

SNEA(P)
DIRECTION EXPLORATION
LABORATOIRE DE GEOLOGIE DE BOUSSENS

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GEO/LAB Bss n° 2/2339 RP
/lg

15/3-4 WELL (NORWAY)

OPTICAL AND GEOCHEMICAL STUDY

(JURASSIC SECTION)

ORGANIC MATTER AND OIL (DST 1)

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Boussens - OCTOBRE 1982

REFERENCE : ORDER N° 103103222

LISTE DE DIFFUSION

DESTINATAIRES :

DIVISION PROGRAMMES PARIS A L'INTENTION DE L'EXPERT REGIONAL EXPLO. EUROPE	1
EXPLO. DIG EUROPE	2
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A B S T R A C T

The optical and geochemical study of the organic matter (and oil) from the 15/3-4 Jurassic section (3654-4040 m) shows mainly that :

- the Upper Jurassic is at the top of the oil generation zone, the rest of the section being in the middle of this zone,
- the sapropelic Upper Jurassic has a high potential, the humic Oxfordian - Bathonian has a medium potential. No potential below,
- the oil from DST 1 (3789-3807,5 m) has probably been produced by an Upper Jurassic source rock at the end of the main oil generation zone.

This report presents the geochemical and optical (reflectance and fluorescence) analyses carried out on the organic matter from 15/3-4 well (location map, plate 1) in the Jurassic interval between 3654 and 4040 m ; and the analyses of the oil sample from DST 1 (3789-3807,5 m : Brent Formation Equivalent).

It takes into account the optical observations in transmitted light on palynological slides*. The main results are summarized on plate 5.

1 - THERMAL EVOLUTION

. The Thermal Alteration Index (TAI) estimated by JF. RAYNAUD * were :

3678 m	:	2.5
3700-3860 m	:	3
3890 m	:	3 ⁺

. The temperatures of pyrolysis (T max in table 1) increase from 425/430° C in the Upper Jurassic to 440/445° C in the Bajocian.

. The thermal evolution of the series is well recognized by the vitrinite Reflectance (normally non-fluorescent) and by the fluorescence colouration of the algae ; these are quite in agreement, giving the following increases with depth :

	3,680 m	:	0.55 - 0.60 % PRV
Malm	3,786 m	:	0,60
Bajocian	3,934 m	:	0.70

.../...

* JF. RAYNAUD Biostratigraphical report (in progress)

- . The catagenetical indices Pristane /nC 17 and Phytane /nC 18 of the 3696 m extract suggest a low degree of maturation.

Hence the Upper Jurassic section is at the top of the oil generation zone, the rest of the section being in the middle of this zone.

2 - ORGANIC MATTER CONTENT

The amount of total organic carbon (TOC) has been measured on 22 samples between 3654 m and 4040 m.

- Lower Cretaceous : TOC < 1 %
- Upper/Middle Jurassic (3680-3900 m) : 2 < TOC < 7 %
- Middle Jurassic (3900-4040 m) : TOC < 1 %

3 - NATURE OF THE ORGANIC MATTER - OIL POTENTIAL

3.1 - REFLECTANCE - FLUORESCENCE

The top Jurassic is sapropelic, the whole section below - Oxfordian to Bajocian - humic.

At 3,680 m, the sapropelic level consists of fair (low fluorescent) sapropelic groundmass, numerous algae Tasmanites, and abundant (brown fluorescent) bitumen. The global fluorescence index - 2.5- is partly due to bitumen.

Below, the Oxfordian to Bajocian section is characterized by a constant humic organic matter. It is fairly hydrogenated and includes fluorescent and normal Vitrinites and some Exinites (Cutinites, Sporinites). A few algae Tasmanites are present at 2 levels, one Oxfordian, the other Bajocian. At 3934 m an objective measurement test has been carried out by means of microhardness : the result (20 kg/mm²) falls into the bitumen range, not in the coal range (J.L. FAGGIONATO).

.../...

3.2.- PALYNOFACIES

- Lower Cretaceous : palynofacies mainly ligneous
- Upper Jurassic 3688-3736 m : 50 to 70 % of amorphous organic matter with very abundant terrestrial microfora at 3720 and 3736 m
- Oxfordian : very abundant dinoflagellates (more than 30 %) in a very ligneous palynofacies
- Dogger : heterogenous palynofacies : amorphous organic matter + cuticles + wood + coal. Marine environment and + brackish environment
- At the top of red sandstones : no palynological residue
- From 4006 m to TD : interval rich in spores and pollens (up to 60 %) with opaque ligneous debris.

3.3 - GEOCHEMICAL DATA

3.3.1 - To check the nature of the hydrocarbons of the Upper Jurassic, a chromatographical analysis of the saturated fraction of the 3696 m sample has been carried out. It confirms the genetical characteristic of these HC : $(Pr/nC\ 17) / (Ph/nC\ 18) = 0,70$ (cf. plate 7).

3.3.2 - The genetic potential of the rock samples is estimated by Rock Eval pyrolysis.

These analyses have been carried out only on the 17 samples with $TOC \geq 0,4\ %$. The results are given on the table 1 ; the related hydrogen indices (HI) and oxygen indices (OI) of the kerogens are plotted in a diagram on plate 4.

The amount of hydrocarbons produced by pyrolysis (peak S2) is :

- very low in the lower Cretaceous and in the Bajocian
- medium to high in the Malm and in the Bathonian

The related HI of the kerogens in the different series are :

- lower Cretaceous $HI \leq 20$ mg HC/g TOC
- Upper Jurassic 180-365 mg HC/g TOC
- Oxfordian 75-280 mg HC/g TOC
- Bathonian 215-335 mg HC/g TOC
- Bajocian 80-120 mg HC/g TOC

.../...

