Dublett

ELF R.E.
D. EXPLOR.
DEPARTEMENT GEOLOGIQUE CENTRAL
LABORATOIRES

2035 n° 6/1380 R
/ed

25/4-1 WELL (NORWAY)

IDENTIFICATION OF THE PETROLEUM SOURCE-ROCKS IN THE JURASSIC

B. PHILIPPE

Boussens, July 1976

Reference : Order nº 031208

LISTE DE DIFFUSION

DESTINATAIRES :

DIRECTION EXPLORATION	1
S.I.D	2
DIVISION 2	1
Division 2 - NORVEGE	22

CONTENTS

1 - INTRODUCTION

This complementary study was carried out primarily in order to locate the main source-rock intervals in the Jurassic of 25/4-1 well and characterize their hydrocarbons. Furthermore a few migrated hydrocarbons from this well are compared with the syngenetical hydrocarbon from Jurassic series.

The geochemical analyses were carried out on core samples selected according to the sedimentological study(*); those previously carried out on a few samples (**) were also used.

This study takes into account the results of the optical studies carried out on the insoluble organic matter, i.e. the data on the palynofacies obtained by J.F. Raynaud, which however has not been set out in any palynological report, and that on the diagenesis of the kerogen undertaken by P. Robert.(***).

2 - ORGANIC INVENTORY

The organic inventory results are given in table form in appendix 1 and on plates 1 to 7 according to their location in the lithological sequences referenced.

These results show 3 main units :

- The cutting samples, between 3165 and 3175, of the Upper Kimmeridgian to Portlandian have 5 to 10% of insoluble organic carbon and a proportion higher than 7000 ppm of organic matter extracted by chloroform; the high yields in extract of their organic matter (10 to 20%) suggest no substantial migration out of this interval.

- The shale core samples, between 3191.5 and 3324.5 m, of the Dogger to Lias have 1 to 11% of insoluble organic carbon, but the most frequent levels encountered are 2 to 3.5%. They have from between 1000 to 9500 ppm of organic matter extracted by chloroform and the yields in extract of their organic matter are low to medium, between 3 to 8% (apart from one sample — 25% — which is probably enriched) and this suggests, in view of the other geochemical data, a partial migration out of these shales.

- The shale core samples, between 3326.4 and 3448.6 m, of the Lias tc Rhetian have 0.2 to 4% of insoluble organic carbon and the most frequent levels are lower than 1.

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* R. CUSSEY - Report 2035 n° 4/1064 R -"Sondage 25/4-1 - Caractérisation des différents types de séquences sédimentaires dans les carottes du Jurassique" Dec 1974

** J. du ROUCHET - Report 2035 n° 3/810 R - "Well Heimdall 25/4-1 - Organic geochemical report" July 1973

J. du ROUCHET - Report 2035 n°4/984 R -"Complementary analyses on Heimdall 25/4-1" September 1974

J. du ROUCHET - Report 2035 n° 4/987 R -"Origine commune des gaz de Frigg, Frigg Est, Heimdall" Août 1974

*** P. ROBERT - Report 2035 n° 2/719 R -"25/4-1 - Rapport sur le Pouvoir Réflecteur des matières carbonées"

The level of organic matter extracted by chloroform in these samples is between 0 and 1550 ppm, but generally lower than 500 ppm, whilst the yields in extract of their organic matter are lower than 3%, apart from one sample.

Furthermore in this Jurassic section exist several beds of coal, located in various different environments but mainly between 3340 and 3351m at the top of marginal littoral sequences (swamps); these beds of organic matter have 10000 to 30000 ppm of hydrocarbons extracted by chloroform.

Comments :

As the location of the sample studied in the referenced lithological sequences is known, these various individual results may be extrapolated to cover the shale intervals in an equivalent location in the other sequences, and so on throughout the whole of the series drilled according to the vertical sedimentological synthesis : see plate 9.

The interpretation of the organic inventory in the sedimentological context shows chiefly that there are three units, rich in total organic matter and relatively rich in extracted hydrocarbons, which may be considered as source-rocks; these three main source-rocks are :

- the marine shale interval of the Upper Kimmeridgian approx between 3160 and 3180 m

- the shales of the bases of the accretion sequences in marine or littoral environment, i.e. approx between 3185 and 3330 m; the total thickness of these shales is about 60 m.

- the beds of coal at the top of the margino-littoral sequences (swamps) between 3340 and 3351 m; their total thickness is about 3 m.

3 - STUDY OF THE KEROGEN

3.1 - Optical study

3.1.1 - Palynofacies

The optical examinations of the palynological preparations shows mainly that :

- In the Upper Kimmeridgian to Portlandian, the palynofacies is fairly homogeneous and composed chiefly of yellow amorphous sapropelic matter.

- In the Dogger-Lias, the nature of the palynofacies is variable and generally heterogeneous; in a few samples, located in the lower part of the littoral accretion sequence, it is chiefly composed of amorphous flocks, but the most common palynofacies is composed, in variable proportions, of amorphous matter and higher plant elements : ligneous particles, fine cellular vegetable debris (cuticles, epiderms), resins, spores and pollens.

3.1.2 - Diagenesis

The study of the vitrinite reflectance shows that the maturation is progressively increasing approx between 0.6 to 0.7 from the Upper Kimmeridgian to the base of the Lias. The low number of thermal alteration index estimations are in agreement with the reflectivity values. This shows that the kerogen of the Jurassic section studied is fairly constant and compatible with liquid hydrocarbon generation.

3.2 - Pyrolysis

Pyrolysis analyses were carried out on a few rock samples after extraction by chloroform. The value in degradable organic carbon (DOC - weight % of the rock) that is obtained by means of this method may be roughly assimilated to the present hydrocarbon potential of the sample.

The analytical results are given in appendix 2; the main results are :

- The DOC value of the Kimmeridgian shale is 0.8% .

- The Doc values of the Dogger-Lias shales of the accretion sequence bases are between 0.25 and 1.45%; the average is approx 0.7%.

- The DOC value of the coal level at 3341.75 is 6.6%

- The DOC value of the Lias shale at 3394 is 0.10%

These values indicate primarily that :

- The DOC values of the Kimmeridgian and Dogger-Lias shales, rich in COT, are relatively low; their present hydrocarbon potential is about 20 to 25 x 10^3 tons per km^2 x m. By comparison with the pyrolysis results and organic inventory of known source-rocks with a roughly equivalent diagenetic state, between 0.6 and 0.7% of reflectance, it is obvious taht these shales had a mean or high initial hydrocarbon potential and that they have already produced a substantial part of their hydrocarbons.

- The high DOC values of the coal bed at 3341.75 shows that the present hydrocarbon potential is high, about 200 x 10^3 tons per km^2 x m. The evolution and migration processes of the hydrocarbons of the coal beds are probably very different to those of hydrocarbons produced by dispersed organic matter, in particular given that the migration is probably more difficult. However this coal and the other equivalent coal beds may be considered as source-rocks.

- The very low DOC value of the shale sample at 3394 shows that it had probably a very low initial hydrocarbon potential.

Comments :

The initial hydrocarbon potential of the various samples is not known, but it is probable, in view of the diagenesis, that the average initial potential of the Dogger-Lias source-rocks shales, i.e. the base of the accretion sequences, was about the same as that of the Kimmeridgian shales.

