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29/9-1 WELL
(NORWAY)

u-390

ORGANIC GEOCHEMICAL STUDY

(3046 - 4700m)

EP/S/EXP/Lab.Pau n°87/101RP

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TITLE : 29/9-1 WELL (NORWAY)
ORGANIC GEOCHEMICAL STUDY (3 046 - 4 700 m)

REFERENCE : EP/S/EXP/Lab.Pau n° 87/101RP

SUMMARY

The geochemical study carried out on the organic matter from well 29/9-1 between 3 046 m (Cretaceous) and 4 690 m (Statfjord Fm) mainly shows that :

- in the Cretaceous the organic matter in not abundant and has a very low petroligen potential

- in the Jurassic the organic matter is abundant and has a medium to high residual petroligen potential (particularly in the coaly levels).

The degree of maturation reaches 1 % to equivalent in the Brent/Dunlin Formation.

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This report presents the results of the study in organic geochemistry carried out on the organic matter from the 29/9-1 well (location map on fig. 1) between 3 046 m (Cretaceous) and 4 700 m (Statfjord Fm).

1 - ORGANIC CARBON CONTENT (TOC on table 7)

The total organic carbon is :

- Lower than 0.6 % in the Cretaceous
- 1 to 5 % in the Draupne and Heather
- 9 and 12.5 in coal from the Brent
- 1 to 8.5 in the Dunlin Fm
- Lower than 1.5 % in the Statfjord Fm.

2 - ORGANIC MATTER MATURATION

2.1 - Tmax of Rock Eval (Table 1)

No reliable Tmax are available from the pyrolysis of the Cretaceous samples, because of the too low S2 amount.

Draupne/heather : Tmax from 430°C to 445°C
Brent/Dunlin : Tmax is around 465°C

No available Tmax on the Statfjord Fm.

2.2 - Data from GC

The methylphenantrene indices (MPI 1 and 2, see table 2) show an increase from ~ 0.6 in the Cretaceous up to 1 in the Dunlin Formation.

The proportion of isoprenoids is low, particularly low phytane/n-C18 ratios.

So the Jurassic section from Heather to the bottom of the Dunlin in throught to be around 1 % Ro equivalent.

3 - NATURE OF ORGANIC MATTER

3.1 - According to the Rock Eval pyrolysis (table 1, fig. 2), hydrogen indices are lower than 110 mg HC/g TOC in the Cretaceous and the oxygen index are higher than 120 mg CO2/g TOC.

In the whole Jurassic the HI are lower than 85 mg HC/g TOC, but the oxygen index are lower than the OI from the Cretaceous.

If the kerogen from the Cretaceous belong exclusively to type III, the kerogen from the Jurassic have to be considered taking into account the high degree of maturation, as bad type II intermediate with type III.

3.2 - Extracts (table 2, fig. 3 and 4)

From Cretaceous to Heather Fm the amonts of chloroformic extract (EOM) are high up to 8 300 ppm in the kimmeridgian and represent up to 32 % of organic carbon contents. These hydrocarbons may be considered as migrated product. In the Brent and Dunlin the EOM amounts are between 1 000 and 2 000 ppm but represent less than 5 % of the organic contents.

All the C15+ fraction are characterised by a rather paraffinic distribution, the abundance of the methylated naphtalenes and the scarcity of the methylated benzothiophene.

(The main characteristics of the condensate* are not found here : high development of the heavy n-alkanes and large predominance of pristane over phytane).

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* 29/9-1 well geochemical study of a condensate sample - P. CAILLEAUX n° 033/85 RP

4 - PETROLIGEN POTENTIAL

The residual petroligen potential is estimated by the peak S2 from the Rock Eval analyses.

Cretaceous : The residual potential is very low (< 1 mg HC/g Rock)

Kimeridgian/Heather : The residual petroligen potential is medium from 1 to 3 mg HC/g Rock.

Brent/Dunlin : The average of the residual potential is medium to high with some coaly levels which reach 7 mg HC/f of rock, in spite of the degree of maturation.

Statfjord : No residual potential.

5 - CONCLUSION

In the Cretaceous the organic matter is not abundant and has a very low petroligen potential. In the Jurassic, the organic matter is abundant and has a medium to high residual petroligen potential (particularly in the coaly levels). The degree of maturation presumably reaches 1 % Ro equivalent in the Brent/Dunlin Formations.

ABBREVIATIONS AND UNITS USED IN THE TABLES

S	Sample type (K=core, S=SWC, C=cutting)
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)
S3	CO2 produced by pyrolysis (mg CO2/g rock)
PI	Production Index = S1/(S1+S2)
HI	Hydrogen Index (mg HC/ g TOC)
OI	Oxygen Index (mg CO2/g TOC)
TM	Temperature recorded at maximum pyrolysis (°C)
EOM	Extractable Organic Matter (ppm of rock)
SAT	Saturated HC)
ARO	Aromatic HC) % EOM
POL	Polar compounds)
S/A	Saturated HC/Aromatic HC ratio
Pr,Ph	Pristane,Phytane (C19,C20 isoprenoids)
A/B	(Pristane/n-C17)/(Phytane/n-C18)
CPI	Carbon Preference Index (C20-C30)
MPI 1	Methylphenantrene Index 1 = 1.5(2MP+3MP)/(P+1MP+9MP)
MPI 2	Methylphenantrene Index 2 = 3(2MP)/(P+1MP+9MP)

