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SOURCE ROCK EVALUATION OF WELL 31/3-1

CLIENT/ OPPDRAGSGIVER

Statoil

RESPONSIBLE SCIENTIST/ PROSJEKTANSVARLIG

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SUMMARY/ SAMMENDRAG

Zone A, 780- 930m: Poor source rock potential for gas. Immature type IV kerogen.
Zone B, 930-1020m: As above.
Zone C, 1050-1200m: No source rock potential. Immature type IV kerogen.
Zone D, 1225-1320m: Fair potential for gas towards base of the zone. Immature type III kerogen.
Zone E, 1320-1350m: Rich potential for oil and gas. Immature type II/III kerogen.
Zone F, 1350-1570m: Predominantly sandstones. Minor amounts of claystones with rich potential for gas and oil. Immature type II/III kerogen.
Zone G, 1570-1840m: As above, but slightly more mature type III kerogen.
Zone H, 1840-1870m: Rich potential for gas. Immature, type III kerogen.
Zone I, 1870-1945m: Good potential for gas. Immature type III kerogen.
Zone J, 1945-2170m: Predominantly sandstones. No potential as source rock.
Zone K, 2170-2374m(T.D.): No potential as source rock.

KEY WORDS/ STIKKORD

Source rock	Evaluation
Potential	Maturity

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1. INTRODUCTION

Analyses by common organic geochemical methods were carried out on cuttings samples and sidewall cores in addition to three coals, for source rock evaluation of the well 31/3-1 from the Troll field. Total depth of this well is 2374m. A list of the formations penetrated by the well is given below, together with the number of samples from the various sections analysed.

A total of 40 cuttings samples were analysed by screening methods. Based on the results of these analyses Statoil selected the samples to be used for the follow up analyses.

Era	Age	Formations	Groups	Formation tops	Screening	Vitr./Ker.	Extr.
Tertiary			Hordaland	541			
		Balder	Rogaland	931	9(+2)	3	-
		Sele		1038			
		Lista		1162			
U. Cretaceous				1225			
	Cenomanian			1272	.2(+2)	3	1
U. Jurassic		Draupne	Humber	1320			
		Sognefjord		1351			
		U. Heather		1497	14(+3)	11	6
M. Jurassic		Fensfjord		1516			
		Krossfjord		1668			
		Tarbert	Brent	1796	5(+3)	6	2
		Ness		1805			
L. Jurassic		Cook	Dunlin	1945			
		Statfjord		2105	5(+1)	3	-
Triassic		Cormorant		2160			
T.D.				2374	5(+1)	2	-

2. EXPERIMENTAL AND DESCRIPTION OF INTERPRETATION LEVELS

2.1 Headspace Gas Analysis

One ml. of the headspace gas from each of the cans was analysed gas chromatographically for light hydrocarbons. The results are shown in Table 1a. The canned samples were washed with temperated water on 4, 2, 1 and 0.125 mm sieves to remove drilling mud and thereafter dried at 35^{O}C.

2.2 Occluded Gas

An aliquot of the 1-2 mm fraction of each sample before drying was crushed in water using an airtight ball mill, and one ml. of the head-space analysed chromatographically. The results are shown in Table 1b.

The composite gas data are also plotted and shown in enclosure 1.

2.3 Total Organic Carbon

Bulk samples were crushed in a centrifugal mill. Aliquots of the samples were then weighed into Leco crucibles and treated with hot 2N HCl to remove carbonate, and washed twice with distilled water to remove traces of HCl. The crucibles were then placed in a vacuum oven at 50^{O}C and evacuated to 20mm Hg for 12 hrs. The total organic carbon (TOC) content of the dried samples was determined using a Leco EC12 carbon analyser.

2.4 Rock-Eval Pyrolysis

Crushed sample (100mg) was weighed into a platinum crucible the base and cover of which are made of sintered steel, and analysed on a Rock-Eval pyrolyser.

2.5 Extractable Organic Matter

Powdered rock was extracted by a flowblending for 3 minutes using dichloromethane (DCM) as solvent. The DCM used was of organic geochemical grade and blank analyses showed the occurrence of negligible amounts of contaminating hydrocarbons.

Activated copper fillings were used to remove any free sulphur from the samples.

After extraction the solvent was removed on a Buchi Rotavapor and the amount of extractable organic matter (EOM) was determined.

2.6 Chromatographic Separation

The extractable organic matter (EOM) was separated into saturated fraction, aromatic fraction and non hydrocarbon fraction using a MPLC system with hexane as eluant (Radke et al., Anal. Chem., 1980). The various fractions were evaporated on a Buchi Rotavapor and transferred to glass vials and dried in stream of nitrogen.

2.7 Urea adduction

Urea-adduction was performed on the same samples that were analysed on GC-MS. The sample containing 5 mg of n-alkanes was dissolved in 2 ml of n-hexane and 1 ml of acetone was added. A saturated solution of urea in methanol (1 ml) was then added dropwise. The solvent was removed (N_2) and the adduction step repeated twice. The white crystals were rinsed (3x5ml hexane) and the combined extract filtered (cotton wool plug covered with Al_2O_3), to afford a non-adduct. GC analyses were performed on the samples after the urea adduction, using the same conditions as for the other GC analyses.

2.8 Gas Chromatographic Analysis

The saturated hydrocarbon fractions were each diluted with n-hexane and analysed on a HP 5730A gas chromatograph, fitted with a 25m OV-101 fused silica capillary column. Hydrogen (0.7ml/min) was used as carrier gas.

The total aromatic fractions were after dilution with n-hexane, analysed on a Carlo Erba Fractovap Series 2150 GC fitted with a 20mm SE-54 fused silica column.

The data processing for all the GC analyses was performed on a VG Multichrom System.

2.9 Pyrolysis gas chromatography (Py-GC; 600°C)

Flash Py-GC (600°C/5sec.) was performed by using a Chemical Data Systems (CDS) Pyroprobe 120 and a platinum ribbon probe. The pyrolysis system was interfaced to a Varian 3700 gas chromatography via a laboratory constructed interface/splitter. Finely ground solvent extracted whole rock or kerogen concentrate samples were suspended in methanol and added to the ribbon probe with disposable Pasteur pipettes. The sample was flash pyrolysed and the pyrolysis gases were passed through the interface/splitter and analysed under the GC conditions given below.

Instrumental conditions:

Pyrolysis:	600°C for 5sec. in nitrogen (30 ml/min.). Ramp in off position (final temperature is reached in ca. 10msec.)
Column:	25m x 0.3mm I.D. fused silica capillary coated with SE30.
Carrier gas:	Nitrogen with inlet pressure 6psi.

Sample split ratio : 1 : 30.
Oven temperature program: 40°C/1min. to 270°C at 4°C/min.

2.10 Vitrinite Reflectance

Vitrinite reflectance measurements of 4 of the samples, were done. The samples were mounted in Bakelite resin blocks; care being taken during the setting of the plastic to avoid temperatures in excess of 100°C. The samples were then ground, initially on a diamond lap followed by two grades of corundum paper. All grinding and subsequent polishing stages in the preparation were carried out using isopropyl alcohol as lubricant, since water leads to the swelling and disintegration of the clay fraction of the samples.

Polishing of the samples was performed on Selvyt cloths using three grades of alumina, 5/20, 3/50 and Gamma, followed by careful cleaning of the surface.

Reflectance determinations were carried out on a Leitz M.P.V. microphotometer under oil immersion, R.I. 1.518 at a wavelength of 546 nm. The surface of the polished block was searched by the operator for suitable areas of vitrinitic material in the sediment. The reflectance of the organic particle was determined relative to optical glass standards of known reflectance. Where possible, a minimum of twenty individual particles of vitrinite was measured.

The samples were also analysed in UV light, and the colour of the fluorescing material determined. Below, a scale comparing the vitrinite reflectance measurements and the fluorescence measurements is given.

VITRINITE REFLECTANCE	0.20		0.30	0.40	0.50	0.60	0.70	0.80	0.90		1.00	1.10
R.AVER. 546 NM	1516											
% CARBON CONTENT DAF.	57		62	70	73	76	79	80.5	82.5		84	85.5
LIPTINITE FLUOR NM	725	750	790	820	840		860	890		940		
EXC. 400 nm BAR. 530 nm colour	G	G/Y	Y	Y/O	L.O	M.O.		D.O.		O/R		R
zone	1	2	3	4	5	6		7		8		9

<u>NOTE</u>: Liptinite NM = Numerical measurements of overall spore colour and not peak fluorescence wavelength.

Relationship between liptinite fluorescence colour, vitrinite reflectance and carbon content is variable with depositional environment and catagenic history. The above is only a guide. Liptinite will often appear to process to deep orange colour and then fade rather than develop or O/R red shade. Termination of fluorescence is also variable.

2.11 Processing of Samples and Evaluation of Visual Kerogen

Crushed rock samples were treated with hydrochloric and hydrofluoric acids to remove the minerals. A series of microscopic slides contain strew mounts of the residue:

<u>T-slide</u> represents the total acid insoluble residue.
<u>N-slide</u> represents a screened residue (15 mesh).
O-slide contains palynodebris remaining after flotation ($ZnBr_2$) to remove heavy minerals.
<u>X-slides</u> contain oxidized residues, (oxidizing may be required to

remove sapropel which embeds palynomorphs, or where high coalification prevents the identification of the various groups).

T and/or O slides are necessary to evaluate kerogen composition/-palynofacies which is closely related to sample lithology.

Screened or oxidized residues are normally required to concentrate the larger fragments, and to study palynomorphs (pollen, spores and dinoflagellates) and cuticles for paleodating and colour evaluation.

So far visual evaluation of kerogen has been undertaken from residues mounted in glycerine jelly, and studied by Leitz Dialux in normal light (halogene) using x10 and x63 objectives. By x63 magnification it is possible to distinguish single particles of diameters about 2 and, if required, to make a more refined classification of the screened residues (particles >15μ).

The colour evaluation is based on colour tones of spores and pollen (preferably) with supporting evidence from colour tones of other types of kerogen (woody material, cuticles and sapropel). These colours are dependant upon the maturity, but are also influenced by the paleo-environment (lithology of the rock, oxidation and decay processes). The colours and the estimated colour index of an individual sample may therefore differ from those of the neighbouring samples. The techniques in visual kerogen studies are adopted from Staplin (1969) and Burgess (1974).

In interpretation of the maturity from the estimated colour indices we follow a general scheme that is calibrated against vitrinite reflectance values (R_0).

Ro	0.45	0.6	0.9	1.0	1.3
colour index	2-	2	2+	3-	3
Maturity intervals	Moderate mature	Mature (oil window)			Condensate window

3. RESULTS AND DISCUSSION

On the basis of mainly lithological variations the sequence analysed (780-2374m) was divided into 11 zones.

Zone A: 780-930m
Zone B: 930-1020m
Zone C: 1050-1200m
Zone D: 1225-1320m
Zone E: 1320-1350m
Zone F: 1350-1570m
Zone G: 1570-1840m
Zone H: 1840-1870m
Zone I: 1870-1945m
Zone J: 1945-2170m
Zone K: 2170-2374m (T.D.)

In the following each method will be discussed separately zone by zone.

3.1. Light hydrocarbon analysis and lithology

Light hydrocarbon values (µl/kg rock) are classified as follows:

C_1-C_4	C_5+		
<1000	<1000	:	poor source rock
1-3000	1-3000	:	fair source rock
>3000	>3000	:	good-rich source rock

Zone A; 780-930m: The dominant lithology in this zone which is the lower part of the Hordaland Group is light greenish grey claystone. Some dark brown claystone is encountered in two of the three samples. This is probably caved material from higher up in the well. Methane is the dominant light hydrocarbon present, the abundance varying from fair to rich. No C_3+ hydrocarbons were encountered in any of the samples.

Zone B; 930-1020m: Tuff is dominant in the two samples from this zone which is part of the Balder formation. In addition small amounts of light greenish claystones are encountered, probably caved from the zone above. The abundance and distribution of light hydrocarbons are similar to what was seen in zone A.

<u>Zone C; 1050-1200m</u>: In this zone, covering the lower part of the Tertiary section in this well, various claystones represent the main lithology. From the light greenish-grey claystone at the top of the zone, the main claystone type changes to more brownish-grey at the base. There is a slightly lower abundance of methane, but it is still the dominant compound, the wetness of the gas is therefore higher in this zone.

<u>Zone D; 1225-1320m</u>: Grey to dark grey claystones and marl dominate in this zone which is the Upper Cretaceous and samples contain good amounts of light hydrocarbons. Towards the base of the zone increased abundance of C_3+ hydrocarbons are encountered. The increased values for the wetness of the gas, indicate that the gas is catagenic. The iC_4/nC_4 is approximately 1.0, suggesting that the gas is immature.

<u>Zone E; 1320-1350m</u>: This zone covers only 30m of the top of the Upper Jurassic section and consists of dark grey claystone and some marl. The marls toward the base of the zone are believed to be caved material. Very rich abundances of light hydrocarbons from methane to C_5+ are encountered. The wetness is higher than in zone D and is probably generated in situ in part, and/or is due to migrated hydrocarbons. While the iC_4/nC_4 suggests hydrocarbons of relatively low maturity or biodegradation.

<u>Zone F; 1350-1570m</u>: The top part of this zone (which includes the rest of the Upper Jurassic and top Middle Jurassic) is dominantly sandstones, varying from fine to very coarse. Deeper down in the zone approximately equal parts of sandstone and grey to dark grey claystone are seen. The whole zone is rich in light hydrocarbons, the very high wetness of these migrated hydrocarbons in sandstones is probably due to greater loss of C_1-C_3 relatively to higher molecular weight compound before samples were sealed in cans. Increasing values of iC_4/nC_4 indicate low maturity or biodegradation.

<u>Zone G; 1570-1840m</u>: Sand and sandstones, varying from fine to very coarse as above, are the main components of this zone, which covers the main part of the Middle Jurassic. Coal and dark grey claystone are seen

in a swc at 1603.36m and towards the base of the zone. Very rich abundances of light hydrocarbons were encountered at the base of the zone, and coupled with the high wetness, this indicates migrated gas in the sandstones. The iC_4/nC_4 decreases downwards, suggesting probably lower microbiological activity or less likely increased maturity relative to the zone above.

Zone H; 1840-1870m: *Only one sample was analysed from this zone* (Ness formation). It consists of sand/sandstone and some silty claystone and coal. The characteristics of the hydrocarbons are similar to the zone above, but in lower abundance.

Zone I; 1870-1945m: The cuttings samples from this zone (bottom part of the Ness formation) consist of casing cement and coal which is believed to be an additive. Two sidewall cores from the interval were found to contain medium grey silty claystone, and this is probably the representative lithology in the zone. The gas distribution was similar to above.

Zone J; 1945-2170m: This zone covering the Lower Jurassic Dunlin and Statfjord Groups, consists of 90-100% sandstone. Small amounts of coal and light grey silty claystone are seen occasionally. The amount of light hydrocarbons decreases from the top of the zone down to approximately the boundary between the Dunlin and Statfjord Groups, where the abundance is high again. The iC_4/nC_4 is high, and the wetness is lower than zone I, with the lowest value at 2110m.

Zone K; 2170-2374m (TD): The Triassic red beds section of the well, consists mainly of different types of claystones. Light greenish-grey and reddish-grey to reddish-brown claystones are seen, with the reddish-brown variety becoming predominant towards the base. Only very low amounts of gas were detected and methane is the main component in this zone.

3.2 Total Organic Carbon

Where shales or claystones constitute 10% or more of a sample they were picked and analysed. Occasionally silty claystones constituting less than 10% were picked and analysed. Sandstones and marl were generally not analysed. In addition to the cuttings samples, sidewall cores and some coal samples were analysed. The classification used for the TOC data is as follows:

<0.5%	:	poor source rock
0.5-1.0%	:	fair source rock
1.0-2.0%	:	good source rock
>2.0%	:	rich source rock

Zone A; 780-930m: The claystones from this zone show fair to good TOC values for two of the three analysed samples. Only poor TOC content was seen in the sample at 915-930m.

Zone B; 930-1020m: The tuff samples showed good TOC values.

Zone C; 1050-1200m: The main lithology in this zone, the greenish grey claystones, shows fair to good TOC abundances.

Zone D; 1225-1320m: The TOC values increase downwards from fair at the top to rich towards the base. This increase was seen at approximately the depth where the C_5+ hydrocarbons were prominent.

Zone E; 1320-1350m: Rich TOC values were seen for the dark grey claystone which is the dominant lithology.

Zone F; 1350-1570m: Only the grey to dark grey claystones were analysed from this zone, which was dominated by sandstones. All the analysed samples have rich TOC values, but since they constitute only a minor part of the lithology the zone as a whole can not be said to have any great source rock potential.

Zone G; 1570-1840m: This section of the well is dominated by sandstones. Rich TOC values were recorded for minor carbonaceous claystones which were analysed.

Zone H; 1840-1870m: The grey to dark grey claystone in this zone showed rich TOC values. A certain amount of coal may be the reason for the increased value here compared to the zone above.

Zone I; 1870-1945m: Only medium grey silty claystones in two sidewall cores showing good abundances of TOC were analysed in this interval in which the cuttings consist mostly of casing cement and additives.

Zone J; 1945-2170: The light grey silty claystones in this zone showed TOC values decreasing from good at the top to fair at the base of the zone. Sandstones which are the main lithology in the zone were not analysed.

Zone K; 2170-2374m (TD): Both the greenish grey and the reddish brown claystones from this zone were analysed. Poor TOC values were recorded for all the samples.

3.3 Rock-Eval pyrolysis

Twenty-four cuttings samples, nine sidewall cores and three coals were analysed by Rock-Eval pyrolysis for evaluation of the source rock potential in this well. The following classification is used:

Petroleum potential
($S_1 + S_2$)

<1	:	Poor source rock potential
1-5	:	Fair source rock potential
>5	:	Good source rock potential

Zone A; 780-930m: The whole zone shows very low hydrogen indices (HI) and low, but varying oxygen indices (OI). A hydrogen-poor type IV kerogen is seen throughout the zone. Petroleum potential is low for all the analysed samples, implying poor potential for oil and gas in this zone. The T_{max} values are very variable, the lowest values indicating the presence of asphaltenes or bitumen. The highest values indicate that the zone is immature. A high value for the production index is seen for the lowermost sample, possibly implying migrated hydrocarbons. This fits in well with the low T_{max} value for this sample. However, the variations in T_{max} and production indices may also reflect the unreliability of values due to the generally low abundance of organic carbon and hydrocarbons respectively.

Zone B; 930-1020m: The two samples which were analysed are very similar to the samples in zone A. Immature hydrogen-poor kerogen is present in this zone.

Zone C; 1050-1200m: Type IV kerogen of low maturity is present in all samples. The two top samples in this zone have higher petroleum potentials than the rest of the samples from this zone. Petroleum potential and production indices are similar to those in the zones above. The very small S_2 values are probably the reason for the very low T_{max}-values and the high production indices in the lower three samples. From the light hydrocarbon results no great abundance of migrated hydrocarbons should be expected in this zone.

Zone D; 1225-1320m: The kerogen type improves in this zone, from type IV kerogen in the top sample similar to the zones above, to a more hydrogen rich type III kerogen in the lower samples. The improved petroleum potential (fair) is in good agreement with the TOC values. From the T_{max} values the zone is immature.

Zone E; 1320-1350m: Improved kerogen type is seen in this zone. The two samples were seen to have a mixed type II/III kerogen, thus having a potential as a source rock for gas and oil (mostly condensate). The swc (claystone) from 1347.5m contains poorer quality kerogen (ie. type III) indicating that the quality in this section is not uniformly type II/III. The low production indices suggest no migrated or generated hydrocarbons, while the T_{max} values indicate that the zone is immature, but possibly of slightly higher maturity than the zone above.

Zone F; 1350-1570m: All the claystones from this zone consist of mixed type II/III kerogen, with a rich potential as source rock for gas and oil. The T_{max} values assign the zone as immature. The coals showed characteristics of type III kerogen, with very low T_{max} values compared to the claystones at the same depth. This is unusual since generally coals show higher T_{max} values to type II and II/III kerogens of similar maturity. Low production indices suggest that no migrated or generated hydrocarbons are present.

Zone G; 1570-1840m: Claystones from this zone contain type III kerogen with slightly higher T_{max} values than above. The coal from this zone gave very high value for the HI, possibly indicating that the coal is rich in exinite macerals while the T_{max} value is similar to that for the overlying coals, being very much lower than the claystones.

Zone H, 1840-1870m: Only one sample from this zone was analysed. The high value for the HI may be due to contamination by some coal (see discussion on TOC results). Thus the claystone in this zone may be similar to that in the zone above.

Zone I; 1870-1945m: Only two sidewall cores from this zone were analysed. The kerogen is at best type III and the claystones are immature even at this depth.

Zone J; 1945-2170m: Very hydrogen-poor kerogen is seen throughout the zone. The T_{max} values are slightly higher (i.e the kerogens are more mature) than the zones above, but not oil window mature (only moderate mature).

Zone K; 2170-2374m (TD): Two claystones in this zone which were analysed have no S_2 peak and therefore have no source rock potential.

3.4 Extractable organic matter and saturated hydrocarbons

Nine samples, four cuttings and five sidewall cores, were extracted for evaluation of the source rock potential of the well. Generally low weights of the samples could be extracted, and this resulted in very low absolute amounts of extractable organic matter, in particular of the swc's. Thus the extraction data should only be applied to support conclusions based on other analyses. Tables 4-7 show the distribution of the various chromatographic fraction, while Table 8 gives the ratios calculated from GC chromatograms.

Source rock classification based on the amount and composition of bitumen:

Extractable organic matter (EOM in ppm)

<100ppm	:	Poor source rock
100-200m	:	Fair source rock
200-500ppm	:	Good source rock
>500ppm	:	Rich source rock

Extractable hydrocarbons (EHC in mgs per gram TOC)

<10mgs/g	:	Poor source rock
10-20mgs/g	:	Fair source rock
20-100 mgs/g	:	Good-rich source rock
>100mgs/g	:	Stain (depends on the kerogen type, type I kerogens can yield more than 100mgs/g

Zones A-C; 780-1200m: No samples from any of these zones were extracted.

Zone D; 1225-1320m: One claystone sample (A-9536) was extracted from this zone. The sample contain fair amounts of extractable organic matter (EOM). Approximately 70% of the EOM are hydrocarbons and the SAT/ARO ratio equals one in this sample.

The chromatogram of A-9536 shows a bimodal n-alkane distribution with maxima at nC_{17} and nC_{28}. Pristane is the most abundant hydrocarbon and the pristane/phytane ratio is 2.0. The high molecular weight n-alkanes elute on top of an unresolved hump, together with other unidentified compounds. The low value for CPI (0.7) is probably erroneous, since it is possible that the nC_{26}-nC_{28} alkanes coelute with other components. This becomes more apparent by looking at the chromatogram of the branched/cyclic hydrocarbons. The high content of complex compounds in the high molecular weight range is typical of samples of low maturity.

Zone E; 1320-1350m: Two swc's and one cuttings sample from the top of the Upper Jurassic were seen to contain good abundances of EOM and of hydrocarbons. The high relative abundance of hydrocarbons in the two swc's could be due to the generally low absolute amounts of the chromatographic fractions. From the low Rock-Eval production indices migrated hydrocarbons, that could have caused increased relative abundance of hydrocarbons are not likely. The SAT/ARO ratios are approximately one in all three samples. The GC traces of the three samples are all fairly similar. The isoprenoids are very prominent, pristane/-phytane ratios vary from 0.7 to 0.8, and the high molecular weight n-alkanes are the most abundant. Values of 1.6 and 1.7 for CPI indicate immature samples. The complex pattern of peaks in the nC_{25}-nC_{30} range represents steranes and triterpanes, and this is also characteristic of immature samples. The branched/cyclic GC's show this pattern of steranes and triterpanes more clearly.

Zone F; 1350-1570m: Two cuttings samples from this zone covering the bottom of the Upper Jurassic and the top of the Middle Jurassic, contain rich abundances of extractable organic matter. The relative amounts of hydrocarbons vary from 60% in the shallowest (A-9551) to only 15% in the deepest (A-9552). This difference could have been caused by difficulties encountered in the work-up procedure, the EOM seems too high in sample A-9552. The SAT/ARO ratios are of the same magnitude as in the zones above, supporting the indications from Rock-Eval production indices about no migrated hydrocarbons.

The chromatograms of the two samples show very different peak patterns. Sample A-9551 showed a bimodal profile with maximum at nC_{15} and a second maximum at nC_{29}. The isoprenoids are still relatively prominent in this sample, and a CPI of 1.7 represents immature hydrocarbons. Migrated hydrocarbons in any great extent should not be expected in this sample, according to the Rock-Eval production index (0.05). Thus the change in the saturated GC to what is seen for A-9551 would indicate a higher input of type II kerogen in this sample. However, almost no difference in HI is seen between the two samples, and it is most likely that the prominent, lighter n-alkanes represent migrated hydrocarbons, although it has not affected the production index. A similar n-alkane profiel was seen in a sandstone core from the same depth interval. This core sample (at 1406.22m) has been analysed and reported elsewhere (Schou et al., IKU-report 05.0198/2/83). The branched/cyclic trace shows the same relative distribution as in the zones above. Sample A-9552 was seen to contain only very small amounts of saturated hydrocarbons, and not much can be concluded from the GC trace.

Zone G; 1570-1840m: Two swc's, one coal (A-9611) and one claystone (A-9612), were extracted from the Middle Jurassic part of the well. The coal showed very rich abundance of EOM and of hydrocarbons. When normalised to TOC the values are only fair. The relative amount of hydrocarbons is high, but again the weights of the chromatographic fractions are low, and thus the calculated ratios may be erroneous. For the claystone sample the extractability is good, but again the weights are low, and inaccuracies in weighing such low amounts is probably the reason why the hydrocarbons in this sample apparently amount to 100%. The SAT/ARO ratios are low in both samples in this zone.

The GC chromatograms support what was said above about low abundance of hydrocarbons. Very poor chromatograms were acquired.

Zone H; 1840-1870m: No samples from this zone were extracted.

Zone I; 1870-1945m: One swc was extracted from this zone. It showed good abundance of EOM and 100% hydrocarbons. As above this seemingly high hydrocarbon abundance is probably caused by the difficulty in weighing such small quantities. The GC trace of this sample was better than for the samples above, with a maximum at nC_{29} and a CPI of 1.3. Pristane is very abundant (Pr/nC_{17}=2.5 and Pr/ph=3.9). Immature hydrocarbons are thus also encountered in this sample.

Zone J-K; 1945-2374m (T.D.): No samples from these zones were extracted.

3.5 Aromatic hydrocarbons

The aromatic hydrocarbon GC's generally mirror the problems encountered in obtaining enough material of the aromatic fractions. Some trends can, however, be revealed from the traces, and the samples will be discussed according to the zones above.

Zones A-C; 780-1200m: No samples from any of these zones were analysed.

Zone D; 1225-1320m: The sample from this zone, A-9536, shows a complex pattern of aromatic hydrocarbons both in the low and high molecular weight range. In the complex pattern typical of immature sediments alkylated naphthalenes and phenanthrenes can be seen. The relative intensity of the two doublets of methylphenanthrenes (MP in Figure 3) indicates immature hydrocarbons.

Zone E; 1320-1350m: The two swc's in this zone show poor chromatograms of aromatic compounds. Some problems with the separation can be seen for sample A-9610 where contamination by n-alkanes (*in Figure 3) is obvious. All three samples seem to have abundant aromatic steranes, and the relative amount of naphthalenes is higher than of phenanthrenes.

Zone F; 1350-1570m: As seen for the saturated hydrocarbons the two samples from this zone showed very different behaviour. A-9551 contain very abundant naphthalenes typical of mature samples with a high input of light components. Sample A-9552 gave a very poor GC trace with one dominating peak in the high molecular weight range. Whether this peak represents genuine aromatic sterane or is due to contamination can not be said from GC chromatogram.

Zone G; 1570-1840m: The coal sample in this zone shows a complex, although relatively clear, pattern of aromatic compounds in the low molecular weight range. In addition to alkylated naphthalenes and phenanthrenes, compounds like biphenyls and other polyaromatic hydrocarbons are tentatively identified. Almost no aromatic steranes are seen in this chromatogram. The other sample from this zone exhibit an even more complex distribution, where the total abundance seems to be decreased and very little information is revealed.

Zone H; 1840-1870m: No samples from this zone were analysed.

Zone I; 1870-1945m: The sample analysed from this zone showed a similar pattern to the lowermost sample in zone G above. The peak intensities in the methylphenanthrenes are typical of samples of relatively low maturity.

Zones J-K; 1945-2374m (T.D.): No samples from these zones were analysed.

3.6 Pyrolysis-gas chromatography (Py-GC; 600°C)

Ten solvent-extracted whole rock samples were analysed by flash Py-GC. The instrumental conditions are described in the experimental section. The peaks are identified on the basis of retention and mass spectrometric data of other kerogens.

Peak identities: 1=toluene; 2=(m+p)-xylenes; 3=o-xylene; 4=C_3-alkylbenzenes and phenol (P); 5=C_4-alkylbenzenes and methylphenols (C_1P); 6=Methylindane/-indene, C_4- and C_5-alkylbenzenes, dimethylphenols and naphthalene; 7=C_{13}-alkene/alkane and C_1-alkylnaphthalenes; 8=C_{14}-alkene/alkane and C_2-alkylnaphthalenes; 9=prist-1-ene and 10=prist-2-ene.

A-9536 (1290m): The pyrogram shows an n-alkene/n-alkane homology ranging from C_7 to C_{27}. The abundance of aromatic compounds is high indicating an input of material from higher plants, i.e. the pyrogram shows a type III kerogen fingerprint. (Note increase of instrument sensitivity after C_7).

A-9540 (1350m): The pyrogram shows an n-alkene/n-alkane homology ranging from C_7 to C_{27}. The relative abundance of aromatics are lower and the aliphatic homology is more pronounced than in A-9536 suggesting a higher input of lipid material. the pyrograms shows a mixed type III/II kerogen fingerprint.

A-9551 (1455m): The pyrogram is almost identical to A-9540, i.e. a mixed type III/II kerogen fingerprint.

A-9552 (1540m): The pyrogram is overall very similar to A-9540; i.e. a mixed type III/II kerogen fingerprint. (Note change of sensitivity after C_7).

A-9611 (1603,36m): The pyrogram shows a very high abundance of aromatic compounds and only low molecular weight (C_7-C_9) n-alkenes/n-alkanes are detectable. The high abundance of phenol and alkylphenols is characteristic for materials derived from higher plants, e.g. vitrinites and coaly material.

A-9609 (1327.5m): The pyrogram shows an n-alkene/n-alkane homology ranging from C_7 to C_{27}. The abundance of aromatics is relatively high indicating an input of material from higher plants. The pyrogram is overall very similar to A-9540, i.e. a mixed type III/II kerogen fingerprint.

A-9610 (1347.5m): The pyrogram shows an n-alkene/n-alkane homology ranging from C_7 to C_{27}. The relative abundance of aromatics is higher than in A-9609 suggesting a higher input of terrestrial plant material. The pyrogram shows a type III kerogen fingerprint.

A-9612 (1830m): The pyrogram shows an n-alkene/n-alkane homology ranging from C_7 to C_{27}. The relative abundance of aromatic compounds is high especially phenols (peaks P and C_1P) which is characteristic for material derived from higher plants. The pyrogram shows a type III kerogen fingerprint. (Note change of sensitivity after C_9.)

A-9613 (1890m): The pyrogram shows an n-alkene/n-alkane homology ranging from C_7 to C_{26}. The abundance of aromatics is relatively high. The pyrogram is very similar to A-9610, i.e. a type III kerogen fingerprint.