So, as the thicknesses of the Dogger-Lias source-rocks shales and of the Kimmeridgian shales are respectively about 60 and 20 m, the quantities of hydrocarbons already produced and the future potential are, at least at the proximity of this well, much greater for the Dogger-Lias source-rocks shales; furthermore there are about 3 m of Lias coal beds which may probably produce hydrocarbons.

4 - STUDY OF THE HYDROCARBONS

4.1 - Characterization of the syngenetical hydrocarbons

Since the diagenesis is moderate and fairly constant in the zone under study, the study of the hydrocarbons can be undertaken in good conditions with a view to characterizing them and comparing them with each other. The reductions of the chromatograms are on the plate 1 to 7.

4.1.1 - Marine shales of the Upper Kimmeridgian

The hydrocarbons of these shales are chiefly characterized by a fairly regular decrease in the n-alkane contents between nC17 and ..., a slight predominance of the even-numbered n-alkanes between nC20 and nC28 and a slight predominance of the pristane over phytane ($1. < (Pr/nC17)/(Ph/nC18) < 1.3$)

4.1.2 - Shales of the Dogger-Lias

The characteristics of the hydrocarbons of these shales show some variations, but there appears a few general characteristics, that are more or less accentuated, and different from the ones of the Kimmeridgian shales :

- relatively abundant heavy n-alkanes level
- predominance of the odd- numbered n-alkanes in the heavy n-alkane range
- high predominance of pristane over phytane ($2 < (Pr/nC17)/(Ph/nC18)$)
- abundance of aromatics in the vapor range (Toluene, Benzene, Xylene).

The chromatograms may be classed under three chromatographical headings :

- type 1 (e.g. 3207?5, 3324.25 and 3324.5) :

The n-alkane contents are quite constant between C15 and C27, with however a slight predominance of the odd-numbered heavy n-alkanes (chiefly the nC25 and nC27). There is a substantial predominance of the pristane over the phytane. ($2 < (Pr/nC17)/(Ph/nC13) < 3$).

According to the palynological examinations, the palynofacies of these samples is mainly composed of sapropelic amorphous matter.

- type 2 (e.g. 3329.5, 3342.2 and 3394) :

There are abundant heavy n-alkanes, with a high predominance of the odd-numbered n-alkanes between nC21 and nC31. The pristane prevails a great deal over the phytane ($(Pr/nC17)/(Ph/nC18) > 3$). Furthermore in the vapor range, there is a great abundance of light aromatics (Toluene, Benzene, Xylene); their proportion is greater than in type 1.

According to the palynological examinations, the palynofacies of these samples is composed of higher plant elements and to a lesser extent of amorphous matter.

- Intermediate type :

Between these two main chromatographical types there are some chromatograms which show intermediate characteristics.

The hydrocarbons from the coal beds are also variable but are fairly close as regards the intermediate type or even the one from the type 1, e.g. the 3341.75 coal sample.

In fact, it is very probable, in view of the few common geochemical characteristics, that the whole of the hydrocarbons of the Dogger-Lias are generated by the same kind of organic material and that their minor variations are mainly due to some variations in deposit conditions; these latter are likewise accompanied by varying proportions of organic matters (amorphous matter, higher plant elements).

4.2 - Comparison of migrated and syngenetical hydrocarbons

A few migrated hydrocarbons in reservoirs of the 25/4-1 well were studied:

- two extracts from reservoir core samples in the Dogger-Lias at 3188 and 3194 m

- one crude oil in the Lias, fit n° 9 at 3299 m

- one crude oil in the Paleocene, fit n° 2 at 2176.90 m.

The chromatograms of these migrated hydrocarbons are given on plate 10. They show some undoubted elements of correlation with each other and with the syngenetical hydrocarbons extracted from Dogger-Lias, in particular the heavy n-alkane character and the high predominance of the pristance over phytane.

The valorization analyses carried out at the Boussens LCP have shown that the crude products of this well (fit n° 9 at 3299 m, fit n° 8 at 3290 m, DST n° 3 at 3179-3184 m, fit n° 2 at 2176.90 m)* "contain relatively abundant heavy n-alkanes and, particularly the hydrocarbons of fit n° 8 and n° 9, have an exceptional aromatic character in the range of vapors (Benzene, Toluene, Xylene"; these two characteristics may be linked to the ones of the Dogger-Lias source-rock.

This suggests that the main origin of the crude products in the Dogger-Lias and Paleocene reservoirs of this well is the Dogger-Lias source-rock intervals.

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* A. BOURGEOIS

October 1972 n° 03.E.10. - 2/2.539 fit n° 2

February 1973 n° 2051 - 3/2.43 fit n° 8 and n° 9

May 1973 n° 2051 - 3/2.217 DST n° 3

5 - CONCLUSIONS

See plate 9

- There are two good source-rock intervals which have somewhat different geochemical characteristics :

  - the Upper Kimmeridgian shale interval between 3160 and 3180 m

  - the Dogger-Lias interval between 3180 and 3360 m corresponding to the shales at the base of the accretion sequences, approx 60 m, and to the coal beds at the top of the margino-littoral sequences, approx 3 m.

- The geochemical characteristics of all the migrated hydrocarbons of 25/4-1 studied, in the Paleocene and Dogger-Lias reservoirs, show that the main origin of these products is from the Dogger-Lias source-rock interval, in line with the greater thickness of this interval.

APPENDIX 1

RESULTS OF THE ORGANIC INVENTORY

Measurements carried out on the non, or slight, reservoir levels.

Cutting samples of Kimmeridgian	IOC % rock	EOM ppm rock	EOM % TOM (*)
3165 m	10	22300	21
3170	6	10800	18
3175	6	7100	12
Core samples of Dogger-Lias			
3189.20 (coal)		13000	
3191.50	3.5	1800	4
3207.50	5.5	4050	5.5
3221.20	9	4700	5
3221.70	11	9500	6
3221.90	9	7250	8
3222.70 (coal)		29700	
3230.30	2.5	1250	4
3231.35	2	1650	6
3232.20	2	1850	7.5
3232.80	2.5	1600	5
3234.50	1.5	850	7
3295.40	3.5	1200	3
3298.80	2	2450	10
3316.00	3	1200	4
3316.20	3	1100	3
3324.25	10	6500	3.5
3324.50	2	8350	25
3326.40	3.5	450	1
3326.70	0.5	200	3
3329.50	1	850	7
3333.50	1	200	1.5
3341.75 (coal)	$\simeq$ 50	8400	$\simeq$ 1
3342.20	4	1550	3
3374.60	3	600	2
3388.55	0.5	150	3
3394.00	0.9	350	3
3402.75	1	350	3
3405.50	1	250	2
3407.60	$<$ 0.5	$<$ 100	2
3408.80	$<$ 0.5	$<$ 100	2
3409.80	0.5	$<$ 100	1
3410.30	$<$ 0.5	$<$ 200	3
3410.80	1	$<$ 200	1
3446.40	$\ll$ 0.5	150	
3448.60	2.5	600	2
3453.65 (coal)	$>$ 40	18550	$\simeq$ 3.5

