Schlumberger GECO-PRAKLA

GEOLAB NOR

Geochemical Report for

Well NOCS 15/12-5

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Summary

Source Rocks

The Upper Jurassic Draupne Fm. (2841 - 2888 m) claystone is an oil- and gas-prone marine type II/III kerogen source rock with a good petroleum potential. The mainly liptinitic Draupne Fm. was deposited under anoxic conditions. The upper part of the Heather Fm. (2888 - 2918 m) consisting partly of liptinitic and partly inertinic/vitrinitic kerogen is considered to have a fair potential for gas generation.

Maturity

The maturity profile established for the well, based on Tmax from Rock-Eval analyses and vitrinite reflectance measurements, suggests that early maturity (Ro = 0.5 % for type II kerogen) occurs at approximately 2000 m. The top of the oil window (Ro = 0.6 %) is considered to be at approximately 2850 m, and the base of the oil window (Ro = 1.0 %), from extrapolation from the SCI-data, is at approximately 4400 m. The established maturity trend is indicative of a low temperature gradient for the well. The Draupne Fm. lies close to the top of the oil window, suggesting that hydrocarbons might have been generated in minor amounts.

Generation

The moderate maturity of the Draupne Fm. claystones indicates that hydrocarbon generation has been modest. Expulsion is not likely to have taken place. The upper part of the Heather Fm. is not considered to have generated gaseous hydrocarbons in significant yields.

Migration

Oil shows, derived from highly mature marine source rocks, are encountered in the Middle Jurassic Hugin Fm. The oil shows have similar compositions indicating homogeneity in the oil leg, which is approximately 25 m thick (i.e. the upper part of the Hugin sandstone). A gas/condensate phase is possibly present in the Heather Fm. sandstone interval, overlying the Hugin Fm.

Chapter 1

INTRODUCTION

1.1 General Comments

The well NOCS 15/12-5 is located in the Norwegian North Sea Sector in the South Viking Graben area (Figure 1). The well is placed centrally on the Beta-Central structure on block 15/12. The primary objective of the well was the Jurassic sandstones, the secondary objective being fractured sandstones of Cretaceous age. The well was drilled to a total depth of 3150 m into the Triassic. All depths given are relative to KB unless otherwise specified.

The geochemical study included investigation of potential source rocks, including the Upper Jurassic Draupne Fm. and of oil shows present in the Middle Jurassic Hugin Fm. sandstone. Both screening and follow-up analyses were performed in order to evaluate potential source rocks and migrated hydrocarbons. 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.

1.2 Analytical Program

The following analysis program was executed for well NOCS 15/12-5, based on the sample availability and quality and the screening analysis results, covering the section 1060 m to 3107 m:

Analysis type	No of samples	Figures	Tables
Lithology description	151	2	1
Rock-Eval Pyrolysis/TOC	77	2,3,4,5	2
Thermal extraction (GHM, S_1)	21	6a-f	
Pyrolysis GC (GHM, S_2)	21	7a-e,8	3
Soxhlet extraction of organic matter	9		
MPLC/HPLC separation	9		4a-d
Saturated hydrocarbon GC	9	9a-d	5
Aromatic hydrocarbon GC	9	10a-e	6
Vitrinite reflectance	20	11	7
Visual kerogen microscopy	10	12	7,8
Isotope composition C_{15}+ fraction	7	13,14	9a-b
GS-MS of saturated HC	7	15a-r	10a-i

1.3 Stratigraphy

The stratigraphy for well NOCS 15/12-5 as supplied by the Norwegian Petroleum Directorate (NPD) is presented below:

Lithostratigraphic Unit	Age	Top RBK (m)	Thickness (m)
Nordland Gp.	Pliocene-Miocene	105	1142
Utsira Fm.	Miocene	1024	223
Hordaland Gp.	Oligocene-Eocene	1247	1029
Rogaland Gp.	Paleocene	2276	163
Balder Fm.	Paleocene	2276	15
Sele Fm.	Paleocene	2291	34
Lista Fm.	Paleocene	2325	93
Maureen Fm.	Paleocene	2418	21
Shetland Gp.	Upper Cretaceous	2439	353
Ekofisk Fm.	Upper Cretaceous	2439	18
Tor Fm.	Upper Cretaceous	2457	158
Hod Fm.	Upper Cretaceous	2615	135
Blodøks Fm.	Upper Cretaceous	2740	52
Cromer Knoll Gp.	Lower Cretaceous	2792	49
Rødby Fm.	Lower Cretaceous	2792	35
Sola Fm.	Lower Cretaceous	2827	14
Viking Gp.	Upper Jurassic	2841	77
Draupne Fm.	Upper Jurassic	2841	47
Heather Fm.	Upper Jurassic	2888	30
Vestland Gp.	Middle Jurassic	2918	109
Hugin Fm.	Middle Jurassic	2918	109
Triassic Gp.	Triassic	3027	123
Skagerrak Fm.	Triassic	3027	123
TD		3150	

Chapter 2

SCREENING ANALYSES

A total of 151 samples covering the depth interval 1060 - 3107 m was described lithologically. The lithology descriptions are presented in Table 1 together with the TOC data. Seventy-seven samples were selected for Rock-Eval pyrolysis/TOC analysis. The Rock-Eval data are presented in Table 2. The Total Organic Carbon versus depth is shown in Figure 2, the Production Index (PI) versus depth and the Tmax versus depth are shown in Figures 3 and 4 respectively. The Tmax versus Hydrogen Index cross plot is presented 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 forty-one Tertiary Hordaland Gp. (1247 - 2276 m) cuttings samples consist mainly of pale yellowish brown to dusky (yellowish) brown siltstone in the upper approximately 350 m, with a change to light brownish grey to pale yellowish brown silty and calcareous claystone from about 1600 m, ranging to light to medium grey to pale yellowish green claystones in the lower part of the group. The fifteen samples picked for Rock-Eval analysis show very variable contents of TOC (0.06 - 5.59 % TOC), with generally higher TOC-contents in the siltstone samples, whereas the claystone samples have contents lower than 2 % TOC. The hydrogen index values (84 - 374 mg HC/g TOC) and oxygen index values (41 - 320 mg CO_2/g TOC) are supportive of type III to type IV kerogen source rocks with poor to good petroleum potential (0.3 - 9.1 mg HC/g rock) for generating gas.

The Tertiary Rogaland Gp. (2276 - 2439 m) consists of light to medium grey claystones alternating with medium to pale brown silty claystones. The two samples analysed by Rock-Eval have fair TOC contents (0.97 and 0.71 % TOC, respectively), and HI-values and OI-values indicative of type III and IV kerogen source rocks with a poor petroleum potential (< 2 mg HC/g rock).

The Upper Cretaceous Shetland Gp. (2439 - 2792 m) is a white chalk unit in the upper approximately 150 m, changing to white to pinkish grey chalk in a 35 m interval in the lower part of the Tor Fm. and upper part of the Hod Fm., changing to white chalk in the lower part of the Shetland Gp. Sandstone occurs in significant amounts in the lowest part, i.e. the Blodøks Fm. The twenty Shetland Gp. chalk samples and four sandstone/composite samples have no source rock potential.

The Lower Cretaceous Cromer Knoll Gp. (2792 - 2841 m) samples, consisting of greyish red silty marl in the upper part, changing to light to medium grey to pale olive to pale yellowish green claystones, have no source rock potential.

The Upper Jurassic Draupne Fm. (2841 - 2888 m) is a medium to dark grey to brownish black calcareous claystone changing to medium to dark grey clayey siltstones in the lower approximately 20 m. The fair to good TOC contents (1.82 - 2.91 % TOC) and HI-values ranging 239 - 338 mg HC/g rock and generally low OI-values indicate a mixed type II/III kerogen source rock with a good potential (PP: 5.5 - 8.9 mg HC/g rock) for generating oil and gas.

The six Upper Jurassic Heather Fm. (2888 - 2918 m) core chip samples consist of brownish grey to dusky brown siltstones in the upper part changing to a brownish grey, silty and micaceous sandstones in the lower part. The upper siltstone sample (2892 m) appears to have a marginally fair petroleum potential (3.2 mg HC/g rock), probably for gas generation. The other samples have no source rock potential.

The Hugin Fm. of the Middle Jurassic Vestland Gp. (2918 - 3027 m) consists of pale yellowish brown, micaceous sandstones in the upper part, changing to white to light grey coarse-grained sandstones, which are cemented and kaolinitic. A total of nineteen samples was described, including ten core chips and nine cuttings samples. The Hugin

Fm. has no source rock potential.

The Triassic Skagerrak Fm. (3027 - 3150 m (TD)), is similar to the overlying Hugin Fm., i.e. a sandstone unit. The fourteen cuttings samples consist of fine to coarse grained partly cemented sandstone. The unit has no source rock potential.

2.2 Maturity

From Section 2.1 it follows that the potential source rocks are limited to the Hordaland and Rogaland Gps. and the Draupne and Heather Fms. of the Viking Gp. The Tmax maturity profile (Figure 4) indicates that early maturity (Tmax = 430°C for type II kerogen) is reached at approximately 2400 m. The top of the oil window, equivalent to Tmax = 435°C for type II kerogen, is considered to be reached at about 3200 m, i.e. below TD. The oil- and gas-prone Draupne and Heather Fms.' claystones are considered to be early to moderately mature.

2.3 Generation

No significant amounts of hydrocarbons are considered to have been generated by the source rocks in this well according to the estimated maturity profile.

2.4 Migrated Hydrocarbons

The presence of migrated hydrocarbons, derived from the S_1-yields and production index values (PI), shows that the Upper Cretaceous Shetland Gp. chalks contain very small amounts of free hydrocarbons (S_1 < 0.10 mg HC/g rock). Possible loss of light hydrocarbons due to evaporation may have occurred however. The uppermost approximately 30 m of the Middle Jurassic Hugin Fm. (2918 - 3027 m) sandstones have fair to good S_1-yields (1.94 - 10.68 mg HC/g rock) as well as high PI-values (0.60 - 0.72). Hence the oil leg is considered to be approximately 30 m. The pronounced decrease in S_1-yields from 2952 m (< 1 mg HC/g rock) suggests an oil - water contact zone at this depth. The Triassic Skagerrak Fm. has similar low S_1-yields, suggesting a continuous water leg from approximately 2950 m to TD.

Chapter 3

DETAILED GEOCHEMICAL ANALYSES

3.1 GHM - Thermal Extraction

A total of twenty-one samples was analysed using the combined GHM thermal extraction - pyrolysis GC technique. The samples include both cuttings and core chips. Selected thermal extract crhomatograms are presented in Figures 6a-f. All the chromatograms are presented in Appendix 3.

The two Nordland Gp. (105 - 1247 m) cuttings samples contain gaseous as well as n-alkanes in the C_{10} - C_{19} range, these being most pronounced in the upper claystone sample (1060 m), indicating staining of migrated hydrocarbons in these immature sediments.

The three Hordaland Gp. (1247 - 2276 m) cuttings samples and one Rogaland Gp. (2276 - 2439 m) sample have similar thermally extractable hydrocarbon distributions to those of the Nordland Gp. samples, e.g. 1930 m in Figure 6a. The pristane/phytane ratios (greater than 2) indicate a terrestrial source, possibly with some marine contributions as well. Additionally, the pristane/nC_{17}- and phytane/nC_{18}-ratios are less than 0.5, indicative of a mature source. The intermediate range hydrocarbons are considered to have migrated into the Hordaland and Rogaland Gps.

The two Shetland Gp. chalk samples are depleted in free hydrocarbons, however, with traces of intermediate range hydrocarbons, indicative of diffusion of hydrocarbons. The upper sample (2462 m) contains only gaseous hydrocarbons.

The two Draupne Fm. carbonaceous claystone samples contain gaseous hydrocarbons and resolved hydrocarbons in the C_{10} - C_{24} range, consisting of both saturated and aromatic hydrocarbons (Figure 6b). Unresolved material also contributes to the thermally extractable organic matter. The composition of generated hydrocarbons is indicative of early generation. The pristane/phytane ratios of about 3 are indicative of mainly land plant derived organic matter. The pristane/nC_{17} and phytane/nC_{18} ratios are about 2 and 1.2 respectively, supportive of early generated hydrocarbons from early mature source rocks, as previously stated in Section 2.2.

The three Heather Fm. samples (2892 m, 2907 m, 2912 m), including silt- and sandstone samples, appear to contain intermediate range migrated hydrocarbons, dominated by n-alkanes in the C_{12} - C_{20} range, indicative of condensate/light oil (Figure 6c). The hydrocarbons do not appear to have originated from the Draupne Fm., mainly due to significantly different pristane/nC_{17}- and phytane/nC_{18}-ratios. These ratios are significantly lower for the Heather Fm. samples, suggesting a relatively high maturity.

The six Middle Jurassic Hugin Fm. sandstones have thermal extracts, which in the upper three samples (2922 m, 2927 m, 2942 m), considered to be within the oil leg (Section 2.4) show the presence of paraffinic hydrocarbons consisting of n-alkanes in the C_{16} - C_{37} range forming unimodal distributions with general maxima at nC_{20}/nC_{22} (Figure 6d). The pristane/phytane ratios are close to 1 in the two upper samples, and about 0.6 in the lowest sample. The pristane/nC_{17}- and phytane/nC_{18}-ratios are approximately 0.6 - 0.7. The samples elute relatively large amounts of unresolved material which form an envelope under the n-alkanes. The source for the mainly paraffinic waxy oils is probably a mature marine source rock, possibly deposited under highly anoxic conditions. The sample from 2952 m seen in Figure 6e has a different composition of n-alkanes, ranging C_{22} - C_{34}, with an overall maximum at nC_{26}. This sample is more waxy compared to the three previously mentioned samples. Additionally, a homologous series elutes between the n-alkanes. These compounds could be straight alkyl chains with an alkyl side chain. Additionally there is no unresolved material in this sample. The two lowest samples (2985 m, 3014 m) are clearly different from the four previously mentioned samples by having more varied compositions of resolved compounds, consisting of both saturated and aromatic hydrocarbons, possibly derived from indigenous organic matter (Figure 6f). The presence of aromatic hydrocarbons and of high isoprenoid/n-alkane ratios indicate early mature sediments, with contribution from both marine and terrestrial organic matter.

The two Triassic Skagerrak Fm. sandstone samples (3065 m, 3107 m) yield both aromatic and saturated hydrocarbons, these being possibly derived from indigenous organic matter or early generated migrated hydrocarbons. The lowest sample is depleted in hydrocarbons. These two samples, together with the two lowest samples from the Hugin Fm. sandstones, are considered to be within the water leg.

3.2 GHM - Pyrolysis Gas Chromatography

A total of twenty-one samples was analysed by GHM pyrolysis GC. The pyrolysis compositions are listed in Table 3, and these data are plotted in a ternary diagram in Figure 8. Exemplary pyrograms are shown Figures 7a-e. All the pyrograms are shown in Appendix 3.

The six cuttings samples from the Tertiary Nordland, Hordaland and Rogaland Gps. consist of claystones, siltstones and sandstones. The results for the claystones and siltstones are considered to represent indigenous organic matter. The pyrolysates of these five samples have relatively uniform distributions of C_1 - C_5, C_6 - C_{14} and C_{15}+ fractions, with dominance of the intermediate range hydrocarbons (45 - 60 %) and subequal contributions from the C_1 - C_5 and C_{15}+ fractions, i.e. within the 10 - 30 % range. The mono- and diaromatic hydrocarbons dominate in the upper samples, most pronounced in the samples 1060 m, 1150 m and 1570 m. The two lowest samples (1930 m, 2345 m) have less dominance of aromatic hydrocarbons, the pyrolysates having a greater amount of paraffinic hydrocarbons (Figure 7a). The pyrolysis products are indicative of mainly terrestrially derived organic matter, possibly with some contribution from marine organic matter. The immature claystones and siltstones have potential for generating both light oil and gaseous hydrocarbons. The sandstone sample (1390 m) has a pyrolysate dominated by monoaromatic hydrocarbons, indicating contribution from terrestrial organic matter with little hydrocarbon generation potential.

The two Upper Cretaceous Shetland Gp. (2439 - 2792 m) chalk samples have pyrolysates consisting of gaseous hydrocarbons, mainly monoaromatic compounds. The pyrolysates are considered to originate from indigenous type IV kerogen organic material.

The two Upper Jurassic Draupne Fm. (2841 - 2888 m) claystone pyrolysates consist mainly of paraffinic hydrocarbons with resolved n-alkene/n-alkane doublets in the C_6 - C_{30} range (Figure 7b). The C_6 - C_{15} n-alkenes dominate relative to the associated n-alkanes, suggesting contribution from asphaltenic compounds. Monoaromatic hydrocarbons are present in abundant peak intensities, probably reflecting some land plant contribution. The type II/III kerogen pyrolysate compositions are indicative of a good to rich potential for oil generation and to a less extent for gas generation.

The three Upper Jurassic Heather Fm. (2888 - 2918 m) siltstone (2892 m) and sandstone samples (2907 m, 2912 m) have similar pyrograms, consisting of n-alkene/n-alkane doublet homologous series ranging C_6 - C_{30} (Figure 7c). The aromatic hydrocarbons are present in abundant amounts, especially in the sandstone samples. The clear predominance of the n-alkenes in the C_6 - C_{15} range suggests that the pyrolysates are generated mainly from asphaltenic material. However, it cannot be ruled out that indigenous organic matter also contributes to the pyrolysates.

The six Middle Jurassic Hugin Fm. (2918 - 3027 m) sandstone samples have pyrolysates with a clear predominance of paraffinic hydrocarbons in the C_6 - C_{30} range, e.g. 2927 m in Figure 7d. The asphaltenic origin of the pyrolysates suggests the waxyness obtained from the S_1-chromatograms (Section 3.1) of the oils are associated with the asphaltenes of the oils, either by cracking of n-alkanes from macromolecular structures (i.e. asphaltenes) or through a natural association of longer chained n-alkanes with the more polar compounds of the oils. The sample, 2952 m, has a pyrolysate with low peak intensities, and is hence significantly different to the three upper samples. This sample has a low S_2-yield (0.33 mg HC/g rock), indicative of low contents of asphaltenic material/indigenous organic matter. The two samples from the water leg (2985 m, 3014 m) have pyrolysates dominated by aromatic hydrocarbons and minor contributions from paraffinic hydrocarbons. The pyrolysate compositions are indicative of mixed contributions from indigenous terrestrial organic matter (type IV kerogen) and from asphaltenic material seen in 3014 m (Figure 7e).

The uppermost Triassic Gp. sample, 3065 m, has a pyrolysate consisting mainly of aromatic hydrocarbons and less abundant paraffinic hydrocarbons. The origin of the pyrolysate is not certain, but the composition suggests derivation from a type III kerogen, possibly reflecting indigenous organic matter. The lowest sample has a number of unidentified compounds eluting between 33 and 50 minutes, possibly reflecting contamination from coal/lignite added to the drilling mud.

3.3 Solvent Extraction and Chromatography

Nine samples, including four cuttings samples and five core chip samples, were solvent extracted, using the Soxtec extraction method. Deasphalting and separation of the maltenes into four fractions by MPLC was subsequently carried out. The EOM amounts and compositions are presented in Tables 4a-d. Bulk data from the extraction and MPLC separation are shown in Enclosure 2. Gas chromatography of the saturated and aromatic hydrocarbon fractions was performed. The derived data from the saturated hydrocarbon GC are presented in Table 5, and selected chromatograms are shown in Figures 9a-d. The aromatic hydrocarbon GC (FID and FPD) data are presented in Table 6 and selected FID- and FPD-chromatograms are shown in Figures 10a-e. All saturated and aromatic hydrocarbon GC chromatograms are found in Appendix 4. Enclosure 4 shows selected saturated hydrocarbon GC ratios.

3.3.1 Extraction

The three Tertiary cuttings samples (1150 m, 1570 m, 1930 m) have fair to marginally good contents of extractable organic matter (1118 - 2110 ppm EOM), with a clear predominance of the non-hydrocarbons (939 - 1764 ppm), whereas the hydrocarbons constitute 178 - 668 ppm. NSO-compounds contribute the single largest fraction (917 - 1730 ppm). The EOM-compositions are indicative of immature source rocks which have not commenced generation of hydrocarbons. The organic carbon normalized extractable hydrocarbons (EHC) contents, ranging 7.21 - 32.43 mg EHC/g TOC, are classified as poor to good. The lowest sample, 1930 m, has the greatest EHC content, this possibly being due to staining by migrated hydrocarbons rather than in-situ generation, which is ruled out due to the low maturity of the claystone.

The single Upper Jurassic Draupne Fm. carbonaceous claystone has a rich EOM-content (6374 ppm), with similar relative contributions from the hydrocarbons and non-hydrocarbons as the Tertiary samples, i.e. having a predominance of the more polar compounds. This is in agreement with a moderately mature oil-prone source rock

(Sections 2.1 and 3.1) which has not yet started to generate hydrocarbons in significant amounts, although there is a rich content of extractable hydrocarbons (75 g EHC/g TOC).

The two Upper Jurassic Heather Fm. samples, including a siltstone (2892 m) and a sandstone (2907 m) have subequal contents of hydrocarbons and non-hydrocarbons (297 - 440 ppm and 297 - 303 ppm respectively). The fair EOM contents (594 - 743 ppm) indicate that oil is present in trace amounts.

The Hugin Fm. (Vestland Gp.) sandstone core chip samples are considered to be located within the oil leg (2927 m, 2942 m) and at the oil-water contact zone (2952 m). The two upper samples have very rich EOM-contents (14274 and 7776 ppm respectively), with a predominance of hydrocarbons (11736 and 5292 ppm). The saturated hydrocarbon fraction is the single most predominant compound class (10362 and 4002 ppm). The poor EOM-content (145 ppm) in the lower sample, dominated by polar compounds, suggests that this sample is from beneath the oil-water contact zone. The oil compositions in the two upper samples vary, the largest relative contribution of hydrocarbons being in the upper sample (82 %), decreasing to 68 % in 2942 m. This suggests a somewhat variable oil composition within the oil leg.

3.3.2 Saturated Hydrocarbon Chromatography

The three Tertiary saturated hydrocarbon GC chromatograms are similar, having a predominance of short-chained n-alkanes in the C_{13} - C_{20} range, and low peak intensities for n-alkanes in the C_{23} - C_{31} range (Figure 9a). The pristane/phytane ratio varies from 2.53 to 3.16, and the pristane/nC_{17}- and phytane/nC_{18}-ratios range 0.49 - 0.55 and 0.32 - 0.41 respectively, suggesting that the hydrocarbons were generated from a mature, mainly terrestrial source rock, possibly with some marine organic matter contribution. These populations of hydrocarbons are probably derived from migrated hydrocarbons staining the silt- and claystones. The long-chained n-alkanes have clear odd/even predominances (CPI: 0.80 - 1.88), suggesting an immature terrestrial origin for this second saturated hydrocarbon population, believed to originate from in-situ organic matter.

The Draupne Fm. claystone (2849 m) has a unimodal n-alkane distribution ranging nC_{13} - nC_{34}, with an overall maximum at nC_{17}, which together with the pristane/phytane ratio of 1.57 suggests a marine source rock with some land plant derived organic matter (Figure 9b). The pristane/nC_{17}- and phytane/nC_{18}-ratios (0.73 and 0.48) and the CPI-index of 1.41 suggest that the Draupne Fm. has a maturity which is less than that of the oil window.

The two Heather Fm. chromatograms (2892 m, 2907 m) have n-alkane compositions dominated by short-chained n-alkanes in the C_{13} - C_{20}-range (Figure 9c). The pristane/phytane-ratios of 2.79 and 3.61 are indicative of a terrestrial source. The nC_{20}+ alkanes are present in smaller amounts. The CPI-values are 1.25 and 1.65, indicating a relatively immature terrestrial source, these hydrocarbons probably being generated from indigenous organic matter in the sand- and siltstones. This might indicate two populations of saturated hydrocarbons, the short-chained hydrocarbons representing migrated hydrocarbons and the latter population representing in-situ generated hydrocarbons.

The two Middle Jurassic Hugin Fm. sandstone samples (2927 m, 2942 m) have n-alkanes ranging C_{15} - C_{39} with unimodal distributions, with overall maxima at nC_{20} (Figure 9d). The n-alkane distributions indicate a high degree of waxyness (C_{22}+), also seen in the thermal extract (S_1)-chromatograms (Section 3.1). The pristane/phytane ratios of 1.04 and 0.91 indicate a marine source rock, possibly deposited under highly anoxic conditions. An odd/even predominance is hardly present (1.08, 1.01), suggesting that the maturity for the migrated hydrocarbons is higher than that of any of the previously discussed samples. The lowest sample (2952 m) has a completely different n-alkane distribution, being dominated by the nC_{14} - nC_{18} alkanes, and has a prominent odd/even predominance (1.77). The pristane/nC_{17}- and phytane/nC_{18}-ratios (0.94 and 0.78) are significantly higher than those of the two upper samples (0.61 - 0.63 and 0.49 respectively), indicating a lower maturity for the lowest sample.

3.3.3 Aromatic Hydrocarbon Chromatography

The aromatic hydrocarbon GC (FID) analyses of the Tertiary samples show very low peak intensities for identified compounds. Therefore the aromatic hydrocarbon ratios in Table 6 are unreliable for maturity assessments. The partly aromatised methyl substituted decalin eluting between the 1-methylnaphthalene and biphenol peaks is indicative of immature aromatic hydrocarbons (Figure 10a), possibly below an Ro-value of 0.5 %. The sulphur-selective FPD-chromatograms do not show any peaks eluting, possibly suggesting that the source of the hydrocarbons is non-marine for all the samples.

The Draupne Fm. claystone (2849 m) has, similar to the Tertiary samples, low peak intensities for aromatic hydrocarbons (Figure 10b). Hence the MPI1-derived Rc-value of 0.83 % is considered to be unrealistically high, given the depth and all maturity data presented so far. The presence of aromatised steranes and triterpanes indicates a relatively low maturity, also suggested by the absence of alkylated dibenzothiophenes in the FPD-chromatogram.

The two Heather Fm. samples (2892 m, 2907 m) have different aromatic hydrocarbon distributions to the above, with a relative dominance of the methyl-naphthalenes (MN) and alkyl-dimethylnaphthalenes (DMN). The upper sample appears to be depleted in methylnaphthalenes, probably due to evaporative loss (Figure 10c). The latter compounds are more prominent in the lower sample. The methyl-phenanthrenes are present in smaller amounts. However, the calculated Rc-values of approximately 0.7 % are considered to be reliable, suggesting that the hydrocarbons were generated from a source rock at pre-peak oil generation maturity (peak oil generation at Rc = 0.8 % for type II kerogen).

The three Hugin Fm. (Vestland Gp.) sandstone core chip samples (2927 m, 2942 m, 2952 m) have aromatic hydrocarbons which are depleted in (or with very low contents of) diaromatic methyl-naphthalenes and alkyl-naphthalenes, and also have relatively low peak intensities for phenanthrene and the methyl-phenanthrenes (Figure 10d). Hence, only the methyl-phenanthrene ratios are calculated for all samples. These ratios are relatively consistent, except for the 2/1 methyl-phenanthrene ratio (2/1MP). However, the MPI1-derived Rc-values are relatively uniform (0.87 - 0.91 % Rc), suggesting that the oil shows present in the Hugin Fm. have high maturities, i.e. past peak oil generation. The high maturity is confirmed by the methyl-dibenzothiophene ratios derived from the FPD-chromatograms, i.e. the 4/1 MDBT- and (3+2)/1 MDBT-ratios for the two oil leg samples (3.37, 2.60 and 0.50 and 0.54, respectively). Additionally the presence of dibenzothiophenic compounds confirms a marine source rock for the oils in the Hugin Fm. sandstones (Figure 10e).

3.4 Vitrinite Reflectance

Twenty samples were selected for vitrinite reflectance measurements for the thermal maturity gradient assessment of well NOCS 15/12-5. The samples, from the interval 1060 - 2892 m, covered the stratigraphic interval from the Tertiary Nordland Gp. to the Upper Jurassic Heather Fm. The thermal maturity data are presented in Table 7, while the vitrinite reflectance versus depth plot is shown in Figure 11. The individual sample histograms are included in Appendix 2.

3.4.1 Description of samples

The three Nordland Gp. (105 - 1247 m) claystone cutting samples have traces to moderate amounts of phytoclasts, consisting almost exclusively of inertinite particles and only trace amounts of vitrinite particles. One sample, 1240 m, contains calcareous shell and foraminifera debris. The bitumen staining varies from light to strong.

The eleven Hordaland Gp. (1247 - 2276 m) claystone and siltstone samples have very low to moderate contents of phytoclasts. The upper four siltstone samples have higher contents than the lower seven samples. The phytoclast distributions vary, with dominance of vitrinite particles in several samples and dominance of inertinite particles in other samples (1330 m, 1420 m, 2177 m, 2258 m). Bitumen staining varies, with strong to very strong staining in the upper four siltstone samples. The bitumen staining of the claystone sample varies from very light to moderate, with a general decrease with depth. Iron oxide is registered in one sample, 2177 m, possibly due to oxidation of pyrite.

The single Rogaland Gp. marly claystone (2375 m) has trace amounts of predominantly inertinite particles and only trace amounts of vitrinite particles. staining being only observed in trace amounts. The presence of iron oxide indicates pyrite oxidation. The low contents of phytoclasts yielded only three vitrinite reflectance readings for this sample.

Two claystone cuttings samples (2597 m, 2765 m) from the Shetland Gp. (2439 - 2792 m) were analysed. Both samples have low contents of phytoclasts, consisting almost only of inertinite particles and with only trace amounts of vitrinite maceral particles. Bitumen staining is low to very light for both samples.

The single Draupne Fm. sample from 2855 m consists of interlayered pyritic clayey siltstone and shale with oxidized iron present. The phytoclast content is low, dominated by inertinite particles and only trace amounts of vitrinite particles. Fluorescent algae and spores are registered, however, in low contents. The bitumen staining is moderate.

One glauconitic siltstone sample from the top of the Heather Fm. (2892 m) has a content of phytoclasts consisting of subequal quantities of vitrinite and inertinite particles. Fluorescent spores and algae are present in low contents. Bitumen staining is light.

3.4.2 Maturity

The vitrinite versus depth plot in Figure 11 shows a maturity trend with a low gradient. Early maturity (Ro = 0.5 % for type II kerogen) is, according to the established Ro-trend, reached at approximately 2000 m. The top of the oil window (Ro = 0.6 %) is reached at about 2850 m, i.e. from the top of the Draupne Fm., suggesting that this source rock may have started to generate hydrocarbons.

3.5 Visual Kerogen Microscopy

Ten samples from well NOCS 15/12-5 were optically examined, these covering the interval 1060 - 3065 m of Tertiary to Triassic age. The detailed kerogen compositions are shown in Table 8, while the gross compositions are plotted in a triangular diagram, Figure 12. Thermal maturity data (Spore Colour Index) is included in Table 7.

3.5.1 Kerogen Typing

Two samples were examined from the Nordland Gp., Utsira Fm. The upper sample (1060 m) is strongly dominated by liptinite (90 %), mainly of yellow orange fluorescent amorphous organic matter (? algal origin), with subordinate spore/pollen, algal cysts and dinoflagellates. Largely reworked inertinite and vitrinite occur in trace to accessory amounts. The lower sample (1150 m) is also dominated by liptinite (85 %), though this is mainly preserved as well preserved algal cysts, with abundant large dinoflagellates, and subordinate liptodetrinite, amorphinite and spore/pollen. Again vitrinite and inertinite occur in minor/accessory amounts. These algal marine kerogen assemblages suggest the Utsira Fm. to have fair to good potential for oil and gas generation at higher maturity.

Three samples were examined from the Hordaland Gp. The uppermost (1300 m) sample has a composition different to those of the above samples. The sample is overwhelmingly dominated by dark brown to non-fluorescent amorphous matter which is recorded as liptinitic but which could include degraded vitrinitic material. Algae and dinoflagellates are subordinate and spores/pollen are rare. Vitrinite and inertinite occur in traces. The underlying samples (1660 m, 1930 m) have quite different textures to the latter sample, although being strongly dominated by liptinite this is mainly as well preserved reworked liptinite (spores). The lowermost sample has a coarser texture and a greater vitrinite content. These samples suggest the Hordaland Gp. to have potential only for limited amounts of gas.

One sample was examined from the Rogaland Gp., Lista Fm., this being dominated by mainly fine grained/amorphous reworked (?oxidized) liptinite (60 %), spores, algae and dinoflagellates being subordinate. Moderately abundant amounts (20 % each) of reworked inertinite and vitrinite are present. This suggests the Lista Fm. to have potential for small amounts of gas at best.

One Draupne Fm. sample was analysed (2849 m). This is dominated by liptinite (65 %), mainly as orange brown to yellowish orange fluorescent amorphinite of good quality, with subordinate liptodetrinite, spores (including anomalously (white) fluorescent spores), algae and dinoflagellates. Inertinite and vitrinite occur in moderate amounts (15 and 20 % respectively), this being relatively high compared with the "average" Draupne Fm. elsewhere in the North Sea, i.e. the formation in this well has a relatively high terrestrial input. This kerogen assemblage infers a good potential for mixed oil and gas.

One Heather Fm. sample was examined (2897 m), this having abundant liptinite (45 %) which is dominated by reworked material, with subordinate spores, algae and dinoflagellates. Inertinite and vitrinite (again largely reworked) also occur in abundant, albeit lesser, amounts (30 and 25 % respectively). This sample suggests the Heather Fm. to have a fair potential for gas.

The sandstone sample from Lower - Middle Jurassic Hugin Fm. yielded a kerogen concentrate consisting practically only of dark brown fluorescent amorphous matter of unknown origin (? very well degraded spores). A high greyish green background fluorescence suggests migrated hydrocarbons may be present in this sample. The high hydrogen index (from Rock-Eval) for this sample in relation to the kerogen observed may in addition reflect the presence of asphaltenes.

3.5.2 Maturity

The SCI data for the individual samples suggests the top of the oil window (SCI 6.0 for type II kerogen) to occur between the 2897 m and 3065 m samples. The linear regression line for the most reliable data (r = 0.88) suggests the top to occur at approximately 2980 m and the base (SCI 8.0), by extrapolation, to occur at approximately 4390 m.

3.6 Isotope Analysis of C_{15+} Fractions

A total of seven samples was analysed for stable carbon isotope composition ($\delta^{13}C$), the analysis being performed on the total extracts and the four separated fractions for each sample. The data are listed in Tables 9a-b. Figure 13 shows a cross plot of $\delta^{13}C$ of the saturated versus aromatic hydrocarbon fractions, and Figure 14 shows the Galimov plot for each sample.

The two Hordaland Gp. saturated versus aromatic hydrocarbon $\delta^{13}C$-values plot relatively close together (Figure 13), indicative of a marine origin. The CV-values calculated by the formula: $-2.53\ \delta^{13}C_{sat} + 2.26\ \delta^{13}C_{aro} - 11.65$ (Sofer, 1984) are negative for both samples (Table 9b). The Draupne Fm. sample is clearly of marine origin seen in the saturated versus aromatic hydrocarbon $\delta^{13}C$ cross-plot, whereas a mixed marine/terrestrial origin is suggested for the Heather Fm. sample, also indicated by the CV-value (0.17). The Hugin Fm. oil shows plot close together. A marine origin is also suggested for these samples. From the Galimov plot in Figure 14 it appears that the two upper samples, 2927 m and 2942 m, both have similar $\delta^{13}C$-values for all fractions, except for the asphaltenes with values of 28.66 ‰ and 28.44 ‰. The two oil shows indicate homogeneity for the oil present in the Hugin Fm. sandstone. The lowest sample, 2952 m, differs only slightly from the two other samples for all the compound classes.

3.7 Gas Chromatography - Mass Spectrometry

Seven samples were selected for GC-MS analysis, including potential source rocks and migrated hydrocarbons. The saturated hydrocarbons were analysed using the M/Z 149, 163, 177, 189, 191, 205, 217, 218, 231, 259, 370 and 384 fragmentograms. Aromatic hydrocarbons were examined using the M/Z 106, 134, 142, 156, 170, 178, 192, 198, 206, 212, 220, 231 and 253 fragmentograms. Figures 15a-r show examples of fragmentograms illustrating points mentioned in the text. The data are listed in Table 10a-i. All the mass fragmentograms are shown in Appendix 5.

3.7.1 Potential Source Rocks

Saturated Hydrocarbons

Terpanes

The Draupne Fm. claystone sample has demethylated triterpane distributions (M/Z 163 and 177 fragmentograms) showing the C_{31} - C_{35} extended $\alpha\beta$ hopane homologous series, indicative of a marine source rock (Figure 15a). The C_{35}/C_{34} extended hopane ratio is slightly higher than 1, indicating anoxic conditions during deposition. Several peaks eluting prior to the $\alpha\beta$ C_{29} norhopane (peak C) are considered to represent C_{27} - C_{29} rearranged steranes and tricyclic terpanes. Similar distributions aare also seen in the Heather Fm. siltstone sample (2892 m) (Figure 15b). The $\beta\alpha$ C_{29} norhopane is abundant in the Heather Fm. siltstone.

The two Hordaland Gp. M/Z 191 fragmentograms (1570 m, 1930 m) show that the samples are immature, e.g. reflected by the high Tm/Ts ratio of 9.40. The C_{31} $\alpha\beta$ homohopane peak (peak H) is present as a dominant peak. The C_{31} - C_{35} extended hopanes are only present as peaks with low intensities, indicating a terrestrial source. The Draupne Fm. and Heather Fm. triterpane distributions are also indicative of immature marine source rocks, reflected by the high Tm/Ts-ratios of 2.75 and 4.94, respectively (Figure 15c). The bisnorhopane/αβ hopane ratio (Z/E), however, varies from 0.04 to 0.11, a variation which could be source related.

Steranes

The two Hordaland Gp. samples (1570 m, 1930 m) have widely differing distributions of steranes, as reflected by the M/Z 217 fragmentograms. The C_{29} regular sterane is the most dominant peak in the upper sample (peak t) shown in Figure 15d, whereas C_{29} 20R βα 24-ethyl-diacholestane (peak k) is the most prominent peak in the lower sample (Figure 15e). However, the broadness of the peak suggests that other compounds might be coeluting, giving the high intensity. The predominance of C_{29} over C_{27} regular steranes (peaks g, j, q and t) in both samples are supportive of mainly terrestrially sourcing. The Draupne Fm. and Heather Fm. samples (2849 m, 2892 m) M/Z 217 fragmentograms are dominated by C_{27} rearranged steranes relative to the C_{29} rearranged steranes shown in Figure 15f (ratio 4 in Table 10B: 1.46 and 1.89 respectively), and also shown by the 14β 17β-steranes in the M/Z 218 fragmentograms (Figure 15g). The low maturity of the samples is confirmed by the low C_{29} 20S/(20R+20S) ααα 24-methyl-cholestane percentages of 45 % and 38 % respectively (ratio 2 in Table 10B), corresponding to 0.5 - 0.6 % Ro. The rearranged steranes derived from the M/Z 259 fragmentograms confirm the C_{27} dominance, supportive of a marine origin.

Aromatic Hydrocarbons

The alkylbenzene specific fragmentograms (M/Z 106, 134) for the two Hordaland Gp. samples have narrow ranges of 1-methyl, 2-alkyl and 1-methyl, 3-alkyl benzene series (doublets, Figure 15h) in the C_9 - C_{16} range. There is a predominance of the 1-methyl, 3-alkyl peaks (the first peak of the doublets) compared to the corresponding 1-methyl, 2-alkyl peaks. The Draupne Fm. (2849 m) alkylbenzene distribution ranging C_{10} - C_{27} is indicative of a marine source rock. The front end biased Heather Fm. sample has the same range of alkylbenzenes as the Draupne Fm. sample.

The Hordaland Gp. alkylnaphthalene specific fragmentograms (M/Z 142, 156, 170) vary significantly. Only the lower sample, 1930 m, has methylnaphthalenes present, with a dominance of 1- over 2-methylnaphthalene. This indicates a low maturity for this sample. The C_2-naphthalenes (M/Z 156) show a similar distribution. The C_3-naphthalenes (M/Z 170) show different patterns for the two samples. The upper sample, 1570 m, has the 1,2,4+1,2,5 C_3-naphthalene as the dominant peak, indicating a low maturity. The same applies to the lower sample (1930 m), however the peaks eluting earlier contribute significantly more, which suggests a higher maturity for this sample. The Draupne Fm. and Heather Fm. samples (2849 m, 2892 m) are both considered to be moderately mature due to a slight predominance of 1-methylnaphthalene to equal abundances of 1- and 2-methylnaphthalenes. The 2,6+2,7 C_2-naphthalene peaks are less abundant peaks in both the Draupne and Heather Fm. samples, indicating relatively low maturities for both samples (Figure 15i). The C_3-naphthalenes have early eluting peaks as slightly more prominent peaks, particularly in the Heather Fm. sample.

The Hordaland Gp. phenanthrene, anthracene and alkylphenanthrene specific fragmentograms (M/Z 178, 192, 206, 220) are relatively uniform. Phenanthrene (M/Z 178) is dominant, whereas the anthracene peak is present as minor peaks. The methyl-phenanthrene (M/Z 192 fragmentograms) show slightly smaller to subequal 3- and 2-methylphenanthrene peaks compared to the 9- and 1-methylphenanthrene peaks, indicating moderate maturity. The lower sample, 1930 m, appears to be more mature compared to the upper sample. The Draupne Fm. (2849 m) and Heather (2892 m) Fm. phenanthrene fragmentograms have dominant phenanthrene peaks. The anthracene peak, however, is present in both samples. The methyl-phenanthrenes are dominated by the 9- and 1-phenanthrene peaks relative to the 3- and 2-phenanthrene peaks, indicating moderate maturities for both samples. All four samples have compatible C_2-phenanthrene (M/Z 206) peak distributions, whereas the C_3-phenanthrene fragmentograms (M/Z 220) show minor variations when the Hordaland Gp. samples are compared with the Draupne and Heather Fm. samples.

The C_1- and C_2-benzothiophene (M/Z 198, 212) fragmentograms vary when the Hordaland samples are compared with the Draupne and Heather Fm. samples. The

Hordaland Gp. C_1-dibenzothiophene (M/Z 198) fragmentograms have 4-/1-methyl-dibenzothiophene ratios of 3.3 and 2.2 respectively and (2+3)-/1-methyl-dibenzothiophene ratios of 0.8, which are significantly higher than those of the Draupne and Heather Fm. ratios. Similar differences are observed in the C_2-dibenzothiophene (M/Z 212) fragmentograms.

The triaromatic sterane specific fragmentograms (M/Z 231) show a predominance of the d1-peak in three of the four samples from the Hordaland Gp., the Draupne Fm. and the Heather Fm., indicating moderate maturities. The upper sample has prominent early eluting a1- and b1-peaks, giving different peak ratios compared to the three other samples (Table 10C). The monoaromatic sterane (M/Z 253) fragmentograms are dominated by the E1- or the G1-peaks, whereas the early eluting A1- and B1-peaks contribute relatively little. However, the Draupne and Heather Fm. monoaromatic steranes have more abundant A1- and B1-peaks, indicative of a higher maturity than in the two Hordaland Gp. samples.

3.7.2 Migrated Hydrocarbons

Saturated Hydrocarbons

<u>Terpanes</u>

For the Hugin Fm. oil show the demethylated triterpane specific (M/Z 163, 177) fragmentograms have C_{27} - C_{29} rearranged steranes present, suggesting a maturity related transformation of regular steranes.

The two Hugin Fm. triterpane fragmentograms (M/Z 191) from the oil leg (2927 m, 2942 m) have compatible C_{31} - C_{35} $\alpha\beta$ extended hopane distributions, indicative of a marine source (Figure 15j). The Tm/Ts-ratios (Table 10A: 0.68 and 0.78 respectively) show a mature source rock, distinctly different to the Tm/Ts values of the previously mentioned Draupne and Heather Fm. samples. The triterpane ratios presented in

Table 10A show a uniformity for practically all ratios, which suggests a homogeneity of the oil shows within the Hugin Fm. reservoir. The sample from 2952 m, believed to be close to the oil-water contact zone, has prominent contributions from tricyclic terpanes (peaks N, O, P, Q, R) seen in Figure 15k, which might be a maturity related difference when compared to the two previously mentioned Hugin Fm. samples. However, the higher Tm/Ts-ratio of 1.24 might contradict this. Alternatively, the Tm/Ts could also reflect a source related difference. Moldowan et al. (in Waples and Machihara, 1991) propose that a higher Tm/Ts ratio is supportive of more oxic conditions.

Steranes

The M/Z 217 fragmentograms have a dominance of rearranged steranes, probably reflecting a maturity related transition from regular steranes (Figure 15l). There is an apparent dominance of C_{27} over C_{29} diasteranes, reflected by peak ratio (a+b+c+d)/(h+k+l+n) (ratio 4 in Table 10B) and supportive of a marine origin. As for the terpane-derived ratios the sterane-derived ratios are similar for the two oil leg samples 2927 m and 2942 m. This supports a homogenous oil composition within the reservoir. The 14β 17β-steranes (M/Z 218 fragmentograms) in Figure 15m show that there is a subequal contribution from C_{27}- and C_{29}-steranes, indicating that land plant material might have contributed a significant part of the oil generating source rock(s). C_{27}, C_{28}- and C_{29}-rearranged sterane distributions in the M/Z 259 fragmentograms are dominated by the first mentioned isomers, supportive of a mainly marine source rock. Maturity related parameters, such as the C_{29} ααα 20S/(20S + 20R) epimer percentages of 46 - 49 % show uniform low maturities in the 0.6 to 0.7 % range (Waples and Machihara, 1991). The low maturities derived from the sterane GC-MS data are contrary to that shown by the aromatic hydrocarbon GC (FID) results, which indicate that the oil shows have been generated from a past peak oil generating source rock (Section 3.3.3).

Aromatic Hydrocarbons

The three Hugin Fm. samples (2927 m, 2942 m, 2952 m) have slightly varying alkylbenzene ranges (M/Z 106 fragmentograms) as well as differences in distributions.

The alkylnapthalene specific fragmentograms (M/Z 142, 156, 170) show varying distributions. The 1- and 2-methylnaphthalene contents vary significantly for the three samples, possibly due to variations in evaporative loss, with increasing loss with depth. The upper sample has a clear 2- over 1-methylnaphthalene predominance, which is indicative of high maturity. Similarly, the C_2-naphthalene fragmentograms (M/Z 156) show variations. The upper sample, 2927 m has the highest relative 2,6+2,7-C_2 naphthalene contribution, suggesting that this sample has a higher maturity than the two other samples (Figure 15n). The C_3-naphthalene fragmentograms (M/Z 170) show a corresponding pattern, with early eluting compounds being more dominant. This is most pronounced for the upper sample, 2927 m, and with an apparent decreasing trend with depth, possibly due to decreasing maturity with depth.

The phenanthrene, anthracene and alkylphenanthrene specific fragmentograms (M/Z 178, 192, 206, 220) are relatively uniform. The M/Z 178 fragmentograms only show phenanthrene. The methylphenanthrenes (M/Z 192) are dominated by the 9- and 1-methylphenanthrene, indicating moderate maturity. This is contradictory to other maturity data, which suggest that the oil shows in the Hugin Fm. are highly mature. The sample 2942 m shown in Figure 15o appears to be slightly less mature than the two other samples, e.g. 2927 m (Figure 15p). The C_2-phenanthrenes (M/Z 206) and C_3-phenanthrenes (M/Z 220) are generally compatible for all three samples, suggesting only minor variations in maturity.

The C_1- and C_2-dibenzothiophene (M/Z 198, 212) fragmentograms are relatively uniform for all three samples, however, with a slightly higher (2+3)-/1-methyldibenzothiophene ratio of 0.9 in sample 2952 m compared to 0.6 to 0.7 in the two upper samples. The 4-/1-methyldibenzothiophene ratios range 2 - 2.4, indicating that the maturity of the oil shows are close to top of the oil window, i.e. early generated oil (Figure 15q). The C_2-dibenzothiophenes distributions are relatively uniform, with the 2952 m sample having the largest differences compared to the two other samples.

The triaromatic sterane fragmentograms (M/Z 231) have the d1-peak and the earliest eluting peaks (a1, b1) as the most prominent peaks, indicative of relatively high maturity (Figure 15r). The two upper samples have compatible triaromatic sterane ratios (Table 10C), whereas the lower sample has ratios which differ significantly from these. This is probably due to a lower maturity of the lower sample. The monoaromatic steranes (M/Z 253) show much larger variations in relative peak intensities, with the top sample, 2927 m, having a prominent A1-peak. The other samples have prominent A1-peaks as well, however, not as dominant as the upper sample. This is reflected in the peak ratios (Table 10D). The upper sample has significantly higher ratios compared to the two lower samples, suggesting a much higher maturity.

3.7.3 GC-MS Summary

The two Draupne and Heather Fm. samples are considered to be moderately mature marine source rocks, supported by the terpane and sterane specific fragmentograms. The Draupne Fm. was probably deposited under highly anoxic conditions, whereas the Heather Fm. was deposited under less anoxic conditions. The moderate maturity of the samples is confirmed by the aromatic hydrocarbon GC-MS results. The two Hordaland Gp. samples are immature, mainly terrestrial source rocks. The Hugin Fm. oil shows are considered to have been generated from a mature marine source rock, although the aromatic hydrocarbon GC-MS data appear to be equivocal. The MDBT-ratios suggest lower maturities for the generated oils than those obtained from other aromatic hydrocarbon ratios. Possibly the sulphur containing moieties in the oil shows were generated at an earlier phase. The similar saturated hydrocarbon terpane and sterane fragmentograms for the two samples 2927 m and 2942 m suggest a homogenous composition of the oil shows within the oil leg. The aromatic hydrocarbon GC-MS results, e.g. the alkylnaphthalene specific fragmentograms (M/Z 142, 156, 170) show minor variations in maturity, i.e. with the more mature oil in the top of the reservoir and lower maturity in the deeper part. Such a maturity distribution would suggest at least two phases of migration of oil, probably from the same source kitchen. Accordingly lighter and more mature oil replaced the heavier and less mature oil in a second migration phase.

