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GeoChem Laboratories (U.K.) Limited

GEOCHEMICAL SERVICE REPORT

Prepared for

STATOIL

GEOCHEMICAL EVALUATION OF STATOIL'S 6610/7-2

TRAENABANKEN WELL

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SUMMARY

The section between (500)995 metres and 4215 metres has been analysed.

Between 1520± metres and 1740± metres the shaly mudstones (except at 1670-1720± metres) are immature but potentially fair and good source rocks for gas and oil. The coaly shales from 1520-1740± metres are a potentially rich source for gas and associated oil. On-structure, no hydrocarbon generation has occurred and, due to the character of the organic matter, significant generation would require burial to below 4000± metres.

The rest of the section comprises poor and uninteresting source rocks for gas.

If present, good quality organic matter would be mature below 3300± metres. The top of the oil window probably lies between 4000 metres and TD.

N.J.L. Bailey
GEOCHEM LABORATORIES (UK) LIMITED

INTRODUCTION

This report presents a geochemical evaluation of the section between 1000 metres and 4215 metres in Statoil's 6610/7-2 Traenabanken North Sea well.

The analytical format was specified by the client and was designed to investigate the hydrocarbon source potential for the penetrated sediments in terms of source richness, organic facies, thermal maturity and potential for oil or gas.

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

A. ANALYTICAL

Two hundred and eighty (280) ditch cuttings samples, composited over fifteen (15) metres, were received from the interval 320-4215 metres (including the sidetrack below 3105 metres) in 6610/7-2. In addition, forty four (44) sidewall cores were submitted from the interval 1470-4158 metres. These samples were assigned the Geochem job number 882.

Geochem were instructed to analyses the sample from 500 metres and the interval below 1000 metres according to a format specified by the client.

Thirty three light hydrocarbon analyses, one hundred and eight organic carbon analyses, fifty two Rockeval pyrolysis analyses, twenty C_{15+} extractions with chromatography, twenty high resolution paraffin-naphthene analyses, thirty kerogen analyses, twenty five vitrinite reflectance determinations and nineteen pyrolysis-GC analyses were performed in this study.

The data are presented in tables 1 through 8 and graphically in figures 1 through 8. A brief description of the analytical techniques employed in the project is included in the back of this report.

B. GENERAL INFORMATION

Ten (10) copies of this report and the kerogen slides prepared for this study have been forwarded to Dr. H. Irwin in Stavanger. A copy of the data has been retained by Geochem for future consultation with authorised Statoil personnel. An IBM magnetic tape of the data will be forwarded to Statoil.

The remaining sample material will returned to Statoil.

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

INTERPRETATION

In this well the samples from the original hole extend down to 3530± metres. The well was sidetracked and this second set of samples ranges from 3105 metres to 4215 metres.

Each of the parameters relevant to the geochemical evaluation of the section will be considered in turn and then integrated to form the "Conclusions".

No well logs or formation tops were available for this study.

A. ZONATION

Due to the sparcity of light hydrocarbon data, this zonation is based upon the organic carbon results. Six (6) zones are recognised.

Zone A 500-515± metres and 995-1250± metres is dominated by shaly mudstones. The sample from 500-515± metres consists of sands with minor proportions of basalt.

Zone B 1295± metres down to 1490± metres, comprises shaly mudstones which are grossly medium dark grey in colour. Interbedded sands are indicated above 1450± metres.

Zone C 1520± metres to 1740± metres, is a sequence of medium dark grey shaly mudstone and coaly shales with occasional sandstones.

Zone D 1740± metres to 2150± metres consists of pale red and medium light grey silty mudstones with interbedded sandstones.

Zone E 2170± metres down to 3520± metres. This thick interval apparently consists of shales and silty shales.

Zone F 3520± metres to 4215± metres, is an interval of sandstones with interbeds of pale red siltstone. The minor dark grey shales are belived to be caved.

The samples from Zones B through E were heavily biased towards sidewall cores.

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 shaly mudstones of Zone A generally contain 0.99-1.30(1.51)% organic carbon, although leaner units are also present. Their organic matter is variously a mixed herbaceous-amorphous-woody-algal-inertinitic assemblage or an assemblage within which the herbaceous fraction is the major component. The amorphous fraction is of poor quality and is not oil-prone.

In Zone B the shaly mudstones are leaner at 0.57-1.07% organic carbon. Again, the organic matter in the sediments is of poor quality, being either inertinitic (with significant proportions of wood) or herbaceous-inertinitic-woody in type.

Zone C is richer. The mudstones generally have very good values of 2.85-5.38% organic carbon but drop to 0.43-0.95(1.87)% at 1670-1720± metres. Their organic matter is dominantly woody in type, although the herbaceous and inertinitic fractions are also significant. Wood is very dominant in the coaly shales, which are very rich at 18.8-38.7(52.8)% organic carbon.

The silty mudstones of Zone D are very lean with 0.12-0.20(0.28)% of inertinite. Minor medium grey shaly mudstones are present within the interval 1780-1850± metres and these are richer at 1.23-2.30% organic carbon, whilst their organic matter is woody with significant proportions of inertinitic and herbaceous debris.

The Zone E shales are apparently much richer at (0.59)0.72-2.12% organic carbon, but this is due to the presence of drilling-introduced contamination after the removal of which, the values drop to 0.35-0.85(1.25)%, seldom exceeding 0.7% organic carbon. Inertinite is very dominant within these sediments, although the woody fraction is fairly significant and herbaceous debris is also occasionally significant.

Zone F, like Zone D, is very lean. The minor shales, which are believed to be caved, contain 0.63-0.90% of inertinitic (and woody) debris but the siltstones contain only 0.10-0.22(0.48)% of organic matter which again, is very dominantly inertinitic in type.

This section is characterised by organic matter is of poor quality and this observation is confirmed by the low hydrogen indices.

C. LEVEL OF THERMAL MATURATION

Thermal maturity has been evaluated with the spore colouration and vitrinite reflectance techniques.

A spore colouration thermal index of 2- is achieved at 2400± metres, whilst 2 is reached at 3300± metres. A level of 2 to 2+ is apparently approached, or may be achieved, below 4000± metres, but these samples are too poor to be certain of this. Good quality organic matter becomes mature at a thermal index of 2 and enters the oil window at 2 to 2+. In contrast, woody material only becomes marginally mature (minor hydrocarbon generation) at 2. Hence in this well, the sediments above 2400± metres are immature, whilst those from 2400-3300± metres are effectively immature and only limited hydrocarbon generation can be anticipated below 3300± metres. It is possible that significant (but not major) gas generation per unit of organic matter has been initiated below approximately 4000± metres but the sidewall cores are lean and their organic matter is unsuitable for measurement.

The vitrinite reflectance data indicates extensive reworking and oxidation. Fortunately, some excellant vitrinite populations were obtained from Zone C and the lower reflecting population from 3242 metres also appears to be reliable. Using these data points to construct the trend line, reflectance values of 0.45% Ro and of 0.53% Ro should be achieved at depths of 2400± metres and of 3250± metres respectively.

Reflectivities of 0.45% Ro and of 0.53% Ro should be equivalent to spore colouration thermal indices of 2- and of 2 and hence, there is a good correlation between the two methods.

The situation within Zone F is unclear due to the leanness of the sediments, but it is suspected that the top of the "oil window" may lie between 4000 metres and TD.

Pyrolysis Tmax data are unreliable in Zones D through F due to the leanness of the sediments in Zones D and F and the severe contamination in Zone E.

D. SOURCE RICHNESS

A consideration of the quality of the organic matter and the organic carbon contents suggests that most of these sediments are only poor source rocks. However, Zone A might merit a fair source rating whilst the mudstones and coaly shales of Zone C are, respectively, classified as potentially good and rich source rocks.

C_{15+} hydrocarbon abundances are very variable within this section, but are extremely high in Zone E where they also comprise 81-93% of the total extract. Indeed, hydrocarbon to total extract ratios tend to be relatively high throughout, which suggests the presence of non-indigenous hydrocarbon species. This is confirmed by the paraffin-naphthene chromatograms which display a pronounced front-end bias and are almost restricted to the C_{22-} fraction. Clearly, drilling-introduced contamination is indicated, probably by a low toxicity light gas-oil. As a result of this contamination, the measured hydrocarbon abundances cannot be employed to evaluate source richness.

This problem is largely avoided by Rockeval pyrolysis in which the abundance of pyrolysate (S2) provides a measure of the hydrocarbon potential which will be achieved by source rocks at optimum maturity. Using this method Zone A is generally poor although a few mudstones are rated as poor to fair (2.17 mg/g). Zone B is lean. The coaly shales of Zone C are potentially rich (22.5-38.9(80.4) mg/g), although not very rich, source rocks whilst the mudstones are classified as (fair or) good (2.09-3.76) except at 1670-1720± metres where they are poor and generally, very poor source rocks. Zone D is extremely lean and even the minor richer shaly mudstones from 1780-1850± metres are poor. Zone E is also a poor source unit whilst Zone F (including the dark grey shales) is lean, with only a minimal potential for hydrocarbons.

Chromatograms of the pyrolysate (S2) fraction define whether a sediment, when mature, will yield oil or condensate or gas. Oil-prone sediments are characterised by a well-defined series of normal alkene-alkane doublets which extend out to the heavy ends and which, in classically oil-prone sediments, totally dominate the chromatogram. If the doublets are restricted to the light ends then a potential for condensate is indicated, whilst the doublets are absent from gas-prone sediments. In this case, the trace consists of the methane and a series of aromatic peaks. It is clear from an examination of the chromatograms that this section is gas-prone, the only exception being Zone C in which the shaly mudstones will yield gas and oil and the coaly shales have a potential for gas with associated oil.

E. MIGRATED HYDROCARBONS

No fluoresence was observed in these samples and the C_{15+} and pyrolysis data cannot be used to detect the presence of migrated, out of place hydrocarbons due to the prevalence of drilling-introduced contamination.

A limited number of light hydrocarbon (C_1-C_7) analyses were performed. These hydrocarbons are generally very sparse but are of fair abundance in Zones C and D (no data for Zone E) where however, the gases are extremely dry with, in general, less than 1% of the C_{2+} fraction. The available data do not indicate any shows.

F. CONCLUSIONS

Six (6) zones are recognised between (500)995 metres and 4215 metres.

Within the interval 995-1250± metres (Zone A) the shaly mudstones generally contain 0.99-1.30(1.51)% of mixed, but very dominantly land plant derived, organic matter. These sediments are immature but, even if mature, would only be poor or occasionally poor to fair source rocks for gas.

Zone B (1295-1490± metres) consists of shaly mudstones with 0.57-1.07% of inertinitic or herbaceous-inertinitic-woody organic matter. These mudstones are not only immature but are also very lean, with a minimal source potential for gas.

Zone C (1520-1704± metres) is a sequence of shaly mudstones and coaly shales. This is the richest interval in the well. The mudstones generally contain 2.85-5.38% organic carbon but are leaner at 1670-1720± metres. Their organic matter is dominantly woody in type, but the herbaceous and inertinitic fractions are also significant. The coaly shales are dramatically richer with 18.8-38.7(52.8)% of organic matter which is very dominantly woody. This interval is immature but the mudstones are potentially fair or good source rocks for gas and oil whilst the coaly shales are potentially rich source rocks for gas with associated oil.

Zone D (1740-2150± metres) is dominated by lean silty mudstones. Minor shaly mudstones are present within the interval 1780-1850± metres and these have good (1.2-2.3%) carbon contents but their organic matter is of poor quality. As a result, even these shaly mudstones are only poor source rocks.

Within Zone E (2170-3520± metres) the shales and silty shales contain 0.35-0.85(1.25)% organic carbon, but seldom exceed 0.7%. Their organic matter is very dominantly inertinitic in type and in consequence, this entire interval is only a poor source for gas. Above 3300± metres these sediments are effectively immature and even below this depth, only minor hydrocarbon generation can be anticipated.

Zone F (3520-4215± metres) is a sequence of sandstones with interbedded pale red siltstones. These siltstones contain sparse inertinitic organic matter. Minor dark grey shales are also present (caved?) but these, like the siltstones, are also lean source rocks with a minimal potential for gas.

The entire analysed section is characterised by poor quality organic matter and, as a result, is rated as a poor source for gas. The one exception to this generalisation is represented by the shaly mudstones and coaly shales of Zone C.

Good quality oil-prone organic matter, if present, would be mature (significant hydrocarbon generation) below 3300± metres. It is suspected that the top of the oil window may lie between 4000 metres and TD.

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)
882-013	500-515m	A 85% Quartz, sand, unconsolidated, medium to coarse grained, subangular, poorly sorted, clear, white	N9	
		B 15% Basalt, blocky, hard, greyish black Minor pyrites and other igneous	N2	
882-046	995-1010m	A 98% Shaly mudstone, subfissile to blocky, soft, non-calc., sig. cavings, light grey Minor igenous	N7	1.11
882-050	1055-1070m	A 60% Shaly mudstone, as 882-046A, abundant cavings	N7	0.99
		B 40% Shaly mudstone, blocky, silty, mud hard, v. sl. calc., sig. cavings, olive grey Minor other mudstone and igenous	5Y4/1	0.37
882-054	1175-1130m	A 35% Shaly mudstone, as 882-046A, dominant cavings	N7	1.08,1.09
		B 35% Shaly mudstone, as 882-050B, abundant cavings	5Y4/1	1.08
		C 30% Quartz, sand, unconsolidated, medium grained, subrounded, poorly sorted, clear, white	N9	
882-058	1175-1190m	A 60% Quartz sand, unconsolidated, fine-medium grained, subangular to sub-rounded, fairly well sorted, clear, white	N9	
		B 25% Shaly mudstone, subfissile, mod. hard, non-calc., sig. to abundant cavings, light grey	N7	1.51
		C 15% Mudstone, blocky, mod. hard, non-calc., sig. cavings, olive grey Minor mica	5Y4/1	1.27
882-062	1235-1250m	A 55% Shaly mudstone, blocky to subfissile soft to mod. hard, non calc. sig. cavings medium grey to medium olive grey	N5-5Y5/1	1.30
		B 45% Sand, as 882-058A	N9	
882-066	1290-1310m	A 60% Sand, as 882-058A	N9	
		B 40% Shaly mudstone, as 882-062A, sig. to abundant cavings Minor glauconite	N5-5Y5/1	0.93,0.93
882-070	1355-1370m	A 85% Shaly mudstone, as 882-062A, abundant to dominant cavings	N5-5Y5/1	0.68
		B 15% Quartz sand, as 882-058A Minor glauconite	N9	
882-074	1415-1430m	A 80% Shaly mudstone, blocky to subfissile soft to mod. hard, non-calc., sig. to abundant cavings	N5-N6	0.67
		B 20% Quartz sand, as 882-058A	N9	
882-078 SWC	1470m	A 98% Shaly mudstone, subfissile, soft, non-calc., medium dark grey	N4	0.57

Abbreviations = **are**naceous, **arg**illaceous, **calc**areous, **Cut**, **dol**omitic, **Fluor**escence, **foram**inifera, **fos**siliferous
Lost Circulation Material, **mod**erately, **occ**asionally, **sl**ightly, **v**ery

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882-079 SWC	1472m	A 98% Shaly mudstone, blocky, mod. hard non calc., medium dark grey to medium grey	N4-N5	0.66
882-080 SWC	1474m	A 98% Shaly mudstone, blocky, soft, non-calc., dark grey to medium dark grey	N3-N4	0.83
882-081 SWC	1478m	A 98% Shaly mudstone, blocky, soft, non-calc., dark grey to medium dark grey	N3-N4	1.07
882-082	1475-1490m	A 98% Shaly mudstone, platy to subfissile soft to mod. hard, non-calc., sig. to abundant cavings, medium light grey Minor sand	N6	0.73,0.73
882-084 SWC	1521.5m	A 98% Shaly mudstone, subfissile, soft, non-calc., sl. micaceous, medium dark grey	N4	2.86,2.84
882-086	1535-1550m	A 95% Quartz sand, unconsolidated, fine-medium grained, subangular, to subrounded, poorly sorted, clear, white	N9	
		B 5% Coaly shale, subfissile to blocky, soft, non-calc., greyish black Minor mudstone	N2	34.2
882-090	1595-1610m	A 90% Quartz sand, as 882-086A,	N9	
		B 10% Coaly shale, as 882-086B, sig. cavings Minor caved mudstone	N2	38.7
882-092 SWC	1629.3m	A 60% Silty mudstone, blocky, soft, non-calc., medium dark grey to dark grey	N4-N3	4.69
		B 40% Coaly shale, subfissile to blocky, soft, non-calc., greyish black	N2	18.8
882-093 SWC	1635.3m	A 55% Claystone, subfissile to platy, soft, non-calc., medium dark grey to medium grey	N4-N5	5.43,5.33
		B 45% Coal, blocky, brittle, greyish black	N2	52.8
882-094 SWC	1637m	A 98% Coaly shale, blocky to subfissile, soft, non-calc., greyish black to pinkish brownish grey	N2-5YR7/1	24.7
882-097	1655-1670m	A 60% Sand, unconsolidated, medium grained subrounded, poorly sorted, clear, white	N9	
		B 40% Coaly shale, blocky to subfissile soft, non-calc., sig. to abundant cavings, greyish black to dark grey	N2-N3	34.4
882-098 SWC	1664.5m	A 98% Shaly mudstone, grading to shale, subfissile to platy, soft to mod. hard, non-calc., medium grey	N5	3.28
882-099 SWC	1678m	A 98% Mudstone, blocky, soft, non-calc., medium dark grey	N4	0.95

Abbreviations = **are**naceous, **arg**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

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882-101 SWC	1684m	A 98% Shaly coal, subfissile, soft, greyish black	N2	37.5
882-102 SWC	1685m	A 98% Shaly mudstone, subfissile, soft, non-calc., medium grey	N5	1.87
882-104 SWC	1705m	A 98% Mudstone, blocky, soft, clayey, non-calc., medium grey to medium light grey Minor coal	N5-N6	0.43
882-106 SWC	1720m	A 98% Mudstone, clayey, blocky, soft, non-calc., medium dark grey	N4	0.65,0.63
882-107	1715-1730m	A 85% Sand, unconsolidated, medium-fine grained, subrounded to subangular, poorly sorted, clear, white	N9	
		B 15% Coaly shale, subfissile, mod. hard, non-calc., sig. cavings, light grey Minor other shale	N7	25.7
882-108 SWC	1730m	A 98% Shaly mudstone, blocky to subfissile soft, non-calc., medium dark grey to dark grey	N4-N3	40.3
882-110 SWC	1751m	A 98% Shaly mudstone, blocky, soft, non-calc., medium light grey	N6	0.15,0.15
882-112 SWC	1766m	A 98% Siltstone, blocky, soft, v. sl. calc. greyish orange pink to greyish orange	5YR7/2 10YR7/4	0.12
882-114 SWC	1777.5m	A 98% Silty mudstone, blocky, soft, non-calc., medium grey	N5	0.28
882-115	1775-1790m	A 85% Sand, unconsolidated, fine-medium grained, subrounded to subangular, poorly sorted, clear, white	N9	
		B 15% Shaly mudstone, subfissile, mod. hard, non-calc., minor cavings, medium grey Minor siltstone and other shale	N5	2.30
882-118 SWC	1821.5m	A 98% Mudstone, blocky, soft, non-calc., medium greyish brown	5YR4/2	0.14
882-120	1835-1850m	A 75% Sand, unconsolidated, medium grained, subangular to subrounded, fairly well sorted, clear, white	N9	
		B 15% Mudstone, blocky, soft, non-calc., sl. silty, sig. cavings, moderate brown to moderate brown	5YR3/4 5YR4/4	0.16
		C 10% Shaly mudstone, subfissile, soft, non-calc., minor cavings, medium grey Minor other carb. mudstone	N5	1.23
882-124	1895-1910m	A 85% Sand, as 882-120A	N9	
		B 15% Mudstone, as 882-120B, sig. cavings Minor other mudstone	5YR3/4 5YR4/4	0.16,0.16

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

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882-125 SWC	1910m	A 98% Silty mudstone, blocky, soft, non-calc., medium light grey to light brownish grey	N6-5YR6/1	0.20
882-129	1955-1970m	A 60% Sand, unconsolidated, medium grained subangular, fairly well sorted, clear white	N9	
		B 40% Silty mudstone, blocky, soft, non-calc., minor cavings, greyish red Minor other mudstone	5R4/2	0.13
882-133	2015-2030m	A 90% Sand, as 882-129A	N9	
		B 10% Silty mudstone, as 882-129B, sig. cavings Minor other mudstone	5R4/2	0.14
882-134 SWC	2039m	A 98% Calc. silty mudstone, blocky, soft light olive grey to dark greenish grey	5Y6/1 5GY6/1	0.19
882-138	2075-2090m	A 80% Sand, unconsolidated, medium to coarse grained, subangular to subrounded, poorly sorted, clear, white	N9	
		B 20% Silty mudstone, blocky, soft, sl. calc., minor cavings greyish red Minor other mudstone	5R4/2	0.15
882-142	2135-2150m	A 75% Silty mudstone, as 882-138B, sig. cavings	5R4/2	0.13,0.13
		B 15% Sand, as 882-138A	N9	
		C 10% Mudstone, subfissile, mod. hard, non calc., minor cavings, medium light grey	N6	0.15
882-145 SWC	2175m	A 98% Siltstone, blocky, soft to mod. hard, non-calc., medium light grey to light olive grey	N6-5Y6/1	0.72
882-158 SWC	2335m	A 98% Silty shale, subfissile, mod. hard sl. calc., medium dark grey	N4	1.35
882-164 SWC	2440m	A 98% Shale, subfissile to fissile, soft to mod. hard, non-calc., medium dark grey	N4	1.37
882-170 SWC	2513m	A 98% Siltstone, blocky, soft, non-calc. grades to fine sandstone, medium grey	N5	0.75
882-178 SWC	2620m	A 98% Mudstone, blocky, mod. hard, sl. silty, non-calc., greyish red	5R4/2	0.57,0.60
882-184 SWC	2683.5m	A 98% Mudstone, subfissile to blocky, soft to mod. hard, non-calc., greyish red	5R4/2	0.78
882-187 SWC	2722m	A 98% Silty shale, blocky to subfissile, mod. hard, non-calc., medium dark grey	N4	0.90
882-190 SWC	2749.5m	A 98% Shale, subfissile, soft, sl.calc., medium dark grey to dark grey	N4-N3	2.11,2.13

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

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882-199 SWC	2863.5m	A 98% Shaly mudstone, subfissile, soft sl. calc., brownish grey	5YR4/1	1.38
882-208 SWC	2988.5m	A 98% Shaly mudstone, subfissile, soft, non- calc., brownish grey	5YR4/1	1.15
882-213 SWC	3044m	A 98% Shaly mudstone, blocky, mod hard, sl. calc., brownish grey	5YR4/1	1.30
882-216 SWC	3088m	A 98% Mudstone, blocky, mod. hard, sl. calc., medium dark grey	N4	1.31,1.32
882-226 SWC	3211m	A 98% Shale, subfissile, soft, v. sl. calc. medium dark grey to dark grey	N4-N3	1.03
882-229 SWC	3242m	A 98% Shale, subfissile, soft, non-calc., medium dark grey to dark grey	N4-N3	1.61
882-239 SWC	3376m	A 98% Shale, subfissile, soft, non-calc., dark grey	N3	1.87
882-245 SWC	3453.5m	A 98% Shale, subfissile, soft to mod. hard, non-calc., dark grey	N3	1.20
882-249 SWC	3502m	A 98% Calc. silty mudstone, blocky, soft very light grey	N7	0.48
882-252 SWC	3577m	A 98% Silty mudstone, blocky, soft to mod hard, non-calc., medium light grey	N6	0.20,0.21
882-253 SWC	3587m	A 98% Silty mudstone, blocky, soft, calc., medium light grey	N6	0.39
882-254 SWC	3804.5m	A 98% Silty mudstone, blocky, soft, calc., medium light grey to light grey	N6-N7	0.22
882-255 SWC	4088m	A 98% Mudstone, blocky, soft, sl. calc., greyish red	5R4/2	0.18
882-256 SWC	4120.5m	A 98% Mudstone, blocky, soft, calc., greyish brown	5YR3/2	0.38
882-257 SWC	4158m	A 98% Mudstone, subfissile, soft, calc., greyish brown	5YR3/2	0.22,0.19
		<u>SIDETRACK</u>		
882-279	3485-3500m	A 45% Shale, platy to blocky, mod. hard, non-calc., minor cavings, medium dark grey	N4	0.72
		B 40% Arg. limestone, blocky, hard, cryptocrystalline, medium dark grey	N4	0.31
		C 15% LCM - cement		
882-283	3545-3560m	A 98% Sandstone, mostly unconsolidated, medium to coarse grained, angular to subangular, poorly sorted, white Minor shale	N9	
882-287	3605-3620m	A 55% Sandstone, blocky, medium grained, subangular, poorly sorted, sl. calc., matrix, pinkish grey	5YR8/1	

