

SNEA (P)  
DIRECTION EXPLORATION  
LABORATOIRE DE GEOLOGIE DE BOUSSENS

GEO/LAB Bss n°9/1843 RP  
/eg

15/5-2 WELL  
(NORWAY)

ORGANIC MATTER STUDY

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P. ROBERT

Boussens - Décembre 1979

REFERENCE : ORDER n°031111

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" Well 15/5-2 (NORWAY) -

Biostratigraphical study of the Cretaceous and Jurassic series -  
(Interval 3490-4320 m) "

R. CUSSEY - J. FOSSAT - GEO/LAB Bss n°9/1826 RP

" 15/5-2 well (NORWAY) -

Sedimentological study of Jurassic deposits" -

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A B S T R A C T

Geochemical and optical studies carried out in the organic matter from the Jurassic interval (3765 to 4315 m) of 15/5-2 well show mainly that :

- the degree of catagenesis progressively increases from the beginning up to the second part of the main oil generation zone,
- the shales from the upper part of this interval (3765 to 4000 m) constitute good oil source rocks, with high potential above 3840 m and low potential from 3840 to 4000 m.

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This report present the geochemical and optical (reflected light and fluorescence) analyses carried out on the organic matter from 15/5-2 well (location map on plate 1) in the Jurassic interval, between 3765 and 4315 m. It takes into account the optical observations in transmitted light on palynological slides\*.

All the samples were cores or sidewall cores.

The main results are summarized on plate 5.

## 1 - CATAGENESIS DATA

### 1.1 - TRANSMITTED LIGHT STUDY

The Thermal Alteration Index (TAI) is estimated at :

- 3765 to 3900 m (Portlandian to upper Callovian)	2.5
- 3900 to 3985 m (Callovian)	2.5 - 3
- 3985 to 4070 m (Bathonian)	3

### 1.2 - REFLECTANCE AND FLUORESCENCE STUDY

12 samples have been studied : 8 sidewall core samples and 4 core samples (from cores n°1 and n°2) between 3765 and 4041.60 m (see plate 2 : Organic matter petrology).

Reflectant organic matter is rare in the section and consists of

- small vitrinite populations in the Oxfordian. Fluorescent vitrinite is present at 3827 m.
- Bitumens\*\* only in the Bathonian. Some rare bitumens are present in the upper Malm.

The only reliable results in vitrinite reflectance have been obtained in the Oxfordian -0.65 to 0.70 % Ro- ; on bitumens in the Bathonian the reflectance result 0.7 % is probably a little lower than the corresponding vitrinite.

In the upper Malm a population of unicellular algae, regularly yellow coloured is to be taken into account, with an equivalence of 0.55-0.60 % RoV.

Thus, the whole progression with depth may be presented, as follows (in RoV or equivalent) :

	<u>depth, m</u>	<u>% RoV</u>
Portlandian	3765	0.55-0.60 eq.
Kimmeridgian	3790	
Oxfordian	3827	0.65 RoV
	3868	0.70 Ro
Bathonian	4015	# 0.7-0.8 Ro
	4040	
		... / ...

\* J. DUCAZEAUX - P. DURIF - E. GROSDIDIER - GEC/LAB Bss n°9/1778 RP  
 "Well 15/5-2 - Biostratigraphical study of the Cretaceous and the Jurassic series (Interval 34690-4320 m)" -

\*\*An objective measurement test has been carried out on these samples, by means of microhardness (after a recent research survey on this subject) : the results obtained, (20 to 25 kg/mm<sup>2</sup>) fall perfectly into the bitumen range and not in the coal range -

### 1.3 - GEOCHEMICAL DATA

The maximum yield of pyrolysis temperatures ( $T_m$ , in table 1) increase with depths from 427°C in the Portlandian to 439°C in the Callovian.

Chromatographical analyses (thermovaporized fraction C5-C15, and saturated fraction C15-C30) carried out on a few selected samples, show that the  $X1(=nC6/MCP)$  and  $X2(=nC7/DMCP)$  ratios are  $< 2$  and  $< 5.5$  respectively, and the Pristane/ $nC17$  and Phytane/ $nC17$  are medium, suggesting a low degree of catagenesis.

### 1.4 - CATAGENESIS CONCLUSION

These corroborative data show that the whole of the studied section is in the first part of the main oil generation zone.

## 2 - ORGANIC MATTER CHARACTERISTICS - OIL POTENTIAL

### 2.1 - PALYNOFACIES\*

- 3705-3712 m (Aptian) : coaly-ligneous organic facies
- 3765 m (upper Portlandian) : typical amorphous sapropelic organic matter
- 3775-3790 m (lower Portlandian-upper Kimmeridgian) : typical sapropelic organic facies
- 3810-3827 m (lower Kimmeridgian-upper Oxfordian) : the opaque particles and the ligneous elements (black or structured) become predominant. Some amorphous organic matter is to be observed.
- 3842-3868 m (Oxfordian) : the organic facies is made up entirely of black and structured ligneous particles.
- 3875-3825 m (lower Oxfordian-upper Callovian) : numerous ligneous particles.
- 3900-3985 m (Callovian) : amorphous material is present throughout this interval, mixed with black particles and ligneous debris.
- 3988-4052 m (Bathonian) : ligneous debris and coaly particles predominate throughout this interval. Some vegetal debris occur in the core samples at 4015.25 and 4034.90 m. Amorphous organic matter has been recovered in moderate amounts at 4038 m.
- 4070-4315 m : The sidewall core samples are practically devoid of organic matter, the organic facies of the cutting is not significant.

... / ...

\* in biostratigraphical report already mentioned -

## 2.2 - ORGANIC FACIES IN FLUORESCENT LIGHT

Fluorescence examination shows the following main facies distinctions :

- 1 - the upper part of Portlandian-Kimmeridgian is made up of sapropelic groundmasses which are rich in alginite, with some algae tasmanaceae and spores.
- 2 - the lower Kimmeridgian-upper Oxfordian contain typical cannel-coal facies\* consisting of groundmasses and spores without any other exinites. Abundant oil generation is visible in veinlets, surface films (green fluorescence).
- 3 - the medium-lower Oxfordian and the only level studied in the Callovian contain a mixture of both facies 1 and 2, poorer in fluorescence though still rich in oil exsudates (including exsudatinite).
- 4 - the Bathonian is characterized by a typical pure humic groundmass, weakly fluorescent in grey-yellow, abundant but without exinite ; this matter is associated with solid bitumens.

## 2.3 - GEOCHEMICAL DATA (tables 1 and 2)

Geochemical analyses were carried out on 19 core or sidewall core samples, for organic inventory (Total Organic Carbon and pyrolyses) and chromatography.

- 2.3.1 - The Total Organic Carbon content (TOC) is medium to high in the upper Jurassic and the Callovian and low in the rest of the Dogger

3765 to 3995 m	1.55	< TOC	< 9.5 % of rock
below 3995 m	TOC	< 1 %	of rock

- 2.3.2 - Characteristics of syngenetical hydrocarbons (chromatograms plates 6 to 16)

The content of hydrocarbon extractables by heating (S1) and of hydrocarbon in the range C5-C15 (thermovaporized fraction) rapidly decreases in the Jurassic. The uppermost Jurassic (Portlandian + upper Kimmeridgian) hydrocarbons present a slight predominance of Pristane over Phytane (type 1), whereas, from 3827 m (in the lower Kimmeridgian) the hydrocarbons belong to type 2 : large predominance of Pristane over Phytane, down to the Bathonian.

This change, type 1 to type 2, correlates with the change observed in transmitted light (sapropelic to ligneous) and in fluorescence (sapropelic to typical "cannel coals").

The reservoir sandstones in Dogger (below 4000 m) are practically devoid of light hydrocarbons, and very poor in saturated ones.

- 2.3.3 - Petroligen potential of kerogen

The petroligen potential of kerogens is estimated by pyrolysis analysis (Rock-Eval).

Pyrolysis results are given in table 1 ; the hydrogen indices (HI) and oxygen indices (OI) are plotted in a diagram on plate 3.

... / ...

\* Such very pure spore cannel coal, although roughly belonging to humic and not sapropelic (algal) facies, can be distinguished from the common humic ones ; devoid of cutinites and other humic (secretion) exinites, it is an aquatic but not autochthonous product and its source rock properties are high.

The content of hydrocarbons produced by pyrolysis (S2) is :

- . relatively high in the uppermost Jurassic samples (3765 to 3827 m), the related HI are medium (between 250 and 350) and OI are low (< 20).
- . medium in Callovian and Oxfordian samples (3842 to 3955 m), HI are low to medium (between 75 and 160, except 295 for 3955 m sample) and OI low (< 30)
- . very low below 4000 m.

The kerogens of all the samples belong to the type II of TISSOT and al. (Pl.3).

#### 2.4 - CONCLUSIONS REGARDING OIL POTENTIAL

The uppermost Jurassic (3765-3830 m), with abundant organic matter of sapropelic and "cannel coal" facies, presents a high petroligen potential and constitutes good, but low mature, source rocks (Pl.5).

The Oxfordian and Callovian (3830 to 4000 m) with cannel coal facies, present low potential.