3.7 Examination in reflected light

Twenty-eight samples were chosen over the depth range 840-2335m in well 31/3-1. Depending on the lithological description some samples were selectively picked whilst others represent bulk cuttings samples. For the cuttings samples that were picked plus the core and sidewall core samples the results can only be representative of that lithology. No additional information was available to confidently assess the possibilities of cavings or the reliability of a given lithology being in-situ for this reported depth interval. Because of this the maturity trends postulated here need to be projected onto to a detailed stratigraphy so that anomalous results can be excluded. In this respect a particular problem arose with "coal" samples. With cuttings samples it is very difficult to know if a coal which may only represent 10% of any sample is actually an in-situ lithology or, as is often the case, a component of the drilling mud. However, because of the nature of vitrinite reflectance analysis any coal that is in-situ should be analysed.

Some core and sidewall core samples which were described as "coal" were analysed. These were very difficult to prepare being of very low rank and soft and therefore would not take up a good polish. However, the results of the samples from 1371.54m (A-9618), 1402.33m (A-9619) and 1603.36 (A-9611) are very low. Despite a poor polish on these samples it is presumed that if in-situ these "coals" (they are actually more like a vitrinite-lignite or even a massive bitumen) must represent a maximum maturity at these depths of 0.3-0.35% Ro!. Some cuttings samples between 1402.33m and 1603.36m give results suggesting ~0.4-0.45% Ro but in all of these samples the vitrinite is poor quality and more like reworked material. It is noticeable that although the above mentioned "coals" are from core and sidewall core samples, from the cuttings descriptions between 1371.54m and 1603.36m no coal is observed - if the "coals" are in-situ at least traces might be expected in the cuttings samples. Only sample A-9540 (1335-1340m) above the zone contains "small amounts" of "lignite" and sample A-9556 (1630-1645m) below the zone contains "small amounts" of "coalified wood".

Formation top and Rock-Eval data indicate that the Upper down to Middle Jurassic claystones contain type II/III or type III kerogens. That is between approximately 1300m and 1600m the approximate limiting zone of the core and sidewall core "coals") which would fall into the Sognefjord and Fensfjord formations of Kimmeridgian and Oxfordian age. This could be taken as indicating that the "coals" are in-situ but represent the massive bitumen/lignitic deposits of low maturity as observed elsewhere in shallow Kimmeridge-Oxfordian organic rich deposits.

Fluorescence analysis of the same samples appears to be in good agreement with the vitrinite reflectance as it indicates lower maturities though most samples contain more than one "level" of fluorescence. If a generalised picture is taken trying to exclude possible cavings/bitumen and reworked material the sequence is of immature to moderate maturity throughout. it is doubtful if any of the analysed sequence has reached even top oil window maturity from this data.

The analysed samples are described below and a table of maturity data together with vitrinite reflectance histograms can be found elsewhere.

A-9506, 825-840m: Mixed claystones, Ro = 0.31(8)
There is a low organic content - dominantly bitumen wisps and light staining. The phytoclast content is dominated by bitumen and very small reworked vitrinite fragments. Possible primary vitrinite is sparse and poor. Green fluorescence is seen from spores and dinoflagellates.

A-9605, 1070m: Claystone, Ro = 0.33(1) and 0.61(8)
There is a low organic content - again dominantly bitumen wisps and a light bitumen staining. The phytoclast content is dominantly reworked vitrinite. There is possibly only one primary vitrinite fragment observed as the higher population recorded is reworked. Green fluorescence is observed from unidentified fragments and from spores.

A-9606, 1192m: Claystone, Ro = 0.43(1) and 0.62(3)
This is a very soft lithology, difficult to polish. The sample is almost barren of organic material and contains only a few very small inertinite or reworked vitrinite particles and occasional bitumen fragments. Only one possible primary vitrinite is recorded. Green and green/yellow fluorescence is observed from unidentified fragments.

3.8 Analyses in transmitted light

The sedimentary organic matter of well 31/3-1 has been analysed on the basis of 25 samples between 825m and 2325m.

The organic material is characterised by the very low level of maturity for all samples above 2000m. TAI 1 to 1/1+ or 1+.

The organic material was evaluated as dominantly derived from terrestrial sources. Woody material being the most important, but with increase of cuticules or pollen, spores and dinoflagellates, especially at levels 1327.5m swc, 1347.5m swc, the intervals 1440-1540m, and 1830-1870m.

A special feature of this well is the presence in the residues of granules of amorphous substance which was evaluated as degraded woody material.

Description of samples

A-9506, 825-840m: Loose aggregates of dominantly amorphous material, embedding strongly degraded woody material and palynomorphs which are fairly well preserved.
Colour index: 1 - 1/1+

A-9515, 960-975m: Loose aggregates as above, but with a major input of thin flimsy sheets, believed to be of cuticular nature. Woody structured particles show traces of hyphae and have very thin walls. Palynomorphs are fairly well preserved (pollen, spores and cysts).
Colour index: 1 - 1/1+

A-9605, 1070m: Woody material dominates as granules of degraded material in loose amorphous aggregates and as structured woody particles. The woody cells have very thin walls and traces of hyphae between them. The palynomorphs are variably well preserved.
Colour index: 1 - 1/1+

A-9606, 1192m: Small residue, grey amorphous with dominantly woody material, partly reworked and oxidised fragments. Palynomorphs are of variably poor preservation.

Colour index: 1/1+

A-9607, 1225m: A very small residue of grey amorphous character. Acid resistant minerals cannot be confidently distinguished from amorphous material. Variably poor preservation.
Colour index: 1 - 1/1+

A-9608 and A-9636, 1267m, swc, 1275-90m: Grey amorphous material embed a major woody element, degraded particles and reworked/oxidised woody material. Well preserved cysts.
Colour index: 1- 1/1+

A-9609 and A-9540, 1327.5m swc, 1335-50m: Aggregates of material. Thin sheets and palynomorphs have adhering nonstructured granules of degraded material, evaluated as of woody origin and the dominant type. Palynomorphs are thinwalled.
Colour index: 1 - 1/1+

A-9610, 1347.5m: Very loose aggregates embedding palynomorphs and woody more or less degraded material. Pale palynomorphs as for the samples above.
Colour index: 1/1+

A-9618 and A-9619, 1371.54m and 1402.33m cores: Coaly fragments dominate and are of low rank.
Colour index: No determination was possible due to lack of suitable palynomorphs.

A-9545, 1410-45m: A sparse residue resembling level 1335-50m above in content of very thin sheets of material (?cuticles) with adhering degraded granules of material.
Colour index: 1 - 1/1+

A-9551, A-9548, A-9549 and A-9552, 1440-1540m: Cuticles are dominant only in A-9552 but sheets of cuticular nature are consistent and dominate together with a major woody input in other samples. There is strong biodegradation and palynomorhps are obscured by adhering material.
Colour index: 1 - 1/1+

A-9611, 1603.35m core: Coaly particles of strongly degraded "granulate" appearance. The material reminds of the cuttings samples at about 1400 metres.
Colour index: No determination was possible.

A-9612 and A-9570, 1830-1870m: The organic material has dominantly terrestrial sources. The two samples differ from each other in the better preservation and higher content of cuticles, spores and pollen in the lower sample (mildly oxidative conditions).
Colour index: 1/1+

A-9613, A-9614, A-9615 and A-9616, 1890-2325m: The residues are very small, strongly sorted and dominated by dark coaly (inertinitic) fragments. Contaminations from caved lithologies were suspected.
Colour index: 1/1+

A-9577, 1960-75m: This sample is situated within the 1890-2325m interval described above, but reflects different conditions. A varied terrestrial assemblage dominates and includes pollen, spores, well preserved cuticles, resinous bodies. Resemblance with A-9570, 1855-1870m.
Colour index: 1/1+, 1+

4. CONCLUSIONS

4.1 Source rocks, richness, type and hydrocarbon potential

The Tertiary sequence of this well which was analysed (780-1225m) was subdivided into three zones. The total organic carbon values for the claystones in this section vary between 0.2 and 1.2% (average 0.84%) and the Rock-Eval petroleum potential has a maximum value of 0.7. Type IV kerogen is seen throughout the whole Tertiary section. Thus this has a very poor source rock potential.

The type of organic matter improves downwards in the Upper Cretaceous sequence (1225-1320m). The claystones in this zone (zone D) show good - rich TOC values (generally greater than 2%) and fair - good petroleum potentials. Type III kerogen is seen, and the zone has a fair potential as a gas source rock.

The Jurassic section of the well (1320-2160m) was subdivided into six zones, the Draupne Formation (zone E) covering only the upper 30m of the sequence. Zone E consists mainly of dark grey claystones with rich amounts of total organic carbon (2.5-3.7% TOC). Both the petroleum potentials (4.0-10.1) and the amount of EOM (490-650ppm) assign these claystones as being rich. The kerogen is a mixed type II/III, and thus this sequence is seen to have a rich potential as source rock for oil and gas.

For the rest of the Humber Group and well into the Brent Group (1350-1840m) the sediments consist predominantly of sandstones. The grey to dark grey claystones encountered in relatively high abundance from 1480-1540m are rich in organic carbon (>3.5% TOC). Petroleum potentials are rich for all the claystones analysed, and the kerogen is a mixed type II/III. Thus the relatively minor amounts of dark claystones seen in this section have a rich potential as source rock for oil and gas. However, the sequence as a whole is predominantly sandstones and have poor source rock potential.

The bottom part of the Brent Group contains some coal. Some of the coal has been assumed to be additives, and coaly fragments may be the reason for the highest TOC and petroleum potentials in this section (1840-1945m). The section consists of mainly type III kerogen with some sandstone.

The claystones can be said to have a rich potential as a gas source.

The change in pristane/phytane ratios from 2.0 (at 1290m) in the Cretaceous to >1.0 in the Upper Jurassic indicates a difference in depositional environments. The Upper Jurassic sediments were probably deposited in a more anoxic environment. The further change from dominant high molecular weight n-alkanes (nC_{21}+) in the Draupne Formation to a dominance of lower molecular weight n-alkanes in the sample from 1455m in the Sognefjord Formation indicates that there is possibly more of a terrestrial input to the samples from the Draupne than the Sognefjord samples. Input from migrated hydrocarbons of low molecular weight to this sample can, however, not be excluded. The GC traces of this sample are very similar to those of a sandstone core extracted from the same depth interval. The saturated hydrocarbon patterns of the samples from Middle Jurassic is indicative of low maturity samples with organic matter derived mainly from terrestrial precursors.

The aromatic hydrocarbons of the Cretaceous and top Upper Jurassic samples are fairly typical for immature samples which are often dominated by the aromatic sterane components. The deeper samples in the Upper Jurassic show a general increase in the alkyl naphthalene components (N, MN, DMN) which is not usual for samples which are immature, and this may be an indicator that migrated hydrocarbons are present, particularly in the sample from 1455m. The coal (1604.36m) shows a more complex pattern than the sample from the Upper Jurassic in which biphenyl is tentatively identified. These are probably indigenous to the coal. The presence of some part of the alkyl naphthalene components could easily be of migrated hydrocarbons.

Predominantly sandstones are encountered in the Dunlin Group and very poor claystones in the Triassic section. This deepest part of the well cannot be said to have any source rock potential.

Maturity

The well is immature down to approximately 2000 metres. This conclusion is supported by all the data available. T_{max} values are generally less than 430. Vitrinite reflectance values are generally less than 0.45%, TAI about 1/1+ and spore fluorescence less than or equal to 4. The saturated hydrocarbon ratios (Pr/Ph, CPI and Pr/nC_{17}) are all indicative of immature claystones.

Below 2000 metres is to be moderate mature, although the changes in various maturity parameters are only slight.

Migration

Migrated light hydrocarbons were encountered in high abundance in the Jurassic sandstones, from 1350m down to approximately 2000m, and in particular in the zones from 1400 to 1470m and from 1750-1800m.

From Rock-Eval production indices no sign of the migrated hydrocarbons could be seen in the claystones. The high values for some of the samples are due to very low S_2 values.

The gas chromatograms of sample A-9552 at 1455m indicate that there may be an input of migrated low molecular weight compounds at this depth.

TABLE I a.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN HEADSPACE.

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 / nC4
A 9503	795	246	3					248	3	1.13	
A 9506	840	60120	813	84				61017	897	1.47	
A 9512	930	6970	116	15				7101	131	1.84	
A 9515	975	22757	161	6				22924	167	0.73	
A 9518	1020	9576	55	3				9635	58	0.60	
A 9521	1065	1069	169	13				1251	182	14.55	
A 9524	1110	4919	66	17				5002	83	1.66	
A 9527	1155	82	22	7				111	29	25.76	
A 9530	1200	3926	181	64				4171	245	5.87	
A 9533	1245	2171	225	101	10	8		2516	345	13.71	1.21
A 9536	1290	2180	733	270	27	19		3230	1050	32.50	1.40
A 9539	1335	48659	11231	3421	603	474		64387	15729	24.43	1.27
A 9540	1350	110952	33515	9752	3058	1624	1141	158901	47950	30.18	1.88
A 9543	1395	2764	881	441	273	114	435	4472	1708	38.20	2.40
A 9545	1425	93	46	45	30		76	214	121	56.44	
A 9551	1455	462	195	96	58	21	46	833	371	44.48	2.72
A 9548	1495	4050	1665	753	440	119	573	7028	2978	42.37	3.69
A 9549	1510	11533	4766	1504	851	250	797	18905	7371	38.99	3.41
A 9552	1540	4117	1658	655	335	102	355	6867	2750	40.05	3.27
A 9554	1615	16966	2114	263	172	27	121	19542	2576	13.18	6.29
A 9556	1645	8129	1676	269	176	31	116	10281	2152	20.93	5.78
A 9558	1675	7865	1428	219	139	32	69	9683	1818	18.77	4.32
A 9560	1705	3981	871	243	90	30	76	5216	1234	23.66	2.97

DATE : 17 - 10 - 83.

TABLE I a.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN HEADSPACE.

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 ----- nC4
A 9562	1750	1811	477	176	55	33	49	2551	740	29.02	1.70
A 9564	1780	4471	842	248	47	33	23	5642	1170	20.74	1.43
A 9566	1810	7417	1795	430	44	36		9722	2305	23.71	1.23
A 9568	1840	15011	1797	358	36	23	16	17226	2215	12.86	1.55
A 9570	1870	3033	957	560	89	58	42	4696	1663	35.42	1.55
A 9572	1900	2157	603	308	46	27	26	3141	984	31.32	1.68
A 9574	1930	13861	4114	1890	330	191	255	20386	6525	32.01	1.72
A 9577	1975	1057	167	64	13	7	8	1308	251	19.18	1.84
A 9580	2020	515	71	38	13	6	6	642	127	19.82	2.19
A 9583	2065	32	6	4				42	10	23.18	
A 9586	2110	25030	1164	251	60	22	13	26526	1496	5.64	2.77
A 9589	2155	8987	3791	70	15	5		12868	3880	30.16	3.11
A 9592	2200	1285	77	21	5			1387	102	7.38	
A 9595	2245	77	6	3				86	9	10.43	
A 9598	2290	81	5					86	5	5.39	
A 9601	2335	49	3	3				55	6	11.36	
A 9604	2380	83	8					92	8	9.12	

DATE : 17 - 10 - 83.

IKU

TABLE I b.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN CUTTINGS .

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 / nC4
A 9503	795	1988	90	22				2100	112	5.35	
A 9506	840	783	74					857	74	8.62	
A 9512	930	165						165		0.00	
A 9515	975	370	35					405	35	8.58	
A 9518	1020	651	38					689	38	5.53	
A 9521	1065	601	86	30				716	116	16.15	
A 9524	1110	197						197		0.00	
A 9527	1155	117						117		0.00	
A 9530	1200	191	56					247	56	22.79	
A 9533	1245	118	34	56				207	90	43.31	
A 9536	1290	191	365	788	215	231	238	1790	1599	89.32	0.93
A 9539	1335	415	1542	2530	1029	1147	698	6663	6249	93.78	0.90
A 9540	1350	1231	6995	8549	5277	4174	4344	26226	24995	95.31	1.26
A 9543	1395	919	941	1848	2213	1591	9005	7511	6592	87.77	1.39
A 9545	1425	251	152	570	727	616	1985	2315	2065	89.18	1.18
A 9551	1455	325	1222	2295	2239	1644	4713	7725	7400	95.79	1.36
A 9548	1495	49		55	82	64	481	249	200	80.32	1.28
A 9549	1510	430	501	847	1139	688	5014	3604	3174	88.07	1.66
A 9552	1540										
A 9554	1615	3400	3903	1748	1809		2257	10859	7460	68.69	
A 9556	1645	100	145	93	110	58	539	506	406	80.16	1.91
A 9558	1675	1165	459	257	284	169	144	2334	1169	50.07	1.68
A 9560	1705	1479	239	246	205	167	557	2336	857	36.70	1.23

DATE : 17 - 10 - 83.

TABLE I b.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN CUTTINGS .

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 / nC4
A 9562	1750	2070	1267	1564	976	998	2651	6874	4805	69.89	0.98
A 9564	1780	4349	2514	1500	380	471	870	9214	4865	52.80	0.81
A 9566	1810	27094	38534	13336	2111	1584	827	82660	55566	67.22	1.33
A 9568	1840	33734	35401	13286	1891	1469	827	85781	52046	60.67	1.29
A 9570	1870	114	324	417	112	136	242	1102	989	89.67	0.83
A 9572	1900	294	217	365	98	119	237	1093	799	73.07	0.83
A 9574	1930	239	428	521	175	171	321	1534	1295	84.44	1.02
A 9577	1975	291	703	604	201	179	435	1979	1688	85.28	1.12
A 9580	2020										
A 9583	2065	136	66					203	66	32.77	
A 9586	2110	252	96	39				387	135	34.96	
A 9589	2155										
A 9592	2200										
A 9595	2245	93	34					128	34	26.82	
A 9598	2290	78						78		0.00	
A 9601	2335										
A 9604	2380	77						77		0.00	

DATE : 17 - 10 - 83.

IKU

TABLE I c.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS (Ia + Ib) .

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 / nC4
A 9503	795	2233	93	22				2348	115	4.90	
A 9506	840	60903	887	84				61874	970	1.57	
A 9512	930	7136	116	15				7266	131	1.80	
A 9515	975	23127	196	6				23329	202	0.87	
A 9518	1020	10228	93	3				10324	96	0.93	
A 9521	1065	1669	255	43				1967	298	15.13	
A 9524	1110	5115	66	17				5198	83	1.59	
A 9527	1155	199	22	7				228	29	12.55	
A 9530	1200	4117	237	64				4418	301	6.82	
A 9533	1245	2289	259	157	10	8		2723	435	15.96	1.21
A 9536	1290	2372	1099	1058	242	250	238	5020	2649	52.76	0.97
A 9539	1335	49073	12774	5950	1632	1621	698	71050	21977	30.93	1.01
A 9540	1350	112182	40510	18301	8336	5798	5485	185127	72945	39.40	1.44
A 9543	1395	3683	1822	2288	2486	1705	9439	11984	8301	69.27	1.46
A 9545	1425	344	198	615	757	616	2062	2530	2186	86.40	1.23
A 9551	1455	787	1416	2391	2297	1665	4759	8558	7771	90.80	1.38
A 9548	1495	4099	1665	808	522	183	1054	7277	3178	43.67	2.85
A 9549	1510	11963	5267	2351	1990	937	5811	22508	10545	46.85	2.12
A 9552	1540	4117	1658	655	335	102	355	6867	2750	40.05	3.27
A 9554	1615	20366	6017	2011	1980	27	2378	30401	10036	33.01	72.56
A 9556	1645	8229	1821	362	286	88	655	10787	2558	23.71	3.25
A 9558	1675	9030	1887	476	423	201	213	12017	2987	24.85	2.10
A 9560	1705	5460	1110	489	295	197	633	7551	2091	27.70	1.50

DATE : 17 - 10 - 83.

IKU

TABLE I c.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS (Ia + Ib) .

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 / nC4
A 9562	1750	3880	1744	1740	1031	1030	2700	9425	5545	58.83	1.00
A 9564	1780	8820	3356	1748	427	504	893	14856	6035	40.63	0.85
A 9566	1810	34511	40329	13766	2155	1620	827	92382	57871	62.64	1.33
A 9568	1840	48746	37198	13645	1926	1492	843	103007	54261	52.68	1.29
A 9570	1870	3147	1280	977	202	193	284	5799	2652	45.74	1.04
A 9572	1900	2452	820	673	143	146	263	4235	1783	42.10	0.98
A 9574	1930	14100	4542	2411	505	363	576	21920	7820	35.68	1.39
A 9577	1975	1349	870	668	214	186	442	3287	1939	58.97	1.15
A 9580	2020	515	71	38	13	6	6	642	127	19.82	2.19
A 9583	2065	168	72	4				245	76	31.12	
A 9586	2110	25282	1260	290	60	22	13	26913	1631	6.06	2.77
A 9589	2155	8987	3791	70	15	5		12868	3880	30.16	3.11
A 9592	2200	1285	77	21	5			1387	102	7.38	
A 9595	2245	170	40	3				213	43	20.25	
A 9598	2290	159	5					164	5	2.82	
A 9601	2335	49	3	3				55	6	11.36	
A 9604	2380	160	8					169	8	4.95	

DATE : 17 - 10 - 83.

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9503	780-795	0.80	70%	Claystone, light greenish grey, micaceous
			30%	Claystone, dark brown, probably caved
A-9506	825-840	1.20	85%	Claystone, light greenish grey, slightly calcareous, occasionally with a slight brownish hue, with abundant radiolaria
			15%	Claystone, carbonaceous, dark brown, probably caved
A-9512	915-930	0.21	80%	Claystone, light greenish grey, silty, pyritic, occasionally tuffaceous, occasionally glauconitic, micaceous
			10%	Sandstone, light grey to white, well cemented, micaceous
			10%	Limestone, light brown to off white, probably somewhat sideritic
A-9515	960-975		5%	Claystone, light greenish grey, as above, probably caved
		B 1.25	95%	Tuff, brownish grey to black, at least partly welded, pyritic
A-9518	1005-1020	B 1.21	100%	Tuff, brownish grey to black, as above
			Sm.am.	Claystone, greenish grey
A-9521	1050-1065	1.17	90%	Claystone, grey, micaceous, with some organic fragments and finely dispersed pyrite, containing some foraminifers, partly tuffaceous, partly glauconitic
			10%	Tuff, as above

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9605 swc	1070	0.84		Claystone, medium grey to olive grey, soft, slightly micaceous, plentiful light coloured grains, pyritic, non-calcareous, occasionally carbonaceous fragments, soft
A-9524	1095-1110	0.89	50%	Claystone, light greenish grey to light grey
			50%	L.C.M., including, muscovite, biotite and nut shells
A-9527	1140-1155	0.39	95%	Claystone, light to medium greenish grey to brownish grey
			5%	L.C.M. (nut shells, mica)
A-9606 swc	1192			Claystone, medium dark brownish - grey to medium dark grey, foraminifers present, fine carbonaceous fragments, non-calcareous
A-9530	1185-1200	0.60	95%	Claystone, greenish grey to brownish grey, occasionally containing tuffaceous material
			5%	Limestone and sideritic limestone, grey to brownish grey
			Sm.am.	Sand; Shell fragments
A-9607 swc	1225			Claystone, dark grey, soft, very slightly calcareous
A-9533	1230-1245	0.85	80%	Claystone, grey, brownish grey, greenish grey
			10%	Marl, light grey
			10%	Chalk, white

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9608 SWC	1267	2.20		Claystone, grey, soft, micaceous, slightly calcareous, slightly silty, pyritic
A-9536	1275-1290	2.90	40%	Claystone, grey to dark grey, micaceous, calcareous, somewhat pyritic
			60%	Marl, white to light grey, occasionally containing some sand
			Sm.am.	L.C.M., mainly as mica; Sandstone
A-9539	1320-1335	2.77	30%	Claystone, grey to dark grey, stringy, rich in organic material, showing fine lamination
			70%	Marl, white to light grey
			Sm.am.	Chalk, white
A-9609 SWC	1327.5	3.67		Claystone, medium dark grey, firm, very slightly calcareous
A-9540	1335-1350	3.44	95%	Claystone, mainly dark grey, occasionally subfissile
			5%	Marl, light grey, probably caved
			Sm.am.	Claystone, light green; L.C.M. (nut shells, lignite etc)
A-9610 SWC	1347.5	2.52		Claystone, medium dark grey, as above
A-9543	1380-1395		95%	Sand/Sandstone, loose, fine to very coarse, occasionally hydrocarbon-stained
			5%	Claystone, grey to dark grey, probably caved
			Sm.am.	Pyrite; Claystone, light grey

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9545	1410-1425		90%	Sand/Sandstone, fine to coarse, as above
		3.18	10%	Claystone, grey to dark grey, probably caved
			Sm.am.	Pyrite; light grey Claystone
A-9551	1440-1455		85%	Sand/Sandstone, fine to coarse, subangular to subrounded, probably hydrocarbon stained
		4.15	15%	Claystone, grey to dark grey, probably caved
			Sm.am.	Claystone, light green
A-9548	1480-1495	3.63	55%	Claystone, grey to dark grey
			5%	Claystone, light greenish grey
			40%	Sand/Sandstone, as above, medium to very coarse
A-9549	1495-1510	3.75	55%	Claystone, grey to dark grey
			5%	Claystone, light greenish grey
			40%	Sand/Sandstone, medium to very coarse, subangular to subrounded
A-9552	1525-1540	3.49	45%	Claystone, grey to dark grey
			5%	Marl, light grey, light brownish grey
			50%	Sand/Sandstone, fine to very coarse
			Sm.am.	Tuff
A-9554	1600-1615		100%	Sandstone/Sand, poorly cemented
			Sm.am.	Mica; Pyrite; L.C.M.
A-9611 swc	1603.36	41.48		Coal/Carbonaceous Claystone, dark grey - brown, pyritic, showing striated texture, fissile, sand, lense

097/j/ah/4

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9556	1630-1645		100%	Sand/Sandstone, fine to very coarse, relatively poorly cemented, subangular to rounded grains
			Sm.am.	Claystone, grey to dark grey; Mica; Coalified wood
A-9558	1660-1675		100%	Sand/Sandstone, medium to very coarse, subangular to subrounded, moderately to poorly cemented
			Sm.am.	Claystone, dark grey; Chalk; Pyrite
A-9560	1690-1705		100%	Sand/Sandstone, medium to very coarse, moderate to poor cementing, subangular to subrounded
			Sm.am.	Pyrite; Mica (L.C.M.)
A-9562	1735-1750		100%	Sand/Sandstone, fine to coarse, angular to subrounded, moderately to poorly cemented
			Sm.am.	Claystone, dark grey; Claystone, light grey; Mica (L.C.M.)
A-9564	1765-1780		95%	Sand/Sandstone, coarse to very coarse, subangular to subrounded grains
			5%	Coal, brownish black, dull luster
A-9566	1795-1810		85%	Sand/Sandstone, fine to very coarse
			15%	Coal, brown to black
			Sm.am.	Pyrite

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9568	1825-1840		70%	Sand/Sandstone, fine to coarse, angular to subrounded grains
		2.32	15%	Claystone, grey to brownish grey, occasionally silty
			15%	Coal, black to brown
			Sm.am.	Marl, light grey; Pyrite
A-9612 swc	1830	4.35		Claystone/Silty Sandstone, claystone is dark brown grey, laminated, sandstone is very fine - fine grained, non-calcareous, coaly stringer within sandstone
A-9570	1865-1870		50%	Sandstone/Sand, fine to medium, moderately to well cemented
		6.06	5%	Claystone, grey to dark grey, often very silty
			5%	Coal, as above
			40%	Casing cement
			Sm.am.	Pyrite; Chalk
A-9572	1885-1900		30%	Casing cement
			70%	Coal, probably additive
			Sm.am.	Sandstone; Mica (additive)
A-9613 swc	1890	1.45		Claystone, medium grey, silty, very micaceous, very slightly calcareous
A-9574	1915-1930		50%	Casing cement
			50%	Coal and other additives
			Sm.am.	Sandstone; Claystone, greenish grey
A-9614 swc	1930	1.22		Claystone, medium grey, silty laminae, slightly micaceous, very slightly calcareous

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9577	1960-1975		75%	Sand/Sandstone, medium to very coarse, subangular to subrounded grains, stained light brown
		1.10	15%	Claystone, light grey often very silty, occasionally light brownish grey
			5%	Coal, as above
			5%	Casing cement
			Sm.am.	Mica
A-9580	2050-2065		95%	Sandstone/Sand, fine to very coarse, moderately to poorly cemented, subangular to subrounded frosted grains
		0.88	5%	Silty Claystone, grey, very micaceous, often very silty
			Sm.am.	Very fine, well cemented Sandstone; Pyrite; Coal
A-9583	2050-2065		100%	Sand/Sandstone, medium to very coarse, angular to subangular grains, moderately to poorly cemented, hydrocarbon stained
			Sm.am.	Coal; Grey Claystone; Mica; Pyrite
A-9586	2095-2110		90%	Sand/Sandstone, fine to coarse, otherwise as above
			10%	Coal, as above
			Sm.am.	Pyrite
A-9589	2140-2155		90%	Sand/Sandstone, fine to very coarse, some ?hydrocarbon staining
			10%	Coal, black, shiny
			Sm.am.	Pyrite; Mica; grey to greenish grey Claystone

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9615 swc	2148	0.65		Claystone, light grey, silty, sandy, micaceous, non-calcareous
A-9592	2185-2200	0.15	40%	Claystone, green, light greenish grey
		0.23	50%	Claystone, reddish grey, reddish brown
			10%	Sand/Sandstone, similar to above (?caved)
			Sm.am.	Coal
A-9595	2230-2245	0.19	15%	Claystone, light green, light greenish grey
		0.14	30%	Claystone, reddish grey, reddish brown
			50%	Sand, fine to coarse, angular to subangular, ?hydrocarbon stained
			5%	Coal, as above
A-9598	2275-2290		5%	Claystone, light green, light greenish grey
		0.23	75%	Claystone, reddish brown, occasionally silty, calcareous
			5%	Sand/Sandstone, as above
			15%	Coal, black, rounded fragments (?caved)
A-9601	2320-2335		5%	Claystone, light grey, light greenish grey
		0.14	60%	Claystone, silty, occasionally very silty, reddish brown, reddish grey, micaceous, calcareous
			10%	Sandstone, very fine to medium, containing abundant mica, unsorted, well cemented
			10%	Sand/Sandstone, medium to very coarse, white or tan, due to ?hydrocarbon staining
			10%	Coal, as above
			5%	Chalk, white

097/j/ah/8

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 31/3-1

Sample	Depth (m)	TOC		Lithology
A-9616 swc	2325	0.22		Claystone, red-brown, slightly micaceous, silty and sandy in part, calcareous
A-9604	2365-2380	0.17	75%	Claystone, reddish brown, occasionally silty
			20%	Coal, black, rounded fragments (?additive)
			5%	Sand/Sandstone, white to tan
			Sm.am.	Limestone, light brown; Sandstone, reddish brown, unsorted, micaceous; Claystone, light green

IKU

TABLE 3.

