L-209

SNEA (P)
DIRECTION EXPLORATION
LABORATOIRE DE GEOLOGIE DE BOUSSENS

GEO/LAB Bss nº 0/1857 RP
/ca

15/3-3 WELL (NORWAY)

ORGANIC MATTER FROM JURASSIC SERIES
(KEROGEN AND OILS)
GEOCHEMICAL AND OPTICAL STUDIES

P. CAILLEAUX - P. ROBERT

Boussens - January 1980

Reference : Order n° 031155

- R. CUSSEY - J. FOSSAT - Report n° 9/1838 RP -
  "15/3-3 well (Norway) - Sedimentological study of Jurassic deposits".

- P. DURIF - E. GROSDIDIER - J. DUCAZEAUX - Report n° 9/1840 RP -
  "Well 15/3-3 (Norway) - Biostratigraphical study of the Cretaceous and the Jurassic (interval 3000 - 5111 metres)".

DISPATCHING LIST

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A B S T R A C T

Geochemical and optical studies were carried out on the organic matter from 15/3-3 well in the interval between 4034 and 5111 m (Jurassic). They show mainly that :

- The degree of catagenesis of the kerogen and the syngenetical hydrocarbons is high : from 0.8 % eq Ro at 4034 m to 1.4 % Ro at TD. The main oil generation zone ends around 4600 m.

- The oil from RFT 26bis (4262 m) and the condensate from DST 2bis (4615 - 4632 m) have been generated by Callovian/Bathonian shaly source rocks ; their degrees of catagenesis correspond with those of the syngenetical hydrocarbons about 200 m below the reservoirs.

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9 pages
2 tables
17 plates

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This report presents the geochemical and optical (reflected light and fluorescence) analyses carried out on the organic matter from 15/3-3 well (location map, plate 1) in the Jurassic interval between 4034 and 5111 m ; and the analyses of the oil from RFT 26bis (4262 m) and the condensate from DST 2bis (4615-4632 m). The work takes into account the optical observations in transmitted light on palynological slides*.

The main results are summarized on Plate 5.

1 - CATAGENESIS

1.1 - TRANSMITTED LIGHT STUDY (see Plate 5)

The Thermal Alteration Index (TAI) is estimated at :

3.5 in the Portlandian - Kimmeridgian (4034 - 4150 m)

4 below 4150 to TD.

1.2 - REFLECTANCE AND FLUORESCENCE STUDY

The whole section is rich in mud products, causing some difficulties in the interpretation of the reflectance results ; thus a pure "ligcon" was checked and its reflectance histogram appears at the top of the diagram. The results are : Ro = 0.30 %, fluorescence index on sporinites and exinites = 1.

The fluorescence of algae tasmanaceae in the Portlandian gives an equivalence of 0.8 % vitrinite reflectance. This value is supported by means of fluorescence spectral measurement in the Pau Laboratory.

The underlying section, with reflectant bitumens and vitrinite gives a scattered diagram, with the following average progression :

		Ro		
Oxfordian	4263.5	1 %	V	Core 1
	4275.05	1.15 %	B	Core 2
	4547	1.1		
Dogger	4800	1.20	V	Cutting
	4996	1.30	V	Core 6

Measurements on vitrinite are performed on typical coal populations, including frequent fusinites.

Plate 2bis gives the comparative results for the 3 boreholes in the 15/3 block and shows a rapid decrease in rank upwards at the top of the Jurassic (geothermal history probably stronger at the end of the Jurassic period).

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* J. DUCAZEAUX in progress

1.3 - GEOCHEMICAL DATA

1.3.1 - The pyrolysis temperatures increase with depth, from 436°C to > 490°C (see T°m table 1 and plate 5).

1.3.2 - Hydrocarbons < C5

"Head space" gases from 18 cutting samples, between 4033 and 5111 m were analysed in the range C1-C5 (see results on plate 6).

- Sampling of a plug in a cutting sample (stored in tin-bos)
- Storage for 15 days at room temperature in well corked plastic bottle
- Sampling of 1 cm3 of gas and analysis on chromatographical column.

In the 4033 - 4400 m interval, the gases are very wet gases : CH_4 < 20 % of hydrocarbons and the iC4/nC4 ratio is lower than 0.8. Both of these characteristics are in agreement with the main oil generation zone location.

Below 4400 m this wetness tends to decrease : CH4 content increases from 20 to 65 % of hydrocarbons, in agreement with the increasing degree of catagenesis, beyond the main oil generation zone. The increase in the iC4/nC4 ratio is also to be noted : below 4450 m iC4/nC4 is higher than 1. According to K. LE TRAN* this value > 1 is generally noted in the gas generation zone where nC4 (and nC5) tends to decrease.

1.3.3 - Hydrocarbons > C5

Chromatographical analyses (thermovaporized fraction C5-C15, and saturated fraction C15-C30) carried out on selected samples show that the X1 (= nC6/methylcyclopentane) and X2 (= nC7/dimethylcyclopentane) ratios are high, and that the Pristane/nC17 and Phytane/nC18 are low, suggesting a high degree of catagenesis in the whole section.

1.4 - CATAGENESIS CONCLUSIONS

These optical and geochemical data show a high degree of catagenesis. The main oil generation zone ends at about 4600 m. Below 4600 m the wet gas generation zone begins.

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* K. LE TRAN - Reconnaissance géochimique par analyse des gaz occlus des déblais de forage (p.21) - Rapport PRST GEO/LAB Pau n° 201/79 RS.

2 - ORGANIC MATTER CHARACTERISTICS - OIL POTENTIAL

2.1 - PALYNOFACIES

4034 - 4120 m (Portlandian - Kimmeridgian) : Sapropelic organic matter

4150 - 4233 m (uncharacterized) : amorphous material is associated with numerous black particles

4239 - 4266 m (Oxfordian) : amorphous material, black ligneous debris and black particles

4274 - 4302 m (Oxfordian) : abundant ligneous black debris

4351 - 4460 m " : amorphous material and black ligneous debris

4480 - 4500 m (Callovian) : ligneous debris

4547 - 4625 m (Bathonian) : black particles, black ligneous debris and finely divided amorphous organic matter

4655 - 4776 m (Bathonian) : abundant black ligneous material and coaly particles predominate associated with finely divided amorphous material

4800 - 4875 m : black ligneous material and coaly particles

4900 - 4965 m : - idem -

4979 - 5003 m : ligneous and coaly material.

2.2 - ORGANIC FACIES IN FLUORESCENCE

The only SWC sample at 4034 m in the Portlandian shows, in massive rock, the common sapropelic facies which is generally typical for the Kimmeridgian = fluorescent groundmass and algae tasmanaceae and microfilamentous algae. The fluorescence colours are dark orange and attempts at fading by long blue exposure proved ineffective : both effects are due to high rank (about 0.8 % Ro vitrinite equivalent). The fluorescence quantitative indices are 2 on the concentrate, 3 on the massive rock ; inversely, the concentrate is richer in reflectant bitumen.

The same facies appears in cuttings at 4166 m in the Kimmeridgian which is diluted by derived cuttings and mud products.

A lot of mud product reflectance histograms can be noted in all cutting samples along the whole section (0.3 % Ro).

In the underlying section, the best results in reflectant matter are given by the 5 core samples, with bitumen and vitrinite and frequent fluorescent groundmasses with low indices (0.5 to 1.5) : due to the high rank, the fluorescent exinites have disappeared and only the groundmasses remain.

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2.3 - GEOCHEMICAL STUDY

Geochemical analyses were carried out on 30 samples (6 SWC, 11 cores, 13 cuttings) and on two fluid samples : oil from RFT 26bis (4262 m) and paraffinic condensate from DST 2bis (4615 - 4632 m).

2.3.1 - Organic matter content

The total organic carbon content (TOC) is high in the whole Jurassic section : $1 < TOC < 15$ % of rock, except in the sandstony samples from the reservoir ($TOC < 1$ %) and in the coal sample at 4547 m (TOC = 77 %).

In the 4262 m - 4285 m reservoir (Oxfordian), the EOM content (Extractable Organic Matter) decreases from 4000 ppm at the top to 200 ppm at the bottom.

2.3.2 - Characteristics of syngenetical hydrocarbons

From Portlandian to Callovian, the samples are rich in hydrocarbons extractable by heating : from 1000 to 18000 ppm (S1), and in hydrocarbons from the range C5-C15. Below 4600 m this content decreases with depth.

The chromatograms of saturated fractions show a slight predominance of Pristane over Phytane ($0.9 < A/B < 1.9$; see plate 4).

2.3.3 - Petroligen potential of kerogen

The petroligen potential of kerogen is estimated by pyrolysis analyses. The results are given in table 1 ; hydrogen indices (HI) and oxygen indices (OI) are plotted in a diagram on plate 3.

Content in hydrocarbons produced by pyrolysis (S2) is high to very high (except for the sandstony samples) from 4034 to 4600 m. Below 4700 m, this content is still medium, considering the high degree of catagenesis.

The related HI are : high for the Portlandian sample at 4034 m (= 436), medium from 4100 to 4562 m and low below 4600 m. Except for the sandstony samples, the OI are lower than 50 mg/g TOC.

2.4 - CONCLUSIONS REGARDING OIL POTENTIAL

The whole section with abundant organic matter presents a medium to high present potential, decreasing with depth, and is/was a good mature oil source rock.

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3 - CHARACTERISTICS AND ORIGIN OF OIL AND CONDENSATE

Two fluid samples have been analysed :

- oil from RFT 26bis, 4262 m
- condensate from DST 2bis, 4615 m.

The gross composition of the condensate from DST 2bis is very close to the composition of oil from RFT 26bis (see table 2) ; but the Saturated/Aromatic hydrocarbon ratio is slight higher (4.1 vs 3.0).

The A/B = (Pristane/nC17)/(Phytane/nC18) ratios (= 1.8 for condensate and 1.55 for oil) show an origin in the Callovian/Bathonian shales.

The catagenetical indices mainly Pristane/nC17 and Phytane/nC18 show that the condensate is more mature than the oil. According to the correlations with the syngenetical hydrocarbons, the average degrees of catagenesis of their source rocks correspond with the degrees observed in the well 15/3-3 at about 4450-4550 and 4700-4800 m respectively.

TABLE 1

TOC	Total organic carbon (% of rock)	
IOC	Insoluble organic carbon (% of rock)	
EOM	Extractable O.M. in chloroform (ppm)	
S1	Hydrocarbons present in the rock	mg HC/g of rock
S2	Hydrocarbons produced by pyrolysis	
HI	Hydrogen index (mg HC/g TOC)	
OI	Oxygen index (mg CO2/g TOC)	
Tm	Temperature at the top of S2	
X1	nC6/methylcyclopentane	
X2	nC7/dimethylcyclopentane	
Y1	nC7/Toluene	
Pr	Pristane	
Ph	Phytane	
A,B	Pr/nC17, Ph/nC18.	

