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S. N. E. A. (P)
DIRECTION EXPLORATION
DIVISION RECHERCHES et APPLICATIONS en GEOLOGIE
LABORATOIRE
ETABLISSEMENT DE BOUSSENS

EP/S/EXP/RAG-Lab.Bss n° 005/86 RP
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30/6-16

(NORWAY)

GEOCHEMICAL STUDY OF OIL SAMPLES
(DST 1 AND DST 2)
COMPARISON WITH OTHER OILS
OF THE 30/6 BLOCK

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REGISTRERT
OLJEDIREKTORATET

D. JONATHAN

Boussens - Mars 1986

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EXPLORATION ELF AQUITAINE NORGE	8
S.I.D. BOUSSENS	2

ABSTRACT

- Oils in intra-Dunlin sands originate from the same source ; this source is upper Jurassic.

- They are less mature than 30/6 oils in Brent reservoirs.

- The oil in the lower reservoir is degraded.

CONTENTS

TABLES

FIGURES

PLATES

INTRODUCTION

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Two oil samples recovered in DST 1 (2920 - 2944 m) and DST 2 (2855 - 2868 m) in intra-DUNLIN sand~~s~~ + Brent were analysed for geochemical characterization.

The main purpose of the study was to determine whether 30/6-16 oils in DULIN group reservoirs are different from other oils in BRENT reservoirs of the 30/6 block.

In a first stage of analysis, the composition of main components (saturates, aromatics and polar compounds) and chromatographic patterns were not thought to be sufficient to assure a comparison in terms of origin and maturation ; so, biological markers (GC-MS analysis) were used in a second stage.

Due to their position in the block, oils from 30/6-7 and 30/6-10A were used for comparison ; both oils were recovered in MFT and DST.

Analytical results are shown in the following tables :

Table I = bulk composition and main chromatographic data
Table II = biological markers - characteristic ratios.

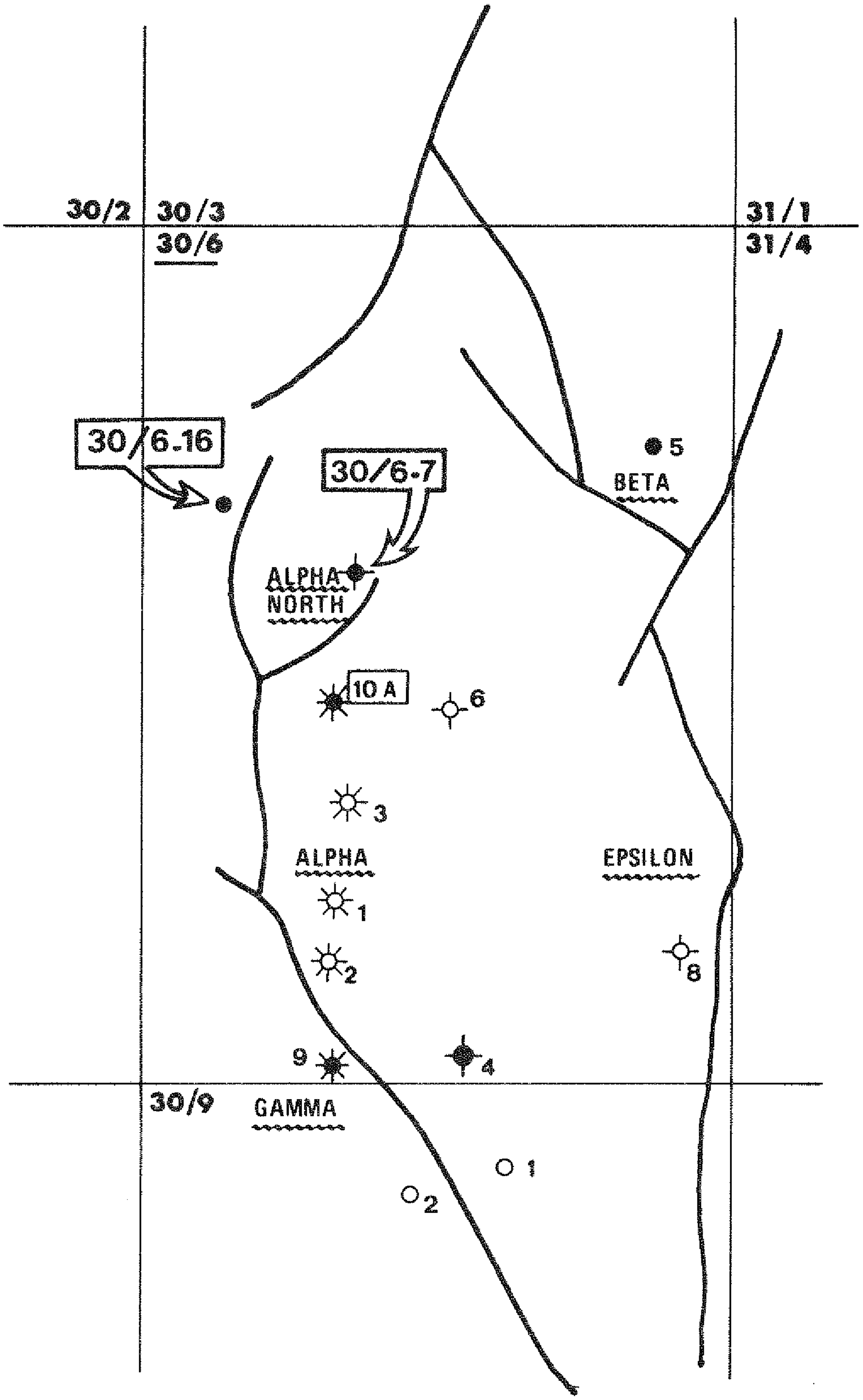

Fig. 1 - LOCATION MAP OF CITED WELLS

1 - COMPOSITION AND GAS CHROMATOGRAPHY

1.1 - 30/6-16 OILS

Whereas specific gravity values are similar, differences appear in the bulk composition of both 30/6-16 oils = less saturates are present in the lower level (DST 1).

S/A = 1.06 (DST 1) and 1.45 (DST 2)

In fact, gas chromatography of saturates fractions shows that the oil in the lower reservoir near the water bearing STATFJORD formation is slightly affected by bacterial degradation.

The DST 2 oil does not seem to be - or is less - affected by degradation, shown by gas chromatograms of saturate and thermovaporized fractions (plates 1 and 2).
In this oil, the distribution of heavy n. alkanes is visible up to n.C38. Connected with the presence of steranes-triterpanes components it may indicate a low to medium state of maturity, that corresponds to the values X_1 and X_2 index calculated from the C_{15}- fraction chromatogram (thermovaporisation).

As for aromatics and thiophenic compounds, chromatograms (Pl 1 and 2) are fairly similar and allow us to suggest the same source for both oils.

1.2 - COMPARISON WITH 30/6-7 AND 30/6-10 A OILS

The comparison of 30/6-16, DST 2 oil with 30/6-7 and 30/6-10 A oils shows their similarity in composition (fig. 2) and it is likely that they originated in the same conditions of deposition environment (Pr/Ph and Pr/C17/Ph/nC18 ratios).

A lower level of maturation state for the 30/6-16 oil is confirmed by Pristane/nC17 and Phytane/nC18 values,

0.8 and 0.5 respectively for 30/6-16
0.6 and 0.3 - 0.4 for 30/6.10 and 30/6-7,

as well as X_1 and X_2 values (table I) for the chromatography of the gazoline fraction (C_5 - C_{15} range).

However, in order to confirm these results, the analysis of saturate fractions was performed by GC-MS coupling : 191 m/z and 217 m/z fragmentograms from terpanic and steranic molecules respectively are given in plates 4,5 and 6.

2 - MATURITY AND ORIGIN

Clear differences appear in biological markers distribution which are linked to the maturation state of oils, according to the scheme given in plate 3 (Steranes). They confirm information obtained from chromatography.

