

SAMPLE DEPTH (METRES)	RELATIVE GASEOUS HYDROCARBON COMPONENT ABUNDANCE (%)					TOTAL ABUNDANCE (ppm)	TOTAL C <sub>2</sub> -C <sub>4</sub> (%)	RATIO i-Butane / n-Butane
	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	i-C <sub>4</sub>	n-C <sub>4</sub>			
3480	72.90	15.10	9.80	.40	1.80	1415	27.10	.20
3506	67.20	20.70	8.50	.30	3.30	10845	32.80	.10
3570	72.60	21.80	4.90	.30	.50	45345	27.40	.50
3600	77.80	17.90	3.80	.20	.30	71930	22.20	.60
3630	70.90	19.80	8.10	.40	.80	7865	29.10	.40
3660	75.60	17.80	6.00	.20	.50	15325	24.40	.30
3690	86.30	10.80	2.30	.20	.40	64430	13.70	.30
3720	84.40	12.40	3.10	.00	.10	5470	15.60	.60
3750	77.40	13.40	4.60	.10	.50	4305	22.60	.30
3780	78.10	16.50	4.70	.10	.50	7490	21.90	.30
3810	91.60	6.60	1.80	.00	.00	7255	8.40	.00
3840	81.60	12.40	5.30	.20	.60	730	18.40	.30
3870	80.60	13.70	5.10	.10	.50	3305	19.40	.30
3900	90.60	6.70	2.50	.00	.20	1340	9.40	.20
3930	91.50	6.00	2.20	.00	.20	2255	8.50	.20
3960	87.30	7.90	4.00	.20	.70	840	12.70	.20
3990	91.10	5.80	2.70	.00	.30	1395	8.90	.20
4020	90.50	6.70	2.40	.00	.40	1045	9.50	.10
4050	90.80	7.50	1.50	.00	.10	1735	9.20	.30
4080	87.30	9.50	2.40	.20	.60	1230	12.70	.40
4110	91.70	6.10	1.70	.10	.30	2905	8.30	.40
4140	91.30	6.40	1.90	.10	.30	2100	8.70	.30
4170	87.90	8.40	2.80	.30	.60	1025	12.10	.50
4200	87.70	8.50	2.80	.30	.60	1130	12.30	.40
4230	88.40	8.50	2.50	.20	.40	2720	11.60	.50
4260	83.60	11.10	4.20	.40	.80	935	16.40	.50
4290	89.10	7.90	2.30	.20	.50	1760	10.90	.40

Note: Total gaseous hydrocarbon abundance values are expressed as volume of hydrocarbon gases relative to volume of airspace

TABLE 4E Airspace Gaseous Hydrocarbon Analysis Data

SAMPLE DEPTH (METRES)	RELATIVE GASEOUS HYDROCARBON COMPONENT ABUNDANCE (%)					TOTAL ABUNDANCE (ppm)	TOTAL C <sub>2</sub> -C <sub>4</sub> (%)	RATIO <i>i</i> -Butane / <i>n</i> -Butane
	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	<i>i</i> -C <sub>4</sub>	<i>n</i> -C <sub>4</sub>			
4320	78.10	13.70	6.10	.60	1.50	410	21.90	.40
4350	81.30	13.20	4.50	.30	.70	435	18.70	.40
4380	86.70	9.40	3.10	.30	.50	505	13.30	.60
4410	92.20	6.10	1.20	.10	.30	135	7.80	.30

Note: Total gaseous hydrocarbon abundance values are expressed as volume of hydrocarbon gases relative to volume of airspace

TABLE 4F Airspace Gaseous Hydrocarbon Analysis Data

DEPTH: METRES	1940	3420	3480	3506	3570	3600	3630
GASOLINE HYDROCARBON COMPONENTS	RELATIVE GASOLINE HYDROCARBON COMPONENT ABUNDANCES (%)						
<i>i</i> -BUTANE	6.7	13.9	14.3	9.8	10.7	16.6	16.5
<i>n</i> -BUTANE	0.8	5.9	13.6	26.8	22.1	31.7	27.3
<i>i</i> -PENTANE	2.0	14.5	7.0	6.9	6.2	7.4	7.0
<i>n</i> -PENTANE	2.8	5.3	7.0	8.8	8.6	8.5	7.4
2,2-DIMETHYL BUTANE	1.5	0.1	0.1	0.1	0.1	0.0	0.0
CYCLOPENTANE	0.1	1.3	1.3	0.9	1.4	0.8	1.0
2,3-DIMETHYL BUTANE	3.9	4.3	1.3	1.5	1.8	0.3	1.5
2-METHYL PENTANE	6.5	1.2	1.7	0.9	0.2	1.5	0.4
3-METHYL PENTANE	5.0	1.1	0.6	1.2	1.0	0.8	0.8
<i>n</i> -HEXANE	6.8	3.3	3.2	2.9	3.8	1.8	2.2
2,2-DIMETHYL PENTANE / METHYL CYCLOPENTANE	4.3	1.3	2.2	1.1	2.3	1.5	1.6
2,4-DIMETHYL PENTANE	2.3	0.1	0.2	0.0	0.1	0.0	0.0
BENZENE	0.5	7.1	28.4	26.6	24.1	19.8	23.1
3,3-DIMETHYL PENTANE	0.8	0.4	1.0	0.3	0.2	0.1	0.1
CYCLOHEXANE	4.5	2.8	5.0	4.1	6.7	4.0	3.6
2-METHYL HEXANE	6.1	1.7	0.4	0.3	0.5	0.2	0.4
1,1-DIMETHYL CYCLOPENTANE	2.7	0.4	0.3	0.3	0.2	0.0	0.2
3-METHYL HEXANE	4.3	6.7	3.9	1.4	0.7	0.3	1.0
1, <i>cis</i> -3-DIMETHYL CYCLOPENTANE	2.4	0.4	0.4	0.2	0.2	0.1	0.2
1, <i>trans</i> -3-DIMETHYL CYCLOPENTANE	2.1	0.2	0.3	0.1	0.2	0.1	0.2
1, <i>trans</i> -2-DIMETHYL CYCLOPENTANE							
3-ETHYL PENTANE	5.1	0.4	0.6	0.3	0.4	0.3	0.3
<i>n</i> -HEPTANE	5.6	4.9	2.0	1.0	1.5	0.5	0.8
1, <i>cis</i> -2-DIMETHYL CYCLOPENTANE / METHYL CYCLOHEXANE	18.8	6.8	4.3	3.8	6.3	3.1	3.8
ETHYL CYCLOPENTANE	1.1	0.6	0.3	0.2	0.2	0.1	0.1
TOLUENE	3.4	15.3	0.7	0.6	0.3	0.2	0.3
TOTAL ABUNDANCE (ppb)	301	1410	4235	1875	29280	42535	10155
ORGANIC CARBON (%)	-	0.71	2.22	5.51	8.83	6.60	2.18
GASOLINE ABUNDANCE AT 1% ORGANIC CARBON	-	1986	1908	340	3316	6445	4658

Note: Total gasoline abundance values are expressed as weight of gas relative to weight of wet rock.

