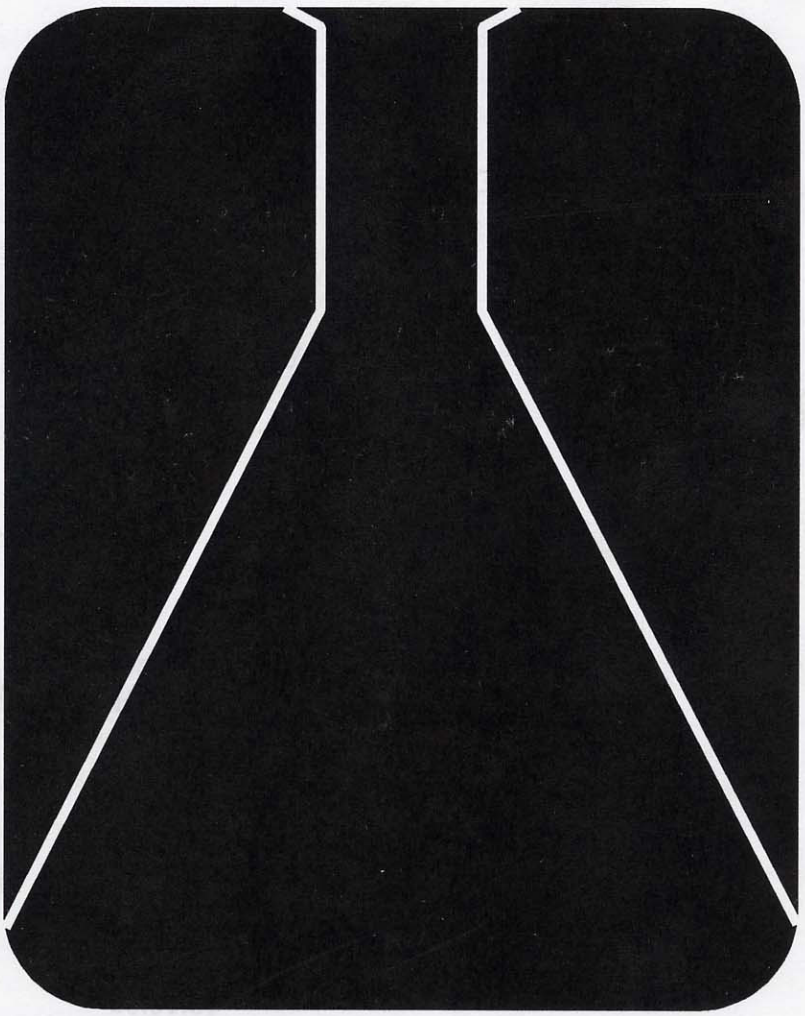
IRISH ROCKALL AREA
SURFACE GEOCHEMICAL SURVEY



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SUMMARY

The surface geochemical analyses were performed on behalf of the Rockall Studies group (RSG) on samples collected by the client. According to the client, bactericide had been added to the samples before the cans were sealed and kept in frozen condition in normal freezers. The samples were analysed using conventional surface geochemistry methods. Based on the analyses, which were also selected by the client, the following conclusions concerning the distribution of hydrocarbons in the surface sediments were drawn.

Quantity of Hydrocarbons

The yields of headspace are generally low while the yields of adsorbed gas range from low to moderate/rich. The headspace gas analysis shows only methane and gives therefore only limited information. The adsorbed gases show a thermogenic composition with a relatively dry molecular composition in some of the samples. Most of the samples which were analysed for carbon isotopic composition are found to have an oil-associated composition. The exceptions are samples RSG 029, 032, 033 and 036 which have an isotope composition indicating mainly a biogenic origin; and samples RSG 013, 015, 016, 018 and 022, where the isotope data indicate the samples to contain a dry gas, originating from either a coaly type source or from a source rock with an oil/gas window maturity.

The extract yield is low for most of the samples. The samples with the highest yields are generally found to be the same samples which were found to have elevated gas values, believed to be of a thermogenic origin. The analysed samples are divided into six groups based on the gas chromatographic patterns. Two of the groups, A and B contain only background material while Group F (Sample RSG 011) is contaminated, probably with grease and/or lubricating oil. The remaining samples contain minor amounts of seeped hydrocarbons.

Sourcing of Hydrocarbons

It is very difficult to evaluate the source(s) of the potentially seeped hydrocarbons due to only two samples being selected for GC-MS analysis by the client, and both of these samples contain only background material plus contaminants for one of the samples. A very tentative interpretation, based on the GC analysis is that the seeped hydrocarbons in samples RSG 008, 010, 022 and 027 are sourced from a lacustrine source while the hydrocarbons in samples RSG 012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 023, 024, 029, 034 and 036 have been generated from a marine source. Regarding the thermogenic gases, the gases in samples RSG 013, 015, 016, 018 and 022 are believed to have been sourced from a terrestrial source while the gases in samples 012, 014, 017, 019, 021, 025 029 and 034 are oil-associated gases.

Maturity of Hydrocarbons

It is difficult to evaluate the maturity of the seeped hydrocarbons due to the client not selecting any samples with seeped hydrocarbons for GC-MS analyses. The GC analyses indicate the seeped hydrocarbons to have an oil window maturity.

CONTENTS

Chapter 1

INTRODUCTION

1.1 Application of Surface Geochemical Analysis to Petroleum Prospecting

The basic principle underlying the use of geochemical analysis of surface sediments as a tool in petroleum prospecting is the assumption that cap-rocks above petroleum reservoirs are unlikely to be totally impervious to hydrocarbons. If this assumption is correct then both light and heavy hydrocarbon molecules migrate upwards from deep sedimentary sequences, either from source rocks or from reservoirs, causing detectable alterations in near surface sediments, sufficiently detailed examination of near-surface sediments above a sedimentary basin by sensitive chemical analysis techniques should therefore be capable of detecting the underlying hydrocarbons.

The first attempts to exploit such methods were made in the thirties in Russia (Sokolov, 1935) and Germany (Laubmeyer, 1933), rapidly followed by work in the Gulf Coast areas published in America by Rosaire (1938) and the first of what was to become a series of classic papers by Horvitz (1939). After the inevitable hiatus of the Second World War, surface geochemical prospecting continued to develop and to exploit the new powerful techniques of instrumental chemical analysis which became available from around 1950 onwards. The science can now be rightly regarded as having reached a reasonable level of maturity and many general principles which aid in the interpretation of data have been recognised (Horvitz, 1980 a, b).

Near-surface geochemical analysis must now be regarded as a reestablished and valid tool in the armoury of petroleum exploration. Surface geochemical exploration has been used in the Gulf of Mexico (Kennicut et al, 1987 a, b, Brooks et al, 1984, 1987, Roberts et al, 1988, 1989, MacDonald et al. 1994), offshore California (Kennicutt and Brooks, 1988), offshore Alaska (Cline and Holmes, 1977, Kvendvolden et al, 1981, Sandstrom et al, 1983), Gulf of Suez (Vargo et al, 1990) The Libyan Desert (Mello et al. 1994a), The Caucasus (Guliyev and Feizullayev 1994), The North Sea (Faber and Stahl, 1983, 1984, Emmel et al 1985, Gervitz et al, 1983, 1985, Shiener et al, 1985, Sweeney, 1989), the Barents Sea (Bjorøy and Løberg 1991), the south Caribbean (Thrasher and Strait 1994), the Atlantic Margin, Bjorøy et al, 1999 and in the Amazon rain Forrest (Mello et al 1994b). However it should be emphasized that results from surface studies should never be used as sole criteria in determining the petroleum potential and possible commercial exploitability of a region. Surface results should always be considered alongside those from other, more traditional, prospecting techniques such as seismic surveys, under these conditions there can be little doubt that they make a contribution to more successful selection of drilling sites.

Even though most surface geochemistry studies reported in the literature deal with situations in which there is leakage from a reservoir we believe that a more general view can be taken and the detection of thermogenic hydrocarbons in the near-surface sediments is clear evidence of hydrocarbon generation in the basin. The hydrocarbons might have migrated into a reservoir which has subsequently have leaked through a permeable cap-rock, but they may as well have seeped to the surface directly from the source rock itself. Thus the presence of thermogenic hydrocarbons in the surface sediments does not necessarily mean that a reservoir is present, but is a general indicator of source rock(s) being present in the basin.

Two basic strategies for detecting the hydrocarbons present in the near-surface sediments have emerged.

The first might be termed "*direct detection*", where the geochemical analyst uses methods such as gas-chromatography or fluorescence spectroscopy to locate, and identify, hydrocarbons which have leaked upwards from the sedimentary basin into the near-surface sediments. Direct detection methods analyse the actual components of the reservoir fluids, i.e. oil, condensate and gas (Jones and Drozd, 1983, Klausman and Voorhers, 1983). An alternative approach is to use "*indirect detection*" methods seeking secondary diagenetic products which are evidenced through a host of agents: plant/soil interaction (Rock 1984), magnetic mineral genesis (Donovan et al, 1979, 1986, Foote, 1987), oxidized soil carbonate "salts" (Durchscherer, 1981, 1988), efflorescence of petroleum-eating bacteria (Beghtel et al, 1987), natural earth gamma radiation (Fisher, 1985, Tesedo, 1988) and as trace metal or elemental constituents (Price, 1985). The most successful application of this type of approach has been in studies which have detected the presence of elevated levels of certain forms of carbonate in surface sediments in the vicinity of petroleum reservoirs. Such materials are generally supposed to arise from the fixation carbon-dioxide generated by the oxidation of hydrocarbons which have migrated upwards into the surface sediments (Durchscherer, 1981). This latter technique has its advocates but unquestionably suffers from the drawback that it is unable to distinguish between the case were a reservoir is currently present and a situation where a reservoir existed in the past, since the elevated carbonate levels may well persist indefinitely after the entire contents of a reservoir have been dispersed. However, not entirely free from being similarly misleading, direct detection of hydrocarbons is less suspect in this respect since it is likely that the lighter components, at least, will eventually escape from the sediment into the overlying water or air. Hence, once a reservoir is no longer present to replenish the surface sediments it is likely that their hydrocarbon content will revert to baseline levels.

The currently reported study deals solely with direct indications of the presence of hydrocarbons and no data on anomalous carbonate concentrations of the type discussed above has been obtained.

Most reported studies on geochemical exploration concern the analysis of gaseous hydrocarbons in recent sediments because these compounds are thought to migrate more easily than the larger molecule, liquid hydrocarbons (Sokolov et al, 1970). However, there are some reports concerning the applications of fluorescence spectroscopy to the measurement of relatively large aromatic hydrocarbon molecules ($>C_6$) in geochemical exploration (Engdahl, 1981, Brooks et al, 1983, Gevitz et al, 1983, Vargo et al, 1990).

Oil and gas prospecting using hydrocarbon gas analysis originally used free soil gas and/or gas dissolved in pore waters (i.e. Sokolov, 1935, Sokolov et al 1970). Horvitz (1980 b) however developed a technique for liberating hydrocarbons adsorbed on soil minerals, so achieving a higher yield. Hydrocarbon gas data from shallow sediments is usually interpreted in terms of the location of areas with high concentrations (anomalies) (Horvitz 1980 b, Gevirtz et al, 1983, 1985, Emmel et al 1985). It is important, however, to consider the various possible origins of the hydrocarbons which may lead to these levels, i.e. whether the hydrocarbons are indeed thermogenic, and if so the result of recent bacterial action in the surface sediments (Kvendvolden and Redden 1980, Kvendvolden and Field 1981, Claypool and Kvendvolden 1983, Jones and Drozd 1983, Faber and Stahl 1984).

Chapter 2

TREATMENT OF SAMPLES

2.1 Collection of Samples

All samples were collected by the client. Bactericide was added to the samples before the cans were sealed. The samples were kept in normal freezers before they were shipped to the laboratory for analyses. From earlier experience, adding of bactericide will not kill the bacteria inside clay samples, only possible bacteria on the surface of the sample, since the bactericide will not penetrate inside solid clay samples. Preservation of sealed samples in a normal freezer will, at best, slow down the bacteriological action on the organic material in the samples, it will not stop it.

2.2 Location of Sampling Area and Patterns

The locations of the samples were not supplied by the client.

2.3 Selection of Material and Analysis

Except in the case of headspace and occluded gas analyses, all analyses were carried out on material passed through a 63 µm sieve. The reason for this is to exploit the observation that the bulk of the hydrocarbons trapped in sediments are associated with clays, and so selection of the finer sediment (silt and clay) fraction allows analysis of what is essentially a pre-concentrated material as regards hydrocarbons. This not only simplifies detection of hydrocarbons but the restriction of analysis to the relevant fine fraction makes anomalous areas more conspicuous. This is particularly true in offshore studies where the proportion of sand in samples may be high (Horvitz 1980), and of cause to eliminate re-worked material. The client selected the samples for isotope, TSF and GC-MS analyses.

Chapter 3
ANALYTICAL RESULTS AND DISCUSSION

3.1 Sediment and Carbon Analysis

The relative yields of sand/clay (as separated through 63 µm sieve) in the part of the cores used as geochemical samples vary strongly, from almost pure clay to quite sandy samples (ranging from 2.9 - 85.9 % sand), with approximately 50 % of the samples containing > 40 % sand. The average sand content is found to be as high as 36.1 ± 29.0 %, see appended Table 1. The statistical values for the sediment data are shown in text Table 3.1

Table 3.1 Sediment characteristics.

	% Sand	% Clay
Maximum	85.9	97.1
Minimum	2.9	14.1
Average	36.1	63.9
Std. dev.	29.0	29.0

3.2 Headspace Gas Analysis

Similar to observations made from several other studies along the north Atlantic Margin, including other Rockall Trough surveys, the headspace gas data show very low yields, generally with very low yields of methane only. The yields of methane are typically < 2 ppb (ng gas/g sediment), which is about what can be expected to be found as low background values. Ethane or higher components were not detected in any of the analysed samples, see appended Table 2. No conclusions can be drawn based on these yields, except tentatively that there are no active macro seeps in the vicinity of the core locations. One reason to the low headspace content could be that the gas molecules were still kept within the pores in the samples due to the freezing of the samples. Analysis of the occluded gas could therefore have given better results. Furthermore, the yields of headspace gas are too low to allow carbon isotope composition analysis. Headspace gas data statistics are found in text Table 3.2. below.

Table 3.2. Headspace gas statistics

	Max.	Min.	Average	Std. dev.
Methane	3.38	0.60	1.45	0.71

3.3 Adsorbed Gas Analysis

The adsorbed methane concentrations are far higher than those found for the headspace gas analysis and range from poor to rich (49.9 - 3392.8 ppb) with an average of 606.8 ± 761.0 ppb. The abundances of the other saturated compounds are also quite high for most of the analysed samples, with ethane values varying from 12.3 - 299.0 ppb with an average of 73.5 ± 77.2 and propane values varying from 6.9 -

169.2 ppb with an average of 43.4 ± 42.9, Table 3a. Similar high abundances are also registered for the higher gas components. The opposite, i.e. low abundances, are registered for the unsaturated compounds, e.g. the alkenes. In general, the samples with the highest yields of ethane and propane are the same as those with the highest yields of methane. However, there is some variation in the composition of the adsorbed gases in the analysed samples, as can be seen by the variation in the wetnesses of the gases which range from 5.8 - 31.5 % with an average of 11.0 ± 4.6 %. The samples with the elevated values of methane, ethane and propane are mainly samples RSG 012 to RSG 019 together with a few other samples, e.g. RSG 021, 025, 029 and 034. With no geographical information regarding the samples, it is not possible to take the interpretation further.

The average concentrations of n-butane, n-pentane and n-hexane are 18.4 ± 17.8 ppb, 6.9 ± 6.1 ppb and 2.6 ± 2.1 ppb respectively. N-heptane is detected in all of the samples and has an average concentration of 0.5 ± 0.4 ppb, while nC_8 (n-octane) is not detected in any samples. It is also noted that the samples contain benzene and different C_7 cyclic compounds, while cyclohexane is not found in any of the samples. Despite the low yields, the presence of the heavier gaseous (i.e all C_2+) components are important for the interpretation as these compounds are indicators of thermogenic gases (being rarely generated by biogenic activity). This, together with the relatively high ethane/methane, propane/methane ratios and the wetness of the gas, indicate that the samples contain thermogenic gases. The elevated yields are, as for ethane and propane, found mainly in the same samples as those having elevated methane yields.

The iso-alkanes (or 1-methyl alkanes) are typically detected in or higher concentrations than their corresponding n-alkanes. The irregular branched-compounds such as neopentane (2,2-dimethyl propane) and 2,2-dimethylbutane are detected in significantly lower concentrations (see text Table 3.3 below and Table 3a). The distributions of the iso-, and other branched-alkanes typically show similar geographical distribution to those of the C_2+ n alkanes, as do the cyclo-alkanes when detected. These observations suggest that the adsorbed gases in the samples from the area mentioned have a clear thermogenic signature, as discussed above.

Summary Adsorbed Gas: The adsorbed gas yields range from very low to moderate/high. Based on the absolute yields (measured in ppb) and calculated parameters the adsorbed gas is thought to be thermogenic (possibly with a very low degree of biogenic influence) showing a relatively uniform composition both with respect to the distribution of n-alkanes, iso-alkanes, cyclo-alkanes and calculated wetness. The richest samples are generally found for a few samples with similar ref. numbers, e.g. RSG 012 to RSG 19 with a few odd samples, e.g. RSG 021, 025, 029 and 034.

Table 3.3 Adsorbed gas statistics

Compound/Ratio	Min.	Max.	Average	Std. Dev.
Methane	49.9	3392.8	606.8	761.0
Ethane	12.3	299.0	73.5	77.2
Ethene	0.1	1.5	0.7	0.4
Propane	6.9	169.2	43.4	42.9
Propene	0.1	1.5	0.6	0.4
I-butane	3.1	71.1	18.4	17.8
N-butane	3.0	70.1	20.0	18.8
Butene	0	0.4	0.1	0.1
Neopentane	0	2.2	0.6	0.6
Cyclopentane	0	2.8	0.9	0.8
I-pentane	2.8	60.3	17.0	16.0
N-pentane	1.0	21.4	6.9	6.1
Pentene	0	0.6	0.2	0.2
2.2-Dimet. Butane	0.2	4.7	1.6	1.3
Cyclohexane	0	0	0.	0.
Met. Cyclopentane	0.1	3.6	1.2	1.0
2-Methylpentane	0.5	10.7	3.5	3.0
3-Methylpentane	0.3	5.7	1.9	1.7
N-hexane	0.3	7.2	2.6	2.1
Hexene	0	0	0	0
Met. Cyclohexane	0.1	4.7	1.5	1.2
I-heptane	0	2.8	1.0	0.8
Heptane	0	1.6	0.5	0.4
Benzene	0.5	4.8	1.8	1.2
I-Octane	0	0	0	0
N-Octane	0	0	0	0
Toluene	0	0	0	0
Sum n-alk.	105.5	3877.7	753.8	898.9
Sum C_2+ n-alk.	24.4	567.9	146.9	146.7
Sum Branched	7.4	157.1	44.0	40.4
Sum Cyclo alk.	0.3	10.7	3.5	2.8
Sum Alkenes	0.2	3.6	1.5	1.0
Ethane/Methane	0.04	0.25	0.08	0.04
Propane/Methane	0.01	0.17	0.03	0.03
% Wetness	5.8	31.5	11.0	4.6
Ethene/Ethane	0	0.06	0.02	0.01
Propene/Propane	0	0.07	0.02	0.02
C_2-C_6 alkene./n-alkane.	0	0.06	0.02	0.01
iC_4/nC_4	0.66	1.74	0.94	0.19

3.4 Carbon Isotope Analysis

Twenty samples were selected by the client for carbon isotope analysis. All the selected samples were adsorbed gas samples having methane yields above background. One of the samples, RSG 035, yielded only weak peaks insufficient for analysis. The carbon isotope analysis was performed to gain information about the origin (source) and maturity of the gases. General guidelines from the literature (Kvendvolden and Field 1981, Faber and Stahl 1983) suggest that oil associated gases have $\delta^{13}C$ values for methane between -40 and -50 ‰ PDB, while $\delta^{13}C$ values < -50 ‰ PDB are associated with biogenic gases and $\delta^{13}C$ values > -40‰ PDB suggest either the gas originating from a source with a gas window maturity or from kerogen type III, i.e. from coaly material. Schoell (1983) suggest the range of oil-associated gases to be between -40 and -55 ‰ PDB, while the range between -55 and -60 ‰ PDB is associated with mixed thermogenic and biogenic gases and values < -60 ‰ PDB associated with biogenic gases. In this report we have used the latter guidelines.

None of the analysed samples contained sufficient material for analysis of the butane, while nine samples gave reliable data for propane and sixteen samples gave reliable data for ethane, Table 4. The carbon isotope compositions of the adsorbed methane show significant variation for the analysed samples, with $\delta^{13}C$ values varying from -13,5 to -58.0 ‰ PDB, Table 4, Volume 2, which would indicate the gases in these samples to vary from dry gas with a gas window maturity (originating from terrestrial material/coal) to biogenic gas. Some of the samples, RSG 006, 007, 008, 009, 012, 014, 019, 020, 025 and 026 have $\delta^{13}C$ values varying from -38.0 to -49.9 ‰ PDB, i.e. probably representing oil-associated gases. This is in good agreement with the isotope data for the ethane and propane components where they are available. These are found to be in the -30.6 to -36.9 ‰ PDB range for these samples, Table 4, Volume 2, i.e. indicating oil associated gases. Four of the samples, RSG 029, 032, 033 and 036 have isotope values < -50 ‰ PDB for the methane, which are associated with biogenic gas. These samples have also low isotope values for the ethane, -36.9 to - 41.5 ‰ PDB, Table 4, Volume 2. Some of the samples with high isotope values for methane have also high values for ethane and propane where these components could be measured. This is in agreement with the previous evaluation that these samples, e.g. samples RSG 013, 015, 016, 018 and 022 most likely originate from a terrestrial/coaly source with a high maturity.

Cross plotting the $\delta^{13}C$ values of methane and ethane in a Schoell diagram (Schoell 1983), as shown in Figure 3.4.1 indicates that most the samples have carbon isotope compositions suggesting thermogenic gas of an oil-associated maturity, possibly mixed with some biogenic gas. The exceptions are samples RSG 032 and 036 which contain mainly biogenic gas and samples RSG 013, 015, 016 and 018 which have a dry gas signature.

Conclusions Gas Analysis: The yields of headspace gas are generally low while the yields of adsorbed gas range from low to moderate/rich. The headspace gas analysis shows only methane and gives therefore only limited information. The adsorbed gases indicate a thermogenic origin with a relatively dry molecular composition in some of the samples. Most of the samples which were analysed for carbon isotopic composition are found to have an oil-associated composition. The exceptions are samples RSG 029, 032, 033 and 036 which have isotope compositions indicating mainly a biogenic origin; and samples RSG 013, 015, 016, 018 and 022 where the isotope data indicate the sample to contain dry gas, originating from either a coaly type source or from a source rock with an oil/gas window maturity.

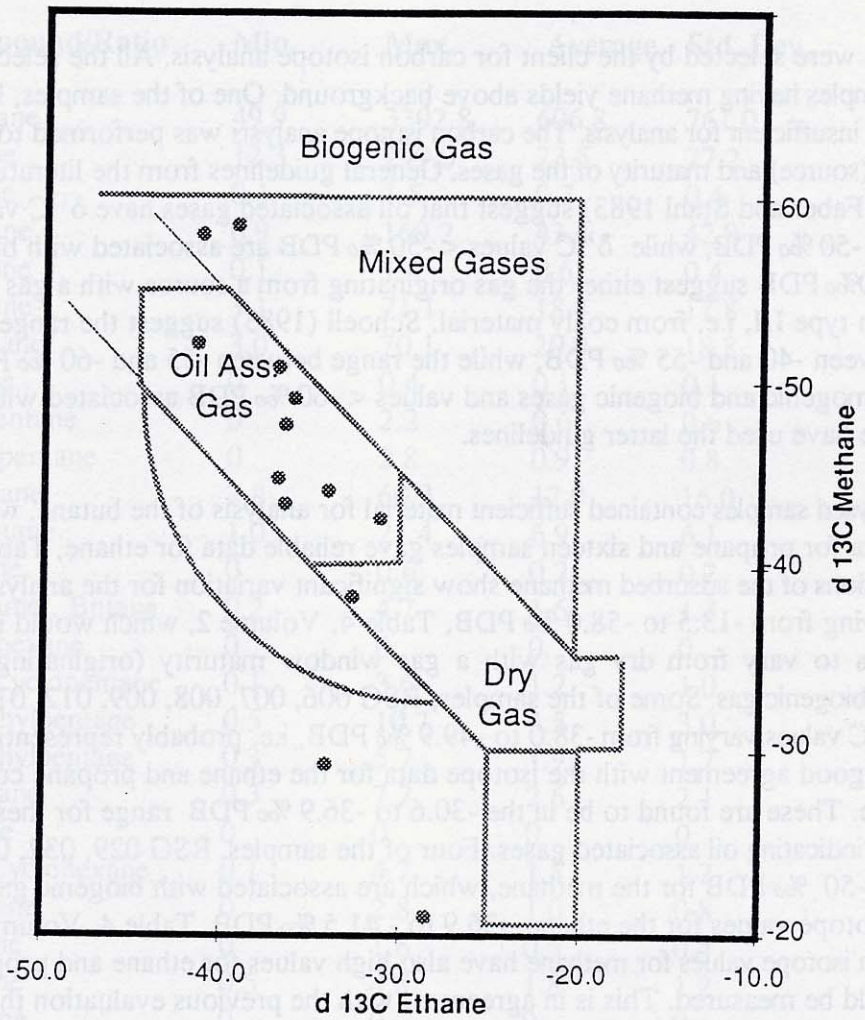

Figure 3.4.1: Cross plot of $\delta^{13}C$ values of methane vs ethane in a Schoell diagram (Schoell 1983)

3.5 Solvent Extraction and Quantitative GC Analysis

3.5.1 Solvent extraction

All samples were solvent extracted using hexane as a solvent (see Analytical Procedures) and analysed by gas chromatography. The extraction was carried out on sieved material (< 63 µm) to minimize the risk of extracting reworked source rocks/shales. Generally, the coarse fraction (> 63 µm) was examined under the microscope and found to contain mainly only small amounts of shale particles and some sand/pebbles. These fragments are not thought to represent any reworked source rock material and will not give problems in the extraction of the sieved material. In the case of highly sandy samples the samples were extracted as bulk samples after removal of visible shale fragments. The yields of higher (liquid) hydrocarbons, measured as extractable organic matter (EOM) vary from low to moderately rich, ranging from 0.7 to 8.5 µg/g dry sediment, with an average of 2.7 ± 1.8 µg/g dry sediment. The EOM yields are on average approximately the same as found for other studies from the Rockall Trough area. In the interpretation of the extraction data, it is important to remember that rich EOM yields do not necessarily imply rich yields of thermogenic aliphatic hydrocarbons, as the bulk of the samples, in addition to any thermogenic hydrocarbons being present, contain hydrocarbons extracted from recent

(unaltered) organic matter (ROM) present in the sediment. This is a known phenomena in most areas (e.g. the North Atlantic Margin and the North Sea etc) where any seeps appear as microseeps. As will be discussed below, the very prominent odd numbered n-alkanes of high molecular weight (in the right half of the chromatograms) and an envelope of unresolved compounds (UCM) are derived mostly from the ROM. See also discussions below. The latter is defined as the envelope(s) of unresolved compounds (the area) below the baseline as seen in the chromatograms, see Appendix 1.

The samples with extraction values above the average, are spread throughout the suite of samples. Those with the highest values are samples RSG 011 to RSG 021 (except sample RSG 018) together with sample RSG 032, i.e. mainly following the same pattern as that seen for the adsorbed gas.

3.5.2. Quantitative GC analysis.

Quantitative GC analyses were performed on all extracted samples using squalane as internal standard. The absolute quantities were calculated for the n-alkanes and selected isoprenoids, together with the amount of unresolved complex mixture (UCM), Tables 5a and 5b. The variation in these data over the sampled area is significant. The discussion below will include a (brief) discussion of the general chromatographic patterns observed, and selected parameters and ratios. Visual inspection of the individual chromatograms shows that the hydrocarbons extracted from the near surface sediments have different compositions. The typical chromatographic patterns observed are described below, and discussed together with relevant parameters with references to exemplary chromatograms presented as Figures 3.5.1 - 3.5.6.

The yields of higher (liquid) hydrocarbons, measured as extractable organic matter (EOM) vary from very low (almost barren) to moderate, as outlined above. However, rich EOM yields do not necessarily imply rich yields of thermogenic aliphatic hydrocarbons. Similar to other studies performed along the North Atlantic Margin a frequent gas chromatographic pattern observed shows a very prominent envelope of odd numbered n-alkanes in the C_{21} to C_{35} range, and only small amounts of compounds in the C_{10} to C_{20} range as the bulk of the samples, in addition to any thermogenic hydrocarbons present, contain hydrocarbons extracted from recent (unaltered) organic matter (ROM) present in the sediment. The very prominent odd numbered n-alkanes of high molecular weight (in the right half of the chromatograms) are derived mostly from the ROM. See also discussions below. Some samples also show an envelope of unresolved compounds (UCM) This is defined as the envelope(s) of unresolved compounds (i.e. the area) below the baseline as seen in the chromatograms (Appendix 1). This unresolved envelope can either be from recent material, then normally together with a large abundance of odd n-alkanes in the C_{23} to C_{31} range. The odd numbered n-alkanes are in most cases derived from cuticular waxes of continental plants, either directly synthesized by the plants or derived though an early diagenesis (defunctionalization) from the even-numbered acids, alcohols or esters (Tissot and Welte 1984). When both marine and continental organic matter are incorporated in the sediment, the continental contribution usually defines the n-alkane fingerprint, especially in the C_{25} to C_{33} range. This is due to a higher proportion of n-alkanes in continental organic matter than in marine planktonic matter. This explains why so many recent marine sediments display a "continental" fingerprint. This pattern is thought to represent the recent organic matter (ROM) in the sediment. Regarding the unresolved envelope, it is normally not difficult to evaluate whether it is due to biodegradation or recent material. This will be pointed out in the discussion.

The samples can be divided into six groups based on the gas chromatograms. Each group of samples will be discussed below.

Group A. This group consists of nine samples, RSG 001, 009, 025, 026, 030, 031, 032, 035 and 037. In general there is a very low abundance of material in all these samples as seen by the low intensities for these gas chromatograms. Most of the samples contain large abundances of unknown compounds compared to the n-alkanes. There is also a significant unresolved envelope for most of the samples. The samples which have significant abundances of the higher molecular weight n-alkanes show a large odd-even predominance. It is difficult to identify the isoprenoids for some of the samples and evaluation of the pristane/phytane ratios are therefore tentative. However, all the samples, except RSG 001, show pristane/phytane ratios of 1.3 to 1.8, i.e. indicating mature samples. Based on the general distribution of the compounds in the gas chromatograms and the low abundance of material, it is believed that these samples mainly represent background material. An example of a gas chromatogram representing this group is shown in Figure 3.5.1.

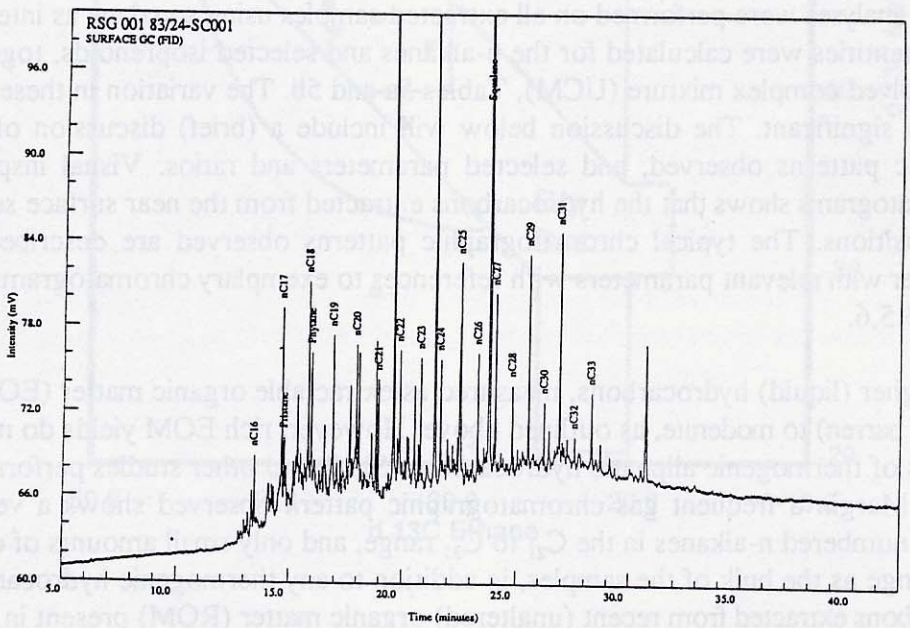

Figure 3.5.1. Exemplary Chromatogram of typical pattern for samples from Group A showing mainly background material (Sample RSG 001)

Group B. Group B consists of eight samples, RSG 002, 003, 004, 005, 006, 007, 028 and 033. The abundance of hydrocarbons is slightly higher than that found for the samples from Group A, but in general, the same patterns as seen for the samples from Group A are found for the samples in this group. The two groups could be put together, but due to the larger relative abundance of hydrocarbons, e.g. n-alkanes compared with the unresolved envelope, they have been destinguished. It is believed that these samples also show mainly background material. An example of the gas chromatograms of samples from this group is shown in Figure 3.5.2.