D A T A   F R O M   R O C K   E V A L   P Y R O L Y S I S

IKU No.	DEPTH m/ft	S1	S2	S3	TOC (%)	HYDR. INDEX	OXYGEN INDEX	PETROLEUM POTENTIAL S1+S2	PROD. INDEX S1/S1+S2	TEMP. MAX (C)
A 9503	795	0.10	0.29	0.72	0.80	36	90	0.39	0.26	415
		Clst lt - gn - gy								
A 9506	840	0.12	0.58	0.94	1.20	48	78	0.70	0.17	420
		Clst lt - gn - gy								
A 9512	930	0.06	0.03	0.53	0.21	14	252	0.09	0.67	330
		Clst lt - gn - gy								
A 9515	975	0.07	0.44	1.39	1.25	35	111	0.51	0.14	426
A 9518	1020	0.11	0.44	1.65	1.21	36	136	0.55	0.20	424
A 9521	1065	0.10	0.50	0.60	1.17	43	51	0.60	0.17	421
		Clst gy								
A 9605	1070	0.23.	0.00	0.30	0.84	0	36	0.23	1.00	351
A 9524	1110	0.12	0.33	0.44	0.89	37	49	0.45	0.27	422
		Clst lt - gn - gy								
A 9527	1155	0.11	0.00	0.27	0.39	0	69	0.11	1.00	287
		Clst lt - gn - gy								
A 9530	1200	0.05	0.03	0.27	0.60	5	45	0.08	0.63	266
		Clst gn - gy								
A 9533	1245	0.07	0.09	0.34	0.85	11	40	0.16	0.44	347
		Clst gy -brn - gy								
A 9608	1267	0.18	1.51	0.75	2.20	69	34	1.69	0.11	435
A 9536	1290	0.14	4.01	0.57	2.90	138	20	4.15	0.03	424
		Clst gy - dk - gy								
A 9609	1327.50	0.22	9.90	0.92	3.67	270	25	10.12	0.02	433
A 9539	1335	0.16	5.54	0.68	2.77	200	25	5.70	0.03	423
		Clst gy - dk - gy								
A 9610	1347.50	0.16	3.81	0.64	2.52	151	25	3.97	0.04	433
A 9540	1350	0.22	9.33	0.82	3.44	271	24	9.55	0.02	429
		Clst dk - gy								
A 9618	1371.54	7.54	89.68	6.60	42.92	209	15	97.22	0.08	405
A 9619	1402.33	9.10	74.71	4.55	39.83	188	11	83.81	0.11	407
A 9545	1425	0.42	9.16	1.62	3.18	288	51	9.58	0.04	422
		Clst gy - dk - gy								
A 9551	1455	0.59	11.14	1.51	4.15	268	36	11.73	0.05	424
		Clst gy - dk - gy								
A 9548	1495	0.43	8.81	2.24	3.63	243	62	9.24	0.05	424
		Clst gy - dk - gy								
A 9549	1510	0.52	9.31	2.45	3.75	248	65	9.83	0.05	427
		Clst gy - dk - gy								

DATE : 7 - 12 - 83.

IKU

TABLE 3.

D A T A F R O M R O C K E V A L P Y R O L Y S I S

IKU No.	DEPTH m/ft	S1	S2	S3	TOC (%)	HYDR. INDEX	OXYGEN INDEX	PETROLEUM POTENTIAL S1+S2	PROD. INDEX S1/(S1+S2)	TEMP. MAX (C)
A 9552	1540	0.45	9.97	1.46	3.49	286	42	10.42	0.04	424
		Clst gy - dk - gy								
A 9611	1603.36	11.14	165.57	3.43	41.48	399	8	176.71	0.06	409
A 9612	1830	0.29	4.02	0.62	4.35	92	14	4.31	0.07	427
A 9568	1840	0.29	1.70	0.41	2.32	73	18	1.99	0.15	438
		Clst gy -brn - gy								
A 9570	1870	0.28	11.65	1.96	6.06	192	32	11.93	0.02	428
		Clst gy - dk - gy								
A 9613	1890	0.11	1.83	0.10	1.45	126	7	1.94	0.06	428
A 9614	1930	0.10	0.74	0.12	1.22	61	10	0.84	0.12	427
A 9577	1975	0.08	1.09	0.33	1.10	99	30	1.17	0.07	434
		Clst lt - gy								
A 9580	2020	0.11	0.43	0.00	0.88	49	0	0.54	0.20	432
		Clst gy								
A 9615	2148	0.07	0.05	0.00	0.65	8	0	0.12	0.58	395
M 9592	2200	****	****	****	0.15	*****	****	******	******	***
		Clst gn - lt - gn								
M 9592	2200	0.03	0.00	0.14	0.23	0	61	0.03	1.00	437
		Clst red - gy								
A 9598	2290	0.11	0.00	0.26	0.23	0	113	0.11	1.00	254
		Clst red -brn								
A 9616	2325	0.13	0.00	0.00	0.22	0	0	0.13	1.00	223
M 9601	2335	****	****	****	0.14	*****	****	******	******	***
		Clst red -brn								

DATE : 7 - 12 - 83.

All samples with IKU numbers higher than A-9605 are SWC's.

IKU

TABLE : 4.

CONCENTRATION OF EOM AND CHROMATOGRAPHIC FRACTIONS

IKU-No	DEPTH (m)	Rock Extr. (g)	EOM (mg)	Sat. (mg)	Aro. (mg)	HC (mg)	Non HC (mg)	TOC (%)
A 9536	1290	12.0	4.3	1.2	1.3	2.5	1.8	2.21
A 9609	1327.50	6.5	4.2	1.6	1.4	3.0	1.2	3.65
A 9610	1347.50	6.3	3.1	1.0	1.3	2.3	0.8	2.72
A 9540	1350	21.6	12.3	2.5	3.1	5.6	6.7	2.99
A 9551	1455	5.2	6.7	1.7	2.4	4.1	2.6	3.43
A 9552	1540	5.8	15.7	1.2	1.2	2.4	13.3	1.57
A 9611	1603.36	0.2	3.4	0.4	1.8	2.2	1.2	56.33
A 9612	1830	0.6	0.5	0.2	1.1	1.3	-0.8	3.11
A 9613	1890	3.6	2.3	1.1	1.7	2.8	-0.5	1.24

DATE : 22 - 11 - 83.

IKU

TABLE : 5.

WEIGHT OF EOM AND CHROMATOGRAPHIC FRACTIONS

(Weight ppm OF rock)

IKU-No	DEPTH (m)	EOM	Sat.	Aro.	HC	Non HC
A 9536	1290	358	100	108	208	150
A 9609	1327.50	646	246	215	462	185
A 9610	1347.50	492	159	206	365	127
A 9540	1350	569	116	144	259	310
A 9551	1455	1288	327	462	788	500
A 9552	1540	2712	207	207	415	2297
A 9611	1603.36	14167	1667	7500	9167	5000
A 9612	1830	847	339	1864	2203	-1356
A 9613	1890	632	302	467	769	-137

DATE : 22 - 11 - 83.

IKU

TABLE : 6.

CONCENTRATION OF EOM AND CHROMATOGRAPHIC FRACTIONS

(mg/g TOC)

IKU-No	DEPTH (m)	EOM	Sat.	Aro.	HC	Non HC
A 9536	1290	16.2	4.5	4.9	9.4	6.8
A 9609	1327.50	17.7	6.7	5.9	12.6	5.1
A 9610	1347.50	18.1	5.8	7.6	13.4	4.7
A 9540	1350	19.0	3.9	4.8	8.7	10.4
A 9551	1455	37.6	9.5	13.5	23.0	14.6
A 9552	1540	172.7	13.2	13.2	26.4	146.3
A 9611	1603.36	25.1	3.0	13.3	16.3	8.9
A 9612	1830	27.2	10.9	59.9	70.8	-43.6
A 9613	1890	51.0	24.4	37.7	62.0	-11.1

DATE : 22 - 11 - 83.

IKU

TABLE : 7.

COMPOSITION IN % OF MATERIAL EXTRACTED FROM THE ROCK

IKU-No	DEPTH (m)	Sat / EOM	Aro / EOM	HC / EOM	SAT / Aro	Non HC / EOM	HC / Non HC
A 9536	1290	27.9	30.2	58.1	92.3	41.9	138.9
A 9609	1327.50	38.1	33.3	71.4	114.3	28.6	250.0
A 9610	1347.50	32.3	41.9	74.2	76.9	25.8	287.5
A 9540	1350	20.3	25.2	45.5	80.6	54.5	83.6
A 9551	1455	25.4	35.8	61.2	70.8	38.8	157.7
A 9552	1540	7.6	7.6	15.3	100.0	84.7	18.0
A 9611	1603.36	11.8	52.9	64.7	22.2	35.3	183.3
A 9612	1830	40.0	220.0	260.0	18.2	-160.0	******
A 9613	1890	47.8	73.9	121.7	64.7	-21.7	******

DATE : 22 - 11 - 83.

IKU

TABLE 8.

TABULATION OF DATA FROM THE GASCHROMATOGRAMS

IKU No.	DEPTH (m)	PRISTANE / n-C17	PRISTANE / PHYTANE	CPI
A 9536	1290	1.7	2.0	0.7*
A 9609	1327.50	1.6	0.7	1.7
A 9610	1347.50	1.6	0.7	1.6
A 9540	1350	1.7	0.8	1.7
A 9551	1455	1.2	1.0	1.7
A 9552	1570	1.2	1.2	1.4
A 9611	1603.36			1.2
A 9612	1830	1.7	1.1	1.3
A 9613	1890	2.5	3.9	1.3

DATE : 25 - 11 - 83.

* too low due to coelution.

IKU

T A B L E 9.

TABULATION OF MATURITY DATA

IKU No.	DEPTH (m/ft)	VITRINITE REFLECTANCE Ro(%) and Counts			MATURATION INDEX (TAI)		FLUOR-ESCENCE
A 9506	840	0.31(8)			1	1/1+	1
		clst		-			
A 9605	1070	0.33(1)	0.61(8)		1	1/1+	1
		clst		-			
A 9606	1192	0.43(1)	0.62(3)		1/1+		1/2
		clst		-			
A 9607	1225	N.D.P.			1	1/1+	2
		clst		-			
A 9608	1267	0.50(9)			1	1/1+	2/4
		clst		-			
A 9536	1290	0.39(6)	0.53(9)		1	1/1+	2
		clst		-			
A 9609	1327.50	0.43(8)	0.58(3)		1/1+		2/3
		clst		-			
A 9610	1347.50	0.48(25)	0.85(1)		1/1+		2/3/4
		clst		-			
A 9540	1350	0.34(16)	0.69(1)		1/1+		2/3
		clst		-			
A 9618	1371.54	0.24(25)			N.A.		1
		coal		-			
A 9619	1402.33	0.28(40)			N.A.		1
		coal		-			
A 9545	1425	0.41(9)			1	1/1+	2
		clst		-			
A 9551	1455	0.58(8)	0.75(2)		1	1/1+	2/4
		clst		-			
A 9548	1495	0.44(6)			1	1/1+	1/2/4
		clst		-			
A 9549	1510	0.46(6)	0.78(2)		1	1/1+	2/3/4
		clst		-			
A 9552	1540	0.46(6)	0.56(3)		1/1+		1/2
		clst		-			
A 9611	1603.36	0.23(25)			N.D.P.		1
		coal		-			
A 9566	1810	0.41(20)			N.D.P.		4/5
				-			
A 9612	1830	0.45(9)			1/1+		5
		clst		-			
A 9570	1870	0.44(1)	0.60(2)		1/1+		4
		clst		-			
A 9613	1890	0.42(3)	0.66(3)		1/1+		4/5
		clst		--			
A 9572	1900	0.46(20)			N.D.P.		4/5
		clst		-			
A 9614	1930	0.26(3)	0.49(1)		N.D.P.		1/4
				-			

DATE : 28 - 11 - 83.

IKU

TABLE 9.

TABULATION OF MATURITY DATA

IKU No.	DEPTH (m/ft)	VITRINITE REFLECTANCE Ro(%) and Counts			MATURATION INDEX (TAI)	FLUOR-ESCENCE
A.9577	1975	0.31(4)	0.77(2)		1/1+ 1+	2
		clst		-		
A 9615	2148	0.67(6)	1.01(11)		1/1+	
		clst		-		
A 9589	2155	0.39(25)			N.D.P.	1/3
		coal		-		
A 9616	2325	0.49(5)			N.D.P.	
		clst		-		
A 9601	2335	0.41(24)			N.D.P.	1/2/4
		clst		-		

DATE : 28 - 11 - 83.

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9506	825-840	Am,Cy/W,P	F-M	good to fair	1-1/1+	Loose aggregates, amorphous material embedding strongly degraded woody material and palynomorphs. Pyrite, some mica.
A-9515	960-975	Cut,W,P,S/Am,Cy	F-M-L	fair	1-1/1+	Loose aggregates flimsy sheets of material (cuticles). Woody structured material with traces of fungi and very thin walls.
A-9605	1070	W,P,S/Am	F-M-L	variable	1-1/1+	Small residue. Loose aggregates embedding granules of degraded woody material. Structured wood with very thin walls and traces of hyphae.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

102/A/jbl/21

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9606	1192	*W,WR!,P/Am,Cy	F-M	poor to fair	1/1+	Abundant pyrite in grey amorphous residue. Structured woody material.
A-9607	1225	*Am,Cy/W	F	poor to fair	1-1/1+	*Poor residue. After screening remain mostly grey amorphous material as poorly defined, rounded aggregates. Minerals are difficult to distinguish from the organic amorphous.
A-9608	1267 swc	WR!,W,P/Am,Cy	F-M	good	1-1/1+	Grey amorphous material embeds woody particles, mostly fairly dark. Occasional fresh looking woody material. Very god preservation of cysts.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9536	1275-90	W,WR!,P,S/Am,Cy	F-M	good	1-1/1+	Abundant pyrite and other acid resistant minerals. Grey amorphous aggregates embed degraded wood particles. Reworking of more mature older deposits.
A-9609	1327.5 swc	W,Cut,P/Am,Cy	F-M-L	fair to good	1/1+	Pyritic residue, aggregates of material. Thin sheets and palynomorphs with adhering rounded nonstructured bodies (of ?woody origin). Pale palynomorphs.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

102/A/jbl/23

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9540	1335-50	W,WR!,P,S/Am,Cy	F-M-L	good to fair	1/1+	Aggregates of granulate amorphous material, mainly strongly degraded woody material. Thin sheets of cuticles. Semifusinite. Some grey amorphous.
A-9610	1347.5 swc	W,P,S/Am,Cy	F-M	fair	1/1+	"Classopollis" well preserved. Very loose aggregates, embedding palynomorphs and small woody particles, but mostly degradation products (remains of microbe activity). Pale palynomorphs.
A-9618	1371.54 core		-	-	-	Coaly fragments, pyrite.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

102/A/jbl/23.1

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9619	1402.23		-	-	-	Coaly fragments. "Amorphous".
A-9545	1410-25	W,WR!,P,S/Am,Cy	F-M-L	good to fair	1-1/1+	Degraded woody material as A-9540 but a sparse residue. Very thin sheets of ?cuticles.
A-9551	1440-55	Cut,W,WR!,P/Am,Cy	F-M-L	variable	1-1/1+	Traces of biodegradation, fungal hyphae and abundant minute rounded granules (?woody material). Some semifusinite.
A-9548	1480-95	Cut,W,WR!,P,S/Am,Cy	F-M-L	variable	1-1/1+	Aggregates, increase of coherent sheets of material. Granulate amorphous material sticks to and obscures palynomorphs.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

102/A/jbl/24

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9549	1495-1510	Cut,W,WR!,P,S/Am,Cy	F-M-L	variable	1-1/1+	As A-9549 above strong biodegradation. Cuticles easier identified.
A-9552	1525-40	Cut,W,WR!,P,S/Am,Cy	F-M-L	variable	1/1+	Sheets of flimsy looking material with adhering granulate amorphous material as A-9540 above. Relative increase in structured woody material.
A-9611	1603.36	W	F-M-L	NDP	NDP	Amorphous (granulate) coaly particles. Strongly degraded/-woody material resembles the cutting samples.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

102/A/jbl/25

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9612	1830	W,Cut,P/	F-M	fair to good	1/1+	Degraded poorly sorted terrestrial material. Mostly woody nonstructured and structured, some poorly preserved fragmented cuticles.
A-9570	1855-70	Cut,W,WR!,P,S/Am,Cy	F-M-L	good to fair	1/1+	Brighter colours, more coherent better, preserved structures. Early Jurassic palynomorphs. Microbe attacks on pollen, spores and vitrinite particles.
A-9613	1890	*W,WR!,P/Am,Cy	F-M	?	1/1+	*Very small residue, contamination from caved lithologies suspected.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

102/A/jbl/26

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9614	1930	*WR!,W,Cut	F-M-L	poor	?	*Strongly sorted sample. Minerals are very abundant. Contamination (cuttings) suspected.
A-9577	1960-75	Cut,W,WR!,R,P,S/Am,Cy	F-M-L	good to fair	1/1+, 1+	Fairly well preserved cuticular structures. Resinous elongate bodies (tubes). Microbe attach. Reminds of A-9570 above.
A-9615	2148	*WR!,W,Cut	F-M-L	poor	(1/1+)?	*Strongly sorted sample. Minerals are very abundant. Pollutions (cuttings) suspect-ed.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

102/A/jbl/27

IKU

Visual Kerogen Analysis

TABLE NO.: 10.
WELL NO.: 31/3-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
A-9616	2325	*WR!/?Am	M	NDP	NDP	*Poor residue. Inertinite fragments and some amorphous (inorganic) remains.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