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

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
882-287	3605-3620m	B 30% Limestone, blocky, hard, sl. arenaceous, pinkish grey	5YR8/1	0.10
		C 10% Sand, unconsolidated, medium grained subangular, poorly sorted, clear, white	N9	
		D 5% Shale, platy, mod. hard, non-calc., sig. cavings, dark grey	N3	0.87
882-291	3665-3680m	A 80% Sandstone, blocky, medium grained, subangular, poorly sorted, sl. calc., matrix, sig. cavings pinkish grey	5YR8/1	
		B 10% Siltstone, blocky, soft, calc., minor cavings, greyish red	5R4/2	0.12
		C 5% Shale, as 882-287D, minor to sig. cavings	N3	0.77
		D 5% Sand, as 882-287C		
882-295	3725-3740m	A 45% Sandstone, as 882-291A, sig. cavings	5YR8/1	
		B 40% Siltstone, as 882-291B, sig. cavings	5R4/2	0.10
		C 10% Sand, as 882-287C	N9	
		D 5% Shale, as 882-287D, sig. cavings	N3	0.80,0.81
882-299	3785-3795m	A 65% Sandstone, blocky, medium grained subangular, fairly well sorted, calc. matrix, pinkish grey	5YR8/1	
		B 30% Sand, unconsolidated, subangular, fairly well sorted, clear, white	N9	
		C 5% Shale, subfissile to blocky, mod. hard, non-calc., sig. to abundant cavings, dark grey to medium dark grey	N3-N4	0.74
		Minor siltstone		
882-303	3840-3855m	A 55% Sandstone, as 882-299A	5YR8/1	
		B 30% Siltstone, blocky, soft to mod. hard sl. calc., minor cavings, greyish red	5R4/2	0.11
		C 15% Sand, as 882-299B	N9	
		Minor caved shale		
882-307	3900-3915m	A 50% Sandstone, as 882-299A, sig. cavings	5YR8/1	
		B 30% Siltstone, as 882-303B, sig. cavings	5R4/2	0.12
		C 20% Sand as 882-299B	N9	
		Minor caved shale		
882-311	3960-3975m	A 90% Sandstone, mostly unconsolidated, medium grained, subangular, fairly well sorted, pinkish grey	5YR8/1	
		B 5% Shale, platy to subfissile, mod. hard, non-calc., sig. to abundant cavings, dark grey	N3	0.90
		C 5% Siltstone, as 882-303B, sig. cavings	5R4/2	0.14,0.16
882-314	4050-4065m	A 50% Sandstne, as 882-311A	5YR8/1	
		B 45% Sand, as 882-311B	N3	
		C 5% Shale, platy, mod. ahrd, non-calc., sig. cavings, dark grey	N3	
		Minor siltstone		

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)
882-316	4080-4095m	A 50% Siltstone, blocky, soft to mod. hard non-calc., minor cavings, greyish blackish red	5R3/2	0.11
		B 25% Sandstone, mostly unconsolidated, medium grained, subangular, fairly well sorted, pinkish grey	5YR8/1	
		C 20% Sand, platy to subfissile, mod. hard, non-calc., sig. to abundant cavings, dark grey	N3	0.90
		D 5% Shale, platy, mod. hard non-calc., sig. cavings, dark grey	N3	0.63
882-320	4140-4155m	A 90% Sandstone, mostly unconsolidated, medium grained, subangular, fairly well sorted, pinkish grey to white	5YR8/1-N9	
		B 10% Siltstone, as 882-316A, minor cavings Minor shale	5R3/2	0.16,0.15

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	$\frac{iC_4}{nC_4}$
882-013	500-515	70	2	1	0	1	74	4	4.9	2	0.43
882-046	995-1010	678	0	0	0	0	679	1	0.1	1	1.95
882-050	1055-1070	322	2	1	0	1	326	4	1.2	1	0.49
882-054	1115-1130	35	1	1	0	0	37	2	5.7	0	1.01
882-058	1175-1190	654	3	1	1	1	659	5	0.8	6	0.84
882-062	1235-1250	6	2	1	0	1	10	4	38.1	1	0.52
882-066	1295-1310	56	1	0	0	0	57	1	2.3	3	0.76
882-070	1355-1370	4	1	0	0	0	5	1	26.2	1	0.49
882-074	1415-1430	68	2	1	1	2	73	5	7.2	10	0.34
882-082	1475-1490	35	2	1	1	2	42	7	16.1	19	0.71
882-086	1535-1550	6551	19	2	0	0	6573	21	0.3	0	0.49
882-090	1595-1610	1683	1	1	0	0	1684	2	0.1	0	0.46
882-097	1655-1670	1156	3	1	1	2	1163	8	0.7	1	0.33
882-107	1715-1730	3025	1	1	0	0	3027	2	0.1	2	0.33
882-115	1775-1790	17854	4	4	2	3	17866	13	0.1	7	0.51
882-120	1835-1850	2269	1	0	0	0	2271	2	0.1	1	0.69
882-124	1895-1910	1863	2	1	1	2	1869	6	0.3	3	0.49
882-129	1955-1970	6739	1	1	0	1	6742	3	0.0	1	0.33
882-133	2015-2030	4940	1	1	0	1	4943	3	0.1	1	0.42
882-138	2075-2090	4531	1	1	1	1	4535	4	0.1	1	0.59
882-142	2135-2150	4874	1	1	0	1	4877	3	0.1	1	0.41
882-279	3485-3500	54	24	22	1	11	112	59	52.3	4	0.14
882-283	3545-3560	35	7	3	0	4	50	15	29.4	2	0.08
882-287	3605-3620	39	9	3	0	2	53	14	26.6	1	0.09
882-291	3665-3680	47	11	4	1	11	74	27	36.6	9	0.09
882-295	3725-3740	42	6	3	1	6	58	15	26.7	3	0.09
882-299	3785-3795	31	8	3	4	50	96	65	67.3	16	0.07
882-303	3840-3855	57	7	4	1	26	96	39	40.5	18	0.06
882-307	3900-3915	28	3	1	1	18	51	23	44.9	8	0.06
882-311	3960-3975	72	4	2	1	15	94	22	23.4	4	0.06

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	$\frac{iC_4}{nC_4}$
882-314	4050-4065	24	4	2	1	17	47	23	49.3	4	0.04
882-316	4080-4095	18	4	3	1	27	53	35	66.2	2	0.04
882-320	4140-4155	60	6	2	1	28	97	36	37.5	7	0.04

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	$\frac{iC_4}{nC_4}$
882-013	500-515	194	14	5	1	9	223	30	13.2	15	0.17
882-046	995-1010	53	3	2	0	2	60	8	12.9	3	0.23
882-050	1055-1070	23	6	2	0	2	33	10	31.3	1	0.19
882-054	1115-1130	18	5	0	0	2	25	7	29.4	2	0.18
882-058	1175-1190	80	12	1	1	5	99	20	19.8	3	0.22
882-062	1235-1250	61	14	8	1	6	90	29	32.7	2	0.22
882-066	1295-1310	84	19	7	1	3	115	30	26.4	3	0.35
882-070	1355-1370	55	12	5	1	5	78	23	29.8	2	0.28
882-074	1415-1430	46	12	4	1	3	65	19	29.9	2	0.20
882-082	1475-1490	56	9	3	0	2	70	15	21.0	2	0.21
882-086	1535-1550	231	12	4	1	2	249	19	7.5	3	0.29
882-090	1595-1610	185	12	4	0	3	204	19	9.4	4	0.15
882-097	1655-1670	59	12	5	1	3	80	20	25.6	3	0.45
882-107	1715-1730	75	8	3	0	1	87	12	13.7	2	0.22
882-115	1775-1790	50	14	6	1	7	78	28	36.2	2	0.17
882-120	1835-1850	345	12	4	0	3	365	20	5.4	2	0.19
882-124	1895-1910	393	9	3	0	2	407	14	3.5	3	0.22
882-129	1955-1970	288	10	6	0	0	304	16	5.3	0	0.24
882-133	2015-2030	195	9	4	0	2	210	15	7.2	2	0.22
882-138	2075-2090	119	7	2	0	1	130	11	8.3	2	0.16
882-142	2135-2150	417	16	2	1	4	440	23	5.2	3	0.19
882-279	3485-3500	219	32	12	3	10	275	57	20.5	59	0.35
882-283	3545-3560	142	22	13	2	10	190	48	25.1	68	0.20
882-287	3605-3620	69	23	12	2	13	119	50	42.0	13	0.14
882-291	3665-3680	68	14	7	1	4	94	26	27.5	8	0.21
882-295	3725-3740	92	20	9	1	9	130	39	29.5	37	0.14
882-299	3785-3795	85	12	5	1	8	111	27	23.8	5	0.18
882-303	3840-3855	103	17	6	1	10	137	34	24.6	49	0.14
882-307	3900-3915	86	12	4	1	8	110	24	22.2	5	0.08
882-311	3960-3975	78	11	6	1	8	105	27	25.9	37	0.16

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	$\frac{iC_4}{nC_4}$
882-314	4050-4065	91	5	4	1	18	119	29	24.0	33	0.08
882-316	4080-4095	91	12	7	1	20	131	41	31.0	30	0.07
882-320	4140-4155	122	19	9	2	20	172	50	29.0	12	0.08

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	$\frac{iC_4}{nC_4}$
882-013	500-515	264	15	7	2	9	297	33	11.2	17	0.18
882-046	995-1010	731	4	2	1	2	739	9	1.2	3	0.27
882-050	1055-1070	345	8	3	1	2	359	14	4.0	2	0.28
882-054	1115-1130	52	6	1	0	2	62	9	15.3	2	0.26
882-058	1175-1190	733	14	2	2	6	758	25	3.3	9	0.32
882-062	1235-1250	67	16	9	2	7	100	33	33.2	3	0.26
882-066	1295-1310	140	20	7	1	4	172	32	18.4	5	0.37
882-070	1355-1370	58	13	6	1	5	83	24	29.6	2	0.28
882-074	1415-1430	113	14	5	1	5	138	25	17.9	12	0.26
882-082	1475-1490	91	12	4	2	4	113	22	19.2	21	0.45
882-086	1535-1550	6782	31	5	1	3	6822	40	0.6	3	0.33
882-090	1595-1610	1868	13	5	0	3	1889	21	1.1	4	0.17
882-097	1655-1670	1215	15	6	2	5	1243	28	2.3	3	0.39
882-107	1715-1730	3101	9	3	0	2	3115	14	0.5	4	0.24
882-115	1775-1790	17904	18	10	3	11	17944	41	0.2	9	0.28
882-120	1835-1850	2614	13	5	1	3	2636	21	0.8	2	0.25
882-124	1895-1910	2256	10	4	1	4	2277	20	0.9	6	0.34
882-129	1955-1970	7027	11	6	0	1	7046	19	0.3	2	0.30
882-133	2015-2030	5135	10	4	1	3	5154	18	0.4	2	0.27
882-138	2075-2090	4649	8	4	1	2	4664	15	0.3	3	0.34
882-142	2135-2150	5291	16	3	1	5	5316	26	0.5	3	0.23
882-279	3485-3500	272	56	34	5	20	388	115	29.7	63	0.24
882-283	3545-3560	177	29	16	2	15	239	62	26.0	70	0.16
882-287	3605-3620	108	32	15	2	15	172	64	37.3	14	0.13
882-291	3665-3680	115	25	11	2	16	169	53	31.5	17	0.12
882-295	3725-3740	134	26	11	2	15	188	54	28.7	40	0.12
882-299	3785-3795	116	20	8	5	58	207	91	44.0	21	0.09
882-303	3840-3855	160	24	10	3	36	233	73	31.2	67	0.08
882-307	3900-3915	113	15	5	2	26	161	47	29.4	13	0.06
882-311	3960-3975	150	16	8	2	23	199	49	24.7	40	0.10

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	$\frac{iC_4}{nC_4}$
882-314	4050-4065	115	9	6	2	35	167	52	31.2	37	0.06
882-316	4080-4095	108	16	9	3	47	184	75	41.0	32	0.05
882-320	4140-4155	183	24	11	3	48	269	86	32.0	19	0.06

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
882-046A	995-1010m	-;H-Am**-W-Al-I;-	**poor quality	25	F-M	F	1+	
882-058B	1175-1190m	H;W-Am**;Al-I	**as 046A	25	M	F	1+	
882-070A	1355-1370m	-;H-I-W;Am-Al		60	M	F	1+	
882-080A	1474m SWC	I;W;H-Al-Am	disseminated Am-like contamination	85	F-M	P-F	1+(?)	
882-084A	1521.5m SWC	W;H-I;Am-Al		60	M-C	G	1+/1+ to 2-	
882-090B	1595-1610m	W;I;H-Al-Am	H at 2- and 2- to 2	15	F-C	F	1+ to 2-(?)	
882-094A	1637m SWC	W;-;I-H-Al-Am	H at 2- to 2		F-C	F	1+ to 2-(?)	
882-101A	1684m SWC	W;-;I-H-Am-Al	H at 2- to 2		F-C	F	2-(?)	
882-108A	1730m SWC	W;H-I;Al-Am	dominant H at 2-		M-C	G	1+ to 2-(?)	
882-115B	1775-1790m	W;I-H;Am-Al	H at 2- and 2- to 2	40	M-C	G	1+ to 2-(?)	
882-125A	1910m SWC	I;-;W-Al-H		95	M	F	2- max (?)	
882-145A	2175m SWC	I;W;Al-H-Am	abundant disseminated Am-like contaminant	95	M-C	F	1+ to 2-(?)	
882-158A	2335m SWC	I;W;H-Al		95	F-M	F	1+ to 2-(?)	
882-170A	2513m SWC	I;W;H-Al		95	F-M	F	2-	
882-184A	2683.5m SWC	I;W;H-Al	finely disseminated haematite	95	M	F	2-	
882-190A	2749.5m SWC	I;W;Al-H	disseminated Am-like contamination	95	F-M	F	2-(??)	
882-199A	2863.5m SWC	I;W;H-Am-Al		95	M	G	2-(?)	
882-208A	2988.5m SWC	I;W;H-Al	abundant disseminated haematite	95	M	F	2-	
882-216A	3088m SWC	I;W;H		95	F-M	F	---	
882-229A	3242m SWC	I;W;Al-H-Am		90	M-C	F-G	2- to 2(?)	
882-239A	3376m SWC	I;W-H;Am-Al		90	F-M	G	2	
882-245A	3453.5m SWC	I;W;H-Al-Am		90	F-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 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
882-279A	3485-3500m	I;W;H-Al		95	M	G	2/2 to 2+	
882-249A	3502m SWC	I;W;H-Al	H at 2- to 2+	90	M-C	G	2	
882-253A	3587m SWC	I;W-H;-	dominant H at 2+ or greater	90	M-C	G	2 (?)	
882-291C	3665-3680m	I;W;H-Al-Am	minor immature H (caving?)	95	F-M	G	2 to 2+	
882-314C	4050-4065m	I;W;H-Al	disseminated Am-like contamination minor material at 2 to 2+	95	F-M	F-G	2	
882-254A	3804.5m SWC	I;-;W-H		95	M-C	G	---	
882-256A	4120.5m SWC	I;W;H-Am		95	M	F-G	---	
882-257A	4158m SWC	I;W;Al-H	lean, finely disseminated haematite	95	F-M	F	---	

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)			REMARKS
			1	2	3	
882-046A	995-1010m	WR	0.36(5)	0.52(1)	0.92(5)	
882-058B	1175-1190m	WR	0.28(7) 0.93(2)	0.49(2)	0.65(2)	
882-070A	1355-1370m	WR	0.34(6)	0.29(5)	1.09(10)	
882-080A	1474m SWC	WR	0.72(8)	0.96(6)	1.29(3)	
882-084A	1521.5m SWC	KC	0.39(51)	-	-	
882-090B	1595-1610m	WR	0.38(58)	-	-	
882-094A	1637m SWC	WR	0.47(40)	-	-	
882-101A	1684m SWC	WR	0.44(62)	-	-	
882-108A	1730m SWC	KC	NO DETERMINATIONS POSSIBLE			
882-115B	1775-1790m	KC	0.42(32)	-	-	
882-125A	1910m SWC	WR	0.46(1)	1.36(19)	-	
882-145A	2175m SWC	WR	0.73(5)	1.06(3)	1.39(2)	
882-158A	2335m SWC	WR	1.08(5)	1.45(12)	-	
882-170A	2513m SWC	WR	0.44(1) 1.22(14)	0.58(1)	0.77(4)	
882-184A	2683.5m SWC	WR	0.88(1)	1.76(24)	-	
882-190A	2749.5m SWC	WR	0.25(1)	1.47(16)	-	
882-199A	2863.5m SWC	WR	1.49(25)	-	-	
882-208A	2988.5m SWC	WR	1.18(4)	-	-	
882-216A	3088m SWC	WR	1.60(2)	-	-	
882-229A	3242m SWC	WR	0.53(14)	0.74(5)	0.93(1)	
882-239A	3376m SWC	WR	0.69(2)	0.97(11)	1.40(17)	
882-245A	3453.5m SWC	KC	0.76(3)	1.53(38)	-	
882-249A	3503m SWC	WR	1.18(10)	-	-	
882-253A	3587m SWC	WR	0.48(6)	0.86(1)	1.18(23)	
882-256A	4120.5m SWC	WR	1.57(2)	2.09(15)	-	

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
882-046	995-1010	70	9	5	15	34	11	9	2
882-058	1175-1190	138	56	13	69	42	10	9	8
882-070	1355-1370	620	168	178	346	115	75	84	0
882-080A	1476	250	133	30	163	45	22	19	0
882-084A	1521.5	621	356	85	441	79	40	35	26
882-094A	1637	4922	1658	822	2480	1895	310	164	73
882-101A	1684	6092	875	1204	2079	2500	1066	368	79
882-108A	1730	342	115	86	201	72	26	27	16
882-115	1775-1790	212	93	18	111	58	20	14	9
882-129	1955-1970	146	54	24	77	35	15	18	0
882-142	2135-2150	67	17	10	26	22	6	8	6
882-158A	2355	6268	5085	239	5323	126	647	154	17
882-170A	2513	38323	30778	1747	32526	391	4687	720	0
882-190A	2749.5	30127	26447	1477	27924	481	729	786	207
882-199A	2863.5	28812	21383	1987	23371	284	3876	1281	0
882-208A	2988.5	16897	11435	1219	12655	102	3455	685	0
882-216A	3080	22956	19033	1203	20236	193	1664	808	55
882-229A	3242	11914	10038	977	11015	140	317	370	71
882-245A	3453.5	21013	17514	913	18427	132	1793	626	34
882-279A	3485-3500	194	71	26	97	35	29	23	10

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
882-046	995-1010	12.99	7.79	48.05	15.58	12.99	2.60
882-058	1175-1190	40.93	9.33	30.57	7.25	6.22	5.70
882-070	1355-1370	27.05	28.71	18.56	12.09	13.60	0.00
882-080A	1476	53.30	12.09	18.13	8.79	7.69	0.00
882-084A	1521.5	57.31	13.70	12.79	6.39	5.71	4.11
882-094A	1637	33.68	16.70	38.50	6.30	3.34	1.48
882-101A	1684	14.36	19.76	41.04	17.49	6.05	1.30
882-108A	1730	33.70	25.00	21.09	7.61	7.83	4.78
882-115	1775-1790	44.08	8.53	27.49	9.24	6.64	4.03
882-129	1955-1970	36.98	16.15	23.96	10.42	12.50	0.00
882-142	2135-2150	24.68	14.56	32.91	8.23	11.39	8.23
882-158A	2355	81.12	3.81	2.01	10.32	2.46	0.28
882-170A	2513	80.31	4.56	1.02	12.23	1.88	0.00
882-190A	2749.5	87.79	4.90	1.60	2.42	2.61	0.69
882-199A	2863.5	74.22	6.90	0.99	13.45	4.45	0.00
882-208A	2988.5	67.68	7.22	0.60	20.45	4.05	0.00
882-216A	3080	82.91	5.24	0.84	7.25	3.52	0.24
882-229A	3242	84.26	8.20	1.18	2.66	3.10	0.60
882-245A	3453.5	83.35	4.35	0.63	8.53	2.98	0.16
882-279A	3485-3500	36.48	13.21	18.24	15.09	11.95	5.03

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
882-046	995-1010	0.81	20.78	0.18	0.87	1.67
882-058	1175-1190	0.22	50.26	3.15	6.27	4.39
882-070	1355-1370	0.41	55.75	8.44	15.13	0.94
882-080A	1476	0.91	65.38	1.80	2.75	4.41
882-084A	1521.5	2.45	71.00	1.80	2.54	4.18
882-094A	1637	22.00	50.38	1.13	2.24	2.02
882-101A	1684	39.20	34.13	0.53	1.55	0.73
882-108A	1730	3.74	58.70	0.54	0.91	1.35
882-115	1775-1790	0.41	52.61	2.72	5.17	5.17
882-129	1955-1970	0.19	53.12	4.07	7.67	2.29
882-142	2135-2150	0.16	39.24	1.65	4.20	1.70
882-158A	2355	1.07	84.93	49.75	58.58	21.29
882-170A	2513	0.36	84.87	903.49	1064.52	17.61
882-190A	2749.5	0.84	92.69	332.43	358.66	17.91
882-199A	2863.5	0.55	81.11	424.92	523.85	10.76
882-208A	2988.5	0.57	74.90	222.02	296.43	9.38
882-216A	3080	0.39	88.15	518.87	588.60	15.82
882-229A	3242	1.23	92.46	89.56	96.86	10.27
882-245A	3453.5	0.70	87.70	263.25	300.18	19.18
882-279A	3485-3500	0.56	49.69	1.72	3.47	2.76

