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REPORT TITLE/ TITTEL			
Source rock analyses of well 7120/9-1.			
CLIENT/ OPPDRAGSGIVER			
Norsk Hydro A/S			
RESPONSIBLE SCIENTIST/ PROSJEKTANSVARLIG			
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DATE/ DATO	REPORT NO./RAPPORT NR.	NO. OF PAGES/ ANT.SIDER	NO. OF ENCLOSURES/ ANT. BILAG
21.1.83	05.7487/1/83	61	7

SUMMARY/ SAMMENDRAG

See next page.

KEY WORDS/ STIKKORD

Source rock	Well 7120/9-1
Troms I.	

Canned samples from the 750 - 2300 m from this interval were analysed. Based on screening analyses (headspace, occluded gas and TOC) together with a few follow up analyses, the following source rock rating is given.

Zone A; 750 - 930m.	Grey to olive-grey claystone, immature with a fair potential as a source rock for hydrocarbons.
Zone B; 960 - 1200m.	Light-grey to grey and grey to dark grey claystone. Immature with a fair potential as a source rock for hydrocarbons. Migrated gas detected in the zone.
Zone C; 1230 - 1620m.	Dark grey to grey claystone. Moderate mature with a fair potential as a source rock for hydrocarbons.
Zone D; 15665 - 1725m.	Dark grey, silty to sandy claystone. Moderate mature with a fair potential as a source rock for gas.
Zone E; 1735 - 1814m.	Dark grey, silty claystone. Moderate mature with a good potential as a source rock for gas.
Zone F; 1814 - 1845m.	Dark grey to black claystone. Moderate mature with a rich potential as a source rock for gas and oil.
Zone G; 1845 - 1965m.	Cored interval.
Zone H; 1965 - 2070m.	Mixture of sandstone and dark grey to black claystone. Indications of migrated hydrocarbons in sandstone. Claystone moderate mature with a rich potential as a source rock for gas and possibly some oil
Zone I; 2100 - 2300m.	Mixture of sandstone, light grey and marly claystone. Moderate mature/mature. Claystone has a fair potential as a source rock for gas. Indication of hydrocarbons in the sandstone from 2220 - 2330m.

CONTENTS

EXPERIMENTAL AND DESCRIPTION OF INTERPRETATION LEVELS

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.

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.

Total Organic Carbon (TOC)

Picked cuttings of the various lithologies in each sample was 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 20 mm Hg for 12 hrs. The samples were then analysed on a Leco E C 12 carbon analyser, to determine the total organic carbon (TOC).

The results are shown in table 2 with the lithological description, also in enclosure 2.

Extractable Organic Matter (EOM)

From the TOC results samples were selected for extraction. Of the selected samples, approximately 100 gm of each was extracted in a flow through system (Radke et al,, 1978, Anal. Chem. 49, 663-665) for 10 min. using dichloromethane (DCM) as solvent. The DCM used as solvent was distilled in an all glass apparatus to remove contaminants.

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

After extraction, the solvent was removed on a Buchi Rotavapor and transferred to a 50 ml flask. The rest of the solvent was then removed and the amount of extractable organic matter (EOM) determined.

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 glassvials and dried in a stream of nitrogen. The various results are given in Tables 3-6, and in enclosure 3.

Gas Chromatographic Analyses

The saturated and aromatic hydrocarbon fractions were each diluted with n-hexane and analysed on a HP 5730 A gas chromatograph, fitted with a 25 m OV101 glass capillary column and an automatic injection system. Hydrogen (0.7 ml/min.) was used as carrier gas and the injection was performed in the split mode (1:20). Ratios determined from the saturated hydrocarbon gas chromatograms are shown in table 7, and in enclosure 4.

Vitrinite Reflectance

Vitrinite reflectance measurements of the samples, taken at various intervals, were done at IKU. The samples were mounted in Bakelite resin blocks; care being taken during the setting of the plastic to avoid temperatures in excess of 100^{o}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, although in many cases this number could not be achieved.

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 R.AVER. 546 NM 1516	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10
% 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

NOTE: 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.

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:

T-slide represents the total acid insoluble residue.
N-slide represents a screened residue (15μ mesh).
O-slide contains palynodebris remaining after flotation ($ZnBr_2$) to remove heavy minerals.
X-slides 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 dino-flagellates) 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_o).

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

Rock-Eval Pyrolysis

100 mg crushed sample was put into a platinum crucible whose bottom and cover are made of sintered steel and analysed on a Rock-Eval pyrolyser.

RESULTS AND DISCUSSION

Light Hydrocarbon Analysis and Lithological Description

Based on gas analyses and lithological description of the samples, the analysed sequence of the well 750-2300m is divided into nine zones:

A; 750-930m
B; 930-1200m
C; 1230-1620m
D; 1665-1725m
E; 1735-1814m
F; 1814-1845m
G; 1845-1965m
H; 1965-2070m
I; 2100-2300m

Zone A; 750-930m: The lithology of this zone consists of grey-olive grey, micromicaceous claystones with a good abundance of light hydrocarbons. The isobutane/n-butane, iC_4/nC_4 ratio decreases sharply over the upper part of the zone while the abundance of C_5+ hydrocarbons show a steady increase with increasing depth.

Zone B; 960-1200m: The lithology of the uppermost sample in this zone consists of grey and light grey claystone while the rest of the zone consist of a dark grey to grey claystones. The zone is separated from zone A on the basis of the very high abundances of hydrocarbons found in this zone. The wetness of the gas is high in the uppermost sample in the zone where a high abundance of C_5+ hydrocarbons is also found. The uppermost sample has the highest abundance of C_1-C_4 hydrocarbons which show a decrease with increasing depth. The iC_4/nC_4 ratio is fairly constant throughout the zone.

Zone C; 1230-1620m: This zone has a rather uniform lithology, grey-dark grey and olive grey micromicaceous claystones, with a small percentage of sandy/silty claystone in the lowermost sample. The abundance of C_1-C_4 hydrocarbons shows a slight decrease with increasing depth while the abundance of C_5+ hydrocarbons is almost uniform throughout. There is some variation in the wetness of the gas in the zone which could be due to a slight variation of the kerogen quality in the different samples.

Zone D; 1665-1725m: The lithology in this zone changes to a dark grey, occasional silty/sandy micromicaceous claystone with a small percentage of a calcareous light brown claystone changing to a marly claystone with increasing depth. The abundance of C_1-C_4 hydrocarbons increases slightly with increasing depth. The wetness of the gas shows a reversed picture of the abundance of the gas. The iC_4/nC_4 ratio and the C_5+ abundance show only minor changes over the interval.

Zone E; 1735-1814m: This zone consists only of two samples with a mixture of dark grey claystone, grey, silty claystone and marly claystone. The abundance of light hydrocarbons, both C_1-C_4 and C_5+ hydrocarbons show a sharp decrease in this zone compared with the zone above and deceases with increasing depth. The wetness of the gas shows a sharp increase compared to zone D and decreases with increasing depth.

Zone F; 1814-1845m: This zone is separated out on the basis of the lithology only. Bagged samples for biostratigraphical analyses showed that this consisted of a dark grey-black claystone.

Zone G; 1845-1965m: This zone was cored and the lithological description of the cutting samples and the gas analysis are therefore unreliable.

Zone H; 1965-2070m: The canned samples from this interval consist of a mixture of sandstone and dark grey to black claystones. The abundance of C_1-C_4 hydrocarbons is high indicating free hydrocarbons in the sandstone. The wetness of the gas shows a decrease with increasing depth while the abundance of C_5+ hydrocarbons is uniform. Analysis in UV light shows a good cut for the sandstone samples indicating migrated hydrocarbons.

Zone I; 2100-2300m: Again a zone with a mixture of lithologies, sandstone, grey-light grey claystone and marly claystone. The percentage of sandstone increases with depth. The abundance of C_1-C_4 and C_5+ hydrocarbons and the wetness of the gas show a marked decrease compared with zone H while the iC_4/nC_4 ratio is uniform throughout. Analysis in UV light shows a good cut for the sandstone in the samples below 2220m indicating migrated hydrocarbons.

Total Organic Carbon

Zone A; 750-930m: This zone consists mainly of a grey to olive-grey micromicaceous, non-calcareous claystone with a fair abundance of organic carbon (0.6-0.8%) for all except the lowermost sample. This has a poor abundance of organic carbon. A decrease in abundance of organic carbon with increasing depth is registered.

Zone B; 960-1200m: The lithology of the uppermost sample consist of a grey to light grey non calcareous claystone with an abundance of organic carbon of 0.4%. The rest of the zone consists of dark grey to grey (very pyritic in parts), micromicaceous, occasionally glauconitic claystones with thin sandstone lamina. The abundance of organic carbon is higher than for the uppermost sample and is found to be approximately 0.7% throughout.

Zone C; 1230-1620m: The upper part of this zone, down to 1310m is dominated by a grey claystone. Below this depth small amounts of green and pale red-brown claystones are present. Siderite and sideritic claystone are common. The grey claystone has a uniform abundance of organic carbon throughout the zone, 0.7-0.9%.

Zone D; 1665-1725m: The lithology of this zone changes compared to the zone above to a dark grey to grey, occasionally silty, sandy claystone. The abundance of organic carbon increases sharply in this zone compared with the zones above and is found to increase with increasing depth, 1.8-2.5%.

Zone E; 1740-1814m: The lithology in this zone consists of a mixture of marly claystone, dark grey-grey carbonaceous claystone and a dark grey-grey micromicaceous claystone. The latter has similar trend in organic carbon values as found for the zone above, while the carbonaceous claystone has far lower values, approximately 1%.

Zone F; 1814-1845m: This zone which is separated out on the basis of lithology only, consists of a dark grey-black claystone with a high abundance of organic carbon of approximately 6%.

Zone G; 1845-1965m: The whole of this interval was cored and is dominated by sandstone. Organic carbon measurement was undertaken on a few claystone core chips found in the cores, which show very different results, 0.6 and 2.3% organic carbon.

Zone H; 1965-2070m: The lithology of this zone consists of a mixture of sandstone and dark grey-black claystone. The claystone has a rich abundance of organic carbon.

Zone I; 2100-2300m: The lithology found in the samples from this zone consists of a mixture of sandstone and grey to light grey claystone, with some dark grey to black claystone in places. The organic carbon content vary considerably from sample to sample and no specific trend is recorded.

Extraction and Chromatographic Separation

Seven samples were chosen by the client for extraction and chromatographic separation.

Zones A, B and C, 750-1620m: No samples from these zones were extracted.

Zone D; 1665-1725m: One sample, 1695-1710m was extracted and found to have a good abundance of extractable hydrocarbons with a higher percentage of saturates than aromatics. The gas chromatogram of the saturated hydrocarbons shows a front biased distribution with maximum at nC_{13}. There is an indication of a bi-modality indicating an input also of hydrocarbons from terrestrial matter. The high pristane/nC_{17} ratio together with a moderate CPI value and a large abundance of geochemical fossils indicate the sample to be immature or moderate mature.

Zone E; 1735-1814m: Two samples from this zone, 1740-55m and 1785-90m were extracted. The uppermost sample has similar values for all parameters as the sample from zone D, and shows a similar gas chromatogram of saturated hydrocarbons. The sample from 1785-90m has a similar abundance of extractable hydrocarbons to those above while the abundance of extractable non-hydrocarbons is higher. The composition of the hydrocarbons is only slightly different to the sample above with a slightly lower percentage of saturated hydrocarbons. The gas chromatogram of the saturated hydrocarbons shows a front biased distribution with a relative large pristane/nC_{17} ratio and a moderate CPI value.

Zone F; 1814-1845m: One sample from this zone a (core chip) from 1822m was extracted and found to have a rich abundance of extractable hydrocarbons. The chromatographic separation shows only slightly higher concentrations of saturated hydrocarbons than of aromatics. The gas chromatogram of the saturated hydrocarbons shows a front biased n-alkane distribution with a shoulder in the C_{23}-C_{29} area, indicating an input from terrestrial material. The isoprenoid ratio is large for this sample indicating immaturity.

Zone G; 1945-1965m: No samples from this zone was extracted.

Zone H; 1965-2070m: Two samples, 1965-80m and 2010-25m, from this zone were extracted and both have a rich abundance of extractable hydrocarbons. The concentration of saturated hydrocarbons is again higher than the aromatics, similar to that found for the zones above. The gas chromatograms of the saturated hydrocarbons shows a smooth, front biased n-alkane distribution typical for well mature hydrocarbons.

Zone I; 2100-2300m: One sample, 2190-2205m from this zone was extracted and it has a rich abundance of extractable hydrocarbons with a similar composition as that of extracted samples above. The gas chromatogram of the saturated hydrocarbon fraction shows a smooth front biased distribution, similar to the two samples from the zone above.

Aromatic Hydrocarbons

No samples were analysed from zones A, B and C.

Zone D; 1665-1725m: One sample in this zone was extracted, M-8699 (1695-1710 metres). This sample consists of a grey to dark grey, silty claystone with a TOC value of 2.3%.

The aromatic hydrocarbon gas chromatogram is dominated by one peak in C_3-naphthalene region (region C). The major compound types are the C_2 and C_3-naphthalenes and peaks in region F which probably include aromatised steranes and triterpanes. The relatively low quantities of C_1 naphthalenes, and the prominence of compounds in region F suggests a sample which contains moderate mature type III kerogens.

Zone E; 1725-1814m: Two samples from this zone were extracted M-8702 (1740-1755m) and M-8705 (1785-1800m). Both samples are dark grey, pyritic claystones with roughly 2.7%-2.8% TOC. The aromatic hydrocarbon distributions of the two samples are fairly similar, being totally dominated by the alkyl naphthalenes. There are differences in distribution however; naphthalene is prominent in M-8705 (N) but not in M-8702; and the C_1-naphthalenes dominate in M-8705 but not in M-8702. The prominent peak in M-8699 from zone D is within the C_3-naphthalene region (C) this same peak is still prominent in M-8702 but less so in the deepest sample M-8705. The changes in samples from zone D and E suggest a trend of reduction in low molecular weight aromatic hydrocarbons (i.e. naphthalene and C_1-naphthalenes) in going from the deepest to shallowest sample. However more sample analysis would be required to confirm this trend. The trend may mark an improvement in kerogen quality downhole.

Zone F; 1814-1845m: One sample of dark grey claystone was analysed from this zone (core 1822 metres - M-9026). The aromatic hydrocarbon distribution is very similar to the lowest sample from Zone E; the main difference is that there is relatively more material in region F of the gas chromatogram for the sample in this zone than the samples in zone E. The trend observed in the three samples above this zone may be continued in the sample from this zone, with a further improvement in kerogen type in this zone.

Zone G; 1845-1965m: No samples were analysed.

Zone H; 1965-2070m: Two samples were analysed in this zone, M-8716 (1965-1980m) and M-8720 (2010-2025m). These samples are dark grey to black claystones with 4.5% and 2.9% TOC respectively. The first sample shows a number of differences to the samples directly above and below. Phenanthrene and the C_1-phenanthrenes are prominent as are 3 peaks tentatively identified as organic sulphur compounds (marked with an asterisk). The other sample in this zone shows a similar pattern to that established in zones E and F.

Zone I; 2100-2300m: One sample of dark grey, carbonaceous, lusterous claystone with 5.1% TOC was analysed from this zone M-8732 (2190-2205m). It resembles very closely the upper sample from zone H.

The samples with the most abundant low molecular weight hydrocarbons also have high Rock-Eval production indices probably indicating that hydrocarbons have migrated into the formations from which these samples were derived. It is probably that the low molecular weight material seen in saturated and aromatic hydrocarbon gas chromatograms from these samples (M-8699, M-8702, M-8705 and M-8720) consists partially of introduced hydrocarbon (perhaps affecting the saturated more than aromatic hydrocarbon distributions). The other samples (M-9026, M-8716 and M-8732) are more representative of the indigenous hydrocarbons.