TABLES

TABLE 1 29/9-1 ORGANIC INVENTORY

AGE	DEPTH (m)	S	TOC	S1	S2	S3	PI	HI	OI	TM
C	3046.5	S	0.21	0.05	-	0.34	-	-	160	-
R	3151	S	0.39	0.06	-	0.95	-	-	245	-
E	3251	S	0.60	0.14	0.18	0.71	44	30	120	-
T	3300	S	0.60	0.13	0.17	0.96	43	30	160	-
A	3400	S	0.45	0.25	0.26	0.88	49	60	195	-
C	3450	S	0.43	0.11	0.07	0.67	61	15	155	-
E	3500.5	S	0.51	0.27	0.22	1.13	55	45	220	-
O	3601	S	0.39	0.11	0.11	0.85	50	30	220	-
U	3649.5	S	0.50	0.19	0.20	0.68	49	40	135	-
S	3799	S	0.95	2.14	1.06	1.28	67	110	135	-
	3850	S	0.45	0.06	0.09	0.45	40	20	100	-
	3950	C	0.83	0.29	0.92	4.28	24	110	515	437
KIM	4000	S	4.71	3.82	2.83	0.86	57	60	20	426
	4010/20	C	3.54	1.66	1.73	2.60	49	50	75	438
H	4050/60	C	3.30	1.17	1.97	1.40	37	60	40	445
E	4100	S	1.51	2.25	1.21	1.81	65	80	120	433
A	4150	S	2.20	2.25	1.83	0.96	55	85	45	438
T	4200/10	C	1.82	0.88	1.35	0.77	39	75	40	450
H	4250/60	C	2.16	1.43	1.53	1.27	48	70	60	451
E	4284	S	1.23	0.71	0.41	1.09	63	35	90	-
R	4300/10	C	2.44	1.20	1.27	1.10	49	50	45	447
	4352	S	1.68	0.89	1.31	1.84	40	80	110	(417)
Br.	4400.07	K1	9.09	1.81	5.36	4.60	25	60	50	485
	4400/10	C	12.53	1.59	7.36	7.04	18	60	55	438
	4434.25	K3	1.24	0.34	0.53	0.50	39	45	40	476
	4440/50	C	2.56	1.11	1.77	0.43	39	70	15	462
	4450/60	C	4.38	1.49	2.98	0.47	33	70	10	470
	4460/70	C	3.49	0.92	1.94	0.43	32	55	10	467
D	4470/80	C	2.93	1.09	1.88	0.40	37	65	15	466
U	4490	C	7.60	1.18	3.82	2.82	24	50	35	465
N	4500	C	6.35	1.12	3.48	1.12	24	55	30	463
L	4520	C	4.17	0.78	1.82	1.67	30	45	40	460
I	4550/60	C	8.45	1.69	6.99	0.56	19	85	5	464
N	4570/80	C	3.06	0.76	1.61	0.96	32	55	30	462
	4600/10	C	2.62	0.80	1.36	1.04	37	50	40	451
	4620/30	C	6.87	1.25	4.57	2.49	21	65	35	451
	4636	S	1.00	0.30	0.40	1.14	43	40	115	-
S	4650/60	C	0.77	0.20	0.32	0.24	38	40	30	-
T	4670/80	C	1.19	0.14	0.29	0.98	33	25	80	-
A	4690/00	C	0.85	0.09	0.19	0.33	32	20	40	-

TABLE 2   Well: 29/9-1

COMPOSITION OF THE EXTRACTS

DEPTH (m)	EOM ppm	EOM %TOC	SAT. %	ARO. %	POL. %	S/A
3799	3089	32	66.3	16.5	17.2	4.02
4000	8362	18	52.7	26.8	20.5	1.96
4100	2790	18	71.5	13.1	15.4	5.45
4400/10	1810	1	55.0	24.5	20.5	2.24
4450/60	1370	3	55.5	24.0	20.5	2.31
4490/00	1047	1	49.4	24.2	26.4	2.04
4620/30	1660	2	46.7	20.3	33.0	2.30

CHROMATOGRAPHIC DATA

DEPTH (m)	nalk %SAT	Pr /nC17	Ph /nC18	Pr /Ph	A/B	MPI 1	MPI 2
3799	17	0.52	0.43	1.25	1.21	0.586	0.628
4000	15	0.37	0.42	0.90	0.89	0.580	0.620
4100	19	0.73	0.48	1.45	1.51	0.771	0.860
4400/10	21	0.49	0.28	1.72	1.74	0.880	0.980
4450/60	23	0.55	0.30	1.88	1.83	0.985	1.114
4490/00	21	0.55	0.30	1.75	1.81	0.994	1.118
4620/30	19	0.52	0.33	1.58	1.58	0.910	1.050

