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PETROLEUM GEOCHEMISTRY REPORT

PREPARED FOR

MOBIL NORWAY

Geochemical Evaluation of Cuttings Samples from Well: 35/11-1.

November 1984

Contents

Summary

1. Molecular parameter and microscopic data suggest that the top of the oil window lies within Early Jurassic strata in the depth range 2800 m to 3000 m BRT. For reasons yet unknown Brent coal sequences have anomalously high reflectances, 0.56% to 0.65% Ro. Homohopane and sterane epimer abundances, in addition to microscopic spore colour assessments and gas chromatographic analysis of indigenous hydrocarbon components, clearly reveal an immature sequence at and above 2533 m BRT.

2. Total gas and wet gas contents (headspace analysis) are exceptionally high within the Middle Jurassic Brent Group. Coal sequences contain up to 400,000 ppm (headspace analysis) total gas. Gas generation on-structure, however, is regarded as minimal and it is conjectured that intraformational migration of gas has occurred from more mature coal sequences (Ro $\geq$ 1.0%) offstructure.

3. No oil prone source rocks are present at this locality due to the lack of the Kimmeridge Clay Formation on-structure. Late Cretaceous sediments unconformably rest upon Late Jurassic (Oxfordian) mudrocks of the Heather Formation, the latter characterised by humic kerogens and occasional lignites.

4. Below 2480 m the Brent Group contains major coal sequences at 2488 m to 2533 m but at maturities not commensurate with significant gas generation onstructure.

5. No oil shows were recorded at this locality. High free oil (P1) contents throughout the well were identified as possible diesel and pipe dope contaminants.

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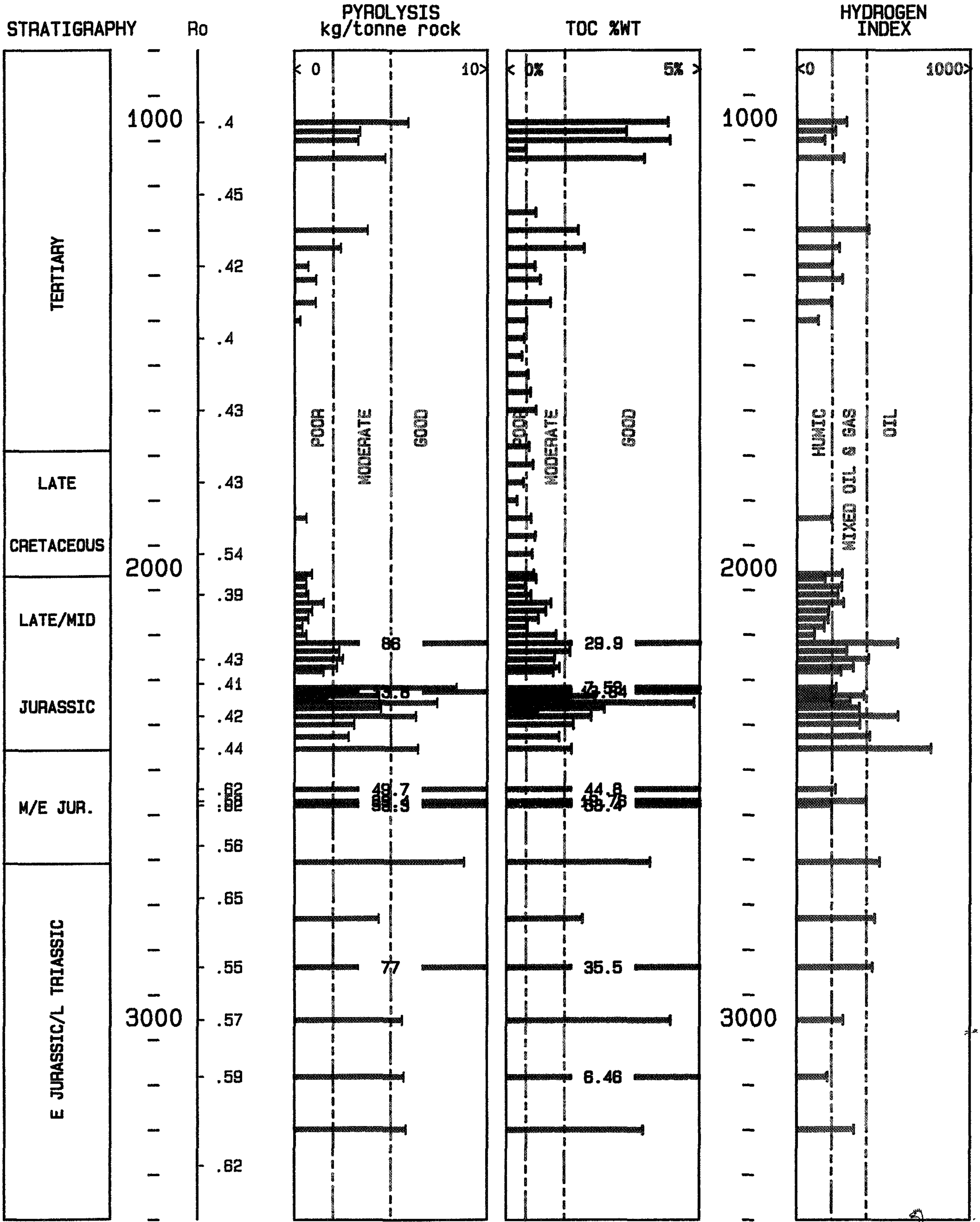
SHORT FORM GEOCHEMICAL LOG

WELL: 35/11-1



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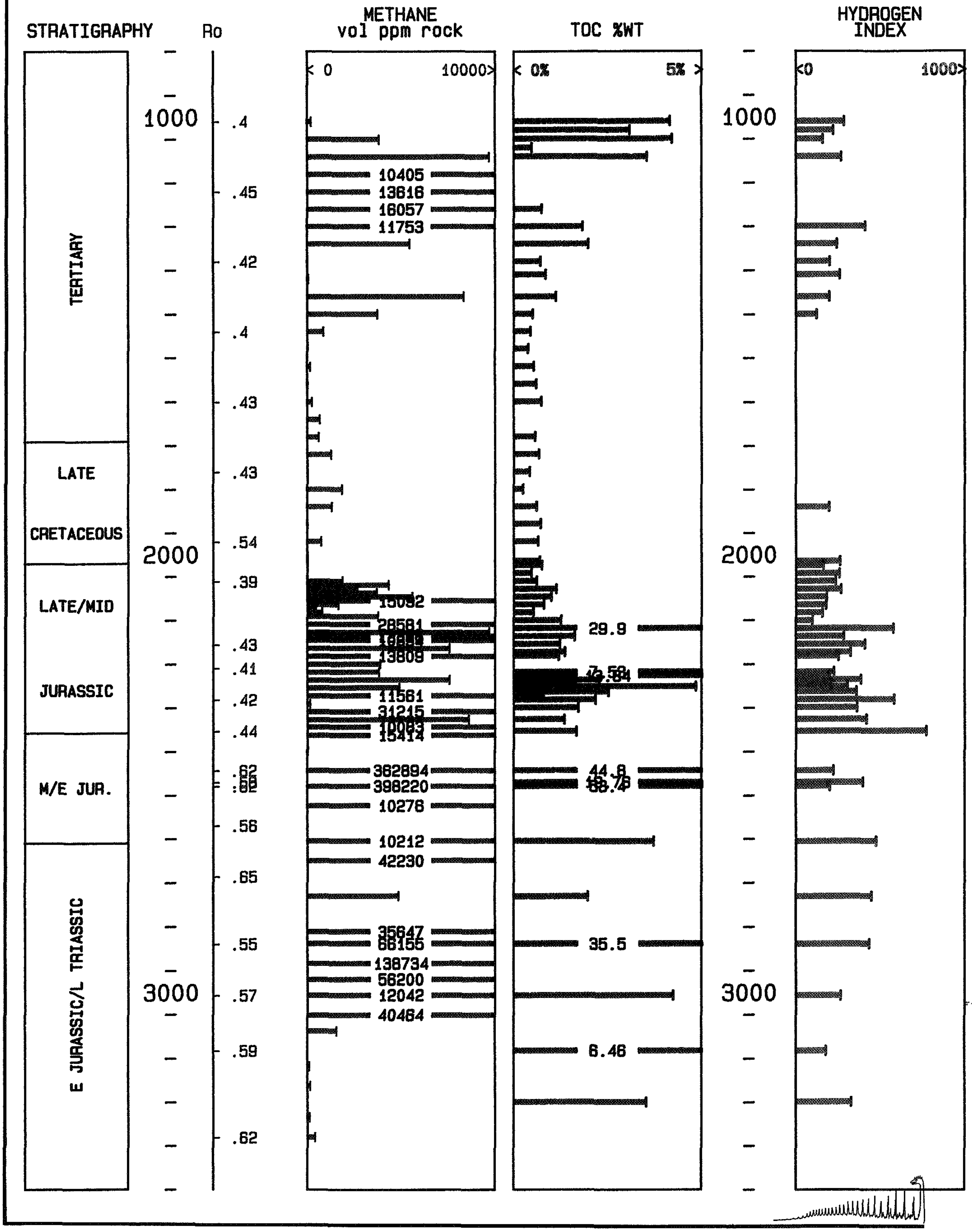
SHORT FORM GEOCHEMICAL LOG (2)

WELL: 35/11-1



1. Introduction

A total of eighty-two cuttings samples were used for a comprehensive geochemical source rock evaluation study of the Well: 35/11-1. The samples range in depth from 1000 m (Tertiary) to 3334 m (Triassic).

Maturity was determined by Vitrinite Reflectance (Ro) and Spore Colouration Indices (SCI) from Visual Kerogen analyses. UV spore fluorescence data additionally corroborated Ro data.

Concentration of headspace gases in tinned cuttings samples from 1000 m to 3334 m were measured.

Pyrolysis techniques were used to establish the hydrocarbon source potential of the sediments and the probable hydrocarbon products or source type where potentials were sufficiently high. Hydrocarbon typing by pyrolysis was supported by Visual Kerogen descriptions completed at the same depth.

2. Samples and Techniques

All the cuttings samples were received in tin cans. Prior to washing the headspace cuttings gases were determined using a Perkin Elmer F11 Gas Chromatograph. Results are recorded in Table 2.

Samples were then thoroughly washed with water and air dried under controlled conditions at 40°C. They were then carefully hand picked to remove obvious caved material and concentrate organic rich lithologies.

Samples for Vitrinte Reflectance measurements were ground ca 1 mm, mounted in an epoxy resin block and polished. Reflectivity values were measured using a reflected light microscope with an oil immersion objective. Results are recorded in Table 3. Histograms of reflectance distributions are present in Figure 1. U.V. spore fluorescence colours are additionally recorded.

Samples for Total Organic Carbon (TOC) measurements were finely ground, sieved to homogenise and digested with fuming hydrochloric acid to remove mineral carbonate. Acid digested samples were then combusted in a Carlo Erba 1106 Carbon, Hydrogen, Nitrogen analyser and the TOC determined relative to those of calibrated standards. The results of these measurements are shown in Table 5. Repeats were run to ensure accuracy.

Samples for Screening Pyrolysis were ground, sieved and examined using a modified Hewlett-Packard 5711 Gas Chromatograph. To measure source rock potential, samples were subjected to two initial isothermal heating periods of 150°C and 325°C and then ramped to 575°C. Two peaks of interpretative significance were evolved, which are conventionally referred to as P1 and P2, and were related to those of a calibrated standard. Standards are run daily to ensure accuracy.

Ground samples, used for Soluble Extract studies, were extracted with geochemical grade dichloromethane using a high velocity mixer. Excess solvent was removed by evaporation and the remaining extract was separated on activated silica to provide a saturate alkane fraction for gas chromatographic analysis. The saturate alkane fractions were examined by quartz capillary gas chromatography using a Carlo Erba 2150 Gas Chromatograph with Grob-type splitless injector system. The results of these measurements are represented in Table 6.

Ground samples for Extended Pyrolysis were extracted with dichloromethane before being heated to 550°C and examined using a modified Hewlett-Packard 5880 Gas Chromatograph. The hydrocarbons evolved were separated according to their boiling points on a non-polar column. This method is adopted in order to analyse the distribution of $C_1 - C_5$ gaseous hydrocarbons and $C_5 - C_{36}+$ liquid hydrocarbons generated from the kerogen. It complements the Visual Kerogen identification of oil and gas prone kerogens. The wet gases/oil ratio is a component of the quantity of paraffinic, naphthenic or naphtheno-aromatic hydrocarbons which a potential source rock can generate at various levels of maturities. Thus, for kerogens which have $\frac{C_1 - C_5}{C_5 - C_{36}+}$ ratios, the following classification is used.

Wet Gases / Oil ratio	Kerogen Type
≤ 0.25	Oil Prone Type 1 Kerogens (Hydrogen Index ≥ 400).
0.25 ≤ 0.7	Mixed Oil and Gas Prone Kerogen. (Hydrogen Index ≥ 200 ≤ 400).
≥ 0.7	Gas Prone (Humic Coals) (Hydrogen Index < 200).

3. Results and Discussion

(a) Gas Analysis

All the cuttings samples were examined for their C_1 (Methane) to C_4 (Butane) hydrocarbon content. From this data, gas wetness values were produced which are shown in Table 2 and on the second geochemical summary log at the front of this report.

(i) Gas Content

In the majority of samples examined, Methane content was extremely high 5000 ppm. From 1000 - 2056 m and 2965 - 3334 m the major proportion of the total $C_2 - C_4$ fraction being present in limited quantities. From 2056 m - 2938 m the cuttings samples showed abundant quantities of Methane, Ethane, Propane, Isobutane and Butane in the headspace gases (in excess of $>$5000 ppm). Within the coal rich Late - Mid Jurassic, total gases increase to a maximum of 436574 ppm.

(ii) The gas wetness value is derived from the following formula.

$$\text{Percent gas wetness} = \frac{C_2 + C_3 + iC_4 + nC_4}{C_1 + C_2 + C_3 + iC_4 + nC_4} \times 100$$

Hunt (1979, 1), has indicated that in a number of sedimentary basins, dry biogenic methane (90% +) may be formed at shallow depths, methane plus heavier gases (wet gases) in deeper catagenic depths, followed by dry gas (thermogenic) in the deepest and oldest sediments.

In the 35/11-1, wet gas contents are exceptionally high, indicative of catagenic gas. The Jurassic contains very high total gas and wet gas values. The maturity (Section 3 b) of the Late Jurassic and Mid Jurassic Brent coal sequences are insufficient to actively generate gas on-structure. The highest gas (total and wet gas ratios) contents are evident within the Middle Jurassic and are probably generated offstructure from more mature counterparts at Reflectances ≥ 1.0%.