4 - OIL FROM DST 1

The oil sample recovered by DST 1 - 3789-3807,5 m - (in the Brent Formation Equivalent) has been analysed (composition and calculated indices in table 2, chromatograms on plate 6) and compared to the other fluids from block 15 (15/3-1, 15/3-3, 15/5-1 and 15/5-2)

The oil from 15/3-4 DST 1 is very similar to the oil from 15/5-1 : they have the same gross composition and the genetical indices show that they have the same Upper Jurassic origin. However the 15/3-4 oil is slightly more mature than the 15/5-1 oil, and has probably been produced by a source rock at the end of the main oil generation zone.

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ABBREVIATIONS AND UNITS USED IN THE TABLES

TOC	Total organic carbon (% weight of rock)
S1	Hydrocarbons present in the rock (mg HC/g rock)
S2	Hydrocarbons produced by pyrolysis (mg HC/g rock)
HI	Hydrogen index (mg HC/g TOC)
OI	Oxygen index (mg CO ₂ /g TOC)
Tm	Temperature at the top of S2
S/A	Saturated HC/aromatic HC
MCP, DMCP	Methylcyclopentane, dimethylcyclopentane
Pr, Ph	Pristane, Phytane.

TABLE 1 - 15/3-4 - ORGANIC INVENTORY

Age	Depth (m)	TOC %	S1 ‰	S2 ‰	HI	OI	Tm °C
LOWER CRETACEOUS	3654	0.65	0.03	0.12	20	75	-
	3664	0.51	0.04	0.06	10	110	-
UPPER JURASSIC	3680	7.01	6.34	23.48	335	20	426
	3696	5.58	5.24	20.37	365	25	428
	3710	3.21	1.43	5.77	180	120	433
OXFORDIAN	3726	5.56	2.23	14.05	250	20	432
	3740	6.11	2.65	17.10	280	20	432
	3756	3.44	0.64	2.62	75	75	436
	3786	2.70	0.89	4.78	175	50	433
BATHONIAN	3846	2.25	1.03	4.82	215	50	435
	3860	28.18	12.73	14.36	335	5	436
	3874	4.12	1.45	11.60	280	15	436
BAJOCIAN	3890	2.10	0.39	2.48	120	80	441
	3906	0.40	0.09	0.33	80	110	445
	3920	0.45	0.12	0.37	80	125	444
	3934	0.73	0.17	0.65	90	70	439
	3954	1.00	0.33	0.81	80	220	433
	3965	0.09					
	3993	0.11					
TRIAS ?	4010	0.32					
	4025	0.22					
	4040	0.11					

TABLE 2

WELL	15/3-4	
TEST	DST 1	
DEPTH	3789-3807,5	
RESERVOIR	Brent Formation Equivalent	
G.O.R.	400 m ³ /m ³	
SPECIFIC GRAVITY	41.5 API (0.818 g/cm ³)	
COMPOSITION OF THE TOTAL PRODUCT (%)	DISTILLATE	44.5
	ASPHALTENES	1.6
	RESINS	2.9
	SATURATED HC (S)	36.1
	AROMATIC HC (A)	14.9
	S / A	2.42
C5 - C15	TV (% total product)	24
	nAlk % TV	35
	X1 = nC ₆ /MCP	2.19
	X2 = nC ₇ /DMCP	5.73
	Y1 = nC ₇ /TOL	0.83
C15 - C30	nAlk % Sat.	20
	Pr/nC ₁₇ = A	0.40
	Ph/nC ₁₈ = B	0.34
	Pr/Ph	1.33
	A / B	1.17

Table 3 - FLUIDS FROM 15/3 AND 15/5

WELL	15/3-1					15/3-3		15/3-4	15/5-1	15/5-2
	FIT 1	FIT 4	FIT 5 bis	FIT 6	FIT 7	RFT 26 b	DST 2 b	DST 1	RFT 1	Condensate
DEPTH	4445	4217	4170	4150	4090	4262	4615 - 32	3789 - 3807	3559 - 3614	4140 - 60
RESERVOIR	Call. / Oxf.	Oxf	Portl / Kim	Portl / Kim	Portl / Kim	Call / Oxf.	Bathon.	Brent.	Callov.	L. Dogger
SPECIFIC GRAVITY	0.816	0.834	0.828	0.832	0.834	0.805	0.818	0.818	0.797/0.811	
G.O.R.	3310	580	710	690	1010		8500	400	1740	
DISTILLATE	36,0	35,1	34,2	34,9	37,4	42,4	33,6	44,5	44,2	75,6
ASPHALTENES	—	—	0,3	—	—	0,3	—	1,6	—	—
RESINS	4,3	6,0	4,2	4,6	4,9	2,1	1,8	2,9	1,7	0,3
SATURATED HC	45,7	40,0	43,6	43,5	40,2	41,5	51,8	36,1	38,5	16,6
AROMATIC HC	14,0	18,9	17,7	17,0	17,5	13,7	12,7	14,9	15,6	7,5
S / A	3,27	2,11	2,46	2,55	2,29	3,03	4,08	2,42	2,47	2,21
Pr / nC 17	0,40	0,52	0,46	0,52	0,47	0,50	0,24	0,40	0,65	0,35
Ph / nC 18	0,28	0,42	0,35	0,40	0,36	0,32	0,13	0,34	0,62	0,10
A / B	1,43	1,23	1,30	1,31	1,31	1,54	1,80	1,17	1,05	3,25
Pr / Ph	1,63	1,48	1,54	1,52	1,60	1,70	1,75	1,33	1,06	3,27
Alk % Sat.	29	22	20	23	24	27	25	20	13	48
X1 = nC 6 / MCP	2,30	1,64	2,17	2,19	2,35	2,39	1,89	2,19	1,69	2,23
X2 = nC 7 / DMCP	7,54	6,69	6,92	7,33	6,85	7,41	8,73	5,73	4,33	6,89
Y1 = nC 7 / TOL	0,58	0,36	0,64	0,70	0,80	0,68	0,30	0,83	0,87	0,39
Alk % TV	26	31	32	24	24	32	26	35	26	19