TABLE 7

ROCKEVAL PYROLYSIS DATA

GEOCHEM SAMPLE NUMBER	DEPTH (METRES)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	HYDROGEN INDEX	PRODUCTION INDEX	TMAX (°C)
882-046A	995-1010	0.27	0.89	0.71	80	0.23	414
882-058B	1175-1190	0.35	2.17	0.80	143	0.14	422
882-070A	1355-1370	0.15	0.20	0.73	29	0.44	366
882-078A	1470 SWC	0.04	0.10	0.45	17	0.29	335
882-079A	1472 SWC	0.03	0.11	0.32	16	0.21	375
882-080A	1476 SWC	0.06	0.11	0.37	13	0.37	352
882-081A	1478 SWC	0.05	0.33	0.42	30	0.13	423
882-084A	1521.5 SWC	0.11	2.09	0.49	73	0.05	419
882-090B	1595-1610	0.66	80.37	4.9	207	0.01	424
882-092A	1629.3 SWC	0.07	5.30	0.94	113	0.01	430
882-093B	1635.3 SWC	0.60	23.33	11.21	44	0.03	440
882-094A	1637 SWC	0.40	22.50	2.40	91	0.02	431
882-098A	1664.5 SWC	0.16	3.76	5.26	114	0.04	426
882-099A	1678 SWC	0.13	0.39	0.52	41	0.25	431
882-101A	1684 SWC	0.60	38.90	4.80	103	0.02	435
882-102A	1685 SWC	0.13	1.48	0.40	79	0.08	432
882-104A	1705 SWC	0.17	0.23	0.25	53	0.42	402
882-106A	1720 SWC	0.02	0.02	0.25	3	0.50	450
882-108A	1730 SWC	0.07	3.37	0.93	83	0.02	438
882-110A	1751 SWC	0.00	0.00	0.15	0	0.00	379
882-112A	1766 SWC	0.00	0.00	0.38	0	0.00	224
882-114A	1777.5 SWC	0.01	0.01	0.17	3	0.50	311
882-115B	1775-1790	0.19	1.86	0.65	80	0.09	434
882-118A	1821.5 SWC	0.00	0.00	0.34	0	0.00	442
882-125A	1910 SWC	0.02	0.00	0.18	0	1.00	443
882-134A	2039 SWC	0.03	0.00	0.46	0	1.00	408
882-145A	2175 SWC	2.89	0.85	0.25	118	0.77	303
882-158A	2355 SWC	3.61	1.56	0.33	115	0.70	309
882-164A	2440 SWC	2.24	1.17	0.72	85	0.66	307
882-170A	2513 SWC	10.36	0.65	0.33	86	0.94	393
882-178A	2620 SWC	11.88	0.61	0.87	103	0.95	336
882-184A	2683.5 SWC	15.74	0.96	0.69	123	0.94	281
882-187A	2722 SWC	14.21	0.78	0.47	86	0.96	284
882-190A	2749.5 SWC	17.13	1.91	0.99	90	0.90	306

TABLE 7

ROCKEVAL PYROLYSIS DATA

GEOCHEM SAMPLE NUMBER	DEPTH (METRES)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	HYDROGEN INDEX	PRODUCTION INDEX	TMAX (°C)
882-199A	2863.5 SWC	9.41	1.50	0.75	108	0.86	303
882-208A	2988.5 SWC	22.43	1.35	0.65	117	0.94	303
882-213A	3044 SWC	8.37	2.20	0.53	169	0.79	308
882-216A	3080 SWC	10.69	1.83	0.56	138	0.85	303
882-226A	3211 SWC	8.87	0.84	0.52	81	0.91	302
882-229A	3242 SWC	25.15	2.17	0.84	134	0.92	447
882-239A	3376 SWC	13.45	1.95	0.44	104	0.87	312
882-245A	3453.5 SWC	10.20	0.77	0.42	64	0.93	329
882-249A	3502 SWC	0.02	0.03	0.55	6	0.50	356
882-279A	3485-3500	0.15	0.14	0.26	19	0.54	275
882-252A	3577 SWC	0.21	0.16	0.97	76	0.58	254
882-253A	3587 SWC	0.11	0.08	0.62	20	0.61	274
882-291C	3665-3680	0.02	0.04	0.19	5	0.33	320
882-254A	3804.5 SWC	0.00	0.00	0.36	0	0.00	441
882-314C	4050-4065	0.09	0.20	0.19	28	0.32	275
882-255A	4088 SWC	0.04	0.08	0.20	44	0.33	405
882-256A	4120.5 SWC	0.58	0.31	0.48	81	0.66	310
882-257A	4158 SWC	0.02	0.02	0.35	9	0.50	238

TABLE 8

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

GEOCHEM SAMPLE NUMBER	-046	-058	-070	-080A	-084A	-094A	-101A	-108A
DEPTH	995-1010m	1175-1190m	1355-1370m	1476m SWC	1521.5m SWC	1637m SWC	1684m SWC	1730m SWC
SAMPLE TYPE								
nC_{15}	7.84	27.36	37.13	12.89	15.47	15.99	19.06	14.49
nC_{16}	23.53	25.15	28.47	17.52	17.79	16.91	16.22	15.46
nC_{17}	21.57	18.91	13.61	17.80	18.22	16.12	12.23	13.77
nC_{18}	12.48	13.68	5.94	17.10	16.78	14.55	8.82	11.96
nC_{19}	7.49	7.24	2.72	15.56	14.75	12.32	6.26	9.06
nC_{20}	4.63	2.82	1.73	9.25	7.95	6.68	3.70	6.28
nC_{21}	3.57	0.80	0.99	3.36	2.75	2.49	2.70	4.71
nC_{22}	3.03	0.60	0.74	1.82	1.30	1.44	2.28	3.38
nC_{23}	3.03	0.60	0.74	1.12	0.87	1.57	3.13	3.74
nC_{24}	3.92	0.60	0.74	0.84	0.58	1.18	2.42	2.54
nC_{25}	2.85	0.50	0.99	0.70	0.58	2.88	5.12	3.38
nC_{26}	2.14	0.40	0.99	0.56	0.43	1.44	2.56	1.81
nC_{27}	1.60	0.40	0.99	0.42	0.58	2.10	4.41	3.50
nC_{28}	0.71	0.20	0.74	0.28	0.29	0.79	2.42	1.45
nC_{29}	0.53	0.20	0.74	0.28	0.58	1.05	4.41	2.05
nC_{30}	0.36	0.20	0.50	0.14	0.29	0.52	1.28	0.72
nC_{31}	0.18	0.10	0.74	0.14	0.29	0.66	1.28	0.72
nC_{32}	0.18	0.10	0.50	0.07	0.14	0.39	0.57	0.48
nC_{33}	0.18	0.10	0.50	0.07	0.14	0.39	0.57	0.24
nC_{34}	0.09	0.00	0.25	0.07	0.14	0.26	0.28	0.12
nC_{35}	0.09	0.00	0.25	0.00	0.07	0.26	0.28	0.12
PARAFFIN	40.95	50.97	39.49	49.19	47.94	53.81	43.80	47.42
ISOPRENOID	8.54	8.72	5.77	11.17	11.09	10.86	7.48	7.62
NAPHTHENE	50.51	40.31	54.74	39.64	40.97	35.33	48.72	44.96
CPI INDEX A	0.97	0.90	1.02	1.02	1.15	1.35	1.50	1.38
CPI INDEX B	1.13	1.10	1.22	1.16	1.51	1.91	1.99	1.82
PRISTANE/PHYTANE	1.92	2.04	2.93	1.28	1.39	1.52	1.86	1.42
PRISTANE/nC_{17}	0.64	0.61	0.80	0.72	0.74	0.76	0.91	0.68

TABLE 8

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

GEOCHEM SAMPLE NUMBER	-115	-129	-142	-158A	-170A	-190A	-199A	-208A
DEPTH	1775-1790m	1955-1970m	2135-2150m	2355m SWC	2513m SWC	2749.5m SWC	2863.5m SWC	2988.5m SWC
SAMPLE TYPE								
nC_{15}	28.33	24.09	22.61	12.69	15.00	13.71	14.86	11.64
nC_{16}	24.29	27.72	25.10	16.12	17.82	18.09	19.97	16.27
nC_{17}	15.48	17.47	16.86	21.96	18.86	16.96	20.61	17.64
nC_{18}	9.29	10.23	9.77	19.21	19.01	17.24	18.69	16.95
nC_{19}	5.00	4.48	5.17	15.78	15.44	15.97	14.38	13.18
nC_{20}	2.38	2.77	3.26	8.76	8.40	10.18	7.51	7.88
nC_{21}	1.67	1.71	2.49	2.40	2.67	4.10	2.24	4.11
nC_{22}	1.43	1.49	2.11	1.03	0.89	1.41	0.80	2.57
nC_{23}	1.67	1.49	1.92	0.51	0.45	0.57	0.32	1.71
nC_{24}	1.19	1.28	1.92	0.34	0.30	0.42	0.16	1.54
nC_{25}	1.90	1.28	1.72	0.34	0.15	0.28	0.16	1.88
nC_{26}	0.95	0.85	1.53	0.17	0.15	0.28	0.08	0.86
nC_{27}	1.67	1.07	1.34	0.17	0.15	0.14	0.08	0.86
nC_{28}	0.71	0.64	0.96	0.17	0.07	0.14	0.08	0.68
nC_{29}	1.19	0.85	0.77	0.17	0.07	0.14	0.08	0.68
nC_{30}	0.48	0.43	0.77	0.17	0.07	0.07	0.00	0.51
nC_{31}	0.71	0.43	0.38	0.17	0.07	0.07	0.00	0.34
nC_{32}	0.48	0.43	0.38	0.09	0.00	0.07	0.00	0.17
nC_{33}	0.48	0.43	0.38	0.09	0.00	0.07	0.00	0.17
nC_{34}	0.48	0.43	0.38	0.00	0.00	0.07	0.00	0.17
nC_{35}	0.24	0.43	0.19	0.00	0.00	0.00	0.00	0.17
PARAFFIN	33.20	34.72	44.24	42.65	43.52	41.88	47.86	36.57
ISOPRENOID	5.53	6.59	6.69	10.17	11.37	11.13	11.70	8.20
NAPHTHENE	61.26	58.70	49.07	47.18	45.11	47.00	40.44	55.23
CPI INDEX A	1.39	1.08	1.00	1.17	1.38	1.33	1.41	1.09
CPI INDEX B	1.87	1.34	0.99	1.21	0.98	0.91	0.00	1.37
PRISTANE/PHYTANE	2.18	2.30	2.29	1.40	1.29	1.19	1.35	0.98
PRISTANE/nC_{17}	0.74	0.76	0.63	0.63	0.78	0.85	0.68	0.63

TABLE 8

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

GEOCHEM SAMPLE NUMBER	-216A	-229A	-245A	-279A
DEPTH	3080m SWC	3242m SWC	3453.5m SWC	3485-3500m
SAMPLE TYPE				
nC_{15}	13.75	13.57	13.46	15.63
nC_{16}	18.05	18.25	16.75	21.78
nC_{17}	18.62	19.31	18.18	20.62
nC_{18}	18.05	19.16	17.47	17.46
nC_{19}	15.62	16.14	17.04	12.80
nC_{20}	9.46	8.14	9.74	6.82
nC_{21}	3.30	2.56	3.29	2.33
nC_{22}	1.29	0.90	1.29	0.83
nC_{23}	0.57	0.45	0.72	0.50
nC_{24}	0.29	0.30	0.43	0.33
nC_{25}	0.29	0.30	0.29	0.17
nC_{26}	0.14	0.15	0.29	0.17
nC_{27}	0.14	0.15	0.14	0.17
nC_{28}	0.14	0.15	0.14	0.08
nC_{29}	0.07	0.15	0.14	0.08
nC_{30}	0.07	0.08	0.14	0.08
nC_{31}	0.07	0.08	0.14	0.08
nC_{32}	0.07	0.08	0.14	0.08
nC_{33}	0.00	0.08	0.07	0.00
nC_{34}	0.00	0.00	0.07	0.00
nC_{35}	0.00	0.00	0.07	0.00
PARAFFIN	46.13	52.45	45.20	46.14
ISOPRENOID	12.62	13.29	12.49	10.74
NAPHTHENE	41.24	34.26	42.32	43.11
CPI INDEX A	1.35	1.33	1.22	1.31
CPI INDEX B	1.11	1.25	0.86	0.98
PRISTANE/PHYTANE	1.30	1.37	1.22	1.46
PRISTANE/nC_{17}	0.83	0.76	0.83	0.67

FIGURE 1 **RATING** WELL 6610/7-2

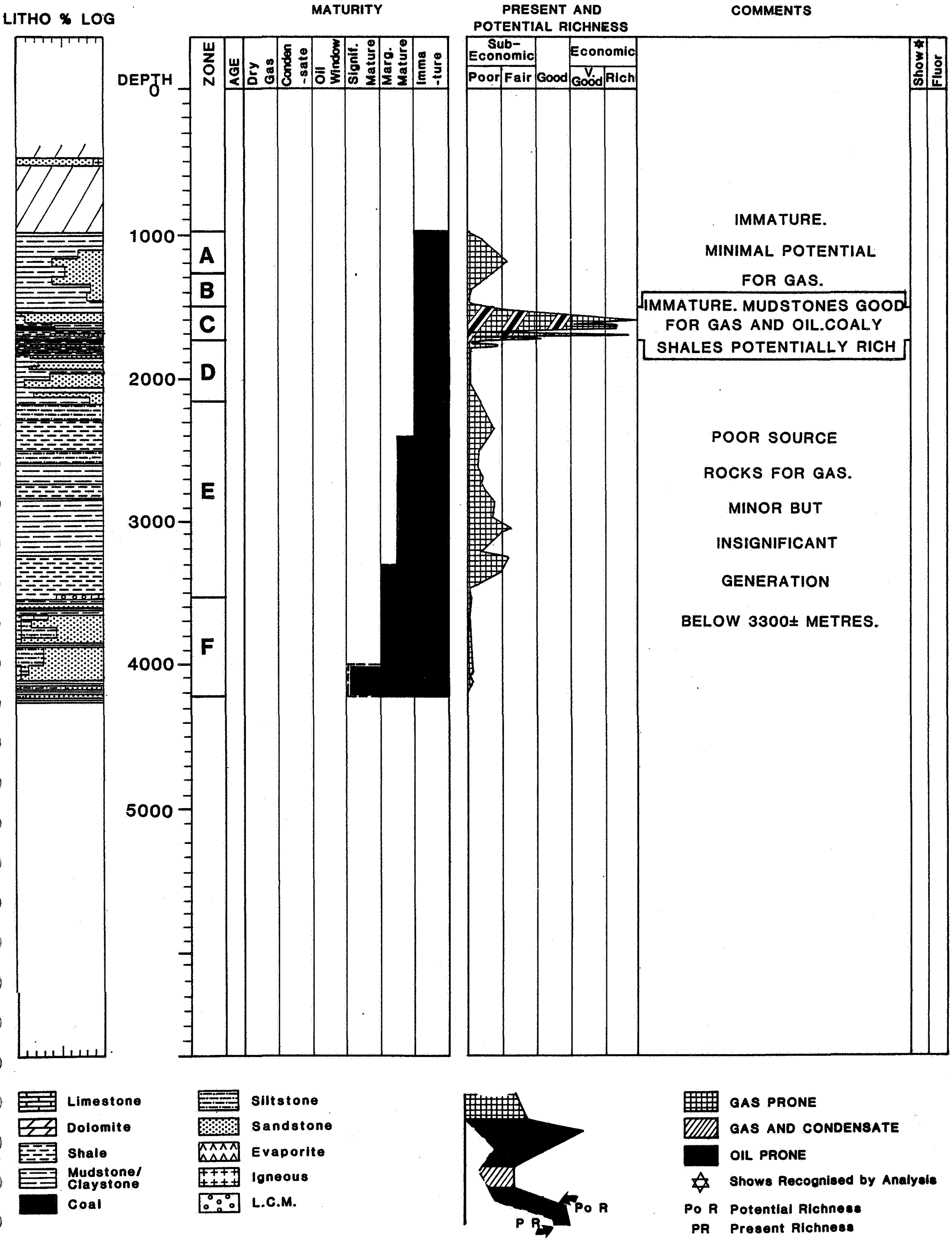
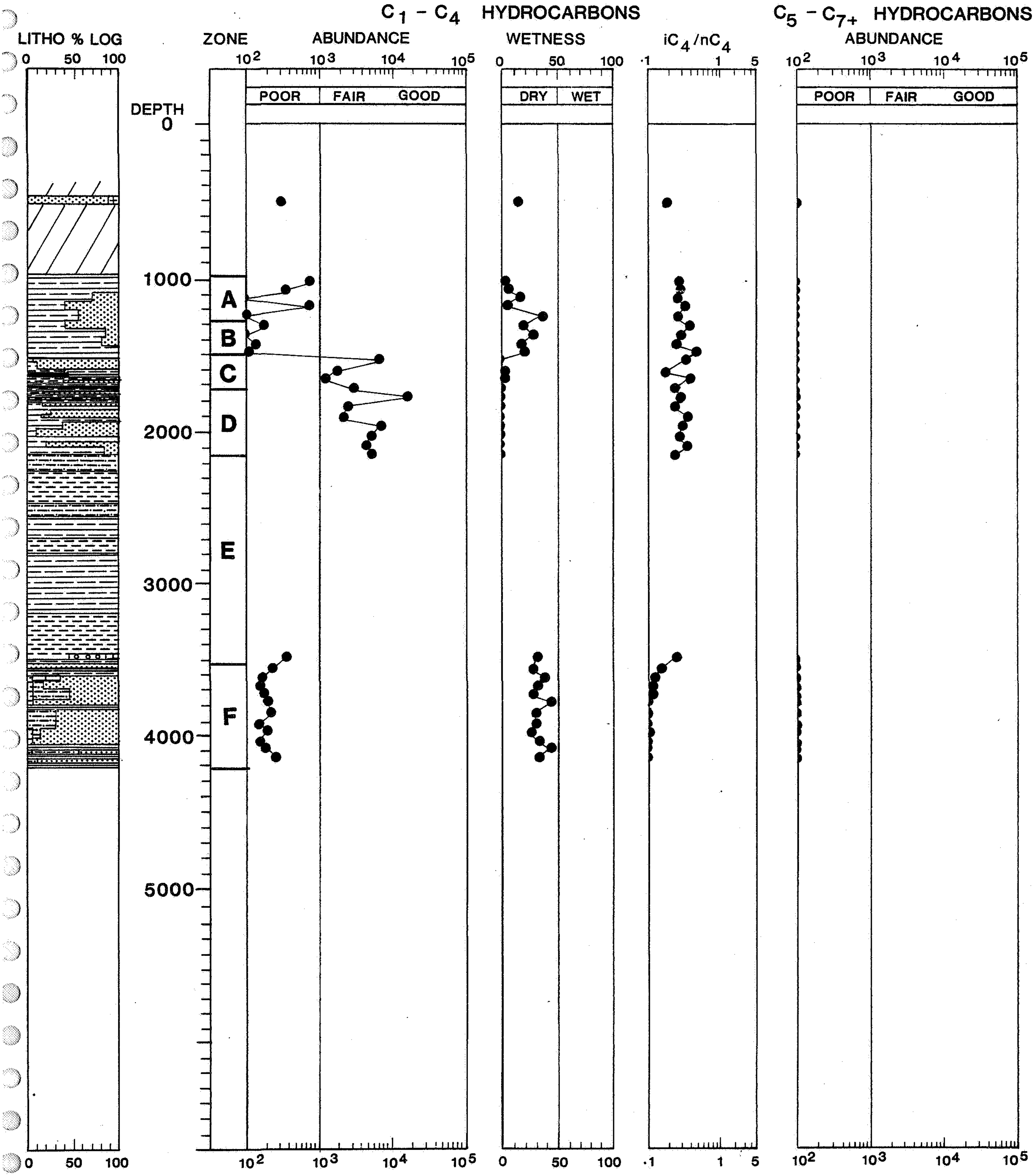


FIGURE 2 $C_1 - C_7$ HYDROCARBONS WELL 6610/7-2



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

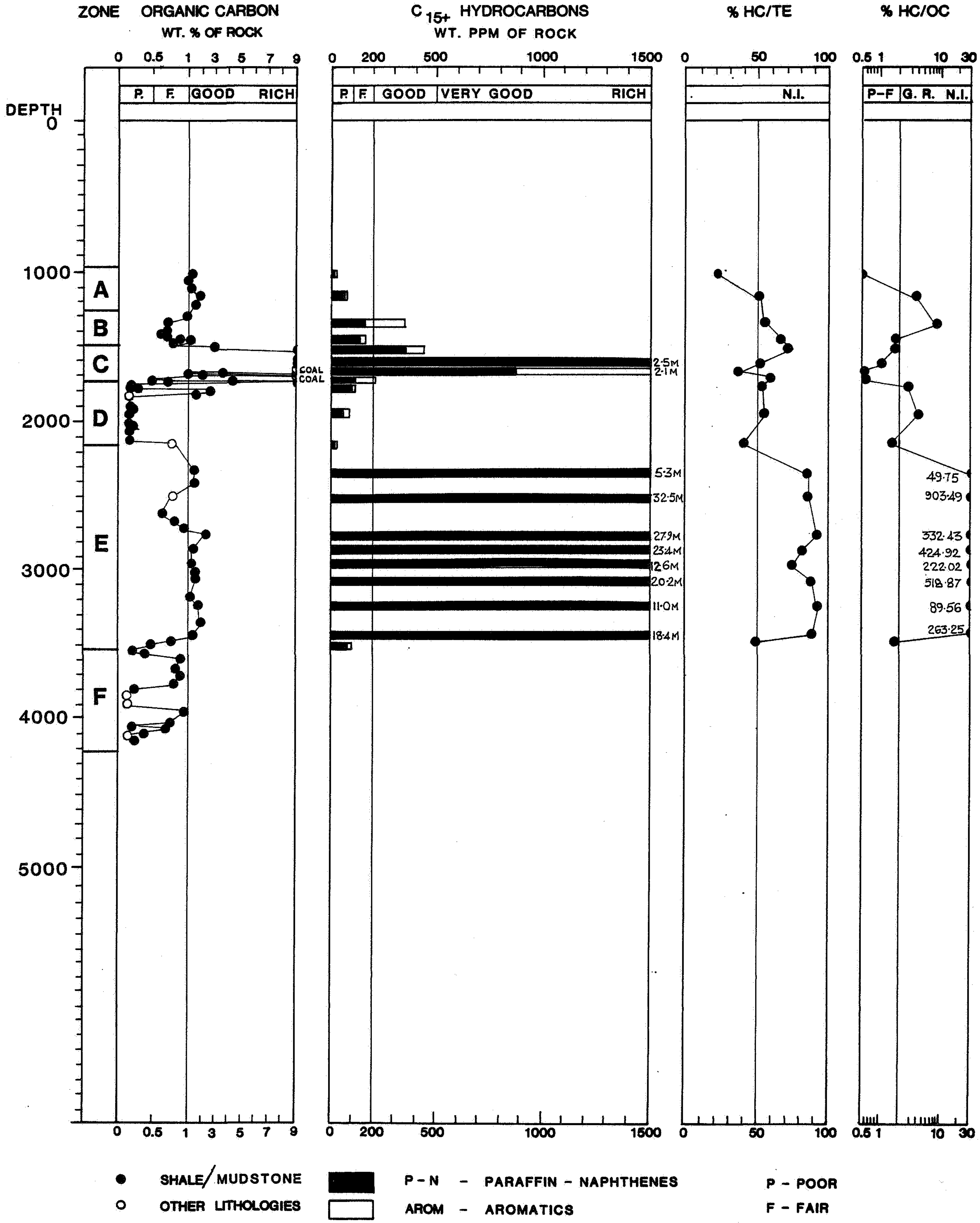
iC_4 – ISOBUTANE

nC_4 – NORMAL BUTANE

ABUNDANCE – VOLUME PPM OF ROCK

WETNESS – % C_2–C_4 IN C_1–C_4

FIGURE 3 **RICHNESS** WELL 6610/7-2



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

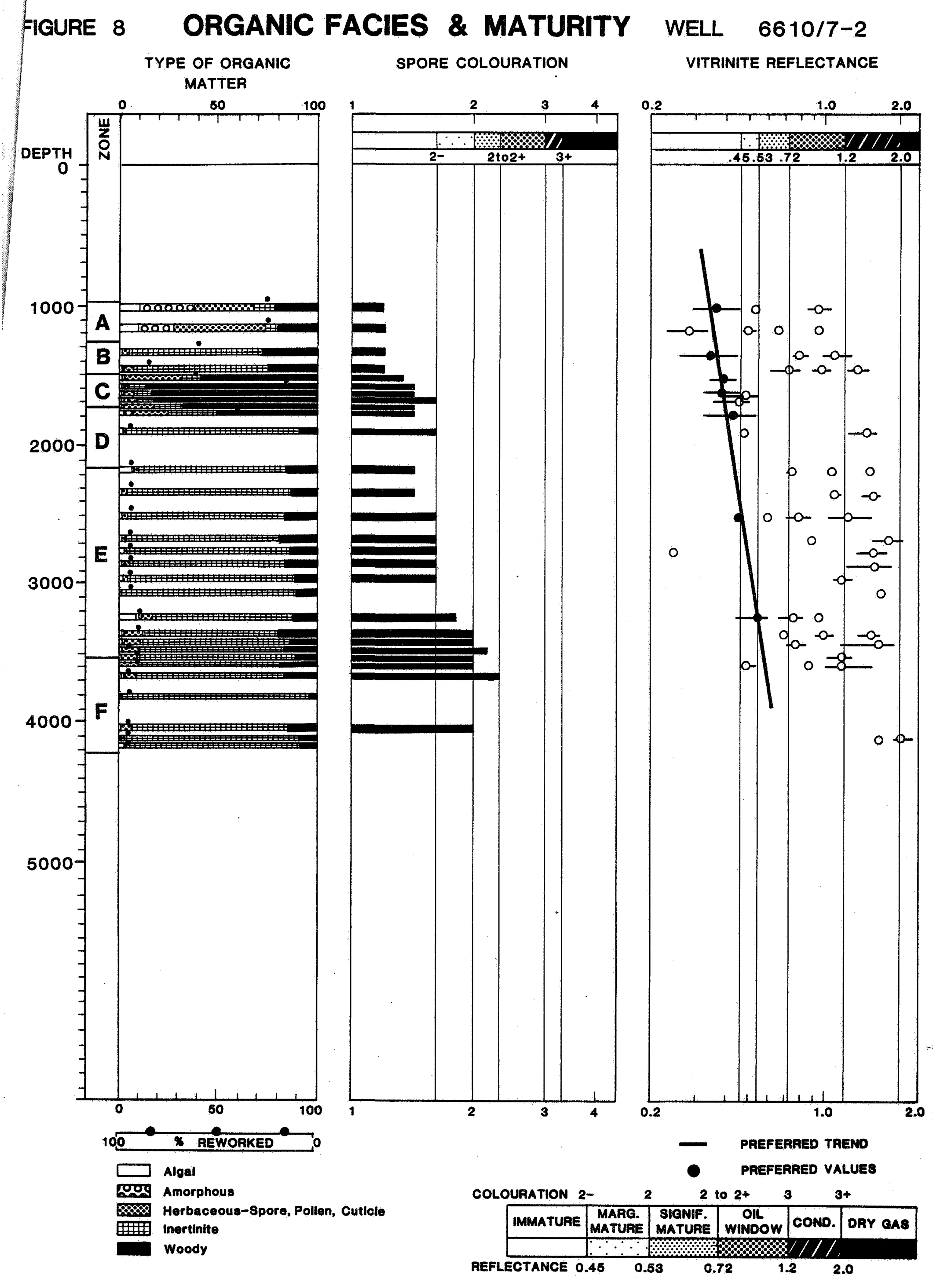
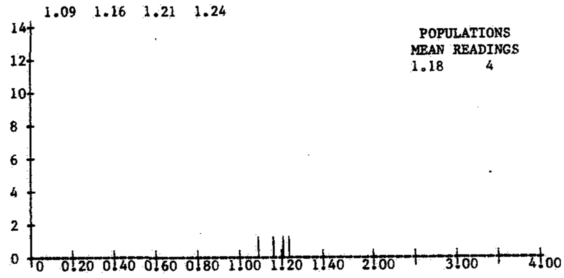