(b) Maturity

Various maturity thresholds based on Vitrinite Reflectance are documented (2, 3). Generation thresholds based on Vitrinite Reflectance and Spore Colouration ratings used at Paleochem are as follows:

	Ro % (Average)	UV Fluorescence Colours	Spore Colours (1 - 7 Scale)
Oil Generation Threshold	0.45 to 0.6	Light Orange to Mid Orange	3/4 Yellow/ Orange-Orange
Peak Oil Generation	0.7 to 0.9	Deep Orange to Orange/Red	4/5 Orange/ Brown
Gas Generation	0.7 to 1.0	Deep Orange to Red	5 Brown
Oil Floor (40 ≤°API oils)	1.3	-	5/6 Brown-Black/Black
Condensate Floor	?2.0		
Gas Floor	3.2		7 Black

The results of individual Vitrinite Reflectance measurements are shown in Table 3. In addition, histograms showing the distribution of the individual reflectance values are given at the end of this report.

Sediments from 1000 m - 2407 m in general showed a low phytoclast content with an Ro range of 0.39% - 0.54% which suggests that sediments from this interval are immature and have not yet reached OGT. At this locality no increase of reflectance occurs across the major unconformity at ca 2020 m BRT. Reflectances within the Heather Formation are ≤0.45% Ro.

At 2488 m to 2497 m vitrinite reflectance measurements show a sudden significant increase in maturity to 0.62%. Sediments from 2488 m to 3010 m contain abundant quantities of phytoclast material with an Ro range of 0.55% - 0.65%, which suggests that these sediments have attained maturity. The database is excellent due to the thick coal sequences within the Brent Group below 2480 m.

However, Spore Colouration Indices from visual kerogen descriptions gave values of 2 to 2/3 for sediments from 1000 m to 2404 m and values of 3 to 3/4 for sediments from 2488 m to 3010 m, which do not agree with the Ro values for these intervals. Additionally, detailed gc/ms data reveal marginally mature indigenous triterpane distributions and immature sterane distributions between 2515 m and 2533 m. Furthermore, gas chromatographic analysis of saturated alkane distributions between 2515 m and 2533 m reveal high carbon preferences indices (1·8) indicative of immaturity even for coal sequences. Thus, although excellent reflectance data for the Brent coals suggests maturity below 2515 m alternative microscopic and molecular parameters clearly indicate an immature sequence. No explanation for this anomaly is presented as it has not been observed before. It is suggested that the top of the oil window is in the range 2800 m to 3000 m, based upon reflectance and spore colour data within Early Jurassic strata.

(c) Source Potential

Samples having Total Organic Carbon values below 0.5% are generally regarded as containing insufficient organic material to be of commercial value (4). Thus this value is used as a cut-off point in this report unless Screening

Pyrolysis indicates otherwise. Source potential ratings, based on conventional geochemical data are given below.

Poor	Less than 0.5% TOC
Moderate	0.5% to 1.5% TOC
Good	Greater than 1.5% TOC

Pyrolytic methods are widely used for estimating the generation capabilities of potential source rocks (5). Pyrolysis techniques complement the more traditional method of assessing hydrocarbon potential using Total Organic Carbon measurements, because they provide more meaningful data. Pyrolysis does not take into account any reworked and/or inertinite present in source rocks. Inertinite adds to the organic carbon value, but has very limited or no hydrocarbon potential.

The first peak (P1) represents the quantity of free hydrocarbons that are present in the sediment at the time of sampling. The second peak represents the quantity of hydrocarbons present and yet to be generated. The P2 peak is produced by conversion of the kerogen content by thermal cracking in the instrument. This represents the amount of hydrocarbons yet to be generated by the complete conversion, under natural conditions, throughout future geological history. Both the P1 and P2 yields are expressed in kg./tonne. Often samples may contain significant quantities of in situ hydrocarbons (P1) relative to the amount of kerogen breakdown products (P2) and during conventional pyrolysis these may elute with the P2 fraction. For this reason, samples with significant hydrocarbon potential, and where the P1 is above 10% of the P2 value, are solvent extracted prior to re-evaluation of the hydrocarbon potential. A more accurate assessment of the P2 yield is thus obtained.

Comparison of pyrolysis data with conventional geochemical data to provide hydrocarbon potential ratings gives P2 yield values in practical exploration terms of:

Poor	0.1 to 2.0 kg./tonne rock
Moderate	2.0 to 5.0 kg./tonne rock
Good	5.0 to 15.0 kg./tonne rock
Excellent	> 15.0 kg./tonne rock

In addition, P1, P2 and TOC values can be used to derive the Hydrogen Index (HI) and Production Index (PI) as follows:-

$$\text{Hydrogen Index} = \frac{\text{P2 yield}}{\%\ \text{TOC}} \times 100$$

$$\text{Production Index} = \frac{\text{P1}}{\text{P1} + \text{P2}}$$

HI is independent of the abundance of organic matter present in a sediment and can be used to determine the type of Kerogen (oil and/or gas prone) present in a source rock. In general, the higher the hydrogen index, the more oil prone the kerogen.

The Production Index is a quantitative evaluation of hydrocarbon generation from kerogen. The P1 yield represents the fraction of the kerogen transformed into hydrocarbons unless affected by migrated or contaminant hydrocarbons. The P2 yield represents hydrocarbons yet to be generated. If unaffected by migrated or contaminant hydrocarbons, the P1/P1 + P2 ratio determines the minimum amount of hydrocarbon generation which has formerly occurred or is presently occurring. It is possible that some of the generated hydrocarbons have migrated from the mature source rock. Hence, the P1/P1 + P2 ratio represents a minimum value. A P1/P1 + P2 ratio of 0.1, equivalent to 10% generation, is therefore equated with a maturity ≥ OGT. If migration has not occurred, and this is not common for mature source rocks, a ratio of 0.5 is equated with ≥ peak oil generation.

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(i) Tertiary

Eighteen cuttings samples from the depth range 1000 m to 1740 m (Tertiary) were analysed. Total Organic Carbon contents ranged from poor to good. (TOC % wt. range 0.38% - 4.16%).

Screening Pyrolysis measurements were in good agreement with the TOC results with P2 values in the range 0.3 to 5.9 kg./tonne rock.

Hydrogen Indices for this section were uniformly low, 60 - 206, which indicates a humic gas prone formation. Visual Kerogen descriptions indicated that these sediments contain predominantly vascular plant material which supports the pyrolysis measurements and suggests the Tertiary interval is gas prone. These samples contained high P1 values, up to 1.9 kg. oil/tonne rock ($\lesssim$38 bbl oil/acre ft) and were extracted to indicate whether or not oil shows were present.

Soluble Extract studies for the Tertiary were carried out on three cuttings samples at 1000 - 1020 m, 1080 - 1100 m, and 1440 - 1460 m. The n-alkane distributions of the sediments show prominent alkanes eluting between nC_{14} and nC_{18}, typical of diesel contamination distributions, and atypical of oil shows.

(ii) Late Cretaceous

Seven cuttings samples from 1760 m to 2020 m were analysed from the Late Cretaceous. The lithologies for this interval consisted predominantly of red/green to medium grey mudstone. TOC contents ranged from poor to moderate with the majority of sediments showing moderate TOC content (TOC % wt. range 0.25% - 0.69%).

Screening Pyrolysis measurements on two Late Cretaceous samples at 1880 - 1900 m and 2010 - 2020 m showed values of

0.6 and 0.9 kg./tonne rock, which suggests poor hydrocarbon source potential. This downrating in source potential is due in part to the presence of inertinite observed during reflected light microscopy.

Hydrogen Indices for this interval are low, 98 - 130, which indicates the sediments are at best gas prone. Pyrolysis potentials, P2, are both below 2.0 kg./tonne rock and are essentially barren with respect to former, present or future hydrocarbon potential.

Visual Kerogen descriptions indicated that these sediments contain only vascular plant material and have negligible source potential, corroborating pyrolysis interpretations.

(iii) <u>Late/Mid Jurassic</u>

Twenty-four cuttings samples from the Late/Mid Jurassic were analysed (2020 m - 2407 m). The lithologies for this interval consisted predominantly of light grey to medium grey mudstones, and limestones with minor quantities of lignite at 2164 m - 2174 m and 2227 m - 2281 m.

Total Organic Carbon contents ranged from poor to excellent, TOC % wt. range 0.47% - 29.9%. Screening Pyrolysis measurements were in general agreement with the TOC results with P2 values in the range 0.4 - 86.0 kg./tonne rock. The latter excellent yield is the result of a lignite at this horizon (2164 to 2173 m). With the exception of lignites, pyrolysis potentials are moderate to low. The Kimmeridge Clay Formation is not present at this locality, Late Cretaceous sediments overly Late Jurassic (Oxfordian) mudrocks of the Heather Formation.

Hydrogen Indices range from 48 - 386 indicative of a predominantly gas prone formation with two sediments at 2326 to 2335 m, and 2398 - 2407 m having potential to source both oil and gas. This is supported by Visual Kerogen descriptions which show these sediments contain significant quantities of amorphous algal material.

Soluble Extract studies carried out on four sediments at 2074 - 2083 m, 2164 - 2173 m, 2272 - 2281 m and 2308 - 2317 m show n-alkane distributions with prominent nC_{14} and nC_{15} peaks, and a large unresolved hump eluting circa nC_{21} and nC_{28} (Fig.3). These distributions are typical of diesel and pipe dope. No crude oil distributions were identified.

(iv) <u>Mid/Early Jurassic</u>

Four cuttings samples of Mid/Early Jurassic age were analysed. The sediments ranged in depth from 2488 m - 2659 m and their lithologies consisted predominantly of light grey siltstone and coals.

TOC contents are in the range good to excellent, TOC % wt. 3.7% - 53.4%. Screening Pyrolysis measurements range from 8.8 kg./tonne rock to 53.3 kg./tonne rock, with a mean P2 potential of 47.5 kg./tonne rock. Hydrogen Indices were in general, low, 100 - 237, indicative of a humic gas prone formation. Visual Kerogen descriptions on two sediments from the interval showed common to abundant quantities of vascular plant material which confirms that the interval is highly gas prone. This is further supported by Extended Pyrolysis measurements which show a gas/oil ratio of 0.48 - 0.60, i.e. gas prone to mixed oil and gas prone kerogens. Although the coal at 2524 m was visually identified as of canneloid (algal) type, chemical data refutes this observation.

Soluble Extract studies for the Mid/Early Jurassic were carried out on four cuttings samples at 2488 - 2492 m, 2515 - 2524 m, 2524 - 2533 m and 2650 - 2659 m.

The n-alkane distributions for samples 2488 - 2492 m, 2515 - 2524 m and 2524 - 2533 m were very similar in appearance with a prominent Pristane and nC_{25} peak with hydrocarbon envelopes that extend beyond nC_{30}, indicative of kerogens receiving a large terrestrial input. Distributions still look immature at 2533 m. The n-alkane distribution for the sediment at 2650 - 2659 m was similar in appearance to the Late/Mid Jurassic gas chromatograms showing prominent nC_{14} and nC_{15} peaks with an unresolved hump eluting ca nC_{21} - nC_{28}, i.e. contaminants.

Steranes (m/z 217), Rearranged Steranes (m/z 218), and Pentacyclanes (m/z 191) distributions, by cgc/ms, were analysed for two sediment extracts at 2515 - 2524 m and 2524 - 2533 m. M/z 191 mass fragmentograms for the sediment extracts were very similar in appearance and show a marginally mature distribution of peak doublets methyl and ethyl hopane. The doublets represent the right handed (R) and left handed (S) forms of the same component. At maturity increases, the naturally occurring R form epimerises into the S form. Equilibrium epimer ratios (22 S/R - 1.5) were not observed and hence the sequence is regarded as immature.

The total sterane fragmentograms (m/z 217), Figs 9 - 13), however, indicates immaturity with R epimers greatly exceeding the S components for the 5α, 14α, 17α cholestanes. Similarly, the 5α 14β 17βsteranes (m/z 218) reveal low 20 S/R ratios corroborating the immaturity of the sediments. Equilibrium values of S/R cholestane epimers is ca 0.8 normally achieved at Ro equivalent 0.7 to 0.8 Ro. Hence, molecular parameter data attest the immaturity of the top Brent at this locality.

(v) Early Jurassic/Late Triassic

Five cuttings samples were analysed from the depth range 2776 m - 3253 m. The predominant lithology of this group of samples was sandstone with minor quantities of siltstone and traces of coal which may represent cavings from the coal rich interval above.

TOC contents are good to excellent, TOC % weight range 1.96% - 35.3%. Screening Pyrolysis measurements of 4.4 - 77.0 kg./tonne rock were recorded, the latter represented a picked coal lithology at 2884 m to 2893 m.

Hydrogen Indices in the range 88 - 224, indicate humic gas prone formations. Visual Kerogen descriptions on four sediments from the Early Jurassic/Late Triassic interval reveal that samples at 2884 - 2893 m, and 3001 - 3010 m contain common/abundant vascular plant material, while sediments at 3127 - 3136 m and 3244 - 3253 m are barren with no source potential. Pyrolysis data for picked mudrock and trace coal (cavings?) lithologies reveal moderate gas potential but lack of sapropelic oil prone kerogens.

4. Conclusions

The top of the oil window at this locality is predicted to occur in the depth range 2800 to 3000 m BRT on the basis of a multiparameter maturity assessment. Enigmatically, however, and contrary to all other data, very good reflectance (Ro 0.58 to 0.62%) data for Brent Group coal sequences at 2488 m to 2533 m indicate the onset of maturity. Reflectance is known to be dependent upon lithology in that vitrinite particles associated with mudrock or sandstone facies adjacent to coal seams are of higher rank, i.e. higher Ro. This, however, is contrary to the observed variation at this locality. Physical data, i.e. spore colour and spore fluorescence, and chemical data, gas chromatographic distributions and immature homohopane and sterane epimer ratios clearly reveal highly immature oil distributions albeit at reflectance values commensurate with the attainment of maturity. The reasons for this discrepancy remain unknown.

No Kimmeridge Clay Formation is present at this locality, the Late Cretaceous System rests unconformably upon Oxfordian dated sediments of the Heather Formation. Gas prone source rocks are present within the Heather with only minor occurrence of oil prone sapropelic kerogens.

Exceptionally high total gas concentrations were observed within Jurassic sediments, in particular up to 440,000 ppm (headspace) total gas concentrations occur within the Brent coal sequence. This gas of thermogenic origin is considered to be derived by intraformational migration, from more mature coals (Ro $\geq$ 1.0%) in the off-structural setting.

Occasional high free oil contents in ditched cuttings (up to 38 bbl/acre ft) were identified as diesel and pipe dope contaminants. No bona fide oil shows were identified throughout the well sequence.

References

1. Hunt, J.M. Petroleum Geochemistry and Geology. pp 178 - 182 (1979).
2. Saxby, J.D. J. Pet. Geol. 5, 2, pp 117 - 128. (1982).
3. Dow, W.G. J. Geochem Expl. 7, pp 79 - 99. (1979).
4. Ronov, A.B. Geochemistry No.5., pp 510 - 536. (1958).
5. Clementz, D.M. Offshore Technology Conference, pp 465 (1979).