102/A/jbl/28

Figure 1

Gas chromatograms of C_{15}+
saturated hydrocarbons

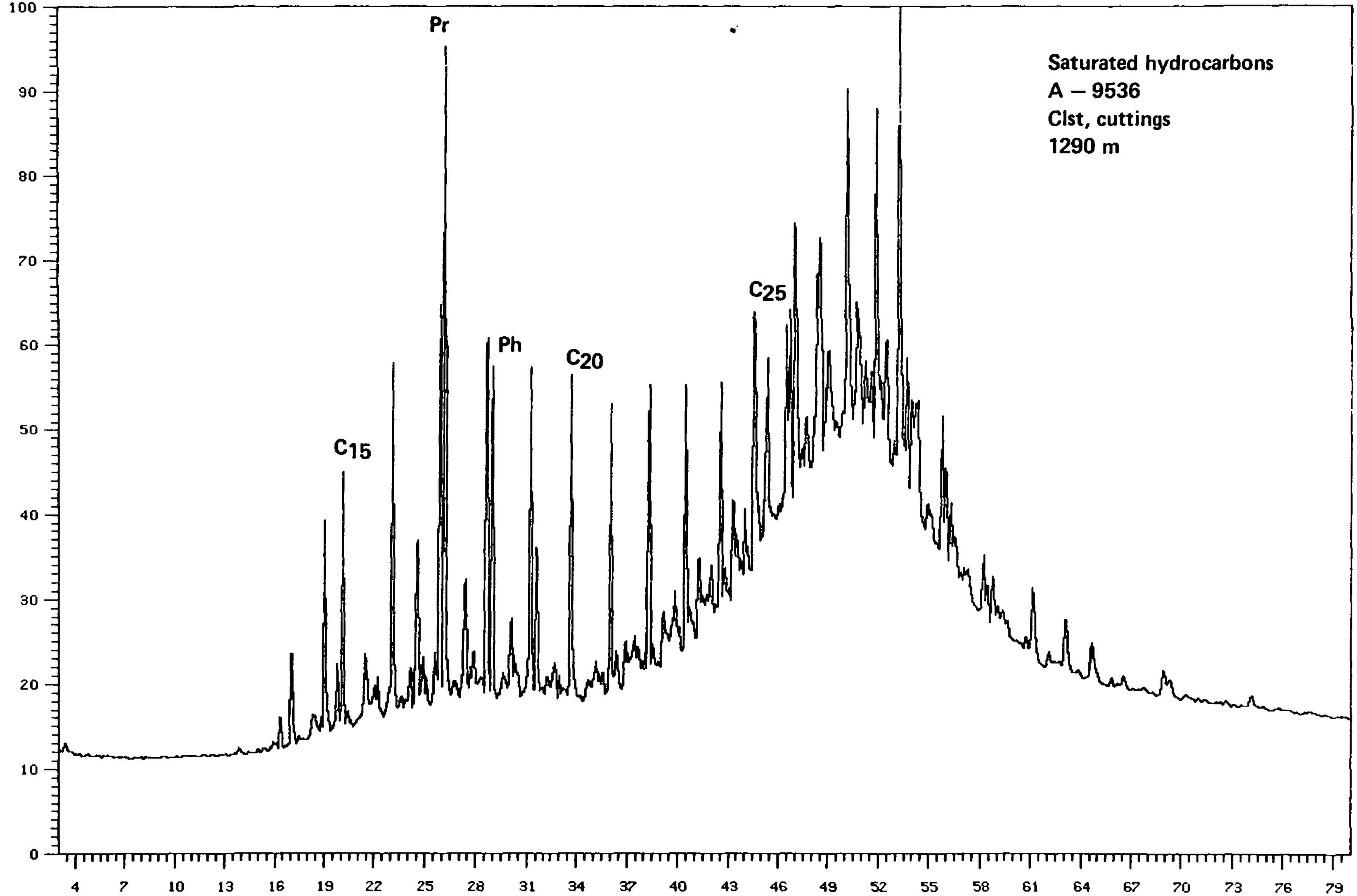
Pr - pristane
Ph - phytane

Printed at 11:16 on 22/Nov/83

RAW DATA PLOT-CHANNEL 3

Analysis :0198A9536S   Sample #: 1   Injection #: 1   Box 1 of 1

Sample Name :A-9536,SAT,LH   Maximum signal (%): 4.10

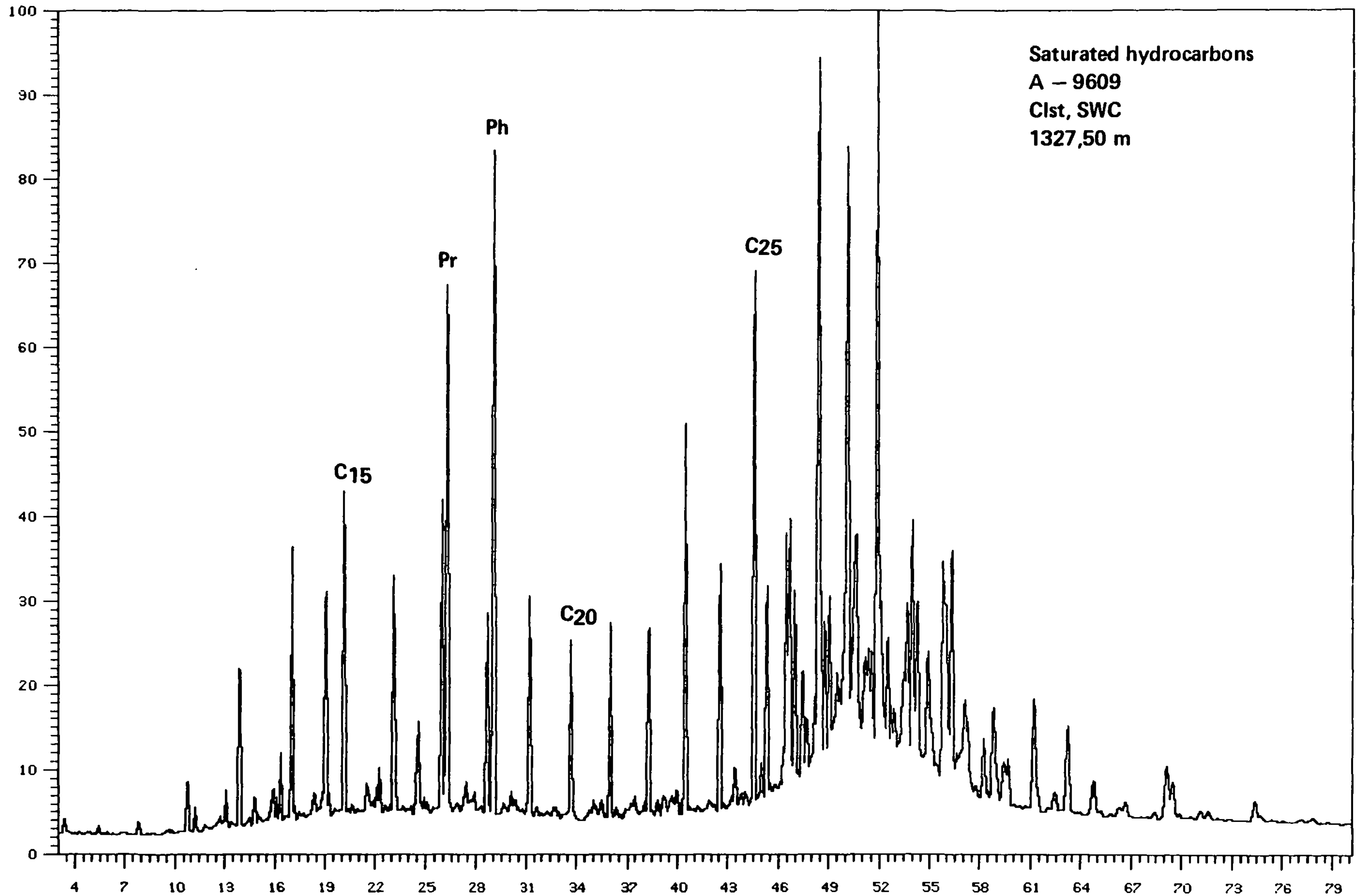


Printed at 14:21 on 23/Nov/83

RAW DATA PLOT-CHANNEL 3

Analysis :0198A9609S Sample #: 1 Injection #: 1 Box 1 of 1

Sample Name :A-9609,SAT,LH Maximum signal (%): 16.88

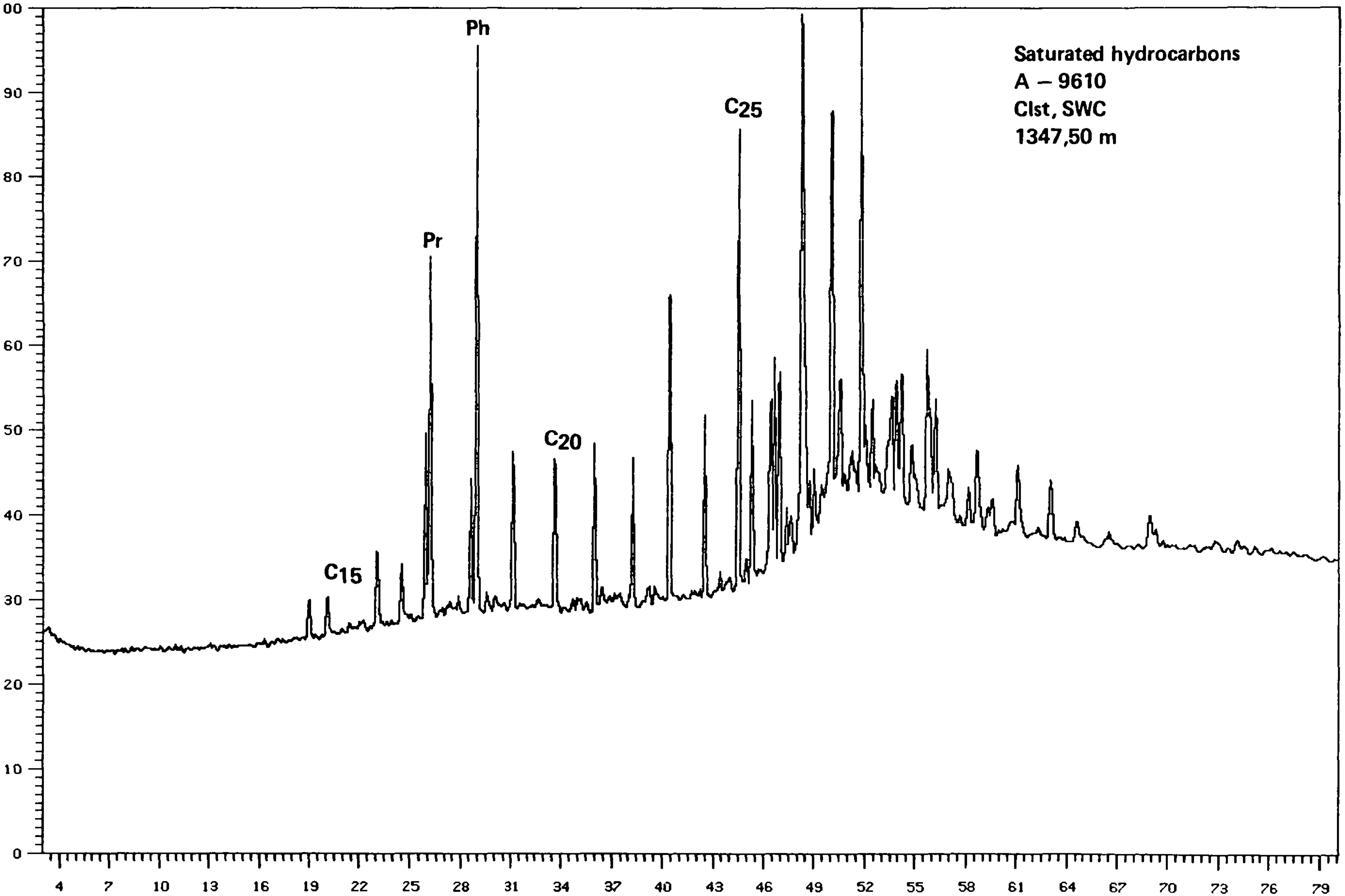


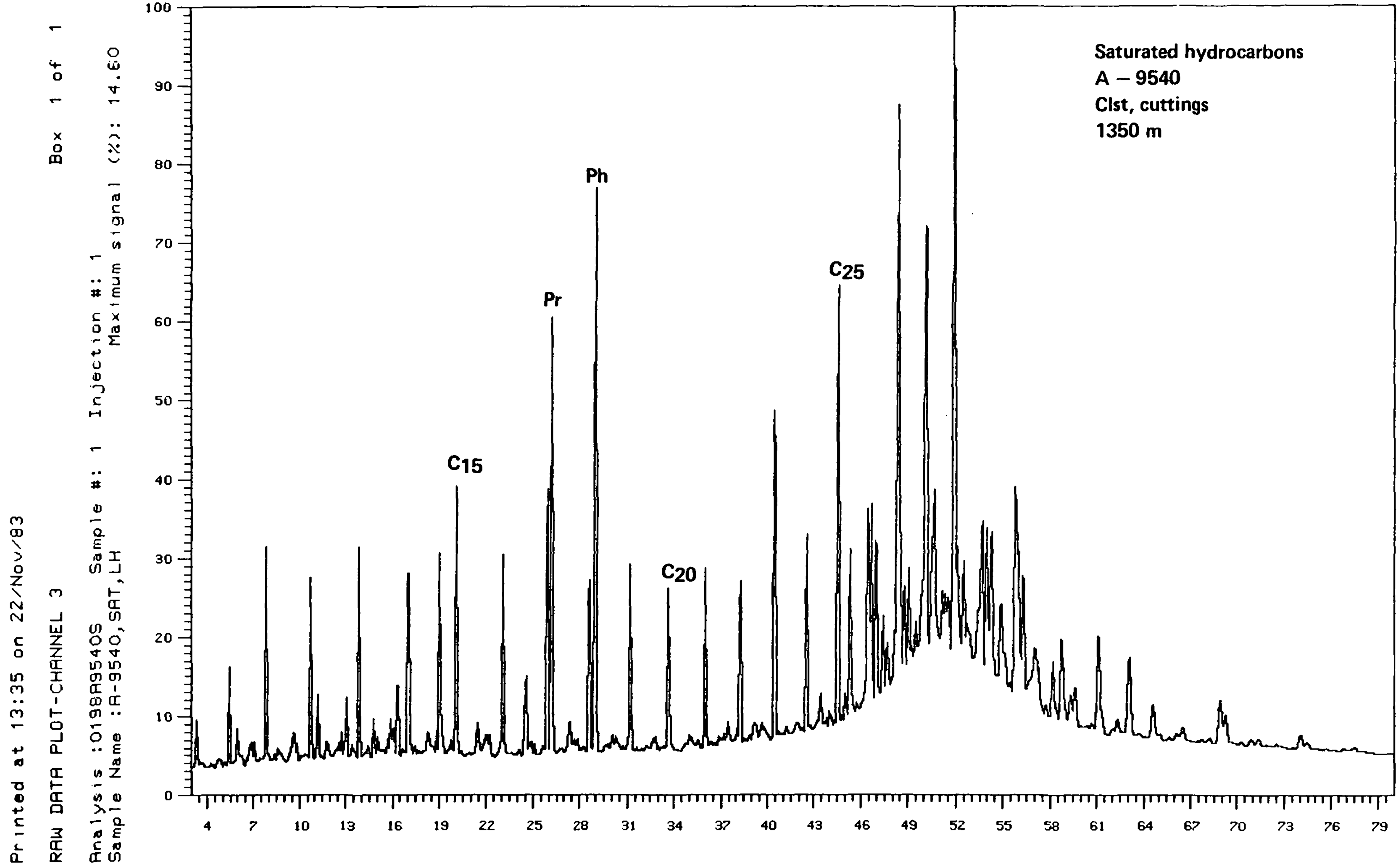
Printed at 14:34 on 25/Nov/83

RAW DATA PLOT-CHANNEL 3 Box 1 of 1

Analysis :0198A9610A Sample #: 1 Injection #: 1

Sample Name :A-9610,SAT,LH Maximum signal (%): 1.66

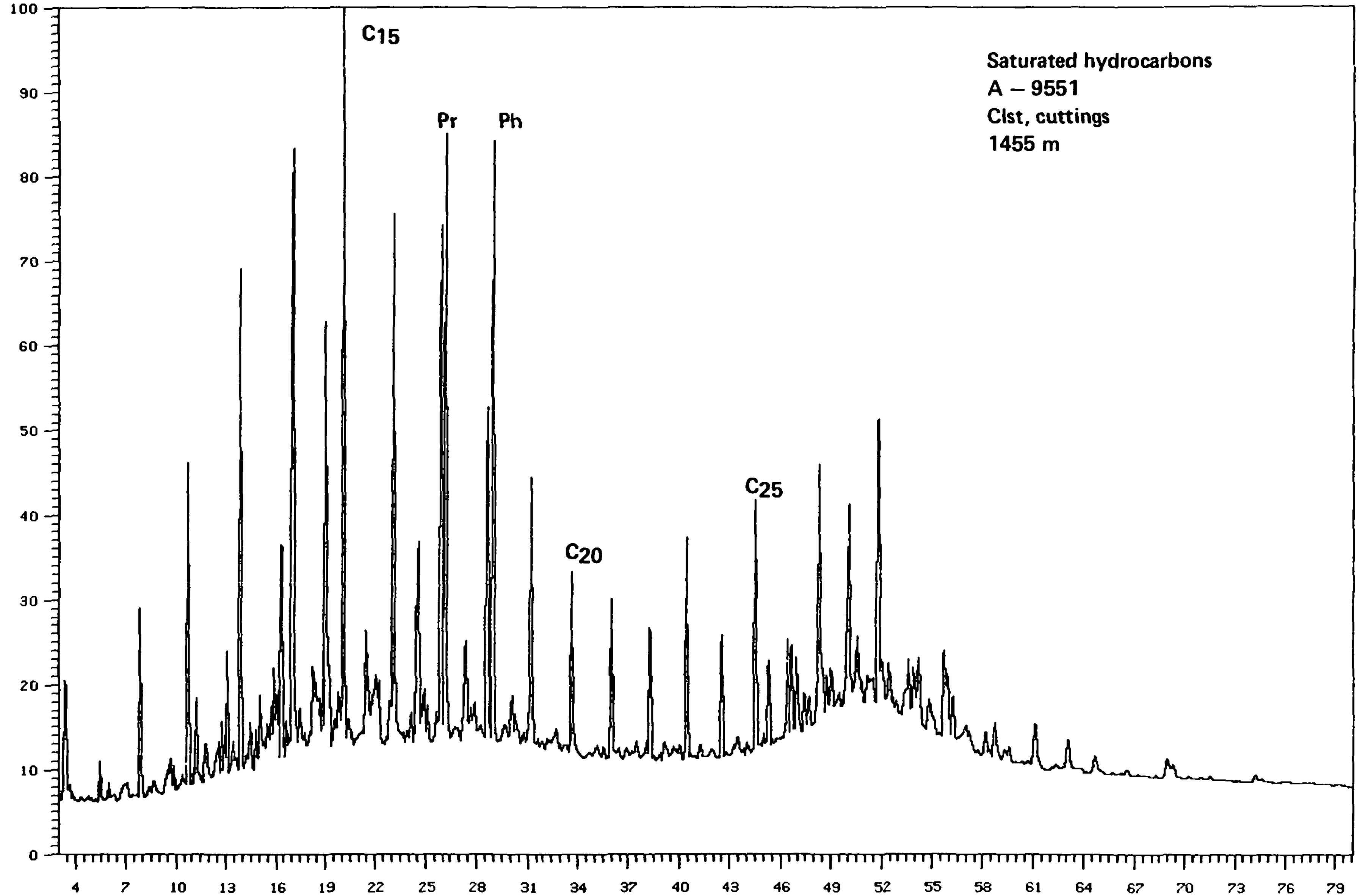


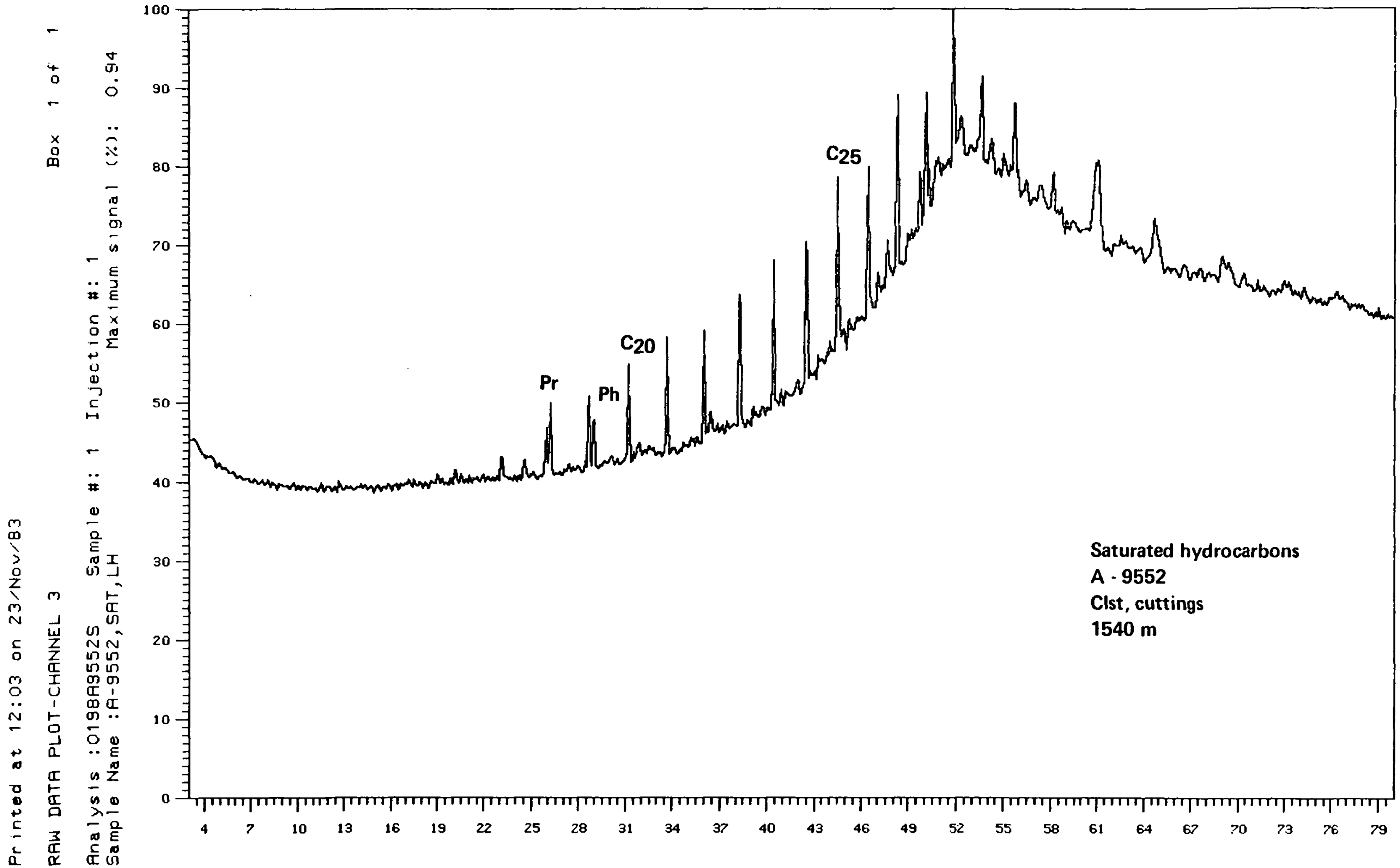

Printed at 13:35 on 22/Nov/83
RAW DATA PLOT-CHANNEL 3
Box 1 of 1
Analysis :0198A9540S Sample #: 1 Injection #: 1
Sample Name :A-9540,SAT,LH
Maximum signal (%): 14.60
Saturated hydrocarbons
A – 9540
Clst, cuttings
1350 m
C15
Pr
Ph
C20
C25
100
90
80
70
60
50
40
30
20
10
0
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79

Printed at 10:16 on 23/Nov/83

RAW DATA PLOT-CHANNEL 3 Box 1 of 1

Analysis :0198A9551S Sample #: 1 Injection #: 1
Sample Name :A-9551,SAT,LH Maximum signal (%): 7.05

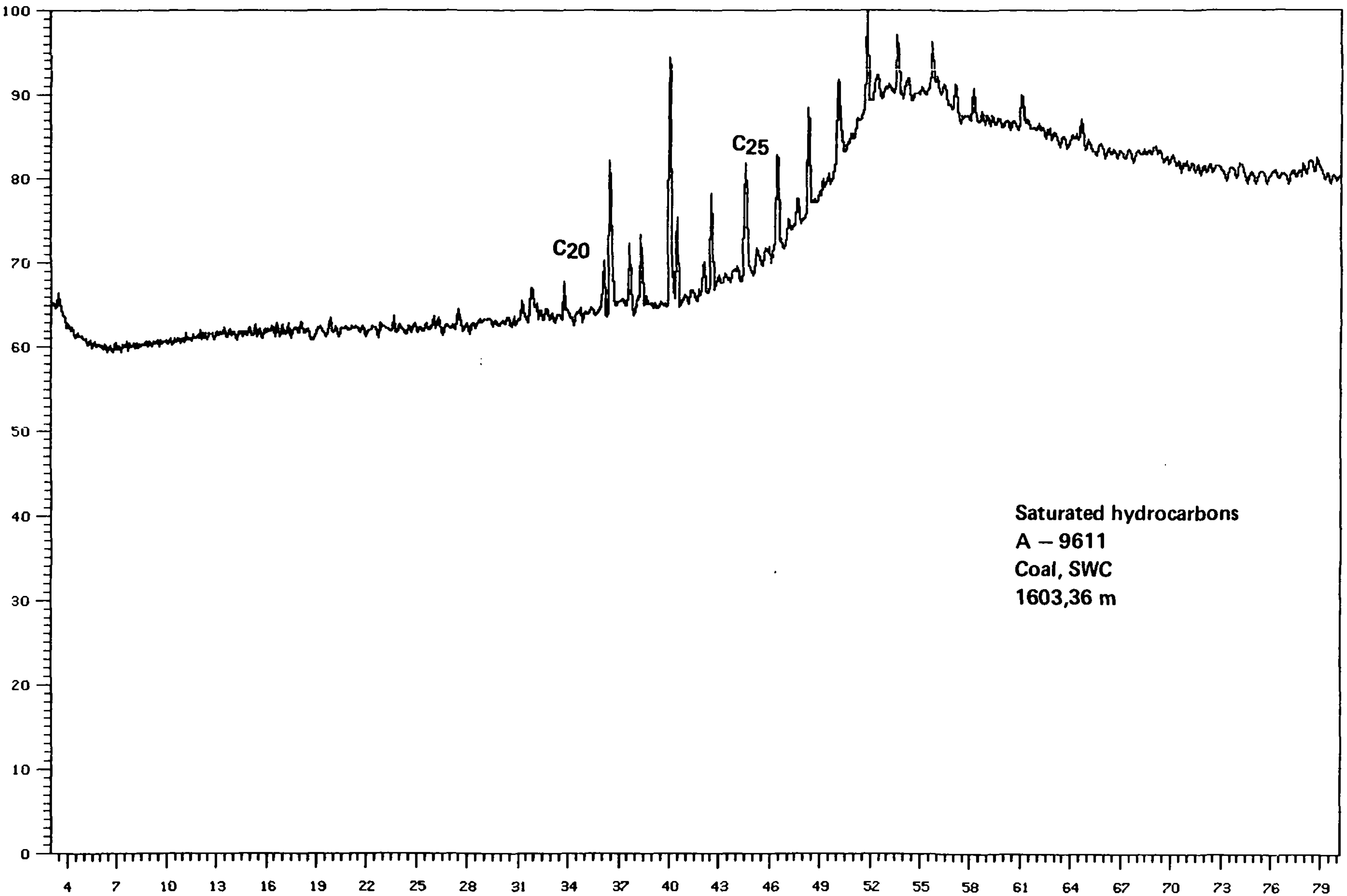


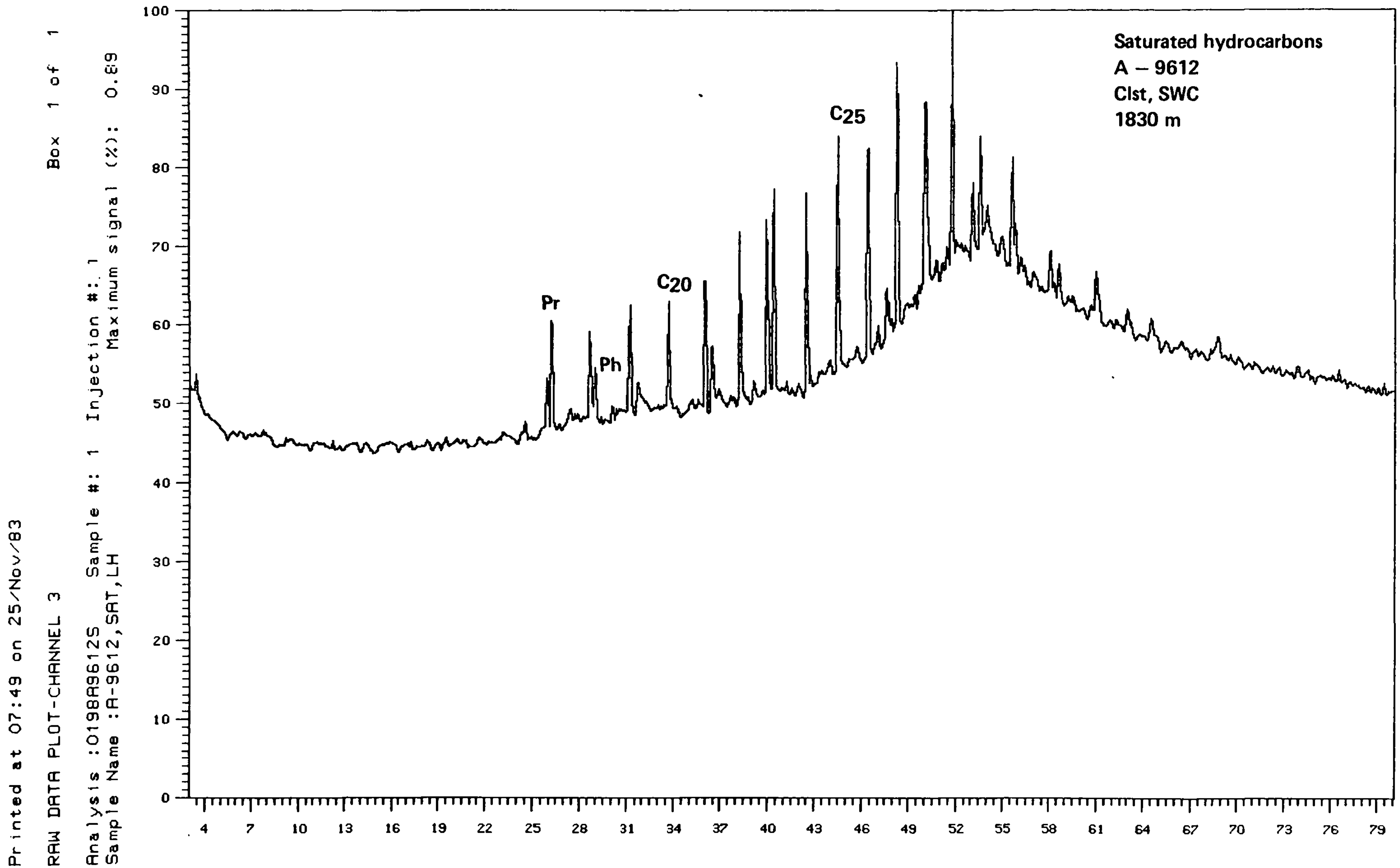

Printed at 12:03 on 23/Nov/83
RAW DATA PLOT-CHANNEL 3
Box 1 of 1
Analysis :0198A9552S Sample #: 1 Injection #: 1
Sample Name :A-9552,SAT,LH Maximum signal (%): 0.94
100
90
80
70
60
50
40
30
20
10
0
4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79
Pr
Ph
C20
C25
Saturated hydrocarbons
A - 9552
Clst, cuttings
1540 m

Printed at 07:51 on 25/Nov/83

RAW DATA PLOT-CHANNEL 3

Analysis :0198A9611S Sample #: 1 Injection #: 1 Box 1 of 1
Sample Name :A-9611,SAT,LH Maximum signal (%): 0.66




Printed at 07:49 on 25/Nov/83
RAW DATA PLOT-CHANNEL 3
Box 1 of 1
Analysis :0198A9612S
Sample #: 1
Injection #: 1
Sample Name :A-9612,SAT,LH
Maximum signal (%): 0.89
Saturated hydrocarbons
A – 9612
Clst, SWC
1830 m
Pr
Ph
C20
C25
100
90
80
70
60
50
40
30
20
10
0
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79

Printed at 10:47 on 25/Nov/83

RAW DATA PLOT-CHANNEL 3

Analysis :0198A9613S Sample #: 1 Injection #: 1 Box 1 of 1

Sample Name :A-9613,SAT,LH Maximum signal (''): 1.48

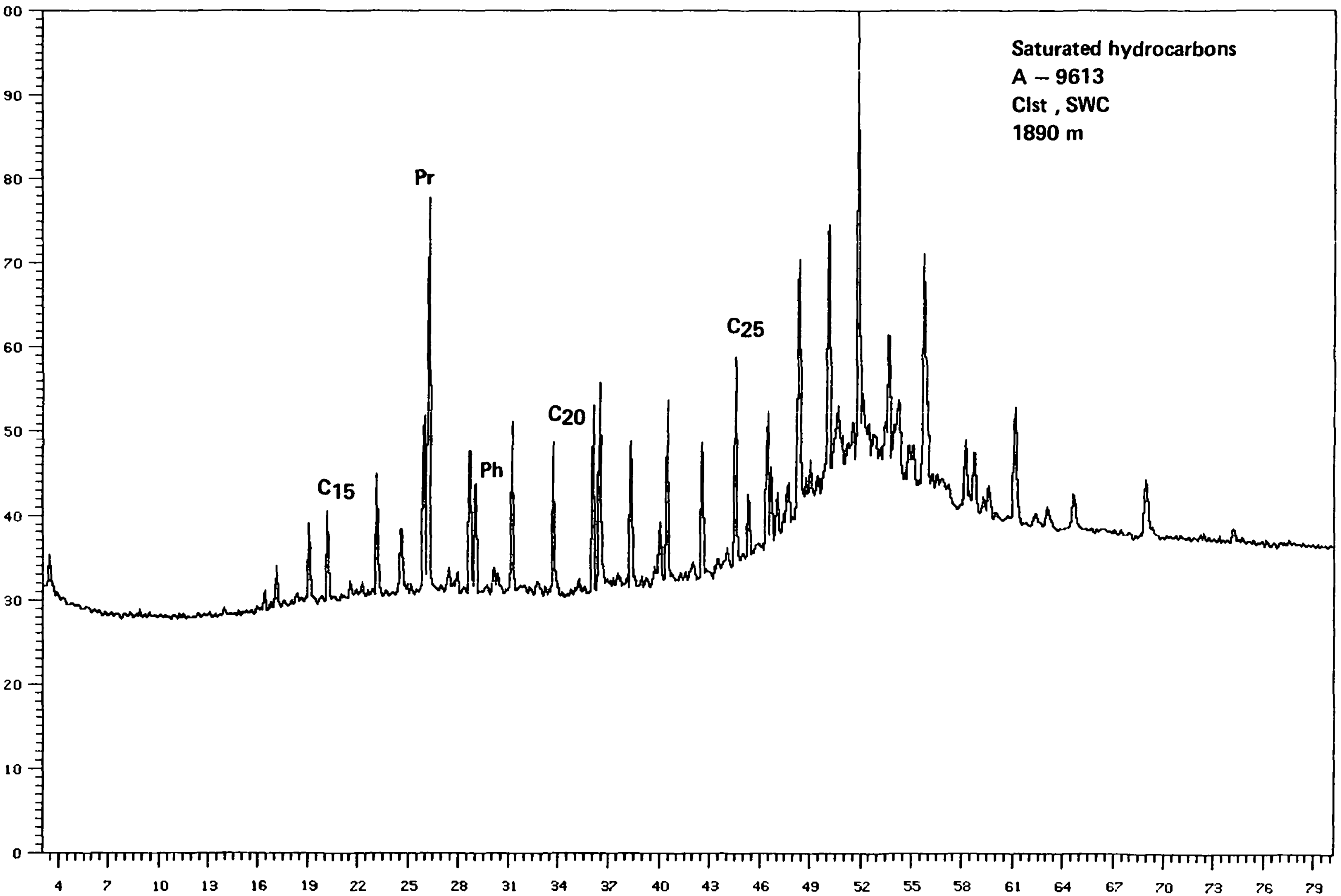


Figure 2

Gas chromatograms of C_{15}+
branched/cyclic hydrocarbons

Pr - pristane
Ph - phytane
iso-C_{15} - isoprenoids with the respective numbers of C-atoms
* - contamination

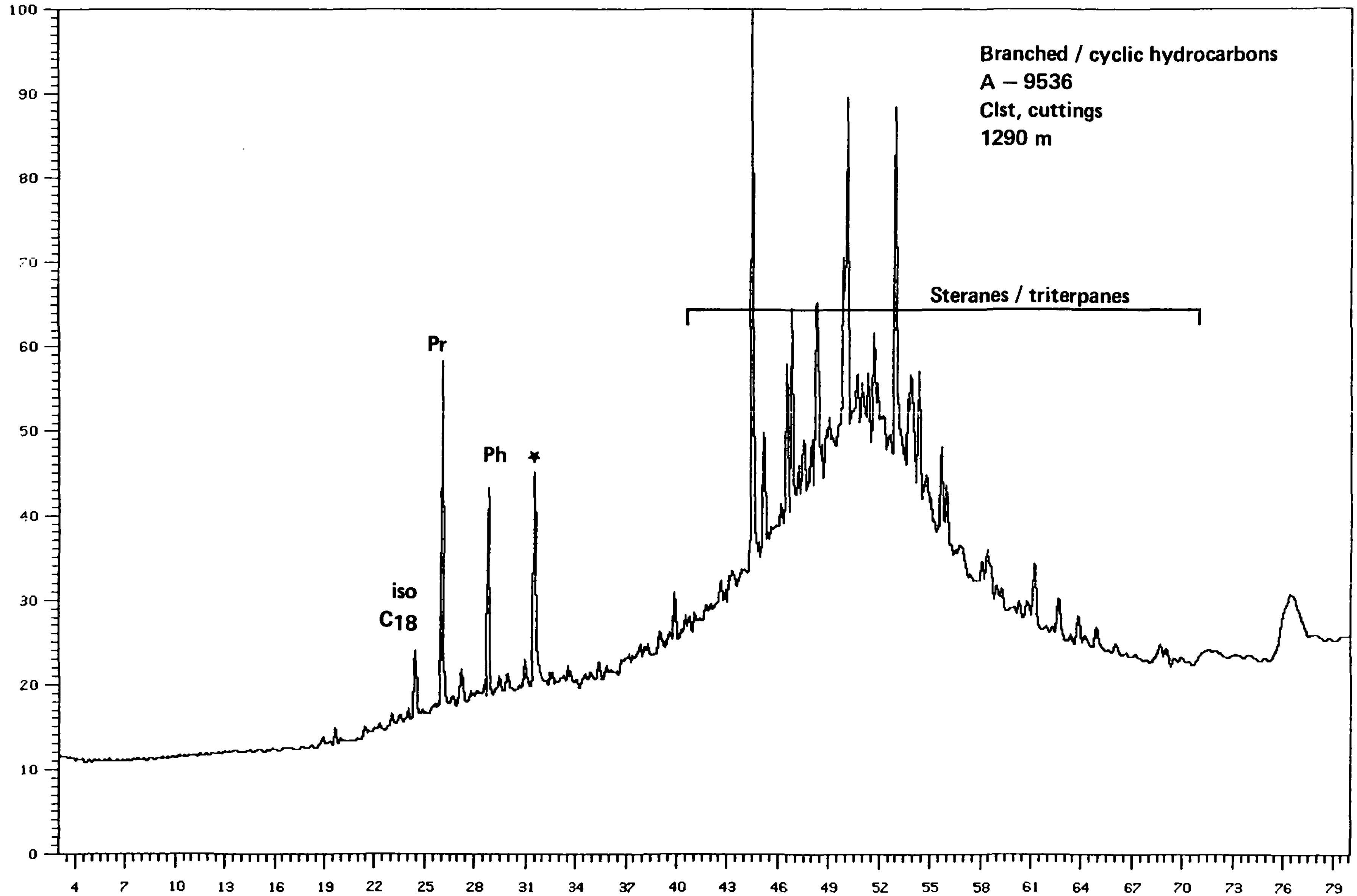
Box 1 of 1

Printed at 15:26 on 02/Dec/83

RAW DATA PLOT-CHANNEL 3

Analysis :050198A9536B Sample #: 1 Injection #: 1

Sample Name :A9536,B/C,EH Maximum signal (%): 3.24

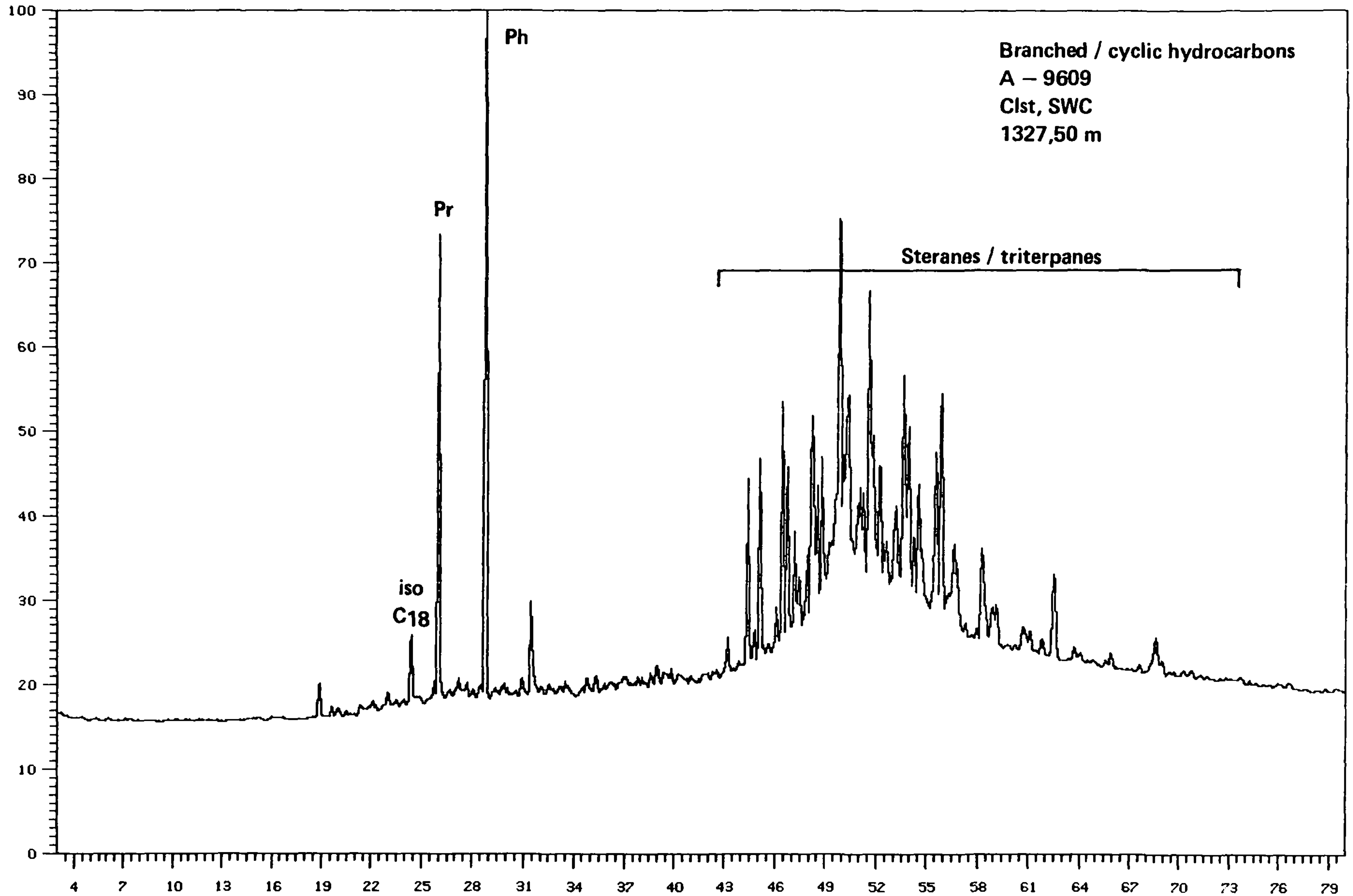


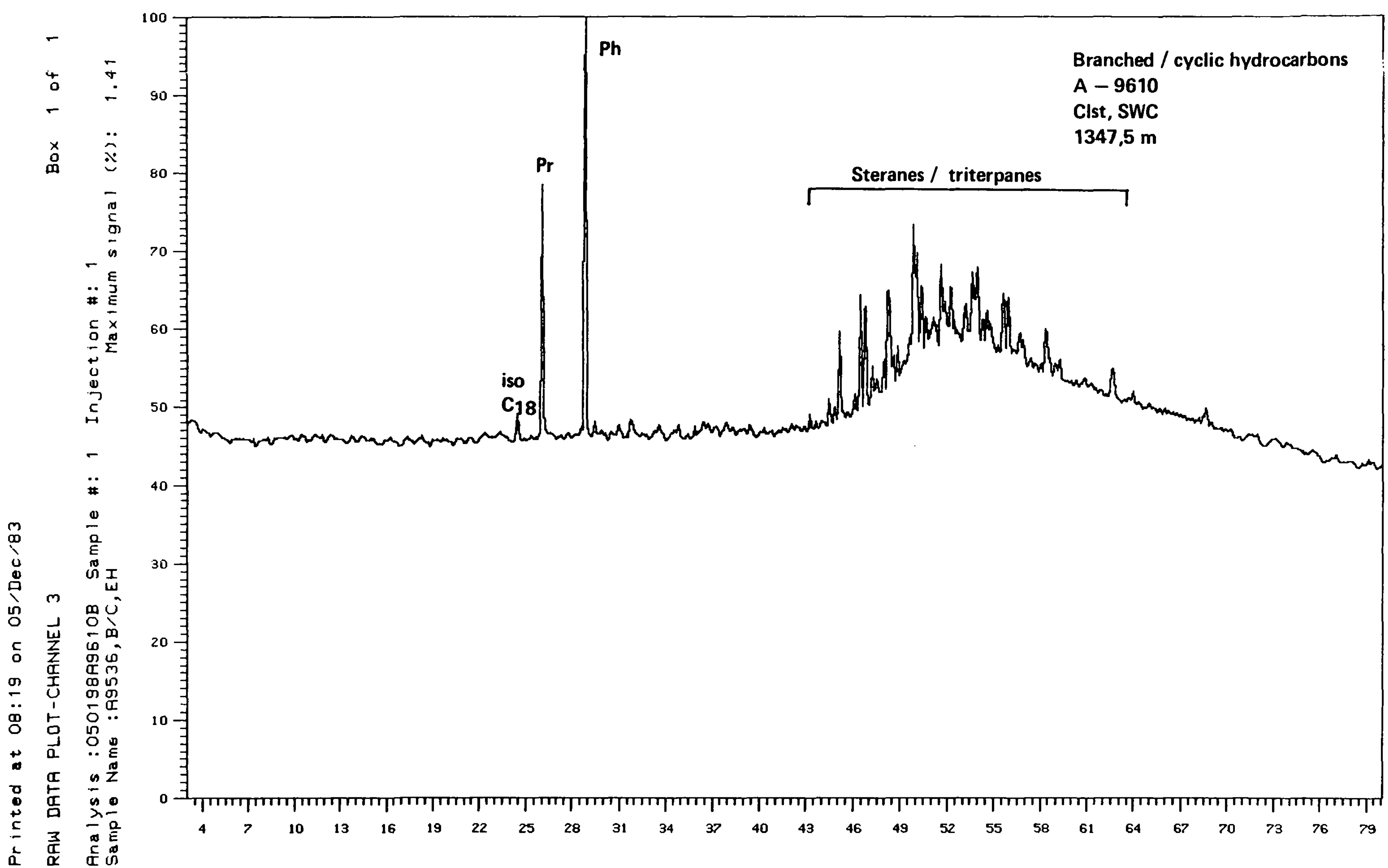
Printed at 08:16 on 05/Dec/83

RAW DATA PLOT-CHANNEL 3

Analysis :05019BA9609B Sample #: 1 Injection #: 1
Sample Name :A9536,B/C,EH Maximum signal (%): 4.02