Examination in Reflected Light

Nineteen samples chosen by the client were examined in reflected light. Each sample is described below.

The series does not vary very much in maturity and a large number of the samples have the same or very similar values. This, together with a rather monotonous lithology (which makes distinction of true lithology for any one depth interval more difficult) and a surprising near absence of fluorescing spores throughout would tend to lead us to suspect large scale sediment reworking or drilling contamination especially in the section from 1470m to 1800m. In addition, many of the samples are described as containing high reworked vitrinite populations or inertinite. A true range of maturity would appear to be from the immature/moderate mature boundary zone to just inside the oil window.

Sample M-8668, 750-780m: Claystone, Ro Lignite = 0.27(1)
The sample has a low organic content which is dominantly reworked vitrinite together with very small stringers (too small to measure) the nature of which is difficult to distinguish. There is a patchy distribution of bitumen wisps and a light bitumen staining. The reflectance of indigenous inertinite is low which implies a low maturity of the sample but the only reading is from a lignite particle. No fluorescence is observed.

Sample M-8678, 1050-1080m: Claystone, Ro = 0.42(4)
The sample has a moderate total organic content but a low vitrinite content. The organic material is dominantly small rounded inertinite fragments together with bitumen staining and wisps. The small amount of vitrinite is very poor and most organic material is too small to distinguish accurately. The sample does have the look of an immature sample. There is a trace of fragments fluorescing green. These may be spore fragments but no identifiable shapes are preserved and the fluorescence colour seems low.

Sample M-8688, 1350-1380m: Claystone, No Determination Possible.
The sample contains only reworked vitrinite and a trace of inertinite with possible irregular bitumen staining. No fluorescence is observed.

Sample M-8692, 1470-1500m: Claystone, Ro = 0.53(2)
The sample has a moderate organic content but this is almost completely reworked vitrinite and inertinite. There is a trace of bituminite but only two possible primary vitrinite particles. No fluorescence is observed.

Sample M-8699, 1695-1710m: Mixed claystone, Ro = 0.54(17)
Overall, the sample is rich in organic material. Again this is dominantly inertinite with reworked vitrinite. Primary vitrinite and bituminite/lignite are subordinate. However, the sample is difficult to assess as there are a number of claystones or the claystone has a

very variable silt and sand component. There is a trace of green fluorescence from bitumen/resin.

Sample M-8702, 1740-1755m: Claystone, Ro = 0.53(21)
The sample is rich in organic material but this is very dominantly inertinite (especially semi-fusinite but with some clear cell structured fusinite). Most of the primary vitrinite is particulate and poor but there are a few good stringers (which give the lower values). There is a trace of bituminite and an occasional fragment that could be spore. However, no fluorescence is observed which is unusual in a sample of this maturity if spores are present.

Sample M-8705, 1785-1800m: Mixed claystone, Ro = 0.55(8)
The sample is dominated by reworked vitrinite. There is subordinate primary vitrinite in one of the minor claystone lithologies and this is recorded. However, due to a mixture of claystones it is not possible to know if this, or any other, is in situ. No fluorescence is observed.

Sample M-9026, 1822m: Claystone, sandstone and coal, Ro = 0.45(20)
There is a moderate to high organic content. This consists dominantly of poor (gnarled and pitted) vitrinite stringers together with bituminite and bitumen staining. There is a moderate inertinite content. The coal is all loose and is probably additive/contaminant. The reflectance value seems to be low but yellow/orange fluorescence from recognisable spores and indistinct fragments appears to be in agreement.

Sample M-8716, Sst, 1965-1980m: Sandstone, Ro = 0.45(23)
The sample has a high organic content. This is dominantly vitrinite and bituminite with associated bitumen staining. There is a low inertinite content. Most of the vitrinite occurs as poor, pitted and gnarled particles but there are a few good stringers. There is a good distribution of values. There is dull orange/brown fluorescence from bitumen/resin and a possible trace of yellow/orange spores.

Sample M-8716, Clst, 1965-1980m: Claystone, Ro = 0.45(23)
The sample has a high organic content. This is dominantly vitrinite and bituminite with associated bitumen staining. There is a low

inertinite content. Most of the vitrinite occurs as poor, pitted and gnarled particles but there are a few good stringers. There is a good distribution of values. There is dull orange/brown fluorescence from bitumen/resin and a possible trace of yellow/orange spores.

Sample M-8720, 2010-2025m: Mixed claystones, Ro = 0.56(20)
The sample has a moderate to high overall organic content. This is dominantly vitrinite and semi-fusinite. Most of the vitrinite occurs as poor, "corroded" stringers but there are a few clean stringers and particles. Bitumen staining is very variable. Again there is the problem of apparently different claystones in the same sample. There is a trace of yellow/orange and light orange indistinct fragments.

Sample M-8723, 2055-2070m: Sandstone and claystone, Ro = 0.56(5)
The sandstone is taken to be the true lithology from the lithological description and total organic carbon values. It has a low organic content with traces of possible primary vitrinite and reworked vitrinite/semi-fusinite. There is a poor distribution of values and low confidence in the result. Coal is noted but is probably additive. A trace of light orange fluorescing spores is noted but these could be from the coal additive.

Sample M-8726, 2110-2115m: Claystone and sandstone, Ro = 0.63(4)
This is a poor sample of mixed lithologies. The claystone was analysed because it has been analysed for total organic carbon. There is a low organic content within the claystone and this is dominantly reworked material. The sandstone appears to be of higher maturity (reworked?). No fluorescence is observed.

Sample M-8729, 2145-2160m: Claystone, sandstone, siltstone, drilling mud, Ro = 0.56(6)?
This is a poor sample but because of the lithological description the claystone element was analysed. There is a low organic content and the vitrinite present is very poor. There is a wide spread of values and confidence in the result is low. There is a trace of yellow/orange fluorescence from spores in one clast only.

Sample M-8732 Clst, 2190-2205m: Mixed claystone, Ro = 0.57(26)
The sample has a rich organic content but this is dominantly inertinite (especially semi-fusinite) and reworked inertinite. Again there are apparently several different claystones with variable organic and silt contents. There is quite a wide spread of values but it is well distributed about the mean. There is a trace of light orange fluorescing patches but these are not identified.

Sample M-8732 Sst, 2190-2205m: Sandstone, Ro = 0.56(9)
There is a low organic content which is dominantly inertinite. Vitrinite is subordinate and poor (corroded) and there is some associated bitumen staining. The result agrees very well with the claystone from the same horizon. No fluorescence is observed.

Sample M-8735, 2235-2250m: Sandstone, claystone and coal, Ro = 0.60(22)
The claystone is rich and has a carbargillitic appearance in places with thick vitrinite bands. The coal has higher reflectivity but it is probably additive. The sandstone is almost barren. Consequently, despite the lithological description and because of the amount and its nature the claystone was analysed. Within the claystone bitumen staining is very variable, locally heavy, and there is a high content of bitumen and degraded spores/resin. This is strange because no fluorescence is observed.

Sample M-8738, 2280-2295m: Claystone, Ro = 0.62(14)
The sample has a moderate to high organic content but this is dominantly reworked vitrinite and inertinite. There is some primary vitrinite but this is subordinate and poor. There is a moderate content of bituminite, bitumen staining and possible degraded spores. However, there is no fluorescence observed.

Sample M-8739, 2295-2300m: Claystone and Coal, Ro = 0.63(21)
The sample has a moderate to high organic content which is dominantly inertinite (semi-fusinite). The vitrinite is poor-gnarled and pitted. The coal could be contaminant/additive and it gives higher results. There is no fluorescence observed.

Visual Analyses in Transmitted Light

The investigated acid insoluble organic residues from 7120/9-1 represent selected lithologies from 6 samples of ditch cuttings and one core sample. The samples were chosen by the client and represent specified levels within the interval of 1710m to 2205m. They represent different geological ages which are reflected in the composition and preservation of the organic material.

All residues were dominated by material derived from terrestrial sources. The maturity seems fairly low, from 1+/2- to 2- (moderately mature) for the samples at least down to 2025m, 2- or 2-/2 at 2205m.

1710m and 1755m: Woody material dominates and includes a major element of fairly large semifusinite-fusinite particles. Pollen, spores and cuticles together with dinoflagellate cysts and tasmanitids are subordinate. The particles are embedded in an amorphous matrix.

The palynomorphs are well or fairly well preserved.
Colour index: 2- for material from a slightly oxidative environment.

1880m and 1822m c: The material is recorded as firm often rounded aggregates. Woody material, mostly as small vitrinite fragments, dominates. Cuticles, pollen and spores, as well as vitrinite are strongly sapropelised. Fungal fruiting bodies, hyphae and traces of fungi were quite common.

The palynomorphs are fairly well preserved.
Colour index: 1+/2-.

1980m: Woody material (mostly vitrinite) dominates and is less strongly sapropelised than in samples 1860m and 1822m above. Cuticles, pollen, spores and cysts are subordinate and embedded in the amorphous matrix.

The palynomorphs are fairly well or well preserved.
Colour index: 2-.

2025m: Strongly sapropelised material as aggregates which were evaluated to consist of woody material and cuticles. We have low confidence in the results.

The palynomorphs are not well preserved.
Colour index: 1+/2-, 2-/2.

2205: Particles of variable sizes. The residue is poorly sorted and consists of semifusinite-fusinite, cuticles and spores (Triassic).

The material is well preserved.
Colour index: 2-/2.

Rock-Eval Pyrolyses

Only seven samples from this well were selected by the client for Rock-Eval pyrolysis.

Zone A, B and C; 750-1620m: No samples from these zones were pyrolysed.

Zone D; 1665-1725m: One sample from this zone, 1695-1710m, was pyrolysed and found to have a low hydrogen index and moderate oxygen index showing the sample probably to contain kerogen type III. The sample has a poor/fair petroleum potential. The moderate production index together with the T_{max} indicate that the sample is at the start of the petroleum generation.

Zone E; 1735-1814m: Two samples from this zone were pyrolysed. The hydrogen and oxygen indices indicate the samples to contain kerogen type III, with a fair petroleum potential.

Zone F; 1814-1845m: One sample, a core chip from 1822m was analysed and found to have moderately high hydrogen index and low oxygen index probably representing kerogen type II or a mixture of type II and III. The T_{max} value of 429^{o}C indicate a moderate mature sample. The high petroleum potential shows the sample to have a rich potential as a source rock while the low production index shows the sample not to have reached the main hydrocarbon generation level yet.

Zone G; 1845-1965m: No samples from this zone was pyrolysed.

Zone H; 1965-2070m: Two samples from this zone were pyrolysed. The sample from 1965-80m contains probably a mixture of kerogen type II and III with a good to rich potential as a source rock while the sample from 2010-2025m contains kerogen type III with a poor/fair potential as a source rock.

Zone I; 2100-2300m: One sample from this zone was pyrolysed and found to contain a mixture of kerogen type II and III with a good/rich potential as a source rock.

CONCLUSIONS

The maturity of the analysed samples from this well is based mainly on vitrinite reflectance, spore fluorescence, kerogen colour in transmitted light and T_{max} values from Rock-Eval analysis. The richness of the samples is based on TOC, Rock-Eval pyrolysis with additional evidence being supplied from the abundance of extractable hydrocarbons. Source rock quality is based mostly on Rock-Eval pyrolysis with additional evidence coming from visual kerogen examination and from the saturated hydrocarbon gas chromatograms.

Zone A; 750-930m: This zone consists mainly of a grey to olive-grey claystone with a low to moderate abundance of light hydrocarbons and a fair abundance of organic carbon. No follow up analysis was performed on this zone. Based on the few screening analyses, the zone is believed to be immature with a fair potential as a source rock for hydrocarbons.

Zone B; 960-1200m: Most of this zone consist of claystones, grey to light grey in the upper part and dark grey to grey in the lower part. The claystone is more silty than in zone A. The screening analyses show a high abundance of light hydrocarbons while the claystone has a fair abundance of organic carbon. As with zone A, no follow up analyses were undertaken on the organic material in the samples, and it is therefore impossible to further evaluate the gas encountered. The analyses shows, however, that it is a petrogenic gas. Vitrinite reflectance measurements were tried on one sample. Only a few vitrinite particles were encountered indicating the zone to be immature. Based on the screening analyses, the zone is believed to be immature with a fair potential as a source rock for hydrocarbons. Gas, believed to be migrated, was encountered in the zone.

Zone C; 1230-1620m: A zone with mainly dark grey to grey claystone. As with zone A and B only screening analyses were performed showing moderate amounts of light hydrocarbons and a fair abundance of organic carbon. Vitrinite reflectance measurements were again difficult, but a value indicating a moderate mature zone was found for a few particles in one sample.

Based on the screening analyses, the zone is found to be moderate mature with a fair potential as a source rock for hydrocarbons.

Zone D; 1665-1725m: The lithology of this zone is mainly a dark grey, occasionally silty to sandy, claystone. The whole of the zone is moderate mature. The organic carbon values are similar to that found in the zones above. Follow up analyses were undertaken on one sample from this zone. Based on the various analyses undertaken throughout the zone, it is found to be moderate mature with a fair potential as a source rock for gas.

Zone E; 1735-1814m: This zone consists of dark grey claystones, silty in places, with a rapidly decreasing abundance of light hydrocarbon with increasing depth. The total organic carbon values increase with increasing depth. A series of follow up analyses were undertaken and the whole zone is found to be moderate mature with a good potential as a source rock for gas.

Zone F; 1814-1845m: This zone consist of a dark grey-black claystone with a very high abundance of organic carbon. Based on the various analyses the zone is found to be moderate mature with a rich potential as a source rock for gas and oil.

Zone G; 1845-1965m: The whole of this zone was cored and the canned samples from the cored interval were not evaluated.

Zone H; 1965-2070m: This zone consists of a mixture of sandstone and dark grey-black claystone. Analysis in UV light show a good cut for most of the samples indicating migrated hydrocarbons in the sandstone. The whole of the zone is found to be moderate mature based on various analyses. The claystone in the zone is found to have a rich potential as a source rock for gas and possibly some oil.

Zone I; 2100-2300m: Again a zone with a mixture of lithologies, sandstone, light grey claystone and marly claystone. The zone moderate mature/mature based on various analyses. Good cut is again found for some of the samples, especially those below 2220m, indicating migrated hydrocarbons in this part of the zone. The claystone in the zone is found to have a fair potential as a source rock for gas.

TABLE I a.

ONCENTRATION (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
8668	780	2424	526	601	131	114	101	3796	1373	36.16	1.15
8669	810	17938	3211	3100	704	755	687	25707	7769	30.22	0.93
8671	870	17768	2324	2358	679	1161	1217	24290	6522	26.85	0.58
8673	930	16251	2737	3899	1607	2702	5835	27195	10944	40.24	0.59
8675	990	4092	749	1848	956	2226	6076	9870	5778	58.54	0.43
8678	1080	175810	48931	61728	15792	32095	33608	334357	158547	47.42	0.49
8680	1140	117015	30914	34187	8375	15835	15325	206326	89311	43.29	0.53
8682	1200	46111	11392	11553	2523	4780	3612	76359	30248	39.61	0.53
8684	1260	32111	6097	5788	1212	2435	2215	47643	15531	32.60	0.50
8686	1320	23175	3194	2244	341	482	238	29437	6262	21.27	0.71
8688	1380	13973	5578	4469	683	939	1028	25642	11669	45.51	0.73
8690	1440	22825	4383	1210	274	139	202	28830	6005	20.83	1.97
8692	1500	8864	1665	1047	178	217	176	11970	3107	25.96	0.82
8694	1560	2271	503	302	59	73	71	3207	936	29.19	0.81
8696	1620	5936	1413	1275	341	454	467	9418	3483	36.98	0.75
8697	1680	12915	4558	1601	357	269	193	19699	6784	34.44	1.33
8698	1695	16618	2851	1756	457	431	300	22113	5496	24.85	1.06
8699	1710	28479	6612	3345	633	593	403	39661	11182	28.19	1.07
8700	1725	44707	11685	4898	790	716	354	62794	18087	28.80	1.10
8702	1755	2526	476	201	41	36	127	3280	755	23.00	1.14
8705	1800	1291	299	152	24	43	53	1808	517	28.61	0.55
8708	1845	190575	76521	16744	1544	2624	1596	288008	97432	33.83	0.59
8711	1890	40222	6947	5345	2043	3587	5448	58144	17922	30.82	0.57

DATE : 8 - 10 - 82.