* TOM = 1.22 TOC

TOC = IOC + 0.82 EOM x 10^{-4}

APPENDIX 2

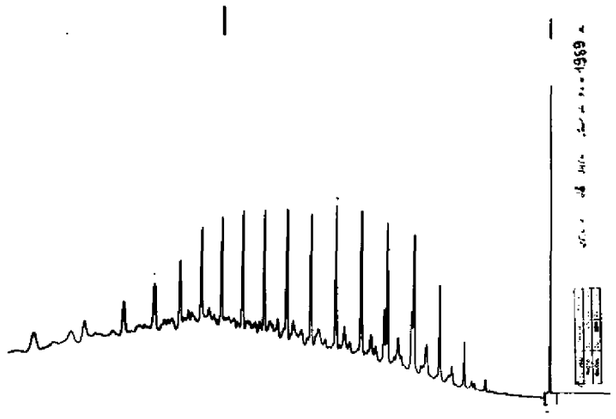
HYDROCARBON POTENTIAL OF THE KEROGEN

					Pyrolysis results			
			IOC % rock	EOM. % rock	DOC (*) % rock	C 5⁻ % DOC	DOC % IOC	EOM + DOC % rock
3175	m	cuttings	6	0.70	0.80	27	13.5	1.50
3207.50	m	core	5.5	0.40	0.55	28.5	10	0.95
3221.20	m	core	9	0.45	0.65	36	7.5	1.15
3232.80	m	core	2.5	0.15	0.55	30.5	22	0.70
3298.80	m	core	2	0.25	0.25	30	15	0.50
3324.25	m	core	10	0.65	1.45	35	14.5	2.10
3341.75	m	core "coal"	>50	0.85	5.80	17	<12	6.65
3394	m	core	1	0.05	0.10	34	12	0.15

* DOC = Organic Carbon Degrades by pyrolysis.

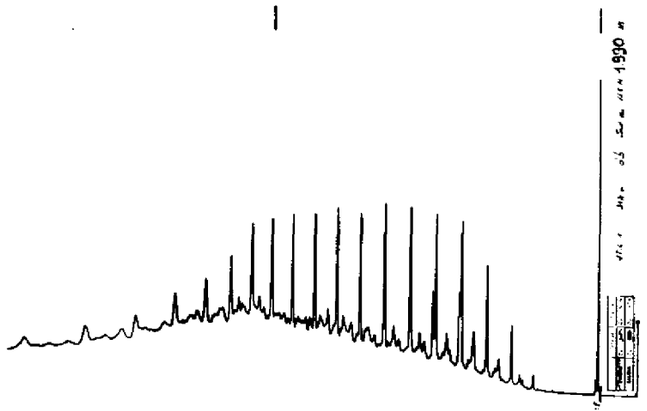
3165 m
(cuttings)
IOC = 10 (% rock)
EOM = 22.300 (ppm rock)
EOM = 20 (% TOM)

brown amorphous matter (100 %)



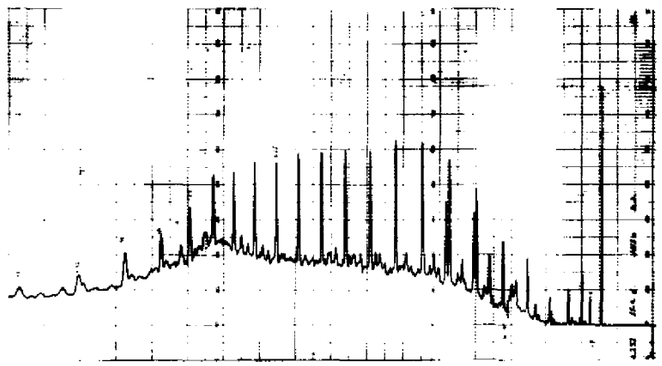
3170 m
(cuttings)
IOC = 6
EOM = 10,800
EOM = 18

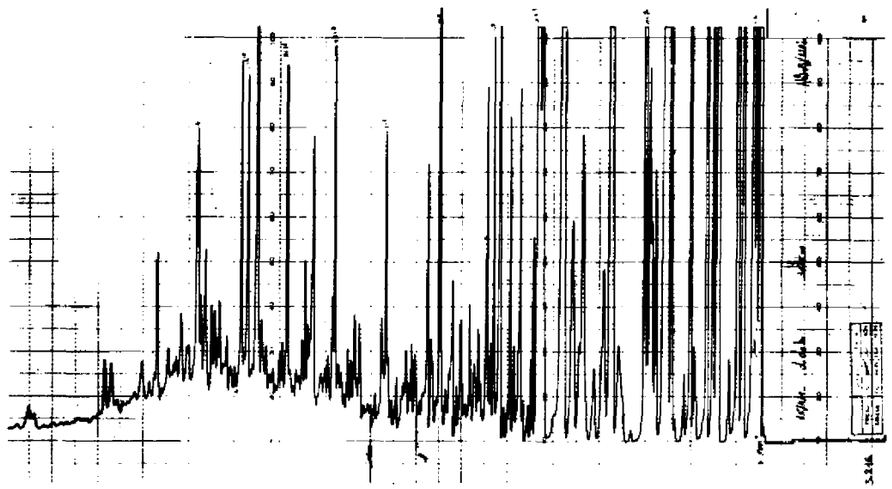
brown amorphous matter (90 %)
+ fusinite + pollens



3175 m
(cuttings)
IOC = 6
EOM = 7100
EOM = 12

compact heterogeneous amorphous matter (100 %)





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25/4-1 WELL

ORGANIC MATTER IN RADIOACTIVE MARINE SHALES
(UPPER KIMMERIDGIAN TO PORTLANDIAN)

elf ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES DIRECTION EXPLORATION LABORATOIRE	PL.1	Date August 76 Auteur PHILIPPE N°classt B 963