Box 1 of 1





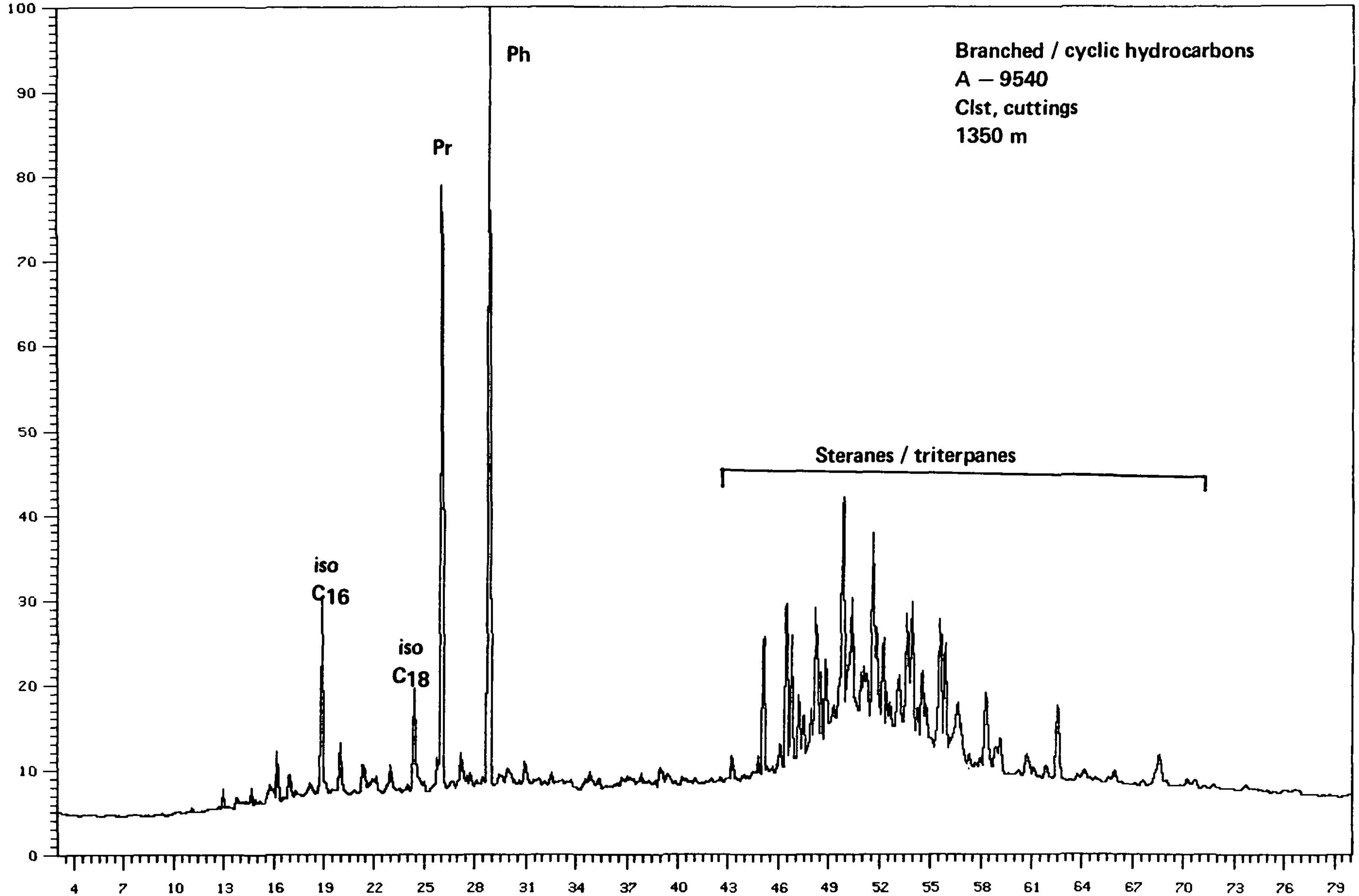
Printed at 08:19 on 05/Dec/83
RAW DATA PLOT-CHANNEL 3
Analysis :05019BA9610B Sample #: 1 Injection #: 1
Sample Name :A9536,B/C,EH Maximum signal (%): 1.41
Box 1 of 1
Branched / cyclic hydrocarbons
A – 9610
Clst, SWC
1347,5 m
Steranes / triterpanes
Ph
Pr
iso
C18

Printed at 12:20 on 02/Dec/83

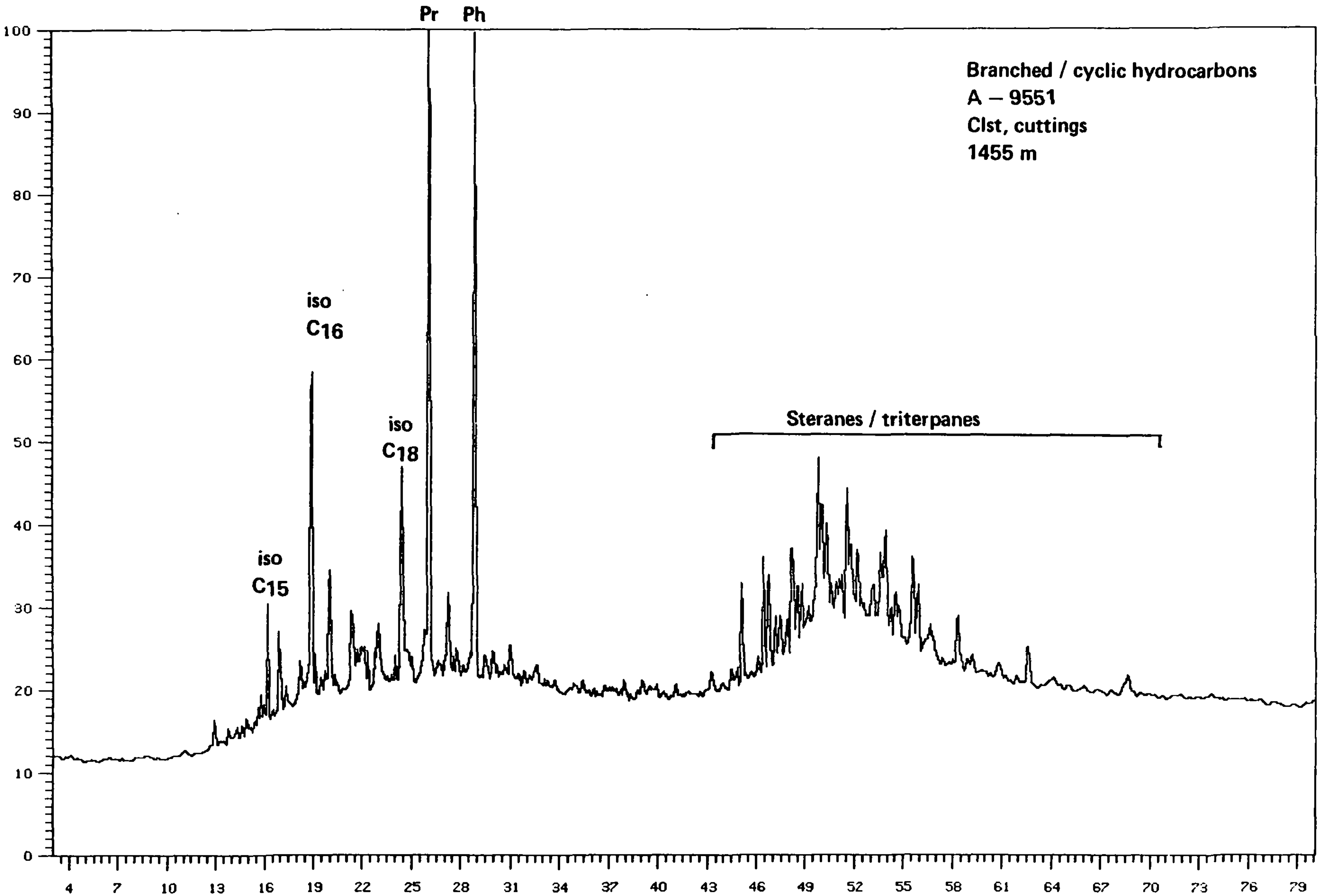
RAW DATA PLOT-CHANNEL 3

Analysis :050198A9540B Sample #: 1 Injection #: 1
Sample Name :A9540,B/C,EH Maximum signal (%): 8.62

Box 1 of 1



Printed at 13:50 on 02/Dec/83
Box 1 of 1
RAW DATA PLOT-CHANNEL 3
Analysis :050198A9551B Sample #: 1 Injection #: 1
Sample Name :A9551,B/C,EH Maximum signal (%): 3.37



Printed at 08:21 on 05/Dec/83

RAW DATA PLOT-CHANNEL 3 Box 1 of 1

Analysis :050198A9613B Sample #: 1 Injection #: 1

Sample Name :A9536,B/C,EH Maximum signal (%): 5.21

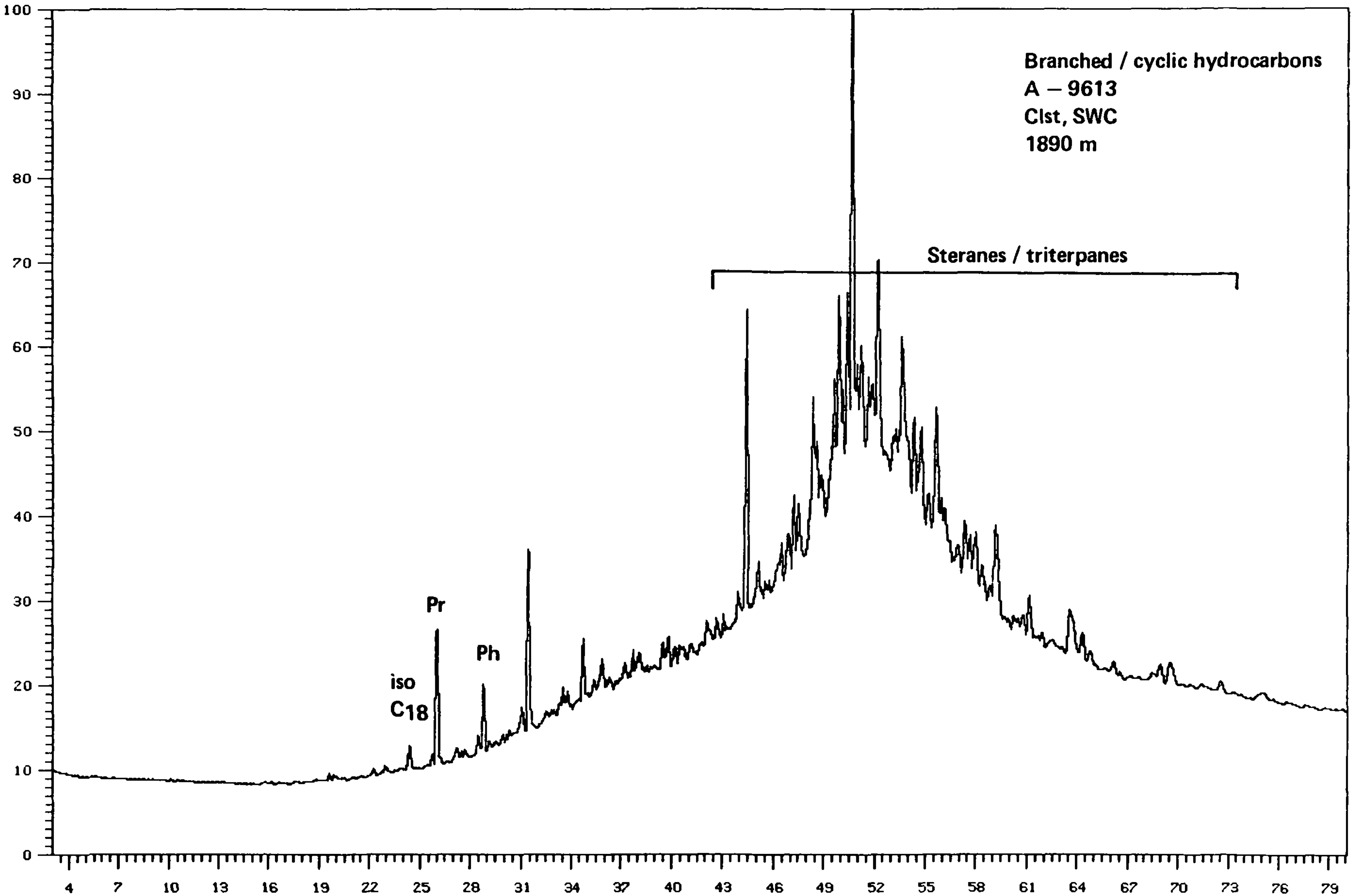
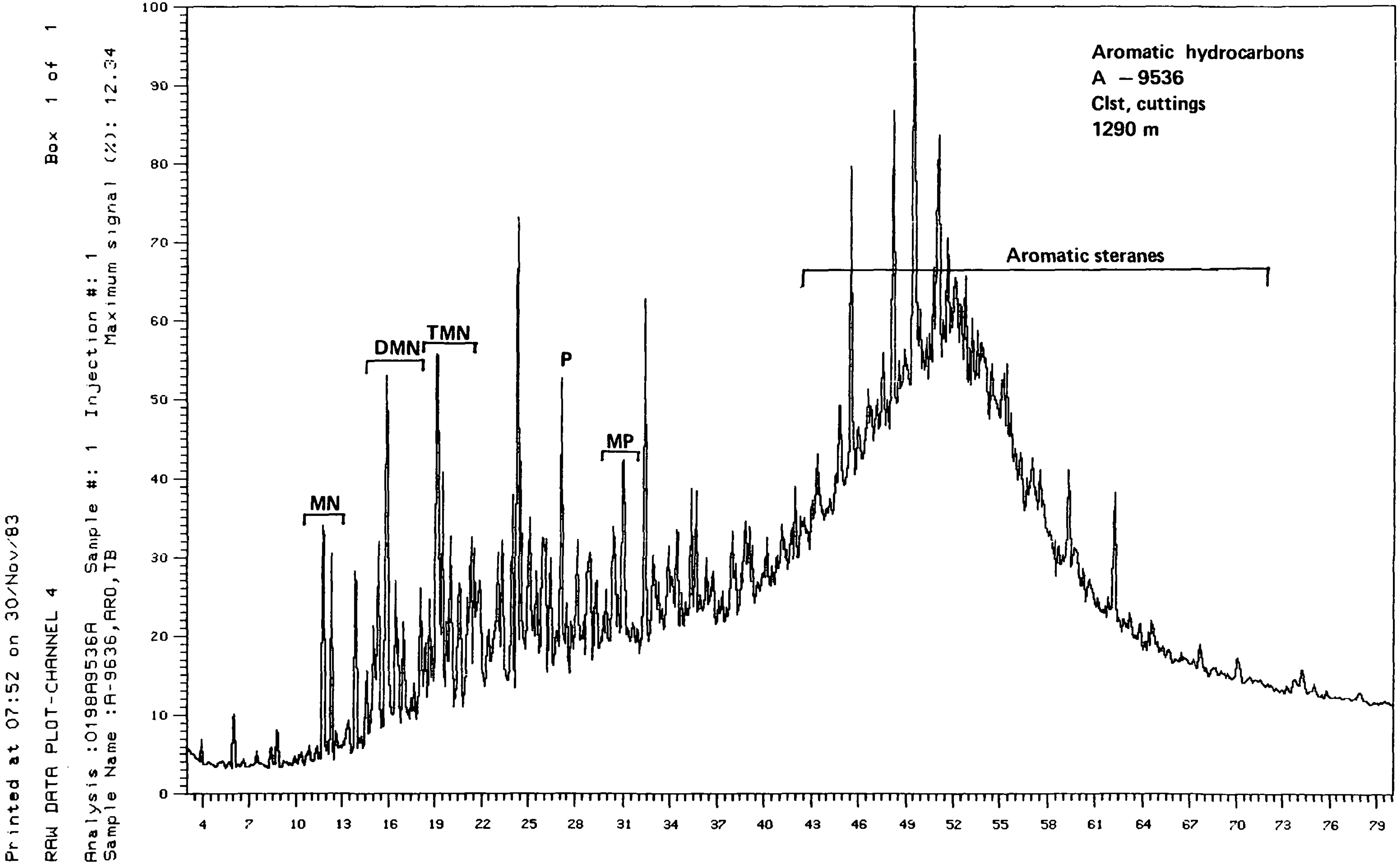


Figure 3

Gas chromatograms of C_{15}+
aromatic hydrocarbons

N	-	naphtalene
MN	-	C_1-naphtalenes
DMN	-	C_2-naphtalenes
TMN	-	C_3-naphtalenes
P	-	phenanthrene
MP	-	C_1-phenanthrenes
DMP	-	C_2-phenanthrenes


Printed at 07:52 on 30/Nov/83
RAW DATA PLOT-CHANNEL 4
Box 1 of 1
Analysis :0198A9536A Sample #: 1 Injection #: 1
Sample Name :A-9636,ARO,TB Maximum signal (%): 12.34
Aromatic hydrocarbons
A – 9536
Clst, cuttings
1290 m
Aromatic steranes
MN
DMN
TMN
P
MP

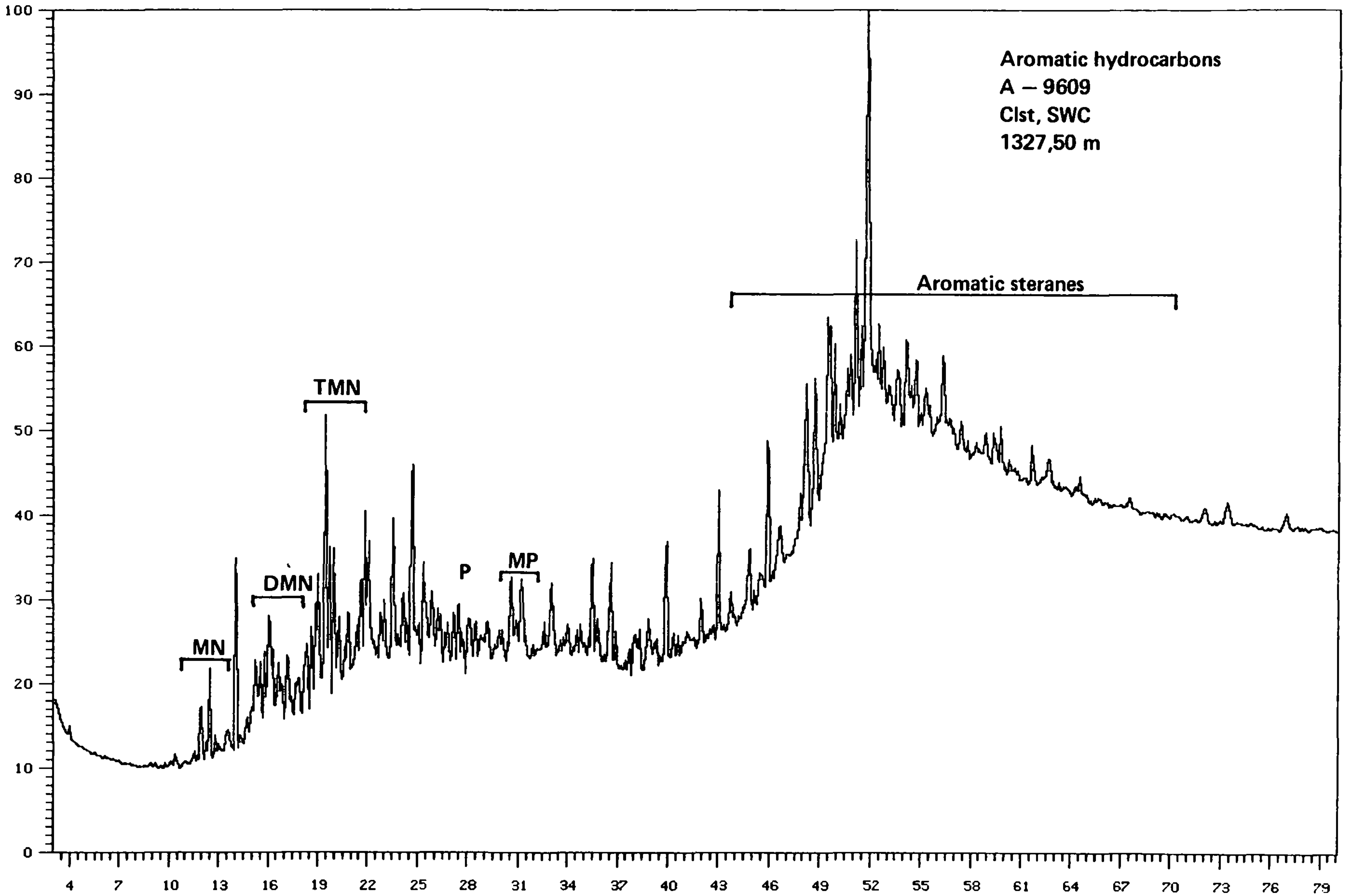
Printed at 10:12 on 01/Dec/83

RAW DATA PLOT-CHANNEL 4

Box 1 of 1

Analysis :0198A9609A Sample #: 1 Injection #: 1

Sample Name :A=9609,ARO,LH Maximum signal (%): 3.06



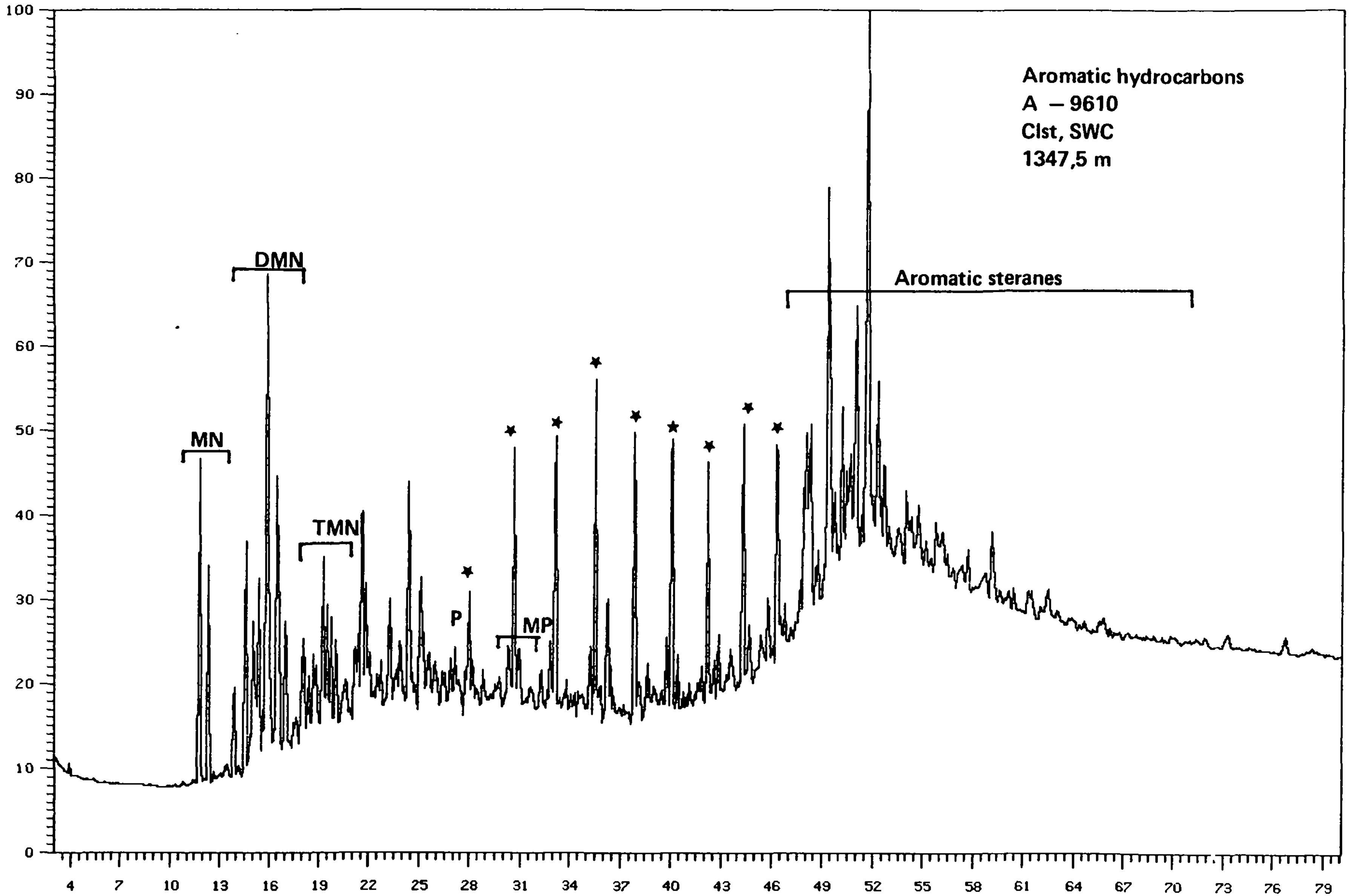
Printed at 12:11 on 01/Dec/83

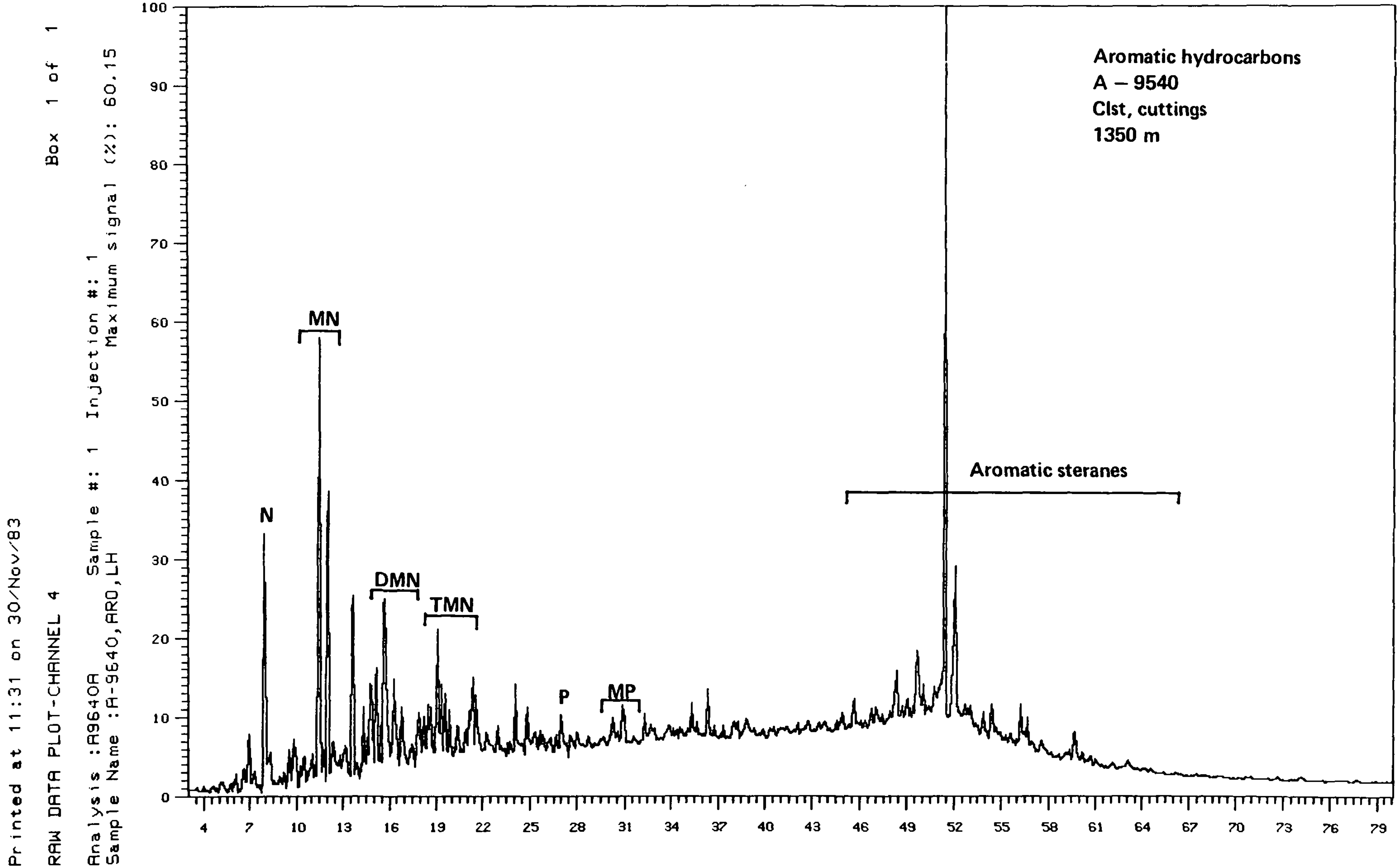
RAW DATA PLOT-CHANNEL 4

Box 1 of 1

Analysis :0198A9610A Sample #: 1 Injection #: 1

Sample Name :A-9610,ARO,LH Maximum signal (%): 5.09

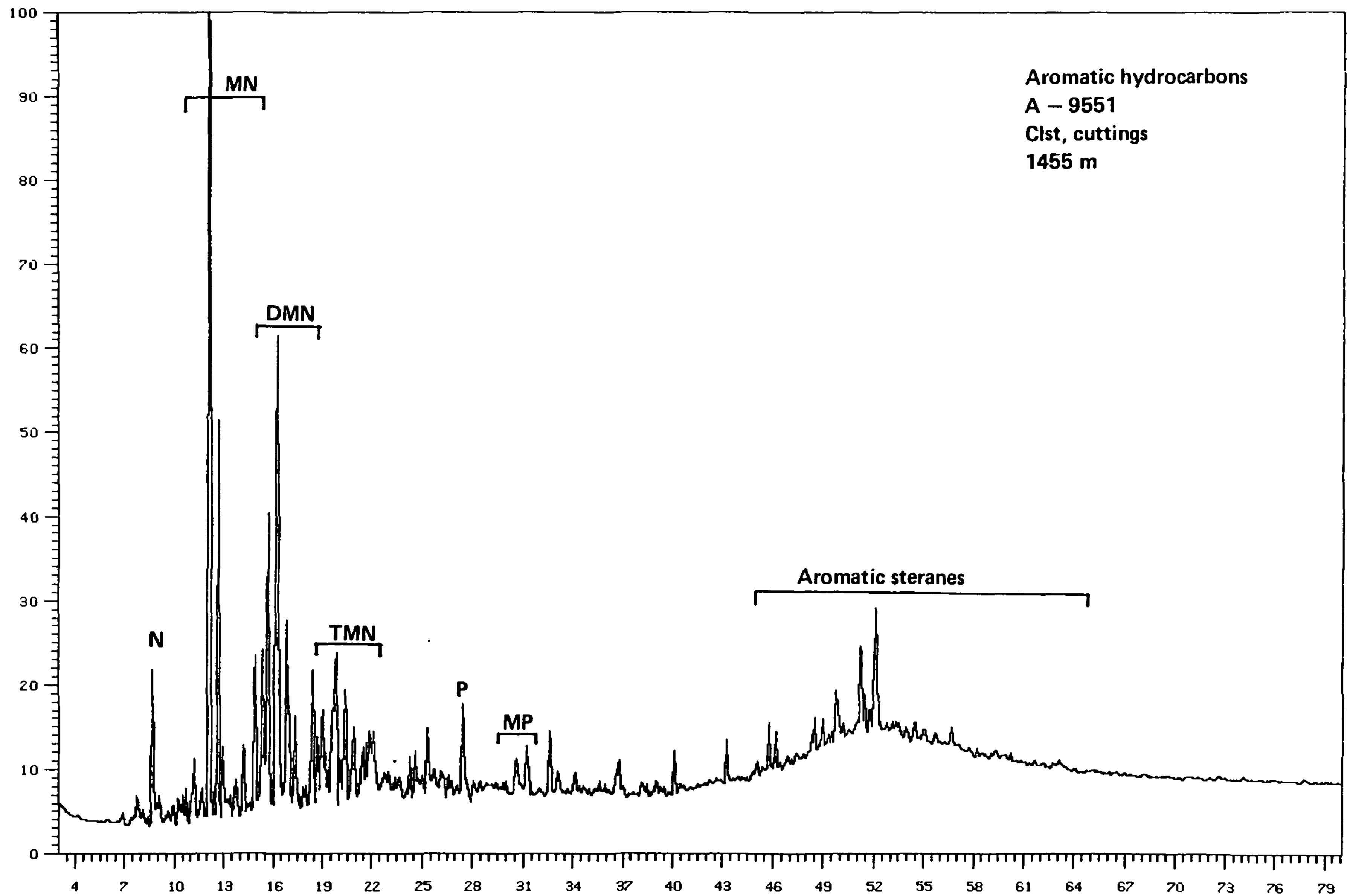



Printed at 11:31 on 30/Nov/83
RAW DATA PLOT-CHANNEL 4
Box 1 of 1
Analysis :A9640A
Sample #: 1
Injection #: 1
Sample Name :A-9540,ARO,LH
Maximum signal (%): 60.15
Aromatic hydrocarbons
A – 9540
Clst, cuttings
1350 m
N
MN
DMN
TMN
P
MP
Aromatic steranes
0
10
20
30
40
50
60
70
80
90
100
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79