TABLE I a.

ONCENTRATION (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
8714	1935	14652	3763	2569	630	1199	1917	22813	8161	35.77	0.53
8716	1980	34047	10805	10052	2460	422	1003	57784	23738	41.08	5.83
8720	2025	9111	2514	1148	220	401	954	13393	4283	31.98	0.55
8723	2070	38369	6881	3604	795	1423	2689	51072	12704	24.87	0.56
8726	2115	7771	1625	849	224	254	556	10723	2952	27.53	0.88
8729	2160	4704	1206	678	109	169	479	6867	2162	31.49	0.65
8732	2205	12773	1180	467	66	80	120	14566	1793	12.31	0.83
8735	2250	11435	919	682	167	244	393	13447	2012	14.96	0.68
8738	2295	5635	810	440	50	78	105	7014	1379	19.66	0.64
8739	2300	9302	1985	1160	119		829	12566	3264	25.973332000.C	

DATE : 8 - 10 - 82.

TABLE I b.

:ONCENTRATION (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
8668	780	140	16	65	34		325	255	116	45.33	
8669	810	95	101	221	106	79	188	603	508	84.24	1.34
8671	870	167	134	222	119	173	1032	816	649	79.53	0.69
8673	930	134	134	259	79	165	3118	769	636	82.63	0.48
8675	990	212	71	129	119	199	8450	730	518	70.99	0.60
8678	1080	417	215	860	464	1590	7845	3547	3130	88.24	0.29
8680	1140	365	288	954	467	1532	8723	3606	3240	89.86	0.30
8682	1200	412	162	620	327	1170	7203	2691	2279	84.70	0.28
8684	1260	265	76	261	121	493	3757	1216	951	78.24	0.25
8686	1320	221	70	208	64	174	292	737	516	69.99	0.37
8688	1380	314	239	811	246	638	1376	2248	1934	86.04	0.39
8690	1440	281	315	432	168	235	1034	1431	1149	80.35	0.71
8692	1500	222	194	622	223	547	924	1809	1587	87.70	0.41
8694	1560	255	240	669	251	622	2883	2036	1781	87.48	0.40
8696	1620	197	230	497	190	374	692	1488	1291	86.74	0.51
8697	1680	2343	4992	4037	874	1296	731	13542	11199	82.70	0.67
8698	1695	2067	3093	4288	1014	1381	1328	11844	9776	82.55	0.73
8699	1710	1424	374	4224	1013	1506	935	8541	7118	83.33	0.67
8700	1725	770	1450	1303	264	376	242	4164	3393	81.50	0.70
8702	1755	3110	6517	5379	1025	1435	890	17465	14355	82.19	0.71
8705	1800	304	565	519	105	170	151	1663	1359	81.72	0.62
8708	1845	750	1599	2466	600	1405	2193	6820	6070	89.00	0.43
8711	1890	17357	8978	5791	8745	5107	3439	45977	28621	62.25	1.71

DATE : 8 - 10 - 82.

TABLE I b.

ONCENTRATION (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
8714	1935	4716	10502	11708	2343	6126	10827	35395	30679	86.68	0.38
8716	1980	1780	3959	5846	1921	4775	15305	18280	16501	90.26	0.40
8720	2025	3134	4739	3946	895	2275	7310	14989	11855	79.09	0.39
8723	2070	3695	7602	9322	1832	4311	7596	26762	23067	86.19	0.42
8726	2115	450	903	876	205	333	1402	2767	2316	83.72	0.62
8729	2160	2216	988	833	232	387	651	4656	2440	52.40	0.60
8732	2205	3120	2278	1627	301	592	2007	7918	4798	60.60	0.51
8735	2250	5647	1619	1423	348	751	3664	9789	4141	42.31	0.46
8738	2295	539	622	658	98	232	613	2149	1610	74.93	0.42
8739	2300	273	492	626	93	221	271	1705	1432	84.01	0.42

DATE : 8 - 10 - 82.

TABLE I c.

ONCENTRATION (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
8668	780	2563	542	667	166	114	427	4052	1488	36.74	1.46
8669	810	18033	3312	3321	810	834	876	26310	8277	31.46	0.97
8671	870	17935	2458	2580	798	1335	2249	25106	7171	28.56	0.60
8673	930	16385	2870	4157	1685	2867	8953	27964	11580	41.41	0.59
8675	990	4303	819	1977	1075	2424	14527	10599	6296	59.40	0.44
8678	1080	176227	49147	62589	16257	33685	41453	337905	161678	47.85	0.48
8680	1140	117380	31202	35141	8842	17367	24048	209932	92552	44.09	0.51
8682	1200	46523	11554	12173	2850	5950	10815	79050	32527	41.15	0.48
8684	1260	32376	6173	6049	1333	2927	5972	48858	16482	33.73	0.46
8686	1320	23396	3264	2452	405	656	530	30174	6777	22.46	0.62
8688	1380	14287	5817	5280	930	1577	2404	27890	13604	48.78	0.59
8690	1440	23106	4697	1642	441	374	1236	30260	7154	23.64	1.18
8692	1500	9086	1859	1669	401	764	1100	13779	4693	34.06	0.52
8694	1560	2526	742	971	310	694	2954	5244	2718	51.83	0.45
8696	1620	6133	1642	1772	531	828	1159	10906	4773	43.77	0.64
8697	1680	15257	9549	5638	1231	1565	924	33241	17983	54.10	0.79
8698	1695	18685	5945	6044	1472	1812	1628	33957	15272	44.98	0.81
8699	1710	29902	6986	7569	1646	2098	1338	48202	18300	37.96	0.78
8700	1725	45477	13135	6201	1054	1092	596	66958	21481	32.08	0.97
8702	1755	5636	6993	5579	1066	1471	1017	20745	15109	72.83	0.72
8705	1800	1595	864	670	129	213	203	3471	1876	54.05	0.61
8708	1845	191326	78119	19210	2144	4029	37892	294828	103502	35.11	0.53
8711	1890	57579	15925	11135	10788	8695	8887	104121	46542	44.70	1.24

DATE : 8 - 10 - 82.

TABLE I c.

ONCENTRATION (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
8714	1935	19368	14265	14277	2972	7325	12744	58208	38840	66.73	0.41
8716	1980	35827	14764	15897	4381	5196	16308	76065	40238	52.90	0.84
8720	2025	12245	7252	5094	1116	2676	8264	28383	16138	56.86	0.42
8723	2070	42064	14484	12926	2626	5734	10285	77835	35771	45.96	0.46
8726	2115	8222	2528	1724	429	587	1958	13489	5268	39.05	0.73
8729	2160	6920	2194	1511	341	556	1130	11523	4602	39.94	0.61
8732	2205	15893	3458	2094	367	672	2127	22484	6591	29.31	0.55
8735	2250	17082	2538	2105	516	995	4056	23236	6154	26.48	0.52
8738	2295	6174	1433	1099	148	310	717	9164	2989	32.62	0.48
8739	2300	9575	2477	1786	212	221	1100	14271	4696	32.91	0.96

DATE : 8 - 10 - 82.

Lithology and Total Organic Carbon measurements

TABLE NO.: 2
WELL NO.: 7120/9-1

Sample	Depth (m)	TOC		Lithology
M-8668	780	0.82	95%	Claystone, grey - olive grey, micromicaceous, very slightly pyritic (finegrained framboidal pyrite), non calcareous.
			5%	Cement and mud-additives.
			Sm.am.	Sand, coarse - very coarse, rounded.
M-8669	810	0.63	93%	Claystone, grey - olive grey, micro-micaceous, slightly pyritic as above, occasionally observed with Glauconite, non calcareous.
			2%	Siderite, brown.
			5%	Cement.
M-8671	870	0.59	90%	Claystone, as M-8669, observed with laminations
			5%	Claystone, olive grey, mostly as small rounded fragments.
			2%	Siderite, brown - light brown.
			3%	Cement.
M-8673	930	0.25	100%	Claystone, grey, greenish grey, greenish, purple, occasionally very glauconitic, occasionally very rich in Shell fragments.
			Sm.am.	Siderite.
			Trace	Lignite (additive).
M-8675	990	0.43	100%	Claystone, grey, light grey, some olive grey, slightly micromicaceous, non calcareous, but disintegrates occasionally in 10% HCl.
			Sm.am.	Siderite, brown - olive brown.

Lithology and Total Organic Carbon measurements

TABLE NO.: 2
WELL NO.: 7120/9-1

Sample	Depth (m)	TOC	Lithology	
			Small sample	
M-8678	1080	0.66	100%	Claystone, dark grey - grey, very pyritic in parts, micromicaceous, occasionally glauconitic, interbedded with thin Sandstone lamina. The Sandstone is fine - subangular, argillaceous, very glauconitic, calcareous, slightly micromicaceous and pyritic.
			Trace	Claystone, purple.
M-8680	1140	0.75	100%	Claystone, dark grey, slightly lusterous, micromicaceous, pyritic (very finegrained framboidal), slightly ? carbonaceous, occasionally calcareous, disintegrates in 10% HCl, occasionally with thin glauconitic sandstone layers as above.
M-8682	1200	0.63	95%	Claystone, dark olive grey, micromicaceous, slightly lustrous, occasionally very pyritic (finegrained framboidal Pyrite).
			2%	Marl/marly Limestone, white - light brownish white.
			3%	Shell fragments.
M-8684	1260	0.69	100%	Claystone, grey - dark olive grey, slightly micromicaceous, occasionally sandy and glauconitic as above.
			Sm.am.	of Shell fragments; Marl.
M-8686	1320	0.64	100%	Claystone, grey, slightly micromicaceous, getting occasionally subfissile, non calcareous.

Lithology and Total Organic Carbon measurements

TABLE NO.: 2
WELL NO.: 7120/9-1

Sample	Depth (m)	TOC		Lithology
M-8688	1380	0.89	95%	Claystone grey - dark grey (olive), very slightly micromicaceous, occasionally pyritic, occasionally sideritic in parts.
			5%	Claystone, light brown, non calcareous.
M-8690	1440	0.89	100%	Claystone, olive grey, micromicaceous, slightly pyritic (finegrained framboidal), ?carbonaceous, occasionally slightly glauconitic, occasionally slightly sandy.
			Sm.am.	Siderite.
M-8692	1500	0.94	100%	Claystone, grey - dark grey, micromicaceous, pyritic and carbonaceous, some slightly calcareous, occasionally disintegrates in 10% HCl.
			Sm.am.	calcareous Claystone, brownish grey, Siderite.
M-8694	1560	0.69	100%	Claystone as M-8692.
M-8696	1620	0.86	80%	Claystone, grey, occasionally sandy.
			15%	Sandy/silty Claystone, light brownish grey, occasionally very sideritic, calcareous, fine - medium.
			5%	Siderite.
			Sm.am.	Claystone, light grey - brownish grey, mottled, slightly calcareous.
			Trace	Claystone, redbrown, slightly calcareous.

Lithology and Total Organic Carbon measurements

TABLE NO.: 2
WELL NO.: 7120/9-1

Sample	Depth (m)	TOC		Lithology
M-8697	1680	1.85	90%	Claystone, occasionally silty, sandy, dark grey, grey, micromicaceous, pyritic.
			10%	Claystone, light brown, calcareous, sideritic, slightly pyritic.
			Sm.am.	Calcite.
			Trace	Cement.
M-8698	1695	1.82	90%	Claystone, as above, occasionally very pyritic.
			10%	Claystone, as above, occasionally very calcareous.
			Sm.am.	Siderite, brown; Cement.
M-8699	1710	2.26	80%	Claystone, as above, occasionally slightly calcareous.
			20%	Claystone/marly Claystone, light brown.
M-8700	1725	2.49	85%	Claystone, as above, occasionally with sandy lamina.
			15%	Marl, light brown occasionally silty, occasionally sandy, slightly pyritic
M-8702	1755	0.95	40%	Claystone, dark grey-grey, pyritic?, carbonaceous with a decrease in Silt and Sand content, occasionally calcareous.
			20%	Marl - calcareous Siltstone/Sandstone, light brown.
		2.77	40%	Claystone, dark grey - grey, micro-micaceous, pyritic, slightly carbonaceous, subfissile.

Lithology and Total Organic Carbon measurements

TABLE NO.: 2
WELL NO.: 7120/9-1

Sample	Depth (m)	TOC		Lithology
M-8705	1800	2.66	75%	Claystone, dark grey, micromicaceous, pyritic, carbonaceous, subfissile.
			15%	Claystone, grey - dark grey, silty, occasionally sandy, marl.
			10%	Claystone/marly Claystone, light brown.
M-9026 Core	1822	6.16	100%	Claystone, dark grey - black.
M-9027 Core	1835	6.54	100%	Claystone, dark grey - black.
M-8708	1845		70%	marly Claystone, red-brown, micromicaceous.
		3.17	25%	Claystone, dark grey, occasionally pyritic.
			5%	Limestone, white. Abundant Pyrite.
A-387	1845	3.17		Claystone, silty, occasionally sandy, grey - brownish grey, micromicaceous - micaceous, non calcareous, subfissile, lustrous, hard.
A-388 Core	1894,90	0.61		Claystone, grey - slightly brownish grey, silty, micromicaceous, non calcareous, slickensides, very hard.
A-389 Core	1939,65	2.33		Claystone, silty, occasionally sandy, grey - brownish grey, micromicaceous - micaceous, non calcareous, subfissile, lustrous, hard.

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2
WELL NO.: 7120/9-1

Sample	Depth (m)	TOC		Lithology
M-8716	1980	0.59	85%	Sandstone, very light brownish white, very fine - medium angular - subangular, micaceous, argillaceous, non calcareous, occasionally carbonaceous.
		4.48	15%	Claystone, dark grey - black, occasionally micromicaceous, occasionally lustrous.
M-8720	2025		15%	Sandstone, very light brownish white - light brown, fine - very fine, occasionally medium as M-8716, occasionally very argillaceous, occasionally carbonaceous.
			40%	Sand, coarse, medium, very coarse, subangular - subrounded, rounded, clear, light brownish white.
		2.93	45%	Claystone, dark grey - black.
			Trace	Coal/Lignite, Kaolin.
M-8723	2070	0.25	90%	Sand/Sandstone, medium, fine coarse, very coarse, angular - subrounded, argillaceous, micaceous, occasionally slightly carbonaceous, occasionally kaolinitic, slightly calcareous in parts.
			10%	Claystone, black - dark grey, micromicaceous, occasionally lustrous.
			Sm.am.	Coal/Lignite, Kaolin, Mica.
			Trace	Claystone, red-brown.