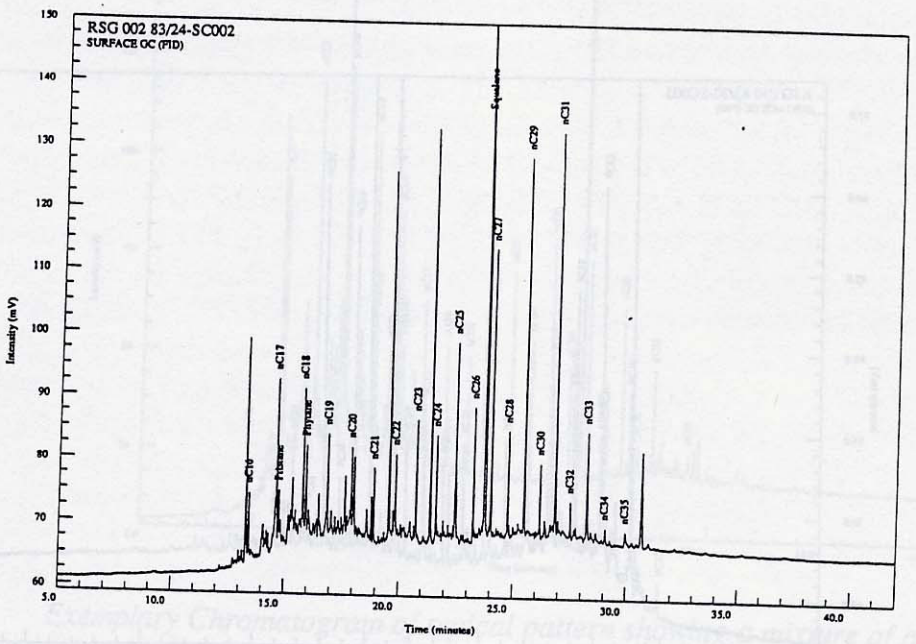

Figure 3.5.2. Exemplary Chromatogram of typical pattern showing mainly immature hydrocarbons from the indigenous organic matter from Group B (Sample RSG 002)

Group C. This group consists of four samples, RSG 008, 010, 022 and 027. The main feature in the gas chromatograms for these samples is a large relative abundance of light molecular weight compounds, together with the heavy molecular weight n-alkanes with a large odd carbon number predominance. There is some variation in the pristane/phytane ratios for the four samples, but most of them have values around 1.0. There is no indication of a loss of light components during the work-up of these samples, i.e. nothing which would affect the pristane/phytane ratios. It is, however, not possible to evaluate how the isoprenoids from the indigenous organic matter have affected the results. The general pattern of the n-alkanes seen for these samples would indicate them to contain well mature hydrocarbons, possibly of condensate type, which are mixed with the material extracted from the indigenous organic matter. When taking into account the isoprenoid distribution , a tentative conclusion would be that the lighter part of the hydrocarbons are generated from a lacustrine source. An example of a gas chromatogram representing this group is shown in Figure 3.5.3.

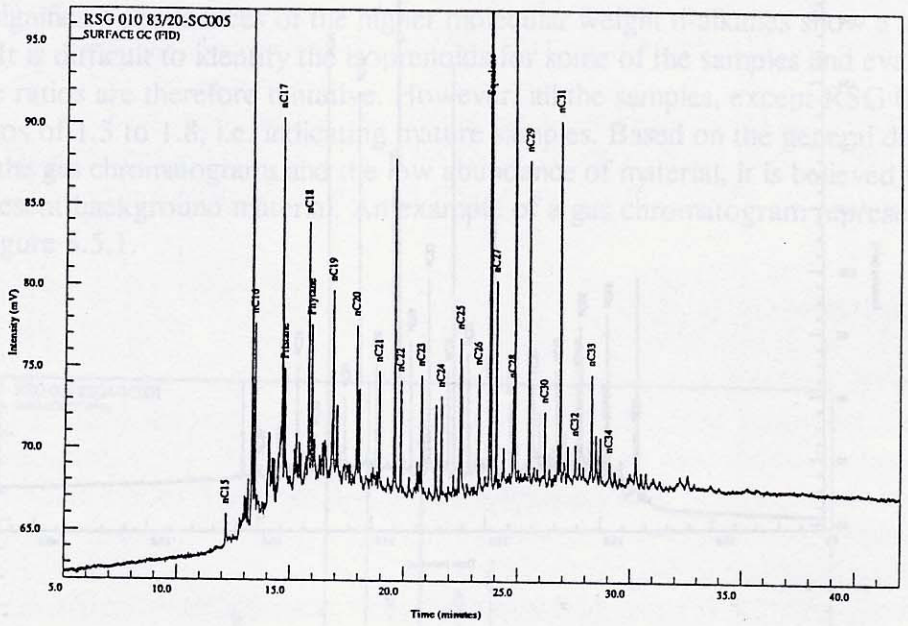

Figure 3.5.3. Exemplary Chromatogram of typical pattern showing a mixture of a minor amount of well mature hydrocarbons together with immature hydrocarbons and unidentified components from the indigenous organic matter from Group C (Sample RSG 010)

Group D. This group consist of two samples, RSG 034 and RSG 036. The gas chromatographic pattern is similar to that found for the samples in Group C, but with a lower relative abundance of the high molecular weight n-alkanes. The odd-even ratio is also lower for these samples than that found for the Group C samples. The pristane/phytane ratio vary only slightly for the two samples, 1.6 and 1.4 respectively for RSG 034 and 036. Based on the pattern seen for the gas chromatograms it is concluded that the two samples contain mature hydrocarbons, generated from a marine source rock. These hydrocarbons are mixed with the hydrocarbons extracted from the indigenous organic matter in the samples. An example of a gas chromatogram representing this group is shown in Figure 3.5.4.

Group E. This group consists of thirteen samples, RSG 012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 023, 024 and 029. The gas chromatogram patterns are similar for these samples, showing a low relative abundance of the C_{15} to C_{22} compounds and a large abundance of the odd numbered n-alkanes in the C_{23} to C_{33} range. The higher molecular n-alkanes represent the indigenous organic matter in the sample. The lower molecular weight n-alkanes, together with the even higher molecular weight n-alkanes show a smooth distribution. This together with a far larger absolute abundance of all components in these samples and a relatively large pristane/phytane ratio, would indicate these samples to contain some seeped, mature hydrocarbons. An example of a gas chromatogram representing this group is shown in Figure 3.5.5.

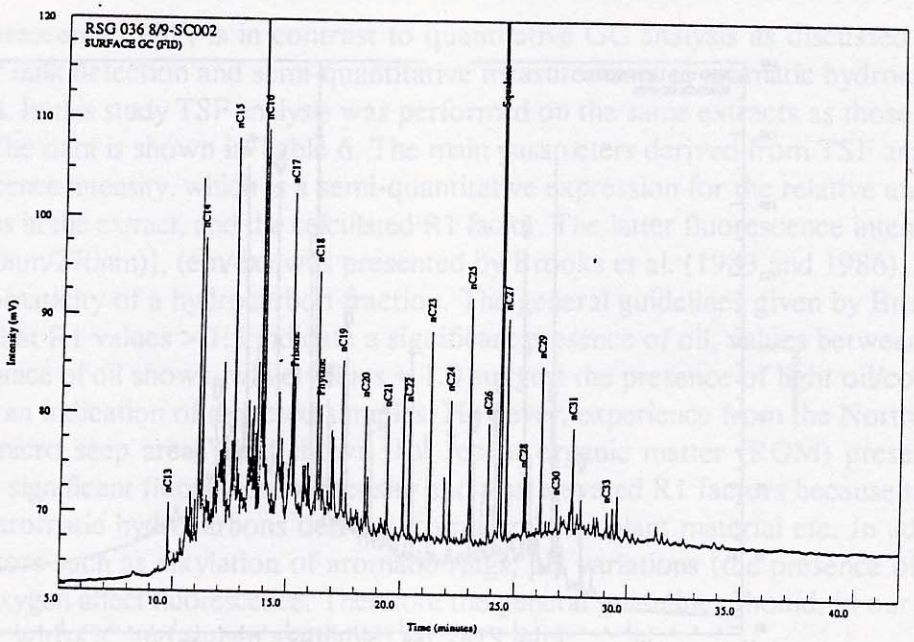

Figure 3.5.4. Exemplary Chromatogram of typical pattern showing a mixture of a minor amount of mature hydrocarbons together with immature hydrocarbons from the indigenous organic matter from Group D (Sample RSG 036)

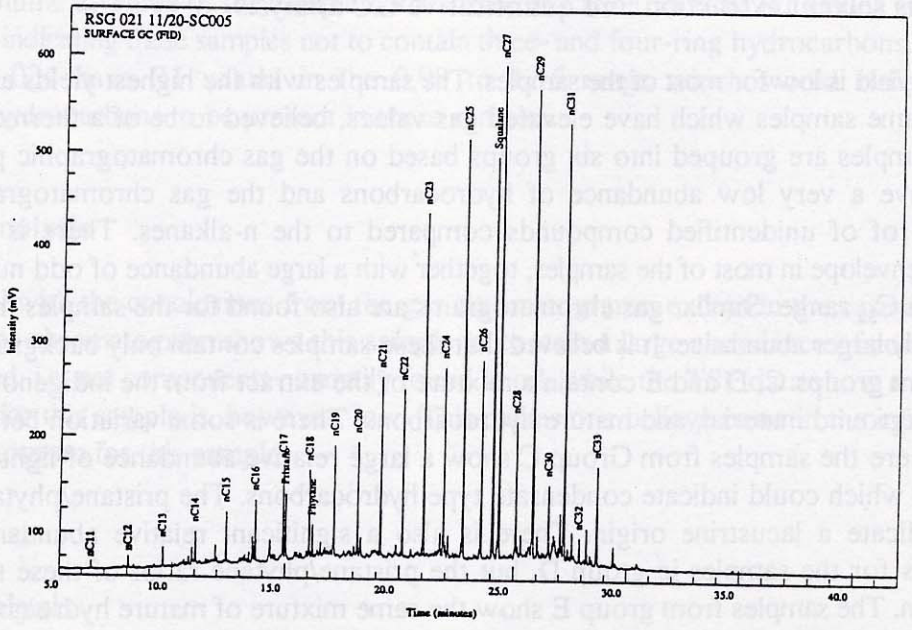

Figure 3.5.5. Exemplary Chromatogram of typical pattern from Group E (Sample RSG 021)

Group F. This group consist only of one sample, RSG 011. The reason this sample is separated from the rest of the groups is a relative large unresolved envelope in the C_{23} to C_{35} range. This could be due to biodegradation of hydrocarbons in the sample. However, both grease and lubricating oil will give unresolved envelopes in the same range and since samples of lubricating oil and/or grease from the ship collecting the samples were not supplied we can not exclude this. If the unresolved envelope is excluded, this sample has the same pattern as the samples in group B. The gas chromatogram of this sample is shown in Figure 3.5.6.

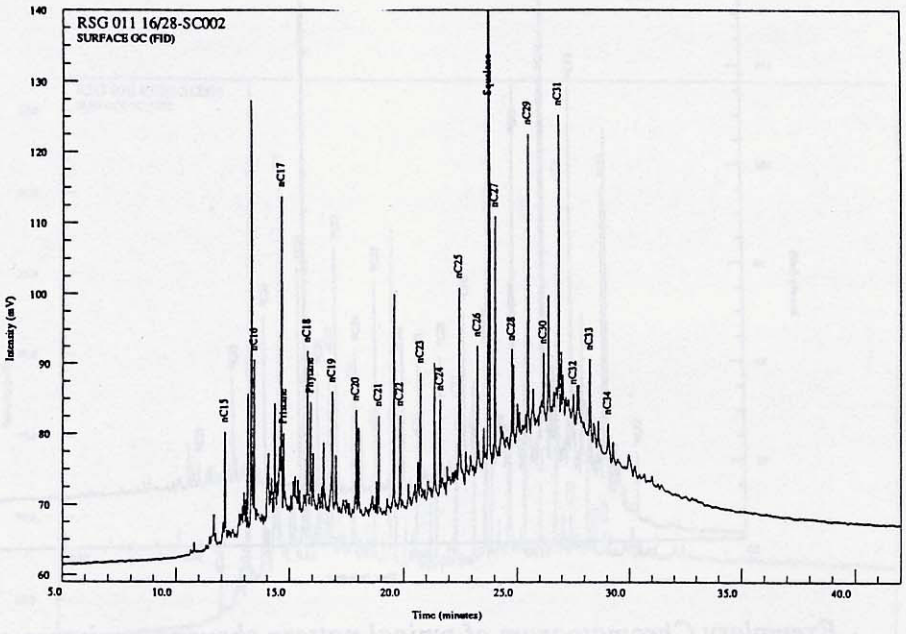

Figure 3.5.6. Gas chromatogram of Sample RSG 011, Group F.

Conclusions solvent extraction and quantitative GC analysis

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The extract yield is low for most of the samples. The samples with the highest yields are generally found to be the same samples which have elevated gas values, believed to be of a thermogenic origin. The analysed samples are grouped into six groups based on the gas chromatographic patterns. Group A samples have a very low abundance of hydrocarbons and the gas chromatograms contain large abundances of of unidentified compounds compared to the n-alkanes. There is also a significant unresolved envelope in most of the samples, together with a large abundance of odd numbered n-alkanes in the C_{23} to C_{33} range. Similar gas chromatograms are also found for the samples from group B, only with a slightly larger abundance. It is believed that these samples contain only background material. The samples from groups C, D and E contain a mixture of the extract from the indigenous organic matter, i.e. the background material, and mature hydrocarbons. There is some variation between the different groups, where the samples from Group C show a large relative abundance of light molecular weight compounds which could indicate condensate type hydrocarbons. The pristane/phytane ratios of these samples indicate a lacustrine origin. There is also a significant relative abundance of the lighter components for the samples in group D, but the pristane/phytane ratios of these samples indicate a marine origin. The samples from group E show the same mixture of mature hydrocarbons and material extracted from the indigenous organic matter. These samples have the largest abundance of extracted hydrocarbons and it is believed that these samples contain seeped, mature hydrocarbons of marine kerogen origin. The one sample in group F contains a large unresolved envelope in the high molecular weight area. This can be due to biodegradation, but one cannot exclude contamination from grease and/or lubricating oil from the sampling vessel since this was not supplied for reference. If contaminated, this sample belongs in Group B.

3.6 TSF Analysis

Total Scanning Fluorescence, TSF, is in contrast to quantitative GC analysis as discussed above, a method developed for bulk detection and semi-quantitative measurements of aromatic hydrocarbons in petroleum exploration. In this study TSF analysis was performed on the same extracts as those analysed by quantitative GC. The data is shown in Table 6. The main parameters derived from TSF analysis are the maximum fluorescence intensity, which is a semi-quantitative expression for the relative amounts of aromatic hydrocarbons in the extract, and the calculated R1 factor. The latter fluorescence intensity ratio [(360nm/270nm)/(320nm/270nm)], (em/ex) was presented by Brooks et al. (1983 and 1986), and is an expression of the aromaticity of a hydrocarbon fraction. The general guidelines given by Brooks et al (1983 and 1986) are that R1 values > 1.5 indicate a significant presence of oil, values between 1.0 and 1.5 a moderate abundance of oil shows, while values ≈ 1.0 suggest the presence of light oil/condensate and values << 1.0 are an indication of depleted samples. However, experience from the North Atlantic Margin and other "micro seep areas" has shown that recent organic matter (ROM) present in the sediment also result in significant fluorescence intensity and also elevated R1 factors because the ROM also contain higher aromatic hydrocarbons derived from terrestrial plant material etc. In addition, a number of other factors such as alkylation of aromatic rings, pH variations (the presence of organic acids) and dissolved oxygen affect fluorescence. Therefore the general guidelines should, in our opinion, be used only together with GC and (when available) GC-MS data.

A total of six samples, one from each of the six groups found from the GC analyses, was analysed by TSF. The intensities are low for four of the samples, RSG 005, 010, 034 and 035, making the measurements unreliable for these samples. The R1 values vary from 0.36 to 1.16 for the analysed samples, Table 6, Volume 2. Three of the samples, RSG 010, 011 and 035 have R1 values in the 0.36 to 0.66 range, clearly indicating these samples not to contain three- and four-ring hydrocarbons. Samples RSG-005, 017 and 034 have R1 values in the 0,99 to 1.16 range which would indicate light oil/condensate type hydrocarbons to be present in these samples.

Conclusions TSF Analysis.

The TSF data fit well with the conclusions from the gas chromatograms, except in the case of sample RSG 005. Here the gas chromatogram shows this sample to contain a large abundance of components which are not identified, i.e. not components normally found in oil, while the TSF data show a R1 value of 1.16. The intensity for this sample is, however, low. This makes one believe more in the information from the gas chromatogram for this sample.

3.7 GC-MS Analysis

A total of 2 samples, RSG 011 (Group F) and RSG 035 (Group A) was selected by the client for analysis by GC-MS, generally based on the GC results, for examination of biomarker molecules and aromatic hydrocarbons present in the extracts. The data are shown in Tables 7a-i. The aim of this examination was to establish the maturity level of the assumed seeped hydrocarbons, and also to characterize likely source rocks for the different hydrocarbon types. The samples were selected for GC-MS analysis based on observations made on the gas chromatograms of the EOM. Samples with chromatographic patterns suggesting the possible presence of seeped thermogenic hydrocarbons and containing sufficient EOM yields for GC-MS analysis, were analysed using the most common masses for traditional biomarker and aromatic hydrocarbon analysis, together with fragment M/Z 141, to get

a clean picture of n-alkanes and isoprenoids in case there was coelution with other compounds in the GC analysis.

A fundamental challenge regarding interpretation of GC-MS data for surface geochemistry is the distinction between organic compounds associated with recent organic material and compounds due to seeped (thermogenic) hydrocarbons. The compounds associated with recent organic material are often dominant. However, certain guidelines can be applied to distinguish between these two suites of compounds. The compounds associated with recent organic material always have a very low maturity signature. These compounds can, however, be the same as some of those associated with seeped hydrocarbons, although in the North Atlantic/North Sea they tend to have a fairly strong terrestrial signature. Compounds that are not associated with mature thermogenic hydrocarbons were also frequently found in the samples. Such compounds include hopenes and ββ-hopanes. Direct examination of the fragmentograms is often made difficult because of this, and it is useful to evaluate selected ratios (interpreted to be indicative of thermogenic hydrocarbons) as an aid to discriminating between thermogenic and biogenic hydrocarbons. For reference: Biomarkers associated with oils and mature source rocks are described in a number of articles, books and publications, among others: Tissot and Welte (1984), Philp (1985) and Waples and Machihara (1991) and references therein.

For aromatic compounds the fragmentograms were examined, the relative amounts of aromatic hydrocarbons estimated and the maturity was proposed based on calculation of the MPI (Radke et al.1982, Radke and Welte 1983) and dibenzothiophenes ratios. The relative amounts of aromatic hydrocarbons as detected by GC-MS analysis seem to vary between the samples, but both methylated naphthalenes and phenanthrenes occur in fairly significant amounts in most samples. Sulphur aromatic hydrocarbons, i.e. dibenzothiophenes, are also detected in most samples, although in highly variable amounts. The level of aromatic hydrocarbons can also be used as an indication of seepage. Although the seeped hydrocarbons can be completely masked in the GC-traces, the presence of aromatic hydrocarbons (especially sulphur-aromatic compounds like the dibenzothiophenes) are indicative of mature (kerogen derived) hydrocarbons, i.e. seepage or reworked material, although at a very low level. As discussed above the Methyl Phenanthrene Index (MPI) is used in order to establish the maturity level based on the aromatic hydrocarbons.

Maturity Evaluation

Predicting maturity from the biomarkers is essentially based on calculating ratios of biological precursor compounds to the more thermally stable isomers. The most commonly applied parameters are, amongst others, the 20S/20S+20R configuration of steranes, Tm/Ts ratio and 22S/22S+22R configuration of the hopanes. The ratio of the 20S/20S+20R configuration of steranes could be calculated from either of the C_{27}, C_{28} or C_{29} steranes. In this report the C_{29} epimers are used (Table 7c, Ratio 2). Equilibrium of this ratio (0.5) is reached around the peak oil generation stage (0.8 % vitrinite reflectance equivalents). In this study this ratio is 0.36 and .44 for samplea RSG 011 and 035 respectively, which indicates a low maturity. Similar observations can be made for similar ratios of the C_{27} and C_{28} steranes. Regarding the triterpane measurements, i.e. using the calculated ratio of the 22S/22S+22R configuration of C_{32} hopane, where equilibrium (0.6) is reached around the top of the oil window. This is found to have a higher maturity for the two samples as seen from Ratio 14, Table 7a. This is found to be 0.59 and 0.58 for the two samples. This would indicate that these samples contain mature hydrocarbons. In contrast to the ratios discussed, the ratio of Tm/Ts begins to decrease quite late during maturation. Thus, this ratio should be able to supplement the above discussed parameters at maturity levels > 0.75% Ro. This ratio (Ratio 1, Table 7a) is 3.3 and 5.4 for the two samples. This would indicate that the two samples contain moderate mature to mature hydrocarbons based on the triterpane data.

When evaluating the maturity of surface geochemical samples, the use of aromatic components is often found to give the most significant results. The main reason for this is the lack of aromatic compounds in immature organic matter, i.e. the aromatic compounds present in the samples represent mainly seeped hydrocarbons (or reworked organic matter when this is not removed). When using aromatic components, the most commonly used maturity parameters are the MPI as defined by Radke et al.(1982) and Radke and Welte (1983) and dibenzothiophenes ratios. The MPI can also be used for direct calculation of the equivalent vitrinite reflectance values (R_0). The different measurements and calculations are shown in Table 7i. This show maturity values of 0.5 % R_0, i.e. moderate mature for the two analysed samples.

The main reason for the discrepancy between the maturity measurements based on biomarker data and those based on aromatic compounds, is that the aromatic data are not affected by the input from the indigenous organic matter, while the biomarker data are strongly affected by this. The maturity of the possibly seeped hydrocarbons would therefore be most correctly assessed by using the aromatic data.

Source Evaluation

Biomarker data from the saturated hydrocarbon fraction are usually good source type indicators. Because biomarkers are derived from biological precursor molecules in specific organisms, and because these organisms live under certain conditions, it is logical to attempt to use biomarkers as indicators of those conditions. Steranes are in general indicators for photosynthetic biota, both terrestrial and aquatic, while triterpanes are indicators of depositional and diagenetic conditions (Waples and Machihara 1991). The sterane distribution in the extract might therefore provide valuable palaeo-environmental information. A predominance of C_{29} steranes would indicate a strong terrestrial contribution, whereas a C_{27} dominance would indicate a dominance of marine phytoplankton (Huang and Meinschein 1979).

From the fragmentograms representing steranes it is seen that sample RSG 035 has a very low signal to noise ratio, making it very difficult to evaluate the data. There is, however an indication of a predominance of C_{29} components in the sample. The signal to noise ratio is far better for the RSG 011 sample. This clearly shows a predominance of the regular steranes over the diasteranes and a clear predominance of the C_{29} components. These observations would indicate a terrestrially influenced source (or a strong influence from terrestrial derived ROM). Figure 3.7.1, shows a triangular plot of the relative abundances of the C_{27}, C_{28} and C_{29} 20R $\alpha\alpha\alpha$ steranes (peaks j, p and t), with inferences of sourcing.

From the fragmentograms representing the triterpanes, significant variations in the composition between the samples can also be observed. Similar to the observations made from the steranes, the amounts of biomarkers vary for the two samples, but not to the same degree as for the steranes. There are no problems in undertaking an evaluation of the triterpane distribution for the two samples.

As discussed above, one of the main concerns in using biomarker distributions on extracts from shallow cores is to separate out the signatures due to thermogenic hydrocarbons from those due to in-situ derived (ROM) hydrocarbons. The relative abundance of tricyclic to pentacyclic terpanes could be a valuable parameter in this discussion, as tricyclic terpanes appear to be more stable to thermal alteration, and hence samples consisting mainly of immature biomarkers would tend to show a dominance of (low mature) pentacyclic terpanes. None of the samples show any abundance of the tricyclic terpanes.

Another triterpane, the 28, 30 bisnorhopane (peak Z, m/z 191) is a minor but important compound as this compound is nearly ubiquitous in Kimmeridge Clay (and equivalents) derived oil in the North Sea (Grantham et al. 1980 A.O.), and hence samples containing 28, 30 bisnorhopane were deposited under

specific, probably highly anoxic conditions. Assuming the presence of 28, 30 bisnorhopane is indicative of similar depositional environments as in the North Sea and further north along the Atlantic Margin this could be an valuable parameter for source indication. There is, however, no indication of 28, 30 bisnorhopane in any of the analysed samples.

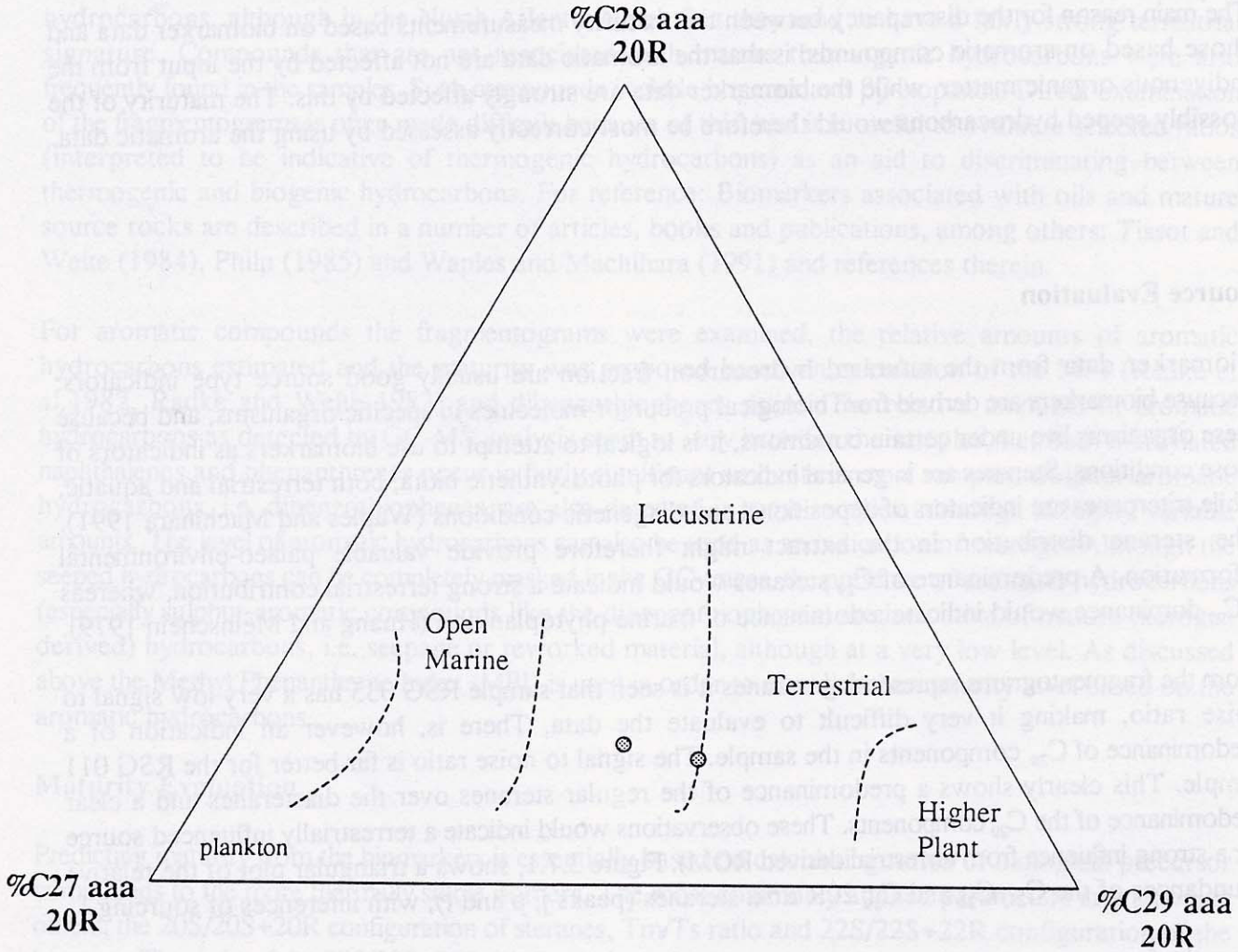

Figure 3.7.1. Sterane Composition : Relative Abundance of C27-C29 ααα 20R compounds

Discussion of separate fragmentograms.

The M/Z 141 fragmentograms for the two samples vary slightly. Sample RSG 011 shows a large relative abundance of the light n-alkanes and a low relative abundance of isoprenoids, together with a large relative abundance of the high molecular weight n-alkanes with an odd predominance. The squalane peak is by far the largest peak in the fragmentogram. The pattern seen here would indicate an extremely low abundance of high maturity hydrocarbons, mixed with dominant extract components from the indigenous organic matter, i.e. basically background material. Sample RSG 035 shows a slightly different distribution with a lower relative abundance of both the lighter and higher molecular weight n-alkanes

compared to the isoprenoids, as well as a smaller odd predominance for the high molecular weight n-alkanes. The squalane peak is also dominant in the fragmentogram of this sample. The pattern seen here indicates a lower maturity for the hydrocarbons in the sample, but as with sample RSG 011, the abundance of the hydrocarbons in the sample is so low that it is believed this sample contains mainly background material. Regarding the different fragmentograms representing various types of terpanes, these vary for the two samples. Sample RSG 011 shows patterns typical for well mature samples in the different fragmentograms, with a good abundance a pentacyclic terpanes. The peaks representing the βα and the ββ components, i.e. immature components originating from the indigenous organic matter are hardly above the background for this sample, Figure 3.7.2 The fragmentograms of the RSG 035 sample show a number of peaks representing the βα and the ββ components. The pattern seen in the M/Z 191 fragmentogram clearly shows the influence of components with a low maturity, i.e. the terpanes in this sample are dominated by the components originating from the indigenous organic matter in the sample, Figure 3.7.3.

The fragmentograms representing the steranes show a very low signal to noise ratio for sample RSG 035, and this is therefore not discussed any further. The signal to noise ratio is far better for sample RSG 011. The fragmentograms for this sample show the regular steranes to dominate while the peaks representing the rearranged steranes are only minor components. For the regular steranes, the C_{29} components are by far the most prominent peaks. A pattern like this would normally indicate that the hydrocarbons originate from a terrestrial source. The steranes in this sample are probably affected by the extract from the indigenous organic matter, i.e. the immature components from recent organic matter.

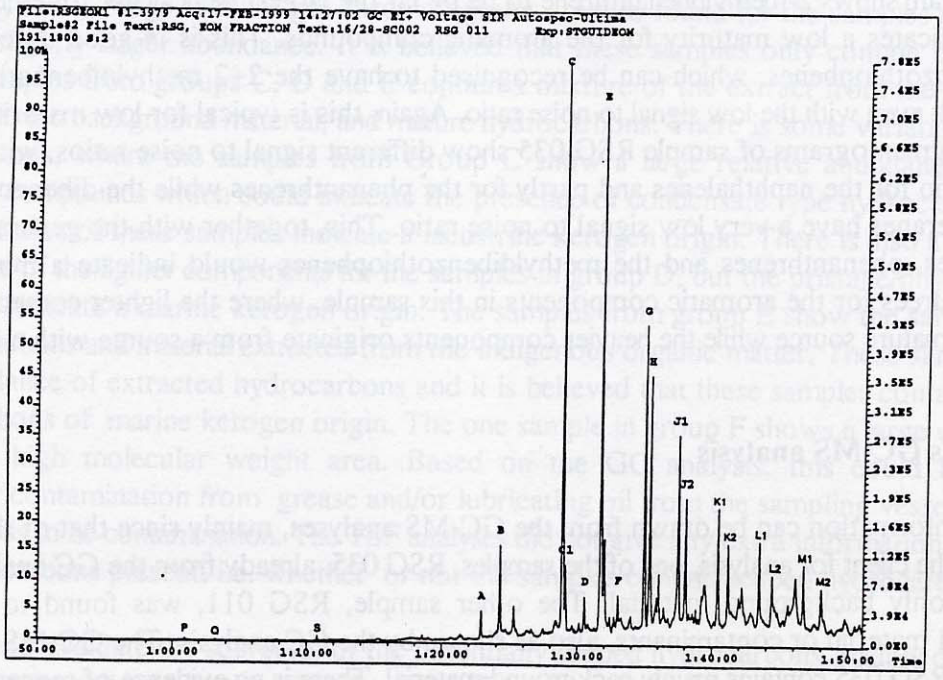

Figure 3.7.2. The M/Z 191 fragmentogram of Group F, sample RSG 011.

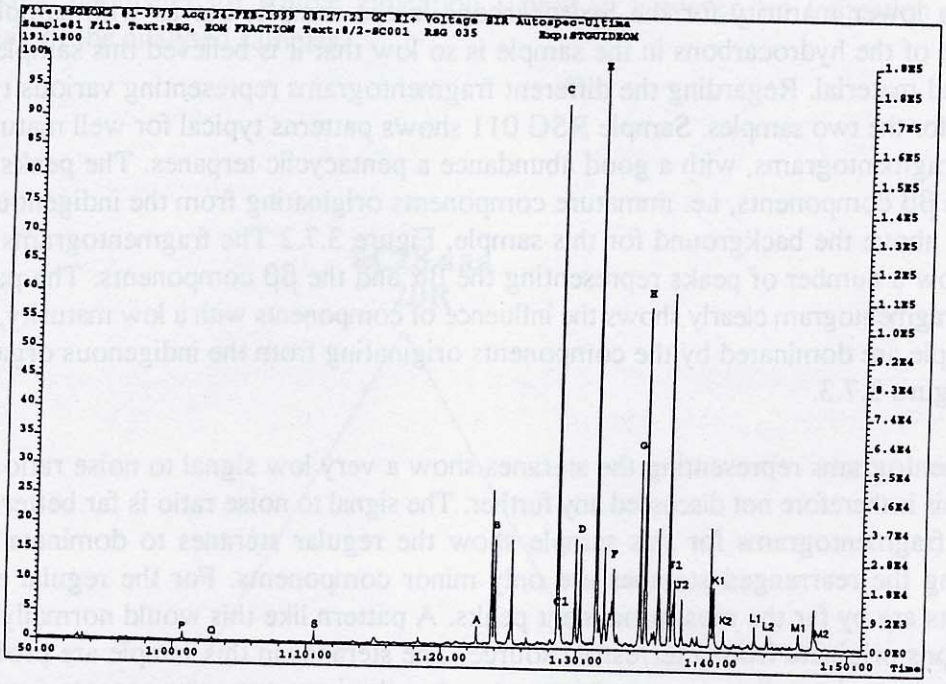

Figure 3.7.3. The M/Z 191 fragmentogram of Group A, sample RSG 035.

The fragmentograms representing the aromatic compounds show some differences for the two samples, both in the signal to noice ratio and in the patterns for the different fragmentograms. Sample RSG 011 shows a very low signal to noise ratio for all the components, except the phenanthrenes. The M/Z 192 fragmentogram shpws 2-methylphenanthrene to be by far the largest peak. This, together with the MPI 1 ratio, indicates a low maturity for the aromatic compounds. This is in good agreement with the methyldibenzothiophenes, which can be recognised to have the 2+2 methyldibenzothiophene as the smallest peak even with the low signal to noise ratio. Again, this is typical for low maturity samples. The different fragmentograms of sample RSG 035 show different signal to noise ratios, with a good signal to noise ratio for the naphthalenes and partly for the phenanthrenes while the dibenzothiophenes and aromatic steranes have a very low signal to noise ratio. This, together with the general pattern of the naphthalenes, phenanthrenes and the methyldibenzothiophenes would indicate a mixture from two different sources for the aromatic components in this sample, where the lighter components originate from a well mature source while the heavier components originate from a source with a lower maturity.