AGE	Samples							PYROLYSIS (ROCK-EVAL)					C5 - C15			C15 - C30		
		N°	Depth (m)	TOC %	TOC %	EOM ppm	EOM % TOC	S1	S2	HI	OI	Tm	X1	X2	Y1	Pr/nC17	Ph/nC18	A/B
Portlandian	SWC	1	4034	6.2				13.04	27.0	436	< 5	436	0.82	1.91	1.36	0.75	0.63	1.20
Kim./Port.	D	2	4100	5.1				4.21	8.85	174	30	438						
?	D	3	4150	7.8				5.97	16.8	215	19	441	1.90	4.66	1.12	0.40	0.43	0.93
?	D	4	4200	6.6				5.88	11.05	167	13	432						
	SWC	5	4239	2.6				1.14	1.88	72	23	444						
	OIL		4262										2.39	7.41	0.68	0.50	0.32	1.54
Oxfordian	C1	6	4262.30	0.7	0.35	4020	57.0	3.74	1.22	174	71	445	-	-	-	048	0.35	1.35
	"	7	4263.50	5.25	5.11	2240	4.3	1.55	10.0	190	8	448	1.83	5.87	0.24	0.40	0.26	1.50
	"	8	4265		0.20	3790	75.8											
	"	9	4268.55	0.8		480	6.0	0.41	0.81	101	49	442	2.2	4.4	0.53			
	C2	10	4275.05	1.65	1.55	1230	7.5						-	-	-	0.46	0.33	1.41
Callove-	"	11	4278.90		0.15	200	11.8											
Oxfordian	"	12	4283.67	0.2		220	11.0						-	-	-	0.98	0.84	1.16
	D	13	4380	4.95				4.2	5.42	109	21	433	2.35	6.8	0.90	0.67	0.61	1.09
	SWC	14	4460	4.15				3.3	6.21	150	10	453	3.02	9.78	0.62	0.38	0.24	1.53
	"	15	4535	15.0				4.9	21.67	144	< 5	459						
			4547/48	77.0				18.6	215	280	< 5							
	C4	16	4562	7.35		1220	1.7	3.26	11.15	152	< 5	459	1.65	5.48	0.22	0.52	0.17	2.96
	Condensate		4615/32										1.89	8.73	0.30	0.24	0.13	1.80
Bathonian	D	17	4625	0.55				0.39	0.30	54	98	439						
	"	18	4635	3.35				1.30	-	-	33.5	- *						
	"	19	4650	3.30				2.37	-	-	28	- *	1.63	10.7	0.14	0.37	0.36	1.04
	"	20	4660	2.75				1.29	-	-	23.5	- *						
	"	21	4715	4.50				1.74	1.69	37.5	24	444						
	SWC	22	4750	3.30				1.74	1.87	57	10	467	2.64	9.37	0.86	0.17	0.09	1.91
	D	23	4850	1.90				1.09	1.20	63	26	469	1.95	6.83	0.40	0.26	0.18	1.43
	"	24	4900	1.30				0.49	0.45	34.5	31.5	480						
Aalenian/	SWC	25	4979	5.90				0.9	3.79	64	< 5	481						
Toarcian	C6	26	4996	4.80				0.84	3.70	77	< 5	483	1.92	7.85	0.08	0.55	0.43	1.25
	"	27	5001.5	1.05				0.105	0.23	22	15	>490						
	"	28	5004	0.42				0.03	0.03	< 10	57	-						
?	D	29	5070										2.41	8.53	0.47	0.19	0.17	1.10
	"	30	5111										2.62	9.95	0.67	0.35	0.26	1.35

SWC = Sidewall core
C = Core
D = Cuttings

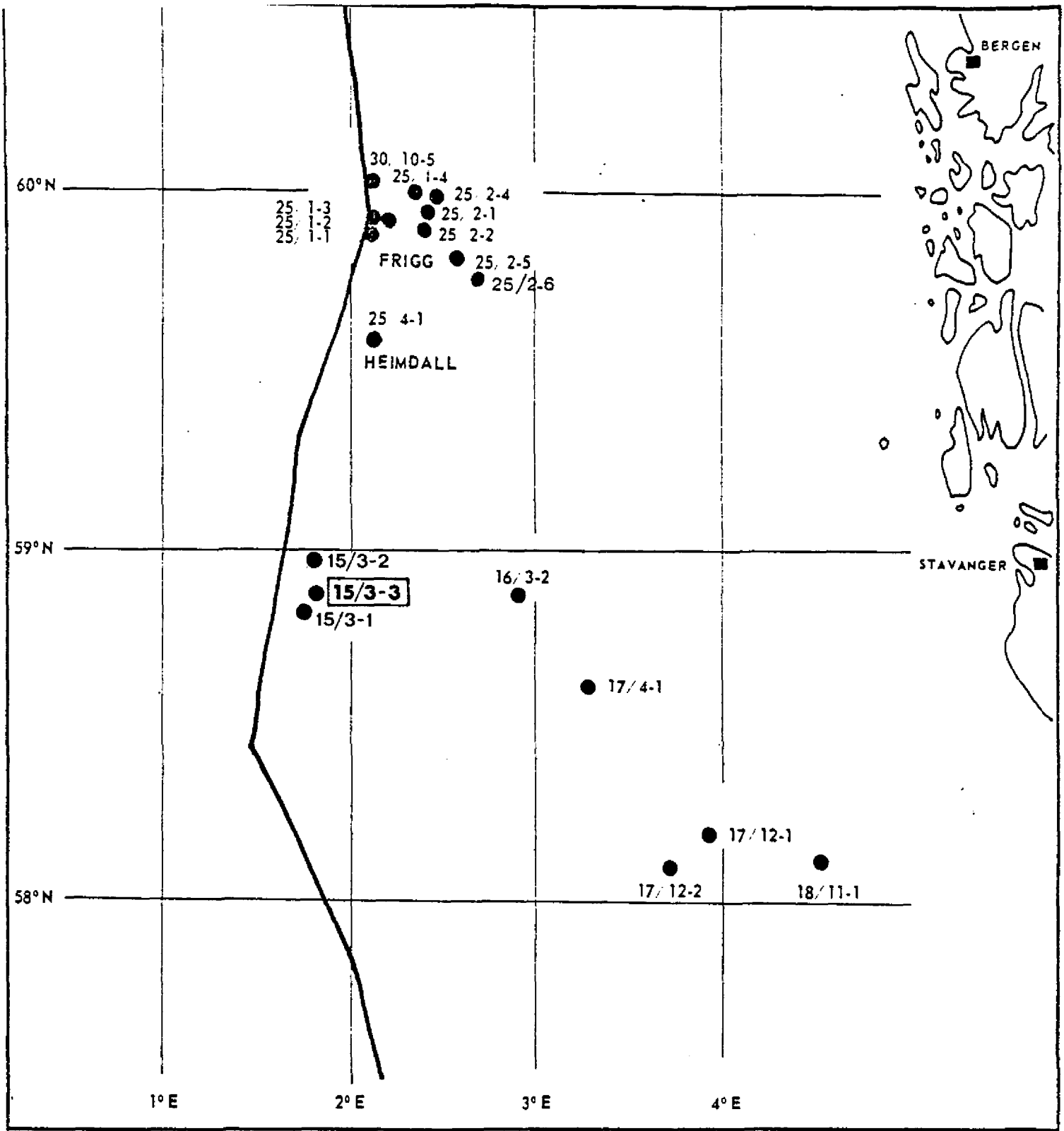
* S2 too low for Tm readings

Table 1 - 15/3-3 : Geochemical results

TABLE 2

15/3-3 - OIL AND CONDENSATE

	RFT 26bis 4262 m	DST 2bis 4615 - 4632 m
Distillate	42.4 %	33.6 %
Saturated HC = S	41.6	51.9
Aromatic HC = A	13.8	12.7
Resins	1.9	1.8
Asphaltenes	0.2	-
S/A	3.01	4.08
Pr/nC17 = A	0.50	0.24
Ph/nC18 = B	0.32	0.13
A/B	1.54	1.80
% Alk/Sat	27	25
% Alk/r	24	18
X2 = nC7/DMCP	7.4	8.73



elf aquitaine

Pays NORVEGE

Permis ou concession tous permis

DIRECTION EXPLORATION

Date Janv.80

Auteur

N° Classt A 4014

PL. 1

NORTH SEA

15/3-3 LOCATION

elf aquitaine

ELF NORGE
NORWAY
D25

DIRECTION GENERALE DES PRODUCTIONS

DIRECTION EXPLORATION

Janv.80
P. Robert
C 4015

PL.2

15/3-3 WELL

ORGANIC MATTER
PETROLOGY

REFLECTANCE (measurements)
- Vitrinite
- Bitumens B

FLUORESCENCE (global amount estimated)
- Fluorescent macerals
- Hydrocarbon traces in reservoirs
- MP Mud products

REFLECTANCE		FLUORESCENCE	
VITRINITE BITUMEN		GLOBAL ESTIMATED	ORGANIC MATTER NATURE
0	1	2% 1 2 3 4	

Ligcon
Mud product

Bitumen
(Fluorescent)

PORTLANDIAN

(+M) SWC 4034

4051

KIMMERIDGIAN

MP

4130

4166

MP B

4200

4239

OXFORDIAN

K1 4263,5

K2 4275,05

K3

4375

MP B

MP B

4450

4480

CALLOVIAN

(M) K4 4547

K5 4562

4620

BATHONIAN

MP

4650

MP

4700

MP

4800

MP

4850

K6 4996

MP

5070

MP

5111

Cannel - coal

S

S

Sapropelic groundmass
Algae - Tasmanaceae
Schizophiceae
(Fluorescence colour
⇒ RoV ≠ 0,8 %)
Free oil
ε Sporinites

Mud product

S

Groundmass (deck)

S

d°

V. F. (coals)

H

Groundmass
yellow - brown
(without alginite)

H

d°

H

d°

B

H

Mud product

d°

pure coal

H

Exsudatinite

V. F. (coals)

d°

H

(Groundmass)

