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Title
GEOCHEMICAL ANALYSIS REPORT FOR WELL NOCS 30/2-3

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Keywords
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Abstract
SEE NEXT PAGE

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Abstract:

MATURITY:

The interpreted vitrinite reflectance data, which are shown with respect to depth in Figures 1 and 2, were obtained by IFE and are tabulated and reported in report IFE/KR/F-93/016.

The results show that hydrocarbon staining has reduced the measured values in the Cretaceous but since the Brent coals are believed to give good reliable results then the proposed interpretation is believed reliable. Such an interpretation is supported by other geochemical data including Tmax values.

Thus the Draupne shales are mature and have reached a maturity (Ro = 0.9%), which is just beyond that of peak oil generation (Ro = 0.8%).

The Heather Formation shales are at the end of the oil window and are presently generating gas condensate.

The Brent Group is in the gas condensate zone as are the claystones of the Dunlin Group (Ro > 1.1%).

POTENTIAL:

The Draupne Formation shales are mature type II kerogens, which originally had good to very good potentials for oil, but presently , because of maturity, have good potentials for light oil and gas.

The shales of the Heather Formation have variable potentials, but where organically rich have fair to good potentials for light oils and gas. When less mature these shales could well have produced some oil.

The Middle Jurassic Brent Group shales have little or no potential, while the coals still have good to excellent potentials for gas and are unlikely to have produced any liquids.

On the other hand, the highly mature Dunlin Group claystones still have good and consistent TOC contents with fair remaining potentials for gas and could well have already generated some light oil.

Figure 1. Vitrinite reflectance (linear scale) versus depth well 30/2-3.

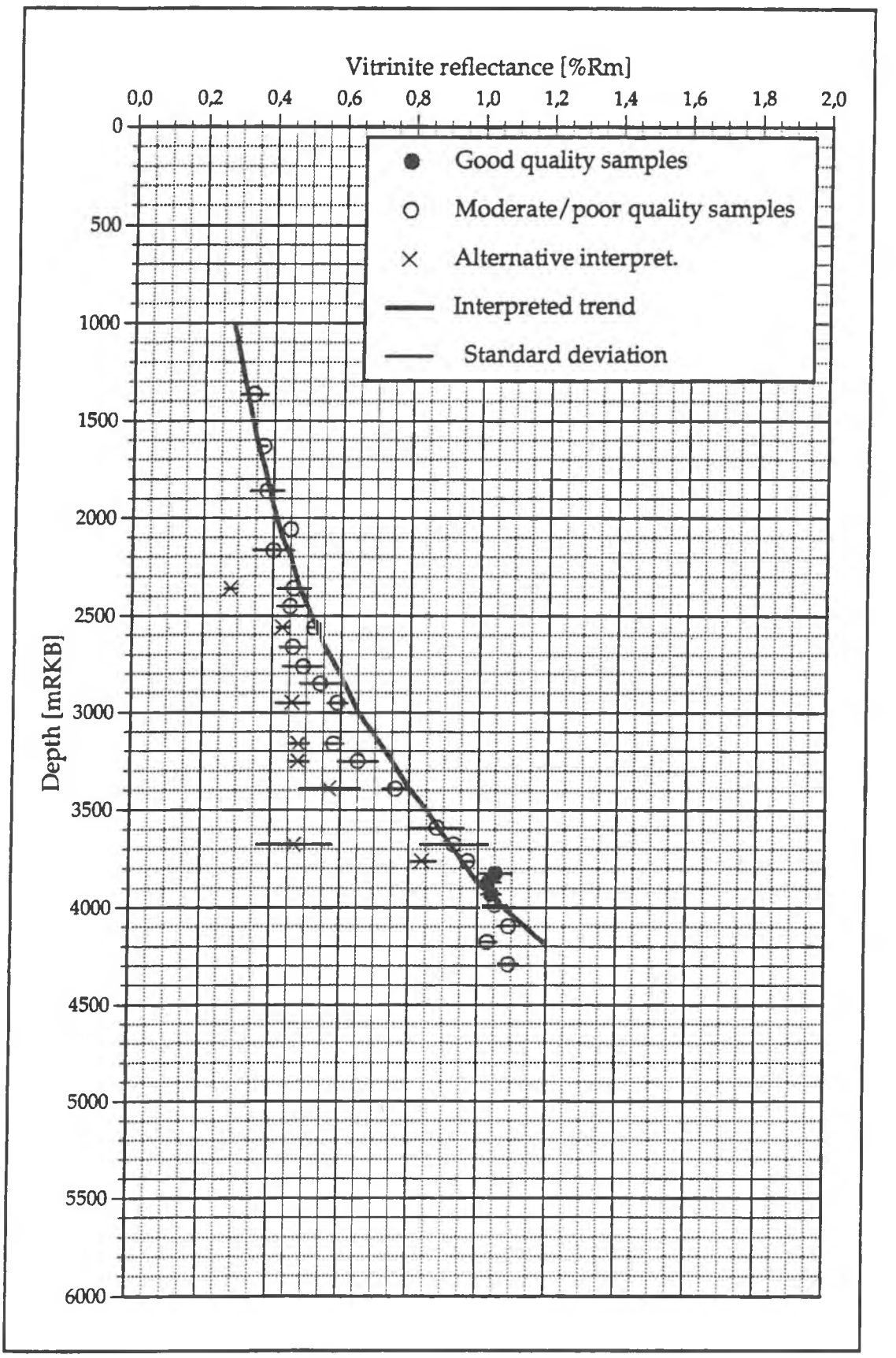
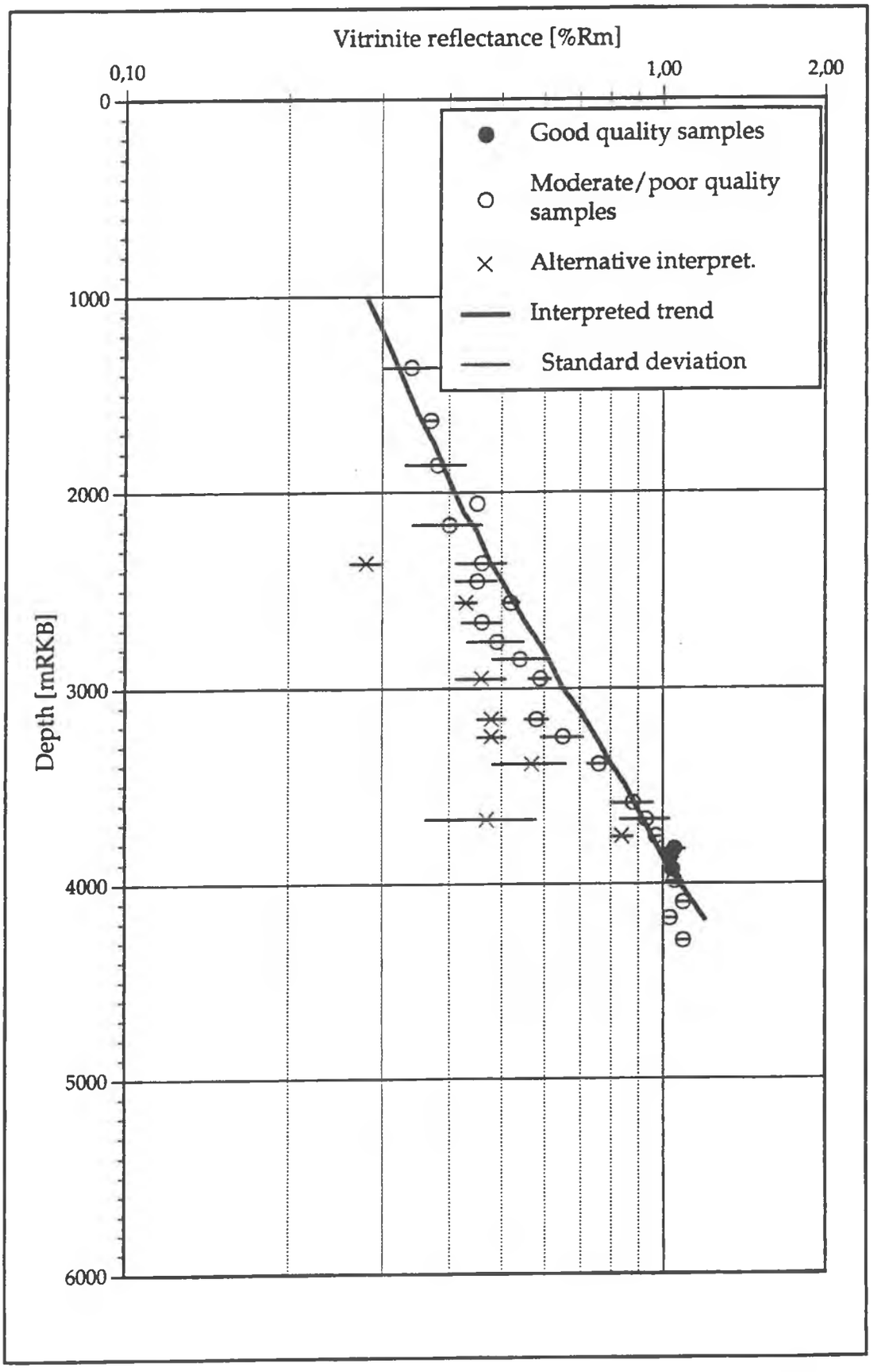


Figure 2. Vitrinite reflectance (log scale) versus depth, well 30/2-3.



Geochemical Report for

Well NOCS 30/2-3

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CONTENTS

LIST OF FIGURES

LIST OF ENCLOSURES

Appendix 1: TABLES

1. Lithology Description
2. Rock-Eval Table
3. Pyrolysis Gas Chromatography Composition
4a-d Solvent Extraction Data
5. Saturated Hydrocarbon Ratios
6. Aromatic Hydrocarbon Ratios
7. Thermal Maturity Data
8. Visual Kerogen Data
9a-i Gas Chromatography - Mass Spectrometry Data

Appendix 2: GHM - THERMAL EXTRACTION GAS CHROMATOGRAMS AND GHM - PYROLYSIS GAS CHROMATOGRAPHY PYROGRAMS

Appendix 3: GAS CHROMATOGRAMS

I. Saturated Fraction Chromatograms (FID)
II. Aromatic Fraction Chromatograms (FID and FPD)

Appendix 4: GAS CHROMATOGRAPHY - MASS SPECTROMETRY, FRAGMENTOGRAMS

Summary

Source Rocks

The screening analyses include potential source rocks covering the Draupne Fm. - Dunlin Gp. interval (3669 - 4288 m), however, with the main objective being the Draupne Fm. shales and the Brent Gp. coals. The Upper Jurassic Draupne Fm. (3669 - 3705 m) is a mature marine type II kerogen source rock, with a good potential for generating light oil and gaseous hydrocarbons. The Upper Jurassic Heather Fm. (3705 - 3792 m) consists of land plant dominated type III kerogen source rocks with a fair potential for generating gaseous hydrocarbons. The mature Middle Jurassic Brent Gp. (3792 - 3980 m) coals have rich generation potential for gas, partly due to the maturity and partly due to the dominantly aromatic hydrocarbon pyrolysate. However, some minor potential for (?)waxy oil can also be expected. The Lower Jurassic Dunlin Gp. (3980 - 4288 m) claystones are highly mature type II/III kerogen source rocks, possibly consisting of mixed marine and terrestrial organic matter, with a fair generation potential for gaseous hydrocarbons.

Maturity

The maturity trend for well NOCS 30/2-3 suggests that the Draupne Fm. is well within the oil window, probably at peak oil generation (Tmax = 440°C for type II kerogen). The base of the oil window (450°C for type II kerogen) is at approx. 3900 m according to the established Tmax trend. Hence the Brent Gp. is believed to be at the base of the oil window, whereas the Dunlin Gp. claystones are considered to be within the condensate window.

Generation

The Draupne Fm. is considered to be at peak oil generation and consequently actively expelling hydrocarbons. The Heather Fm. shales and the Brent Gp. coals are past peak oil generation maturity, however, with fair to rich generation potentials left.

Migration

No analyses were performed on migrated hydrocarbons.

Chapter 1

INTRODUCTION

The well NOCS 30/2-3, analysed on behalf of Statoil, is located in the Norwegian North Sea Sector, in the North Viking Graben area. The well was drilled to a total depth of 4325 m in the Lower Jurassic Statfjord Fm. All depths given are relative to KB unless otherwise specified. The location of the well is shown in Figure 1.

The geochemical study included investigation of potential source rocks, ranging from the Upper Jurassic Draupne Fm. to the Lower Jurassic Dunlin Gp. Both screening and follow-up analyses were performed in order to evaluate the potential source rocks. The samples for follow-up analysis were selected by Statoil. The samples comprised twenty six cuttings samples, four side wall cores and nine core chips. The report is divided into chapters according to the various analytical methods used. Within the chapters the results are discussed mainly in a stratigraphic context.

1.1 General Comments

The NOCS 30/2-3 well is situated south of the NOCS 34/10-35 well. Geolab Nor carried out a geochemical study for the latter well on behalf of Statoil. This geochemical report for well NOCS 34/10-35 is referred to in section 3.3.3 in this report, due to similarities in benzothiophenic compounds seen in the Draupne Fm. for the two respective wells.

1.2 Analytical Program

The analytical program for well NOCS 30/2-3 was based on the samples selected by Statoil both for screening and detailed follow up analyses. The number of samples for the individual analyses are listed below:

Analysis type	No of samples	Figures	Tables
Washing	39		
Lithology description	39	2	1
TOC analysis (LECO)	39	2	1,2
Rock-Eval pyrolysis	27	3,4,5	2
Thermal Extraction (GHM, S_1)	7	6a-d	
Pyrolysis GC (GHM, S_2)	7	7a-b,8	3
Soxhlet Extraction of organic matter	6		
MPLC/HPLC separation	6		4a-d
Saturated hydrocarbon GC	6	9a-c	5
Aromatic hydrocarbon GC	6	10a-d	6
Visual kerogen microscopy	6	11	7,8
GC-MS of saturated and aromatic HC	6	12a-j	9a-i

1.3 Stratigraphy

The following stratigraphy was supplied by Statoil. The depths are given as measured depths.

Lithostratigraphic Unit	Age	Top RKB (m)	Thickness (m)
Seafloor		145	
Norland Gp.	Pliocene-Miocene	145	734
Utsira Fm.	Miocene	815	64
Hordaland Gp.	Oligocene-Eocene	879	1057
Rogaland Gp.	Paleocene	1936	225
Balder Fm.	Paleocene	1936	74
Sele Fm.	Paleocene	2010	67
Lista Fm.	Paleocene	2077	84
Shetland Gp.	Upper Cretaceous	2161	1463
Cromer Knoll Gp.	Lower Cretaceous	3624	45
Viking Gp.	Upper Jurassic	3669	123
Draupne Fm.	Upper Jurassic	3669	36
Heather Fm.	Upper Jurassic	3705	87
Brent Gp.	Middle Jurassic	3792	188
Dunlin Gp.	Lower Jurassic	3980	308
Statfjord Fm.	Lower Jurassic	4288	37
TD		4325	

TD = Total Depth

Chapter 2

SCREENING ANALYSES

A total of thirty nine samples covering the depth interval 1587.5 m to 4290 m was described lithologically. All cutting samples were washed and described together with side wall core and core chip samples. All thirty nine samples were analysed for TOC content by the LECO Carbon Analyser. A total of twenty seven samples were analysed using the Rock-Eval pyrolysis. The TOC-data are presented in Tables 1 and 2 and the Rock-Eval data are found in Table 2. The Total Organic Carbon versus Depth, the Production Index versus Depth and the Tmax versus Depth plots are presented in Figures 2, 3 and 4 respectively. The Tmax versus Hydrogen Index cross plot is shown in Figure 5. Enclosure 1 includes the Rock-Eval data.

2 Lithology, TOC and Rock-Eval

2.1 Source Rock Potential and Kerogen Type

The three side wall core samples from the Tertiary Hordaland Gp. (879 - 1936 m) consist of dark grey, light greenish brown, light greenish brown and dark greenish grey claystones. The TOC contents are poor to fair (0.11 - 0.97 % TOC). No Rock-Eval analyses were carried out for these samples.

The one sample form the Eocene - Paleocene Rogaland Gp. (1936 - 2161 m) consists of a medium grey claystone with a good TOC-content (1.51 %). However, the S2-yield of 1.0 mg HC/g rock is poor and gives a low Hydrogen Index value (HI) of 65 mg HC/g TOC, indicative of a type IV kerogen. Additionally the Petroleum Potential (PP) of 1.2 mg HC/g rock is poor.

The two cuttings samples from the Cromer Knoll Gp. (3624 - 3669 m) consist primarily of medium to dark grey calcareous and pyritic shale. Subordinate contributions of light grey silty claystone is registered in the upper sample (3639 m), whereas fine-grained white carbonate is seen in the lower sample (3651 m). The fair TOC-contents for the claystone fractions are 0.72 and 0.60 % TOC respectively for the two samples.

The seven cuttings samples from the Upper Jurassic Draupne Fm. (3669 - 3705 m) consist of greyish black and dark grey silty claystones, with minor contributions of light and medium grey claystones. The TOC-contents, ranging 1.68 to 6.51 % TOC, are classified as good to rich. The S_2-yields, ranging 2.07 to 13.80 mg HC/g rock, give HI-values varying from 123 to 234 mg HC/g TOC. The relatively rich S_1-yields and high derived production index (PI) values indicates, that the source rocks have started to generate hydrocarbons, hence lowering the S_2-yields and the derived HI-values. The petroleum potential (PP) of the source rocks ranges from 3.0 to 19.1 mg HC/g rock, indicating that there is a rich potential mainly for generation of oil. However, the two upper samples (3672 m, 3675 m) have significantly lower PP-values, suggesting that the upper part of the Draupne Fm. has a fair source rock potential, possibly for generation of light oil and gas.

The five Upper Jurassic Heather Fm. (3705 - 3792 m) consist of dark to greyish black claystones, with TOC-contents ranging 1.57 to 5.84 %. The S_2-yields are considerably lower ranging 2.50 to 4.64 mg HC/g rock, except for the upper sample, 3711 m (S_2: 10.29 mg HC/g rock). This upper sample might be cavings from the Draupne Fm. due to the compatible Rock-Eval and TOC-values when compared with those of the Draupne Fm. The petroleum potential for the four lower samples (3729 - 3759.59 m), varying from 4.3 to 7.5 mg HC/g rock, is classified as fair to good for the highly mature source rock. The residual potential is probably for generation of light oil and gas.

The Middle Jurassic Brent Gp. (3792 - 3980 m) consists of black coal and interlayered dark grey claystones. The three coal samples have TOC-values ranging from 16.70 to 63.90 % TOC, whereas the three claystone samples have TOC-contents of 0.72, 1.78 and 7.83 %. The highly mature coals PP-values ranging 14.1 - 113.3 mg HC/g rock, whereas the carbonaceous claystones have PP-values ranging 0.5 to 11.1 mg

HC/g rock. The coal HI-values vary from 73 to 182 mg HC/g TOC and the low OI-values (6 - 16 mg CO_2/g rock), which would indicate a mixed type II/III kerogen source rock. The claystone HI-values range 49 to 121 mg HC/g TOC and OI-values range 39 to 219 mg CO_2/g TOC which suggest mainly type III kerogen source rock with potential for generation of mainly gaseous hydrocarbons.

The eight Lower Jurassic Dunlin Gp. (3980 - 4288 m) samples consist of medium to dark grey to greyish black silty claystones with organic carbon contents ranging 2.00 to 2.61 % TOC. The Rock-Eval analyses show that the S_2-yields are rather constant, ranging 2.52 to 3.37 mg HC/g rock, giving derived HI-values from 123 to 156 mg HC/g TOC. The low OI-values (5 - 11 mg CO_2/g TOC) indicate together with the HI-values a type II kerogen or type II/III kerogen source rock, taking the high maturity of the claystones into consideration. The fair PP-values (3.9 - 4.9 mg HC/g rock) indicate that the Dunlin Gp. claystones have some hydrocarbon generation potential.

2.2 Maturity

The Tmax versus depth plot in Figure 4 shows a broad regular distribution of Tmax-values (438°C - 470°C) in the interval covering the Draupne Fm. - Dunlin Gp. (3669 - 4288 m). The Draupne Fm. samples all plot within the oil window (Tmax-values: 438 - 447°C). The Heather Fm. samples have Tmax-values varying from 442°C to 455°C, indicating a higher maturity compared to the Draupne Fm. The Heather Fm. is considered either to be at the base of the oil window or within the condensate window. The high Tmax-values for the Brent coals and shales (459°C - 470°C) suggest that this unit has reached the condensate window maturity. The Dunlin Gp. claystones have relatively constant Tmax-values (451°C - 457°C), indicating that the source rocks are either at the base of the oil window or within the condensate window. The profound distribution of Tmax-values for the entire Draupne Fm. - Dunlin Gp. interval indicates that kerogen type and possibly organic carbon content have influenced on the Tmax-values. The significantly higher values for the Brent Gp. samples suggest that the dominantly type III kerogen source rocks have higher Tmax-values than type II or type II/III source rocks such as the Draupne, Heather and Dunlin Gp. samples.

2.3 Generation

From the previous sections (2.1 and 2.2) it follows that the source rocks, including the Draupne and Heather Fm. claystones, the Brent Gp. coals and the Dunlin Gp. claystones have started to generate hydrocarbons in significant amounts and most likely also expulsion. The Draupne Fm. claystones have poor to good S_1-yields for (S1: 0.90 - 6.61 mg HC/g rock) and high production index (PI) values (0.28 - 0.38), suggesting that the claystones are actively generating and expelling hydrocarbons, provided that the hydrocarbons are in-situ generated. The Heather Fm. samples show a slightly increasing trend in PI-values (0.33 - 0.42) relative to the Draupne Fm., probably due to slightly higher maturities (Section 2.2). The Brent coals have generated and probably expelled mainly gaseous hydrocarbons. The relatively low PI-values might also indicate that these source rocks have a poor potential for generating oil. The Dunlin Gp. PI-values ranging 0.25 - 0.36 suggest generation and most likely expulsion of oil and gaseous hydrocarbons, due to the high maturity. Figure 5 shows that the source rocks from the Draupne and Heather Fms. and the Dunlin Gp. are placed in continuous sequence with decreasing hydrogen index values and increasing Tmax values reflecting increasing maturity with depth for a mixed type II/III kerogen source rocks.

2.4 Migrated Hydrocarbons

Migrated hydrocarbons from potential reservoir rocks have not been analysed by Rock-Eval. The previously mentioned high PI-values (Section 2.3) seen in the Draupne and Heather Fms. and the Dunlin Gp. are considered to reflect in-situ generated hydrocarbons and not staining from migrated hydrocarbons.

Chapter 3

DETAILED GEOCHEMICAL ANALYSES

3.1 GHM - Thermal Extraction

A total of seven samples was analysed using the combined GHM thermal extraction - pyrolysis GC. The samples include cuttings (Draupne Fm.) and core chips (Brent Gp.). Selected thermal extract chromatograms are presented in Figures 6a-d. All the chromatograms are shown in Appendix 2.

The four Draupne Fm. (3669 - 3705 m) cuttings samples have thermal extracts dominated by n-alkanes in the nC_{11} - nC_{26} range, with nC_{13} and nC_{14} as the largest peaks for three of the samples (3678 m, 3681 m, 3693 m) (Figure 6a), whereas the sample 3684 m has a different n-alkane distribution dominated by intermediate range n-alkanes and with nC_{20} as the dominant peak (Figure 6b). The pristane/nC_{17}- and phytane/nC_{18}-ratios are less than 0.5 for all samples. The pristane/phytane ratios are approx. 1.5 for three of the samples. The fourth sample, 3684 m, has a pristane/phytane ratio around 1.1. The paraffinic composition of the thermal extracts and the previously mentioned pristane/phytane ratios indicate a marine origin for these in-situ generated hydrocarbons. The hydrocarbons are considered to have generated from the oil window mature Draupne Fm. source rock, which is actively generating hydrocarbons in significant amounts. However, the sample 3684 m might be a slightly different source rock, with contribution from (?)algal derived organic matter owing to the earlier mentioned contribution from intermediate range n-alkanes and the lower pristane/phytane ratio.

The two coal samples, 3911.38 m and 3929.35 m, from the Brent Gp. (3792 - 3980 m) have thermally extractable hydrocarbons consisting mainly of light hydrocarbons (Figure 6c), believed mainly to be mono- and diaromatic(?) hydrocarbons, and

subordinate contribution from n-alkanes. The composition of the hydrocarbons are indicative of a coaly source rock. Hence the thermally extractable hydrocarbons are considered to be in-situ generated. The heterogenous claystone/coaly sample, 3851.85 m, has the same dominantly aromatic hydrocarbons composition as well as a significant presence of n-alkanes, most clearly seen in the nC_{10} - nC_{25} range (Figure 6d). The lithological heterogeneity of the sample taken into consideration suggests that the chromatogram is reflecting thermally extracted hydrocarbons from both coaly material as well as carbonaceous claystone.

3.2 GHM - Pyrolysis Gas Chromatography

Seven samples, the same as those chosen for the GHM thermal extraction GC, were chosen for GHM pyrolysis GC. The pyrolysis compositions are listed in Table 3 and the data are plotted in the pyrolysis products triangle in Figure 8. Exemplary pyrograms are presented in Figures 7a-b. All the pyrograms are presented in Appendix 2.

The four cuttings samples from the Upper Jurassic Draupne Fm. (3669 - 3705 m) have pyrograms dominated by n-alkenes/n-alkanes in the nC_6 - nC_{30} range, with subordinate contributions from monoaromatic hydrocarbons (Figure 7a). Prist-1-ene, eluting between the nC_{17} and nC_{18} alkene/alkane doublets, is present in all the samples. The n-alkenes dominate clearly over the n-alkanes in the C_6 - C_{14} range, suggesting that at least a part of the pyrolysate could originate from asphaltenic material. The C_1 - C_5, C_6 - C_{14} and C_{15}+ pyrolysate distributions shown in Figure 8 are compatible for all the samples. The pyrograms are typical for marine type II kerogen source rocks, which have generated hydrocarbons and still have a remaining potential for generating oil and gaseous hydrocarbons.

The three Brent Gp. pyrolysates (3851.85 m, 3911.38 m, 3929.35 m) are dominated by mono- and diaromatic hydrocarbons and the alkyl aromatic hydrocarbon moieties relative to n-alkenes/n-alkanes (Figure 7b). This predominance is most clearly seen in the two lower samples. Hence the Brent Gp. source rocks have a remaining potential for generating light hydrocarbons (wet gas and condensate), also reflected by the thermally extractable hydrocarbons discussed in section 3.1. The significant generation of aromatic hydrocarbons is indicative of land plant derived type III kerogen source rocks. Additionally, the high diaromatic hydrocarbon peak intensities confirm the coal origin.

3.3 Solvent Extraction and Chromatography

A total of six samples was solvent extracted using the Soxtec apparatus and the solvent extracts were subsequently fractionated using MPLC. The results from the extraction and fractionation are presented in Tables 4a-d, and the data are plotted in Enclosures 2 and 3. The hydrocarbon fractions (saturated and aromatic) were analysed using gas chromatography. The results from these analyses are presented in Tables 5 and 6 respectively. The chromatograms are presented in Appendix 3. Selected saturated hydrocarbon chromatograms are presented in Figures 9a-c and aromatic hydrocarbon chromatograms (FID and FPD) are presented in Figures 10a-d.

3.3.1 Extraction

The four Draupne Fm. (3669 - 3705 m) shale samples have very rich contents of extractable organic matter, ranging 7600 - 9345 wt ppm EOM/g rock. The extractable hydrocarbons (EHC) constitute the largest fraction (5234 - 7000 wt ppm EHC/g rock), whereas the non-hydrocarbons (NSOs and asphaltenes) constitute 2345 to 2842 ppm/g rock. However, the EOM contents relative to the TOC contents are classified as good to rich (142 - 326 mg EOM/g TOC). The hydrocarbon contents relative to the TOC are classified as rich to very rich (94 - 224 mg EHC/g TOC), indicative of significant active hydrocarbon generation from a mature source rock. Saturated hydrocarbons constitute the largest single fraction (42 - 50 % of EOM), whereas the aromatic hydrocarbons constitute approx. 25 - 26 %. The asphaltenes and NSOs constitute subequal quantities (11 - 20 % and 14 - 15 % respectively).

The two Brent Gp. (3792 - 3980 m) coal samples (3824.54 m, 3911.38 m) have very rich EOM contents (9170 and 31417 ppm EOM/g rock), consisting primarily of non-hydrocarbons, mainly asphaltenes (6269 and 26398 ppm/g rock). The hydrocarbons constitute 2901 and 5019 ppm EHC/g rock, with dominance of aromatic hydrocarbons (2383 and 4252 ppm/g rock respectively) relative to saturated hydrocarbons. However, the EHC content is classified as being poor to fair when normalized against TOC (17

and 8 mg EHC/g TOC), whereas the non-hydrocarbons constitute 37 mg/g TOC and 41 mg/g TOC respectively. The significant EOM contribution supports the high maturity of the Brent Gp. coals.

3.3.2 Saturated Hydrocarbon Chromatography

The four Draupne Fm. saturated hydrocarbon chromatograms consist of n-alkanes, ranging nC_{11} to nC_{35} with unimodal distributions, dominated by short chained n-alkanes (Figure 9a). The pristane/phytane ratios are relatively constant (1.20 - 1.50), indicative of marine source rocks. The pristane/nC_{17} and phytane/nC_{18} ratios (0.40 - 0.44 and 0.33 - 0.36 respectively) indicate, together with the front biased n-alkane distributions, generation from mature source rocks. However, the sample 3684 m shown in Figure 9b has more contribution from intermediate range n-alkanes, suggesting a slightly different source compared to the other Draupne Fm. samples.

The two Brent Gp. chromatograms (3824.54 m, 3911.38 m) from coal extracts consist of n-alkanes in the nC_{11} to nC_{31} range, with predominance of short chained n-alkanes and intermediate range n-alkanes (Figure 9c). The pristane/phytane ratios (3.67 and 2.46 respectively) are indicative of land plant contribution. The low pristane/nC_{17}- and phytane/nC_{18} ratios are indicative of generation from mature source rocks. The upper sample has significantly higher values compared to the lower sample, possibly due to differences in source rather than maturity.

3.3.3 Aromatic Hydrocarbon Chromatography

The four Draupne Fm. FID chromatograms are dominated by the methyl- and dimethylnaphthalenes with slightly lower peak intensities for the phenanthrene and methyl-phenanthrene compounds (Figure 10a). The maturity parameters including the MNR-, DMNR-, 2/1MP-, MPI1- and the MPI2-ratios are all constant. Accordingly the calculated Rc-values range 0.79 - 0.81 %, suggesting that the hydrocarbons were generated from a mature source rock at peak oil generation. An interesting feature is

the prominent 4MDBT peaks, seen in the FPD-chromatograms (Figure 10b), whereas the lack of DMBT, 1DMBT and 2+3DMBT either indicate a high maturity of the source rock (past oil generation), i.e. higher than those obtained from other geochemical data (Tmax, Rc), which indicate a source rock at peak oil generation. Alternatively, the lack of the aforementioned compounds might indicate a different type of source rock. An earlier project carried out for Statoil (October 1992), including the well NOCS 34/10-35, showed similar high 4DMBT peak intensities and absence of DMBT, 1DMBT and 2+3DMBT for Draupne Fm. shale extracts with compatible maturities (Rc ≈ 0.80 %). Hence a source related distribution of dimethylbenzothiophene compounds are suggested as a plausible explanation.

The two Brent Gp. coal samples (3824.54 m, 3911.38 m) have methyl-naphthalenes, dimethyl naphthalenes and alkylphenanthrenes present as prominent peaks (Figure 10c). The high maturities of the samples are confirmed by the aromatic hydrocarbon ratios including 2/1MP-, MPI1- and MPI2-ratios. The MPI1-derived Rc-values of 0.94 % and 0.97 % indicate that the coals are close to the base of the oil window. The presence of sulphur containing dibenzothiophene (DBT) and alkyl-dibenzothiophenic compounds seen in the FPD-chromatograms (Figure 10d) supports a marine depositional environment. The high 4/1MDBT- and (3+2)/1MDBT-ratios support the high maturities for the coals.

3.4 Visual Kerogen Microscopy

Six samples from well NOCS 30/2-3 were optically examined, these covering the depth range 3675 - 3883.59 m of Upper to Middle Jurassic age. The detailed kerogen compositions are shown in Table 8, while the gross compositions are plotted in a triangular diagram, Figure 11. Thermal maturity data (Spore Colour Index) are included in Table 7.

3.4.1 Kerogen typing

Three samples from the Draupne Fm. interval were examined, all being from cuttings. These all have quite similar kerogen compositions, being strongly dominated by liptinite (55 - 75 %), which is overwhelmingly of low fluorescent amorphinite. Spores are common in the uppermost sample however and it can be commented that these samples otherwise show rather higher amounts of woody organic material than is usual in the Draupne Fm., i.e. a higher input of terrestrial organic matter. It is difficult to judge the original quality of the amorphous matter in these samples due to the advanced maturity, such that it is unknown whether or not this includes significant reworked or degraded matter. However, the presence of abundant pyrite infers a highly anoxic environment conductive to good preservation. It is tentatively concluded that it is most likely that the Draupne Fm. in this well have originally had a very good potential for oil generation, and that the present low potential is the result of mainly advanced maturity.

Three samples from the Brent Gp. were examined, all being from core chips. The two uppermost samples are of "coal", though the kerogen assemblages rather suggest them to be carbargillites since they have high liptinite/low vitrinite+inertinite contents. All the Brent Gp. samples have fairly similar compositions, the kerogen concentrates containing abundant liptinite (30 - 65 %), which consists mainly of spore material, together with amorphous/very fine-grained material which is often evidently of degraded spores. Cuticle is subordinate, while identifiable algal remains are scarce.

Vitrinite and inertinite, mainly as telinitic and semifusinitic clasts, range 20 - 60 % and 5 - 15 % respectively. These samples suggest the Brent Gp. shales to have good generation potential for gas, together with (?)waxy oil.

3.4.2 Maturity

Insufficient samples were analysed over too short a vertical interval from this well for establishment of a maturity gradient. The samples examined infer a maturity for the interval ranging SCI 7.0 - 7.5, i.e. at and above peak oil generation (top and base of oil window for type II kerogen: SCI 6.0 and SCI 8.0 respectively). This would correspond to a vitrinite reflectance of Ro 0.8 %+.

3.5 Gas Chromatography - Mass Spectrometry

Six samples, including four samples from the Upper Jurassic Draupne Fm. (3669 - 3705 m) and two samples from the Middle Jurassic Brent Gp. (3792 - 3980 m) were selected for GC-MS analyses. Both the saturated hydrocarbons and aromatic hydrocarbons were analysed, using multiple ion detection. All the data are presented in Tables 9A-I. Selected fragmentograms are shown in Figures 12a-j. All fragmentograms are found in Appendix 4.

3.5.1 Potential Source Rocks

Saturated Hydrocarbons

Terpanes

The triterpane distributions are shown in the M/Z 171 (demethylated triterpanes), 191, and the 205 (methylated triterpanes). The four Upper Jurassic Draupne Fm. samples have demethylated hopanes, represented by the M/Z 177 fragmentograms, with presence of the C_{27} - C_{29} rearranged steranes and tricyclic terpanes, reflecting relatively high maturities for the samples (Figure 12a). There appear to be minor differences for the samples, with one sample, 3684 m, being slightly more enriched in (?)C_{27} rearranged steranes (eluting at low retention time at about 51 and 52 minutes) compared to the three other samples, due to minor differences in source rather than maturity.

The two Brent Gp. samples have demethylated hopanes significantly different to the Draupne Fm. samples by being depleted in tricyclic terpanes and rearranged steranes.

The Draupne Fm. triterpanes (M/Z 191 fragmentograms) have C_{31} - C_{35} extended $\alpha\beta$ hopane distributions (peaks G/H to J1/J2) with homologous distributions, indicating a marine source rock (Figure 12b). There is a minor difference in the C_{34}/C_{35} extended

hopane ratio with the lowest sample, 3693 m, having a lower ratio compared to the three upper samples. This might indicate a less anoxic depositional environment for the lowest sample. T_m/T_s ratios range 0.10 - 0.15, supporting a relatively high maturity for the Draupne Fm. shales. The tricyclic terpanes (Peaks N, O, P, Q, R, S and T) are abundant peaks, supportive of high maturities, with the lowest sample (3693 m) having the highest peak intensities. Other parameters including the C_{30} αβ diahopane/αβ hopane ratio (X/E) ranging 0.36 to 0.43 and the tricyclic C_{24} terpane/αβ hopane ratio (Q/E) ranging 0.27 to 0.35, with the 3693 m sample having significantly higher values, suggest a slightly different source compared to the other three samples rather than maturity differences. Using the relatively higher content of the C_{30} diahopane (X) in the lower sample suggests a relatively higher terrestrial input compared to the other samples. The peak eluting immediately after the C_{29} αβ norhopane (C) is probably C_{29} neohopane (peak C1 in Figure 12c), which is present in abundant intensities, probably due to the relatively high maturity of the shales.

The two Brent Gp. coal samples (3824.54 m, 3911.38 m) have hopane compositions significantly different to the Draupne Fm. shale samples (Figure 12d). The C_{30} αβ diahopane peaks (X) are dominant, also reflected by the C_{30} αβ diahopane/αβ hopane ratios (1.41 and 4.95 respectively), indicating partly a higher maturity and partly a land plant derived source rock compared to the Draupne Fm. shales. The large differences in the X/E ratios could be due to maturity and/or a source related difference. The C_{29} neohopane (C1) is also more abundant than the C_{30} αβ hopane. The C_{31} - C_{33} extended hopanes are only present as minor peaks, whereas the C_{34} and C_{35} extended hopanes are nearly absent, believed to be due to the high maturities. The prominent presence of the C_{24} tetracyclic terpane (peak S) confirms the terrestrial origin of the source rock.

Steranes:

The sterane distributions are shown in the M/Z 217, 218 (14β 17β-steranes), 231 (methyl steranes) and 259 (diasteranes) fragmentograms. From the M/Z 217 fragmentograms (Figure 12e) it appears that the four Draupne Fm. shale samples are

dominated by the C_{27} - C_{29} rearranged steranes, and the C_{27} rearranged steranes in particular (peaks a and b), reflecting a relatively high maturity for a predominantly marine source rock. The C_{27}/C_{29}-diasterane ratio (ratio 4 in Table 9B) ranging 1.52 - 1.69 supports a marine origin. The M/Z 259 fragmentograms show predominance of the C_{27} diasteranes, with clearly minor and subequal contributions from the C_{28} and C_{29} diasteranes, supporting the mainly marine origin. The M/Z 218 fragmentograms, representing the 14β 17β sterane distributions are biased towards the C_{27}-steranes, with less contributions from the C_{28}-, C_{29}- and C_{30}-steranes, implying a marine source.

The Brent Gp. coal (3824.54 m, 3911.38 m) 14β 17β steranes (M/Z 218 fragmentograms) shown in Figure 12f are dominated by the C_{29}-steranes, indicating a mainly terrestrial source rock. The M/Z 259 fragmentograms show a predominance of C_{29}-rearranged steranes supportive of a terrestrial origin, even though the peak intensities are low. In the lower sample, 3911.38 m, several unidentified compounds having prominent peak intensities, making the relative isomer distributions more uncertain. Unidentified compounds might coelute with the C_{28}- and C_{29}-rearranged steranes.

