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GeoChem Laboratories (U.K.) Limited

GEOCHEMICAL SERVICE REPORT

Prepared for

STATOIL

GEOCHEMICAL EVALUATION OF STATOIL's 7121/4-1

TROMS WELL

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GEOCHEMICAL EVALUATION OF STATOIL'S 7121/4-1

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SUMMARY

The section between 430 metres (Paleocene) and 2586 metres (Jurassic?) has been evaluated.

The clays and mudstones which dominate the interval down to 2225± metres are poor, or at best fair, and immature source rocks with a potential either for gas or for gas and minor condensate.

In contrast, the Upper Jurassic clays and mudstones at 2225-2330± metres are potentially very good and rich source rocks for a light or mixed base crude oil. Minor to significant hydrocarbon generation has occurred on-structure but shows of a relatively mature (but not highly mature) crude oil (condensate to light oil in type) at 2305-2330± metres, suggests that their off-structure lateral equivalents are more mature and would, therefore, be more prospective.

The sands which characterise the section below 2330± metres contain good shows of a young and relatively paraffinic crude oil. Potential source rocks in this interval are sparse and are restricted to the thin mudstones at 2419.9 metres and 2586 metres. These are only poor and fair source rocks and have only a limited potential for gas or gas and minor condensate.

Intermittant shows of dry gas were detected above 1400± metres (details in text).

Despite variations in the composition of the crude oil shows observed at 2305-2330± metres and in the underlying sands, it is believed that they have a common source and correlate positively to the rich Upper Jurassic clays and mudstones.

G.E. Harriman
GEOCHEM LABORATORIES (UK) LIMITED

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INTRODUCTION

This report presents a geochemical evaluation of the section between 430 metres and 2586 metres in Statoil's 7121/4-1 well.

The analytical format was specified by Statoil and was designed to investigate the hydrocarbon source potential of the section in terms of:

- organic facies
- source richness
- thermal maturity
- potential for oil, condensate or gas.

This project was authorised by Dr. H. Irwin, Statoil, Stavanger.

A. ANALYTICAL

A total for one hundred and forty four (144) canned samples, each composited over fifteen (15) metres, together with forty three(43) sidewall core samples were received from the 7121/4-1 well. These samples were assigned the Geochem job number 966.

Geochem were instructed to perform the light hydrocarbon analysis upon sixty four samples and the total organic carbon analysis and Rockeval pyrolysis analysis upon seventy five samples. In total, seventy two light hydrocarbon analyses, one hundred and six organic carbon analyses, seventy Rockeval pyrolysis analyses, thirty four kerogen analyses, thirty four vitrinite reflectance determinations, ten solvent extractions with chromatographic separation, ten capillary gas chromatographic analyses of the C_{15+} saturate and C_{15+} aromatic fractions respectively, ten pyrolysis-GC analyses, six mass spectroscopic (11-ion) analyses and twenty four stable carbon isotope analyses were performed in this study.

The data are presented in tables 1 through 13 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 Dr. H. Irwin at Statoil in Stavanger, together with the kerogen slides prepared for this study.

The remaining sample material will be returned to Statoil.

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

RESULTS AND INTERPRETATION

The section between 430 metres and 2586 metres has been analysed. Each of the parameters relevant to the geochemical evaluation of these sediments will be discussed in turn and then combined to form the "Conclusions".

Stratigraphic information was not available for this well but a summary of the formation tops was supplied by the client.

A. ZONATION

A zonation integrating the formation tops with the cuttings gas data is employed in this report. Five zones are recognised.

Zone A — 430 metres to 1010± metres (equivalent to GRP. T7 and T6) is Paleocene in age and is composed of olive grey and medium to medium dark grey silty mudstones.

The C_1-C_4 gases, released from the ditch cuttings between 520-625± metres and 730-860± metres are generally marginally wet to wet (24.5-62% C_{2+}) and range in abundance from a poor 358 ppm to a fair 6646 ppm. In contrast, the remaining Zone A sediments are characterised by fair to good (1030-13530 ppm) abundances of, generally, dry gas. The C_5-C_7 hydrocarbons commonly range from 92 ppm up to 564 ppm but are more abundant (1045-3180 ppm) near the top of the zone (520-625± metres) where the gases are also somewhat wetter.

Zone B^1 — 1025± metres to 1820± metres (GRP T6 - GRP T4-4 inclusive) is an interval dominated by claystones and shaly mudstones which vary in colour from greyish black to olive grey. Thin sandstone horizons are apparent at 1024-1070± metres.

The C_1-C_4 gases are generally poor to fair with abundances ranging from 90 ppm up to 5329 ppm. These gases are commonly dry but do show a trend of increasing wetness with depth. The heavier C_5-C_7 gasoline range hydrocarbons are extremely sparse with less than 52 ppm being observed. Butane ratios are high and extremely variable (0.69-2.88).

Zone B^2 lies between 1835± metres and 2210± metres (T4-3 - T4-1?) and is, again, an interval of greyish black to dark grey and olive grey clays and shaly mudstones.

The C_1-C_4 gases are generally more abundant than in Zone B^1 and range from 305 ppm up to 9727 ppm, but reach 21215 ppm and 16072 ppm at 2045-2060± metres and 2135-2150± metres respectively. The gases are marginally wet to wet but become wet to very wet (55-86% C_{2+}) in the 1955-2150± metre interval. C_5-C_7 abundances are enhanced relative to Zone B^1 but are still low at 19-261(1338) ppm. Isobutane to normal butane ratios are variable but show a general decrease with depth, falling to 0.36 at the base of the zone.

Zone C extends from 2225± metres down to 2330± metres and is understood to be Jurassic (GRP. T3) in age. Lithologically, Zone C is comparable to the overlying sediments consisting essentially of greyish black to dark grey and olive grey clays and shaly mudstones.

In contrast to the overlying sediments, this interval is rich. The C_1-C_4 gases range from (10496)35967 ppm up to 47939 ppm and exhibit a progressive change from wet (64% C_{2+}) at the top of the interval to very wet (81-91% C_{2+}) below 2255± metres. Gasoline range hydrocarbons improve from 2059 ppm at 2225-2240± metres to 29262-36318 ppm below 2240± metres.

Zone D 2330± metres down to the deepest sample analysed at 2570± metres (T2), is a sequence of sands and interbedded evaporites with thin horizons of olive grey shaly mudstone.

The sands below 2465± metres fluoresced pale yellow.

The C_1-C_4 gaseous hydrocarbons are less abundant then those in Zone C but are still rich, lying within the limits of 4768-24318 ppm. These gases are not as wet (49-69% C_{2+}) as those in Zone C but have lower (0.24-0.46) isobutane to normal butane ratios. Gasoline (C_5-C_7) range hydrocarbons at 3098-32467 ppm are comparable in abundance to those observed in Zone C.

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 silty mudstones which dominate Zone A have variable organic carbon contents. Values range from a poor 0.38% up to an average 1.16% but generally exceed 0.60% organic carbon. They are characterised by organic matter which is cheifly inertinitic and woody in type although herbaceous and algal material are also present in minor amounts.

In Zone B^1 the clays and shaly mudstones exhibit similar variations in organic richness with total organic carbon contents ranging from 0.22% up to 1.27%. The overlying trend is, however, for an increase in richness compared to the Zone A lithologies, with average organic carbon contents commonly in excess of 0.86% organic carbon. Their organic matter is similar in character to that of the Zone A mudstones, being dominantly woody and inertinitic with minor to significant proportions of herbaceous and algal debris.

A continuing trend of increasing organic richness (with increasing depth) is also observed in Zone B^1 where the mixed clays and shaly mudstones have organic carbon contents which although range from (0.19)0.70-2.92% are generally greater than 1.5% organic carbon. Organic matter in these sediments is, again, chiefly woody or woody and inertinitic in type with only minor amounts of the herbaceous, algal and amorphous fractions being detected.

Zone C contains the richest sediments encountered within the drilled section. These comprise greyish black to dark grey clays and shaly mudstones and contain 7.27-14.7% organic carbon. Similar clays and mudstones, also in Zone C, are less rich but have good and very good (0.90-4.90% organic carbon) contents of organic matter which, like in the richest lithologies in this interval, is composed chiefly of algal (amorphous at 2280 metres) kerogen with only minor to significant proportions of inertinitic and woody material.

Argillaceous lithologies within the Zone D sands (apart from caving) are sparse and are restricted to the sidewall core material taken at 2419.4 metres and 2586 metres. These contain 0.61-1.13% organic carbon and have wood as the major constituent of their organic matter.

Reworking of the organic matter is prevalent throughout the analysed section.

C. LEVEL OF THERMAL MATURATION

The level of thermal maturation has been assessed using the spore colouration and vitrinite reflectance techniques.

The colouration method indicates that a thermal index of 2- is achieved at a depth close to 1800± metres whilst an index of 2 is achieved at approximately 2300± metres.

Organic matter with an index of less than 2- is immature. At a level of 2- amorphous, herbaceous ± algal organic matter becomes marginally mature resulting in minor hydrocarbon generation whilst significant generation (mature, not oil window) is achieved at an index of 2. The corresponding values for woody organic matter are 2 and 2 to 2+. Hence, in 7121/4-1 the sediments above 1800± metres are immature. The Zone B^2 (T4-3 - T4-1) mudstones, due to the overall character of their organic matter (wood), are effectively immature but the rich Jurassic (below 2225± metres) clays and mudstones are not only marginally mature to mature but are realising a significant proportion of their total hydrocarbon potential.

Unfortunately, due to the prevalence of reworked organic matter throughout the analysed section the vitrinite data are unreliable in confirming the maturation profile as defined above. Plottted against depth, the vitrinite data show considerable scatter with a number of vitrinite populations being observed. However, the data below 2200± metres is believed to be more reliable with populations of 0.54% Ro (27) at 2300± metres and 0.55% Ro (40) at 2410± metres. A trend through these points, although speculative, passes through 0.49% Ro (8) at 2030± metres and intersects the surface at approximately 0.23% Ro. From this "preferred" vitrinite trend a reflectivity of 0.45% Ro is achieved at 1800± metres and a value of 0.53% Ro at 2260± metres. These values should be equivalent to thermal indices of 2- and 2 respectively and hence the agreement between the two methods (despite the overall poor quality of the vitrinite data) is good.

Tmax data obtained from the Rockeval pyrolysis analysis can also be used in defining the maturity of the sediments within the analysed section. The observed values may, however, be suppressed or enhanced by the effects of contamination or of reworking of the indigenous organic matter. Nevertheless, the observed values suggest that a value of 435°C is achieved at approximately 1500± metres whilst 440°C is reached at approximately 2225± metres.

D. SOURCE RICHNESS

A preliminary assessment of present and potential source richness can be obtained from an inspection of the light hydrocarbon and total organic carbon data respectively.

The light hydrocarbon data indicate a poor to fair source rating for both the Paleocene (Zone A) and the GRP. T6 to GRP. T4-4 (Zone B^1) sediments. The clays lying between 1835± metres and 2210± metres (Zone B^2) are generally poor to fair but contain good interbeds at 2045-2060± metres and at 2135-2150± metres. In marked contrast to the overlying sediments, the Upper Jurassic clays and mudstones of Zone C are, by this method, rated as good and very good source rocks. Zone D is comparable in richness to Zone C but the lack of suitable source rocks and the high gas wetness values suggest that the gases are associated with liquid hydrocarbon shows and are not, therefore, related to source richness.

Total organic carbon values suggest a poor to fair source potential for the Paleocene. Variations in organic richness are evident throughout the Zone B^1 and B^2 sediments but a general increase in richness with depth is observed, rating Zone B^1 as fair and the Zone B^2 lithologies as potentially good source rocks. Very good and rich clays and mudstones dominate the Upper Jurassic lithologies occurring in the 2275-2305± metres and 2315-2330± metre intervals.

Only a selection of the "richer" lithologies from below 1900± metres were extracted. C_{15+} hydrocarbon yields range from a poor 96 ppm at 1928 metres to a good 269 ppm at 2045-2060± metres, rating the Zone B^2 sediments as variously poor to good. The Upper Jurassic clays and mudstones however, are considerably richer at (336)1361-9263 ppm, and these are clearly very good to rich source rocks.

Potential richness at conditions of optimum maturity is evaluated using the pyrolysis analysis. The mixed clays and mudstones which characterise Zones A and B^1 (Paleocene through GRP. T6 - GRP. T4-4) yielded (0.01)0.05-0.93 mg/g pyrolysate and are, therefore, uniformly poor source rocks. Yields of 0.33-3.10 mg/g pyrolysate indicate that the Zone B^2 sediments are variously poor to fair but the Upper Jurassic clays and mudstones of Zone C, with pyrolysate yields ranging from (0.10)1.42-37.00 mg/g, are, in general, richer being rated as fair and rich source rocks. The richest intervals occurring between 2250-2305± metres and 2315-2330± metres. The thin mudstones in Zone D yielded 0.58-2.26 mg/g pyrolysate and are thus poor to fair source rocks.

The nature of the hydrocarbons that will be released from a potential source rock can be deduced from an examination of the chromatograms resulting from the pyrolysis of the isolated kerogen. Oil prone source rocks are characterised by pyrograms which show a well developed series of normal alkene-alkane doublets extending out to nC_{25} and beyond. If restricted to the front ends then a potential for condensate is indicated whilst gas-prone source rocks are typified by pyrograms which contain methane followed by only a limited number of low boiling point (mostly aromatic) hydrocarbons.

Zones B^1 and B^2 have a potential primarily for gas although some of the mudstones (containing better quality organic matter) will also yield some associated condensate. The pyrograms corresponding to the Upper Jurassic clays and mudstones (Zone C) have much stronger doublets which extend out to beyond nC_{25}. Clearly these have a significantly better potential for sourcing liquid hydrocarbons and although <u>not</u> classically oil prone, they will yield a mixed base (not highly paraffinic) crude oil.

Summarising:

- Zones A (Paleocene) and B^1 (GRP. T6 - GRP. T4-4) are poor source rocks which have a negligble potential probably for gas.

- Zone B^2 (T4-3 to T4-1?). Poor and fair rocks source for gas or gas and minor associated condensate.

- Zone C (Upper Jurassic). Fair and rich source rocks. Intervals at 2250-2305± metres and 2315-2330± metres, although NOT classically oil-prone, are a rich source for a mixed base crude oil.

- Zone D (T2) lacks effective source rocks but does contain minor poor to fair mudstones at 2419.4 metres and 2586 metres respectively.

E. MIGRATED HYDROCARBONS

The sands in the ditch cuttings samples from below 2465±metres in Zone D (T2) fluoresced yellow and yielded a milky cut. Sandstone core at 2480 metres also yeilded a milky cut.

The light (C_1-C_7) hydrocarbon data indicate fair and good abundances of essentially dry gas above 505±metres with further fair abundances below 875±metres in Zone A. Fair shows of dry gas are also apparent within Zone B but are rather intermittant. In contrast, the rich Upper Jurassic clays and mudstones of Zone C are characterised by very good abundances of both the gaseous (C_1-C_4) and the gasoline (C_5-C_7) hydrocarbons. Gas wetness values commonly exceed 80% thus suggesting that shows of migrated crude oil are mixed with the source indigeneous hydrocarbons in this interval. Similarly, very good shows of liquid hydrocarbons are present within the Zone D (T_2) sands however, their more mature (0.24-0.46) butane ratios infer that these shows, rather than being a result of diffusion from the overlying Upper Jurassic clays, are more likely derived from their more mature (off-structure) lateral equivalents.

The sample extracted from the 2225-2240± metre interval, yeilded 336ppm C_{15+} hydrocarbons with the hydrocarbons constituting 46% of the total extract. An inspection of the corresponding paraffin-naphthene chromatogram, however, suggests that these hydrocarbons are not crude oil but a mixture of source indigenous and drilling introduced contamination. Within the Upper Jurassic, the clays that lie between 2250± metres and 2292± metres yielded 1737-9263ppm C_{15+} hydrocarbons and with hydrocarbon to total extract ratios of 50-65%, migrated liquid hydrocarbons are, again, suspected. This conclusion is also supported by the extremely wet (81-90% C_{2+}) gases detected in this interval, and by the corresponding paraffin-naphthene chromatograms which indicate a mixture of source indigeneous and migrated liquid hydrocarbons. Similarly, the sediments extracted from the 2305-2330± metre interval (also Upper Jurassic) have high (5450-7035ppm) C_{15+} hydrocarbon yields and hydrocarbon to total (50-51%) extract ratios. Their chromatograms however are quite different from those of the overlying clays and mudstones, and although some indigeneous hydrocarbons are believed to be present, the gross paraffin profile is more mature with the distribution of the normal paraffins suggesting the presence of an oil which is condensate to light oil in type.

Sands from the 2480-2570± metre interval in Zone D (T2) were also extracted. That from 2480 metres yeilded 1361ppm C_{15+} hydrocarbons accounting for 67% of the total extract whereas the sands at 2555-2570± metres are relatively lean (165ppm C_{15+} hydrocarbons). The paraffin-naphthene chromatograms obtained from these sands are quite different from those observed for the overlying sediments. The normal paraffin distribution still ranges from nC_{15} to approximately nC_{35} but the C_{20+} paraffins are much stronger peaking at around nC_{23} to nC_{25}. The iso-paraffins are relatively abundant and some contamination is suggested by the naphthenic baseline. Nevertheless, these sands clearly contain migrated liquid hydrocarbons with the evidence indicating that they are of a relatively paraffinic, not very mature (odd carbon preference), crude oil. It is possible that the apparent loss of front ends (C_{20-} fraction) reflect diffusion of the lighter components upwards into the Upper Jurassic mudstones.

A selection of the extracted samples were further characterised by GC-MS. Mass fragmentograms prepared for the terpanes (m/z 191), with the exception of the sample at 2225-2240± metres, show little variation from sample to sample inferring a high degree of correlation between the various shows analysed. A higher concentration of the C_{30} moretane and gammacerane components in the sample at 2225-2240± metres separates it from the other samples and is normally assumed to indicate derivation from organic matter containing a significant proportion of higher land plant debris. The molecular ratios (table 9) show that isomerisation at C-22 in the C_{31+} hopanes is complete for all of the shows but the Tm/Ts ratios for the shows at 2225-2240± metres and 2555-2570± metres indicate immaturity at these depths. This is also supported by the observed ratios of the C_{29} (20S) and C_{29} (20R) sterane components. Apart from these differences, the shows between 2250± metres and 2480± metres have comparable mass fragmentogram 'fingerprints' and possess similar molecular ratios.

Further evidence in favour of a single common source is provided by a triangular diagram plot (figure 10) of the C_{27}, C_{28} and C_{29} steranes possessing the geologically stable 5α(H), 14β(H), 17β(H) stereochemistry which indicate that the shows have a similar composition.

Fragmentograms were also prepared for the Phenanthrene and Dibenzothiophene series of C_{15+} aromatic hydrocarbons. An inspection of these traces (Fig. 9) suggest that, in general, the composition and distribution of these components indicate a correlation, although not perfect, between all of the analysed samples. Interestingly, the predominance of methyl dibenzothiophene over dibenzothiophene suggests that the crude oil shows are relatively mature.

Stable carbon isotope determinations were performed upon the paraffin-naphthene, aromatic and total extract fractions. The kerogens representing potenital source rocks were also analysed. Kerogens isolated from the Upper Jurassic (Zone C) clays and mudstones gave values of -26.53 to -27.35, a range of 0.82 per mil. Isotopic ratios for the paraffin-naphthene fractions exhibit a larger variation with values ranging from -25.95^{o}/oo to -29.84^{o}/oo with the corresponding aromatic fractions giving values of -23.53^{o}/oo to -28.99^{o}/oo. A graph plotting the above isotope ratios (Fig. 11) shows the extent of these variations. Clearly the extracted hydrocarbons from the 2225-2240± metre interval have anomalous values which neither correlate with the other observed shows or the suspected potential source rocks. The shows from 2045-2060± metres and 2315-2330± metres also appear to correlate poorly. However, the shows from 2250± metres, 2255-2270± metres, 2292± metres, 2305± metres and 2555-2570± metres, despite some inter-sample variations, all correlate with the kerogens isolated from the Upper Jurassic clays and mudstones.

To summarise:

1. Fair and moderate shows of dry gas occur above 505± metres and below 875± metres in Zone A (Paleocene). Further, intermittant, shows of dry gas were detected in Zone B^1.

2. Contrastingly, there are good to very good shows of migrated liquid hydrocarbons in the Upper Jurassic of Zone C. At 2305-2330± metres these are of a mature, but not very mature, crude oil which is condensate to light oil in type. Traces of the same oil appear to have diffused into the overlying (2250-2292± metres) mudstones mixing with the source indigenous hydrocarbons observed in that interval.

3. Good and very good shows of crude oil are apparent in Zone D (T2), particularly at 2480± metres. These are different from the shallower shows in that they are heavier, more paraffinic and less mature.

To conclude, despite the variations in both type and quality of the observed crude oil shows, a correlation between the shows at 2250-2305± metres and 2555-2570± metres does exist and suggests derivation from a common source, the likely source being the rich Upper Jurassic clays and mudstones.

F. CONCLUSIONS

Five (5) zones are recognised between 430 metres and 2586 metres in 7121/4-1.

The Paleocene of Zone A (430-1010± metres) consists almost entirely, of silty mudstones which are generally poor to fair having organic carbon contents ranging from 0.38% up to 1.16%. Their organic matter is chiefly inertinitic and woody in type and consequently they are only poor, immature and uninteresting source rocks.

Zone B^1 extends from 1025± metres down to 1820± metres (GRP. T6 to GRP. T4-4). The clays and shaly mudstones which characterise this interval have organic carbon contents which although commonly in excess of 0.86%, range from 0.22% up to 1.27% organic carbon. Their organic matter is composed of wood and inertinite (with minor to significant herbaceous and algal debris) and is largely reworked. Immature, these sediments are poor source rocks with a negligble potential, probably for gas.

Zone B^2 1835± metres to 2210± metres (T4-3 to T4-1?) is a sequence of greyish black to dark grey clays and shaly mudstones. Organic carbon contents are variable ([0.19]0.70-2.92%) but generally exceed 1.5% organic carbon. Unfortunately their dominantly woody or woody and inertinitic organic matter is effectively immature and, at best, the Zone B^2 mudstones have only a poor to fair potential for gas or gas and minor condensate.

The Upper Jurassic sediments of Zone C (2225-2330± metres) contain the richest sediments observed in the analysed section. Greyish black to dark grey in colour, the clays and mudstones in this interval exhibit (as in the overlying sediments) a wide variation in organic richness. The 'leanest' intervals at 0.90-4.90% organic carbon rate as good to very good but the richer lithologies are rated as very good to rich containing 7.27-14.7% organic carbon. In contrast to the overlying sediments their organic matter consists chiefly of algal (amorphous at 2280± metres) kerogen with only minor to significant proportions of woody and inertinitic debris. Minor to significant hydrocarbon generation has already been initiated within these sediments and they represent a very good and rich source for a light or mixed base crude oil. Clearly, these are very prospective, per unit volume, source rocks and shows within this interval suggest migration from their more mature, off-structure, lateral equivalents.

Zone D (T2) extends from 2330± metres down to the deepest sample analysed at 2586 metres, and is a sequence of sands, evaporites and minor interbeds of shaly mudstone. These thin mudstones contain 0.61-1.13% organic carbon and organic matter which is dominantly woody in type. They would, even in a mature state, only be poor to fair source rocks, their likely potential being for gas or gas and minor associated liquids.

There are fair to moderate shows of dry gas within the Paleocene, particularly above 505± metres and below 875± metres.

There are good to very good shows of a light oil or condensate within the Upper Jurassic of Zone C, particularly at 2305-2330± metres.

Shows of a relatively paraffinic (but not very mature) oil are present in the Zone D (T2) sands and although different from the shallower shows, follow up analyses suggest that a correlation (ignoring contamination) between the shows exists and that they were derived from a common source.

Stable carbon isotope data indicate the rich Upper Jurassic clays and mudstones as the most likely potential source.

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
966-001	430-445m	A 98% Silty mudstone, blocky to sub-platy, mod. soft, non-calc., abundant caving, medium grey to medium olive grey Minor chalcedony	N5-5Y5/1	0.90
966-003	460-475m	A 98% Silty mudstone, as 966-001A, abundant caving Minor granite, chalcedony	N5-5Y5/1	0.98
966-005	490-505m	A 98% Silty mudstone, as 966-001A, abundant caving Minor chalcedony	N5-5Y5/1	0.94
966-007	520-535m	A 98% Silty mudstone, as 966-001A, abundant caving Minor muscovite	N5-5Y5/1	0.88,0.88
966-009	550-565m	A 98% Silty mudstone, as 966-001A, abundant caving	N5-5Y5/1	1.16
966-011	580-595m	A 98% Silty mudstone, as blocky to sub-platy, mod. soft, non-calc., sig. caving, medium grey to medium brownish grey	N5-5Y5/1	1.04
966-013	610-625m	A 98% Silty mudstone, as 966-011A, abundant caving	N5-5Y5/1	0.82
966-015	640-655m	A 98% Silty mudstone, as 966-011A, sig. caving	N5-5Y5/1	0.81
966-017	670-685m	A 98% Silty mudstone, as 966-011A, sig. caving Minor sandstone	N5-5Y5/1	0.77,0.77
966-019	700-715m	A 98% Silty mudstone, as 966-011A, sig. caving	N5-5Y5/1	0.75
966-021	730-745m	A 98% Silty mudstone, as 966-011A, sig. caving Minor LCM - salt	N5-5Y5/1	0.69
966-023	760-775m	A 98% Silty mudstone, as 966-011A, sig. caving	N5-5Y5/1	0.75
966-025	790-805m	A 98% Silty mudstone, blocky, mod. hard, non-calc., sig. caving, medium olive grey	5Y5/1	0.67
966-027	815-830m	A 70% Silty mudstone, as 966-025A, sig. caving B 30% LCM - cement	5Y5/1	0.71,0.71
966-029	845-860m	A 98% Silty mudstone, as 966-025A, abundant caving Minor LCM - cement	5Y5/1	0.63
966-030	863m SWC	A 98% Shaly mudstone, massive, mod. soft, non-calc., olive grey	5Y4/1	0.63

Abbreviations = **a**renaceous, **a**r**g**illaceous, **calc**areous, **Cut**, **dol**omitic, **Fluor**escence, **foram**inifera, **foss**iliferous
Lost **C**irculation **M**aterial, **mod**erately, **occ**asionally, **sl**ightly, **v**ery

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
966-032	875-890m	A 98% Silty mudstone, blocky, mod. hard, non-calc., abundant caving, medium olive grey Minor LCM - cement	5Y5/1	0.66
966-034	905-920m	A 98% Shaly mudstone, occ. silty, blocky to sub-platy, mod. hard, non-calc., abundant caving, dark grey to medium dark grey Minor silty mudstone	N3-4	0.62
966-035	913m SWC	A 98% Shaly mudstone, massive, mod. soft, non-calc., olive grey	5Y4/1	0.38
966-037	935-950m	A 98% Shaly mudstone, as 966-034A Minot silty mudstone	N3-4	0.71
966-039	961m SWC	A 98% Shaly mudstone, as 966-035A	5Y4/1	0.65
966-040	965-980m	A 98% Shaly mudstone, as 966-034A Minor siltstone	N3-4	0.65
966-042	995-1010m	A 98% Shaly mudstone, as 966-034A Minor siltstone, sandstone	N3-4	0.44
966-043	1015m SWC	A 98% Claystone, massive, soft, non-calc., greyish black	N2	0.54,0.55
966-045	1025-1040m	A 55% Glauconitic sandstone, fine grained, mod. well sorted, non-calc. cement, sig. caving, light greenish grey	5GY8/1	
		B 45% Shaly mudstone, sub-platy, mod. hard, non-calc., abundant caving, medium dark grey to olive grey	N4-5Y4/1	0.59
966-047	1055-1070m	A 70% Claystone, blocky, mod. hard, non-calc., sig. caving, medium dark grey to olive grey	N4-5Y4/1	0.50
		B 30% Galconitic sandstone, as 966-045A	5GY8/1	
966-048	1063.5m SWC	A 98% Shaly mudstone, massive, mod. soft, non-calc., olive grey	5Y4/1	0.35
966-050	1085-1100m	A 98% Claystone, blocky, mod. hard, non-calc., sig. caving, medium dark grey to olive grey	N4-5Y4/1	0.78,0.79
966-051	1107m SWC	A 98% Claystone, as 966-043A	N2	0.66
966-053	1115-1130m	A 95% Shaly mudstone, platy, mod. hard, non-calc., sig. caving, dark grey to medium grey	N3-5	0.92
		B 5% LCM - muscovite, walnut shell Minor anhydrite, limestone		
966-055	1145-1160m	A 60% Shaly mudstone, as 966-053A, sig. caving	N3-4	0.93
		B 40% LCM - muscovite		
966-056	1164m SWC	A 98% Claystone, as 966-043A	N2	0.99

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

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
966-058	1175-1190m	A 85% Shaly mudstone, platy, mod. hard, non-calc., sig. caving, dark grey to medium grey	N3-5	0.97,0.99
		B 15% LCM - muscovite and biotite		
966-060	1205-1220m	A 80% Shaly mudstone, as 966-058A, abundant caving	N3-5	0.99
		B 20% LCM - muscovite, biotite, walnut shell		
966-061	1218m SWC	A 98% Claystone, massive, soft, non-calc., greyish black	N2	0.94
966-063	1235-1250m	A 60% Shaly mudstone, as 966-058A, abundant caving	N3-4	0.88
		B 40% LCM - muscovite		
		Minor siltstone		
966-065	1265-1280m	A 70% LCM - muscovite, biotite		
		B 30% Shaly mudstone, platy, mod. hard, non-calc., abundant caving, dark grey to medium dark grey	N3-4	0.91
966-066	1277m SWC	A 98% Claystone, as 966-061A	N2	0.89,0.87
966-068	1295-1310m	A 65% Shaly mudstone, as 966-065B, abundant	N3-4	0.87,0.86
		B 35% LCM - biotite, muscovite		
966-070	1323m SWC	A 98% Claystone, massive, soft, non-calc., olive grey	5Y4/1	0.57
966-071	1325-1340m	A 60% Shaly mudstone, as 966-065B, abundant caving	N3-4	0.68
		B 40% LCM - biotite, muscovite		
966-073	1355-1370m	A 65% Shaly mudstone, as 966-065B, sig. caving	N3-4	0.71
		B 25% LCM - cement		
		C 10% LCM - biotite		
966-074	1367m SWC	A 98% Shaly mudstone, massive, mod. soft to mod. hard, mod. calc., olive grey	5Y4/1	0.22
966-076	1385-1400m	A 98% Shaly mudstone, as 966-065B, sig. caving	N3-4	0.65
		Minor LCM - cement		
966-078	1415m SWC	A 98% Claystone, as 966-070A	5Y4/1	0.54
966-079	1415-1430m	A 98% Shaly mudstone, platy, mod. hard, non-calc., sig. caving, dark grey to medium dark grey	N3-4	0.67
		Minor anhydrite		
966-081	1445-1460m	A 98% Shaly mudstone, as 966-079A, abundant caving	N3-4	0.73,0.72
		Minor chalcedony		
966-082	1465m SWC	A 98% Claystone, massive, soft, non-calc., greyish black	N2	0.92

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)
966-084	1475-1490m	A 98% Shaly mudstone, platy, mod. hard, non-calc., abundant caving, dark grey to medium dark grey Minor salt	N3-4	0.85
966-086	1505-1520m	A 98% Shaly mudstone, as 966-084A, sig. caving Minor anhydrite	N3-4	1.04
966-087	1516m SWC	A 98% Claystone, massive, soft, non-calc., olive grey	5Y4/1	1.23,1.23
966-089	1535-1550m	A 98% Shaly mudstone, as 966-084A, abundant caving Minor anhydrite	N3-4	1.08
966-091	1570m SWC	A 98% Claystone, as 966-087A	5Y4/1	1.20
966-092	1565-1580m	A 98% Shaly mudstone, occ. silty, platy, mod. hard, non-calc., sig. caving, dark grey Minor siltstone, biotite	N3	0.95
966-094	1595-1610m	A 98% Shaly mudstone, as 966-092A, sig. caving Minor anhydrite	N3	1.04,1.04
966-095	1610m SWC	A 98% Shaly mudstone, massive, mod. soft to mod. hard, non-calc., dark grey	N3	1.16
966-097	1625-1640m	A 98% Shaly mudstone, as 966-092A, sig. caving Minor anhydrite	N3	1.18
966-099	1655-1670m	A 98% Shaly mudstone, as 966-092A, sig. caving Minor siltstone, anhydrite	N3	1.09,1.08
966-101	1680m SWC	A 98% Claystone, massive, mod. soft, non-calc., dark grey	N3	1.01
966-102	1685-1700m	A 98% Shaly mudstone, as 966-092A, abundant caving Minor siltstone	N3	0.93
966-104	1715-1730m	A 98% Shaly mudstone, platy, mod. hard, non-calc., sig. caving, greyish black Minor siltstone	N2	1.03
966-105	1730m SWC	A 98% Claystone, as 966-101A	N3	0.93
966-107	1745-1760m	A 98% Shaly mudstone, as 966-104A, sig. caving	N2	0.99
966-109	1775-1790m	A 98% Shaly mudstone, as 966-104A, abundant caving	N2	0.94
966-110	1795m SWC	A 98% Claystone, as 966-101A	N3	1.27,1.26
966-112	1805-1820m	A 98% Shaly mudstone, as 966-104A, abundant caving	N2	1.05,1.05

Abbreviations = **ar**enaceous, **arg**illaceous, **calc**areous, **C**ut, **dol**omitic, **Fluor**escence, **foram**inifera, **foss**iliferous
Lost **C**irculation **M**aterial, **mod**erately, **occ**asionally, **s**lightly, **v**ery

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
966-114	1835-1850m	A 98% Shaly mudstone, platy, mod. hard, non-calc., abundant caving, greyish black Minor limestone, red shale	N2	1.35
966-116	1865m SWC	A 98% Shaly mudstone, massive, mod. hard, non-calc., olive grey	5Y4/1	1.43
966-117	1865-1880m	A 98% Shaly mudstone, as 966-114A, abundant caving Minor siltstone	N2	1.27
966-119	1895-1910m	A 98% Shaly mudstone, platy, mod. hard, non-calc., abundant caving, greyish black	N2	1.03
966-121	1928m SWC	A 98% Claystone, massive, mod. soft, non-calc., dark grey	N3	2.02
966-122	1925-1940m	A 98% Shaly mudstone, as 966-119A, abundant caving Minor salt, siltstone	N2	1.47
966-124	1966-1970m	A 98% Shaly mudstone, as 966-119A, abundant caving Minor siltstone	N2	1.79,1.81
966-126	1985m SWC	A 98% Claystone, as 966-121A	N3	2.01
966-127	1985-2000m	A 98% Shaly mudstone, as 966-119A, sig. caving Minor salt	N2	1.86
966-129	2015-2030m	A 98% Shaly mudstone, as 966-119A, abundant caving	N2	1.48
966-130	2032m SWC	A 98% Claystone, as 966-121A	N3	1.84
966-132	2045-2060m	A 98% Shaly mudstone, platy, mod. hard, non-calc., abundant caving, greyish black to dark grey Minor siltstone	N2-3	2.43
966-134	2078m SWC	A 98% Claystone, as 966-121A	N3	0.76,0.77
966-135	2075-2090m	A 98% Shaly mudstone, as 966-132A, sig. caving	N2-3	1.89
966-137	2105-2120m	A 98% Shaly mudstone, as 966-132A, abundant caving	N2-3	1.23,1.23
966-139	2130m SWC	A 98% Claystone, as 966-121A	N3	0.70
966-140	2135-2150m	A 98% Shaly mudstone, as 966-132A, abundant caving Minor siltstone	N2-3	2.92
966-142	2165-2180m	A 98% Shaly mudstone, as 966-132A, abundant caving Minor siltstone, mudstone	N2-3	1.39
966-144	2198m SWC	A 98% Shaly mudstone, asssive, mod. hard, non-calc., olive grey	5Y4/1	0.28

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

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
966-145	2195-2210m	A 98% Shaly mudstone, platy, mod. hard, non-calc., abundant caving, greyish black to dark grey Minor limestone, mudstone	N2-3	1.41
966-147	2225-2240m	A 98% Shaly mudstone, platy, mod. hard, non-calc., abundant caving, greyish black Minor mudstone, twine	N2	2.71
966-148	2233m SWC	A 98% Claystone, massive, mod. soft to mod. hard, non-calc., olive grey	5Y4/1	0.33
966-149	2237m SWC	A 98% Claystone, as 966-148A	5Y4/1	0.48
966-150	2243m SWC	A 98% Shaly mudstone, massive, mod. hard, non-calc., dark grey	N3	1.54,1.54
966-152	2250m SWC	A 98% Shaly mudstone, as 966-150A	N3	4.38
966-153	2250m SWC	A 98% Shaly mudstone, massive, mod. hard to mod. soft, non-calc., dark grey to greyish black	N3-2	4.10
966-154	2255-2270m	A 98% Shaly mudstone, as 966-147A, sig. caving Minor mudstone	N2	3.94,3.98
966-155	2275m SWC	A 98% Shaly mudstone, as 966-153A	N3-2	7.56
966-157	2280m SWC	A 98% Shaly mudstone, as 966-153A	N3-2	9.47
966-158	2292m SWC	A 98% Shaly mudstone, as 966-153A	N3-2	11.2,11.2
966-159	2285-2300m	A 80% Shaly mudstone, as 966-147A, sig. caving	N2	4.90
		B 20% LCM - cement (?), (occ. mud clasts?), blocky, mod. hard to hard, non-calc., light grey to very light grey Minor mudstone	N7-8	
966-160	2302m SWC	A 98% Shaly mudstone, massive, mod. hard, non-calc., greyish black	N2	7.27
966-161	2305m SWC	A 98% Shaly mudstone, as 966-160A	N2	14.4
966-162	2307m SWC	A 98% Claystone, massive, mod. soft, non-calc., olive grey	5Y4/1	1.30
966-164	2310m SWC	A 98% Claystone, as 966-162A	5Y4/1	1.24
966-165	2315m SWC	A 98% Shaly mudstone, massive, mod. hard, non-calc., greyish black	N2	0.96,1.00
966-166	2317.5m SWC	A 98% Claystone, massive, mod. soft, non-calc., greyish black	N2	1.41
966-167	2315-2330m	A 70% Shaly mudstone, as 966-147A, sig. caving	N2	14.7
		B 30% LCM - cement, as 966-159B	N7-8	
966-169	2345-2360m	A 65% Evaporite(?), blocky, mod. soft, sl. calc., sig. caving, very light grey to white	N8-9	

Abbreviations = **are**naceous, **arg**illaceous, **calc**areous, **C**ut, **dol**omitic, **F**luorescence, **foram**inifera, **foss**iliferous
Lost **C**irculation **M**aterial, **mod**erately, **occ**asionally, **s**light**l**y, **v**ery