15/5-2 - TABLE 1 AND 2

GEOCHEMICAL RESULTS

TOC	Total Organic Carbon (% of rock)
S1	Hydrocarbons extractable by heating (mg HC/g of rock)
S2	Hydrocarbons produced by pyrolysis (mg HC/g of rock)
S3	CO <sub>2</sub> produced by pyrolysis (mg CO <sub>2</sub> /g of rock)
HI	Hydrogen Index (mg HC/gTOC)
OI	Oxygen index (mg CO <sub>2</sub> /g TOC)
Tm	Maximum yield of pyrolysis temperature (peak S2)
GC	Gas chromatography
TV	Hydrocarbons in the range C5-C14 (ppm)
Alk % TV	Percentage of n-Alkanes in the range C5-C14
X1	nC6/methylcyclopentane
X2	nC7/dimethylcyclopentane
Y1	nC7/Toluene
Alk ppm	n-Alkanes content in the range C15-C30 (ppm)
Pr, Ph	Pristane, Phytane

15/5-2 - TABLE 1 - GEOCHEMICAL RESULTS  
 ORGANIC CARBON CONTENTS AND ROCK EVAL RESULTS

Stratigraphy	n°	Depth m	TOC	S1	S2	S3	HI	OI	Tm	S1/TOC	GC table 2
Portlandian	1	3765	9.5	11.8	29.47	0.59	310	6	427	12.4	×
Low. Portlandian/ Up. Kimmeridgian	2	3790	8.1	9.6	22.51	1.34	278	16	428	11.8	
Low. Kimmeridgian	3	3810	3.65	3.49	12.07	0.37	331	10	430	9.6	
Up. Oxfordian	4	3827	5.3	3.13	13.53	0.38	255	7	428	5.9	×
Oxfordian	5	3842	1.55	0.42	2.21	0.29	138	18	433	2.7	
	6	3868	2.00	0.31	1.54	0.52	77	26	433	1.6	×
Low. Oxfordian	7	3875	2.20	0.43	2.13	0.49	97	22	435	1.9	
Up. Callovian	8	3885	2.60	0.69	2.71	0.54	104	21	435	2.6	
Callovian	9	3900	1.80	0.67	2.37	0.54	133	30	436	3.7	
	10	3935	4.80	1.28	7.49	0.43	156	9	437	2.7	×
	11	3955	2.80	1.63	8.27	0.32	295	12	439	5.8	
Bathonian	12	4014									×
	13(C1)	4015.25	0,70	0.23	1.15	0.30	162	42	445	3.3	×
	14(C2)	4040	**0.48								×
	15(C2)	4041,60									×
Dogger ?	16	4047.50									×
	17	4148.50									×
	18	4275									×
	19	* 4300.50	0.20	0.05	<0.01	0.60	< 5	302	-	2.5	×

Below 4000 m : Sandstones and Siltstones -

\* Red shale

\*\* Calculated TOC from  $\begin{cases} \text{IOC} = 0.25 \% \\ \text{EOM} = 2830 \text{ ppm} \end{cases}$

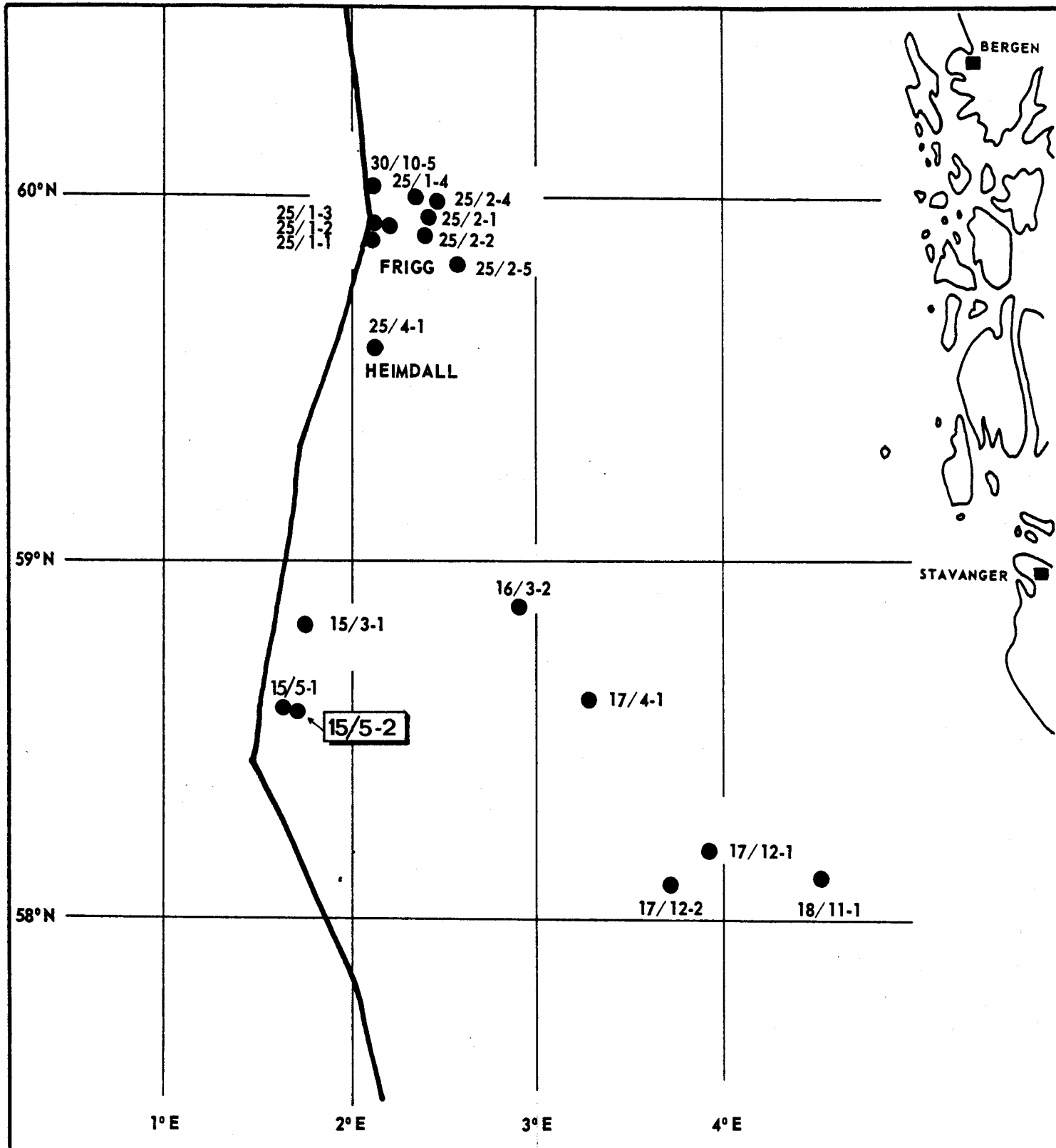
$$\text{with } (\text{TOC}) = (\text{IOC}) + 0.82 \times 10^{-4} \times (\text{EOM})$$

## 15/5-2 - TABLE 2 - GEOCHEMICAL RESULTS

## MAIN CHROMATOGRAPHICAL RESULTS

	n°	Depth m	TV ppm	Alk % TV	X1	X2	Y1	Alk ppm	Pr/nC17 A	Ph/nC18 B	A/B	C medium
Upper Jurassic	1	3765	2525	16	0.72	-	-	361	1.15	0.92	1.24	16
	2	3790										
	3	3810										
	4	3827	1200	24	0.91	1.65	0.95	178	1.50	0.73	2.04	18
	5	3742										
	6	3868	121	23	2.0	5.01	0.36	6	0.94	0.26	3.60	19
	7	3875										
	8	3885										
Callovian	9	3900										
	10	3935	396	23	1.34	2.43	0.53	70	2.30	0.41	5.59	22
	11	3955										
Bathonian	12	4014	10	17	-	-	-	25	1.19	0.29	4.06	22 ✓
	13	4015.25	89	14	1.75	2.38	-	18	0.76	0.16	4.70	22
	14	4040							0.63	0.36	1.76	21 ✓
	15	4041.60	136	12	1.89	5.28	-	48	0.91	0.33	2.75	19 ✓
	16	4047.50	12	29	-	-	-	46	0.69	0.68	1.02	17 ✓
Dogger	17	4148.50	0	0	-	-	-	0				
	18	4275	6	44	-	-	-	34	0.64	0.63	1.01	16 ✓
	19	4300.50	0	0	-	-	-	1	0.53	0.41	1.29	22

- non computable



**elf aquitaine**

Pays **NORWAY**  
 Permis ou concession

DIRECTION EXPLORATION  
 Date **Déc. 79**  
 Auteur **CRILLEAUX**  
 N° Classif **A 3904**

**PL. 1**

**15/5-2**  
**WELL LOCATION**

S: Sapropelic  
 H: Humic  
 C: Cannel coal facies

REFLECTANCE  
 (measurements)

□ Vitrinite  
 ▨ Bitumens

FLUORESCENCE  
 (global amount estimated)