F I G U R E S

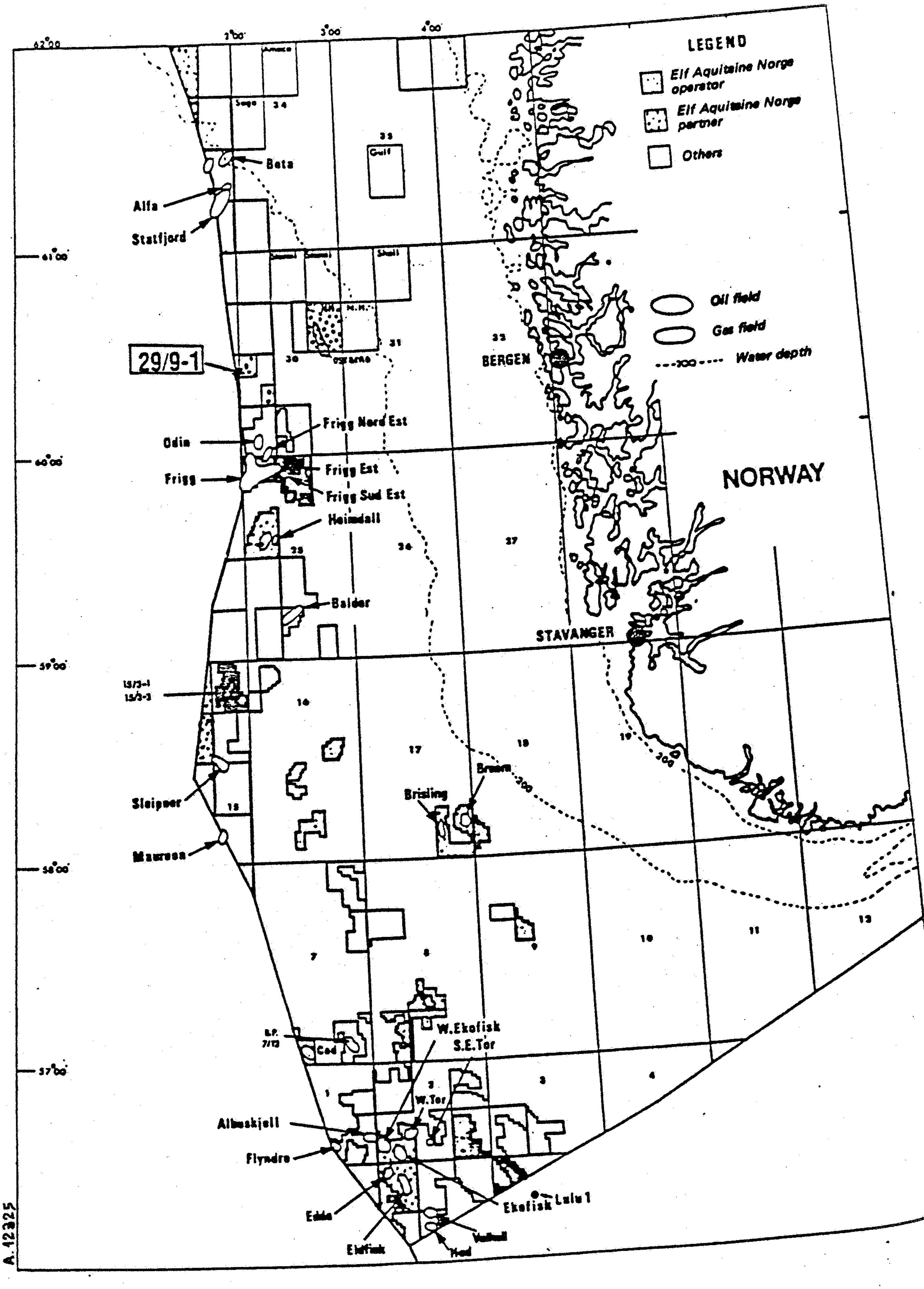
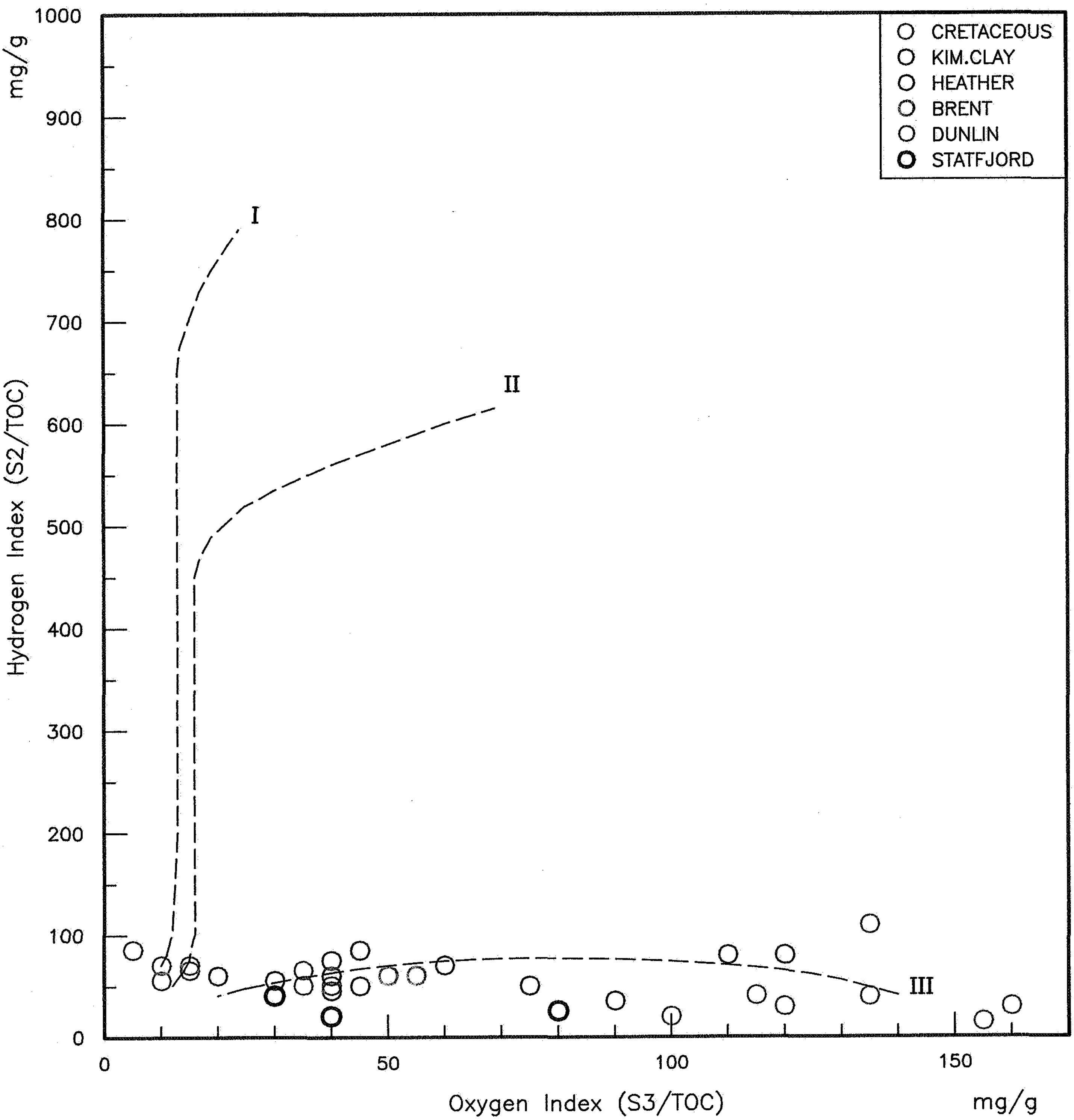