TABLE 1

ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
966-169	2345-2360m	B 35% Shaly mudstone, platy, mod. hard, non-calc., dominant caved, greyish black	N2	
966-171	2375-2390m	A 50% Sandstone, silty matrix, fine grained, mod. well sorted, sig. caving, white	N9	
		B 30% LCM - muscovite		
		C 20% Shaly mudstone, as 966-169B, domiant caved	N2	
966-173	2405-2420m	A 80% Sandstone, as 966-171A, sig. caving	N9	
		B 10% Shaly mudstone, as 966-169B, dominant caved	N2	
		C 10% LCM - muscovite		
966-174	2419.4m SWC	A 98% Shaly mudstone, massive, mod. hard, non-calc., olive grey	5Y4/1	1.13
966-177	2435-2450m	A 98% LCM - muscovite and biotite Minor shale, sandstone		
966-182	2465-2480m	A 90% Sandstone, silty matrix, blocky, fine grained, well sorted, sig. caving, yellow F., milky cut, yellowish grey	5Y8/1	
		B 10% LCM - muscovite Minor shale		
966-184	2480m SWC	A 98% Sandstone, with organic material, med. to coarse grained, poorly sorted, milky cut, white	N9	
966-188	2495-2510m	A 98% Sandstone, as 966-182A, sig. caving, pale yellow F., milky cut Minor shale	5Y8/1	
966-190	2525-2540m	A 98% Sandstone, as 966-182A, sig. caving, pale milky cut Minor shale	5Y8/1	
966-192	2555-2570m	A 98% Sandstone, as 966-182A, sig. caving, pale milky cut	5Y8/1	
966-194	2586m SWC	A 98% Shaly mudstone, massive, mod. soft, non-calc., olive grey	5Y4/1	0.61

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

TABLE 2A
CONCENTRATION (VOL. PPM OF ROCK) OF C_1 - C_7 HYDROCARBONS IN AIR SPACE GAS

GEOCHEM SAMPLE NUMBER	DEPTH	C_1 Methane	C_2 Ethane	C_3 Propane	iC_4 Isobutane	nC_4 Butane	TOTAL C_1 - C_4	TOTAL C_2 - C_4	% GAS WETNESS	TOTAL C_5 - C_7	$\frac{iC_4}{nC_4}$
966-001	430-445	1325	14	2	1	1	1342	17	1.3	7	1.43
966-003	460-475	2676	181	61	71	29	3017	341	11.3	84	2.43
966-005	490-505	1811	120	59	25	59	2075	264	12.7	72	0.43
966-007	520-535	2538	601	231	83	196	3650	1112	30.5	193	0.42
966-009	550-565	130	19	12	4	12	177	48	26.8	52	0.38
966-011	580-595	384	129	106	44	101	765	381	49.8	204	0.43
966-013	610-625	1318	262	221	79	145	2025	707	34.9	138	0.55
966-015	640-655	6737	914	359	84	94	8188	1451	17.7	57	0.89
966-017	670-685	1811	96	29	9	10	1954	144	7.4	15	0.89
966-019	700-715	861	46	22	8	4	942	81	8.6	19	1.70
966-021	730-745	377	24	22	14	12	450	73	16.2	36	1.13
966-023	760-775	33	3	4	4	5	48	15	32.0	35	0.75
966-025	790-805	436	22	67	40	30	596	160	26.8	75	1.32
966-027	815-830	142	4	4	3	3	156	14	8.8	13	1.26
966-029	845-860	122	2	7	7	6	146	23	15.9	36	1.14
966-032	875-890	258	2	2	1	1	263	5	1.9	5	1.20
966-034	905-920	295	3	2	2	1	304	8	2.8	5	1.24
966-037	935-950	1884	104	43	16	13	2060	175	8.5	39	1.19
966-040	965-980	2585	84	36	13	11	2729	144	5.3	40	1.22
966-042	995-1010	1447	28	10	4	3	1492	45	3.0	10	1.19
966-045	1025-1040	1954	18	8	3	3	1986	32	1.6	2	1.21
966-047	1055-1070	301	4	2	1	0	308	7	2.4	0	1.66
966-050	1085-1100	1342	33	18	8	4	1405	63	4.5	3	2.31
966-053	1115-1130	1623	34	12	6	1	1675	52	3.1	1	8.73
966-055	1145-1160	19	3	3	1	1	27	8	29.5	7	0.69
966-058	1175-1190	2542	70	24	11	5	2650	109	4.1	1	2.32
966-060	1205-1220	1489	60	17	8	3	1576	88	5.6	4	2.71
966-063	1235-1250	631	16	9	5	2	663	32	4.8	1	3.15
966-065	1265-1280	178	5	3	2	1	189	11	5.6	1	2.47
966-068	1295-1310	3179	47	13	5	3	3247	68	2.1	5	1.87

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	$\frac{iC_4}{nC_4}$
966-071	1325-1340	1657	24	8	2	1	1693	36	2.1	2	1.76
966-073	1355-1370	189	5	3	1	0	198	9	4.4	0	1.91
966-076	1385-1400	4004	70	27	8	4	4113	109	2.7	2	1.91
966-079	1415-1430	3788	66	25	9	4	3892	104	2.7	1	2.24
966-081	1445-1460	21	2	1	1	1	26	5	18.7	2	1.33
966-084	1475-1490	918	46	24	12	4	1004	85	8.5	1	2.67
966-086	1505-1520	1392	50	19	9	3	1473	81	5.5	1	2.66
966-089	1535-1550	3796	217	81	34	12	4140	345	8.3	8	2.95
966-092	1565-1580	16	2	2	1	1	23	7	29.1	2	1.53
966-094	1595-1610	10	2	2	2	1	17	7	41.0	5	1.44
966-097	1625-1640	524	39	20	10	5	598	74	12.4	1	2.09
966-099	1655-1670	4375	258	70	22	11	4737	362	7.6	7	1.98
966-102	1685-1700	133	22	23	8	4	190	57	29.9	1	1.81
966-104	1715-1730	1	0	0	0	0	1	0	34.3	0	1.20
966-107	1745-1760	451	50	20	2	2	526	75	14.3	0	1.00
966-109	1775-1790	370	74	43	4	3	494	124	25.1	1	1.52
966-112	1805-1820	1838	303	63	5	2	2211	373	16.9	0	2.29
966-114	1835-1850	3	0	0	0	0	3	0	12.7	0	0.50
966-117	1865-1880	413	43	34	6	4	501	88	17.6	1	1.61
966-119	1895-1910	3678	525	220	36	17	4477	799	17.8	4	2.09
966-122	1925-1940	1465	420	174	31	15	2105	640	30.4	9	2.04
966-124	1955-1970	87	26	29	6	4	153	66	43.0	1	1.31
966-127	1985-2000	19	6	9	2	2	38	19	50.2	3	1.12
966-129	2015-2030	90	142	166	42	34	474	385	81.1	22	1.25
966-132	2045-2060	3602	663	249	51	42	4607	1005	21.8	38	1.21
966-135	2075-2090	96	104	135	36	31	401	305	76.2	26	1.14
966-137	2105-2120	34	18	18	5	5	79	45	57.2	5	1.02
966-140	2135-2150	5333	1842	367	27	29	7598	2265	29.8	27	0.95
966-142	2165-2180	3818	1482	304	18	25	5647	1829	32.4	14	0.70
966-145	2195-2210	1062	196	72	8	13	1352	290	21.4	16	0.65

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	$\frac{iC_4}{nC_4}$
966-147	2225-2240	2250	929	624	93	284	4180	1930	46.2	215	0.33
966-154	2255-2270	4871	3220	3766	2177	2654	16688	11817	70.8	5352	0.82
966-159	2285-2300	1422	1071	1183	631	779	5086	3664	72.0	1823	0.81
966-167	2315-2330	166	327	997	175	611	2276	2110	92.7	567	0.29
966-169	2345-2360	4164	1981	2159	291	992	9587	5423	56.6	1699	0.29
966-171	2375-2390	159	58	113	27	92	449	290	64.6	655	0.29
966-173	2405-2420	1559	550	635	117	320	3181	1622	51.0	360	0.37
966-177	2435-2450	5610	2579	2121	626	1221	12157	6547	53.9	3494	0.51
966-182	2465-2480	5160	2625	2415	841	1563	12604	7444	59.1	4634	0.54
966-188	2495-2510	1559	809	806	376	833	4383	2824	64.4	2784	0.45
966-190	2525-2540	1545	678	348	73	108	2752	1207	43.9	329	0.68
966-192	2555-2570	5584	1618	705	111	235	8253	2669	32.3	1218	0.47

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	$\frac{iC_4}{nC_4}$
966-001	430-445	8307	45	17	13	16	8398	91	1.1	182	0.84
966-003	460-475	9853	286	129	162	82	10513	660	6.3	480	1.97
966-005	490-505	2104	126	98	56	173	2558	454	17.7	671	0.32
966-007	520-535	2076	291	185	92	353	2996	920	30.7	1023	0.26
966-009	550-565	1018	200	188	93	309	1807	790	43.7	3128	0.30
966-011	580-595	342	100	136	62	256	897	555	61.9	2178	0.24
966-013	610-625	587	111	136	63	211	1108	521	47.0	907	0.30
966-015	640-655	462	91	86	27	70	736	275	37.3	165	0.39
966-017	670-685	962	98	76	36	65	1236	274	22.2	280	0.55
966-019	700-715	544	58	68	38	62	770	226	29.4	259	0.61
966-021	730-745	171	23	36	36	48	314	143	45.5	265	0.74
966-023	760-775	104	20	48	67	72	310	206	66.4	484	0.93
966-025	790-805	83	7	26	29	54	198	115	58.2	273	0.53
966-027	815-830	290	15	27	40	45	417	127	30.4	455	0.88
966-029	845-860	268	8	37	45	60	418	151	36.0	355	0.75
966-032	875-890	716	8	14	12	17	767	51	6.7	209	0.73
966-034	905-920	2713	38	35	25	37	2846	134	4.7	370	0.68
966-037	935-950	1904	34	28	15	26	2007	103	5.1	310	0.60
966-040	965-980	1332	31	31	20	30	1442	111	7.7	245	0.66
966-042	995-1010	967	16	14	9	14	1020	53	5.2	81	0.64
966-045	1025-1040	225	9	5	2	4	245	20	8.2	39	0.53
966-047	1055-1070	116	6	4	1	2	130	14	10.4	29	0.64
966-050	1085-1100	198	15	15	11	11	251	53	21.2	46	0.96
966-053	1115-1130	113	9	8	6	3	139	26	18.8	14	1.71
966-055	1145-1160	500	16	9	6	5	536	37	6.9	30	1.35
966-058	1175-1190	365	15	15	12	9	416	51	12.3	26	1.41
966-060	1205-1220	1245	40	29	20	16	1349	104	7.7	48	1.28
966-063	1235-1250	53	5	5	5	4	71	19	26.0	26	1.27
966-065	1265-1280	331	10	6	4	5	356	25	7.1	4	0.84
966-068	1295-1310	302	9	5	3	3	322	20	6.1	28	0.84

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	$\frac{iC_4}{nC_4}$
966-071	1325-1340	275	10	6	3	4	298	23	7.7	14	0.93
966-073	1355-1370	49	4	3	1	1	59	10	16.3	11	0.57
966-076	1385-1400	192	8	6	3	4	213	21	9.8	10	0.67
966-079	1415-1430	124	8	7	4	5	149	25	16.6	14	0.84
966-081	1445-1460	55	6	4	4	4	72	17	24.0	11	1.00
966-084	1475-1490	96	17	34	25	17	189	93	49.3	27	1.52
966-086	1505-1520	1061	59	56	39	26	1240	180	14.5	51	1.52
966-089	1535-1550	445	54	70	43	27	639	194	30.4	27	1.61
966-092	1565-1580	59	13	29	32	23	156	97	62.3	23	1.38
966-094	1595-1610	18	4	17	18	16	73	56	75.6	26	1.16
966-097	1625-1640	73	15	24	18	14	144	71	49.4	14	1.32
966-099	1655-1670	384	68	77	36	27	592	209	35.2	19	1.31
966-102	1685-1700	45	10	28	16	16	114	70	61.0	16	0.97
966-104	1715-1730	63	19	36	9	12	139	77	55.0	14	0.76
966-107	1745-1760	85	24	28	5	8	150	65	43.4	22	0.61
966-109	1775-1790	336	54	85	17	17	509	173	34.0	12	1.00
966-112	1805-1820	118	26	19	2	2	168	49	29.4	1	1.21
966-114	1835-1850	172	22	63	21	25	302	130	43.1	19	0.81
966-117	1865-1880	262	65	191	48	49	615	353	57.4	26	0.99
966-119	1895-1910	2410	578	718	126	107	3940	1529	38.8	52	1.18
966-122	1925-1940	4239	1357	1503	285	237	7622	3383	44.4	116	1.20
966-124	1955-1970	113	53	350	170	180	866	753	87.0	114	0.95
966-127	1985-2000	68	33	289	101	104	596	528	88.6	53	0.97
966-129	2015-2030	594	202	611	195	253	1856	1262	68.0	164	0.77
966-132	2045-2060	5953	3515	4308	1417	1415	16608	10655	64.2	1300	1.00
966-135	2075-2090	94	85	427	162	230	998	904	90.6	182	0.70
966-137	2105-2120	280	231	774	212	230	1727	1447	83.8	141	0.92
966-140	2135-2150	1877	3829	2304	219	246	8474	6598	77.9	234	0.89
966-142	2165-2180	820	573	364	30	80	1866	1047	56.1	70	0.37
966-145	2195-2210	1323	217	179	27	84	1830	507	27.7	152	0.32

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	$\frac{iC_4}{nC_4}$
966-147	2225-2240	1568	976	1592	351	1830	6317	4749	75.2	1844	0.19
966-154	2255-2270	2931	4472	7314	3094	7113	24924	21993	88.2	30966	0.44
966-159	2285-2300	5940	7144	9025	6353	14390	42852	36912	86.1	31893	0.44
966-167	2315-2330	3050	4951	7375	6220	11194	32790	29740	90.7	28695	0.56
966-169	2345-2360	948	600	2048	584	2587	6767	5819	86.0	10087	0.23
966-171	2375-2390	1898	329	682	297	1112	4318	2420	56.0	23192	0.27
966-173	2405-2420	1757	854	1912	460	1511	6494	4737	72.9	2738	0.30
966-177	2435-2450	3813	1489	2409	1136	3314	12161	8348	68.6	24481	0.34
966-182	2465-2480	2094	1543	2403	1462	3398	10900	8806	80.8	27833	0.43
966-188	2495-2510	3138	1147	1733	1156	3335	10509	7371	70.1	24964	0.35
966-190	2525-2540	5022	1924	1619	342	1218	10125	5103	50.4	8628	0.28
966-192	2555-2570	2089	2383	2218	248	1023	7961	5872	73.8	2886	0.24

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	$\frac{iC_4}{nC_4}$
966-001	430-445	9632	59	19	14	16	9740	108	1.1	188	0.86
966-003	460-475	12529	467	190	233	111	13530	1001	7.4	564	2.09
966-005	490-505	3915	246	157	82	233	4633	717	15.5	743	0.35
966-007	520-535	4614	892	416	175	550	6646	2032	30.6	1215	0.32
966-009	550-565	1148	219	200	98	321	1985	837	42.2	3180	0.30
966-011	580-595	726	229	243	107	358	1662	936	56.3	2382	0.30
966-013	610-625	1905	373	357	142	356	3133	1228	39.2	1045	0.40
966-015	640-655	7198	1006	445	111	164	8924	1726	19.3	222	0.68
966-017	670-685	2772	194	105	45	75	3190	418	13.1	295	0.60
966-019	700-715	1405	105	90	46	67	1712	307	17.9	277	0.68
966-021	730-745	548	47	58	50	61	764	216	28.3	301	0.82
966-023	760-775	137	22	52	70	77	358	221	61.8	518	0.92
966-025	790-805	519	29	93	69	84	794	275	34.6	348	0.82
966-027	815-830	433	19	31	43	48	573	140	24.5	468	0.90
966-029	845-860	390	11	44	52	67	564	174	30.8	391	0.78
966-032	875-890	974	10	15	13	18	1030	56	5.4	215	0.75
966-034	905-920	3008	41	37	26	38	3150	142	4.5	375	0.69
966-037	935-950	3788	137	71	31	39	4066	279	6.9	349	0.80
966-040	965-980	3917	114	67	33	41	4172	255	6.1	285	0.81
966-042	995-1010	2413	44	24	13	17	2512	99	3.9	92	0.74
966-045	1025-1040	2179	26	13	5	7	2231	52	2.3	41	0.81
966-047	1055-1070	417	10	6	2	3	438	21	4.8	29	0.83
966-050	1085-1100	1541	48	34	19	15	1657	116	7.0	50	1.29
966-053	1115-1130	1736	43	19	12	4	1813	78	4.3	16	2.88
966-055	1145-1160	518	19	12	7	6	563	45	7.9	37	1.20
966-058	1175-1190	2907	85	38	23	13	3066	160	5.2	28	1.72
966-060	1205-1220	2734	100	46	28	18	2925	191	6.5	52	1.50
966-063	1235-1250	683	21	15	10	5	734	50	6.9	27	1.85
966-065	1265-1280	509	15	9	6	6	544	36	6.6	5	1.06
966-068	1295-1310	3482	56	18	8	6	3569	87	2.5	33	1.33

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	iC_4/nC_4
966-071	1325-1340	1932	34	14	6	5	1990	58	2.9	16	1.16
966-073	1355-1370	238	9	6	2	2	256	18	7.1	11	0.91
966-076	1385-1400	4196	78	33	11	8	4326	130	3.0	12	1.32
966-079	1415-1430	3912	73	33	13	9	4041	129	3.2	14	1.46
966-081	1445-1460	76	8	6	5	4	99	22	22.6	14	1.06
966-084	1475-1490	1014	63	58	37	21	1193	178	15.0	28	1.76
966-086	1505-1520	2453	109	75	47	29	2714	261	9.6	52	1.65
966-089	1535-1550	4241	271	151	77	38	4779	539	11.3	35	2.02
966-092	1565-1580	75	16	31	33	24	178	104	58.0	25	1.39
966-094	1595-1610	28	6	20	20	17	90	62	69.1	31	1.18
966-097	1625-1640	597	53	44	29	19	742	145	19.6	15	1.52
966-099	1655-1670	4758	326	148	58	39	5329	570	10.7	26	1.51
966-102	1685-1700	178	32	50	24	21	304	126	41.6	18	1.15
966-104	1715-1730	64	19	36	9	12	141	77	54.8	14	0.77
966-107	1745-1760	535	74	48	7	11	676	140	20.7	22	0.69
966-109	1775-1790	705	128	128	21	20	1002	297	29.6	12	1.07
966-112	1805-1820	1956	329	82	7	4	2379	422	17.8	1	1.77
966-114	1835-1850	175	22	63	21	26	305	131	42.8	19	0.81
966-117	1865-1880	675	108	225	55	53	1116	441	39.5	27	1.04
966-119	1895-1910	6089	1103	938	162	124	8417	2328	27.7	56	1.30
966-122	1925-1940	5704	1777	1677	316	252	9727	4023	41.4	125	1.25
966-124	1955-1970	200	80	379	176	184	1019	819	80.3	115	0.96
966-127	1985-2000	87	40	298	104	106	635	548	86.3	56	0.97
966-129	2015-2030	684	344	777	237	287	2330	1646	70.7	186	0.83
966-132	2045-2060	9555	4178	4557	1468	1457	21215	11660	55.0	1338	1.01
966-135	2075-2090	190	189	562	197	261	1399	1209	86.4	208	0.75
966-137	2105-2120	314	249	792	217	234	1806	1492	82.6	145	0.92
966-140	2135-2150	7209	5671	2670	247	275	16072	8863	55.1	261	0.90
966-142	2165-2180	4638	2055	668	48	105	7513	2876	38.3	84	0.45
966-145	2195-2210	2385	413	251	35	97	3182	797	25.0	169	0.36

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	$\frac{iC_4}{nC_4}$
966-147	2225-2240	3818	1905	2216	444	2114	10497	6679	63.6	2059	0.21
966-154	2255-2270	7802	7692	11080	5271	9767	41612	33810	81.3	36318	0.54
966-159	2285-2300	7362	8215	10208	6984	15169	47938	40576	84.6	33716	0.46
966-167	2315-2330	3216	5278	8372	6395	11805	35066	31850	90.8	29262	0.54
966-169	2345-2360	5112	2581	4207	875	3579	16354	11242	68.7	11786	0.24
966-171	2375-2390	2057	387	795	324	1204	4767	2710	56.8	23847	0.27
966-173	2405-2420	3316	1404	2547	577	1831	9675	6359	65.7	3098	0.32
966-177	2435-2450	9423	4068	4530	1762	4535	24318	14895	61.3	27975	0.39
966-182	2465-2480	7254	4168	4818	2303	4961	23504	16250	69.1	32467	0.46
966-188	2495-2510	4697	1956	2539	1532	4168	14892	10195	68.5	27748	0.37
966-190	2525-2540	6567	2602	1967	415	1326	12877	6310	49.0	8957	0.31
966-192	2555-2570	7673	4001	2923	359	1258	16214	8541	52.7	4104	0.29

TABLE 3

KEROGEN TYPE AND MATURATION

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC MATTER DESCRIPTION					THERMAL MATURATION	
		TYPES 40%; 10-40%; 10%	REMARKS	RE-WORKED (%)	PARTICLE SIZE	PRESERV-ATION	INDEX	1 – 10 SCALE
966-030A	863m SWC	W-I;-;H-Al	Am-like contamination dominant H at 2- to 2	90	F-M	F	1+(?)	
966-035A	913m SWC	I-W;-;H-Al	contamination	90	F-M	F	1+(?)	
966-039A	961m SWC	I-W;H;Al	contamination. H at 2- to 2	90	F-M	F	1+ to 2-	
966-043A	1015m SWC	I-W;H;Al	contamination	90	F-M	F	1+ to 2-	
966-048A	1063.5m SWC	I;W;H-Al	contamination dominant H marginally mature	90	F-M	F-G	1+	
966-051A	1107m SWC	I-W;-;H-Al	contamination H at 2- and 2- to 2	95	F-C	F	1+	
966-056A	1164m SWC	W-I;H;Al	disseminated Am-like contamination	90	F-C	G	1+	
966-061A	1218m SWC	W-I;H;Al	dominant H at 2- and 2- to 2	95	F-C	G	1+	
966-066A	1277m SWC	W-I;H;Al	contamination dominant H marginally mature	90	F-C	G	1+ to 2-	
966-070A	1323m SWC	I;W; H-Al		95	F-M	F	1+ to 2-(?)	
966-074A	1367m SWC	I;W;Al-H-Am		90	F-M	P-F	1+ to 2-(?)	
966-078A	1415m SWC	I;W;H-Al-Am	contamination dominant H at 2- and 2- to 2	95	F-M	F	1+ to 2-	
966-082A	1465m SWC	W-I;H;Al-Am	widespread disseminated Am-like contamination	90	F-M	F-G	1+ to 2-	
966-087A	1516m SWC	W-I; H;Al		90	M-C	G	1+ to 2-	
966-091A	1570m SWC	W;I-H;Al	H very dominantly 2- or 2- to 2	80	M	G	1+ to2-	
966-095A	1610m SWC	W-I-H;Al-Am	H at 2- and 2- to 2	85	F-C	F	1+ to 2-	
966-101A	1680m SWC	W;I-H;Al	frequent good H at 2	80	F-M	G	1+ to2-/2-(?)	
966-105A	1730m SWC	W-I;-;H-Al	H at 2- to 2	85	F-M	F	2-(?)	

Algal, Amorphous, Herbaceous, Inertinite, Resin, Wood

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

Dominant, Major, Significant, Minor

TABLE 3

KEROGEN TYPE AND MATURATION

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC MATTER DESCRIPTION: TYPES 40%; 10-40%; 10%	ORGANIC MATTER DESCRIPTION: REMARKS	RE-WORKED (%)	PARTICLE SIZE	PRESERV-ATION	THERMAL MATURATION: INDEX	THERMAL MATURATION: 1 – 10 SCALE
966-110A	1795m SWC	W-I:-;H-Al	disseminated Am-like contamination	90	F-M	F	2-	
966-116A	1865m SWC	W;I-H;Al-Am	dominant H marginally mature	75	F-C	G	1+to 2-/2-(?)	
966-121A	1928m SWC	W;I-H;Al-Am		80	F-M	F-G	2-	
966-126A	1985m SWC	W;I-H;Al-Am	H at 2- to 2 and 2	85	F-C	F-G	2-	
966-130A	2032m SWC	W;I-H;Al-Am	H at 2- to 2	80	F-C	F	2-	
966-134A	2078m SWC	W;I;H-Al-Am	dominant H at 2	85	F-C	F-G	2- to 2	
966-139A	2130m SWC	W;I-H;Al-Am	dominant H at 2, also material at 2 to 2+ and 2+	90	F-M	F	2- to 2	
966-144A	2198m SWC	W;I;H-Al		95	F-M	F	2- to 2(?)	
966-152A	2250m SWC	Al;W;Am+-H-I	sapropelisation +not prime quality material at 2	15	F-C	F-G	2- to 2/2	
966-155A	2275m SWC	Al;W;I-Am-H		20	F-C	F-G	2 max	
966-157A	2280m SWC	Am**;Al*;I-W-H	** not typically oil prone * passing to Am		F-C	F	2(?)	
966-161A	2305m SWC	Al**;Am*;W-I-H	** atypical, unrecognisable, includes material apparently passing to Am * includes incompletely developed material		F-C	F	2(?)	
966-162A	2307m SWC	W;I-H-Al;-	frequent disseminated Am-like material believed to be contaminated		F-M	F-G	2	
966-174A	2419.4m SWC	W;H-I;Al	good H at 2		M-C	G	2- to 2(?)	
966-184A	2480m SWC	W;-;I-Am-H-Al	dominant H at 2+		F-M	P-F	2(??)	
966-194A	2586m SWC	W;I-H;Al	H at 2 to 2+ and 2+		M	G	2	

Algal, Amorphous, Herbaceous, Inertinite, Resin, Wood

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

Dominant, Major, Significant, Minor

TABLE 4

VITRINITE REFLECTANCE DATA

GEOCHEM SAMPLE NUMBER	DEPTH	SAMPLE TYPE	AVERAGE REFLECTIVITY Ro (%), (NUMBER OF PARTICLES) 1	2	3	REMARKS
966-030A	863m SWC	WR	0.73(16)	0.98(8)	1.37(1)	
966-035A	913m SWC	WR	0.71(1)	1.02(3)	-	
966-039A	961m SWC	WR	0.82(4)	1.01(8)	-	
966-043A	1015m SWC	WR	0.65(2) 1.37(2)	0.86(7)	1.02(1)	
966-048A	1063.5m SWC	WR	0.46(2) 1.08(5)	0.69(6)	0.90(2)	
966-051A	1107m SWC	WR	0.93(14)	1.16(21)	1.47(2)	
966-056A	1164m SWC	WR	0.82(14)	0.98(9)	1.20(7)	
966-061A	1218m SWC	WR	0.76(6)	0.94(15)	1.17(11)	
966-066A	1277m SWC	WR	0.76(3)	0.99(22)	1.27(11)	
966-070A	1323m SWC	WR	0.86(5)	1.08(4)	1.27(6)	
966-074A	1367m SWC	WR	0.75(1)	1.05(7)	1.27(3)	
966-078A	1415m SWC	WR	0.72(1)	1.13(4)	1.48(2)	
966-082A	1465m SWC	WR	0.70(7)	0.90(11)	1.15(19)	
966-087A	1516m SWC	WR	0.64(2) 1.43(2)	0.82(13)	1.14(28)	
966-091A	1570m SWC	WR	0.54(4) 1.41(12)	0.75(11)	1.10(33)	
966-095A	1610m SWC	WR	0.06(16)	0.86(10)	1.07(14)	
966-101A	1680m SWC	WR	1.14(16)	1.41(13)	1.80(1)	
966-105A	1730m SWC	WR	0.91(5)	1.14(12)	1.45(24)	
966-110A	1795m SWC	WR	0.83(1)	1.11(21)	1.41(9)	
966-116A	1865m SWC	KC	0.56(27)	0.79(4)	1.02(13)	
966-121A	1928m SWC	KC	0.50(7)	0.97(9)	1.18(24)	
966-126A	1985m SWC	WR	1.21(29)	1.51(11)		
966-130A	2032m SWC	KC	0.49(8) 1.14(23)	0.63(1)	0.82(1)	
966-134A	2078m SWC	WR	1.22(26)	1.65(9)	2.07(1)	
966-139A	2130m SWC	WR	1.00(1)	1.20(14)	1.52(22)	
966-144A	2198m SWC	WR	0.82(1)	1.23(12)	1.62(8)	
966-152A	2250m SWC	WR	1.11(5)	-	-	
966-157A	2280m SWC	KC	0.71(3)	0.91(4)	1.19(9)	
966-161A	2305m SWC	KC	0.61(24)	-	-	
966-162A	2307m SWC	WR	0.54(27)	0.68(3)	-	
966-174A	2419.4m SWC	WR	0.55(40)	0.70(5)	-	
966-184A	2480m SWC	WR	0.76(8)	0.96(3)	-	
966-194A	2586m SWC	WR	0.82(29)	0.99(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	Preciptd. Asphaltenes	Eluted NSO's	Non-eluted NSO's	Sulphur
966-121	1928	1851	67	29	96	986	375	394	0
966-132	2045-2060	2039	176	94	269	1063	384	323	0
966-147	2225-2240	732	230	105	336	214	103	79	0
966-153	2250	3929	1188	1000	2188	793	618	329	0
966-154	2255-2270	3429	825	913	1737	911	551	230	0
966-158A	2292	14146	4829	4434	9263	1929	2046	908	0
966-161	2305	13884	3087	3948	7035	3256	1938	1651	4
966-167	2315-2330	10599	2387	3063	5450	2992	1312	770	75
966-184	2480	2024	1044	317	1361	332	157	148	26
966-192	2555-2570	766	96	68	165	404	102	95	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
966-121	1928	3.64	1.56	53.25	20.26	21.30	0.00
966-132	2045-2060	8.62	4.59	52.14	18.83	15.82	0.00
966-147	2225-2240	31.49	14.40	29.18	14.14	10.80	0.00
966-153	2250	30.25	25.44	20.20	15.74	8.38	0.00
966-154	2255-2270	24.04	26.61	26.55	16.07	6.72	0.00
966-158A	2292	34.14	31.35	13.64	14.46	6.42	0.00
966-161	2305	22.23	28.44	23.45	13.96	11.89	0.03
966-167	2315-2330	22.53	28.90	28.23	12.37	7.26	0.71
966-184	2480	51.60	15.64	16.42	7.75	7.31	1.29
966-192	2555-2570	12.59	8.92	52.81	13.33	12.35	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
966-121	1928	1.84	5.19	0.52	10.06	2.33
966-132	2045-2060	2.15	13.21	1.25	9.48	1.88
966-147	2225-2240	1.31	45.89	2.56	5.59	2.19
966-153	2250	3.33	55.69	6.57	11.80	1.19
966-154	2255-2270	3.07	50.66	5.66	11.17	0.90
966-158A	2292	10.60	65.48	8.74	13.34	1.09
966-161	2305	13.70	50.67	3.42	6.74	0.78
966-167	2315-2330	8.08	51.43	6.75	13.12	0.78
966-184	2480	0.62	67.24	21.95	32.65	3.30
966-192	2555-2570	0.84	21.52	1.96	9.12	1.41

TABLE 7

ROCKEVAL PYROLYSIS DATA

GEOCHEM SAMPLE NUMBER	DEPTH	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	HYDROGEN INDEX	PRODUCTION INDEX	Tmax
966-001	430-445m	0.03	0.62	0.69	68.88	0.04	432
966-005	490-505m	0.03	0.52	0.47	55.32	0.05	431
966-009	550-565m	0.03	0.63	0.55	54.31	0.04	434
966-013	610-625m	0.03	0.43	0.44	52.44	0.07	431
966-017	670-685m	0.04	0.30	0.37	38.96	0.13	431
996-021	730-745m	0.03	0.28	0.28	40.57	0.10	425
996-025	790-805m Tert.	0.07	0.50	0.81	74.63	0.14	433
966-030	863m SWC	0.003	0.09	0.28	14.28	0.03	-
966-032	875-890m	0.00	0.11	0.14	16.66	-	432
966-039	961m SWC	0.006	0.05	0.09	7.69	0.12	-
966-051	1107m SWC Ø. Kritt	0.001	0.07	0.25	10.60	0.01	-
966-056 TORSVÅG	1164m SWC	0.001	0.14	0.28	14.14	0.01	430
966-060	1205-1220m	0.02	0.21	0.44	21.12	0.09	431
966-061	1218m SWC	0.002	0.12	0.13	12.76	0.02	430
966-063	1235-1250m	0.02	0.17	0.36	19.31	0.11	432
966-065	1265-1280m	0.01	0.18	0.39	19.78	0.05	432
966-066	1277m SWC	0.003	0.15	0.16	17.04	0.02	435
966-068	1295-1310m	0.02	0.16	0.38	18.39	0.12	428
966-071	1325-1340m	0.003	0.02	0.36	2.94	0.15	-
966-073	1355-1370m	0.01	0.02	0.39	2.81	0.50	-
966-078	1415m SWC	0.005	0.06	0.35	11.11	0.08	-
966-082	1465m SWC	0.001	0.16	0.23	17.39	0.06	-
966-084	1475-1490m	0.04	0.22	0.37	25.88	0.18	-
966-087	1516m SWC	0.05	0.93	0.23	75.61	0.05	436
966-089	1535-1550m	0.06	0.59	0.32	54.63	0.10	435
966-091	1570m SWC	0.001	0.69	0.28	57.50	0.01	436
966-092	1565-1580m	0.03	0.27	0.41	28.42	0.11	434
966-094	1595-1610m	0.05	0.49	0.44	47.11	0.10	435
966-095	1610m SWC	0.001	0.57	0.28	49.14	0.01	437
966-097	1625-1640m Nedre Kritt	0.08	0.73	0.52	61.86	0.11	436
966-099	1655-1670m	0.05	0.62	0.52	56.88	0.08	434
966-101	1680m SWC	0.008	0.40	0.23	39.60	0.02	436
966-102	1685-1700m	0.09	0.51	0.58	54.84	0.17	-
966-105	1730m SWC	0.02	0.09	0.18	9.67	0.22	-
966-107	1745-1760m	0.11	0.001	0.56	0.10	-	-
966-109	1775-1790m	0.04	0.11	0.47	11.70	0.36	-
966-112	1805-1820m	0.02	0.26	0.46	24.76	0.07	435
966-114 ANDA	1835-1850m	0.13	0.51	0.57	37.77	0.25	441
966-116	1865m SWC	0.07	1.10	0.44	76.92	0.06	441
966-117	1865-1880m	0.05	0.63	0.42	49.60	0.08	437
966-119	1895-1910m	0.02	0.33	0.41	32.20	0.06	437
966-121	1928m SWC	0.06	1.65	1.68	81.16	0.03	440
966-126	1985m SWC	0.08	1.53	0.28	76.61	0.05	439
966-129	2015-2030m	0.10	1.53	0.85	103.37	0.06	437
966-130	2032m SWC	0.10	1.82	1.54	98.91	0.05	439
966-132 TAMSØY	2045-2060m	0.12	2.91	0.37	119.75	0.04	438
966-134	2078m SWC	0.03	0.15	0.38	19.73	0.20	-
966-137	2105-2120m	0.04	0.66	0.34	53.65	0.06	440
966-139	2130m SWC	0.02	0.18	0.30	14.63	0.11	436
966-140 SLETTNES	2135-2150m	0.20	3.10	0.39	106.16	0.06	438
966-147	2225-2240m	0.11	2.48	0.33	91.51	0.04	442

TABLE 7

ROCKEVAL PYROLYSIS DATA

GEOCHEM SAMPLE NUMBER	DEPTH	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	HYDROGEN INDEX	PRODUCTION INDEX	Tmax
966-148	2233m SWC	0.05	0.10	0.89	30.30	0.50	-
966-149 ALDERFJORD	2237m SWC	0.07	0.18	0.59	37.50	0.38	434
966-150	2243m SWC	0.31	2.26	0.47	147.71	0.13	440
966-152	2250m SWC	2.11	11.48	0.14	262.10	0.18	442
966-153	2250m SWC	2.05	11.20	0.16	273.17	0.18	442
966-154	2255-2270m	1.07	10.62	0.23	268.18	0.10	444
966-155	2275m SWC	3.87	19.04	0.19	251.85	0.20	435
966-157	2280m SWC	4.27	21.71	0.29	229.25	0.19	440
966-158	2292m SWC U. Jura	5.54	25.95	0.29	233.78	0.21	439
966-159	2285-2300m	4.16	23.80	0.46	485.71	0.17	442
966-160	2302m SWC Jura	4.28	20.09	0.25	276.34	0.21	444
966-161	2305m SWC	6.39	37.00	0.28	256.90	0.17	440
966-162 EISFJORD	2307m SWC	0.53	1.98	0.44	152.30	0.26	444
966-164	2310m SWC	0.39	1.90	0.32	153.22	0.20	444
966-165	2315m SWC	0.18	1.42	0.20	144.89	0.12	444
966-166 STØ	2317.5m SWC	0.48	2.94	0.26	208.51	0.16	442
966-167	2315-2330m M. Jura	5.64	33.41	0.52	227.27	0.16	440
966-174 NORDM.	2419.4m SWC	0.30	2.26	0.83	200.00	0.13	44
966-194 YTTERØY	2586m SWC	0.11	0.58	0.34	95.08	0.18	446

TABLE 8
COMPOSITION (NORMALISED %) OF C_{15+} PARAFFIN – NAPHTHENE HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-121	-132	-147	-153	-154	-158	-161
DEPTH	1928m SWC	2045-2060m	2225-2240m	2250m SWC	2255 2270m	2292m SWC	2305m SWC
SAMPLE TYPE							
nC_{15}	1.95	1.99	5.05	6.19	8.96	11.15	6.72
nC_{16}	5.37	3.43	7.49	7.90	8.60	10.72	10.71
nC_{17}	9.38	4.84	8.35	9.17	9.57	9.30	11.88
nC_{18}	10.65	5.04	8.27	7.85	8.06	9.31	11.99
nC_{19}	9.72	6.03	7.96	9.64	9.03	9.73	12.29
nC_{20}	8.11	5.41	7.03	6.97	6.39	7.47	8.28
nC_{21}	7.72	5.76	6.29	6.66	6.12	6.04	6.89
nC_{22}	8.50	5.41	6.52	6.24	6.21	6.67	6.84
nC_{23}	7.96	6.80	6.09	6.08	5.47	4.57	4.90
nC_{24}	7.28	9.23	6.02	5.45	5.21	4.34	4.51
nC_{25}	7.82	9.33	5.98	5.71	4.95	4.33	3.77
nC_{26}	3.03	8.54	4.50	4.16	3.51	2.79	2.50
nC_{27}	1.81	7.97	3.80	4.51	3.86	2.64	1.85
nC_{28}	1.61	7.30	6.29	2.91	2.59	2.34	1.02
nC_{29}	1.47	4.79	2.45	2.95	2.68	1.91	0.89
nC_{30}	2.05	3.38	2.48	2.76	2.94	1.46	1.16
nC_{31}	2.20	0.62	1.48	1.49	1.85	1.59	1.42
nC_{32}	1.17	1.22	0.85	1.09	1.34	0.68	0.68
nC_{33}	0.98	0.84	1.05	0.71	0.93	0.84	0.80
nC_{34}	0.73	0.92	1.13	1.46	1.57	1.13	0.68
nC_{35}	0.49	1.17	0.93	0.08	0.18	0.99	0.23
PARAFFIN	19.26	32.74	11.70	32.35	27.71	18.50	54.58
ISOPRENOID	3.08	4.16	2.04	6.72	6.39	4.04	11.96
NAPHTHENE	77.67	63.10	86.26	60.93	65.89	77.46	33.46
CPI INDEX A	1.09	1.01	0.94	1.11	1.06	0.96	0.98
CPI INDEX B	1.32	0.96	0.84	1.15	1.11	1.20	1.17
PRISTANE/PHYTANE	1.75	3.49	2.17	2.65	2.61	1.21	1.36
PRISTANE/nC_{17}	1.08	2.04	1.43	1.65	1.74	1.29	1.06

