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GEOCHEMICAL EVALUATION OF SAGA'S 34/4-3 WELL

OFFSHORE NORWAY

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GEOCHEMICAL EVALUATION OF SAGA'S 34/4-3 WELL OFFSHORE NORWAY

SUMMARY

The section between 900 metres and 4460 metres has been examined, although detailed analyses were only authorised for the interval below 3000 metres.

Above 2700± metres the sediments in this well are immature whilst, due to the character of their organic matter, they are effectively immature down to 3450± metres. Throughout this interval they are poor and uninteresting source rocks for gas with the exception of the mudstones from 1260-1440± metres which, although immature, are potentially good source rocks for gas with minor associated condensate.

Between 3450± metres and the top of the oil window at approximately 4500± metres, significant hydrocarbon generation could be anticipated from good quality organic matter. However in most of these sediments, only limited generation has occured. Furthermore, they are generally only poor and gas-prone source rocks. There are two significant exceptions to this generalisation. The first is provided by interbeds within the gross intervals 3790-3860± metres (minor) and 4000-4330± metres which are potentially good source rocks for oil, although unable to generate major oil. The second and most significant exception is represented by the minor dark brownish grey silty shales within the interval 3563-3670± metres which are mature and potentially very good source rocks for oil. It is suspected that these shales are under-represented in the samples and indeed, are caved from 3500-3554± metres. If they are representive of a thick unit, economic accumulations of oil can be anticipated in associated reservoirs.

There is a show of locally-derived crude oil at 3550-3670± metres (with traces of condensate and wet gas up to 3450± metres and down to 3860± metres), a weak show of paraffinic oil at 3860-4000± metres and a weak show of light to medium gravity crude at 4140-4300± metres. It is possible that the oils responsible for the two deepest shows may be derived from a common source.

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INTRODUCTION

This report presents a geochemical evaluation of the section between 900 metres and 4460 metres in Saga's 34/4-3 well, drilled in the Norwegian sector of the North Sea.

The analytical format was specified by Saga and is compatible with that employed in earlier studies. It was designed to provide a preliminary evaluation of the hydrocarbon source potential of the entire well and a detailed evaluation of the section below 3000 metres.

This project was authorised by T O Throndsen, Saga Petroleum A.S., Oslo.

A ANALYTICAL

A total of two hundred and eighty-nine (289) canned ditch cuttings samples were received for the interval 900-4460 metres in 34/4-3. These samples were collected every twenty metres down to 2500 metres and then every ten metres down to 3410 metres. A nine metre interval was employed below this depth. In addition, four mud samples and a sample of pipe dope were received. These samples were assigned the Geochem job number 630.

During the preparation steps, slight contamination was observed only below 3420 metres. However, the samples were fine-grained and difficult to pick.

Geochem were instructed to screen every second sample with the light hydrocarbon, organic carbon and mini-pyrolysis analyses. These data were then forwarded to Mr Throndsen who specified fill-in analyses over the intervals 3500-3554 metres, 3590-3704 metres, 3788-3987 metres and 4128-4353 metres together with detailed analyses on selected samples from below 3000 metres.

Relative to the proposal for this study, the following analyses were not run: one mass fragmentogram, one branched-cylic chromatogram, one aromatic chromatogram, two carbon isotopes upon C_{15+} fractions, twenty carbon isotopes upon head space methane and fifteen detailed gasoline range analyses. Additional analyses included extended pyrolysis, fifteen vitrinite reflectance, twenty five organic carbon and twenty five mini pyrolysis analyses.

The data are presented in tables 1 through 9 and graphically in figures 1 through 13. A brief description of the analytical techniques employed in this study is included in the back of the report.

B GENERAL INFORMATION

Ten (10) copies of this report have been forwarded to T Throndsen together with the kerogen slides and vitrinite plugs. A copy of the data has been retained by Geochem for future consultation with authorised Saga personnel.

The remaining sample material will be handled as directed.

The results of this study are proprietary to Saga Petroleum A.S.

RESULTS AND INTERPRETATION

Preliminary analyses were performed upon the entire section between 900 metres and 4460 metres in 34/4-3, but detailed analyses were only authorised for the interval below 3000 metres.

Each of the parameters relevant to the geochemical evaluation of this well will be considered in turn and will then be combined to form the "Conclusions".

Well logs and formation tops were not available for this study. However it is understood (T. Throndsen, personal communication) that the Kimmeridge lies between 3500± metres and 3554± metres. This information merely emphasises the fact that there is a severe cavings problem added to which, the interval from 3000± metres down to 3500± metres was turbodrilled.

A ZONATION

This zonation is primarily based upon the light hydrocarbon (C_1-C_7) data. Eight (8) zones are recognised, although some of them are only poorly defined and in addition, there appears to be a severe cavings problem which probably lowers the zone boundaries quite significantly.

Zone A^1 900 metres to 1720± metres, is lithologically rather varied. Above 1200± metres the samples consist of sands with significant proportions of basalt whereas below this depth, they are composed of shaly mudstones which are olive to light olive grey in colour.

The C_1-C_4 gases vary in abundance from 48 ppm up to 3717 (5065) ppm, but exceed 2000 ppm only at 900 metres and 1170-1270± metres. These gases are extremely dry whilst the heavier C_5-C_7 hydrocarbon fraction was not detected.

Zone A^2 lies between 1720± metres and 2440± metres. It comprises shaly mudstones which are generally olive to light olive grey in colour.

Lithologically, Zone A^2 resembles the base of Zone A^1, but it is leaner with few samples containing more than 100 ppm of the

C_1-C_4 gaseous hydrocarbons, the chief exception being the interval 2090-2150± metres where the values reach 1543-2483 ppm. The gases are dry.

Zone B extends from 2440± metres down to 3510± metres. It is dominated by medium dark to medium grey mudstones and shales with some silty intervals. Lignite is occasionally present in the samples but may have been introduced from the drilling mud. Certainly, there is abundant lost circulation material below 3410± metres.

The gases are generally sparse at 15-620 (821) ppm but exceed 1000 ppm at 3090-3190± metres. They are normally marginally wet (23-58% C_{2+}), but are dry at 3050-3310± metres and become increasingly wet below 3450± metres. Isobutane to normal butane ratios are very variable. The C_5-C_7 hydrocarbons are now present and range up to 535 ppm, tending to be most abundant above 3110± metres and again at 3509 metres. This basal sample is also very wet and has a low butane ratio.

Zone C^1 3510± metres to 3670± metres. Above 3585± metres the samples are dominated by medium dark grey shales. Minor limestones are present down to 3540± metres and there are sands below 3550± metres. Significant proportions of a dark grey shale occur at 3563 metres. Below 3585± metres the sands are dominant. Minor to significant proportions of dark brownish grey shale are present below 3640± metres.

A milky cut was detected in the sands below 3620± metres.

Zone C^1 is characterised by extremely wet gases (87-98% C_{2+}) with low isobutane to normal butane ratios. The gases are also relatively abundant, varying from 2742 ppm up to 16778 ppm and exceding 10,000 ppm at 3563 metres and below 3625± metres. The heavier C_5-C_7 hydrocarbons are dramatically enhanced at (3225) 6118-8951 ppm.

Zone C^2 3670± metres to 3860± metres, apparently consists of medium dark grey shales (sometimes silty) with interbedded

sandstones.

A pale milky cut was observed in the sand from 3687 metres.

Zone C^2 is somewhat leaner. The C_1-C_4 and C_5-C_7 fractions have values of 607-3019 (4849) ppm and 844-3204 (4337) ppm respectively, tending to be richest at the top of the zone. In contrast the butane ratio increases with depth from 0.16 up to 0.27. The gases are still very wet at 70-85 (93)% C_{2+} but do not exhibit any obvious trend with depth, although they do tend to be "driest" in the sand-rich samples.

Zone C^3 3860± metres to 4000± metres, comprises medium dark grey silty shales and shales.

Zone C^3 differs only slightly from Zone C^3. Thus the gases are somewhat more abundant at (1613) 2456-5420 ppm but are similarly wet at 72-89% C_{2+}, whilst the C_5-C_7 fraction is depleted at 831-1473 (2716) ppm.

Zone D^1 extends from 4000± metres down to 4330± metres and is dominated by medium dark grey shales with interbedded silty shales and occasional sandstones.

A milky cut was detected at 4112 metres.

The C_1-C_4 gases range from (180)2681 ppm up to 9549 ppm and generally exceed 4500 ppm. They are commonly (44)54-78 (81)% wet, tending to be wettest at 4140-4300± metres. The C_5-C_7 hydrocarbons lie within the limits of (17) 513-2581 ppm and are most abundant within the wettest interval.

Zone D^2 4330± metres to 4460± metres. The samples suggest a sandstone - medium dark grey shale sequence, overlying greyish to pale brown silty shales below 4420± metres.

The C_1-C_4 and C_5-C_7 hydrocarbons are now less abundant at (75) 1847-3844 ppm and 157-629 (1102) ppm respectively, whilst the gases are (33) 48-59 (69)% wet.

The mud samples included in this study have relatively low contents of the gaseous hydrocarbons.

B AMOUNT AND TYPE OF ORGANIC MATTER

The amount of organic matter within a sediment is measured by its organic carbon content. Average shales contain approximately one percent organic carbon, and this is the standard to which these samples will be compared.

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.

The mudstones of Zone A^1 generally contain (0.24)0.36-0.59(0.68)% organic carbon, although the dominant shaly mudstones from 1260-1440± metres are significantly richer at 1.53-1.69% organic carbon. The organic matter in these richer mudstones is mixed algal-amorphous-woody in type, with fairly significant herbaceous debris. That in the leaner mudstones is inertinitic-woody-herbaceous in type with minor to significant proportions of amorphous and algal kerogen, the amorphous fraction being of poor quality.

In Zone A^2 the mudstones have values of 0.29-0.54(0.62)% organic carbon and do not show a correlation against colour, although they do tend to be "richest" below 2160± metres. Their organic matter is dominantly inertinitic in type, although fairly significant proportions of woody, amorphous ± algal debris are also present. The amorphous fraction is grainy and is not the typical oil-prone variety.

Throughout Zone B the mudstones and shales generally contain 0.46-0.75% organic carbon although a few interbeds, particularly at 3390-3460± metres, have better values of 0.83-1.26% organic carbon. However, although Zone B is marginally richer than Zone A^2, the organic matter in these sediments is dominantly inertinitic and woody in type, with only minor proportions of the more oil-prone fractions. The occasional lignites are rich but were probably introduced in drilling.

The pattern continues into Zone C^1 where the major medium dark grey shales

have values of 0.48-0.70% organic carbon. The limestones at the top of this interval are very lean. However in contrast, the dark brownish grey silty shales from 3563 metres and below 3640± metres are rich at 4.18-5.70% organic carbon. This difference is emphasised by the character of their organic matter. Thus, whereas that in the medium dark grey shales is inertinitic (with significant wood) in type, these rich shales are characterised by an amorphous-algal assemblage, although the inertinitic fraction is still significant. The algal debris exhibits partial alteration towards the amorphous state.

It is assumed that the rich shales of Zone C^1 belong to and are caved from, the Kimmeridge. They are not present in the samples from 3500-3554± metres.

As in Zone C^1, the major shales of Zone C^2 are medium dark grey in colour and indeed, have similar values of 0.50-0.73% organic carbon. Interbeds of silty shale are present below 3790± metres and particularly below 3825± metres. These are not only richer at 0.98-1.68% orgnaic carbon but also contain a mixed inertinitic-amorphous-algal-woody assemblage which is therefore, of better quality than that in the medium dark grey shales.

In Zone C^3 the medium dark grey shales contain (0.46)0.62-1.07% organic carbon. The silty shales are slightly richer at 0.83-1.45% but their organic matter is inertinitic and woody, or inertinitic-woody-herbaceous in type and hence, is dominantly of rather poor quality.

The same pattern is evident in Zone D^1 although, in this case, the sediments are somewhat richer. Thus, the medium dark grey shales contain (0.45)0.72-1.62(1.86)% of organic matter which is dominantly inertinitic but also includes significant proportions of woody and herbaceous debris. These shales give the impression of belonging to two populations with values of less than 0.9% and greater than approximately 1.1% organic carbon respectively. The silty shales are enriched at (0.54)1.13-1.99(2.30)% organic carbon but their organic matter, again, is inertinitic and woody in type with significant algal and herbaceous debris.

In Zone D^2 the medium dark grey shales resemble those of Zone D^1 at (0.66)1.08-1.88% organic carbon but the greyish to pale brown silty shales at the base of this unit are lean, containing only 0.13-0.23% organic carbon.

The organic matter in the medium dark grey shales is dominantly inertinitic with significant proportions of woody, herbaceous, algal and amorphous debris.

As noted below, the herbaceous fraction of the total organic matter in Zones C^2 through D^2 is dominantly relatively immature and is believed to represent caved material. The samples are fine-grained and difficult to pick and, if the herbaceous fraction is largely non-indigenous, then the organic matter in the dominant shales of Zone C^2 and in the shales of Zone C^3 through D^2 is very dominantly inertinitic and woody in type. It is suspected that cavings may be present in Zone D^1 and also, that the medium dark grey shales in Zone D^2 may be largely caved, although the lean greyish to pale brown silty shales are probably in situ.

C LEVEL OF THERMAL MATURITY

Maturity determinations were authorised for the interval below 3000 metres. Both the spore colouration and vitrinite reflectivity methods were employed.

The spore colouration technique suggests that a thermal index of 2- is achieved at approximately 2600± metres. A thermal index of 2- to 2 is indicated throughout the analysed section below 3000 metres down to the base of Zone D^1. However, relatively abundant obviously caved material is also present and it is believed that the apparent thermal index of 2- to 2 is, at least below 3600± metres, due to the same effect. Thus, an index of 2 is just achieved at 3599± metres but all of the underlying samples are less mature. However, they do contain sparse herbaceous material with a thermal index of 2 and indeed, this was detected as high as 3500 metres. Therefore, in the belief that cavings pose a very significant problem, it is tentatively suggested that an index of 2 may be achieved at approximately 3500± metres.

This would indicate that the amorphous, herbaceous ± algal fractions of the total organic matter are immature above 2600± metres and then marginally mature down to 3500± metres, resulting in minor hydrocarbon generation, and mature (significant generation) below this depth. In view of the character of the indigenous organic matter in these sediments, the section is effectively immature and marginally mature above and below 3500± metres respectively. The only exceptions to this generalisation are the minor but rich shales within Zone C^1 and the silty shales at the base of Zone C^2, both of which are mature.

At first sight, the reflectively data do not show any depth-related trend, although a large number (up to sixty-two) of readings were attempted for each sample. However, the samples from above 3500 metres were turbodrilled (resulting in the "destruction" of the vitrinite) and the readings were made upon loose lignite particles which are believed to be from the mud system. Hence the values approximating 0.3% Ro, which were sometimes also recorded in the deeper samples, should be ignored. This also applies to the values in excess of 0.9% Ro which are interpretated to indicate reworking. The spread of vitrinite population data points is now much narrower but a single trend is not evident. In most samples, due to the poor quality of the vitrinite, the spread of readings is such that distinct populations are not defined, although there are fairly good populations at 4157 metres and in the deepest analysed sample. The following interpretation is advanced. It is believed that the populations with mean reflectivities of approximately 0.40% Ro below 3650± metres reflect caved material and that the trend must therefore, be based upon the remaining data points. A reasonable trend is now defined.

This trend line reaches a value of 0.53% Ro at approximately 3450± metres and, by projection, 0.45% Ro at approximately 2750± metres and 0.72% Ro at 4500± metres. It intersects the surface at 0.20% Ro which indicates that the section below 3000 metres is currently at its maximum depth of burial. A reflectivity of 0.53% Ro should be equivalent to a thermal index of 2 and hence, the correlation between the two methods is quite satisfactory and suggests that the interpretations applied to the data are correct. It also supports that hypothesis that the sediments of Zones C^2 through D^2 contain significant proportions of indigenous vitrinite.

D SOURCE RICHNESS

Preliminary assessments of present and potential source richness can be obtained from the the light hydrocarbon and organic carbon abundances respectively. The light hydrocarbon data suggest that, although fair source intervals are present, Zones A^1 through B are generally only poor source rocks. Migrated hydrocarbons complicate the picture below this depth, but Zones C^2 through D^2 are rated as fair source rocks. Organic carbon values indicate a poor rating for Zones A^1 and A^2 although the mudstones from 1270-1440± metres are good. Zones B through C^2 are generally poor to fair, although the minor dark brownish grey silty shales in Zone C^1 are rich and the silty shales at the base of Zone C^2 are potentially good source rocks. Zone C^3 is generally fair whilst Zones D^1 and D^2 are fair to good with good

interbeds.

The samples specified for extraction from Zone B yielded 46-9340 ppm C_{15+} hydrocarbons, although only one of them exceeded 250 ppm. This rich sample is clearly contaminated and characterised by a paraffin-naphthene chromatogram with a very mature normal paraffin distribution with a front-end bias and particularly, by a strong peak between nC_{19} and nC_{20}. This peak is also evident in the chromatograms of the other samples which are therefore, also contaminated. Allowing for this problem, these mudstones are probably only poor source rocks. A wide range of abundances (234-593(2579)ppm) was also obtained from Zone C^1 but, although some contamination is evident in two of the samples, this is not the reason for the variation. Instead, it reflects both lithology and the presence of shows. The medium dark grey shales yielded 234-392 ppm and the dark brownish grey silty shales 564-2579 ppm C_{15+} hydrocarbons. These richer shales tend to have chromatograms with a high pristane peak and a slight even carbon preference index, although that from 3651 metres (which is also contaminated) is different. These features appear to be source indigenous but, below 3540± metres, the hydrocarbons constitute a moderately high (34)39-50% of the total extract. This applies to both lithologies whilst the medium dark grey shale from 3599 metres shows an unexpected even carbon preference in its chromatogram. Hence it is suspected that the samples from below 3540± metres, and particularly those from 3563 metres and 3669 metres, contain migrated hydrocarbons in addition to the source-indigenous hydrocarbons (see Section E). Nevertheless, the dark brownish grey silty shales are still potentially good and very good source rocks although the medium dark grey shales are probably, at best, fair. The single sample analysed from Zone C^2 (92 ppm) is poor but those from Zone C^3, at 354-373 ppm C_{15+} hydrocarbons, are good. However these hydrocarbons constitute a somewhat high 40-44% of the total extract and the chromatograms suggest a paraffinic crude oil. In Zone D^1 the values range from a poor 43 ppm up to a good 360 ppm C_{15+} hydrocarbons but, in the richest sample, these hydrocarbons constitute a suspicious 55% of the total extract. In fact, above 4290+ metres (see Section E), migrated hydrocarbons are suspected.

Ultimate source richness is measured with the pyrolysis technique. Zones A^1 and A^2 generally yielded only 171-667(1235) ppm pyrolysate, resulting in a poor source rock rating, although the Zone A^1 mudstones from 1270-1440± metres are good (3063-4089 ppm). Although a few interbeds approach a fair rating, the Zone B shales and mudstones are also poor source rocks

(214-1177(1953)ppm). The scattered lignites are rich but are believed to be derived from the drilling mud. Poor values of 169-1189(1790)ppm characterise the dominant shales of Zones C^1 and C^2, but the minor dark brownish grey silty shales within Zones C^1 are potentially very good (14539-25382 ppm) source rocks, whilst the minor medium dark grey silty shales at the base of Zone C^2 are good (3460-4277 ppm) at 3794 metres and 3821 metres but only fair at 3857 metres. The medium dark grey shales of Zone C^3 are poor (893-1926 ppm) but the silty shales are poor and fair (1259(1784-2829)ppm) and, at 3923 metres, good. This lithology control is also evident in Zone D^1 where the shales generally yielded (572)949-2651 ppm pyrolysate and are classified as potentially poor and fair source rocks, whilst the silty shales at (1382)1782-4329 ppm vary from poor to good. A few of the shales are also good source rocks whilst the silty shales from 4272-4281± metres are rated as very good. In Zone D^2 the medium dark grey shales generally vary from 1467 ppm up to 3189 ppm pyrolysate and may be grossly described as fair, although there are occasional very good (5476-6287 ppm) shales. In contrast, the dark brownish grey silty shales are extremely lean.

Chromatograms of the pyrolysate material define whether a potential source rock will, when mature, yield gas, condensate or oil. In this study, the chromatograms belong to two basic types. In the first of these, which is oil-prone, the traces are dominated by a well-developed series of normal alkane-alkene doublets which extend out to C_{25}-C_{30}. In the second these doublets are absent and the chromatograms consist of methane followed by a series of aromatic peaks. Such samples are gas prone. The richer mudstones in Zone A^1 will yield gas with minor associated condensate, whilst the dominant shales of Zones B, C^1 and C^2 have a potential only for gas. In contrast, the dark brownish grey silty shales within Zone C^1 are beautifully oil prone and the richer medium dark grey silty shales at the base of Zone C^2 also have a potential for oil. Zone C^3 is gas prone. The analysed shales and silty shales from Zone D^1 which are rated as good and very good have a potential for oil, but the leaner lithologies are gas prone.

In summary therefore:

- Zone A^1: poor source rocks encompassing potentially good interval for gas (and minor condensate) at 1270-1440± metres

- Zones A^1 and B: poor and gas prone

- Zones C^1 and C^2: dominant shales poor and gas prone. Minor dark brownish grey silty shales in Zone C^1 potentially very good source rocks for oil. Minor medium dark grey silty shales at 3794 metres and 3821 metres in Zone C^2 potentially good for oil.

- Zone C^3: shales poor, silty shales poor and fair, source rocks for gas.

- Zone D^1: shales generally poor and fair but occasional good source intervals also present. Silty shales normally fair and good source rocks but sometimes poor or, at 4272-4281± metres, very good. Good and very good source rocks oil-prone but leaner lithologies have a potential for gas.

- Zone D^2: medium dark grey shales mainly fair but occasionally very good source rocks.

E MIGRATED HYDROCARBONS

Milky cuts were detected in the sands from 3620-3687± metres and at 4112 metres.

The light hydrocarbon data indicate shows of migrated liquid hydrocarbons throughout Zone C^1 (particularly below 3525± metres), with insignificantly minor traces extending into Zone B at least up to 2450± metres. Traces of migrated hydrocarbons are suggested within Zones C^2 and C^3, whilst there is a weak show at 4140-4300± metres in Zone D^1.

The results obtained from the heavy C_{15+} hydrocarbon analyses have been discussed in detail above (Section D). In Zone C_1 they are interpreted to indicate the presence of shows of crude oil below 3540± metres, although the shows do not appear to be strong. The interpretation of the data is complicated by the source-indigenous hydrocarbons and it is particularly difficult to characterise the oil. However it is suspected that this is a medium gravity oil which was probably derived from the associated (but minor) rich shales and has not been involved in long-range migration. The C_{15+} paraffin-naphthene chromatogram of the sample from 3923 metres in Zone C^3 indicates a medium gravity, paraffinic crude oil and the same oil is also present at 3894 metres. Only a weak show is involved and this is also true of the samples analysed from the gross intercal 4148-4272± metres in Zone D^1

where, rather than a paraffinic crude, there is a normal light to medium gravity oil. Thus (weak) shows of three different oils are present in this well section.

Combining the light and heavy hydrocarbon data the following picture is obtained:

- below 3450± metres in Zone B, insignificantly minor traces of wet gas or condensate
- above 3550± metres in Zone C^1, traces of migrated hydrocarbons, possibly condensate in type
- below 3550± metres in Zone C^1, shows of crude oil. This is possibly a locally-derived medium gravity oil
- traces of wet gas(?) in Zone C^2
- weak shows of paraffinic crude oil in Zone C^3
- weak show of light to medium gravity crude oil at 4140-4300± metres in Zone D^1
- these crude oils do not appear to be related (but see below)
- no strong shows were detected

The samples from 3500 metres and 3563 metres have fairly similar carbon isotope compositions for their C_{15+} paraffin-naphthene and aromatic hydrocarbons, although the deeper sample is isotopically lighter. When their mass fragmentograms are compared, the traces for the $^m/_e$ 253 fragment ions are seen to be almost identical but the $^m/_e$ 191, 217 and 239 traces are quite dissimilar. This is also true of the aromatic and sulphur-aromatic chromatograms. Hence different materials are involved and the isotope value from 3563 metres reflects the origin of the mixed source indigneous/crude oil hydrocarbons in this sample. As the oil is believed to have been sourced from the lateral equivalents of this shale, the data suggest that the shale was deposited in a restricted environment.

Mass fragmentograms were also prepared (free of charge) to characterise the

other two oil types discussed above. There was insufficient material for the $^{m}/e$ 239 and $^{m}/e$ 253 ions but the fragmentograms of the phenanthrene series were run both for these samples and for the other two samples discussed above. Ignoring the plasticiser peak in the $^{m}/e$ 191 chromatogram from 4272 metres, this sample is very similar to that from 3923 metres in all of the fragmentograms (and in its aromatic chromatogram), whereas the samples from 3500 metres and 3563 metres are each different. A relationship is suggested between the shows in Zones C^3 and D^1 (see above) which is not shared by the shows below 3550± metres in Zone C^1. This would be compatible with the concept of local derivation advanced for the Zone C^1 oil.

The carbon isotope composition was measured for the methane in the head space gas in a suite of the richer samples. The sample from 980 metres has a value of $-49.5^{o}/oo$ but otherwise, all of the analysed samples from Zones A^1 and A^2 have values in the range of $-57.6^{o}/oo$ to $-63.3^{o}/oo$ suggesting that these gases are either biogenic or a very early maturation product, the second alternative being perhaps the more likely. Some of the deeper samples were size limited but, even allowing for this, the methane from Zones C^1 through D^2 is at least as heavy as -39.8‰ to -47.4‰ and would appear therefore, to have been generated from thermally mature sediments.

F CONCLUSIONS

Eight (8) zones are recognised between 900 metres and 4460 metres in 34/4-3. Two points should be emphasised. Firstly, detailed analyses were only authorised for the section below 3000 metres. Secondly, in the absence of well logs and sidewell cores, this interpretation is based upon the samples as received. The samples were fine-grained and difficult to pick and it is believed the cavings pose a significant problem below approximately 3500± metres.

In Zone A^1 (900-1720± metres) the samples from above 1200± metres consist of sands and basalts. Below this depth the shaly mudstones and those of Zone A^2 (1720-2440± metres) generally contain (0.24)0.29-0.59(0.68)% organic carbon whilst their organic matter is dominantly inertinitic or inertinitic and woody in type. The only exceptions to this generalisation are the mudstones from 1260-1440± metres in Zone A^1 which are not only richer at 1.53-1.69% organic carbon but also have a better quality, mixed algal-amorphous-woody organic matter assemblege, Zones A^1 and A^2 are immature. Even if mature, they would normally only be poor and uninteresting source rocks for gas.

However the mudstones from 1260-1440± metres represent potentially good source rocks for gas with minor associated condensate.

The shales and mudstones of Zone B (2440-3510± metres) generally contain 0.46-0.75% of inertinitic and woody organic matter although a few interbeds, especially at 3390-3460± metres, are enhanced at 0.83-1.26% organic carbon. Minor hydrocarbon generation would be anticipated from good quality organic matter below approximately 2700± metres but these sediments, due to the character of their organic matter, are effectively immature. In addition, they are only poor source rocks for gas.

Zone C^1 (3510-3670± metres) is dominated by medium dark grey shales and by sandstones above and below 3585± metres respectively. The shales resemble those of Zone B, with 0.48-0.70% of organic matter which is dominantly inertinitic in type, although with significant proportions of woody debris. These are poor source rocks for gas within which only minor hydrocarbon generation has occured.

However, the samples from 3563 metres and below 3640± metres contain minor to significant proportions of dark brownish grey shale. Not only are they rich at 4.18-5.70% organic carbon but they are also characterised by good quality amorphous-algal organic matter with only significant proportions of inertinite. These samples are potentially very good source rocks for oil and, as such organic matter is mature below 3450± metres, significant hydrocarbon generation has been initiated. It is understood (T Throndsen, personal communication) that the Kimmeridge lies at 3500-3554± metres and it is therefore believed, that these shales are caved from the top of Zone C^1 and are under-represented in the samples.

There are shows of a medium-gravity crude oil below 3550± metres in Zone C^1. It is suspected that this oil may have been locally derived and has not been involved in long-range migration. The parent source rock from which it was derived was deposited in a restricted enviroment and indeed, probably corresponds to the medium dark brownish-grey shales discussed above. Above 3550± metres in Zone C^1 there are traces of migrated hydrocarbons which are possibly condensate in type, whilst insignificant minor traces of wet gas or condensate extend up to 3450± metres in Zone B. Traces of wet gas were detected in Zone C^2. It is interesting to note that the methane gas in Zones A^1 and A^2 is a biogenic or (more probably) an early maturation product whilst that in Zone C^1 and below was derived from mature sediments.

In Zone C^2 (3670-3860± metres) the medium dark grey shales resemble those in Zone C^1 with 0.50-0.73% organic carbon but the minor silty shales below 3790± metres have better values of 0.98-1.68% organic carbon, their organic matter being a mixed inertinitic-amorphous-algal-woody assemblage. Zone C^1 is a poor and effectively marginally mature source unit for gas but a few of the minor silty shales are potentially good source rocks for oil. However, unless they are under-represented in the samples, they are too sparse to be effective.

Zone C^3 (3860-4000± metres) apparently comprises interbedded medium dark grey shales and silty shales. The former contain (0.46)0.62-1.07% organic carbon but the silty shales are improved at 0.83-1.45%, although their organic matter consists of poor inertinitic-woody material. As a result, the shales are poor source rocks whilst the silty shales are only poor or fair source rocks. Both lithologies are gas-prone and only relatively minor hydrocarbon generation has occurred.

In Zone D^1 (4000-4330± metres), as in Zone C^3, the silty shales tend to be richer than the shales, although they are both generally characterised by inertinitic and woody organic matter, but algal debris is significant in the siltier lithology. The shales contain (0.45)0.72-1.82(1.86)% organic carbon and appear to fall into two populations (cavings?) whilst the silty shales have values of (0.54)1.13-1.99(2.30)% organic carbon. The shales are generally poor and fair (but occasionally good) source rocks and the silty shales range from poor through to good but are very good at 4272-4281± metres. Most of these sediments are gas prone but some of the good and very good interbeds will yield oil. Minor to significant hydrocarbon generation has occured within this interval which, if the organic matter was of better quality, would be mature.

There are weak shows of paraffinic crude oil in Zone C^3 and a weak show of a light to medium gravity crude at 4140-4300± metres in Zone D^1. Although these differ in character, the available data suggest that they were derived from a similar type of organic matter and perhaps, from a common source horizon. Possible source rocks are present within Zone D^1 and, as minor interbeds, at the base of Zone C^2. These oils do not correlate to that in Zone C^1.

Zone D^2 (4330-4460± metres) apparently comprises a sandstone-shale sequence passing, below 4420± metres, into brownish grey shales. The latter are very lean but the overlying medium dark grey shales contain (0.66)1.08-1.88% of dominantly inertinitic organic matter. It is suspected that these shales are caved but they are rated as fair and occasionally good source rocks. The sediments below 4420± metres have a minimal source potential.