Fig. 1 - 29 / 9 - 1 - LOCATION MAP

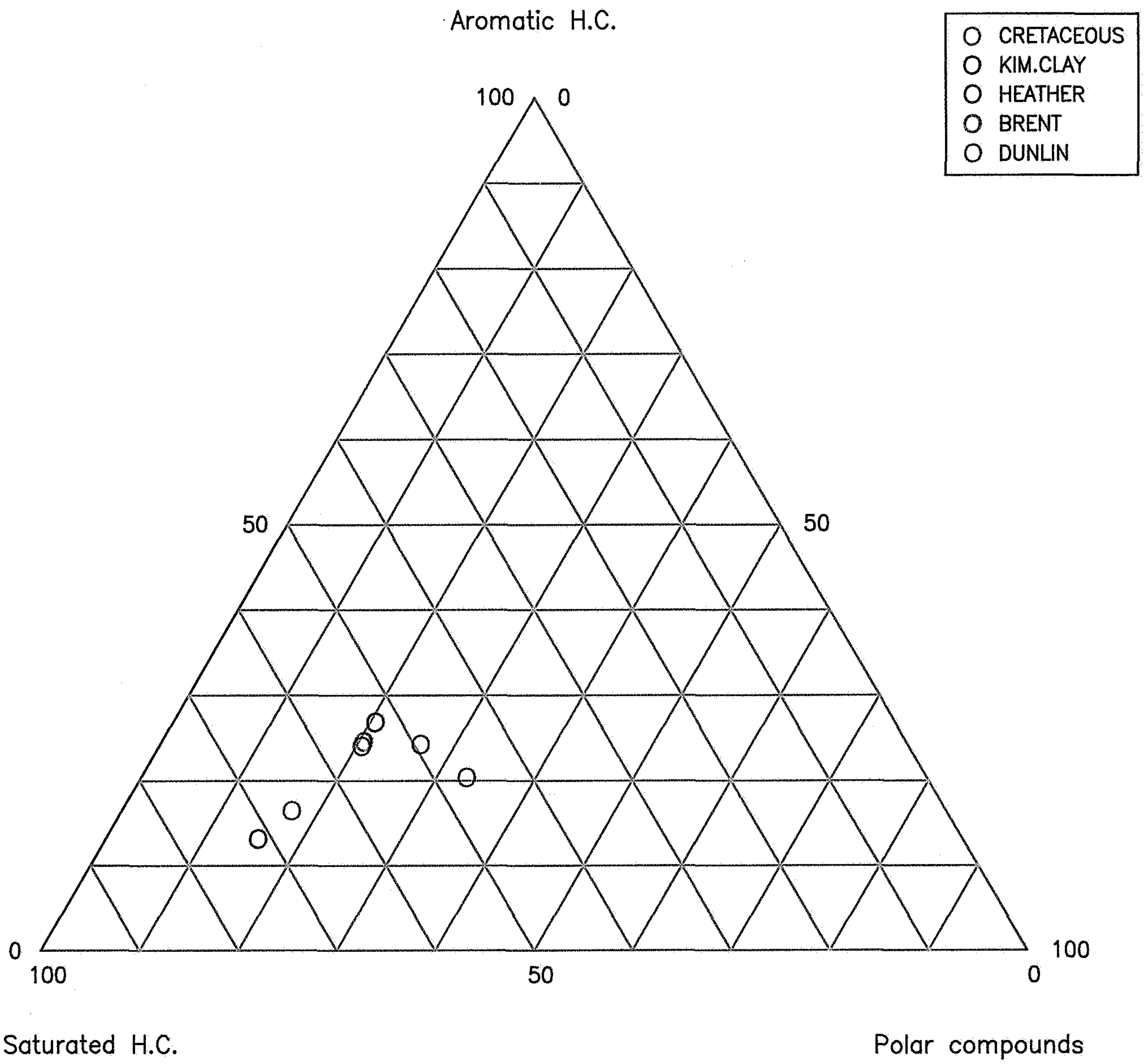
FIG.2 WELL: 29/9-1

HI-OI DIAGRAM



COMPOSITION OF THE EXTRACTS

FIG.3 Well : 29/9-1



INFOLAB

FIG.4 – WELL: 29/9-1

PRISTANE/n-C17 vs PHYTANE/n-C18

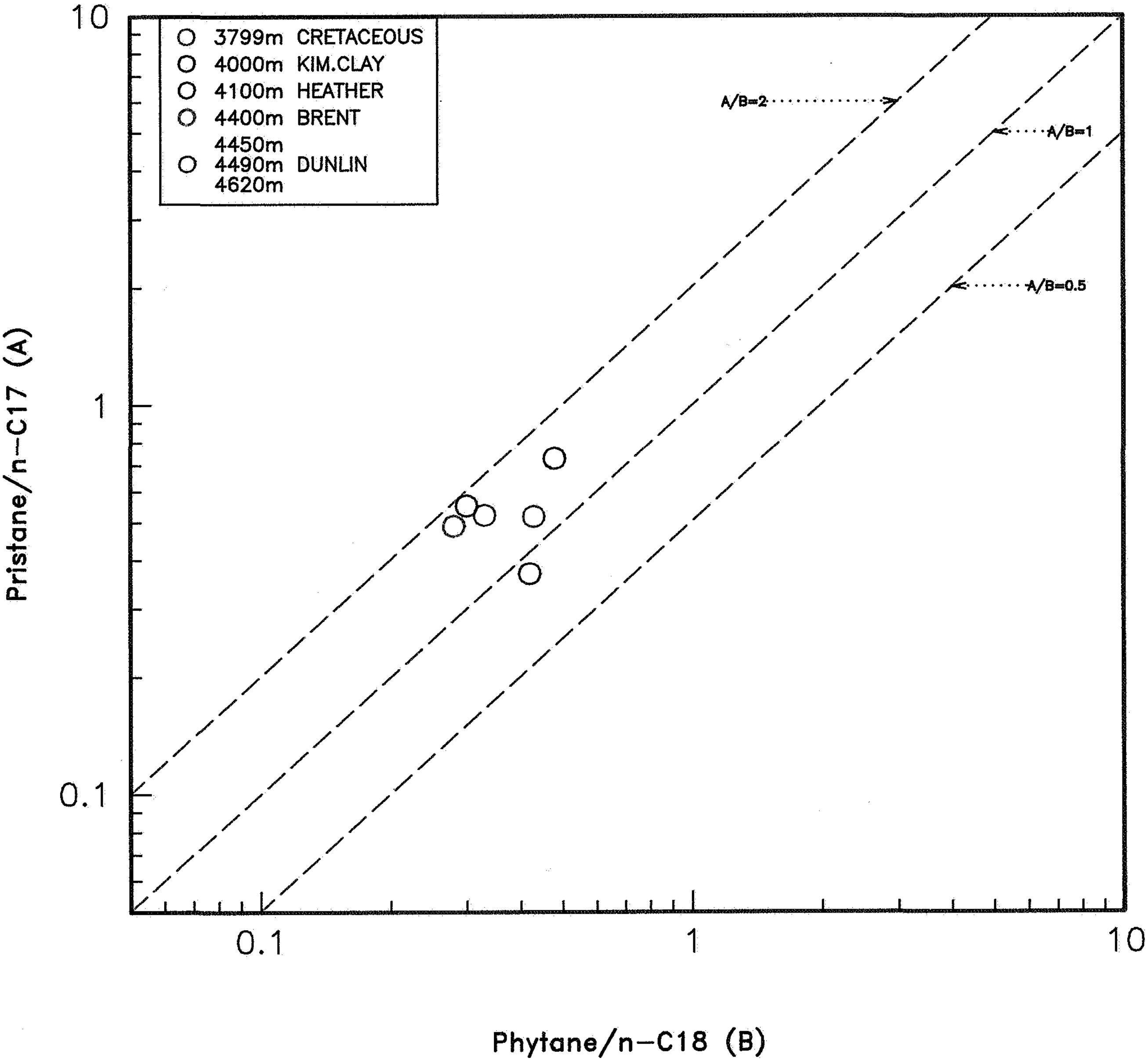


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Fig. 5

PAYS *Country*	:	**NORWAY**
SONDAGE *Well*	:	**29 / 9 - 1**

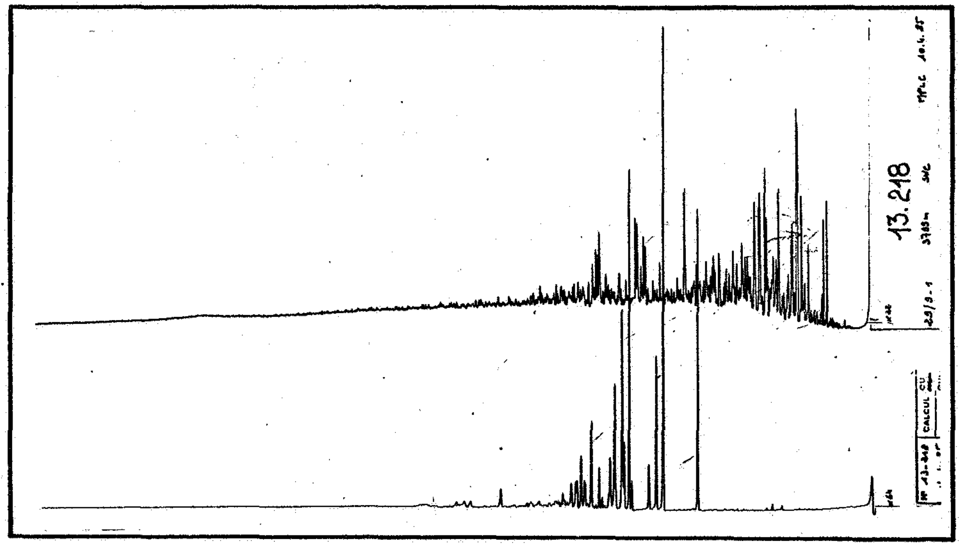
Roche *Rock*	Cote *Depth*	**3799 m**
	Identification *Identification*	**SWC**
	Formation *Formation*	
	Age *Age*	**CRETACEOUS**