Values of $\frac{29\,\alpha\alpha\,S}{29\,\alpha\alpha\,R}$ and $\frac{27\quad Sdia}{29\,\alpha\alpha\,R}$ ratios are respectively 0.92 and 3 for 30/6-7 and 30/6-10 oils but only 0.75 and 1 for the less mature 30/6-16 oil.

From Terpanes (m/e = 191), Trisnorhopane to trisnorneohopane ratio Tm/Ts (table II and fig. 4) confirm that 30/6-16 oil is the less mature pole.

Genetic information is less obvious : from (C_{27}, C_{28}, C_{29}) Steranes distribution, the relative abundance of the $\beta\beta$S form indicates that the organic source is almost identical (fig. 5). However values of diasteranes ratio 21St + 22St/29St differ somewhat for 30/6-16 on the one hand and 30/6-7 and 30/6-10 on the other. Although is was not apparent from A/B values that difference could be attributed to the influence of deposition conditions.

From Terpanes spectra, 29 Hopane/30 Hopane (table II) ratio indicates that the 3 oils originate from the same organic material.

3 - KEROGEN IN DUNLIN Fm AT 2889,6 m

In order to determine whether liasic shales could have contributed to the formation of oils found in DUNLIN reservoirs, analyses were carried out on a sample from the core ≠ 3 (shaly level at 2889,60 metres) between reservoirs of 30/6-16 well.

. Optical characteristics in transmitted light are (J. DUCAZEAUX) : organic facies (Palynofacies): dominant terrestrial organic matter with abundant spores and pollens and ligneous material.
Marine originating organic matter (dinocysts).

T.A.I : 2.5

. Main geochemical data for organic matter content and pyrolysis are :

Extractable organic matter	4950 ppm ≈ 0.5 % W/W
Insoluble organic carbon	1.6 % W/W
S_2 : hydrocarbon from pyrolysis (mg/g of rock)	2.12
Hydrogen Index, mg hydrocarbons/g of insoluble carbon	200
Oxygen Index, mg CO_2/g of insoluble carbon	30
T_m, °C (temperature of the maximum formation of hydrocarbons by pyrolysis)	439

composition of the extract and data from gas chromatography of saturates are given in Table I.

At this level, organic matter is scarce (1 %) , in a low evolution state corresponding to the beginning of the main oil generation zone ; genetic potential is low (eq. 2 kg/Ton) and the related hydrogen Index (200) shows a gas-prone kerogen, in agreement with the dominant organic material. This H.I value was the highest value formerly measured in the liasic section in 30/6-1 well, at the same catagenetic level.

A tentative simulation of hydrocarbon formation was carried out from organic matter in core 3 by heating a rock sample in a sealed glass tube at 330 °C for 48 hours : the amount of gaseous components was not determined but was probably high, whereas heavy compounds (700 ppm), mainly consisted of polar compounds (75 % W/W of liquid pyrolysate) and aromatics (23 % W/W).

So, it is not likely that regional liasic (late Toarcian) levels could have greatly contributed to the generation of 30/6-16 oils. Solvent extracted organic matter present in the sampled level of the core ≠ 3 forms a very large part of the total organic matter (EOM/IOC = 30 %) ; it is very similar to DST 1 oil in composition (S/A = 1.2 and 1.06 respectively). Moreover, gas chromatograms of saturates, where bacterial degradation is apparent are quite similar (plate 7, b and c).

This extract in core 3 is allochtonous and it is likely that this shaly level is impregnated by the same oil as sampled in DST 1.

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CONCLUSIONS

Both oils found in intra-DUNLIN sands originate from the same source but the oil in the lower reservoir is incipient degraded by a bacterial activity.

Using composition and the distribution of biological markers, a comparison with oils found in other compartments of the 30/6 block in the Brent formation, shows that they originate from the same organic material in similar environmental conditions ; this origin is upper Jurassic.

The maturity level of 30/6-10 oils is lower than those of 30/6-7 and 30/6-10 oils in Brent reservoirs.

In order to make sure that liquid and gaseous effluents are cogenetic, a geochemical study of associated gases is advisable.

obs : the upper sand was later attributed to Brent.

VF.

TABLE I

30/6-16 - COMPOSITION AND CHROMATOGRAPHY DATA
(COMPARISON WITH 30/6-7 AND 30/6-10A OILS)

	WELL	30/6-16		30/6-16	30/6-7	30/6-10 A
	RESERVOIR FORMATION	DUNLIN	DUNLIN	DUNL. Core 3	BRENT	BRENT
	TEST	DST 1	DST 2		MFT 4	DST 1
	Depth, m.	2920 - 44	2855 - 68		2651 - 76	2600 - 2602
	G.O.R. (m^3/m^3)	147	195		135	150
	Spec. grav. 15°C (g/cm^3)	0.860	0.852		0.851	0.846
Composition of the total product (%)	DISTILLATE = D	32.1	31.9		30,8	32
	ASPHALTENES	0.7	0.9	9,5	1,8	2.0
	RESINS	8.2	6.9	20,4	6.3	6.3
	SATURATED H.C. = S	30.3	35.6	38,1	37.0	37.6
	AROMATIC H.C. = A	28.5	24.6	31,8	24.1	22.1
	S / A	1.06	1.45	1,20	1.53	1.7
	S + D	62.4	67.5		67.8	69.6
C 15^- (T.V.)	X1 = n-C6/MCP	1.52	1.39		2.07	2.02
	X2 = n-C7/DMCP	1.22	1.31		4.91	5.37
	Y1 = n-C7/TOL				1.72	1.39
	n-Alk % TV	8	13		34	32
C 15^+	n-Alk % Sat.	2	15		10	14
	Pr/n-C17 = A	2.19	0.83	1,28	0.50	0.58
	Ph/n-C18 = B	1.48	0.58	0,76	0.33	0.44
	Pr/Ph	1.59	1.49	2,10	1.62	1.41
	A / B	1.48	1.43	1,69	1.50	1.32
	References				(1)	(2)

MCP : methylcyclopentane
DMCP : dimethylcyclopentane
TOL : toluene
TV : thermovaporized fraction (C15^-)
Pr, Ph : Pristane, Phytane

(1) P. CAILLEAUX - 30/6-7 well geochemical study of fluids (MFT 2 and 4) EP/S/EXP/RAG - Lab Bss n° 137/84 RP

(2) P. CAILLEAUX - 30/6-10 A well geochemical study of oil, condensat and gases (DST 1 and 4) in progress

TABLE II

CHARACTERISTIC RATIOS FROM STERANES AND TERPANES

	STERANES (m/e 217)				TERPANES (m/e 191)		
	$\frac{29\alpha\alpha S}{29\alpha\alpha R}$	$\frac{29\beta\beta R}{29\alpha\alpha R}$	$\frac{21\ St + 22\ St}{\Sigma\ 29\ St}$	$\frac{27 S dia}{29\alpha\alpha\ R}$	$\frac{Tm}{Ts}$	$\frac{24/3}{30\ H}$	$\frac{29\ H}{30\ H}$
30/6-16 (DST 2)	0.75	2.0	0.30	1.0	1.37	0.02	0.37
30/6-7 (MFT 4)	0.92	2.6	0.72	3.0	0.93	0.04	0.39
30/6-10 A (DST 1)	0.92	2.8	0.93	3.4	0.81	0.08	0.41