None of the shows discussed above could be described as "strong".

Good quality organic matter would be mature (significant hydrocarbon generation) below 3450± metres and would pass into the oil window at approximately 4500± metres. Many of the sediments within this well and particularly in Zones C^3 and D^1 have good organic carbon contents which should be adequate to generate significant (but perhaps not economic) hydrocarbon reserves but only the minor (as represented) dark brownish grey shales within Zone C^1 could, per unit of rock, generate major oil accumulations. Thus the sediments below 3500± metres and their off-structure equivalents are not limited by immaturity, are only partially limited by the quantity of organic matter which they contain, but are limited by its poor quality.

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)
630-001	900m	A 85% Sand, unconsolidated, med. grained, subrounded to subangular, clear, white to medium light grey B 15% Shell fragments Minor drilling mud	N9-N6	
630-003	940m	A 75% Sand, as 630-001A B 25% Basalt, blocky, hard, medium dark grey to dark grey Minor shell fragments Minor drilling mud	N9-N6 N4-N3	
630-005	980m	A 70% Sand, as 630-001A B 30% Basalt, as 630-003B Minor shell fragments	N9-N6 N4-N3	
630-007	1020m	A 70% Sand, as 630-001A B 30% Basalt, as 630-003B Minor drilling mud	N9-N6 N4-N3	
630-009	1060m	A 70% LCM - cement B 30% Sand, as 630-001A Minor basalt Minor drilling mud	N9-N6	
630-011	1100m	A 75% Sand, as 630-001A B 20% Basalt, as 630-003B C 5% LCM - cement Minor shell fragments Minor drilling mud	N9-N6 N4-N3	
630-013	1140m	A 70% Sand, as 630-001A B 30% Basalt, as 630-003B LCM - cement and metal	N9-N6 N4-N3	
630-015	1180m	A 70% Sand, as 630-001A B 30% Basalt, as 630-003B LCM - metal and cement	N9-N6 N4-N3	
630-017	1220m	A 90% Mudstone, blocky, soft, sl. calc., B 10% Basalt, as 630-003B Minor drilling mud	5Y4/1 N4-N3	0.51
630-019	1260m	A 90% Mudstone, as 630-017A B 10% Drilling mud Minor basalt and shell fragments	5Y4/1	0.59
630-021	1300m	A 98% Mudstone, blocky to platy, soft, non calc., minor cavings, medium olive grey	5Y5/1	1.53,1.52
630-023	1340m	A 98% Shaly Mudstone, blocky to subfissile, soft to mod. hard, non calc., mod. caved, light olive grey	5Y6/1	1.69
630-025	1380m	A 55% Shaly Mudstone, as 630-023A, minor cavings B 45% Shaly Mudstone, blocky to subfissile, soft to mod. hard, non calc., mod. caved, medium dark greenish grey	5Y6/1 5GY5/1	1.59 0.24

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

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GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
630-027	1420m	A 45% Shaly Mudstone, blocky to subfissile, soft to mod. hard, non calc., olive grey	5Y4/1	0.68
		B 35% Shaly Mudstone, blocky to subfissile, soft to mod. hard, non calc., mod. caved, light olive grey	5Y6/1	1.52
		C 25% Shaly Mudstone, blocky to subfissile, soft to mod. hard, non calc., mod. caved medium dark greenish grey	5GY5/1	0.44,0.42
630-029	1460m	A 98% Shaly Mudstone, as 630-027A, minor cavings	5Y4/1	0.44
630-031	1500m	A 98% Shaly Mudstone, as 630-027A, mod. to abundantly caved	5Y4/1	0.57
630-033	1540m	A 98% Shaly Mudstone, as 630-027A, mod. caved Minor other mudstone	5Y4/1	0.45
630-035	1580m	A 98% Shaly Mudstone, subfissile to blocky, soft to mod. hard, non calc., mod. caved, olive grey Minor other mudstone	5Y4/1	0.44
630-037	1620m	A 98% Shaly Mudstone, as 630-035A mod. caved Minor other mudstone	5Y4/1	0.36
630-039	1660m	A 98% Shaly Mudstone, as 630-035A mod. caved Minor other mudstone	5Y4/1	0.32,0.31
630-041	1700m	A 98% Shaly Mudstone, platy, soft to mod. hard, non calc., minor cavings, olive grey to med. olive grey Minor other mudstone	5Y4/1-5/1	0.49
630-043	1740m	A 98% Shaly Mudstone, as 630-041A, mod. caved Minor other mudstone	5Y4/1-5/1	0.46
630-045	1780m	A 90% Shaly Mudstone, as 630-041A, mod. caved	5Y4/1-5/1	0.45
		B 10% Mudstone, blocky, soft to mod. hard, non calc., medium greyish brown	5YR4/2	0.13
630-047	1820m	A 65% Shaly Mudstone, platy to subfissile, soft to mod. hard, non calc., mod. caved., olive grey to medium olive grey	5Y4/1-5/1	0.44
		B 30% Mudstone, blocky, mod. hard, non to v.sl. calc., light olive grey	5Y6/1	0.50,0.50
		C 5% Mudstone, as 630-045B	5YR4/2	0.11
630-049	1860m	A 65% Shaly Mudstone, as 630-047A mod. caved	5Y4/1-5/1	0.32
		B 35% Mudstone, as 630-047B, mod. caved Minor other mudstone	5Y6/1	0.29

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)
630-051	1900m	A 85% Shaly Mudstone, platy to subfissile, soft to mod. hard, non calc., minor cavings, olive grey to medium olive grey	5Y4/1-5/1	0.40
		B 15% Mudstone, blocky, mod. hard, non to v.sl. calc., light olive grey Minor other mudstone	5Y6/1	0.29
630-053	1940m	A 80% Shaly Mudstone, as 630-051A mod. to abundantly caved	5Y4/1-5/1	0.32,0.32
		B 20% Mudstone, as 630-051B, mod. caved Minor other mudstone	5Y6/1	0.33
630-055	1980m	A 70% Shaly Mudstone, as 630-051A abundantly caved	5Y4/1-5/1	0.32
		B 30% Mudstone, as 630-051B, mod. caved Minor other mudstone	5Y6/1	0.36
630-057	2020m	A 70% Mudstone, blocky, soft to mod. hard, non calc., abundantly caved, light olive grey	5Y6/1	0.35
		B 30% Mudstone, blocky, soft, sl. calc., minor cavings, yellowish grey Minor other mudstone	5Y8/1	0.50
630-059	2060m	A 80% Mudstone, as 630-057A, abundantly caved	5Y6/1	0.44,0.44
		B 20% Mudstone, as 630-057B, minor cavings Minor other mudstone	5Y8/1	0.37
630-061	2100m	A 98% Shaly Mudstone, platy, soft to mod. hard, non calc., minor cavings, medium olive grey	5Y5/1	0.48
630-063	2140m	A 75% Shaly Mudstone, blocky to subfissile, soft to mod. hard, non calc., mod. to abundantly caved, medium olive grey	5Y5/1	0.38
		B 25% Mudstone, blocky, soft to mod. hard, calc., minor cavings, light to very light olive grey	5Y6/1-7/1	0.39
630-065	2180m	A 80% Shaly Mudstone, as 630-063A, mod. caved	5Y5/1	0.52
		B 20% Mudstone, as 630-063B, minor cavings Minor other mudstone and pyrites	5Y6/1-7/1	0.55,0.59
630-067	2220m	A 65% Shaly Mudstone, as 630-063A, mod. caved	5Y5/1	0.54
		B 35% LCM - cement and metal turnings Minor other mudstone		
630-069	2260m	A 98% Shaly Mudstone, platy, mod. hard, non calc., minor cavings, medium olive grey Minor pyrites Minor LCM - metal turnings	5Y5/1	0.62
630-071	2300m	A 98% Shale, platy to thinly fissile, soft to mod. hard, non calc., minor cavings, medium grey. Minor LCM	N5	0.54

Abbreviations = **ar**enaceous, **arg**illaceous, **calc**areous, Cut, **dol**omitic, Fluorescence, **foram**inifera, **foss**iliferous
Lost Circulation Material, **mod**erately, **occ**asionally, **sl**ightly, 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)
630-073	2340m	A 98% Shale, platy to thinly fissile, soft to mod. hard, non calc., minor cavings, medium grey Minor drilling mud	N5	0.49
630-075	2380m	A 98% Shale, as 630-073A, sl. foss., minor cavings Minor drilling mud	N5	0.62
630-077	2420m	A 98% Shale, as 630-073A, minor cavings Minor drilling mud	N5	0.54,0.54
630-079	2460m	A 98% Shale, as 630-073A, minor cavings Minor LCM	N5	0.68
630-081	2500m	A 98% Shale, platy to subfissile, mod. hard, non calc., minor cavings, medium grey Minor siltstone Minor LCM	N5	0.54
630-083	2520m	A 98% Shale, as 630-081A, minor cavings Minor siltstone Minor LCM	N5	0.54
630-085	2540m	A 98% Shale, as 630-081A, mod. caved Minor siltstone Minor LCM	N5	0.64
630-087	2560m	A 95% Shale, as 630-081A, mod. caved B 5% Siltstone, blocky, soft to mod. hard, non calc., grades to fine sandstone, light grey Minor LCM - metal turnings	N5 N7	0.68 0.20
630-089	2580m	A 65% Shale, platy, soft to mod. hard, non calc., mod. caved, medium grey B 35% Siltstone, as 630-087B Minor LCM - metal turnings	N5 N7	0.57,0.55 0.18
630-091	2600m	A 90% Shale, as 630-089A, minor cavings B 10% Siltstone, as 630-087B Minor LCM	N5 N7	0.54 0.09
630-093	2620m	A 90% Shale, as 630-089A, minor cavings B 10% Siltstone, as 630-087B Minor LCM - metal turnings	N5 N7	0.50 0.16,0.14
630-095	2640m	A 98% Shale, as 630-089A, minor cavings Minor siltstone Minor LCM	N5	0.59
630-097	2660m	A 98% Shale, platy, soft to mod. hard, non calc., minor cavings, medium grey Minor siltstone and mudstone Minor LCM	N5	0.49
630-099	2680m	A 98% Shale, as 630-097A, minor cavings Minor siltstone and mudstone Minor LCM - metal	N5	0.61

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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)
630-101	2700m	A 90% Mudstone, blocky, soft, non calc., medium dark grey	N4	0.67
		B 10% Shale, platy, soft to mod. hard, non calc., mod. caved, medium grey Minor LCM - metal	N5	0.84
630-103	2720m	A 80% Shale, platy, soft to mod. hard, non calc., minor cavings, medium grey	N5	0.74,0.76
		B 20% Mudstone, blocky, soft, non calc., occ. v.sl. calc., medium grey Minor LCM	N5	0.57
630-105	2740m	A 80% Mudstone, blocky, soft, non calc., medium dark grey	N4	1.18
		B 20% Shale, as 630-103A, minor cavings	N5	0.29
630-107	2760m	A 95% Mudstone, as 630-105A	N4	0.56
		B 5% Shale, as 630-103A, mod. caved Minor drilling mud	N5	0.69
630-109	2780m	A 98% Mudstone, as 630-105A Minor shale LCM - metal turnings	N4	0.45,0.47
630-111	2800m	A 98% Mudstone, as 630-105A, minor cavings Minor shale LCM - metal turnings	N4	0.64
630-113	2820m	A 98% Mudstone, blocky, soft, non calc., minor cavings, medium dark grey Minor shale Minor LCM - metal turnings	N4	0.51
630-115	2840m	A 98% Mudstone, as 630-113A, minor cavings Minor caved shale LCM - metal	N4	0.56
630-117	2860m	A 98% Mudstone, as 630-113A, minor cavings Minor shale LCM - metal	N4	0.61
630-119	2880m	A 90% Shale, platy to thinly fissile, mod. hard, brittle, non calc., minor cavings, medium grey	N5	0.51
		B 5% Silty Mudstone, blocky, soft, non calc., light to medium light grey	N7-N6	0.50,0.52
		C 5% LCM - metal turnings and mica		
630-121	2900m	A 85% Shale, as 630-119A, mod. caved	N5	0.51
		B 15% LCM - metal and plastic Minor drilling mud		
630-123	2920m	A 70% Shale, as 630-119A, mod. caved	N5	0.52
		B 20% Drilling Mud		
		C 10% LCM - metal and plastic		

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)
630-125	2940m	A 90% Shale, thinly fissile to platy, soft to mod. hard, brittle, non calc., mod. caved, medium grey occ. medium dark grey	N5 occ. N4	0.57
		B 10% Drilling mud LCM - metal turnings		
630-127	2960m	A 65% Shale, grading to shaly mudstone, platy, soft to mod. hard, non calc., mod. caved, medium grey	N5	0.61
		B 35% Lignite, blocky, brittle, finely divided, dark grey Minor drilling mud	N3	34.10
630-129	2980m	A 80% Shale, as 630-127A, mod. caved	N5	0.74,0.72
		B 20% Mudstone, blocky, mod. hard, sl. silty, sl. calc., medium grey to medium light grey Minor drilling mud	N5-N6	0.46
630-131	3000m	A 95% Mudstone, as 630-129B	N5-N6	1.26
		B 5% Lignite, as 630-127B Minor other mudstone and shale	N3	
630-133	3020m	A 85% Shale, platy, soft to mod. hard, non calc., medium grey to medium dark greenish grey	N5-5GY5/1	0.43
		B 15% Silty Mudstone, blocky, mod. hard, sl. calc., medium light grey Minor other mudstone Minor LCM - metal turnings	N6	0.58
630-135	3040m	A 85% Shale, as 630-133A, minor cavings	N5-5GY5/1	0.59
		B 15% Silty Mudstone, as 630-133B Minor pyrites Minor drilling mud and LCM	N6	0.82,0.84
630-137	3060m	A 98% Silty Mudstone, blocky, mod. hard, non calc., turbodrilled, medium dark grey to medium grey Minor shale	N4-N5	0.56
630-139	3080m	A 98% Silty Mudstone, as 630-137A turbodrilled Minor shale	N4-N5	0.62
630-141	3100m	A 98% Silty Mudstone, as 630-137A turbodrilled Minor shale Minor drilling mud	N4-N5	0.63
630-143	3120m	A 98% Silty Mudstone, as 630-137A turbodrilled Minor shale. Minor drilling mud	N4-N5	0.66
630-145	3140m	A 98% Silty Mudstone, as 630-137A turbodrilled Minor shale. Minor drilling mud	N4-N5	1.00

Abbreviations = **a**renaceous, **a**rgillaceous, **c**alcareous, **C**ut, **d**olomitic, **F**luorescence, **f**oram**i**nifera, **f**ossil**i**ferous
Lost **C**irculation **M**aterial, **m**oderately, **o**ccasionally, **s**lightly, **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)
630-147	3160m	A 98% Silty Mudstone, blocky, mod. hard, non calc., turbodrilled, medium dark grey to medium grey Minor shale	N4-N5	0.69,0.66
630-149	3180m	A 98% Silty Mudstone, as 630-147A, turbodrilled Minor shale	N4-N5	0.65
630-151	3200m	A 98% Silty Mudstone, as 630-147A, turbodrilled Minor shale	N4-N5	0.71
630-153	3220m	A 98% Silty Mudstone, as 630-147A, turbodrilled Minor shale. Minor drilling mud	N4-N5	0.60
630-155	3240m	A 85% Silty Mudstone, blocky, mod. hard, non calc., turbodrilled, medium dark grey to medium grey	N4-N5	0.69
		B 15% Shale, platy, soft to mod. hard, non calc., minor cavings, medium to medium light grey	N5-N6	0.56
630-157	3260m	A 98% Mudstone, blocky, soft to mod. hard, sl. silty, non calc., turbodrilled in part, medium dark to medium grey Minor shale Minor drilling mud and LCM	N4-N5	0.76,0.74
630-159	3280m	A 98% Mudstone, blocky, soft to mod. hard, sl. silty, non calc., turbodrilled in part, medium dark grey to medium grey Minor shale Minor LCM	N4-N5	1.09
630-161	3300m	A 98% Mudstone, as 630-159A, turbodrilled Minor shale Minor drilling mud	N4-N5	0.73
630-163	3320m	A 98% Mudstone, as 630-159A, turbodrilled Minor shale Minor drilling mud	N4-N5	0.53
630-165	3340m	A 85% Shale, platy to thinly fissile, mod. hard, non calc., mod. caved, medium dark grey to medium grey	N4-N5	0.53
		B 15% Silty Mudstone, blocky, mod. hard, non calc., medium grey to medium light grey Minor LCM	N5-N6	0.61
630-167	3360m	A 50% Shale, as 630-165A, mod. caved	N4-N5	0.67,0.70
		B 50% Silty Mudstone, as 630-165B, minor cavings Minor drilling mud and LCM	N5-N6	0.57
630-169	3380m	A 55% Shale, as 630-165A, mod. caved	N4-N5	0.53

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TABLE 1
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GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
630-169	3380m	B 45% Lignite, blocky, finely divided, dark grey Minor mudstone and drilling mud	N3	38.38
630-171	3400m	A 60% Shale, platy to thinly fissile, mod. hard, non calc., mod. caved, medium dark grey to medium grey	N4-N5	1.14
		B 40% Lignite, as 630-169B Minor mudstone and drilling mud	N3	43.63
630-173	3419m	A 75% Shale, platy to thinly fissile, mod. hard, brittle, non calc., minor cavings, medium dark grey to medium grey	N4-N5	0.87,0.90
		B 25% LCM - cement and metal turnings		
630-175	3437m	A 50% LCM - metal turnings and cement		
		B 50% Shale, as 630-173A, minor cavings	N4-N5	0.84
630-177	3455m	A 55% Shale, as 630-173A, minor cavings	N4-N5	0.83
		B 45% LCM - metal turnings and cement		
630-179	3473m	A 65% Shale, as 630-173A, minor cavings	N4-N5	0.69
		B 35% LCM - metal turnings		
630-181	3491m	A 55% Shale, thinly fissile, mod. hard, brittle, non calc., minor cavings, medium dark grey	N4	0.67
		B 45% LCM - metal turnings Minor sandstone		
630-182	3500m	A 80% Shale, as 630-181A, mod. caved	N4	0.61
		B 20% LCM - metal turnings, minor fibre Minor sandstone and other shale		
630-183	3509m	A 65% Shale, as 630-181A, minor cavings	N4	0.68
		B 35% LCM - metal turnings and cement Minor drilling mud		
630-184	3518m	A 80% Shale, as 630-181A, mod. caved	N4	0.60
		B 10% Limestone, blocky to platy, soft, very light grey to pinkish grey	N8-5YR8/1	0.12
		C 10% LCM - metal turnings, mica and fibre		
630-185	3527m	A 55% Shale, as 630-181A, minor cavings	N4	0.65
		B 35% Limestone, platy, soft, pinkish grey	5YR8/1	0.08,0.08
		C 10% LCM - metal turnings		
630-186	3536m	A 75% Shale, as 630-181A, mod. caved	N4	0.58
		B 15% Limestone, as 630-185B	5YR8/1	0.11
		C 10% LCM - metal turnings, mica and fibre		
630-187	3545m	A 65% Shale, as 630-181A, minor cavings	N4	0.59
		B 35% LCM - metal turnings Minor limestone		
630-188	3554m	A 50% Shale, as 630-181A, mod. caved	N4	0.54,0.55
		B 50% Sandstone, very fine grained, well sorted, calc. matrix, very light grey	N8	
		Minor other shale Minor LCM		

Abbreviations = **a**renaceous, **a**rgillaceous, **c**alcareous, **C**ut, **d**olomitic, **F**luorescence, **f**oram**i**nifera, **f**ossi**l**iferous
Lost **C**irculation **M**aterial, **m**oderately, **o**ccasionally, **s**lightly, **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)
630-189	3563m	A 45% Shale, platy to thinly fissile, mod. hard, brittle, non calc. mod. caved, medium grey	N5	0.48
		B 35% Silty Shale, subfissile to blocky, mod. hard, non calc., minor cavings, dark grey to very dark brownish grey	N3-5YR3/1	4.72,4.76
		C 25% Sandstone, mostly unconsolidated, fine grained, subangular, fairly well sorted, clear, white	N9	
		LCM - metal turnings Minor other shale and siltstone		
630-191	3581m	A 80% Shale, platy to thinly fissile, mod. hard, brittle, non calc., mod. caved, medium dark grey	N4	0.70
		B 20% Sandstone, mostly unconsolidated, fine grained, subangular, fairly well sorted, clear, white	N9	
		Minor pyrites and other shale LCM - metal turnings, paint, fibre and brick		
630-192	3590m	A 70% Sandstone, as 630-189C	N9	
		B 30% Shale, as 630-191A, mod. caved	N4	0.57
		Minor other shale and caved limestone		
630-193	3599m	A 55% Sandstone, blocky, v. fine grained, subangular, fairly well sorted, sl. calc. cement, very light grey	N8	
		B 45% Shale, platy to thinly fissile, mod. hard, brittle, non calc., mod. caved, medium dark grey	N4	0.64
		Minor pyrites and other shale Minor LCM		
630-194	3606m	A 85% Sandstone, as 630-193A, mostly unconsolidated	N8	
		B 15% Shale, as 630-191A, mod. caved	N4	0.55
		Minor other shale and limestone Minor LCM		
630-195	3615m	A 85% Sandstone, as 630-193A	N8	
		B 15% Shale, as 630-191A, mod. caved	N4	0.56
		Minor other shale and siltstone LCM - metal turnings		
630-196	3624m	A 85% Sandstone, as 630-193A, milky C.	N8	
		B 15% Shale, as 630-191A, mod. caved	N4	0.53
		Minor other shale LCM - metal turnings		
630-197	3633m	A 80% Sand, unconsolidated, v. fine grained, subrounded to subangular, fairly well sorted, clear, milky C., very light grey	N8	

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)
630-197	3633m	B 20% Shale, platy to subfissile, mod. hard, non calc., mod. to abundantly caved, medium dark grey Sl. oil stained sample Minor LCM	N4	0.54
630-198	3642m	A 85% Sand, as 630-197A, milky C.	N8	
		B 10% Silty Shale, platy to blocky, soft to mod. hard, non calc., minor cavings, dark brownish grey	5YR3/1	6.00
		C 5% Shale, as 630-197B, mod. caved Minor other shale Minor LCM	N4	0.63
630-199	3651m	A 65% Sand, as 630-197A, milky C.	N8	
		B 20% Silty Shale, blocky to subfissile, soft to mod. hard, non calc., minor cavings, dark brownish grey	5YR3/1	5.20,5.24
		C 15% Shale, as 630-197B, mod. caved Minor other shale LCM - metal turnings and lignite	N4	0.97
630-200	3660m	A 70% Sandstone, blocky, fine grained, subangular, well sorted, sl. calc. cement, pale milky C., very light grey to white	N8-N9	
		B 20% Silty Shale, as 630-199B	5YR3/1	5.78,5.62
		C 10% Shale, as 630-197B, mod. caved Minor LCM	N4	0.67
630-201	3669m	A 45% Sandstone, mostly unconsolidated, fine grained, subangular, well sorted, sl. calc. cement, pale milky C., very light grey to white	N8-N9	
		B 30% Silty Shale, as 630-199B, minor cavings	N4	4.99
		C 25% Shale, as 630-197B, mod. caved Minor LCM	N4	0.62
630-202	3678m	A 60% Sandstone, as 630-201A	N8-N9	
		B 35% Shale, thinly fissile to platy, mod. hard, non calc., mod. caved, medium dark grey	N4	0.58
		C 5% Silty Shale, as 630-199B Minor LCM	5YR3/1	4.18
630-203	3687m	A 80% Shale, thinly fissile, mod. hard, brittle, non calc., mod. caved, medium dark grey	N4	0.58
		B 20% Sandstone, as 630-201A, pale milky C. Minor other shale	N8-N9	
630-204	3696m	A 65% Shale, as 630-203A, mod. caved	N4	0.60
		B 35% Sandstone, as 630-201A Minor other Shale Minor LCM	N8-N9	
630-205	3705m	A 75% Sand, unconsolidated, v. fine, sub-angular, well sorted, clear, white	N9	

Abbreviations = **a**renaceous, **a**rgillaceous, **c**alcareous, **C**ut, **d**olomitic, **F**luorescence, **f**oraminifera, **f**ossiliferous
Lost Circulation Material, **m**oderately, **o**ccasionally, **s**lightly, **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)
630-205	3705m	B 25% Shale, thinly fissile, mod. hard, brittle, non calc., mod. caved, medium dark grey, minor cavings Minor LCM	N4	0.56
630-207	3723m	A 85% Sand, unconsolidated, v. fine sub-angular, well sorted, clear, white	N9	
		B 15% Shale, as 630-205B, minor cavings Minor LCM	N4	0.58,0.58
630-209	3741m	A 65% Sand, unconsolidated, fine to med. grained, subangular, clear, white	N9	
		B 35% Shale, platy to thinly fissile, mod. hard, brittle, non calc., minor cavings, medium dark grey	N4	0.65
630-211	3759m	A 55% Sand, as 630-209A	N9	
		B 45% Shale, as 630-209B, minor cavings Minor LCM	N4	0.56
630-213	3777m	A 50% Sand, as 630-209A	N9	
		B 50% Shale, as 630-209B, minor cavings	N4	0.59
630-215	3794m	A 90% Shale, platy to thinly fissile, mod. hard, brittle, non calc., minor cavings, medium dark grey	N4	0.73
		B 10% Silty Shale, blocky to platy, soft, calc., medium dark grey to medium grey Minor sand	N4-N5	1.68
630-216	3803m	A 60% Shale, thinly fissile to platy, mod. hard, brittle, non calc., medium dark grey	N4	0.51
		B 40% Sandstone, mostly unconsolidated, medium to coarse grained, subrounded, poorly sorted, pinkish grey	5YR8/1	
630-217	3812m	A 95% Shale, as 630-215A, minor cavings	N4	0.67,0.69
		B 5% Siltstone, blocky, soft, calc., medium light grey Minor LCM - metal turnings	N6	0.61
630-218	3821m	A 85% Shale, platy, mod. hard, brittle, non calc., medium dark grey	N4	0.51,0.50
		B 10% Silty Shale, blocky, soft, non calc., brownish grey	5YR4/1	1.58
		C 5% Sandstone, as 630-216B	5YR8/1	
630-219	3830m	A 75% Shale, thinly fissile to platy, mod. hard, brittle, non calc., patchy vitreous lustre, minor cavings, medium dark grey	N4	0.52
		B 25% Silty Shale, blocky to platy, non calc., medium light grey LCM - metal turnings and brick	N6	0.98
630-220	3839m	A 60% Shale, as 630-219A, mod. caved	N4	0.52
		B 35% Sand, unconsolidated, very fine, subrounded, clear, white	N9	

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)
630-220	3839m	C 5% Silty Shale, as 630-219B Minor LCM	N6	1.27
630-221	3840m	A 80% Shale, thinly fissile to platy, mod. hard, brittle, non calc., patchy vitreous lustre, medium dark grey, minor cavings	N4	0.90
		B 20% Sand, unconsolidated, v. fine, subrounded, clear, white Minor siltstone	N9	
630-222	3857m	A 70% Shale, as 630-221A, mod. caved	N4	0.50
		B 30% Silty Shale, blocky to platy, non calc., medium light grey Minor Sand	N6	0.98
630-223	3867m	A 80% Siltstone, blocky, soft to mod. hard, non calc., grading to silty shale, medium dark grey	N4	1.25
		B 20% Shale, as 630-221A	N4	1.04,1.06
630-224	3876m	A 55% Silty Shale, blocky to subfissile, soft to mod. hard, non calc., brownish grey	5YR4/1	1.08,1.08
		B 45% Shale, platy, mod. hard, non calc., patchy pearly lustre, medium dark grey	N4	0.72
630-225	3885m	A 75% Silty Shale, blocky to platy, soft to mod. hard, non calc., medium dark grey	N4	1.18
		B 25% Shale, platy to fissile, mod. hard, non calc., patchy pearly lustre, medium dark grey Minor LCM	N4	0.73
630-226	3894m	A 60% Silty Shale, as 630-225A	N4	1.18
		B 40% Shale, as 630-225B, mod. caved Minor other shale Minor LCM	N4	0.93
630-227	3905m	A 65% Silty Shale, blocky to platy, soft to mod. hard, non calc., medium dark grey	N4	1.44
		B 35% Shale, as 630-225B, minor cavings Minor LCM	N4	0.87
630-228	3914m	A 50% Silty Shale, as 630-225A	N4	1.06
		B 50% Shale, as 630-225B, mod. caved Minor other shale Minor LCM	N4	0.66
630-229	3923m	A 55% Silty Shale, as 630-227A	N4	1.43
		B 45% Shale, as 630-225B, minor cavings Minor LCM	N4	0.99
630-230	3932m	A 50% Silty Shale, as 630-225A	N4	1.29,1.25
		B 50% Shale, as 630-225B, minor cavings Minor sandstone and pyrites	N4	0.90
630-231	3941m	A 60% Silty Shale, as 630-227A	N4	0.96

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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)
630-231	3941m	B 40% Shale, as 630-225B Minor LCM	N4	0.98,0.96
630-232	3950m	A 60% Silty Shale, blocky to platy, soft to mod. hard, non calc., medium dark grey	N4	1.35
		B 25% Shale, platy to fissile, mod. hard, non calc., patchy pearly lustre, medium dark grey, minor cavings Minor LCM	N4	0.75
630-233	3959m	A 60% Silty Shale, as 630-227A	N4	1.26
		B 40% Shale, as 630-232B Minor LCM	N4	1.07
630-234	3968m	A 50% Silty Shale, as 630-232A	N4	1.45
		B 50% Shale, as 630-232B, minor cavings	N4	0.62
630-235	3977m	A 50% Silty Shale, as 630-227A	N4	0.83
		B 50% Shale, as 630-232B, minor cavings Minor LCM	N4	0.66,0.66
630-236	3986m	A 50% Silty Shale, as 630-232A	N4	1.20,1.20
		B 50% Shale, as 630-232B, mod. caved Minor sandstone	N4	0.46
630-237	3995m	A 70% Shale, platy to thinly fissile, mod. brittle, non calc., minor cavings, medium dark grey	N4	0.83
		B 30% Silty Shale, blocky, soft. v.sl. calc., medium dark to medium grey Minor sandstone Minor LCM	N4-N5	0.92
630-239	4013m	A 65% Shale, as 630-237A, minor cavings	N4	0.72
		B 20% Sandstone, blocky, v. fine grained subrounded to subangular, non calc. matrix, very light grey	N8	
		C 15% Silty Shale, as 630-237B Minor LCM	N4-N5	1.32
630-241	4031m	A 80% Shale, as 630-237A, minor cavings	N4	0.77
		B 10% Silty Shale, as 630-237B.	N4-N5	1.38,1.46
		C 10% Sandstone, as 630-239B Minor LCM	N8	
630-243	4049m	A 70% Shale, as 630-237A, minor cavings	N4	0.72
		B 30% Silty Shale, as 630-237B Minor sandstone Minor LCM	N4-N5	1.37
630-245	4067m	A 60% Shale, platy to thinly fissile, mod. hard, brittle, non calc., mod. caved, medium dark grey	N4	1.30
		B 25% Silty Shale, blocky to platy, soft to mod. hard, non calc., medium dark grey to brownish grey	N4-5YR4/1	1.22
		C 15% Sandstone, as 630-239B	N8	
630-248	2900m	MUD SAMPLE		