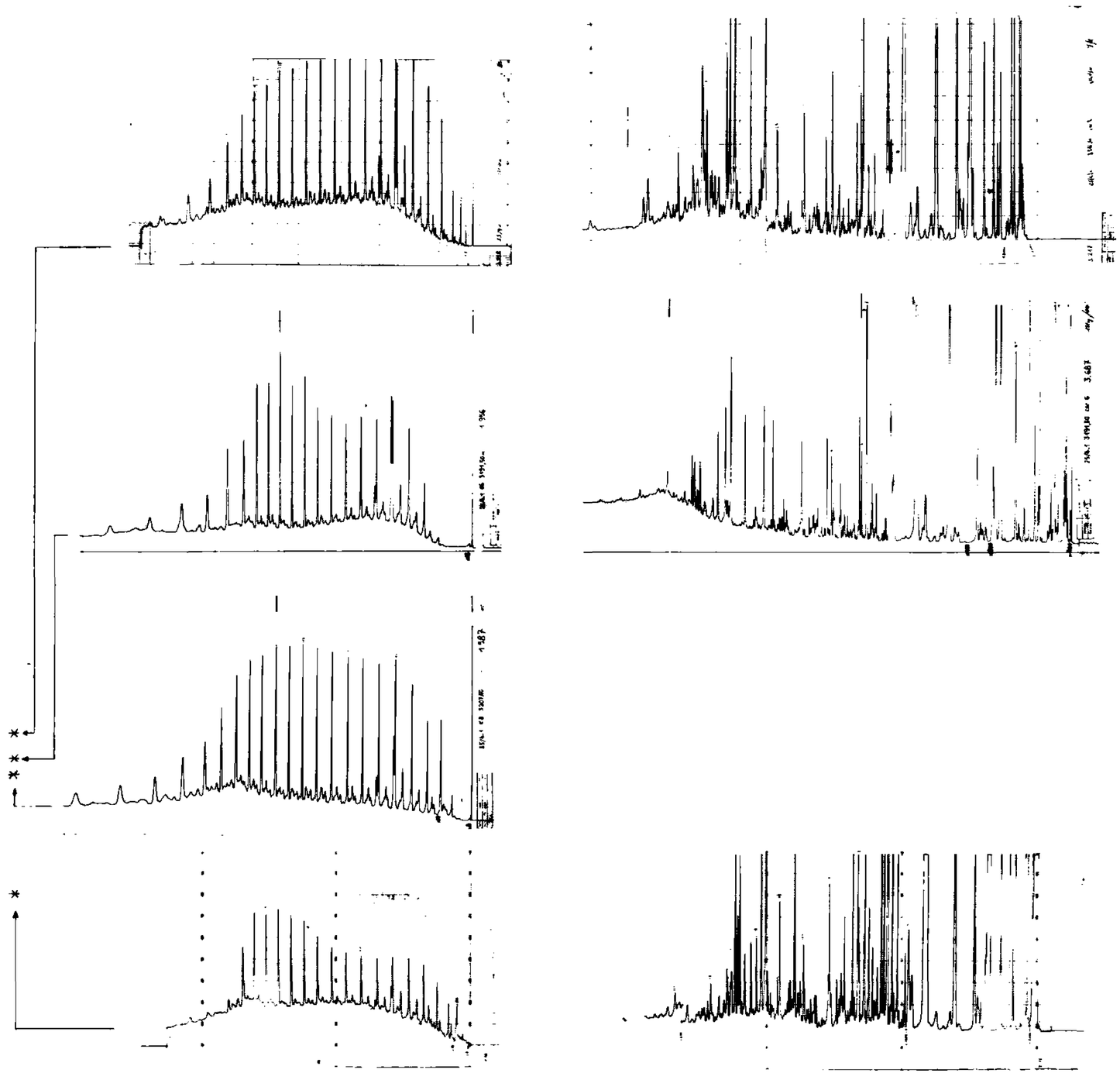
LITHOLOGICAL SECTION Depths	SAMPLES in reference sequence	IOC % rock	EOM ppm rock	EOM % TOM	SAMPLES in approx. equivalent location	PALYNOFACIES
3215.20						
3216.60						
3219						
3219.60						
3220						
3221						
	3221.20 →	9.5	4700	5		Amorphous flocks ± ligneous particles and fine cellular vegetable debris
		3.5	1800	4	← 3191.5	
		5.5	4050	5.5	← 3207.5 (RSC)	
	3221.70 →	11	9500	6		
3222	3221.90 →	9	7250	8		
3222.30						
	3222.70 →		29750 12700		← 3189.2	Coal

elf | Section: Mer du Nord | Operator: elf NORGE | Zone: Norvégienne | PETRONORD

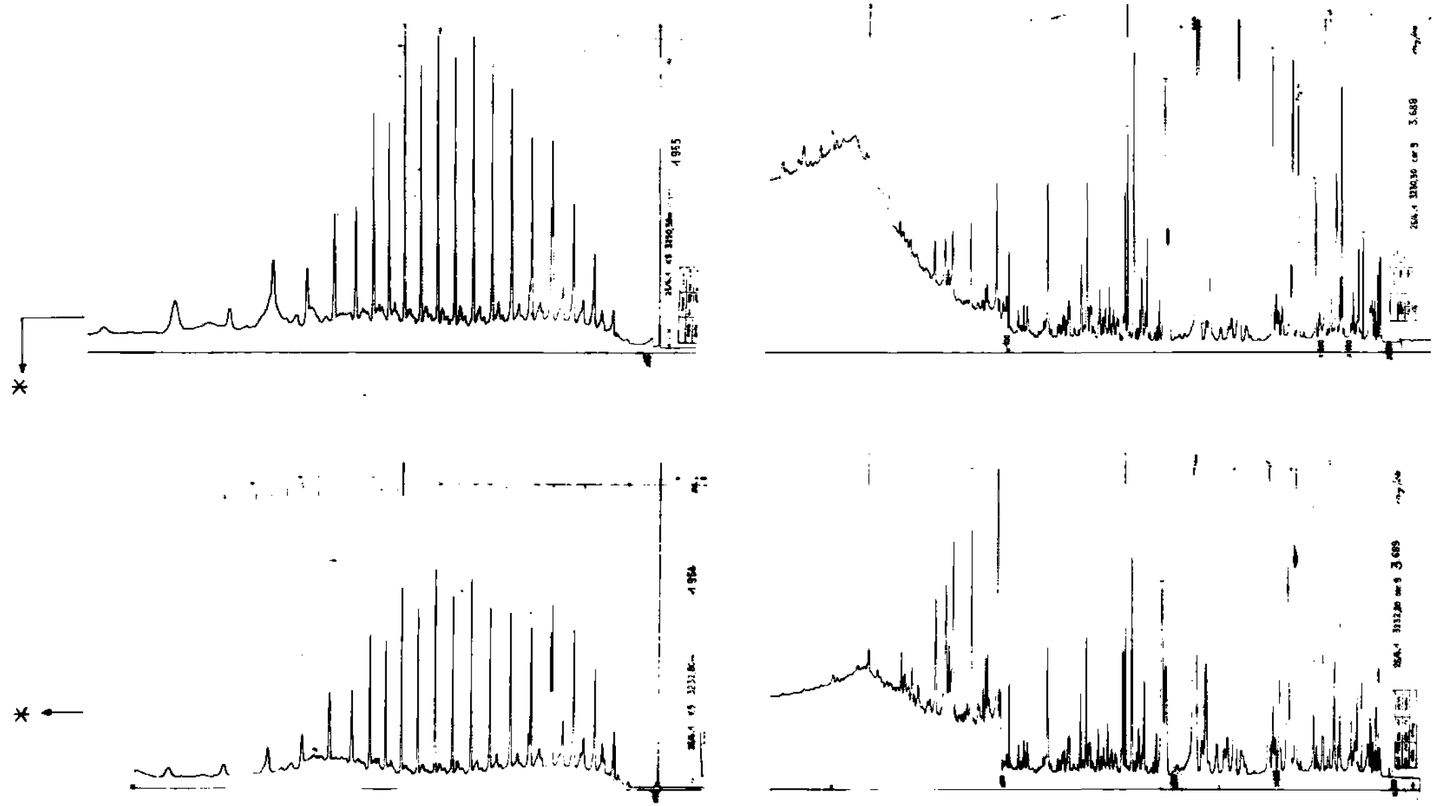
25 4-1 WELL

ORGANIC MATTER IN LITTORAL ACCRETION SEQUENCE (DOGGER - BAJOCIAN ?)