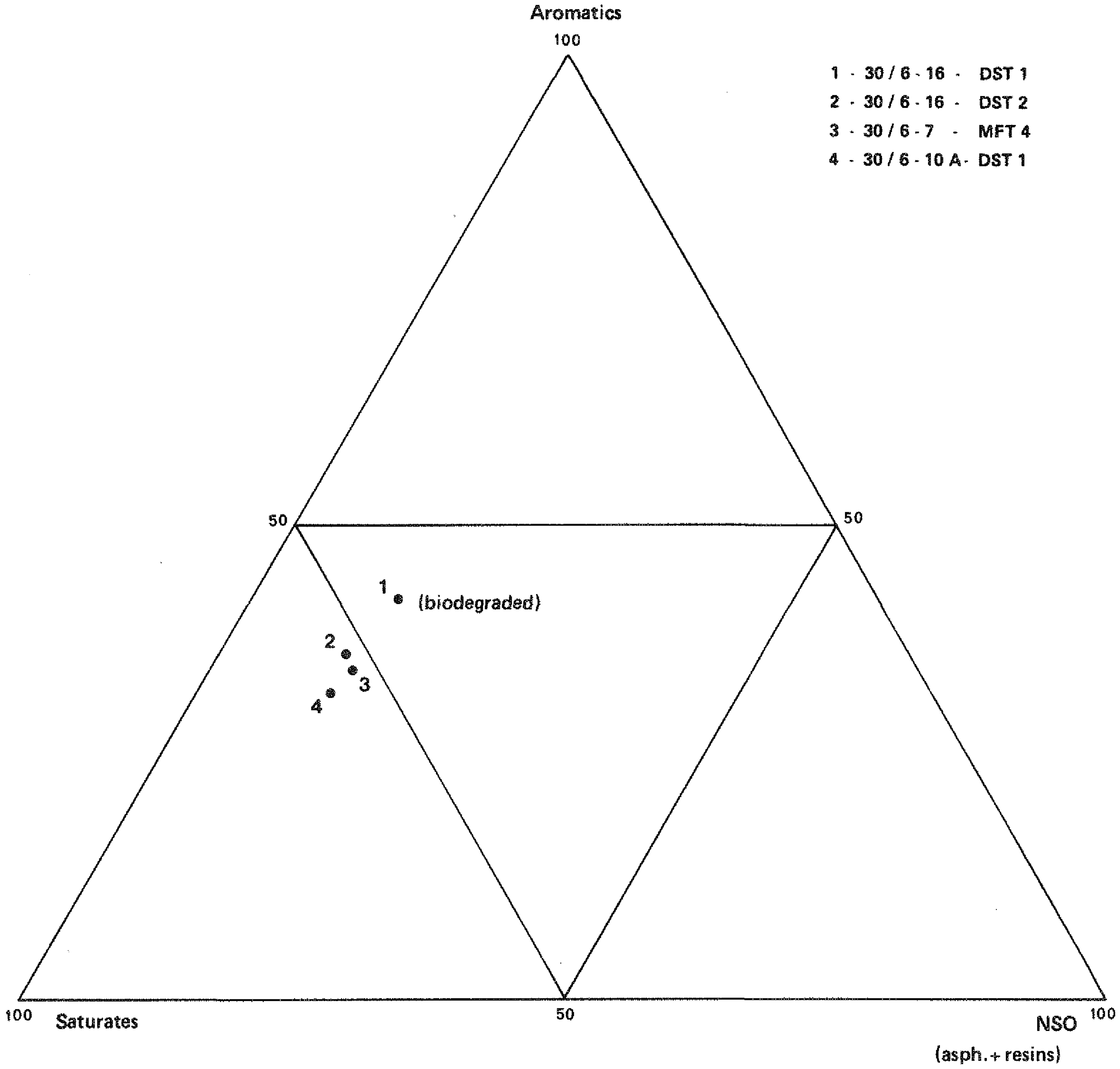

Fig. 2 - COMPOSITION OF TOPPED OILS (> 220 °C)

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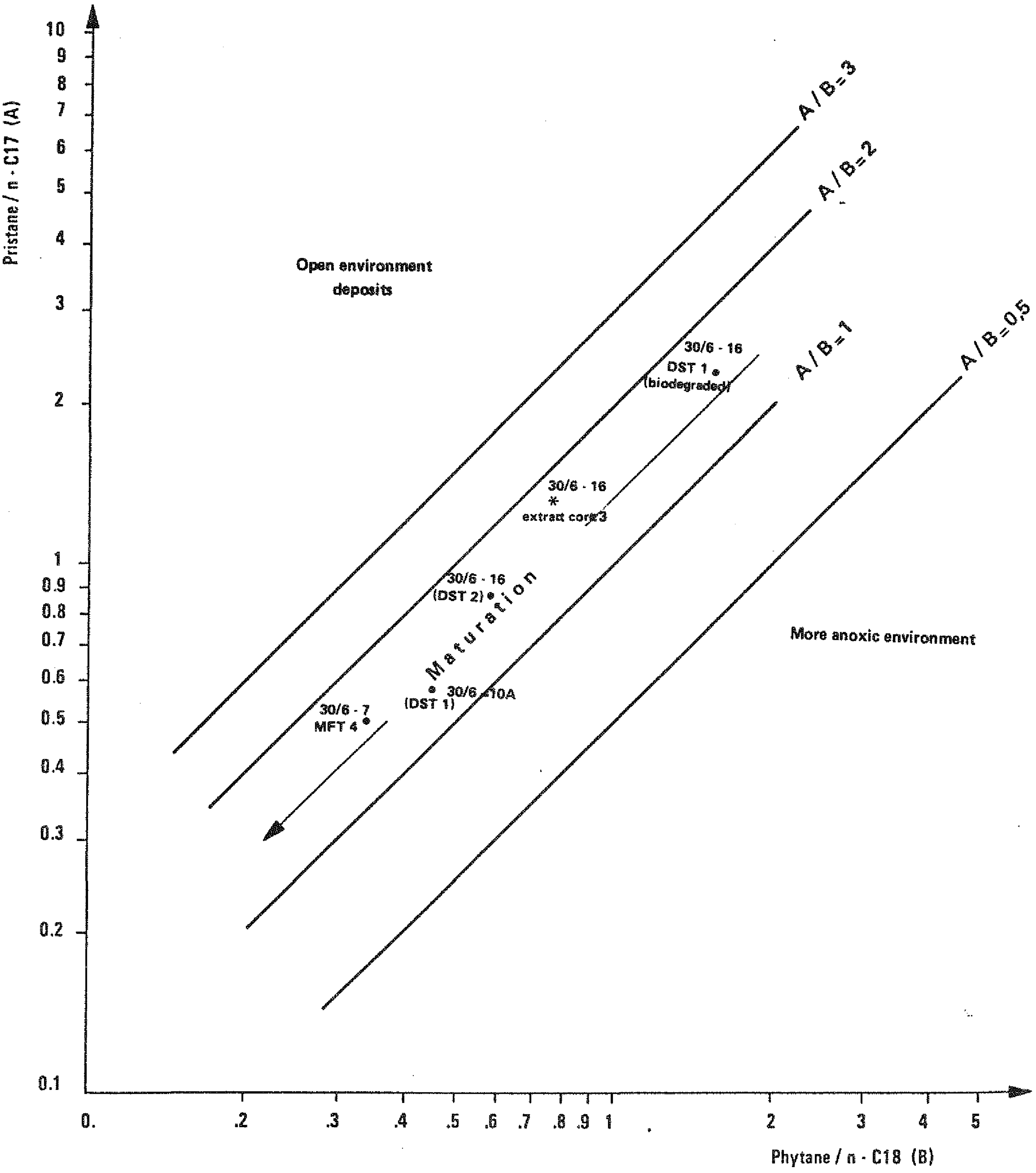