Lithology and Total Organic Carbon measurements

TABLE NO.: 2
WELL NO.: 7120/9-1

Sample	Depth (m)	TOC		Lithology
M-8726	2115	0.27	30%	Sandstone, light brownish white, very fine - fine, medium, subangular, argillaceous.
		0.68	50%	Claystone, grey - light grey, occasionally very slightly micromicaceous, occasionally slightly carbonaceous.
			15%	marly Claystone, occasionally silty, sandy light brown - white.
			5%	Claystone, dark grey - black.
			Sm.am.	Kaolin, Lignite/Coal.
M-8729	2160		40%	Sandstone, greyish white, fine, very fine, medium, subangular, argillaceous, slightly - very calcareous.
			20%	Sand; coarse - very coarse, subangular, occasionally subrounded, clear, milky white.
			5%	Claystone, brown - light bronw.
		1.24	35%	Claystone, grey, dark grey, micromicaceous, slightly carbonaceous - carbonaceous.
			Sm.am.	Kaolin.
M-8732	2205	0.32	50%	Sandstone, light brown, fine subangular, argillaceous, micaceous, non calcareous, interbedded with
		5.14	40%	Claystone, dark grey - black, very micaceous, carbonaceous, pyritic, occasionally sandy, occasionally very lustrous.
			5%	Sand, very coarse, subangular - subrounded.
			5%	Kaolin.

Lithology and Total Organic Carbon measurements

TABLE NO.: 2
WELL NO.: 7120/9-1

Sample	Depth (m)	TOC		Lithology
M-8735	2250	0.35	95%	Sandstone, light brown fine, occasionally medium as M-8732, interbedded.
			5%	Coal/Lignite.
			Sm.am.	Claystone, black, micaceous, also interbedded with the sandstone; Kaolin.
M-8738	2295	0.69	100%	Sandstone, greyish white, fine very fine, occasionally silty, subangular, very argillaceous, slightly micaceous, occasionally with very thin lamina of a dark micaceous and carbonaceous claystone, slightly calcareous.
			Sm.am.	Kaolin.
M-8739	2300		20%	Sandstone as M-8738.
		0.40	80%	Interbedded. Siltstone - silty Sandstone, light brownish grey, very fine, subangular, very argillaceous and grey - light grey Claystone, micromicaceous, slightly pyritic.

T A B L E : 3.

CONCENTRATION OF EOM AND CHROMATOGRAPHIC FRACTIONS

J-No	DEPTH (m)	Rock Extr. (g)	EOM (mg)	Sat. (mg)	Aro. (mg)	HC (mg)	Non HC (mg)	TOC (%)
3699	1710.00	15.5	9.6	2.6	1.3	3.9	5.7	2.26
3702	1755.00	22.4	13.1	4.1	2.0	6.1	7.0	2.77
3705	1800.00	44.5	45.4	6.7	4.0	10.7	34.7	2.66
9026	1822.00	34.1	122.2	24.7	19.1	43.8	78.4	6.16
8716	core 1980.00	7.6	42.1	5.9	3.7	9.6	32.5	4.48
8720	2025.00	15.8	31.5	6.2	3.1	9.3	22.2	2.93
8732	2205.00	17.2	49.1	11.5	6.7	18.2	30.9	5.14

DATE : 14 - 1 - 83.

TABLE : 4.

WEIGHT OF EOM AND CHROMATOGRAPHIC FRACTIONS

(Weight ppm OF rock)

IKU-No	DEPTH (m)	EOM	Sat.	Aro.	HC	Non HC
M 8699	1710.00	619	168	84	252	368
M 8702	1755.00	585	183	89	272	313
M 8705	1800.00	1020	151	90	240	780
M 9026	1822.00	3584	724	560	1284	2299
M 8716	core 1980.00	5539	776	487	1263	4276
M 8720	2025.00	1994	392	196	589	1405
M 8732	2205.00	2855	669	390	1058	1797

DATE : 14 - 1 - 83.

TABLE : 5.

CONCENTRATION OF EOM AND CHROMATOGRAPHIC FRACTIONS

(mg/g TOC)

IKU-No	DEPTH (m)	EOM	Sat.	Aro.	HC	Non HC
M 8699	1710.00	27.4	7.4	3.7	11.1	16.3
M 8702	1755.00	21.1	6.6	3.2	9.8	11.3
M 8705	1800.00	38.4	5.7	3.4	9.0	29.3
M 9026	1822.00 core	58.2	11.8	9.1	20.9	37.3
M 8716	1980.00	123.6	17.3	10.9	28.2	95.5
M 8720	2025.00	68.0	13.4	6.7	20.1	48.0
M 8732	2205.00	55.5	13.0	7.6	20.6	35.0

DATE : 14 - 1 - 83.

IKU

TABLE : 6.

COMPOSITION IN % OF MATERIAL EXTRACTED FROM THE ROCK

U-No	DEPTH (m)	Sat / EOM	Aro / EOM	HC / EOM	SAT / Aro	Non HC / EOM	HC / Non HC
8699	1710.00	27.1	13.5	40.6	200.0	59.4	68.4
8702	1755.00	31.3	15.3	46.6	205.0	53.4	87.1
8705	1800.00	14.8	8.8	23.6	167.5	76.4	30.8
9026	1822.00	20.2	15.6	35.8	129.3	64.2	55.9
8716	core 1980.00	14.0	8.8	22.8	159.5	77.2	29.5
8720	2025.00	19.7	9.8	29.5	200.0	70.5	41.9
8732	2205.00	23.4	13.6	37.1	171.6	62.9	58.9

DATE : 14 - 1 - 83.

IKU

TABLE 7

TABULATION OF DATAS FROM THE GASCHROMATOGRAMS

IKU No.	DEPTH (m)	PRISTANE / n-C17	PRISTANE / PHYTANE	CPI
M 8699	1710	1.9	3.7	1.3
M 8702	1755	1.8	2.4	1.1
M 8705	1800	1.4	1.8	1.3
M 9026	1822	2.7	3.1	1.0
M 8716	1980	0.9	2.1	1.0
M 8720	2025	0.9	2.2	1.2
M 8732	2205	0.8	2.1	1.1

DATE : 17 - 1 - 83.

KU

Vitrinite Reflectance measurements

TABLE NO.: 8
WELL NO.: 7120/9-1

mple	Depth	Vitrinite reflectance	Fluorescence in UV light	Exinite content
-8668	750 - 780	0.27 (1) Lignite	Nil	Nil
-8678	1050 - 1080	0.42 (4)	Trace green (spore?) fragments	Trace?
-8688	1350 - 1380	N.D.P.	Nil	Nil
-8692	1470 - 1500	0.53 (2)	Nil	Nil
-8699	1695 - 1710	0.54 (17)	Trace green bitumen	Trace?
-8702	1740 - 1755	0.53 (21)	Nil	Nil
-8705	1785 - 1800	0.55 (8)	Nil	Nil
-9026	1822	0.45 (20)	Yellow/orange spores and small indistinct particles	Low - moderate
-8716 st	1965 - 1980	0.44 (7)	Dull orange mineral fluore-scence	Nil
-8716 1st.	1965 - 1980	0.45 (23)	Dull orange/brown bitumen and trace yellow/orange spores?	Trace?
-8720	2010 - 2025	0.56 (20)	Trace yellow/orange and light orange indistinct fragments	Trace?
-8723	2055 - 2070	0.56 (5)	Trace light orange (spores?) possibly in the coal	Trace?

061/G/ah/1

Vitrinite Reflectance measurements

TABLE NO.: 8
WELL NO.: 7120/9-1

mple	Depth	Vitrinite reflectance	Fluorescence in UV light	Exinite content
-8726	2110 - 2115	0.63 (4)	Nil	Nil
-8729	2145 - 2160	0.56 (6)	Trace yellow/orange (spore?) fragments	Trace?
-8732 st.	2190 - 2205	0.57 (26)	Trace light orange indistinct patches	Trace?
-8732	2190 - 2205	0.56 (9)	Nil	Nil
-8735	2235 - 2250	0.60 (22)	Nil	Nil
-8738	2280 - 2295	0.62 (14)	Nil	Nil
-8739	2295 - 2300	0.63 (21)	Nil	Nil

IKU

Visual Kerogen Analysis

TABLE NO.: 9
WELL NO.: 7120/9-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
M-8699	1710	W,Cut,S,P/Am,Cy	F-M-L	good to fair	2-	Pyritic residue where woody material (dominantly semi-fusinite/fusinite) is embedded in a fine amorphous matrix. Pollen, spores and cuticles are subordinate. Strong light re-fraction, stained cysts. Cica-tricose spores common.
M-8702	1755	W,Cut,S,P/Am,Cy	F-M-L	good to fair	2-	As above.
M-8705	1800	W,Cut,P,S/Am,Cy	F-M-L	fair	1+/2-	Denser, rounded aggregates of more strongly sapropelised material. Woody material vit-rinite dominates and mostly is finely fragmented. Fungal fruit-ing bodies, hyphae and traces of fungi in woody material.

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

059/J/jbl/1

IKU

Visual Kerogen Analysis

TABLE NO.: 9
WELL NO.: 7120/9-1

Sample	Depth (m)	Composition of residue	Particle size	Preservation palynomorphs	Thermal maturation index	Remarks
M-9026	1822c	W,Cut,P,S/Am,Cy	F-M-L	fair	1+/2-	Aggregates as above. Tasmanitids.
M-8716	1980	W,Cut,P,S/Am,Cy	F-M	good to fair	2-	Aggregates embed woody material. Less strongly sapropelised than in the interval above. Better preserved vitrinite.
M-8720	2025	W,Cut,P,S/Am,Cy	F-M	poor to fair	1+/2-, 2-/2	Strongly sapropelised material. Confident distinction of categories is difficult.
M-8732	2205	Cut,W,/S,P/Am,Cy	F-M-L	good	2-/2	Residue rich in semifusinite/fusinite, cuticles, and Triassic spores.

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

059/J/jbl/2

IKU

TABLE 10

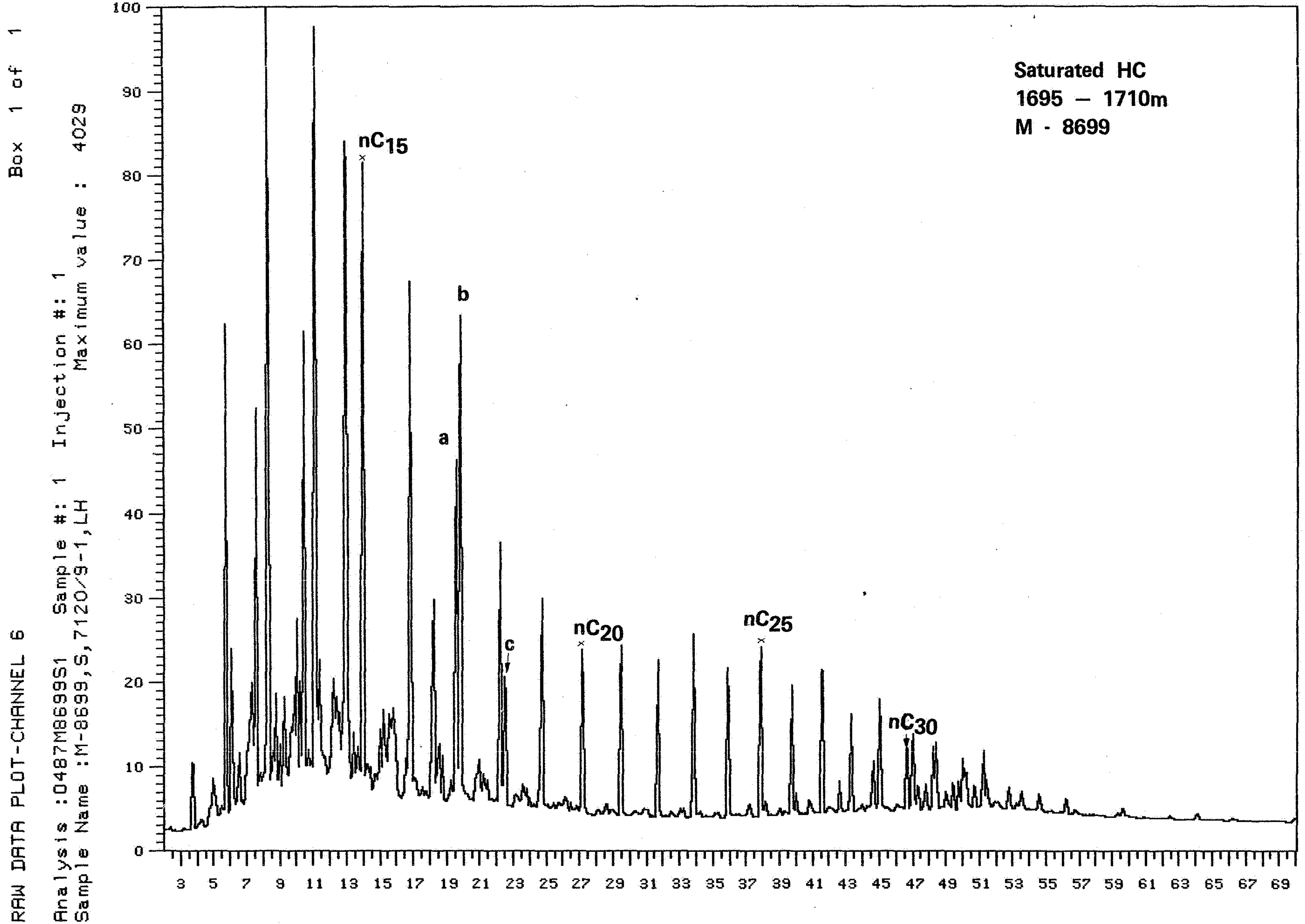
R O C K   E V A L   P Y R O L Y S E S

J	DEPTH m/ft	S1	S2	S3	TOC (%)	HYDR. INDEX	OXYGEN INDEX	OIL OF GAS CONTENT S1+S2	PROD. INDEX S1 / S1+S2	TEMP. MAX (C)
699	1710	0.52	1.87	0.31	2.26	83	14	2.39	0.22	437
702	1755	0.68	2.74	0.41	2.27	121	18	3.42	0.20	439
		Clst	dk - gy							
705	1800	0.77	3.02	0.36	2.66	114	14	3.79	0.20	437
026	1822	2.28	20.63	0.36	6.16	335	6	22.91	0.10	429
716	1980	1.97	10.55	0.82	4.48	235	18	12.52	0.16	431
		Clst								
720	2025	0.86	2.93	0.34	2.93	100	12	3.79	0.23	439
		Clst								
732	2205	1.70	9.47	0.46	5.14	184	9	11.17	0.15	437
		Clst								

DATE : 16 - 12 - 82.