TABLE 8

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

GEOCHEM SAMPLE NUMBER	-167	-184	-192
DEPTH	2315-2330m	2480m SWC	2555-2570m
SAMPLE TYPE			
nC_{15}	10.62	2.50	3.52
nC_{16}	11.57	4.21	4.82
nC_{17}	11.54	5.63	6.10
nC_{18}	10.22	6.10	6.39
nC_{19}	10.98	8.05	7.57
nC_{20}	8.84	7.53	6.73
nC_{21}	6.23	6.77	6.94
nC_{22}	5.82	7.38	7.05
nC_{23}	4.48	7.25	6.86
nC_{24}	3.91	7.29	7.02
nC_{25}	3.58	7.99	8.51
nC_{26}	2.39	6.17	6.59
nC_{27}	2.13	5.67	5.64
nC_{28}	1.78	4.38	4.67
nC_{29}	1.35	3.75	3.61
nC_{30}	0.91	2.36	2.12
nC_{31}	0.74	1.80	1.39
nC_{32}	0.66	1.25	0.70
nC_{33}	0.39	1.53	1.44
nC_{34}	0.99	1.60	1.54
nC_{35}	0.87	0.99	0.78
PARAFFIN	33.20	53.92	30.78
ISOPRENOID	7.56	6.13	3.00
NAPHTHENE	59.24	39.96	66.22
CPI INDEX A	0.98	1.04	1.06
CPI INDEX B	1.11	1.15	1.15
PRISTANE/PHYTANE	1.28	1.86	2.18
PRISTANE/nC_{17}	1.11	1.31	1.10

TABLE 9

METHYL PHENANTHRENE INDEX

GEOCHEM SAMPLE NUMBER	DEPTH	MPI (HT)	MPI (AREA)	MPI (GC-MS)	% Ro (FROM) (PREFERRED) (VITRINITE) (TREND)
966-121	1928m	0.74	0.68		0.47
966-132	2045-2060m	1.07	0.59		0.49
966-147	2225-2240m	1.23	1.35	0.43	0.52
966-153	2250m	1.05	0.91	0.58	0.53
966-154	2255-2270m	0.38	0.67	0.41	0.53
966-158A	2292m	0.72	0.59		0.54
966-161	2305m	0.48	0.47		0.54
966-167	2315-2330m	0.82	0.61	0.41	0.54
966-184	2480m	0.64	0.71	0.78	0.58
966-192	2555-2570m	0.69	0.67	0.58	0.59

TABLE 10

MOLECULAR MATURATION PARAMETERS

GEOCHEM SAMPLE NO.	DEPTH	STERANES M/Z 217 (259): $\frac{C_{29}\ 20S\ (\alpha\alpha)}{C_{29}\ 20R\ (\alpha\alpha)}$	$\frac{C_{29}\ 20R\ (\beta\beta)}{C_{29}\ 20R\ (\alpha\alpha)}$	$\frac{C_{27}\ (20S)\ \text{Diasteranes}}{C_{27}\ (20R)\ \text{Diasteranes}}$	TERPANES M/Z 191: $\frac{Tm}{Ts}$	$\frac{C_{30}\ \text{Moretane}}{C_{30}\ \text{Hopane}}$	$\frac{C_{29}\ \text{normoretane}}{C_{29}\ \text{norhopane} + C_{29}\ \text{normoretane}}$	$\frac{\text{Bisnorhopane}\ (C_{28})}{Tm + \text{Bisnorhopane} + C_{29}\ \text{norhopane}}$	$\frac{C_{31}\ (20S)}{C_{31}\ (20S) + C_{31}\ (20R)} \times 100$
966-147	2225-2240m	0.57	0.65	1.50	3.68	0.32	0.21	0.09	62.16%
966-153	2250m SWC	0.88	0.86	1.41	1.52	0.07	0.04	-	60%
966-154	2255-2270m	0.87	0.88	1.44	1.59	0.08	0.05	-	61%
966-167	2315-2330m	0.69	0.80	1.33	1.09	0.06	0.04	-	59.1%
966-184	2480m SWC	0.76	1.05	1.52	1.14	0.05	0.04	0.23	60.6%
966-192	2555-2570m	0.53	0.71	1.42	1.91	0.07	0.07	0.17	61.16%

TABLE 11

STABLE CARBON ISOTOPE RATIOS ($^{o}/oo$ PDB)

GEOCHEM SAMPLE NUMBER	DEPTH	PARAFFIN-NAPHTHENE	AROMATICS	TOTAL EXTRACTS	KEROGEN
966-132	2045-2060m	-28.28	-26.62	-27.79	
966-147	2225-2240m	-25.95	-23.53	-26.64	
966-153	2250m SWC	-29.84	-27.94	-28.40	-27.33
966-154	2255-2270m	-29.58	-28.99	-28.78	
966-158	2292m SWC	-28.97	-27.79	-	-26.89
966-161	2305m SWC	-28.66	-28.16	-	-27.35
966-167	2315-2330m	-28.42	-27.86	-27.99	-26.53

TABLE 12

COMPOSITION (NORMALISED %) OF C15+ AROMATIC HYDROCARBONS

- PHENANTHRENE SERIES

GEOCHEM SAMPLE NUMBER	DEPTH	PHENANTHRENE (M/Z 178)	METHYL PHENANTHRENE (M/MZ 192)	DIMETHYL PHENANTHRENE (M/Z 206)	TRIMETHYL PHENANTHRENE (M/Z 220)
966-147	2225-2240m	24%	31%	29%	16%
966-153	2250m SWC	16%	36%	32%	16%
966-154	2255-2270m	27%	34%	26%	13%
966-167	2315-2330m	19%	35%	29%	17%
966-184	2480m SWC	11%	33%	36%	20%
966-192	2555-2570m	21%	37%	29%	13%

TABLE 13

COMPOSITIONS (NORMALISED%) OF C15+ HYDROCARBONS

- DIBENZOTHIOPHENE SERIES

GEOCHEM SAMPLE NUMBER	DEPTH	DIBENZOTHIOPHENE (M/Z 184)	METHYL DIBENZOTHIOPHENE (M/Z 198)	DIMETHYL DIBENZOTHIOPHENE (M/Z 212)
966-147	2225-2240m	18%	43%	39%
966-153	2250m SWC	23%	43%	34%
966-154	2255-2270m	29%	41%	30%
966-167	2315-2330m	20%	41%	39%
966-184	2480 SWC	17%	37%	46%
966-192	2555-2570m	20%	41%	39%

FIGURE 1

RATING

WELL 7121/4-1

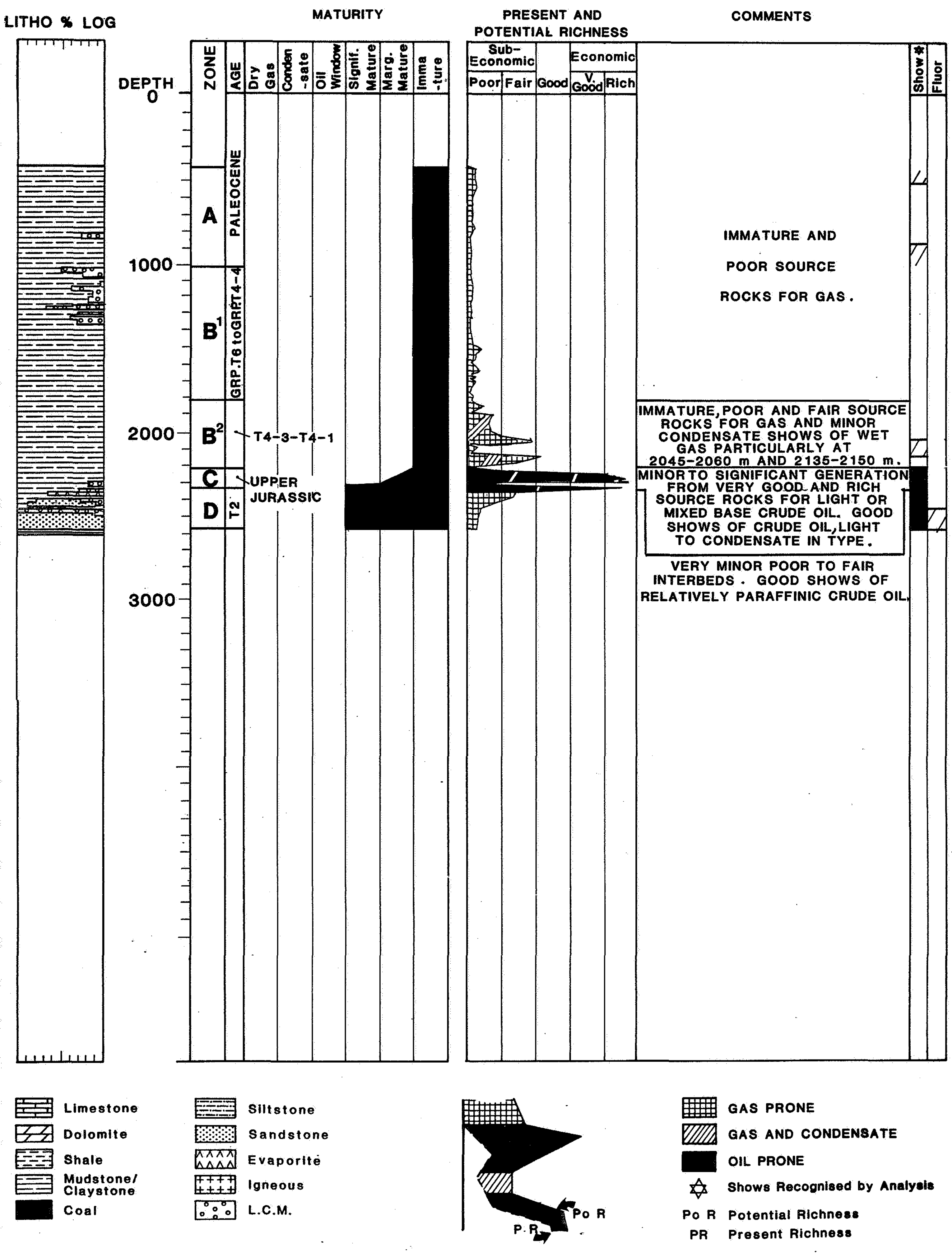
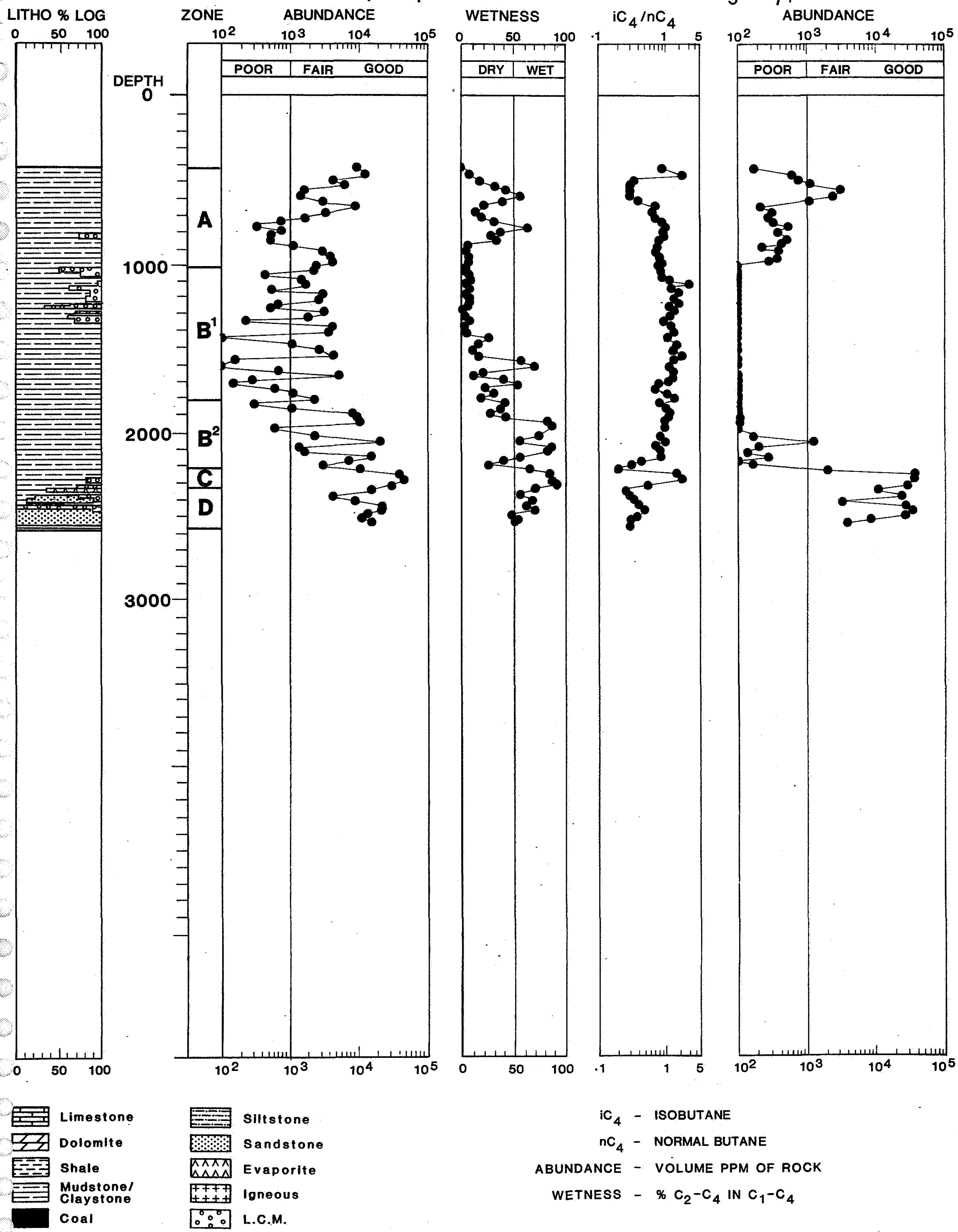


FIGURE 2 $C_1 - C_7$ HYDROCARBONS WELL 7121/4-1



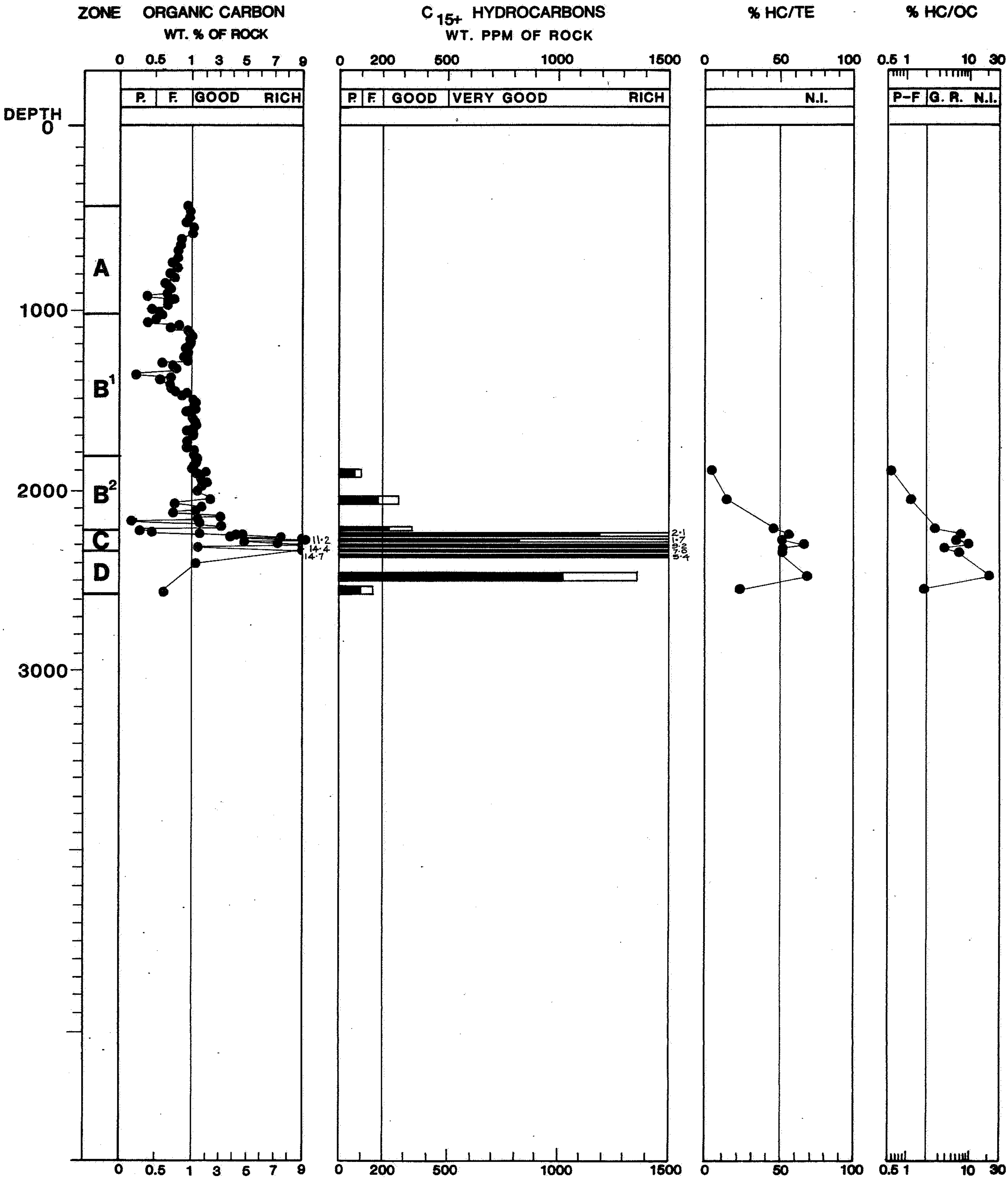
iC_4 - ISOBUTANE

nC_4 - NORMAL BUTANE

ABUNDANCE - VOLUME PPM OF ROCK

WETNESS - % C_2-C_4 IN C_1-C_4

FIGURE 3 **RICHNESS** WELL 7121/4-1



● SHALE /MUDSTONES

○ OTHER LITHOLOGIES

P-N – PARAFFIN – NAPHTHENES

AROM – AROMATICS

HC – C_{15+} HYDROCARBONS

OC – ORGANIC CARBON

TE – TOTAL C_{15+} EXTRACT

P – POOR

F – FAIR

G – GOOD

R – RICH

N.I. – NON-INDIGENOUS HYDROCARBONS

FIGURE 4 ROCKEVAL DATA WELL 7121/4-1

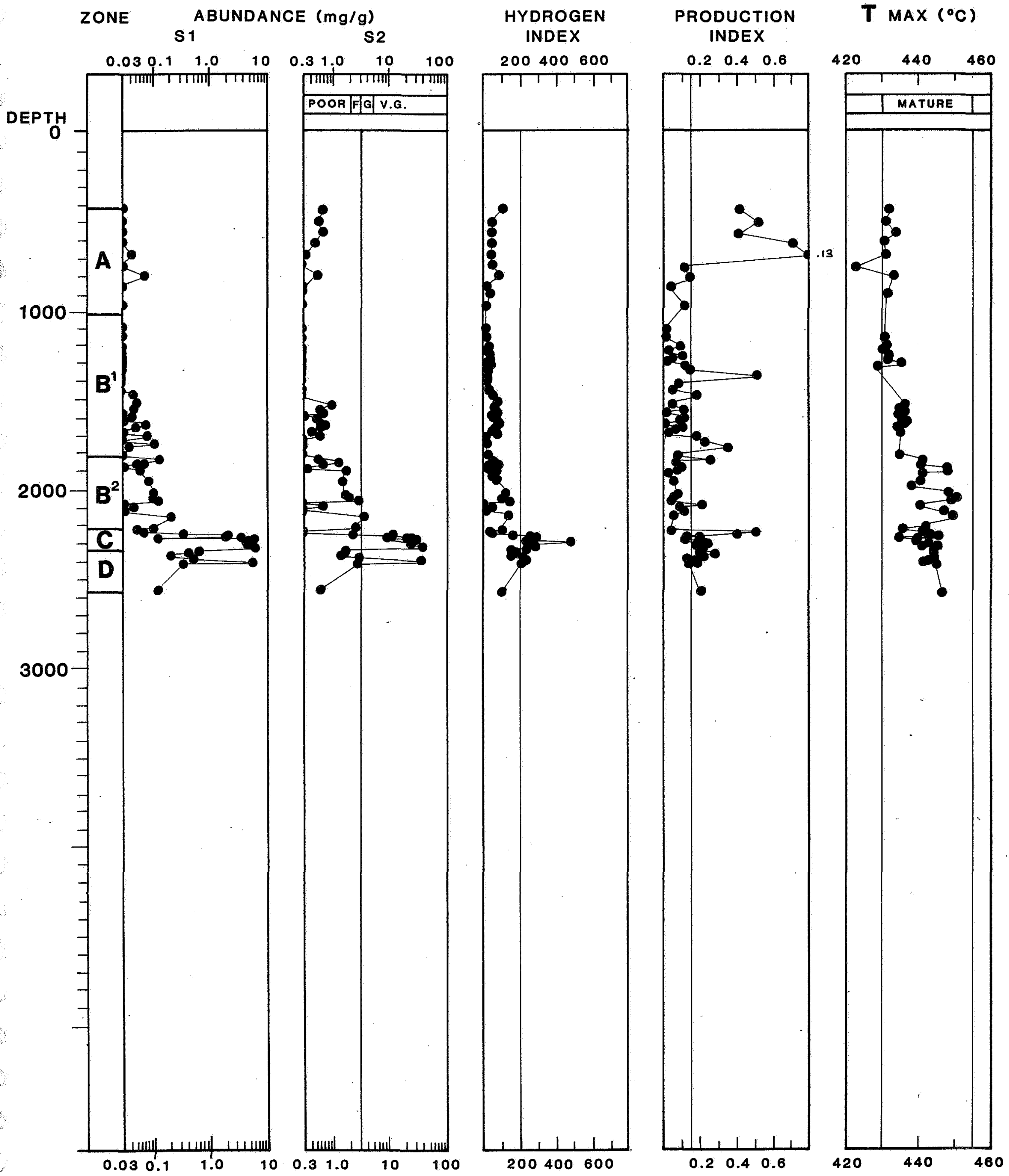
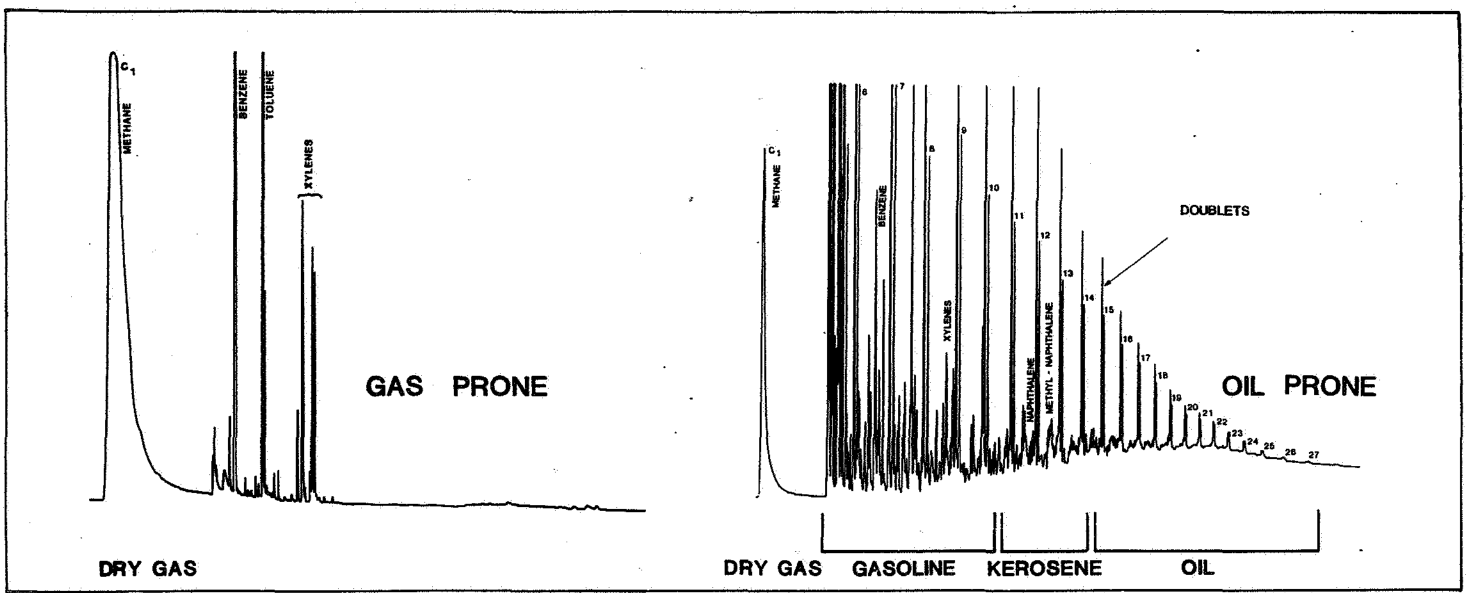


FIGURE 5a **PYROLYSIS GC** WELL 7121/4-1



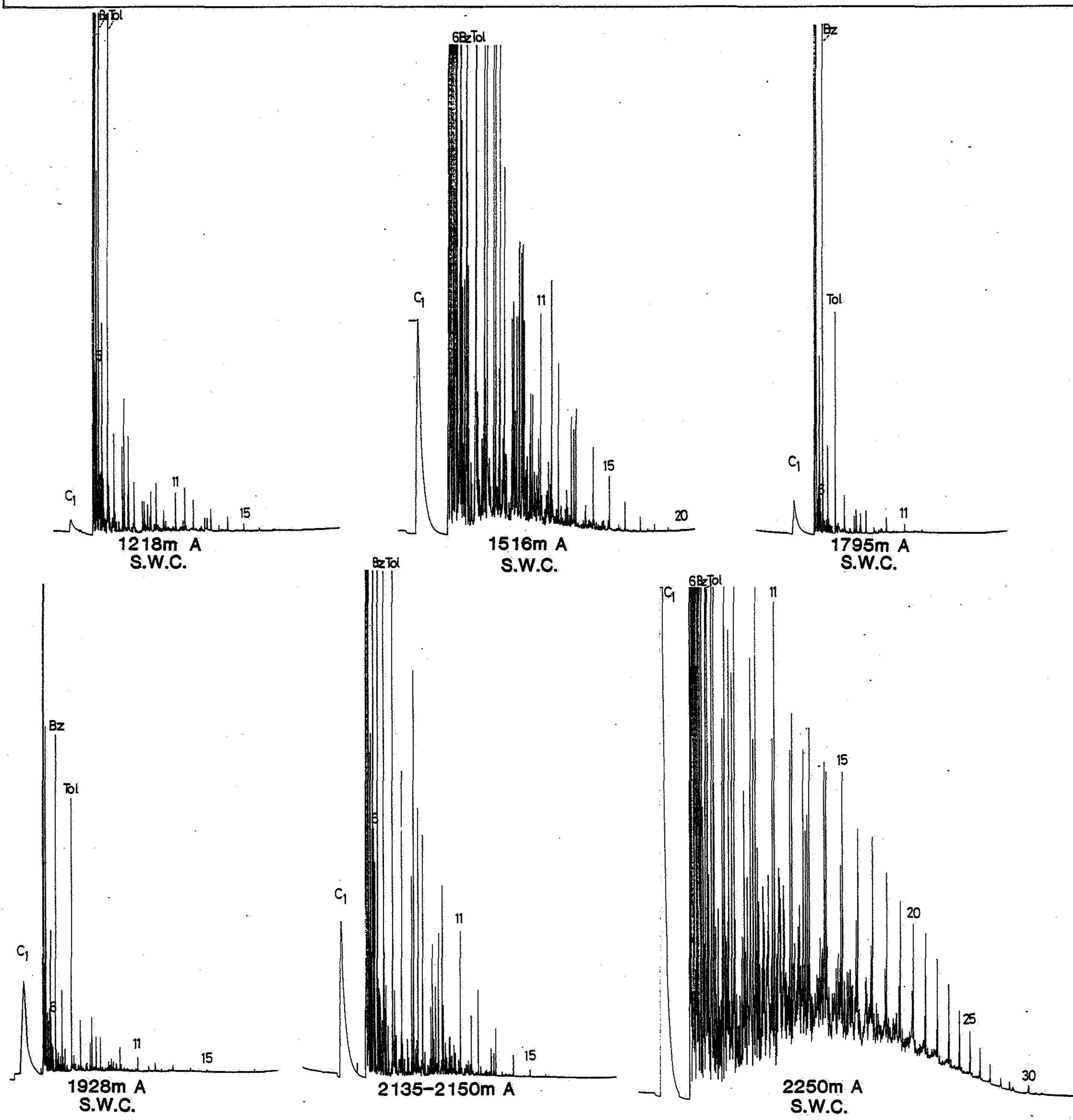


FIGURE 5b **PYROLYSIS GC** WELL 7121/4-1

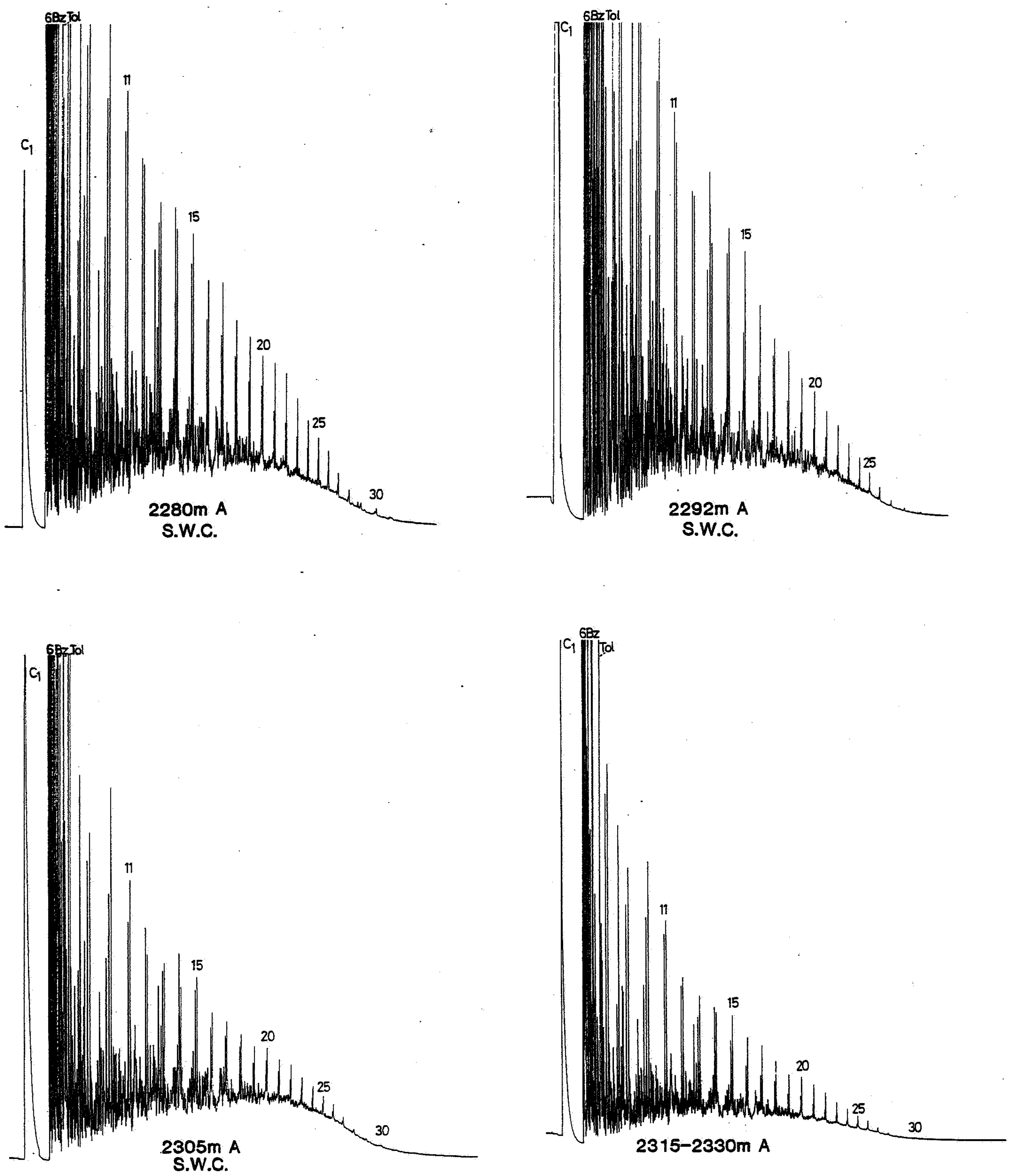
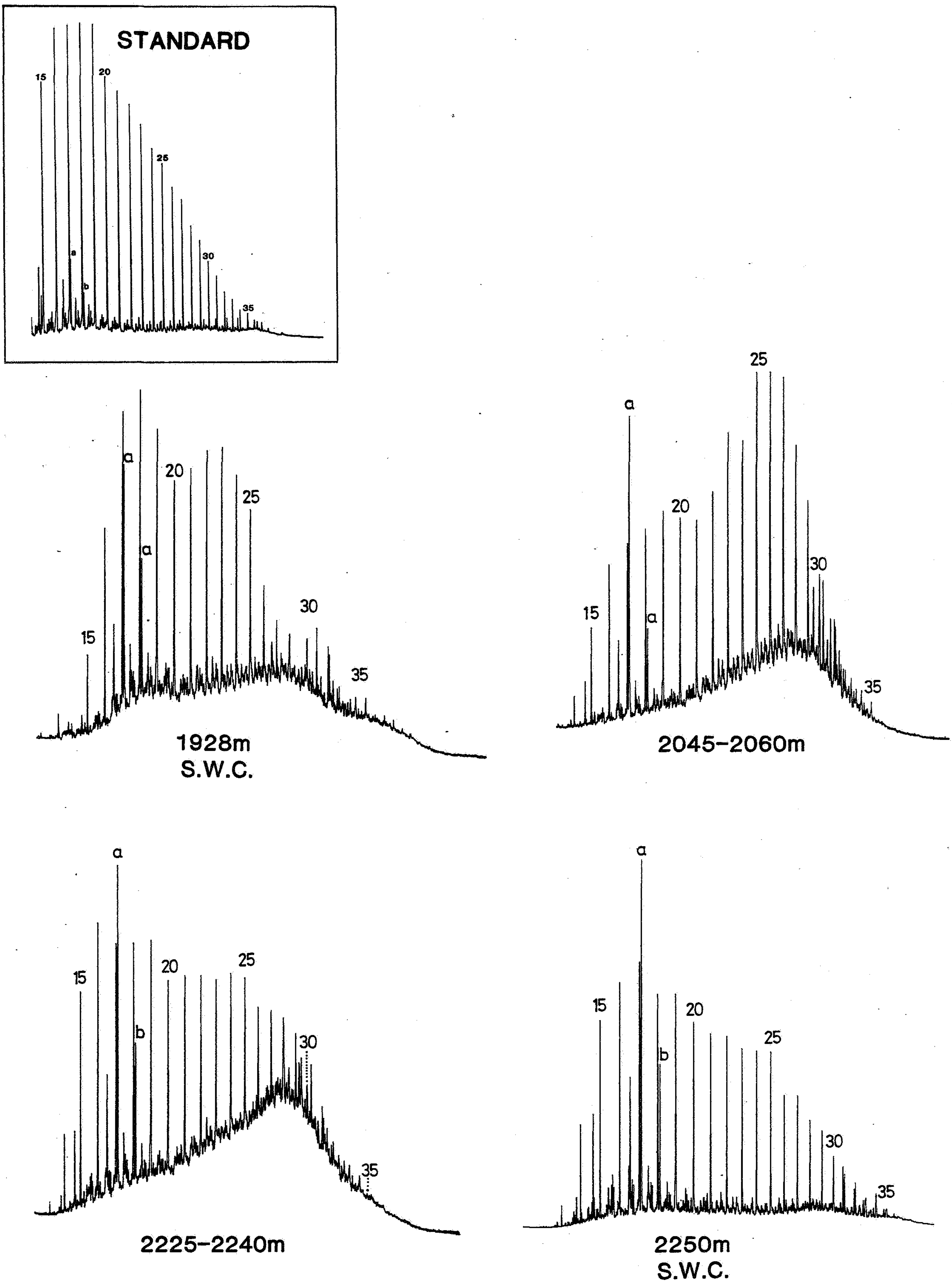