Fig. 3 - (PRISTANE / n - C17) / (PHYTANE / n - C18) DIAGRAM

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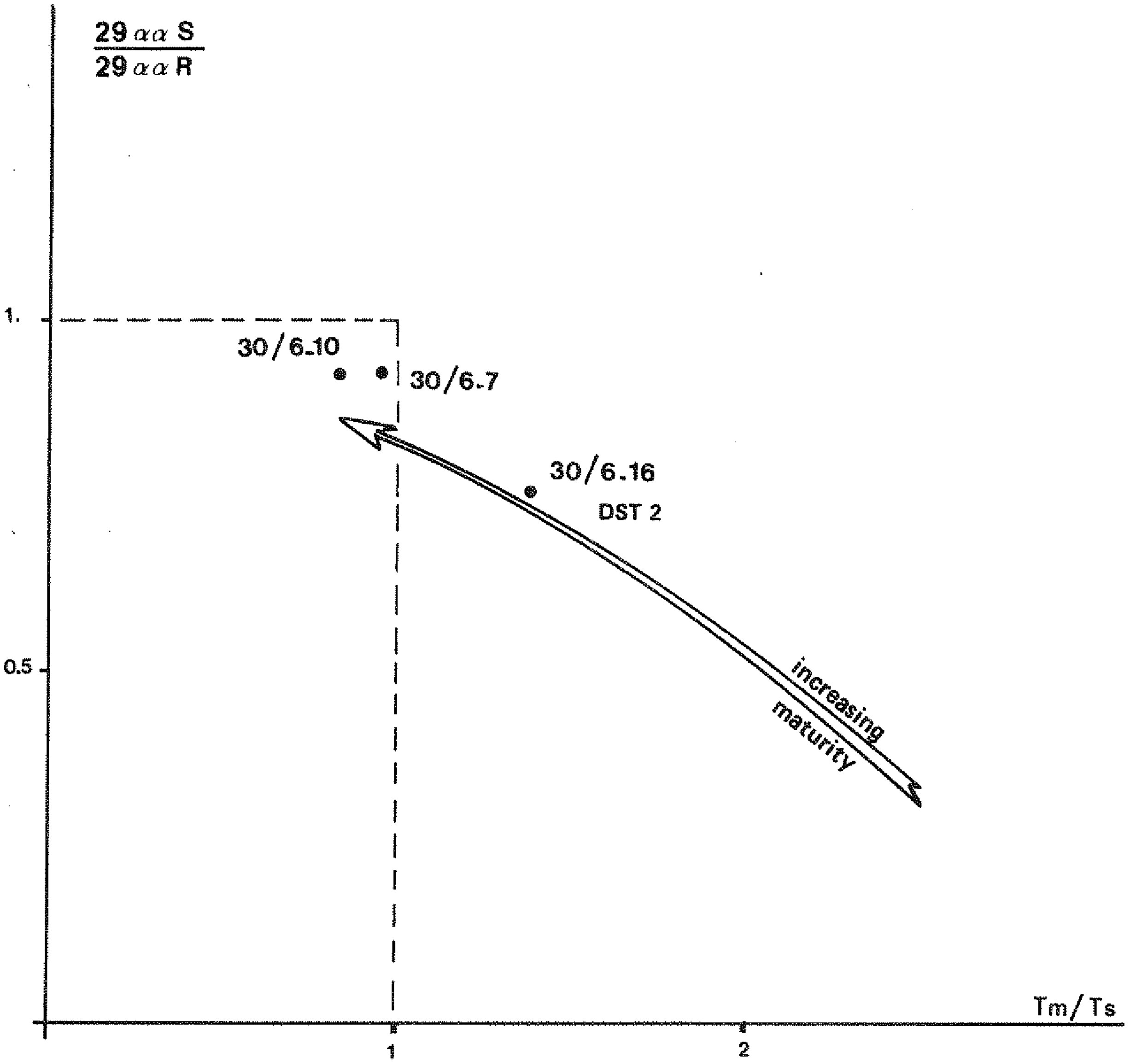