GAS CHROMATOGRAMS OF SATURATED HYDROCARBONS

a = nC_{17}
b = pristane
c = phytane
nC_{15} = normal alkanes of carbon number 15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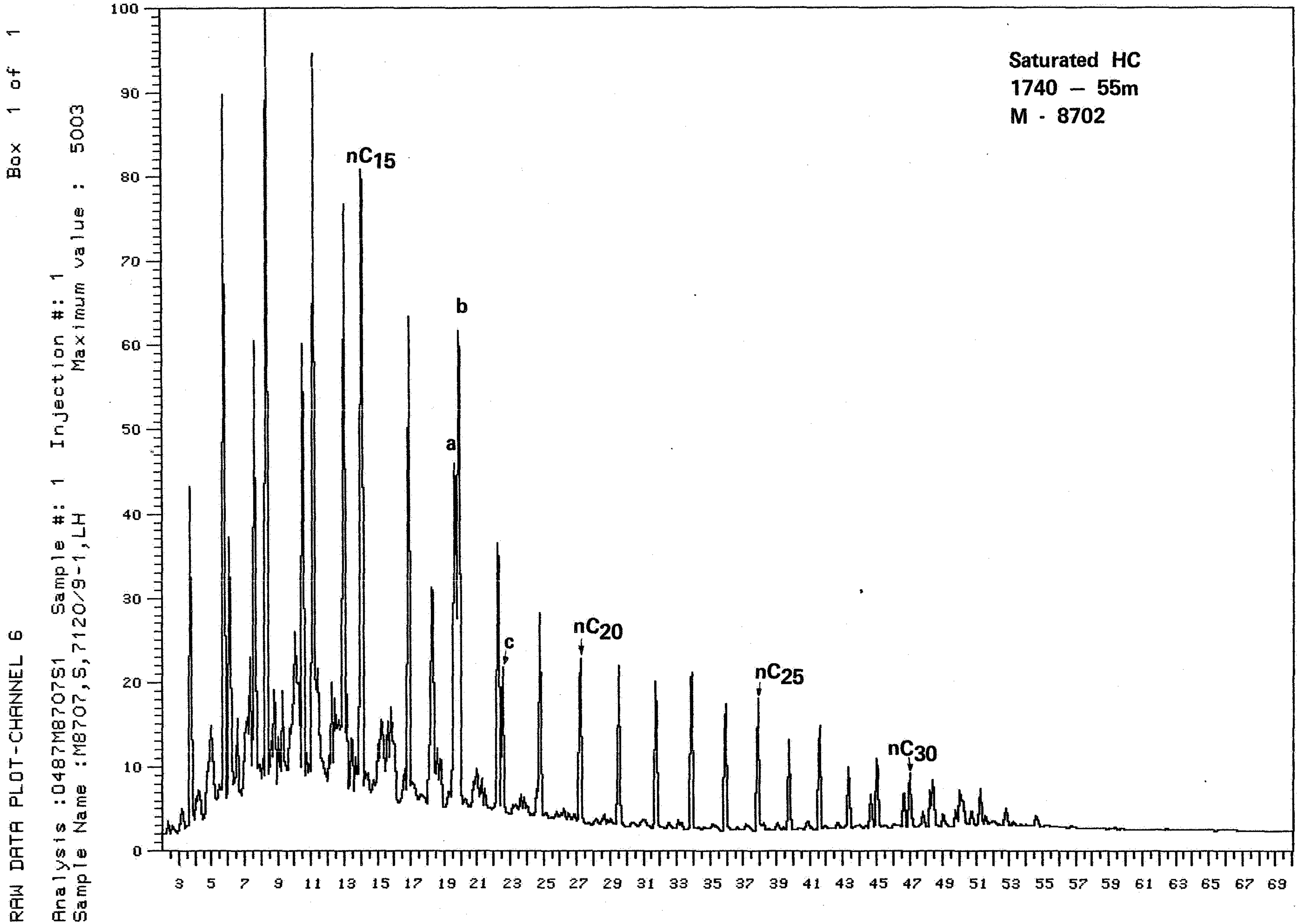
Box 1 of 1
Analysis :0487M8699S1 Sample #: 1 Injection #: 1
Sample Name :M-8699,S,7120/9-1,LH Maximum value : 4029
Saturated HC
1695 – 1710m
M - 8699
nC15
a
b
c
nC20
nC25
nC30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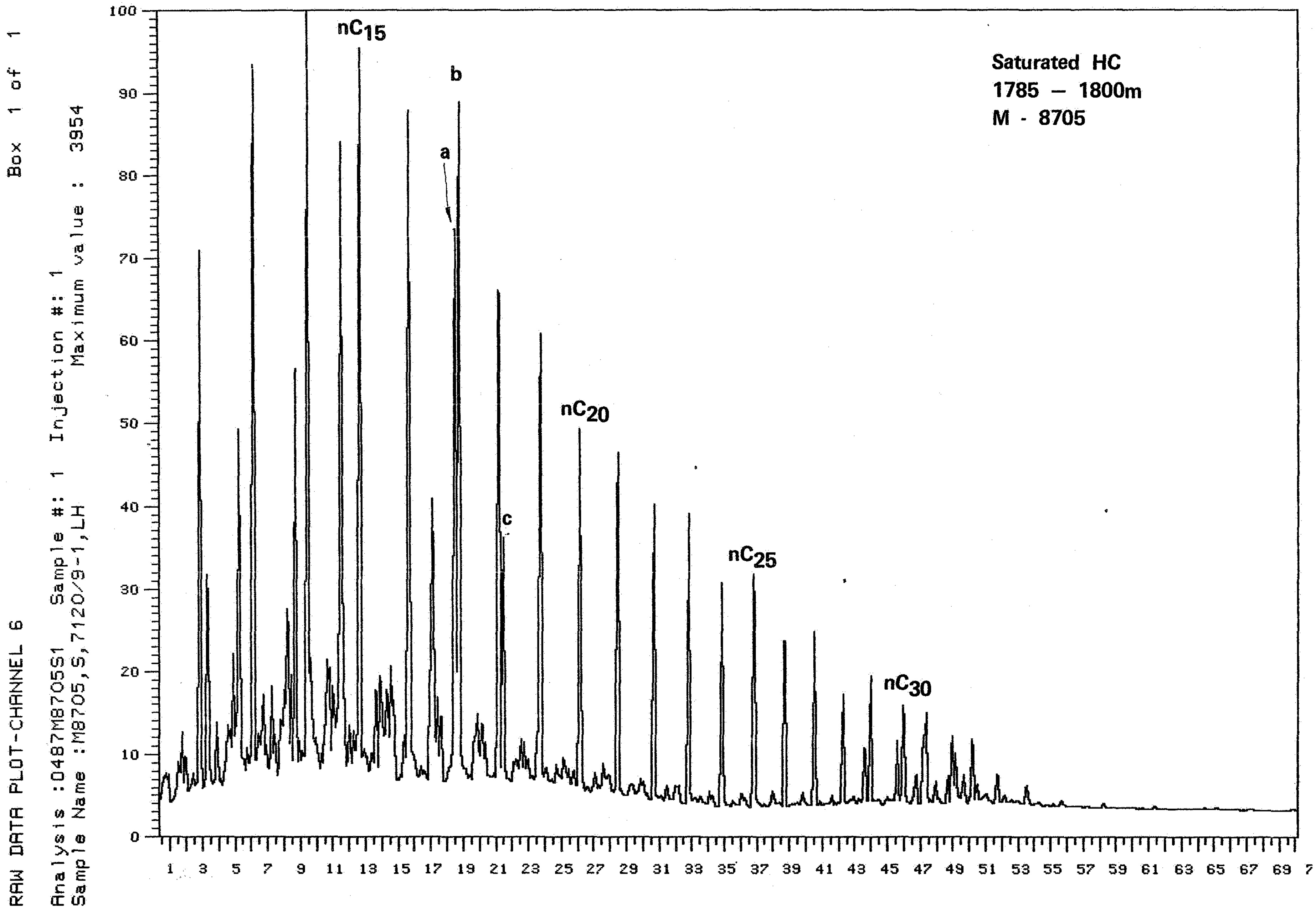
Box 1 of 1
Analysis :0487M8707S1 Sample #: 1 Injection #: 1
Sample Name :M8707,S,7120/9-1,LH Maximum value : 5003
Saturated HC
1740 – 55m
M - 8702
nC15
nC20
nC25
nC30
a
b
c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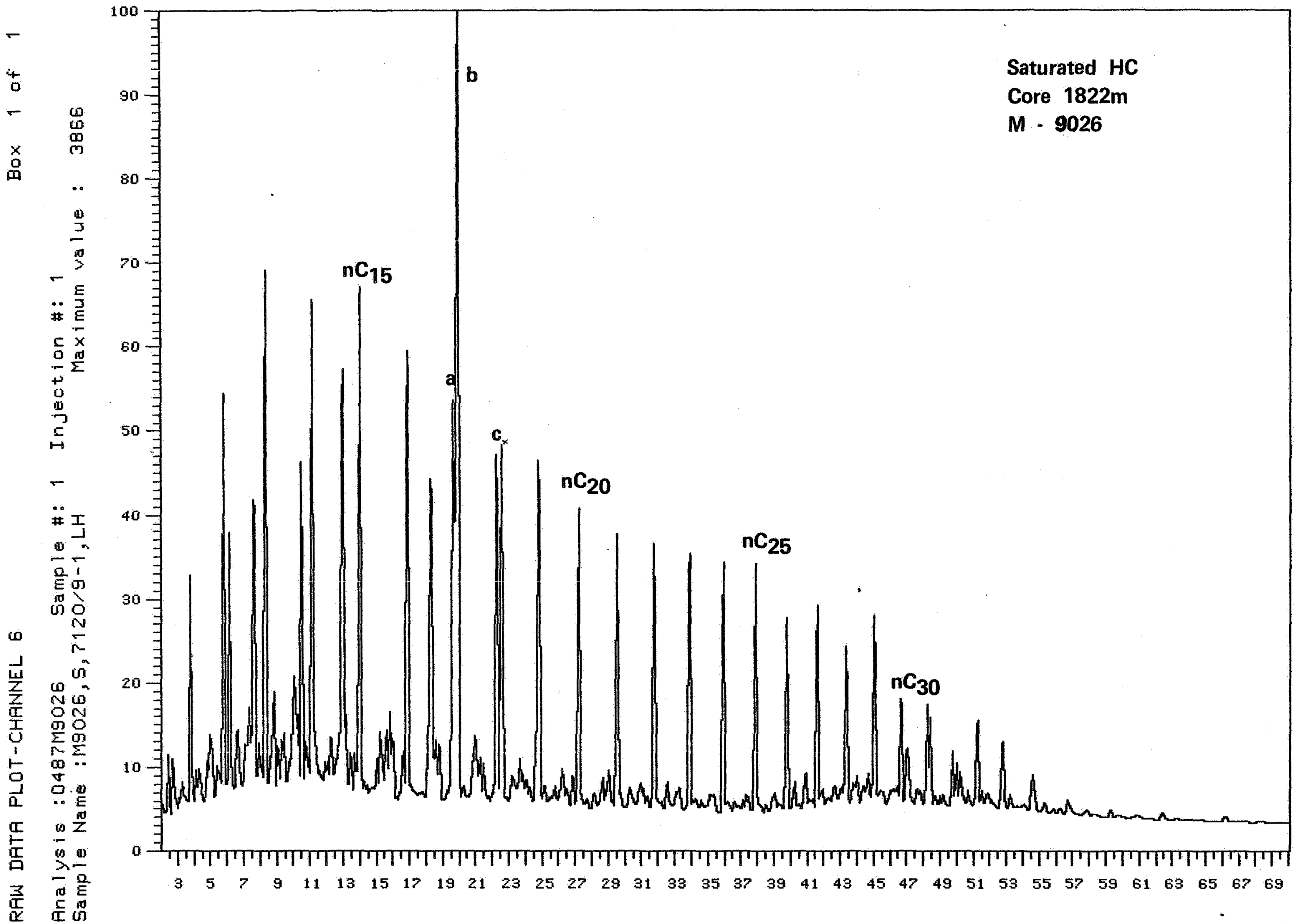
Analysis :04B7M8705S1 Sample #: 1 Injection #: 1
Sample Name :M8705,S,7120/9-1,LH
Maximum value : 3954
Saturated HC
1785 – 1800m
M - 8705
nC15
nC20
nC25
nC30
a
b
c
0
10
20
30
40
50
60
70
80
90
100
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 7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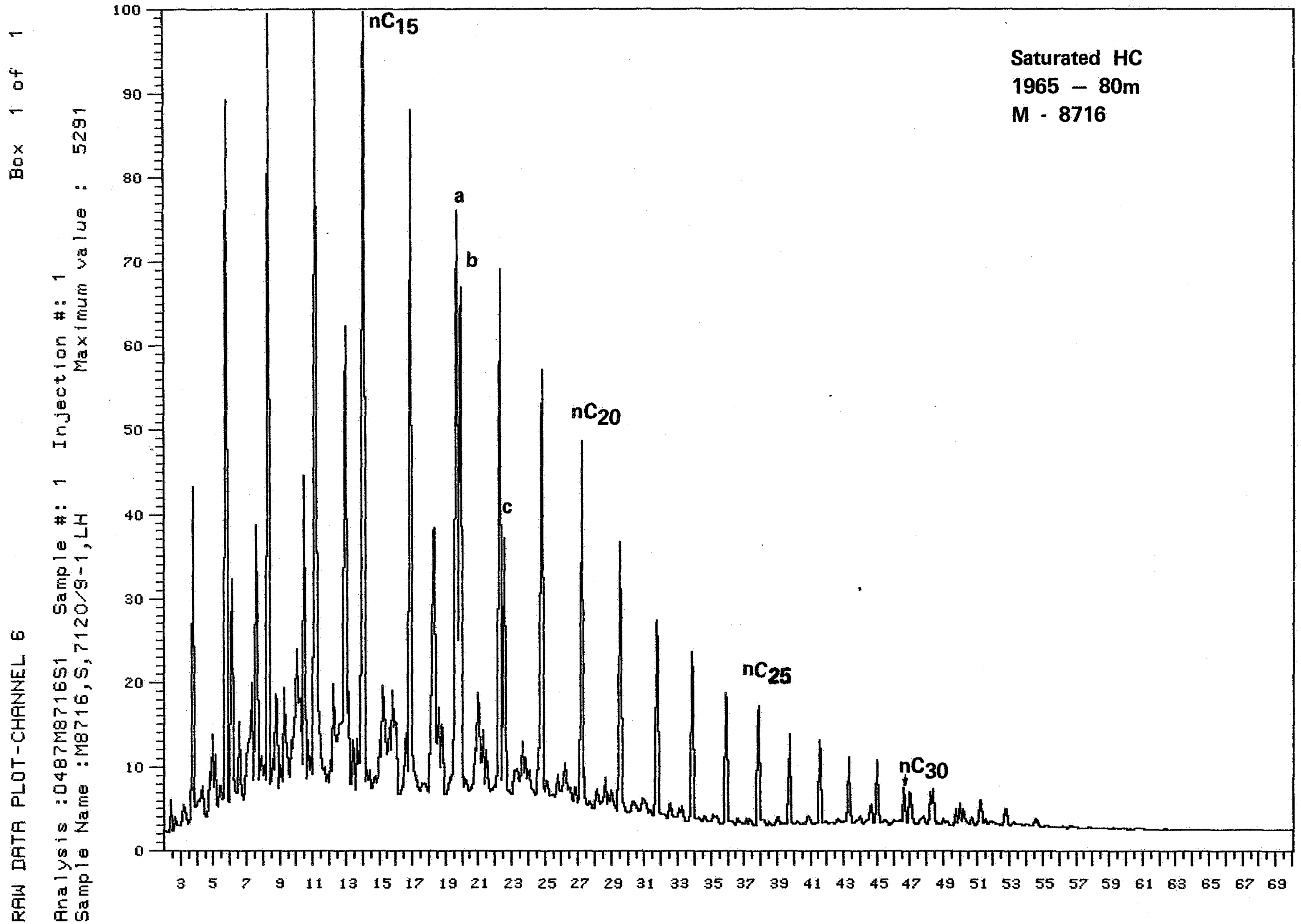
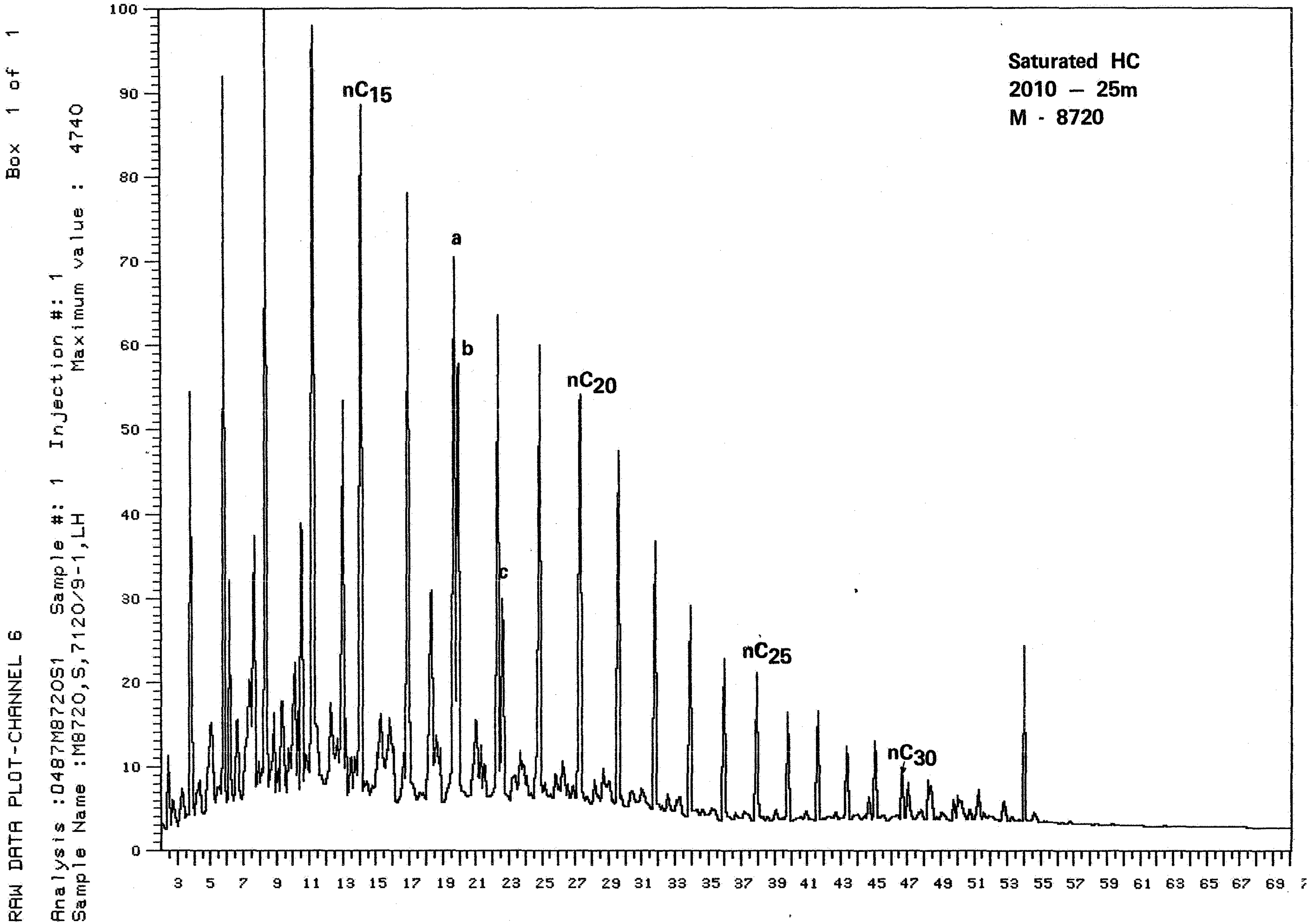
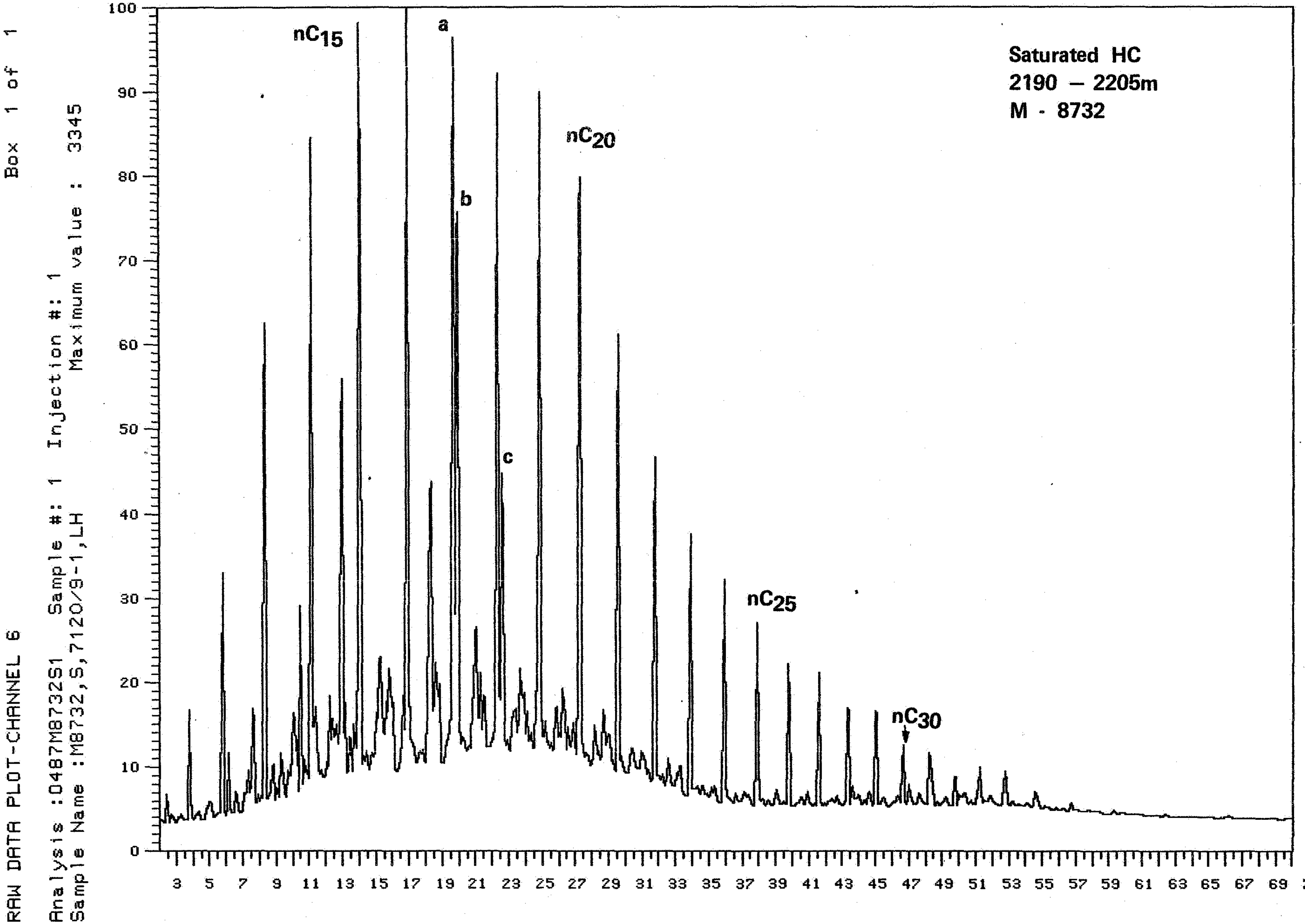
Box 1 of 1
Analysis :0487M9026
Sample #: 1
Injection #: 1
Sample Name :M9026,S,7120/9-1,LH
Maximum value : 3866
Saturated HC
Core 1822m
M - 9026
nC15
nC20
nC25
nC30
a
b
c