Chapter 4

CONCLUSIONS

4.1 Source Rock Potential

The Upper Jurassic Draupne Fm. (2841 - 2888 m), an organic carbon-rich claystone unit, is a dominantly marine type II/III kerogen source rock with a good potential for generating oil as well as a gas generation potential at high maturity. The Draupne Fm. was probably deposited under highly anoxic conditions, according to the C_{35}/C_{34}-extended hopane ratio of > 1. However, the visual kerogen data show moderate contributions of vitrinite and inertinite, indicating a relatively high contribution from land-derived organic matter when compared to the "average" Draupne Fm. The upper part of the Heather Fm. is a siltstone unit with a fair to good organic carbon content. The Heather Fm. siltstones' kerogen composition appears to be more biased towards land derived vitrinitic and inertinitic material, whereas reworked liptinitic kerogen contributes less compared to the Draupne Fm. Hence the upper part of the Heather Fm. is mainly a light oil/gas-prone source rock with a fair to good generation potential.

4.2 Maturity

The maturity profile for the well has been asssessed from vitrinite reflectance measurements, visual kerogen microscopy, saturated and aromatic hydrocarbon GC and GC-MS analyses. Vitrinite reflectance measurements, the most reliable maturity profile, show that early maturity (Ro = 0.5 % for a type II kerogen) is reached at approximately 2000 m. The top of the oil window (R0 = 0.6 %) is at about 2850 m coinciding with the level of the Draupne Fm., indicating a low thermal gradient for the well. The SCI-data from the visual microscopy analyses suggest that the top of the oil window is reached at ≈ 2980 m. Extrapolation of the SCI-data indicates that the base of the oil window is at about 4390 m.

4.3 Generation

According to the established maturity profile the Draupne Fm. is moderately mature or within the top of the oil window. The rich EOM-contents suggest that generation has started, however, consisting mainly of the heavier compounds (i.e. NSOs) typical for early generating source rocks. Expulsion is not likely to have taken place. A similar interpretation is valid for the Heather Fm. siltstone, lying immediately below the Draupne Fm.

4.4 Migration

The Middle Jurassic Hugin Fm. sandstone, the primary object of the well, has oil present in an approximately 25 m thick interval (≈ 2918 - 2943 m). The S_1-yields indicate that the oil saturation varies in this interval. The homogenous oil shows were probably sourced from a mature to highly mature marine source rock (Rc: ≈ 0.9 %), suggesting a filling history in one phase. Vertical maturity variations indicate more mature oil shows at the top. Hence, a continuous filling episode is considered, with gradually lighter and more mature oil replacing earlier generated oil in the top of the reservoir. This tentative assessment is based on the aromatic hydrocarbon GC-MS data, which show small but consistent maturity variations for the three Hugin Fm. samples. The Heather Fm. sandstones overlying the Hugin Fm. reservoir sandstone contain fair contents of light hydrocarbons, probably of condensate origin, as shown by the thermal extract (S_1)-chromatograms.

References

Sofer, Z., 1984. Stable carbon isotope compositions of crude oils: Application to source depositional environments and petroleum alteration. AAPG Bull., vol. 68, pp. 31-49.

Waples, D.W. and Machihara, T. 1991. Biomarkers for geologists - A practical guide to the application of steranes and triterpanes in petroleum geology. AAPG Methods in Exploration, No. 9, pp. 91.

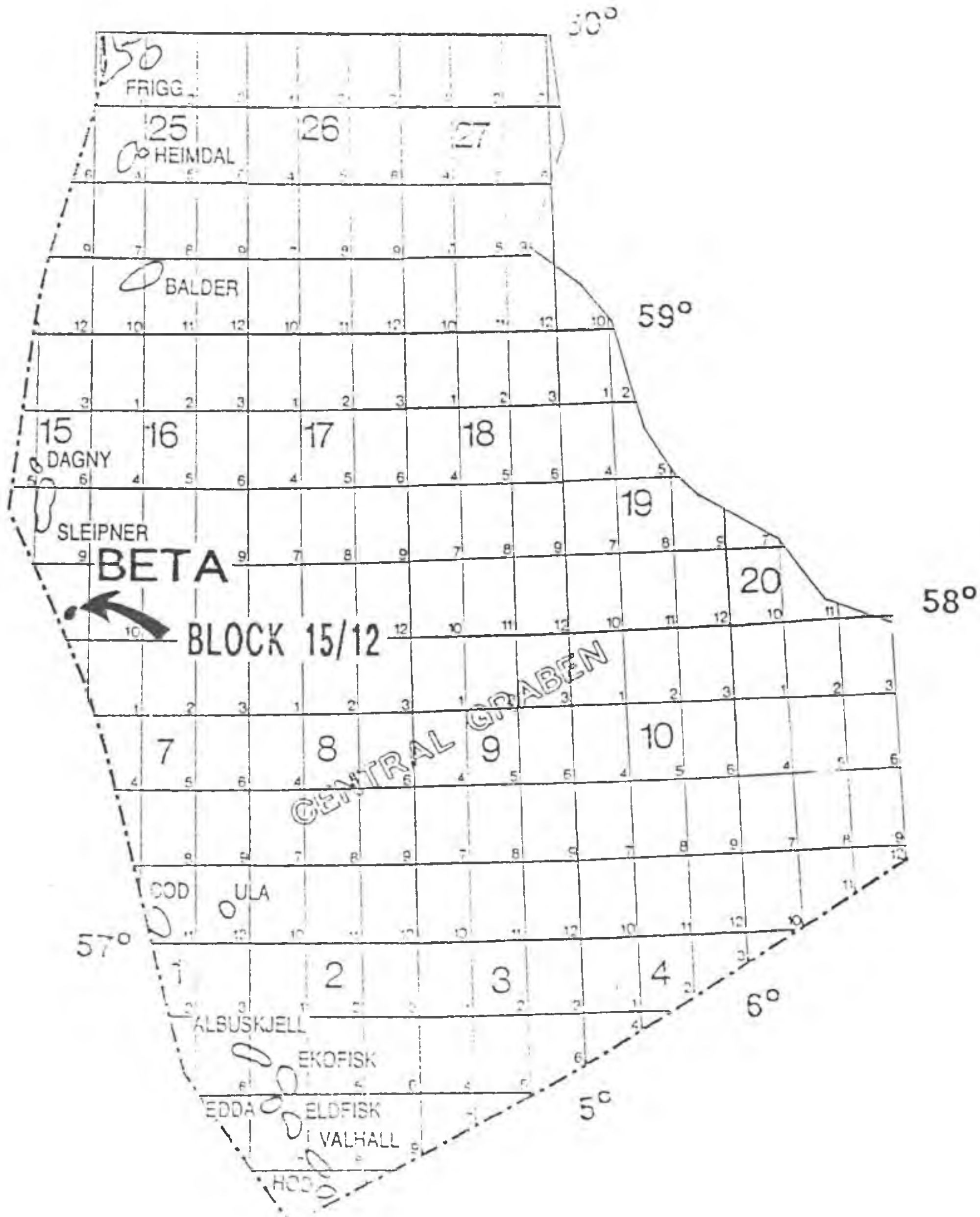


Figure 1: Location Map showing block 15/12.

Figure: 2

Client: VARIOUS

TOC Data for Well NOCS 15/12-5

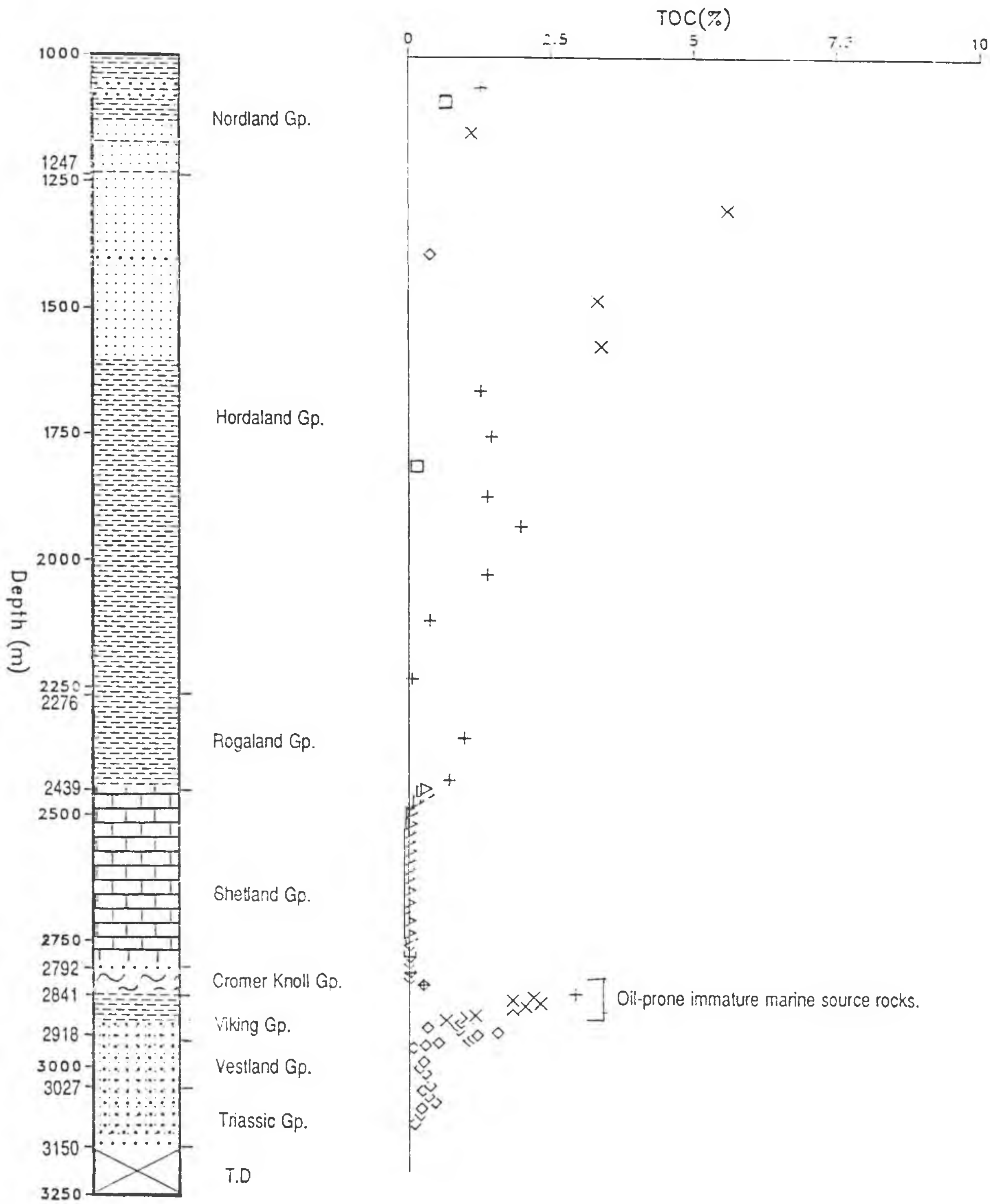


Figure: 3 Client: VARIOUS

Production Index Data for Well NOCS 15/12-5

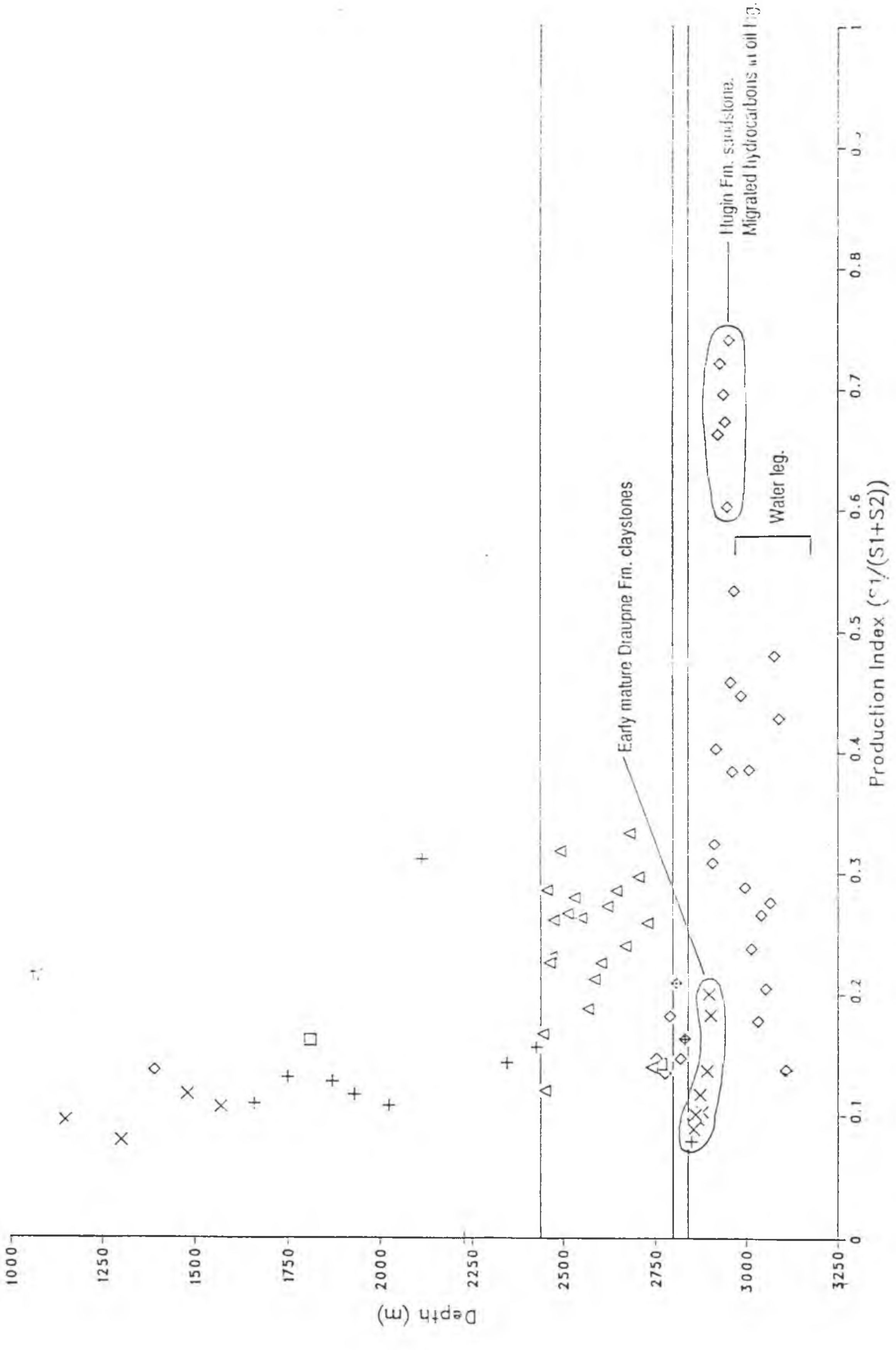


Figure: 4

Client: VARIOUS

Tmax Data for Well NOCS 15/12-3

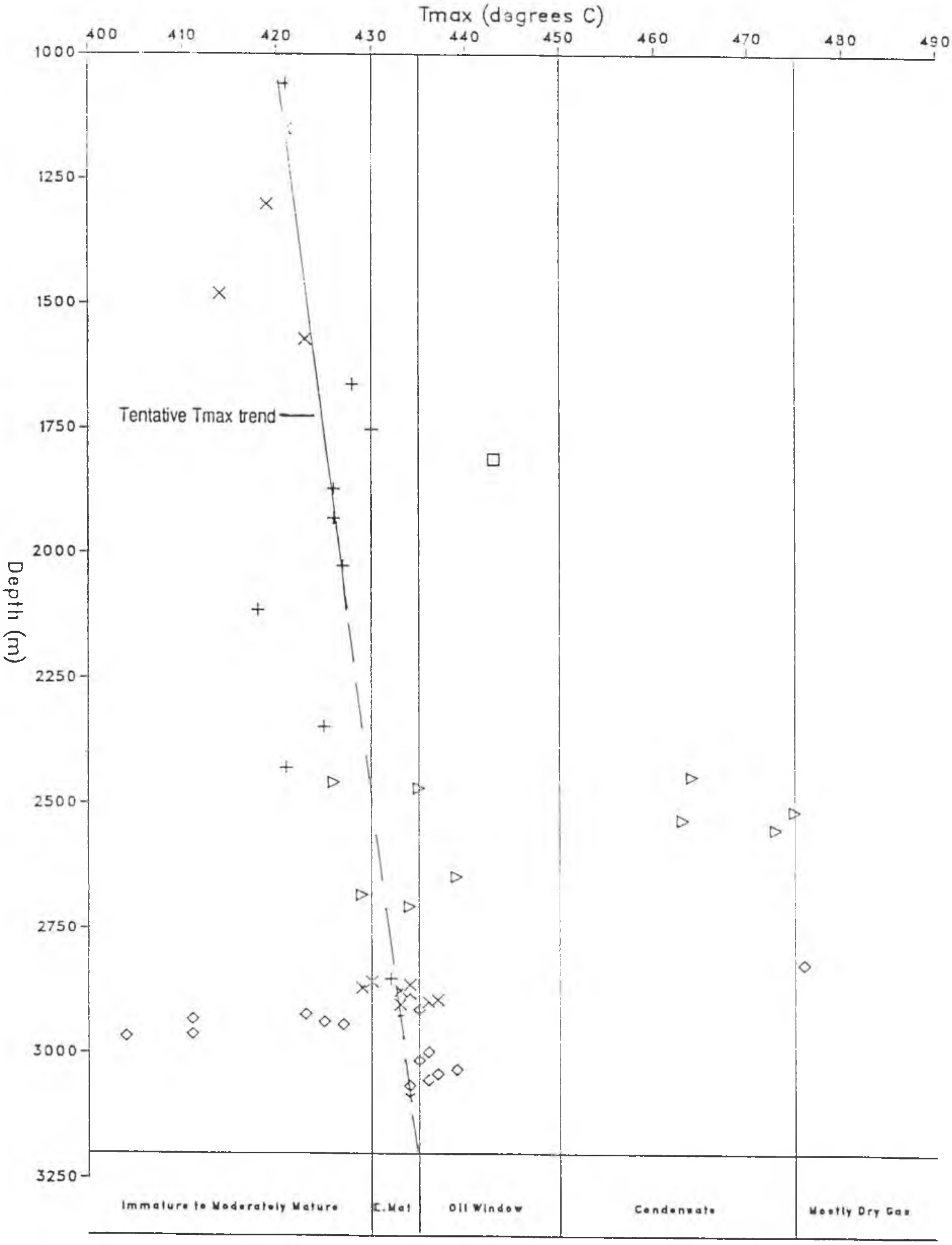
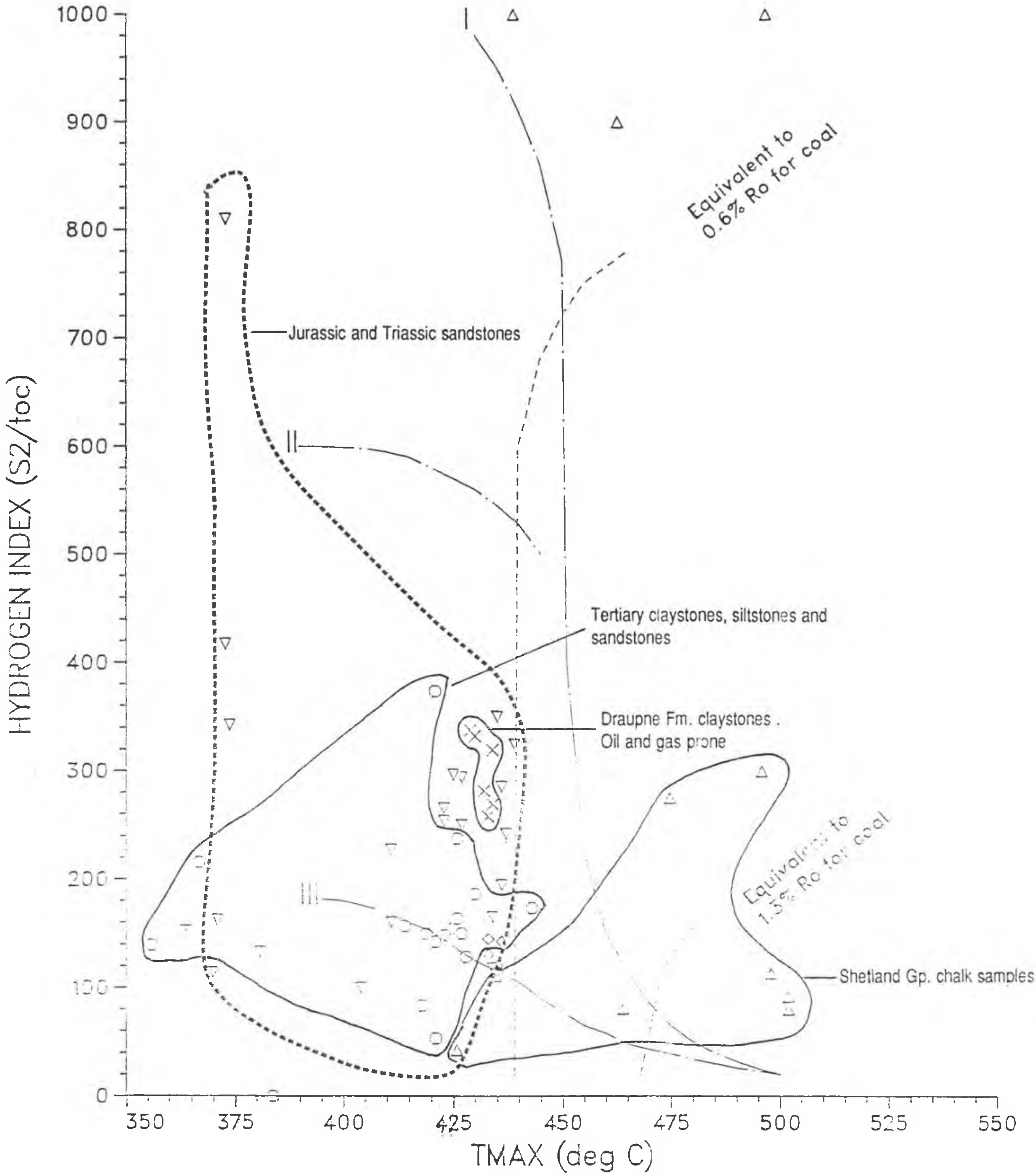


Figure 5 : Hydrogen Index v.s. Tmax values
Well NOCS 15/12–5



Analysis Name : [522020] 22 PH79C.6.1.

Multichrom

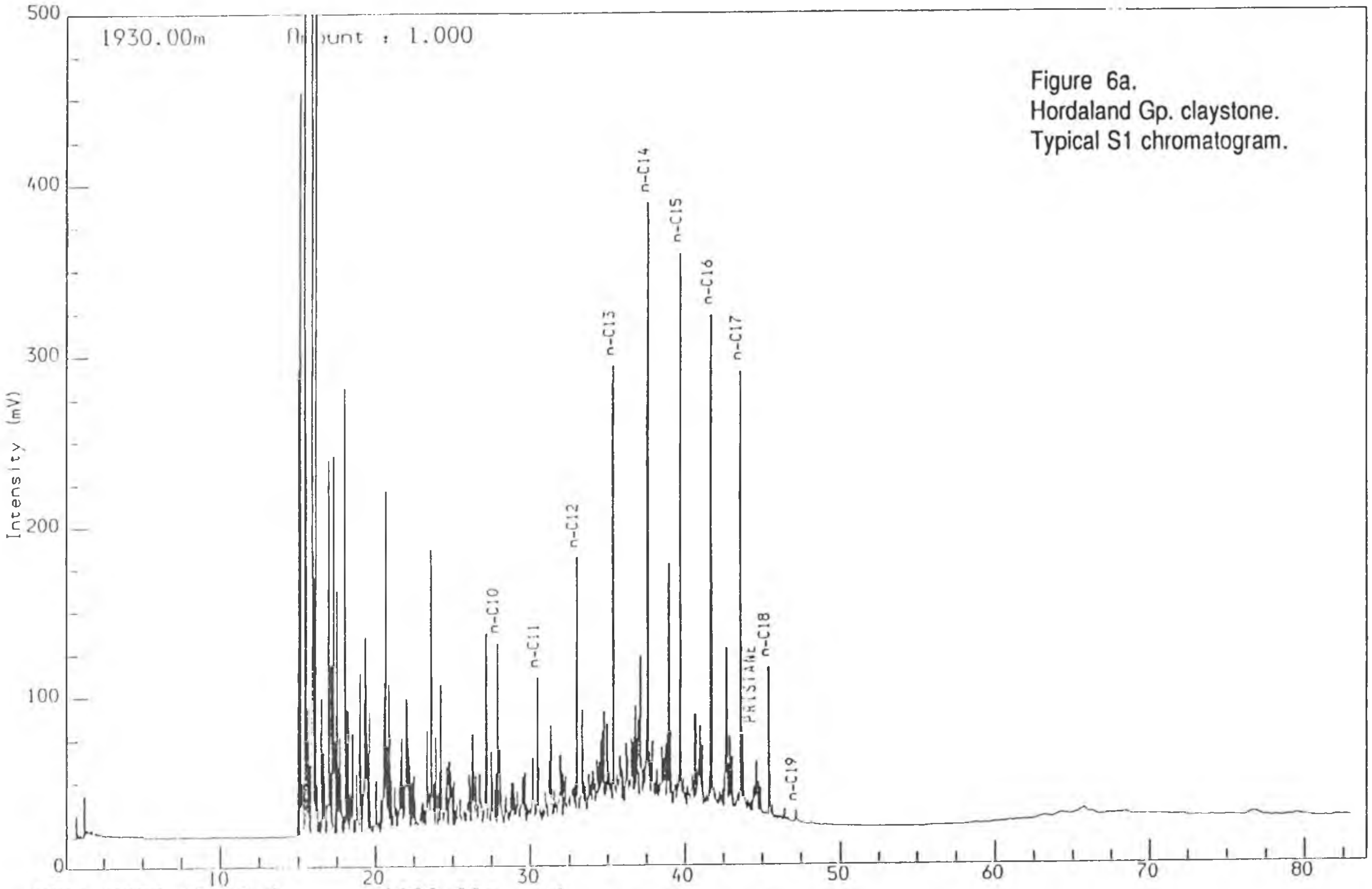


Figure 6a.
Hordaland Gp. claystone.
Typical S1 chromatogram.

WELL NOCS 15/12-5 1930.00m cut
THERMAL EXTRACTION GC (S1)
Sh/Clst: lt brn gy to pl y brn

Reported on 5-JAN-1993 at 13:01

Analysis Name : [522020] 22 PH79C,11,1.

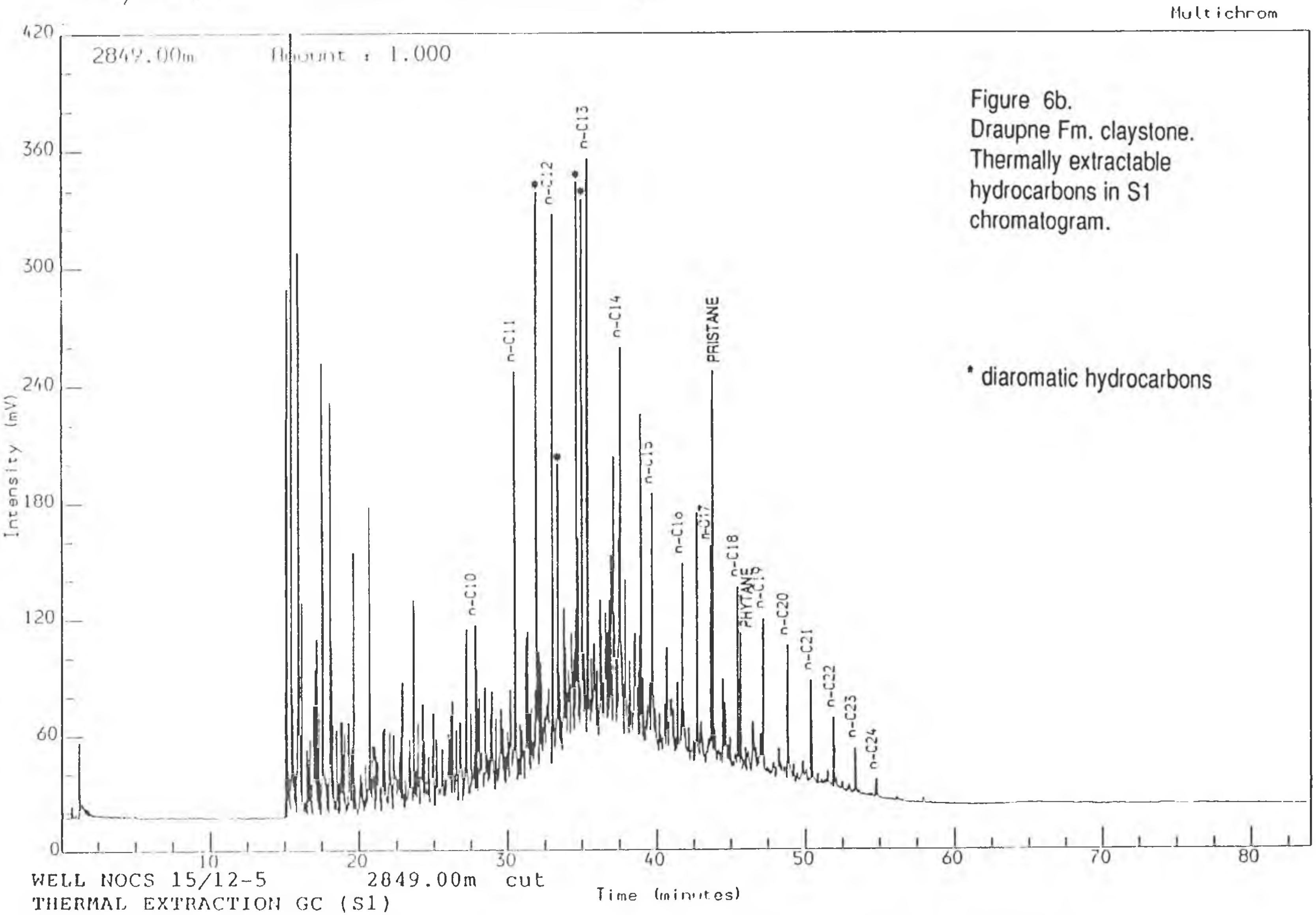


Figure 6b.
Draupne Fm. claystone.
Thermally extractable hydrocarbons in S1 chromatogram.

WELL NOCS 15/12-5 2849.00m cut
THERMAL EXTRACTION GC (S1)
Sh/Clst: drk gy to brn blk

Reported on 5-JAN-1993 at 09:52

Analysis Name : [522020] 22 PH79B,8,1.

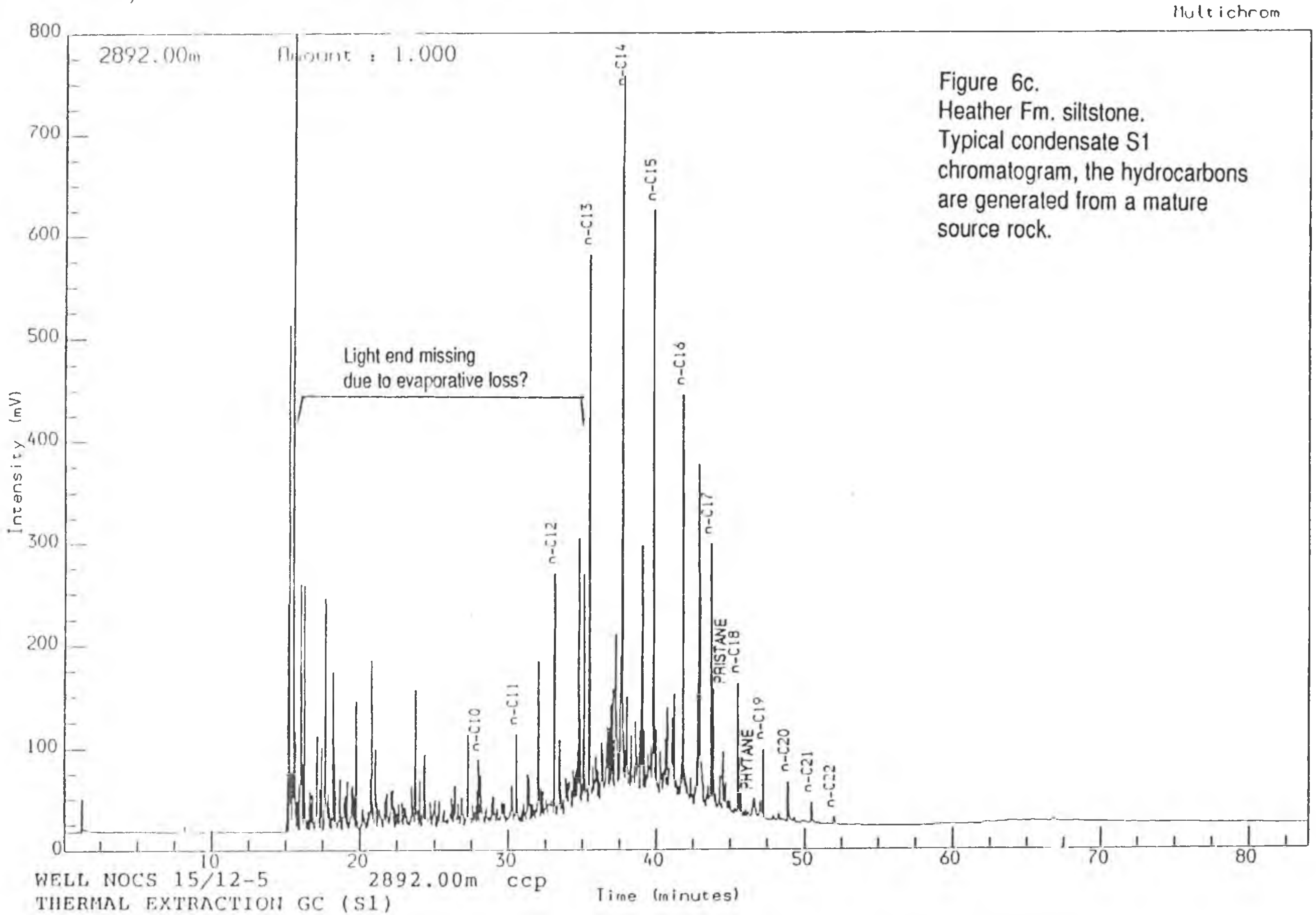


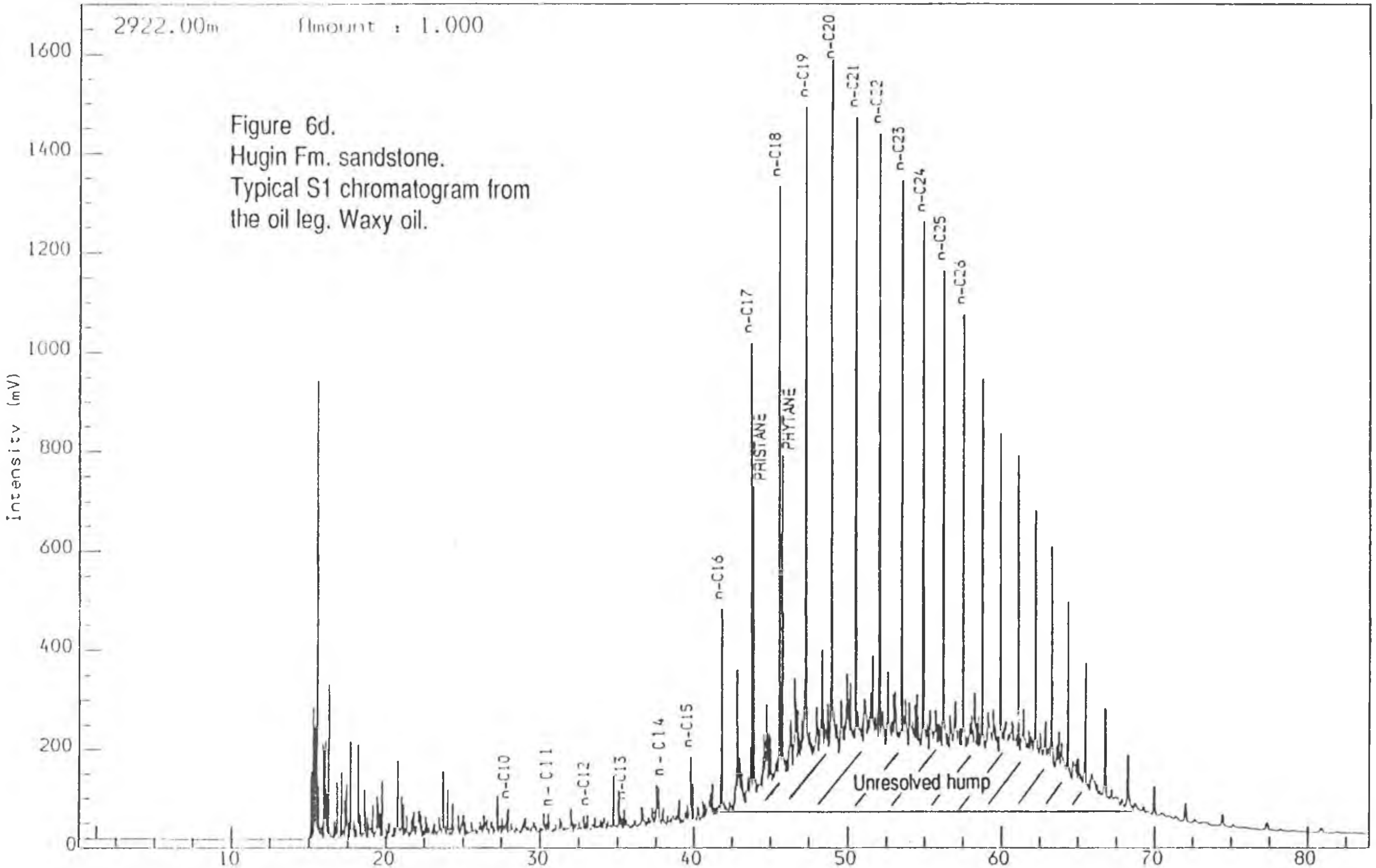
Figure 6c.
Heather Fm. siltstone.
Typical condensate S1 chromatogram, the hydrocarbons are generated from a mature source rock.

WELL NOCS 15/12-5 2892.00m ccp
THERMAL EXTRACTION GC (S1)
Sltst: brn gy to dsk brn

Reported on 5-JAN-1993 at 09:56

Analysis Name : [S22020] 22 PH79B,7,1.

Multichrom



WELL NOCS 15/12-5 2922.00m ccp
THERMAL EXTRACTION GC (S1)
S/Sst: pl y brn

Reported on 5-JAN-1993 at 09:59

Analysis Name : [522020] 22 PV38B.2.1.

Multichrom

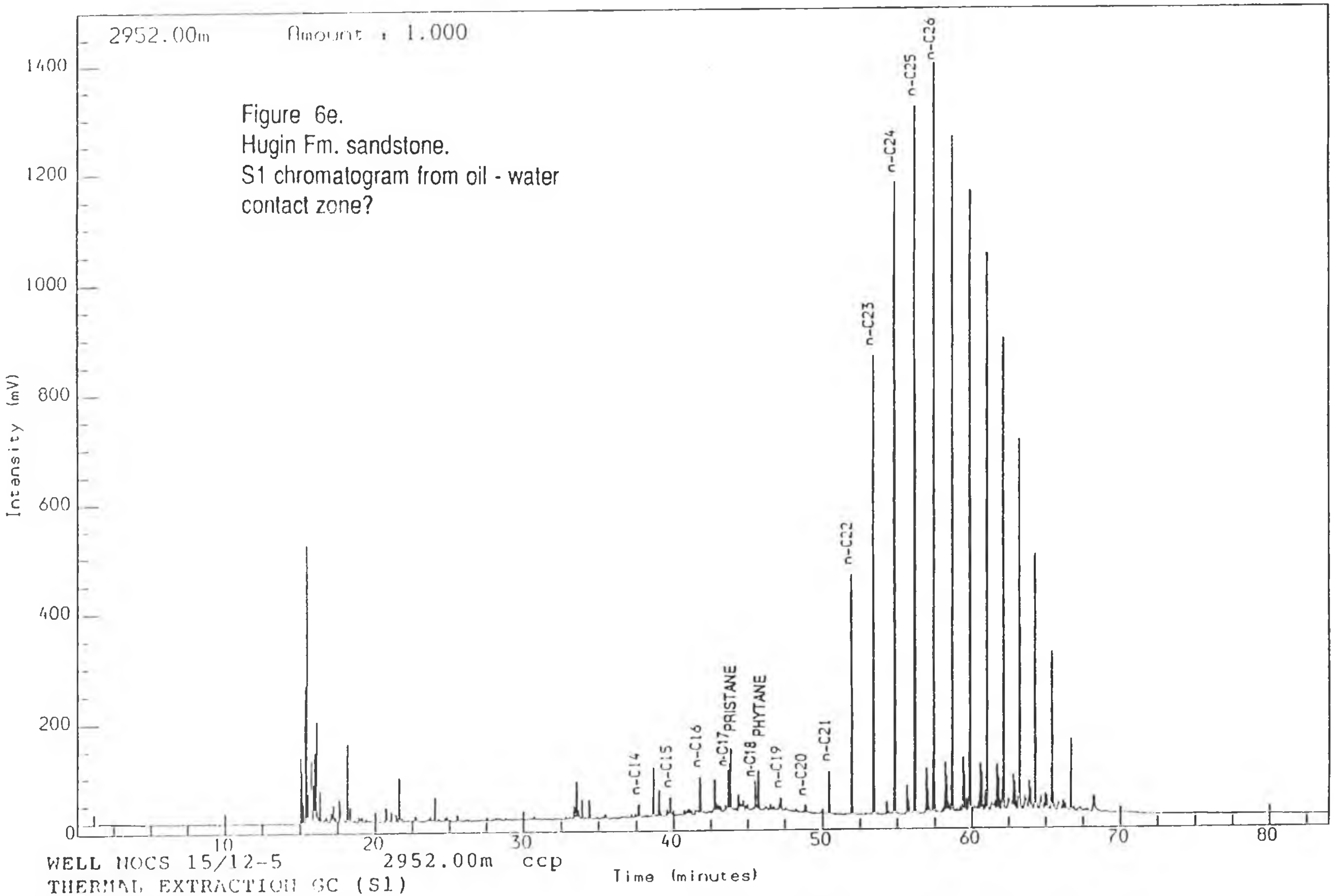


Figure 6e.
Hugin Fm. sandstone.
S1 chromatogram from oil - water contact zone?

WELL NOCS 15/12-5 2952.00m ccp
THERMAL EXTRACTION GC (S1)
S/Sst: w to lt gy

Reported on 8-JAN-1993 at 10:21

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Analysis Name : [522020] 22 PH79B,3,1.

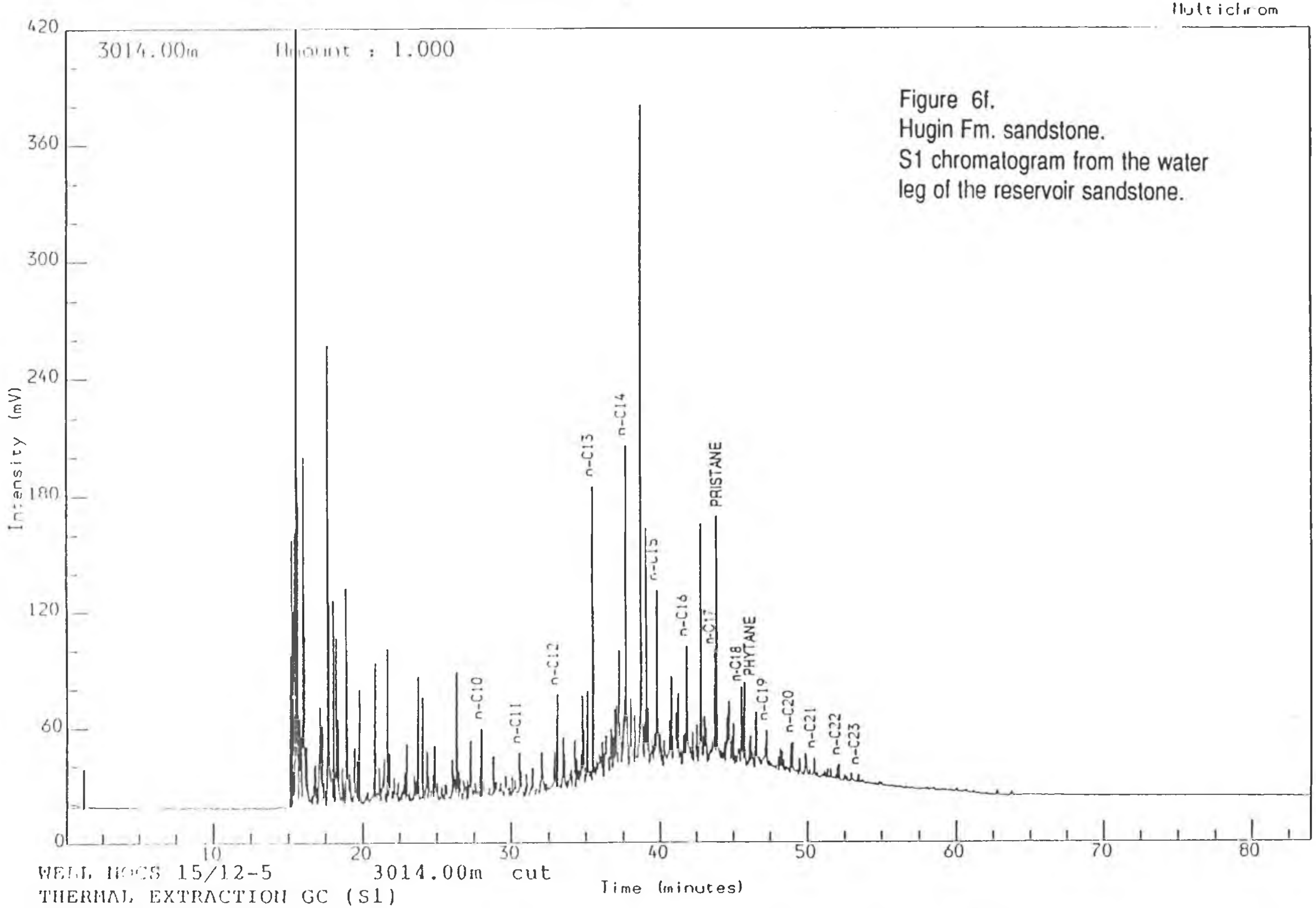


Figure 6f.
Hugin Fm. sandstone.
S1 chromatogram from the water leg of the reservoir sandstone.

WELL NOCS 15/12-5 3014.00m cut
THERMAL EXTRACTION GC (S1)
S/Sst: w to m gy

Reported on 5-JAN-1993 at 10:02

Analysis Name : [522020] 21 PH79C,6,1.

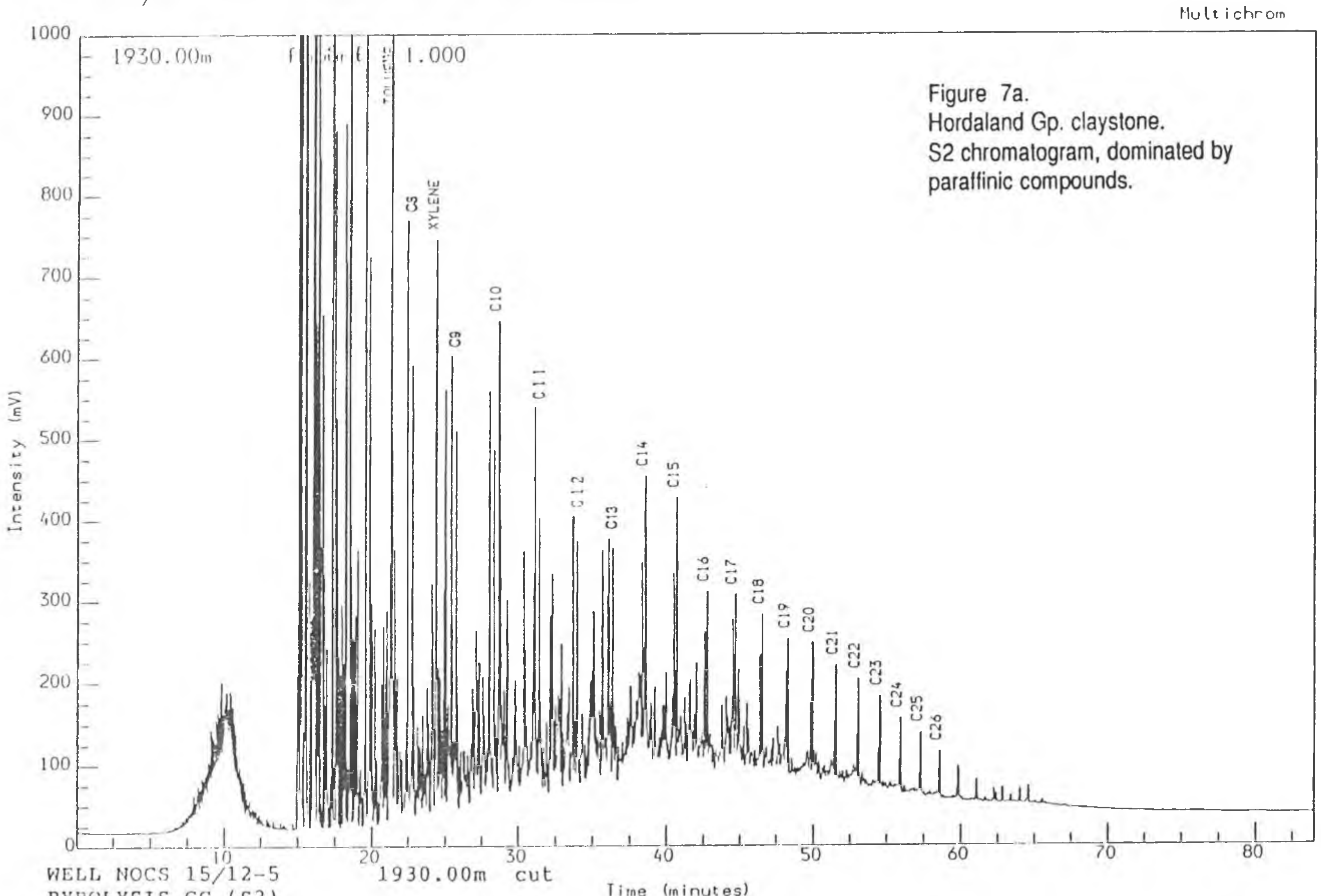


Figure 7a.
Hordaland Gp. claystone.
S2 chromatogram, dominated by paraffinic compounds.