TABLE 5A Gasoline Hydrocarbon Analysis Data

DEPTH: METRES	3660	3690	3780	3870	3930	4110	4320
GASOLINE HYDROCARBON COMPONENTS	RELATIVE GASOLINE HYDROCARBON COMPONENT ABUNDANCES (%)						
<i>i</i> -BUTANE	17.6	6.1	6.9	10.4	5.2	*	*
<i>n</i> -BUTANE	37.0	16.0	12.4	11.7	7.2	*	*
<i>i</i> -PENTANE	6.0	6.3	3.7	5.5	2.0	*	*
<i>n</i> -PENTANE	7.1	9.3	3.3	3.9	3.1	*	*
2,2-DIMETHYL BUTANE	0.1	0.2	0.1	0.1	0.1	*	*
CYCLOPENTANE	1.0	1.1	0.5	0.6	0.4	*	*
2,3-DIMETHYL BUTANE	1.3	0.5	0.4	0.2	0.1	*	*
2-METHYL PENTANE	0.2	2.8	1.4	1.4	0.8	*	*
3-METHYL PENTANE	0.5	1.8	0.9	0.7	1.9	*	*
<i>n</i> -HEXANE	1.7	6.2	4.2	2.7	2.5	*	*
2,2-DIMETHYL PENTANE/ METHYL CYCLOPENTANE	1.2	3.5	3.3	2.1	2.1	*	*
2,4-DIMETHYL PENTANE	0.1	0.3	0.5	0.2	0.3	*	*
BENZENE	18.9	22.9	23.2	22.3	8.4	*	*
3,3-DIMETHYL PENTANE	0.3	0.2	0.2	0.3	0.1	*	*
CYCLOHEXANE	2.3	5.5	6.4	5.3	7.1	*	*
2-METHYL HEXANE	0.4	1.7	2.6	2.1	2.7	*	*
1,1-DIMETHYL CYCLOPENTANE	0.1	0.4	0.5	0.4	0.5	*	*
3-METHYL HEXANE	0.6	1.5	3.2	3.5	5.6	*	*
1, <i>cis</i> -3-DIMETHYL CYCLOPENTANE	0.1	0.5	0.6	0.6	1.1	*	*
1, <i>trans</i> -3-DIMETHYL CYCLOPENTANE	0.1	0.4	0.6	0.5	0.8	*	*
1, <i>trans</i> -2-DIMETHYL CYCLOPENTANE	0.2	0.8	1.2	1.0	1.5	*	*
3-ETHYL PENTANE							
<i>n</i> -HEPTANE	0.6	3.5	6.8	6.3	9.8	*	*
1, <i>cis</i> -2-DIMETHYL CYCLOPENTANE/ METHYL CYCLOHEXANE	2.6	8.0	15.4	16.3	26.7	*	*
ETHYL CYCLOPENTANE	0.1	0.3	0.5	0.6	1.0	*	*
TOLUENE	0.2	0.6	0.9	1.1	8.9	*	*
TOTAL ABUNDANCE (ppb)	5605	30810	2895	3245	780	<100	<100
ORGANIC CARBON (%)	2.62	3.44	-	-	1.29	1.07	1.04
GASOLINE ABUNDANCE AT 1% ORGANIC CARBON	2139	8956	-	-	605	<100	<100

Note: Total gasoline abundance values are expressed as weight of gas relative to weight of wet rock.

TABLE 5 B Gasoline Hydrocarbon Analysis Data

COMPANY: TOTAL MARINE NORSK WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

DEPTH: (METRES)	2500 (MUD)						
GASOLINE HYDROCARBON COMPONENTS	RELATIVE GASOLINE HYDROCARBON COMPONENT ABUNDANCES (%)						
<i>i</i> -BUTANE	3.8						
<i>n</i> -BUTANE	12.6						
<i>i</i> -PENTANE	5.4						
<i>n</i> -PENTANE	11.3						
2,2-DIMETHYL BUTANE	0.2						
CYCLOPENTANE	0.6						
2,3-DIMETHYL BUTANE	0.4						
2-METHYL PENTANE	2.7						
3-METHYL PENTANE	1.7						
<i>n</i> -HEXANE	7.0						
2,2-DIMETHYL PENTANE / METHYL CYCLOPENTANE	4.9						
2,4-DIMETHYL PENTANE	1.6						
BENZENE	2.1						
3,3-DIMETHYL PENTANE	0.1						
CYCLOHEXANE	4.2						
2-METHYL HEXANE	3.1						
1,1-DIMETHYL CYCLOPENTANE	0.6						
3-METHYL HEXANE	3.9						
1, <i>cis</i> -3-DIMETHYL CYCLOPENTANE	1.0						
1, <i>trans</i> -3-DIMETHYL CYCLOPENTANE	0.8						
1, <i>trans</i> -2-DIMETHYL CYCLOPENTANE	1.8						
3-ETHYL PENTANE							
<i>n</i> -HEPTANE	8.7						
1, <i>cis</i> -2-DIMETHYL CYCLOPENTANE / METHYL CYCLOHEXANE	10.9						
ETHYL CYCLOPENTANE	1.0						
TOLUENE	9.8						
TOTAL ABUNDANCE (ppb)	1115						
ORGANIC CARBON (%)	-						
GASOLINE ABUNDANCE AT 1% ORGANIC CARBON	-						

Note: Total gasoline abundance values are expressed as weight of gas relative to weight of wet rock.

TABLE 5C Gasoline Hydrocarbon Analysis Data

TABLE 6

Gasoline Hydrocarbon Ratios

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

DEPTH (METRES)	GASOLINE RATIO				
	1	2	3	4	5
1940	10.6	1.1	6.2	0.0	0.6
3420	19.7	7.0	2.2	1.0	3.1
3480	11.4	3.3	2.3	6.6	0.4
3506	8.6	2.2	2.0	7.0	0.6
3570	8.9	1.5	3.2	3.8	0.2
3600	5.8	1.4	1.2	6.4	0.4
3630	7.6	1.9	1.9	6.1	0.4
3660	8.5	2.5	1.8	7.3	0.3
3690	15.5	1.9	6.1	2.9	0.2
3780	18.0	2.5	5.6	1.5	0.1
3870	17.2	2.8	4.7	1.4	0.2
3930	17.3	2.6	5.0	0.3	0.9
2500(Mud)	24.2	2.2	9.4	0.2	1.1

Explanation of Ratios:

- 1 - Heptane value (n-heptane % of compounds cyclohexane to methylcyclohexane inclusive)
- 2 - Isoheptane value (methylhexanes/dimethylcyclopentanes)
- 3 - Kerogen type index (heptane value-4/isoheptane value)
- 4 - Late mature index (benzene/methylcyclohexane)
- 5 - Aromaticity index (toluene/n-heptane)

TABLE 7

Carbon Isotope Data

COMPANY: TOTAL MARINE NORSK      WELL: 29/3-1      LOCATION: NORWEGIAN NORTH SEA

<u>DEPTH (METRES)</u>	<u><math>\delta^{13}\text{C}</math> (METHANE)</u>
320	-76.3
880	-80.4

Note:

Carbon isotopic compositions of methane measured in parts per mil ( $^{\circ}/\text{oo}$ ) relative to Pee Dee Formation Belemnite (PDB) standard.

TABLE 8  
Temperature-Time Index Calculations

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

Temperature degrees C	Time myBF	P-Value	TTI-Value	VR (%)
10	195	*****	0	*****
20	190	3.00	0	*****
30	180	4.61	0	*****
40	165	5.83	0	*****
50	150	6.71	0	*****
60	138	7.37	1	*****
70	125	8.09	2	*****
40	97	8.22	2	*****
50	95	8.23	2	*****
60	90	8.31	2	*****
70	83	8.51	2	.34
80	72	8.96	4	.37
90	55	9.71	8	.44
100	35	10.52	18	.52
110	22	11.06	31	.58
120	15	11.43	45	.62
130	9	11.86	69	.68
140	3	12.39	117	.76
150	0	12.73	165	.82

Times of reaching key reflectances

VR from P Time	.50	.55	.75	1.2	VR from TTI Time	.50	.55	.75	1.2
	39	28	4	***		41	33	15	3

\*\*\* : No relevant data



FIGURE 10

Alkane Gas Chromatogram

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

DEPTH (METRES)

3535.5-3536.1(core)

Pristane/phytane ratio (Pr/Ph)	=	3.59
Pristane/ <u>n</u> -C <sub>17</sub> ratio	=	0.81
Phytane/ <u>n</u> -C <sub>18</sub> ratio	=	0.38
Carbon preference index	=	1.07

Note:

Carbon preference index (CPI) calculated from

$$\frac{2(\underline{n}\text{-C}_{25} \text{ to } \underline{n}\text{-C}_{31} \text{ odd})}{(\underline{n}\text{-C}_{24} \text{ to } \underline{n}\text{-C}_{30} \text{ even} + \underline{n}\text{-C}_{26} \text{ to } \underline{n}\text{-C}_{32} \text{ even})} \quad (\text{Radke et al., 1980})$$

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ROBERTSON RESEARCH INTERNATIONAL LIMITED

REPORT NO. 6061/Ic

GEOCHEMICAL EVALUATION OF THE TESTED  
OIL AND OF MIGRANT OIL STAINING IN THE  
TOTAL MARINE NORSK 29/3-1 WELL, NORWEGIAN  
NORTH SEA.