Fig. 4 - MATURATION STATE OF OILS FROM STERANES AND TERPANES

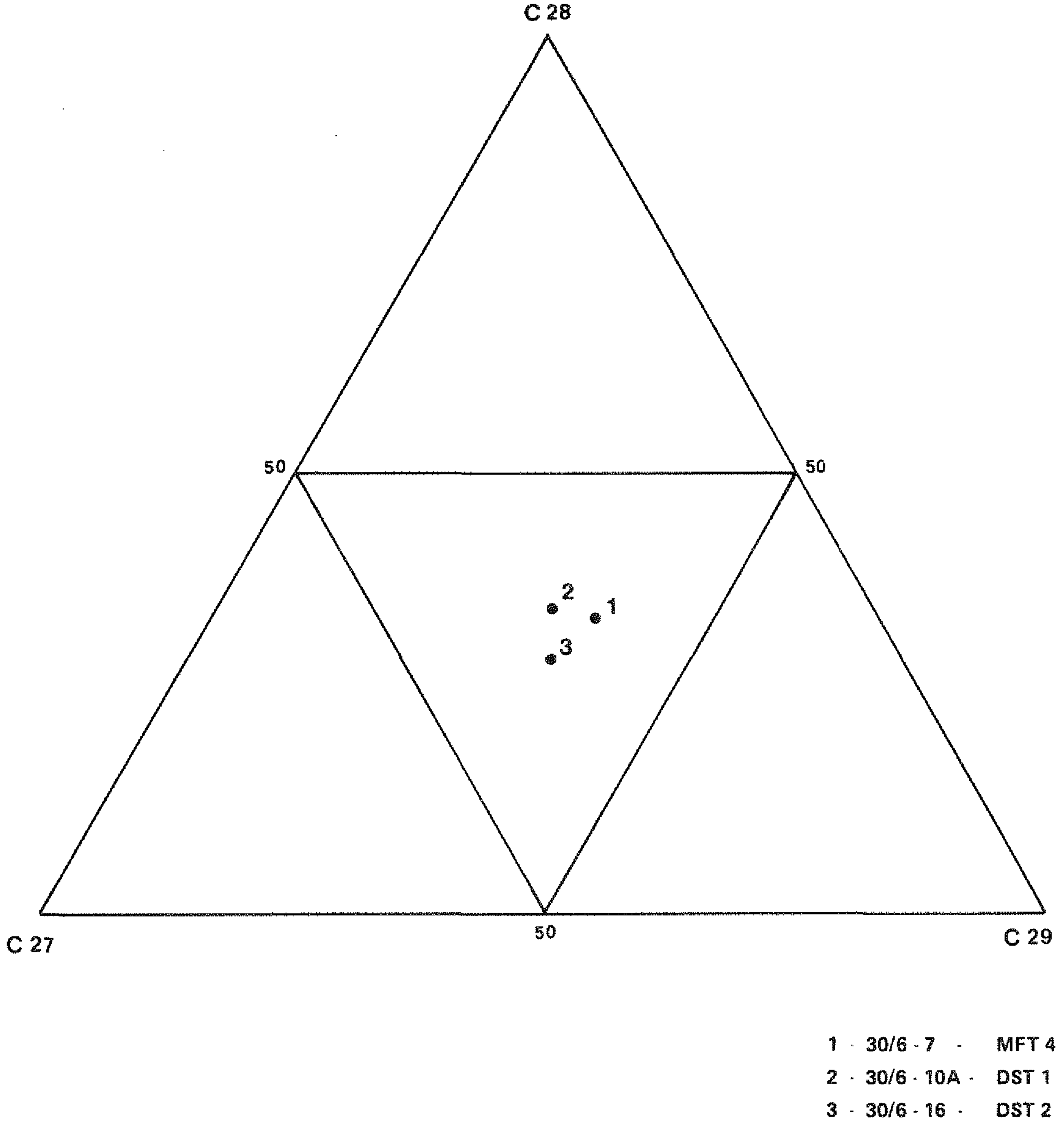

Fig. 5 - DISTRIBUTION OF C27, C28 AND C29 $\beta\beta$ S STERANES

A.10691

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PAYS *Country* : **NORWAY**

SONDAGE *Well* : **30 / 6 - 16**

Huile *Oil*

Cote *Depth* **2920 - 2944 m**

Identification *Identification* **DST 1**

Formation *Formation* **DUNLIN**

Age *Age* **L. JURASSIC**

Plate 1

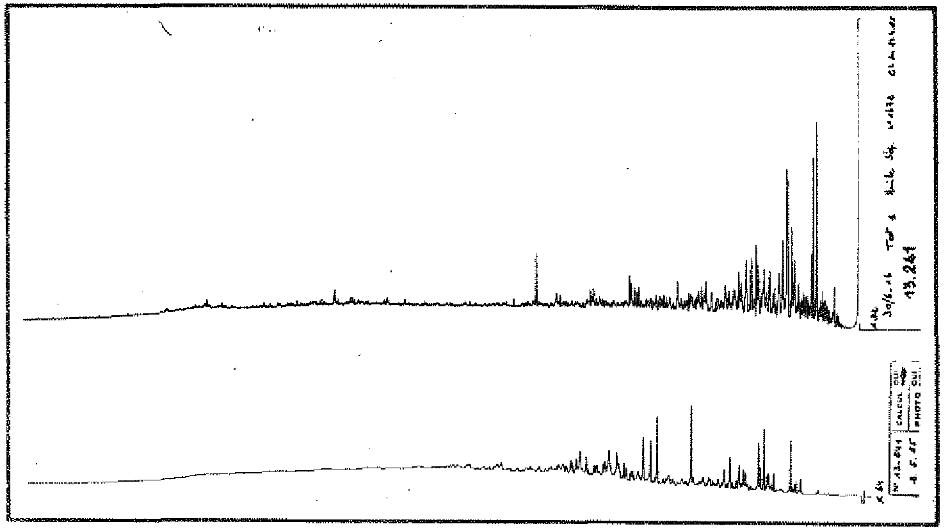
sp. gravity . 860

Sulphur (%) . 38

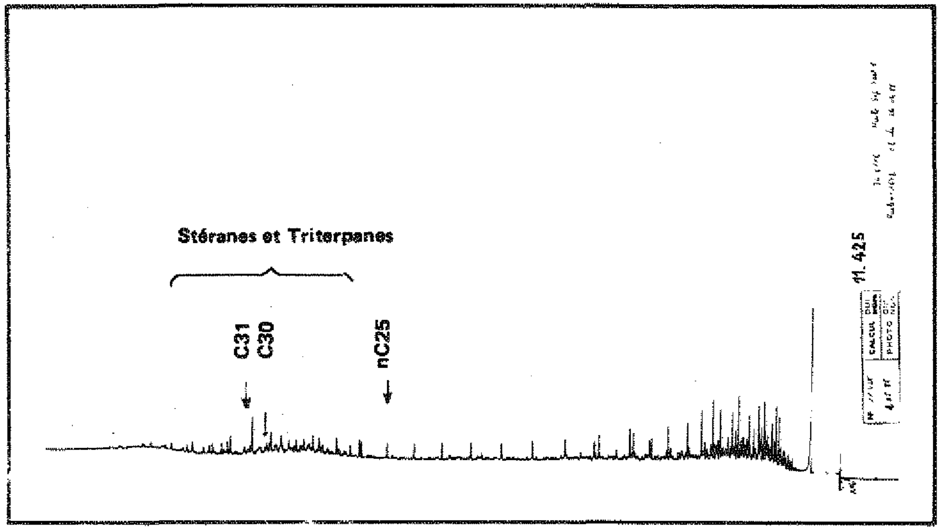
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	: 0.7
Résines *Resins*	R	: 8.2
HC saturés *Saturated HC*	S	: 30.3
HC aromatiques *Aromatic HC*	A	: 28.5
Distillat *Distillate*	D	: 32.1

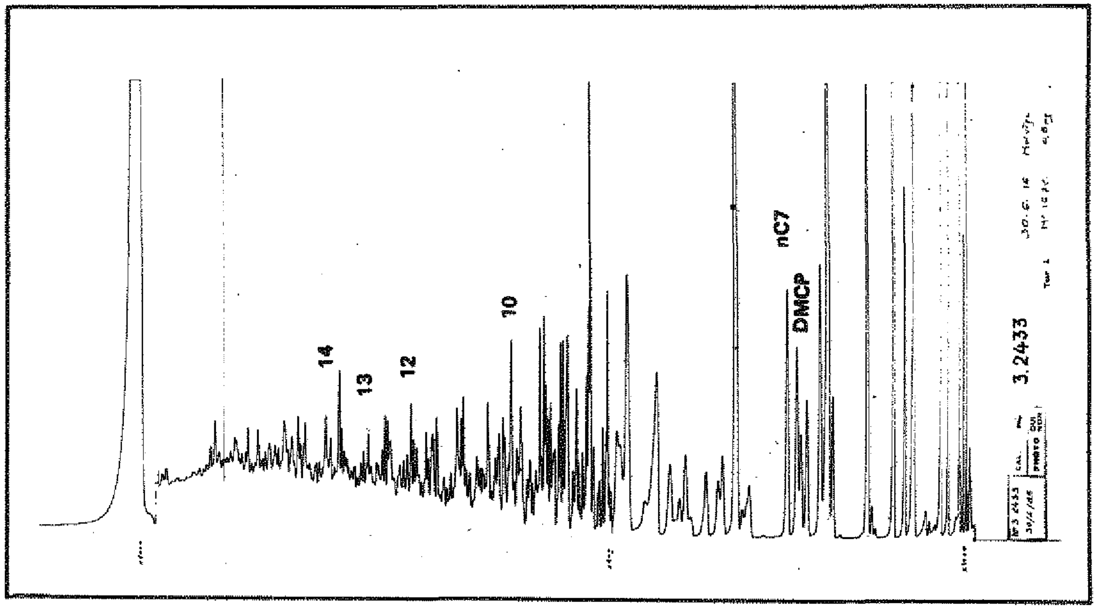
$$\frac{S}{A} = 1.06$$



HC AROMATIQUES *AROMATIC. HC.*



HC SATURES *SATURATED HC.*



HC THERMOVAPORISES *THERMOVAPORIZED HC.*

A.10692

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PAYS / *Country* : **NORWAY**

SONDAGE / *Well* : **30 / 6 - 16**

Huile / *Oil*

Cote / *Depth*	**2855 - 2868 m**
Identification / *Identification*	**DST 2**
Formation / *Formation*	**DUNLIN**
Age / *Age*	**L. JURASSIC**

Plate 2

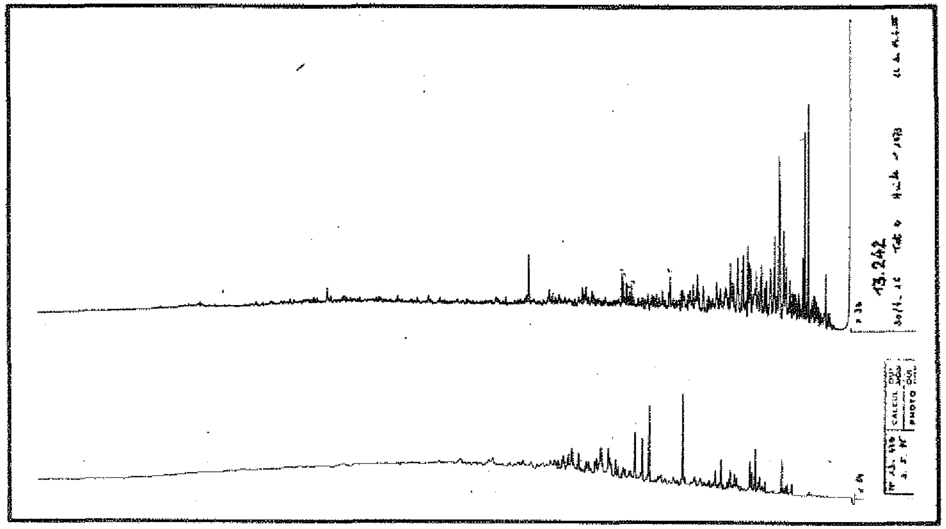
sp. gravity .852

Sulphur (%) .31

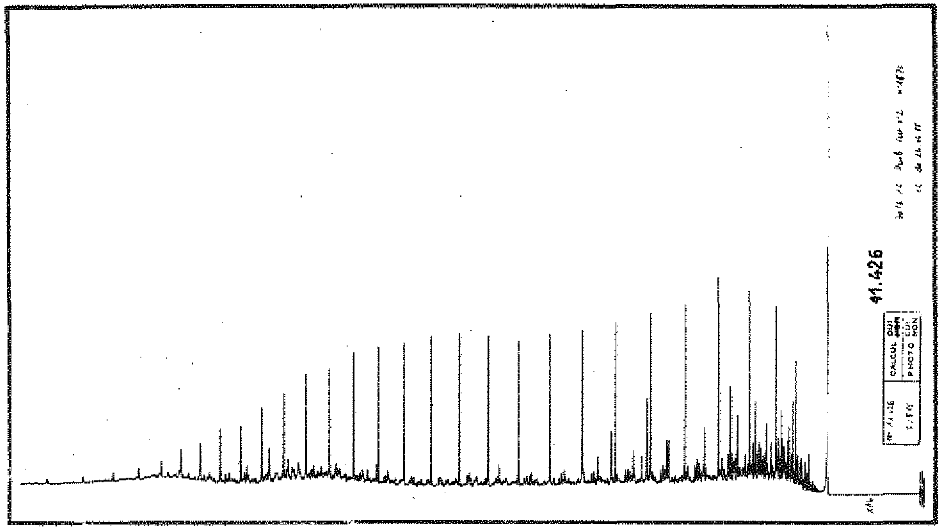
Composition du produit total (%)
Composition of total product