FIGURE 8 ORGANIC FACIES & MATURITY WELL 6610/7-2
TYPE OF ORGANIC MATTER
SPORE COLOURATION
VITRINITE REFLECTANCE
DEPTH
ZONE
A
B
C
D
E
F
0
1000
2000
3000
4000
5000
0 50 100
1 2 3 4
0.2 1.0 2.0
2- 2to2+ 3+
.45 .53 .72 1.2 2.0
% REWORKED
100 0
Algal
Amorphous
Herbaceous-Spore, Pollen, Cuticle
Inertinite
Woody
PREFERRED TREND
PREFERRED VALUES
COLOURATION 2- 2 2 to 2+ 3 3+
IMMATURE
MARG. MATURE
SIGNIF. MATURE
OIL WINDOW
COND.
DRY GAS
REFLECTANCE 0.45 0.53 0.72 1.2 2.0

FIGURE 7c VITRINITE REFLECTANCE WELL 6610/7-2

SAMPLE 882-208A DEPTH 2988 VITRINITE REFLECTANCE VALUES

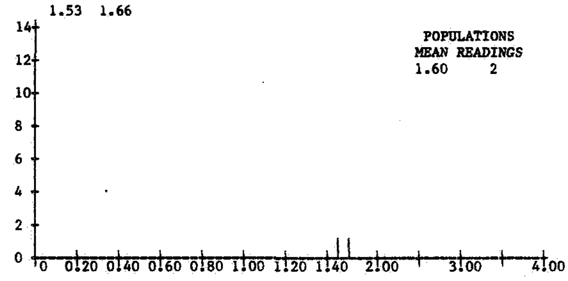
1.09 1.16 1.21 1.24



REMARKS RED BED
VIRTUALLY BARREN MEASUREMENTS ON
UNRECOGNISABLE PARTICLES

SAMPLE 882-216A DEPTH 3080 VITRINITE REFLECTANCE VALUES

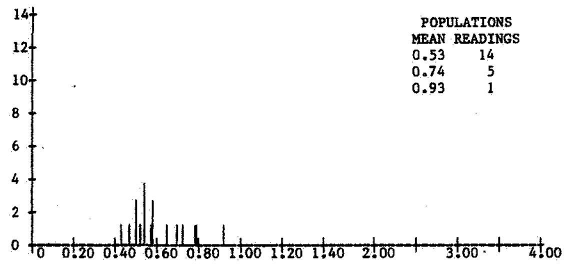
1.53 1.66



REMARKS VIRTUALLY BARREN.
POOR SAMPLE.

SAMPLE 882-229A DEPTH 3242 VITRINITE REFLECTANCE VALUES

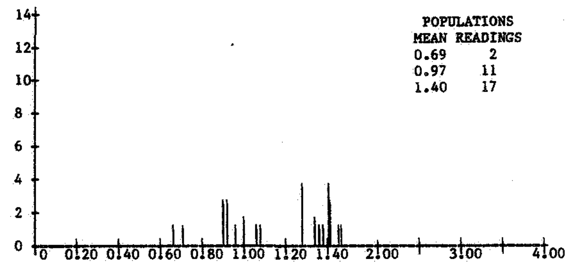
0.43 0.47 0.50 0.50 0.51 0.52 0.54 0.54 0.54 0.54
0.57 0.58 0.59 0.59 0.65 0.70 0.73 0.79 0.80 0.93



REMARKS LEAN.
SOME VARIATION IN REFLECTANCE APPARENT.
POOR SAMPLE.

SAMPLE 882-239A DEPTH 3376 VITRINITE REFLECTANCE VALUES

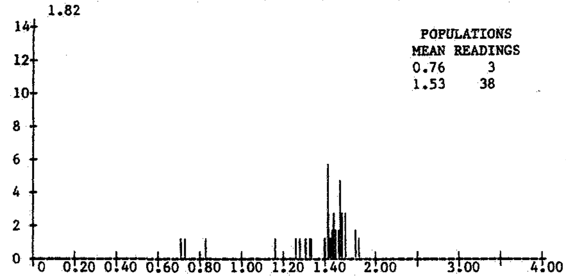
0.66 0.71 0.90 0.90 0.91 0.92 0.92 0.93 0.96 1.00
1.01 1.06 1.08 1.28 1.29 1.29 1.29 1.34 1.35 1.36
1.38 1.42 1.43 1.43 1.43 1.44 1.44 1.45 1.54 1.57



REMARKS WIDESPREAD REWORKING.
POOR SAMPLE.

SAMPLE 882-245A DEPTH 3453 VITRINITE REFLECTANCE VALUES

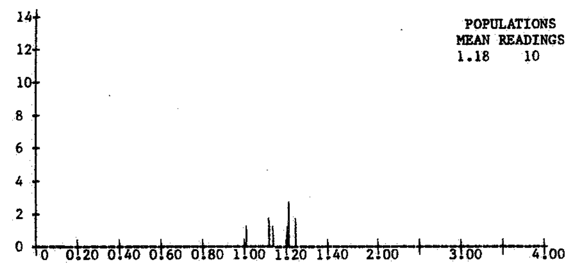
0.71 0.73 0.83 1.16 1.26 1.28 1.31 1.33 1.34 1.41
1.45 1.45 1.45 1.45 1.45 1.45 1.47 1.48 1.50 1.51
1.52 1.53 1.53 1.54 1.54 1.58 1.59 1.60 1.60 1.61
1.61 1.61 1.62 1.62 1.63 1.66 1.66 1.67 1.78 1.78
1.82



REMARKS DOMINANTLY PARTICLES OF HIGH R_o
VITRINITE AND INERTINITE.
DIFFERENTIATION DIFFICULT.

SAMPLE 882-249A DEPTH 3502 VITRINITE REFLECTANCE VALUES

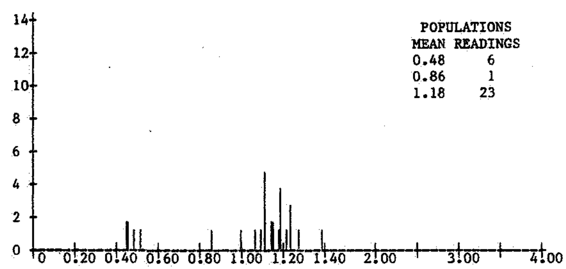
1.01 1.12 1.12 1.14 1.21 1.22 1.23 1.23 1.25 1.25



REMARKS VIRTUALLY BARREN.
OCCASIONAL UNRECOGNISABLE PARTICLES.
POOR SAMPLE.

SAMPLE 882-253A DEPTH 3587 VITRINITE REFLECTANCE VALUES

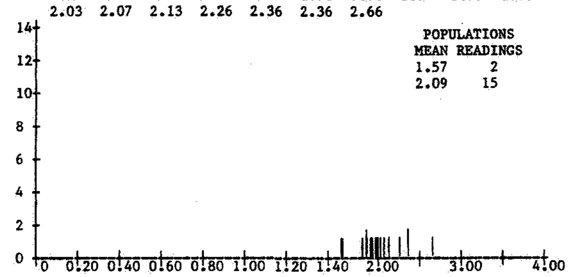
0.45 0.45 0.46 0.47 0.49 0.52 0.86 1.00 1.07 1.10
1.12 1.12 1.13 1.13 1.13 1.15 1.15 1.16 1.16 1.19
1.20 1.20 1.20 1.21 1.23 1.25 1.25 1.25 1.29 1.41



REMARKS LEAN. CHIEFLY INERTINITE.
POOR SAMPLE.

SAMPLE 882-256A DEPTH 4120 VITRINITE REFLECTANCE VALUES

1.56 1.58 1.81 1.86 1.87 1.91 1.93 1.97 1.99 2.00
2.03 2.07 2.13 2.26 2.36 2.36 2.66



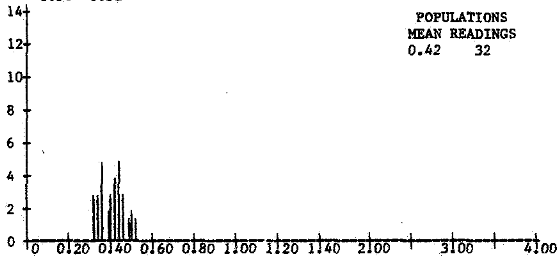
REMARKS RED BED
EXCLUSIVELY MATERIAL OF HIGH R_o.
POOR SAMPLE.

FIGURE 7b VITRINITE REFLECTANCE WELL 6610/7-2

SAMPLE 882-115B DEPTH 1775 — VITRINITE REFLECTANCE VALUES

0.32 0.33 0.33 0.34 0.34 0.35 0.36 0.37 0.37 0.37
0.37 0.39 0.39 0.40 0.40 0.41 0.42 0.42 0.42 0.43
0.44 0.45 0.45 0.45 0.45 0.46 0.47 0.47 0.49 0.50
0.50 0.52

POPULATIONS MEAN	READINGS
0.42	32

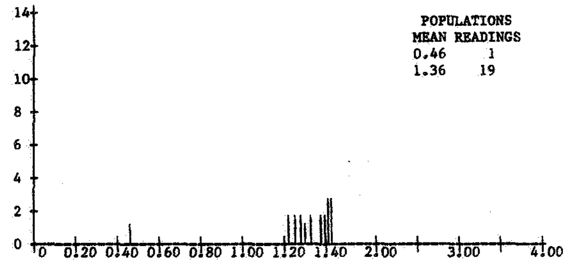


REMARKS CHIEFLY VITRINITE.
SOME VARIATION IN REFLECTANCE APPARENT.

SAMPLE 882-125A DEPTH 1910 — VITRINITE REFLECTANCE VALUES

0.46 1.22 1.23 1.25 1.27 1.28 1.28 1.30 1.33 1.33
1.38 1.39 1.40 1.40 1.44 1.44 1.44 1.48 1.49 1.49

POPULATIONS MEAN	READINGS
0.46	1
1.36	19

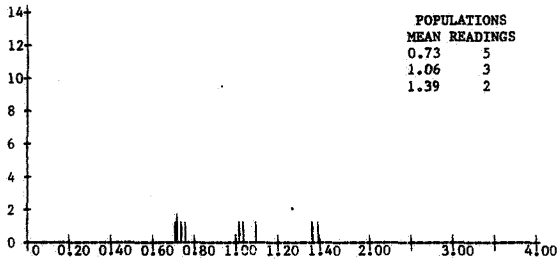


REMARKS LEAN. OCCASIONAL SMALL REWORKED/OXIDISED PARTICLES.
POOR SAMPLE.

SAMPLE 882-145A DEPTH 2175 — VITRINITE REFLECTANCE VALUES

0.71 0.72 0.72 0.74 0.76 1.02 1.04 1.10 1.37 1.40

POPULATIONS MEAN	READINGS
0.73	5
1.06	3
1.39	2

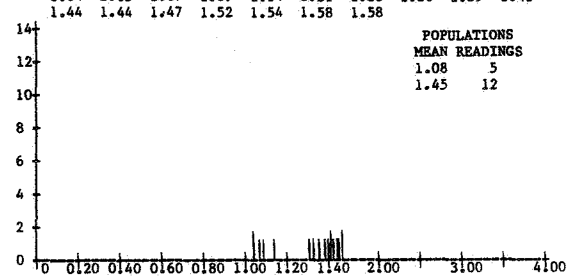


REMARKS VIRTUALLY BARREN.
POOR SAMPLE

SAMPLE 882-158A DEPTH 2355 — VITRINITE REFLECTANCE VALUES

1.04 1.05 1.07 1.09 1.14 1.31 1.33 1.36 1.39 1.41
1.44 1.44 1.47 1.52 1.54 1.58 1.58

POPULATIONS MEAN	READINGS
1.08	5
1.45	12

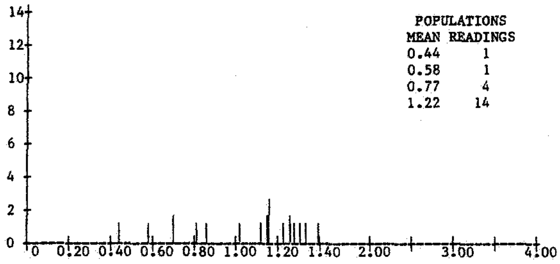


REMARKS EXTREMELY LEAN
- DOMINANTLY INERTINITE.
POOR SAMPLE.

SAMPLE 882-170A DEPTH 2513 — VITRINITE REFLECTANCE VALUES

0.44 0.58 0.70 0.70 0.81 0.86 1.02 1.12 1.15 1.15
1.16 1.17 1.17 1.23 1.26 1.27 1.28 1.31 1.34 1.40

POPULATIONS MEAN	READINGS
0.44	1
0.58	1
0.77	4
1.22	14

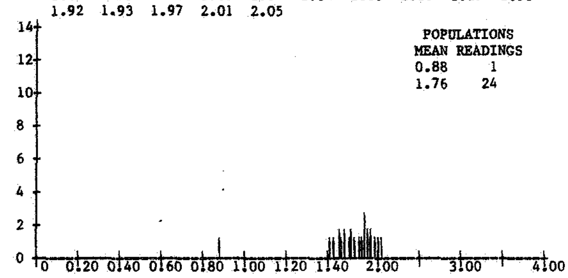


REMARKS EXTREMELY LEAN.
WIDESPREAD REWORKING.
POOR SAMPLE.

SAMPLE 882-184A DEPTH 2683 — VITRINITE REFLECTANCE VALUES

0.88 1.42 1.47 1.54 1.55 1.56 1.60 1.60 1.66 1.68
1.68 1.72 1.78 1.81 1.84 1.84 1.85 1.88 1.89 1.91
1.92 1.93 1.97 2.01 2.05

POPULATIONS MEAN	READINGS
0.88	1
1.76	24

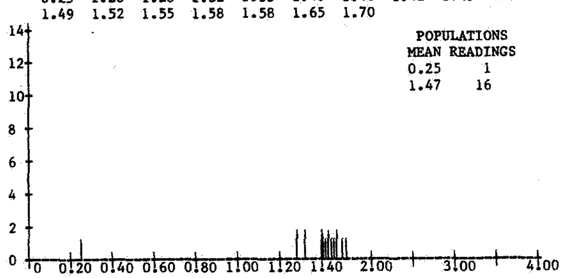


REMARKS RED BED
WIDESPREAD OXIDATION/REWORKING.

SAMPLE 882-190A DEPTH 2749 — VITRINITE REFLECTANCE VALUES

0.25 1.28 1.28 1.32 1.33 1.40 1.40 1.42 1.45 1.48
1.49 1.52 1.55 1.58 1.58 1.65 1.70

POPULATIONS MEAN	READINGS
0.25	1
1.47	16

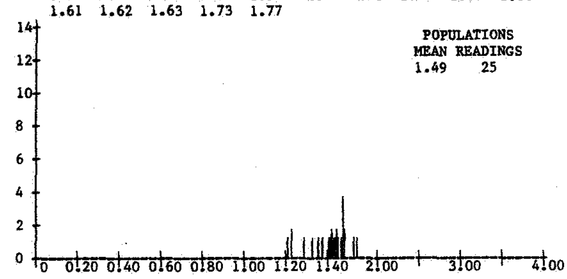


REMARKS RED BED
TINY LIGNITE PARTICLE ALSO PRESENT.

SAMPLE 882-199A DEPTH 2863 — VITRINITE REFLECTANCE VALUES

1.21 1.23 1.23 1.29 1.33 1.36 1.38 1.43 1.45 1.46
1.47 1.48 1.50 1.52 1.52 1.54 1.58 1.60 1.60 1.60
1.61 1.62 1.63 1.73 1.77

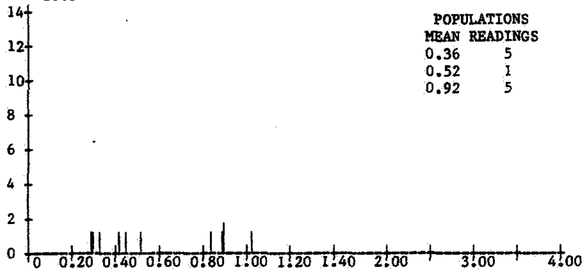
POPULATIONS MEAN	READINGS
1.49	25



REMARKS RED BED
WIDESPREAD OXIDATION/REWORKING.

SAMPLE 882-046A DEPTH 995 VITRINITE REFLECTANCE VALUES

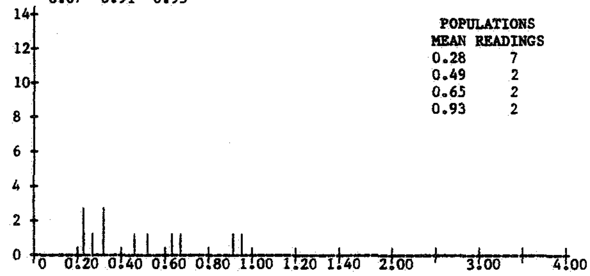
0.29 0.30 0.33 0.42 0.45 0.52 0.84 0.89 0.90 0.90
1.03



REMARKS CHIEFLY BITUMEN STAINING.
REWORKING.
POOR SAMPLE.

SAMPLE 882-058B DEPTH 1175 VITRINITE REFLECTANCE VALUES

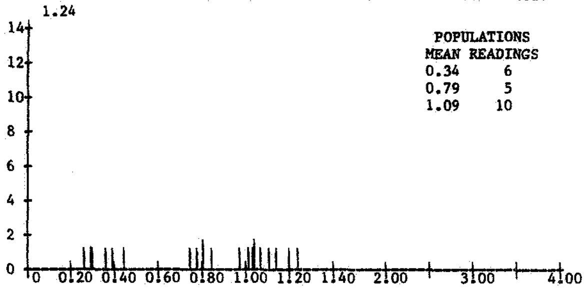
0.23 0.23 0.23 0.27 0.32 0.33 0.33 0.46 0.52 0.63
0.67 0.91 0.95



REMARKS OCCASIONAL PARTICLES OF VARIABLE
REFLECTANCE MEASURED
POOR SAMPLE.

SAMPLE 882-070A DEPTH 1355 VITRINITE REFLECTANCE VALUES

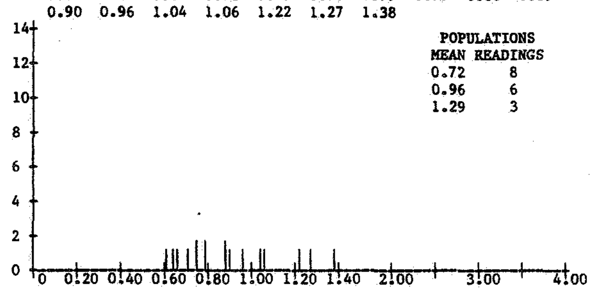
0.26 0.29 0.30 0.36 0.39 0.44 0.74 0.77 0.80 0.80
0.84 0.97 1.01 1.03 1.04 1.04 1.07 1.11 1.14 1.20
1.24



REMARKS REWORKING.

SAMPLE 882-080A DEPTH 1476 VITRINITE REFLECTANCE VALUES

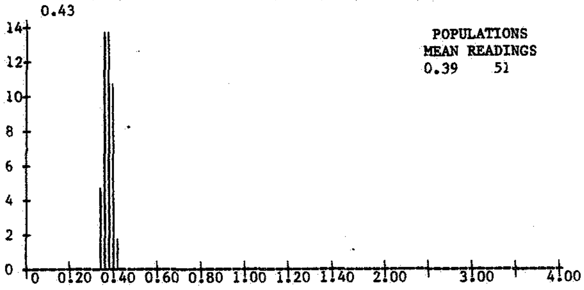
0.61 0.64 0.66 0.71 0.75 0.76 0.79 0.79 0.88 0.89
0.90 0.96 1.04 1.06 1.22 1.27 1.38



REMARKS POOR SAMPLE.
CHIEFLY SMALL INERTINITE PARTICLES

SAMPLE 882-084A DEPTH 1521 VITRINITE REFLECTANCE VALUES

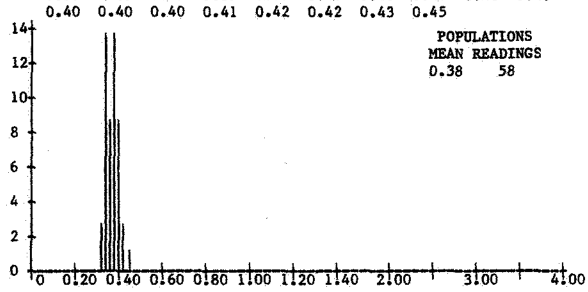
0.34 0.34 0.34 0.34 0.35 0.36 0.36 0.36 0.36 0.36
0.37 0.37 0.37 0.37 0.37 0.37 0.37 0.37 0.37 0.37
0.38 0.38 0.38 0.38 0.38 0.38 0.38 0.39 0.39 0.39
0.39 0.39 0.39 0.39 0.39 0.39 0.39 0.39 0.40 0.40
0.40 0.40 0.40 0.40 0.40 0.40 0.41 0.41 0.41 0.42
0.43



REMARKS CHIEFLY VITRINITE

SAMPLE 882-090B DEPTH 1595 VITRINITE REFLECTANCE VALUES

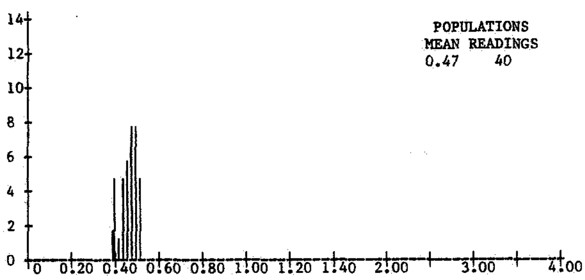
0.32 0.33 0.33 0.34 0.34 0.34 0.34 0.34 0.35 0.35
0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35
0.35 0.35 0.36 0.36 0.36 0.36 0.37 0.37 0.37 0.37
0.37 0.38 0.38 0.38 0.38 0.38 0.38 0.38 0.39 0.39
0.39 0.39 0.39 0.39 0.39 0.40 0.40 0.40 0.40 0.40
0.40 0.40 0.40 0.41 0.42 0.42 0.43 0.45



REMARKS COAL.
CHIEFLY VITRINITE.

