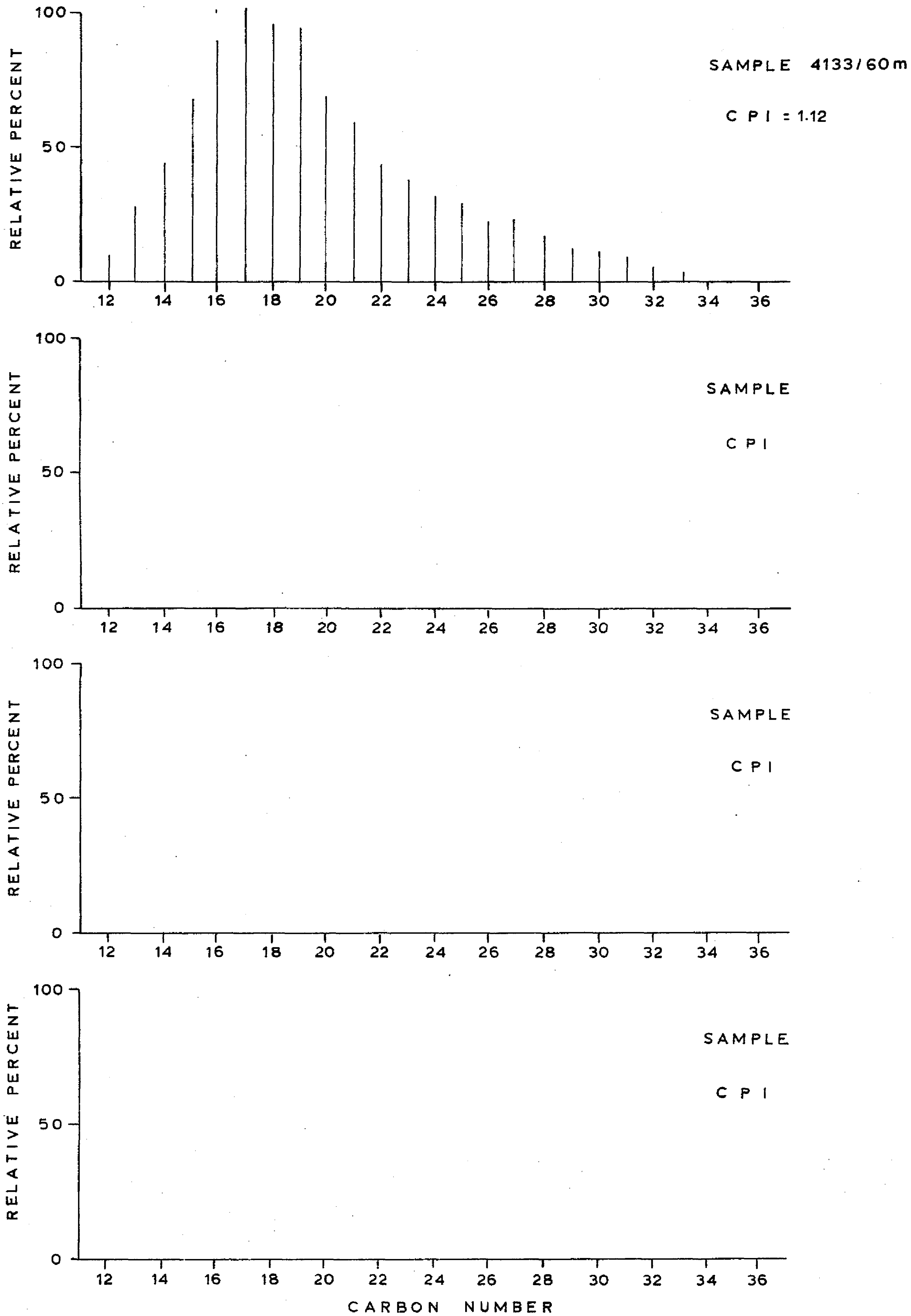


FIG. 8

APPENDIX 1

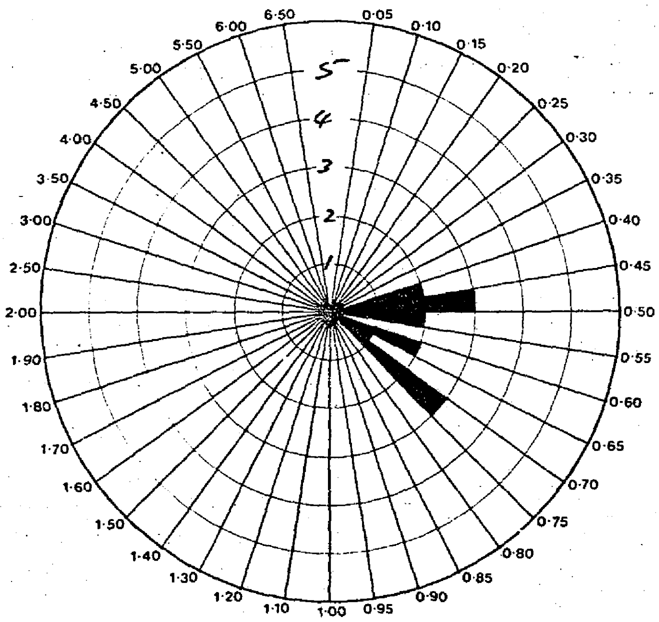
ORIGIN B.P.	SAMPLE Our Ref: A.S./J.M.J. Your Ref: II 15 2410-20
LITHOLOGY Shale 2410-20m	
MINERALOGY	GENERAL COMMENTS
ORGANIC MATERIAL Low-Moderate Organic Content. Small, Gnarled Particles of Inertinite + Vitrinite - Largely Reworked. Lowest Particles Measured. Bitumen Wisps.	
APPEARANCE IN U.V. Light + Mid. Orange Fluorescence From Spores	**Geo-optics Ltd.** Ash House Bell Villas Ponteland Northumberland NE20 9BE Signature [signature] Date 20.11.80
EXINITE CONTENT IN U.V. Low-Moderate	

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol	546nm.	1·516

0·62	0·43	0·72			
0·45	0·52	0·46			
0·66	0·54	0·43			
0·61	0·72				
0·45	0·74				

TOTAL No. OF PARTICLES MEASURED 13

REFLECTIVITY (%)		No. OF PARTICLES