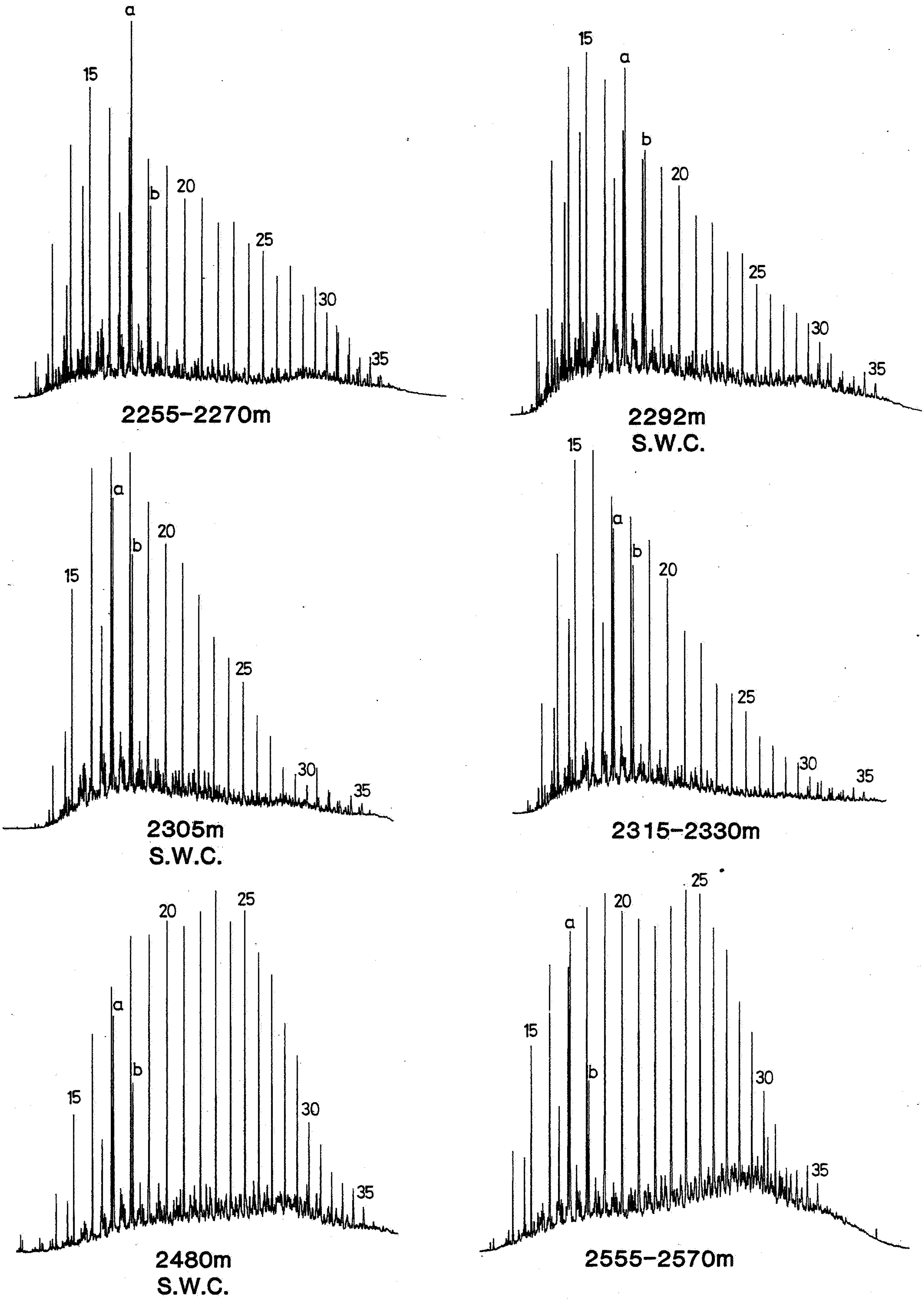
FIGURE 6a C_{15+} PARAFFIN-NAPHTHENES WELL 7121/4-1



a - PRISTANE
b - PHYTANE

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

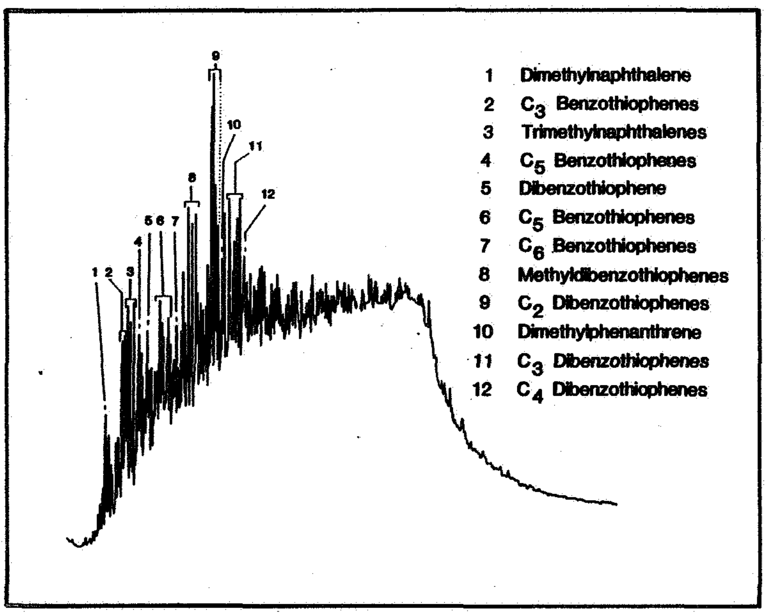
FIGURE 6b C_{15+} PARAFFIN-NAPHTHENES WELL 7121/4-1

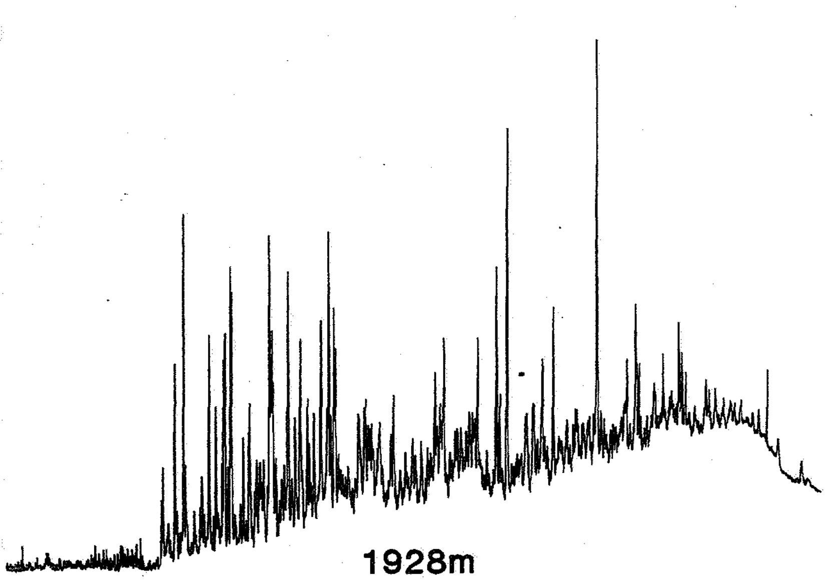


a - PRISTANE
b - PHYTANE

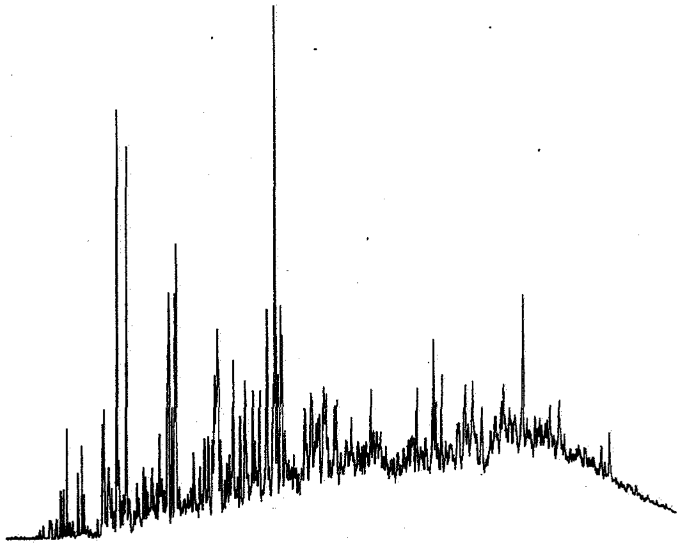
CARBON NUMBERS OF NORMAL PARAFFINS INDICATED (20 - nC_{20})

FIGURE 7a AROMATIC CHROMATOGRAMS WELL 7121/4-1

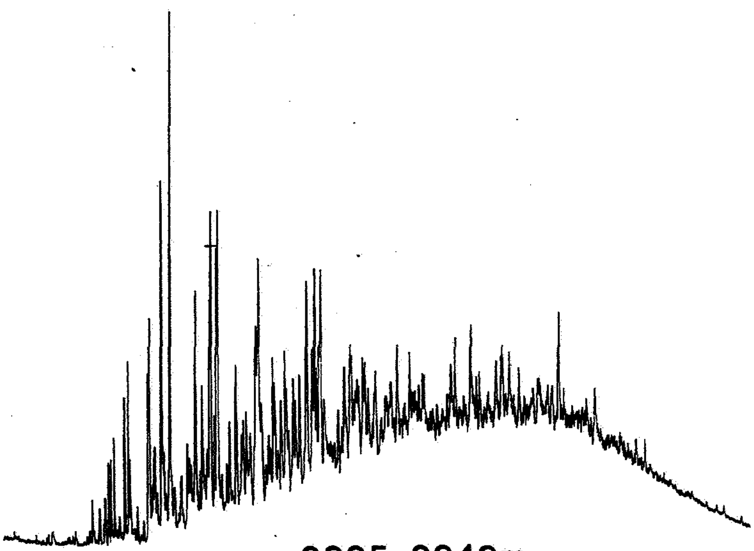




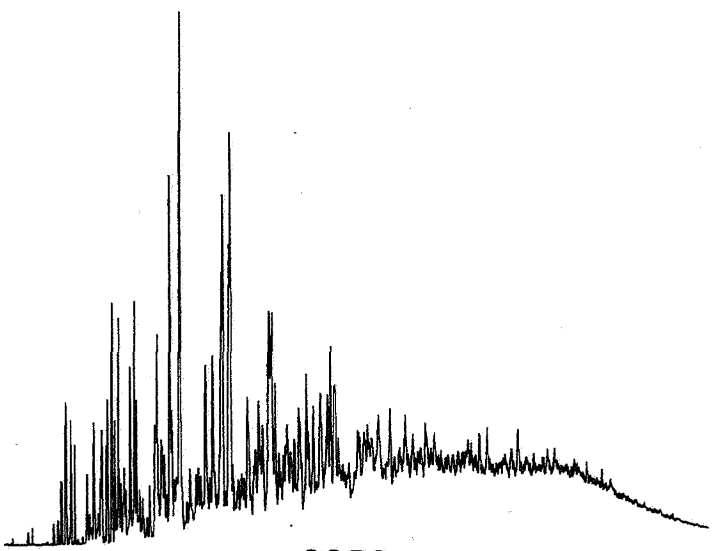
1928m
S.W.C.



2045-2060m

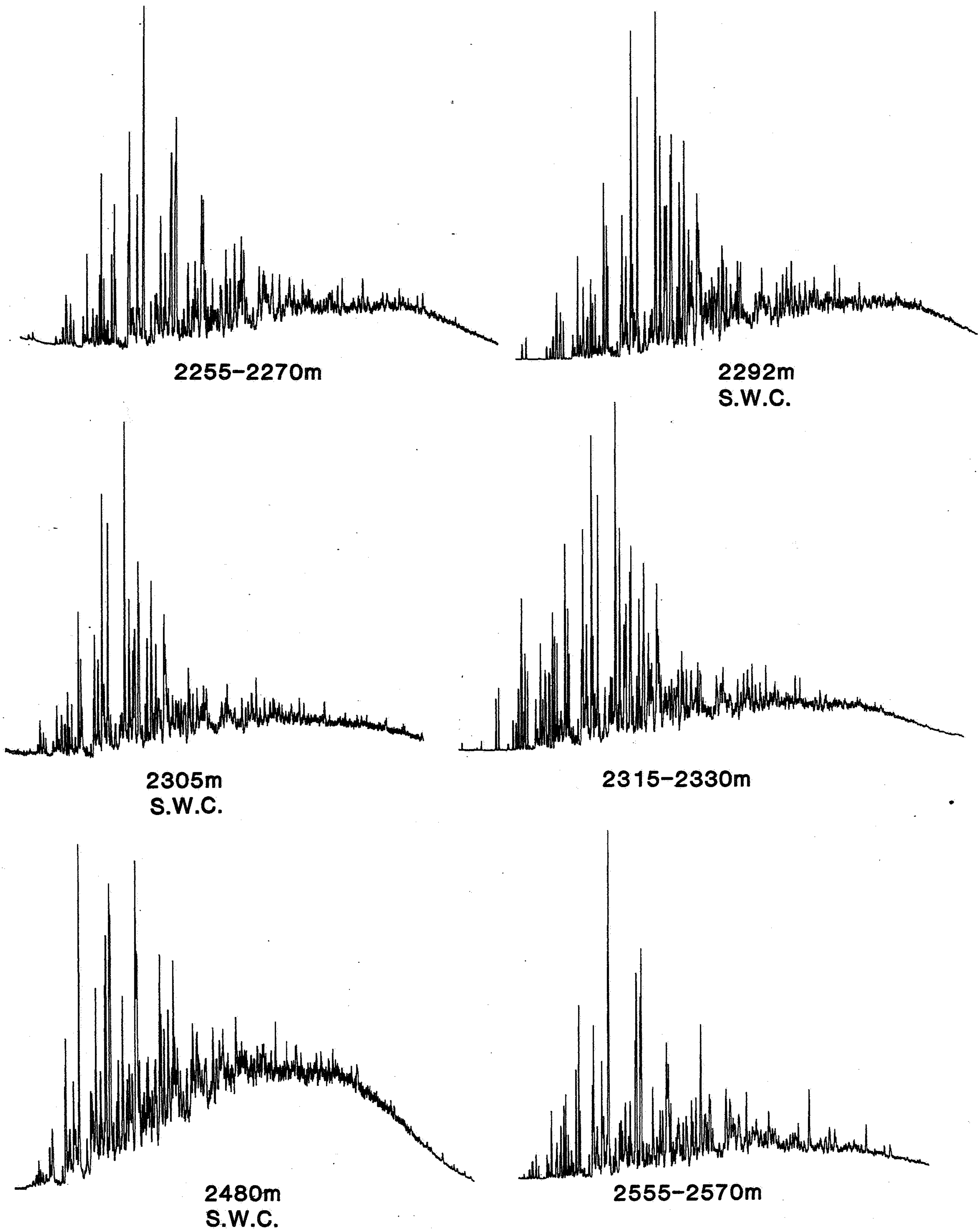


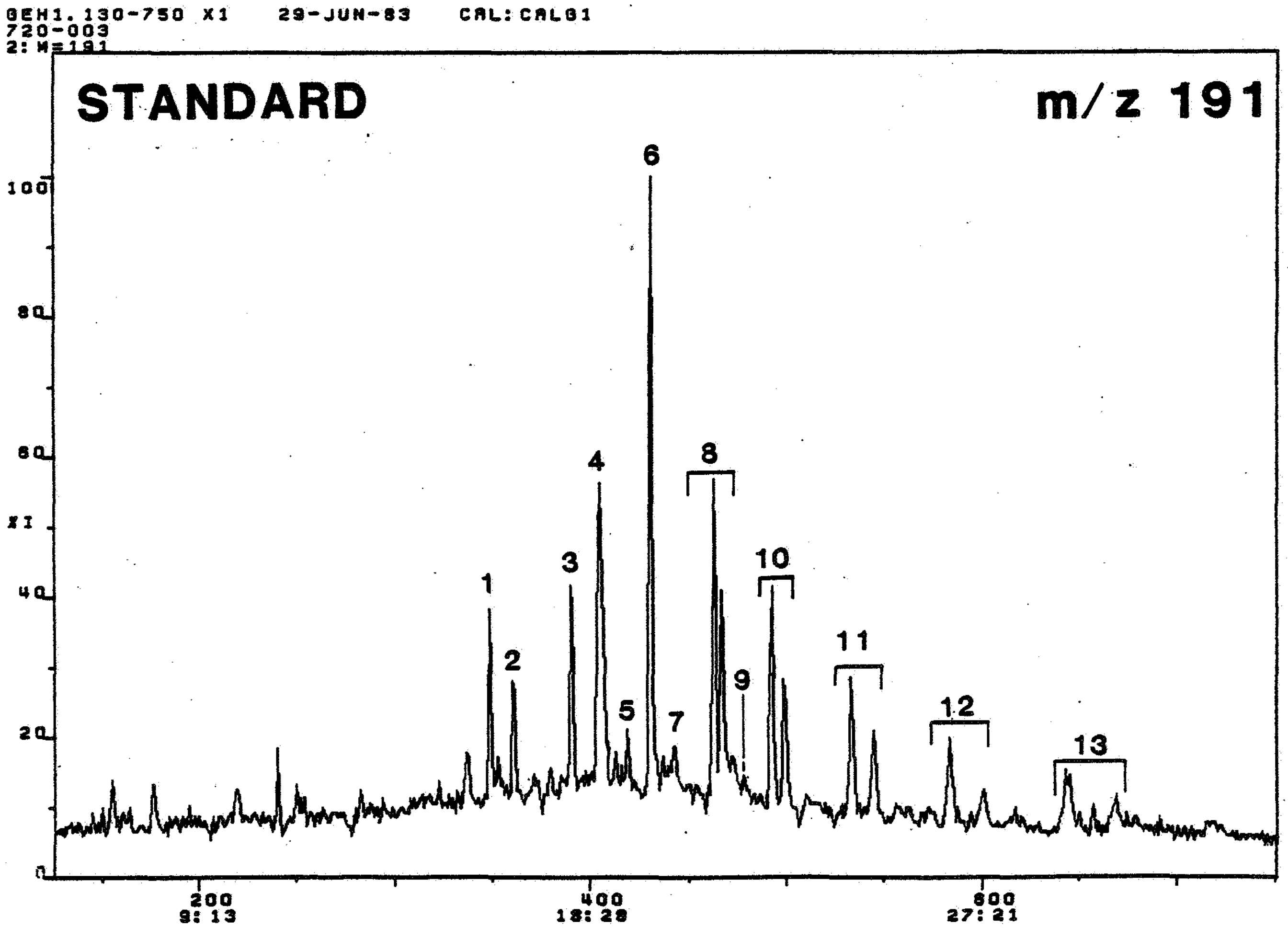
2225-2240m



2250m
S.W.C.

FIGURE 7b **AROMATIC CHROMATOGRAMS** WELL 7121/4-1





<u>LIST OF IDENTIFIED TRITERPANES</u>

1		17αH TRISNORHOPANE (C_{27})
2		17αH TRISNORHOPANE (C_{27})
3		BISNORHOPANE (C_{28})
4		17αH NORHOPANE (C_{29})
5		NORMORETANE (C_{29})
6		17αH HOPANE (C_{30})
7		17αH MORETANE (C_{30})
8	(22S) (22R)	17αH HOMOHOPANES (C_{31})
9		GAMMACERANE
10	(22S) (22R)	BISHOMOHOPANE (C_{32})
11	(22S) (22R)	TRISHOMOHOPANES (C_{33})
12	(22S) (22R)	TETRAHOPANES (C_{34})
13	(22S) (22R)	HOPANES (C_{35})

FIGURE 8a **MASS FRAGMENTOGRAMS** WELL 7121/4-1

TRITERPANES m/z 191

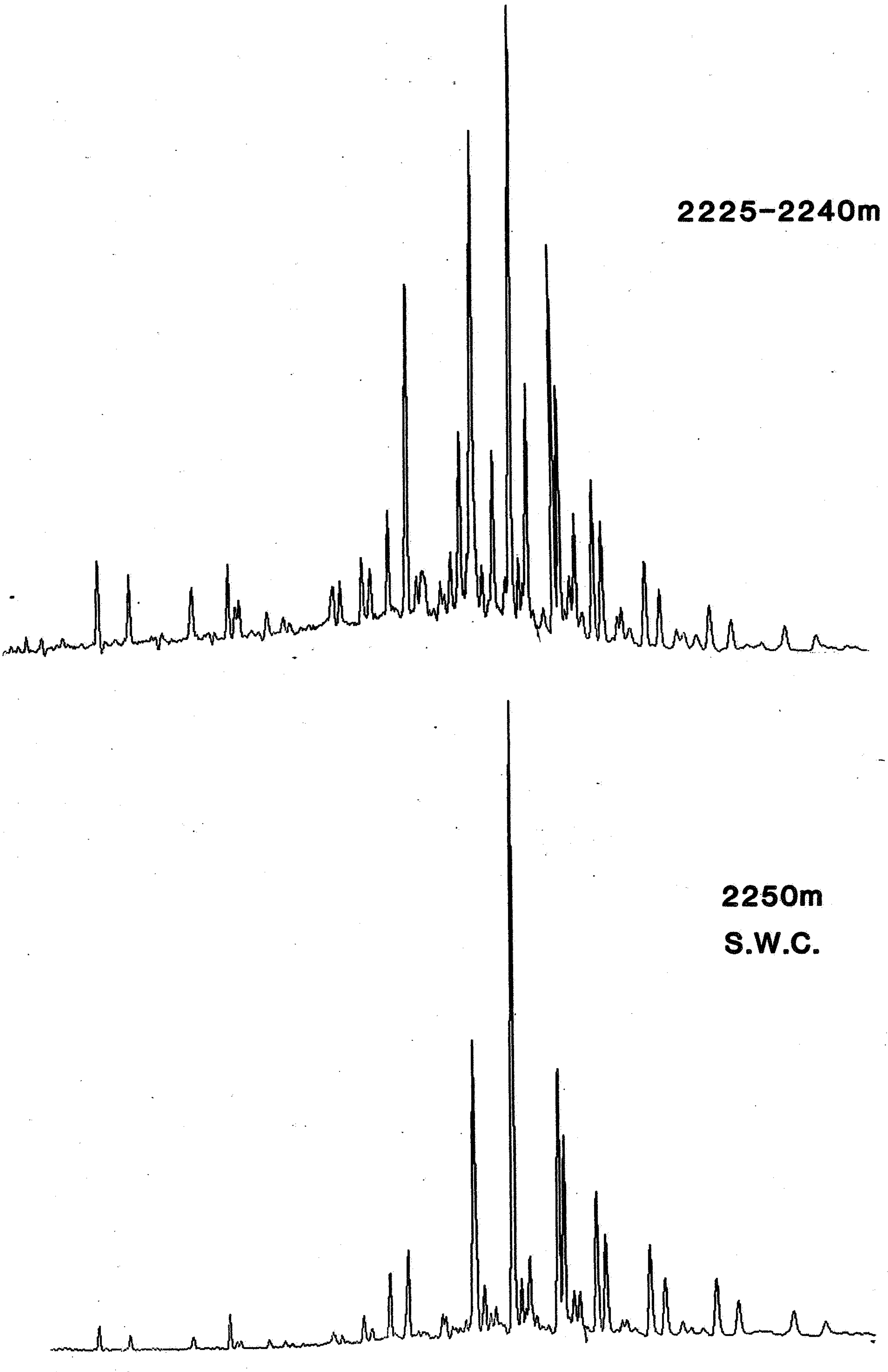
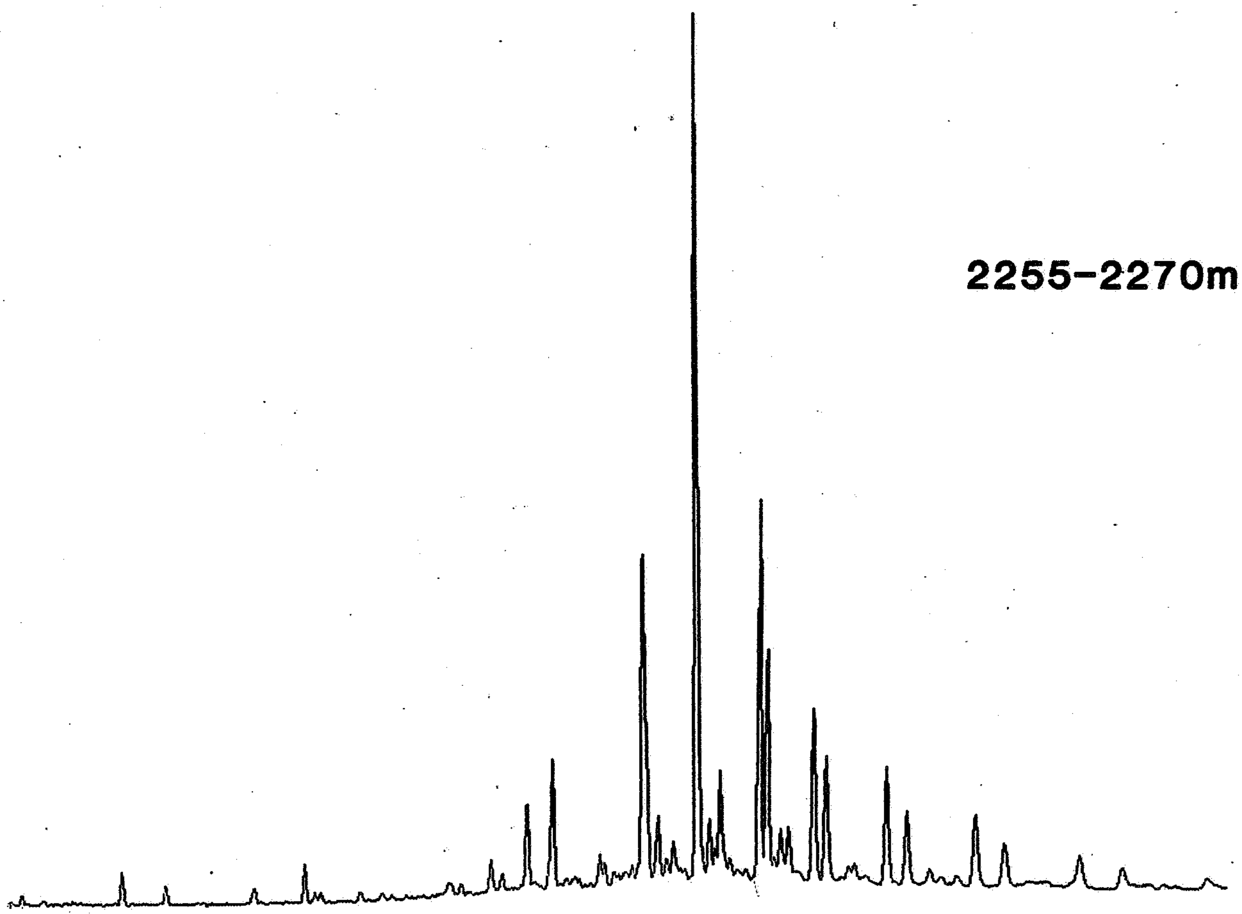


FIGURE 8b MASS FRAGMENTOGRAMS WELL 7121/4-1

TRITERPANES m/z 191



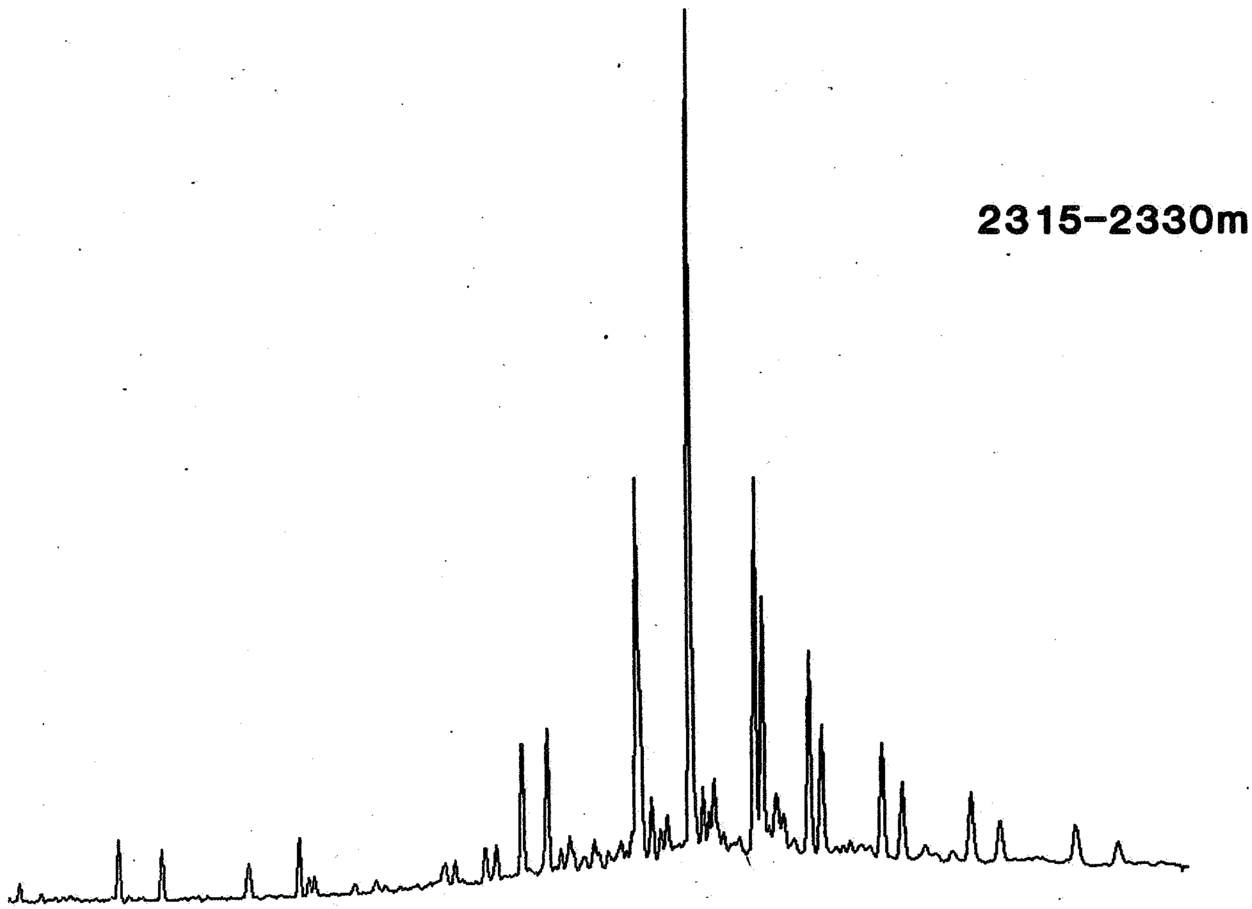
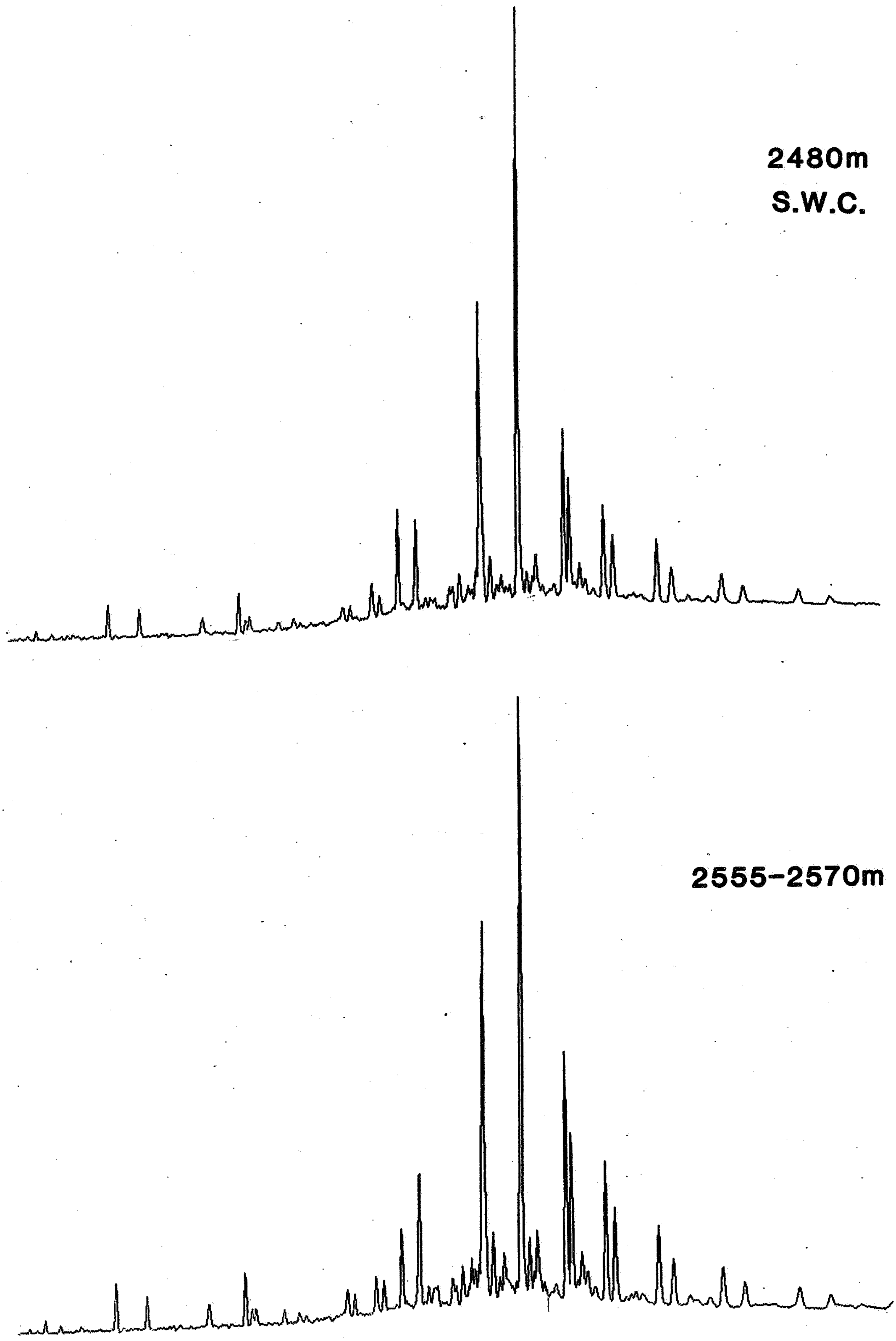
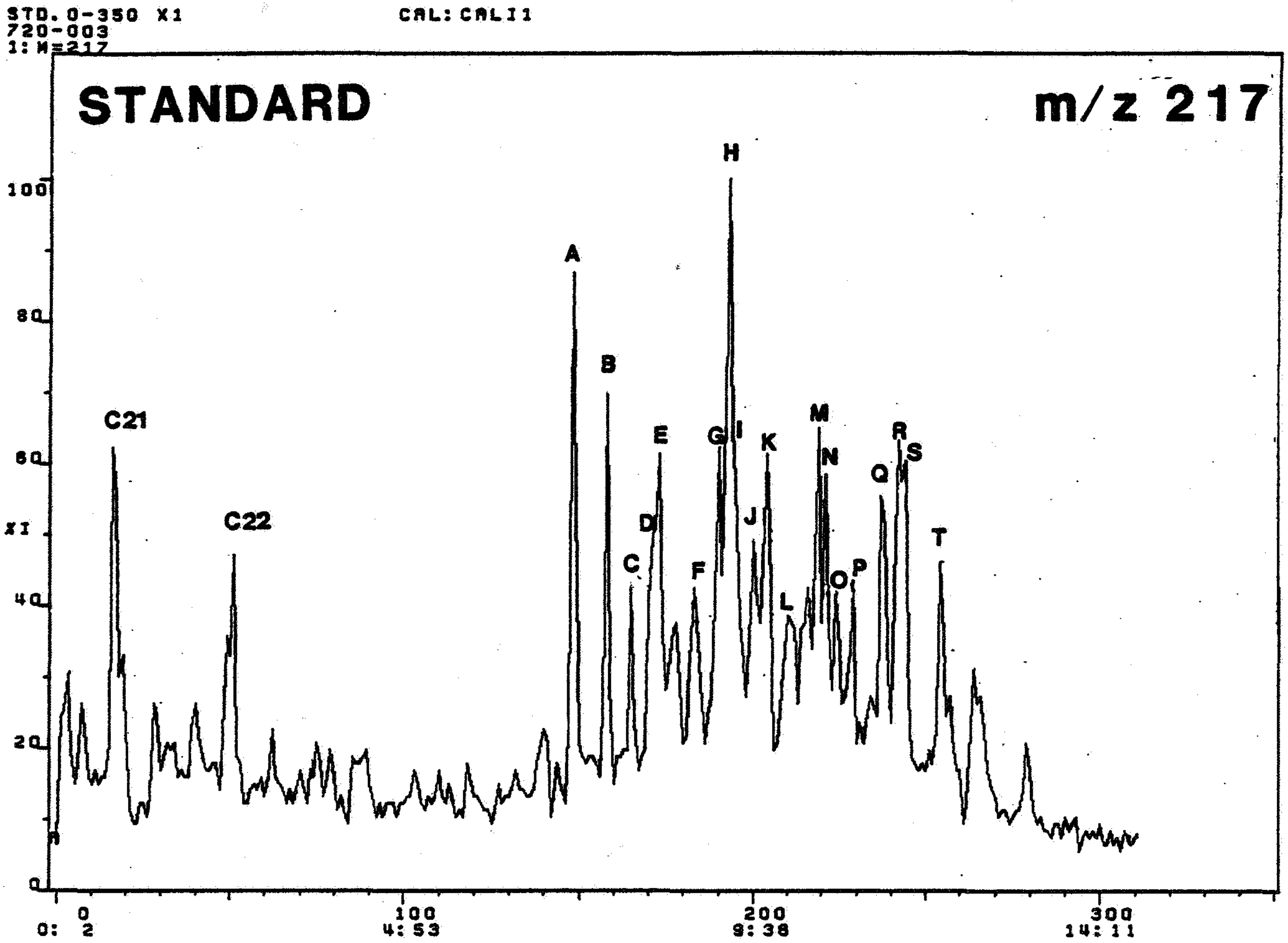


FIGURE 8c **MASS FRAGMENTOGRAMS** WELL 7121/4-1

TRITERPANES m/z 191



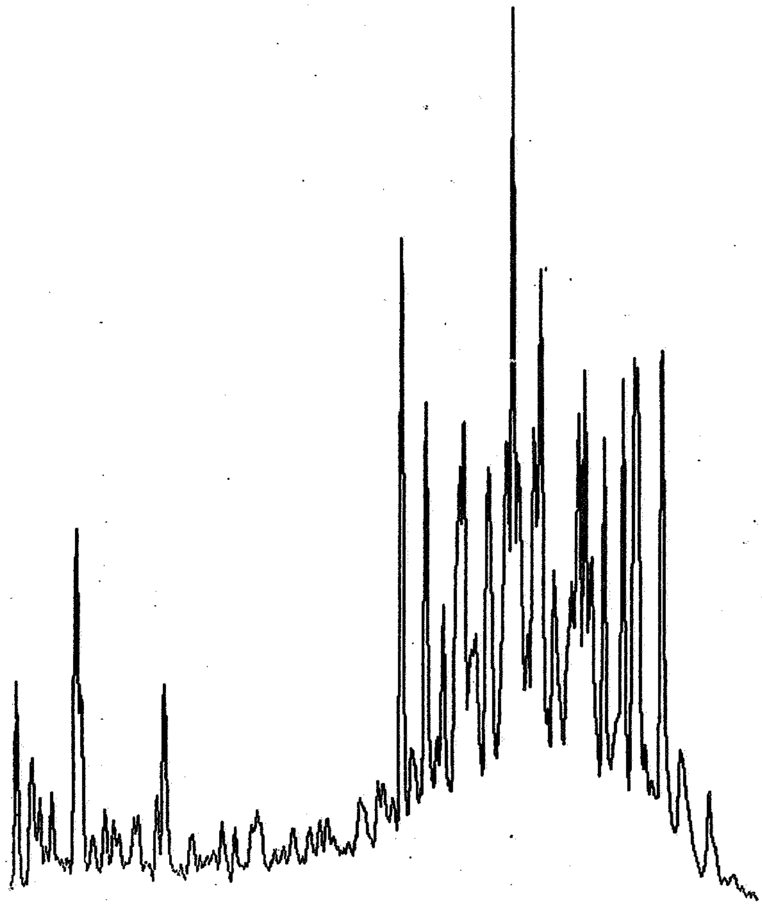


LIST OF IDENTIFIED STERANES

A C_{27} DIACHOLESTANE (20S)
B C_{27} DIACHOLESTANE (20R)
C C_{27} DIACHOLESTANE (20S)
D C_{27} DIACHOLESTANE (20R)
E C_{28} METHYL DIACHOLESTANE (20S)
F C_{28} METHYL DIACHOLESTANE (20R)
G C_{28} METHYL DIACHOLESTANE (20S)
H C_{29} ETHYL DIACHOLESTANE (20S)
I C_{27} CHOLESTANE (20S) & C_{28} METHYL DIACHOLESTANE (20R)
J C_{27} CHOLESTANE (20R)
K C_{29} ETHYL DIACHOLESTANE (20R)
L C_{29} ETHYL DIACHOLESTANE (20S)
M C_{28} METHYL CHOLESTANE (20S)
N C_{29} ETHYL DIACHOLESTANE (20R)
O C_{28} METHYL CHOLESTANE (20S)
P C_{28} METHYL CHOLESTANE (20R)
Q C_{29} ETHYL CHOLESTANE (20S) [$\alpha\alpha$]
R C_{29} ETHYL CHOLESTANE (20R) [$\beta\beta$]
S C_{29} ETHYL CHOLESTANE (20S) [$\beta\beta$]
T C_{29} ETHYL CHOLESTANE (20R) [$\alpha\alpha$]

