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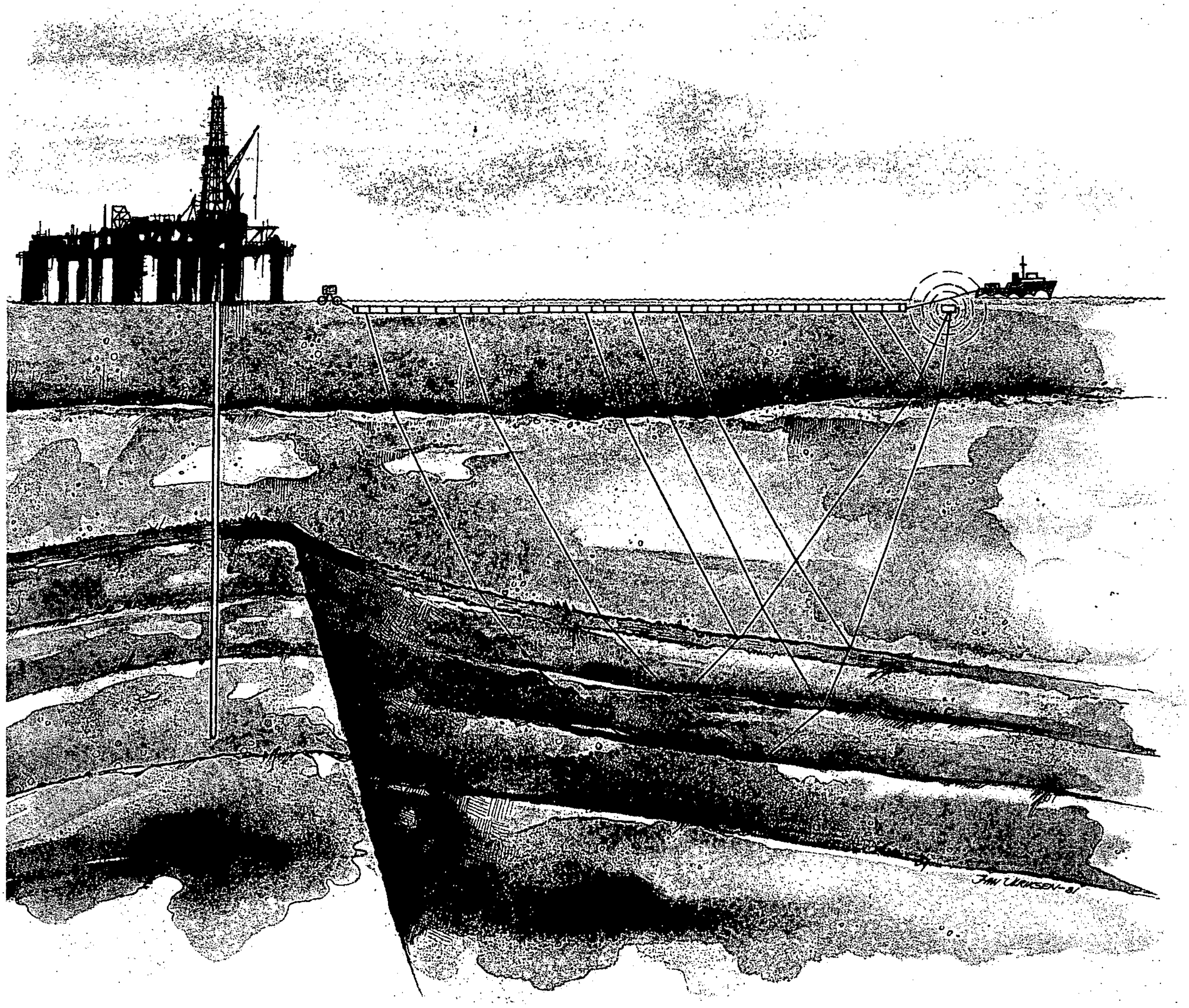
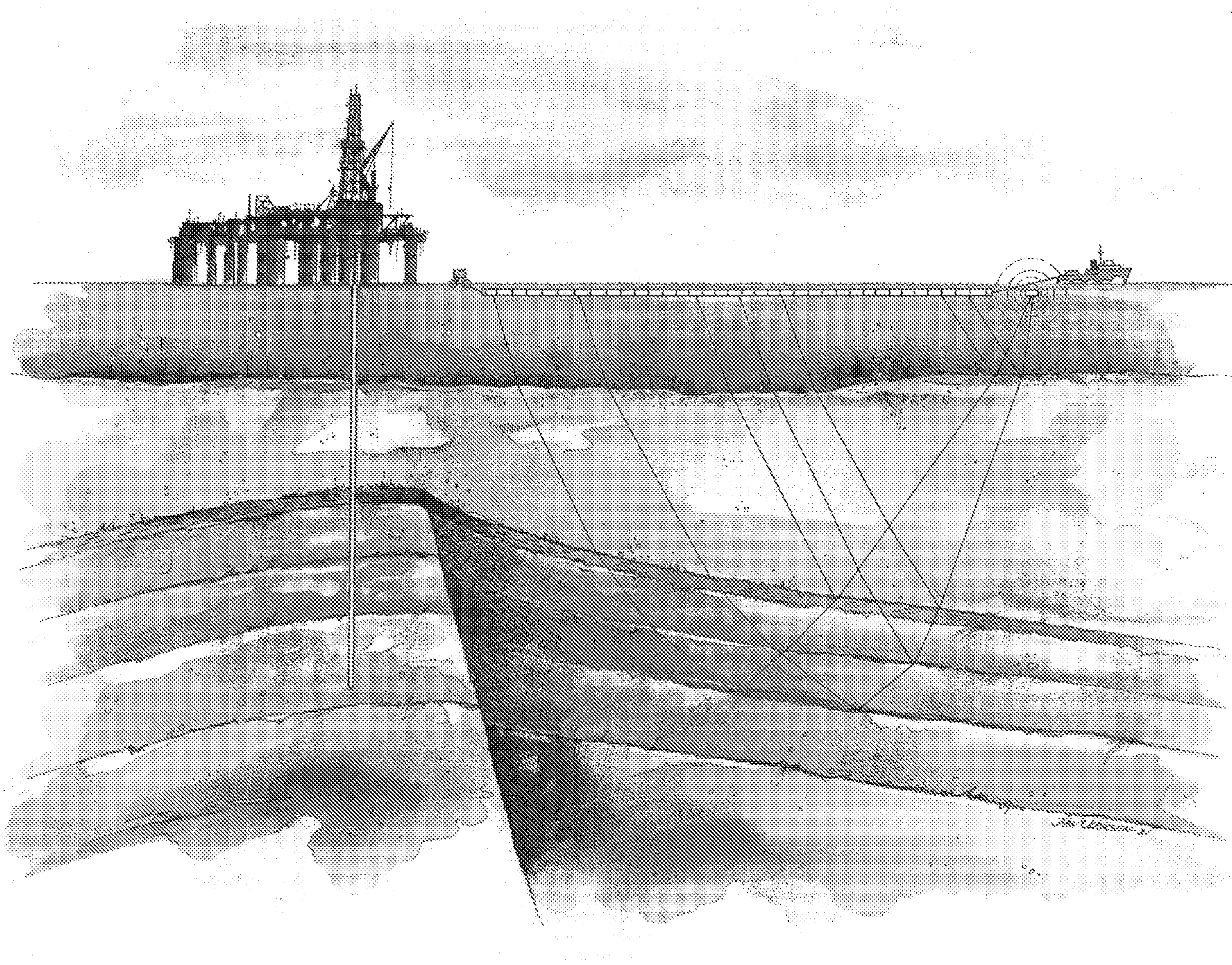


Geochemical Evaluation of Statoil's 34/10-23 Well

Statoil



Geochemical Evaluation of Statoil's 34/10-23 Well

GEOLAB

BRIEF DESCRIPTION OF THE ANALYSES PERFORMED BY GEOCHEM

"Screen Analyses" are described in sections A, C and D, "Sample Preparation" in section B, "Follow-up Analyses" in sections E through K and "Correlation Studies" in section L. The analyses can be run on either core or cuttings material with the proviso that samples must be canned for the C_1-C_7 analysis and should be canned (or at least wet) for the C_4-C_7 analysis. The other analyses can be run on both canned and bagged samples.

A) C_1-C_7 LIGHT HYDROCARBON ANALYSIS

The abundance and composition of the C_1-C_7 hydrocarbons in sediments reflects their source richness, maturity and the character of the hydrocarbons they can yield. Most importantly, it is extremely sensitive to the presence of migrated hydrocarbons and is an excellent method for their detection. As it provides the information on most of the critical parameters and is also economical, this analysis is excellent for screening samples to decide which of them merit further analysis.

During the time which elapses between the collection of the sample at the wellsite and its analysis in the laboratory, a fraction of the total gas passes from the rock to the air space at the top of the can. For this reason, both the air space and the cuttings are analysed.

The analysis involves the gas chromatographic separation of the individual C_1-C_4 gaseous hydrocarbons (methane, ethane, propane, isobutane and normal butane) and a partial resolution of the C_5-C_7 gasoline-range hydrocarbons (for their complete resolution see Section E). The ppm abundance of the five gases and of the total C_5-C_7 hydrocarbons are calculated from their electronically integrated peak areas (<u>not</u> from peak height) by comparison with a standard.

In the report, the following data are tabulated: the abundance and composition of the air space gas, of the cuttings gas and of the combined air space and cuttings gases. The combined results are also presented graphically.

B) SAMPLE WASHING AND HAND PICKING

All of the analyses described in subsequent sections are run on washed and hand picked samples.

Cuttings are washed to remove the drilling mud, care being taken not to remove soft clays and fine sand during the washing procedure. Using the C_1-C_7 hydrocarbon data profile of the well, or the organic carbon profile (if this analysis is used for screening), electric logs (if supplied) and the appearance of the cuttings under the binocular microscope, samples are selected to represent the lithological and geochemical zones penetrated by the well. These samples are then carefully hand picked and the lithology of the uncaved material is described. It is these samples which are submitted for further analysis.

Sample material remaining after analysis is retained for six months. Unless instructions are received to the contrary, Geochem Laboratories may then destroy the samples.

Our reports incorporate a gross lithological description of <u>all</u> the samples which have been analysed and litho percentage logs. As screen analyses are recommended at narrow intervals, a complete lithological profile is obtained.

C) ORGANIC CARBON ANALYSIS

The organic carbon content of a rock is a measure of its total organic richness. Combined with the visual kerogen, C_1-C_7, C_4-C_7, pyrolysis and C_{15+} analyses, the organic carbon content is used to evaluate the potential (not necessarily actual) hydrocarbon source richness of the sediment. This analysis is an integral part of a total evaluation and it can also be used as an economical screen analysis for dry samples (when the C_1-C_7 analysis cannot be used).

Hand picked samples are dried, crushed and then acidised to remove the inorganic calcium and magnesium carbonates. The actual analysis involves combustion in a Leco carbon analyser. Blanks, standards and duplicates are run routinely for purposes of quality control at no extra cost to the client.

The data are tabulated and presented diagramatically in our reports in a manner which facilitates comparison with the gross lithology (see Section B) of the samples.

D) MINI-PYROLYSIS

An ideal screen analysis which provides a definitive measure of potential source richness upon those samples whose organic carbon contents suggest fair or good source potential. This is described in detail in section K.

E) DETAILED C_4-C_7 HYDROCARBON ANALYSIS

The abundance and composition of the C_4-C_7 gasoline-range hydrocarbons in sediments reflects their source quality, level of thermal maturation and organic facies. In addition, the data also reveal the present of migrated hydrocarbons and can be used for crude oil-parent source rock correlation studies.

This powerful analysis, performed upon hand picked lithologies, is employed as a follow-up to confirm the potential of samples which have been selected using the initial screen analysis. It is used in conjunction with the organic carbon, visual kerogen and C_{15+} analyses.

The individual normal paraffins, isoparaffins, naphthenes and aromatics with between four and seven carbon atoms in the molecule (but also including toluene) are resolved by capillary gas chromatography and their peak areas electronically integrated.

Normalised compositions, selected ratios and the ppm abundance of the total gasoline-range fraction are tabulated in the report and also presented graphically.

F) KEROGEN TYPE AND MATURATION

Kerogen is the insoluble organic matter in rocks. Visual examination of the kerogen gives a direct measure of thermal maturity and of the composition of the organic matter (organic facies) and indicates the source quality of the sediment - which is confirmed using the organic carbon, light hydrocarbon, pyrolysis and C_{15+} analyses.

The type of hydrocarbon (oil or gas) generated by a source rock is a function of the types and level of thermal maturation of the organic matter which are present. Both of these parameters are measured directly by this method.

Kerogen is separated from the inorganic rock matrix by acid digestion and flotation methods which avoid oxidation of the organic matter. It is then mounted on a glass slide and examined at high and low magnifications with a Leitz microscope. Chemical methods measure the total kerogen population but, with this technique, individual particles can be selected for examination and spurious material identified. This is particularly valuable in reworked, contaminated and turbodrilled sediments.

The following data are generated: the types of the organic matter present and their relative abundances, an estimate of the proportion of reworked material, preservation state, the thermal maturity of the non-reworked organic matter using the spore colouration technique.

Our maturation scale has been developed to digitise small but recognisable changes in organic matter colouration resulting from increasing maturity and to place particular emphasis upon the immature to mature transition. In the absence of a universal colouration scale, the most significant points on our scale have been calibrated against equivalent vitrinite reflectance values. The following maturation stages are recognised at the low end of the scale:-

a) immature; thermal index less than 2- (0.45% Ro)
b) marginally mature; indices between 2- and 2. Minor hydrocarbon generation from amorphous and herbaceous (± algal) organic matter
c) mature; indices between 2 (0.53% Ro) and 2 to 2+ (0.72% Ro), significant generation from amorphous, algal and herbaceous organic matter but wood only marginally mature
d) oil window; indices of 2 to 2+ (0.72% Ro) through to 3 (1.2% Ro).. Peak hydrocarbon generation.

The condensate zone starts at a thermal index of 3 whilst indices of 3+ (2.0% Ro) and higher indicate the eometamorphic dry gas stage.

A total of fourteen types of organic matter are sought based upon the major categories of algal, amorphous, herbaceous (spore, pollen, cuticle), wood, inertinite and resin. This detail is essential for a proper understanding of hydrocarbon source potential as the different sub-groups within each category have different properties.

Upon completion of the study, the kerogen slides are sent to the client.

G) VITRINITE REFLECTANCE

Vitrinite reflectance is an alternative/confirmatory method for evaluating thermal maturation which is used in conjection with the visual kerogen analysis. The reflectivity of vitrinite macerals increases in response to thermal alteration and is used to define maturation levels and, by projection, to predict maturity at depth or the thicknesses of section removed by erosion.

Measurements are made upon kerogen separations in conjunction with polished whole rock samples. In general, this analysis is performed upon the same samples as the visual kerogen analysis, thus facilitating a direct comparison of the two sets of results.

If possible, forty to fifty measurements are taken per sample - unless the sediments are organically lean, vitrinite is sparse or only a single uniform population is present. The data are plotted in a histogram which distinguishes the indigenous vitrinite from possible reworked or caved material. Averages are calculated for each population. Comments upon exinite fluorescence and upon the character of the phytoclasts are noted on the histograms. The reports contain the tabulated data, histograms and the reflectivities plotted against depth.

The vitrinite and visual kerogen techniques provide mutually complementary information upon maturity, organic matter type and diagenesis.

H) C_{15+} EXTRACTION, DEASPHALTENING AND CHROMATOGRAPHIC SEPARATION

Sections "A" and "E" dealt with analyses covering the light end of the hydrocarbon spectrum. This section is concerned with the solvent extractable oranic material in the rock with more than fourteen carbon atoms in the molecule (i.e. the heavy end). The amount and composition of this extract indicates source richness and type, the level of thermal maturation and the possible presence of migrated hydrocarbons.

These results are integrated with those derived from the pyrolysis, visual kerogen, organic carbon and light hydrocarbon analyses.

The techniques involved in this analysis employ pure solvents and have been designed to give reproducible results. Hand picked samples are ground and then solvent extracted in a soxhlet apparatus, or by blending, with dichloromethane (the solvent system can be adapted to client's specifications). After asphaltene precipitation, the total extract is separated by column chromatography or high pressure liquid chromatography into the following fractions: paraffin-naphthene hydrocarbons, aromatic hydrocarbons, eluted NSO's (nitrogen-, sulphur-, and oxygen- containing non-hydrocarbons) and non-eluted NSO's. Note that the non-hydrocarbons are split into three fractions and not reported as a gross value. These fractions can be submitted for further analyses (carbon isotopes, gas chromatography, mass spectroscopy) including correlation studies.

For convenience and thoroughness, the data are reported in three formats: the weights of the fractions, ppm abundances and normalised percentage compositions. The data are also presented diagramatically.

J) GC ANALYSIS OF C_{15+} PARAFFIN-NAPHTHENE HYDROCARBONS

The gas chromatographic configurations of the heavy C_{15+} paraffin-naphthene hydrocarbons reflect source type, the degree of thermal maturation and the presence and character of migrated hydrocarbons or contamination.

Not only is this analysis an integral part of any source rocks study but it also provides a fingerprint for correlation purposes and helps to define the geochemical/palynological environmental character of the source rocks from which crude oils were derived.

The paraffin-naphthene hydrocarbons obtained by column chromatography are separated by high resolution capillary chromatography. Excellent resolution of the individual normal paraffins, isoprenoids and significant individual isoparaffins and naphthenes is achieved. Runs are normally terminated at nC_{35}. A powerful in-house microprocessor system is being introduced to correct for the change in response factor with chain length.

The normal paraffin carbon preference indices (C.P.I.) indicate if odd (values in excess of 1) or even (values less than 1) normal paraffins are dominant.

Strong odd preferences (± strong pristane peaks) are characteristic of immature land plant organic matter whilst even preferences (± strong phytane peaks) suggest a reducing environment of deposition. With increasing maturity, values approach 1.0 and oils are typically close to 1.0. The indices are calculated using the following formulae:

$$C.P.I_A = \frac{\dfrac{C_{21} + C_{23} + C_{25} + C_{27}}{C_{20} + C_{22} + C_{24} + C_{26}} + \dfrac{C_{21} + C_{23} + C_{25} + C_{27}}{C_{22} + C_{24} + C_{26} + C_{28}}}{2}$$

$$C.P.I_B = \frac{\dfrac{C_{25} + C_{27} + C_{29} + C_{31}}{C_{24} + C_{26} + C_{28} + C_{30}} + \dfrac{C_{25} + C_{27} + C_{29} + C_{31}}{C_{26} + C_{28} + C_{30} + C_{32}}}{2}$$

Chromatograms are reproduced in the report for use as visual fingerprints and in addition, the following data are tabulated: normalised normal paraffin distributions; proportions of paraffins, isoprenoids and naphthenes in the total paraffin-naphthene fraction; $C.P.I_A$ and $C.P.I_B$; pristane to phytane ratio; pristane to nC_{17} ratio.

K) <u>PYROLYSIS</u>

The process of thermal maturation can be simulated in the laboratory by pyrolysis, which involves heating the sample under specified conditions and measuring the oil-like material which is freed/generated from the rock. With this analysis, the potential richness of immature sediments can be determined and, by coupling the pyrolysis unit to a gas chromatograph, the liberated material can be characterised. These results are correlated with those obtained from the organic carbon, kerogen and C_{15+} analyses.

Small amounts of powdered sample are heated in helium to release the thermal bitumen (up to 340°C) and pyrolysate (340-550°C). The thermal bitumen correlates with the solvent extractable material (see above) whilst the pyrolysate fraction does not exist in a "free" state but is generated from the kerogen, thus simulating maturation in the subsurface. Abundances (weight ppm of rock) are measured with a flame ionisation detector against a standard. Thermal bitumen includes source indigenous, contaminant and migrated hydrocarbons but the pyrolysate abundance is a measure of ultimate source richness. The capillary gas chromatogram of the pyrolysate is used to evaluate the character of the parent organic matter and whether it is oil or gas prone. Peak temperature(s) of pyrolysate evolution is recorded. Carbon dioxide can be measured if requested but is normally ignored as the separation of the organic and inorganic species has been found to be artificial and unreliable.

Pyrolysate yields provide a definitive measure of potential source richness which avoids the ambiguities of the organic carbon data and the problem of contamination. This analysis is also used to evaluate the quality and character of the organic matter and the degree to which it has realised its ultimate hydrocarbon potential. Geochem does not employ the pyrolysis technique to evaluate maturation, preferring the kerogen and vitrinite reflectance analyses which avoid the problem of reworking and hence, are more reliable.

Capillary chromatograms produced for the pyrolysate hydrocarbons range from C_1 (methane) out towards C_{35} but exhibit considerable variations. They are used to define whether a source rock will yield oil, condensate or gas. With this new technique, it is now possible to complete the evaluation of a source rock.

The data are tabulated and presented graphically. MINI-PYROLYSIS includes ppm thermal bitumen and ppm pyrolysate. PYROLYSIS also provides the above together with the temperature of peak pyrolysate evolution. The capillary chromatograms of the pyrolysate obtained by PYROLYSIS-GC are reproduced in the report. The Mini-Pyrolysis analysis is recommended as a screening technique.

L) CORRELATION STUDY ANALYSES

Oil to oil and oil to parent source rock correlation studies require high resolution analytical techniques. This requirement is satisfied by some of the analyses discussed above but others have been selected specifically for correlation work. Many of these analyses also provide information upon the character of the environment of deposition of the parent source rocks.

- detailed C_4-C_7 hydrocarbon (gasoline range) analysis. See Section E. Although these hydrocarbons can be affected by migrational/alteration processes, they commonly provide a very useful correlation parameter.

- capillary gas chromatography of the C_{15+} paraffin-naphthenes. See section J. The branched±normal paraffin distributions are used to "fingerprint" the samples.

- capillary chromatograms of whole oils and of the C_{4+} fraction of source rocks.

- capillary gas chromatography of C_{15+} aromatic hydrocarbons. Separate chromatograms of the hydrocarbons and of the sulphur-bearing species are reproduced.

- high pressure liquid chromatograms.

- mass spectrometric carbon isotope analyses of crude oil and rock extract fractions and of kerogen separations. A powerful tool for comparing hydrocarbons and correlating hydrocarbons to organic matter. With this technique the problem of source rock contamination can be avoided. The data are recorded on x-y or Galimov plots.

- mass fragmentograms (mass chromatograms) of fragment ions characteristic of selected hydrocarbon groups such as the steranes and terpanes. The fragmentograms provide a convenient and simple means of presenting detailed mass spectrometric data and are used as a sophisticated fingerprinting technique. This provides the ultimate resolution for correlating hydrocarbons and facilitates the examination of hydrocarbon classes.

- vanadium and nickel contents.

Suites of (rather than single) analyses are employed in correlation studies, the actual selection depending upon the complexity of the problem. See also section N.

M) ANALYSES FOR SPECIAL CASES

M-1) ELEMENTAL KEROGEN ANALYSIS

This analysis evaluates source quality, whether the sediments are oil or gas prone, the character of the organic matter and its level of thermal maturation. It is the chemical equivalent of the visual kerogen analysis. The pyrolysis analysis is generally preferred to this technique, both methods providing similar information.

M-2) SULPHUR ANALYSIS

The abundance of sulphur in source rocks and crude oils.

M-3) CARBONATE CONTENT

The mineral carbonate content of sediments is determined by acid treatment. These data are particularly useful when used in conjunction with organic carbon contents as a screening technique.

M-4) NORMAL PARAFFIN ANALYSIS

Following the removal of the branched paraffins and naphthenes from the total paraffin-naphthene fraction, a chromatogram of the normal paraffins is obtained. The resulting less complicated chromatogram facilitates the examination of normal paraffin distributions.

M-5 SOLID BITUMEN EVALUATION

Residual solid bitumen after crude oil is generated by three prime processes; the action of waters, gas deasphalting, thermal alteration. Thus it provides a means of determining the reservoir history of a crude and of evaluating whether adjacent traps will or will not be prospective for oil. In carbonate sections, where organic matter is sometimes sparse, this technique is also used to evaluate thermal maturation levels.

The analysis involves the determination of the solubility (in CS_2) of the solid bitumen and of the atomic hydrogen to carbon ratio of the insoluble fraction.

N) CRUDE OIL ANALYSIS

N-1) API GRAVITY

This can be performed upon large (hydrometer) and small (SG bottle, pycnometer) samples and even upon stains extracted from sediments (refractive index).

N-2) SULPHUR CONTENTS (ASTM E30-47)

N-3) POUR POINT (ASTM D97-66, IP15/67)

N-4) VISCOSITY (ASTM D445-72, IP71/75)

N-5) FRACTIONAL DISTILLATION

Graph of cumulative distillation yield against temperature. Five percent cuts taken for further analysis. Mass spectrometric studies of these fractions provide a detailed picture of the distribution of paraffins and of the various naphthene and aromatic groups within a crude, which is useful both for correlation and for refinery evaluation purposes.

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Title

Geochemical evaluation of Statoil's 34/10-23 Well

Requested by	Project	
E. Undersrud		
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29.04.1986	146	

Key words

Geochemical evaluation, source rocks, maturation, oil/source correlation

Abstract

The approximately 60 m thick Kimmeridge Clay penetrated in the 34/10 Gamma structure is a potentially good to very good source for oil and gas at present generating hydrocarbons at a significant maturity level (above Ro 0.65).
Interbedded shales in the Middle Jurassic are good source rocks at optimally maturity. The drainage efficiancy is excellent.
Shows in lower Cretaceous and Kimmeridge Clay were sourced from the Kimmeridge Clay. Deeper shows might be generated from Middle Jurassic interbedded shales.
A possible oil-water contact is indicated between 4113 m and 4117.5 m.

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Approved by

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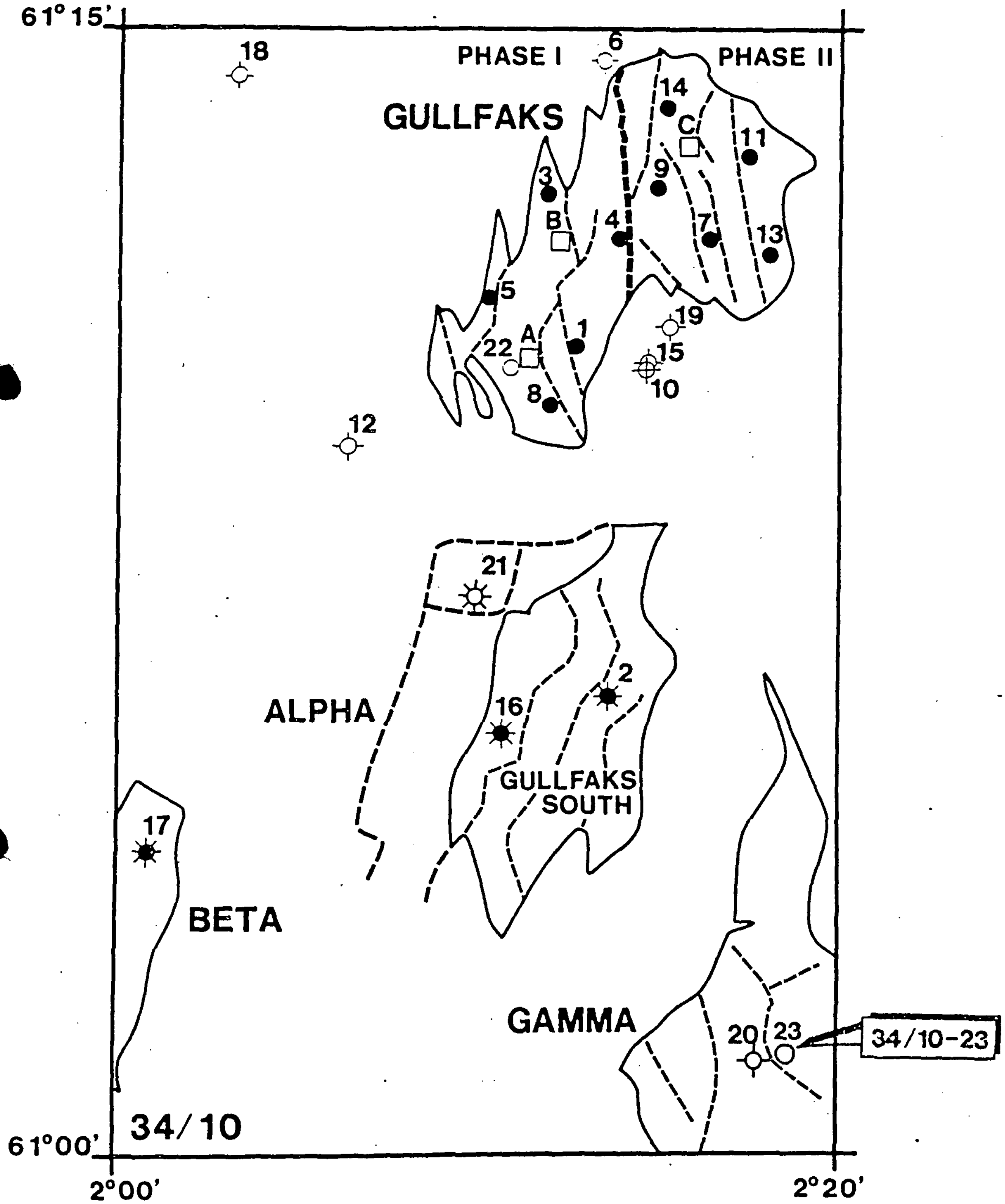

61°15'
PHASE I
PHASE II
GULLFAKS
18
6
14
C
11
3
9
B
4
7
13
5
19
A
1
22
15
10
8
12
21
ALPHA
2
16
GULLFAKS SOUTH
17
BETA
GAMMA
20
23
34/10-23
34/10
61°00'
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Prepared for

STATOIL

GEOCHEMICAL EVALUATION OF STATOIL'S

34/10-23 WELL

February 1986

GEOCHEM

Petroleum
Geochemistry
Division

GEOCHEMICAL EVALUATION OF STATOIL'S

34/10-23 WELL

GEOCHEMICAL EVALUATION OF STATOIL'S 34/10-23 WELL

EXECUTIVE SUMMARY

The TERTIARY and CRETACEOUS sediments are poor source rocks for gas which are effectively immature down to 3400± metres and have experienced only insignificant hydrocarbon generation below this depth. Oil-prone sediments would be mature below 3400± metres.

In contrast the KIMMERIDGE is a potentially good to very good source for oil and gas from which significant hydrocarbon generation has already occurred. The HEATHER FORMATION will also yield oil and gas and lies within the oil window below 4000± metres, but is only fair to good in richness.

The interbedded shales within the TARBERT through RANNOCH interval and particularly in the NESS FORMATION are optimally mature, good source rocks for oil and gas from which migration will be efficient. However, the shales of the DRAKE FORMATION generally have only a poor potential for gas, although there are good source interbeds within the interval 4420-4495± metres.

The OIL SHOWS between 3440± metres in the Cretaceous and the base of the Kimmeridge (and probably the weak shows at 2630-2900± metres) were sourced from the Kimmeridge. A SECOND OIL TYPE is present in the Heather Formation and down to 4270± metres in the Etive Formation (and probably in the Drake Formation). This was not sourced from the Kimmeridge but may have been derived from the shale interbeds within the Tarbert-Rannoch interval and particularly within the Ness Formation.

It is tentatively suggested firstly, that the oil-water contact in the Tarbert sands might lie between 4113.5 metres and 4117.5 metres and secondly, that the oils above approximately 4102± metres are lighter, perhaps due to the injection of a mature condensate into the oil-containing reservoir.

Additional analyses should be run to test the oil correlation.

N.J.L. Bailey

GEOCHEM LABORATORIES LIMITED

CONTENTS

TABLES

CONTENTS - Cont'd.

APPENDIX FIGURES

RECOMMENDATIONS

The conclusions obtained from the limited number of oil correlation analyses performed in this study are potentially very significant. They do however, need to be tested with a more complete data set.

It is recommended that:-

1. additional shows should be analysed
2. extra carbon isotope analyses should be run upon source rock kerogens
3. a suite of samples should be selected for the pyrolysate (S2) carbon isotope analysis.

Furthermore, it is suggested that the gasoline-range analysis should be added to the suite of analyses performed for routine well evaluations.

INTRODUCTION

This report presents a geochemical evaluation of the section between 740 metres and 4764 metres (TD) in Statoil's 34/10-23 well. An evaluation of the DST 1 crude oil is also included in this study.

The analytical format employed in the study was specified by Steiner Ulvoen and was designed to:

- investigate the hydrocarbon source potential of the section in terms of richness, organic facies, maturity and potential for oil or gas
- detect and characterise shows of migrated hydrocarbons with particular reference to the oil in the Tarbert sands
- examine the correlation between the shows and to perform a limited oil to source correlation.

Detailed discussion of Organic Facies, Source Richness, Thermal Maturity, Show Detection, Show Characterisation and Oil Correlation are presented in the appropriate text chapters and have been integrated to form the Conclusions.

This project was authorised by Steiner Ulvoen, Statoil.

ANALYTICAL

A total of one hundred and ninety five (195) canned ditch cuttings samples were received from 230-4764 metres in this well. These samples were composited over thirty (30) metres above 3110 metres and then at fifteen (15) metres. In addition, sixteen (16) mud samples, six (6) samples of core mud, eight (8) conventional core samples (4085.35-4117.40 metres) and the fluid sample from DST 1 (4085-4095 metres) were included in this study. These samples were assigned the Geochem job number 1189.

Depths are reported relative to KB. Geochem were advised of the following casing points: 225 metres, 1239 metres, 3104 metres, 3834 metres and 4525 metres. The section between 3104 metres and 3863 metres was turbodrilled.

The following composite playback logs were provided by Statoil: LDL-CNL-GR, ISF-SONIC-GR.

No significant contamination was observed during the sample preparation steps, but some of the cans were in a bad condition.

Geochem were instructed to analyse eleven (11) samples from the interval 750-1950 metres, sixty four (64) samples from 1950-3863 metres (i.e. thirty (30) metre interval) and every sample from 3863 metres to T.D.

The total number of analyses performed in this study are tabulated below.

ANALYSIS	NUMBER OF ANALYSES			
	CUTTINGS	SWC	CORE	FLUID
Headspace and cuttings gas	131			
Sample preparation	131		8	
Total organic carbon	200			
Pyrolysis	79			
Vitrinite reflectance	40			
Kerogen type and spore colouration	40			
C_{15+} extraction and chromatography	12		8	1
Capillary GC - paraffin-naphthenes	12		8	1
Capillary GC - aromatics	12		8	1
Pyrolysis-GC	11			
Carbon isotopes - extract fractions	20			5
Carbon isotopes - kerogen	5			
GC-MS biomarker analysis	5			1
Capillary GC - whole oil				1
Gasoline range analysis				1
API gravity				1

The data are presented in tables 1 through 13 and graphically in figures 1 through 17. A brief description of the analytical techniques employed in this study is included in the back of the report.

GENERAL INFORMATION

Ten (10) copies of this report have been forwarded to Steiner Ulvoen at Statoil in Stavanger together with the kerogen slides prepared for this study and the logs provided by Statoil. A copy of the data has been retained by Geochem for future consultation with authorised Statoil personnel. A magnetic tape of the analytical results will be sent to Statoil.

The remaining sample material will be handled as directed.

All of the results related to this study are proprietary to Statoil A.S.

CONCLUSIONS

Seven (7) geochemical zones are recognised between 717 metres and 4764 metres (TD).

The claystones within the MIOCENE (717-1052 metres, Zone A) contain 0.62-0.19% of poor quality organic matter. They are immature source rocks with only a poor potential for gas.

Above 1500± metres the OLIGOCENE (1052-1500 metres, Zone B^1) shaly mudstones and claystones have better values of 1.08-1.39% organic carbon. Their organic matter is largely woody and algal in type. Hence these sediments are richer than these of the Miocene (and of the Oligocene below 1500± metres) but are, nevertheless, still poor source rocks which will probably yield gas, perhaps with associated condensate. On-structure, they are completely immature and no hydrocarbon generation has occurred.

Below 1500± metres the OLIGOCENE AND PALEOCENE (1500-2109 metres, Zone B^2) are dominated by medium grey shaly mudstones which contain only 0.36-0.62(0.77)% of a mixed algal-herbaceous-woody-inertinitic organic matter assemblage. These mudstones are immature and very poor source rocks which, even if mature, would have only a minimal potential for hydrocarbons.

The CRETACEOUS (2109-3863 metres, Zone C) is geochemically continuous with the Paleocene. These sediments contain 0.37-0.55(0.62)% organic carbon above 2750± metres but do then improve slightly to 0.54-0.86(1.16)% organic carbon. Furthermore, their organic matter is dominantly inertinitic in type (with significant proportions of wood), thus resembling the basal Paleocene. As a result, they are very poor and uninteresting source rocks which above 3400± metres, are effectively immature. Below this depth, minor hydrocarbon generation has occurred, but this is not of any economic significance.

In contrast, the KIMMERIDGE CLAY AND HEATHER FORMATIONS (3863-4083 metres, Zone D) are much richer. The Kimmeridgian shaly mudstones have values of 3.65-6.54% organic carbon, being richest below 3895± metres, whilst those in the Heather contain 2.29-3.64% organic carbon. Although the Kimmeridge is organically richer, there are no obvious depth-related organic facies trends within this interval. Instead, these sediments are characterised by a mixed woody-inertinitic-amorphous-algal organic matter assemblage within which wood, inertinite and amorphous kerogen are variably the major components, although the amorphous kerogen is generally not of prime quality. In consequence, these are not rich source rocks and are not classically oil-prone. The Kimmeridge Clay Formation is a potentially good to very good source for oil and gas within which significant hydrocarbon generation has occurred on-structure and which, off-structure (below 4000± metres) lies within the oil window. The Heather Formation has achieved the optimum maturity conditions of the oil window on-structure but, although major hydrocarbon generation has been initiated below 4000± metres, these are only fair or fair to good source rocks for oil and gas.

WEAK SHOWS of a medium gravity crude oil are present at 2630-2900± metres in the Cretaceous, with scattered traces of wet gas up to the top of the Paleocene and traces, possibly of both wet gas/condensate and of oil, down to 3440± metres. SHOWS of mature, light to medium gravity crude are present from 3440± metres down to the base of the Cretaceous (strong shows at 3550, 3670, 3790 and 3850 metres) and are apparently associated with the thin limestone stringers in this interval. There are STRONG OIL SHOWS in the Kimmerdigian and good shows in the Heather Formation.

All of the oil shows down to the base of the Kimmeridge appear to involve a SINGLE OIL type which was probably derived from the source rocks of the Kimmeridge Clay Formation. The shows in the Heather will be discussed below.

The TARBERT, NESS, ETIVE AND RANNOCH FORMATIONS (4083-4335 metres, Zone E) consists of sandstones with interbeds of shale, which are most abundant in the Ness Formation. These shales contain 2.54-3.45% organic carbon, whilst the associated but less abundant silty mudstones have lower values of 1.81-2.28% organic carbon. Clearly, these shales are of above-average organic richness and resemble the Heather shales on this parameter. Their organic matter is a mixed amorphous-algal-inertinitic-woody assemblage. Major oil generation (oil window) has already been initiated in these shales. However, they are not rich source rocks but instead, have a good potential which is variably for oil and gas or for gas and light oil. Migration from these shales should be efficient.

The sandstone cores of the TARBERT FORMATION have been partially flushed but contain shows of a mature (but not highly mature) medium gravity crude oil. This oil is not waxy but does, in some cores, show a hint of waxiness. There are no trends in hydrocarbon abundance values within these cores, but it is tentatively suggested on the basis of the gas chromatographic data that the OIL-WATER CONTACT might lie between 4113.5 metres and 4117.4 metres.

STRONG SHOWS are apparently present in the Ness and Etive Formations down to approximately 4270± metres and also at 4450-4525± metres (and perhaps elsewhere) in the Drake Formation. It is suspected that the shows in the Drake Formation might be of residual oil. These oils together with those in the Tarbert and Heather Formations are generally medium gravity and belong to a SECOND OIL TYPE.

It is tentatively suggested that, within the TARBERT reservoir sands, the oil above approximately 4102± metres is lighter (estimated gravity for DST 1 of 43.1° API) and that this may reflect a later injection and segregation of an aromatic-rich condensate into the top of the oil-containing reservoir. Such a condensate would presumably have been sourced from a very mature source rock containing a mixed organic matter assemblage with a high proportion of land plant debris.

The shows in the Heather Formation, the Tarbert-Etive section and in the Drake Formation were not SOURCED from the facies of the Kimmeridge Clay Formation analysed in this well. It would appear that the parent source rocks from which they were derived contain a higher proportion of land plant organic matter and were deposited in a more open environment than the Kimmeridge. Based upon the available data, the most likely source for these oils is the interbedded shales within the Tarbert-Rannoch interval and particularly within the Ness Formation. The Heather Formation probably contains a mixture of the two oil types.

Drake — 4335-4413, Cook - 4413 - 4450, Amundsen - 4450 - 4714 mRKB.

In the DRAKE FORMATION (4335-4764 metres, Zone F) the shales generally contain (0.98)1.32-2.21(2.45)% organic carbon but occasionally reach 3.24-4.08% organic carbon. The major component of their organic matter is normally wood or inertinite and wood, although some of the shales from above 4550± Amundsen fm. metres contain significant proportions of amorphous (commonly of poor quality) and algal material. This unit generally has only a poor source potential for gas with minor associated liquids and due to its organic facies, is only just starting to realise its maximum potential for hydrocarbons at T.D. However, the interbeds of richer shale which occur within the interval 4420-4495± metres represent good source rocks for gas and condensate.

Both og øvre Amundsen fm.

There appear to be weak shows of dry gas in the sands below 4720± metres.

Good source rocks are restricted to the Kimmeridge, the shales within the gross Tarbert-Rannoch interval and particularly in the Ness Formation, the relatively minor better shales within the Drake Formation and perhaps, the Heather shales. Excluding the Drake Formation, these source units generally have a mixed potential for oil and gas, but are not classically oil-prone.

Oil-prone organic matter would be mature below 3400± metres and enter the oil window at 4000± metres.

No significant inversion is indicated in this well section.

ZONATION

The formation tops (RKB) supplied by Statoil and employed in this study are listed below.

MIOCENE	717m
OLIGOCENE	1052m
PALEOCENE	1892m
LISTA FM.	1949m
CRETACEOUS	2109m
JURASSIC	3863m
HEATHER FM.	3923m
TARBERT FM.	4083m
NESS FM.	4124m
ETIVE FM.	4242m
RANNOCH FM.	4286m
DRAKE FM.	4335m
T.D.	4764m

These tops have been integrated with the geochemical data to create the following zonation:

Zone A — 717 metres to 1052 metres corresponds to the MIOCENE and consists of light olive grey claystones with interbedded sands.

Zone B^1 — 1052 metres to 1500± metres is OLIGOCENE in age and comprises olive grey and light olive grey shaly mudstones and claystones.

Zone B^2 — 1500± metres to 2109 metres, includes the rest of the OLIGOCENE (above 1892± metres) together with the PALEOCENE. It is dominated by very shaly mudstones.

Zone C — corresponds to the CRETACEOUS (2109-3863 metres). This is an interval of claystones which are grossly medium light grey in colour. Occasional thin limestone stringers are present between 3440± metres and 3700± metres. Very light brownish grey marls are present at the base of the unit.

Zone D — 3863 metres to 4083 metres corresponds to the JURASSIC KIMMERIDGE CLAY and HEATHER FORMATIONS (below 3923 metres). These shaly mudstones are dark grey to dark brownish grey in colour at the top of the zone, but are somewhat lighter below 3940± metres. A light grey silty mudstone appears just above the underlying sands.

Zone E — 4083 metres down to 4335 metres includes the sandstones of the

TARBERT, NESS, ETIVE and RANNOCH FORMATIONS. Interbedded shales are present, and are most abundant within the Ness Formation.

Zone F 4335 metres to 4764± metres (TD) apparently all belongs to the DRAKE FORMATION. It is dominated by medium grey shales but there are sandy intervals at 4413-4450± metres and below 4714± metres.

ORGANIC FACIES AND SOURCE RICHNESS

The amount of organic matter within a sediment is measured by its organic carbon content. Average shales contain approximately one percent organic carbon.

Organic matter type influences not only source richness but also the character of the hydrocarbon product (oil, gas) and the response of the organic matter to thermal maturation. Richness and oiliness decrease in the order: amorphous-algal-herbaceous-woody. Wood has a primary (but not exclusive) potential for gas whilst inertinitic (oxidised, mineral charcoal) material has only a limited hydrocarbon potential. Pyrolysis-derived hydrogen indices increase with organic matter quality.

Hydrocarbon source richness has been evaluated from the yields of extractable C_{15+} hydrocarbons (C_{15+} HC) and of pyrolysate (S2) in association with the total organic carbon (TOC) contents. The following rating scheme has been employed:

	S2 ppm (mg/g)	C_{15+} HC (ppm)	TOC (%)
POOR SOURCE	below 2000 (2 mg/g)	below 100	below 0.5
FAIR SOURCE	2000-3000 (2-3 mg/g)	100-250	0.5-1.0
GOOD SOURCE	3000-5000 (3-5 mg/g)	200-500	1 - 3
VERY GOOD	5000-10,000 (5-10 mg/g)	500-1000	3 - 5
RICH SOURCE	over 10,000 (10 mg/g)	over 1000	over 5

The type of product (oil, gas) has been determined from the gas chromatograms of the pyrolysate (S2) fractions for which the gas-oil indices have also been calculated. Oil-prone sediments have indices of less than 20%, 20-35% indicates a mixed potential for oil and gas, 35-50% for condensate and values in excess of 50% are indicative of dry gas.

The solvent extractable C_{15+} hydrocarbons are commonly enhanced by non-indigenous species (see below) and hence are of limited value in evaluating source richness in this well.

The MIOCENE claystones of Zone A contain 0.62-0.91% of organic matter in which wood is the major component, although significant proportions of inertinitic, herbaceous ± algal debris are also present. These samples yielded 0.42-0.76 mg/g pyrolysate and have hydrogen indices of less than 84. They represent poor and uninteresting source rocks for gas.

In the upper part of the OLIGOCENE (down to 1500± metres, Zone B^1) the dominant mudstones have higher values of 1.08-1.39% organic carbon. Their organic matter is also of better quality, being largely woody and algal in type with only minor to significant proportions of inertinitic, herbaceous and amorphous kerogens. These improvements are reflected in their higher pyrolysate yields (i.e. (0.70)1.18-1.75 mg/g) and in the hydrogen indices, which generally lie within the limits of 100-147. Source quality appears to deteriorate below 1400± metres but, although better than the Miocene claystones, they are all still poor source rocks. No pyrolysate chromatograms were authorised but these mudstones probably have a primary potential for gas, perhaps with associated condensate.

Over the remainder of the TERTIARY (below 1500± metres, Zone B^2) the dominant shaly mudstones contain 0.36-0.62(0.77)% organic carbon and are generally characterised by a mixed algal-herbaceous-woody-inertinitic organic matter assemblage, although inertinite and wood tend to become dominant towards the base (below 2000± metres). The minor greyish brown mudstones below 1800± metres are still leaner at 0.19-0.24% organic carbon. Not surprisingly, the pyrolysate yields of 0.14-0.39 mg/g S2 indicate that Zone B^2 has a minimal source potential for hydrocarbons.

The CRETACEOUS claystones range from 0.37% to 0.55(0.62)% organic carbon above 2750± metres but then improve to 0.54-0.86(1.16)% organic carbon. The claystones, shales and marls cannot normally be distinguished from each other on this parameter, but the occasional minor greyish brown claystones are significantly leaner (0.19-0.26%). All of these sediments are of below-average richness and the problem is compounded by the fact that their organic matter is dominantly inertinitic in type. Significant proportions of woody material are also present, but the other constituents are only minor and amorphous kerogen is generally absent. Pyrolysate yields tend to be very low (0.14-0.48 mg/g S2) but some of the samples below 3520± metres do improve to 0.69-1.16 mg/g) and even to 2.17 mg/g (3670 metres) S2. However, these apparently richer samples also have higher thermal bitumen (S1) values and, below 3520± metres, contamination was observed in the kerogen preparations. Hence it is believed that this apparent improvement is misleading and that in fact, the entire Cretaceous consists of very poor source rocks with a minimal potential for hydrocarbons. This interpretation is confirmed by the low yield (35 ppm) of extractable hydrocarbons recovered from 2660-2690 metres, but the deeper analysed samples from this zone are all enhanced by migrated crude oil (see below).

In contrast the KIMMERIDGE CLAY and HEATHER FORMATIONS (Zone D) are much richer. The shaly mudstones of the Kimmeridge contain 3.65-6.54% organic carbon (being richest below 3895± metres) whilst those of the Heather Formation have lower values of 2.29-3.64% organic carbon. Their organic matter however is not of prime quality but instead, is a mixed woody-inertinitic-amorphous-algal assemblage within which the major component is variably woody, inertinitic or amorphous kerogen. The amorphous kerogen is generally not typically oil-prone. Drilling-introduced lignite complicates the evaluation of this interval but there are no apparent depth or formation-related trends. C_{15+} hydrocarbon abundances are enhanced by the presence of migrated crude oil and the thermal bitumen (S1) abundances are also high, especially in the Kimmeridge. Pyrolysate yields of 8.49-9.89 mg/g and of 2.72-3.75(7.01) mg/g were obtained from the Kimmeridge Clay and from the Heather Formations, suggesting that they are very good and fair to good source intervals respectively. It is interesting to note that the gamma ray response is also higher in the Kimmeridge and particularly at 3906-3917± metres. The chromatograms of the pyrolysate (S2) material are not classically oil prone but instead, indicate a mixed potential for oil and gas, tending to be most oil-prone within the Kimmeridge. It should be noted that the presence of migrated crude oil will artificially enhance the apparent source richness of this interval, whilst the prevalence of drilling-introduced lignite will make the pyrolysate chromatograms less oily. Indeed, after extraction the pyrolysate yields from the Kimmeridge fell to 3.27-6.13 mg/g whilst none of the Heather samples exceed 3.75 mg/g S2. Hence the Kimmeridge Clay Formation is a potentially good to very good source unit for oil and gas whilst the Heather Formation has only a fair or fair to good potential for oil and gas.

The sandstones of the TARBERT, NESS, ETIVE and RANNOCH FORMATIONS (Zone E) are interbedded with shales, which are most abundant in the Ness Formation. These shales contain 2.54-3.45% organic carbon although the associated but less abundant silty mudstones are somewhat leaner at 1.81-2.28% organic carbon. The organic matter in the shales is a mixed amorphous-algal-inertinitic-woody assemblage. Yields of 4.42-7.73 mg/g pyrolysate were obtained, resulting in hydrogen indices of 173-224. However, after extraction, the yields dropped to 3.55-3.81 mg/g S2 and hence these are good rather than very good source rocks. Their pyrolysate chromatograms indicate that they will yield, variably, oil and gas or gas and light oil. Hence these shales are good source rocks for oil and gas or for gas and light oil.

The shales of the DRAKE FORMATION (Zone F) are generally rather leaner at (0.98)1.32-2.21(2.45)% organic carbon, but occasionally reach values of 3.24-4.08% organic carbon. Not only do they tend to be leaner than the overlying shales but their organic matter is of poorer quality with wood, or inertinite and wood, commonly being the major components. Drilling-introduced lignite complicates the kerogen evaluations, but some of the samples from above 4550± metres do contain significant proportions of amorphous and algal kerogen, although the amorphous fraction is commonly of poor quality. As a result, these shales generally yielded only 0.69-1.51 mg/g pyrolysate, but do jump to 7.44 mg/g in the medium dark grey shale from 4480-4495 metres. After extraction however, this sample drops to 3.54 mg/g S2. Chromatograms of the pyrolysate fraction indicate a potential for gas and condensate for the richest shale but the others will yield gas, perhaps with minor associated liquids. Hence the shales of the Drake Formation are generally poor source rocks for gas with minor associated liquids, but that from 4480-4495 metres is a good source for gas and condensate.

In summary:

- MIOCENE, poor and uninteresting gas source
- OLIGOCENE above 1500± metres, somewhat better but still poor source rocks for gas and (perhaps) associated condensate
- TERTIARY below 1500± metres, minimal potential for hydrocarbons
- CRETACEOUS, minimal source potential for hydrocarbons
- KIMMERIDGE CLAY, good to very good (not rich) source for oil and gas
- HEATHER FORMATION, fair or fair to good source unit for oil and gas
- TARBERT THROUGH RANNOCH FORMATIONS, shales good source rocks for oil and gas and for gas and light oil
- DRAKE FORMATION, poor source rocks for gas with minor associated liquids. Good source intervals for gas and condensate within the gross interval 4420-4495± metres.

THERMAL MATURITY

Thermal maturity has been evaluated with the spore colouration and vitrinite reflectance techniques. Pyrolysis Tmax data are also available but the methyphenanthrene indices cannot be employed as a maturity parameter due to the presence of non-indigenous hydrocarbons in most of the analysed samples.

The correlation between spore colouration and vitrinite reflectance is shown in the following table, in which the maturation interpretations refer to oil-prone organic matter and the spore colouration and vitrinite reflectance values define the top of the relevant maturation zone. Spore colouration is reported both as thermal alteration indices (TAI) and on the equivalent 1-10 scale.

MATURATION STATE	SPORE COLOURATION		VITRINITE
	TAI	1-10	REFLECTANCE (% Ro)
IMMATURE	less than 2-	below 3	less than 0.45
MARGINALLY MATURE	2-	3	0.45
MATURE	2	4	0.55
OIL WINDOW	2 to 2+	5	0.72
GAS CONDENSATE	3	8	1.3
DRY GAS	3+	9	2.0

By definition, thermal hydrocarbon generation does not occur in immature sediments. Minor, non-economic generation is initiated with marginal maturity but significant hydrocarbon generation requires mature sediments. Peak oil generation is achieved within the oil window. The character of the hydrocarbon product changes with increasing maturity from young condensates and oils in marginally mature sediments to conventional crudes in mature sediments. With more advanced maturity, oil generation ceases and is replaced by gas condensate and then by dry gas. Gas-prone organic facies mature more slowly than oil-prone facies and peak gas generation is only initiated in the lower half of the oil window.

A spore colouration thermal index of 2- is achieved at a depth of 2550± metres, whilst levels of 2 and of 2 to 2+ are reached at 3450± metres and at 3950± metres respectively. The thermal index at TD is 2+.

Most of the analysed samples contain several vitrinite populations but the distinction between them is diffuse and there are very few well-defined populations. There are no evident trends against depth and hence the data must be examined in detail in an attempt to resolve the problem. The best populations appear to be those from below 3800± metres which approximate 0.6% Ro. However, their reflectivity does not increase with depth and they appear to be somewhat immature. It is believed therefore that this population group represents the lignite-like additive observed in the kerogen preparations and should be ignored. Instead, the following populations are believed to be more reliable: 0.73% Ro at 4015-4030 metres, 0.79% at 4212-4225 metres, 0.84% at 4375-4390 metres, 0.77% at 4480-4495 metres and 0.80% Ro at 4570-4585 metres. Above 3800± metres reworking is prevalent and the only reliable data point appears to be the population of 0.49% Ro at 2810-2840 metres. The trend line based upon these data intercepts the surface at approximately 0.22% Ro, reaches 0.45% Ro at 2450± metres, 0.55% Ro at 3200± metres and 0.72% Ro at 4100± metres.

This approach is admittedly subjective but actually results in a reasonable correlation with the spore colouration data. The predicted depths of the tops of the maturation zones are tabulated below.

ZONE	SPORE COLOURATION	VITRINITE REFLECTANCE	PREFERRED DEPTH
MARGINALLY MATURE	2550	2450	2500
MATURE	3450	3200	3400
OIL WINDOW	3950	4100	4000

In this well the section is totally immature above 2500± metres and is effectively immature down to 3400± metres. Very minor hydrocarbon generation has occurred between this depth and the top of the Kimmeridge, but there has been significant generation above 4000± metres in the Jurassic, whilst below this depth the sediments lie within the oil window. The shales between 4000± metres and the base of the Rannoch Formation are experiencing optimum maturity conditions but, due to the change in organic facies, the Drake Formation is only just starting to realise its maximum potential for gas at TD.

Significant hydrocarbon generation would have been anticipated from oil-prone sediments below 3400± metres.

Pyrolysis Tmax values are relatively constant down to 3000± metres but then start to increase, reaching 430°C at 3300± metres, 435°C at 3500± metres and 450°C at approximately 4200± metres. Below this depth they decrease.

The maturation profile does not suggest significant inversion in this well section.

In summary:

- the section is immature down to 2500± metres, effectively immature down to 3400± metres and has experienced only very minor hydrocarbon generation between 3400± metres and the top of the Jurassic.
- significant generation has occurred in the Jurassic above 4000± metres, whilst below this depth it lies within the oil window.
- the Drake Formation is only just starting to realise its maximum potential for gas at TD.
- oil-prone sediments would have been mature below 3400± metres.
- no significant inversion is indicated in this section.

SHOW DETECTION AND CHARACTERISATION

Shows of migrated wet gas, condensate and crude oil are most effectively detected with the light C_1-C_7 hydrocarbons. Mature liquid hydrocarbons are characterised by high gas wetnesses and by low isobutane to normal butane ratios. Preliminary assessments of the character of the hydrocarbons in the shows can also be obtained from the light hydrocarbons but must be confirmed with the heavy C_{15+} hydrocarbon analyses, whilst the abundances of both fractions are used to determine the strength of the shows. The pyrolysis S1 parameter also detects shows but is severely affected by drilling-introduced contamination.

No fluorescence was detected in this study but a milky cut was observed in the thin limestones from (3440)3550± metres to 3605± metres and in the Tarbert sands above 4109± metres.

The light hydrocarbon (C_1-C_7) data do not suggest any shows above 1900± metres but, within the gross interval 1900-3440± metres, the gases range in wetness from approximately 30% C_{2+} up to a maximum of 78% C_{2+}. This variability coupled with the organic facies and effective immaturity of the sediments suggests the presence of scattered shows of migrated hydrocarbons throughout this thick interval. However, gas abundances tend to be low, generally ranging from 868 ppm up to 6618 ppm and thus indicating that only traces (rather than shows) could be involved. Higher values in the range 10061-20858 ppm are restricted to 2000-2060± metres, 2660-2690± metres, 2780-2810± metres and 2870-2900± metres but do not correlate with the wettest gases. It is suspected that the shows down to at least 2480± metres probably involve wet gas rather than oil, but weak oil shows are suggested at 2630-2900± metres. Between 2900± metres and 3440± metres it is possible that there could be weak traces of wet gas/condensate and of oil.

The rest of the Cretaceous is wetter and much richer. The gases are wet rather than very wet (i.e. (44)54-72(86)% C_{2+}) and have low isobutane to normal butane ratios (0.2-0.3). Richness improves at 3460 metres but the change is most dramatic over the intervals 3470-3680± metres, 3790 metres and below 3840± metres where the C_1-C_4 gases and the C_5-C_7 fractions lie within the ranges of 15751-43945(67294) ppm and 16022-48105 ppm respectively. The strongest shows are at 3550 metres, 3670 metres, 3790 metres and also 3850 metres. It is believed that these shows are of oil (confirmed below) and it is also interesting to note that the thick interval of good shows at 3470-3680± metres grossly correlates with the presence of the thin limestones.

Gas abundances are good (17127-35335(91255) ppm) and moderate (9322-20348 (28981) ppm) respectively in the Kimmeridge Clay and Heather Formations and the same pattern is evident in the heavier C_5-C_7 hydrocarbons (grossly 29772-41921 ppm against 9144-23765 ppm). The gases are very wet in both formations down to 4060± metres but then drop from 76-97% to 65-70% C_{2+}. The author does not believe it is possible to explain these data simply in terms of source-indigenous hydrocarbons but equally, the measured abundances are clearly enhanced by the source. Hence it is suggested that the Kimmeridge contains good shows of oil and the Heather, fair shows of oil. Better ratings are obtained from the heavy C_{15+} hydrocarbons (see below).

Excluding the samples of mud scraped from the cores, high gas abundances (39050-78978 ppm) extend from the top of the Tarbert sands down to at least 4255± metres in the Etive Formation. Butane ratios are however, somewhat higher, the gases are now wet (49-68% C_{2+}) rather than very wet and the C_5-C_7 hydrocarbons (i.e. (7915)15029-19623 ppm) are, in a relative sense, less abundant. Making allowance for the gases derived from the interbedded shale source rocks, it is not unreasonable to assume the presence of good shows, probably of oil, throughout this interval.

Below approximately 4255± metres gas abundances seldom exceed 2600 ppm and, although they are commonly wet to very wet, there is no definitive evidence of shows, although there could be a weak show at 4450-4525± metres. Better abundances (5863-7719 ppm) of dry gas (18-32% C_{2+}) are present in the sands below 4720± metres, suggesting weak shows.

The data obtained from the heavy C_{15+} hydrocarbons will now be considered.

A very low yield of 35 ppm was obtained at 2660-2690 metres but the sample from 2870-2900 metres is richer (319 ppm) and has a high (74.3%) proportion of hydrocarbons in the total soluble extract. The chromatogram of its saturate hydrocarbons indicates a mixture of crude oil and source-indigenous hydrocarbons and hence this sample contains a fairly weak show of medium gravity crude oil.

The sample from 3490-3505 metres yielded 503 ppm C_{15+} hydrocarbons (79.5% of total extract) whilst those from 3550 metres and 3670 metres approximate 3000 ppm, with these hydrocarbons constituting over 86% of the total extract. Non-indigenous hydrocarbons are clearly present and the chromatograms indicate a mature crude oil which is probably of light to medium gravity. The shows below 3520± metres are strong.

C_{15+} hydrocarbon abundances of 3763-3945 ppm and of 1417 ppm respectively were obtained from the Kimmeridge Clay and Heather Formations, with these hydrocarbons representing 79-86% of the total soluble extract. Regardless of the source potential of these intervals, the hydrocarbon yields and the hydrocarbon to total extract ratios indicate the presence of non-indigenous hydrocarbons. This is confirmed by the saturate chromatograms which reveal a mature crude oil.

The oil within the Kimmeridge resembles that in the overlying Cretaceous and probably also the oil at 2870-2900 metres, but that in the Heather Formation has relatively lower pristane and phytane peaks and a rather different isoparaffin fingerprint. Strong shows characterise the Kimmeridge whilst the shows in the Heather are good.

Sandstone cores were analysed from the interval 4085.4-4117.5 metres in the Tarbert Formation and yielded 158-631 ppm C_{15+} hydrocarbons. These abundance values are much lower than expected and suggest the likelihood of flushing during drilling. The hydrocarbons constitute (55)75-84% of the total extract which is also rather lower than expected and could be interpreted in the same way, particularly as the yields both above and below the cored interval are so much higher. Probably because of the hypothesised flushing, the chromatograms of these oils are not all identical, although they are similar enough to indicate the presence of a single oil. This crude is mature and of medium gravity. It is not waxy, but there is a hint of waxiness in the C_{20}-C_{28} normal paraffins which is most pronounced at 4092.25 metres and 4110.6 metres.

There are no depth-related trends in either the abundance of C_{15+} hydrocarbons or the hydrocarbon to total extract ratios which could indicate the oil-water contact. However, the saturate chromatogram from 4117.4 metres is unlike the others in its background envelope, the "busy" baseline, the overall normal paraffin distribution and particularly the loss of the front ends. It is tentatively suggested therefore, that this may be a residual oil and that the oil-water content might lie between 4113.5 metres and 4117.4 metres.

Three samples were analysed from the interval between the cores and the base of the Etive Formation, two of which consisted of the rock recovered from the mud scraped off the cores (S. Ulvoen). These samples, which consisted of shale and sandstone, yielded 1568-4005 ppm C_{15+} hydrocarbons and apparently become leaner with depth, although they are much richer than the overlying cores. Their hydrocarbon to total extract ratios (69.5-73.4%) are not particularly high, but non-indigenous hydrocarbons are again indicated. The chromatograms reveal the presence of crude oil which probably correlates with that in the sandstone cores although contamination is suggested at 4255-4270 metres ("core mud").

The one sample from the Drake Formation (4480-4495 metres) is relatively rich (3749 ppm) and has a high hydrocarbon to total extract ratio (90.8%). It also contains oil and the chromatogram suggests a correlation with the oil in the Tarbert sandstone cores.

By combining the light and heavy hydrocarbon data, the following picture is obtained:

- no shows were detected in the MIOCENE or OLIGOCENE
- scattered traces of wet gas are apparently present from the top of the PALEOCENE down to at least 2480± metres in the CRETACEOUS and perhaps down to 2630± metres
- weak shows of medium gravity crude oil at 2630-2900± metres
- traces, possibly of both wet gas/condensate and of oil from 2900± metres down to 3440± metres
- shows of a mature, light to medium gravity crude oil from 3440± metres to the base of the CRETACEOUS. Good shows down to 3680± metres, with strong shows at 3550 metres, 3670 metres, 3790 metres and 3850 metres. These shows frequently appear to be associated with thin limestone interbeds.
- strong oil shows in the KIMMERIDGE with good shows in the HEATHER.
- a SINGLE OIL TYPE appears to be responsible for all of the shows in

the KIMMERIDGE and the CRETACEOUS (at least up to 3440± metres). It would appear likely therefore, that this oil was sourced from the Kimmeridge.

- the sandstone cores of the TARBERT FORMATION have probably been partially flushed but still contain shows of oil. This oil is mature and of medium gravity. It is not waxy but, in some of the cores, does show a hint of waxiness.
- it is tentatively suggested that the OIL-WATER CONTACT might lie between 4113.5 metres and 4117.4 metres.
- strong shows are apparently present in the NESS and ETIVE FORMATIONS down to approximately 4270± metres.
- there are strong shows at 4450-4525± metres and perhaps elsewhere in the DRAKE FORMATION. The light hydrocarbons are relatively sparse, which might indicate that this is residual oil.
- there appear to be weak shows of dry gas in the sands below 4720± metres.
- a SECOND OIL TYPE is present in the Heather and the underlying Jurassic. This oil is apparently of medium gravity (see below) but is very similar to the oil in the Kimmeridge and Cretaceous. It is perhaps slightly more mature, has lower pristane and phytane peaks, but the same isoparaffin fingerprint.

Oil correlations will be discussed in detail in the next text chapter.

OIL CORRELATION

The DST 1 crude oil (4085-4095 metres) sample was too small for a hydrometer gravity determination, but its gravity was estimated by the refractive index method to be approximately 43.1° API. Clearly it is a light oil and this is not incompatible with the chromatograms of the saturates and aromatics which both suggest that this oil is lighter than the shows extracted from most of the cores. The flushing which has apparently affected the cores complicates this evaluation, but it would appear that the oil at the top of the reservoir is lighter.

The C_{15+} saturates chromatogram also suggests that the DST 1 oil is mature but not very mature. However, the gasoline range hydrocarbons have a most unusual composition as this fraction is characterised by high concentrations of benzene, toluene, cyclohexane and methylcyclohexane. The whole oil chromatogram shows a depletion of the front ends but also indicates that the xylenes are abundant. Hence this oil has anomalously high concentrations of the lighter aromatics which cannot be explained by the loss of the front ends (presumably during sample collection) which would have to involve preferential stripping of the normal paraffins.

Assuming that the sample container was not contaminated, the enhancement of the light aromatics relative to the normal paraffins is difficult to explain:

- thermal alteration, deasphalting and preferential vapourisation could not explain this phenomenon
- partial biodegradation is possible, but it must have occurred without water washing. Hence natural biodegradation is unlikely but, if bacteria had been introduced into the subsurface during the drilling of earlier wells, then biodegradation could have occurred without water washing. It is suspected however, that the reservoir temperature is too high for bacteria.
- the final possibility is that these features are source-related. This raises two options. Firstly, a marginally mature source unit involving a coaly sequence or secondly, a very mature source such as those which generated the aromatic condensates in other parts of the world (e.g. Western Canada Basin). A marginally mature source is unacceptable in the context of this well and we are therefore, left with the option of an

aromatic condensate which presumably entered the reservoir subsequent to the accumulation of the oil.

If an aromatic condensate, generated from very mature source rocks (in which the organic matter was largely land plant in type?), did enter the reservoir subsequent to the oil, it could have been preferentially concentrated at the top of the reservoir which, in turn, could explain why the DST 1 crude is apparently lighter than the underlying extracted shows. It must be emphasised that this hypothesis is very tentative and cannot be tested against other samples as no other gasoline range analyses were authorised for this study.

The shows extracted from the sandstone cores of the Tarbert Formation are all related but are not identical to each other, although the inter-sample differences are probably at least partly due to the flushing which has occurred and to the fact that some of the sands are not very clean. Allowing for these effects they do correlate. It is interesting to note that the biomarker mass fragmentograms indicate that the DST 1 crude oil correlates the most closely with the sands above 4102± metres.

In fact however, this correlation (e.g. C_{29} norhopane to C_{30} hopane ratio, m/z 191) is due to the physical lightness of the sample and hence the biomarker analyses indicate that the oils above 4102± metres are lighter. It is also clear (m/z 191, 217) that the crude in the Tarbert reservoir although mature, is not very mature. The Tm/Ts ratios (m/z 191) of the shows extracted from below 4200± metres suggest higher levels of maturity.

In the previous text chapter, the distinction between the shows above and below the base of the Kimmeridge was based upon the abundance of pristane relative to the adjacent normal paraffin (0.61-0.92 vs 0.47-0.66) and to phytane (1.35-1.94(2.54) vs 1.82-2.56). This breakdown is grossly supported by the chromatograms of the C_{15+} aromatics which group the Kimmeridge with most of the stronger shows in the Cretaceous (up to 3440± metres), but separates them from the Tarbert and Ness samples. The single samples from the Heather and the Drake Formations appear to be intermediate between the two major groupings.

Using the biomarker mass fragmentograms, the shows in the two analysed Kimmeridge samples correlate (no Cretaceous samples were analysed). The

Tarbert and Ness samples belong to a separate group, whilst the single Heather Formation sample is intermediate between the Kimmeridge and Tarbert oil shows. It is assumed that the C_{31} hopane isomers (m/z 191) in this sample reflect the influence of source indigenous hydrocarbons. The show from 4480-4495 metres in the Drake Formation also belongs, rather loosely, to the Tarbert group, although the triterpanes (m/z 191) are more like the Kimmeridge group.

The Kimmeridge samples have relatively higher abundances of trisnorneohopane (Ts), the unidentified triterpane adjacent to norhopane, of bisnorhopane and of the C_{27} steranes than the other shows. In the Heather Formation the C_{29} steranes (m/z 218) are approximately equal to the C_{28} steranes, whilst in the deeper samples the C_{29} steranes are the more abundant (but less abundant that the C_{27} steranes).

The DST 1 crude oil and the shows in the Tarbert cores are characterised by a strong norhopane peak but the absence of bisnorhopane and of the unidentified triterpane adjacent to norhopane (m/z 191); different sterane fingerprints (m/z 217, 259); dominant C_{29} steranes (m/z 218). They do not correlate with the Kimmeridge shows and indeed, although better, do not correlate convincingly with the shows below 4200± metres (sample quality?).

Based upon the biomarker data it is concluded that:-

1. the shows in the Kimmeridge do not correlate with the deeper extracted shows which were apparently generated from a source rock containing a higher proportion of land plant debris.

2. the DST 1 crude oil and the shows in the Tarbert cores do not correlate with the Kimmeridge.

3. the DST 1 crude and the Tarbert shows do not correlate satisfactorily with the shows below 4200± metres, although this could be partly due to the contribution of source-indigenous hydrocarbons from non-reservoir facies.

4. the proportion of land-plant debris (assuming that the C_{29} steranes are a reliable indicator) is highest in the parent source rock (i.e. Tarbert-Rannoch shale interbeds, see below) for the DST 1 oil and the shows in the sandstone cores from the Tarbert Formation.

5. the shows in the Heather may have a dual source.

Turning to the carbon isotope data the Galimov plot shows that the two shows extracted from the Kimmeridge, although not identical, are not only isotopically lighter than the other samples but also become progressively heavier from the saturates to the aromatics and then to the NSO's and asphaltenes. The DST 1 crude oil and the single show extracted from the Ness Formation resemble each other (except on the asphaltenes) but are isotopically heavier than the Kimmeridge (1-1.7^{o}/oo on saturates, 2.7-3.6^{o}/oo on aromatics) and have a different pattern, with the aromatics being heavier than the NSO's. The sample from the Heather is over 1^{o}/oo heavier on the saturates but otherwise, resembles the show from the Ness Formation. Finally, the show from the Drake Formation, although intermediate between those from the Kimmeridge and the Ness, groups more satisfactorily with the latter.

Thus on their carbon isotope compositions, these samples fall into two groups. The first comprises the Kimmeridgian shows and the second, which is somewhat loose with the inclusion of the Drake Formation sample, the sub-Kimmeridgian shows. The DST 1 crude oil belongs to the second group.

Oil to source correlations have, in this study, to be based upon the carbon isotope data, using the isotopic composition of the show hydrocarbons and, for the source, the composition of the isolated kerogens. The Kimmeridgian kerogens have values of -28.5^{o}/oo and of -29.1^{o}/oo and hence are heavier than the extract fractions from the same samples, comparable or slightly heavier than the saturates from the deeper samples (lighter than the Heather), but lighter by 0.5-1.0^{o}/oo than the likely total extract values (not authorised) of these deeper samples including the DST 1 oil. It would be expected that the total extracts (or whole oils) would be isotopically lighter than the kerogens from which they were derived. Thus the shows in the Kimmeridge could have been (and probably were) sourced from the associated shales, but it is likely that a different source was responsible for the other shows. Further analyses are required but, from the available data base, the analysed source facies from the Ness and Drake Formations appear to be the most likely candidates, the single analysed sample from the Heather Formation being too heavy. The Drake Formation shales are not oil-prone and hence the most likely sources for the sub-Kimmeridgian oils, from the available limited data base, are the shales within the Tarbert-Rannoch interval and particularly in the Ness Formation.

In summary therefore:-

- the shows in the Kimmeridge and (at least up to 3440± metres) in the Cretaceous were sourced from the Kimmeridge Clay Formation
- the shows from the top of the Heather Formation down to at least 4270± metres in the Etive Formation and perhaps to TD belong to a second oil family which was not sourced from the Kimmeridge. It is assumed that the loose grouping of this second family is due to the fact that many of the shows were extracted from non-reservoir facies. However, it is quite possible that the shows in the Heather Formation represent a mixture of the oil types present in the Kimmeridge Clay and the Tarbert Formations.
- the most likely source (from the available data) for this second family is the shales within the Tarbert-Rannoch interval and particularly in the Ness Formation
- certainly, the source facies responsible for this second family (and particularly for the oils in the Tarbert reservoir sands) would appear to contain a higher proportion of land plant debris than the Kimmeridge and was probably deposited in a less restricted environment
- it is tentatively suggested that the top of the Tarbert reservoir from which the DST 1 crude was produced contains a lighter oil than that below approximately 4102± metres and that this lighter oil may have been generated by a later injection of an aromatic condensate into the reservoir. Such a condensate would presumably have been sourced from a very mature sediment containing largely land plant organic matter.
- these conclusions need to be tested with further analyses.

SAMPLE QUALITY AND TURBODRILLING

The samples from the intervals 3865-4015 metres, 4310-4330 metres and 4495-4705 metres contain abundant lost circulation material, whilst the samples from 4225-4330 metres, 4405-4480 metres and 4615-4705 metres are very finely ground and difficult to pick.

However, the poor quality samples do not correspond to the turbodrilled interval which extends from 3104 metres down to 3863 metres.

It is difficult to ascribe any of the trends in the analytical data to the effects of turbodrilling. Thus:

- organic carbon contents are variable although, on average, they are higher than in the overlying Cretaceous. Below 3440± metres this is at least partly due to an enhancement by migrated hydrocarbons but, in the absence of a facies change, it is possible that these values may have been affected by turbodrilling (especially above 3440± metres).
- S1 and S2 values (and hydrogen indices) are erratically higher below 3520± metres. This however correlates with, and is probably related to, the presence of migrated oil.
- no pyrolysis-GC traces were run within the turbodrilled interval.
- contamination and lignite were observed in the kerogen preparation below 3520± metres, but not above this depth. The lignite is also present below the turbodrilled section.
- the C_1-C_4 gases do tend to be somewhat wetter below 3080± metres, although there is no increase in the abundance either of the gases or of the gasoline-range hydrocarbons.

In summary therefore, the more obvious changes within the turbodrilled interval probably reflect the presence of crude oil and indeed, the slight increase in gas wetness may also be due to traces of migrated hydrocarbons.