■ Fluorescent macerals  
 ▨ Hydrocarbon traces in reservoirs  
 ▨ Mud products

Elf aquitaine

Pays: NORWAY  
 Permis ou concession

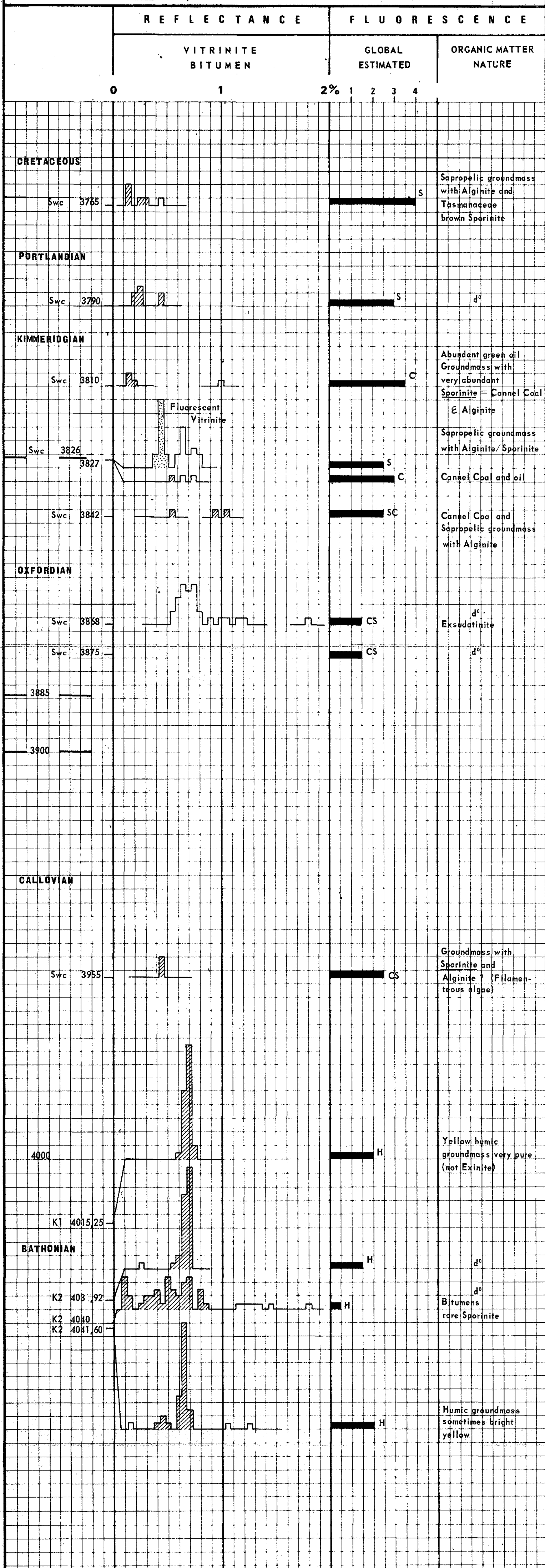
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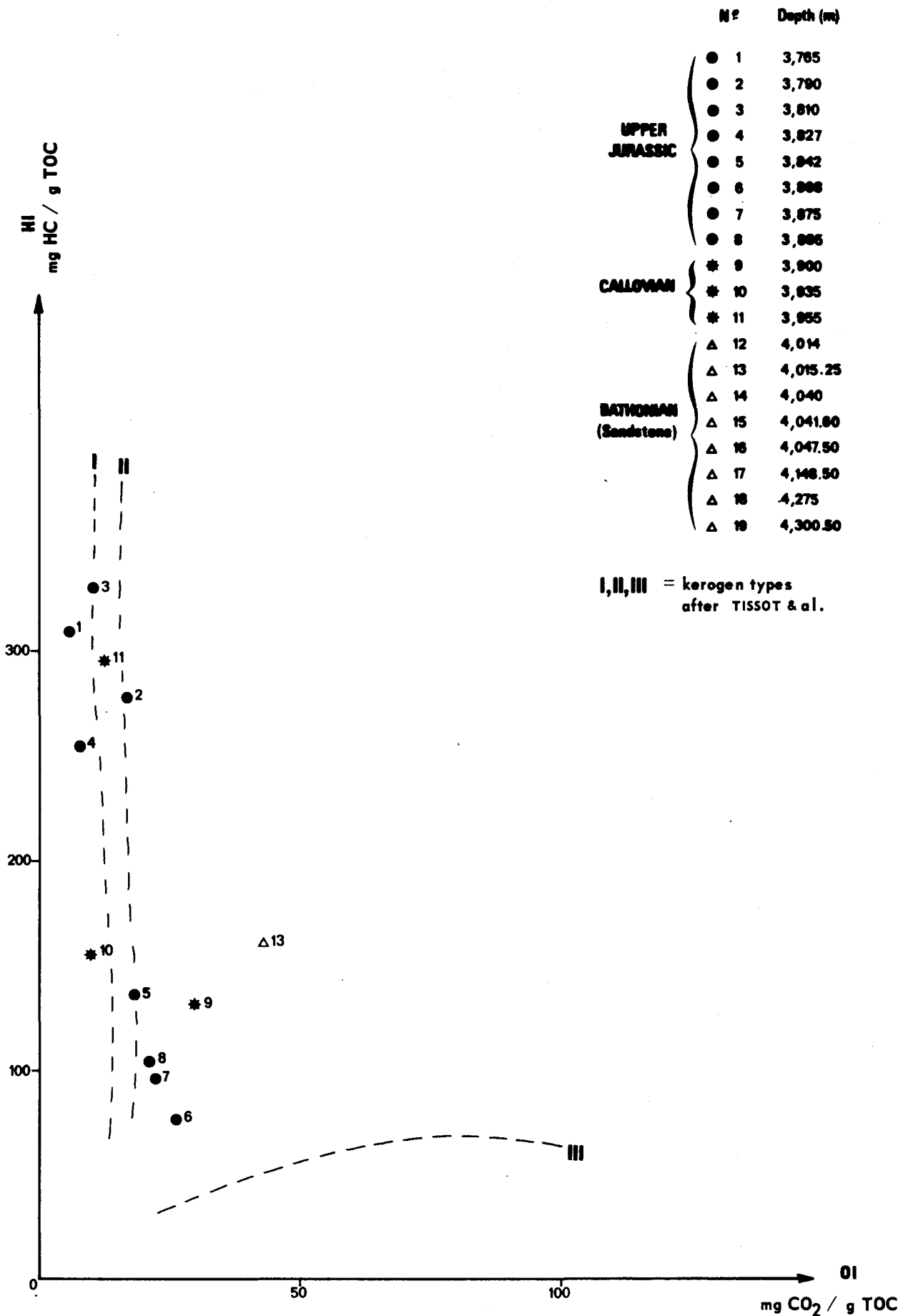
DIRECTION EXPLORATION

Date: Dec. 79  
 Auteur: P. ROBERT  
 No Class: C 3905

PL.2

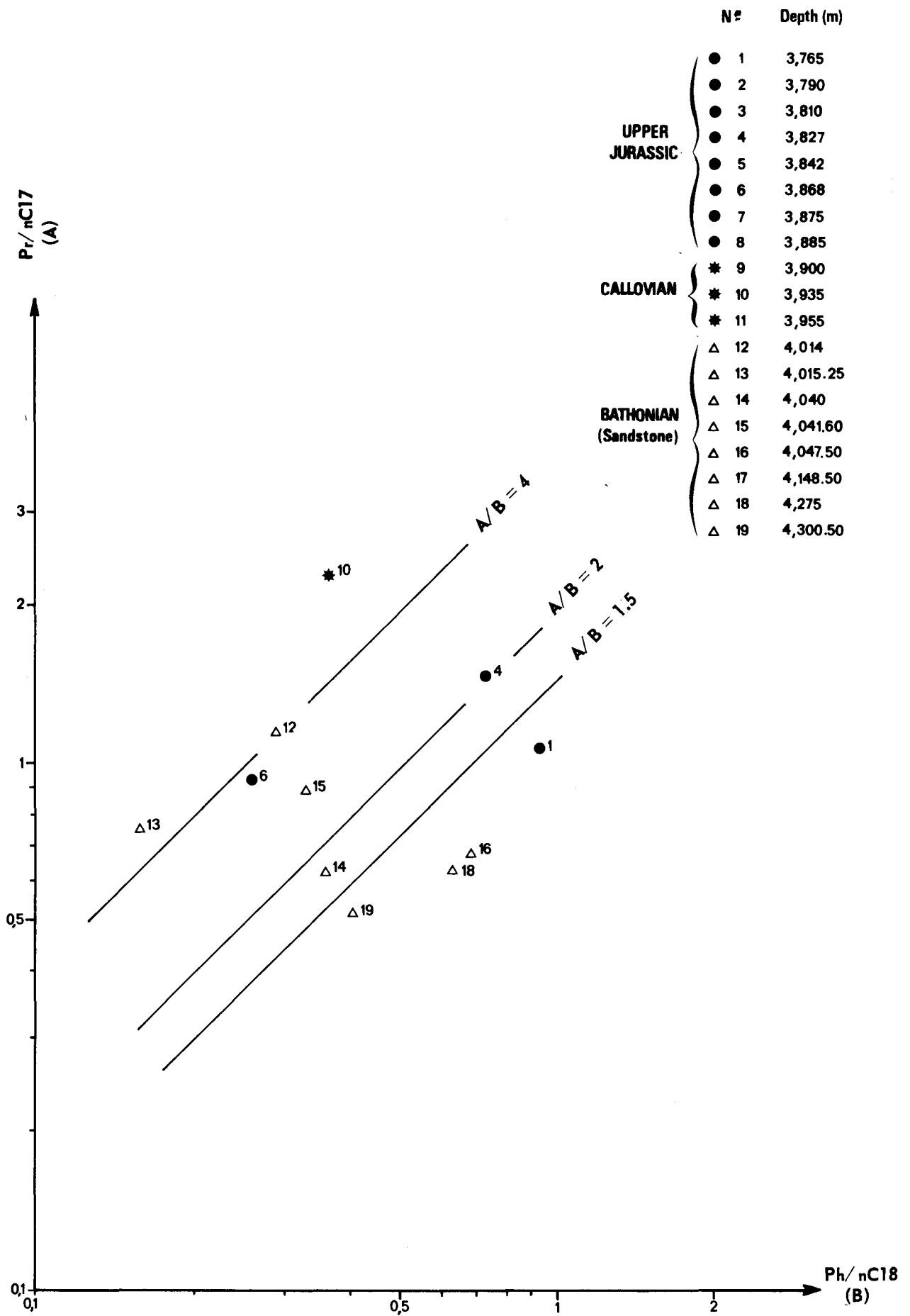
15/5-2  
 ORGANIC MATTER  
 PETROLOGY





PI.3 : 15/5-2 WELL - HYDROGEN INDEX - OXYGEN INDEX DIAGRAM

P. CAILLEAUX



PI.4 : 15/ 5-2 WELL - PRISTANE/ PHYTANE DIAGRAM

P. CAILLEAUX

Pr = Pristane  
Ph = Phytane



B.3908

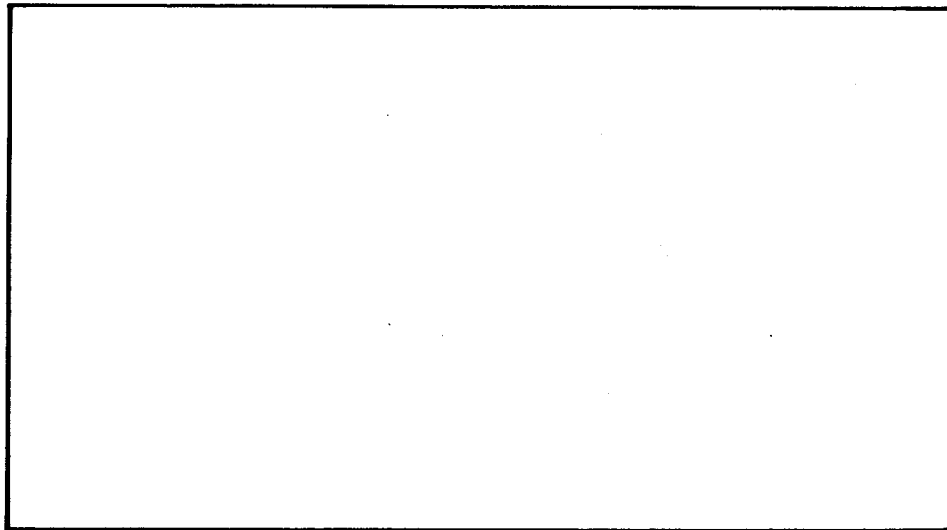


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PAYS NORWAY  
 Country  
 SONDAGE 15/5-2  
 Well

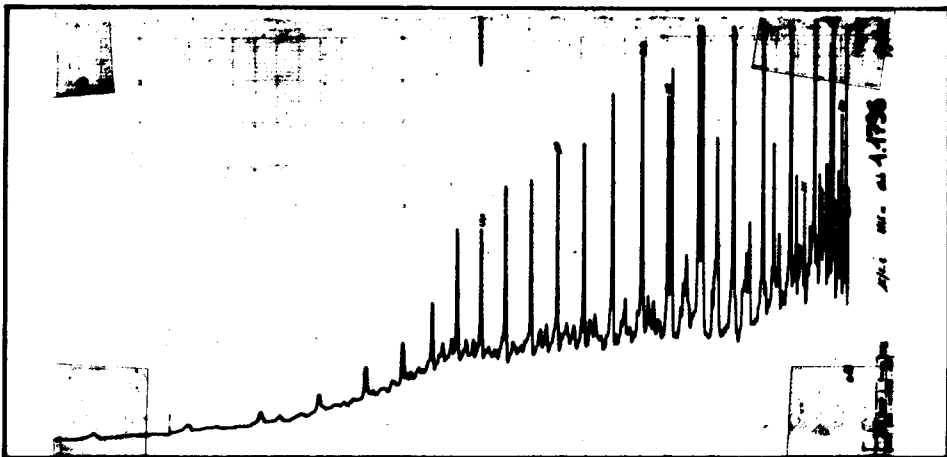
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Condensat Condensate	Identification Identification	Swc
Roche Rock	Formation Formation	PORTLANDIAN
	Age Age	