Asphaltènes / *Asphaltenes*	As	: 0.9
Résines / *Resins*	R	: 6.9
HC saturés / *Saturated HC*	S	: 35.6
HC aromatiques / *Aromatic HC*	A	: 24.6
Distillat / *Distillate*	D	: 31.9

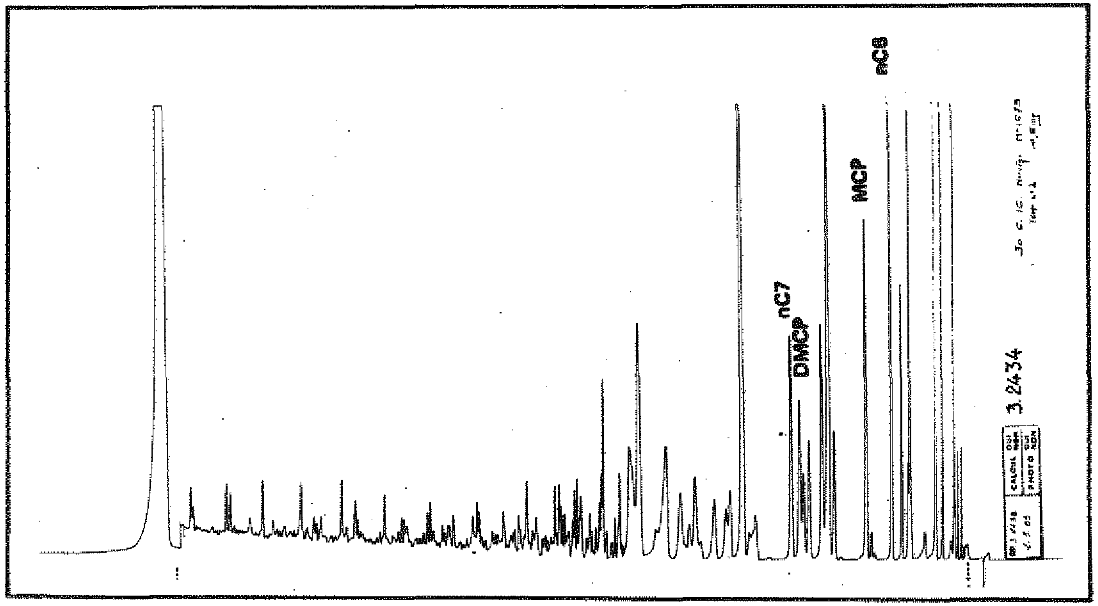
$\frac{S}{A} = 1.45$



HC AROMATIQUES *AROMATIC HC.*



HC SATURES *SATURATED HC.*



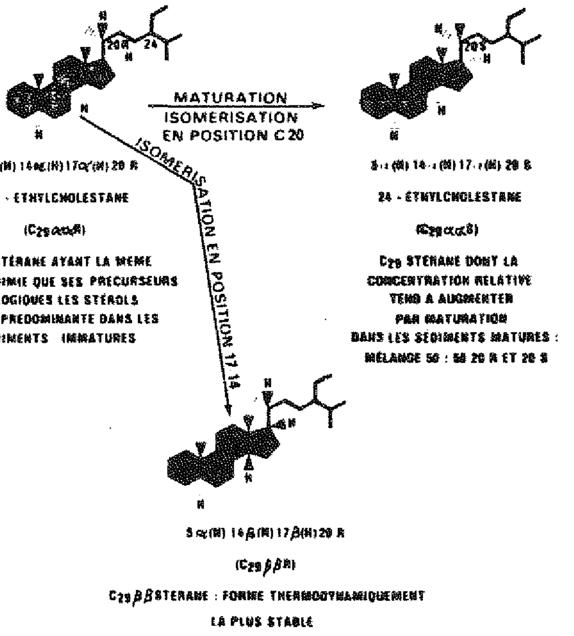
HC THERMOVAPORISES *THERMOVAPORIZED HC.*

A.10693

L'ÉVALUATION DE LA MATURITÉ DE LA MATIÈRE ORGANIQUE PAR L'ANALYSE CG-SM DES STÉRANES

● LES BASES DE L'INTERPRÉTATION

- LES STÉRANES SE RÉORGANISENT PAR ISOMÉRISATION EN POSITION 20,14 ET 17
- L'APPARITION DES DIFFÉRENTES STRUCTURES DÉPEND DE L'HISTOIRE THERMIQUE



5α(H) 14α(H) 17α(H) 20 R

24 - ETHYLCHOLESTANE

($C_{29}\alpha\alpha R$)

C_{29} STÉRANE AYANT LA MEME STEREOCHIMIE QUE SES PRECURSEURS BIOLOGIQUES LES STÉROLS FORME PREDOMINANTE DANS LES SEDIMENTS IMMATURES

5α(H) 14α(H) 17α(H) 20 S

24 - ÉTHYLCHOLESTANE

($C_{29}\alpha\alpha S$)

C_{29} STERANE DONT LA CONCENTRATION RELATIVE TEND A AUGMENTER PAR MATURATION DANS LES SÉDIMENTS MATURES : MÉLANGE 50 : 50 20 R ET 20 S

5α(H) 14β(H) 17β(H) 20 R

($C_{29}\beta\beta R$)

$C_{29}\beta\beta$ STERANE : FORME THERMODYNAMIQUEMENT LA PLUS STABLE

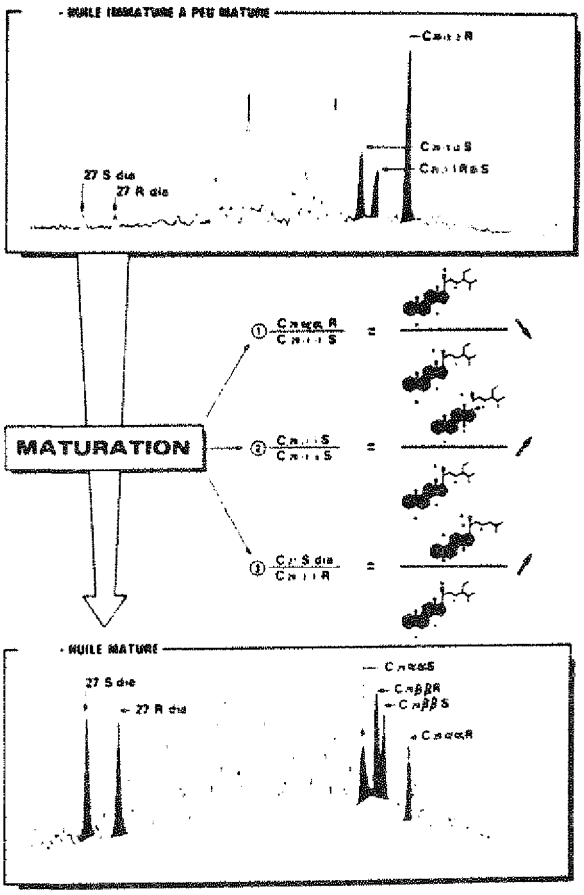
▨ STÉRANES RÉGULIERS $\alpha\alpha$ R et S-CONFIGURATION 5α(H) 14α(H) 17α(H)

■ STERANES RÉGULIERS $\beta\beta$ R et S-CONFIGURATION 5α(H) 14β(H) 17β(H)