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-019	740-70m	A 70% Clay, blocky, soft, non-calc., light olive grey	5Y6/1	0.62
		B 20% Sand, unconsolidated, medium grained, subangular to sub-rounded, poorly sorted, clear, white	N9	
		C 10% Shell fragments		
		Minor igneous? basalt		
1189-022	830-60m	A 60% Sand, as 1189-019B	N9	
		B 25% Shell fragments		
		C 15% Clay, as 1189-019A	5Y6/1	0.62
		Minor basalt?		
1189-026	950-80m	A 60% Sand, as 1189-019B	N9	
		B 30% Claystone, blocky, soft, sl. micaceous, non-calc., light olive grey	5Y6/1	0.91
		C 10% Glauconite, blocky, soft, dark greenish grey	5GY4/1	
		Minor shell fragments		
1189-029	1040-070m	A 65% Claystone, as 1189-026B	5Y6/1	1.16,1.18
		B 30% Sand, as 1189-019B	N9	
		C 5% Glauconite, as 1189-026C	5GY4/1	
		Minor shell		
1189-032	1130-160m	A 98% Claystone, blocky, soft, non-calc., minor cavings, light olive grey	5Y6/1	1.22
		Minor other claystone		
1189-036	1250-280m	A 45% Claystone, as 1189-032A, minor cavings	5Y6/1	1.20
		B 45% Shale, platy, soft to mod. hard, non-calc., minor cavings, medium dark grey to brownish grey	N4-5YR4/1	1.19
		C 10% LCM - cement		
1189-039	1340-370m	A 90% Shaly mudstone, subfissile, soft, non-calc., minor cavings, olive grey	5Y4/1	1.39
		B 10% LCM - cement		
		Minor claystone		
1189-042	1430-460m	A 65% Shaly mudstone, as 1189-039A, minor cavings	5Y4/1	1.08
		B 35% Claystone, subfissile, soft, non-calc., light olive grey	5Y6/1	0.51,0.51
		Minor other claystone		
1189-046	1550-580m	A 65% Shaly mudstone/claystone, subfissile, soft, non-calc., minor cavings, medium light grey to light olive grey	N6-5Y6/1	0.77
		B 35% Sand, unconsolidated, medium grained, subrounded, fairly well sorted, clear, white	N9	
		Minor other claystone		
		Minor LCM		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-049	1640-670m	A 98% Shaly mudstone/claystone, subfissile, soft, non-calc., minor cavings, medium light grey to light olive grey Minor sand and claystone LCM - cement	N6- 5Y6/1	0.48
1189-052	1730-760m	A 98% Shaly mudstone, as 1189-049A, minor cavings Minor claystone and sand	N6- 5Y6/1	0.46
1189-056	1850-880m	A 55% Shaly mudstone, platy to subfissile, soft to mod. hard, non-calc., minor cavings, medium grey to olive grey	N5- 5Y4/1	0.36
		B 45% Shaly mudstone, subfissile, soft, non-calc., non-calc., greyish brown Minor claystone	5YR3/2	0.20,0.19
1189-059	1940-970m	A 55% Shaly mudstone, subfissile to blocky, soft, non-calc., minor cavings, medium grey to olive grey	N5- 5Y4/1	0.62
		B 30% Shale, platy to subfissile, soft to mod. hard, non-calc., medium dark grey to medium grey	N4-5	0.62
		C 15% Shaly mudstone, subfissile, soft to mod. hard, non-calc., greyish brown	5YR3/2	0.21
1189-060	1970-2000m	A 85% Shaly mudstone, as 1189-059A	N5- 5Y4/1	0.38
		B 10% Shale, as 1189-059B	N4-5	0.42
		C 5% Shaly mudstone, as 1189-059C, minor cavings	5YR3/2	0.20,0.19
1189-061	2000-030m	A 90% Shaly mudstone, as 1189-059A	N5- 5Y4/1	0.43
		B 10% Shaly mudstone, as 1189-059C, minor cavings Minor sand and shale	5YR3/2	0.24
1189-062	2030-060m	A 70% Shaly mudstone, as 1189-059A	N5- 5Y4/1	0.44
		B 15% Shale, platy to subfissile, mod. hard, non-calc., minor cavings, medium dark grey	N4	0.40
		C 10% Shaly mudstone, as 1189-059C, minor cavings	5YR3/2	0.20,0.19
		D 5% Sandstone, blocky, fine grained, subangular, fairly well sorted, non-calc. matrix, v. light grey	N8	
1189-063	2060-090m	A 65% Shaly mudstone, as 1189-059A, minor cavings	N5- 5Y4/1	0.54
		B 15% Shale, as 1189-062B	N4	0.49
		C 10% Shaly mudstone, as 1189-059C, minor cavings	5YR3/2	0.22
		D 10% Sandstone, as 1189-062D	N8	

Abbreviations = **are**naceous, **arg**illaceous, **calc**areous, **Cut**, **dol**omitic, **Fl**uorescence, **foram**inifera, **foss**iliferous
Lost **C**irculation **M**aterial, **mod**erately, **occ**asionally, **s**lightly, **v**ery

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-064	2090-120m	A 98% Shaly mudstone, subfissile to blocky, soft, non-calc., minor cavings, medium grey to olive grey Minor sand and other mudstone	N5- 5Y4/1	0.57
1189-065	2120-150m	A 98% Shaly mudstone, as 1189-064A, minor cavings Minor sandstone and other mudstone	N5- 5Y4/1	0.54,0.57
1189-066	2150-180m	A 98% Shaly mudstone, as 1189-064A, minor cavings Minor sandstone and other mudstone	N5- 5Y4/1	0.49
1189-067	2180-210m	A 98% Shaly mudstone, as 1189-064A, minor cavings Minor sandstone and other mudstone	N5- 5Y4/1	0.50
1189-068	2210-240m	A 60% Shaly mudstone, platy, soft to mod. hard, non-calc., light grey	N7	0.37
		B 30% Claystone, blocky, soft, non-calc., medium light grey to light grey	N6-7	0.50
		C 10% Shaly mudstone, subfissile, soft to mod. hard, non-calc., light greyish brown	5YR4/2	0.21,0.22
1189-069	2240-270m	A 60% Shaly mudstone, as 1189-068A, minor cavings	N7	0.41
		B 30% Claystone, as 1189-068B	N6-7	0.45
		C 10% Shaly mudstone, as 1189-068C, sig. cavings	5YR4/2	0.23
1189-070	2270-300m	A 70% Shaly mudstone, as 1189-068A, minor to sig. cavings	N7	0.49
		B 25% Claystone, as 1189-068B, minor cavings	N6-7	0.51
		C 5% Shaly mudstone, as 1189-068C, sig. cavings	5YR4/2	0.25,0.26
1189-071	2300-330m	A 98% Claystone, shaly in part, subfissile, soft, non-calc., minor cavings, medium light grey to light grey Minor sand and other claystone	N6-7	0.50
1189-072	2330-360m	A 75% Claystone/shaly mudstone, subfissile, soft, non-calc., minor to sig. cavings, medium grey	N5	0.40
		B 25% Claystone, blocky, soft, non-calc., sig. cavings, medium grey to medium light grey Minor sand and other claystone	N5-6	0.54
1189-073	2360-390m	A 60% Claystone, as 1189-072A, minor to sig. cavings	N5	0.41
		B 35% Claystone, as 1189-072B, sig. cavings	N5-6	0.43,0.44
		C 5% Claystone, subfissile to blocky, soft to mod. hard, non-calc., minor to sig. cavings, greyish brown	5YR3/2	0.26

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-074	2390-420m	A 75% Claystone/shaly mudstone, subfissile, soft, non-calc., minor to sig. cavings, medium grey	N5	0.46
		B 15% Claystone, blocky, soft, non-calc., sig. cavings, medium grey to medium light grey	N5-6	0.44
		C 10% Claystone, subfissile to blocky, soft to mod. hard, non-calc., sig. cavings, greyish brown	5YR3/2	0.21
1189-075	2420-450m	A 80% Claystone/shaly mudstone, platy to subfissile, soft to mod. hard, sl. calc., minor cavings, medium light grey to light olive grey	N6-5Y6/1	0.47,0.49
		B 10% Claystone, subfissile, soft to mod. hard, sl. calc., minor to sig. cavings, greyish red	5R4/2	0.19
		C 10% Claystone, blocky, soft, sl. calc., sig. cavings, light grey to v. light olive grey	N7-5Y7/1	0.40
1189-076	2450-480m	A 70% Claystone, as 1189-075A, minor cavings	N6-5Y6/1	0.54
		B 30% Claystone, as 1189-075B	5R4/2	0.26,0.26
		Minor sand/limestone and other claystone		
1189-077	2480-510m	A 90% Claystone, as 1189-075A, minor cavings	N6-5Y6/1	0.54
		B 10% Claystone, as 1189-075B, minor to sig. cavings	5R4/2	0.21
		Minor limestone and other claystone		
1189-078	2510-540m	A 95% Claystone, as 1175-075A, minor to sig. cavings	N6-5Y6/1	0.55
		B 5% Claystone, as 1189-075B, minor cavings	5R4/2	0.20
1189-079	2540-570m	A 95% Claystone, as 1189-075A, minor cavings	N6-5Y6/1	0.55
		B 5% Claystone, as 1189-075B, sig. cavings	5R4/2	0.20,0.19
		Minor other claystone		
1189-081	2570-600m	A 98% Claystone, as 1189-075A, minor cavings	N6-5Y6/1	0.58
		Minor other claystone		
1189-082	2600-630m	A 98% Claystone, as 1189-075A, minor to sig. cavings	N6-5Y6/1	0.53
		Minor other claystone		
1189-083	2630-660m	A 98% Claystone/shale, platy to subfissile, soft to mod. hard, v. sl. calc., minor to sig. cavings, medium light grey to light grey	N6-7	0.55
		Minor other claystone		

Abbreviations = **arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous**
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION			G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-084	2660-690m	A	98%	Shale, platy, mod. hard, non-calc., minor to sig. cavings, medium light grey	N6	0.52
				Minor claystone		
1189-085	2690-720m	A	98%	Shale, as 1189-084A, minor cavings	N6	0.54,0.53
				Minor claystone		
1189-087	2720-750m	A	70%	Shale, as 1189-084A, minor to sig. cavings	N6	0.50
		B	30%	Claystone, blocky, soft, non-calc., medium light grey to light olive grey	N6-5Y6/1	0.62
				Minor other claystone		
1189-088	DEPTH OBSCURED	A	65%	Claystone, as 1189-087B, minor cavings	N6-5Y6/1	0.66
		B	35%	Shale, as 1189-084A, minor to sig. cavings	N6	0.54
				Minor other claystone		
1189-090	2780-810m	A	60%	Claystone, as 1189-087B, minor cavings	N6-5Y6/1	0.65
		B	40%	Shale, as 1189-084A, minor to sig. cavings	N6	0.55,0.55
				Minor other claystone		
1189-091	2810-840m	A	55%	Claystone, as 1189-087B, minor cavings	N6-5Y6/1	0.64
		B	45%	Shale, as 1189-084A, sig. cavings	N6	0.62
				Minor other claystone		
1189-093	DEPTH OBSCURED	A	70%	Claystone, blocky, soft, non-calc., medium light grey	N6	0.71
		B	30%	Claystone/shale, subfissile, soft to mod. hard, non-calc., minor cavings, medium grey to medium light grey	N5-6	0.61
				Minor other mudstone		
1189-094	2870-900m	A	75%	Claystone, blocky, soft, non-calc., minor cavings, medium light grey	N6	0.78,0.77
		B	25%	Claystone/shale, subfissile, soft to mod. hard, non-calc., minor to sig. cavings, medium grey to medium light grey	N5-6	0.65
				Minor other claystone		
1189-095	2900-930m	A	90%	Claystone, blocky to subfissile, shaly in part, soft to mod. hard, v. sl. calc., minor cavings, medium grey	N5	0.64
		B	10%	LCM - metal		
1189-097	2930-960m	A	98%	Claystone, as 1189-095A, minor to sig. cavings	N5	0.54
				Minor other claystones		

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Lost Circulation Material, moderately, occasionally, slightly, very

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ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-100	2960-990m	A 98% Claystone, blocky to subfissile, shaly in part, soft to mod. hard, v. sl. calc., minor cavings, medium grey	N5	0.66
		Minor other claystones		
1189-101	2990-3020m	A 65% Claystone, blocky, soft, non-calc., minor cavings, light grey	N7	0.55
		B 30% Shale, platy, mod. hard, non-calc., minor to sig. cavings, medium grey	N5	0.69,0.70
		C 5% Claystone, blocky, soft, non-calc., greyish red	5R4/2	0.21
1189-103	3020-050m	A 70% Claystone, as 1189-101A, minor cavings	N7	0.58
		B 30% Shale, as 1189-101B, sig. cavings	N5	1.03
		Minor other claystone		
		Minor LCM		
1189-104	3050-080m	A 65% Claystone, as 1189-101A, minor cavings	N7	0.62
		B 35% Shale, as 1189-101B, sig. cavings	N5	0.69,0.69
		Minor other claystone		
1189-106	3080-110m	A 98% Claystone, blocky, soft, sl. calc., medium grey to medium light grey	N5-6	0.65
		Minor shale and other mudstone		
1189-107	3120-135m	A 98% Claystone, as 1189-106A, minor cavings	N5-6	0.69
		Minor shale and other claystone		
1189-109	3150-165m	A 98% Claystone, as 1189-106A, minor cavings	N5-6	0.73
		Minor other claystone		
1189-111	3180-195m	A 98% Claystone, as 1189-106A, minor cavings	N5-6	0.79
		Minor shale		
1189-113	3210-220m	A 98% Claystone, as 1189-106A, minor to sig. cavings	N5-6	0.82
		Minor shale		
		LCM - fibre and cement		
1189-115	3235-250m	A 98% Claystone, as 1189-106A, minor cavings	N5-6	0.71,0.70
		Minor shale		
1189-117	3267-280m	A 90% Claystone, as 1189-106A, minor cavings	N5-6	0.62
		B 10% Shale, platy, mod. hard, non-calc., medium grey	N5	0.55
1189-119	3295-310m	A 90% Claystone, as 1189-106A, minor cavings	N5-6	0.73
		B 10% Shale, as 1189-117B, minor cavings	N5	0.67

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GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-121	3325-340m	A 98% Claystone, blocky, soft, calc., minor cavings, medium grey to medium light grey	N5-6	0.73,0.72
		Minor limestone and shale		
1189-123	3355-370m	A 90% Claystone, as 1189-121A, minor cavings	N5-6	0.67
		B 10% Shale, platy to subfissile, mod. hard, v. sl. calc., minor cavings, medium grey	N5	0.74
		Minor limestone		
1189-125	3400m	A 95% Claystone, as 1189-121A, minor cavings	N5-6	0.74
		B 5% Shale, as 1189-123B, minor cavings	N5	0.71
		Minor limestone		
1189-127	3430m	A 98% Claystone, as 1189-121A, minor to sig. cavings	N5-6	0.66,0.67
		Minor shale		
1189-129	3460m	A 98% Claystone, as 1189-121A, minor cavings	N5-6	0.76
		Minor shale		
		LCM - metal		
1189-132	3490-505m	A 90% Claystone, blocky, soft, calc., minor cavings, medium light grey	N6	0.81
		B 10% Shale, platy, mod. hard, calc., minor to sig. cavings, medium grey	N5	0.79
		Minor LCM		
1189-133	3520m	A 75% Claystone, as 1189-132A, minor cavings	N6	0.80,0.81
		B 15% Shale, as 1189-132B, sig. cavings	N5	0.69
		C 10% LCM - lignite		
1189-135	3550m	A 65% Claystone, as 1189-132A, minor cavings	N6	0.85
		B 15% Shale, as 1189-132B, sig. cavings	N5	0.68
		C 10% Limestone, blocky, soft to mod. hard, creamy F., milky cut, pinkish grey	5YR8/1	0.79
		D 10% LCM - lignite		
1189-137	3580m	A 30% Claystone, as 1189-132A, minor cavings	N6	0.82
		B 30% Shale, as 1189-132B, sig. cavings	N5	0.65,0.67
		C 20% Limestone, as 1189-135C, pale milky cut	5YR8/1	0.66
		D 20% LCM - lignite		
1189-140	3610-625m	A 75% Claystone, as 1189-132A, minor cavings	N6	0.71
		B 15% Shale, as 1189-132B, sig. cavings	N5	0.62
		C 5% Limestone, as 1189-135C, pale milky cut	5YR8/1	0.66
		D 5% LCM - lignite		

Abbreviations = **ar**enaceous, **arg**illaceous, **calc**areous, Cut, **dol**omitic, **F**luorescence, **foram**inifera, **foss**iliferous
Lost **C**irculation **M**aterial, **mod**erately, **occ**asionally, **sl**ightly, **v**ery

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-141	3625-640m	A 75% Claystone/marl, blocky, soft, medium grey to medium light grey	N5-6	0.68,0.69
		B 15% Shale, platy, mod. hard, sl. calc., sig. cavings, medium dark grey	N4	0.69
		C 10% Limestone, platy to blocky, soft to mod. hard, pinkish grey	5YR8/1	0.36
		Minor LCM - lignite		
1189-143	3670m	A 50% Marl, blocky, soft, minor cavings, v. light brownish grey	5YR7/1	0.86
		B 45% Claystone, as 1189-141A, minor cavings	N5-6	0.88
		C 5% Shale, as 1189-141B, abundant cavings	N4	
		Minor LCM		
1189-145	3700m	A 40% Claystone, as 1189-141A, minor to sig. cavings	N5-6	0.97
		B 35% Marl, as 1189-143A	5YR7/1	0.61,0.61
		C 25% LCM - lignite		
		Minor sandstone and shale		
1189-147	3730m	A 55% Claystone, as 1189-141A, minor to sig. cavings	N5-6	0.58
		B 30% Marl, as 1189-143A	5YR7/1	0.60,0.60
		C 15% Shale, platy, mod. hard, sl. calc., abundant cavings, medium dark grey to medium grey	N4-5	0.54
		LCM - lignite		
1189-149	3760m	A 70% Claystone, blocky, soft, non-calc., minor cavings, medium dark grey to olive grey	N4-5YR4/1	0.68,0.69
		B 30% Shale, platy, mod. hard, non-calc., sig. cavings, medium dark grey	N4	0.69
		Minor other claystone		
		LCM - lignite		
1189-151	3790m	A 55% Claystone/marl, blocky, soft, medium brownish grey	5YR5/1	0.74
		B 45% Shale, as 1189-149B, sig. cavings	N4	0.95
		Minor other claystone and limestone		
		LCM - lignite		
1189-153	3820m	A 65% Claystone, as 1189-151A, minor cavings	5YR5/1	0.53
		B 25% Shale, as 1189-149B, sig. to abundant cavings	N4	1.16
		C 10% Shale, platy to subfissile, soft to mod. hard, sl. calc., medium light grey	N6	0.37,0.39
		Rare lignite		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-155	3850m	A 70% Marl, blocky, soft, light brownish grey	5YR6/1	0.54
		B 15% Shale, platy, mod. hard, non-calc., sig. to abundant cavings, medium dark grey	N4	0.79
		C 15% Shale, platy to subfissile, soft to mod. hard, sl. calc., minor cavings, medium light grey	N6	0.35
		Rare pyrites and lignite		
1189-156	3865-880m	A 50% LCM - cement		
		B 50% Shaly mudstone, subfissile, mod. hard, non-calc., dark grey to dark brownish grey	N3-5YR3/1	3.86
1189-157	3880-895m	A 55% Shaly mudstone, as 1189-156B, minor cavings	N3-5YR3/1	3.65,3.66
		B 45% LCM - cement and fibre		
1189-158	3895-910m	A 98% Shaly mudstone, as 1189-156B, minor cavings	N3-5YR3/1	6.54
		Minor LCM		
1189-159	3910-925m	A 98% Shaly mudstone, as 1189-156B, minor cavings	N3-5YR3/1	5.64
		Minor other mudstone		
		Minor LCM		
1189-160	3925-940m	A 60% Shaly mudstone, as 1189-156B, minor cavings	N3-5YR3/1	2.56
		B 40% LCM - lignite and cement		
		Minor other mudstone and shale		
1189-161	3940-955m	A 55% Mudstone, blocky, soft, v. sl. calc., minor cavings, medium dark grey to olive grey	N4-5YR4/1	2.40
		B 45% LCM - lignite and cement		
		Rare limestone and shale		
1189-162	3955-970m	A 60% Mudstone, as 1189-161A, minor cavings	N4-5YR4/1	2.83
		B 40% LCM - lignite		
		Minor shale		
1189-163	3970-985m	A 50% Mudstone, as 1189-161A, minor cavings	N4-5YR4/1	3.64
		B 50% LCM - lignite and cement		
		Minor other mudstone and sand		
1189-164	3985-4000m	A 70% Mudstone, as 1189-161A, minor cavings	N4-5YR4/1	2.29
		B 30% LCM - lignite and cement		
1189-165	4000-015m	A 75% Mudstone, as 1189-161A, minor cavings	N4-5YR4/1	2.61
		B 25% LCM - lignite and cement		

Abbreviations = **ar**enaceous, **arg**illaceous, **calc**areous, **C**ut, **dol**omitic, **F**luorescence, **foram**inifera, **foss**iliferous
Lost **C**irculation **M**aterial, **mod**erately, **occ**asionally, **sl**ightly, **v**ery

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-166	4015-030m	A 85% Mudstone, blocky, soft, non-calc., minor cavings, medium dark grey to olive grey	N4-5YR4/1	2.51
		B 15% LCM - cement and lignite		
1189-167	4030-045m	A 70% Mudstone, as 1189-166A, minor cavings	N4-5YR4/1	2.96
		B 30% LCM - lignite and cement		
1189-168	4045-060m	A 80% Mudstone, as 1189-066A, minor cavings	N4-5YR4/1	2.93,2.91
		B 20% LCM - lignite and cement		
1189-169	4060-075m	A 80% Mudstone, as 1189-166A, minor cavings	N4-5YR4/1	3.15
		B 20% LCM - lignite and cement		
1189-170	4075-090m	A 50% Mudstone, as 1189-166A, minor cavings	N4-5YR4/1	3.47
		B 40% Silty mudstone, blocky, mod. hard, non-calc., light grey	N7	0.37
		C 10% LCM - lignite and cement Minor sandstone		
1189-171 CORE	4085.35m	A 89% Sandstone, massive, medium grained, subangular to subrounded, well sorted, non-calc., pale milky cut, pale brown	10YR5/2	
1189-172 CORE	4092.25m	A 98% Sandstone, massive, medium grained, subangular, well sorted, grain supported, micaceous, non-calc., pale milky cut, brownish grey	5YR4/1	
1189-173 CORE	4100.50m	A 98% Sandstone, massive, medium grained, well sorted, grain supported, non-calc., sl. micaceous, pale milky cut, brownish grey	5YR4/1	
1189-174 CORE	4105.70m	A 98% Silty sandstone, massive, fine grained, well sorted, non-calc. matrix, pale milky cut, brownish grey	5YR4/1	
1180-175 CORE	4108.60m	A 98% Sandstone, blocky, fine to medium grained, subangular, well sorted, grain supported, non-calc., pale milky cut, olive grey	5YR4/1	
1189-176 CORE	4110.60m	A 98% Sandstone, blocky, fine to medium grained, subangular, well sorted, sl. calc. matrix, sl. micaceous, medium grey to medium brownish grey	N5-5YR5/1	
1189-177 CORE	4113.50m	A 98% Sandstone, blocky, fine grained, well sorted, non-calc. matrix, sl. micaceous, medium brownish grey	5YR5/1	
1189-178 CORE	4117.40m	A 98% Sandstone, massive, banded, fine grained, well sorted, sl. micaceous, non-calc. matrix, medium brownish grey	5YR5/1	

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH		GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-179	4105-120m	A 55%	Shale, platy to thinly fissile, mod. hard, non-calc., minor cavings, medium dark grey	N4	3.45
		B 25%	Silty mudstone, subfissile, soft, non-calc., minor cavings, medium grey	N5	1.81,1.81
		C 10%	Silty mudstone, blocky, hard, non-calc., light grey to v. light brownish grey	N7-5YR7/1	0.66
		D 10%	LCM - cement		
			Minor sandstone		
1189-180	4120-4130.5m	A 55%	Shale, as 1189-179A, sig. cavings	N4	2.91
		B 25%	Silty mudstone, as 1189-179B, minor to sig. cavings	N5	1.81
		C 20%	LCM - cement and lignite		
			Minor sand		
1189-214 CORE MUD	4145-4167.5m	A 65%	Shale, platy to thinly fissile, mod. hard, non-calc., sig. cavings, dark olive grey	5Y3/1	3.09,3.11
		B 20%	Silty mudstone, blocky to subfissile, soft to mod. hard, non-calc., minor to sig. cavings, brownish grey	5YR4/1	2.28
		C 15%	LCM - lignite and cement		
			Minor sand and other mudstone		
1189-215 CORE MUD	4170-180m	A 45%	Shale, as 1189-214A, sig. cavings	5Y3/1	2.96
		B 40%	Sand, unconsolidated, medium grained, subangular, well sorted, clear, white	N9	
		C 10%	Silty mudstone, as 1189-214B	5YR4/1	1.94
		D 5%	LCM - lignite		
1189-216 CORE MUD	4180-195m	A 45%	Shale, as 1189-214A, sig. cavings	5Y3/1	2.74
		B 45%	Sand, as 1189-215B	N9	
		C 5%	Silty mudstone, as 1189-214B	5YR4/1	2.06
		D 5%	LCM - lignite		
1189-181	4212-225m	A 60%	Shale/shaly mudstone, subfissile, mod. hard, non-calc., sl. silty, minor to sig. cavings, brownish grey	5YR4/1	2.53,2.56
		B 30%	Sand, unconsolidated, medium grained, subangular, well sorted, clear, white	N9	
		C 10%	LCM - lignite		
			Minor coal? and other mudstone		
1189-182	4225-240m	A 60%	Shale, as 1189-181A, minor to sig. cavings	5YR4/1	2.92
		B 20%	Sand, as 1189-181B	N9	
		C 20%	LCM - lignite and cement		
			Minor coal? and other mudstone		
1189-183	4240-255m	A 45%	Shale, as 1189-181A, minor to sig. cavings	5YR4/1	3.42
		B 35%	Sand, as 1189-181B	N9	
		C 20%	LCM - lignite		
			Minor chert		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous Lost Circulation Material, moderately, occasionally, slightly, very

GEOCHEM

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-217 CORE MUD	4255-270m	A 75% Sand, unconsolidated, medium grained, subangular, well sorted, clear, white	N9	
		B 20% Shale, subfissile to blocky, mod. hard, non-calc., minor to sig. cavings, medium dark grey to brownish grey	N4-5YR4/1	2.91
		C 5% LCM - lignite		
1189-218 CORE MUD	4280-300m	A 65% Sand, as 1189-217A	N9	
		B 15% Shale, as 1189-217B	N4-5YR4/1	2.62
		C 10% LCM - lignite		
		D 10% Chert, blocky, hard, light grey	N7	
1189-184	4310-330m	A 50% Sandstone, mostly unconsolidated, medium grained, subangular, well sorted, white to pinkish grey	N9-5YR8/1	
		B 50% LCM - lignite		
		Minor shale and claystone		
1189-186	4330-345m	A 90% Claystone, blocky, soft, non-calc., minor cavings, medium grey to medium brownish grey	N5-5YR5/1	2.20,2.23
		B 10% LCM - lignite		
1189-187	4345-360m	A 90% Claystone, as 1189-186A, minor cavings	N5-5YR5/1	1.57
		B 10% LCM - lignite		
1189-188	4360-375m	A 95% Claystone, as 1189-186A, minor cavings	N5-5YR5/1	1.55
		B 5% LCM - lignite		
1189-189	4375-390m	A 95% Claystone, as 1189-186A, minor cavings	N5-5YR5/1	1.60
		B 5% LCM - lignite		
1189-190	4390-405m	A 95% Claystone, as 1189-186A, minor cavings	N5-5YR5/1	1.50
		B 5% LCM - lignite		
1189-191	4405-420m	A 60% Sand, unconsolidated, medium grained, subangular, fairly well sorted, clear, white	N9	
		B 40% Claystone, blocky, soft, sl. calc., non-calc., minor cavings, medium grey to medium brownish grey	N5-5YR5/1	1.43,1.40
		Minor LCM - lignite		
1189-192	4420-450m	A 95% Sand, as 1189-191A	N9	
		B 5% Claystone, as 1189-191B	N5-5YR5/1	3.86
		Minor LCM - lignite		
1189-193	4435-450m	A 90% Sand, as 1189-191A	N9	
		B 5% Claystone, as 1189-191B, minor cavings	N5-5YR5/1	2.45
		C 5% LCM - lignite		

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TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-194	4450-465m	A 50% Sand, unconsolidated, medium grained, subangular, fairly well sorted, clear, white	N9	
		B 20% Claystone, blocky, soft, sl. calc., non-calc., minor cavings, medium grey to medium brownish grey	N5-5YR5/1	1.48
		C 15% Shale, platy, mod. hard, non-calc., minor to sig. cavings, medium dark grey	N4	3.40
		D 15% LCM - lignite		
1189-195	4465-480m	A 40% Sand, as 1189-194A	N9	
		B 30% Shale, as 1189-194C, sig. cavings	N4	3.93,3.89
		C 15% Claystone, as 1189-194B, minor cavings	N5-5YR5/1	1.64
		D 15% LCM - lignite		
1189-196	4480-495m	A 45% Claystone, blocky, soft, sl. calc., silty in part, minor cavings, medium grey to medium brownish grey	N5-5YR5/1	2.02
		B 35% Shale, as 1189-194C, sig. cavings	N4	3.24
		C 15% Sand, as 1189-194A	N9	
		D 5% LCM - lignite		
1189-197	4495-510m	A 80% Claystone, as 1189-196A, minor cavings	N5-5YR5/1	1.32
		B 20% LCM - fibre and lignite Minor shale and sand		
1189-198	4510-525m	A 70% Claystone, as 1189-196A, minor cavings	N5-5YR5/1	1.48
		B 25% LCM - fibre and lignite		
		C 5% Shale, platy, mod. hard, non-calc., sig. cavings, medium dark grey Minor sand	N4	4.10,4.06
1189-199	4525-540m	A 80% LCM - cement and lignite		
		B 20% Claystone, blocky, soft, v. sl. calc., medium grey to medium brownish grey Minor sand and shale	N5-5YR5/1	2.20
1189-200	4540-555m	A 70% Claystone, as 1189-199B, minor cavings	N5-5YR5/1	1.47
		B 30% LCM - cement and lignite		
1189-201	4555-570m	A 80% Claystone, as 1189-199B, minor cavings	N5-5YR5/1	1.55
		B 20% LCM - lignite and cement		
1189-202	4510-585m	A 75% Claystone, as 1189-199B, minor cavings	N5-5YR5/1	1.95
		B 25% LCM - lignite		
1189-203	4585-600m	A 85% Claystone, as 1189-199B, minor cavings	N5-5YR5/1	1.92
		B 15% LCM - lignite		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1189-204	4600-615m	A 65% Claystone, blocky, soft, v. sl. calc., minor cavings, medium grey to medium brownish grey	N5-5YR5/1	1.65,1.63
		B 35% LCM - lignite		
1189-205	4615-630m	A 65% Claystone, 1189-204A, minor cavings	N5-5YR5/1	1.76
		B 35% LCM - lignite		
1189-206	4630-645m	A 98% LCM - lignite and cement		
1189-207	4645-660m	A 70% Claystone, blocky, soft, v. sl. calc. to non-calc., minor cavings, medium grey to medium brownish grey	N5-5YR5/1	1.69
		B 30% LCM - lignite		
1189-208	4660-675m	A 90% LCM - lignite		
		B 10% Claystone, as 1189-207A, minor to sig. cavings Minor sand	N5-5YR5/1	1.33
1189-209	4690-705m	A 70% Claystone, blocky, soft, sl. silty, sl. calc., minor cavings, medium light grey to light grey	N6-7	0.98
		B 30% LCM - lignite Minor sand		
1189-210	4705-720m	A 98% Sand, unconsolidated, medium grained, subangular to subrounded, fairly well sorted, clear, white Minor shale and claystone Minor LCM - lignite	N9	
1189-211	4720-735m	A 98% Sand, as 1189-210A Minor shale LCM - lignite	N9	
1189-212	4735-750m	A 98% Sand, as 1189-210A Minor shale LCM - lignite	N9	
1189-213	4750-765m	A 98% Sand, as 1189-210A Minor LCM	N9	
1189-219 (CORE MUD?, CORE 3?)	DEPTH OBSCURED	A 65% Shale, platy, mod. hard, non-calc., sig. cavings, medium dark grey	N4	3.37
		B 20% Silty shale, blocky to subfissile, mod. hard, non-calc., sig. cavings, olive grey	5YR4/1	1.96,1.95
		C 15% LCM - lignite and cement? Minor sand		

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 2A

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN AIR SPACE GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-019	740-770	3024	3	10	0	1	3038	15	0.5	8	0.15
1189-022	830-860	1860	7	23	0	0	1890	31	1.6	13	2.39
1189-026	950-980	20	1	3	0	0	24	4	15.2	23	0.64
1189-029	1040-1070	2200	1	19	1	1	2223	23	1.0	12	1.09
1189-032	1130-1160	894	1	22	0	0	917	23	2.5	26	0.78
1189-036	1250-1280	90	18	18	0	0	126	36	28.7	2	1.06
1189-039	1340-1370	23	1	1	0	0	26	3	11.7	9	1.04
1189-042	1430-1460	14	0	0	0	0	15	1	5.9	4	1.66
1189-046	1550-1580	252	1	13	1	0	267	14	5.4	7	1.98
1189-049	1640-1670	53	2	1	0	0	57	3	5.5	2	1.17
1189-052	1730-1760	3	0	1	0	0	4	1	22.4	20	0.94
1189-056	1850-1880	238	31	10	5	3	286	49	16.9	2	1.83
1189-059	1940-1970	415	230	97	44	55	841	426	50.6	39	0.79
1189-060	1970-2000	1492	152	79	21	40	1784	292	16.4	41	0.53
1189-061	2000-2030	4647	1059	1041	483	1088	8318	3671	44.1	1423	0.44
1189-062	2030-2060	5648	1647	1914	555	1497	11260	5612	49.8	1552	0.37
1189-063	2060-2090	1332	534	549	179	429	3024	1692	56.0	670	0.42
1189-064	2090-2120	777	203	207	55	138	1380	603	43.7	212	0.40
1189-065	2120-2150	307	99	107	27	56	596	289	48.5	99	0.47
1189-066	2150-2180	358	107	74	15	42	596	238	39.9	75	0.36
1189-067	2180-2210	523	58	66	20	47	713	190	26.7	71	0.42
1189-068	2210-2240	547	91	108	39	55	841	294	34.9	211	0.72
1189-069	2240-2270	8	1	1	0	0	10	3	26.5	9	0.53
1189-070	2270-2300	2872	356	525	142	96	3990	1119	28.0	1285	1.48
1189-071	2300-2330	952	123	269	122	134	1601	648	40.5	451	0.91
1189-072	2330-2360	766	121	226	94	98	1305	539	41.3	265	0.96
1189-073	2360-2390	2102	469	500	199	142	3411	1309	38.4	844	1.40
1189-074	2390-2420	1099	230	440	167	173	2110	1011	47.9	658	0.96
1189-075	2420-2450	1114	141	187	63	66	1570	456	29.1	351	0.95
1189-076	2450-2480	1120	91	238	42	42	1534	413	26.9	415	1.00

TABLE 2A

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN AIR SPACE GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-077	2480-2510	1104	79	84	37	36	1340	237	17.7	221	1.04
1189-078	2510-2540	939	67	76	30	36	1148	209	18.2	220	0.82
1189-079	2540-2570	896	64	61	23	25	1069	173	16.2	142	0.94
1189-081	2570-2600	80	19	22	9	8	138	58	42.2	55	1.08
1189-082	2600-2630	14	1	1	1	1	17	4	21.3	8	1.05
1189-083	2630-2660	0	0	0	0	0	0	0	60.0	0	0.93
1189-084	2660-2690	69	4	3	4	6	85	16	19.1	44	0.67
1189-085	2690-2720	136	69	21	4	6	237	101	42.6	97	0.69
1189-087	2720-2750	552	278	100	14	32	977	425	43.5	372	0.45
1189-088	2750-2780	14	1	3	0	3	21	7	31.6	25	0.11
1189-090	2780-2810	1	0	2	1	0	4	3	67.8	5	1.52
1189-091	2810-2840	0	0	0	0	0	0	0	60.0	0	0.93
1189-093	2840-2870	26	3	8	3	4	44	18	40.6	15	0.57
1189-094	2870-2900	57	1	16	4	9	88	30	34.4	53	0.45
1189-095	2900-2930	2	1	0	0	0	4	2	57.5	2	1.08
1189-097	2930-2960	8	3	1	1	1	12	5	38.8	6	1.05
1189-100	2960-2990	1285	176	266	65	59	1851	566	30.6	272	1.11
1189-101	2990-3020	20	8	3	8	1	40	21	51.3	8	8.12
1189-103	3020-3050	3785	62	194	57	107	4205	420	10.0	200	0.53
1189-104	3050-3080	367	79	214	70	134	863	496	57.5	299	0.52
1189-106	3080-3110	594	88	228	60	123	1094	500	45.7	232	0.49
1189-107	3120-3135	815	204	719	167	194	2098	1283	61.2	605	0.86
1189-109	3150-3165	467	109	390	101	207	1273	807	63.4	350	0.49
1189-111	3180-3195	405	96	217	42	156	917	512	55.8	69	0.27
1189-113	3210-3220	475	164	395	75	141	1250	775	62.0	91	0.53
1189-115	3235-3250	274	32	83	34	54	477	203	42.6	97	0.63
1189-117	3267-3280	217	33	113	40	63	466	249	53.4	132	0.64
1189-119	3295-3310	0	0	0	0	0	0	0	61.3	0	0.54
1189-121	3325-3340	216	45	170	51	94	576	360	62.6	37	0.55
1189-123	3355-3370	32	4	19	7	12	74	42	56.7	26	0.53

TABLE 2A

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN AIR SPACE GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-125	3400	95	15	72	17	43	241	147	60.8	86	0.40
1189-127	3430	594	229	566	94	269	1753	1158	66.1	309	0.35
1189-129	3460	45	1164	16	6	16	1247	1202	96.4	50	0.38
1189-132	3490-3505	3804	246	2009	400	1282	7740	3937	50.9	1293	0.31
1189-133	3520	0	0	0	0	0	0	0	61.3	0	0.54
1189-135	3550	456	61	132	28	70	746	290	38.9	233	0.40
1189-137	3580	0	0	0	0	0	0	0	61.3	0	0.54
1189-140	3610-3625	770	201	463	83	197	1713	943	55.0	441	0.42
1189-141	3625-3640	929	306	1066	248	633	3183	2254	70.8	1059	0.39
1189-143	3670	1022	84	502	159	570	2336	1315	56.3	882	0.28
1189-145	3700	5128	491	1000	175	547	7342	2213	30.2	891	0.32
1189-147	3730	4069	962	1723	216	445	7416	3347	45.1	856	0.48
1189-149	3760	2317	785	1231	163	503	4998	2681	53.6	383	0.32
1189-151	3790	2245	977	2431	437	1344	7435	5190	69.8	2286	0.33
1189-153	3820	3967	655	1700	315	974	7612	3645	47.9	1682	0.32
1189-155	3850	2822	991	3828	800	2640	11081	8259	74.5	3837	0.30
1189-156	3865-3880	4596	4271	5364	1068	3336	18635	14039	75.3	3239	0.32
1189-157	3880-3895	314	293	433	81	258	1379	1065	77.2	260	0.31
1189-158	3895-3910	3944	2768	3158	737	2516	13123	9179	69.9	2126	0.29
1189-159	3910-3925	21341	13236	16449	4373	16007	71407	50065	70.1	5642	0.27
1189-160	3925-3940	904	535	1289	212	494	3432	2529	73.7	977	0.43
1189-161	3940-3955	1115	501	1212	192	594	3614	2499	69.1	1077	0.32
1189-162	3955-3970	1567	439	1193	237	841	4276	2710	63.4	1767	0.28
1189-163	3970-3985	6424	2813	6597	1052	4376	21262	14838	69.8	3698	0.24
1189-164	3985-4000	0	0	0	0	0	0	0	61.3	0	0.54
1189-165	4000-4015	625	189	342	65	292	1513	888	58.7	432	0.22
1189-166	4015-4030	2026	1013	1545	248	395	5226	3200	61.2	1045	0.63
1189-167	4030-4045	1655	756	1206	207	632	4456	2801	62.9	855	0.33
1189-168	4045-4060	1306	768	897	116	272	3359	2053	61.1	445	0.43
1189-169	4060-4075	5076	2539	2250	340	660	10864	5788	53.3	819	0.52
1189-170	4075-4090	2314	1376	1555	251	444	5941	3626	61.0	797	0.56

TABLE 2A

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN AIR SPACE GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-179	4105-4120	29493	15549	7975	1042	2249	56308	26815	47.6	2856	0.46
1189-180	4120-4130	12170	7249	4549	503	1646	26118	13948	53.4	1603	0.31
1189-214	4145-4167	5507	4752	3072	440	813	14584	9077	62.2	625	0.54
1189-215	4170-4180	3293	4741	6670	908	2639	18250	14957	82.0	3433	0.34
1189-216	4180-4195	555	410	990	168	577	2700	2145	79.4	840	0.29
1189-181	4212-4225	35065	18462	7640	902	1165	63234	28169	44.5	2452	0.77
1189-182	4225-4240	30776	15445	9063	1278	2533	59095	28319	47.9	5363	0.50
1189-183	4240-4255	12271	9277	10672	1914	4476	38610	26339	68.2	7289	0.43
1189-217	4255-4270	1565	604	471	78	158	2875	1311	45.6	356	0.50
1189-218	4280-4300	4	1	1	0	0	6	3	40.8	1	0.42
1189-184	4310-4330	897	300	187	33	59	1476	579	39.2	89	0.57
1189-186	4330-4345	103	38	48	13	32	234	131	56.1	51	0.39
1189-187	4345-4360	1226	488	515	132	200	2560	1334	52.1	490	0.66
1189-188	4360-4375	678	391	415	106	152	1742	1064	61.1	300	0.70
1189-189	4375-4390	0	0	0	0	0	0	0	76.0	0	0.43
1189-190	4390-4405	3	1	2	1	2	8	5	58.8	3	0.47
1189-191	4405-4420	31	18	38	9	33	130	99	75.9	47	0.27
1189-192	4420-4435	179	102	35	3	5	323	145	44.7	7	0.68
1189-193	4435-4450	0	0	0	0	0	0	0	76.0	0	0.43
1189-194	4450-4465	525	325	301	60	138	1349	824	61.1	322	0.44
1189-195	4465-4480	12	3	5	1	3	24	12	51.7	13	0.42
1189-196	4480-4495	16	6	8	1	2	33	17	52.1	18	0.66
1189-197	4495-4510	434	261	304	71	170	1240	806	65.0	360	0.42
1189-198	4510-4525	99	67	86	12	27	291	192	66.0	77	0.45
1189-199	4525-4540	21	12	10	5	7	54	33	61.3	88	0.66
1189-200	4540-4555	1800	583	697	256	345	3682	1881	51.1	925	0.74
1189-201	4555-4570	497	127	160	74	108	966	469	48.6	239	0.69
1189-202	4570-4585	138	57	97	49	84	425	287	67.5	220	0.58
1189-203	4585-4600	660	136	135	42	52	1026	365	35.6	90	0.82

TABLE 2A

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN AIR SPACE GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-204	4600-4615	614	146	141	42	75	1019	404	39.7	116	0.57
1189-205	4615-4630	481	214	341	126	193	1355	873	64.5	206	0.66
1189-206	4630-4645	7	2	2	1	2	15	8	52.2	14	0.72
1189-207	4645-4660	139	25	27	8	21	219	80	36.7	14	0.38
1189-208	4660-4675	221	51	57	20	19	367	147	39.9	43	1.06
1189-209	4690-4705	263	46	41	11	11	372	108	29.2	26	1.00
1189-210	4705-4720	0	0	0	0	0	0	0	5.8	2	0.59
1189-211	4720-4735	4218	1051	96	10	8	5382	1164	21.6	15	1.30
1189-212	4735-4750	3785	1033	91	12	7	4928	1143	23.2	19	1.64
1189-213	4750-4765	6075	1093	123	16	22	7328	1253	17.1	36	0.75
1189-219	DEPTH OBSCURED	2347	2990	4110	593	1399	11439	9092	79.5	2062	0.42

TABLE 2B

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN CUTTING GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-019	740-770	88	0	1	0	0	90	2	2.2	5	0.43
1189-022	830-860	121	4	9	1	0	134	14	10.1	4	1.47
1189-026	950-980	22	8	1	0	0	32	10	32.1	6	0.57
1189-029	1040-1070	365	3	1	0	0	369	4	1.2	5	1.69
1189-032	1130-1160	112	8	7	1	1	129	16	12.6	3	1.18
1189-036	1250-1280	8	3	2	1	0	14	6	42.4	4	1.46
1189-039	1340-1370	4	13	2	0	0	19	15	80.0	9	2.06
1189-042	1430-1460	6	2	0	0	0	8	2	26.8	9	1.23
1189-046	1550-1580	163	3	3	0	0	170	6	3.8	5	1.87
1189-049	1640-1670	11	0	1	0	0	12	1	7.5	38	1.59
1189-052	1730-1760	8	1	1	0	0	10	3	26.6	3	0.88
1189-056	1850-1880	27	4	4	2	4	40	13	31.7	11	0.49
1189-059	1940-1970	393	203	296	40	64	996	603	60.5	228	0.63
1189-060	1970-2000	16	5	12	0	16	49	33	67.4	37	0.01
1189-061	2000-2030	1187	453	54	20	30	1743	556	31.9	803	0.67
1189-062	2030-2060	745	296	18	37	91	1186	442	37.2	435	0.41
1189-063	2060-2090	990	425	104	41	108	1668	678	40.6	645	0.38
1189-064	2090-2120	722	355	123	8	34	1242	520	41.8	285	0.23
1189-065	2120-2150	427	185	139	19	30	801	373	46.6	163	0.64
1189-066	2150-2180	274	104	54	3	5	439	165	37.7	40	0.55
1189-067	2180-2210	555	234	92	22	26	929	373	40.2	198	0.83
1189-068	2210-2240	696	355	145	14	15	1226	530	43.2	300	0.94
1189-069	2240-2270	2494	1115	477	46	63	4194	1701	40.5	1746	0.74
1189-070	2270-2300	1232	562	371	90	100	2356	1123	47.7	393	0.90
1189-071	2300-2330	1725	714	349	80	102	2971	1246	41.9	835	0.79
1189-072	2330-2360	1347	554	132	57	107	2197	850	38.7	1002	0.53
1189-073	2360-2390	1452	564	290	14	15	2336	884	37.8	854	0.92
1189-074	2390-2420	477	202	57	27	30	792	315	39.8	286	0.90
1189-075	2420-2450	1484	584	339	13	14	2433	949	39.0	681	0.89
1189-076	2450-2480	2456	949	643	51	34	4133	1677	40.6	1010	1.49

TABLE 2B

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN CUTTING GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-077	2480-2510	793	308	148	16	76	1341	547	40.8	482	0.21
1189-078	2510-2540	432	343	122	69	313	1278	847	66.2	296	0.22
1189-079	2540-2570	583	239	58	10	21	910	328	36.0	375	0.46
1189-081	2570-2600	746	329	54	32	121	1283	537	41.8	530	0.27
1189-082	2600-2630	1199	584	141	160	396	2481	1281	51.7	874	0.40
1189-083	2630-2660	2386	1000	228	163	1128	4905	2518	51.3	1895	0.14
1189-084	2660-2690	7652	3665	394	277	2968	14956	7304	48.8	6731	0.09
1189-085	2690-2720	3226	1576	176	102	548	5628	2402	42.7	2108	0.19
1189-087	2720-2750	3172	1538	165	77	690	5641	2469	43.8	2831	0.11
1189-088	2750-2780	2708	1491	204	89	295	4787	2078	43.4	2520	0.30
1189-090	2780-2810	6591	1568	852	196	880	10086	3495	34.7	4240	0.22
1189-091	2810-2840	3127	1533	186	64	214	5123	1997	39.0	2744	0.30
1189-093	2840-2870	1623	844	209	88	553	3317	1694	51.1	1960	0.16
1189-094	2870-2900	13014	5533	495	360	1368	20770	7756	37.3	8762	0.26
1189-095	2900-2930	1103	663	267	27	174	2235	1131	50.6	845	0.16
1189-097	2930-2960	1450	811	84	41	277	2663	1213	45.6	1167	0.15
1189-100	2960-2990	104	1	1	0	2	107	3	3.0	314	0.17
1189-101	2990-3020	65	14	8	1	10	98	33	33.8	44	0.11
1189-103	3020-3050	1127	365	225	113	338	2168	1041	48.0	1249	0.33
1189-104	3050-3080	1	1	2	1	0	5	4	87.3	28	2.54
1189-106	3080-3110	283	518	305	201	614	1921	1638	85.3	286	0.33
1189-107	3120-3135	73	28	48	18	178	345	273	79.0	2563	0.10
1189-109	3150-3165	123	72	171	19	24	409	286	69.9	869	0.81
1189-111	3180-3195	302	79	155	41	33	610	308	50.5	231	1.27
1189-113	3210-3220	437	86	247	82	12	864	427	49.4	289	6.57
1189-115	3235-3250	140	113	88	34	72	447	307	68.6	487	0.48
1189-117	3267-3280	240	268	965	50	51	1574	1333	84.7	37	0.99
1189-119	3295-3310	491	433	124	67	46	1162	671	57.7	378	1.47
1189-121	3325-3340	661	397	268	58	60	1443	783	54.2	383	0.96
1189-123	3355-3370	351	498	157	45	84	1135	784	69.1	517	0.53

TABLE 2B

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN CUTTING GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-125	3400	802	354	376	104	377	2014	1211	60.1	1618	0.28
1189-127	3430	1173	398	562	155	632	2921	1747	59.8	1183	0.24
1189-129	3460	2064	671	664	264	1106	4770	2705	56.7	13975	0.24
1189-132	3490-3505	10541	2294	3487	1924	7347	25593	15052	58.8	30578	0.26
1189-133	3520	7293	2107	3831	2058	6972	22261	14968	67.2	31178	0.30
1189-135	3550	11998	4191	8301	4263	14446	43199	31201	72.2	40260	0.30
1189-137	3580	10154	2511	3086	1716	6165	23633	13479	57.0	27711	0.28
1189-140	3610-3625	8230	1886	2214	1173	4498	18002	9772	54.3	20182	0.26
1189-141	3625-3640	6120	1603	2390	1384	3850	15348	9227	60.1	14963	0.36
1189-143	3670	13360	4908	13979	7729	24982	64958	51598	79.4	47224	0.31
1189-145	3700	453	81	570	204	1262	2572	2119	82.4	9966	0.16
1189-147	3730	56	18	127	90	575	866	810	93.6	12944	0.16
1189-149	3760	50	98	638	200	1183	2169	2119	97.7	9276	0.17
1189-151	3790	182	267	2692	1228	6082	10451	10269	98.3	29288	0.20
1189-153	3820	160	43	276	176	1112	1768	1608	90.9	16266	0.16
1189-155	3850	93	58	814	522	3183	4671	4578	98.0	25934	0.16
1189-156	3865-3880	349	574	4302	1879	7163	14267	13919	97.6	30118	0.26
1189-157	3880-3895	234	529	4582	2612	7792	15748	15514	98.5	32401	0.34
1189-158	3895-3910	1150	3448	3191	7481	6942	22211	21062	94.8	6983	1.08
1189-159	3910-3925	626	1322	5486	3640	8774	19848	19223	96.8	36278	0.41
1189-160	3925-3940	284	418	3467	1003	5245	10417	10133	97.3	21345	0.19
1189-161	3940-3955	364	152	1438	542	3437	5933	5569	93.9	22688	0.16
1189-162	3955-3970	331	253	2299	639	3335	6856	6525	95.2	14674	0.19
1189-163	3970-3985	305	385	2795	722	3511	7718	7413	96.0	16102	0.21
1189-164	3985-4000	380	340	2778	1057	4767	9322	8942	95.9	23661	0.22
1189-165	4000-4015	718	720	3065	807	4025	9336	8618	92.3	17263	0.20
1189-166	4015-4030	365	280	1583	451	2717	5397	5032	93.2	14265	0.17
1189-167	4030-4045	598	459	2341	659	3449	7507	6909	92.0	17156	0.19
1189-168	4045-4060	474	871	2759	563	2768	7436	6961	93.6	8699	0.20
1189-169	4060-4075	937	1146	3537	744	3120	9484	8547	90.1	8948	0.24
1189-170	4075-4090	2133	500	1813	530	1958	6933	4800	69.2	11401	0.27

TABLE 2B

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN CUTTING GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-179	4105-4120	4091	3628	3159	673	2666	14217	10125	71.2	16766	0.25
1189-180	4120-4130	1328	3363	4314	1032	4058	14095	12766	90.6	16306	0.25
1189-214	4145-4167	1564	1817	3220	763	3074	10437	8873	85.0	11562	0.25
1189-215	4170-4180	237	722	2132	413	1917	5421	5184	95.6	7690	0.22
1189-216	4180-4195	296	495	1275	184	825	3075	2779	90.4	6658	0.22
1189-181	4212-4225	4887	4322	3774	603	2158	15744	10858	69.0	12756	0.28
1189-182	4225-4240	1177	2590	2889	472	1660	8788	7611	86.6	9666	0.28
1189-183	4240-4255	83	60	134	38	126	440	357	81.1	626	0.30
1189-217	4255-4270	153	259	373	53	223	1061	909	85.6	2764	0.24
1189-218	4280-4300	317	144	211	38	150	859	542	63.1	2302	0.26
1189-184	4310-4330	168	84	85	20	51	407	240	58.8	637	0.38
1189-186	4330-4345	255	233	501	130	465	1583	1328	83.9	2069	0.28
1189-187	4345-4360	174	111	230	61	208	784	610	77.9	2277	0.29
1189-188	4360-4375	212	63	214	78	283	850	638	75.1	1859	0.28
1189-189	4375-4390	161	120	403	102	386	1173	1012	86.3	2356	0.26
1189-190	4390-4405	73	42	127	41	152	435	362	83.2	2039	0.27
1189-191	4405-4420	120	77	269	86	305	856	736	86.0	4285	0.28
1189-192	4420-4435	473	417	554	145	383	1972	1499	76.0	4735	0.38
1189-193	4435-4450	888	363	380	44	131	1807	918	50.8	1622	0.33
1189-194	4450-4465	238	161	327	76	329	1132	894	79.0	2660	0.23
1189-195	4465-4480	964	914	1226	257	871	4231	3267	77.2	3989	0.29
1189-196	4480-4495	768	565	1101	245	1041	3720	2952	79.3	5990	0.24
1189-197	4495-4510	193	55	136	50	205	639	446	69.8	5442	0.25
1189-198	4510-4525	146	290	417	110	346	1310	1164	88.9	4626	0.32
1189-199	4525-4540	190	28	40	16	34	307	118	38.2	1684	0.46
1189-200	4540-4555	105	30	89	70	160	453	348	76.8	2274	0.44
1189-201	4555-4570	129	28	75	47	112	391	262	67.0	2636	0.42
1189-202	4570-4585	136	37	133	98	182	587	450	76.8	2167	0.54
1189-203	4585-4600	82	32	80	53	104	352	270	76.6	1994	0.52

TABLE 2B

CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN CUTTING GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-204	4600-4615	81	31	91	69	133	405	323	79.9	2254	0.52
1189-205	4615-4630	107	46	145	101	169	569	462	81.2	1971	0.60
1189-206	4630-4645	10	7	23	26	37	103	93	90.5	764	0.72
1189-207	4645-4660	51	17	34	22	34	158	107	67.7	1049	0.65
1189-208	4660-4675	31	11	32	17	25	116	85	73.4	1001	0.65
1189-209	4690-4705	75	11	17	10	18	131	56	43.0	899	0.57
1189-210	4705-4720	353	345	88	11	12	808	455	56.3	1070	0.95
1189-211	4720-4735	265	190	22	2	3	481	216	44.9	778	0.62
1189-212	4735-4750	701	870	126	6	8	1710	1009	59.0	788	0.73
1189-213	4750-4765	279	71	25	7	9	391	112	28.7	489	0.71
1189-219	DEPTH OBSCURED	322	556	2336	603	3088	6906	6584	95.3	15120	0.20

TABLE 2 C

TOTAL CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS (2A + 2B)

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-019	740-770	3112	4	12	0	1	3128	17	0.5	14	0.19
1189-022	830-860	1980	11	32	1	1	2025	44	2.2	16	1.73
1189-026	950-980	42	9	4	0	1	56	14	24.9	29	0.59
1189-029	1040-1070	2565	4	20	2	1	2592	27	1.0	17	1.21
1189-032	1130-1160	1007	9	29	1	1	1046	39	3.8	29	1.07
1189-036	1250-1280	98	21	20	1	1	140	42	30.1	6	1.35
1189-039	1340-1370	27	14	3	1	0	45	18	40.6	18	1.38
1189-042	1430-1460	20	2	1	0	0	23	3	13.3	12	1.37
1189-046	1550-1580	415	4	15	1	0	436	21	4.8	12	1.95
1189-049	1640-1670	65	2	2	0	0	69	4	5.9	39	1.38
1189-052	1730-1760	11	1	2	0	0	15	4	25.4	23	0.89
1189-056	1850-1880	265	35	14	7	6	327	61	18.8	13	1.07
1189-059	1940-1970	808	433	393	84	119	1836	1028	56.0	267	0.70
1189-060	1970-2000	1508	157	90	21	56	1832	324	17.7	77	0.38
1189-061	2000-2030	5834	1512	1095	503	1118	10061	4227	42.0	2226	0.45
1189-062	2030-2060	6393	1943	1932	592	1587	12447	6054	48.6	1988	0.37
1189-063	2060-2090	2322	959	653	220	537	4692	2370	50.5	1314	0.41
1189-064	2090-2120	1500	557	330	63	172	2622	1122	42.8	496	0.37
1189-065	2120-2150	734	284	246	46	87	1396	662	47.4	262	0.53
1189-066	2150-2180	632	211	128	18	46	1035	403	39.0	114	0.38
1189-067	2180-2210	1078	292	157	42	73	1642	564	34.3	268	0.57
1189-068	2210-2240	1243	446	254	54	70	2067	823	39.8	511	0.76
1189-069	2240-2270	2501	1116	478	47	63	4205	1703	40.5	1755	0.74
1189-070	2270-2300	4104	918	896	232	196	6346	2242	35.3	1678	1.18
1189-071	2300-2330	2677	837	618	202	236	4572	1895	41.4	1285	0.86
1189-072	2330-2360	2113	675	359	150	205	3502	1389	39.7	1267	0.73
1189-073	2360-2390	3554	1033	790	213	157	5747	2193	38.2	1698	1.35
1189-074	2390-2420	1576	432	497	194	203	2902	1326	45.7	944	0.96
1189-075	2420-2450	2598	724	526	75	80	4003	1406	35.1	1033	0.94
1189-076	2450-2480	3576	1040	881	93	76	5666	2090	36.9	1425	1.22

TABLE 2 C

TOTAL CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS (2A + 2B)

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-077	2480-2510	1897	387	232	53	112	2681	784	29.3	703	0.48
1189-078	2510-2540	1371	410	198	99	350	2427	1056	43.5	516	0.28
1189-079	2540-2570	1479	303	119	33	45	1979	500	25.3	518	0.72
1189-081	2570-2600	826	348	76	41	129	1420	595	41.9	585	0.32
1189-082	2600-2630	1213	585	143	161	397	2498	1285	51.5	882	0.40
1189-083	2630-2660	2386	1000	228	163	1128	4905	2518	51.3	1895	0.14
1189-084	2660-2690	7721	3668	397	281	2974	15040	7320	48.7	6775	0.09
1189-085	2690-2720	3362	1644	197	107	555	5865	2503	42.7	2205	0.19
1189-087	2720-2750	3724	1816	265	91	721	6618	2894	43.7	3203	0.13
1189-088	2750-2780	2723	1491	207	90	297	4808	2085	43.4	2545	0.30
1189-090	2780-2810	6593	1568	854	196	880	10091	3498	34.7	4244	0.22
1189-091	2810-2840	3127	1533	186	64	214	5123	1997	39.0	2744	0.30
1189-093	2840-2870	1650	848	216	91	557	3362	1712	50.9	1975	0.16
1189-094	2870-2900	13072	5534	511	364	1377	20858	7786	37.3	8816	0.26
1189-095	2900-2930	1105	664	268	28	175	2238	1134	50.6	847	0.16
1189-097	2930-2960	1457	813	85	42	277	2675	1218	45.5	1174	0.15
1189-100	2960-2990	1388	176	267	66	60	1958	569	29.1	585	1.09
1189-101	2990-3020	84	21	12	10	11	138	54	38.9	52	0.85
1189-103	3020-3050	4912	427	419	170	445	6374	1461	22.9	1449	0.38
1189-104	3050-3080	367	79	216	71	134	868	501	57.7	327	0.53
1189-106	3080-3110	876	607	533	261	737	3014	2138	70.9	518	0.35
1189-107	3120-3135	888	232	768	184	372	2444	1556	63.7	3167	0.50
1189-109	3150-3165	590	181	561	121	231	1682	1093	65.0	1219	0.52
1189-111	3180-3195	707	175	372	83	189	1526	820	53.7	300	0.44
1189-113	3210-3220	912	250	643	157	153	2114	1202	56.9	380	1.02
1189-115	3235-3250	414	145	171	69	126	924	510	55.2	584	0.54
1189-117	3267-3280	458	301	1078	91	113	2040	1582	77.6	169	0.80
1189-119	3295-3310	491	433	124	67	46	1162	671	57.7	378	1.47
1189-121	3325-3340	876	442	438	109	154	2019	1143	56.6	420	0.71
1189-123	3355-3370	383	502	176	52	96	1209	826	68.3	543	0.53

TABLE 2 C

TOTAL CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS (2A + 2B)

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-125	3400	897	368	447	121	421	2255	1358	60.2	1704	0.29
1189-127	3430	1768	628	1128	249	901	4673	2905	62.2	1492	0.28
1189-129	3460	2110	1835	680	270	1122	6017	3907	64.9	14025	0.24
1189-132	3490-3505	14345	2540	5496	2324	8629	33333	18988	57.0	31872	0.27
1189-133	3520	7293	2107	3831	2058	6972	22261	14968	67.2	31178	0.30
1189-135	3550	12454	4252	8433	4291	14516	43945	31491	71.7	40494	0.30
1189-137	3580	10154	2511	3086	1716	6165	23633	13479	57.0	27711	0.28
1189-140	3610-3625	9000	2087	2677	1256	4695	19715	10714	54.3	20623	0.27
1189-141	3625-3640	7049	1910	3456	1632	4483	18531	11481	62.0	16022	0.36
1189-143	3670	14382	4992	14481	7887	25552	67294	52913	78.6	48105	0.31
1189-145	3700	5581	572	1571	380	1809	9913	4332	43.7	10857	0.21
1189-147	3730	4125	980	1851	306	1020	8282	4157	50.2	13800	0.30
1189-149	3760	2367	882	1869	363	1686	7167	4800	67.0	9659	0.22
1189-151	3790	2428	1244	5123	1665	7426	17886	15459	86.4	31574	0.22
1189-153	3820	4127	698	1977	491	2086	9380	5252	56.0	17948	0.24
1189-155	3850	2915	1049	4642	1322	5823	15751	12836	81.5	29772	0.23
1189-156	3865-3880	4945	4845	9666	2947	10499	32902	27957	85.0	33357	0.28
1189-157	3880-3895	548	822	5015	2692	8050	17127	16579	96.8	32661	0.33
1189-158	3895-3910	5094	6216	6349	8218	9458	35335	30241	85.6	9109	0.87
1189-159	3910-3925	21967	14558	21935	8014	24781	91255	69288	75.9	41921	0.32
1189-160	3925-3940	1187	953	4756	1215	5739	13850	12662	91.4	22323	0.21
1189-161	3940-3955	1479	653	2650	734	4032	9547	8069	84.5	23765	0.18
1189-162	3955-3970	1898	692	3492	876	4176	11133	9235	83.0	16441	0.21
1189-163	3970-3985	6730	3198	9393	1774	7887	28981	22251	76.8	19800	0.22
1189-164	3985-4000	380	340	2778	1057	4767	9322	8942	95.9	23661	0.22
1189-165	4000-4015	1343	909	3407	872	4318	10849	9506	87.6	17695	0.20
1189-166	4015-4030	2391	1293	3128	699	3112	10623	8232	77.5	15310	0.22
1189-167	4030-4045	2253	1215	3547	867	4081	11963	9710	81.2	18010	0.21
1189-168	4045-4060	1780	1639	3655	679	3041	10795	9014	83.5	9144	0.22
1189-169	4060-4075	6013	3685	5786	1084	3780	20348	14335	70.4	9767	0.29
1189-170	4075-4090	4447	1876	3368	781	2420	12873	8426	65.5	12198	0.33

TABLE 2 C

TOTAL CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS (2A + 2B)

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-179	4105-4120	33584	19177	11134	1715	4914	70525	36941	52.4	19623	0.35
1189-180	4120-4130	13498	10612	8863	1535	5704	40213	26714	66.4	17909	0.27
1189-214	4145-4167	7071	6569	6292	1203	3887	25021	17950	71.7	12187	0.31
1189-215	4170-4180	3530	5463	8802	1320	4556	23671	20141	85.1	11123	0.29
1189-216	4180-4195	851	905	2265	352	1402	5775	4924	85.3	7497	0.25
1189-181	4212-4225	39951	22784	11414	1506	3323	78978	39026	49.4	15208	0.45
1189-182	4225-4240	31953	18034	11953	1750	4193	67883	35930	52.9	15029	0.42
1189-183	4240-4255	12354	9336	10806	1952	4601	39050	26695	68.4	7915	0.42
1189-217	4255-4270	1717	863	844	132	381	3936	2219	56.4	3120	0.35
1189-218	4280-4300	320	145	211	38	150	865	545	63.0	2303	0.26
1189-184	4310-4330	1065	384	271	53	110	1883	819	43.5	726	0.48
1189-186	4330-4345	358	271	549	142	497	1817	1460	80.3	2120	0.29
1189-187	4345-4360	1400	599	744	193	408	3344	1944	58.1	2767	0.47
1189-188	4360-4375	890	454	628	185	436	2592	1703	65.7	2159	0.42
1189-189	4375-4390	161	120	403	102	386	1173	1012	86.3	2356	0.26
1189-190	4390-4405	76	42	128	42	154	443	367	82.7	2042	0.27
1189-191	4405-4420	151	95	307	95	338	986	835	84.7	4332	0.28
1189-192	4420-4435	652	519	589	148	387	2295	1643	71.6	4742	0.38
1189-193	4435-4450	888	363	380	44	131	1807	918	50.8	1622	0.33
1189-194	4450-4465	763	486	629	136	467	2481	1718	69.3	2982	0.29
1189-195	4465-4480	976	917	1230	258	874	4255	3279	77.1	4002	0.30
1189-196	4480-4495	784	571	1109	246	1043	3753	2969	79.1	6007	0.24
1189-197	4495-4510	627	316	440	122	375	1879	1252	66.6	5802	0.32
1189-198	4510-4525	245	357	503	122	374	1600	1356	84.7	4703	0.33
1189-199	4525-4540	210	40	50	20	40	361	150	41.7	1772	0.50
1189-200	4540-4555	1906	613	785	326	505	4135	2229	53.9	3198	0.64
1189-201	4555-4570	626	155	235	121	219	1357	731	53.9	2874	0.55
1189-202	4570-4585	274	94	230	147	266	1012	737	72.9	2387	0.55
1189-203	4585-4600	742	169	215	96	155	1377	635	46.1	2084	0.62

TABLE 2C

TOTAL CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS (2A + 2B)

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
1189-204	4600-4615	696	176	232	111	208	1423	728	51.1	2369	0.54
1189-205	4615-4630	588	260	486	228	362	1923	1335	69.4	2177	0.63
1189-206	4630-4645	17	10	26	28	38	119	101	85.5	777	0.72
1189-207	4645-4660	190	42	60	30	54	377	187	49.7	1063	0.55
1189-208	4660-4675	252	62	89	37	44	483	232	47.9	1044	0.83
1189-209	4690-4705	338	57	58	21	29	503	165	32.8	925	0.73
1189-210	4705-4720	354	345	88	11	12	809	455	56.3	1072	0.95
1189-211	4720-4735	4483	1241	117	12	10	5863	1380	23.5	793	1.13
1189-212	4735-4750	4486	1902	216	18	15	6638	2152	32.4	807	1.17
1189-213	4750-4765	6354	1164	147	23	31	7719	1365	17.7	525	0.74
1189-219	DEPTH OBSCURED	2669	3547	6446	1195	4488	18345	15576	85.5	17182	0.27

TABLE 3

STANDARD PYROLYSIS DATA

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC CARBON	S1 (mg/g)	S2 (mg/g)	PRODUCTION INDEX	HYDROGEN INDEX	Tmax (°C)
1189-019A	740-770	0.62	0.12	0.42	0.22	67.7	427
1189-026B	950-980	0.91	0.16	0.76	0.17	83.5	418
1189-029A	1040-1070	1.17	0.21	1.18	0.15	100.9	412
1189-032A	1130-1160	1.22	0.23	1.30	0.15	106.6	407
1189-036B	1250-1280	1.19	0.11	1.75	0.06	147.1	425
1189-039A	1340-1370	1.39	0.11	1.44	0.07	103.6	426
1189-042A	1430-1460	1.08	0.09	0.70	0.11	64.8	422
1189-046A	1550-1580	0.77	0.08	0.39	0.17	50.6	417
1189-049A	1640-1670	0.48	0.04	0.20	0.17	41.7	399
1189-052A	1730-1760	0.46	0.03	0.20	0.13	43.5	422
1189-056A	1850-1880	0.36	0.05	0.14	0.26	38.9	423
1189-059B	1940-1970	0.62	0.04	0.27	0.13	43.5	422
1189-062A	2030-2060	0.44	0.03	0.14	0.18	31.8	421
1189-066A	2150-2180	0.49	0.05	0.21	0.19	42.9	412
1189-070A	2270-2300	0.49	0.08	0.23	0.26	46.9	420
1189-074A	2390-2420	0.46	0.05	0.16	0.24	34.8	422
1189-078A	2510-2540	0.54	0.06	0.22	0.21	40.7	427
1189-081A	2570-2600	0.58	0.04	0.25	0.14	43.1	425
1189-084A	2660-2690	0.52	0.05	0.16	0.24	30.8	423
1189-087A	2720-2750	0.50	0.06	0.15	0.29	30.0	422
1189-090A	2780-2810	0.65	0.08	0.27	0.23	41.5	422
1189-091A	2810-2840	0.64	0.11	0.27	0.29	42.2	419
1189-094A	2870-2900	0.78	0.27	0.57	0.32	73.1	422
1189-097A	2930-2960	0.54	0.07	0.17	0.29	31.5	414
1189-100A	2960-2990	0.66	0.07	0.21	0.25	31.8	419
1189-104A	3050-3080	0.62	0.06	0.18	0.25	29.0	421
1189-106A	3080-3110	0.65	0.09	0.22	0.29	33.8	427
1189-109A	3150-3165	0.73	0.17	0.32	0.35	43.8	427
1189-111A	3180-3195	0.79	0.15	0.45	0.25	57.0	428
1189-113A	3210-3220	0.82	0.15	0.48	0.24	58.5	422
1189-117A	3267-3280	0.62	0.14	0.24	0.37	38.7	427
1189-119A	3295-3310	0.73	0.19	0.35	0.35	47.9	424
1189-121A	3325-3340	0.72	0.16	0.26	0.38	36.1	423
1189-123A	3355-3370	0.67	0.20	0.33	0.38	49.3	419
1189-125B	3400	0.71	0.20	0.28	0.42	39.4	423
1189-127A	3430	0.66	0.17	0.26	0.40	39.4	430
1189-129A	3460	0.76	0.24	0.40	0.38	52.6	434
1189-132A	3490-3505	0.81	0.35	0.44	0.44	54.3	434
1189-135A	3550	0.85	1.18	1.19	0.50	140.0	416
1189-137A	3580	0.82	0.43	0.69	0.38	84.1	427
1189-140A	3610-3625	0.71	0.29	0.31	0.48	43.7	419
1189-143A	3670	0.86	1.42	2.17	0.40	252.3	403
1189-145A	3700	0.97	0.33	0.58	0.36	59.8	429
1189-149B	3760	0.69	0.19	0.35	0.35	50.7	439
1189-151A	3790	0.74	0.72	1.16	0.38	156.8	404
1189-153B	3820	1.16	0.35	0.71	0.33	61.2	443
1189-155A	3850	0.54	0.58	0.78	0.43	144.4	396
1189-156B	3865-3880	3.86	3.06	9.89	0.24	256.2	442
1189-158A	3895-3910	6.54	3.60	8.49	0.30	129.8	439
1189-159A	3910-3925	5.64	4.14	8.77	0.32	155.5	447
1189-161A	3940-3955	2.40	1.25	3.75	0.25	156.3	442

TABLE 3

STANDARD PYROLYSIS DATA

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC CARBON	S1 (mg/g)	S2 (mg/g)	PRODUCTION INDEX	HYDROGEN INDEX	Tmax (°C)
1189-163A	3970-3985	3.64	2.68	7.01	0.28	192.6	445
1189-166A	4015-4030	2.51	0.91	2.72	0.25	108.4	445
1189-168A	4045-4060	2.92	1.25	3.73	0.25	127.7	445
1189-170A	4075-4090	3.47	1.22	2.74	0.31	79.0	451
1189-179A	4105-4120	3.45	2.46	7.73	0.24	224.1	445
1189-180A	4120-30.5	2.91	1.86	6.17	0.23	212.0	448
1189-181A	4212-4225	2.55	11.38	4.42	0.72	173.3	444
1189-183A	4240-4255	3.42	2.01	6.27	0.24	183.3	445
1189-186A	4330-4345	2.21	0.70	1.47	0.32	66.5	444
1189-187A	4345-4360	1.57	0.45	0.70	0.39	44.6	450
1189-189A	4375-4390	1.60	0.39	0.69	0.36	43.1	429
1189-191B	4405-4420	1.41	0.62	0.87	0.42	61.7	427
1189-194B	4450-4465	1.48	0.49	0.89	0.36	60.1	419
1189-196A	4480-4495	2.02	0.92	2.06	0.31	102.0	440
1189-196B	4480-4495	3.24	2.32	7.44	0.24	229.6	441
1189-198A	4510-4525	1.48	0.58	1.04	0.36	70.3	448
1189-200A	4540-4555	1.47	2.02	1.23	0.62	83.7	441
1189-202A	4570-4585	1.95	1.84	1.43	0.56	73.3	433
1189-205A	4615-4630	1.76	2.16	1.51	0.59	85.8	432
1189-207A	4645-4660	1.69	1.53	1.14	0.57	67.5	424
1189-209A	4690-4705	0.98	1.47	0.84	0.64	85.7	418

TABLE 3a

STANDARD PYROLYSIS DATA
REPEAT ANALYSES AFTER EXTRACTION

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC CARBON	S1 (mg/g)	S2 (mg/g)	PRODUCTION INDEX	HYDROGEN INDEX	Tmax (°C)
1189-156B	3865-3880	3.86	0.27	6.13	0.04	158.8	445
1189-158A	3895-3910	6.54	0.42	3.27	0.11	50.0	444
1189-159A	3910-3925	5.64	0.63	4.95	0.11	87.8	435
1189-163A	3970-3985	3.64	0.21	3.60	0.06	98.9	444
1189-179A	4105-4120	3.45	0.28	3.81	0.07	110.4	446
1189-181A	4212-4225	2.55	0.40	3.55	0.10	139.2	450
1189-196B	4480-4495	3.24	0.33	3.54	0.09	109.3	446

TABLE 4
GAS – OIL INDEX

GEOCHEM SAMPLE NUMBER	DEPTH	DRY GAS	WET GAS	GASOLINES KEROSENES	GAS OIL DISTILLATE	GAS-OIL INDEX
		% C_1	% $C_2 - C_5$	% $C_6 - C_{14}$	% C_{15+}	$\frac{\% C_1 - C_5}{\text{TOTAL}}$
1189-156B	3865-880m	14.85	26.90	53.32	4.93	41.75
1189-159A	3910-925m	8.33	21.56	58.46	11.65	29.89
1189-163A	3970-985m	12.54	32.78	52.29	2.39	45.32
1189-168A	4045-060m	16.37	27.11	52.84	3.68	43.48
1189-179A	4105-120m	13.72	26.51	49.15	10.62	40.23
1189-180A	4120-130.5m	8.91	28.94	60.86	1.29	37.85
1189-183A	4240-255m	17.32	26.86	52.68	3.14	44.18
1189-196A	4480-495m	15.06	31.26	52.65	1.03	46.32
1189-196B	4480-495m	14.98	26.98	50.91	7.13	41.96
1189-200A	4540-555m	29.48	38.93	30.40	1.19	68.41
1189-205A	4615-630m	28.96	35.07	28.95	7.06	64.03

TABLE 5

KEROGEN TYPE AND MATURATION

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC MATTER DESCRIPTION					THERMAL MATURATION	
		TYPES >35%; 10-35%; <10%	REMARKS	RE-WORKED (%)	PARTICLE SIZE	PRESERV-ATION	THERMAL ALTERATION INDEX	1 – 10 SCALE
1189-019A	740-770m	W;H-I;Al-Am	dominant H at 2-	40	F-M/C	F-G	1+	1.5
1189-026B	950-980m	W;Al-I-H;Am	H at 2-	30	F-C	F-G	1+/1+ to 2-	1.8
1189-032A	1130-160m	W-Al;I-Am;H	sapropelisation	20	F-M	F-G	1+	1.5
1189-039A	1340-370m	W;Al-I-H-Am;-	H at 2-	30	F-M	F	1+	1.5
1189-046A	1550-580m	-;Al-W-H-I;Am	H at 2-	30	F-M	F-G	1+	1.5
1189-052A	1730-760m	-;Al-H-W-I;Am	lean, unreliable	30	F-M	F	1+ to 2-	2
1189-056A	1850-880m	Al;H-W-I;Am	fairly lean significant H at 2-	40	F-M	F	1+ to 2-(?)	2
1189-059B	1940-970m	-;Al-H-I-W;Am		25	F-M	F	1+ to 2-	2
1189-062A	2030-060m	I-W;H;Al-Am		70	F-M	F	1+ to 2-	2
1189-066A	2150-180m	I-W;Al-H;Am	material at 2- amorphous-like contamination	70	F-M	F	1+ to 2-(?)	2
1189-070A	2270-300m	I;W-H;Al-Am	**2- at best, possibly immature (1+ to 2-)	75	F-M	F-G	**	
1189-074A	2390-420m	-;I-Al-W-H;Am	material at 2-. Fairly lean	50	F-M	F-G	1+ to 2-(?)	2
1189-078A	2510-540m	I;W;H-Al	contamination H at 2- through 2	80	F-M/C	F	1+ to 2-/ 2-(?)	2.5
1189-084A	2660-690m	I;W;H-Al	**as 070A, further H at 2- to 2 and 2	90	F-M	G	**	
1189-087A	2720-750m	I;W;H-Al	H at 1+ to 2- through 2-	90	F-M	F-G	2- max (?)	3
1189-091A	2810-840m	I;W;Al-H		85	F-M	F	2-(?)	3
1189-097A	2930-960m	I;W;H-Al		90	M	F-G	2-	3

Algal, **A**morphous, **H**erbaceous, **I**nertinite, **R**esin, **W**ood

preservation = **P**oor, **F**air, **G**ood   size = **F**ine, **M**edium, **C**oarse

TA1 SCALE	1	1 + to 2–	2–	2	2 to 2+	2+ to 3–	3	3+	4	5
1 – 10 SCALE	1	2	3	4	5	6	7	8	9	10

GEOCHEM

TABLE 5

KEROGEN TYPE AND MATURATION

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC MATTER DESCRIPTION					THERMAL MATURATION	
		TYPES >35%; 10-35%; <10%	REMARKS	RE-WORKED (%)	PARTICLE SIZE	PRESERV-ATION	THERMAL ALTERATION INDEX	1 - 10 SCALE
1189-104A	3050-080m	I;W;H-Al		90	F-M	F	2-/2- to 2	3.3
1189-109A	3150-165m	I;W;H-Al	H at 2	90	M	F-G	2- to 2	3.5
1189-117A	3267-280m	I;W;H-Al-Am	lean	95	F-M	F-G	2- to 2	3.5
1189-123A	3355-370m	I-W;-;H-Am-Al		90	F-M/C	F-G	2- to 2	3.5
1189-127A	3430m	I-W;-;H-Al		90	M	F-G	2- to 2/2	3.8
1189-132A	3490-505m	I-W;-;H-Al-Am		90	F-M	F	2(?)	4
1189-135A	3550m	W*;I;H-Al-Am	*frequently resembles lignite **unreliable, H variable between 1+ to 2- through 2 but dominated by lignite derived material		F-C	F-G	**	
1189-140A	3610-625m	I;W;H-Al-Am	contamination and lignite	90	F-M/C	F-G	2(?)	4
1189-143A	3670m	I-W;-;Am-H-Al	contains lignite (additive) and amorphous-like contamination	90	F-M	F	2 to 2+(??)	5
1189-149B	3760m	I;W;H-Al-Am	H at 2 to 2+	80	F-C	G	2(?)	4
1189-156B	3865-880m	-;W**-Am*-I-Al*;H	**may include lignite *includes material passing to amorphous		M-C	F-G	2(?)	4
1189-159A	3910-925m	I;W-Am**-Al**;H	differentiation difficult, significant material at 2 to 2+. **not prime quality, includes material passing to amorphous	60	M-C	F	2(?)	4
1189-161A	3940-955m	W;I;H-Al-Am	resembles lignite	-	F-C	F-G	1+/1+ to 2-	1.8

Algal, **Am**orphous, **H**erbaceous, **I**nertinite, **R**esin, **W**ood

preservation = **P**oor, **F**air, **G**ood size = **F**ine, **M**edium, **C**oarse

TAI SCALE	1	1+ to 2-	2-	2	2 to 2+	2+ to 3-	3	3+	4	5
1 - 10 SCALE	1	2	3	4	5	6	7	8	9	10

GEOCHEM

TABLE 5

KEROGEN TYPE AND MATURATION

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC MATTER DESCRIPTION: TYPES >35%; 10-35%; <10%	REMARKS	RE-WORKED (%)	PARTICLE SIZE	PRESERV-ATION	THERMAL MATURATION: THERMAL ALTERATION INDEX	THERMAL MATURATION: 1 – 10 SCALE
1189-166A	4015-030m	I-W;-;Al-H-Am	contains significant lignite H at 2+	70	F-C	F-G	2 to 2+	5
1189-170A	4075-090m	-;Am**-I-W-Al**;H	**includes material passing to amorphous	35	F-M/C	F-G	2 to 2+	5
1189-180A	4120-130.5m	-;Am**-I-W-Al**;H	significant material at 2+ **as 170A differentiation difficult	35	M	F-G	2 to 2+(?)	5
1189-181A	4212-225m	-;Al**-Am**-I-W;H	**as 170A. Good H at 2+	35	F-VC	F-G	2 to 2+(?)	5
1189-186A	4330-345m	Am**;W-I;Al-H	**finely disseminated, not typically oil-prone	30	F-M	F	2 to 2+/ 2+(?)	5.5
1189-191B	4405-420m	-;I-W-Am**-Al**;H	minor lignite. **as 170A	40	F-C	F-G	2+ max	5.5
1189-196B	4480-495m	-;Am**-I-W-Al**;H	**as 170A	35	M	F	2+(?)	5.5
1189-202A	4510-585m	W**;Am**;I-H-Al	**resembles lignite *disseminated, unrecognisable, not typically oil-prone	-	F-C	F	---	
1189-207A	4645-660m	I-W;-;H-Am-Al	significant lignite	75	F-C	F-G	2+(?)	5.5
1189-209A	4690-705m	W;-;I-H-Am-Al	resembles lignite	-	F-C	G	1+/1+ to 2-	1.8