RAW DATA PLOT-CHANNEL 6
Analysis :0487M8716S1 Sample #: 1 Injection #: 1
Sample Name :M8716,S,7120/9-1,LH Maximum value : 5291
Box 1 of 1
Saturated HC
1965 – 80m
M - 8716
nC15
a
b
c
nC20
nC25
nC30
0
10
20
30
40
50
60
70
80
90
100
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69

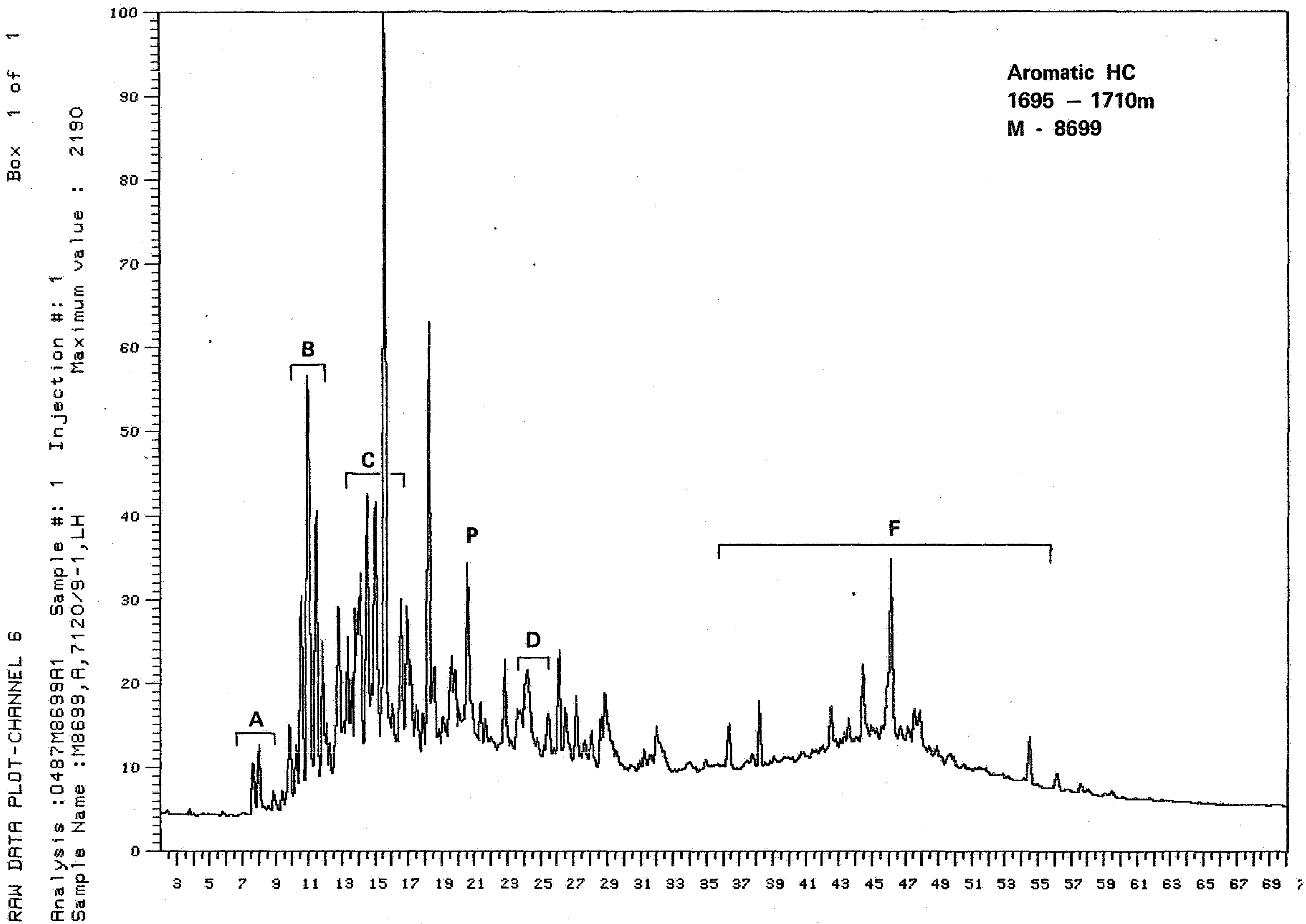


Saturated HC
2010 – 25m
M - 8720
nC15
a
b
c
nC20
nC25
nC30
RAW DATA PLOT-CHANNEL 6
Box 1 of 1
Analysis :0487M8720S1 Sample #: 1 Injection #: 1
Sample Name :M8720,S,7120/9-1,LH Maximum value : 4740


Box 1 of 1
RAW DATA PLOT-CHANNEL 6
Analysis :0487M8732S1 Sample #: 1 Injection #: 1
Sample Name :M8732,S,7120/9-1,LH Maximum value : 3345
Saturated HC
2190 – 2205m
M - 8732
nC15
a
b
c
nC20
nC25
nC30
0
10
20
30
40
50
60
70
80
90
100
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69

GAS CHROMATOGRAMS OF
AROMATIC HYDROCARBONS

N = Naphthalene
A = C_1-naphthalenes
B = C_2-naphthalenes
C = C_3-napthalenes
P = Phenanthrene
D = C_1-Phenanthrenes
E = C_2-Phenanthrenes
F = Region in which aromatised steranes and triterpanes occur