Well: 35/11-1

LITHOLOGY DESCRIPTION

Depth (m)	Sample Type	Stratigraphy	Lithological Description
1000-20	Cu	Tertiary	80% Siltstone, med. grey, 20% Mudstone, light grey.
1020-40	Cu	Tertiary	100% Mudstone, med. grey.
1040-60	Cu	Tertiary	100% Mudstone, med. grey.
1060-80	Cu	Tertiary	100% Mudstone, med. grey/ dk. red.
1080-1100	Cu	Tertiary	100% Mudstone, med. grey.
1200-20	Cu	Tertiary	100% Mudstone, med./dk. grey.
1240-60	Cu	Tertiary	100% Mudstone, med. grey/ green.
1280-1300	Cu	Tertiary	100% silty Mudstone, light grey/green/red.
1320-40	Cu	Tertiary	100% silty Mudstone, light grey/green/red.
1340-80	Cu	Tertiary	100% silty Mudstone, light grey/green/red.
1400-20	Cu	Tertiary	100% Mudstone, med. grey
1440-60	Cu	Tertiary	80% Mudstone, med.grey-dk red, 20% Siltstone, med. grey.
1480-1500	Cu	Tertiary	80% Mudstone, med.grey/ dk. red, 20% Siltstone, med. grey.
1520-40	Cu	Tertiary	50% Sandstone, white, 50% Siltstone, med.grey/ red.
1560-80	Cu	Tertiary	100% Mudstone, med.grey/ dk. red.
1600-20	Cu	Tertiary	100% Mudstone, med.grey/ dk. red.
1640-60	Cu	Tertiary	100% Mudstone, med. grey.

Table 1

Well: 35/11-1

LITHOLOGY DESCRIPTION

Depth (m)	Sample Type	Stratigraphy	Lithological Description
1720-40	Cu	Tertiary	100% Mudstone, med.grey/ green, micaceous, calc.
1760-80	Cu	Late Cretaceous	100% Mudstone, med.grey/ red.
1800-20	Cu	Late Cretaceous	95% Mudstone, med. grey, 5% Limestone, brown/white.
1840-60	Cu	Late Cretaceous	95% Mudstone, med. grey, 5% Limestone, brown/white
1880-1900	Cu	Late Cretaceous	100% Mudstone, med.grey/ red.
1920-40	Cu	Late Cretaceous	100% Mudstone, med. grey/ red.
1960-80	Cu	Late Cretaceous	100% Mudstone, med. grey/ red.
2010-20	Cu	Late Cretaceous	100% Mudstone, med. grey/ red.
2020-30	Cu	Late/Mid Jurassic	100% Mudstone, med.grey/ green/red.
2038-47	Cu	Late/Mid Jurassic	100% Mudstone, med. grey/ green
2056-65	Cu	Late/Mid Jurassic	100% Mudstone, med./dk grey.
2074-83	Cu	Late/Mid Jurassic	60% Limestone, light grey, 40% Shale, dark grey
2092-2101	Cu	Late/Mid Jurassic	50% quartz sand, 40% Mudstone, med. grey, 10% Limestone.
2110-19	Cu	Late/Mid Jurassic	50% quartz sand, 40% Mudstone, med. grey, 10% Limestone.
2128-37	Cu	Late/Mid Jurassic	80% quartz sand, 20% Mudstone, med. grey.

Table 1 - continued

Well: 35/11-1

LITHOLOGY DESCRIPTION

Depth	Sample Type	Stratigraphy	Lithological Description
2146-55	Cu	Late/Mid Jurassic	50% Sandstone, light grey, 50% Limestone
2164-73	Cu	Late/Mid Jurassic	50% Sandstone, light grey, 45% Limestone, 5% lignite.
2182-91	Cu	Late/Mid Jurassic	10% Sandstone, light grey, 40% Limestone, 50% Mudstone, med. grey
2200-09	Cu	Late/Mid Jurassic	10% Sandstone, light grey, 40% Limestone, 50% Mudstone, med. grey
2218-27	Cu	Late/Mid Jurassic	100% Sandstone, light grey, slightly calc.
2227-36	Cu	Late/Mid Jurassic	90% Sandstone, light grey, 10% lignite.
2263-72	Cu	Late/Mid Jurassic	98% Sandstone, light grey, 2% lignite
2272-81	Cu	Late/Mid Jurassic	99% Sandstone, light grey, 1% lignite
2281-90	Cu	Late/Mid Jurassic	95% Sandstone, light grey, 5% Mudstone, med. grey
2290-99	Cu	Late/Mid Jurassic	95% Sandstone, light grey, 5% Mudstone, med. grey
2299-2308	Cu	Late/Mid Jurassic	80% Sandstone, light grey, 20% Mudstone, med. grey
2308-17	Cu	Late/Mid Jurassic	80% Sandstone, light grey, 20% Mudstone, med. grey
2317-26	Cu	Late/Mid Jurassic	60% Siltstone, med. grey 40% Mudstone, med. grey
2326-35	Cu	Late/Mid Jurassic	90% Siltstone, med./ light grey, 10% Sandstone, light grey
2344-53	Cu	Late/Mid Jurassic	90% Siltstone, med. grey, 10% Sandstone, light grey

Table 1 - continued

Well: 35/11-1

LITHOLOGY DESCRIPTION

Depth (m)	Sample Type	Stratigraphy	Lithological Description
2371-80	Cu	Late/Mid Jurassic	100% Siltstone, med. grey.
2398-2407	Cu	Late/Mid Jurassic	100% Siltstone, med. grey.
2488-97	Cu	Mid/Early Jurassic	50% Siltstone, light grey, 50% Coal.
2515-24	Cu	Mid/Early Jurassic	10% Coal, dull, 10% Siltstone, light grey. 80% Siltstone, dark grey.
2524-33	Cu	Mid/Early Jurassic	50% Coal, canneloid, 20% Mudstone, med. grey. 30% Siltstone, dark grey.
2650-59	Cu	Mid/Early Jurassic	95% Sandstone, 5% Siltstone, med.grey. Tr. coal.
2731-40	Cu	Early Jurassic /Late Triassic	98% Sandstone, 2% Siltstone, med. grey, Tr. coal.
2776-85	Cu	Early Jurassic /Late Triassic	95% Sandstone, 5% Mudstone, light grey, Tr. coal.
2884-93	Cu	Early Jurassic /Late Triassic	95% Sandstone, 5% Mudstone, light grey, Tr. coal.
3001-10	Cu	Early Jurassic /Late Triassic	98% quartz sand, 2% Shale, tr. coal.
3127-36	Cu	Early Jurassic /Late Triassic	98% quartz sand, 2% Shale, dark grey.
3244-53	Cu	Early Jurassic /Late Triassic	95% quartz sand, 2% Shale, dark grey, 3% feldspathic sand.

Table 1 - continued

Well: 35/11-1

HEADSPACE GAS ANALYSIS
CONCENTRATION PPM BY VOLUME (IN HEADSPACE)

Depth (m)	Methane C_1 (ppm)	Ethane C_2 (ppm)	Propane C_3 (ppm)	Isobutane iC_4 (ppm)	Butane nC_4 (ppm)	Gas Wetness %
1000-20	230	12	39	-	-	18.1
1040-60	3853	119	252	-	-	8.8
1080-1100	9698	238	281	-	-	5.1
1120-40	10405	351	279	-	-	5.7
1160-80	13616	351	170	-	-	3.7
1200-20	16057	511	78	-	-	3.5
1240-60	11753	270	71	-	-	2.8
1280-1300	5491	73	25	-	-	1.8
1320-40	25	-	-	-	-	-
1360-80	61	9	-	-	-	12.9
1400-20	8349	233	62	-	-	3.4
1440-60	3757	128	42	-	-	3.4
1480-1500	870	71	75	-	-	14.3
1520-40	19	-	-	-	-	-
1560-80	179	14	-	-	-	7.3

Table 2

PALEOCHEM

Well: 35/11-1

HEADSPACE GAS ANALYSIS
CONCENTRATION PPM BY VOLUME (IN HEADSPACE)

Depth (m)	Methane C_1 (ppm)	Ethane C_2 (ppm)	Propane C_3 (ppm)	Isobutane iC_4 (ppm)	Butane nC_4 (ppm)	Gas Wetness %
1600-20	34	4	-	-	-	10.5
1640-60	271	59	42	-	-	27.2
1680-1700	684	253	130	-	-	35.9
1720-40	629	252	146	-	-	38.8
1760-80	1284	447	-	-	-	25.8
1800-20	-	-	-	-	-	-
1840-60	1888	271	250	-	-	21.6
1880-1900	1335	149	175	-	-	19.7
1920-40	29	-	-	-	-	-
1960-80	751	334	601	117	248	65.6
2000-10	29	8	-	-	-	21.6
2010-20	26	15	42	-	-	68.7
2029-38	-	-	-	-	-	-
2038-47	-	-	-	-	-	-

Table 2 - continued

PALEOCHEM

Well: 35/11-1

HEADSPACE GAS ANALYSIS
CONCENTRATION PPM BY VOLUME (IN HEADSPACE)

Depth (m)	Methane C_1 (ppm)	Ethane C_2 (ppm)	Propane C_3 (ppm)	Isobutane iC_4 (ppm)	Butane nC_4 (ppm)	Gas Wetness %
2047-56	11	-	-	-	-	-
2056-65	1894	2653	7515	2268	5196	90.3
2065-74	4367	5030	10771	3183	5562	84.9
2074-83	2692	3195	6727	1683	3403	84.8
2083-92	3725	3106	5010	1134	1976	75.1
2092-2101	5620	5334	7515	1661	2773	75.5
2101-10	15092	19733	2881	6111	9880	80.9
2110-19	1653	2012	3650	1024	2524	84.8
2119-28	458	353	1072	297	775	84.5
2128-37	799	306	687	-	307	61.9
2137-46	3789	3731	5010	878	2268	75.8
2146-55	-	-	-	-	-	-
2155-64	28581	24321	24513	4866	5891	67.6
2164-73	-	-	-	-	-	-
2173-82	9698	9397	11809	2459	3439	73.6

Table 2 - continued

Well: 35/11-1

PALEOCHEM

HEADSPACE GAS ANALYSIS
CONCENTRATION PPM BY VOLUME (IN HEADSPACE)

Depth (m)	Methane C_1 (ppm)	Ethane C_2 (ppm)	Propane C_3 (ppm)	Isobutane iC_4 (ppm)	Butane nC_4 (ppm)	Gas Wetness %
2182-91	12396	9618	16640	2495	3359	72.1
2191-2200	10854	10281	12560	2707	3329	72.7
2209-18	7579	5959	-	1976	2561	57.8
2227-36	13809	9314	8624	1683	2195	61.2
2245-54	3901	3007	3256	805	841	67.0
2263-72	3837	3714	4562	1280	1390	74.0
2281-90	7579	5289	6244	1390	1500	65.6
2299-2308	4913	5444	5349	1244	1390	73.2
2317-26	11561	7490	7264	1536	1463	60.6
2335-44	144	547	1574	380	336	95.2
2353-62	31215	29186	12614	2561	2232	59.9
2371-80	8606	6577	6513	1427	1427	64.9
2389-98	10083	6135	5385	1061	1061	57.5
2407-16	15414	7490	6423	1353	1170	51.6

Table 2 - continued

Well: 35/11-1

HEADSPACE GAS ANALYSIS
CONCENTRATION PPM BY VOLUME (IN HEADSPACE)

Depth (m)	Methane C_1 (ppm)	Ethane C_2 (ppm)	Propane C_3 (ppm)	Isobutane iC_4 (ppm)	Butane nC_4 (ppm)	Gas Wetness %
2443-52	49	30	307	204	175	93.6
2488-97	362894	26145	6888	1244	365	8.7
2524-33	398220	27514	8499	1427	914	8.8
2569-78	10276	2653	1395	-	-	28.3
2614-23	-	2122	8517	2341	1097	-
2650-59	10212	2391	2970	1170	695	41.4
2695-2704	42230	5582	3143	902	731	19.7
2731-40	-	-	-	-	-	-
2776-85	4881	2072	2254	951	841	55.6
2812-21	-	-	-	-	-	-
2857-66	35647	6154	2880	507	478	21.9
2884-93	66155	4947	2165	-	-	9.7
2929-38	138734	7876	2469	439	292	7.4
2965-74	56200	4278	1681	-	-	9.6
3001-10	12042	2266	1010	-	-	21.3

Table 2 - continued

Well: 35/11-1

HEADSPACE GAS ANALYSIS
CONCENTRATION PPM BY VOLUME (IN HEADSPACE)

Depth (m)	Methane C_1 (ppm)	Ethane C_2 (ppm)	Propane C_3 (ppm)	Isobutane iC_4 (ppm)	Butane nC_4 (ppm)	Gas Wetness %
3046-55	40464	1813	644	-	-	5.7
3082-91	1571	169	53	-	-	12.3
3127-36	950	113	53	-	-	14.9
3163-72	96	6	-	-	-	5.9
3208-17	154	24	-	-	-	13.5
3244-53	-	-	-	-	-	-
3280-89	125	37	-	-	-	22.8
3325-34	419	80	-	-	-	16.0

Table 2 - continued

Well: 35/11-1

VITRINITE REFLECTANCE DATA

Depth m	Lithology	Special Mineralogy	Bitumen Form	Bitumen Content	Phytoclasts Inert/Rew/Vit.	Fluorescence Typ/Cont/Col.	Vitrinite Ro_{Av} (Points)
1000-20	Shale/ Limestone	-	Staining	Strong	Inert > Vit.	Sp/Tr/Y	$0.40_{(20)}$
1160-80	Shale	-	Wisps/ Staining	Mod.	Inert < Vit.	Sp/Low/Y-Y/O	$0.45_{(20)}$
1320-40	Silty Shale	-	Wisps/ Staining	Mod.	Inert= Vit.	Sp/Low/Y	$0.42_{(20)}$
1480-1500	Shale	Iron oxide	Wisps/ Staining	Mod.	Inert < Vit.	NDP	$0.40_{(20)}$
1640-60	Shale	-	Wisps/ Staining	Mod.	Inert > Vit.	Sp/Tr/Y-Y/O	$0.43_{(20)}$
1800-20	Shale	-	Wisps	Mod.	Inert > Vit.	Sp/Tr/Y	$0.43_{(8)}$
1960-80	Shale	-	Wisps	Mod.	Inert > Vit.	Sp/Tr/Y-Y/O	$0.54_{(8)}$
2056-65	Shale	-	Wisps/ Staining	Mod.	Inert < Vit.	Carb/Low/Y/O	$0.39_{(20)}$
2123-37	Sandstone	Iron oxide	-	-	- -	Carb/Low/Y/O	NDP
2200-09	Sandstone/ Coal	-	Wisps/ Staining	Low	Inert < Vit.	Sp/Tr/Y/O	$0.43_{(20)}$
2254-63	Coal	Pyrite	-	-	Vit.	-	$0.41_{(20)}$