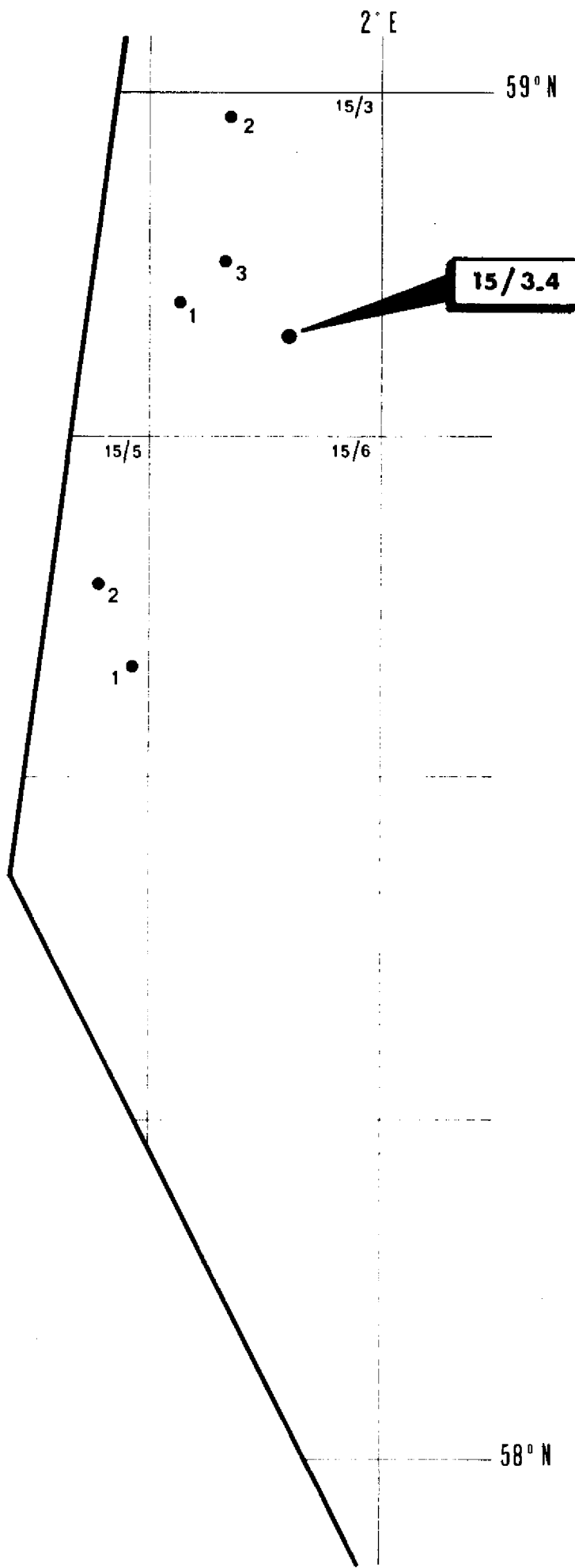


Plate 1 - 15/3-4 - LOCATION MAP

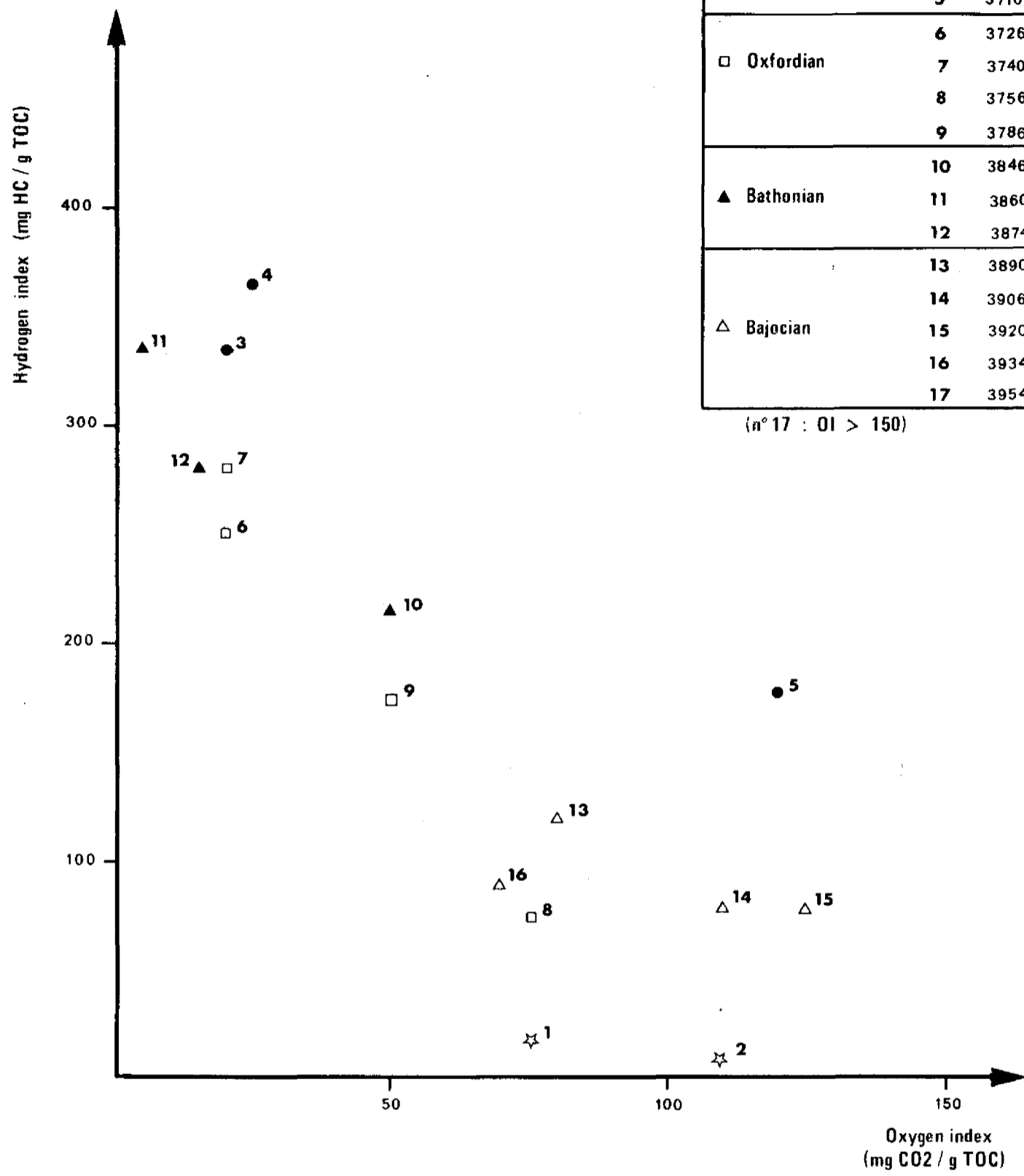


Plate 4 - HYDROGEN INDEX - OXYGEN INDEX DIAGRAM

15 / 3 - 4

ORGANIC MATTER STUDY

Plate: 5

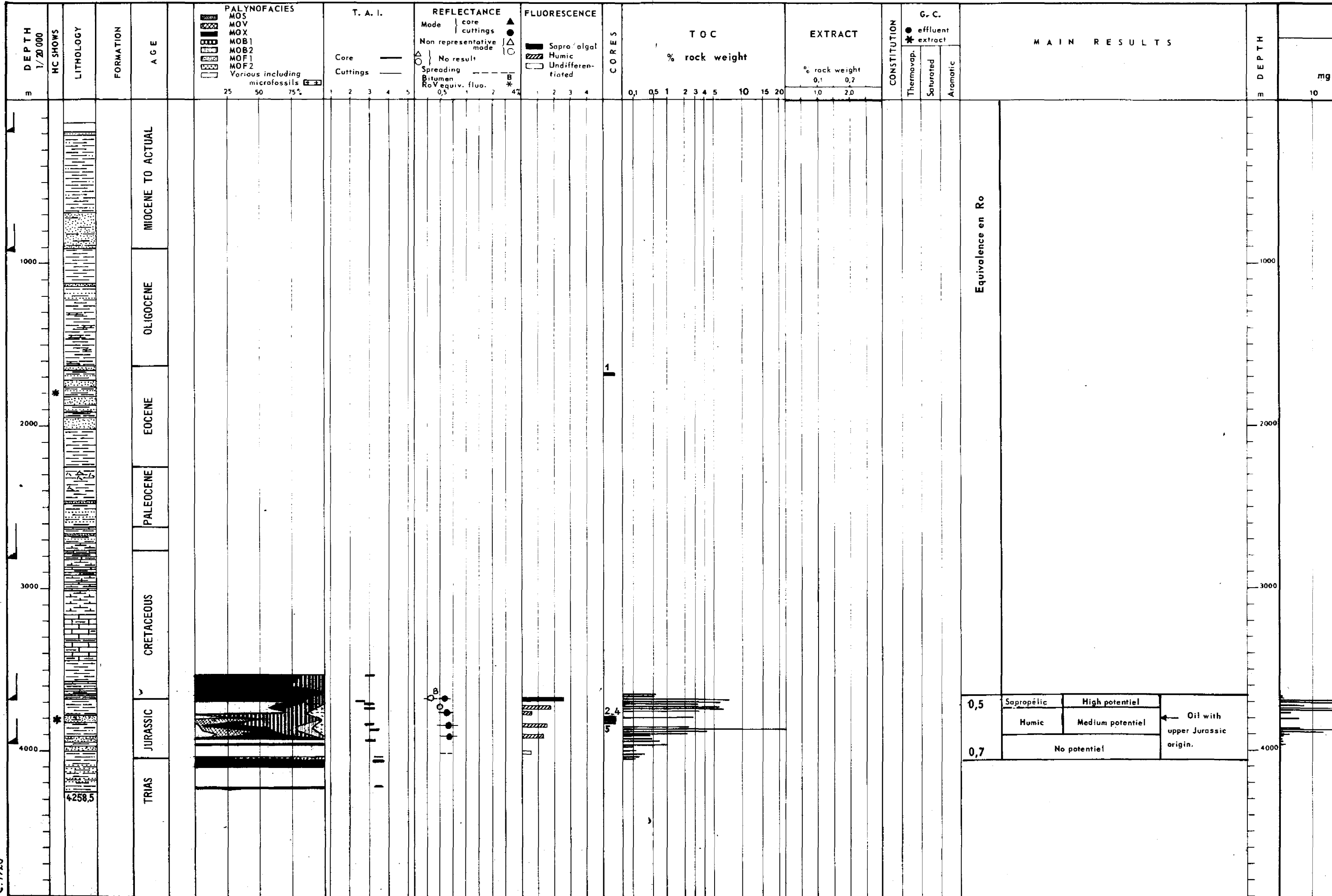
15/3-4

SYNTHESIS OF RESULTS

WELL : 15 / 3 - 4

COUNTRY : NORWAY

DATE September 1982



WELL : 15 / 3 - 4
COUNTRY : NORWAY

DATE September 1982

TOC % rock weight											EXTRACT % rock weight		CONSTITUTION G. C. ● effluent * extract	MAIN RESULTS	DEPTH m	PYROLYSIS - ROCK-EVAL																						