ε

d°

Vitrinite

ε

d°

Vitrinite

ε

d°

ε

d°

H

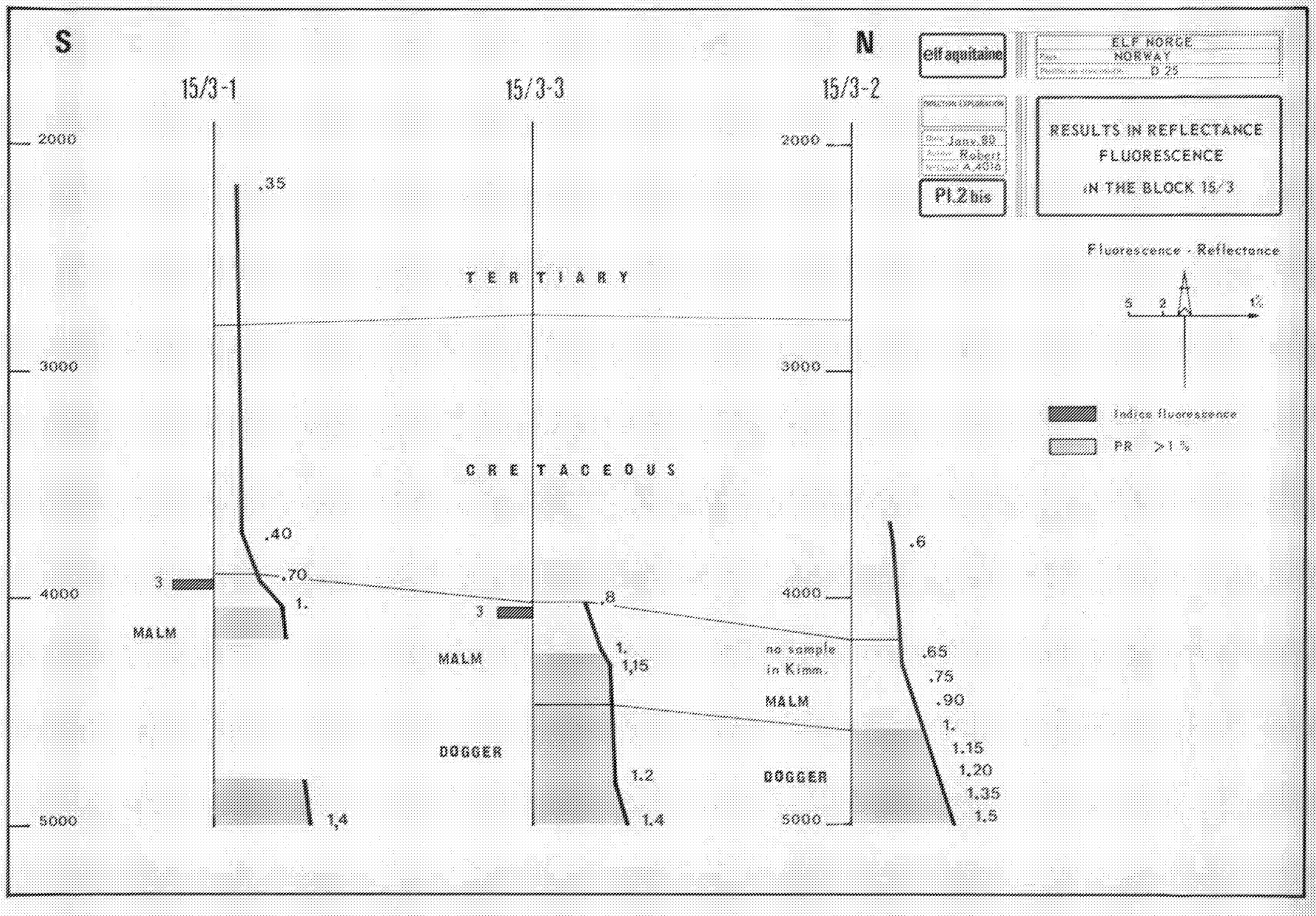
Groundmass
dark yellow

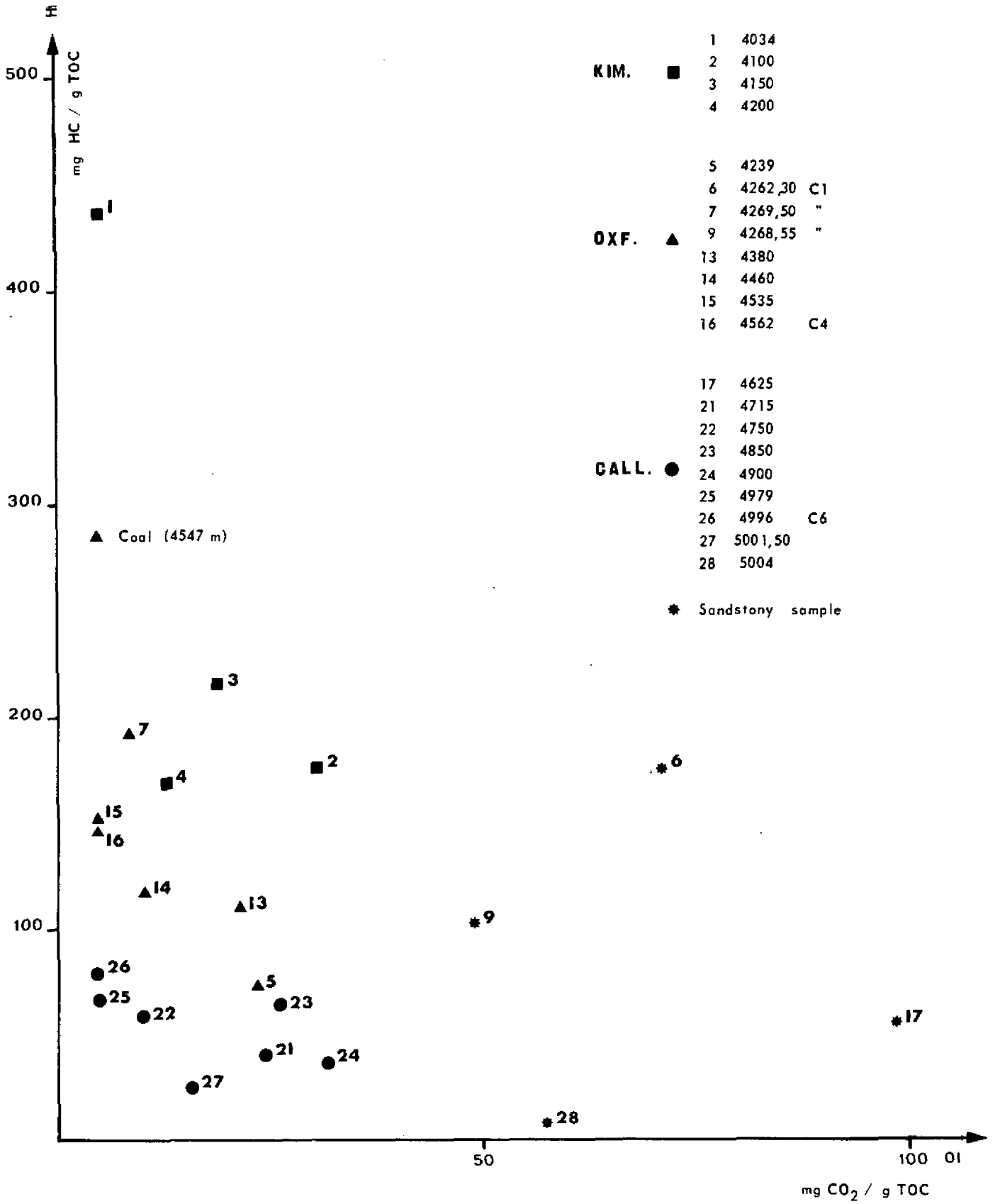
H

d°

ε

d°


S
N
15/3-1
15/3-3
15/3-2
2000
3000
4000
5000
.35
.40
.70
1.
3
MALM
1,4
TERTIARY
CRETACEOUS
.8
3
MALM
1.
1,15
1.2
1.4
DOGGER
no sample
in Kimm.
MALM
.6
.65
.75
.90
1.
1.15
1.20
1.35
1.5
DOGGER
elf aquitaine
ELF NORGE
NORWAY
D 25
Jan. 82
Robert
A 4018
Pl.2 bis
RESULTS IN REFLECTANCE
FLUORESCENCE
IN THE BLOCK 15/3
Fluorescence - Reflectance
5
2
1%
Indice fluorescence
PR >1 %



elf aquitaine	ELF NORGE	
	Pays NORWAY	
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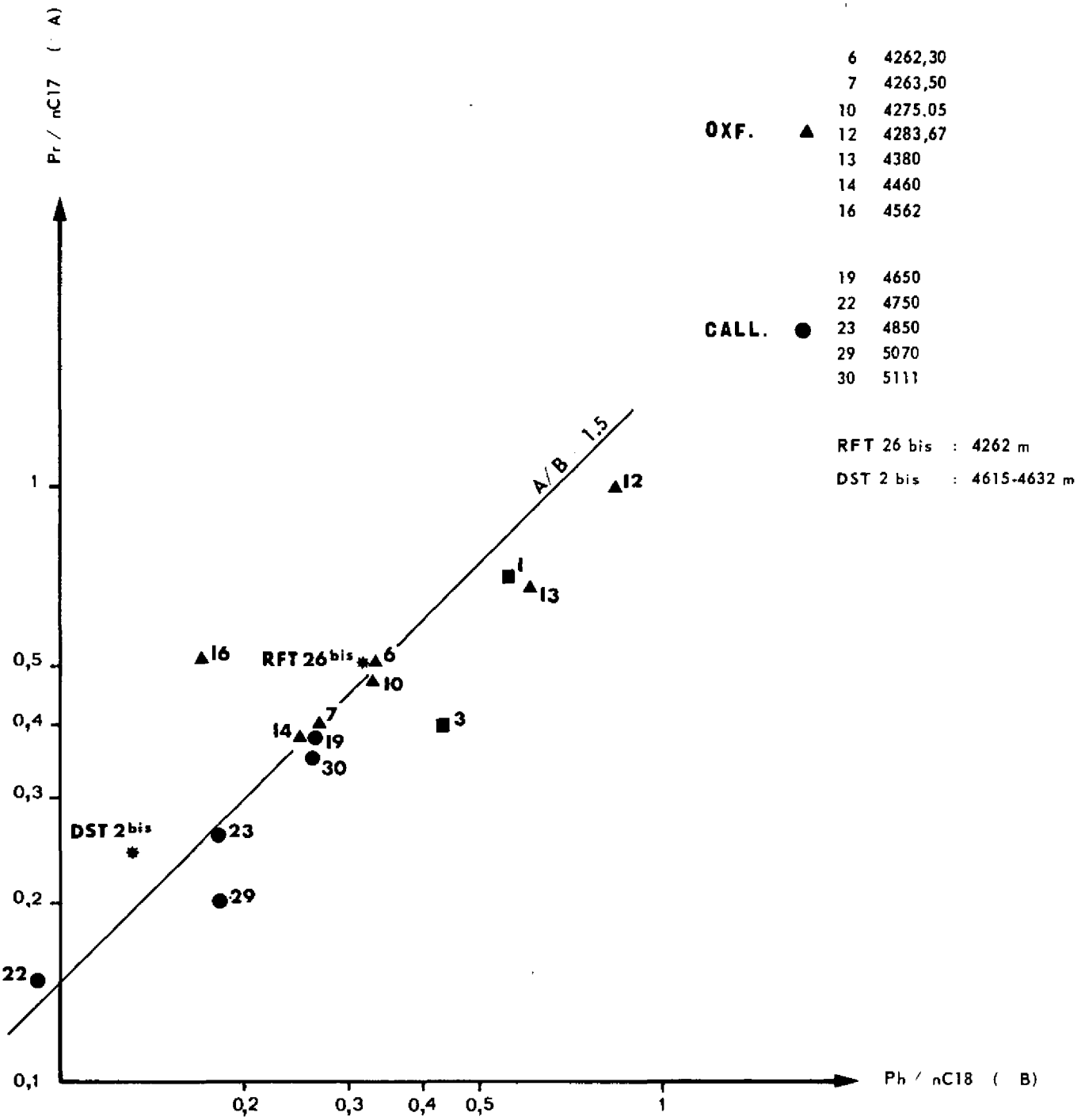
DIRECTION GENERALE DES PRODUCTIONS		
DIRECTION EXPLORATION	15/3-3 WELL	
Date Janv.80	HI - OI diagram	
P.Caillaux		
N°Classt A 4017		
PL.3		