Table 3

Well: 35/11-1

VITRINITE REFLECTANCE DATA

Depth m	Lithology	Special Mineralogy	Bitumen Form	Bitumen Content	Phytoclasts Inert/Rew/Vit.	Fluorescence Typ/Cont/Col.	Vitrinite Ro_{Av} (Points)
2326-35	Siltstone	-	Wisps/ Staining	Low	Inert < Vit.	Sp/Tr/Y	$0.42_{(20)}$
2398-2407	Silty Shale	-	Wisps	Low	Inert < Vit.	Sp/Low/Y-Y/O	$0.44_{(20)}$
2488-97	Coal/Shale	-	Staining	Strong	Inert > Vit.	Sp/Rich/L/MO	$0.62_{(20)}$
2515-24	Shale	-	Staining	Strong	Inert > Vit.	Sp/Rich/YO/DO	$0.58_{(15)}$
2524-33	Coal	-	-	-	Inert < Vit.	Sp/Rich/Y-DO	$0.62_{(20)}$
2614-23	Coal/Shale	-	Wisps/ Staining	Mod.	Inert < Vit.	Sp/Mod./Y/O-L/O	$0.56_{(15)}$
2731-40	Shale	-	Wisps/ Staining	Strong	Inert > Rew= Vit.	Sp/Rich/Y/O-L/O	$0.65_{(20)}$
2884-93	Coal/Shale	-	Wisps/ Staining	Mod.	Inert = Vit.	Sp/Low/LO	$0.55_{(20)}$
3001-10	Shale	-	Wisps/ Staining	Strong	Inert > Rew= Vit.	Sp/Low/Y/O-LO	$0.57_{(20)}$
3127-36	Sandstone/ Shale	Quartz Specks	Wisps/ Staining	Mod.	Inert > Vit.	Sp/Tr/YO-LO	$0.59_{(6)}$ $4.93_{(1)}$
3325-34	Sandstone/ Shale	Graphite Specks	Wisps/ Staining	Mod.	Inert > Vit.	Sp/Tr/YO-LO	$0.62_{(2)}$ $4.87_{(2)}$

Table 3 - continued

Well: 35/11-1

VISUAL KEROGEN DATA

Depth	Palynomorphs	Brown Wood	Black Wood & Inertinite	Amorphous	Predominant Source Type	Colour Maturation Rating
1000-20	Common*°	Abundant	-	-	Gas	2
1160-80	Common*	Common	Trace	Trace	-	2
1320-40	Common*	Trace	Trace	-	-	2
1480-1500	Common*	Trace	Trace	Trace	Gas	2
1640-60	Common*	Trace	Common	-	Gas	2
1800-20	Common*	Common	Common	-	Gas	2
1960-80	Abundant*	Trace	Common	-	Gas	2/3
2056-65	Trace	Abundant	-	-	Gas	2/3?
2128-37	-	-	-	-	None	NDP
2200-09	Trace*	Common	-	-	Gas	2/3
2254-63	Trace*	Trace	-	-	Gas	2/3
2326-35	Trace*	Common	Trace	Common	Gas/? oil	2/3

PALEOCHEM

Table 4

Well: 35/11-1

VISUAL KEROGEN DATA

Depth	Palynomorphs	Brown Wood	Black Wood & Inertinite	Amorphous	Predominant Source Type	Colour Maturation Rating
2398-2404	Trace*	Trace	-	Abundant	Gas /? Oil	2/3
2488-97	Abundant	Abundant	Common	-	Gas	3
2614-23	Trace	Abundant	Trace	-	Gas	3
2734-40	Common	Abundant	-	-	Gas	3
2884-93	Trace	Common	-	-	Gas	3
3001-10	Trace	Common	-	-	Gas	3/4
3127-36	-	-	-	-	Barren	
3325-34	-	-	-	-	Barren	

o = Dinoflagellates

* = Botyrococcus

NDP = No determination possible.

Table 4 - continued

PALEOCHEM

PALEOCHEM

Well: 35/11-1

T.O.C. AND PYROLYSIS DATA

Depth (m)	TOC	Yield (kg./tonne) P1 Peak	P2 Peak	Hydrogen Index	Production Index
1000-20	4.16	1.8	5.9	142	0.23
1020-40	3.08	1.1	3.4	110	0.24
1040-60	4.21	0.7	3.3	78	0.18
1060-80	0.48				
1080-1100	3.54	1.8	4.7	133	0.28
1200-20	0.74				
1240-60	1.84	0.4	3.8	206	0.09
1280-1300	1.99	0.6	2.4	121	0.20
1320-40	0.71	0.2	0.7	99	0.22
1340-80	0.85	0.6	1.1	129	0.35
1400-20	1.12	0.7	1.1	98	0.39
1440-60	0.50	1.9	0.3	60	0.86
1480-1500	0.44				
1520-40	0.38				
1560-80	0.54				
1600-20	0.60				
1640-1660	0.74				
1720-40	0.57				
1760-80	0.67				
1800-20	0.42				
1840-60	0.25				
1880-1900	0.61	0.4	0.6	98	0.40
1920-40	0.72				
1960-80	0.65				
2010-20	0.69	0.5	0.9	130	0.36

Table 5

PALEOCHEM
Well: 35/11-1

T.O.C. AND PYROLYSIS DATA

Depth (m)	TOC	Yield (kg./tonne) P1 Peak	P2 Peak	Hydrogen Index	Production Index
2020-30	0.75	0.8	0.6	80	0.57
2038-47	0.47	0.3	0.6	128	0.33
2056-65	0.61	0.8	0.7	117	0.53
2074-83	1.13	1.7	1.5	133	0.53
2092-2101	1.0	0.3	0.9	90	0.25
2110-19	0.8	1.1	0.7	88	0.61
2128-37	0.52	0.3	0.4	77	0.43
2146-55	1.26	0.2	0.6	48	0.25
2164-73	29.9	7.9	86.0	288	0.08
2182-91	1.62	0.7	2.3	142	0.23
2200-09	1.22	1.0	2.5	205	0.30
2218-27	1.36	0.1	2.2	162	0.04
2227-36	1.19	0.3	1.5	126	0.16
2263-72	7.53	1.6	8.4	112	0.16
2272-81	13.84	1.7	13.8	100	0.10
2281-90	2.27	0.7	4.4	193	0.13
2290-99	1.64	0.6	1.7	104	0.46
2299-2308	4.83	0.7	7.4	153	0.09
2308-17	2.51	0.6	4.5	179	0.12
2317-26	0.79				
2326-35	2.17	0.4	6.3	290	0.06
2344-53	1.71	0.5	3.1	181	0.13
2371-80	1.34	0.5 (0.4R)	2.8 (2.8R)	209	0.15
2398-2407	1.66	0.3 (0.6R)	6.4 (6.7R)	386	0.04

Table 5 - continued

PALEOCHEM

Well: 35/11-1

T.O.C. AND PYROLYSIS DATA

Depth (m)	TOC	Yield (kg./tonne) P1 Peak	P2 Peak	Hydrogen Index	Production Index
2488-97	44.8	6.9	49.7	111	0.15
2515-24	19.76	2.8	39.4	199	0.07
2524-33	53.4	4.7	53.3	100	0.08
2650-59	3.7	1.6	8.8	237	0.15
2776-85	1.96	0.6	4.4	224	0.12
2884-93	35.5	12.1	77.0	217	0.14
3001-10	4.23	1.1	5.6	132	0.16
3127-36	6.46	0.6	5.7	88	0.10
3244-53	3.52	0.7	5.8	164	0.11

Table 5 - continued

PALEOCHEM

Well: 35/11-1

SOLUBLE EXTRACT DATA

Depth m	Total Soluble Extract % Wt.	Saturate Alkane Content	Aromatics	Residue
1000-20	0.154	64.3	18.9	16.7
1080-1100	0.058	26.2	13.3	60.5
1440-60	0.137	42.8	34.0	23.1
2074-83	0.079	60.6	25.6	13.8
2164-73	0.134	33.3	41.6	25.1
2272-81	0.053	36.8	33.2	30.0
2308-17	0.044	47.5	30.3	22.2
2488-97	0.367	49.1	34.1	16.8
2575-24	0.153	33.4	35.6	31.0
2524-33	0.374	22.2	51.4	26.4
2650-59	0.104	35.3	20.1	44.7

Table 6

Well: Mobil 35/11-1

KEROGEN BREAKDOWN PRODUCTS

Depth (m)	Wet Gases	Gasoline	Kerosine	Gas Oil	Wax Distillate	Gas/Oil Ratio
2515-24	32.2	18.4	15.2	21.4	12.7	0.48
2524-33	37.3	12.2	15.2	21.9	13.3	0.60

Table 7

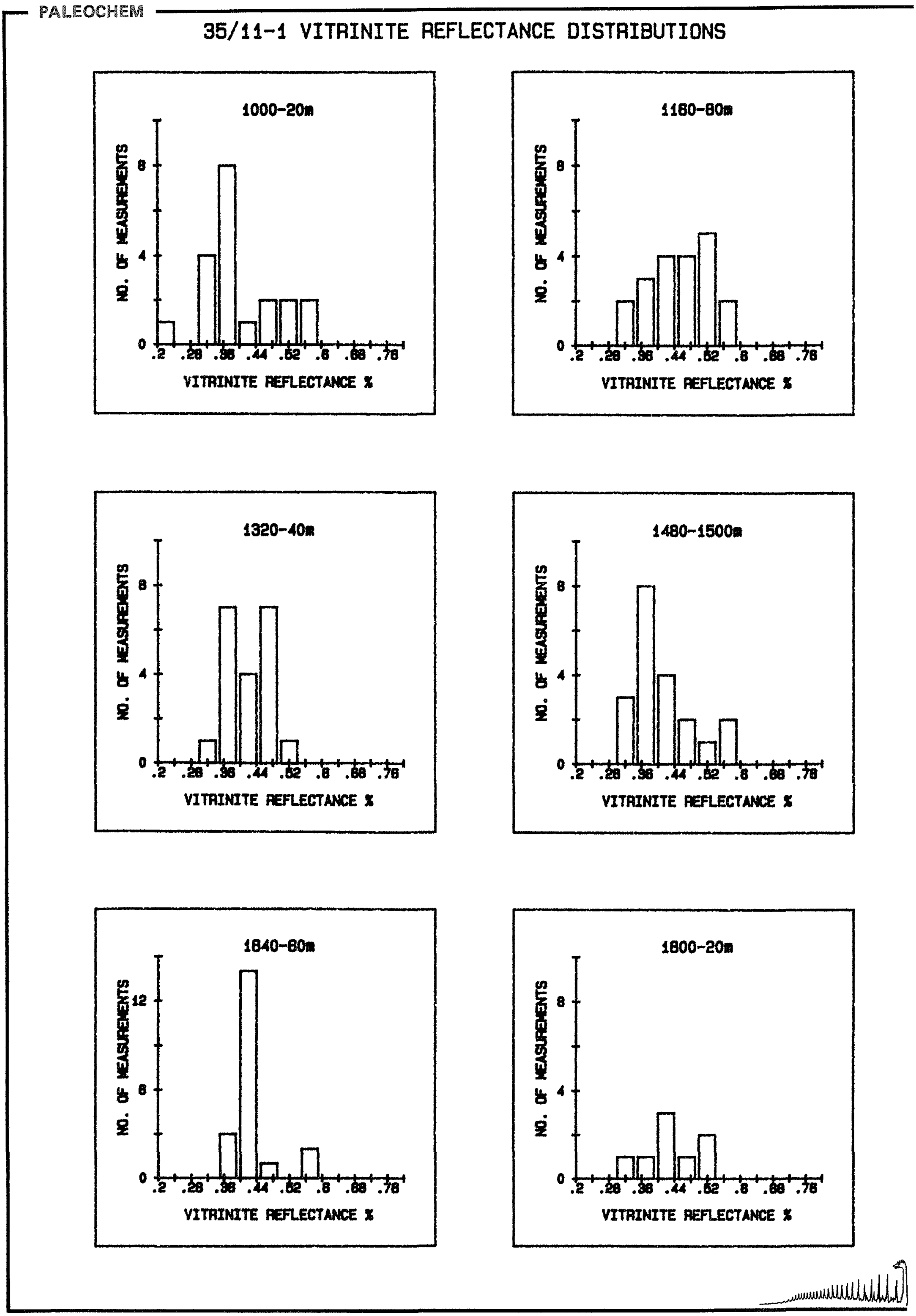

PALEOCHEM
35/11-1 VITRINITE REFLECTANCE DISTRIBUTIONS
1000-20m
1160-80m
1320-40m
1480-1500m
1640-60m
1800-20m
NO. OF MEASUREMENTS
VITRINITE REFLECTANCE %
.2 .28 .36 .44 .52 .6 .68 .76