Conclusions GC-MS analysis

Not much information can be drawn from the GC-MS analyses, mainly since that of the two samples selected by the client for analysis, one of the samples, RSG 035, already from the GC analysis was found to contain only background material. The other sample, RSG 011, was found to contain either biodegraded material or contaminants, also as shown by the GC analysis. The GC-MS analyses verify that sample RSG 035 contains mainly background material. There is no evidence of seeped hydrocarbons in this sample. Regarding sample RSG 011, the fragmentograms for the triterpanes indicate the sample to contain well-mature hydrocarbons while the fragmentograms representing the aromatics show the higher molecular aromatic compounds either to have a low abundance or to have a low maturity. The GC-MS data is in agreement with the possibility of this sample being contaminated.

Chapter 4

CONCLUSIONS

The conclusions on the distribution of hydrocarbons in the near surface sediments for this surface geochemical exploration study offshore Irland, are based on sediment characteristics, headspace gas analysis, adsorbed gas analysis, carbon isotope composition of adsorbed gas, solvent extraction with quantitative gas chromatography analysis, total scanning fluorescence (TSF), and gas chromatography-mass spectrometry. Table 4.1 below, shows the suggested distribution of the hydrocarbon types present within the examined area.

The yields of headspace ags are generally low while the yields of adsorbed gas range from low to moderate/rich. The headspace gas analysis shows only methane and gives therfore only limited information.The adsorbed gases show a thermogenic composition with a relatively dry molecular composition in some of the samples. Most of the adsorbed gas samples which were analysed for carbon isotopic composition are found to have an oil-associated composition. The exceptions are samples RSG 029, 032, 033 and 036 which have isotope compositions indicating a mainly biogenic origin and samples RSG 013, 015, 016, 018 and 022, where the isotope data indicate the sample to contain dry gas, originating from either a coaly type source or from a source rock with an oil/gas window maturity.

The extract yield is low for most of the samples. The samples with the highest yields are generally found to be the same samples which were found to have elevated gas values, believed to be of a thermogenic origin. The analysed samples are divided into six groups based on the gas chromatographic patterns. Group A samples have a very low abundance of hydrocarbons and the gas chromatograms contain large abundances of of unidentified compounds compared to the n-alkanes. There is also a significant unresolved envelope for most of the samples, together with a large abundance of odd numbered n-alkanes in the C_{23} to C_{33} range. Similar gas chromatograms are also found for the samples from group B, only with a slightly larger abundance. It is believed that these samples only contain background material. The samples from groups C, D and E contain a mixture of the extract from the indigenous organic matter, i.e. the background material, and mature hydrocarbons. There is some variation between the different groups, where the samples from Group C show a large relative abundance of light molecular weight compounds which could indicate the presence of condensate type hydrocarbons. The pristane/phytane ratios of these samples indicate a lacustrine kerogen origin. There is also a significant relative abundance of the lighter components for the samples in group D, but the pristane/phytane ratios of these samples indicate a marine kerogen origin. The samples from group E show the same mixture of mature hydrocarbons and material extracted from the indigenous organic matter. These samples have the largest abundance of extracted hydrocarbons and it is believed that these samples contain seeped, mature hydrocarbons of marine kerogen origin. The one sample in group F shows a large unresolved envelope in the high molecular weight area. Based on the GC analysis, this could be due to biodegradation or contamination from grease and/or lubricating oil from the sampling vessel. GC-MS analysis indicate this to be contamination. The TSF analyses did not give any extra information regarding the type of hydrocarbons present, i.e. whether or not the samples contain seeped hydrocarbons.

It is very difficult to evaluate the source(s) of the potentially seeped hydrocarbons, mainly due to that only two samples were selected by the client for GC-MS analysis and of these one sample had already been determined to contain mainly background material based on the GC analysis. If samples from groups C, D and E had been selected for GC-MS analysis, the possibility of deciding on both source and maturity would have been present.

Table 4.1 Conclusive list of hydrocarbons present in cores. Unlisted samples are interpreted to contain mainly immature/biogenic hydrocarbons, or low yields of thermogenic gas.

Traces of liquid seeped HC (Lacustrine source?)	Traces of liquid seeped HC (Marine source)		Thermogenic gas (Terrestrial source)	Thermogenic gas (Oil-associated)
008	012	020	013	012
010	013	021	015	014
022	014	023	016	017
027	015	024	018	019
	016	029	022	021
	017	034		025
	018	036		029
	019			034

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ANALYTICAL PROCEDURES

The analytical results reported herein are achieved according to Geolab Nor AS procedures, LAB-2601-LAB-2618, for analysis of shallow cores (near surface samples) as outlined in the QA manual, Department Level 3, Procedures.

Simple Particle Size Analysis

The sediments were separated by wet sieving into two fractions, < 63 µm, and > 63 µm, and the fractions dried at 40°C before weighing. Except for headspace and occluded gas analyses all analyses were undertaken on the sived (< 63 µm) sediment fraction.

Headspace Gas Aanalysis

The cans are punctured through a septum and the pressure equalized by adding water. From each can, 2 ml of free headspace gas is taken and injected into the gas chromatograph for analysis. The headspace gas was analysed on either a Perkin Elmer model 8310, or a Varian 3400 gas chromatograph. A 50 m Plot Fused Silica column with 0.32 mm internal diameter and 5μm Al_2O_3/KCl film thickness (Chromopack inc.) were used in both gas chromatographs. The temperature program on the column has an initial temperature of 70°C, 12°C/min heating rate up to 200°C and held for 5 mins. The detectors are standard FIDs. Correlation and quantification is achieved by use of external standards.

Occluded (Interstitial) Gas Aanalysis

A 50 g (wet weight) aliquot of total sediment was ball-milled in a sealed container fitted with a septum from which the released interstitial gas was withdrawn for analysis by gas chromatography. The interstitial gas was analysed on either a Perkin Elmer model 8310, or a Varian 3400 gas chromatograph. A 50 m Plot Fused Silica column with 0.32 mm internal diameter coated with 5μm Al_2O_3/KCl film (Chromopack inc.) were used in both gas chromatographs. The temperature program on the column has an initial temperature of 70°C, 12°C/min heating rate up to 200°C held for 5 mins. The detectors are standard FIDs. Correlation and quantification is achieved by use of external standards.

Adsorbed (Acid released) Gas Analysis

This analysis was carried out on a 100 g aliquot (wet weight) of the < 63 μm sediment fraction. The gas was released by acid treatment with orthophosphoric acid at 70°C. The resulting gas was passed through concentrated potassium-hydroxide solution, to remove carbon dioxide, and analysed by gas chromatography. The adsorbed gas was analysed on either a Perkin Elmer model 8310, or a Varian 3400 gas chromatograph. A 50 m Plot Fused Silica column with 0.32 mm internal diameter and 5 μm Al_2O_3/KCl film thickness (Chromopack inc.) were used in both gas chromatographs. The temperature program on the column has an initial temperature of 50°C, a heating rate of 8°C/min up to 200°C held for 15 mins. The detectors are standard FIDs. Correlation and quantification is achieved by use of external standards.

Carbon Combustion Analysis

This analysis was carried out on a standard LECO CS224 Carbon Analyser with IR detection of the CO_2. Dried whole sediment was crushed using a pestle and a mortar and approximately 200 mg is accurately

weighed into LECO crucibles.

The samples for Total Organic Carbon (TOC) analysis are then treated three times with 10 % hydrocloric acid, to remove oxidized (carbonate) carbon, and washed four times with distilled water. The samples are dried on a hotplate at 100°C and then loaded into the instrument for analysis of total organic carbon. Total Carbon (TC) is also analysed using the same instrument and similar weights as for TOC analysis. The oxidized (carbonate) carbon are calculated by weight difference.

Isotope Analysis

A 1 ml aliquot of adsorbed gas was analysed for the concentration of ^{13}C isotope composition of methane relative to PDB (Pee Dee Belemnite) on a Hewlett Packard 5890 A gas chromatograph coupled to Isochrom 2 Mass Spectrometer. The gas chromatograph was fitted with a 25 m Plot Fused Silica column with an internal diameter of 0.32 mm coated with 10 μm Paraplot Q film. The temperature program of the column has an internal temperature of -40°C (cooled down by liquid Nitrogen) held isothermally for 2 minutes, heated at a rate of 8°C/min to -10°C, and further heated at a rate of 15°C/min up to 200°C with a final holdtime of 5 minutes.

Liquid Extraction

The < 63 μm sediment (clay) fraction was air dried, in an effort to minimize the loss of volatile compounds, and extracted for 3 hours at 90°C with hexane as a solvent, using SOXTEC extraction system. Activated copper was used to remove elemental sulphur from the solution. The extract was then rotavapored and air-dried to near dryness.

Gas Chromatographic Analysis

The Gas Chromatographic analysis of the extracted hydrocarbons was performed on a Dani 8500 Gas Chromatograph. A 10 m WCOT Fused Silica column with 0.27 mm internal diameter and 1.20 μm film thickness (Chromopack inc.) were used. The temperature program on the column has an initial temperature of 50°C, a heating rate of 10 C/min up to 310 C held for 15 mins. The detectors are standard FIDs. Correlation is achieved by use of external standards, while the quantification is achivied by squalane as internal standard.

Total Scanning Fluorescence Analysis

The same extract as used for Gas Chromatographic analysis were diluted by extra pure hexane (fluorescence quality) to appropriate volume and then scanned by Total Scanning Fluorescence between 200 and 500 nm wavelengths. Fluorescence spectra, including maximum fluorescence intensity, and single wavelength measurements were carried out on a computerized Perkin Elmer LS-50B spectrometer.

Gas Chromatography - Mass Spectrometry (GC-MS)

The GC-MS analyses are performed on a VESTEC QUADROPOL system interfaced to a Varian 3400 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 (11 psi) is used as carrier gas and the injections are performed in splitless mode. The GC oven is programmed from 40°C to 150 C at 10 C/min, at which point the programme rate is 2.5°C/min up to 310°C where the column is held isothermally for 15 min.

The data system used is a Teknivent Vector/Two GC/LC-MS system for peak processing the data. 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

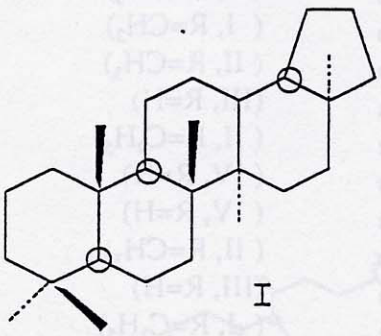
Monoaromatic steranes are detected using the M/Z 253 fragment ion, while the triaromatic steranes are detected using the M/Z 231 fragment ion.

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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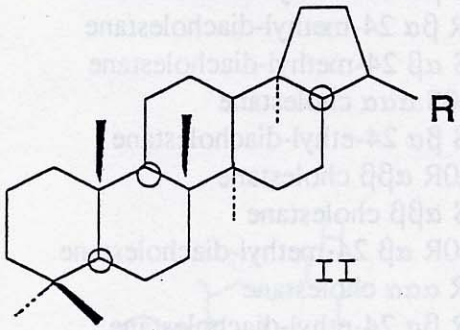

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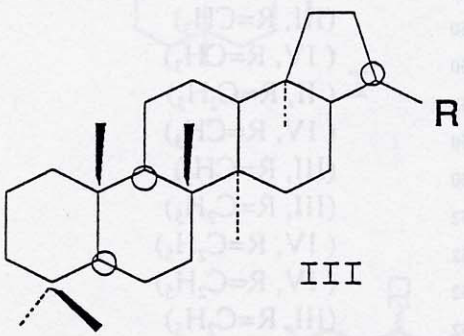

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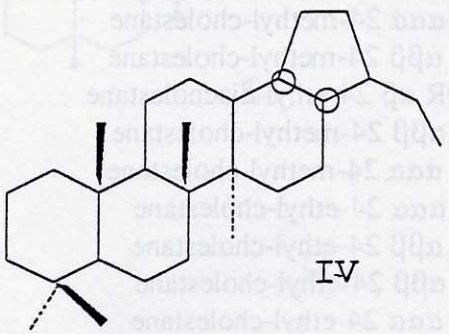

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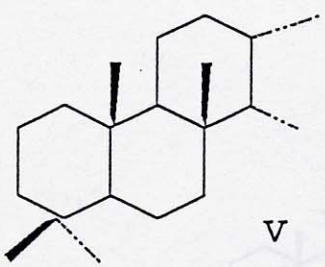

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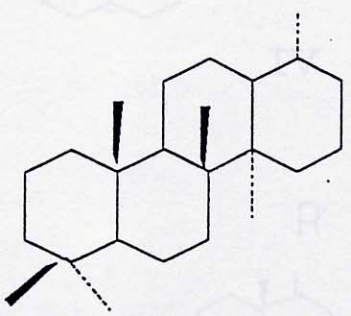

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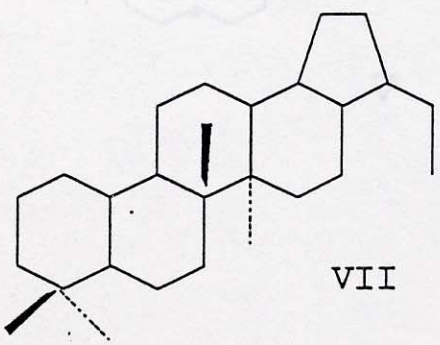


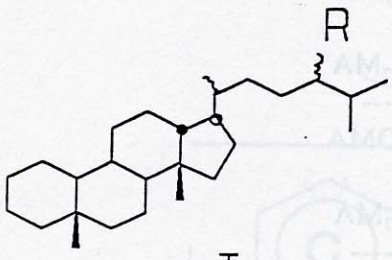
VII

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

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

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

STRUCTURES REPRESENTING STERANES



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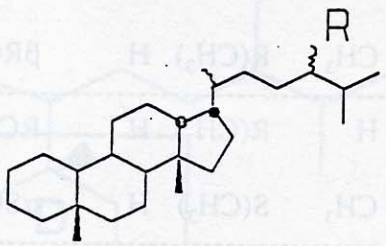

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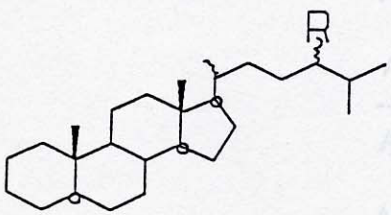

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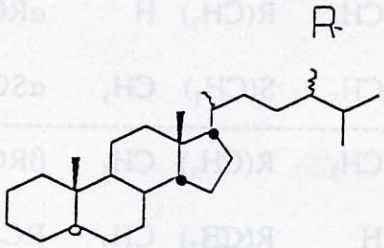

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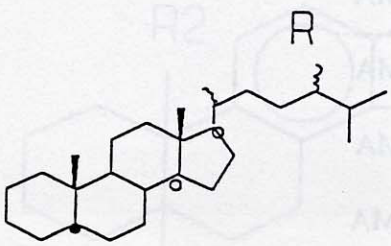

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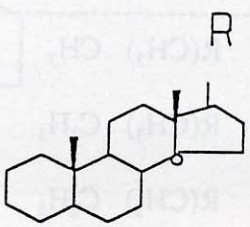


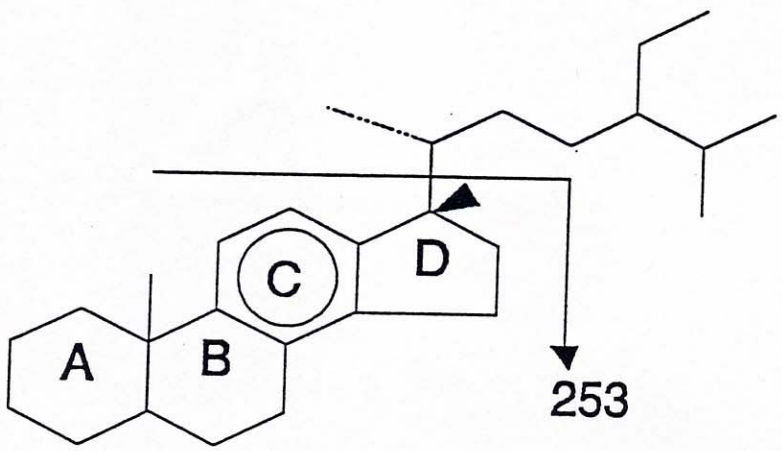
VI

Mass Fragmentograms representing Monoaromatic Steranes (M/Z 253)

Description of C-ring monoaromatic steroid hydrocarbons

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

STRUCTURES REPRESENTING MONOAROMATIC STERANES



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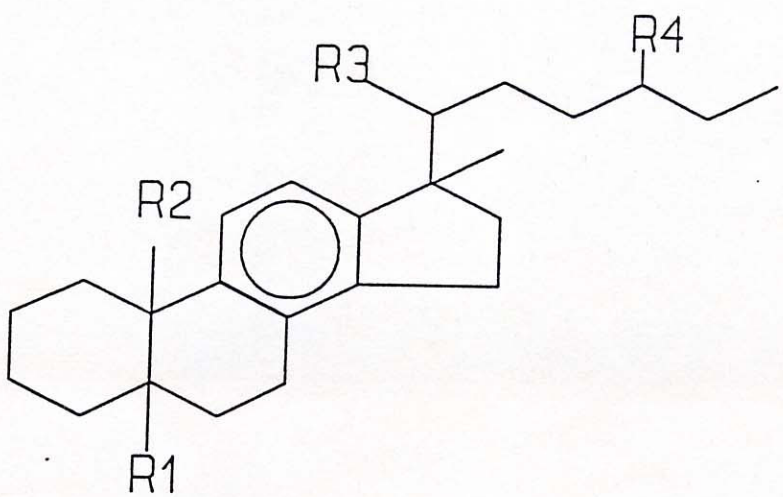

Table 1: Sediment Characteristics

RSG Surface Geochemistry

Sample*	Core Number**	% Sand	% Clay
RSG001	83/24 SC001	50.45	49.55
RSG002	83/24 SC002	72.85	27.15
RSG003	83/24 SC003	41.65	58.36
RSG004	83/24 SC004	85.91	14.09
RSG005	83/24 SC005	18.10	81.90
RSG006	83/20 SC001	72.66	27.34
RSG007	83/20 SC002	67.33	32.67
RSG008	83/20 SC003	12.53	87.47
RSG009	83/20 SC004	43.89	56.11
RSG010	83/20 SC005	80.87	19.13
RSG011	16/28 SC002	79.37	20.64
RSG012	11/20 SC006	17.35	82.65
RSG013	11/20 SC007	4.41	95.59
RSG014	11/20 SC008	8.99	91.01
RSG015	11/20 SC009	5.40	94.60
RSG016	11/20 SC010	4.13	95.87
RSG017	11/20 SC001	2.90	97.10
RSG018	11/20 SC002	11.76	88.24
RSG019	11/20 SC003	3.09	96.91
RSG020	11/20 SC004	4.29	95.71
RSG021	11/20 SC005	4.36	95.64
RSG022	78/28 SC005	53.75	46.25
RSG023	78/28 SC007	77.99	22.01
RSG024	83/29 SC001	28.21	71.79
RSG025	83/30 SC001	11.77	88.24
RSG026	83/23 SC002	20.81	79.19
RSG027	83/5 SC002	47.46	52.55
RSG028	83/5 SC001	56.94	43.07
RSG029	83/3 SC002	82.45	17.55
RSG030	74/1 SC001	55.02	44.98
RSG031	74/6 SC001	74.45	25.55
RSG032	77/9 SC001	5.07	94.93
RSG033	78/30 SC001	45.27	54.73
RSG034	8/1 SC001	12.01	87.99
RSG035	8/2 SC001	15.86	84.15
RSG036	8/9 SC001	42.43	57.57
RSG037	9/7 SC001	12.92	87.08
Min		2.90	14.09
Max		85.91	97.10
Av		36.07	63.93
StD		28.95	28.95

* Geolab Nor sample i.d.
** RSG Sample designation

Table 2: Headspace Gas Data

RSG Surface Geochemistry

Sample	METHANE	ETHANE	ETHENE	PROPANE	PROPENE	i-BUTANE	BUTANE	BUTENE	PENTANE	PENTENE	HEXANE	HEXENE
RSG001	2.556	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG002	2.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG003	1.879	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG004	0.818	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG005	1.860	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG006	1.177	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG007	0.941	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG008	0.992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG009	1.121	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG010	1.143	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG011	1.513	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG012	2.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG013	3.377	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG014	1.402	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG015	2.362	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG016	0.771	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG017	0.998	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG018	1.876	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG019	1.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG020	0.810	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG021	1.121	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG022	1.281	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG023	0.857	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG024	2.525	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG025	0.893	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG026	0.697	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG027	1.357	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG028	1.336	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG029	0.845	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG030	3.325	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG031	1.073	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG032	0.725	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG033	1.438	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG034	0.602	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Yields in ppb

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Table 2: Headspace Gas Data

RSG Surface Geochemistry

Sample	METHANE	ETHANE	ETHENE	PROPANE	PROPENE	i-BUTANE	BUTANE	BUTENE	PENTANE	PENTENE	HEXANE	HEXENE
RSG035	0.898	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG036	2.222	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RSG037	1.807	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min	0.602	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max	3.377	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Av	1.452	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
StD	0.710	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Yields in ppb

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Table 3a: Adsorbed Gas Data

RSG Surface Geochemistry

Sample	Pentene	22-Dimethylbutane	Cyclohexane	Methylcyclopentane	2-Methylpentane	3-Methylpentane	Hexane	Hexene
RSG003	0.039	0.573	0.000	0.321	1.206	0.646	0.839	0.000
RSG004	0.612	0.539	0.000	0.305	0.967	0.587	1.060	0.000
RSG006	0.101	0.545	0.000	0.304	1.329	0.688	0.998	0.000
RSG007	0.042	0.494	0.000	0.541	1.124	0.684	0.990	0.000
RSG008	0.101	0.846	0.000	0.621	1.686	0.959	1.375	0.000
RSG009	0.097	0.610	0.000	0.447	1.245	0.686	0.878	0.000
RSG012	0.309	2.426	0.000	1.723	5.374	2.982	3.501	0.000
RSG013	0.610	4.556	0.000	2.891	10.699	5.737	7.124	0.000
RSG014	0.270	2.434	0.000	1.932	5.259	2.904	3.917	0.000
RSG015	0.429	4.668	0.000	3.595	9.706	5.475	7.201	0.000
RSG016	0.262	2.335	0.000	1.926	5.419	3.010	3.803	0.000
RSG017	0.000	1.527	0.000	1.254	2.920	1.747	1.901	0.000
RSG018	0.448	3.652	0.000	2.688	8.817	4.864	6.051	0.000
RSG019	0.390	2.864	0.000	2.297	5.799	3.242	4.506	0.000
RSG020	0.192	0.648	0.000	0.541	1.386	0.791	1.538	0.000
RSG021	0.057	2.674	0.000	2.111	5.523	3.177	4.572	0.000
RSG022	0.000	0.696	0.000	0.541	1.400	0.782	1.211	0.000
RSG023	0.000	0.183	0.000	0.081	0.483	0.312	0.276	0.000
RSG025	0.122	2.305	0.000	1.543	5.020	2.776	3.935	0.000
RSG026	0.000	0.579	0.000	0.398	1.118	0.713	1.151	0.000
RSG027	0.000	0.452	0.000	0.418	1.126	0.615	0.850	0.000
RSG029	0.173	3.905	0.000	2.360	8.736	4.622	5.751	0.000
RSG032	0.178	0.847	0.000	0.751	1.448	0.775	1.653	0.000
RSG033	0.000	0.908	0.000	0.904	1.905	1.039	1.731	0.000
RSG034	0.000	1.190	0.000	0.774	2.520	1.405	1.770	0.000
RSG035	0.000	1.595	0.000	1.342	2.703	1.597	2.854	0.000
RSG036	0.115	0.982	0.000	0.624	1.890	1.047	1.471	0.000
RSG037	0.000	0.289	0.000	0.277	0.619	0.365	0.603	0.000
Min	0.00	0.18	0.00	0.08	0.48	0.31	0.28	0.00
Max	0.61	4.67	0.00	3.60	10.70	5.74	7.20	0.00
Av	0.16	1.62	0.00	1.20	3.48	1.94	2.63	0.00
StdD	0.19	1.34	0.00	0.95	3.03	1.65	2.05	0.00

Data in ppb (ng/g sediment)

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Table 3a: Adsorbed Gas Data

Sample	Methylcyclohexane	2-Methylhexane	Heptane	Benzene	2-Methylheptane	Octane	Toluene
RSG003	0.357	0.312	0.180	0.510	0.000	0.000	0.000
RSG004	0.320	0.000	0.000	0.836	0.000	0.000	0.000
RSG006	0.283	0.287	0.167	0.671	0.000	0.000	0.000
RSG007	0.861	0.648	0.542	0.999	0.000	0.000	0.000
RSG008	1.503	0.762	0.304	1.257	0.000	0.000	0.000
RSG009	0.806	0.511	0.217	0.648	0.000	0.000	0.000
RSG012	2.725	1.444	1.206	3.170	0.000	0.000	0.000
RSG013	4.004	2.576	1.117	4.536	0.000	0.000	0.000
RSG014	2.085	1.565	0.634	2.533	0.000	0.000	0.000
RSG015	4.730	2.790	1.546	4.776	0.000	0.000	0.000
RSG016	2.370	1.335	0.681	2.962	0.000	0.000	0.000
RSG017	1.504	1.145	0.455	2.413	0.000	0.000	0.000
RSG018	3.077	2.328	0.788	3.496	0.000	0.000	0.000
RSG019	2.351	1.490	0.499	1.840	0.000	0.000	0.000
RSG020	0.736	0.445	0.252	0.877	0.000	0.000	0.000
RSG021	2.031	1.420	0.616	2.038	0.000	0.000	0.000
RSG022	0.723	0.446	0.292	0.996	0.000	0.000	0.000
RSG023	0.119	0.100	0.035	0.657	0.000	0.000	0.000
RSG025	1.443	1.141	0.483	1.760	0.000	0.000	0.000
RSG026	1.030	0.934	0.355	1.154	0.000	0.000	0.000
RSG027	0.450	0.380	0.139	0.548	0.000	0.000	0.000
RSG029	2.543	2.341	0.874	2.790	0.000	0.000	0.000
RSG032	0.512	0.479	0.341	1.865	0.000	0.000	0.000
RSG033	0.914	0.646	0.284	1.075	0.000	0.000	0.000
RSG034	0.991	0.720	0.314	1.103	0.000	0.000	0.000
RSG035	1.511	0.771	0.873	2.284	0.000	0.000	0.000
RSG036	0.806	0.488	0.303	1.182	0.000	0.000	0.000
RSG037	0.170	0.130	0.165	0.655	0.000	0.000	0.000
Min	0.12	0.00	0.00	0.51	0.00	0.00	0.00
Max	4.73	2.79	1.55	4.78	0.00	0.00	0.00
Av	1.46	0.99	0.49	1.77	0.00	0.00	0.00
StdD	1.17	0.77	0.37	1.19	0.00	0.00	0.00

Data in ppb (ng/g sediment)

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Table 3b: Adsorbed Gas, Derived Parameters

RSG Surface Geochemistry

Sample	Sum n-alk.	Sum C2+ n-alk.	Sum Branched	Sum Cyclo alk.	Sum Alkenes	Ethane/Methane*	Propane/Methane*	% Wetness*	Ethene/Ethane*
RSG003	220.26	51.37	16.06	0.98	0.82	0.08	0.03	11.38	0.02
RSG004	144.75	36.59	13.03	0.63	1.92	0.09	0.04	12.27	0.06
RSG006	158.00	52.11	18.86	0.99	0.62	0.11	0.06	16.52	0.02
RSG007	121.68	28.15	10.85	1.69	0.38	0.07	0.03	10.60	0.01
RSG008	285.28	60.84	20.81	2.57	1.09	0.07	0.03	10.13	0.01
RSG009	224.72	44.96	14.88	1.57	0.73	0.07	0.03	9.49	0.01
RSG012	1111.04	231.90	69.42	5.72	1.82	0.07	0.03	10.06	0.01
RSG013	2979.22	567.90	157.11	9.71	3.62	0.07	0.03	9.23	0.01
RSG014	1210.26	234.78	65.57	5.41	1.76	0.07	0.03	9.34	0.01
RSG015	1694.52	367.03	115.67	10.65	3.02	0.07	0.03	10.38	0.01
RSG016	1218.94	268.04	76.76	5.56	2.04	0.08	0.03	10.75	0.01
RSG017	814.49	108.04	33.24	3.45	1.01	0.04	0.02	6.15	0.01
RSG018	3877.67	484.92	129.67	7.79	3.16	0.04	0.01	5.84	0.01
RSG019	1159.02	270.54	49.21	6.20	2.11	0.08	0.03	11.39	0.01
RSG020	336.36	53.41	15.03	1.63	0.53	0.05	0.02	7.31	0.01
RSG021	1501.89	278.92	73.34	5.60	1.81	0.06	0.02	8.89	0.01
RSG022	210.57	44.95	16.20	1.66	0.50	0.07	0.03	10.04	0.01
RSG023	171.92	30.06	8.92	0.32	0.21	0.06	0.02	8.48	0.01
RSG025	710.88	189.47	63.53	4.21	2.42	0.09	0.04	13.00	0.01
RSG026	105.52	55.67	28.48	1.70	2.80	0.25	0.17	31.52	0.06
RSG027	170.70	39.88	12.36	1.11	0.27	0.08	0.03	11.31	0.01
RSG029	904.55	250.51	96.39	6.90	1.09	0.09	0.04	13.42	0.00
RSG032	183.34	43.16	17.70	1.73	1.18	0.06	0.03	10.47	0.03
RSG033	256.59	50.03	18.13	2.31	0.52	0.06	0.03	8.89	0.01
RSG034	660.26	113.35	33.04	2.37	1.25	0.06	0.02	8.10	0.01
RSG035	222.66	53.90	22.98	3.40	1.26	0.07	0.03	10.70	0.03
RSG036	314.58	78.97	28.50	1.96	2.00	0.09	0.04	12.36	0.03
RSG037	135.70	24.42	7.39	0.64	0.87	0.06	0.02	8.52	0.03
Min	105.52	24.42	7.39	0.32	0.21	0.04	0.01	5.84	0.00
Max	3877.67	567.90	157.11	10.65	3.62	0.25	0.17	31.52	0.06
Av	753.76	146.92	44.04	3.52	1.46	0.08	0.03	10.95	0.02
StdD	898.90	146.65	40.38	2.83	0.94	0.04	0.03	4.60	0.01

Contents in ppb, ratios from mol.units

GEOLAB NOR

Table 3b: Adsorbed Gas, Derived Parameters

RSG Surface Geochemistry

Sample	Propene/Propane*	C2-C6 alkenes/n-alkanes*	iC4/nC4
RSG003	0.02	0.02	0.97
RSG004	0.03	0.05	1.24
RSG006	0.01	0.01	0.99
RSG007	0.02	0.01	0.80
RSG008	0.03	0.02	0.92
RSG009	0.02	0.02	0.92
RSG012	0.01	0.01	0.92
RSG013	0.01	0.01	1.01
RSG014	0.01	0.01	0.90
RSG015	0.01	0.01	0.89
RSG016	0.01	0.01	0.96
RSG017	0.01	0.01	0.94
RSG018	0.01	0.01	0.94
RSG019	0.01	0.01	0.81
RSG020	0.01	0.01	0.79
RSG021	0.01	0.01	0.83
RSG022	0.02	0.01	0.90
RSG023	0.01	0.01	1.11
RSG025	0.02	0.01	0.87
RSG026	0.07	0.06	1.74
RSG027	0.01	0.01	0.84
RSG029	0.00	0.00	0.93
RSG032	0.04	0.03	0.66
RSG033	0.02	0.01	0.85
RSG034	0.02	0.01	0.88
RSG035	0.04	0.03	0.71
RSG036	0.03	0.03	0.99
RSG037	0.07	0.04	1.04
Min	0.00	0.00	0.66
Max	0.07	0.06	1.74
Av	0.02	0.02	0.94
StdD	0.02	0.01	0.19

Contents in ppb, ratios from mol.units

GEOLAB NOR

Table 4: Carbon Isotope Data, Adsorbed Gas

RSG Surface Geochemistry

Sample	Metane	Ethane	Propane	Iso-butane	N-butane	Pentane	Hexane
RSG006	-49.9	-	-	-	-	-	-
RSG007	-48.8	-	-	-	-	-	-
RSG008	-47.7	-36.5	-	-	-	-	-
RSG009	-43.4	-36.5	-35.2	-	-	-	-
RSG012	-42.6	-31.2	-30.6	-	-	-	-
RSG013	-18.2	-27.1	-	-	-	-	-
RSG014	-38.4	-32.7	-31.2	-	-	-	-
RSG015	-21.0	-28.5	-30.2	-	-	-	-
RSG016	-13.5	-25.4	-31.1	-	-	-	-
RSG018	-29.3	-34.1	-	-	-	-	-
RSG019	-44.1	-34.1	-33.2	-	-	-	-
RSG020	-49.1	-36.0	-31.2	-	-	-	-
RSG022	-34.0	-	-	-	-	-	-
RSG025	-44.8	-36.9	-34.2	-	-	-	-
RSG027	-38.0	-	-	-	-	-	-
RSG029	-50.8	-36.9	-35.6	-	-	-	-
RSG032	-58.5	-39.3	-	-	-	-	-
RSG033	-52.1	-41.5	-	-	-	-	-
RSG036	-58.0	-41.3	-	-	-	-	-

Sample RSG 035, selected by client, yielded only weak peaks insufficient for analysis.