WELL NOCS 15/12-5 1930.00m cut
PYROLYSIS GC (S2)
Sh/Clst: lt brn gy to pl y brn

Reported on 5-JAN-1993 at 12:59

Analysis Name : [522020] 21 PH79C,11,1.

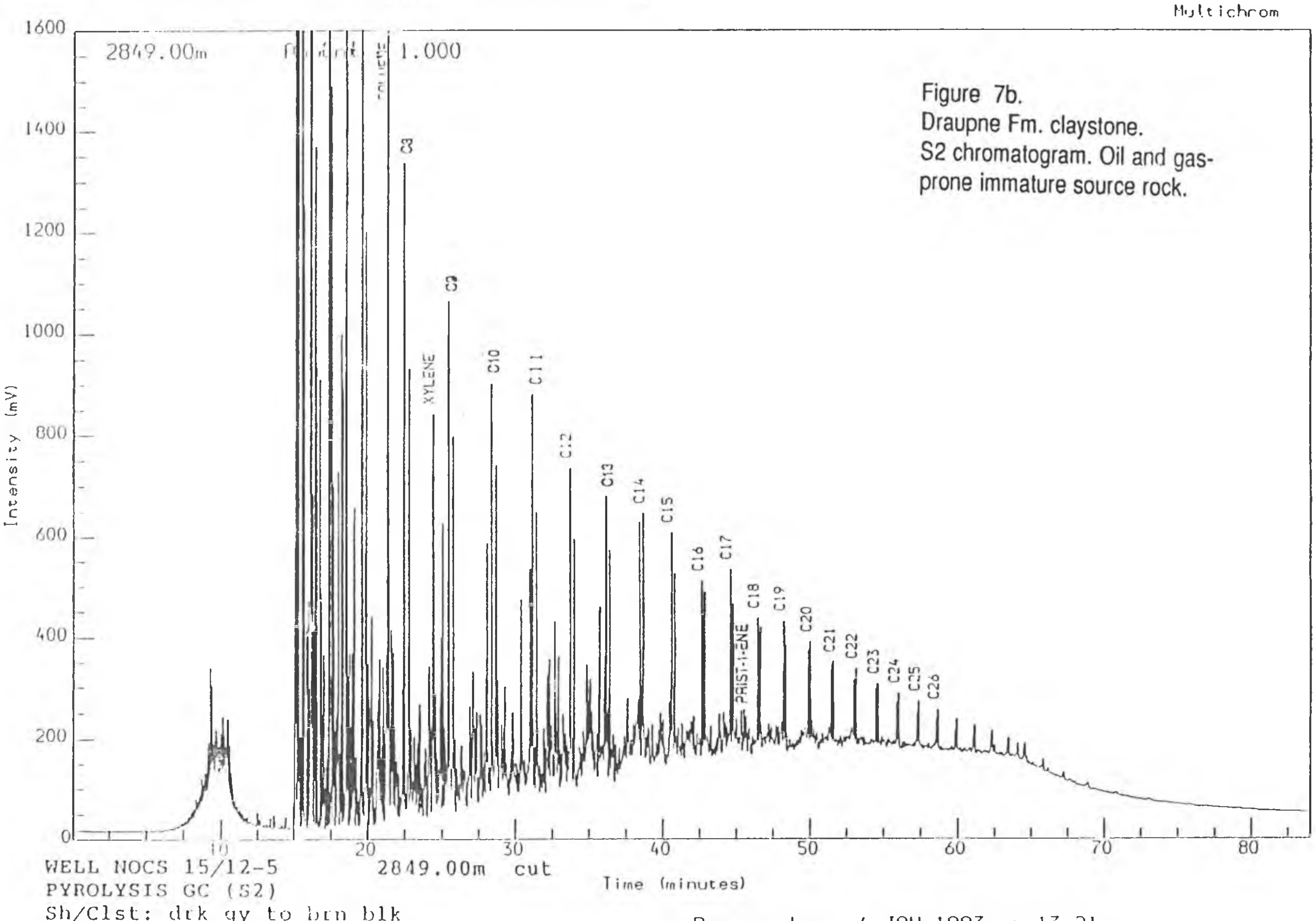


Figure 7b.
Draupne Fm. claystone.
S2 chromatogram. Oil and gas-prone immature source rock.

Reported on 4-JAN-1993 at 13:21

Analysis Name : [522020] 21 PH79B,4,1.

Multichrom

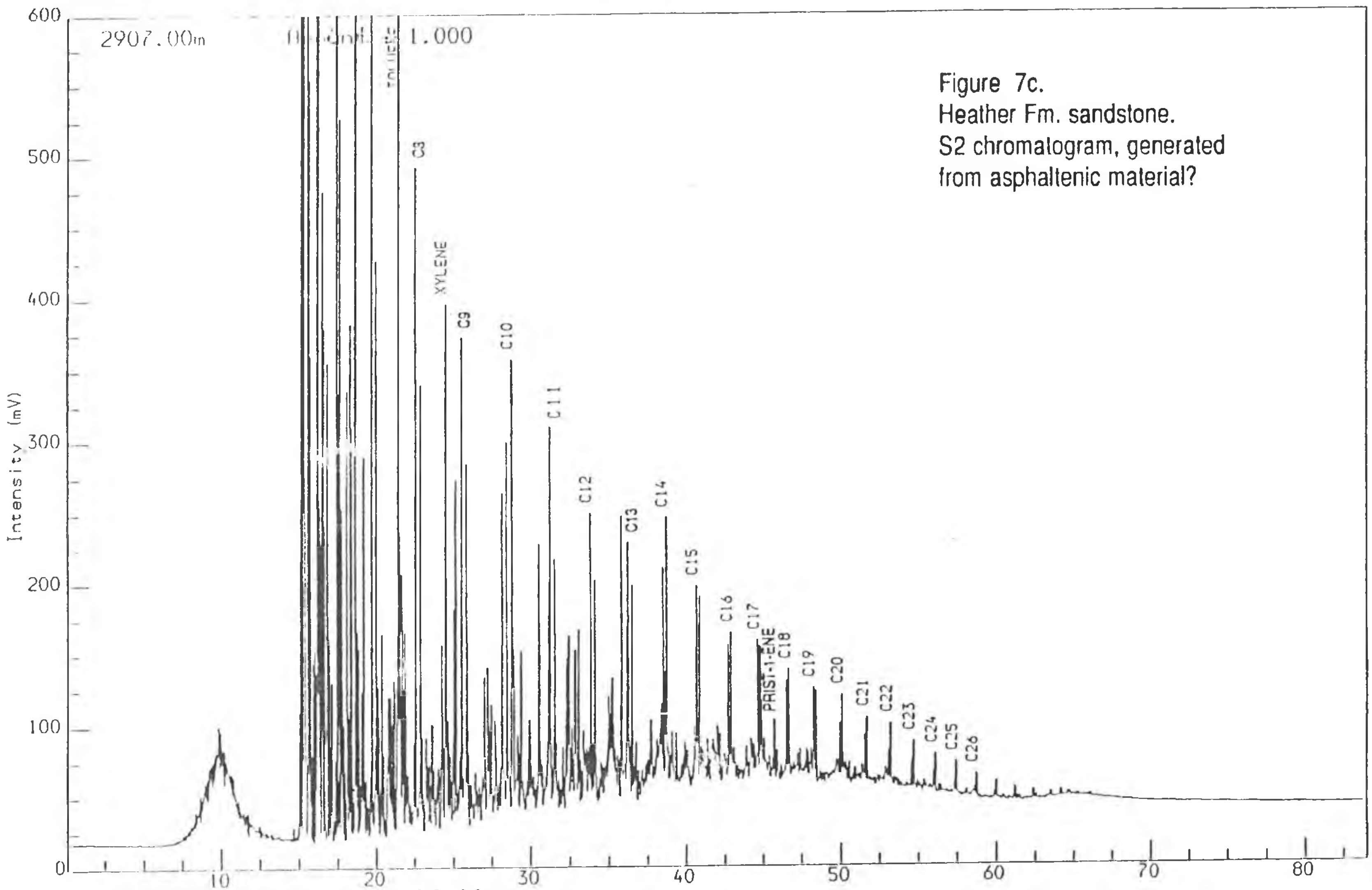


Figure 7c.
Heather Fm. sandstone.
S2 chromatogram, generated from asphaltenic material?

WELL NOCS 15/12-5 2907.00m ccp
PYROLYSIS GC (S2)
S/Sst: brn gy

Reported on 5-JAN-1993 at 09:25

Analysis Name : [522020] 21 PH79C,4,1.

Multichrom

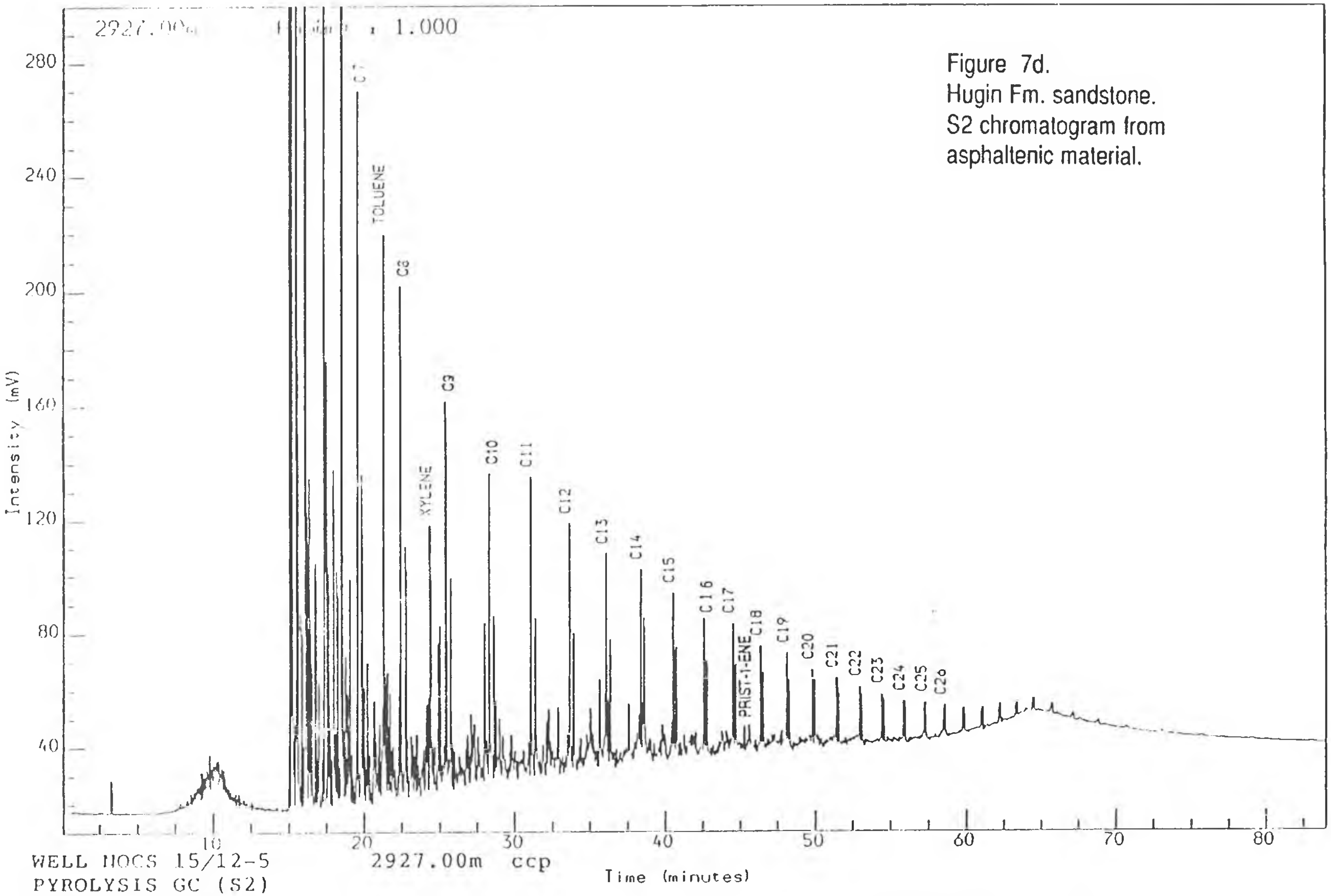


Figure 7d.
Hugin Fm. sandstone.
S2 chromatogram from
asphaltenic material.

WELL NOCS 15/12-5
PYROLYSIS GC (S2)
S/Sst: pl y brn

Reported on 4-JAN-1993 at 13:34

Analysis Name : [522020] 21 PH79B.3.1.

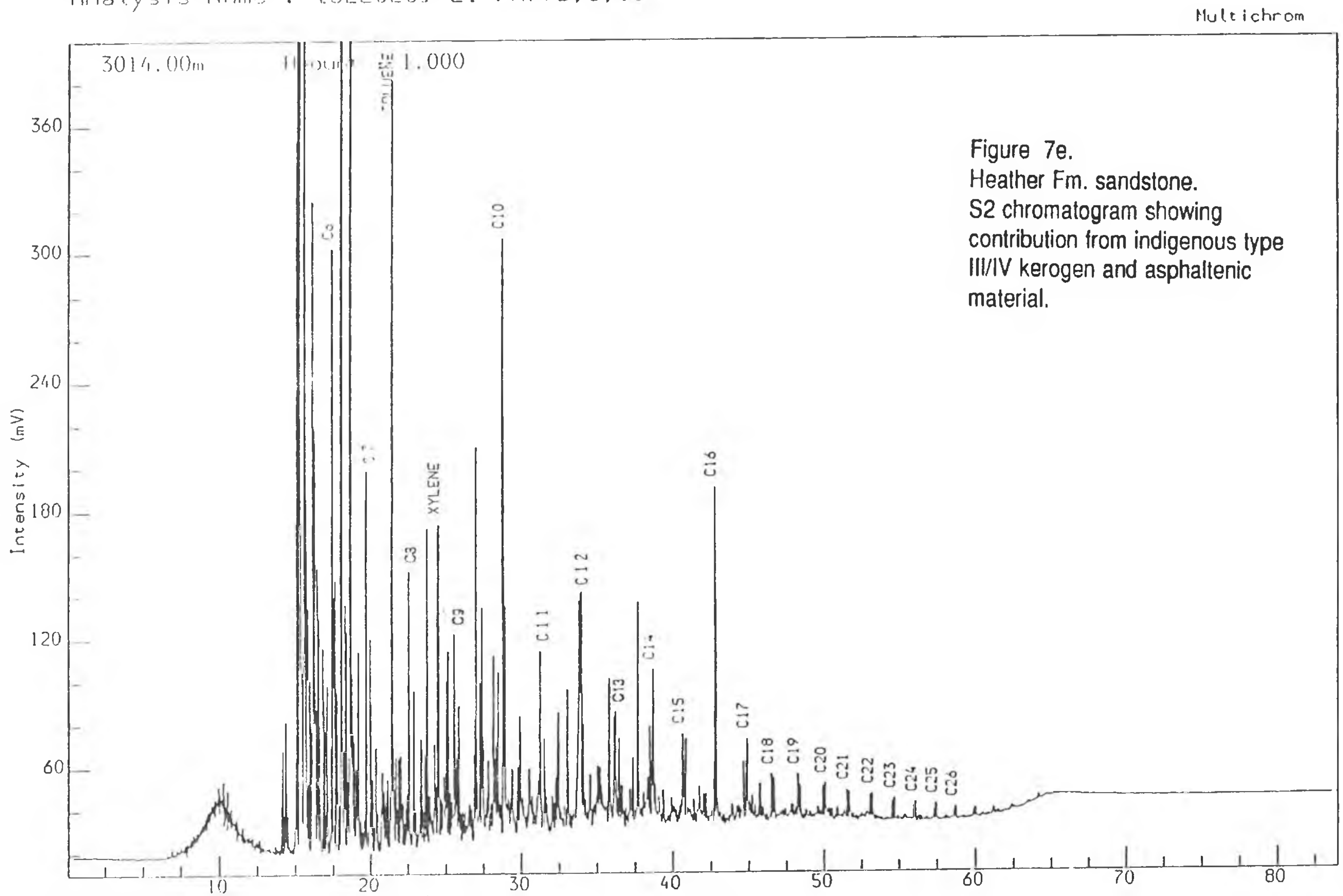


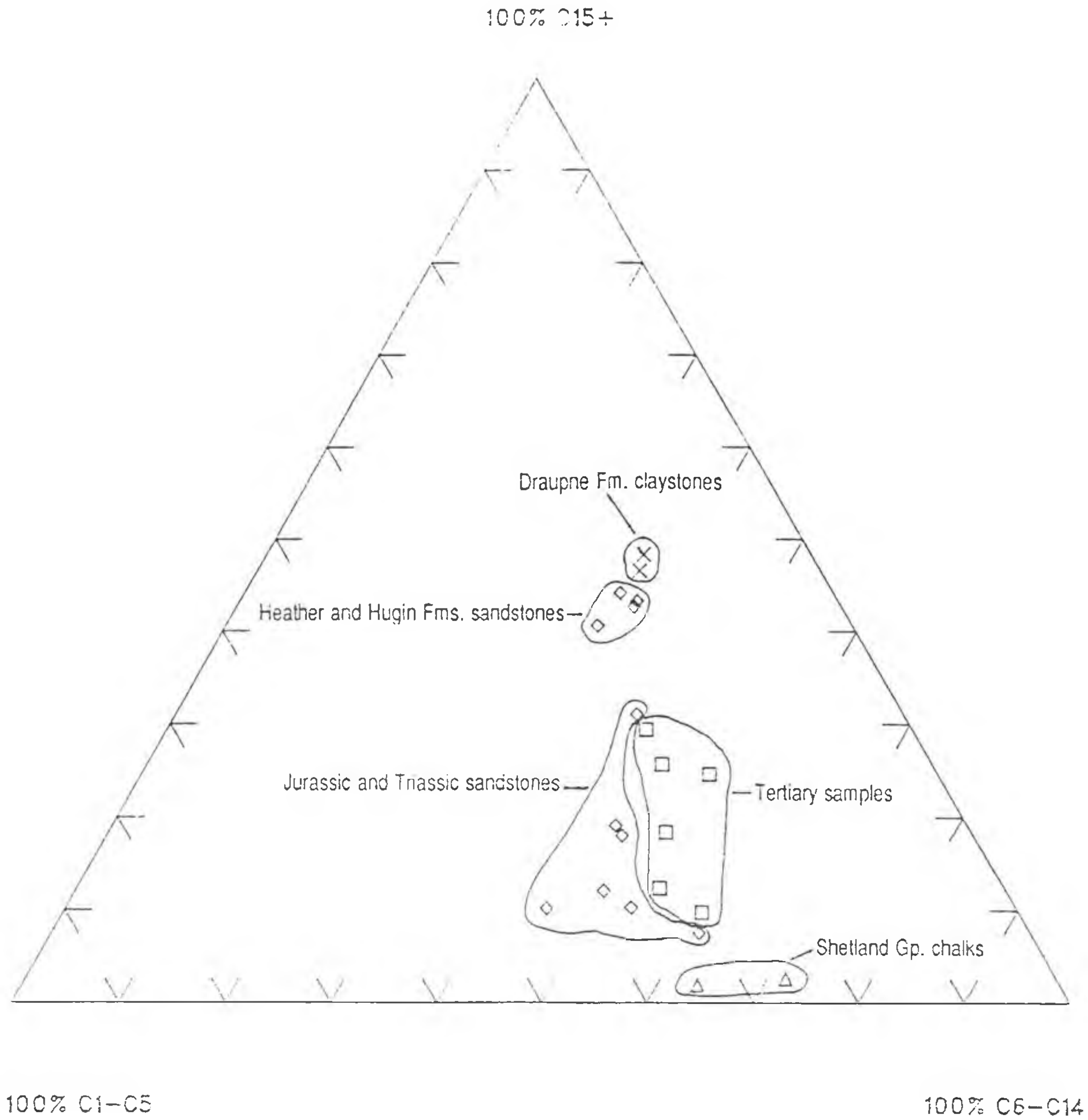
Figure 7e.
Heather Fm. sandstone.
S2 chromatogram showing contribution from indigenous type III/IV kerogen and asphaltenic material.

WELL NOCS 15/12-5 3014.00m cut
PYROLYSIS GC (S2)
S/Sst: w to m gy

Reported on 5-JAN-1993 at 09:30

Figure 8 : Pyrolysis GC Composition

Well NOCS 15/12-5



Analysis Name : [522020] 5 SH7900054L.2.1.

Multichrom

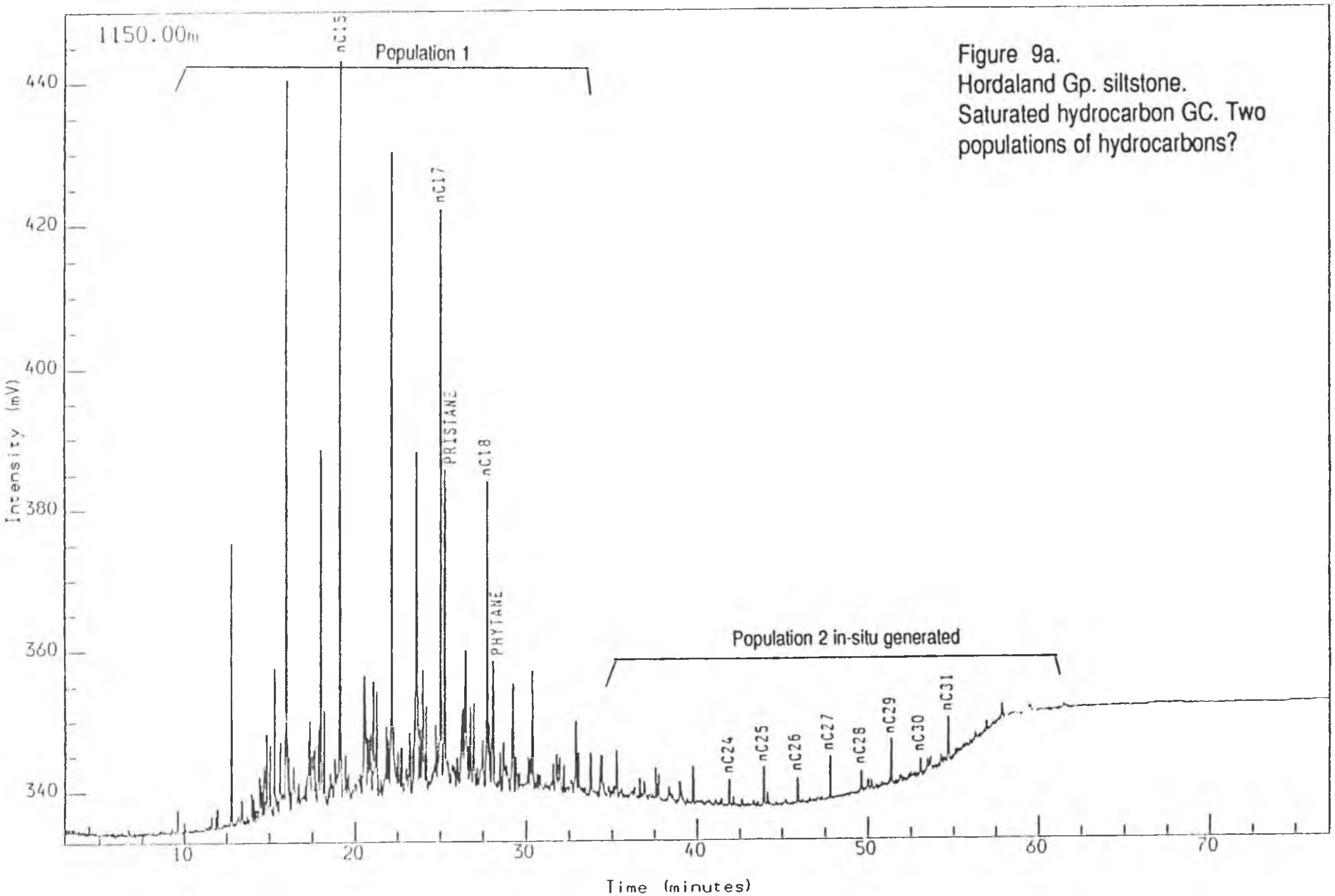


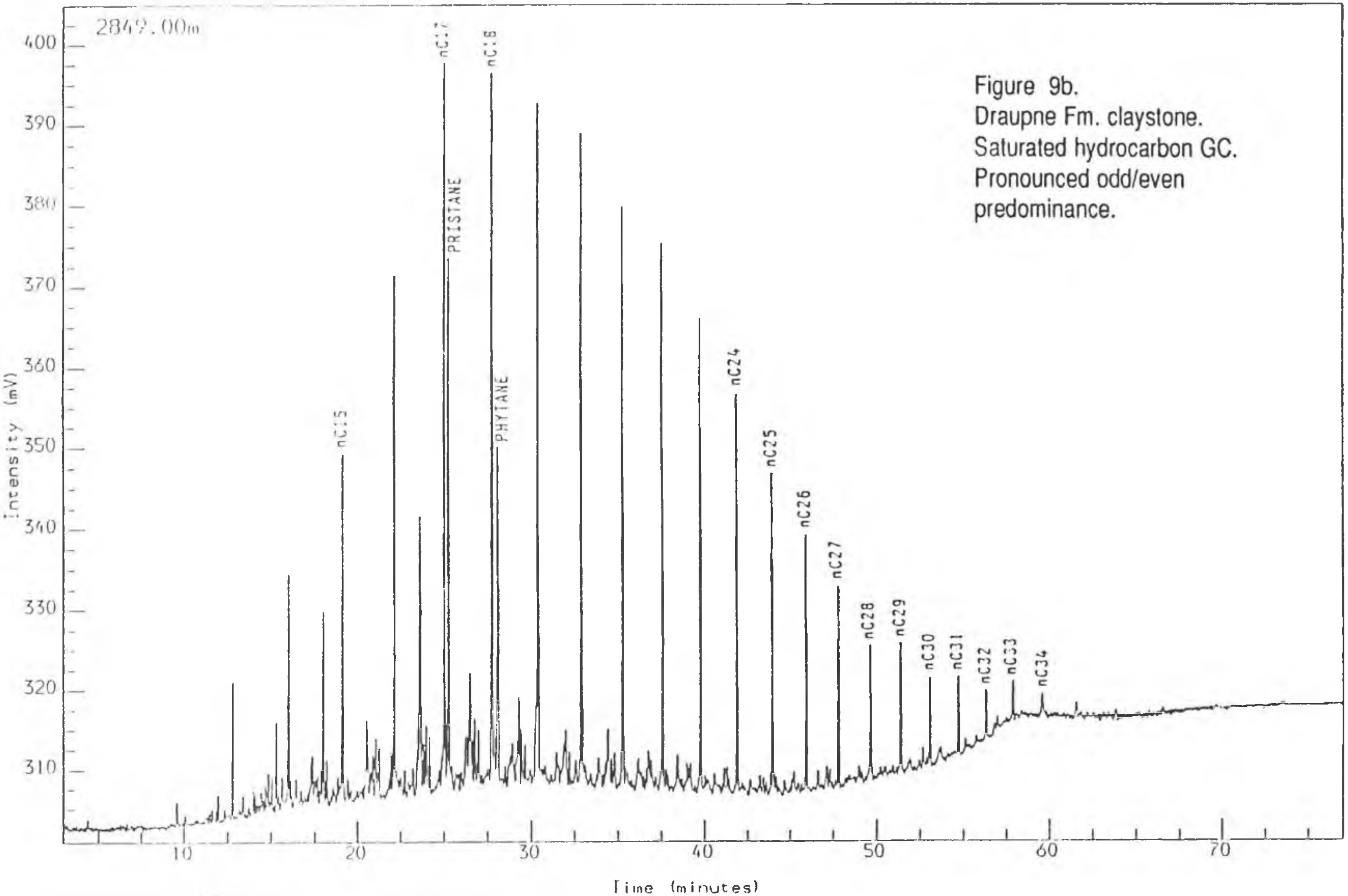
Figure 9a.
Hordaland Gp. siltstone.
Saturated hydrocarbon GC. Two populations of hydrocarbons?

WELL NOCS 15/12-5 1150.00m cut
SATURATED GC
Sltst: pl y brn

Reported on 2-DEC-1992 at 13:40

Analysis Name : [522020] 5 SH7900054L.5.1.

Multichrom



WELL NOCS 15/12-5 2849.00m cut

SATURATED GC

Sh/Clst: drk gy to brn blk

Reported on 2-DEC-1992 at 13:48

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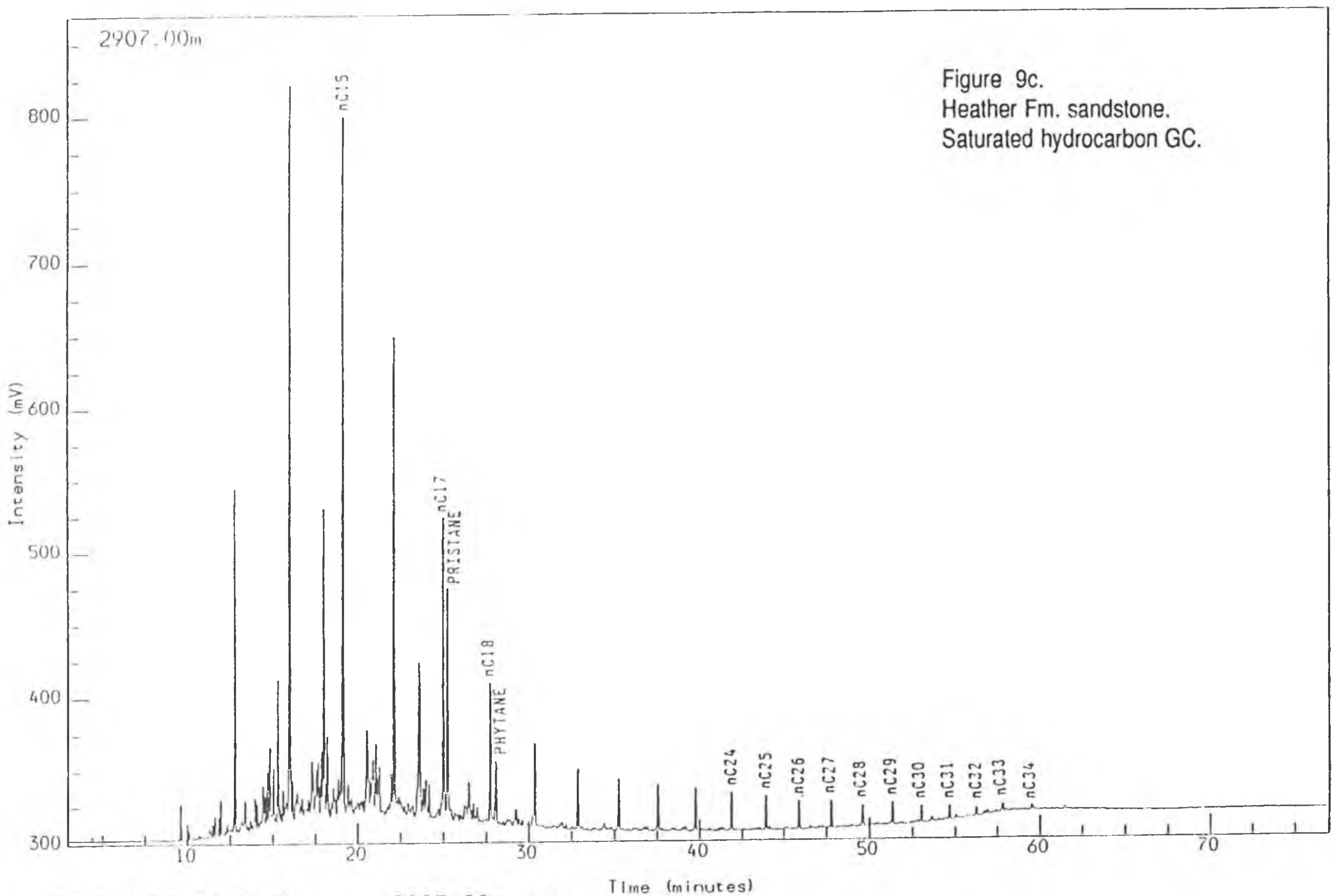
Analysis Name : [522020] 5 SH7900054L.7.1.

Multichrom



WELL NOCS 15/12-5 2907.00m ccp
SATURATED GC
S/Sst: brn gy

Reported on 2-DEC-1992 at 13:54

Analysis Name : [522020] 5 SH7900054L,8,1.

Multichrom

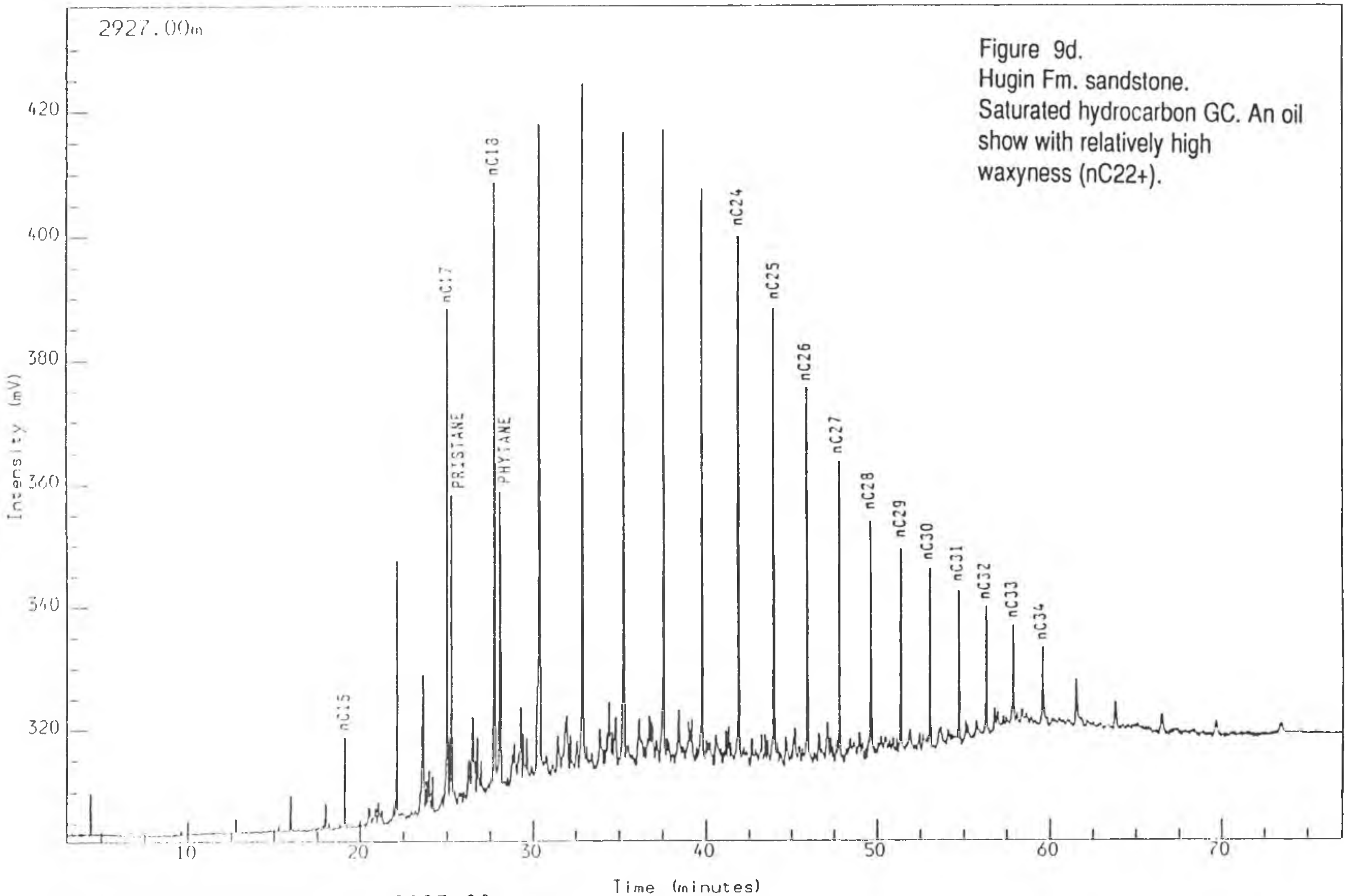


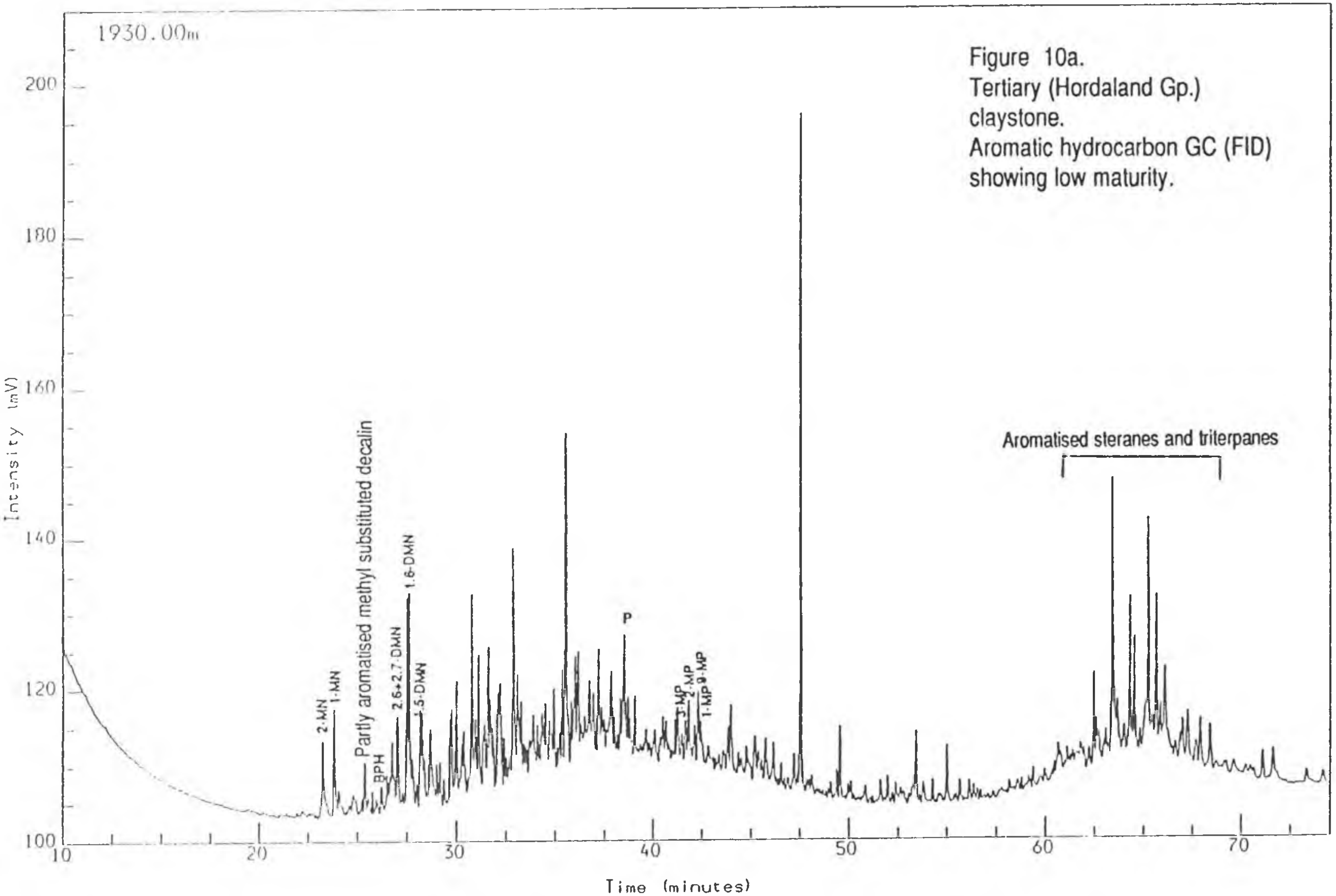
Figure 9d.
Hugin Fm. sandstone.
Saturated hydrocarbon GC. An oil show with relatively high waxyness (nC22+).

WELL NOCS 15/12-5 2927.00m ccp
SATURATED GC
S/Sst: pl y brn

Reported on 2-DEC-1992 at 13:56

Analysis Name : [522020] 29 AH7900054L.4.1.

Multichrom



WELL NOCS 15/12-5 1930.00m cut
AROMATIC GC (FID)
Sh/Clst: lt brn gy to pl y brn

Reported on 2-DEC-1992 at 14:05

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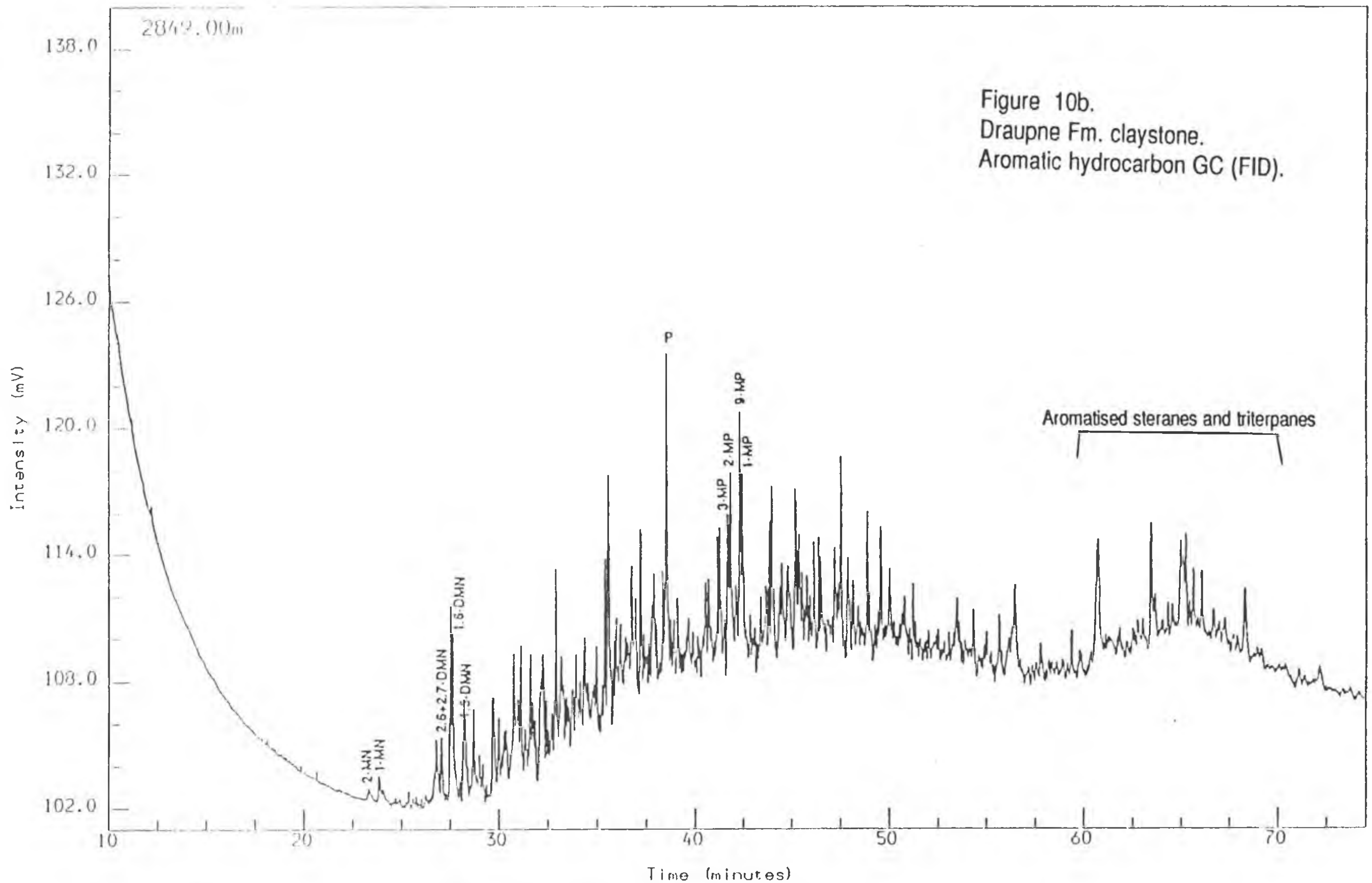
Analysis Name : [522020] 29 AH7900054L,5,1.

Multichrom

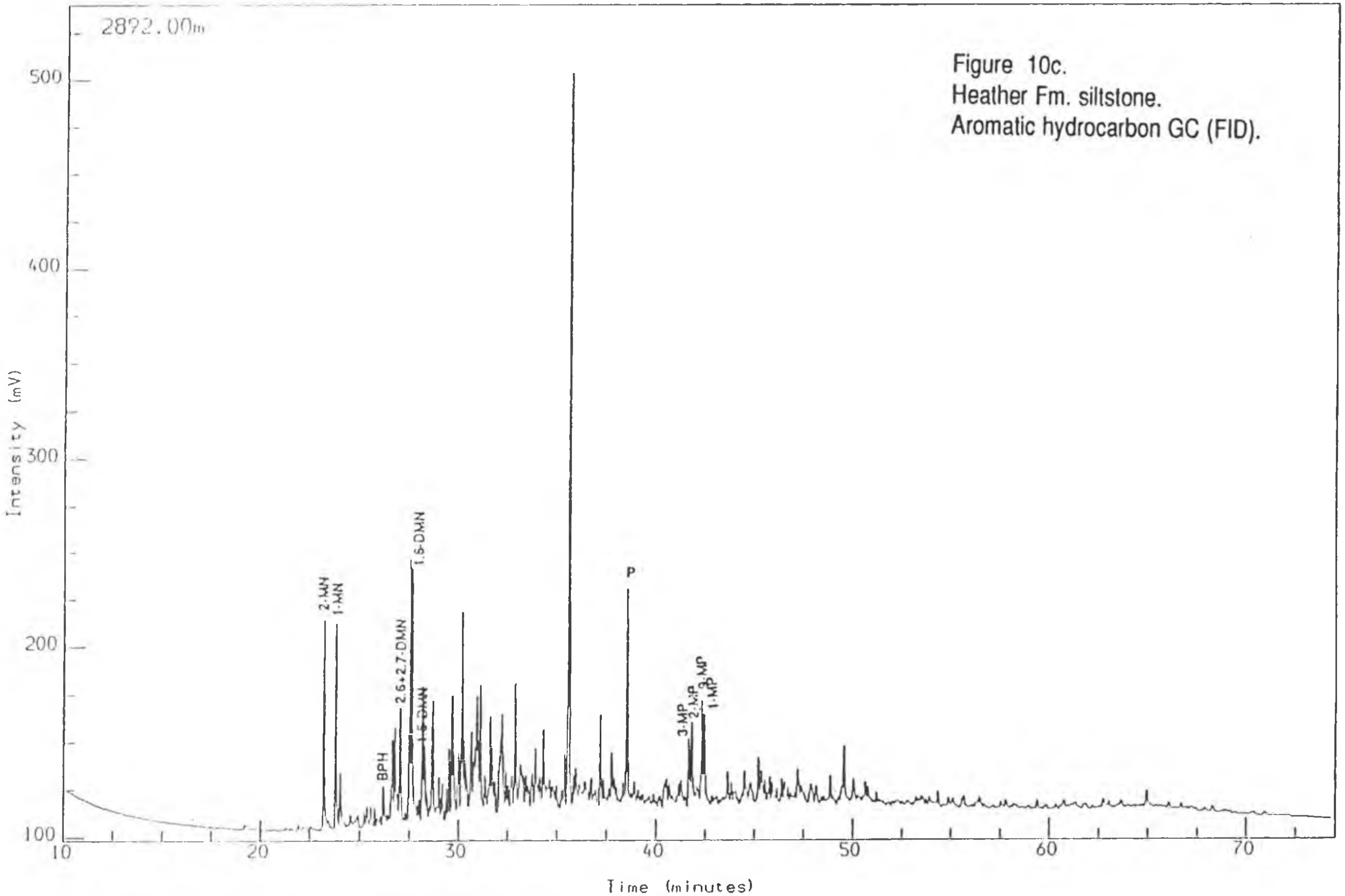


WELL NOCS 15/12-5 2849.00m cut
AROMATIC GC (FID)
Sh/Clst: drk gy to brn blk

Reported on 2-DEC-1992 at 14:07

Analysis Name : [522020] 29 AH7900054L.6.1.