R̄max.		
R̄aver.	0·56	13



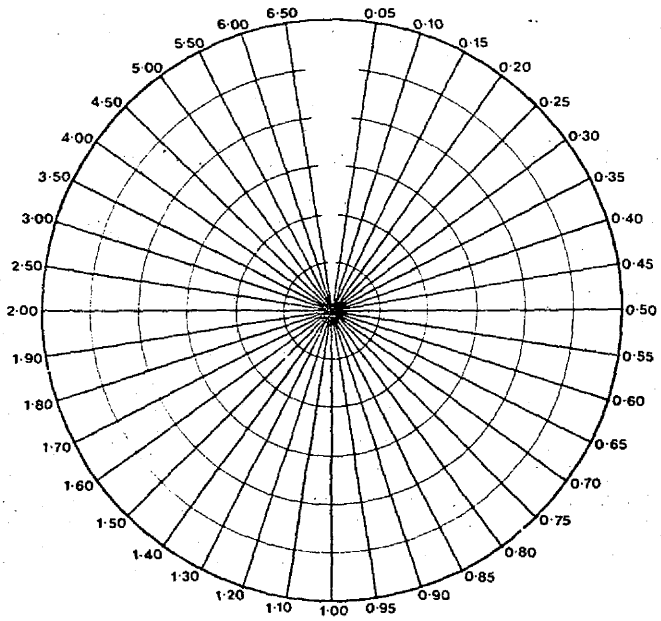
EQUIVALENT CHEMICAL PARAMETERS
DRY ASH FREE

CARBON (%)	VOLATILE MATTER YIELD (%)	CARBON RATIO
75		

ORIGIN B.P.	SAMPLE Our Ref: A.S./J.M.J. Your Ref: II/6 3092
LITHOLOGY SHALE 3092m	
MINERALOGY GLAUCONITE TRACES	GENERAL COMMENTS NO DETERMINATION POSSIBLE
ORGANIC MATERIAL LOW CONTENT OF HIGH R.o, CHARRED PARTICLES OF INERTINITE + REWORKED MATERIAL. NO TRUE VITRINITE.	
APPEARANCE IN U.V. LIGHT ORANGE FLUORESCENCE FROM SPORES	Signature **Geo-optics Ltd.** Ash House Bell Villas Ponteland Northumberland NE20 9BE Date 20.11.80
EXINITE CONTENT IN U.V. TRACE	

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol	546nm.	1.576

TOTAL No. OF PARTICLES MEASURED: No Determination Possible



	REFLECTIVITY (%)	No. OF PARTICLES
$\bar{R}$max.		
$\bar{R}$aver.		