<p>87-0342-1-BA</p> <p>11 MARS 1987</p> <p><b>REGISTRERT</b></p> <p>OLJEDIREKTORATET</p>
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by

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FEBRUARY 1987



## 2 INTRODUCTION

This report describes the results of geochemical studies carried out on behalf of Total Marine Norsk of a produced oil, and of migrant oil staining in core samples from the interval 3526.4m to 3536.8m in the 29/3-1 well, drilled offshore in the Norwegian North Sea.

The primary aim of this geochemical study has been to characterise the properties of the 29/3-1 oil, particularly with regard to the likely maturity level of generation, source rock type and any indications of reservoir alteration. Core samples have been studied in order to evaluate the possibility of the presence of a "heavy" (i.e. biodegraded) residual oil component or tar mat development in sandstones above the main reservoir as noted during core logging.

A proposal for this study, with an outline of the recommended work programme, was forwarded to the client on 9th December 1986 (telex ref. 16720/DG). Authorisation to proceed with the study was received from the client on 12th December 1986 (telex ref. 1102). The sample of produced oil from the 29/3-1 well was obtained by Mr. P. Barnard of Robertson Research International Limited during a visit to Total Marine Norsk (Bergen) on 3rd December 1986.

Four core samples from Core No. 1 (3526.4m, 3529.5m, 3533.8m, 3536.8m) in the 29/3-1 well were received on 31st December 1986. The core sample 3535.5m-3536.1m was obtained whilst the core was at Robertson Research International's North Wales laboratories for sedimentological studies.

Preliminary analytical data were forwarded to the client on 9th January 1987 and a proof copy of this report was sent on 13th February 1987. Our client contact with Total Marine Norsk throughout the course of the study has been Mr. P. Raingeard, whose co-operation and assistance is acknowledged.

For the purposes of comparison this report contains and describes the geochemical data from the earlier study, Report No. 6040/Ic, entitled "A geochemical evaluation of the Total Marine Norsk 29/3-1 well, Norwegian North Sea", which was issued in December 1986.

The Robertson Research International Limited personnel involved in this study were as follows:

Project co-ordination	-	S. Thompson
Geochemical interpretation and report preparation	-	M.A. Bastow
Chemical analysis	-	supervised by D. Bell

The following numbers of analyses have been carried out during the course of the study:

Oil Analysis

API gravity	:	1
Pour point	:	1
Viscosity (3 temperatures)	:	1
Asphaltene content	:	1
Sulphur content	:	1
Nickel content	:	1
Vanadium content	:	1
Whole oil gas chromatography	:	1
Gasoline hydrocarbon analysis	:	1
Iatroscan fractionation	:	1
Column chromatography	:	1
Alkane gas chromatography	:	1
Alkane gas chromatography - mass spectrometry	:	1
Carbon isotopic composition of oil fractions	:	2

Core Samples

Sample preparation	:	5
Solvent extraction	:	5
Alkane gas chromatography	:	3
Alkane gas chromatography - mass spectrometry	:	1

Mud Sample

Solvent treatment for preparation of alkane fraction	:	1
Alkane gas chromatography	:	1

The analytical techniques and procedures employed during the course of this study are outlined in Appendix 2 of this report, and the principles of interpretation for the correlation of oils and source rocks are described in Appendix 3. The alkane gas chromatography - mass spectrometry quantitation data are given in Appendix 4(1-2).

GENERAL DATA			CHEMICAL ANALYSIS DATA											
SAMPLE DEPTH (METRES)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS					SOLVENT EXTRACTION					
				TEMPERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS		ALKANES % OF HYDRO-CARBONS
											mg/g OF ORGANIC CARBON	% OF EXTRACT		
3526.4	Core	SST, v lt gy	-							3865				
3529.5	"	SST, v lt gy+ tr pyr	-							4865				
3533.8	"	SST, v lt gy	-							2880				
3535.5-536.1	"	SST, lt gy	-							3110				
3536.8	"	SST, v lt gy+ mn pyr	-							845				

Chemical Analysis Data

TABLE 1



TABLE 2

Physical Properties Data: 29/3-1 Oil

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

GRAVITY °API	POUR POINT (°C)	VISCOSITY (cSt)			VOLATILE CONTENT (TOPPING LOSS, %)	ASPHALTENE CONTENT (%)	SULPHUR CONTENT (%)
		20°C	40°C	60°C			
30.0	+18	170	22.8	6.2	9.8	0.55	0.11

TABLE 3

Nickel - Vanadium Content Data: 29/3-1 Oil

COMPANY: TOTAL MARINE NORSK      WELL: 29/3-1      LOCATION: NORWEGIAN NORTH SEA

<u>NICKEL (PPM)</u>	<u>VANADIUM (PPM)</u>	<u>Ni/V (1)</u>	<u>V/(Ni+V) (2)</u>
4	<1	>4	>0.2

Notes:

(1) - nickel/vanadium ratio

(2) - vanadium - nickel fraction (Lewan, 1984)



COMPANY: TOTAL MARINE NORSK WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

	OIL						
GASOLINE HYDROCARBON COMPONENTS	RELATIVE GASOLINE HYDROCARBON COMPONENT ABUNDANCES (%)						
i-BUTANE	1.85						
n-BUTANE	7.35						
i-PENTANE	4.74						
n-PENTANE	6.25						
2,2-DIMETHYL BUTANE	0.44						
CYCLOPENTANE	0.56						
2,3-DIMETHYL BUTANE	0.67						
2-METHYL PENTANE	3.89						
3-METHYL PENTANE	2.68						
n-HEXANE	8.42						
2,2-DIMETHYL PENTANE/ METHYL CYCLOPENTANE	3.87						
2,4-DIMETHYL PENTANE	0.57						
BENZENE	4.69						
3,3-DIMETHYL PENTANE	0.29						
CYCLOHEXANE	6.06						
2-METHYL HEXANE	4.09						
1,1-DIMETHYL CYCLOPENTANE	0.53						
3-METHYL HEXANE	3.39						
1, cis-3-DIMETHYL CYCLOPENTANE	0.71						
1, trans-3-DIMETHYL CYCLOPENTANE	0.65						
1, trans-2-DIMETHYL CYCLOPENTANE	1.29						
3-ETHYL PENTANE							
n-HEPTANE	8.47						
1, cis-2-DIMETHYL CYCLOPENTANE/ METHYL CYCLOHEXANE	11.35						
ETHYL CYCLOPENTANE	0.40						
TOLUENE	16.92						
TOTAL ABUNDANCE (ppm)	67610						
ORGANIC CARBON (%)							
GASOLINE ABUNDANCE AT 1% ORGANIC CARBON							

Note: Total gasoline abundance values are expressed as weight of gas relative to weight of oil.