SAMPLE 882-094A DEPTH 1637 VITRINITE REFLECTANCE VALUES

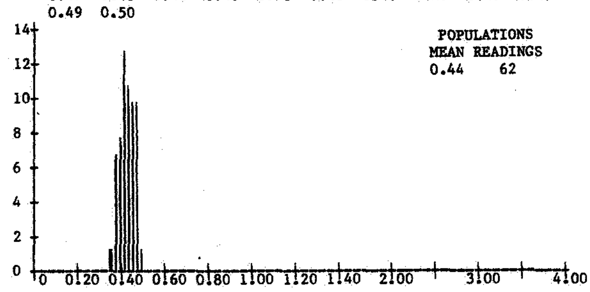
0.39 0.39 0.40 0.40 0.41 0.41 0.41 0.42 0.44 0.44
0.44 0.45 0.45 0.46 0.47 0.47 0.47 0.47 0.47 0.48
0.48 0.48 0.48 0.49 0.49 0.49 0.49 0.50 0.50 0.50
0.50 0.50 0.51 0.51 0.51 0.52 0.52 0.52 0.53 0.53



REMARKS COAL.

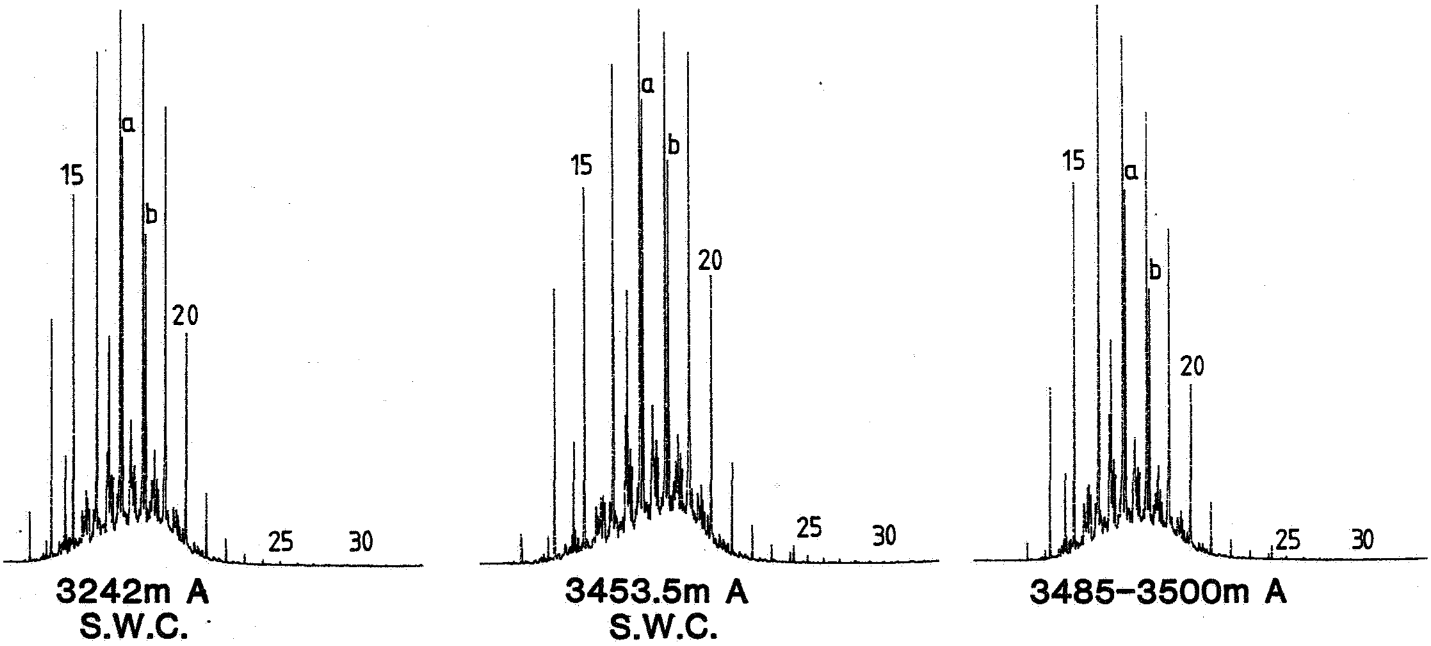
SAMPLE 882-101A DEPTH 1684 VITRINITE REFLECTANCE VALUES

0.35 0.36 0.38 0.38 0.38 0.39 0.39 0.39 0.39 0.40
0.40 0.40 0.40 0.40 0.41 0.41 0.41 0.42 0.42 0.42
0.42 0.42 0.43 0.43 0.43 0.43 0.43 0.43 0.43 0.43
0.44 0.44 0.44 0.45 0.45 0.45 0.45 0.45 0.45 0.45
0.45 0.46 0.46 0.46 0.46 0.46 0.47 0.47 0.47 0.47
0.47 0.48 0.48 0.48 0.48 0.48 0.48 0.49 0.49 0.49
0.49 0.50



REMARKS COAL.
VERY DOMINANTLY VITRINITE.

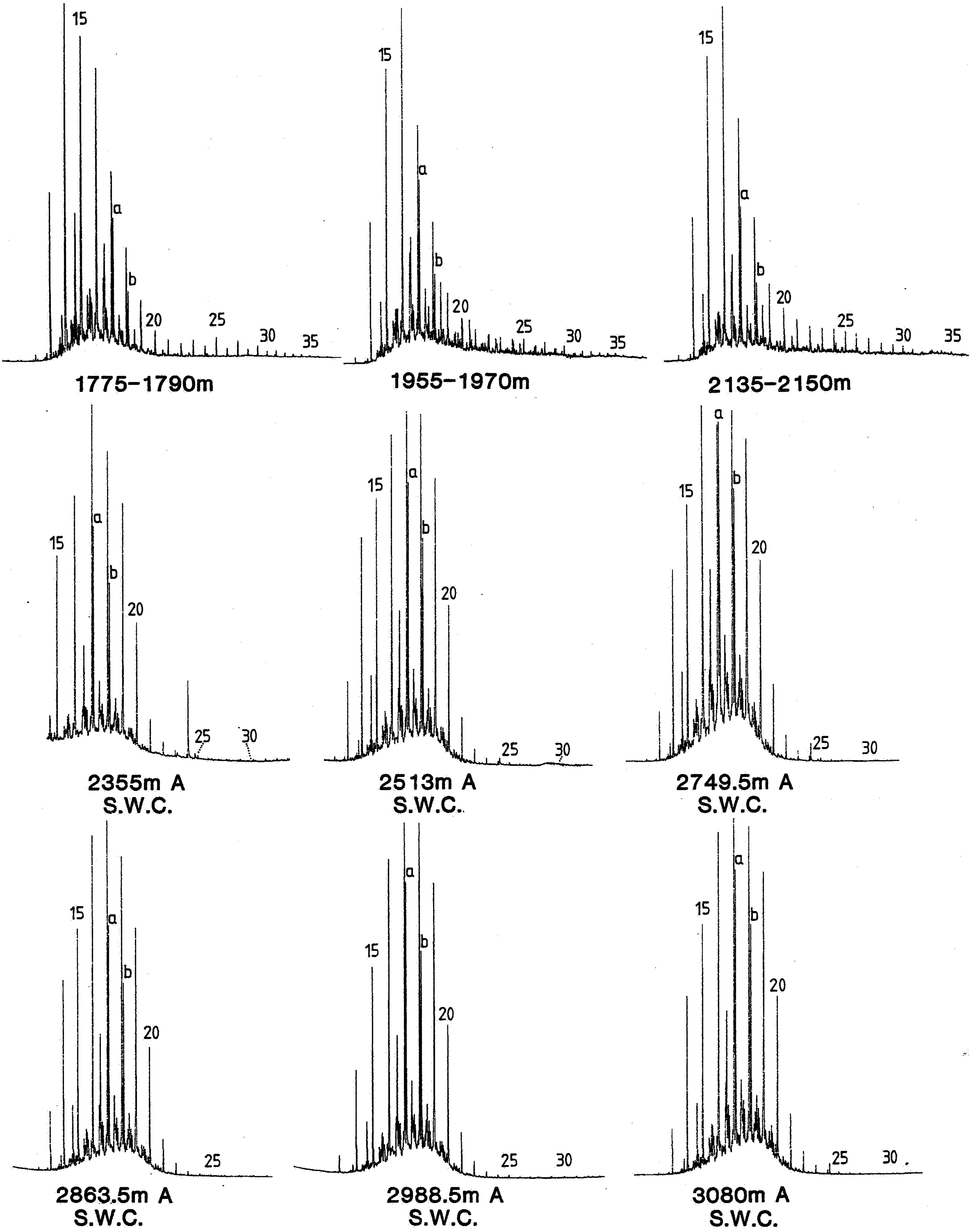
FIGURE 6c C_{15+} PARAFFIN - NAPHTHENES WELL 66/10/7-2