Multichrom



WELL NOCS 15/12-5 2892.00m ccp
AROMATIC GC (FID)
Sltst: brn gy to dsk brn

Reported on 2-DEC-1992 at 14:08

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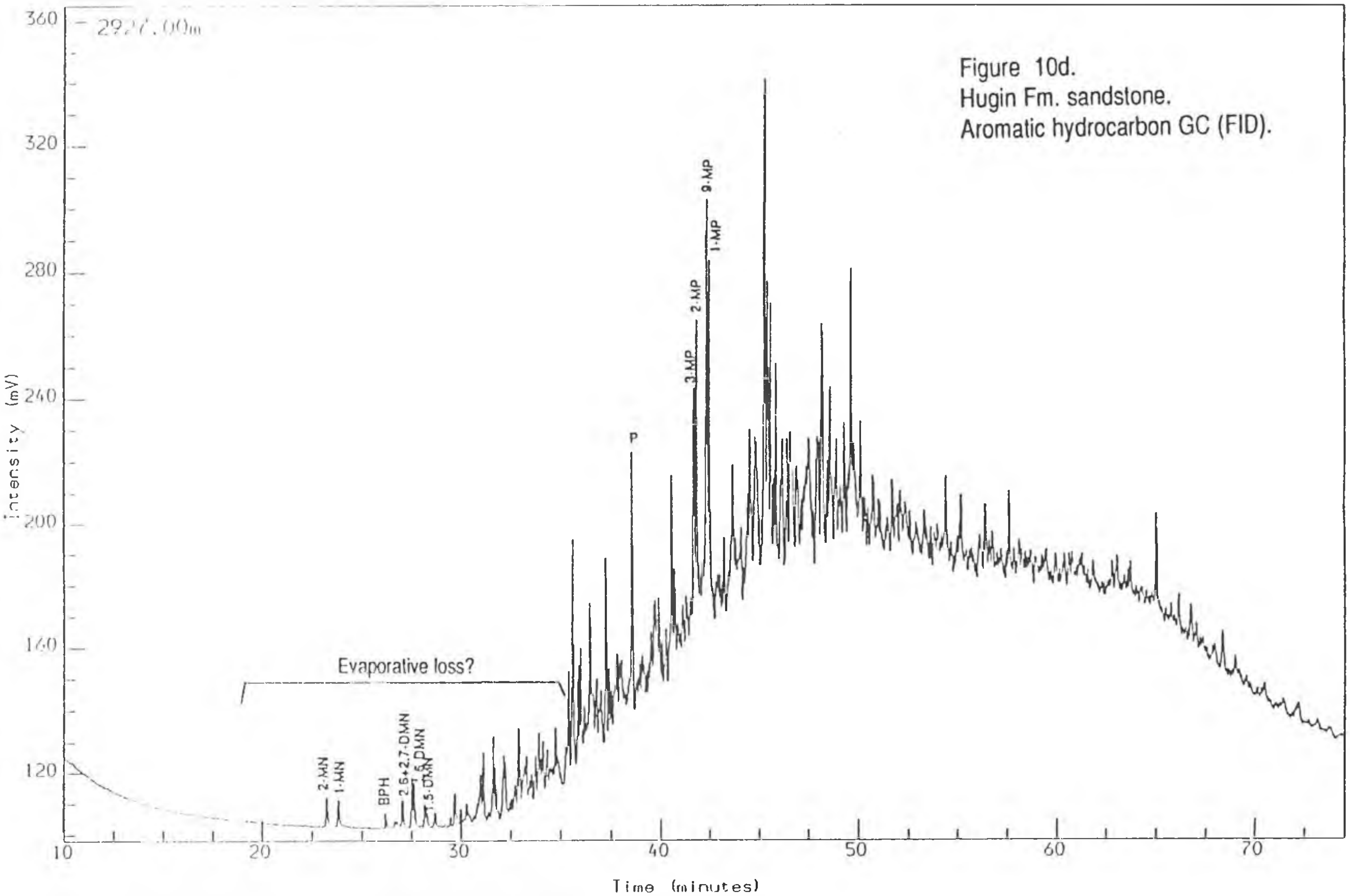
Analysis Name : [522020] 29 AH7900054L.8.1.

Multichrom

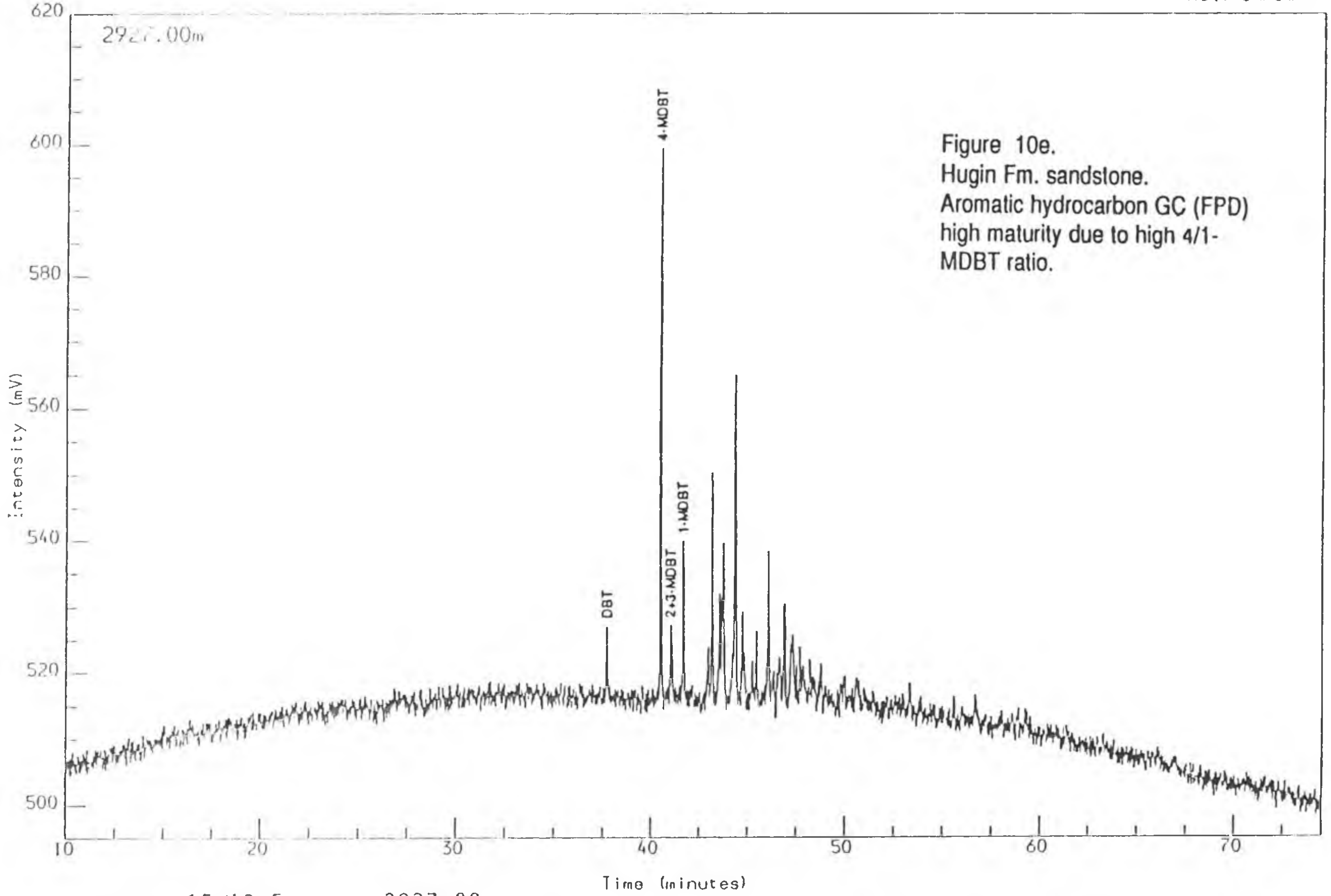


WELL NOCS 15/12-5 2927.00m ccp
AROMATIC GC (FID)
S/Sst: pl y brn

Reported on 2-DEC-1992 at 14:11

Analysis Name : [522020] 30 AH7900054L,8,1.

Multichrom



WELL NOCS 15/12-5 2927.00m ccp
AROMATIC GC (FPD)
S/Sst: pl y brn

Reported on 2-DEC-1992 at 14:30

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Figure 11: Vitrinite Reflectance versus Depth
Well NOCS 15/12-5

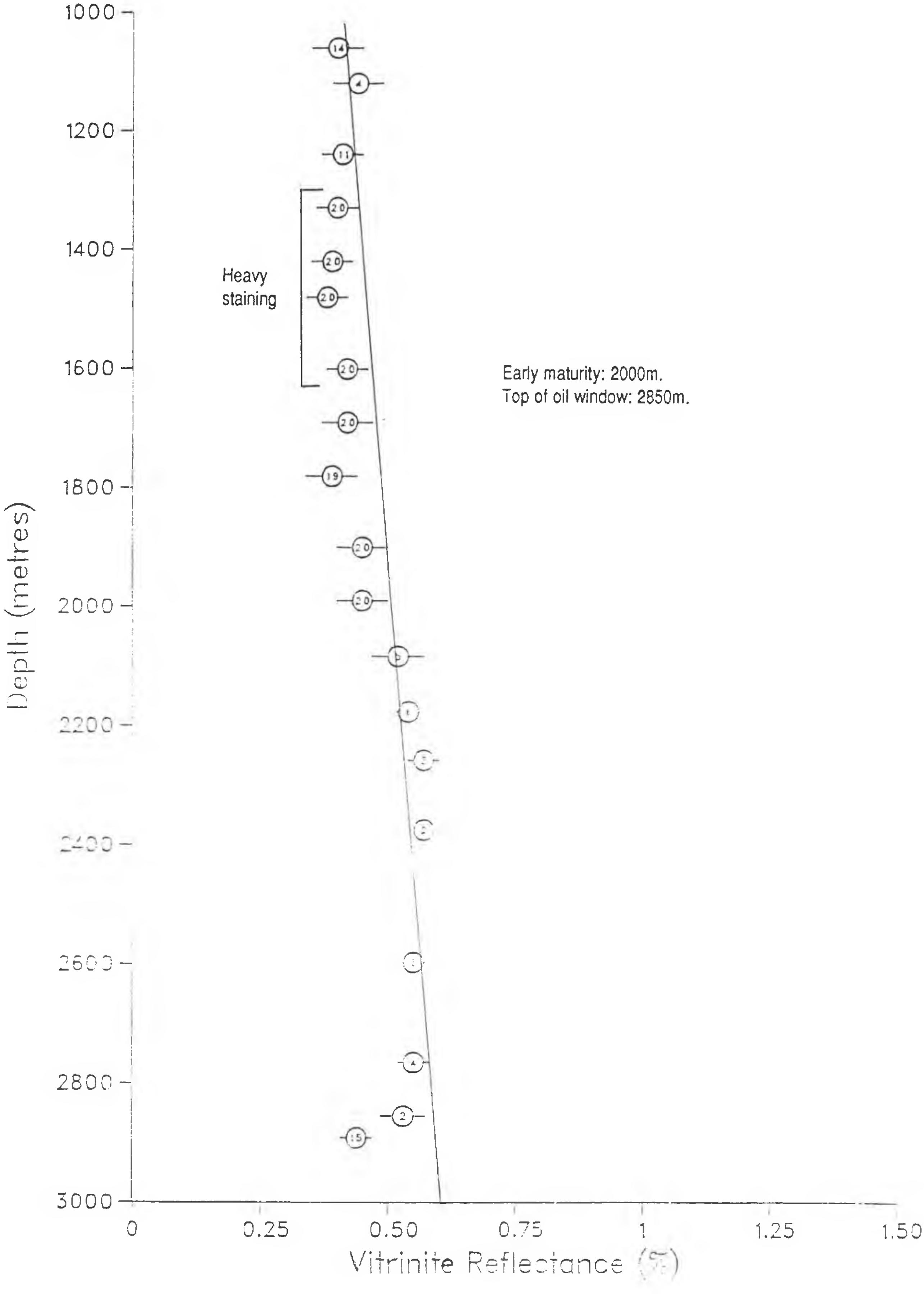

Figure 12: Kerogen Composition and Potential Hydrocarbon Products Well NOCS 15/12-5

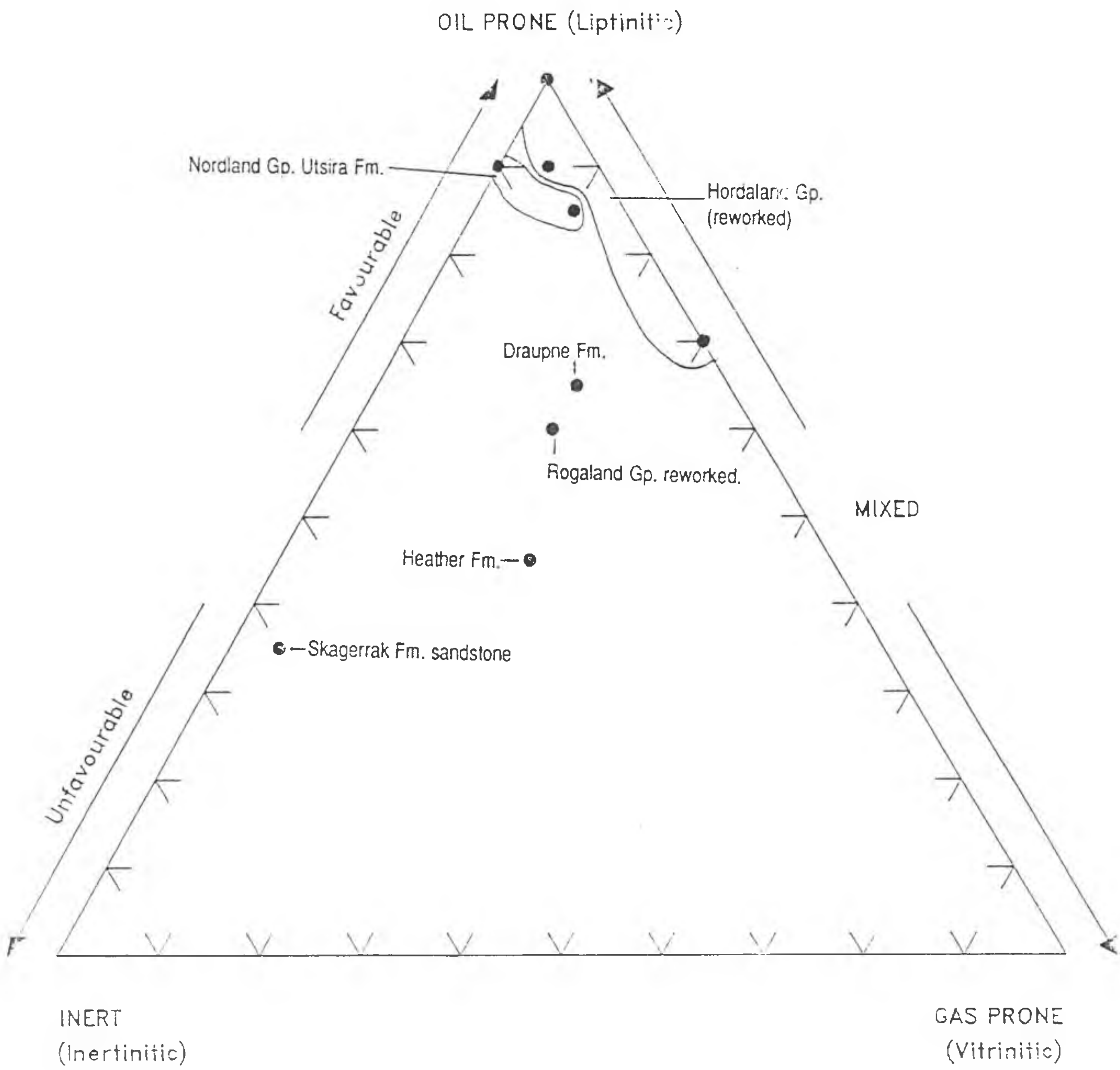

Figure 13: Aromatic v.s. saturate isotope values
Well NOCS 15/12–5

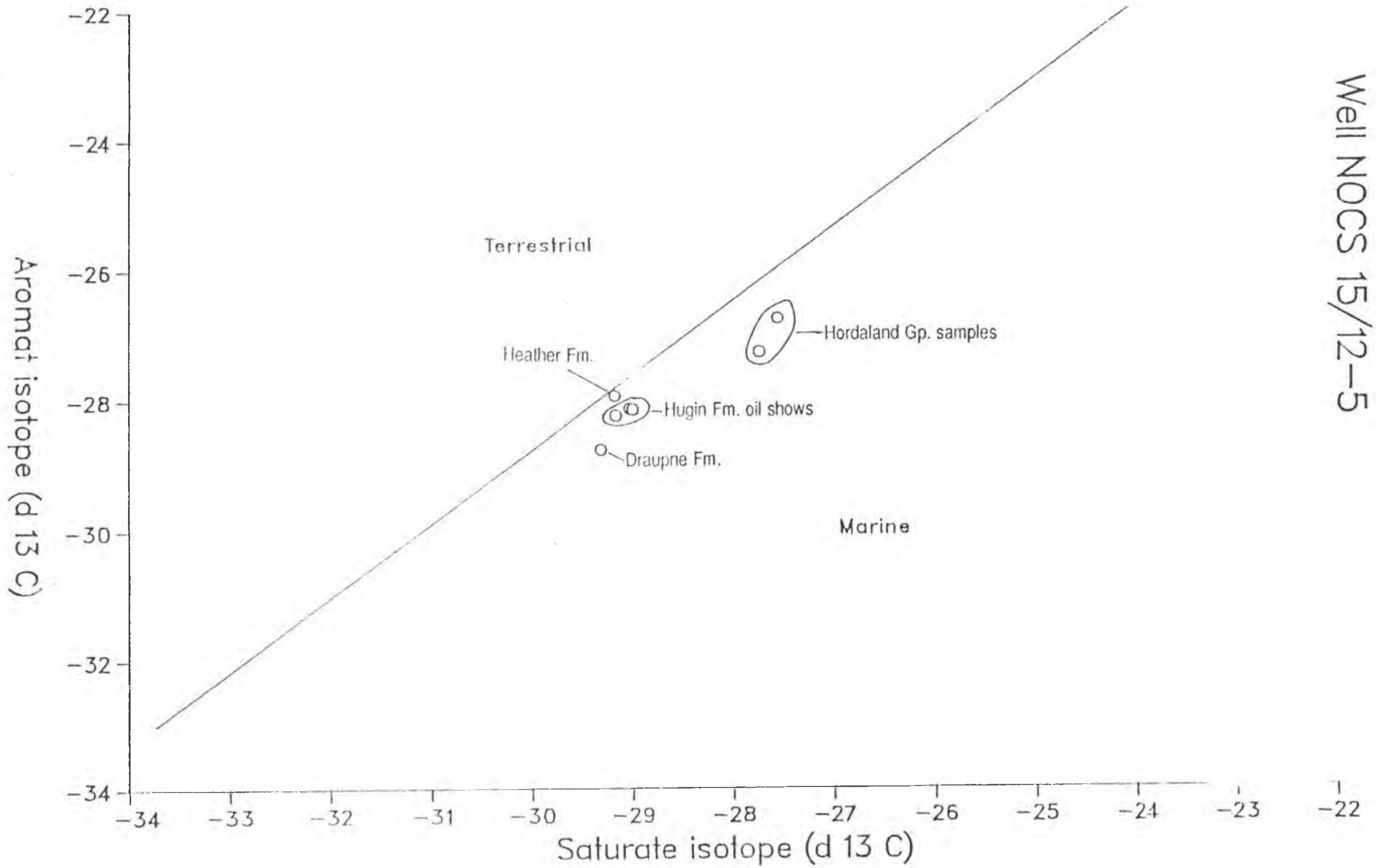

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Figure 14: 13C/12C isotope ratios. Galimov plot. Well NOCS 15/12-5

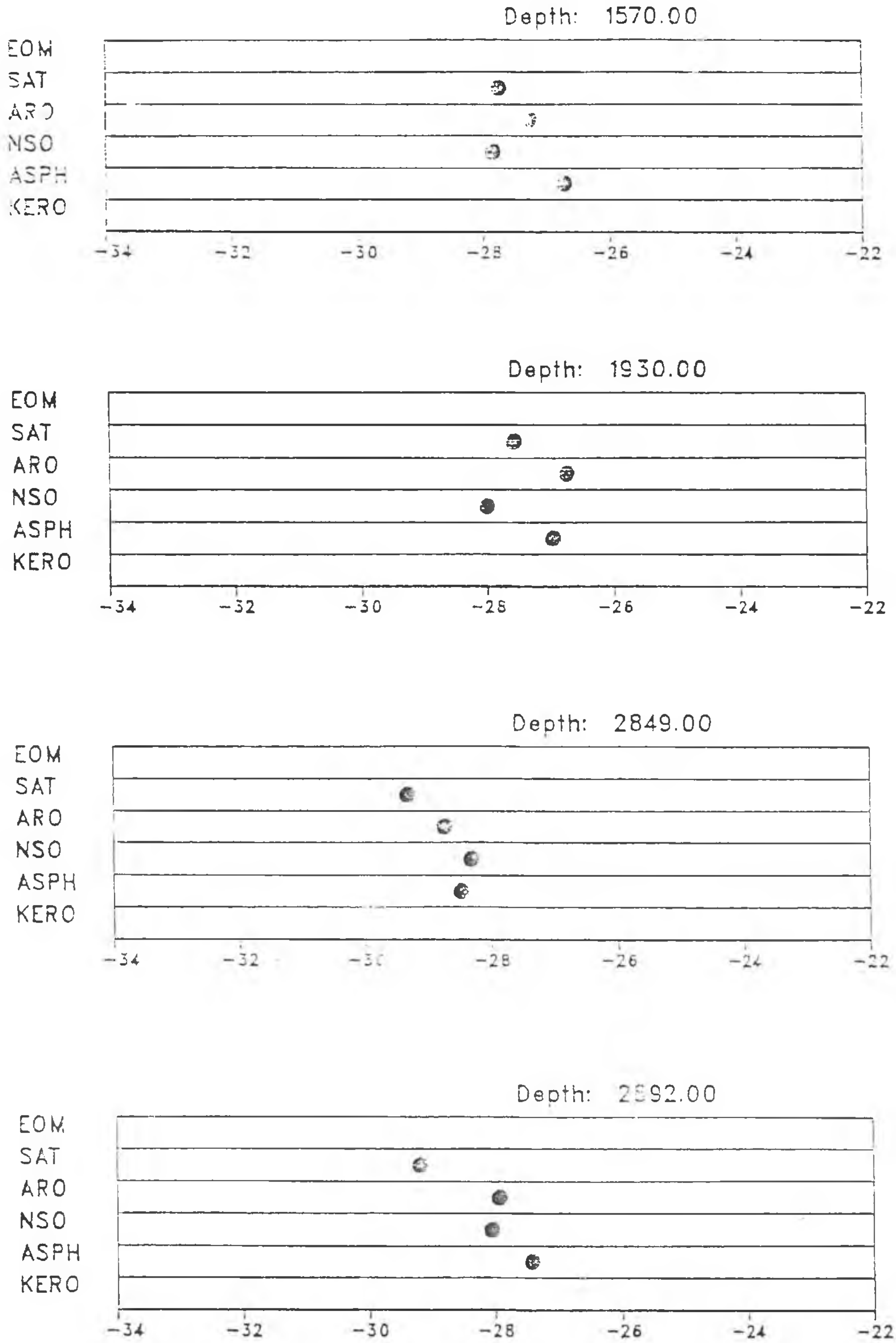
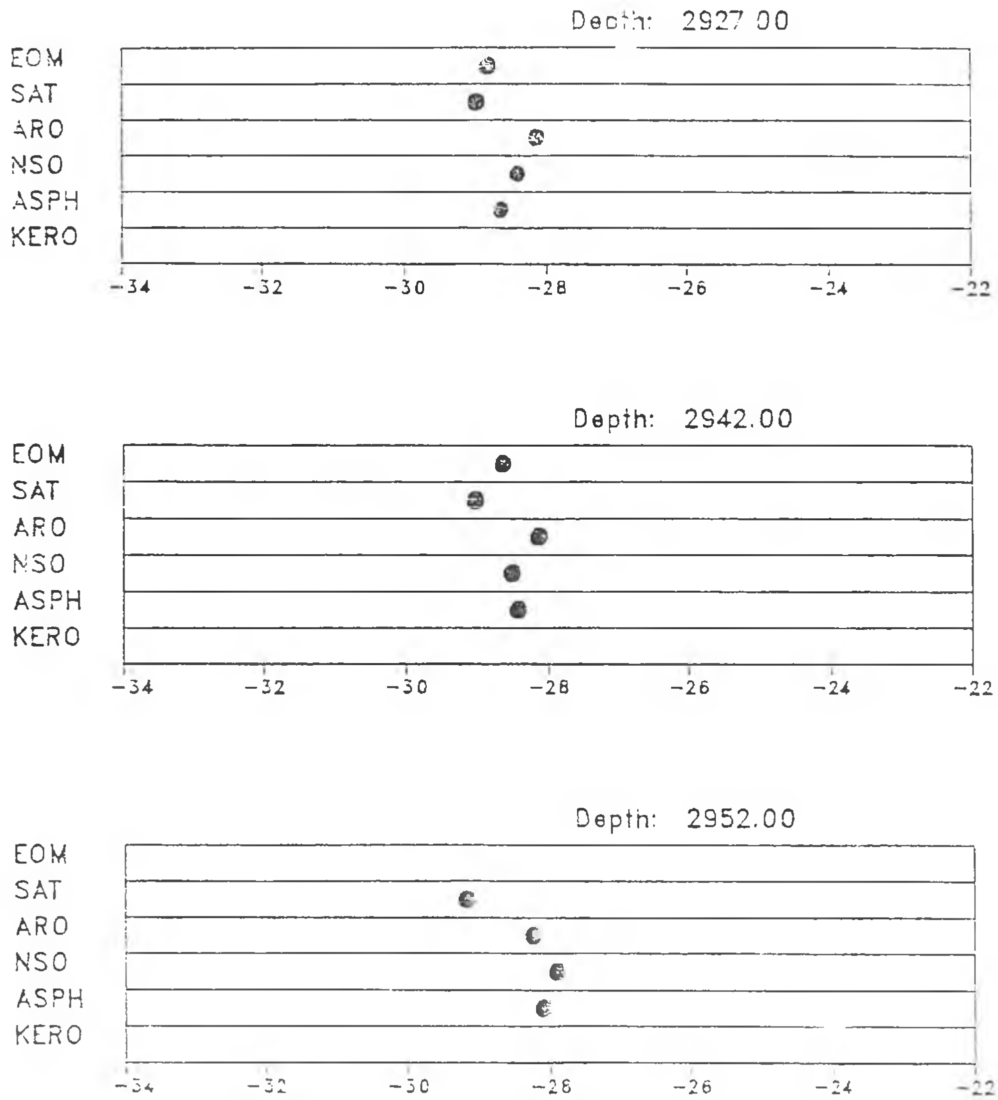
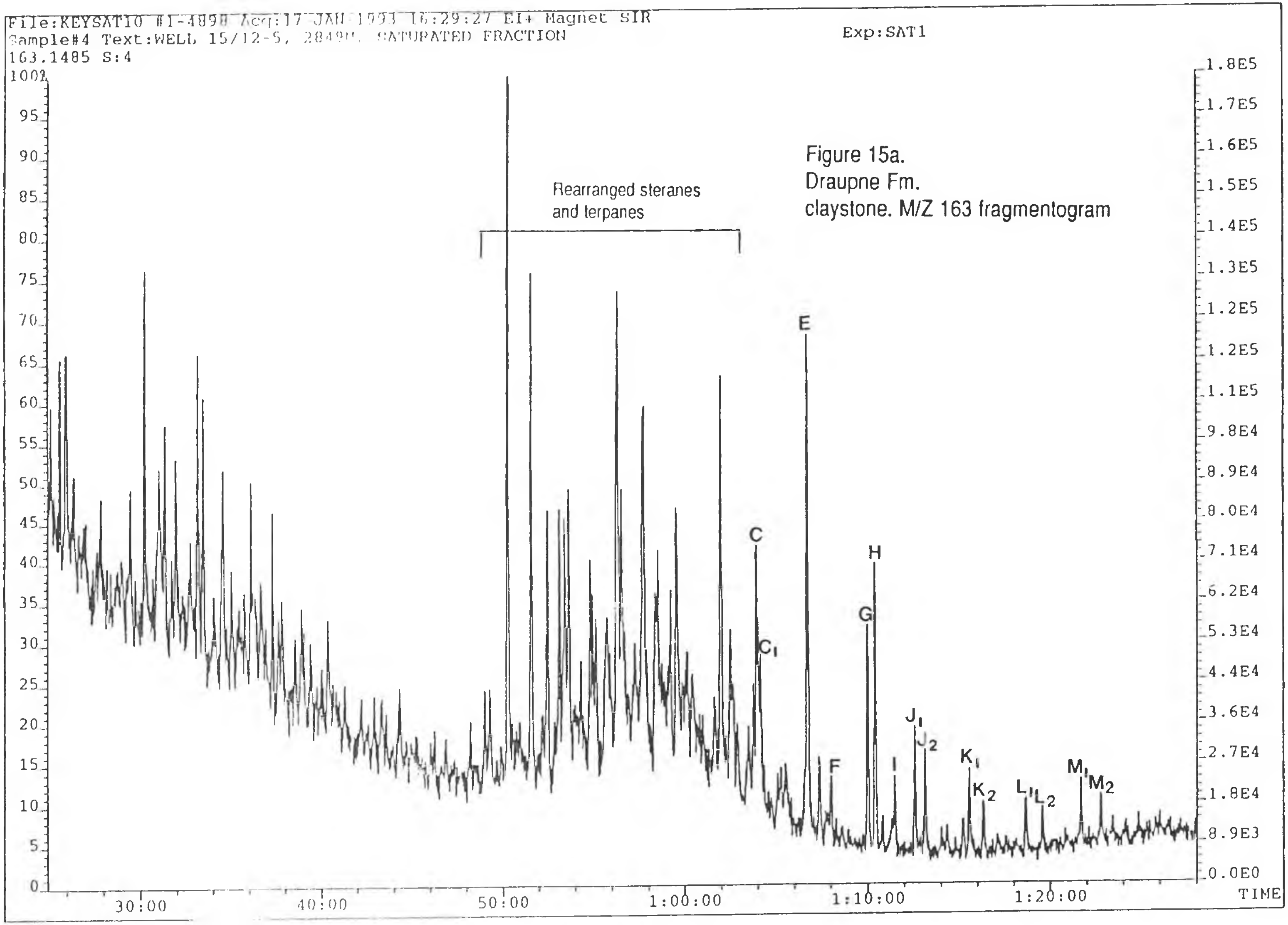


Figure 14: 13C/12C isotope ratios. Galimov plot. Well NOCS 15/12–5





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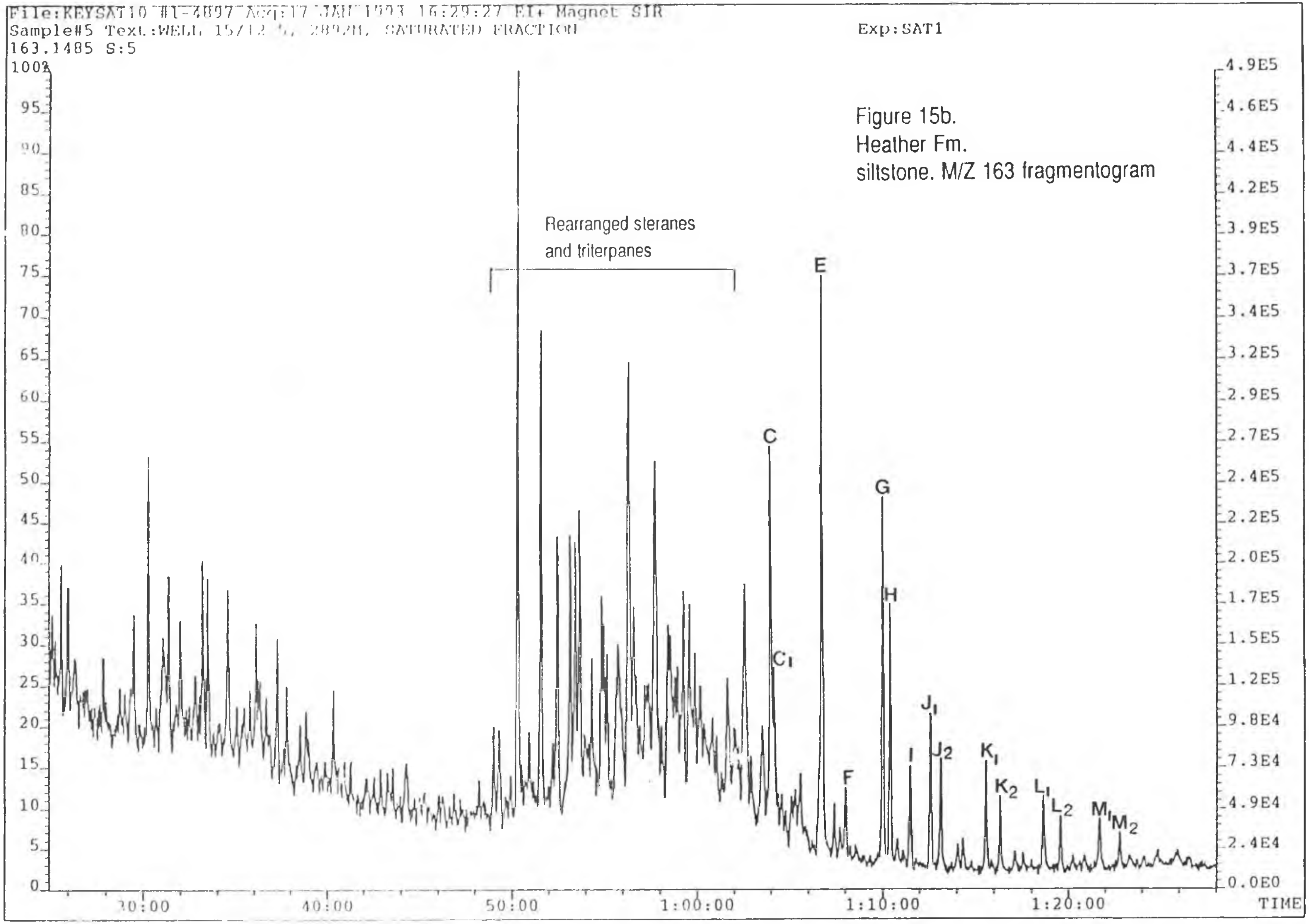


Figure 15b.
Heather Fm.
siltstone. M/Z 163 fragmentogram

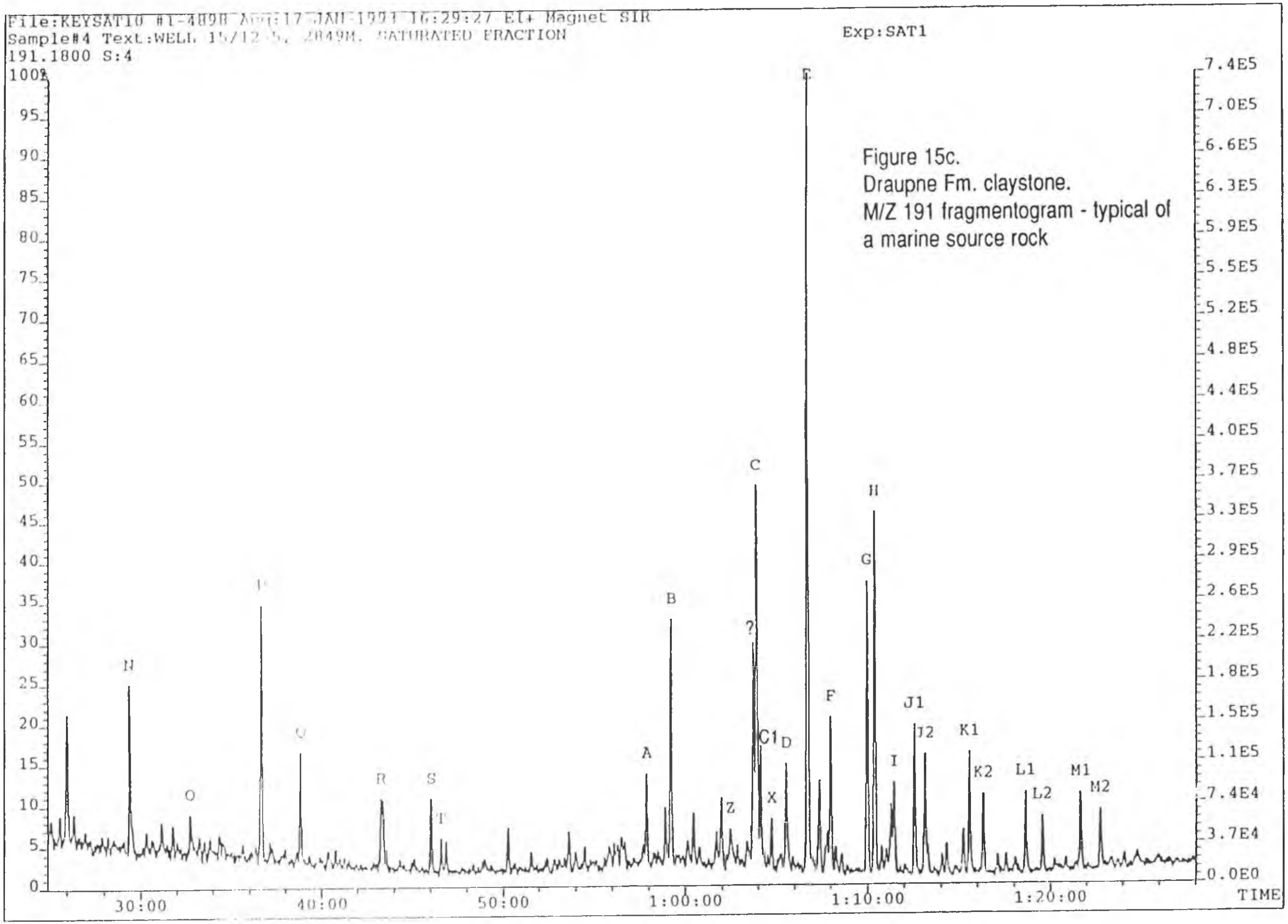
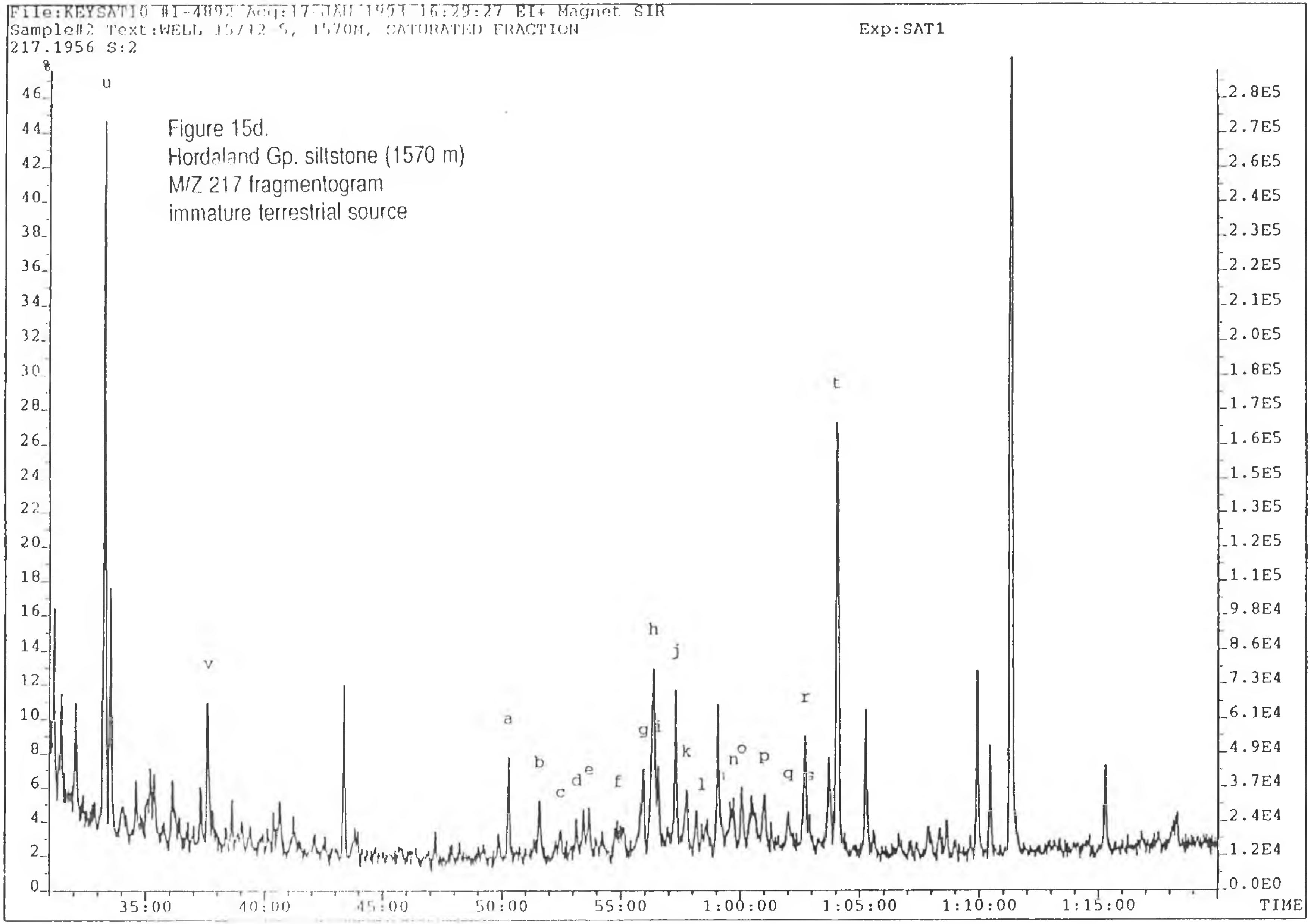


Figure 15c.
Draupne Fm. claystone.
M/Z 191 fragmentogram - typical of a marine source rock


File:KEYSAT10 #1-4892 Acq:17-JAN-1993 16:29:27 EI+ Magnet SIR
Sample#2 Text:WELL 15/12-5, 1570M, SATURATED FRACTION
Exp:SAT1
217.1956 S:2
Figure 15d.
Hordaland Gp. siltstone (1570 m)
M/Z 217 fragmentogram
immature terrestrial source
TIME