Pr Pristane

Ph Phytane

✱ OILS

elf aquitaine

ELF NORGE

Pays NORWAY

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DIRECTION GENERALE DES PRODUCTIONS

DIRECTION EXPLORATION

Date Janv.80

P.Cailleaux

N°Class A 4018

PL.4

15/3-3 WELL

Pristane / Phytane diagram

SNEA (P) 15/3-3

DEPARTEMENT LABORATOIRE DE GEOLOGIE
DE BOUSSENS

ORGANIC MATTER STUDY

SYNTHESIS OF RESULTS

WELL : 15/3-3

COUNTRY : NORWAY

Plate: 5

Date : October 1979

DEPTH 1/20 000 m

HC SHOWS

LITHOLOGY

FORMATION

AGE

PALYNOFACIES
MOS
MOV
MOX
MOB1
MOB2
MOF1
MOF2
Various including microfossils
25 50 75%

T. A. I.
Core
Cuttings
1 2 3 4 5

REFLECTANCE
Mode: core / cuttings
Non representative mode
No result
Spreading
Bitumen
RoV equiv. fluo.
0,5 1 2 4%

FLUORESCENCE
Sapro/algal
Humic
Undifferentiated
1 2 3 4

CORES

TOC
% rock weight
0,1 0,5 1 2 3 4 5 10 15 20

EXTRACT
% rock weight
0,1 0,2 1,0 2,0

CONSTITUTION

G. C.
effluent
extract

Thermovap.

Saturated

Aromatic

MAIN RESULTS

CATAGENESIS

PRESENT POTENTIAL (10^3 T/Km^2 m)

INITIAL POTENTIAL

HYDROCARBONS

DEPTH m

PYROLYSIS ROCK-EVAL

S1 + S2
mg HC / g of rocks
10 20 30 40

S1 / S1 + S2
0,25 0,50 0,75

HI
mg HC / g TOC
200 400 600

OI
mg CO_2/g TOC
50 100 150

Tm
°C
420 450 480

1000

2000

3000

4000

5000

MIOCENE PLEISTOCENE

MIDDLE UPPER EOCENE OLIGOCENE

DANIAN TO PAL.

DANIAN

MAAST.

CAMPANIAN

CONIACIAN SANTONIAN

TURONIAN

CENOMANIAN

ALBO-APTIAN

BARREMIAN / GLD.

PORTL./KIM

?

OXFORDIAN /CALLOV.

?

BATHONIAN

?

AAL./TOARC

?

4262

4615
4632

5111m

1a 3 4 5 6

18 17

?

WET GAS

10 to 60 Very high

< 5 high

GOOD SOURCE ROCKS MATURE TO VERY MATURE

← OIL with catagenetical degree of 4450-4550 m shales

← CONDENSATE with catagenetical degree of 4700-4800 m shales

B 4019 *

HEAD SPACE GASES FROM 18 CUTTING SAMPLES

IDENT.	C1	C2	C3	IC4	NC4	IC5	C5	C6+	SUM C1..C5	iC4/nC4
4033.0	17.8	1.9	7.2	23.0	67.9	49.7	44.1	103.4	201.5	0.40
4100.0	16.2	3.2	29.7	15.3	26.9	12.6	7.2	13.2	110.3	0.59
4150.0	70.9	284.2	2032.1	562.4	911.5	231.9	144.9	128.9	4236.9	0.62
4200.0	106.2	12.3	63.5	113.2	163.5	110.7	64.6	116.9	634.2	0.69
4375.0	30.6	4.9	15.9	21.1	41.6	33.9	23.3	64.6	175.3	0.51
4400.0	25.7	37.3	247.9	92.0	105.1	32.7	12.8	27.2	553.5	0.87
4450.0	79.1	29.1	156.5	67.1	75.9	37.0	16.1	34.3	480.8	1.15
4500.0	94.0	25.3	97.7	37.0	23.1	9.5	2.7	15.6	289.3	1.60
4650.0	56.7	42.0	34.2	8.4	5.1	3.8	0.3	3.5	150.5	1.65
4700.0	10.2	1.1	6.9	7.4	5.7	5.2	1.3	5.5	37.7	1.30
4800.0	41.7	52.0	54.7	10.7	6.1	2.9	0.4	1.4	178.5	1.75
4850.0	218.9	194.6	87.9	14.9	5.5	2.5	0.4	1.5	525.8	2.71
4970.0	95.1	319.7	105.7	22.6	9.6	4.3	0.6	1.5	557.5	2.35
5070.0	147.1	293.4	120.4	29.7	15.7	6.3	0.9	3.4	613.5	1.89
5075.0	187.5	406.9	176.1	41.4	29.5	8.1	1.1	3.4	841.6	2.02
5085.0	1284.5	527.4	198.2	44.7	21.0	7.4	1.2	4.1	2084.5	2.13
5095.0	128.5	193.6	103.3	29.3	16.6	6.9	1.4	2.6	479.5	1.76
5111.0	5.0	17.8	44.7	17.0	10.9	4.5	1.0	3.3	101.0	1.56

PERCENTAGE OF Ci, COMPARED WITH Σ (C1-C5)

4033.0	8.8	1.0	3.6	11.4	28.7	24.7	21.9
4100.0	14.7	2.9	27.0	13.9	23.5	11.5	6.6
4150.0	1.7	6.7	48.9	13.3	21.5	5.5	3.4
4200.0	16.7	1.9	10.0	17.9	25.8	17.5	10.2
4375.0	17.7	2.5	7.7	12.2	24.0	22.4	13.5
4400.0	4.6	6.7	44.8	16.6	19.0	5.9	2.3
4450.0	16.5	6.0	32.6	18.1	15.8	7.7	3.3
4500.0	32.5	8.8	33.8	12.8	8.0	3.3	0.9
4650.0	37.7	27.9	22.7	5.6	3.4	2.5	0.2
4700.0	26.9	2.8	18.2	19.7	15.3	13.7	3.3
4800.0	23.4	29.1	36.2	6.0	3.4	1.6	0.2
4850.0	41.6	37.2	16.6	2.8	1.1	0.5	0.1
4970.0	17.1	57.3	19.0	4.0	1.7	0.8	0.1
5070.0	24.0	47.8	19.6	4.8	2.6	1.0	0.1
5075.0	22.3	48.3	20.9	4.9	2.4	1.0	0.1
5085.0	61.6	25.3	9.5	2.1	1.0	0.4	0.1
5095.0	26.8	40.4	21.5	6.1	3.5	1.4	0.3
5111.0	5.0	17.7	44.5	16.9	10.8	4.5	1.0

The contents are in µl/kg of rock

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PI.7

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

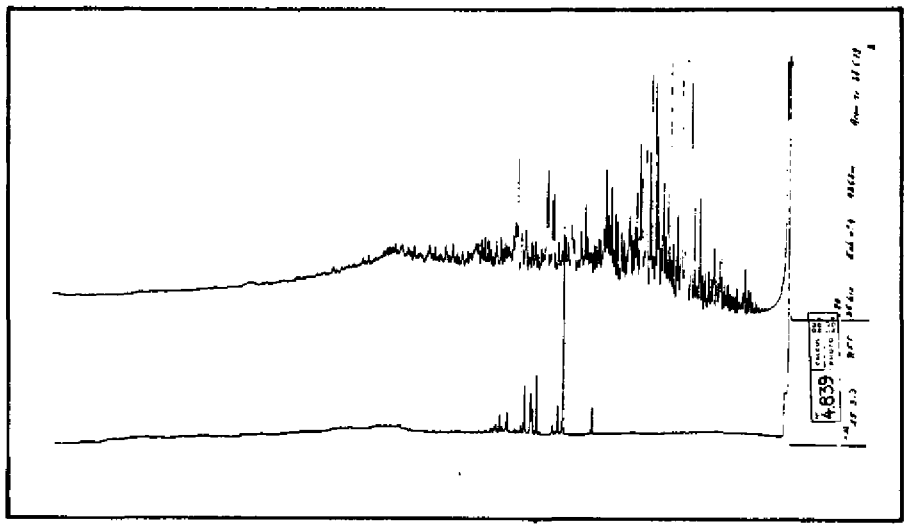
Huile *Oil*

Cote *Depth* : 4262 m

Identification *Identification* : RFT 26 bis

Formation *Formation* :