ERAP ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES | DIRECTION EXPLORATION | LABORATOIRE | PL 2 | Date: August 78 | Auteur: PHILIPPE | N° rapport: C 964



LITHOLOGICAL SECTION Depths	SAMPLES in reference sequence	IOC % rock	EOM ppm rock	EOM % TOM	SAMPLES in approx. equivalent location	PALYNOFACIES
3227.45						**Ligneous particles**
3230.10	3230.30 →	2.5	1250	4		Ligneous particles and fine cellular vegetable debris
	3231.35 →	2	1650	6		
3232	3232.20 →	2.5	1850	7.5		
	3232.80 →	2.5	1600	5		Ligneous particles and fine cellular vegetable debris
	3234.50 →	1.5	850	7		
3235						



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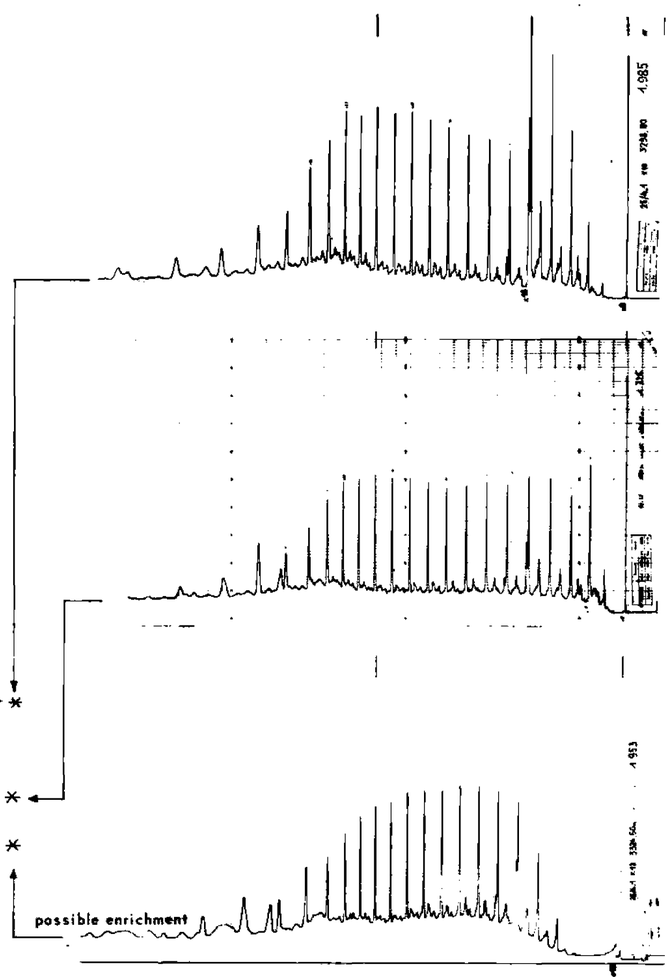
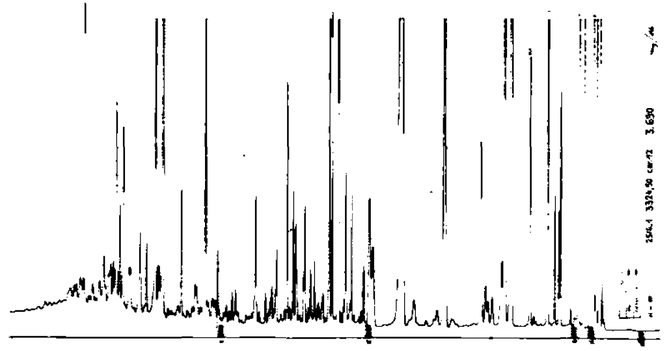
25/4-1 WELL

ORGANIC MATTER IN ACCRETION SEQUENCE IN MARINE ENVIRONMENT (LIAS)

DES ENTREPRISES DE RECHERCHES ET D'ACTIVITES PETROLIERES DIRECTION EXPLORATION LABORATOIRE	PL. 3	Date: August 76 Auteur: PHILIPPE N° rapport: C 965

LITHOLOGICAL SECTION Depths	SAMPLES in reference sequence	IOC % rock	EOM ppm rock	EOM % TOM	SAMPLES in approx. equivalent location	PALYNOFACIES
3310.40						
3311.20						
3314.30						
3314.40						
3314.80						Ligneous particles
3315.80		3.5	1200	3	— 3295.40	
	3316	3 →	1200	4		Ligneous particles + waxes resins, cuticles —
	3316.20	1.8 3 →	2450 1000	10 3	— 3298.80	Ligneous particles ± fine cellular vegetable debris ± amorphous matter
3316.50						
		10	6500	3.5	← 3324.25	Amorphous matter —
3317.15		2	8400	25	← 3324.50	
3317.25						
3317.35						





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25/4-1 WELL

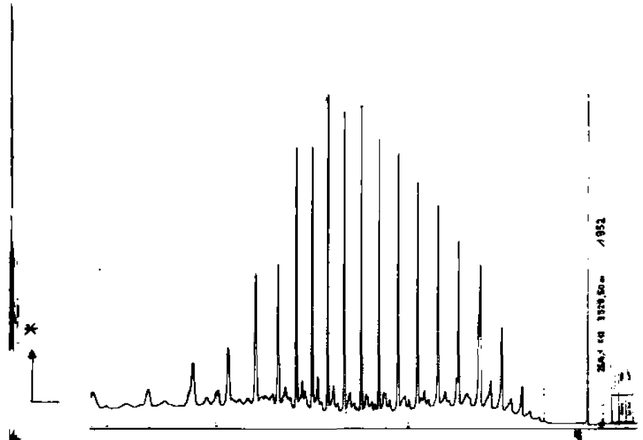
ORGANIC MATTER IN LITTORAL ACCRETION SEQUENCE (LIAS)

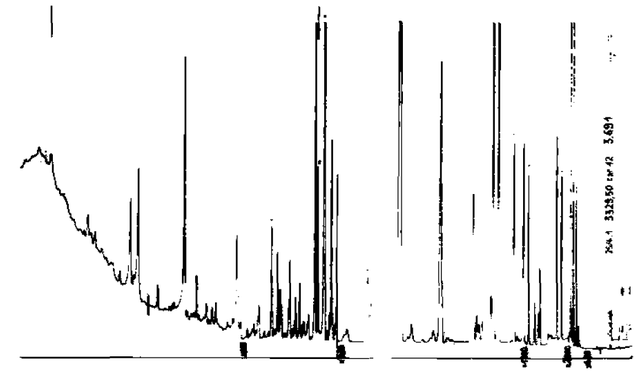
DIRECTION EXPLORATION — LABORATOIRE

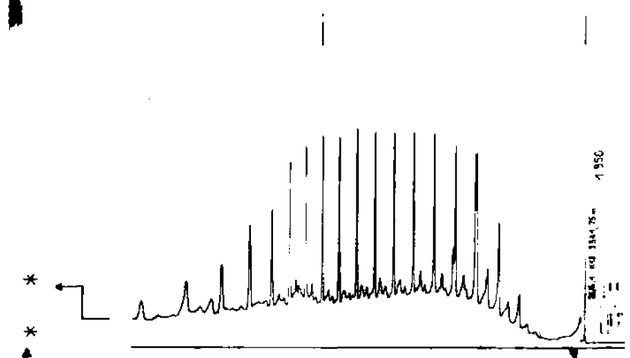
PL 4

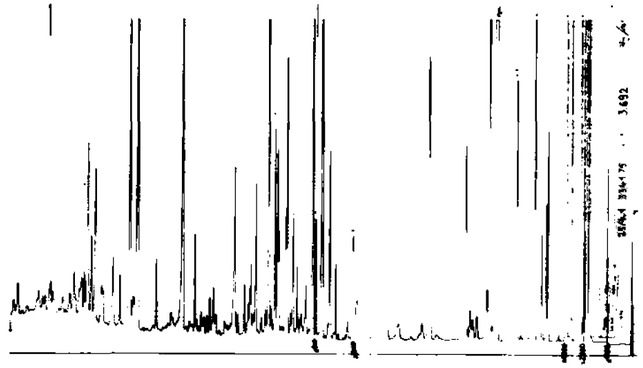
Date: August 76
Auteur: PHILIPPE
N° dossier: C 966