5	1	2	3	4	5	10	15	20	0.1	0.2	Thermovap.	Saturated				Aromatic	S1 + S2 mg HC / g Rock				S1 / S1 + S2			HI mg HC / g TOC			OI mg CO2 / g TOC			Tm °C								
											1.0	2.0				10	20	30	40	0.25	0.50	0.75	200	400	600	50	100	150	420	450	480							

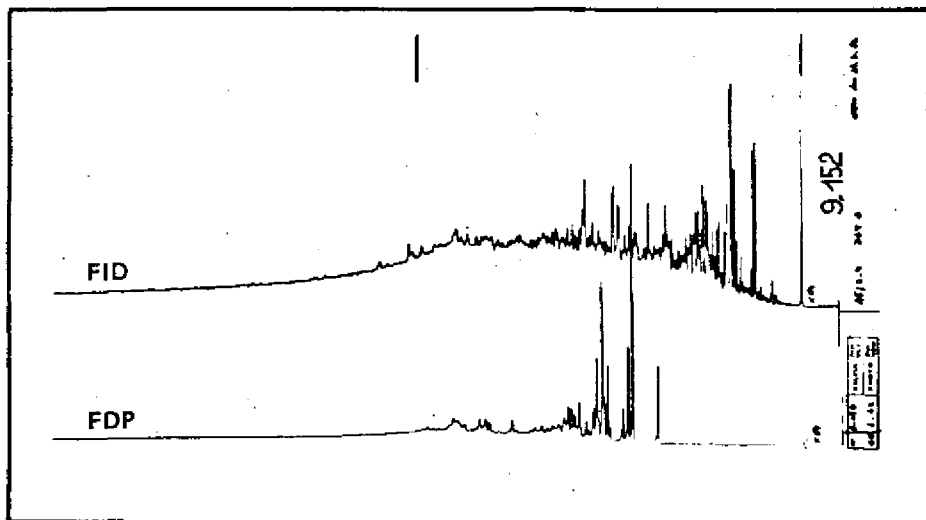
S. N. E. A. (P)

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS : NORWAY
Country
SONDAGE : 15/3-4
Well

Huile / Oil : Cote / Depth : 3789 - 3807,5 m
Identification : DST 1
Formation : BRENT Equivalent
Age : BATHONIAN