'-' Denotes insufficiently intense peak for analysis

Table 5a: Extraction and Gas Chromatographic Data (ppm of EOM)

RSG Surface Geochemistry

Sample	Yield nC10 (ppm)	Yield nC11 (ppm)	Yield nC12 (ppm)	Yield nC13 (ppm)	Yield nC14 (ppm)	Yield nC15 (ppm)	Yield nC16 (ppm)	Yield nC17 (ppm)	Yield Pristane (ppm)	Yield nC18 (ppm)
RSG001 83/24-SC001	0.00	0.00	0.00	0.00	0.00	0.00	2093.30	6365.23	2557.66	6873.57
RSG002 83/24-SC002	0.00	0.00	0.00	0.00	0.00	0.00	4108.45	9036.19	3550.36	8202.56
RSG003 83/24-SC003	0.00	0.00	0.00	0.00	0.00	0.00	2521.10	7462.90	2454.32	6008.33
RSG004 83/24-SC004	0.00	0.00	0.00	0.00	0.00	3341.14	9639.91	13884.18	5341.97	7555.54
RSG005 83/24-SC005	0.00	0.00	0.00	0.00	0.00	3291.61	6187.73	8955.20	3778.25	7318.52
RSG006 83/20-SC001	0.00	0.00	0.00	0.00	0.00	3883.09	7362.69	10706.04	3673.59	6929.25
RSG007 83/20-SC002	0.00	0.00	0.00	0.00	0.00	2546.71	6928.32	10649.95	5262.09	6920.67
RSG008 83/20-SC003	0.00	0.00	0.00	0.00	0.00	2046.67	11715.20	14134.69	11174.45	9208.90
RSG009 83/20-SC004	0.00	0.00	0.00	0.00	0.00	1091.51	4983.95	17522.56	8242.24	8636.99
RSG010 83/20-SC005	0.00	0.00	0.00	0.00	0.00	1103.56	7361.64	13347.56	6106.40	8664.38
RSG011 16/28-SC002	0.00	0.00	0.00	0.00	0.00	2760.87	4690.70	8508.34	2990.42	4391.44
RSG012 11/20-SC006	0.00	0.00	0.00	0.00	0.00	3352.47	6992.47	10262.35	8298.01	8255.21
RSG013 11/20-SC007	0.00	0.00	0.00	0.00	0.00	4299.87	8305.70	10918.25	6902.40	8328.85
RSG014 11/20-SC008	0.00	0.00	0.00	0.00	0.00	1281.73	4305.39	8582.72	6358.47	7470.74
RSG015 11/20-SC009	0.00	0.00	0.00	0.00	2753.15	3903.24	4304.77	7089.29	6048.22	6505.67
RSG016 11/20-SC010	0.00	0.00	0.00	0.00	0.00	2698.18	4850.38	8589.90	7320.25	7820.75
RSG017 11/20-SC001	0.00	2543.99	1815.48	2537.71	5530.60	5431.92	4949.05	7145.31	4875.91	5345.65
RSG018 11/20-SC002	0.00	0.00	0.00	0.00	0.00	1630.61	4462.31	7839.80	5670.17	6193.23
RSG019 11/20-SC003	0.00	0.00	0.00	1213.20	3701.45	5215.80	5385.01	6708.83	5153.35	5908.09
RSG020 11/20-SC004	0.00	0.00	0.00	2032.29	4261.89	4431.15	5253.47	6206.87	4223.24	5753.23
RSG021 11/20-SC005	0.00	834.52	1063.94	1842.40	3120.40	3925.20	5318.35	7318.57	6287.50	6767.05
RSG022 78/28-SC005	0.00	0.00	0.00	0.00	5478.32	8350.05	10055.43	11099.22	6033.26	7278.57
RSG023 78/28-SC007	0.00	0.00	0.00	0.00	0.00	0.00	4064.97	9962.10	4503.20	6956.83
RSG024 83/29-SC001	0.00	0.00	1257.04	2855.95	8670.80	7523.69	9119.51	8134.95	3664.61	5706.21
RSG025 83/30-SC001	0.00	0.00	1763.10	2218.89	7542.77	5481.98	7730.34	7848.77	3550.57	4906.43
RSG026 83/23-SC002	0.00	0.00	0.00	1907.03	14029.47	6842.85	7513.67	9803.03	4430.82	5295.84
RSG027 83/5-SC002	0.00	0.00	0.00	0.00	5324.74	5395.02	7200.74	8819.22	4094.63	6648.56
RSG028 83/5-SC001	0.00	0.00	0.00	0.00	0.00	0.00	3676.23	10085.75	4362.31	11245.60
RSG029 83/3-SC002	0.00	1736.70	3203.04	3389.29	9096.38	7743.09	7694.91	9602.93	3582.00	4177.10
RSG030 74/1-SC001	0.00	1527.77	4706.42	2732.29	7882.68	8244.57	9197.52	11200.44	6155.31	6908.67
RSG031 74/6-SC001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4986.73	4321.70	5123.85
RSG032 77/9-SC001	0.00	0.00	0.00	0.00	0.00	2550.91	7876.48	14253.76	7928.52	8210.30

Table 5a: Extraction and Gas Chromatographic Data (ppm of EOM)

RSG Surface Geochemistry

Sample	Yield nC10 (ppm)	Yield nC11 (ppm)	Yield nC12 (ppm)	Yield nC13 (ppm)	Yield nC14 (ppm)	Yield nC15 (ppm)	Yield nC16 (ppm)	Yield nC17 (ppm)	Yield Pristane (ppm)	Yield nC18 (ppm)
RSG033 78/30-SC001	0.00	0.00	0.00	0.00	0.00	0.00	5953.77	14103.27	6147.01	9246.46
RSG034 8/1-SC001	0.00	1414.39	4884.43	6650.58	10757.41	8701.77	8397.60	10660.65	4708.09	6056.53
RSG035 8/2-SC001	0.00	0.00	0.00	0.00	0.00	0.00	3670.32	8708.09	3523.47	5511.52
RSG036 8/9-SC001	0.00	0.00	0.00	2055.88	10740.39	11947.78	12272.13	13326.78	5223.31	7463.42
RSG037 9/7-SC001	0.00	5131.11	4084.37	4086.87	14251.81	12434.34	14820.75	14835.49	5700.61	6264.00
Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4986.73	2454.32	4177.10
Max.	0.00	5131.11	4884.43	6650.58	14251.81	12434.34	14820.75	17522.56	11174.45	11245.60
Av.	0.00	356.45	615.62	906.01	3057.90	3823.01	6512.55	9963.94	5248.61	6920.50
St.Dev.	0.00	1002.03	1374.81	1544.65	4410.00	3354.68	2961.41	2849.59	1813.69	1486.01

Table 5a: Extraction and Gas Chromatographic Data (ppm of EOM)

RSG Surface Geochemistry

Sample	Yield Phytane (ppm)	Yield nC19 (ppm)	Yield nC20 (ppm)	Yield nC21 (ppm)	Yield nC22 (ppm)	Yield nC23 (ppm)	Yield nC24 (ppm)	Yield nC25 (ppm)	Yield nC26 (ppm)	Yield nC27 (ppm)	Yield nC28 (ppm)
RSG001 83/24-SC001	4661.99	4575.95	6522.58	3045.32	4260.54	3467.98	3814.76	4620.81	3321.31	4762.40	2134.48
RSG002 83/24-SC002	5113.91	5109.32	4415.11	3490.26	5181.90	7030.87	5694.38	12556.43	5953.70	13444.84	4833.79
RSG003 83/24-SC003	6401.18	4376.99	3974.30	2403.56	3702.87	3617.57	3709.73	13990.54	3233.63	4667.63	3303.15
RSG004 83/24-SC004	5210.60	4526.05	4004.91	3465.15	4750.70	7098.24	5770.70	15390.27	7347.56	15963.14	4951.54
RSG005 83/24-SC005	5336.72	4863.29	5099.08	3651.77	5169.72	4999.60	4186.43	19053.87	5055.69	9479.85	4273.04
RSG006 83/20-SC001	4085.14	4742.98	4768.12	2915.96	5042.34	8143.44	6682.97	17738.18	9192.50	26916.71	8354.96
RSG007 83/20-SC002	4370.28	5107.72	5334.47	4292.53	4512.90	5183.78	3693.59	11689.77	5065.66	11486.39	4323.12
RSG008 83/20-SC003	5473.25	5636.71	5408.51	3225.16	3589.55	3727.96	2912.62	6651.49	4642.77	9473.32	3373.00
RSG009 83/20-SC004	6821.65	11264.67	10209.65	5780.75	5172.73	4883.67	3210.51	5543.48	4230.93	7260.66	3341.62
RSG010 83/20-SC005	6055.91	5873.48	5400.06	4118.20	3598.67	3469.47	3225.08	4681.34	4148.72	6336.33	3398.33
RSG011 16/28-SC002	3035.41	2977.56	2726.33	2501.77	2231.51	3171.32	2404.07	4673.39	2710.66	5352.31	2137.32
RSG012 11/20-SC006	4622.07	10229.00	9648.95	10861.73	10457.22	16208.34	10262.14	20281.52	9965.36	24320.31	7142.15
RSG013 11/20-SC007	4426.02	9508.48	7420.48	8931.24	7406.53	12395.39	8685.06	20300.13	9008.72	25792.21	8123.59
RSG014 11/20-SC008	3612.48	9966.62	9656.84	12356.68	10926.84	19070.69	11737.97	26409.94	11773.06	30148.91	8001.21
RSG015 11/20-SC009	3223.53	7512.32	7283.12	10075.75	9612.07	17253.73	11298.08	22393.05	12912.55	29620.37	7832.20
RSG016 11/20-SC010	3406.57	10333.59	9354.03	13225.42	12439.86	21124.82	13115.09	26706.85	12685.04	32111.64	9588.49
RSG017 11/20-SC001	2013.02	7408.60	6688.30	10639.37	9385.05	17911.60	11433.84	24676.57	11742.52	33981.36	11404.58
RSG018 11/20-SC002	2597.69	7027.15	6041.19	7706.63	7071.37	11683.73	7569.72	18589.08	7749.28	21688.88	5935.66
RSG019 11/20-SC003	2851.44	9637.16	7245.77	11291.60	10853.20	20593.35	12289.08	28539.55	12340.45	30351.29	9139.67
RSG020 11/20-SC004	2306.19	7630.65	6575.07	10919.09	9845.93	17433.11	9703.89	23810.20	11894.78	33070.75	10986.29
RSG021 11/20-SC005	3036.26	9685.85	8446.14	13564.30	12794.41	25283.42	13281.01	32609.27	14295.75	39119.44	11564.86
RSG022 78/28-SC005	3543.18	4869.38	3636.13	3539.89	3388.27	4702.13	4121.15	9110.61	5056.64	10106.15	4412.60
RSG023 78/28-SC007	3377.40	4995.30	3505.20	2949.19	3139.02	3928.71	4759.43	9130.43	6730.36	11393.94	6058.14
RSG024 83/29-SC001	3008.08	5571.19	5030.78	8223.06	8688.71	16972.85	10760.93	24078.29	10120.84	27392.23	7294.86
RSG025 83/30-SC001	2574.20	5614.01	3899.07	3602.71	3430.25	4410.97	2912.31	5549.22	3170.34	7230.34	2560.03
RSG026 83/23-SC002	3411.36	3259.84	2542.22	1774.41	1527.85	1546.28	998.12	1153.77	1054.13	1048.31	2102.19
RSG027 83/5-SC002	4363.00	4579.73	3424.04	3397.90	3054.48	3802.20	3067.39	4520.29	3142.77	5686.49	2172.10
RSG028 83/5-SC001	4854.01	5504.23	5086.28	4360.26	5531.37	4104.16	3366.87	5431.50	4194.56	8031.62	3369.17
RSG029 83/3-SC002	2265.18	4596.71	3231.70	3176.93	4182.08	7322.81	6110.82	15928.93	8789.95	24045.87	8192.71
RSG030 74/1-SC001	4221.42	4795.16	3221.29	2480.73	2551.88	2285.92	1944.02	4078.85	2699.78	5321.47	2740.55
RSG031 74/6-SC001	2935.33	4344.23	3377.54	3216.42	3405.45	5233.05	5016.60	9213.92	5973.50	12181.57	5205.63
RSG032 77/9-SC001	5080.58	5695.58	4779.07	4303.17	4269.96	4450.93	3442.00	8985.62	3946.91	8143.89	3858.07

Table 5a: Extraction and Gas Chromatographic Data (ppm of EOM)

Sample	Yield Phytane (ppm)	Yield nC19 (ppm)	Yield nC20 (ppm)	Yield nC21 (ppm)	Yield nC22 (ppm)	Yield nC23 (ppm)	Yield nC24 (ppm)	Yield nC25 (ppm)	Yield nC26 (ppm)	Yield nC27 (ppm)	Yield nC28 (ppm)
RSG033 78/30-SC001	4772.18	6395.16	4146.34	3322.11	3373.68	5310.34	4763.68	9040.47	6243.18	12492.12	4826.18
RSG034 8/1-SC001	2899.45	7204.25	5411.48	5492.90	4546.69	5894.88	3855.23	7098.97	4040.62	8307.92	3404.61
RSG035 8/2-SC001	2837.48	5138.10	4517.24	4403.58	4147.59	3913.23	2865.65	5340.78	3318.53	7757.82	3047.20
RSG036 8/9-SC001	3829.02	6735.51	3673.36	3561.83	3340.64	5471.22	3912.50	6581.97	3490.31	6299.90	1677.70
RSG037 9/7-SC001	3963.47	6288.74	3886.20	4155.25	3379.79	4321.74	3073.77	6340.44	3674.41	7022.23	2681.04
Min.	2013.02	2977.56	2542.22	1774.41	1527.85	1546.28	998.12	1153.77	1054.13	1048.31	1677.70
Max.	6821.65	11264.67	10209.65	13564.30	12794.41	25283.42	13281.01	32609.27	14295.75	39119.44	11564.86
Av.	3962.07	6313.01	5394.35	5687.10	5674.69	8579.01	5936.52	13310.53	6619.39	15616.50	5344.48
St.Dev.	1203.62	2146.05	2077.43	3540.29	3089.78	6540.58	3586.14	8551.57	3620.90	10784.23	2870.88

Table 5a: Extraction and Gas Chromatographic Data (ppm of EOM)

RSG Surface Geochemistry

Sample	Yield nC29 (ppm)	Yield nC30 (ppm)	Yield nC31 (ppm)	Yield nC32 (ppm)	Yield nC33 (ppm)	Yield nC34 (ppm)	Yield nC35 (ppm)	UCM RT <nC23 (ppm)	UCM RT =>nC23 (ppm)	C10-C35 n-alk. (ppm)	EOM (mg)	Ratio Pr/Ph
RSG001 83/24-SC001	5329.62	1470.88	5673.07	736.32	2729.03	0.00	0.00	257327.46	444153.08	71797.14	0.03	0.55
RSG002 83/24-SC002	17157.57	3515.08	18949.32	1847.40	6799.23	1210.71	1716.30	287970.71	395984.00	140253.41	0.03	0.69
RSG003 83/24-SC003	5804.35	2034.03	8398.85	1106.54	4440.33	1711.83	0.00	253888.43	431156.36	86468.22	0.02	0.38
RSG004 83/24-SC004	17883.89	3600.20	23160.72	1986.11	7628.91	0.00	862.45	409119.46	262720.37	162811.31	0.02	1.03
RSG005 83/24-SC005	11288.83	3374.44	14840.03	2308.66	7625.62	1033.83	0.00	307319.74	242533.50	132056.79	0.03	0.71
RSG006 83/20-SC001	43415.73	8324.54	59733.17	5080.20	13466.66	1973.67	1089.41	303157.43	284723.08	256462.61	0.03	0.90
RSG007 83/20-SC002	18109.51	4713.86	28279.21	2275.07	10393.61	1118.27	1516.24	378140.47	288608.10	154141.36	0.03	1.20
RSG008 83/20-SC003	13638.59	2742.70	16827.29	1439.44	6029.13	0.00	0.00	394219.62	324460.46	126423.69	0.02	2.04
RSG009 83/20-SC004	9157.92	2696.41	12303.22	1704.71	5105.41	961.81	0.00	423831.11	308979.23	125063.17	0.02	1.21
RSG010 83/20-SC005	8664.38	2057.27	12522.82	926.63	3845.12	1157.03	0.00	381401.91	382236.52	103900.06	0.02	1.01
RSG011 16/28-SC002	6702.02	3006.64	8447.21	2754.09	3229.02	1843.52	0.00	182594.23	586131.16	77220.09	0.05	0.99
RSG012 11/20-SC006	27888.42	5063.96	30386.28	2353.88	12168.62	814.51	1353.22	324199.17	292969.30	238268.11	0.07	1.80
RSG013 11/20-SC007	47275.88	6097.93	73746.68	4584.43	29743.35	1116.92	1997.22	282209.52	238201.81	313986.91	0.06	1.56
RSG014 11/20-SC008	34838.97	6089.91	36987.77	2756.08	12423.58	1107.08	1593.63	271216.01	318433.57	267486.36	0.05	1.76
RSG015 11/20-SC009	31641.89	6940.57	34275.45	2793.57	12586.91	966.24	1855.05	323134.63	297204.04	251409.06	0.09	1.88
RSG016 11/20-SC010	37911.15	7522.00	39512.25	3123.10	13014.33	1051.82	1759.08	282860.67	315654.49	288537.76	0.15	2.15
RSG017 11/20-SC001	46222.72	13214.05	55932.99	4311.02	20159.27	831.31	1920.97	264290.38	226395.15	323163.83	0.09	2.42
RSG018 11/20-SC002	28309.14	7061.56	33860.01	3372.70	12306.90	931.94	1454.07	276963.94	319001.20	208484.97	0.03	2.18
RSG019 11/20-SC003	34099.73	6336.08	33139.44	2290.58	9734.02	0.00	0.00	300780.44	272344.71	266013.33	0.07	1.81
RSG020 11/20-SC004	49365.36	12869.79	68174.08	6087.65	27434.63	0.00	0.00	248718.92	232825.32	333740.19	0.10	1.83
RSG021 11/20-SC005	42137.11	8486.20	38651.32	2905.37	10971.27	0.00	0.00	267666.79	269498.39	313986.16	0.07	2.07
RSG022 78/28-SC005	14157.66	2743.69	16757.13	1449.30	6134.98	0.00	0.00	437861.98	290706.73	136447.29	0.02	1.70
RSG023 78/28-SC007	19940.80	4073.42	27539.78	2157.94	10312.30	0.00	0.00	364020.80	388633.94	141597.86	0.01	1.33
RSG024 83/29-SC001	38828.26	3832.21	43165.86	1706.73	13485.44	0.00	0.00	373733.14	231220.01	268420.37	0.02	1.22
RSG025 83/30-SC001	8857.07	2081.76	12402.16	1090.09	5179.37	2285.20	0.00	434146.31	276106.49	111767.17	0.03	1.38
RSG026 83/23-SC002	949.15	0.00	1010.00	0.00	0.00	0.00	0.00	454329.31	313315.54	64358.14	0.01	1.30
RSG027 83/5-SC002	6525.53	1290.19	7341.94	1052.58	2371.78	0.00	0.00	411749.33	302813.40	88817.68	0.02	0.94
RSG028 83/5-SC001	10577.19	2325.08	14089.78	1135.52	5110.87	0.00	0.00	363601.00	418769.54	107226.05	0.02	0.90
RSG029 83/3-SC002	38056.83	5778.69	50890.52	3222.82	18300.43	0.00	0.00	351254.84	209986.04	248471.22	0.02	1.58
RSG030 74/1-SC001	7231.38	2115.90	8491.33	0.00	3726.28	0.00	0.00	439874.73	262927.01	106084.90	0.02	1.46
RSG031 74/6-SC001	17454.29	2981.36	19519.40	1318.79	6114.53	0.00	0.00	349135.66	514397.51	114666.85	0.02	1.47
RSG032 77/9-SC001	9693.64	2298.15	10370.56	1213.54	4179.63	0.00	0.00	413139.95	300354.85	112522.17	0.05	1.56

Table 5a: Extraction and Gas Chromatographic Data (ppm of EOM)

RSG Surface Geochemistry

Sample	Yield nC29 (ppm)	Yield nC30 (ppm)	Yield nC31 (ppm)	Yield nC32 (ppm)	Yield nC33 (ppm)	Yield nC34 (ppm)	Yield nC35 (ppm)	UCM RT <nC23 (ppm)	UCM RT =>nC23 (ppm)	C10-C35 n-alk. (ppm)	EOM (mg)	Ratio Pr/Ph
RSG033 78/30-SC001	16929.99	3341.22	22191.50	2117.16	8566.93	0.00	0.00	415103.70	355316.62	142363.57	0.01	1.29
RSG034 8/1-SC001	8952.84	1855.31	9309.72	639.54	3186.45	0.00	0.00	386422.19	255645.90	136724.79	0.02	1.62
RSG035 8/2-SC001	9168.51	2924.99	10667.22	1115.73	4097.05	0.00	0.00	245175.03	535150.32	90313.15	0.03	1.24
RSG036 8/9-SC001	4457.11	814.59	3364.30	0.00	789.73	0.00	0.00	407415.44	247822.63	111977.02	0.02	1.36
RSG037 9/7-SC001	9843.35	3801.70	9016.19	2513.44	3328.65	0.00	0.00	444885.57	243184.28	149235.66	0.02	1.44
Min.	949.15	0.00	1010.00	0.00	0.00	0.00	0.00	182594.23	209986.04	64358.14	0.01	0.38
Max.	49365.36	13214.05	73746.68	6087.65	29743.35	2285.20	1997.22	454329.31	586131.16	333740.19	0.15	2.42
Av.	20499.09	4310.17	24862.93	2093.97	8830.25	543.67	462.64	343590.81	321096.34	172234.28	0.04	1.40
St.Dev.	14570.88	2993.90	18710.88	1377.93	6713.07	693.13	744.53	71700.17	89875.79	82670.86	0.03	0.48

Table 5b: Extraction and Gas Chromatography Data (ug/g sediment)

RSG Surface Geochemistry

Sample	Yield nC10 (ug/g)	Yield nC11 (ug/g)	Yield nC12 (ug/g)	Yield nC13 (ug/g)	Yield nC14 (ug/g)	Yield nC15 (ug/g)	Yield nC16 (ug/g)	Yield nC17 (ug/g)	Yield Pristane (ug/g)	Yield nC18 (ug/g)
RSG001 83/24-SC001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
RSG002 83/24-SC002	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.02
RSG003 83/24-SC003	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
RSG004 83/24-SC004	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01
RSG005 83/24-SC005	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.02
RSG006 83/20-SC001	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.02
RSG007 83/20-SC002	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01
RSG008 83/20-SC003	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
RSG009 83/20-SC004	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.02
RSG010 83/20-SC005	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01
RSG011 16/28-SC002	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.01	0.02
RSG012 11/20-SC006	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.05	0.04	0.04
RSG013 11/20-SC007	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.05	0.03	0.04
RSG014 11/20-SC008	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.02	0.03
RSG015 11/20-SC009	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03
RSG016 11/20-SC010	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.07	0.06	0.07
RSG017 11/20-SC001	0.00	0.02	0.01	0.01	0.03	0.03	0.03	0.04	0.03	0.03
RSG018 11/20-SC002	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01
RSG019 11/20-SC003	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.03
RSG020 11/20-SC004	0.00	0.00	0.00	0.01	0.03	0.03	0.03	0.04	0.03	0.04
RSG021 11/20-SC005	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0.03
RSG022 78/28-SC005	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
RSG023 78/28-SC007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
RSG024 83/29-SC001	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
RSG025 83/30-SC001	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.01	0.01
RSG026 83/23-SC002	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
RSG027 83/5-SC002	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01
RSG028 83/5-SC001	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
RSG029 83/3-SC002	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
RSG030 74/1-SC001	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.01
RSG031 74/6-SC001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
RSG032 77/9-SC001	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.03	0.04

GEOLAB NOR

Table 5b: Extraction and Gas Chromatography Data (ug/g sediment)

RSG Surface Geochemistry

Sample	Yield nC10 (ug/g)	Yield nC11 (ug/g)	Yield nC12 (ug/g)	Yield nC13 (ug/g)	Yield nC14 (ug/g)	Yield nC15 (ug/g)	Yield nC16 (ug/g)	Yield nC17 (ug/g)	Yield Pristane (ug/g)	Yield nC18 (ug/g)
RSG033 78/30-SC001	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
RSG034 8/1-SC001	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
RSG035 8/2-SC001	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01
RSG036 8/9-SC001	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.01	0.01
RSG037 9/7-SC001	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01
Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Max.	0.00	0.02	0.01	0.01	0.03	0.03	0.04	0.07	0.06	0.07
Av.	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.01	0.02
St.Dev.	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01

Table 5b: Extraction and Gas Chromatography Data (ug/g sediment)

Sample	Yield Phytane (ug/g)	Yield nC19 (ug/g)	Yield nC20 (ug/g)	Yield nC21 (ug/g)	Yield nC22 (ug/g)	Yield nC23 (ug/g)	Yield nC24 (ug/g)	Yield nC25 (ug/g)	Yield nC26 (ug/g)	Yield nC27 (ug/g)	Yield nC28 (ug/g)
RSG001 83/24-SC001	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
RSG002 83/24-SC002	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.03	0.01	0.03	0.01
RSG003 83/24-SC003	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.03	0.01	0.01	0.01
RSG004 83/24-SC004	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.02	0.01
RSG005 83/24-SC005	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.02	0.01
RSG006 83/20-SC001	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.04	0.02	0.06	0.02
RSG007 83/20-SC002	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01
RSG008 83/20-SC003	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00
RSG009 83/20-SC004	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
RSG010 83/20-SC005	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00
RSG011 16/28-SC002	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01
RSG012 11/20-SC006	0.02	0.05	0.05	0.05	0.05	0.08	0.05	0.10	0.05	0.12	0.04
RSG013 11/20-SC007	0.02	0.05	0.04	0.04	0.04	0.06	0.04	0.10	0.04	0.12	0.04
RSG014 11/20-SC008	0.01	0.04	0.04	0.05	0.04	0.07	0.04	0.10	0.04	0.11	0.03
RSG015 11/20-SC009	0.02	0.04	0.04	0.05	0.05	0.08	0.05	0.11	0.06	0.14	0.04
RSG016 11/20-SC010	0.03	0.09	0.08	0.11	0.11	0.18	0.11	0.23	0.11	0.27	0.08
RSG017 11/20-SC001	0.01	0.04	0.04	0.06	0.06	0.11	0.07	0.15	0.07	0.20	0.07
RSG018 11/20-SC002	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.04	0.02	0.05	0.01
RSG019 11/20-SC003	0.01	0.05	0.04	0.06	0.05	0.10	0.06	0.14	0.06	0.15	0.05
RSG020 11/20-SC004	0.01	0.05	0.04	0.07	0.06	0.11	0.06	0.15	0.08	0.21	0.07
RSG021 11/20-SC005	0.01	0.05	0.04	0.06	0.06	0.12	0.06	0.15	0.07	0.19	0.05
RSG022 78/28-SC005	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
RSG023 78/28-SC007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00
RSG024 83/29-SC001	0.00	0.01	0.01	0.01	0.01	0.03	0.02	0.04	0.02	0.04	0.01
RSG025 83/30-SC001	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
RSG026 83/23-SC002	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RSG027 83/5-SC002	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
RSG028 83/5-SC001	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00
RSG029 83/3-SC002	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.04	0.01
RSG030 74/1-SC001	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00
RSG031 74/6-SC001	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
RSG032 77/9-SC001	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.04	0.02	0.03	0.02

Table 5b: Extraction and Gas Chromatography Data
(ug/g sediment)

RSG Surface Geochemistry

Sample	Yield Phytane (ug/g)	Yield nC19 (ug/g)	Yield nC20 (ug/g)	Yield nC21 (ug/g)	Yield nC22 (ug/g)	Yield nC23 (ug/g)	Yield nC24 (ug/g)	Yield nC25 (ug/g)	Yield nC26 (ug/g)	Yield nC27 (ug/g)	Yield nC28 (ug/g)
RSG033 78/30-SC001	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00
RSG034 8/1-SC001	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.00
RSG035 8/2-SC001	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
RSG036 8/9-SC001	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00
RSG037 9/7-SC001	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00
Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max.	0.03	0.09	0.08	0.11	0.11	0.18	0.11	0.23	0.11	0.27	0.08
Av.	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.05	0.02	0.06	0.02
St.Dev.	0.01	0.02	0.02	0.03	0.02	0.04	0.03	0.06	0.03	0.07	0.02

Table 5b: Extraction and Gas Chromatography Data (ug/g sediment)

Sample	Yield nC29 (ug/g)	Yield nC30 (ug/g)	Yield nC31 (ug/g)	Yield nC32 (ug/g)	Yield nC33 (ug/g)	Yield nC34 (ug/g)	Yield nC35 (ug/g)	UCM RT <nC23 (ug/g)	UCM RT =>nC23 (ug/g)	C10-C35 n-alk. (ug/g)	EOM (ug/g)
RSG001 83/24-SC001	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.54	0.92	0.15	2.08
RSG002 83/24-SC002	0.04	0.01	0.05	0.00	0.02	0.00	0.00	0.69	0.95	0.34	2.41
RSG003 83/24-SC003	0.01	0.00	0.02	0.00	0.01	0.00	0.00	0.51	0.86	0.17	2.00
RSG004 83/24-SC004	0.02	0.00	0.03	0.00	0.01	0.00	0.00	0.54	0.34	0.21	1.31
RSG005 83/24-SC005	0.03	0.01	0.04	0.01	0.02	0.00	0.00	0.73	0.58	0.32	2.39
RSG006 83/20-SC001	0.10	0.02	0.13	0.01	0.03	0.00	0.00	0.68	0.64	0.57	2.23
RSG007 83/20-SC002	0.04	0.01	0.06	0.00	0.02	0.00	0.00	0.77	0.59	0.31	2.03
RSG008 83/20-SC003	0.01	0.00	0.02	0.00	0.01	0.00	0.00	0.42	0.34	0.13	1.06
RSG009 83/20-SC004	0.02	0.00	0.02	0.00	0.01	0.00	0.00	0.76	0.55	0.22	1.79
RSG010 83/20-SC005	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.47	0.47	0.13	1.24
RSG011 16/28-SC002	0.02	0.01	0.03	0.01	0.01	0.01	0.00	0.65	2.08	0.27	3.55
RSG012 11/20-SC006	0.14	0.03	0.15	0.01	0.06	0.00	0.01	1.61	1.45	1.18	4.96
RSG013 11/20-SC007	0.23	0.03	0.35	0.02	0.14	0.01	0.01	1.35	1.14	1.50	4.77
RSG014 11/20-SC008	0.13	0.02	0.14	0.01	0.05	0.00	0.01	1.02	1.20	1.01	3.77
RSG015 11/20-SC009	0.15	0.03	0.17	0.01	0.06	0.00	0.01	1.56	1.44	1.22	4.84
RSG016 11/20-SC010	0.32	0.06	0.34	0.03	0.11	0.01	0.01	2.40	2.68	2.45	8.49
RSG017 11/20-SC001	0.27	0.08	0.33	0.03	0.12	0.00	0.01	1.56	1.34	1.91	5.90
RSG018 11/20-SC002	0.06	0.01	0.07	0.01	0.03	0.00	0.00	0.58	0.67	0.44	2.10
RSG019 11/20-SC003	0.17	0.03	0.17	0.01	0.05	0.00	0.00	1.50	1.36	1.33	4.99
RSG020 11/20-SC004	0.32	0.08	0.44	0.04	0.18	0.00	0.00	1.60	1.50	2.15	6.45
RSG021 11/20-SC005	0.20	0.04	0.18	0.01	0.05	0.00	0.00	1.27	1.28	1.49	4.74
RSG022 78/28-SC005	0.02	0.00	0.02	0.00	0.01	0.00	0.00	0.59	0.39	0.18	1.35
RSG023 78/28-SC007	0.01	0.00	0.02	0.00	0.01	0.00	0.00	0.24	0.26	0.09	0.66
RSG024 83/29-SC001	0.06	0.01	0.07	0.00	0.02	0.00	0.00	0.58	0.36	0.41	1.54
RSG025 83/30-SC001	0.02	0.00	0.03	0.00	0.01	0.01	0.00	0.98	0.62	0.25	2.26
RSG026 83/23-SC002	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.21	0.04	0.66
RSG027 83/5-SC002	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.75	0.55	0.16	1.82
RSG028 83/5-SC001	0.01	0.00	0.02	0.00	0.01	0.00	0.00	0.51	0.58	0.15	1.39
RSG029 83/3-SC002	0.06	0.01	0.08	0.00	0.03	0.00	0.00	0.54	0.32	0.38	1.54
RSG030 74/1-SC001	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.66	0.40	0.16	1.51
RSG031 74/6-SC001	0.03	0.00	0.03	0.00	0.01	0.00	0.00	0.55	0.82	0.18	1.59
RSG032 77/9-SC001	0.04	0.01	0.04	0.01	0.02	0.00	0.00	1.76	1.28	0.48	4.27

Table 5b: Extraction and Gas Chromatography Data (ug/g sediment)

RSG Surface Geochemistry

Sample	Yield nC29 (ug/g)	Yield nC30 (ug/g)	Yield nC31 (ug/g)	Yield nC32 (ug/g)	Yield nC33 (ug/g)	Yield nC34 (ug/g)	Yield nC35 (ug/g)	UCM RT <nC23 (ug/g)	UCM RT =>nC23 (ug/g)	C10-C35 n-alk. (ug/g)	EOM (ug/g)
RSG033 78/30-SC001	0.02	0.00	0.02	0.00	0.01	0.00	0.00	0.40	0.34	0.14	0.97
RSG034 8/1-SC001	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.45	0.30	0.16	1.17
RSG035 8/2-SC001	0.02	0.01	0.03	0.00	0.01	0.00	0.00	0.62	1.36	0.23	2.54
RSG036 8/9-SC001	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.30	0.14	1.23
RSG037 9/7-SC001	0.02	0.01	0.01	0.00	0.01	0.00	0.00	0.69	0.38	0.23	1.56
Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.21	0.04	0.66
Max.	0.32	0.08	0.44	0.04	0.18	0.01	0.01	2.40	2.68	2.45	8.49
Av.	0.07	0.02	0.09	0.01	0.03	0.00	0.00	0.85	0.83	0.56	2.68
St.Dev.	0.09	0.02	0.11	0.01	0.04	0.00	0.00	0.50	0.56	0.64	1.84

Table 6: Total Scanning Fluorescence

RSG Surface Geochemistry

Sample		Max. int	Max. ex	Max. em	R1	Dilution Factor	Max Int
RSG005	83/24-SC005	222.40	220.00	343.00	1.16	1.00	222.40
RSG010	83/20-SC005	149.20	230.00	329.00	0.48	1.00	149.20
RSG011	16/28-SC002	586.30	210.00	302.00	0.36	1.00	586.30
RSG017	11/20-SC001	828.70	230.00	341.00	0.99	2.00	1657.40
RSG034	8/1-SC001	199.30	230.00	340.50	1.01	1.00	199.30
RSG035	8/2-SC001	133.30	200.00	295.00	0.66	1.00	133.30