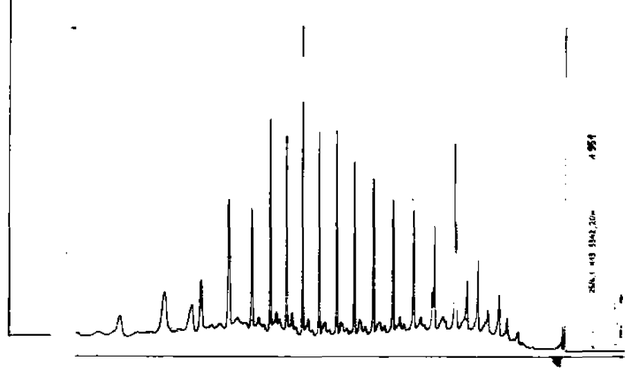
LITHOLOGICAL SECTION Depths	SAMPLES in reference sequence	IOC % rock	EOM ppm rock	EOM % TOM	SAMPLES in approx. equivalent location	PALYNOFACIES
(a)						
3325.90 Gully erosion		1	850	7	← 3329.50	Ligneous particles ± fine cellular vegetable debris rare amorphous matter
		1	200	1.5	← 3333.20	
	3326.40	3.5	450	1		
	3326.70	0.5	200	3		
3327						
3327.40						
3327.70						
3328.30						
(b)						
3341.55						Coal
3341.90	3341.75	50	8400	1		
3342.25	3342.20	4	1550	3		Mainly ligneous particles
3343.30						
3343.70						

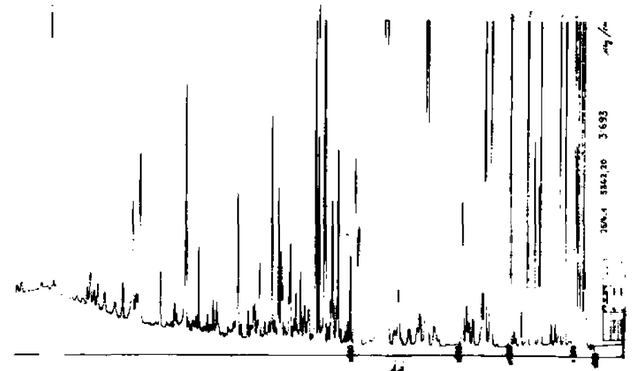












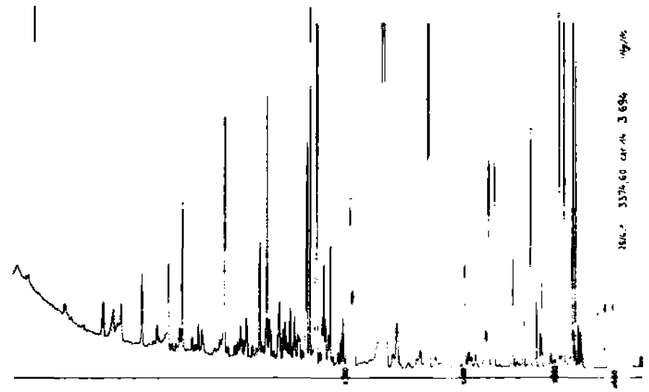
elf	Mer du Nord elf NORGE Zone Norvégienne	PETRONORD

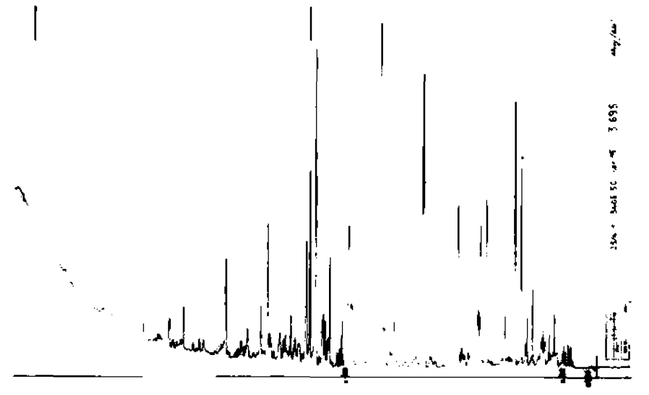
25 4-1 WELL

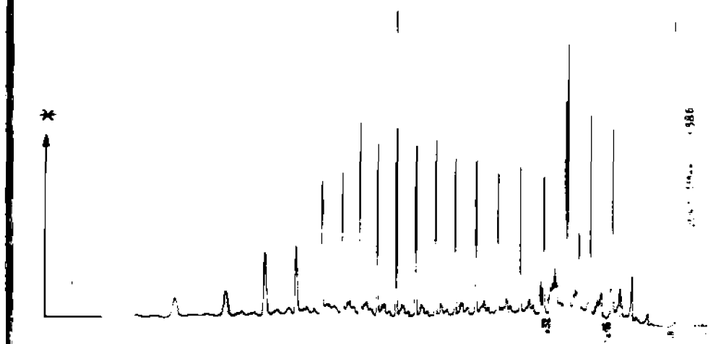
ORGANIC MATTER IN MARGINO-LITTORAL SEQUENCE : SWAMPS (LIAS)

ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES DIRECTION EXPLORATION LABORATOIRE	PL 5	Date August 78 Auteur PHILIPPE N° rapport C 967

LITHOLOGICAL SECTION Depths	SAMPLES in reference sequence	IOC % rock	EOM ppm rock	EOM % TOM	SAMPLES in approx. equivalent location	PALYNOFACIES
3404.70						
3405.15		3	600	2	← 3374.60	
		0.5	160	3	← 3388.50	
	3405.50 →	1	270	2		
3405.90		1	300	3	← 3402.75	
						Ligneous particles – Fusinite – Fine cellular vegetable debris
	3407.60	< 0.5	<100	≤ 0		
3408.35						
3408.60						
	3408.80	< 0.5	<100	≤ 0		
	3409.80	0.5	<100	≤ 0		
3410						Fusinite
	3410.30	0.5	150	< 3		
3410.40		0.9	350	3	← 3394	Fusinite + ligneous particles
	3410.80	1	150	1		
3411						







elf	Mer du Nord elf NORGE Zone Norvégienne	PETRONORD

25 4-f WELL

ORGANIC MATTER IN MARGINO-LITTORAL SEQUENCE WITH A HIGH CONTINENTAL INFLUENCE (LIAS)

ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES DIRECTION EXPLORATION LABORATOIRE	PL.6	Date August 76 Auteur PHILIPPE N° d'ordre C 968

LITHOLOGICAL SECTION Depths	SAMPLES in reference sequence	IOC % rock	EOM ppm rock	EOM % TOM	SAMPLES in approx. equivalent location	PALYNOFACIES
3445,90						
	3446.40	< 0.2	150	≃ 0		Dark ligneous particles + Fusinite
3447.50						
3448.70	3448.60	2.5	600	2		Red-brown ligneous particles + Fusinite (+ "bitumens" ?)
3450.80						
3451.15						
						Ligneous particles + amorphous coal (- resins ?) "Coal"
3453.65	3453.65	> 40	18600	≃ 3		
3454 m						

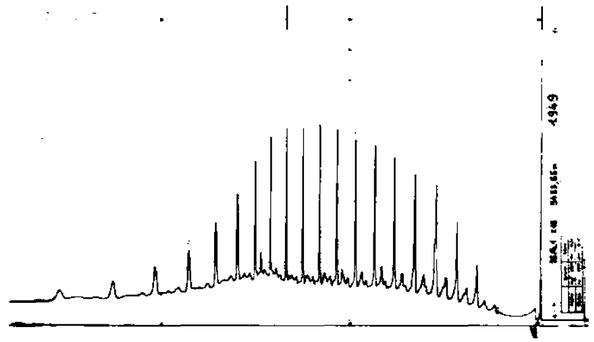
elf	Secteur: Mer du Nord Opérateur: elf NORGE Permis ou Concession: Zone Norvégienne	PETRONORD