TABLE 4 Gasoline Hydrocarbon Analysis Data

TABLE 5

Gasoline Hydrocarbon Ratios: 29/3-1 Oil

COMPANY: TOTAL MARINE NORSK      WELL: 29/3-1      LOCATION: NORWEGIAN NORTH SEA

1	2	3	4	5	6	7	8
0.76	1.45	22.72	2.96	6.33	0.41	2.02	27/28/45

Explanation of Ratios:

- 1 - i-pentane/n-pentane
- 2 - 2-methylpentane/3-methylpentane
- 3 - Heptane value (n-heptane % of compounds cyclohexane to methylcyclohexane inclusive)
- 4 - Isoheptane value (methylhexanes/dimethylcyclopentanes)
- 5 - Kerogen type index (heptane value-4/isoheptane value)
- 6 - Late mature index (benzene/methylcyclohexane)
- 7 - Aromaticity index (toluene/n-heptane)
- 8 - Relative composition of C<sub>7</sub> components (normal/iso/cyclic; aromatics excluded)

TABLE 6

Fractionation Data: 29/3-1 Oil

COMPANY: TOTAL MARINE NORSK      WELL: 29/3-1      LOCATION: NORWEGIAN NORTH SEA

LIQUID COLUMN CHROMATOGRAPHY

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ALKANES (%)	AROMATICS (%)	POLARS (%)	COLUMN LOSSES (%)	ALKANE/AROMATIC RATIO
76.0	11.7	5.3	7.0	6.50

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IATROSCAN FRACTIONATION

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ALKANES (%)	AROMATICS (%)	POLARS (%)	ALKANE/AROMATIC RATIO
79	12	9	6.60

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TABLE 7

Alkane Gas Chromatography Interpretative Data

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

FIGURE	SAMPLE TYPE	DEPTH (METRES)	Pr/Ph	Pr/ <u>n</u> -C <sub>17</sub>	Pr/ <u>n</u> -C <sub>18</sub>	CPI	COMMENTS
2	OIL	-	1.96	0.51	0.29	1.00	Higher molecular weight, "waxy" normal alkanes extending up to <u>n</u> -C <sub>36</sub> indicative of significant contribution of terrestrially derived organic matter. Pristane/phytane ratio indicates deposition in marginally marine, slightly oxic environment.
3.1	CORE	3526.4	2.98	0.81	0.42	1.04	Hydrocarbons in the range <u>n</u> -C <sub>12</sub> to <u>n</u> -C <sub>18</sub> derived mainly from contamination by oil-based drilling fluid (compare mud sample, Figure 4). Normal alkane envelope extending to approximately <u>n</u> -C <sub>36</sub> indicates migrant oil stain similar to produced oil. Flat chromatograph baseline indicates absence of biodegraded oil component.
3.2	CORE	3529.5	3.30	0.79	0.39	1.06	As above.
3.3	CORE	3535.5- 3536.1	3.59	0.81	0.38	1.07	As above.
4	MUD	2500	5.09	0.75	0.38	*	Hydrocarbons in the range <u>n</u> -C <sub>12</sub> to <u>n</u> -C <sub>18</sub> .

Explanatory notes:

Pr/Ph - pristane/phytane ratio  
Pr/n-C<sub>17</sub> - pristane/normal heptadecane ratio  
Pr/n-C<sub>18</sub> - pristane/normal octadecane ratio  
CPI - carbon preference index,  $2(\underline{n}\text{-C}_{25} \text{ to } \underline{n}\text{-C}_{31} \text{ odd}) / (\underline{n}\text{-C}_{24} \text{ to } \underline{n}\text{-C}_{30} \text{ even} + \underline{n}\text{-C}_{26} \text{ to } \underline{n}\text{-C}_{32} \text{ even})$

TABLE 8

Alkane Gas Chromatography - Mass Spectrometry Ratios

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE	1	2	3	4	5	6	7	8	9
OIL	5.19	0.11	*	*	60	58	32/18/50	0.85	0.45
3529.5m (CORE)	2.22	0.10	0.12	*	59	69	41/13/46	1.30	0.38

Explanation of ratios:

- 1 C<sub>27</sub> 18α(H) trisnorneohopane/17α(H) trisnorhopane (Ts/Tm) (m/e 191)
- 2 C<sub>30</sub> 17β(H)21α(H) moretane/17α(H)21β(H) hopane (m/e 191)
- 3 C<sub>29</sub> 17β(H)21α(H) normoretane/17α(H)21β(H) norhopane (m/e 191)
- 4 22S/22R of C<sub>31</sub> 17α(H)21β(H) homohopanes (m/e 191)
- 5 % 20S of 5α(H)14α(H)17α(H) 20S and 20R C<sub>29</sub> steranes (m/e 217)
- 6 % 5α(H)14β(H)17β(H) 20S and 20R (m/e 218) of total C<sub>29</sub> steranes (m/e 217, m/e 218)
- 7 Carbon number distribution of C<sub>27</sub>/C<sub>28</sub>/C<sub>29</sub> 5α(H)14α(H)17α(H) 20R steranes (m/e 217)
- 8 17α(H)21β(H) hopane (m/e 191)/total C<sub>29</sub> steranes (m/e 217, m/e 218)
- 9 13β(H)17α(H) 20S and 20R C<sub>29</sub> diasteranes (m/e 259)/total C<sub>29</sub> steranes (m/e 217, m/e 218)

TABLE 9

Carbon Isotope Data: 29/3-1 Oil

COMPANY: TOTAL MARINE NORSK      WELL: 29/3-1      LOCATION: NORWEGIAN NORTH SEA

$\delta^{13}$  (ALKANES)       $\delta^{13}$ C (AROMATICS)

-28.4

-27.4

Note:

Carbon isotopic compositions of alkane and aromatic fractions of oil given as parts per mil ( $^{\circ}/_{\infty}$ ) measured relative to Pee Dee Formation Belemnite (PDB) standard.