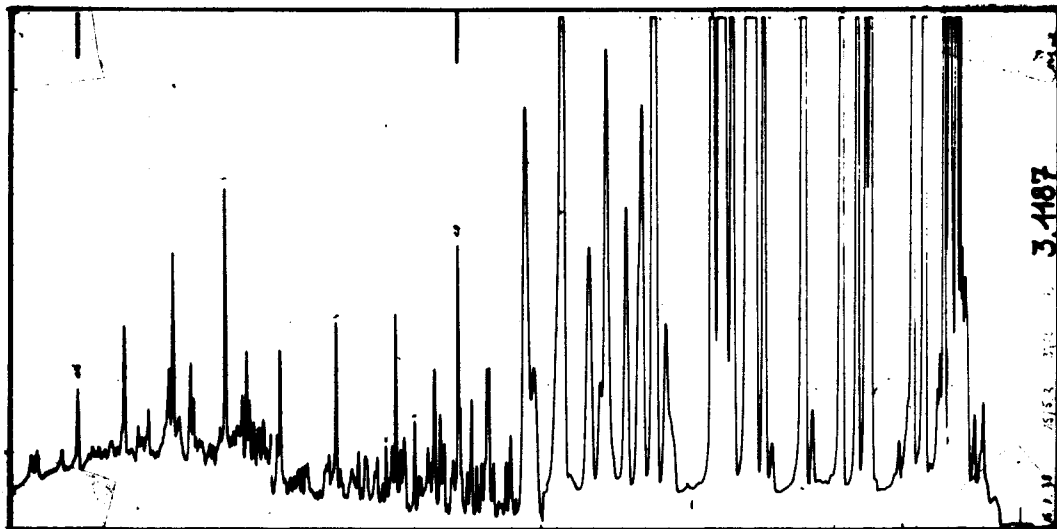
HC AROMATIQUES AROMATIC HC

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	:	A
Distillat Distillate	D	:	



HC SATURES SATURATED HC



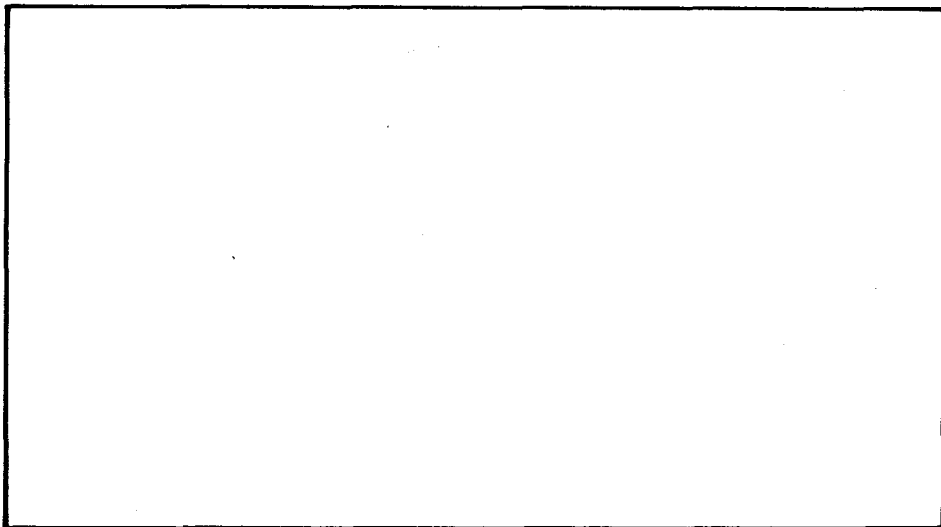
HC THERMOVAPORISES THERMOVAPORIZED HC

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PAYS **NORWAY**  
 Country  
 SONDRAGE **15/5-2**  
 Well

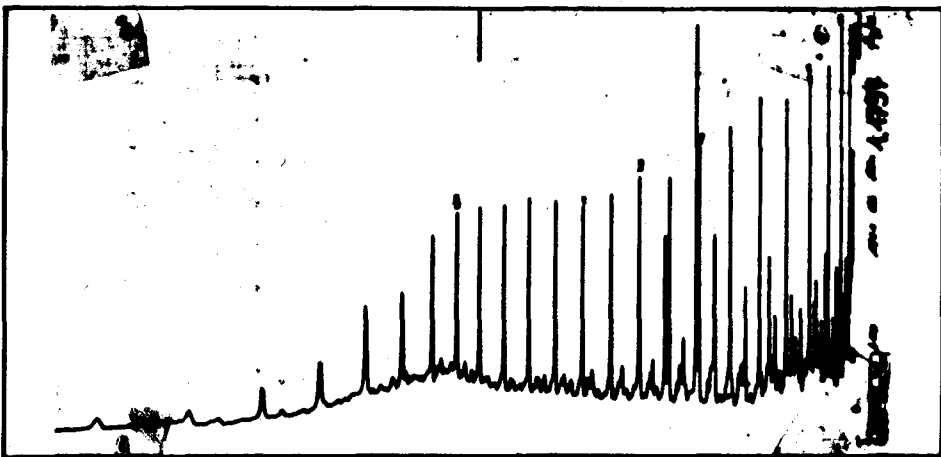
Huile <del>Oil</del>	Cote Depth	3827 m	PI.7
Condensat <del>Condensate</del>	Identification Identification	Swc	
Roche Rock	Formation Formation	LOWER KIMMERIDGIAN - UPPER OXFORDIAN	
	Age Age		



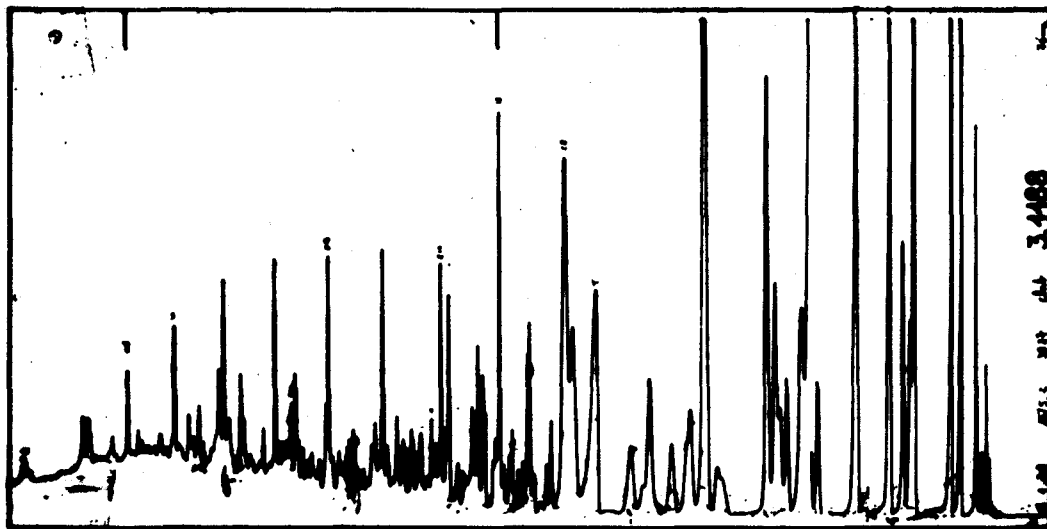
HC AROMATIQUES AROMATIC HC

Composition du produit total (%)  
 Composition of total product

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



HC SATURES SATURATED HC



HC THERMOVAPORISES THERMOVAPORIZED HC

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PAYS **NORWAY**  
Country

SONDAGE **15/5-2**  
Well

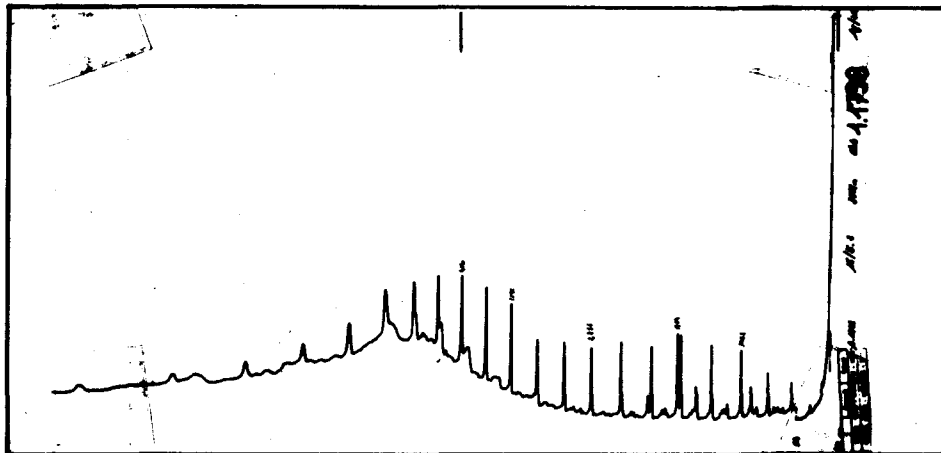
Huile **Oil**  
Cote **3868 m**  
Depth  
Condensat **Swc**  
Condensate Identification  
Roche **OXFORDIAN**  
Rock Formation  
Age