Algal, **Am**orphous, **H**erbaceous, **I**nertinite, **R**esin, **W**ood

preservation = **P**oor, **F**air, **G**ood   size = **F**ine, **M**edium, **C**oarse

TA1 SCALE	1	1+ to 2-	2-	2	2 to 2+	2+ to 3-	3	3+	4	5
1 – 10 SCALE	1	2	3	4	5	6	7	8	9	10

TABLE 6
VITRINITE REFLECTANCE DATA

GEOCHEM SAMPLE NUMBER	DEPTH	SAMPLE TYPE	AVERAGE REFLECTIVITY Ro (%), (NUMBER OF PARTICLES)			REMARKS
			1	2	3	
1189-019A	740-770m	WR	0.45(3)	0.66(4)*	1.00(1)*	
1189-024B	890-920m	WR	0.43(8)	0.61(2)*	0.54(4)*	
1189-032A	1130-1160m	WR	0.46(7)	0.81(2)*	-	
1189-039A	1340-1370m	WR	0.46(2) 1.28(1)*	0.59(2)*	0.74(1)*	
1189-046A	1550-1580m	WR	NO DETERMINATIONS POSSIBLE			
1189-052A	1730-1760m	WR	NO DETERMINATIONS POSSIBLE			
1189-056A	1850-1880m	WR	0.44(1)	-	-	
1189-059B	1940-1970m	WR	0.47(4)	0.65(4)*	0.90(5)*	
1189-062A	2030-2060m	WR	0.42(1) 0.96(1)*	0.53(2)*	0.67(1)*	
1189-066A	2150-2180m	WR	0.62(5)*	0.80(2)*	1.12(3)*	
1189-070A	2270-2300m	WR	0.45(1) 1.16(4)*	0.70(6)*	0.95(2)*	
1189-078A	2510-2540m	WR	0.42(2) 0.96(5)*	0.59(5) 1.14(3)*	0.75(13)*	
1189-084A	2660-2690m	WR	0.55(1)	0.76(6)*	0.94(8)*	
1189-087A	2720-2750m	WR	0.66(4)	0.98(12)*	-	
1189-091A	2810-2840m	WR	0.49(7) 0.98(2)*	0.61(6)	0.81(5)*	
1189-097A	2930-2960m	WR	0.49(3)	0.61(5)	0.88(12)*	
1189-104A	3050-3080m	WR	0.48(5) 0.90(11)*	0.58(3)	0.70(11)*	
1189-109A	3150-3165m	WR	0.49(4) 0.95(8)*	0.61(5)	0.75(8)*	
1189-117A	3267-3280m	WR	0.67(15)	0.94(8)*	-	
1189-123A	3355-3370m	WR	0.49(1) 1.11(2)*	0.60(5)	0.83(7)*	
1189-127A	3430m	WR	0.34(2) 0.89(3)*	0.59(6)	0.74(8)*	
1189-132A	3490-3505m	WR	0.50(5)	0.77(7)*	-	
1189-135A	3550m	WR	0.45(1) 1.44(4)*	0.66(1)	1.13(5)*	
1189-140A	3610-3625m	WR	0.67(2) 1.39(3)*	0.91(18)*	1.20(2)*	
1189-143A	3670m	WR	1.20(13)*	-	-	
1189-149B	3760m	WR	1.37(13)*	-	-	
1189-156B	3865-3880m	WR	0.56(23)	0.66(7)	-	
1189-159A	3910-3925m	WR	0.60(20)	0.81(6)*	1.16(2)*	
1189-161A	3940-3955m	WR	0.56(8)	0.66(6)	0.77(1)	

CT—ditch cuttings; CO—core; WR—whole rock; KC—kerogen concentrate. Colours – spore fluorescence. *Reworked

TABLE 6
VITRINITE REFLECTANCE DATA

GEOCHEM SAMPLE NUMBER	DEPTH	SAMPLE TYPE	AVERAGE REFLECTIVITY Ro (%), (NUMBER OF PARTICLES)			REMARKS
			1	2	3	
1189-166A	4015-4030m	WR	0.62(9) 0.96(7)*	0.73(3)	0.82(9)	
1189-170A	4075-4090m	WR	0.61(11)	0.81(9)	0.96(9)*	
1189-180A	4120-4130.5m	WR	0.58(8)	0.66(6)	0.83(11)	
1189-181A	4212-4225m	WR	0.63(18)	0.79(5)	0.95(5)*	
1189-189A	4375-4390m	WR	0.61(5) 1.19(2)*	0.84(6)	1.01(4)*	
1189-191B	4405-4420m	WR	0.49(6)	0.62(12)	0.84(1)	
1189-196B	4480-4495m	WR	0.63(10)	0.77(13)	0.99(7)*	
1189-202A	4510-4585m	WR	0.34(5) 0.80(5)	0.52(2) 1.04(10)*	0.65(2) 1.25(3)*	
1189-207A	4645-4660m	WR	0.68(1) 1.32(7)*	0.89(9)	1.08(12)*	

CT–ditch cuttings; CO–core; WR–whole rock; KC–kerogen concentrate. Colours – spore fluorescence. *Reworked

TABLE 7

METHYL PHENANTHRENE INDEX

GEOCHEM SAMPLE NUMBER	DEPTH	% AREA	% HEIGHT
1189-084A	2660-2690m	0.66	0.65
1189-094A	2870-2900m	0.56	0.53
1189-132	3490-3505m	0.51	0.52
1189-135	3550m	0.46	0.47
1189-143	3670m	0.51	0.52
1189-156B	3865-3880m	0.54	0.57
1189-159A	3910-3925m	0.49	0.59
1189-166A	4015-4030m	0.57	0.58
1189-001	4085-4095m	0.98	0.92
1189-171A	4085.35m CORE	0.95	0.97
1189-172A	4092.25m CORE	0.87	0.98
1189-173A	4100.50m CORE	0.87	0.92
1189-174A	4105.70m CORE	0.98	1.00
1189-175A	4108.60m CORE	0.88	1.03
1189-176A	4110.60m CORE	0.89	0.87
1189-177A	4113.50m CORE	0.82	0.88
1189-178A	4117.40m CORE	0.79	0.98
1189-214	4145-4167m	0.58	0.68
1189-181	4212-4225m	0.71	0.77
1189-217	4255-4270m	0.65	0.68
1189-196	4480-4495m	0.61	0.64

TABLE 8a
CONCENTRATION (PPM) OF EXTRACTED C_{15+} MATERIAL IN ROCK

GEOCHEM SAMPLE NUMBER	DEPTH	TOTAL EXTRACT	HYDROCARBONS			NON HYDROCARBONS			
			Paraffin - Naphthenes	Aromatics	TOTAL	Preciptd. Asphaltenes	Eluted NSO's	Non-eluted NSO's	Sulphur
1189-084A	2660--2690	83	28	7	35	42	5	1	0
1189-094A	2870-2900	430	249	70	319	59	48	4	0
1189-132	3490-3505	633	347	156	503	67	51	12	0
1189-135	3550	3612	2649	471	3120	80	388	24	0
1189-143	3670	3474	2380	611	2991	75	374	35	0
1189-156B	3865-3880	4502	2767	996	3763	244	469	26	0
1189-159A	3910-3925	4589	2934	1011	3945	193	439	12	0
1189-166A	4015-4030	1798	956	461	1417	149	214	19	0
1189-171A	Tarbert 4085.35	274	192	35	227	22	23	3	0
1189-172A	4092.25	651	422	120	543	47	54	6	0
1189-173A	4100.50	491	312	95	406	39	45	0	0
1189-174A	4105.70	209	126	32	158	31	19	0	0
1189-175A	4108.60	1097	497	106	603	434	59	0	0
1189-176A	4110.60	620	359	108	467	107	41	6	0
1189-177A	4113.50	539	371	79	450	45	39	5	0
1189-178A	4117.40	758	541	89	631	73	48	7	0
1189-214	Ness 4145-4167	5456	2861	1144	4005	688	715	48	0
1189-181	4212-4225	3887	1759	973	2732	775	377	3	0
1189-217	Etiv 4255-4270	2256	1154	414	1568	284	375	29	0
1189-196	4480-4495	4129	2758	991	3749	284	52	45	0

TABLE 8b

COMPOSITION (NORMALISED %) OF C_{15+} MATERIAL EXTRACTED FROM ROCK

GEOCHEM SAMPLE NUMBER	DEPTH	HYDROCARBONS		NON HYDROCARBONS			
		Paraffin – Naphthenes	Aromatics	Preciptd. Asphaltenes	Eluted NSO's	Non eluted NSO's	Sulphur
1189-084A	2660-2690	34.42	8.44	50.65	5.84	0.65	0.00
1189-094A	2870-2900	57.89	16.39	13.63	11.18	0.92	0.00
1189-132	3490-3505	54.87	24.64	10.56	8.07	1.86	0.00
1189-135	3550	73.34	13.05	2.20	10.75	0.65	0.00
1189-143	3670	68.50	17.60	2.14	10.75	1.00	0.00
1189-156B	3865-3880	61.46	22.13	5.42	10.41	0.58	0.00
1189-159A	3910-3925	63.94	22.03	4.21	9.57	0.25	0.00
1189-166A	4015-4030	53.17	25.64	8.28	11.88	1.04	0.00
1189-171A	4085.35	69.93	12.90	7.95	8.29	0.92	0.00
1189-172A	4092.25	64.90	18.51	7.28	8.33	0.99	0.00
1189-173A	4100.50	63.44	19.25	8.04	9.18	0.08	0.00
1189-174A	4105.70	60.29	15.31	14.83	9.33	0.24	0.00
1189-175A	4108.60	45.32	9.68	39.54	5.41	0.04	0.00
1189-176A	4110.60	57.93	17.36	17.21	6.61	0.90	0.00
1189-177A	4113.50	68.79	14.66	8.28	7.33	0.95	0.00
1189-178A	4117.40	71.40	11.75	9.58	6.32	0.95	0.00
1189-214	4145-4167	52.43	20.97	12.60	13.11	0.88	0.00
1189-181	4212-4225	45.24	25.04	19.94	9.69	0.08	0.00
1189-217	4255-4270	51.16	18.34	12.59	16.61	1.30	0.00
1189-196	4480-4495	66.80	23.99	6.88	1.25	1.08	0.00
1189-001	4085-4095 DST-1	87.89	10.33	0.38	1.20	0.19	0.01

TABLE 9
SIGNIFICANT RATIOS (%) OF C_{15+} FRACTIONS AND ORGANIC CARBON

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC CARBON (wt. %)	HYDROCARBONS / TOTAL EXTRACT	HYDROCARBONS / ORG. CARBON	TOTAL EXTRACT / ORG. CARBON	P-NAPHTHENES / AROMATICS
1189-084A	2660-2690	0.54	42.86	0.66	1.53	4.08
1189-094A	2870-2900	0.72	74.27	4.44	5.97	3.53
1189-132	3490-3505	0.80	79.50	6.29	7.91	2.23
1189-135	3550	1.04	86.40	30.00	34.73	5.62
1189-143	3670	0.68	86.10	43.99	51.09	3.89
1189-156B	3865-3880	3.00	83.59	12.54	15.01	2.78
1189-159A	3910-3925	4.45	85.96	8.86	10.31	2.90
1189-166A	4015-4030	2.41	78.81	5.88	7.46	2.07
1189-171A	4085.35	0.17	82.83	13.36	16.13	5.42
1189-172A	4092.25	0.58	83.41	9.36	11.22	3.51
1189-173A	4100.50	0.55	82.70	7.38	8.93	3.30
1189-174A	4105.70	0.34	75.60	4.64	6.13	3.94
1189-175A	4108.60	0.68	55.00	8.87	16.13	4.68
1189-176A	4110.60	0.96	75.28	4.86	6.46	3.34
1189-177A	4113.50	0.60	83.45	7.49	8.98	4.69
1189-178A	4117.40	0.38	83.15	16.59	19.96	6.08
1189-214	4145-4167	3.36	73.41	11.92	16.24	2.50
1189-181	4212-4225	4.80	70.28	5.69	8.10	1.81
1189-217	4255-4270	1.92	69.50	8.17	11.75	2.79
1189-196	4480-4495	2.59	90.79	14.48	15.94	2.78

TABLE 10
COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-001	-084A	-094A	-132	-135	-143	-156B
DEPTH	DST 1	2660-2690m	2870-2900m	3490-3505m	3550m	3670m	3865-3880m
SAMPLE TYPE							
nC_{15}	11.23	6.15	7.10	15.84	9.56	10.55	11.10
nC_{16}	10.49	8.79	7.69	14.09	11.32	11.01	11.22
nC_{17}	10.34	10.14	8.10	12.29	10.64	11.01	11.12
nC_{18}	9.18	10.85	7.48	9.83	10.24	9.87	10.91
nC_{19}	8.73	9.85	8.15	7.88	11.25	9.34	9.54
nC_{20}	7.29	8.02	6.52	6.07	8.07	6.68	6.94
nC_{21}	6.38	6.27	5.61	4.83	5.16	5.81	5.54
nC_{22}	5.47	6.24	5.51	4.73	6.03	6.19	5.24
nC_{23}	5.09	4.90	5.69	4.52	4.34	4.61	4.79
nC_{24}	5.43	5.04	10.00	3.76	3.80	4.47	3.62
nC_{25}	3.97	4.16	5.73	3.55	4.31	4.01	3.19
nC_{26}	3.30	2.74	4.65	2.70	3.05	2.94	3.67
nC_{27}	2.64	3.37	3.58	2.06	2.40	1.99	2.19
nC_{28}	2.53	3.18	2.57	1.71	2.04	2.96	2.14
nC_{29}	1.89	2.49	2.32	1.48	1.71	1.68	1.75
nC_{30}	1.35	1.52	1.93	1.03	1.19	1.40	1.45
nC_{31}	1.22	1.64	1.70	1.02	1.24	1.18	1.39
nC_{32}	0.93	1.16	1.63	0.66	0.86	1.08	1.14
nC_{33}	1.05	1.32	1.31	0.69	1.04	1.17	0.97
nC_{34}	0.84	1.14	1.53	0.76	1.01	1.18	1.20
nC_{35}	0.64	1.02	1.21	0.53	0.72	0.87	0.90
PARAFFIN	38.53	25.01	23.39	16.99	20.12	18.15	14.20
ISOPRENOID	3.17	2.83	2.35	2.67	2.88	2.09	1.63
NAPHTHENE	58.29	72.16	74.27	80.34	77.00	79.76	84.17
CPI INDEX 1	0.96	0.97	0.84	1.01	0.93	0.90	0.94
CPI INDEX 2	0.99	1.14	0.97	1.11	1.16	0.91	0.90
CPI INDEX 3	0.91	1.14	0.99	0.92	0.94	0.67	0.75
PRISTANE/PHYTANE	2.24	1.35	1.94	2.54	1.78	1.52	1.45
PRISTANE/nC_{17}	0.55	0.64	0.82	0.92	0.86	0.63	0.61
PHYTANE/nC_{18}	0.28	0.44	0.46	0.45	0.50	0.46	0.43

$$\text{C.P.I. } 1 = \frac{1}{2}\left(\frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}\right)$$

$$\text{C.P.I. } 2 = \frac{1}{2}\left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right)$$

$$\text{C.P.I. } 3 = \frac{2x\ (C27)}{C26+C28}$$

CT – ditch cuttings **CO** – core **SWC** – sidewall core

TABLE 10

COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-159A	-166A	-171A	-172A	-173A	-174A	-175A
DEPTH	3910-3925m	4015-4030m	4085.35m CORE	4092.25m CORE	4100.50m CORE	4105.70m CORE	4108.60m CORE
SAMPLE TYPE							
nC_{15}	11.99	11.14	5.92	8.76	9.06	2.97	7.71
nC_{16}	11.49	9.84	7.81	8.08	9.16	4.53	7.80
nC_{17}	10.98	9.56	8.89	8.79	9.43	7.38	8.39
nC_{18}	8.91	9.55	8.35	7.16	8.36	6.84	8.66
nC_{19}	9.01	9.65	8.17	7.48	8.96	8.52	8.79
nC_{20}	7.37	6.87	7.02	6.18	8.23	7.59	7.85
nC_{21}	6.54	5.76	6.53	5.94	6.45	7.48	6.74
nC_{22}	4.85	5.50	6.49	5.47	6.87	6.28	6.59
nC_{23}	5.45	4.91	5.63	5.16	5.20	6.14	5.95
nC_{24}	3.68	5.26	5.53	4.87	5.68	5.70	6.04
nC_{25}	4.32	4.57	5.07	5.60	4.86	6.95	5.36
nC_{26}	3.07	3.91	4.37	4.77	3.68	4.98	4.24
nC_{27}	2.28	3.10	3.56	3.61	2.82	5.36	3.34
nC_{28}	2.32	2.44	3.04	3.39	2.28	3.51	2.65
nC_{29}	1.69	1.90	2.75	2.84	1.92	3.38	2.18
nC_{30}	1.31	1.27	2.47	2.25	1.67	2.80	1.62
nC_{31}	1.26	1.09	2.11	2.56	1.34	2.29	1.50
nC_{32}	0.89	1.55	1.61	1.99	1.02	2.39	1.15
nC_{33}	0.99	0.88	1.95	1.97	1.27	1.38	1.40
nC_{34}	0.93	0.74	1.63	2.05	1.05	1.96	1.24
nC_{35}	0.68	0.52	1.10	1.07	0.71	1.54	0.82
PARAFFIN	15.19	20.10	26.22	25.49	25.89	25.68	26.24
ISOPRENOID	1.92	1.51	2.15	1.76	2.19	1.83	1.81
NAPHTHENE	82.88	78.38	71.63	72.75	71.92	72.49	71.95
CPI INDEX 1	1.16	0.96	0.98	1.03	0.92	1.16	0.98
CPI INDEX 2	1.09	0.99	1.02	1.07	1.04	1.19	1.07
CPI INDEX 3	0.84	0.98	0.96	0.88	0.94	1.26	0.97
PRISTANE/PHYTANE	1.84	2.14	2.10	2.02	2.54	2.10	1.86
PRISTANE/nC_{17}	0.75	0.54	0.63	0.53	0.64	0.65	0.53
PHYTANE/nC_{18}	0.50	0.25	0.32	0.32	0.29	0.34	0.28

$$\text{C.P.I. } 1 = \frac{1}{2}\left(\frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}\right)$$

$$\text{C.P.I. } 2 = \frac{1}{2}\left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right)$$

$$\text{C.P.I. } 3 = \frac{2x\ (C27)}{C26+C28}$$

CT – ditch cuttings **CO**– core **SWC** – sidewall core

TABLE 10
COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-176A	-177A	-178A	-181	-196	-214	-217
DEPTH	4110.60m CORE	4113.50m CORE	4117.40m CORE	4212-4225m	4480-4495m	4145-4167.5m	4255-4270m
SAMPLE TYPE							
nC_{15}	6.31	6.57	1.94	13.16	11.11	12.22	11.36
nC_{16}	6.35	7.01	3.27	10.48	10.70	11.43	10.21
nC_{17}	7.30	8.54	4.39	10.18	11.38	10.53	9.28
nC_{18}	6.57	8.16	5.25	8.99	7.69	8.37	7.72
nC_{19}	6.87	8.78	6.61	10.08	7.84	8.84	8.45
nC_{20}	5.98	7.31	6.28	7.12	6.35	7.44	7.06
nC_{21}	5.49	6.93	6.93	5.97	6.49	5.98	5.89
nC_{22}	5.96	6.82	6.82	5.07	5.21	5.51	5.50
nC_{23}	5.62	7.84	6.98	5.81	5.15	4.91	6.03
nC_{24}	5.77	6.65	7.98	4.92	3.94	4.44	4.07
nC_{25}	5.81	5.29	6.93	4.12	3.83	4.00	4.46
nC_{26}	5.51	3.81	5.92	2.99	2.94	3.48	3.75
nC_{27}	4.64	3.11	4.87	2.41	2.90	2.85	3.89
nC_{28}	4.23	2.62	4.31	2.48	2.66	2.23	3.31
nC_{29}	3.63	2.17	3.70	1.42	2.03	1.71	2.45
nC_{30}	2.97	1.72	3.19	1.04	2.11	1.23	1.09
nC_{31}	3.09	1.56	3.10	0.94	3.40	1.31	1.96
nC_{32}	2.03	1.33	2.37	0.73	1.18	0.87	0.67
nC_{33}	2.45	1.53	4.15	0.75	1.23	1.02	1.03
nC_{34}	1.84	1.32	2.96	0.74	1.03	0.97	1.10
nC_{35}	1.58	0.92	2.05	0.52	0.83	0.65	0.70
PARAFFIN	28.72	28.49	21.93	17.33	15.61	20.27	12.05
ISOPRENOID	1.41	2.24	1.01	1.44	1.28	1.64	0.88
NAPHTHENE	69.87	69.27	77.07	81.23	83.11	78.10	87.07
CPI INDEX 1	0.97	1.05	0.99	1.05	1.12	0.99	1.11
CPI INDEX 2	1.05	1.05	1.02	1.00	1.21	1.07	1.24
CPI INDEX 3	0.95	0.97	0.95	0.88	1.04	1.00	1.10
PRISTANE/PHYTANE	2.25	2.56	2.51	1.96	1.82	1.75	1.86
PRISTANE/nC_{17}	0.47	0.66	0.75	0.54	0.47	0.49	0.51
PHYTANE/nC_{18}	0.23	0.27	0.25	0.31	0.38	0.35	0.33

$$\text{C.P.I. } 1 = \frac{1}{2}\left(\frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}\right)$$

$$\text{C.P.I. } 2 = \frac{1}{2}\left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right)$$

$$\text{C.P.I. } 3 = \frac{2x\ (C27)}{C26+C28}$$

CT – ditch cuttings **CO**– core **SWC** – sidewall core

TABLE 11

DETAILED GASOLINE (C4-C7) ANALYSIS

GEOCHEM SAMPLE NUMBER	001
DEPTH	DST 1
isobutane	0.29
n-butane	1.00
isopentane	1.69
n-pentane	2.49
2,2-dimethylB	0.19
cyclopentane(CP)	0.79
2,3-dimethylB	0.04
2-methylP	2.26
3-methylP	1.48
n-hexane	4.97
methylCP(MCP)	3.20
2,2-dimethylP	0.33
2,4-dimethylP	0.06
2,2,3-trimethylB	0.10
benzene	7.30
cyclohexane(CH)	8.03
3,3-dimethylP	0.00
1,1-dimethylCP	0.00
2-methylH	3.01
2,3-dimethylP	0.46
3-methylH	0.75
1,c,3-dimethylCP	2.55
1,t,3-dimethylCP	0.73
1,t,2-dimethylCP	1.44
3-ethylP	0.00
n-heptane	8.53
methylCH(MCH)	19.02
1,c,2-dimethylCP	0.00
toluene	29.26
ABUNDANCE	
nC7/C7nap x100	35.92
MCP/Bz	0.44
MH/DMCP	0.80
nC6/MCP	1.56
%n-PARAFFINS	16.99
%iso-PARAFFINS	10.68
% NAPHTHENES	35.77
% AROMATICS	36.56

NBS 22 STANDARD	

TABLE 12
CARBON ISOTOPE COMPOSITIONS (^{o}/oo, PDB)

GEOCHEM SAMPLE NUMBER	DEPTH	TOTAL EXTRACT WHOLE OIL	SATURATES	AROMATICS	NSO	ASPHALTENES	KEROGEN	PYROLYSATE S2
1189-001 DST 1	4085-095m	-28.05	-29.30	-26.05	-27.91	-28.23	-	-
1189-156B	3865-880m	-	-31.03	-30.22	-30.04	-29.96	-29.11	-
1189-159	3910-925m	-	-30.26	-29.34	-29.18	-28.98	-28.54	-
1189-166A	4015-030m	-	-27.86	-26.36	-27.56	-26.39	-26.14	-
1189-181	4212-225m	-	-29.12	-26.63	-27.44	-26.41	-26.59	-
1189-196	4480-495m	-	-29.38	-28.04	-28.65	-27.91	-27.26	-

TABLE 13
BIOMARKER MOLECULAR RATIOS

GEOCHEM SAMPLE NUMBER	SAMPLE DEPTH/ IDENTITY	SAMPLE TYPE	STERANES (m/z 217, 218)				TERPANES (m/z 191, 177)					
			$C_{29}\ \frac{\alpha\alpha\alpha\ 20S\ [Q]}{\alpha\alpha\alpha\ 20R\ [T]}$	$C_{29}\ \frac{\alpha\beta\beta\ 20R\ [R]}{\alpha\alpha\alpha\ 20R\ [T]}$	$C_{27}\ \frac{20S\,DIAST\ [A]}{20R\,DIAST\ [B]}$	$\frac{C_{27}\ \beta\beta}{C_{29}\ \beta\beta}$ (218)	$\frac{Tm\ [B]}{Ts\ [A]}$	$\frac{C_{29},\ 17\alpha\text{-}NH\ [C]}{[C] + C_{30},\ 17\alpha\text{-}H\ [E]}$	$C_{29}\ \frac{NM\ [D]}{[D] + NH\ [C]}$	$\frac{28,30\text{-}BNH\ [Z]}{[Z] + C_{29},\ 17\text{-}NH\ [C]}$	$\frac{28,30\text{-}BNH\ [Z]}{[Z] + 25,28,30\text{-}TNH\ (177)}$	$C_{31}\ \frac{20S\ [G]}{[G] + 20R\ [H]}$ %
1189-001	DST 1		1.15	1.40	1.56	0.73	2.01	0.54	0.07	0.02	0.55	54.4
1189-156	3865-880m		2.43	3.13	1.36	1.13	0.42	0.20	0.11	0.07	-	62.1
1189-159	3910-925m		2.02	2.60	1.34	0.99	0.40	0.24	0.09	0.35	0.88	53.3
1189-166	4015-030m		1.43	1.74	1.36	1.02	0.68	0.35	1.15	0.11	0.58	32.9
1189-171A	4085.35m	CORE	0.85	1.10	1.23	0.68	1.43	0.50	0.11	0.02	-	54.2
1189-172A	4092.25m	CORE	0.97	1.38	1.42	0.81	1.69	0.53	0.08	0.02	0.56	58.0
1189-173A	4100.50m	CORE	1.10	1.58	1.41	0.73	1.71	0.52	0.08	-	-	55.1
1189-174A	4105.70m	CORE	1.13	1.39	1.13	0.80	1.19	0.51	0.08	0.05	0.61	55.6
1189-175A	4108.60m	CORE	0.98	1.45	1.35	0.67	1.12	0.49	0.09	0.05	-	58.2
1189-176A	4110.60m	CORE	1.05	1.52	1.44	0.75	0.60	0.49	0.08	0.04	0.64	57.2
1189-177A	4113.50m	CORE	1.32	1.66	-	0.75	0.92	0.48	0.07	0.07	0.61	59.2
1189-178A	4117.40m	CORE	0.96	1.15	1.28	0.78	1.82	0.51	0.09	0.03	0.57	57.1
1189-181A	4212-225m		1.44	1.93	1.24	0.97	0.63	0.29	0.13	0.13	0.84	53.0
1189-196A	4480-495m		1.32	1.66	1.25	0.95	0.90	0.36	0.15	0.18	0.63	54.5

[A] etc. REFERS TO IDENTIFICATION ON APPROPRIATE MASS FRAGMENTOGRAM **DIAST** – DIASTERANES **H** – HOPANE **NH** – NORHOPANE **BNH** – BISNORHOPANE

CT – ditch cuttings **CO** – core **SWC** – sidewall core **TNH** – TRISNORHOPANE **NM** – NORMORETANE

TABLE 14a

GC-MS DATA INTEGRATED PEAK AREAS

TERPANES (M/Z 177)

GEOCHEM SAMPLE NUMBER	DEPTH	A
1189-156B	3865-880m	-
1189-159	3910-925m	650
1189-166	4015-030m	1479
1189-001 DST 1	4085-095m	557
1189-171A	4085.35m CORE	-
1189-172A	4092.25m CORE	2358
1189-173A	4100.50m CORE	2814
1189-174A	4105.70m CORE	5199
1189-175A	4108.60m CORE	-
1189-176A	4110.60m CORE	892
1189-177A	4113.50m CORE	1162
1189-178A	4117.40m CORE	3936
1189-181	4212-225m	337
1189-196	4480-495m	11375

TABLE 14b

GC-MS DATA INTEGRATED PEAK AREAS

TERPANES (M/Z 191)

GEOCHEM SAMPLE NUMBER	DEPTH	A	B	C	D	E	F	X	Z	G	H
1189-156B	3865-880m	24376	10358	15399	1816	62625	5377	13292	1162	24376	14853
1189-159	3910-925m	12522	5010	8588	892	27925	2055	5721	4686	10320	9058
1189-166	4015-030m	14675	9929	15754	2709	29167	2943	9195	2032	13455	27413
1189-001 DST 1	4085-095m	3975	8023	29387	2385	24766	1635	746	684	14118	11747
1189-171A	4085.35m CORE	49912	71376	200737	25024	202276	24410	22448	5100	162295	137275
1189-172A	4092.25m CORE	25489	43150	149521	13089	130932	9810	7155	2992	78498	56845
1189-173A	4100.50m CORE	22605	38718	145809	12494	135540	9952	9881	--	81496	66478
1189-174A	4105.70m CORE	33582	39895	142561	13185	137967	11205	13150	8147	74133	59292
1189-175A	4108.60m CORE	6576	7387	25503	2586	26328	1950	4091	1252	15355	11008
1189-176A	4110.60m CORE	20754	12386	33692	3127	35383	2205	15340	1576	22012	16477
1189-177A	4113.50m CORE	8629	7932	24371	1816	26927	2280	8342	1813	14588	10051
1189-178A	4117.40m CORE	31462	57334	187592	19489	176990	15391	9986	5264	120279	90508
1189-181	4212-225m	12280	7687	11721	1725	29173	3122	6637	1710	11207	9924
1189-196	4480-495m	51303	46084	90219	15842	159746	19598	20775	19777	67569	56397

TABLE 14c

GC-MS INTEGRATED PEAK AREAS

STERANES (M/Z 217)

GEOCHEM SAMPLE NUMBER	DEPTH	A	B	Q	R	S	T
1189-156B	3865-880m	17137	12637	6504	8373	6903	2678
1189-159	3910-925m	10678	7987	3560	4586	4241	1766
1189-166	4015-030m	8468	6242	3752	4566	4678	2631
1189-001 DST 1	4085-095m	3359	2153	3495	4245	4669	3026
1189-171A	4085.35m CORE	38752	31535	50141	65074	57385	59146
1189-172A	4092.25m CORE	16634	11697	16058	22804	19642	16583
1189-173A	4100.50m CORE	20127	14320	20039	28914	25292	18247
1189-174A	4105.70m CORE	28440	25090	29670	36531	37145	26356
1189-175A	4108.60m CORE	4095	3026	3565	5266	5020	3637
1189-176A	4110.60m CORE	13191	9180	9495	13768	10864	9072
1189-177A	4113.50m CORE	--	--	8059	10171	9029	6111
1189-178A	4117.40m CORE	13816	10762	18610	22152	23640	19309
1189-181	4212-225m	5924	4761	3074	4137	3597	2141
1189-196	4480-495m	19027	15227	13925	17533	17245	10533

TABLE 14d

GC-MS DATA INTEGRATED PEAL AREAS

(STERANES M/Z 218)

GEOCHEM SAMPLE NUMBER	DEPTH	A	B	C	D	E	F	Q	T
1189-156B	3865-880m	9906	6802	6778	7007	7006	7764	2785	1461
1189-159	3910-925m	5604	3883	4376	4242	4625	4934	1643	919
1189-166	4015-030m	5654	3611	3621	3692	4424	4688	1600	1226
1189-001 DST 1	4085-095m	4327	3501	2981	3460	4917	5684	1965	1400
1189-171A	4085.35m CORE	43414	31601	33749	35738	55186	55856	24615	21855
1189-172A	4092.25m CORE	21670	16296	15895	16179	22575	24578	9735	6551
1189-173A	4100.50m CORE	25642	18160	17460	19391	39302	29304	11859	8006
1189-174A	4105.70m CORE	34463	25355	23902	25401	24548	40317	15784	11713
1189-175A	4108.60m CORE	3562	2458	2756	2852	4164	4799	1849	1378
1189-176A	4110.60m CORE	10483	6006	7231	7067	14424	10496	4463	3192
1189-177A	4113.50m CORE	7615	5882	5522	6804	8861	9060	4089	2808
1189-178A	4117.40m CORE	22756	17089	15555	15682	23487	27740	10485	8001
1189-181	4212-225m	4603	3015	3157	3114	3745	4078	1559	1031
1189-196	4480-495m	18913	15235	14826	15420	16033	19854	7244	5059

FIGURE 1 **RATING** WELL 34/10-23

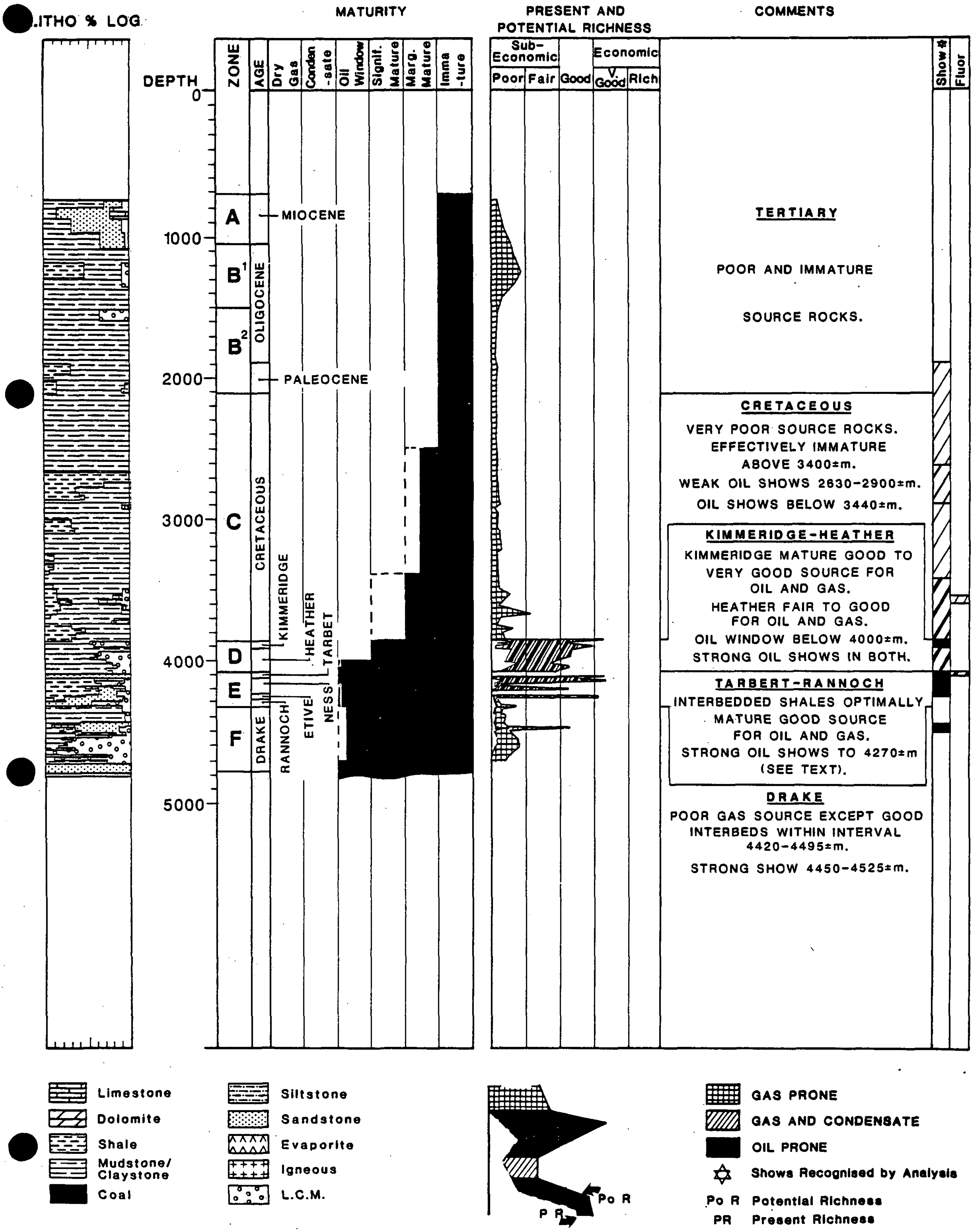


FIGURE 2 PYROLYSIS WELL 34/10-23

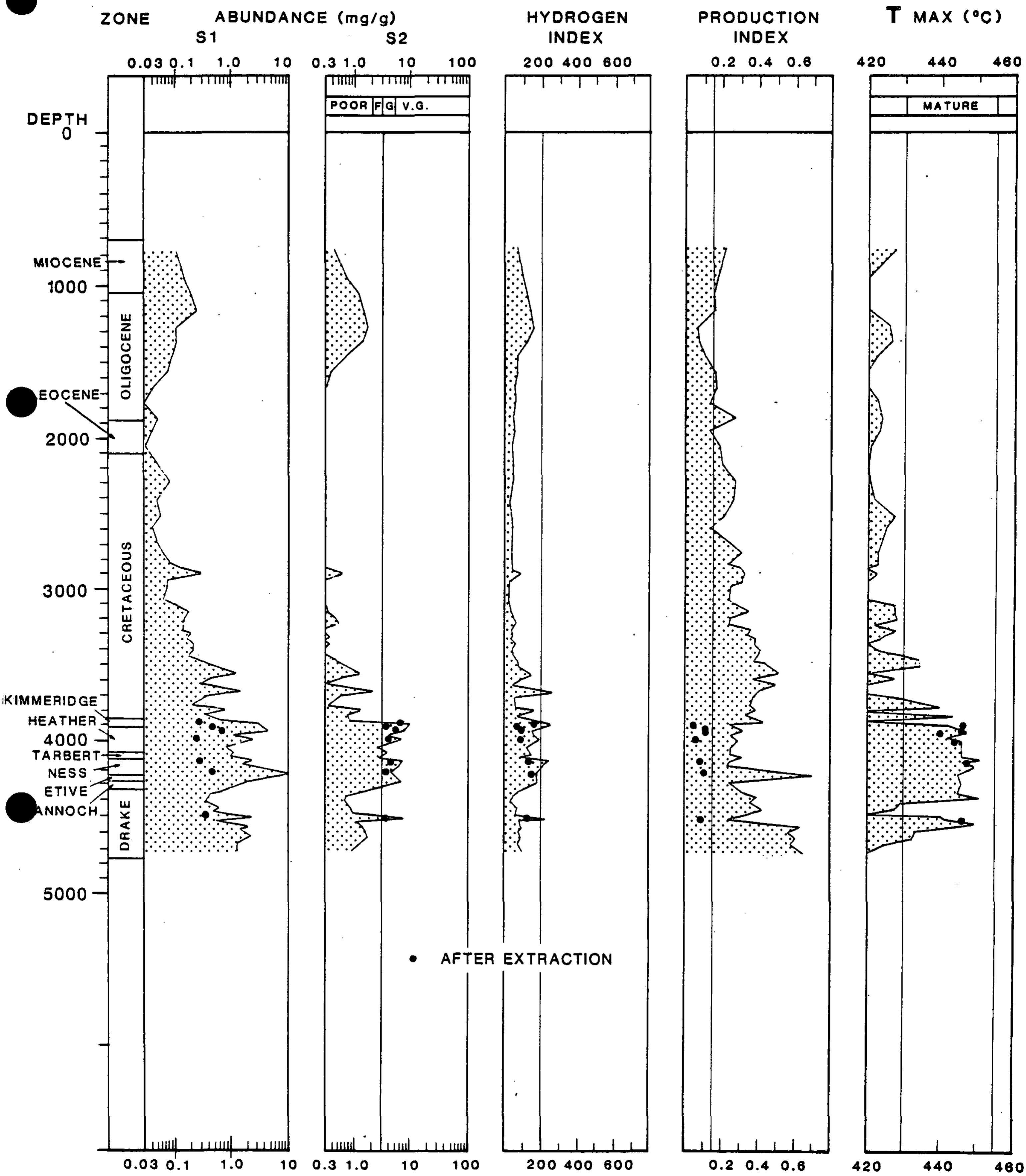
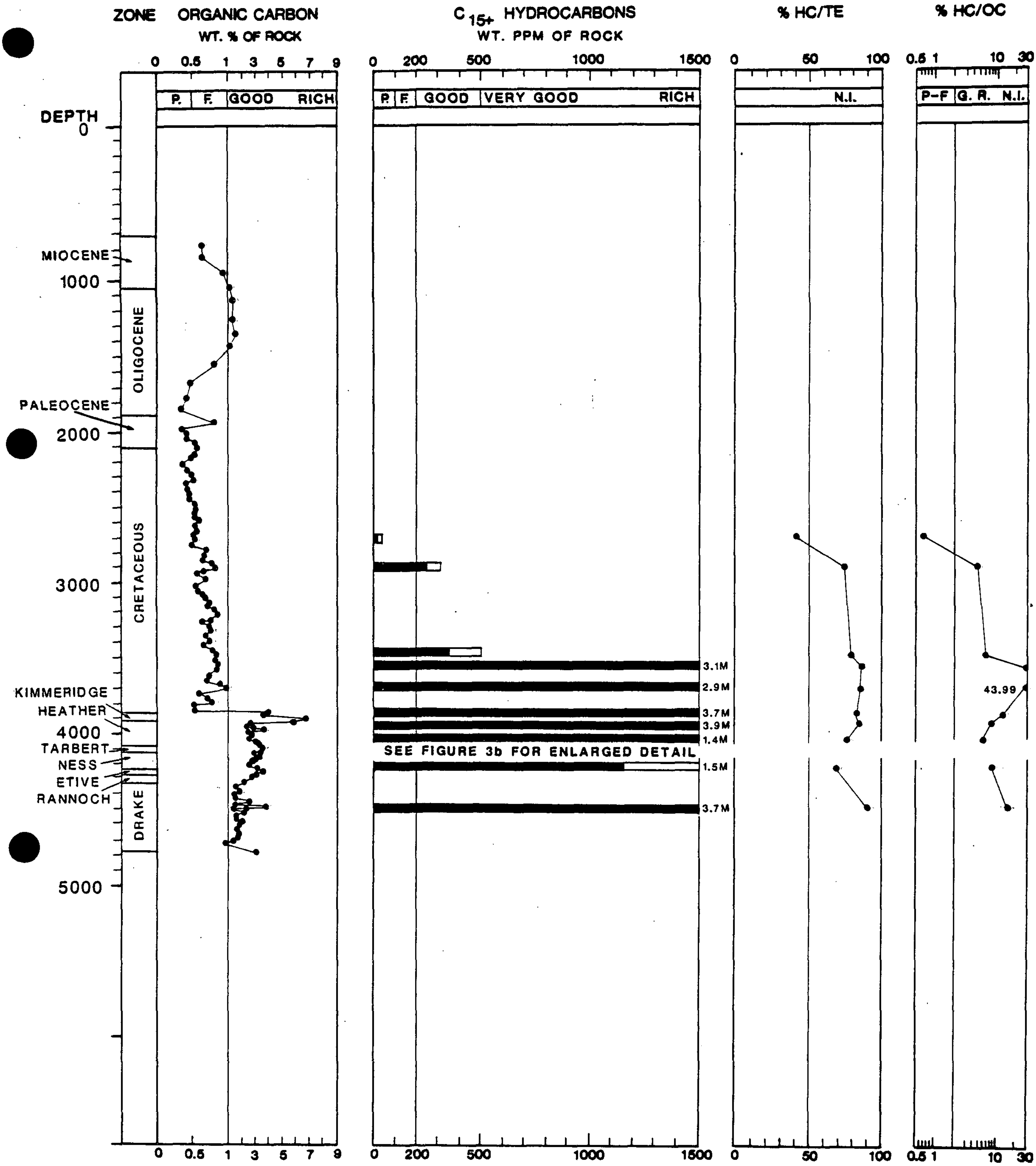


FIGURE 3a

RICHNESS

WELL 34/10-23



● SHALE / MUDSTONE

○ OTHER LITHOLOGIES

P-N - PARAFFIN - NAPHTHENES

AROM - AROMATICS

HC - C_{15+} HYDROCARBONS

OC - ORGANIC CARBON

TE - TOTAL C_{15+} EXTRACT

P - POOR

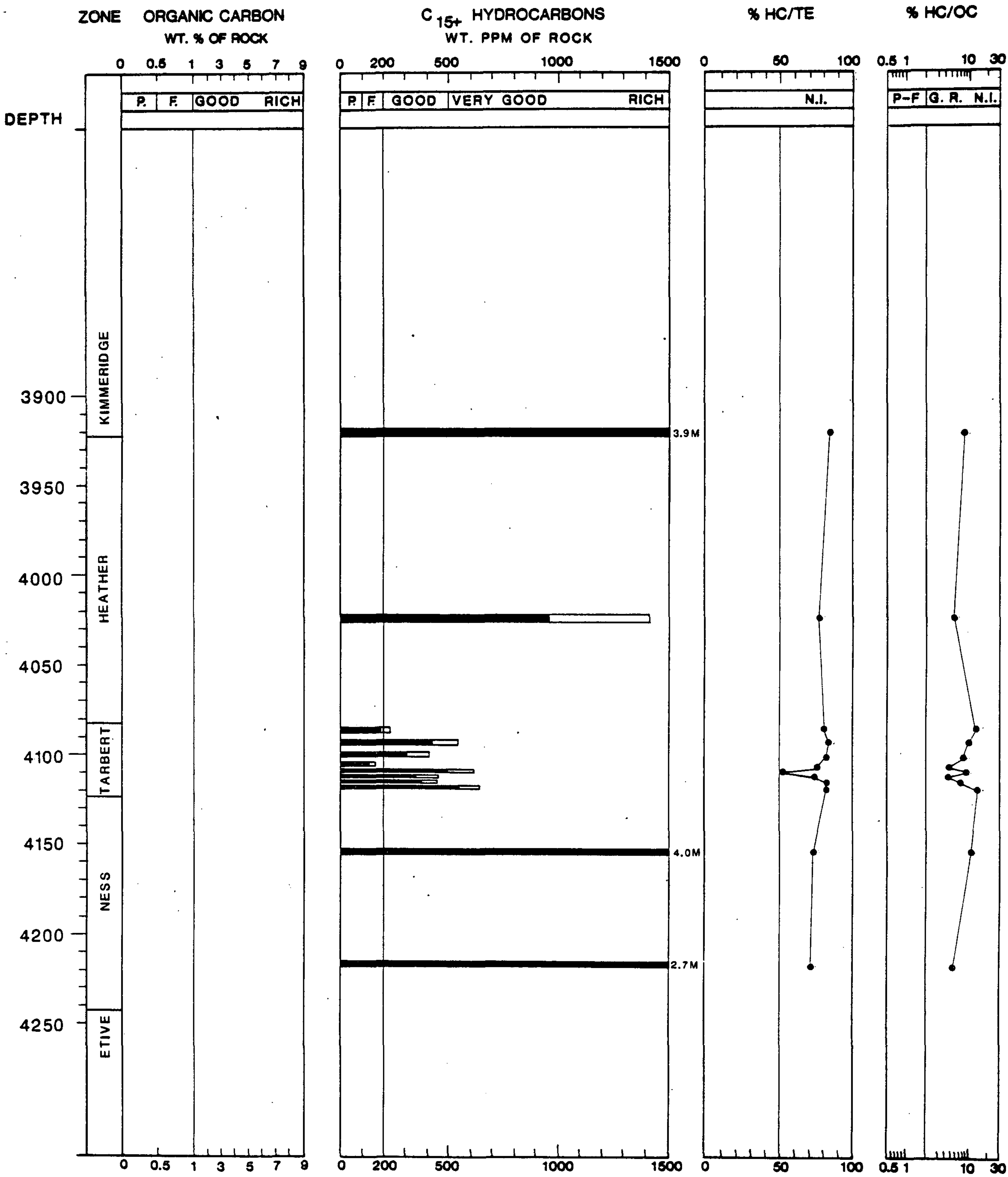
F - FAIR

G - GOOD

R - RICH

N.I. - NON-INDIGENOUS HYDROCARBONS

FIGURE 3b **RICHNESS** WELL 34/10-23



- SHALE / MUDSTONE
- OTHER LITHOLOGIES

P-N - PARAFFIN - NAPHTHENES

AROM - AROMATICS

HC - C_{15+} HYDROCARBONS

OC - ORGANIC CARBON

TE - TOTAL C_{15+} EXTRACT

P - POOR

F - FAIR

G - GOOD

R - RICH

N.I. - NON-INDIGENOUS HYDROCARBONS

FIGURE 4 ORGANIC FACIES & MATURITY WELL 34/10-23

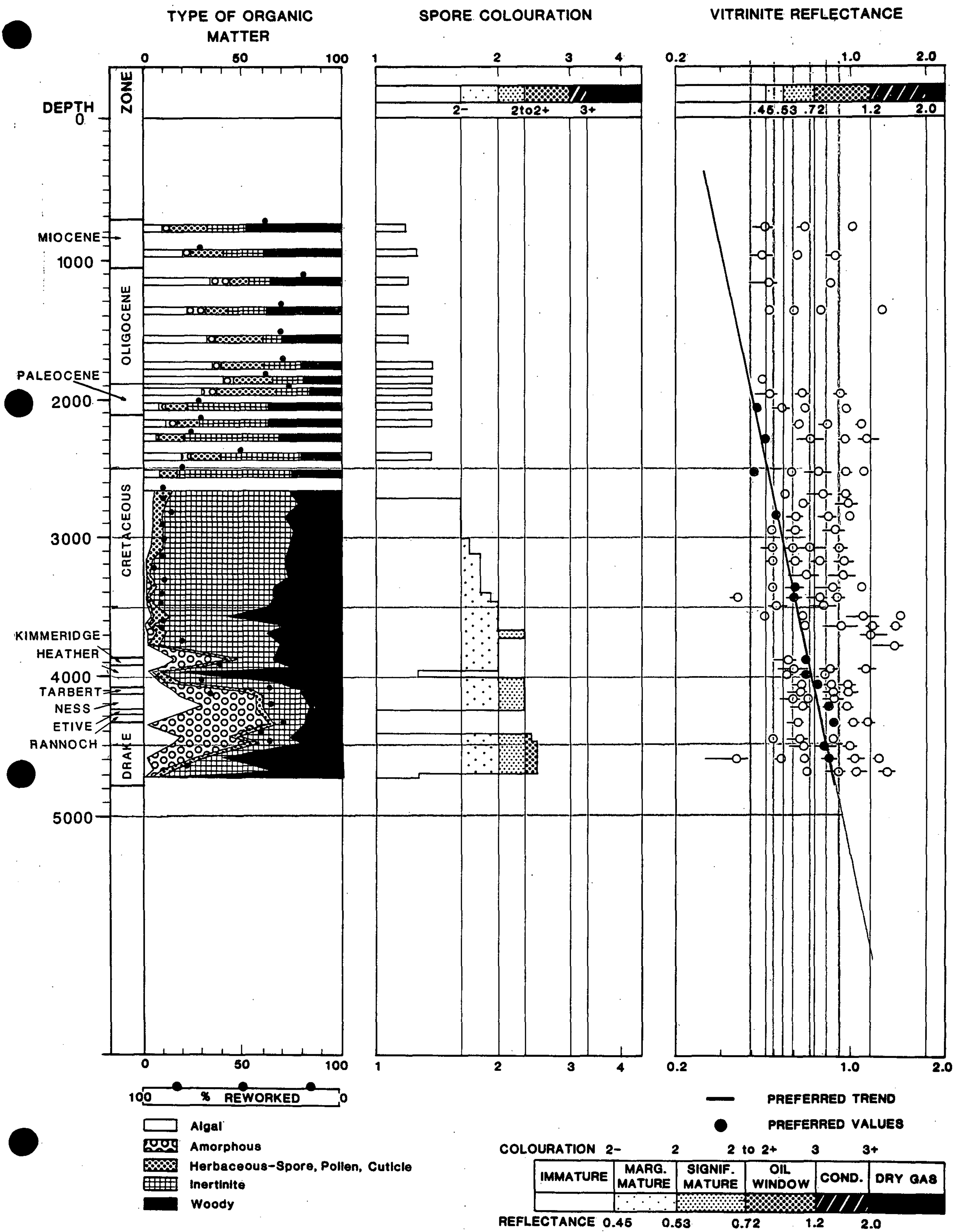
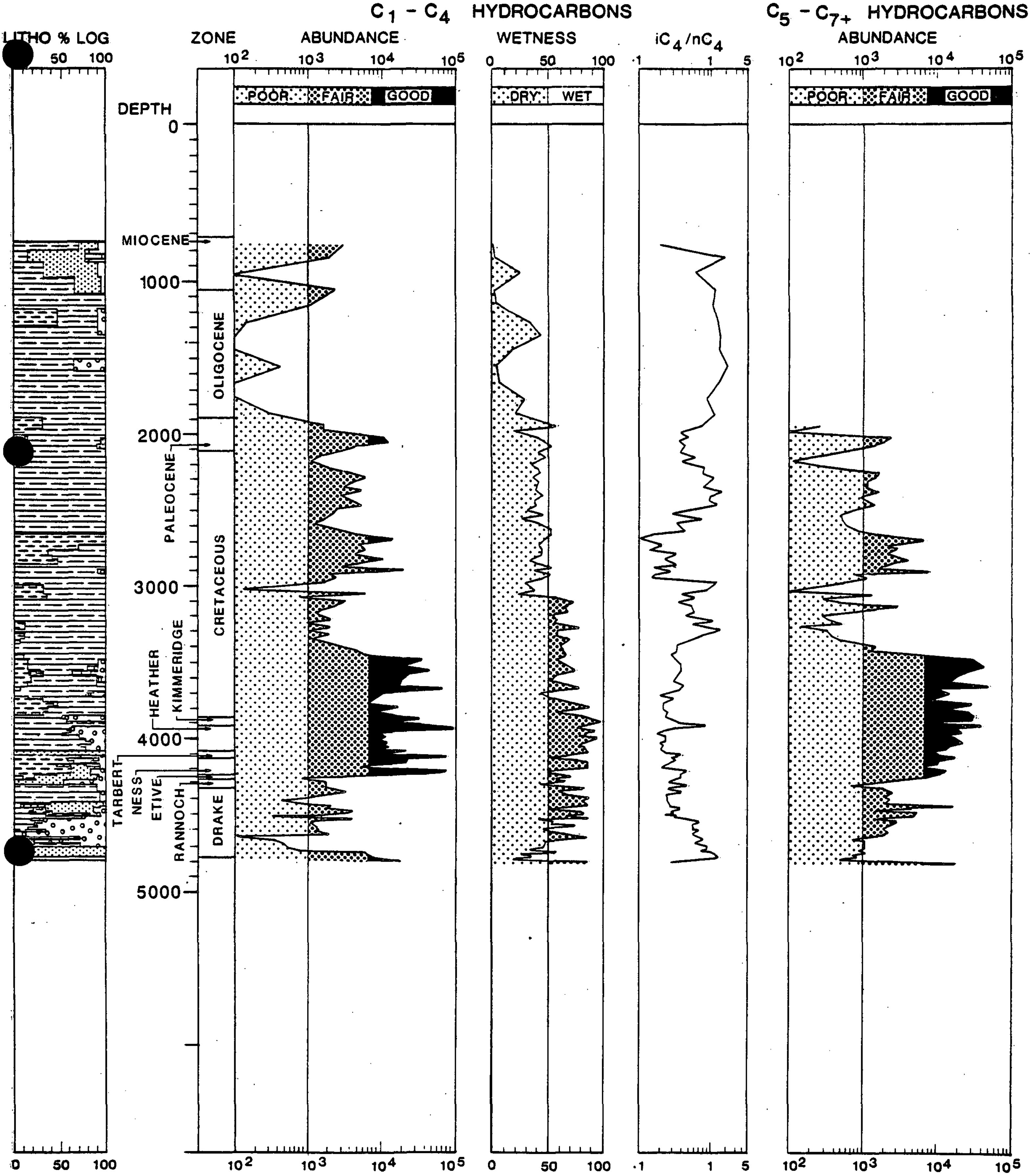


FIGURE 5 $C_1 - C_7$ HYDROCARBONS WELL 34/10-23



Limestone
Dolomite
Shale
Mudstone/ Claystone
Coal
Siltstone
Sandstone
Evaporite
Igneous
L.C.M.

iC_4 - ISOBUTANE

nC_4 - NORMAL BUTANE

ABUNDANCE - VOLUME PPM OF ROCK

WETNESS - % C_2-C_4 IN C_1-C_4

FIGURE 6

WELL 34/10-23

GALIMOV CARBON ISOTOPE PLOT
(‰, PDB)

GEOCHEM

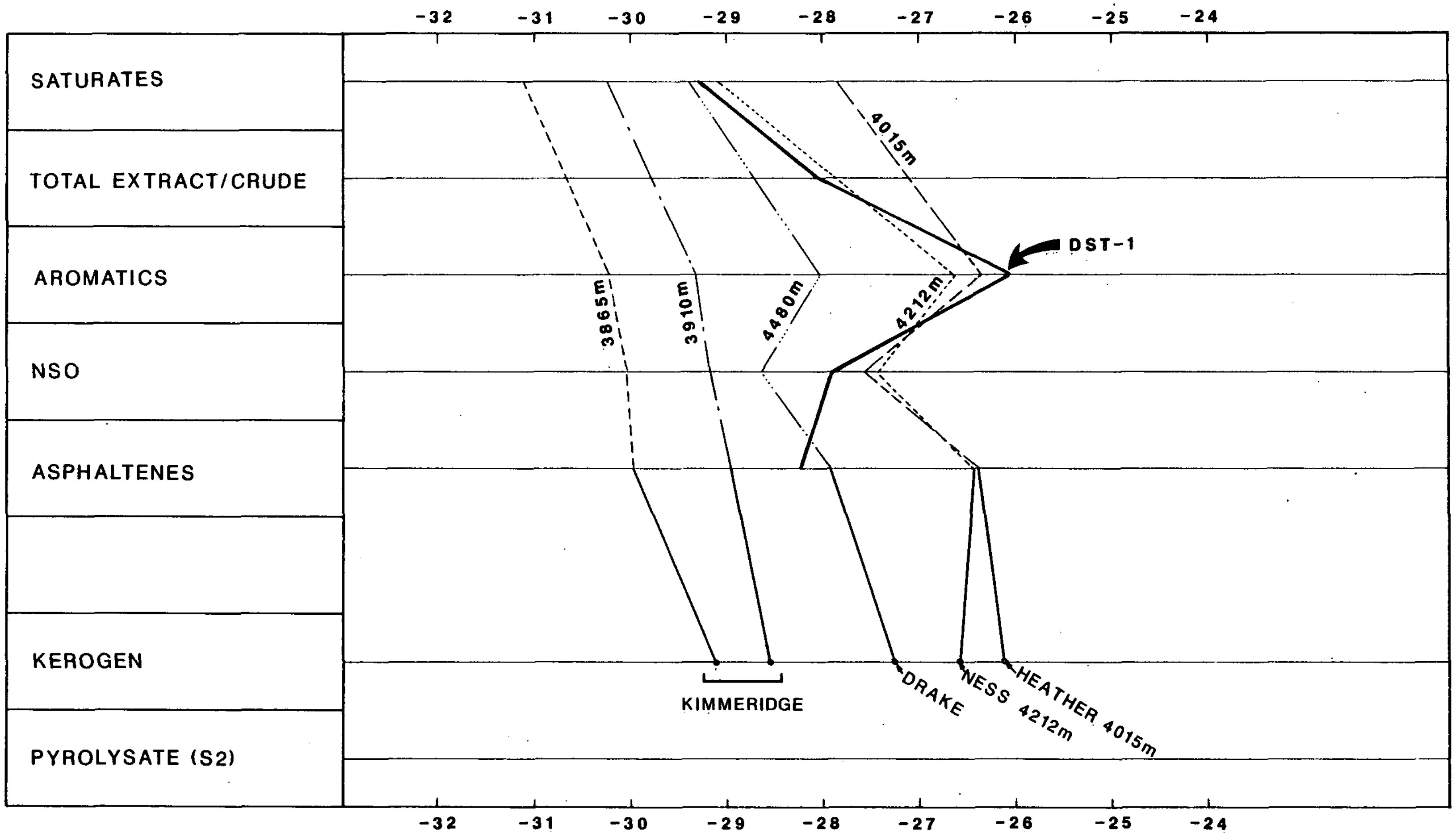


FIGURE 7

WELL 34/10-23

OIL CORRELATION

3865-3880m

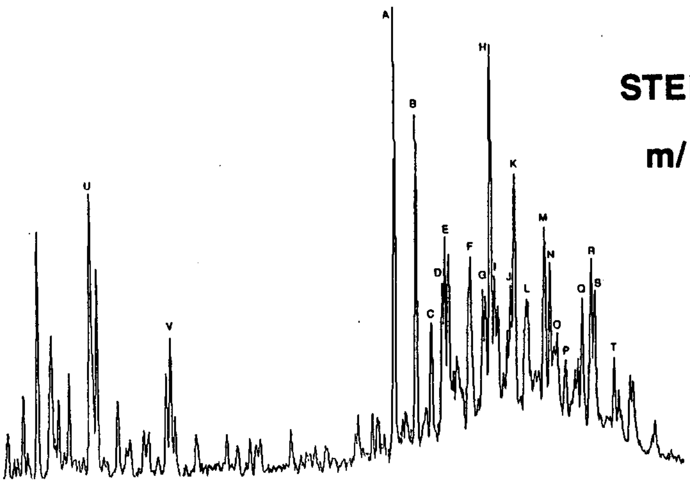
KIMMERIDGE

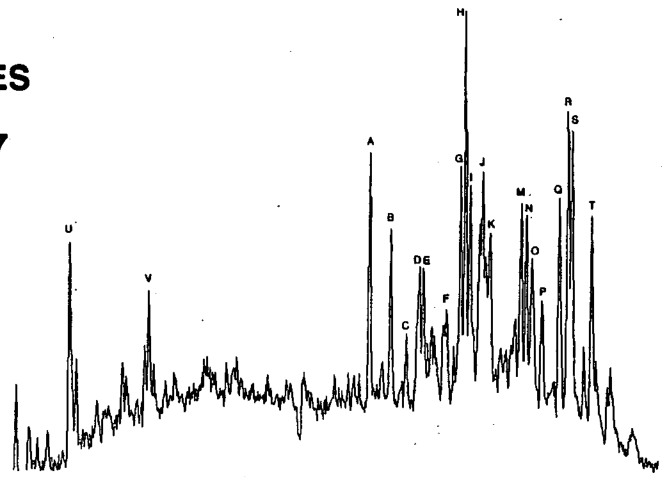
4085-4095m

DST 1

STERANES

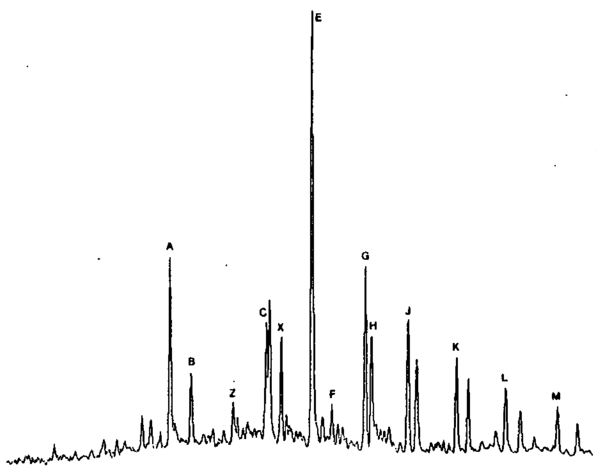
m/z 217

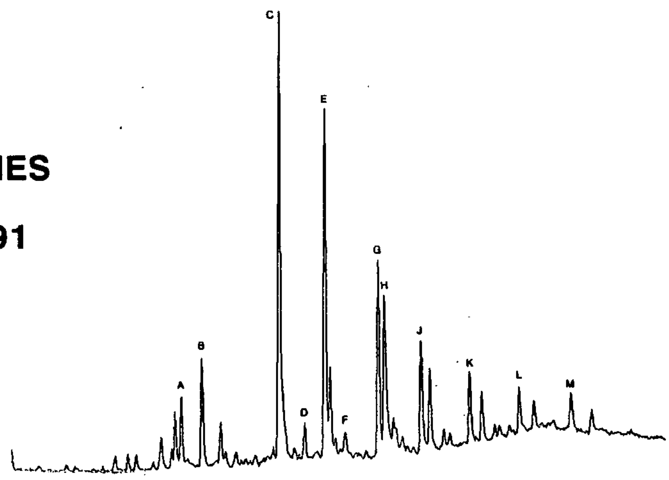




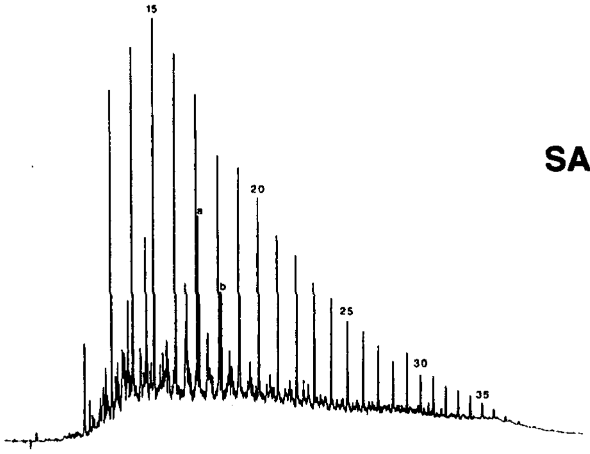
TERPANES

m/z 191





SATURATES



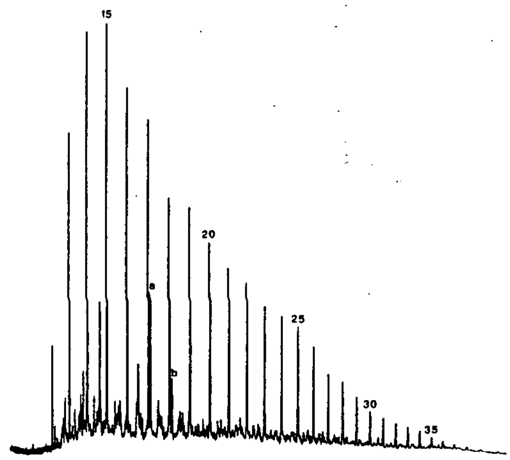
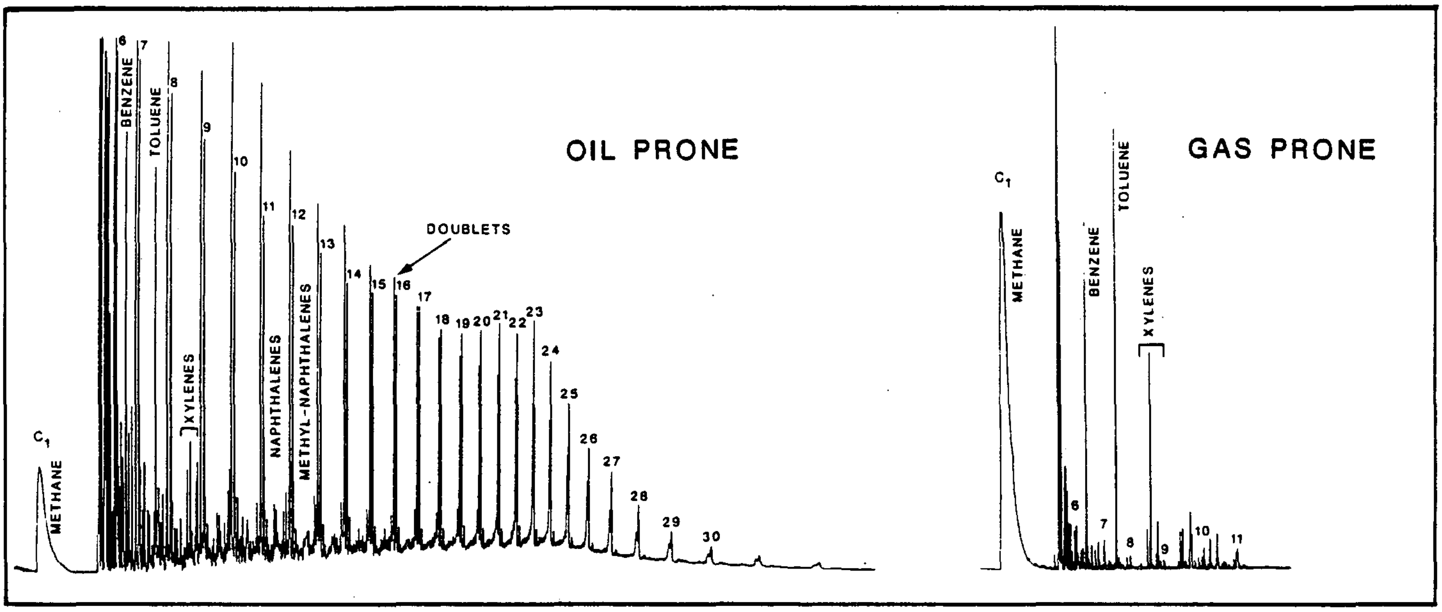


FIGURE 8a

WELL 34/10-23

PYROLYSIS GC



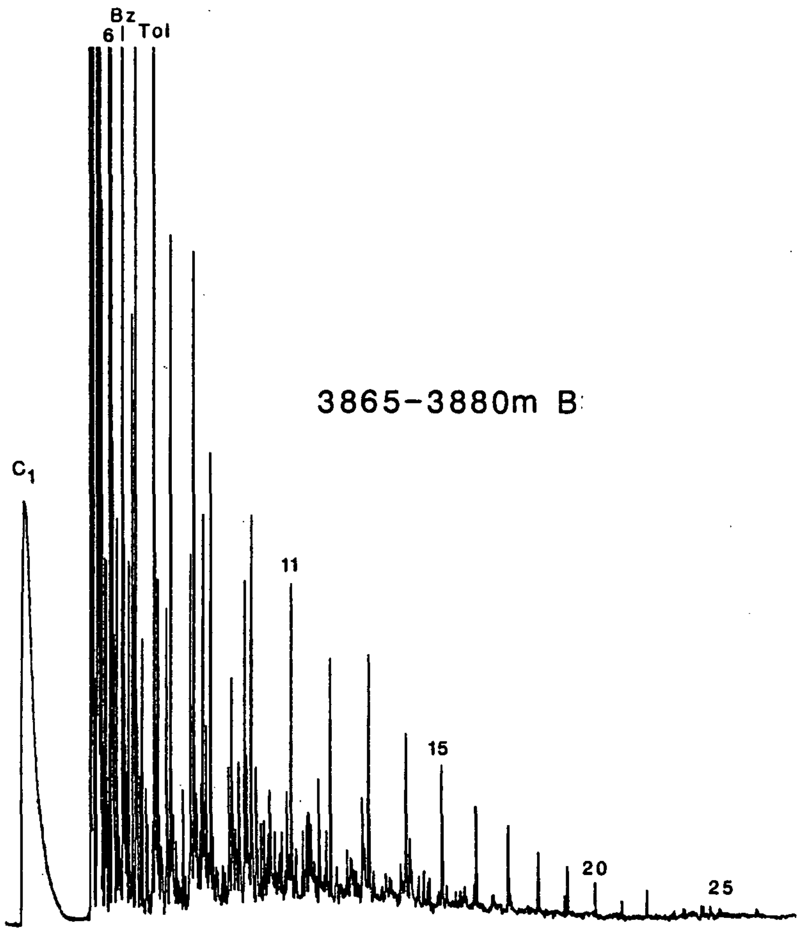
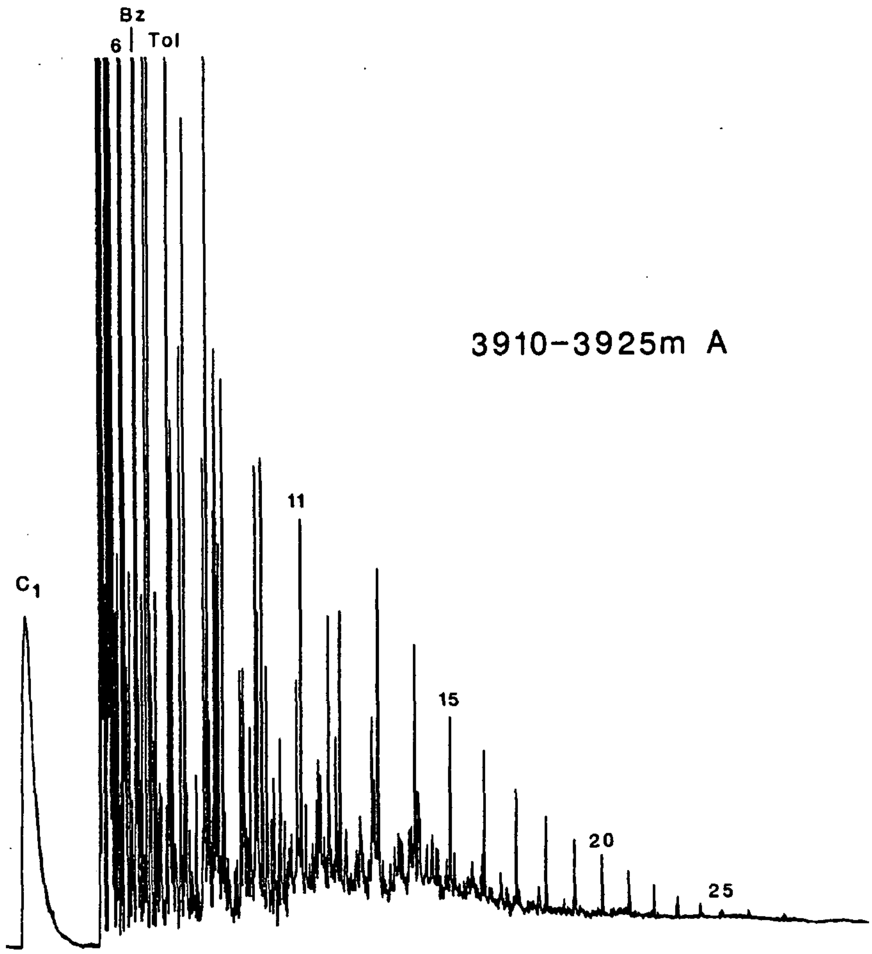
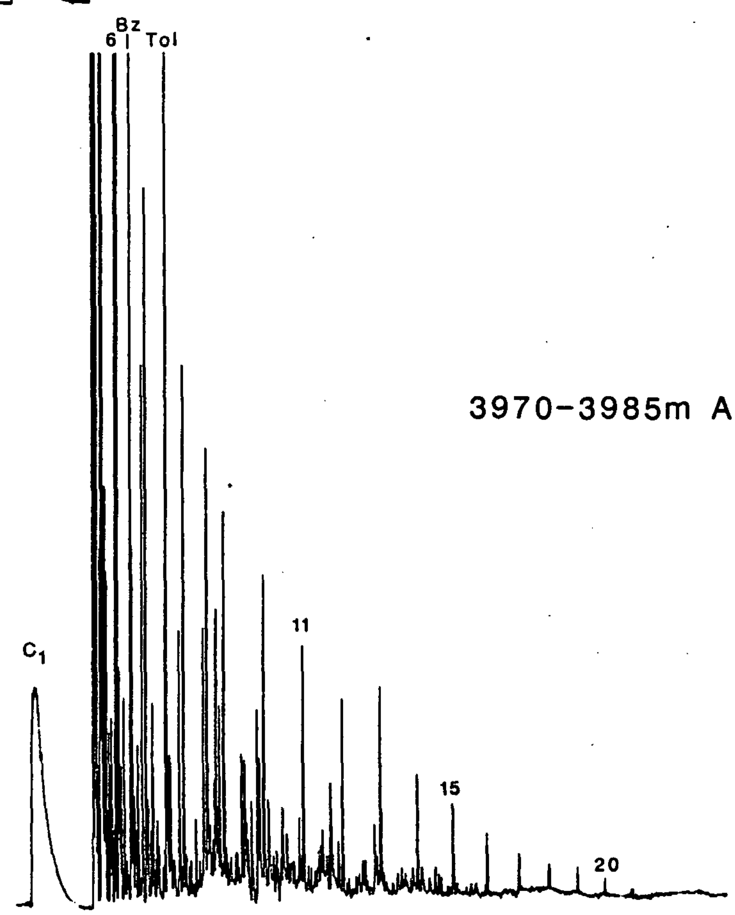


FIGURE 8b

WELL 34/10-23

PYROLYSIS GC





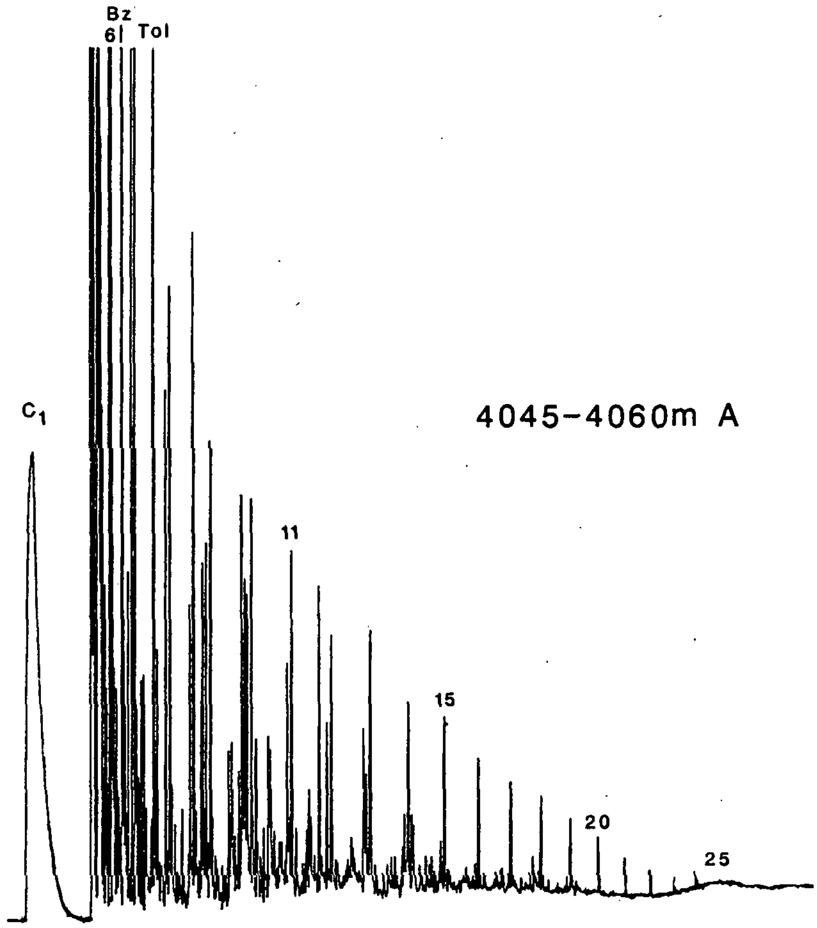
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