FIGURE 1

Whole Oil Gas Chromatogram: 29/3-1 Oil

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

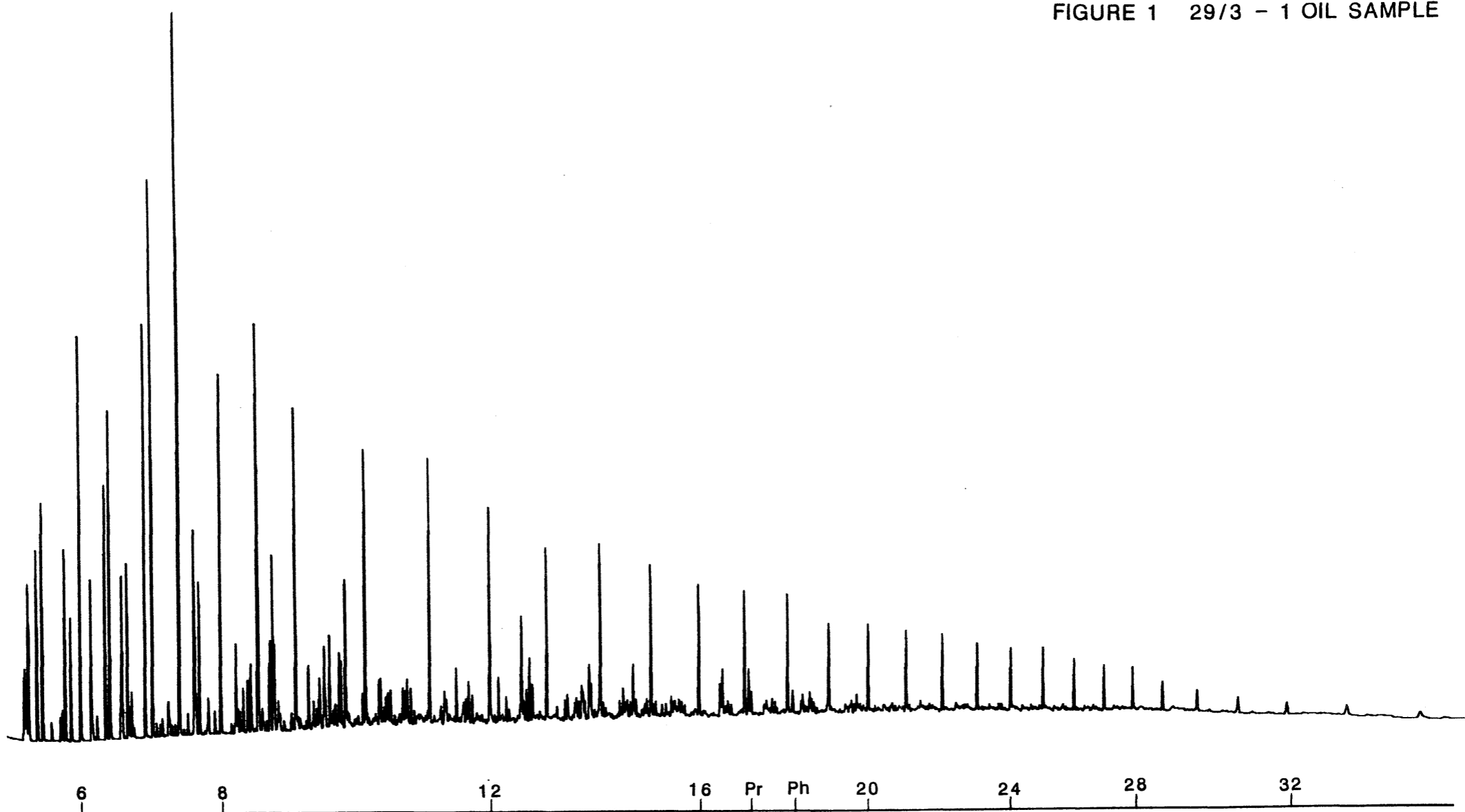


FIGURE 1 29/3 - 1 OIL SAMPLE



FIGURE 2

Alkane Gas Chromatogram: 29/3-1 Oil

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

Pristane/phytane ratio (Pr/Ph) = 1.96

Pristane/n-C<sub>17</sub> ratio (Pr/n-C<sub>17</sub>) = 0.51

Phytane/n-C<sub>18</sub> ratio (Ph/n-C<sub>18</sub>) = 0.29

Carbon preference index (CPI) = 1.00

Note:

Carbon preference index (CPI) calculated from

$$\frac{2(\underline{n}\text{-C}_{25} \text{ to } \underline{n}\text{-C}_{31} \text{ odd})}{(\underline{n}\text{-C}_{24} \text{ to } \underline{n}\text{-C}_{30} \text{ even} + \underline{n}\text{-C}_{26} \text{ to } \underline{n}\text{-C}_{26} \text{ to } \underline{n}\text{-C}_{32} \text{ even})}$$

(Radke et al., 1980)

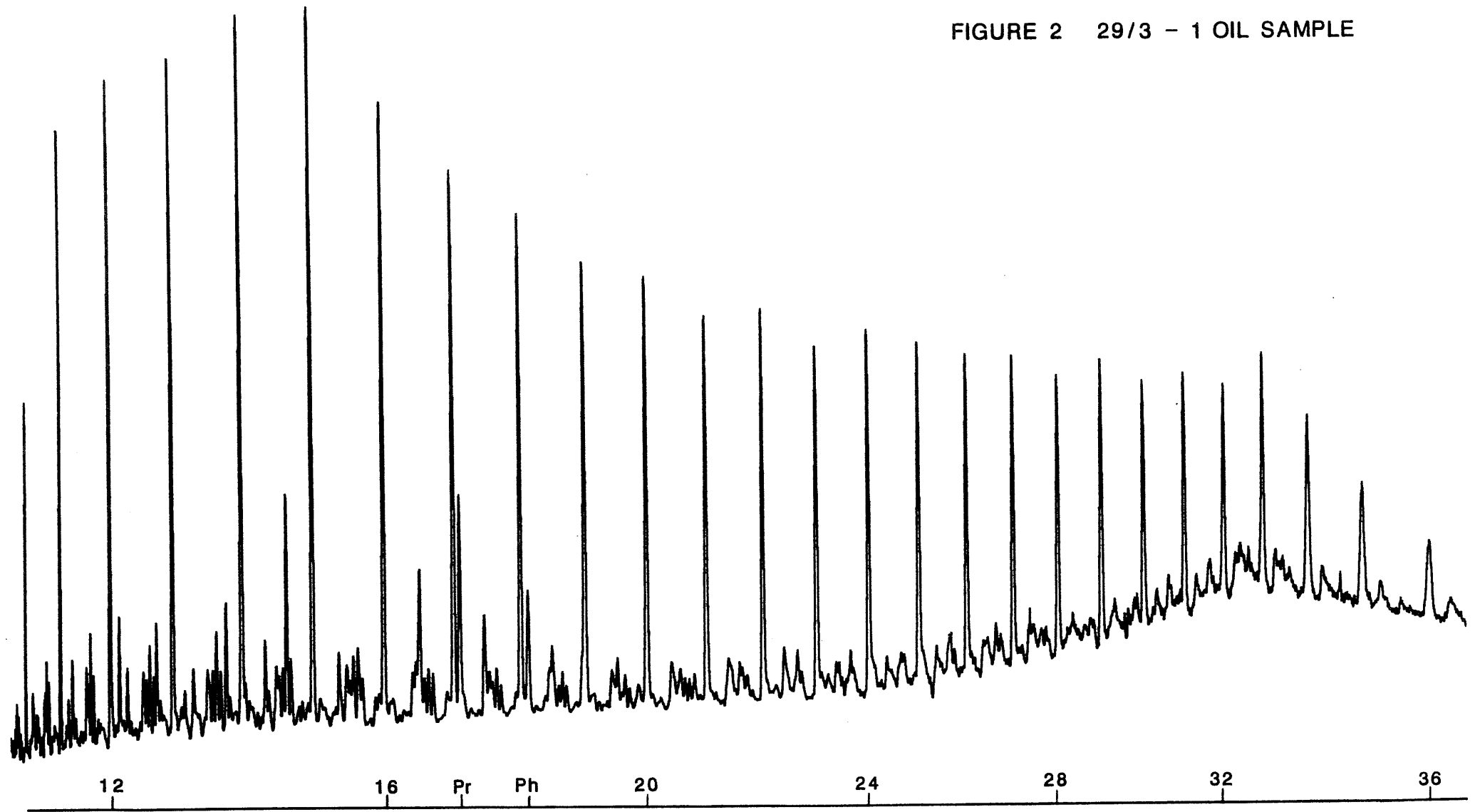


FIGURE 2 29/3 - 1 OIL SAMPLE

Trilab 2000 Analysis 4.8G  
 SAMPLE C213 TOTALMARINE 29/3-1 6M1326 ( .50R)  
 Method : C SATS AI

C SATS AI (Area)

RETN TIME	REL RET	PEAK HT	PEAK AREA	PEAK CONC	%CONC	PEAK NAME
878.5		21.079	137.198	137.198	6.415	NC 14
1103.5		21.139	136.773	136.773	6.395	NC 15
1328.5		18.308	130.976	130.976	6.124	NC 16
1549.5		16.386	129.268	129.268	6.044	NC 17
1569.0		6.686	65.728	65.728	3.073	PR
1763.5		14.772	117.518	117.518	5.495	NC 18
1787.0		3.609	33.616	33.616	1.572	PH
1967.5		13.120	119.066	119.066	5.567	NC 19
2164.0		12.596	103.908	103.908	4.858	NC 20
2351.0		11.425	98.137	98.137	4.588	NC 21
2531.0		11.405	89.669	89.669	4.192	NC 22
2703.0		10.356	91.138	91.138	4.261	NC 23
2868.0		10.805	97.511	97.511	4.559	NC 24
3028.0		9.979	97.090	97.090	4.539	NC 25
3182.0		9.548	86.125	86.125	4.027	NC 26
3329.0		9.087	76.668	76.668	3.585	NC 27
3470.5		8.283	74.575	74.575	3.487	NC 28
3608.0		8.466	76.267	76.267	3.566	NC 29
3740.5		7.416	73.383	73.383	3.431	NC 30
3869.0		6.996	60.998	60.998	2.852	NC 31
3994.5		6.305	57.720	57.720	2.699	NC 32
4117.0		6.970	68.915	68.915	3.222	NC 33
4259.5		5.218	60.984	60.984	2.851	NC 34
4431.0		3.704	55.589	55.589	2.599	NC 35