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)
630-249	3915.2m	MUD SAMPLE		
630-251		"PIPE DOPE"		
630-253	4094m	A 50% Shale, thinly fissile, mod. hard, brittle, non calc., patchy pearly lustre, minor cavings, medium dark grey	N4	0.84
		B 30% Sandstone, blocky, v. fine grained, subangular, well sorted, non calc. cement, very light grey to white	N8-N9	
		C 20% Silty Shale, blocky, soft to mod. hard, v.sl. to non calc., medium dark grey to brownish grey	N4-5YR4/1	1.78,1.80
		Minor LCM - metal turnings and fibre		
630-255	4712m	A 70% Shale, as 630-253A, mod. caved	N4	1.38
		B 20% Sandstone, as 630-253B, milky C.	N8-N9	
		C 10% Silty Shale, as 630-253C	N4-5YR4/1	0.54
		Minor LCM		
630-257	4130m	A 75% Shale, as 630-253A, mod. caved	N4	1.14
		B 15% Sandstone, as 630-253B	N8-N9	
		C 10% Silty Shale, as 630-253C	N4-5YR4/1	1.36
		Minor LCM		
630-258	4139m	A 60% Shale, as 630-253A, minor cavings	N4	0.58
		B 40% Silty Shale, as 630-253C, minor cavings	N4-5YR4/1	1.13
		Minor sandstone		
630-259	4148m	A 75% Shale, as 630-253A, minor cavings	N4	1.27
		B 25% Silty Shale, as 630-253C	N4-5YR4/1	1.30,1.30
		Minor LCM		
630-260	4157m	A 50% Shale, as 630-253A, minor cavings	N4	0.45
		B 50% Silty Shale, as 630-253C, minor cavings	N4-5YR4/1	2.30
		Minor sandstone		
630-261	4166m	A 75% Shale, as 630-253A, minor cavings	N4	1.12
		B 25% Silty Shale, as 630-253C	N4-5YR4/1	1.45
		Minor sandstone		
		Minor LCM		
630-262	4175m	A 55% Shale, as 630-253A, mod. caved	N4	0.91,0.86
		B 45% Silty Shale, as 630-253C	N4-5YR4/1	1.32
		Minor sandstone		
630-263	4184m	A 65% Shale, platy to subfissile, mod. hard, brittle, non calc., patchy pearly lustre, mod. caved, medium dark grey	N4	1.41
		B 35% Silty Shale, blocky, soft to mod. hard, non calc., medium dark grey to brownish grey	N4-5YR4/1	1.19
		LCM - metal turnings		

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)
630-264	4193m	A 60% Shale, platy to subfissile, mod. hard, brittle, non calc., patchy pearly lustre, mod. caved	N4	0.98
		B 40% Silty Shale, blocky, soft to mod. hard, non calc., medium dark grey to brownish grey Minor LCM - lignite	N4-5YR4/1	1.78
630-265	4202m	A 85% Shale, as 630-264A	N4	1.86
		B 15% Sand, unconsolidated, v. fine, sub-angular, clear, white Minor lignite and LCM - brick and metal	N9	
630-266	4209m	A 65% Shale, as 630-264A, mod. caved	N4	1.51
		B 25% Silty Shale, as 630-264B	N4-5YR4/1	1.45
		C 10% LCM as brick and lignite		
630-267	4218m	A 95% Shale, as 630-264A	N4	0.80,0.79
		B 5% Silty Shale, as 630-264B Minor sand Minor LCM	N4-5YR4/1	1.99
630-268	4227m	A 70% Shale, as 630-264A, minor cavings	N4	0.82,0.82
		B 25% Silty Shale, as 630-264B	N4-5YR4/1	2.29
		C 5% LCM - metal, brick and lignite		
630-269	4236m	A 98% Shale, platy to thinly fissile, mod. hard, brittle, non calc., mod. caved, medium dark grey Minor silty shale and sandstone	N4	1.16
630-270	4245m	A 80% Shale, as 630-269A, minor cavings	N4	0.89
		B 20% Silty Shale, blocky to subfissile, soft to mod. hard, non calc., sl. micaceous, medium dark grey to brownish grey Minor sandstone Minor LCM - metal, fibre and mica	N4-5YR4/1	2.16
630-271	4254m	A 80% Shale, platy to subfissile, mod. hard, brittle, non calc., patchy pearly lustre, minor cavings, medium dark grey	N4	1.21
		B 20% Silty Shale, blocky to subfissile, soft to mod. hard, non calc., sl. micaceous, medium dark grey to brownish grey Minor LCM	N4-5YR4/1	1.63
630-272	4263m	A 45% Shale, as 630-271A, minor cavings	N4	1.43
		B 30% Silty Shale, as 630-271B	N4-5YR4/1	1.48
		C 25% Sand, unconsolidated, very fine grained, subangular, well sorted, clear, white	N9	
630-273	4272m	A 65% Shale, as 630-271A, minor cavings	N4	1.03
		B 35% Silty Shale, as 630-271B Minor LCM	N4-5YR4/1	2.14,2.16

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)
630-274	4281m	A 55% Shale, platy to subfissile, mod. hard, brittle, non calc., patchy pearly lustre, minor cavings, medium dark grey	N4	0.80,0.80
		B 25% Sand, unconsolidated, very fine grained, subangular, well sorted, clear, white	N9	
		C 20% Silty Shale, blocky to subfissile, soft to mod. hard, non calc., sl. micaceous, medium dark grey to brownish grey	N4-5YR4/1	1.31
630-275	4290m	A 65% Shale, as 630-274A, minor cavings	N4	0.88
		B 20% Sandstone, blocky, v. fine grained, subangular, well sorted, non calc. cement, very light grey to white	N8-N9	
		C 15% Silty Shale, as 630-271B	N4-5YR4/1	1.55
		Minor LCM - metal turnings		
630-276	4299m	A 50% Shale, as 630-274A, minor cavings	N4	1.38
		B 30% Silty Shale, as 630-274C	N4-5YR4/1	1.44
		C 20% Sandstone, as 630-275B	N8-N9	
		Minor LCM		
630-277	4308m	A 60% Shale, as 630-274A, mod. caved	N4	1.62
		B 40% Silty Shale, as 630-274C	N4-5YR4/1	1.89
		Minor sand and sandstone		
		Minor LCM - metal turnings		
630-278	4317m	A 75% Shale, as 630-274A, mod. caved	N4	1.20
		B 25% Silty Shale, as 630-274C	N4-5YR4/1	1.83
		Minor sandstone		
		Minor LCM		
630-279	4326m	A 98% Shale, platy, mod. hard, brittle, non calc., mod. caved, medium dark grey	N4	0.73
		Minor silty shale and sand		
		LCM - metal turnings		
630-280	4335m	A 70% Shale, as 630-279A, mod. caved	N4	0.64,0.68
		B 30% Silty Shale, platy to subfissile, soft to mod. hard, non calc., sl. micaceous, medium dark grey to brownish grey	N4-5YR4/1	1.63
		Minor sand		
630-281	4344m	A 65% Shale, as 630-279A	N4	1.09,1.06
		B 35% Sandstone, mostly unconsolidated, fine grained, subangular, well sorted, light to very light grey	N7-N8	
		Minor silty shale		
630-282	4353m	A 90% Sand, unconsolidated, fine grained, subangular, well sorted, clear, white	N9	

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)
630-282	4353m	B 10% Shale, platy, mod. hard, non calc., patchy pearly lustre, medium dark grey Minor coal and other shale Minor LCM	N4	1.85
630-283	4362m	A 70% Sand, unconsolidated, fine to med. grained, subangular, fairly well sorted, clear, white	N9	
		B 30% Shale, platy to subfissile, mod. hard, brittle, non calc., sl. silty in part, patchy pearly lustre, medium dark grey Minor LCM	N4	1.32
630-285	4379m	A 75% Shale, as 630-283B, minor cavings	N4	1.88
		B 25% Sand, as 630-283A Minor siltstone	N9	
630-287	4397m	A 70% Shale, silty in part, subfissile to blocky, soft to mod. hard, non calc., medium dark grey	N4	1.45
		B 30% Sandstone, blocky, fine grained, sub-angular, fairly well sorted, non calc. matrix, very light grey to white Minor siltstone and other shale	N8-N9	
630-289	4415m	A 80% Sand, unconsolidated, fine grained, subangular, well sorted, clear, white	N9	
		B 15% Shale, platy to subfissile, brittle, non calc., patchy pearly lustre, medium dark grey	N4	1.84
		C 5% Silty Shale, platy to blocky, mod. hard, non calc., medium greyish brown	5YR4/2	0.20
630-291	4434m	A 70% Silty Shale, as 630-289C	5YR4/2	0.12,0.14
		B 15% Shale, as 630-289B, mod. caved	N4	1.60
		C 15% Sand, as 630-289A	N9	
630-293	4452m	A 65% Silty Shale, as 630-289C	5YR4/2	0.23
		B 20% Shale, as 630-289B, mod. caved	N4	1.36
		C 15% Sand, as 630-289A	N9	

Abbreviations = **a**renaceous, **a**rgillaceous, **c**alcareous, **C**ut, **d**olomitic, **F**luorescence, **f**oraminifera, **f**ossiliferous
Lost Circulation Material, **m**oderately, **o**ccasionally, **s**lightly, **v**ery

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	$\frac{iC_4}{nC_4}$
630-001	900	3643	0	0	0	0	3643	0	0.0	0	0.00
630-003	940	464	1	0	0	0	465	1	0.1	0	0.00
630-005	980	739	0	0	0	0	740	1	0.2	0	2.43
630-007	1020	0	0	0	0	0	0	0	0.0	0	0.00
630-009	1060	2	1	0	0	0	2	1	26.9	0	0.00
630-011	1100	2	0	0	0	0	2	0	0.0	0	0.00
630-013	1140	1100	1	0	1	0	1102	2	0.1	0	0.00
630-015	1180	713	1	0	0	0	714	1	0.1	0	0.00
630-017	1220	1027	1	0	0	0	1029	2	0.2	0	0.00
630-019	1260	1640	1	0	0	0	1641	1	0.1	0	0.00
630-021	1300	105	0	0	0	0	105	0	0.0	0	0.00
630-023	1340	9	0	0	0	0	9	0	0.0	0	0.00
630-025	1380	25	0	0	0	0	25	0	0.0	0	0.00
630-027	1420	765	1	0	0	0	766	1	0.1	0	0.00
630-029	1460	379	0	0	0	0	379	0	0.0	0	0.00
630-031	1500	285	0	0	0	0	285	0	0.0	0	0.00
630-033	1540	4	0	0	0	0	4	0	0.0	0	0.00
630-035	1580	610	0	0	0	0	610	0	0.1	0	0.00
630-037	1620	206	0	0	0	0	206	0	0.1	0	0.00
630-039	1660	365	0	0	0	0	365	0	0.0	0	0.00
630-041	1700	561	0	0	0	0	561	0	0.1	0	0.00
630-043	1740	3	0	0	0	0	3	0	0.0	0	0.00
630-045	1780	49	1	0	0	0	49	1	1.2	0	0.00
630-047	1820	28	0	0	0	0	28	0	0.8	0	0.00
630-049	1860	3	0	0	0	0	3	0	0.0	0	0.00
630-051	1900	168	0	0	0	0	169	1	0.3	0	0.00
630-053	1940	1	0	0	0	0	1	0	0.0	0	0.00
630-055	1980	1	0	0	0	0	1	0	0.0	0	0.00
630-057	2020	4	0	0	0	0	4	0	3.0	0	1.97
630-059	2060	2	0	0	0	0	2	0	0.0	0	0.00

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	$\frac{iC_4}{nC_4}$
630-061	2100	1163	6	2	2	1	1174	10	0.9	0	2.59
630-063	2140	1238	9	7	4	2	1260	22	1.8	4	1.86
630-065	2180	5	0	0	0	0	5	0	1.9	0	3.45
630-067	2220	0	0	0	0	0	0	0	0.0	0	0.00
630-069	2260	1	0	0	0	0	1	0	0.0	0	0.00
630-071	2300	1	0	0	0	0	1	0	0.0	0	0.00
630-073	2340	47	1	1	1	0	50	3	6.5	2	2.34
630-075	2380	0	0	0	0	0	0	0	9.9	0	0.00
630-077	2420	33	1	1	1	1	37	4	10.7	2	2.35
630-079	2460	79	3	4	6	2	95	15	16.1	10	2.51
630-081	2500	3	0	0	0	0	4	1	13.6	0	0.00
630-083	2520	2	0	0	0	0	3	1	26.5	0	0.00
630-085	2540	0	0	0	0	0	0	0	0.0	0	0.00
630-087	2560	0	0	0	0	0	0	0	28.6	0	0.00
630-089	2580	1	0	0	0	0	1	1	37.0	0	1.68
630-091	2600	0	0	0	0	0	0	0	0.0	0	0.00
630-093	2620	3	0	1	1	0	5	2	43.4	2	1.61
630-095	2640	0	0	0	0	0	0	0	28.8	0	0.00
630-097	2660	0	0	0	0	0	0	0	0.0	0	0.00
630-099	2680	14	1	1	1	1	18	4	22.5	7	2.17
630-101	2700	0	0	0	0	0	1	0	25.3	0	1.75
630-103	2720	0	0	0	0	0	0	0	19.6	0	0.00
630-105	2740	0	0	0	0	0	0	0	0.0	0	0.00
630-107	2760	0	0	0	0	0	1	0	21.9	0	1.59
630-109	2780	0	0	0	0	0	0	0	16.0	0	0.00
630-111	2800	0	0	0	0	0	0	0	23.7	0	1.46
630-113	2820	0	0	0	0	0	0	0	14.0	0	0.00
630-115	2840	0	0	0	0	0	0	0	20.7	0	0.00
630-117	2860	0	0	0	0	0	0	0	13.6	0	0.00
630-119	2880	113	9	11	12	3	149	36	24.0	1	3.50

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	$\frac{iC_4}{nC_4}$
630-121	2900	3	0	0	0	0	4	1	25.0	0	3.38
630-123	2920	1	0	0	0	0	1	0	0.0	0	0.00
630-125	2940	1	0	0	0	0	1	0	0.0	0	0.00
630-127	2960	0	0	0	0	0	0	0	0.0	0	0.00
630-129	2980	25	1	1	1	0	29	4	15.3	0	3.56
630-133	3020	0	0	0	0	0	0	0	0.0	0	0.00
630-135	3040	0	0	0	0	0	0	0	0.0	0	0.00
630-137	3060	0	0	0	0	0	0	0	0.0	0	0.00
630-139	3080	0	0	0	0	0	0	0	28.1	0	0.00
630-141	3100	0	0	0	0	0	0	0	0.0	0	0.00
630-143	3120	6	1	1	0	0	8	2	25.7	0	0.41
630-145	3140	2	0	0	0	0	2	0	21.9	0	0.42
630-147	3160	4	0	0	0	0	5	1	17.7	0	0.62
630-149	3180	1	0	0	0	0	1	0	17.5	0	0.00
630-151	3200	0	0	0	0	0	0	0	17.0	0	0.00
630-153	3220	13	2	1	0	0	16	3	19.6	0	0.64
630-155	3240	0	0	0	0	0	0	0	5.4	0	0.00
630-157	3260	8	1	1	0	0	11	3	26.8	1	0.97
630-159	3280	38	5	3	2	1	47	10	20.9	4	1.64
630-161	3300	140	21	9	4	3	177	38	21.2	10	1.33
630-163	3320	35	4	2	1	1	42	7	17.7	3	0.95
630-165	3340	1	0	0	0	0	1	0	25.0	0	1.65
630-167	3360	44	9	5	2	1	60	16	26.2	0	2.54
630-169	3380	0	0	0	0	0	0	0	36.9	0	0.00
630-171	3400	75	37	21	5	3	141	67	47.2	19	1.46
630-173	3419	1	1	1	0	0	3	1	49.4	0	0.00
630-175	3437	238	95	22	2	2	359	120	33.6	0	0.98
630-177	3455	16	11	7	1	1	36	20	54.6	0	0.94
630-179	3473	2	1	1	0	0	5	3	58.1	0	1.25

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	$\frac{iC_4}{nC_4}$
630-181	3491	78	40	25	3	3	148	70	47.2	0	1.02
630-183	3509	87	52	72	10	23	243	156	64.4	14	0.44
630-185	3527	227	181	405	68	327	1208	981	81.2	1144	0.21
630-189	3563	757	583	623	123	450	2536	1779	70.2	576	0.27
630-191	3581	3	3	5	1	3	14	11	79.3	16	0.17
630-193	3599	304	364	484	85	355	1592	1288	80.9	395	0.24
630-197	3633	657	777	980	147	731	3293	2636	80.0	738	0.20
630-199	3651	464	533	788	110	553	2448	1985	81.1	700	0.20
630-203	3687	42	38	90	11	53	235	192	82.0	143	0.21
630-205	3705	139	119	231	30	133	651	512	78.6	282	0.22
630-207	3723	81	64	155	18	89	408	327	80.1	176	0.21
630-209	3741	59	37	62	8	27	194	135	69.4	64	0.28
630-211	3759	1	1	2	0	1	6	5	79.7	8	0.25
630-213	3777	15	9	11	1	4	40	25	63.2	13	0.32
630-215	3794	136	98	154	23	71	482	346	71.9	122	0.33
630-217	3812	20	12	13	2	5	52	32	60.8	10	0.36
630-219	3830	2	1	3	0	1	7	5	74.0	4	0.36
630-221	3840	10	6	8	1	3	29	19	64.7	27	0.31
630-223	3867	455	290	283	39	77	1144	689	60.2	92	0.50
630-225	3885	374	295	323	45	100	1137	762	67.1	112	0.46
630-229	3923	406	303	289	37	80	1113	707	63.5	86	0.46
630-231	3941	579	376	481	72	174	1682	1102	65.5	290	0.41
630-233	3959	417	538	757	115	376	2203	1786	81.1	674	0.31
630-235	3977	15	15	23	3	10	66	51	77.6	26	0.33
630-237	3995	48	61	61	7	17	194	146	75.2	31	0.39
630-239	4013	741	468	299	24	69	1601	860	53.7	82	0.35

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	$\frac{iC_4}{nC_4}$
630-241	4031	230	138	103	13	22	506	277	54.6	20	0.59
630-243	4049	28	9	6	1	1	44	17	37.4	2	0.65
630-245	4067	347	130	63	7	11	558	211	37.9	14	0.58
630-248	2900	14	1	0	0	0	15	1	7.9	13	1.02
630-249	3915.2	302	51	46	7	19	425	123	28.9	90	0.36
630-251	-	45	4	1	0	0	50	5	10.0	0	0.00
630-253	4094	702	256	172	16	44	1190	488	41.0	46	0.36
630-255	4112	821	267	153	16	43	1299	479	36.8	72	0.37
630-257	4130	10	5	4	1	2	21	11	51.2	17	0.31
630-259	4148	/	3	2	0	1	13	6	49.8	1	0.43
630-261	4166	106	67	71	10	26	280	174	62.2	42	0.40
630-263	4184	1	0	0	0	0	3	1	55.5	1	1.22
630-265	4202	174	123	150	19	51	516	342	66.3	105	0.37
630-267	4218	0	0	0	0	0	1	0	65.9	1	1.19
630-269	4236	321	183	165	21	55	746	425	57.0	103	0.38
630-271	4254	591	341	327	51	103	1413	822	58.2	119	0.49
630-273	4272	413	208	174	23	49	867	454	52.3	55	0.47
630-275	4290	1	0	0	0	0	2	1	41.8	14	0.31
630-277	4308	0	0	0	0	0	0	0	51.1	0	0.41
630-279	4326	553	102	67	9	22	753	200	26.5	41	0.40
630-281	4344	1	0	0	0	0	2	1	40.7	0	0.00
630-283	4362	759	261	134	14	33	1201	442	36.8	52	0.41
630-285	4379	10	1	0	0	0	12	2	15.7	0	0.51
630-287	4397	697	389	294	48	84	1512	815	53.9	44	0.57
630-289	4415	287	73	61	15	29	464	177	38.1	68	0.50
630-291	4434	1	0	0	0	1	2	1	53.4	0	0.04
630-293	4452	68	33	28	4	7	141	73	51.7	7	0.56

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	$\frac{iC_4}{nC_4}$
630-001	900	70	3	2	0	0	74	5	6.1	0	0.00
630-003	940	501	3	1	0	0	504	4	0.7	0	0.00
630-005	980	581	2	2	0	0	584	3	0.5	0	0.00
630-007	1020	47	1	0	0	0	48	1	1.7	0	0.00
630-009	1060	53	0	0	0	0	53	0	0.0	0	0.00
630-011	1100	70	1	0	0	0	71	1	1.2	0	0.00
630-013	1140	5	0	0	0	0	5	0	0.0	0	0.00
630-015	1180	1618	2	2	1	0	1623	5	0.3	0	0.00
630-017	1220	1276	6	2	0	0	1284	8	0.6	0	0.00
630-019	1260	3419	2	2	1	0	3424	5	0.1	0	0.00
630-021	1300	495	1	1	1	0	497	3	0.5	0	0.00
630-023	1340	490	2	2	1	0	495	5	0.9	0	0.00
630-025	1380	134	1	1	0	0	135	2	1.4	0	0.00
630-027	1420	349	2	2	0	0	353	4	1.1	0	0.00
630-029	1460	1055	3	1	2	0	1060	5	0.5	0	0.00
630-031	1500	557	2	1	1	0	561	4	0.7	0	0.00
630-033	1540	179	2	2	1	0	184	5	2.5	0	0.00
630-035	1580	273	2	1	1	11	288	15	5.1	0	0.06
630-037	1620	566	1	2	0	0	568	2	0.4	0	0.00
630-039	1660	474	1	0	0	0	474	1	0.2	0	0.00
630-041	1700	443	0	0	0	0	443	0	0.0	0	0.00
630-043	1740	29	2	1	0	0	31	2	7.0	0	0.00
630-045	1780	23	2	0	0	0	24	2	6.8	0	0.00
630-047	1820	41	1	1	4	7	54	13	24.3	0	0.62
630-049	1860	38	3	2	0	0	44	5	12.3	0	0.00
630-051	1900	539	3	2	0	0	543	4	0.7	0	0.00
630-053	1940	34	3	2	0	0	40	6	14.5	0	0.00
630-055	1980	21	2	0	0	0	23	2	7.2	0	0.00
630-057	2020	84	2	0	0	0	86	2	1.9	0	0.00
630-059	2060	43	3	2	0	0	47	4	8.6	0	0.00

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	$\frac{iC_4}{nC_4}$
630-061	2100	1302	4	3	0	0	1309	7	0.5	0	0.00
630-063	2140	267	5	4	4	3	283	16	5.7	0	1.10
630-065	2180	499	5	6	0	0	510	11	2.1	0	0.00
630-067	2220	17	0	0	0	0	17	0	0.0	0	0.00
630-069	2260	32	3	2	1	0	37	5	13.7	0	0.00
630-071	2300	20	2	0	0	0	22	2	7.7	0	0.00
630-073	2340	117	5	4	5	3	134	17	13.0	0	1.53
630-075	2380	14	0	0	0	0	14	0	0.0	0	0.00
630-077	2420	81	6	4	4	3	99	18	17.8	0	1.31
630-079	2460	129	9	13	16	11	179	50	28.0	260	1.43
630-081	2500	80	8	6	6	5	104	24	23.4	0	1.05
630-083	2520	76	15	23	23	23	159	83	52.0	243	1.00
630-085	2540	7	2	2	2	3	15	8	54.8	416	0.62
630-087	2560	52	7	14	15	15	102	51	49.5	242	1.01
630-089	2580	138	29	41	41	42	292	154	52.7	397	0.97
630-091	2600	96	12	22	26	24	181	85	46.7	326	1.05
630-093	2620	214	35	64	55	47	415	202	48.6	394	1.16
630-095	2640	4	3	3	2	5	16	12	72.8	23	0.40
630-097	2660	13	1	3	2	2	22	8	38.4	35	1.00
630-099	2680	68	10	9	14	11	112	44	39.2	486	1.19
630-101	2700	58	11	11	12	10	101	44	43.0	279	1.23
630-103	2720	39	5	6	8	5	63	24	38.8	233	1.62
630-105	2740	40	6	5	7	5	62	22	35.9	263	1.32
630-107	2760	56	12	8	6	5	87	31	35.4	211	1.08
630-109	2780	37	8	5	3	3	57	20	34.8	91	1.14
630-111	2800	49	9	8	7	6	78	29	37.2	321	1.14
630-113	2820	24	4	3	159	0	190	166	87.5	0	0.00
630-115	2840	46	9	7	4	4	69	24	33.9	109	1.14
630-117	2860	49	8	6	6	5	74	25	34.1	32	1.14
630-119	2880	65	9	8	9	6	98	33	33.4	161	1.50

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	$\frac{iC_4}{nC_4}$
630-121	2900	74	14	14	13	7	123	49	39.8	79	1.73
630-123	2920	42	8	11	9	4	74	32	43.5	81	2.20
630-125	2940	38	7	8	10	6	69	32	45.8	35	1.67
630-127	2960	46	13	13	13	8	93	47	50.1	336	1.52
630-129	2980	84	16	17	17	10	143	59	41.3	245	1.71
630-131	3000	65	8	10	15	7	105	39	37.7	66	2.29
630-133	3020	77	12	14	15	8	127	50	39.3	302	1.82
630-135	3040	212	28	20	24	12	295	84	28.3	535	2.04
630-137	3060	488	45	20	15	12	582	93	16.0	58	1.25
630-139	3080	502	48	24	18	15	606	104	17.2	146	1.23
630-141	3100	951	89	35	11	20	1107	156	14.1	359	0.56
630-143	3120	1032	105	47	15	31	1230	198	16.1	0	0.48
630-145	3140	955	95	45	12	28	1134	179	15.8	45	0.42
630-147	3160	922	96	43	13	21	1095	173	15.8	51	0.62
630-149	3180	1873	171	71	19	36	2169	297	13.7	0	0.53
630-151	3200	654	66	29	11	15	775	121	15.6	38	0.72
630-153	3220	503	48	21	8	13	592	89	15.1	8	0.61
630-155	3240	502	60	30	13	15	620	119	19.1	38	0.87
630-157	3260	620	66	29	12	14	740	119	16.1	18	0.85
630-159	3280	373	13	16	10	3	415	42	10.2	23	3.02
630-161	3300	512	19	29	22	6	588	76	12.9	9	3.85
630-163	3320	9	110	3	8	6	135	126	93.5	11	1.31
630-165	3340	59	21	17	0	0	97	38	38.9	0	0.00
630-167	3360	32	11	7	1	1	53	21	40.1	0	0.88
630-169	3380	30	13	14	6	7	71	41	57.9	50	0.79
630-171	3400	55	36	1	24	10	128	72	56.6	107	2.36
630-173	3419	61	18	17	5	7	107	47	43.5	84	0.81
630-175	3437	156	134	62	13	20	386	230	59.6	1	0.66
630-177	3455	35	24	17	1	3	79	44	55.7	94	0.23
630-179	3473	107	74	37	36	12	265	158	59.6	11	3.01

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	$\frac{iC_4}{nC_4}$
630-181	3491	94	85	100	11	23	313	219	69.9	72	0.49
630-183	3509	97	106	215	31	130	578	481	83.3	278	0.24
630-185	3527	158	116	464	152	892	1781	1623	91.1	6911	0.17
630-187	3545	238	282	1328	323	1833	4004	3766	94.1	8824	0.18
630-189	3563	936	1641	4124	601	3298	10600	9663	91.2	8375	0.18
630-191	3581	312	423	1018	165	810	2728	2417	88.6	3209	0.20
630-193	3599	241	539	2238	343	2156	5516	5275	95.6	6330	0.16
630-195	3615	235	549	2883	428	2886	6980	6746	96.6	6118	0.15
630-197	3633	361	1298	5766	852	5209	13485	13125	97.3	7480	0.16
630-199	3651	623	1113	4913	690	4346	11686	11063	94.7	6847	0.16
630-201	3669	239	767	5001	787	4994	11787	11548	98.0	7872	0.16
630-203	3687	159	163	980	201	1281	2784	2625	94.3	3061	0.16
630-205	3705	599	446	1474	269	1411	4198	3600	85.7	4056	0.19
630-207	3723	238	95	320	58	354	1065	828	77.7	2044	0.16
630-209	3741	194	75	183	33	169	655	461	70.4	1477	0.20
630-211	3759	186	57	167	35	187	632	446	70.6	1322	0.19
630-213	3777	290	186	540	96	459	1571	1281	81.5	1875	0.21
630-215	3794	204	216	614	116	553	1703	1499	88.0	1551	0.21
630-217	3812	407	411	1004	182	724	2729	2322	85.1	1984	0.25
630-219	3830	228	137	451	90	366	1271	1044	82.1	1307	0.24
630-221	3840	125	89	196	36	133	578	453	78.4	816	0.27
630-223	3867	461	494	769	104	362	2190	1729	79.0	796	0.29
630-225	3885	280	383	732	105	377	1876	1597	85.1	946	0.28
630-227	3905	272	362	1037	159	626	2456	2184	88.9	1128	0.25
630-229	3923	768	973	1603	216	746	4307	3538	82.2	1387	0.29
630-231	3941	210	177	393	77	293	1151	941	81.7	1075	0.26
630-233	3959	207	353	993	224	814	2591	2383	92.0	2043	0.28
630-235	3977	387	467	1083	185	672	2794	2407	86.2	1398	0.28
630-237	3995	193	300	561	80	284	1419	1226	86.4	800	0.28
630-239	4013	780	840	843	93	342	2898	2118	73.1	1014	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	$\frac{iC_4}{nC_4}$
630-241	4031	3170	1780	1345	147	428	6870	3700	53.9	970	0.34
630-243	4049	2315	2272	2239	194	633	7652	5337	69.8	740	0.31
630-245	4067	3363	1895	1547	172	562	7540	4177	55.4	917	0.31
630-248	2900	57	44	60	11	39	211	154	73.2	258	0.28
630-249	3915.2	148	50	68	12	48	326	178	54.6	447	0.25
630-251	-	381	68	12	2	4	467	85	18.3	18	0.39
630-253	4094	2045	1681	2520	304	923	7473	5428	72.6	721	0.33
630-255	4112	4364	1676	1431	191	588	8250	3886	47.1	1466	0.33
630-257	4130	67	39	34	4	14	158	91	57.3	0	0.27
630-259	4148	1128	1189	2099	350	1312	6078	4950	81.4	2478	0.27
630-261	4166	946	776	1170	174	600	3666	2720	74.2	1070	0.29
630-263	4184	779	620	1018	147	546	3110	2331	75.0	1106	0.27
630-265	4202	491	398	783	142	351	2165	1674	77.3	1	0.40
630-267	4218	1781	1608	2680	470	1376	7915	6134	77.5	2281	0.34
630-269	4236	1024	1031	1531	244	822	4652	3628	78.0	1970	0.30
630-271	4254	914	916	1559	273	944	4604	3691	80.2	2462	0.29
630-273	4272	4502	1008	1438	239	773	7960	3458	43.4	1449	0.31
630-275	4290	1086	955	1532	283	868	4724	3637	77.0	1944	0.33
630-277	4308	2772	2359	2429	340	998	8897	6125	68.8	666	0.34
630-279	4326	3075	248	310	56	240	3928	853	21.7	473	0.23
630-281	4344	884	611	815	130	435	2875	1991	69.3	368	0.30
630-283	4362	981	142	158	23	77	1382	401	29.0	105	0.30
630-285	4379	6	3	12	3	38	63	57	90.6	1	0.08
630-287	4397	970	398	554	89	320	2333	1362	58.4	1058	0.28
630-289	4415	678	186	278	55	186	1383	705	51.0	415	0.30
630-291	4434	1413	709	746	120	317	3306	1893	57.3	629	0.38
630-293	4452	723	367	439	68	205	1802	1079	59.9	601	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	$\frac{iC_4}{nC_4}$
630-001	900	3713	3	2	0	0	3717	5	0.1	0	0.00
630-003	940	965	3	1	0	0	969	4	0.4	0	0.00
630-005	980	1320	2	2	0	0	1325	5	0.3	0	2.43
630-007	1020	47	1	0	0	0	48	1	1.7	0	0.00
630-009	1060	55	1	0	0	0	55	1	1.0	0	0.00
630-011	1100	72	1	0	0	0	73	1	1.1	0	0.00
630-013	1140	1105	1	0	1	0	1106	2	0.1	0	0.00
630-015	1180	2331	2	2	1	0	2336	6	0.2	0	0.00
630-017	1220	2303	7	2	0	0	2313	10	0.4	0	0.00
630-019	1260	5059	3	2	1	0	5065	6	0.1	0	0.00
630-021	1300	600	1	1	1	0	603	3	0.4	0	0.00
630-023	1340	500	2	2	1	0	504	5	0.9	0	0.00
630-025	1380	158	1	1	0	0	160	2	1.2	0	0.00
630-027	1420	1114	2	2	0	0	1118	5	0.4	0	0.00
630-029	1460	1433	3	1	2	0	1439	5	0.4	0	0.00
630-031	1500	842	2	1	1	0	845	4	0.5	0	0.00
630-033	1540	183	2	2	1	0	188	5	2.5	0	0.00
630-035	1580	883	2	1	1	11	898	15	1.7	0	0.06
630-037	1620	772	1	2	0	0	774	2	0.3	0	0.00
630-039	1660	838	1	0	0	0	839	1	0.1	0	0.00
630-041	1700	1004	0	0	0	0	1004	0	0.0	0	0.00
630-043	1740	32	2	1	0	0	34	2	6.4	0	0.00
630-045	1780	71	2	0	0	0	74	2	3.1	0	0.00
630-047	1820	69	1	1	4	7	82	13	16.3	0	0.63
630-049	1860	41	3	2	0	0	47	5	11.6	0	0.00
630-051	1900	707	3	2	0	0	712	5	0.7	0	0.00
630-053	1940	35	3	2	0	0	41	6	14.1	0	0.00
630-055	1980	23	2	0	0	0	25	2	6.8	0	0.00
630-057	2020	88	2	0	0	0	90	2	2.0	0	1.97
630-059	2060	45	3	2	0	0	49	4	8.2	0	0.00