Table 7a: GC-MS Data, Triterpane Ratios

RSG Surface Geochemistry

Sample	Ratio 1	Ratio 2	Ratio 3	Ratio 4	Ratio 5	Ratio 6	Ratio 7	Ratio 8	Ratio 9	Ratio 10	Ratio 11	Ratio 12	Ratio 13	Ratio 14
RSG 11 16/28 SC002	3.26	0.77	0.14	1.10	0.52	0.00	0.00	0.00	0.00	0.00	0.92	0.52	0.08	59.41
RSG 35 8/2 SC001	5.36	0.84	0.14	0.93	0.48	0.00	0.00	0.00	0.00	0.01	0.88	0.49	0.16	58.34

Table 7b: GC-MS Data, Triterpane Peak Heights

RSG Surface Geochemistry

Sample	23/3 (P)	24/3 (Q)	25/3 (R)	24/4 (S)	26/3 (T)	27Ts (A)	27Tm (B)	28ab (Z)	25nor30ab (Z1)	29ab (C)	29Ts (C1)	30d (X)	29ba (D)	30O
RSG 11 16/28 SC002	39.9	22.9	18.6	0.0	71.1	384.0	1253.0	0.0	0.0	7687.8	984.3	0.0	564.2	0.0
RSG 35 8/2 SC001	27.6	12.8	7.0	38.2	5.8	61.8	331.6	0.0	0.0	1713.1	95.4	0.0	323.6	0.0

Table 7b: GC-MS Data, Triterpane Peak Heights

RSG Surface Geochemistry

Sample	30ab (E)	30ba (F)	30G	31abS (G)	31abR (H)	31ba (I)	32abS (J1)	32abR (J2)	33abS (K1)	33abR (K2)	34abS (L1)	34abR (L2)
RSG 11 16/28 SC002	7000.0	575.5	0.0	4169.3	3494.7	411.3	2699.0	1844.1	1642.2	1093.3	1132.6	704.0
RSG 35 8/2 SC001	1836.9	247.3	0.0	593.2	1075.8	0.0	216.8	154.8	198.6	61.4	70.8	46.1

Table 7b: GC-MS Data, Triterpane Peak Heights

RSG Surface Geochemistry

Sample	35abS (M1)	35abR (M2)
RSG 11 16/28 SC002	863.7	563.3
RSG 35 8/2 SC001	52.0	34.3

Table 7d:GC-MS Data, Sterane Peak Heights

RSG Surface Geochemistry

Sample	21a (u)	22a (v)	27dbS (a)	27dbR (b)	27daR (c)	27daS (d)	28dbS (e)	28dbR (f)	28daR+27aaS (g)	29dbS+27bbR (h)	28daS+27bbS (i)
RSG 11 16/28 SC002	17.6	15.2	63.2	39.4	18.3	21.1	37.0	19.7	72.4	172.2	111.0
RSG 35 8/2 SC001	18.5	14.1	15.7	10.6	7.2	6.3	9.7	9.4	19.5	27.7	21.0

Table 7d:GC-MS Data, Sterane Peak Heights

RSG Surface Geochemistry

Sample	27aaR (j)	29dbR (k)	29daR (l)	28aaS (m)	29daS+28bbR (n)	28bbS (o)	28aaR (p)	29aaS (q)	29bbR (r)	29bbS (s)	29aaR (t)
RSG 11 16/28 SC002	127.5	65.2	28.6	50.2	82.3	112.6	57.9	116.7	263.1	221.3	203.7
RSG 35 8/2 SC001	32.6	14.5	7.2	22.5	20.6	22.6	15.0	28.1	53.3	40.0	35.5

Table 7c: GC-MS Data, Sterane Ratios

RSG Surface Geochemistry

Sample	Ratio 1	Ratio 2	Ratio 3	Ratio 4	Ratio 5	Ratio 6	Ratio 7	Ratio 8	Ratio 9	Ratio 10
RSG 11 16/28 SC002	0.33	36.43	75.15	0.41	0.81	0.04	0.03	0.60	0.57	2.38
RSG 35 8/2 SC001	0.33	44.24	74.59	0.57	0.77	0.17	0.13	0.59	0.79	2.63

GEOLAB NOR

Table 7e: GC-MS Data,
Triaromatic Sterane Ratios

RSG Surface Geochemistry

GEOLAB NOR

Sample	Ratio 1	Ratio 2	Ratio 3	Ratio 4	Ratio 5
RSG 11 16/28 SC002	0.06	0.05	0.04	0.03	0.10
RSG 35 8/2 SC001	0.29	0.18	0.14	0.14	0.30

Table 7f: GC-MS Data,
Triaromatic Sterane Peak Heights

RSG Surface Geochemistry

Sample	a1	b1	c1	d1	e1	f1	g1
RSG 11 16/28 SC002	9.6	7.6	18.3	90.8	112.3	61.2	152.4
RSG 35 8/2 SC001	9.6	5.4	9.1	22.6	22.6	11.9	24.0

Table 7g: GC-MS Data,
Monoaromatic Sterane Ratios

RSG Surface Geochemistry

Sample	Ratio 1	Ratio 2	Ratio 3	Ratio 4
RSG 11 16/28 SC002	0.14	0.09	0.07	0.05
RSG 35 8/2 SC001	0.25	0.23	0.12	0.10

Table 7i: GC-MS Data,
Phenanthrenes

RSG Surface Geochemistry

Sample	P	3MP	2MP	9MP	1MP	MPI1	Rc
RSG 11 16/28 SC002	3193.10	68.00	152.50	83.70	79.10	0.10	0.46
RSG 35 8/2 SC001	949.50	50.00	64.90	73.30	62.20	0.16	0.50

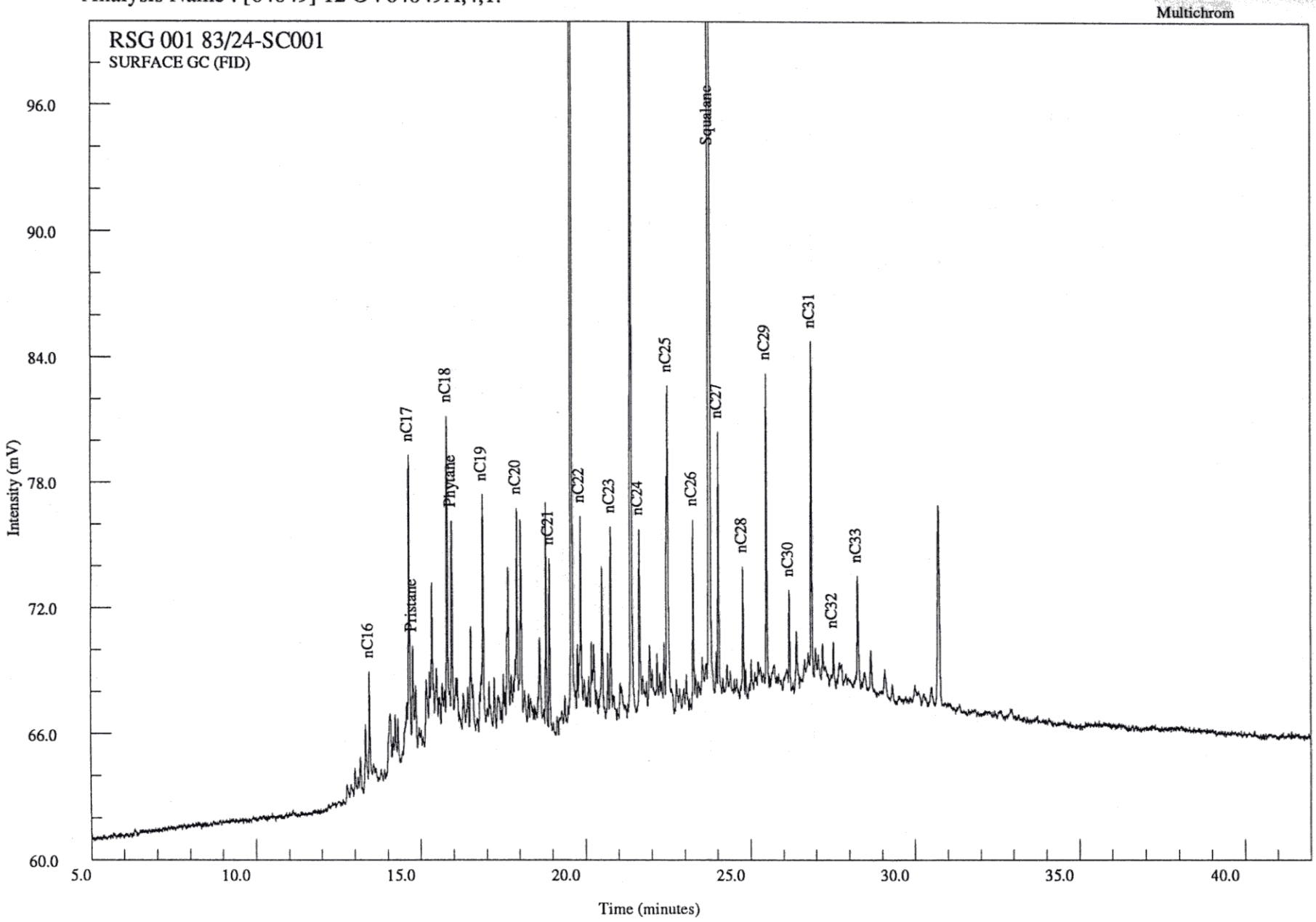
Table 7h: GC-MS Data,
Monoaromatic Sterane Peak Heights

RSG Surface Geochemistry

Sample	A1	B1	C1	D1	E1	F1	G1	H1	I1
RSG 11 16/28 SC002	3.2	2.0	9.3	6.9	19.7	6.4	25.2	19.6	8.5
RSG 35 8/2 SC001	4.6	4.0	4.6	10.8	13.5	3.5	19.7	15.6	6.1

APPENDIX 1 :

Analysis Name : [64049] 12 OV64049A,4,1.



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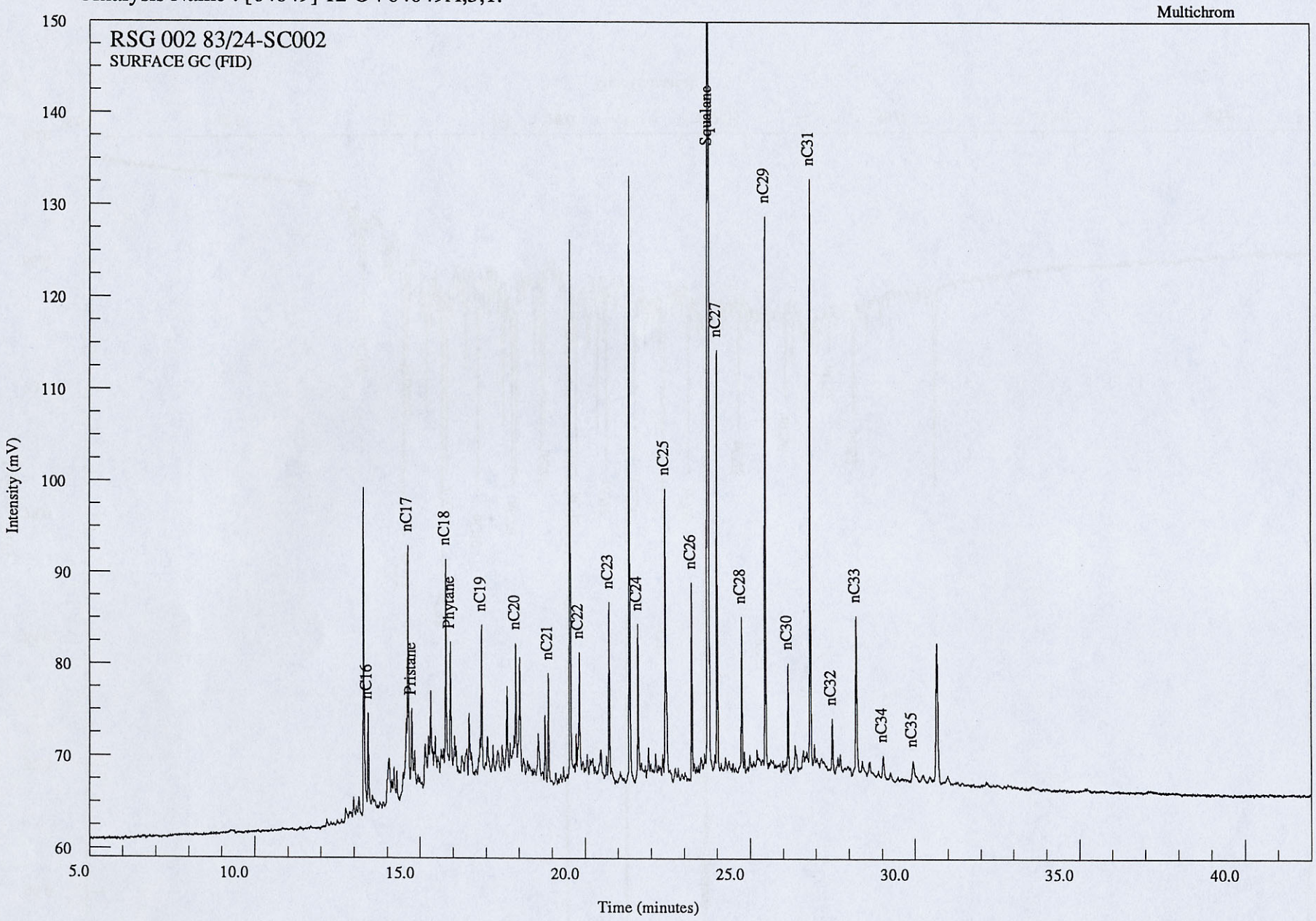

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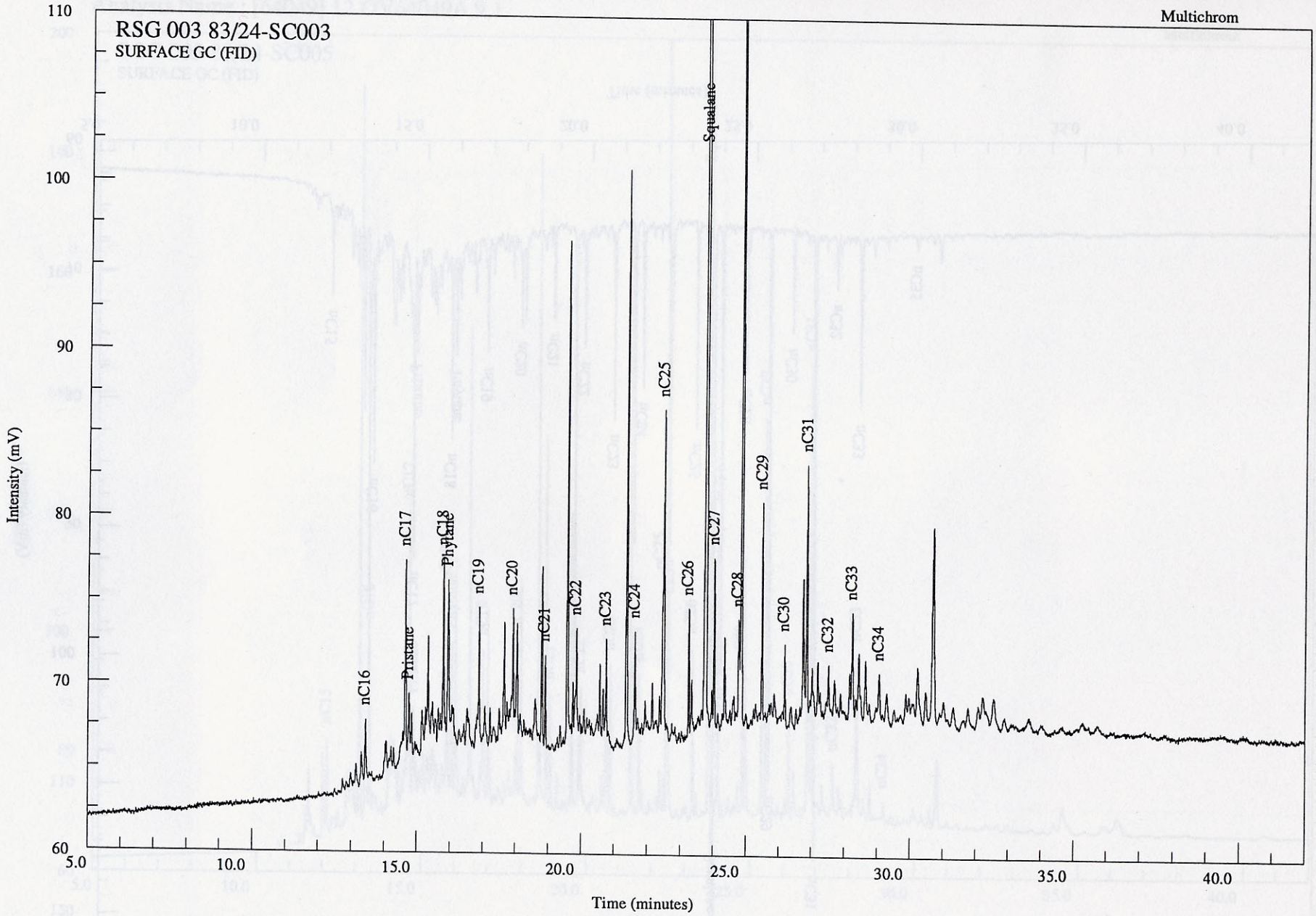

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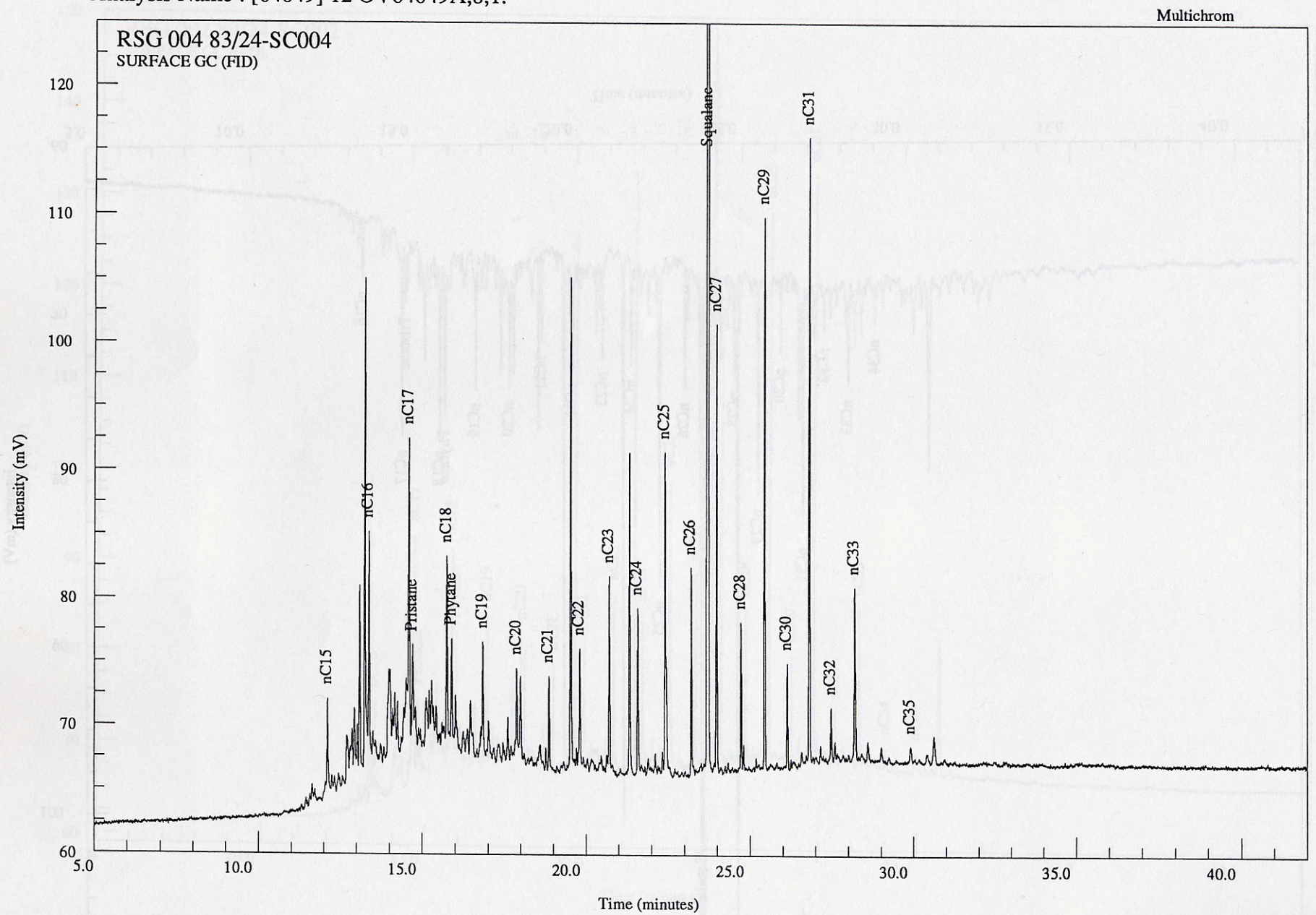

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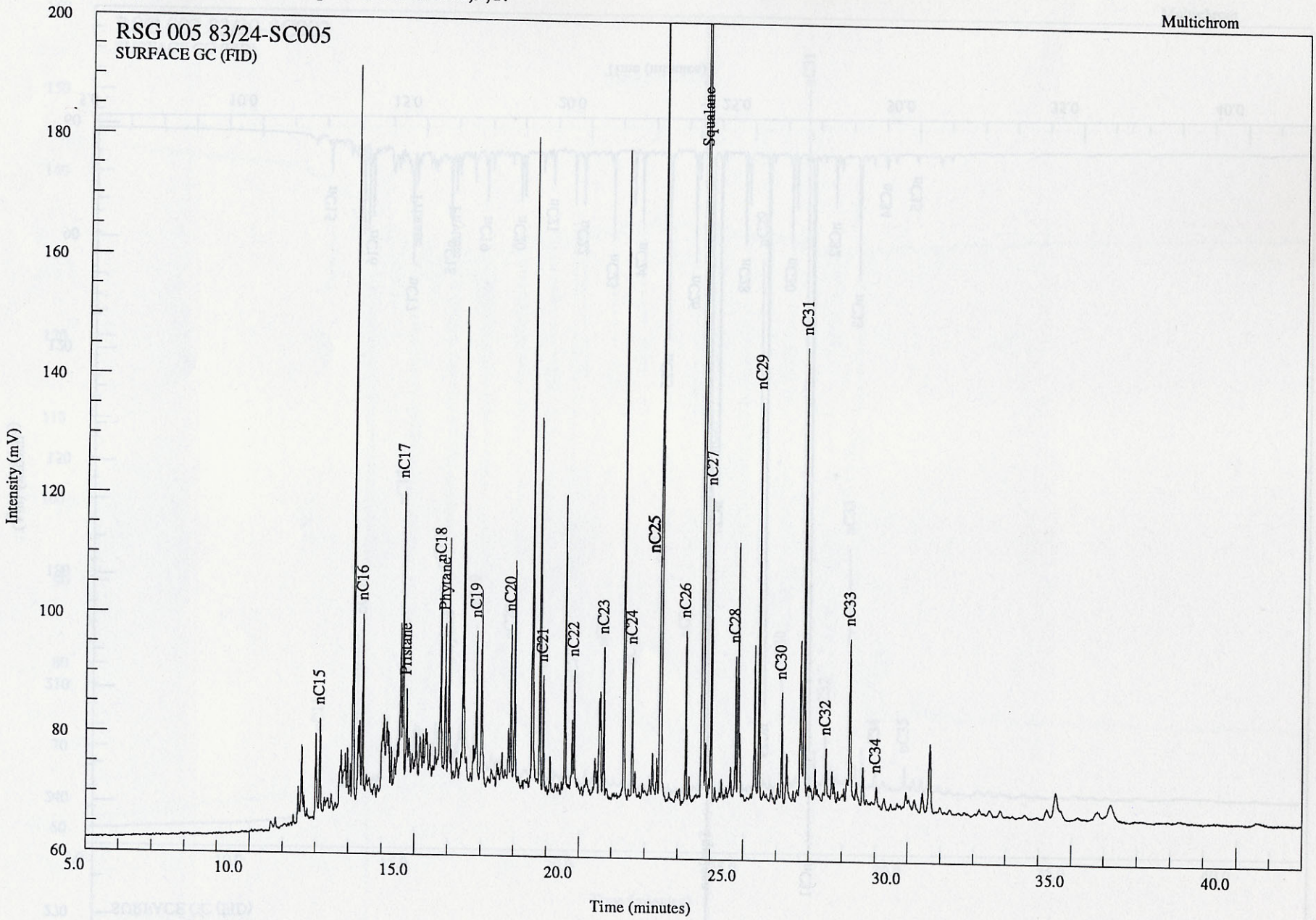

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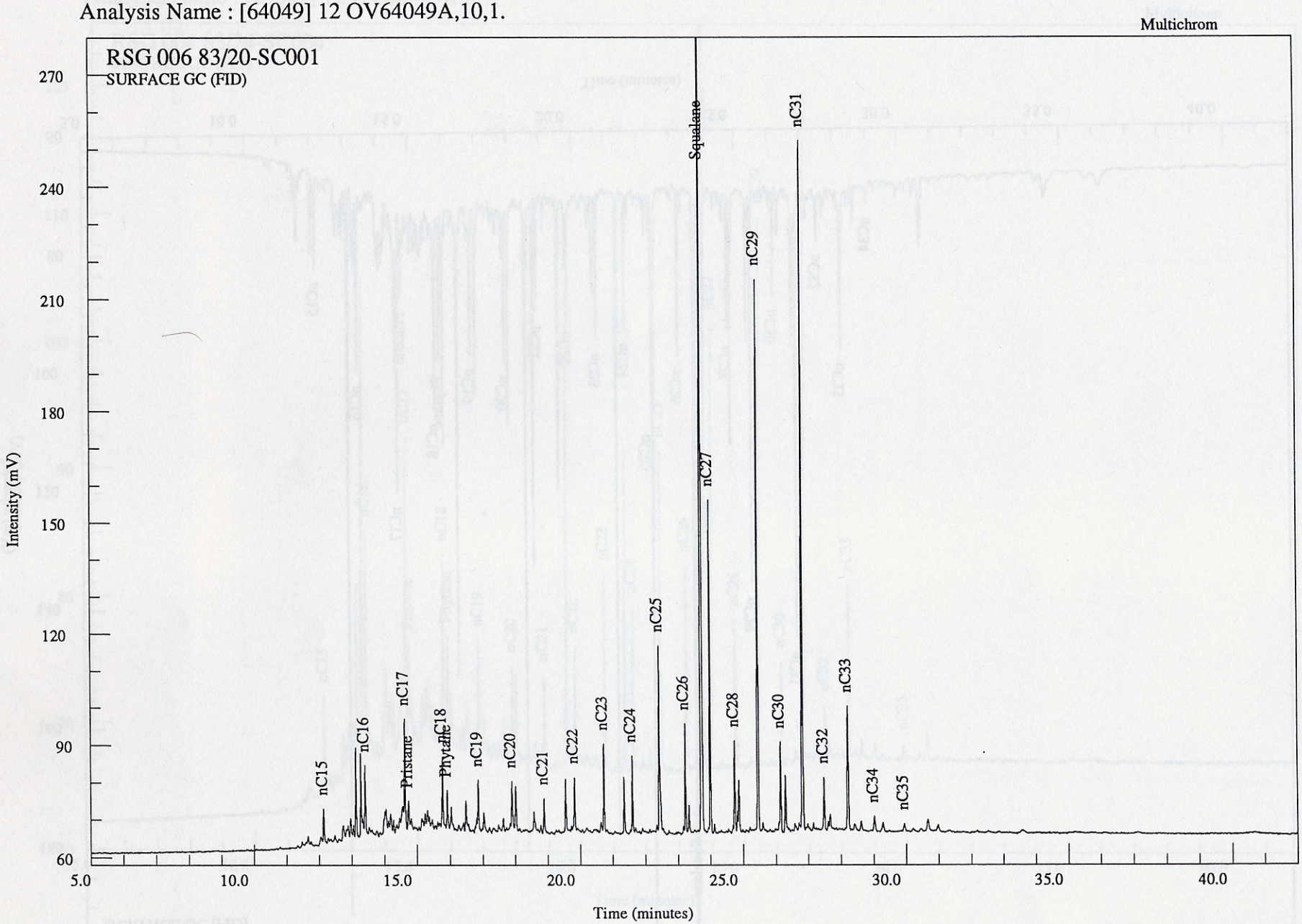

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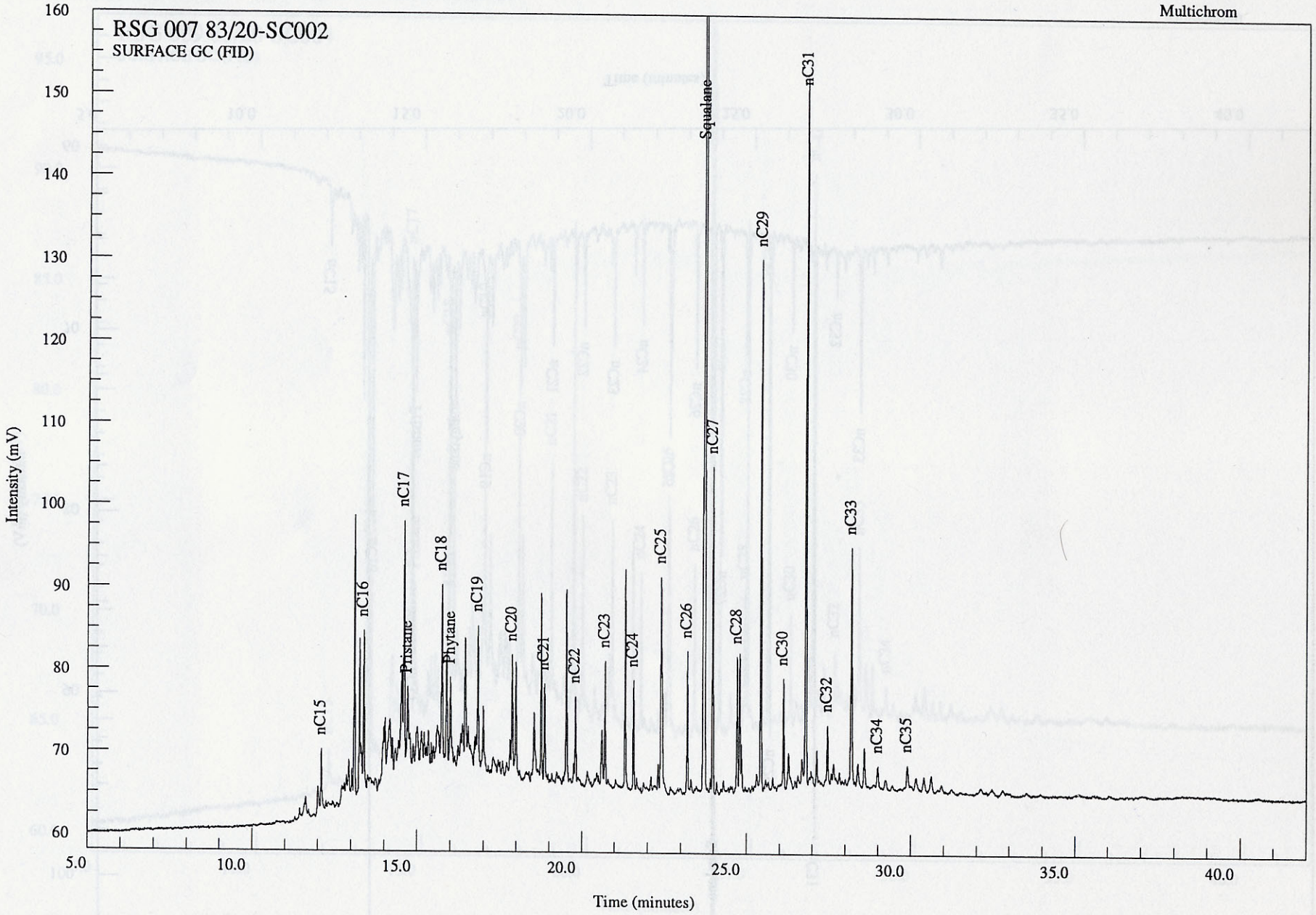

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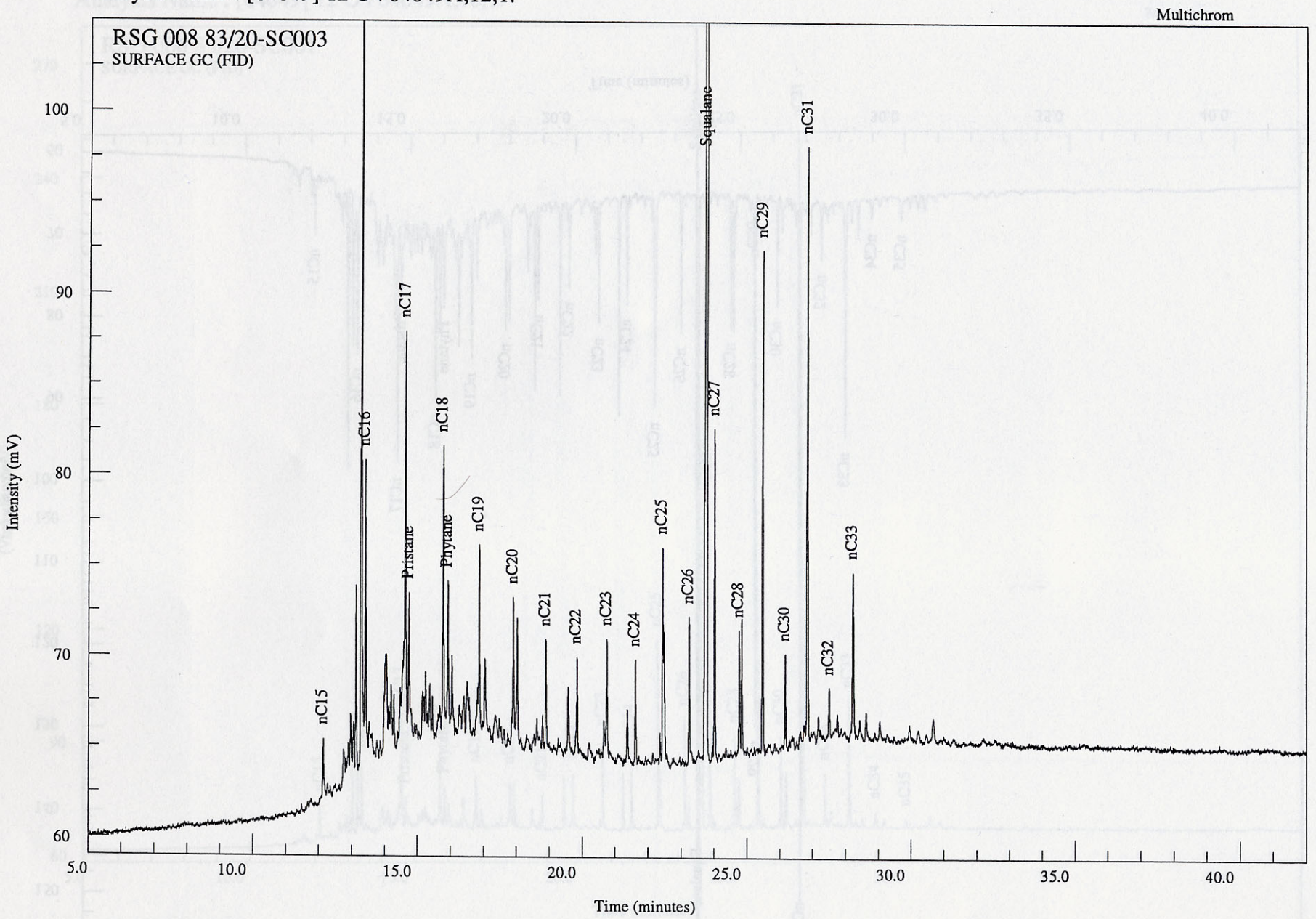