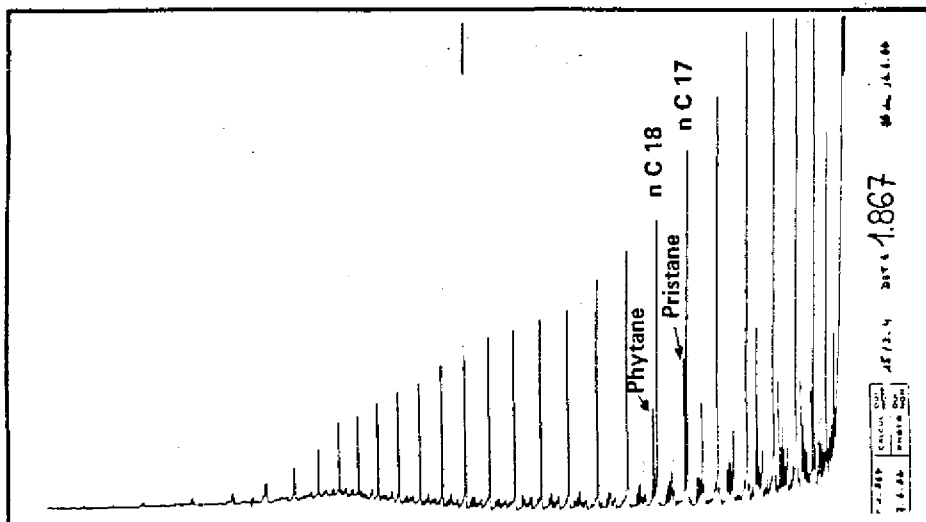
Pl. 6



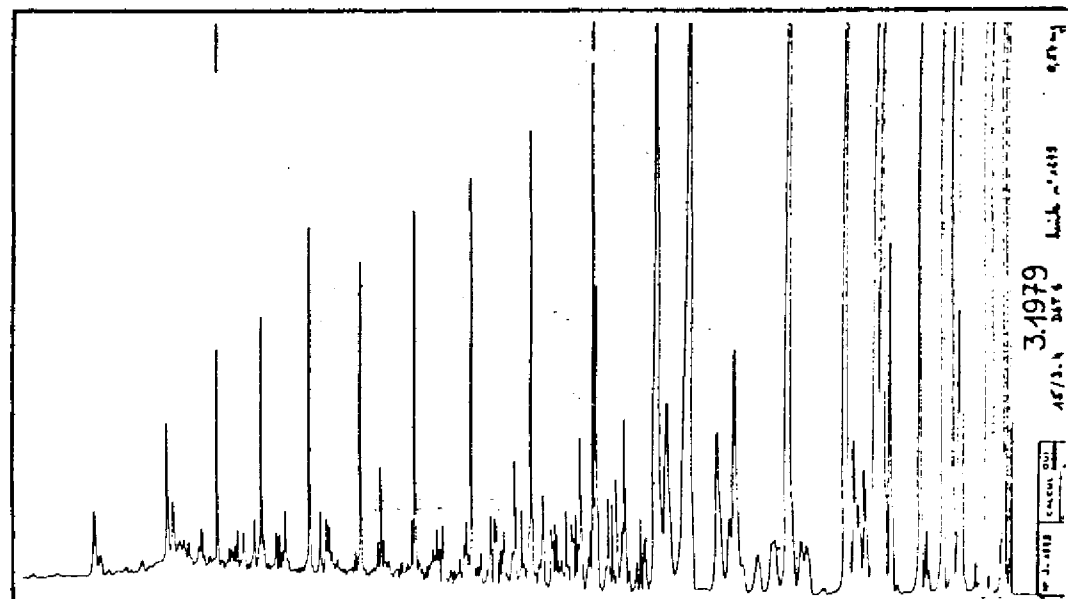
HC AROMATIQUES AROMATIC HC.

Composition du produit total (%)
Composition of total product

Asphaltènes Asphaltenes	As	: 1,6	
Résines Resins	R	: 2,9	
HC saturés Saturated HC	S	: 36,1	$\frac{S}{A} = 2,42$
HC aromatiques Aromatic HC	A	: 14,9	
Distillat Distillate	D	: 44,5	



HC SATURES SATURATED HC.



HC THERMOVAPORISES THERMOVAPORIZED HC.