FIGURE 8d MASS FRAGMENTOGRAMS WELL 7121/4-1

STERANES m/z 217



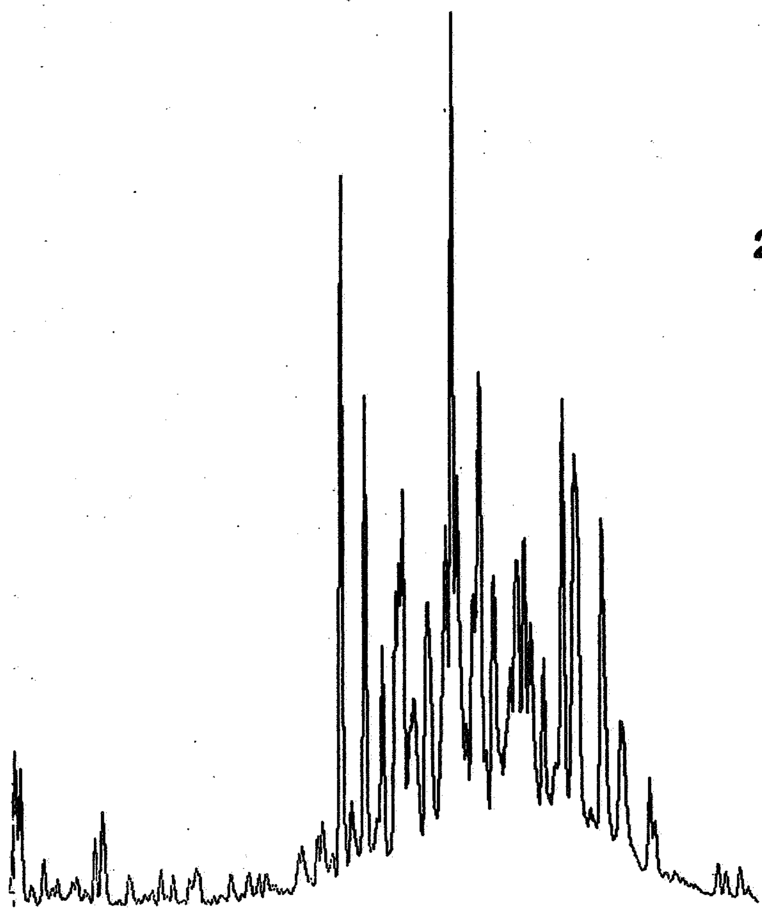
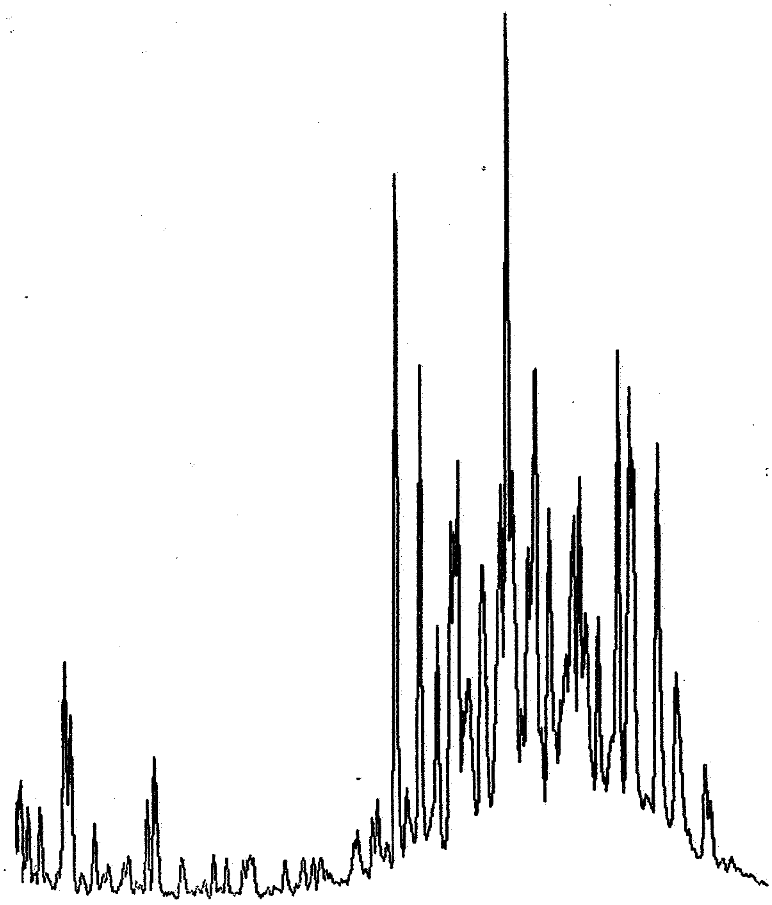
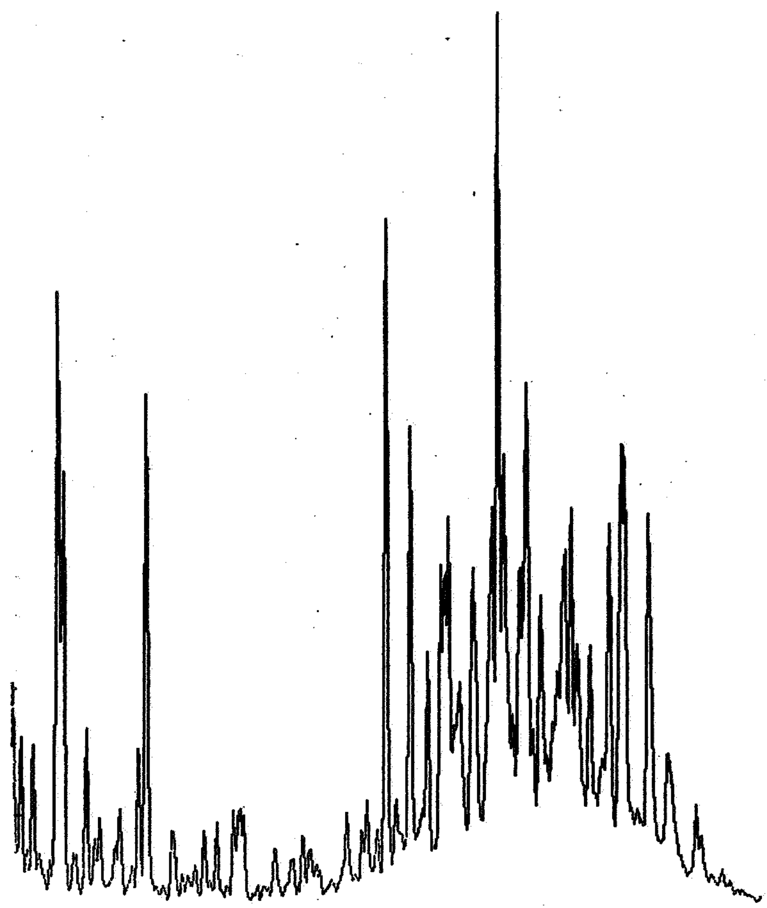


FIGURE 8e MASS FRAGMENTOGRAMS WELL 7121/4-1

STERANES m/z 217



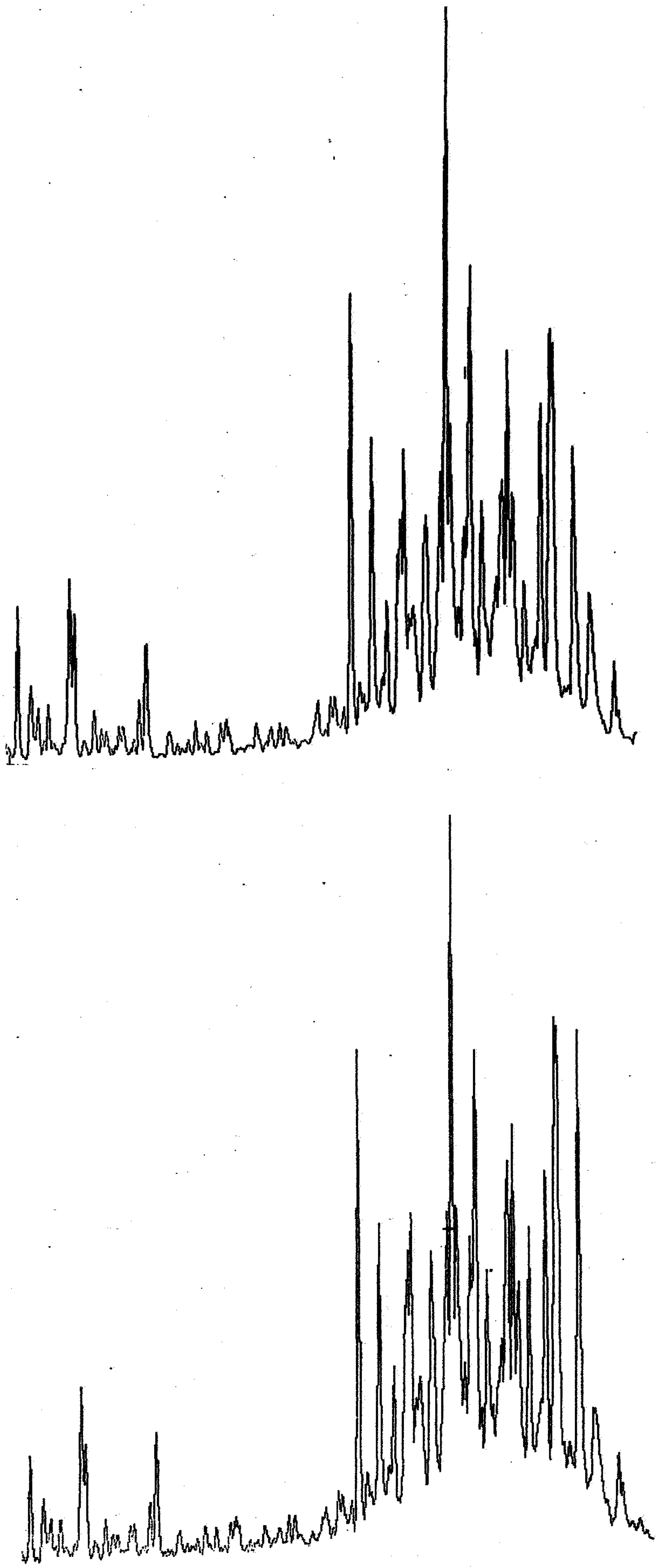
2255-2270m



2315-2330m

FIGURE 8f **MASS FRAGMENTOGRAMS** WELL 7121/4-1

STERANES m/z 217

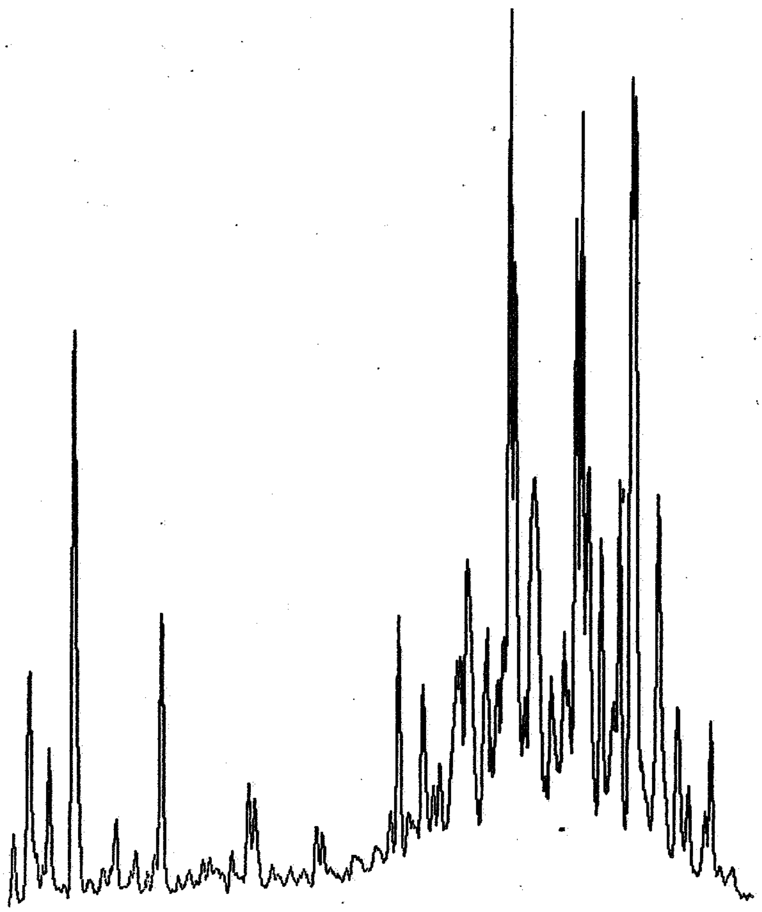


2480m
S.W.C.

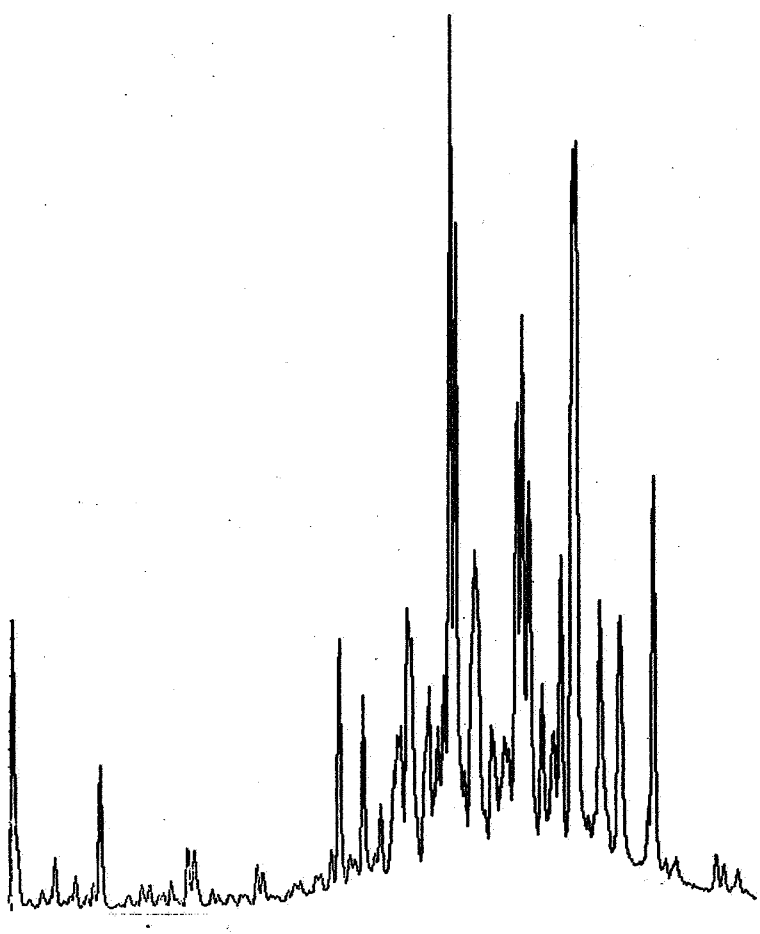
2555-2570m

FIGURE 8g **MASS FRAGMENTOGRAMS** WELL 7121/4-1

STERANES m/z 218



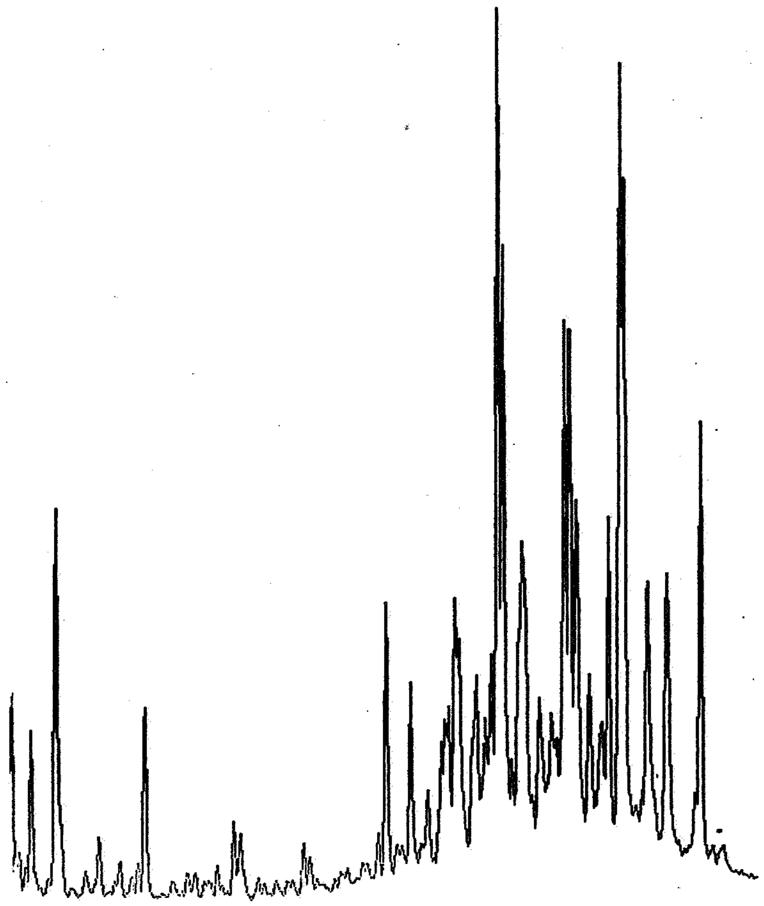
2225-2240m



2250m
S.W.C.

FIGURE 8h MASS FRAGMENTOGRAMS WELL 7121/4-1

STERANES m/z 218



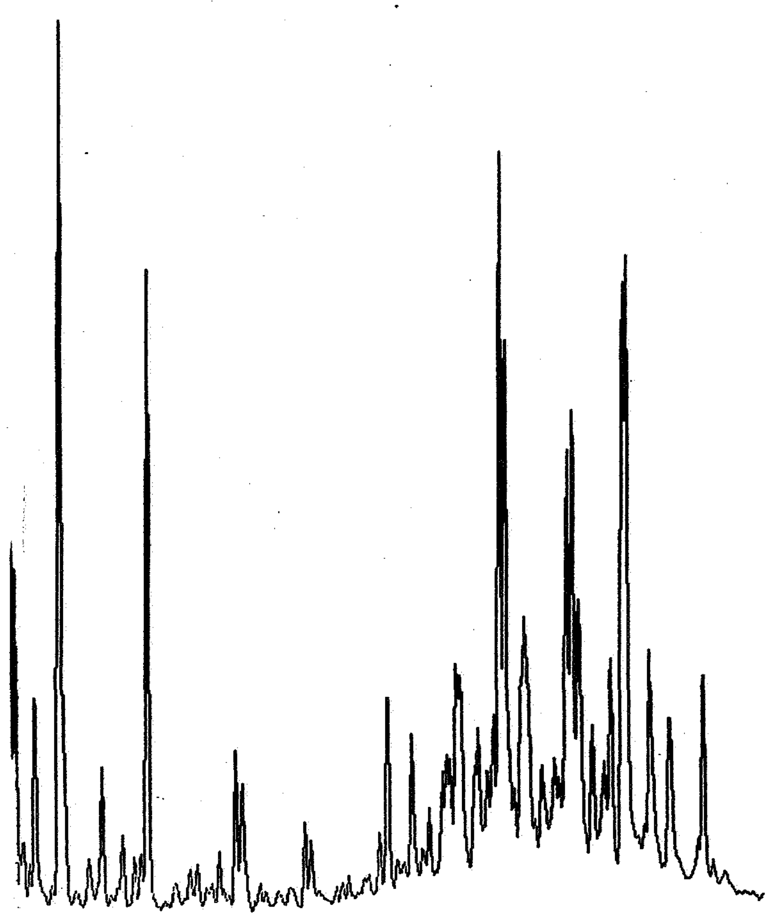
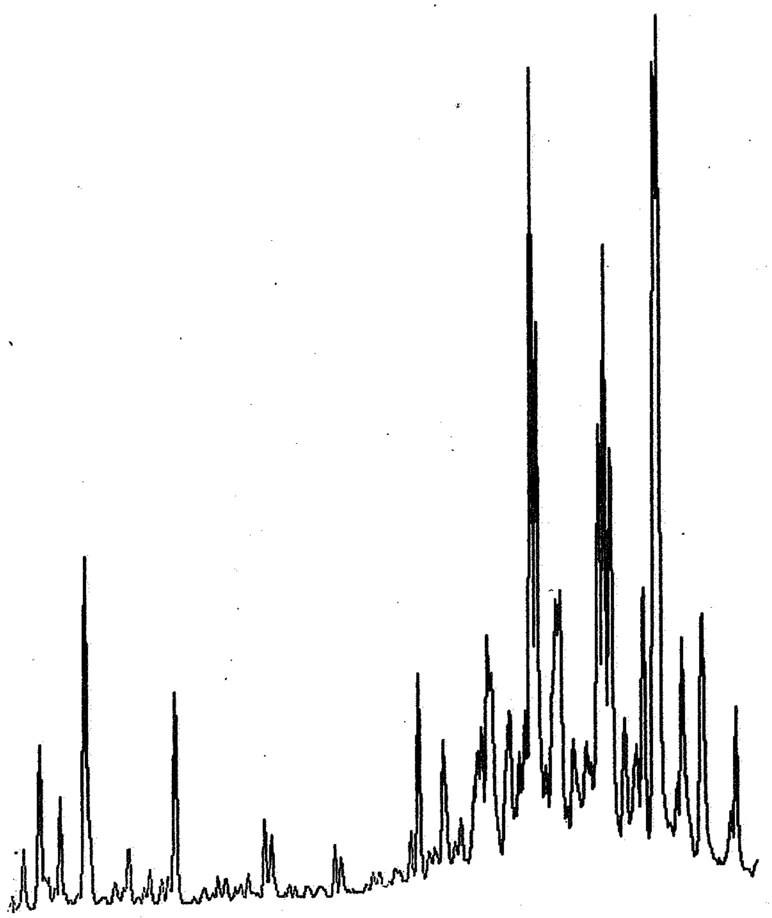
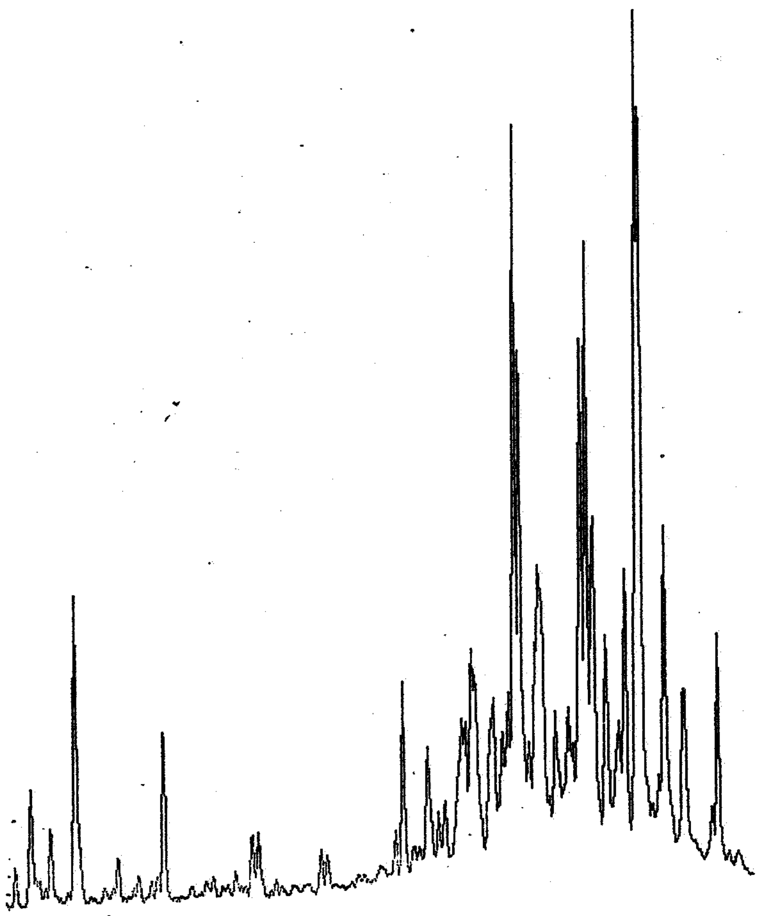


FIGURE 8i **MASS FRAGMENTOGRAMS** WELL 7121/4-1

STERANES m/z 218



2480m
S.W.C.



2555-2570m

FIGURE 8j **MASS FRAGMENTOGRAMS** WELL 7121/4-1

REARRANGED STERANES m/z 259

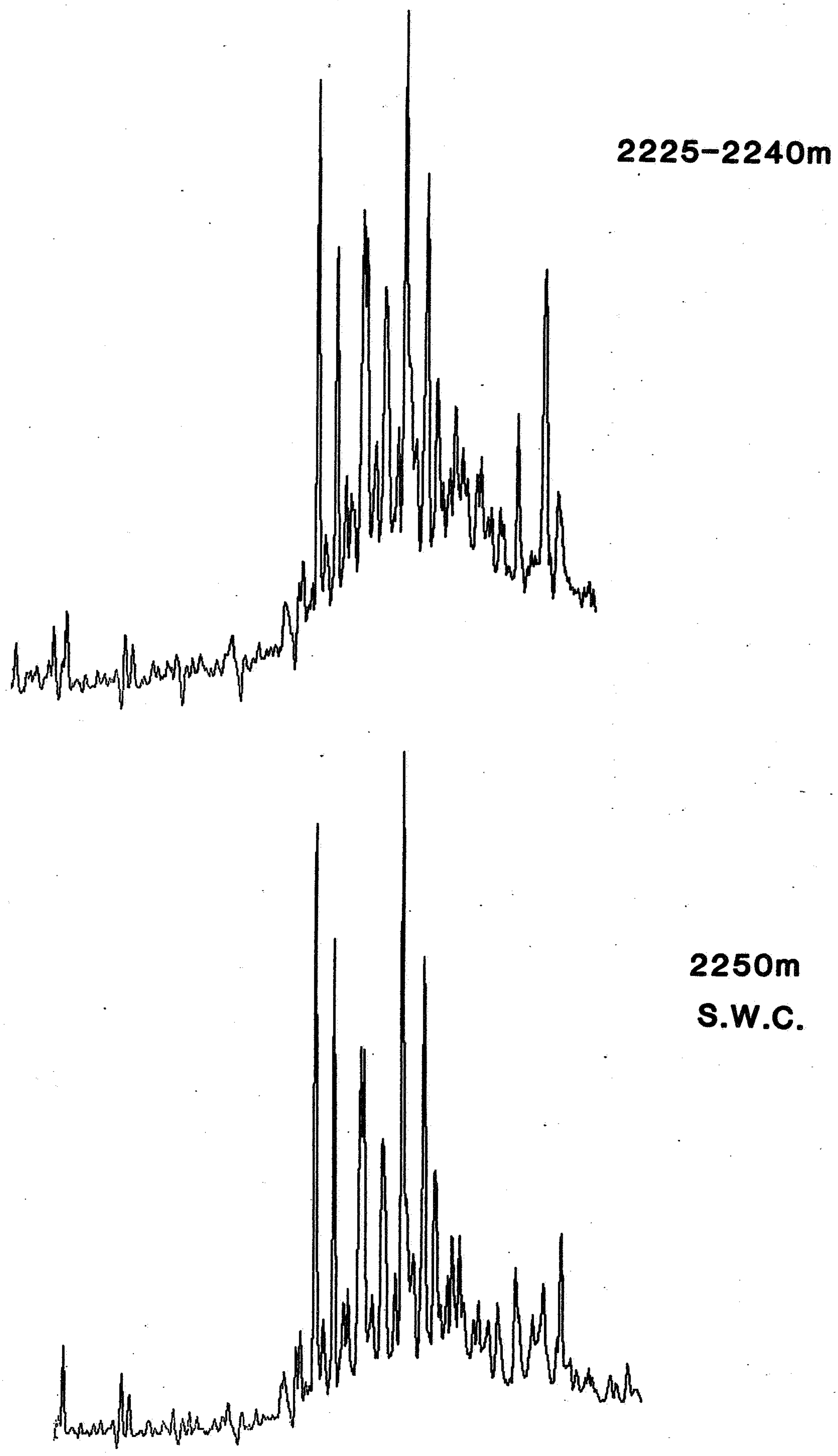
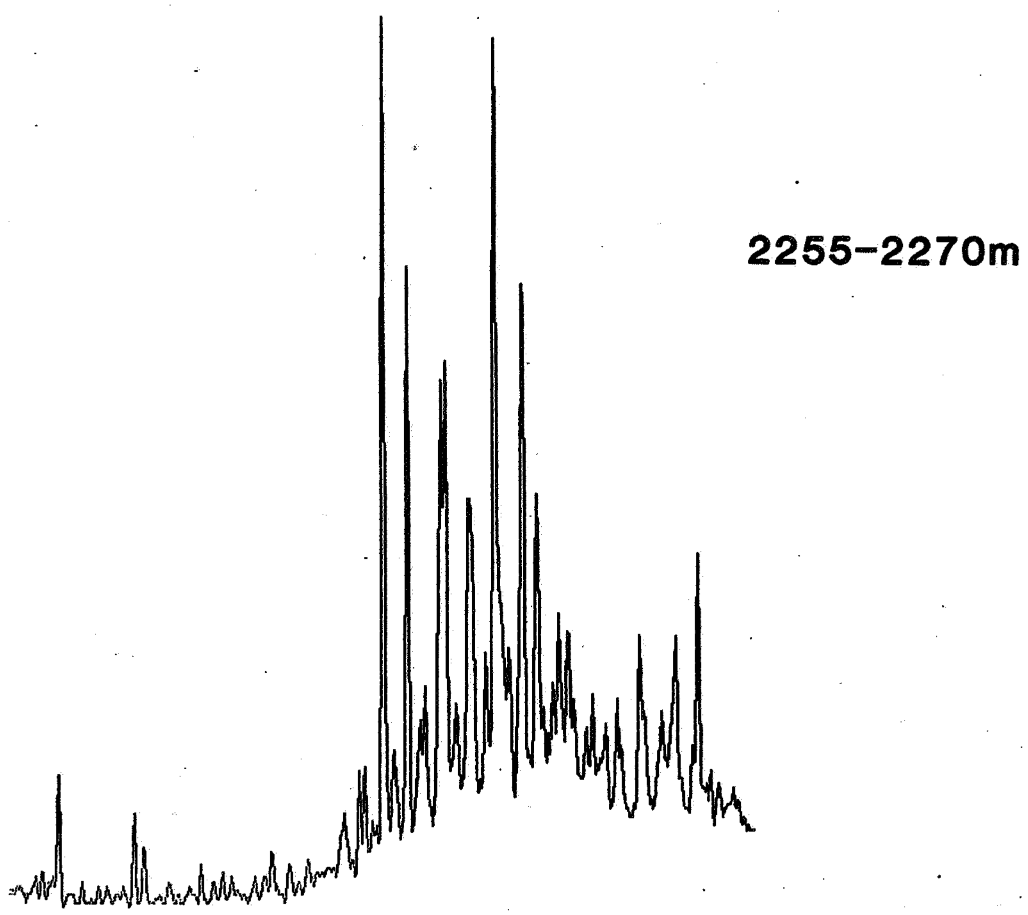


FIGURE 8k **MASS FRAGMENTOGRAMS** WELL 7121/4-1

REARRANGED STERANES m/z 259



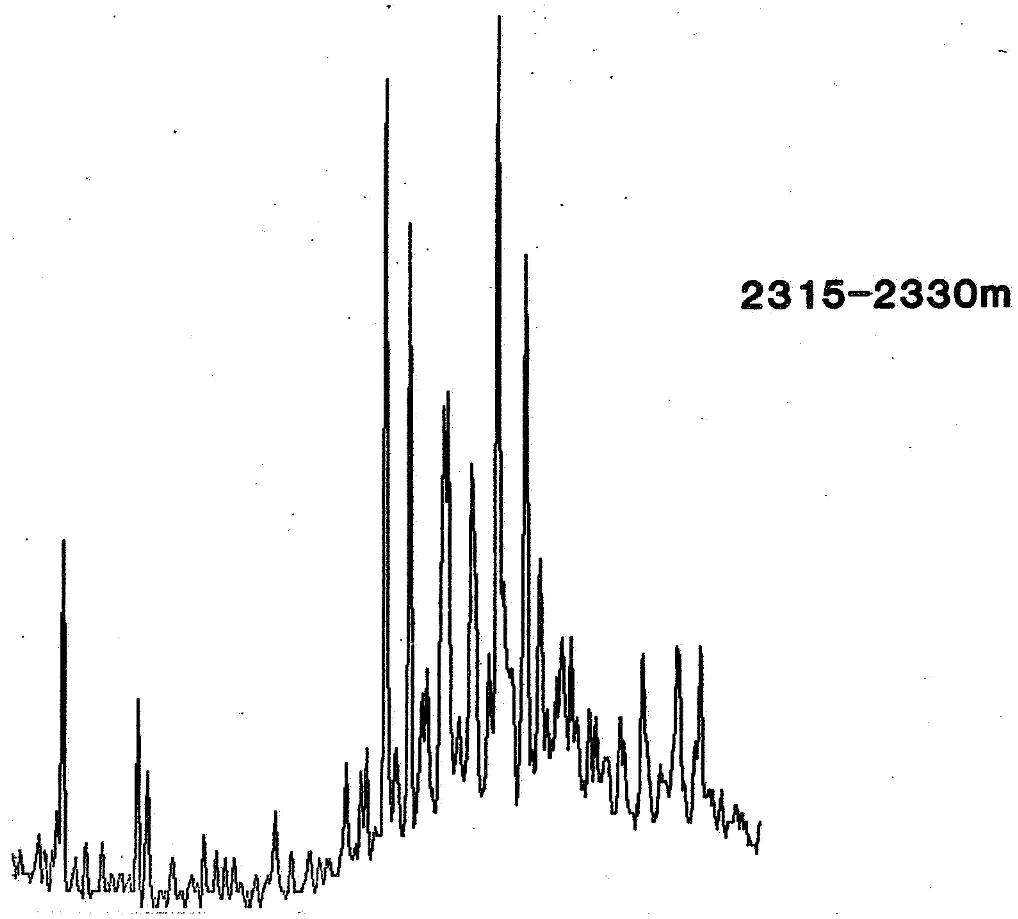
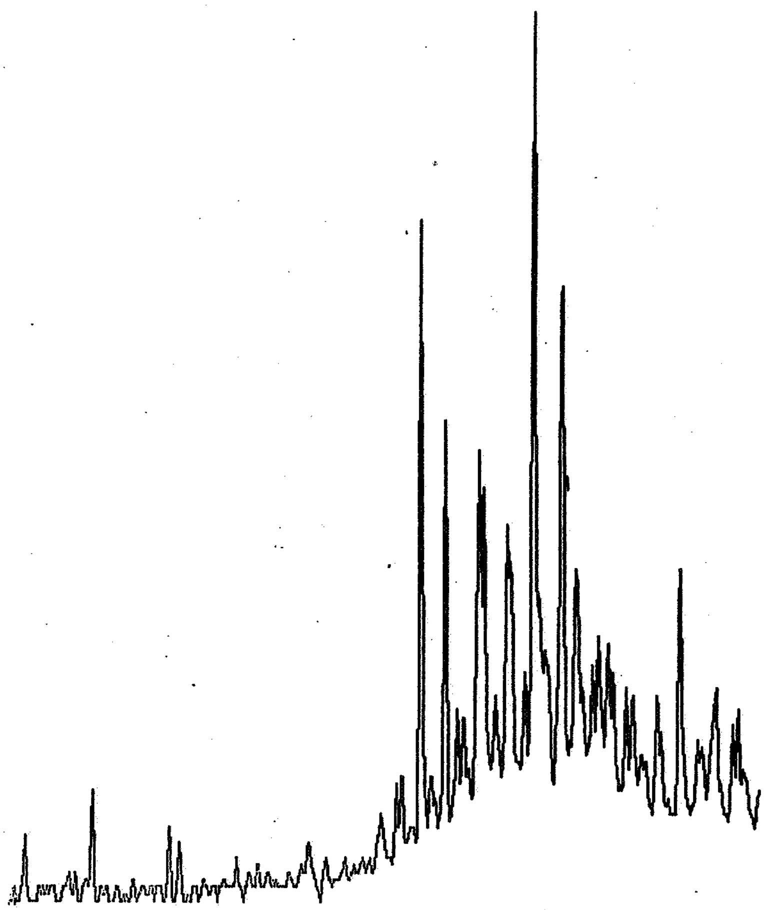
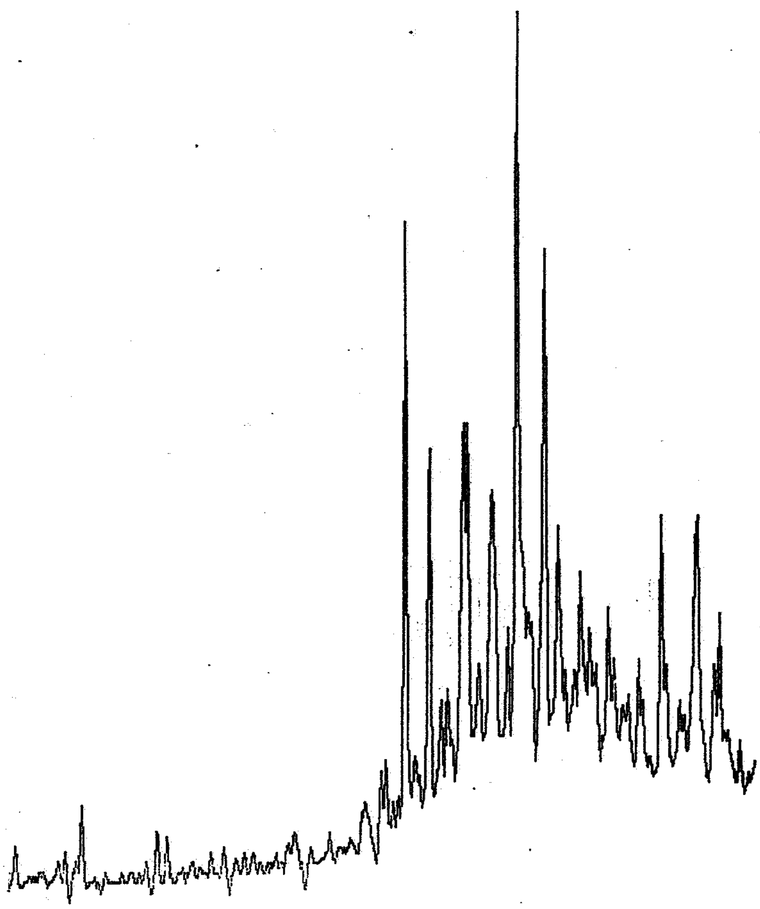


FIGURE 8L **MASS FRAGMENTOGRAMS** WELL 7121/4-1

REARRANGED STERANES m/z 259



2480m
S.W.C.