Age *Age* : CALLOVIAN

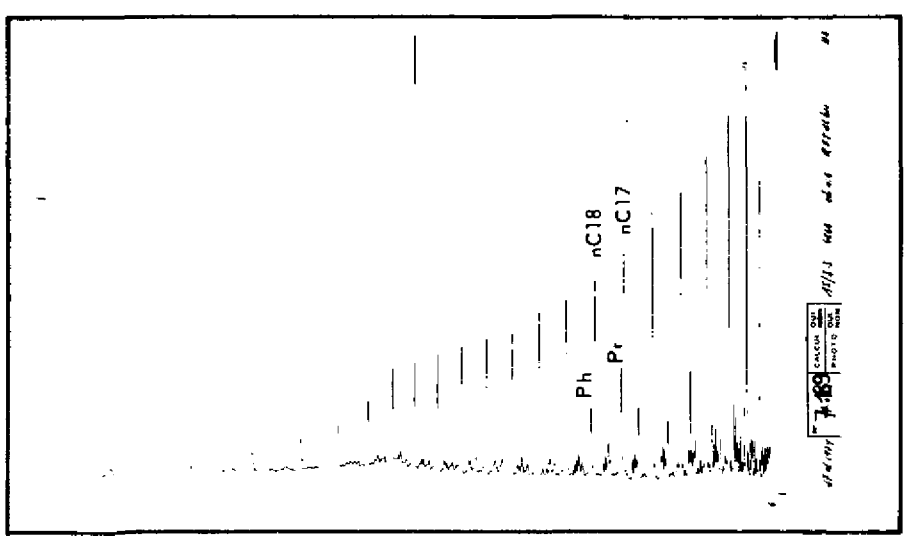


HC AROMATIQUES *AROMATIC HC*

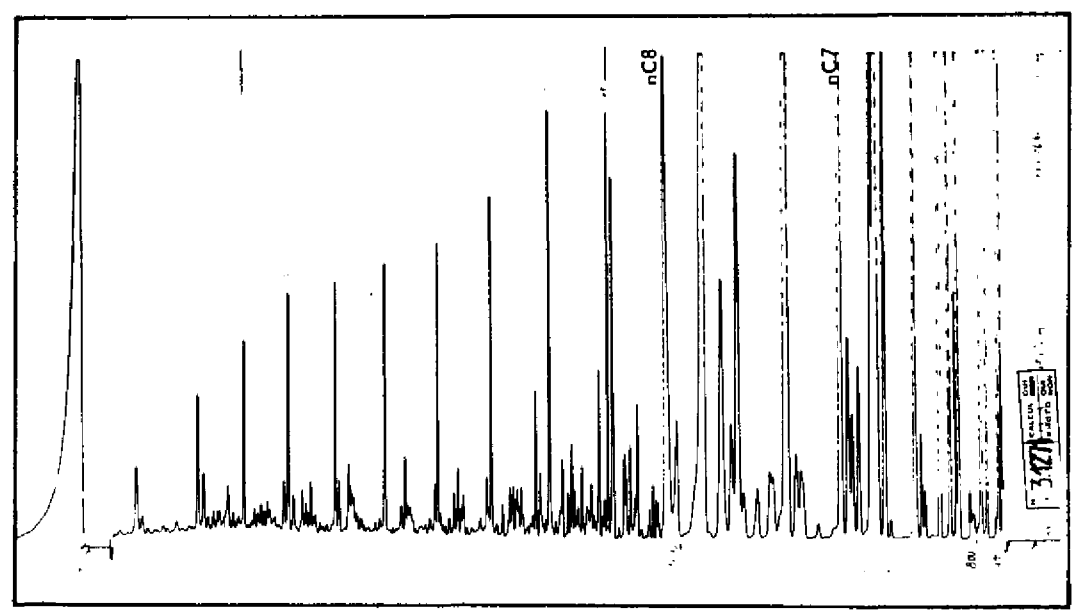
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	0.2
Résines *Resins*	R	:	1.9
HC saturés *Saturated HC*	S	:	41.6
HC aromatiques *Aromatic HC*	A	:	13.8
Distillat *Distillate*	D	:	42.4

$\frac{S}{A} = 3.01$



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC*

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PI.8

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

Condensat *Condensate*

Cote *Depth* : 4615-4632 m

Identification *Identification* : DST 2 bis

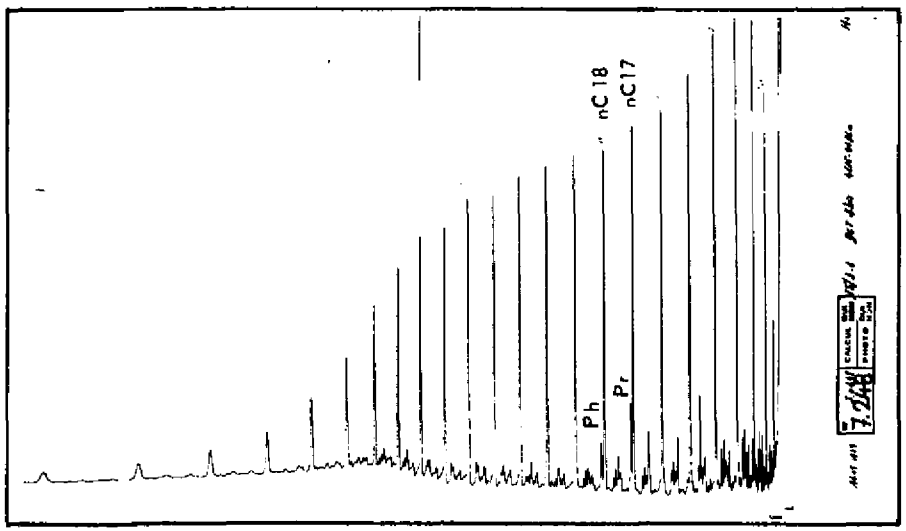
Formation *Formation* :

Age *Age* : BATHONIAN

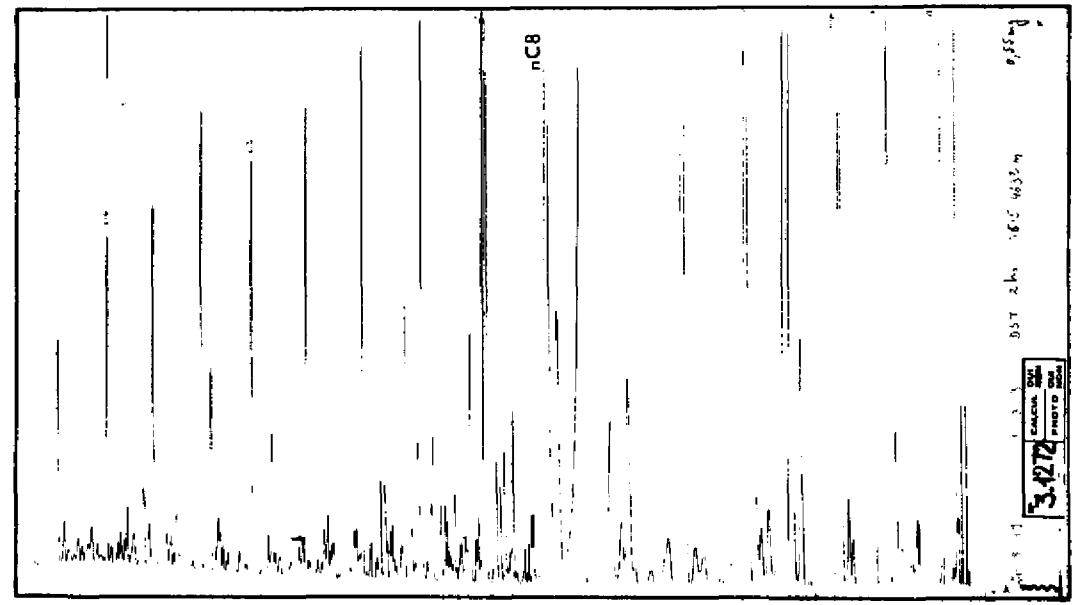
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:		
Résines *Resins*	R	:	1,8	
HC saturés *Saturated HC*	S	:	51.9	$\frac{S}{A} = 4.08$
HC aromatiques *Aromatic HC*	A	:	12.7	
Distillat *Distillate*	D	:	33.6	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC*

4020 bis

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PI.9

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

Roche *Rock*

Cote *Depth* : 4034 m

Identification *Identification* : SWC

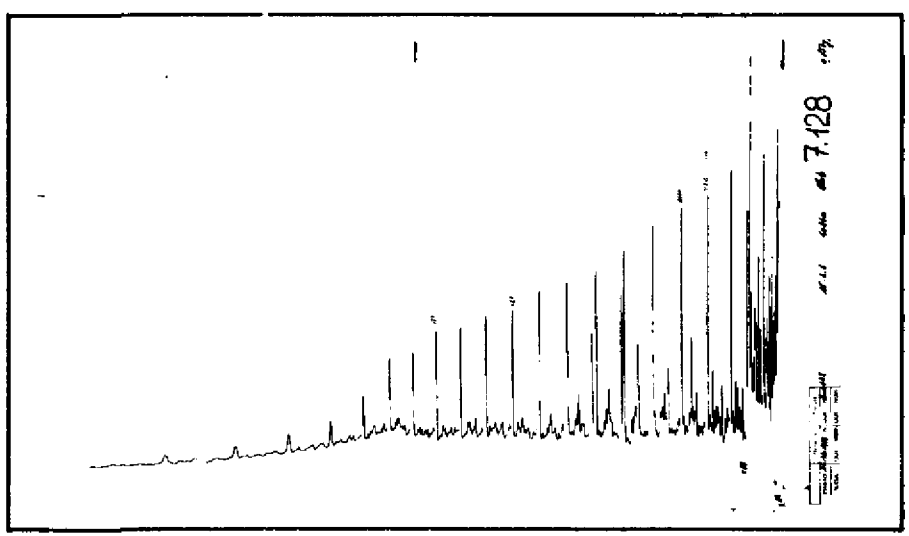
Formation *Formation* :

Age *Age* : PORTLANDIAN

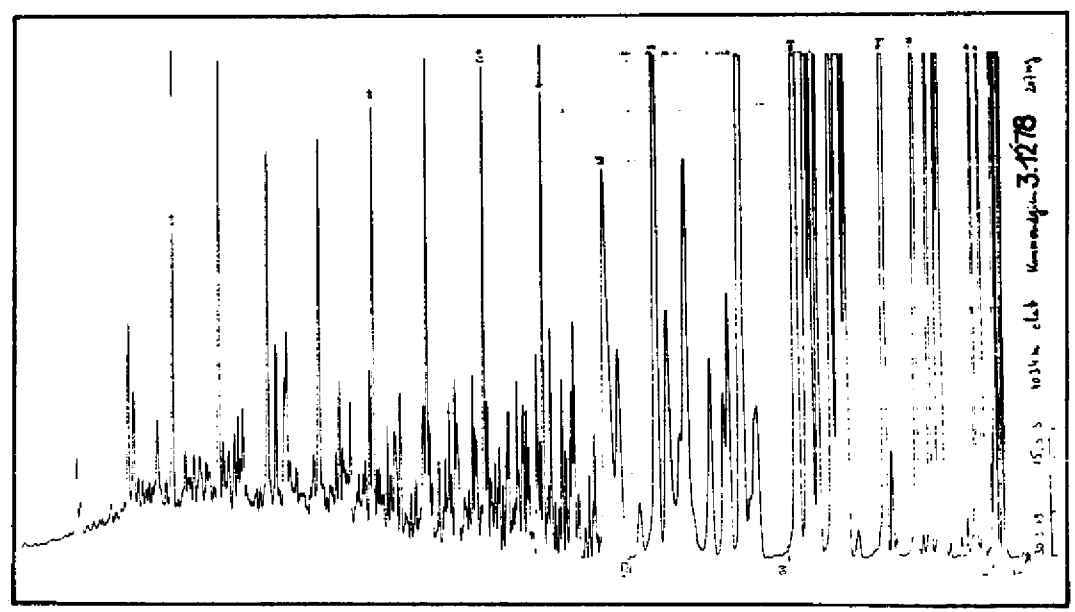
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	$\frac{S}{A}$
HC aromatiques *Aromatic HC*	A	:	
Distillat *Distillate*	D	:	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC*