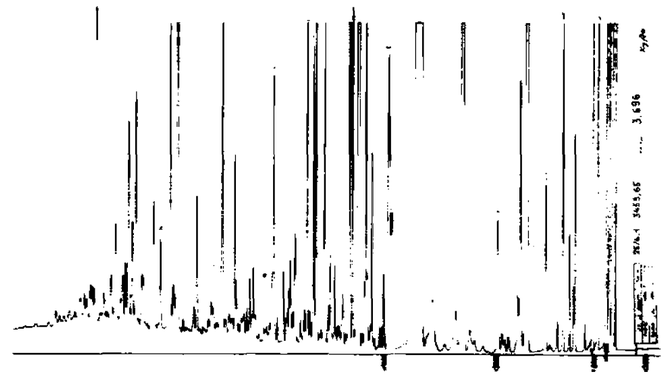
25 4-1 WELL

ORGANIC MATTER IN FLUVIAL SEQUENCE

(LIAS)

SOCIETE FRANCAISE DE RECHERCHES ET D'ACTIVITES PETROLIERES DIRECTION EXPLORATION LABORATOIRE	PL.7	Date August 78 Auteur PHILIPPE N° client C 969





Pristane / nC17

HYDROCARBONS FROM LIAS-DOGGER

HYDROCARBONS FROM KIMMERIDGIAN - PORTLANDIAN

Pr / Ph = 4

Pr / Ph = 2

Pr / Ph = 1,3

Pr / Ph = 1

3221.20
3191.50
3341.75
3175
3232.80
Fit 9 at 3199
3394
3329.50
3298.8
3230.30
Fig 2 at 2176.90
3194
3324.50
3207.5
3138
3189.20
3453.65
3324.25
3170
3165

KEY
+ Syngenetical hadrocarbons
● Migrated hydrocarbons

1
0,8
0,6
0,4
0,2
0
0,2
0,4
0,6
1
Phytane / nC18

elf	Secteur: Mer du Nord	PETRONORD
	Opérateur: elf NORGE	
	Permis ou Concession: Zone Norvégienne	

25/4-1 WELL

RELATIONSHIPS BETWEEN
N. ALKANES AND ISOPRENOIDES

elf ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES	PL. 8	Date August 76
DIRECTION EXPLORATION		Auteur PHILIPPE
LABORATOIRE		N° classt B 970

PALYNOLOGICAL ZONATION AND PROPOSED STRATIGRAPHY (J.F. RAYNAUD)	SEDIMENTOLOGICAL STUDIES (R. CUSSEY) — DEPTHS	ENVIRONMENT: MARINE	LITTORAL ACCRETION	MARGINAL-LITTORAL	SWAMPS FRESH WATER	FLUVIATILE	GEOCHEMICAL ANALYSES — SEA PLATES	ORGANIC INVENTORY (Shale levels): IOC % rock	EOM ppm rock	EOM % TOM	INTERPRETATION: IDENTIFICATION OF THE SOURCE-ROCKS	MAIN CHARACTERISTICS OF THE SYNGENETICAL HYDROCARBONS
Upper KIMMERIDG. to Lower PORTLAND. ? D7 ?	3175						1	5 to 10	>7000	10 to 20	Good source rock interval (≃20 m)	. even predominance . Pr / Ph < 1.30
CALLOVO-OXFORDIAN D 5 b-c												
DOGGER (Bajocian ?) to LIAS ζ2	3200						2	1 to 11 ; generally 2 to 3.5	1000 to 9500 ; average approx. 3000	3 to 8	The shales ✳ (total thickness in approx. 60 m) are good source rocks	. abundant heavy n.alkanes . odd predominance . Pr / Ph ⩾ 2 . abundant light aromatics (Toluene, Benzene, Xylene)
LIAS ζ to γ	3250						3					
	3300						4				✳ Lower part of the littoral accretion sequences	
LIAS β to α3 ?	3350						5a 5b	1 to 4	< 1500	< 3	The shales are slightly source-rock The coal beds seem good source-rock (approx. 3 m)	
	3400						6	generally < 1	generally ≪ 500	< 3	No important source-rock intervals	Roughly the same characteristics as above
LIAS α 1-2	3450						7					
RHETIAN												
KEUPER	3500										In view of lithology : no source-rock	

elf	Secteur: Mer du Nord Opérateur: elf NORGE Permis ou Concession: Zone Norvégienne	PETRONORD

25/8-1 WELL

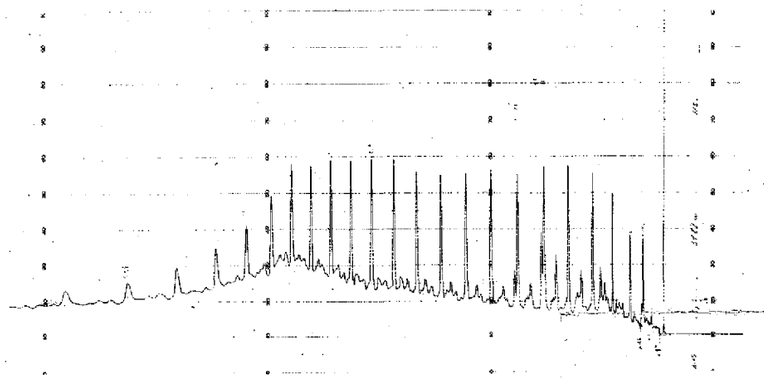
IDENTIFICATION OF THE SOURCE ROCKS IN THE JURASSIC - SYNTHESIS

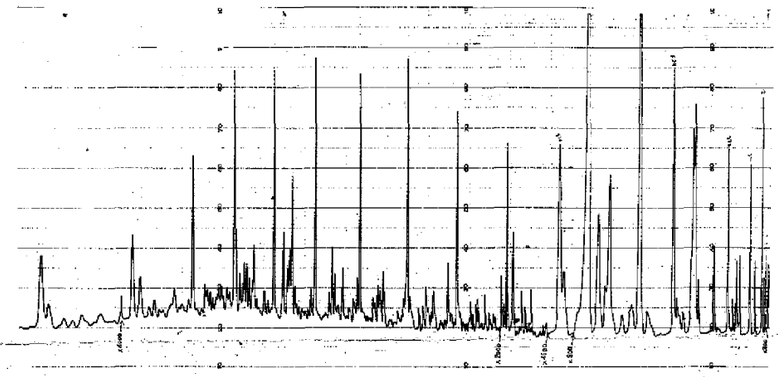
Echelle : 1/ 0000000

elf ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES	PL.9	Date August 76
DIRECTION EXPLORATION		Auteur PHILIPPE
LABORATOIRE		N° classt B 971