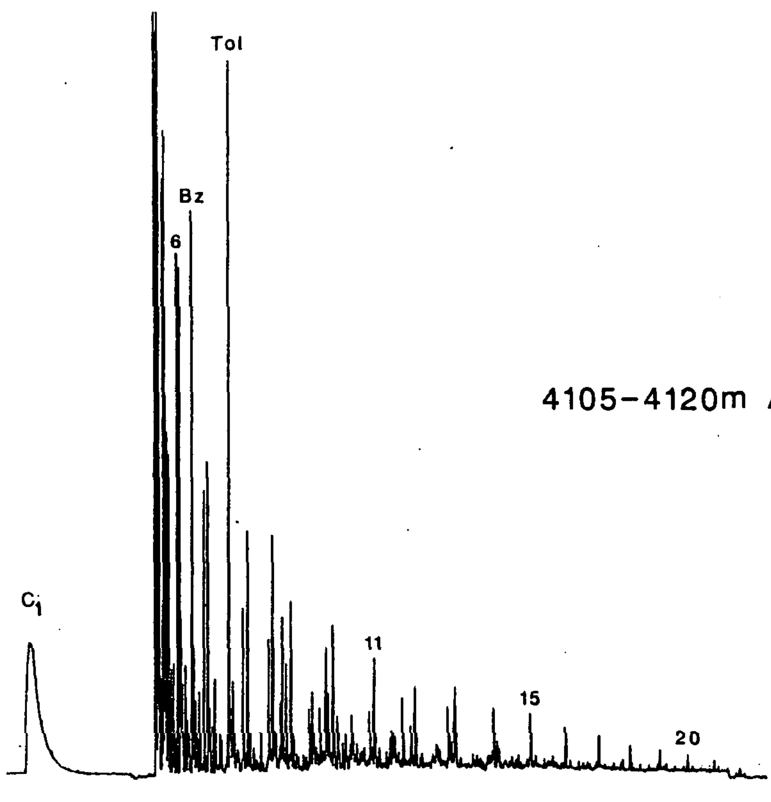
Bz - Benzene
To - Toluene

FIGURE 8c

PYROLYSIS GC

WELL 34/10-23





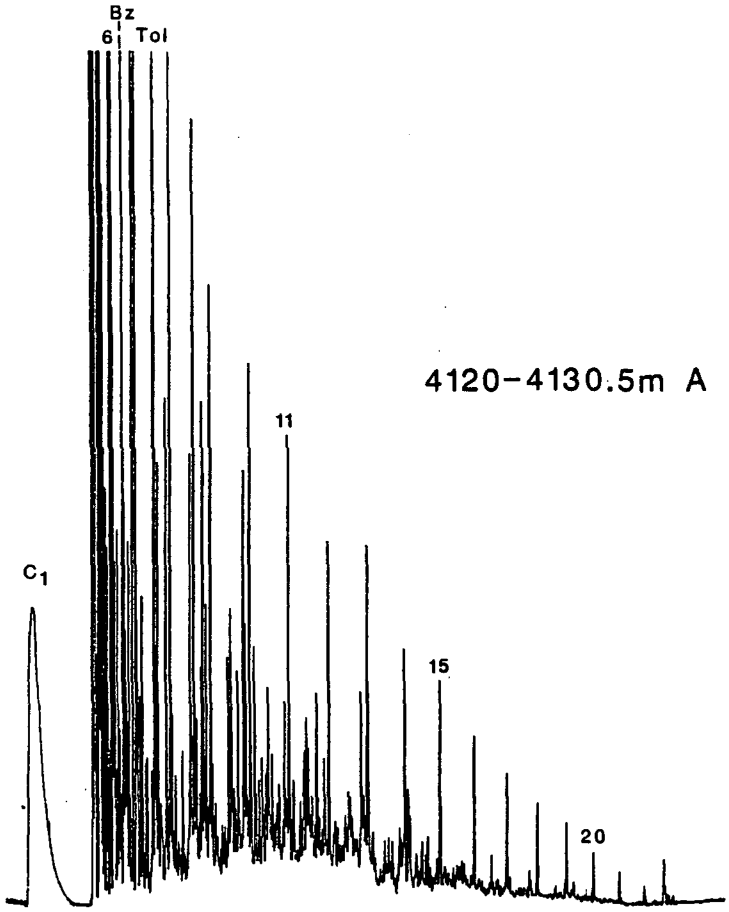
Bz - Benzene
To - Toluene

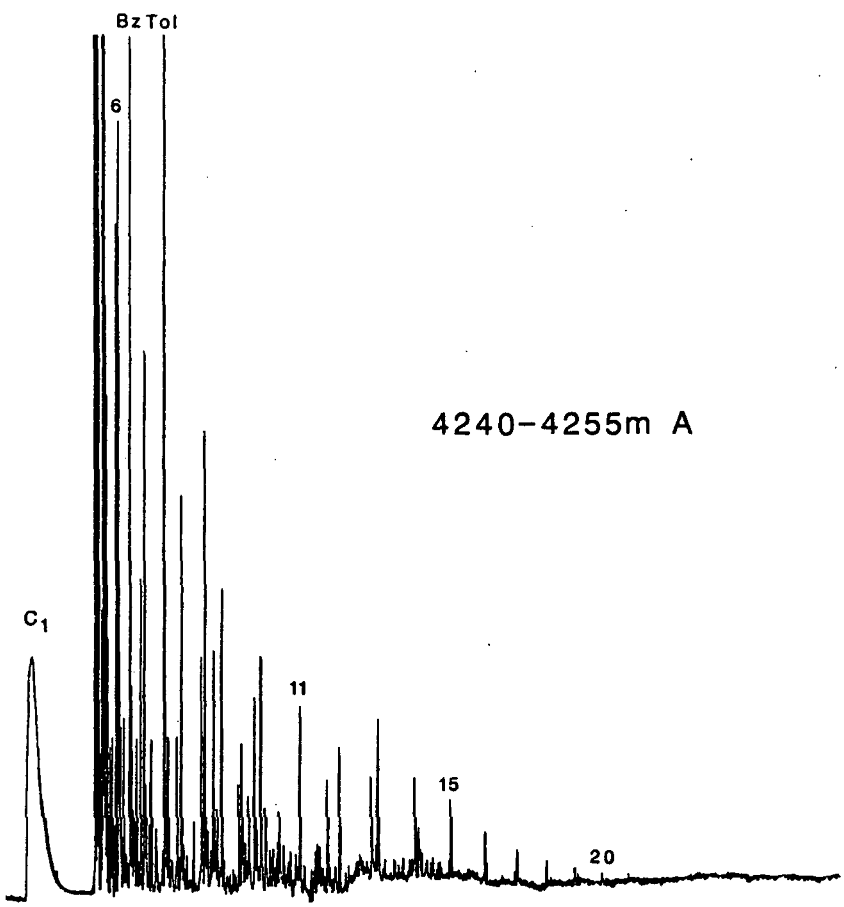
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

FIGURE 8d

WELL 34/10-23

PYROLYSIS GC





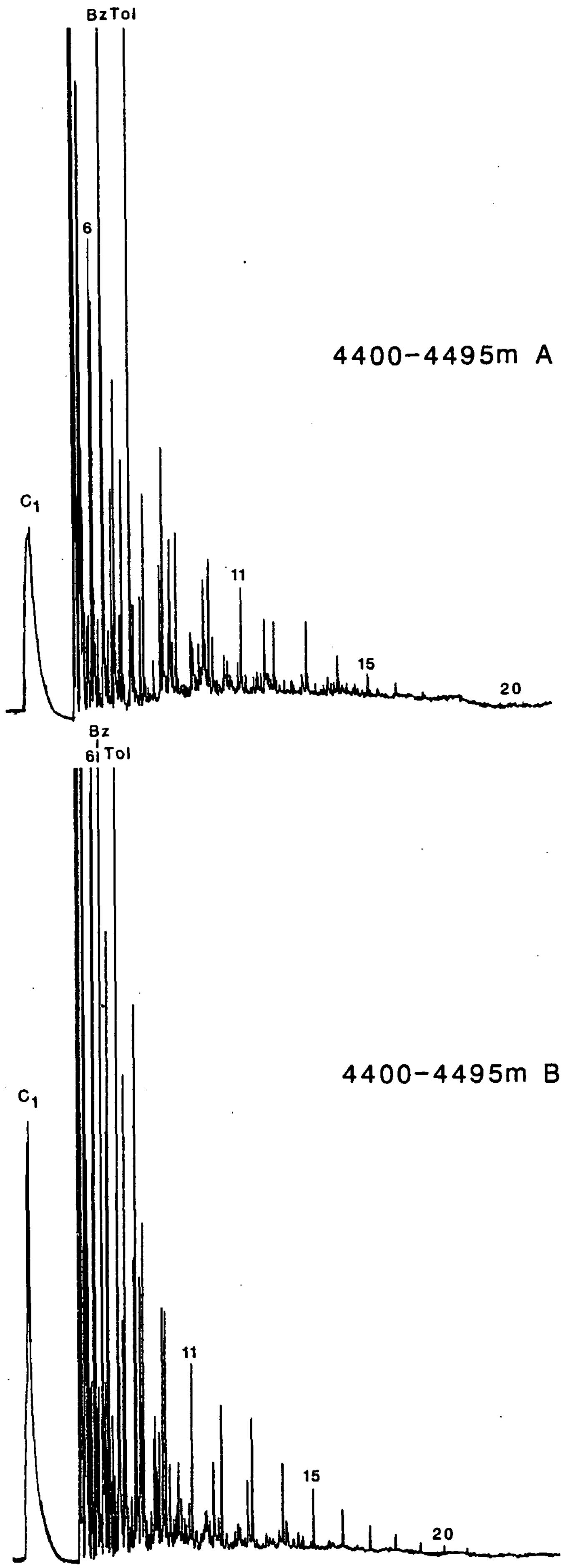
Bz - Benzene
To - Toluene

STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

FIGURE 8e

PYROLYSIS GC

WELL 34/10-23



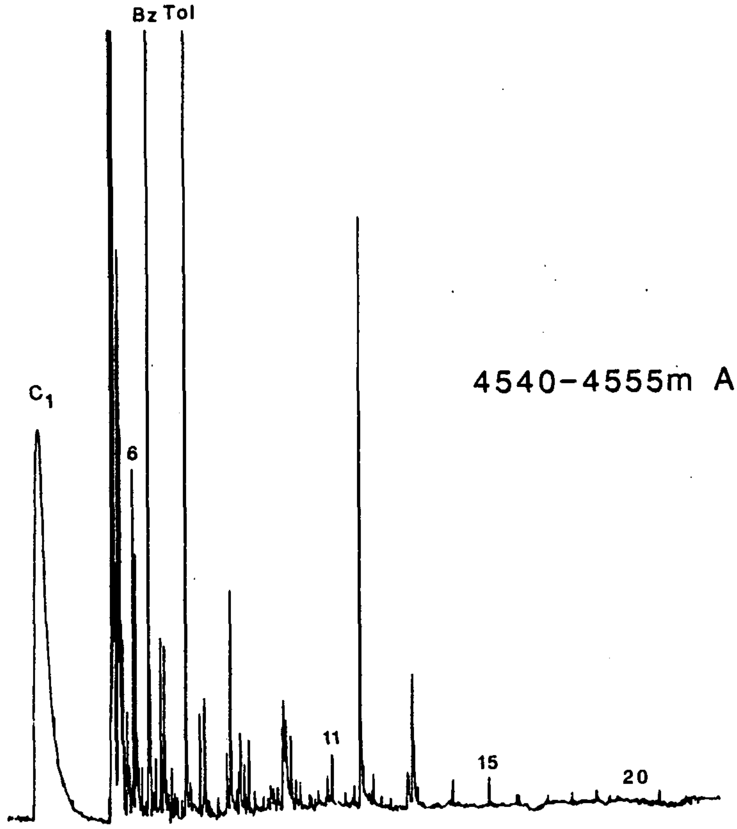
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

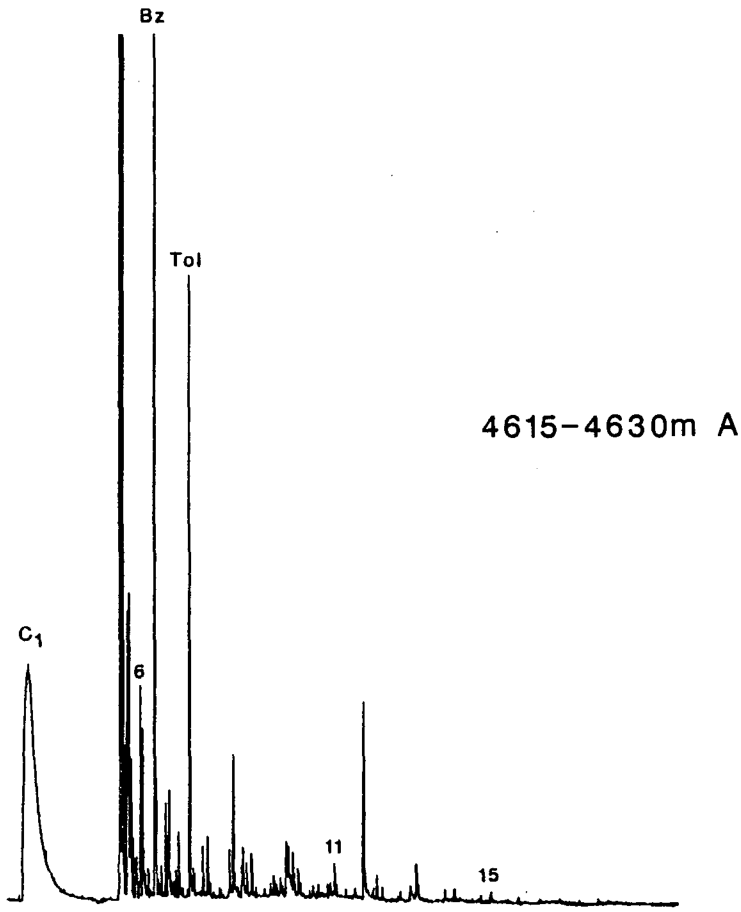
Bz - Benzene
To - Toluene

FIGURE 8f

PYROLYSIS GC

WELL 34/10-23





Bz - Benzene
To - Toluene

STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

FIGURE 9a

WELL 34/10-23

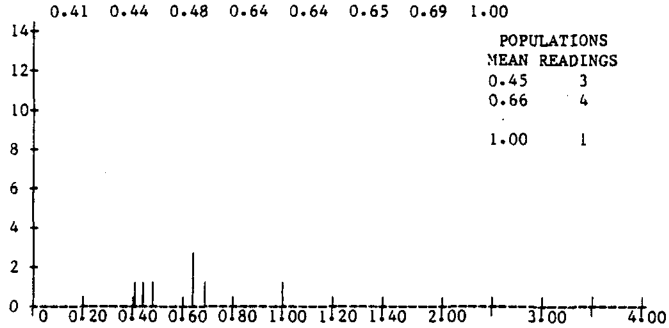
VITRINITE REFLECTANCE HISTOGRAMS

GEOCHEM

SAMPLE 1189-019A DEPTH 740 — VITRINITE REFLECTANCE VALUES

0.41 0.44 0.48 0.64 0.64 0.65 0.69 1.00

POPULATIONS MEAN	READINGS
0.45	3
0.66	4
1.00	1

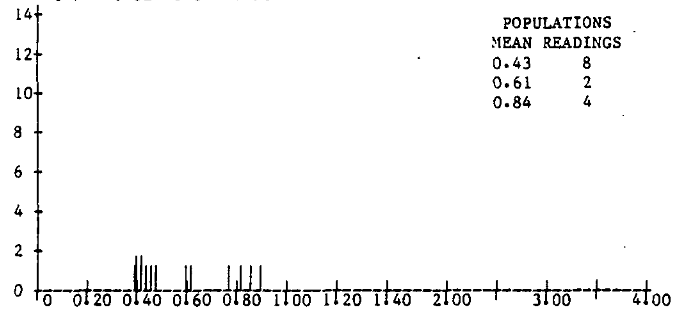


REMARKS SMALL FRAGMENTS, DIFFERENTIATION DIFFICULT.

SAMPLE 1189-026B DEPTH 950 — VITRINITE REFLECTANCE VALUES

0.39 0.40 0.41 0.42 0.43 0.44 0.46 0.48 0.60 0.62
0.77 0.82 0.86 0.90

POPULATIONS MEAN	READINGS
0.43	8
0.61	2
0.84	4

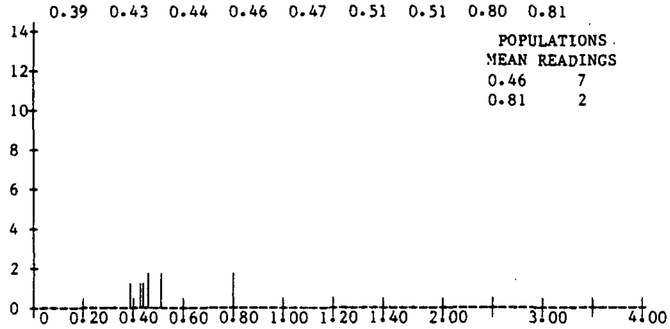


REMARKS VERY LEAN

SAMPLE 1189-032A DEPTH 1130 — VITRINITE REFLECTANCE VALUES

0.39 0.43 0.44 0.46 0.47 0.51 0.51 0.80 0.81

POPULATIONS MEAN	READINGS
0.46	7
0.81	2

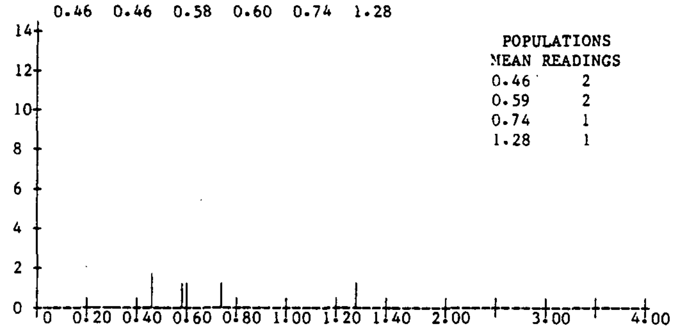


REMARKS AS 026B

SAMPLE 1189-039A DEPTH 1340 — VITRINITE REFLECTANCE VALUES

0.46 0.46 0.58 0.60 0.74 1.28

POPULATIONS MEAN	READINGS
0.46	2
0.59	2
0.74	1
1.28	1

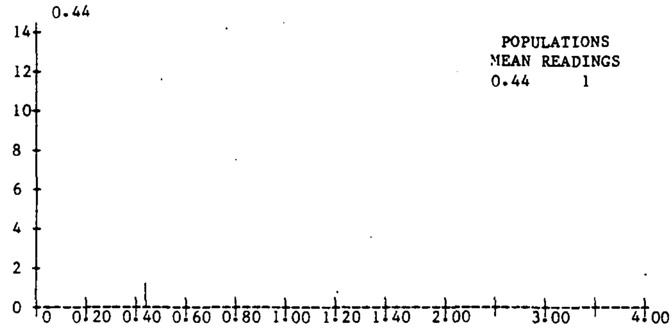


REMARKS AS 026B

SAMPLE 1189-056A DEPTH 1850 — VITRINITE REFLECTANCE VALUES

0.44

POPULATIONS MEAN	READINGS
0.44	1

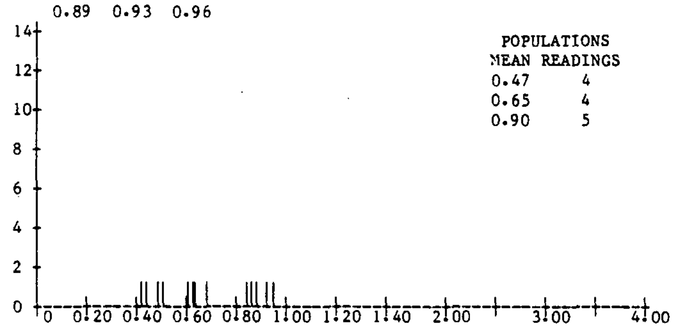


REMARKS ALMOST BARREN

SAMPLE 1189-059B DEPTH 1940 — VITRINITE REFLECTANCE VALUES

0.42 0.44 0.49 0.51 0.61 0.63 0.64 0.69 0.85 0.87
0.89 0.93 0.96

POPULATIONS MEAN	READINGS
0.47	4
0.65	4
0.90	5

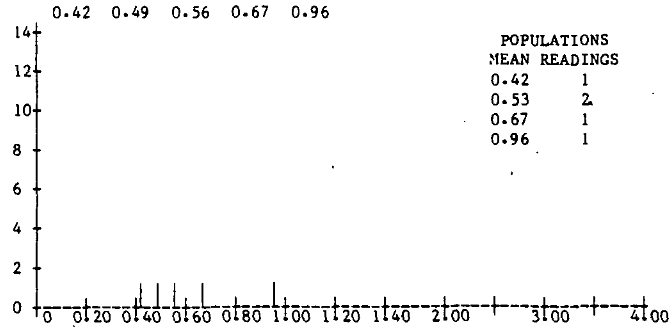


REMARKS SMALL FRAGMENTS, UNRELIABLE.

SAMPLE 1189-062A DEPTH 2030 — VITRINITE REFLECTANCE VALUES

0.42 0.49 0.56 0.67 0.96

POPULATIONS MEAN	READINGS
0.42	1
0.53	2
0.67	1
0.96	1

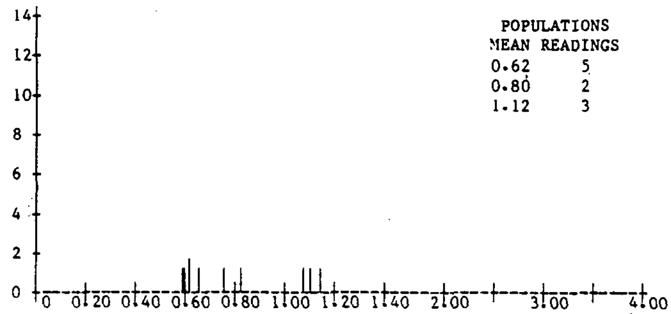


REMARKS AS 059B

SAMPLE 1189-066A DEPTH 2150 — VITRINITE REFLECTANCE VALUES

0.59 0.60 0.62 0.62 0.66 0.76 0.83 1.08 1.11 1.15

POPULATIONS MEAN	READINGS
0.62	5
0.80	2
1.12	3



REMARKS SMALL FRAGMENTS, EXCLUSIVELY REWORKED

FIGURE 9b

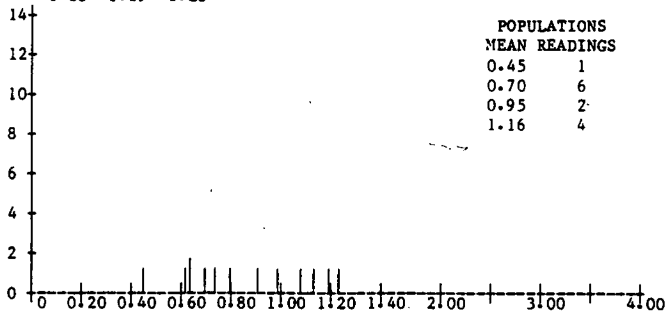
WELL 34/10-23

VITRINITE REFLECTANCE HISTOGRAMS

GEOCHEM

SAMPLE 1189-070A DEPTH 2270 — VITRINITE REFLECTANCE VALUES

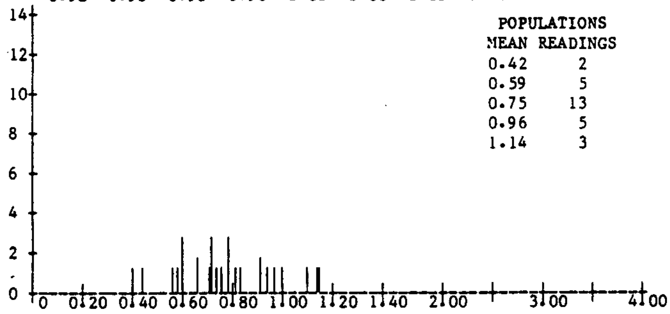
0.45 0.62 0.64 0.65 0.70 0.74 0.80 0.91 0.99 1.08
1.13 1.19 1.23



REMARKS DOMINANTLY REWORKED.

SAMPLE 1189-078A DEPTH 2510 — VITRINITE REFLECTANCE VALUES

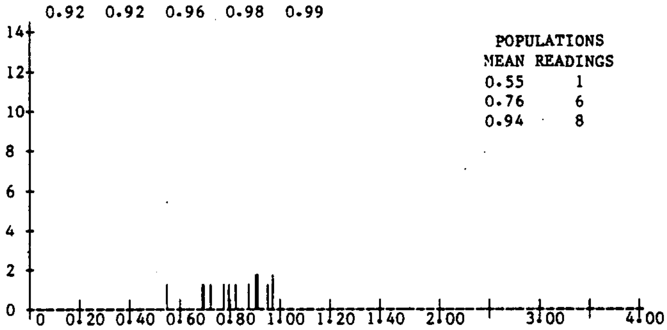
0.40 0.44 0.56 0.58 0.60 0.60 0.60 0.66 0.67 0.71
0.72 0.73 0.73 0.74 0.76 0.79 0.79 0.79 0.82 0.84
0.92 0.93 0.95 0.98 1.01 1.11 1.15 1.16



REMARKS REWORKING EVIDENT, DIFFERENTIATION DIFFICULT.

SAMPLE 1189-084A DEPTH 2660 — VITRINITE REFLECTANCE VALUES

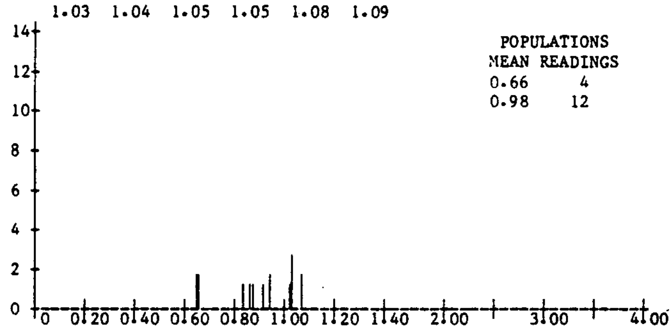
0.55 0.69 0.70 0.73 0.78 0.80 0.83 0.88 0.91 0.91
0.92 0.92 0.96 0.98 0.99



REMARKS AS 078A.

SAMPLE 1189-087A DEPTH 2720 — VITRINITE REFLECTANCE VALUES

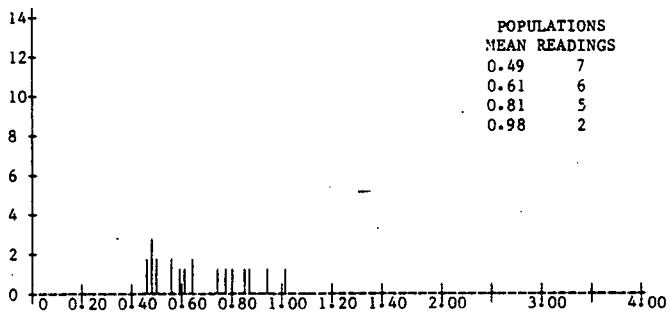
0.65 0.65 0.66 0.67 0.84 0.87 0.88 0.92 0.95 0.95
1.03 1.04 1.05 1.05 1.08 1.09



REMARKS AS 078 A

SAMPLE 1189-091A DEPTH 2810 — VITRINITE REFLECTANCE VALUES

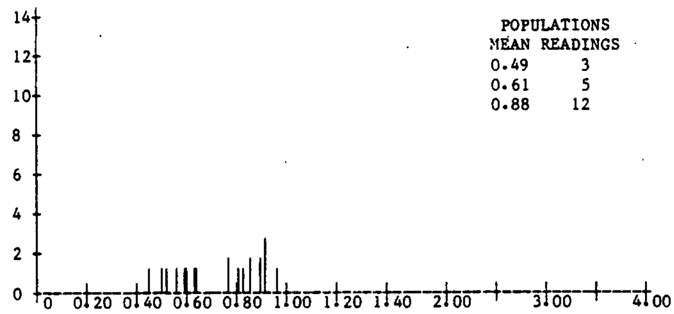
0.46 0.47 0.48 0.48 0.49 0.50 0.51 0.56 0.57 0.59
0.61 0.64 0.65 0.74 0.77 0.80 0.85 0.87 0.94 1.01



REMARKS MAINLY REWORKED.

SAMPLE 1189-097A DEPTH 2930 — VITRINITE REFLECTANCE VALUES

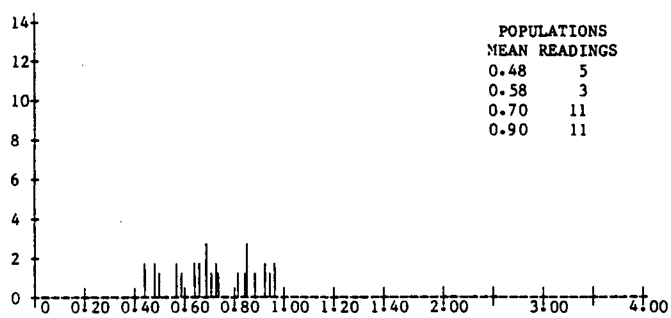
0.45 0.50 0.52 0.56 0.59 0.60 0.63 0.64 0.77 0.77
0.81 0.83 0.86 0.87 0.90 0.90 0.92 0.92 0.93 0.97



REMARKS AS 091A

SAMPLE 1189-104A DEPTH 3050 — VITRINITE REFLECTANCE VALUES

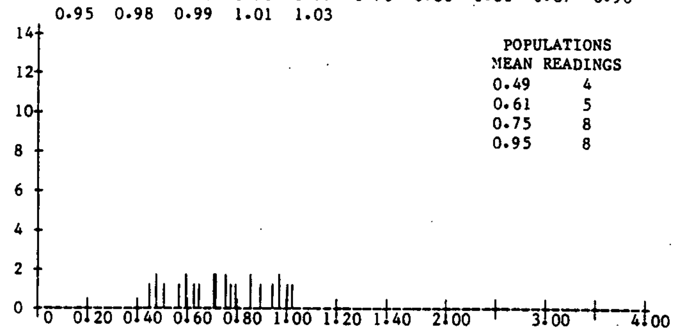
0.44 0.45 0.48 0.49 0.50 0.57 0.57 0.59 0.64 0.65
0.66 0.67 0.69 0.69 0.69 0.71 0.73 0.73 0.74 0.82
0.85 0.86 0.86 0.87 0.89 0.93 0.93 0.95 0.97 0.97



REMARKS OXIDATION EVIDENT.

SAMPLE 1189-109A DEPTH 3150 — VITRINITE REFLECTANCE VALUES

0.45 0.48 0.49 0.51 0.57 0.60 0.60 0.63 0.65 0.71
0.71 0.72 0.73 0.76 0.77 0.78 0.80 0.86 0.87 0.90
0.95 0.98 0.99 1.01 1.03



REMARKS AS 104 A.

FIGURE 9c

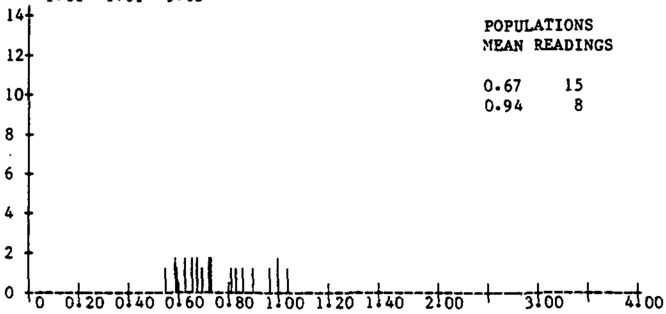
WELL 34/10-23

VITRINITE REFLECTANCE HISTOGRAMS

GEOCHEM

SAMPLE 1189-117A DEPTH 3267 — VITRINITE REFLECTANCE VALUES

0.55 0.59 0.59 0.60 0.63 0.63 0.66 0.66 0.68 0.69
0.70 0.73 0.73 0.74 0.74 0.82 0.84 0.87 0.91 0.98
1.01 1.01 1.05

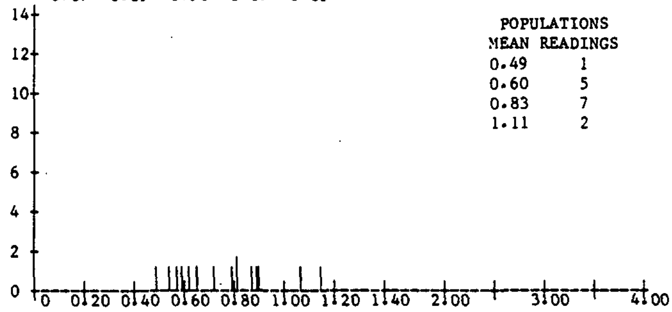


POPULATIONS MEAN	READINGS
0.67	15
0.94	8

REMARKS DIFFERENTIATION DIFFICULT.

SAMPLE 1189-123A DEPTH 3355 — VITRINITE REFLECTANCE VALUES

0.49 0.54 0.57 0.59 0.62 0.65 0.72 0.79 0.81 0.81
0.87 0.89 0.90 1.07 1.15

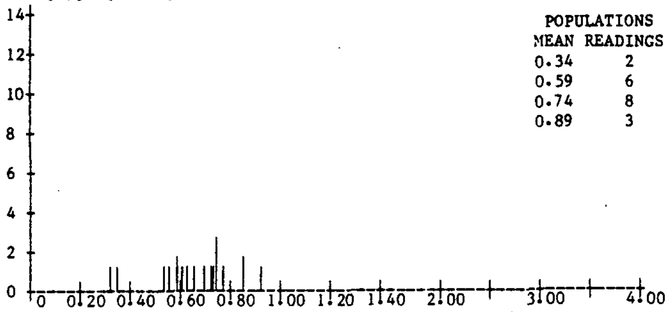


POPULATIONS MEAN	READINGS
0.49	1
0.60	5
0.83	7
1.11	2

REMARKS AS 117A.

SAMPLE 1189-127A DEPTH 3430 — VITRINITE REFLECTANCE VALUES

0.32 0.35 0.54 0.56 0.59 0.59 0.61 0.63 0.66 0.70
0.73 0.74 0.75 0.77 0.77 0.78 0.86 0.86 0.93

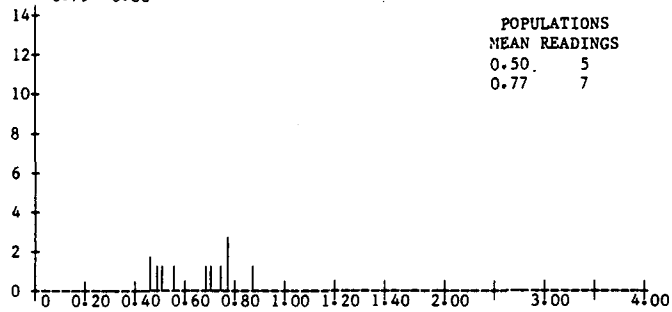


POPULATIONS MEAN	READINGS
0.34	2
0.59	6
0.74	8
0.89	3

REMARKS MAINLY REWORKED

SAMPLE 1189-132A DEPTH 3490 — VITRINITE REFLECTANCE VALUES

0.46 0.46 0.49 0.51 0.56 0.69 0.71 0.75 0.78 0.78
0.79 0.88

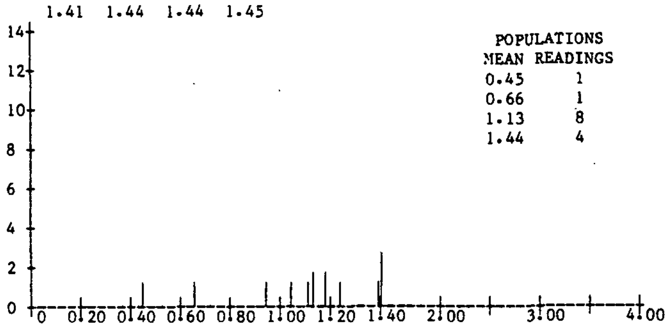


POPULATIONS MEAN	READINGS
0.50	5
0.77	7

REMARKS AS 127A.

SAMPLE 1189-135A DEPTH 3550 — VITRINITE REFLECTANCE VALUES

0.45 0.66 0.95 1.05 1.12 1.14 1.14 1.19 1.19 1.25
1.41 1.44 1.44 1.45

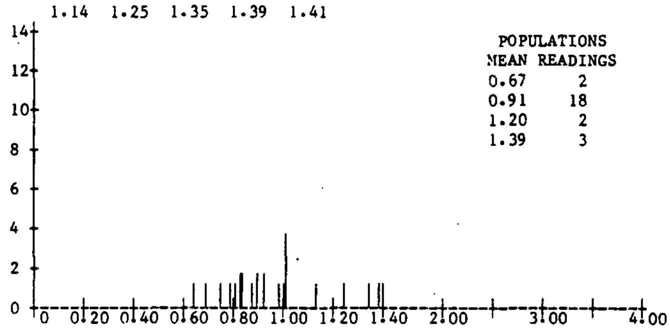


POPULATIONS MEAN	READINGS
0.45	1
0.66	1
1.13	8
1.44	4

REMARKS AS 127A

SAMPLE 1189-140A DEPTH 3610 — VITRINITE REFLECTANCE VALUES

0.64 0.69 0.75 0.79 0.81 0.83 0.83 0.84 0.85 0.88
0.90 0.90 0.93 0.93 0.99 1.01 1.02 1.02 1.03 1.03
1.14 1.25 1.35 1.39 1.41

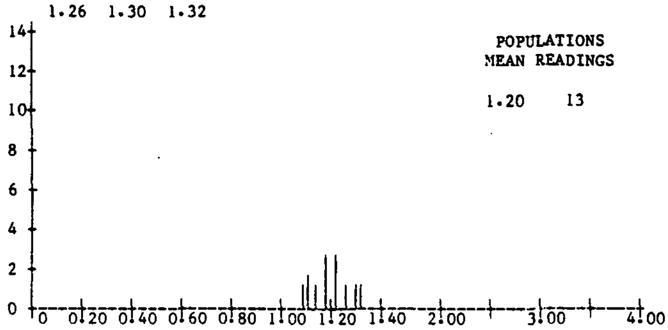


POPULATIONS MEAN	READINGS
0.67	2
0.91	18
1.20	2
1.39	3

REMARKS OXIDATION EVIDENT.

SAMPLE 1189-143A DEPTH 3670 — VITRINITE REFLECTANCE VALUES

1.09 1.11 1.11 1.14 1.18 1.19 1.19 1.22 1.22 1.23
1.26 1.30 1.32

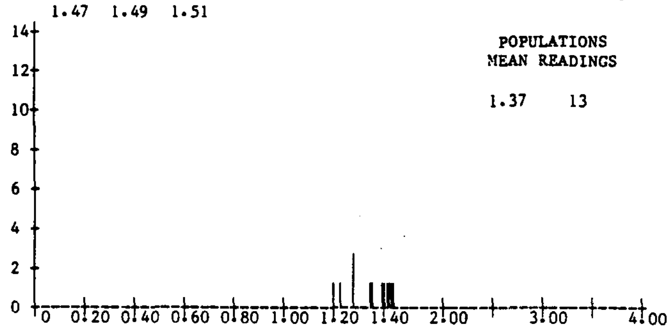


POPULATIONS MEAN	READINGS
1.20	13

REMARKS EXCLUSIVELY REWORKED

SAMPLE 1189-149B DEPTH 3760 — VITRINITE REFLECTANCE VALUES

1.20 1.23 1.28 1.28 1.29 1.35 1.36 1.40 1.42 1.45
1.47 1.49 1.51



POPULATIONS MEAN	READINGS
1.37	13

REMARKS AS 143A.

FIGURE 9d

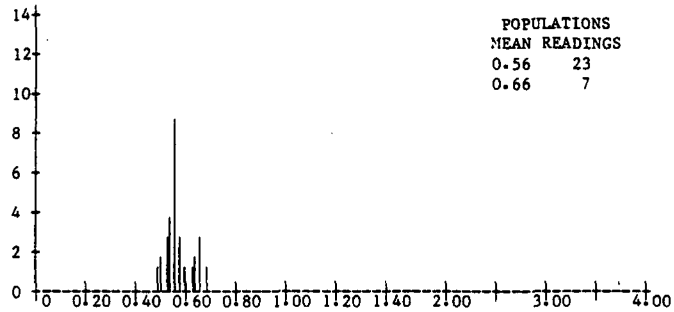
WELL 34/10-23

VITRINITE REFLECTANCE HISTOGRAMS

GEOCHEM

SAMPLE 1189-156B DEPTH 3865 — VITRINITE REFLECTANCE VALUES

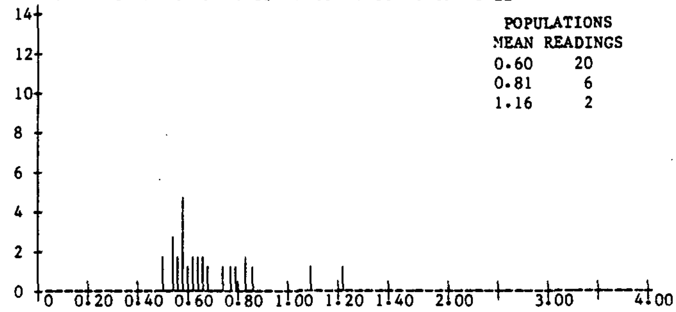
0.49	0.50	0.51	0.53	0.53	0.53	0.54	0.54	0.54	0.55
0.56	0.56	0.56	0.56	0.56	0.57	0.57	0.57	0.57	0.58
0.58	0.59	0.60	0.63	0.64	0.64	0.66	0.66	0.67	0.69



REMARKS VITRINITE ABUNDANT.

SAMPLE 1189-159A DEPTH 3910 — VITRINITE REFLECTANCE VALUES

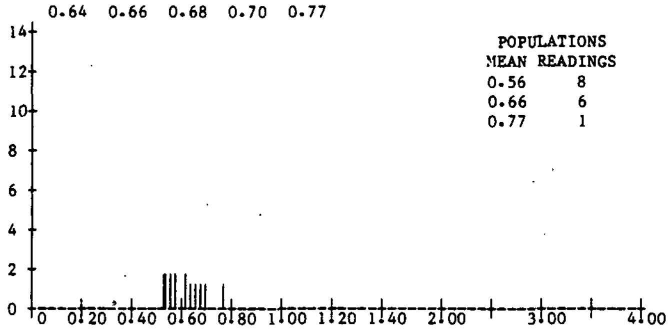
0.50	0.51	0.54	0.54	0.55	0.56	0.57	0.58	0.58	0.58
0.59	0.59	0.60	0.62	0.63	0.64	0.65	0.66	0.67	0.68
0.74	0.77	0.79	0.83	0.83	0.86	1.09	1.22		



REMARKS AS 156B

SAMPLE 1189-161A DEPTH 3940 — VITRINITE REFLECTANCE VALUES

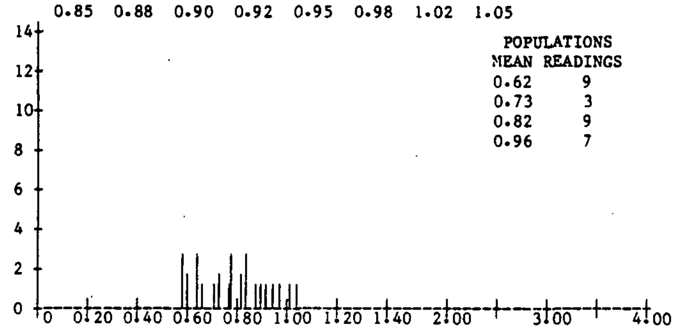
0.53	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.62	0.62
0.64	0.66	0.68	0.70	0.77					



REMARKS SMALL FRAGMENTS OF VITRINITE, SIGNIFICANT INERTINITE.

SAMPLE 1189-166A DEPTH 4015 — VITRINITE REFLECTANCE VALUES

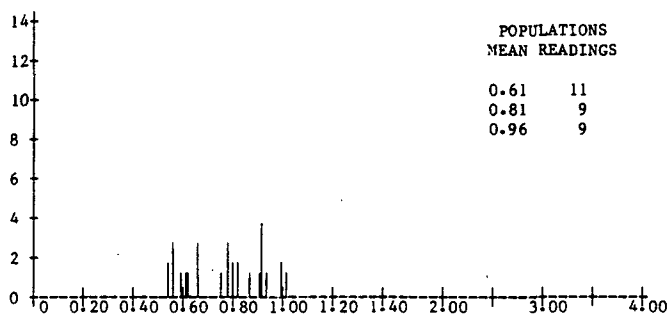
0.58	0.59	0.59	0.60	0.60	0.64	0.64	0.65	0.66	0.71
0.73	0.73	0.77	0.78	0.78	0.78	0.82	0.83	0.84	0.85
0.85	0.88	0.90	0.92	0.95	0.98	1.02	1.05		



REMARKS SMALL FRAGMENTS, REWORKING EVIDENT.

SAMPLE 1189-170A DEPTH 4075 — VITRINITE REFLECTANCE VALUES

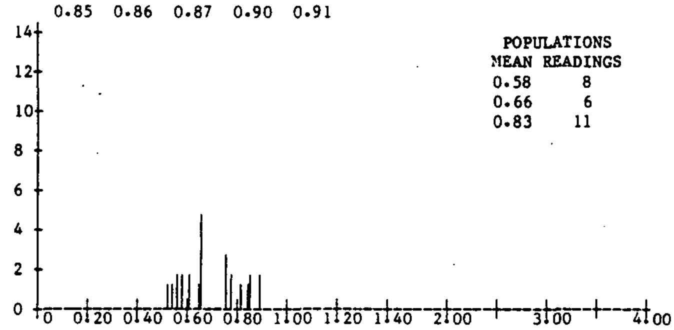
	0.54	0.55	0.56	0.57	0.57	0.59	0.61	0.62	0.66
0.67	0.67	0.75	0.78	0.79	0.79	0.80	0.81	0.82	0.83
0.87	0.91	0.92	0.92	0.92	0.92	0.94	1.00	1.01	1.02



REMARKS AS 166A

SAMPLE 1189-180A DEPTH 4120 — VITRINITE REFLECTANCE VALUES

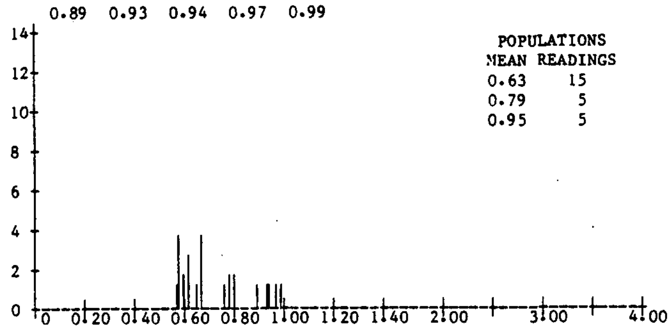
0.52	0.54	0.56	0.57	0.58	0.59	0.61	0.61	0.65	0.66
0.66	0.66	0.66	0.67	0.76	0.77	0.77	0.78	0.79	0.82
0.85	0.86	0.87	0.90	0.91					



REMARKS AS 166A

SAMPLE 1189-181A DEPTH 4212 — VITRINITE REFLECTANCE VALUES

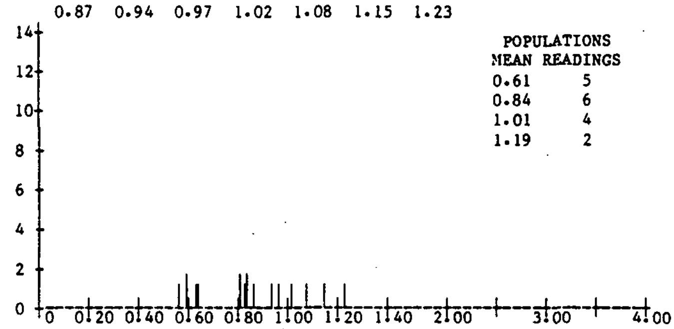
0.57	0.58	0.58	0.59	0.59	0.60	0.61	0.62	0.62	0.63
0.65	0.67	0.67	0.67	0.67	0.76	0.78	0.79	0.80	0.81
0.89	0.93	0.94	0.97	0.99					



REMARKS GOOD FRAGMENTS OF VITRINITE, INERTINITE DOMINANT.

SAMPLE 1189-186A DEPTH 4330 — VITRINITE REFLECTANCE VALUES

0.56	0.59	0.59	0.63	0.64	0.81	0.81	0.83	0.84	0.85
0.87	0.94	0.97	1.02	1.08	1.15	1.23			



REMARKS AS 181A

FIGURE 9e

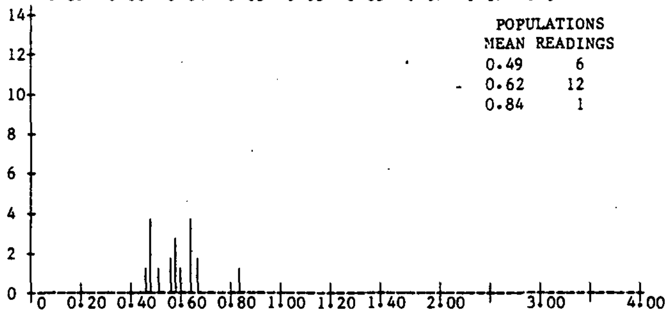
WELL 34/10-23

VITRINITE REFLECTANCE HISTOGRAMS

GEOCHEM

SAMPLE 1189-191B DEPTH ~~4406~~ VITRINITE REFLECTANCE VALUES

0.46 0.48 0.48 0.48 0.48 0.51 0.56 0.57 0.58 0.59
0.59 0.60 0.64 0.65 0.65 0.65 0.67 0.67 0.84

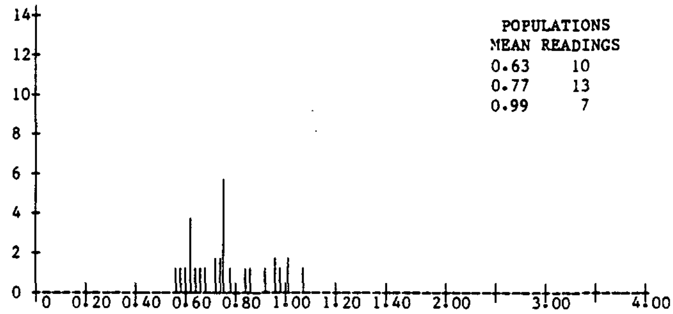


POPULATIONS MEAN	READINGS
0.49	6
0.62	12
0.84	1

REMARKS SMALL FRAGMENTS, VITRINITE DOMINANT.

SAMPLE 1189-196B DEPTH 4480 VITRINITE REFLECTANCE VALUES

0.56 0.58 0.60 0.62 0.62 0.62 0.63 0.64 0.66 0.68
0.72 0.72 0.74 0.74 0.75 0.75 0.75 0.76 0.77 0.77
0.78 0.84 0.86 0.92 0.96 0.96 0.98 1.01 1.01 1.07

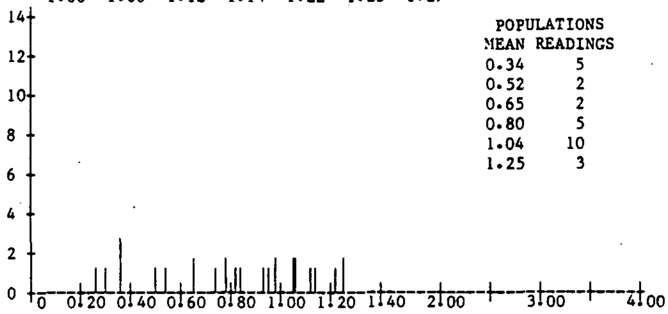


POPULATIONS MEAN	READINGS
0.63	10
0.77	13
0.99	7

REMARKS AS 191 A

SAMPLE 1189-202A DEPTH 4570 VITRINITE REFLECTANCE VALUES

0.26 0.30 0.36 0.37 0.37 0.50 0.54 0.65 0.65 0.74
0.78 0.79 0.82 0.84 0.93 0.95 0.98 0.99 1.05 1.05
1.06 1.06 1.12 1.14 1.22 1.25 1.27

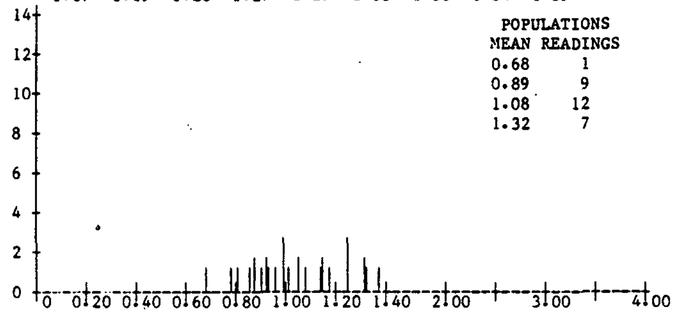


POPULATIONS MEAN	READINGS
0.34	5
0.52	2
0.65	2
0.80	5
1.04	10
1.25	3

REMARKS LIGNITE PRESENT, SMALL FRAGMENT DIFFERTIATION DIFFICULT.

SAMPLE 1189-207A DEPTH 4665 VITRINITE REFLECTANCE VALUES

0.68 0.78 0.81 0.86 0.88 0.89 0.91 0.93 0.93 0.94
0.97 1.00 1.00 1.01 1.02 1.06 1.07 1.09 1.15 1.16
1.17 1.19 1.26 1.27 1.27 1.33 1.33 1.34 1.39

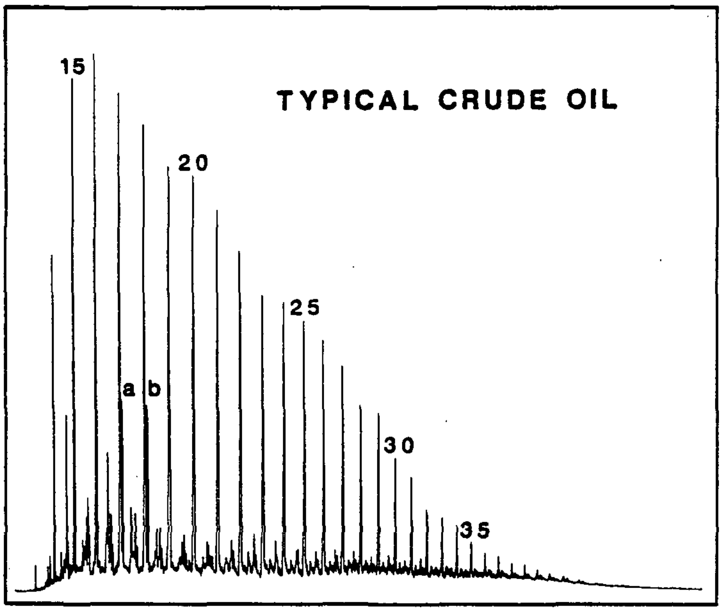


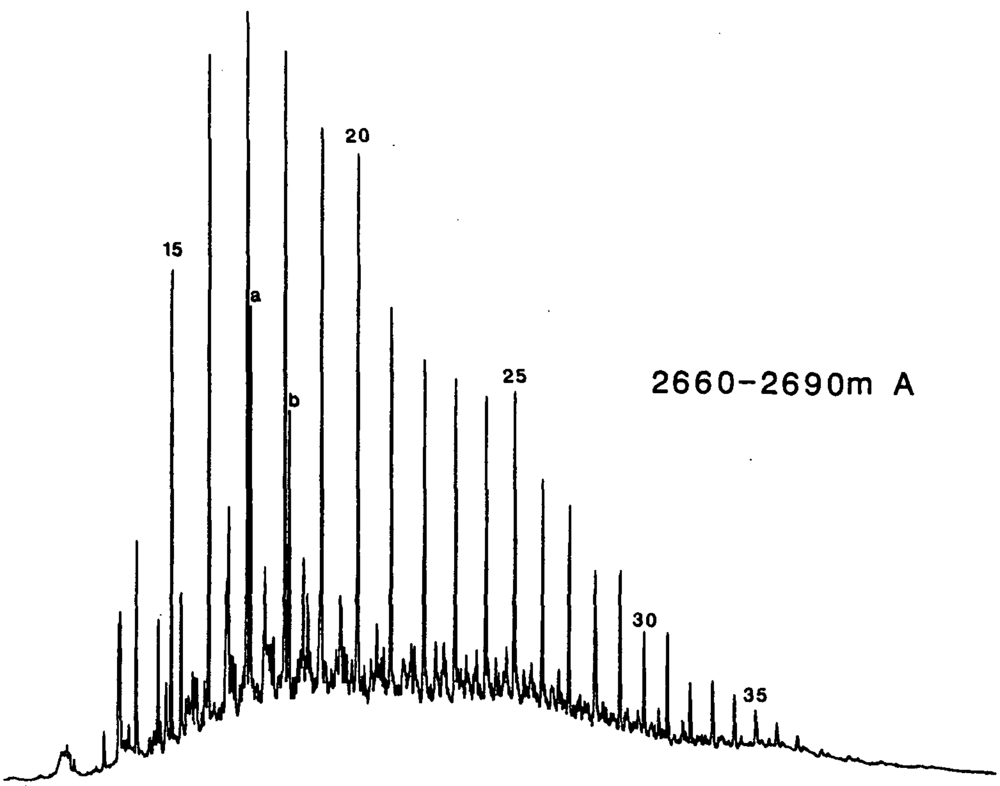
POPULATIONS MEAN	READINGS
0.68	1
0.89	9
1.08	12
1.32	7

REMARKS DIFFERENTIATION DIFFICULT.

FIGURE 10a C_{15+} SATURATES CHROMATOGRAMS

WELL 34/10-23





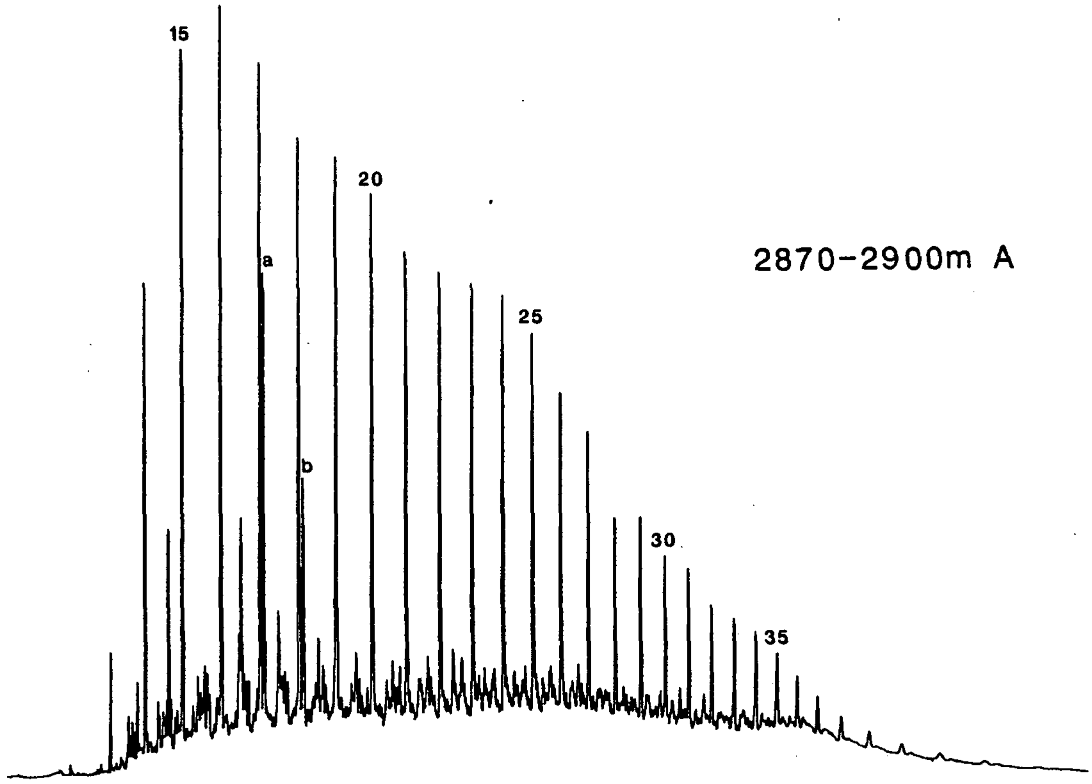
a - PRISTANE

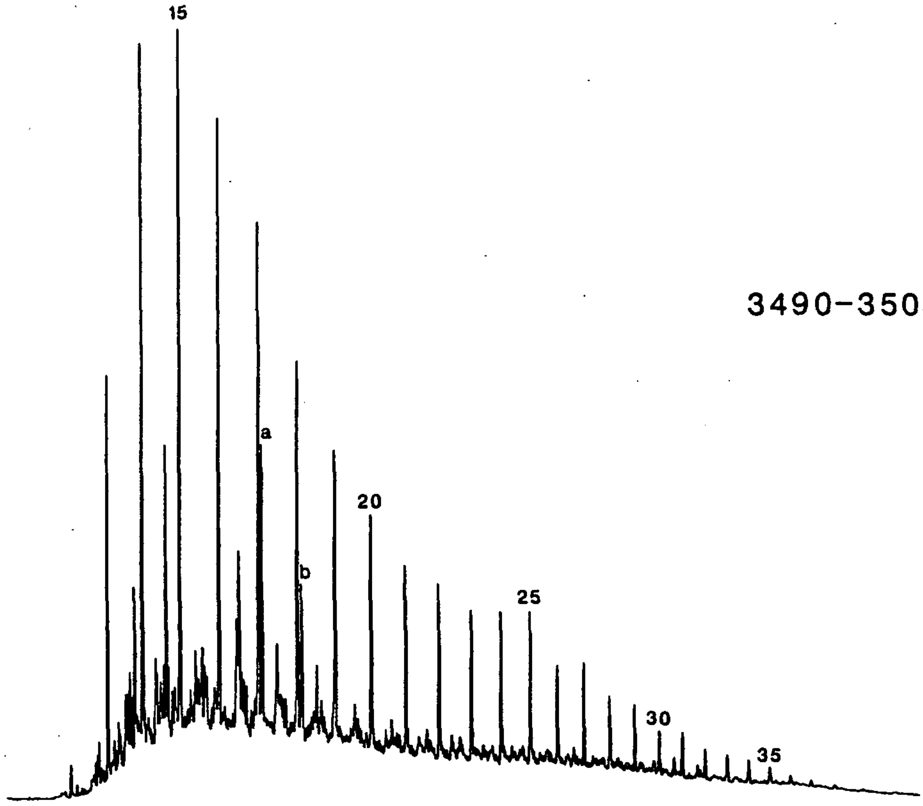
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED ($20-nC_{20}$)

FIGURE 10b **C_{15+} SATURATES CHROMATOGRAMS**

WELL 34/10-23





a - PRISTANE

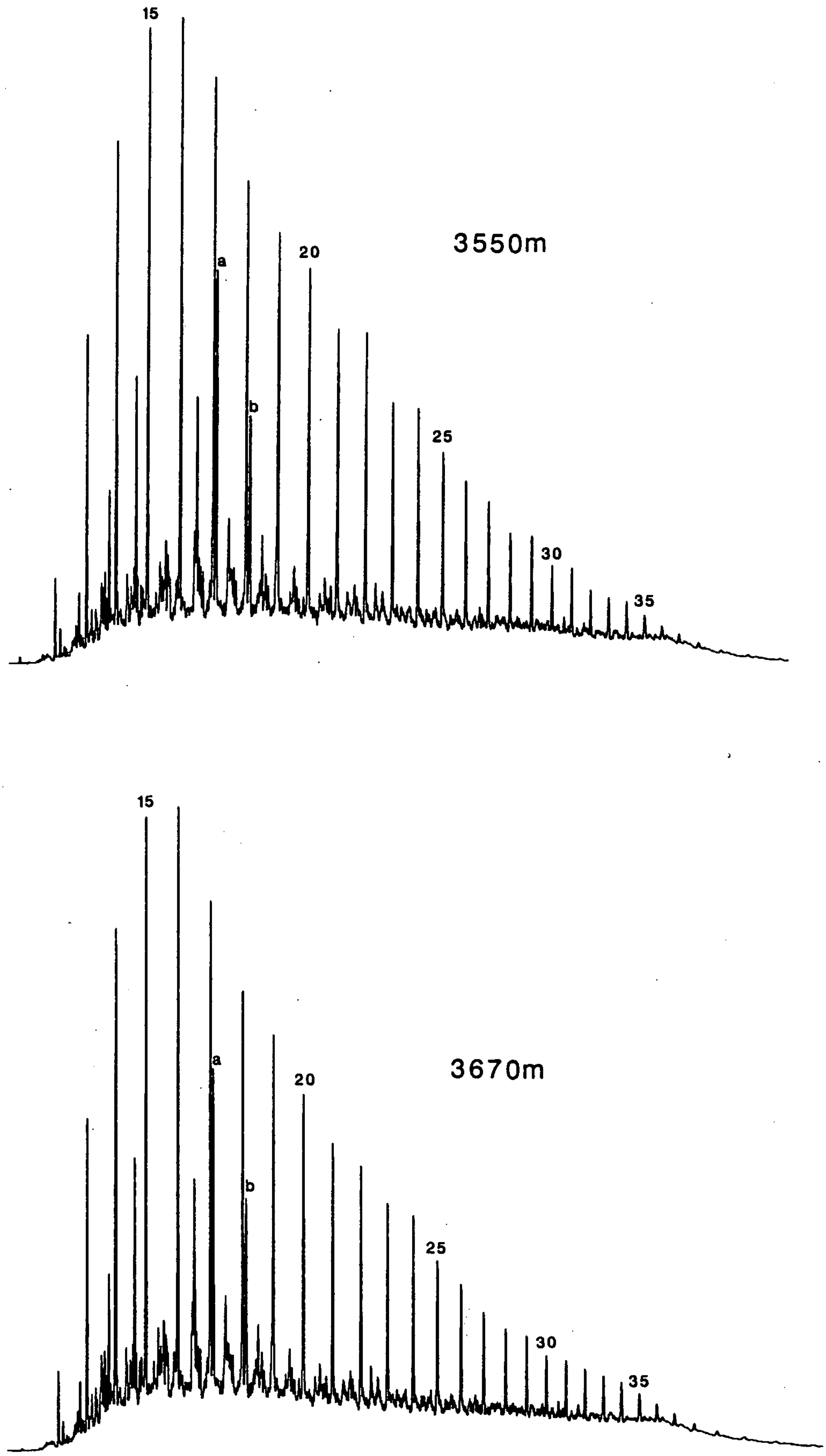
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 10c C_{15+} SATURATES CHROMATOGRAMS

WELL 34/10-23

GEOCHEM



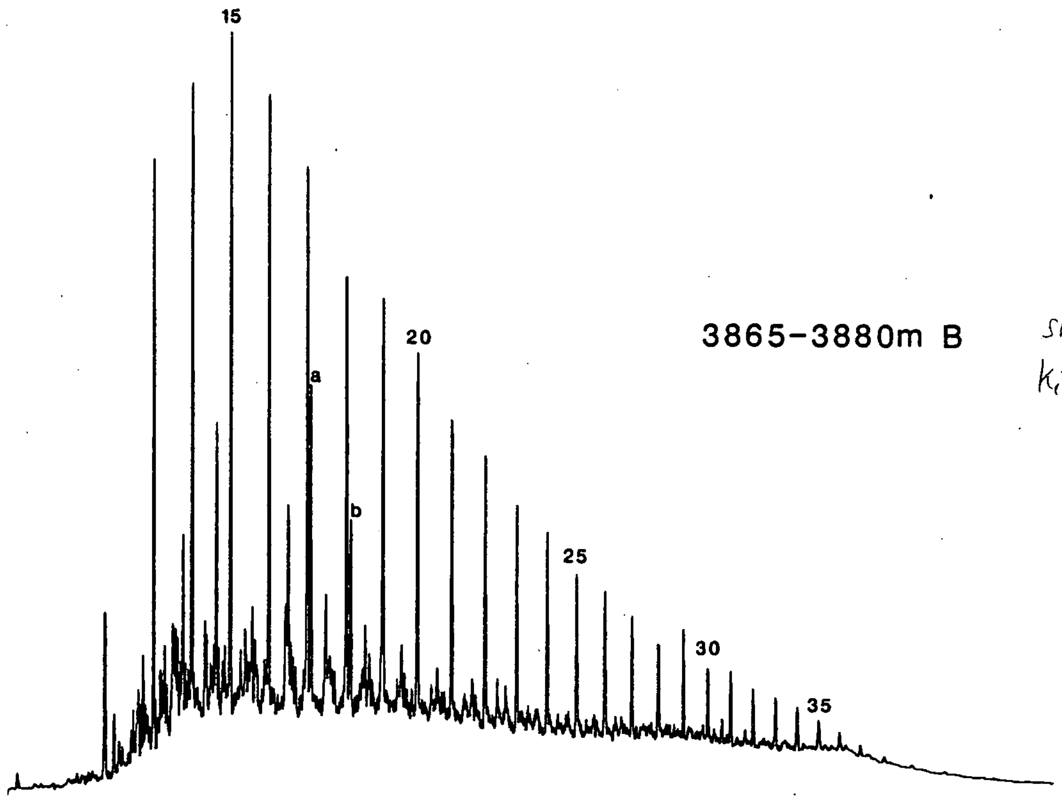
a - PRISTANE

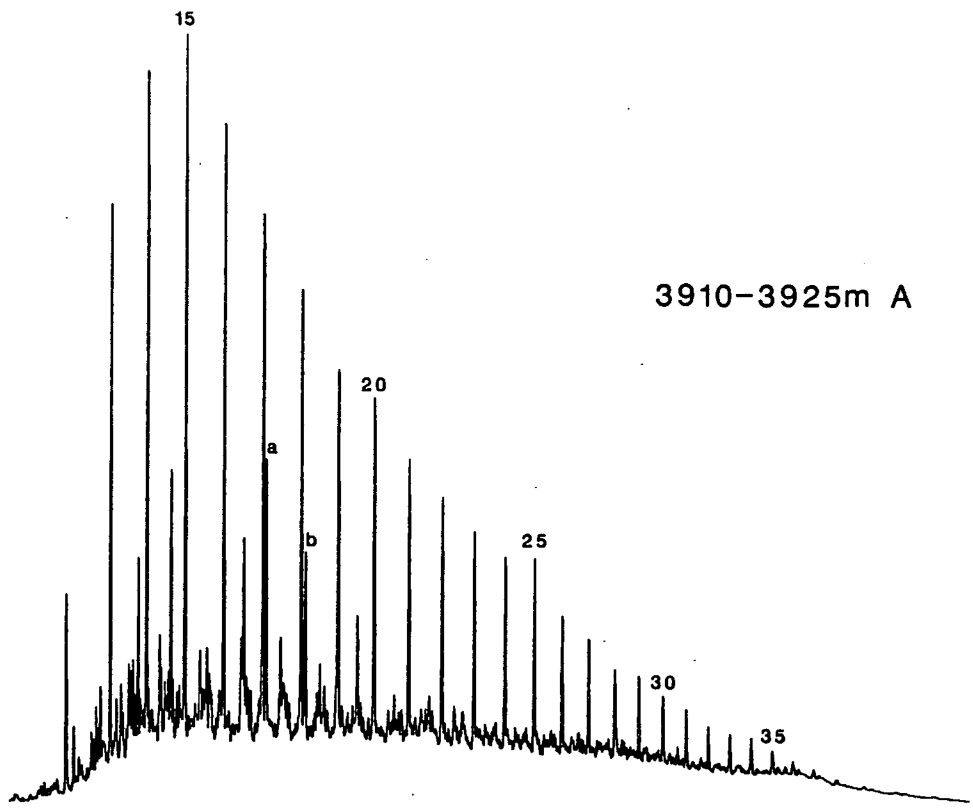
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 10d
WELL 34/10-23

C_{15+} SATURATES CHROMATOGRAMS



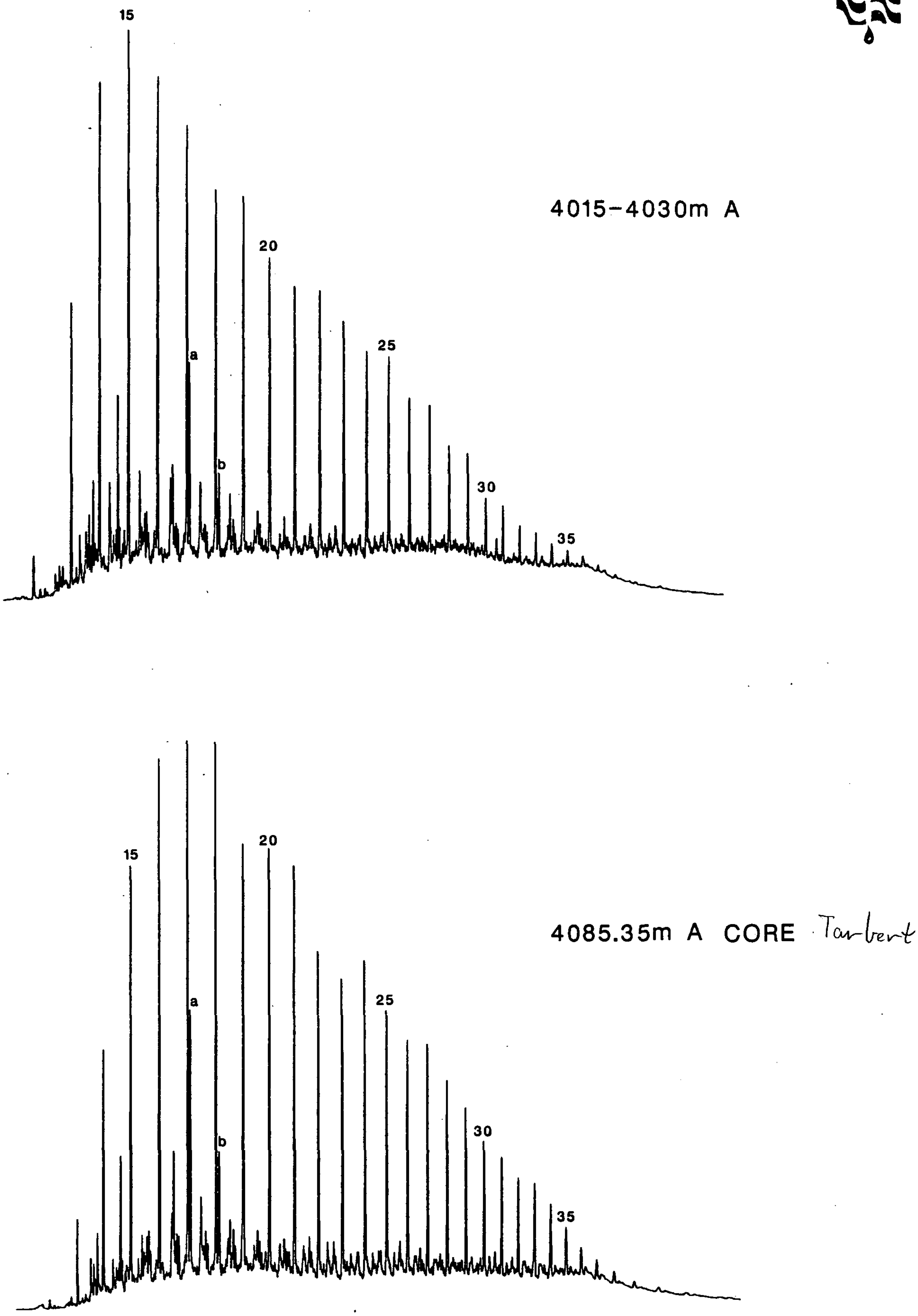


a - PRISTANE
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 10e C_{15+} SATURATES CHROMATOGRAMS

WELL 34/10-23



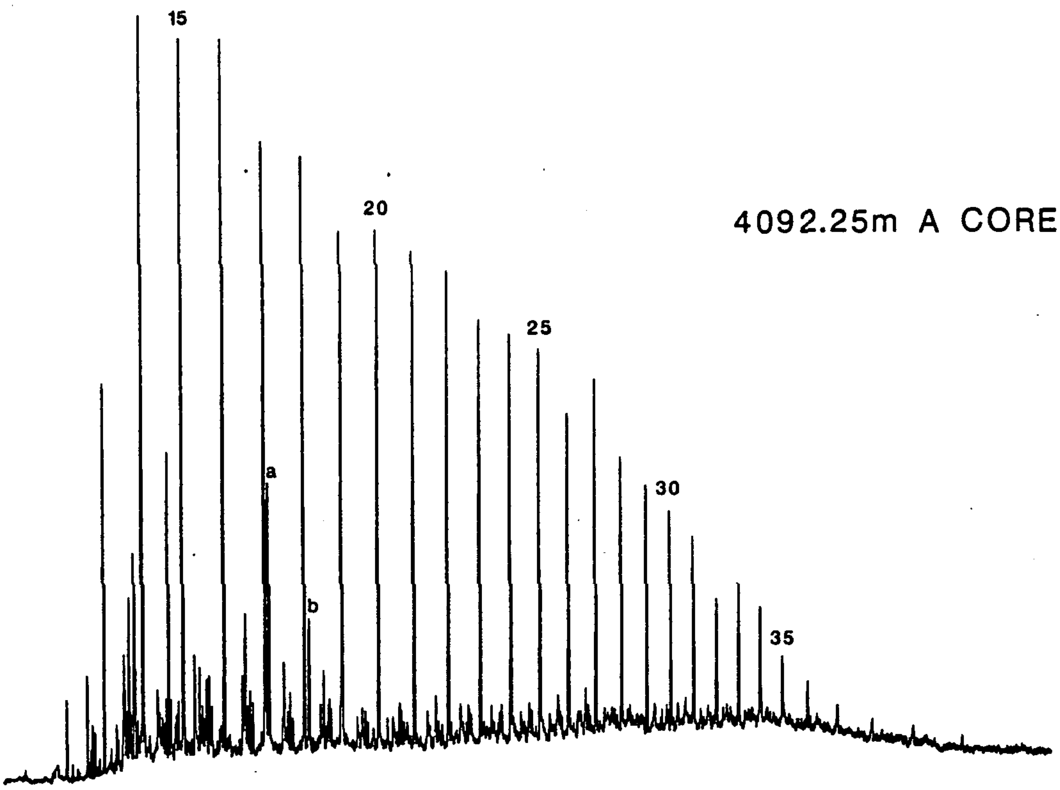
a - PRISTANE

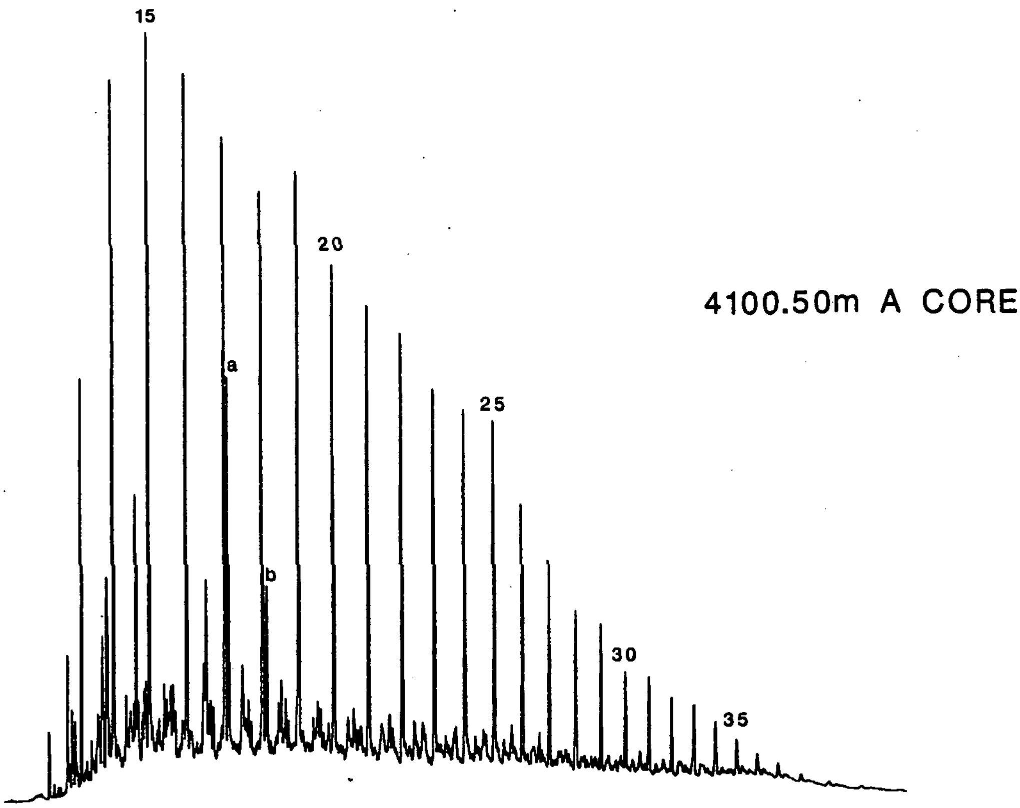
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 10f C_{15+} SATURATES CHROMATOGRAMS