Printed at 13:37 on 30/Nov/83

RAW DATA PLOT-CHANNEL 4 Box 1 of 1

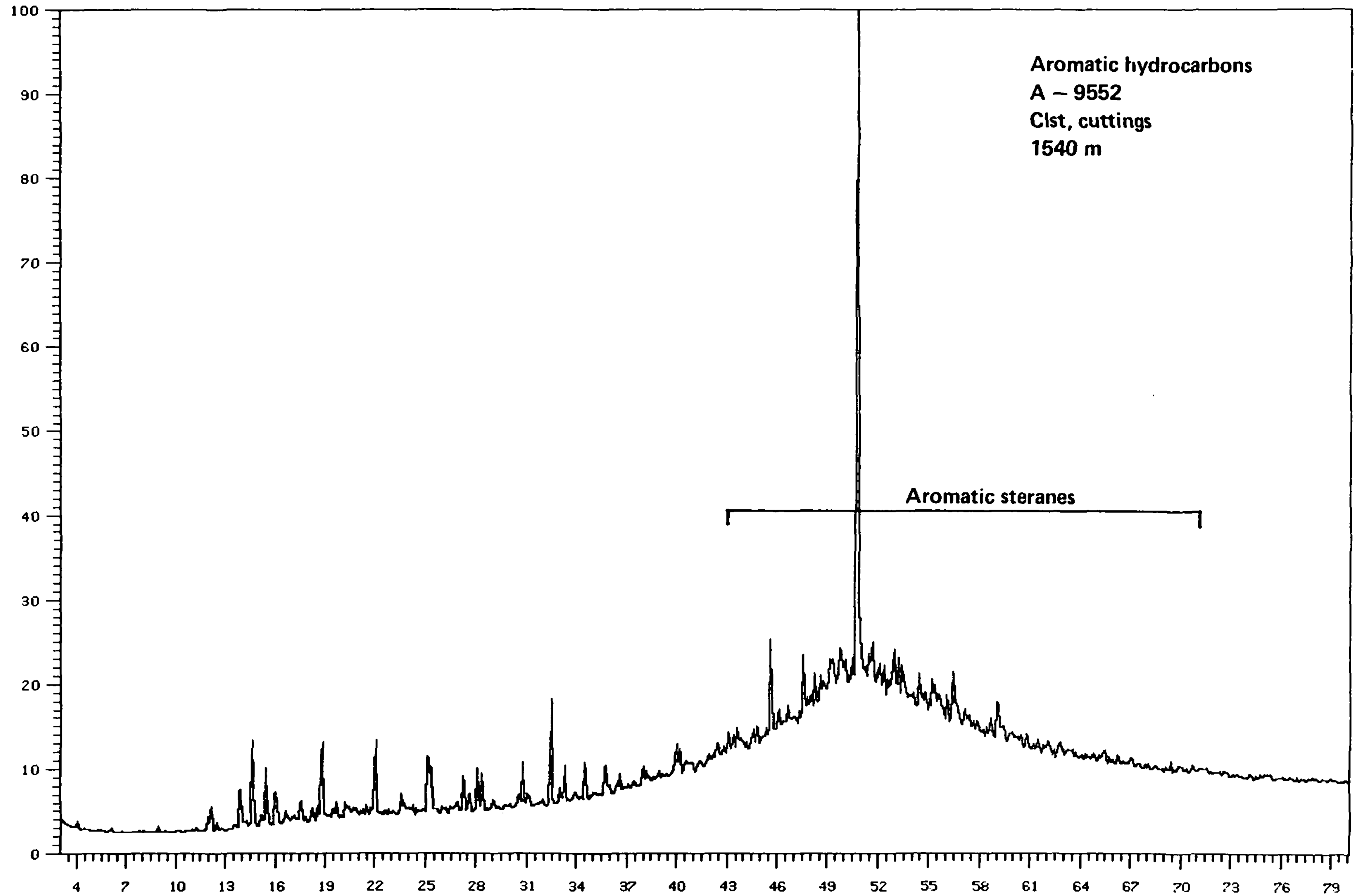
Analysis :0198A9551A Sample #: 1 Injection #: 1
Sample Name :A-9551,ARO,LH Maximum signal (%): 11.03



Printed at 16:58 on 30/Nov/83

RAW DATA PLOT-CHANNEL 4 Box 1 of 1

Analysis :0198A9552A2 Sample #: 1 Injection #: 1
Sample Name :A-9552,ARO,LH Maximum signal (%): 12.27

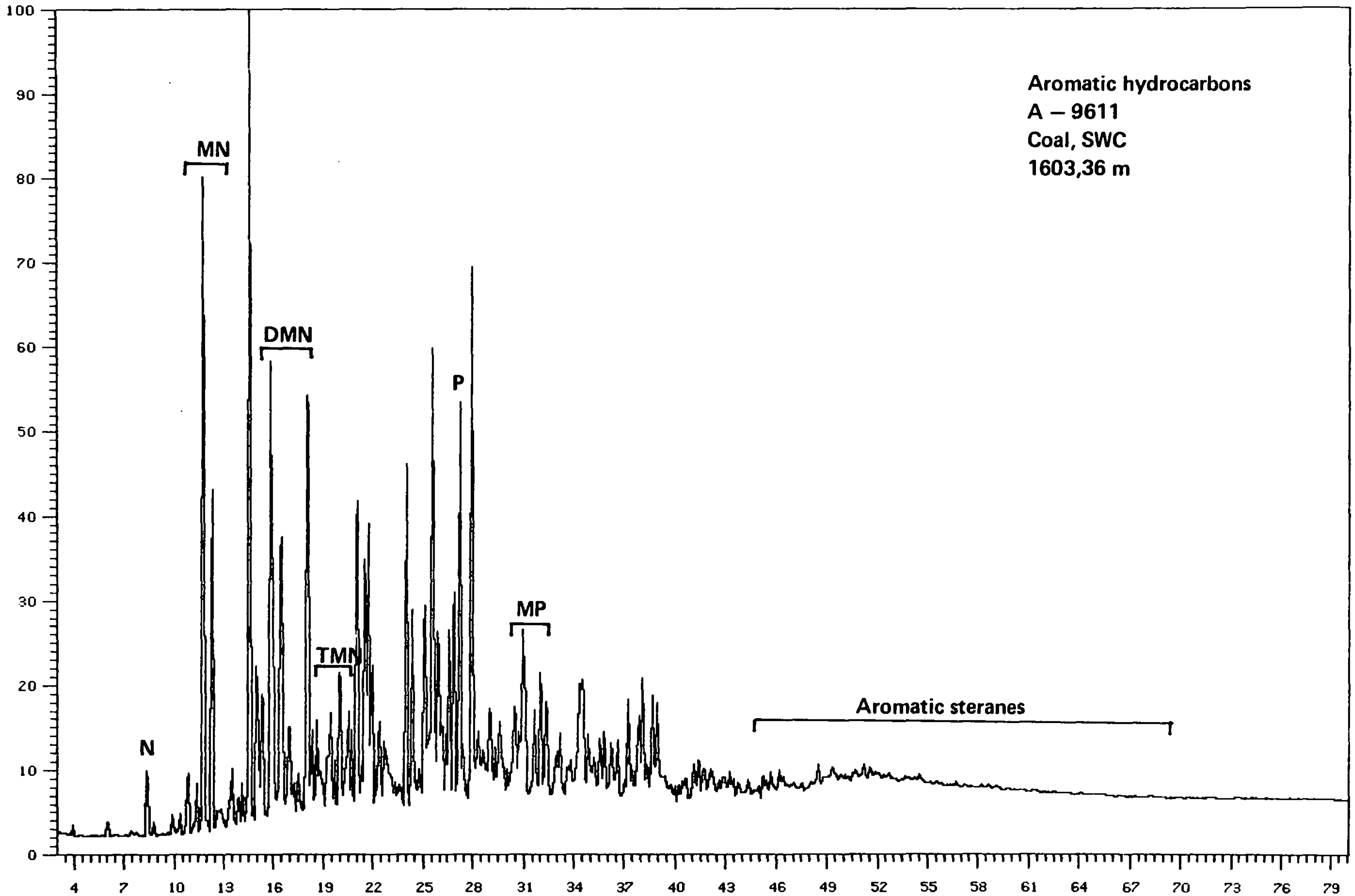


Printed at 13:46 on 01/Dec/83

RAW DATA PLOT-CHANNEL 4

Analysis :0198A9611A Sample #: 1 Injection #: 1 Box 1 of 1

Sample Name :A-9611,ARO,LH Maximum signal (%): 17.57

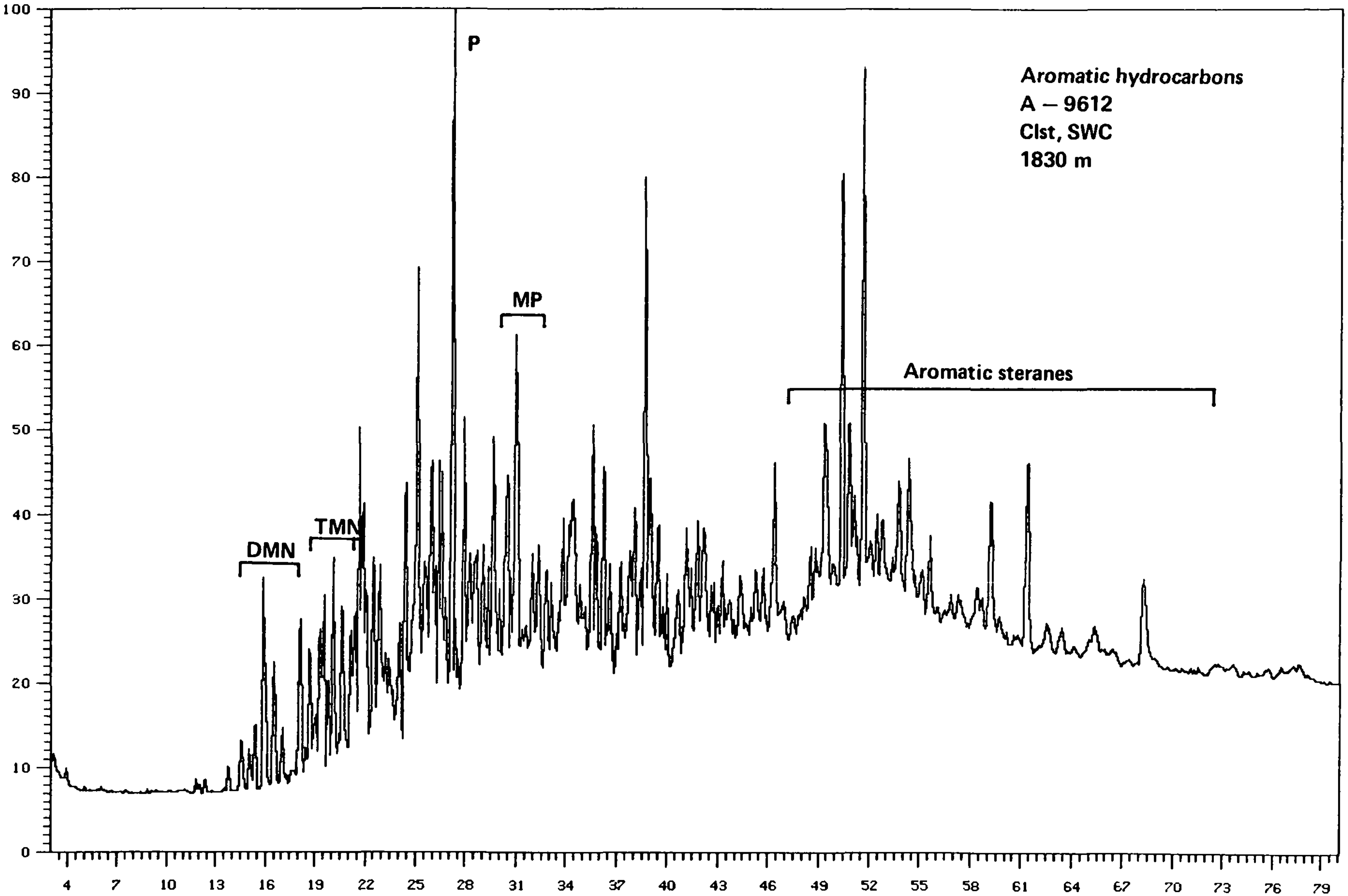


Printed at 15:36 on 01/Dec/83

RAW DATA PLOT-CHANNEL 4

Analysis :0198A9612A Sample #: 1 Injection #: 1 Box 1 of 1

Sample Name :A-9612,ARO,LH Maximum signal (%): 5.92



Printed at 07:34 on 02/Dec/83
Box 1 of 1

RAW DATA PLOT-CHANNEL 4

Analysis :0198A9613A Sample #: 1 Injection #: 1
Sample Name :A-9613,ARO,LH Maximum signal (%): 4.24

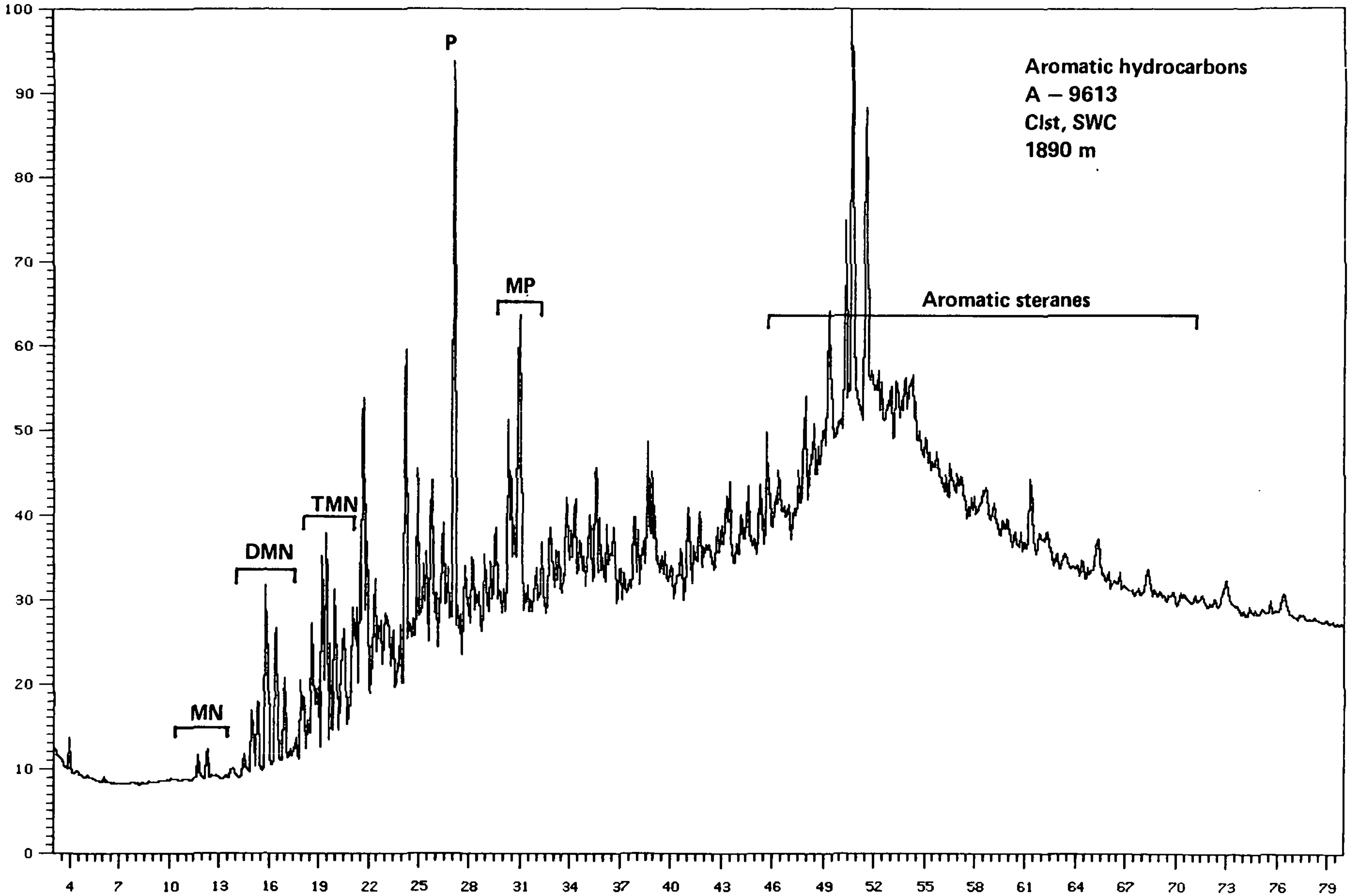
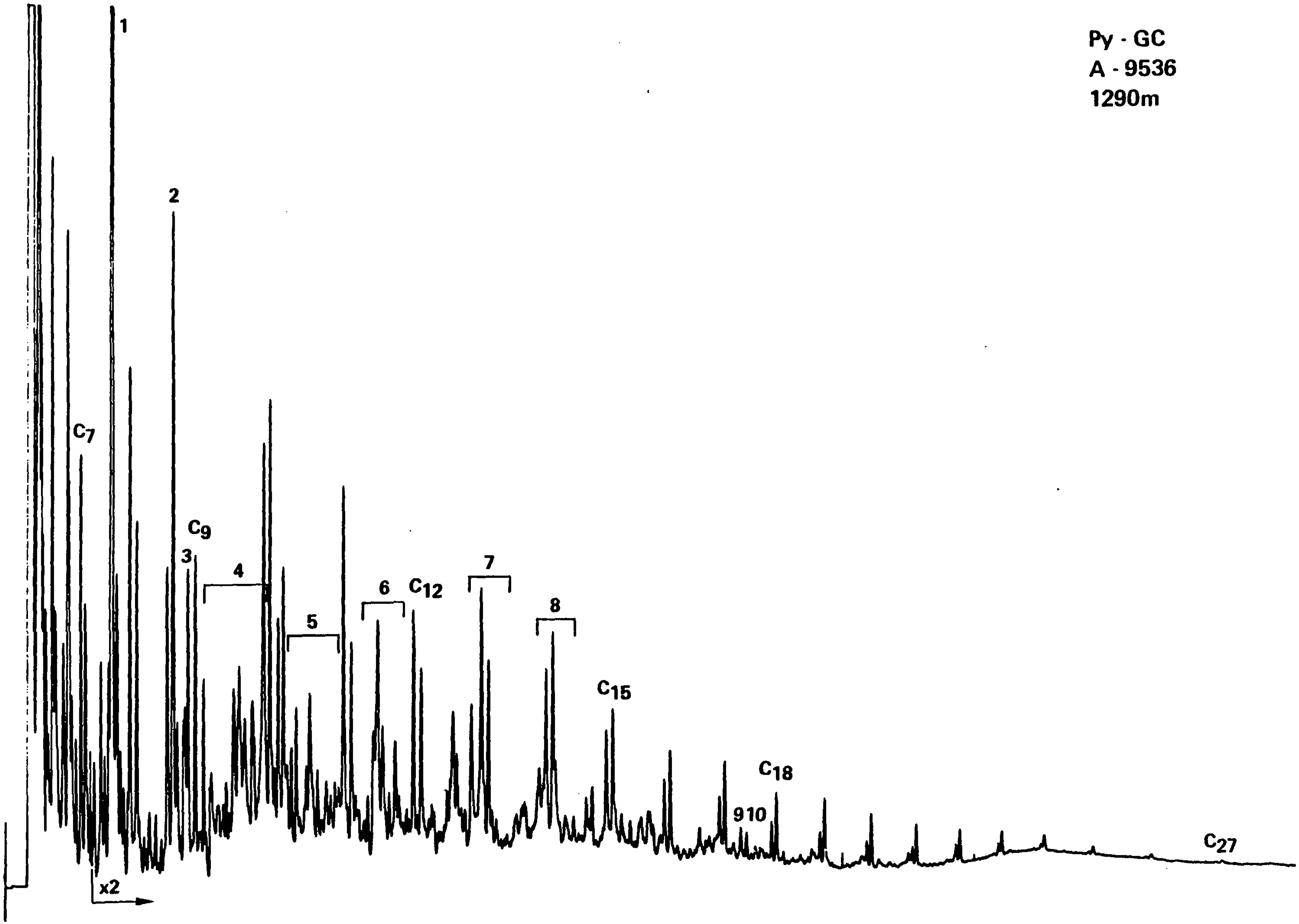
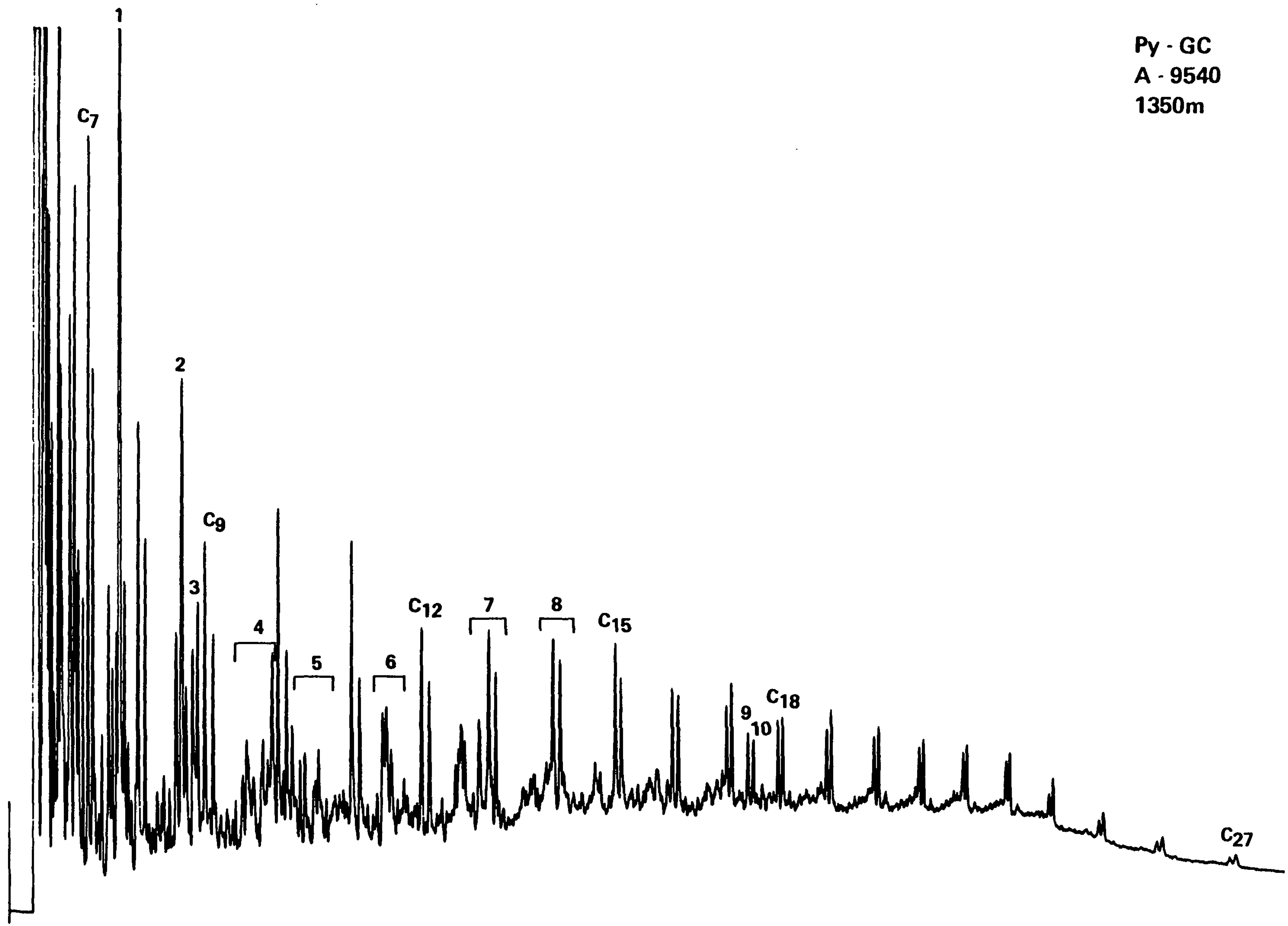