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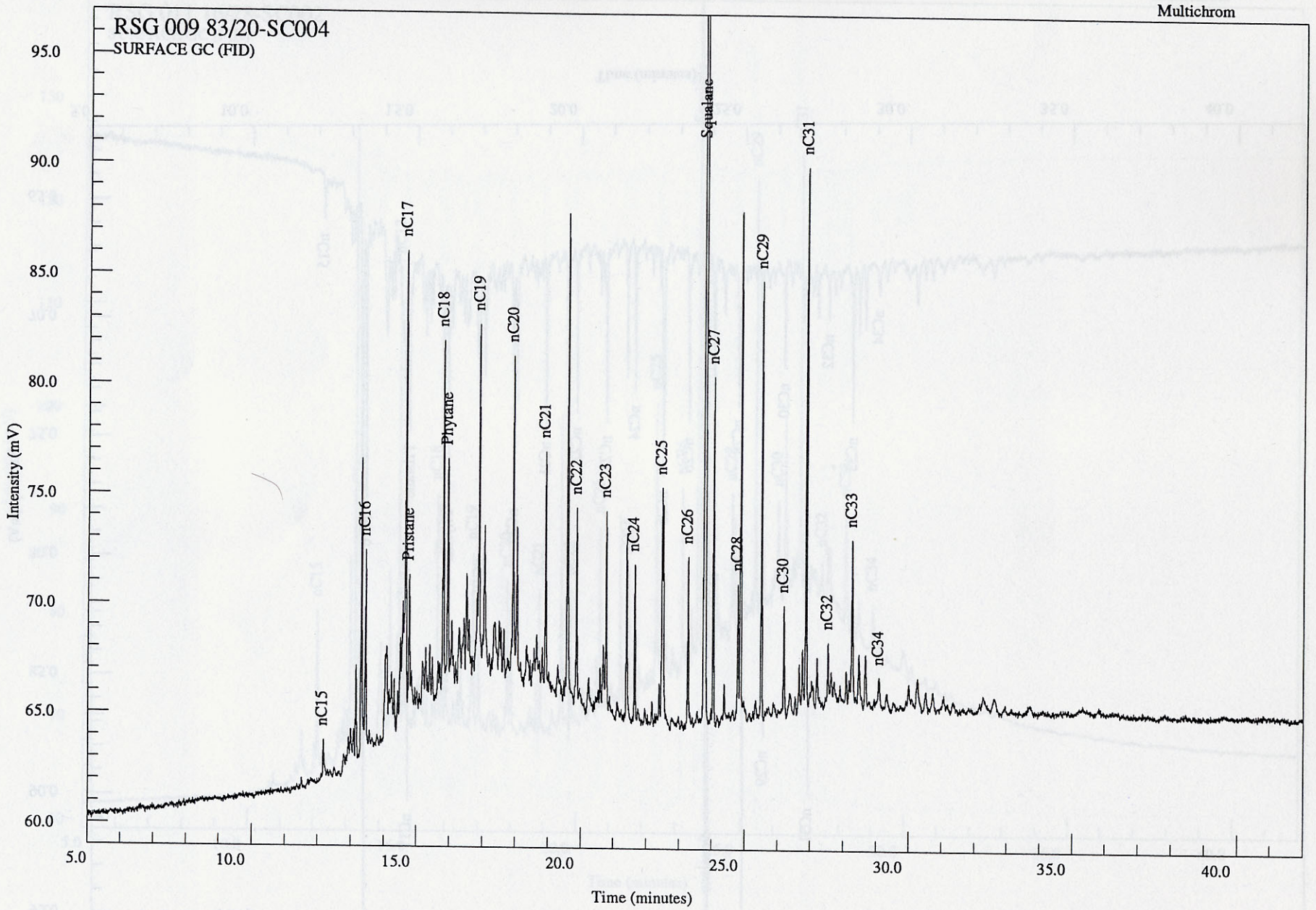

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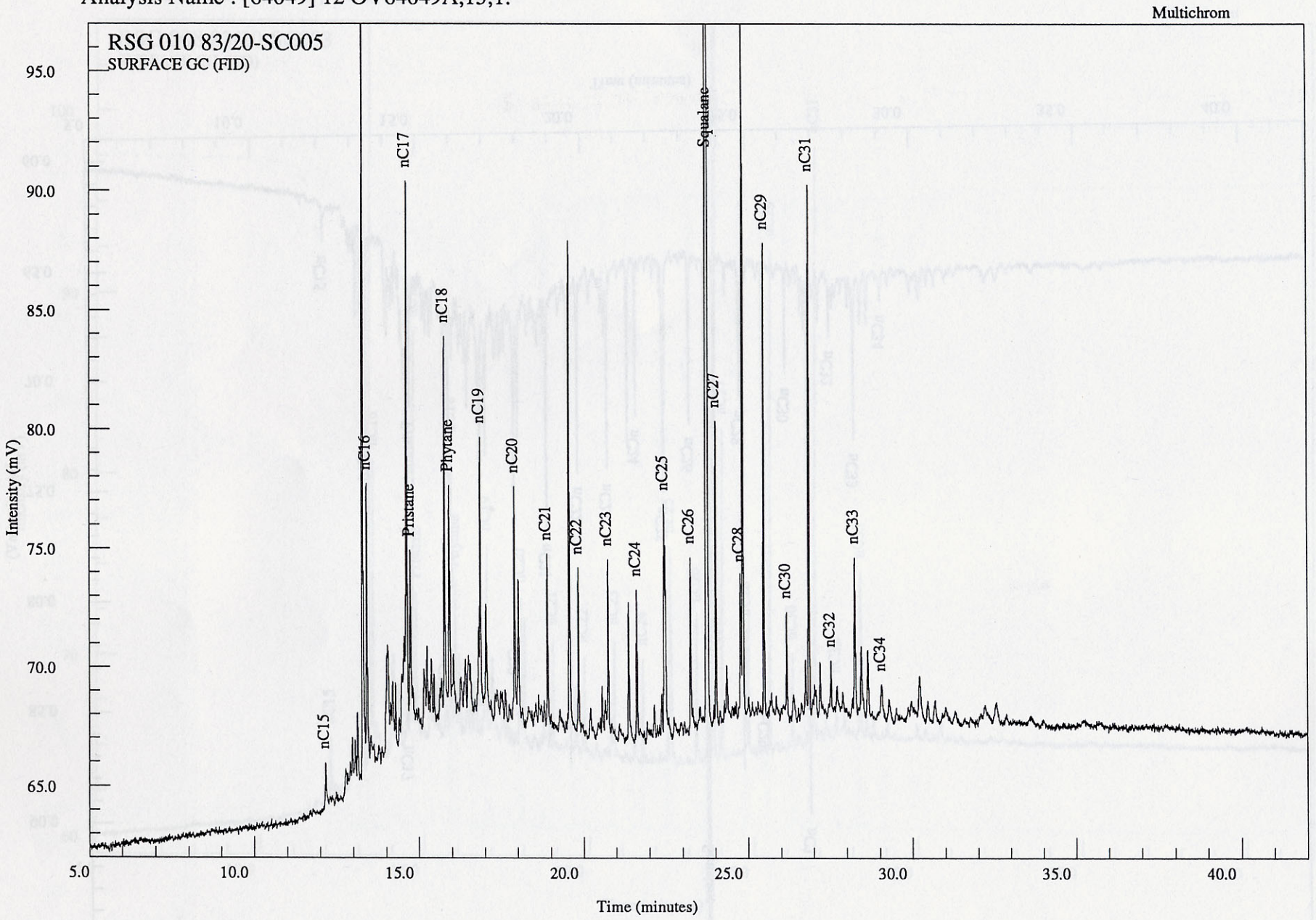

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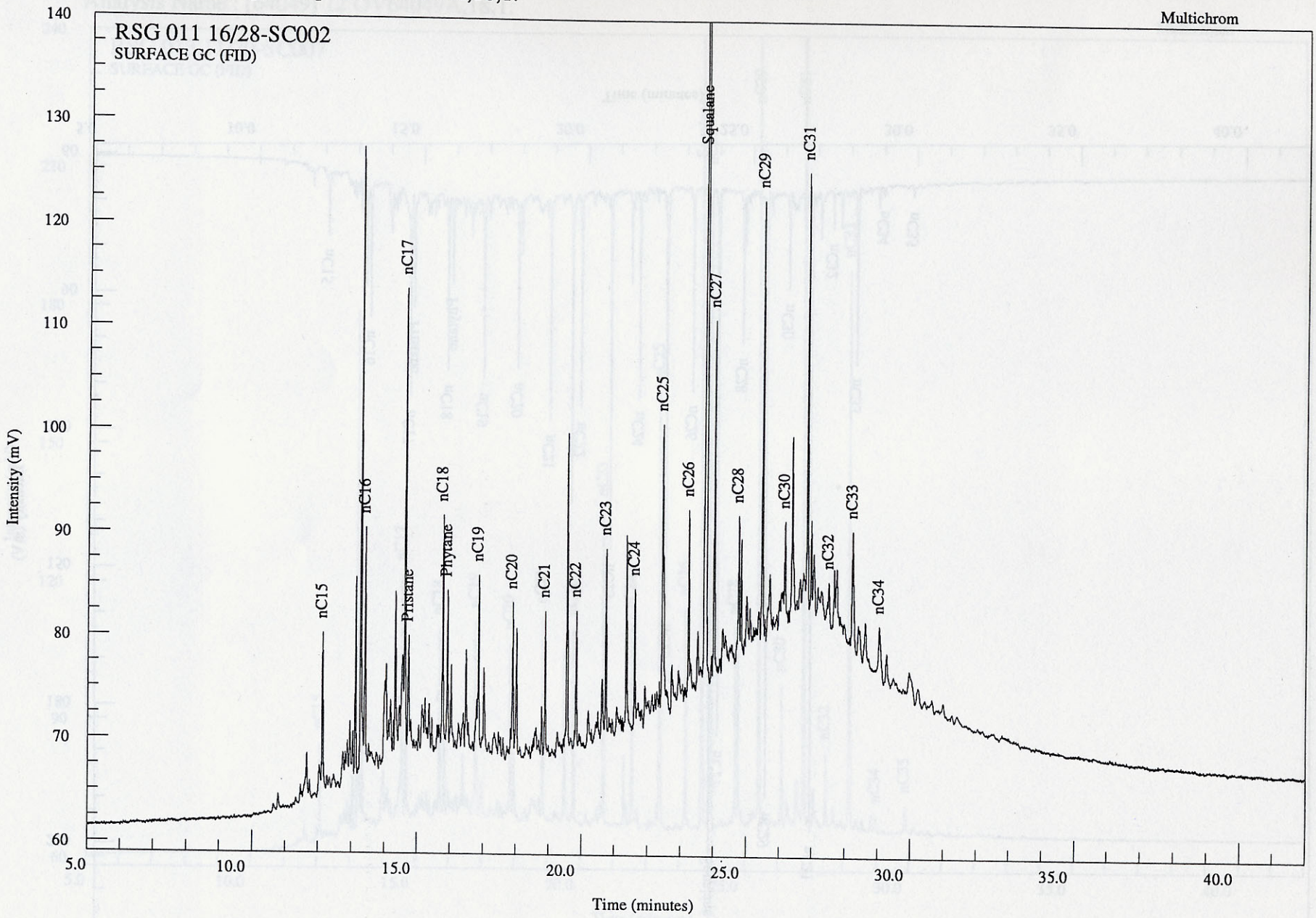

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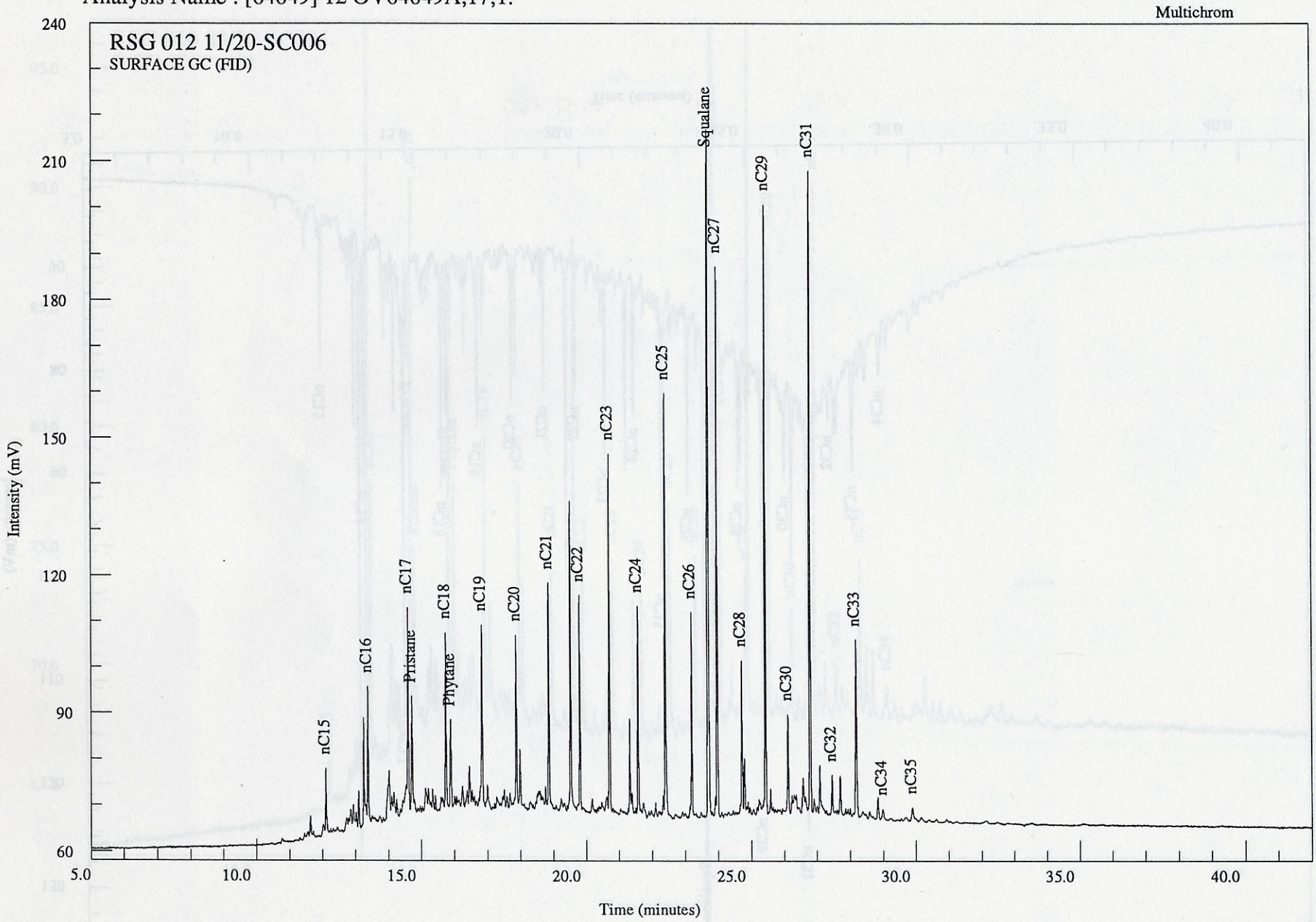

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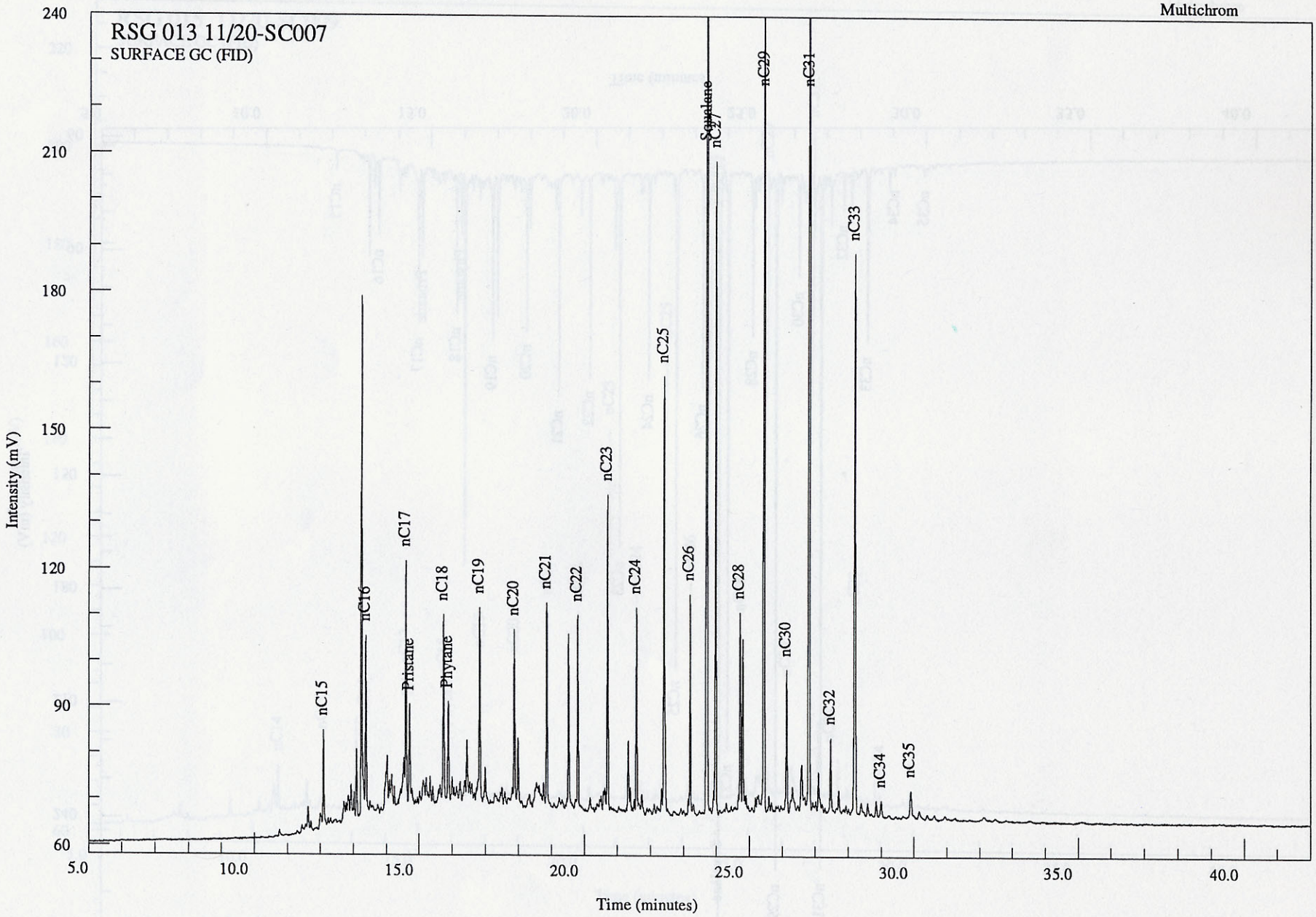

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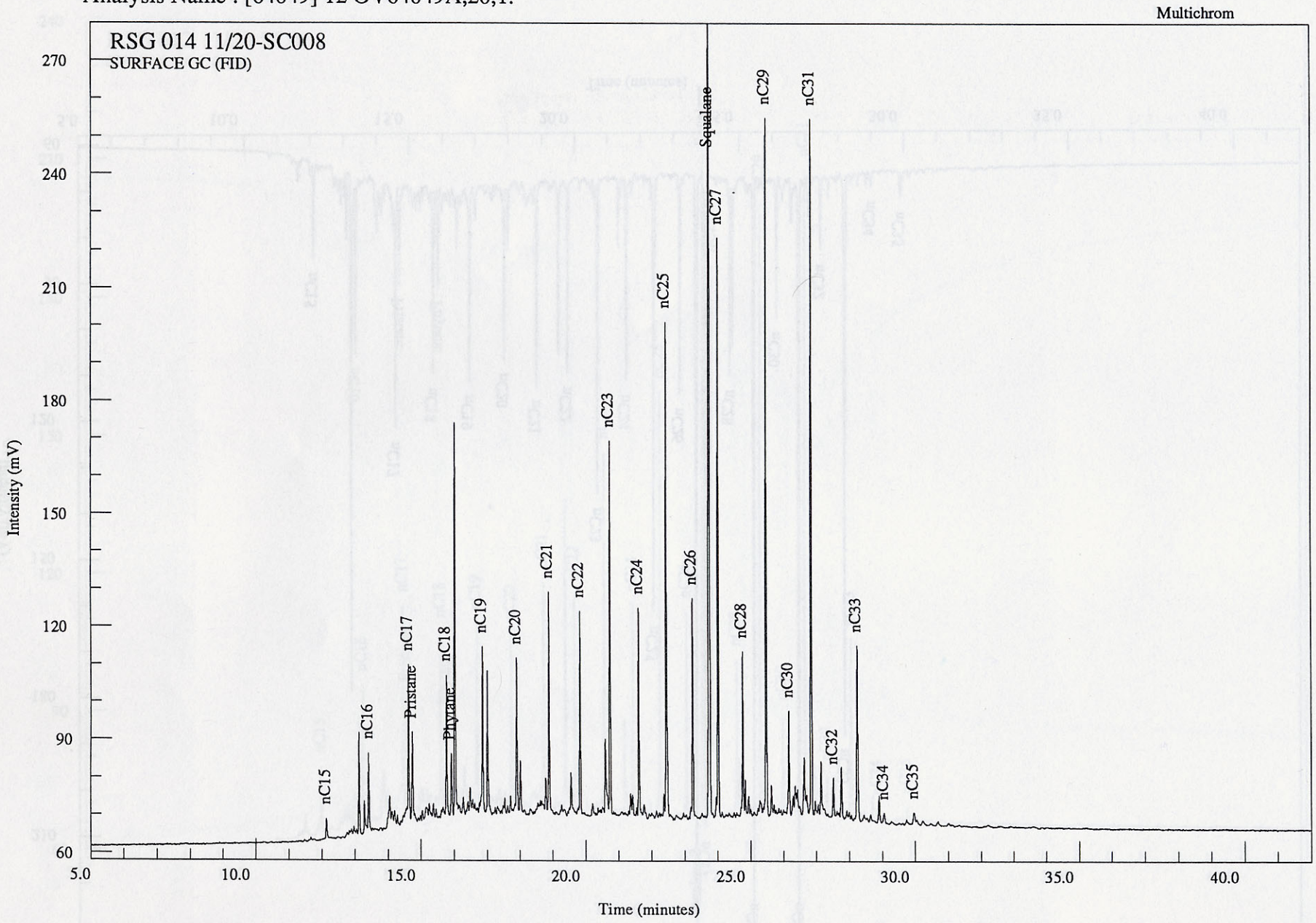

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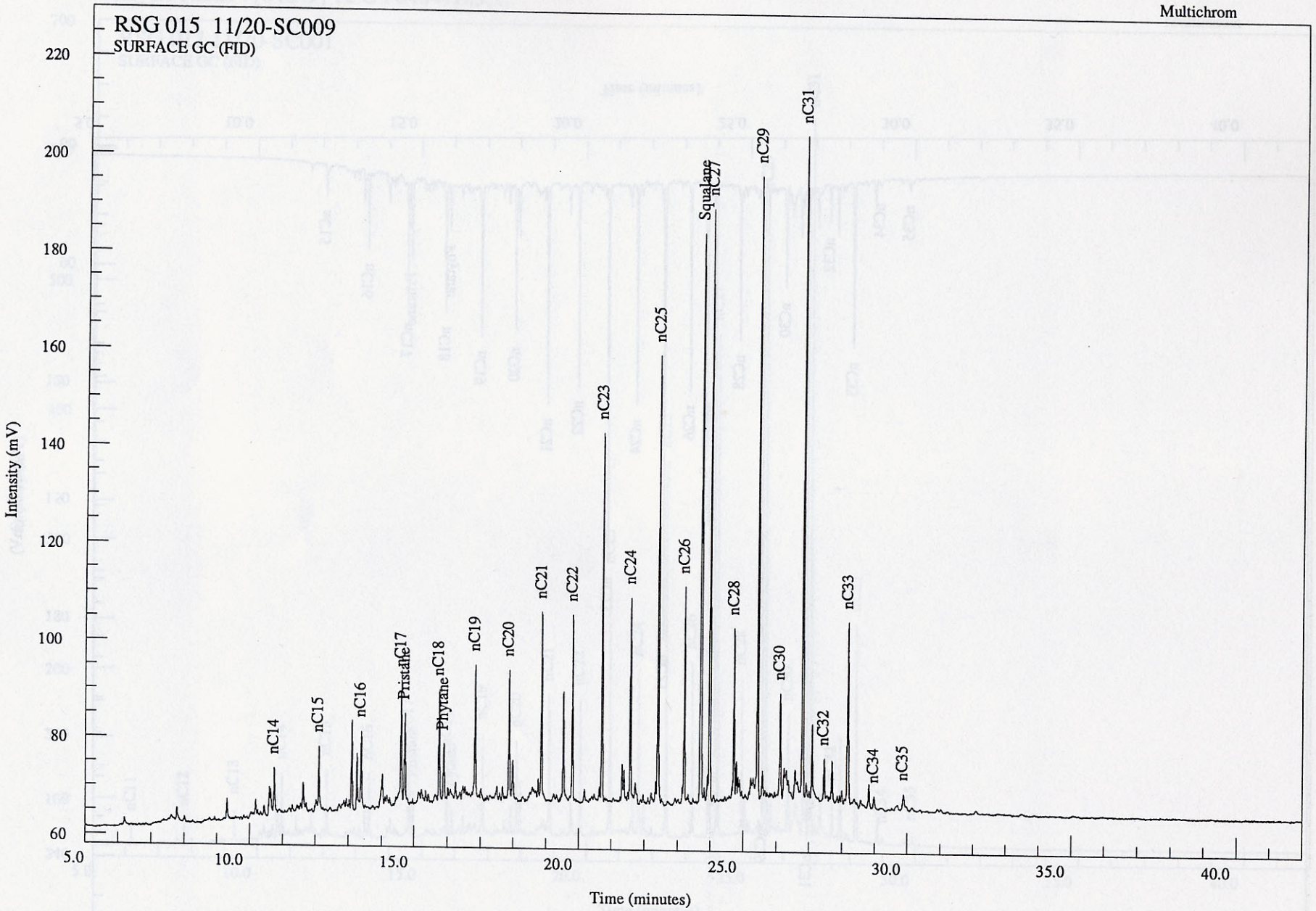

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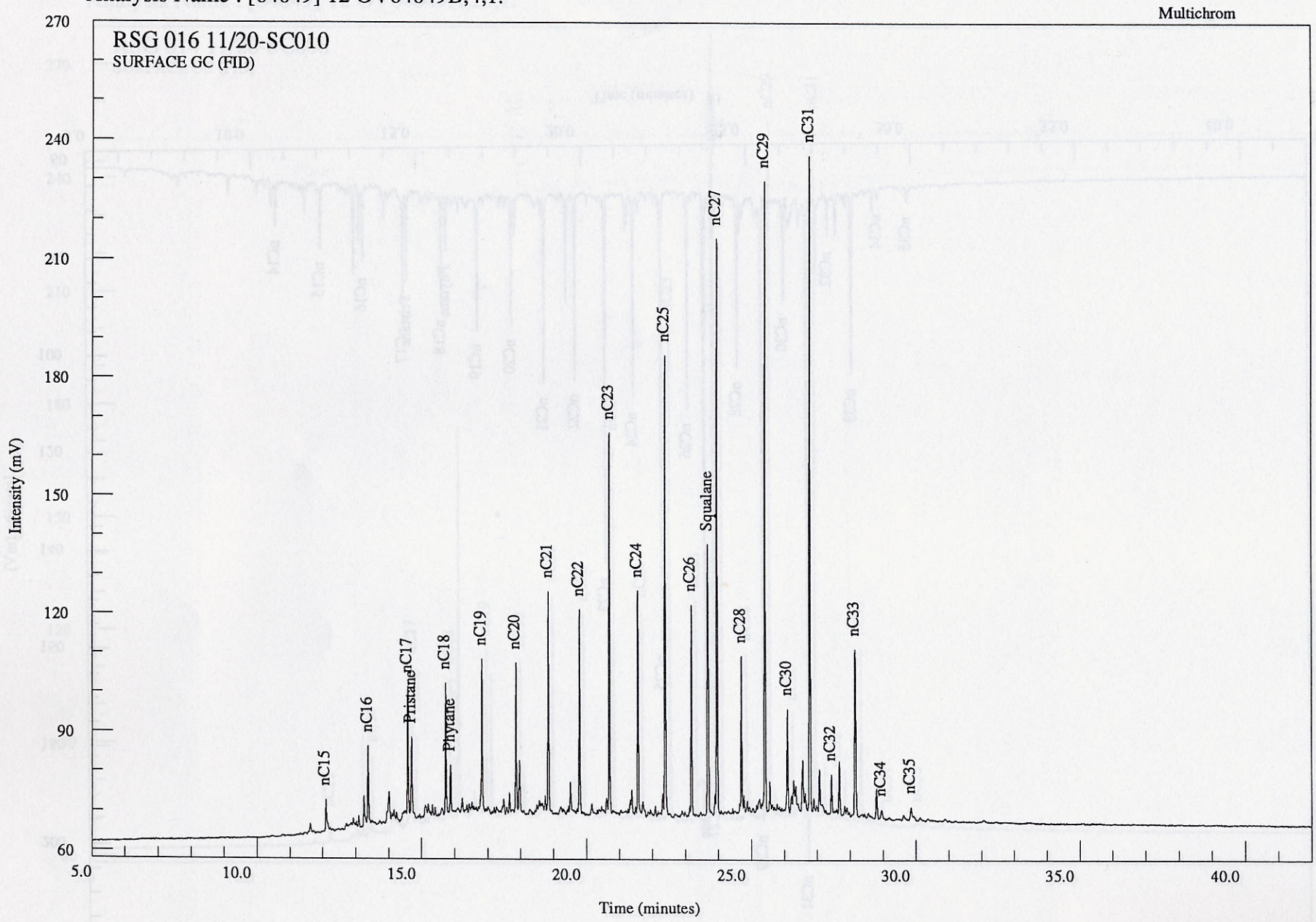

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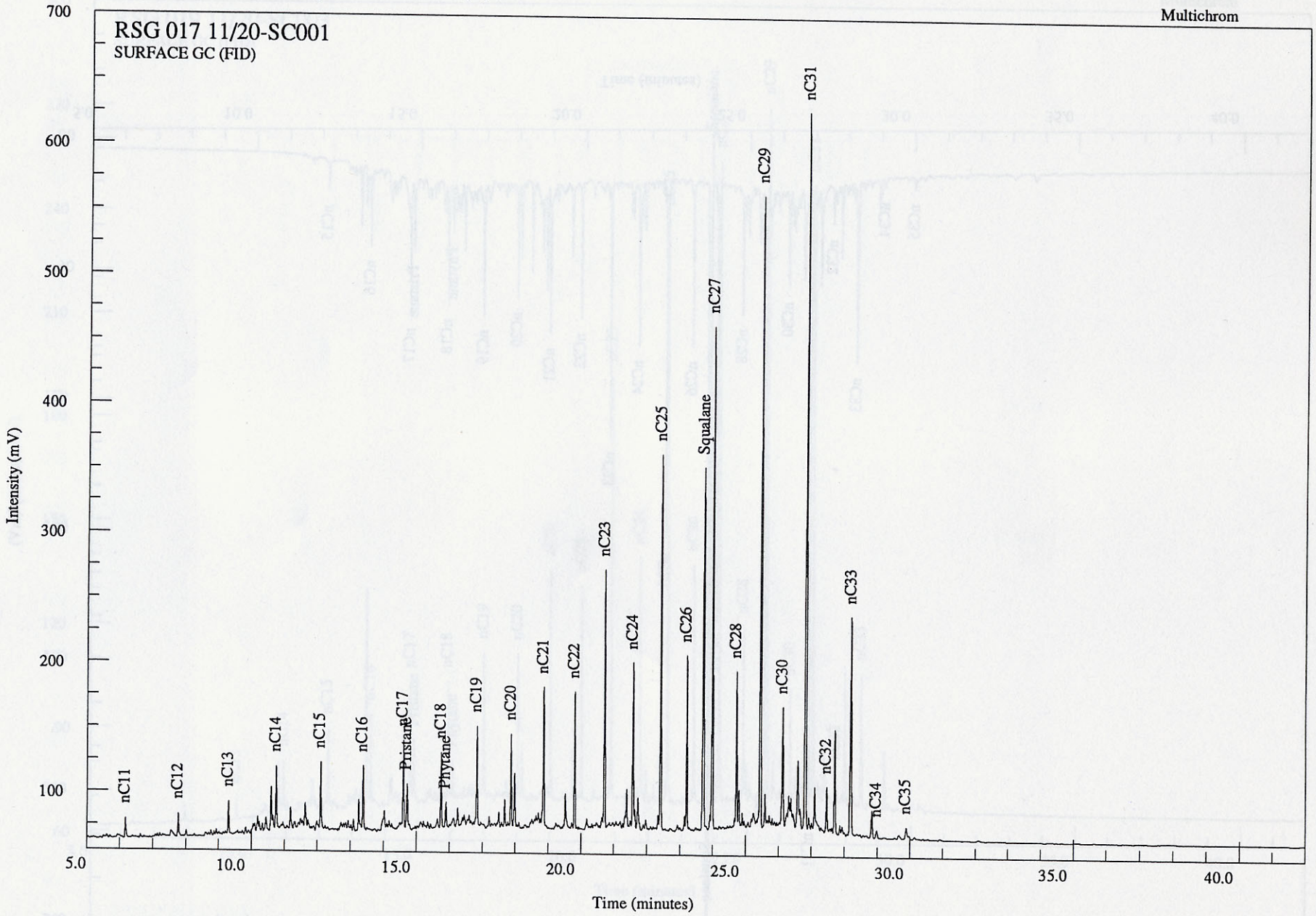