Fig.1

PALEOCHEM

35/11-1 VITRINITE REFLECTANCE DISTRIBUTIONS

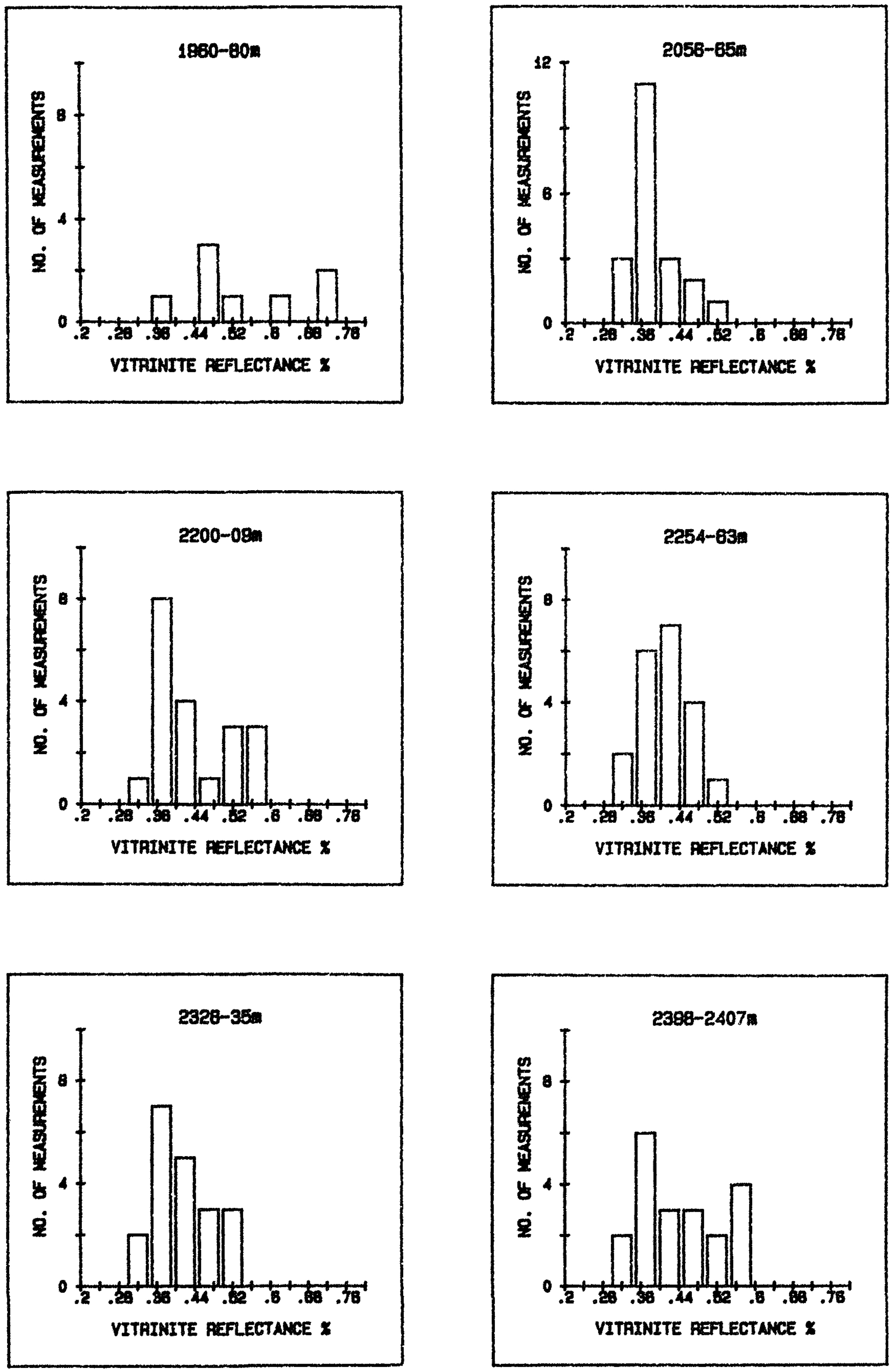


Fig.1 - continued

PALEOCHEM

35/11-1 VITRINITE REFLECTANCE DISTRIBUTIONS

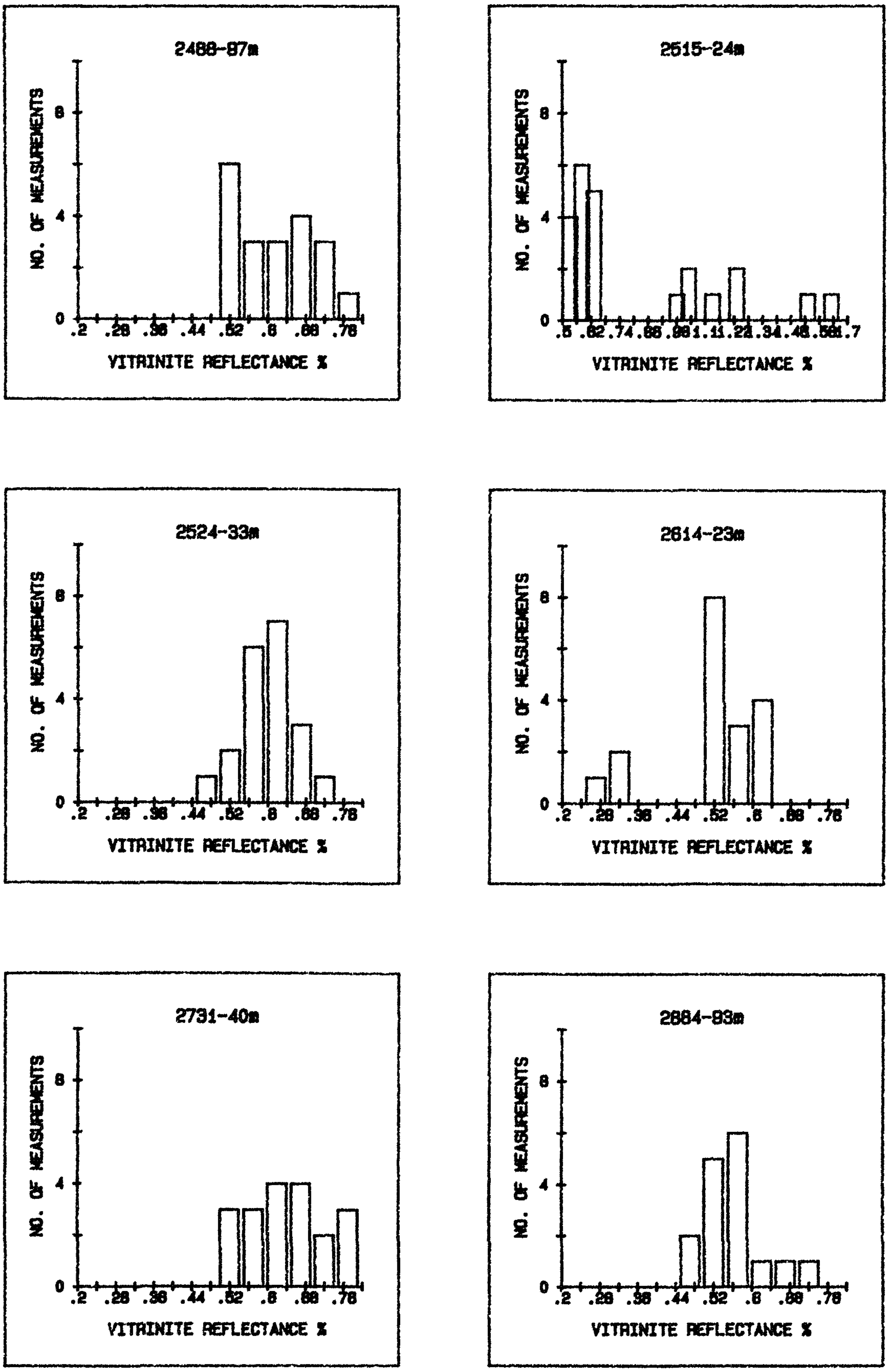


Fig.1 - continued

PALEOCHEM

35/11-1 VITRINITE REFLECTANCE DISTRIBUTIONS

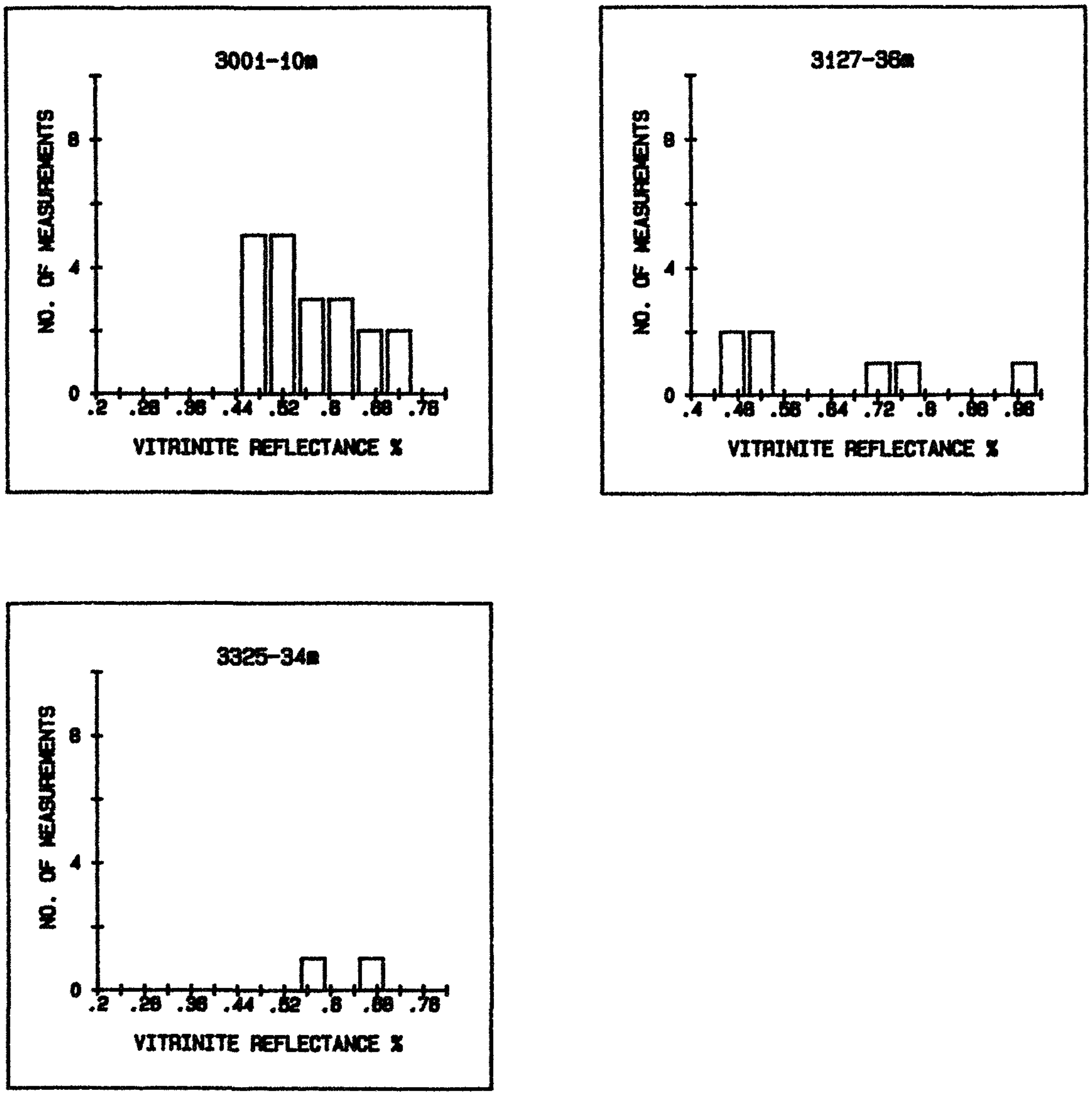


Fig.1 - continued

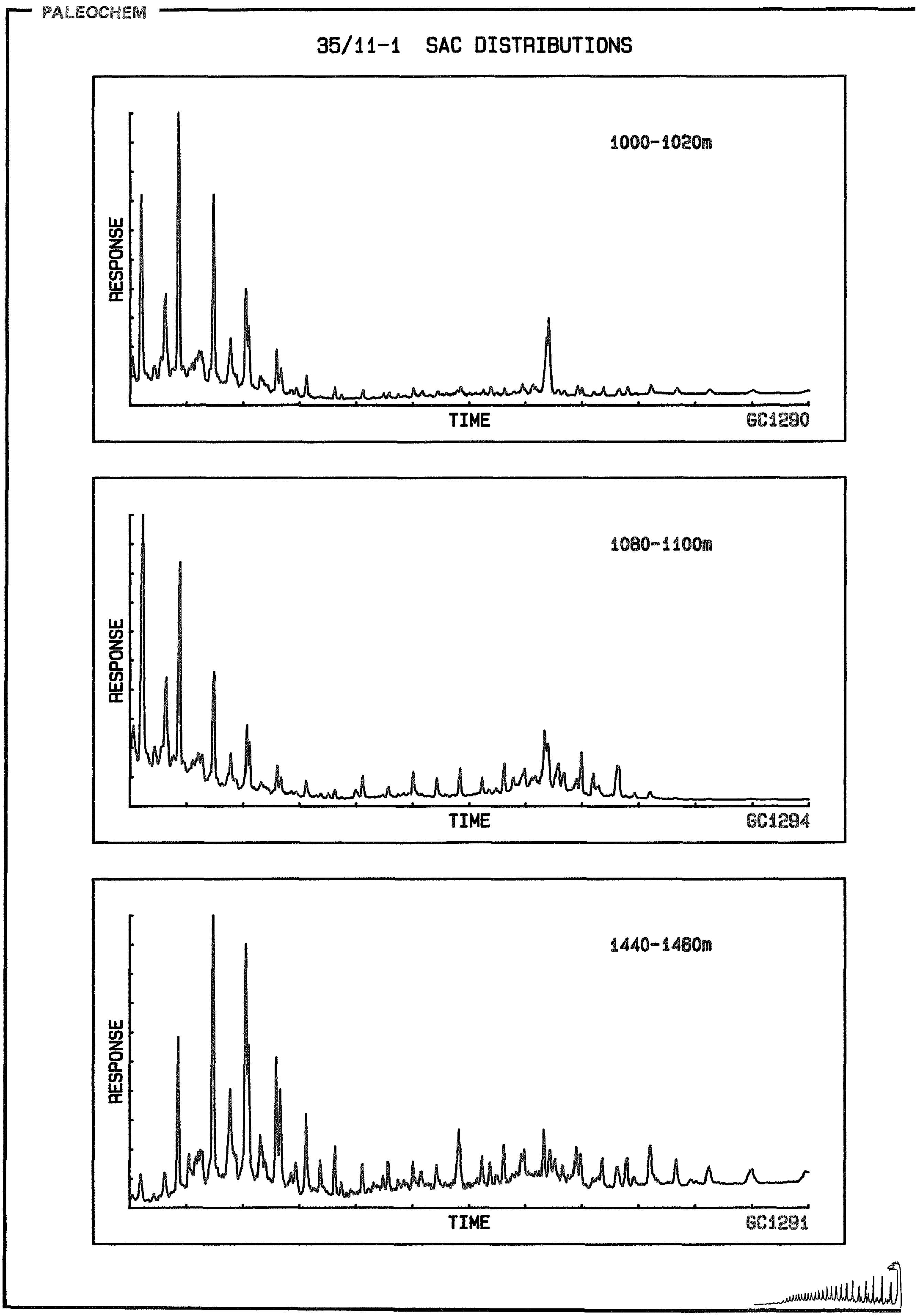

PALEOCHEM
35/11-1 SAC DISTRIBUTIONS
RESPONSE
1000-1020m
TIME
GC1290
RESPONSE
1080-1100m
TIME
GC1294
RESPONSE
1440-1460m
TIME
GC1291