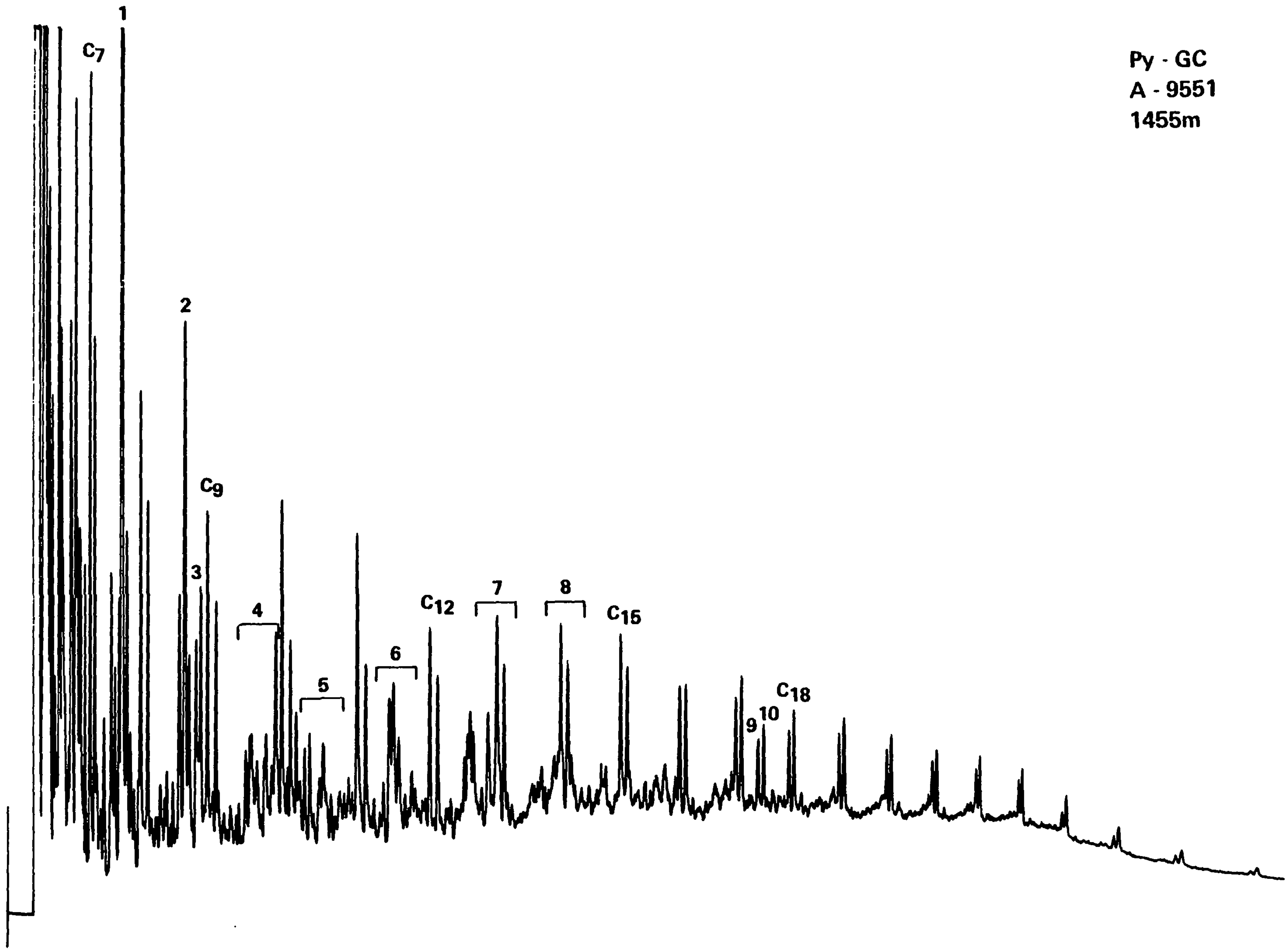
Figure 4

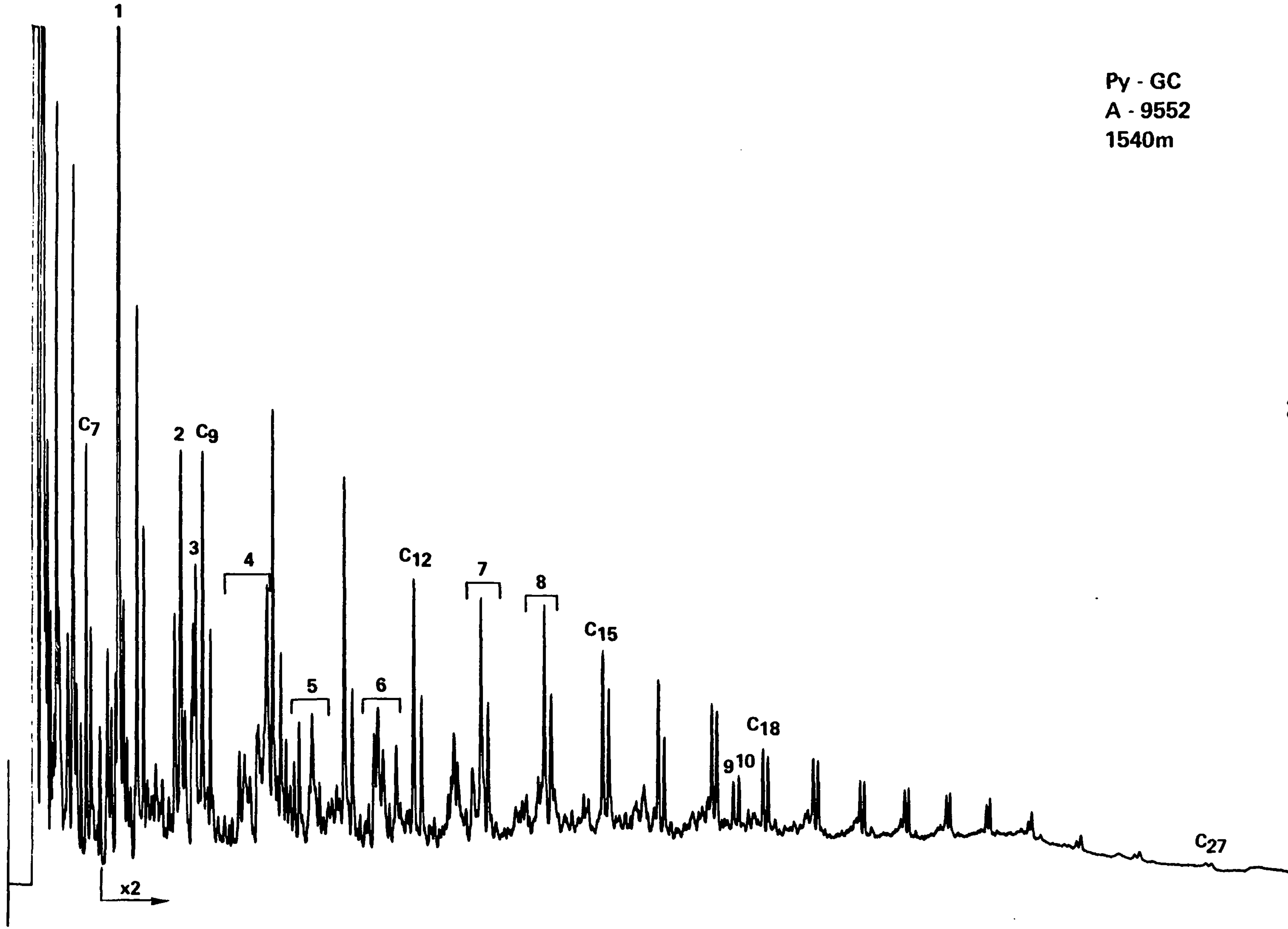
Pyrolysis gas chromatograms

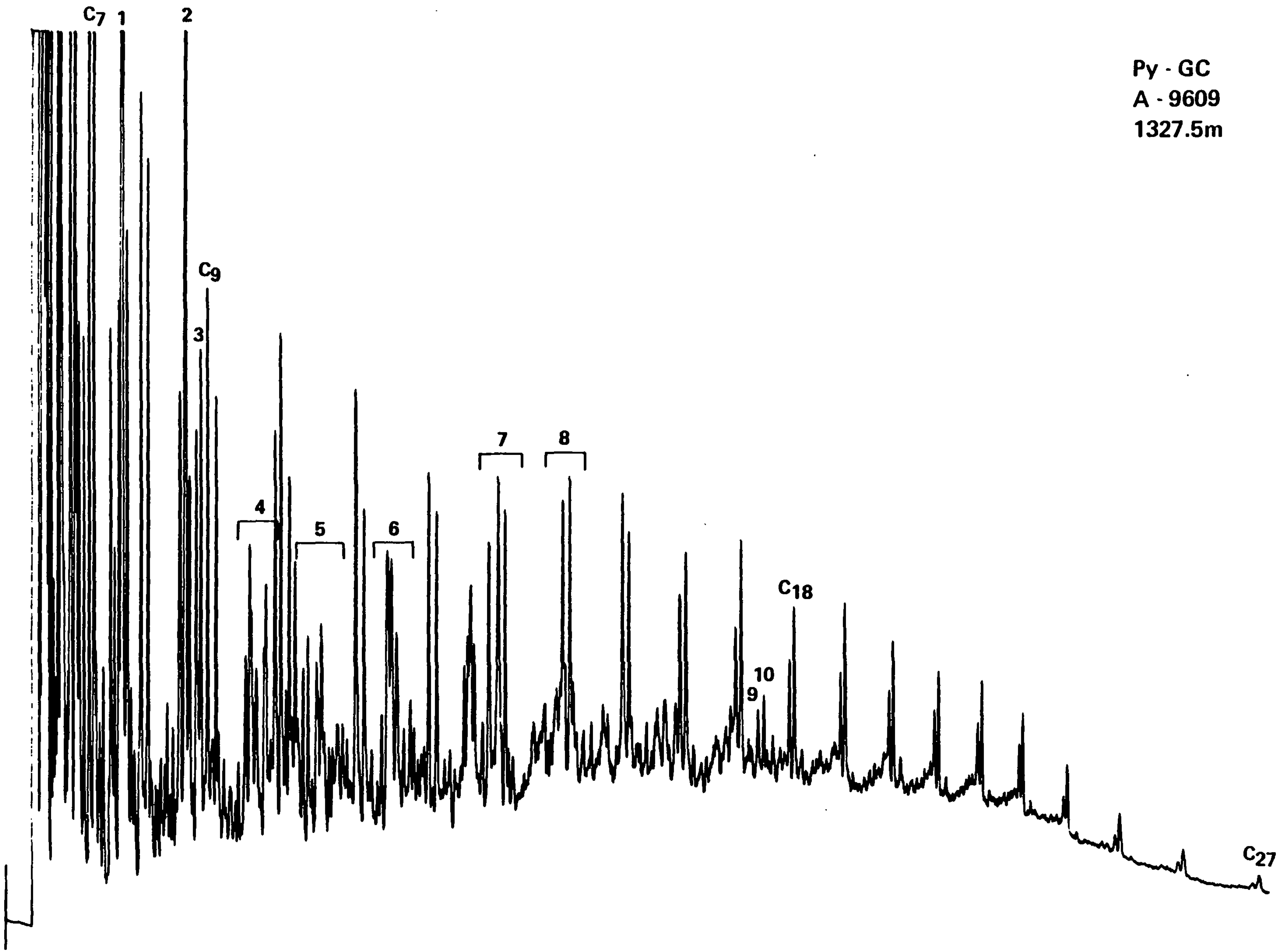
1	-	toluene
2	-	(m+p)-xylenes
3	-	o-xylene
4	-	C_3-alkylbenzenes + phenol
5	-	C_4-alkylbenzenes + C_1-phenols
6	-	C_1-indane/-indene + C_4- and C_5 alkylbenzenes + C_2-phenols and naphtalene
7	-	C_{13}-alkane/alkane + C_1-alkylnaphtalenes
8	-	C_{14}-alkene/alkane + C_2-alkylnaphtalenes
9	-	prist-1-ene
10	-	pirst-2-ene
P	-	phenol
C_1P	-	C_1-phenols

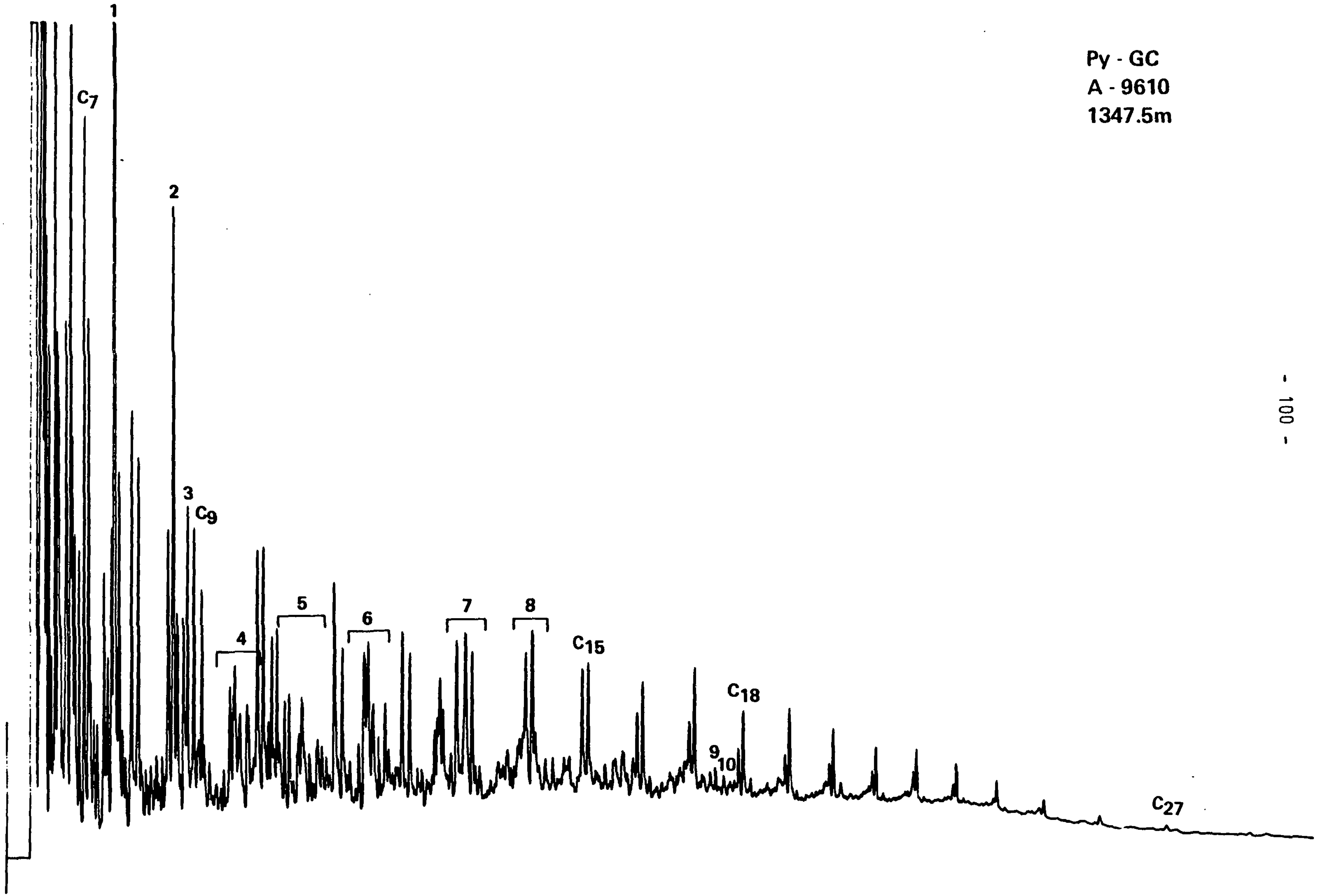

Py - GC
A - 9536
1290m
1
2
C7
C9
3
4
5
6
C12
7
8
C15
C18
910
C27
x2

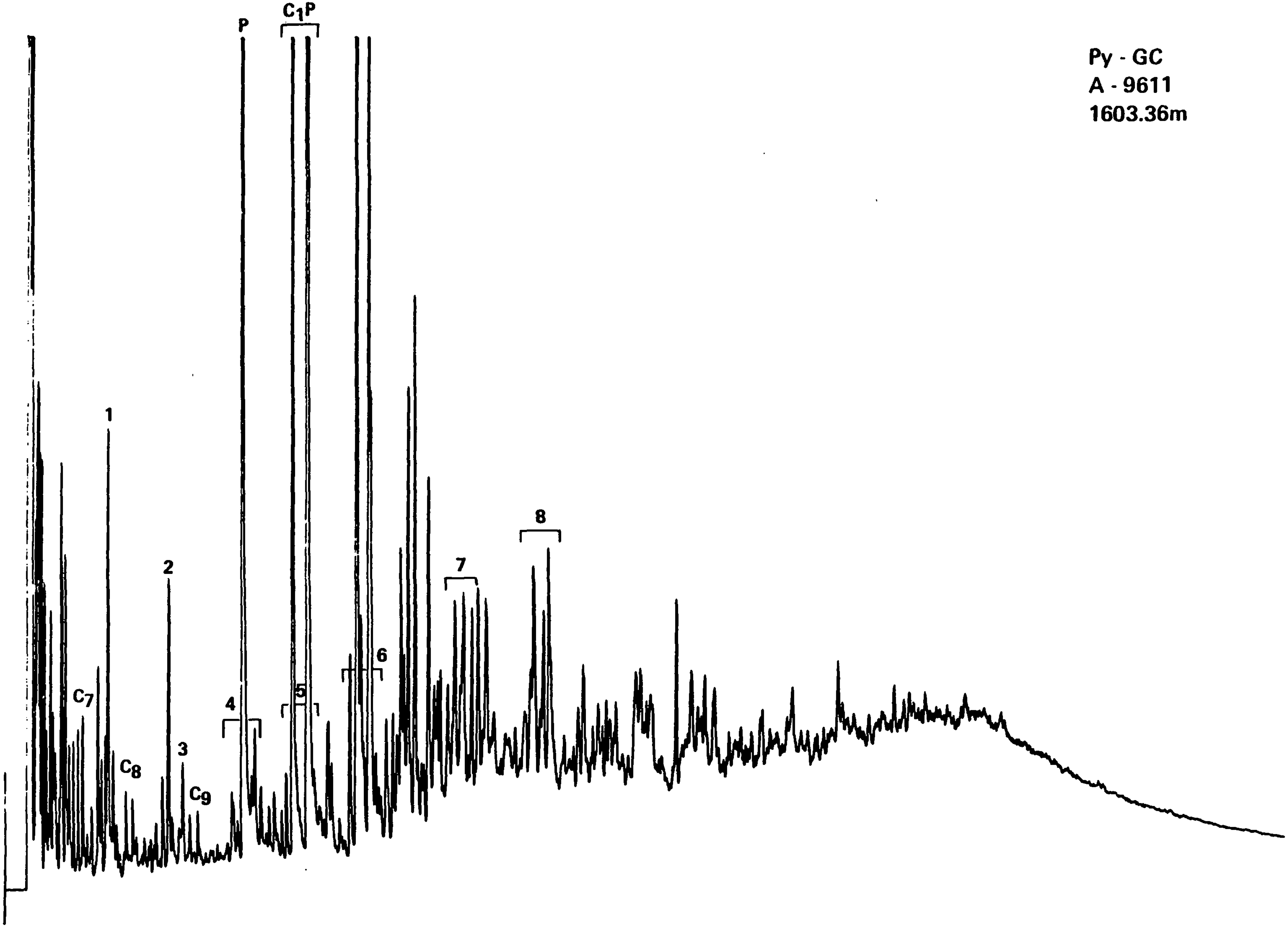

Py - GC
A - 9540
1350m
C7
1
2
C9
3
4
5
6
C12
7
8
C15
9
10
C18
C27

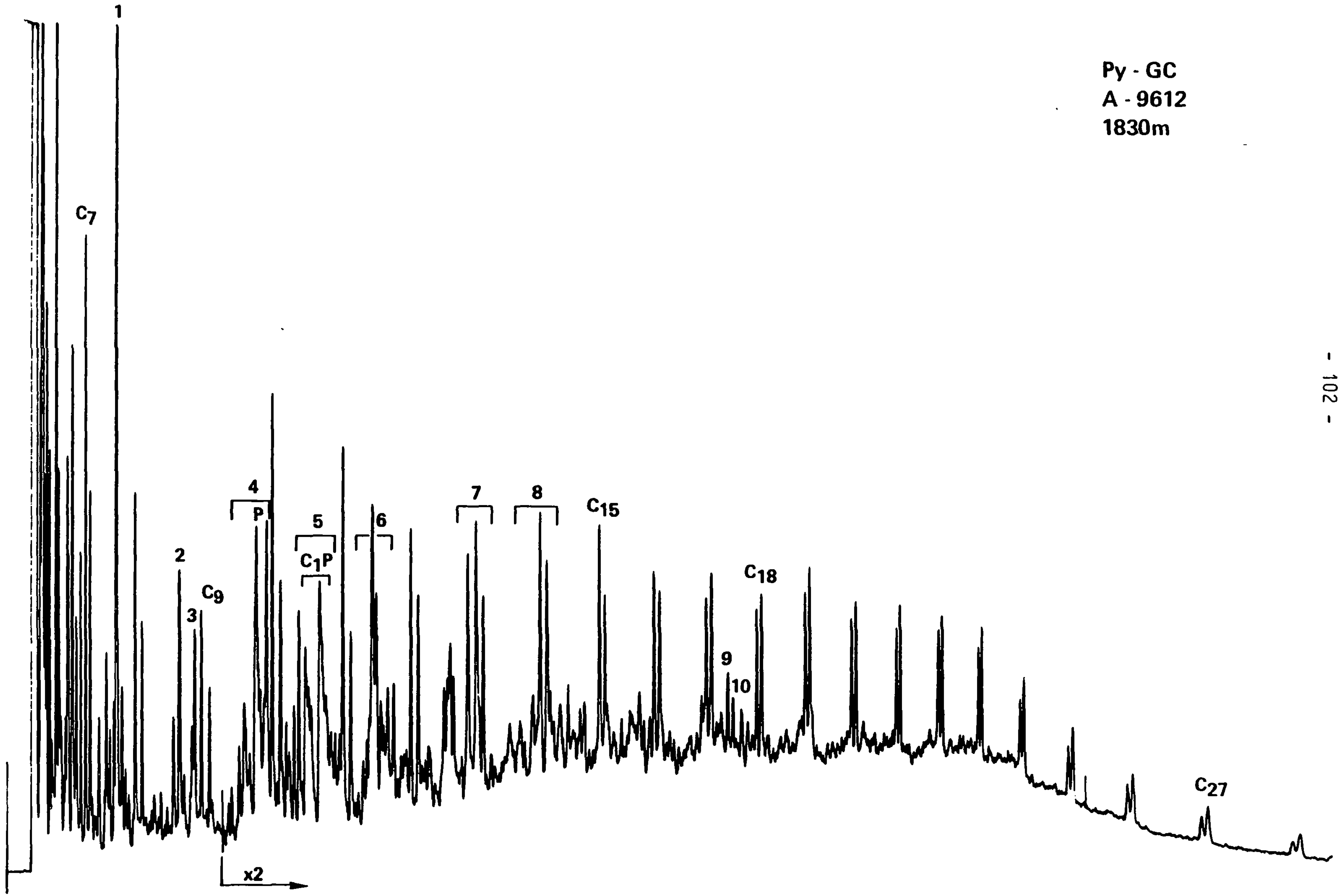

Py - GC
A - 9551
1455m
C7
1
2
3
C9
4
5
6
C12
7
8
C15
9
10
C18


Py - GC
A - 9552
1540m
1
C7
2
C9
3
4
5
6
C12
7
8
C15
9
10
C18
C27
x2


Py - GC
A - 9609
1327.5m
C7
1
2
C9
3
4
5
6
7
8
9
10
C18
C27


Py - GC
A - 9610
1347.5m
1
2
3
4
5
6
7
8
9
10
C7
C9
C15
C18
C27


Py - GC
A - 9611
1603.36m
P
C_1P
1
2
3
4
5
6
7
8
C_7
C_8
C_9


Py - GC
A - 9612
1830m
1
C_7
2
3
C_9
4
P
5
C_1P
6
7
8
C_{15}
9
10
C_{18}
C_{27}
x2

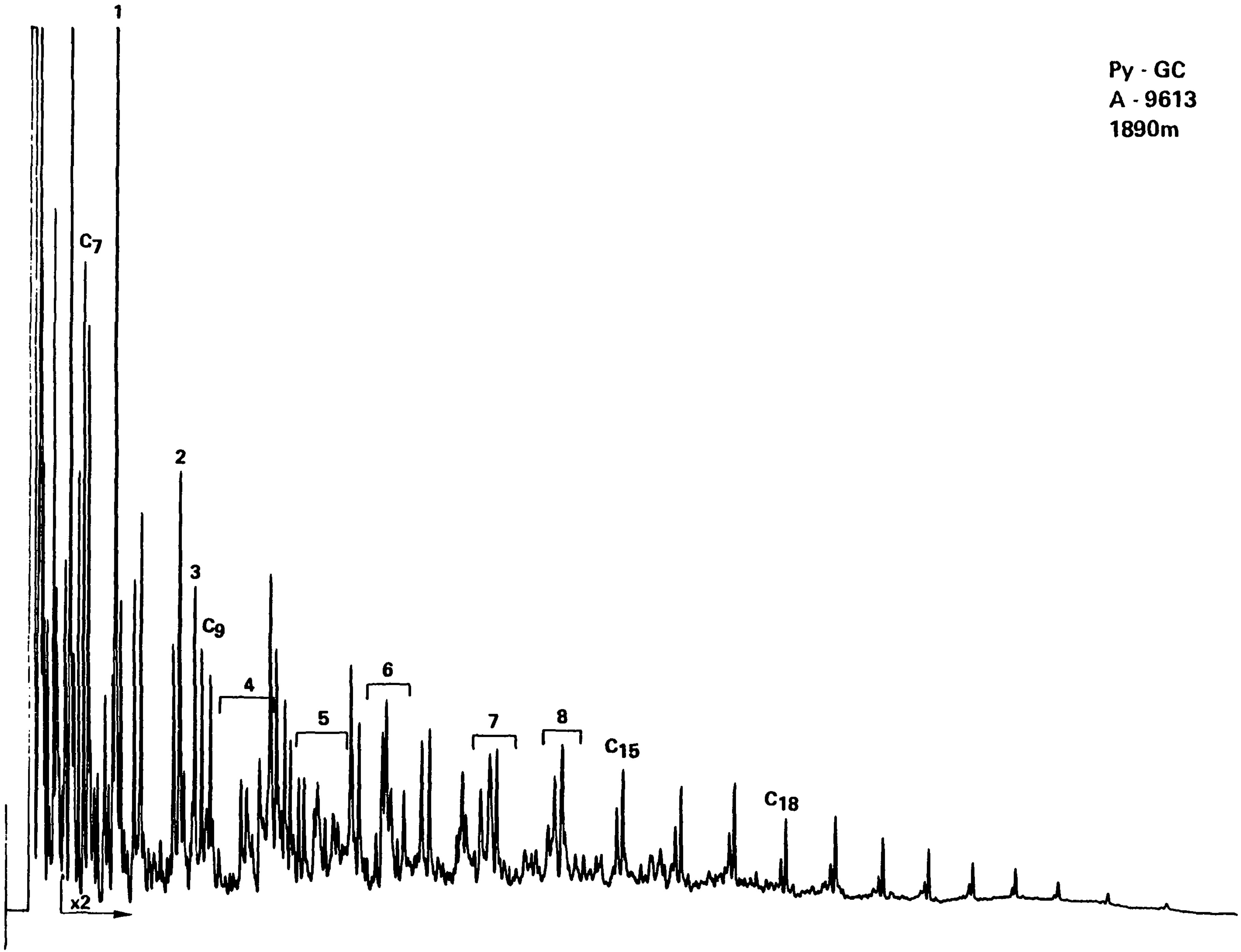

Py - GC
A - 9613
1890m
1
C_7
2
3
C_9
4
5
6
7
8
C_{15}
C_{18}
x2

Figure 5

Vitrinite reflectance histograms

```
IKU# A 9506   840.0M 31/3-1
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|
    |
 2-|    AA  A
    |    AAAAA
 0--+----+----+----+----+----+----+----+----+----+----+---
  0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
FP LOW HIGH LIT #VAL MEAN STDV
Y 0.20 0.45 ALL    8 0.31 0.08
          OVERALL  8 0.31 0.08
```

ORDERED VALUES FOLLOW:

0.22A 0.24A 0.25A 0.26A 0.30A 0.38A 0.40A 0.40A

IKU

```
IKU# A 9605  1070.0M 31/3-1
    |
14- |
    |
12- |
    |
10- |
    |
 8- |
    |
 6- |
    |
 4- |
    |                a
 2- |             aa a
    |      A      aaaa
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
FP LOW  HIGH LIT #VAL MEAN STDV
Y 0.30 0.35 ALL     1 0.33 0.00
N 0.50 0.70 ALL     8 0.61 0.08
          OVERALL   9 0.57 0.12
```

ORDERED VALUES FOLLOW:

0.33A 0.50a 0.52a 0.57a 0.57a 0.63a 0.67a 0.69a 0.69a

IKU

```
IKU# A 9606  1192.0M 31/3-1
    |
14--|
    |
12--|
    |
10--|
    |
 8--|
    |
 6--|
    |
 4--|
    |
 2--|
    |        A  aaa
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.40 0.45 ALL     1 0.43 0.00
N 0.55 0.70 ALL     3 0.62 0.03
          OVERALL   4 0.57 0.10

ORDERED VALUES FOLLOW:

 0.43A 0.59a 0.63a 0.65a
```

IKU

```
IKU# A 3607      0.0M 31/3-1
      :
 14--:
      :
 12--:
      :
 10--:
      :
  8--:
      :
  6--:
      :
  4--:
      :
  2--:
      :                      n d
  0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
          OVERALL  2 1.05 0.07
```

ORDERED VALUES FOLLOW:

1.00n 1.10d

IKU

```
IKU# A 9608  1267.0M 31/3-1
    :
 14-:
    :
 12-:
    :
 10-:
    :
  8-:
    :
  6-:
    :
  4-:          a
    :          a
  2-:          a
    :      aaaa a
  0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
N 0.35 0.65 ALL     8 0.49 0.07
          OVERALL   8 0.49 0.07
```

ORDERED VALUES FOLLOW:

0.39a 0.44a 0.45a 0.51a 0.51a 0.52a 0.52a 0.61a

IKU

```
IKU# A 9536  1290,0M 31/3-1
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|      B  b
   |      B  b
 2-|      BBbbb
   |      BBbbbb
 0--+----+----+----+----+----+----+----+----+----+----+---
  0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
Y 0.35 0.45 ALL    6 0.39 0.02
N 0.45 0.65 ALL    9 0.53 0.05
          OVERALL 15 0.47 0.08
```

ORDERED VALUES FOLLOW:

0.37B 0.37B 0.38B 0.38B 0.40B 0.43B 0.46b 0.48b 0.50b 0.50b 0.52b 0.53b 0.57b
0.58b 0.62b

```
IKU# A 9609  1327.5M 31/3-1
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|
   |       BB b
 2-|      BBB b
   |      BBB b
 0--+----+----+----+----+----+----+----+----+----+----+---
  0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW  HIGH LIT #VAL MEAN STDV
Y 0.35 0.50 ALL     8 0.43 0.04
N 0.55 0.60 ALL     3 0.58 0.01
          OVERALL 11 0.47 0.08
```

ORDERED VALUES FOLLOW:

0.38B 0.39B 0.40B 0.41B 0.42B 0.46B 0.47B 0.48B 0.57b 0.57b 0.59b

IKU

```
IKU# A 9610  1347.5m 31/3-1
   !
14-!
   !
12-!
   !
10-!
   !
 8-!
   !          B
 6-!          B
   !         BB
 4-!        BBB
   !       BBBBB
 2-!       BBBBB
   !      BBBBBBBB   b
 0--+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
Y 0.30 0.70 ALL   25 0.48 0.08
N 0.85 0.90 ALL    1 0.85 0.00
          OVERALL 26 0.50 0.11
```

ORDERED VALUES FOLLOW:

```
 0.31B 0.35B 0.38B 0.39B 0.40B 0.41B 0.42B 0.43B 0.45B 0.45B 0.48B 0.48B 0.49B
 0.50B 0.50B 0.50B 0.51B 0.52B 0.54B 0.54B 0.56B 0.57B 0.58B 0.62B 0.66B 0.85b
```

IKU

```
IKU# A 9540  1350.0M 31/3-1
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
   |      B
 4-|      B
   |     BBB B
 2-|    BBBB B
   |    BBBB B   b
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.20 0.50 ALL   16 0.34 0.08
N 0.65 0.70 ALL    1 0.69 0.00
          OVERALL 17 0.36 0.11

ORDERED VALUES FOLLOW:

 0.23B 0.24B 0.26B 0.27B 0.28B 0.32B 0.32B 0.32B 0.33B 0.33B 0.35B 0.36B 0.39B
 0.45B 0.45B 0.49B 0.69b
```

IKU

```
IKU# A 9618  1371.5M 31/3-1
   |    K
14-|    K
   |    K
12-|    K
   |    K
10-|    K
   |    K
 8-|    K
   |    K
 6-|    KK
   |    KK
 4-|    KK
   |    KKK
 2-|    KKK
   |   KKKK
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.15 0.35 ALL   25 0.24 0.04
          OVERALL 25 0.24 0.04

ORDERED VALUES FOLLOW:

 0.18K 0.20K 0.20K 0.21K 0.21K 0.22K 0.22K 0.23K 0.23K 0.23K 0.23K 0.24K 0.24K
 0.24K 0.24K 0.24K 0.25K 0.26K 0.26K 0.27K 0.27K 0.28K 0.30K 0.31K 0.33K
```

IKU

```
IKU# A 9619  1402,3M 31/8-1
    !     ^
 14-!     K
    !     K
 12-!     K
    !     K
 10-!     K
    !     KK
  8-!     KK
    !    KKK
  6-!    KKK
    !    KKK
  4-!    KKK
    !    KKKK
  2-!    KKKK
    !    KKKK
  0--+----+----+----+----+----+----+----+----+----+----+---
    0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.20 0.40 ALL   40 0.28 0.04
           OVERALL 40 0.28 0.04

ORDERED VALUES FOLLOW:

 0.20K 0.20K 0.22K 0.23K 0.23K 0.23K 0.24K 0.25K 0.25K 0.25K 0.25K 0.26K 0.26K
 0.26K 0.26K 0.26K 0.26K 0.26K 0.27K 0.27K 0.27K 0.27K 0.27K 0.27K 0.28K 0.29K
 0.29K 0.29K 0.30K 0.30K 0.31K 0.31K 0.31K 0.32K 0.32K 0.32K 0.34K 0.36K 0.36K
 0.39K
```

IKU

```
IKU# A 9545  1425.0m 31/3-1
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|      B
   |      B
 2-|      B  BB
   |      BB BB
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
Y 0.30 0.55 ALL     9 0.40 0.09
        OVERALL   9 0.40 0.09
```

ORDERED VALUES FOLLOW:

0.31B 0.32B 0.32B 0.34B 0.37B 0.45B 0.49B 0.51B 0.53B

IKU

```
IKU# A 9551  1455.0M 31/3-1
    |
 14-|
    |
 12-|
    |
 10-|
    |
  8-|
    |
  6-|
    |
  4-|
    |           uu
  2-|           uuu
    |           uuu  u u
  0--+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+---
    0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

FP	LOW	HIGH	LIT	#VAL	MEAN	STDV
N	0.45	0.60	ALL	8	0.51	0.04
N	0.70	0.85	ALL	2	0.75	0.06
			OVERALL	10	0.56	0.11

ORDERED VALUES FOLLOW:

0.46u 0.47u 0.48u 0.50u 0.51u 0.53u 0.56u 0.56u 0.71u 0.80u

```
IKU# A 2548  1475.0M 31/3-1
    |
14--|
    |
12--|
    |
10--|
    |
 8--|
    |
 6--|
    |
 4--|
    |
 2--|       B B
    |       BBBB
 0--+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+---
  0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
Y 0.35 0.55 ALL     6 0.44 0.06
          OVERALL   6 0.44 0.06
```

ORDERED VALUES FOLLOW:

0.38B 0.38B 0.41B 0.47B 0.49B 0.52B

IKU

```
IKU# A 9549  1510.0M 31/3-1
   :
 14-:
   :
 12-:
   :
 10-:
   :
  8-:
   :
  6-:
   :
  4-:
   :
  2-:         A       a
   :        A AAAA    a
  0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
FP LOW  HIGH LIT  #VAL MEAN STDV
Y  0.30 0.60 ALL     6 0.46 0.09
N  0.75 0.80 ALL     2 0.78 0.01
             OVERALL 8 0.54 0.17
```

ORDERED VALUES FOLLOW:

0.32A 0.43A 0.43A 0.45A 0.51A 0.59A 0.77a 0.79a

IKU

```
CHJ# A 9552  1540.0M 31/3-1
   :
14-:
   :
12-:
   :
10-:
   :
 8-:
   :
 6-:
   :
 4-:
   :           a
 2-:         a a
   :        aaaa
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
          OVERALL   7 0.51 0.05
```

ORDERED VALUES FOLLOW:

0.44a 0.45a 0.47a 0.50a 0.56a 0.56a 0.56a

IKU