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	$\frac{iC_4}{nC_4}$
630-061	2100	2465	10	5	2	1	2483	17	0.7	0	2.59
630-063	2140	1505	14	11	8	6	1543	38	2.5	4	1.42
630-065	2180	504	5	6	0	0	515	11	2.1	0	3.45
630-067	2220	17	0	0	0	0	17	0	0.0	0	0.00
630-069	2260	33	3	2	1	0	39	5	13.3	0	0.00
630-071	2300	21	2	0	0	0	22	2	7.5	0	0.00
630-073	2340	164	6	5	6	4	184	21	11.2	2	1.64
630-075	2380	14	0	0	0	0	14	0	0.3	0	0.00
630-077	2420	115	7	5	6	4	136	22	15.8	2	1.47
630-079	2460	208	12	17	22	14	274	65	23.9	269	1.61
630-081	2500	83	8	6	6	5	108	25	23.1	0	1.05
630-083	2520	78	15	23	23	23	162	84	51.6	243	1.01
630-085	2540	7	2	2	2	3	15	8	54.2	416	0.62
630-087	2560	52	7	14	15	15	102	51	49.4	242	1.01
630-089	2580	139	29	41	41	43	293	154	52.6	397	0.97
630-091	2600	97	12	22	26	24	181	85	46.7	326	1.05
630-093	2620	216	36	65	55	48	420	204	48.5	396	1.16
630-095	2640	5	3	3	2	5	16	12	72.6	23	0.40
630-097	2660	13	1	3	2	2	22	8	38.1	35	1.00
630-099	2680	82	11	10	15	12	130	48	36.9	493	1.25
630-101	2700	58	11	11	12	10	102	44	42.9	279	1.24
630-103	2720	39	5	6	8	5	63	24	38.8	233	1.62
630-105	2740	40	6	5	7	5	63	22	35.8	263	1.32
630-107	2760	57	12	8	6	5	88	31	35.3	211	1.08
630-109	2780	37	8	5	3	3	57	20	34.7	91	1.14
630-111	2800	49	9	8	7	6	78	29	37.2	321	1.14
630-113	2820	24	4	3	159	0	190	166	87.5	0	0.00
630-115	2840	46	9	7	4	4	70	24	33.8	109	1.14
630-117	2860	49	8	6	6	5	74	25	34.0	32	1.14
630-119	2880	179	19	19	21	9	247	69	27.8	163	2.23

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	$\frac{iC_4}{nC_4}$
630-121	2900	77	14	15	13	8	127	50	39.3	79	1.76
630-123	2920	43	8	11	9	4	76	32	42.9	81	2.20
630-125	2940	39	7	8	10	6	71	32	45.0	35	1.67
630-127	2960	46	13	13	13	8	93	47	50.1	336	1.52
630-129	2980	109	17	19	18	10	172	64	36.9	245	1.79
630-131	3000	65	8	10	15	7	105	39	37.7	66	2.29
630-133	3020	77	12	14	15	8	127	50	39.3	302	1.82
630-135	3040	212	28	20	24	12	295	84	28.3	535	2.04
630-137	3060	489	45	20	15	12	582	93	16.0	58	1.25
630-139	3080	502	48	24	18	15	606	105	17.2	146	1.23
630-141	3100	951	89	35	11	20	1107	156	14.1	359	0.56
630-143	3120	1038	106	47	15	31	1238	200	16.1	0	0.48
630-145	3140	957	95	45	12	28	1136	180	15.8	45	0.42
630-147	3160	926	97	43	13	21	1100	174	15.8	51	0.62
630-149	3180	1873	172	71	19	36	2170	297	13.7	0	0.53
630-151	3200	654	66	29	11	15	775	121	15.6	38	0.72
630-153	3220	516	49	22	8	13	609	93	15.2	8	0.61
630-155	3240	502	60	30	13	15	620	119	19.1	38	0.87
630-157	3260	628	67	29	12	14	750	122	16.3	19	0.85
630-159	3280	410	17	19	12	4	462	52	11.3	28	2.71
630-161	3300	651	41	38	26	9	765	114	14.8	19	2.98
630-163	3320	43	114	5	9	7	177	134	75.5	14	1.27
630-165	3340	60	21	17	0	0	98	38	38.8	0	*.**
630-167	3360	76	20	12	3	2	113	37	32.8	0	1.38
630-169	3380	30	13	14	6	7	71	41	57.9	50	0.79
630-171	3400	130	74	22	29	14	269	139	51.7	127	2.14
630-173	3419	62	19	17	5	7	110	48	43.7	84	0.81
630-175	3437	394	229	84	15	22	744	350	47.1	1	0.69
630-177	3455	51	35	24	2	4	115	64	55.4	94	0.42
630-179	3473	109	75	38	36	12	270	161	59.6	11	2.99

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	$\frac{iC_4}{nC_4}$
630-181	3491	172	125	125	14	25	461	289	62.6	72	0.54
630-183	3509	183	157	286	41	153	821	638	77.7	293	0.27
630-185	3527	385	297	869	220	1219	2989	2605	87.1	8055	0.18
630-187	3545	238	282	1328	323	1833	4004	3766	94.1	8824	0.18
630-189	3563	1693	2224	4747	724	3748	13136	11443	87.1	8951	0.19
630-191	3581	314	426	1023	166	813	2742	2428	88.5	3225	0.20
630-193	3599	544	903	2722	427	2511	7108	6563	92.3	6725	0.17
630-195	3615	235	549	2883	428	2886	6980	6746	96.6	6118	0.15
630-197	3633	1018	2076	6745	999	5940	16778	15760	93.9	8218	0.17
630-199	3651	1087	1647	5701	801	4899	14134	13047	92.3	7547	0.16
630-201	3669	239	767	5001	787	4994	11787	11548	98.0	7872	0.16
630-203	3687	202	201	1070	212	1334	3019	2817	93.3	3204	0.16
630-205	3705	738	564	1705	298	1544	4849	4111	84.8	4337	0.19
630-207	3723	319	159	475	77	443	1473	1155	78.4	2221	0.17
630-209	3741	254	113	246	41	197	850	596	70.1	1541	0.21
630-211	3759	187	58	169	35	189	638	451	70.7	1330	0.19
630-213	3777	305	194	551	97	464	1611	1306	81.1	1888	0.21
630-215	3794	340	314	768	139	624	2185	1845	84.4	1672	0.22
630-217	3812	428	424	1017	183	729	2781	2353	84.6	1994	0.25
630-219	3830	229	138	454	90	367	1279	1049	82.1	1312	0.25
630-221	3840	135	95	204	37	136	607	472	77.8	844	0.27
630-223	3867	916	784	1052	143	439	3334	2418	72.5	887	0.32
630-225	3885	654	678	1055	150	476	3013	2359	78.3	1058	0.31
630-227	3905	272	362	1037	159	626	2456	2184	88.9	1128	0.25
630-229	3923	1174	1276	1892	253	826	5420	4246	78.3	1473	0.31
630-231	3941	790	553	874	149	467	2833	2043	72.1	1366	0.32
630-233	3959	625	891	1750	339	1189	4794	4169	87.0	2716	0.29
630-235	3977	402	482	1106	189	682	2860	2459	86.0	1423	0.28
630-237	3995	241	361	623	87	302	1613	1372	85.1	831	0.29
630-239	4013	1521	1308	1143	117	410	4498	2978	66.2	1096	0.29

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	$\frac{iC_4}{nC_4}$
630-241	4031	3400	1919	1449	160	450	7376	3977	53.9	990	0.35
630-243	4049	2343	2280	2245	195	634	7697	5354	69.6	742	0.31
630-245	4067	3710	2025	1611	179	573	8098	4388	54.2	932	0.31
630-248	2900	70	44	61	11	39	226	155	68.8	272	0.28
630-249	3915.2	450	101	114	19	67	751	301	40.1	537	0.28
630-251	-	426	72	13	2	4	516	90	17.5	18	0.39
630-253	4094	2747	1937	2691	320	967	8663	5915	68.3	767	0.33
630-255	4112	5184	1943	1584	208	631	9549	4365	45.7	1538	0.33
630-257	4130	78	44	38	4	16	180	102	56.6	17	0.27
630-259	4148	1134	1192	2102	351	1313	6091	4957	81.4	2480	0.27
630-261	4166	1051	843	1241	184	626	3945	2894	73.4	1111	0.29
630-263	4184	780	620	1018	147	547	3112	2333	74.9	1108	0.27
630-265	4202	665	521	932	161	402	2681	2016	75.2	105	0.40
630-267	4218	1781	1608	2680	470	1376	7916	6135	77.5	2282	0.34
630-269	4236	1345	1214	1697	265	877	5398	4053	75.1	2073	0.30
630-271	4254	1505	1256	1886	324	1047	6017	4513	75.0	2581	0.31
630-273	4272	4915	1217	1612	262	821	8827	3911	44.3	1504	0.32
630-275	4290	1088	955	1532	283	868	4726	3638	77.0	1958	0.33
630-277	4308	2772	2359	2429	340	998	8897	6126	68.8	666	0.34
630-279	4326	3628	350	376	64	262	4681	1052	22.5	513	0.25
630-281	4344	885	611	815	130	435	2877	1992	69.2	368	0.30
630-283	4362	1740	403	293	37	110	2583	843	32.6	157	0.34
630-285	4379	16	4	13	3	39	75	59	78.6	1	0.08
630-287	4397	1667	787	848	138	405	3844	2177	56.6	1102	0.34
630-289	4415	965	259	338	70	215	1847	882	47.8	483	0.32
630-291	4434	1414	709	746	120	318	3307	1893	57.2	629	0.38
630-293	4452	791	400	467	72	212	1943	1151	59.3	608	0.34

TABLE 3
KEROGEN TYPE AND MATURATION

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC MATTER DESCRIPTION					THERMAL MATURATION INDEX
		TYPES 40%; 10–40%; 10%	REMARKS	REWORKED (%)	PARTICLE SIZE	PRESERV-ATION	
630-023A	1340m	-;Al**-Am*-W-H;I	**includes material passing to Am *includes material incompletely developed	-	F-M	F-G	1+
630-031A	1500m	-;W-I-H-Am**-Al;-	**poor quality H at 2- to 2	-	M	F	1+
630-075A	2380m	I;Am**-W-Al;H	**grainy poor quality approaching 2-	-	M	F	1+ to 2-
630-103A	2720m	I;W-H-Am**-Al;-	**as 075A	-	M	G	2-
630-131A	3000m	W-I;-;Am**-H-Al	**disseminated, unrecognisable, poor quality cavings	-	F-M/C	F	2- to 2
630-159A	3280m	I-W;Am**;Al-H	**as 131A cavings	-	F-M/C	F	2- to 2
630-171A	3400m	I-W;-;H-Am-Al	significant caving at 1+ to 2-	-	M-C	G	2- to 2
630-182A	3500m	I;W:H-Al-Am	significant caving, spore at 2	-	M	G	2- to 2
630-185A	3527m	I;W-Al;H-Am	frequent cavings	-	F-M	F	2- to 2
630-189B	3563m	Al**-Am*;I;W-H	**frequently passing to Am *often Al, includes incompletely developed material dominant H at 1+ to 2-; trace of H at 2	-	F-C	F-G	2- to 2(?)
630-193B	3599m	I;W;Al**-H-Am*	abundant cavings ** * as 189B	-	F-M	G	2 max
630-199B	3651m	-;Am*-Al**-I;W-H	** * as 189B	-	F-M/C	F	2-(?)
630-201B	3669m	-;Am*-I-Al**-W;H	** * as 189B very sparse H at 2, minor H at 1+ to 2-, organic material generally at 2-/2- to 2	-	F-M/C	F-G	see remark
630-215B	3794m	-;I-Am**-Al*-W;H	very sparse H at 2 max cavings	-	M-C	F-G	2- to 2

Algal, Amorphous, Herbaceous, Inertinite, Resin, Wood

postscript = coarse, cuticle, cysts, degraded, fine, other,. structured, spore-pollen, thick-walled, unstructured

TABLE 3

KEROGEN TYPE AND MATURATION

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC MATTER DESCRIPTION					THERMAL MATURATION INDEX
		TYPES 40%; 10–40%; 10%	REMARKS	REWORKED (%)	PARTICLE SIZE	PRESERV-ATION	
630-226A	3894m	I-W;H;Am-Al	dominated H caved, minor H at 2	-	M	G	2- to 2
630-229A	3923m	-;I-W-H;Al-Am	minor H at 2- to 2	-	M	G	2-(?)
630-259A	4148m	I;W-H;Al-Am	dominant cavings, very sparse material at 2 max	-	M	F-G	2- to 2
630-273B	4272m	I-W;Al-H;Am	frequent cavings	-	M-C	G	2- to 2
630-277B	4308m	I-W;H-Al;Am	significant material at 1+ to 2-; very minor material at 2	-	M-C	G	2- to 2
630-285A	4379m	I;W-Al**-Am*-H;-	significant cavings **includes Al passing to Am	-	M	F	2

Algal, Amorphous, Herbaceous, Inertinite, Resin, Wood

postscript = coarse, cuticle, cysts, degraded, fine, other,. structured, spore-pollen, thick-walled, unstructured

TABLE 4
VITRINITE REFLECTANCE DATA

GEOCHEM SAMPLE NUMBER	DEPTH	SAMPLE TYPE	AVERAGE REFLECTIVITY Ro (%), (NUMBER OF PARTICLES)				REMARKS
			1	2	3	4	
630-131A	3000m	KC	0.30(40)	-	-	-	
630-141A	3100m	WR	0.28(2)	0.70(1)	0.98(2)	-	
630-151A	3200m	WR	0.29(30)	-	-	-	
630-159A	3280m	WR	0.27(6)	-	-	-	
630-215B	3794m	WR	0.40(6)	0.65(4)	0.77(10)	-	
630-226A	3894m	KC	0.30(2)	0.41(20)	0.60(14)	-	
630-237A	3995m	WR	0.65(4)	0.77(5)	1.00(4)	-	
630-255A	4112m	WR	1.38(15)	-	-	-	
630-260B	4157m	WR	0.63(14)	0.81(8)	1.28(1)	-	
630-265A	4202m	KC	0.40(24)	0.64(36)	-	-	
630-277B	4308m	KC	0.44(15)	0.64(21)	0.77(26)	-	
630-287A	4397m	WR	0.70(29)	1.20(1)	-	-	

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

TABLE 5a

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

GEOCHEM SAMPLE NUMBER	DEPTH	TOTAL EXTRACT	HYDROCARBONS			NON HYDROCARBONS			
			Paraffin-Naphthenes	Aromatics	TOTAL	Precipitd. Asphaltenes	Eluted NSO's	Non-eluted NSO's	Sulphur
630-248	2900 MUD	3590	702	817	1520	323	1434	301	12
630-131A	3000	1248	115	96	211	681	211	125	19
630-159A	3280	19480	5467	3873	9340	286	7290	2506	59
630-171A	3400	1984	161	80	241	1260	402	80	0
630-182A	3500	297	27	18	46	178	69	5	0
630-185A	3527	1107	156	78	234	625	143	91	13
630-189A	3563	5118	1101	1478	2579	1254	1101	116	67
630-193	3599	1016	199	194	392	309	175	106	32
630-199	3651	1678	282	282	564	707	300	103	4
630-201	3669	1305	303	290	593	466	163	70	13
630-215	3794	789	37	55	92	578	78	37	5
630-226	3894	841	246	127	373	282	136	41	9
630-229	3923	890	209	145	354	395	73	68	0
630-259	4148	677	114	133	246	289	90	52	0
630-267	4218	434	83	73	156	184	80	10	3
630-273	4272	650	182	178	360	186	95	9	0
630-277	4308	86	26	17	43	13	22	9	0
630-251	5000 PIPE DOPE	660974	248766	328312	577078	65195	15526	3169	0

TABLE 5b

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
630-248	2900	19.57	22.76	9.01	39.93	8.39	0.34
630-131A	3000	9.23	7.69	54.62	16.92	10.00	1.54
630-159A	3280	28.07	19.88	1.47	37.42	12.86	0.30
630-171A	3400	8.11	4.05	63.51	20.27	4.05	0.00
630-182A	3500	9.23	6.15	60.00	23.08	1.54	0.00
630-185A	3527	14.12	7.06	56.47	12.94	8.24	1.18
630-189A	3563	21.52	28.88	24.51	21.52	2.27	1.31
630-193	3599	19.55	19.09	30.45	17.27	10.45	3.18
630-199	3651	16.80	16.80	42.13	17.87	6.13	0.27
630-201	3669	23.23	22.22	35.69	12.46	5.39	1.01
630-215	3794	4.65	6.98	73.26	9.88	4.65	0.58
630-226	3894	29.19	15.14	33.51	16.22	4.86	1.08
630-229	3923	23.47	16.33	44.39	8.16	7.65	0.00
630-259	4148	16.78	19.58	42.66	13.29	7.69	0.00
630-267	4218	19.20	16.80	42.40	18.40	2.40	0.80
630-273	4272	28.00	27.33	28.67	14.67	1.33	0.00
630-277	4308	30.00	20.00	15.00	25.00	10.00	0.00
630-251	5000	37.64	49.67	9.86	2.35	0.48	0.00

TABLE 6

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
630-248	2900	0.63	42.33	24.12	56.98	0.86
630-131A	3000	1.82	16.92	1.16	6.85	1.20
630-159A	3280	2.05	47.95	45.56	95.02	1.41
630-171A	3400	1.06	12.16	2.28	18.72	2.00
630-182A	3500	0.57	15.38	0.80	5.21	1.50
630-185A	3527	0.56	21.18	4.19	19.76	2.00
630-189A	3563	3.55	50.40	7.27	14.42	0.75
630-193	3599	0.66	38.64	5.95	15.39	1.02
630-199	3651	2.26	33.60	2.49	7.42	1.00
630-201	3669	0.86	45.45	6.90	15.17	1.05
630-215	3794	2.85	11.63	0.32	2.77	0.67
630-226	3894	0.98	44.32	3.81	8.58	1.93
630-229	3923	1.18	39.80	3.00	7.54	1.44
630-259	4148	1.39	36.36	1.77	4.87	0.86
630-267	4218	1.85	36.00	0.85	2.35	1.14
630-273	4272	1.42	55.33	2.53	4.58	1.02
630-277	4308	1.37	50.00	0.32	0.63	1.50
630-251	5000	26.64	87.31	216.62	248.11	0.76

TABLE 7a
PYROLYSIS RESULTS

GEOCHEM SAMPLE NUMBER	DEPTH	WT. % ORGANIC CARBON (OC)	WT. PPM		RATIOS		Tmax (°C) Pyrolysate
			Thermal Bitumen (P1)	Pyrolysate (P2)	$\frac{P1}{P1+P2}$	$\frac{P2}{OC}$	
630-017A	1220	0.51	69	667	0.09	0.13	
630-019A	1260	0.59	65	1051	0.06	0.18	
630-021A	1300	1.53	218	3914	0.05	0.26	
630-023A	1340	1.69	94	3948	0.02	0.23	
630-025A	1380	1.59	153	4089	0.04	0.26	
630-027B	1420	1.52	133	3063	0.04	0.20	
630-027A	1420	0.68	76	443	0.15	0.07	
630-029A	1460	0.44	69	411	0.14	0.09	
630-031A	1500	0.57	80	389	0.17	0.07	
630-033A	1540	0.46	72	301	0.19	0.07	
630-035A	1580	0.44	14	267	0.05	0.06	
630-037A	1620	0.36	114	263	0.30	0.07	
630-039A	1660	0.31	37	219	0.14	0.07	
630-041A	1700	0.49	53	455	0.10	0.09	
630-043A	1740	0.46	37	1235	0.03	0.27	
630-045A	1780	0.45	93	543	0.15	0.12	
630-047A	1820	0.44	29	286	0.09	0.07	
630-047B	1820	0.50	77	536	0.13	0.11	
630-049A	1860	0.32	30	467	0.06	0.15	
630-051A	1900	0.40	177	357	0.33	0.09	
630-053A	1940	0.32	57	579	0.09	0.18	
630-055A	1980	0.32	24	171	0.12	0.05	
630-055B	1980	0.36	26	263	0.09	0.07	
630-057A	2020	0.35	108	382	0.22	0.11	
630-057B	2020	0.50	74	532	0.12	0.11	
630-059A	2060	0.44	63	612	0.09	0.14	
630-061A	2100	0.48	22	307	0.07	0.06	
630-063A	2140	0.38	27	583	0.04	0.15	
630-065A	2180	0.52	30	313	0.09	0.06	
630-065B	2180	0.55	90	479	0.16	0.09	
630-067A	2220	0.54	41	324	0.11	0.06	
630-069A	2260	0.62	66	554	0.11	0.09	
630-071A	2300	0.54	143	259	0.36	0.05	
630-073A	2340	0.49	43	474	0.08	0.10	
630-075A	2380	0.62	41	400	0.09	0.06	
630-077A	2420	0.54	79	617	0.11	0.11	
630-079A	2460	0.68	48	364	0.12	0.05	
630-081A	2500	0.54	147	525	0.22	0.10	
630-083A	2520	0.54	27	239	0.10	0.04	
630-085A	2540	0.64	19	397	0.05	0.06	
630-A087	2560	0.68	203	382	0.35	0.06	
630-089A	2580	0.57	90	444	0.17	0.08	
630-091A	2600	0.54	197	281	0.41	0.05	
630-093A	2620	0.50	152	396	0.28	0.08	
630-095A	2640	0.59	135	608	0.18	0.10	
630-097A	2660	0.49	32	367	0.08	0.07	
630-099A	2680	0.61	88	689	0.11	0.11	
630-101A	2700	0.67	116	791	0.13	0.12	
630-101B	2700	0.84	171	1177	0.13	0.14	
630-103A	2720	0.75	8	488	0.02	0.07	

Thermal Bitumen (Peak 1) evolved up to 340°C. Pyrolysate (Peak 2) evolved 340 – 550°C.

TABLE 7a
PYROLYSIS RESULTS

GEOCHEM SAMPLE NUMBER	DEPTH	WT. % ORGANIC CARBON (OC)	WT. PPM		RATIOS		Tmax (°C) Pyrolysate
			Thermal Bitumen (P1)	Pyrolysate (P2)	$\frac{P1}{P1+P2}$	$\frac{P2}{OC}$	
630-105A	2740	1.18	441	474	0.48	0.04	
630-107A	2760	0.56	119	449	0.21	0.08	
630-109A	2780	0.45	32	560	0.05	0.12	
630-111A	2800	0.64	84	620	0.12	0.10	
630-113A	2820	0.51	18	428	0.04	0.08	
630-115A	2840	0.56	107	522	0.17	0.09	
630-117A	2860	0.61	153	805	0.16	0.13	
630-119A	2880	0.51	31	426	0.07	0.08	
630-119B	2880	0.50	20	763	0.03	0.15	
630-121A	2900	0.51	16	333	0.05	0.07	
630-123A	2920	0.52	67	697	0.09	0.13	
630-125A	2940	0.57	338	610	0.36	0.11	
630-127A	2960	0.61	21	561	0.04	0.09	
630-127B	2960	34.10	1945	29180	0.06	0.09	
630-129A	2980	0.74	57	386	0.13	0.05	
630-131A	3000	1.26	82	1868	0.04	0.15	
630-133A	3020	0.43	14	252	0.05	0.06	
630-133B	3020	0.58	19	598	0.03	0.10	
630-135A	3040	0.59	248	518	0.32	0.09	
630-135B	3040	0.82	257	1044	0.20	0.13	
630-137A	3060	0.56	50	343	0.13	0.06	
630-139A	3080	0.62	33	452	0.07	0.07	
630-141A	3100	0.63	72	225	0.24	0.04	
630-143A	3120	0.66	28	420	0.06	0.06	
630-145A	3140	1.00	166	831	0.17	0.08	
630-147A	3160	0.66	84	217	0.28	0.03	
630-149A	3180	0.65	30	246	0.11	0.04	
630-151A	3200	0.71	123	307	0.29	0.04	
630-153A	3220	0.60	148	214	0.41	0.04	
630-155A	3240	0.69	127	400	0.24	0.06	
630-155B	3240	0.56	61	430	0.12	0.08	
630-157A	3260	0.76	81	272	0.23	0.04	
630-159A	3280	1.09	223	1953	0.10	0.18	
630-161A	3300	0.73	53	480	0.10	0.07	
630-163A	3320	0.53	187	374	0.33	0.07	
630-165A	3340	0.53	22	515	0.04	0.10	
630-165B	3340	0.61	19	351	0.05	0.06	
630-167A	3360	0.67	12	512	0.02	0.08	
630-169A	3380	0.98	12	567	0.02	0.06	
630-169B	3380	38.38	711	28427	0.02	0.07	
630-171A	3400	1.14	18	1120	0.02	0.10	
630-171B	3400	43.63	491	35095	0.01	0.08	
630-173A	3419	0.90	31	842	0.04	0.09	
630-175B	3437	0.84	20	450	0.04	0.05	
630-177A	3455	0.83	32	467	0.06	0.06	
630-179A	3473	0.69	75	442	0.15	0.06	
630-181A	3491	0.67	202	458	0.31	0.07	
630-182A	3500	0.60	21	244	0.08	0.04	
630-183A	3509	0.68	60	329	0.15	0.05	
630-184A	3518	0.60	15	177	0.08	0.03	

Thermal Bitumen (Peak 1) evolved up to 340°C. Pyrolysate (Peak 2) evolved 340 – 550°C.

TABLE 7a
PYROLYSIS RESULTS

GEOCHEM SAMPLE NUMBER	DEPTH	WT. % ORGANIC CARBON (OC)	WT. PPM		RATIOS		Tmax (°C) Pyrolysate
			Thermal Bitumen (P1)	Pyrolysate (P2)	$\frac{P1}{P1+P2}$	$\frac{P2}{OC}$	
630-185A	3527	0.65	258	388	0.40	0.06	
630-186A	3536	0.58	11	288	0.04	0.05	
630-187A	3545	0.59	99	390	0.20	0.07	
630-188A	3554	0.55	7	223	0.03	0.04	
630-189A	3563	0.48	41	454	0.08	0.09	
630-189B	3563	4.72	888	14539	0.06	0.31	
630-191A	3581	0.70	52	501	0.09	0.07	
630-192B	3590	0.57	5	169	0.03	0.03	
630-193B	3599	0.64	59	844	0.07	0.13	
630-194B	3606	0.55	14	217	0.06	0.04	
630-195B	3615	0.56	40	465	0.08	0.08	
630-196B	3624	0.53	12	238	0.05	0.04	
630-197B	3633	0.54	25	1189	0.02	0.22	
630-198B	3642	6.00	627	25382	0.02	0.42	
630-199B	3651	5.24	1266	18714	0.06	0.36	
630-199C	3651	0.97	63	1047	0.06	0.11	
630-200B	3660	5.70	1090	14819	0.07	0.26	
630-201B	3669	4.99	1008	16116	0.06	0.32	
630-201C	3669	0.62	64	584	0.10	0.09	
630-202C	3678	4.18	1382	14780	0.09	0.35	
630-203A	3687	0.58	116	249	0.32	0.04	
630-204A	3696	0.60	21	246	0.08	0.04	
630-205B	3705	0.56	78	1790	0.04	0.32	
630-207B	3723	0.58	95	1172	0.07	0.20	
630-209B	3741	0.65	17	490	0.03	0.08	
630-211B	3759	0.56	18	437	0.04	0.08	
630-213B	3777	0.59	10	565	0.02	0.10	
630-215A	3794	0.73	98	455	0.18	0.06	
630-215B	3794	1.68	151	3460	0.04	0.21	
630-216A	3803	0.51	45	323	0.12	0.06	
630-217A	3812	0.68	82	689	0.11	0.10	
630-218B	3821	1.58	168	4277	0.04	0.27	
630-219B	3830	0.98	183	954	0.16	0.10	
630-220A	3839	0.52	81	684	0.11	0.13	
630-221A	3840	0.90	65	1071	0.06	0.12	
630-222B	3857	1.25	64	2260	0.03	0.18	
630-223A	3867	1.25	154	2829	0.05	0.23	
630-223B	3867	1.04	75	1415	0.05	0.14	
630-224A	3876	1.08	105	1878	0.05	0.17	
630-225A	3885	1.18	20	2323	0.01	0.20	
630-225B	3885	0.73	45	1193	0.04	0.16	
630-226A	3894	1.18	117	1534	0.07	0.13	
630-226B	3894	0.93	33	893	0.04	0.10	
630-227A	3905	1.44	118	2664	0.04	0.19	
630-228A	3914	1.06	37	2391	0.02	0.23	
630-229A	3923	1.43	194	4109	0.05	0.29	
630-229B	3923	0.99	107	1426	0.07	0.14	
630-230A	3932	1.27	79	2364	0.03	0.19	
630-230B	3932	0.90	111	1782	0.06	0.20	
630-231A	3941	0.96	62	2028	0.03	0.21	

Thermal Bitumen (Peak 1) evolved up to 340°C. Pyrolysate (Peak 2) evolved 340 – 550°C.