a - PRISTANE
b - PHYTANE

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

FIGURE 6b C_{15+} PARAFFIN - NAPHTHENES WELL 6610/7-2



a - PRISTANE
b - PHYTANE

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

FIGURE 6a C_{15+} PARAFFIN - NAPHTHENES WELL 6610/7-2

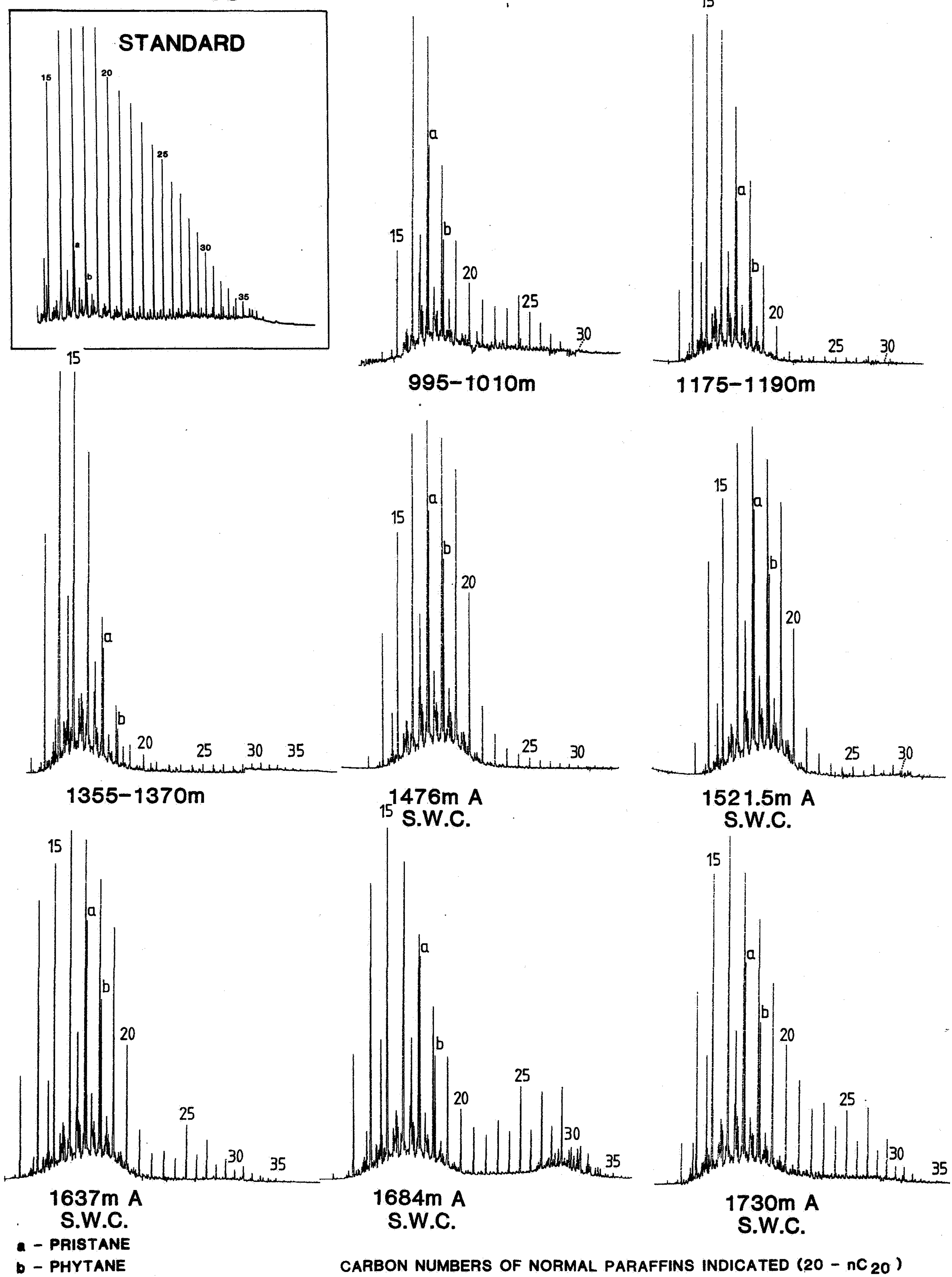


FIGURE 5c

PYROLYSIS GC

WELL 6610/7-2

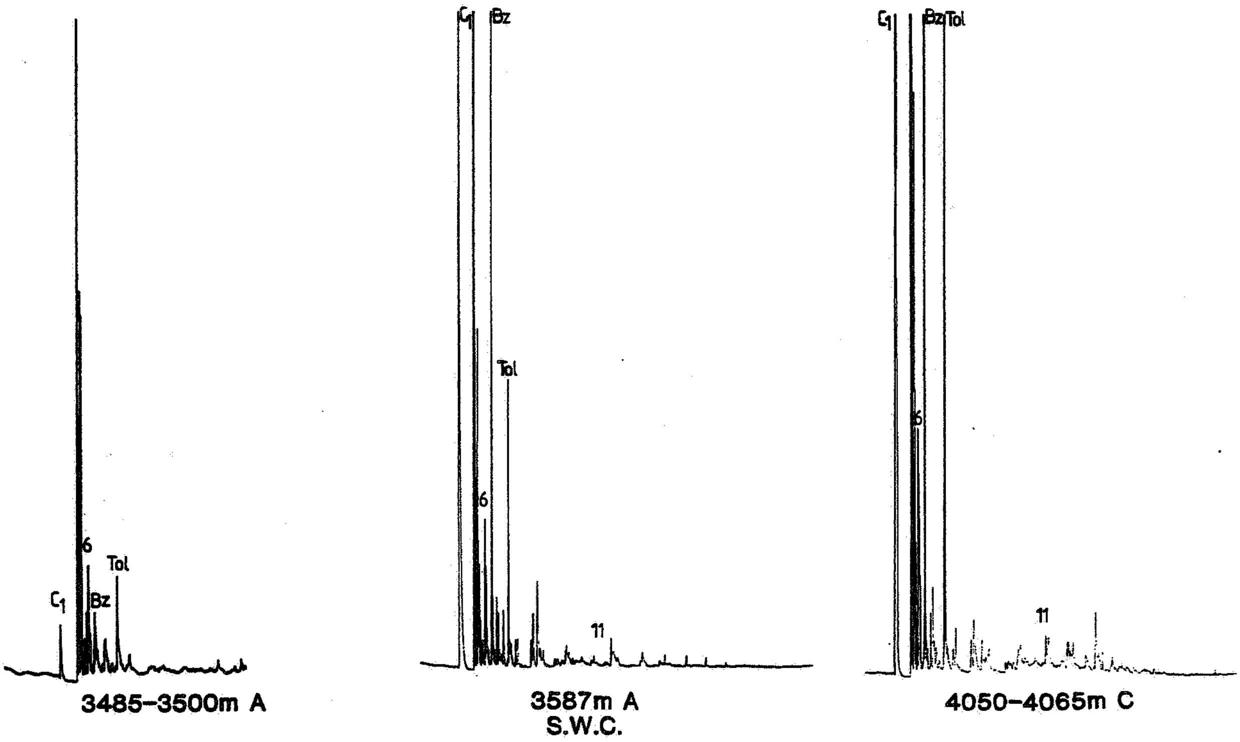


FIGURE 5b **PYROLYSIS GC** WELL 6610/7-2

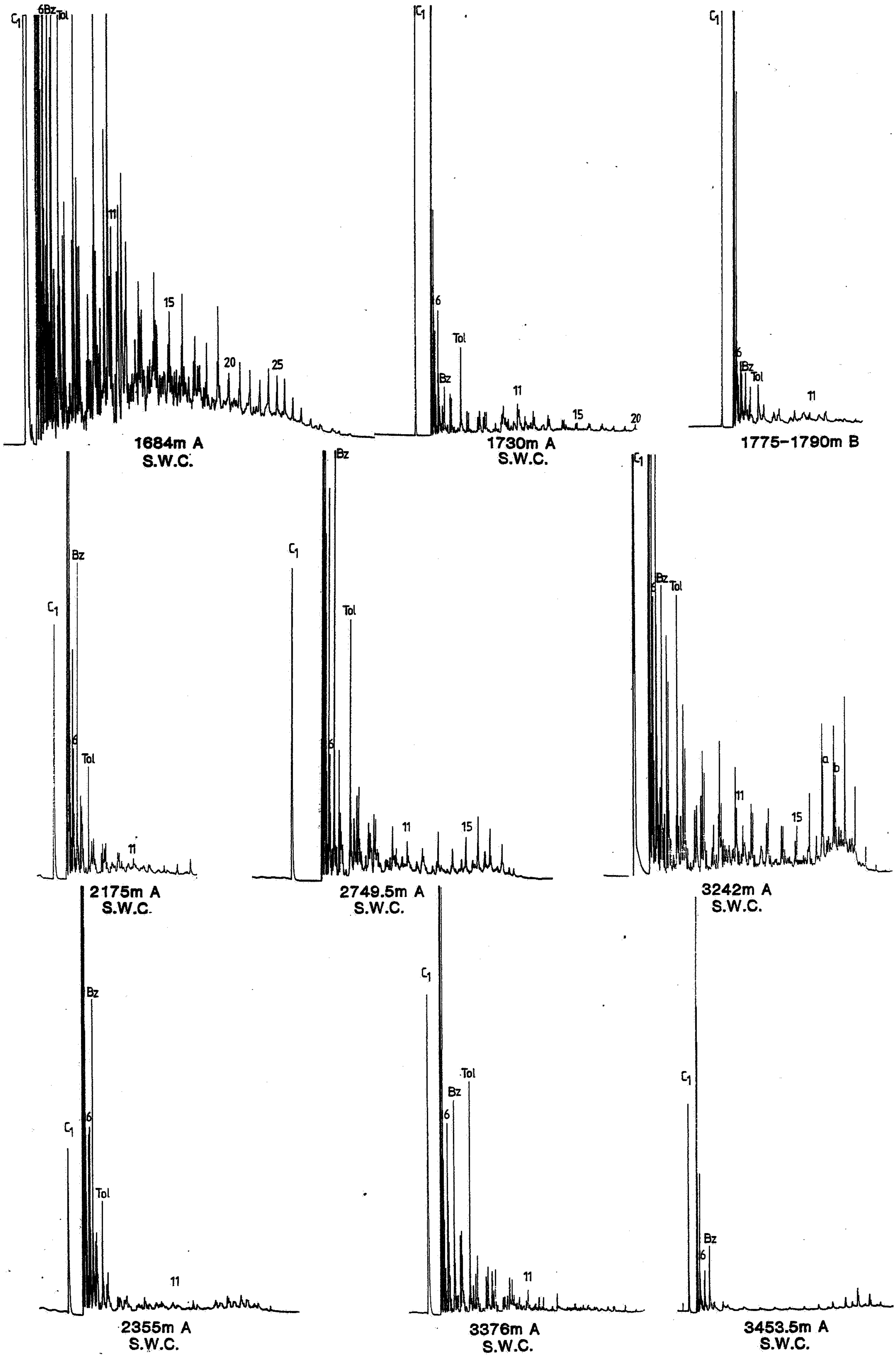


FIGURE 5a **PYROLYSIS GC** WELL 6610/7-2

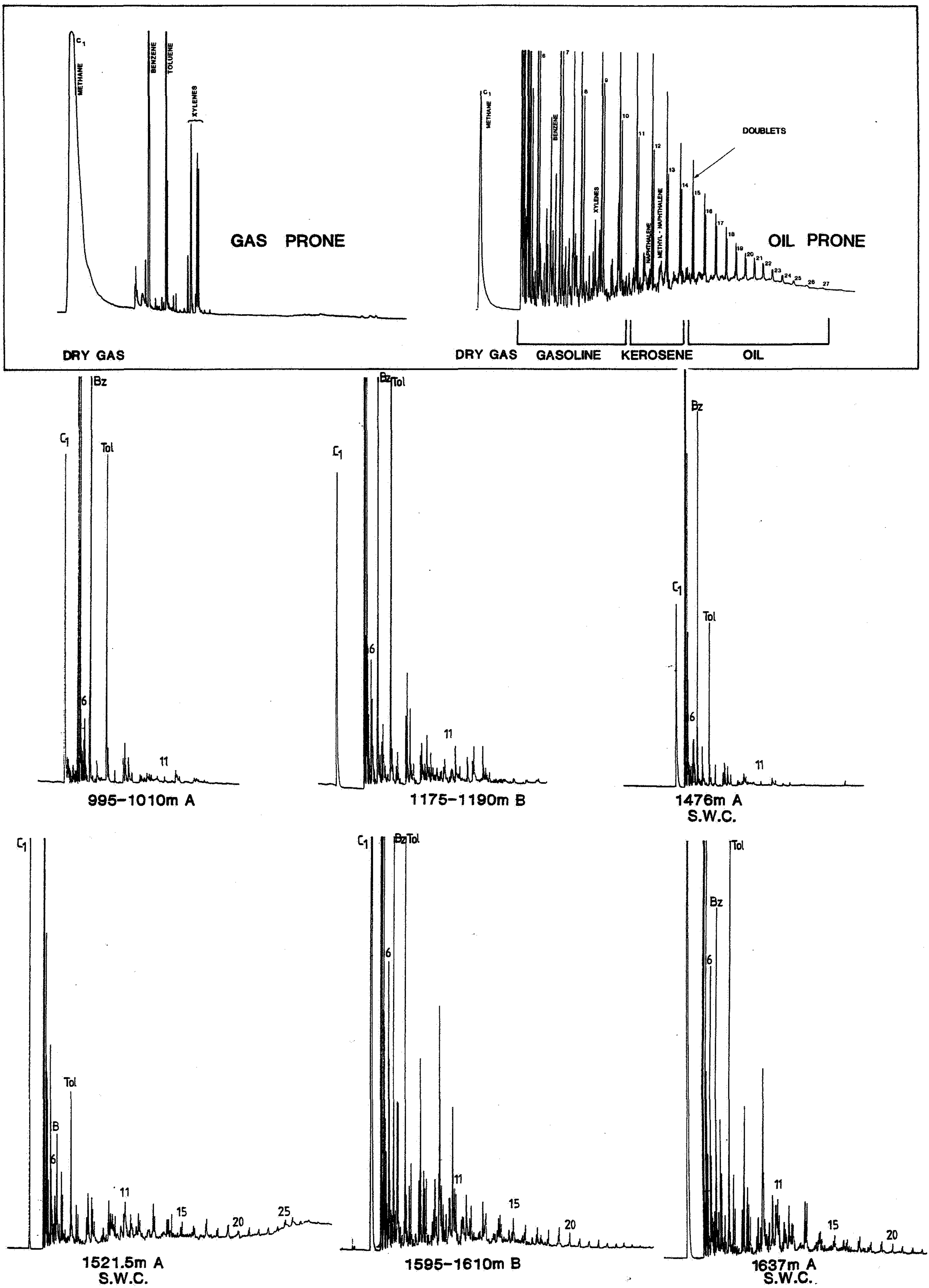


FIGURE 4 **ROCKEVAL DATA** WELL 6610/7-2

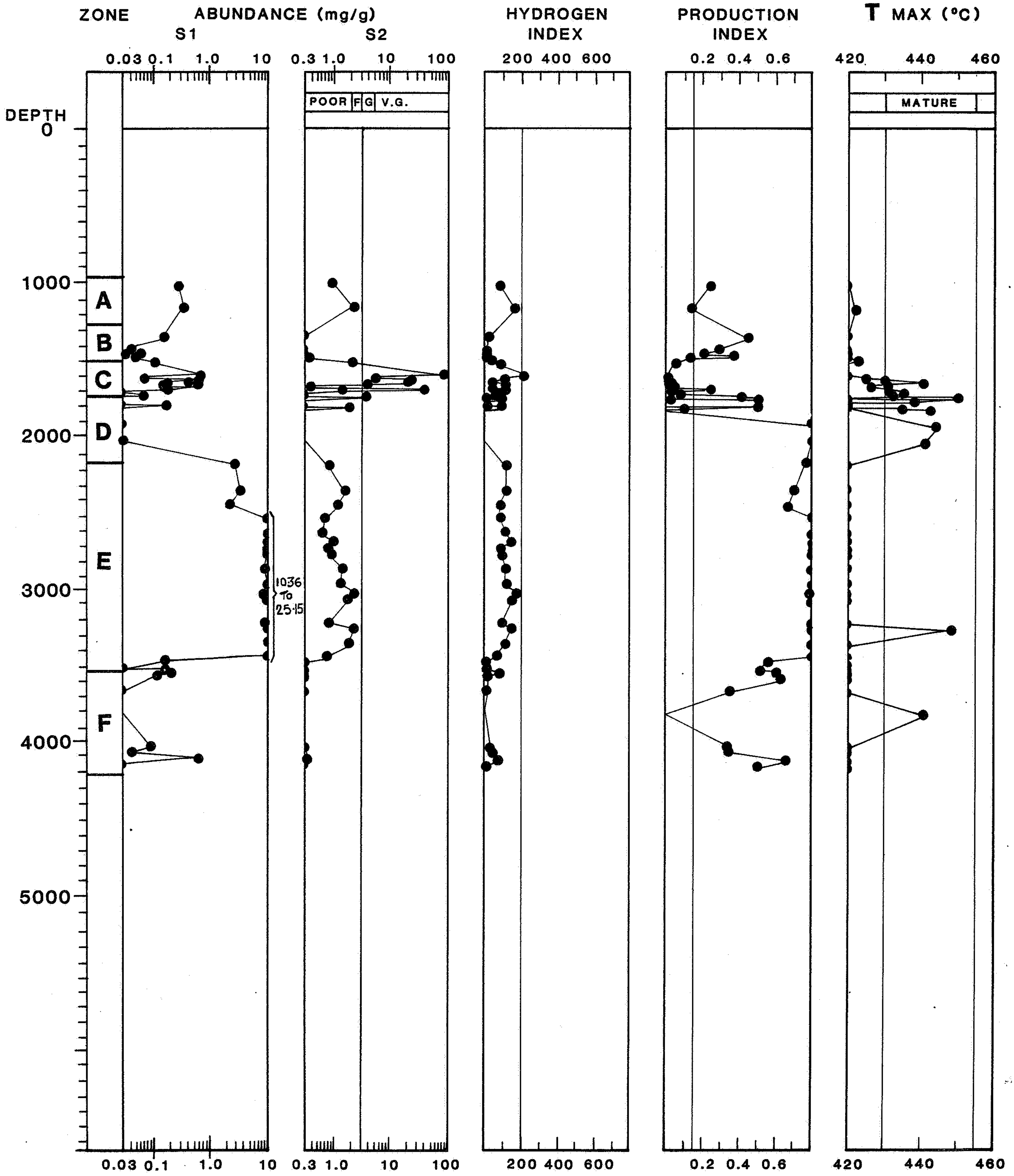
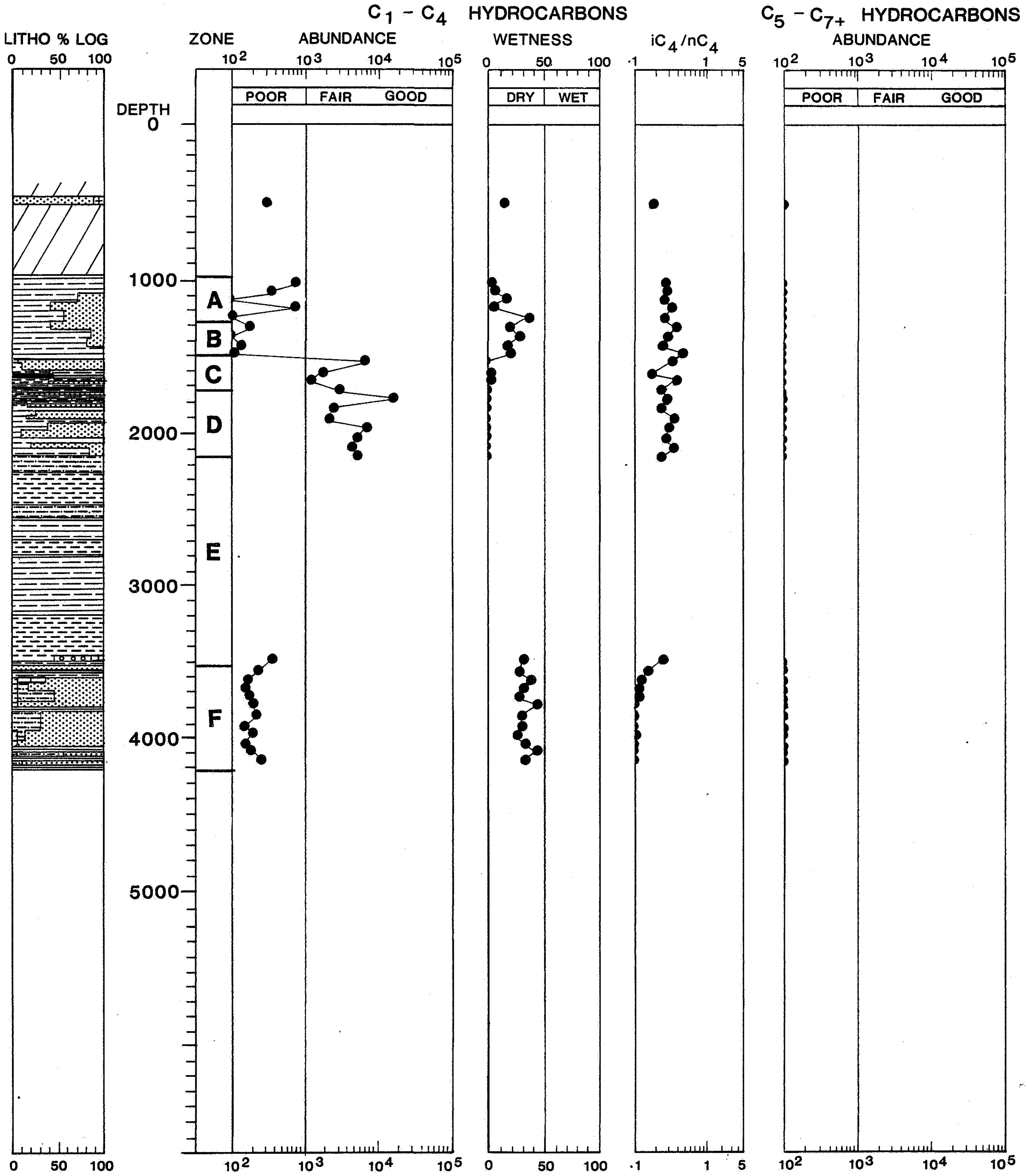


FIGURE 2 $C_1 - C_7$ HYDROCARBONS WELL 6610/7-2



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

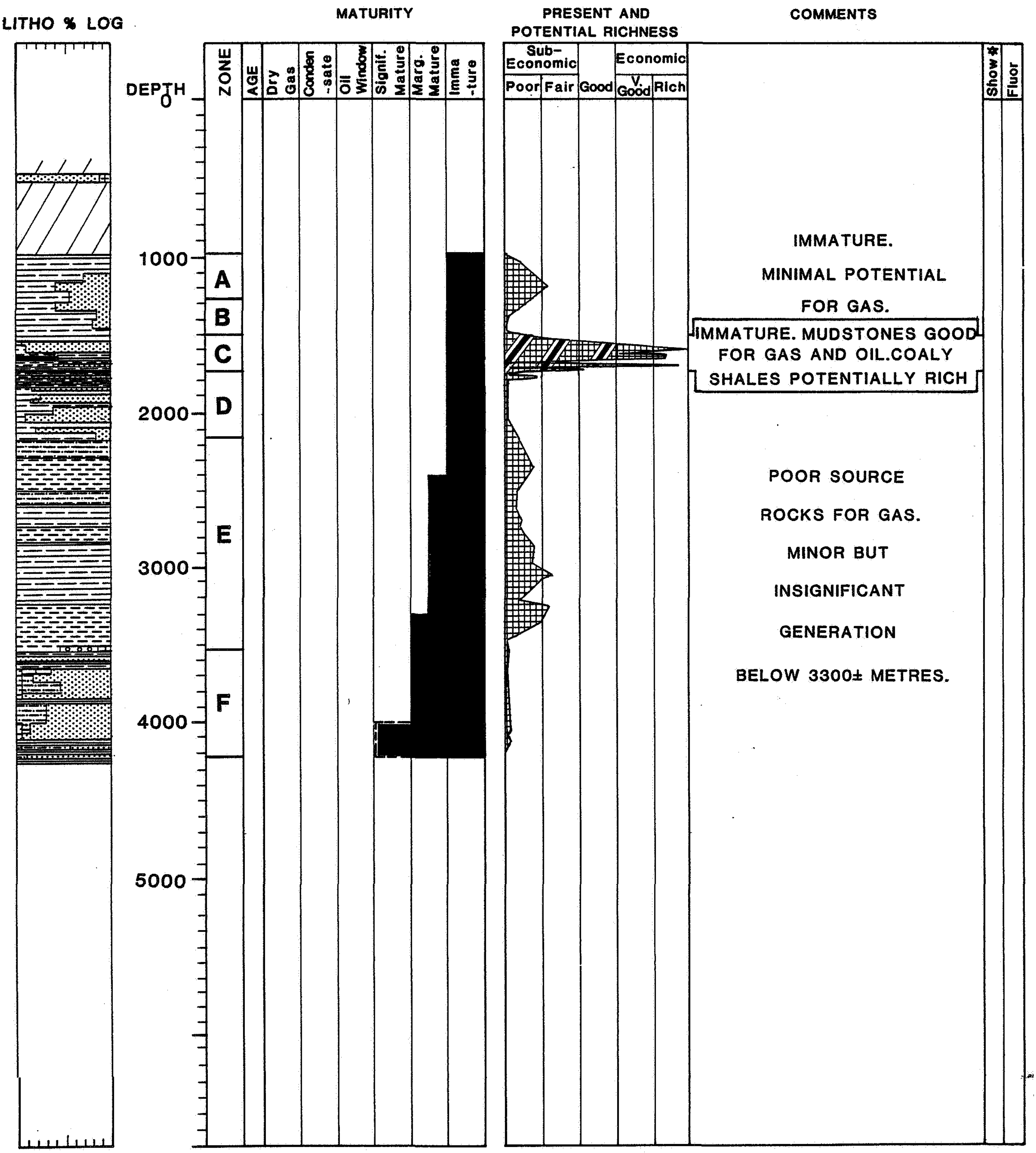
iC_4 – ISOBUTANE

nC_4 – NORMAL BUTANE

ABUNDANCE – VOLUME PPM OF ROCK

WETNESS – % C_2–C_4 IN C_1–C_4

FIGURE 1 **RATING** WELL 6610/7-2



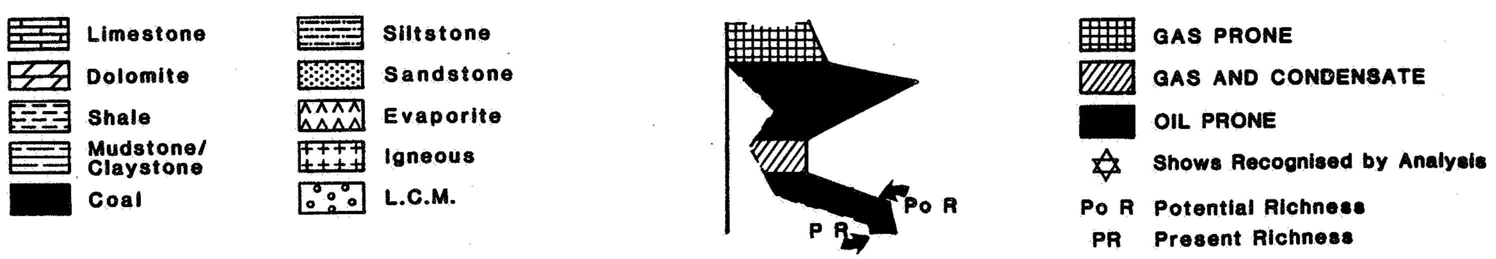
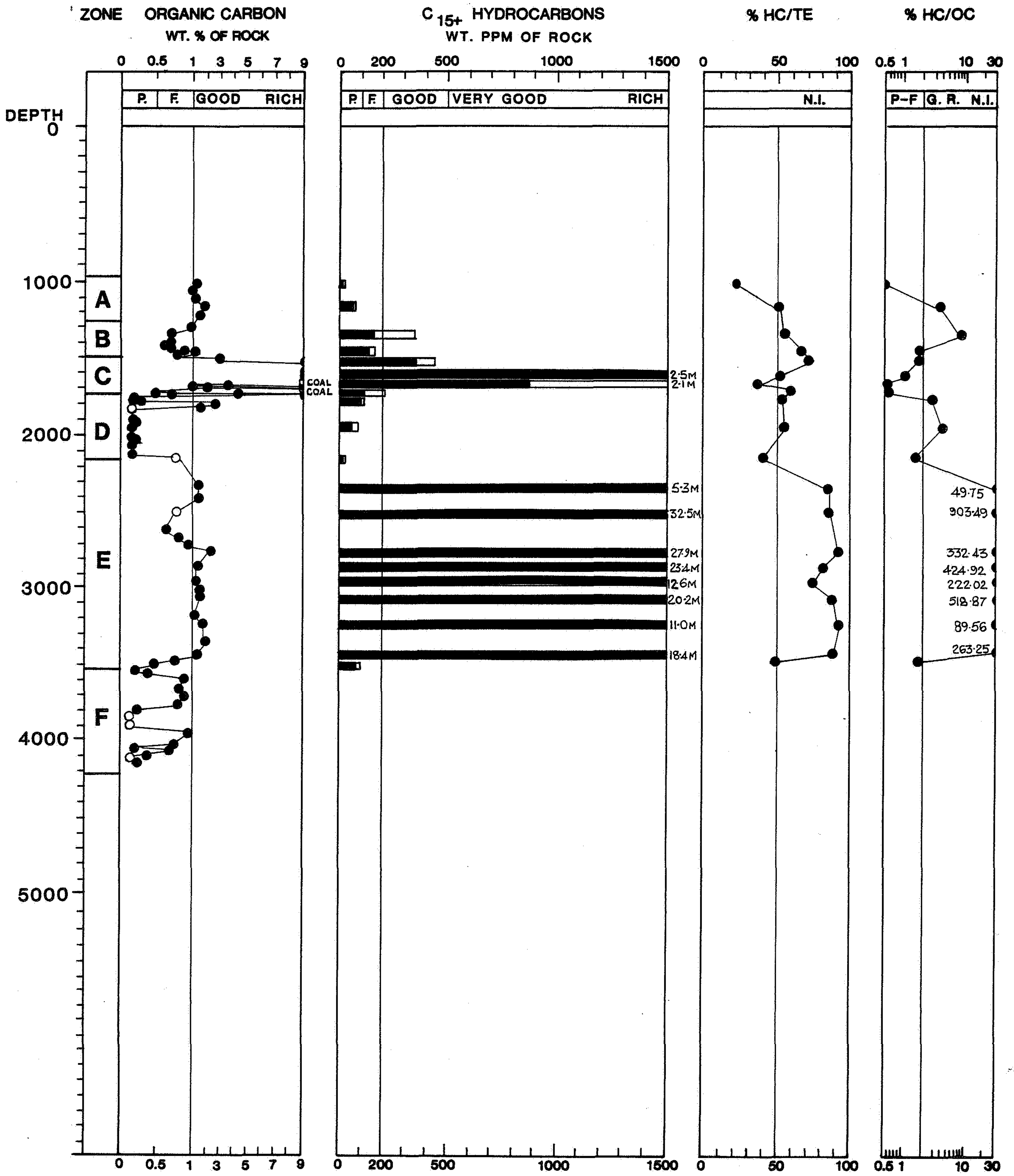