PI.8

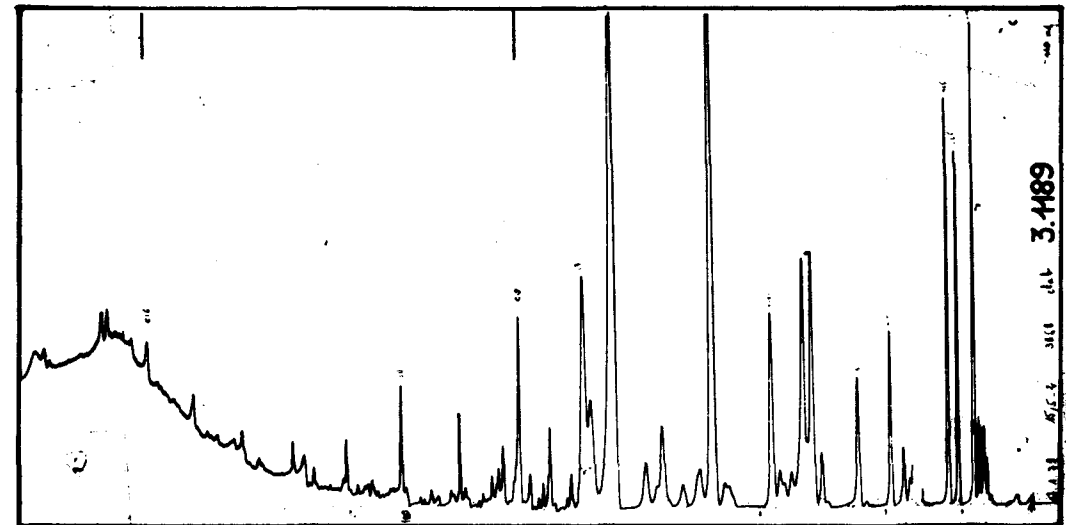
Composition du produit total (%)  
Composition of total product

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

HC AROMATIQUES AROMATIC HC



HC SATURES SATURATED HC



HC THERMOVAPORISES THERMOVAPORIZED HC

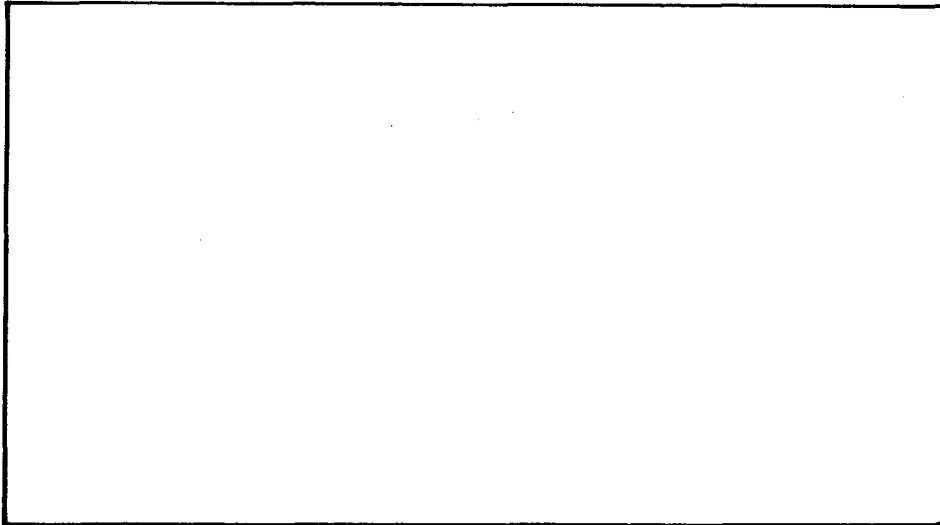
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PAYS **NORWAY**  
 Country  
 SONDAGE **15/5-2**  
 Well

Huile Oil	Cote Depth	3935 m	
Condensat Condensate	Identification Identification	Swc	
Roche Rock	Formation Formation		
	Age Age	<b>CALLOVIAN</b>	

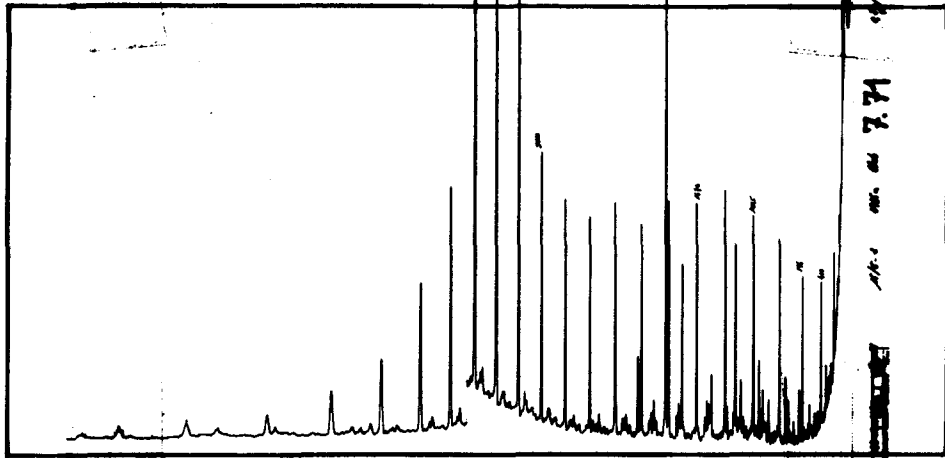
PI.9



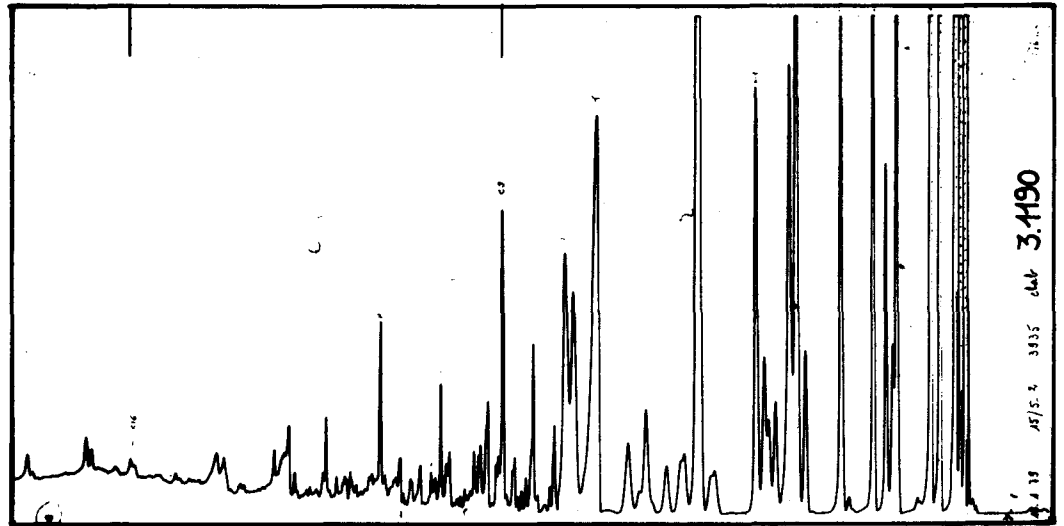
Composition du produit total (%)  
 Composition of total product

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

HC AROMATIQUES AROMATIC HC



HC SATURES SATURATED HC



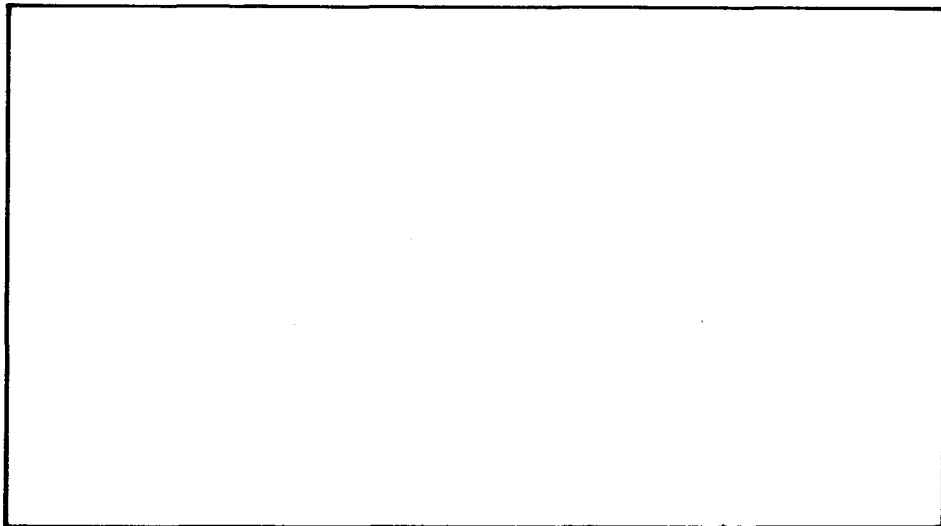
HC THERMOVAPORISES THERMOVAPORIZED HC

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PAYS **NORWAY**  
Country  
SONDAGE **15/5-2**  
Well

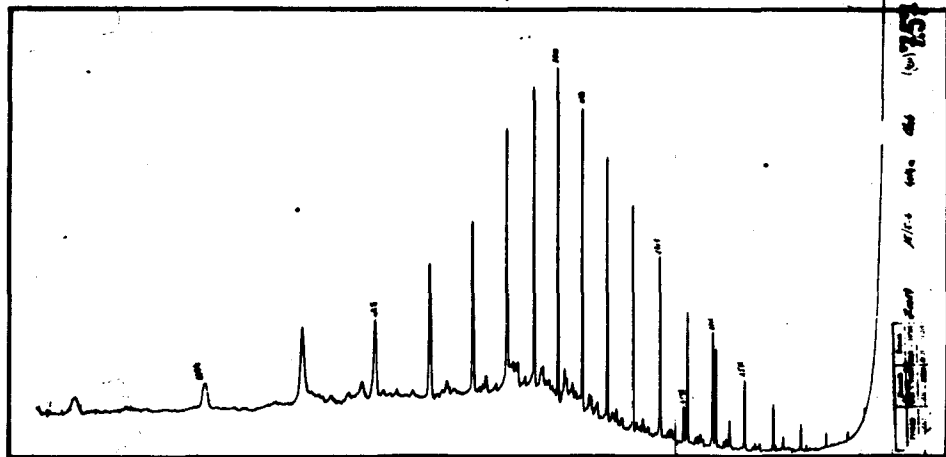
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<del>Condensat</del> <del>Condensate</del>	Identification Identification	Swc
<del>Roche</del> <del>Rock</del>	Formation Formation	
	Age Age	<b>BATHONIAN</b>



Composition du produit total (%)  
Composition of total product

Asphaltènes Asphaltenes	As	:	
Résines Resins	R	:	
HC saturés Saturated HC	S	:	S
HC aromatiques Aromatic HC	A	:	A
Distillat Distillate	D	:	