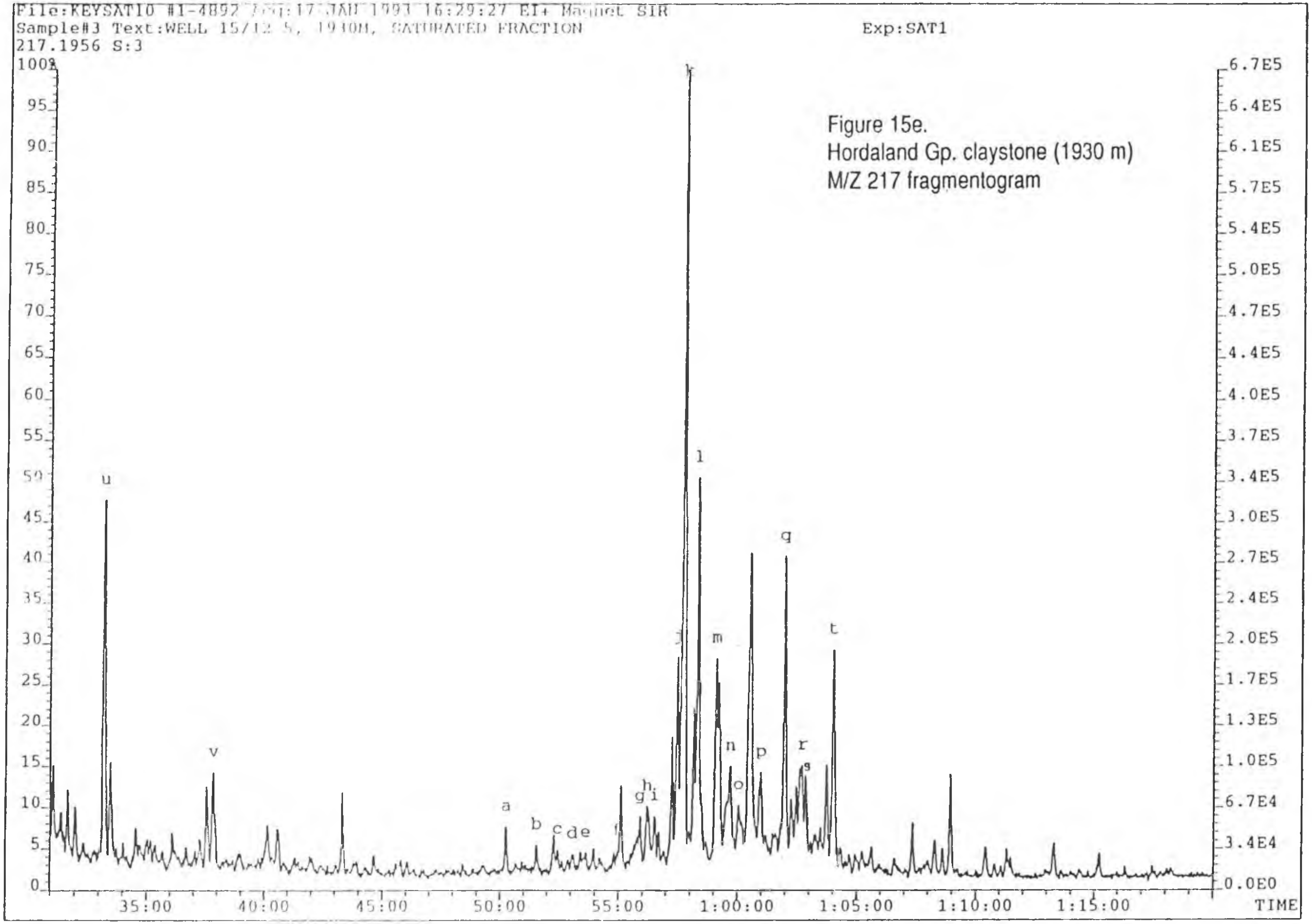


Figure 15e.
Hordaland Gp. claystone (1930 m)
M/Z 217 fragmentogram

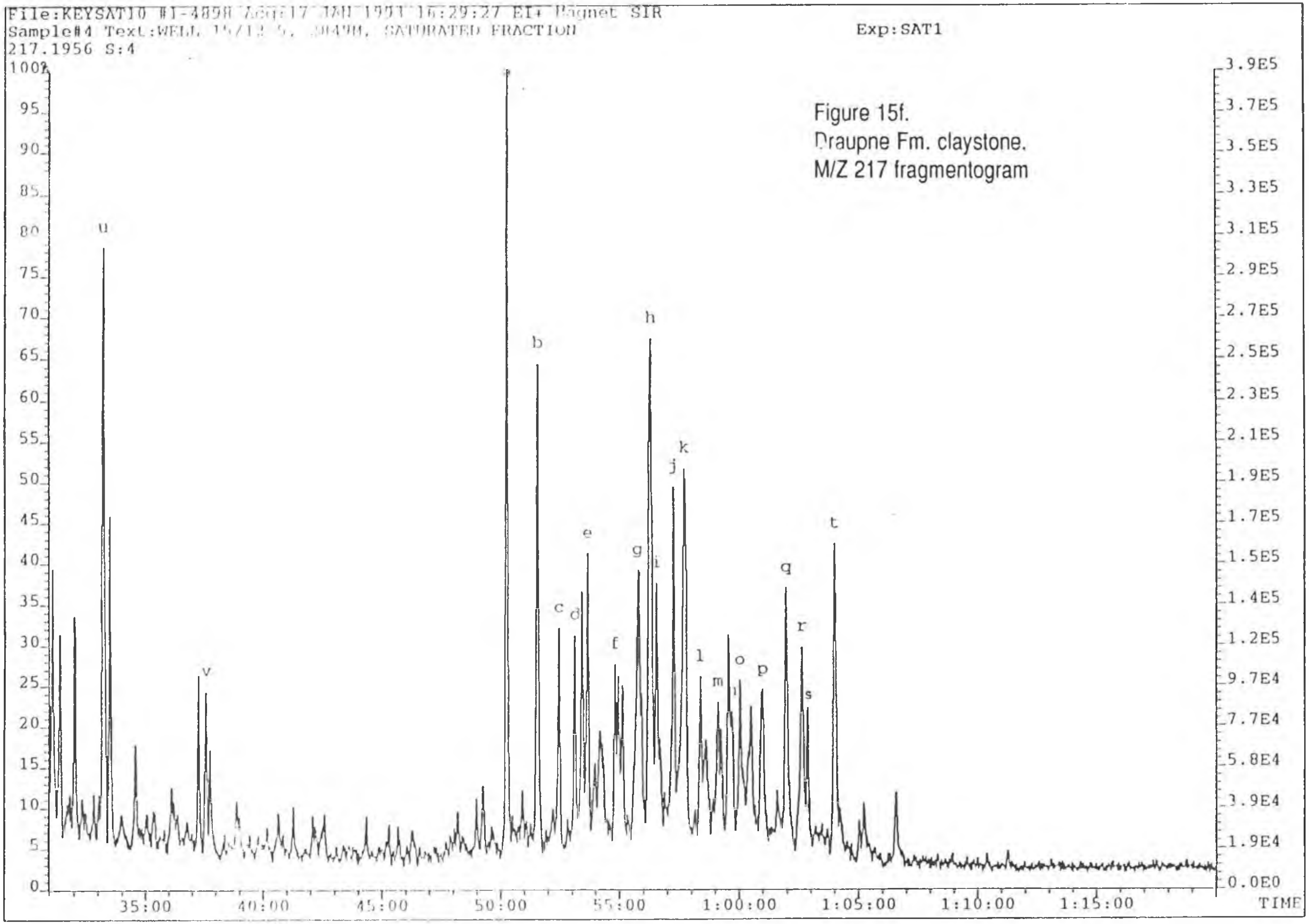


Figure 15f.
Draupne Fm. claystone.
M/Z 217 fragmentogram

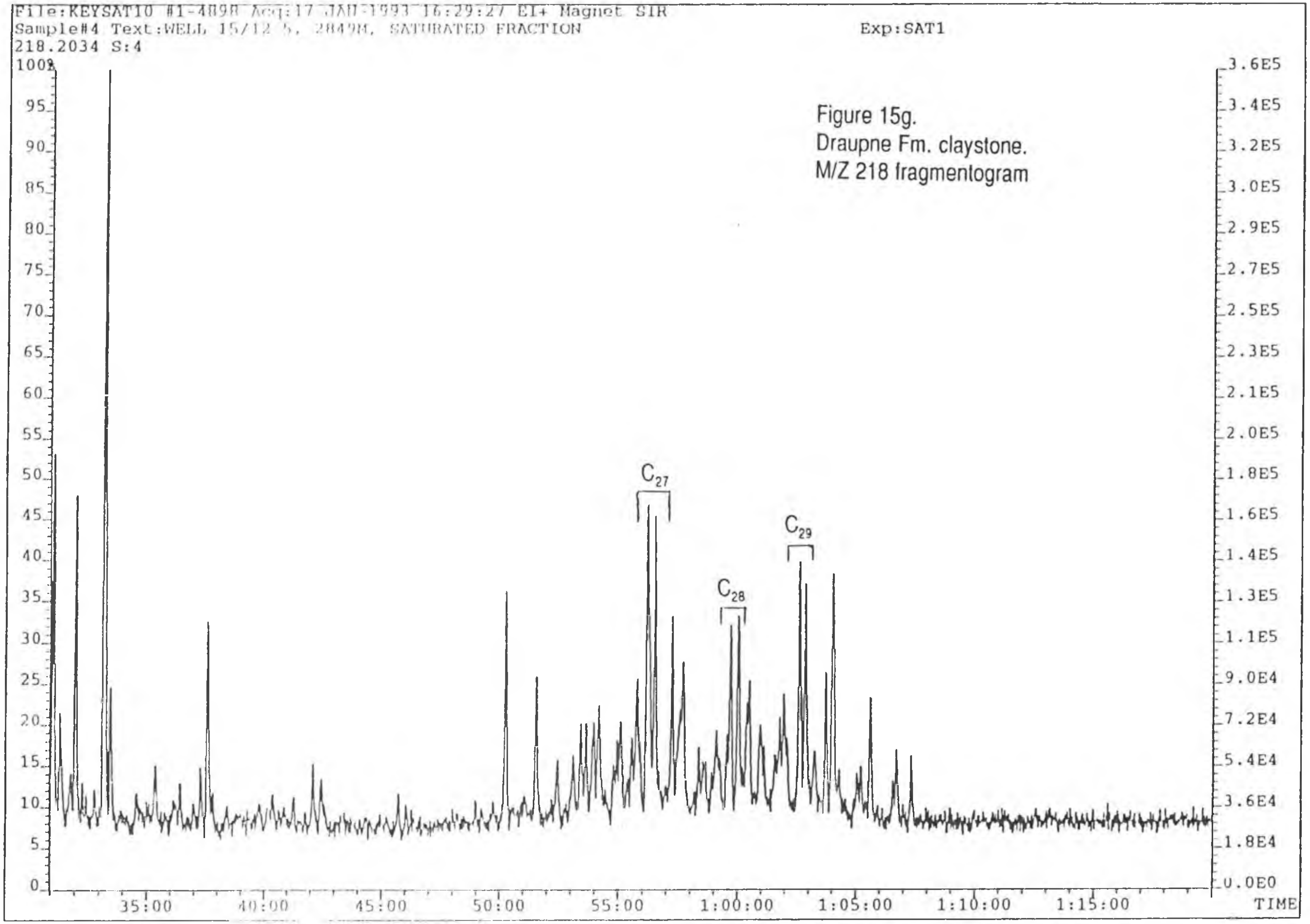
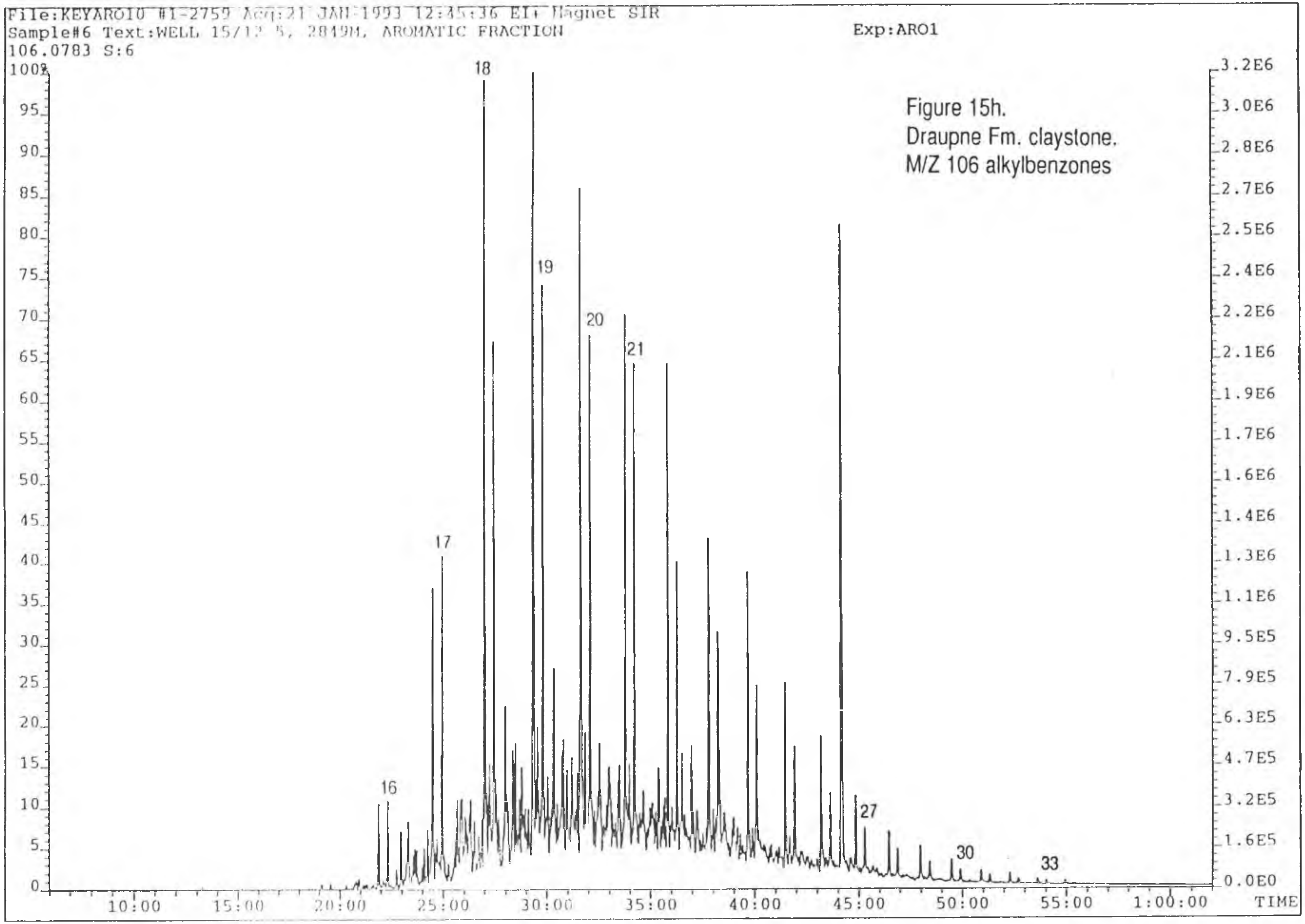
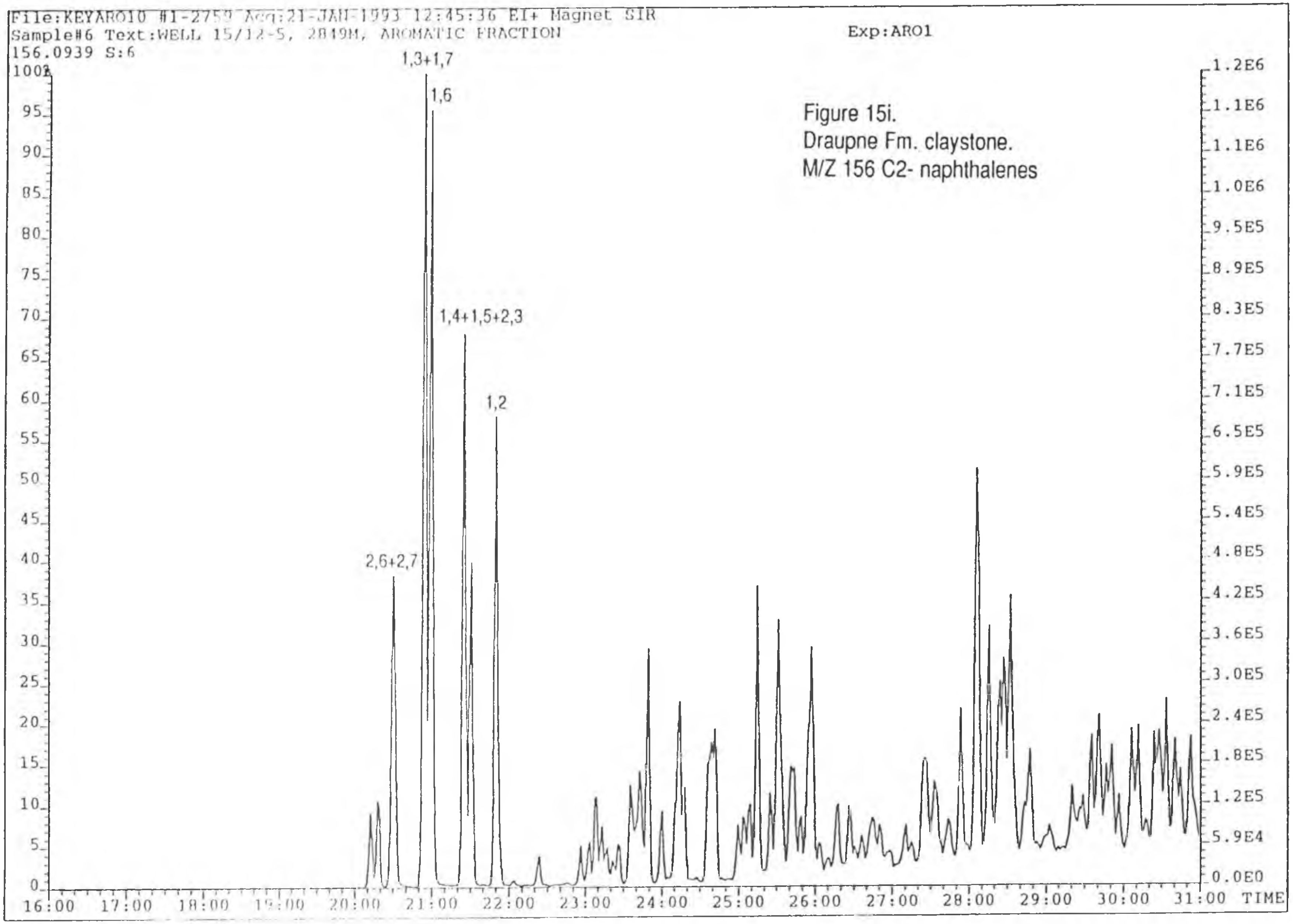


Figure 15g.
Draupne Fm. claystone.
M/Z 218 fragmentogram


File:KEYARO1U #1-2759 Acq:21-JAN-1993 12:45:36 EI+ Magnet SIR
Sample#6 Text:WELL 15/12-5, 2849M, AROMATIC FRACTION
Exp:ARO1
106.0783 S:6
Figure 15h.
Draupne Fm. claystone.
M/Z 106 alkylbenzones
16
17
18
19
20
21
27
30
33
TIME



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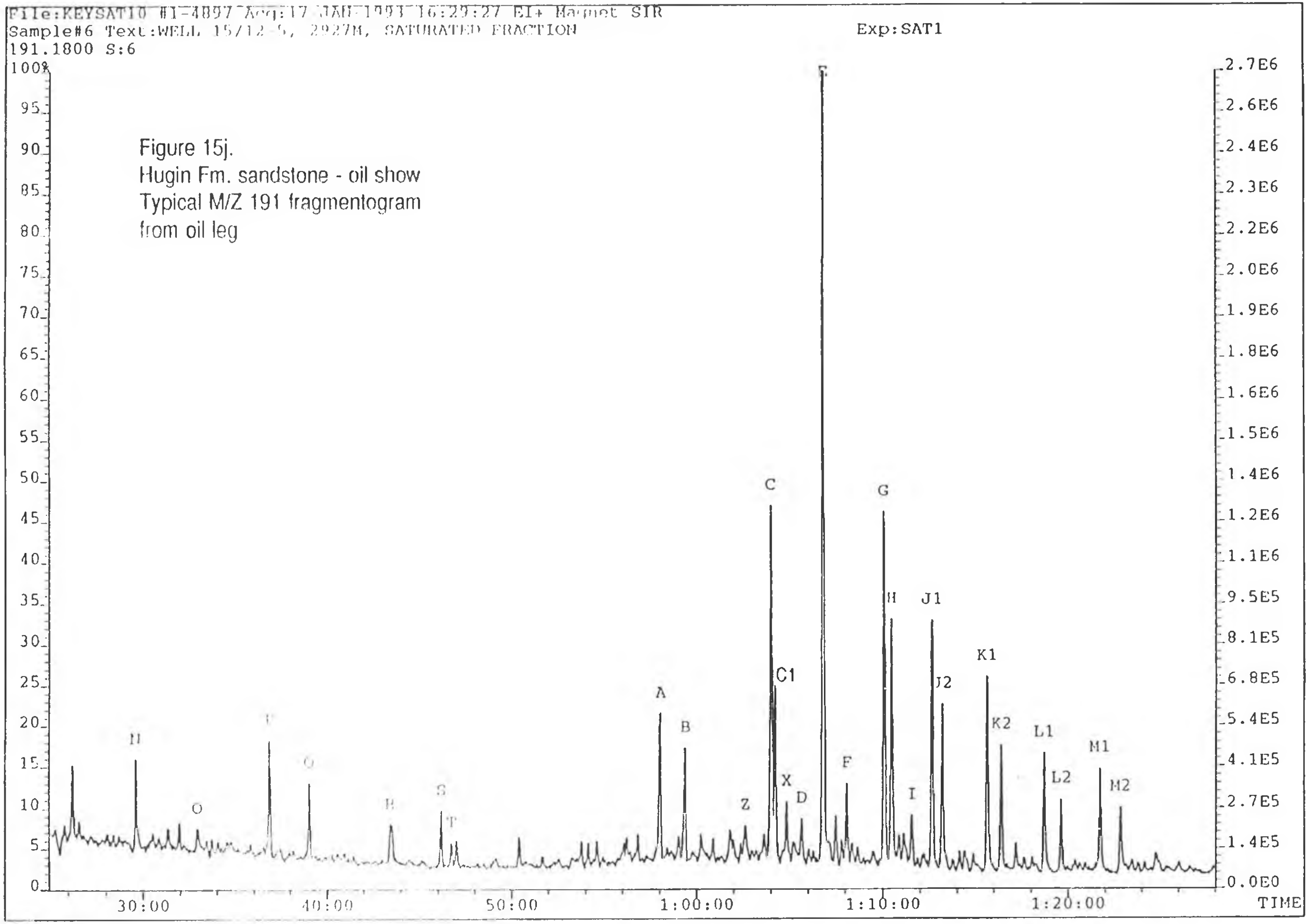


Figure 15j.
Hugin Fm. sandstone - oil show
Typical M/Z 191 fragmentogram
from oil leg

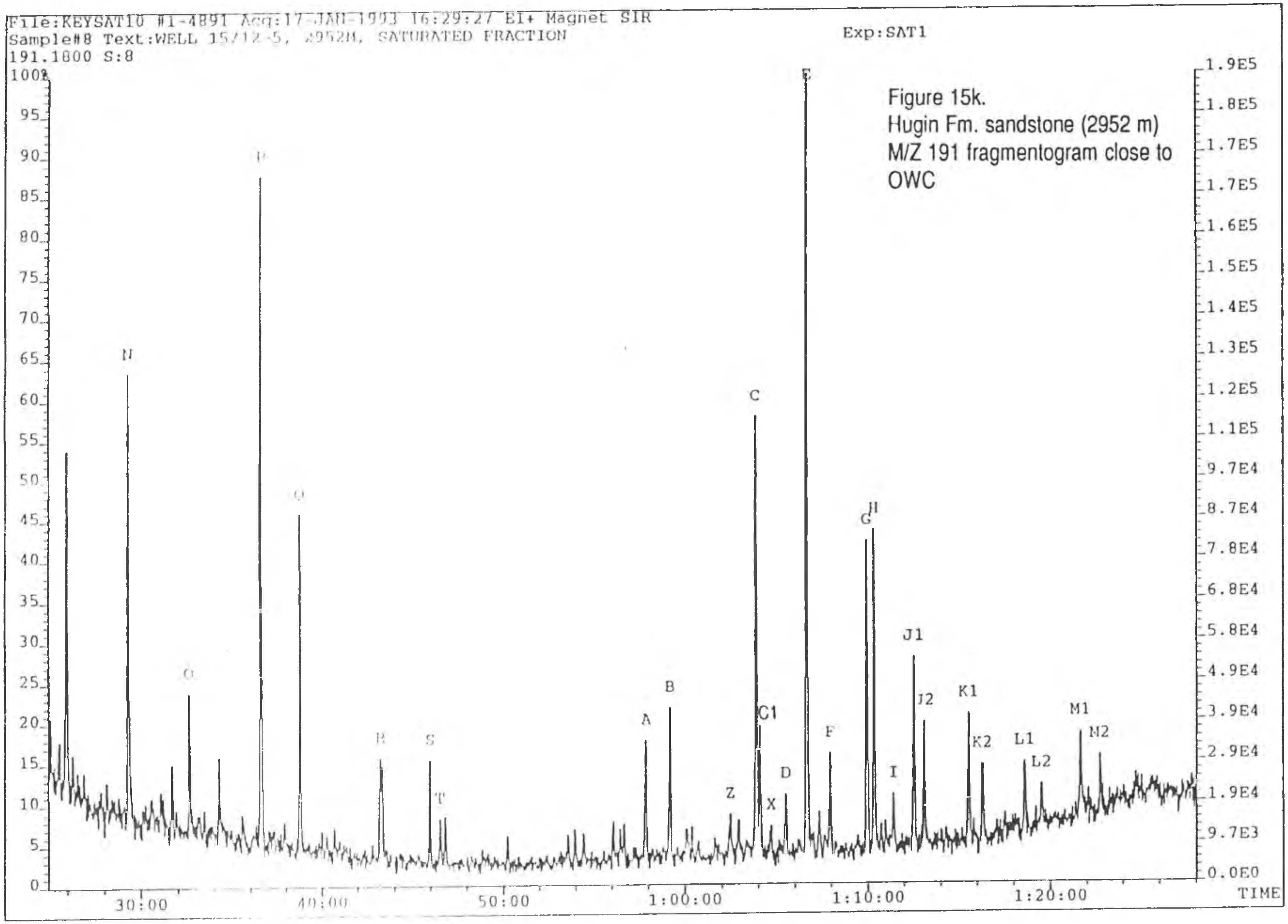


Figure 15k.
Hugin Fm. sandstone (2952 m)
M/Z 191 fragmentogram close to OWC

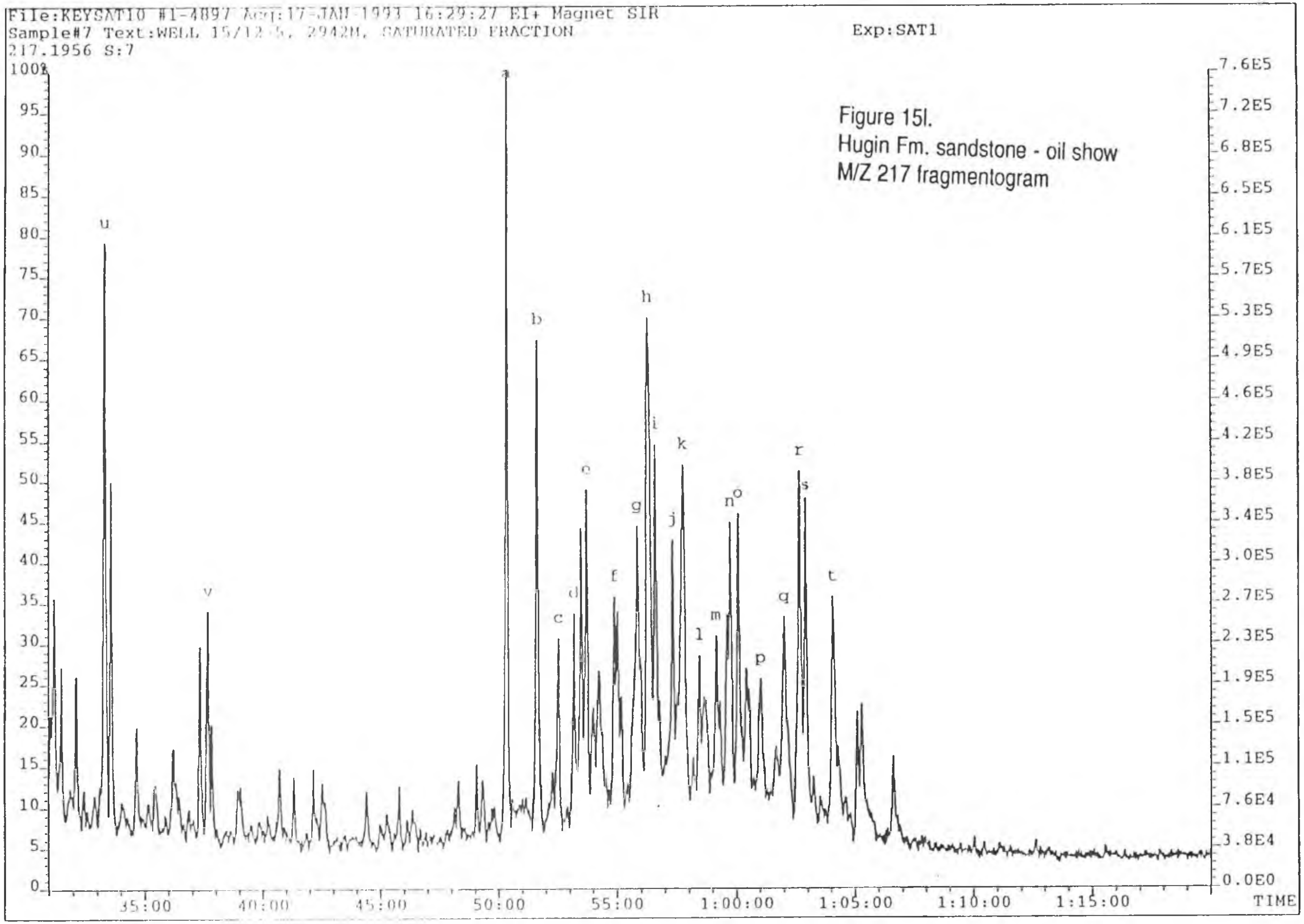


Figure 15l.
Hugin Fm. sandstone - oil show
M/Z 217 fragmentogram

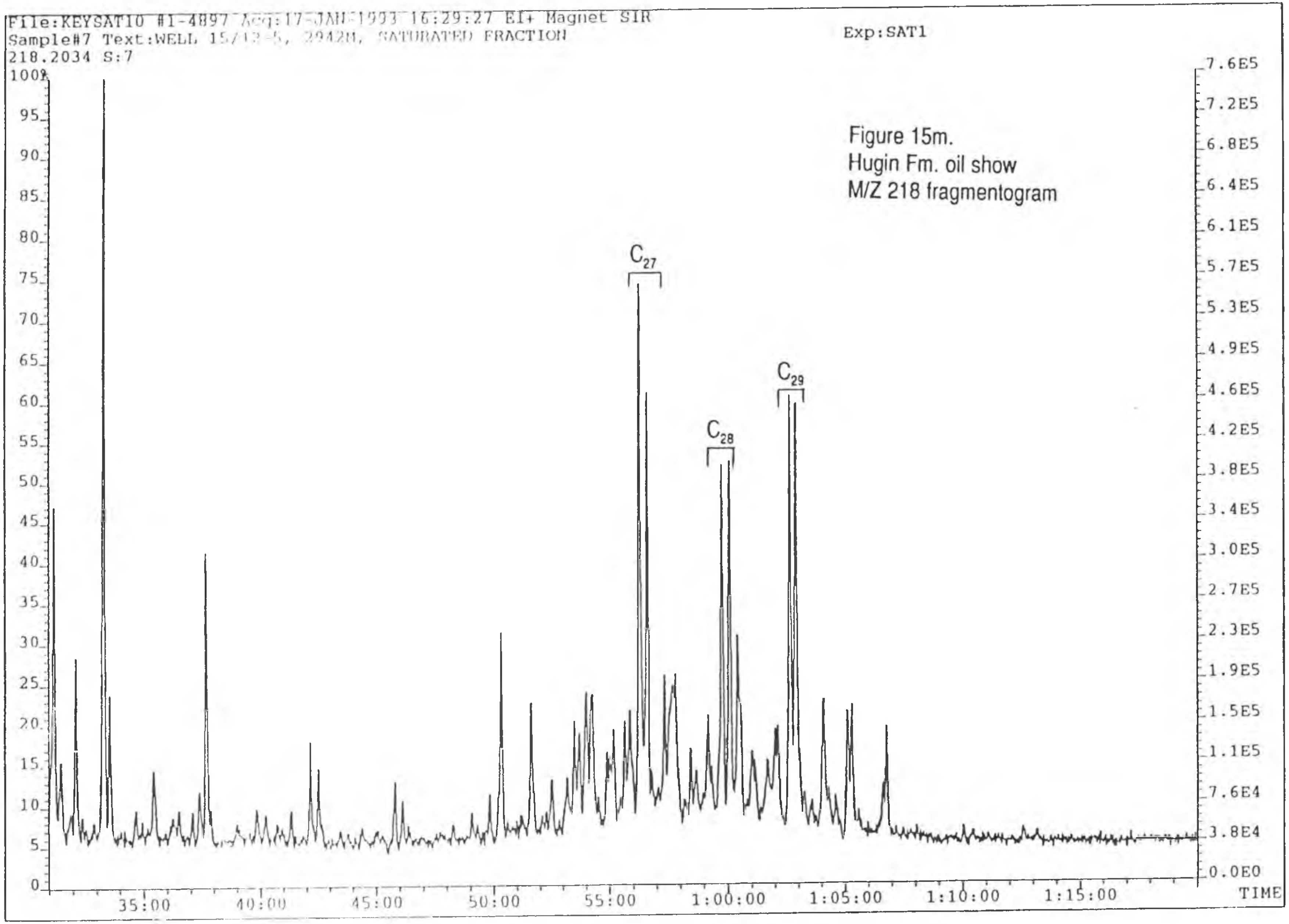


Figure 15m.
Hugin Fm. oil show
M/Z 218 fragmentogram

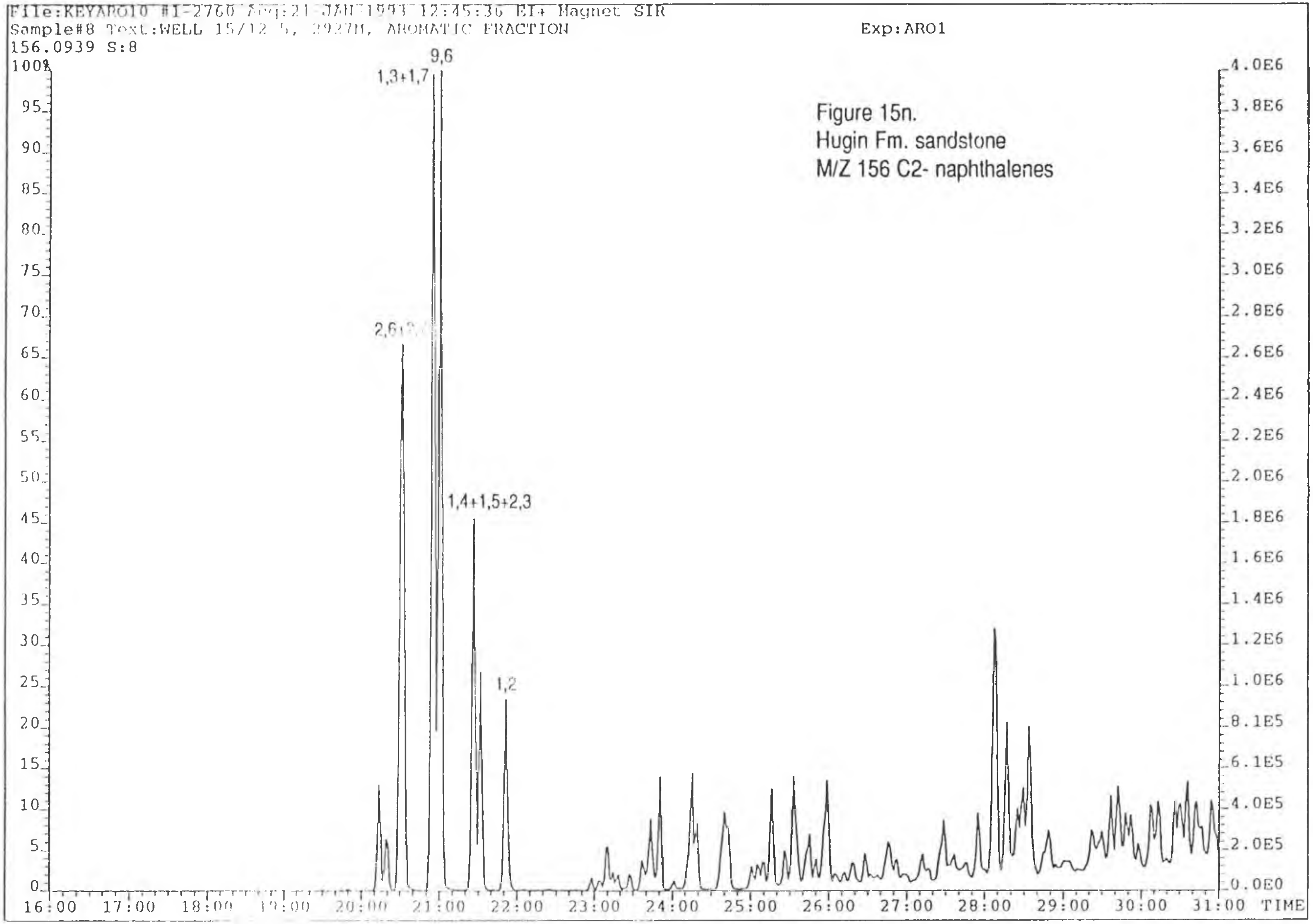


Figure 15n.
Hugin Fm. sandstone
M/Z 156 C2- naphthalenes

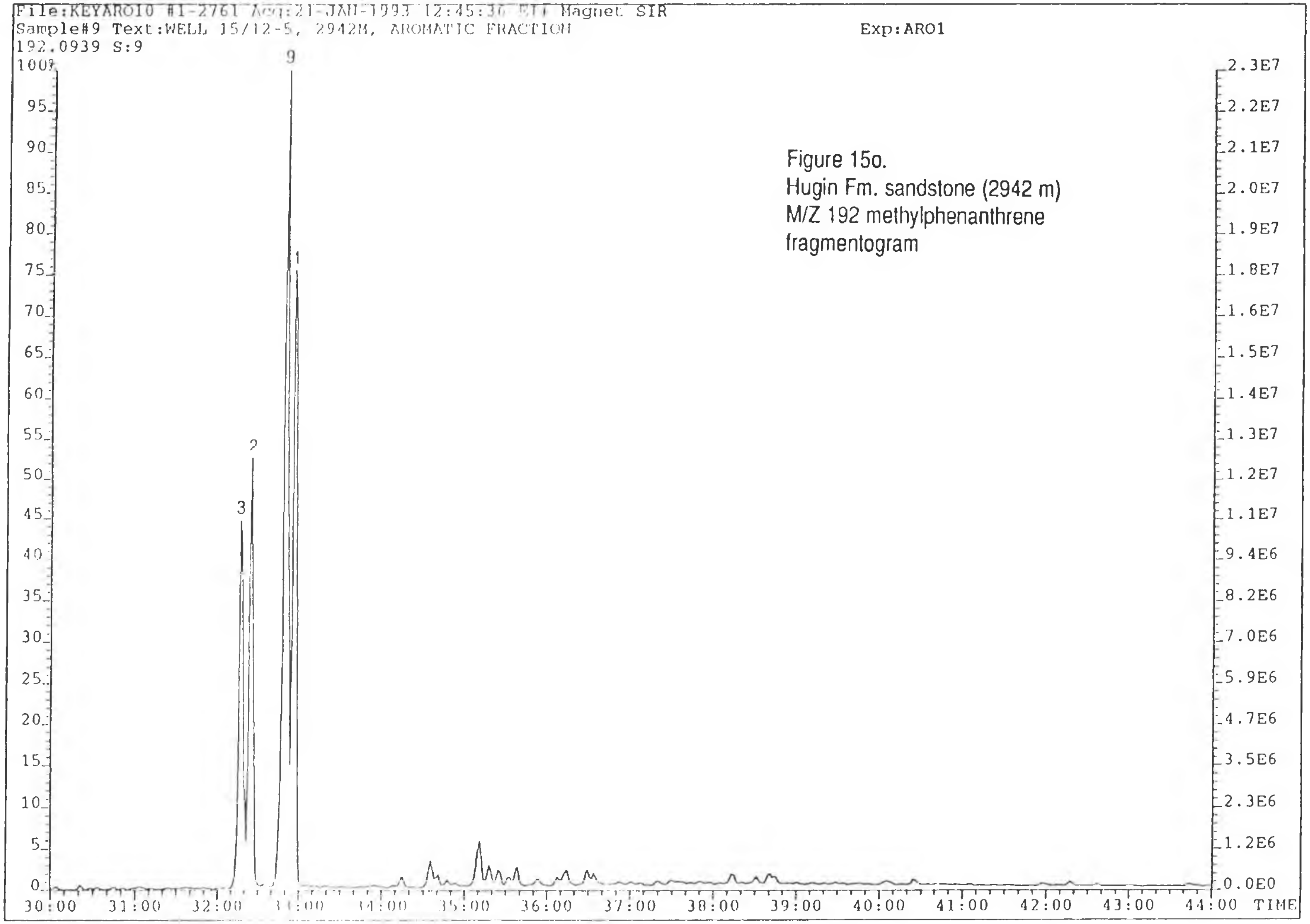


Figure 15o.
Hugin Fm. sandstone (2942 m)
M/Z 192 methylphenanthrene fragmentogram

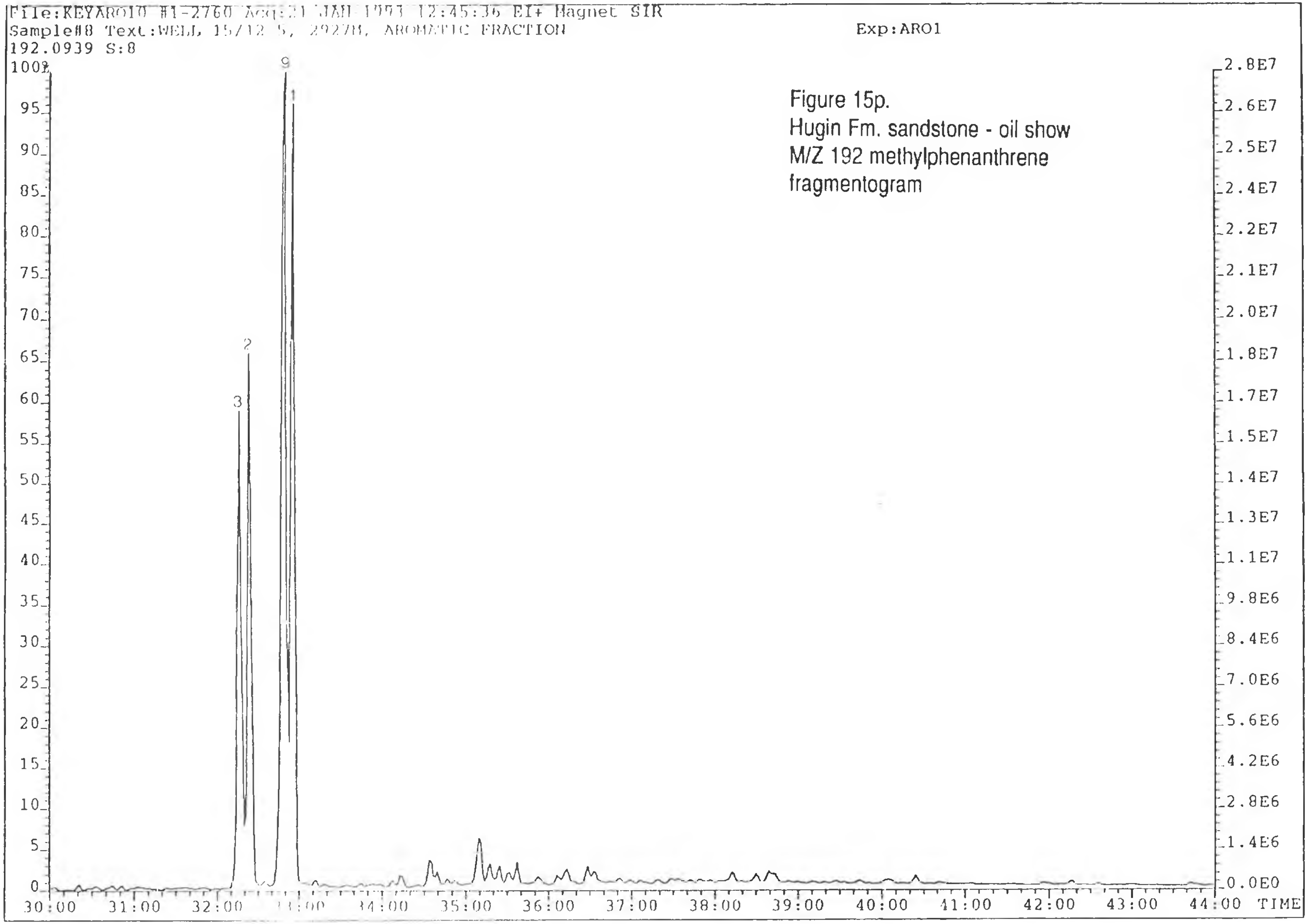


Figure 15p.
Hugin Fm. sandstone - oil show
M/Z 192 methylphenanthrene
fragmentogram

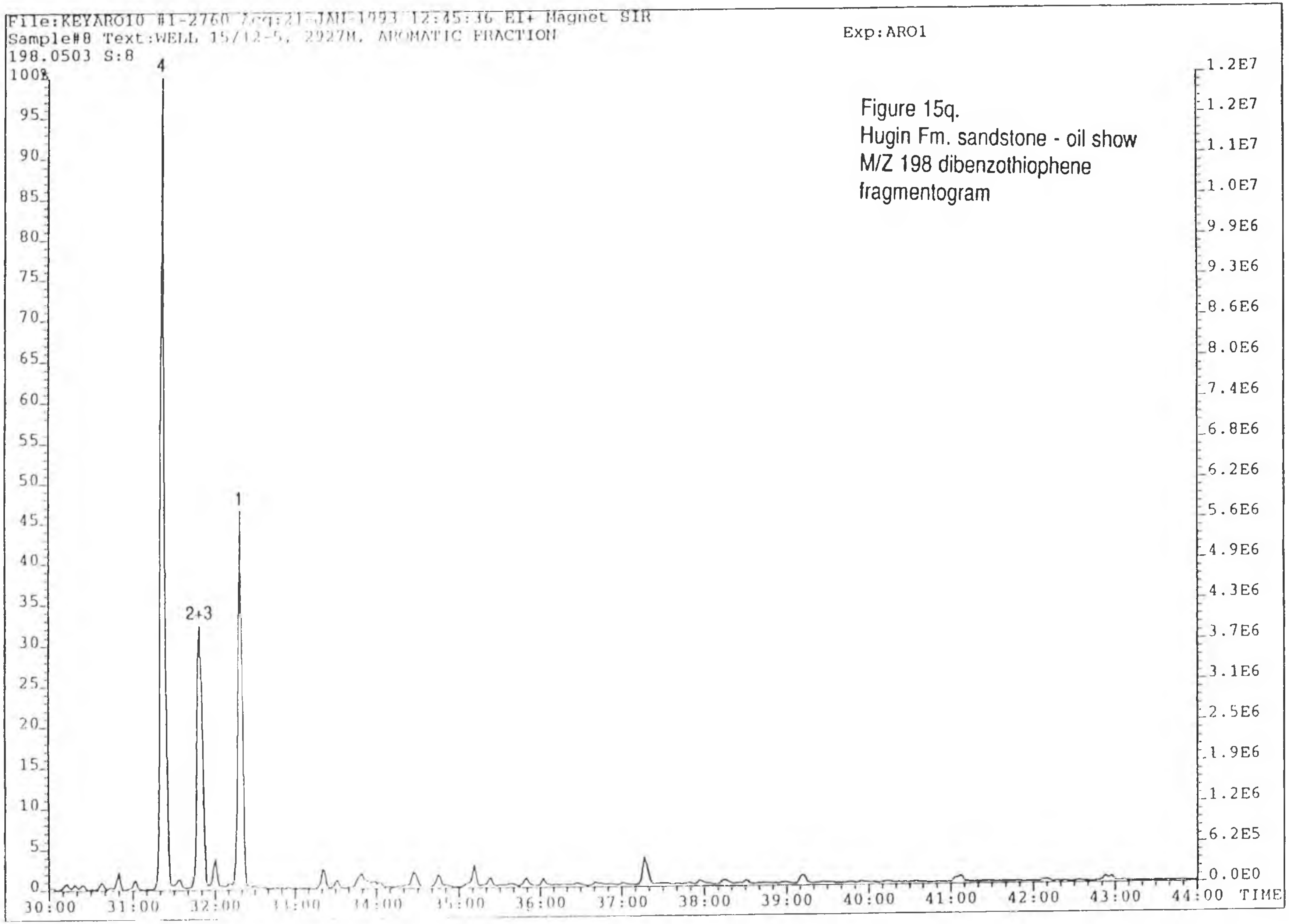


Figure 15q.
Hugin Fm. sandstone - oil show
M/Z 198 dibenzothiophene
fragmentogram

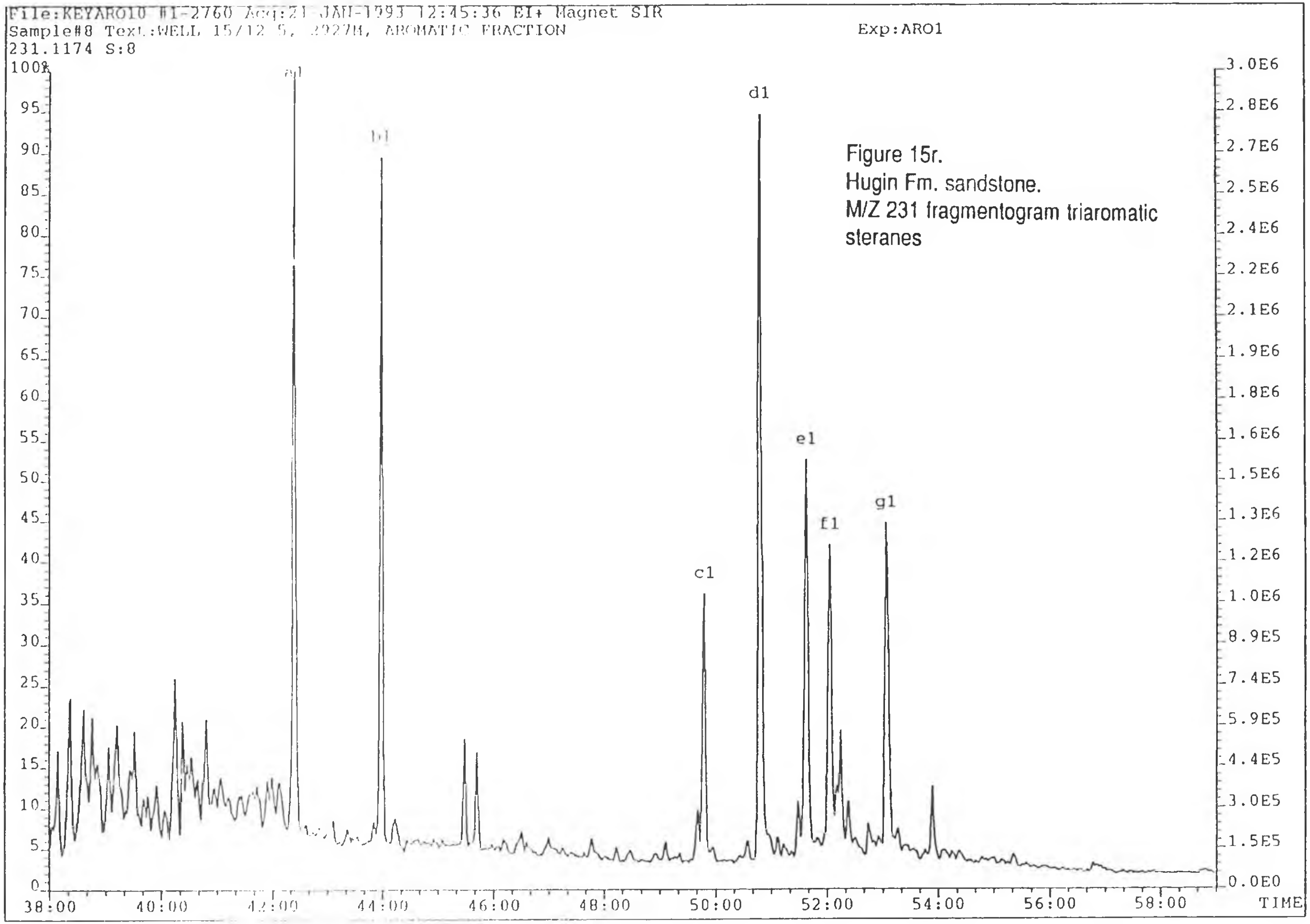


Figure 15r.
Hugin Fm. sandstone.
M/Z 231 fragmentogram triaromatic steranes

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, $0.5 \times \left(\frac{C25+C27+C29+C31+C33}{C24+C26+C28+C30+C32} + \frac{C25+C27+C29+C31+C33}{C26+C28+C30+C32+C34} \right)$
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 Procedures

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 Chromatograph 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 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

Asphaltenes are removed from the EOM by precipitation in n-pentane. N-pentane is added to the EOM and 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 dissolved in dichloromethane are returned to the original flask. The solvent is removed by rotary evaporation (200 mb and 30°C).

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.

Vitrinite Reflectance Analysis

Samples to be analysed for vitrinite reflectance are ground to small granules (if necessary) using a pestle and mortar and are then mounted in a fast setting resin. The resin blocks are first ground flat using a coarse corundum paper to expose the rock granule surfaces and then with three finer grades of corundum paper to improve these surfaces and reduce scratches. The blocks are finally polished on a rotating Selvyt-covered lap using three grades of diamond suspension fluid. An appropriate lubricant is used when necessary.

Reflectance measurements are made under oil immersion at 546 nm using a Zeiss Universal Photo microscope II equipped with a HP 9000 series computer system. The polished blocks are mounted on the microscope stage and scanned manually in order to locate and measure particles of vitrinite. An attempt is made to obtain readings from 15-20 individual particles per sample, but this is not always possible in samples with low amounts of phytoclasts.

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 310oC 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 1500 (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 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

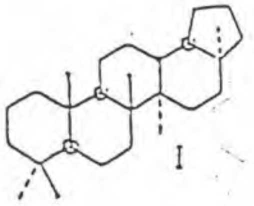
Monoaromatic steranes are detected using the M/Z 253 fragment ion, while the triaromatic steranes are detected using the M/Z 231 fragment ion.

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})
	22R 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})
	22R 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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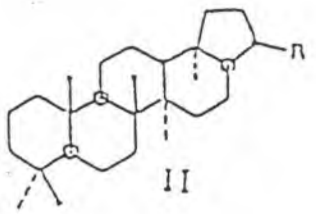

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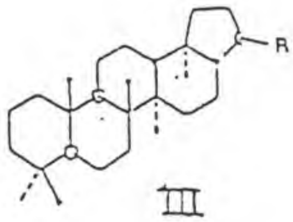

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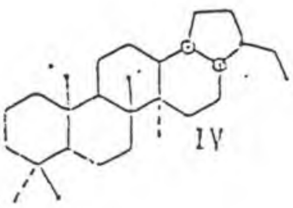

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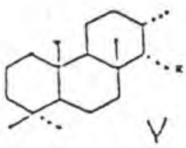

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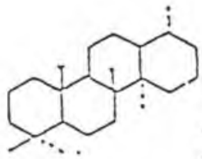

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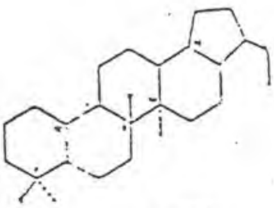

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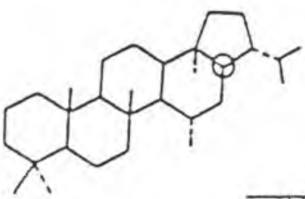


VIII

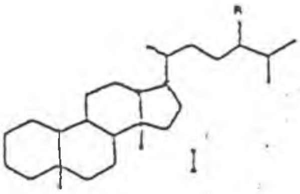
Mass Fragmentograms representing Steranes

(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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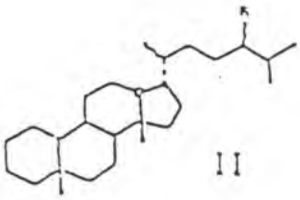
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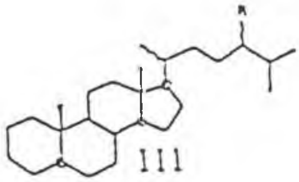
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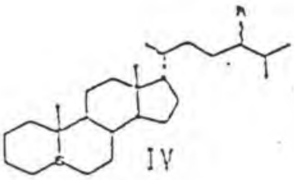
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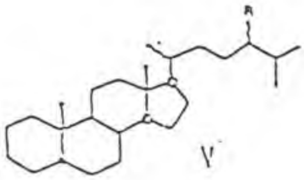
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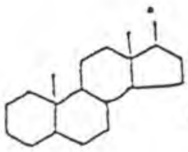
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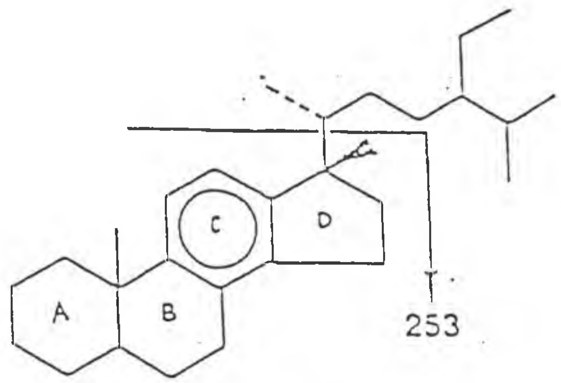
Mass Fragmentograms representing Monoaromatic Steranes (M/Z 253)

Description of C-ring monoaromatic steroid hydrocarbons

Peak	R_1	Substituents 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	β$SC_{27}MA$
	β(H)	CH_3	R(CH_3)	H	β$RC_{27}MA$
D1	CH_3	H	R(CH_3)	H	$RC_{27}DMA$
	α(H)	CH_3	S(CH_3)	H	α$SC_{27}MA$
E1	β(H)	CH_3	S(CH_3)	CH_3	β$SC_{28}MA$
	CH_3	H	S(CH_3)	CH_3	$SC_{28}DMA$
F1	α(H)	CH_3	R(CH_3)	H	α$RC_{27}MA$
	α(H)	CH_3	S(CH_3)	CH_3	α$SC_{28}MA$
	β(H)	CH_3	R(CH_3)	CH_3	β$RC_{28}MA$
G1	CH_3	H	R(CH_3)	CH_3	$RC_{28}DMA$
	β(H)	CH_3	S(CH_3)	C_2H_5	β$SC_{29}MA$
	CH_3	H	S(CH_3)	C_2H_5	$SC_{29}DMA$
	α(H)	CH_3	R(CH_3)	CH_3	α$RC_{28}MA$
H1	β(H)	CH_3	R(CH_3)	C_2H_5	β$RC_{29}MA$
	CH_3	H	R(CH_3)	C_2H_5	$RC_{29}DMA$
I1	α(H)	CH_3	R(CH_3)	C_2H_5	α$RC_{29}MA$

STRUCTURES REPRESENTING MONOAROMATIC STERANES



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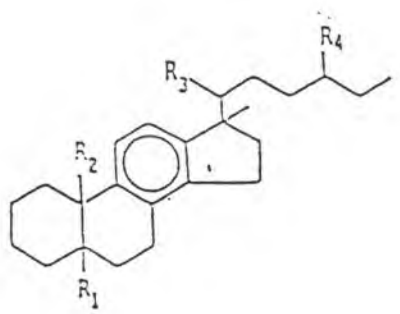
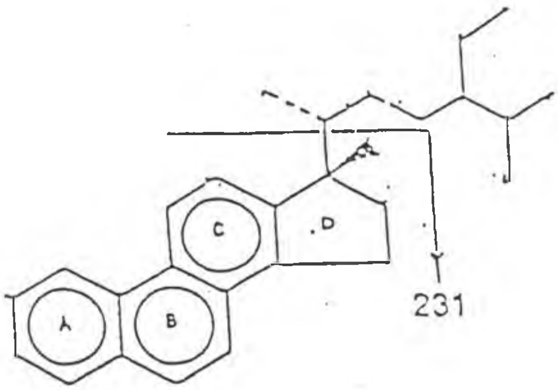


Mass Fragmentograms representing Triaromatic Steranes (M/Z 231)

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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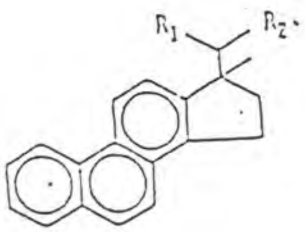


Stable Carbon Isotope Ratio Mass Spectrometry

Carbon isotope analysis is performed on a dual inlet VG SIRA 10 instrument. The combustion of the samples is performed by a Carlo Erba EA 1108 element analyser directly connected to the inlet system of the mass spectrometer.