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PI.10

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

Roche *Rock*

Cote *Depth* : 4150 m

Identification *Identification* : Cutting sample

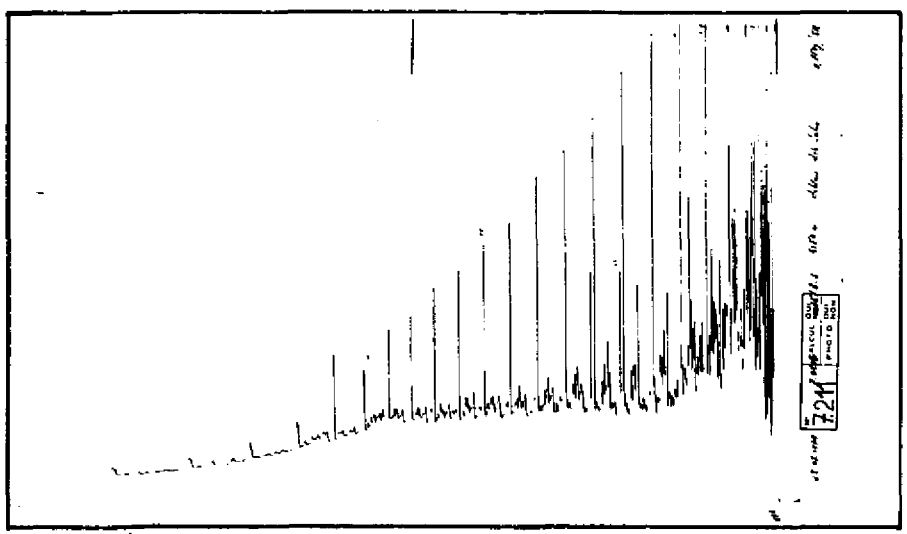
Formation *Formation* :

Age *Age* : KIMMERIDGIAN

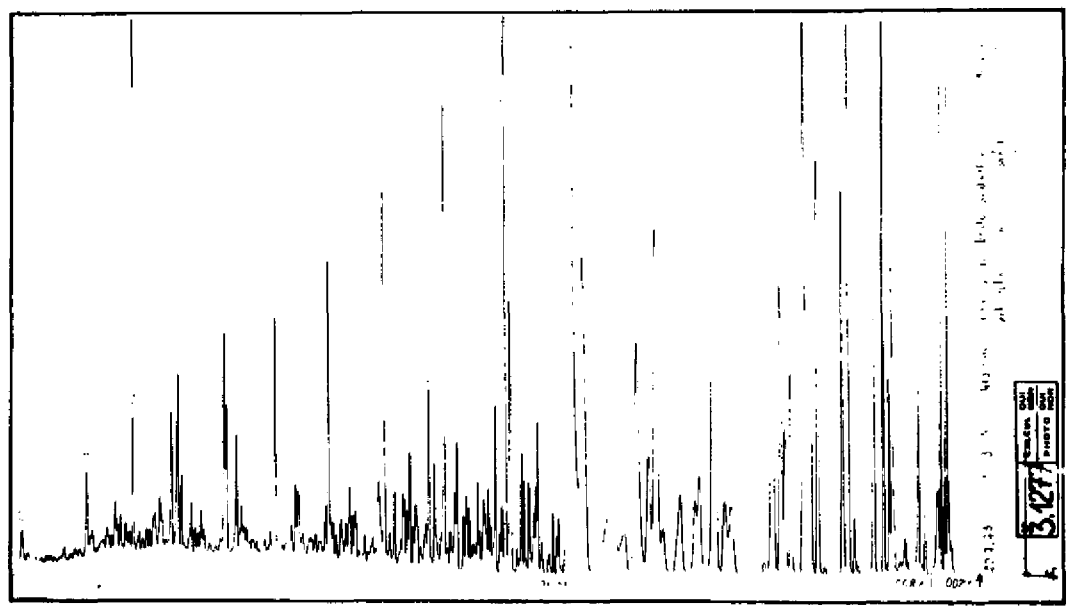
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	$\frac{S}{A}$ =
HC aromatiques *Aromatic HC*	A	:	
Distillat *Distillate*	D	:	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC*

4020 bis

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

Pl.11

Roche *Rock*

Cote *Depth* : 4380 m

Identification *Identification* : Cutting sample

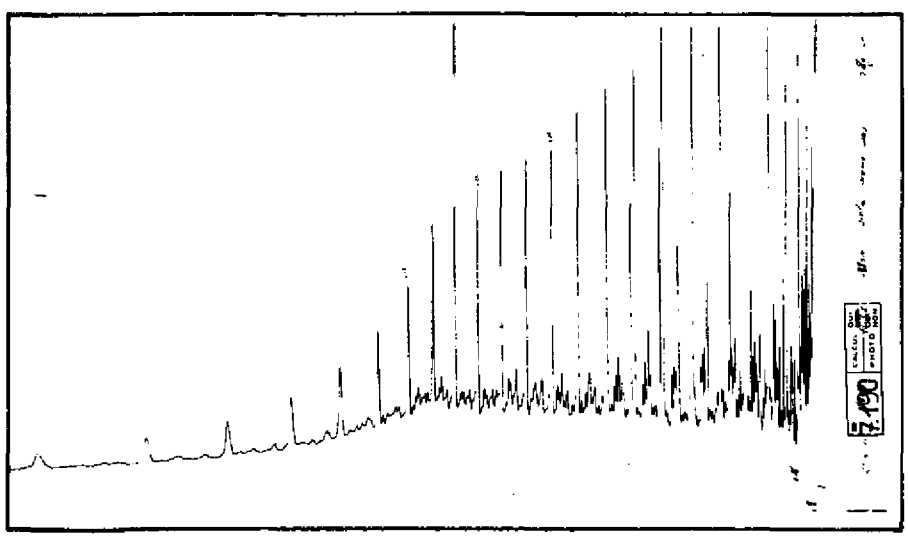
Formation *Formation* :

Age *Age* : CALLOVIAN

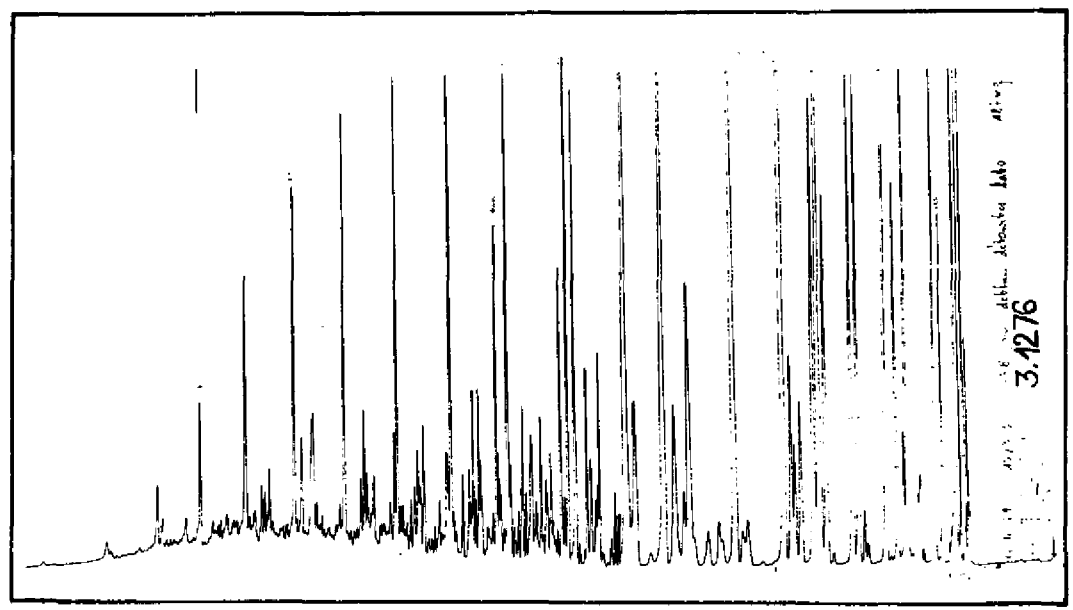
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	$\frac{S}{A}$ =
HC aromatiques *Aromatic HC*	A	:	
Distillat *Distillate*	D	:	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC*

4020 6is

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

PI.12

Roche *Rock*

Cote *Depth* : 4460 m

Identification *Identification* : SWC

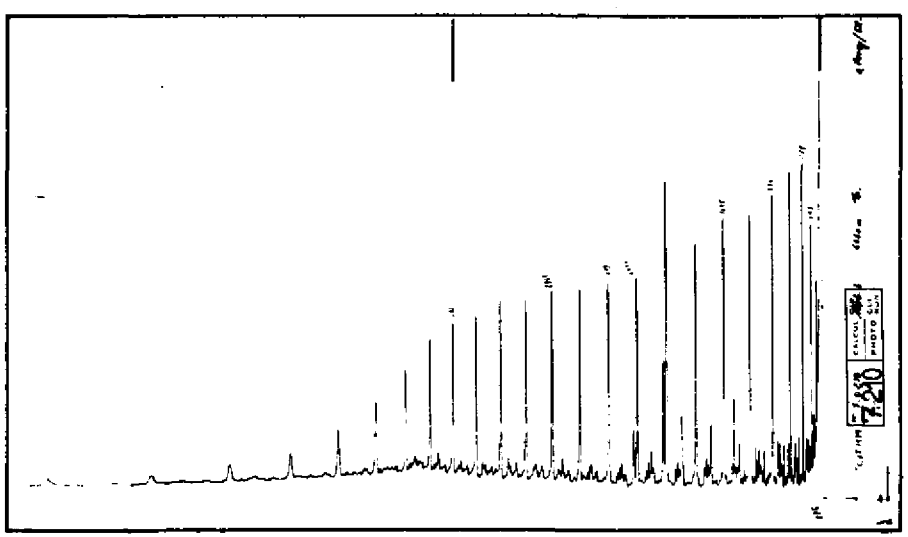
Formation *Formation* :

Age *Age* : CALLOVIAN

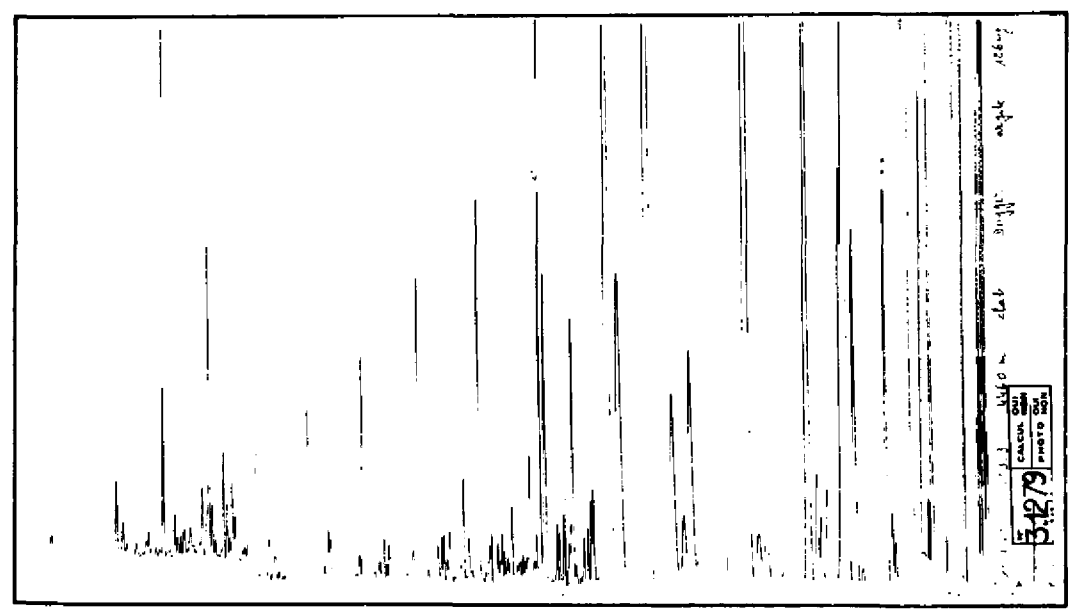
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	$\frac{S}{A} =$
HC aromatiques *Aromatic HC*	A	:	
Distillat *Distillate*	D	:	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC*