HC AROMATIQUES AROMATIC HC



HC SATURES SATURATED HC



HC THERMOVAPORISES THERMOVAPORIZED HC

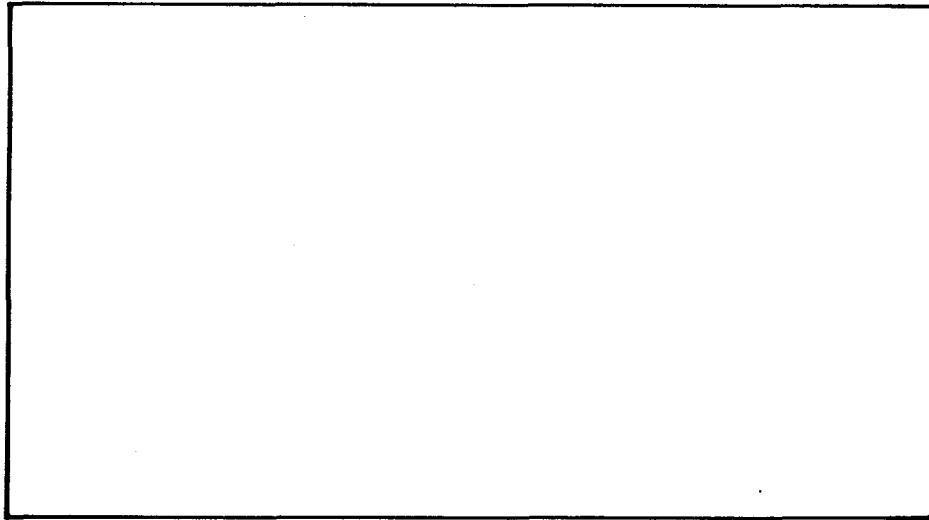
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PAYS **NORWAY**  
Country  
SONDAGE **15/5-2**  
Well

Huile **Oil**  
Cote **4015,25 m**  
Depth  
Condensat **Core 1**  
Condensate Identification  
Roche **BATHONIAN**  
Rock Formation  
Age

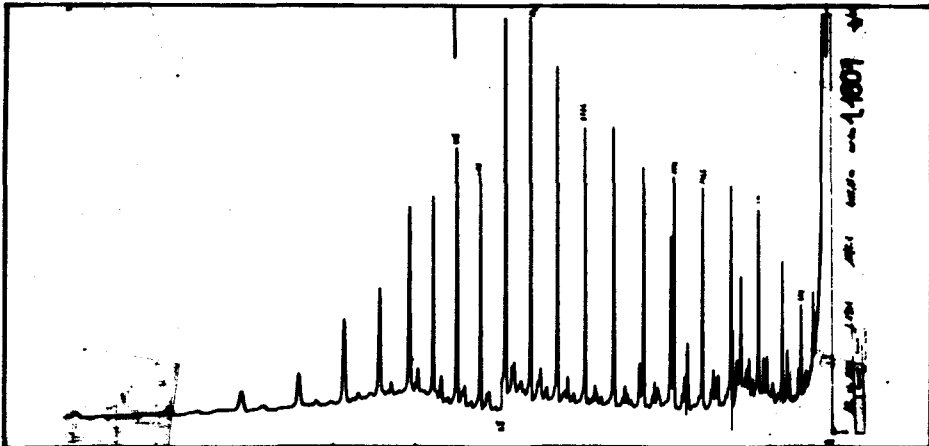
Pl.11



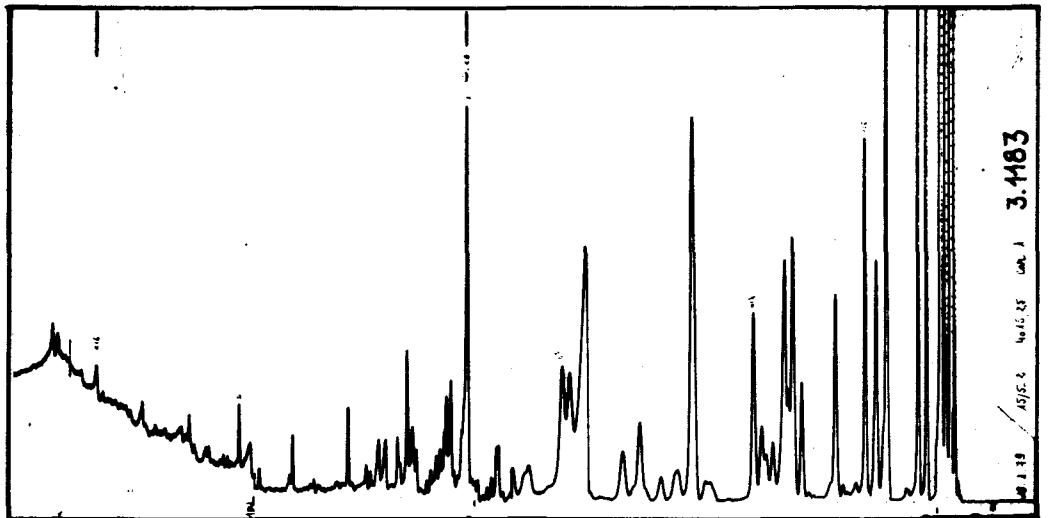
HC AROMATIQUES AROMATIC HC

Composition du produit total (%)  
Composition of total product

Asphaltènes As :  
Asphaltenes  
Résines R :  
Resins  
HC saturés S :  
Saturated HC S  
HC aromatiques A :  
Aromatic HC A  
Distillat D :  
Distillate



HC SATURES SATURATED HC



HC THERMOVAPORISES THERMOVAPORIZED HC

S. N. E. A. (P)

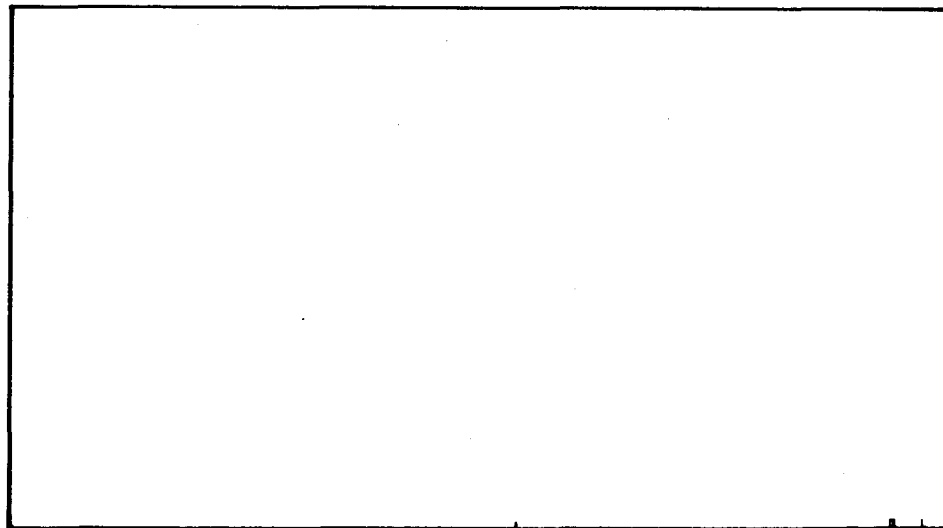
PL12

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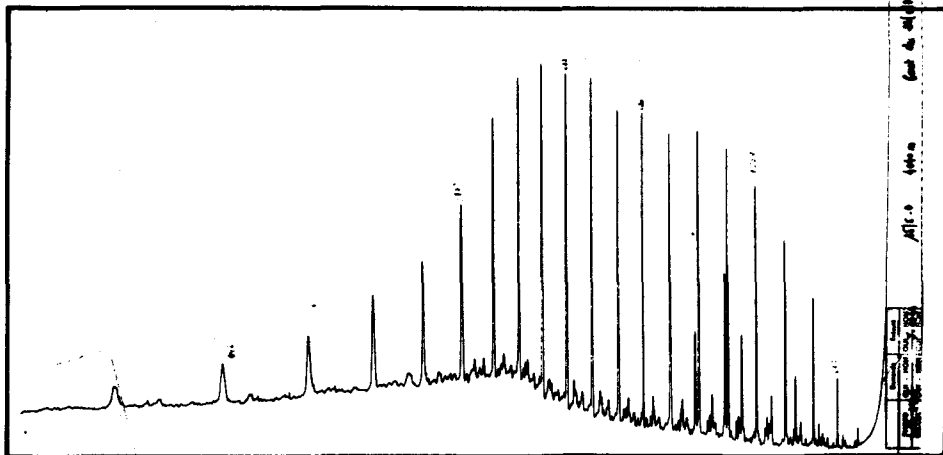
PAYS **NORWAY**  
Country

SONDAGE **15/5-2**  
Well

Huile <i>Oil</i>	Cote Depth	4040 m
Condensat Condensate	Identification	Core 2
Roche Rock	Formation Formation	Sandstone reservoir
	Age	BATHONIAN



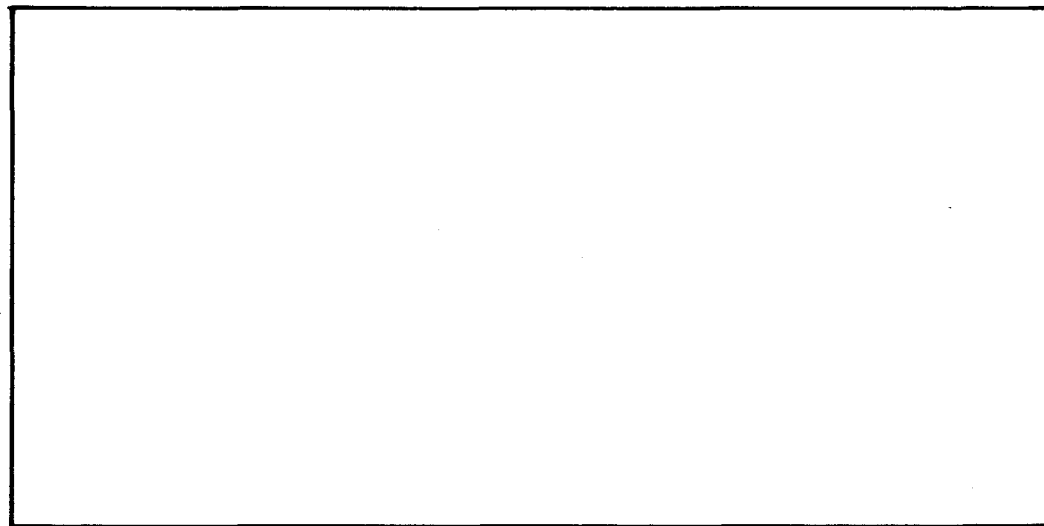
HC AROMATIQUES | AROMATIC HC



HC SATURES | SATURATED HC

Composition du produit total (%)  
Composition of total product

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



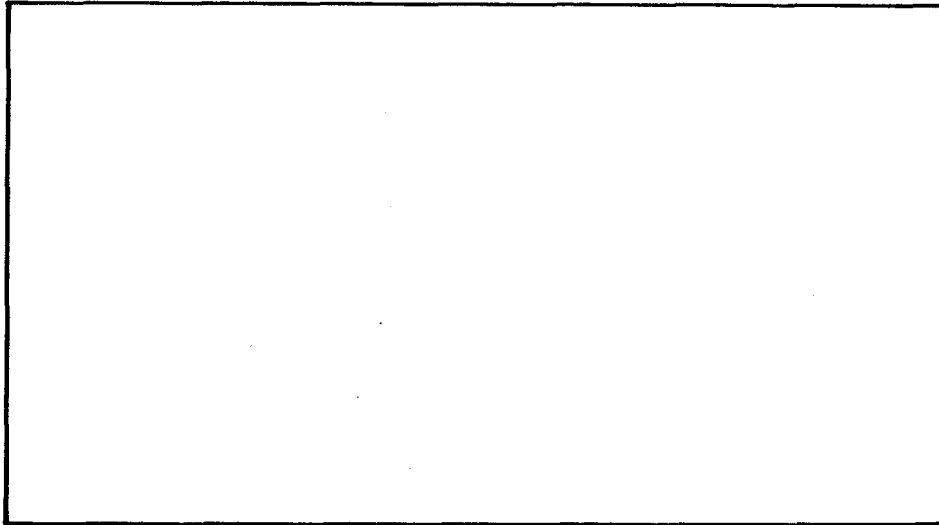
HC THERMOVAPORISES | THERMOVAPORIZED HC

S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS NORWAY  
Country  
SONDAGE 15/5-2  
Well