▧ STERANES RÉARRANGÉS OU DIASTÉRANES

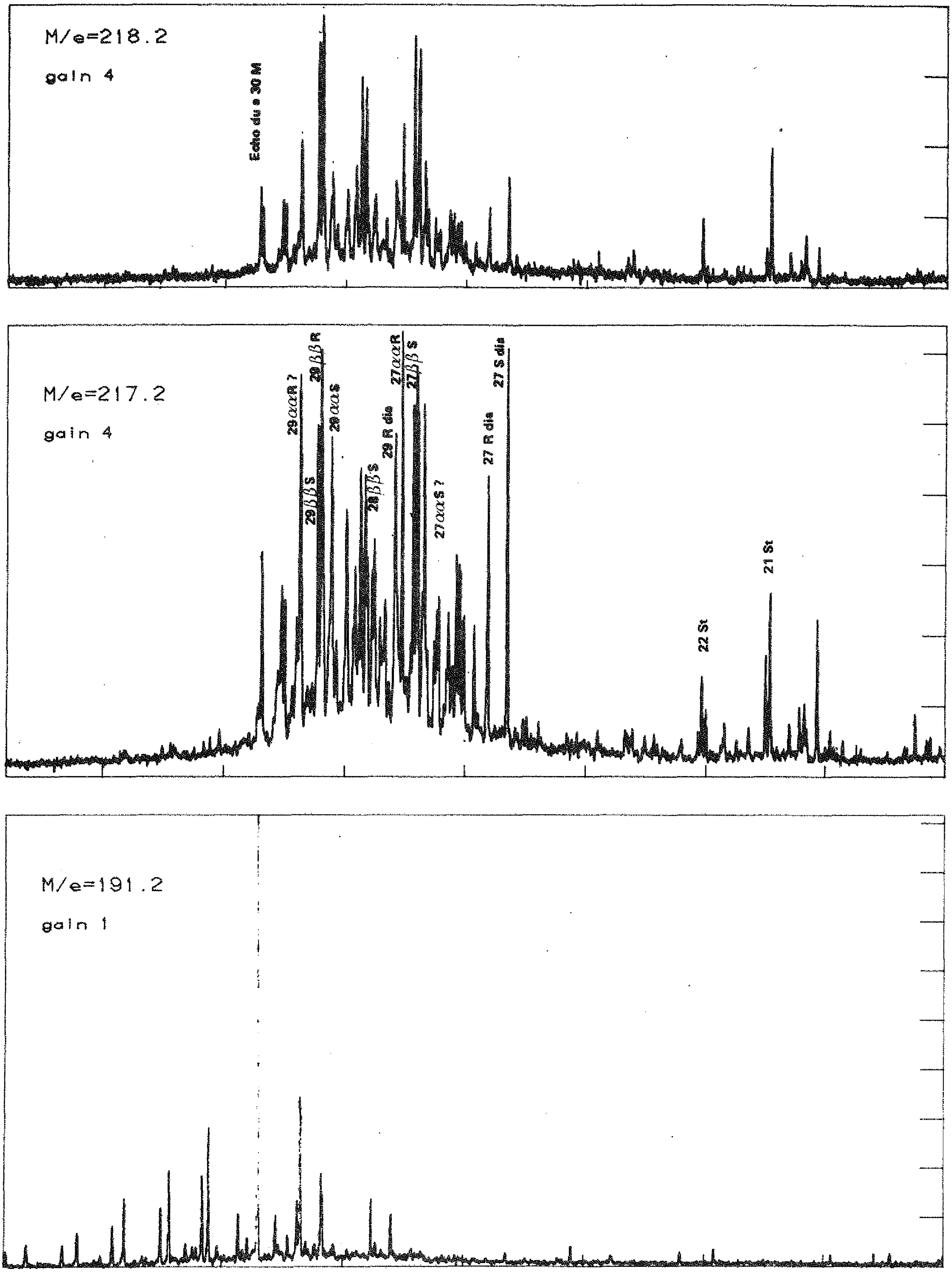
● L'ANALYSE DES STÉRANES PAR FRAGMENTOMÉTRIE DE MASSE (m/z 217)

- MODIFICATION DES EMPREINTES STÉRANIQUES PAR MATURATION
- ÉVALUATION DE LA MATURITÉ PAR MESURE DE RAPPORTS CARACTÉRISTIQUES SUR STÉRANES

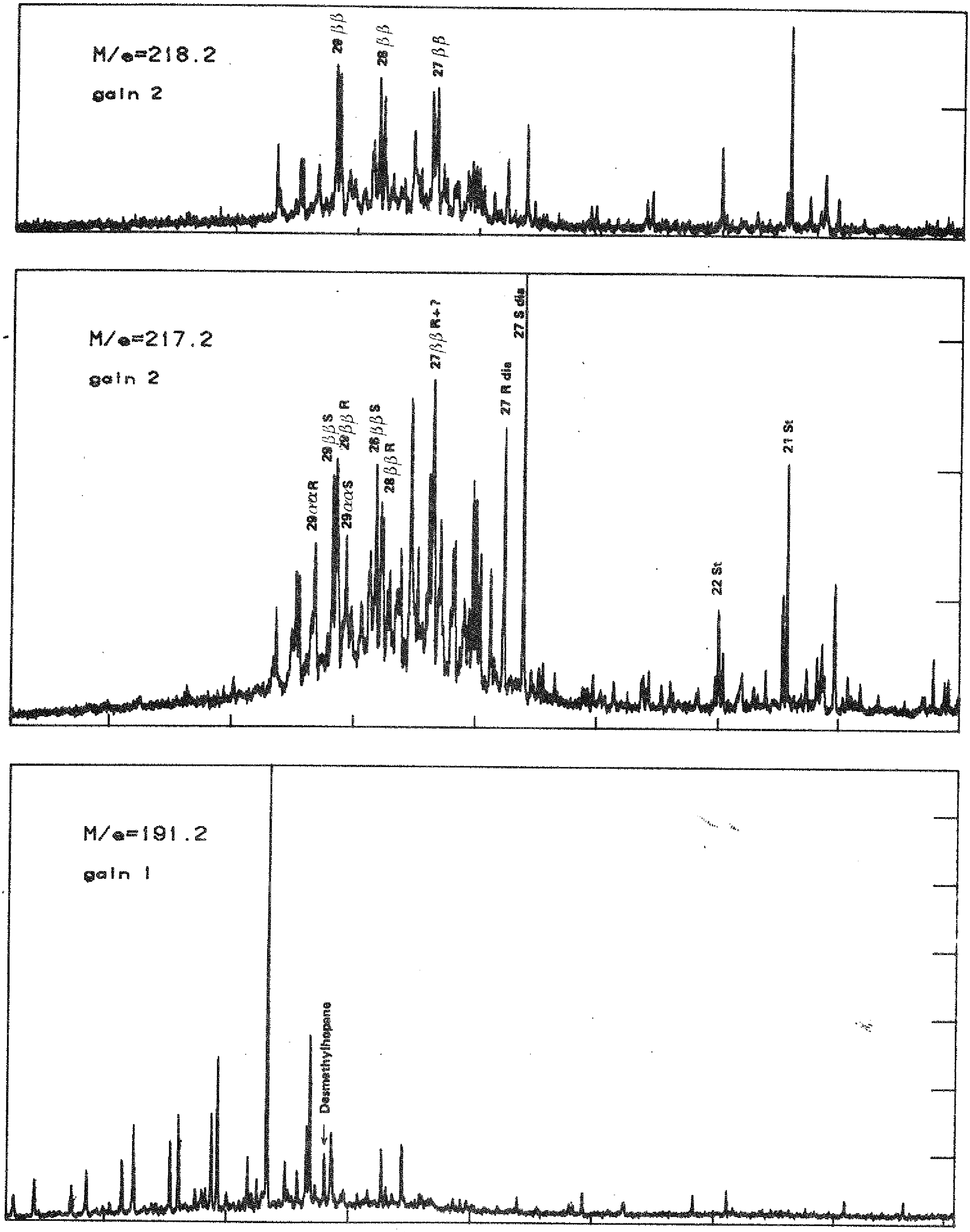


D'après J. CONNAN (1984) poster Séminaire Exploration (non publié)