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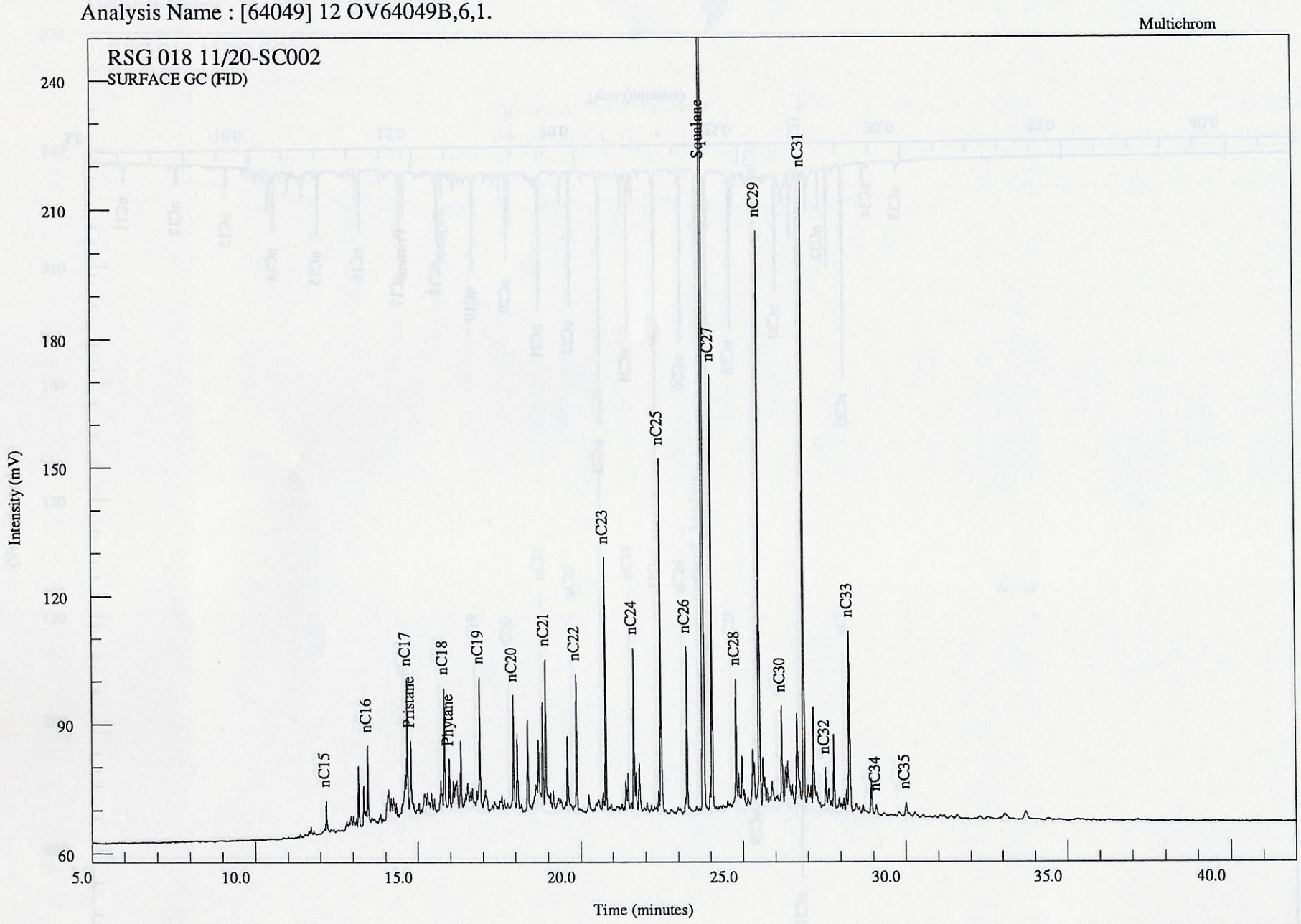

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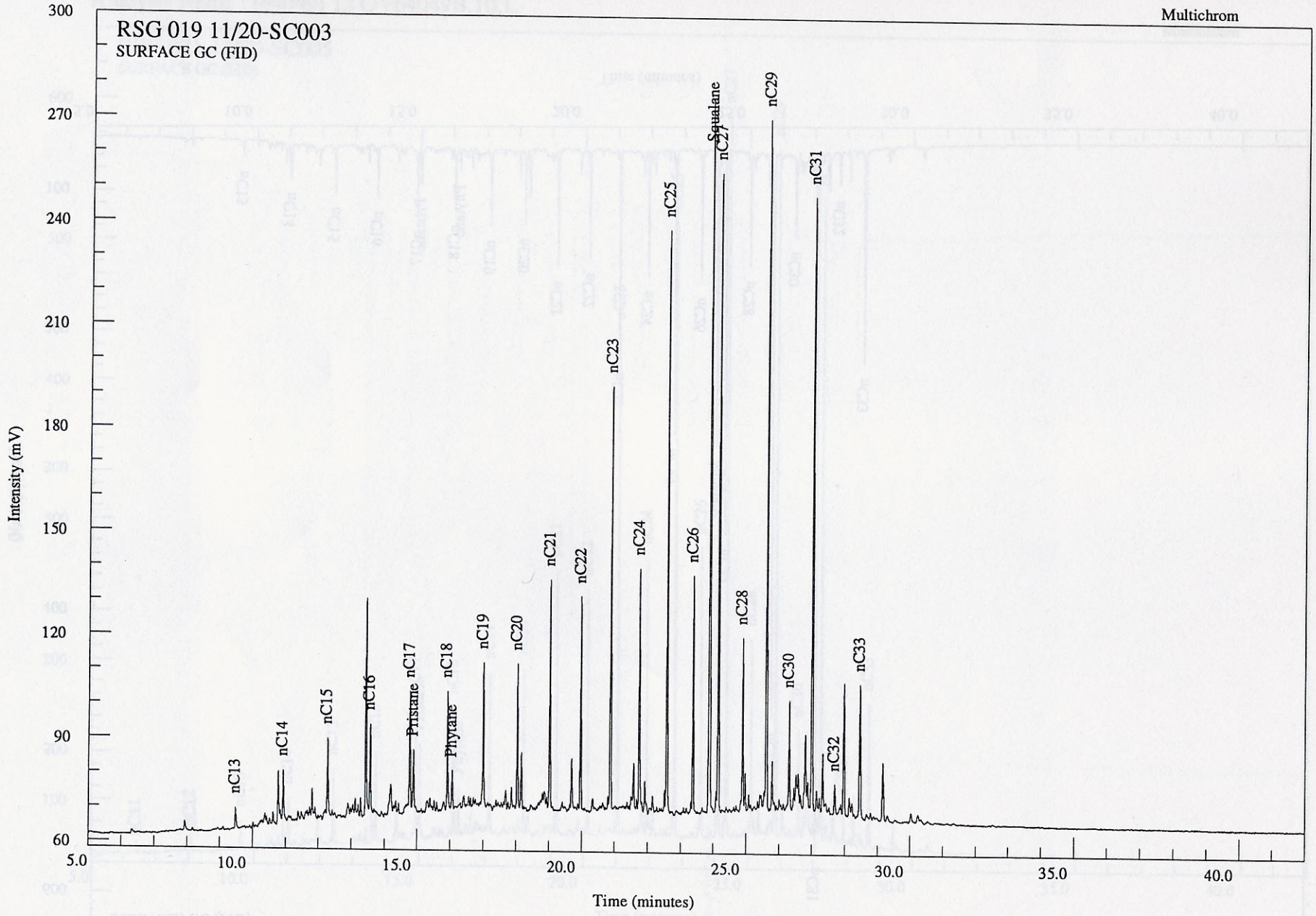

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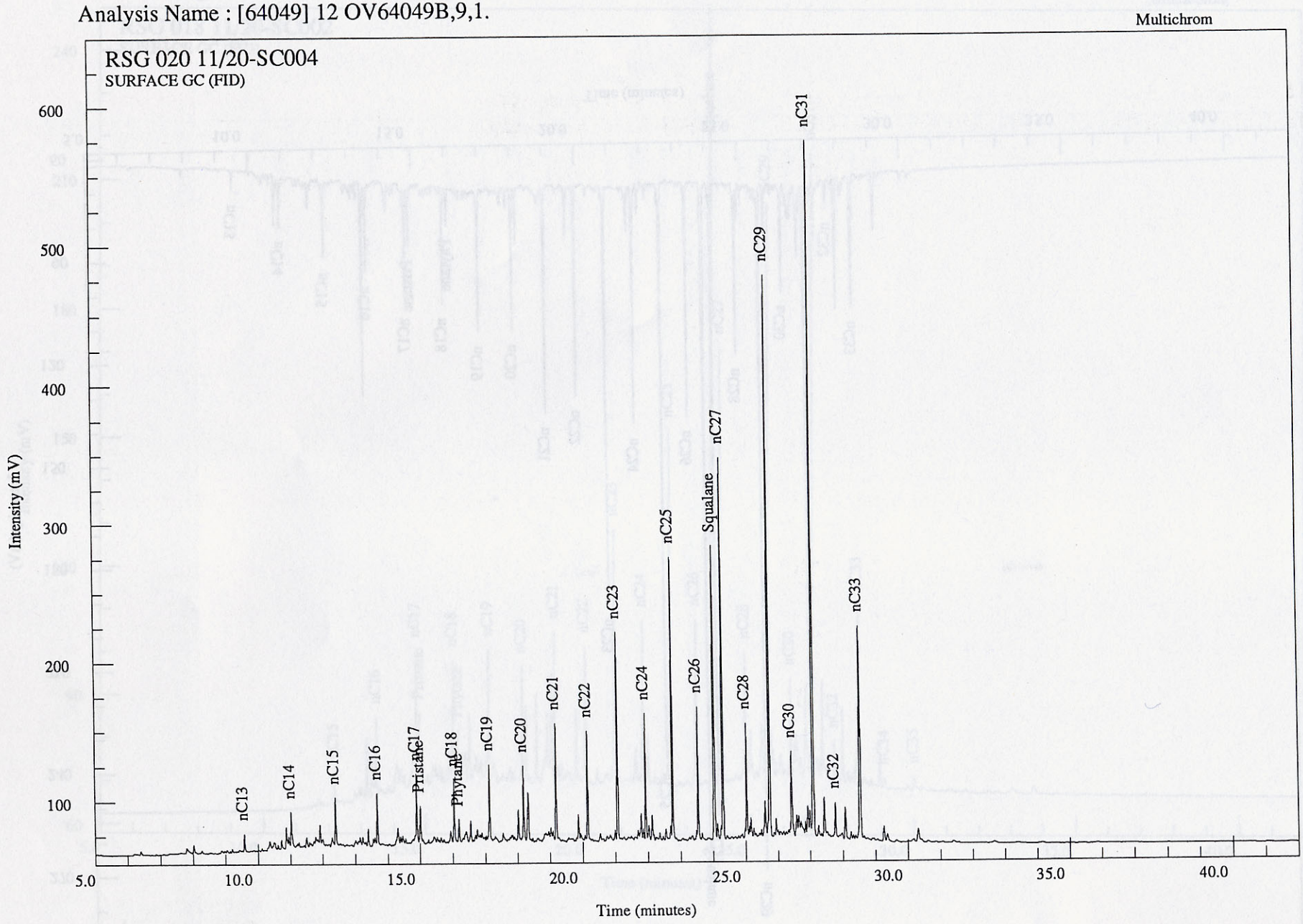

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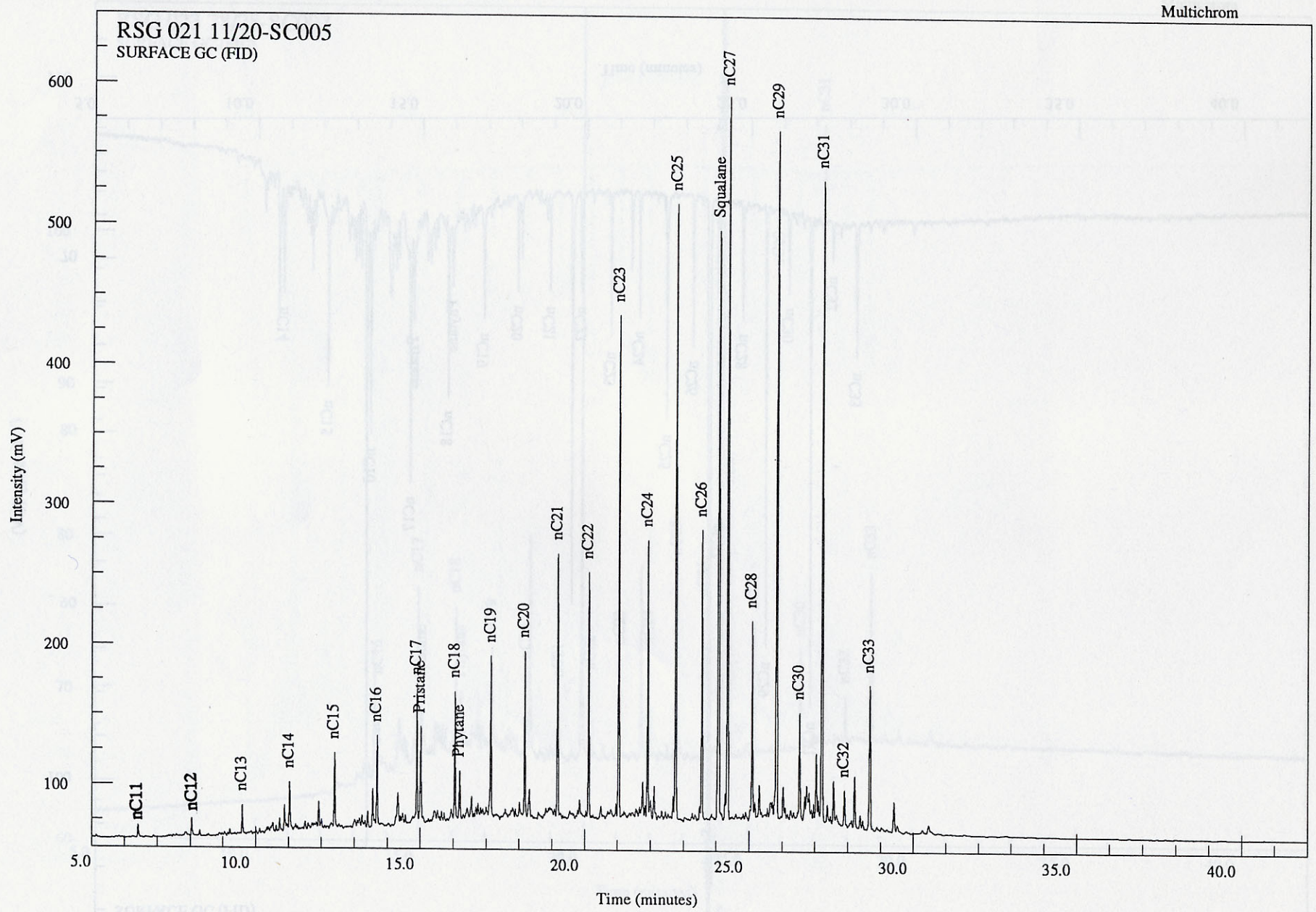

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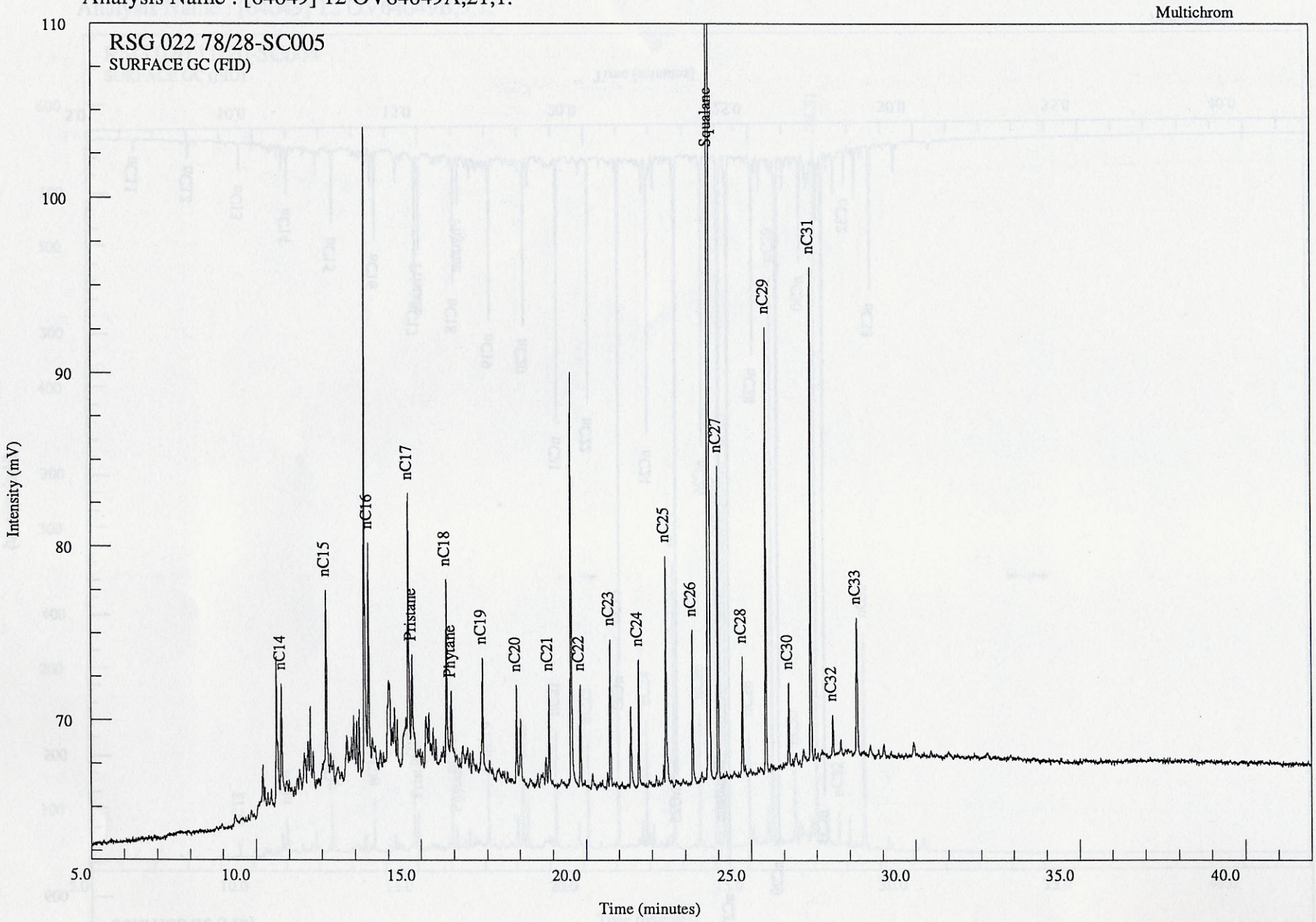

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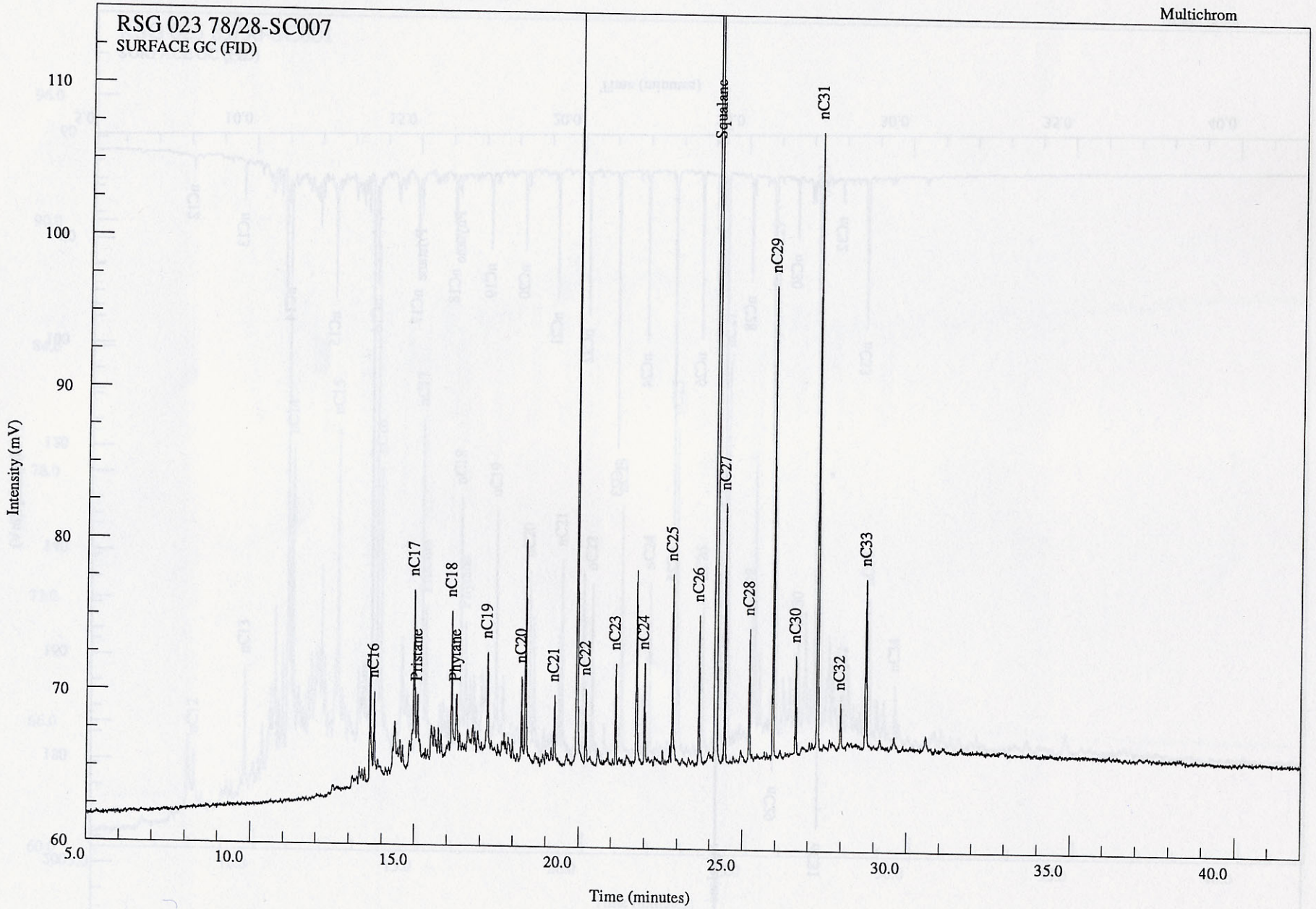

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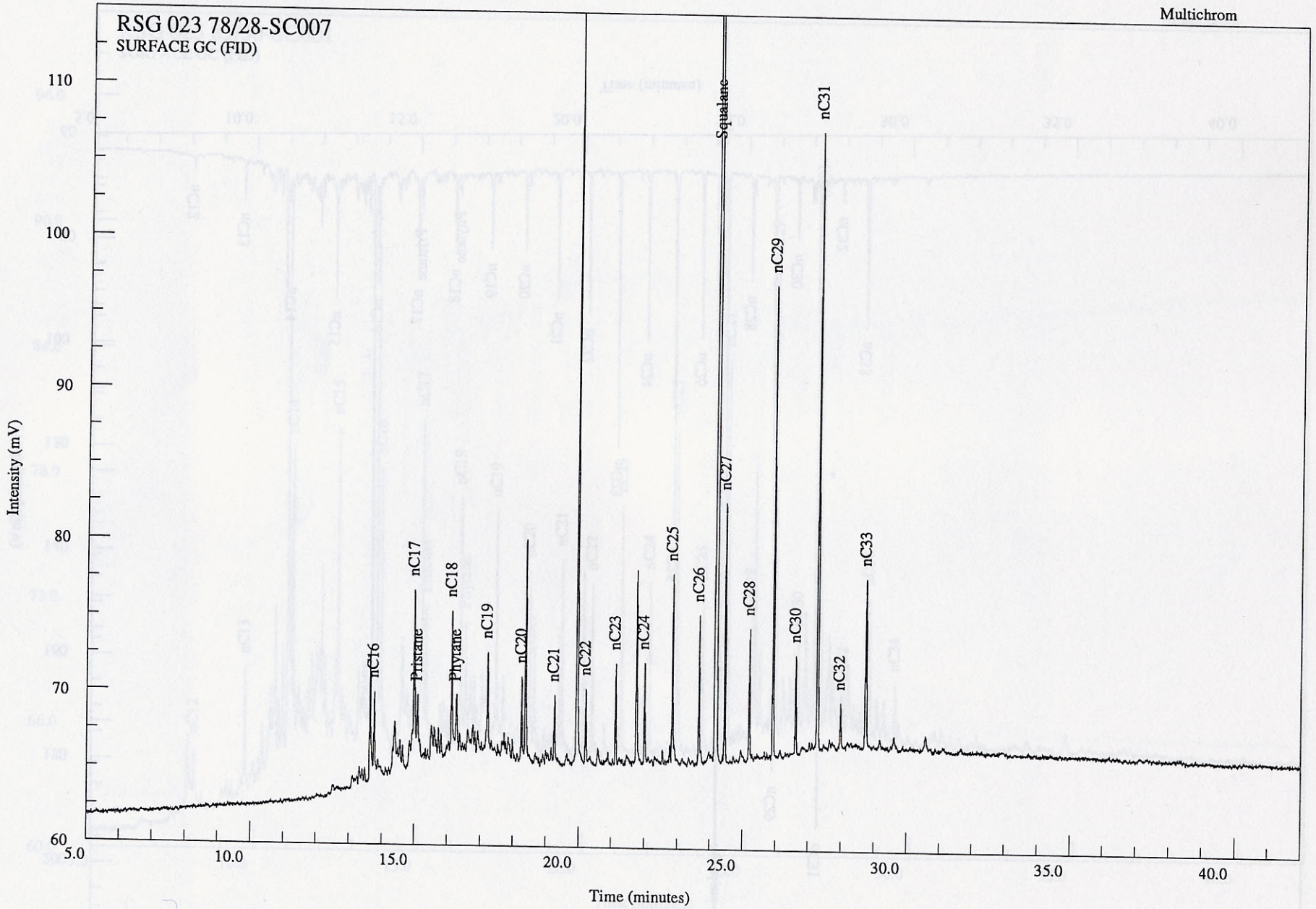

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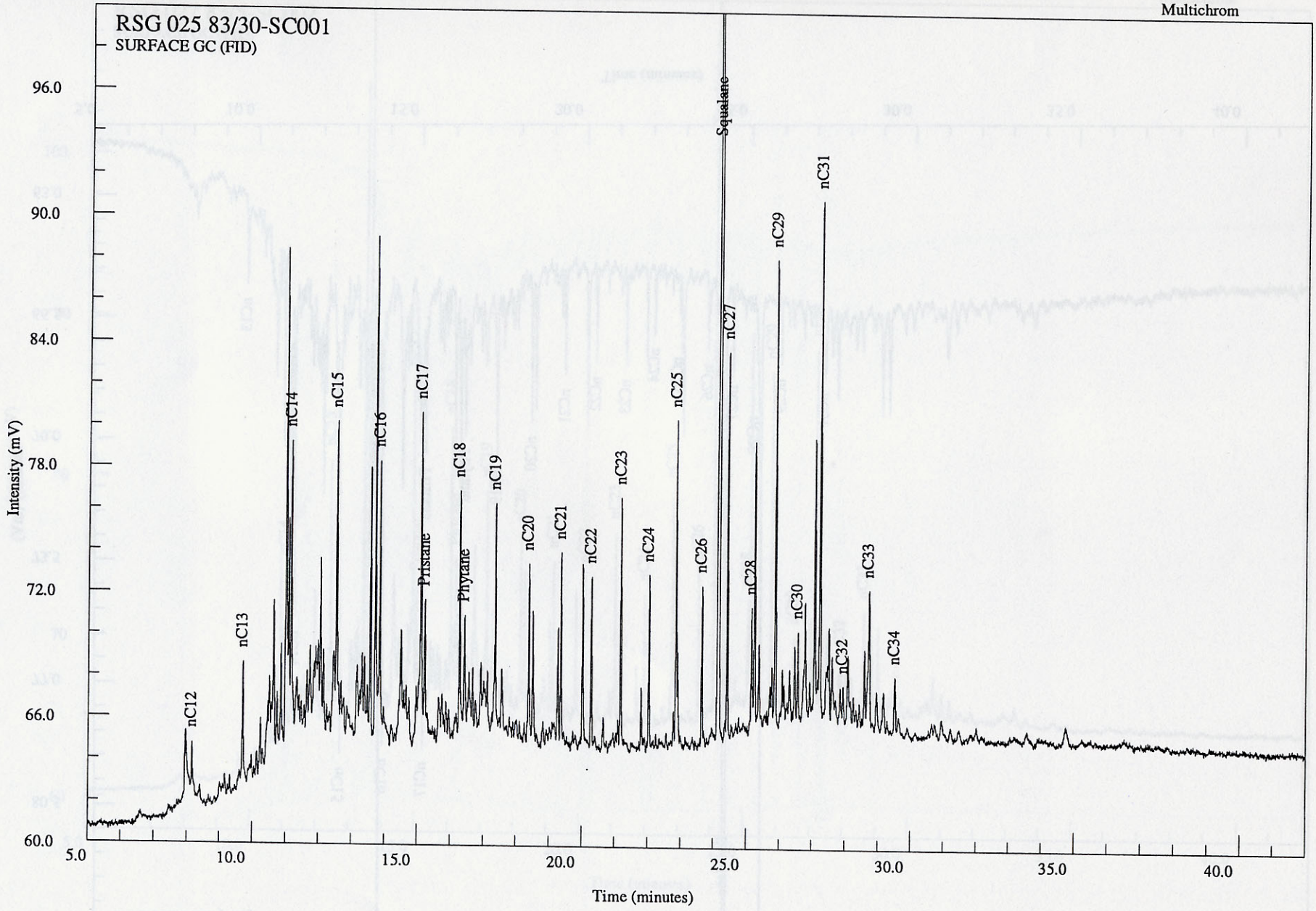

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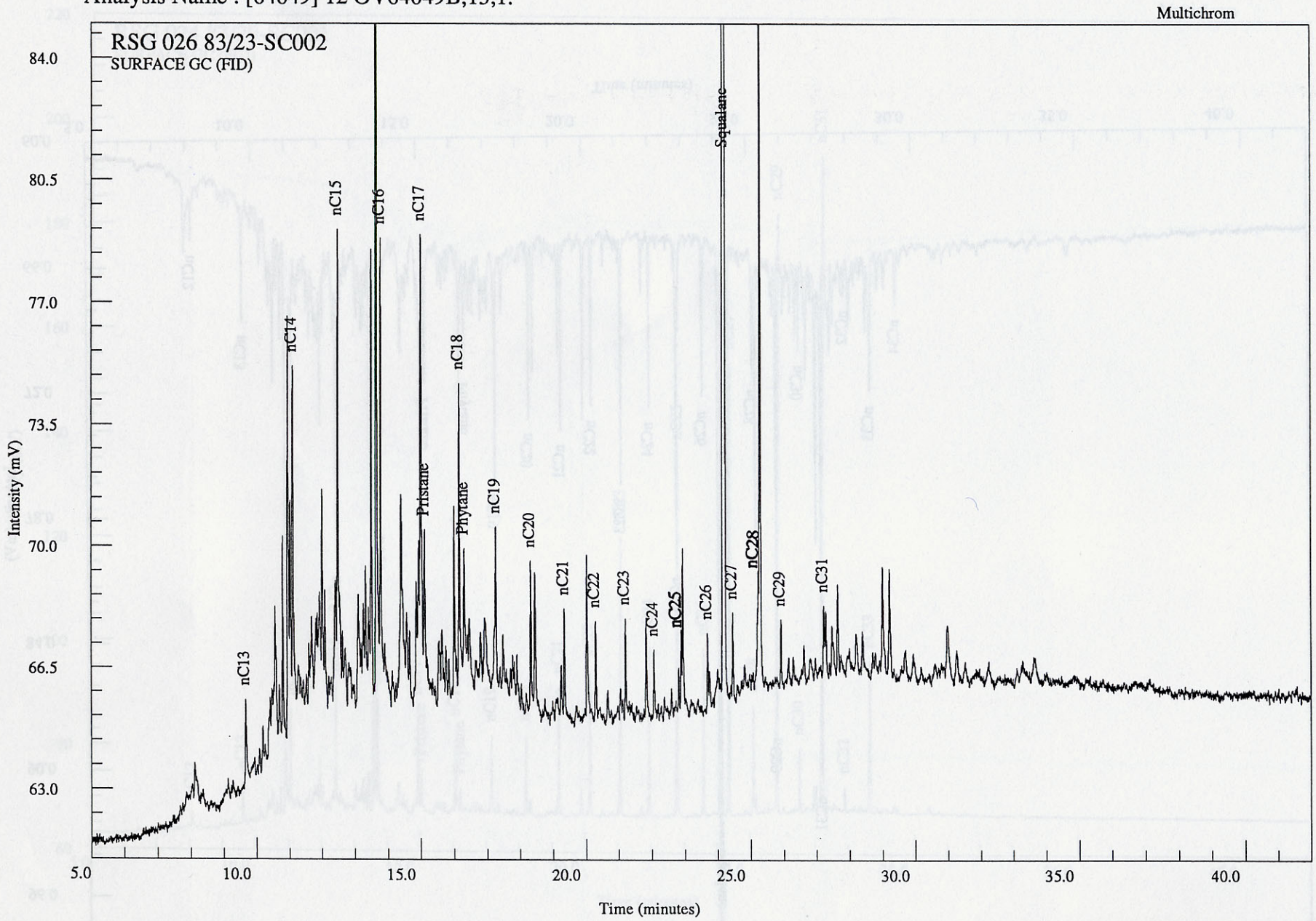