2138.818

FIGURE 3(1-3)

Alkane Gas Chromatograms: Core Samples

COMPANY: TOTAL MARINE NORSK      WELL: 29/3-1      LOCATION: NORWEGIAN NORTH SEA

<u>FIGURE</u>	<u>DEPTH (METRES)</u>
3.1	3526.4
3.2	3529.5
3.3	3535.5-3536.1

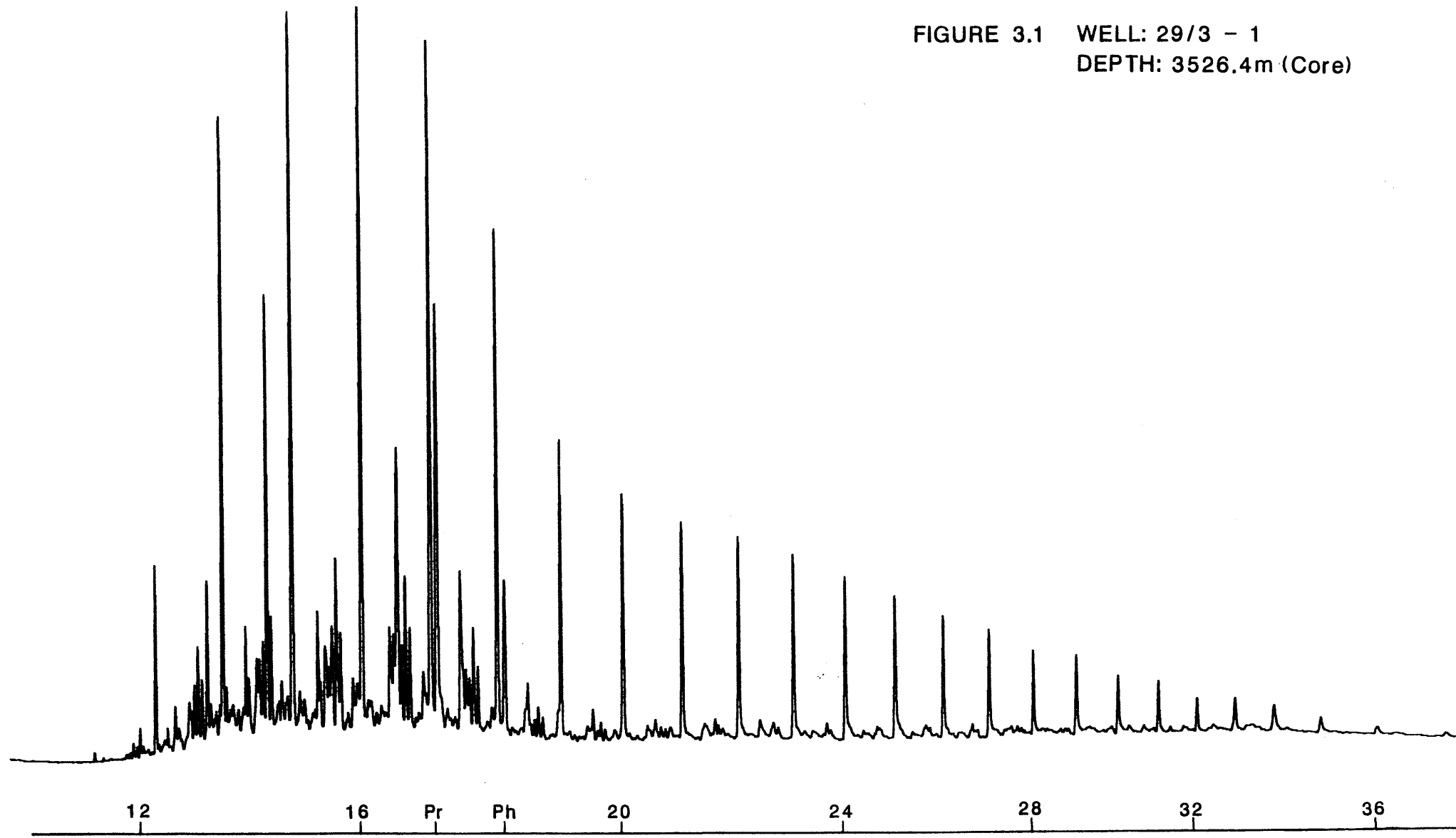


FIGURE 3.1 WELL: 29/3 - 1  
DEPTH: 3526.4m (Core)

Trilab 2000 Analysis 4.86  
 SAMPLE D312 TOTALMARINE 29/3-1 87A179 ( .50R)  
 Method : D SATS AI

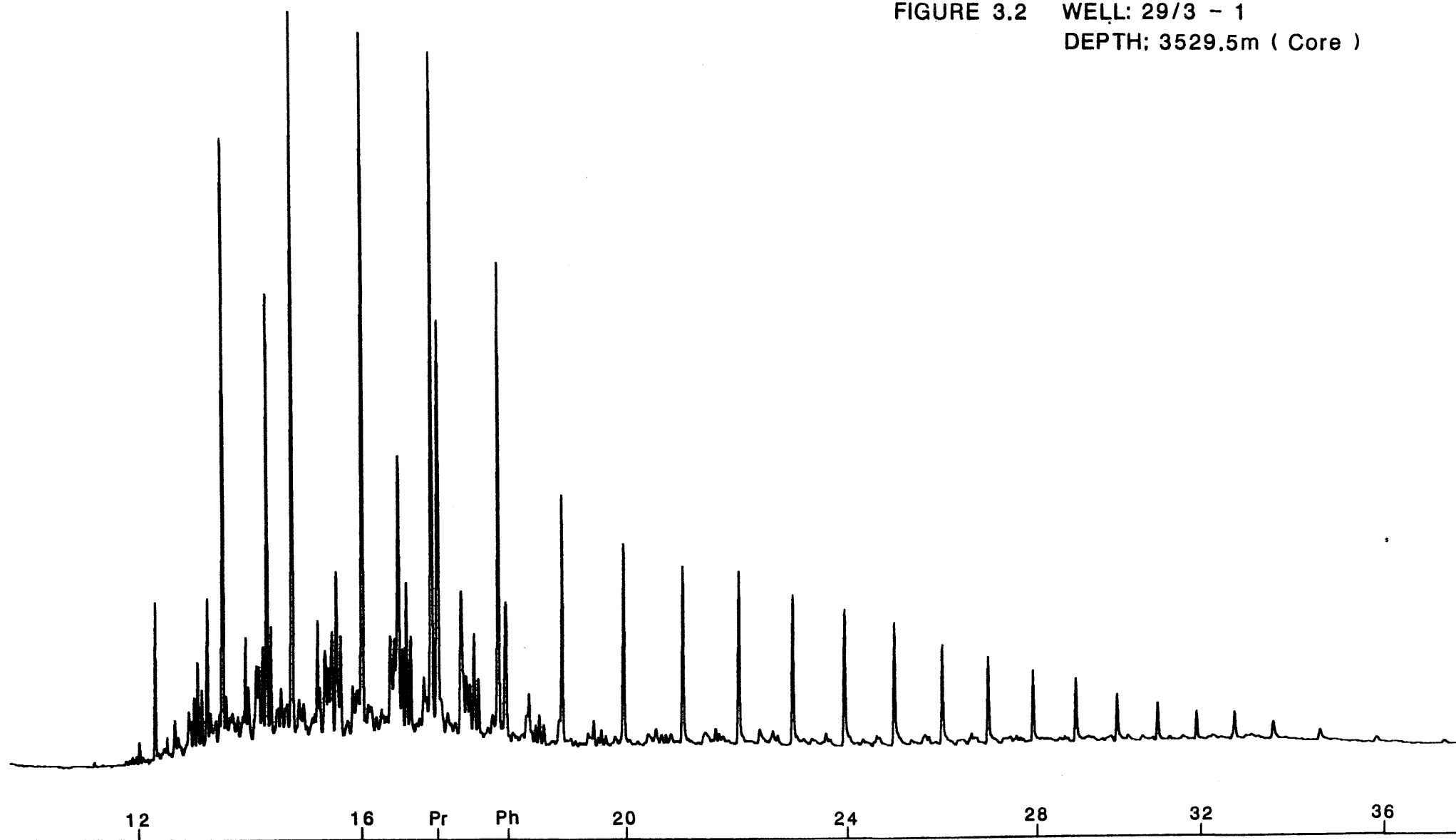
D SATS AI (Area)