FIGURE 3 **RICHNESS** **WELL 6610/7-2**



● SHALE/MUDSTONE

○ OTHER LITHOLOGIES

P - N - PARAFFIN - NAPHTHENES

AROM - AROMATICS

HC - C_{15+} HYDROCARBONS

OC - ORGANIC CARBON

TE - TOTAL C_{15+} EXTRACT

P - POOR

F - FAIR

G - GOOD

R - RICH

N.I. - NON-INDIGENOUS HYDROCARBONS

FIGURE 4 **ROCKEVAL DATA** WELL 6610/7-2

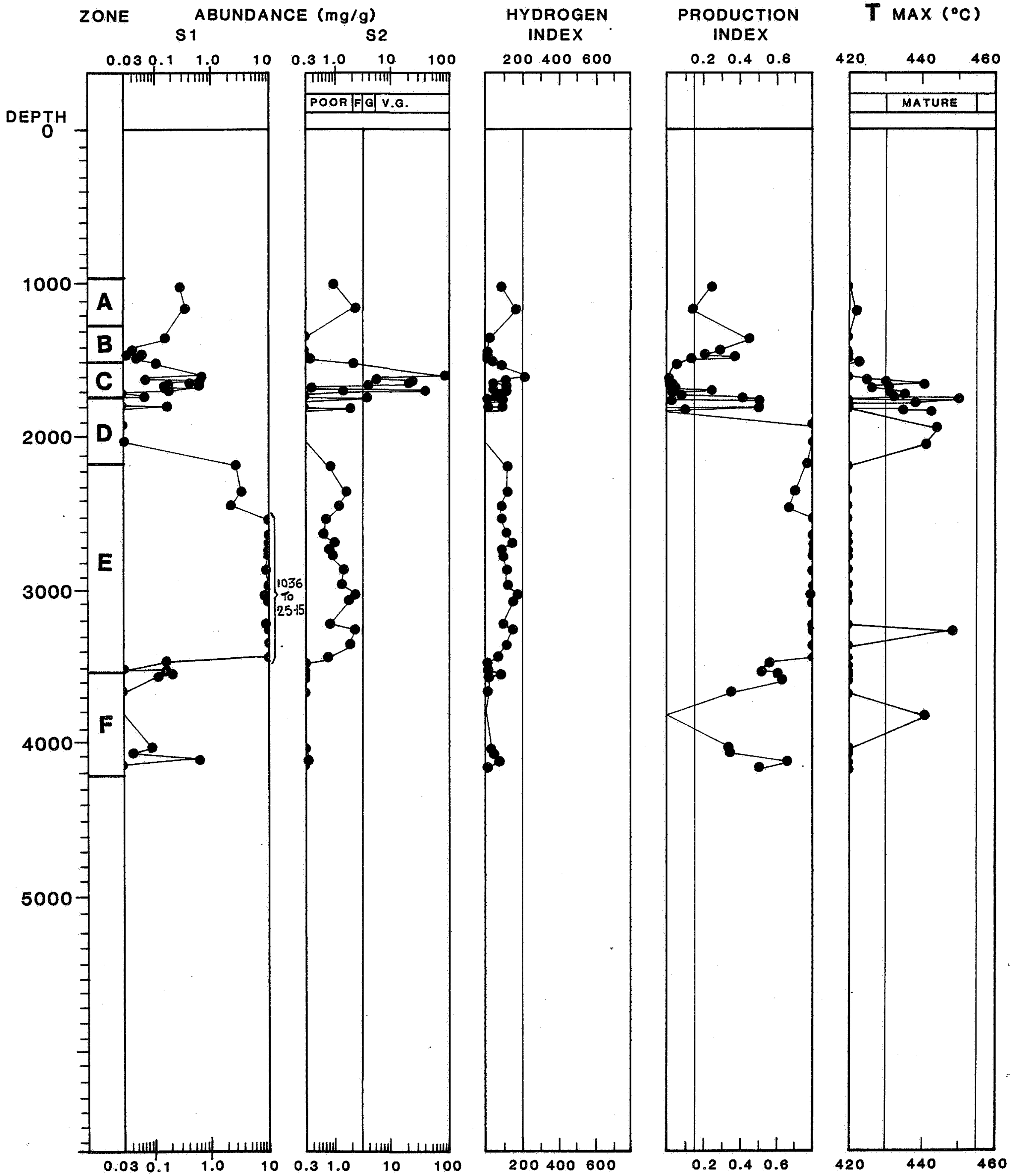


FIGURE 5a **PYROLYSIS GC** WELL 6610/7-2

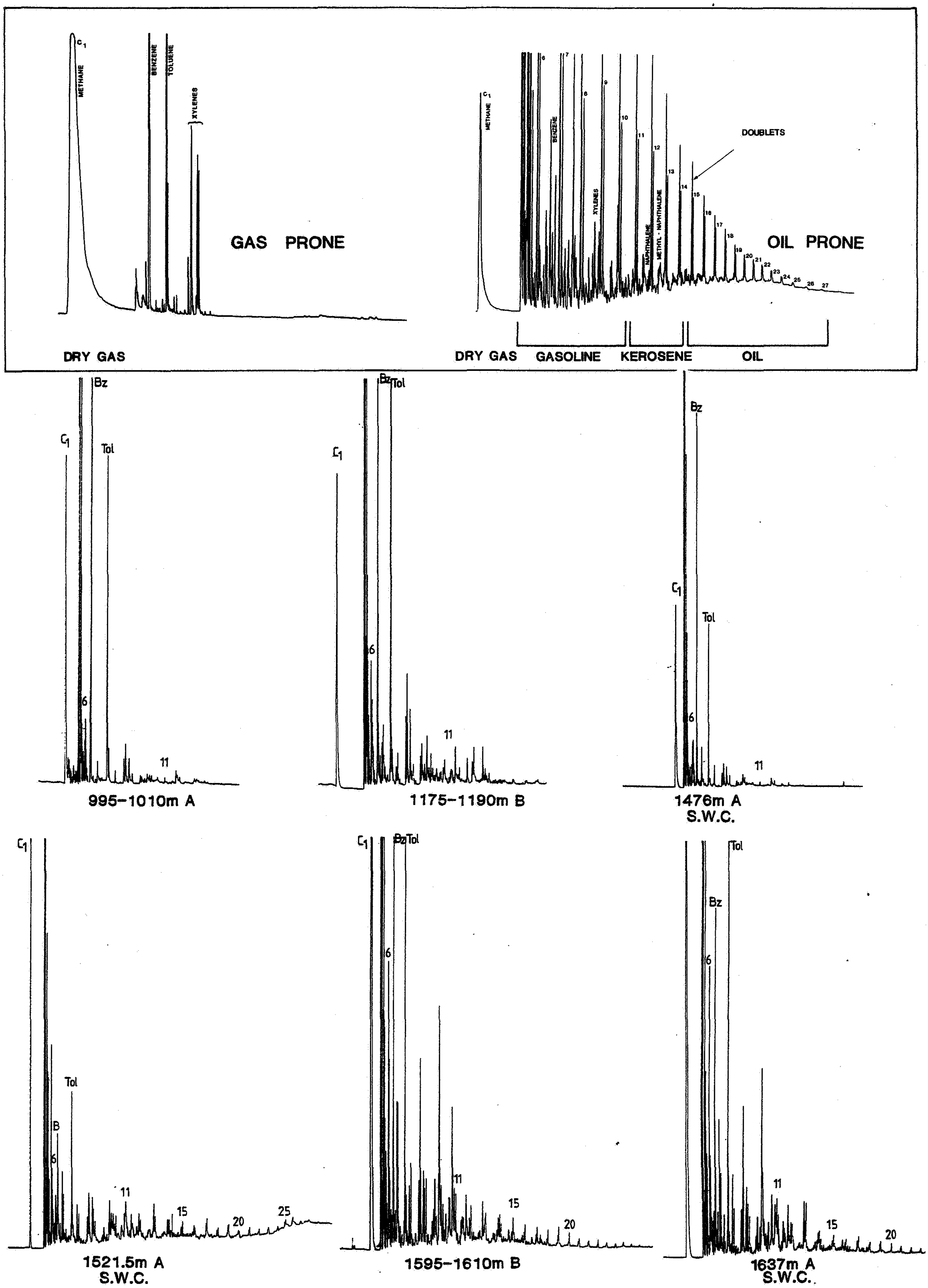


FIGURE 5b **PYROLYSIS GC** WELL 6610/7-2

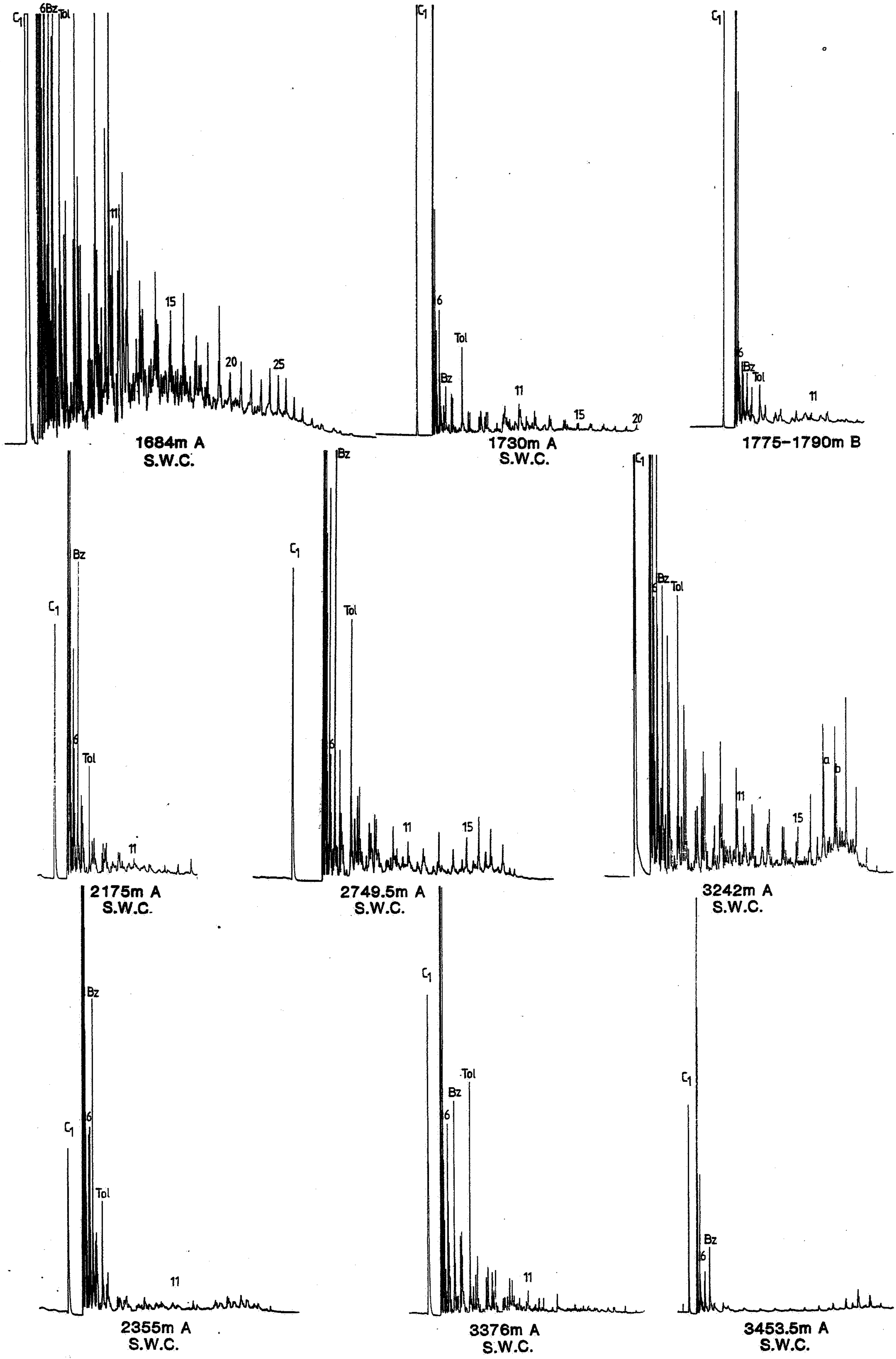


FIGURE 5c **PYROLYSIS GC** WELL 6610/7-2

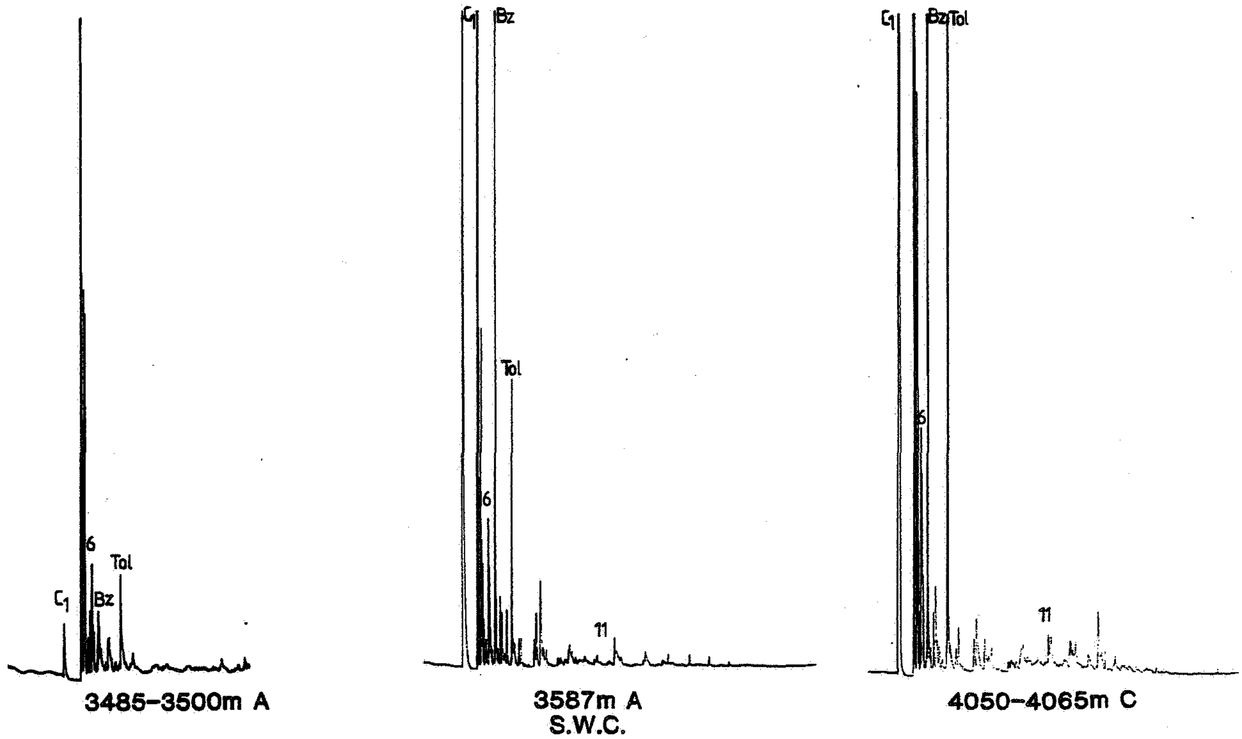
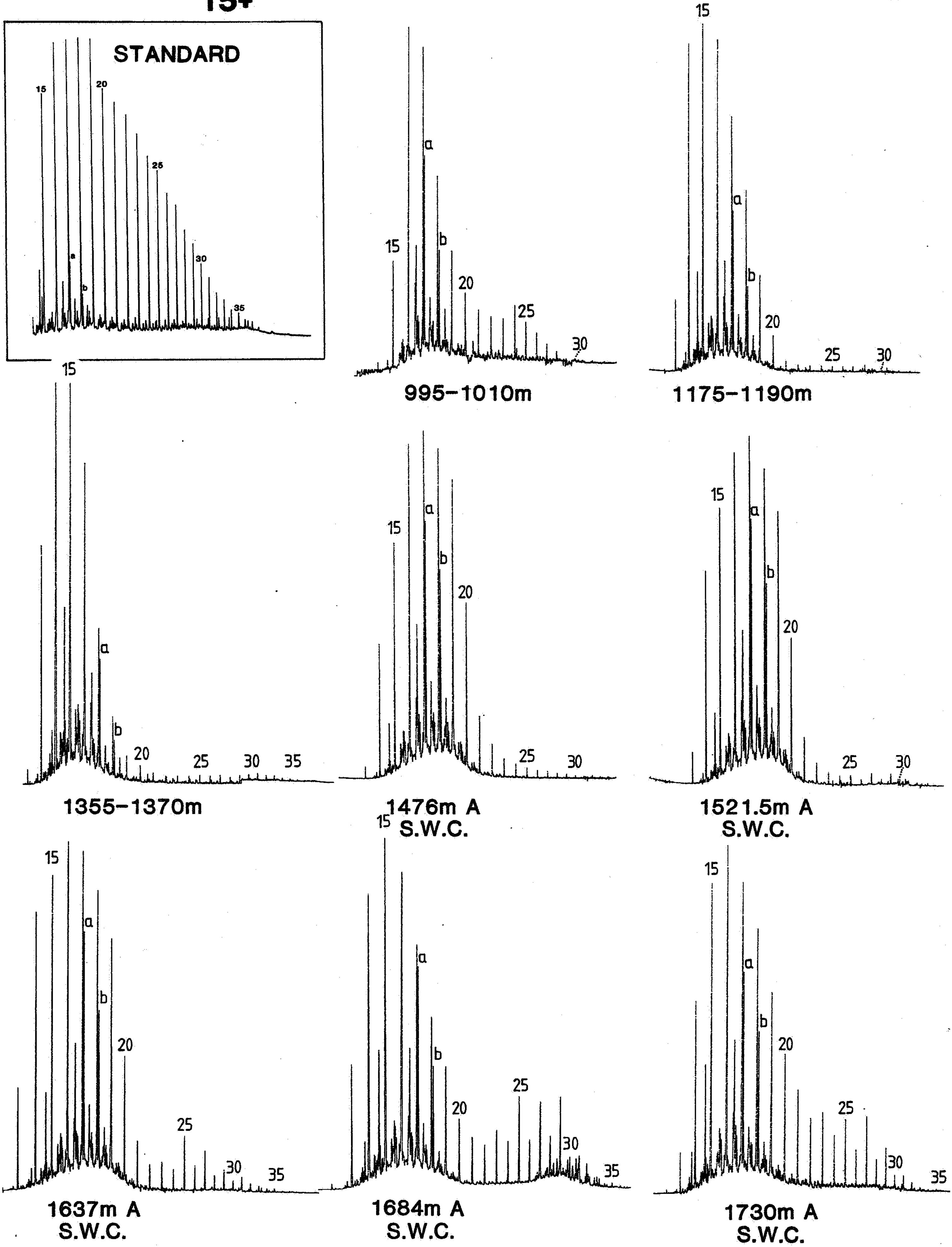


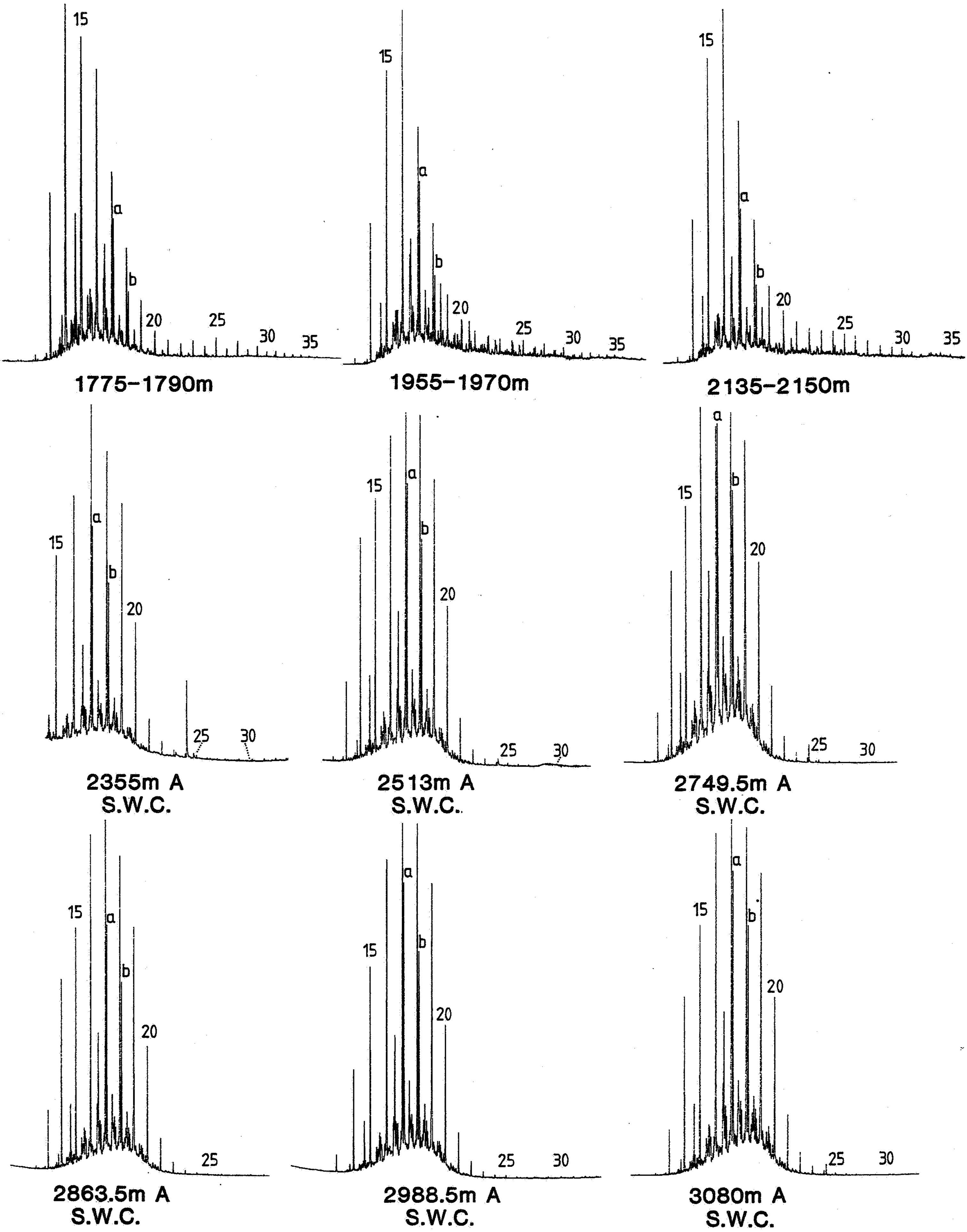
FIGURE 6a C_{15+} PARAFFIN - NAPHTHENES WELL 6610/7-2



a - PRISTANE
b - PHYTANE

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

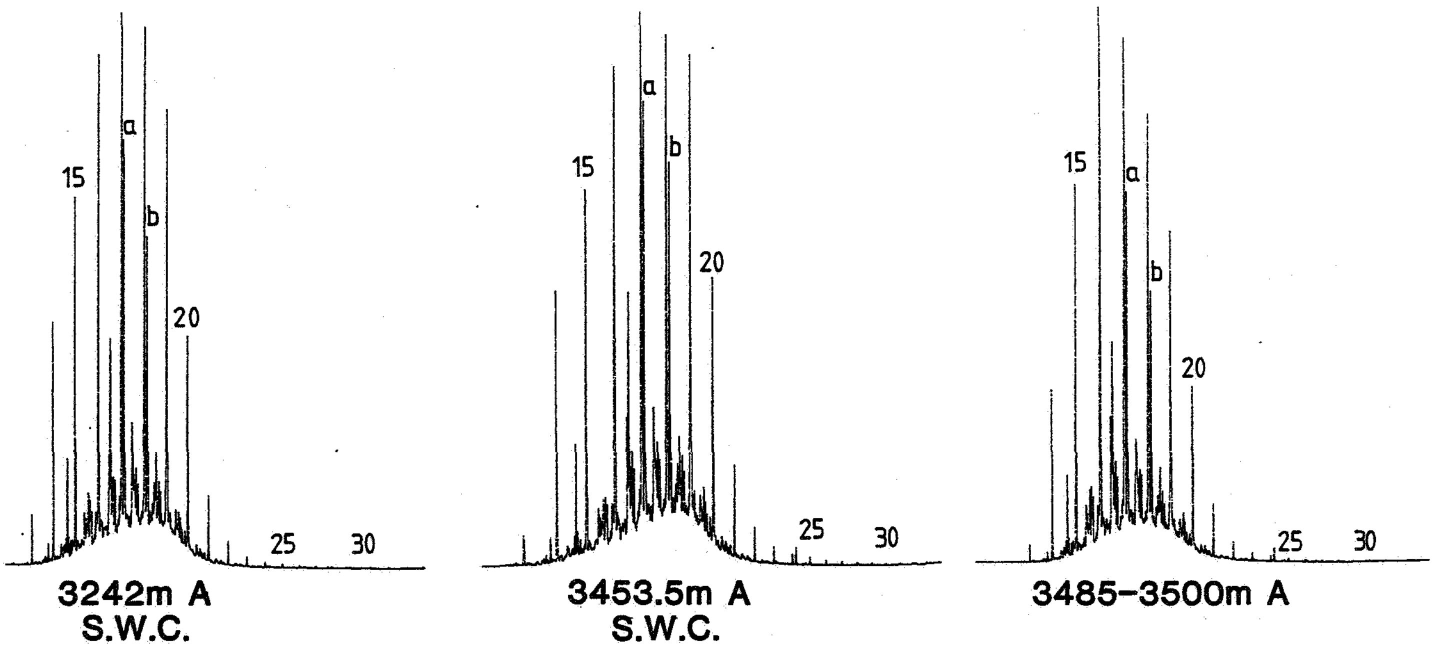
FIGURE 6b C_{15+} PARAFFIN - NAPHTHENES WELL 6610/7-2



a - PRISTANE
b - PHYTANE

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

FIGURE 6c C_{15+} PARAFFIN - NAPHTHENES WELL 66/10/7-2



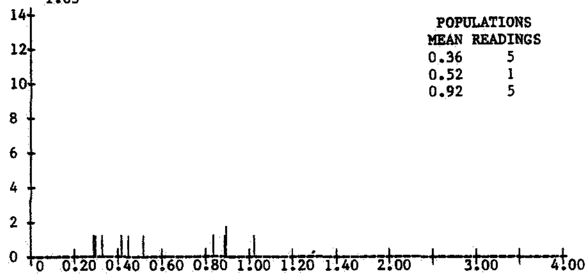
a - PRISTANE
b - PHYTANE

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

FIGURE 7a VITRINITE REFLECTANCE WELL 6610/7-2

SAMPLE 882-046A DEPTH 995 — VITRINITE REFLECTANCE VALUES

0.29 0.30 0.33 0.42 0.45 0.52 0.84 0.89 0.90 0.90
1.03

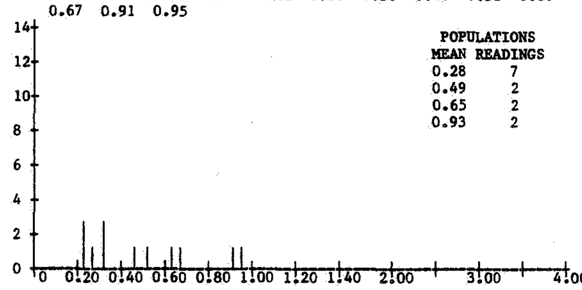


POPULATIONS MEAN	READINGS
0.36	5
0.52	1
0.92	5

REMARKS CHIEFLY BITUMEN STAINING.
REWORKING.
POOR SAMPLE.

SAMPLE 882-058B DEPTH 1175 — VITRINITE REFLECTANCE VALUES

0.23 0.23 0.23 0.27 0.32 0.33 0.33 0.46 0.52 0.63
0.67 0.91 0.95

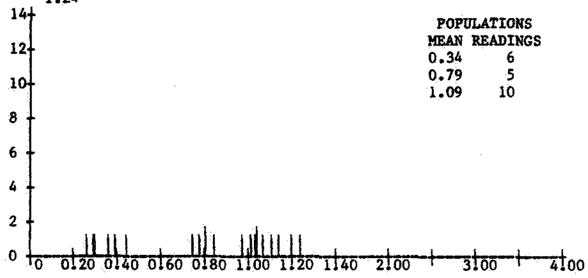


POPULATIONS MEAN	READINGS
0.28	7
0.49	2
0.65	2
0.93	2

REMARKS OCCASIONAL PARTICLES OF VARIABLE
REFLECTANCE MEASURED
POOR SAMPLE.

SAMPLE 882-070A DEPTH 1355 — VITRINITE REFLECTANCE VALUES

0.26 0.29 0.30 0.36 0.39 0.44 0.74 0.77 0.80 0.80
0.84 0.97 1.01 1.03 1.04 1.04 1.07 1.11 1.14 1.20
1.24

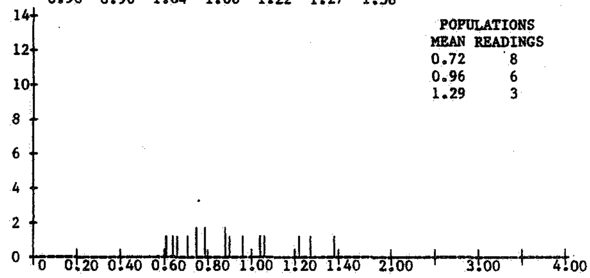


POPULATIONS MEAN	READINGS
0.34	6
0.79	5
1.09	10

REMARKS REWORKING.