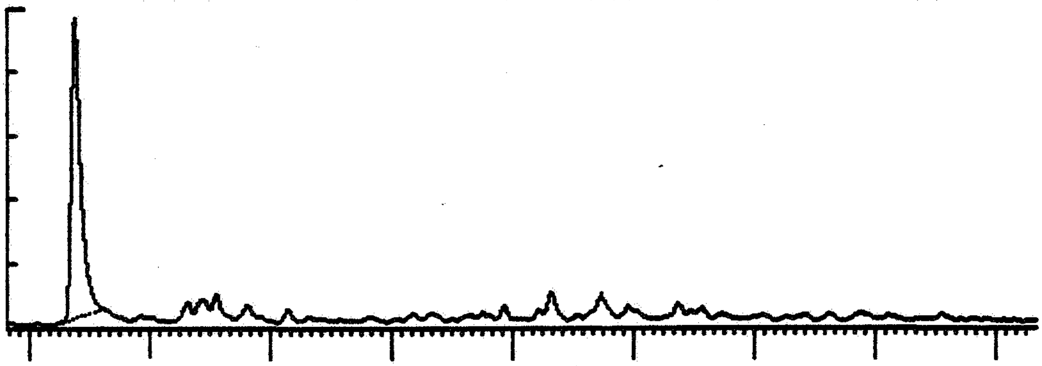
2555-2570m

AROMATIC MASS FRAGMENTOGRAMS
PHENANTHRENE SERIES

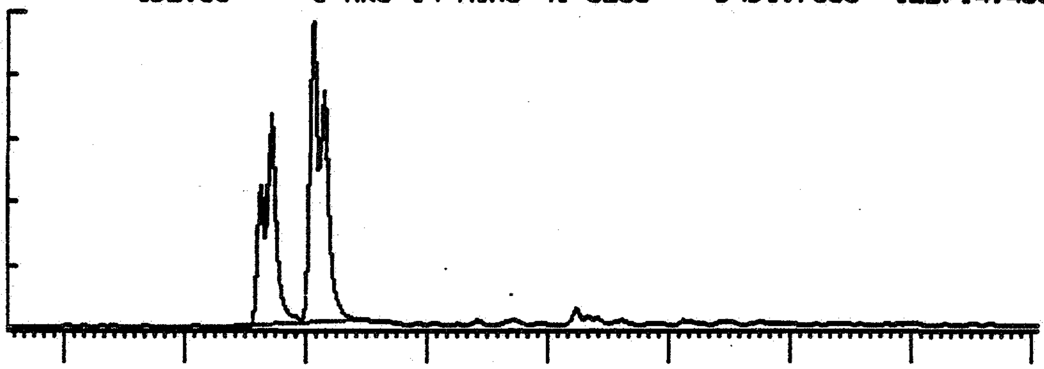
SIR REPORT. FILE - STD. .SD RUN - 1

UNCALIBRATED.

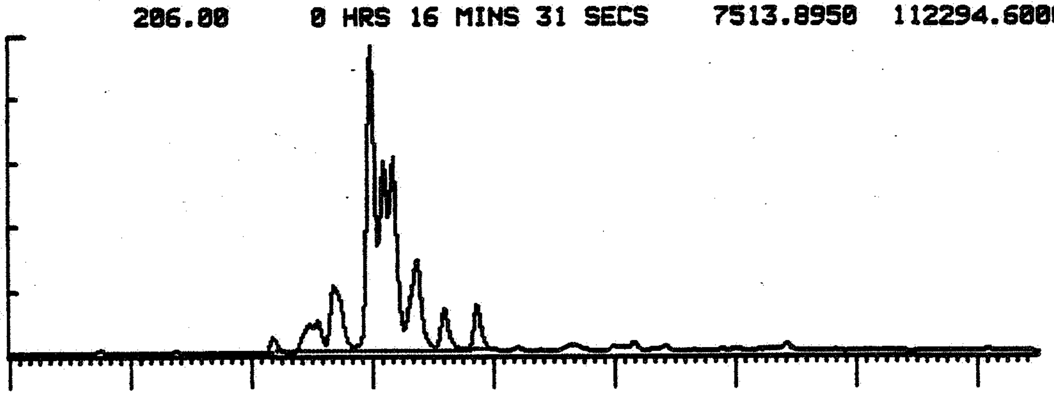
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
178.00	0 HRS 12 MINS 17 SECS	9885.1530	52863.6900	0.0000	0.0000



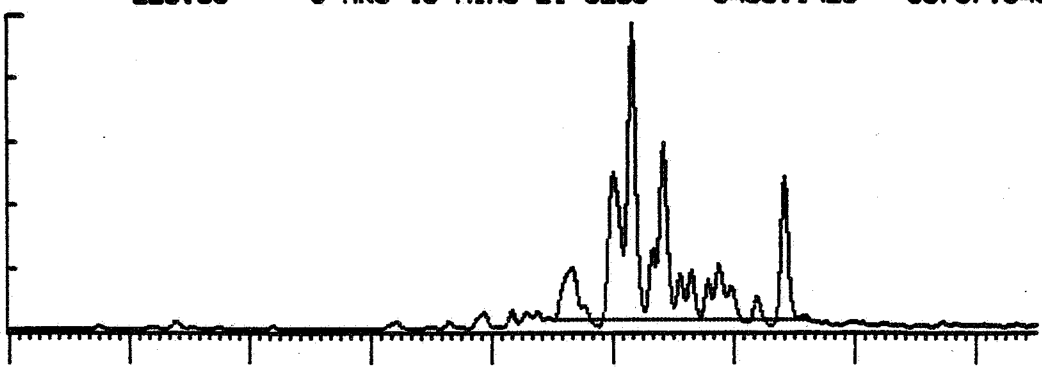
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
192.00	0 HRS 14 MINS 41 SECS	9491.7360	122714.4000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
206.00	0 HRS 16 MINS 31 SECS	7513.8950	112294.6000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
220.00	0 HRS 18 MINS 21 SECS	3435.1420	60707.0400	0.0000	0.0000



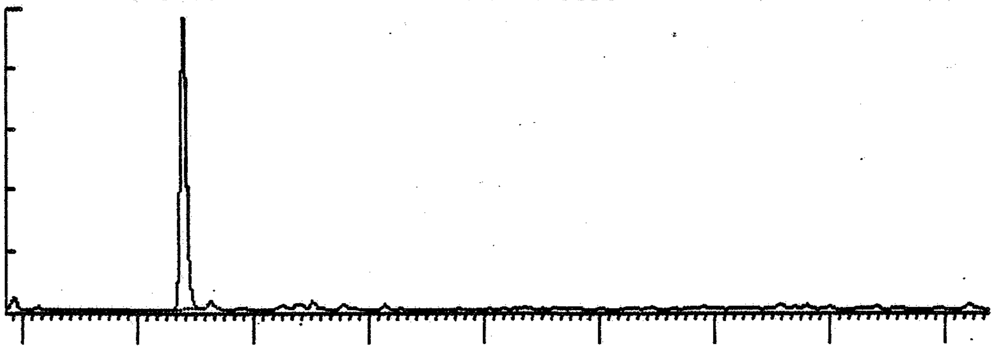
0 HRS 13 MINS 59 SECS 0 HRS 22 MINS 10 SECS

FIGURE 9a AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
PHENANTHRENE SERIES

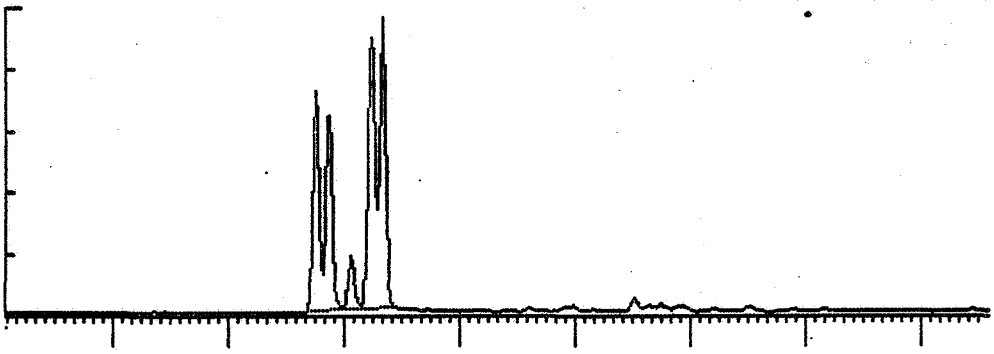
SIR REPORT. FILE - 966147 .SD RUN - 1

UNCALIBRATED.

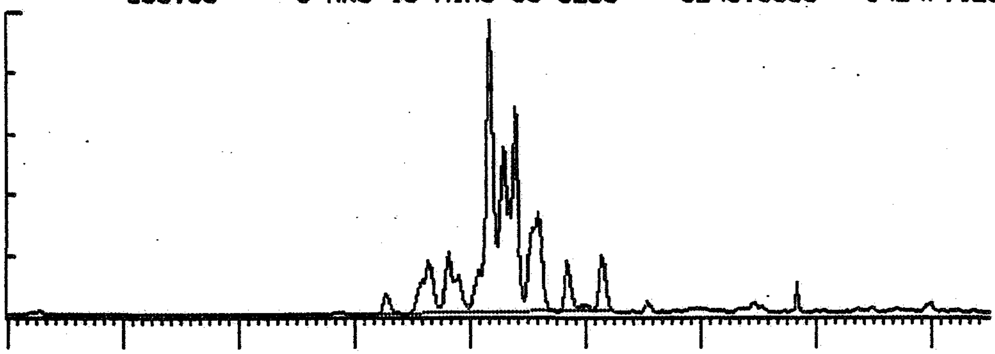
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
178.00	0 HRS 12 MINS 8 SECS	19416.6500	70589.8700	0.0000	0.0000



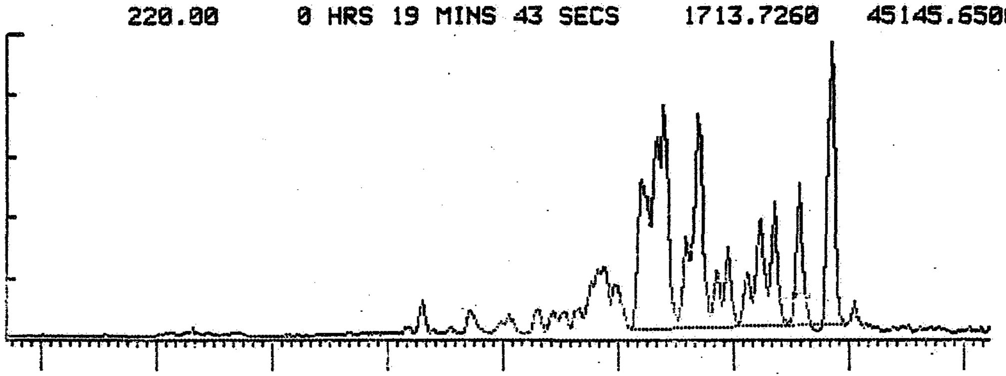
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
192.00	0 HRS 14 MINS 40 SECS	6832.1990	90862.2200	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
206.00	0 HRS 16 MINS 30 SECS	5240.0080	84247.1200	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
220.00	0 HRS 19 MINS 43 SECS	1713.7260	45145.6500	0.0000	0.0000



0 HRS 13 MINS 41 SECS 0 HRS 21 MINS 53 SECS

2225-2240m

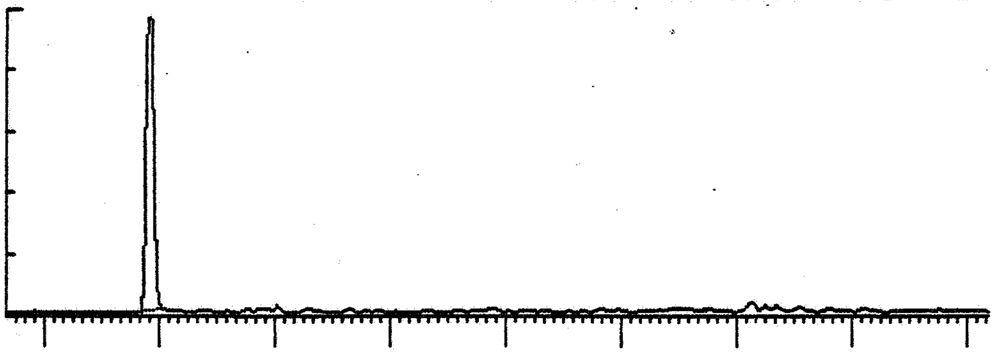
FIGURE 9b AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

PHENANTHRENE SERIES

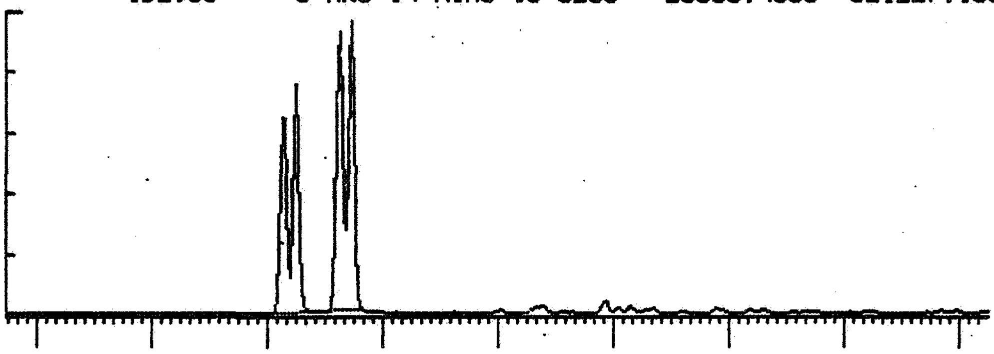
SIR REPORT. FILE - 966153 .SD RUN - 1

UNCALIBRATED.

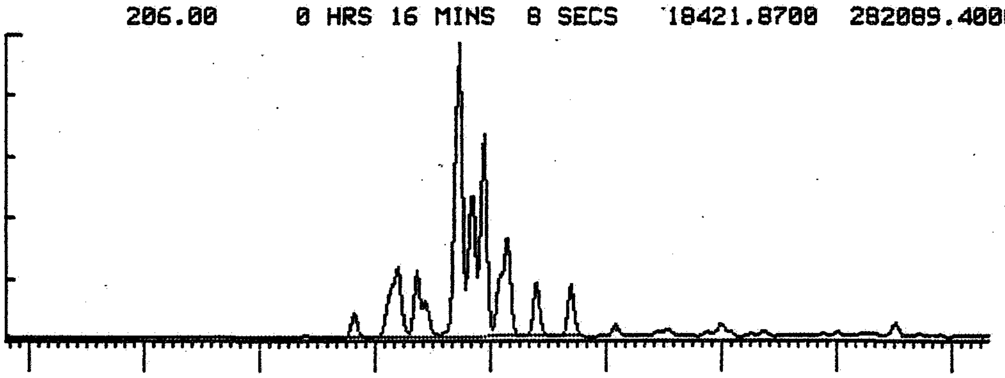
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
178.00	0 HRS 11 MINS 44 SECS	31546.8600	146767.2000	0.0000	0.0000



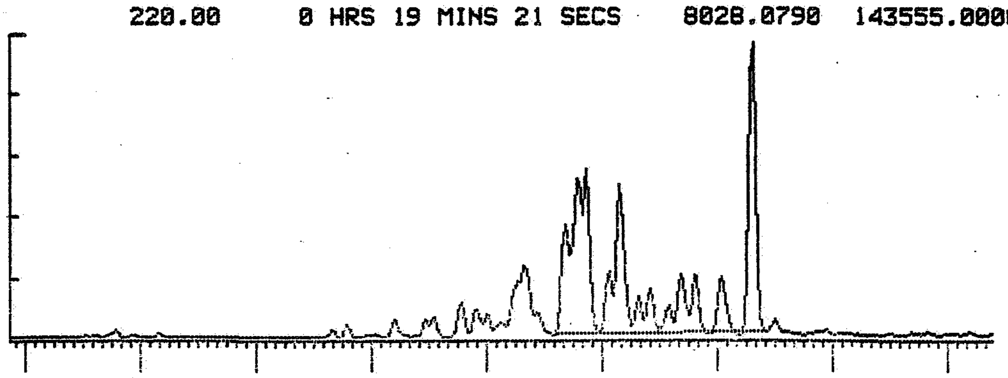
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
192.00	0 HRS 14 MINS 16 SECS	25685.4800	321227.1000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
206.00	0 HRS 16 MINS 8 SECS	18421.8700	282089.4000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
220.00	0 HRS 19 MINS 21 SECS	8028.0790	143555.0000	0.0000	0.0000



0 HRS 13 MINS 52 SECS

2250m

0 HRS 22 MINS 3 SECS

S.W.C.

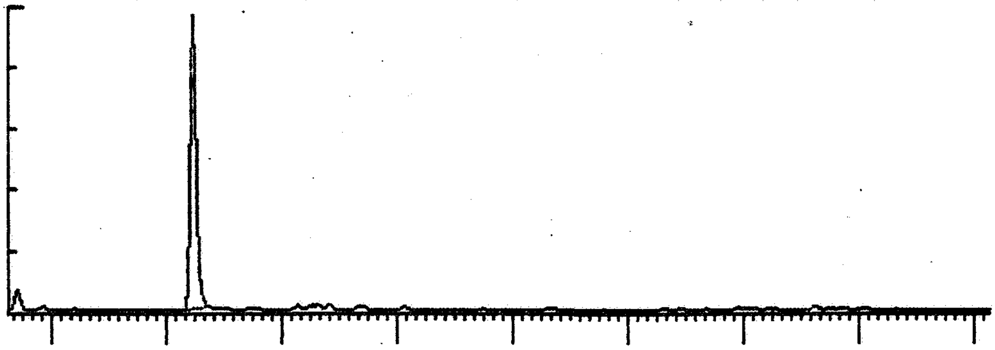
FIGURE 9c AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

PHENANTHRENE SERIES

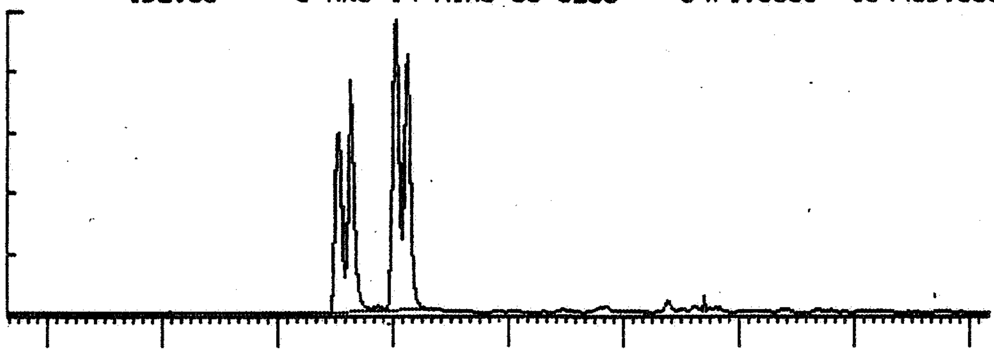
SIR REPORT. FILE - 966154 .SD RUN - 1

UNCALIBRATED.

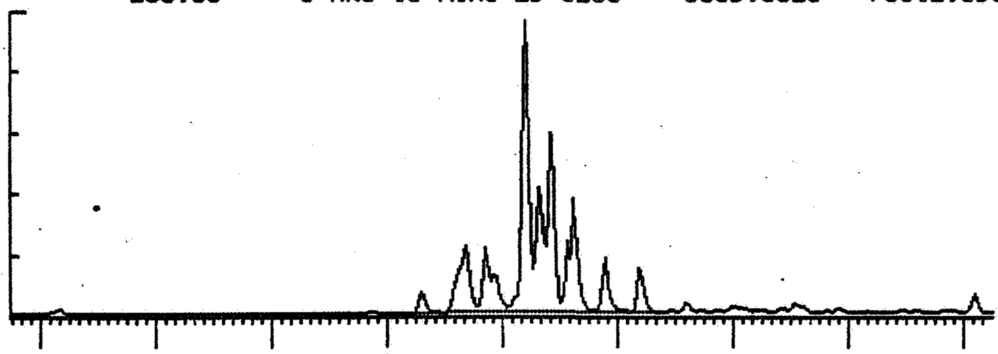
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
178.00	0 HRS 11 MINS 57 SECS	23862.9600	82544.8500	0.0000	0.0000



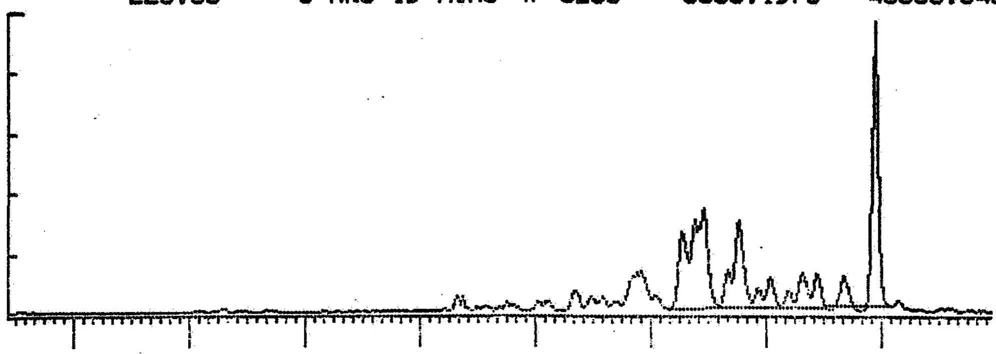
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
192.00	0 HRS 14 MINS 30 SECS	8471.8080	104489.6000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
206.00	0 HRS 16 MINS 29 SECS	5309.8520	78512.3900	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
220.00	0 HRS 19 MINS 47 SECS	3330.1970	40303.5400	0.0000	0.0000



0 HRS 13 MINS 26 SECS 0 HRS 21 MINS 37 SECS

2255-2270m

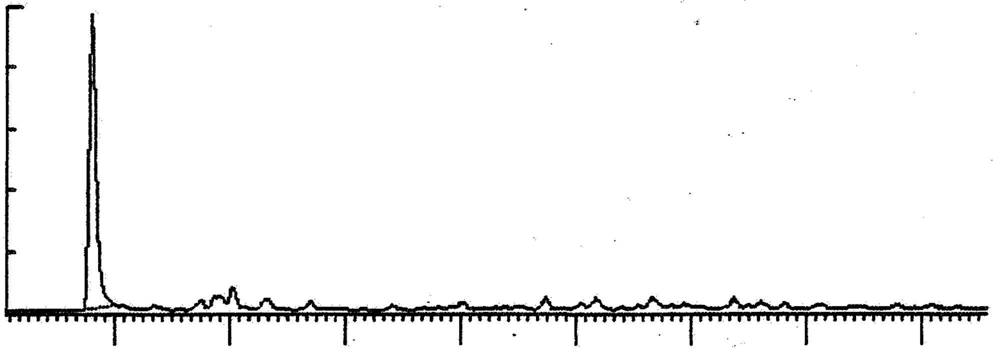
FIGURE 9d AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

PHENANTHRENE SERIES

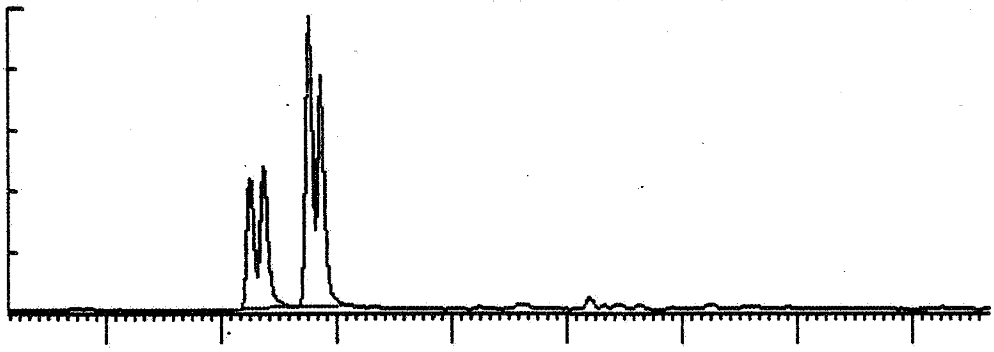
SIR REPORT. FILE - 966167 .SD RUN - 1

UNCALIBRATED.

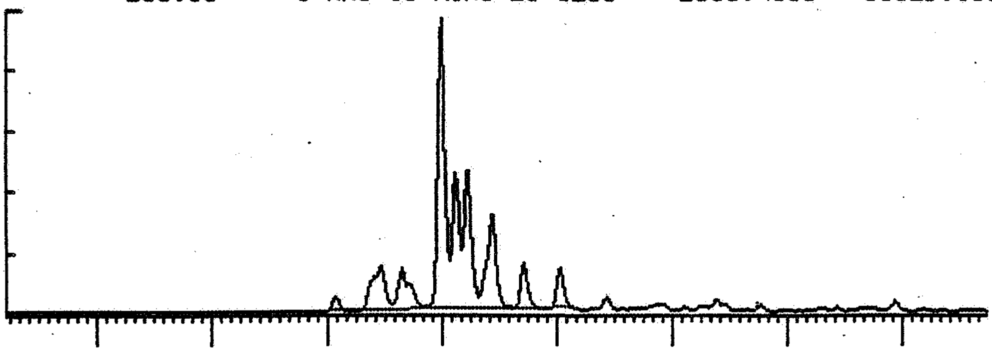
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
178.00	0 HRS 11 MINS 41 SECS	6082.7180	25409.9400	0.0000	0.0000



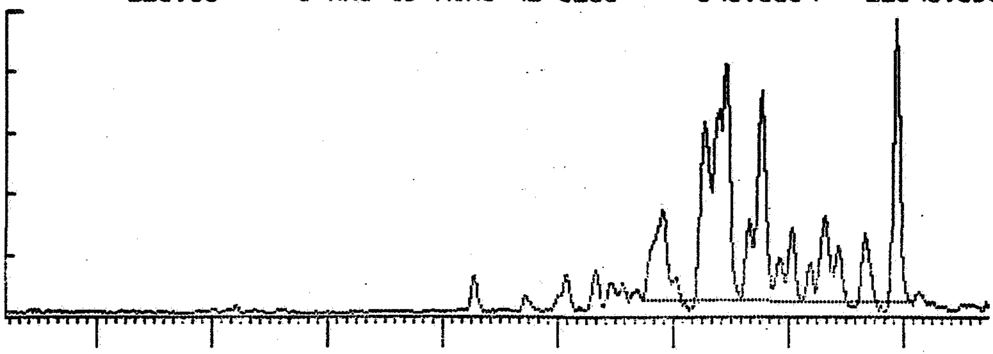
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
192.00	0 HRS 14 MINS 21 SECS	4123.5780	46514.8300	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
206.00	0 HRS 16 MINS 23 SECS	2860.4800	38629.1000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
220.00	0 HRS 19 MINS 42 SECS	843.3034	22543.0900	0.0000	0.0000



0 HRS 13 MINS 13 SECS 0 HRS 21 MINS 24 SECS

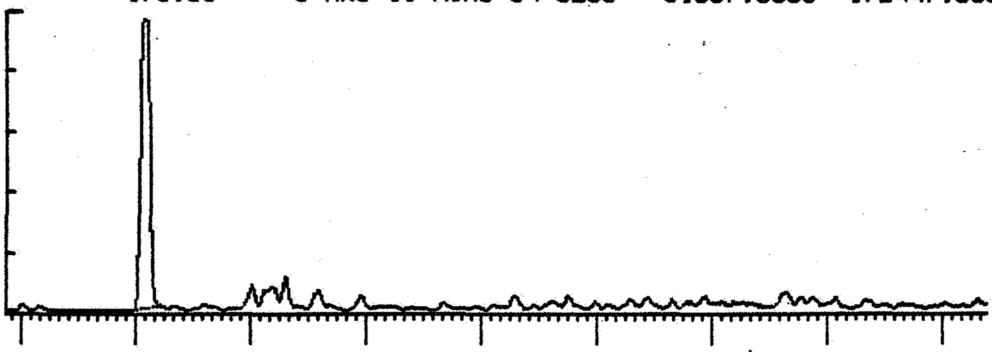
2315-2330m

FIGURE 9e AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1
PHENANTHRENE SERIES

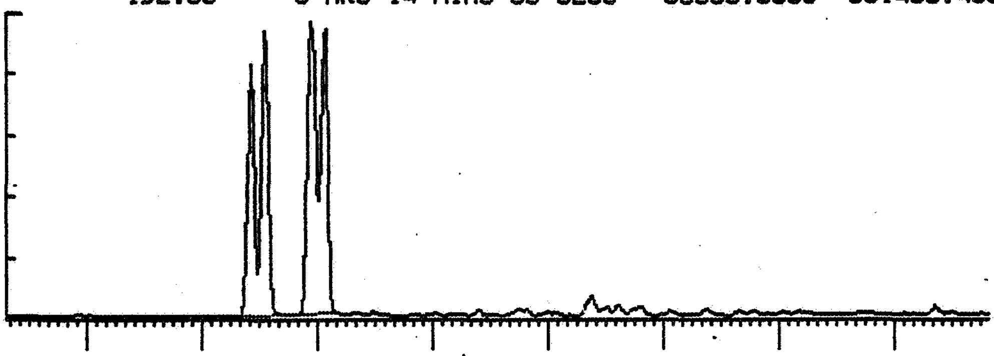
SIR REPORT. FILE - 966184 .SD RUN - 1

UNCALIBRATED.

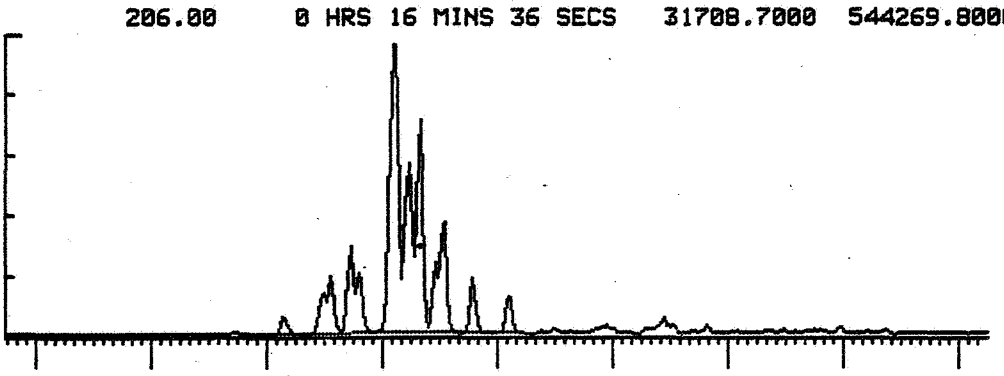
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
178.00	0 HRS 11 MINS 54 SECS	31607.8000	172447.3000	0.0000	0.0000



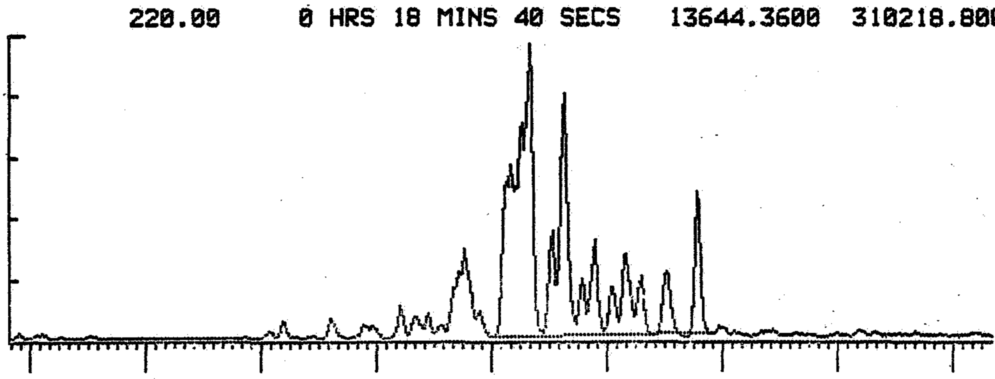
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
192.00	0 HRS 14 MINS 33 SECS	30833.8500	501400.4000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
206.00	0 HRS 16 MINS 36 SECS	31708.7000	544269.8000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
220.00	0 HRS 18 MINS 40 SECS	13644.3600	310218.8000	0.0000	0.0000



0 HRS 14 MINS 48 SECS **2480m** 0 HRS 22 MINS 60 SECS

S.W.C.

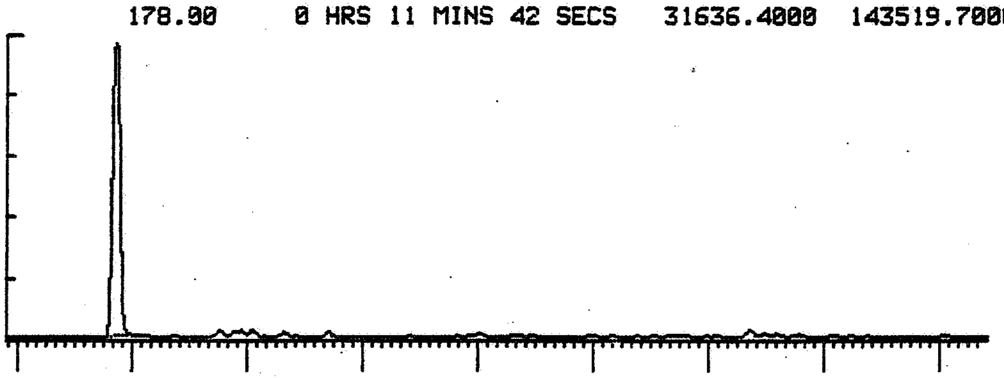
FIGURE 9f AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

PHENANTHRENE SERIES

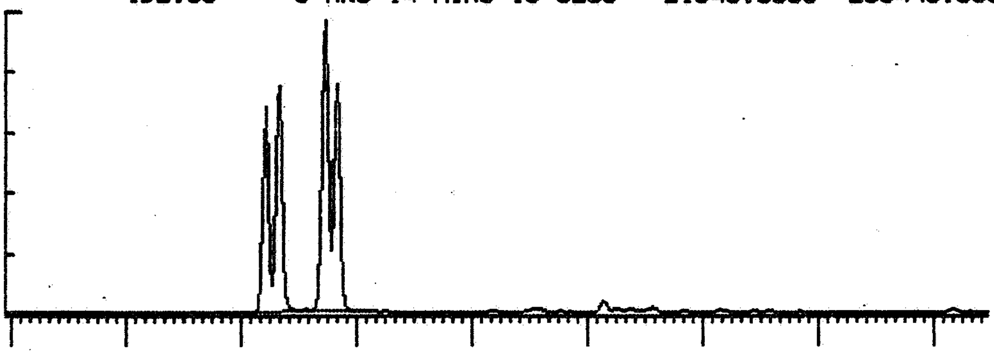
SIR REPORT. FILE - 966192 .SD RUN - 1

UNCALIBRATED.

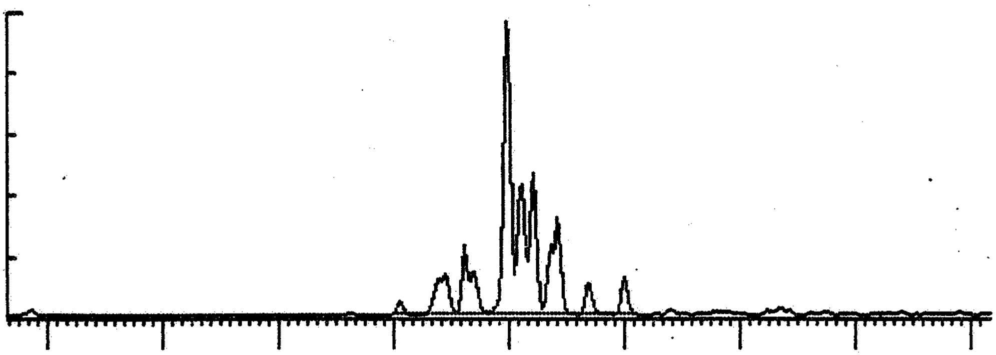
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
178.00	0 HRS 11 MINS 42 SECS	31636.4000	143519.7000	0.0000	0.0000



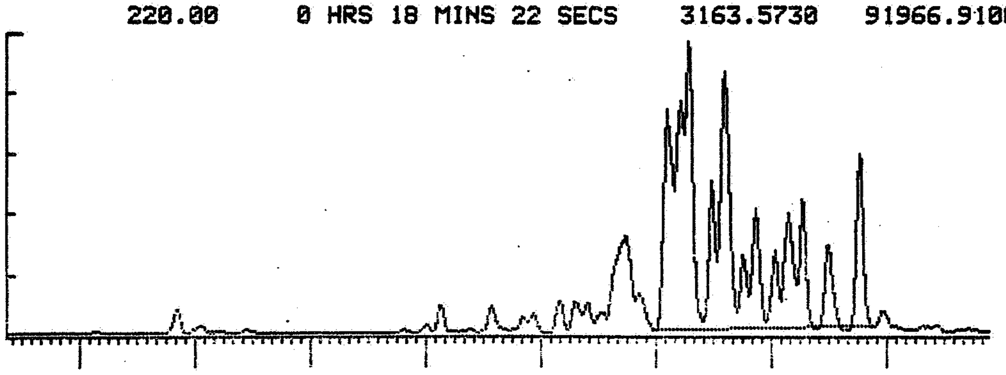
192.00	0 HRS 14 MINS 18 SECS	21646.5500	260440.8000	0.0000	0.0000



206.00	0 HRS 16 MINS 20 SECS	14737.5300	199256.1000	0.0000	0.0000



220.00	0 HRS 18 MINS 22 SECS	3163.5730	91966.9100	0.0000	0.0000



0 HRS 13 MINS 22 SECS **2555-2570m** 0 HRS 21 MINS 34 SECS.

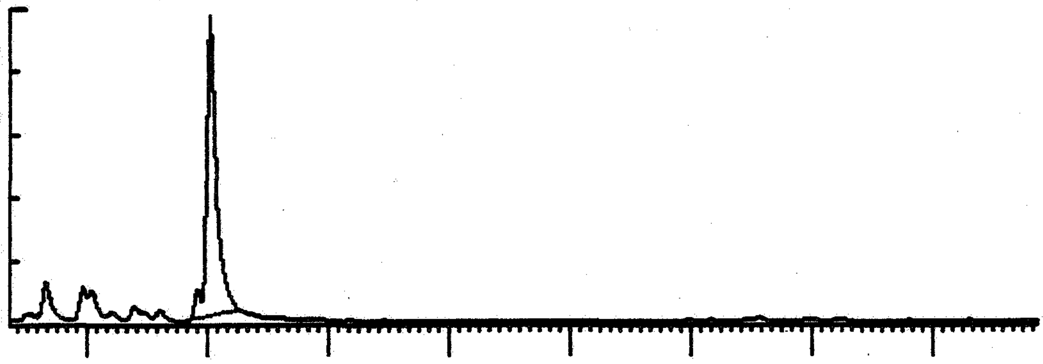
AROMATIC MASS FRAGMENTOGRAMS

DIBENZOTHIOPHENE SERIES

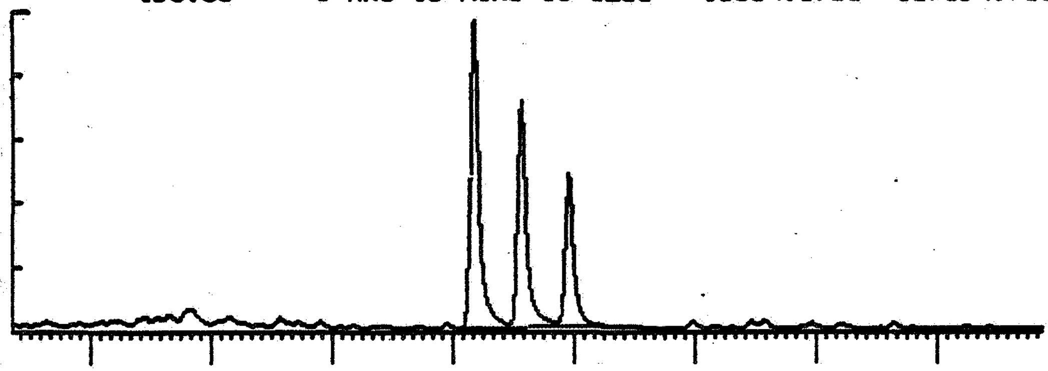
SIR REPORT. FILE - STD. .SD RUN - 1

UNCALIBRATED.