RETN TIME	REL RET	PEAK HT	PEAK AREA	PEAK CONC	%CONC	PEAK NAME
828.5		61.070	321.644	321.644	8.166	NC 14
1051.0		71.480	458.264	458.264	11.634	NC 15
1274.0		71.969	435.859	435.859	11.066	NC 16
1492.5		68.680	485.587	485.587	12.328	NC 17
1512.5		42.805	392.653	392.653	9.969	PR
1703.5		50.165	313.578	313.578	7.961	NC 18
1726.0		15.515	131.868	131.868	3.348	PH
1906.0		29.561	179.492	179.492	4.557	NC 19
2101.0		24.099	151.666	151.666	3.851	NC 20
2288.0		21.405	138.611	138.611	3.519	NC 21
2467.0		19.883	134.359	134.359	3.411	NC 22
2639.0		18.195	127.375	127.375	3.234	NC 23
2803.5		16.071	120.115	120.115	3.049	NC 24
2961.5		14.079	112.058	112.058	2.845	NC 25
3114.0		12.134	86.540	86.540	2.197	NC 26
3260.5		10.307	65.396	65.396	1.660	NC 27
3401.5		8.095	53.798	53.798	1.366	NC 28
3538.0		7.790	53.409	53.409	1.356	NC 29
3669.5		5.744	43.525	43.525	1.105	NC 30
3797.5		5.051	34.570	34.570	.878	NC 31
3921.0		3.298	21.944	21.944	.557	NC 32
4041.0		3.251	29.039	29.039	.737	NC 33
4164.0		2.489	28.680	28.680	.728	NC 34
4310.0		1.512	18.825	18.825	.478	NC 35

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 3938.851



FIGURE 3.2 WELL: 29/3 - 1  
DEPTH: 3529.5m ( Core )



Trilab 2000 Analysis 4.86  
 SAMPLE D313 TOTALMARINE 29/3-1 87A180 ( .50R)  
 Method : D SATS AI

D SATS AI (Area)

RETN TIME	REL RET	PEAK HT	PEAK AREA	PEAK CONC	%CONC	PEAK NAME
826.0		55.919	269.741	269.741	8.372	NC 14
1049.0		68.606	406.388	406.388	12.613	NC 15
1271.5		65.382	370.554	370.554	11.501	NC 16
1490.5		64.504	425.152	425.152	13.195	NC 17
1510.0		39.152	335.380	335.380	10.409	PR
1700.5		44.825	260.445	260.445	8.083	NC 18
1723.0		12.686	101.507	101.507	3.150	PH
1902.0		23.651	140.919	140.919	4.374	NC 19
2096.5		18.806	116.174	116.174	3.606	NC 20
2283.5		16.592	101.282	101.282	3.143	NC 21
2462.5		16.288	100.614	100.614	3.123	NC 22
2633.5		13.797	84.158	84.158	2.612	NC 23
2798.0		12.880	85.903	85.903	2.666	NC 24
2956.0		11.702	86.307	86.307	2.679	NC 25
3108.0		9.441	69.717	69.717	2.164	NC 26
3254.5		8.259	58.252	58.252	1.808	NC 27
3395.0		6.631	42.975	42.975	1.334	NC 28
3531.0		6.004	40.966	40.966	1.271	NC 29
3662.5		4.527	34.918	34.918	1.084	NC 30
3789.0		3.598	25.148	25.148	.781	NC 31
3912.5		2.657	15.498	15.498	.481	NC 32
4032.0		2.526	19.655	19.655	.610	NC 33
4154.5		1.649	17.134	17.134	.532	NC 34
4301.5		1.053	13.237	13.237	.411	NC 35

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 3222.025



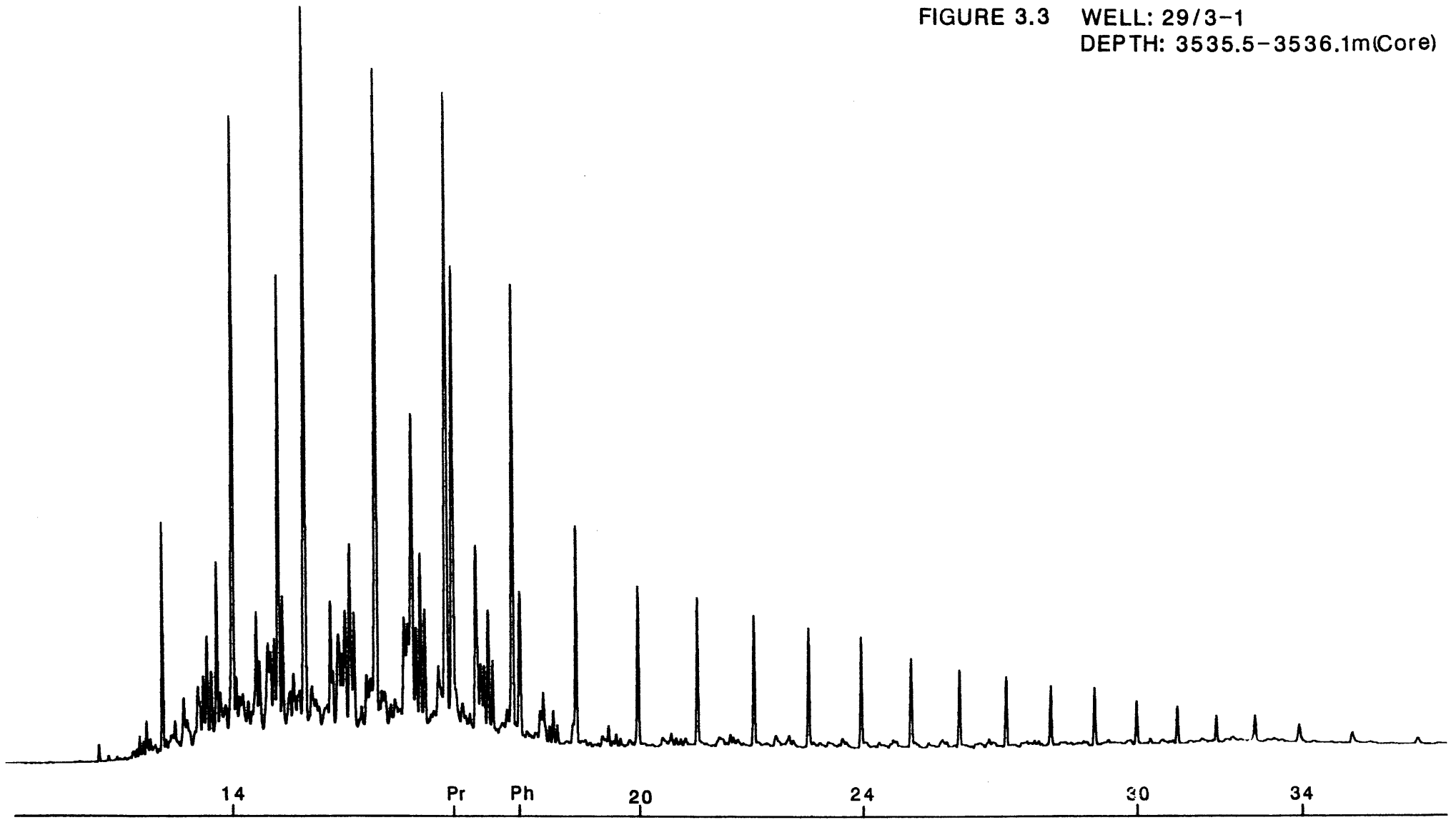


FIGURE 3.3 WELL: 29/3-1  
DEPTH: 3535.5-3536.1m(Core)