A. 7721

S. N. E. A. (P)

Pl. 7

DEPARTEMENT LABORATOIRE DE GEOLOGIE DE BOUSSENS

PAYS : NORWAY
Country

SONDAGE : 15/3-4
Well

Cote : 3696 m
Depth

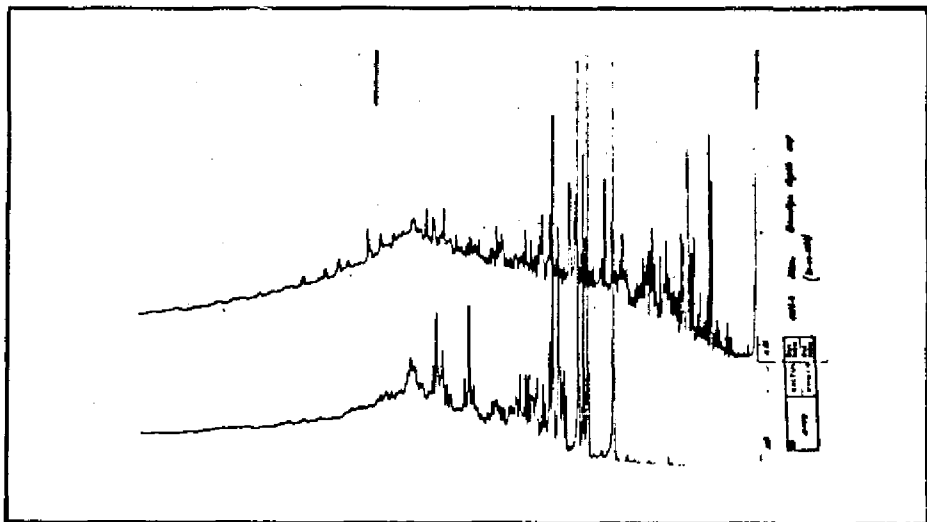
Identification : Cutting
Identification

Roche : KIMMERIDGE CLAY
Rock Formation

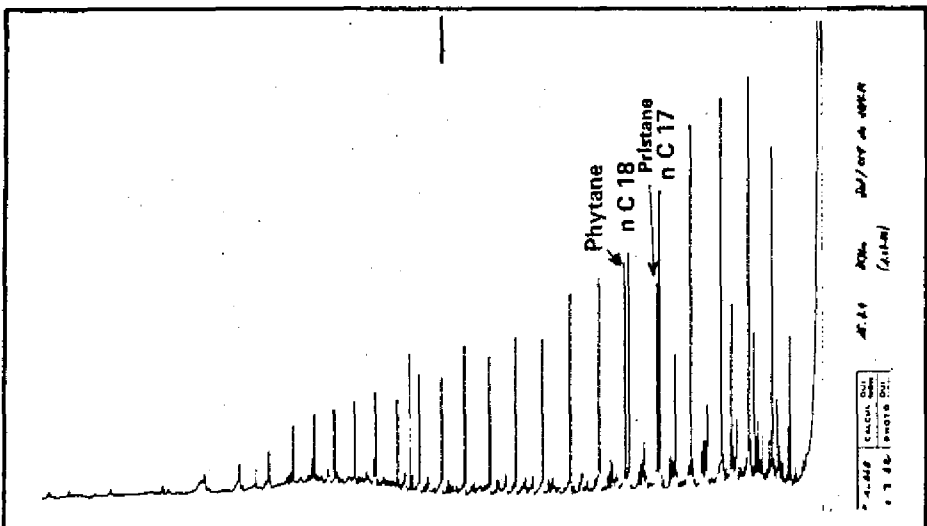
Age : UPPER JURASSIC
Age

Composition du produit total (%)
Composition of total product

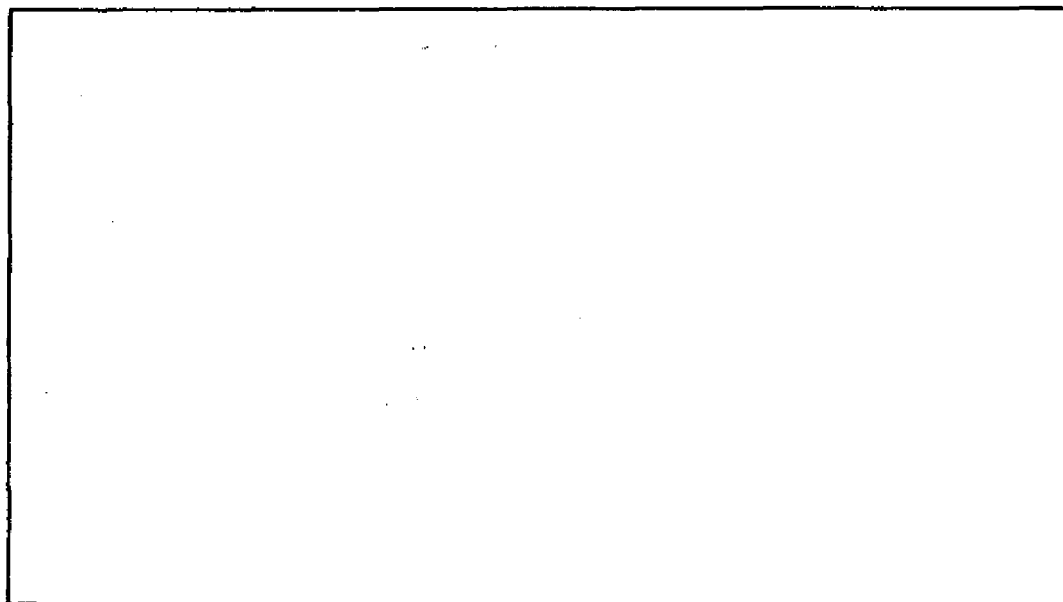
Asphaltènes Asphaltenes	As	:	} 29,5	$\frac{S}{A} = 0,61$
Résines Resins	R	:		
HC saturés Saturated HC	S	:	26,8	
HC aromatiques Aromatic HC	A	:	43,7	



HC AROMATIQUES AROMATIC HC.



HC SATURES SATURATED HC.



HC THERMOVAPORISES THERMOVAPORIZED HC.

A. 7722

elf aquitaine

NORWAY

DIRECTION GENERALE DES PRODUCTIONS





15/3-4




ORGANIC MATTER
PETROLOGY

* Ro equivalent (fluorescence)

REFLECTANCE
(measurements)

FLUORESCENCE
(global amount estimated)