Aromatic Hydrocarbons

The four Draupne Fm. M/Z 106 fragmentograms show the presence of C_6 to C_{25} 1-methyl, 2-alkyl and 1-methyl, 3-alkyl benzene series (doublets, Figure 12g). This distribution of alkylbenzenes is indicative of a marine source. The samples are considered to be mature, owing to the predominance of the 1-methyl, 3-alkyl peaks (the first peak of the doublets) relative to the corresponding 1-methyl, 2-alkyl peaks. The two Brent Gp. coal fragmentograms (3824.54 m, 3911.38 m) with C_6 to C_{25} 1-methyl, 2-alkyl and 1-methyl, 3-alkyl benzene series are both highly mature, due to the higher 1-methyl, 3-alkyl peaks and the emergence of the (?) 1-methyl, 4-alkyl benzene series, eluting between the two previously mentioned peaks (Figure 12h).

The four Draupne Fm. M/Z 134 fragmentograms of the C_4-alkylbenzenes are rather similar to each other, except for the variation in the relative abundance of the earliest eluting compounds. This is probably an evaporation effect. The two Brent Gp. coal

samples are also similar to each other (again except for the relative abundance of the earliest eluting compounds). The Brent Gp. coal samples are however different to the Draupne Fm. samples; the Brent Gp. samples having a very prominent peak just before 25 minutes retention time.

Generally Draupne Fm. alkylnaphthalene specific fragmentograms (M/Z 142, 156, 170) are similar, however, with minor variations. The three upper methylnaphthalene fragmentograms (M/Z 142) have subequal distribution of 1- and 2-methylnaphthalene, whereas the lowest sample (3693 m) has a clearly higher 1-methylnaphthalene peak. This might be due to evaporative loss. The Brent Gp. coals show predominance of 2- over the 1-methylnaphthalene, indicative of high maturity. The C_2-naphthalene fragmentograms (M/Z 156) of the Draupne Fm. are very similar to each other. The 2,6+2,7-C_2 naphthalene peak is fairly high compared with the other peaks, indicating a quite high maturity. The Brent Gp. coal samples have an even larger 2,6+2,7-C_2 naphthalene peak, indicating an even higher maturity. The C_3-naphthalene fragmentograms (M/Z 170) show a corresponding pattern with the early eluting compounds slightly more prominent for the Brent Gp. coal samples than for the Draupne Fm. shales.

The phenanthrene, anthracene and alkylphenanthrene specific fragmentograms (M/Z 178, 192, 206, 220) are relatively uniform for the Draupne Fm. shales. The M/Z 178 fragmentograms of all six samples show almost only phenanthrene. Anthracene is only present as an almost unidentifiable peak. The methylphenanthrenes (M/Z 192) are dominated by the 9- and 1-methylphenanthrene relative to the 3- and 2-methylphenanthrene, indicating relative moderate maturity as opposed to most of the other maturity data. Contrary, the 9- and 1-methylphenanthrene peaks of the Brent Gp. coal samples are smaller relative to the 3- and 2-methylphenanthrenes, indicating a high maturity. The C_2-phenanthrenes (M/Z 206) and C_3-phenanthrenes (M/Z 220) show a similar difference in maturity, with those of the Draupne Fm. suggesting a lower maturity than those of the Brent Gp. coals.

The C_1- and C_2-dibenzothiophene (M/Z 198, 212) fragmentograms are relatively uniform for the Draupne Fm. samples. The (2+3)-/1-methyldibenzothiophene (M/Z 198)

ratio is approximately 1.3 and indicative of a mature source rock (probably close to 0.8 % Ro equivalent). The 4-/1-methyldibenzothiophene ratio is larger than 10, supporting a maturity close to or past peak oil generation (see Figure 12i). The Brent Gp. coals have (2+3)-/1-methyldibenzothiophene ratios significantly higher (> 3) than the Draupne Fm. samples, reflecting a higher maturity (well past peak oil generation, 0.8 % Ro equivalent) (see Figure 12j). The C_2-dibenzothiophenes show similarity within the Draupne Fm. and the Brent Gp. respectively, but differences between these two suites of samples.

The fragmentograms of the triaromatic steranes (M/Z 231) are similar for the four Draupne Fm. samples. The early eluting compounds are very dominant and only traces at the later eluting compounds are present. This is indicative of a maturity at or past peak oil generation. The Brent Gp. coal samples have fragmentograms lacking the peaks found in the Draupne Fm. The lack of these peaks are usually interpreted as being due to a high maturity, i.e. well past peak oil generation. Similar observations apply for the monoaromatic steranes (M/Z 253) and the same interpretation applies. No ratios could be calculated for the Brent Gp. Those that could be calculated for the Draupne Fm. are similar for the four samples and indicate a fairly high maturity (see Table 9c-e).

Chapter 4

CONCLUSIONS

4.1 Source Rock Potential

The Upper Jurassic Draupne Fm. (3669 - 3705 m), consisting of dark grey to greyish black shales, is a mature marine type II kerogen source rock, with a good potential for generation of light oil and gaseous hydrocarbons. The mainly liptinitic kerogen source rocks contain relatively high contents of woody organic material, indicating a significant terrestrial contribution. The abundant pyrite contents seen in the visual kerogen descriptions however suggest an anoxic depositional environment. The Heather Fm. (3705 - 3792 m) claystones are organic-rich greyish black claystones having fair to good petroleum potentials. The lower petroleum potential values relative to the Draupne Fm. might be due to contribution from land derived organic matter rather than marine organic matter, giving a gas-prone source rock potential for the Heather Fm. The highly mature Middle Jurassic Brent Gp. (3792 - 3980 m) coals and carbonaceous shales have very rich petroleum potential. The coals have abundant liptinite contents, consisting mainly of spore material, whereas vitrinite and inertinite range 20 - 60 % and 5 - 15 % of the coal samples respectively. The maturity of the samples taken into consideration suggests that the coals are gas-prone. The GC-MS and aromatic hydrocarbon GC (FID/FPD) data suggest that the Brent Gp. coals are mainly terrestrial source rocks deposited in a marine environment. The highly mature Lower Jurassic Dunlin Gp. (3980 - 4288 m) claystones have good TOC-contents with fair petroleum potential for generating gaseous hydrocarbons.

4.2 Maturity

The Draupne Fm. shales are considered to be at peak oil generation, when Tmax and aromatic hydrocarbon GC (FID) ratios are applied (Rc = 0.8 %), with peak oil generation at Ro = 0.8 % for type II kerogen. The consistent derived Rc-values of about 0.8 % confirm a maturity close to peak oil generation. The Heather Fm. has Tmax-values ranging 442 - 455°C, suggesting that the Heather Fm. is past peak oil generation (Tmax = 440°C for type II kerogen). The Brent Gp. coals are highly mature, suggesting a maturity close to the base of the oil window (Ro = 1.0 %, Tmax = 450°C for type II kerogen). The calculated Rc-values in the 0.9 - 1.0 % range derived from the aromatic hydrocarbon GC (FID) confirm the high maturity of the coals. The Dunlin Gp. claystones are considered to be close to the base of the oil window or below.

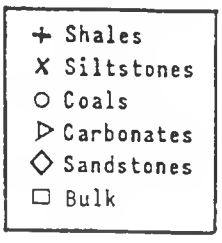
4.3 Generation

The analysed potential source rocks, including the Upper Jurassic Draupne Fm. - Lower Jurassic Dunlin Gp. (3669 - 4288 m) have started to generate and expel hydrocarbons, owing to the high maturities and petroleum potentials. The oil- and gas-prone Draupne Fm. is considered to be at peak oil maturity level, hence hydrocarbons are being generated and expelled actively, also obtained from rich bitumen contents obtained from solvent extraction. The Heather Fm., being past peak oil generation, is considered to generate and expel gaseous hydrocarbons and (?)light oil, however, to a less extent compared with the Draupne Fm. The Brent Gp. coals have generated hydrocarbons and are still generating mainly gaseous hydrocarbons.

4.4 Migration

No analyses have been performed on migrated hydrocarbons.

LEGEND TO FIGURES 2, 3 AND 4



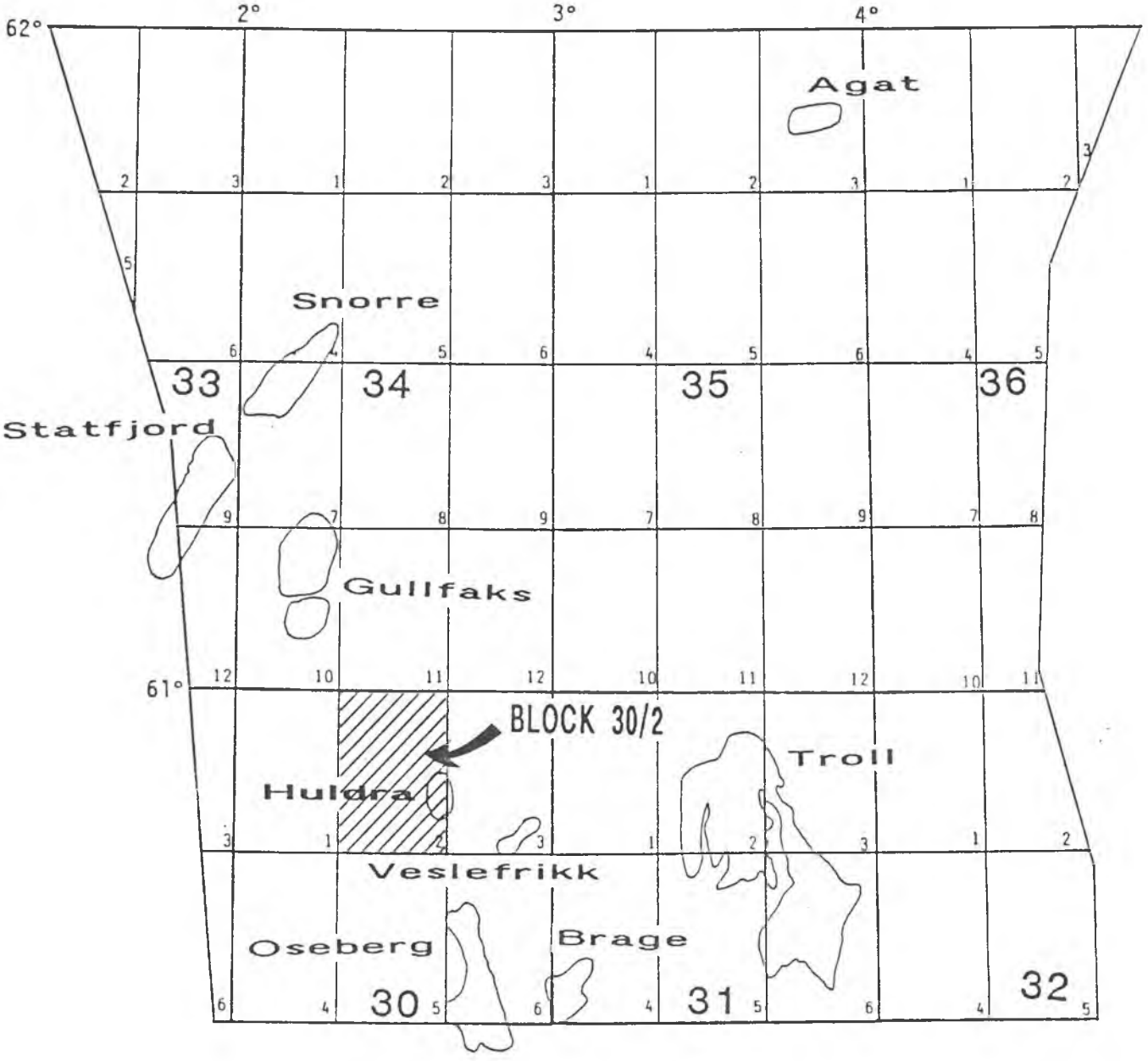


Figure 1: Location Map showing block 30/2.

Figure: 2 Client: STATOIL

TOC Data for Well NOCS 30/2-3

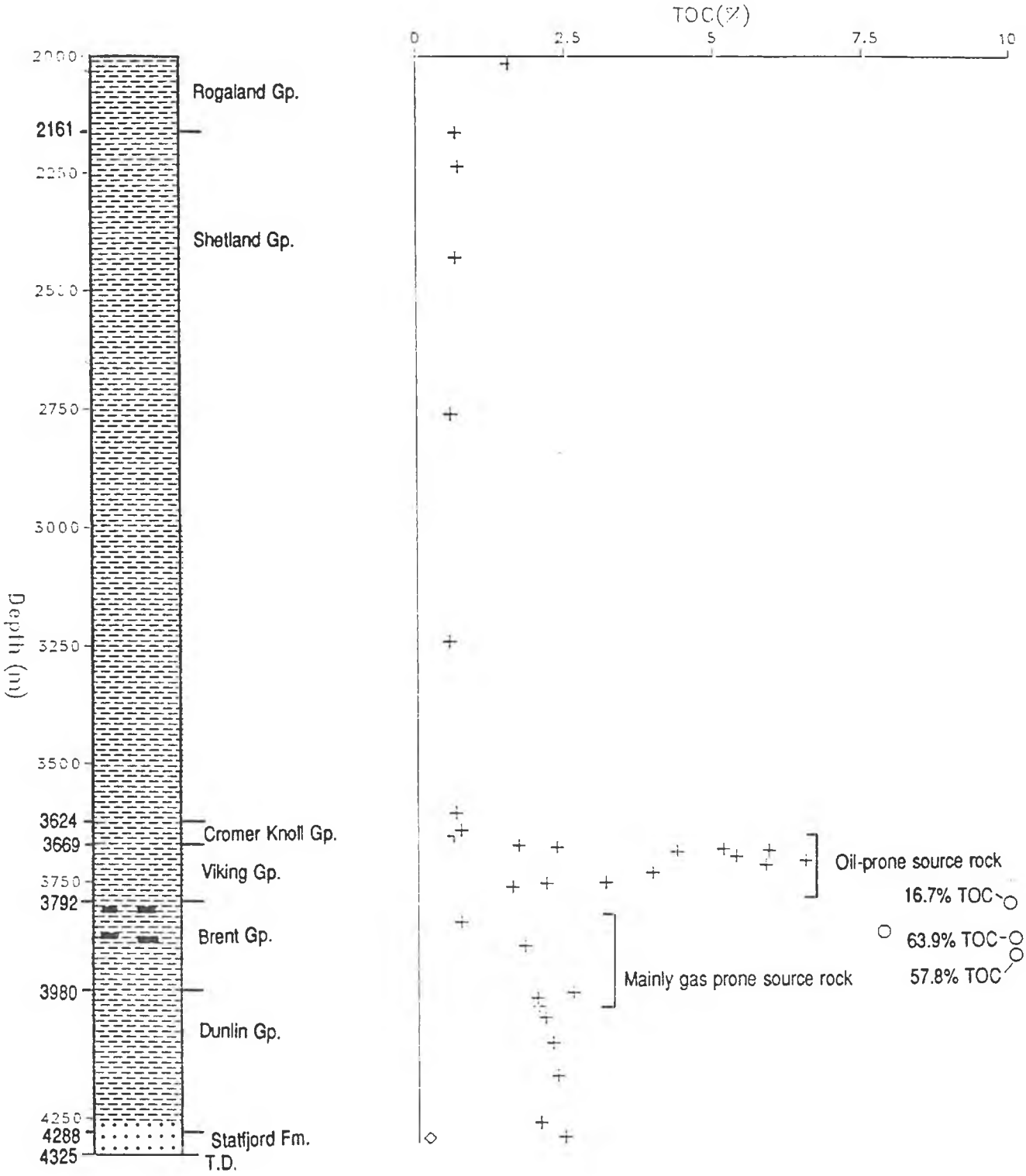


Figure: 3 Client: STATOIL

Production Index Data for Well NOCS 30/2-3

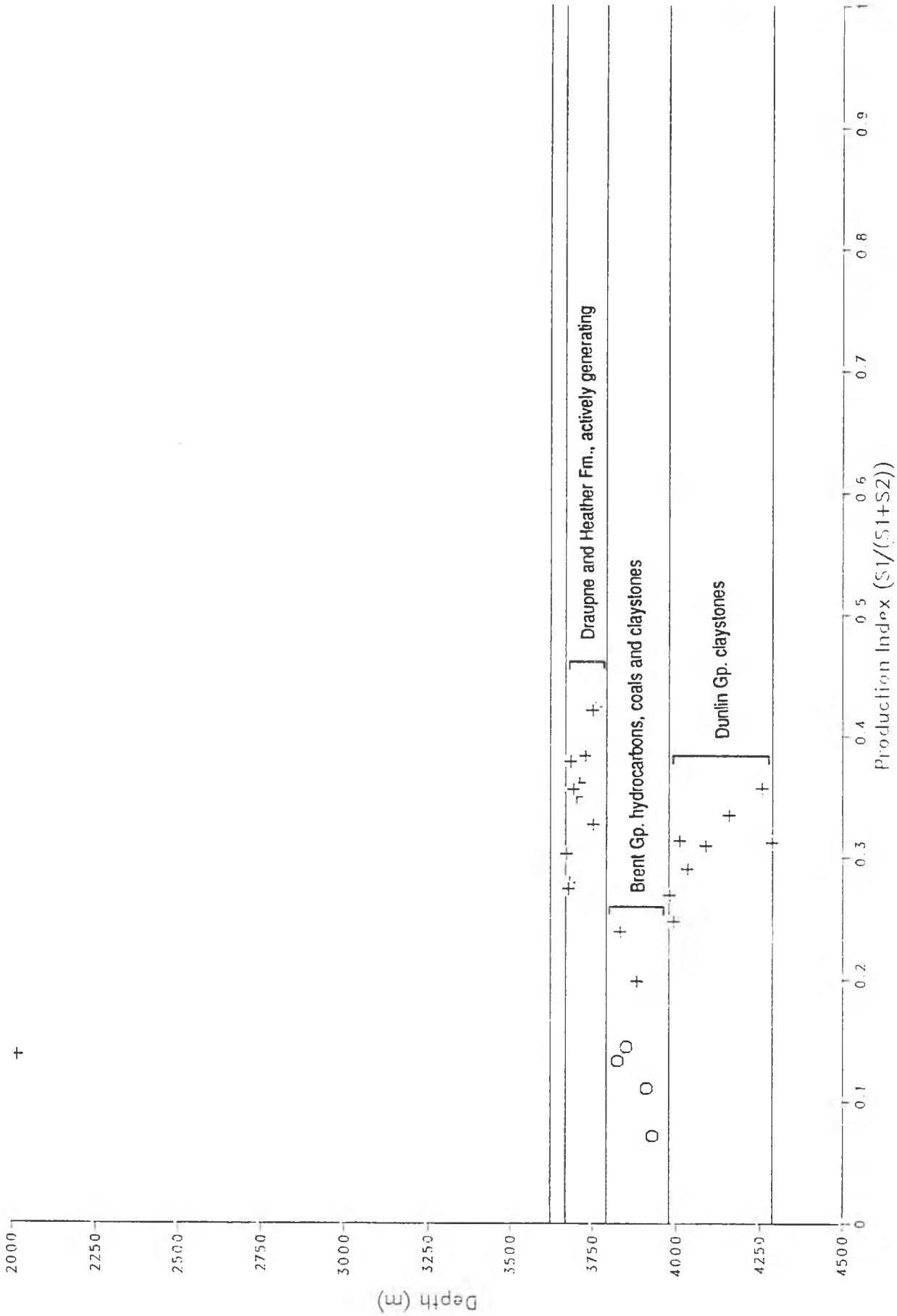


Figure: 4 Client: STATOIL

Tmax Data for Well NOCS 30/2-3

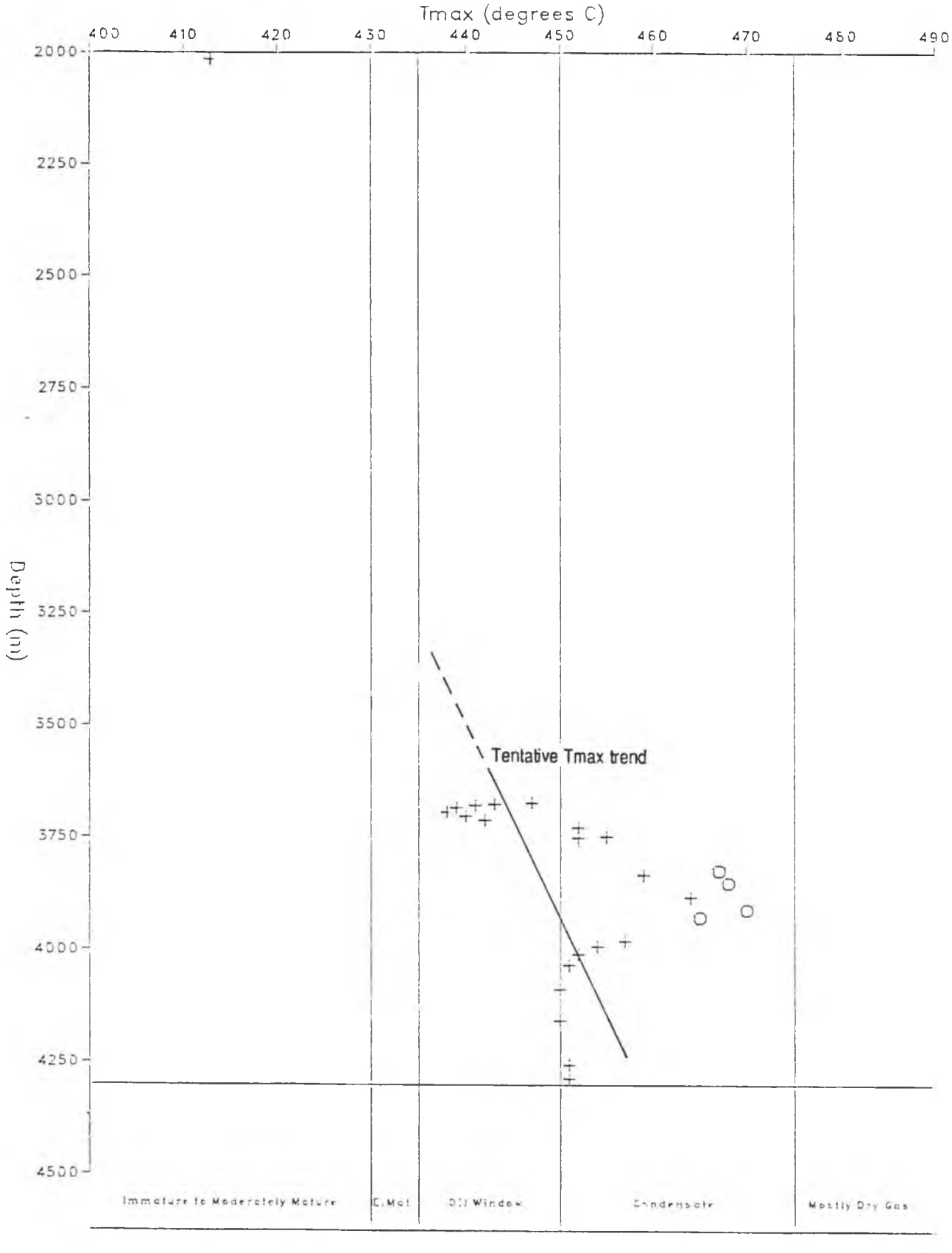
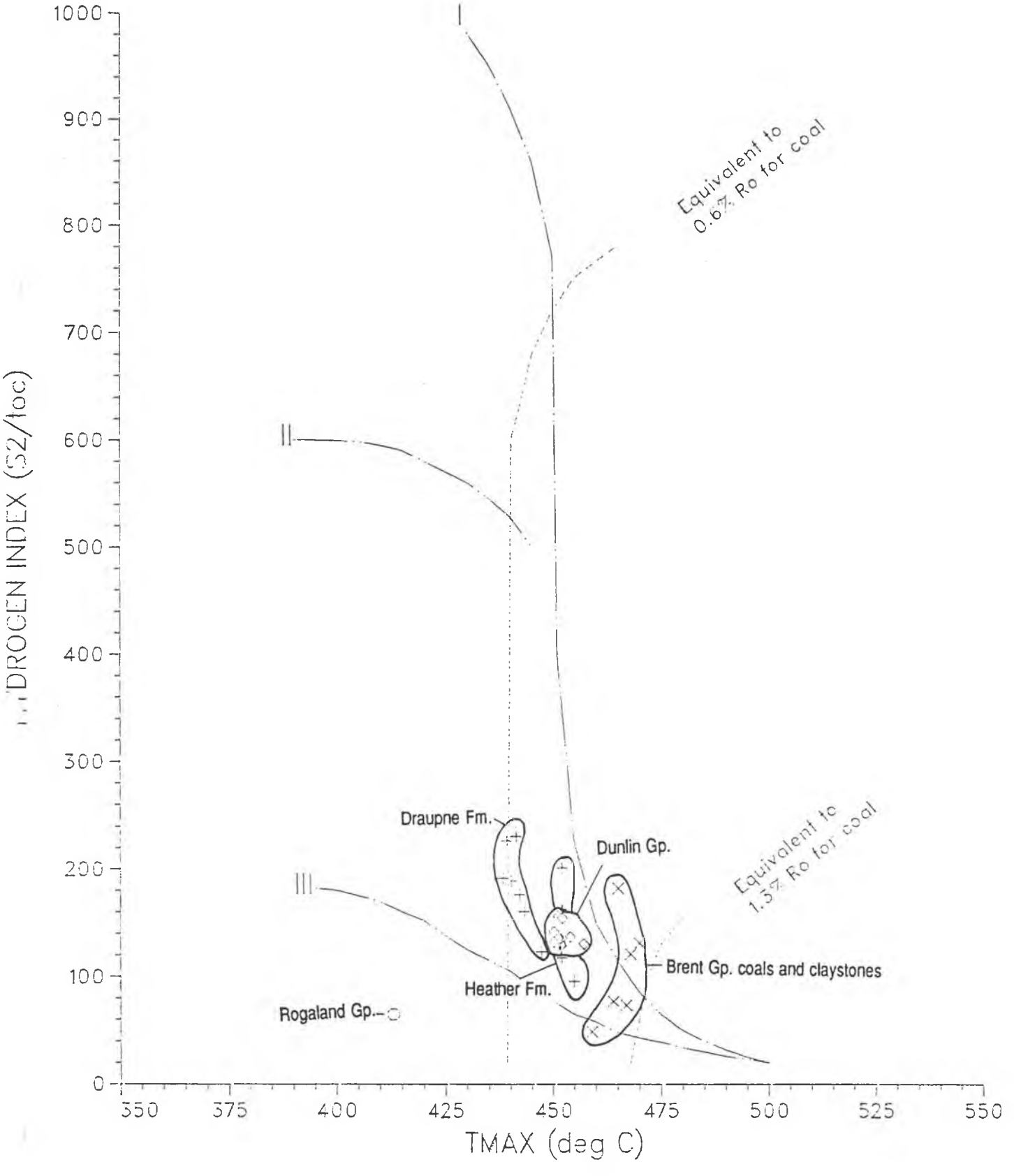


Figure 5 : Hydrogen Index v.s. Tmax values
Well NOCS 30/2-3



Analysis Name : [62019] 23 PH9500111,1,1.

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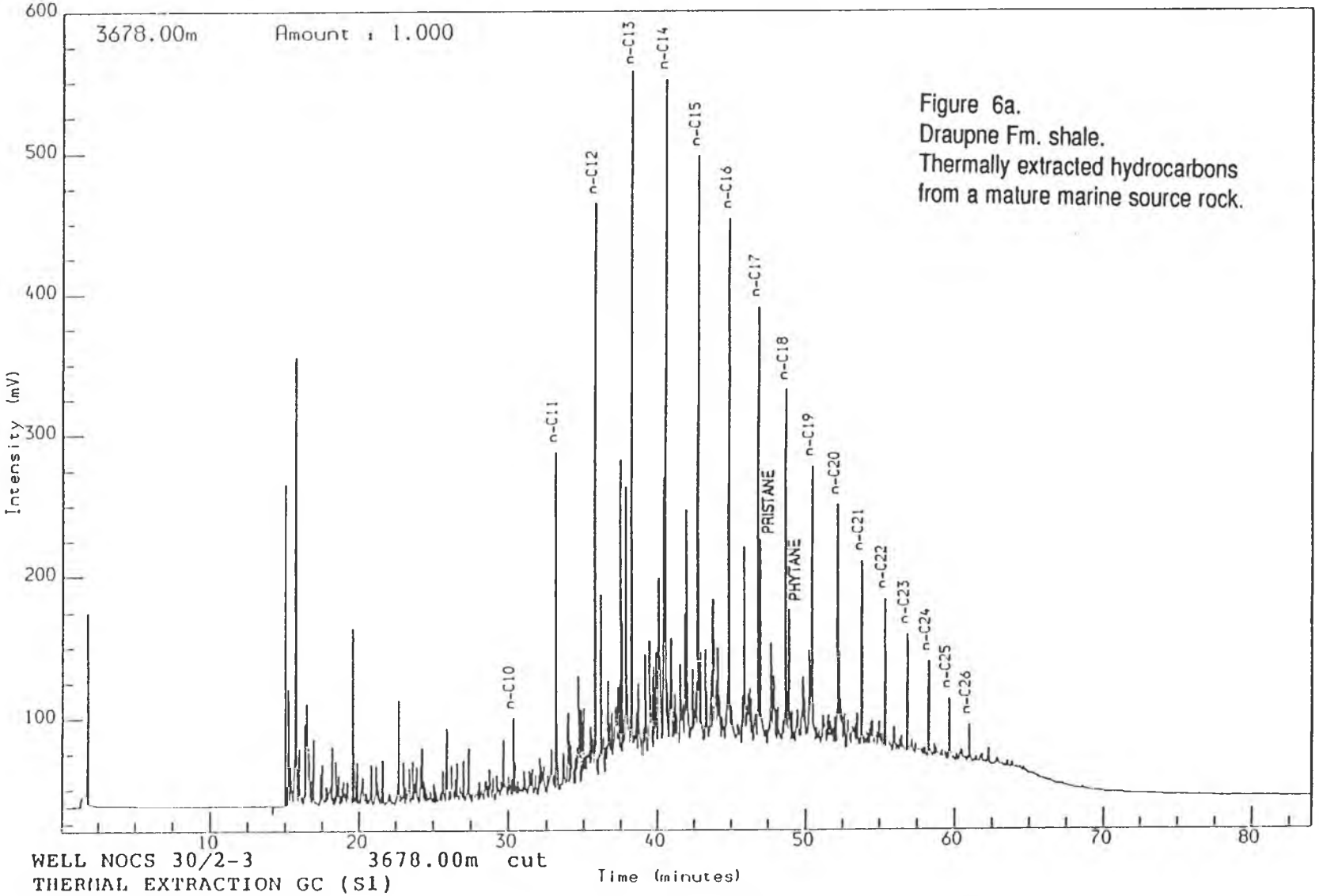


Figure 6a.
Draupne Fm. shale.
Thermally extracted hydrocarbons
from a mature marine source rock.

WELL NOCS 30/2-3 3678.00m cut
THERMAL EXTRACTION GC (S1)
Sh/Clst: gy blk

Reported on 15-DEC-1992 at 21:47

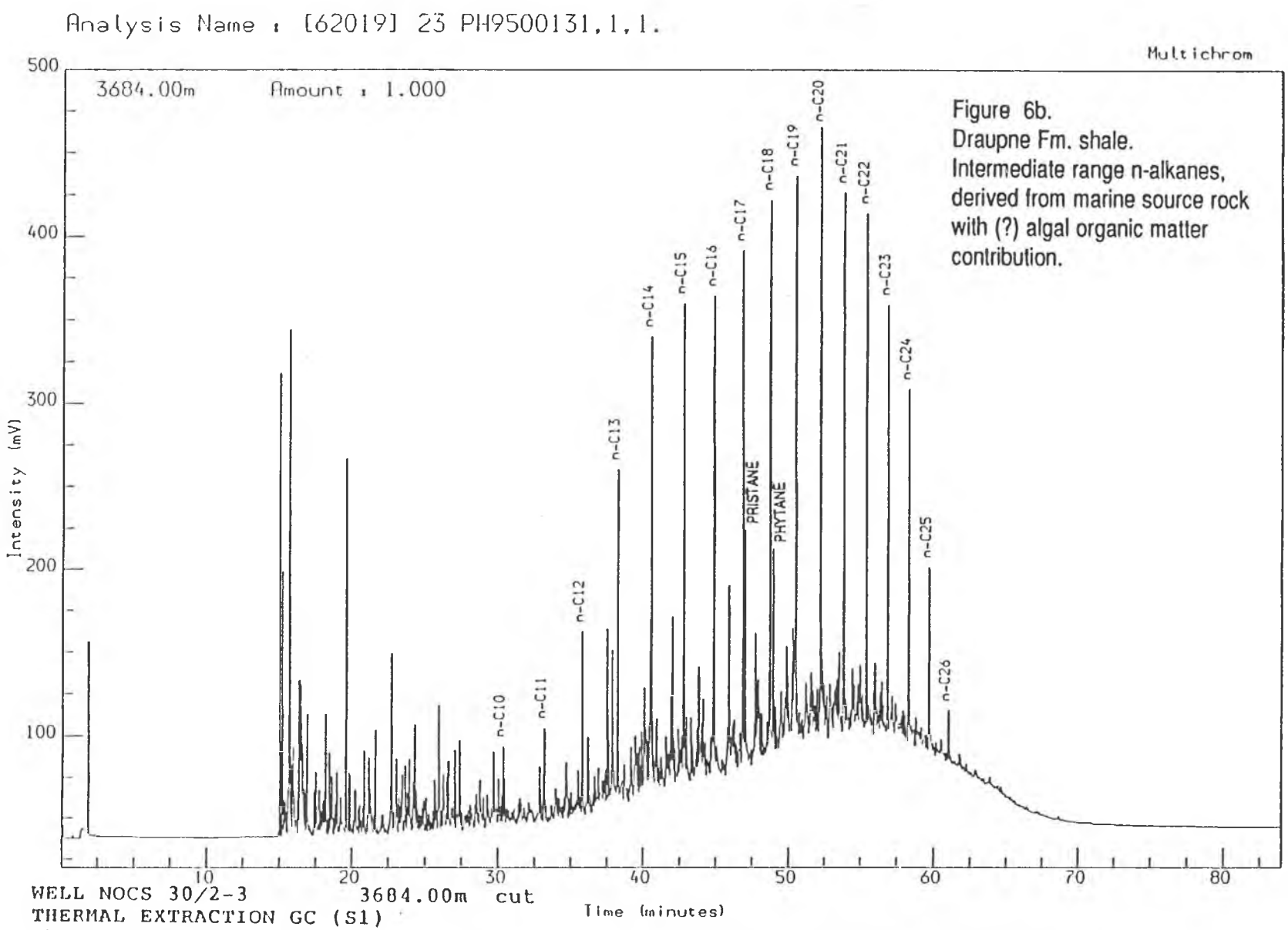


Figure 6b.
Draupne Fm. shale.
Intermediate range n-alkanes, derived from marine source rock with (?) algal organic matter contribution.

Analysis Name : [62019] 23 PH9500331.1.1.

Multichrom

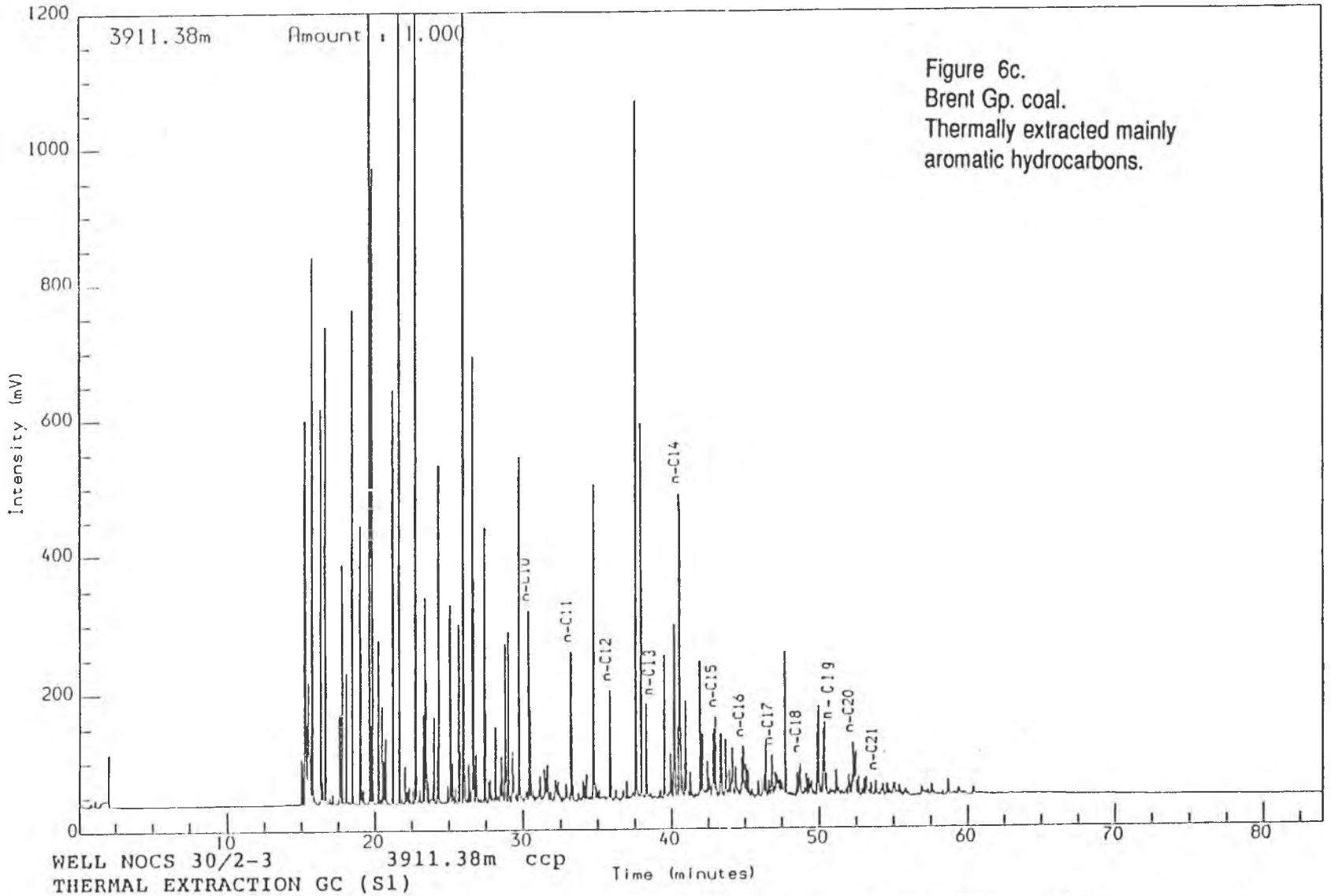


Figure 6c.
Brent Gp. coal.
Thermally extracted mainly aromatic hydrocarbons.