EQUIVALENT CHEMICAL PARAMETERS
DRY ASH FREE

CARBON (%)	VOLATILE MATTER YIELD (%)	CARBON RATIO

ORIGIN B.P.	SAMPLE Our Ref: A.S./J.M.J. Your Ref: GG 98

LITHOLOGY Shale 3162m

MINERALOGY

Glauconite

ORGANIC MATERIAL

Low - Moderate Organic Content. Small Gnarled Particles of Reworked Material + Inertinite Only a Handfull of True Vitrinite Particles.

APPEARANCE IN U.V.

Light Orange Fluorescence From Spores

EXINITE CONTENT IN U.V. Low

GENERAL COMMENTS

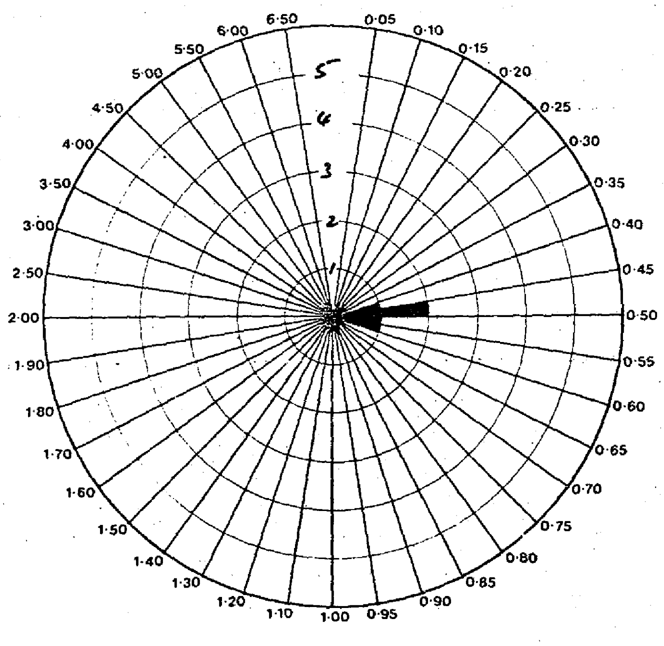
Geo-optics Ltd.
Ash House
Bell Villas
Ponteland
Northumberland
NE20 9BE

Signature John M. Jones

Date 7.10.80

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol	546 nm.	1.516

0.47					
0.50					
0.58					
0.43					
0.48					



TOTAL No. OF PARTICLES MEASURED 5

REFLECTIVITY (%)		No. OF PARTICLES
$\bar{R}$max.		
$\bar{R}$aver.	0.49	5

EQUIVALENT CHEMICAL PARAMETERS

DRY ASH FREE

CARBON (%)	VOLATILE MATTER YIELD (%)	CARBON RATIO
73		

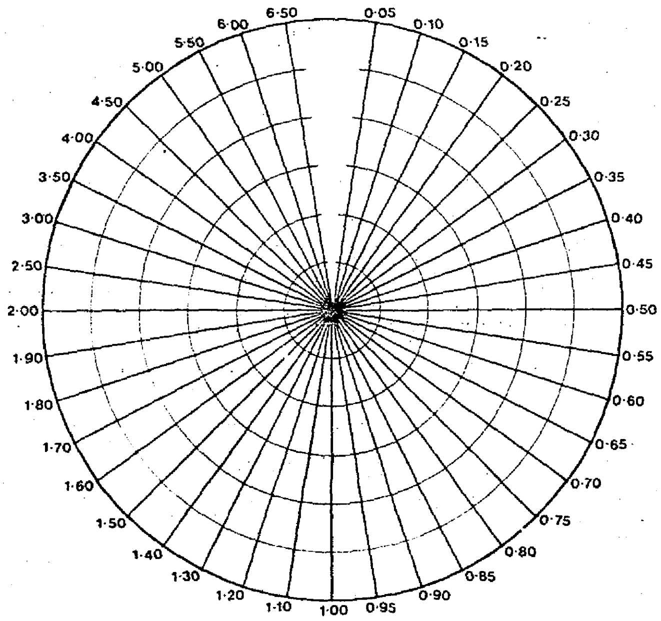
ORIGIN B.P.	SAMPLE Our Ref: A.S./J.M.J. Your Ref: GG 99

LITHOLOGY SHALE 3207m

MINERALOGY GLAUCONITE TRACES	GENERAL COMMENTS NO DETERMINATION POSSIBLE
ORGANIC MATERIAL LOW ORGANIC CONTENT. GNARLED, HIGH R.o. PARTICLES OF INERTINITE + REWORKED MATERIAL. NO MATERIAL UNDER 1% R.o. LOCATED. NOTHING WORTH MEASURING.	
APPEARANCE IN U.V. LIGHT/MID. ORANGE FLUORESCENCE FROM SPORES	Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE
EXINITE CONTENT IN U.V. LOW	Signature [signature] Date 7.10.80

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol	546nm	1·516

TOTAL No. OF PARTICLES MEASURED No Determination Possible



	REFLECTIVITY (%)	No. OF PARTICLES
$\bar{R}$max.		
$\bar{R}$aver.		