The combustion temperature is 1020°C and the carrier gas used was Helium. After the combustion H_2O and CO_2 are trapped in individual cool traps. The CO_2 gas is then heated up before admission into the mass spectrometer. The whole operation is controlled by an IBM PC50 computer system.

δ-values

The isotope ratios are given as δ-values in ‰ versus the PDB-standard:

$$\delta^{13}C = (R\ sample - R\ standard/R\ standard) \times 1000$$
$$R = {}^{13}C/{}^{12}C$$

The PDB-standard (a marine chalk of the Pee Dee-formation, USA) was created by Craig 1957. All results of $^{13}C/^{12}C$-analysis of organic matter today are calculated (Craig correction) against this international standard.

Reproducibility

The precision of the combustion system and the mass spectrometer is controlled by determination of an international calibrated standard, NBS22 oil and a house standard carbon. Replicate analyses are also performed on samples.

Appendix 1

Tables

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type / TOC%	%	Grp Frm Age / Lithology description	Trb	Sample
1060.00				Nord Utsi Tertiary		0001
		1.27	50	Sh/Clst: m gy, calc, slt, s		0001-1L
			50	S/Sst : w to lt gy, calc, f, cem, l		0001-2L
			tr	Cont : fib, dd		0001-3L
			tr	Sh/Clst: gy pi		0001-4L
1090.00				Nord Utsi Tertiary		0003
			65	S/Sst : w to lt gy, f, l		0003-2L
			25	Sh/Clst: lt gy to m gy, calc, slt, s		0003-1L
			10	Cont : fib, prp, dd, Mica-ad		0003-3L
1120.00				Nord Utsi Tertiary		0004
			80	Sh/Clst: lt gy to drk gy, slt		0004-1L
			20	S/Sst : w to lt gy, f, crs, l		0004-2L
			tr	Cont : dd, fib		0004-3L
1150.00				Nord Utsi Tertiary		0005
		1.11	90	Sltst : pl y brn, cly		0005-4L
			10	Sh/Clst: lt gy to drk gy, slt		0005-1L
			tr	S/Sst : w to lt gy, f, crs, l		0005-2L
			tr	Cont : dd, fib		0005-3L
			tr	Ca : lt gy		0005-5L
1180.00				Nord Utsi Tertiary		0006
			65	Sh/Clst: lt brn gy, slt		0006-1L
			35	Sltst : gy brn to pl y brn, cly		0006-3L
			tr	Cont : dd, fib		0006-2L
			tr	Ca : lt gy		0006-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
1210.00				Nord	Utsi	Tertiary		0007
			50	Sltst : gy brn to pl y brn, cly				0007-3L
			40	S/Sst : w, f, crs, l				0007-5L
			10	Sh/Clst: lt brn gy, slt				0007-1L
			tr	Cont : dd, prp				0007-2L
			tr	Ca : lt gy				0007-4L
1240.00				Nord	Utsi	Tertiary		0008
			90	Sh/Clst: gy brn to pl y brn, lt brn gy, slt				0008-2L
			10	S/Sst : w, f, crs, l				0008-4L
			tr	Cont : dd, prp				0008-1L
			tr	Ca : lt gy				0008-3L
1270.00				Hord		Tertiary		0009
			50	Sltst : gy brn to pl y brn to dsk y brn, cly				0009-2L
			50	Sh/Clst: lt brn gy, slt				0009-4L
			tr	Cont : dd, prp				0009-1L
			tr	S/Sst : w, f, crs, l				0009-3L
1300.00				Hord		Tertiary		0010
		5.59	90	Sltst : dsk brn to dsk y brn				0010-2L
			10	Sh/Clst: lt brn gy, slt				0010-4L
			tr	Cont : dd, prp				0010-1L
			tr	S/Sst : w, f, crs, l				0010-3L
			tr	Ca : lt gy				0010-5L
1330.00				Hord		Tertiary		0011
			65	Sltst : dsk brn to dsk y brn				0011-2L
			25	Cont : fib, Mica-ad				0011-1L
			10	Sh/Clst: lt brn gy, slt				0011-4L
			tr	S/Sst : w, f, crs, l				0011-3L
			tr	Ca : lt gy				0011-5L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int Cvd	Type TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
1360.00			Hord		Tertiary		0012
		65	Sltst : dsk brn to dsk y brn				0012-2L
		25	Cont : fib, Mica-ad				0012-1L
		10	Sh/Clst: lt brn gy, slt				0012-4L
		tr	S/Sst : w, f, crs, l				0012-3L
		tr	Ca : lt gy				0012-5L
1390.00			Hord		Tertiary		0013
	0.38	60	S/Sst : w, f, crs, l				0013-3L
		15	Sltst : dsk brn to dsk y brn				0013-2L
		15	Sh/Clst: lt brn gy, slt				0013-4L
		10	Cont : fib, Mica-ad				0013-1L
		tr	Ca : lt gy				0013-5L
1420.00			Hord		Tertiary		0014
		45	Sltst : dsk brn to dsk y brn				0014-2L
		30	Cont : fib, Mica-ad				0014-1L
		15	S/Sst : w, f, crs, l				0014-3L
		10	Sh/Clst: lt brn gy, slt				0014-4L
		tr	Ca : lt gy				0014-5L
1450.00			Hord		Tertiary		0015
		50	Cont : fib, Mica-ad				0015-1L
		40	Sltst : dsk brn to dsk y brn				0015-2L
		10	Sh/Clst: lt brn gy to lt gy to pl ol, slt				0015-4L
		tr	S/Sst : w, f, crs, l				0015-3L
		tr	Ca : lt gy				0015-5L
1480.00			Hord		Tertiary		0016
	3.31	80	Sltst : pl y brn to dsk y brn to dsk brn, cly				0016-2L
		15	Cont : fib				0016-1L
		5	Sh/Clst: lt brn gy to lt gy to pl ol, slt				0016-4L
		tr	S/Sst : w, f, crs, l				0016-3L
		tr	Ca : lt gy to lt brn gy				0016-5L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
1510.00				Hord		Tertiary		0017
			65	Sltst : pl y brn to dsk y brn to dsk brn, cly				0017-2L
			20	Sh/Clst: lt brn gy to lt gy to pl ol, slt				0017-4L
			15	Cont : fib, dd				0017-1L
			tr	S/Sst : w, f, crs, l				0017-3L
			tr	Ca : lt gy to lt brn gy				0017-5L
1540.00				Hord		Tertiary		0018
			70	Sltst : pl y brn to dsk y brn to dsk brn, cly				0018-2L
			20	Cont : fib, dd				0018-1L
			10	Sh/Clst: lt brn gy to lt gy to pl ol, slt				0018-4L
			tr	S/Sst : w, f, crs, l				0018-3L
			tr	Ca : lt gy to lt brn gy				0018-5L
1570.00				Hord		Tertiary		0019
		3.38	85	Sltst : pl y brn to dsk y brn to dsk brn, cly				0019-2L
			10	Cont : fib, dd				0019-1L
			5	Sh/Clst: lt brn gy to lt gy to pl ol, slt				0019-4L
			tr	S/Sst : w, f, crs, l				0019-3L
			tr	Ca : lt gy to lt brn gy				0019-5L
1600.00				Hord		Tertiary		0020
			65	Sltst : pl y brn to dsk y brn to dsk brn, cly				0020-2L
			25	Cont : fib, dd				0020-1L
			10	Sh/Clst: lt brn gy to lt gy to pl ol, slt				0020-4L
			tr	S/Sst : w, f, crs, l				0020-3L
			tr	Ca : lt gy to lt brn gy				0020-5L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int Cvd	Type TOC%	%	Grp Frm Age / Lithology description	Trb	Sample
1630.00			Hord Tertiary		0021
		80	Sh/Clst: lt brn gy to lt gy to pl ol, slt		0021-3L
		20	Cont : cem		0021-1L
		tr	Sltst : pl y brn to dsk y brn to dsk brn, cly		0021-2L
		tr	Ca : lt gy to lt brn gy		0021-4L
1660.00			Hord Tertiary		0022
	1.27	95	Sh/Clst: lt brn gy, slt		0022-3L
		5	Ca : w, chk		0022-4L
		tr	Cont : prp		0022-1L
		tr	Sltst : pl y brn to dsk y brn to dsk brn, cly		0022-2L
1690.00			Hord Tertiary		0023
		75	Sh/Clst: lt brn gy to pl y brn, slt		0023-3L
		15	Cont : fib		0023-1L
		10	Ca : m y brn, dol		0023-4L
		tr	Sltst : dsk y brn to dsk brn, cly		0023-2L
1720.00			Hord Tertiary		0024
		80	Sh/Clst: lt brn gy to pl y brn, calc, slt		0024-2L
		20	Ca : w, chk		0024-3L
		tr	Cont : fib		0024-1L
1750.00			Hord Tertiary		0025
	1.46	80	Sh/Clst: lt brn gy to pl y brn, calc, slt		0025-2L
		20	Ca : w, chk		0025-3L
		tr	Cont : fib		0025-1L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
1780.00				Hord		Tertiary		0026
			80	Sh/Clst: lt brn gy to pl y brn, calc, slt				0026-2L
			20	Ca : w, chk				0026-3L
			tr	Cont : fib				0026-1L
1810.00				Hord		Tertiary		0027
			80	Sh/Clst: lt brn gy to pl y brn, calc, slt				0027-2L
			20	Ca : w, chk				0027-3L
			tr	Cont : fib				0027-1L
1840.00				Hord		Tertiary		0028
			95	Sh/Clst: lt brn gy to pl y brn, calc, slt				0028-2L
			5	Ca : w, chk				0028-3L
			tr	Cont : fib				0028-1L
1870.00				Hord		Tertiary		0029
		1.38	95	Sh/Clst: lt brn gy to pl y brn, calc, slt				0029-2L
			5	Ca : w, chk				0029-3L
			tr	Cont : fib				0029-1L
1900.00				Hord		Tertiary		0030
			95	Sh/Clst: lt brn gy to pl y brn, calc, slt				0030-2L
			5	Ca : w, chk				0030-3L
			tr	Cont : fib				0030-1L
1930.00				Hord		Tertiary		0031
		1.97	85	Sh/Clst: lt brn gy to pl y brn, calc, slt				0031-2L
			15	Ca : w, chk				0031-3L
			tr	Cont : fib				0031-1L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth (Int Cvd)	Type (TOC%)	%	Grp	Frm	Age / Lithology description	Trb	Sample
1960.00			Hord		Tertiary		0032
		95	Sh/Clst:		lt brn gy to pl y brn, calc, slt		0032-2L
		5	Ca :		w, chk		0032-3L
		tr	Cont :		fib		0032-1L
1990.00			Hord		Tertiary		0033
		95	Sh/Clst:		brn gy to pl y brn, calc, slt		0033-2L
		5	Ca :		w, chk		0033-3L
		tr	Cont :		fib		0033-1L
2024.00			Hord		Tertiary		0034
	1.38	100	Sh/Clst:		brn gy to pl y brn to m gy, slt		0034-2L
		tr	Cont :		fib		0034-1L
		tr	Ca :		lt brn		0034-3L
2054.00			Hord		Tertiary		0035
		50	Sh/Clst:		brn gy to pl y brn, slt		0035-1L
		50	Sh/Clst:		lt gy to m gy, slt		0035-3L
		tr	Ca :		lt brn		0035-2L
2084.00			Hord		Tertiary		0036
		95	Sh/Clst:		lt gy to m gy to pl ol, slt		0036-3L
		5	Sh/Clst:		brn gy to pl y brn, slt		0036-1L
		tr	Ca :		lt brn		0036-2L
2114.00			Hord		Tertiary		0037
	0.37	100	Sh/Clst:		lt gy to m gy to pl ol, slt		0037-2L
		tr	Sh/Clst:		brn gy to pl y brn, slt		0037-1L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
2147.00				Hord		Tertiary		0038
			95	Sh/Clst: lt gy to m gy to pl ol				0038-2L
			5	Sh/Clst: brn gy to pl y brn, slt				0038-1L
2177.00				Hord		Tertiary		0039
			90	Sh/Clst: lt gy to m gy to pl ol				0039-2L
			10	Sh/Clst: brn gy to pl y brn, slt				0039-1L
2195.00				Hord		Tertiary		0040
			95	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0040-2L
			5	Sh/Clst: brn gy to pl y brn, slt				0040-1L
2228.00				Hord		Tertiary		0041
		0.06	100	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0041-2L
			tr	Sh/Clst: brn gy to pl y brn, slt				0041-1L
2258.00				Hord		Tertiary		0042
			100	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0042-2L
			tr	Sh/Clst: brn gy to pl y brn, slt				0042-1L
2288.00				Rogl	Bald	Tertiary		0043
			50	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0043-2L
			50	Sh/Clst: m brn to pl brn, dsk y brn, m gy, slt				0043-3L
			tr	Sh/Clst: brn gy to pl y brn, slt				0043-1L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
2318.00				Rogl	Sele	Tertiary		0044
			50			Sh/Clst: lt gy to m gy to pl ol to pl y gn		0044-1L
			50			Sh/Clst: m brn to pl brn, m gy to drk gy, slt		0044-2L
2345.00				Rogl	List	Tertiary		0045
		0.97	80			Sh/Clst: m gy, pl brn, slt		0045-2L
			15			Cont : dd		0045-3L
			5			Sh/Clst: lt gy to m gy to pl ol to pl y gn		0045-1L
2375.00				Rogl	List	Tertiary		0046
			80			Sh/Clst: lt gy to pl ol, brn gy to gy brn		0046-1L
			20			Cont : dd		0046-3L
			tr			Sh/Clst: m gy, pl brn, slt		0046-2L
2402.00				Rogl	List	Tertiary		0047
			100			Sh/Clst: lt gy to pl ol, brn gy to gy brn		0047-1L
			tr			Sh/Clst: m gy, pl brn, slt		0047-2L
			tr			Cont : dd		0047-3L
2408.00				Rogl	List	Tertiary		0048
			100			Sh/Clst: lt gy to pl ol, brn gy to gy brn		0048-1L
			tr			Sh/Clst: m gy, pl brn, slt		0048-2L
			tr			Cont : dd		0048-3L
2414.00				Rogl	List	Tertiary		0049
			95			Sh/Clst: lt gy to pl ol, brn gy to gy brn		0049-1L
			5			Cont : fib, dd		0049-2L
			tr			Ca : w, chk		0049-3L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth (Int Cvd)	Type / TOC%	%	Grp Frm Age / Lithology description	Trb	Sample
2420.00			Rogl Maur Tertiary		0050
		65	Sh/Clst: lt gy to pl ol to brn gy to gy brn		0050-1L
		35	Cont : fib, dd		0050-2L
		tr	Ca : w, chk		0050-3L
2426.00			Rogl Maur Tertiary		0051
	0.71	65	Sh/Clst: gy red, gy brn		0051-4L
		35	Sh/Clst: lt gy to pl ol		0051-1L
		tr	Cont : fib, dd		0051-2L
		tr	Ca : w, chk		0051-3L
2432.00			Rogl Maur Tertiary		0052
		45	Sh/Clst: lt gy to pl ol to pl y gn		0052-1L
		45	Sh/Clst: gy red, gy brn		0052-4L
		10	Cont : fib, dd		0052-2L
		tr	Ca : w, chk		0052-3L
2444.00			Chlk Ekof Upper Cretaceous		0053
		35	Sh/Clst: lt gy to pl ol to pl y gn		0053-1L
	0.31	30	Ca : w, chk		0053-3L
		25	Sh/Clst: gy red, gy brn		0053-4L
		10	Cont : fib, dd		0053-2L
2450.00			Chlk Ekof Upper Cretaceous		0054
	0.24	50	Ca : w, chk		0054-3L
		35	Sh/Clst: lt gy to pl ol to pl y gn		0054-1L
		15	Sh/Clst: gy red, gy brn		0054-4L
		tr	Cont : fib, dd		0054-2L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
2456.00				Chlk	Ekof	Upper Cretaceous		0055
		0.35	55	Ca		: w, chk		0055-3L
			25	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0055-1L
			20	Sh/Clst:		gy red, gy brn		0055-4L
			tr	Cont		: fib, dd		0055-2L
2462.00				Chlk	Tor	Upper Cretaceous		0056
		0.30	85	Ca		: w, chk		0056-3L
			15	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0056-1L
			tr	Cont		: fib, dd		0056-2L
			tr	Sh/Clst:		gy red, gy brn		0056-4L
2468.00				Chlk	Tor	Upper Cretaceous		0057
		0.18	85	Ca		: w, chk		0057-3L
			15	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0057-1L
			tr	Cont		: fib, dd		0057-2L
			tr	Sh/Clst:		gy red, gy brn		0057-4L
2474.00				Chlk	Tor	Upper Cretaceous		0058
		0.15	90	Ca		: w, chk		0058-3L
			10	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0058-1L
			tr	Cont		: fib, dd		0058-2L
			tr	Sh/Clst:		gy red, gy brn		0058-4L
2480.00				Chlk	Tor	Upper Cretaceous		0059
			90	Ca		: w, chk		0059-3L
			10	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0059-1L
			tr	Cont		: fib, dd		0059-2L
			tr	Sh/Clst:		gy red, gy brn		0059-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp / Lithology	Frm	Age / description	Trb	Sample
2486.00				Chlk	Tor	Upper Cretaceous		0060
			100	Ca		: w, chk		0060-3L
			tr	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0060-1L
			tr	Cont		: fib, dd		0060-2L
			tr	Sh/Clst:		gy red, gy brn		0060-4L
2492.00				Chlk	Tor	Upper Cretaceous		0061
		0.05	100	Ca		: w, chk		0061-3L
			tr	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0061-1L
			tr	Cont		: fib, dd		0061-2L
			tr	Sh/Clst:		gy red, gy brn		0061-4L
2498.00				Chlk	Tor	Upper Cretaceous		0062
			100	Ca		: w, chk		0062-3L
			tr	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0062-1L
			tr	Cont		: fib, dd		0062-2L
			tr	Sh/Clst:		gy red, gy brn		0062-4L
2504.00				Chlk	Tor	Upper Cretaceous		0063
			100	Ca		: w, chk		0063-3L
			tr	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0063-1L
			tr	Cont		: fib, dd		0063-2L
			tr	Sh/Clst:		gy red, gy brn		0063-4L
2513.00				Chlk	Tor	Upper Cretaceous		0064
		0.04	85	Ca		: w, chk		0064-3L
			15	Sh/Clst:		lt gy to m gy to pl ol to pl y gn		0064-1L
			tr	Cont		: fib, dd		0064-2L
			tr	Sh/Clst:		gy red, gy brn		0064-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
2519.00				Chlk	Tor	Upper Cretaceous		0065
			90	Ca		: w, chk		0065-3L
			10	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0065-1L
			tr	Cont		: fib, dd		0065-2L
			tr	Sh/Clst		: gy red, gy brn		0065-4L
2522.00				Chlk	Tor	Upper Cretaceous		0066
			100	Ca		: w, chk		0066-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0066-1L
			tr	Cont		: fib, dd		0066-2L
			tr	Sh/Clst		: gy red, gy brn		0066-4L
2531.00				Chlk	Tor	Upper Cretaceous		0067
		0.02	100	Ca		: w, chk		0067-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0067-1L
			tr	Cont		: fib, dd		0067-2L
			tr	Sh/Clst		: gy red, gy brn		0067-4L
2537.00				Chlk	Tor	Upper Cretaceous		0068
			100	Ca		: w, chk		0068-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0068-1L
			tr	Cont		: fib, dd		0068-2L
			tr	Sh/Clst		: gy red, gy brn		0068-4L
2543.00				Chlk	Tor	Upper Cretaceous		0069
			100	Ca		: w, chk		0069-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0069-1L
			tr	Cont		: fib, dd		0069-2L
			tr	Sh/Clst		: gy red, gy brn		0069-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
2549.00				Chlk	Tor	Upper Cretaceous		0070
		0.01	100	Ca : w, chk				0070-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0070-1L
			tr	Cont : fib, dd				0070-2L
			tr	Sh/Clst: gy red, gy brn				0070-4L
2555.00				Chlk	Tor	Upper Cretaceous		0071
			100	Ca : w, chk				0071-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0071-1L
			tr	Cont : fib, dd				0071-2L
			tr	Sh/Clst: gy red, gy brn				0071-4L
2561.00				Chlk	Tor	Upper Cretaceous		0072
			100	Ca : w, chk				0072-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0072-1L
			tr	Cont : fib, dd				0072-2L
			tr	Sh/Clst: gy red, gy brn				0072-4L
2567.00				Chlk	Tor	Upper Cretaceous		0073
		0.03	100	Ca : w, chk				0073-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0073-1L
			tr	Cont : fib, dd				0073-2L
			tr	Sh/Clst: gy red, gy brn				0073-4L
2573.00				Chlk	Tor	Upper Cretaceous		0074
			100	Ca : w, chk				0074-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0074-1L
			tr	Cont : fib, dd				0074-2L
			tr	Sh/Clst: gy red, gy brn				0074-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth	Type		Grp	Frm	Age	Trb	Sample
Int Cvd	TOC%	%	Lithology description				
2579.00			Chlk	Tor	Upper Cretaceous		0075
		95	Ca : w, chk				0075-3L
		5	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0075-1L
		tr	Cont : fib, dd				0075-2L
		tr	Sh/Clst: gy red, gy brn				0075-4L
2585.00			Chlk	Tor	Upper Cretaceous		0076
	0.02	95	Ca : w to gy pi, chk				0076-3L
		5	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0076-1L
		tr	Cont : fib, dd				0076-2L
		tr	Sh/Clst: gy red, gy brn				0076-4L
2591.00			Chlk	Tor	Upper Cretaceous		0077
		100	Ca : w to gy pi, chk				0077-3L
		tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0077-1L
		tr	Cont : fib, dd				0077-2L
		tr	Sh/Clst: gy red, gy brn				0077-4L
2597.00			Chlk	Tor	Upper Cretaceous		0078
		80	Ca : w to gy pi, chk				0078-3L
		20	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0078-1L
		tr	Cont : fib, dd				0078-2L
		tr	Sh/Clst: gy red, gy brn				0078-4L
2603.00			Chlk	Tor	Upper Cretaceous		0079
	0.02	100	Ca : w to gy pi, chk				0079-3L
		tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0079-1L
		tr	Cont : fib, dd				0079-2L
		tr	Sh/Clst: gy red, gy brn				0079-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
2609.00				Chlk	Tor	Upper Cretaceous		0080
			100	Ca		: w to gy pi, chk		0080-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0080-1L
			tr	Cont		: fib, dd		0080-2L
			tr	Sh/Clst		: gy red, gy brn		0080-4L
2615.00				Chlk	Hod	Upper Cretaceous		0081
			100	Ca		: w to gy pi, chk		0081-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0081-1L
			tr	Cont		: fib, dd		0081-2L
			tr	Sh/Clst		: gy red, gy brn		0081-4L
2621.00				Chlk	Hod	Upper Cretaceous		0082
		0.01	100	Ca		: w to gy pi, chk		0082-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0082-1L
			tr	Cont		: fib, dd		0082-2L
			tr	Sh/Clst		: gy red, gy brn		0082-4L
2633.00				Chlk	Hod	Upper Cretaceous		0083
			100	Ca		: w, chk		0083-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0083-1L
			tr	Cont		: fib, dd		0083-2L
			tr	Sh/Clst		: gy red, gy brn		0083-4L
2645.00				Chlk	Hod	Upper Cretaceous		0084
		0.02	100	Ca		: w, chk		0084-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0084-1L
			tr	Cont		: fib, dd		0084-2L
			tr	Sh/Clst		: gy red, gy brn		0084-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
2657.00				Chlk	Hod	Upper Cretaceous		0085
			100	Ca : w, chk				0085-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0085-1L
			tr	Cont : fib, dd				0085-2L
			tr	Sh/Clst: gy red, gy brn				0085-4L
2669.00				Chlk	Hod	Upper Cretaceous		0086
		0.01	100	Ca : w, chk				0086-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0086-1L
			tr	Cont : fib, dd				0086-2L
			tr	Sh/Clst: gy red, gy brn				0086-4L
2681.00				Chlk	Hod	Upper Cretaceous		0087
		0.01	100	Ca : w, chk				0087-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0087-1L
			tr	Cont : fib, dd				0087-2L
			tr	Sh/Clst: gy red, gy brn				0087-4L
2693.00				Chlk	Hod	Upper Cretaceous		0088
			100	Ca : w, chk				0088-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0088-1L
			tr	Cont : fib, dd				0088-2L
			tr	Sh/Clst: gy red, gy brn				0088-4L
2705.00				Chlk	Hod	Upper Cretaceous		0089
		0.02	100	Ca : w to gy pi, chk				0089-3L
			tr	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0089-1L
			tr	Cont : fib, dd				0089-2L
			tr	Sh/Clst: gy red, gy brn				0089-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
2717.00				Chlk	Hod	Upper Cretaceous		0090
			100	Ca		: w to gy pi, chk		0090-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0090-1L
			tr	Cont		: fib, dd		0090-2L
			tr	Sh/Clst		: gy red, gy brn		0090-4L
2729.00				Chlk	Hod	Upper Cretaceous		0091
		0.02	100	Ca		: w, crs, s		0091-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0091-1L
			tr	Cont		: fib, dd		0091-2L
			tr	Sh/Clst		: gy red, gy brn		0091-4L
2741.00				Chlk	Blod	Upper Cretaceous		0092
		0.04	100	Ca		: w to gy pi, crs, s, glauc		0092-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0092-1L
			tr	Cont		: fib, dd		0092-2L
			tr	Sh/Clst		: gy red, gy brn		0092-4L
2753.00				Chlk	Blod	Upper Cretaceous		0093
			70	Ca		: w to gy pi, crs, s, glauc		0093-3L
		0.02	30	S/Sst		: gy pi to w, calc, glauc		0093-5L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0093-1L
			tr	Cont		: fib, dd		0093-2L
			tr	Sh/Clst		: gy red, gy brn		0093-4L
2765.00				Chlk	Blod	Upper Cretaceous		0094
			50	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0094-1L
			30	Ca		: w to gy pi, crs, s, glauc		0094-3L
			20	S/Sst		: gy pi to w, calc, glauc		0094-5L
			tr	Cont		: fib, dd		0094-2L
			tr	Sh/Clst		: gy red, gy brn		0094-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
2777.00				Chlk	Blod	Upper Cretaceous		0095
		0.02	80	S/Sst		: w to lt gy, calc, glauc, cem		0095-5L
			10	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0095-1L
			10	Ca		: w to gy pi, crs, s, glauc		0095-3L
			tr	Cont		: fib, dd		0095-2L
			tr	Sh/Clst		: gy red, gy brn		0095-4L
2789.00				Chlk	Blod	Upper Cretaceous		0096
		0.01	100	S/Sst		: w to lt gy, calc, cem, glauc		0096-4L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0096-1L
			tr	Ca		: w to gy pi, crs, s, glauc		0096-2L
			tr	Sh/Clst		: gy red, gy brn		0096-3L
2801.00				Crom	Rødb	Lower Cretaceous		0097
			100	S/Sst		: w to lt gy to gy red, calc, cem, glauc		0097-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0097-1L
			tr	Ca		: w to gy pi, crs, s, glauc		0097-2L
2807.00				Crom	Rødb	Lower Cretaceous		0098
		0.03	95	Marl		: gy red		0098-4L
			5	S/Sst		: w to lt gy to gy red, calc, cem, glauc		0098-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0098-1L
			tr	Ca		: w to gy pi, crs, s, glauc		0098-2L
2813.00				Crom	Rødb	Lower Cretaceous		0099
			80	Marl		: gy red, slt		0099-4L
			20	S/Sst		: w to lt gy to gy red, calc, cem, glauc		0099-3L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0099-1L
			tr	Ca		: w to gy pi, crs, s, glauc		0099-2L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp Frm Age / Lithology description	Trb	Sample
2819.00				Crom Rødb Lower Cretaceous		0100
		0.02	60	S/Sst : w to lt gy to gy red, calc, cem, glauc		0100-3L
			30	Sh/Clst: lt gy to m gy to pl ol to pl y gn		0100-1L
			10	Marl : gy red, slt		0100-4L
			tr	Ca : w to gy pi, crs, s, glauc		0100-2L
			tr	Cont : prp, fib		0100-5L
2825.00				Crom Rødb Lower Cretaceous		0102
			65	Marl : gy red, slt		0102-4L
			35	Sh/Clst: lt gy to m gy to pl ol to pl y gn		0102-1L
			tr	Ca : w to gy pi, crs, s, glauc		0102-2L
			tr	S/Sst : w to lt gy to gy red, calc, cem, glauc		0102-3L
			tr	Cont : prp, fib		0102-5L
2831.00				Crom Sola Lower Cretaceous		0101
			40	Sh/Clst: lt gy to m gy to pl ol to pl y gn		0101-1L
		0.26	40	Marl : gy red, slt		0101-4L
			20	Ca : w to gy pi, crs, s, glauc		0101-2L
			tr	S/Sst : w to lt gy to gy red, calc, cem, glauc		0101-3L
			tr	Cont : prp, fib		0101-5L
2837.00				Crom Sola Lower Cretaceous		0103
			65	Marl : gy red, slt		0103-4L
			25	Sh/Clst: lt gy to m gy to pl ol to pl y gn		0103-1L
			10	Ca : w to gy pi, crs, s, glauc		0103-2L
			tr	S/Sst : w to lt gy to gy red, calc, cem, glauc		0103-3L
			tr	Cont : prp, fib		0103-5L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type / TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
2843.00				Viki	Drau	Upper Jurassic		0104
			60	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0104-1L
			20	Ca : w to gy pi, crs, s, glauc				0104-2L
			20	Marl : gy red, slt				0104-3L
			tr	Cont : prp, fib				0104-4L
			tr	Sh/Clst: drk gy to brn blk, slt				0104-5L
2849.00				Viki	Drau	Upper Jurassic		0105
		2.91	50	Sh/Clst: drk gy to brn blk, slt, calc				0105-5L
			45	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0105-1L
			5	Ca : w to gy pi, crs, s, glauc				0105-2L
			tr	Marl : gy red, slt				0105-3L
			tr	Cont : prp, fib				0105-4L
2855.00				Viki	Drau	Upper Jurassic		0106
		2.19	80	Sltst : drk gy to dsk y brn to brn blk, cly, s, calc				0106-5L
			10	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0106-1L
			10	Marl : gy red, slt				0106-3L
			tr	Ca : w to gy pi, crs, s, glauc				0106-2L
			tr	Cont : prp, fib				0106-4L
2861.00				Viki	Drau	Upper Jurassic		0107
		1.82	80	Sltst : m gy to drk gy to dsk y brn, cly, s, calc				0107-5L
			15	Sh/Clst: lt gy to m gy to pl ol to pl y gn				0107-1L
			5	Marl : gy red, slt				0107-3L
			tr	Ca : w to gy pi, crs, s, glauc				0107-2L
			tr	Cont : prp, fib				0107-4L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp / Frm / Age / Lithology description	Trb	Sample
2867.00				Viki Drau Upper Jurassic		0108
		2.31	85	Sltst : m gy to drk gy to dsk y brn, cly, s, calc		0108-5L
			10	Sh/Clst: lt gy to m gy to pl ol to pl y gn		0108-1L
			5	Marl : gy red, slt		0108-3L
			tr	Ca : w to gy pi, crs, s, glauc		0108-2L
			tr	Cont : prp, fib		0108-4L
2873.00				Viki Drau Upper Jurassic		0109
		2.04	85	Sltst : m gy to drk gy to dsk y brn, cly, s, calc		0109-5L
			10	Cont : fib		0109-4L
			5	Sh/Clst: lt gy to m gy to pl ol to pl y gn		0109-1L
			tr	Ca : w to gy pi, crs, s, glauc		0109-2L
			tr	Marl : gy red, slt		0109-3L
2879.00				Viki Drau Upper Jurassic		0110
		1.82	55	Sltst : m gy to drk gy to dsk y brn, s		0110-5L
			20	Cont : fib, dd		0110-4L
			10	Sh/Clst: lt gy to m gy to pl ol to pl y gn		0110-1L
			10	S/Sst : lt gy, f, l		0110-6L
			5	Marl : gy red, slt		0110-3L
			tr	Ca : w to gy pi, crs, s, glauc		0110-2L
2885.00				Viki Drau Upper Jurassic		0111
			50	Cont : Coal-ad, fib		0111-4L
			35	S/Sst : lt gy, f, l		0111-6L
			10	Sltst : m gy to drk gy to dsk y brn, s		0111-5L
			5	Sh/Clst: lt gy to m gy to pl ol to pl y gn		0111-1L
			tr	Ca : w to gy pi, crs, s, glauc		0111-2L
			tr	Marl : gy red, slt		0111-3L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
2892.00				Viki	Heat	Upper Jurassic		0112
			100	Cont		: cem		0112-4L
			tr	Sh/Clst		: lt gy to m gy to pl ol to pl y gn		0112-1L
			tr	Ca		: w to gy pi, crs, s, glauc		0112-2L
			tr	Marl		: gy red, slt		0112-3L
			tr	Sltst		: m gy to drk gy to dsk y brn, s		0112-5L
			tr	S/Sst		: lt gy, f, l		0112-6L
2892.00		ccp		Viki	Heat	Upper Jurassic		0142
		1.16	100	Sltst		: brn gy to dsk brn, mic		0142-1L
2897.00		ccp		Viki	Heat	Upper Jurassic		0143
		1.01	100	Sltst		: brn gy to dsk brn, s, mic		0143-1L
2902.00		ccp		Viki	Heat	Upper Jurassic		0144
		0.65	100	Sltst		: brn gy, s, mic		0144-1L
2907.00		ccp		Viki	Heat	Upper Jurassic		0145
		0.91	100	S/Sst		: brn gy, slt, mic		0145-1L
2912.00		ccp		Viki	Heat	Upper Jurassic		0146
		0.83	100	S/Sst		: brn gy, slt, mic		0146-1L
2917.00		ccp		Viki	Heat	Upper Jurassic		0147
		0.33	100	S/Sst		: m gy, slt, mic		0147-1L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Depth Cvd	Type TOC%	%	Grp Frm Age / Lithology description	Trb	Sample
2922.00		ccp		Vest Hugi Middle Jurassic		0148
		0.87	100	S/Sst : pl y brn, mic		0148-1L
2927.00		ccp		Vest Hugi Middle Jurassic		0149
		1.56	100	S/Sst : pl y brn, mic		0149-1L
2932.00		ccp		Vest Hugi Middle Jurassic		0150
		1.20	100	S/Sst : pl y brn, mic		0150-1L
2937.00		ccp		Vest Hugi Middle Jurassic		0151
		1.12	100	S/Sst : pl gy to gy brn, crs		0151-1L
2942.00		ccp		Vest Hugi Middle Jurassic		0152
		1.05	100	S/Sst : gy brn to dsk brn, crs		0152-1L
2947.00		ccp		Vest Hugi Middle Jurassic		0141
		0.52	100	S/Sst : w to m gy		0141-1L
2952.00		ccp		Vest Hugi Middle Jurassic		0140
		0.29	100	S/Sst : w to lt gy		0140-1L
2957.00		ccp		Vest Hugi Middle Jurassic		0139
		0.08	100	S/Sst : w to lt gy		0139-1L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type / TOC%	%	Grp / Lithology	Frm / description	Age	Trb	Sample
2962.00		ccp		Vest	Hugi	Middle Jurassic		0138
		0.05	100	S/Sst	: w to lt gy			0138-1L
2966.75		ccp		Vest	Hugi	Middle Jurassic		0137
		0.07	100	S/Sst	: w to lt gy			0137-1L
2973.00				Vest	Hugi	Middle Jurassic		0113
			100	S/Sst	: w, f, crs, l			0113-6L
			tr	Sh/Clst	: lt gy to m gy to pl ol to pl y gn			0113-1L
			tr	Ca	: w to gy pi, crs, s, glauc			0113-2L
			tr	Marl	: gy red, slt			0113-3L
			tr	Cont	: Coal-ad			0113-4L
			tr	Sltst	: m gy to drk gy to dsk y brn, s			0113-5L
2979.00				Vest	Hugi	Middle Jurassic		0114
			50	Cont	: Coal-ad, prp, dd			0114-4L
			50	S/Sst	: w, crs, l			0114-6L
			tr	Sh/Clst	: lt gy to m gy to pl ol to pl y gn			0114-1L
			tr	Ca	: w to gy pi, crs, s, glauc			0114-2L
			tr	Marl	: gy red, slt			0114-3L
			tr	Sltst	: m gy to drk gy to dsk y brn, s			0114-5L
2985.00				Vest	Hugi	Middle Jurassic		0115
		0.26	90	S/Sst	: w to lt gy, f, crs, cem, l, kln			0115-3L
			10	Cont	: Coal-ad, prp, dd			0115-1L
			tr	Sltst	: m gy to drk gy to dsk y brn, s			0115-2L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth (Int Cvd)	Type / TOC%	%	Grp Frm Age / Lithology description	Trb	Sample
2991.00			Vest Hugi Middle Jurassic		0116
		90	S/Sst : w to lt gy, f, crs, cem, l, kln		0116-3L
		10	Cont : Coal-ad, prp, dd		0116-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s		0116-2L
2997.00			Vest Hugi Middle Jurassic		0117
	0.19	100	S/Sst : w to lt gy, f, crs, cem		0117-3L
		tr	Cont : Coal-ad, prp, dd		0117-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s		0117-2L
3002.00			Vest Hugi Middle Jurassic		0118
		100	S/Sst : w to lt gy, f, crs, cem		0118-3L
		tr	Cont : prp		0118-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s		0118-2L
3008.00			Vest Hugi Middle Jurassic		0119
	0.29	95	S/Sst : w to lt gy, f, crs, cem, l		0119-3L
		5	Cont : prp, Coal-ad		0119-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s		0119-2L
3014.00			Vest Hugi Middle Jurassic		0120
	0.32	100	S/Sst : w to m gy, f, crs, cem, l		0120-3L
		tr	Cont : prp, Coal-ad		0120-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s		0120-2L
3020.00			Vest Hugi Middle Jurassic		0121
		95	S/Sst : w to m gy, f, crs, cem, l		0121-3L
		5	Cont : prp, Coal-ad		0121-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s		0121-2L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp Frm Age / Lithology description	Trb	Sample
3026.00				Vest Hugi Middle Jurassic		0122
			90	S/Sst : w to m gy, f, crs, cem, l		0122-3L
			10	Cont : prp, Coal-ad		0122-1L
			tr	Sltst : m gy to drk gy to dsk y brn, s		0122-2L
3032.00				Tria Skag Triassic		0123
		0.37	100	S/Sst : lt gy to m gy, f, crs, cem, l		0123-3L
			tr	Cont : prp, Coal-ad		0123-1L
			tr	Sltst : m gy to drk gy to dsk y brn, s		0123-2L
3038.00				Tria Skag Triassic		0124
			100	S/Sst : lt gy to m gy, f, crs, cem, l		0124-3L
			tr	Cont : prp, Coal-ad		0124-1L
			tr	Sltst : m gy to drk gy to dsk y brn, s		0124-2L
3041.00				Tria Skag Triassic		0125
		0.24	100	S/Sst : lt gy to m gy, f, crs, cem, l		0125-3L
			tr	Cont : prp, Coal-ad		0125-1L
			tr	Sltst : m gy to drk gy to dsk y brn, s		0125-2L
3047.00				Tria Skag Triassic		0126
			100	S/Sst : lt gy to m gy, f, crs, cem, l		0126-3L
			tr	Cont : prp, Coal-ad		0126-1L
			tr	Sltst : m gy to drk gy to dsk y brn, s		0126-2L
3053.00				Tria Skag Triassic		0127
		0.34	100	S/Sst : lt gy to m gy, f, crs, cem, l		0127-3L
			tr	Cont : prp, Coal-ad		0127-1L
			tr	Sltst : m gy to drk gy to dsk y brn, s		0127-2L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth Int	Cvd	Type TOC%	%	Grp	Frm	Age / Lithology description	Trb	Sample
3059.00				Tria	Skag	Triassic		0128
			100	S/Sst		: lt gy to m gy, f, crs, cem, l		0128-3L
			tr	Cont		: prp, Coal-ad		0128-1L
			tr	Sltst		: m gy to drk gy to dsk y brn, s		0128-2L
3065.00				Tria	Skag	Triassic		0129
		0.46	100	S/Sst		: lt gy to m gy, f, crs, cem, l		0129-3L
			tr	Cont		: prp, Coal-ad		0129-1L
			tr	Sltst		: m gy to drk gy to dsk y brn, s		0129-2L
3071.00				Tria	Skag	Triassic		0130
			100	S/Sst		: lt gy to m gy, f, crs, cem, l		0130-3L
			tr	Cont		: prp, Coal-ad		0130-1L
			tr	Sltst		: m gy to drk gy to dsk y brn, s		0130-2L
3077.00				Tria	Skag	Triassic		0131
		0.22	100	S/Sst		: lt gy to m gy, f, crs, cem, l		0131-3L
			tr	Cont		: prp, Coal-ad		0131-1L
			tr	Sltst		: m gy to drk gy to dsk y brn, s		0131-2L
3083.00				Tria	Skag	Triassic		0132
			100	S/Sst		: lt gy to m gy, f, crs, cem, l		0132-3L
			tr	Cont		: prp, Coal-ad		0132-1L
			tr	Sltst		: m gy to drk gy to dsk y brn, s		0132-2L
3089.00				Tria	Skag	Triassic		0133
		0.21	100	S/Sst		: w to lt gy, f, crs, cem, l		0133-3L
			tr	Cont		: prp, Coal-ad		0133-1L
			tr	Sltst		: m gy to drk gy to dsk y brn, s		0133-2L

Table 1 : Lithology description for well NOCS 15/12-5

Depth unit of measure: m

Depth (Int Cvd)	Type TOC%	%	Grp / Lithology description	Frm	Age	Trb	Sample
3095.00			Tria	Skag	Triassic		0134
		100	S/Sst : w to lt gy, f, crs, l				0134-3L
		tr	Cont : prp, Coal-ad				0134-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s				0134-2L
3101.00			Tria	Skag	Triassic		0135
		100	S/Sst : w to lt gy, f, crs, l				0135-3L
		tr	Cont : prp, Coal-ad				0135-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s				0135-2L
3107.00			Tria	Skag	Triassic		0136
	0.10	100	S/Sst : w to lt gy, f, crs, l				0136-3L
		tr	Cont : prp, Coal-ad				0136-1L
		tr	Sltst : m gy to drk gy to dsk y brn, s				0136-2L

Table 2 : Rock-Eval table for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	S1	S2	S3	S2/S3	TOC	HI	OI	PP	PI	Tmax	Sample
1060.00	cut	Sh/Clst: m gy	0.50	1.81	1.13	1.60	1.27	143	89	2.3	0.22	421	0001-1L
1090.00	com	bulk	0.25	0.92	0.48	1.92	0.66	139	73	1.2	0.21	356	0154-0B
1150.00	cut	Sltst : pl y brn	0.44	4.15	1.18	3.52	1.11	374	106	4.6	0.10	421	0005-4L
1300.00	cut	Sltst : dsk brn to dsk y brn	0.72	8.38	3.15	2.66	5.59	150	56	9.1	0.08	419	0010-2L
1390.00	cut	S/Sst : w	0.13	0.82	0.51	1.61	0.38	216	134	0.9	0.14	367	0013-3L
1480.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	0.69	5.18	2.10	2.47	3.31	156	63	5.9	0.12	414	0016-2L
1570.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	0.60	5.01	2.05	2.44	3.38	148	61	5.6	0.11	423	0019-2L
1660.00	cut	Sh/Clst: lt brn gy	0.20	1.63	1.05	1.55	1.27	128	83	1.8	0.11	428	0022-3L
1750.00	cut	Sh/Clst: lt brn gy to pl y brn	0.41	2.72	1.08	2.52	1.46	186	74	3.1	0.13	430	0025-2L
1810.00	com	bulk	0.05	0.26	0.48	0.54	0.15	173	320	0.3	0.16	443	0155-0B
1870.00	cut	Sh/Clst: lt brn gy to pl y brn	0.33	2.26	0.90	2.51	1.38	164	65	2.6	0.13	426	0029-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	0.62	4.68	0.80	5.85	1.97	238	41	5.3	0.12	426	0031-2L
2024.00	cut	Sh/Clst: brn gy to pl y brn to m gy	0.25	2.07	0.74	2.80	1.38	150	54	2.3	0.11	427	0034-2L

Table 2 : Rock-Eval table for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	S1	S2	S3	S2/S3	TOC	HI	OI	PP	PI	Tmax	Sample
2114.00	cut	Sh/Clst: lt gy to m gy to pl ol	0.14	0.31	0.49	0.63	0.37	84	132	0.5	0.31	418	0037-2L
2228.00	cut	Sh/Clst: lt gy to m gy to pl ol to pl y gn	–	–	0.26	–	0.06	–	433	–	–	384	0041-2L
2345.00	cut	Sh/Clst: m gy, pl brn	0.25	1.50	0.61	2.46	0.97	155	63	1.8	0.14	425	0045-2L
2426.00	cut	Sh/Clst: gy red, gy brn	0.07	0.38	0.60	0.63	0.71	54	85	0.4	0.16	421	0051-4L
2444.00	cut	Ca : w	0.05	0.25	0.39	0.64	0.31	81	126	0.3	0.17	464	0053-3L
2450.00	cut	Ca : w	0.03	0.22	0.40	0.55	0.24	92	167	0.3	0.12	502	0054-3L
2456.00	cut	Ca : w	0.06	0.15	0.54	0.28	0.35	43	154	0.2	0.29	426	0055-3L
2462.00	cut	Ca : w	0.07	0.24	0.44	0.55	0.30	80	147	0.3	0.23	502	0056-3L
2468.00	cut	Ca : w	0.06	0.20	0.43	0.47	0.18	111	239	0.3	0.23	435	0057-3L
2474.00	cut	Ca : w	0.06	0.17	0.41	0.41	0.15	113	273	0.2	0.26	498	0058-3L
2492.00	cut	Ca : w	0.07	0.15	0.39	0.38	0.05	300	780	0.2	0.32	496	0061-3L
2513.00	cut	Ca : w	0.04	0.11	0.41	0.27	0.04	275	1025	0.2	0.27	475	0064-3L
2531.00	cut	Ca : w	0.07	0.18	0.56	0.32	0.02	900	2800	0.3	0.28	463	0067-3L
2549.00	cut	Ca : w	0.05	0.14	0.41	0.34	0.01	1400	4100	0.2	0.26	473	0070-3L