TABLE 7a

PYROLYSIS RESULTS

GEOCHEM SAMPLE NUMBER	DEPTH	WT. % ORGANIC CARBON (OC)	WT. PPM		RATIOS		Tmax (°C) Pyrolysate
			Thermal Bitumen (P1)	Pyrolysate (P2)	$\frac{P1}{P1+P2}$	$\frac{P2}{OC}$	
630-232A	3950	1.35	257	2822	0.08	0.21	
630-233A	3959	1.26	128	1784	0.07	0.14	
630-233B	3959	1.07	52	1448	0.03	0.14	
630-234A	3968	1.45	107	2060	0.05	0.14	
630-235A	3977	1.57	122	1812	0.06	0.12	
630-236A	3986	1.20	137	1259	0.10	0.10	
630-237A	3995	0.83	77	1511	0.05	0.18	
630-239B	4013	1.32	125	3287	0.04	0.25	
630-241A	4031	0.77	45	949	0.05	0.12	
630-241B	4031	1.38	442	4129	0.10	0.30	
630-243B	4049	1.37	322	1382	0.19	0.10	
630-245B	4067	1.22	89	1792	0.05	0.15	
630-245A	4067	1.30	120	2403	0.05	0.18	
630-253A	4094	0.84	155	988	0.14	0.12	
630-253C	4094	1.80	522	2659	0.16	0.15	
630-255A	4112	1.38	270	1434	0.16	0.10	
630-257A	4130	1.14	313	2022	0.13	0.18	
630-257C	4130	1.36	329	2059	0.14	0.15	
630-258B	4139	1.13	130	1835	0.07	0.16	
630-259A	4148	1.27	347	2228	0.13	0.18	
630-259B	4148	1.30	394	3069	0.11	0.24	
630-260B	4157	2.30	247	4168	0.06	0.18	
630-261B	4166	1.45	465	3080	0.13	0.21	
630-262A	4175	0.89	43	979	0.04	0.11	
630-262B	4175	1.32	151	2488	0.06	0.19	
630-263A	4184	1.41	641	3974	0.14	0.28	
630-263B	4184	1.19	532	1822	0.23	0.15	
630-264B	4193	1.78	142	3720	0.04	0.21	
630-265A	4202	1.86	979	4736	0.17	0.25	
630-266A	4209	1.51	191	1970	0.09	0.13	
630-266B	4209	1.45	68	1615	0.04	0.11	
630-267A	4218	0.80	406	1329	0.23	0.17	
630-268B	4227	2.29	353	3555	0.09	0.16	
630-269A	4236	1.16	311	2324	0.12	0.20	
630-270A	4245	0.89	68	572	0.11	0.06	
630-270B	4245	2.16	190	3432	0.05	0.16	
630-271A	4254	1.21	198	2512	0.07	0.21	
630-271B	4254	1.63	576	3985	0.13	0.24	
630-272A	4263	1.43	123	2651	0.04	0.19	
630-272B	4263	1.48	165	1258	0.12	0.09	
630-273A	4272	1.03	341	1374	0.20	0.13	
630-273B	4272	2.14	615	6138	0.09	0.29	
630-274C	4281	1.31	242	9761	0.02	0.75	
630-275C	4290	1.55	697	3100	0.18	0.20	
630-276A	4299	1.38	161	2094	0.07	0.15	
630-276B	4299	1.44	118	1782	0.06	0.12	
630-277A	4308	1.62	447	3531	0.11	0.22	
630-277B	4308	1.89	333	4329	0.07	0.23	
630-278A	4317	1.20	221	1475	0.13	0.12	
630-278B	4317	1.83	194	2250	0.08	0.12	

Thermal Bitumen (Peak 1) evolved up to 340°C. Pyrolysate (Peak 2) evolved 340 – 550°C.

TABLE 7a
PYROLYSIS RESULTS

GEOCHEM SAMPLE NUMBER	DEPTH	WT. % ORGANIC CARBON (OC)	WT. PPM		RATIOS		Tmax (°C) Pyrolysate
			Thermal Bitumen (P1)	Pyrolysate (P2)	$\frac{P1}{P1+P2}$	$\frac{P2}{OC}$	
630-279A	4326	0.73	236	671	0.26	0.09	
630-280B	4335	1.63	213	3123	0.06	0.19	
630-281A	4344	1.09	242	1467	0.14	0.13	
630-282B	4353	1.85	139	1775	0.07	0.10	
630-283B	4362	1.32	181	1875	0.09	0.14	
630-285A	4379	1.88	163	5476	0.03	0.29	
630-287A	4397	1.45	52	3189	0.02	0.22	
630-289B	4415	1.84	103	6287	0.02	0.34	
630-291B	4434	1.60	42	2757	0.02	0.17	
630-293A	4452	0.23	25	64	0.28	0.03	
630-293B	4452	1.36	38	2764	0.01	0.20	

Thermal Bitumen (Peak 1) evolved up to 340°C. Pyrolysate (Peak 2) evolved 340 – 550°C.

TABLE 7b

EXTENDED PYROLYSIS RESULTS

GEOCHEM SAMPLE NUMBER	DEPTH	WT. % ORGANIC CARBON (OC)	WT. PPM		RATIOS		Tmax (°C) Pyrolysate
			Thermal Bitumen (P1)	Pyrolysate (P2)	$\frac{P1}{P1+P2}$	$\frac{P2}{OC}$	
630-131A	3000	1.26	124	1591	0.07	0.13	513
630-159A	3280	1.09	126	1756	0.07	0.16	510
630-171A	3400	1.14	15	1146	0.01	0.10	516
630-182A	3500	0.60	31	381	0.07	0.06	525
630-185A	3527	0.65	209	353	0.37	0.05	507
630-189B	3563	4.72	940	15532	0.06	0.33	514
630-193B	3599	0.64	45	561	0.08	0.09	518
630-199B	3651	5.24	1048	17765	0.06	0.34	530
630-201B	3669	5.24	1155	18976	0.06	0.36	533
630-215B	3794	1.68	157	4240	0.04	0.25	526
630-226A	3894	1.18	200	1833	0.10	0.16	516
630-229A	3923	1.43	162	4342	0.04	0.30	520
630-259A	4148	1.27	399	2454	0.14	0.19	520
630-273B	4272	2.14	662	6805	0.09	0.32	532
630-277B	4308	1.89	256	4011	0.06	0.21	525

Thermal Bitumen (Peak 1) evolved up to 340°C. Pyrolysate (Peak 2) evolved 340 – 550°C.

TABLE 8

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

GEOCHEM SAMPLE NUMBER	-131A	-159A	-171A	-182A	-185A	-189B	-193
DEPTH	3000m	3280m	3400m	3500m	3527m	3563m	3599m
SAMPLE TYPE							
nC_{15}	11.47	6.20	2.78	3.47	10.68	12.34	8.50
nC_{16}	14.76	10.68	8.13	9.17	13.33	11.64	10.15
nC_{17}	13.76	15.61	13.03	14.75	12.29	10.06	10.68
nC_{18}	13.16	16.53	15.81	17.35	13.52	9.45	10.90
nC_{19}	9.97	14.58	13.25	12.14	10.40	9.01	9.40
nC_{20}	9.37	11.02	10.91	9.54	9.55	8.31	8.87
nC_{21}	6.18	6.89	8.69	6.94	6.90	7.35	7.29
nC_{22}	4.59	4.71	6.90	5.58	5.86	6.56	7.07
nC_{23}	3.89	3.44	5.90	5.08	4.82	5.69	5.94
nC_{24}	3.29	2.64	5.35	4.83	4.16	5.86	6.47
nC_{25}	3.39	2.64	4.01	4.46	3.31	4.20	4.51
nC_{26}	2.49	1.61	2.78	3.22	2.46	4.20	3.98
nC_{27}	2.09	1.49	1.22	1.73	1.32	2.27	2.56
nC_{28}	0.80	0.69	0.33	0.62	0.57	1.49	1.80
nC_{29}	0.20	0.57	0.22	0.37	0.28	0.79	1.05
nC_{30}	0.10	0.11	0.11	0.12	0.09	0.35	0.30
nC_{31}	0.10	0.11	0.11	0.12	0.09	0.09	0.15
nC_{32}	0.10	0.11	0.11	0.12	0.09	0.09	0.15
nC_{33}	0.10	0.11	0.11	0.12	0.09	0.09	0.08
nC_{34}	0.10	0.11	0.11	0.12	0.09	0.09	0.08
nC_{35}	0.10	0.11	0.11	0.12	0.09	0.09	0.08
PARAFFIN	37.15	42.78	29.62	29.38	36.22	35.16	43.44
ISOPRENOID	6.07	5.80	3.66	4.91	6.61	7.47	6.04
NAPHTHENE	56.78	51.42	66.72	65.71	57.17	57.37	50.52
CPI INDEX A	1.09	1.11	1.03	1.03	1.00	0.93	0.91
CPI INDEX B	1.26	1.43	1.16	1.20	1.12	0.91	0.99
PRISTANE/PHYTANE	1.52	1.23	1.02	1.18	1.47	1.45	1.31
PRISTANE/nC_{17}	0.72	0.48	0.48	0.61	0.88	1.25	0.74

TABLE 8

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

GEOCHEM SAMPLE NUMBER	-199	-201	-215	-226	-229	-248	-259
DEPTH	3651m	3669m	3794m	3894m	3923m	2900m	4148m
SAMPLE TYPE							
nC_{15}	5.96	11.99	4.00	6.31	6.38	12.78	8.52
nC_{16}	6.91	11.74	7.39	8.44	8.10	16.22	10.92
nC_{17}	8.37	10.57	9.59	9.15	8.28	15.90	10.63
nC_{18}	8.11	9.58	11.69	9.47	8.90	14.39	10.35
nC_{19}	8.87	9.58	12.89	9.47	9.39	13.32	9.86
nC_{20}	7.73	8.66	9.59	8.70	8.83	9.13	8.87
nC_{21}	7.29	6.66	9.29	7.99	8.28	6.55	7.61
nC_{22}	6.40	5.91	7.99	6.96	7.67	4.51	6.62
nC_{23}	6.40	5.00	7.49	6.57	7.06	2.79	6.20
nC_{24}	6.40	5.00	6.39	5.99	6.26	2.04	4.65
nC_{25}	5.58	3.58	5.99	5.61	5.71	1.18	4.37
nC_{26}	4.82	3.58	3.20	4.38	4.42	0.64	3.73
nC_{27}	4.37	2.25	2.00	4.38	4.23	0.21	2.96
nC_{28}	3.42	1.67	1.00	2.84	2.52	0.11	1.83
nC_{29}	3.74	1.42	0.50	2.06	2.02	0.11	1.34
nC_{30}	1.84	0.92	0.30	0.77	0.86	0.11	0.56
nC_{31}	1.90	0.67	0.30	0.52	0.61	0.00	0.35
nC_{32}	0.82	0.42	0.10	0.13	0.18	0.00	0.21
nC_{33}	0.63	0.33	0.10	0.13	0.12	0.00	0.21
nC_{34}	0.32	0.25	0.10	0.06	0.12	0.00	0.14
nC_{35}	0.13	0.25	0.10	0.06	0.06	0.00	0.07
PARAFFIN	45.49	37.07	46.91	44.05	67.61	47.77	50.64
ISOPRENOID	5.77	7.04	4.83	3.38	3.65	9.18	4.78
NAPHTHENE	48.75	55.90	48.27	52.57	28.74	43.05	44.58
CPI INDEX A	1.03	0.92	1.12	1.08	1.07	1.06	1.07
CPI INDEX B	1.19	0.96	1.36	1.22	1.24	0.00	1.13
PRISTANE/PHYTANE	1.41	1.59	1.45	1.90	2.52	1.32	3.06
PRISTANE/nC_{17}	0.89	1.10	0.64	0.55	0.47	0.69	0.67

TABLE 8

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

GEOCHEM SAMPLE NUMBER	-267	-273	-277
DEPTH	4218m	4272m	4308
SAMPLE TYPE			
nC_{15}	2.89	9.95	0.09
nC_{16}	8.16	10.49	0.09
nC_{17}	10.27	10.56	0.92
nC_{18}	10.56	9.74	5.34
nC_{19}	10.70	9.26	11.05
nC_{20}	9.64	8.50	13.08
nC_{21}	8.52	7.41	13.81
nC_{22}	7.39	6.38	12.06
nC_{23}	6.83	5.56	12.06
nC_{24}	5.42	4.73	9.58
nC_{25}	5.42	4.39	9.58
nC_{26}	4.08	3.29	5.80
nC_{27}	4.01	3.22	3.50
nC_{28}	2.25	2.19	1.47
nC_{29}	2.04	1.78	0.64
nC_{30}	0.84	1.03	0.28
nC_{31}	0.49	0.69	0.18
nC_{32}	0.21	0.34	0.18
nC_{33}	0.14	0.27	0.09
nC_{34}	0.07	0.14	0.09
nC_{35}	0.07	0.07	0.09
PARAFFIN	56.06	61.70	46.17
ISOPRENOID	4.38	5.33	0.72
NAPHTHENE	39.57	32.97	53.10
CPI INDEX A	1.11	1.07	1.15
CPI INDEX B	1.28	1.18	1.30
PRISTANE/PHYTANE	3.27	3.06	0.70
PRITANE/nC_{17}	0.58	0.62	0.70

TABLE 9A

CARBON ISOTOPE VALUES
METHANE IN HEAD SPACE GAS
(^{o}/oo, PDB)

GEOCHEM SAMPLE NUMBER	DEPTH (METRES)	VALUE
630-005	980m	-49.50
630-015	1180m	-57.61
630-017	1220m	-63.29
630-039	1660m	CONTAMINATED
630-061	2100m	-60.80
630-189	3563m	-47.40
630-241	4031m	-45.80
630-271	4254m	-32.55*
630-273	4272m	-39.78*
630-287	4397m	-29.68*
630-293	4452m	-24.97*

*very small samples.

TABLE 9B

CARBON ISOTOPE VALUES
(^{o}/oo PDB)

GEOCHEM SAMPLE NUMBER	DEPTH (METRES)	SATURATES	AROMATICS
630-182A	3500m	-30.140	-29.494
630-189B	3563m	-30.564	-30.487

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 betwwen 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 (not 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 all 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 presence 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 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 ($\pm$ 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 organic 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, high 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 rock 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:

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

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

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) PYROLYSIS

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 pyrolsate. 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_{8+} 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 determing 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.

FIGURE 1a

$C_1 - C_7$ HYDROCARBONS

WELL 34/4-3

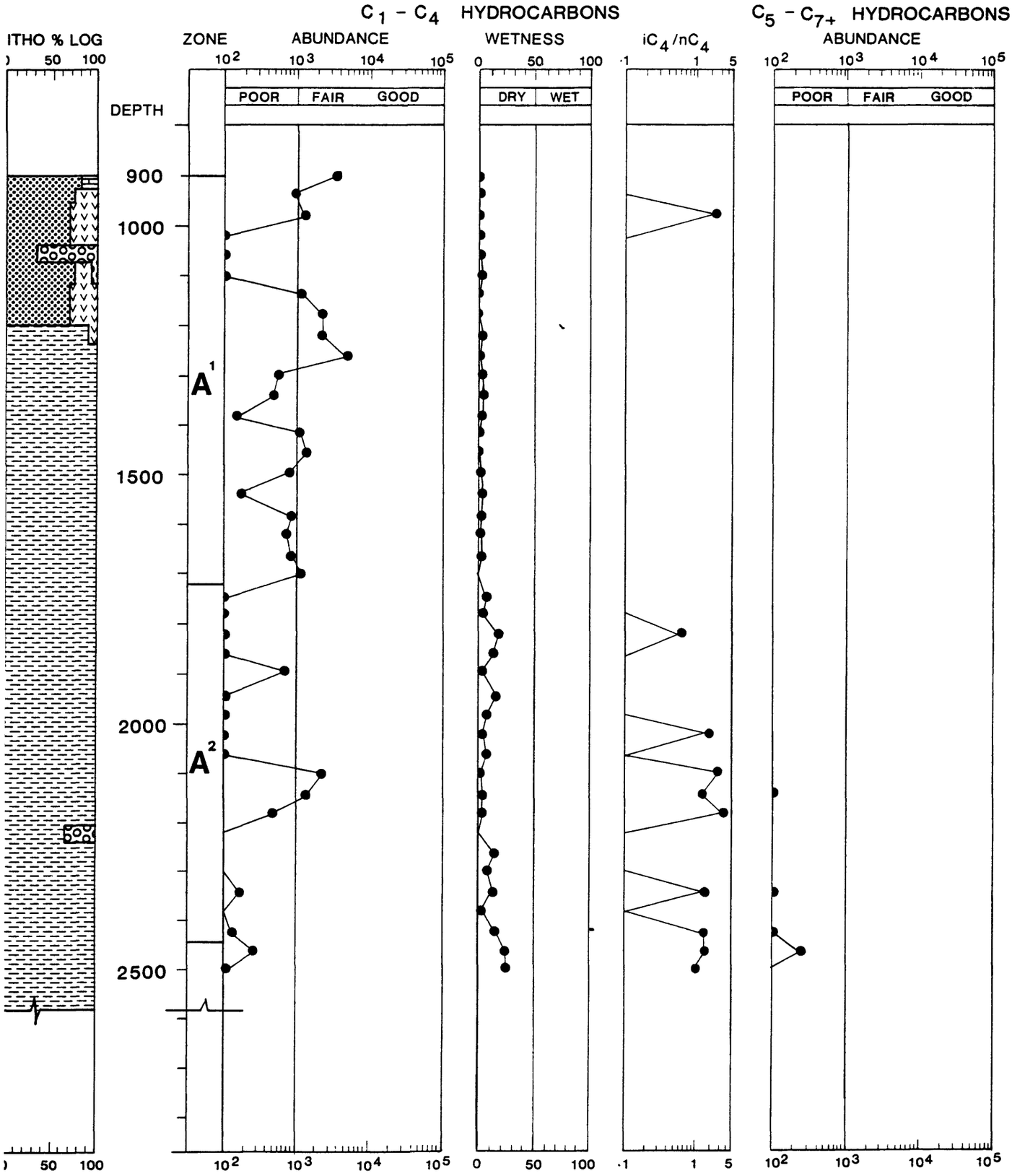
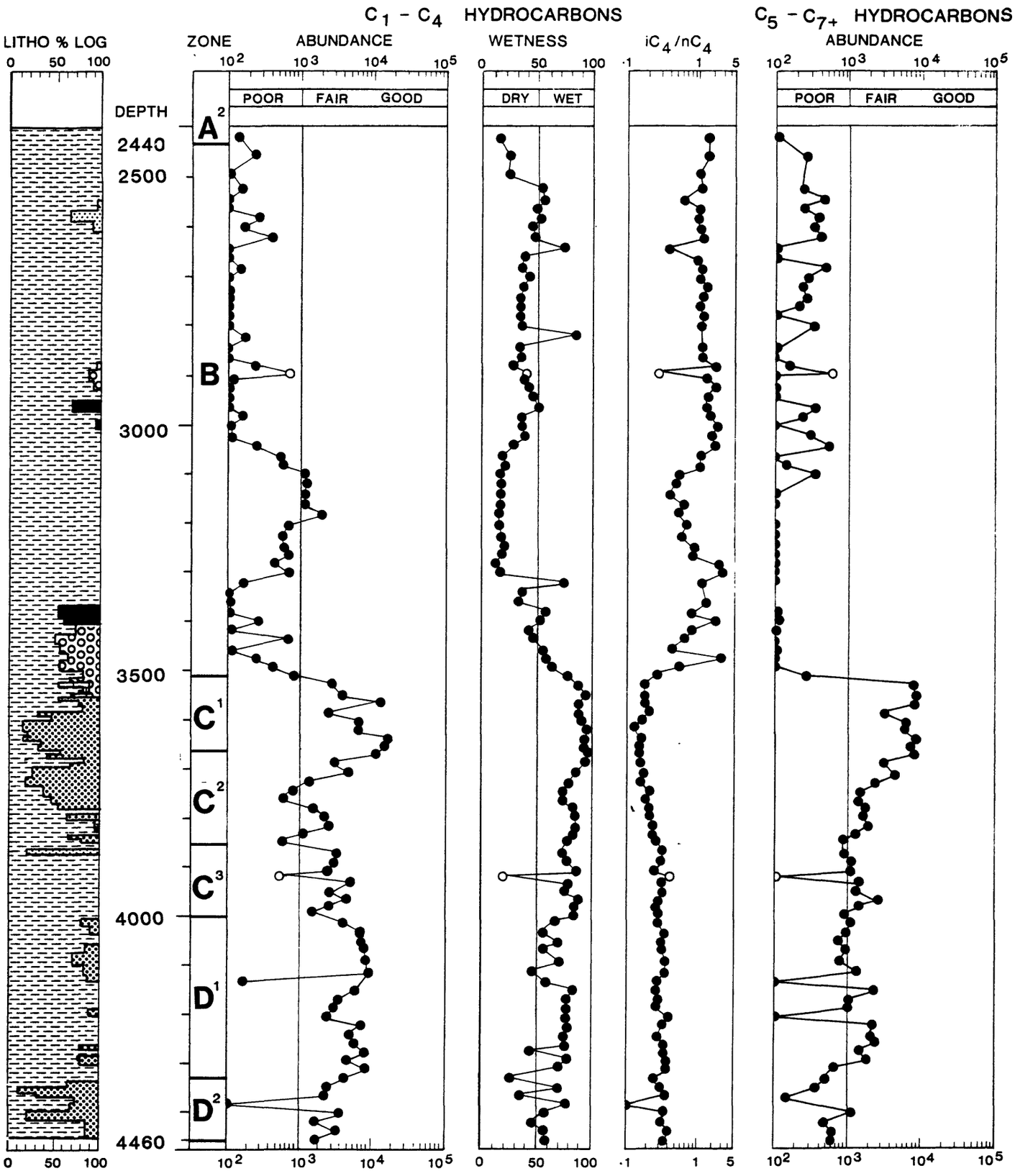


FIGURE 1b

C_1-C_7 HYDROCARBONS

WELL 34/4-3



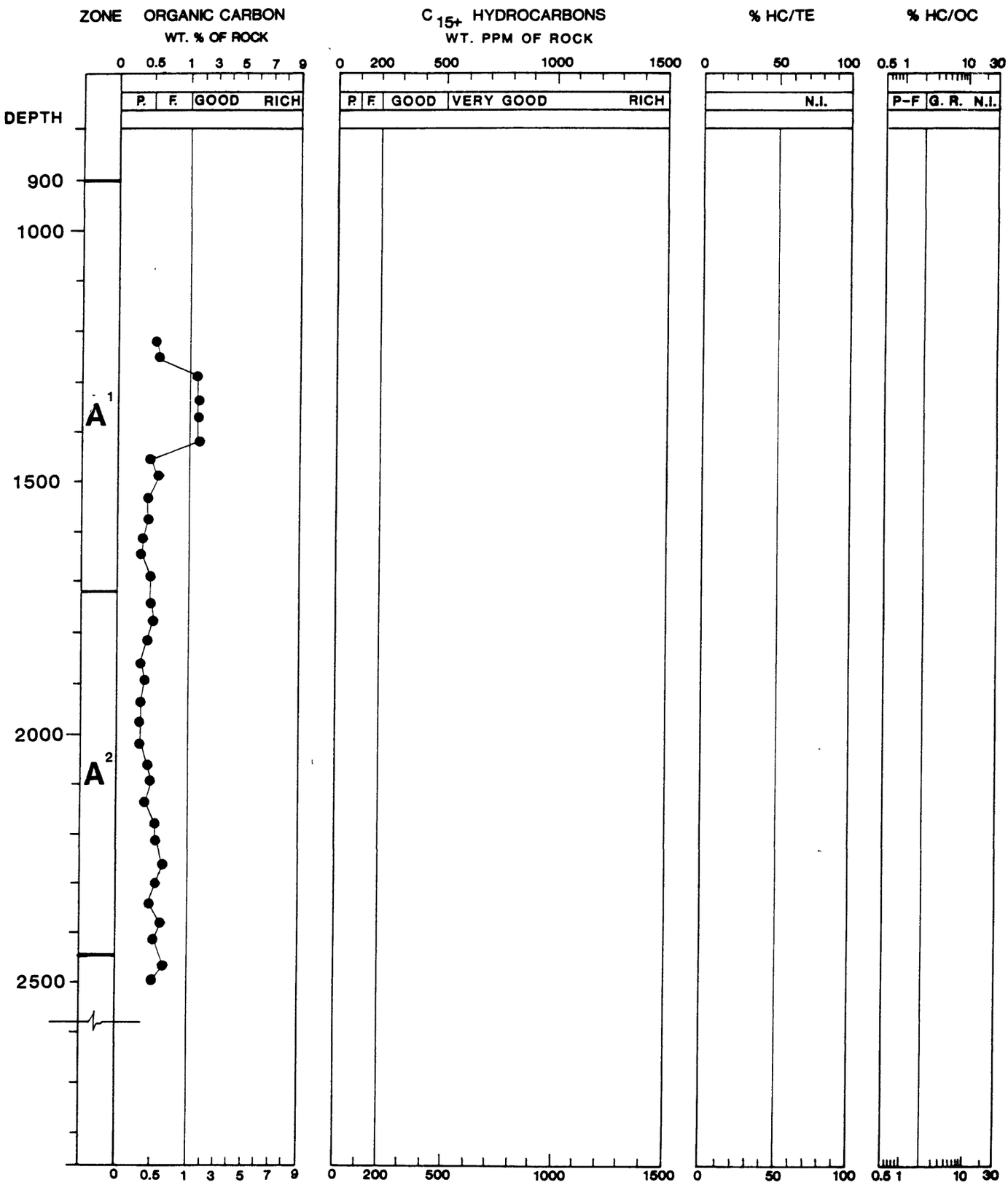
Carbonate
Shale/Mudstone
Siltstone
Evaporite
Sandstone/Sand
Coal
Igneous
L.C.M.
O MUD SAMPLE

iC_4 - ISOBUTANE
nC_4 - NORMAL BUTANE
ABUNDANCE - VOLUME PPM OF ROCK
WETNESS - % C_2-C_4 IN C_1-C_4

FIGURE 2a

RICHNESS

WELL 34/4-3

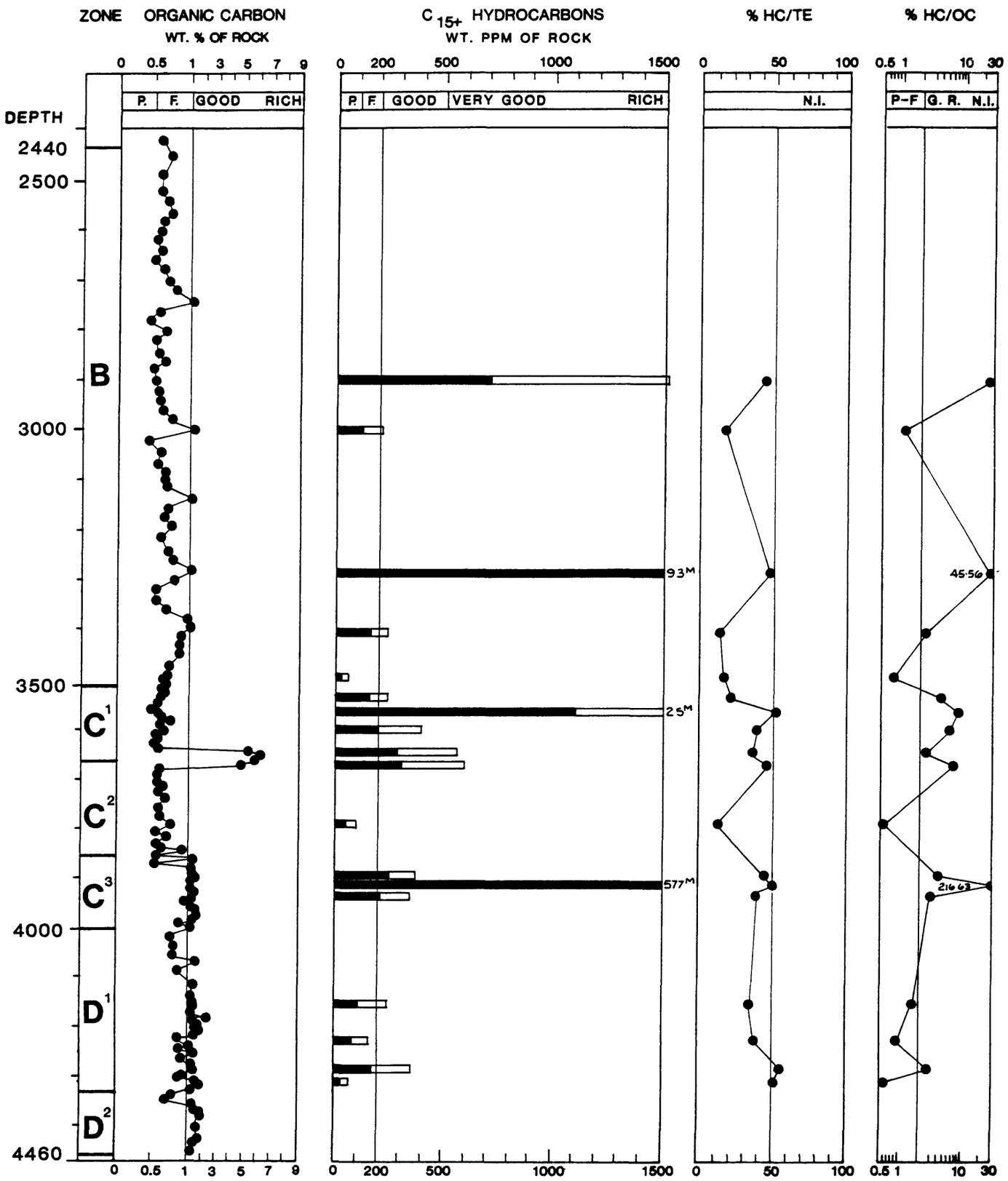


- ● SHALE
- ○ OTHER LITHOLOGIES

- 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 2b **RICHNESS** WELL 34/4-3