Trilab 2000 Analysis 4.86  
 SAMPLE C169 TOTALMARINE 29/3-1 6L352 (.50R)  
 Method : C SATS AI

C SATS AI (Area)

RETN TIME	REL RET	PEAK HT	PEAK AREA	PEAK CONC	%CONC	PEAK NAME
881.5		113.788	754.516	754.516	11.275	NC 14
1109.0		132.693	909.521	909.521	13.591	NC 15
1335.5		121.948	925.257	925.257	13.827	NC 16
1556.5		117.796	947.164	947.164	14.154	NC 17
1576.0		85.863	770.996	770.995	11.521	PR
1767.0		83.572	568.940	568.940	8.502	NC 18
1789.0		26.763	214.665	214.665	3.208	PH
1968.0		40.401	241.864	241.864	3.614	NC 19
2163.5		29.687	190.341	190.341	2.844	NC 20
2351.5		26.978	149.170	149.170	2.229	NC 21
2531.0		23.896	140.209	140.209	2.095	NC 22
2702.5		22.088	136.321	136.321	2.037	NC 23
2868.0		20.059	113.644	113.644	1.698	NC 24
3026.0		16.573	111.697	111.697	1.669	NC 25
3178.5		14.260	87.423	87.423	1.306	NC 26
3325.5		12.984	77.462	77.462	1.158	NC 27
3467.5		11.188	68.734	68.734	1.027	NC 28
3604.0		10.616	63.271	63.271	.945	NC 29
3736.5		8.045	49.168	49.168	.735	NC 30
3864.0		6.914	43.184	43.184	.645	NC 31
3988.5		5.005	31.653	31.653	.473	NC 32
4109.5		4.838	38.376	38.376	.573	NC 33
4249.0		3.291	33.761	33.761	.505	NC 34
4418.0		2.129	24.565	24.565	.367	NC 35

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 6691.895

FIGURE 4

Alkane Gas Chromatogram: Mud Sample (2500m)

COMPANY: TOTAL MARINE NORSK

WELL: 29/3-1

LOCATION: NORWEGIAN NORTH SEA

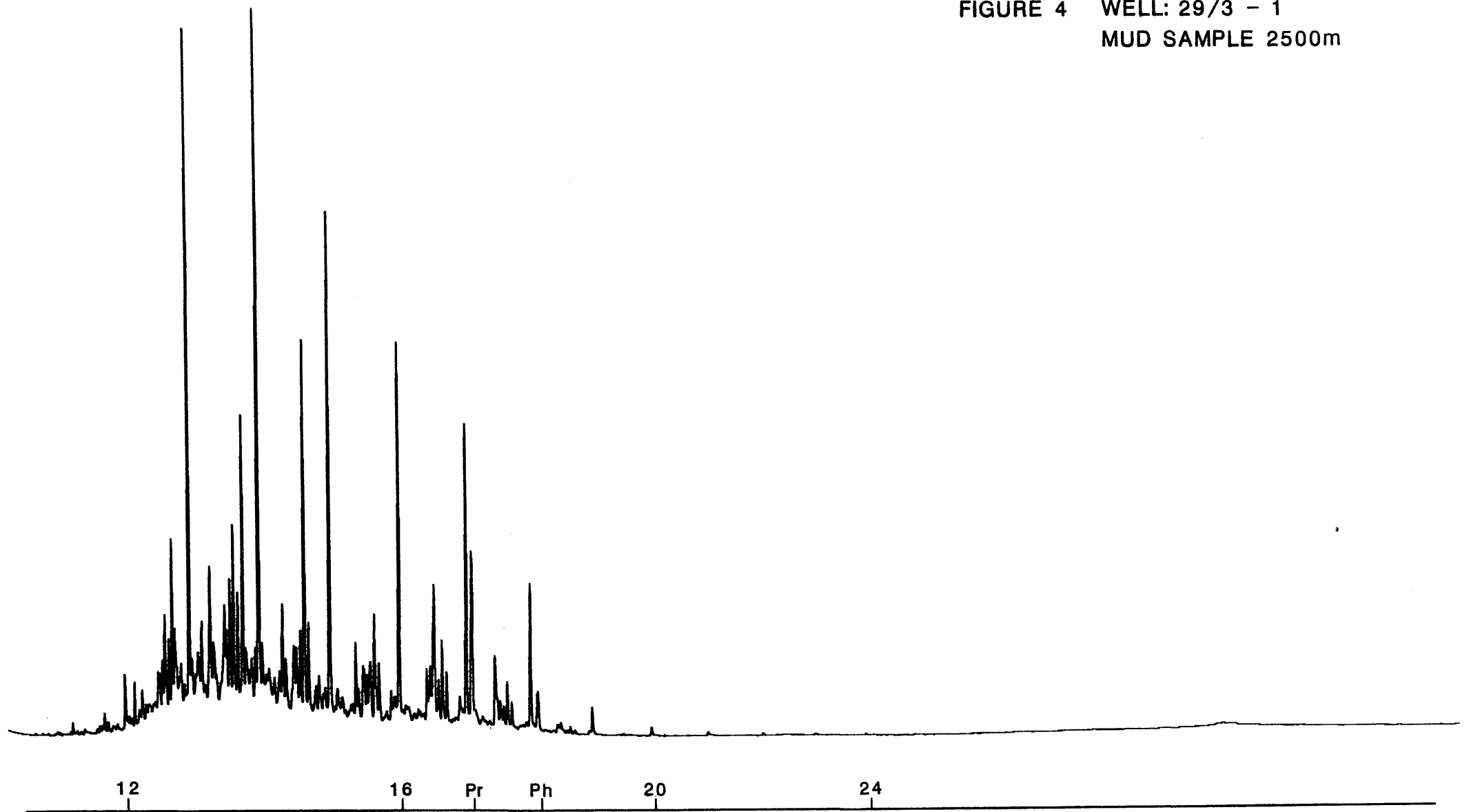


FIGURE 4 WELL: 29/3 - 1  
MUD SAMPLE 2500m

Trilab 2000 Analysis 4.8G  
 SAMPLE A562 TOTALMARINE 29/3-1 6M1088 ( .50R)  
 Method : CE(2) SATS

CE(2) SATS (Area)

RETN TIME	REL RET	PEAK HT	PEAK AREA	PEAK CONC	%CONC	PEAK NAME
818.0		293.536	1490.625	1490.625	28.321	NC 14
1051.0		212.754	1020.078	1020.078	19.381	NC 15
1278.5		161.529	829.137	829.137	15.753	NC 16
1498.5		128.140	793.814	793.814	15.082	NC 17
1517.5		72.477	591.841	591.841	11.244	PR
1707.5		61.085	309.317	309.317	5.877	NC 18
1731.5		15.887	116.328	116.328	2.210	PH
1909.0		11.446	59.760	59.760	1.135	NC 19
2103.5		3.554	21.268	21.268	.404	NC 20
2289.5		1.597	17.578	17.578	.334	NC 21
2467.5		1.129	9.015	9.015	.171	NC 22
2640.5		.771	4.626	4.626	.088	NC 23
NC 24	NOT FOUND					
NC 25	NOT FOUND					
NC 26	NOT FOUND					
NC 27	NOT FOUND					
NC 28	NOT FOUND					
NC 29	NOT FOUND					
NC 30	NOT FOUND					
NC 31	NOT FOUND					
NC 32	NOT FOUND					
NC 33	NOT FOUND					
NC 34	NOT FOUND					
NC 35	NOT FOUND					

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 5263.387