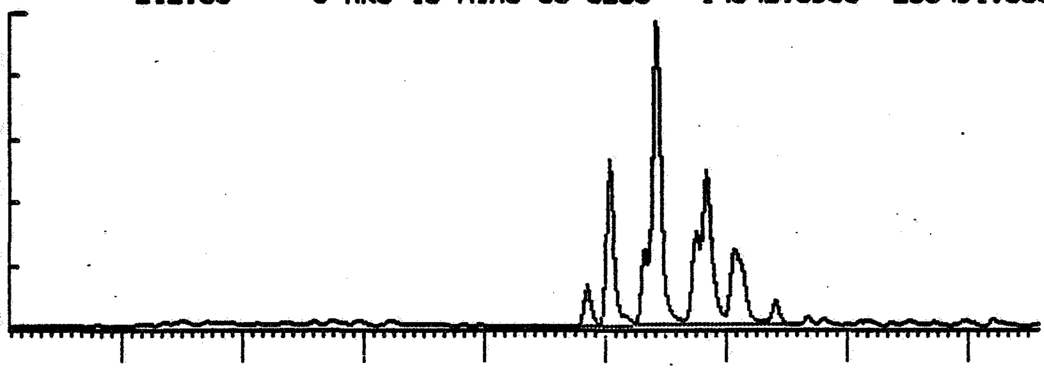
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
184.00	0 HRS 11 MINS 47 SECS	26003.8900	144753.9000	0.0000	0.0000



198.00	0 HRS 13 MINS 36 SECS	16854.6700	187694.7000	0.0000	0.0000



212.00	0 HRS 15 MINS 36 SECS	14042.6900	208491.3000	0.0000	0.0000



0 HRS 11 MINS 4 SECS

0 HRS 19 MINS 16 SECS

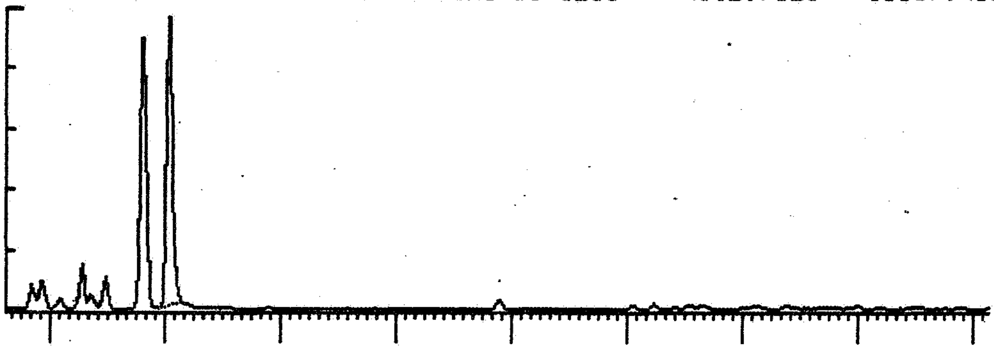
FIGURE 9g AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

DIBENZOTHIOPHENE SERIES

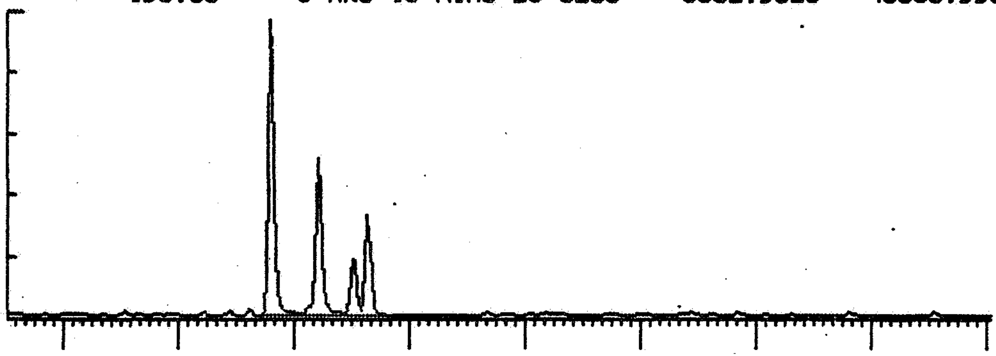
SIR REPORT. FILE - 966147 .SD RUN - 1

UNCALIBRATED.

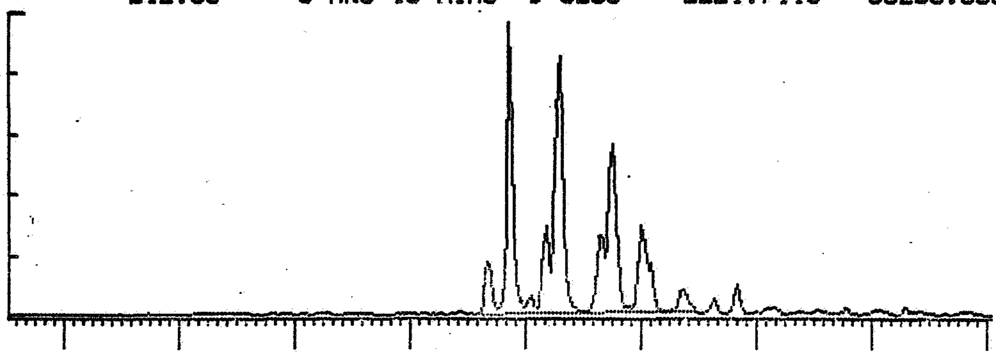
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
184.00	0 HRS 11 MINS 38 SECS	4512.7820	16357.4600	0.0000	0.0000



198.00	0 HRS 13 MINS 26 SECS	5562.9320	40303.9900	0.0000	0.0000



212.00	0 HRS 15 MINS 9 SECS	2221.7110	36280.8500	0.0000	0.0000



0 HRS 11 MINS 31 SECS 0 HRS 19 MINS 42 SECS

2225-2240m

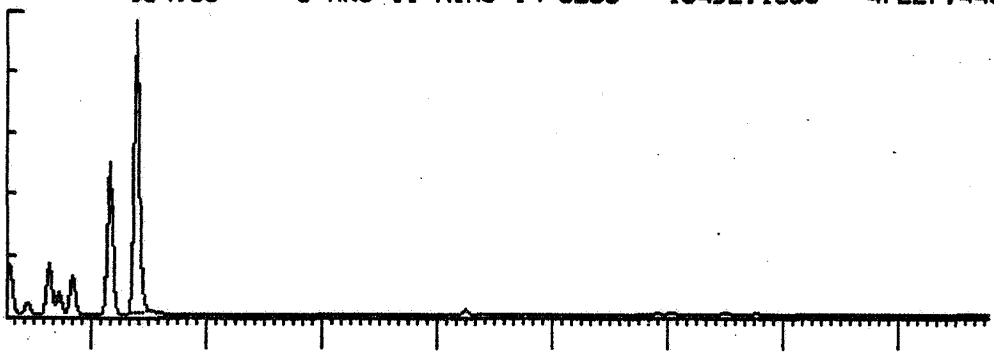
FIGURE 9h AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

DIBENZOTHIOPHENE SERIES

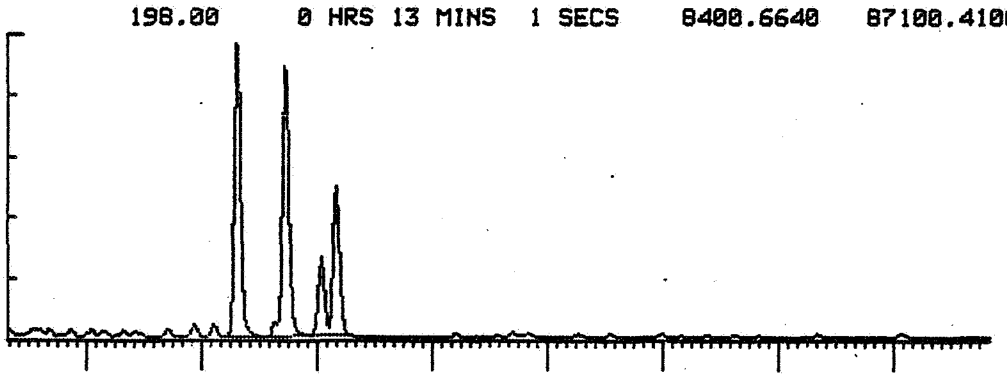
SIR REPORT. FILE - 966153 .SD RUN - 1

UNCALIBRATED.

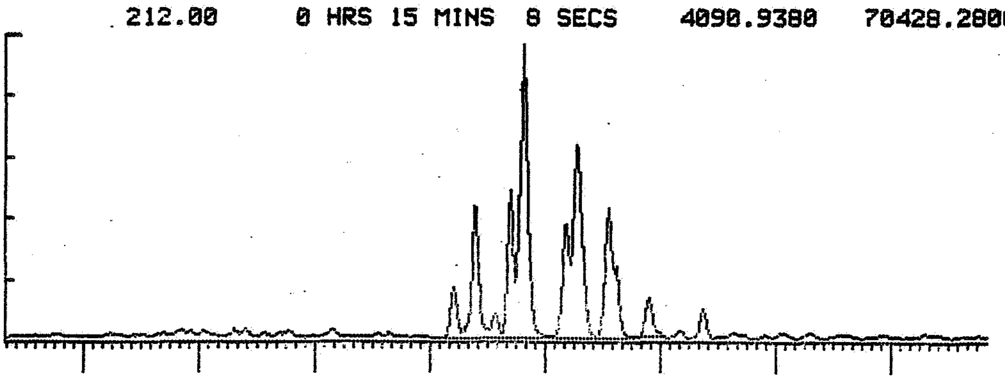
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
184.00	0 HRS 11 MINS 14 SECS	15492.1800	47227.4400	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
198.00	0 HRS 13 MINS 1 SECS	8400.6640	87100.4100	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
212.00	0 HRS 15 MINS 8 SECS	4090.9380	70428.2800	0.0000	0.0000



0 HRS 11 MINS 19 SECS 0 HRS 19 MINS 31 SECS

2250m

S.W.C.

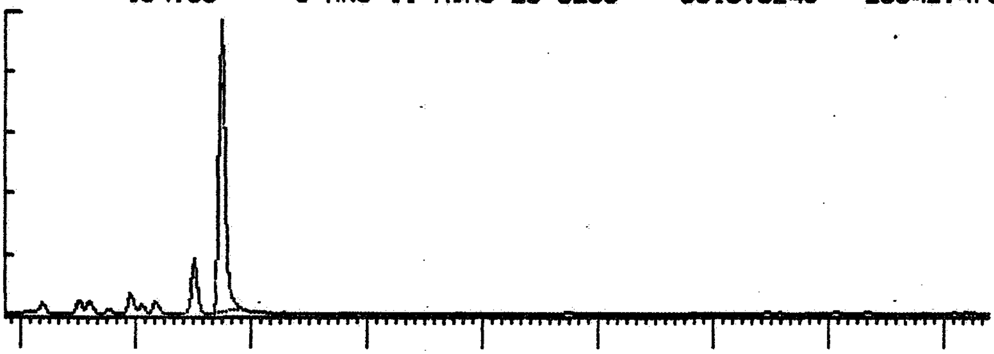
FIGURE 9i AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

DIBENZOTHIOPHENE SERIES

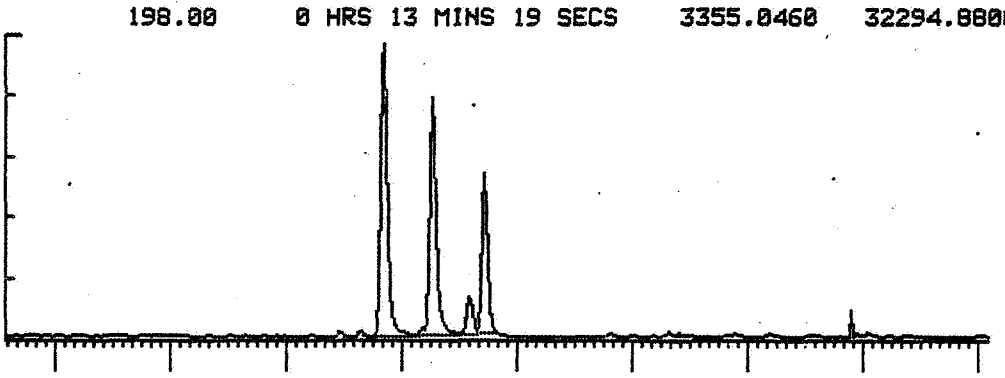
SIR REPORT. FILE - 966154 .SD RUN - 1

UNCALIBRATED.

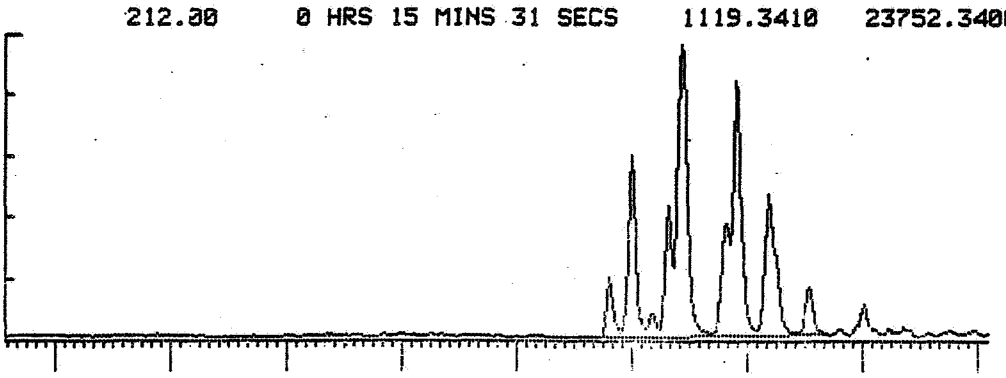
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
184.00	0 HRS 11 MINS 26 SECS	6515.6240	23542.4700	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
198.00	0 HRS 13 MINS 19 SECS	3355.0460	32294.8800	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
212.00	0 HRS 15 MINS 31 SECS	1119.3410	23752.3400	0.0000	0.0000



0 HRS 10 MINS 34 SECS 0 HRS 18 MINS 46 SECS

2255-2270m

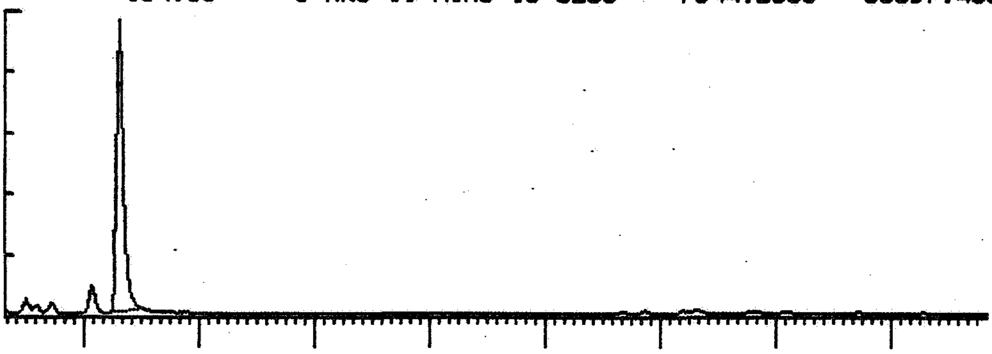
FIGURE 9j AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

DIBENZOTHIOPHENE SERIES

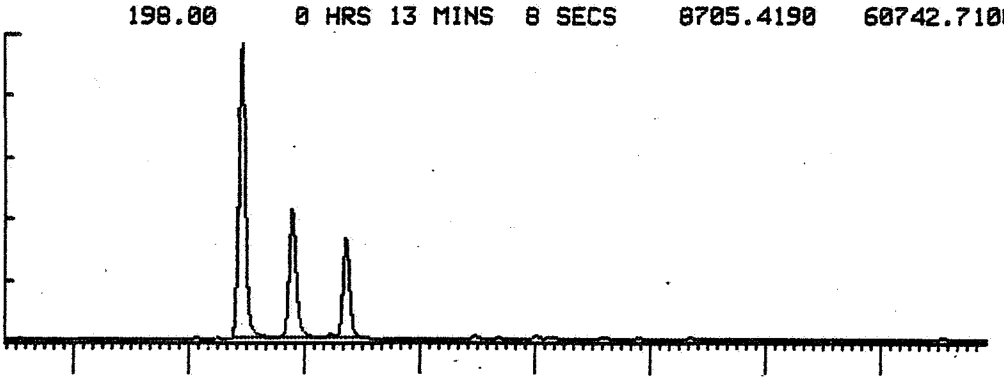
SIR REPORT. FILE - 966167 .SD RUN - 1

UNCALIBRATED.

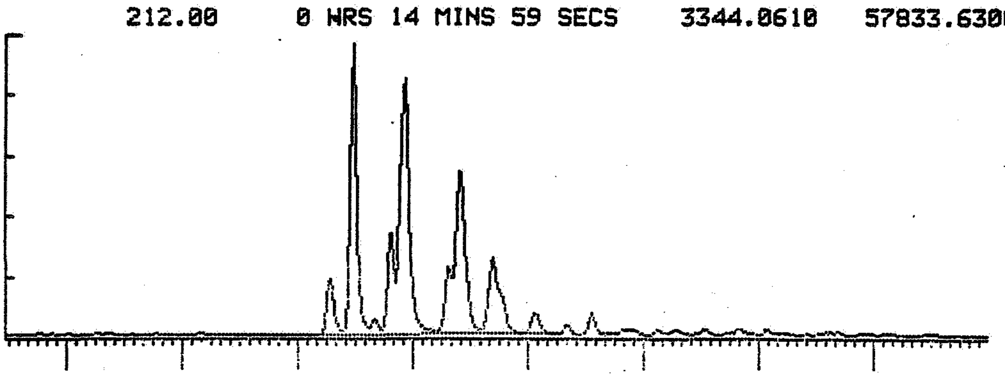
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
184.00	0 HRS 11 MINS 10 SECS	7544.2680	30397.4500	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
198.00	0 HRS 13 MINS 8 SECS	8705.4190	60742.7100	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
212.00	0 HRS 14 MINS 59 SECS	3344.0610	57833.6300	0.0000	0.0000



0 HRS 12 MINS 27 SECS 0 HRS 20 MINS 39 SECS

2315-2330m

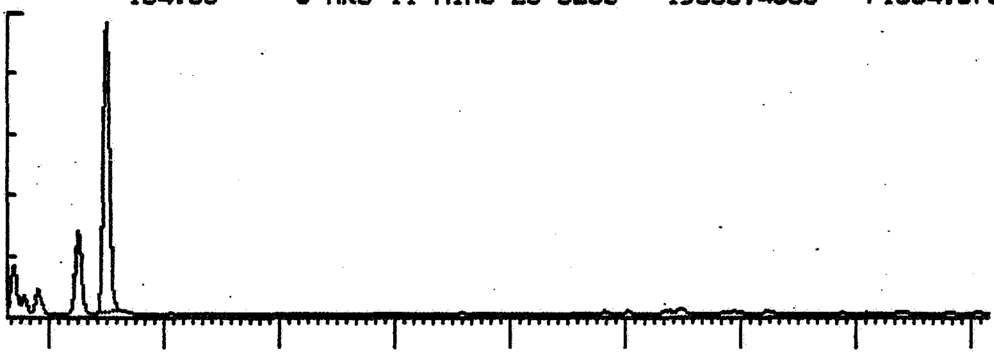
FIGURE 9k AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

DIBENZOTHIOPHENE SERIES

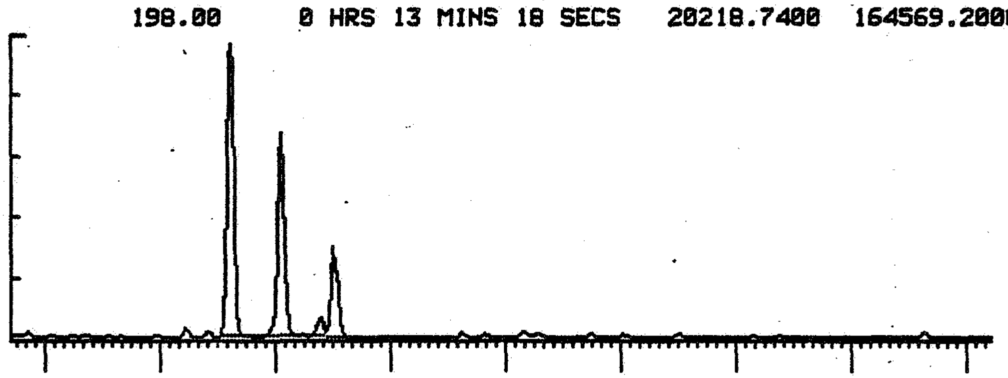
SIR REPORT. FILE - 966184 .SD RUN - 1

UNCALIBRATED.

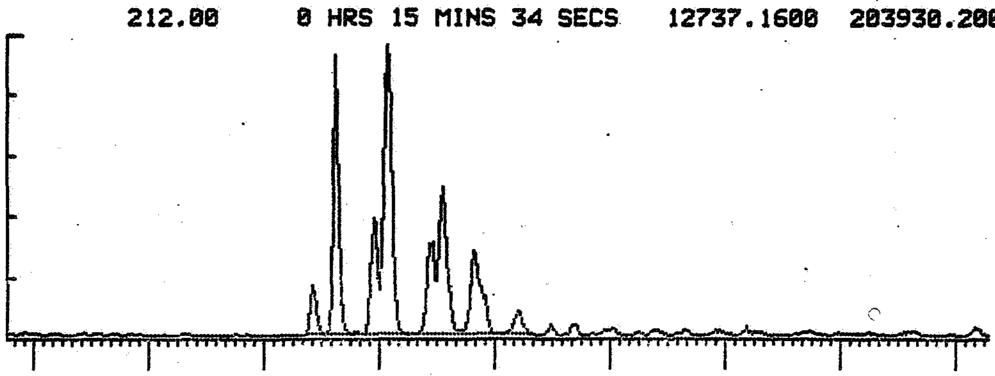
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
184.00	0 HRS 11 MINS 20 SECS	19385.4000	71864.8700	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
198.00	0 HRS 13 MINS 18 SECS	20218.7400	164569.2000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
212.00	0 HRS 15 MINS 34 SECS	12737.1600	203930.2000	0.0000	0.0000



0 HRS 12 MINS 46 SECS 0 HRS 20 MINS 57 SECS

2480m

S.W.C.

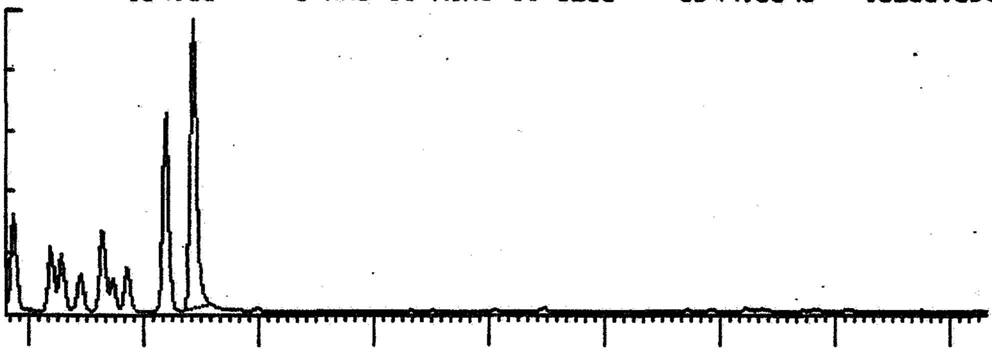
FIGURE 9L AROMATIC MASS FRAGMENTOGRAMS WELL 7121/4-1

DIBENZOTHIOPHENE SERIES

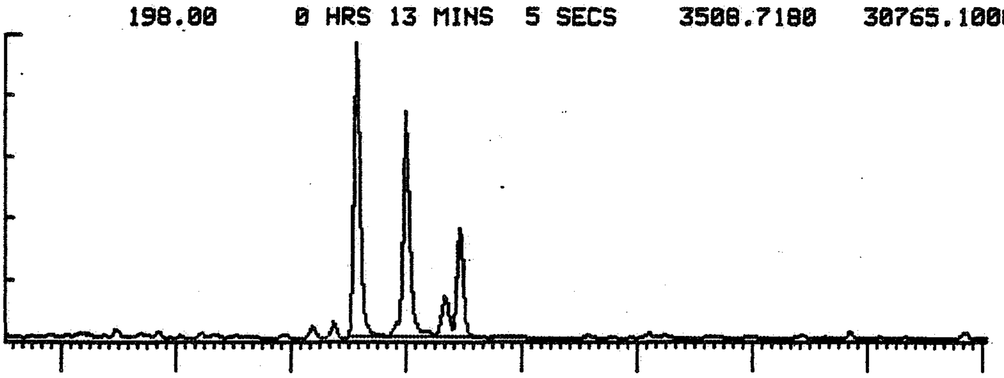
SIR REPORT. FILE - 966192 .SD RUN - 1

UNCALIBRATED.

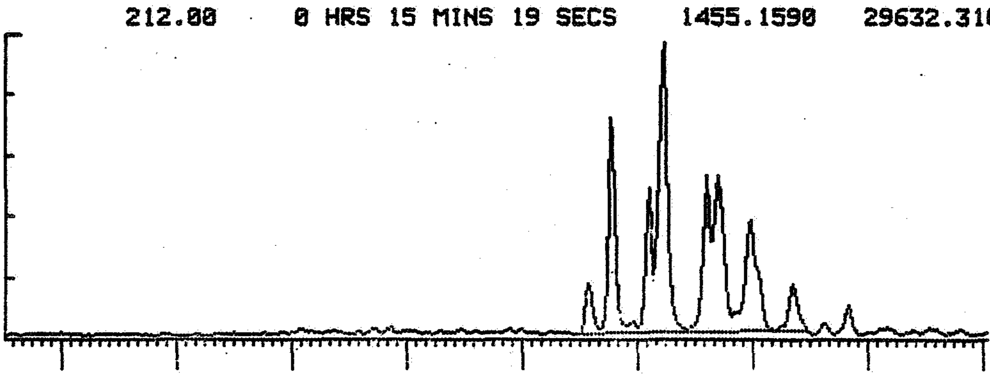
MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
184.00	0 HRS 11 MINS 11 SECS	3944.3340	15256.3900	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
198.00	0 HRS 13 MINS 5 SECS	3508.7180	30765.1000	0.0000	0.0000



MASS	RETENTION TIME	HEIGHT	AREA	CONC.(H)	CONC.(A)
212.00	0 HRS 15 MINS 19 SECS	1455.1590	29632.3100	0.0000	0.0000



0 HRS 10 MINS 30 SECS   0 HRS 18 MINS 42 SECS

2555-2570m

FIGURE 10

TERTIARY DIAGRAM SHOWING RELATIVE ABUNDANCE OF C_{27}, C_{28} and C_{29} 5α(H), 14β(H), 17β(H) STERANES

WELL 7121/4-1

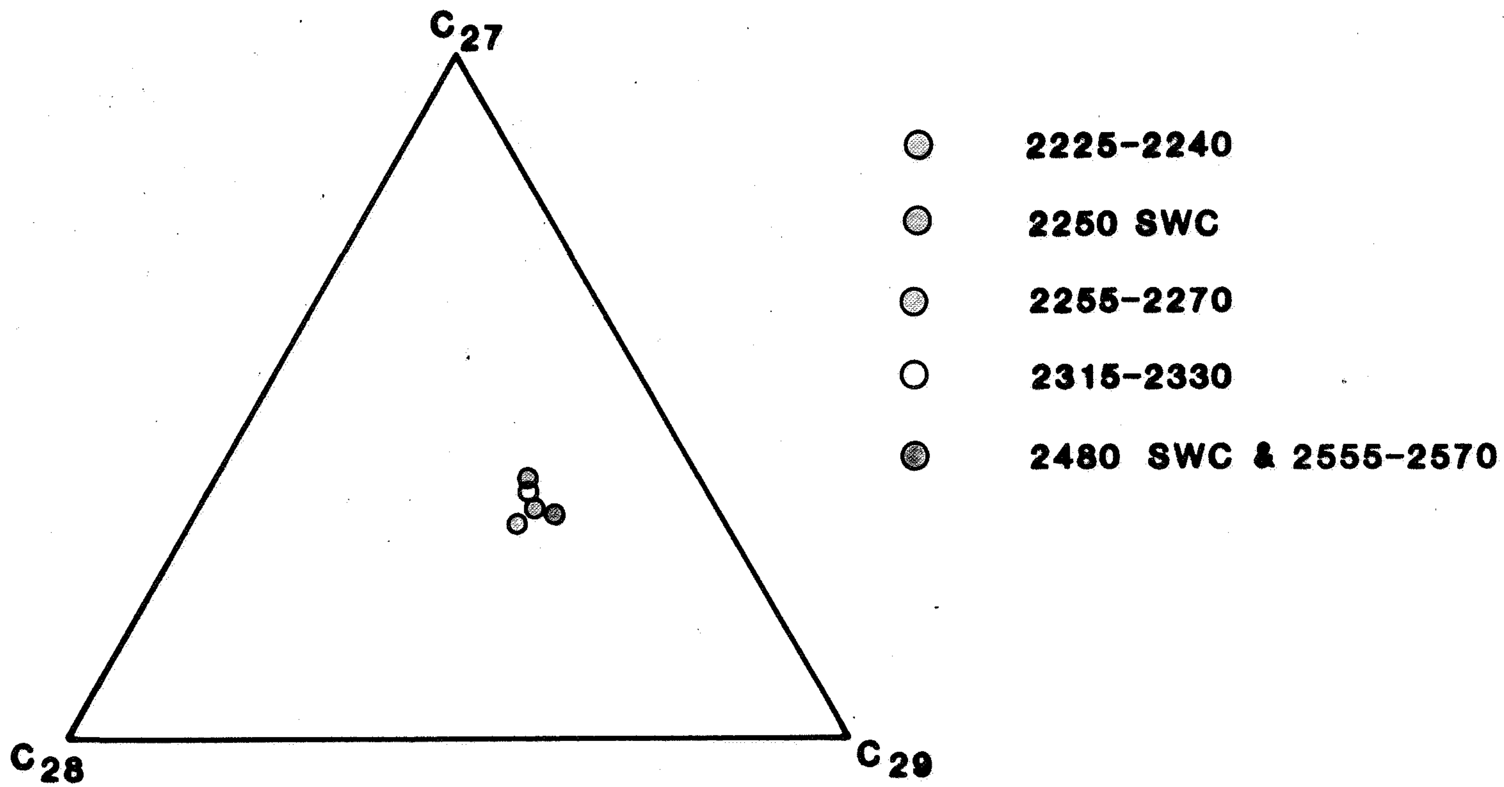


FIGURE 11 STABLE CARBON ISOTOPE RATIOS WELL 7121/4-1

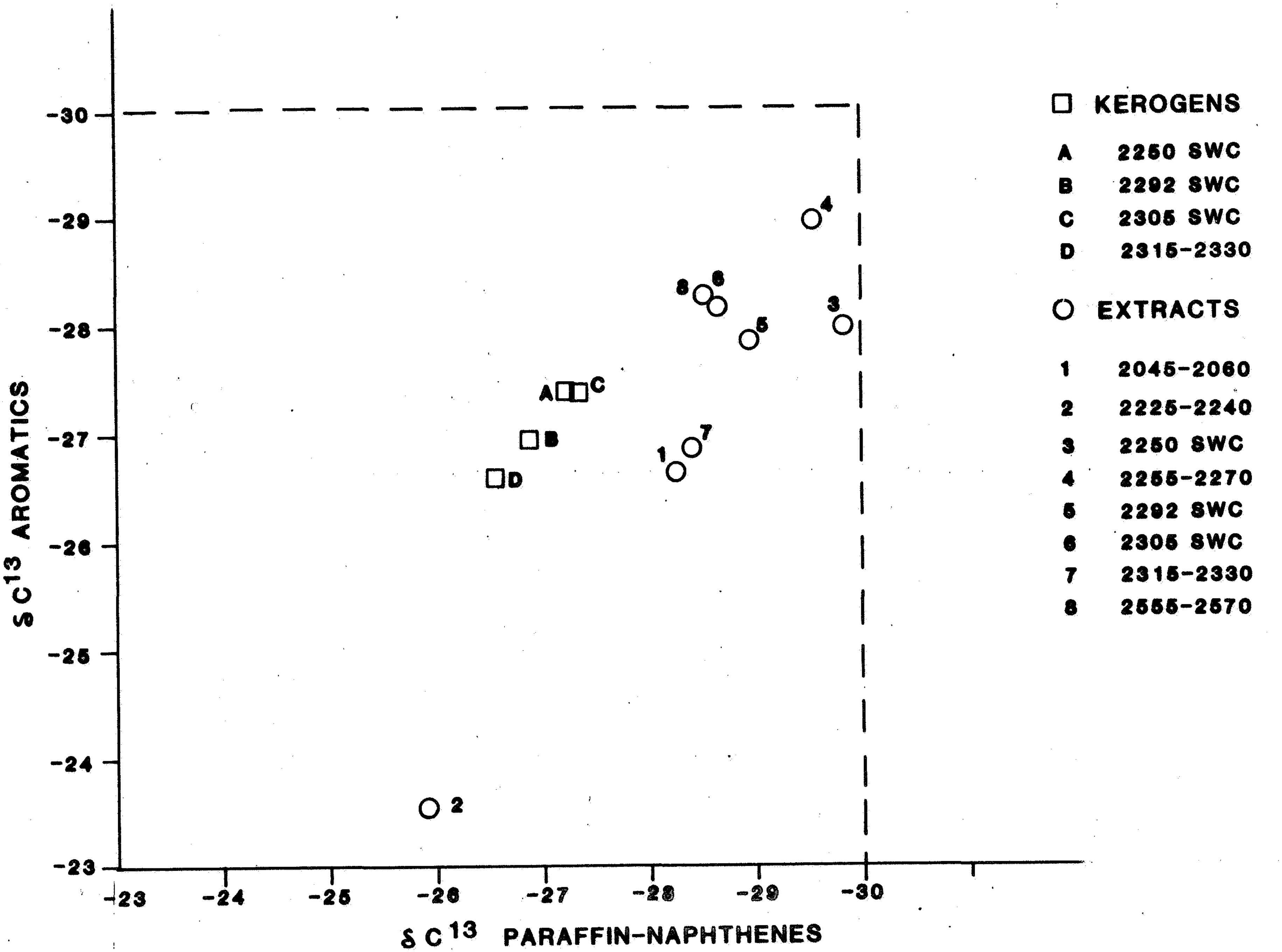


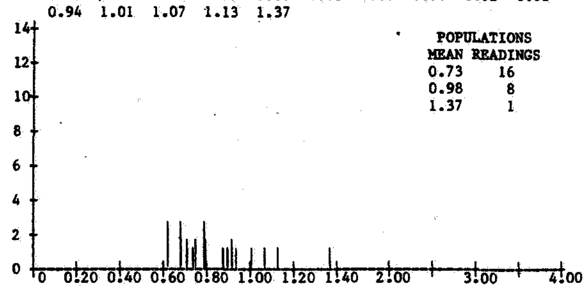
FIGURE 12a VITRINITE REFLECTANCE WELL 7121/4-1

SAMPLE 966-030A DEPTH 863 — VITRINITE REFLECTANCE VALUES

0.62	0.63	0.63	0.68	0.69	0.69	0.71	0.71	0.74	0.75
0.75	0.79	0.79	0.79	0.80	0.81	0.88	0.90	0.92	0.92
0.94	1.01	1.07	1.13	1.37					

POPULATIONS

MEAN	READINGS
0.73	16
0.98	8
1.37	1



REMARKS

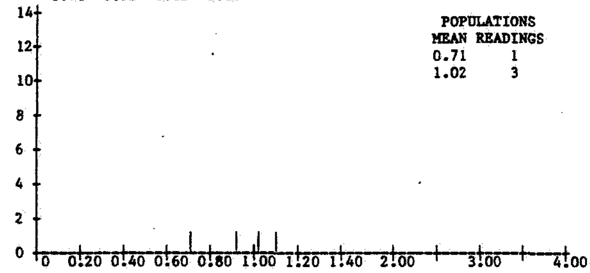
SPARSE, REWORKED VITRINITE.

SAMPLE 966-035A DEPTH 913 — VITRINITE REFLECTANCE VALUES

0.71 0.92 1.02 1.10

POPULATIONS

MEAN	READINGS
0.71	1
1.02	3



REMARKS

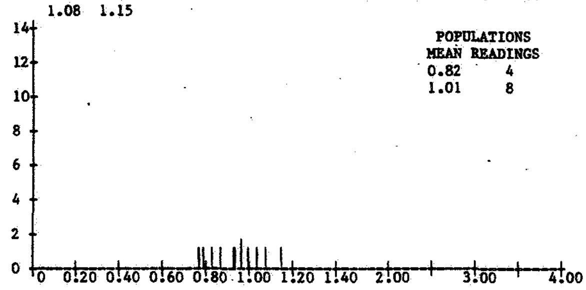
LEAN. POOR SAMPLE.