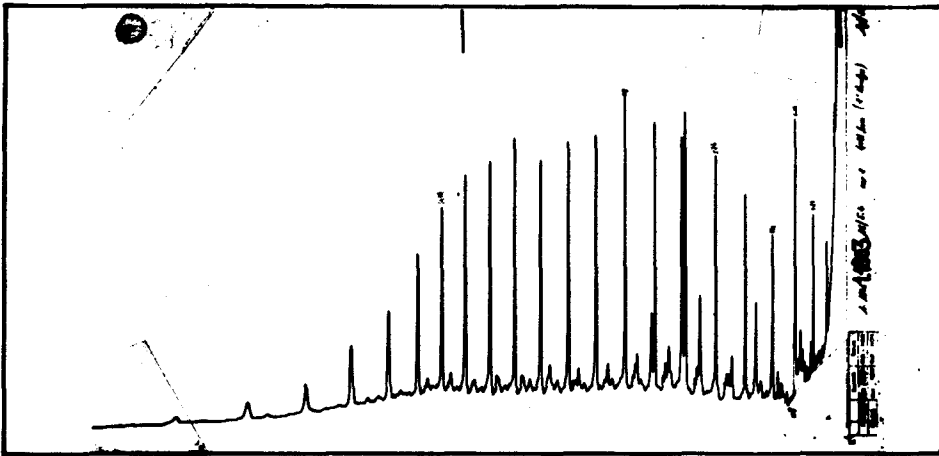
Huile Oil	Cote Depth	4041,60 m
Condensat Condensate	Identification Identification	Core 2
Roche Rock	Formation Formation	
	Age Age	BATHONIAN



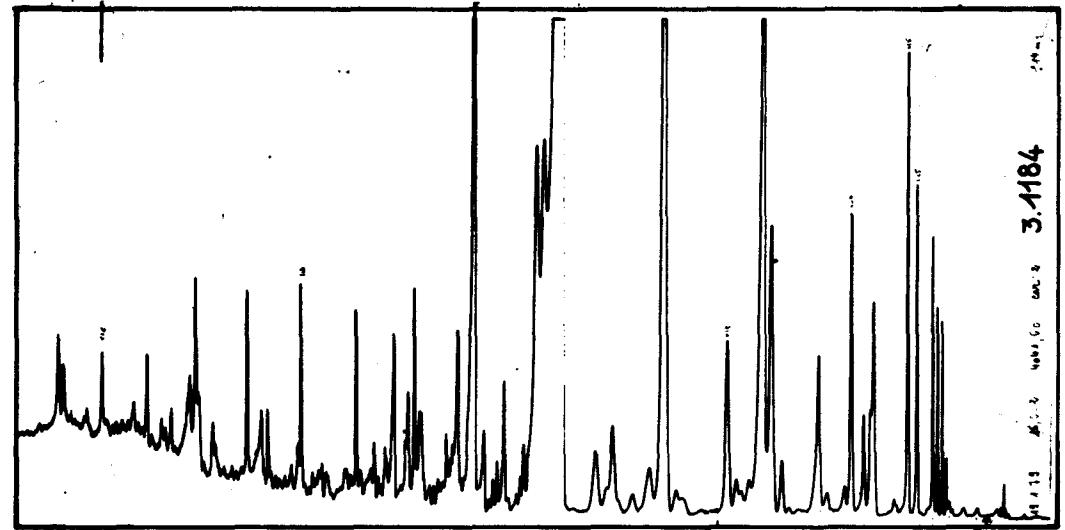
HC AROMATIQUES AROMATIC HC

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	:	$\frac{A}{S}$
Distillat Distillate	D	:	



HC SATURES SATURATED HC



HC THERMOVAPORISES THERMOVAPORIZED HC



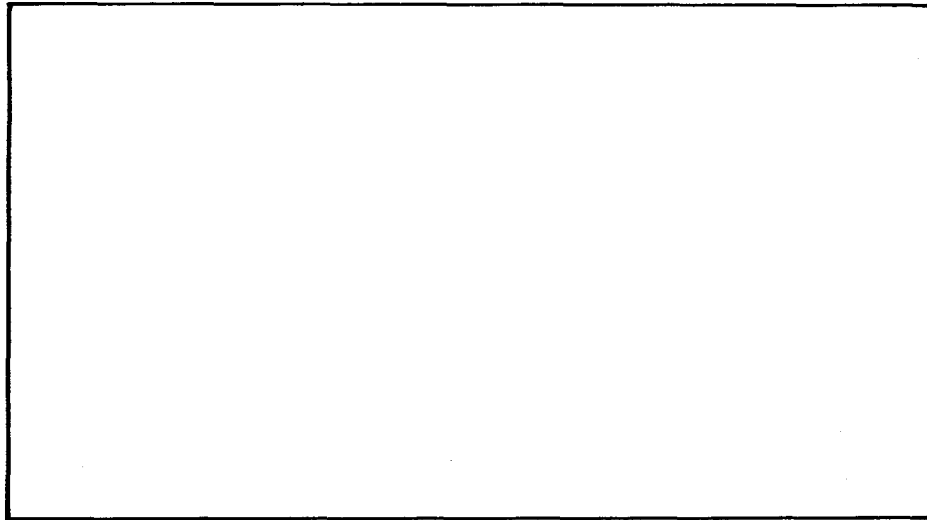
S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS **NORWAY**  
Country  
SONDAGE **15/5-2**  
Well

Huile Oil	Cote Depth	4047,50 m
Condensat Condensate	Identification Identification	Swc
Roche Rock	Formation Formation	
	Age Age	BATHONIAN

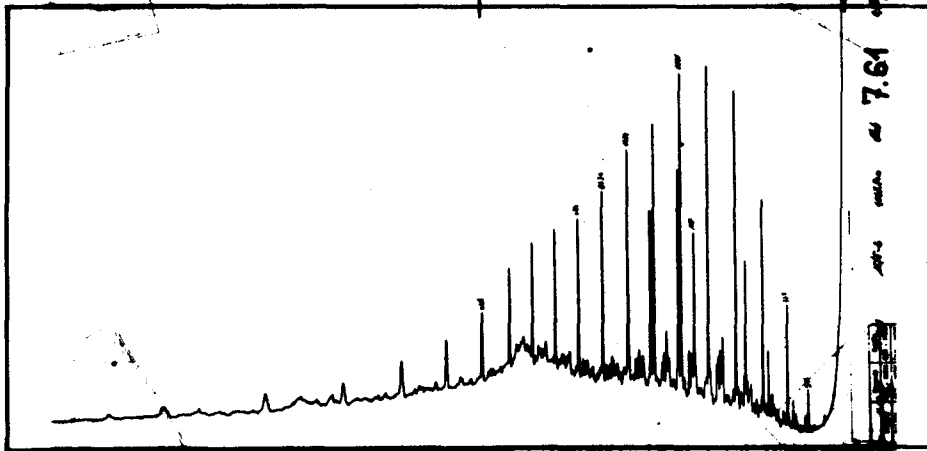
PI.14



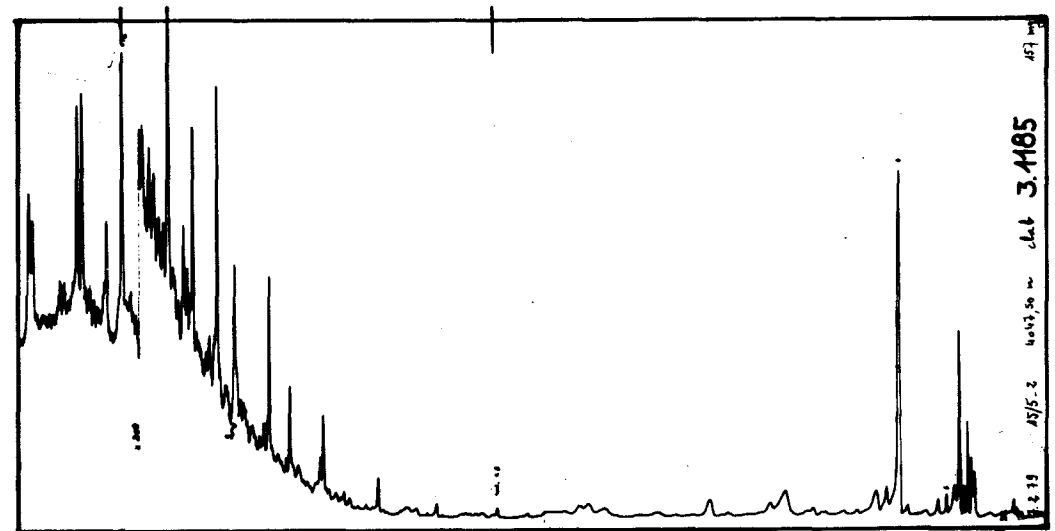
Composition du produit total (%)  
Composition of total product