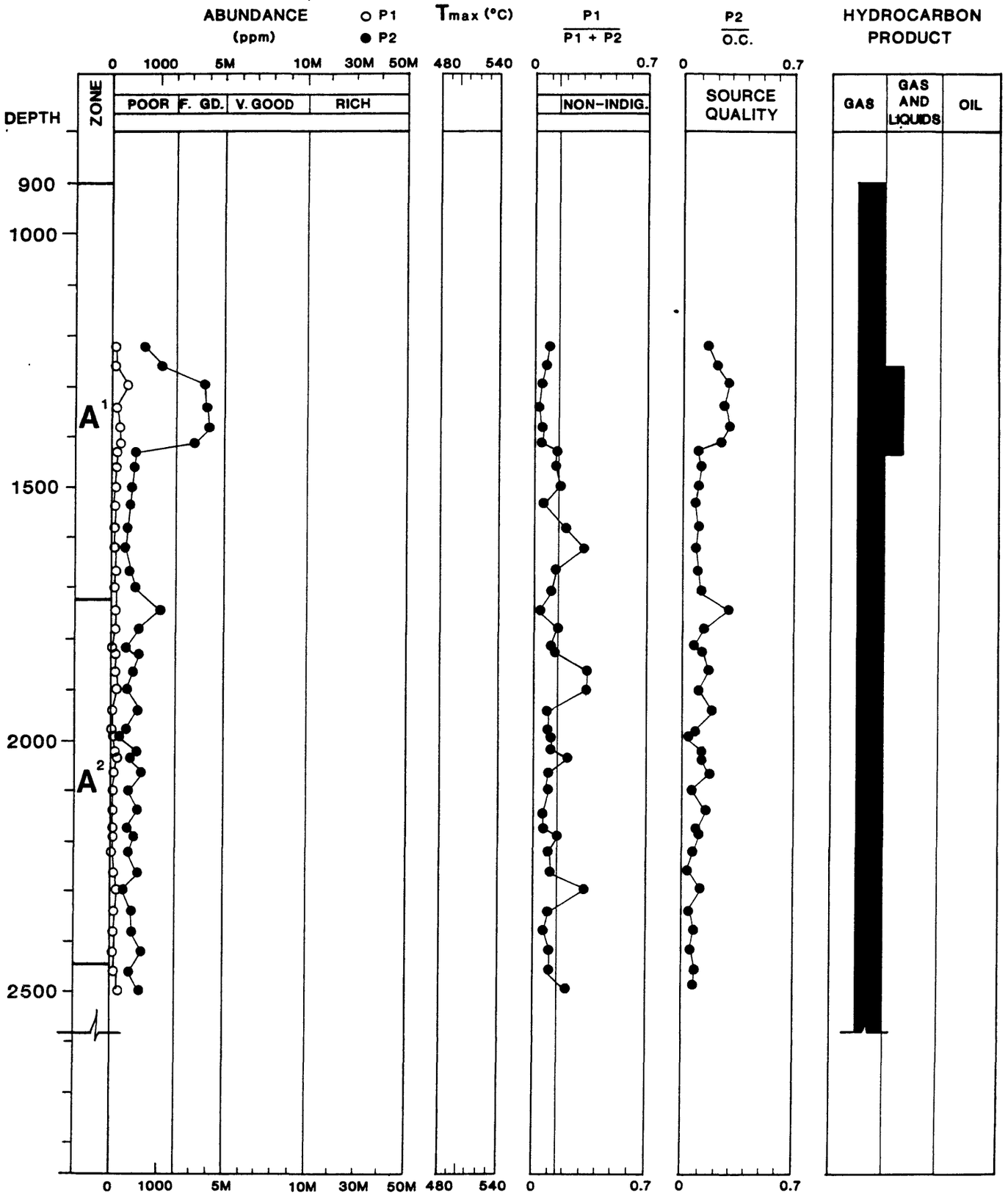


● SHALE
○ OTHER LITHOLOGIES

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 3a **PYROLYSIS** WELL 34/4-3



M - 1000

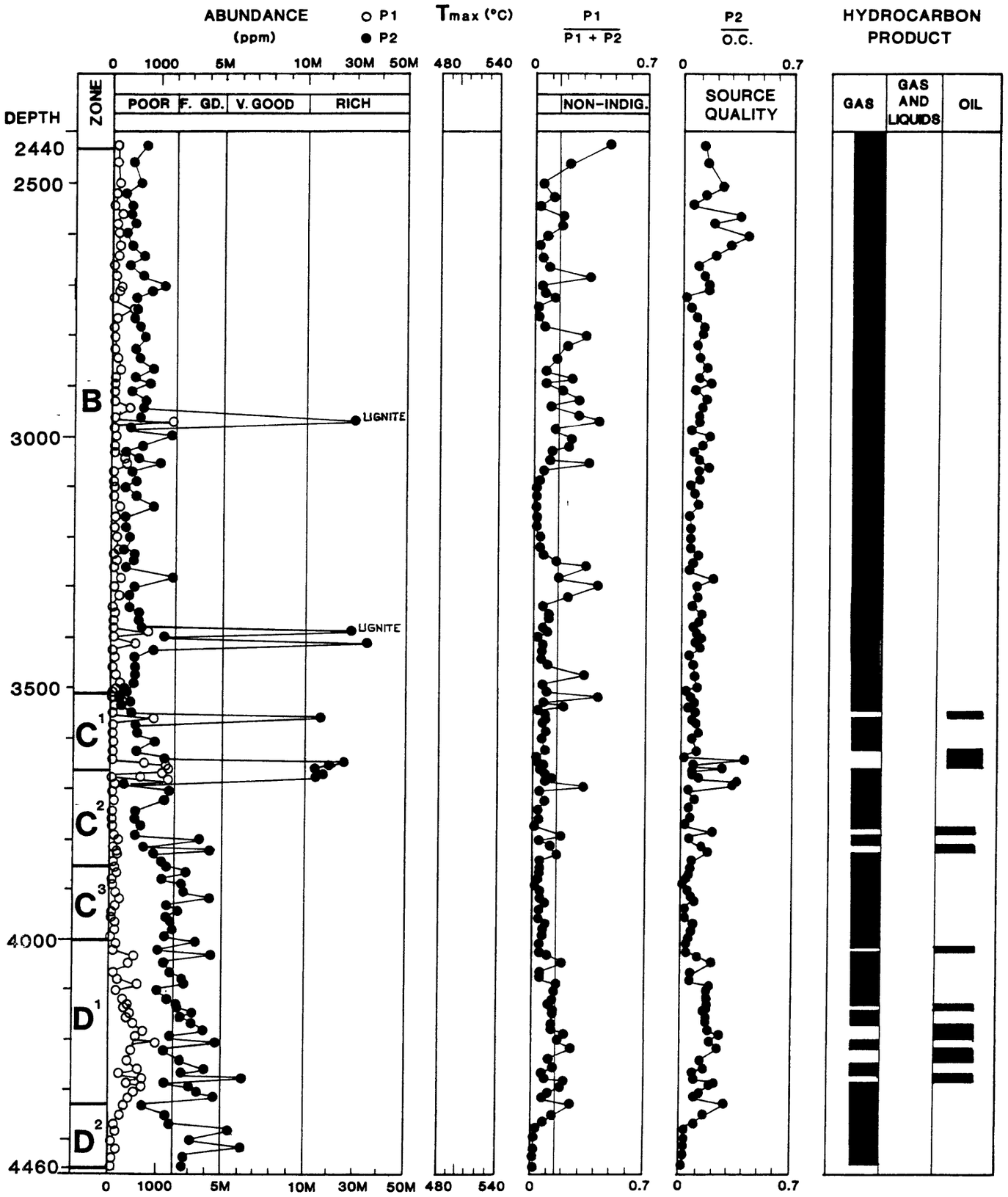
P1 — THERMAL BITUMEN

P2 — PYROLYSATE

O.C. — ORGANIC CARBON

NON-INDIG. — NON-INDIGENOUS HYDROCARBONS (SHOWS OR CONTAMINATION)

FIGURE 3b **PYROLYSIS** WELL 34/4-3



M - 1000

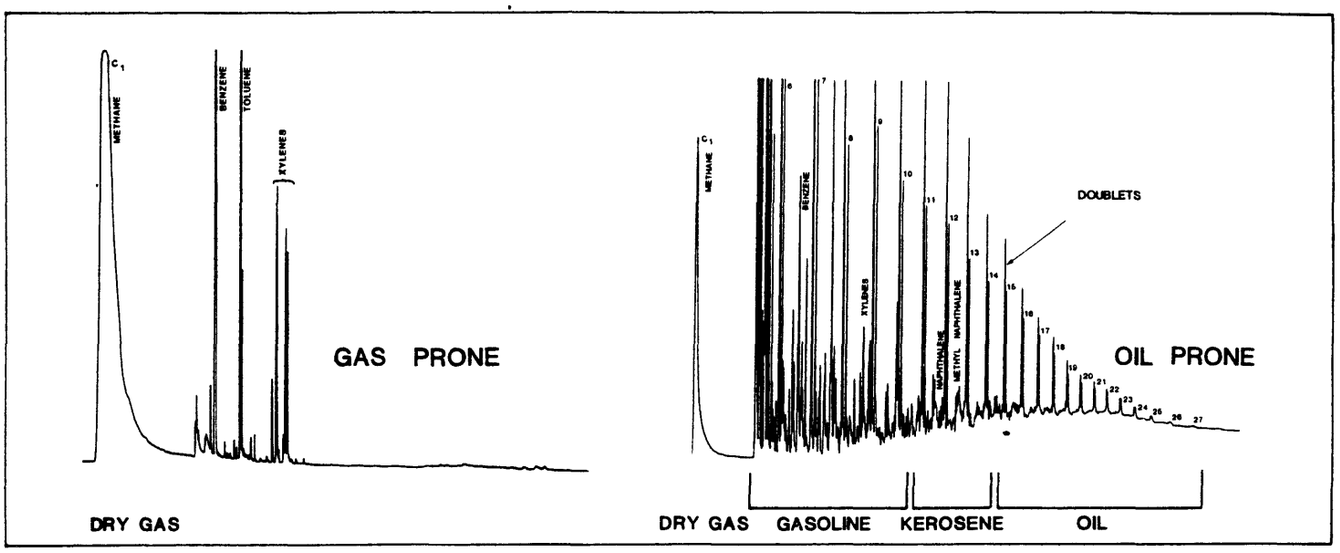
P1 — THERMAL BITUMEN

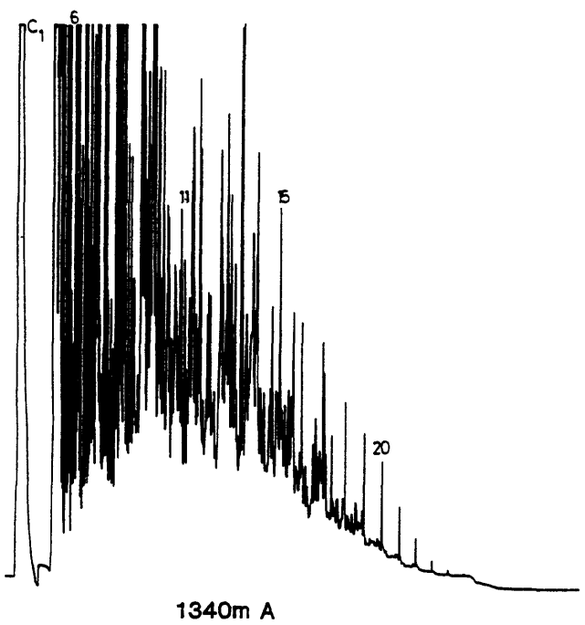
P2 — PYROLYSATE

O.C. — ORGANIC CARBON

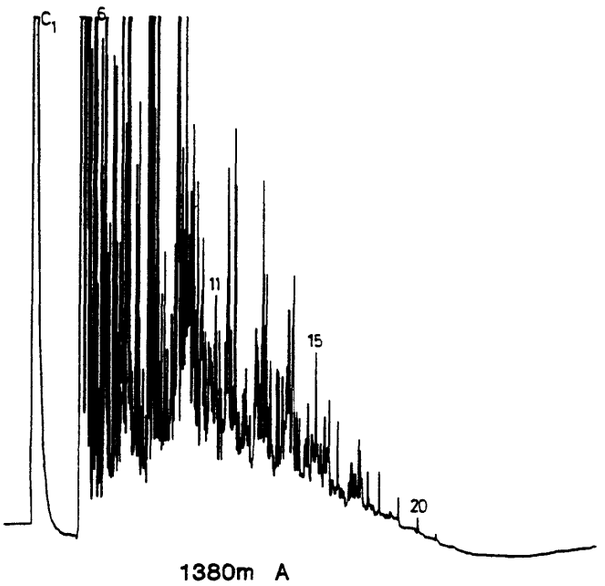
NON-INDIG. — NON-INDIGENOUS HYDROCARBONS (SHOWS OR CONTAMINATION)

FIGURE 4a **PYROLYSIS GC** WELL 34/4-3

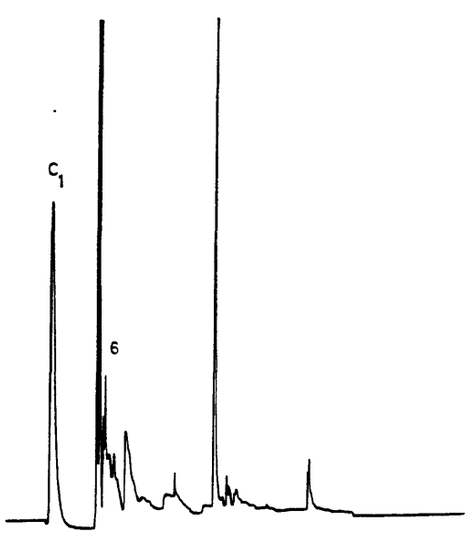




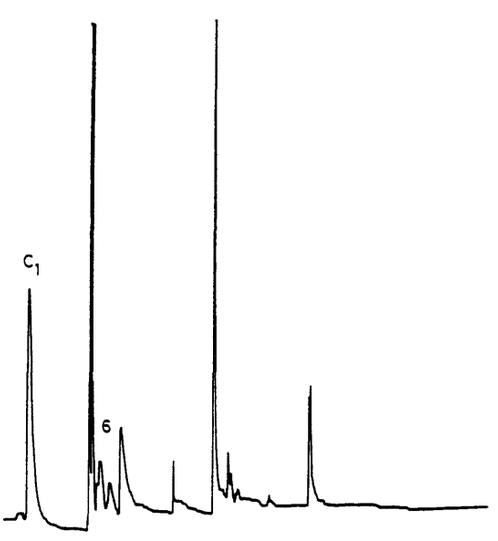
1340m A



1380m A

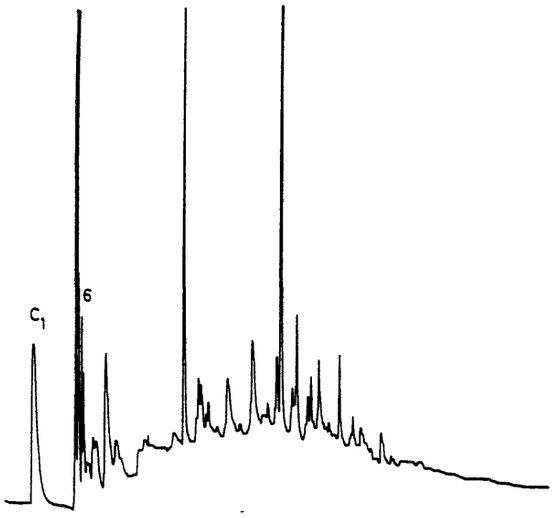


3000m A

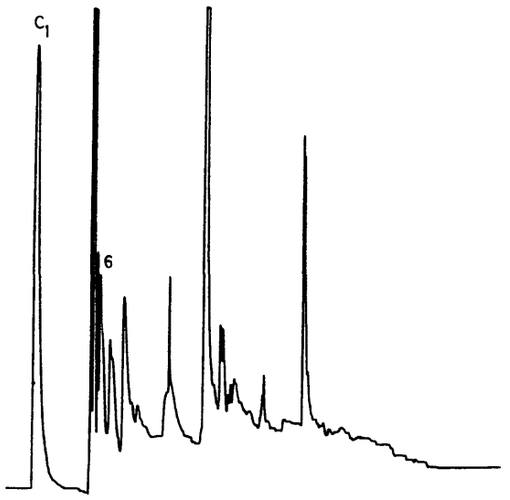


3280m A

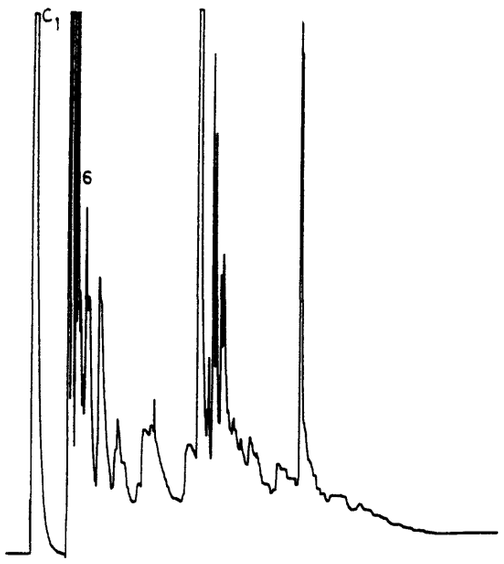
FIGURE 4b **PYROLYSIS GC** WELL 34/4-3



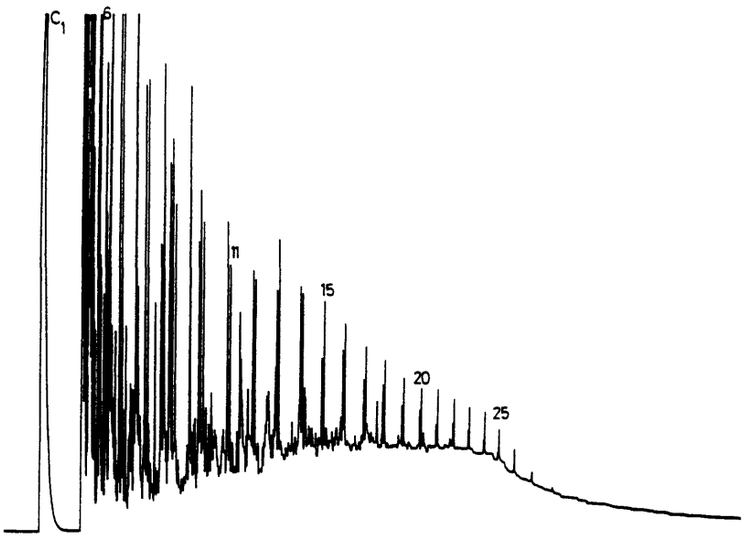
3400m A



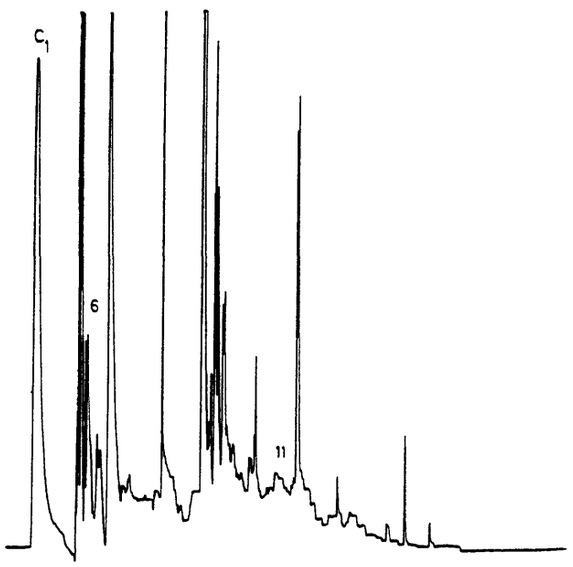
3500m A



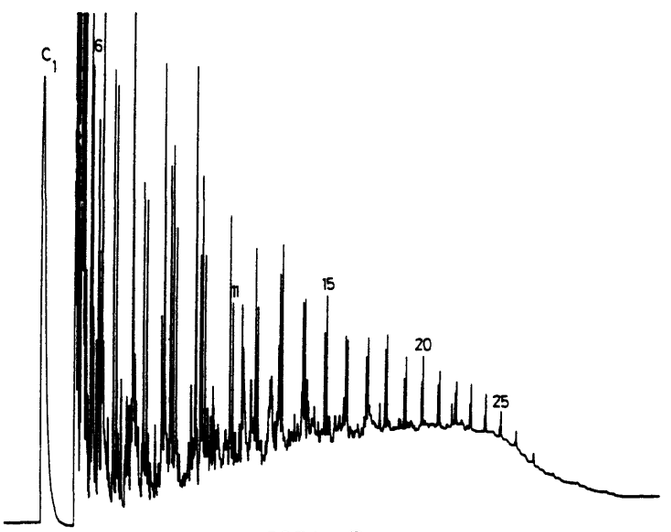
3527m A



3563m B

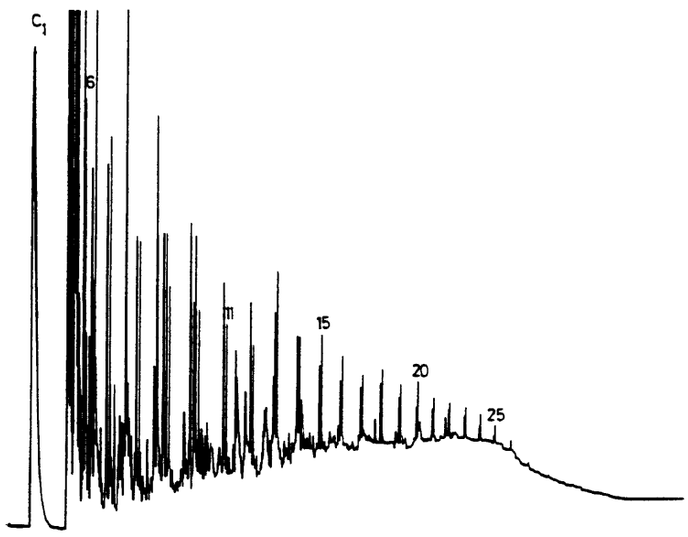


3599m B

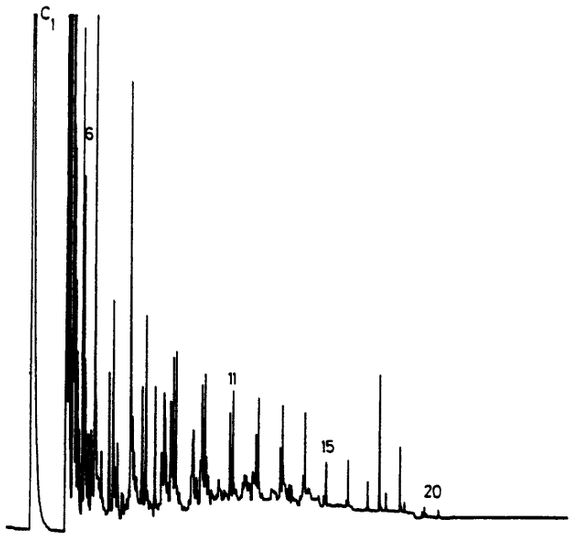


3651m B

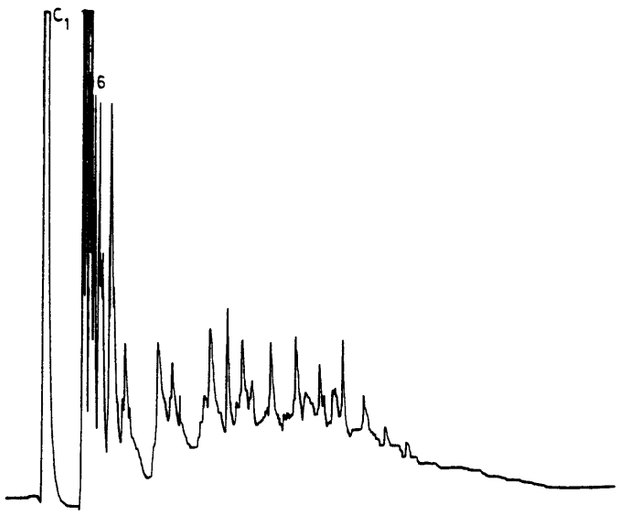
FIGURE 4c **PYROLYSIS GC** WELL 34/4-3



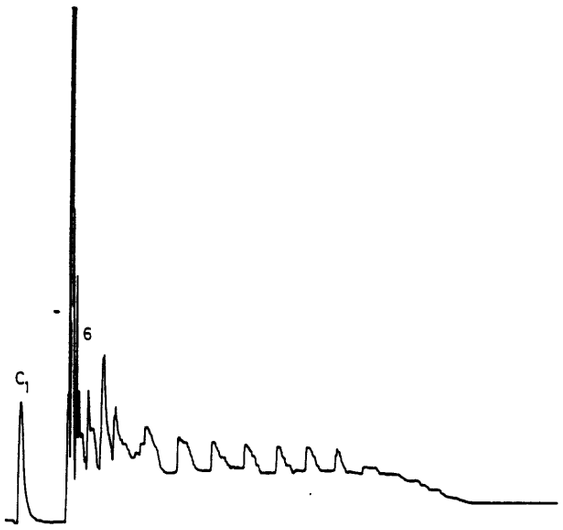
3669m B



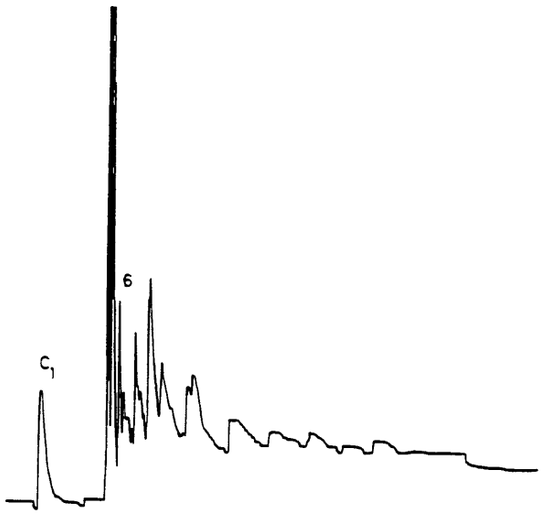
3794m B



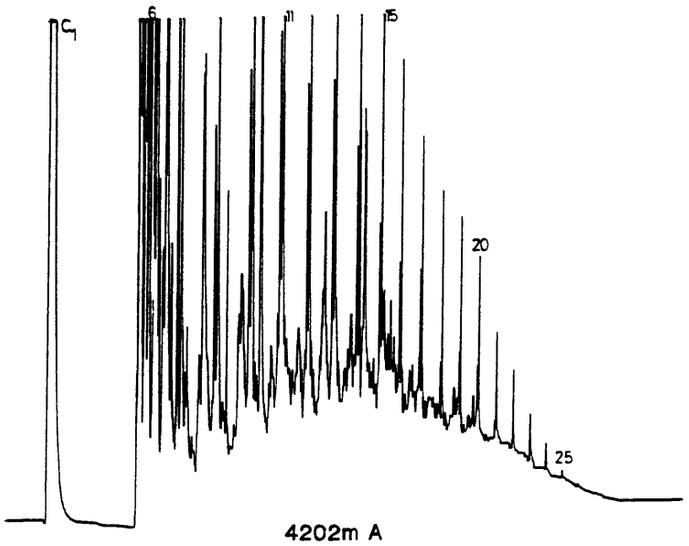
3894m A



3923m

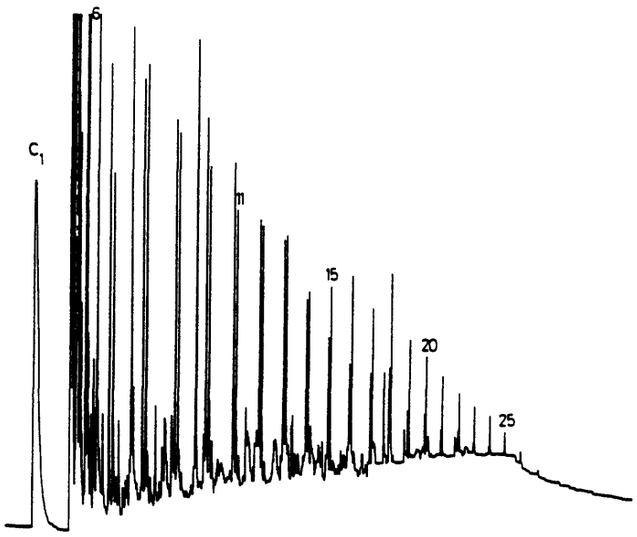


4148m

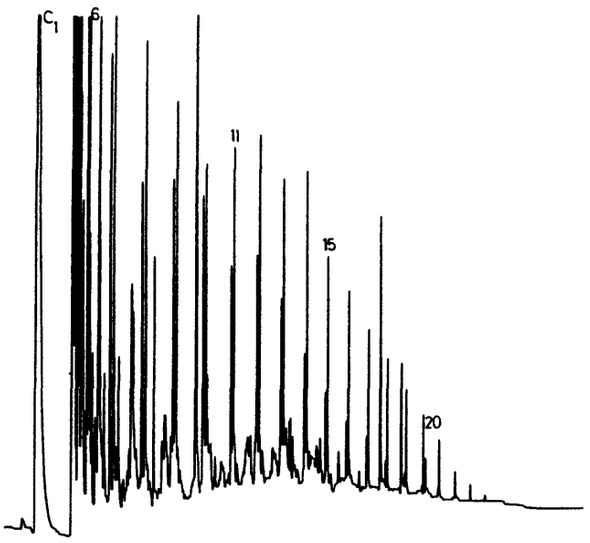


4202m A

FIGURE 4d **PYROLYSIS GC** WELL 34/4-3

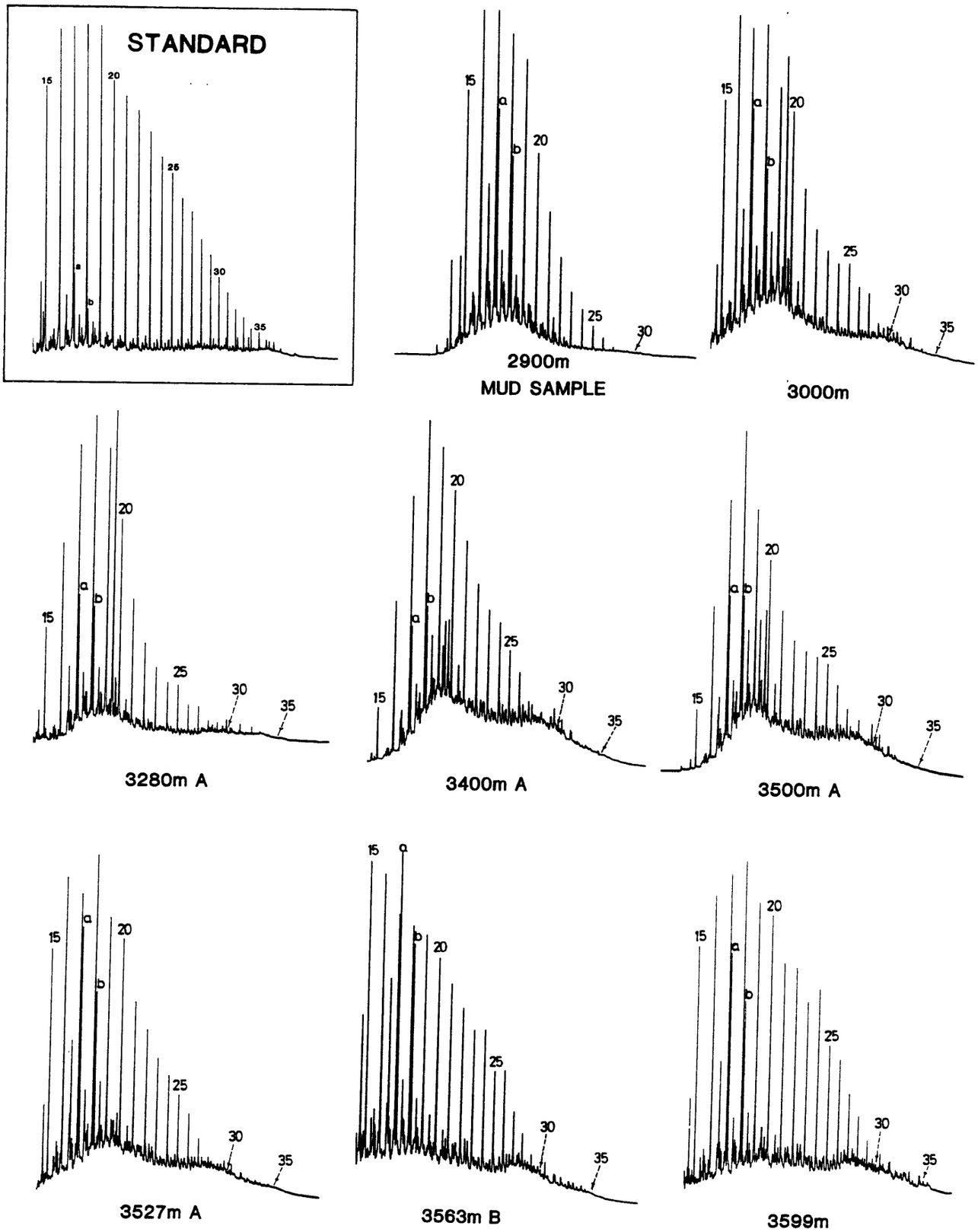


4272m B



4308m B

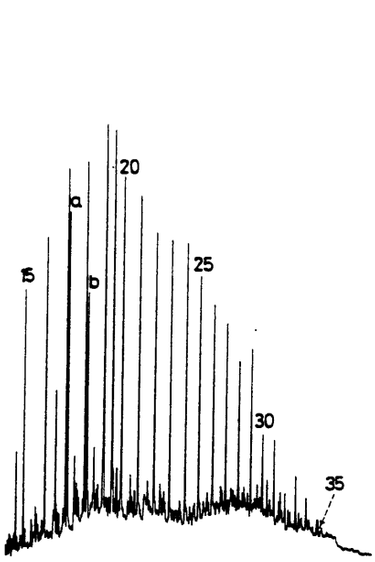
FIGURE 5a C_{15+} PARAFFIN-NAPHTHENES WELL 34/4-3