SAMPLE 966-039A DEPTH 961 — VITRINITE REFLECTANCE VALUES

0.77	0.79	0.83	0.87	0.93	0.94	0.97	0.97	1.00	1.04
1.08	1.15								

POPULATIONS

MEAN	READINGS
0.82	4
1.01	8



REMARKS

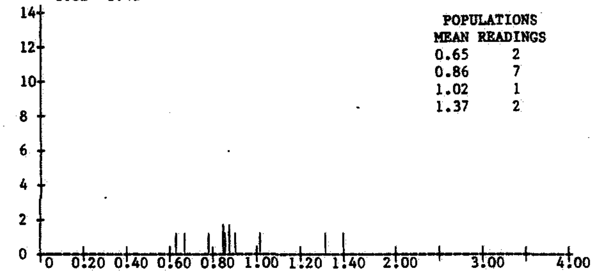
LEAN. OXIDISED.

SAMPLE 966-043A DEPTH 1015 — VITRINITE REFLECTANCE VALUES

0.63	0.67	0.78	0.85	0.85	0.86	0.88	0.88	0.91	1.02
1.32	1.41								

POPULATIONS

MEAN	READINGS
0.65	2
0.86	7
1.02	1
1.37	2



REMARKS

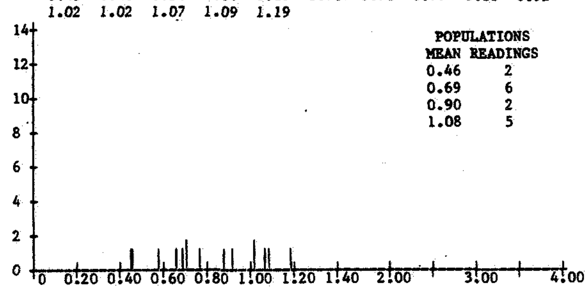
VERY LEAN. VITRINITE REWORKED.

SAMPLE 966-048A DEPTH 1063.5 — VITRINITE REFLECTANCE VALUES

0.45	0.46	0.58	0.66	0.69	0.71	0.71	0.77	0.88	0.92
1.02	1.02	1.07	1.09	1.19					

POPULATIONS

MEAN	READINGS
0.46	2
0.69	6
0.90	2
1.08	5



REMARKS

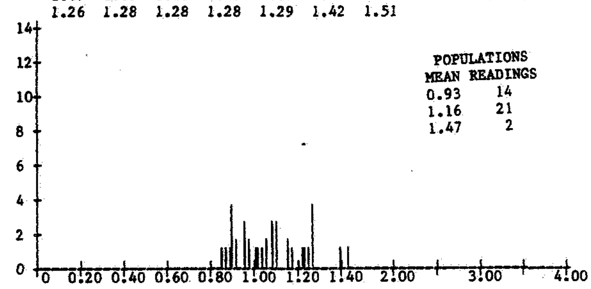
SPARSE, REWORKED VITRINITE

SAMPLE 966-051A DEPTH 1107 — VITRINITE REFLECTANCE VALUES

0.85	0.87	0.89	0.90	0.90	0.91	0.91	0.92	0.93	0.96
0.96	0.96	0.98	0.99	1.01	1.02	1.04	1.06	1.07	1.09
1.09	1.09	1.11	1.11	1.11	1.16	1.17	1.18	1.23	1.24
1.26	1.28	1.28	1.28	1.29	1.42	1.51			

POPULATIONS

MEAN	READINGS
0.93	14
1.16	21
1.47	2



REMARKS

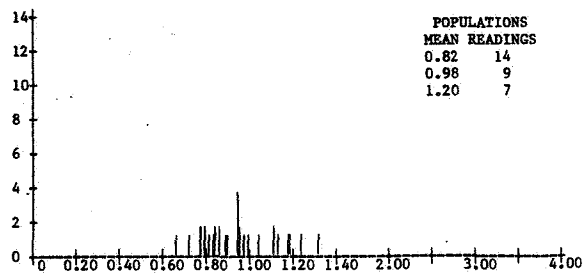
SPARSE, REWORKED ORGANIC MATTER.

SAMPLE 966-056A DEPTH 1164 — VITRINITE REFLECTANCE VALUES

0.66	0.72	0.77	0.77	0.79	0.79	0.81	0.83	0.84	0.85
0.86	0.87	0.89	0.90	0.95	0.95	0.95	0.95	0.96	0.97
0.98	1.00	1.05	1.12	1.13	1.14	1.19	1.20	1.25	1.33

POPULATIONS

MEAN	READINGS
0.82	14
0.98	9
1.20	7



REMARKS

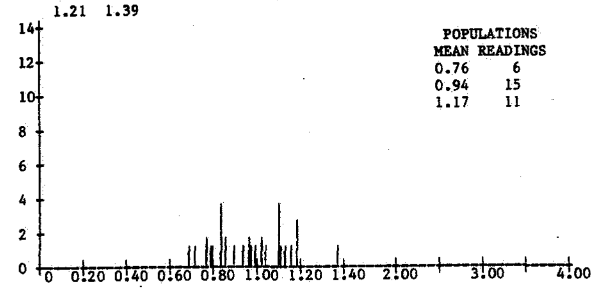
SPARSE, REWORKED VITRINITE.

SAMPLE 966-061A DEPTH 1218 — VITRINITE REFLECTANCE VALUES

0.69	0.72	0.77	0.77	0.79	0.80	0.84	0.84	0.84	0.84
0.86	0.87	0.90	0.94	0.97	0.97	0.98	1.00	1.03	1.03
1.05	1.11	1.11	1.11	1.11	1.12	1.14	1.17	1.20	1.20
1.21	1.39								

POPULATIONS

MEAN	READINGS
0.76	6
0.94	15
1.17	11



REMARKS

SMALL, SPARSE VITRINITE PARTICLES. LOWER READING ON FRESH MATERIAL.

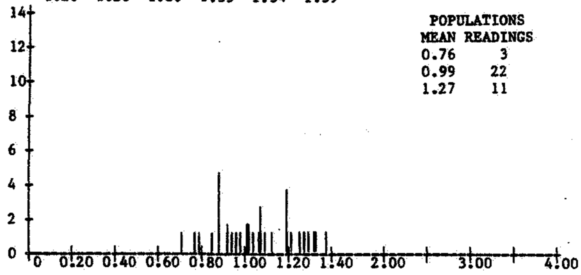
FIGURE 12b VITRINITE REFLECTANCE WELL 7121/4-1

SAMPLE 966-066A DEPTH 1277 VITRINITE REFLECTANCE VALUES

0.71	0.77	0.79	0.85	0.88	0.89	0.89	0.89	0.89	0.92
0.92	0.94	0.96	0.98	1.01	1.01	1.02	1.03	1.04	1.07
1.08	1.08	1.09	1.10	1.13	1.20	1.21	1.21	1.21	1.22
1.26	1.28	1.30	1.33	1.34	1.39				

POPULATIONS

MEAN	READINGS
0.76	3
0.99	22
1.27	11



REMARKS

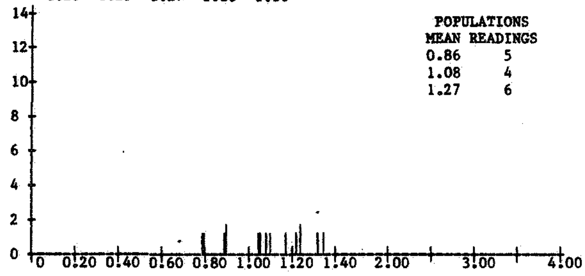
SMALL, SPARSE VITRINITE PARTICLES. LOWER READINGS ON FRESH MATERIAL.

SAMPLE 966-070A DEPTH 1323 VITRINITE REFLECTANCE VALUES

0.79	0.80	0.89	0.90	0.91	1.05	1.06	1.09	1.11	1.18
1.23	1.25	1.27	1.33	1.36					

POPULATIONS

MEAN	READINGS
0.86	5
1.08	4
1.27	6



REMARKS

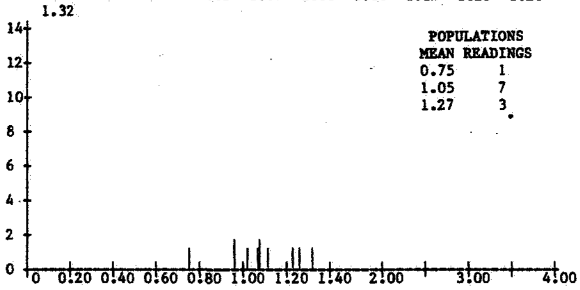
SMALL, REWORKED PARTICLES.

SAMPLE 966-074A DEPTH 1367 VITRINITE REFLECTANCE VALUES

0.75	0.96	0.97	1.02	1.07	1.08	1.08	1.12	1.23	1.26
1.32									

POPULATIONS

MEAN	READINGS
0.75	1
1.05	7
1.27	3



REMARKS

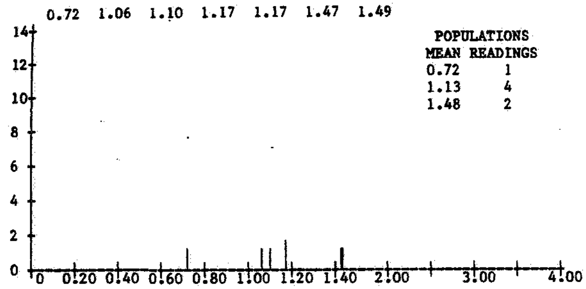
LEAN.

SAMPLE 966-078A DEPTH 1415 VITRINITE REFLECTANCE VALUES

0.72	1.06	1.10	1.17	1.17	1.47	1.49

POPULATIONS

MEAN	READINGS
0.72	1
1.13	4
1.48	2



REMARKS

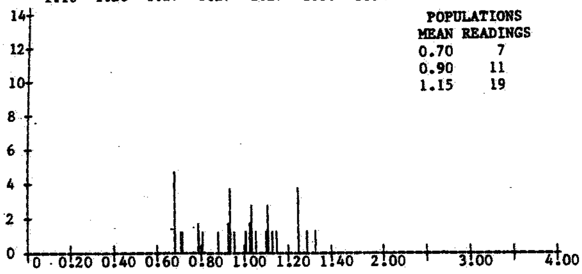
SMALL, LEAN, REWORKED VITRINITE PARTICLES. MILD OXIDATION.

SAMPLE 966-082A DEPTH 1465 VITRINITE REFLECTANCE VALUES

0.68	0.68	0.69	0.69	0.69	0.71	0.72	0.79	0.79	0.81
0.88	0.93	0.93	0.94	0.94	0.94	0.94	0.96	1.01	1.03
1.03	1.04	1.04	1.04	1.06	1.11	1.12	1.12	1.13	1.14
1.16	1.26	1.27	1.27	1.27	1.30	1.34			

POPULATIONS

MEAN	READINGS
0.70	7
0.90	11
1.15	19



REMARKS

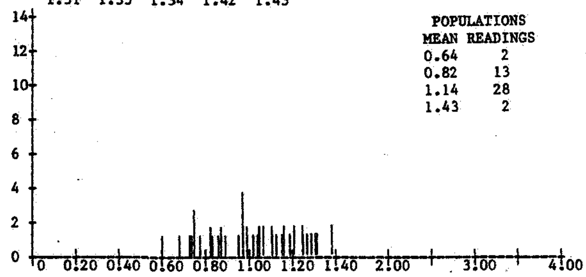
SMALL, REWORKED VITRINITE PARTICLES.

SAMPLE 966-087A DEPTH 1516 VITRINITE REFLECTANCE VALUES

0.60	0.68	0.73	0.74	0.75	0.76	0.77	0.78	0.83	0.83
0.84	0.87	0.88	0.89	0.90	0.96	0.98	0.98	0.98	0.99
1.00	1.01	1.03	1.05	1.06	1.07	1.08	1.08	1.12	1.13
1.14	1.17	1.18	1.19	1.21	1.23	1.23	1.27	1.27	1.29
1.31	1.33	1.34	1.42	1.43					

POPULATIONS

MEAN	READINGS
0.64	2
0.82	13
1.14	28
1.43	2



REMARKS

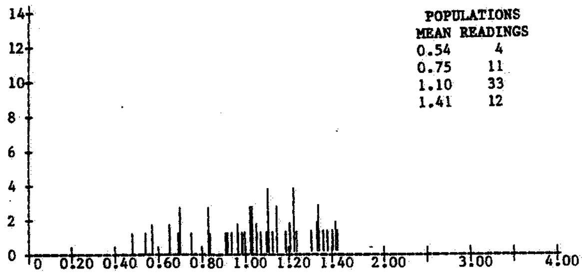
RICH IN ORGANIC MATTER. SIGNIFICANT REWORKING. MILD OXIDATION.

SAMPLE 966-091A DEPTH 1570 VITRINITE REFLECTANCE VALUES

0.48	0.54	0.57	0.57	0.65	0.65	0.69	0.70	0.70	0.70
0.75	0.83	0.83	0.83	0.84	0.91	0.92	0.94	0.97	0.97
0.99	1.00	1.03	1.03	1.03	1.04	1.04	1.05	1.06	1.06
1.08	1.11	1.12	1.12	1.12	1.13	1.14	1.16	1.16	1.16
1.20	1.22	1.22	1.24	1.24	1.24	1.24	1.25	1.32	1.35
1.35	1.36	1.37	1.37	1.38	1.40	1.46	1.50	1.50	1.52

POPULATIONS

MEAN	READINGS
0.54	4
0.75	11
1.10	33
1.41	12



REMARKS

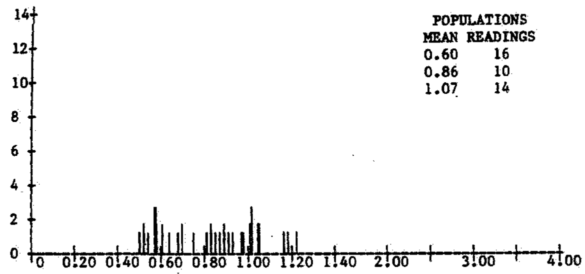
RICH IN ORGANIC MATTER. ALMOST EXCLUSIVELY REWORKED.

SAMPLE 966-095A DEPTH 1610 VITRINITE REFLECTANCE VALUES

0.50	0.52	0.52	0.54	0.57	0.57	0.57	0.58	0.58	0.59
0.61	0.61	0.64	0.68	0.70	0.71	0.75	0.81	0.83	0.83
0.85	0.87	0.89	0.89	0.91	0.93	0.97	0.98	1.01	1.01
1.02	1.03	1.03	1.05	1.05	1.06	1.07	1.17	1.19	1.23

POPULATIONS

MEAN	READINGS
0.60	16
0.86	10
1.07	14



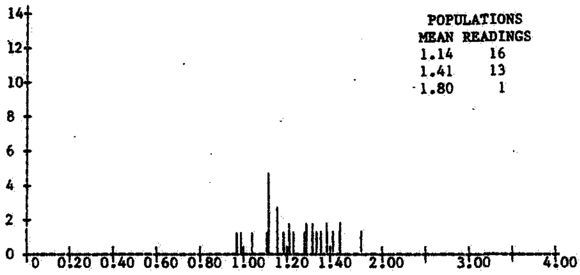
REMARKS

CHIEFLY VITRINITE. SIGNIFICANT INERTINITE. WIDESPREAD REWORKING.

FIGURE 12c VITRINITE REFLECTANCE WELL 7121/4-1

SAMPLE 966-101A DEPTH 1680 VITRINITE REFLECTANCE VALUES

0.97	0.99	1.04	1.11	1.12	1.13	1.13	1.13	1.13	1.16
1.16	1.17	1.19	1.22	1.23	1.24	1.29	1.30	1.30	1.33
1.33	1.35	1.37	1.40	1.41	1.47	1.55	1.56	1.57	1.80

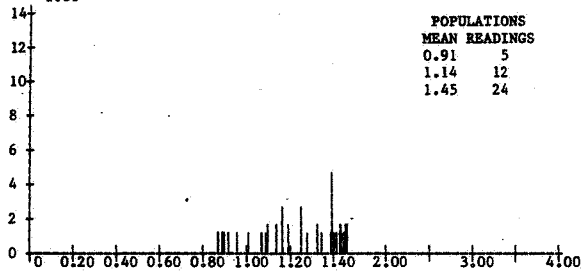


REMARKS

SMALL, REWORKED VITRINITE. MILD OXIDATION. SIGNIFICANT INERTINITE.

SAMPLE 966-105A DEPTH 1730 VITRINITE REFLECTANCE VALUES

0.87	0.89	0.90	0.92	0.96	1.01	1.07	1.09	1.10	1.11
1.14	1.15	1.17	1.17	1.17	1.20	1.21	1.26	1.27	1.27
1.29	1.34	1.34	1.36	1.41	1.42	1.42	1.42	1.43	1.43
1.44	1.47	1.51	1.52	1.53	1.55	1.56	1.58	1.58	1.60
1.61									

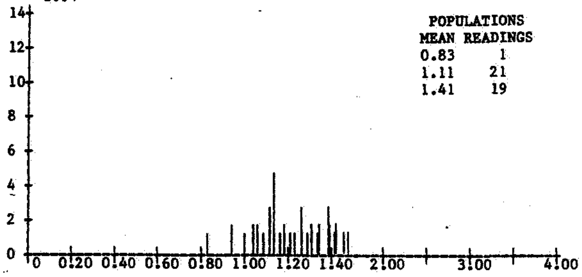


REMARKS

ORGANIC MATTER RICH BUT CHIEFLY REWORKED.

SAMPLE 966-110A DEPTH 1795 VITRINITE REFLECTANCE VALUES

0.83	0.94	0.95	1.00	1.04	1.05	1.06	1.07	1.09	1.12
1.12	1.13	1.14	1.14	1.14	1.15	1.15	1.17	1.19	1.19
1.22	1.24	1.27	1.27	1.27	1.30	1.32	1.33	1.35	1.36
1.36	1.41	1.41	1.41	1.42	1.42	1.48	1.50	1.51	1.59
1.64									

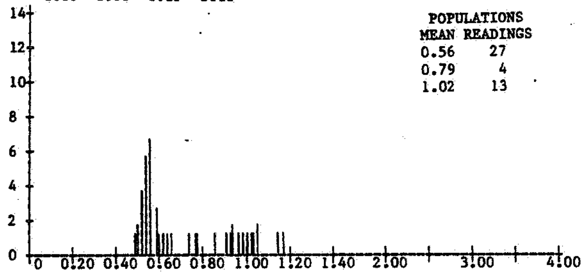


REMARKS

VITRINITE DOMINANTLY REWORKED

SAMPLE 966-116A DEPTH 1865 VITRINITE REFLECTANCE VALUES

0.49	0.50	0.50	0.52	0.53	0.53	0.53	0.54	0.54	0.54
0.55	0.55	0.55	0.56	0.56	0.56	0.56	0.56	0.56	0.57
0.59	0.59	0.59	0.60	0.62	0.64	0.66	0.74	0.77	0.78
0.86	0.91	0.93	0.94	0.95	0.97	0.99	1.01	1.03	1.04
1.06	1.06	1.15	1.18						

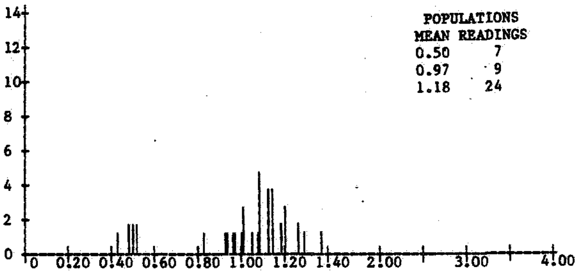


REMARKS

DOMINANT VITRINITE. SIGNIFICANT INERTINITE. WIDESPREAD REWORKING.

SAMPLE 966-121A DEPTH 1928 VITRINITE REFLECTANCE VALUES

0.43	0.48	0.49	0.50	0.50	0.52	0.52	0.83	0.93	0.94
0.97	0.98	1.01	1.02	1.02	1.03	1.06	1.09	1.10	1.10
1.10	1.10	1.11	1.14	1.14	1.14	1.14	1.16	1.17	1.17
1.17	1.20	1.21	1.22	1.23	1.23	1.28	1.29	1.31	1.39

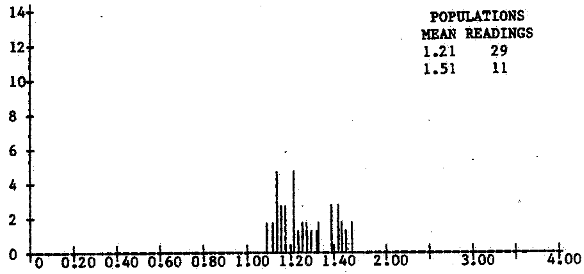


REMARKS

DOMINANTLY VITRINITE. WIDESPREAD REWORKING.

SAMPLE 966-126A DEPTH 1985 VITRINITE REFLECTANCE VALUES

1.09	1.09	1.12	1.12	1.14	1.14	1.15	1.15	1.15	1.16
1.16	1.17	1.18	1.19	1.19	1.22	1.22	1.22	1.23	1.23
1.24	1.26	1.27	1.28	1.29	1.30	1.33	1.34	1.35	1.40
1.41	1.41	1.48	1.48	1.49	1.52	1.52	1.57	1.64	1.65

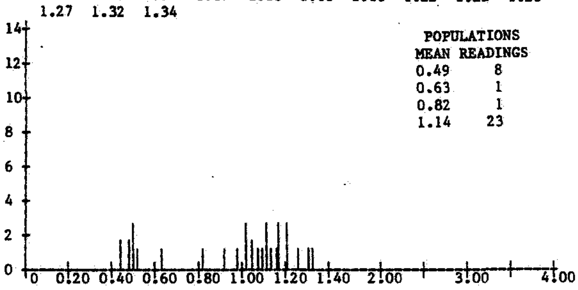


REMARKS

RICH IN ORGANIC MATTER. CHIEFLY REWORKED.

SAMPLE 966-130A DEPTH 2032 VITRINITE REFLECTANCE VALUES

0.44	0.45	0.48	0.49	0.50	0.50	0.51	0.52	0.63	0.82
0.92	0.98	1.02	1.03	1.03	1.05	1.05	1.08	1.10	1.12
1.13	1.13	1.14	1.17	1.18	1.18	1.18	1.22	1.22	1.23
1.27	1.32	1.34							

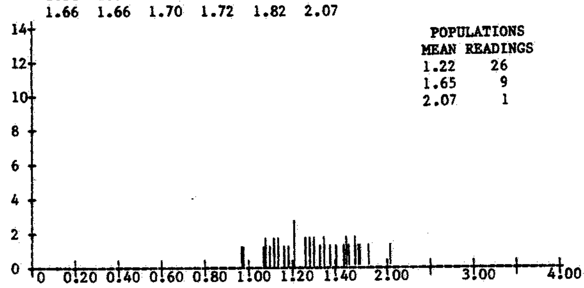


REMARKS

VITRINITE DOMINANT. SIGNIFICANT INERTINITE.

SAMPLE 966-134A DEPTH 2078 VITRINITE REFLECTANCE VALUES

0.97	0.98	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.15
1.17	1.19	1.22	1.23	1.23	1.27	1.27	1.29	1.29	1.31
1.31	1.34	1.36	1.37	1.39	1.44	1.53	1.56	1.56	1.59
1.66	1.66	1.70	1.72	1.82	2.07				



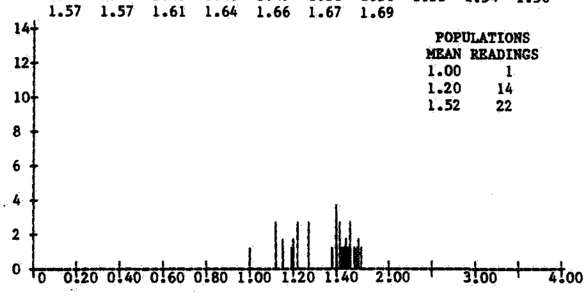
REMARKS

SMALL, SPARSE VITRINITE PARTICLES.

FIGURE 12d VITRINITE REFLECTANCE WELL 7121/4-1

SAMPLE 966-139A DEPTH 2130 VITRINITE REFLECTANCE VALUES

1.00 1.12 1.12 1.13 1.15 1.15 1.19 1.20 1.20 1.22
1.22 1.23 1.27 1.27 1.27 1.38 1.40 1.40 1.41 1.41
1.44 1.44 1.45 1.46 1.49 1.51 1.51 1.53 1.54 1.56
1.57 1.57 1.61 1.64 1.66 1.67 1.69

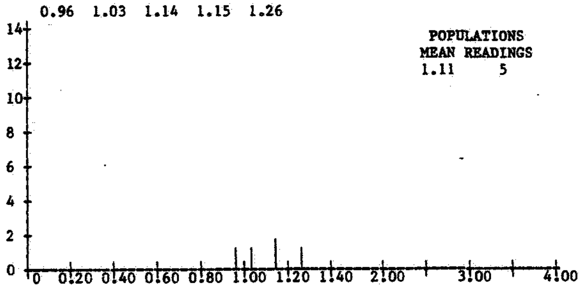


REMARKS

SMALL, REWORKED VITRINITE PARTICLES. OXIDISED.

SAMPLE 966-152A DEPTH 2250 VITRINITE REFLECTANCE VALUES

0.96 1.03 1.14 1.15 1.26

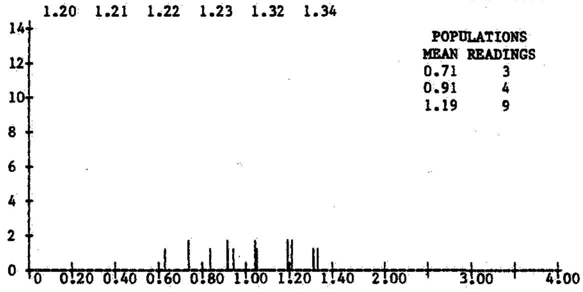


REMARKS

LEAN

SAMPLE 966-157A DEPTH 2280 VITRINITE REFLECTANCE VALUES

0.63 0.74 0.74 0.84 0.92 0.92 0.95 1.05 1.05 1.06
1.20 1.21 1.22 1.23 1.32 1.34

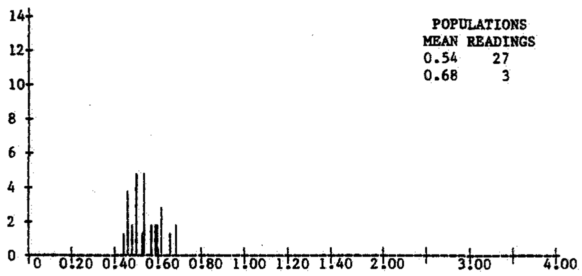


REMARKS

DOMINANTLY FINE GRAINED AMORPHOUS MATERIAL. POOR SAMPLE.

SAMPLE 966-162A DEPTH 2307 VITRINITE REFLECTANCE VALUES

0.44 0.46 0.47 0.47 0.47 0.48 0.48 0.50 0.50 0.50
0.51 0.51 0.53 0.54 0.54 0.54 0.54 0.55 0.57 0.57
0.59 0.59 0.60 0.60 0.62 0.63 0.63 0.66 0.69 0.69

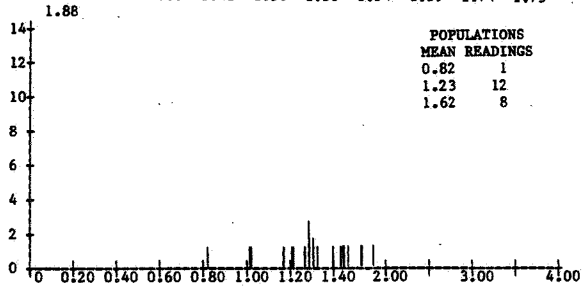


REMARKS

SPARSE VITRINITE. MINOR OXIDATION SIGNIFICANT PYRITE.

SAMPLE 966-144A DEPTH 2198 VITRINITE REFLECTANCE VALUES

0.82 1.01 1.02 1.17 1.21 1.22 1.27 1.29 1.29 1.29
1.31 1.31 1.33 1.41 1.50 1.53 1.54 1.59 1.74 1.75
1.88

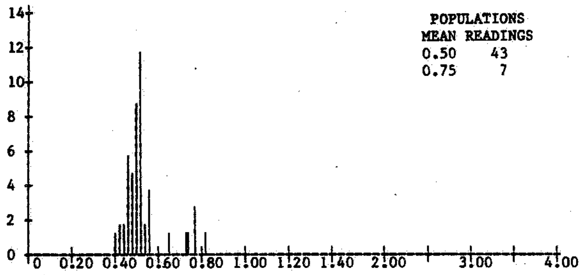


REMARKS

SPARSE, REWORKED VITRINITE

SAMPLE 966-155A DEPTH 2275 VITRINITE REFLECTANCE VALUES

0.40 0.42 0.43 0.44 0.45 0.46 0.46 0.46 0.46 0.46
0.46 0.48 0.49 0.49 0.49 0.49 0.50 0.50 0.50 0.50
0.51 0.51 0.51 0.51 0.51 0.52 0.52 0.52 0.52 0.52
0.52 0.52 0.52 0.52 0.53 0.53 0.53 0.54 0.54 0.56
0.56 0.57 0.57 0.65 0.73 0.74 0.77 0.77 0.77 0.82

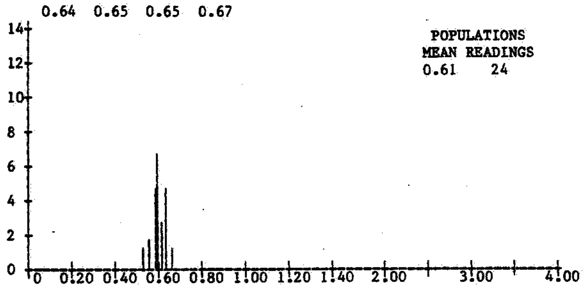


REMARKS

MIXED ASSEMBLAGE. FREQUENT VITRINITE.

SAMPLE 966-161A DEPTH 2305 VITRINITE REFLECTANCE VALUES

0.53 0.56 0.56 0.59 0.59 0.59 0.59 0.59 0.60 0.60
0.60 0.60 0.61 0.61 0.61 0.62 0.62 0.63 0.64 0.64
0.64 0.65 0.65 0.67

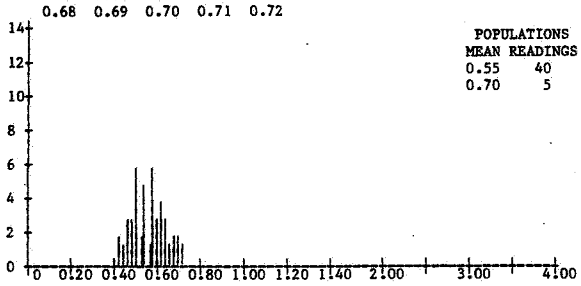


REMARKS

DOMINANTLY FINE GRAINED AMORPHOUS MATERIAL.

SAMPLE 966-174A DEPTH 2419.4 VITRINITE REFLECTANCE VALUES

0.42 0.43 0.44 0.46 0.47 0.47 0.48 0.48 0.48 0.50
0.51 0.51 0.51 0.51 0.51 0.53 0.53 0.54 0.54 0.55
0.55 0.55 0.57 0.58 0.58 0.58 0.59 0.59 0.59 0.60
0.60 0.61 0.62 0.63 0.63 0.63 0.64 0.64 0.65 0.66
0.68 0.69 0.70 0.71 0.72



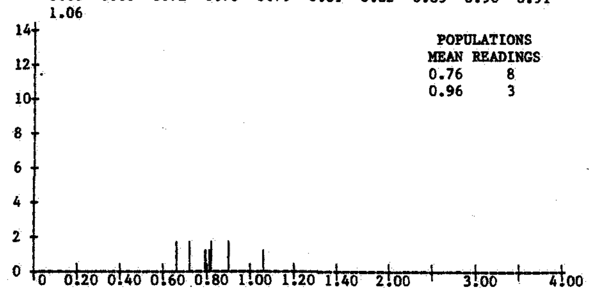
REMARKS

SMALL VITRINITE PARTICLES

FIGURE 12e VITRINITE REFLECTANCE WELL 7121/4-1

SAMPLE 966-184A DEPTH 2480 VITRINITE REFLECTANCE VALUES

0.66 0.66 0.72 0.73 0.79 0.81 0.82 0.83 0.90 0.91
1.06

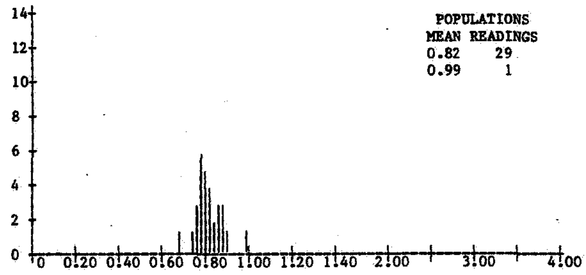


REMARKS

SPARSE, REWORKED VITRINITE PARTICLES.

SAMPLE 966-194A DEPTH 2586 VITRINITE REFLECTANCE VALUES

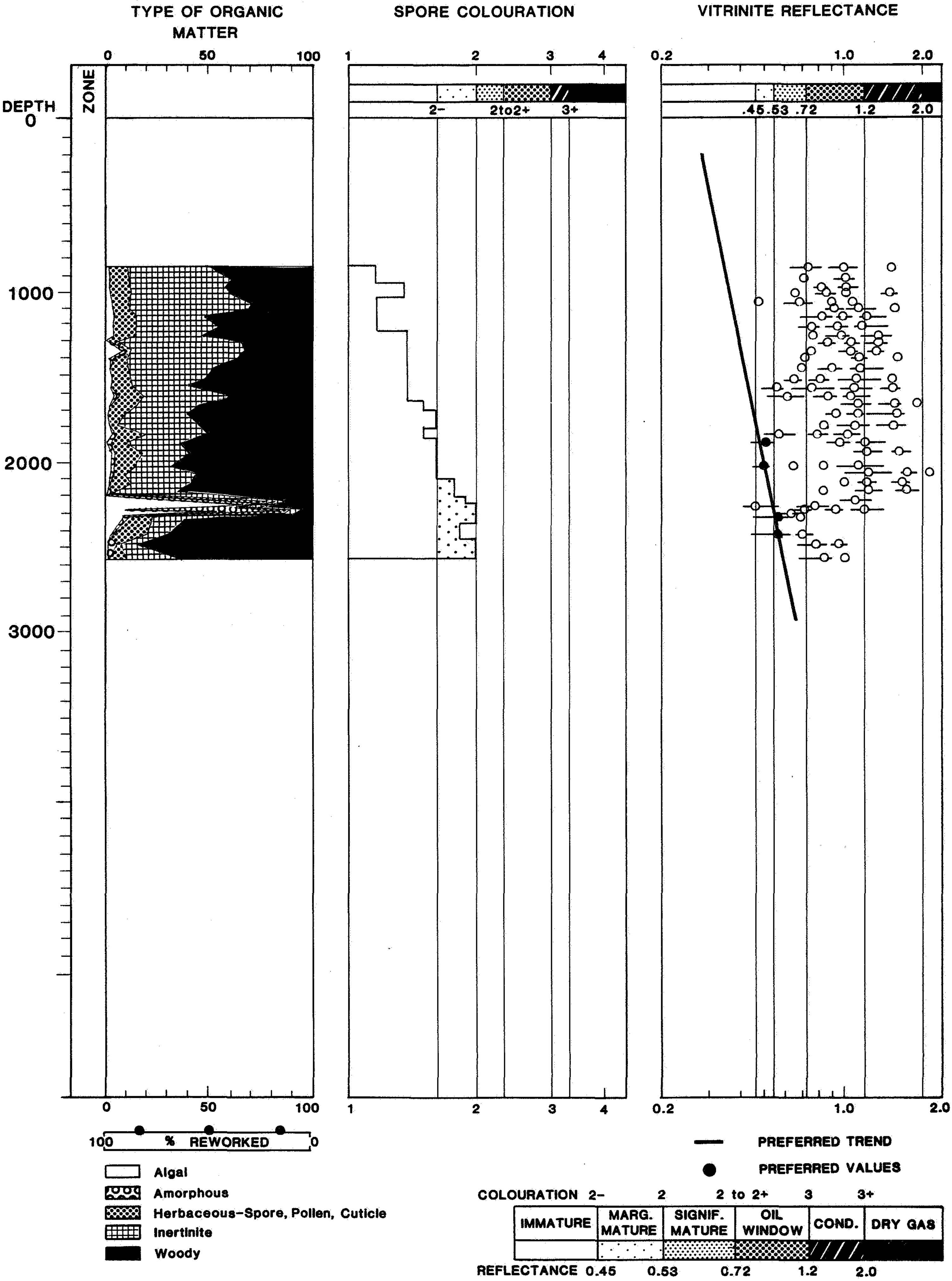
0.68 0.74 0.76 0.76 0.76 0.78 0.78 0.79 0.79 0.79
0.79 0.80 0.80 0.80 0.81 0.81 0.82 0.82 0.83 0.83
0.84 0.85 0.86 0.87 0.87 0.88 0.89 0.89 0.90 0.99



REMARKS

RICH IN SMALL VITRINITE PARTICLES.

FIGURE 13 **ORGANIC FACIES & MATURITY** WELL 7121/4-1



BRIEF DESCRIPTION OF THE ANALYSES PERFORMED BY GEOCHEM

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

A) C_1-C_7 LIGHT HYDROCARBON ANALYSIS

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

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

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

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

B) SAMPLE WASHING AND HAND PICKING

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

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

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

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

C) ORGANIC CARBON ANLYSIS

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

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

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

D) MINI-PYROLYSIS

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

E) DETAILED C_4-C_7 HYDROCARBON ANALYSIS

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

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

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

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

F) KEROGEN TYPE AND MATURATION

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

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

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

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

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

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

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

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

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

G) VITRINITE REFLECTANCE

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

K) 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 pyrolysate. PYROLYSIS also provides the above together with the temperature of peak pyrolysate evolution. The capillary chromatograms of the pyrolysate obtained by PYROLYSIS-GC are reproduced in the report. The Mini-Pyrolysis analysis is recommended as a screening technique.

L) CORRELATION STUDY ANALYSES

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

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

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

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

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

- high pressure liquid chromatograms.

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

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

- vanadium and nickel contents.

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

M) <u>ANALYSES FOR SPECIAL CASES</u>

M-1) <u>ELEMENTAL KEROGEN ANALYSIS</u>

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) <u>SULPHUR ANALYSIS</u>

The abundance of sulphur in source rocks and crude oils.

M-3) <u>CARBONATE CONTENT</u>

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) <u>NORMAL PARAFFIN ANALYSIS</u>

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 <u>SOLID BITUMEN EVALUATION</u>

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

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

N) <u>CRUDE OIL ANALYSIS</u>

N-1) <u>API GRAVITY</u>

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

N-2) <u>SULPHUR CONTENTS</u> (ASTM E30-47)

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

N-4) <u>VISCOSITY</u> (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.