WELL 34/10-23





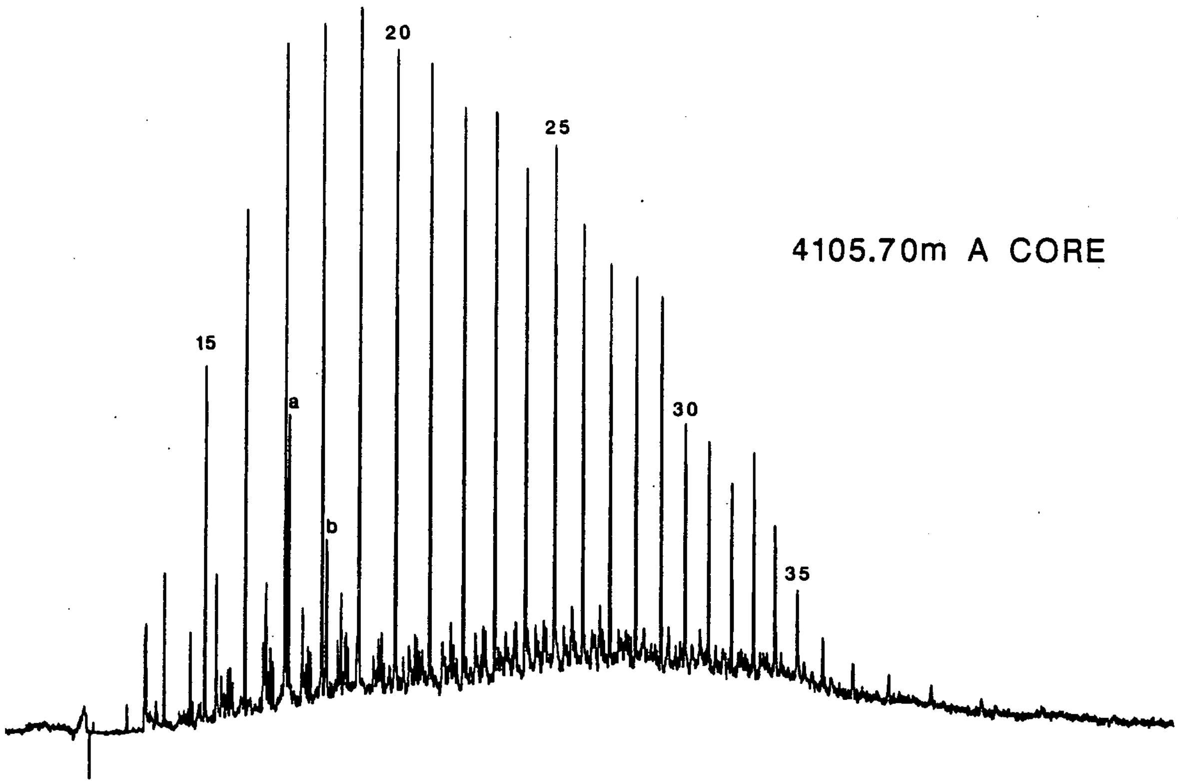
a - PRISTANE

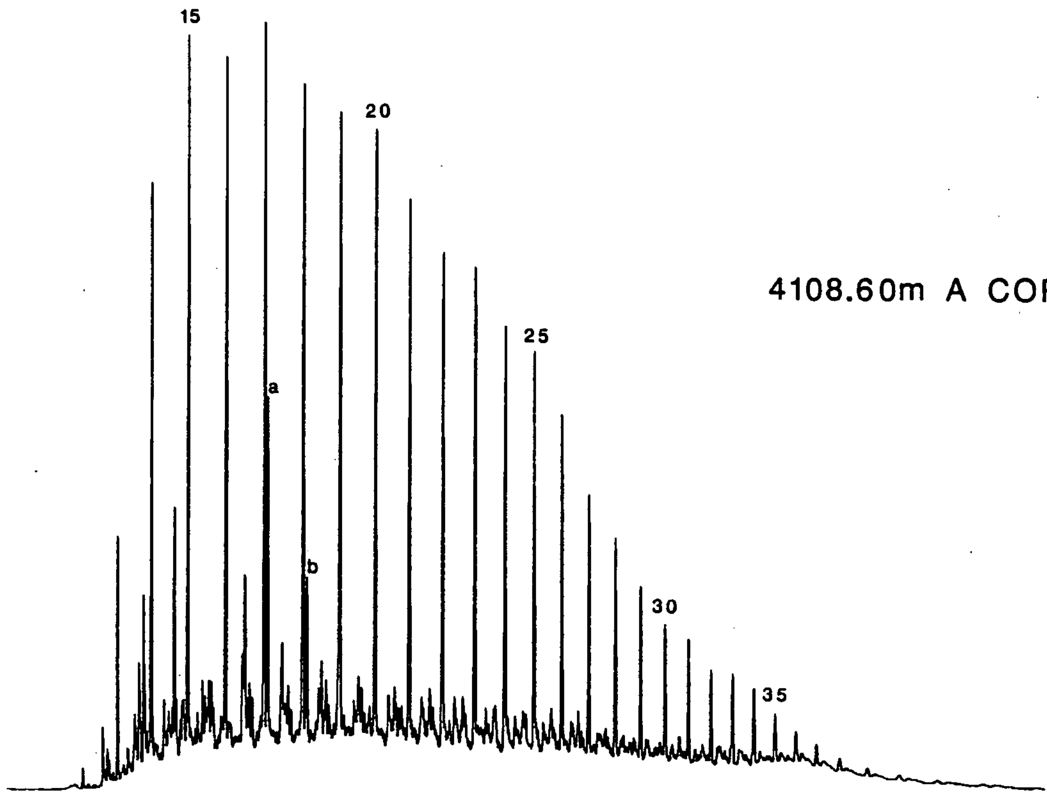
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 10g **C_{15+} SATURATES CHROMATOGRAMS**

WELL 34/10-23





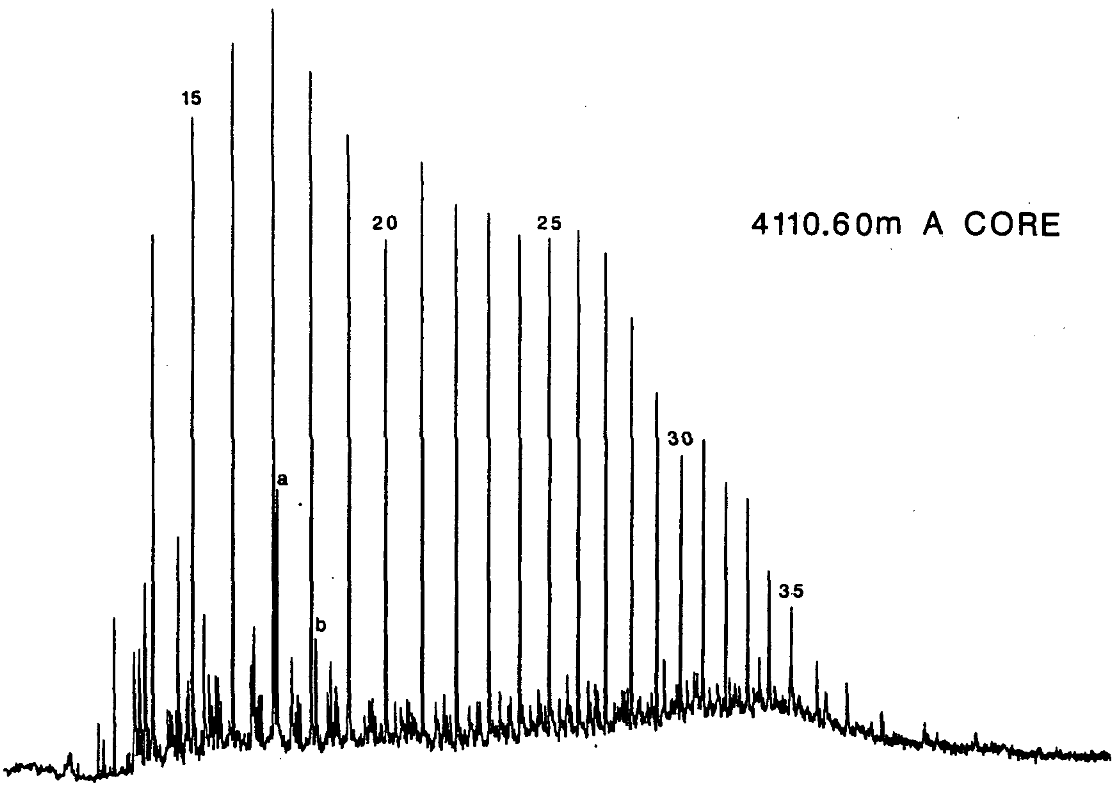
a - PRISTANE

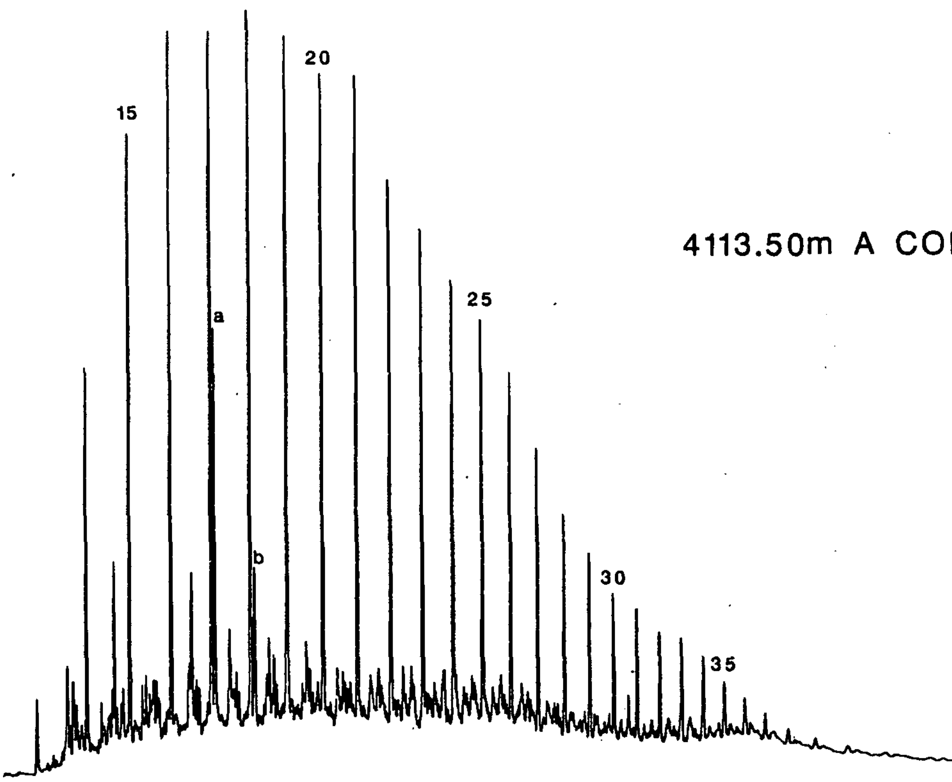
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC)

FIGURE 10h C_{15+} SATURATES CHROMATOGRAMS

WELL 34/10-23





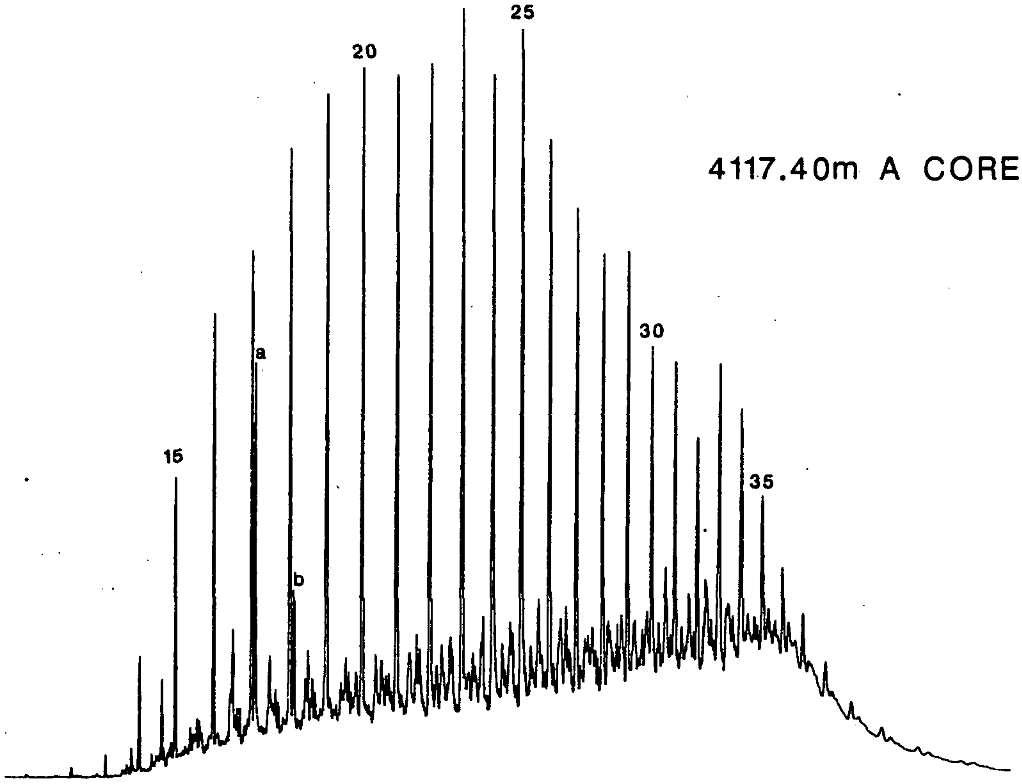
a - PRISTANE

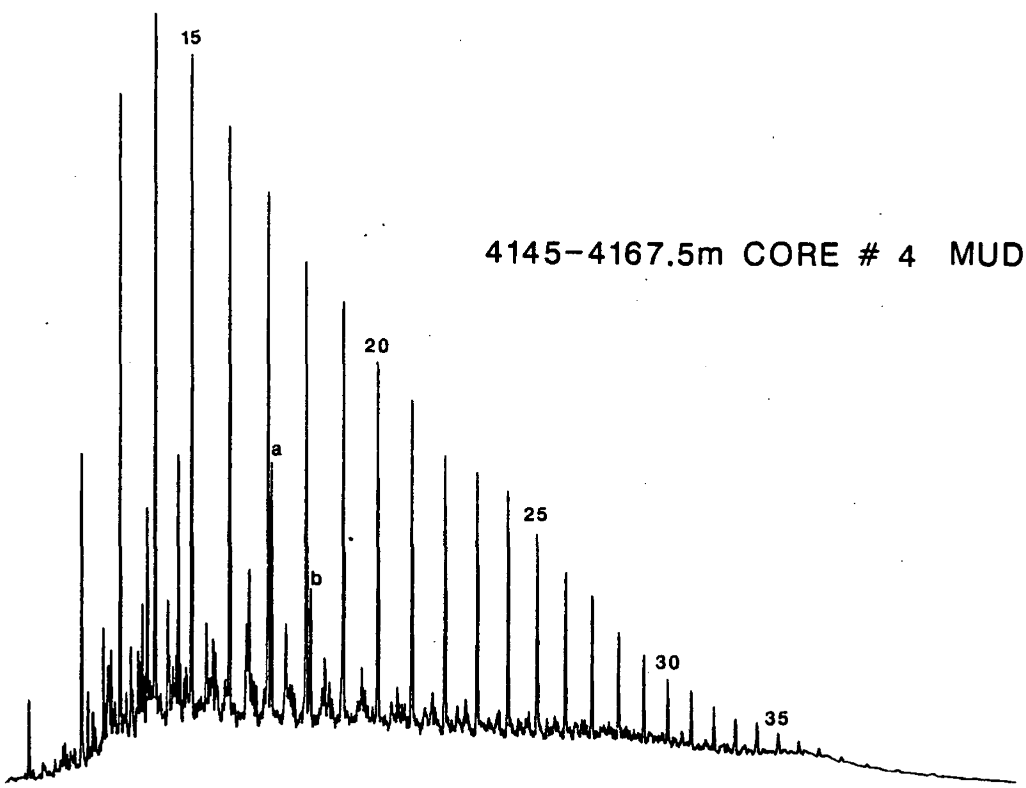
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 10i C_{15+} SATURATES CHROMATOGRAMS

WELL 34/10-23





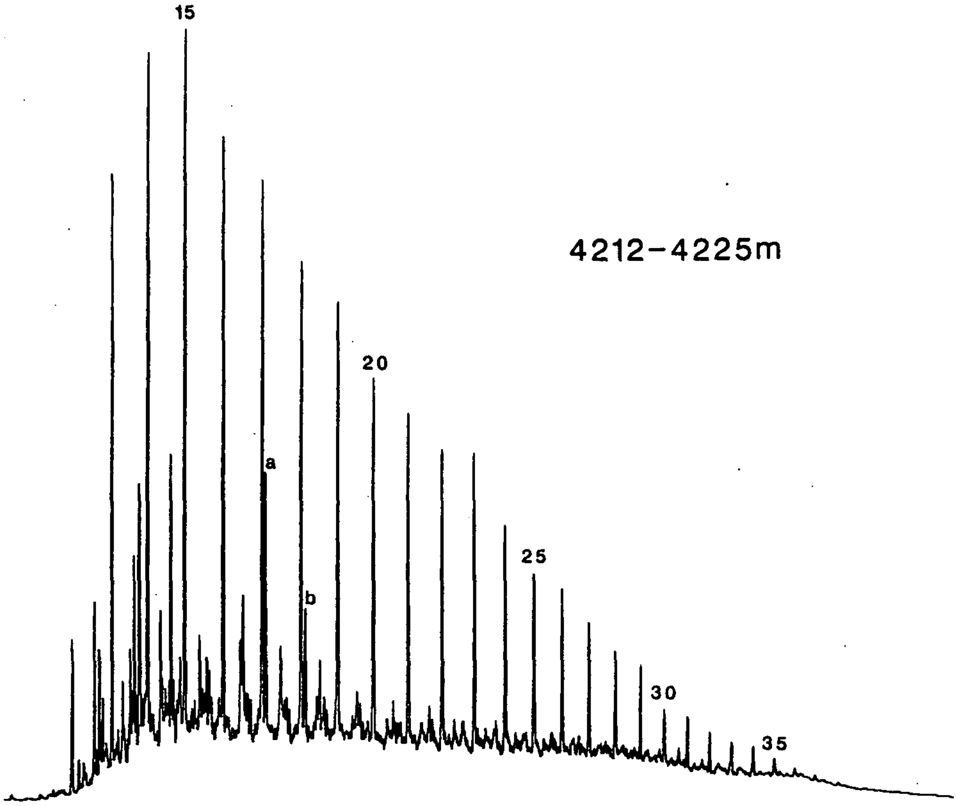
a - PRISTANE

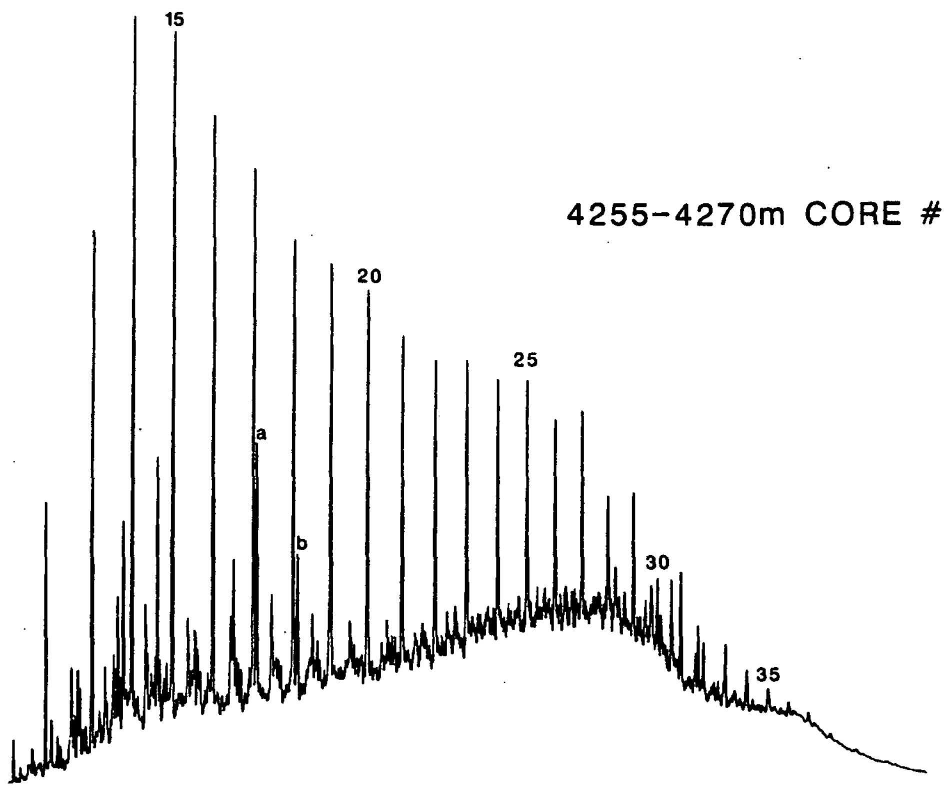
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 10j C_{15+} SATURATES CHROMATOGRAMS

WELL 34/10-23





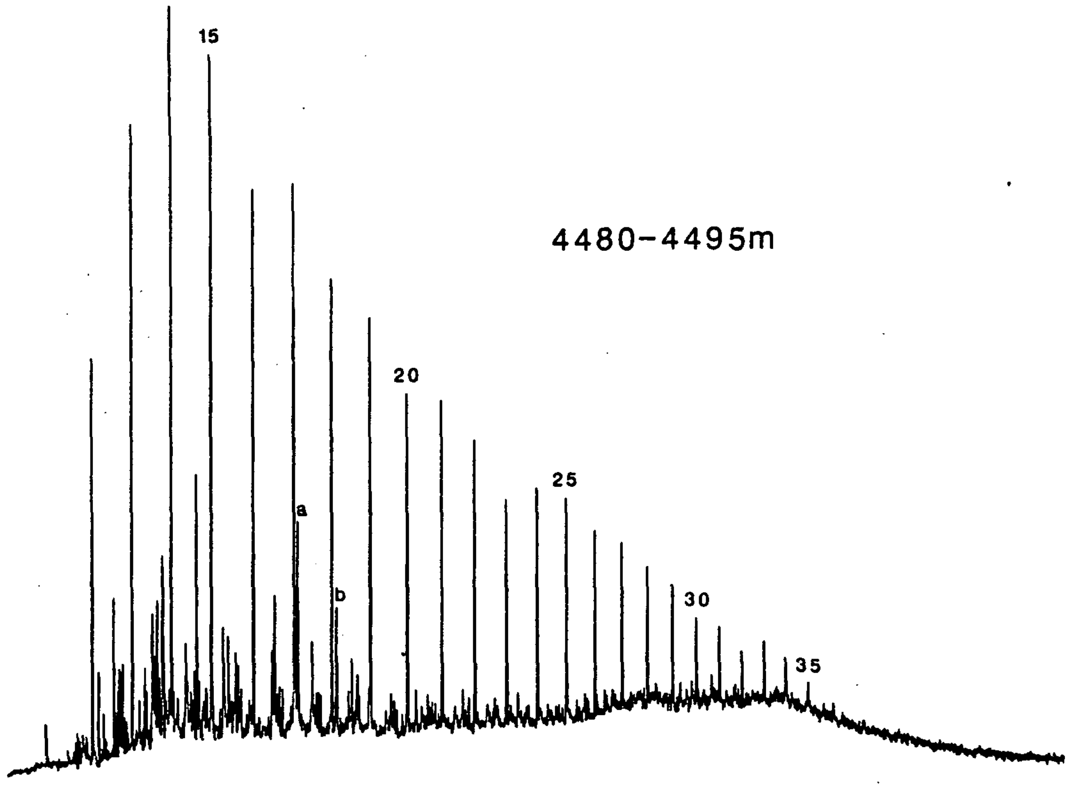
a - PRISTANE

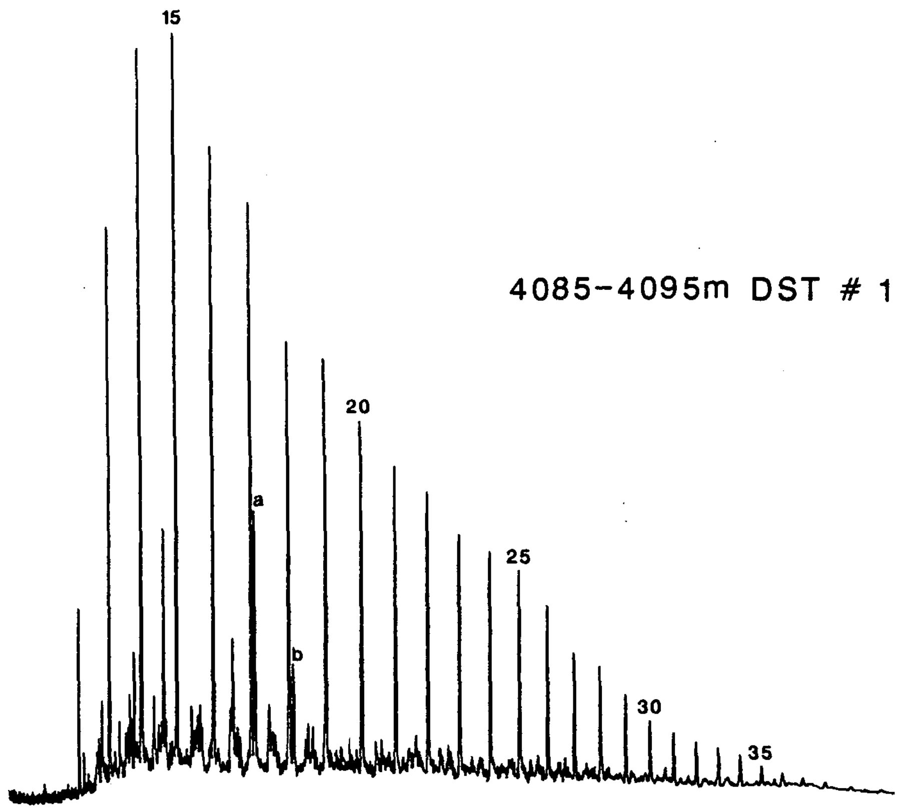
b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 10k C_{15+} SATURATES CHROMATOGRAMS

WELL 34/10-23





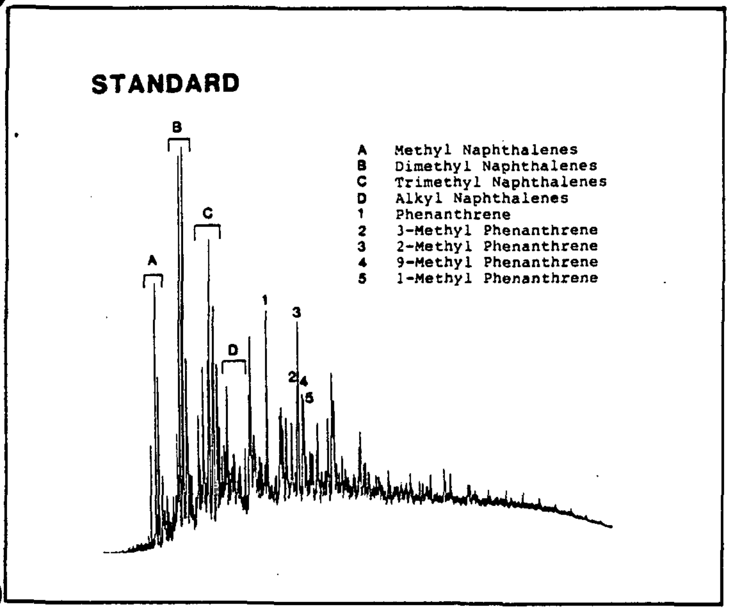
a - PRISTANE

b - PHYTANE

CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 11a **C_{15+} AROMATIC CHROMATOGRAMS**

WELL 34/10-23



2660-2690m

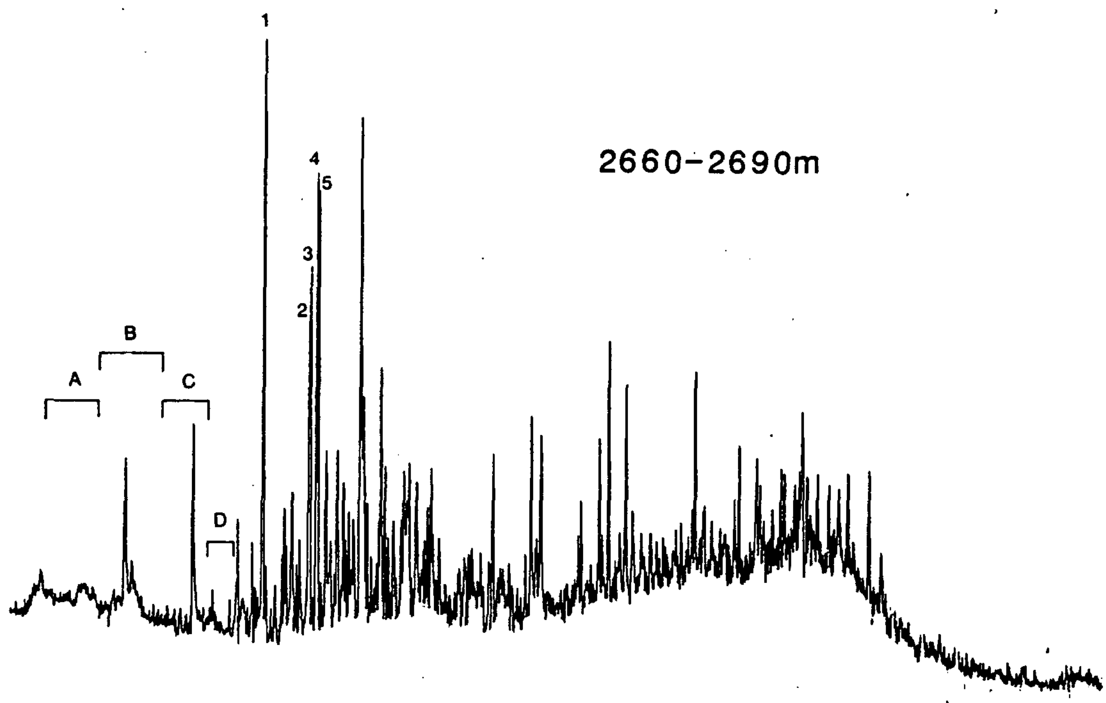
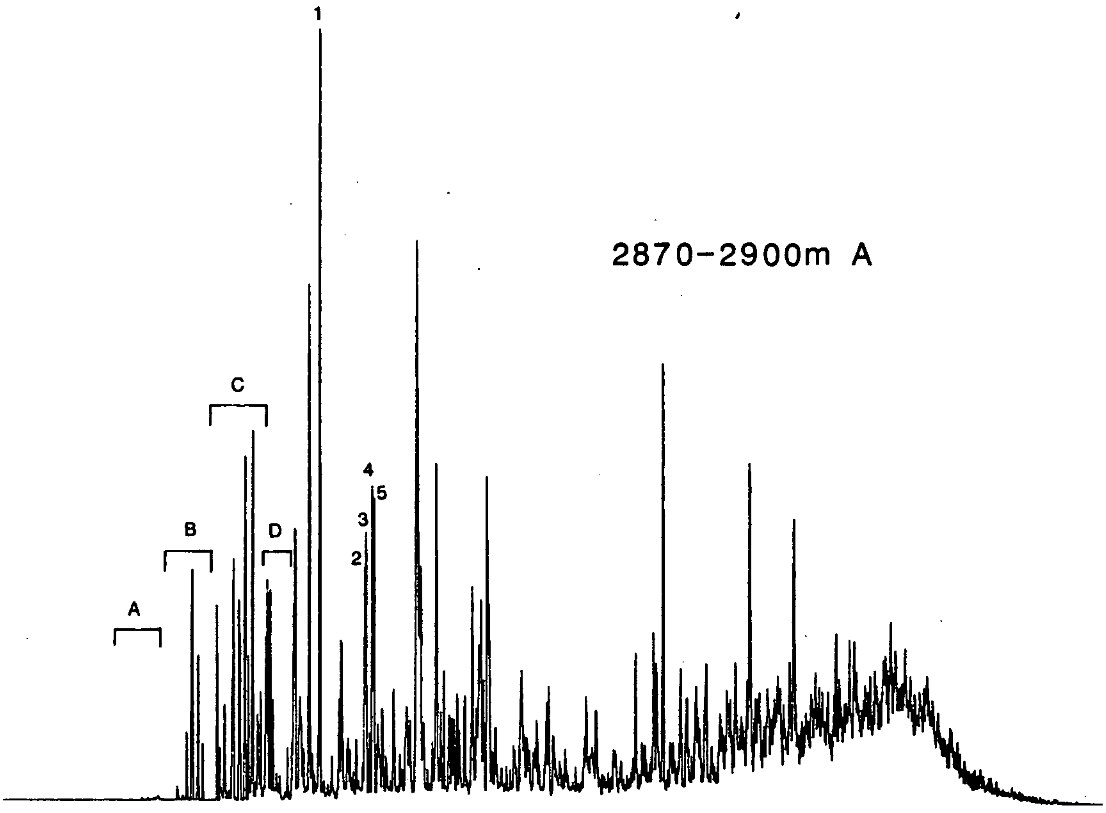
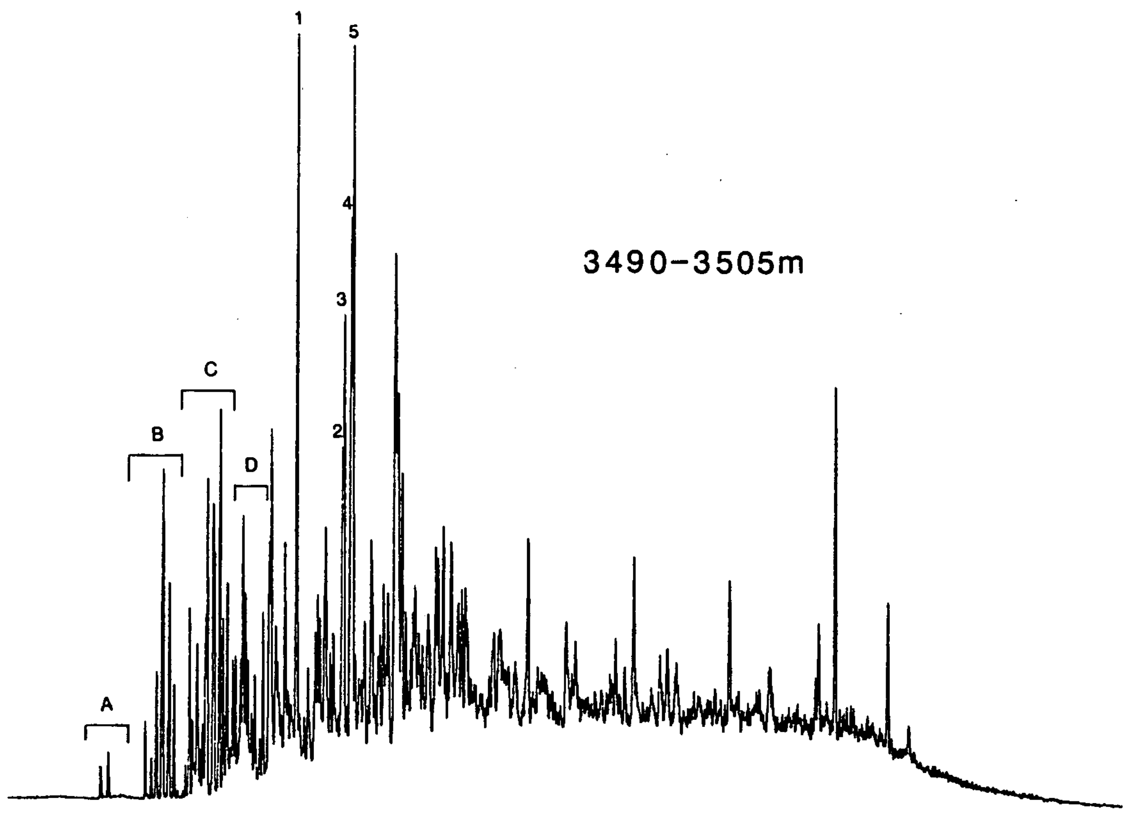


FIGURE 11b **C_{15+} AROMATIC CHROMATOGRAMS**

WELL 34/10-23

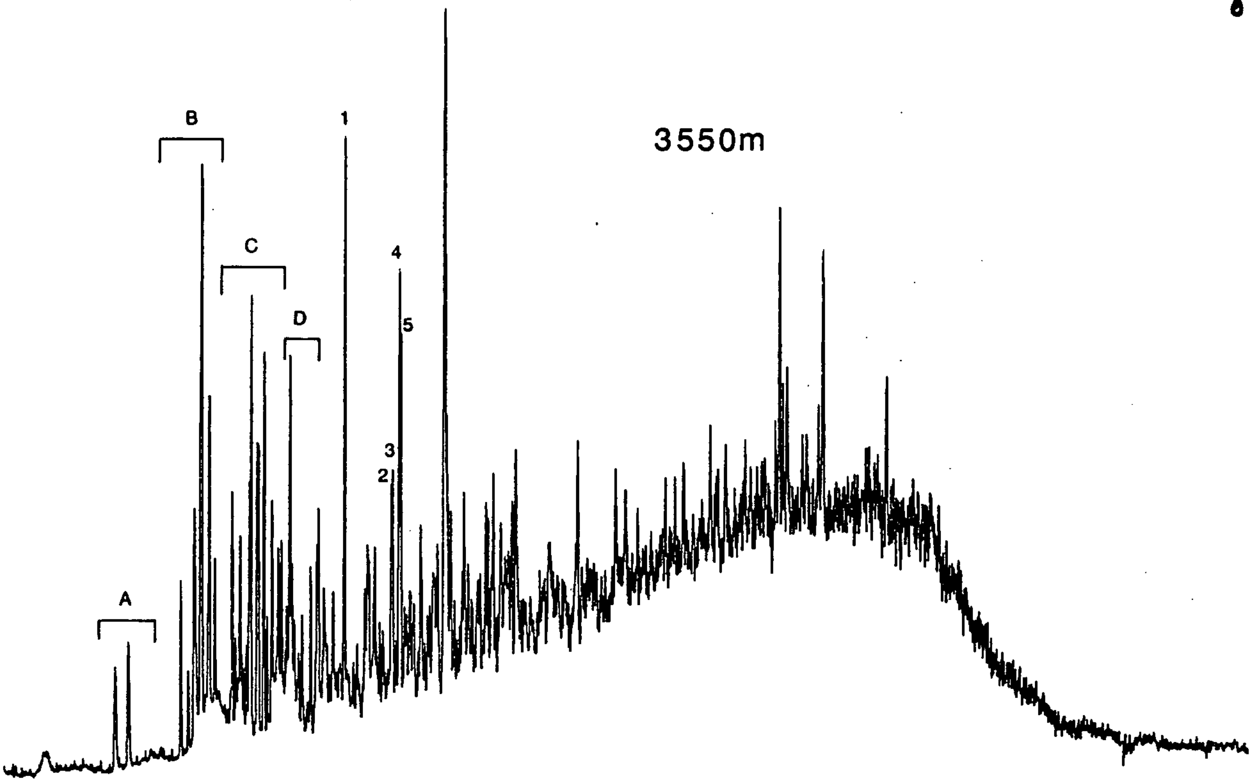


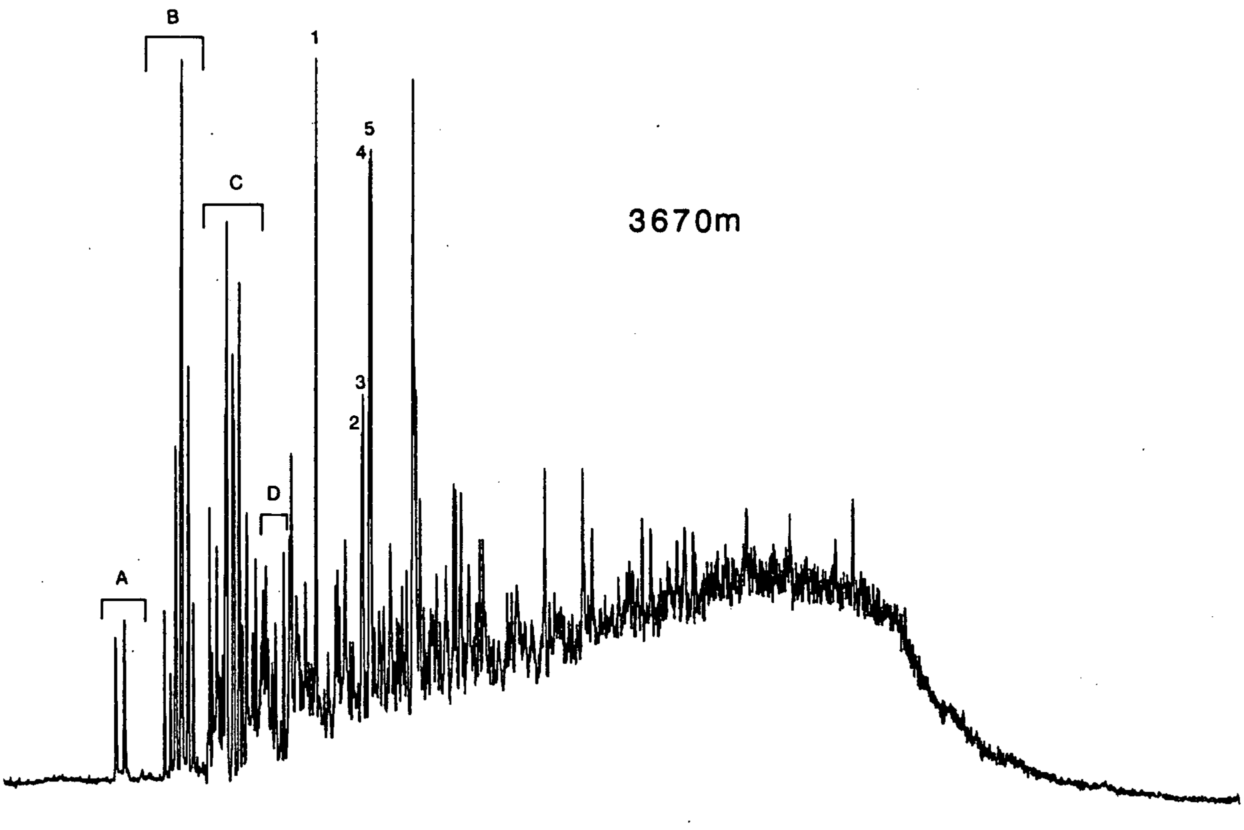


PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 11c C_{15+} AROMATIC CHROMATOGRAMS

WELL 34/10-23





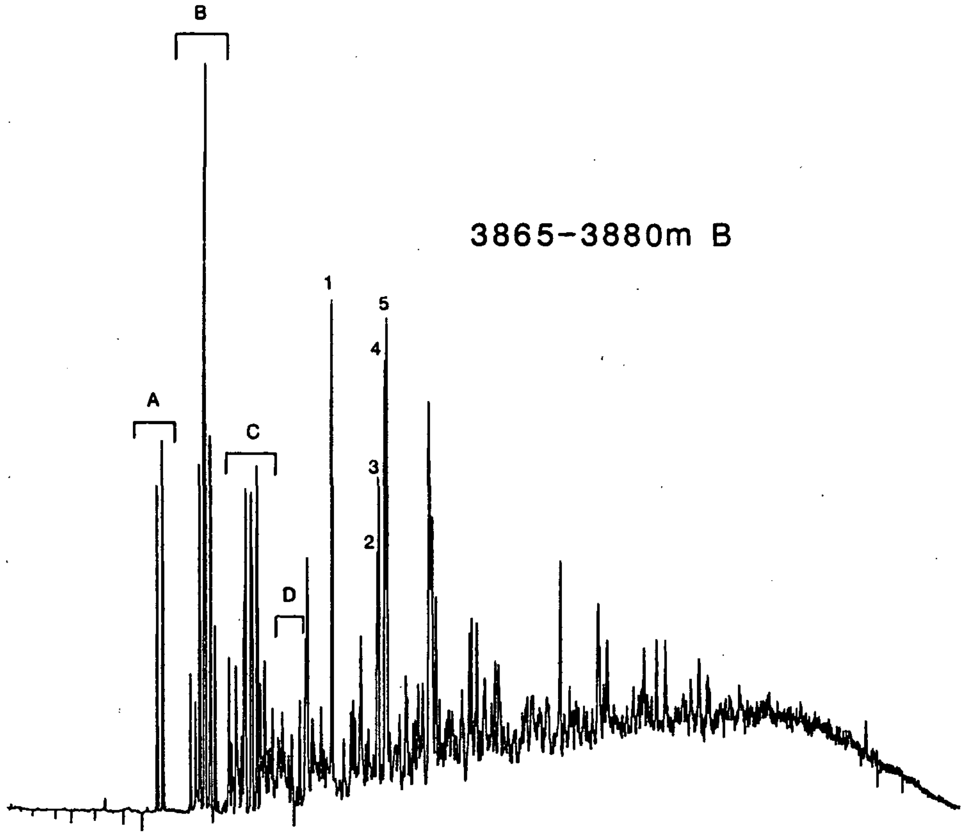
PEAK IDENTIFICATION ON FIRST SHEET

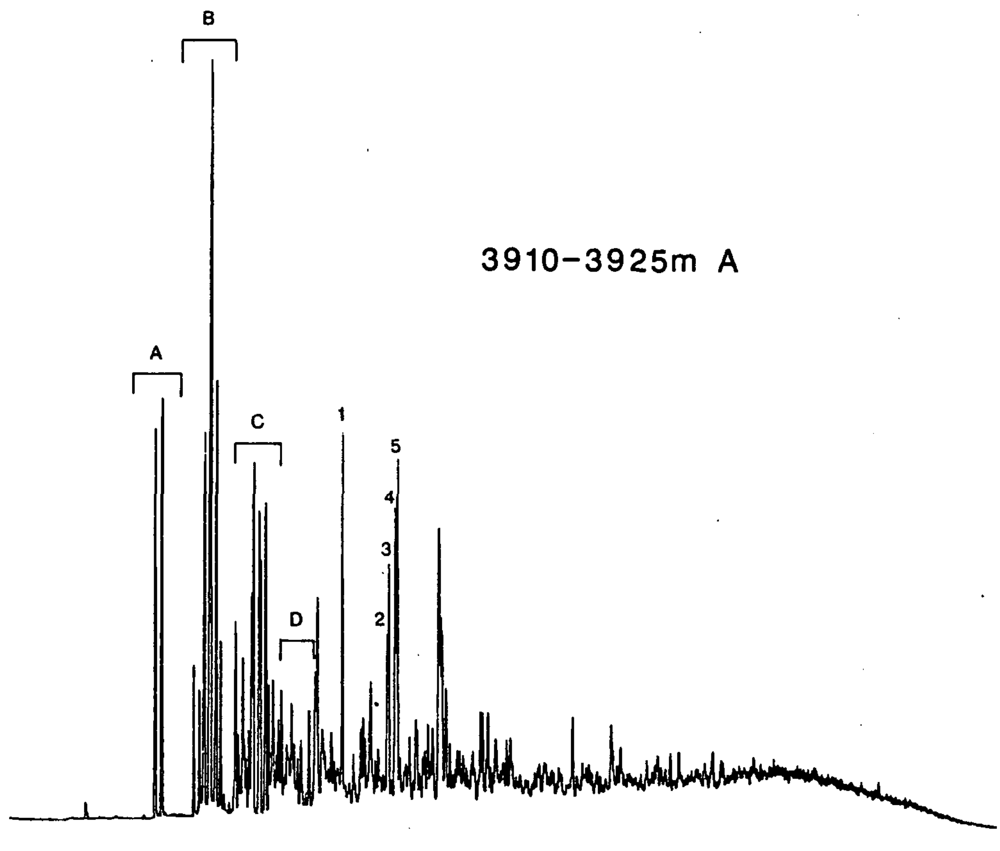
FIGURE 11d

C_{15+} AROMATIC CHROMATOGRAMS

WELL 34/10-23

GEOCHEM

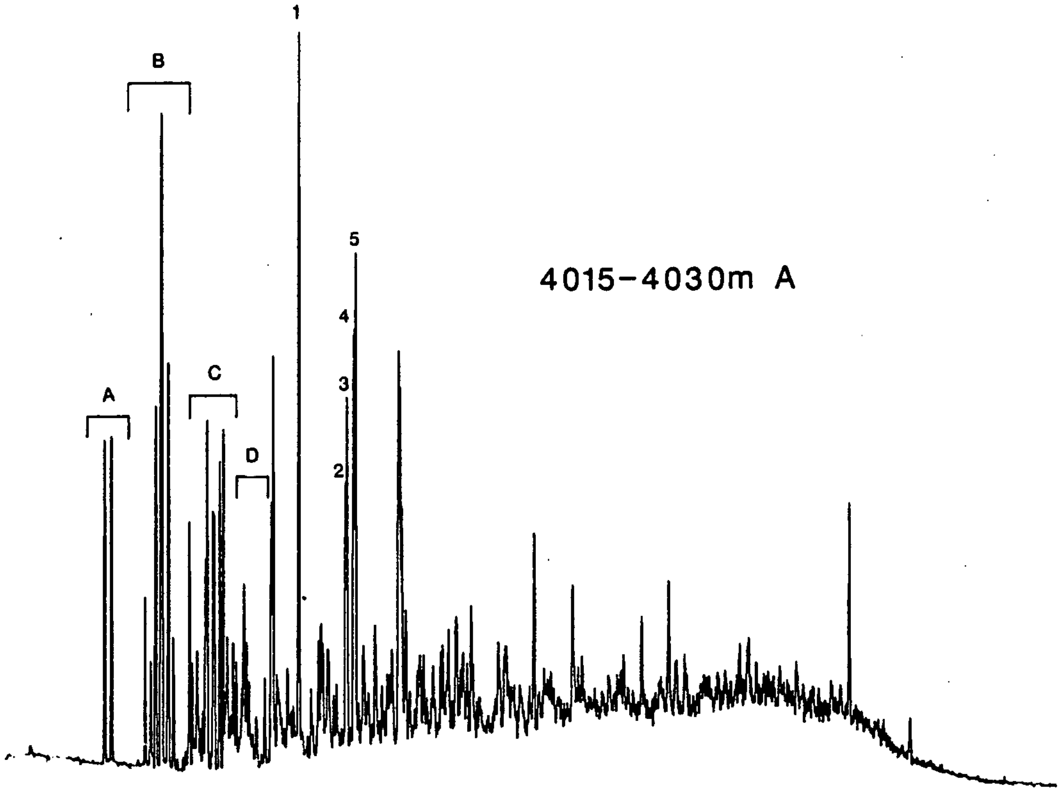


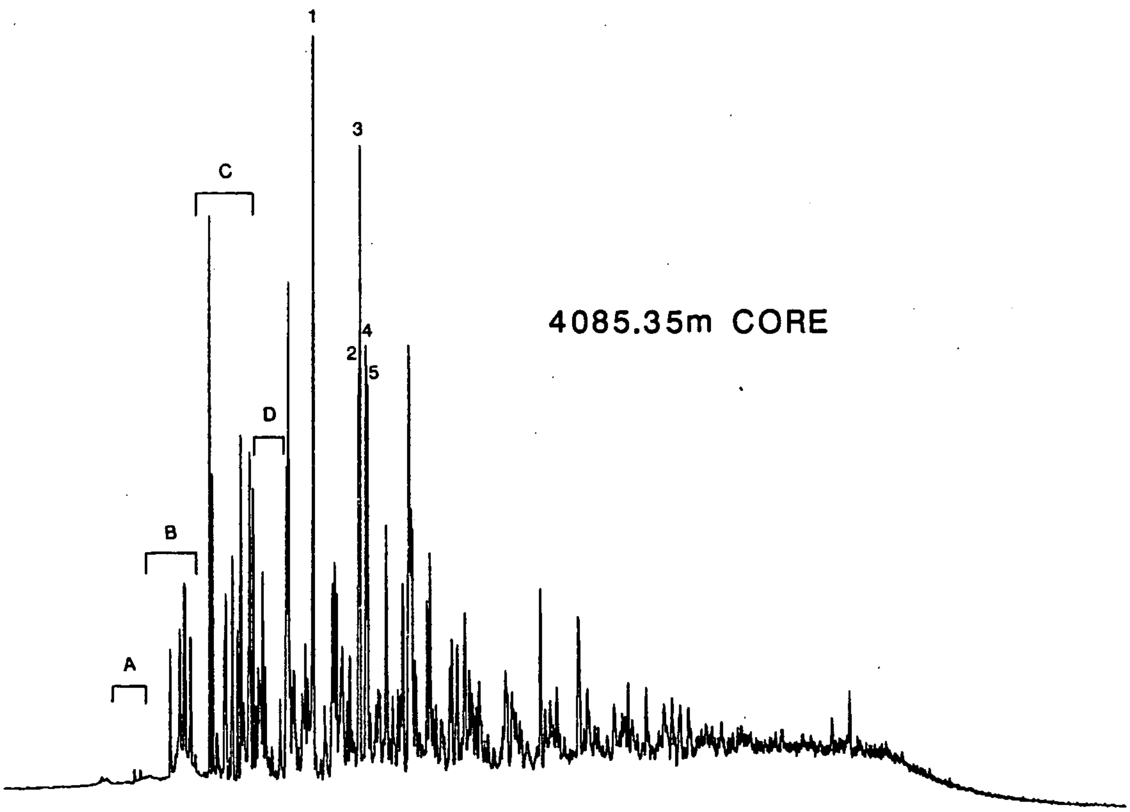


PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 11e C_{15+} AROMATIC CHROMATOGRAMS

WELL 34/10-23

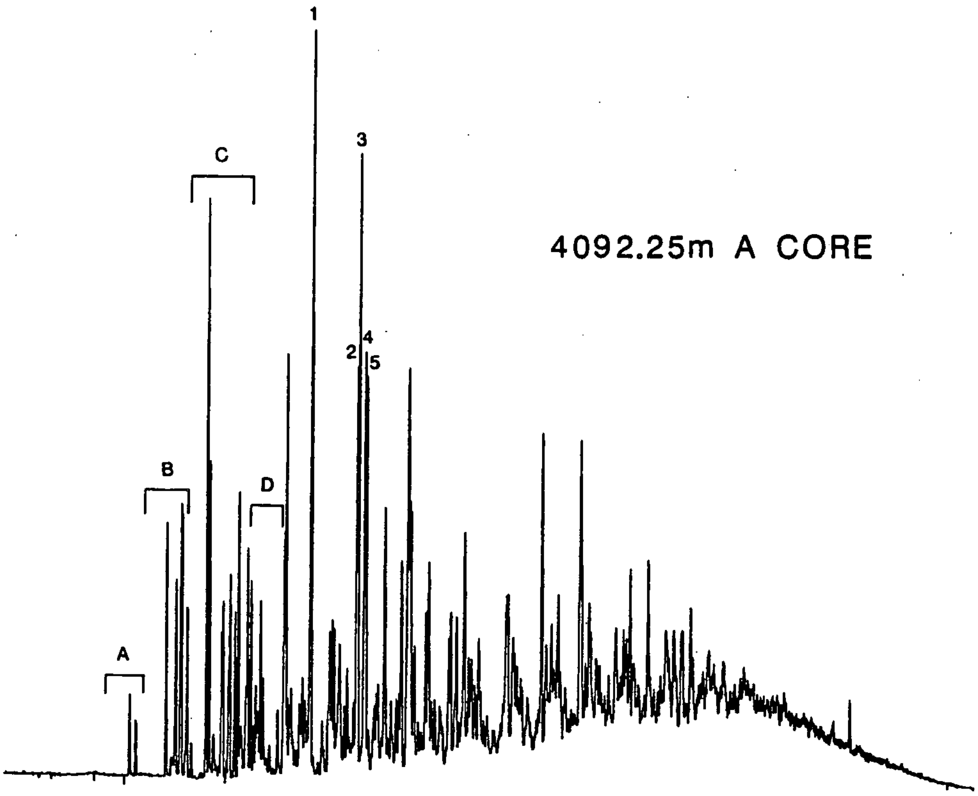


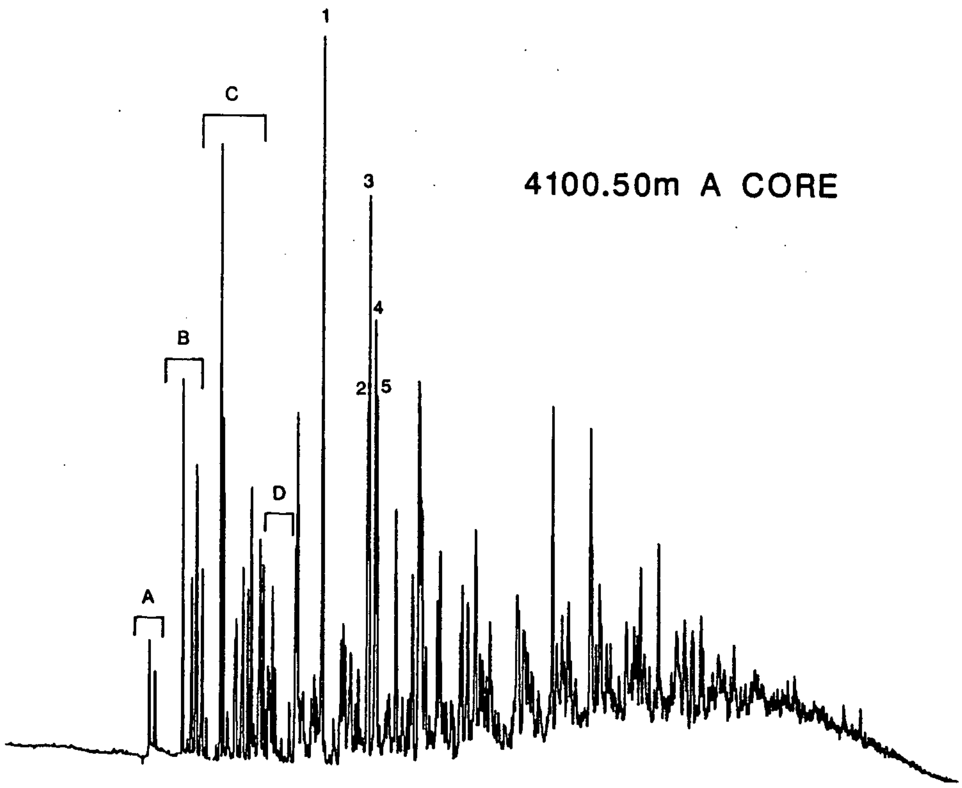


PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 11f C_{15+} AROMATIC CHROMATOGRAMS

WELL 34/10-23

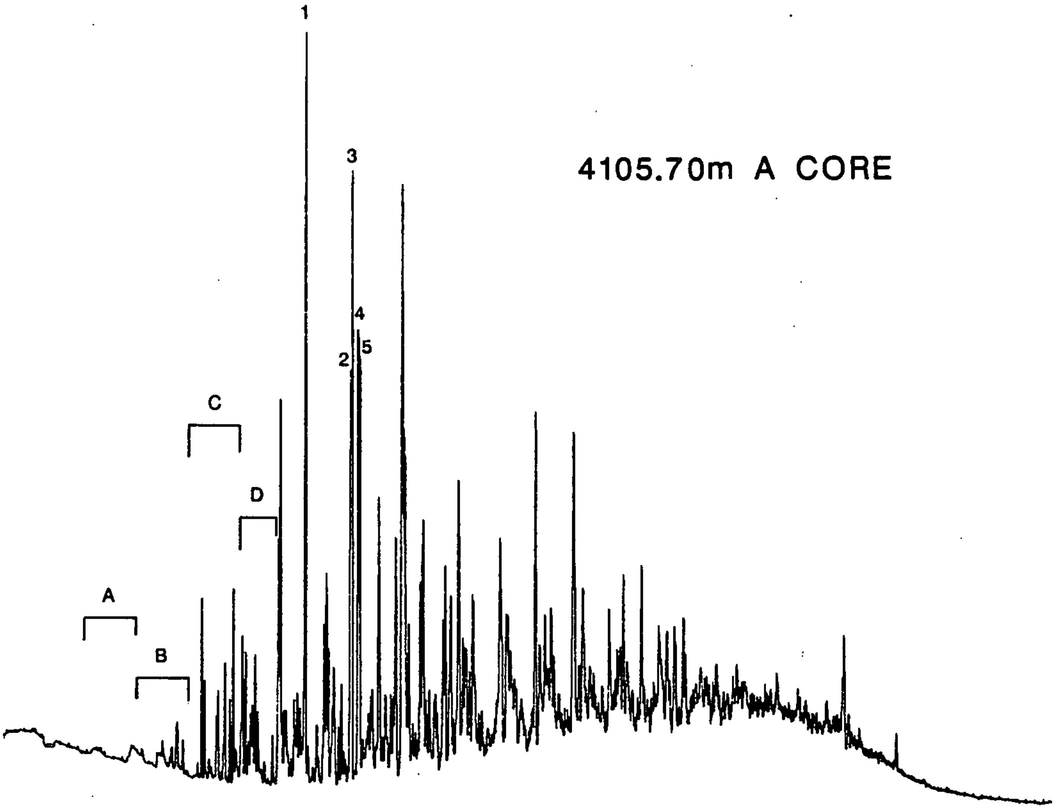


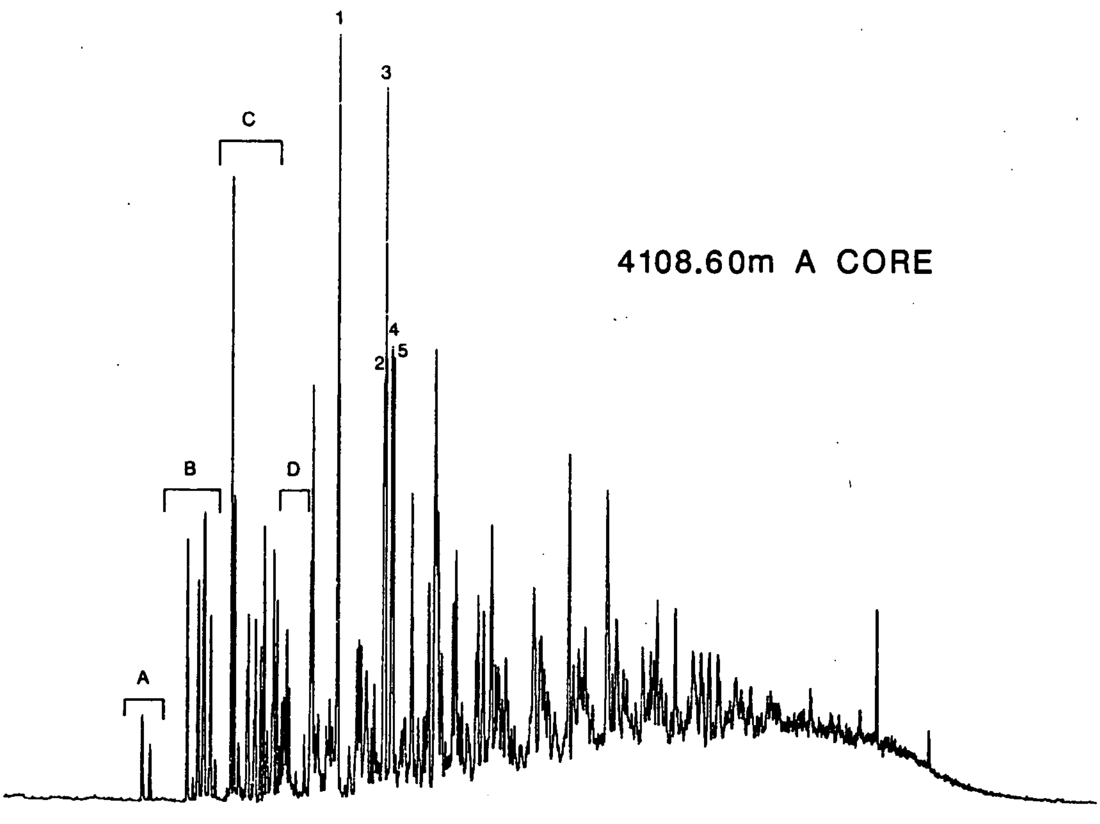


PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 11g C_{15+} AROMATIC CHROMATOGRAMS

WELL 34/10-23

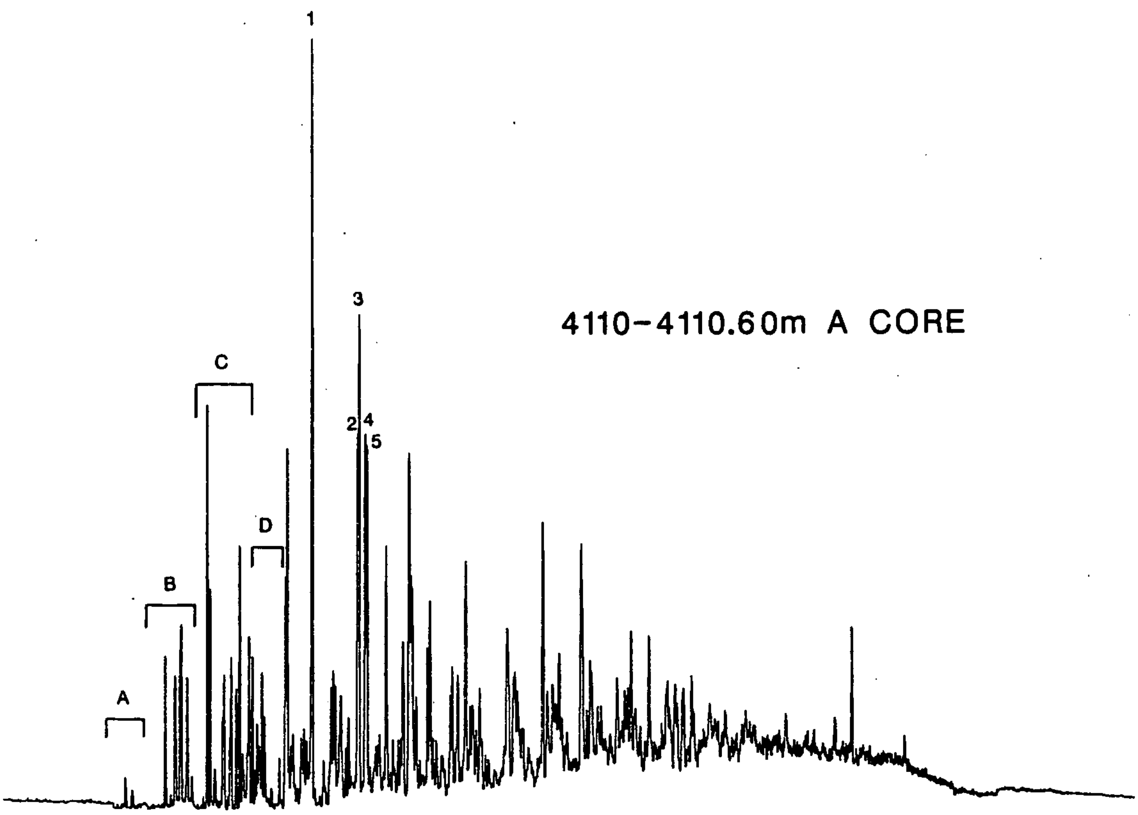


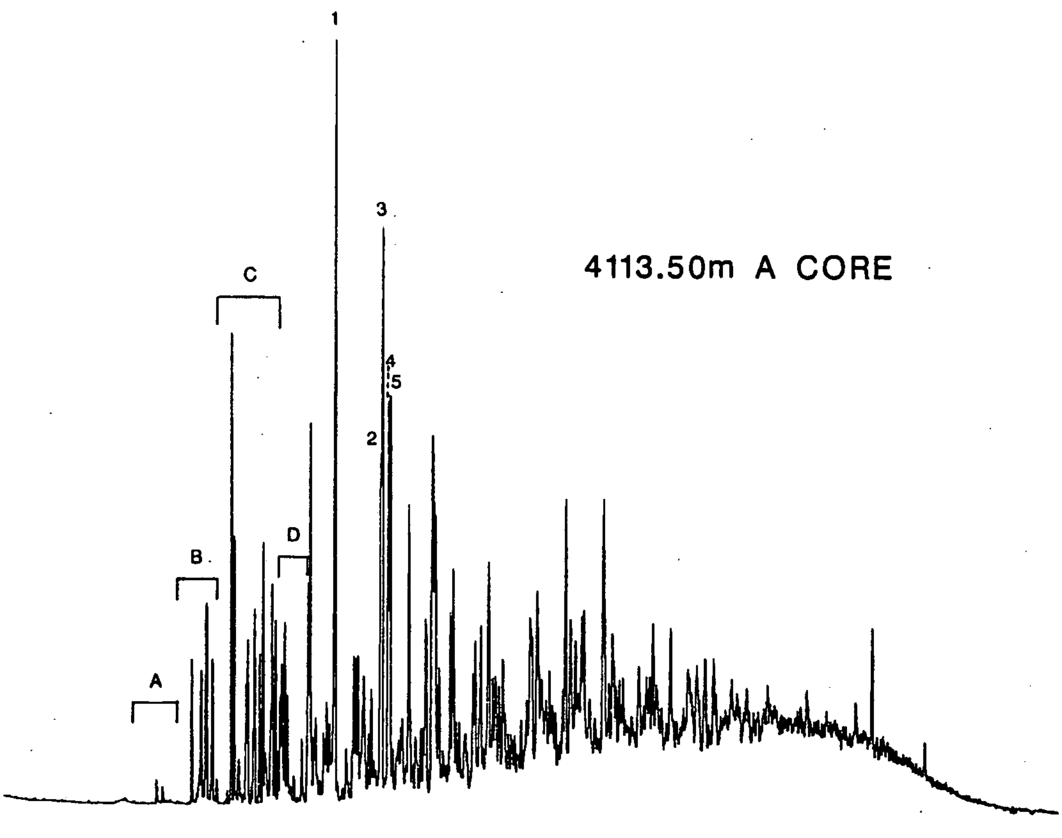


PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 11h C_{15+} AROMATIC CHROMATOGRAMS

WELL 34/10-23



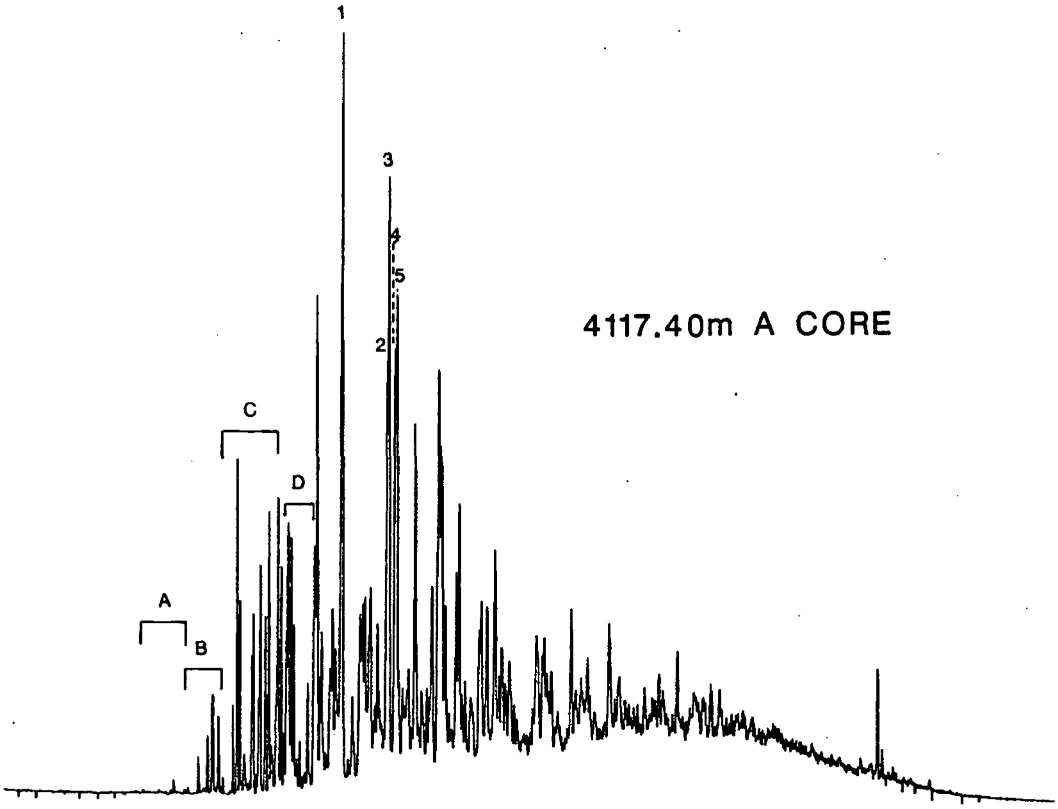


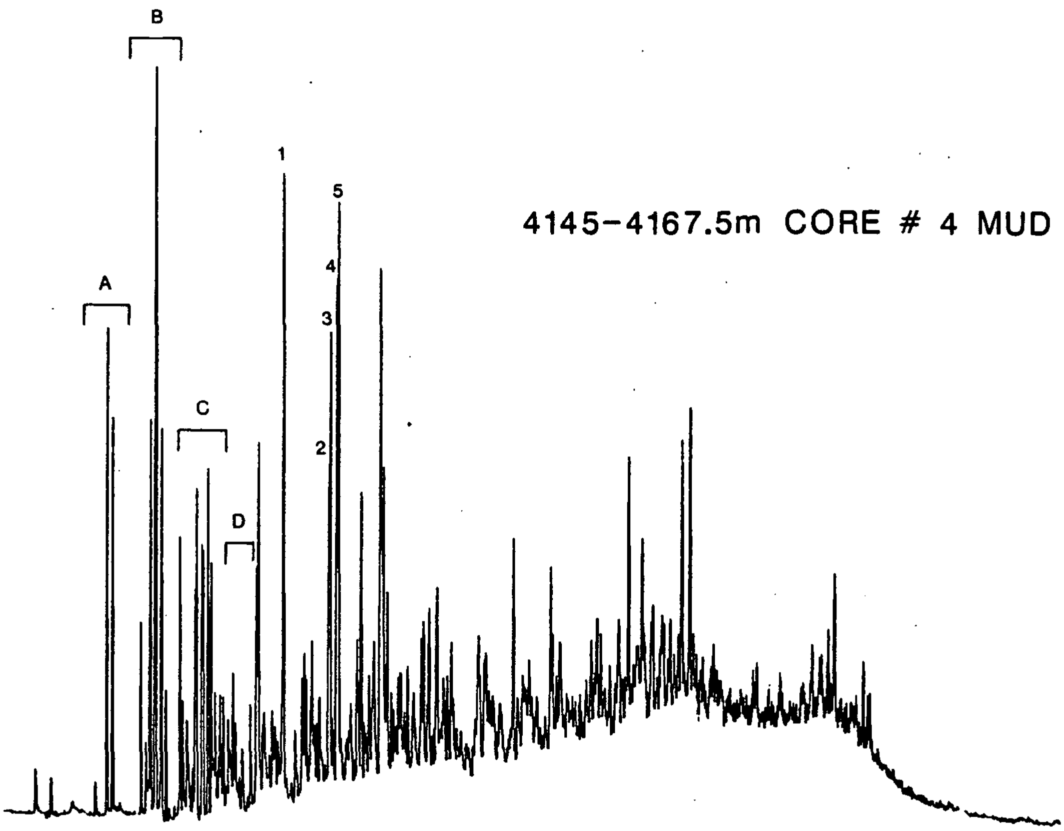
PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 11i

C_{15+} AROMATIC CHROMATOGRAMS

WELL 34/10-23



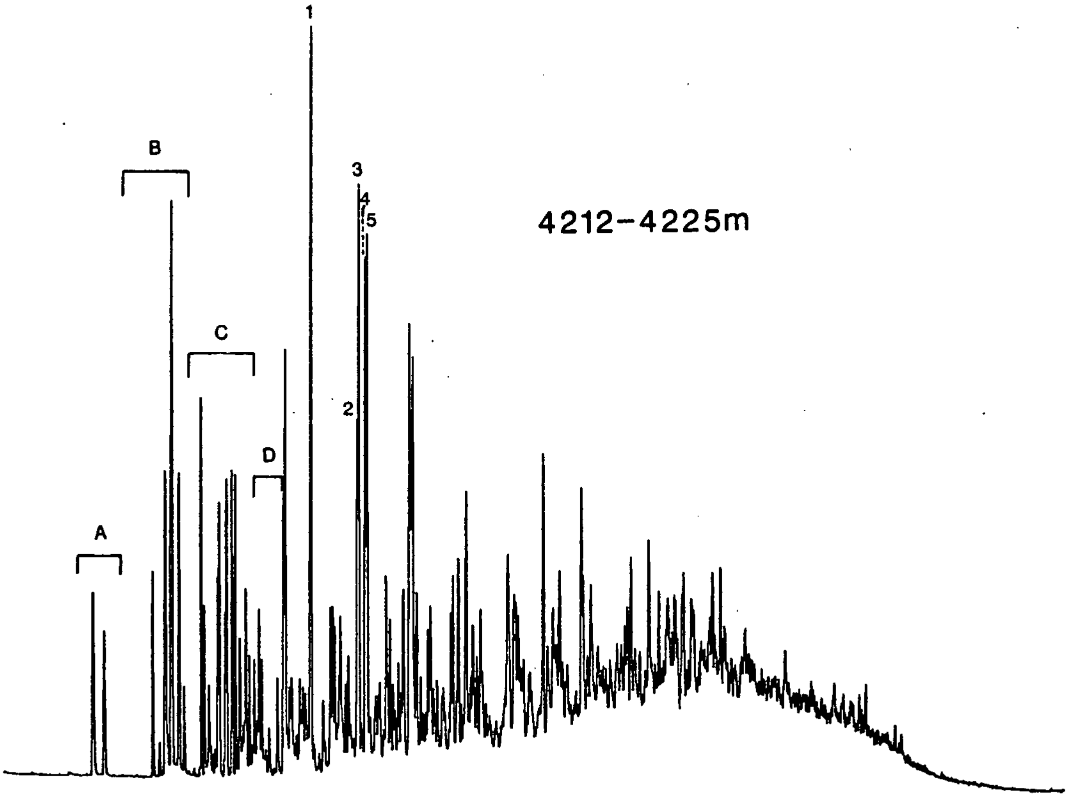


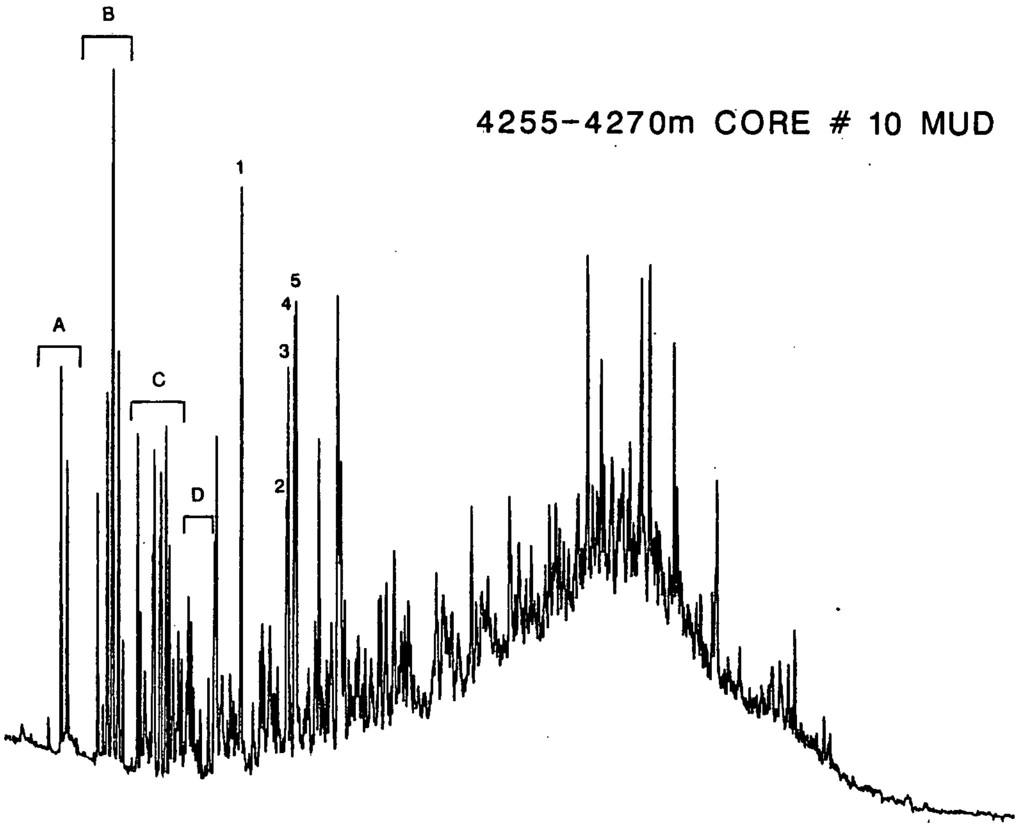
PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 11j