EOM : 3089 ppm

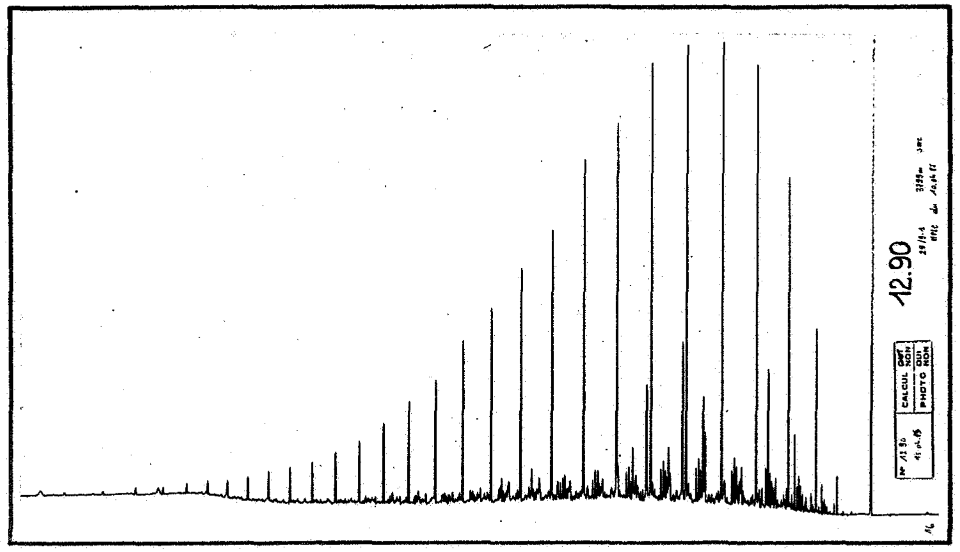
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	17,2 (As + R)
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	66,3
HC aromatiques *Aromatic HC*	A	:	16,5

$\frac{S}{A} = 4,02$



HC AROMATIQUES *AROMATIC HC.*



HC SATURES *SATURATED HC.*

HC THERMOVAPORISES *THERMOVAPORIZED HC.*

A.12326

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Fig. 6

PAYS *Country*	:	**NORWAY**
SONDAGE *Well*	:	**29/9-1**

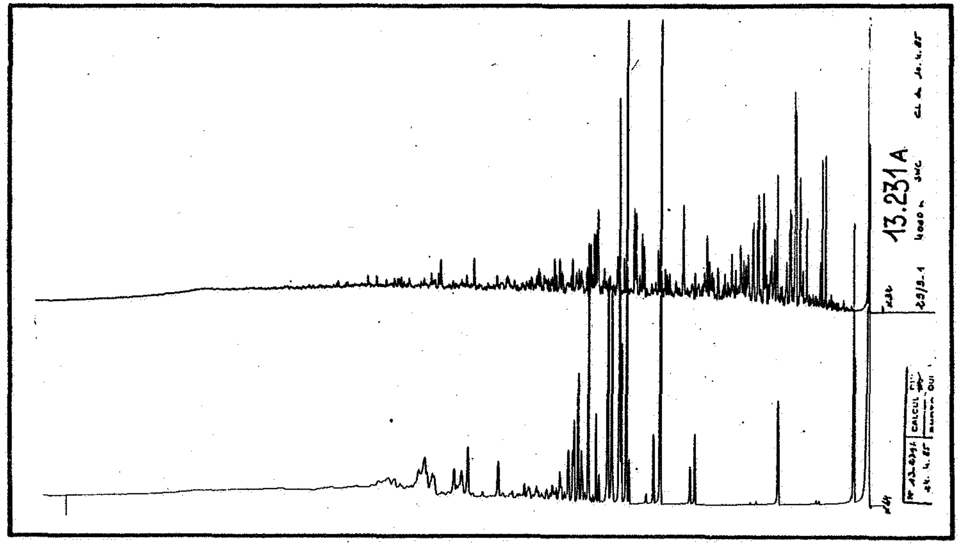
Roche *Rock*		
	Cote *Depth*	**4000 m**
	Identification *Identification*	**SWC**
	Formation *Formation*	**Kimmeridge clay**
	Age *Age*	

EOM : 8632 ppm

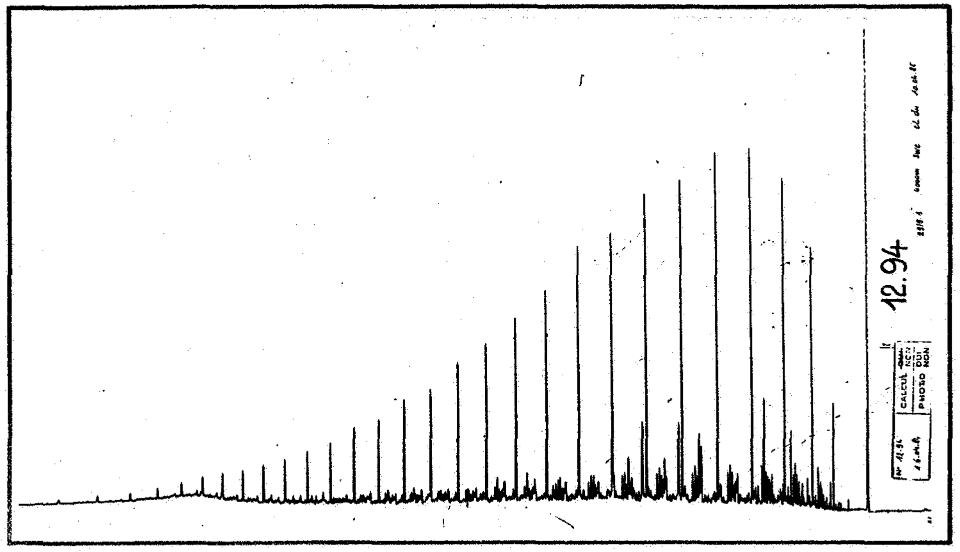
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	20,5 (As + R)
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	52,7
HC aromatiques *Aromatic HC*	A	:	26,8

$\frac{S}{A} = 1,96$



HC AROMATIQUES *AROMATIC HC.*



HC SATURES *SATURATED HC.*

HC THERMOVAPORISES *THERMOVAPORIZED HC.*

A.12327

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PAYS / *Country* : **NORWAY**