4020 bis

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS / *Country* : NORWAY

SONDAGE / *Well* : 15/3-3

Roche / *Rock*

Cote / *Depth* : 4562 m

Identification / *Identification* : Core n° 4

Formation / *Formation*

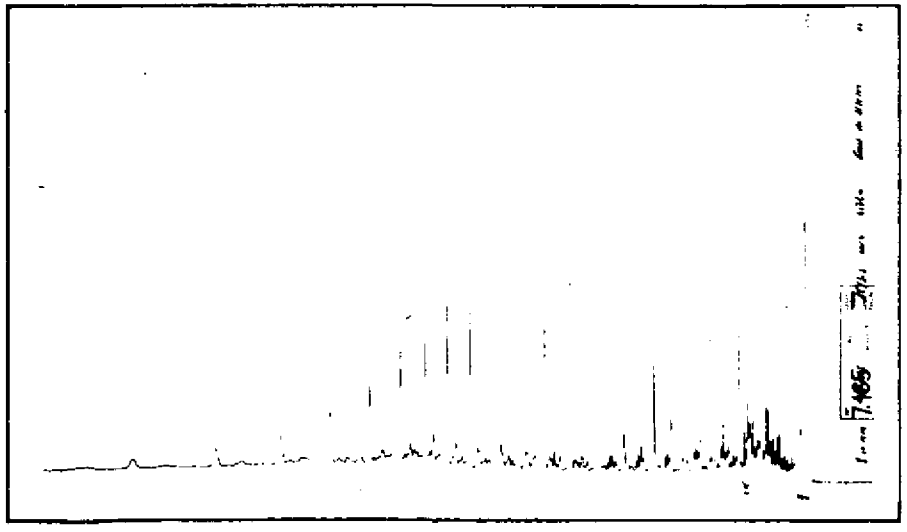
Age / *Age* : BATHONIAN

PI.13

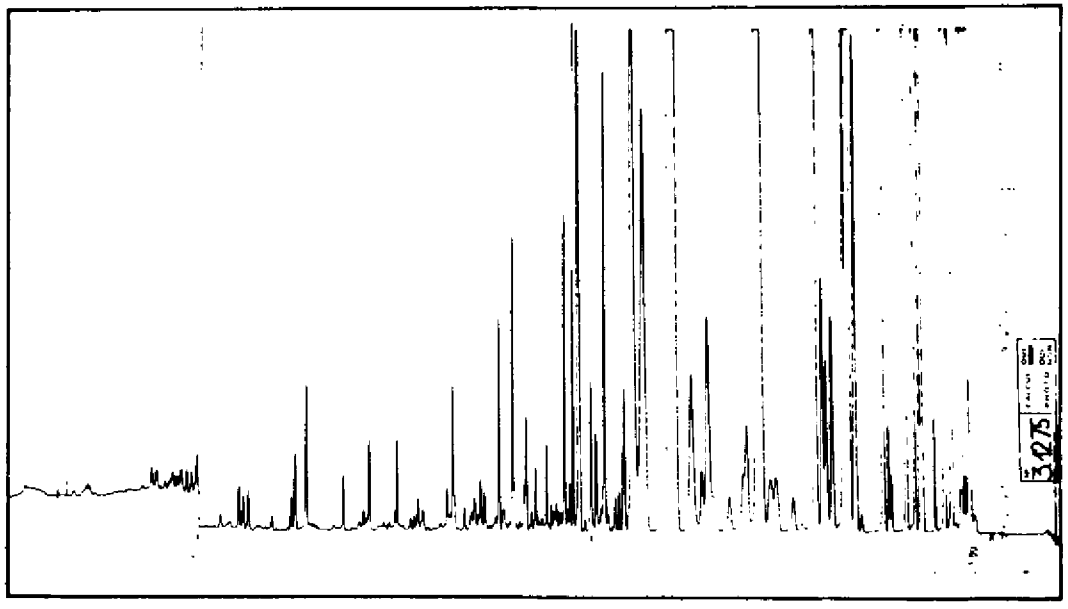
Composition du produit total (%)
Composition of total product

Asphaltènes / *Asphaltenes*	As	:	21,6	
Résines / *Resins*	R	:	22,5	
HC saturés / *Saturated HC*	S	:	25,0	$\frac{S}{A} = 0.8$
HC aromatiques / *Aromatic HC*	A	:	30,9	
Distillat / *Distillate*	D	:		

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC*

4020 bis

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

Pl.14

Cote *Depth* : 4650 m

Identification *Identification* : Cutting sample

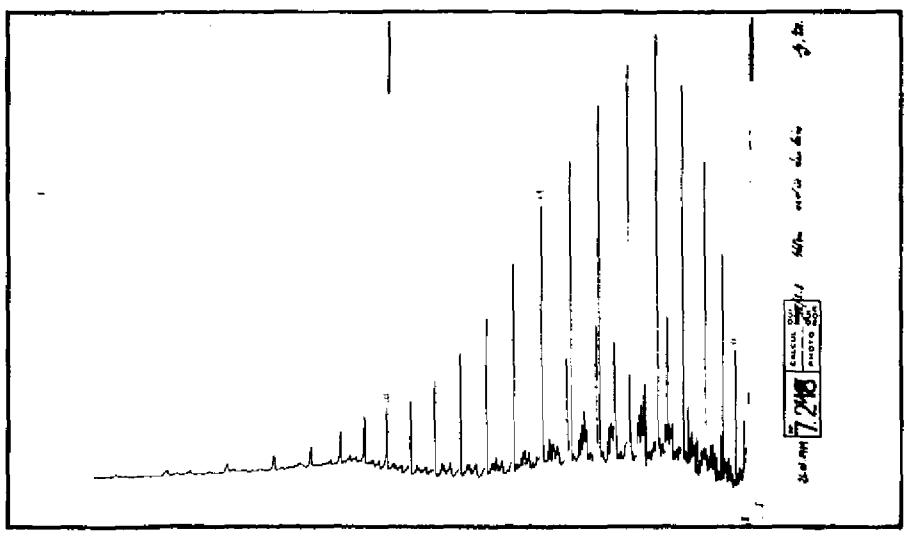
Roche *Rock* — Formation *Formation* :

Age *Age* : BATHONIAN

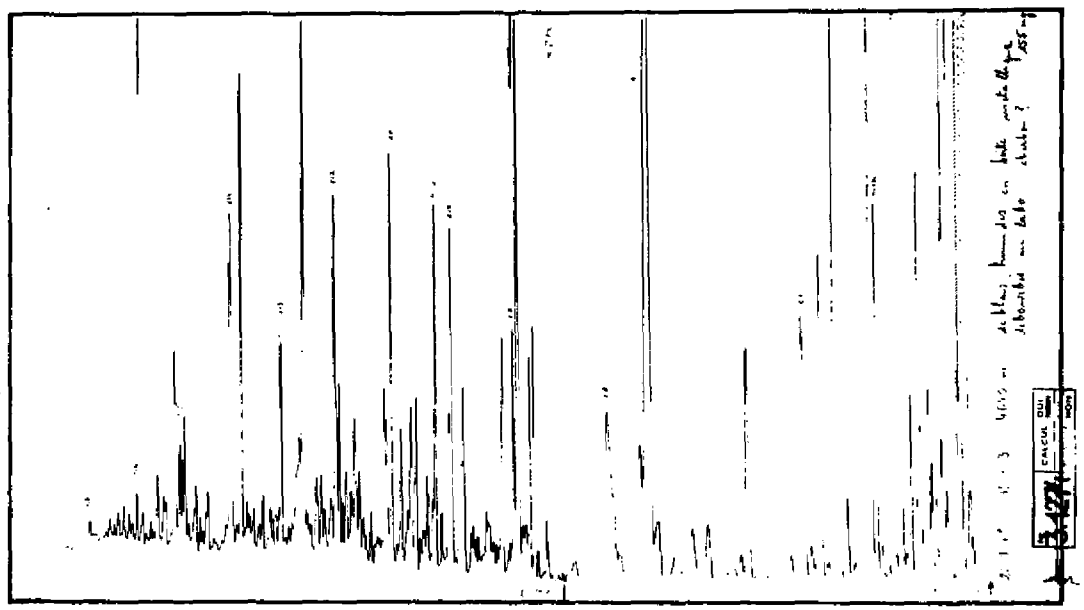
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	$\frac{S}{A}$ =
HC aromatiques *Aromatic HC*	A	:	
Distillat *Distillate*	D	:	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC*

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PI.15

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

Roche *Rock*

Cote *Depth* : 4750 m

Identification *Identification* : SWC

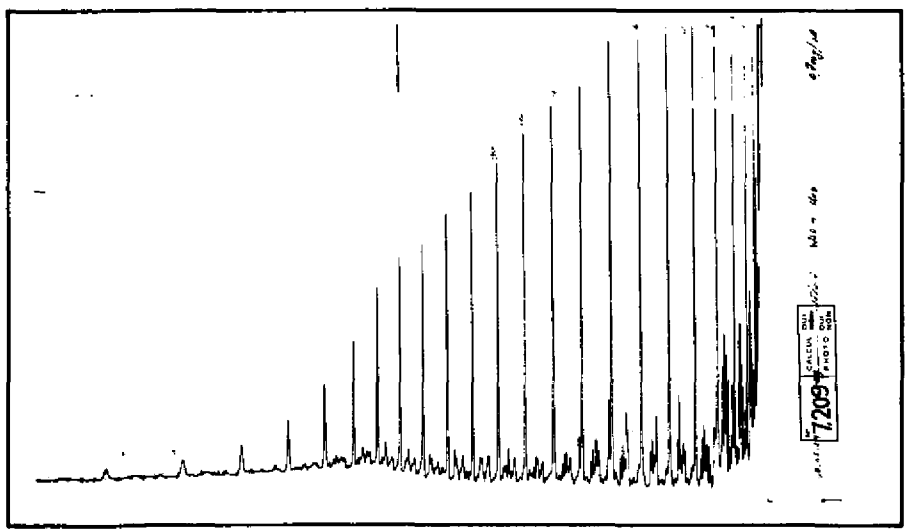
Formation *Formation* :