Fig.2

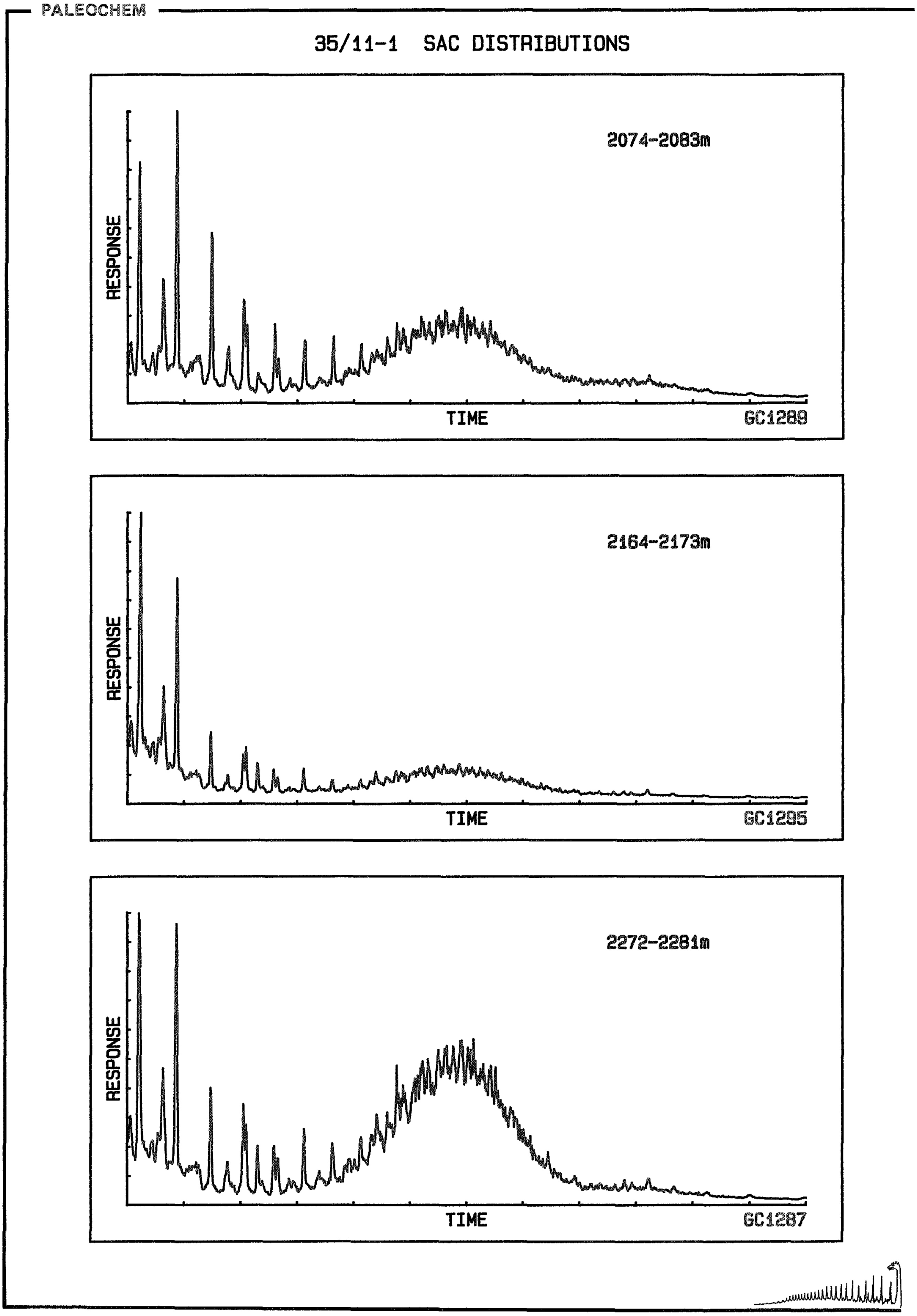

PALEOCHEM
35/11-1 SAC DISTRIBUTIONS
2074-2083m
RESPONSE
TIME
GC1289
2164-2173m
RESPONSE
TIME
GC1295
2272-2281m
RESPONSE
TIME
GC1287

Fig.3

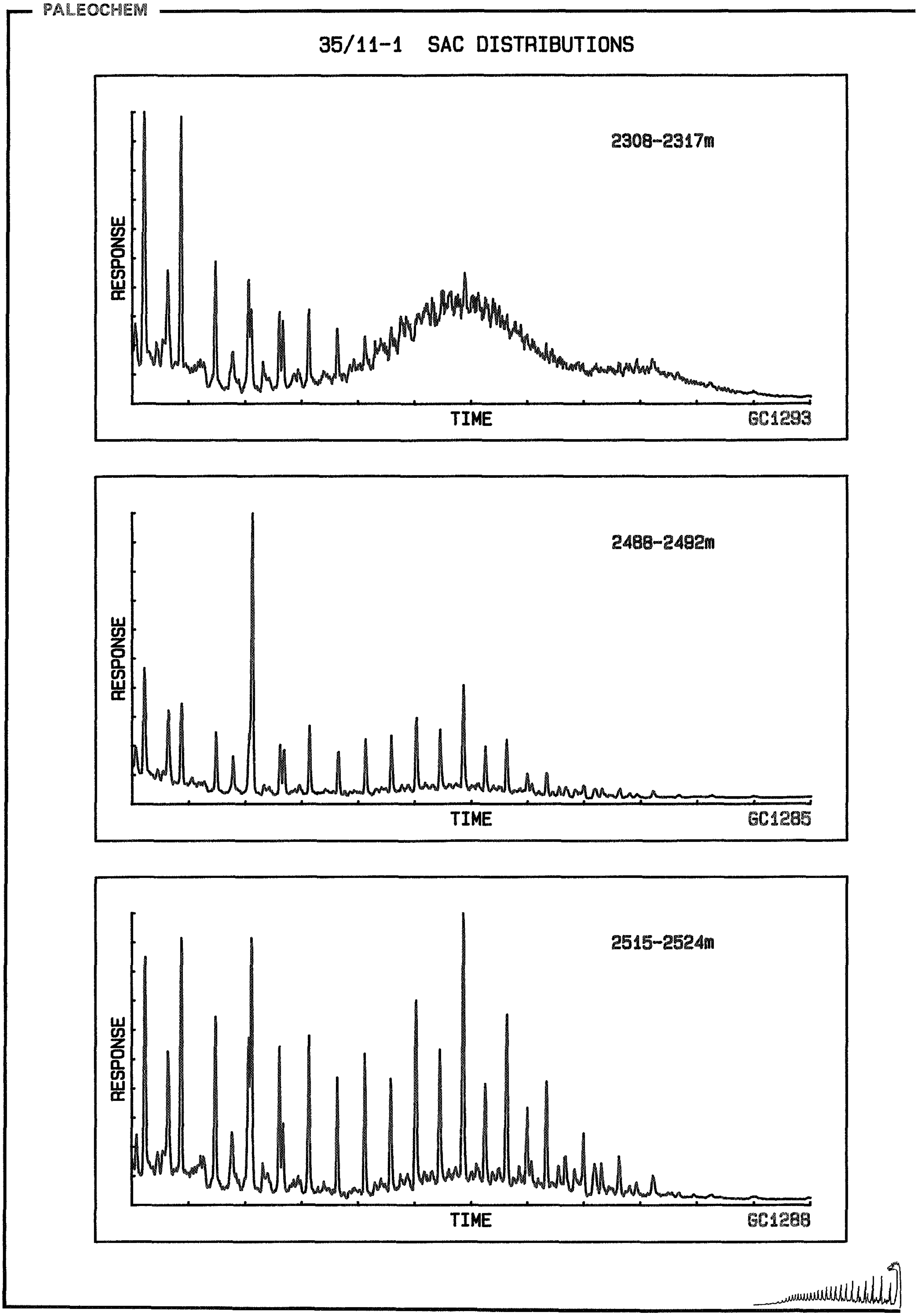
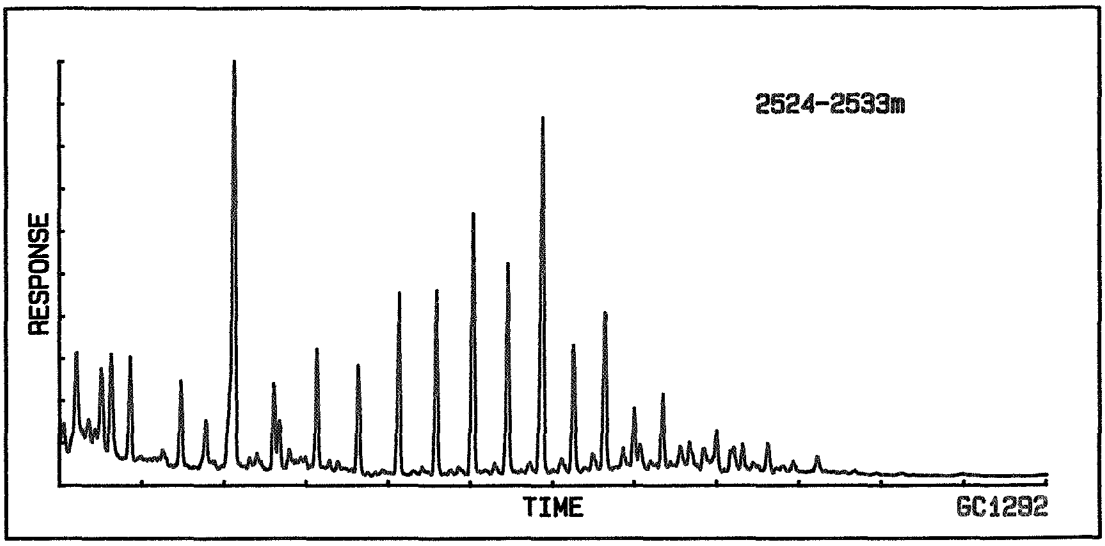

PALEOCHEM
35/11-1 SAC DISTRIBUTIONS
2308-2317m
RESPONSE
TIME
GC1283
2488-2492m
RESPONSE
TIME
GC1285
2515-2524m
RESPONSE
TIME
GC1288