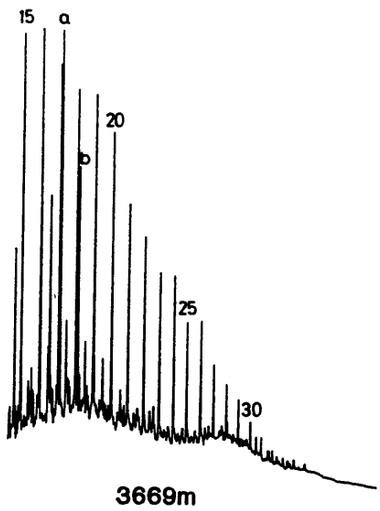
a - PRISTANE
b - PHYTANE

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

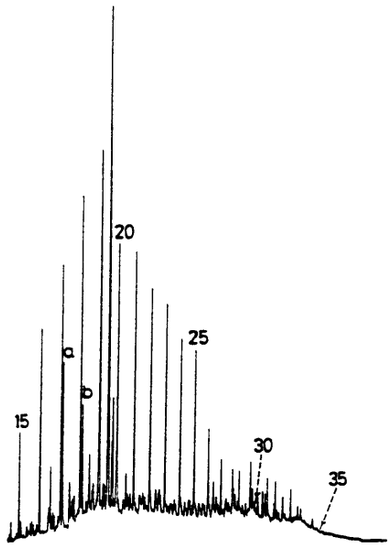
FIGURE 5b C_{15+} PARAFFIN - NAPHTHENES WELL 34/4-3



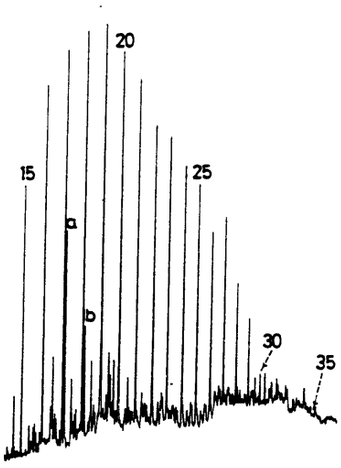
3651m



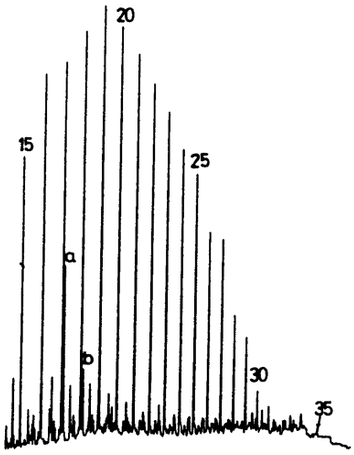
3669m



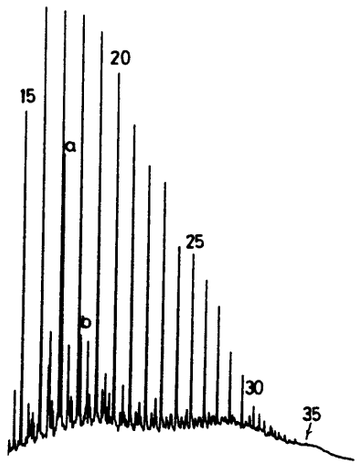
3794m



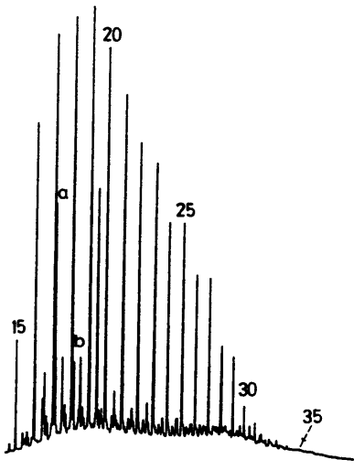
3894m



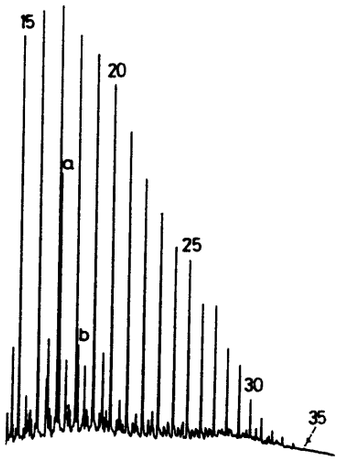
3923m



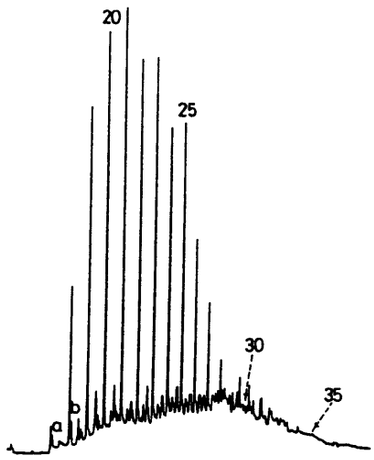
4148m



4218m



4272m

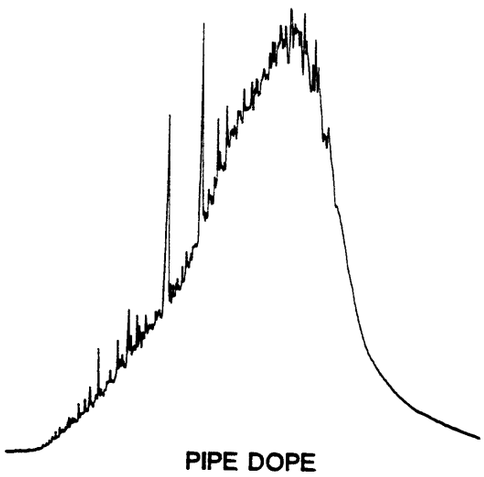


4308m

a - PRISTANE
b - PHYTANE

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

FIGURE 5c C_{15+} PARAFFIN - NAPHTHENES WELL 34/4-3



PIPE DOPE

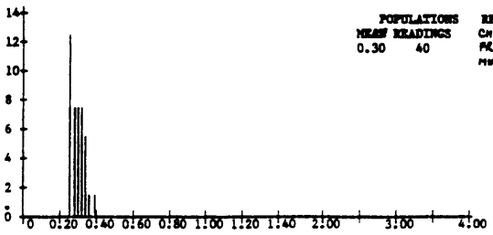
a - PRISTANE
b - PHYTANE

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

FIGURE 6a VITRINITE REFLECTANCE WELL 34/4-3

SAMPLE 630-131A DEPTH 3000 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.25 0.25 0.25 0.25 0.25 0.26 0.26 0.26 0.26 0.26
0.27 0.27 0.28 0.28 0.28 0.28 0.28 0.28 0.29 0.30
0.30 0.30 0.30 0.30 0.31 0.31 0.32 0.32 0.32 0.33
0.33 0.33 0.33 0.34 0.34 0.34 0.35 0.35 0.36 0.39

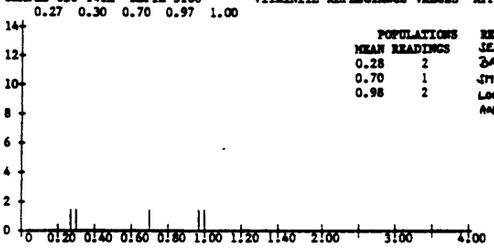


POPULATIONS MEAN READINGS	
0.30	40

REMARKS: CHIEFLY VITRINITE FREQUENT INERTINITE MINOR EXINITE.

SAMPLE 630-141A DEPTH 3100 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.27 0.30 0.70 0.97 1.00

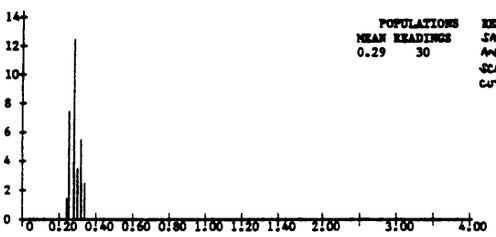


POPULATIONS MEAN READINGS	
0.28	2
0.70	1
0.98	2

REMARKS: SEDIMENT APPARENTLY BARREN. SEVERAL SMALL, POOR QUALITY LOOSE PARTICLES SEEN AND MEASURED.

SAMPLE 630-151A DEPTH 3200 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.24 0.25 0.26 0.26 0.26 0.27 0.27 0.27 0.28 0.28
0.28 0.28 0.28 0.28 0.29 0.29 0.29 0.29 0.29 0.29
0.30 0.31 0.31 0.32 0.32 0.32 0.32 0.33 0.34 0.35

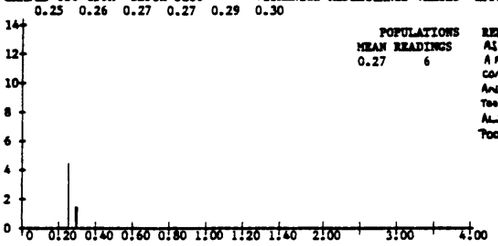


POPULATIONS MEAN READINGS	
0.29	30

REMARKS: SAMPLE TUMBLE-MILLED AND APPARENTLY BARREN SCATTERED SMALL LIGNITE CUTTINGS.

SAMPLE 630-159A DEPTH 3280 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.25 0.26 0.27 0.27 0.29 0.30

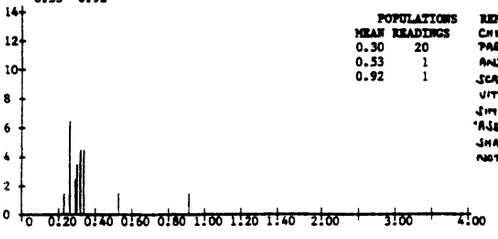


POPULATIONS MEAN READINGS	
0.27	6

REMARKS: AS 630-151A A FEW LEAN CUTTINGS CONTAINING INERTINITE AND TINY VITRINITE SCRAPS TOO SMALL FOR MEASUREMENT ALSO PRESENT. POOR SAMPLE

SAMPLE 630-171A DEPTH 3400 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.23 0.26 0.26 0.27 0.27 0.27 0.27 0.29 0.29 0.30
0.31 0.31 0.32 0.32 0.32 0.32 0.34 0.34 0.35 0.35
0.53 0.92

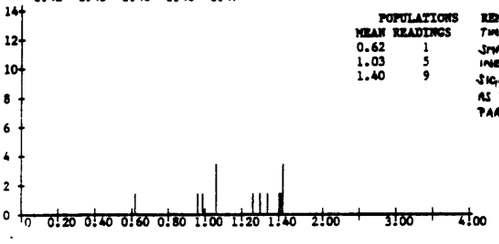


POPULATIONS MEAN READINGS	
0.30	20
0.53	1
0.92	1

REMARKS: CHIEFLY SMALL POOR PARTICLES OF INERTINITE AND REWORKED VITRINITE SCATTERED LIGNITE PLUS VITRINITE PARTICLES OF SIMILAR REFLECTANCE "ASSOCIATED" WITH THE SHALE ALTHOUGH POSSIBLY NOT IN SITU

SAMPLE 630-182A DEPTH 3500 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.62 0.96 0.99 1.06 1.06 1.07 1.26 1.30 1.34 1.41
1.42 1.45 1.46 1.46 1.47

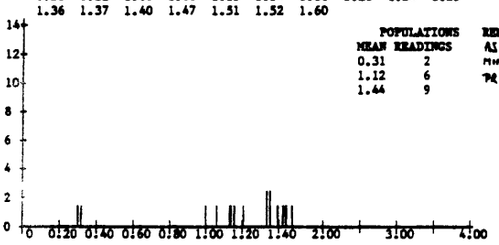


POPULATIONS MEAN READINGS	
0.62	1
1.03	5
1.40	9

REMARKS: TINY SCRAPS AND SMALL PARTICLES OF INERTINITE CHIEFLY SIGNIFICANT VITRINITE AS POOR REWORKED PARTICLES

SAMPLE 630-193B DEPTH 3599 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.30 0.32 1.00 1.06 1.13 1.14 1.16 1.21 1.34 1.35
1.36 1.37 1.40 1.47 1.51 1.52 1.60

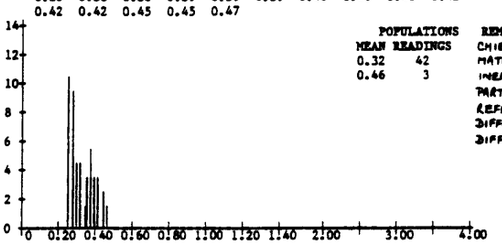


POPULATIONS MEAN READINGS	
0.31	2
1.12	6
1.44	9

REMARKS: AS 630-182A MINOR LIGNITE ALSO PRESENT

SAMPLE 630-201B DEPTH 3669 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.25 0.25 0.25 0.26 0.26 0.26 0.26 0.27 0.27 0.27
0.28 0.28 0.28 0.29 0.29 0.29 0.29 0.29 0.29 0.30
0.31 0.31 0.31 0.32 0.33 0.33 0.33 0.35 0.36 0.36
0.36 0.38 0.38 0.39 0.39 0.39 0.40 0.40 0.41 0.42
0.42 0.42 0.45 0.45 0.47

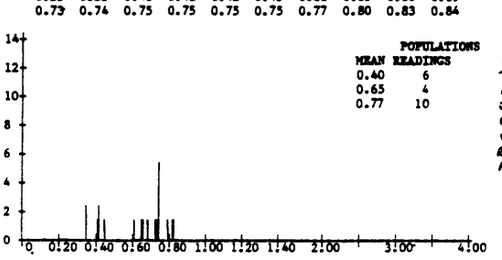


POPULATIONS MEAN READINGS	
0.32	42
0.46	3

REMARKS: CHIEFLY ALGAL/AMORPHOUS MATERIAL FREQUENT INERTINITE AND VITRINITE PARTICLES OF VARIABLE REFLECTANCE DIFFERENTIATION RATHER DIFFICULT

SAMPLE 630-215A DEPTH 3794 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.35 0.35 0.41 0.42 0.42 0.45 0.61 0.65 0.66 0.69
0.73 0.74 0.75 0.75 0.75 0.75 0.77 0.80 0.83 0.84

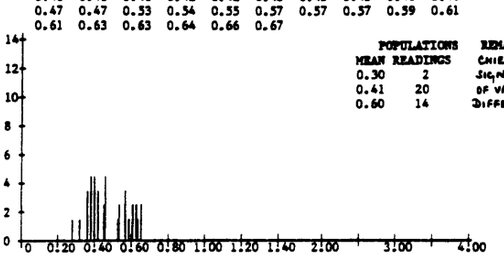


POPULATIONS MEAN READINGS	
0.40	6
0.65	4
0.77	10

REMARKS: FREQUENTLY GRADED PARTICLES OF INERTINITE AND REWORKED VITRINITE OCCASIONAL CUTTINGS CONTAINING FEBRUHER VITRINITE AND OTHERS RICH IN BITUMEN STAINING ALSO APPARENT

SAMPLE 630-226A DEPTH 3894 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.28 0.32 0.36 0.37 0.37 0.38 0.38 0.38 0.39 0.40
0.41 0.41 0.41 0.42 0.42 0.43 0.45 0.45 0.46 0.46
0.47 0.47 0.53 0.54 0.55 0.57 0.57 0.57 0.59 0.61
0.61 0.63 0.63 0.64 0.66 0.67



POPULATIONS MEAN READINGS	
0.30	2
0.41	20
0.60	14

REMARKS: CHIEFLY INERTINITE. SIGNIFICANT VITRINITE OF VARIABLE REFLECTANCE. DIFFERENTIATION DIFFICULT

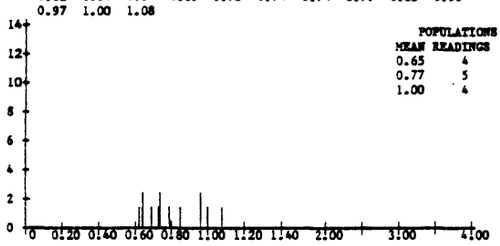
FIGURE 6b VITRINITE REFLECTANCE WELL 34/4-3

SAMPLE 630-237A DEPTH 3995 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.62 0.64 0.64 0.69 0.73 0.74 0.74 0.79 0.85 0.96
0.97 1.00 1.08

POPULATIONS MEAN	READINGS
0.65	4
0.77	5
1.00	4

REMARKS
GENERALLY CHARLED POOR PARTICLES OF INERTINITE AND RENDERED VITRINITE. SEVERAL POOR QUALITY PARTICLES OF VARIABLE REFLECTANCE MEASURED.

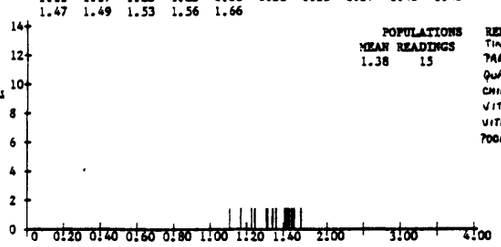


SAMPLE 630-255A DEPTH 4112 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

1.11 1.17 1.23 1.25 1.31 1.32 1.35 1.37 1.43 1.45
1.47 1.49 1.53 1.56 1.66

POPULATIONS MEAN	READINGS
1.38	15

REMARKS
TINY SLIVERS AND SMALL PARTICLES OF VERY POOR QUALITY, CHARLED INERTINITE CHIEFLY PLUS RENDERED VITRINITE. NO INDIGENOUS VITRINITE SEEN. POOR SAMPLE.

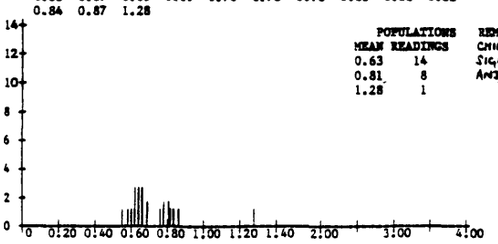


SAMPLE 630-260B DEPTH 4157 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.55 0.58 0.60 0.62 0.62 0.63 0.64 0.64 0.64 0.66
0.66 0.67 0.69 0.69 0.76 0.78 0.78 0.81 0.81 0.82
0.84 0.87 1.28

POPULATIONS MEAN	READINGS
0.63	14
0.81	8
1.28	1

REMARKS
CHIEFLY INERTINITE. SIGNIFICANT VITRINITE AND BITUMEN STAINING.

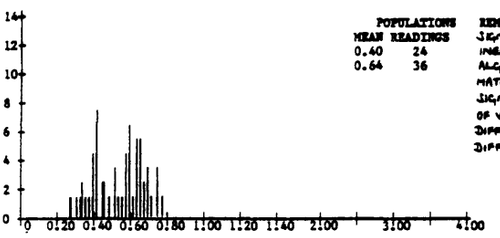


SAMPLE 630-265A DEPTH 4202 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.27 0.28 0.31 0.33 0.34 0.35 0.36 0.38 0.40 0.40
0.40 0.41 0.42 0.42 0.42 0.42 0.43 0.43 0.43 0.45
0.45 0.46 0.47 0.49 0.52 0.53 0.53 0.54 0.56 0.58
0.58 0.59 0.59 0.60 0.60 0.61 0.61 0.61 0.61 0.62
0.64 0.64 0.64 0.65 0.65 0.66 0.66 0.66 0.66 0.67
0.68 0.69 0.70 0.71 0.71 0.72 0.75 0.75 0.76 0.78

POPULATIONS MEAN	READINGS
0.60	24
0.64	36

REMARKS
SIGNIFICANT TO MAJOR INERTINITE. FREQUENT ALGAL/AMORPHOUS MATERIAL AND EXINITE. SIGNIFICANT VITRINITE OF VARIABLE REFLECTANCE. DIFFERENTIATION OCCASIONALLY DIFFICULT.

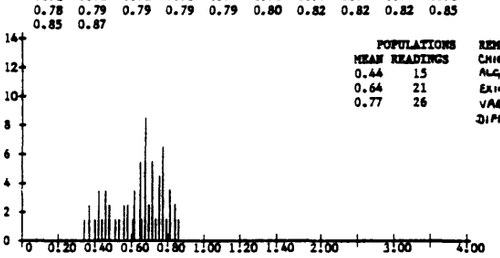


SAMPLE 630-277B DEPTH 4308 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.34 0.37 0.37 0.40 0.42 0.42 0.42 0.44 0.46 0.46
0.47 0.48 0.49 0.51 0.53 0.56 0.56 0.58 0.59 0.61
0.62 0.63 0.63 0.65 0.65 0.65 0.65 0.65 0.66 0.68
0.68 0.68 0.68 0.68 0.68 0.68 0.69 0.70 0.71 0.72
0.72 0.72 0.72 0.73 0.74 0.76 0.77 0.77 0.77 0.78
0.78 0.79 0.79 0.79 0.79 0.80 0.82 0.82 0.82 0.85
0.85 0.87

POPULATIONS MEAN	READINGS
0.44	15
0.64	21
0.77	26

REMARKS
CHIEFLY INERTINITE. SIGNIFICANT ALGAL/AMORPHOUS MATERIAL, EXINITE AND VITRINITE OF VARIABLE REFLECTANCE. DIFFERENTIATION OFTEN DIFFICULT.



SAMPLE 630-287A DEPTH 4397 VITRINITE REFLECTANCE VALUES APPEARANCE IN UV

0.63 0.64 0.64 0.65 0.66 0.67 0.67 0.67 0.67 0.67
0.67 0.68 0.68 0.69 0.69 0.71 0.71 0.71 0.71 0.72
0.72 0.72 0.74 0.74 0.75 0.75 0.76 0.76 0.77 1.20

POPULATIONS MEAN	READINGS
0.70	29
1.20	1

REMARKS
SMALL CHARLED POOR QUALITY PARTICLES OF INERTINITE AND RENDERED VITRINITE IN THE MAJORITY OF CUTTINGS. OCCASIONAL BETTER VITRINITE PARTICLES AND LIPTS IN A FEW CUTTINGS.

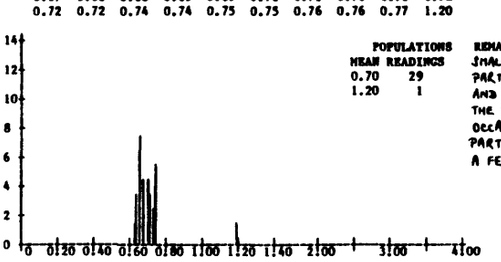
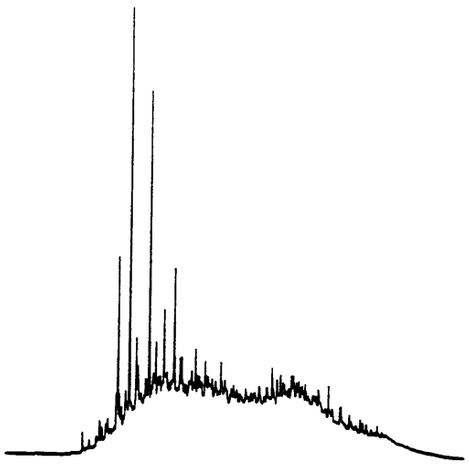
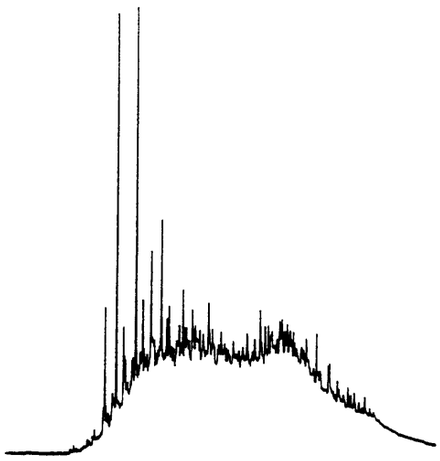


FIGURE 7 C_{15+} BRANCHED/CYCLICS WELL 34/4-3



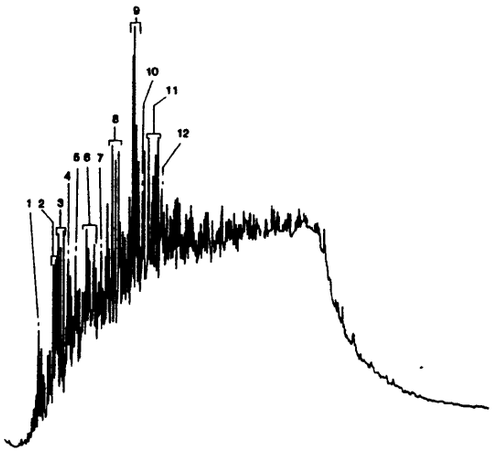
3500m A

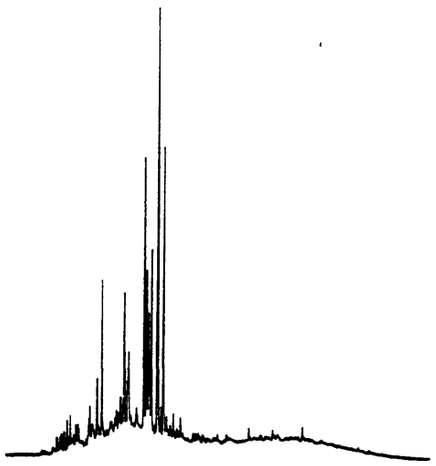


3563m B

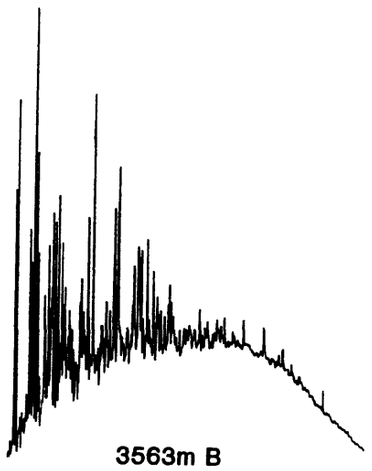
FIGURE 8 **AROMATICS** WELL 34/4-3

1 Dimethylnaphthalene
2 C_3 Benzothiophenes
3 Trimethylnaphthalenes
4 C_5 Benzothiophenes
5 Dibenzothiophene
6 C_5 Benzothiophenes
7 C_6 Benzothiophenes
8 Methyldibenzothiophenes
9 C_2 Dibenzothiophenes
10 Dimethylphenanthrene
11 C_3 Dibenzothiophenes
12 C_4 Dibenzothiophenes