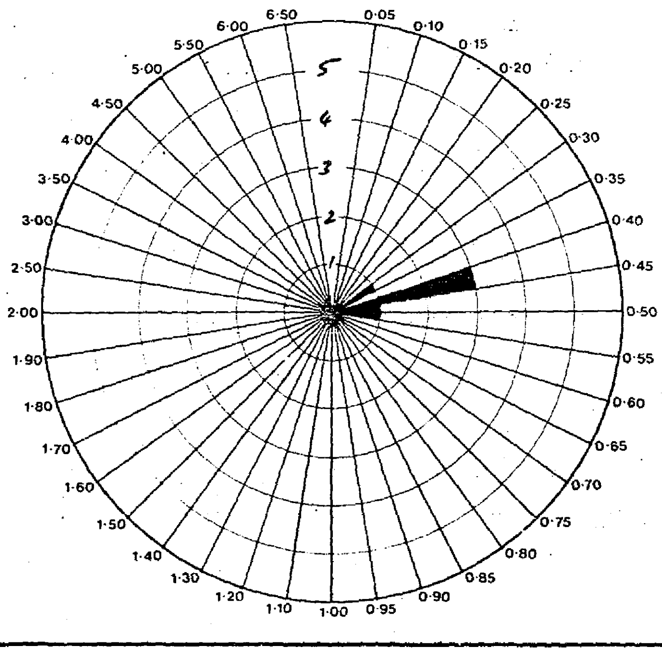
EQUIVALENT CHEMICAL PARAMETERS DRY ASH FREE

CARBON (%)	VOLATILE MATTER YIELD (%)	CARBON RATIO

ORIGIN B.P.	SAMPLE Our Ref: A.S./J.M.J Your Ref: HH01
LITHOLOGY SHALE 3336m	
MINERALOGY FORAMS	GENERAL COMMENTS
ORGANIC MATERIAL LOW ORGANIC CONTENT. GNARLED PARTICLES OF INERTINITE + REWORKED MATERIAL. BITUMEN WISPS. A FEW TRUE VITRINITE WISPY PARTICLES.	
APPEARANCE IN U.V. LIGHT/MID. ORANGE FLUORESCENCE FROM SPORES + HYDROCARBON SPECKS	Geo-optics Ltd. Ash House Bell Villas Ponteland Northumberland NE20 9BE
EXINITE CONTENT IN U.V. LOW	Signature [signature] Date 7.10.80

PREPARATION	WAVELENGTH	R.I. OF IMMERSION OIL
Isopropyl Alcohol	546nm	1.516

0.53	0.34				
0.46					
0.41					
0.41					
0.42					



TOTAL No. OF PARTICLES MEASURED 6

	REFLECTIVITY (%)	No. OF PARTICLES
$\bar{R}$max.		
$\bar{R}$aver.	0.43	6

EQUIVALENT CHEMICAL PARAMETERS

DRY ASH FREE

CARBON (%)	VOLATILE MATTER YIELD (%)	CARBON RATIO
71		

ORIGIN B.P.	SAMPLE Our Ref: A.S./J.M.J. Your Ref: HH02
LITHOLOGY SHALE 3391m	
MINERALOGY GLAUCONITE TRACES	GENERAL COMMENTS
ORGANIC MATERIAL MODERATE ORGANIC CONTENT. VERY GNARLED PARTICLES OF INERTINITE + REWORKED MATERIAL. ONLY A COUPLE OF TRUE PARTICLES LOCATED.	
APPEARANCE IN U.V. LIGHT ORANGE FLUORESCENCE FROM SPORES + HYDROCARBON SPECKS AND IMPREGNATION	**Geo-optics Ltd.** Ash House Bell Villas Ponteland Northumberland NE20 9BE
EXINITE CONTENT IN U.V. TRACE	Signature [signature] Date 7·10·80