Fig.4

PALEOCHEM

35/11-1 SAC DISTRIBUTIONS



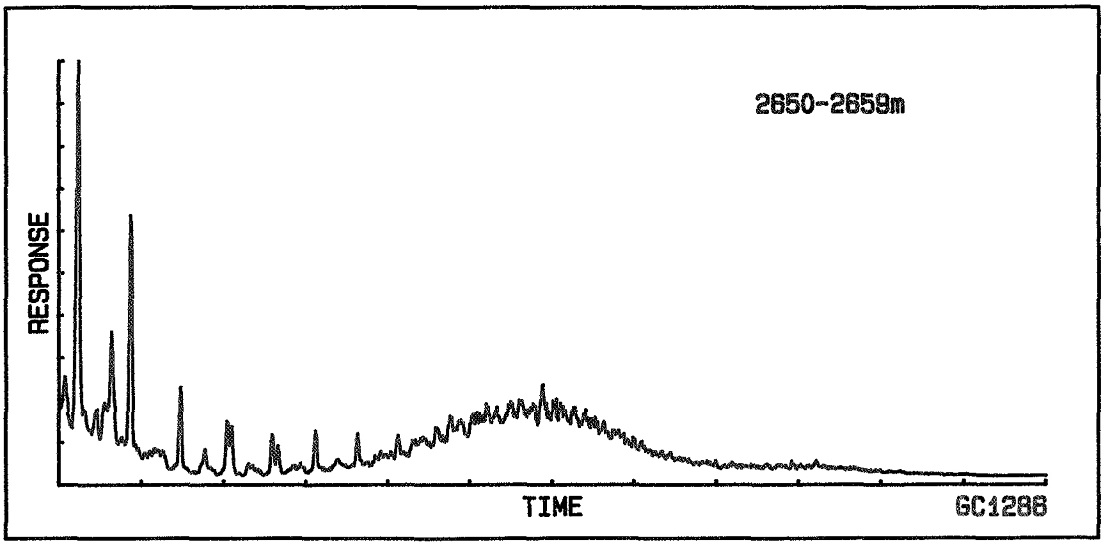


Fig.5

PALEOCHEM

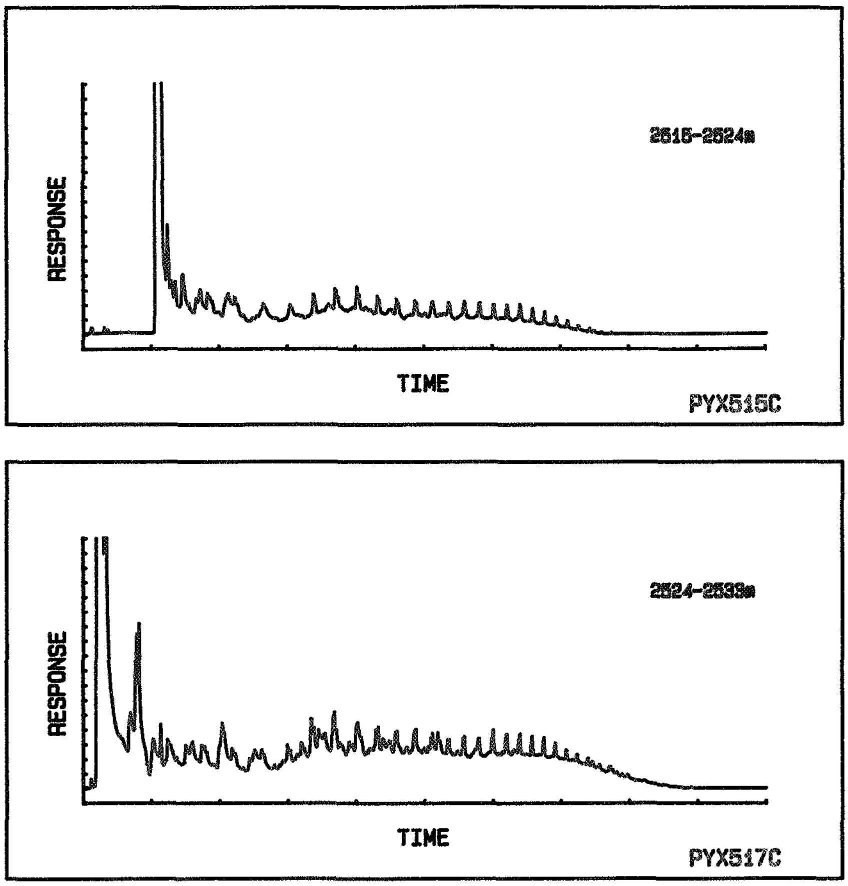
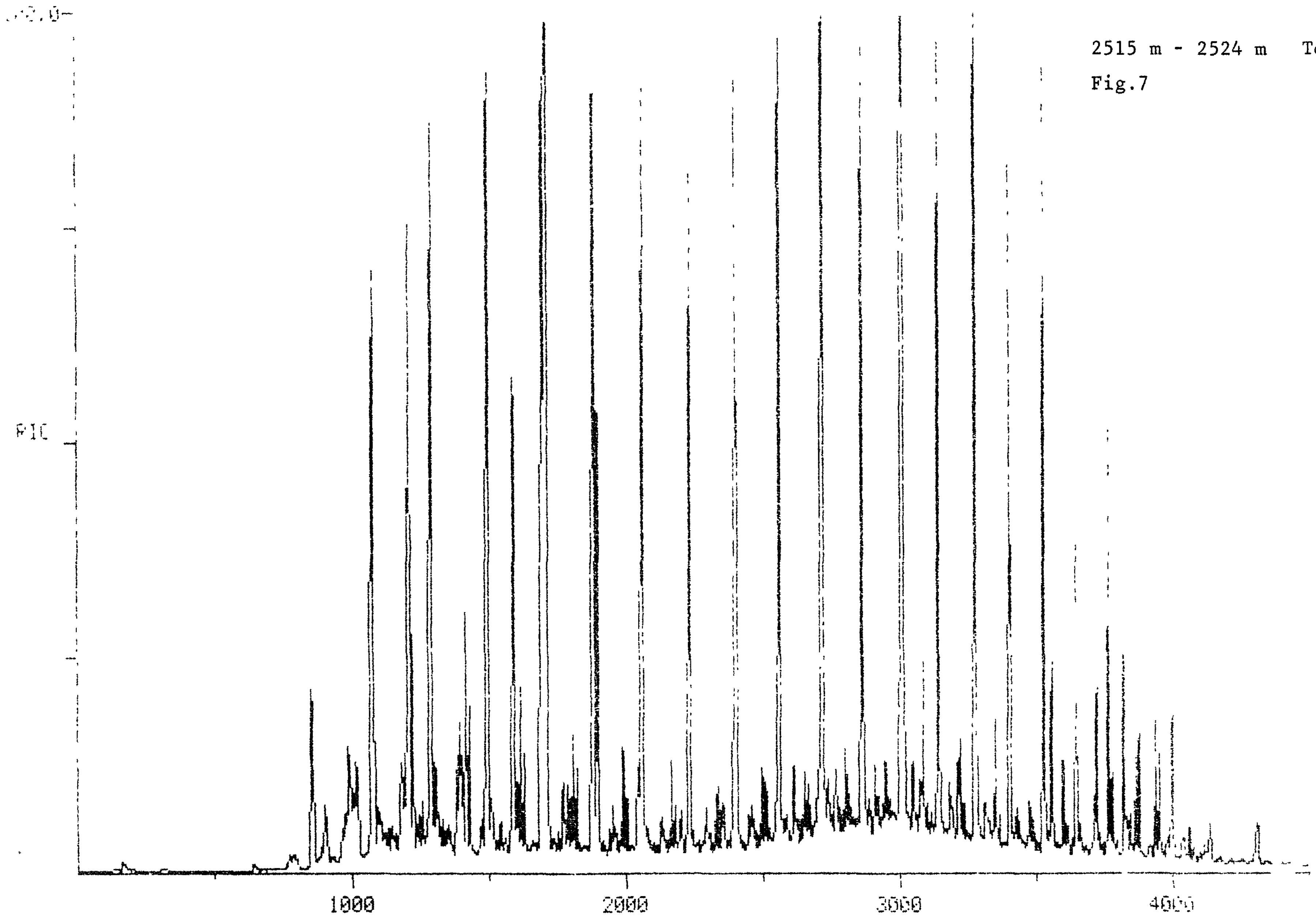
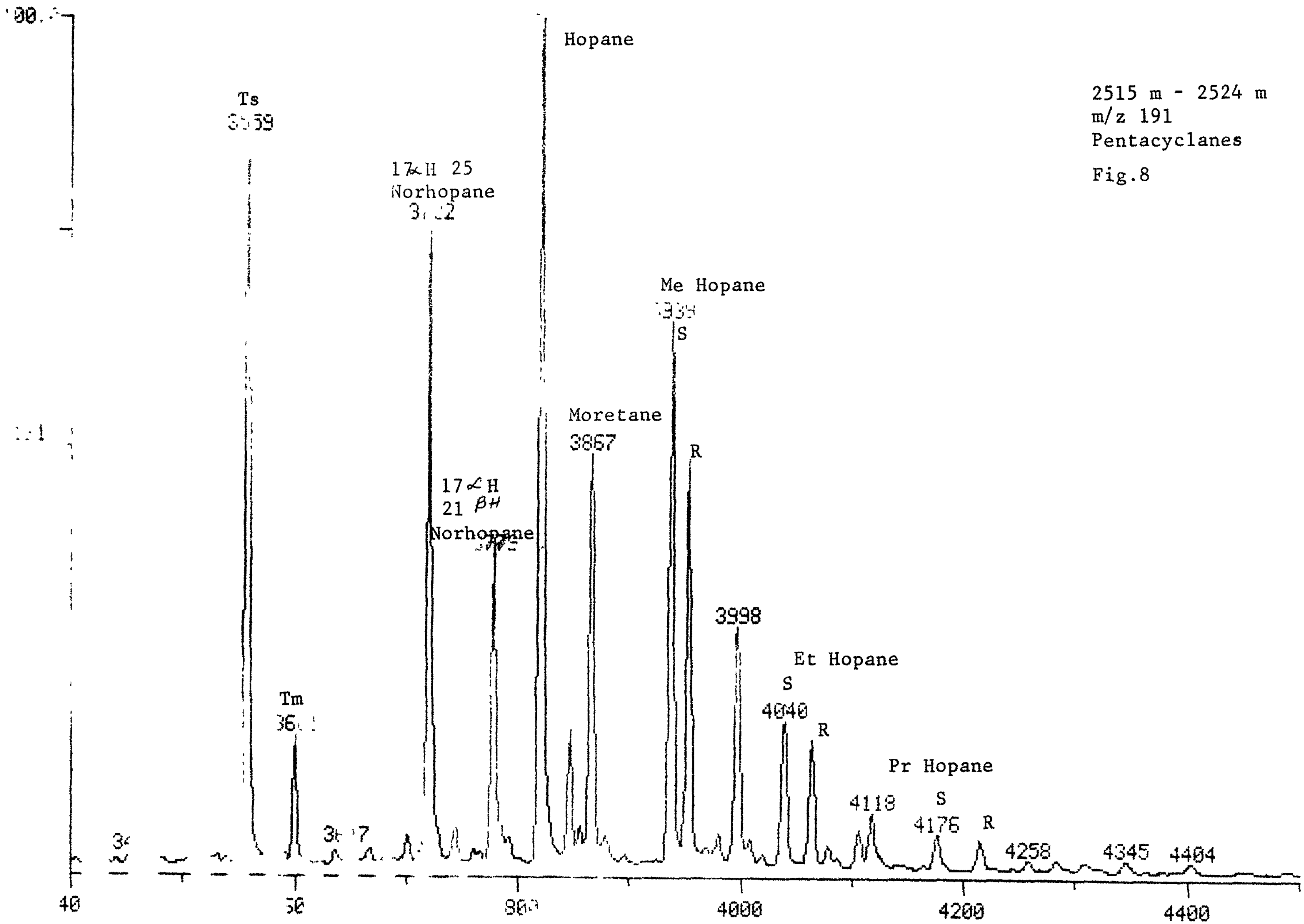


Fig.6

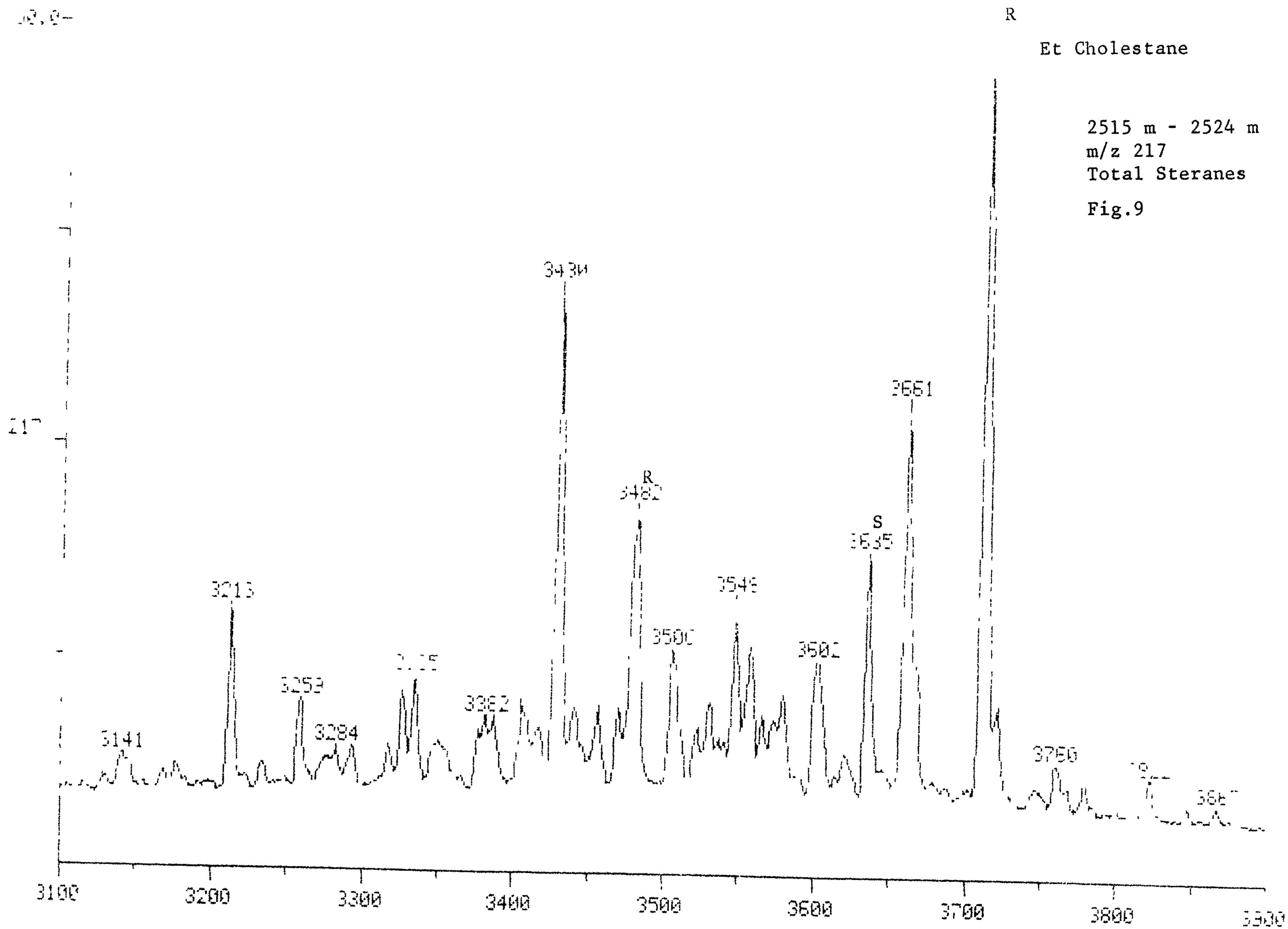
2515 m - 2524 m   Total Ions

Fig.7

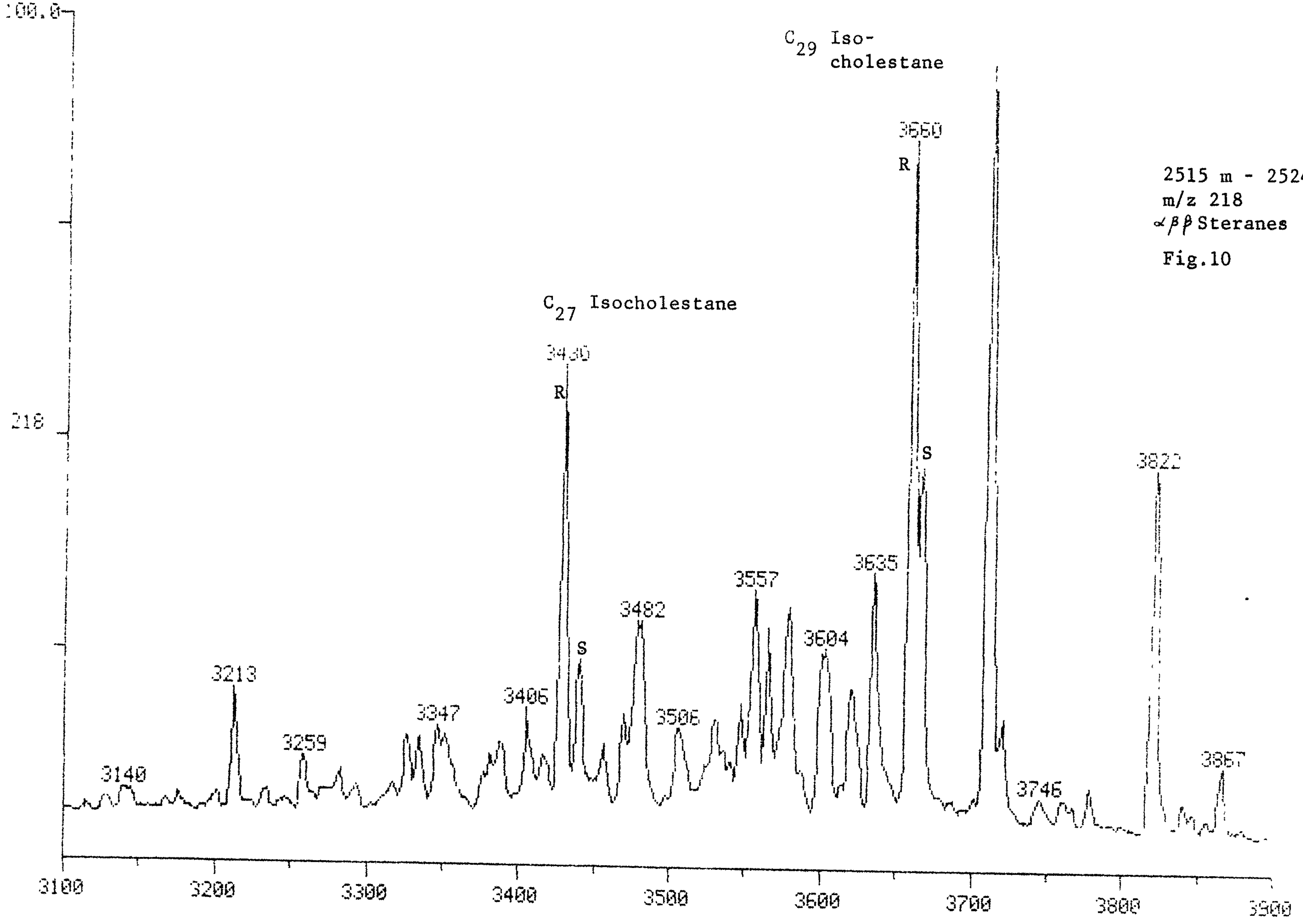




2515 m - 2524 m
m/z 191
Pentacyclanes
Fig.8
Ts
17αH 25
Norhopane
Hopane
Me Hopane
S
R
Moretane
3867
17αH
21 βH
Norhopane
3998
Et Hopane
S
4040
R
Tm
Pr Hopane
4118
S
4176
R
4258
4345
4404
4000
4200
4400