Depth unit of measure: m

Depth	Typ	Lithology	S1	S2	S3	S2/S3	TOC	HI	OI	PP	PI	Tmax	Sample
2567.00	cut	Ca : w	0.09	0.39	0.47	0.83	0.03	1300	1567	0.5	0.19	497	0073-3L
2585.00	cut	Ca : w to gy pi	0.07	0.26	0.48	0.54	0.02	1300	2400	0.3	0.21	498	0076-3L
2603.00	cut	Ca : w to gy pi	0.07	0.24	0.56	0.43	0.02	1200	2800	0.3	0.23	501	0079-3L
2621.00	cut	Ca : w to gy pi	0.06	0.16	0.46	0.35	0.01	1600	4600	0.2	0.27	501	0082-3L
2645.00	cut	Ca : w	0.08	0.20	0.57	0.35	0.02	1000	2850	0.3	0.29	439	0084-3L
2669.00	cut	Ca : w	0.06	0.19	0.65	0.29	0.01	1900	6500	0.3	0.24	501	0086-3L
2681.00	cut	Ca : w	0.08	0.16	0.59	0.27	0.01	1600	5900	0.2	0.33	429	0087-3L
2705.00	cut	Ca : w to gy pi	0.11	0.26	0.50	0.52	0.02	1300	2500	0.4	0.30	434	0089-3L
2729.00	cut	Ca : w	0.07	0.20	0.34	0.59	0.02	1000	1700	0.3	0.26	497	0091-3L
2741.00	cut	Ca : w to gy pi	0.08	0.49	0.53	0.92	0.04	1225	1325	0.6	0.14	508	0092-3L
2753.00	cut	S/Sst : gy pi to w	0.05	0.29	0.26	1.12	0.02	1450	1300	0.3	0.15	496	0093-5L
2765.00	com	bulk	0.03	0.18	0.28	0.64	0.01	1800	2800	0.2	0.14	496	0156-0B
2777.00	cut	S/Sst : w to lt gy	0.05	0.32	0.28	1.14	0.02	1600	1400	0.4	0.14	505	0095-5L
2789.00	cut	S/Sst : w to lt gy	0.04	0.18	0.20	0.90	0.01	1800	2000	0.2	0.18	501	0096-4L
2807.00	cut	Marl : gy red	0.09	0.34	0.63	0.54	0.03	1133	2100	0.4	0.21	494	0098-4L

Depth unit of measure: m

Depth	Typ	Lithology	S1	S2	S3	S2/S3	TOC	HI	OI	PP	PI	Tmax	Sample
2819.00	cut	S/Sst : w to lt gy to gy red	0.05	0.29	0.25	1.16	0.02	1450	1250	0.3	0.15	476	0100-3L
2831.00	cut	Marl : gy red	0.08	0.41	0.40	1.02	0.26	158	154	0.5	0.16	364	0101-4L
2849.00	cut	Sh/Clst: drk gy to brn blk	0.70	8.20	0.63	13.02	2.91	282	22	8.9	0.08	432	0105-5L
2855.00	cut	Sltst : drk gy to dsk y brn to brn blk	0.71	7.28	0.72	10.11	2.19	332	33	8.0	0.09	430	0106-5L
2861.00	cut	Sltst : m gy to drk gy to dsk y brn	0.55	4.90	0.95	5.16	1.82	269	52	5.5	0.10	434	0107-5L
2867.00	cut	Sltst : m gy to drk gy to dsk y brn	0.84	7.80	0.76	10.26	2.31	338	33	8.6	0.10	429	0108-5L
2873.00	cut	Sltst : m gy to drk gy to dsk y brn	0.70	5.26	0.75	7.01	2.04	258	37	6.0	0.12	433	0109-5L
2879.00	cut	Sltst : m gy to drk gy to dsk y brn	0.67	5.81	0.67	8.67	1.82	319	37	6.5	0.10	434	0110-5L
2892.00	ccp	Sltst : brn gy to dsk brn	0.44	2.77	0.39	7.10	1.16	239	34	3.2	0.14	437	0142-1L
2897.00	ccp	Sltst : brn gy to dsk brn	0.36	1.44	0.23	6.26	1.01	143	23	1.8	0.20	436	0143-1L
2902.00	ccp	Sltst : brn gy	0.19	0.85	0.22	3.86	0.65	131	34	1.0	0.18	433	0144-1L
2907.00	ccp	S/Sst : brn gy	0.59	1.32	0.21	6.29	0.91	145	23	1.9	0.31	433	0145-1L

Depth unit of measure: m

Depth	Typ	Lithology	S1	S2	S3	S2/S3	TOC	HI	OI	PP	PI	Tmax	Sample
2912.00	ccp	S/Sst : brn gy	0.48	1.00	0.21	4.76	0.83	120	25	1.5	0.32	435	0146-1L
2917.00	ccp	S/Sst : m gy	0.29	0.43	0.13	3.31	0.33	130	39	0.7	0.40	433	0147-1L
2922.00	ccp	S/Sst : pl y brn	4.33	2.21	0.19	11.63	0.87	254	22	6.5	0.66	423	0148-1L
2927.00	ccp	S/Sst : pl y brn	10.68	4.14	0.10	41.40	1.56	265	6	14.8	0.72	423	0149-1L
2932.00	ccp	S/Sst : pl y brn	7.04	2.73	0.18	15.17	1.20	227	15	9.8	0.72	411	0150-1L
2937.00	ccp	S/Sst : pl gy to gy brn	7.57	3.32	0.21	15.81	1.12	296	19	10.9	0.70	425	0151-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	6.35	3.09	0.15	20.60	1.05	294	14	9.4	0.67	427	0152-1L
2947.00	ccp	S/Sst : w to m gy	1.97	1.30	0.22	5.91	0.52	250	42	3.3	0.60	427	0141-1L
2952.00	ccp	S/Sst : w to lt gy	0.94	0.33	0.65	0.51	0.29	114	224	1.3	0.74	370	0140-1L
2957.00	ccp	S/Sst : w to lt gy	0.11	0.13	0.33	0.39	0.08	163	413	0.2	0.46	371	0139-1L
2962.00	ccp	S/Sst : w to lt gy	0.05	0.08	0.10	0.80	0.05	160	200	0.1	0.38	411	0138-1L
2966.75	ccp	S/Sst : w to lt gy	0.08	0.07	0.31	0.23	0.07	100	443	0.2	0.53	404	0137-1L
2985.00	cut	S/Sst : w to lt gy	0.72	0.89	0.16	5.56	0.26	342	62	1.6	0.45	374	0115-3L
2997.00	cut	S/Sst : w to lt gy	0.15	0.37	0.12	3.08	0.19	195	63	0.5	0.29	436	0117-3L
3008.00	cut	S/Sst : w to lt gy	0.76	1.21	0.15	8.07	0.29	417	52	2.0	0.39	373	0119-3L

Table 2 : Rock-Eval table for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	S1	S2	S3	S2/S3	TOC	HI	OI	PP	PI	Tmax	Sample
3014.00	cut	S/Sst : w to m gy	0.35	1.12	0.17	6.59	0.32	350	53	1.5	0.24	435	0120-3L
3032.00	cut	S/Sst : lt gy to m gy	0.26	1.20	0.14	8.57	0.37	324	38	1.5	0.18	439	0123-3L
3041.00	cut	S/Sst : lt gy to m gy	0.21	0.58	0.11	5.27	0.24	242	46	0.8	0.27	437	0125-3L
3053.00	cut	S/Sst : lt gy to m gy	0.25	0.97	0.12	8.08	0.34	285	35	1.2	0.20	436	0127-3L
3065.00	cut	S/Sst : lt gy to m gy	0.29	0.76	0.14	5.43	0.46	165	30	1.0	0.28	434	0129-3L
3077.00	cut	S/Sst : lt gy to m gy	0.24	0.26	0.11	2.36	0.22	118	50	0.5	0.48	434	0131-3L
3089.00	cut	S/Sst : w to lt gy	0.21	0.28	0.10	2.80	0.21	133	48	0.5	0.43	381	0133-3L
3107.00	cut	S/Sst : w to lt gy	0.13	0.81	0.08	10.13	0.10	810	80	0.9	0.14	373	0136-3L

Table 3 : Pyrolysis GC Data (S2 peak) as Percentage of Total Area for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	C1	C2-C5	C6-C14	C15+	S2 from Rock-Eval	Sample
1060.00	cut	Sh/Clst: m gy	5.16	24.70	60.39	9.74	1.81	0001-1L
1150.00	cut	Sltst : pl y brn	3.93	17.69	53.78	24.61	4.15	0005-4L
1390.00	cut	S/Sst : w	5.61	26.90	55.13	12.36	0.82	0013-3L
1570.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	7.17	18.40	48.78	25.65	5.01	0019-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	5.88	19.28	45.46	29.39	4.68	0031-2L
2345.00	cut	Sh/Clst: m gy, pl brn	5.27	23.62	52.77	18.34	1.50	0045-2L
2462.00	cut	Ca : w	3.28	22.33	71.84	2.55	0.24	0056-3L
2705.00	cut	Ca : w to gy pi	6.02	28.25	63.89	1.85	0.26	0089-3L
2849.00	cut	Sh/Clst: drk gy to brn blk	3.72	13.39	36.32	46.57	8.20	0105-5L
2867.00	cut	Sltst : m gy to drk gy to dsk y brn	3.02	12.78	35.83	48.37	7.80	0108-5L
2892.00	ccp	Sltst : brn gy to dsk brn	3.25	15.74	37.71	43.31	2.77	0142-1L
2907.00	ccp	S/Sst : brn gy	5.17	19.99	43.74	31.09	1.32	0145-1L
2912.00	ccp	S/Sst : brn gy	7.50	25.70	48.82	17.99	1.00	0146-1L

Table 3 : Pyrolysis GC Data (S2 peak) as Percentage of Total Area for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	C1	C2-C5	C6-C14	C15+	S2 from Rock-Eval	Sample
2922.00	ccp	S/Sst : pl y brn	3.09	16.50	37.73	42.69	2.21	0148-1L
2927.00	ccp	S/Sst : pl y brn	3.02	17.12	35.65	44.21	4.14	0149-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	4.23	19.85	35.30	40.62	3.09	0152-1L
2952.00	ccp	S/Sst : w to lt gy	8.75	29.18	50.02	12.06	0.33	0140-1L
2985.00	cut	S/Sst : w to lt gy	1.88	29.38	61.23	7.51	0.89	0115-3L
3014.00	cut	S/Sst : w to m gy	5.52	30.72	53.51	10.24	1.12	0120-3L
3065.00	cut	S/Sst : lt gy to m gy	7.50	36.79	45.53	10.18	0.76	0129-3L
3107.00	cut	S/Sst : w to lt gy	0.89	32.35	47.66	19.09	0.81	0136-3L

Table 4 a: Weight of EOM and Chromatographic Fraction for well NOCS 15/12-5

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
1150.00	cut	Sltst : pl y brn	4.5	5.0	0.6	0.2	0.1	4.1	0.8	4.2	1.69	0005-4L
1570.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	2.9	6.1	0.8	0.2	0.1	5.0	1.0	5.1	4.80	0019-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	4.6	9.4	2.6	0.5	0.1	6.2	3.1	6.3	2.06	0031-2L
2849.00	cut	Sh/Clst: drk gy to brn blk	1.7	10.9	2.1	0.8	1.4	6.6	2.9	8.0	2.25	0105-5L
2892.00	ccp	Sltst : brn gy to dsk brn	9.8	5.8	1.4	1.5	0.3	2.6	2.9	2.9	1.09	0142-1L
2907.00	ccp	S/Sst : brn gy	6.6	4.9	1.8	1.1	0.8	1.2	2.9	2.0	0.98	0145-1L
2927.00	ccp	S/Sst : pl y brn	9.1	129.9	94.3	12.5	5.8	17.3	106.8	23.1	1.35	0149-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	9.2	71.7	36.9	11.9	8.2	14.7	48.8	22.9	1.05	0152-1L
2952.00	ccp	S/Sst : w to lt gy	9.6	1.4	0.2	0.2	0.1	0.9	0.4	1.0	0.14	0140-1L

Table 4 b: Concentration of EOM and Chromatographic Fraction (wt ppm rock) for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	EOM	Sat	Aro	Asph	NSO	HC	Non-HC	Sample
1150.00	cut	Sltst : pl y brn	1118	134	44	22	917	178	939	0005-4L
1570.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	2110	276	69	34	1730	346	1764	0019-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	2025	560	107	21	1336	668	1357	0031-2L
2849.00	cut	Sh/Clst: drk gy to brn blk	6374	1228	467	818	3859	1695	4678	0105-5L
2892.00	ccp	Sltst : brn gy to dsk brn	594	143	153	30	266	297	297	0142-1L
2907.00	ccp	S/Sst : brn gy	743	273	166	121	182	440	303	0145-1L
2927.00	ccp	S/Sst : pl y brn	14274	10362	1373	637	1901	11736	2538	0149-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	7776	4002	1290	889	1594	5292	2483	0152-1L
2952.00	ccp	S/Sst : w to lt gy	145	20	20	10	93	41	103	0140-1L

Table 4 c: Concentration of EOM and Chromatographic Fraction (mg/g TOC(e)) for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	EOM	Sat	Aro	Asph	NSO	HC	Non-HC	Sample
1150.00	cut	Sltst : pl y brn	66.19	7.94	2.65	1.32	54.27	10.59	55.60	0005-4L
1570.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	43.97	5.77	1.44	0.72	36.04	7.21	36.76	0019-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	98.34	27.20	5.23	1.05	64.86	32.43	65.91	0031-2L
2849.00	cut	Sh/Clst: drk gy to brn blk	283.30	54.58	20.79	36.39	171.54	75.37	207.93	0105-5L
2892.00	ccp	Sltst : brn gy to dsk brn	54.58	13.17	14.11	2.82	24.46	27.29	27.29	0142-1L
2907.00	ccp	S/Sst : brn gy	75.87	27.87	17.03	12.39	18.58	44.90	30.97	0145-1L
2927.00	ccp	S/Sst : pl y brn	1057.39	767.60	101.75	47.21	140.82	869.35	188.03	0149-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	740.63	381.16	122.92	84.70	151.84	504.08	236.55	0152-1L
2952.00	ccp	S/Sst : w to lt gy	103.73	14.82	14.82	7.41	66.69	29.64	74.10	0140-1L

Table 4 d: Composition of material extracted from the rock (%) for well NOCS 15/12-5

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
1150.00	cut	Sltst : pl y brn	12.00	4.00	2.00	82.00	16.00	84.00	300.00	19.05	0005-4L
1570.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	13.11	3.28	1.64	81.97	16.39	83.61	400.00	19.61	0019-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	27.66	5.32	1.06	65.96	32.98	67.02	520.00	49.21	0031-2L
2849.00	cut	Sh/Clst: drk gy to brn blk	19.27	7.34	12.84	60.55	26.61	73.39	262.50	36.25	0105-5L
2892.00	ccp	Sltst : brn gy to dsk brn	24.14	25.86	5.17	44.83	50.00	50.00	93.33	100.00	0142-1L
2907.00	ccp	S/Sst : brn gy	36.73	22.45	16.33	24.49	59.18	40.82	163.64	145.00	0145-1L
2927.00	ccp	S/Sst : pl y brn	72.59	9.62	4.46	13.32	82.22	17.78	754.40	462.34	0149-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	51.46	16.60	11.44	20.50	68.06	31.94	310.08	213.10	0152-1L
2952.00	ccp	S/Sst : w to lt gy	14.29	14.29	7.14	64.29	28.57	71.43	100.00	40.00	0140-1L

Table 5 : Saturated Hydrocarbon Ratios for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	Pristane / nC17	Pristane / Phytane	Pristane + Phytane / nC17 + nC18	Phytane / nC18	CPI	Sample
1150.00	cut	Sltst : pl y brn	0.55	2.53	0.51	0.41	0.80	0005-4L
1570.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	0.49	2.66	0.46	0.39	1.88	0019-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	0.53	3.16	0.46	0.32	1.64	0031-2L
2849.00	cut	Sh/Clst: drk gy to brn blk	0.73	1.57	0.61	0.48	1.41	0105-5L
2892.00	ccp	Sltst : brn gy to dsk brn	0.78	2.79	0.66	0.46	1.25	0142-1L
2907.00	ccp	S/Sst : brn gy	0.77	3.61	0.67	0.46	1.65	0145-1L
2927.00	ccp	S/Sst : pl y brn	0.63	1.04	0.55	0.49	1.08	0149-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	0.61	0.91	0.54	0.49	1.01	0152-1L
2952.00	ccp	S/Sst : w to lt gy	0.94	2.11	0.88	0.78	1.77	0140-1L

Table 6 : Aromatic Hydrocarbon Ratios for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	MNR	DMNR	BPhR	2/1MP	MPI1	MPI2	Rc	DBT/P	4/1MDBT	(3+2) /1MDBT	Sample
1150.00	cut	Sltst : pl y brn	–	0.65	–	2.13	1.04	1.31	1.02	–	–	–	0005-4L
1570.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	–	–	–	–	–	–	–	–	–	–	0019-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	0.73	1.04	0.12	1.45	0.62	0.76	0.77	–	–	–	0031-2L
2849.00	cut	Sh/Clst: drk gy to brn blk	0.40	0.76	–	1.05	0.71	0.79	0.83	–	–	–	0105-5L
2892.00	ccp	Sltst : brn gy to dsk brn	1.02	1.54	0.15	0.92	0.55	0.61	0.73	0.25	1.22	0.86	0142-1L
2907.00	ccp	S/Sst : brn gy	1.05	1.65	0.18	0.94	0.53	0.58	0.72	–	–	–	0145-1L
2927.00	ccp	S/Sst : pl y brn	1.08	1.88	0.34	0.88	0.83	0.92	0.90	0.28	3.37	0.50	0149-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	–	–	–	0.94	0.85	0.97	0.91	–	2.60	0.54	0152-1L
2952.00	ccp	S/Sst : w to lt gy	–	–	–	1.24	0.79	0.90	0.87	–	–	–	0140-1L

Table 7 : Thermal Maturity Data for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	Vitrinite Reflectance (%)	Number of Readings	Standard Deviation	Spore Fluorescence Colour	SCI	Tmax (°C)	Sample
1060.00	cut	Sh/Clst: m gy	0.40	14	0.05	3-4	3.0-3.5	421	0001-1L
1120.00	cut	Sh/Clst: lt gy to drk gy	0.44	4	0.05	3	-	-	0004-1L
1150.00	cut	Sltst : pl y brn	-	-	-	-	4.0-4.5	421	0005-4L
1240.00	cut	Sh/Clst: gy brn to pl y brn, lt brn gy	0.41	11	0.04	3-4	-	-	0008-2L
1300.00	cut	Sltst : dsk brn to dsk y brn	-	-	-	-	4.0(??)	419	0010-2L
1330.00	cut	Sltst : dsk brn to dsk y brn	0.40	20	0.04	3+4	-	-	0011-2L
1420.00	cut	Sltst : dsk brn to dsk y brn	0.39	20	0.04	4	-	-	0014-2L
1480.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	0.38	20	0.04	3+4	-	414	0016-2L
1600.00	cut	Sltst : pl y brn to dsk y brn to dsk brn	0.42	20	0.04	3-4	-	-	0020-2L
1660.00	cut	Sh/Clst: lt brn gy	-	-	-	-	4.5	428	0022-3L
1690.00	cut	Sh/Clst: lt brn gy to pl y brn	0.42	20	0.05	3-4	-	-	0023-3L
1780.00	cut	Sh/Clst: lt brn gy to pl y brn	0.39	19	0.05	3-4	-	-	0026-2L

Table 7 : Thermal Maturity Data for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	Vitrinite Reflectance (%)	Number of Readings	Standard Deviation	Spore Fluorescence Colour	SCI	Tmax (°C)	Sample
1900.00	cut	Sh/Clst: lt brn gy to pl y brn	0.45	20	0.05	3-4	-	-	0030-2L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	-	-	-	-	4.5(?)	426	0031-2L
1990.00	cut	Sh/Clst: brn gy to pl y brn	0.45	20	0.05	4+5	-	-	0033-2L
2084.00	cut	Sh/Clst: lt gy to m gy to pl ol	0.52	5	0.05	3-6	-	-	0036-3L
2177.00	cut	Sh/Clst: lt gy to m gy to pl ol	0.54	6	0.02	3+5	-	-	0039-2L
2258.00	cut	Sh/Clst: lt gy to m gy to pl ol to pl y gn	0.57	3	0.03	4-5	-	-	0042-2L
2345.00	cut	Sh/Clst: m gy, pl brn	-	-	-	-	4.5	425	0045-2L
2375.00	cut	Sh/Clst: lt gy to pl ol, brn gy to gy brn	0.57	2	0.01	4-5	-	-	0046-1L
2597.00	cut	Sh/Clst: lt gy to m gy to pl ol to pl y gn	0.55	5	0.02	4+5	-	-	0078-1L
2765.00	cut	Sh/Clst: lt gy to m gy to pl ol to pl y gn	0.55	4	0.03	4+5	-	-	0094-1L
2849.00	cut	Sh/Clst: drk gy to brn blk	-	-	-	-	5.0	432	0105-5L
2855.00	cut	Sltst : drk gy to dsk y brn to brn blk	0.53	2	0.04	4	-	430	0106-5L

Table 7 : Thermal Maturity Data for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	Vitrinite Reflectance (%)	Number of Readings	Standard Deviation	Spore Fluorescence Colour	SCI	Tmax (°C)	Sample
2892.00	ccp	Sltst : brn gy to dsk brn	0.44	15	0.03	4	-	437	0142-1L
2897.00	ccp	Sltst : brn gy to dsk brn	-	-	-	-	5.5-6.0	436	0143-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	-	-	-	-	NDP	427	0152-1L
3065.00	cut	S/Sst : lt gy to m gy	-	-	-	-	6.5(?)	434	0129-3L

Table 8 : Visual Kerogen Composition Data for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	LIPT %	Amor L	Lip Det	Sp/Pol	Cuticl	Resin	Algae	Dinofl	Acrit	Bit L	INERT %	Fusin	SemFus	IntDet	Micrin	Sclero	Bit I	VITR %	Tellin	Collin	VitDet	Amor V	Bit V	Sample
1060.00	cut	Sh/Clst: m gy	90	**		*			*	*			10			*				TR	*		**			0001-1L
1150.00	cut	Sltst : pl y brn	85	*	*	*			**	*			5			*				10	*		**			0005-4L
1300.00	cut	Sltst : dsk brn to dsk y brn	100	**	**	*			*	*			TR			*				TR			*			0010-2L
1660.00	cut	Sh/Clst: lt brn gy	90	*	**	*			*				5			*				5			*			0022-3L
1930.00	cut	Sh/Clst: lt brn gy to pl y brn	70		**	*			*	*			TR			*				30			*			0031-2L
2345.00	cut	Sh/Clst: m gy, pl brn	60	**	**	*			*	*			20			*				20			*			0045-2L
2849.00	cut	Sh/Clst: drk gy to brn blk	65	**	*	*			*	*			15		*	*				20	*		**			0105-5L
2897.00	ccp	Sltst : brn gy to dsk brn	45		**	*			*	*			30		*	**				25	*		**			0143-1L
2942.00	ccp	S/Sst : gy brn to dsk brn	NDP	**								?	NDP			*				NDP			*			0152-1L
3065.00	cut	S/Sst : lt gy to m gy	35	*	*	*			*	*			60	*	*	*				5			*			0129-3L

Table 9A: Tabulation of carbon isotope data for EOM/EOM - fractions for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	EOM	Saturated	Aromatic	NSO	Asphaltenes	Kerogen	Sample
1570.00	cut	Sltst	-	-27.75	-27.27	-27.85	-26.73	-	0019-2
1930.00	cut	Sh/Clst	-	-27.57	-26.75	-28.01	-26.97	-	0031-2
2849.00	cut	Sh/Clst	-	-29.33	-28.75	-28.33	-28.49	-	0105-5
2892.00	ccp	Sltst	-	-29.19	-27.94	-28.06	-27.42	-	0142-1
2927.00	ccp	S/Sst	-28.84	-29.01	-28.15	-28.42	-28.66	-	0149-1
2942.00	ccp	S/Sst	-28.65	-29.04	-28.14	-28.52	-28.44	-	0152-1
2952.00	ccp	S/Sst	-	-29.18	-28.24	-27.91	-28.10	-	0140-1

Table 9B: Tabulation of cv values from carbon isotope data for well NOCS 15/12-5

Depth unit of measure: m

Depth	Typ	Lithology	Saturated	Aromatic	cv value	Interpretation	Sample
1570.00	cut	Sltst	-27.75	-27.27	-1.98	Marine	0019-2
1930.00	cut	Sh/Clst	-27.57	-26.75	-1.28	Marine	0031-2
2849.00	cut	Sh/Clst	-29.33	-28.75	-1.27	Marine	0105-5
2892.00	ccp	Sltst	-29.19	-27.94	0.17	Marine	0142-1
2927.00	ccp	S/Sst	-29.01	-28.15	-0.75	Marine	0149-1
2942.00	ccp	S/Sst	-29.04	-28.14	-0.65	Marine	0152-1
2952.00	ccp	S/Sst	-29.18	-28.24	-0.52	Marine	0140-1

Table 10A: Variation in Triterpane Distribution (peak height) SIR for Well NOCS 15/12-5

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
1570.00	Sltst	9.40	0.90	0.20	1.05	0.51	0.04	-	-	-	0.18	0.55	0.53	0.88	30.74	0019-2
1930.00	Sh/Clst	9.40	0.90	0.23	0.53	0.35	0.02	0.27	0.50	0.21	0.10	0.71	0.43	0.61	14.66	0031-2
2849.00	Sh/Clst	2.75	0.73	0.20	0.48	0.32	0.06	0.04	0.08	0.04	0.13	0.84	0.34	0.22	55.47	0105-5
2892.00	Sltst	4.94	0.83	0.21	0.58	0.37	0.07	0.11	0.19	0.10	0.10	0.83	0.37	0.21	59.73	0142-1
2927.00	S/Sst	0.78	0.44	0.12	0.45	0.31	0.07	0.04	0.10	0.04	0.09	0.91	0.31	0.10	59.99	0149-1
2942.00	S/Sst	0.68	0.41	0.11	0.45	0.31	0.07	0.04	0.10	0.04	0.09	0.91	0.31	0.10	59.74	0152-1
2952.00	S/Sst	1.24	0.55	0.14	0.56	0.36	0.05	0.05	0.10	0.05	0.43	0.89	0.36	0.13	59.65	0140-1

Table 10B: Variation in Sterane Distribution (peak height) SIR for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Lithology	Ratio1	Ratio2	Ratio3	Ratio4	Ratio5	Ratio6	Ratio7	Ratio8	Ratio9	Ratio10	Sample
1570.00	Sltst	0.39	7.23	36.92	0.67	0.80	0.59	0.49	0.23	0.08	0.32	0019-2
1930.00	Sh/Clst	0.27	57.92	38.72	0.08	0.35	0.39	0.31	0.24	1.38	0.75	0031-2
2849.00	Sh/Clst	0.69	45.17	54.73	1.46	0.57	0.45	0.35	0.38	0.82	1.10	0105-5
2892.00	Sltst	0.71	37.78	55.06	1.89	0.62	0.42	0.32	0.38	0.61	0.98	0142-1
2927.00	S/Sst	0.74	45.52	75.70	1.29	0.77	0.45	0.32	0.61	0.84	2.86	0149-1
2942.00	S/Sst	0.74	46.05	76.34	1.32	0.78	0.43	0.30	0.62	0.85	2.99	0152-1
2952.00	S/Sst	0.74	48.87	69.60	1.49	0.70	0.68	0.54	0.53	0.96	2.24	0140-1

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 10C: Variation in Triaromatic Sterane Distribution for Well Well NOCS 15/12-5

Depth unit of measure: m

Depth	Lithology	Ratio1	Ratio2	Ratio3	Ratio4	Ratio5	Sample
1570.00	Sltst	0.67	0.53	0.35	0.40	0.51	0019-2
1930.00	Sh/Clst	0.53	0.52	0.20	0.22	0.22	0031-2
2849.00	Sh/Clst	0.46	0.39	0.20	0.22	0.29	0105-5
2892.00	Sltst	0.58	0.44	0.22	0.29	0.33	0142-1
2927.00	S/Sst	0.69	0.67	0.41	0.42	0.50	0149-1
2942.00	S/Sst	0.67	0.65	0.39	0.41	0.47	0152-1
2952.00	S/Sst	0.64	0.54	0.32	0.35	0.44	0140-1

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 10D: Variation in Monoaromatic Sterane Distribution for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Lithology	Ratio1	Ratio2	Ratio3	Ratio4	Sample
1570.00	Sltst	0.44	0.26	0.22	0.17	0019-2
1930.00	Sh/Clst	0.10	0.06	0.05	0.04	0031-2
2849.00	Sh/Clst	0.34	0.22	0.21	0.17	0105-5
2892.00	Sltst	0.31	0.20	0.20	0.16	0142-1
2927.00	S/Sst	0.78	0.60	0.67	0.56	0149-1
2942.00	S/Sst	0.50	0.36	0.37	0.30	0152-1
2952.00	S/Sst	0.53	0.36	0.39	0.32	0140-1

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 10E: Aromatisation of Steranes for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Lithology	Ratio1	Ratio2	Sample
1570.00	Sltst	0.74	0.36	0019-2
1930.00	Sh/Clst	0.91	0.12	0031-2
2849.00	Sh/Clst	0.39	0.89	0105-5
2892.00	Sltst	0.38	0.94	0142-1
2927.00	S/Sst	0.13	0.98	0149-1
2942.00	S/Sst	0.36	0.93	0152-1
2952.00	S/Sst	0.37	0.94	0140-1

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

Ratio2: g1 / g1 + I1

Table 10F: Raw GCMS triterpane data (peak height) SIR for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Lithology	p	q	r	s	t	a	b	z	c	Sample
1570.00	Sltst	314160.0	82520.2	33725.4	39020.8	8406.1	21577.3	202888.4	0.0	474506.3	0019-2
1930.00	Sh/Clst	218763.7	78473.6	34473.8	42376.6	0.0	35558.9	334204.0	208413.1	419002.5	0031-2
2849.00	Sh/Clst	228874.8	96441.5	64879.7	66739.5	28494.0	79453.9	218296.4	26460.3	343539.8	0105-5
2892.00	Sltst	669653.1	212628.5	137505.3	172488.4	50788.3	138017.9	682214.8	240318.6	1254701.9	0142-1
2927.00	S/Sst	378833.4	237767.3	122409.3	176775.5	73604.4	474130.3	371714.5	115581.8	1167557.9	0149-1

Depth	Lithology	x	d	e	f	g	h	i	j1
1570.00	Sltst	16281.8	447246.5	453838.6	369688.0	154416.8	2824173.0	1261834.6	29230.8
1930.00	Sh/Clst	15326.1	412472.5	785031.5	322176.2	134633.5	1599811.4	277239.1	25615.0
2849.00	Sh/Clst	44325.9	93604.1	718333.1	138945.1	263121.3	325028.0	77433.9	133039.3
2892.00	Sltst	160644.8	248390.7	2145038.0	451554.5	1121247.9	753264.1	283678.1	513149.7
2927.00	S/Sst	175929.5	126719.0	2579593.0	262715.7	1149000.5	785536.9	153390.0	807878.1

Depth	Lithology	j2	k1	k2	l1	l2	m1	m2
1570.00	Sltst	65864.0	14520.1	20312.0	15277.4	17476.6	12212.8	7053.6
1930.00	Sh/Clst	149122.7	750350.0	43279.4	6348.2	16658.0	6375.5	10042.0
2849.00	Sh/Clst	106812.7	108560.4	69915.2	71116.7	49136.1	66458.9	51914.6
2892.00	Sltst	345899.9	345038.9	235322.4	248187.2	164474.3	159226.0	109276.5
2927.00	S/Sst	538789.1	639506.5	401734.4	390430.0	232488.9	324610.8	200450.5

Depth unit of measure: m

Depth	Lithology	p	q	r	s	t	a	b	z	c	Sample
2942.00	S/Sst	347511.8	222743.3	108570.0	170679.8	67020.4	467383.1	318223.0	103392.8	1079434.8	0152-1
2952.00	S/Sst	161754.9	81294.6	25007.6	25858.3	12332.3	28809.0	35749.1	10199.7	105011.1	0140-1

Depth	x	d	e	f	g	h	i	j1
2942.00	157522.0	117794.0	2414886.0	235442.6	1055268.8	718319.3	138201.5	772595.0
2952.00	8434.9	14703.9	187418.6	23761.6	74573.4	77373.3	11454.4	47603.7

Depth	j2	k1	k2	l1	l2	m1	m2
2942.00	520732.9	571713.4	389376.8	345564.6	225304.2	313721.6	202476.0
2952.00	32203.8	32338.1	19597.1	17728.9	12095.4	21087.4	15544.0

Table 10G: Raw GCMS sterane data (peak height) SIR for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Lithology	u	v	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	Sample
1570.00	Sltst	251525.6	49603.8	35078.3	19721.6	8430.7	11817.0	15824.4	13415.2	29224.8	65382.6	30806.6	53959.1	20299.8	8430.2	51930.4	17499.5	21201.3	18318.4	11631.4	37757.8	9330.7	149302.8	0019-2
1930.00	Sh/Clst	291648.0	62709.1	36193.3	19304.2	17613.6	13575.5	12970.0	12014.8	36992.4	45333.4	37086.0	96408.2	637336.8	305317.4	159285.1	66446.8	35428.2	65368.8	238950.5	69162.7	61139.0	173571.9	0031-2
2849.00	Sh/Clst	281170.3	76323.0	367515.2	230737.0	103431.7	93341.0	132910.0	84084.0	128187.3	236865.4	121476.1	166700.4	174961.6	75392.8	62404.3	56916.6	70772.1	69231.7	121244.8	95957.6	66279.7	147157.9	0105-5
2892.00	Sltst	487706.0	133710.5	997723.1	612130.0	282550.8	288070.3	359776.8	205574.1	323064.0	519049.8	204210.6	399257.1	376578.5	160289.6	134300.9	96140.5	114853.4	156678.5	203500.0	197908.1	132101.3	335195.2	0142-1
2927.00	S/Sst	650993.8	247485.4	767181.9	460961.0	208470.8	217967.1	324043.6	225022.9	280522.2	506217.6	360237.3	268657.9	354912.6	141544.1	173436.0	279908.9	304936.7	120100.6	193980.1	354886.4	308691.1	232126.2	0149-1

Table 10G: Raw GCMS sterane data (peak height) SIR for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Lithology	u	v	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	Sample
2942.00	S/Sst	547427.8	202661.9	707804.0	454724.7	166953.5	197850.0	311689.2	204964.1	266950.1	458136.3	339246.1	246262.8	314441.0	130752.8	146183.9	252176.0	256449.8	107616.0	178685.1	325340.3	300604.3	209371.0	0152-1
2952.00	S/Sst	101512.0	29212.0	47379.5	29080.9	13094.6	12097.7	18830.1	12360.5	17633.1	30029.1	23006.5	16477.6	17941.9	7879.9	12077.6	12316.0	17658.7	14178.1	14281.8	17244.0	16204.0	14943.3	0140-1

Table 10H: Raw GCMS triaromatic sterane data (peak height) for Well NOCS 15/12-5

Depth unit of measure: m

Depth	Lithology	a1	b1	c1	d1	e1	f1	g1	Sample
1570.00	Sltst	205490.2	117845.3	102629.9	200826.5	110445.0	89039.2	103369.9	0019-2
1930.00	Sh/Clst	92964.5	90203.1	71149.7	337377.5	128472.4	121618.8	82649.5	0031-2
2849.00	Sh/Clst	765632.0	571433.8	832931.9	1902115.8	1049993.4	775772.2	899051.3	0105-5
2892.00	Sltst	1803114.3	1037376.0	1791537.8	3601578.8	1598329.6	1515180.8	1325015.0	0142-1
2927.00	S/Sst	2748631.5	2475099.5	967475.1	2698196.3	1453235.8	1140259.5	1222281.9	0149-1
2942.00	S/Sst	2040667.0	1889590.9	791603.2	2258099.8	1118759.0	856580.4	1006802.8	0152-1
2952.00	S/Sst	281713.5	186527.9	132795.8	360610.3	174159.4	182663.8	161607.6	0140-1

Table 10I: Raw GCMS monoaromatic sterane data (peak height) for Well NOCS 15/12-5

Depth unit of measure: m

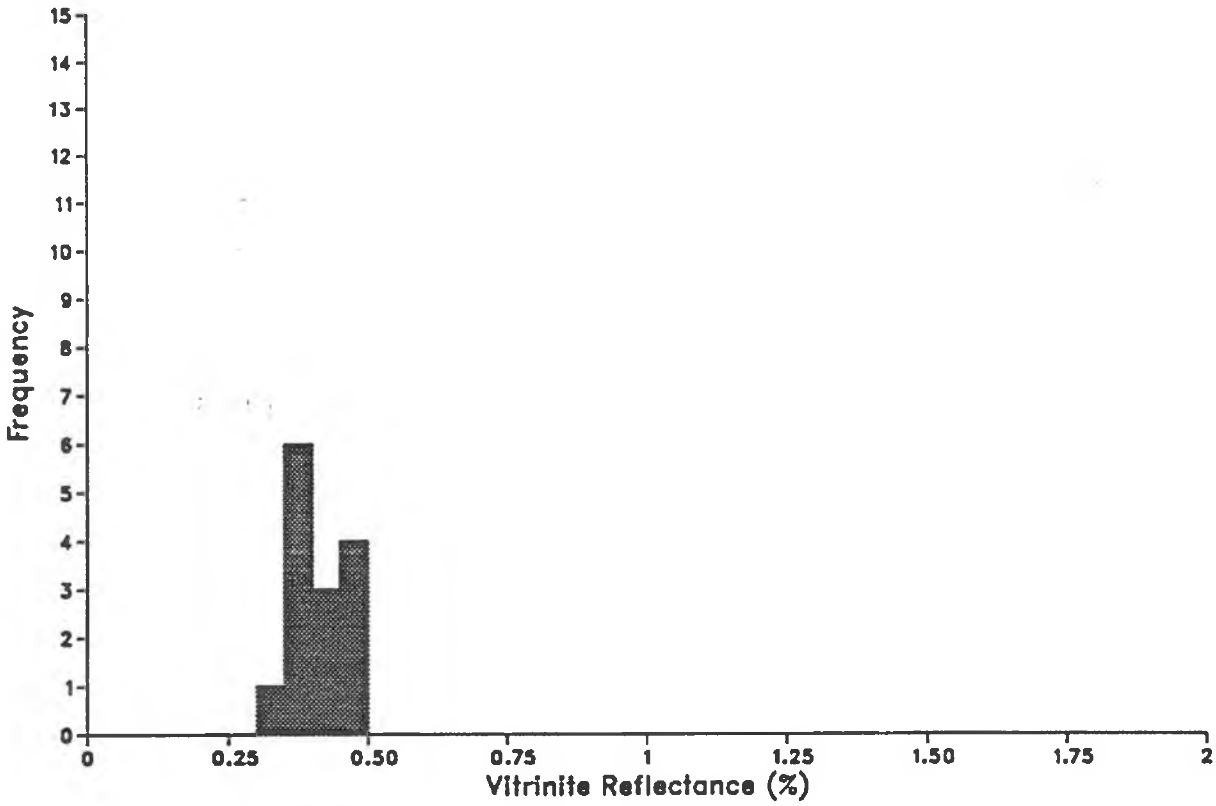
Depth	Lithology	a1	b1	c1	d1	e1	f1	g1	h1	i1	Sample
1570.00	Sltst	235037.8	103155.0	90968.4	88329.6	298943.9	37353.6	546945.6	434225.3	186186.5	0019-2
1930.00	Sh/Clst	193588.3	104254.2	408110.3	418125.4	1776728.8	157471.4	2308741.3	1644546.3	626813.0	0031-2
2849.00	Sh/Clst	451296.0	257673.3	473014.9	378526.0	892567.5	224933.2	834255.6	510852.9	108952.6	0105-5
2892.00	Sltst	751375.2	424589.5	1075580.3	786296.4	1656927.8	516931.2	1281286.4	722559.1	87984.8	0142-1
2927.00	S/Sst	961453.0	389074.0	243542.7	157069.3	264412.9	49584.0	214988.9	109648.0	31324.8	0149-1
2942.00	S/Sst	948750.6	526722.9	736373.0	478212.8	936866.9	195958.7	677369.4	359183.3	70777.6	0152-1
2952.00	S/Sst	186179.7	94537.3	107082.9	85049.4	164722.4	37598.2	124335.2	67621.4	10629.0	0140-1

APPENDIX 2

Histograms

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1060.00(m)



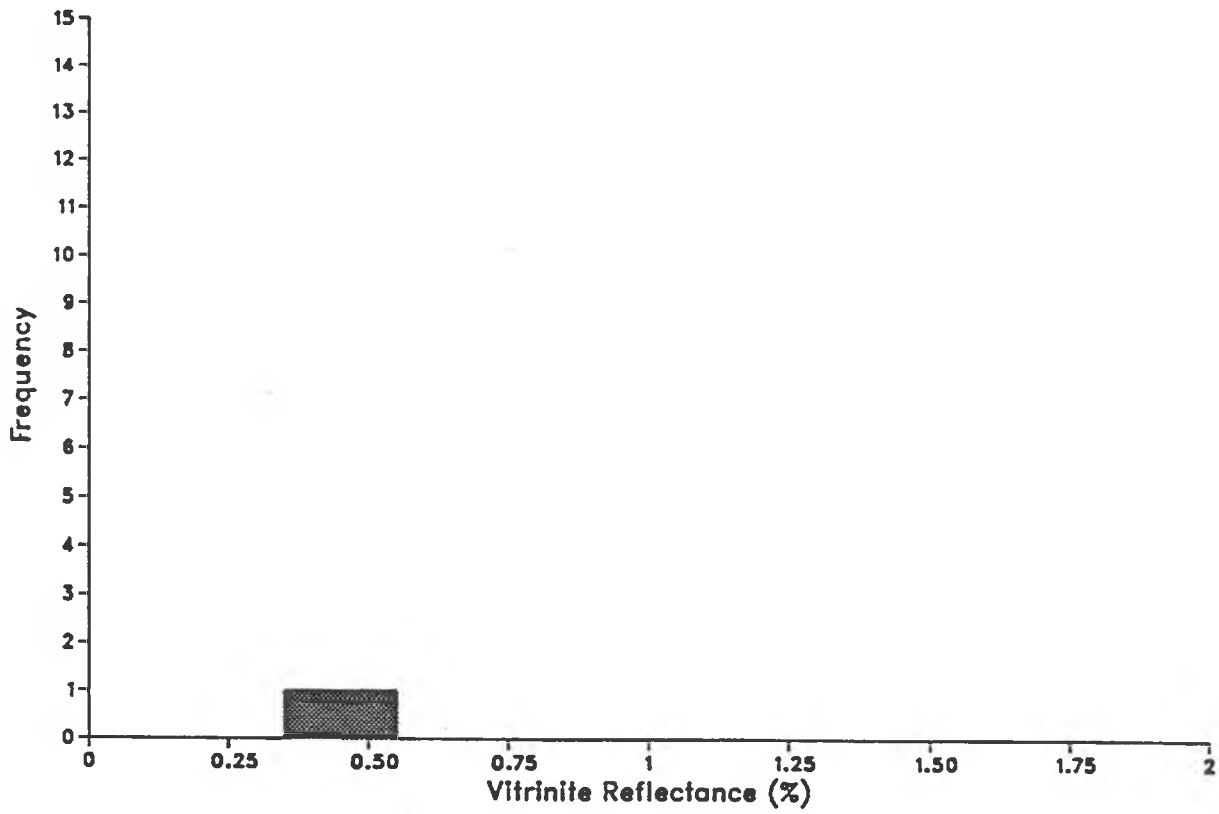
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.300 to 0.500):	0.40	0.05	14

Readings:

0.320	0.350	0.360	0.370	0.380	0.390	0.391	0.400	0.410	0.420
0.450	0.451	0.470	0.480						

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1120.00(m)



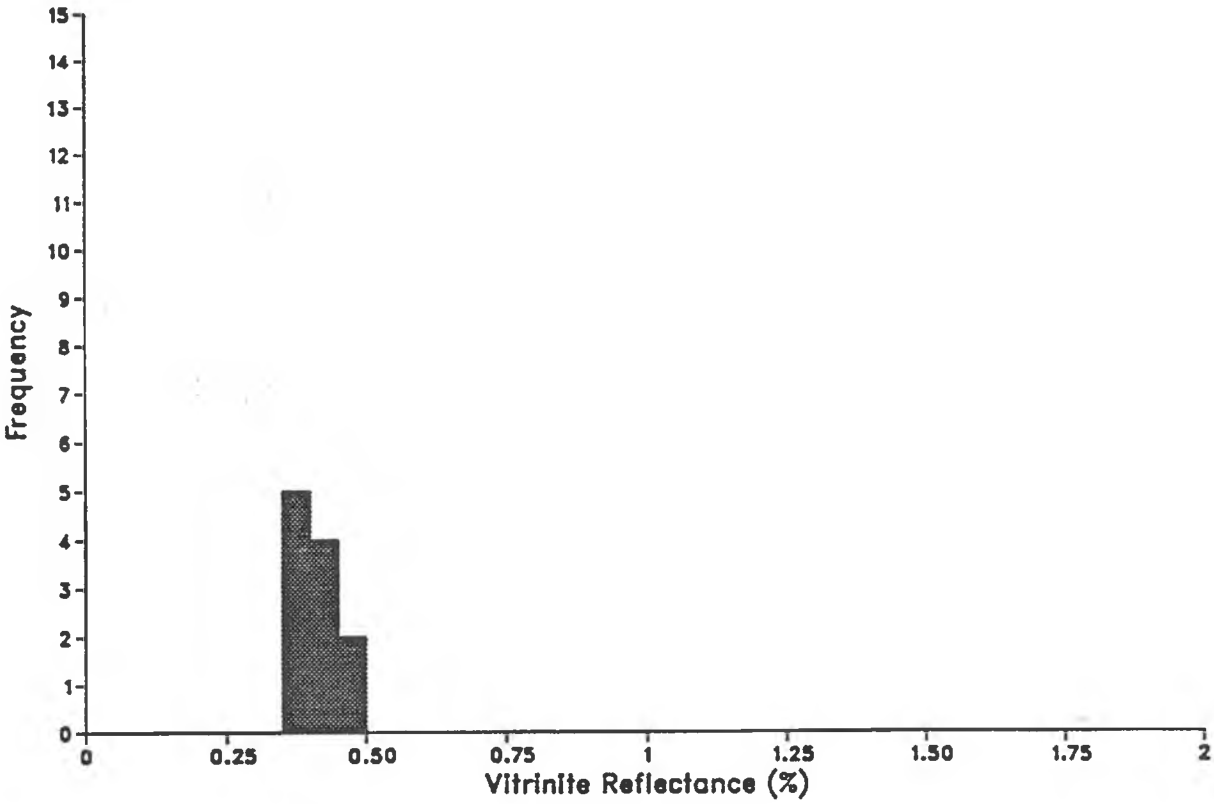
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.350 to 0.550):	0.45	0.05	4

Readings:

0.380 0.440 0.450 0.510

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1240.00(m)



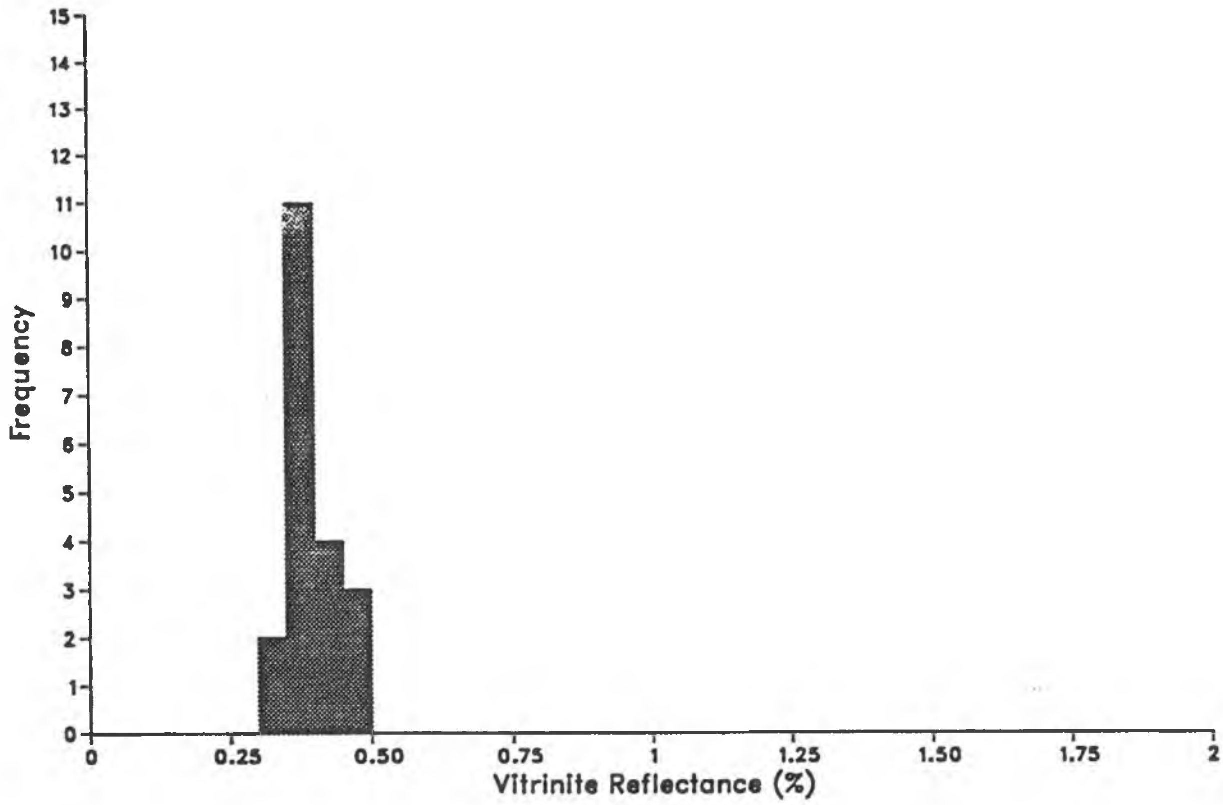
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.350 to 0.500):	0.41	0.04	11

Readings:

0.370 0.371 0.380 0.390 0.391 0.400 0.410 0.420 0.421 0.460
0.490

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1330.00(m)