WELL NOCS 30/2-3 3911.38m ccp
THERMAL EXTRACTION GC (S1)
Coal: blk

Reported on 16-DEC-1992 at 08:17

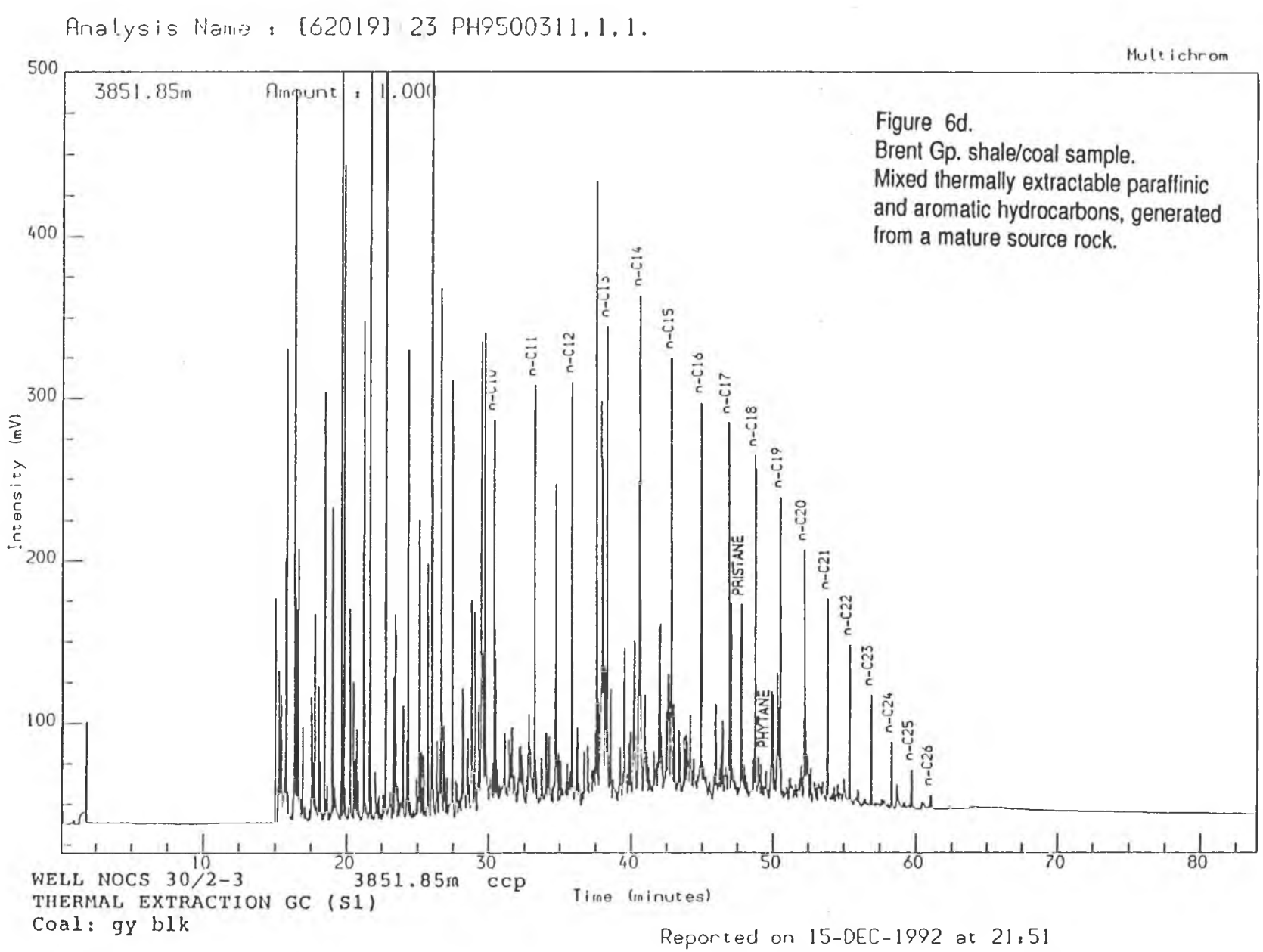


Figure 6d.
Brent Gp. shale/coal sample.
Mixed thermally extractable paraffinic and aromatic hydrocarbons, generated from a mature source rock.

Analysis Name : [62019] 24 PH9500121.1.1.

Multichrom

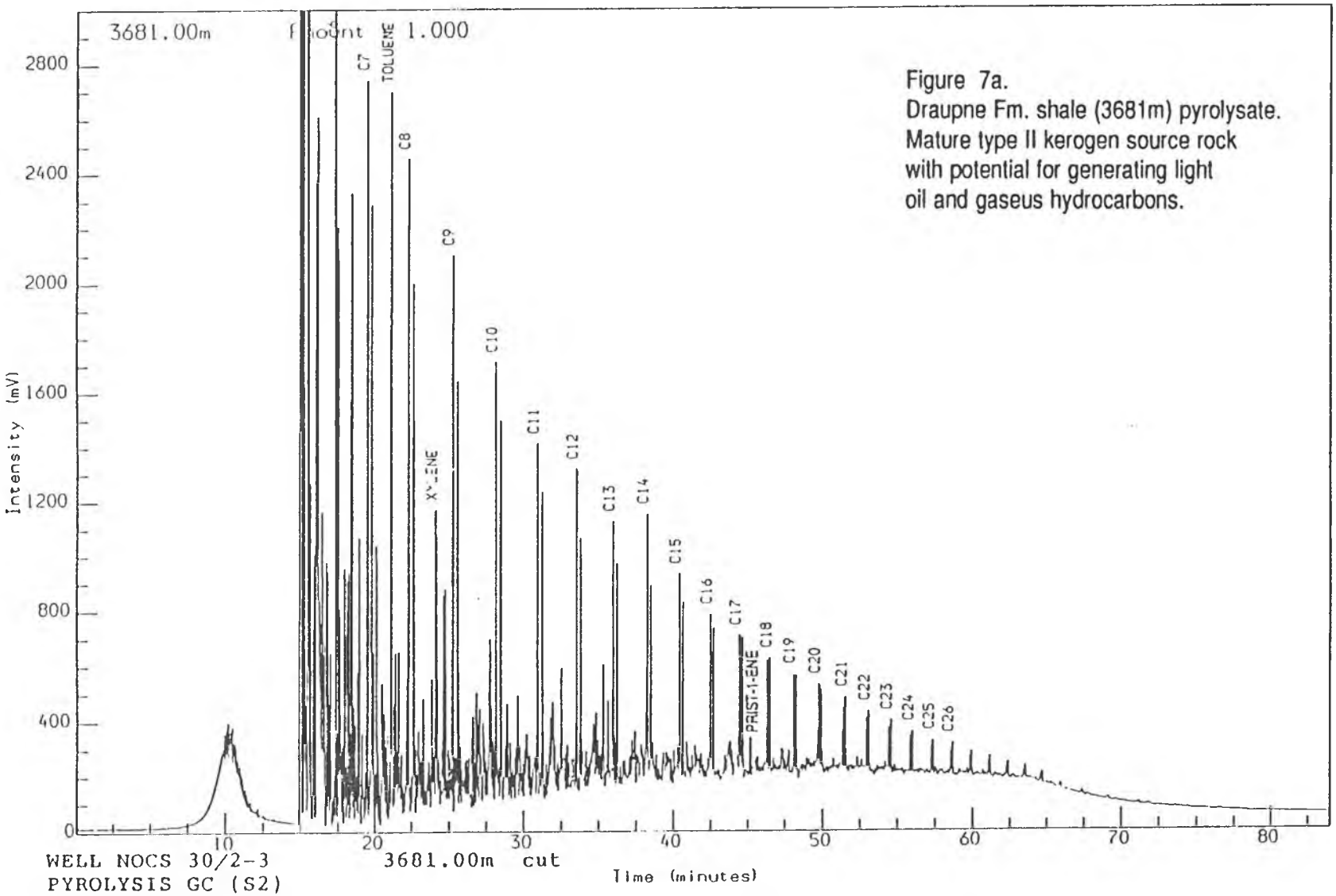


Figure 7a.
Draupne Fm. shale (3681m) pyrolysate.
Mature type II kerogen source rock
with potential for generating light
oil and gaseus hydrocarbons.

WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Sh/Clst: gy blk

3681.00m cut

Reported on 15-DEC-1992 at 21:54

Analysis Name : [62019] 24 PH9500331.1.1.

Multichrom

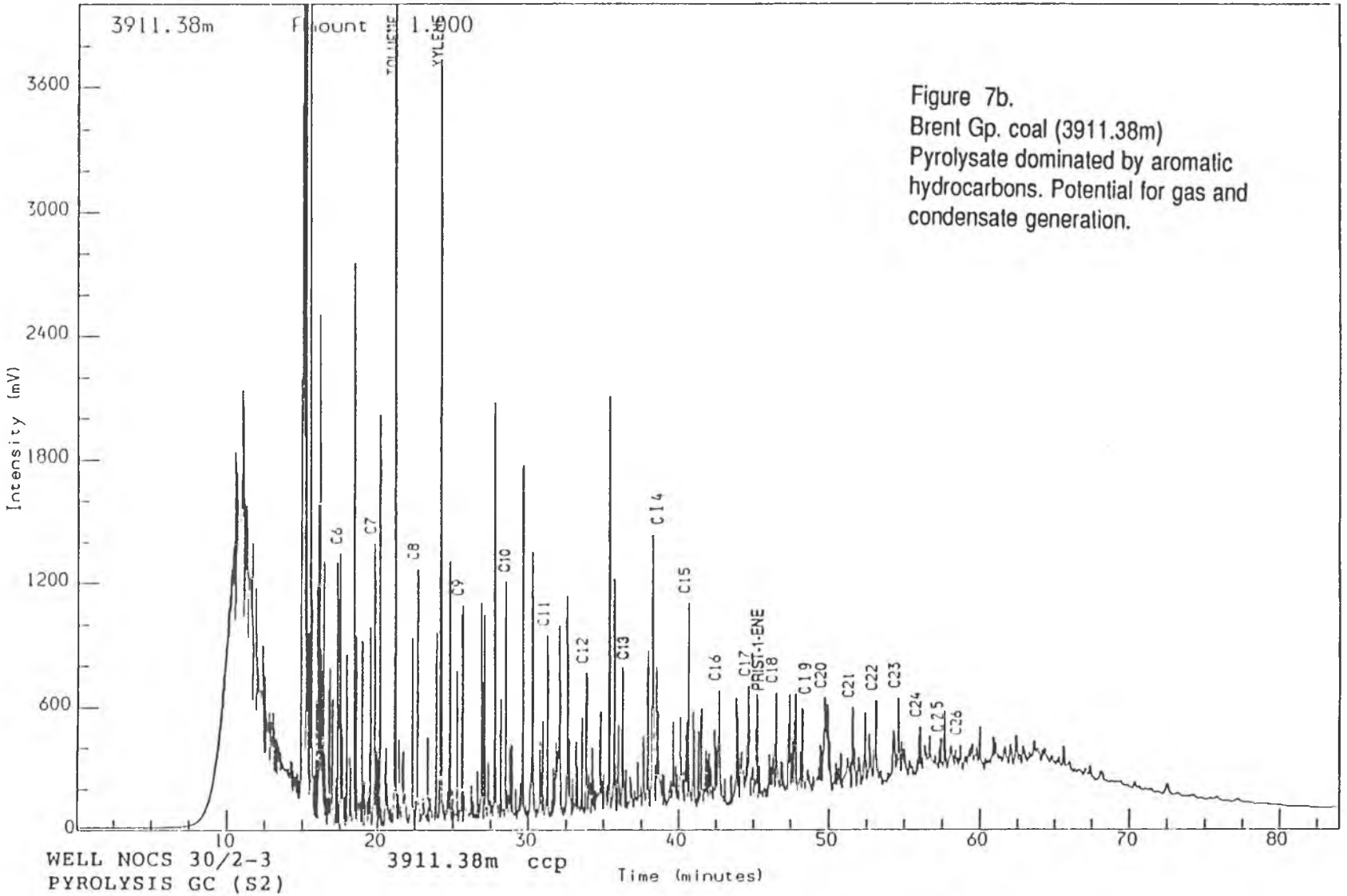


Figure 7b.
Brent Gp. coal (3911.38m)
Pyrolysate dominated by aromatic hydrocarbons. Potential for gas and condensate generation.

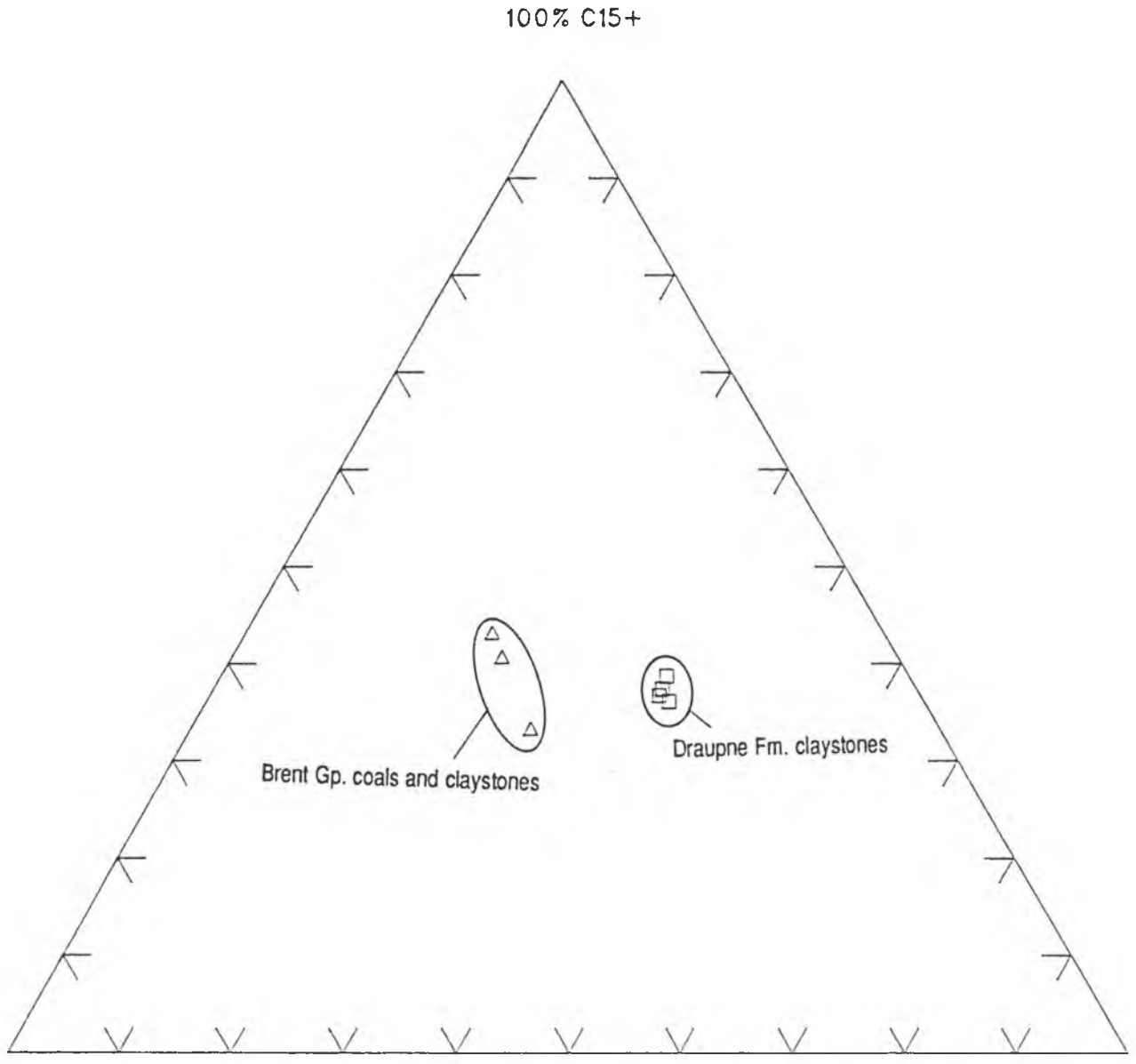
WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Coal: blk

3911.38m ccp

Reported on 15-DEC-1992 at 21:59

Figure 8 : Pyrolysis GC Composition

Well NOCS 30/2-3



Analysis Name : [62019] 5 SH9500101L.3.1.

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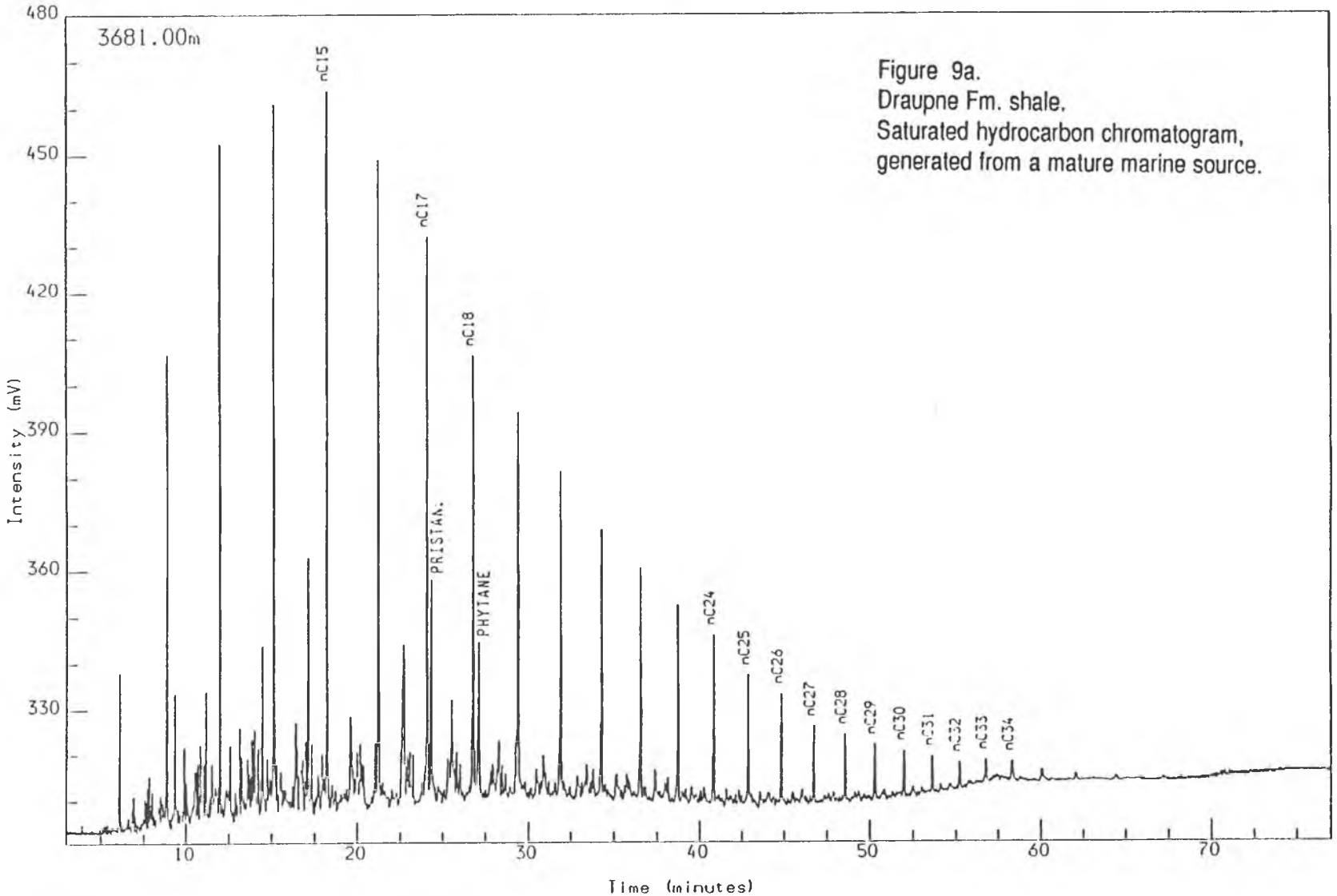

Figure 9a.
Draupne Fm. shale.
Saturated hydrocarbon chromatogram,
generated from a mature marine source.

WELL NOCS 30/2-3 3681.00m cut
SATURATED GC
Sh/Clst: gy blk

Reported on 21-DEC-1992 at 13:28

Analysis Name : [62019] 5 SH9500101L.4.1.

Multichrom

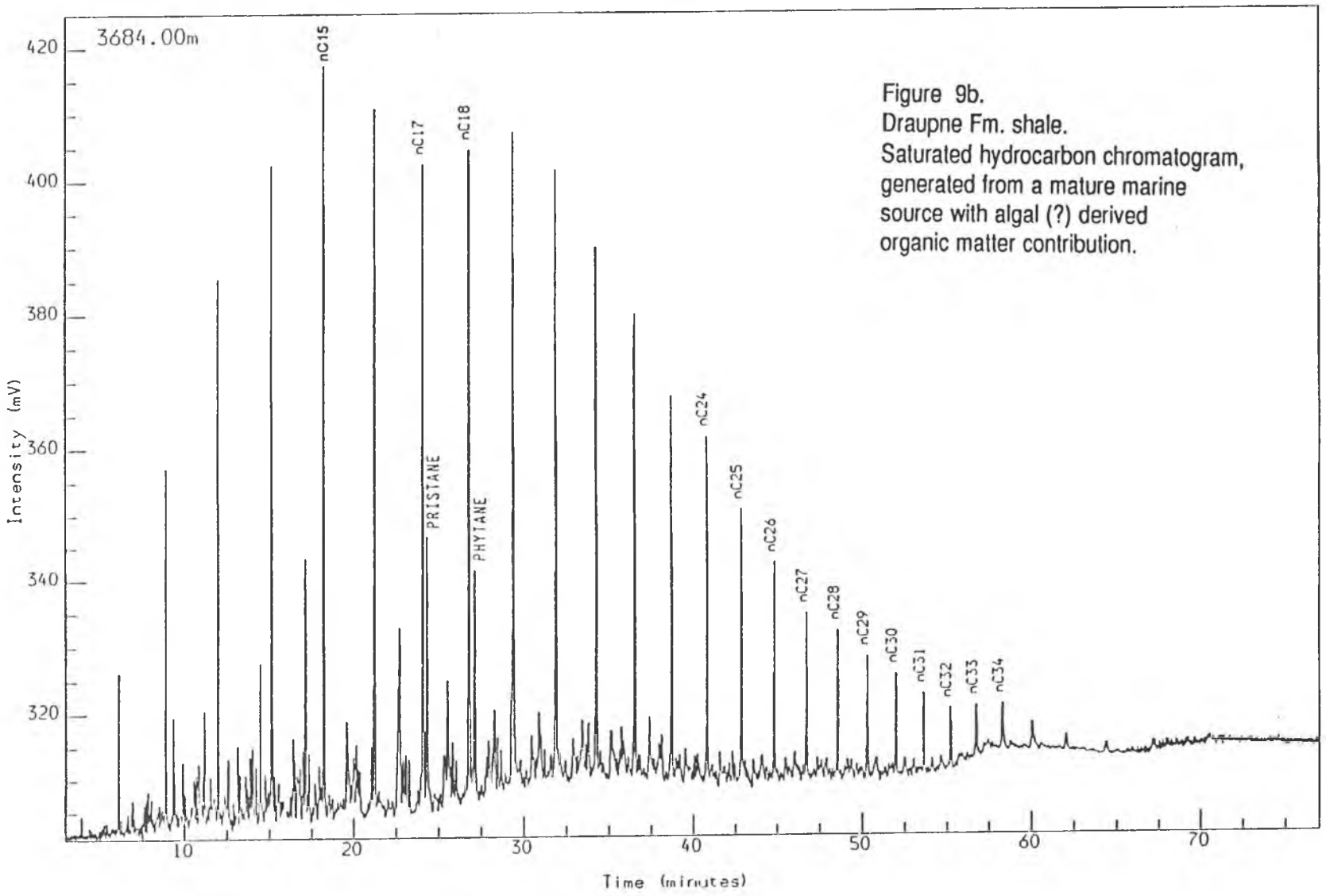

Figure 9b.
Draupne Fm. shale.
Saturated hydrocarbon chromatogram, generated from a mature marine source with algal (?) derived organic matter contribution.

WELL NOCS 30/2-3 3684.00m cut
SATURATED GC
Sh/Clst: gy blk

Reported on 21-DEC-1992 at 13:40

Analysis Name : [62019] 5 SH9500101L,6,1.

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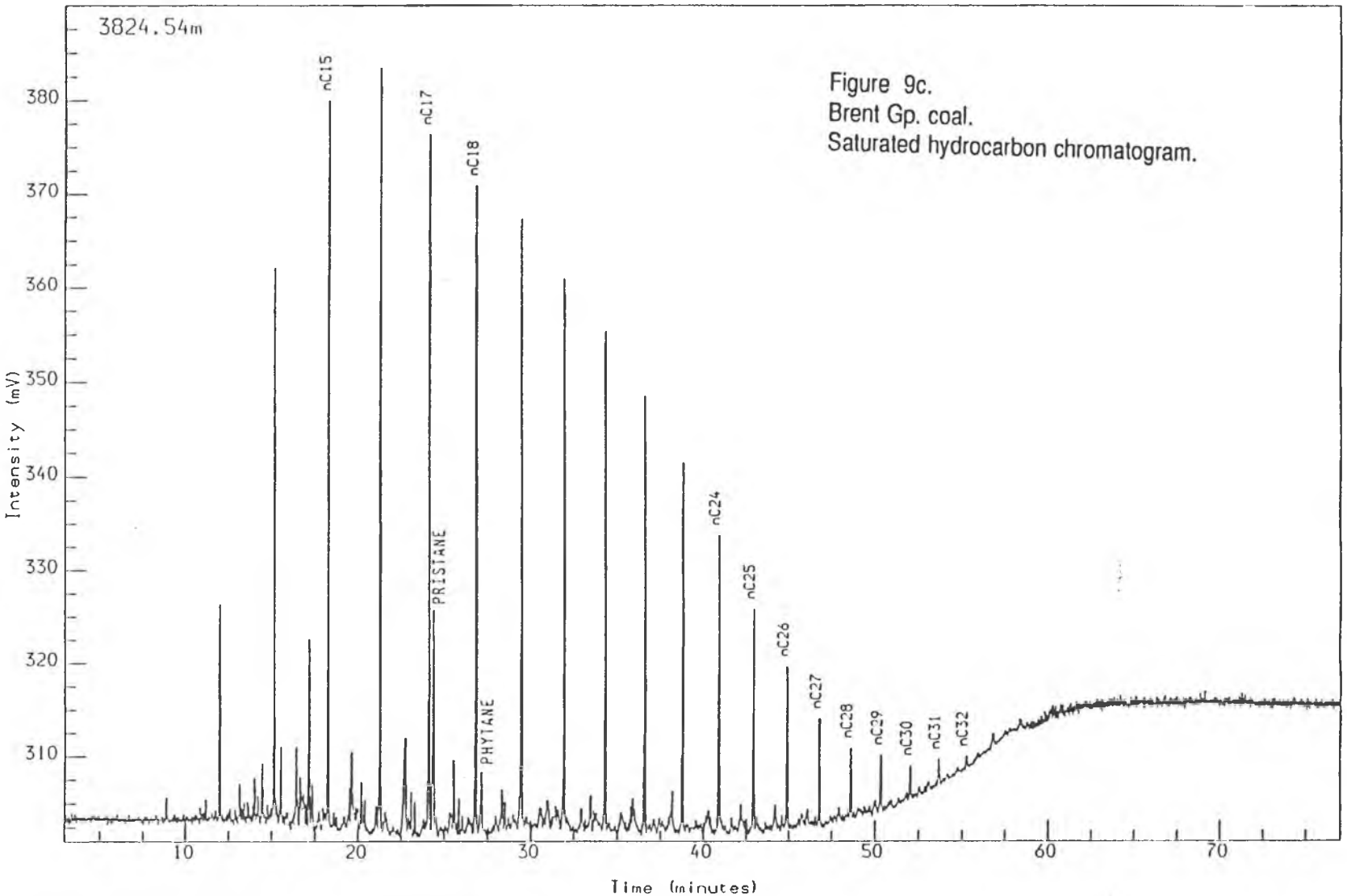


Figure 9c.
Brent Gp. coal.
Saturated hydrocarbon chromatogram.

WELL NOCS 30/2-3 3824.54m ccp
SATURATED GC
Coal: brn blk

Reported on 21-DEC-1992 at 13:51

Analysis Name : [62019] 29 NH9500101L.3.1.

Multichrom

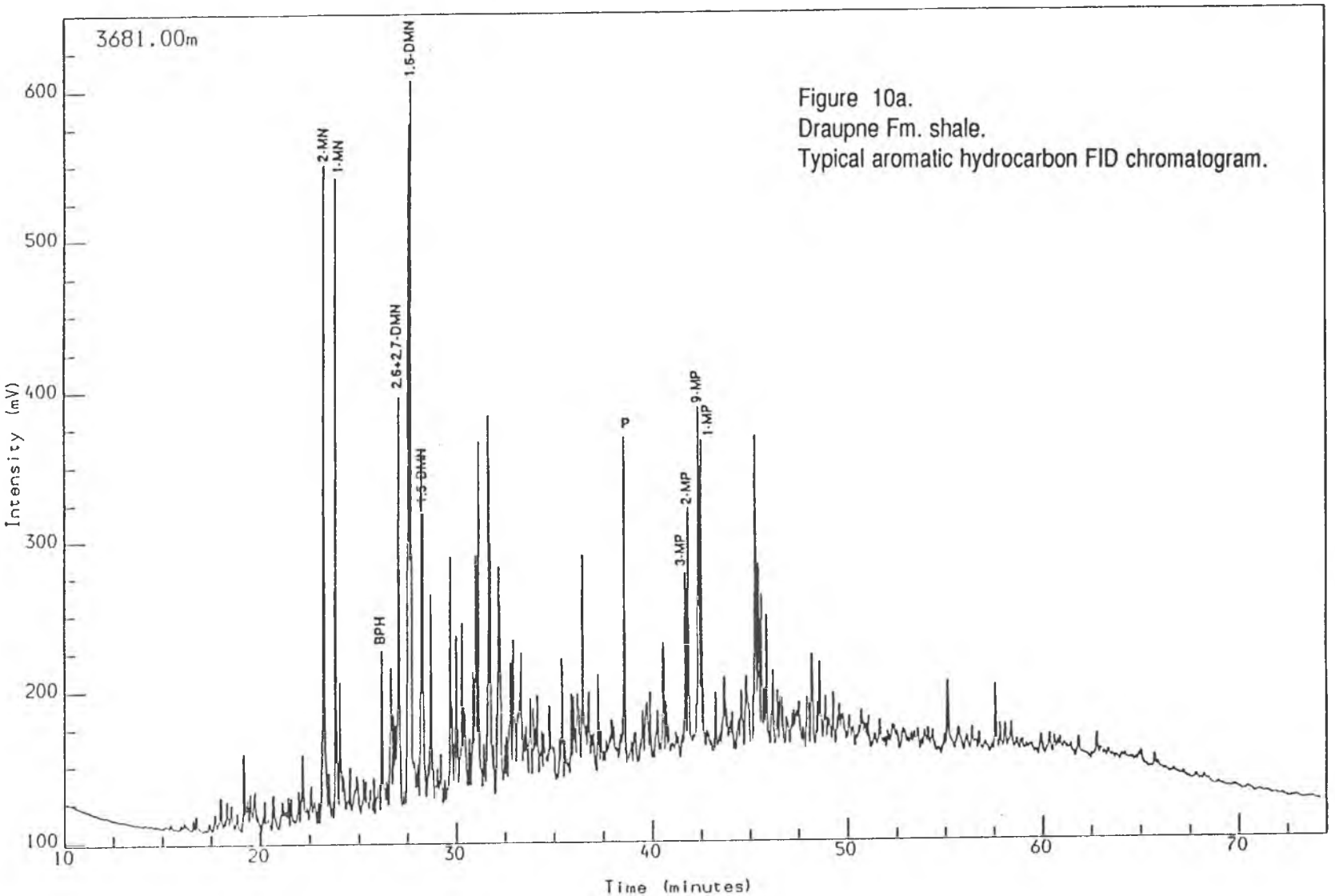


Figure 10a.
Draupne Fm. shale.
Typical aromatic hydrocarbon FID chromatogram.

WELL NOCS 30/2-3
AROMATIC GC (FID)
Sh/Clst: gy blk

3681.00m cut

Reported on 22-DEC-1992 at 10:08

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 30 AH9500101L,4,1.

Multichrom

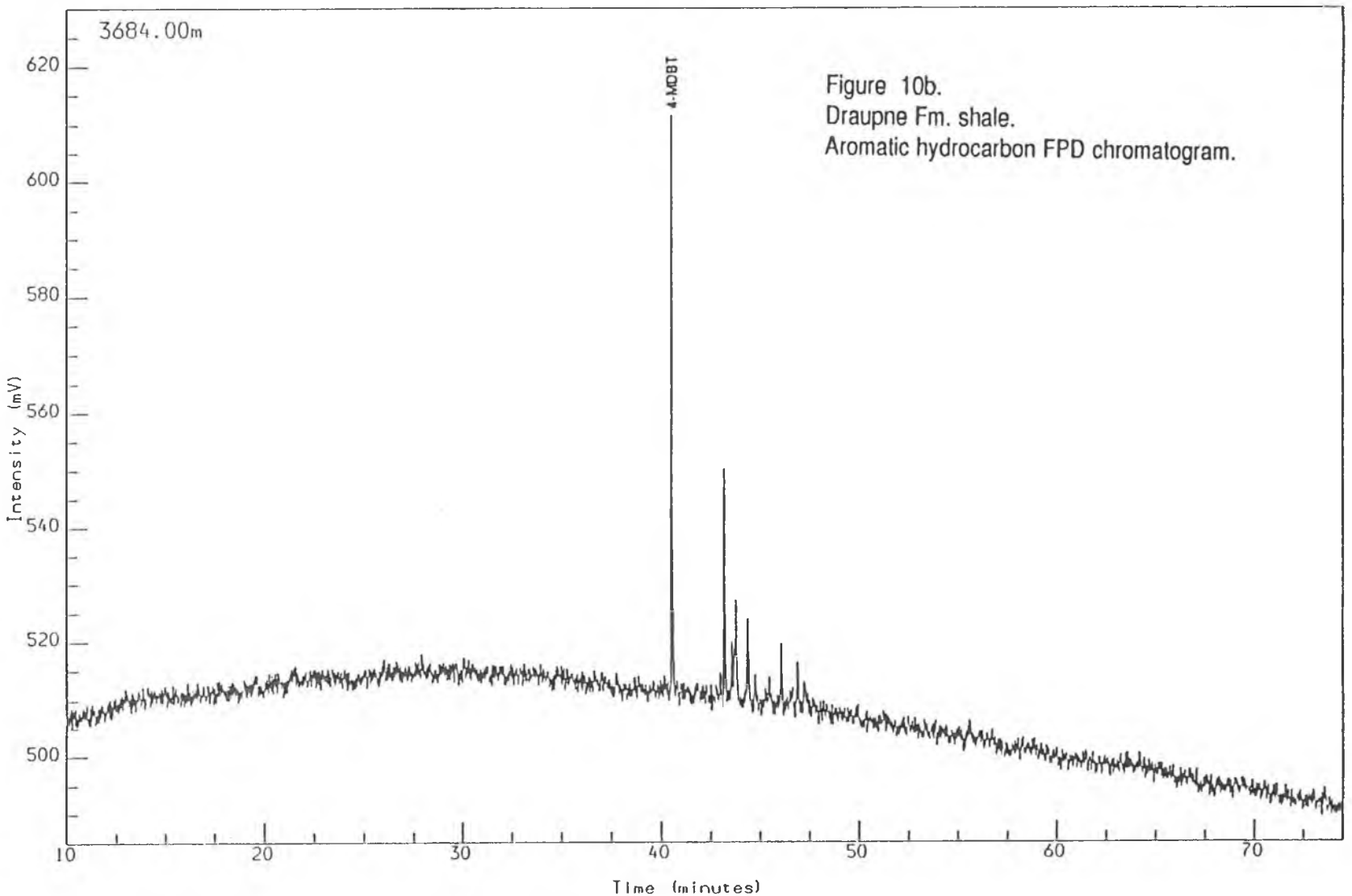


Figure 10b.
Draupne Fm. shale.
Aromatic hydrocarbon FPD chromatogram.

WELL NOCS 30/2-3 3684.00m cut
AROMATIC GC (FPD)
Sh/Clst: gy blk

Reported on 22-DEC-1992 at 10:32

Analysis Name : [62019] 29 AH9500101L,5,1.

Multichrom

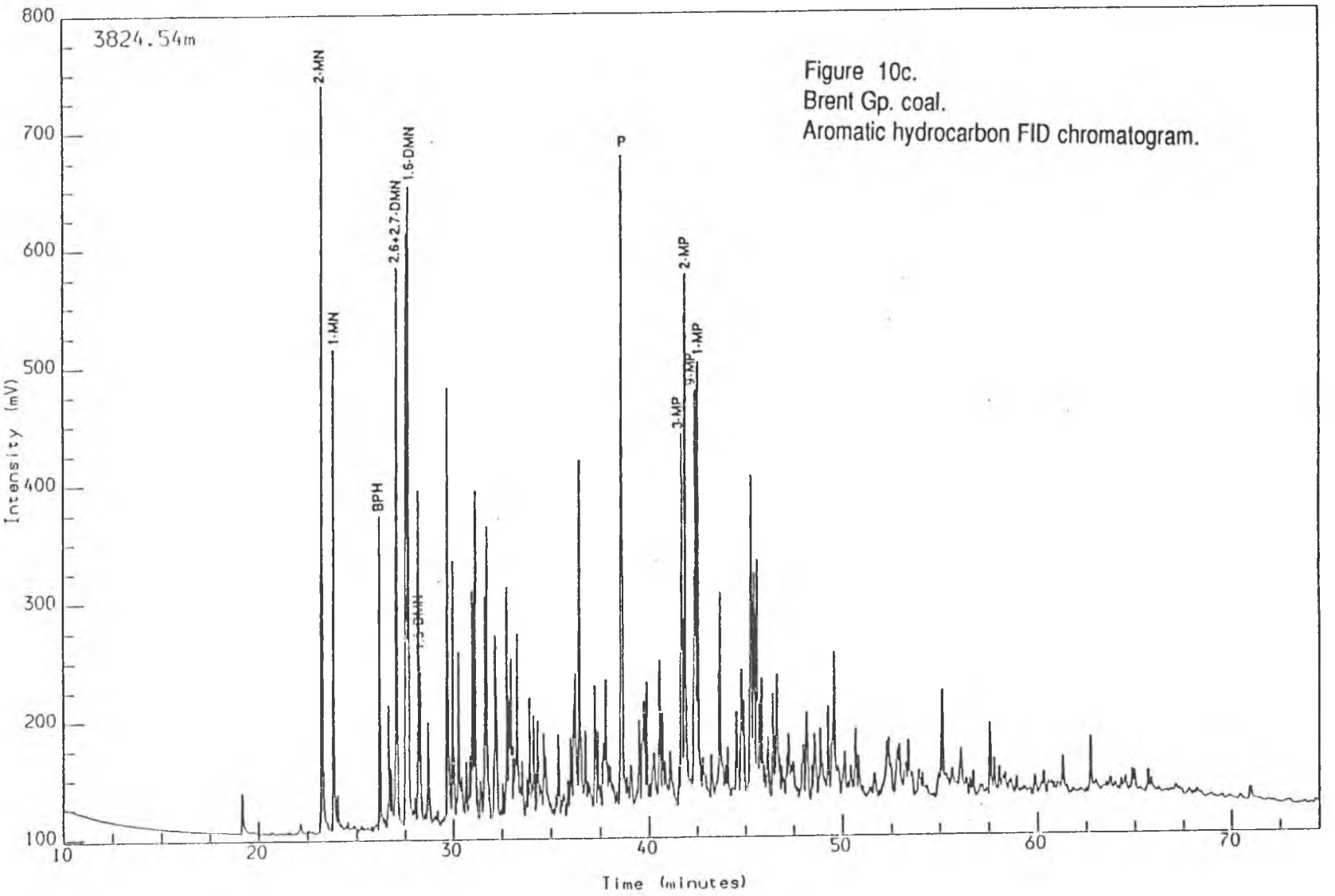


Figure 10c.
Brent Gp. coal.
Aromatic hydrocarbon FID chromatogram.