DOGGER

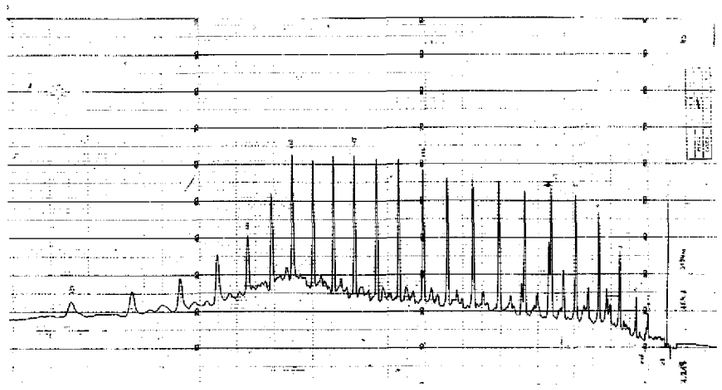
3188 m
Reservoir core sample
EOM = 11.300 ppm

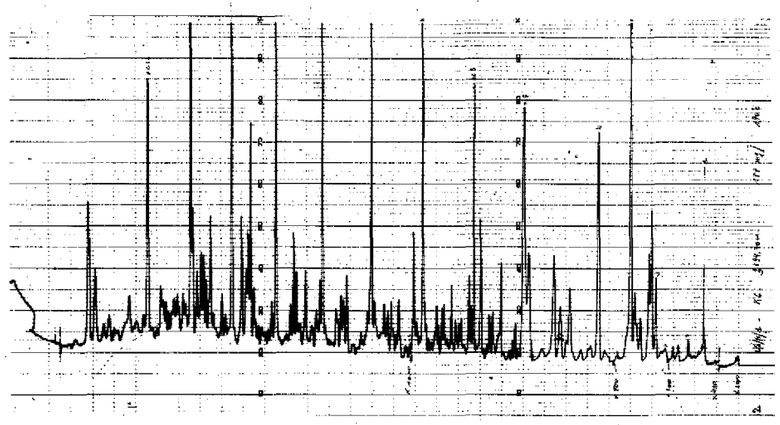




DOGGER

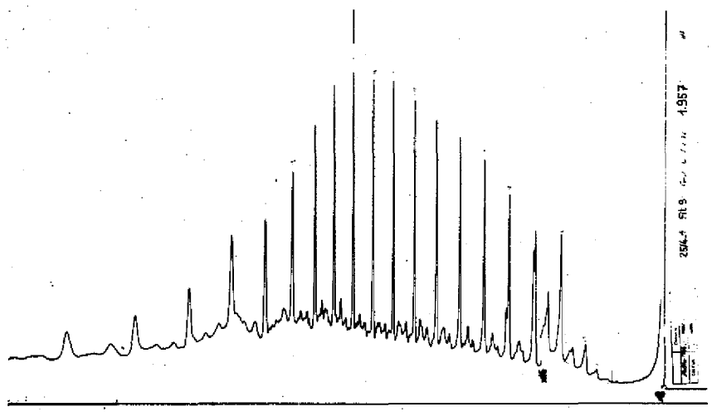
3194 m
Reservoir core sample
EOM = 4000 ppm





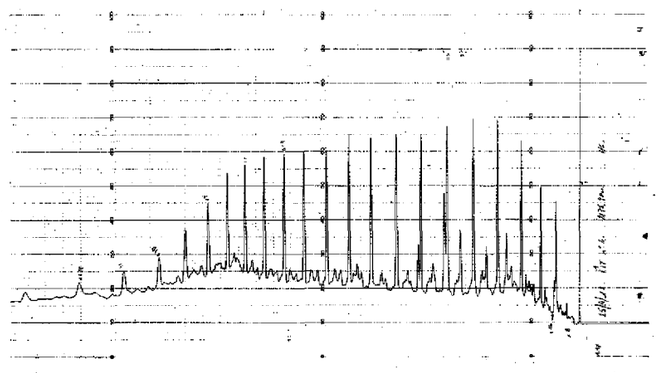
LIAS

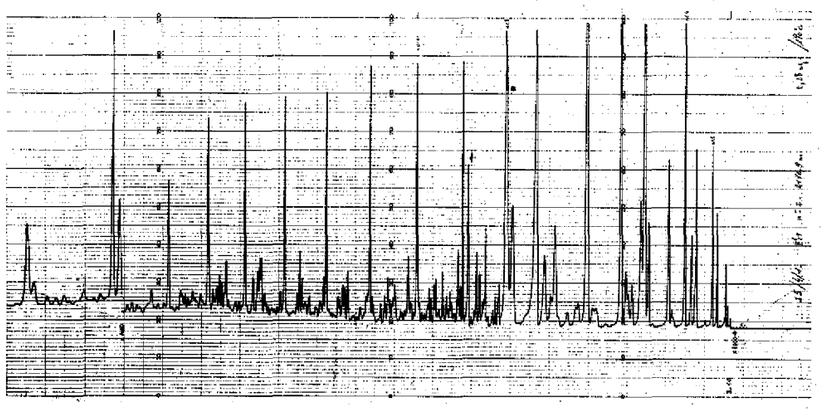
3299 m
Fit n° 9



PALEOCENE

2176.90 m
Fit n° 2





elf	Secteur	Mer du Nord	PETRONORD
	Opérateur	elf NORGE	
	Permis ou Concession	Zone Norvégienne	

25/4-1 WELL

MIGRATED HYDROCARBONS

CRUDE-OILS AND EXTRACTS FROM CORE SAMPLES

elf ENTREPRISE DE RECHERCHES ET D'ACTIVITES PETROLIERES	PL. 10	Date August 76
DIRECTION EXPLORATION		Auteur PHILIPE
LABORATOIRE		N°classeur 6 972

elf-r.e.
CENTRE DE RECHERCHES DE BOUSSENS
elf DEPARTEMENT GEOLOGIQUE CENTRAL LABORATOIRE

ORGANIC MATTER STUDY

Synthesis of results

Country NORVEGE
Well HEIMDALL N° 1
Section 25/4-1 X
Date August 1976

Plate 11

TECHNICAL SECTION DEPTH SCALE 1 : 20000 | CORES | HC. SHOWS | LITHOLOGY | STRATIGRAPHY | INTERVALS STUDIED IN ORGANIC GEOCHEMISTRY | TOC % rock (2 4 6 %) | EOM ppm rock (2000 8000) | EOM % TOM (2 4 6 8 % / 20 40 60 80)

Profond N° ech. Ech. 1/20000

SEA BED 145m

462

PLEISTOCENE TO MIOCENE

815

1000

OLIGOCENE TO EOCENE

1652

1917

LOWER EOCENE

2000

PALEOCENE TO DANIAN

DANIAN 2503

DANIAN 2564

SENO-MAESTRICHTIAN 3068

TURONIAN ? CENOMANIAN 3171

CRETACEOUS

3000

DOGGER TO LIAS

3502.5

JURASSIC TO LIAS

TRIASSIC

4000

4060m

← Oil study (fit n° 2)

Study of rock samples and of one oil

10 9 11 >40 22300 18550 21 12

ORGANIC FACIES (palyno processing)
Amorphous (isopropanic)
Divided amorph mat.
Black powdery mat.
Coal
Fusinit
Lignous material
Cuticles, epiderms
20 40 60 80 %

VITRINITE AND BITUMEN REFLECTANCE
Dominant mode (from core) ▲
(from cuttings) ●
Lack of coal or no representative population △ ○
Spreading.
Bitumen B
0 % 0,5 1 2 4 8 %

THERMAL ALTERATION INDEX
Core samples •
Cuttings samples +
1 2 3 4 5

ORGANIC GEOCH. | Extracts | Crude Oils

PYROLYSIS

INTERPRETATION

All°

Good source-rock

Good source-rock intervals

* See plate n° 9

C 973