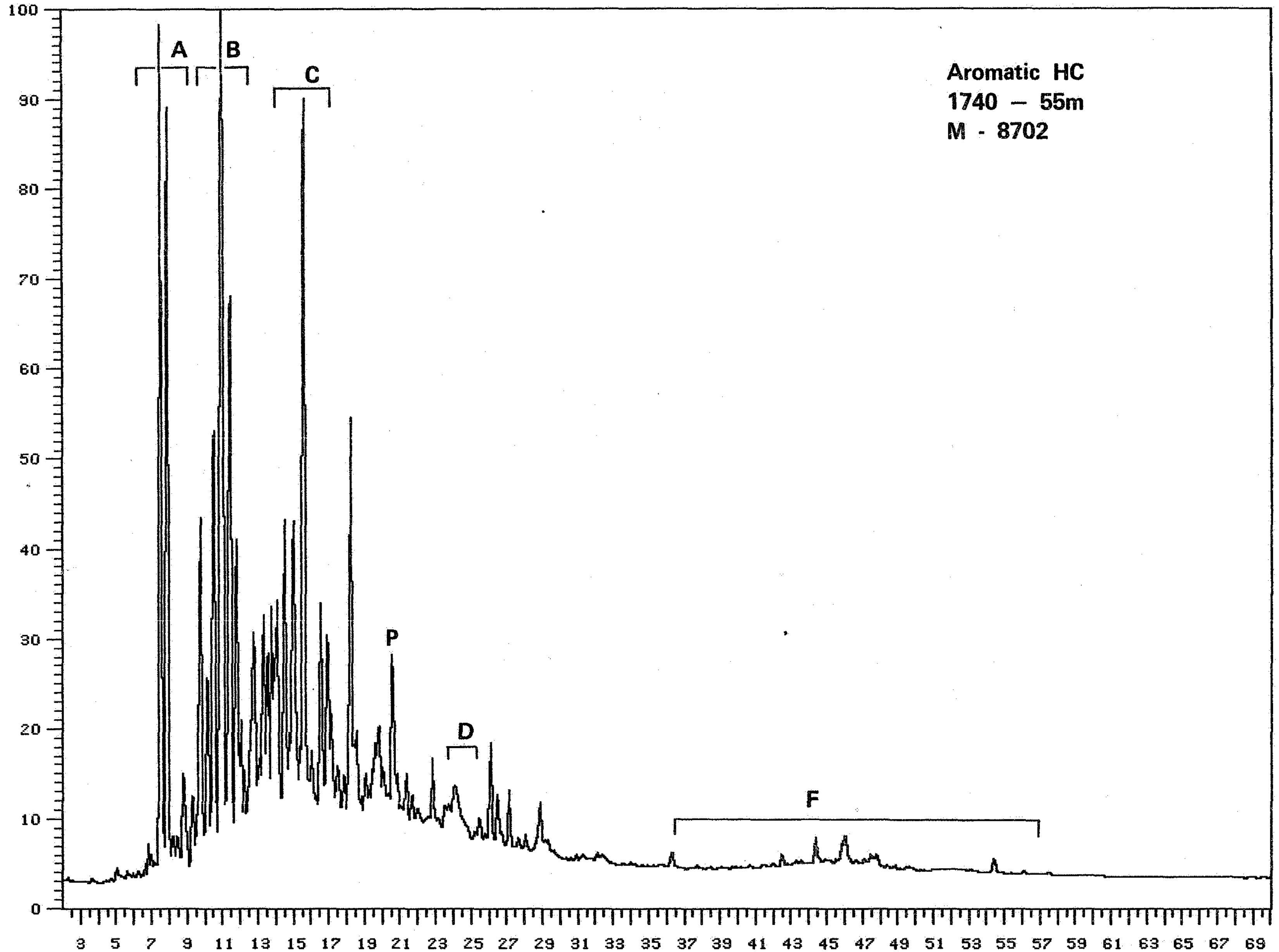


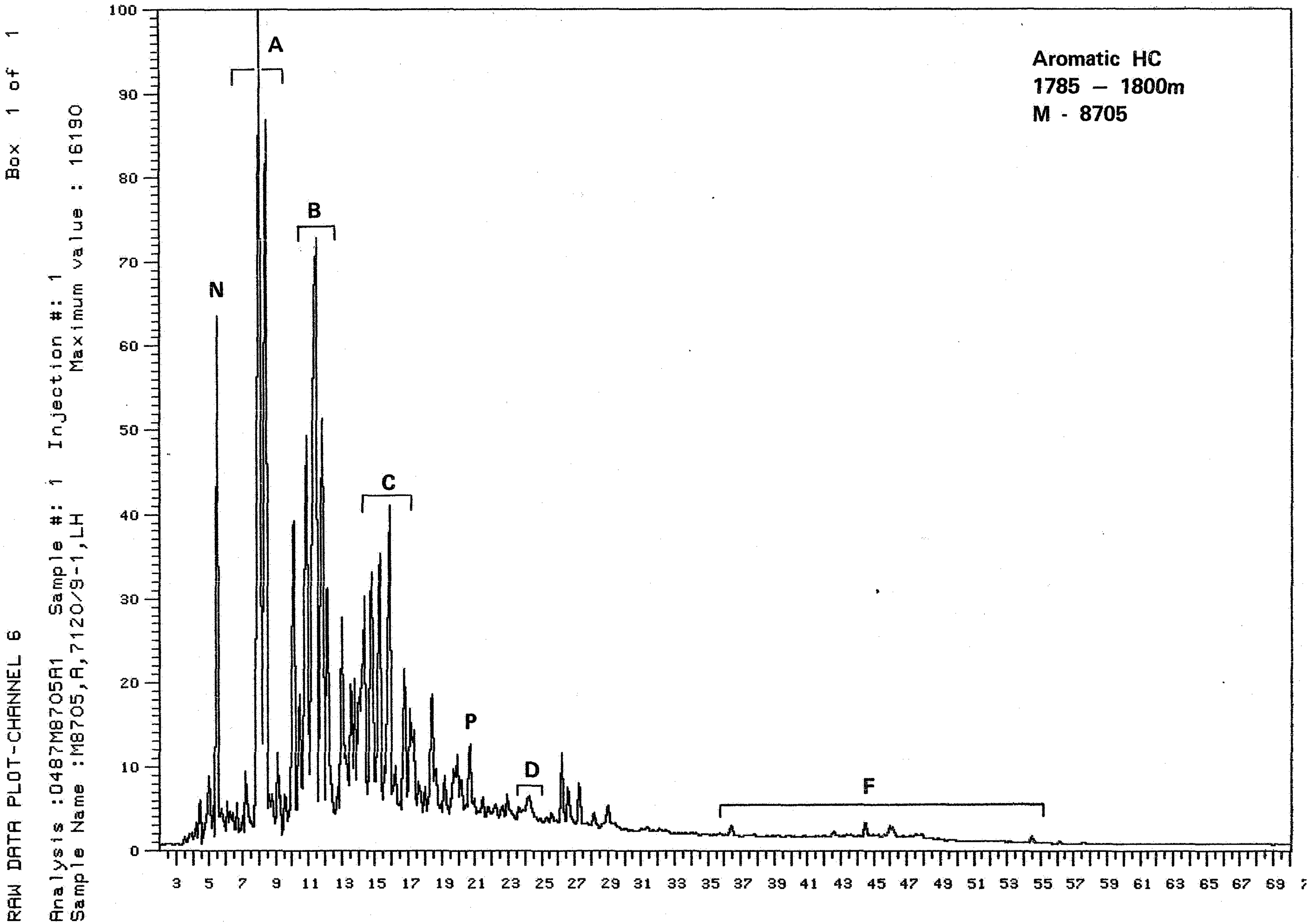
Aromatic HC
1695 – 1710m
M - 8699
A
B
C
P
D
F
RAW DATA PLOT-CHANNEL 6
Analysis :0487M8699A1 Sample #: 1 Injection #: 1 Box 1 of 1
Sample Name :M8699,A,7120/9-1,LH Maximum value : 2190

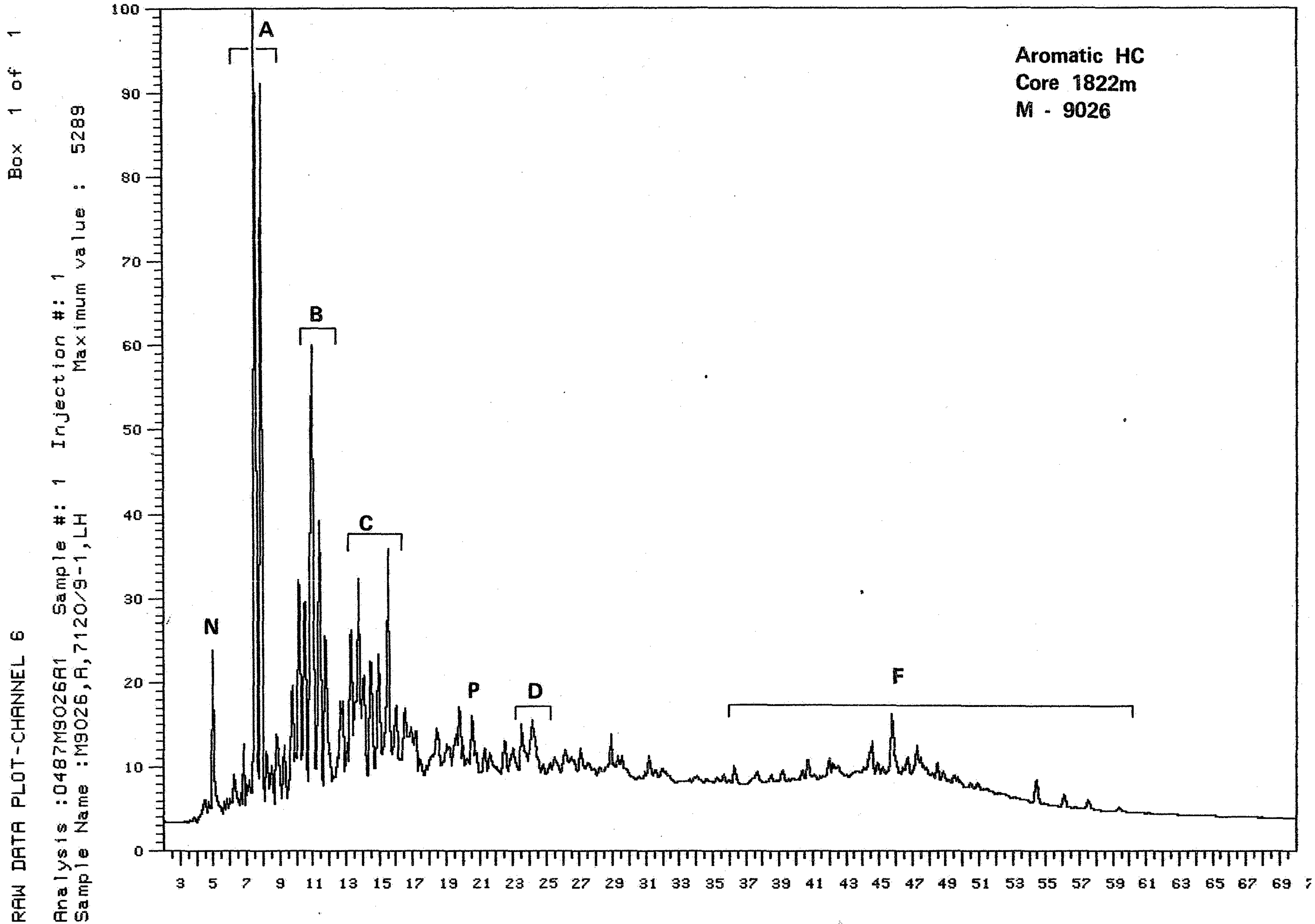
RAW DATA PLOT-CHANNEL 6

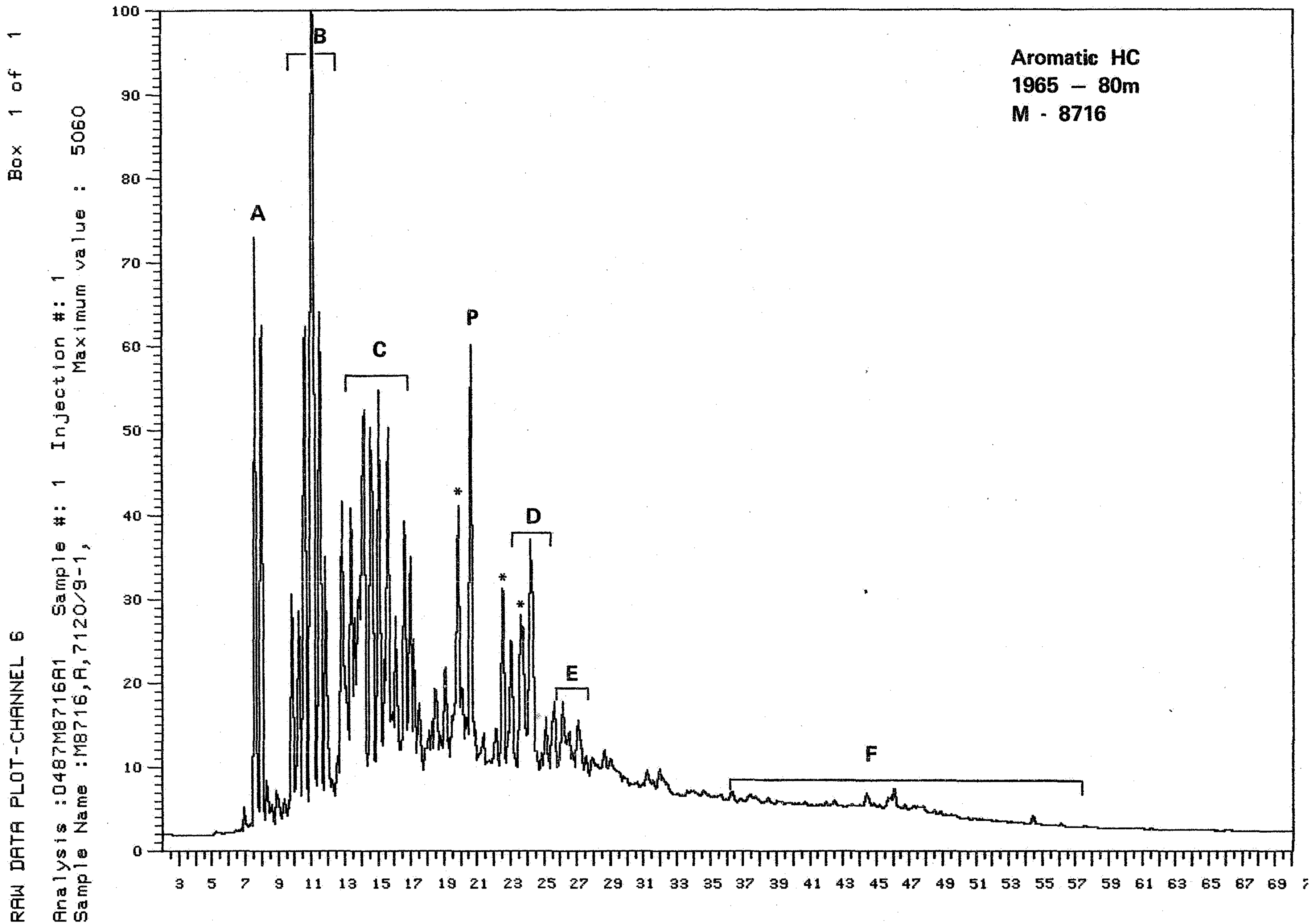
Analysis :0487M8707A1   Sample #: 1   Injection #: 1   Box 1 of 1

Sample Name :M-8707,A,7120/9-1,TV   Maximum value : 3393




Box 1 of 1
RAW DATA PLOT-CHANNEL 6
Analysis :0487M8705A1 Sample #: 1 Injection #: 1
Sample Name :M8705,A,7120/9-1,LH Maximum value : 16190
Aromatic HC
1785 – 1800m
M - 8705
N
A
B
C
P
D
F
100
90
80
70
60
50
40
30
20
10
0
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69