SAMPLE 882-080A DEPTH 1476 — VITRINITE REFLECTANCE VALUES

0.61 0.64 0.66 0.71 0.75 0.76 0.79 0.79 0.88 0.89
0.90 0.96 1.04 1.06 1.22 1.27 1.38

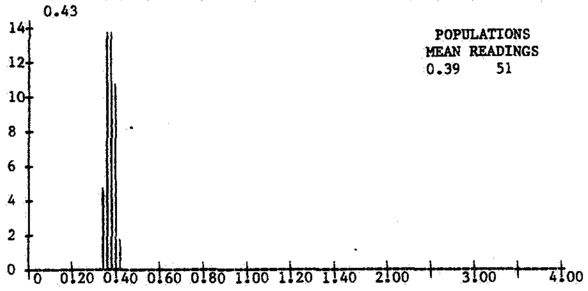


POPULATIONS MEAN	READINGS
0.72	8
0.96	6
1.29	3

REMARKS POOR SAMPLE.
CHIEFLY SMALL INERTINITE PARTICLES

SAMPLE 882-084A DEPTH 1521 — VITRINITE REFLECTANCE VALUES

0.34 0.34 0.34 0.34 0.35 0.36 0.36 0.36 0.36 0.36
0.37 0.37 0.37 0.37 0.37 0.37 0.37 0.37 0.37 0.37
0.38 0.38 0.38 0.38 0.38 0.38 0.38 0.39 0.39 0.39
0.39 0.39 0.39 0.39 0.39 0.39 0.39 0.39 0.40 0.40
0.40 0.40 0.40 0.40 0.40 0.40 0.41 0.41 0.41 0.42
0.43

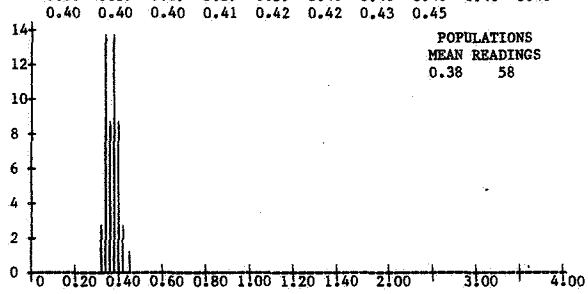


POPULATIONS MEAN	READINGS
0.39	51

REMARKS CHIEFLY VITRINITE

SAMPLE 882-090B DEPTH 1595 — VITRINITE REFLECTANCE VALUES

0.32 0.33 0.33 0.34 0.34 0.34 0.34 0.34 0.35 0.35
0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35
0.35 0.35 0.36 0.36 0.36 0.36 0.37 0.37 0.37 0.37
0.37 0.38 0.38 0.38 0.38 0.38 0.38 0.38 0.39 0.39
0.39 0.39 0.39 0.39 0.39 0.40 0.40 0.40 0.40 0.40
0.40 0.40 0.40 0.41 0.42 0.42 0.43 0.45

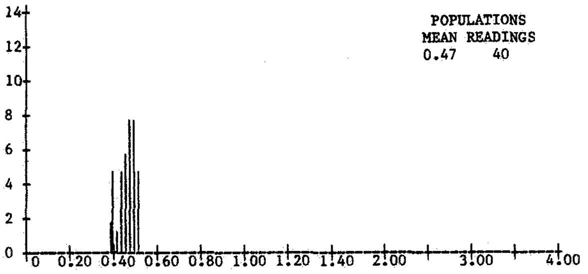


POPULATIONS MEAN	READINGS
0.38	58

REMARKS COAL.
CHIEFLY VITRINITE.

SAMPLE 882-094A DEPTH 1637 — VITRINITE REFLECTANCE VALUES

0.39 0.39 0.40 0.40 0.41 0.41 0.41 0.42 0.44 0.44
0.44 0.45 0.45 0.46 0.47 0.47 0.47 0.47 0.47 0.48
0.48 0.48 0.48 0.49 0.49 0.49 0.49 0.50 0.50 0.50
0.50 0.50 0.51 0.51 0.51 0.52 0.52 0.52 0.53 0.53

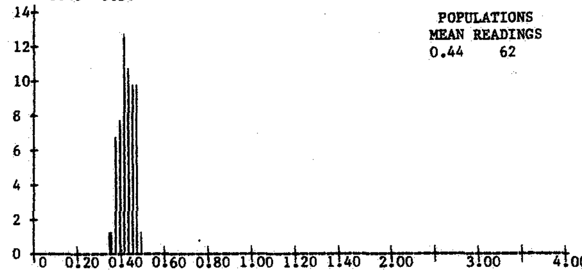


POPULATIONS MEAN	READINGS
0.47	40

REMARKS COAL.

SAMPLE 882-101A DEPTH 1684 — VITRINITE REFLECTANCE VALUES

0.35 0.36 0.38 0.38 0.38 0.39 0.39 0.39 0.39 0.40
0.40 0.40 0.40 0.40 0.41 0.41 0.41 0.42 0.42 0.42
0.42 0.42 0.43 0.43 0.43 0.43 0.43 0.43 0.43 0.43
0.44 0.44 0.44 0.45 0.45 0.45 0.45 0.45 0.45 0.45
0.45 0.46 0.46 0.46 0.46 0.46 0.47 0.47 0.47 0.47
0.47 0.48 0.48 0.48 0.48 0.48 0.48 0.49 0.49 0.49
0.49 0.50



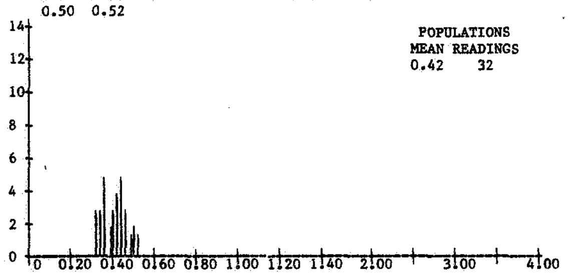
POPULATIONS MEAN	READINGS
0.44	62

REMARKS COAL.
VERY DOMINANTLY VITRINITE.

FIGURE 7b VITRINITE REFLECTANCE WELL 6610/7-2

SAMPLE 882-115B DEPTH 1775 — VITRINITE REFLECTANCE VALUES

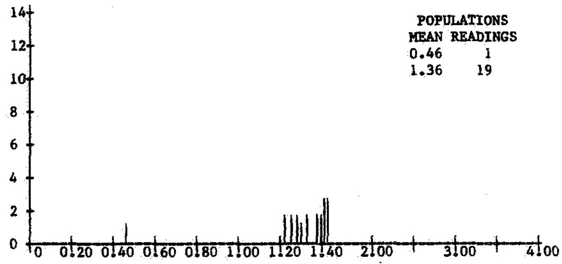
0.32 0.33 0.33 0.34 0.34 0.35 0.36 0.37 0.37 0.37
0.37 0.39 0.39 0.40 0.40 0.41 0.42 0.42 0.42 0.43
0.44 0.45 0.45 0.45 0.45 0.46 0.47 0.47 0.49 0.50
0.50 0.52



REMARKS CHIEFLY VITRINITE.
SOME VARIATION IN REFLECTANCE APPARENT.

SAMPLE 882-125A DEPTH 1910 — VITRINITE REFLECTANCE VALUES

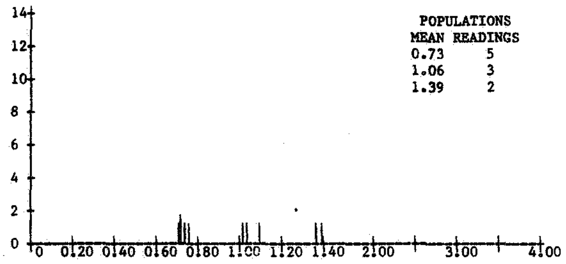
0.46 1.22 1.23 1.25 1.27 1.28 1.28 1.30 1.33 1.33
1.38 1.39 1.40 1.40 1.44 1.44 1.44 1.48 1.49 1.49



REMARKS LEAN. OCCASIONAL SMALL REWORKED/OXIDISED PARTICLES.
POOR SAMPLE.

SAMPLE 882-145A DEPTH 2175 — VITRINITE REFLECTANCE VALUES

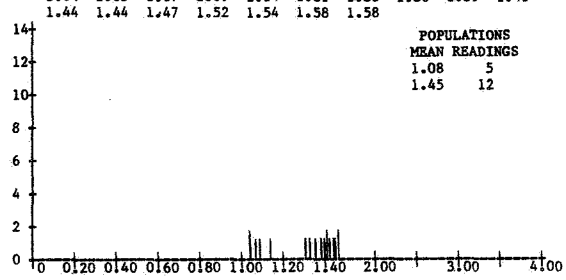
0.71 0.72 0.72 0.74 0.76 1.02 1.04 1.10 1.37 1.40



REMARKS VIRTUALLY BARREN.
POOR SAMPLE

SAMPLE 882-158A DEPTH 2355 — VITRINITE REFLECTANCE VALUES

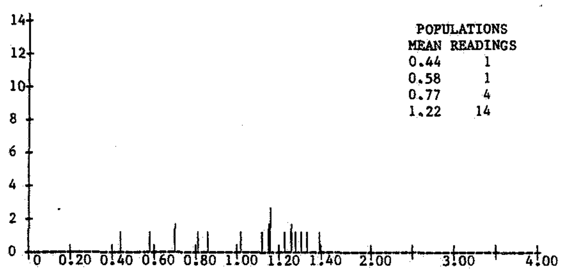
1.04 1.05 1.07 1.09 1.14 1.31 1.33 1.36 1.39 1.41
1.44 1.44 1.47 1.52 1.54 1.58 1.58



REMARKS EXTREMELY LEAN.
DOMINANTLY INERTINITE.
POOR SAMPLE.

SAMPLE 882-170A DEPTH 2513 — VITRINITE REFLECTANCE VALUES

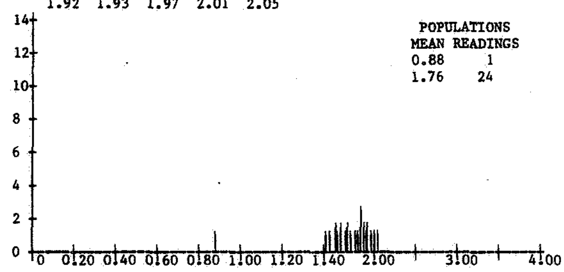
0.44 0.58 0.70 0.70 0.81 0.86 1.02 1.12 1.15 1.15
1.16 1.17 1.17 1.23 1.26 1.27 1.28 1.31 1.34 1.40



REMARKS EXTREMELY LEAN.
WIDESPREAD REWORKING.
POOR SAMPLE.

SAMPLE 882-184A DEPTH 2683 — VITRINITE REFLECTANCE VALUES

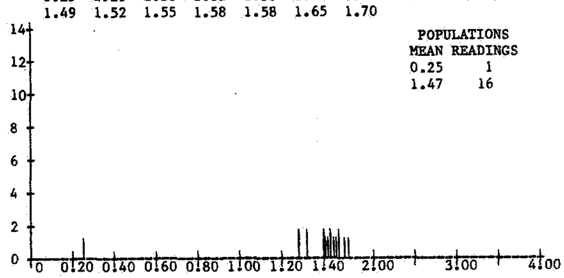
0.88 1.42 1.47 1.54 1.55 1.56 1.60 1.60 1.66 1.68
1.68 1.72 1.78 1.81 1.84 1.84 1.85 1.88 1.89 1.91
1.92 1.93 1.97 2.01 2.05



REMARKS RED BED
WIDESPREAD OXIDATION/REWORKING.

SAMPLE 882-190A DEPTH 2749 — VITRINITE REFLECTANCE VALUES

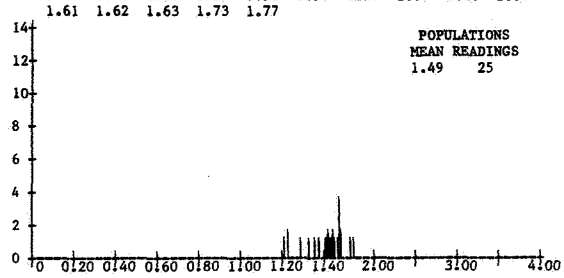
0.25 1.28 1.28 1.32 1.33 1.40 1.40 1.42 1.45 1.48
1.49 1.52 1.55 1.58 1.58 1.65 1.70



REMARKS RED BED
TINY LIGNITE PARTICLE ALSO PRESENT.

SAMPLE 882-199A DEPTH 2863 — VITRINITE REFLECTANCE VALUES

1.21 1.23 1.23 1.29 1.33 1.36 1.38 1.43 1.45 1.46
1.47 1.48 1.50 1.52 1.52 1.54 1.58 1.60 1.60 1.60
1.61 1.62 1.63 1.73 1.77

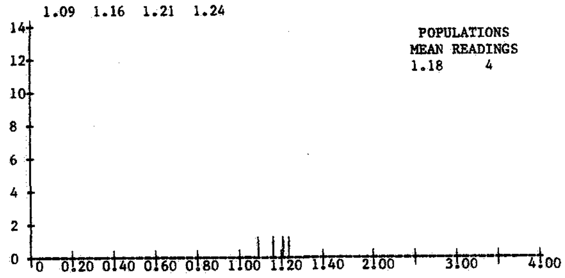


REMARKS RED BED
WIDESPREAD OXIDATION/REWORKING.

FIGURE 7c VITRINITE REFLECTANCE WELL 6610/7-2

SAMPLE 882-208A DEPTH 2988 VITRINITE REFLECTANCE VALUES

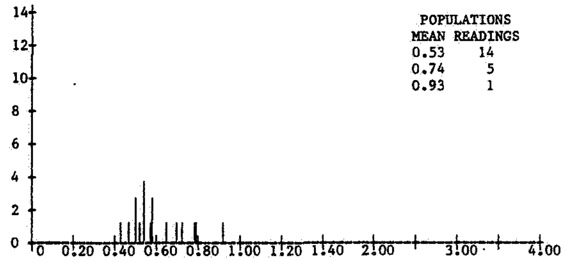
1.09 1.16 1.21 1.24



REMARKS RED BED
VIRTUALLY BARREN MEASUREMENTS ON UNRECOGNISABLE PARTICLES

SAMPLE 882-229A DEPTH 3242 VITRINITE REFLECTANCE VALUES

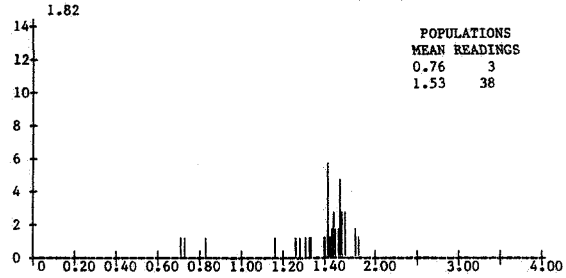
0.43	0.47	0.50	0.50	0.51	0.52	0.54	0.54	0.54	0.54
0.57	0.58	0.59	0.59	0.65	0.70	0.73	0.79	0.80	0.93



REMARKS LEAN.
SOME VARIATION IN REFLECTANCE APPARENT.
POOR SAMPLE.

SAMPLE 882-245A DEPTH 3453 VITRINITE REFLECTANCE VALUES

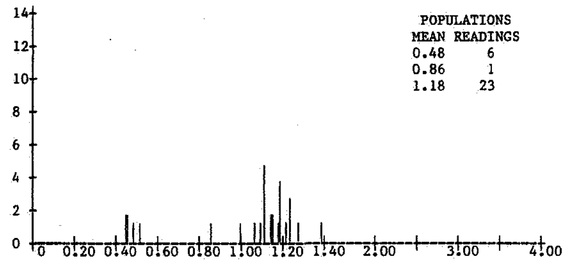
0.71	0.73	0.83	1.16	1.26	1.28	1.31	1.33	1.34	1.41
1.45	1.45	1.45	1.45	1.45	1.45	1.47	1.48	1.50	1.51
1.52	1.53	1.53	1.54	1.54	1.58	1.59	1.60	1.60	1.61
1.61	1.61	1.62	1.62	1.63	1.66	1.66	1.67	1.78	1.78
1.82									



REMARKS DOMINANTLY PARTICLES OF HIGH R_o
VITRINITE AND INERTINITE.
DIFFERENTIATION DIFFICULT.

SAMPLE 882-253A DEPTH 3587 VITRINITE REFLECTANCE VALUES

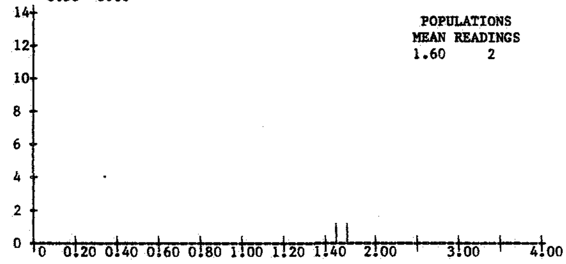
0.45	0.45	0.46	0.47	0.49	0.52	0.86	1.00	1.07	1.10
1.12	1.12	1.13	1.13	1.13	1.15	1.15	1.16	1.16	1.19
1.20	1.20	1.20	1.21	1.23	1.25	1.25	1.25	1.29	1.41



REMARKS LEAN. CHIEFLY INERTINITE
POOR SAMPLE.

SAMPLE 882-216A DEPTH 3080 VITRINITE REFLECTANCE VALUES

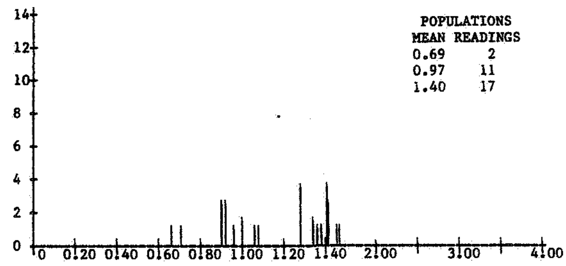
1.53 1.66



REMARKS VIRTUALLY BARREN.
POOR SAMPLE.

SAMPLE 882-239A DEPTH 3376 VITRINITE REFLECTANCE VALUES

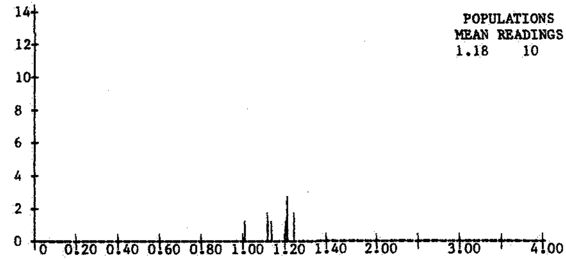
0.66	0.71	0.90	0.90	0.91	0.92	0.92	0.93	0.96	1.00
1.01	1.06	1.08	1.28	1.29	1.29	1.29	1.34	1.35	1.36
1.38	1.42	1.43	1.43	1.43	1.44	1.44	1.45	1.54	1.57



REMARKS WIDESPREAD REWORKING.
POOR SAMPLE.

SAMPLE 882-249A DEPTH 3502 VITRINITE REFLECTANCE VALUES

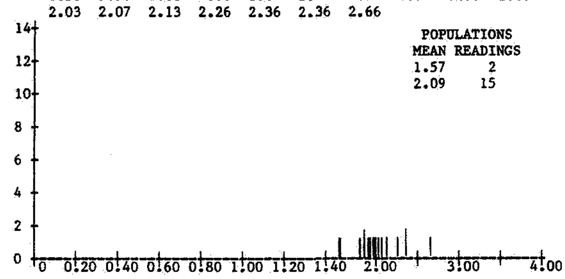
1.01 1.12 1.12 1.14 1.21 1.22 1.23 1.23 1.25 1.25



REMARKS VIRTUALLY BARREN.
OCCASIONAL UNRECOGNISABLE PARTICLES.
POOR SAMPLE.

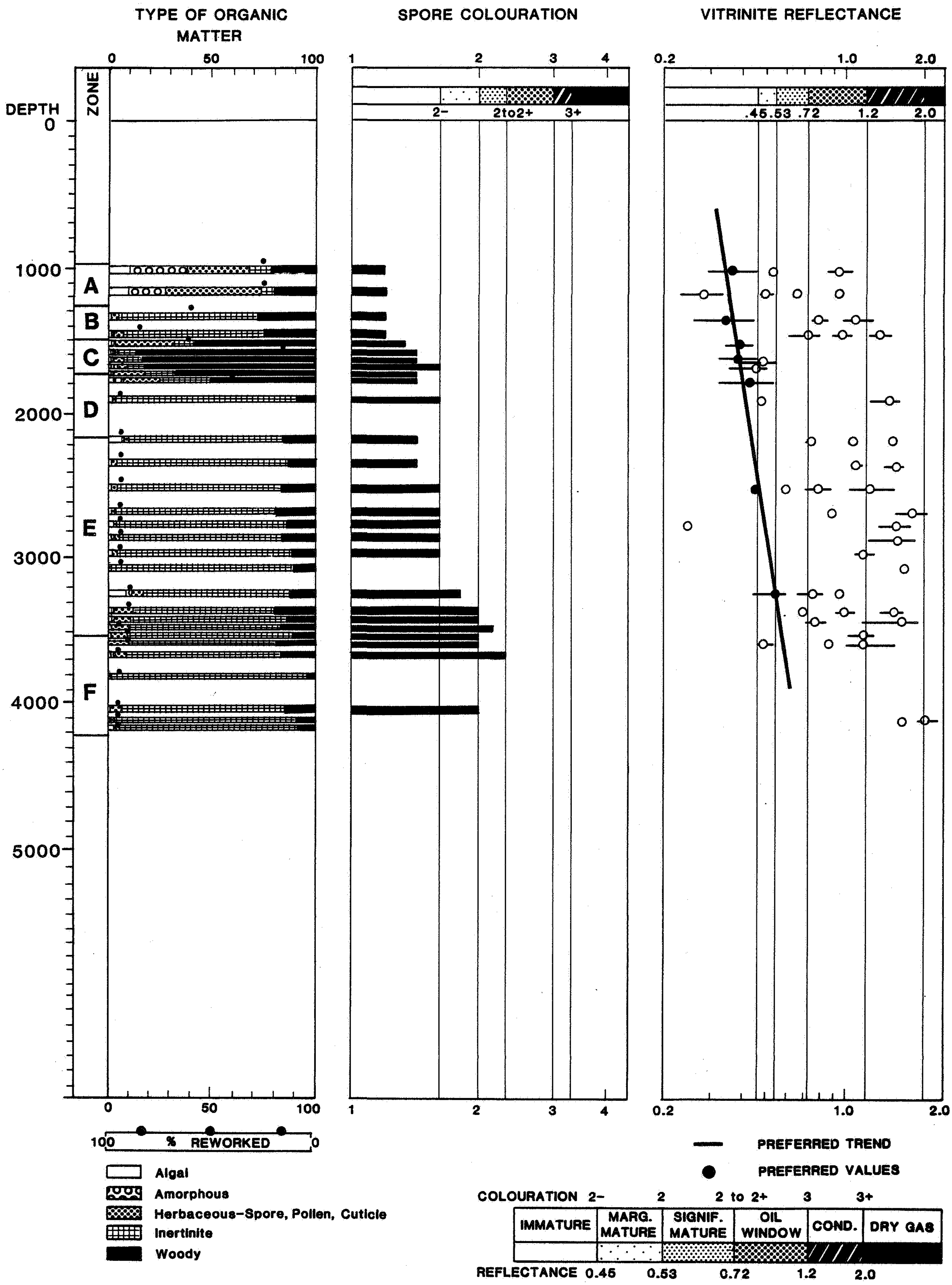
SAMPLE 882-256A DEPTH 4120 VITRINITE REFLECTANCE VALUES

1.56	1.58	1.81	1.86	1.87	1.91	1.93	1.97	1.99	2.00
2.03	2.07	2.13	2.26	2.36	2.36	2.66			



REMARKS RED BED
EXCLUSIVELY MATERIAL OF HIGH R_o.
POOR SAMPLE.

FIGURE 8 **ORGANIC FACIES & MATURITY** WELL 6610/7-2



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 (not from peak height) by comparison with a standard.

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

B) SAMPLE WASHING AND HAND PICKING

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

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

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

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

C) ORGANIC CARBON 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) <u>VITRINITE REFLECTANCE</u>

Vitrinite reflectance is an alternative/confirmatory method for evaluating thermal maturation which is used in conjection with the <u>visual kerogen</u> 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 than1) 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) ANALYSES FOR SPECIAL CASES

M-1) ELEMENTAL KEROGEN ANALYSIS

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

M-2) SULPHUR ANALYSIS

The abundance of sulphur in source rocks and crude oils.

M-3) CARBONATE CONTENT

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

M-4) NORMAL PARAFFIN ANALYSIS

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

M-5 SOLID BITUMEN EVALUATION

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

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

N) CRUDE OIL ANALYSIS

N-1) API GRAVITY

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

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

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

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

N-5) FRACTIONAL DISTILLATION

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