C_{15+} AROMATIC CHROMATOGRAMS

WELL 34/10-23

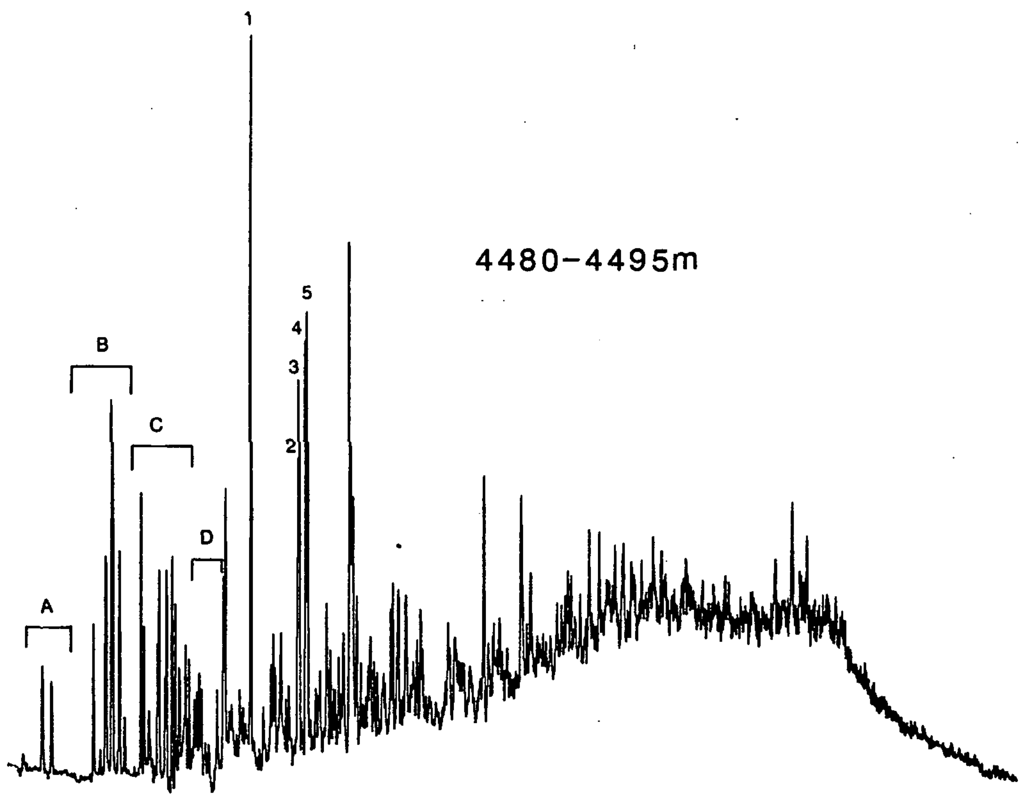


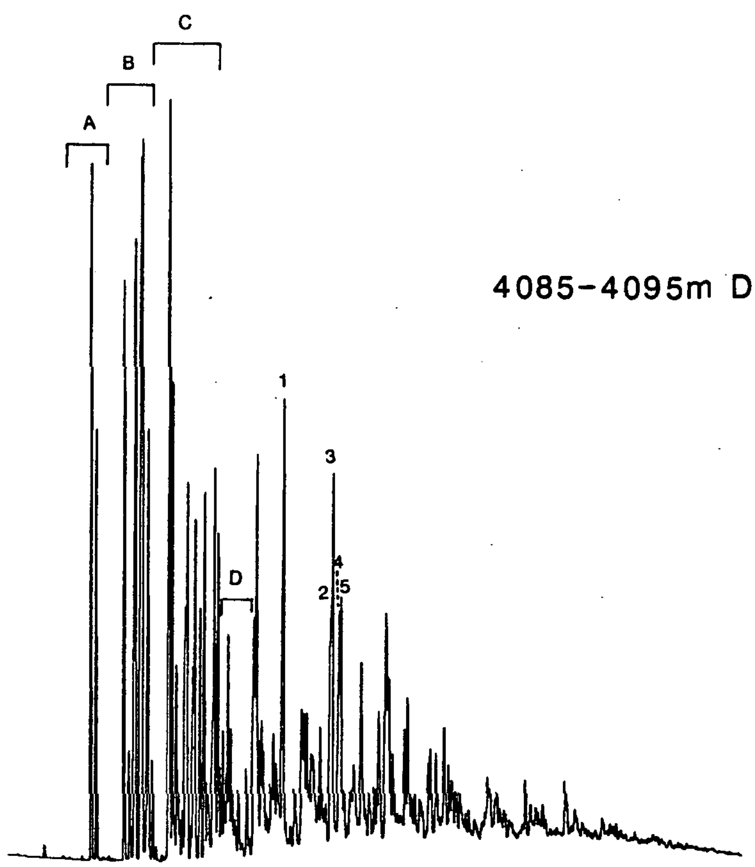


PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 11k **C_{15+} AROMATIC CHROMATOGRAMS**

WELL 34/10-23

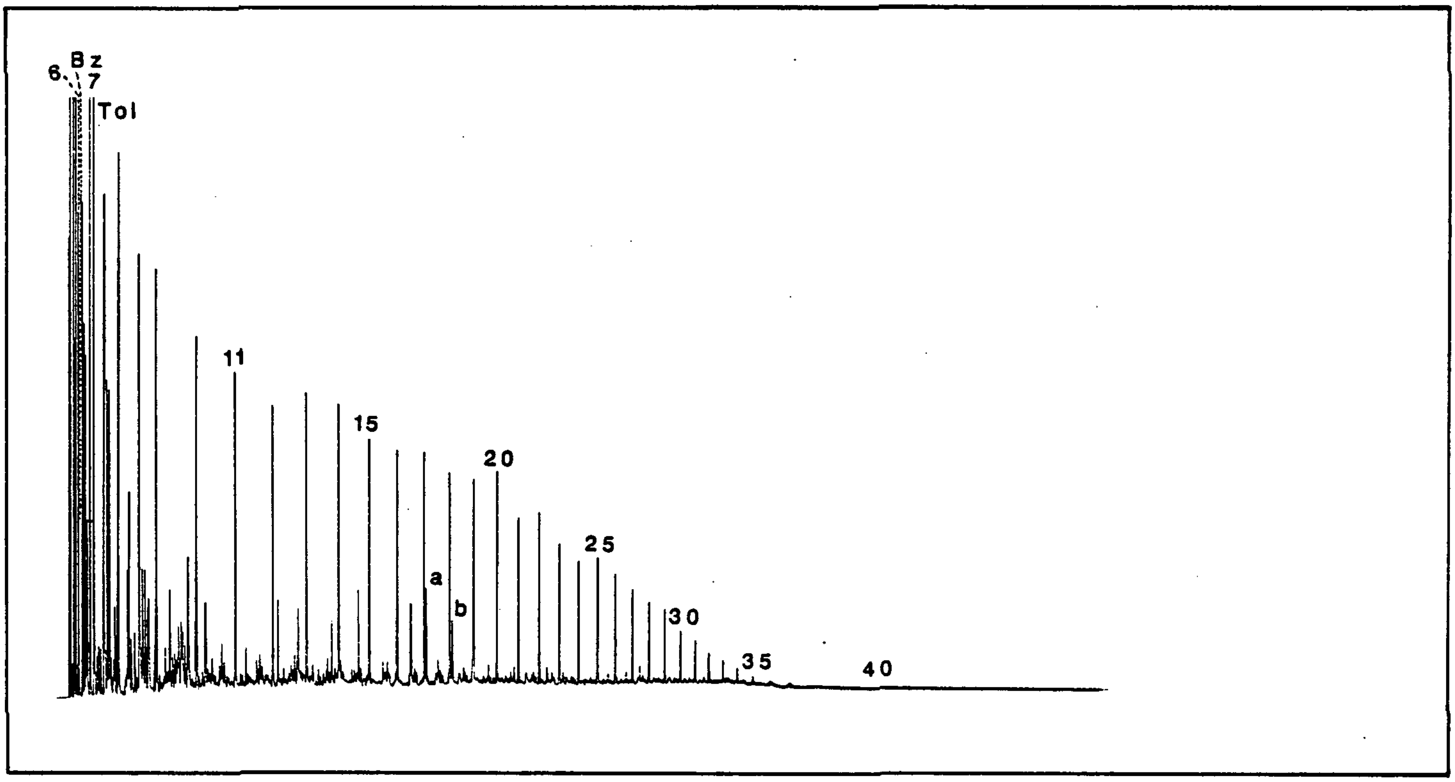


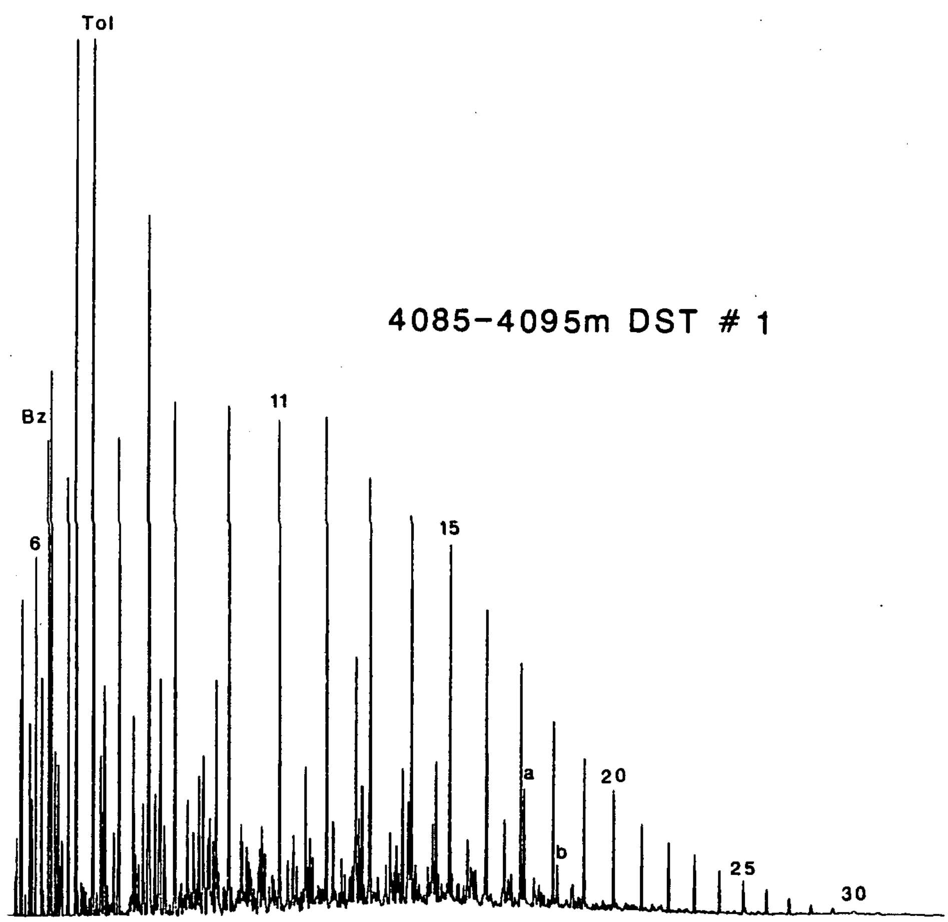


PEAK IDENTIFICATION ON FIRST SHEET

FIGURE 12 **WHOLE OIL CHROMATOGRAMS**

WELL 34/10-23

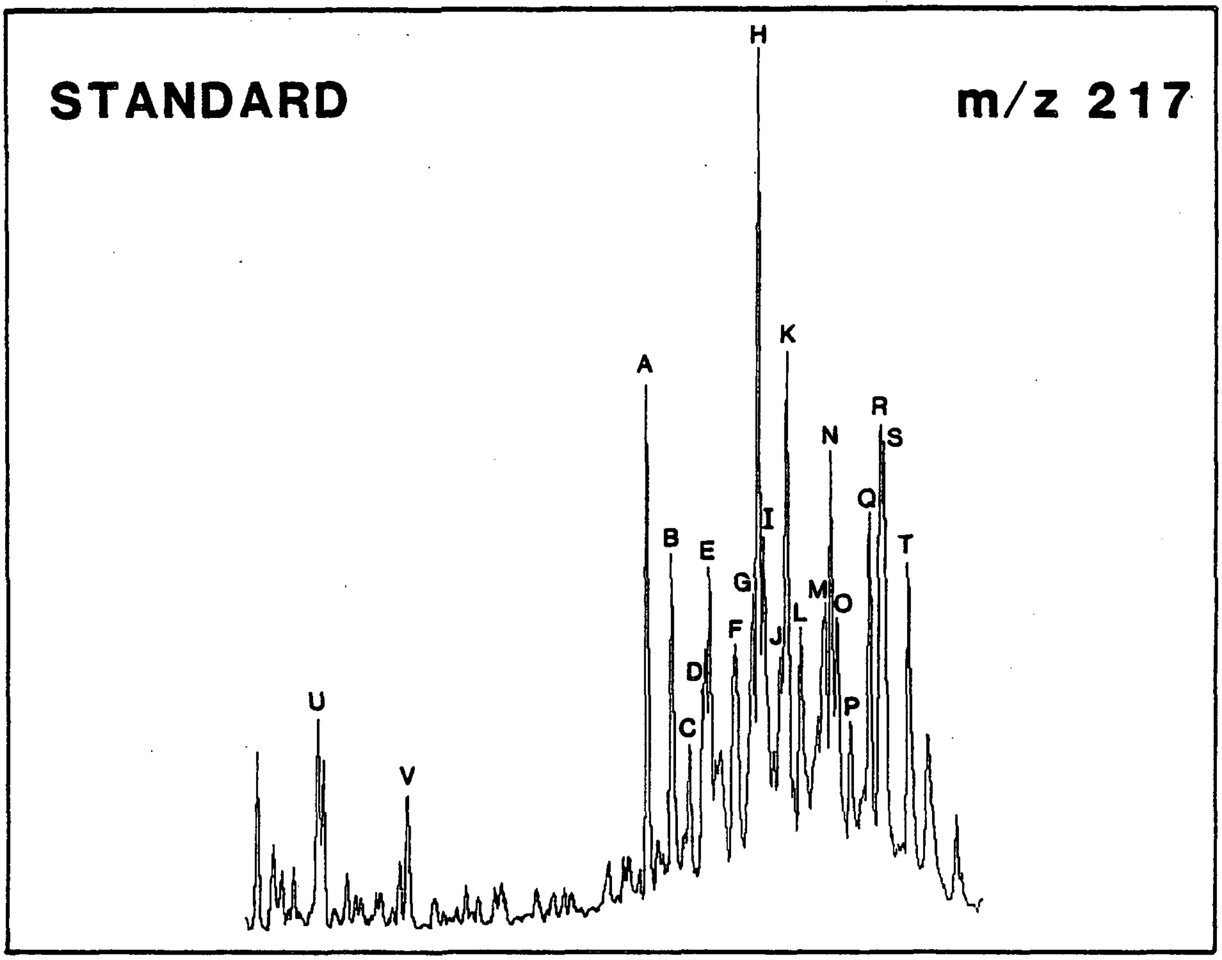




a - PRISTANE
b - PHYTANE

Bz - BENZENE
To - TOLUENE

NORMAL PARAFFINS IDENTIFIED BY CARBON NUMBERS



STERANE IDENTIFICATION

(M/Z 217 FRAGMENTOGRAM)

	COMPOUND	ELEMENTAL COMPOSITION
A	13β,17α-diacholestane (20S)	$C_{27}H_{48}$
B	13β,17α-diacholestane (20R)	$C_{27}H_{48}$
C	13α,17β-diacholestane (20S)	$C_{27}H_{48}$
D	13α,17β-diacholestane (20R)	$C_{27}H_{48}$
E	24-methyl-13β,17α-diacholestane (20S)	$C_{28}H_{50}$
F	24-methyl-13β,17α-diacholestane (20R)	$C_{28}H_{50}$
G	24-methyl-13α,17β-diacholestane (20S)	$C_{28}H_{50}$
+	14α,17α-cholestane (20S)	$C_{27}H_{48}$
H	24-ethyl-13β,17α-diacholestane (20S)	$C_{29}H_{52}$
+	14β,17β-cholestane (20R)	$C_{27}H_{48}$
I	14β,17β-cholestane (20S)	$C_{27}H_{48}$
+	24-methyl-13α,17β-diacholestane (20R)	$C_{28}H_{50}$
J	14α,17α-cholestane (20R)	$C_{27}H_{48}$
K	24-ethyl-13β,17α-diacholestane (20R)	$C_{29}H_{52}$
L	24-ethyl-14α,17β-diacholestane (20S)	$C_{29}H_{52}$
M	24-methyl-13α,17α-cholestane (20S)	$C_{28}H_{50}$
N	24-ethyl-13α,17β-diacholestane (20R)	$C_{29}H_{52}$
+	24-methyl-14β,17β-cholestane (20R)	$C_{28}H_{50}$
O	24-methyl-14β,17β-cholestane (20S)	$C_{28}H_{50}$
P	24-methyl-14α,17α-cholestane (20R)	$C_{28}H_{50}$
Q	24-ethyl-14α,17α-cholestane (20S)	$C_{29}H_{52}$
R	24-ethyl-14β,17β-cholestane (20R)	$C_{29}H_{52}$
+	UNKNOWN STERANE	
S	24-ethyl-14β,17β-cholestane (20S)	$C_{29}H_{52}$
T	24-ethyl-14α,17α-cholestane (20R)	$C_{29}H_{52}$
U	5α(H)-pregnane	$C_{21}H_{36}$
V	5α(H)-bisnorcholane	$C_{22}H_{38}$

FIGURE 13a

MASS FRAGMENTOGRAMS

WELL 34/10-23

STERANES m/z 217

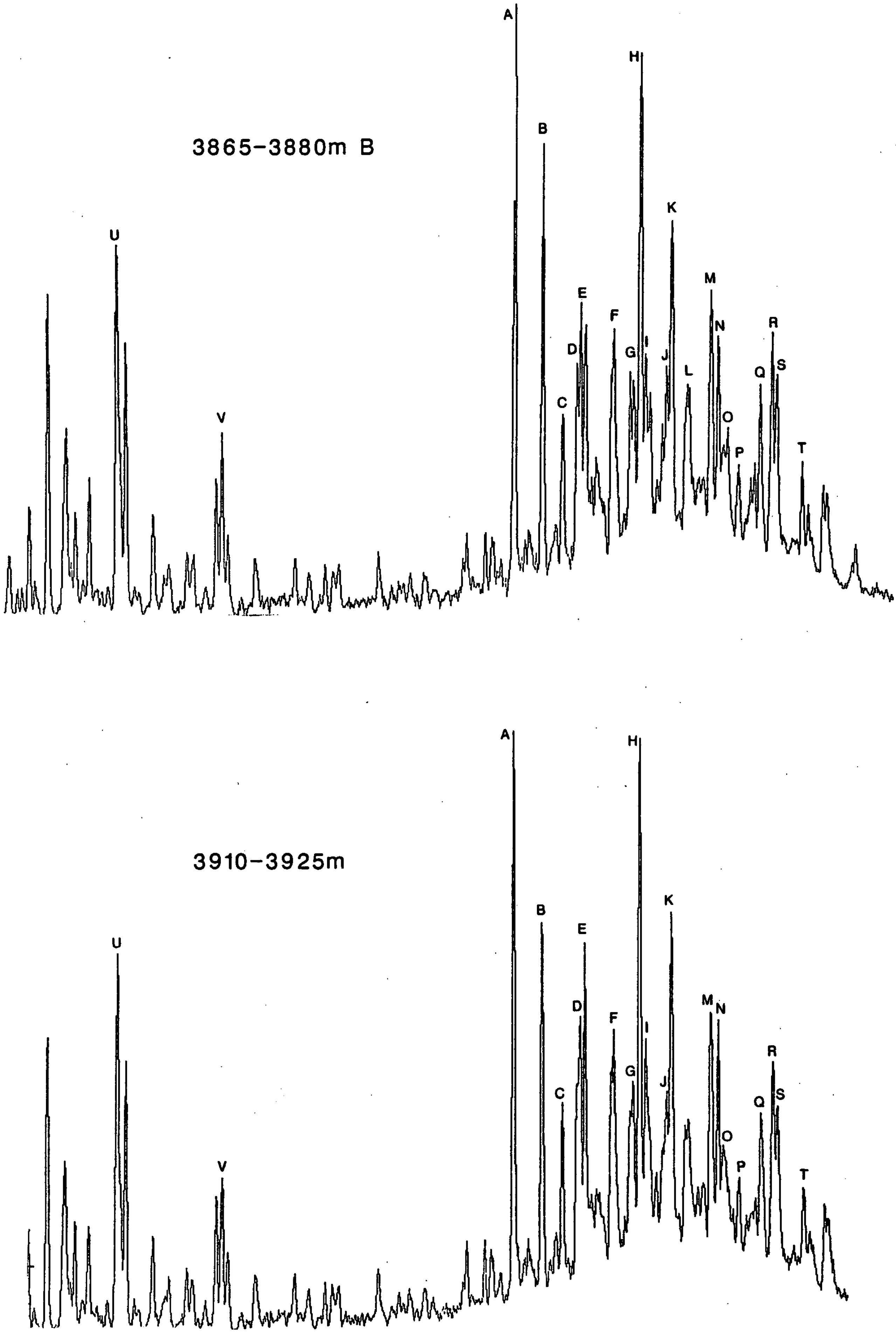


FIGURE 13b

MASS FRAGMENTOGRAMS

WELL 34/10-23

STERANES m/z 217

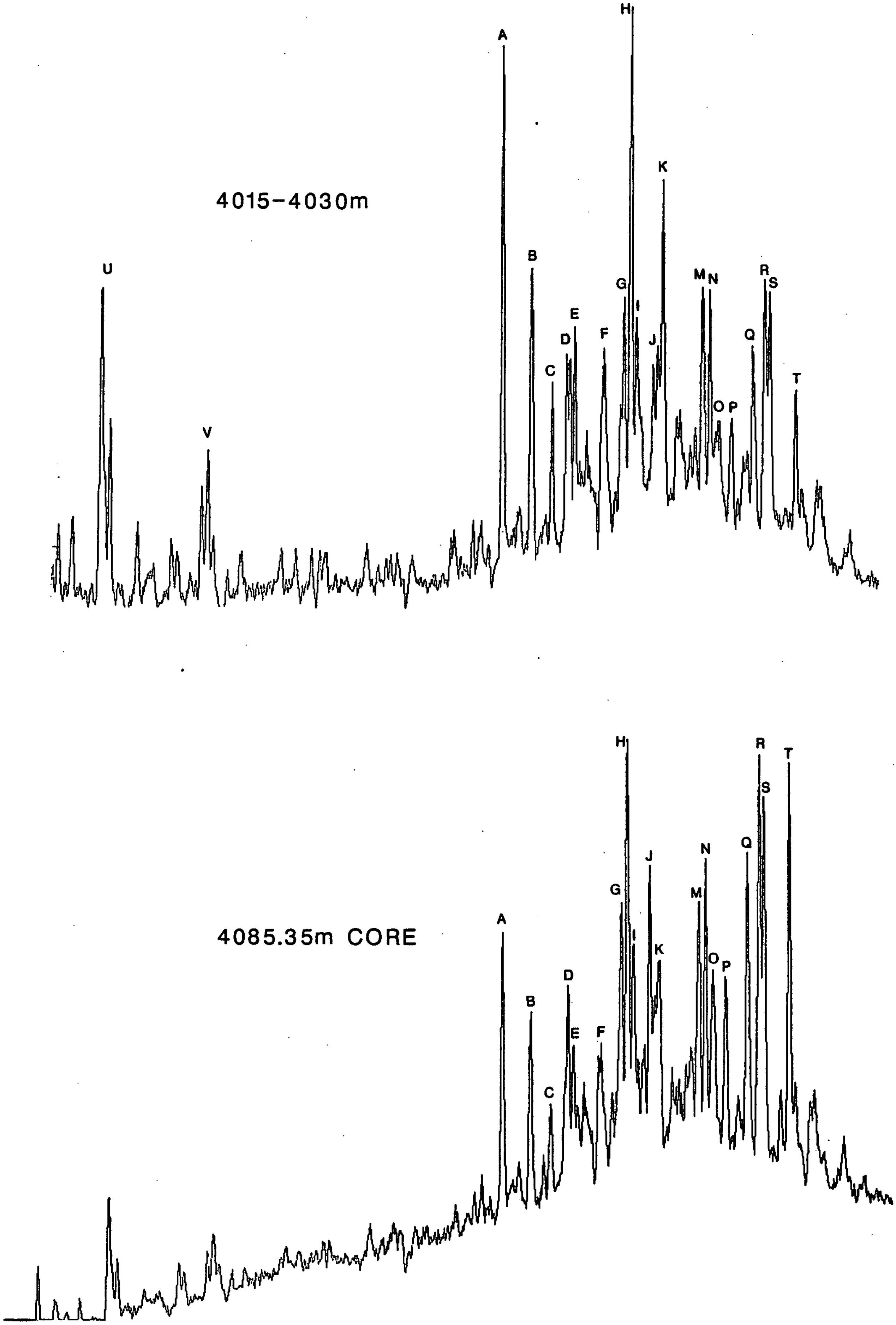
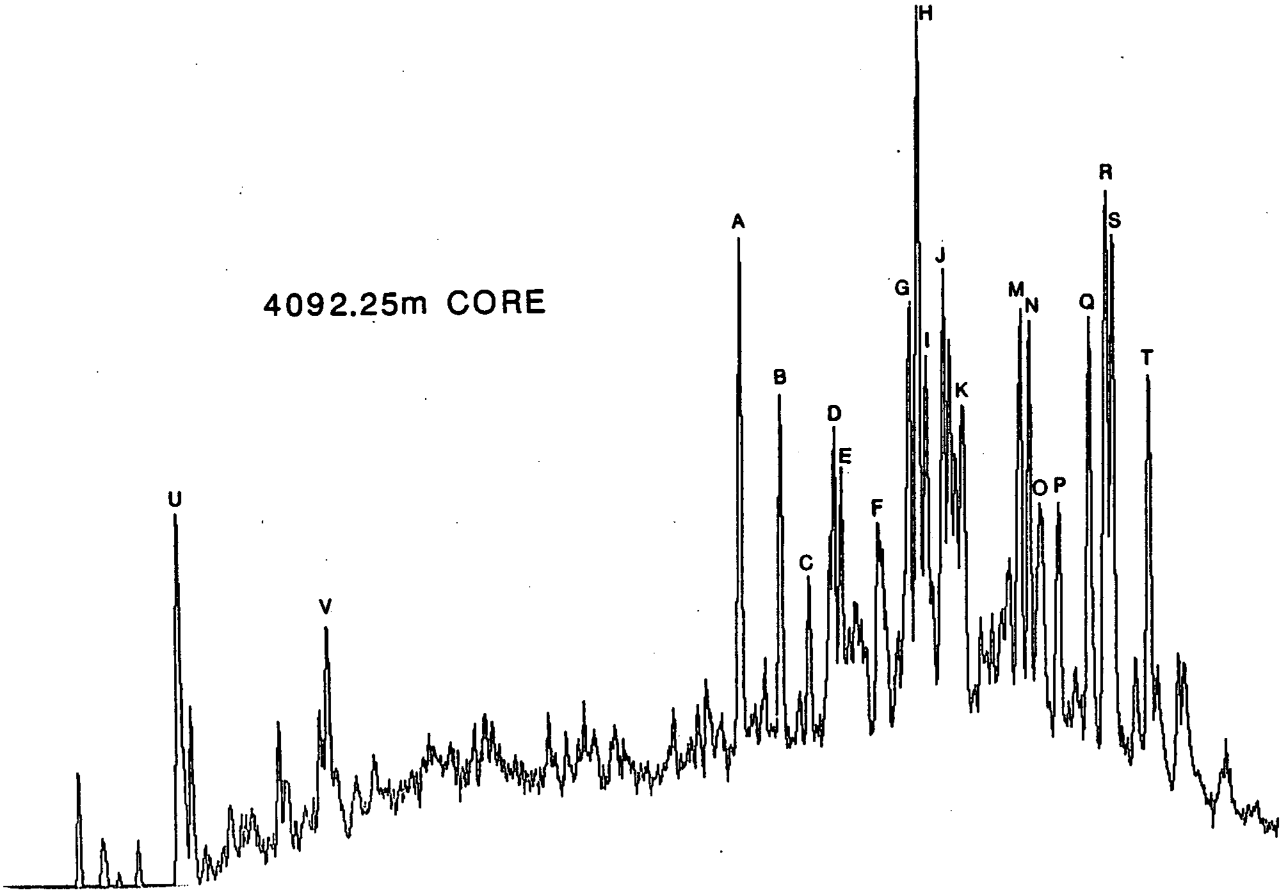


FIGURE 13c

WELL 34/10-23

MASS FRAGMENTOGRAMS

STERANES m/z 217



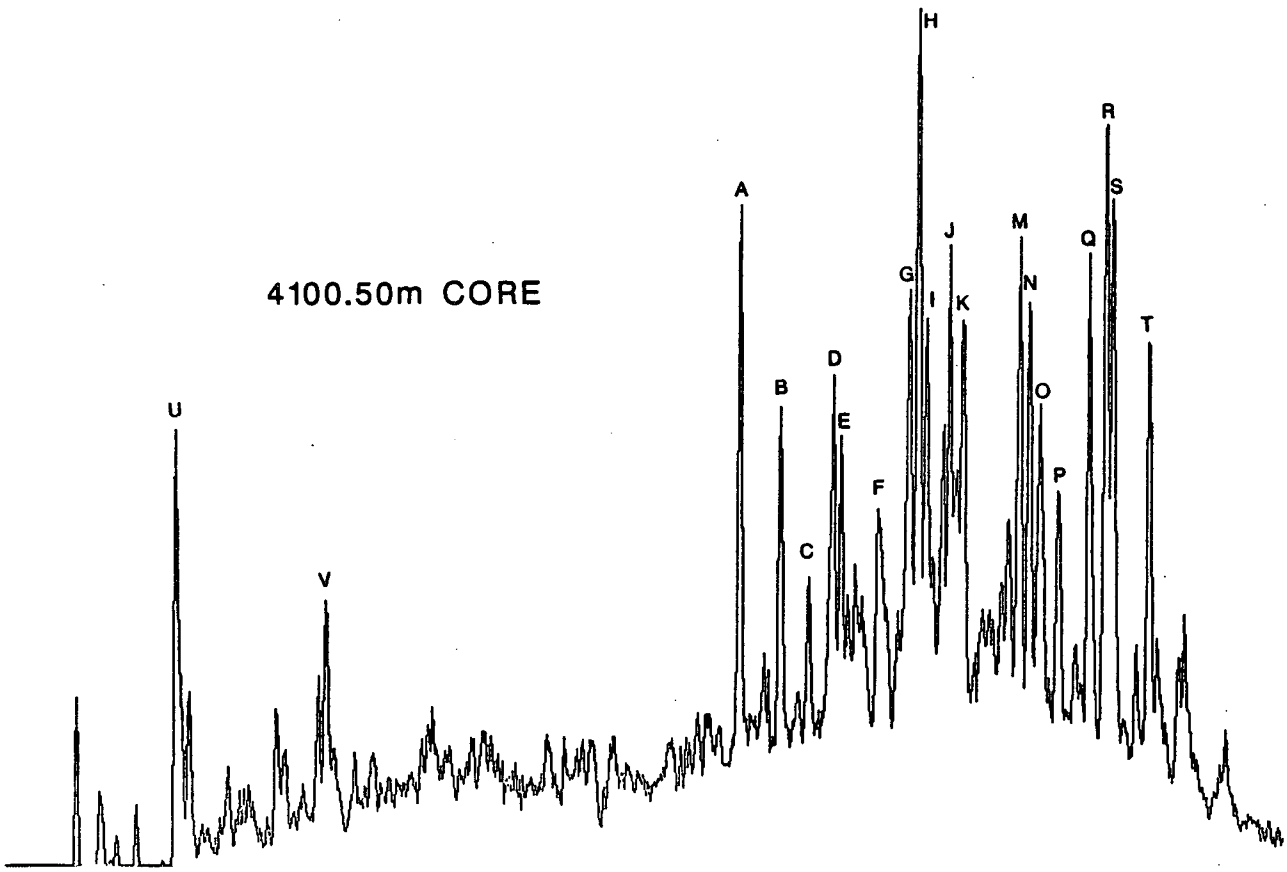
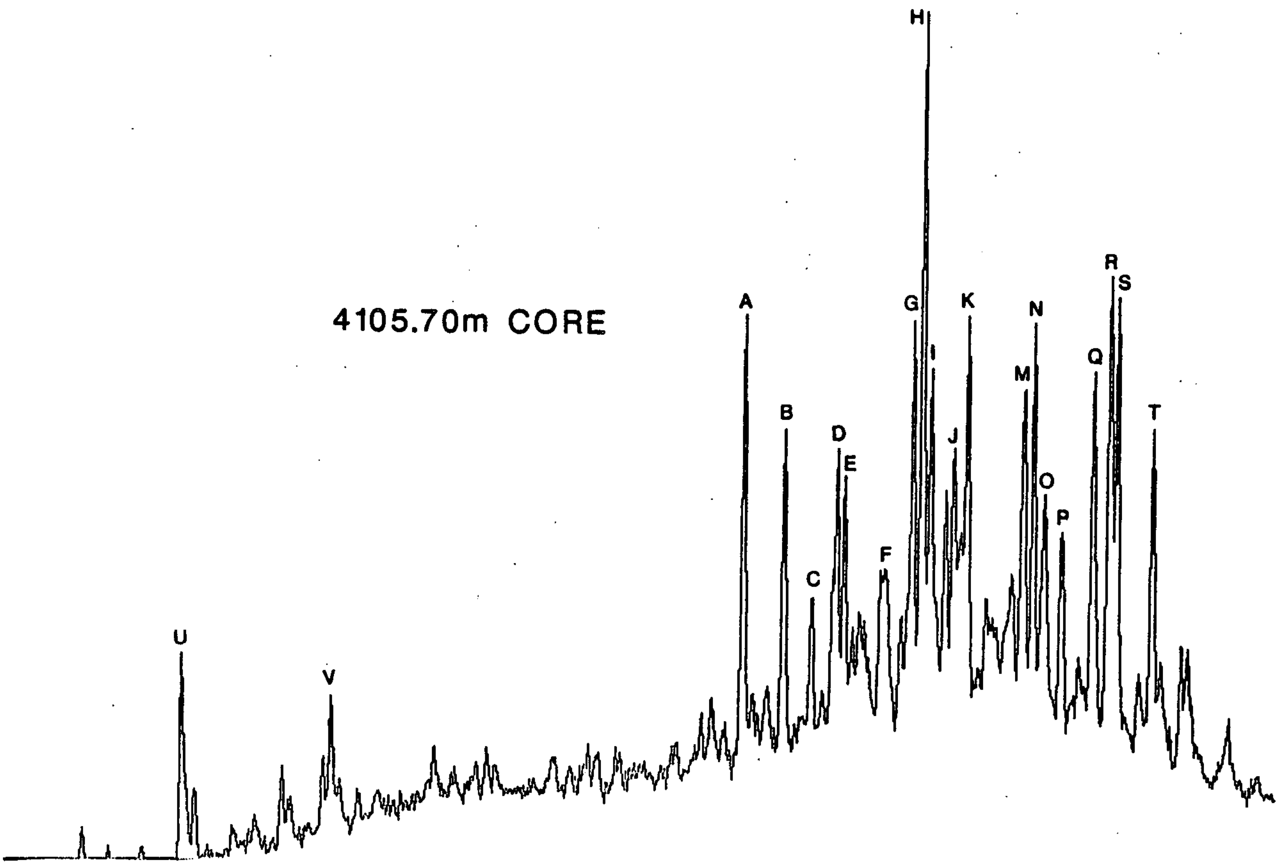


FIGURE 13d

MASS FRAGMENTOGRAMS

WELL 34/10-23

STERANES m/z 217



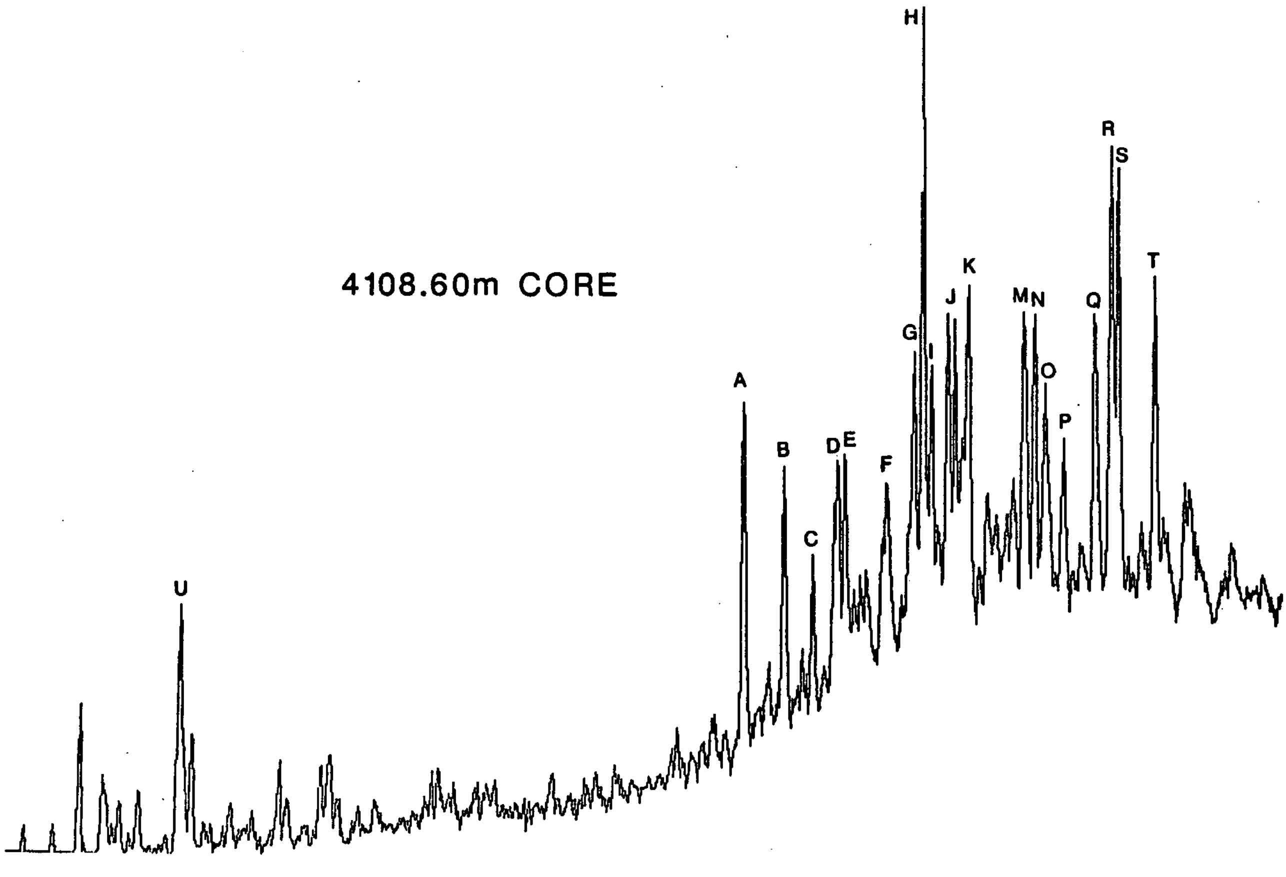
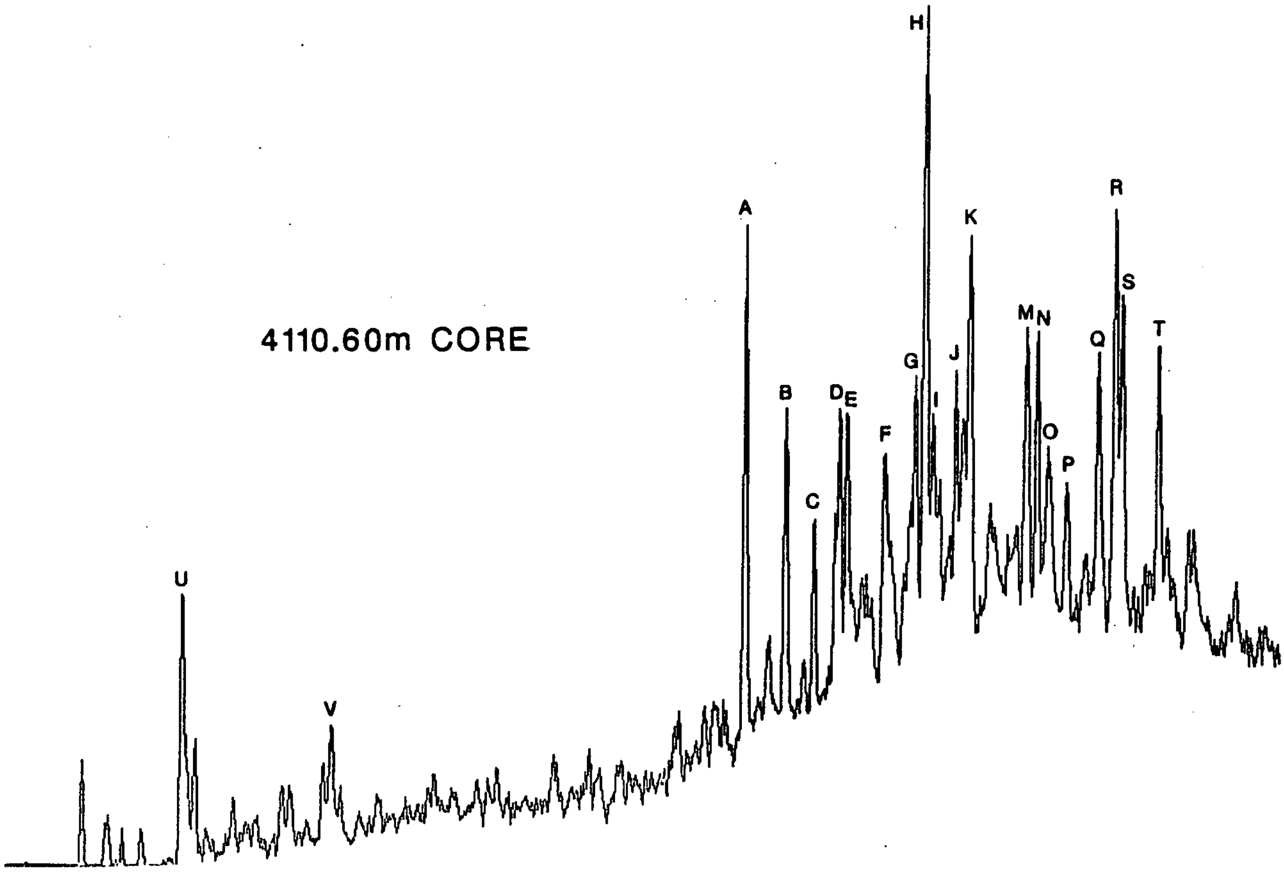


FIGURE 13e

MASS FRAGMENTOGRAMS

WELL 34/10-23

STERANES m/z 217



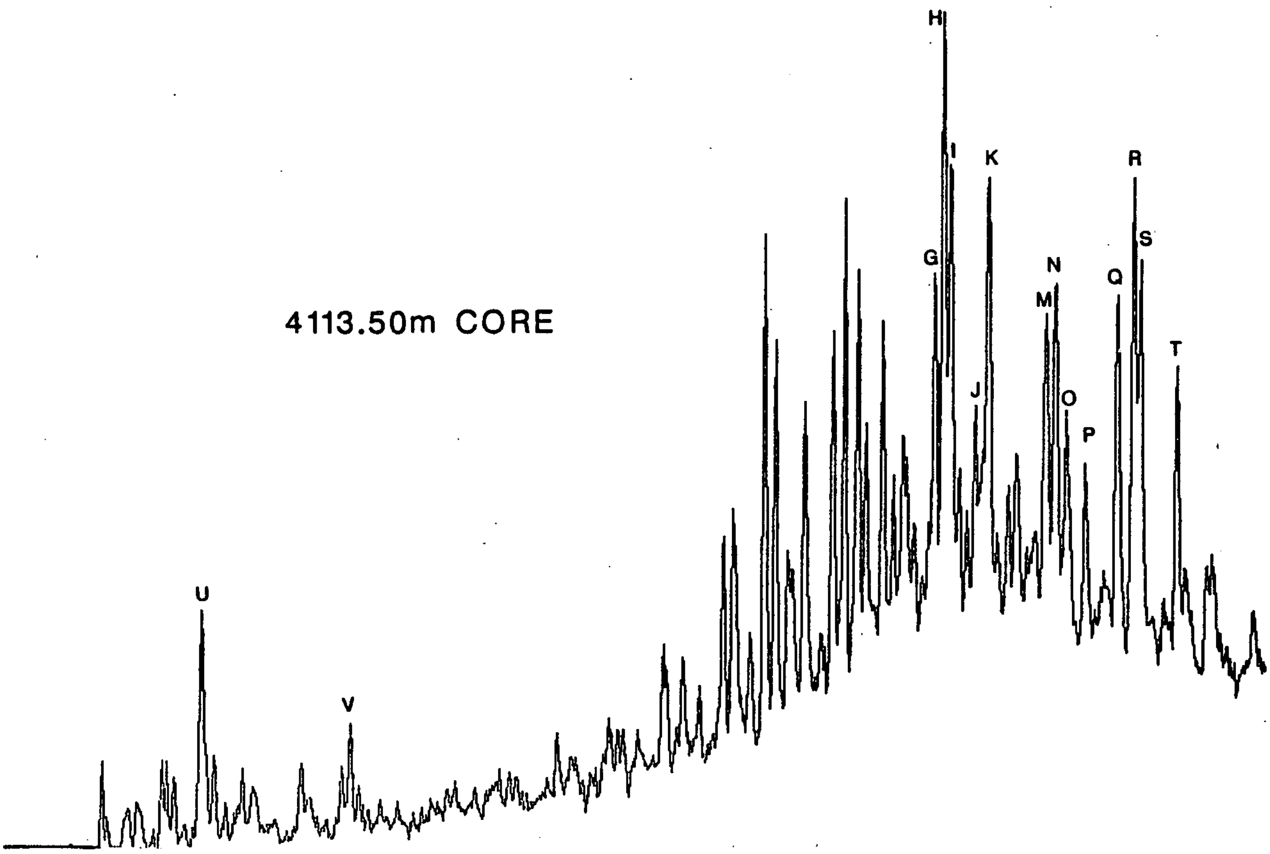
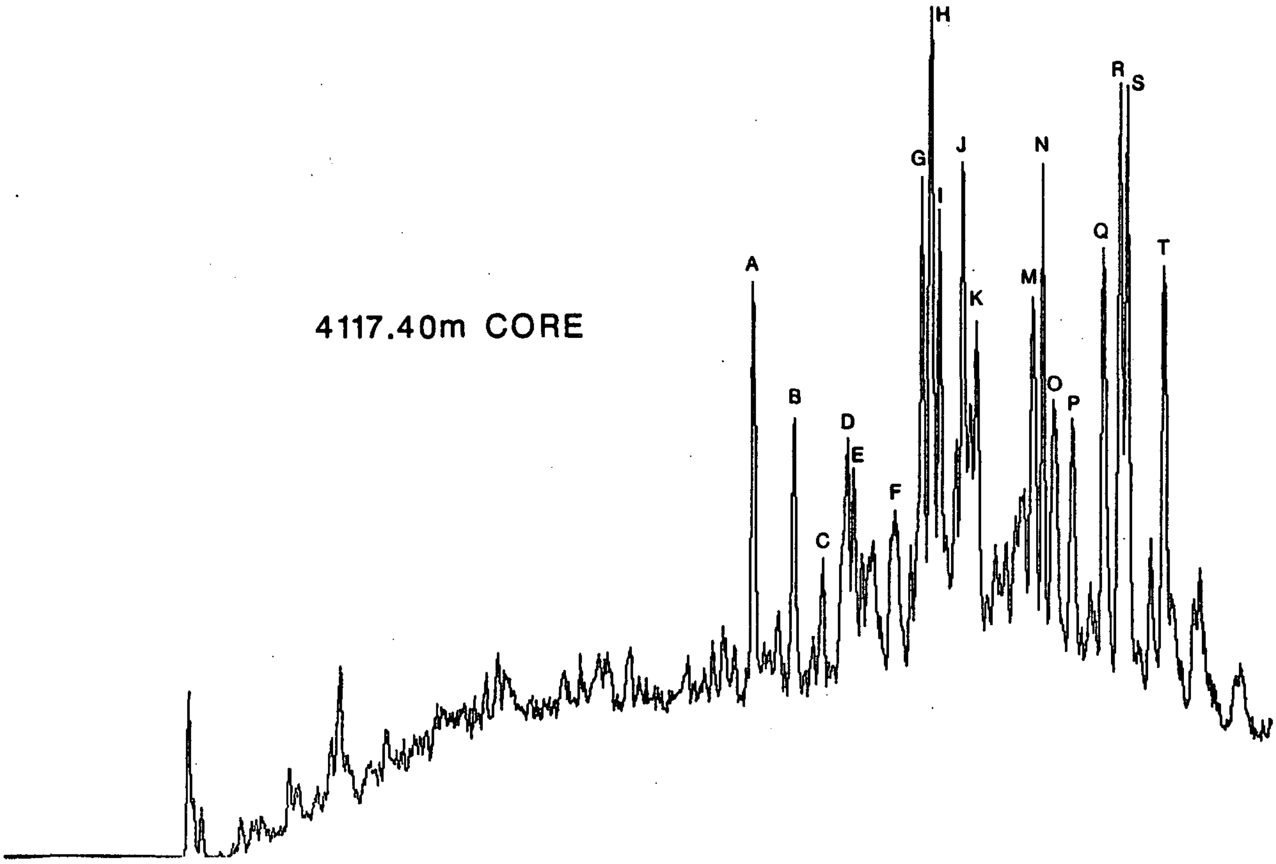


FIGURE 13f

MASS FRAGMENTOGRAMS

WELL 34/10-23

STERANES m/z 217



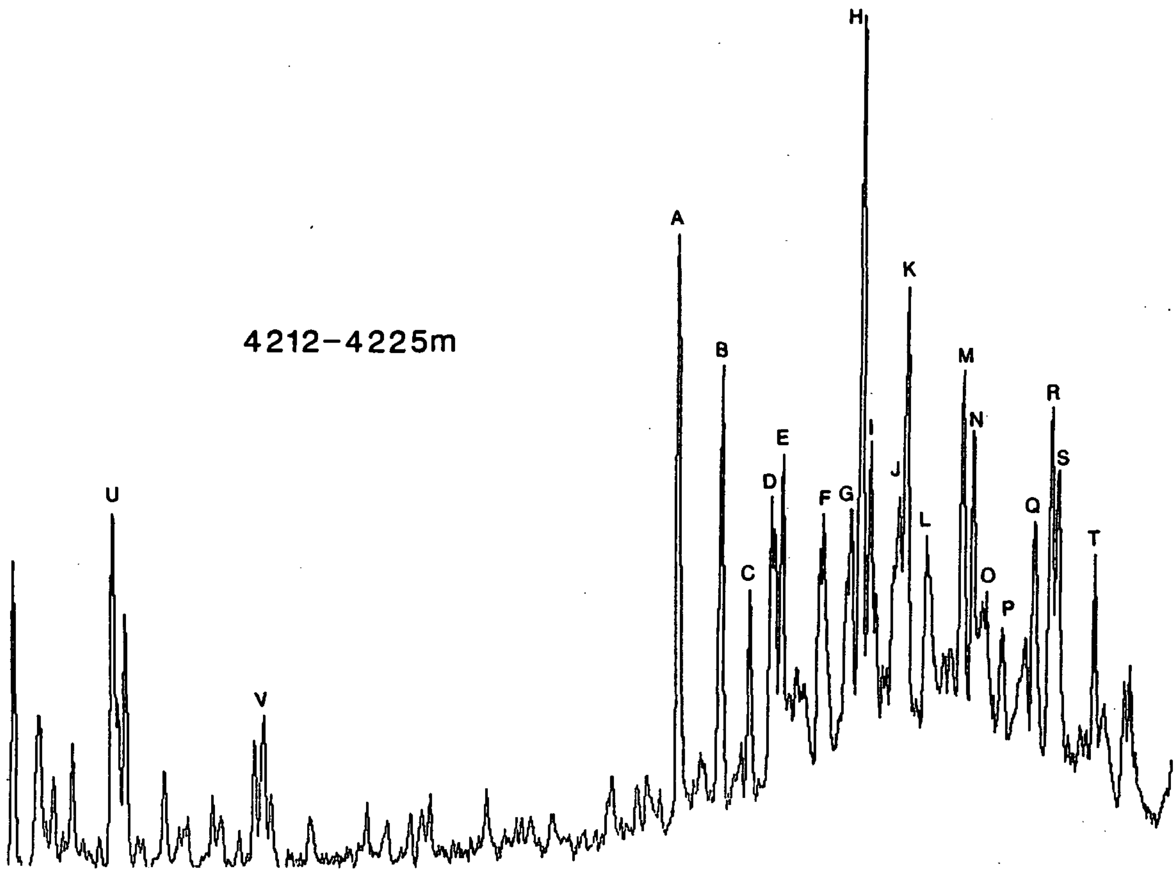
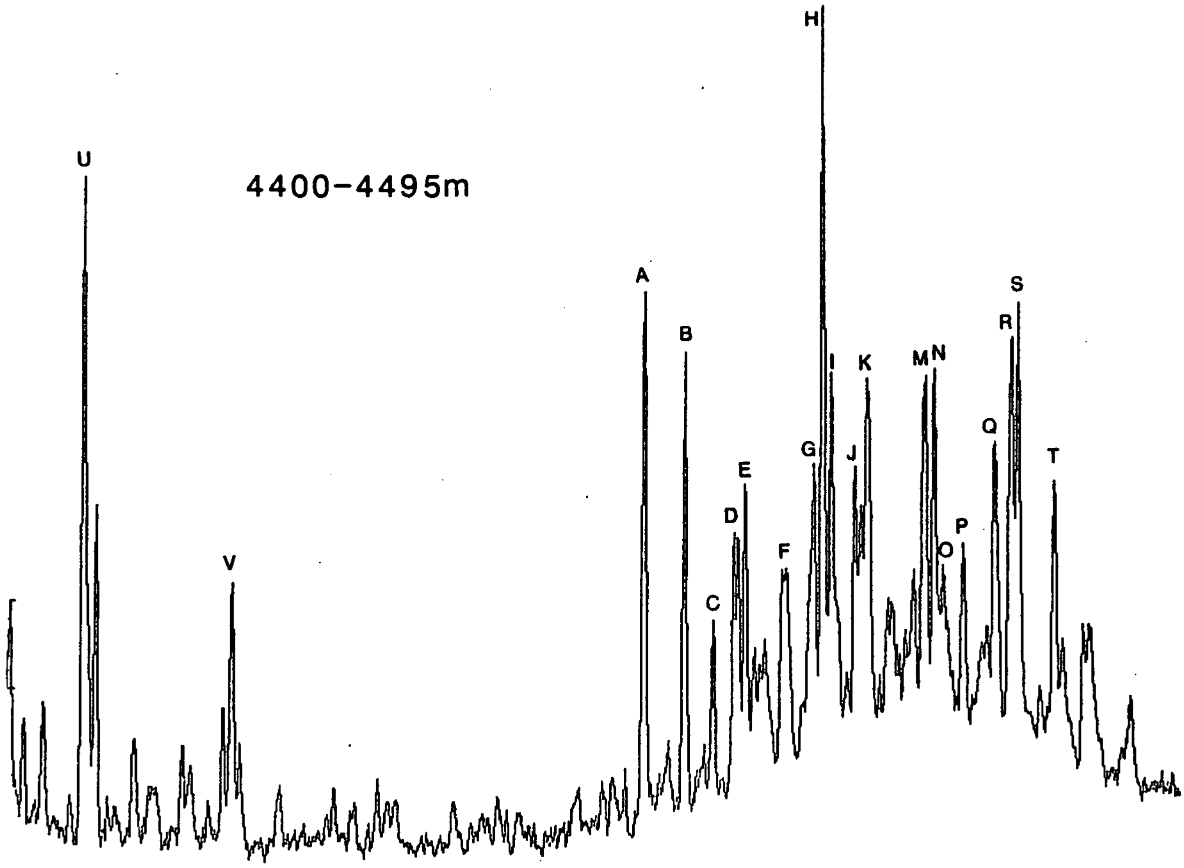


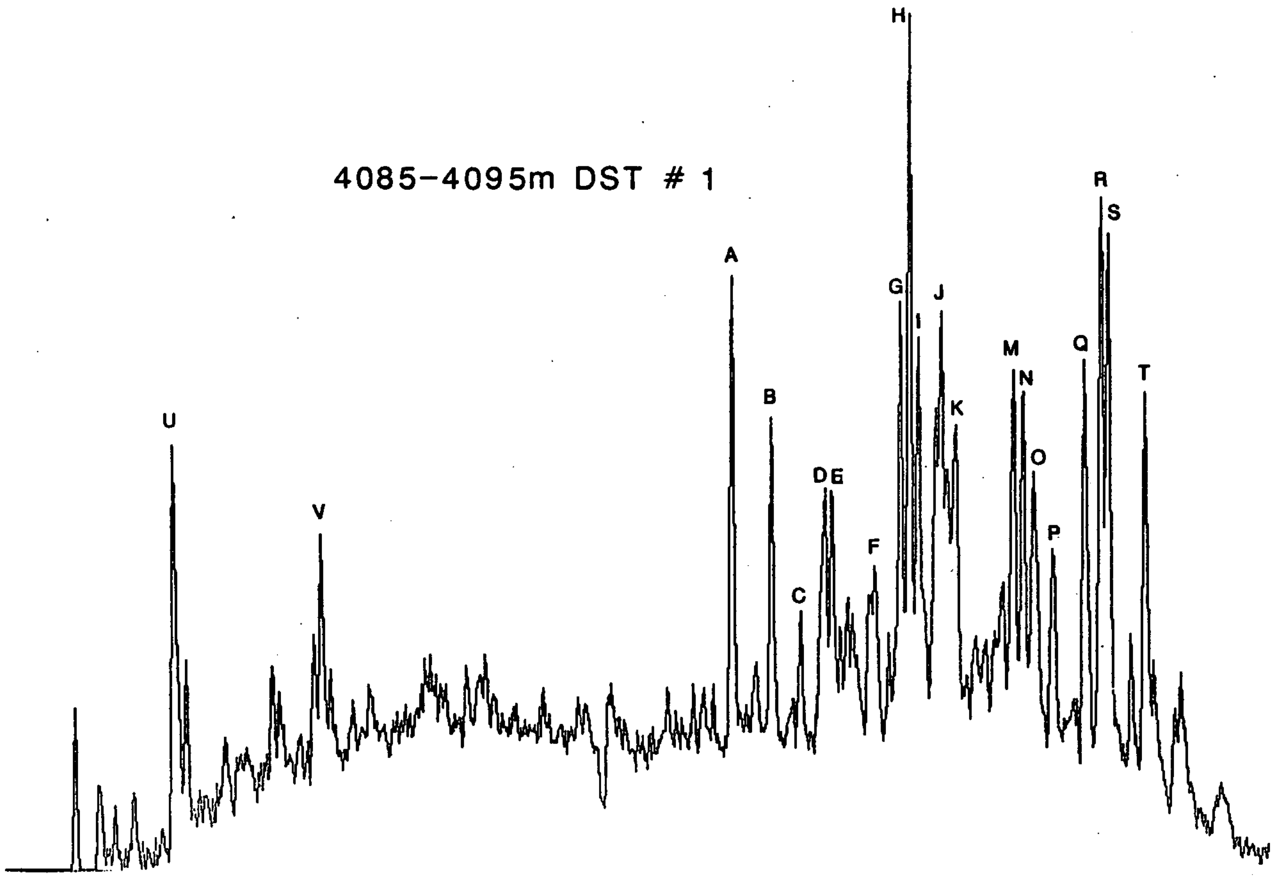
FIGURE 13g

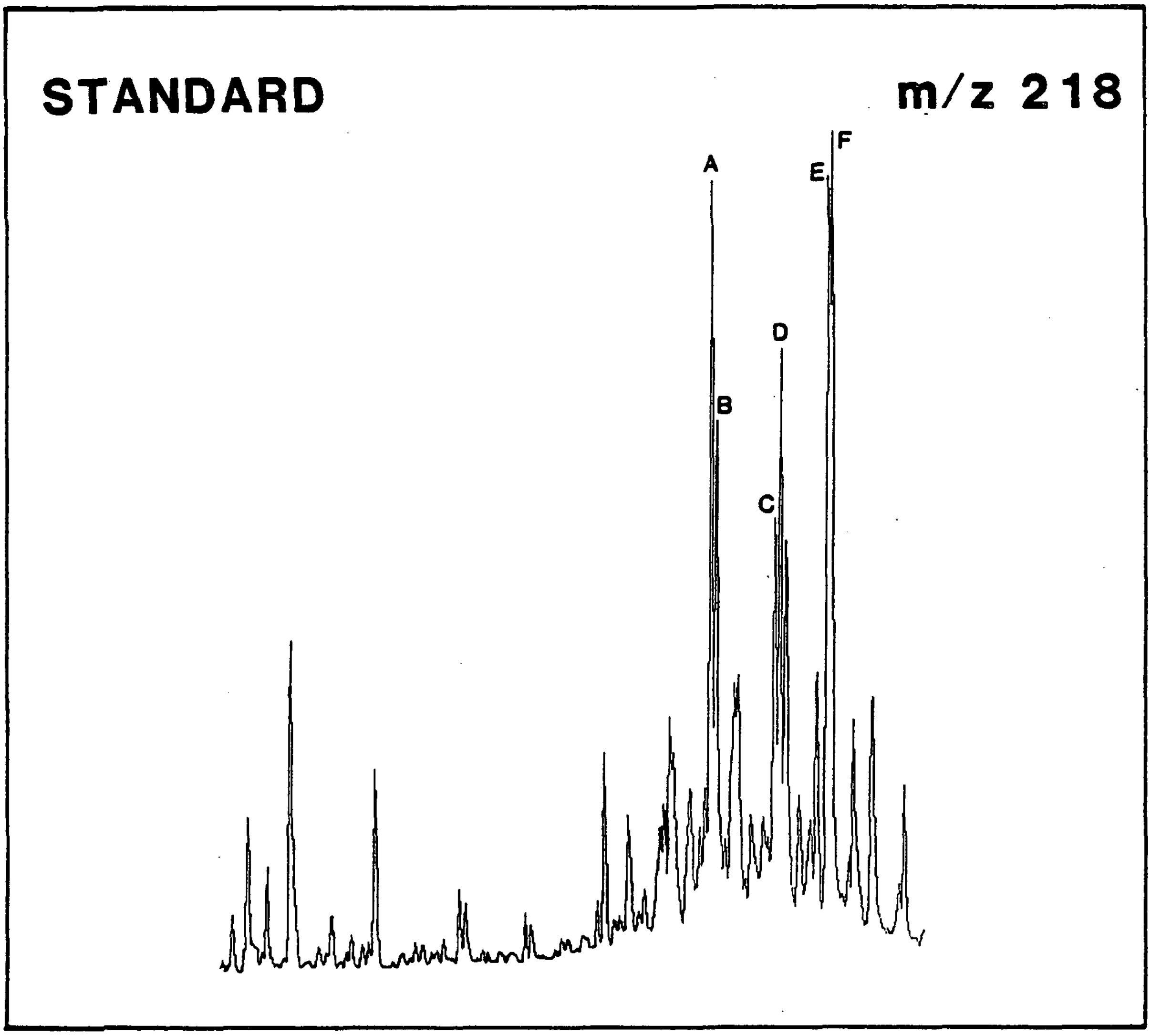
MASS FRAGMENTOGRAMS

WELL 34/10-23

STERANES m/z 217







STERANE IDENTIFICATION

(M/Z 218 FRAGMENTOGRAM)

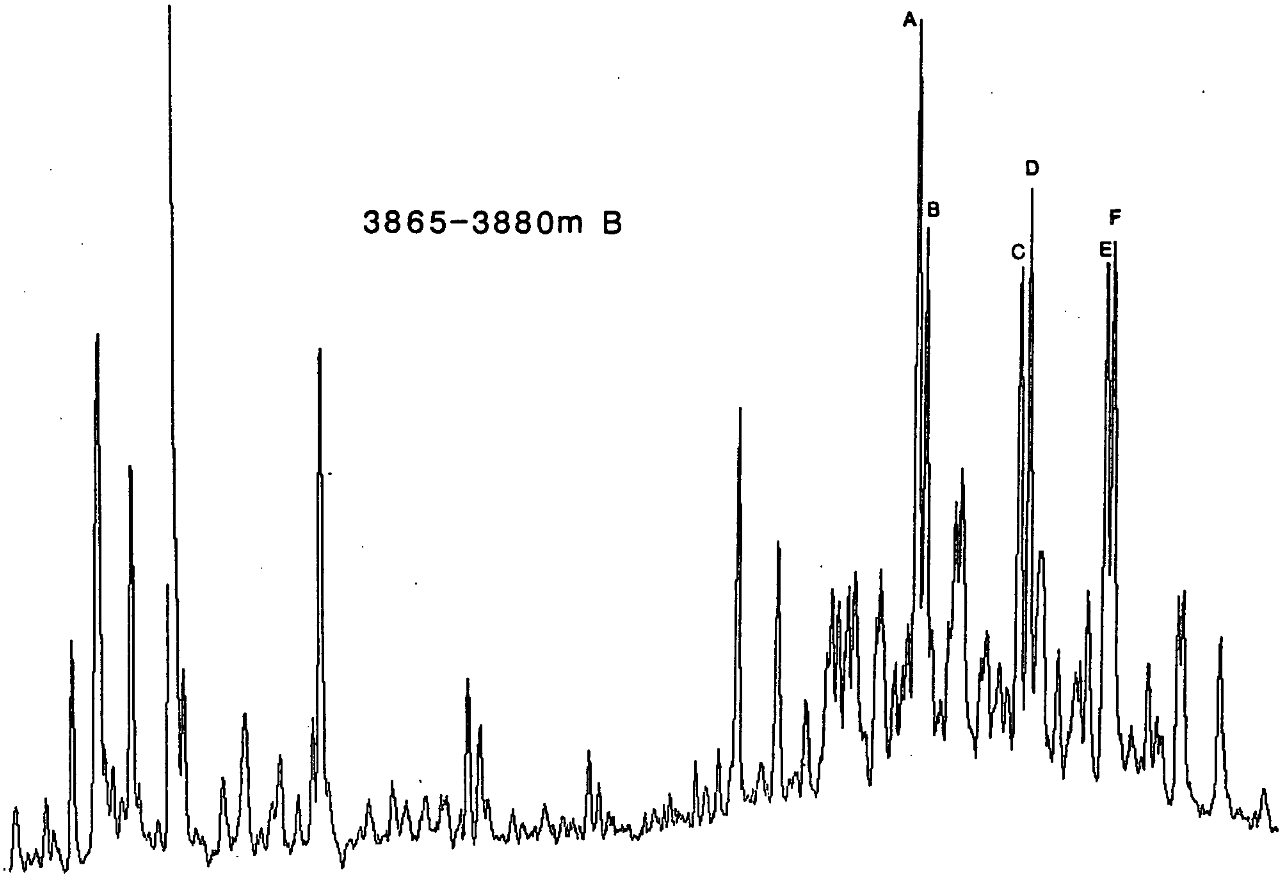
	COMPOUND	ELEMENTAL COMPOUND
A	14β,17β-cholestane (20R)	$C_{27}H_{48}$
B	14β,17β-cholestane (20S)	$C_{27}H_{48}$
C	24-methyl-14β,17β-cholestane (20R)	$C_{28}H_{50}$
D	24-methyl-14β,17β-cholestane (20S)	$C_{28}H_{50}$
E	24-ethyl-14β,17β-cholestane (20R)	$C_{29}H_{52}$
F	24-ethyl-14β,17β-cholestane (20S)	$C_{29}H_{52}$

FIGURE 14a

MASS FRAGMENTOGRAMS

WELL 34/10-23

$\beta\beta$ STERANES m/z 218



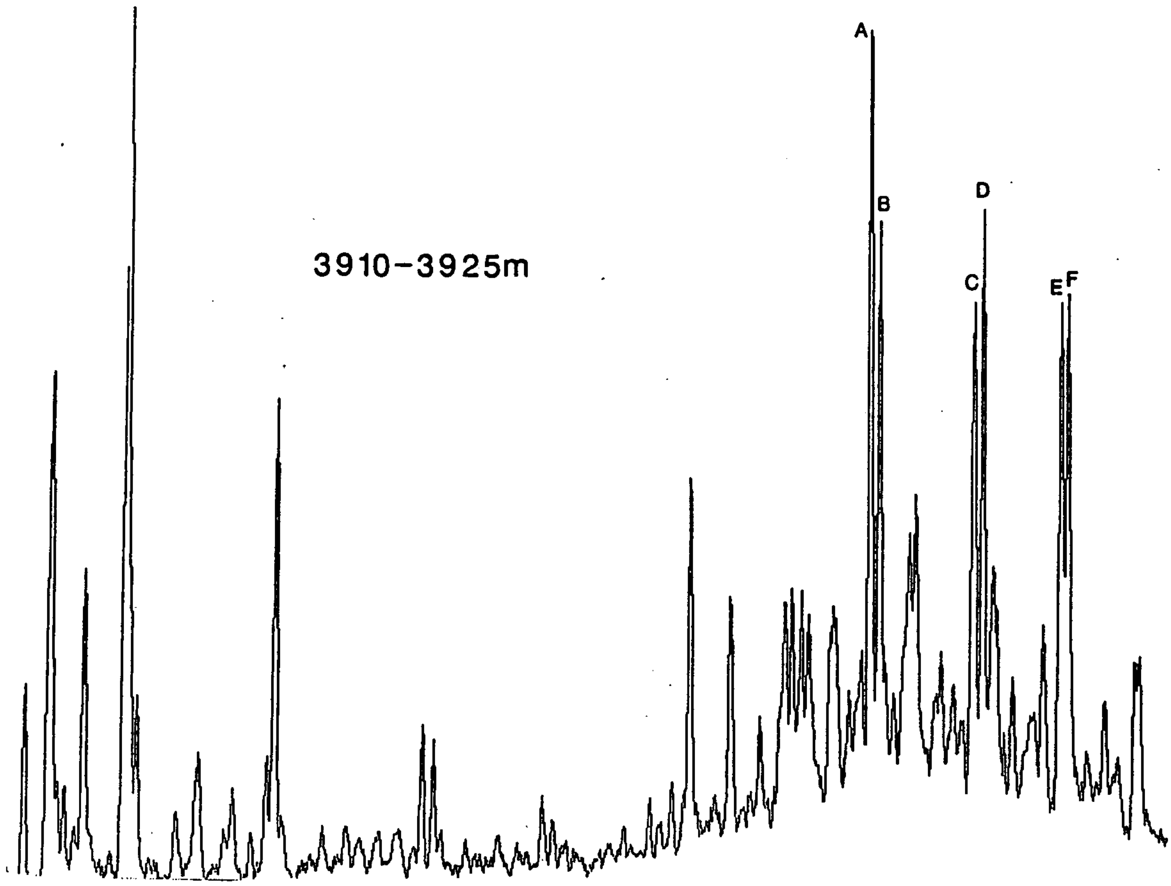
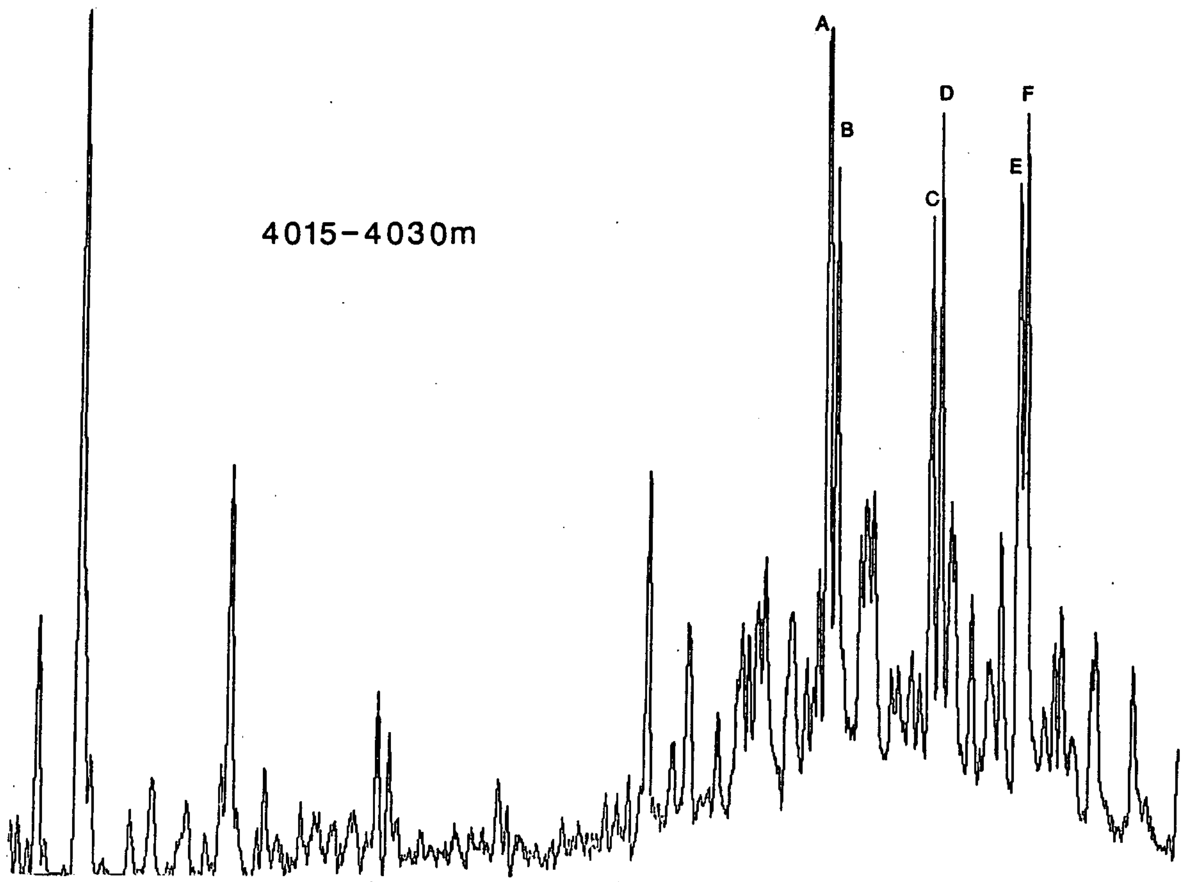


FIGURE 14b

WELL 34/10-23

MASS FRAGMENTOGRAMS

$\beta\beta$ STERANES m/z 218



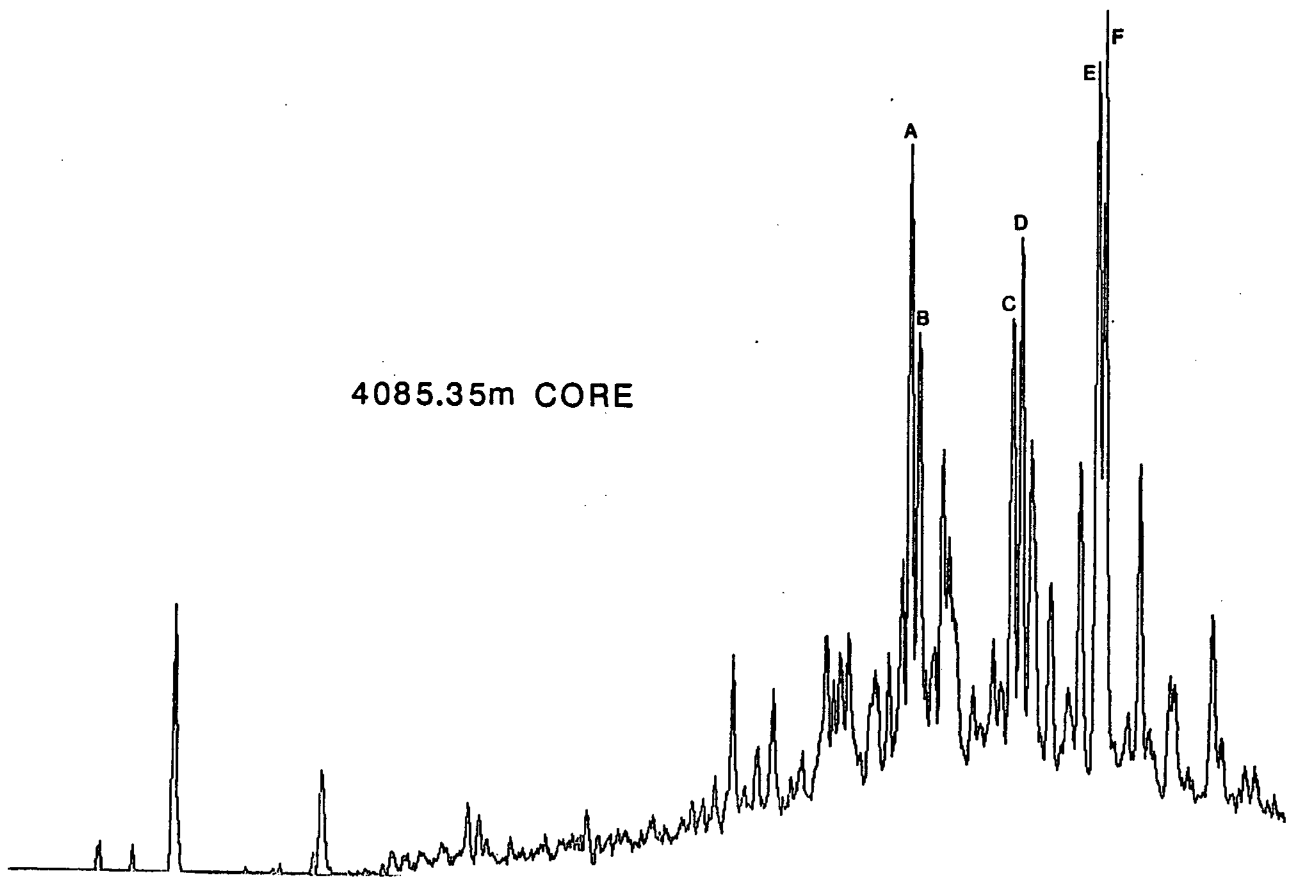
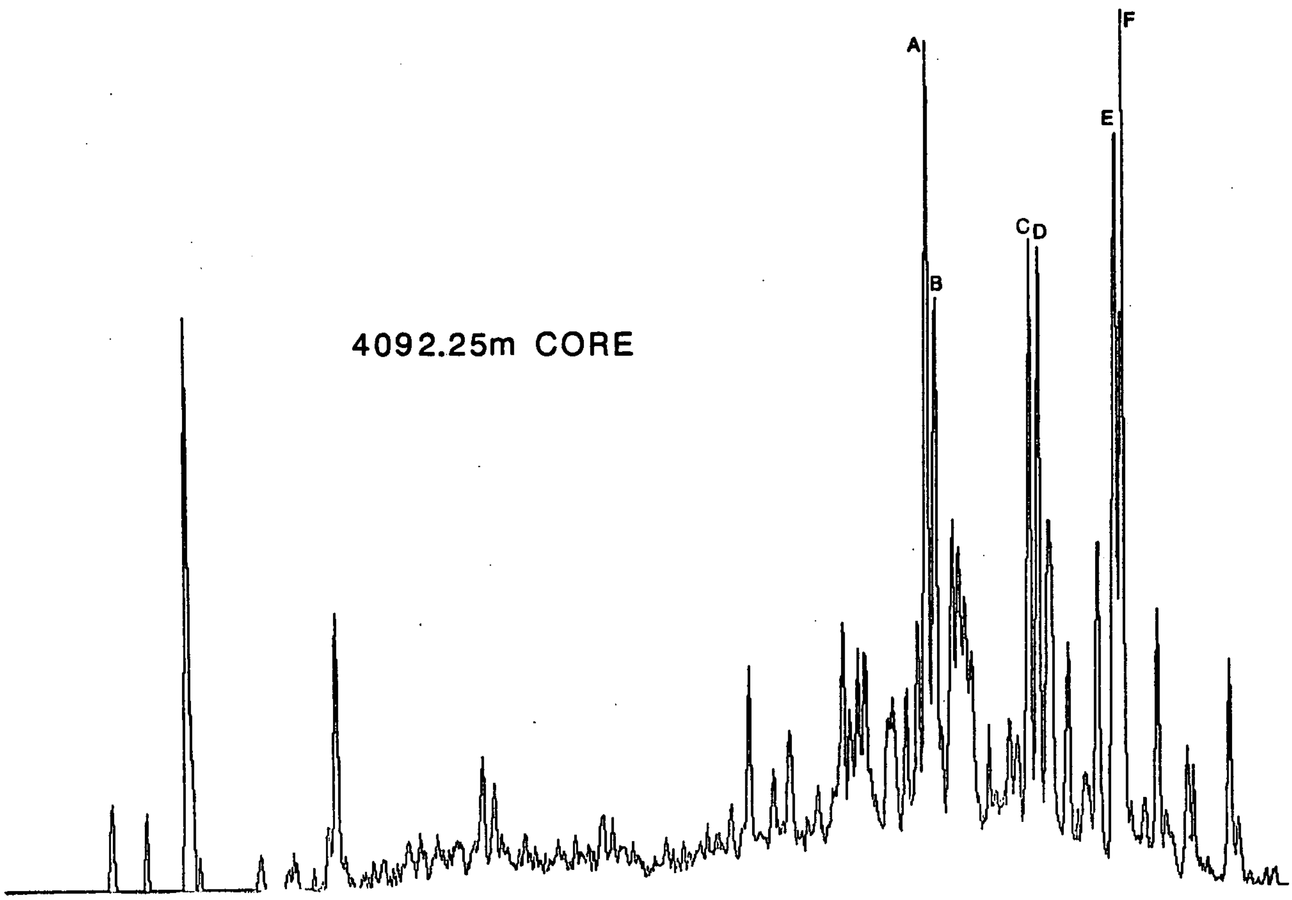