```
IKU# A 9611  1603.4m 31/3-1
   !      K
14-!      K
   !      K
12-!      K
   !      K
10-!      K
   !      K
 8-!      K
   !      KK
 6-!      KK
   !      KK
 4-!      KK
   !     KKK
 2-!     KKK
   !     KKK
 0--+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+--
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.15 0.30 ALL   25 0.23 0.03
         OVERALL 25 0.23 0.03

ORDERED VALUES FOLLOW:

 0.15K 0.18K 0.19K 0.20K 0.21K 0.21K 0.21K 0.22K 0.22K 0.22K 0.22K 0.23K 0.23K
 0.23K 0.23K 0.24K 0.24K 0.24K 0.25K 0.25K 0.26K 0.26K 0.27K 0.28K 0.29K
```

IKU

```
DH# A 9966  1810.0M 3173-1
    |
 14-|
    |
 12-|
    |
 10-|        K
    |        K
  8-|        K
    |        K
  6-|       KK
    |       KK
  4-|       KKK
    |       KKK
  2-|       KKK
    |       KKK
  0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
FP LOW  HIGH LIT  #VAL MEAN STDV
Y  0.35 0.50 ALL    20 0.42 0.04
          OVERALL   20 0.42 0.04
```

ORDERED VALUES FOLLOW:

0.35K 0.36K 0.37K 0.38K 0.39K 0.39K 0.40K 0.41K 0.41K 0.41K 0.41K 0.41K 0.41K
0.42K 0.43K 0.43K 0.47K 0.48K 0.49K 0.49K

IKU

```
IKU# A 9612  1830.0M 31/3-1
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|
   |           A
 2-|        AA A
   |       AAA AA
 0--+----+----+----+----+----+----+----+----+----+----+---
  0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
Y 0.30 0.60 ALL     9 0.45 0.08
          OVERALL   9 0.45 0.08
```

ORDERED VALUES FOLLOW:

0.32A 0.38A 0.39A 0.41A 0.43A 0.50A 0.52A 0.53A 0.55A

IKU

```
IKU# A 9570  1870.0m 3173-1
   |
14-|
   |
12-|
   |
10-|
   |
 8-|
   |
 6-|
   |
 4-|            a
   |            a
 2-|           aa
   |        A aaa
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

FP LOW HIGH LIT #VAL MEAN STDV
Y 0.40 0.45 ALL     1 0.44 0.00
N 0.50 0.65 ALL     7 0.60 0.04
          OVERALL   8 0.58 0.07

ORDERED VALUES FOLLOW:

 0.44A 0.54a 0.57a 0.58a 0.62a 0.63a 0.64a 0.64a
```

IKU

```
IKU# A 9613  1590.0M 31/3-1
    :
 14-:
    :
 12-:
    :
 10-:
    :
  8-:
    :
  6-:
    :
  4-:
    :
  2-:           a
    :     AAA  aa
  0--+----+----+----+----+----+----+----+----+----+----+---
    0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.35 0.50 ALL    3 0.42 0.07
N 0.60 0.70 ALL    3 0.65 0.04
         OVERALL   6 0.54 0.14

ORDERED VALUES FOLLOW:

 0.35A 0.43A 0.49A 0.61a 0.66a 0.69a
```

IKU

```
IKU# A 9572  1900.0M 31/3-1
    !
14-!
    !
12-!
    !         K
10-!         K
    !         K
 8-!         K
    !         K
 6-!         K
    !        KK
 4-!        KK
    !        KKK
 2-!        KKK
    !       KKKK
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

PP	LOW	HIGH	LIT	#VAL	MEAN	STDV
Y	0.35	0.55	ALL	20	0.46	0.04
			OVERALL	20	0.46	0.04

ORDERED VALUES FOLLOW:

0.38K 0.42K 0.42K 0.43K 0.43K 0.44K 0.45K 0.46K 0.46K 0.47K 0.47K 0.47K 0.48K
0.48K 0.49K 0.49K 0.49K 0.50K 0.51K 0.53K

IKU

```
IKU# A 9614  1930.0M 31/3-1
     |
 14--|
     |
 12--|
     |
 10--|
     |
  8--|
     |
  6--|
     |
  4--|
     |
  2--|     A
     |    AA   A
  0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

PP	LOW	HIGH	LIT	#VAL	MEAN	STDV
Y	0.45	0.50	ALL	1	0.49	0.00
Y	0.20	0.50	ALL	4	0.32	0.11
			OVERALL	4	0.32	0.11

ORDERED VALUES FOLLOW:

0.24A 0.27A 0.28A 0.49A

IKU

```
IKU# A 2577  1975.0M 31/3-1
    |
14-|
    |
12-|
    |
10-|
    |
 8-|
    |
 6-|
    |
 4-|      a
   |      a
 2-|      a
   |      a        aa
0--+----+----+----+----+----+----+----+----+----+----+---
  0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
N 0.30 0.35 ALL    4 0.31 0.01
N 0.75 0.85 ALL    2 0.78 0.04
         OVERALL  6 0.47 0.24
```

ORDERED VALUES FOLLOW:

0.30a 0.31a 0.32a 0.32a 0.75a 0.80a

IKU

IKU# A 9615 2148.0M 31/3-1

```
  :
14-:
  :
12-:
  :
10-:
  :
 8-:
  :
 6-:
  :
 4-:
  :            a    a
 2-:           a    aaaa
  :        a aaa  aaaaaa
 0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

PP	LOW	HIGH	LIT	#VAL	MEAN	STDV
N	0.50	0.75	ALL	6	0.67	0.08
N	0.85	1.15	ALL	11	1.01	0.08
			OVERALL	17	0.89	0.18

ORDERED VALUES FOLLOW:

0.53a 0.64a 0.69a 0.70a 0.71a 0.74a 0.86a 0.91a 0.95a 0.96a 0.99a 1.00a 1.04a
1.06a 1.09a 1.10a 1.11a

IKU

```
IKU# A 9589  2155.0M 31/3-1
    :
 14-:
    :
 12-:
    :
 10-:       K
    :       K
  8-:       K
    :       K
  6-:       K
    :    . KKK
  4-:      KKK
    :      KKK
  2-:      KKKKK
    :     KKKKKK
  0--+----+----+----+----+----+----+----+----+----+----+---
   0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

FP LOW  HIGH LIT #VAL MEAN STDV
Y 0.25 0.55 ALL    25 0.39 0.06
            OVERALL 25 0.39 0.06

ORDERED VALUES FOLLOW:

 0.29K 0.30K 0.32K 0.32K 0.32K 0.33K 0.35K 0.37K 0.37K 0.37K 0.38K 0.38K 0.38K
 0.39K 0.39K 0.39K 0.40K 0.40K 0.40K 0.42K 0.44K 0.47K 0.48K 0.53K 0.53K
```

IKU

```
IKU# A 7616  2325.0M 31/3-1
    !
14-!
    !
12-!
    !
10-!
    !
 8-!
    !
 6-!
    !
 4-!
    !
 2-!         u
    !         uuu u
 0--+----+----+----+----+----+----+----+----+----+----+---
  0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
```

```
PP LOW HIGH LIT #VAL MEAN STDV
         OVERALL  5 0.49 0.08
```

ORDERED VALUES FOLLOW:

0.42u 0.43u 0.48u 0.51u 0.61u

IKU

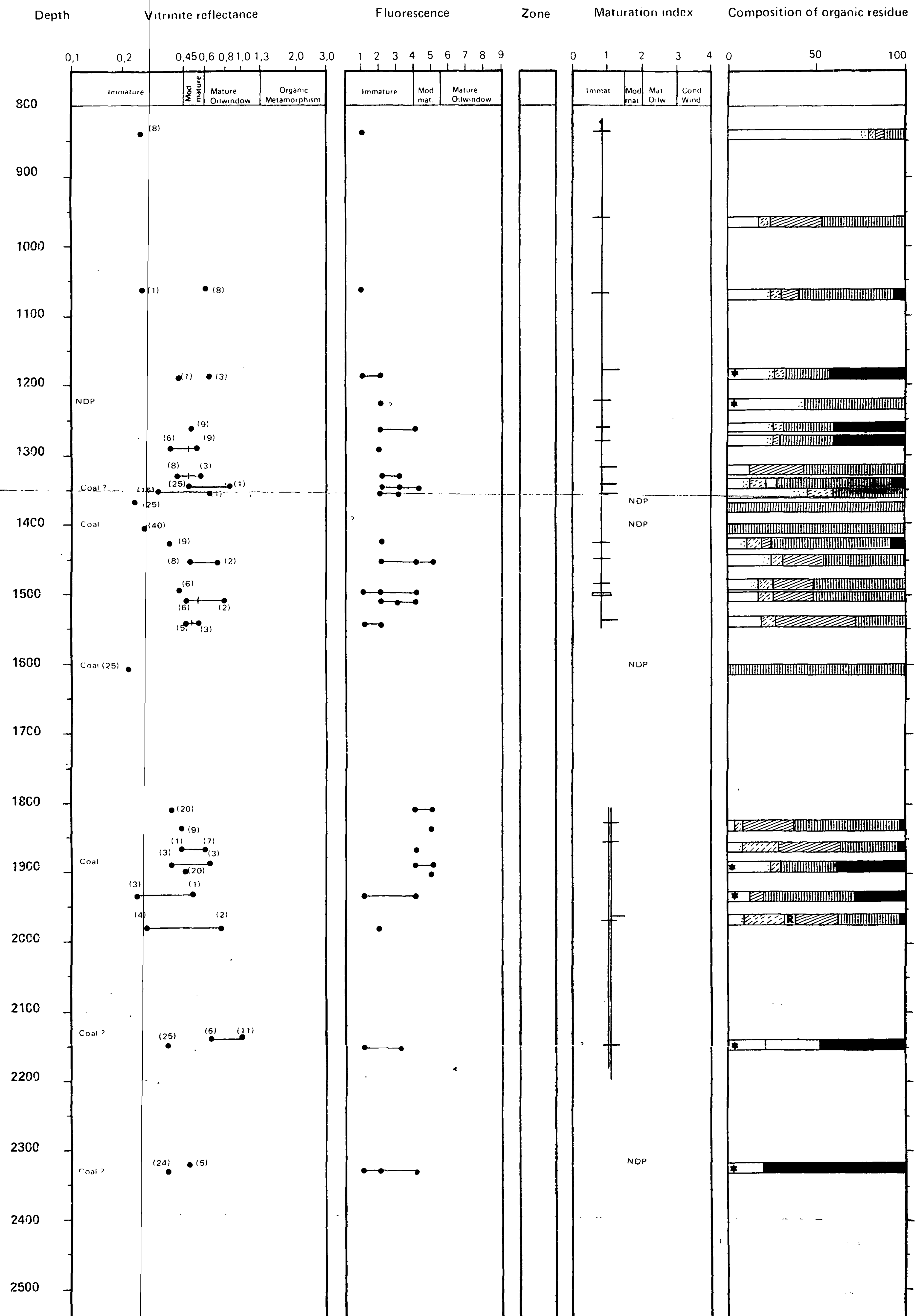
```
IKU# A 9601  2335.0M 31/3-1
      !
 14-!
      !
 12-!
      !        K
 10-!        K
      !        K
  8-!        K
      !        KK
  6-!        KK
      !        KK
  4-!        KK
      !        KKK
  2-!        KKKK
      !        KKKK
  0--+----+----+----+----+----+----+----+----+----+----+---
    0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50

PP LOW HIGH LIT #VAL MEAN STDV
Y 0.35 0.55 ALL    23 0.41 0.05
          OVERALL 23 0.41 0.05

ORDERED VALUES FOLLOW:

 0.35K 0.35K 0.36K 0.36K 0.36K 0.37K 0.37K 0.37K 0.39K 0.39K 0.39K 0.40K 0.41K
 0.41K 0.41K 0.42K 0.42K 0.43K 0.45K 0.46K 0.48K 0.50K 0.50K
```

Organic Geochemistry Department

MATURATION

Well no.: 31/3 – 1
Company: STATOIL

VISUAL KEROGEN
COLORATION AND COMPOSITION OF ORGANIC RESIDUE



VITRINITE REFLECTANCE :

denotes one sample with two apparently separate populations

denotes one sample possibly with two separate populations but also indicating overall average

FLUORESCENCE :

denotes one sample with fluorescence of two or more levels

Amorphous material, Sapropel

Algal

Spores and pollen

Cuticles

Wood remains

Undifferentiated disperse herbaceous material

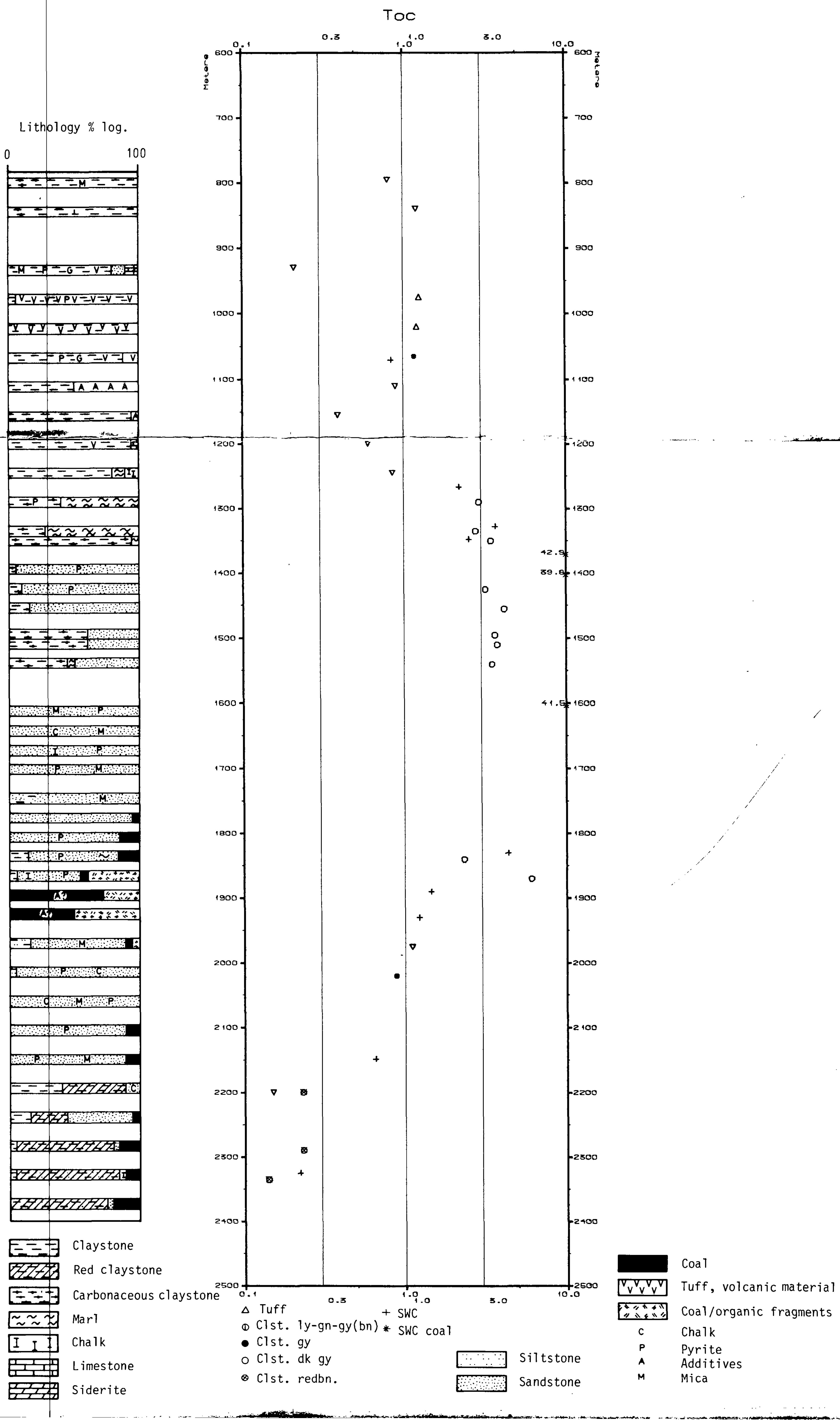
Black coal fragments

Organic Geochemistry Department

TOTAL ORGANIC CARBON (TOC)

Well no :

31/3-1

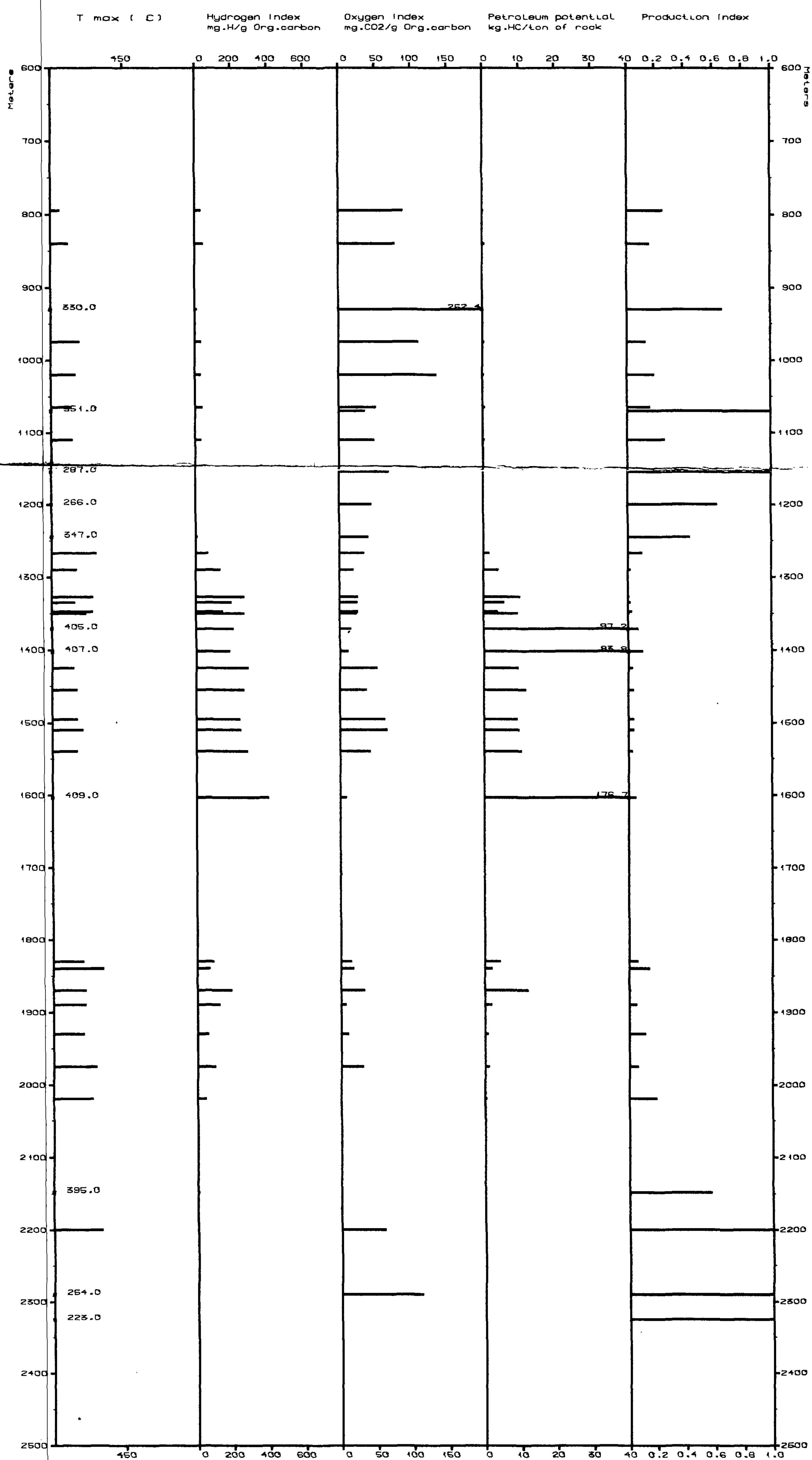


IKU Organic Geochemistry Department

ROCK-EVAL PYROLYSIS

Well no :

31/3-1

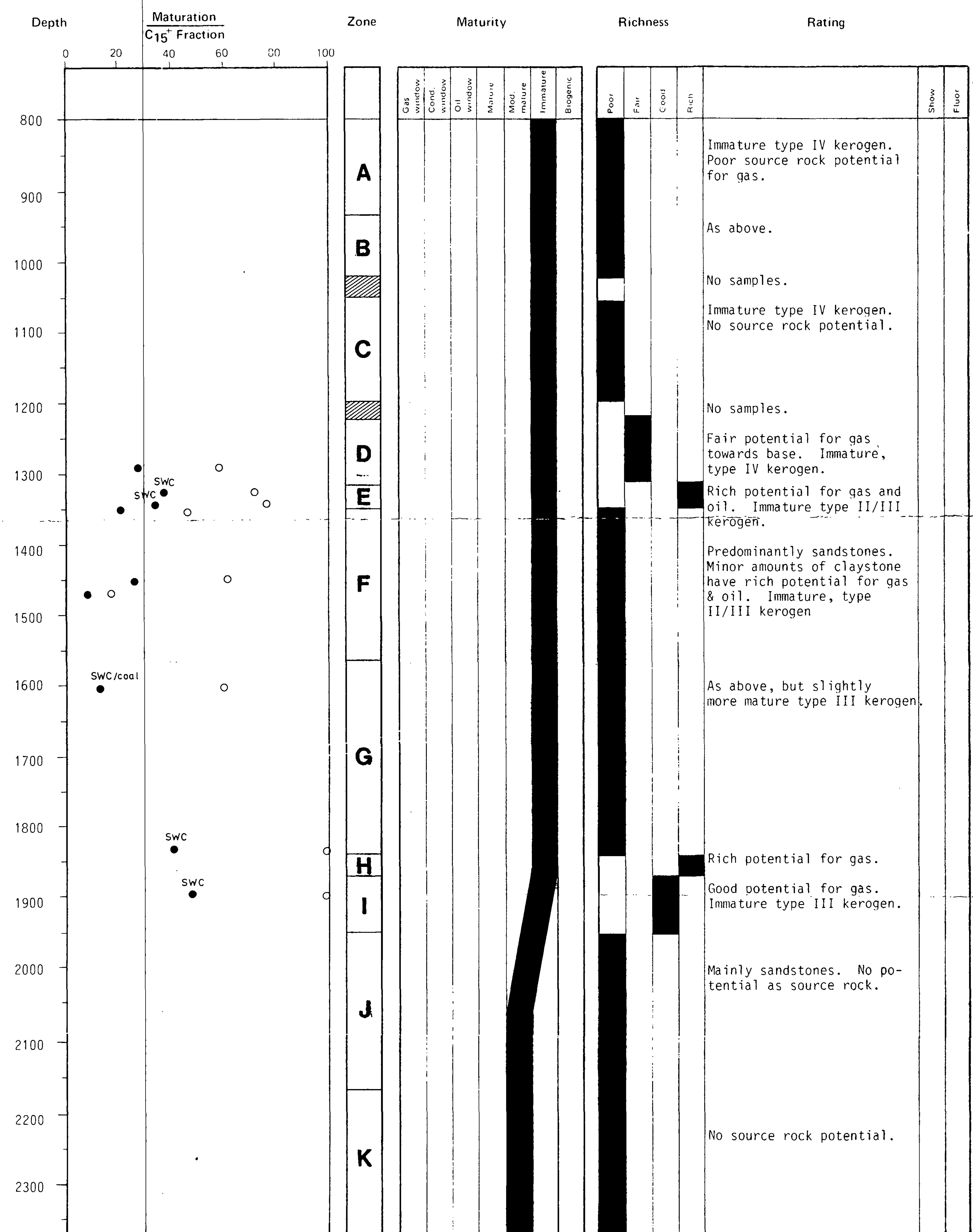


IKU Organic Geochemistry Department

INTERPRETATION DIAGRAM

Well no.:31/3-1
Company:

SUMMARY OF SOURCE POTENTIAL



● % Sat./EOM ○ % HC/EOM

Sat: Saturated Hydrocarbons.
HC: Hydrocarbons.
EOM: Extractable Organic Matter.

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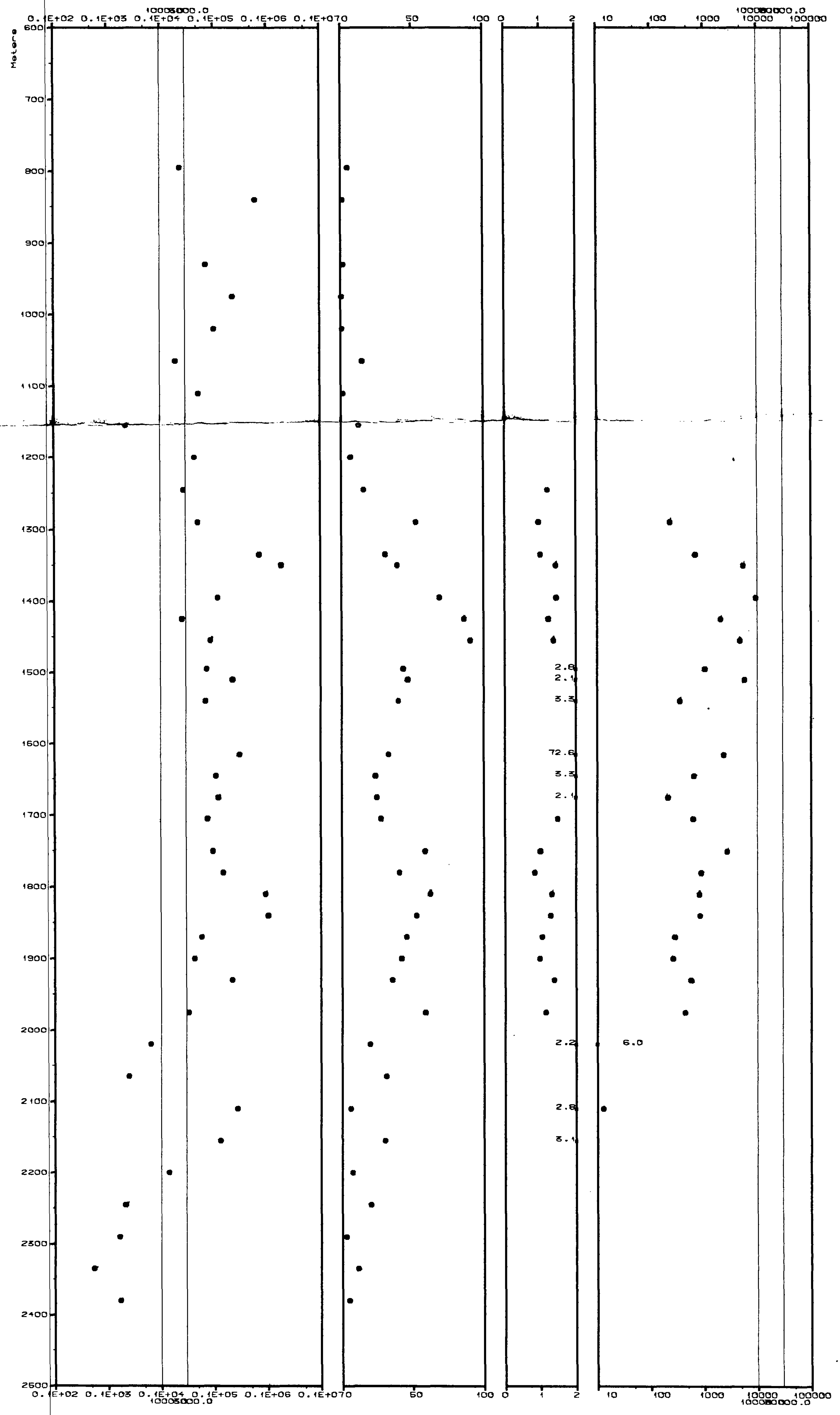
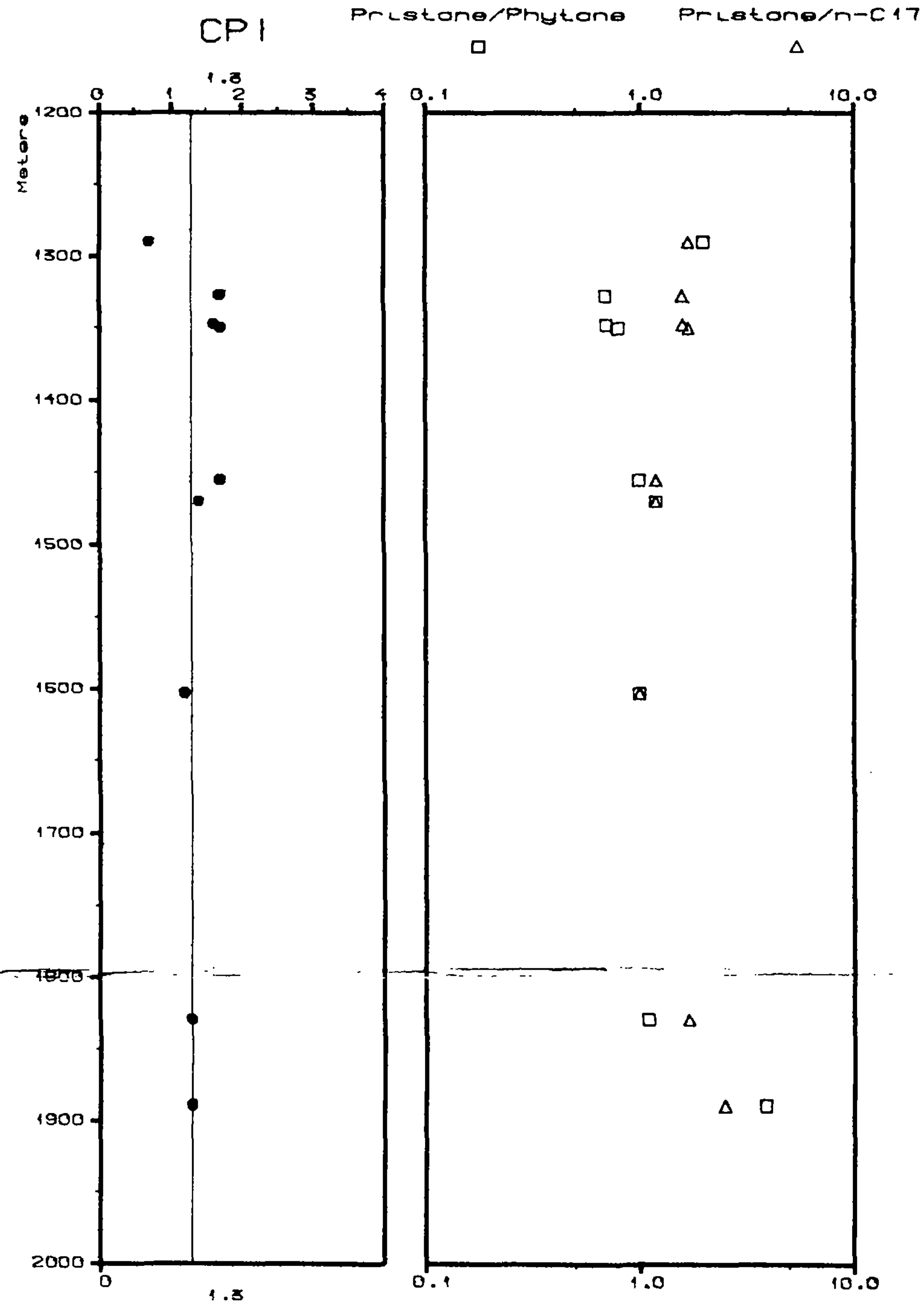
$C_1 - C_7$ HYDROCARBONS

Well no : **31/3-1**



WELL :

31/3-1


CPI
Pristane/Phytane □
Pristane/n-C17 △
Meters
0
1
1.5
2
3
4
0.1
1.0
10.0
1200
1300
1400
1500
1600
1700
1800
1900
2000

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C_{15}^{+} HYDROCARBONS

Well no :

31/3-1