PL.4 30/6-16 TEST2. SATURES



PL. 5 30/6-7 MFT4 2676m SATURES



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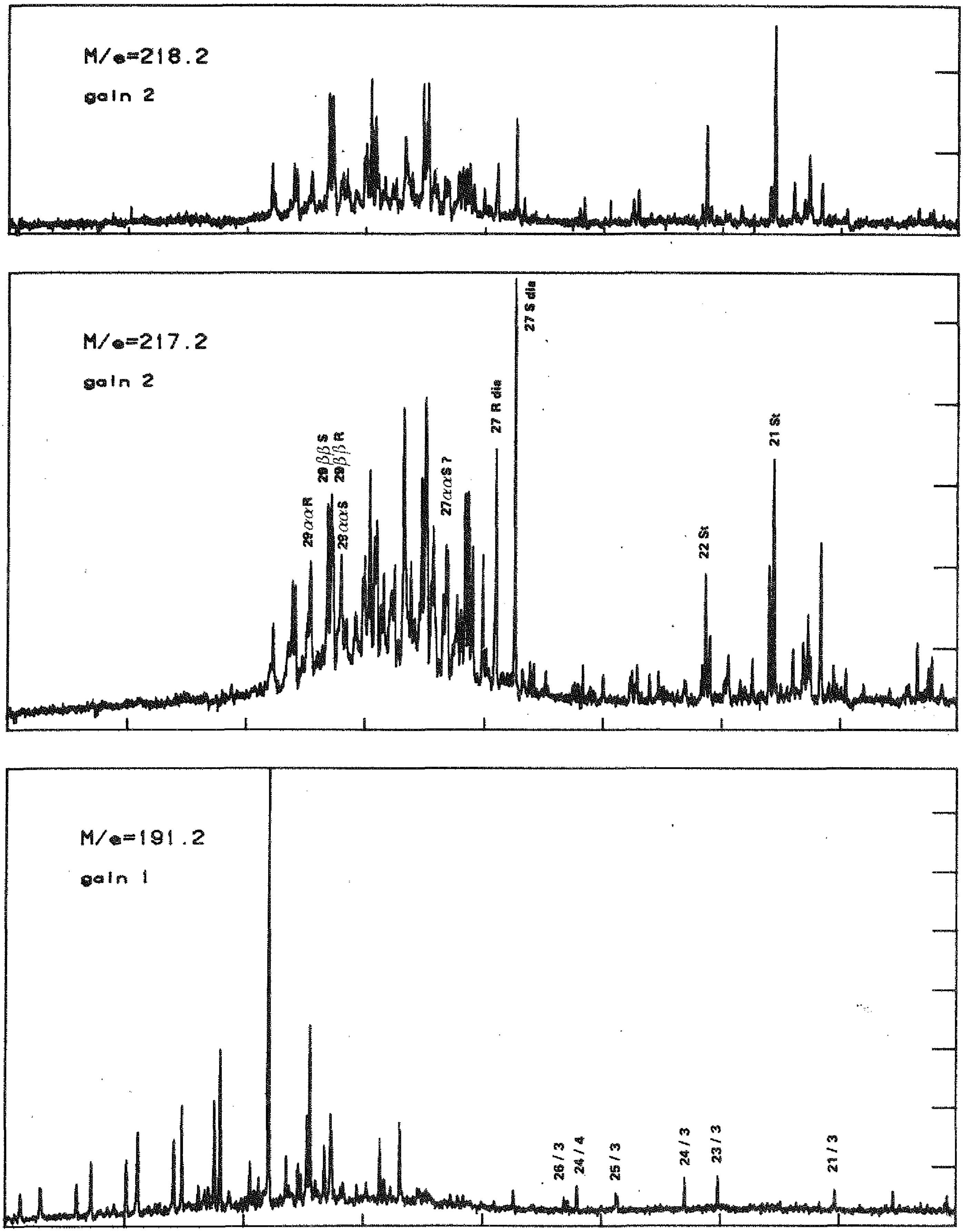
PL.6 30/6-10A DST1 SATURES



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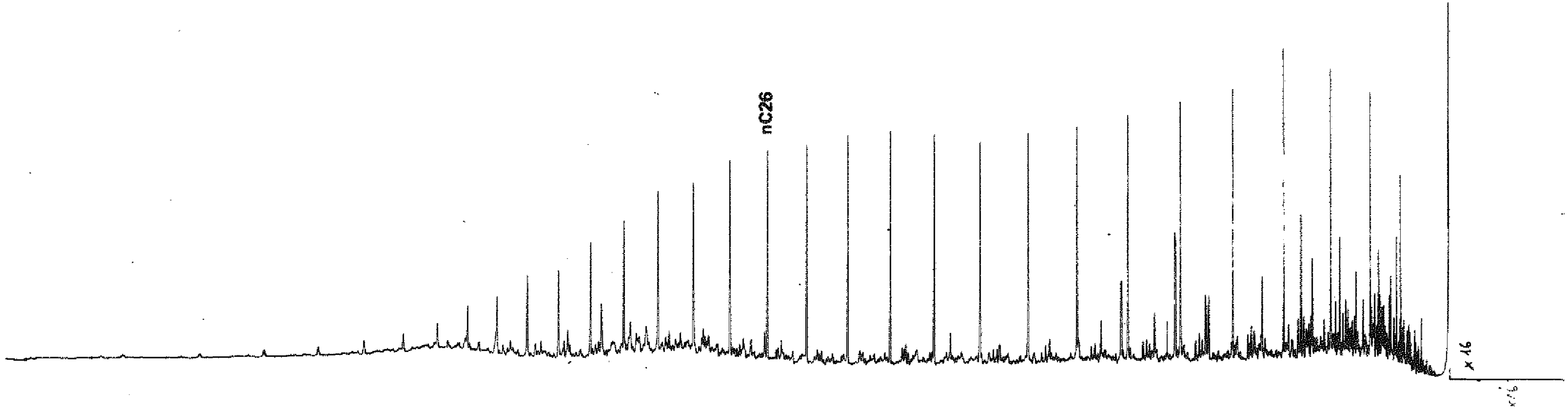
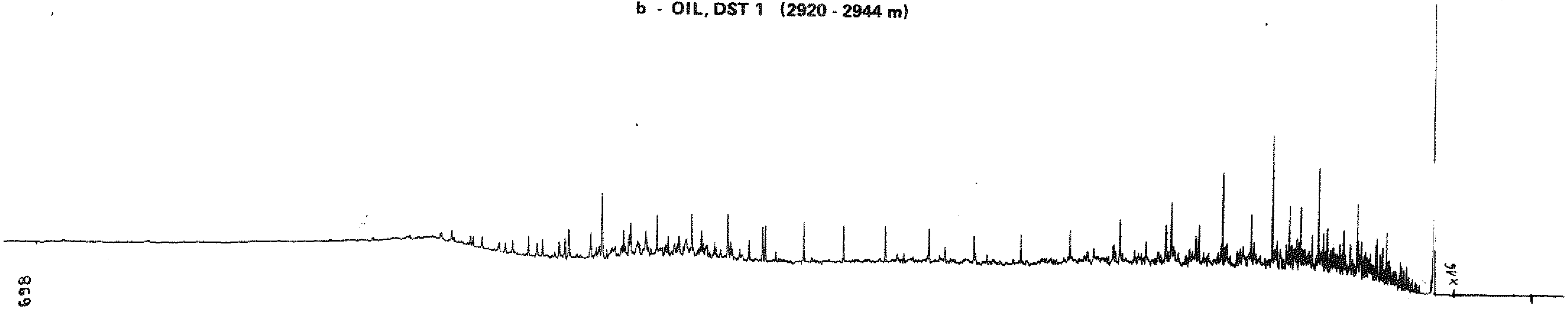
Pl. 7 - CHROMATOGRAMS OF SATURATES



a - OIL, DST 2 (2855 - 2868 m)

b - OIL, DST 1 (2920 - 2944 m)



c - EXTRACT, CAR. 3 (2889,6 m)

A. 10698