FIGURE 14c

WELL 34/10-23

MASS FRAGMENTOGRAMS

$\beta\beta$ STERANES m/z 218



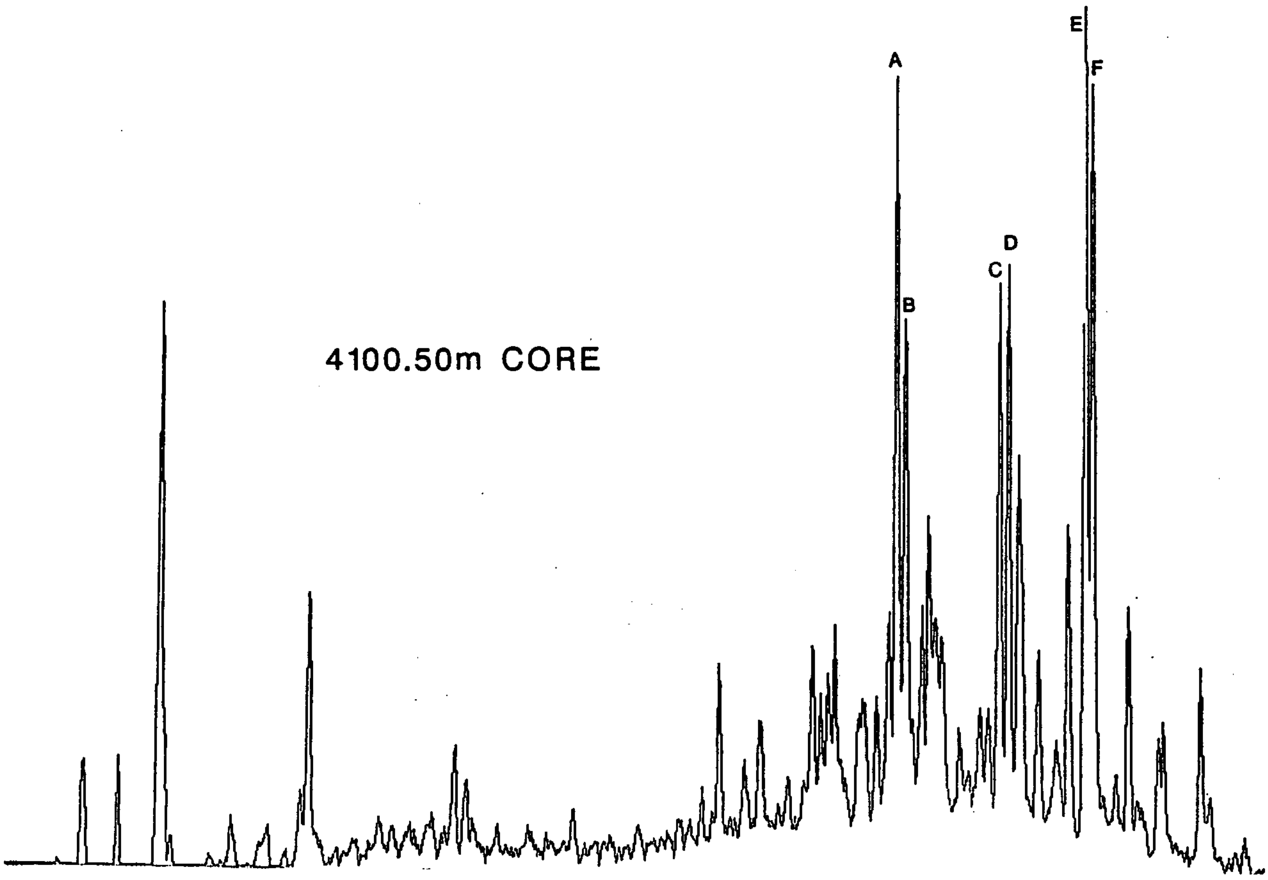
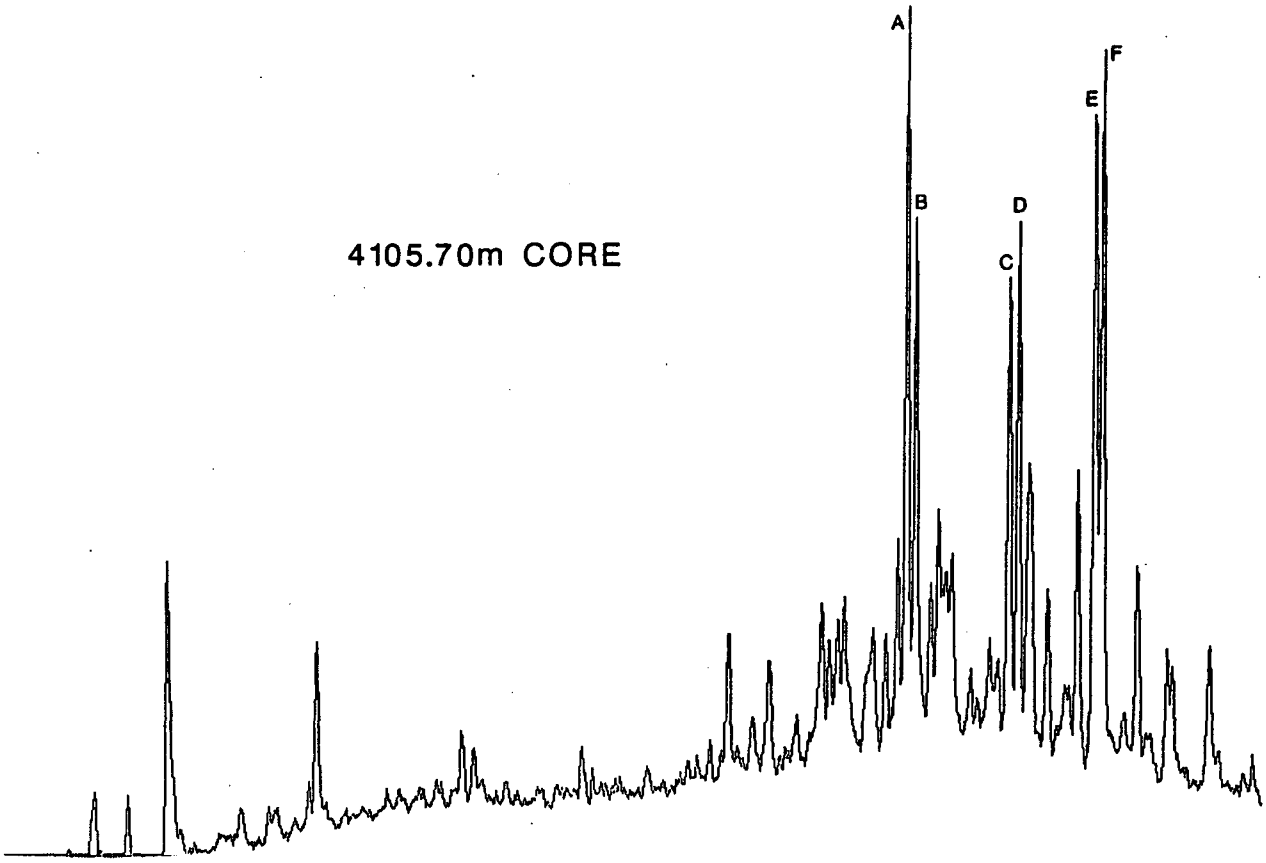


FIGURE 14d

WELL 34/10-23

MASS FRAGMENTOGRAMS

$\beta\beta$ STERANES m/z 218



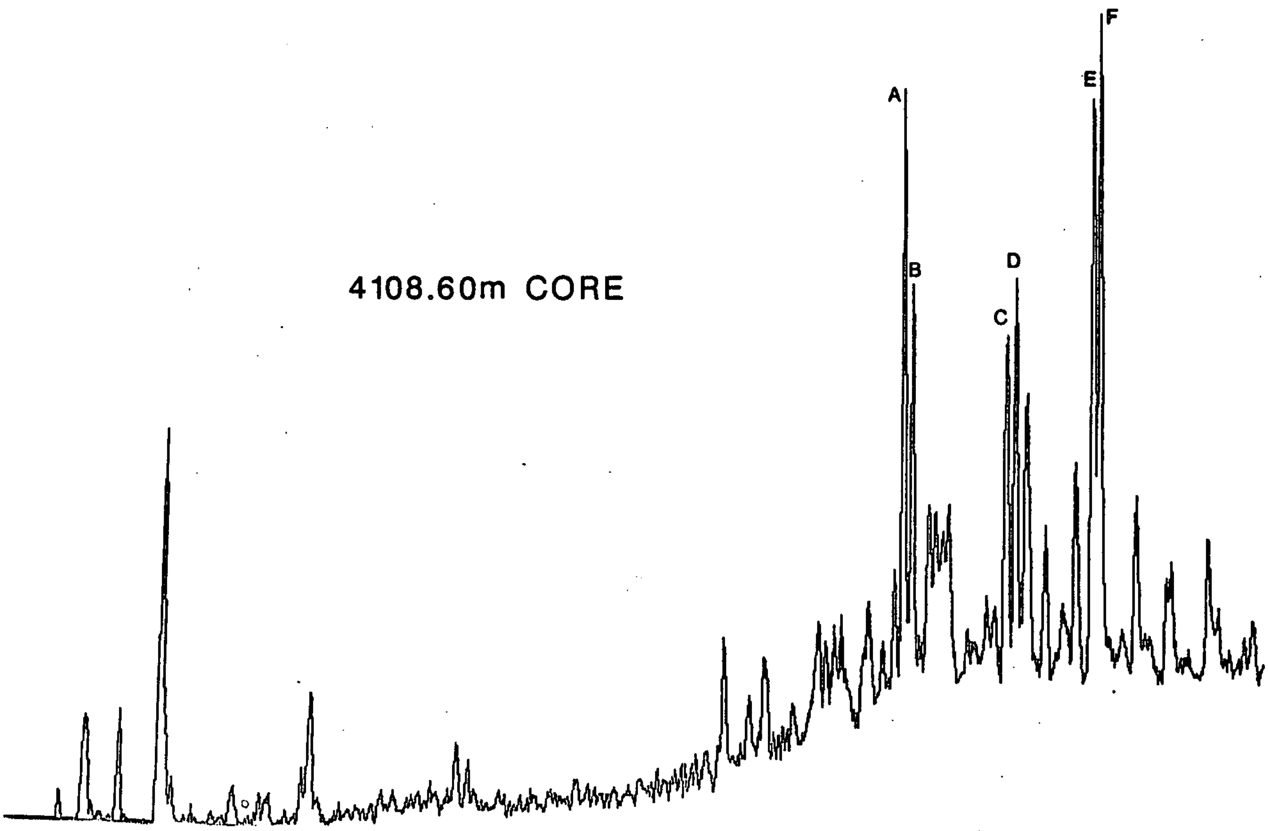
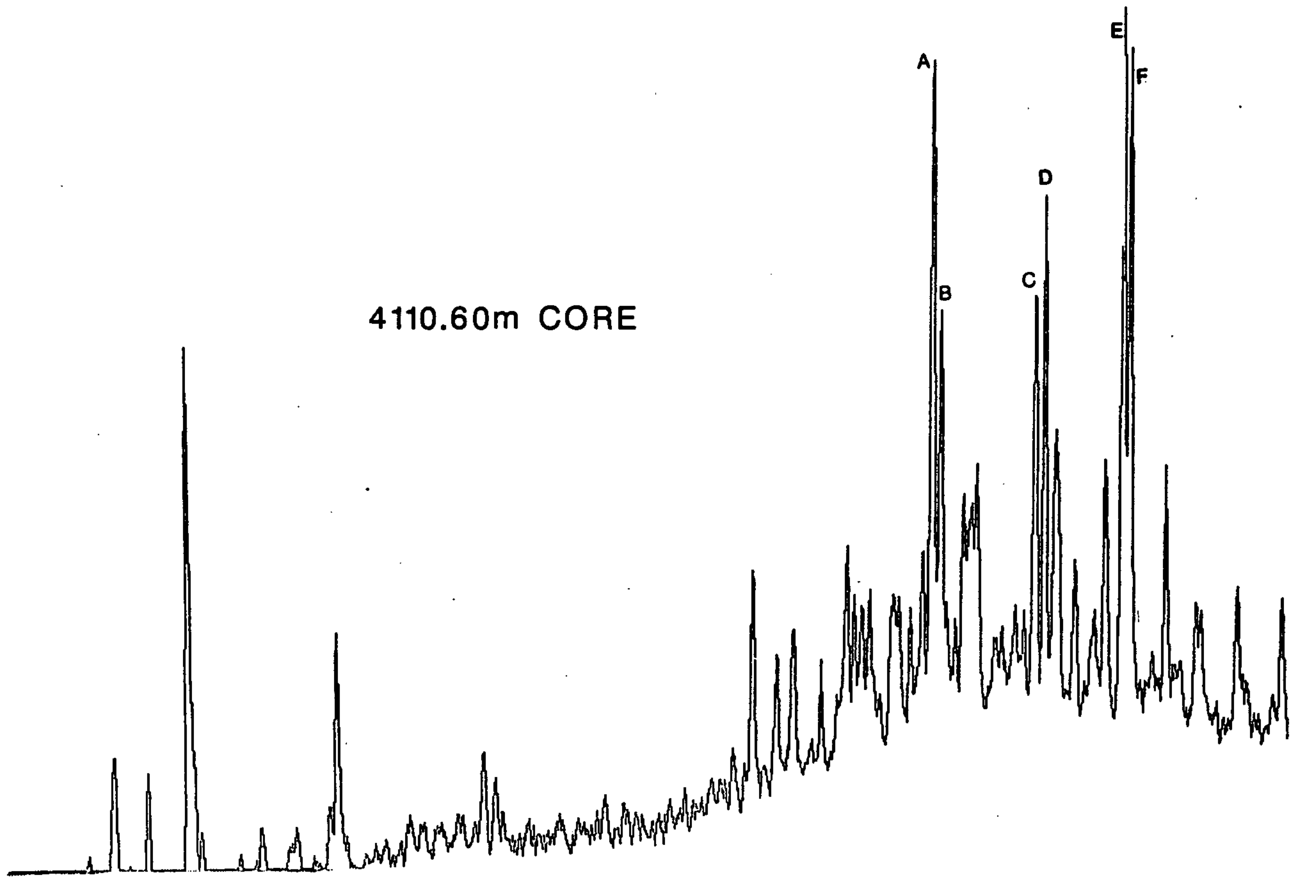


FIGURE 14e

WELL 34/10-23

MASS FRAGMENTOGRAMS

$\beta\beta$ STERANES m/z 218



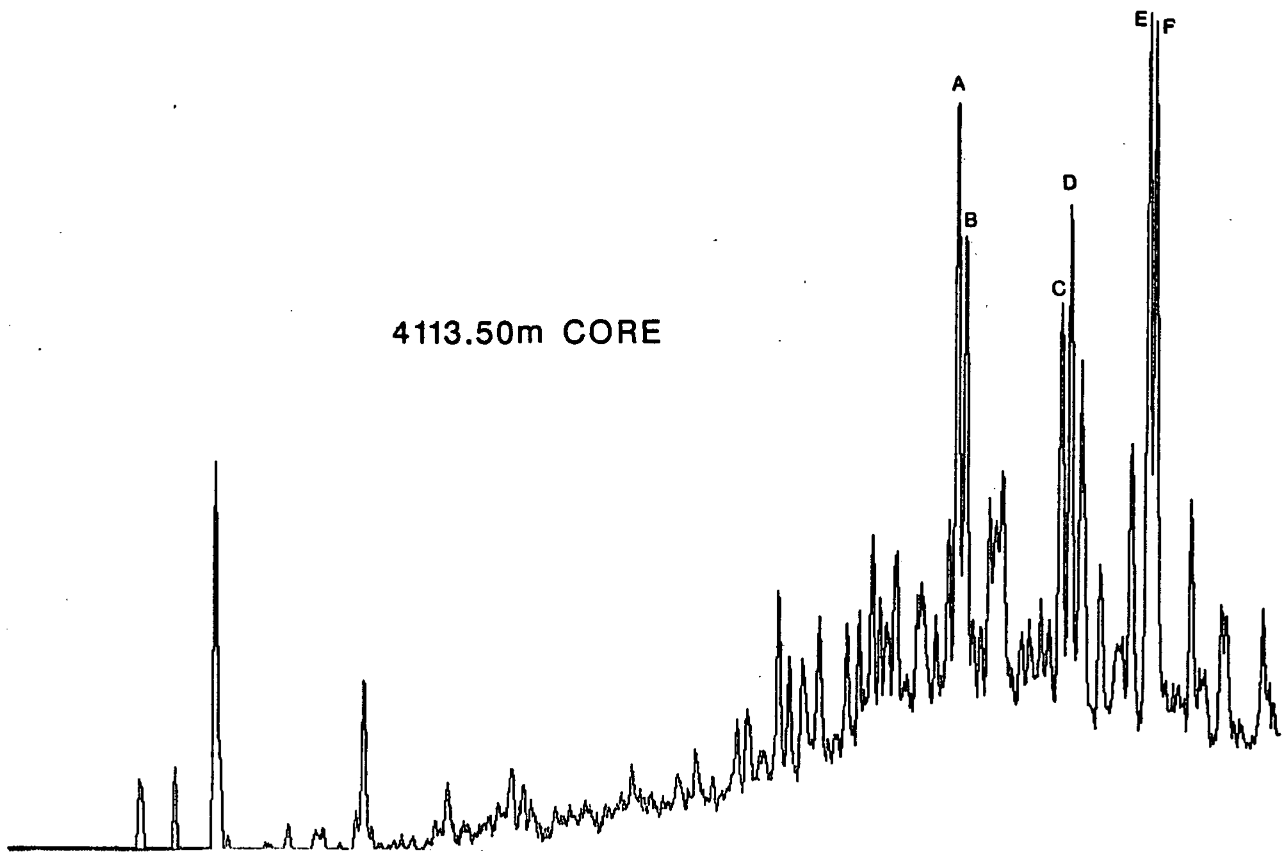


FIGURE 14f

MASS FRAGMENTOGRAMS

WELL 34/10-23

$\beta\beta$ STERANES m/z 218

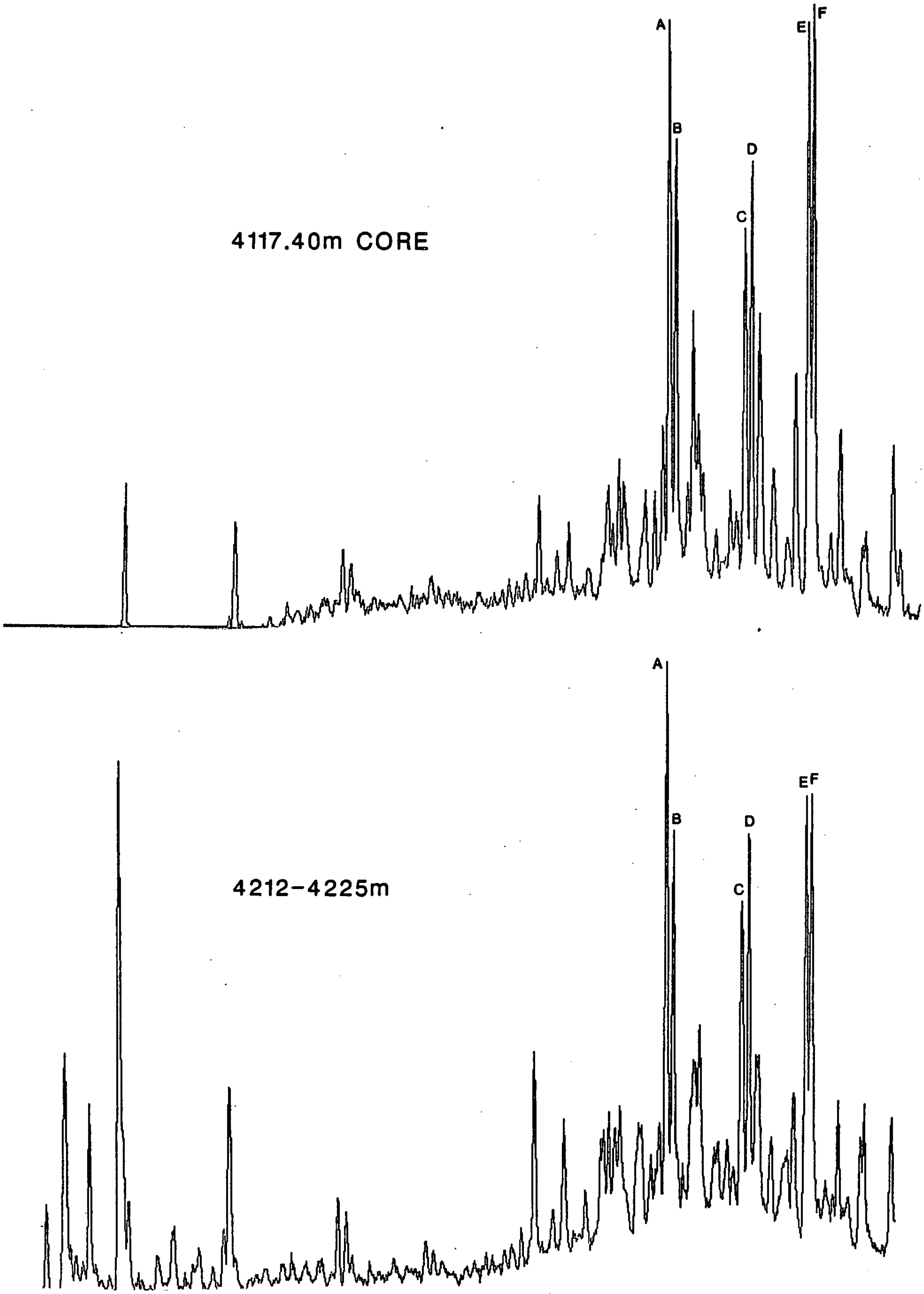
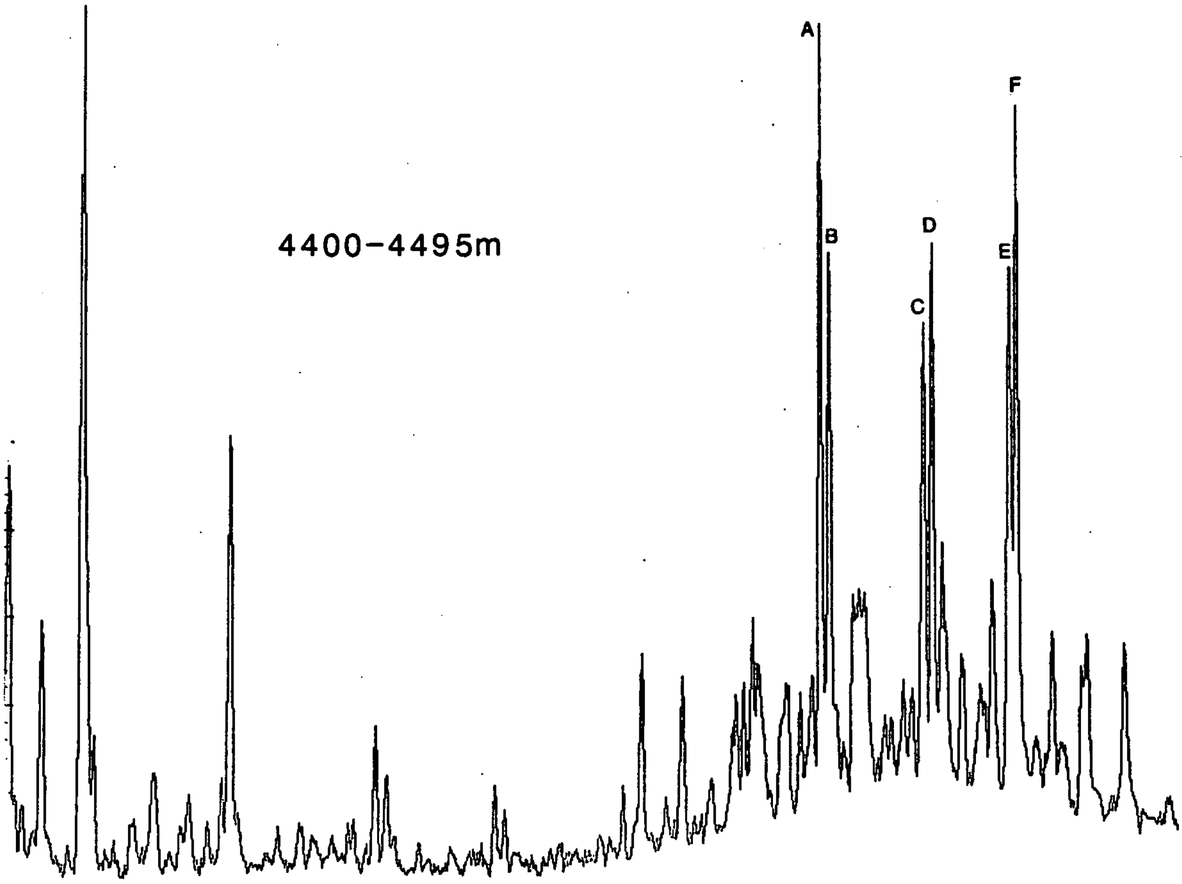


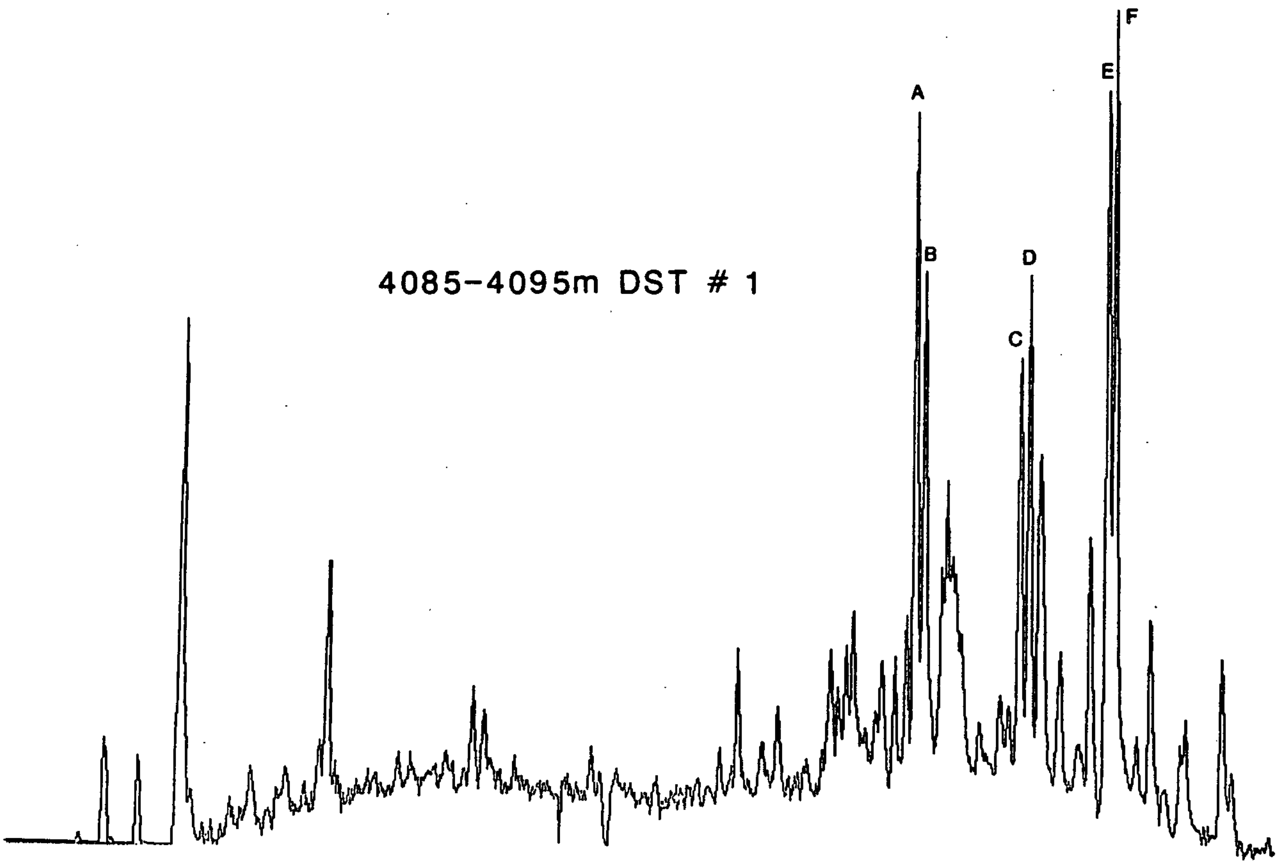
FIGURE 14g

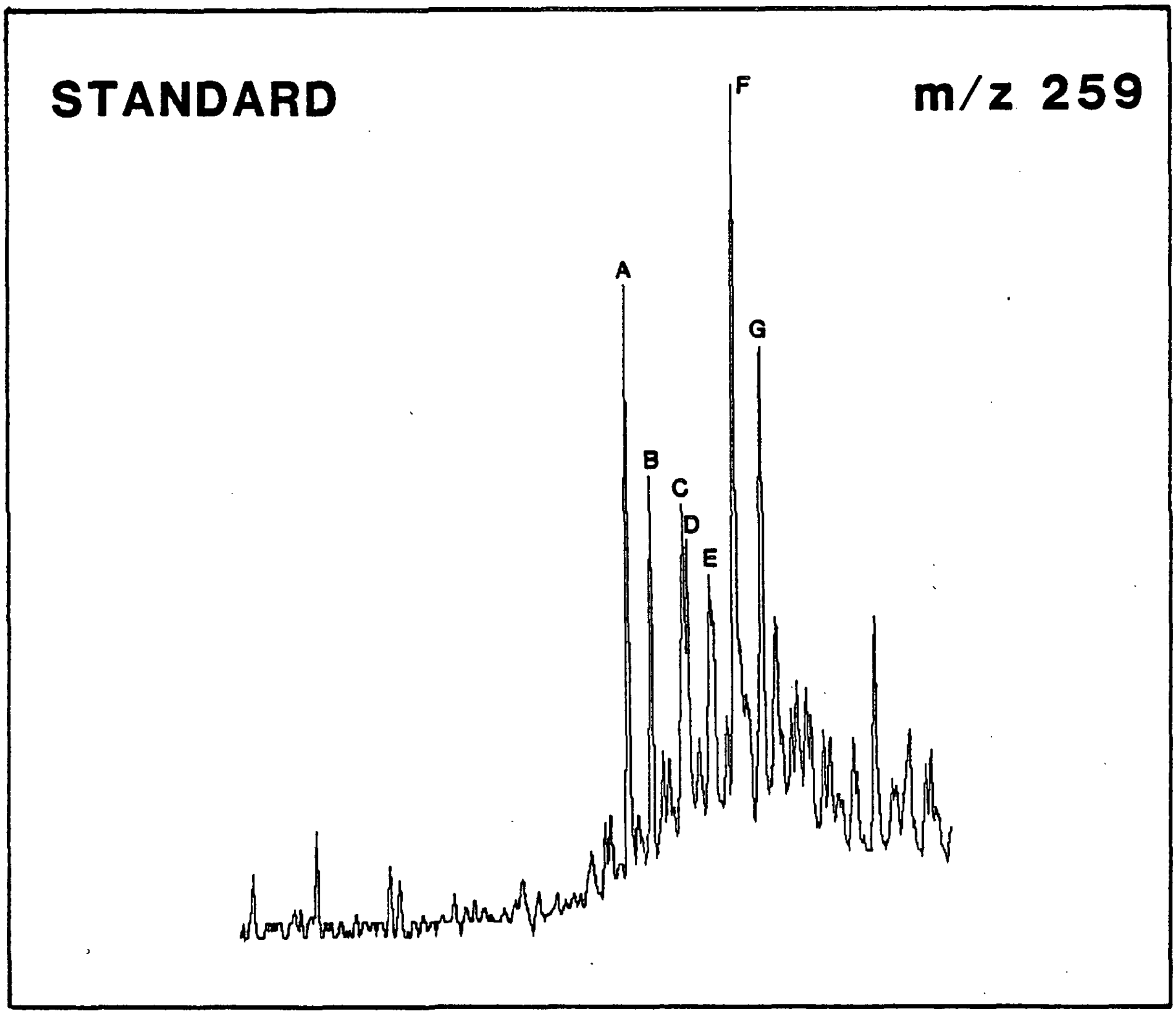
WELL 34/10-23

MASS FRAGMENTOGRAMS

$\beta\beta$ STERANES m/z 218







STERANE IDENTIFICATION

(M/Z 259 FRAGMENTOGRAM)

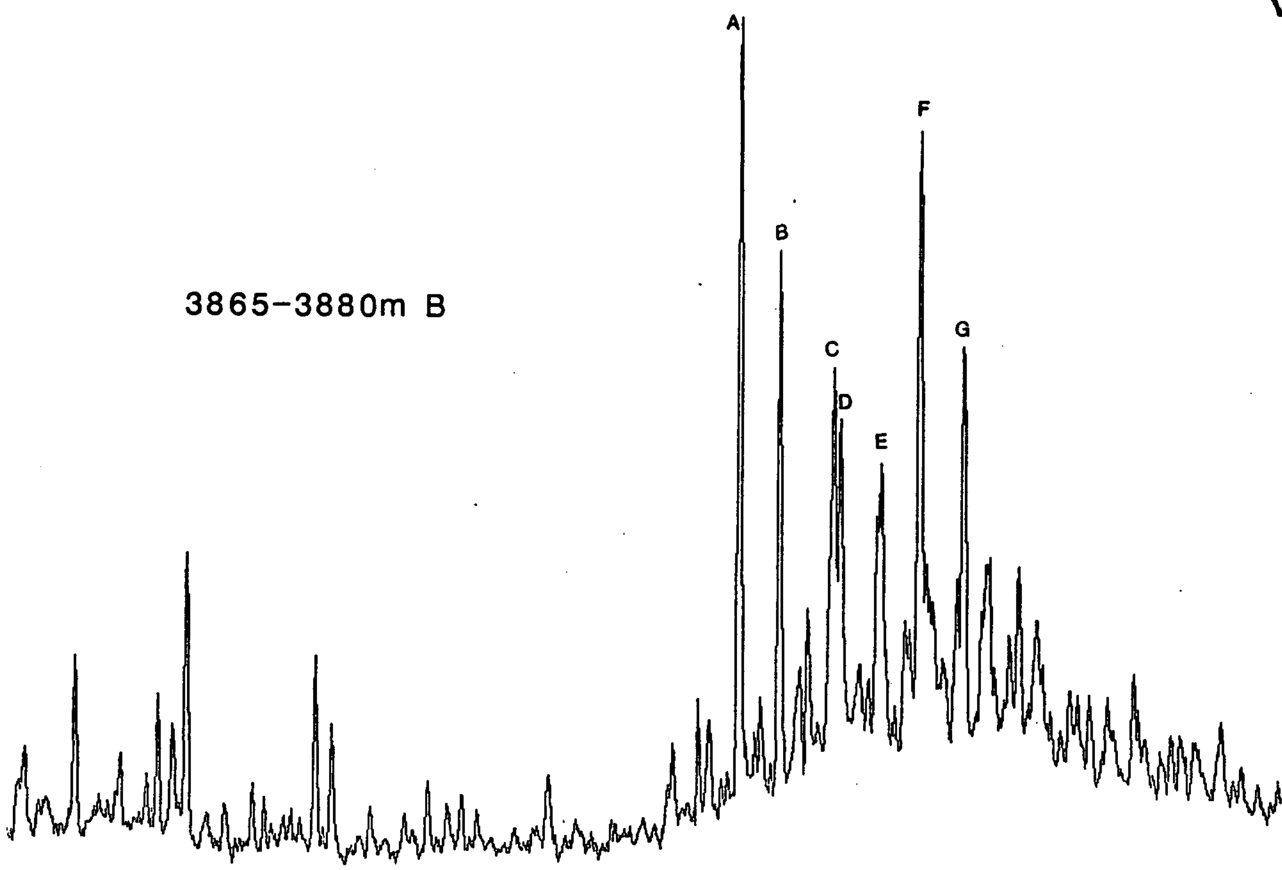
	COMPOUND	ELEMENTAL COMPOSITION
A	13β,17α-diacholestane (20S)	$C_{27}H_{48}$
B	13β,17α-diacholestane (20R)	$C_{27}H_{48}$
C	13α,17β-diacholestane (20R)	$C_{27}H_{48}$
D	24,-methyl-13β,17α-diacholestane (20S)	$C_{28}H_{50}$
E	24,-methyl-13β,17α-diacholestane (20R)	$C_{28}H_{50}$
F	24,-ethyl-13β,17α-diacholestane (20S)	$C_{29}H_{52}$
G	24,-ethyl-13β,17α-diacholestane (20R)	$C_{29}H_{52}$

FIGURE 15a

MASS FRAGMENTOGRAMS

WELL 34/10-23

REARRANGED STERANES m/z 259



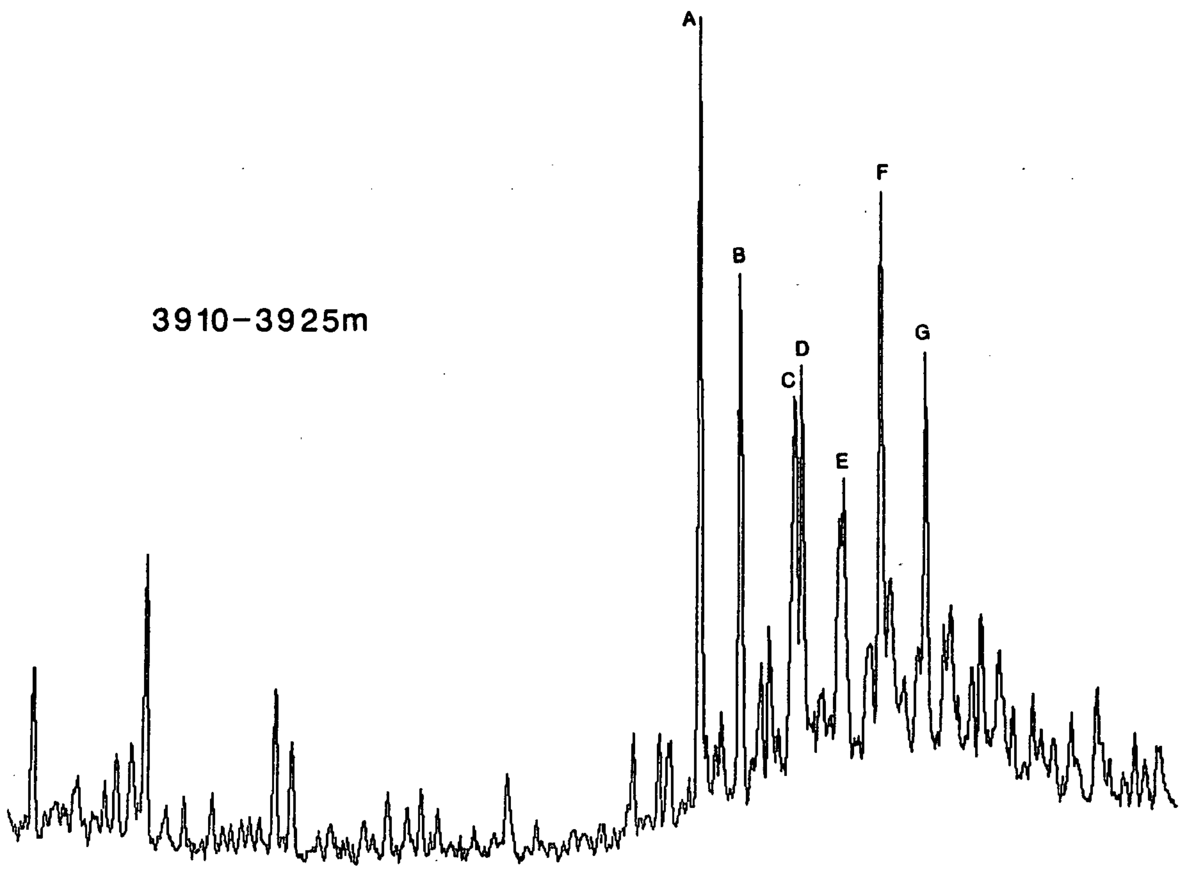
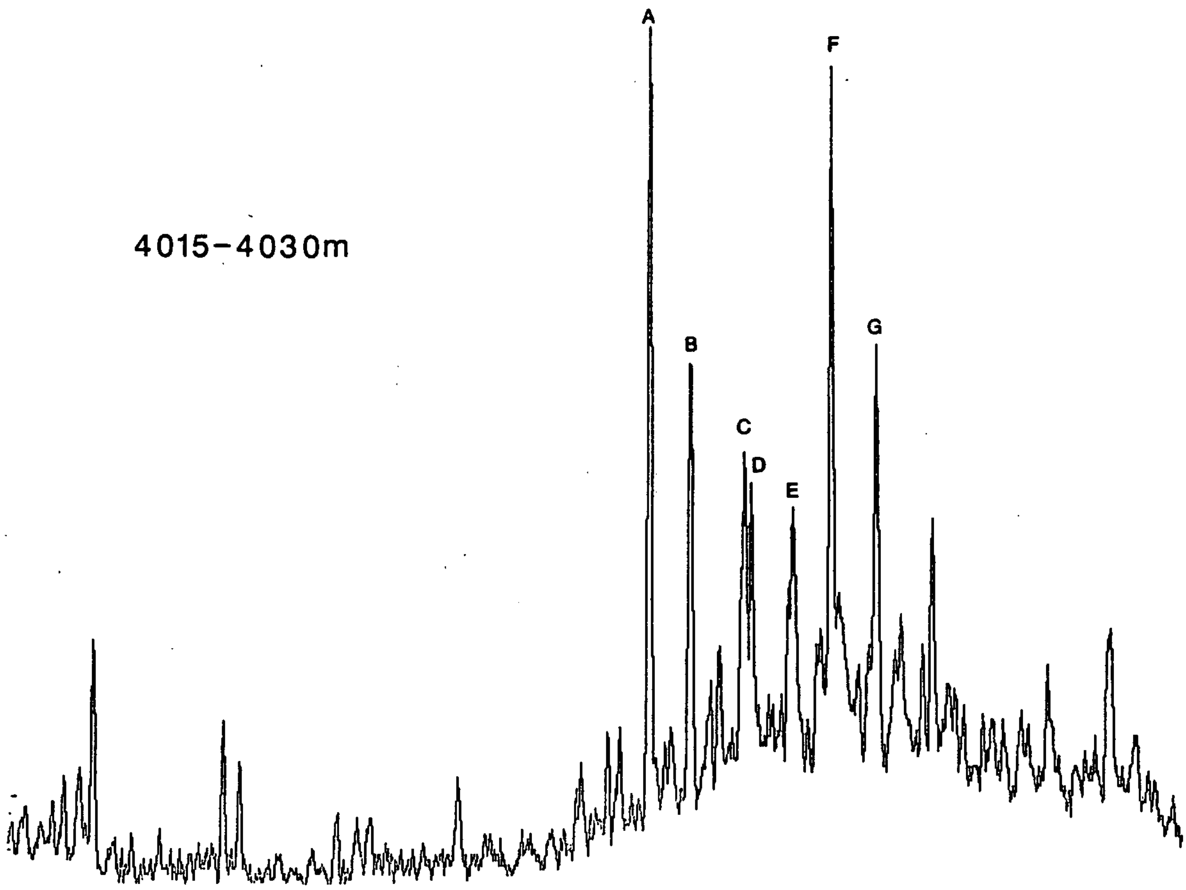


FIGURE 15b

MASS FRAGMENTOGRAMS

WELL 34/10-23 REARRANGED STERANES m/z 259

GEOCHEM



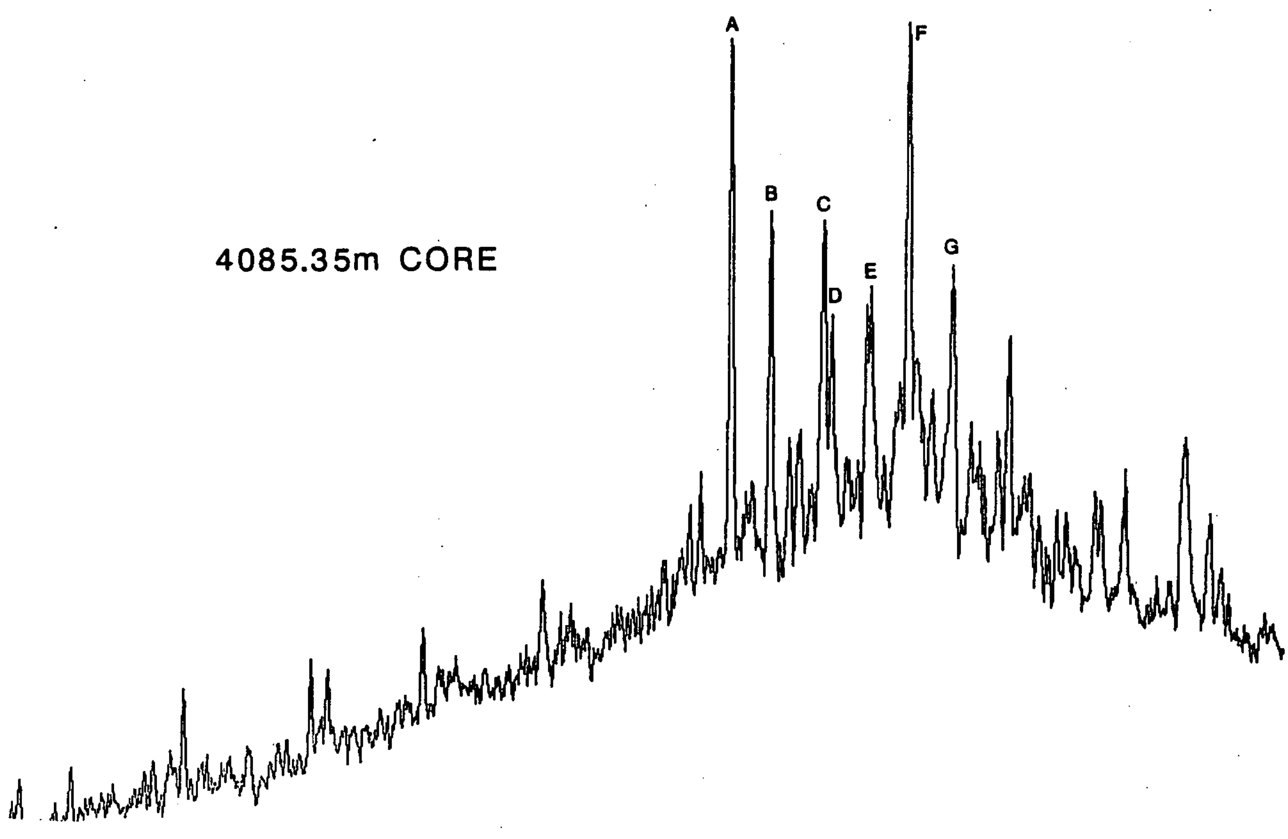
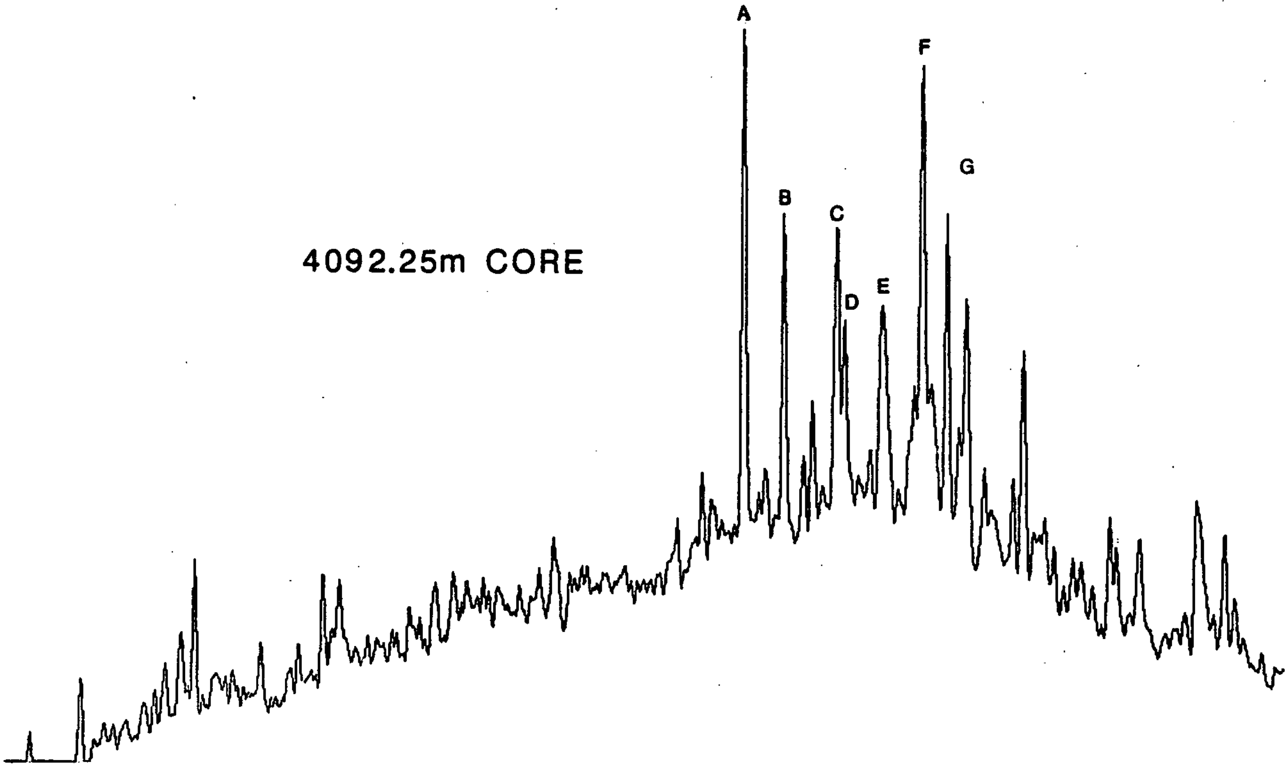


FIGURE 15c

WELL 34/10-23

MASS FRAGMENTOGRAMS

REARRANGED STERANES m/z 259



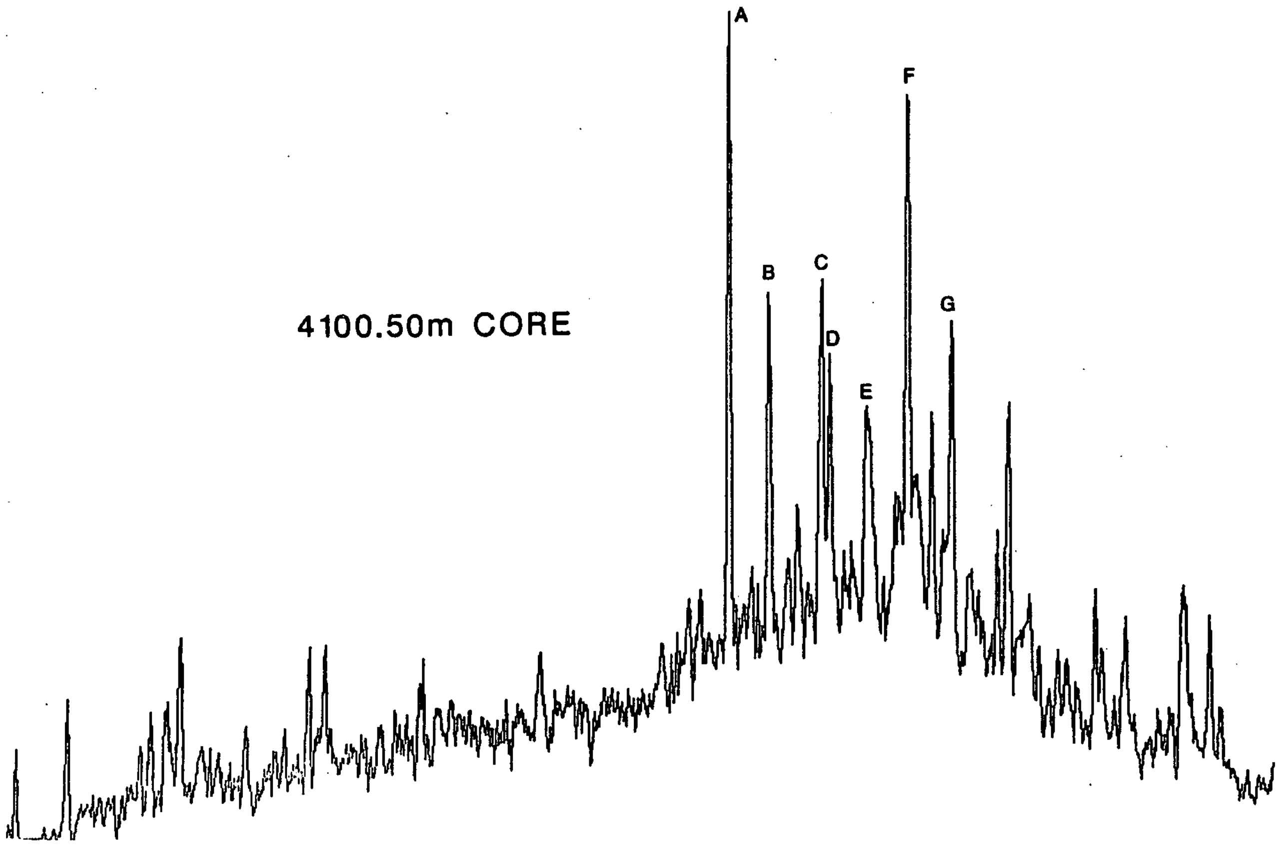


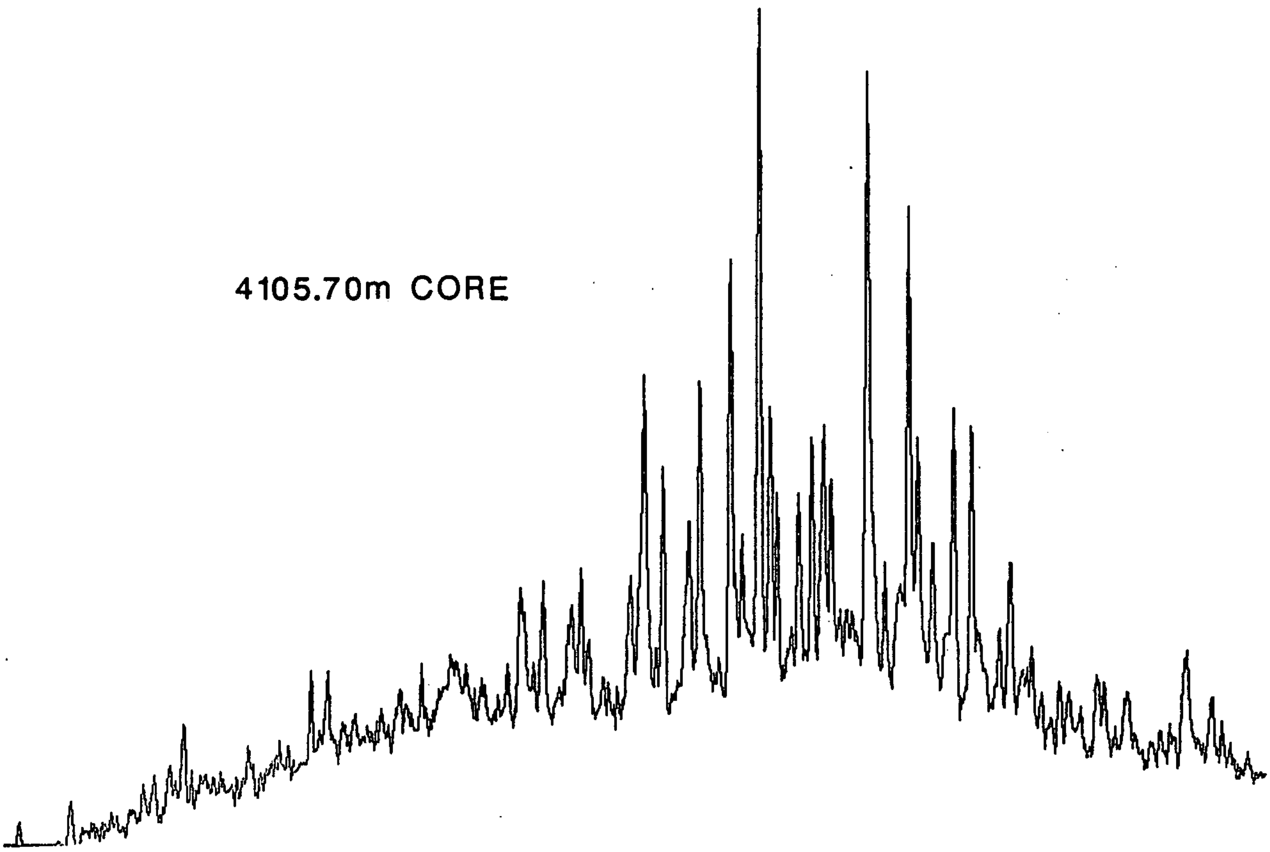
FIGURE 15d

MASS FRAGMENTOGRAMS

WELL 34/10-23

REARRANGED STERANES m/z 259

4105.70m CORE



4108.60m CORE

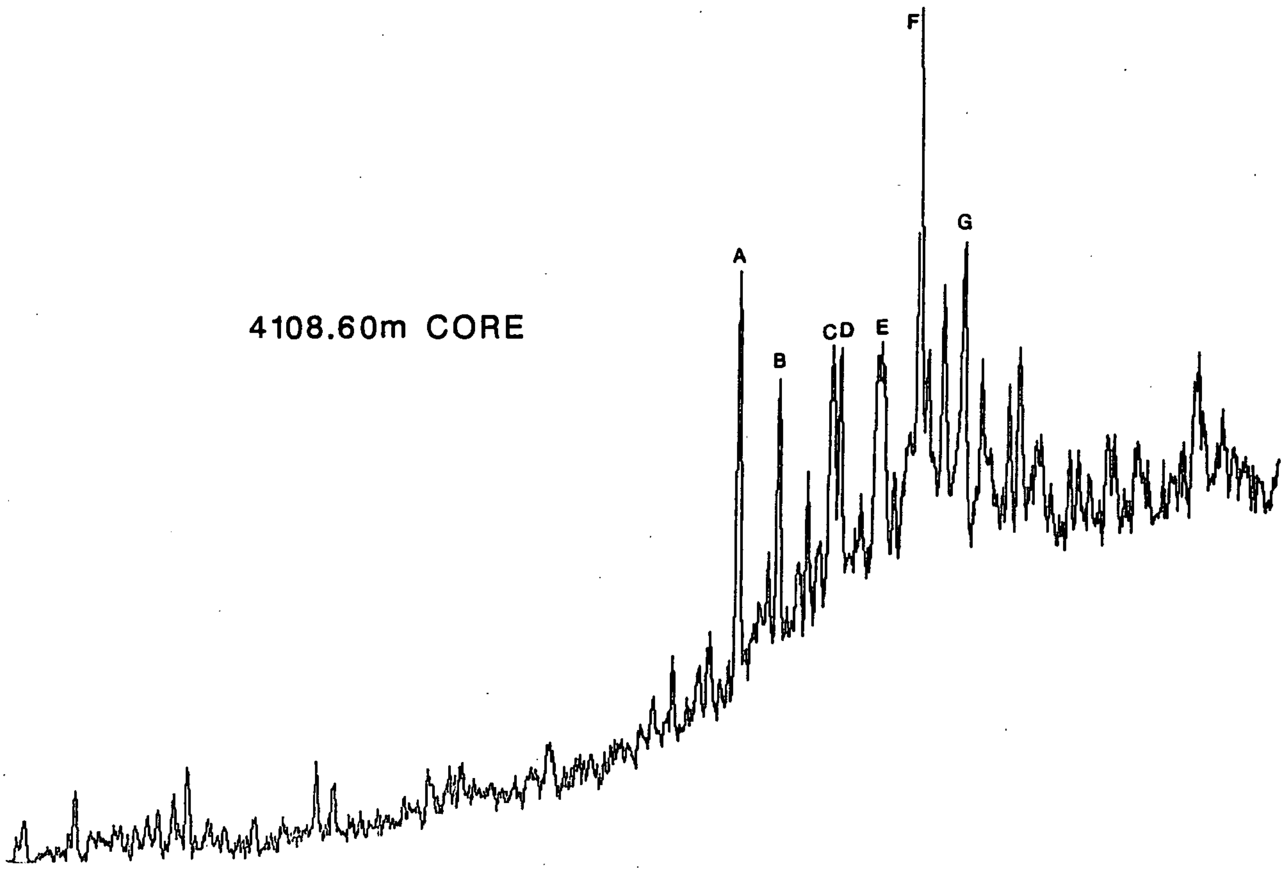
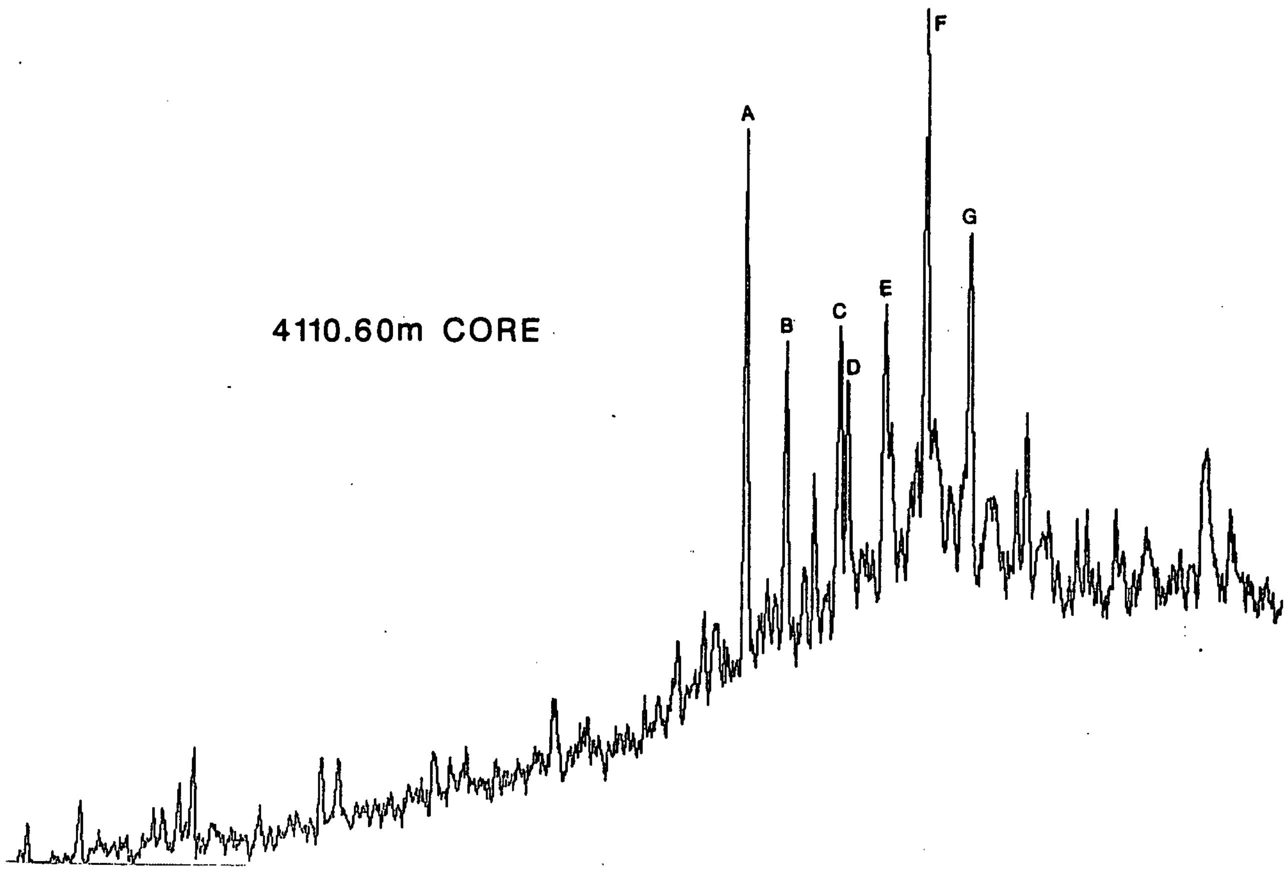


FIGURE 15e

MASS FRAGMENTOGRAMS

WELL 34/10-23

REARRANGED STERANES m/z 259



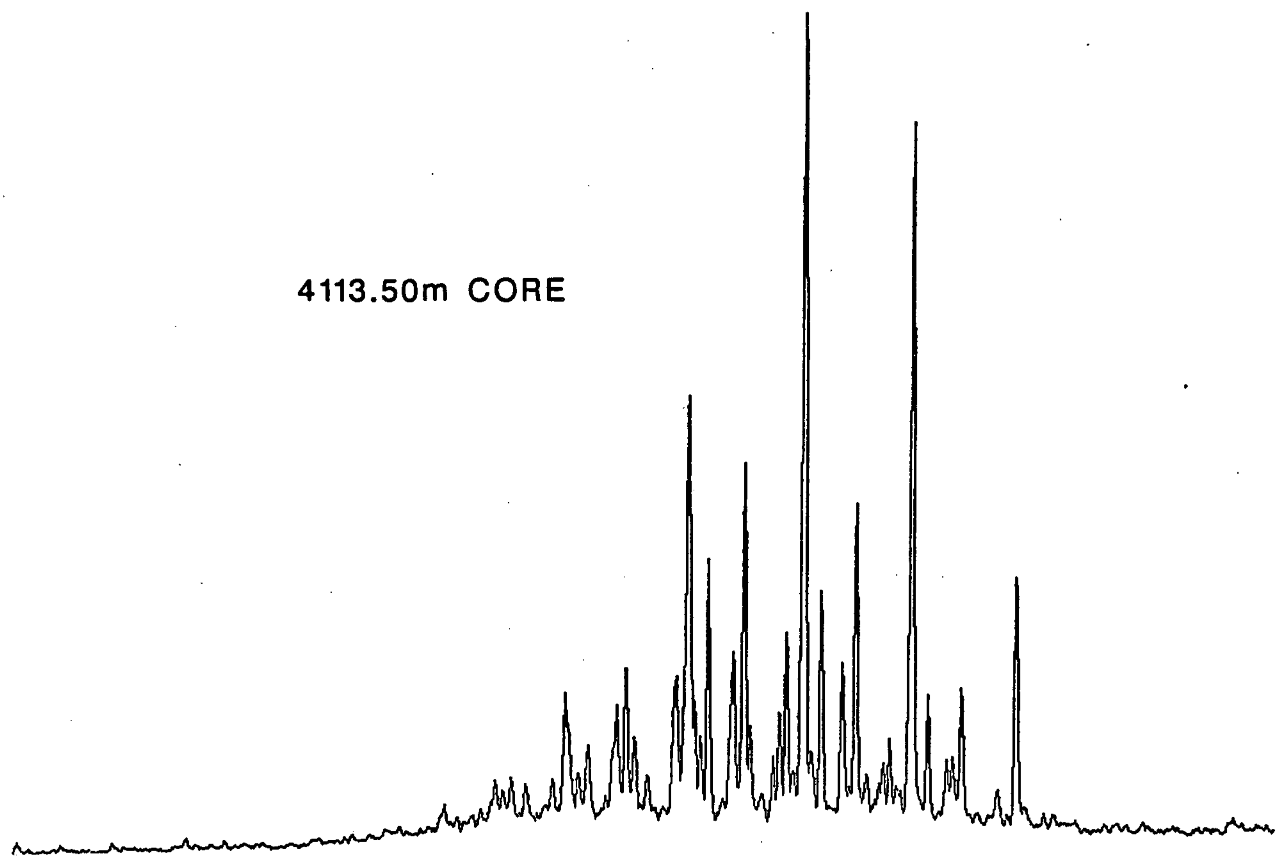
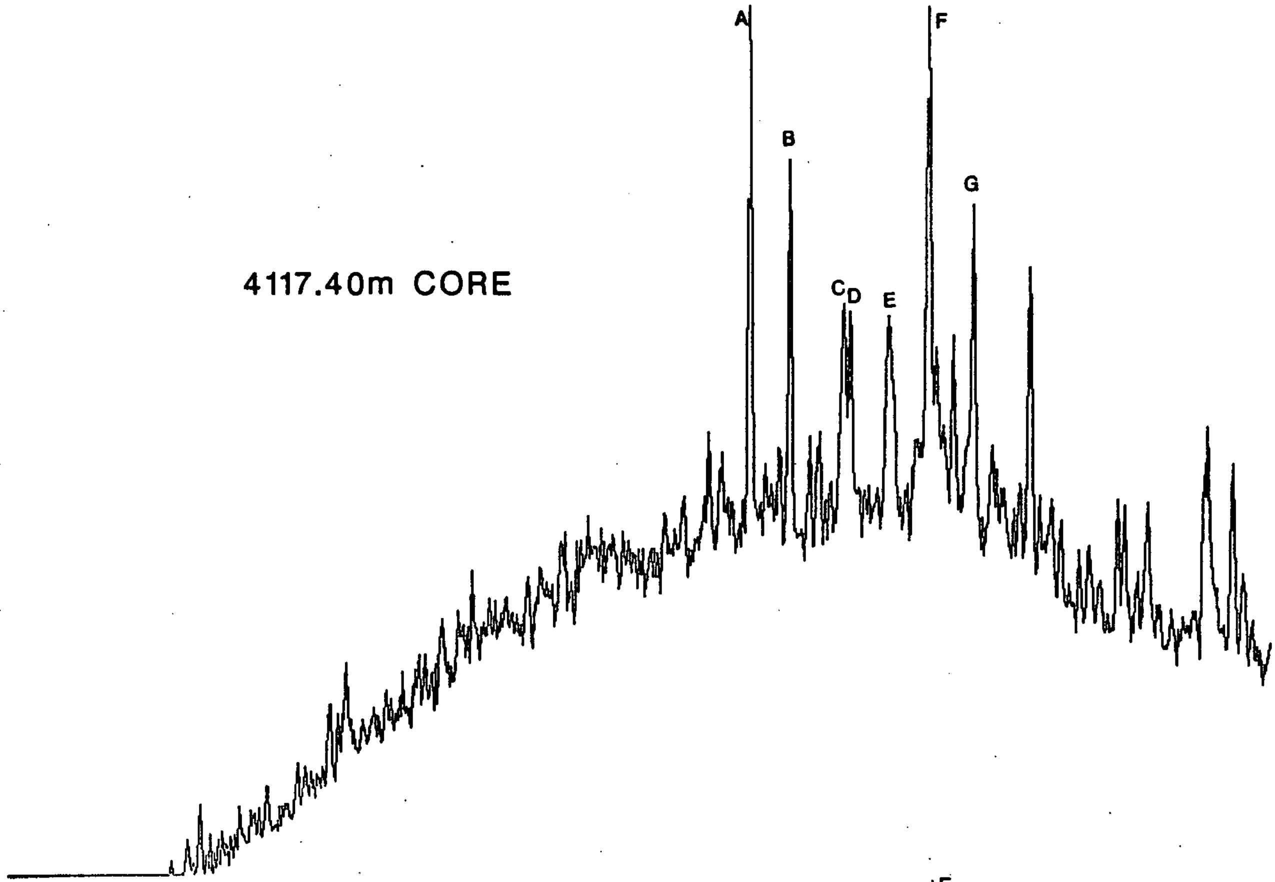


FIGURE 15f

MASS FRAGMENTOGRAMS

WELL 34/10-23

REARRANGED STERANES m/z 259



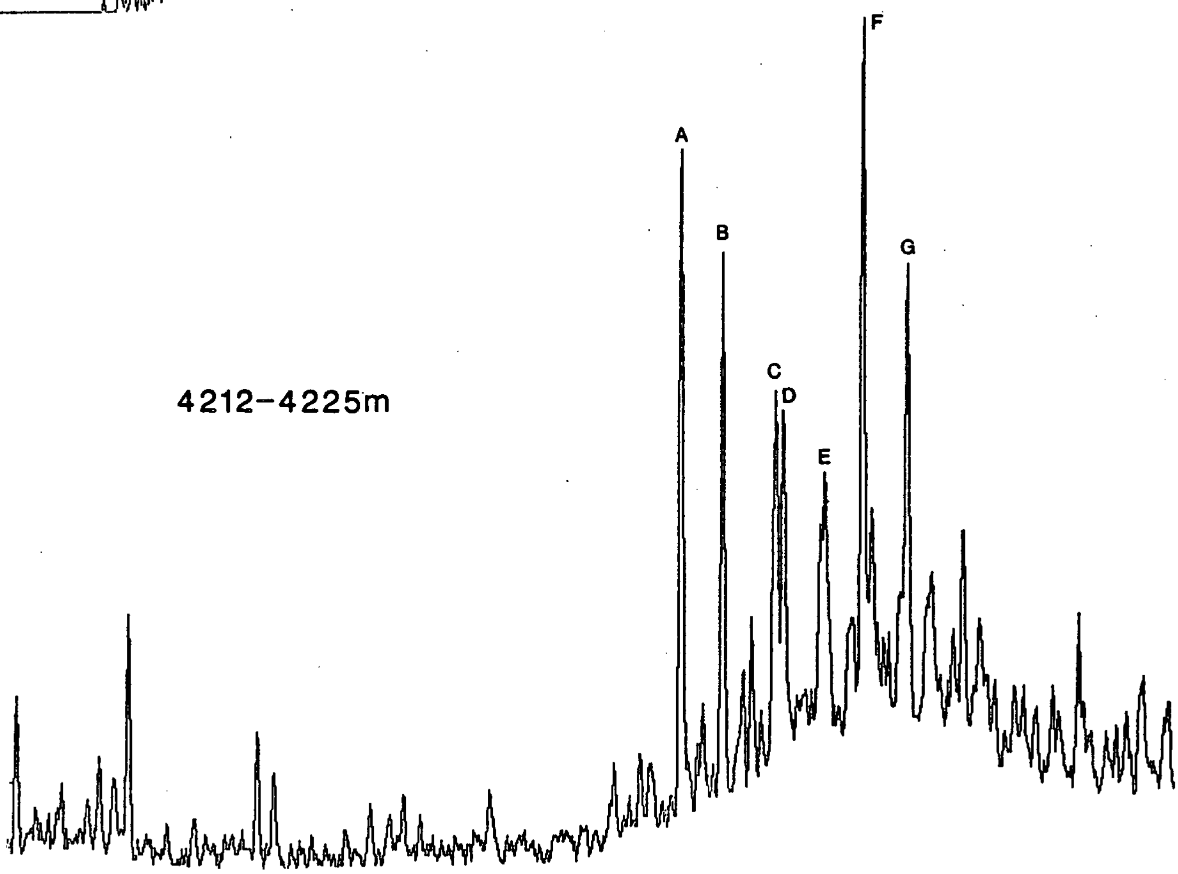
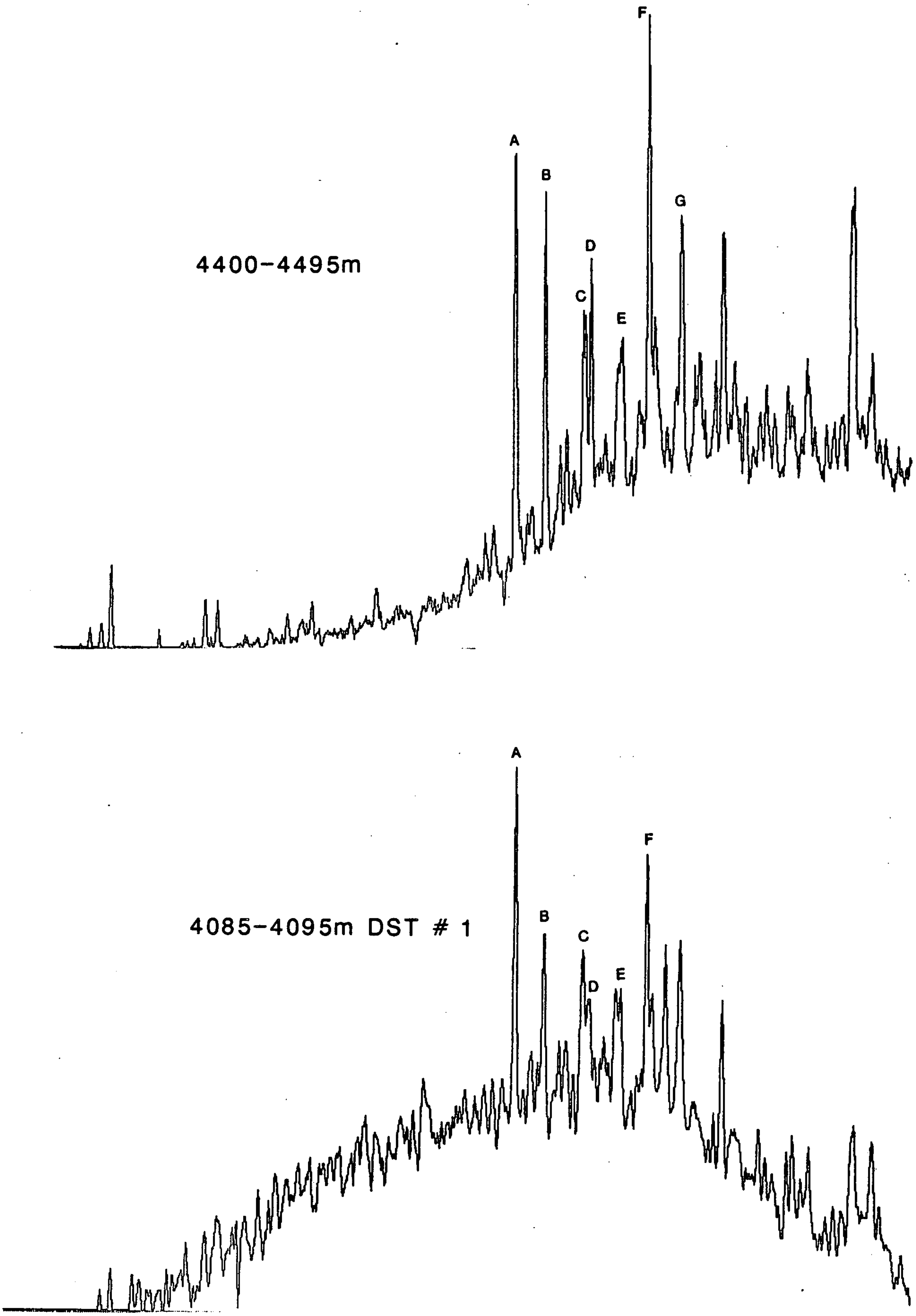