-  Vitrinite
-  Bitumens
-  Fluorescent vitrinite
-  Mud additives

-  Fluorescent macerals
-  Hydrocarbon traces in reservoirs
-  Mud additives

G. NICOLAS
c. 7717

PL.2

REFLECTANCE

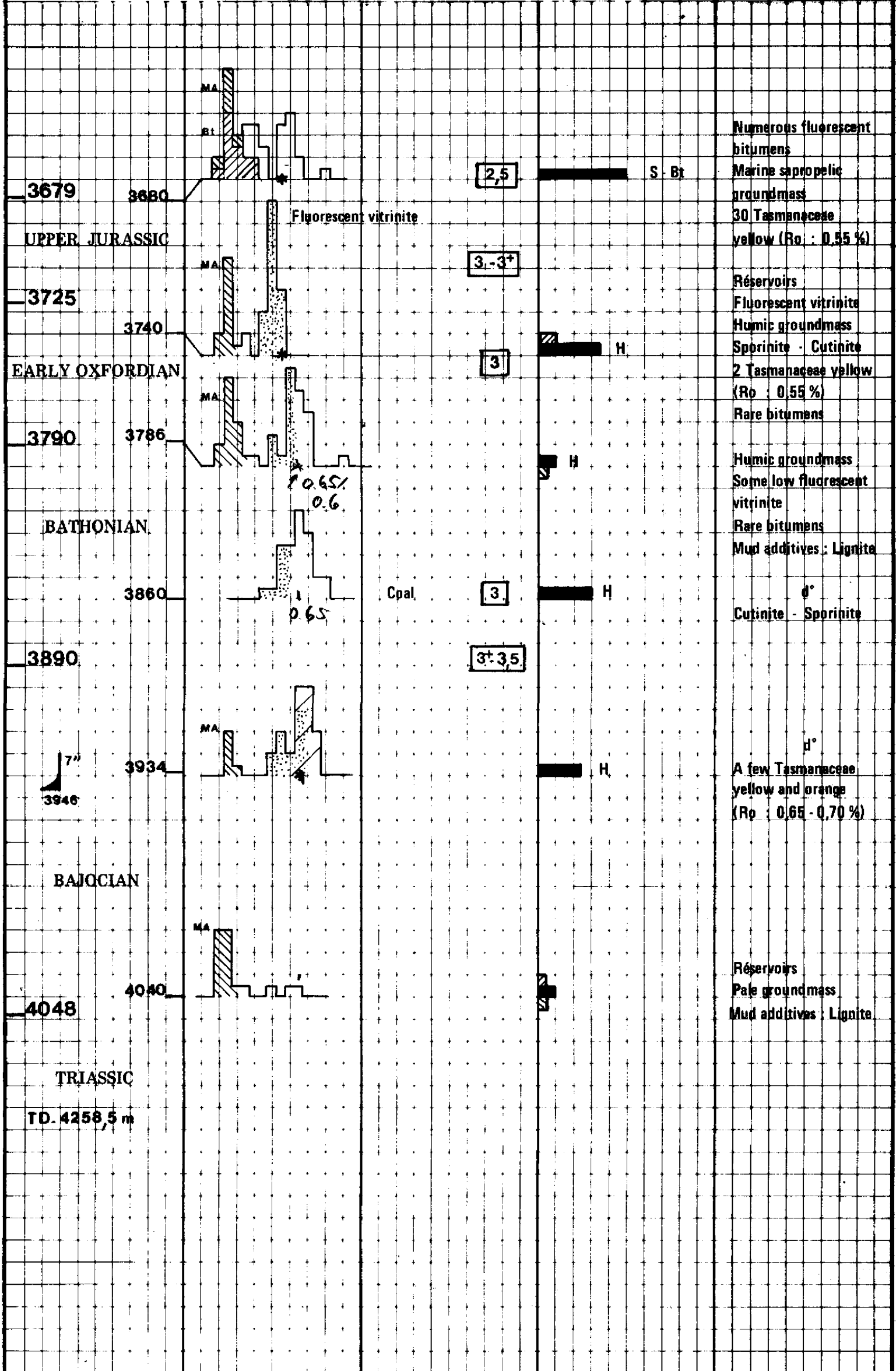