Age *Age* : BATHONIAN

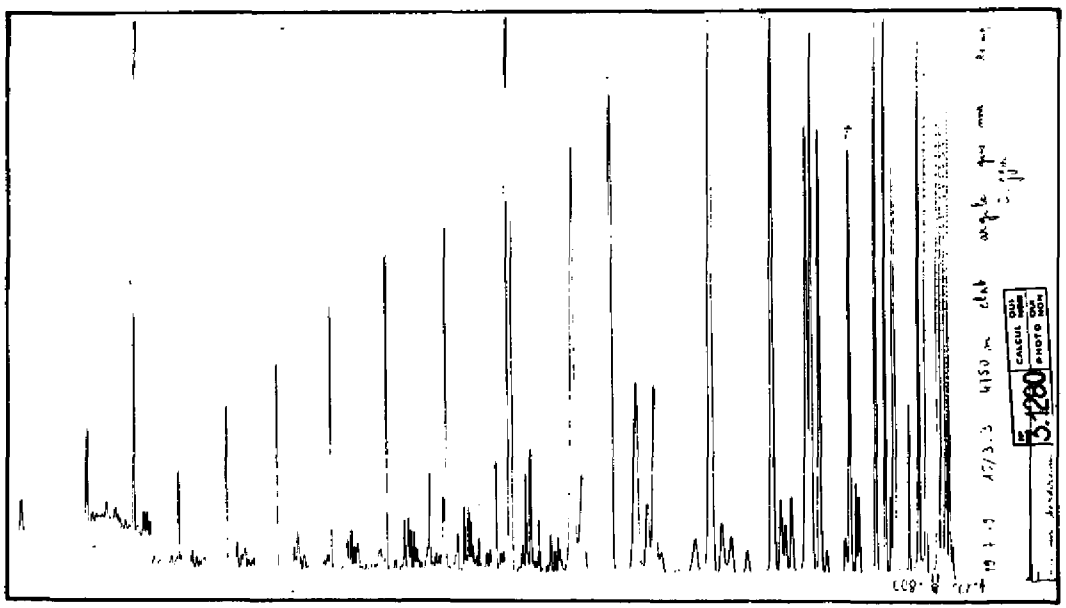
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	$\frac{S}{A}$ =
HC aromatiques *Aromatic HC*	A	:	
Distillat *Distillate*	D	:	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC.*



HC THERMOVAPORISES *THERMOVAPORIZED HC.*

4020 bis

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

P1.16

Roche *Rock*

Cote *Depth* : 4850 m

Identification *Identification* : Cutting sample

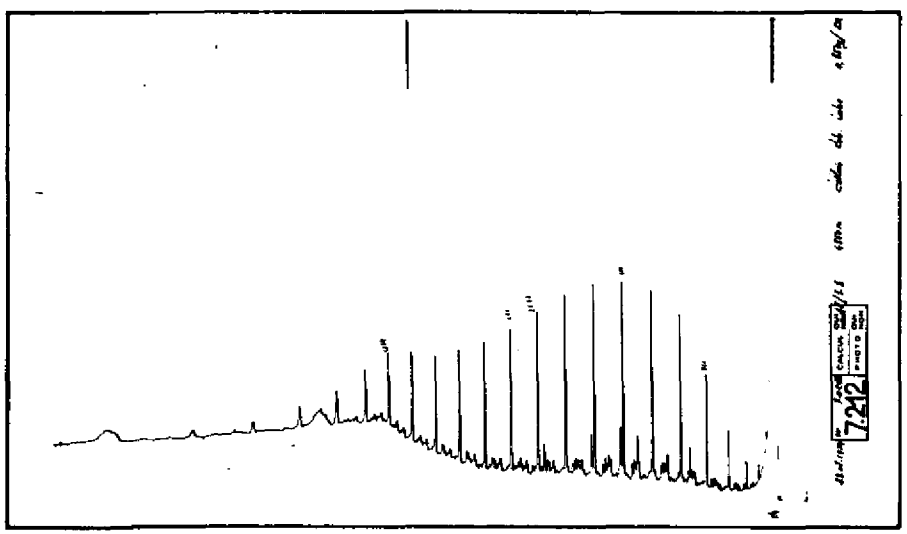
Formation *Formation*

Age *Age* : BATHONIAN

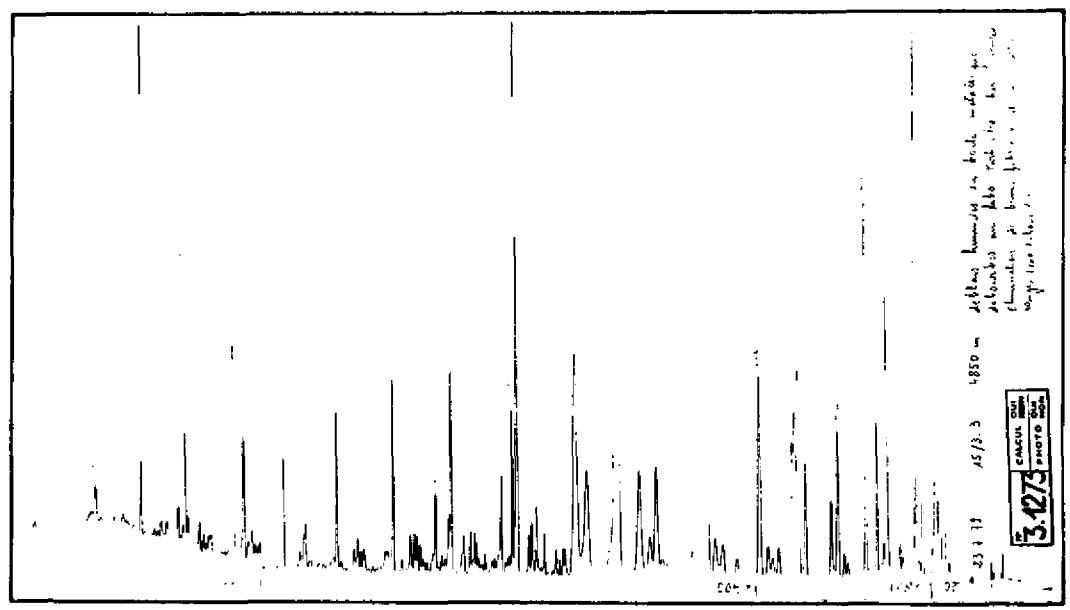
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	$\frac{S}{A}$ =
HC aromatiques *Aromatic HC*	A	:	
Distillat *Distillate*	D	:	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC.*



HC THERMOVAPORISES *THERMOVAPORIZED HC.*

4020 bis

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PL.17

PAYS *Country* : NORWAY

SONDAGE *Well* : 15/3-3

Roche *Rock*

Cote *Depth* : 5111 m

Identification *Identification* : Cutting sample

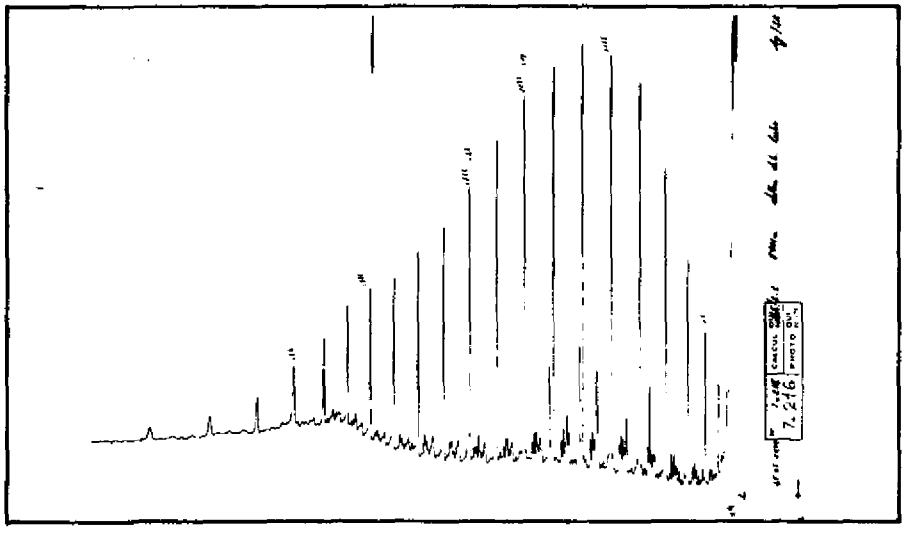
Formation *Formation* :

Age *Age* : LIAS

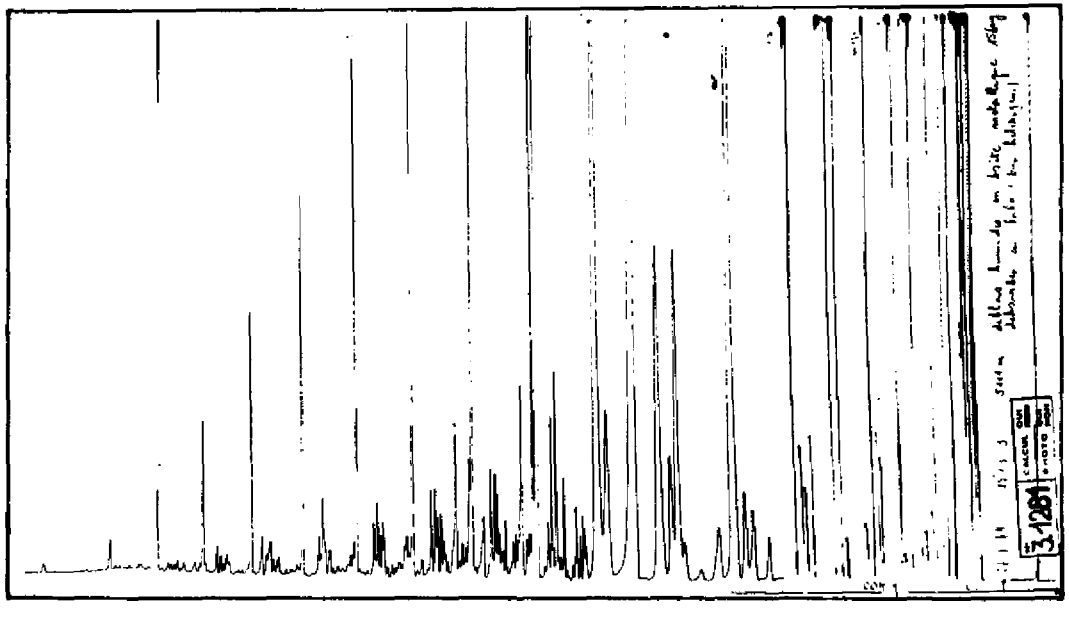
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	$\frac{S}{A}$ =
HC aromatiques *Aromatic HC*	A	:	
Distillat *Distillate*	D	:	

HC AROMATIQUES *AROMATIC HC*



HC SATURES *SATURATED HC*



HC THERMOVAPORISES *THERMOVAPORIZED HC.*