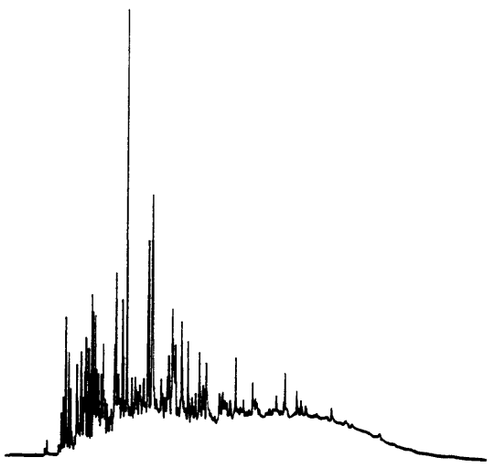




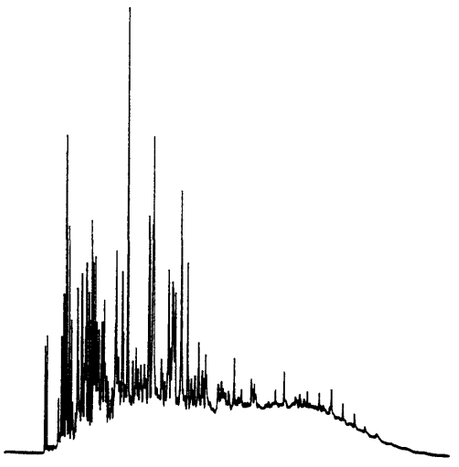
3500m A



3563m B

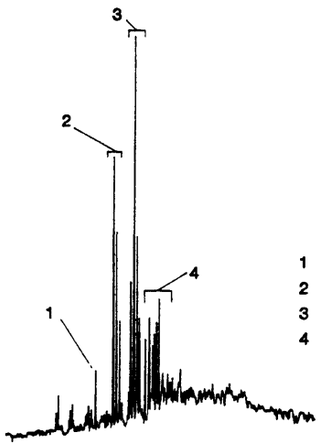


3923m

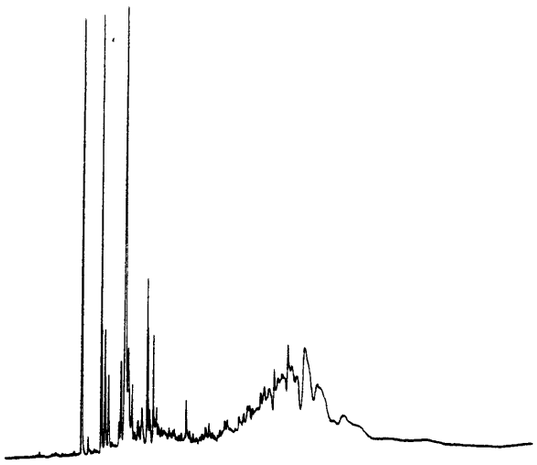


4272m

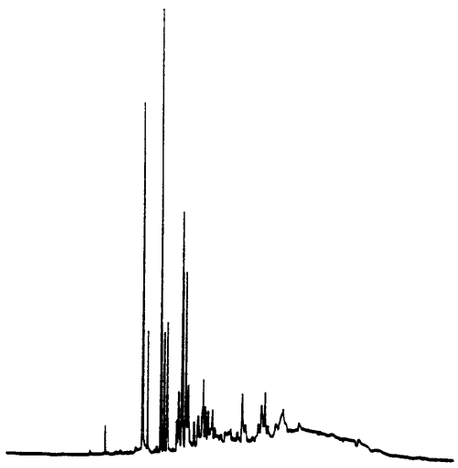
FIGURE 9 **SULPHUR AROMATICS** WELL 34/4-3



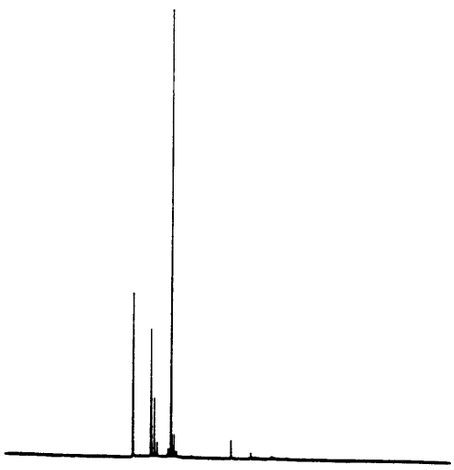
1 Dibenzothiophenes
2 Methyldibenzothiophenes
3 C_2 Alkyldibenzothiophenes
4 C_3 Alkyldibenzothiophenes



3500m A



3563m B

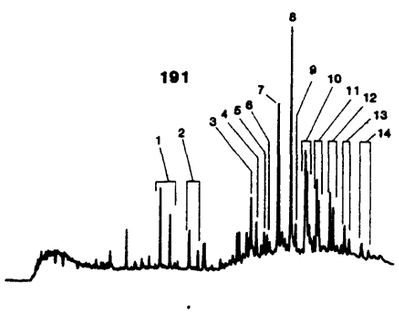


3923m

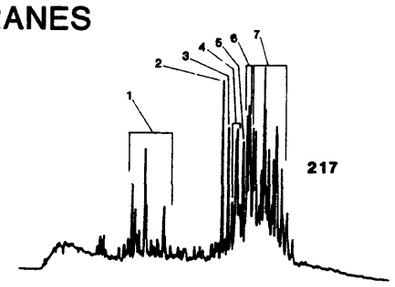
4272m

FIGURE 10a **MASSFRAGMENTOGRAMS** WELL 34/4-3

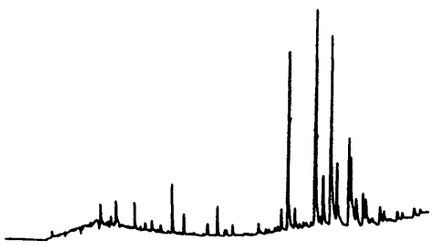
TERPANES & STERANES

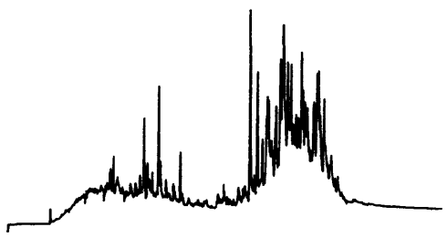


1 TRICYCLIC TERPANES C_{28}
2 TRICYCLIC TERPANES C_{29}
3 17 α H TRISNORHOPANE C_{27}
4 17 β H TRISNORHOPANE C_{27}
5 17 α H 28NORHOPANE C_{29}
6 17 β H 28NORHOPANE C_{29}
7 17α(H) 21β(H), NORHOPANE C_{29}
8 17α(H), 21β(H) HOPANE C_{30}
9 C_{30} MORETANE
10 22S/22R 17α(H),21β HOMOHOPANES C_{31}
11 22S/22R 17α(H),21 β 28NORHOPANES C_{32}
12 22S/22R 17α(H),21β TRISNORHOPANES C_{33}
13 22S/22R 17α(H),21 β TETRAHOPANES C_{34}
14 22S/22R HOPANES C_{35}

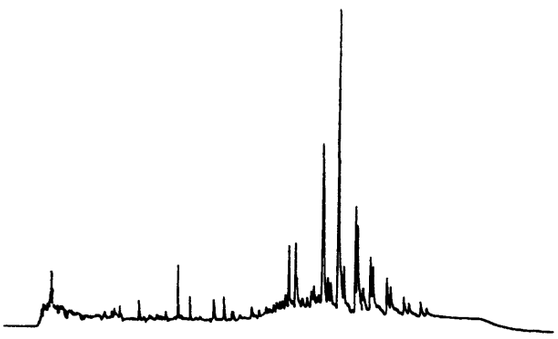


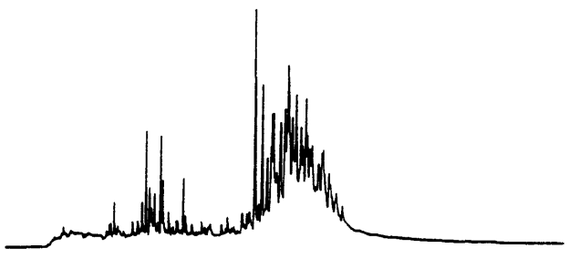
1 UNIDENTIFIED
2 5α CHOLESTANES
3 5β CHOLESTANES
4 CHOLESTANE TYPE
5 ERGOSTANE TYPE
6 CHOLESTANE TYPE
7 STIGMASTANE TYPE



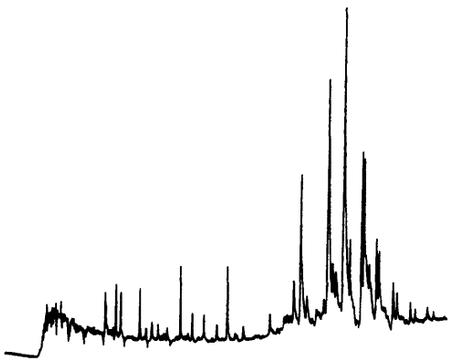


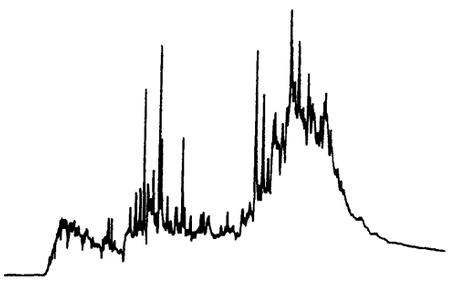
3500m





3563m

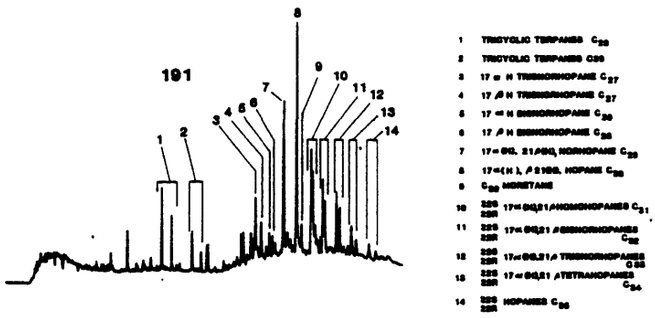




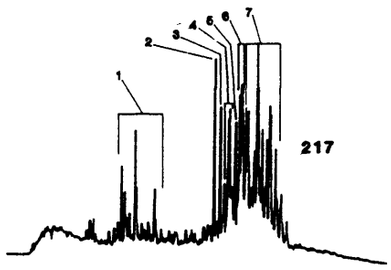
3923m

FIGURE 10b **MASSFRAGMENTOGRAMS** WELL 34/4-3

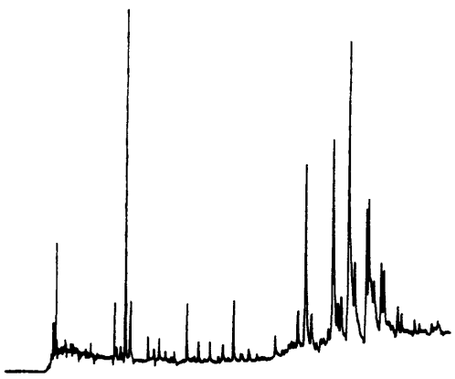
TERPANES & STERANES

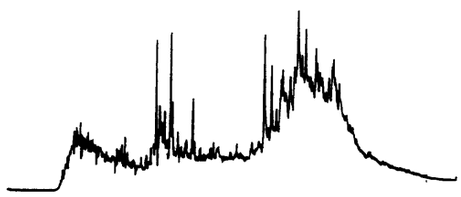


1 TRICYCLIC TERPANES C_{23}
2 TRICYCLIC TERPANES C24
3 17 α H TRISNORHOPANE C_{27}
4 17 β H TRISNORHOPANE C_{27}
5 17 α H 28NORHOPANE C_{29}
6 17 β H 28NORHOPANE C_{29}
7 17α 21β, NORHOPANE C_{29}
8 17α(H), β 21Bb, HOPANE C_{30}
9 C_{30} MORETANE
10 17α 21β, HOMOHOPANES C_{31}
11 17α 21β, BISNORHOPANES C_{32}
12 17α 21β, TRISNORHOPANES C 35
13 17α 21β, TETRAHOPANES C_{34}
14 HOPANES C_{35}



1 UNIDENTIFIED
2 5α CHOLESTANES
3 5β CHOLESTANES
4 CHOLESTANE TYPE
5 ERGOSTANE TYPE
6 CHOLESTANE TYPE
7 STIGMASTANE TYPE





4272m

FIGURE 10c **MASSFRAGMENTOGRAMS** WELL 34/4-3

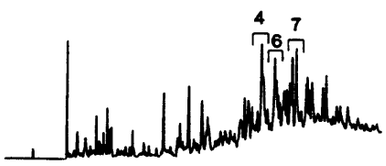
STERANES

4 17β H TRISNORHOPANE C_{27}

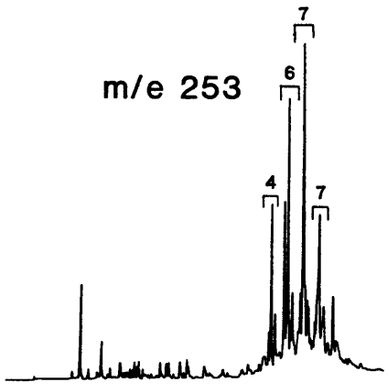
6 17β H BISNORHOPANE C_{28}

7 17α (H), 21β (H), NORHOPANE C_{29}

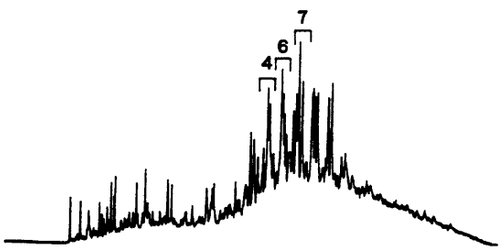
m/e 239

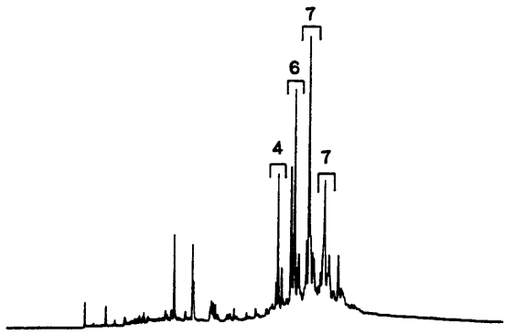


m/e 253



3500m

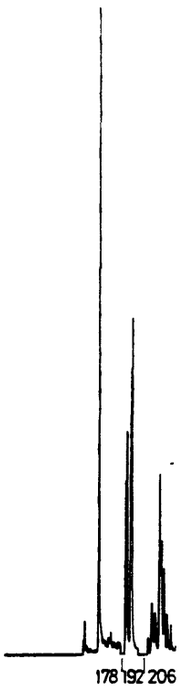




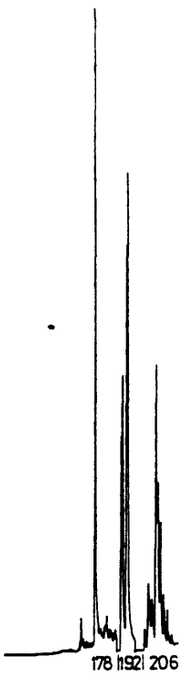
3563m

FIGURE 10d **MASSFRAGMENTOGRAMS** WELL 34/4-3

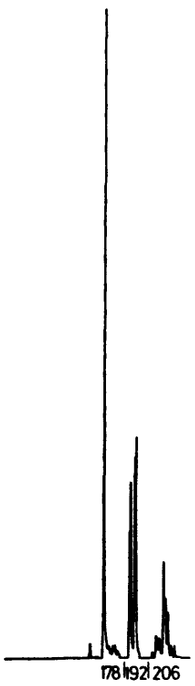
PHENANTHRENES



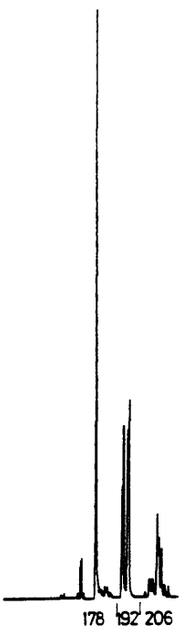
3500m



3563m



3923m



4272m

FIGURE 11a ORGANIC FACIES & MATURITY WELL 34/4-3

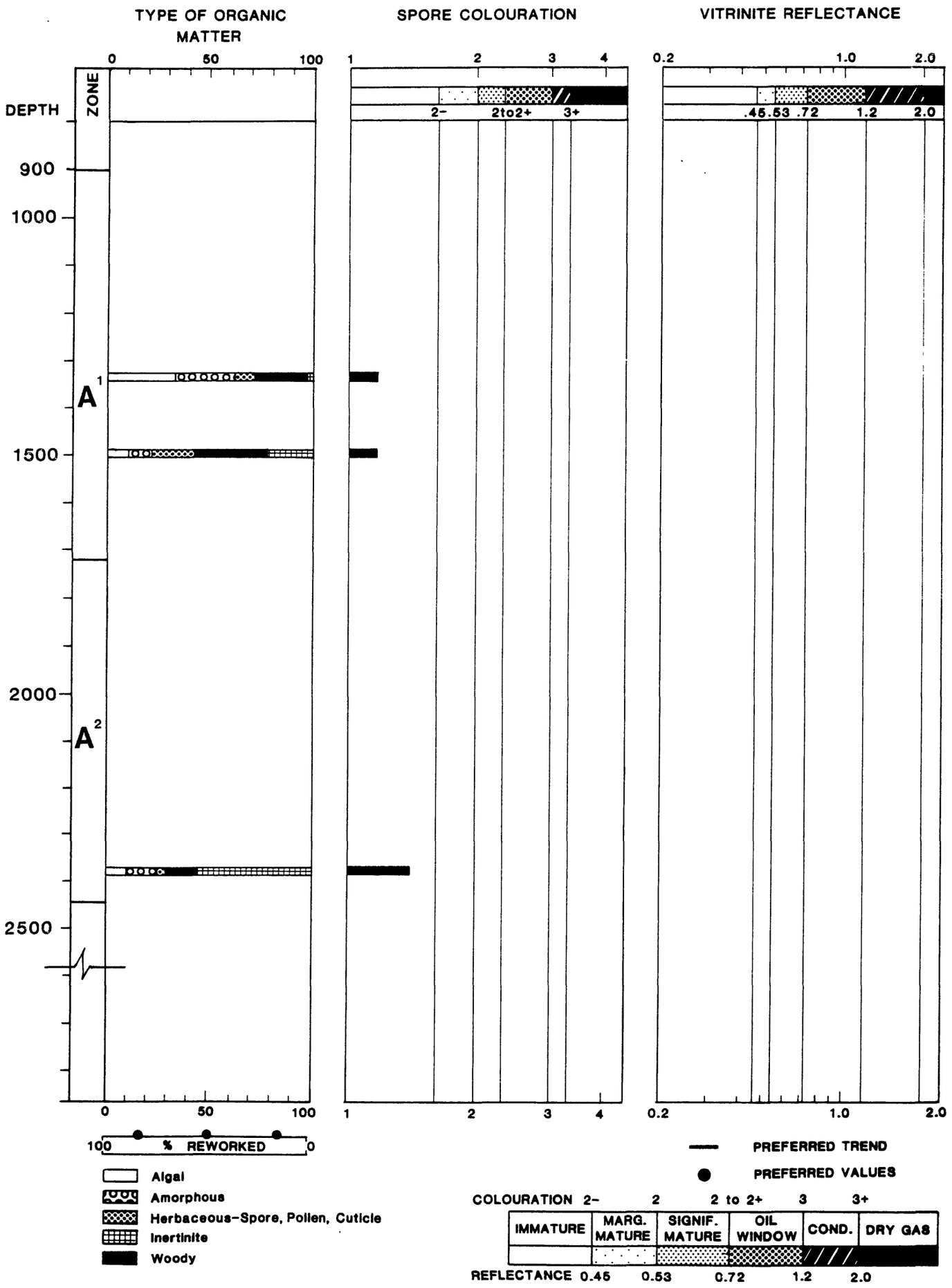


FIGURE 11b ORGANIC FACIES & MATURITY WELL 34/4-3

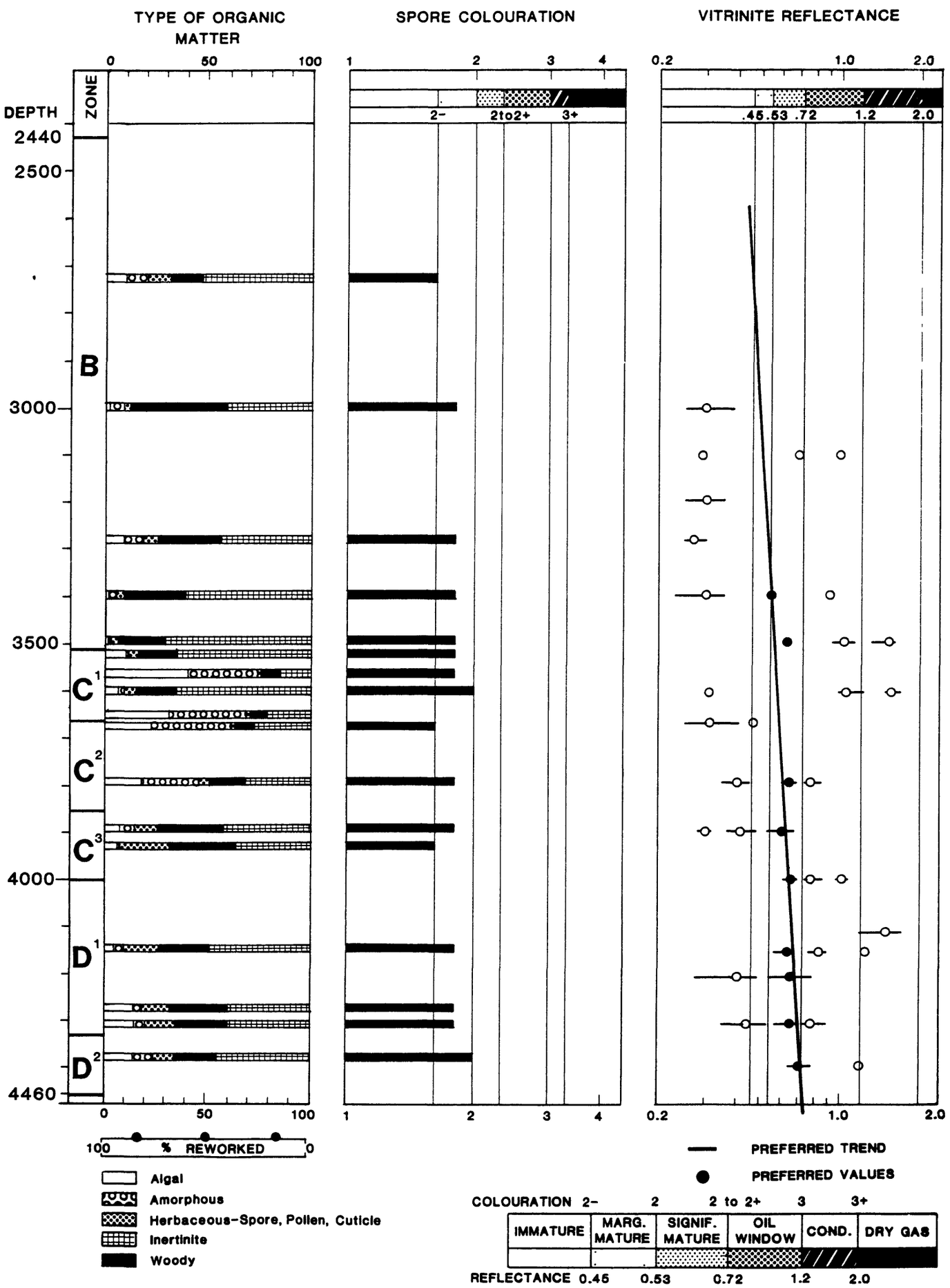
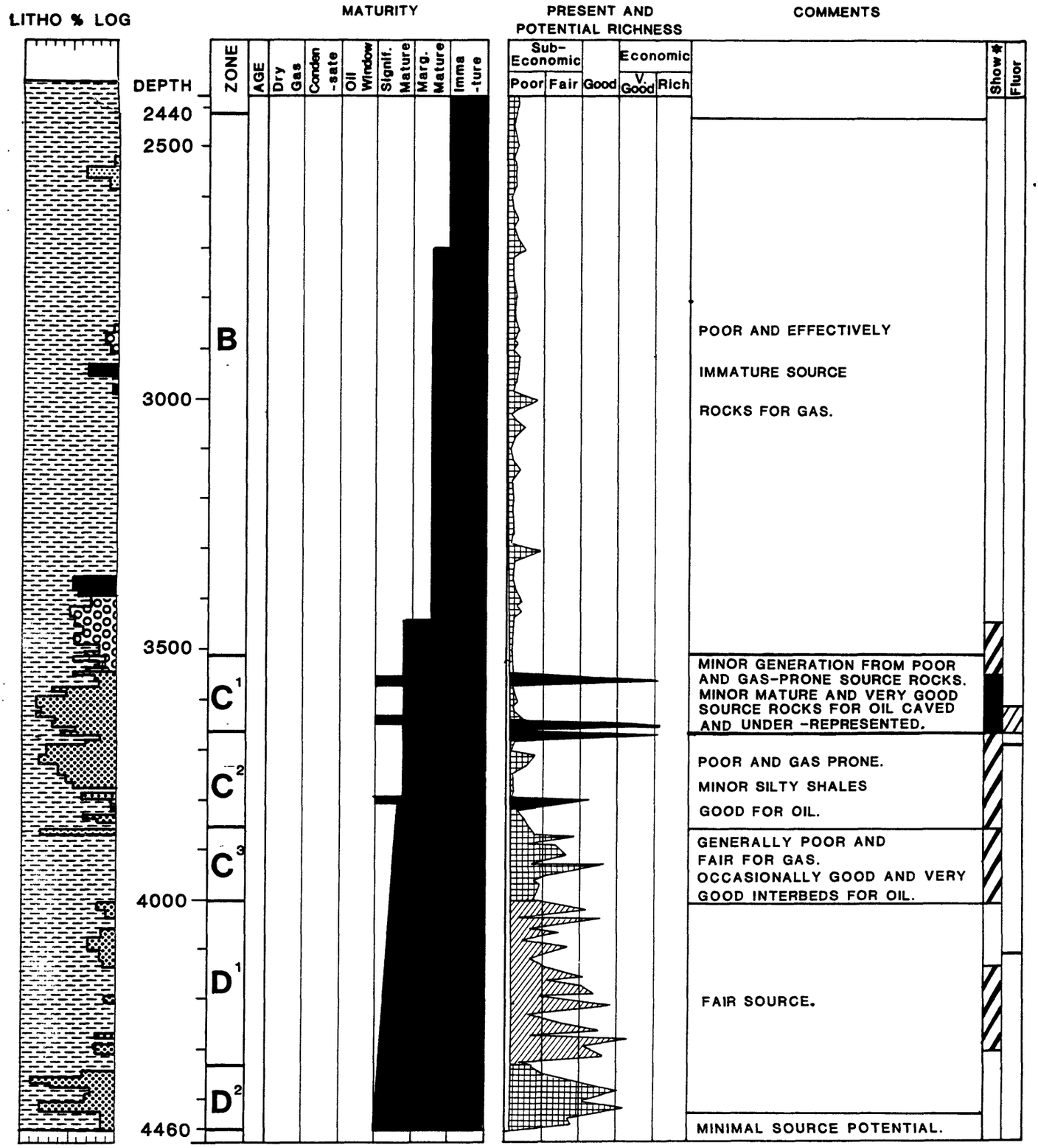
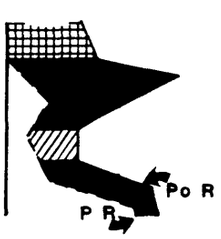


FIGURE 12a **RATING** WELL 34/4-3

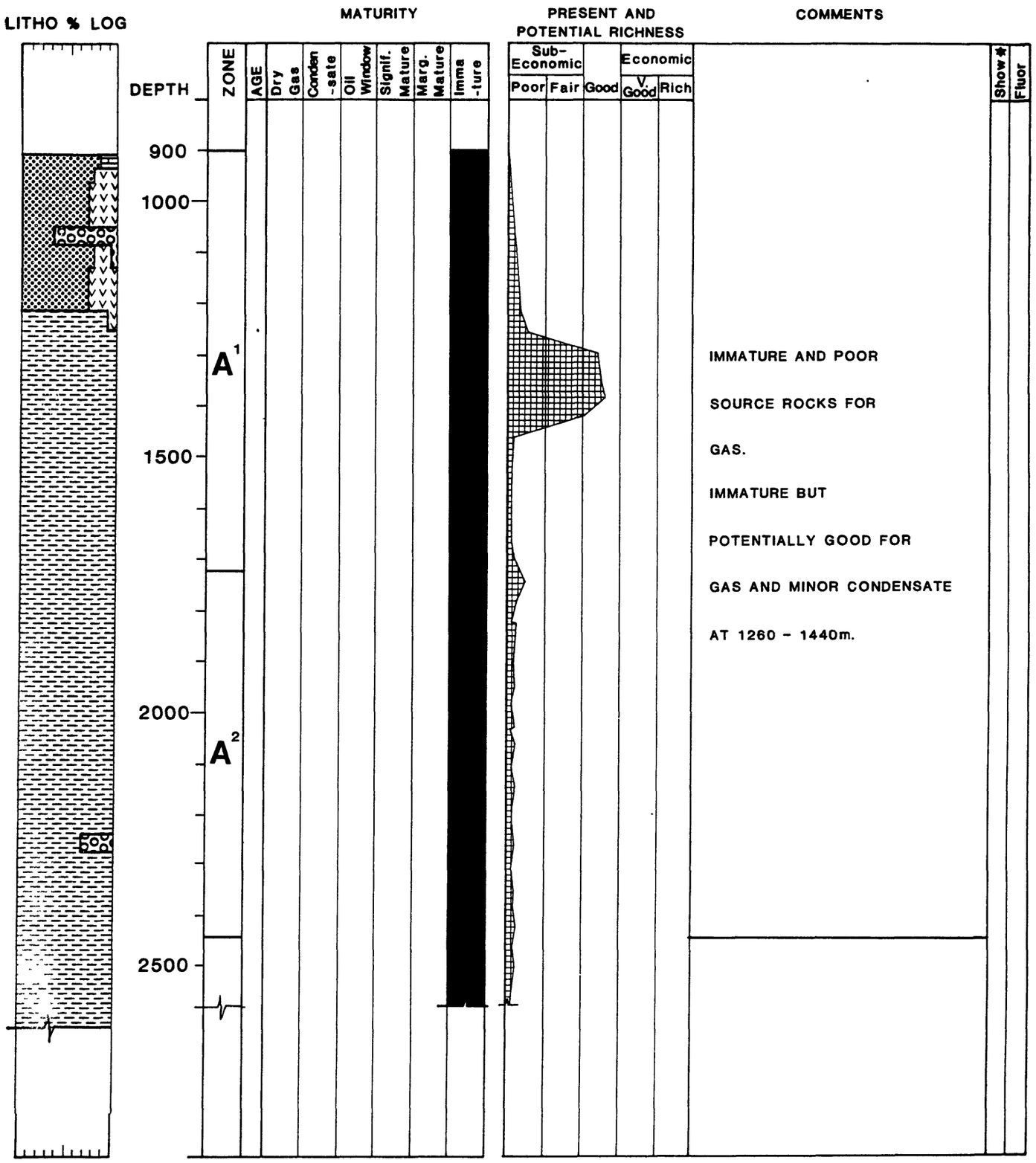


Carbonate
Shale/Mudstone
Siltstone
Evaporite
Sand
Coal
Igneous
L.C.M.

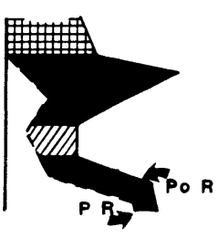


GAS PRONE
GAS AND CONDENSATE
OIL PRONE
Shows Recognised by Analysis
Po R Potential Richness
PR Present Richness

FIGURE 12b **RATING** WELL 34/4-3



Carbonate
Shale/Mudstone
Siltstone
Evaporite
Sand
Coal
Igneous
L.C.M.



GAS PRONE
GAS AND CONDENSATE
OIL PRONE
Shows Recognised by Analysis
Po R Potential Richness
PR Present Richness