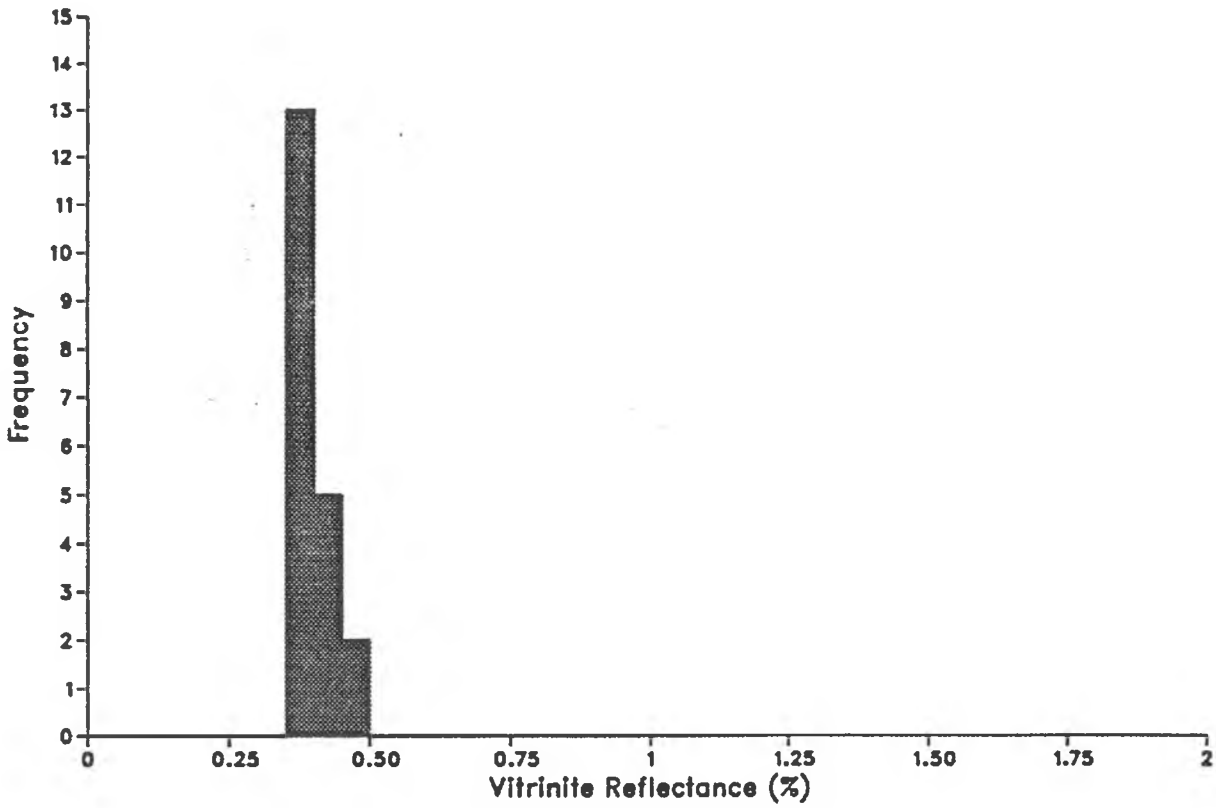
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.300 to 0.500):	0.40	0.04	20

Readings:

0.340	0.341	0.360	0.361	0.370	0.371	0.378	0.379	0.380	0.381
0.382	0.390	0.391	0.400	0.401	0.420	0.430	0.470	0.490	0.491

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1420.00(m)



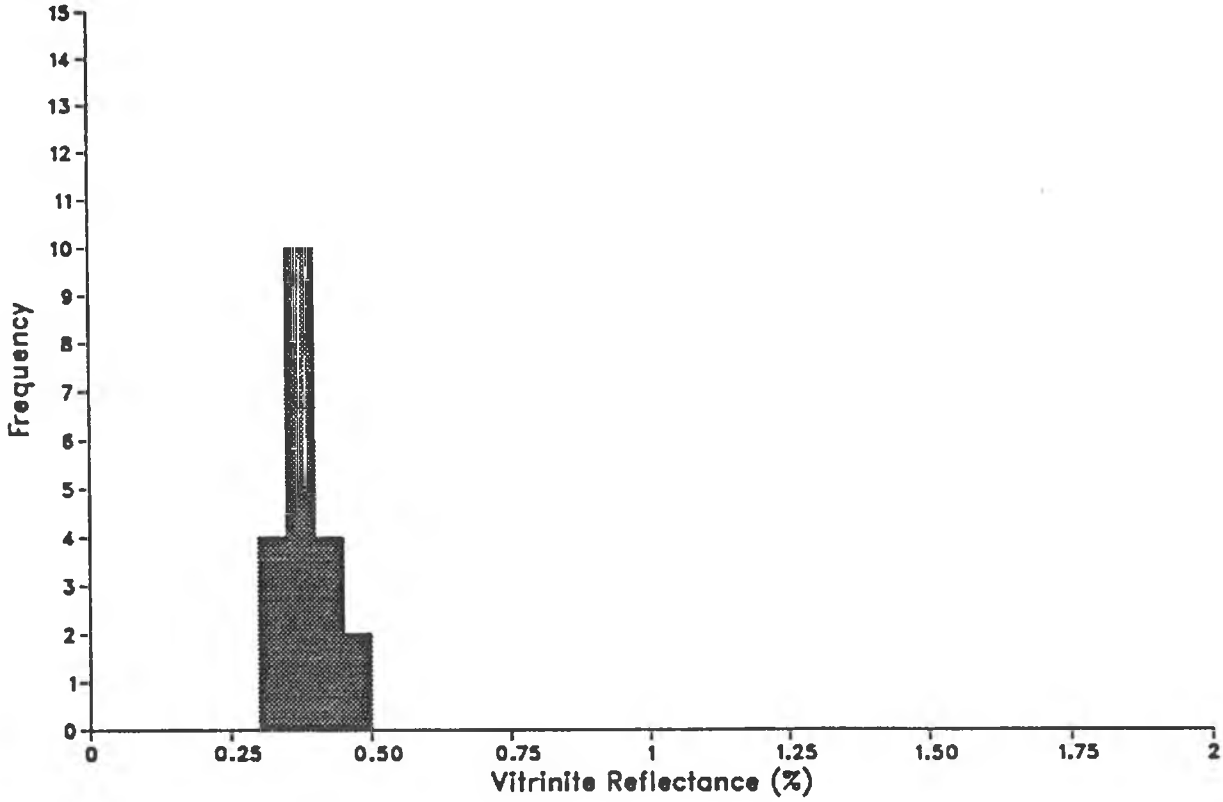
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.350 to 0.500):	0.39	0.04	20

Readings:

0.350	0.351	0.359	0.360	0.361	0.369	0.370	0.371	0.372	0.380
0.381	0.390	0.391	0.400	0.410	0.411	0.420	0.430	0.470	0.471

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1480.00(m)



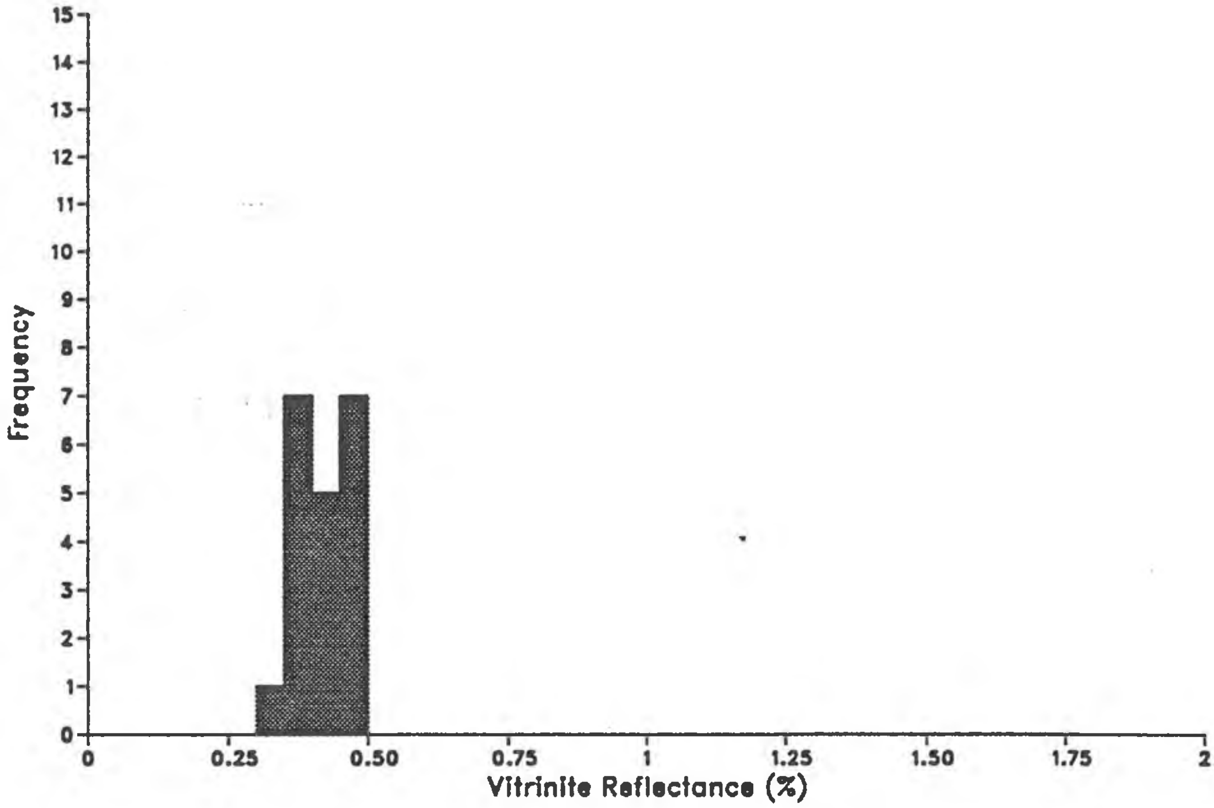
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.300 to 0.500):	0.38	0.04	20

Readings:

0.340	0.341	0.348	0.349	0.350	0.351	0.352	0.360	0.361	0.369
0.370	0.371	0.380	0.381	0.400	0.401	0.430	0.431	0.470	0.471

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1600.00(m)



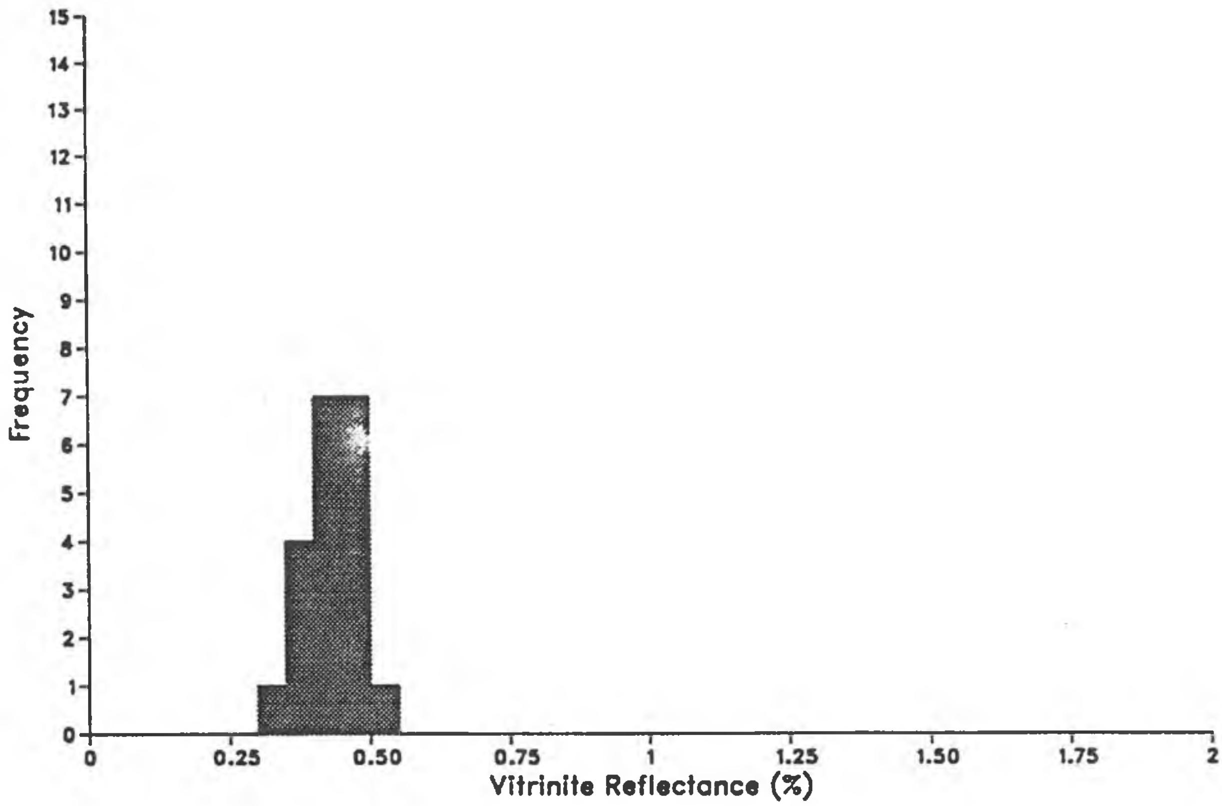
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.300 to 0.500):	0.42	0.04	20

Readings:

0.340	0.350	0.388	0.389	0.390	0.391	0.392	0.399	0.400	0.401
0.402	0.430	0.440	0.450	0.451	0.469	0.470	0.471	0.480	0.490

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1690.00(m)



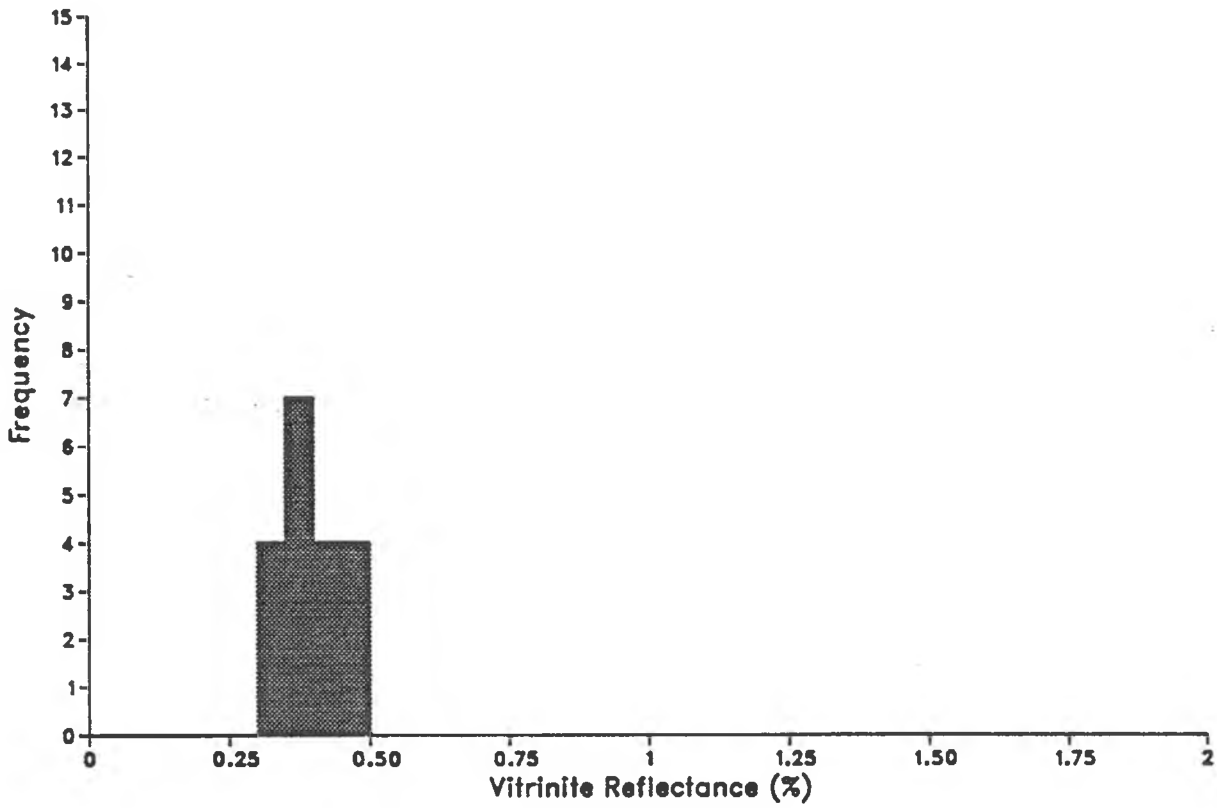
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.300 to 0.500):	0.42	0.05	20

Readings:

0.300	0.360	0.370	0.371	0.380	0.400	0.401	0.409	0.410	0.411
0.430	0.431	0.450	0.460	0.461	0.470	0.480	0.481	0.490	0.500

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1780.00(m)



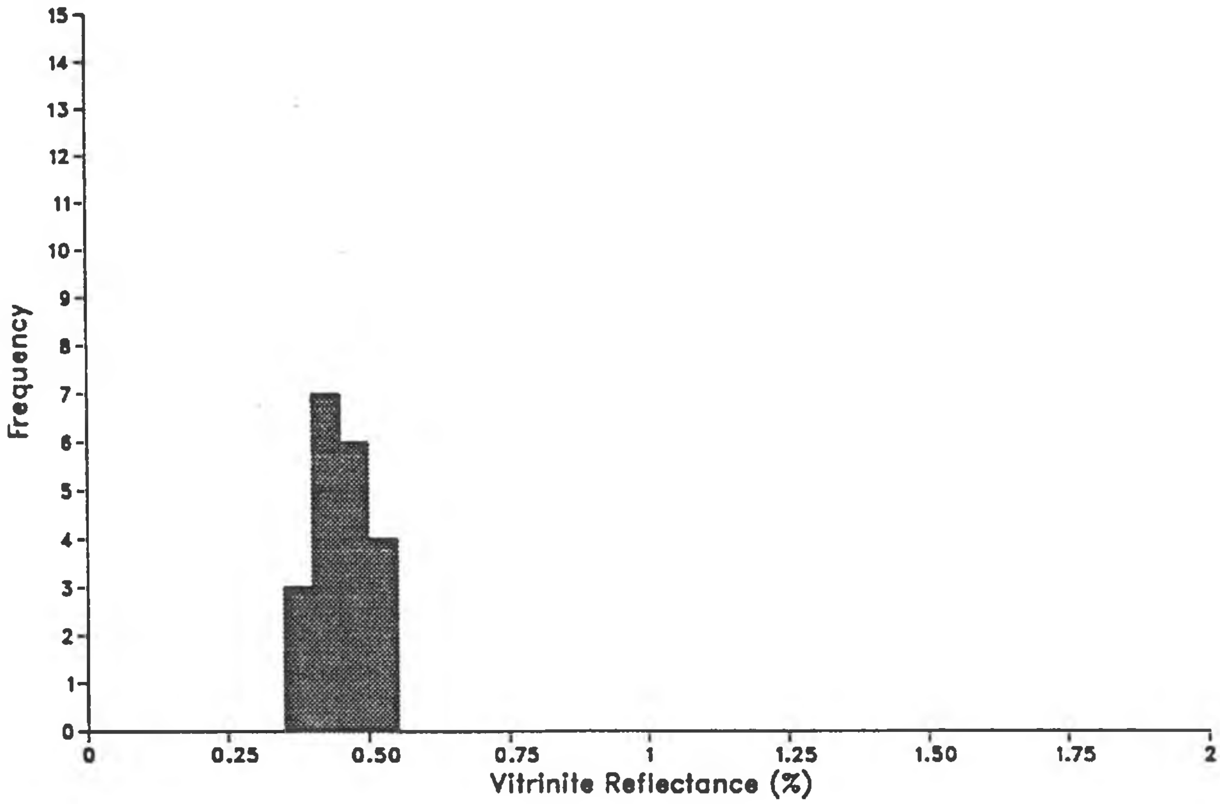
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.300 to 0.500):	0.39	0.05	19

Readings:

0.300	0.320	0.330	0.340	0.360	0.361	0.379	0.380	0.381	0.382
0.390	0.419	0.420	0.421	0.430	0.450	0.460	0.461	0.470	

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1900.00(m)



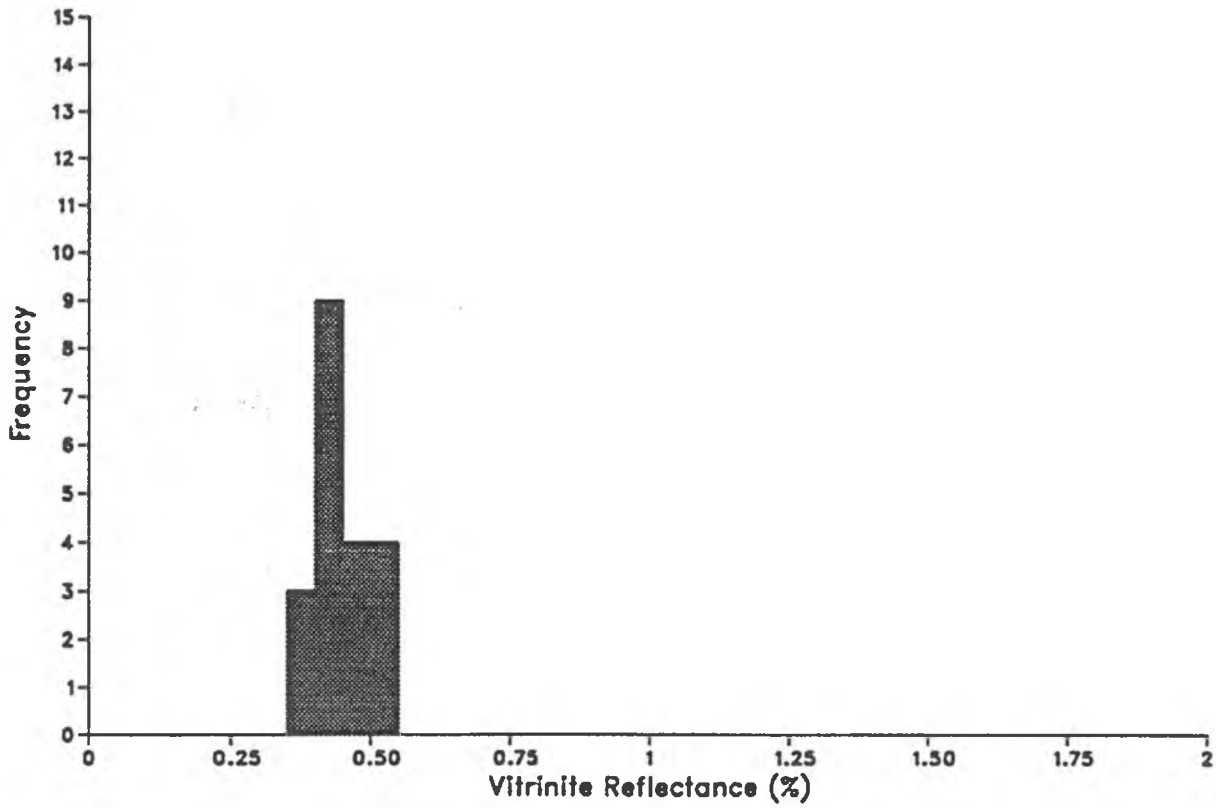
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.350 to 0.550):	0.45	0.05	20

Readings:

0.360	0.380	0.381	0.400	0.410	0.420	0.421	0.429	0.430	0.431
0.450	0.451	0.460	0.470	0.480	0.490	0.500	0.501	0.520	0.540

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 1990.00(m)



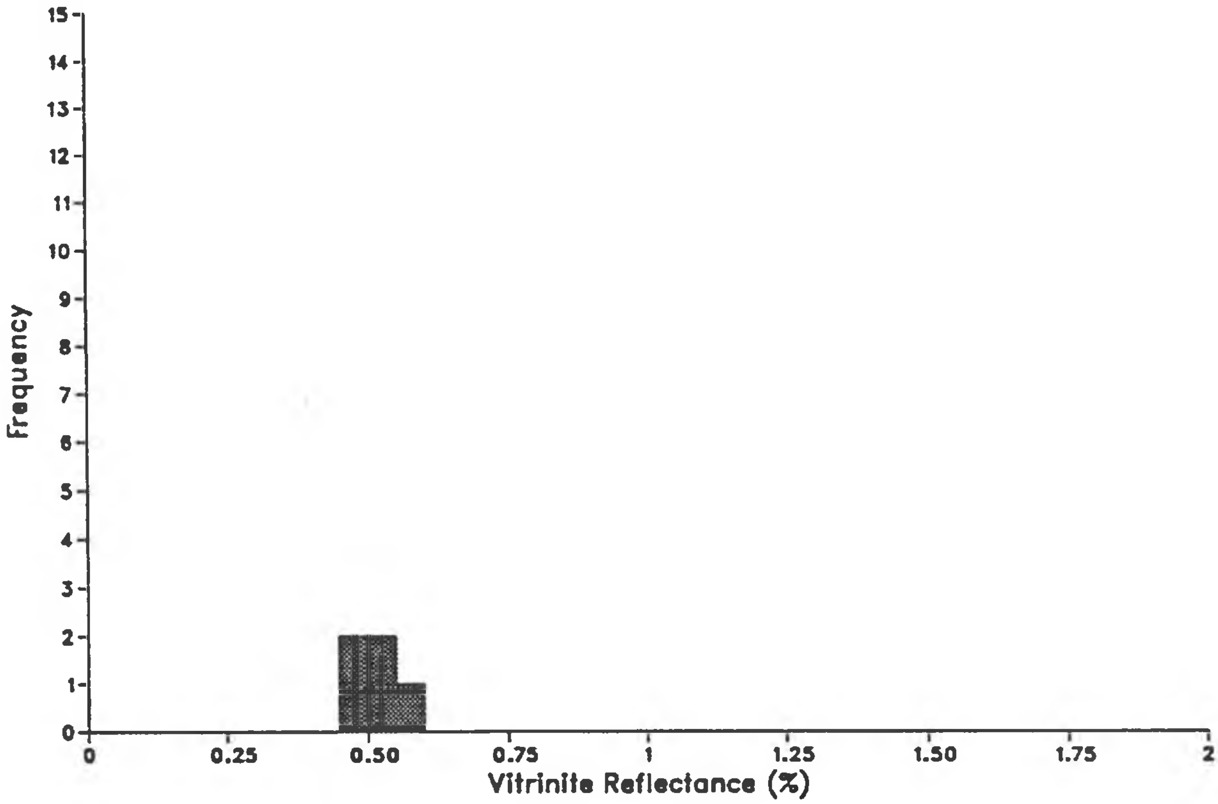
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.350 to 0.550):	0.45	0.05	20

Readings:

0.360	0.390	0.391	0.400	0.401	0.420	0.421	0.438	0.439	0.440
0.441	0.442	0.450	0.489	0.490	0.491	0.500	0.501	0.510	0.520

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 2084.00(m)



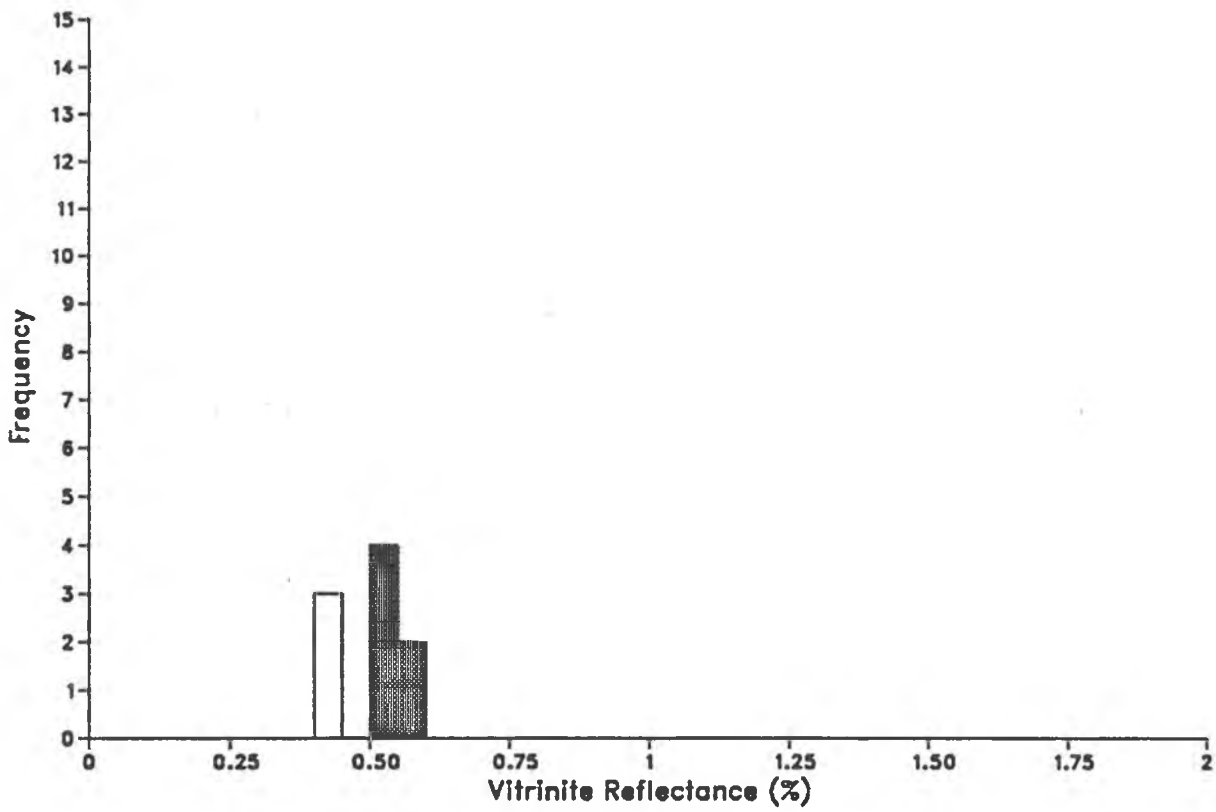
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.450 to 0.600):	0.52	0.05	5

Readings:

0.450 0.490 0.530 0.540 0.570

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 2177.00(m)



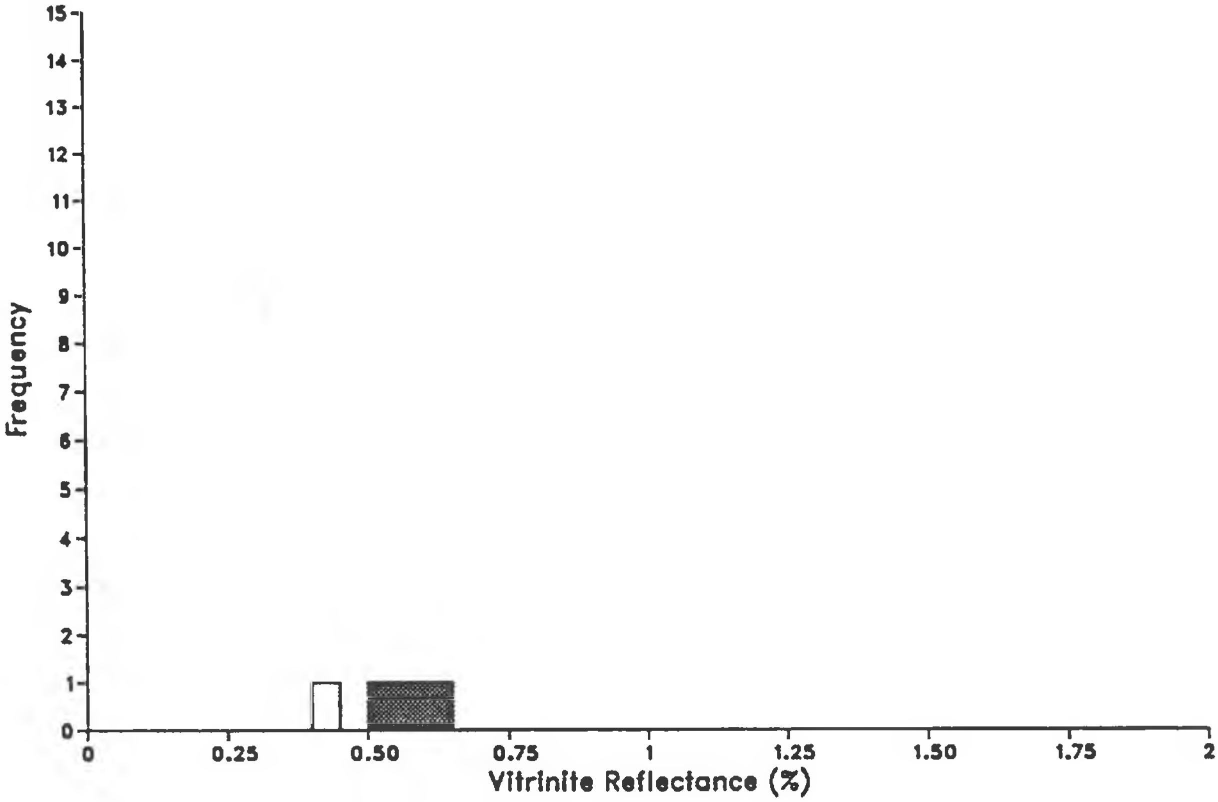
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.500 to 0.600):	0.54	0.02	6
Population Two (from 0.400 to 0.450):	0.40	0.01	3

Readings:

0.400 0.401 0.410 0.520 0.521 0.530 0.540 0.550 0.580

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 2258.00(m)



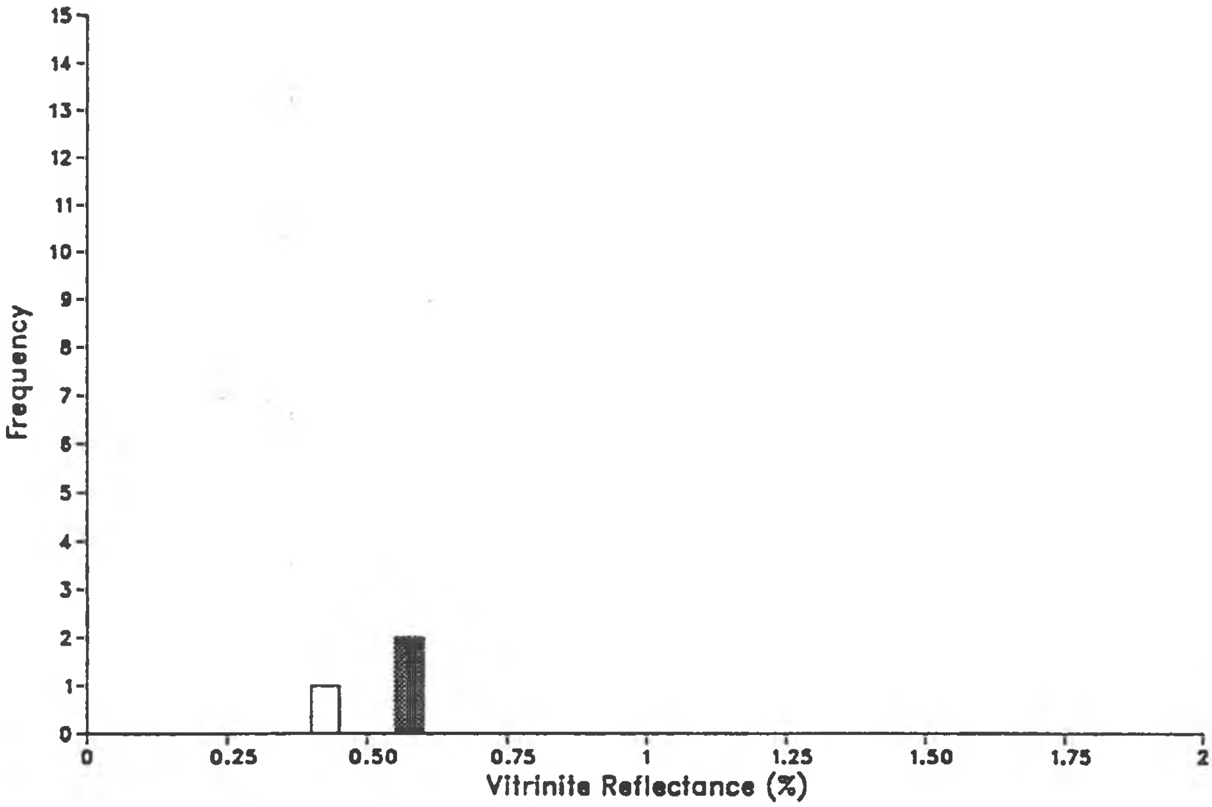
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.500 to 0.600):	0.57	0.03	3
Population Two (from 0.400 to 0.450):	0.40	0.00	1

Readings:

0.400 0.540 0.560 0.600

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 2375.00(m)

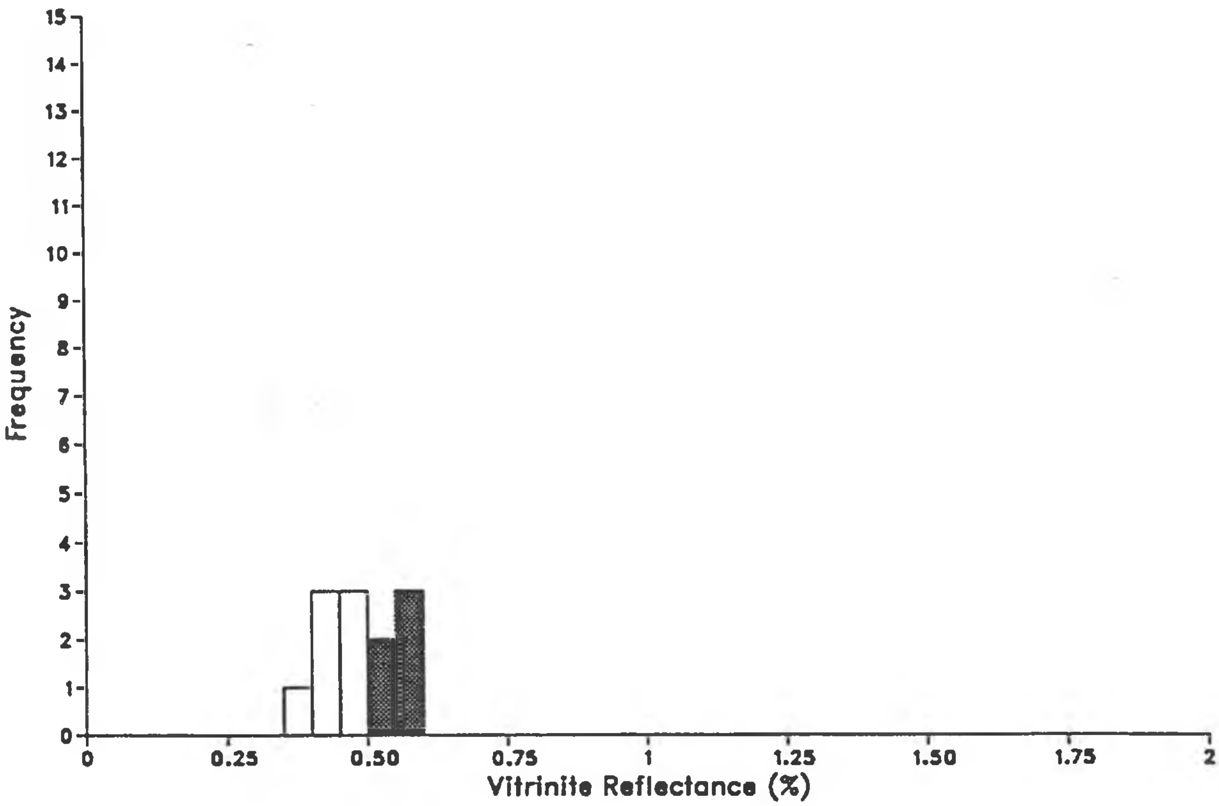


Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.550 to 0.600):	0.57	0.01	2
Population Two (from 0.400 to 0.450):	0.43	0.00	1

Readings:
0.430 0.560 0.580

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 2597.00(m)



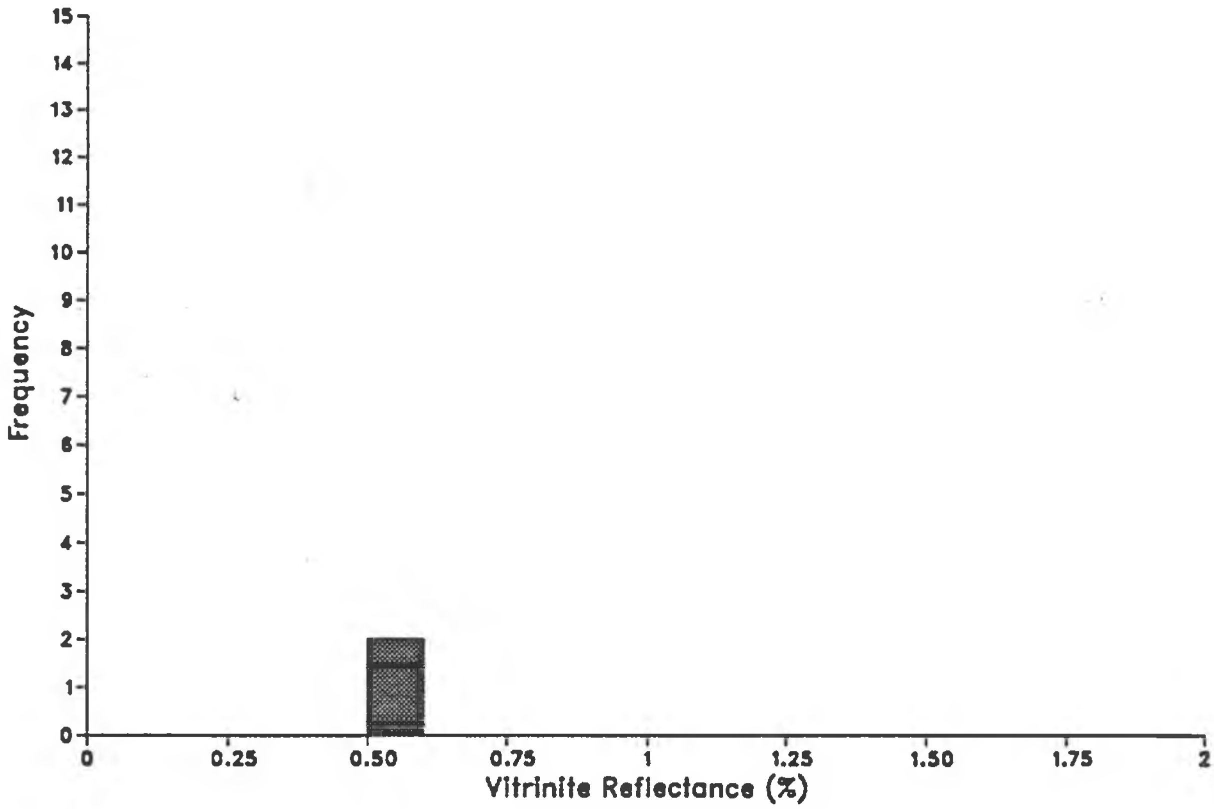
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.500 to 0.600):	0.55	0.02	5
Population Two (from 0.350 to 0.500):	0.44	0.04	7

Readings:

0.380 0.410 0.420 0.440 0.480 0.490 0.491 0.520 0.540 0.550
0.551 0.580

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 2765.00(m)



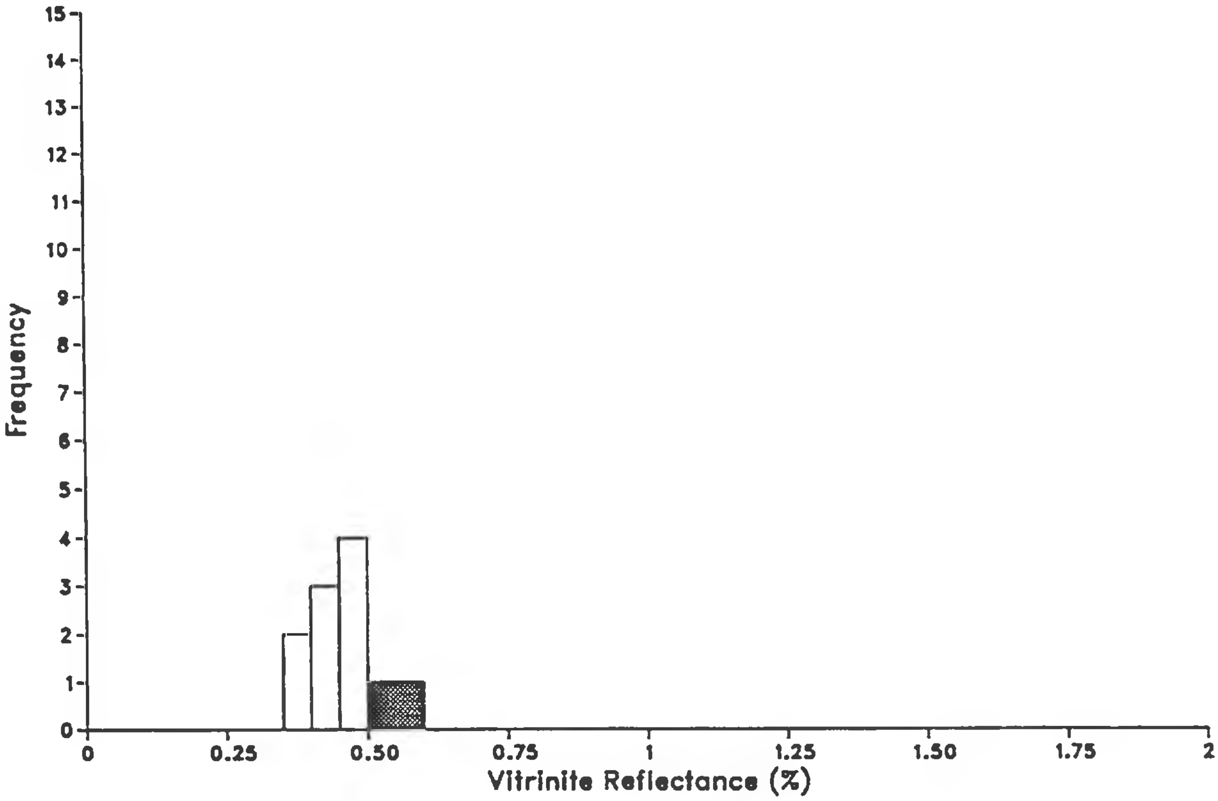
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.500 to 0.600):	0.55	0.03	4

Readings:

0.500 0.540 0.560 0.580

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 2855.00(m)



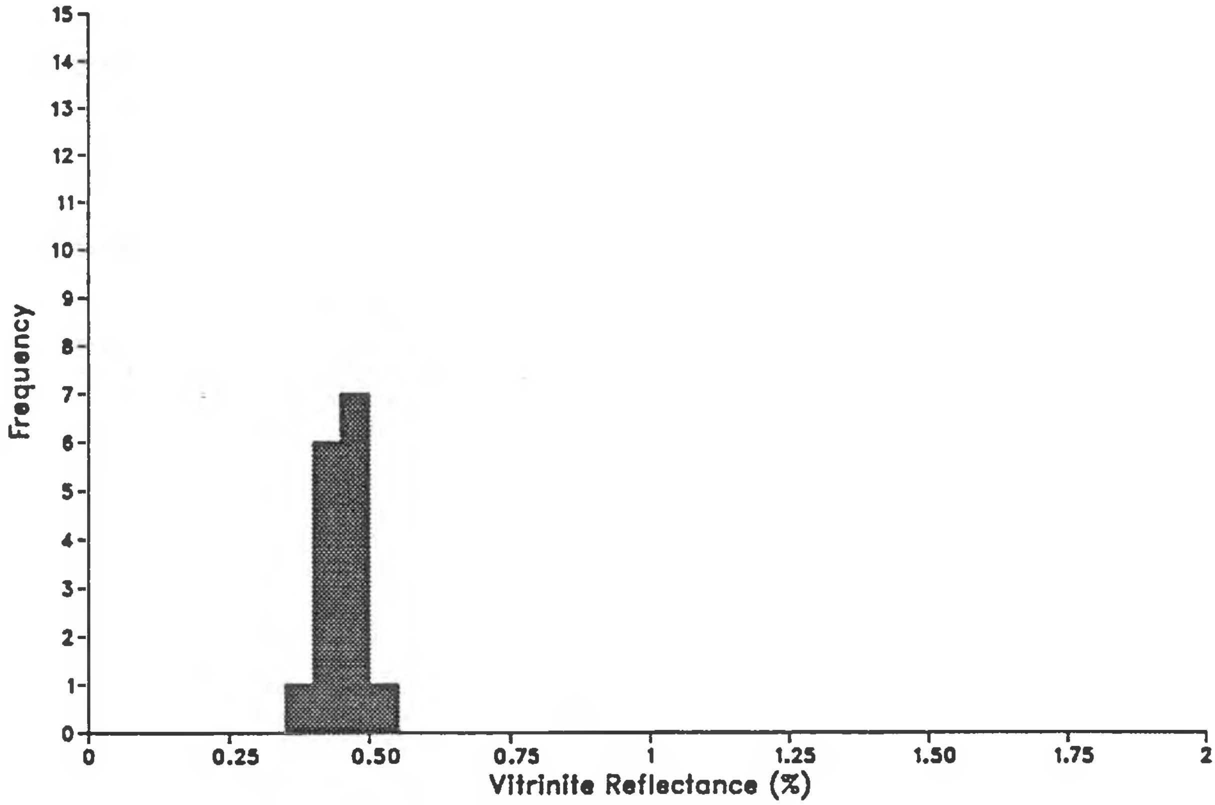
Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.500 to 0.600):	0.53	0.04	2
Population Two (from 0.350 to 0.499):	0.43	0.04	9

Readings:

0.370 0.390 0.410 0.420 0.440 0.450 0.460 0.461 0.480 0.500
0.560

Vitrinite Reflectance Histogram

Well: NOCS 15/12-5
Depth: 2892.00(m)



Statistics:	Mean	St.Dev.	n
Indigenous Population (from 0.350 to 0.500):	0.44	0.03	15

Readings:

0.390	0.400	0.420	0.421	0.429	0.430	0.431	0.450	0.451	0.460
0.461	0.470	0.471	0.480	0.500					

Appendix 3

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