SONDAGE / *Well* : **29 / 9 - 1**

Fig. 7

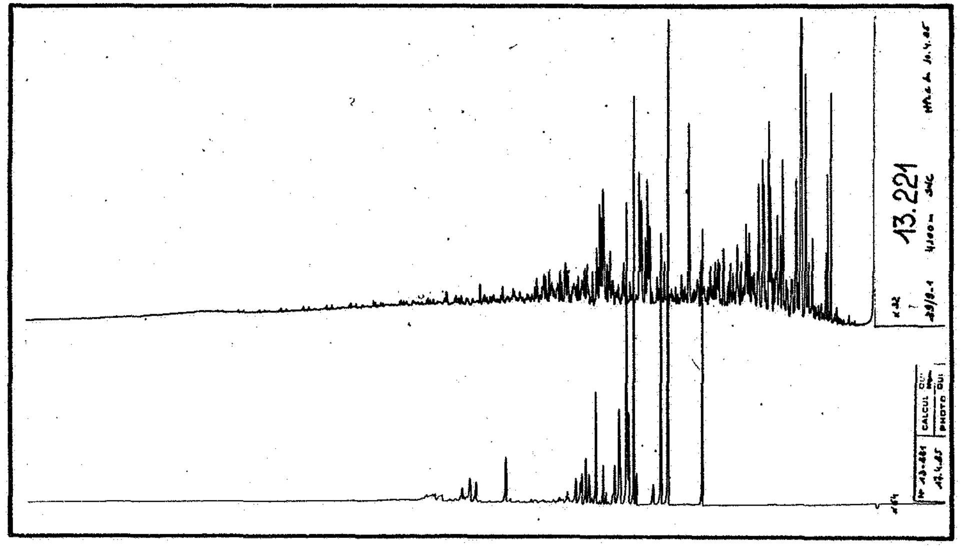
Roche / *Rock*	Cote / *Depth*	**4100 m**
	Identification / *Identification*	**SWC**
	Formation / *Formation*	**Heather**
	Age / *Age*	

EOM : 2790 ppm

Composition du produit total (%)
Composition of total product

Asphaltènes / *Asphaltenes*	As	} 15,4
Résines / *Resins*	R	
HC saturés / *Saturated HC*	S	71,5
HC aromatiques / *Aromatic HC*	A	13,1

$\frac{S}{A} = 5,45$



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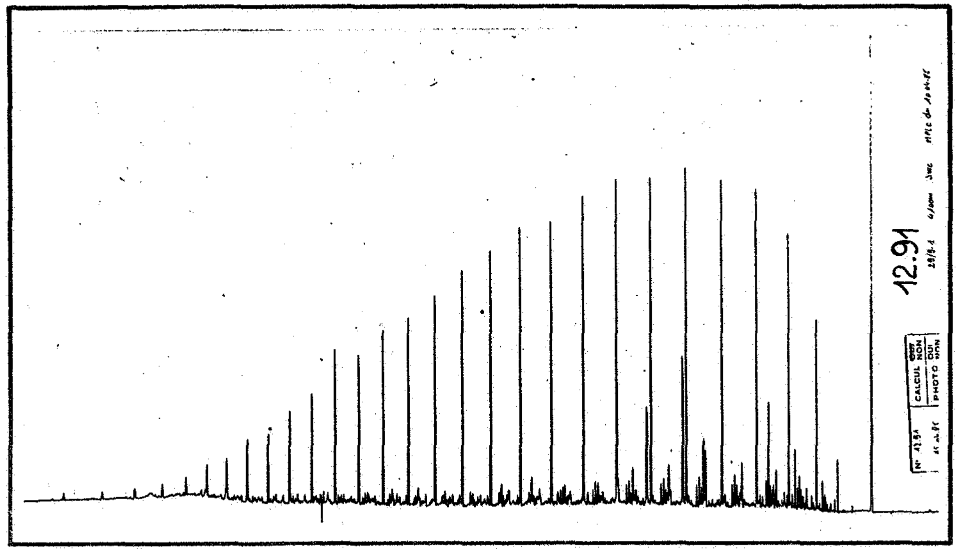

HC SATURES *SATURATED HC.*

HC THERMOVAPORISES *THERMOVAPORIZED HC.*

A. 12328

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Fig. 8

PAYS / *Country* : **NORWAY**

SONDAGE / *Well* : **29 / 9 - 1**

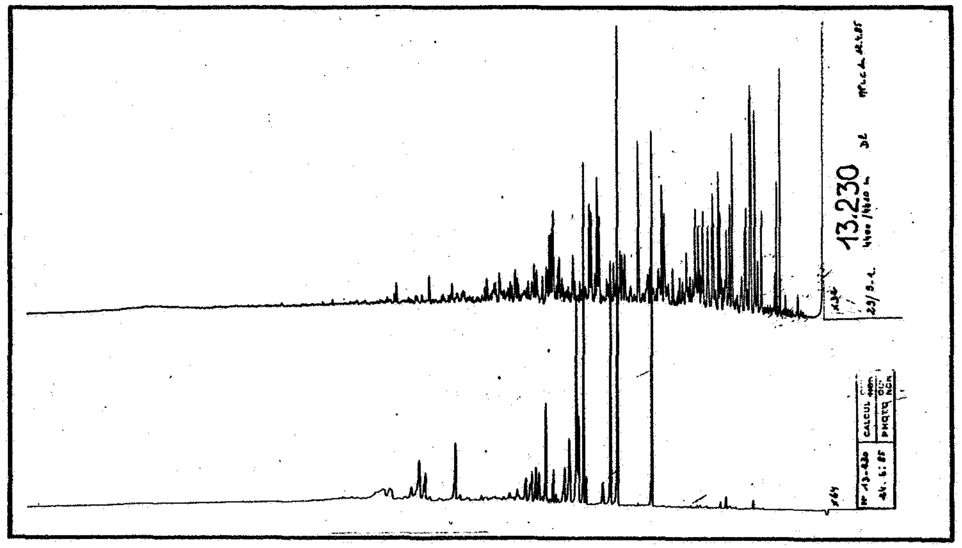
	Cote / *Depth*	**4400 - 4410 m**
	Identification / *Identification*	**Cutting**
Roche / *Rock*	Formation / *Formation*	**Brent**
	Age / *Age*	

EOM : 1810 ppm

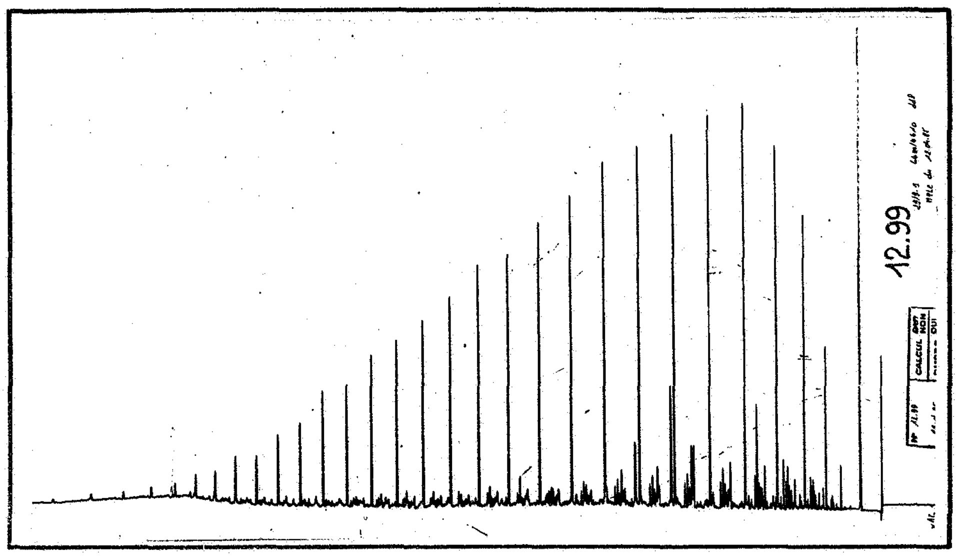
Composition du produit total (%)
Composition of total product