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

HC AROMATIQUES AROMATIC HC



HC SATURES SATURATED HC



HC THERMOVAPORISES THERMOVAPORIZED HC

S. N. E. A. (P)

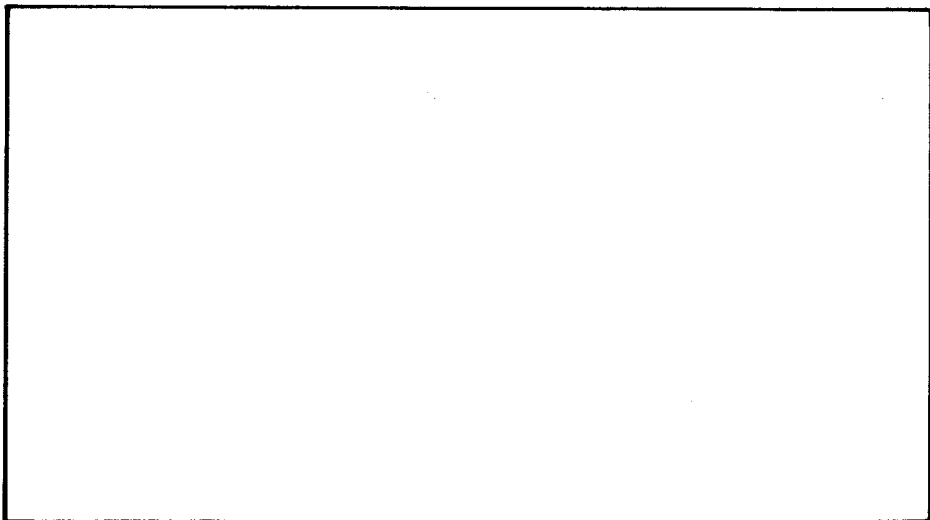
DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS **NORWAY**  
Country

SONDAGE **15/5-2**  
Well

PI.15

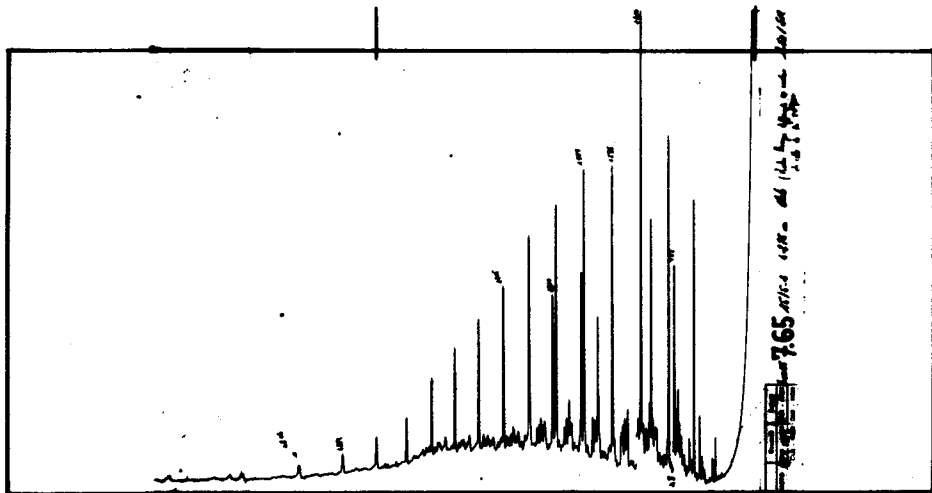
Huile Oil	Cote Depth	4275 m
Condensat Condensate	Identification Identification	Swc
Roche Rock	Formation Formation	
	Age Age	DOGGER ?



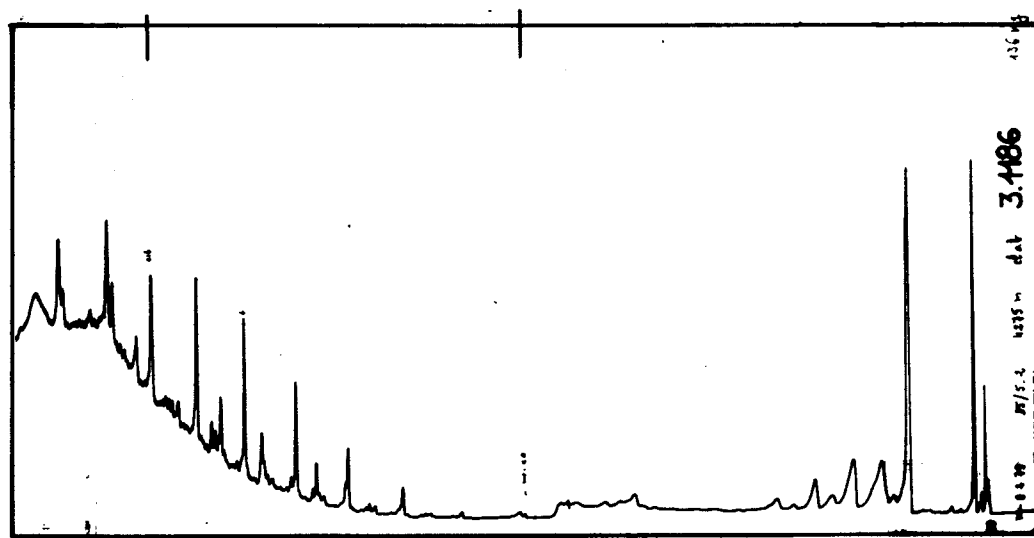
Composition du produit total (%)  
Composition of total product

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

HC AROMATIQUES AROMATIC HC



HC SATURES SATURATED HC



HC THERMOVAPORISES THERMOVAPORIZED HC

S. N. E. A. (P)

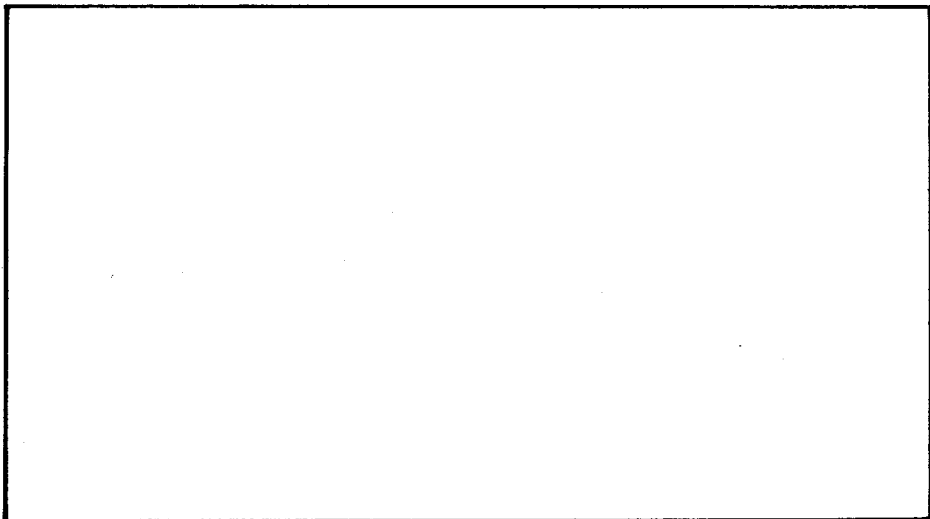
DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS : NORWAY  
Country

SONDAGE : 15/5-2  
Well

PI.16

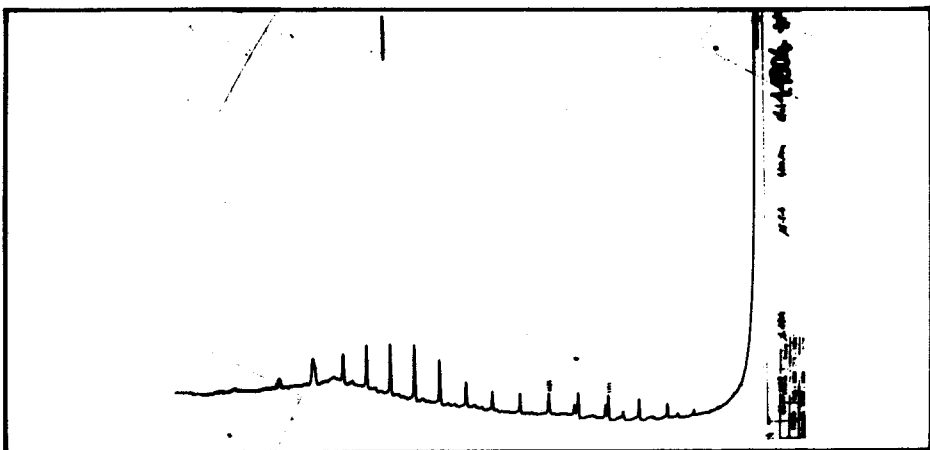
Huile Oil	Cote Depth	4300,5 m
Condensat Condensate	Identification Identification	Swc
Roche Rock	Formation Formation	
	Age Age	DOGGER ?



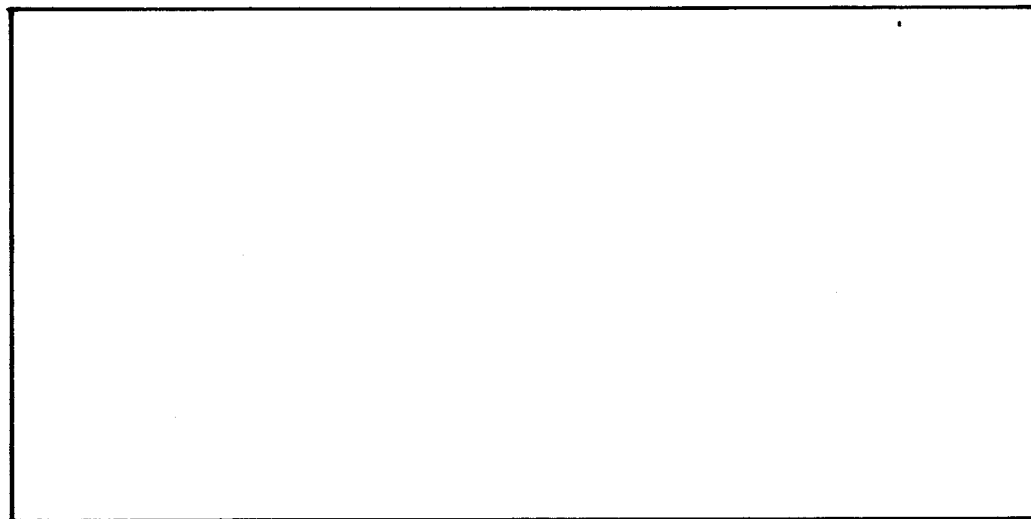
HC AROMATIQUES AROMATIC HC

Composition du produit total (%)  
Composition of total product

Asphaltènes Asphaltenes	As	:	
Résines Resins	R	:	
HC saturés Saturated HC	S	:	S
HC aromatiques Aromatic HC	A	:	A
Distillat Distillate	D	:	



HC SATURES SATURATED HC



HC THERMOVAPORISES THERMOVAPORIZED HC