FLUORESCENCE

VITRINITE
BITUMEN

GLOBAL
ESTIMATED

ORGANIC MATTER
NATURE

0 1 2 3 4 I.A.T. 2%



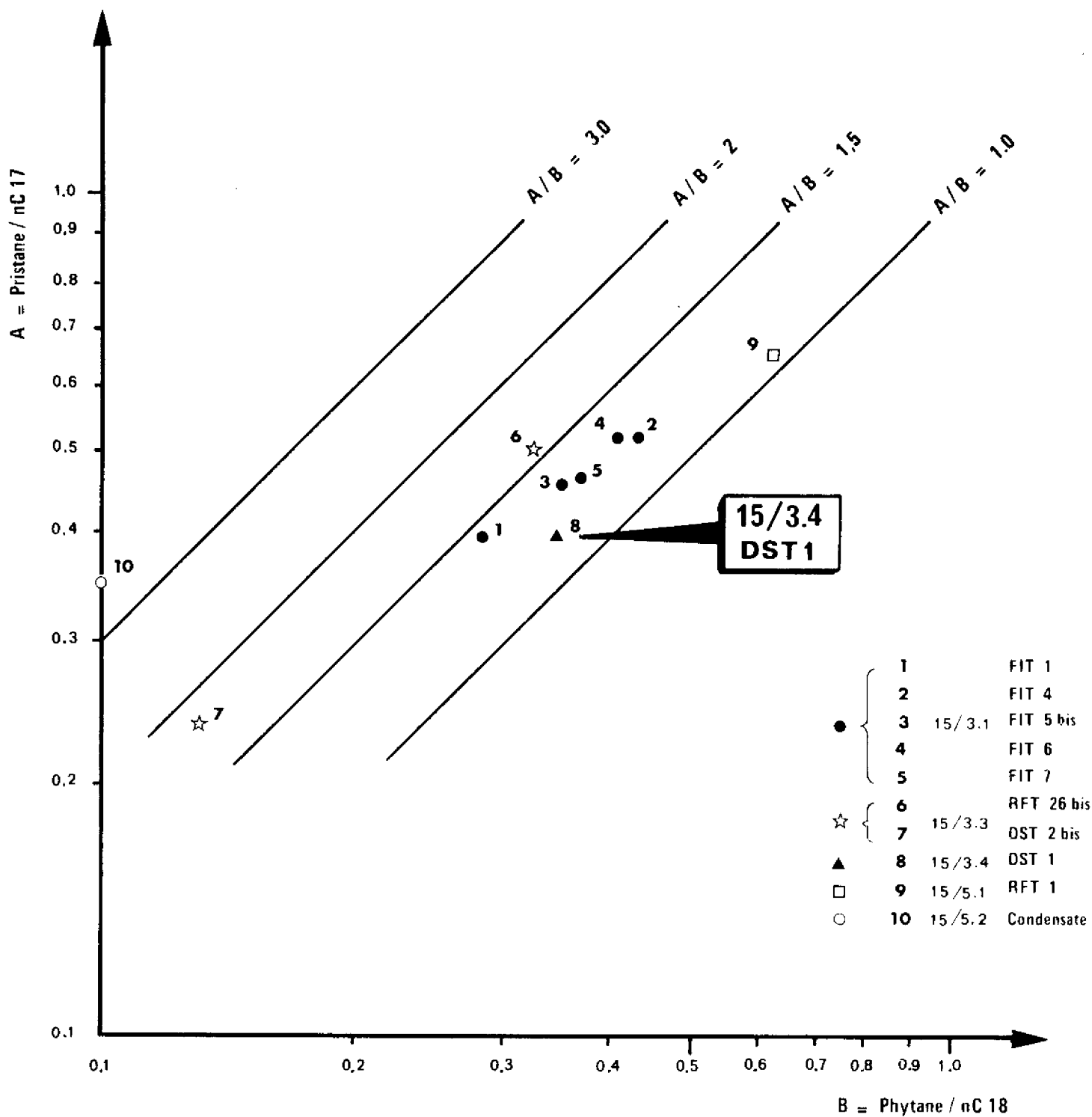


Plate 3 - 15 / 3 - 4 - PRISTANE / PHYTANE DIAGRAM