WELL NOCS 30/2-3
AROMATIC GC (FID)
Coal: brn blk

3824.54m ccp

Reported on 22-DEC-1992 at 10:18

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 30 AH9500101L.5.1.

Multichrom

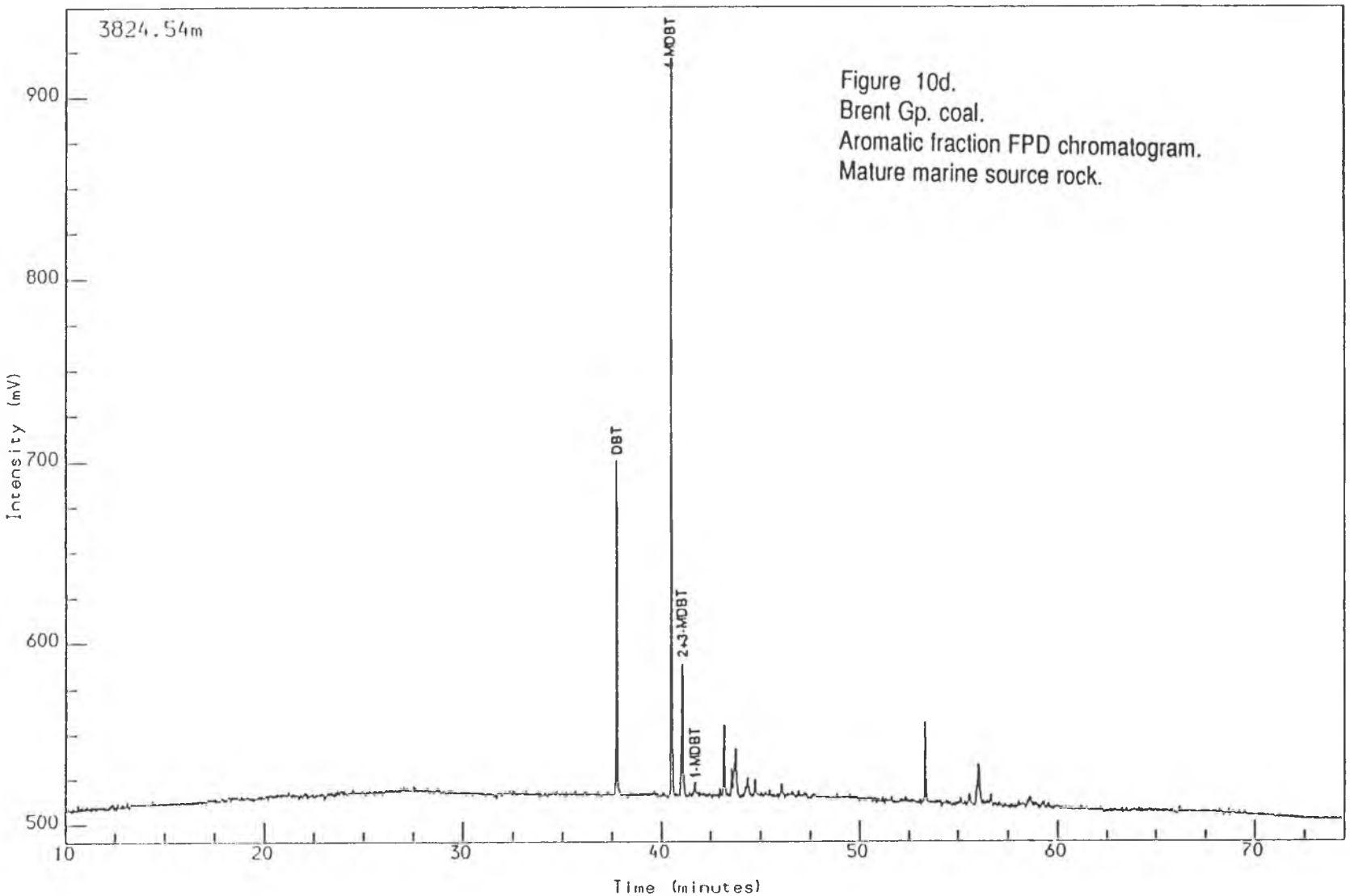


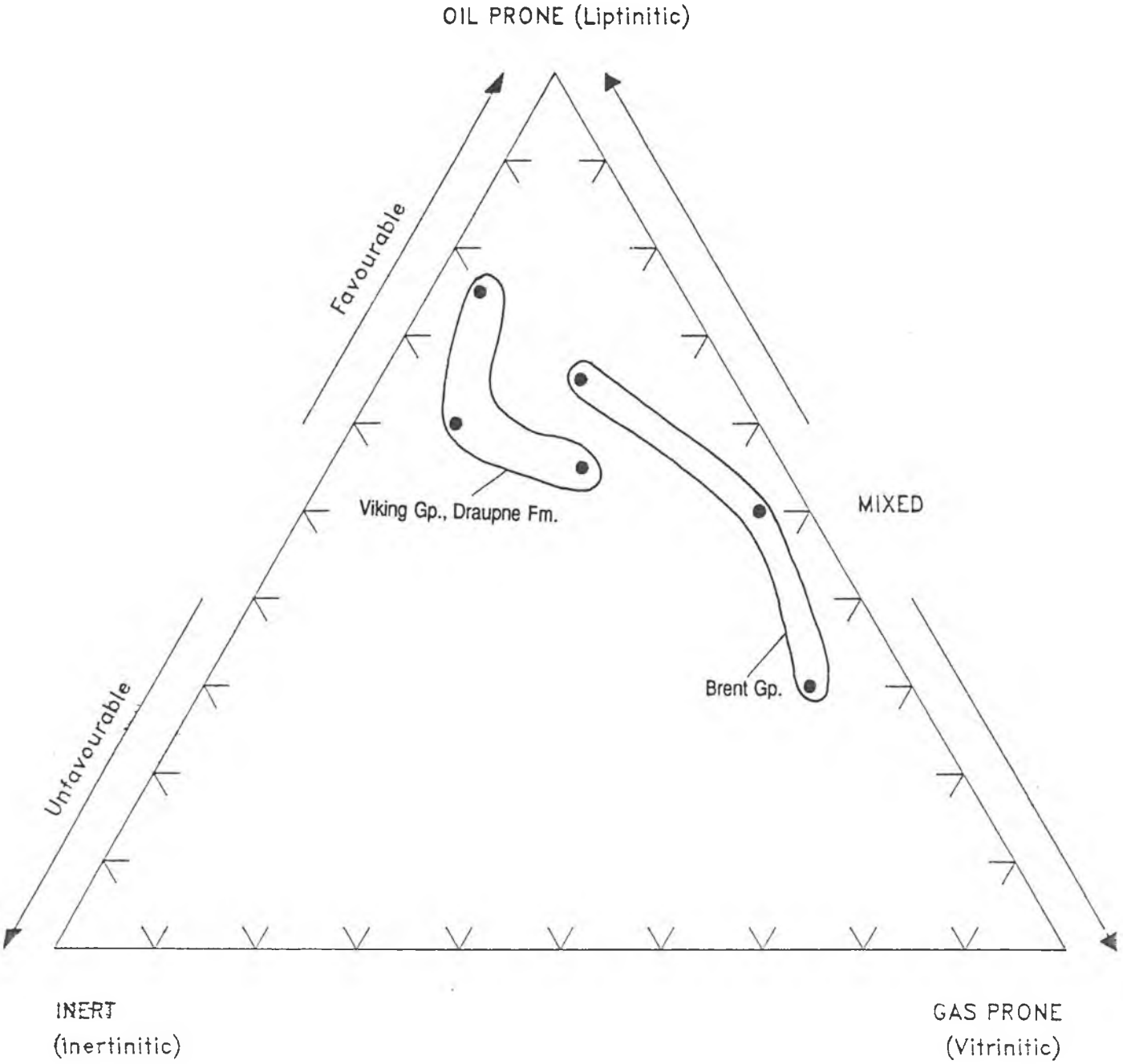
Figure 10d.
Brent Gp. coal.
Aromatic fraction FPD chromatogram.
Mature marine source rock.

WELL NOCS 30/2-3 3824.54m ccp
AROMATIC GC (FPD)
Coal: brn blk

Reported on 22-DEC-1992 at 10:34

Figure 11: Kerogen Composition and Potential Hydrocarbon Products

Well NOCS 30/2-3



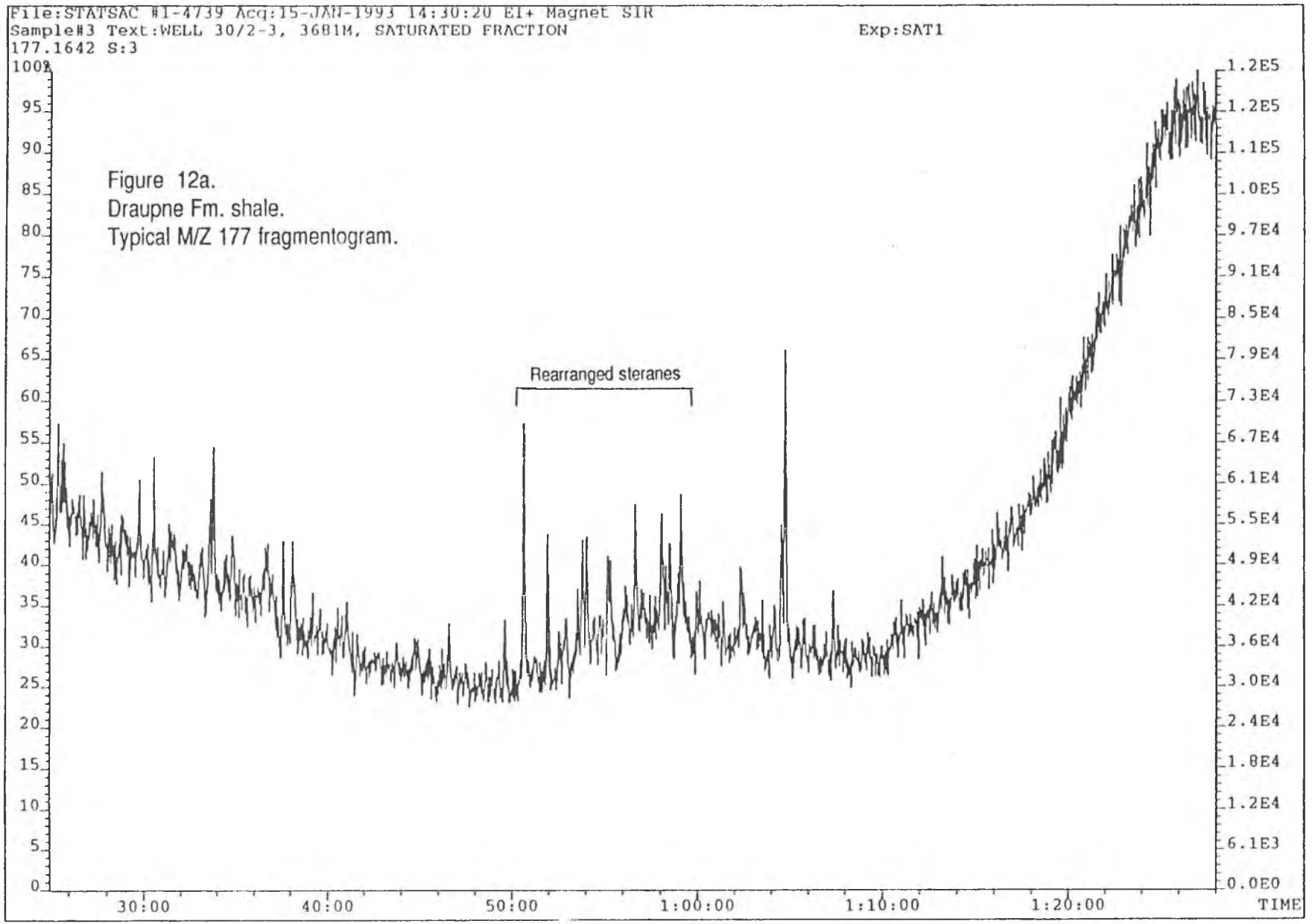
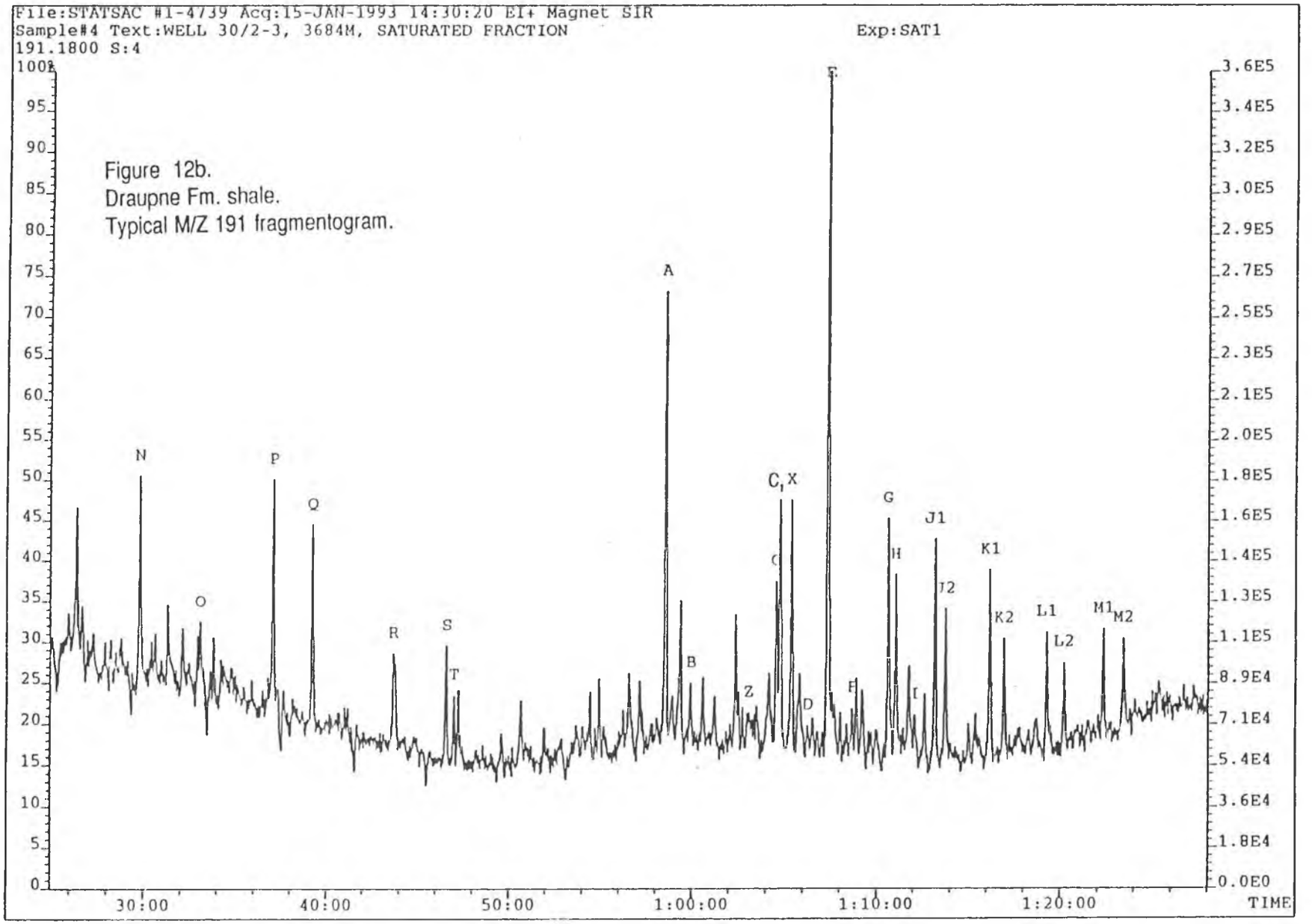
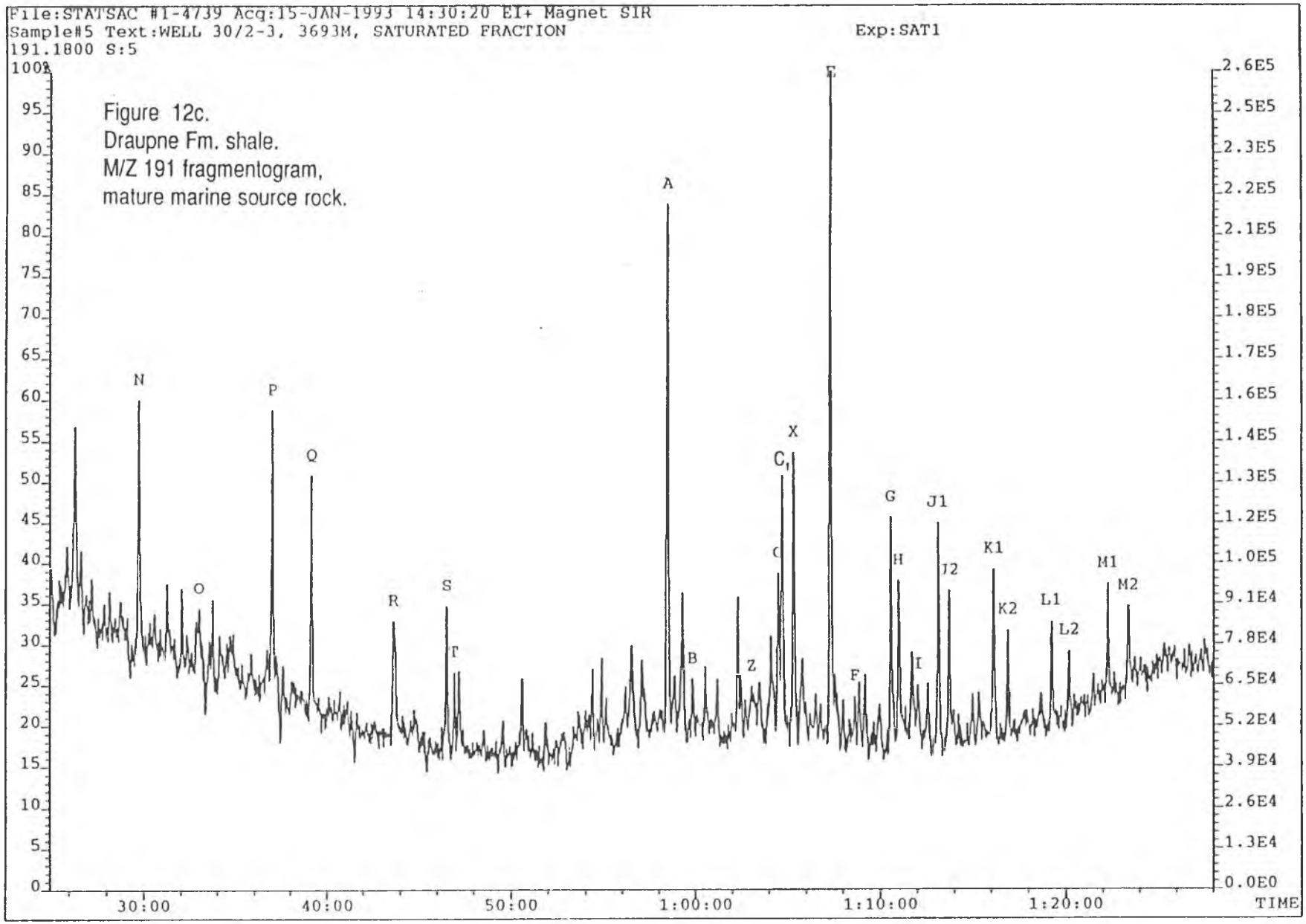
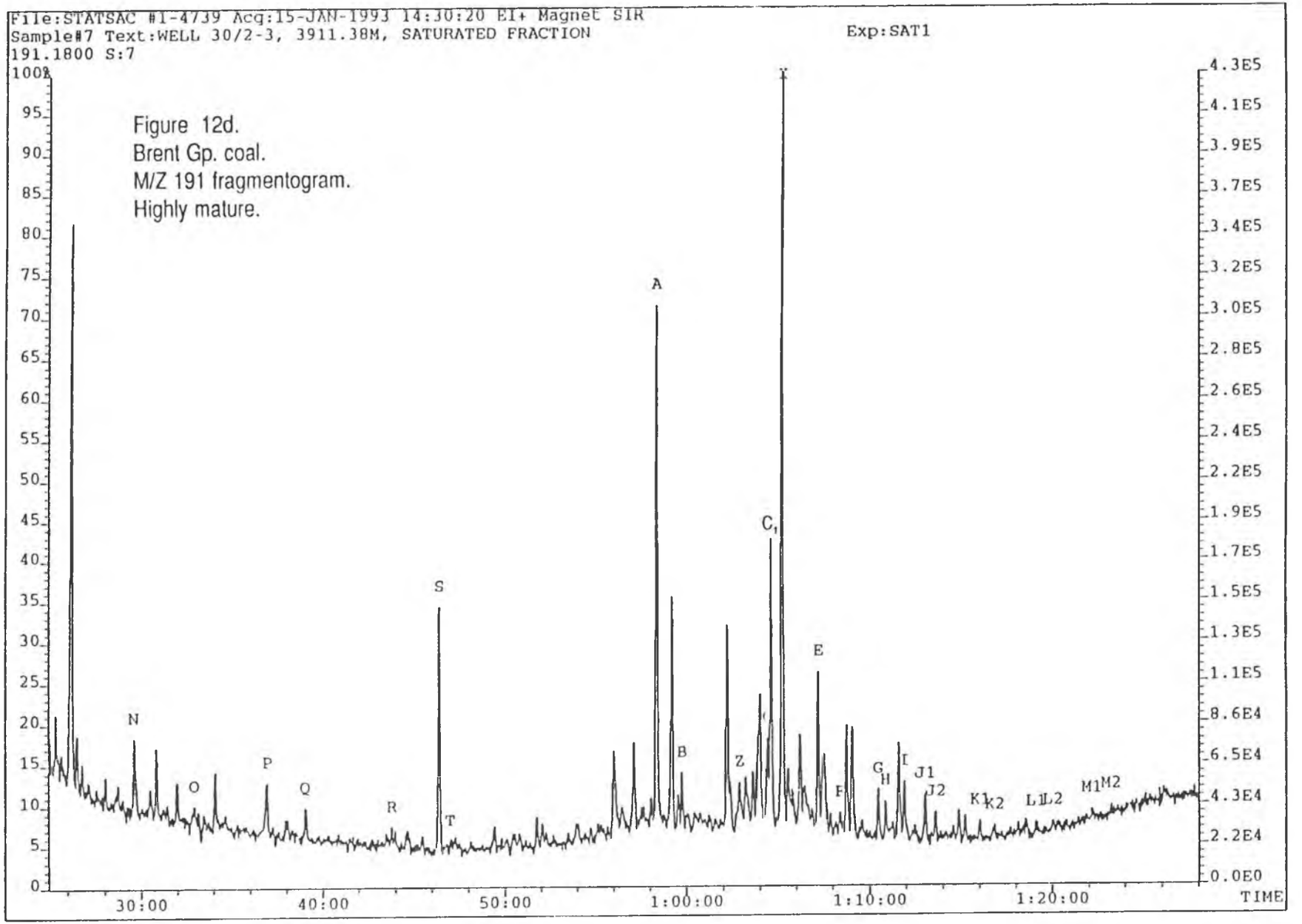


Figure 12a.
Draupne Fm. shale.
Typical M/Z 177 fragmentogram.


File:STATSAC #1-4739 Acq:15-JAN-1993 14:30:20 EI+ Magnet SIR
Sample#4 Text:WELL 30/2-3, 3684M, SATURATED FRACTION
Exp:SAT1
191.1800 S:4
Figure 12b.
Draupne Fm. shale.
Typical M/Z 191 fragmentogram.
N
O
P
Q
R
S
T
A
B
Z
C, X
D
E
F
G
H
I
J1
J2
K1
K2
L1
L2
M1
M2
30:00
40:00
50:00
1:00:00
1:10:00
1:20:00
TIME


File:STATSAC #1-4739 Acq:15-JAN-1993 14:30:20 EI+ Magnet SIR
Sample#5 Text:WELL 30/2-3, 3693M, SATURATED FRACTION
Exp:SAT1
191.1800 S:5
Figure 12c.
Draupne Fm. shale.
M/Z 191 fragmentogram,
mature marine source rock.
N
O
P
Q
R
S
T
A
B
Z
C
C1
X
E
F
G
H
I
J1
J2
K1
K2
L1
L2
M1
M2
30:00
40:00
50:00
1:00:00
1:10:00
1:20:00
TIME


File:STATSAC #1-4739 Acq:15-JAN-1993 14:30:20 EI+ Magnet SIR
Sample#7 Text:WELL 30/2-3, 3911.38M, SATURATED FRACTION
Exp:SAT1
191.1800 S:7
Figure 12d.
Brent Gp. coal.
M/Z 191 fragmentogram.
Highly mature.
N
O
P
Q
R
S
T
A
B
Z
C1
E
F
G
H
I
J1
J2
K1
K2
L1
L2
M1
M2
30:00
40:00
50:00
1:00:00
1:10:00
1:20:00
TIME

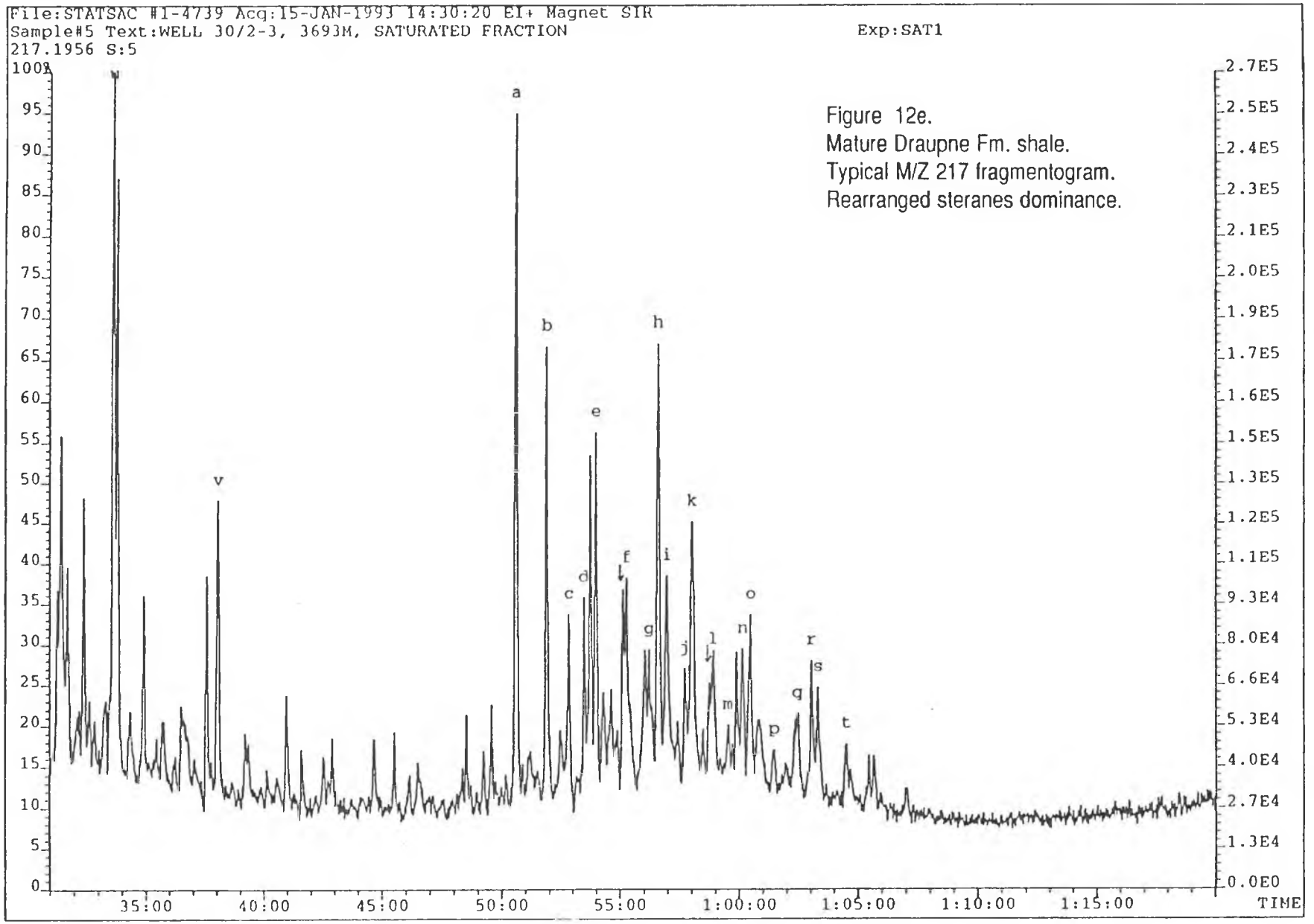
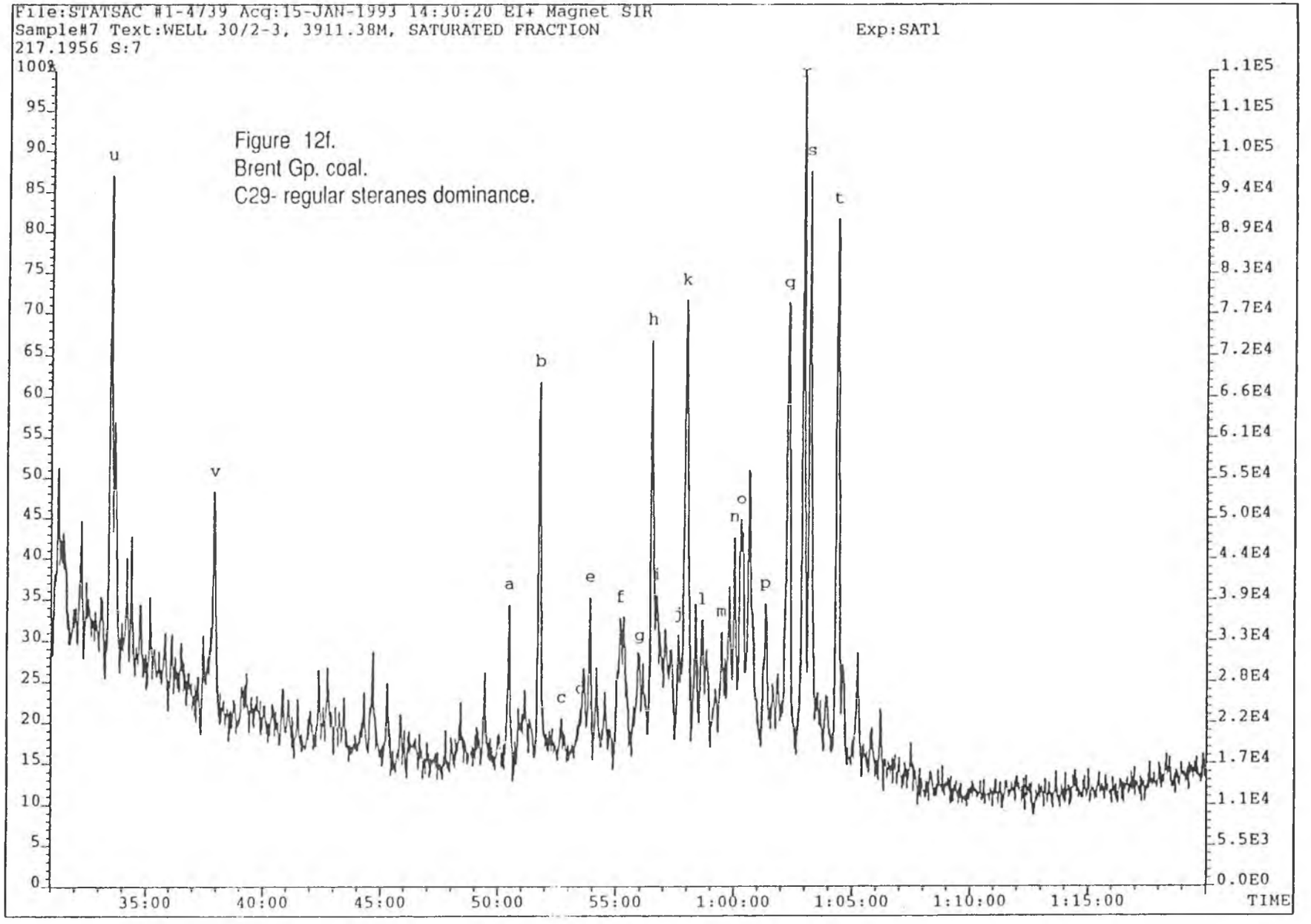


Figure 12e.
Mature Draupne Fm. shale.
Typical M/Z 217 fragmentogram.
Rearranged steranes dominance.


File:STATSAC #1-4739 Acq:15-JAN-1993 14:30:20 EI+ Magnet SIR
Sample#7 Text:WELL 30/2-3, 3911.38M, SATURATED FRACTION
Exp:SAT1
217.1956 S:7
Figure 12f.
Brent Gp. coal.
C29- regular steranes dominance.
u
v
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
s
t
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.1E5
1.1E5
1.0E5
9.4E4
8.9E4
8.3E4
7.7E4
7.2E4
6.6E4
6.1E4
5.5E4
5.0E4
4.4E4
3.9E4
3.3E4
2.8E4
2.2E4
1.7E4
1.1E4
5.5E3
0.0E0
35:00
40:00
45:00
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
TIME

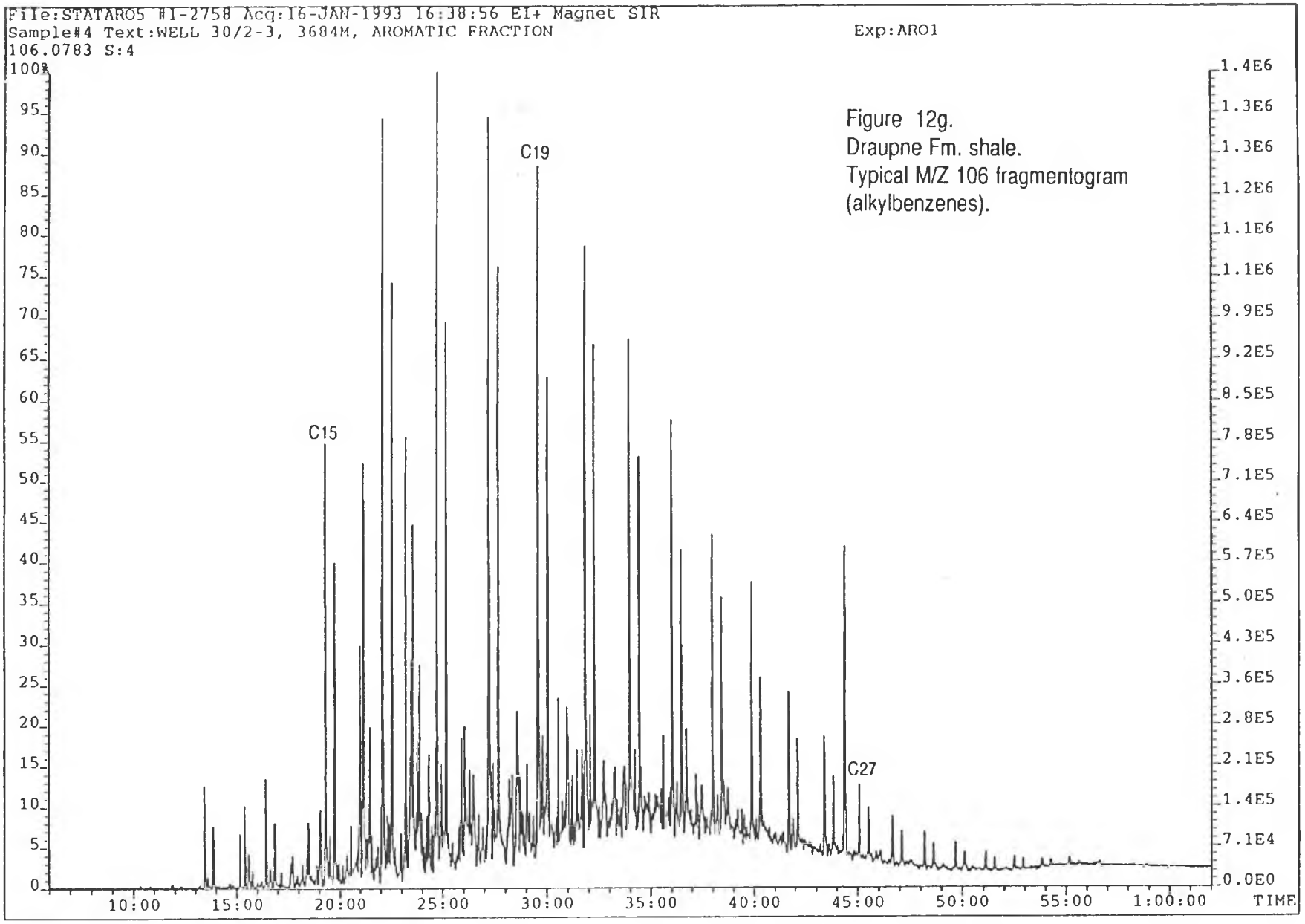


Figure 12g.
Draupne Fm. shale.
Typical M/Z 106 fragmentogram
(alkylbenzenes).