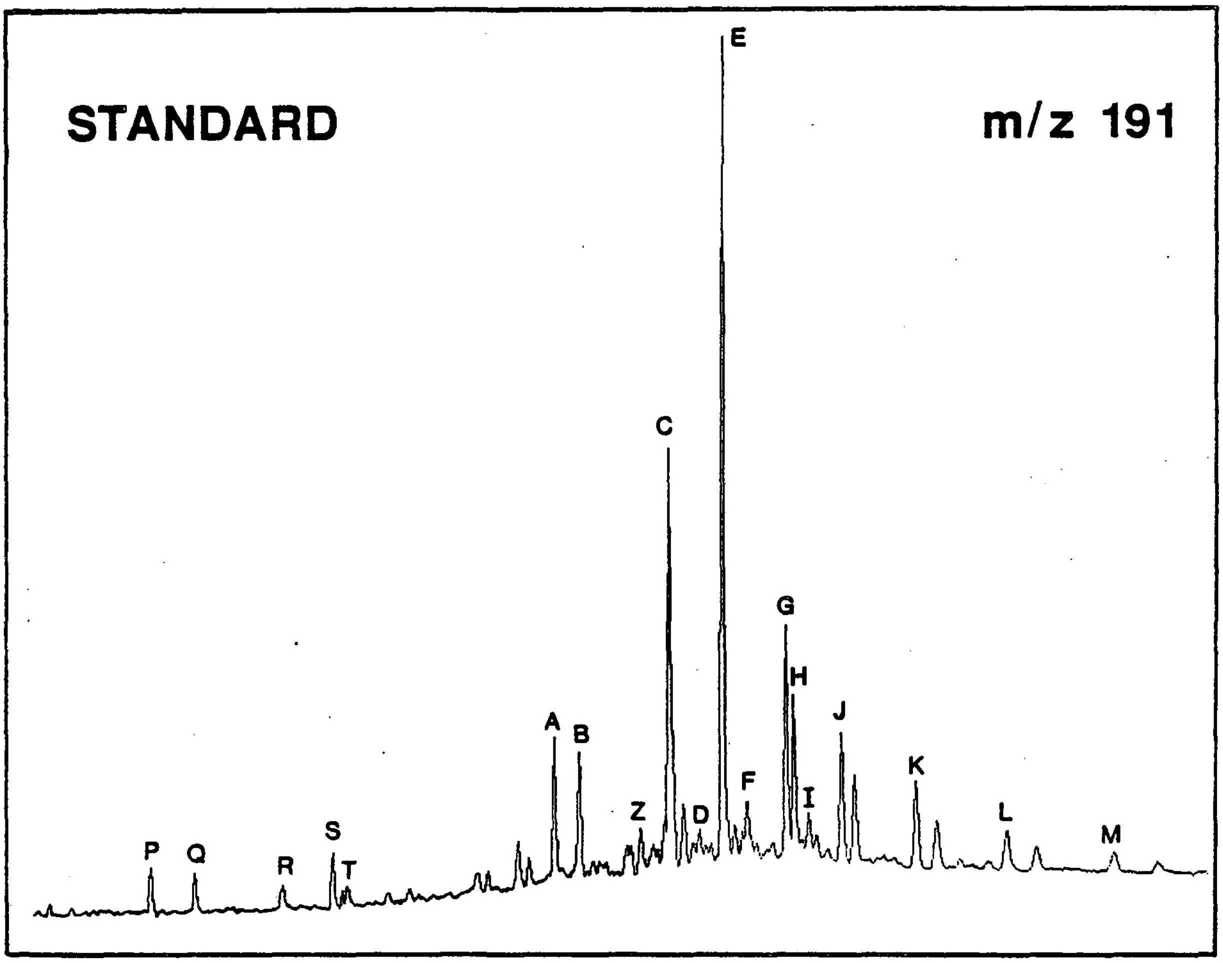
FIGURE 15g

MASS FRAGMENTOGRAMS

WELL 34/10-23

REARRANGED STERANES m/z 259





TRITERPANE IDENTIFICATION

(M/Z 191 FRAGMENTOGRAM)

	COMPOUND	ELEMENTAL COMPOSITION
A	18 (H),21 (H)-trisnorneohopane (Ts)	$C_{27}H_{46}$
B	17 (H),21 (H)-trisnorhopane (Tm)	$C_{27}H_{46}$
C	17 (H),21 (H)-norhopane	$C_{29}H_{50}$
D	17 (H),21 (H)-norhopane (normoretane)	$C_{29}H_{50}$
E	17 (H),21 (H)-hopane	$C_{30}H_{52}$
F	17 (H),21 (H)-hopane (moretane)	$C_{30}H_{52}$
G	17 (H),21 (H)-homohopane (22S)	$C_{31}H_{54}$
H	17 (H),21 (H)-homohopane (22R)	$C_{31}H_{54}$
I	17 (H),21 (H)-homohopane (homomoretane)	$C_{31}H_{54}$
J	17 (H),21 (H)-bishomohopane (22S and 22R)	$C_{32}H_{56}$
K	17 (H),21 (H)-trishomohopane (22S and 22R)	$C_{33}H_{58}$
L	17 (H),21 (H)-tetrakishomohopane (22S and 22R)	$C_{34}H_{58}$
M	17 (H),21 (H)-pentakishomohopane (22S and 22R)	$C_{35}H_{60}$

Z = C_{28} bisnorhopane

TRICYCLIC AND TETRACYCLIC TERPANES (M/Z 191)

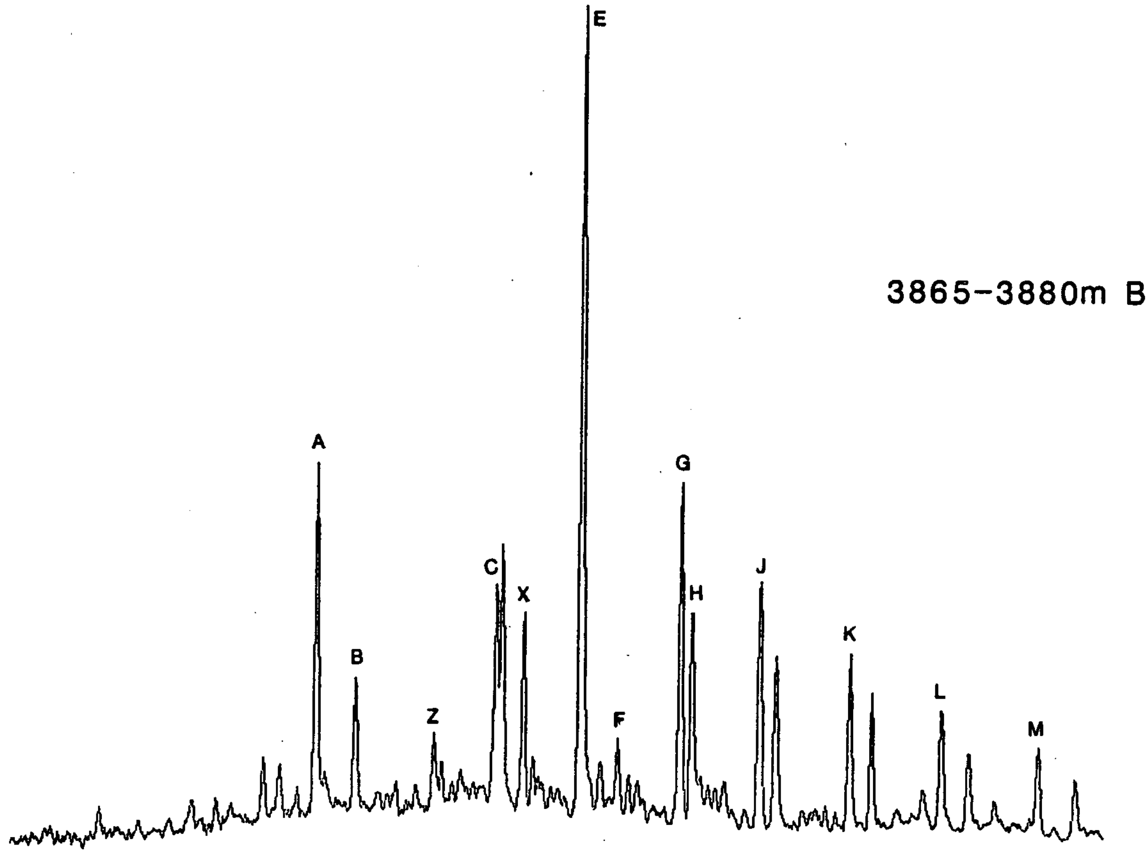
P	$C_{23}H_{42}$
Q	$C_{24}H_{44}$
R	$C_{25}H_{46}$
S	$C_{24}H_{42}$
T	$C_{26}H_{48}$

FIGURE 16a

MASS FRAGMENTOGRAMS

WELL 34/10-23

TRITERPANES m/z 191



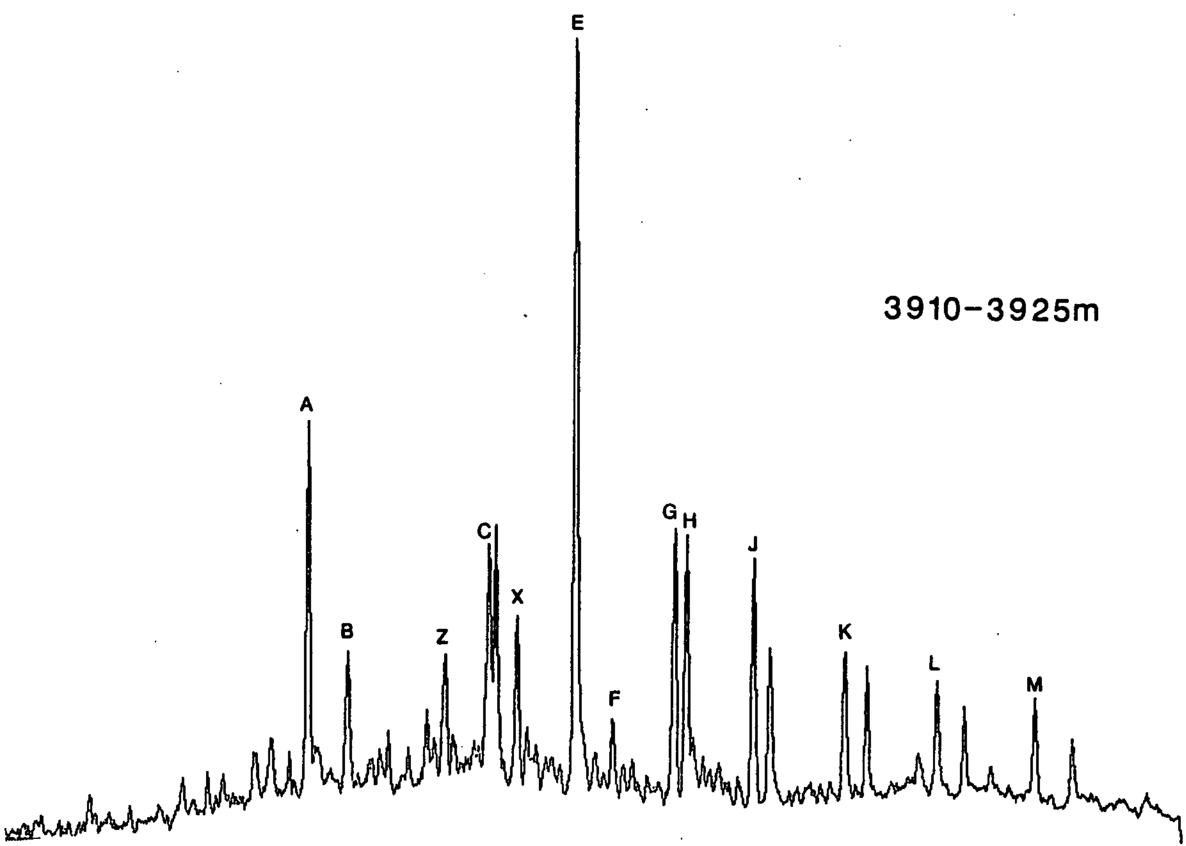


FIGURE 16b

MASS FRAGMENTOGRAMS

WELL 34/10-23

TRITERPANES m/z 191

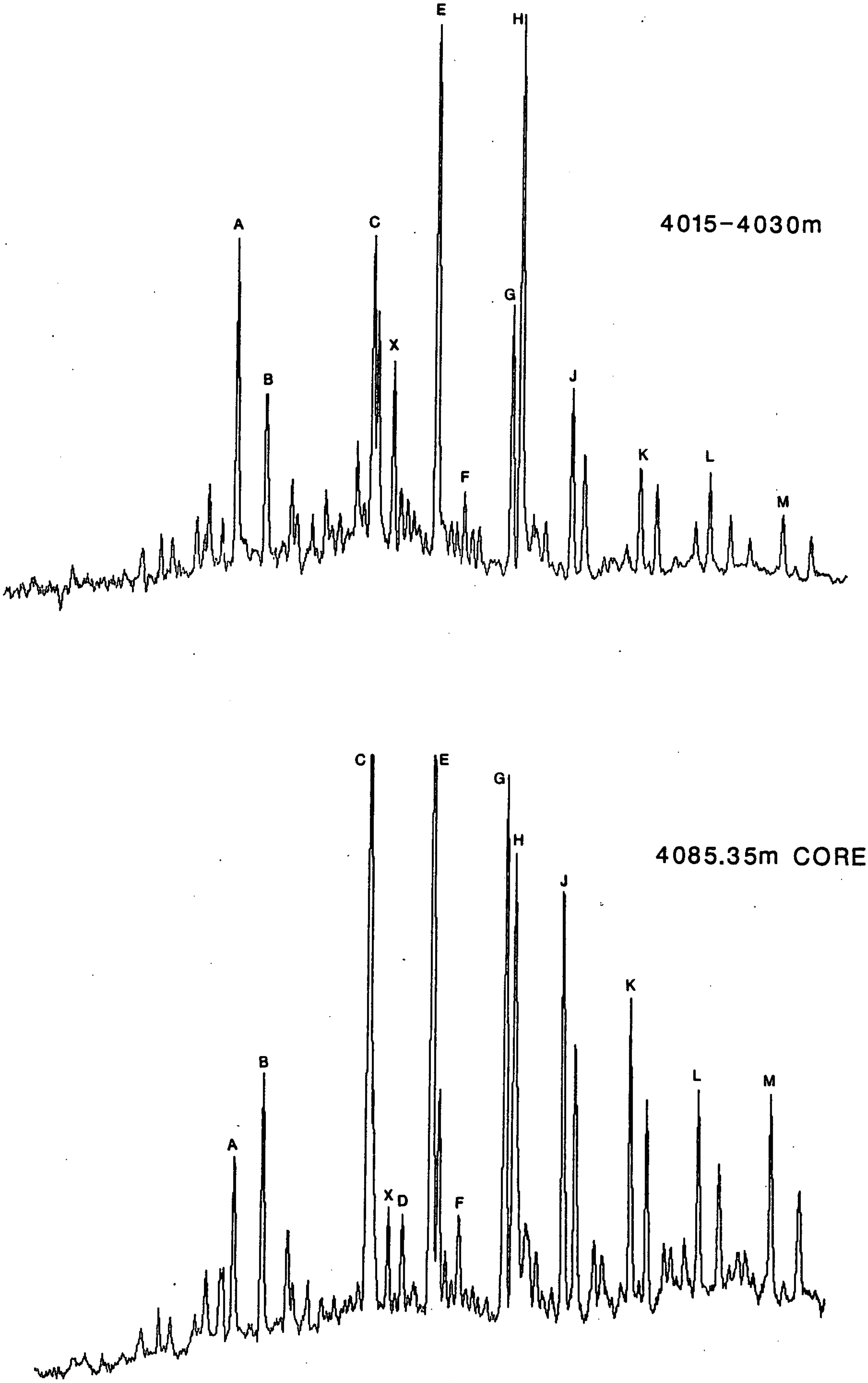
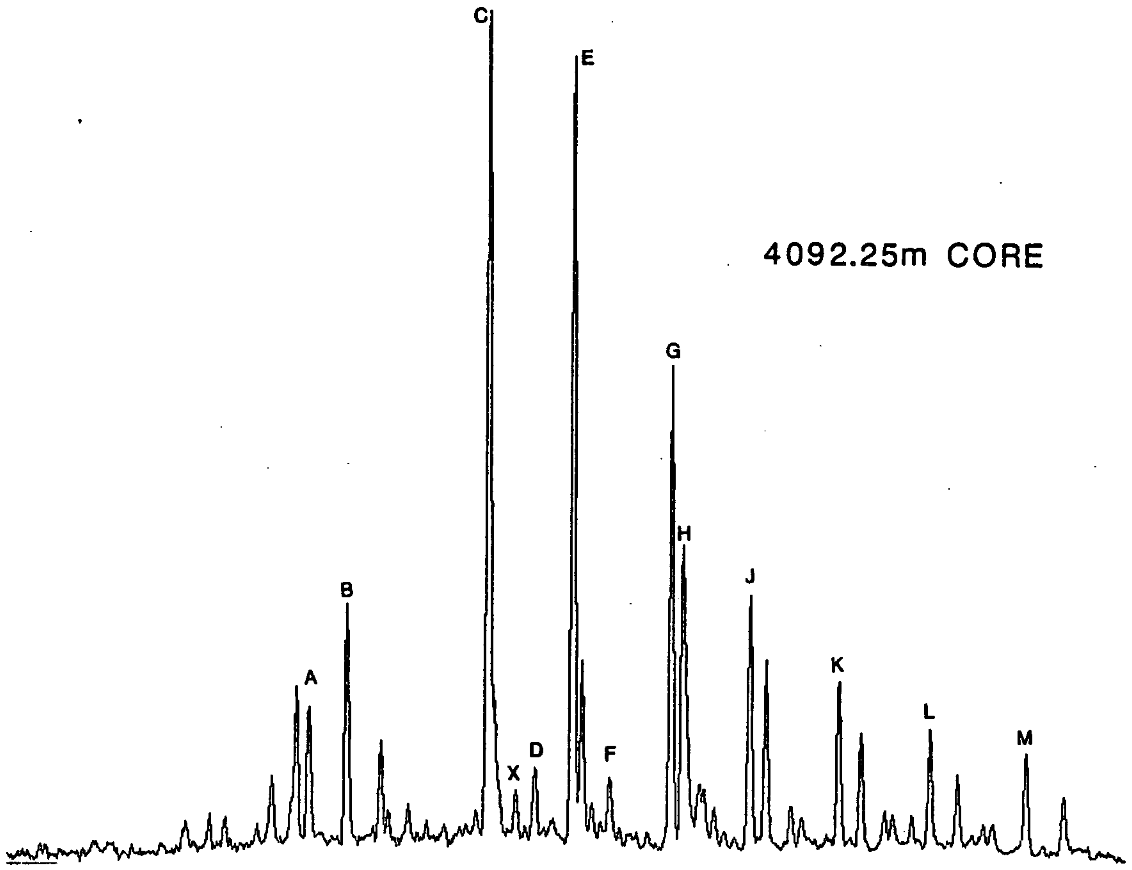


FIGURE 16c

MASS FRAGMENTOGRAMS

WELL 34/10-23

TRITERPANES m/z 191



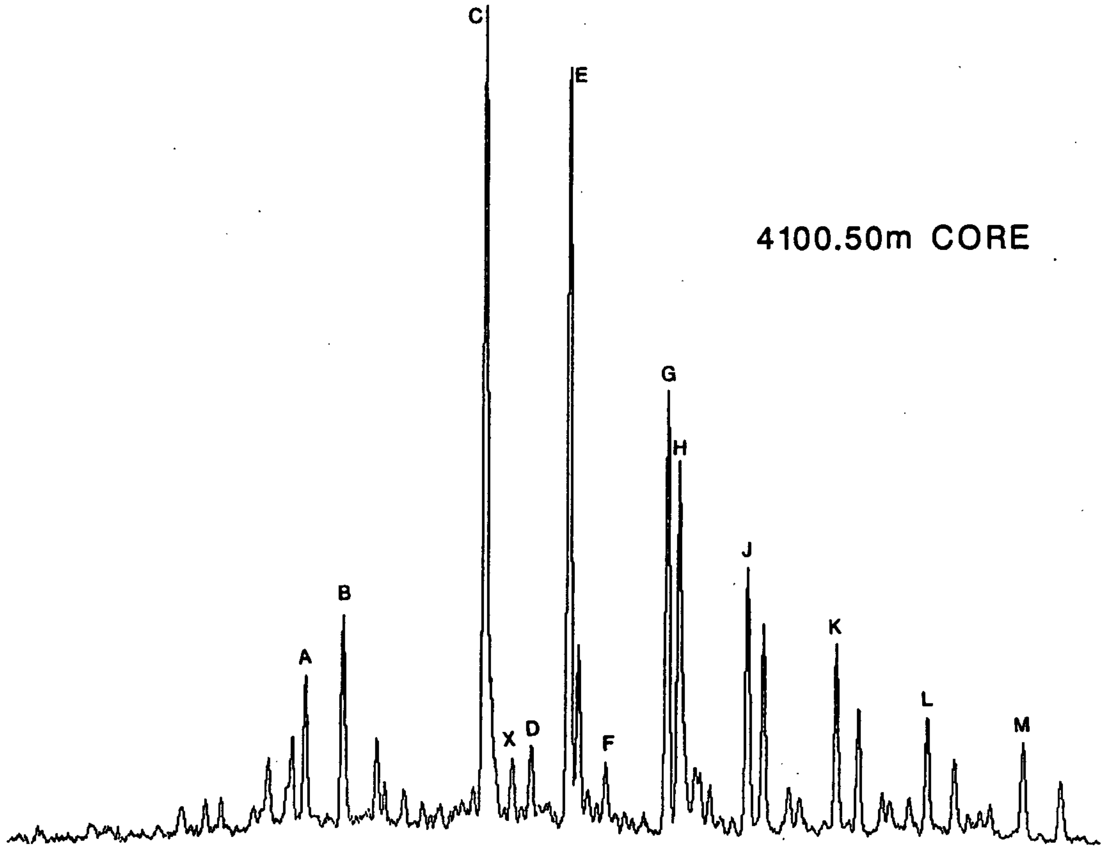
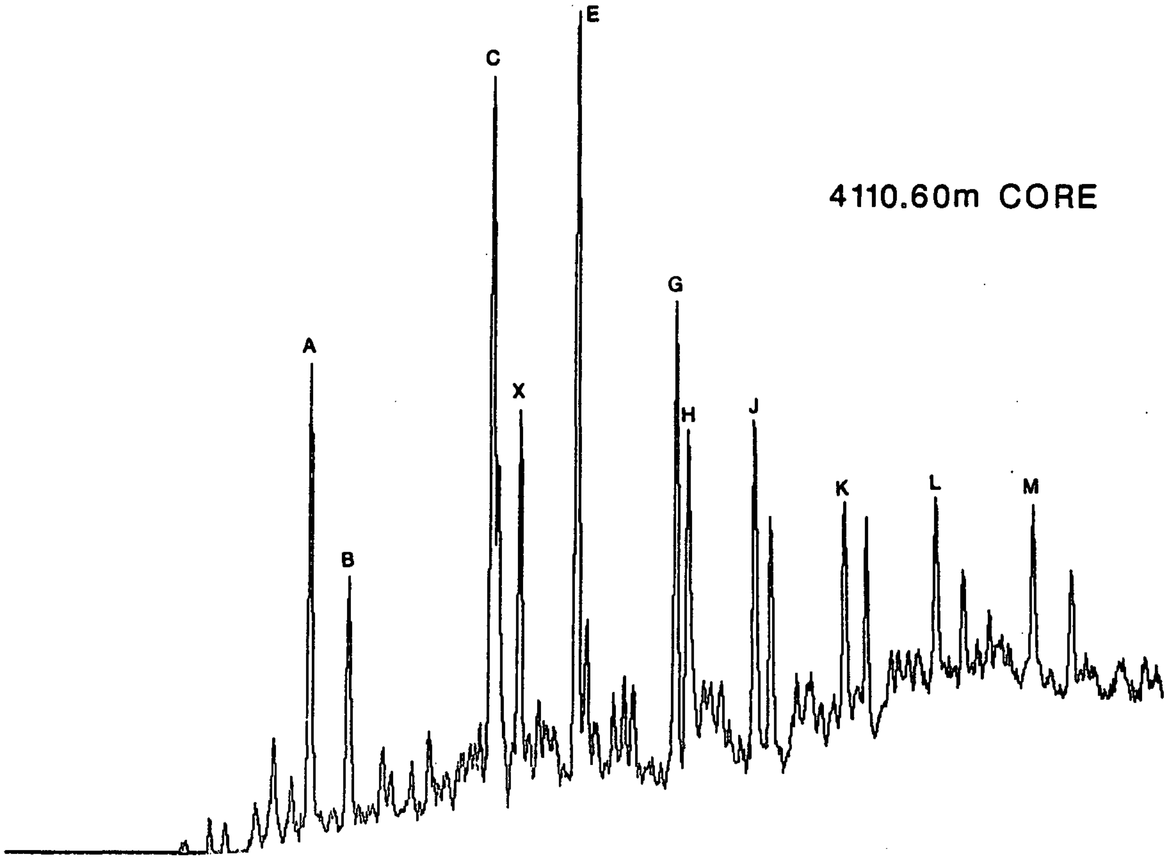


FIGURE 16e

MASS FRAGMENTOGRAMS

WELL 34/10-23

TRITERPANES m/z 191



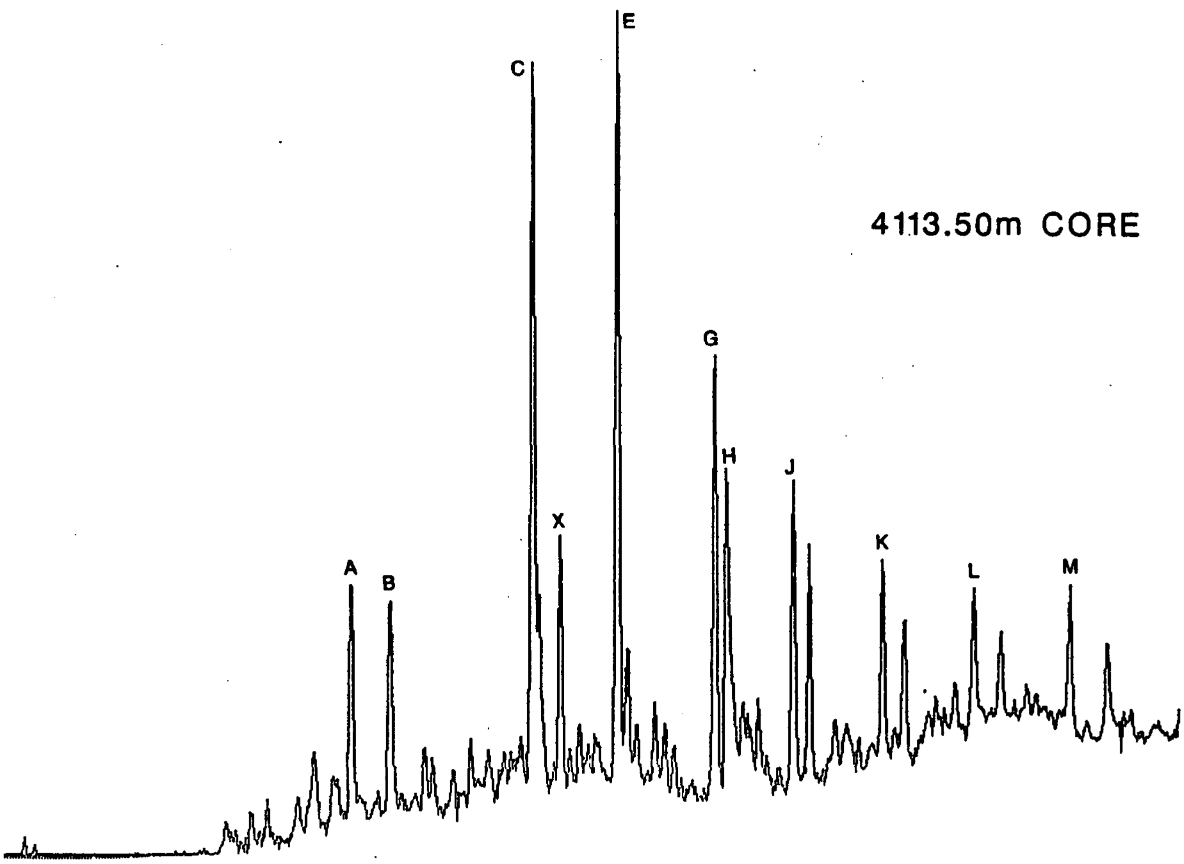
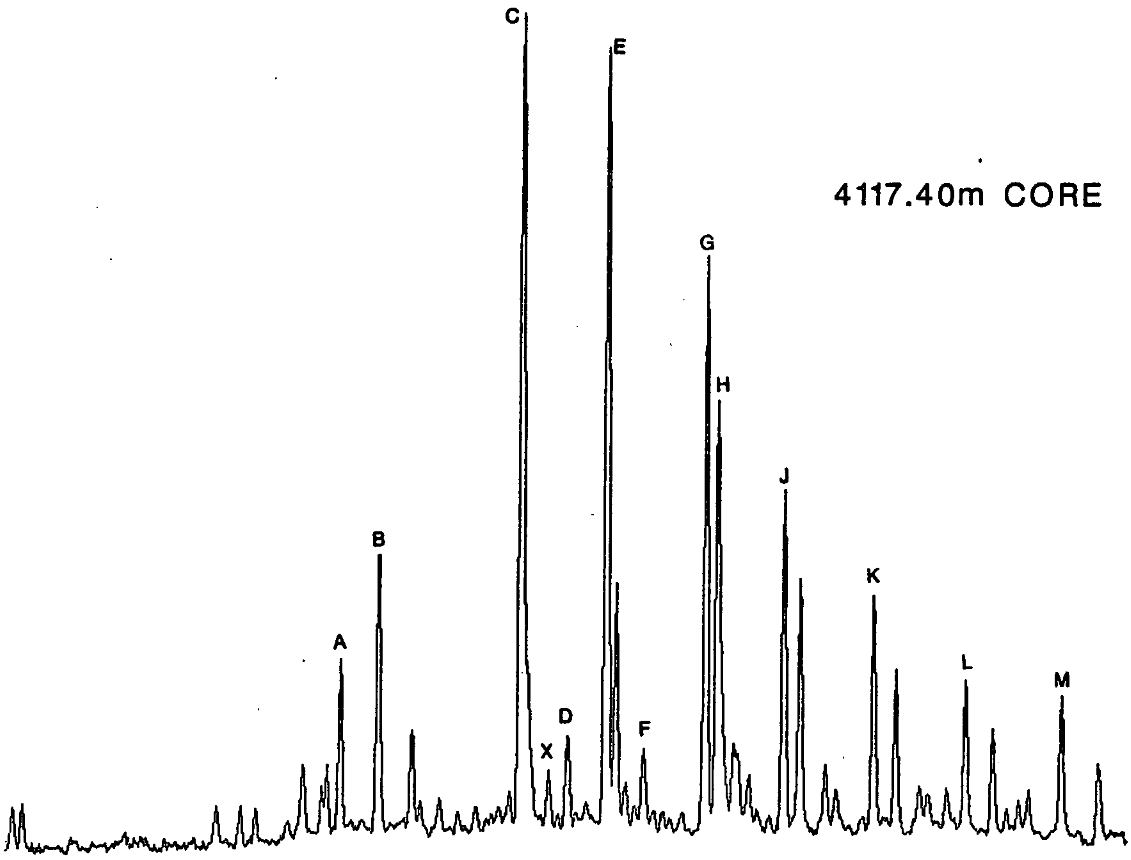


FIGURE 16f

MASS FRAGMENTOGRAMS

WELL 34/10-23

TRITERPANES m/z 191



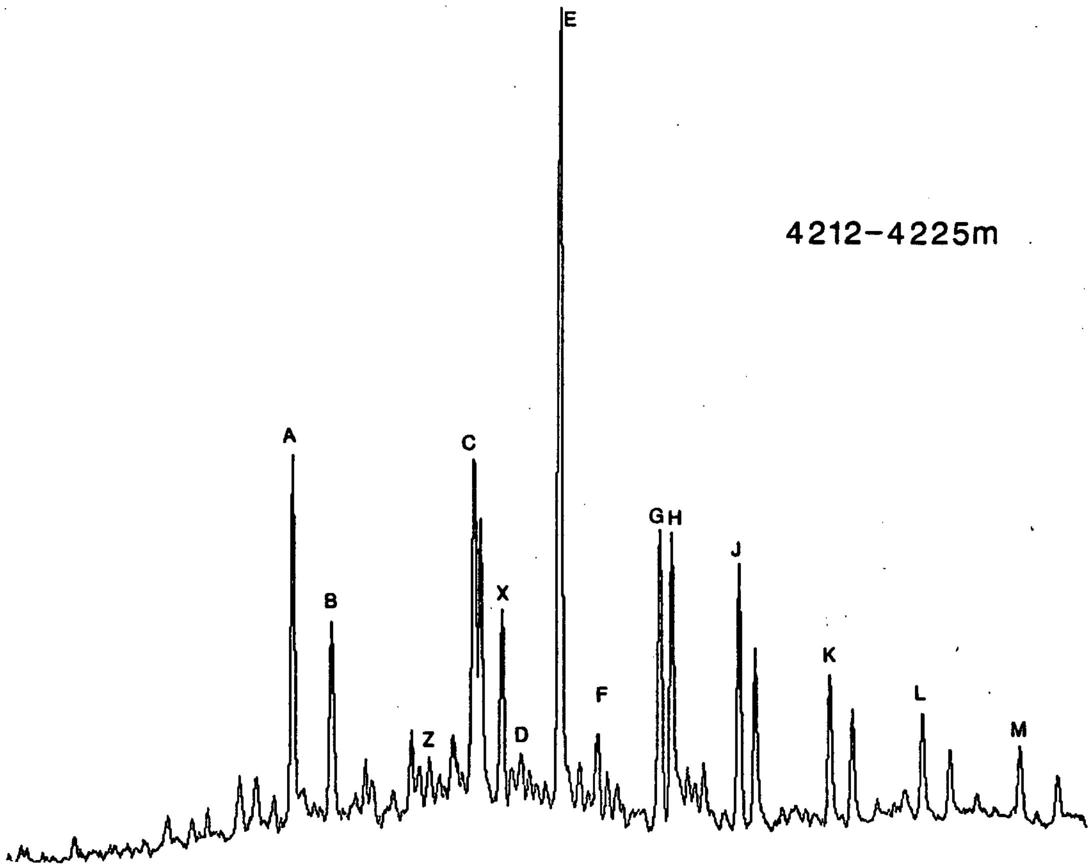
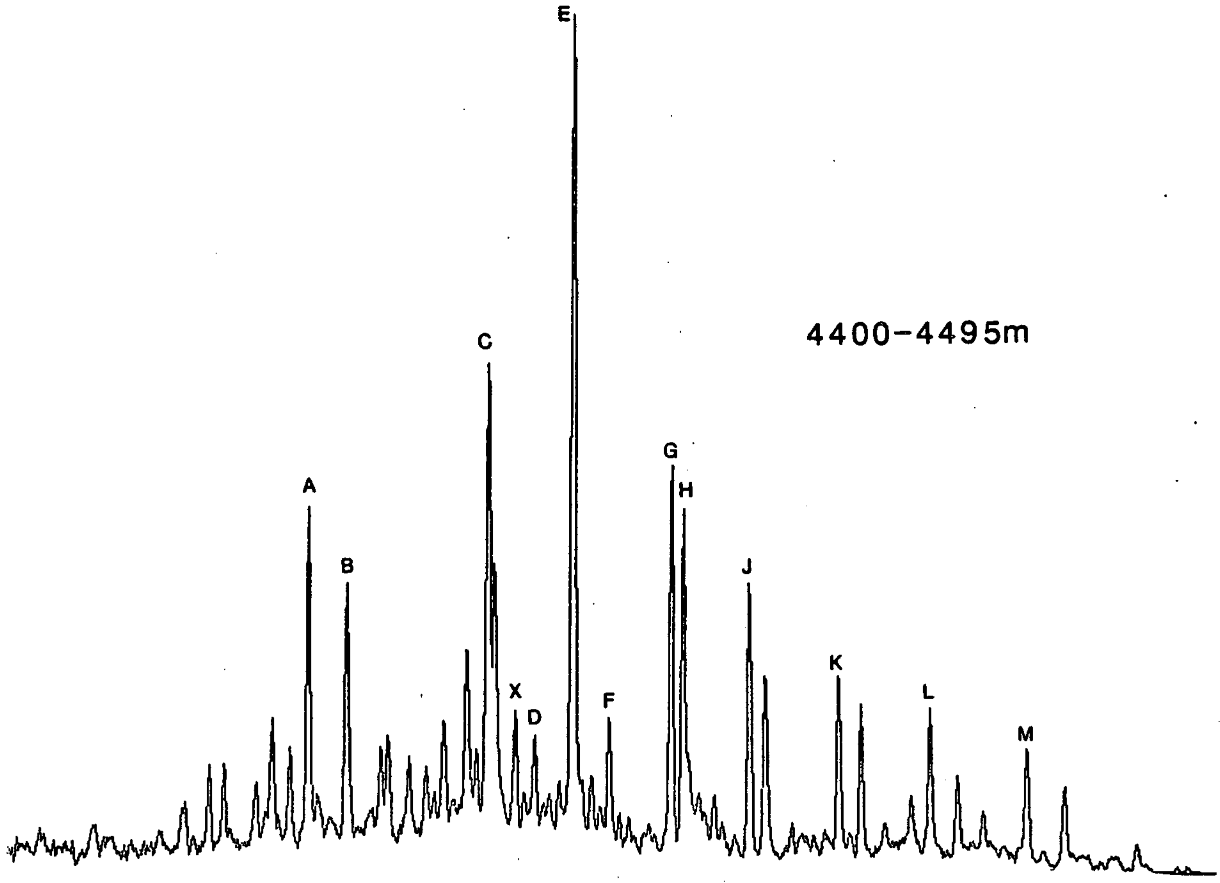


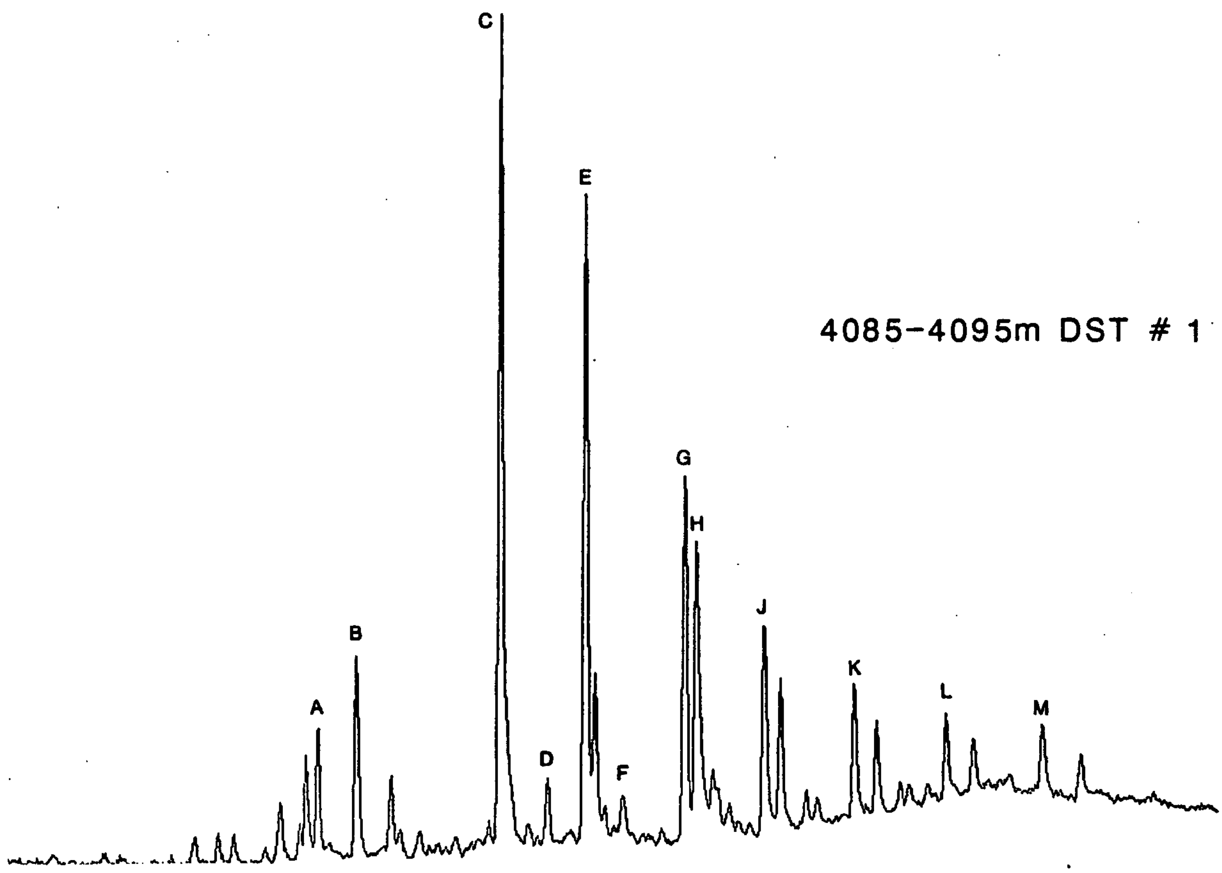
FIGURE 16g

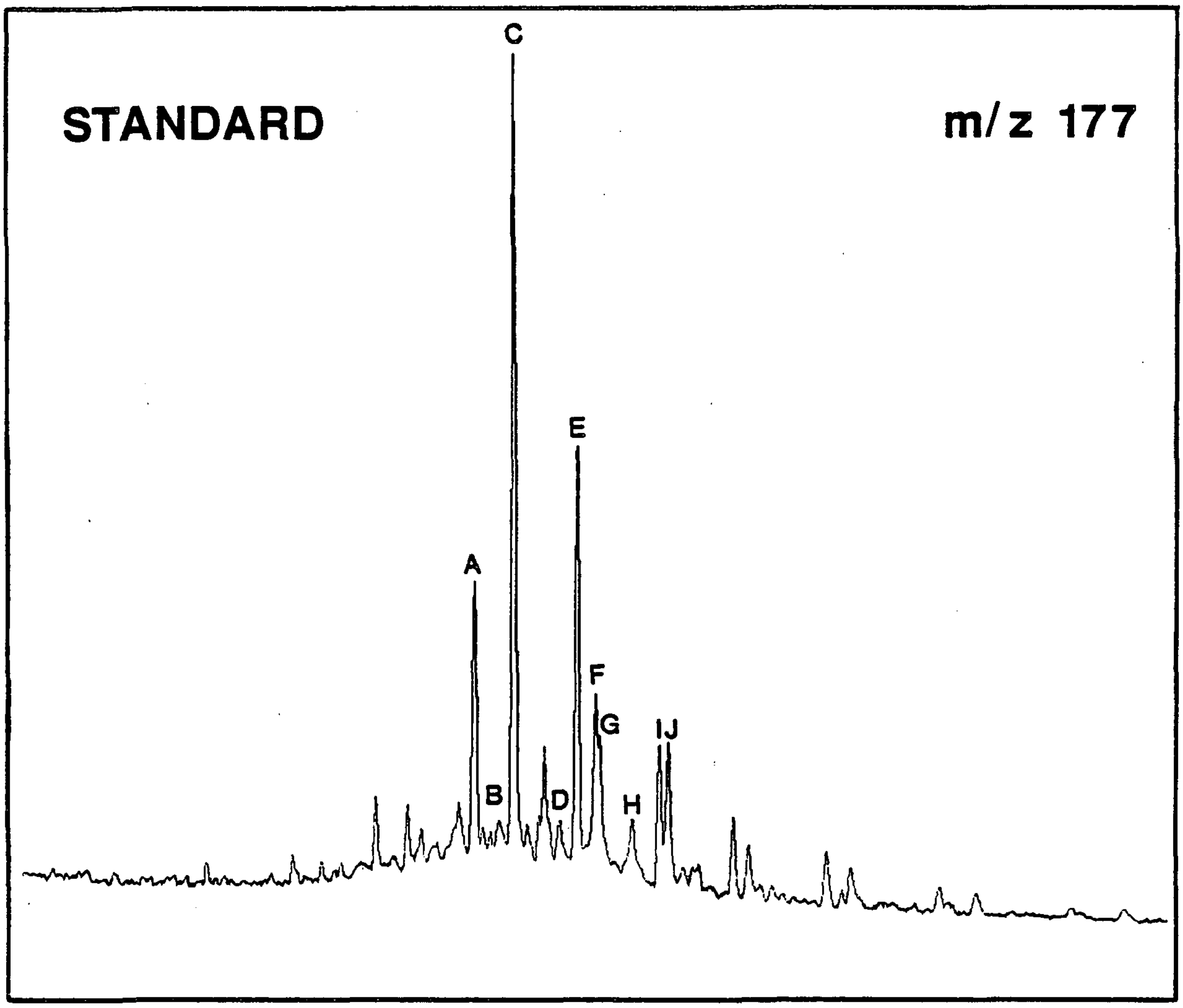
MASS FRAGMENTOGRAMS

WELL 34/10-23

TRITERPANES m/z 191







DEMETHYLATED HOPANES

(m/z 177 FRAGMENTOGRAM)

	COMPOUND	
A	17 α (H), 18 α (H), 21 β (H) 25, 28, 30 - trisnorhopane	C_{27}
B	17 β (H), 18 α (H), 21 α (H) 25, 28, 30 - trisnormoretane	C_{27}
C	17 α (H) -25, 30 - bisnorhopane	C_{28}
D	17 α (H), 18 α (H), 21 β (H) -28, 30 bisnorhopane	C_{28}
E	17 α (H) -25 - norhopane	
F	17 α (H) -30 - norhopane	
G	?	
H	17 β (H) -30 - normoretane	
I	(22S) -17 α (H) -25 - norhomohopane	
J	(22R) -17 α (H) - homohopane	

FIGURE 17a

MASS FRAGMENTOGRAMS

WELL 34/10-23

DEMETHYLATED HOPANES m/z 177

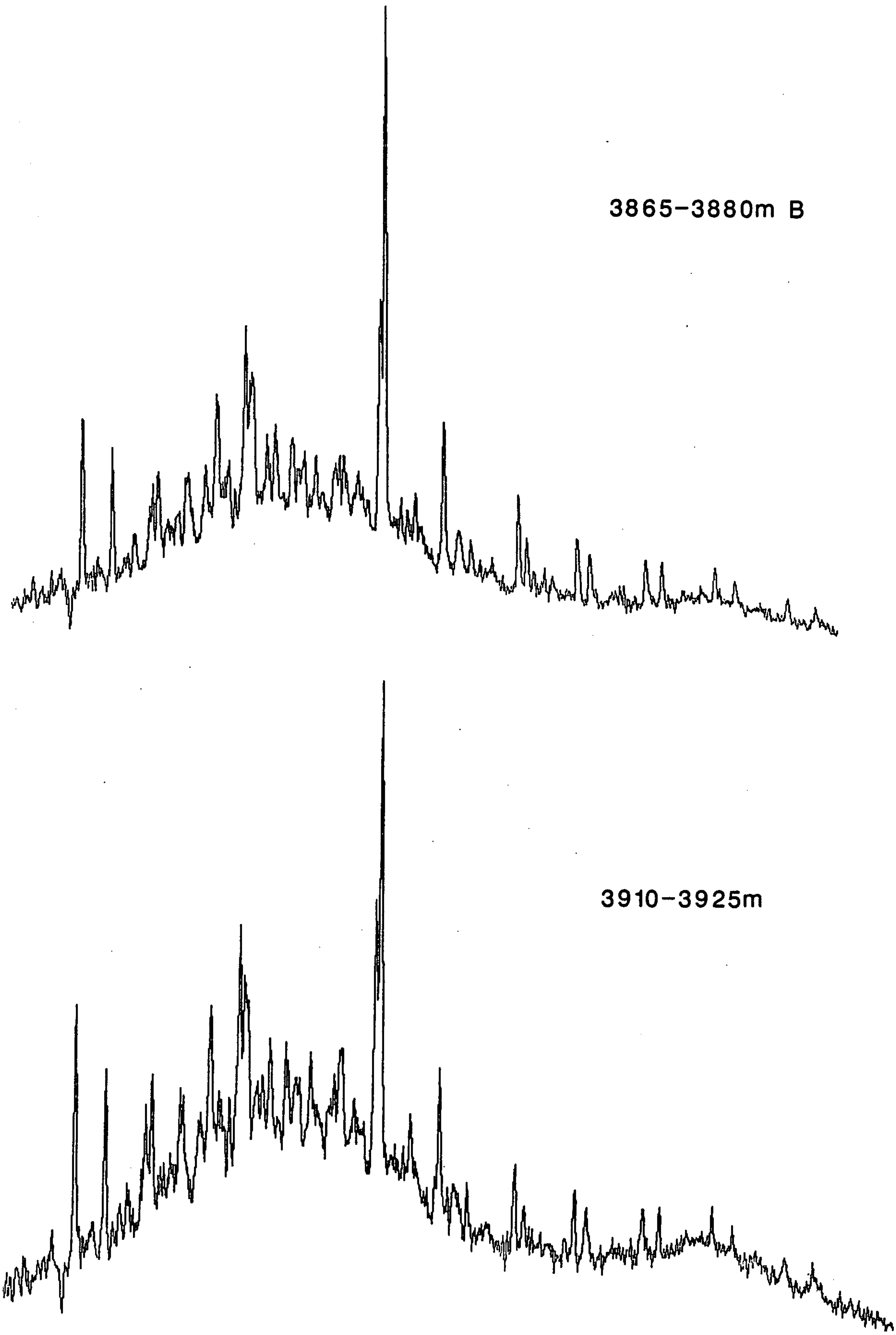
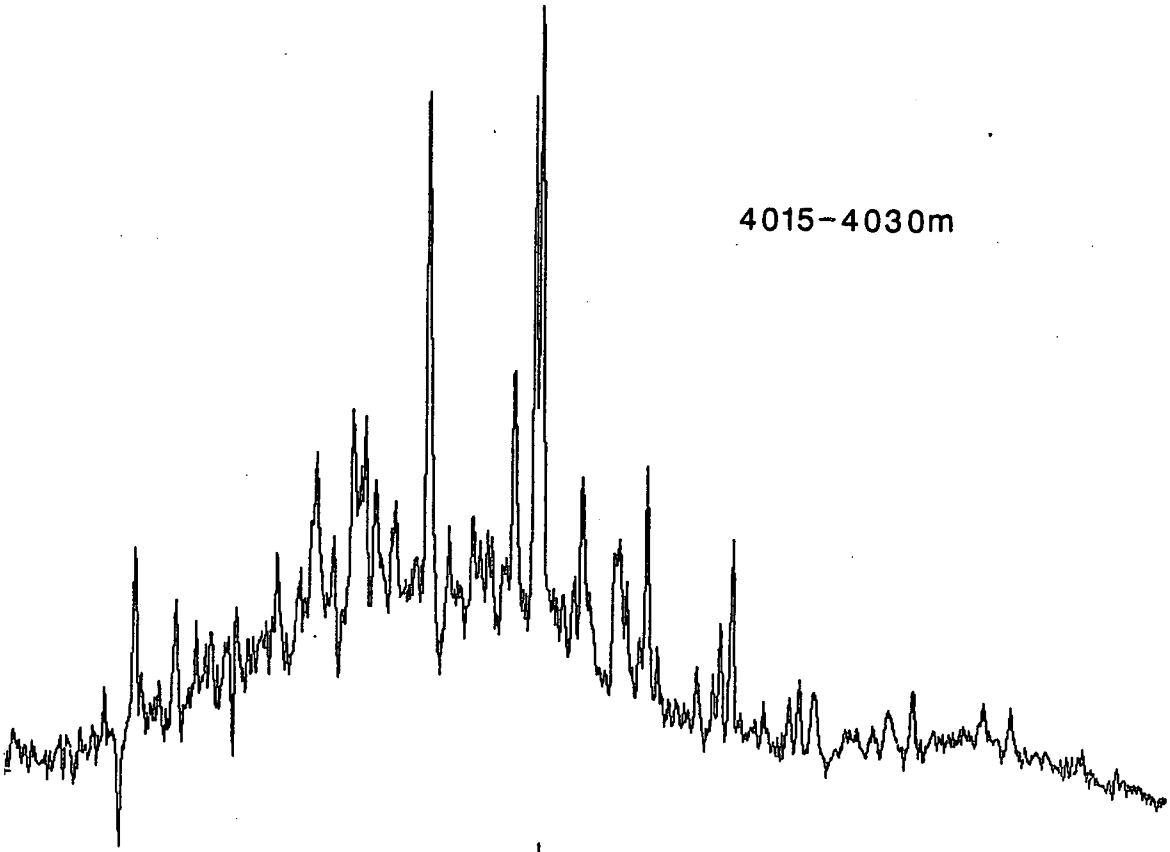


FIGURE 17b

MASS FRAGMENTOGRAMS

WELL 34/10-23 DEMETHYLATED HOPANES m/z 177



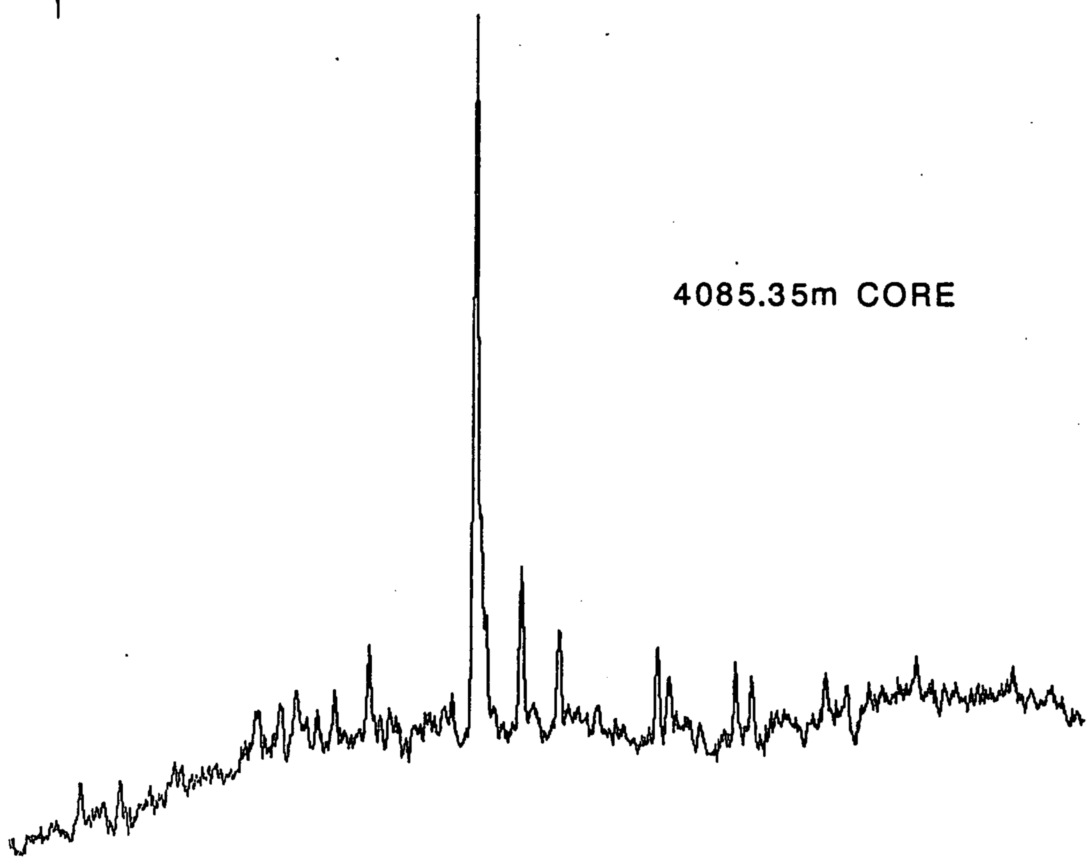
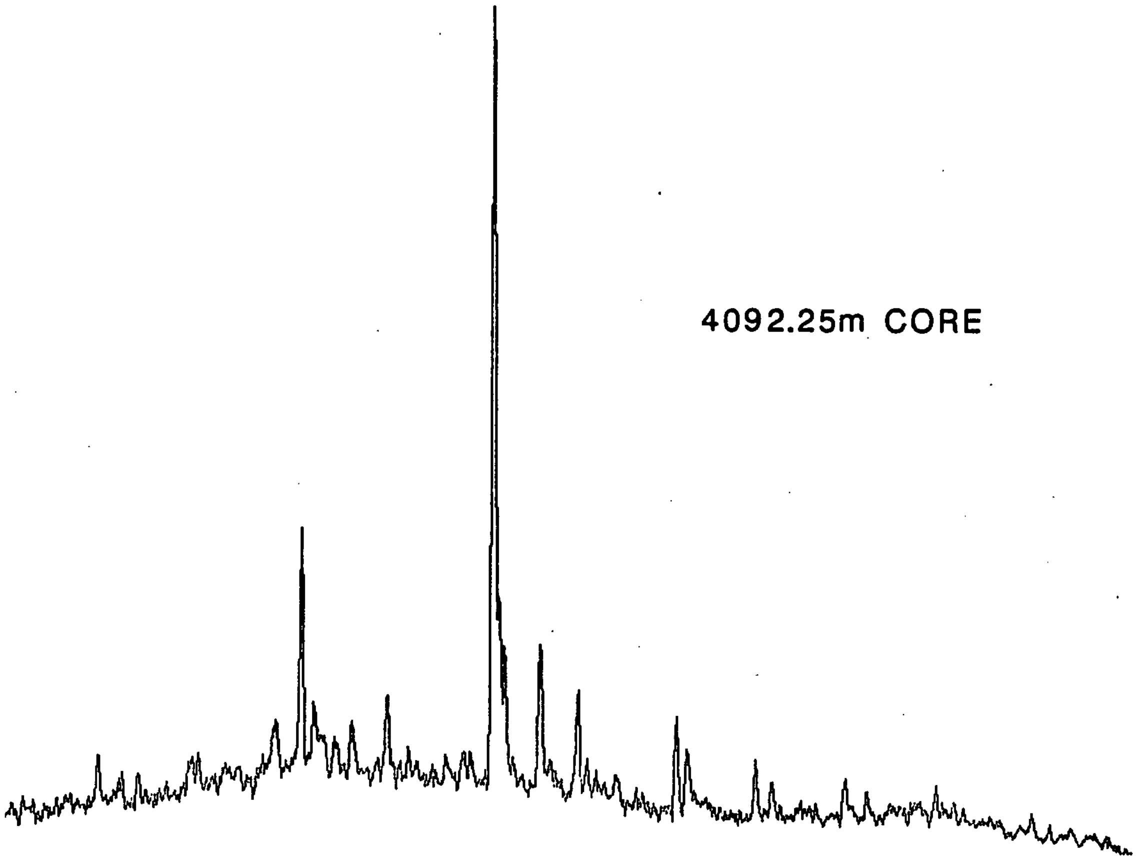


FIGURE 17c

MASS FRAGMENTOGRAMS

WELL 34/10-23

DEMETHYLATED HOPANES m/z 177



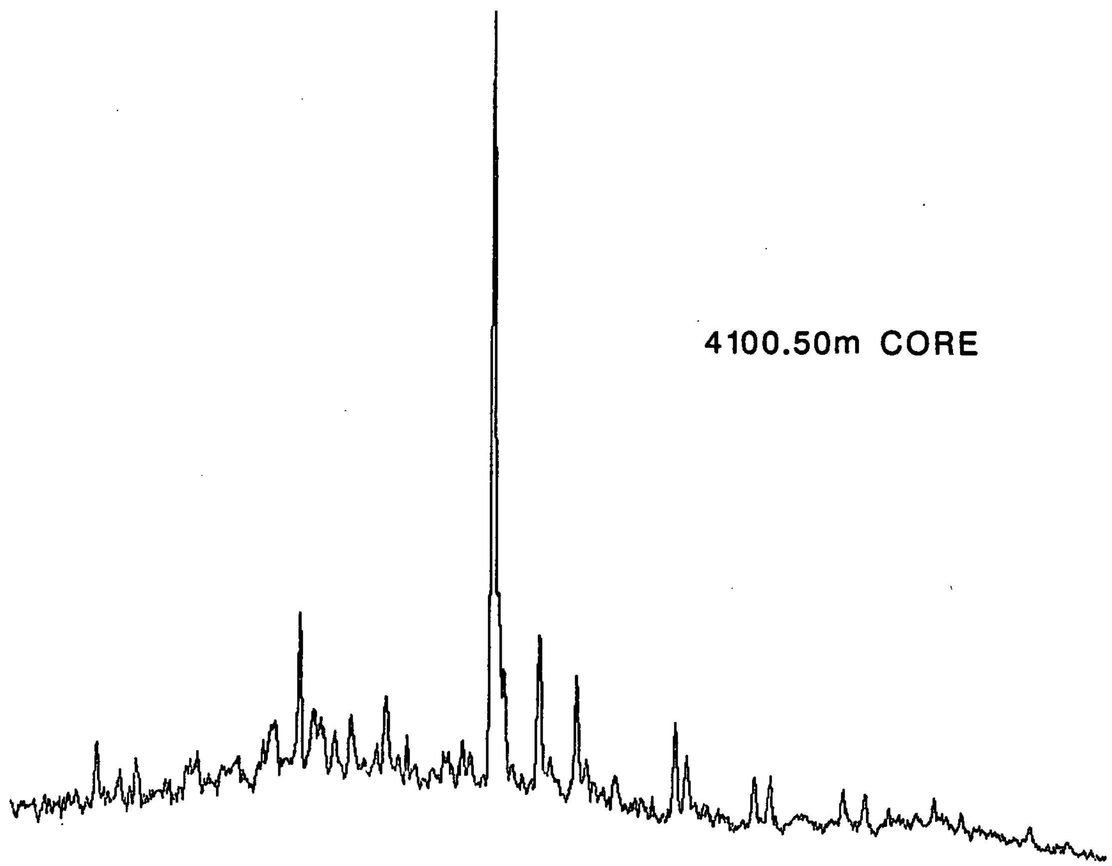
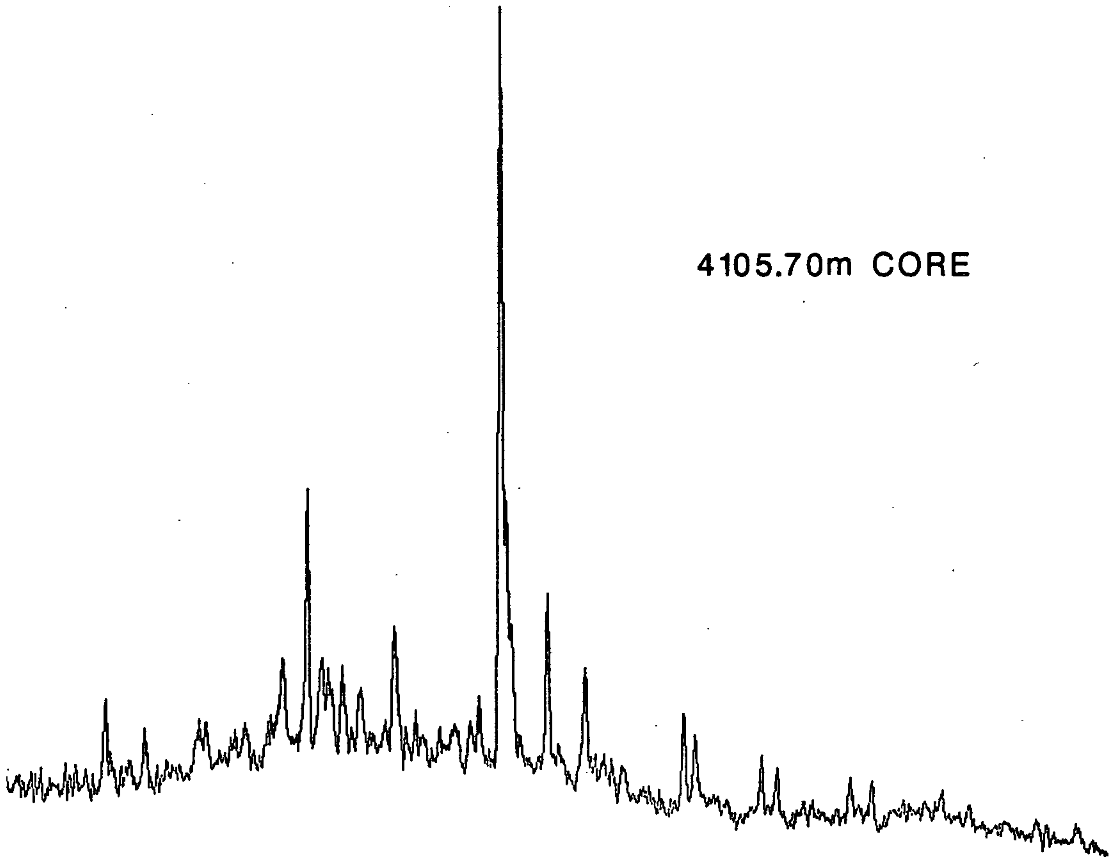


FIGURE 17d

MASS FRAGMENTOGRAMS

WELL 34/10-23

DEMETHYLATED HOPANES m/z 177



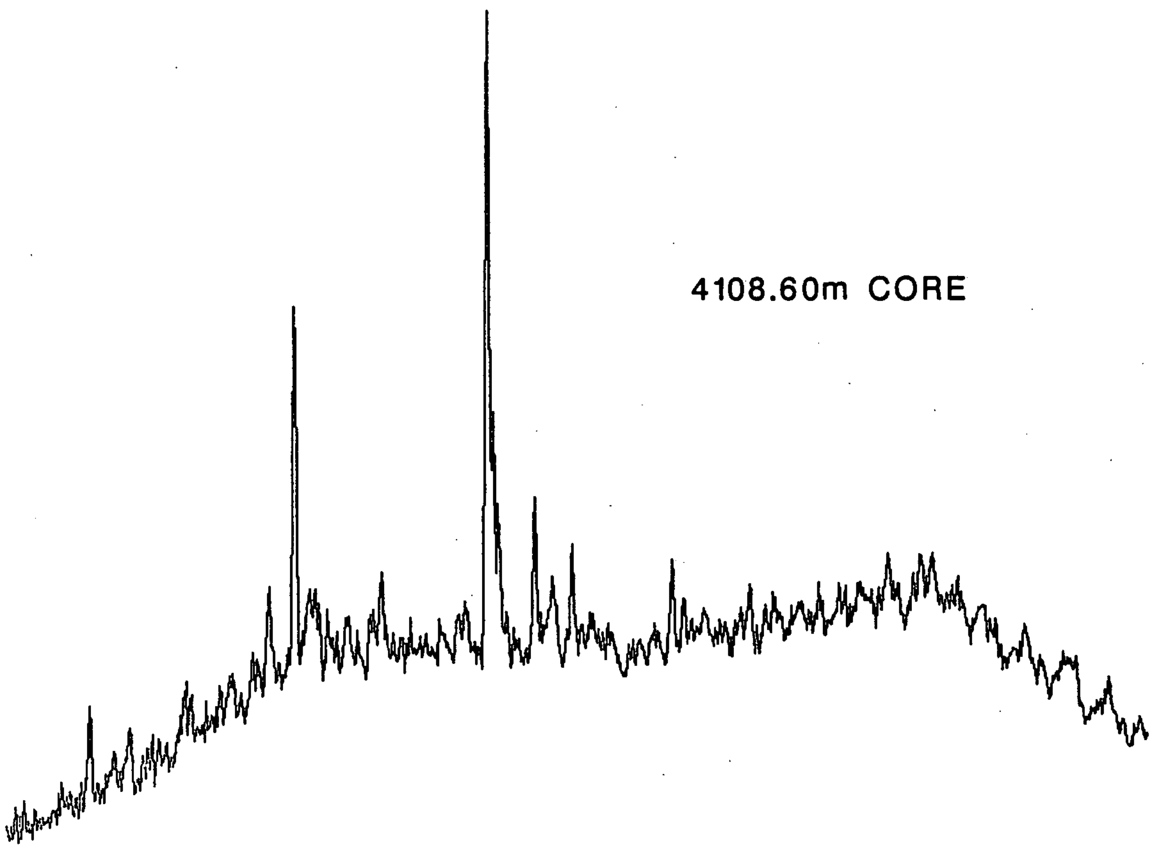
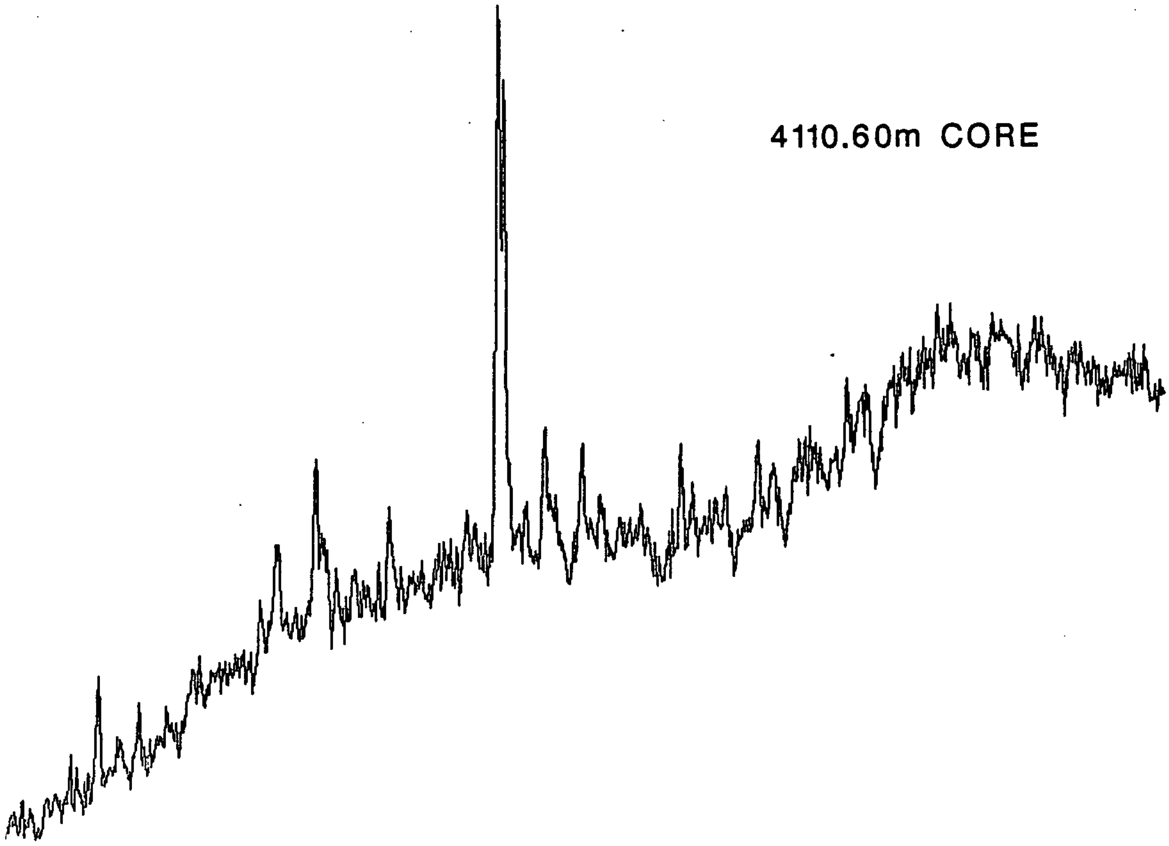


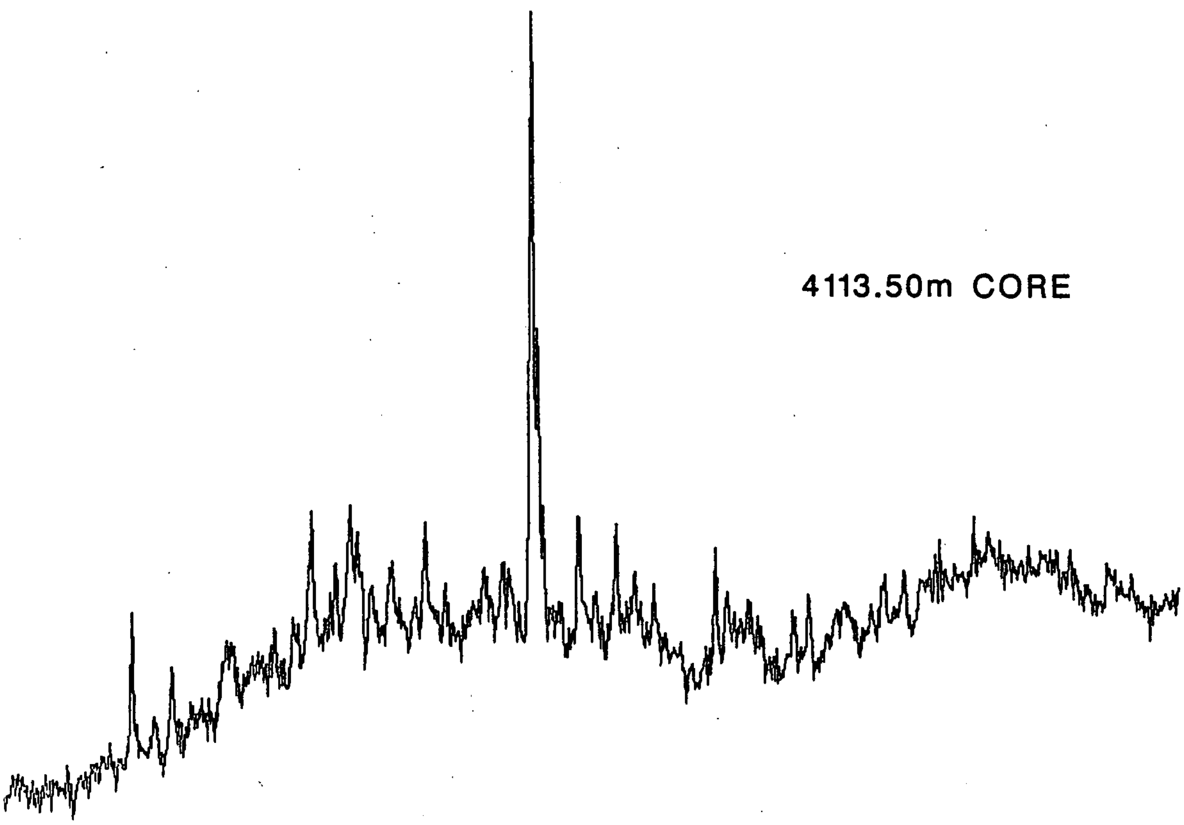
FIGURE 17e

MASS FRAGMENTOGRAMS

WELL 34/10-23 DEMETHYLATED HOPANES m/z 177



4110.60m CORE



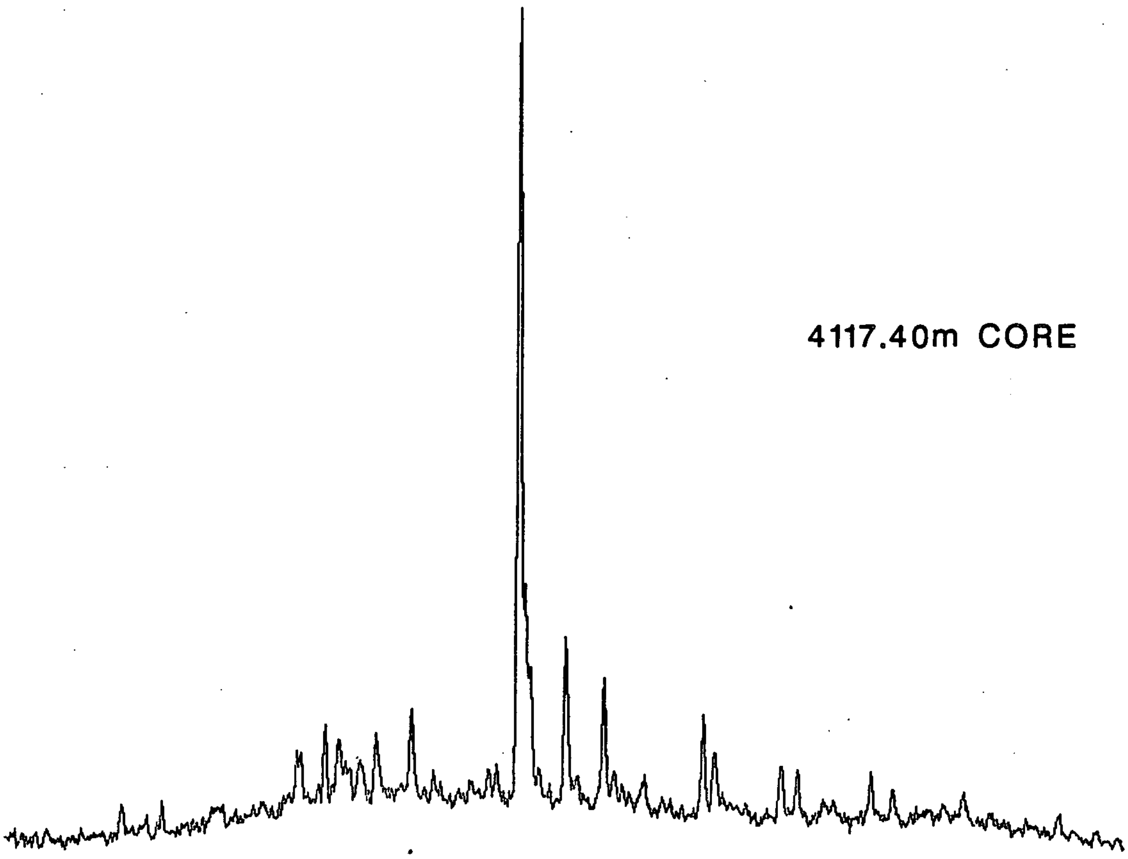
4113.50m CORE

FIGURE 17f

MASS FRAGMENTOGRAMS

WELL 34/10-23

DEMETHYLATED HOPANES m/z 177



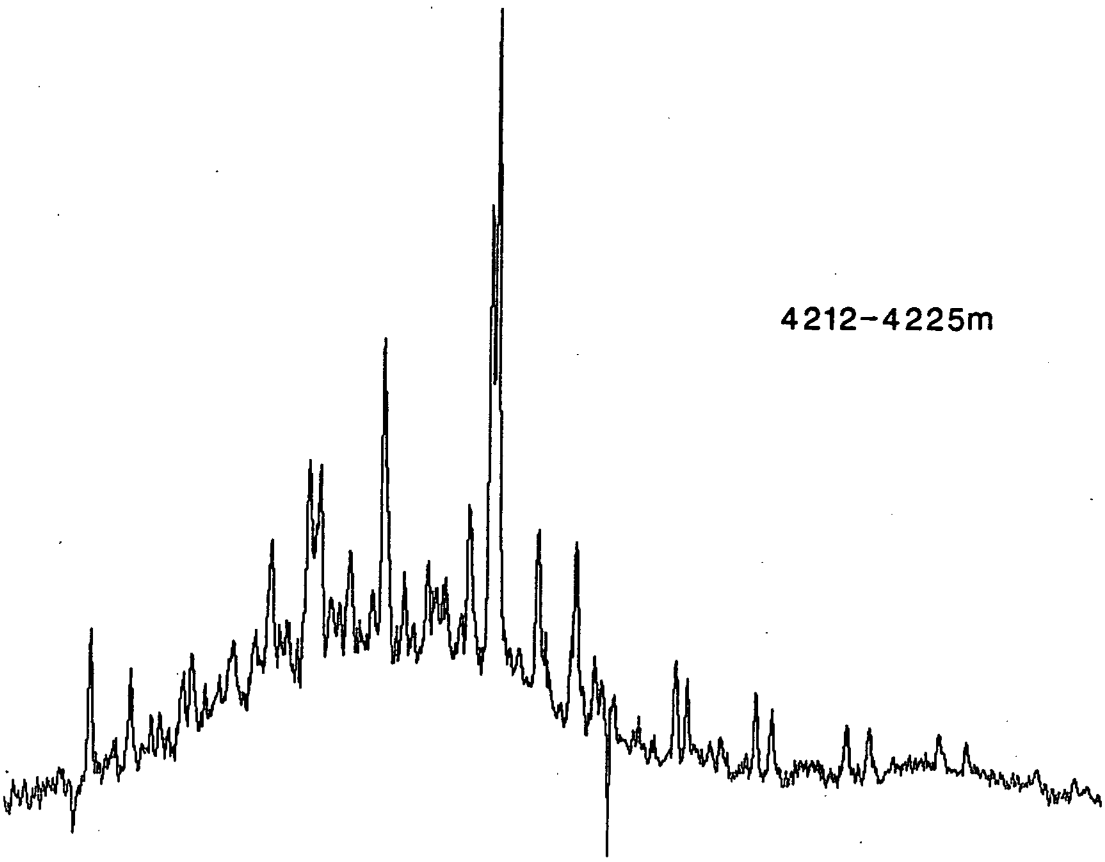


FIGURE 17g

MASS FRAGMENTOGRAMS

WELL 34/10-23 DEMETHYLATED HOPANES m/z 177