Box 1 of 1
RAW DATA PLOT-CHANNEL 6
Analysis :0487M9026A1 Sample #: 1 Injection #: 1
Sample Name :M9026,A,7120/9-1,LH Maximum value : 5289
Aromatic HC
Core 1822m
M - 9026
A
B
C
N
P
D
F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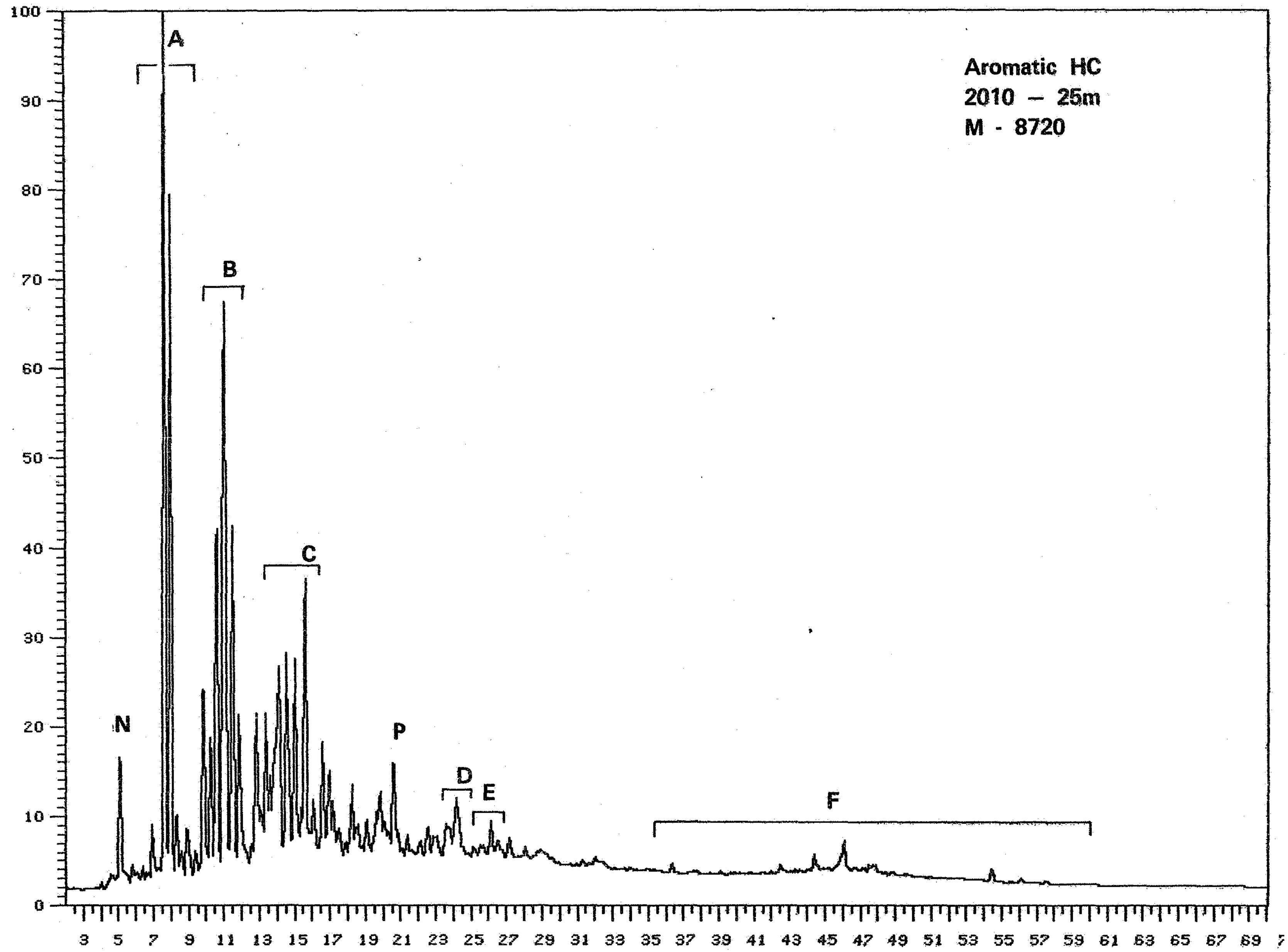
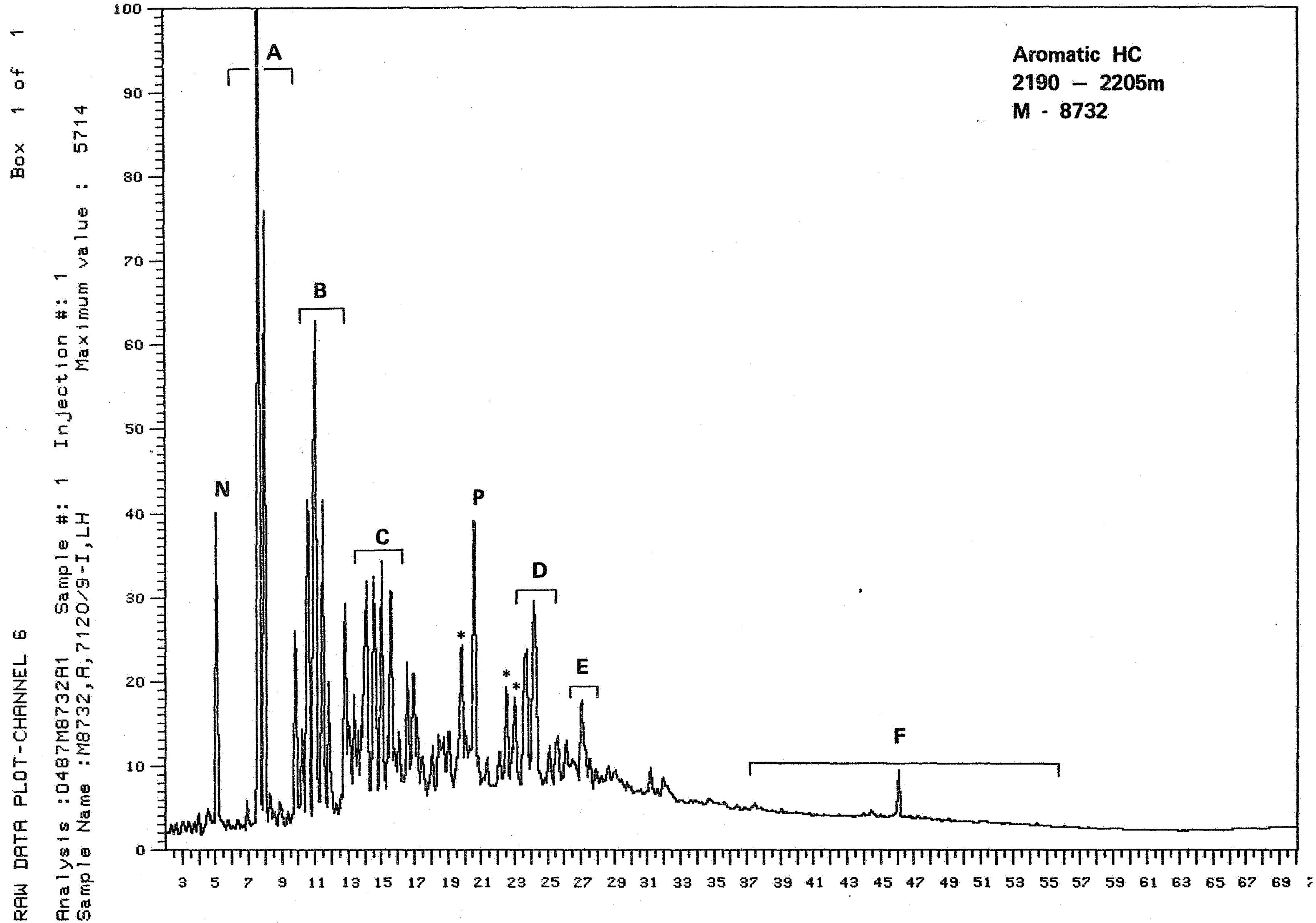
Analysis :0487M8716A1 Sample #: 1 Injection #: 1 Box 1 of 1
Sample Name :M8716,A,7120/9-1, Maximum value : 5060
Aromatic HC
1965 – 80m
M - 8716
A
B
C
P
D
E
F
*

RAW DATA PLOT-CHANNEL 6

Analysis :0487M8720A1 Sample #: 1 Injection #: 1 Box 1 of 1

Sample Name :M8720,A,7120/9-1,LH Maximum value : 5649





Aromatic HC
2190 – 2205m
M - 8732
A
B
C
D
E
F
N
P
*
RAW DATA PLOT-CHANNEL 6
Analysis :0487M8732A1 Sample #: 1 Injection #: 1 Box 1 of 1
Sample Name :M8732,A,7120/9-I,LH Maximum value : 5714
0
10
20
30
40
50
60
70
80
90
100
3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69

3

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AVAILABILITY

Private
Confidential

REPORT TYPE		
	REPORT NO. IFE/KR/F-86/058	DATE 1986-05-07
	REPORT TITLE REPORT ON STABLE ISOTOPES ($\delta^{13}C$, δD, $\delta^{18}O$) ON A NATURAL GAS FROM WELL 7120/9-1, DST 2A	DATE OF LAST REV. REV. NO.
	CLIENT Norsk Hydro a.s	NUMBER OF PAGES 4
	CLIENT REF. Jan Augustson	NUMBER OF ISSUES 15

SUMMARY

The gas components C_1-C_4 and CO_2 have been separated from the natural gas of well 7120/9-1, DST 2A, and the $\delta^{13}C$ values of these components have been measured. The isotopic composition of hydrogen from CH_4 has also been measured.

DISTRIBUTION

Norsk Hydro (10)
Andresen, B.
Brevik, E.M.
Råheim, A.

KEYWORDS

	NAME	DATE	SIGNATURE
PREPARED BY	Bjørg Andresen Einar Brevik Arne Råheim	1986-05-07 1986-05-07 1986-05-07	Bjørg Andresen Einar Brevik Arne Råheim
REVIEWED BY			
APPROVED BY	Karen Garder	1986-05-07	Karen Garder

1. ANALYTICAL PROCEDURE

The natural gases have been quantified and separated into the different gas components by a Carlo-Erba 4200 instrument. This gas chromatograph is equipped with a special injection loop in order to concentrate the samples, in the case of low concentration of the gas components. The hydrocarbon gas components were oxidized in separate CuO-ovens in order to prevent cross contamination. The combustion products CO_2 and H_2O were frozen into collection vessels and separated.

The water was reduced with zinc metal in a sealed tube to prepare hydrogen for isotopic analysis. The isotopic measurements were performed on a Finnigan Mat 251 mass spectrometer. Our $\delta^{13}C$ value on NBS-22 is -29.77 ± .06 o/oo.

2. RESULTS

The composition of the samples are given in Table 1. The results have been normalized to 100%. The stable isotope results are given in Table 2.

Our uncertainty on the $\delta^{13}C$ value is estimated to be ± 0.3 o/oo and includes all the different analysis step. The uncertainty on the δD value is likewise estimated to be ± 5 o/oo.

Table 1 Composition of a natural gas from well 7120/9-1, DST 2A

Sample	C_1 %	C_2 %	C_3 %	$i-C_4$ %	$n-C_4$ %	CO_2 %	ΣC_1-C_4	$\frac{\Sigma C_2-C_4}{\Sigma C_1-C_4}$	$\frac{i-C_4}{n-C_4}$
7120/9-1 DST 2A	83.5	5.4	2.4	0.4	0.8	7.5	92.5	0.10	0.52

Table 2 Isotopic composition of a natural gas from well 7120/9-1, DST 2A

Sample	C_1		C_2	C_3	i-C_4	n-C_4	CO_2	
	$\delta^{13}C$	δD_{SMOW}	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{18}O_{PDB}$
7120/9-1 DST 2A	-41.9	-170	-30.1	-28.6	-27.1	-27.7	-7.6	-10.3

* James, Alan T. (1983): Correlation of Natural Gas by Use of Carbon Isotopic Distribution between Hydrocarbon Components, AAPG, Vol. 67, No. 7, July 1983.

** Schoell, M. (1983): Genetic Characterization of Natural Gases, AAPG, December 1983.

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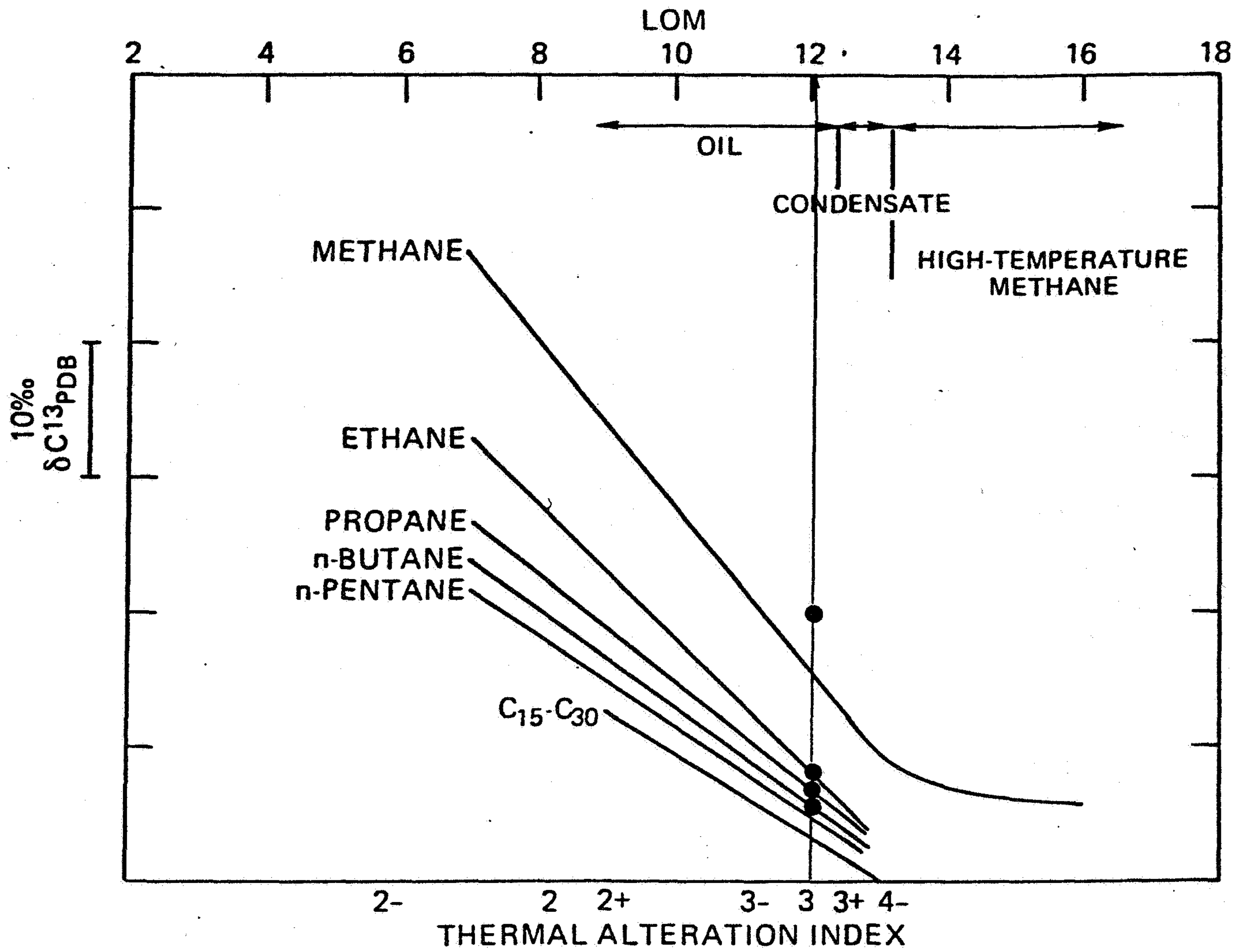

Figure 1. Carbon isotopic separations of a gas sample from well 7120/9-1, DST 2A, are plotted on the maturity diagram (after James, 1983). A source LOM of about 12 is indicated for the gas.

The calculated carbon isotopic separations between gas components are plotted on the vertical axis using a sliding scale that is simply the algebraic difference, in parts per mil, between the isotopic compositions of the natural gas components. The scale does not possess a fixed origin, but is oriented with the more depleted $\delta^{13}C$ values at the upper end. Use of this sliding scale allows the maturity of a gas to be assessed without prior knowledge of the isotopic composition of the gas source.

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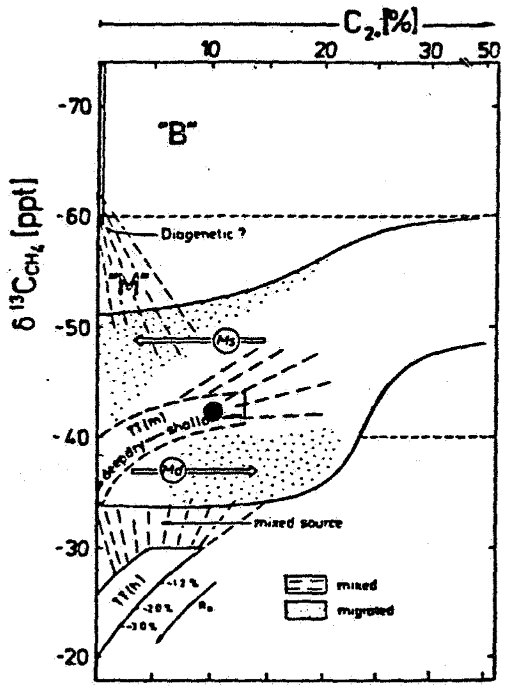

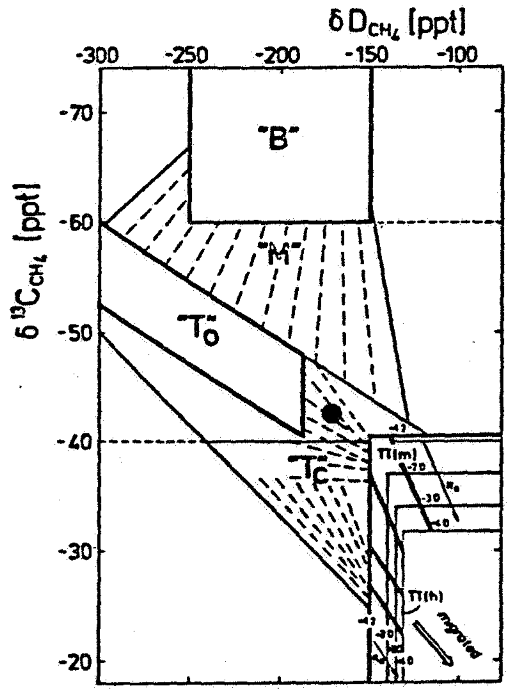

Figure 2a

Variations of molecular composition in natural gases related to the isotope variations of methane.

Figure 2b

Carbon and hydrogen isotope variations in methanes.

The principle for the genetic characterization of natural gases is that the primary gases (B-biogenic gas, T-associated gas, TT-non-associated gas) are defined by fields of compositional variations. These primary gases may become mixed and form various mixtures "M" of intermediate composition. "TT(m)" and "TT(h)" are non-associated gases from marine source rocks and coal gases from N.W. Germany, respectively, compositional shifts due to migration are indicated by arrows Md (deep migration) and Ms (shallow migration), respectively. "T_0" are gases associated with petroleum in an initial phase of formation. "T_c" are gases associated with condensates. (Schoell 1983).