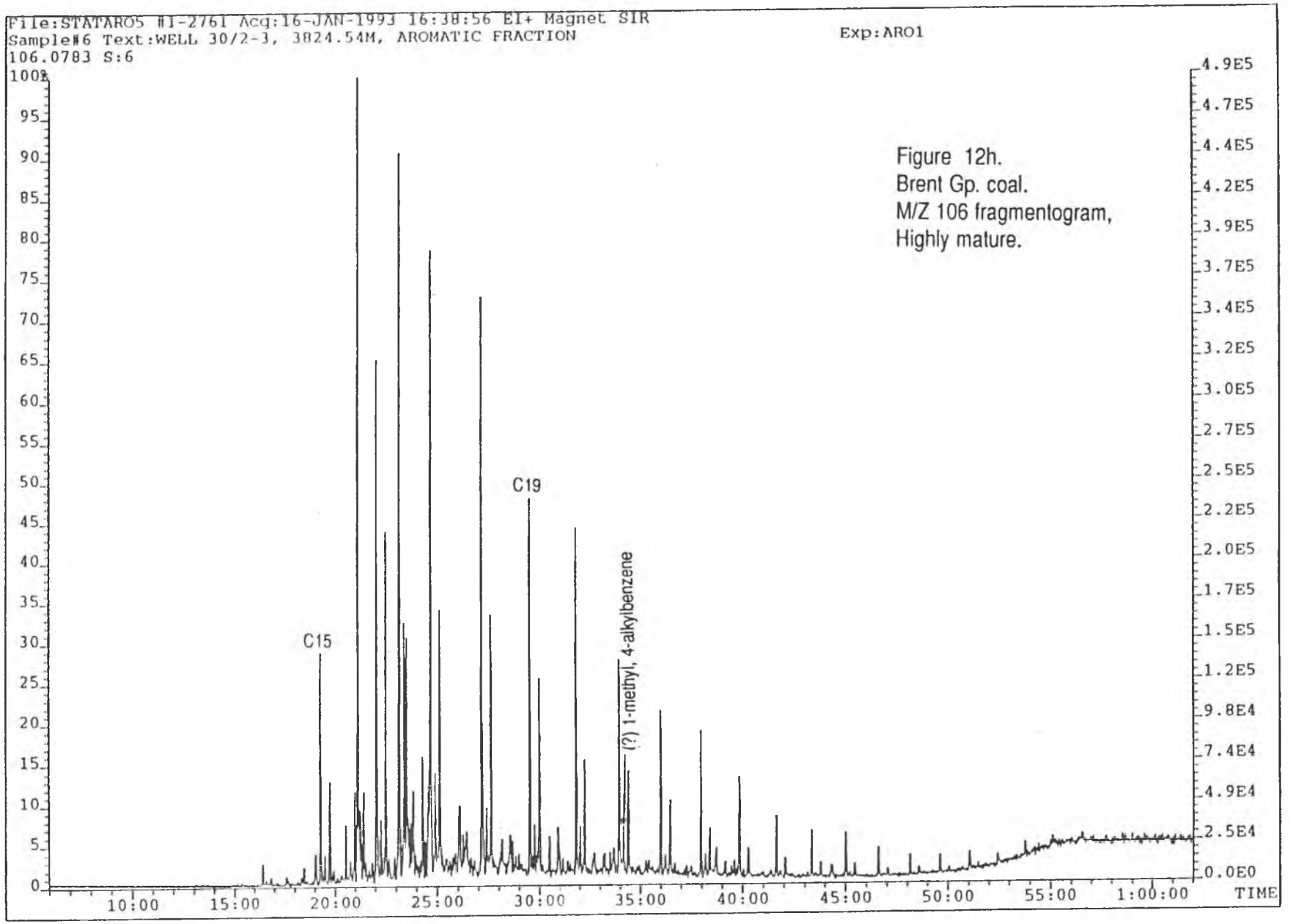


Figure 12h.
Brent Gp. coal.
M/Z 106 fragmentogram,
Highly mature.

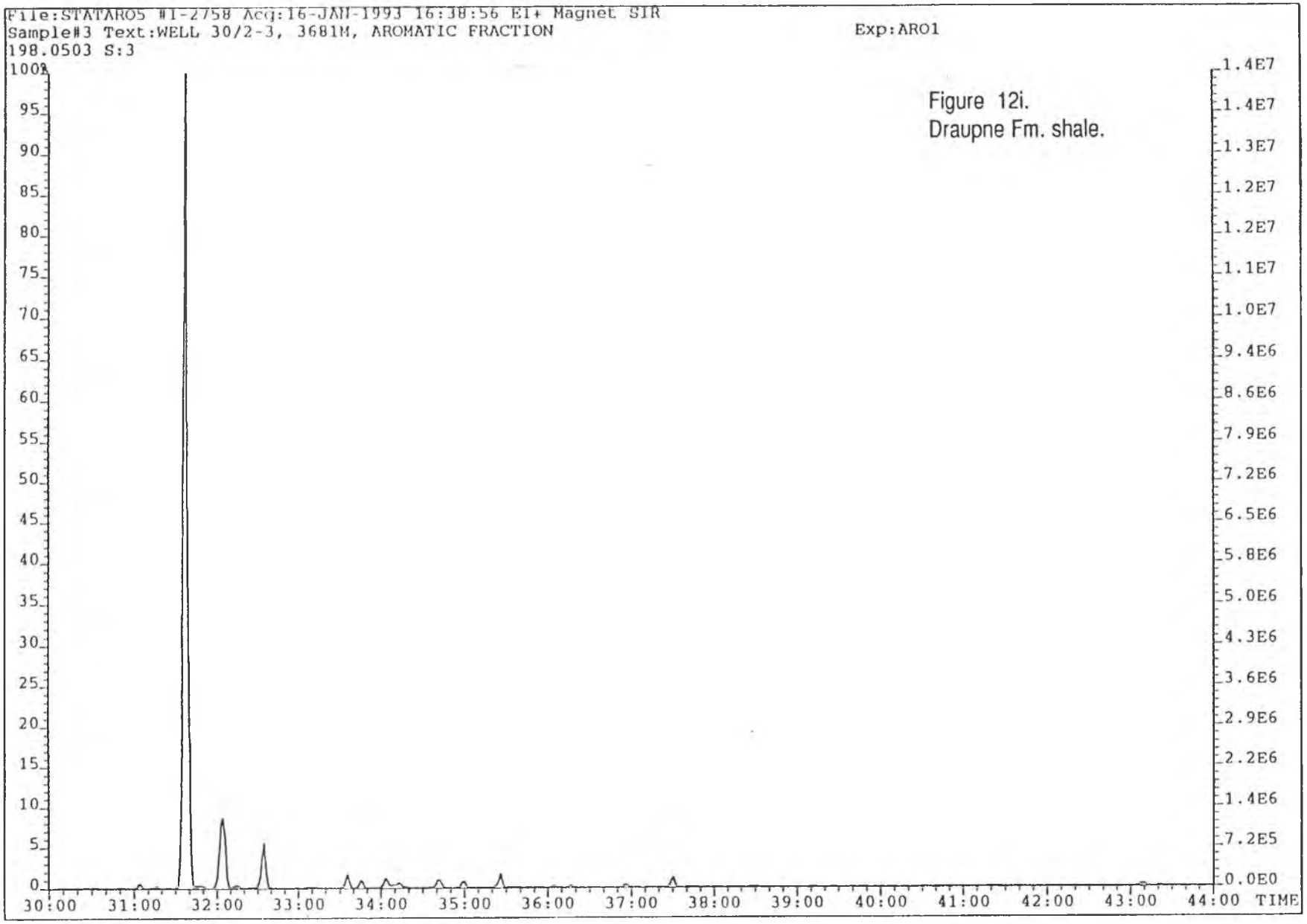


Figure 12i.
Draupne Fm. shale.

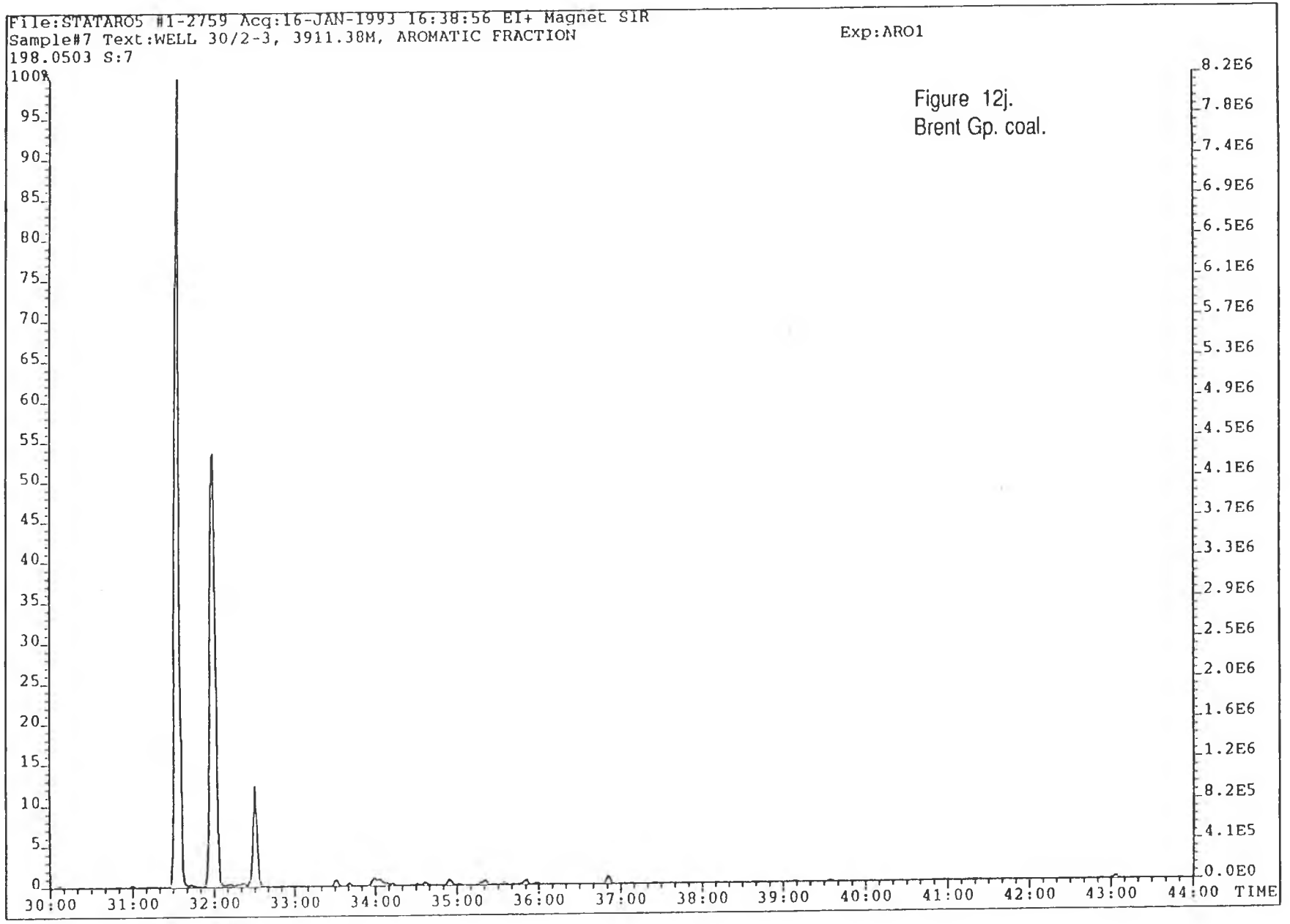


Figure 12j.
Brent Gp. coal.

Abbreviations

List of abbreviations used for lithology description
(sorted alphabetically)

ang	=	angular
bar	=	Baryte (mud additive)
bit	=	bituminous
bl	=	blue/blueish
blk	=	black
br	=	brittle
brn	=	brown/brownish
Ca	=	Carbonate (limestone/chalk/dolomite/siderite)
calc	=	calcareous
carb	=	carbonaceous
cem	=	cement used as additive (under "cont") or to describe cemented S/Sst
Chert	=	Chert
chk	=	Chalk/chalky
cly	=	clayey/shaly
cngl	=	conglomeratic
Coal	=	Coal
Coal-ad	=	Coal-like additive (e.g. chromlignosulfonate)
Congl	=	Conglomerat
Cont	=	Contamination(s)
crs	=	coarse grained
dd	=	dried drilling mud
dol	=	Dolomite/dolomitic
drk	=	dark (colour)
dsk	=	dusk/dusky (colour)
evap	=	Salt/Gypsum/Halite (natural "Other" or as additive "Cont"
f	=	fine grained
fe	=	ferruginous
fib	=	fibres (mud additive/contamination)
fis	=	fissile
fos	=	fossiliferous
glauc	=	glauconite/glauconitic
gn	=	green/greenish
gy	=	grey/greyish
hd	=	hard
ign	=	Igneous (material derived from igneous source)
Kaolin	=	Kaolin(ite)
kln	=	kaolinitic
l	=	loose
lam	=	laminated/laminae
lt	=	light (colour)
m	=	medium (colour or grain size)
Marl	=	Marl (calcareous claystone/mudstone)
mic	=	micaceous
Mica-ad	=	Mica used as mud additive

mrl	= marly
No Mat.	= No material left over after washing
ns	= nutshells (mud additive)
ol	= olive
ool	= Oolite/oolitic
or	= orange
Other	= Other lithology/mineral, specified after this word
pi	= pink/pinkish
pl	= pale (colour)
prp	= paint/rust/plastic contaminations/additives
pu	= purple
pyr	= Pyrite/pyritic
red	= red/reddish
rnd	= round/rounded
s	= sandy
sft	= soft
S/Sst	= Sand and/or sandstone
Sh/Clst	= Shale and/or claystone
sid	= Siderite/sideritic
sil	= siliceous/cherty
slt	= silty
Sltst	= siltstone
st	= stained (with natural oil or oil-like additive)
tar-ad	= Tar-like additive (e.g. "Black Magic")
trbfgs	= turbodrilled fragments
Tuff	= Tuff
tuff	= tuffaceous
v col	= various colours
w	= white
wx	= waxy
y	= yellow/yellowish

List of abbreviations used for parameters, ratios and analytical methods
(sorted alphabetically)

CPI	=	Carbon Preference Index, $0.5 \times \frac{C25+C27+C29+C31+C33}{C24+C26+C28+C30+C32} + \frac{C25+C27+C29+C31+C33}{C26+C28+C30+C32+C34}$
EOM	=	Extractable Organic Matter
FID	=	Flame Ionisation Detector
FPD	=	Flame Photometric Detector
GC	=	Gas Chromatograph
GC-MS	=	Gas Chromatograph - Mass Spectrometer
GHM	=	Geofina Hydrocarbon Meter (combined thermal extraction - pyrolysis gas chromatograph)
HC	=	Hydrocarbons
HI	=	Hydrogen Index (100 x S2/TOC)
HPLC	=	High Pressure Liquid Chromatograph
MDBT(4/1)	=	Ratio of 4-/1-methyl dibenzothiophene
MNR	=	Ratio of 2-/1-methyl naphthalene
MP	=	Methyl phenanthrene
MPI1	=	Methyl phenanthrene Index, 1.5x(3MP+2MP) / P+9MP+1MP
MPLC	=	Medium Pressure Liquid Chromatograph
NSO	=	Nitrogen-, Sulphur- and Oxygen-compounds
OI	=	Oxygen Index (100 x S3/TOC)
P	=	Phenanthrene
PI	=	Production Index (S1/(S1+S2))
PP	=	Petroleum Potential (S1+S2)
Ro (%)	=	Measured Vitrinite Reflectance in Percent
Rock-Eval	=	Oil show and source rock evaluation instrument
S1	=	Amount of Free Hydrocarbons, Rock-Eval
S2	=	Amount of Kerogen pyrolysate, Rock-Eval
S3	=	Amount of Oxidised Organic Material
SCI	=	Spore Colour Index (maturity indicator)
TCD	=	Thermal Conductivity Detector
TAI	=	Thermal Alteration Index (maturity indicator)
Tmax	=	Temperature of maximum pyrolysate yield, Rock-Eval
TOC	=	Total Organic Carbon

Experimental

Total Organic Carbon (TOC) and Total Carbon Analysis

This analysis is performed using a LECO CS244 Carbon Analyser.

Hand-picked lithologies from cuttings samples are crushed with a mortar and pestle and approximately 200 mg (50 mg for coals) are accurately weighed into LECO crucibles. The samples are then treated three times with 10 % hydrochloric acid to remove oxidized (carbonate) carbon, and washed four times with distilled water. The samples are dried on a hotplate at 60 - 70°C before analysis of total organic carbon. Total carbon is also analysed on the same instrument using approximately 200 mg of untreated crushed whole rock. Oxidized (carbonate) carbon is calculated by weight difference.
Total organic carbon can also be analysed on the Rock-Eval II Pyrolyser during the normal run of the instrument.

Rock-Eval Pyrolysis

This analysis is performed by using a Rock-Eval II Pyrolyser. Approximately 100 mg crushed whole rock is analysed. The sample is first heated at 300°C for three min in an atmosphere of helium to release the free hydrocarbons present (S1 peak) and then pyrolysed by increasing the temperature from 300°C to 600°C (temp. gradient 25°C/min) (S2 peak). Both the S1 and S2 yields are measured using a flame ionization detector (FID). In the temperature interval between 300°C and 390°C, the released gases are split and a proportion passed through a carbon dioxide trap, which is connected to a thermal conductivity detector (TCD). The value obtained from the TCD corresponds to the amount of oxygen contained in the kerogen of the sample and is reported as the S3 peak.

The Rock-Eval II Pyrolyser also analyses the TOC of each sample during the normal

run of the instrument.

Thermal Extraction/Pyrolysis Gas Chromatography

The instrument used for this analysis is a Varian 3400 Gas Chromatogaph interfaced to a pyrolysis oven (the pyrolyser). Up to 15 mg of whole rock sample is loaded on the pyrolyser and heated isothermally, at 300°C, for 4 min, during which time thermal extraction of the free hydrocarbons occurs (equivalent to the S1 peak of the Rock-Eval). The released gases pass to a 25 m OV1 column with a liquid nitrogen-cooled trap.

After 4 min the pyrolysis oven is temperature programmed up to 530°C, at a rate of 37°C/min, causing bound hydrocarbons to be released from the kerogen (equivalent to the S2 peak of the Rock-Eval). The released gases pass to a 25 m OV1 column with a liquid nitrogen-cooled trap.

The temperature program of the gas chromatograph oven, in which the columns are housed is -10°C to 290°C at a rate of 6°C/min.
Both the columns are linked to a FID.

Solvent Extraction of Organic Matter (EOM)

The samples are extracted using a Tecator Soxtec HT-System. Carefully weighed samples are taken in a pre-extracted thimble. Some activated copper is added to the extraction cup and dichloromethane/methanol (93/7) is used as an extraction solvent. The samples are boiled for 1 hour and then rinsed for 2 hours. If the samples contain more than 10 % TOC, then the whole procedure is repeated once. The resulting solution is filtered and the solvent removed by rotary evaporation (200 mb, 30°C). The amount of EOM is gravimetrically established.

Removal of Asphaltenes

The EOM is dissolved in tetrahydrofuran in a flask and n-pentane is added to precipitate the asphaltenes.The solution is then stored in the dark and at ambient temperature for at least 8 hours. The solution is then filtered (Baker 10-spe system) and the precipitated asphaltenes returned to the original flask by dissolution in dichloromethane. The solvent is removed by rotary evaporation at 200 mB and 30oC.

Chromatographic Separation of deasphaltened EOM

Chromatographic separation is performed using an MPLC system developed by the company. The EOM (minus asphaltenes) is injected into the MPLC and separated using hexane as an eluent. The saturated and aromatic hydrocarbon fractions are collected and the solvent removed using a rotary evaporator at 30°C. The fractions are then transferred to small pre-weighed vials and evaporated to dryness in a stream of nitrogen. The vials are re-weighed to obtain the weights of both the saturated and the aromatic fractions. The weight of the NSO fraction which is retained on the column, is obtained by weight difference.

Gas Chromatographic Analyses

Saturated hydrocarbon fractions:

The instrument used for this analysis is a PERKIN ELMER 8320 Gas Chromatograph equipped with an FID detector and an OV1 column. The carrier gas is helium and the temperature program runs from 80°C to 300°C at a rate of 4°C/min. Final hold time is 20 mins. The saturated hydrocarbon fraction is diluted by 1:30 and a 1 microlitre aliquot of this is injected into the instrument.

Aromatic hydrocarbon fractions:

The instrument used is a Varian 3400 Gas Chromatograph with a 25 m SE 54 capillary column, split injector and a column splitter leading to FID and FPD detectors, which allows simultaneous analysis of co-eluting hydrocarbons and sulphur compounds. The carrier gas is helium and the temperature program runs from 40°C to 290°C at a rate of 4°C/min. Final hold time is 10 mins. The aromatic hydrocarbon fraction is diluted by 1:30 and a 1 microlitre aliquot of this is injected into the instrument.

Visual Kerogen Misroscopy

Kerogen concentrates are obtained from samples prepared by HCl and HF digestion followed by zinc bromide flotation to remove pyrite and other heavy mineral residues. The cleaned concentrates are mounted on slides by smearing, these being analysed microscopically in transmitted white light and UV light (530 nm barrier filter) to determine the Spore Colour or Thermal Alteration Indices (SCI or TAI) and the colour and intensity of spore fluorescence. The spore colour index ,backed by spore fluorescence, is used as an alternative maturity parameter to verify the results obtained from vitrinite reflectance.

Fluorescence Colour	Colour Index	Corresp. Vitrinite Reflectance
Green	1	0.2 %
Green/yellow	2	0.2-0.3 %
Yellow	3	0.3 %
Yellow/orange	4	0.4 %
Light orange	5	0.5 %
Moderate-orange	6	0.6 %
Dark orange	7	0.8 %
Dark orange/red	8	1.0 %
Spore fluorescence extinction	9	1.3 %

NB. This table only provides a rudimentary correlation as vitrinite reflectance and spore fluorescence colour are both independently affected by factors such as depositional environment and categanic history.

Combined Gas Chromatography - Mass Spectrometry (GC-MS)

The GC-MS analyses are performed on a VG TS250 system interfaced to a Hewlett Packard 5890 gas chromatograph. The GC is fitted with a fused silica SE54 capillary column (40 m x 0.22 mm i.d.) directly into the ion source. Helium (12 psi) is used as carrier gas and the injections are performed in splitless mode. The GC oven is programmed from 45°C to 150°C at 35°C/min, at which point the programme rate is 2°C/min up to 310°C where the column is held isothermally for 15 min. For the aromatic hydrocarbons, the GC oven is programmed from 50°C to 310°C at 5°C/min. and held isothermally at 310°C for 15 min. The mass spectrometer is operated in electron impact (EI) mode at 70 eV electron energy, a trap current of 500 uA and a source temperature of 220°C. The instrument resolution used is 2500 (10 % value).

The data system used is a VG PDP11/73 for acquiring data, and a Vax station 3100 for peak processing the data. The samples are analysed in multiple ion detection

mode (MID) at a scan cycle time of approximately 1.1 sec.
Calculation of peak ratios is performed from peak heights in the appropriate mass fragmentograms.

Saturated Fractions

Terpanes

The most commonly used fragment ions for detection of terpanes are M/Z 163 for detection of 25,28,30 trisnormoretane or 25,28,30 trisnorhopane, M/Z 177 for detection of demethylated hopanes or moretanes, M/Z 191 for detection of tricyclic, tetracyclic- and pentacyclic terpanes and M/Z 205 for methylated hopanes or moretanes. The molecular ions M/Z 370 and 384 are also recorded for identification of C_{27} and C_{28} triterpanes respectively.

Steranes

The most commonly used fragment ions for detection of steranes are M/Z 149 to distinguish between 5α and 5β steranes, M/Z 189 and 259 for detection of rearranged steranes, M/Z 217 for detection of rearranged and normal steranes and M/Z 218 for detection of 14β(H) 17β(H) steranes.

The M/Z 231 fragment ion is used to detect possible aromatic contamination of the saturated fraction. It is also used for detection of methyl steranes.

Aromatic Fractions

Alkyl-substituted Benzenes

The M/Z 106 fragment ion is often used to detect the alkyl-substituted benzenes. It is especially useful for the detection of di-substituted benzenes. M/Z 134 can also be used for the detection of C_4-alkylbenzenes, but benzothiophene will also give a signal with this fragment ion.

Naphthalenes

Methyl naphthalenes are normally detected by the M/Z 142 fragment ion, while C_2-naphthalenes are detected by M/Z 156 and C_3-naphthalenes by M/Z 170.

Benzothiophenes and Dibenzothiophenes

Benzothiophene can be detected, as mentioned above, by M/Z 134. The M/Z 184 fragment ion is used to detect the dibenzothiophenes. The M/Z 198 and M/Z 212 fragment ions are used for methyl-substituted dibenzothiophenes and dimethyl-substituted dibenzothiophenes respectively.

Phenanthrenes

Phenanthrene is detected using the M/Z 178 fragment ion. Anthracene will, if present, also give a signal in the M/Z 178 fragment ion. Methyl-substituted phenanthrenes give signals in the M/Z 192 fragment ion, while the M/Z 206 fragment ion shows the dimethyl-substituted phenanthrenes and the M/Z 220 fragment ion shows the C_3 substituted phenanthrenes.

Aromatic Steranes

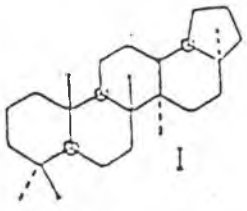
Monoaromatic steranes are detected using the M/Z 253 fragment ion, while the triaromatic steranes are detected using the M/Z 231 fragment ion.

Mass Fragmentograms representing Terpanes
(M/Z 163, 177, 191, 205, 370, 384, 398, 412 and 426)

Peak Identification: (α and β refer to hydrogen atoms at C-17 and C-21 respectively unless indicated otherwise)

A.	18α trisnorneohopane (T_s)	$C_{27}H_{44}$	(I)
B.	17α trisnorhopane (T_m)	$C_{27}H_{46}$	(II, R=H)
Z.	Bisnorhopane	$C_{28}H_{48}$	(IV)
C.	αβ norhopane	$C_{29}H_{50}$	(II, R=C_2H_5)
D.	βα norhopane	$C_{29}H_{50}$	(III, R=C_2H_5)
E.	αβ hopane	$C_{30}H_{52}$	(II, R=i-C_3H_7)
F.	βα hopane	$C_{30}H_{52}$	(III, R=i-C_3H_7)
G.	22S αβ homohopane	$C_{31}H_{54}$	(II, R=i-C_4H_9)
H.	22R αβ homohopane	$C_{31}H_{54}$	(II, R=i-C_4H_9)
I.	βα homohopane	$C_{31}H_{54}$	(III, R=i-C_4H_9)
J.	22S αβ bishomohopane	$C_{32}H_{56}$	(II, R=i-C_5H_{11})
	22R αβ bishomohopane	$C_{32}H_{56}$	(II, R=i-C_5H_{11})
K.	22S αβ trishomohopane	$C_{33}H_{58}$	(II, R=i-C_6H_{13})
	22R αβ trishomohopane	$C_{33}H_{58}$	(II, R=i-C_6H_{13})
L.	22S αβ tetrakishomohopane	$C_{34}H_{60}$	(II, R=i-C_7H_{15})
	22E αβ tetrakishomohopane	$C_{34}H_{60}$	(II, R=i-C_7H_{15})
M.	22S αβ pentakishomohopane	$C_{35}H_{62}$	(II, E=i-C_8H_{17})
	22E αβ pentakishomohopane	$C_{35}H_{62}$	(II, R=i-C_8H_{17})
P.	Tricyclic terpane	$C_{23}H_{42}$	(V, R=i-C_4H_9)
Q.	Tricyclic terpane	$C_{24}H_{44}$	(V, R=i-C_5H_{11})
R.	Tricyclic terpane (17R, 17S)	$C_{25}H_{66}$	(V, R=i-C_6H_{13})
S.	Tetracyclic terpane	$C_{24}H_{42}$	(VI)
T.	Tricyclic terpane (17R, 17S)	$C_{26}H_{48}$	(V, R=i-C_7H_{15})
N.	Tricyclic terpane	$C_{21}H_{38}$	(V, R=C_2H_5)
O.	Tricyclic terpane	$C_{22}H_{40}$	(V, R=C_3H_7)
Y.	25,28,30-trisnorhopane/moretane	$C_{27}H_{46}$	(VII)
X.	αβ diahopane	$C_{30}H_{52}$	(VIII)

STRUCTURES REPRESENTING TERPANES



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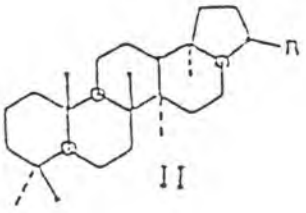

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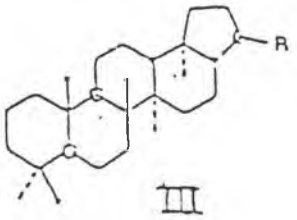

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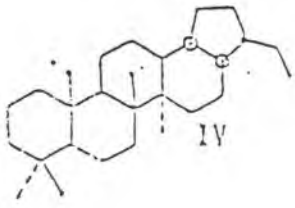

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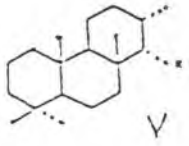

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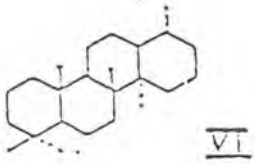
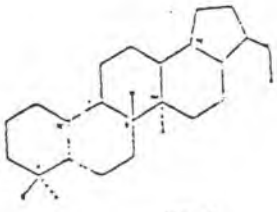
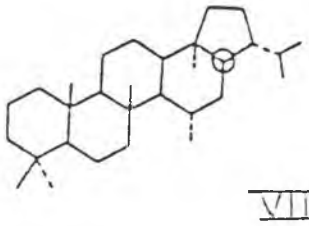


VI



VII



VIII

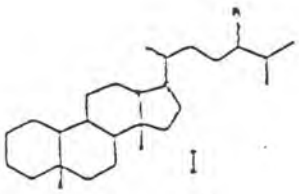
Mass Fragmentograms representing Steranes

(M/Z 149, 189, 217, 218, 259, 372, 386, 400 and 414)

Peak Identifications: α and β refer to hydrogen atoms at C-5, C-14 and C-17 in regular steranes and at C-13 and C-17 in diasteranes).

a.	20S βα diacholestane	$C_{27}H_{48}$	(I, R=H)
b.	20R βα diacholestane	$C_{27}H_{48}$	(I, R=H)
c.	20S αβ diacholestane	$C_{27}H_{48}$	(II, R=H)
d.	20R αβ diacholestane	$C_{27}H_{48}$	(II, R=H)
e.	20S βα 24-methyl-diacholestane	$C_{28}H_{50}$	(I, R=CH_3)
f.	20R βα 24-methyl-diacholestane	$C_{28}H_{50}$	(I, R=CH_3)
g.	20S αβ 24-methyl-diacholestane	$C_{28}H_{50}$	(II, R=CH_3)
	+ 20S ααα cholestane	$C_{27}H_{48}$	(III, R=H)
h.	20S βα 24-ethyl-diacholestane	$C_{29}H_{52}$	(II, R=C_2H_5)
	+ 20R αββ cholestane	$C_{27}H_{48}$	(IV, R=H)
i.	20S αββ cholestane	$C_{27}H_{48}$	(IV, R=H)
	+ 20R αβ 24-methyl-diacholestane	$C_{28}H_{50}$	(II, R=CH_3)
j.	20R ααα cholestane	$C_{27}H_{48}$	(III, R=H)
k.	20R βα 24-ethyl-diacholestane	$C_{29}H_{52}$	(I, R=C_2H_5)
l.	20R αβ 24-ethyl-diacholestane	$C_{29}H_{52}$	(II, R=C_2H_5)
m.	20S ααα 24-methyl-cholestane	$C_{28}H_{50}$	(III, R=CH_3)
n.	20R αββ 24-methyl-cholestane	$C_{28}H_{50}$	(IV, R=CH_3)
	+ 20R αβ 24-ethyl-diacholestane	$C_{29}H_{52}$	(II, R=C_2H_5)
o.	20S αββ 24-methyl-cholestane	$C_{28}H_{50}$	(IV, R=CH_3)
p.	20R ααα 24-methyl-cholestane	$C_{28}H_{50}$	(III, R=CH_3)
q.	20S ααα 24-ethyl-cholestane	$C_{29}H_{52}$	(III, R=C_2H_5)
r.	20R αββ 24-ethyl-cholestane	$C_{29}H_{52}$	(IV, R=C_2H_5)
s.	20S αββ 24-ethyl-cholestane	$C_{29}H_{52}$	(IV, R=C_2H_5)
t.	20R ααα 24-ethyl-cholestane	$C_{29}H_{52}$	(III, R=C_2H_5)
u.	5α sterane	$C_{21}H_{36}$	(VI, R=C_2H_5)
v.	5α sterane	$C_{22}H_{38}$	(VI, R=C_3H_7)

STRUCTURES REPRESENTING STERANES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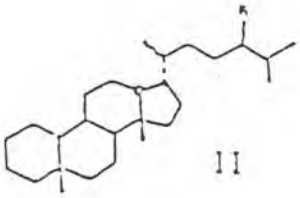
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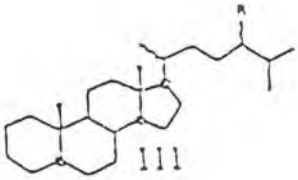
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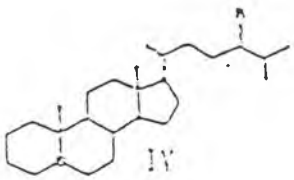
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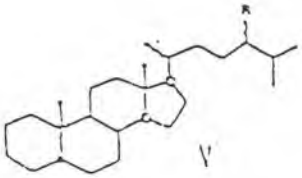
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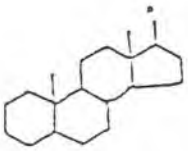
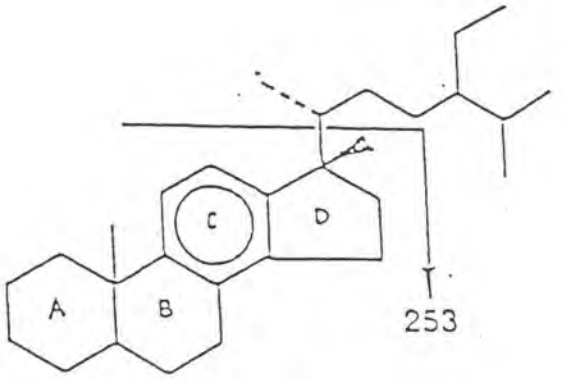

VI

Mass Fragmentograms representing Monoaromatic Steranes (M/Z 253)

Description of C-ring monoaromatic steroid hydrocarbons

Peak	Substituents R_1	R_2	R_3	R_4	Abbreviation of Compound
A1					$C_{21}M$
B1					$C_{22}MA$
C1	β(H)	CH_3	$S(CH_3)$	H	$\beta SC_{27}MA$
	β(H)	CH_3	$R(CH_3)$	H	$\beta RC_{27}MA$
D1	CH_3	H	$R(CH_3)$	H	$RC_{27}DMA$
	α(H)	CH_3	$S(CH_3)$	H	$\alpha SC_{27}MA$
E1	β(H)	CH_3	$S(CH_3)$	CH_3	$\beta SC_{28}MA$
	CH_3	H	$S(CH_3)$	CH_3	$SC_{28}DMA$
F1	α(H)	CH_3	$R(CH_3)$	H	$\alpha RC_{27}MA$
	α(H)	CH_3	$S(CH_3)$	CH_3	$\alpha SC_{28}MA$
	β(H)	CH_3	$R(CH_3)$	CH_3	$\beta RC_{28}MA$
G1	CH_3	H	$R(CH_3)$	CH_3	$RC_{28}DMA$
	β(H)	CH_3	$S(CH_3)$	C_2H_5	$\beta SC_{29}MA$
	CH_3	H	$S(CH_3)$	C_2H_5	$SC_{29}DMA$
	α(H)	CH_3	$R(CH_3)$	CH_3	$\alpha RC_{28}MA$
H1	β(H)	CH_3	$R(CH_3)$	C_2H_5	$\beta RC_{29}MA$
	CH_3	H	$R(CH_3)$	C_2H_5	$RC_{29}DMA$
I1	α(H)	CH_3	$R(CH_3)$	C_2H_5	$\alpha RC_{29}MA$

RUCTURES REPRESENTING MONOAROMATIC STERANES



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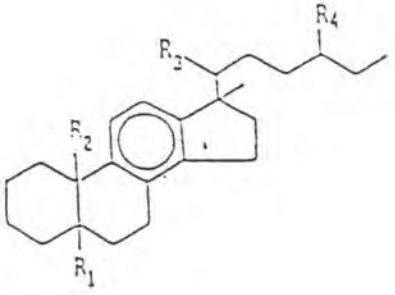
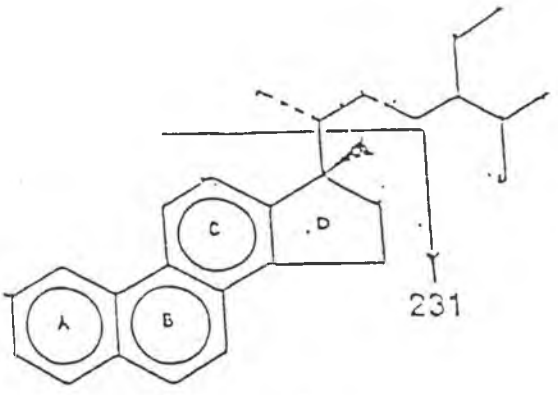


Mass Fragmentograms representing Triaromatic Steranes (M/Z 231)

Description of ABC-ring triaromatic steroid hydrocarbons

	Substituents		Abbreviation
Peak	**R_1**	**R_2**	**of Compound**
a1	CH_3	H	$C_{20}TA$
b1	CH_3	CH_3	$C_{21}TA$
c1	$S(CH_3)$	C_6H_{1-3}	$SC_{26}TA$
d1	$R(CH_3)$	C_6H_{13}	$RC_{26}TA$
	$S(CH_3)$	C_7H_{15}	$SC_{27}TA$
e1	$S(CH_3)$	C_8H_{17}	$SC_{28}TA$
f1	$S(CH_3)$	C_7H_{15}	$RC_{27}TA$
g1	$R(CH_3)$	C_8H_{17}	$RC_{28}TA$

STRUCTURES REPRESENTING TRIAROMATIC STERANES



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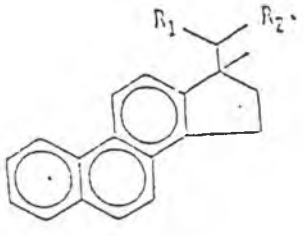


Appendix 1

Tables

Table 1 : Lithology description for well NOCS 30/2-3

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
1587.50		swc		Hord		Tertiary		0036
		0.97	100	Sh/Clst: drk gy				0036-1L
1744.00		swc		Hord		Tertiary		0037
		0.51	100	Sh/Clst: lt gn brn				0037-1L
1910.00		swc		Hord		Tertiary		0038
		0.11	100	Sh/Clst: drk gn gy				0038-1L
2015.00		swc		Roga	Sele	Eocene - Paleocene		0039
		1.54	100	Sh/Clst: m gy				0039-1L
2164.00				Shet		Upper Cretaceous		0001
		0.66	100	Sh/Clst: lt gy to m gy to brn gy, slt, mic				0001-1L
			tr	Sh/Clst: drk brn to gy brn, slt				0001-2L
			tr	Sh/Clst: dsk y gn, glauc				0001-3L
			tr	Other : pyr				0001-4L
2236.00				Shet		Upper Cretaceous		0002
		0.70	85	Sh/Clst: lt gy to m gy to brn gy, slt, mic				0002-1L
			10	Sh/Clst: drk brn to gy brn, slt				0002-2L
			5	Other : pyr				0002-3L
			tr	Sltst : lt gy				0002-4L
			tr	Cont : prp				0002-5L