Asphaltènes / *Asphaltenes*	As	:	20,5 (As + R)
Résines / *Resins*	R	:	
HC saturés / *Saturated HC*	S	:	55,0
HC aromatiques / *Aromatic HC*	A	:	24,5

$\frac{S}{A} = 2,24$



HC AROMATIQUES *AROMATIC HC.*



HC SATURES *SATURATED HC.*

HC THERMOVAPORISES *THERMOVAPORIZED HC.*

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Fig. 9

PAYS *Country* : **NORWAY**

SONDAGE *Well* : **29/9-1**

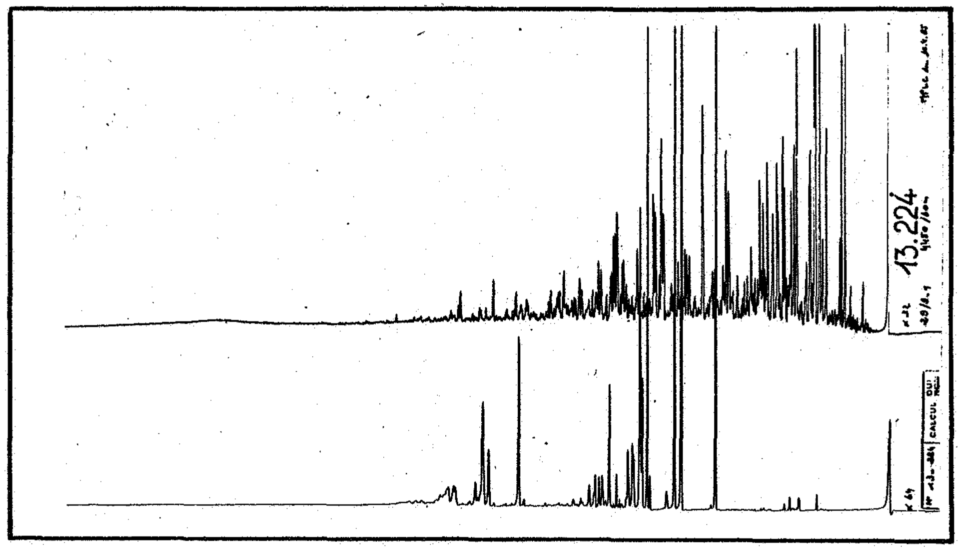
Roche *Rock*	Cote *Depth*	**4450 - 4460 m**
	Identification *Identification*	**Cutting**
	Formation *Formation*	**Dunlin**
	Age *Age*	

EOM : 1370 ppm

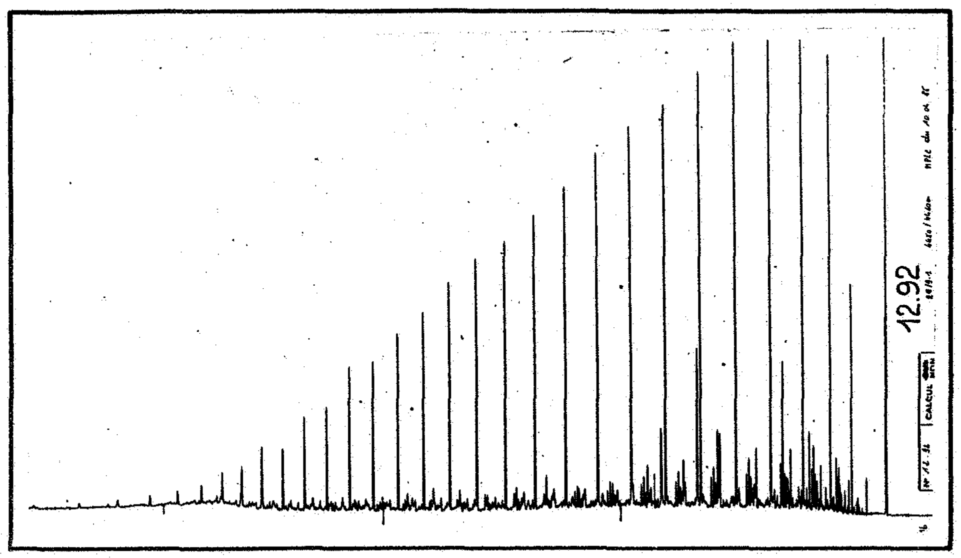
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	20,5 (As + R)
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	55,5
HC aromatiques *Aromatic HC*	A	:	24,0

$\frac{S}{A} = 2,31$



HC AROMATIQUES *AROMATIC HC.*



HC SATURES *SATURATED HC.*

HC THERMOVAPORISES *THERMOVAPORIZED HC.*

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PAYS *Country*	:	**NORWAY**
SONDAGE *Well*	:	**29 / 9 - 1**

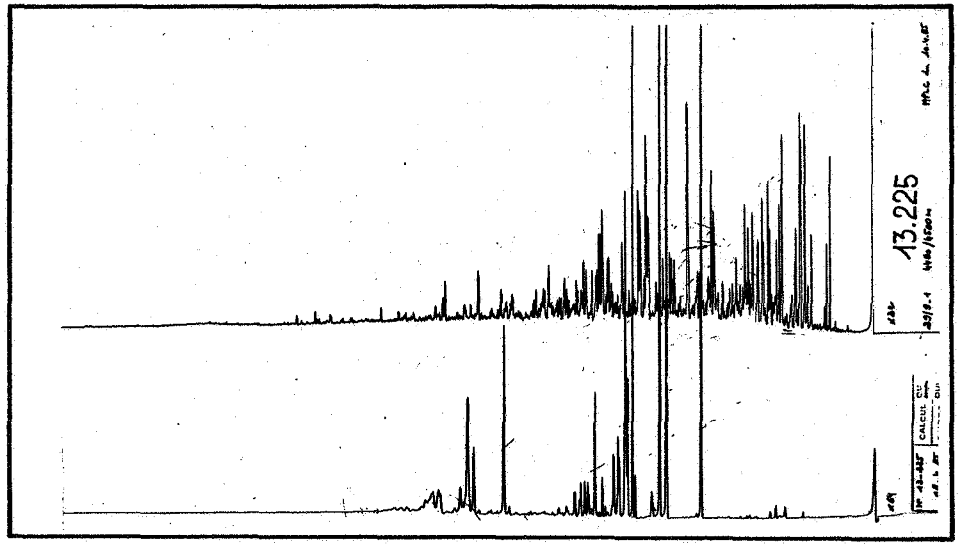
Fig. 10

Roche *Rock*	Cote *Depth*	**4490 - 4500 m**
	Identification *Identification*	**Cutting**
	Formation *Formation*	**Dunlin (Cook)**
	Age *Age*	