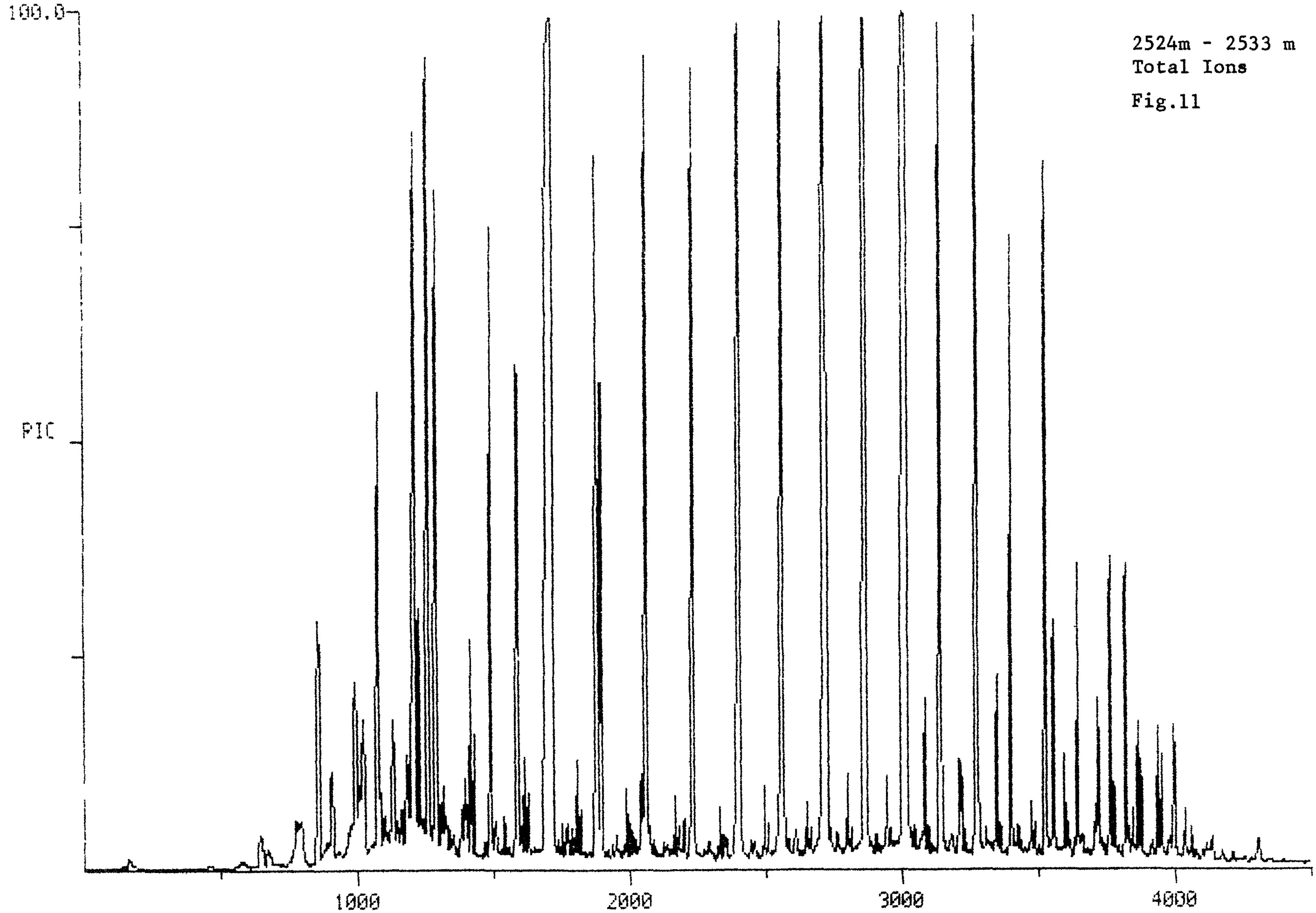


R
Et Cholestane
2515 m - 2524 m
m/z 217
Total Steranes
Fig.9
3430
R
3482
3661
S
3635
3213
3549
3500
3602
3253
3382
3284
3141
3750
3100
3200
3300
3400
3500
3600
3700
3800



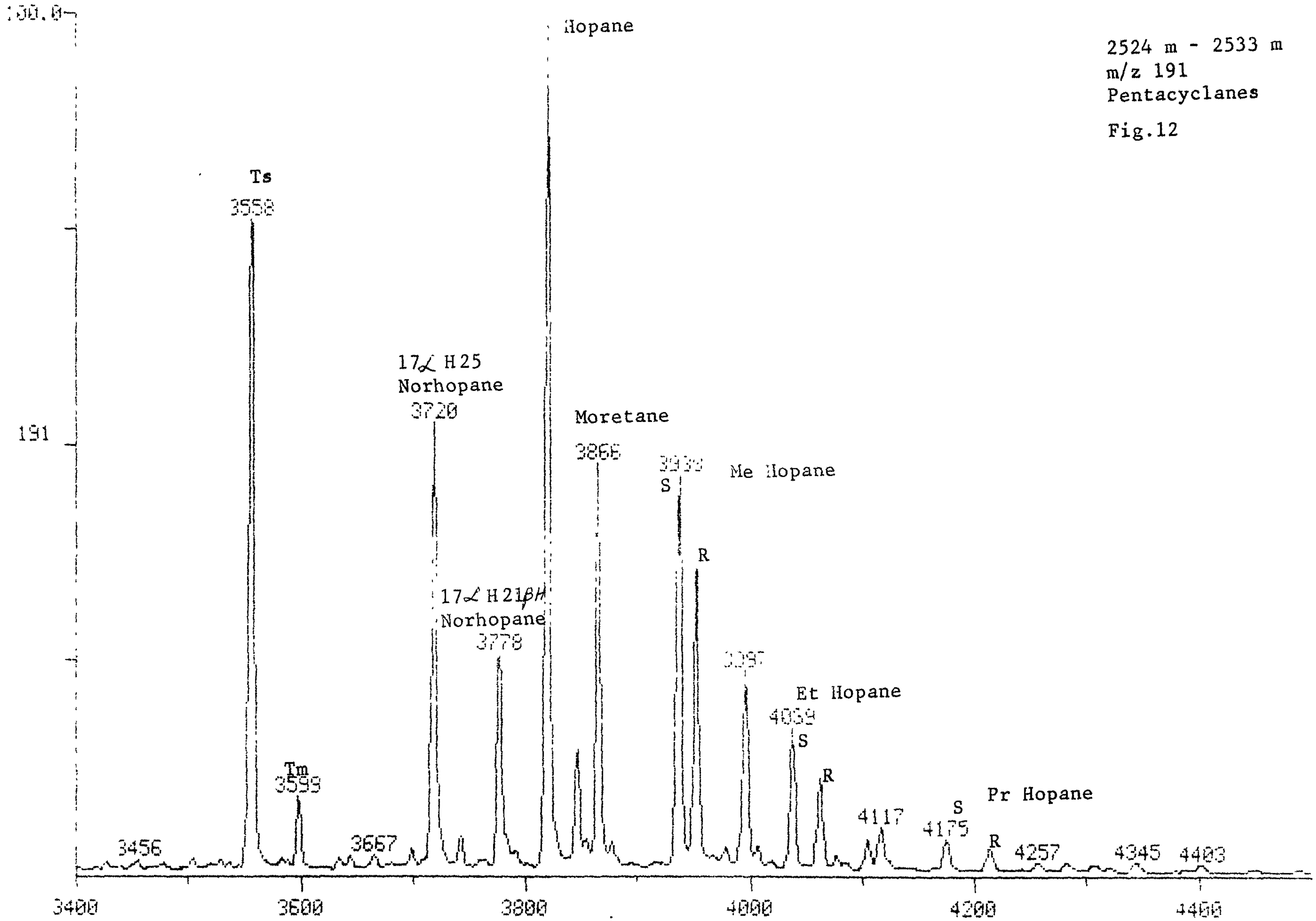
2515 m - 2524 m
m/z 218
$\alpha\beta\beta$ Steranes

Fig.10



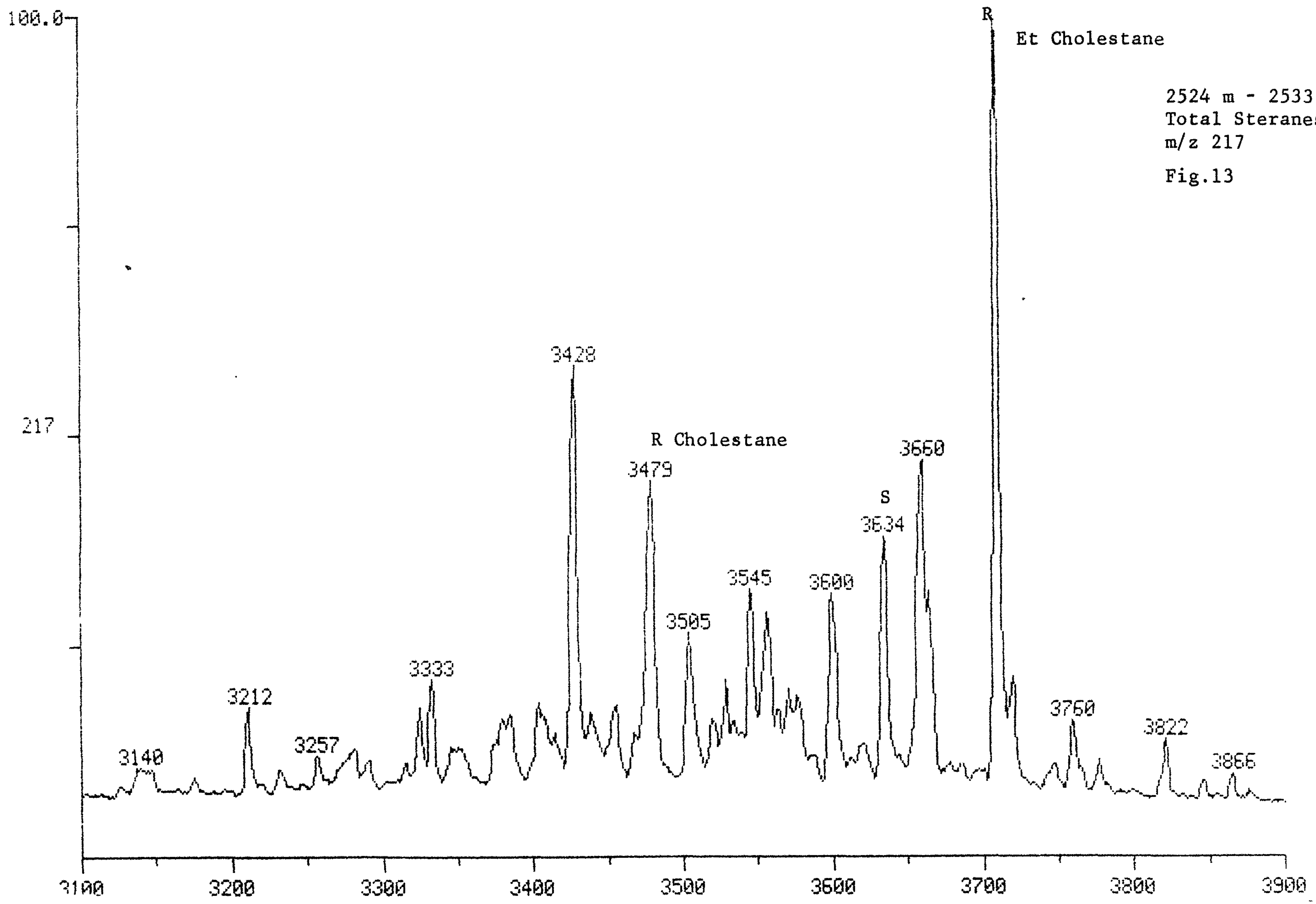
2524m - 2533 m
Total Ions

Fig.11



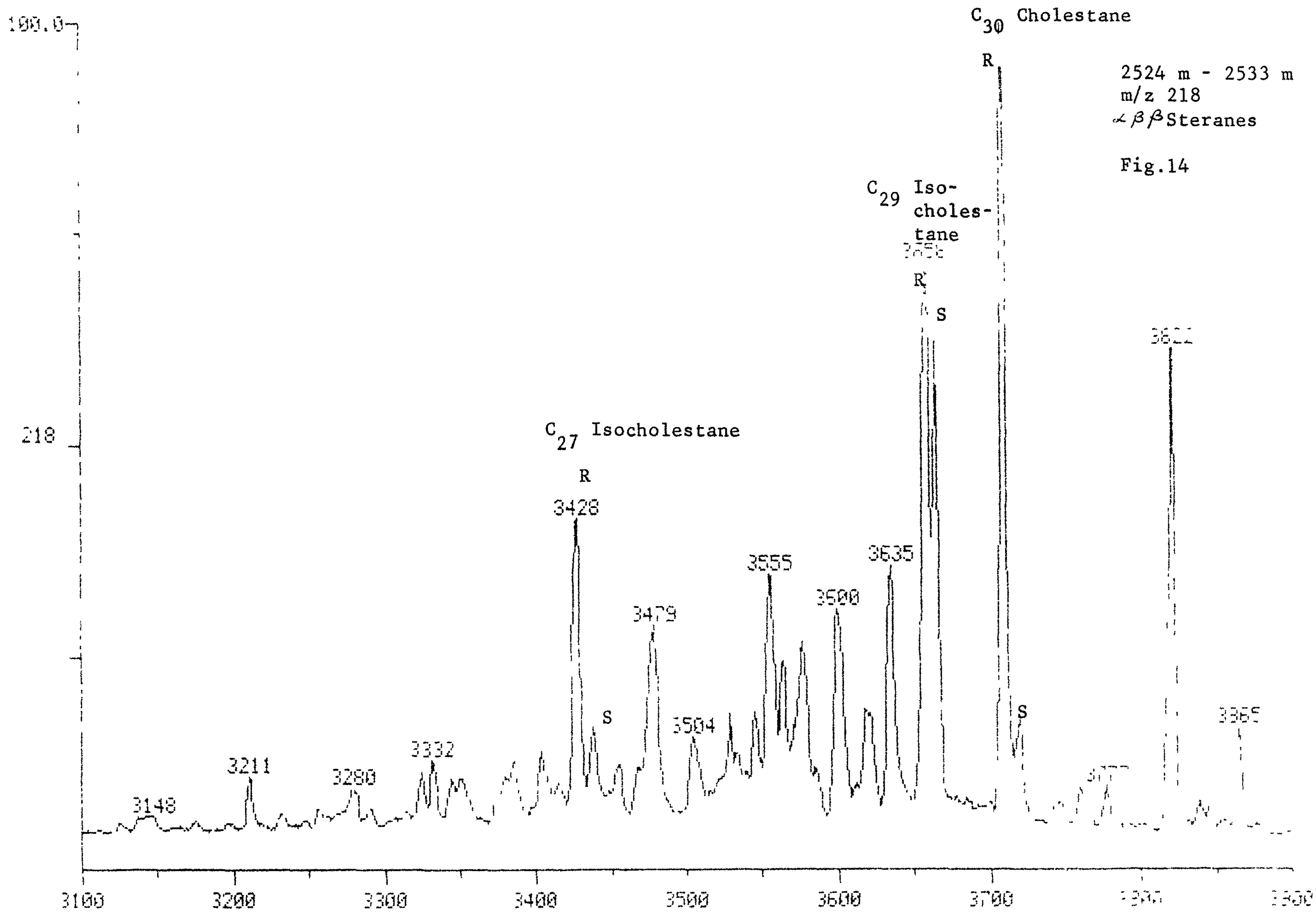
2524 m - 2533 m
m/z 191
Pentacyclanes

Fig.12



2524 m - 2533 m
Total Steranes
m/z 217

Fig.13


C30 Cholestane
R
2524 m - 2533 m
m/z 218
αββSteranes
Fig.14
C29 Iso-
choles-
tane
R
S
C27 Isocholestane
R
S
S
100.0
218
3148
3211
3280
3332
3428
3479
3504
3555
3600
3635
3100
3200
3300
3400
3500
3600
3700