Table 1 : Lithology description for well NOCS 30/2-3

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
2430.00				Shet		Upper Cretaceous		0003
		0.65	85	Sh/Clst:		m gy to drk gy, calc, slt, pyr		0003-1L
			15	Cont	:	prp, bar		0003-2L
			tr	Sltst	:	brn gy		0003-3L
			tr	Sh/Clst:		or gy		0003-4L
2760.00				Shet		Upper Cretaceous		0004
		0.56	90	Sh/Clst:		m gy to drk gy, calc, slt, pyr		0004-1L
			5	Sltst	:	brn gy		0004-2L
			5	Cont	:	dd		0004-3L
3240.00				Shet		Upper Cretaceous		0005
		0.54	95	Sh/Clst:		lt gy to m gy, calc, slt, pyr		0005-1L
			5	Sh/Clst:		drk gy, slt		0005-2L
			tr	Sh/Clst:		or gy		0005-3L
3603.00				Shet		Upper Cretaceous		0006
		0.64	100	Sh/Clst:		lt gy to m gy to drk gy, calc, slt, pyr, mic		0006-1L
3639.00				Crom		Lower Cretaceous		0007
		0.72	75	Sh/Clst:		m gy to drk gy, slt, carb, pyr		0007-1L
			25	Sh/Clst:		lt gy, calc, slt		0007-2L
			tr	Sltst	:	lt gy w, glauc		0007-3L
			tr	Cont	:	prp		0007-4L
3651.00				Crom		Lower Cretaceous		0008
		0.60	70	Sh/Clst:		m gy to drk gy, slt, carb, pyr		0008-1L
			25	Ca	:	lt gy w to w, f		0008-2L
			5	Cont	:	prp		0008-3L

Table 1 : Lithology description for well NOCS 30/2-3

Depth unit of measure: m

Depth	Type		Grp	Frm	Age	Trb	Sample
Int Cvd	TOC%	%	Lithology description				
3672.00					Viki Drau Upper Jurassic		0009
	1.68	90	Sh/Clst: gy blk to drk gy, slt				0009-1L
		5	Sh/Clst: m gy, slt				0009-2L
		5	Ca : lt gy w, f				0009-3L
3675.00					Viki Drau Upper Jurassic		0010
	2.33	90	Sh/Clst: gy blk to drk gy, slt, trbofgs				0010-1L
		5	Sh/Clst: lt gy, slt				0010-2L
		5	Ca : lt gy w, f				0010-3L
		tr	Sltst : m gy, mic				0010-4L
3678.00					Viki Drau Upper Jurassic		0011
	5.13	95	Sh/Clst: gy blk, slt, trbofgs				0011-1L
		5	Sh/Clst: lt gy, slt				0011-2L
		tr	Ca : lt gy w, f				0011-3L
		tr	Sltst : m gy, mic				0011-4L
3681.00					Viki Drau Upper Jurassic		0012
	5.89	95	Sh/Clst: gy blk, slt, trbofgs				0012-1L
		5	Sh/Clst: lt gy, slt				0012-2L
		tr	Sltst : lt gy, mic				0012-3L
3684.00					Viki Drau Upper Jurassic		0013
	4.36	95	Sh/Clst: gy blk, slt, trbofgs				0013-1L
		5	Sh/Clst: m gy, slt				0013-2L
		tr	Sltst : lt gy, mic, st				0013-3L

Table 1 : Lithology description for well NOCS 30/2-3

Depth unit of measure: m

Depth	Type		Grp Frm Age	Trb	Sample
Int Cvd	TOC%	%	Lithology description		
3693.00			Viki Drau Upper Jurassic		0014
	5.34	95	Sh/Clst: gy blk, slt, trbofgs		0014-1L
		5	Sh/Clst: lt gy, slt		0014-2L
		tr	Sltst : lt gy, mic, st		0014-3L
3702.00			Viki Drau Upper Jurassic		0015
	6.51	100	Sh/Clst: gy blk, slt, trbofgs		0015-1L
		tr	Sh/Clst: lt gy, slt		0015-2L
3711.00			Viki Heat Upper Jurassic		0016
	5.84	100	Sh/Clst: gy blk, slt, trbofgs		0016-1L
		tr	Sh/Clst: lt gy, slt		0016-2L
		tr	Sltst : lt gy, st		0016-3L
3729.00			Viki Heat Upper Jurassic		0017
		70	Cont : prp, dd, bar		0017-1L
	3.95	20	Sh/Clst: gy blk to drk gy, slt		0017-2L
		10	Sh/Clst: m gy, slt		0017-3L
3750.00			Viki Heat Upper Jurassic		0018
	3.16	70	Sh/Clst: gy blk to drk gy, carb, slt		0018-1L
		30	Cont : prp		0018-2L
		tr	Sh/Clst: lt gy, calc		0018-3L
		tr	Sltst : m brn		0018-4L
3751.56 ccp			Viki Heat Upper Jurassic		0027
	2.15	100	Sh/Clst: drk gy, slt, hd		0027-1L

Table 1 : Lithology description for well NOCS 30/2-3

Depth unit of measure: m

Depth	Type		Grp	Frm	Age	Trb	Sample
Int Cvd	TOC%	%	Lithology description				
3759.59	ccp		Viki	Heat	Upper Jurassic		0028
	1.57	100	Sh/Clst: drk gy, slt, hd				0028-1L
3824.54	ccp		Bren		Middle Jurassic		0029
	16.70	100	Coal : brn blk, hd, pyr				0029-1L
3833.65	ccp		Bren		Middle Jurassic		0030
	0.72	100	Sh/Clst: m gy, slt, mic, hd, carb				0030-1L
3851.85	ccp		Bren		Middle Jurassic		0031
	7.83	80	Sh/Clst: gy blk, hd, slt				0031-1L
		20	Coal : blk, hd				0031-2L
3883.59	ccp		Bren		Middle Jurassic		0032
	1.78	100	Sh/Clst: m gy to lt gy, slt, hd, lam, fos				0032-1L
3911.38	ccp		Bren		Middle Jurassic		0033
	63.90	50	Coal : blk, hd				0033-1L
		50	Sh/Clst: gy blk, hd, carb				0033-2L
3929.35	ccp		Bren		Middle Jurassic		0034
	57.80	100	Coal : blk, hd				0034-1L

Table 1 : Lithology description for well NOCS 30/2-3

Depth unit of measure: m

Depth	Type		Grp	Frm	Age	Trb	Sample
Int Cvd	TOC%	%	Lithology description				
3981.28	ccp		Dunl		Lower Jurassic		0035
	2.61	100	Sh/Clst: drk gy, slt, hd				0035-1L
3993.00			Dunl		Lower Jurassic		0019
	2.00	90	Sh/Clst: m gy to drk gy to gy blk, carb, slt				0019-1L
		10	Sltst : lt gy to lt ol gy				0019-2L
		tr	Coal : blk				0019-3L
		tr	Cont : prp				0019-4L
4011.00			Dunl		Lower Jurassic		0020
	2.02	75	Sh/Clst: drk gy to gy blk, carb, slt				0020-1L
		15	Cont : prp				0020-2L
		5	Sltst : lt gy to m gy				0020-3L
		5	Sh/Clst: brn gy				0020-4L
		tr	Coal : blk				0020-5L
4035.00			Dunl		Lower Jurassic		0021
	2.13	55	Sh/Clst: drk gy to gy blk, carb, slt				0021-1L
		35	Cont : prp				0021-2L
		5	Sltst : lt gy to m gy				0021-3L
		5	Sh/Clst: brn gy				0021-4L
		tr	Coal : blk				0021-5L
4089.00			Dunl		Lower Jurassic		0022
	2.26	80	Sh/Clst: gy blk, carb, slt				0022-1L
		10	S/Sst : lt gy w, f				0022-2L
		5	Cont : prp				0022-3L
		5	Ca : lt gy w to lt gy, cly, f				0022-4L
		tr	Sltst : gy brn to lt gy				0022-5L

Table 1 : Lithology description for well NOCS 30/2-3

Depth unit of measure: m

Depth	Type		Grp	Frm	Age	Trb	Sample
Int Cvd	TOC%	%	Lithology description				
4158.00			Dunl		Lower Jurassic		0023
	2.34	85	Sh/Clst:		gy blk to drk gy, carb, slt		0023-1L
		10	Cont	:	prp		0023-2L
		5	Ca	:	lt gy w to lt gy, cly, f		0023-3L
		tr	Sltst	:	gy brn to lt gy		0023-4L
4257.00			Dunl		Lower Jurassic		0024
	2.05	70	Sh/Clst:		drk gy to gy blk, carb, slt		0024-1L
		25	Cont	:	prp, bar		0024-2L
		5	Sltst	:	gy brn to lt gy		0024-3L
		tr	Ca	:	lt gy, f		0024-4L
4287.00			Dunl		Lower Jurassic		0025
	2.46	85	Sh/Clst:		drk gy to gy blk to brn gy, carb, slt		0025-1L
		10	Cont	:	prp, bar		0025-2L
		5	Sltst	:	gy brn to lt gy		0025-3L
		tr	Coal	:	blk		0025-4L
4290.00			Stat		Lower Jurassic		0026
	0.18	45	S/Sst	:	w, f, cem, l		0026-1L
		45	Sh/Clst:		drk gy to gy blk, slt		0026-2L
		10	Cont	:	prp		0026-3L

Table 2 : Rock-Eval table for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	S1	S2	S3	S2/S3	TOC	HI	OI	PP	PI	Tmax	Sample
2015.00	swc	Sh/Clst: m gy	0.16	1.00	0.26	3.85	1.54	65	17	1.2	0.14	413	0039-1L
3672.00	cut	Sh/Clst: gy blk to drk gy	0.90	2.07	0.14	14.79	1.68	123	8	3.0	0.30	447	0009-1L
3675.00	cut	Sh/Clst: gy blk to drk gy	1.63	3.74	0.23	16.26	2.33	161	10	5.4	0.30	443	0010-1L
3678.00	cut	Sh/Clst: gy blk	4.46	11.82	0.41	28.83	5.13	230	8	16.3	0.27	441	0011-1L
3681.00	cut	Sh/Clst: gy blk	5.35	13.80	0.31	44.52	5.89	234	5	19.1	0.28	441	0012-1L
3684.00	cut	Sh/Clst: gy blk	6.03	9.87	0.51	19.35	4.36	226	12	15.9	0.38	439	0013-1L
3693.00	cut	Sh/Clst: gy blk	5.65	10.23	0.32	31.97	5.34	192	6	15.9	0.36	438	0014-1L
3702.00	cut	Sh/Clst: gy blk	6.61	12.30	0.38	32.37	6.51	189	6	18.9	0.35	440	0015-1L
3711.00	cut	Sh/Clst: gy blk	5.82	10.29	0.23	44.74	5.84	176	4	16.1	0.36	442	0016-1L
3729.00	cut	Sh/Clst: gy blk to drk gy	2.89	4.64	0.23	20.17	3.95	117	6	7.5	0.38	452	0017-2L
3750.00	cut	Sh/Clst: gy blk to drk gy	2.20	3.02	0.24	12.58	3.16	96	8	5.2	0.42	455	0018-1L
3751.56	ccp	Sh/Clst: drk gy	2.10	4.32	0.11	39.27	2.15	201	5	6.4	0.33	452	0027-1L
3759.59	ccp	Sh/Clst: drk gy	1.84	2.50	0.24	10.42	1.57	159	15	4.3	0.42	452	0028-1L
3824.54	ccp	Coal : brn blk	1.88	12.26	2.64	4.64	16.70	73	16	14.1	0.13	467	0029-1L
3833.65	ccp	Sh/Clst: m gy	0.11	0.35	1.58	0.22	0.72	49	219	0.5	0.24	459	0030-1L

Table 2 : Rock-Eval table for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	S1	S2	S3	S2/S3	TOC	HI	OI	PP	PI	Tmax	Sample
3851.85	ccp	Sh/Clst gy blk	1.60	9.46	3.03	3.12	7.83	121	39	11.1	0.14	468	0031-1L
3883.59	ccp	Sh/Clst: m gy to lt gy	0.34	1.37	1.46	0.94	1.78	77	82	1.7	0.20	464	0032-1L
3911.38	ccp	Coal : blk	10.41	83.75	3.54	23.66	63.90	131	6	94.2	0.11	470	0033-1L
3929.35	ccp	Coal : blk	8.12	105.20	6.66	15.80	57.80	182	12	113.3	0.07	465	0034-1L
3981.28	ccp	Sh/Clst: drk gy	1.25	3.40	0.33	10.30	2.61	130	13	4.7	0.27	457	0035-1L
3993.00	cut	Sh/Clst: m gy to drk gy to gy blk	0.90	2.74	0.13	21.08	2.00	137	7	3.6	0.25	454	0019-1L
4011.00	cut	Sh/Clst: drk gy to gy blk	1.43	3.12	0.12	26.00	2.02	154	6	4.5	0.31	452	0020-1L
4035.00	cut	Sh/Clst: drk gy to gy blk	1.36	3.32	0.12	27.67	2.13	156	6	4.7	0.29	451	0021-1L
4089.00	cut	Sh/Clst: gy blk	1.44	3.20	0.14	22.86	2.26	142	6	4.6	0.31	450	0022-1L
4158.00	cut	Sh/Clst: gy blk to drk gy	1.56	3.09	0.14	22.07	2.34	132	6	4.7	0.34	450	0023-1L
4257.00	cut	Sh/Clst: drk gy to gy blk	1.40	2.52	0.22	11.45	2.05	123	11	3.9	0.36	451	0024-1L
4287.00	cut	Sh/Clst: drk gy to gy blk to brn gy	1.53	3.37	0.12	28.08	2.46	137	5	4.9	0.31	451	0025-1L

Table 3 : Pyrolysis GC Data (S2 peak) as Percentage of Total Area for Well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	C1	C2-C5	C6-C14	C15+	S2 from Rock-Eval	Sample
3678.00	cut	Sh/Clst: gy blk	4.75	17.82	40.04	37.40	11.82	0011-1L
3681.00	cut	Sh/Clst: gy blk	4.52	16.97	39.77	38.73	13.80	0012-1L
3684.00	cut	Sh/Clst: gy blk	4.71	18.44	40.11	36.74	9.87	0013-1L
3693.00	cut	Sh/Clst: gy blk	4.05	18.54	41.29	36.11	10.23	0014-1L
3851.85	ccp	Coal : gy blk	18.64	17.91	30.09	33.35	9.46	0031-1L
3911.38	ccp	Coal : blk	20.59	14.75	23.90	40.76	83.75	0033-1L
3929.35	ccp	Coal : blk	20.23	14.71	21.81	43.25	105.20	0034-1L

Table 4 a: Weight of EOM and Chromatographic Fraction for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	Rock Extracted (g)	EOM (mg)	Sat (mg)	Aro (mg)	Asph (mg)	NSO (mg)	HC (mg)	Non-HC (mg)	TOC(e) (%)	Sample
3675.00	cut	Sh/Clst: gy blk to drk gy	6.0	45.3	19.3	11.9	7.3	6.8	31.2	14.1	2.33	0010-1L
3681.00	cut	Sh/Clst: gy blk	5.7	47.9	19.2	12.5	9.5	6.7	31.7	16.2	5.89	0012-1L
3684.00	cut	Sh/Clst: gy blk	5.5	51.4	25.7	12.8	5.6	7.3	38.5	12.9	4.36	0013-1L
3693.00	cut	Sh/Clst: gy blk	6.1	51.6	24.2	12.8	6.7	7.9	37.0	14.6	5.34	0014-1L
3824.54	ccp	Coal : brn blk	1.9	17.7	1.0	4.6	10.4	1.7	5.6	12.1	16.70	0029-1L
3911.38	ccp	Coal : blk	2.6	82.0	2.0	11.1	66.9	2.0	13.1	68.9	63.90	0033-1L

Table 4 b: Concentration of EOM and Chromatographic Fraction (wt ppm rock) for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	EOM	Sat	Aro	Asph	NSO	HC	Non-HC	Sample
3675.00	cut	Sh/Clst: gy blk to drk gy	7600	3238	1996	1224	1140	5234	2365	0010-1L
3681.00	cut	Sh/Clst: gy blk	8403	3368	2192	1666	1175	5561	2842	0012-1L
3684.00	cut	Sh/Clst: gy blk	9345	4672	2327	1018	1327	7000	2345	0013-1L
3693.00	cut	Sh/Clst: gy blk	8528	4000	2115	1107	1305	6115	2413	0014-1L
3824.54	ccp	Coal : brn blk	9170	518	2383	5388	880	2901	6269	0029-1L
3911.38	ccp	Coal : blk	31417	766	4252	25632	766	5019	26398	0033-1L

Table 4 c: Concentration of EOM and Chromatographic Fraction (mg/g TOC(e)) for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	EOM	Sat	Aro	Asph	NSO	HC	Non-HC	Sample
3675.00	cut	Sh/Clst: gy blk to drk gy	326.21	138.98	85.69	52.57	48.97	224.67	101.54	0010-1L
3681.00	cut	Sh/Clst: gy blk	142.67	57.19	37.23	28.30	19.96	94.42	48.25	0012-1L
3684.00	cut	Sh/Clst: gy blk	214.35	107.17	53.38	23.35	30.44	160.55	53.79	0013-1L
3693.00	cut	Sh/Clst: gy blk	159.72	74.91	39.62	20.74	24.45	114.53	45.19	0014-1L
3824.54	ccp	Coal : brn blk	54.92	3.10	14.27	32.27	5.27	17.37	37.54	0029-1L
3911.38	ccp	Coal : blk	49.17	1.20	6.66	40.11	1.20	7.85	41.31	0033-1L

Table 4 d: Composition of material extracted from the rock (%) for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	Sat EOM	Aro EOM	Asph EOM	NSO EOM	HC EOM	Non-HC EOM	Sat Aro	HC Non-HC	Sample
3675.00	cut	Sh/Clst: gy blk to drk gy	42.60	26.27	16.11	15.01	68.87	31.13	162.18	221.28	0010-1L
3681.00	cut	Sh/Clst: gy blk	40.08	26.10	19.83	13.99	66.18	33.82	153.60	195.68	0012-1L
3684.00	cut	Sh/Clst: gy blk	50.00	24.90	10.89	14.20	74.90	25.10	200.78	298.45	0013-1L
3693.00	cut	Sh/Clst: gy blk	46.90	24.81	12.98	15.31	71.71	28.29	189.06	253.42	0014-1L
3824.54	ccp	Coal : brn blk	5.65	25.99	58.76	9.60	31.64	68.36	21.74	46.28	0029-1L
3911.38	ccp	Coal : blk	2.44	13.54	81.59	2.44	15.98	84.02	18.02	19.01	0033-1L

Table 5 : Saturated Hydrocarbon Ratios for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	Pristane / nC17	Pristane / Phytane	Pristane + Phytane / nC17 + nC18	Phytane / nC18	CPI	Sample
3675.00	cut	Sh/Clst: gy blk to drk gy	0.40	1.49	0.37	0.33	1.15	0010-1L
3681.00	cut	Sh/Clst: gy blk	0.40	1.42	0.38	0.36	1.18	0012-1L
3684.00	cut	Sh/Clst: gy blk	0.43	1.20	0.39	0.35	0.87	0013-1L
3693.00	cut	Sh/Clst: gy blk	0.44	1.50	0.40	0.36	0.78	0014-1L
3824.54	ccp	Coal : brn blk	0.32	3.67	0.21	0.10	1.05	0029-1L
3911.38	ccp	Coal : blk	0.15	2.46	0.11	0.07	1.28	0033-1L

Table 6 : Aromatic Hydrocarbon Ratios for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	MNR	DMNR	BPhR	2/1MP	MPI1	MPI2	Rc	DBT/P	4/1MDBT	(3+2) /1MDBT	Sample
3675.00	cut	Sh/Clst: gy blk to drk gy	1.04	1.43	0.22	0.82	0.67	0.77	0.80	-	-	-	0010-1L
3681.00	cut	Sh/Clst: gy blk	1.02	1.44	0.23	0.79	0.65	0.75	0.79	-	-	-	0012-1L
3684.00	cut	Sh/Clst: gy blk	1.00	1.44	0.21	0.82	0.66	0.75	0.80	-	-	-	0013-1L
3693.00	cut	Sh/Clst: gy blk	0.98	1.40	0.21	0.85	0.68	0.79	0.81	-	-	-	0014-1L
3824.54	ccp	Coal : brn blk	1.55	3.73	0.49	1.21	0.90	1.06	0.94	0.20	46.85	8.46	0029-1L
3911.38	ccp	Coal : blk	1.43	2.97	0.56	1.17	0.95	1.13	0.97	0.36	41.83	12.09	0033-1L

Table 7 : Thermal Maturity Data for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	Vitrinite Reflectance (%)	Number of Readings	Standard Deviation	Spore Fluorescence Colour	SCI	Tmax (°C)	Sample
3675.00	cut	Sh/Clst: gy blk to drk gy	-	-	-	-	7.0-7.5	443	0010-1L
3681.00	cut	Sh/Clst: gy blk	-	-	-	-	7.5	441	0012-1L
3693.00	cut	Sh/Clst: gy blk	-	-	-	-	7.5	438	0014-1L
3824.54	ccp	Coal : brn blk	-	-	-	-	7.0	467	0029-1L
3851.85	ccp	Sh/Clst: gy blk	-	-	-	-	7.5	468	0031-1L
3883.59	ccp	Sh/Clst: m gy to lt gy	-	-	-	-	7.5	464	0032-1L

Table 8 : Visual Kerogen Composition Data for well NOCS 30/2-3

Depth unit of measure: m

Depth	Typ	Lithology	LIPT %	Amor L	Lip Det	Sp/Pol	Cutic	Resin	Algae	Dinof	Acrit	Bit L	INERT %	Fusin	Sem Fus	Inert Det	Mic rin	Sclero	Bit I	VITR %	Tell in	Coll inn	Vit Det	Amor V	Bit V	Sample
3675.00	cut	Sh/Clst: gy blk to drk gy	55	**		*			*	*			20		*	**				25	*		**			0010-1L
3681.00	cut	Sh/Clst: gy blk	75	**		*			*			?	20		*	**				5	*		*			0012-1L
3693.00	cut	Sh/Clst: gy blk	60	**		*			*				30		*	**				10	*		*			0014-1L
3824.54	ccp	Coal : brn blk	65	*	?	*	*		?				15		*	*				20	*		*			0029-1L
3851.85	ccp	Sh/Clst: gy blk	50	*		**	*		*				5		*	*				45	*	*	*			0031-1L
3883.59	ccp	Sh/Clst: m gy to lt gy	30			**	*		?				10		*					60	**	*	*			0032-1L

Table 9A: Variation in Triterpane Distribution (peak height) SIR for Well NO[illegible]S 30/2-3

Depth unit of measure: m

Depth	Lithology	B/A	B/B+A	B B+E+F	C/E	C/C+E	X/E	Z/E	Z/C	Z/Z+E	Q/E	E/E+F	C+D C+D+E+F	D+F/C+E	J1 J1+J2%	Sample
3675.00	Sh/Clst	0.15	0.13	0.09	0.26	0.21	0.36	-	-	-	0.27	0.94	0.24	0.11	60.93	0010-1
3681.00	Sh/Clst	0.12	0.10	0.07	0.24	0.19	0.37	-	-	-	0.25	0.94	0.21	0.10	59.81	0012-1
3684.00	Sh/Clst	0.13	0.12	0.07	0.24	0.19	0.37	-	-	-	0.29	0.93	0.18	0.06	61.40	0013-1
3693.00	Sh/Clst	0.10	0.09	0.07	0.22	0.18	0.43	-	-	-	0.35	0.94	0.17	0.05	60.05	0014-1
3824.54	Coal	0.24	0.19	0.21	0.49	0.33	1.41	0.06	0.12	0.05	0.09	0.93	0.31	0.05	63.25	0029-1
3911.38	Coal	0.10	0.09	0.22	0.50	0.33	4.95	0.22	0.44	0.18	0.20	0.88	0.31	0.09	62.02	0033-1

Table 9B: Variation in Sterane Distribution (peak height) SIR for Well NOCS 30/2-3

Depth unit of measure: m

Depth	Lithology	Ratio1	Ratio2	Ratio3	Ratio4	Ratio5	Ratio6	Ratio7	Ratio8	Ratio9	Ratio10	Sample
3675.00	Sh/Clst	0.84	55.66	77.07	1.52	0.75	0.72	0.57	0.63	1.26	3.79	0010-1
3681.00	Sh/Clst	0.84	56.82	76.54	1.54	0.74	0.71	0.56	0.62	1.32	3.78	0012-1
3684.00	Sh/Clst	0.86	56.11	76.87	1.69	0.75	0.71	0.56	0.62	1.28	3.79	0013-1
3693.00	Sh/Clst	0.86	53.49	77.59	1.66	0.76	0.73	0.57	0.63	1.15	3.72	0014-1
3824.54	Coal	0.63	51.29	70.90	0.35	0.70	0.17	0.15	0.55	1.05	2.50	0029-1
3911.38	Coal	0.62	44.32	72.01	0.50	0.74	0.24	0.21	0.56	0.80	2.31	0033-1

Ratio1: a / a + j
Ratio2: q / q + t * 100%
Ratio3: 2(r + s)/(q + t + 2(r + s)) * 100%
Ratio4: a + b + c + d / h + k + l + n
Ratio5: r + s / r + s + q

Ratio6: u + v / u + v + q + r + s + t
Ratio7: u + v / u + v + i + m + n + q + r + s + t
Ratio8: r + s / q + r + s + t
Ratio9: q / t
Ratio10: r + s / t

Table 9C: Variation in Triaromatic Sterane Distribution for Well Well NOCS 3/2-3

Depth unit of measure: m

Depth	Lithology	Ratio1	Ratio2	Ratio3	Ratio4	Ratio5	Sample
3675.00	Sh/Clst	0.95	0.94	0.86	0.87	0.90	0010-1
3681.00	Sh/Clst	0.96	0.95	0.86	0.88	0.90	0012-1
3684.00	Sh/Clst	0.95	0.94	0.84	0.85	0.88	0013-1
3693.00	Sh/Clst	0.95	0.94	0.86	0.87	0.90	0014-1
3824.54	Coal	1.00	1.00	1.00	1.00	1.00	0029-1
3911.38	Coal	1.00	1.00	1.00	1.00	1.00	0033-1

Ratio1: a1 / a1 + g1
Ratio2: b1 / b1 + g1
Ratio3: a1 + b1 / a1 + b1 + c1 + d1 + e1 + f1 + g1
Ratio4: a1 / a1 + e1 + f1 + g1
Ratio5: a1 / a1 + d1

Table 9D: Variation in Monoaromatic Sterane Distribution for Well NOCS 30/2-3

Depth unit of measure: m

Depth	Lithology	Ratio1	Ratio2	Ratio3	Ratio4	Sample
3675.00	Sh/Clst	0.86	0.75	0.80	0.70	0010-1
3681.00	Sh/Clst	0.85	0.74	0.77	0.67	0012-1
3684.00	Sh/Clst	0.83	0.72	0.75	0.67	0013-1
3693.00	Sh/Clst	0.85	0.75	0.78	0.70	0014-1
3824.54	Coal	-	-	-	-	0029-1
3911.38	Coal	-	-	-	-	0033-1

Ratio1: A1 / A1 + E1
Ratio2: B1 / B1 + E1
Ratio3: A1 / A1 + E1 + G1
Ratio4: A1+B1 / A1+B1+C1+D1+E1+F1+G1+H1+I1

Table 9E: Aromatisation of Steranes for Well NOCS 30/2-3

Depth unit of measure: m

Depth	Lithology	Ratio1	Ratio2	Sample
3675.00	Sh/Clst	0.41	0.79	0010-1
3681.00	Sh/Clst	0.40	1.00	0012-1
3684.00	Sh/Clst	0.43	1.00	0013-1
3693.00	Sh/Clst	0.40	1.00	0014-1
3824.54	Coal	-	-	0029-1
3911.38	Coal	-	-	0033-1

Ratio1: $\dfrac{C1+D1+E1+F1+G1+H1+I1}{C1+D1+E1+F1+G1+H1+I1 + c1+d1+e1+f1+g1}$

Ratio2: g1 / g1 + I1

Depth unit of measure: m

Depth	Lithology	p	q	r	s	t	a	b	z	c	Sample
		x	d	e	f	g	h	i	j1		
		j2	k1	k2	l1	l2	m1	m2			
3675.00	Sh/Clst	79674.1	65062.2	35577.6	46424.0	23392.0	175312.0	26108.0	0.0	64603.8	0010-1
		87710.6	17692.6	244899.5	16048.0	90392.8	63446.9	13310.2	76201.6		
		48852.5	61347.4	42851.2	36002.9	25810.5	31312.0	25960.4			
3681.00	Sh/Clst	47745.2	43776.0	18308.5	28648.7	16310.8	111604.0	12888.0	0.0	41107.5	0012-1
		63664.0	8589.8	172132.2	11677.4	54080.0	36056.0	10061.6	52444.8		
		35237.3	42502.0	26144.0	29713.4	17891.0	23552.0	14517.3			
3684.00	Sh/Clst	98542.9	85753.6	38853.3	51986.7	30051.4	194995.2	25610.6	0.0	71193.1	0013-1
		110480.0	0.0	300666.7	21644.7	108196.6	77400.8	20509.8	98752.0		
		62072.0	84961.8	51769.5	53318.2	38917.3	48247.8	39306.8			
3693.00	Sh/Clst	83333.4	75741.9	36153.4	45240.9	25784.0	167298.9	16576.0	0.0	47740.8	0014-1
		91115.8	0.0	213817.1	13225.5	74330.7	48612.9	16258.9	69308.9		
		46112.9	53581.5	34459.3	33672.8	24368.0	36299.2	24544.0			
3824.54	Coal	16656.0	9004.9	0.0	90710.0	0.0	121504.0	28610.0	5772.5	48430.2	0029-1
		140315.2	0.0	99742.2	8081.4	27732.0	26680.0	13313.1	30877.3		
		17944.0	13080.0	10461.4	7870.8	9512.8	0.0	0.0			

Depth unit of measure: m

Depth	Lithology	p	q	r	s	t	a	b	z	c	Sample
		x	d	e	f	g	h	i	j1		
		j2	k1	k2	l1	l2	m1	m2			
3911.38	Coal	25900.0	15738.9	0.0	125998.9	0.0	271601.5	25896.0	17716.5	40136.6	0033-1
		394805.5	0.0	79777.9	10514.0	26233.7	18253.9	28157.0	25253.6		
		15462.0	10144.9	6970.2	0.0	0.0	0.0	0.0			

Depth unit of measure: m

Depth	Lithology	u	v	a	b	c	d	e	f	g	Sample
		h	i	j	k	l	m	n	o		
		p	q	r	s	t					
3675.00	Sh/Clst	213402.7	99173.2	208765.3	135164.3	54395.3	50451.1	99026.3	59204.8	35991.8	0010-1
		149271.8	62103.8	39004.7	83797.9	27722.9	15963.2	33640.0	47212.0		
		13134.9	25209.7	42120.6	33999.5	20081.9					
3681.00	Sh/Clst	124229.3	61720.4	126313.3	84385.5	34211.6	36995.5	63937.3	35123.2	21395.5	0012-1
		92442.3	39830.6	24074.5	52059.9	15486.7	9653.9	23600.3	31465.6		
		9768.8	16178.7	26214.5	20241.5	12294.1					
3684.00	Sh/Clst	270631.3	120115.5	278359.4	181238.7	69352.3	70091.2	143574.4	80779.1	43521.0	0013-1
		160033.0	80609.0	45057.0	109665.0	37875.5	22018.0	47106.0	72386.0		
		15332.6	33771.9	55100.2	44904.4	26414.4					
3693.00	Sh/Clst	226223.5	94533.7	223002.7	147308.4	58601.1	60589.7	113618.3	64984.0	39529.2	0014-1
		139401.2	63817.2	36924.3	84609.3	30004.1	13675.6	40760.0	52077.9		
		13620.8	23452.4	42139.4	33748.0	20389.8					
3824.54	Coal	15120.3	9268.0	8987.0	16044.7	0.0	0.0	11139.2	4507.1	4246.3	0029-1
		30512.7	6116.7	5177.6	21397.6	6846.0	4941.4	12041.9	12226.4		
		8533.6	26997.2	34583.7	29551.0	25642.2					

Table 9G: Raw GCMS sterane data (peak height) SIR for Well NOCS 30/2-3

Depth unit of measure: m

Depth	Lithology	u	v	a	b	c	d	e	f	g	Sample
		h	i	j	k	l	m	n	o		
		p	q	r	s	t					
3911.38	Coal	64820.4	28046.4	22089.9	50393.0	4336.0	0.0	20196.3	17950.4	11717.4	0033-1
		55225.5	20477.0	13483.4	59178.0	15135.5	12781.2	25219.2	27169.3		
		18110.5	56732.5	89597.6	75041.5	71284.1					

Table 9H: Raw GCMS triaromatic sterane data (peak height) for Well NOCS 30/2-3

Depth unit of measure: m

Depth	Lithology	a1	b1	c1	d1	e1	f1	g1	Sample
3675.00	Sh/Clst	1048536.2	835897.5	46143.4	113186.5	53162.7	48894.7	55505.3	0010-1
3681.00	Sh/Clst	1110089.8	913857.9	46305.5	117979.8	52073.0	53701.3	49584.0	0012-1
3684.00	Sh/Clst	593055.1	494529.3	31256.6	77735.8	38403.9	31383.1	30794.0	0013-1
3693.00	Sh/Clst	880888.1	711609.3	41373.0	99840.0	41708.0	36232.0	49230.5	0014-1
3824.54	Coal	30272.0	19567.0	0.0	0.0	0.0	0.0	0.0	0029-1
3911.38	Coal	42808.6	30460.1	0.0	0.0	0.0	0.0	0.0	0033-1

Table 9I: Raw GCMS monoaromatic sterane data (peak height) for Well NOCS 30/2-3

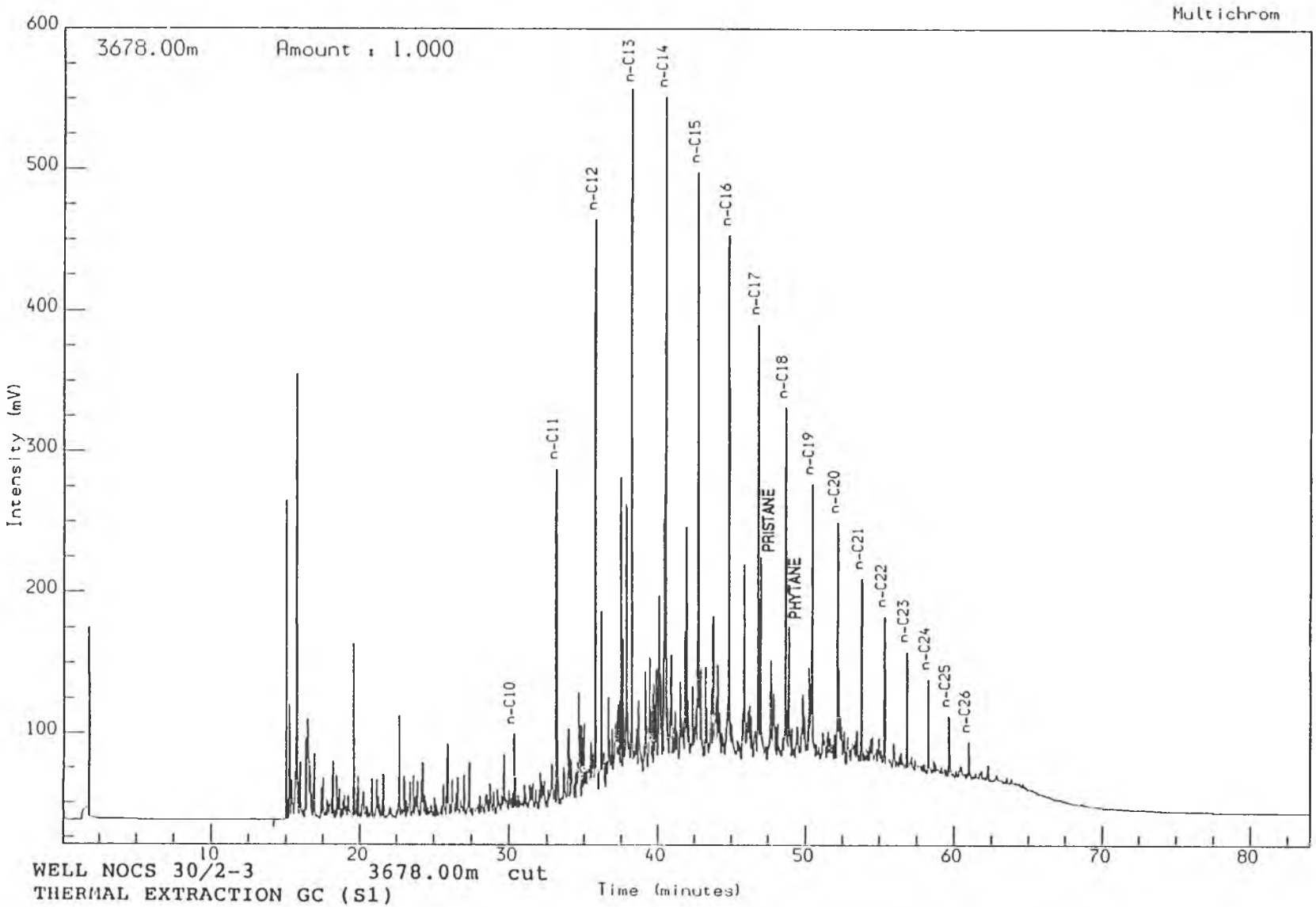
Depth unit of measure: m

Depth	Lithology	a1	b1	c1	d1	e1	f1	g1	h1	i1	Sample
3675.00	Sh/Clst	337953.1	173681.8	41278.2	33252.3	57168.0	17873.9	29121.8	24664.3	14490.2	0010-1
3681.00	Sh/Clst	288987.5	145709.3	47012.2	32474.9	50042.3	17172.8	34306.5	30486.5	0.0	0012-1
3684.00	Sh/Clst	217694.0	114116.8	29794.8	25445.7	44050.0	17820.9	27154.7	15967.5	0.0	0013-1
3693.00	Sh/Clst	271718.2	143194.2	36243.4	24827.4	47802.5	16399.0	27754.8	23107.6	0.0	0014-1
3824.54	Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0029-1
3911.38	Coal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0033-1

Appendix 2

GHM-Thermal Extraction Gas Chromatograms and Pyrolysis Gas Chromatography (Pyrograms)

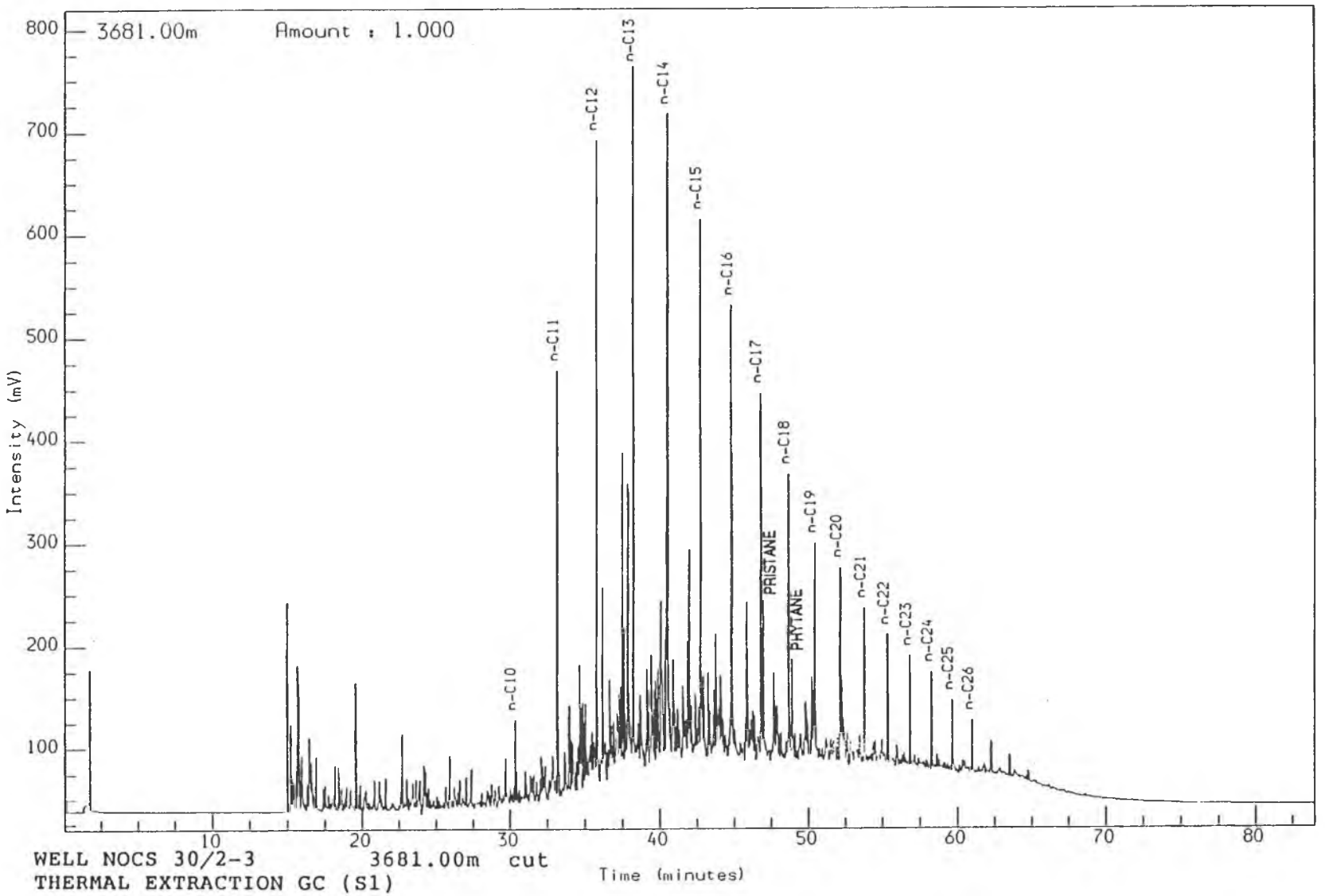
Analysis Name : [62019] 23 PH9500111.1.1.