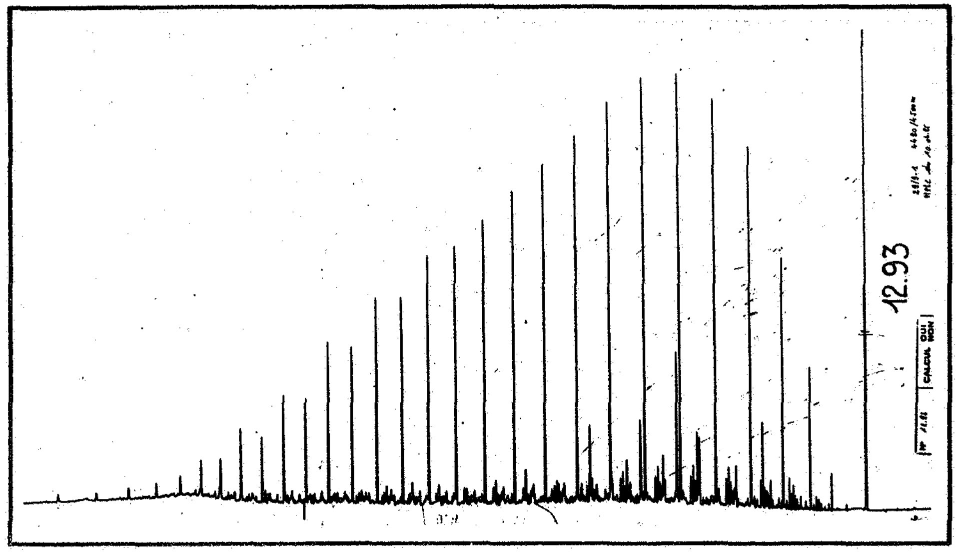
EOM : 1047 ppm

Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	26,4 (As + R)	
Résines *Resins*	R	:		
HC saturés *Saturated HC*	S	:	49,4	$\frac{S}{A} = 2,04$
HC aromatiques *Aromatic HC*	A	:	24,2	



HC AROMATIQUES *AROMATIC HC.*



HC SATURES *SATURATED HC.*

HC THERMOVAPORISES *THERMOVAPORIZED HC.*

A. 12331

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Fig. 11

PAYS *Country* : **NORWAY**

SONDAGE *Well* : **29 / 9 - 1**

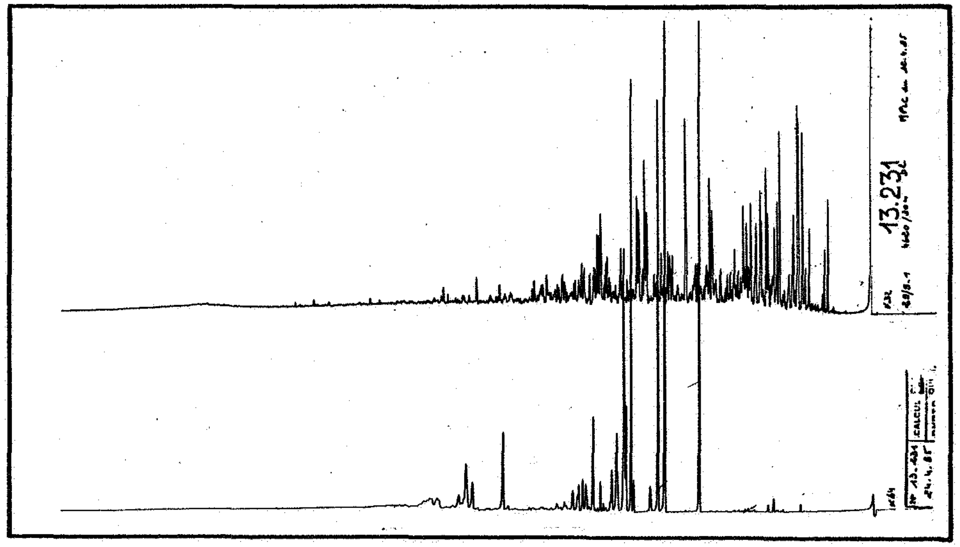
Roche *Rock*	Cote *Depth*	**4620 - 4630 m**
	Identification *Identification*	**Cutting**
	Formation *Formation*	**Dunlin (Burton)**
	Age *Age*	

EOM : 1660 ppm

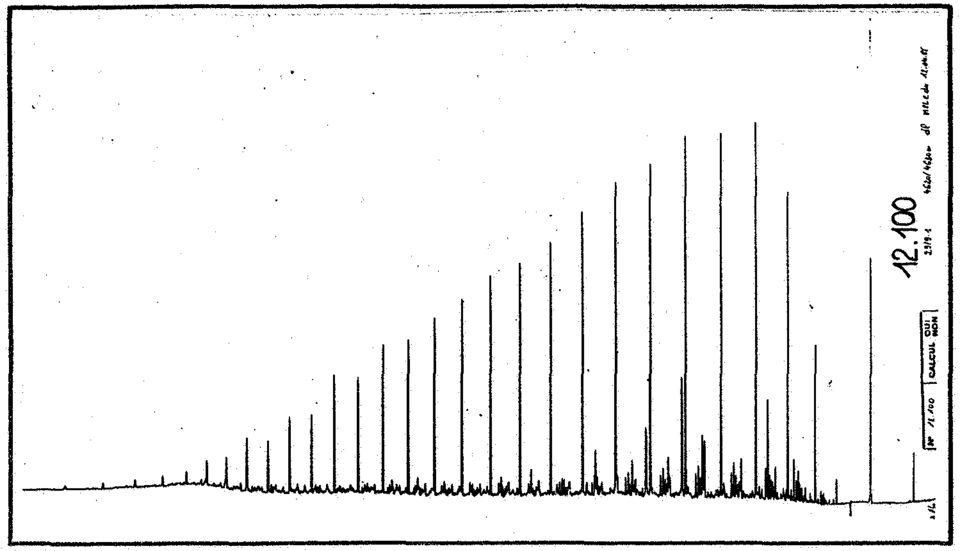
Composition du produit total (%)
Composition of total product

Asphaltènes *Asphaltenes*	As	:	33,0 (As + R)
Résines *Resins*	R	:	
HC saturés *Saturated HC*	S	:	46,7
HC aromatiques *Aromatic HC*	A	:	20,3

$\frac{S}{A} = 2,30$



HC AROMATIQUES *AROMATIC HC.*



HC SATURES *SATURATED HC.*

HC THERMOVAPORISES *THERMOVAPORIZED HC.*