Reported on 15-DEC-1992 at 21:47

Analysis Name : [62019] 23 PH9500121,1,1.

Multichrom



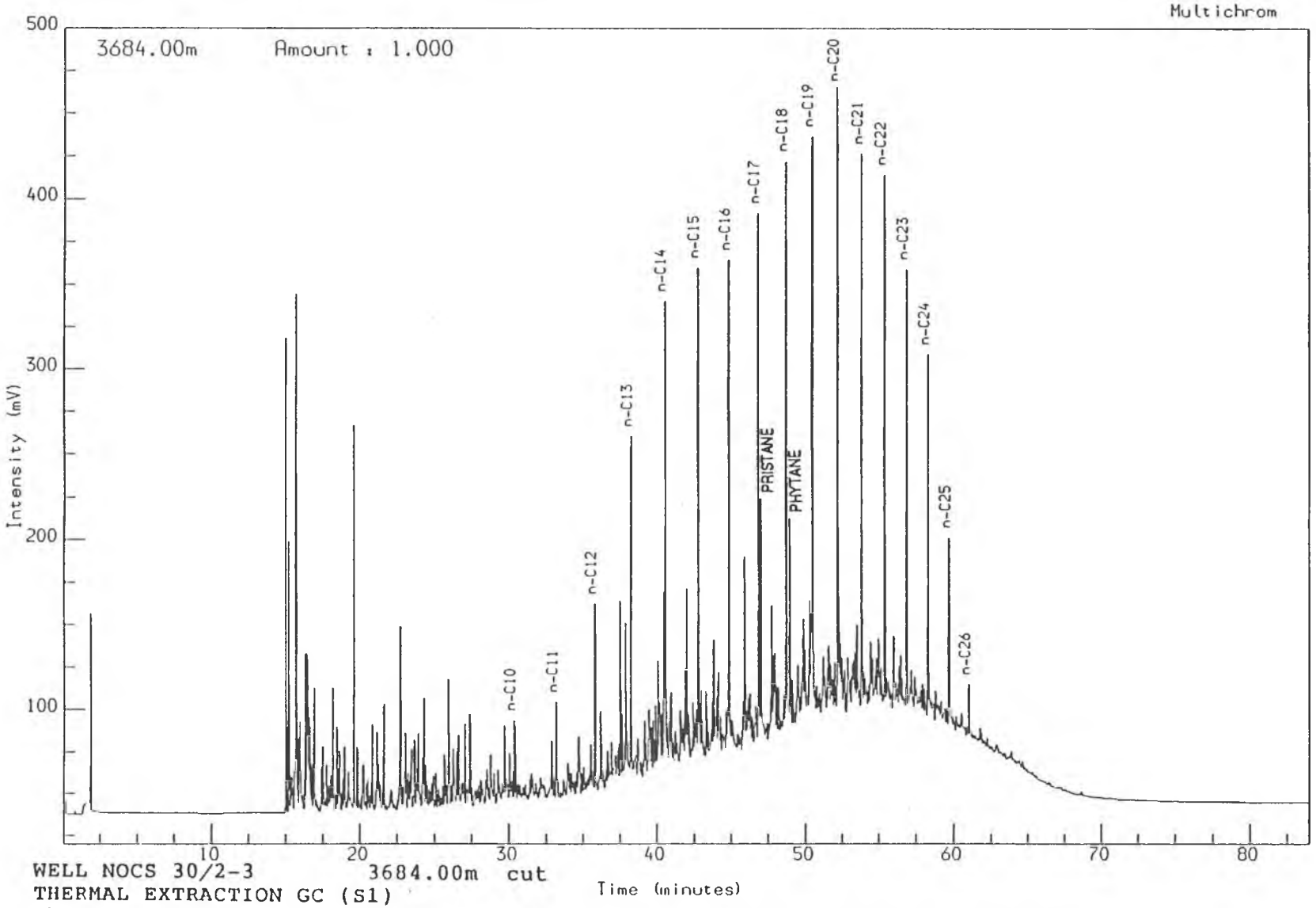
WELL NOCS 30/2-3 3681.00m cut
THERMAL EXTRACTION GC (S1)
Sh/Clst: gy blk

Reported on 15-DEC-1992 at 21:48

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 23 PH9500131.1.1.

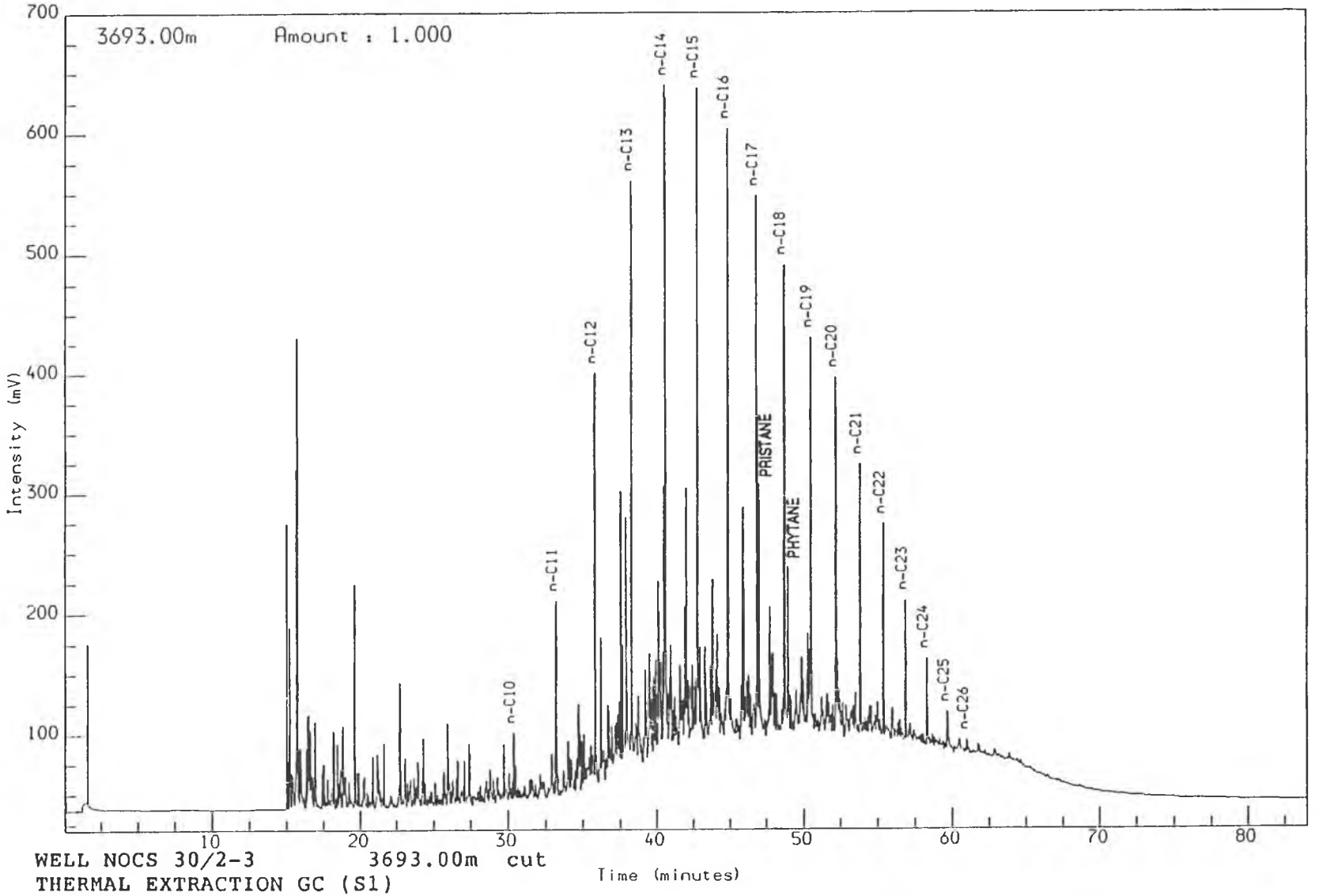


WELL NOCS 30/2-3 3684.00m cut
THERMAL EXTRACTION GC (S1)
Sh/Clst: gy blk

Reported on 15-DEC-1992 at 21:49

Analysis Name : [520191 23 PH9500141.1.1.

Multichrom



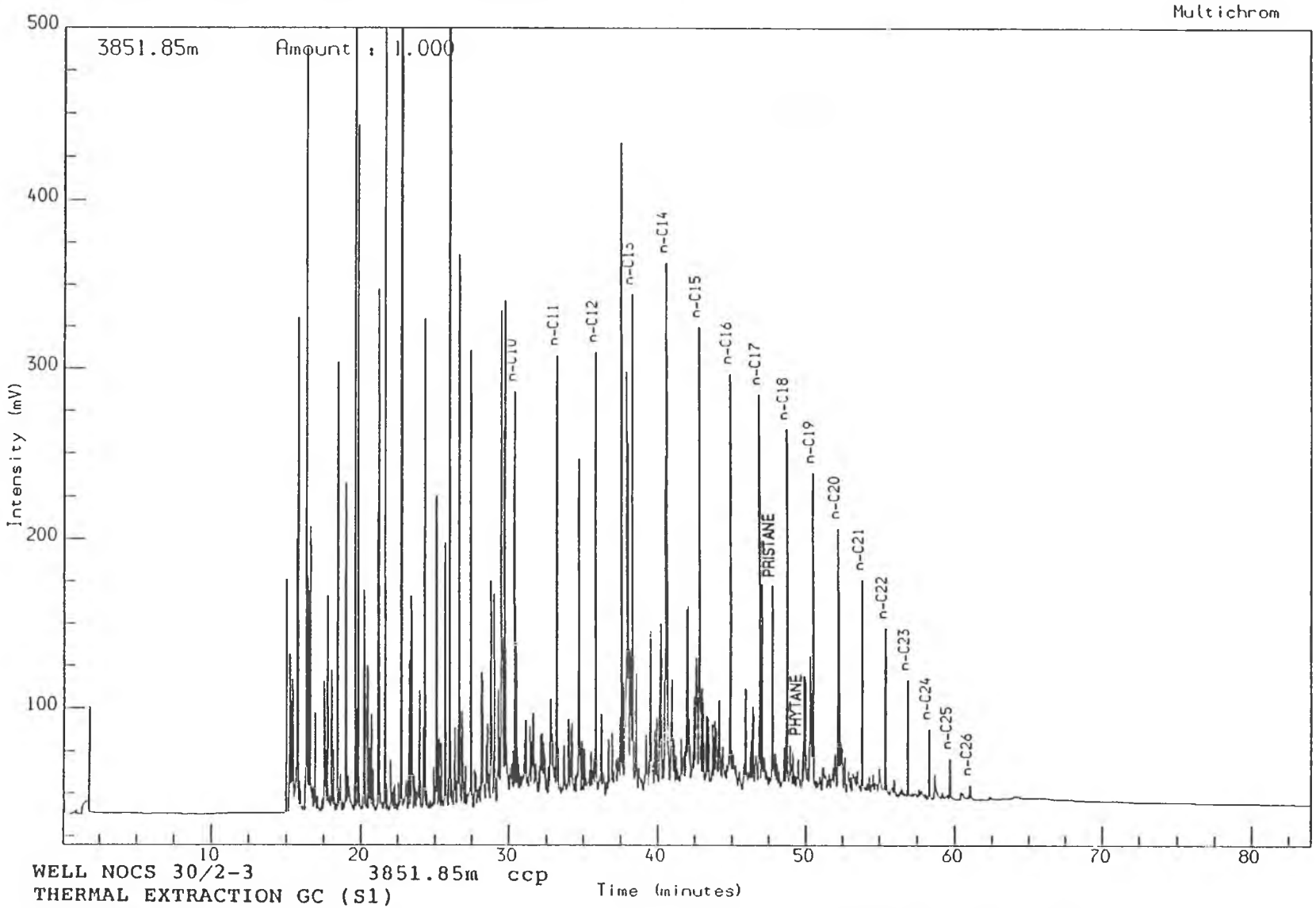
WELL NOCS 30/2-3 3693.00m cut
THERMAL EXTRACTION GC (S1)
Sh/Clst: gy blk

Reported on 15-DEC-1992 at 21:50

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 23 PH9500311.1.1.

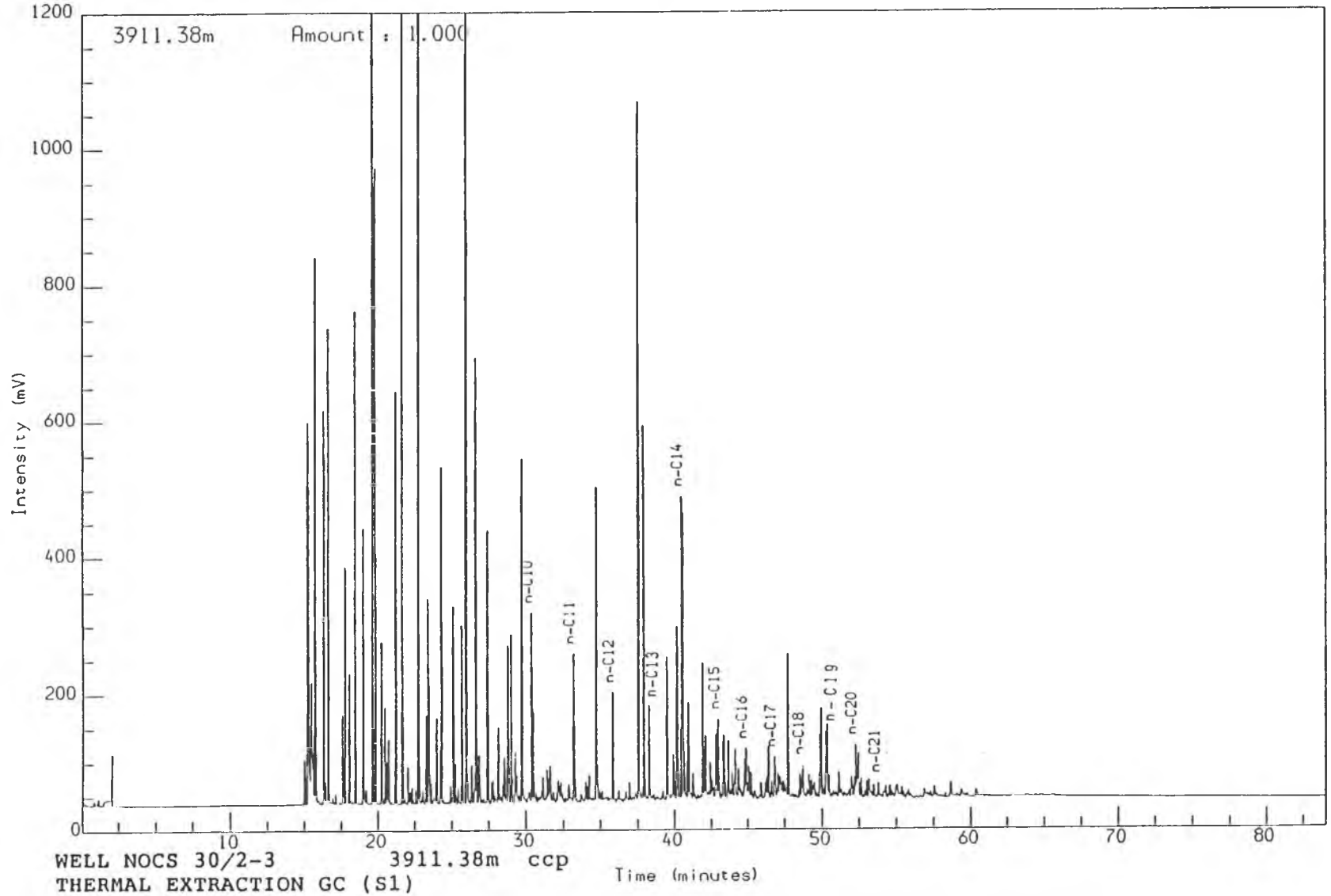


WELL NOCS 30/2-3 3851.85m ccp
THERMAL EXTRACTION GC (S1)
Coal: gy blk

Reported on 15-DEC-1992 at 21:51

Analysis Name : [62019] 23 PH9500331.1.1.

Multichrom

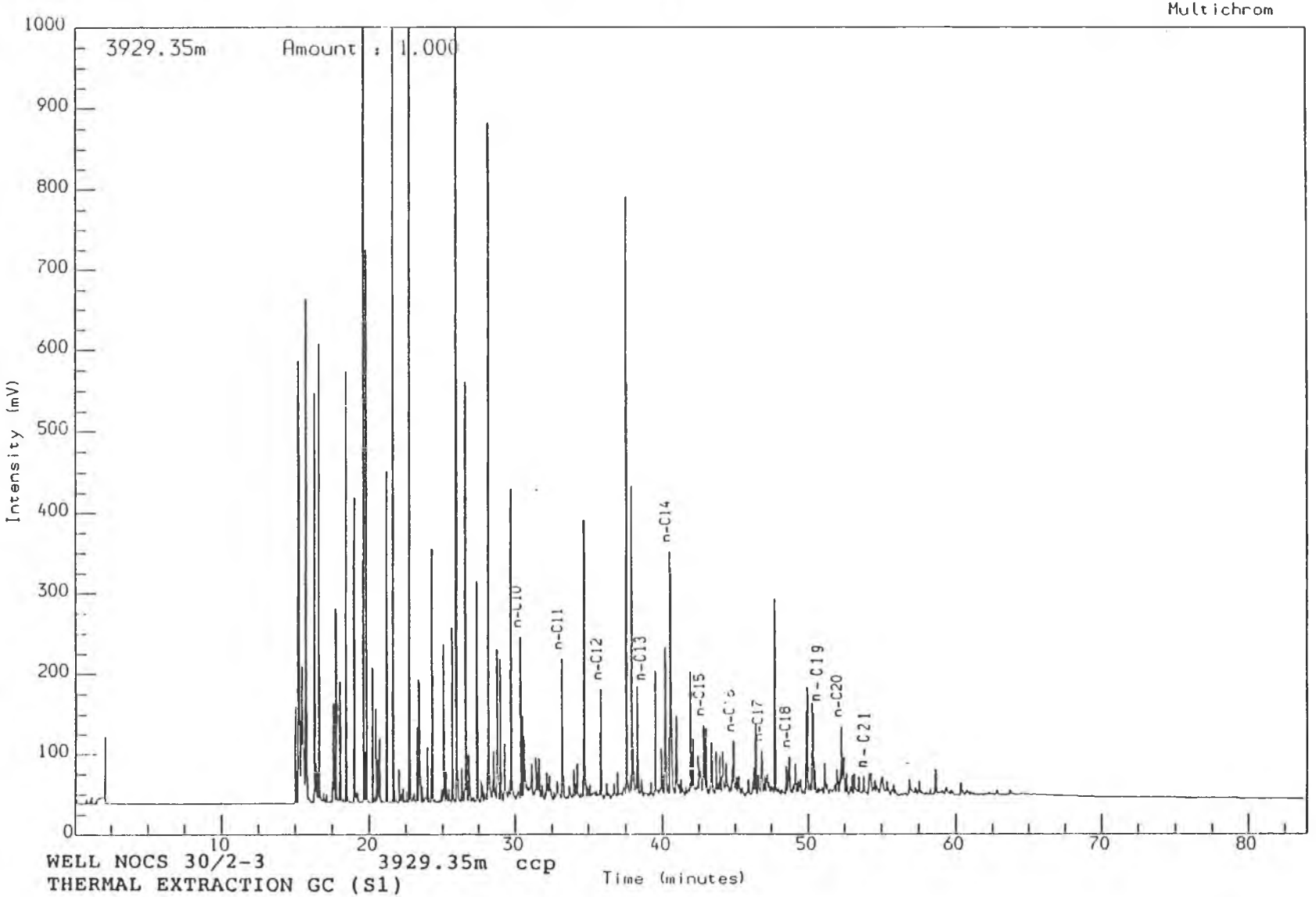


WELL NOCS 30/2-3 3911.38m ccp
THERMAL EXTRACTION GC (S1)
Coal: blk

Reported on 16-DEC-1992 at 08:17

Analysis Name : [62019] 23 PH9500341.1.1.

Multichrom

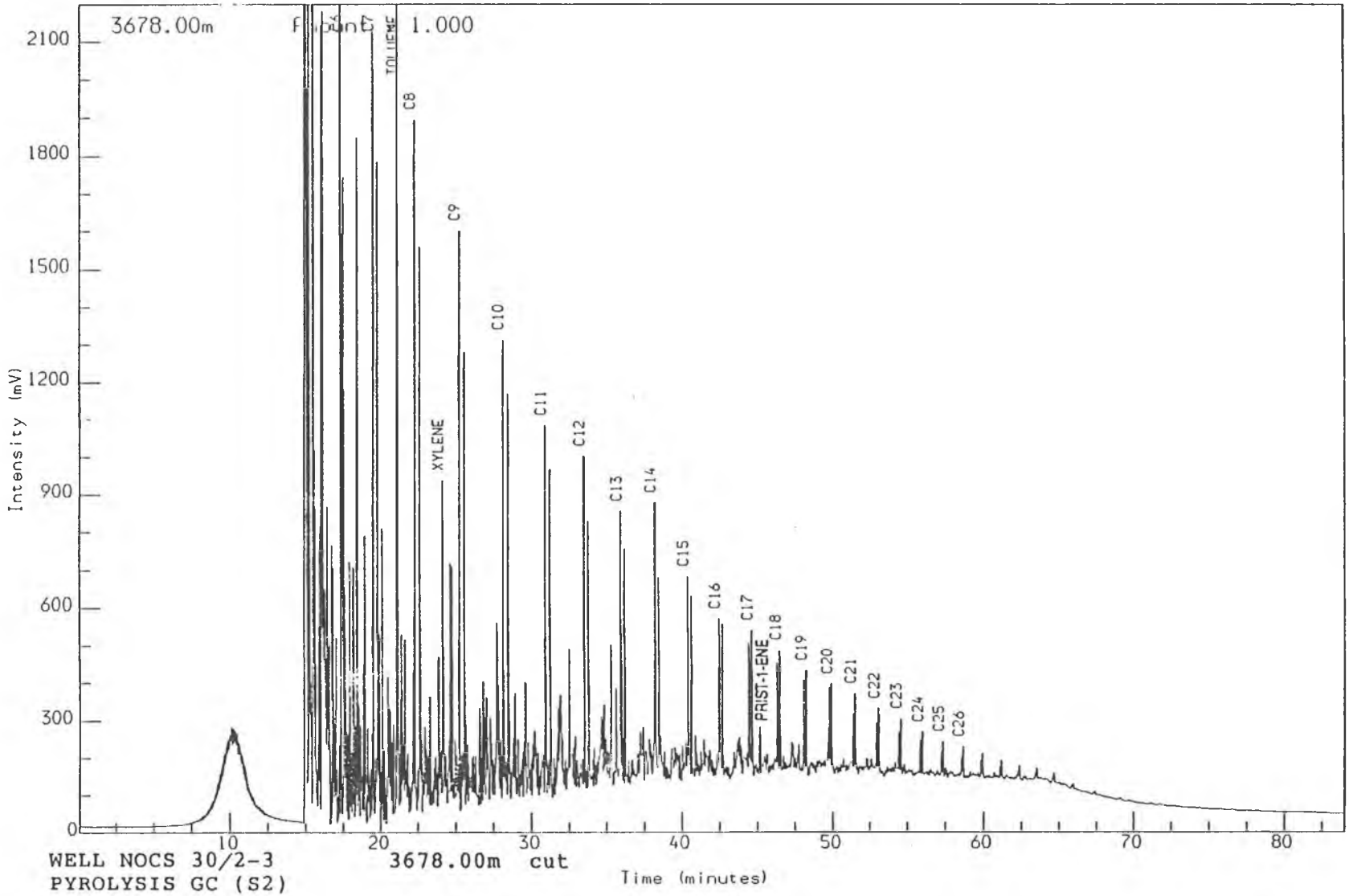


WELL NOCS 30/2-3 3929.35m ccp
THERMAL EXTRACTION GC (S1)
Coal: blk

Reported on 16-DEC-1992 at 08:17

Analysis Name : [62019] 24 PH9500111,1,1.

Multichrom



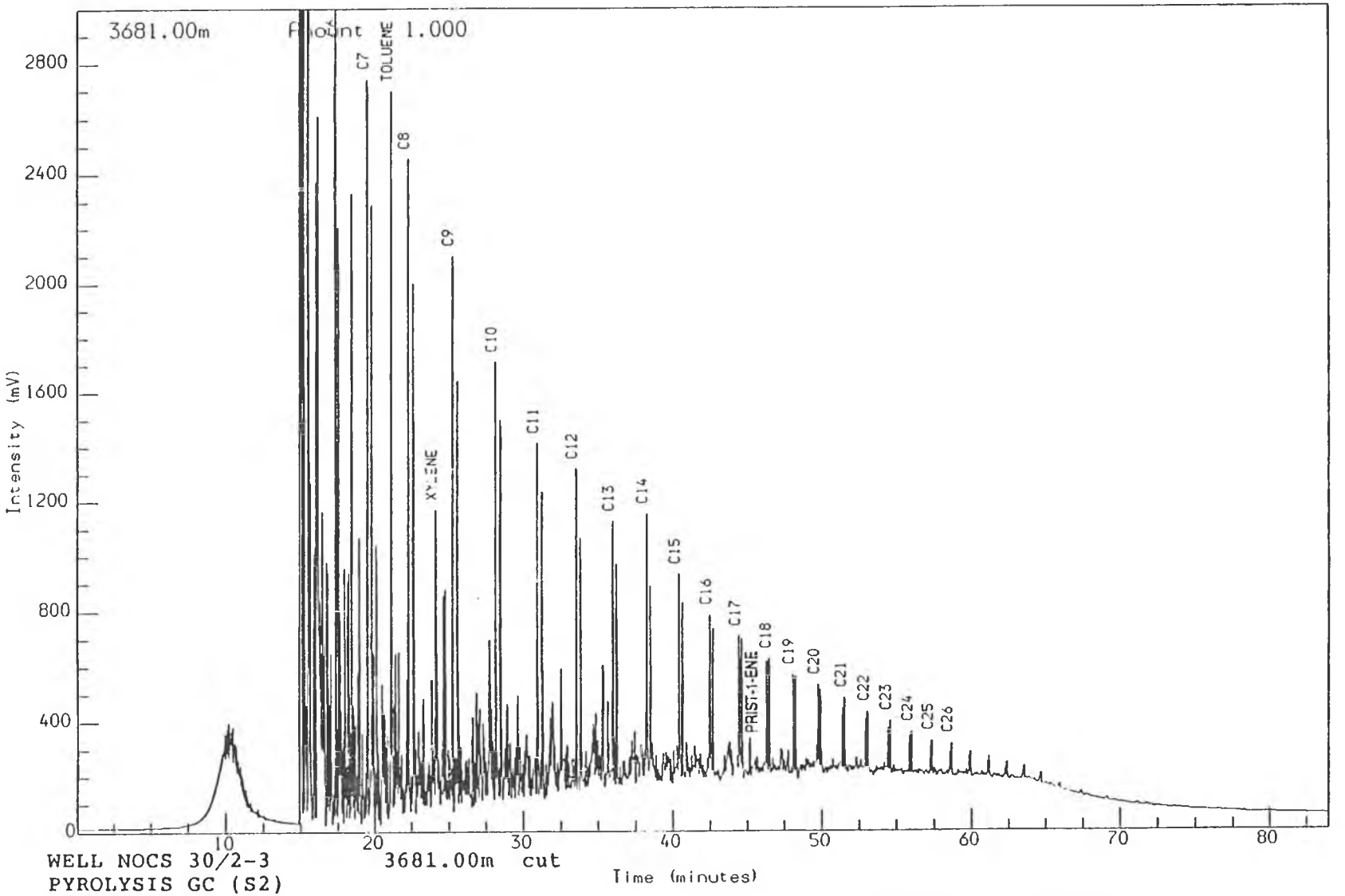
WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Sh/Clst: gy blk

3678.00m cut

Reported on 15-DEC-1992 at 21:53

Analysis Name : [620019] 24 PH9500121.1.1.

Multichrom



WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Sh/Clst: gy blk

3681.00m cut

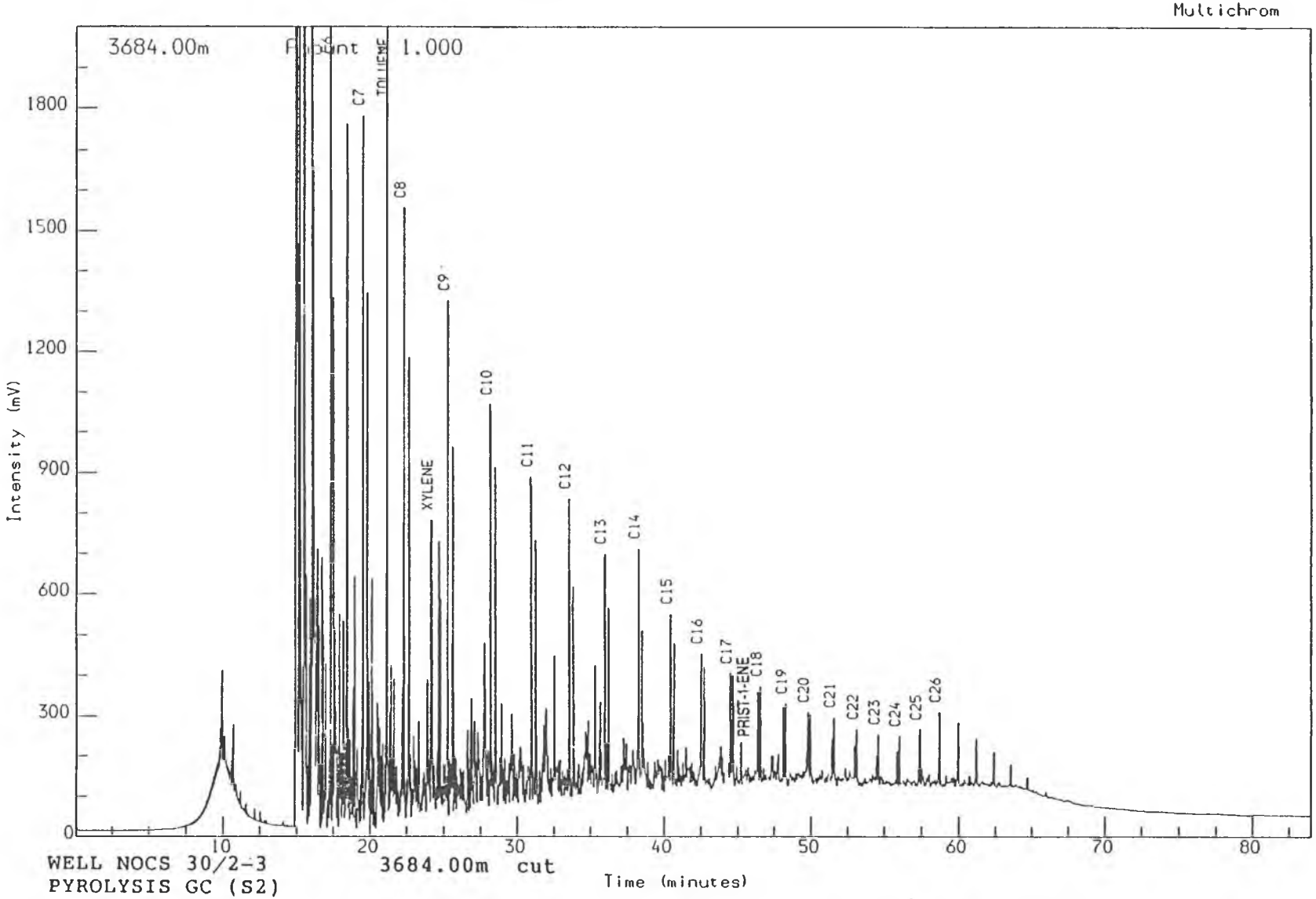
Reported on 15-DEC-1992 at 21:54

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 24 PH9500131,1,1.

Multichrom



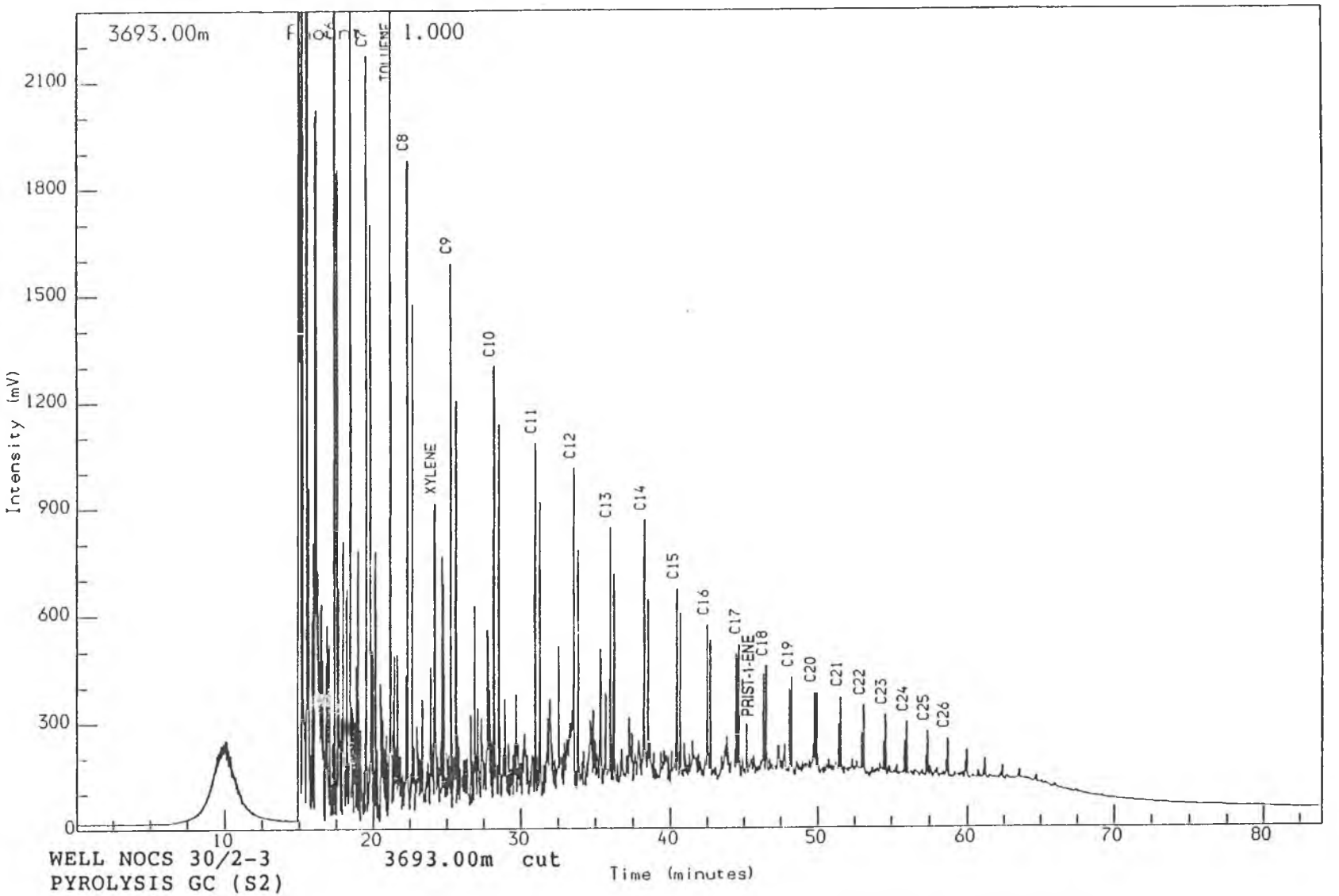
WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Sh/Clst: gy blk

3684.00m cut

Reported on 15-DEC-1992 at 21:55

Analysis Name : [62019] 24 PH9500141.1.1.

Multichrom



WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Sh/Clst: gy blk

3693.00m cut

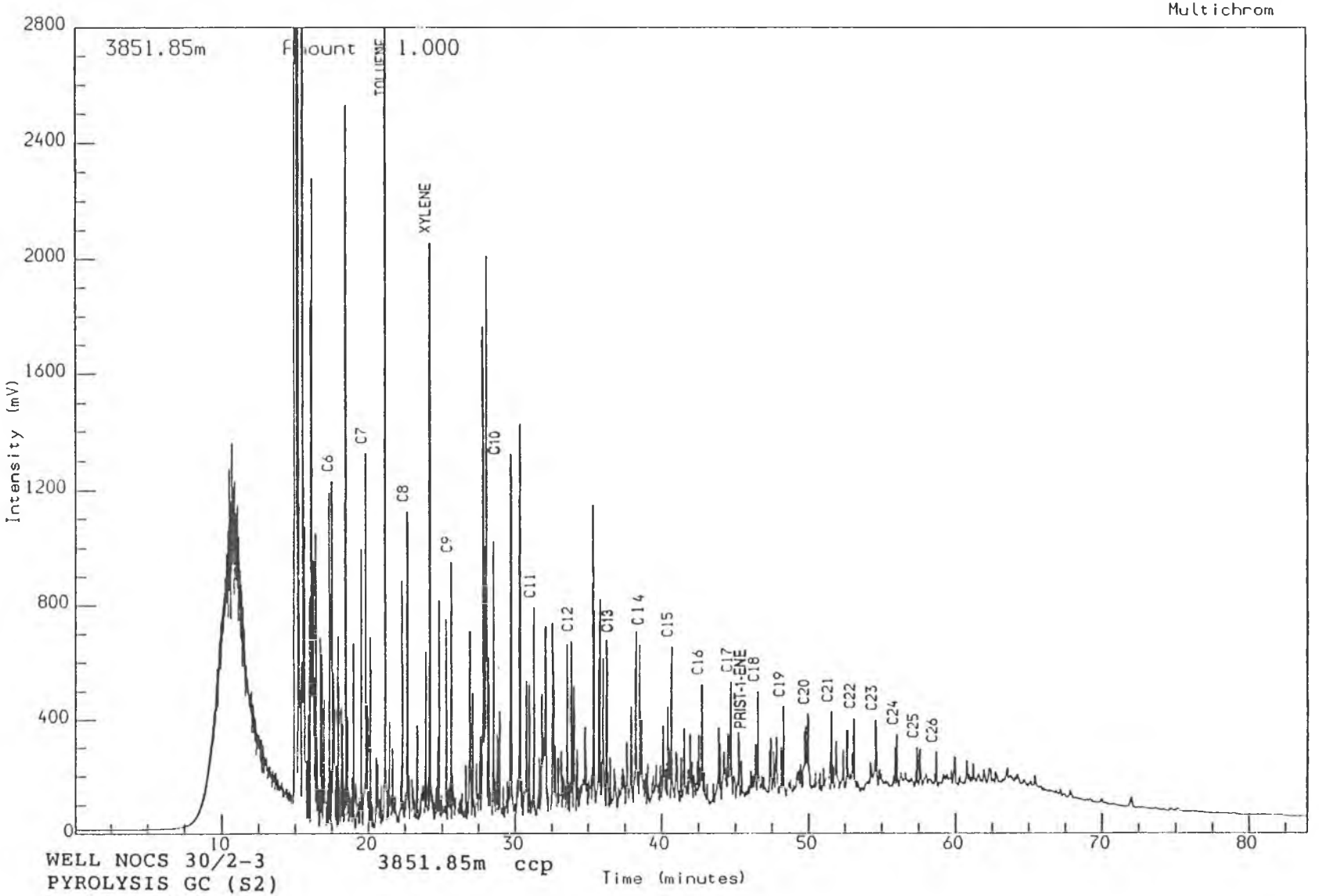
Reported on 15-DEC-1992 at 21:57

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 24 PH9500311,1,1.

Multichrom



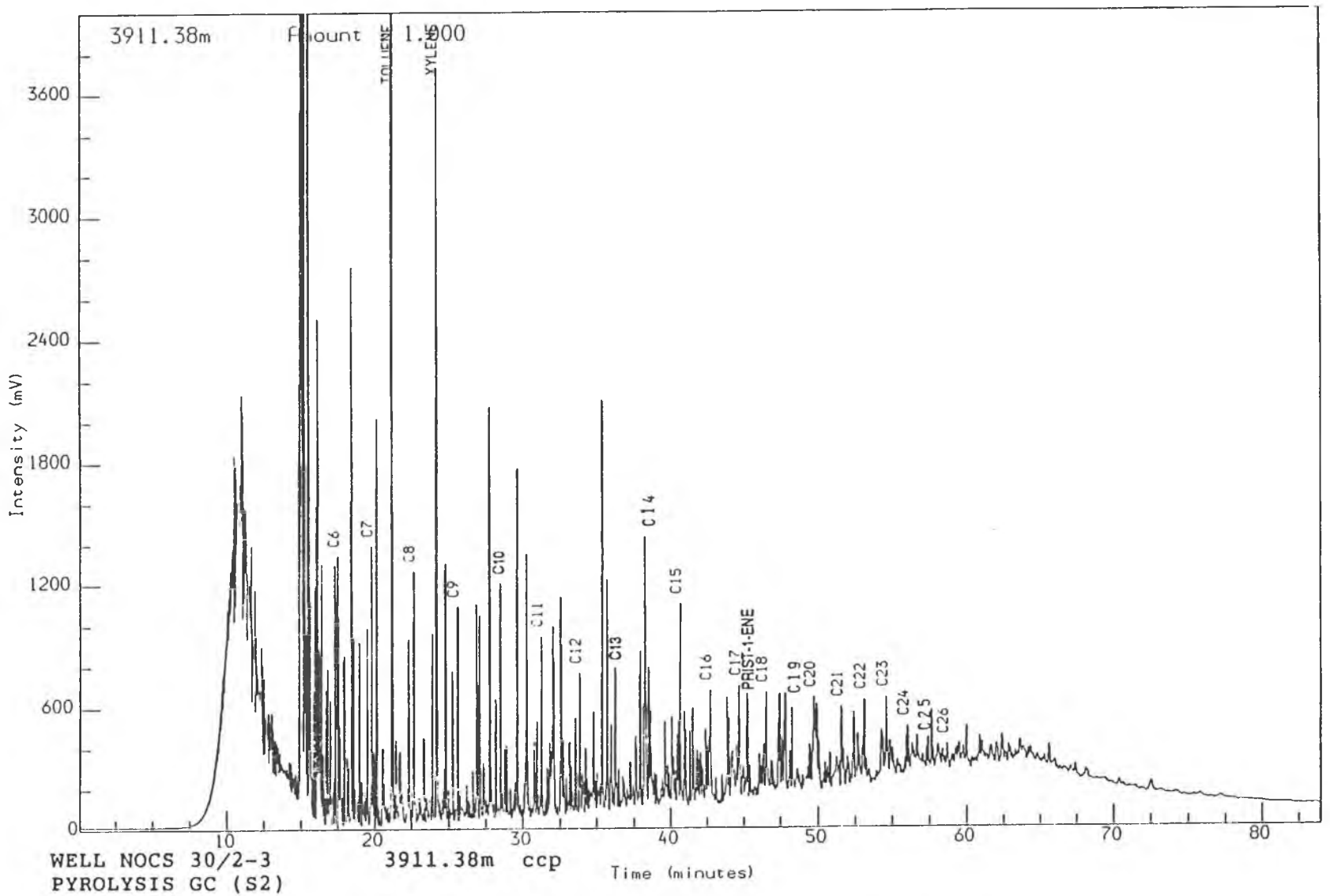
WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Coal: gy blk

3851.85m ccp

Reported on 15-DEC-1992 at 21:58

Analysis Name : [62019] 24 PH9500331,1,1.

Multichrom



WELL NOCS 30/2-3 3911.38m ccp
PYROLYSIS GC (S2)
Coal: blk

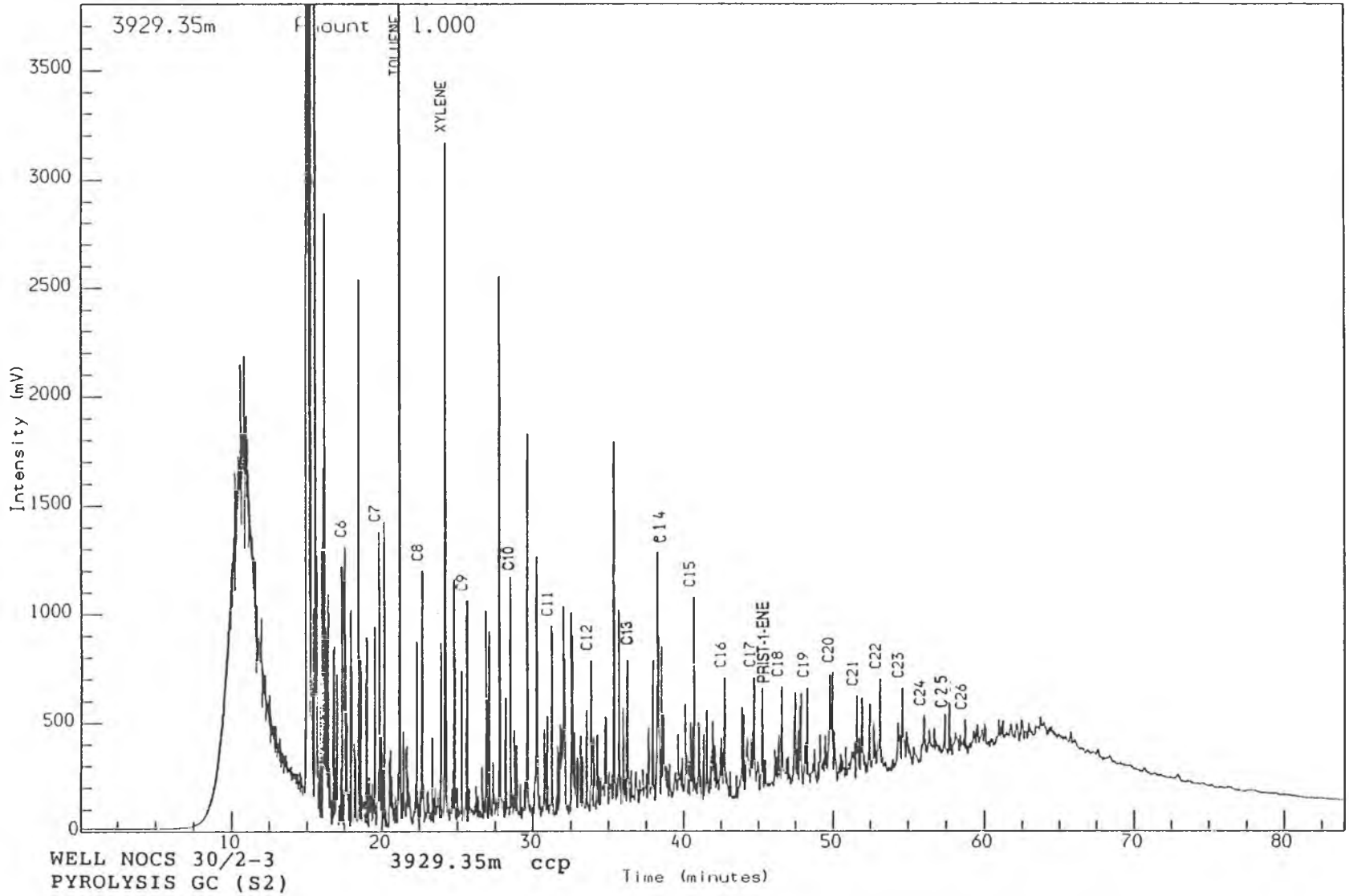
Reported on 15-DEC-1992 at 21:59

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 24 PH9500341.1.1.

Multichrom



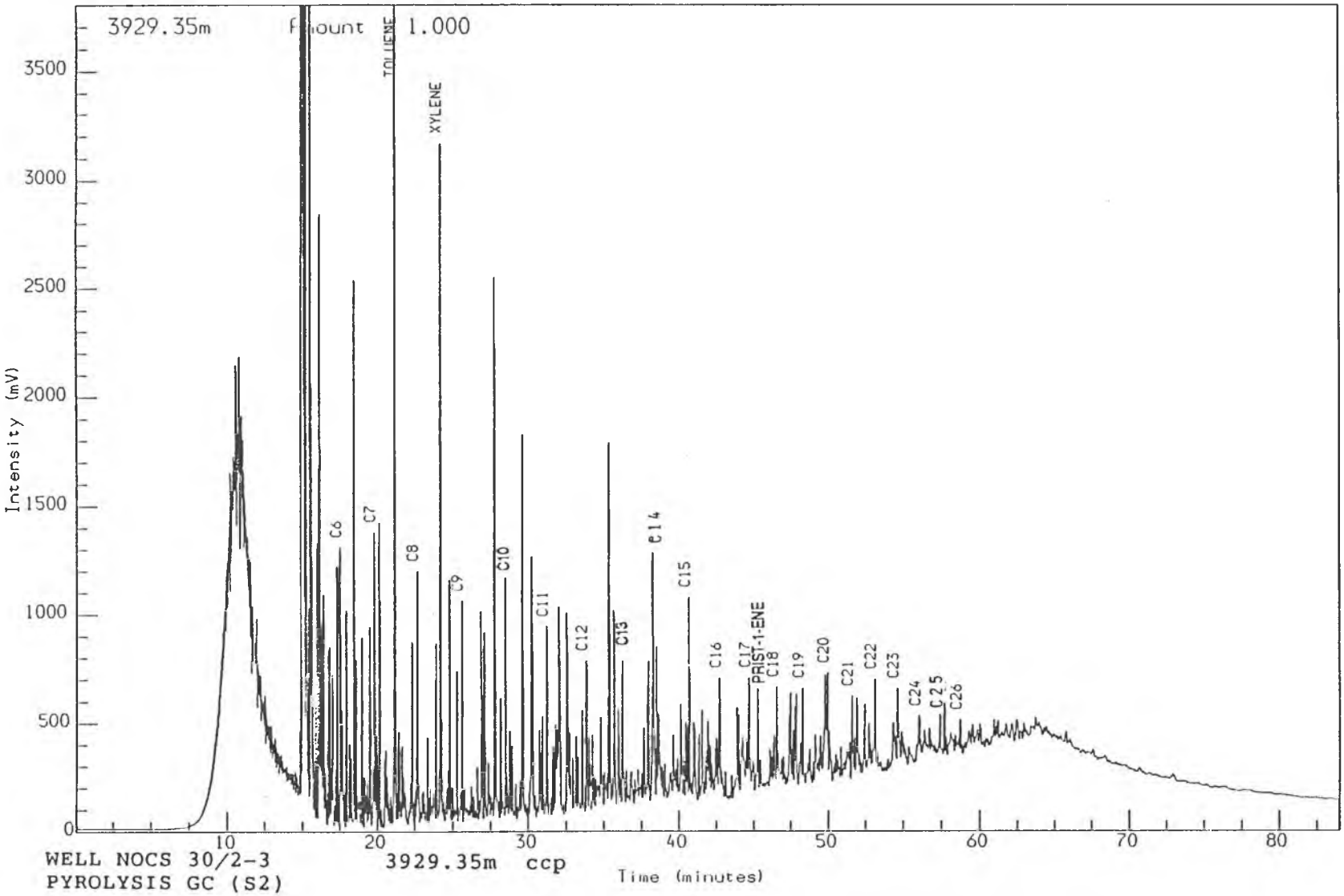
WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Coal: blk

3929.35m ccp

Reported on 15-DEC-1992 at 22:00

Analysis Name : [62019] 24 PH9500341.1.1.

Multichrom



WELL NOCS 30/2-3
PYROLYSIS GC (S2)
Coal: blk

3929.35m ccp

Reported on 15-DEC-1992 at 22:00

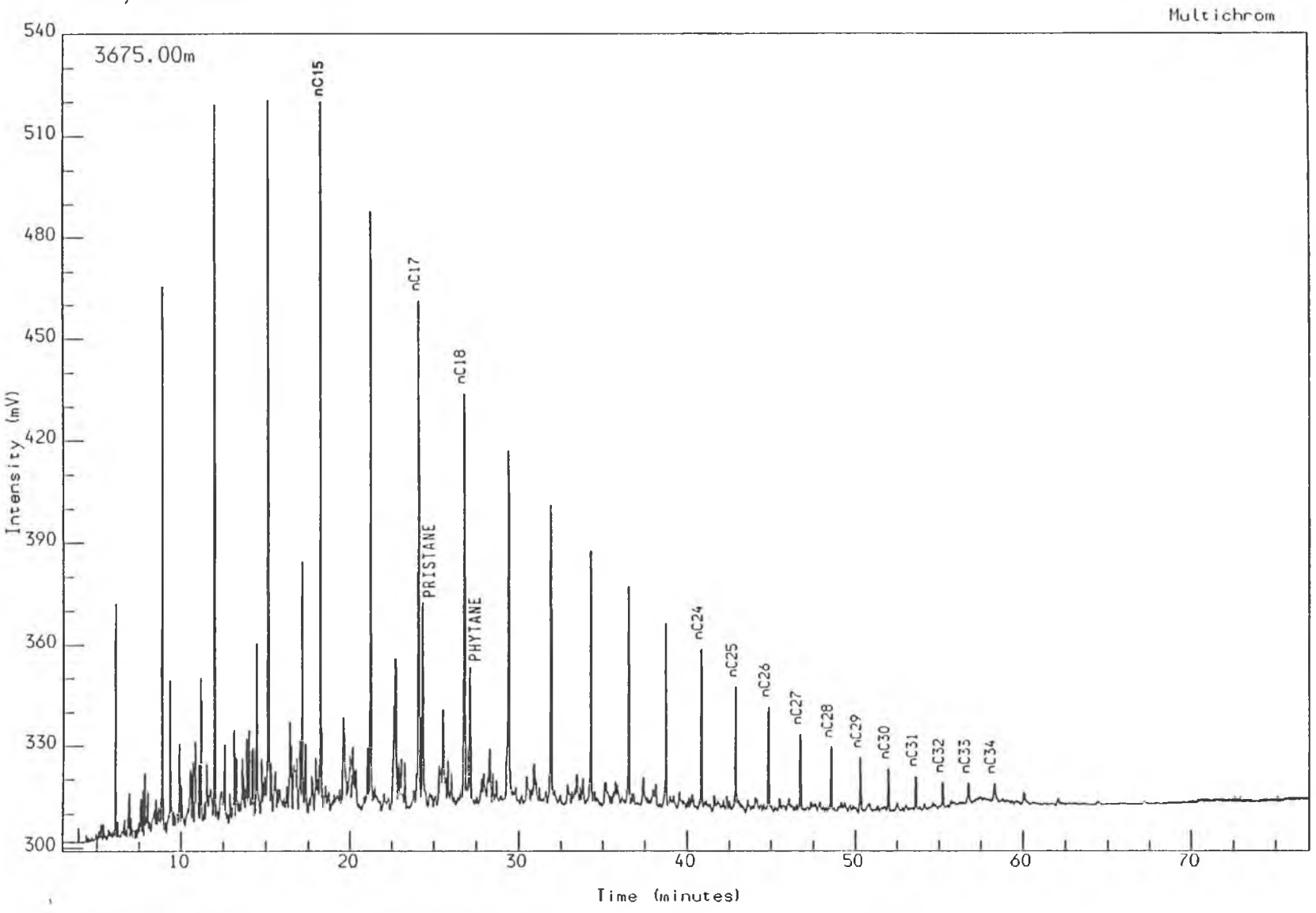
Appendix 3

I Saturated Fraction Chromatograms (FID)

II Aromatic Fraction Chromatograms (FID& FPD)

Saturated Fraction Chromatograms (FID)

Analysis Name : [62019] 5 SH9500101L,2,1.

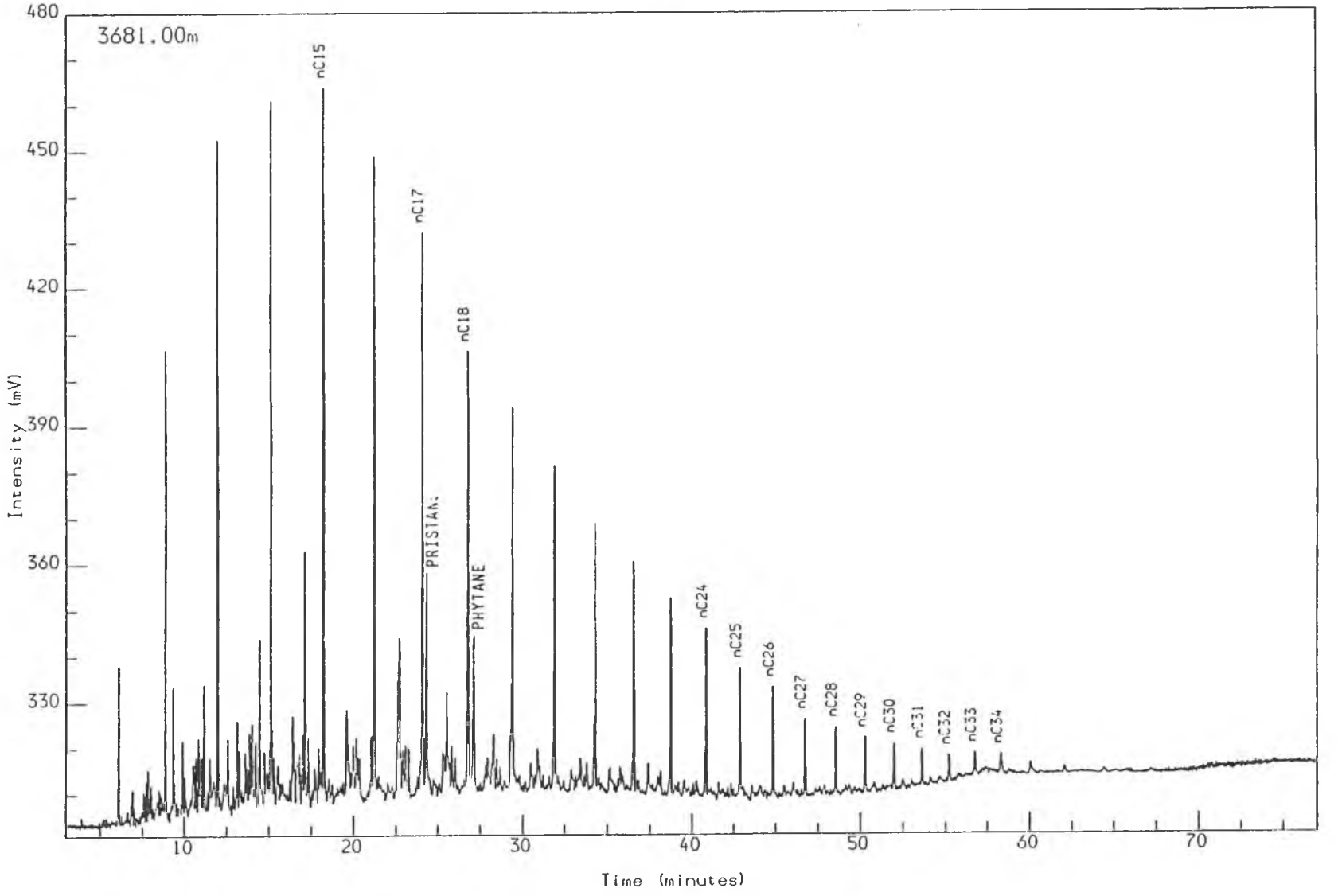


WELL NOCS 30/2-3 3675.00m cut
SATURATED GC
Sh/Clst: gy blk to drk gy

Reported on 21-DEC-1992 at 12:53

Analysis Name : [62019] 5 SH9500101L,3,1.

Multichrom



WELL NOCS 30/2-3 3681.00m cut

SATURATED GC

Sh/Clst: gy blk

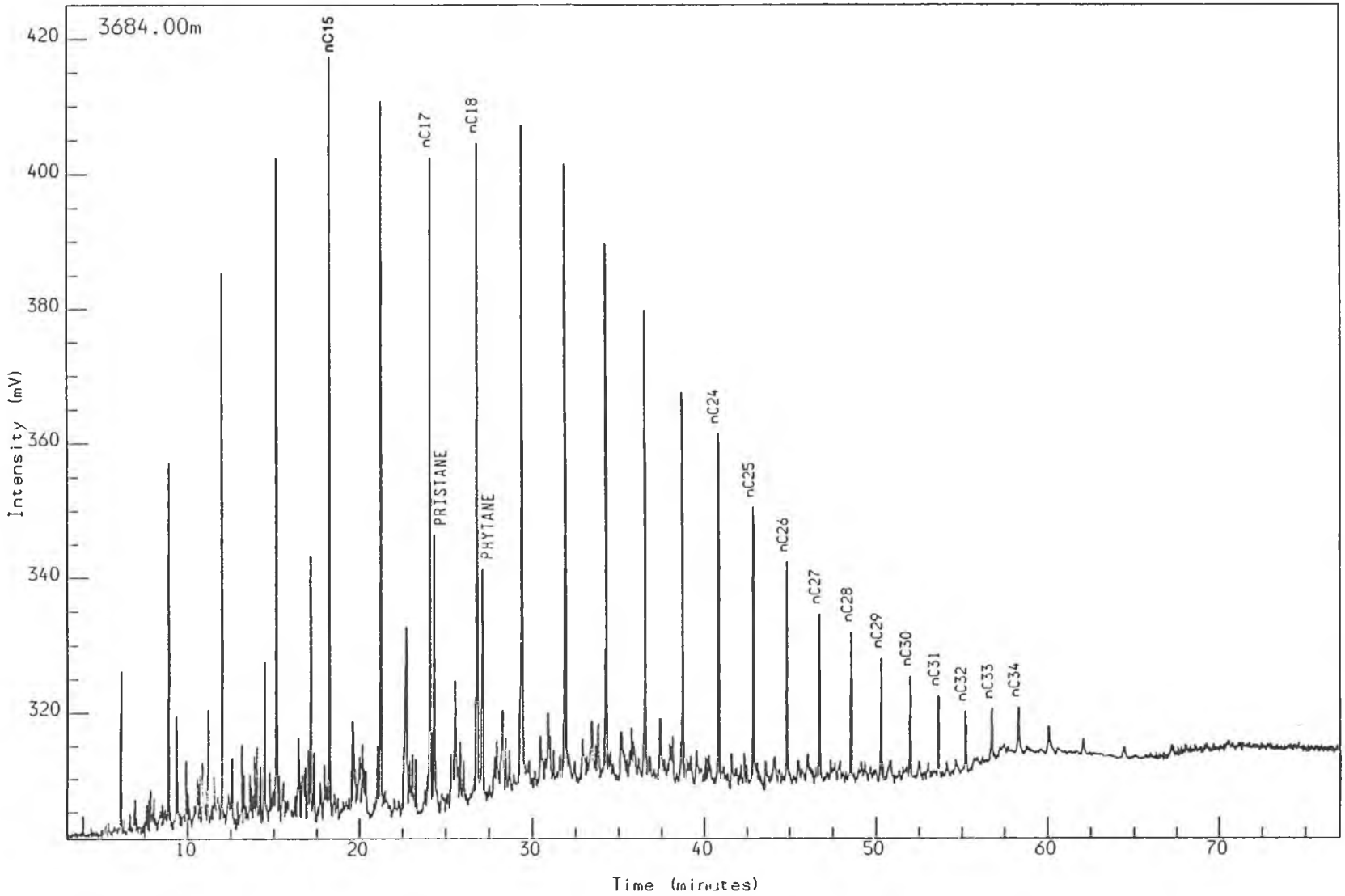
Reported on 21-DEC-1992 at 13:28

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 5 SH9500101L,4,1.

Multichrom



WELL NOCS 30/2-3 3684.00m cut

SATURATED GC

Sh/Clst: gy blk

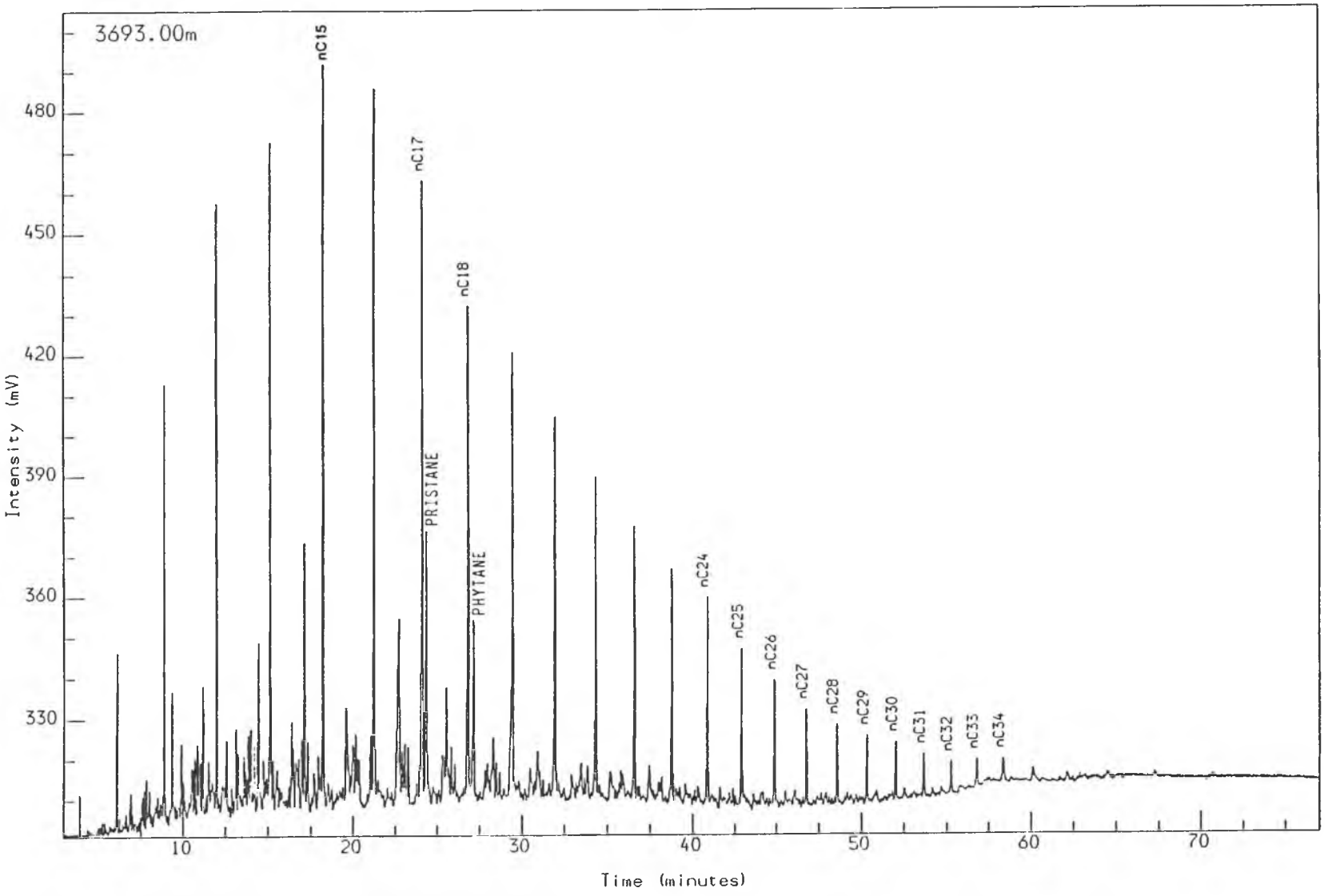
Reported on 21-DEC-1992 at 13:40

Schlumberger GECO-PRAKLA

GEOLAB NOR

Analysis Name : [62019] 5 SH9500101L,5,1.

Multichrom



WELL NOCS 30/2-3 3693.00m cut

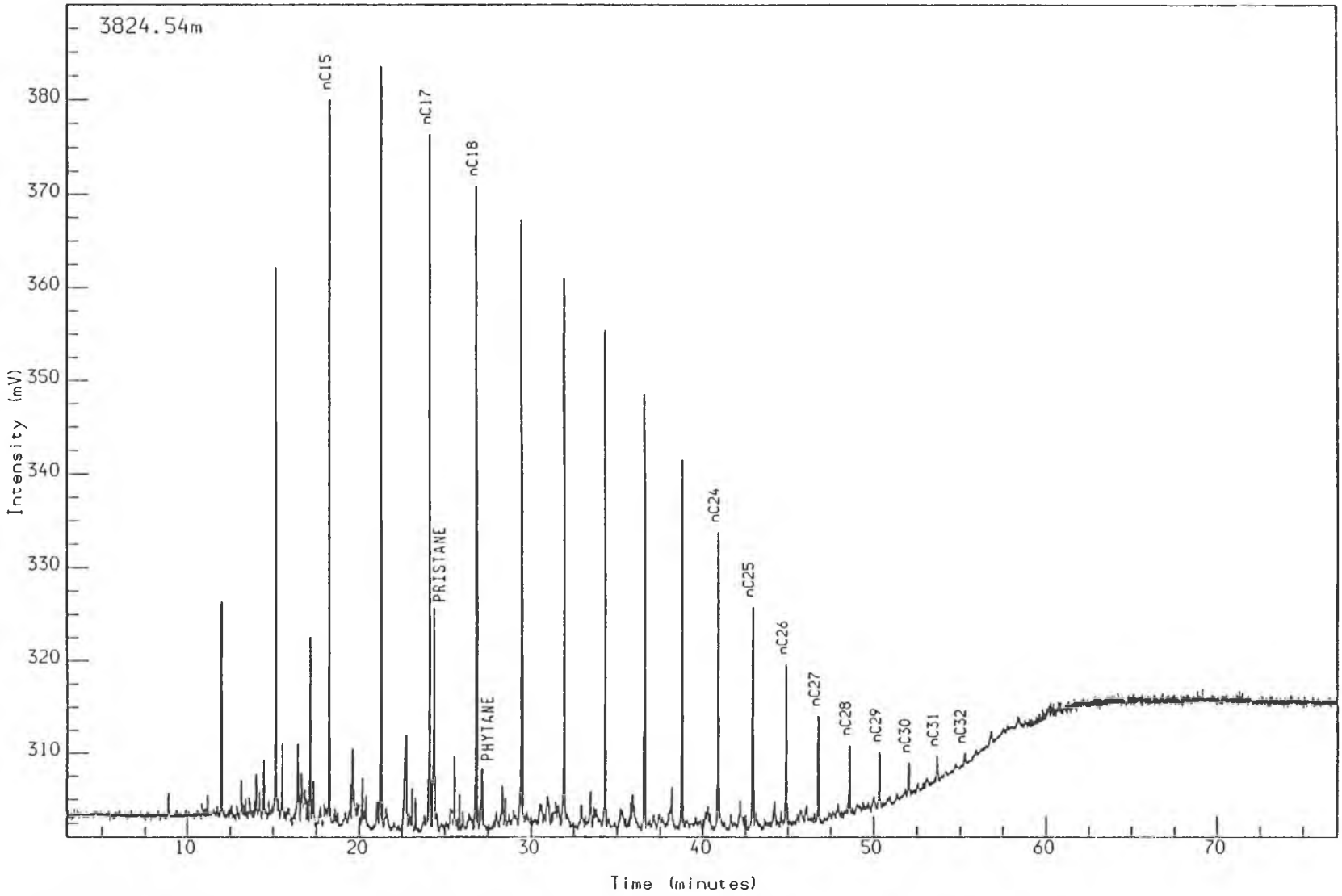
SATURATED GC

Sh/Clst: gy blk

Reported on 21-DEC-1992 at 13:42

Analysis Name : [62019] 5 SH9500101L,6,1.

Multichrom

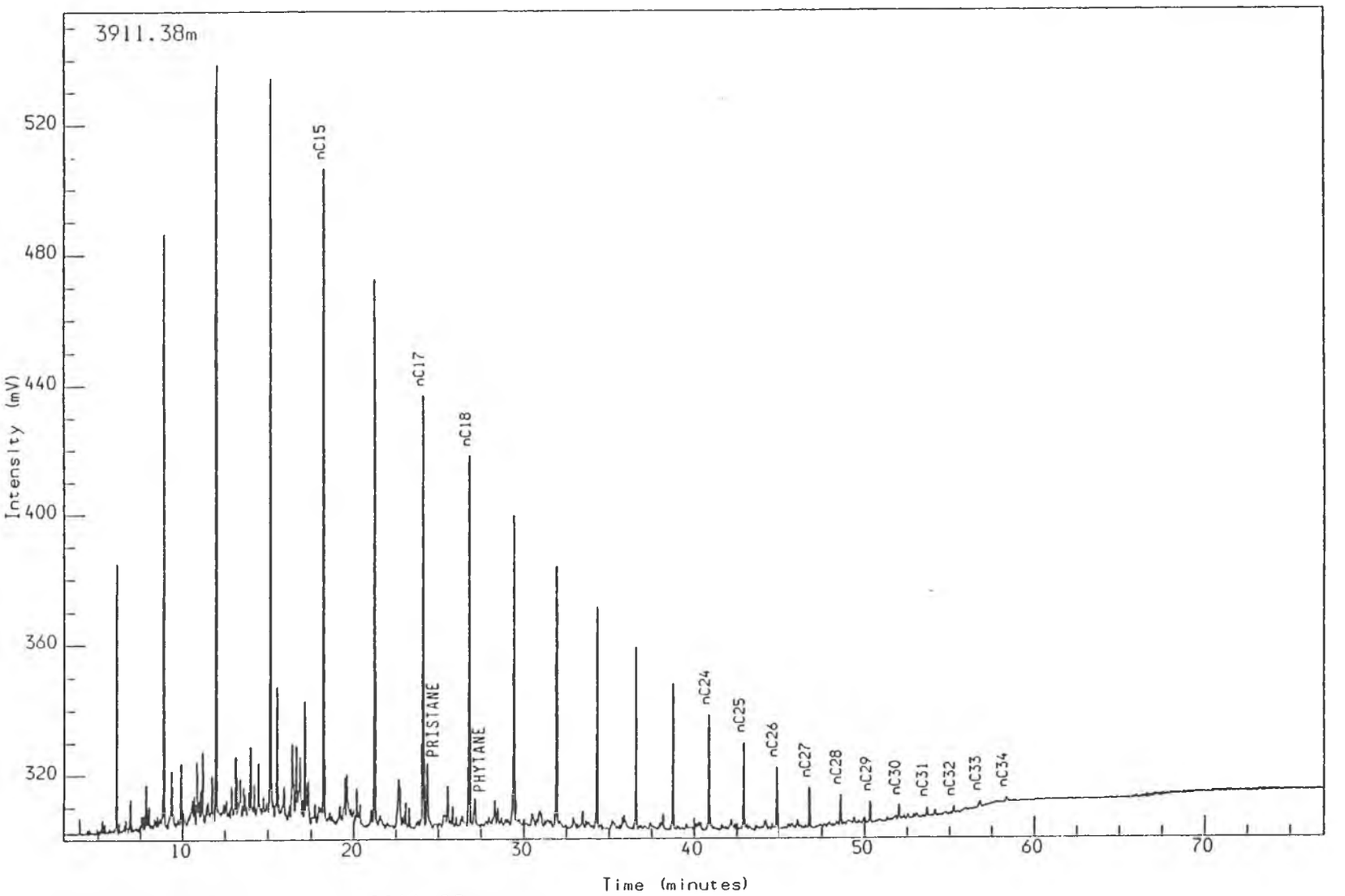


WELL NOCS 30/2-3 3824.54m ccp
SATURATED GC
Coal: brn blk

Reported on 21-DEC-1992 at 13:51

Analysis Name : [62019] 5 SH9500101L,7,1.

Multichrom



WELL NOCS 30/2-3 3911.38m ccp

SATURATED GC

Coal: blk

Reported on 21-DEC-1992 at 13:59

Schlumberger GECO-PRAKLA

GEOLAB NOR