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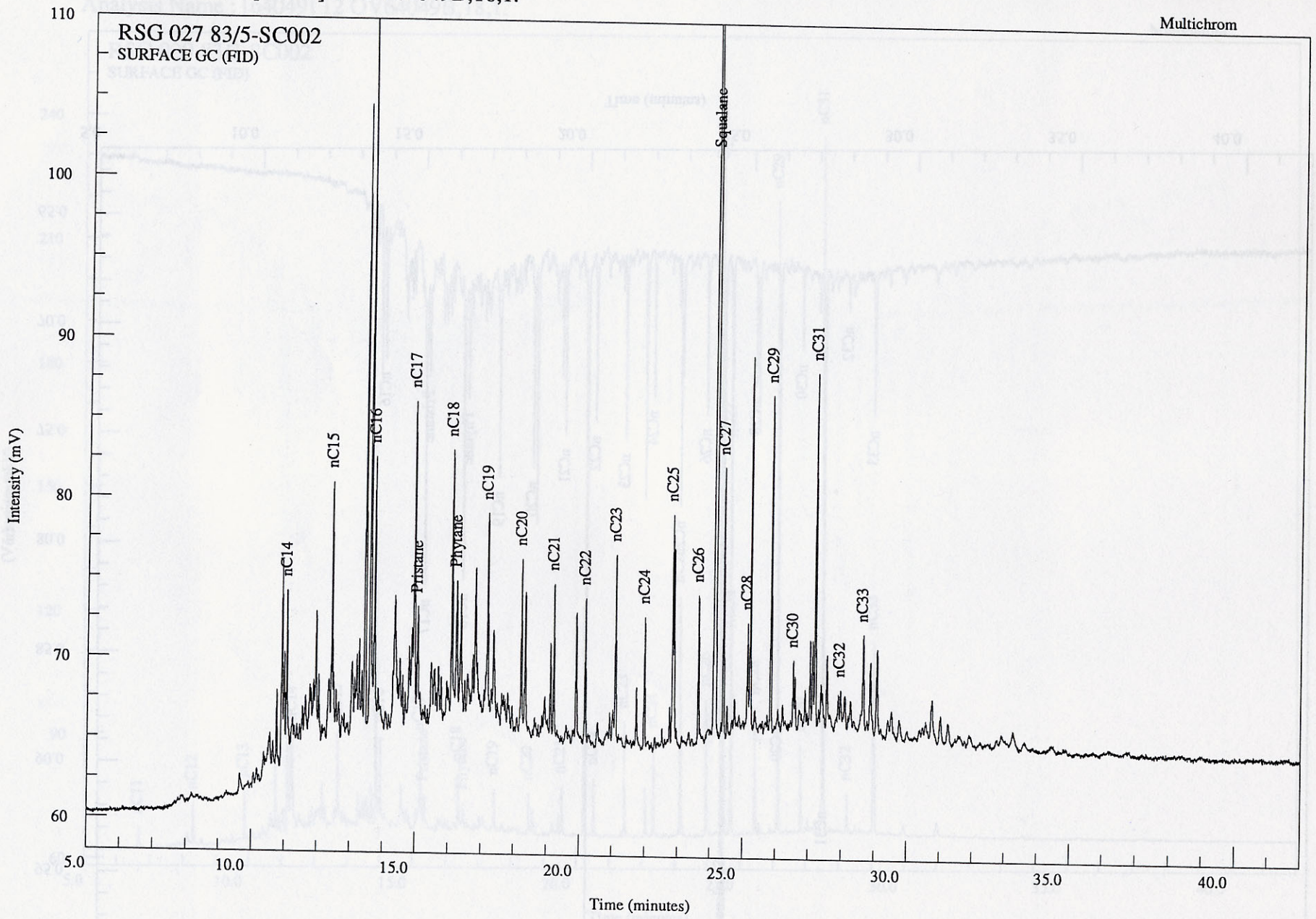
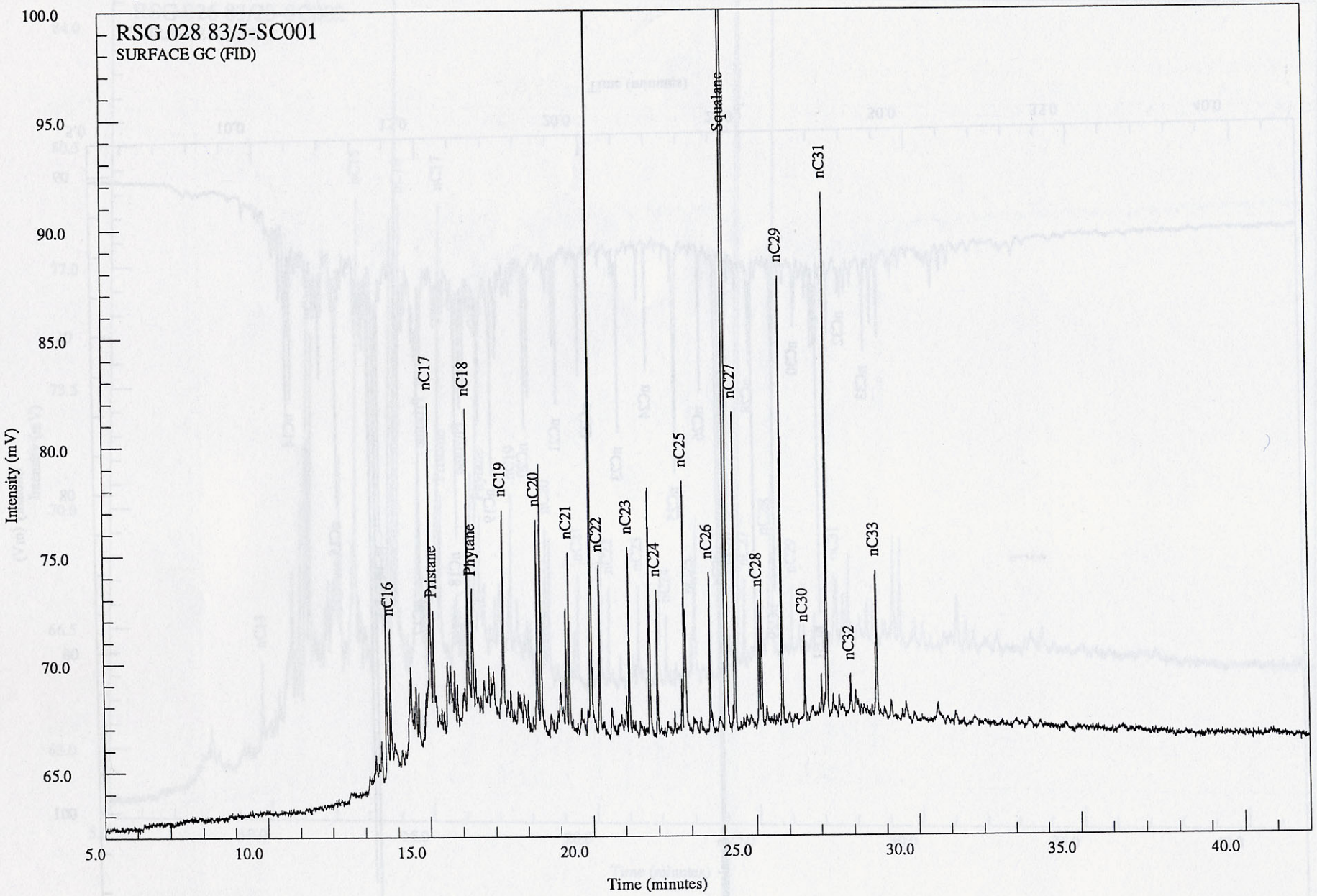


Analysis Name : [64049] 12 OV64049B,17,1.

Multichrom



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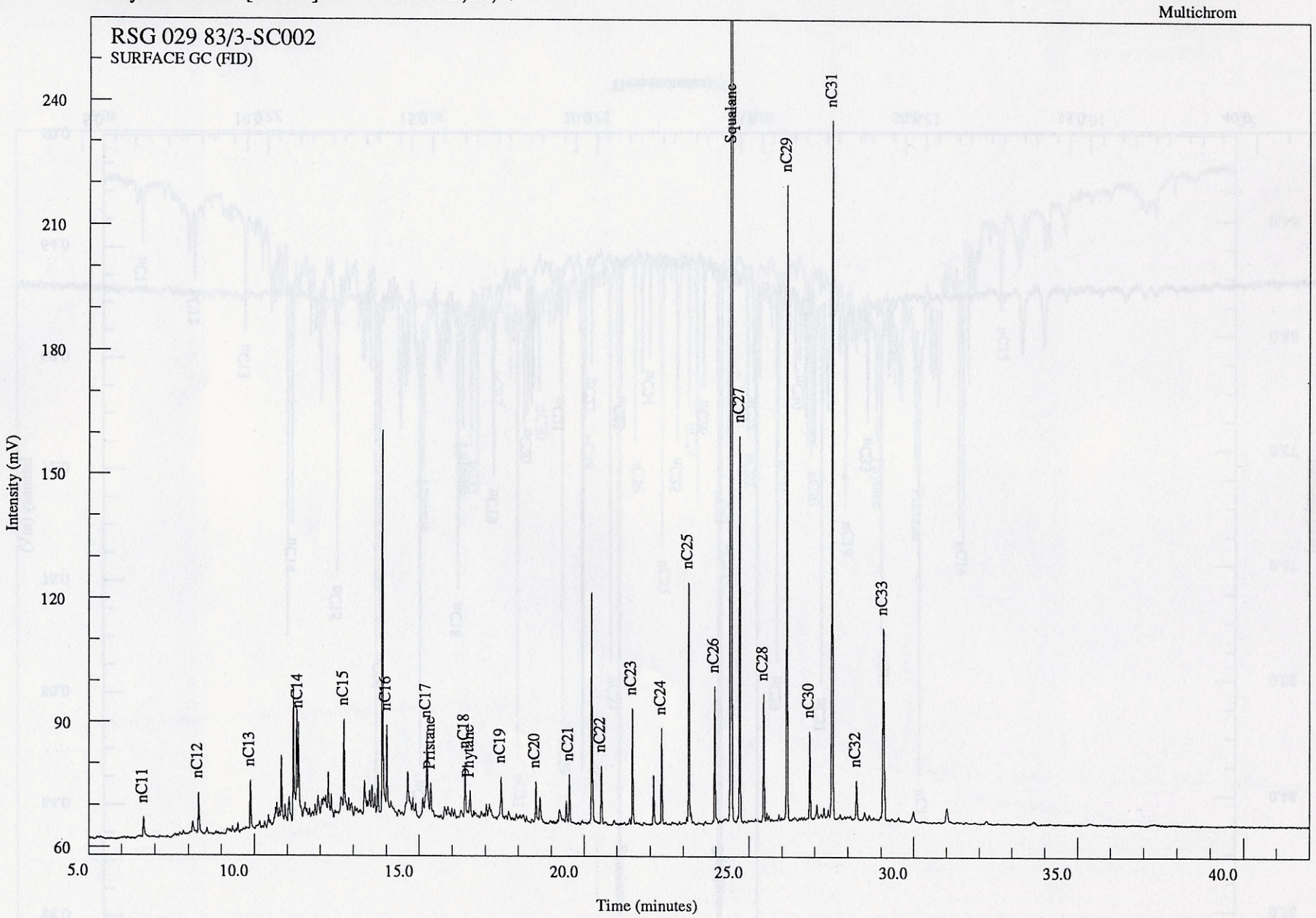
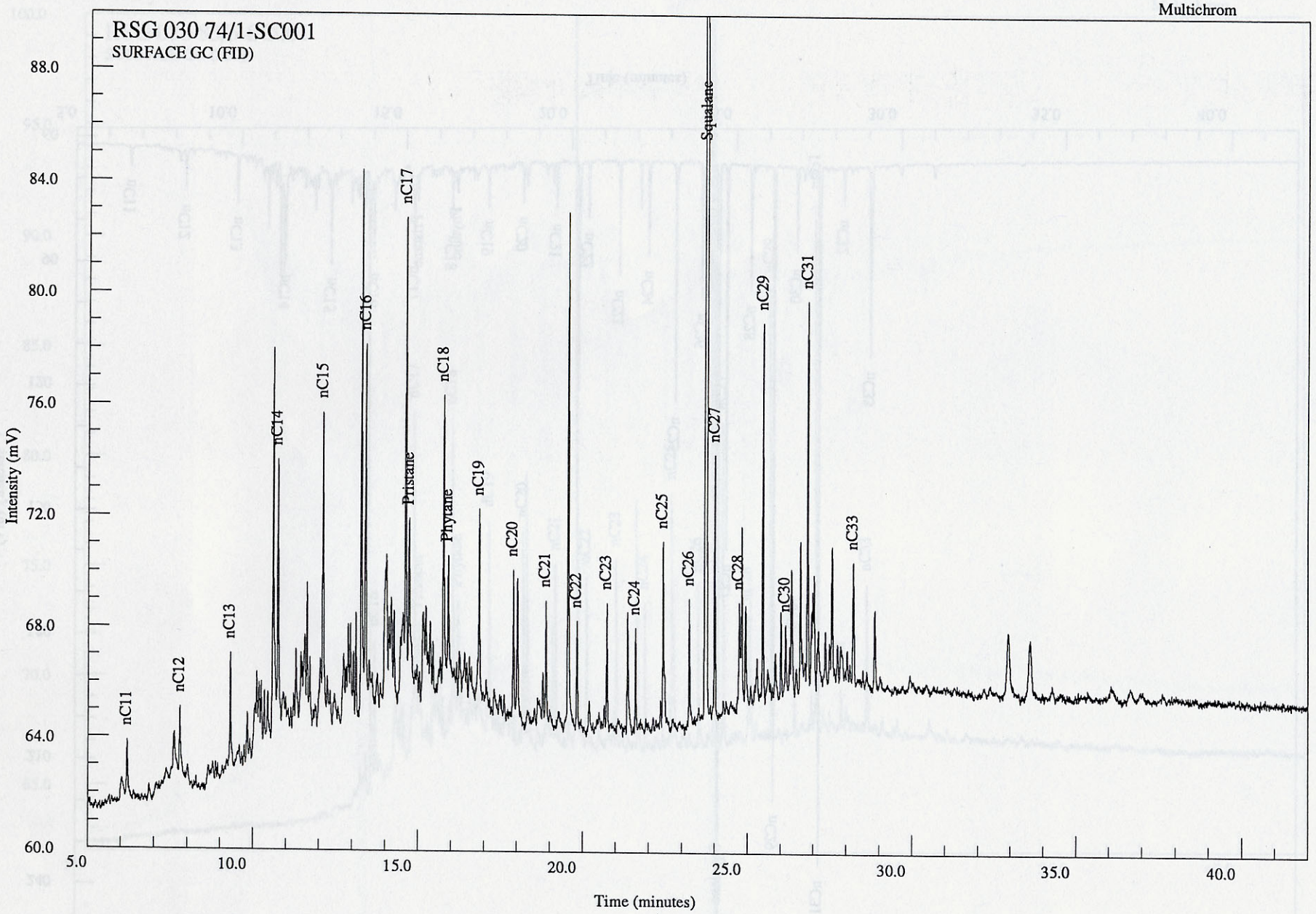


Analysis Name : [64049] 12 OV64049A,22,1.



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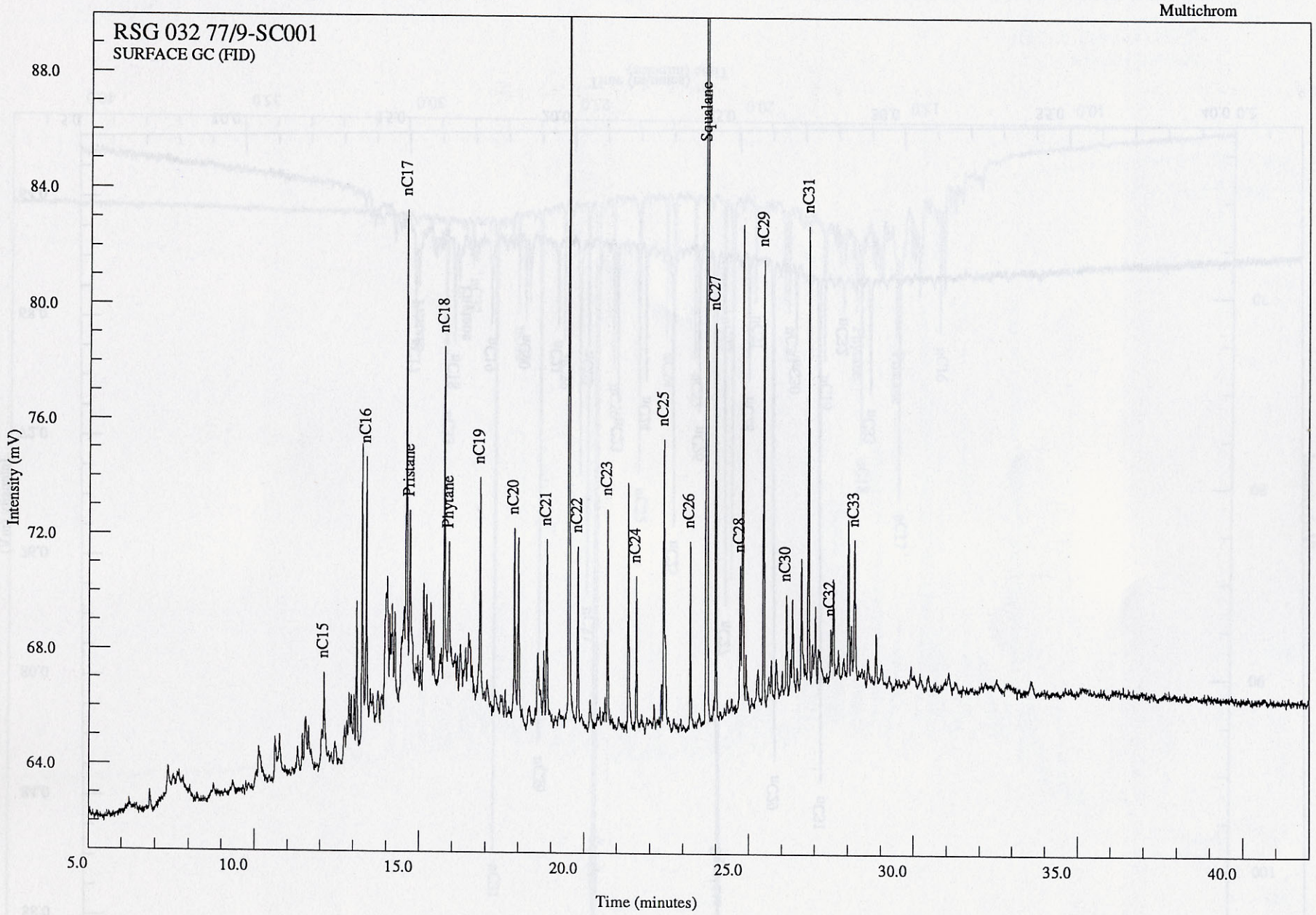

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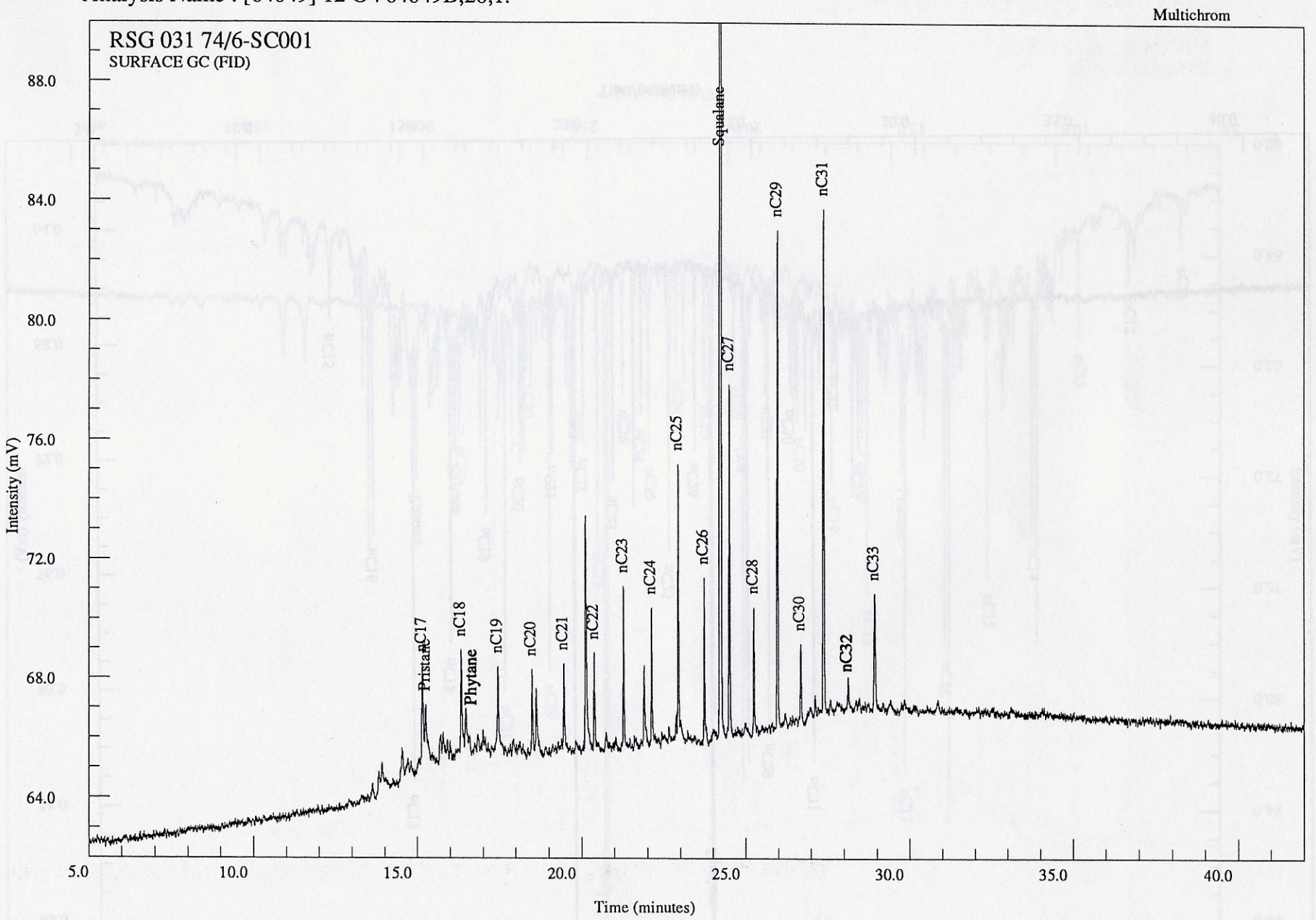

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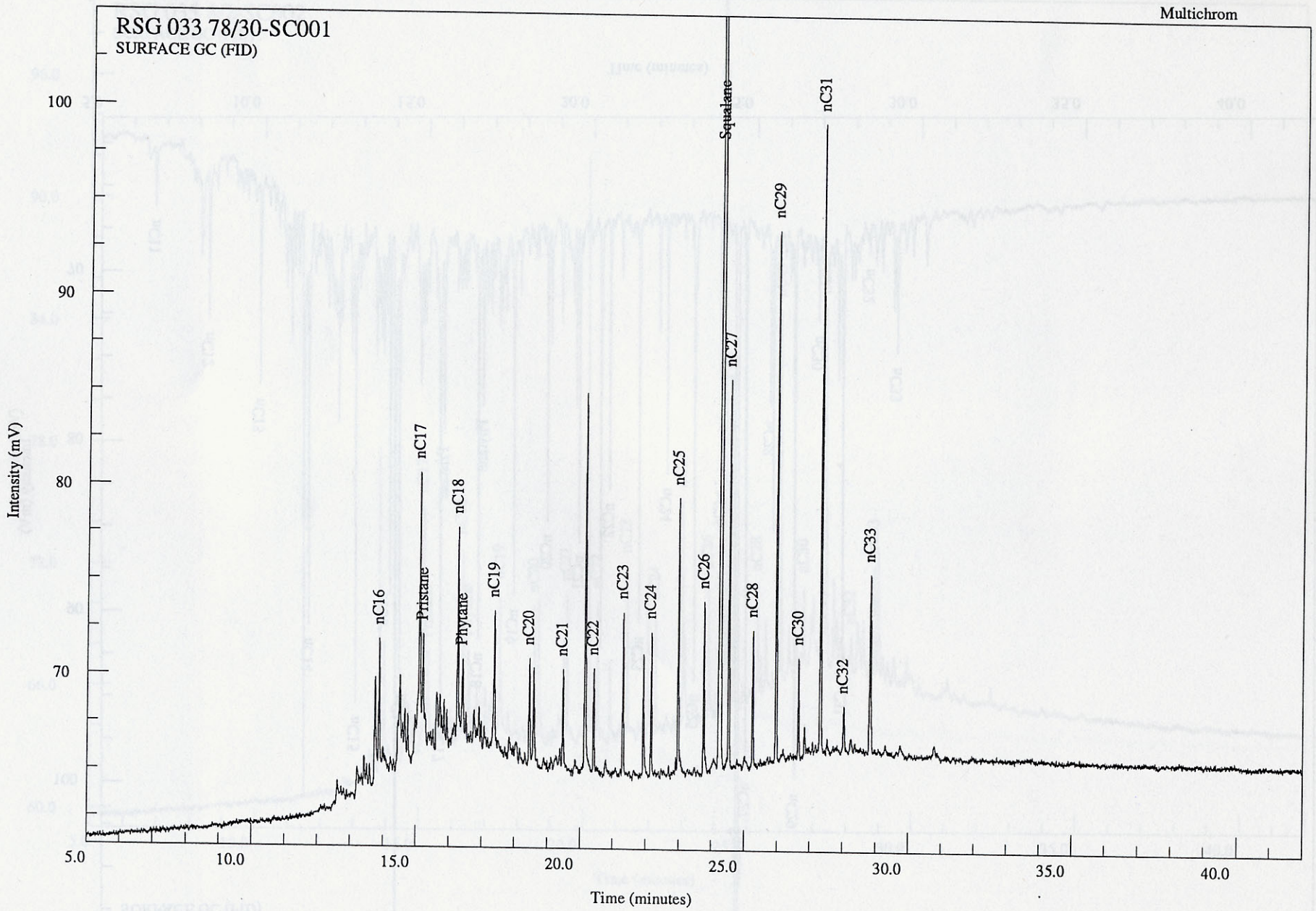

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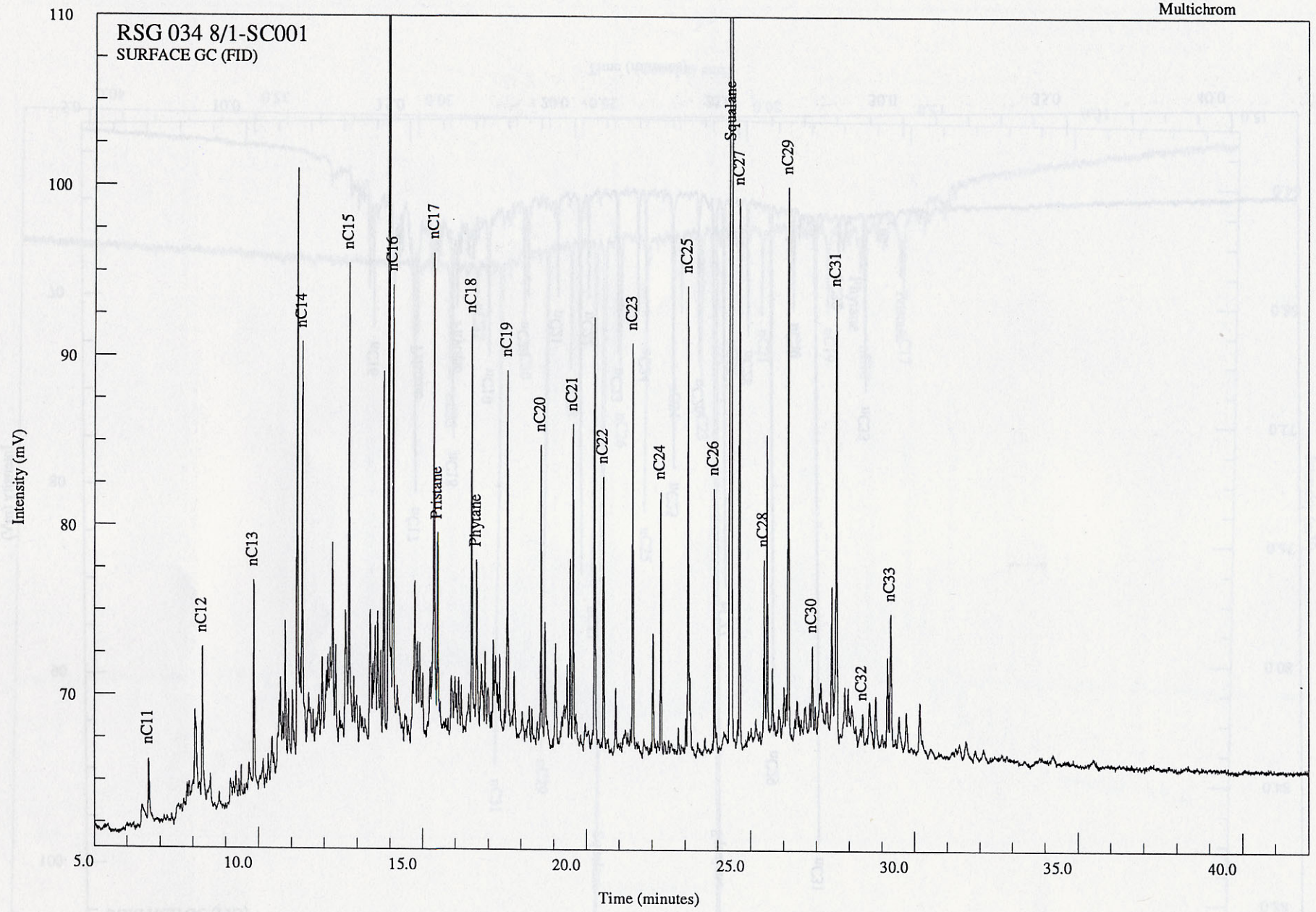

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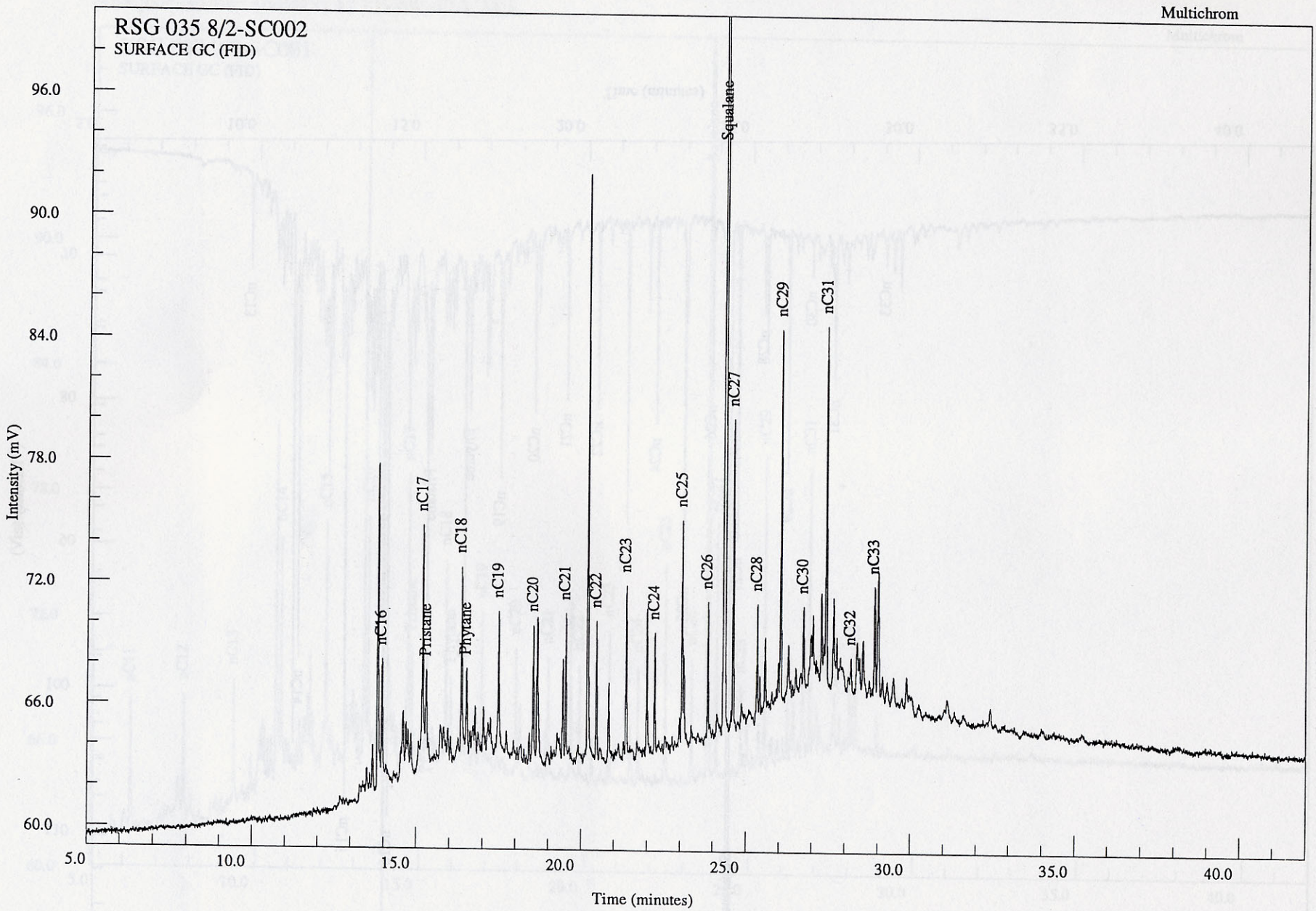
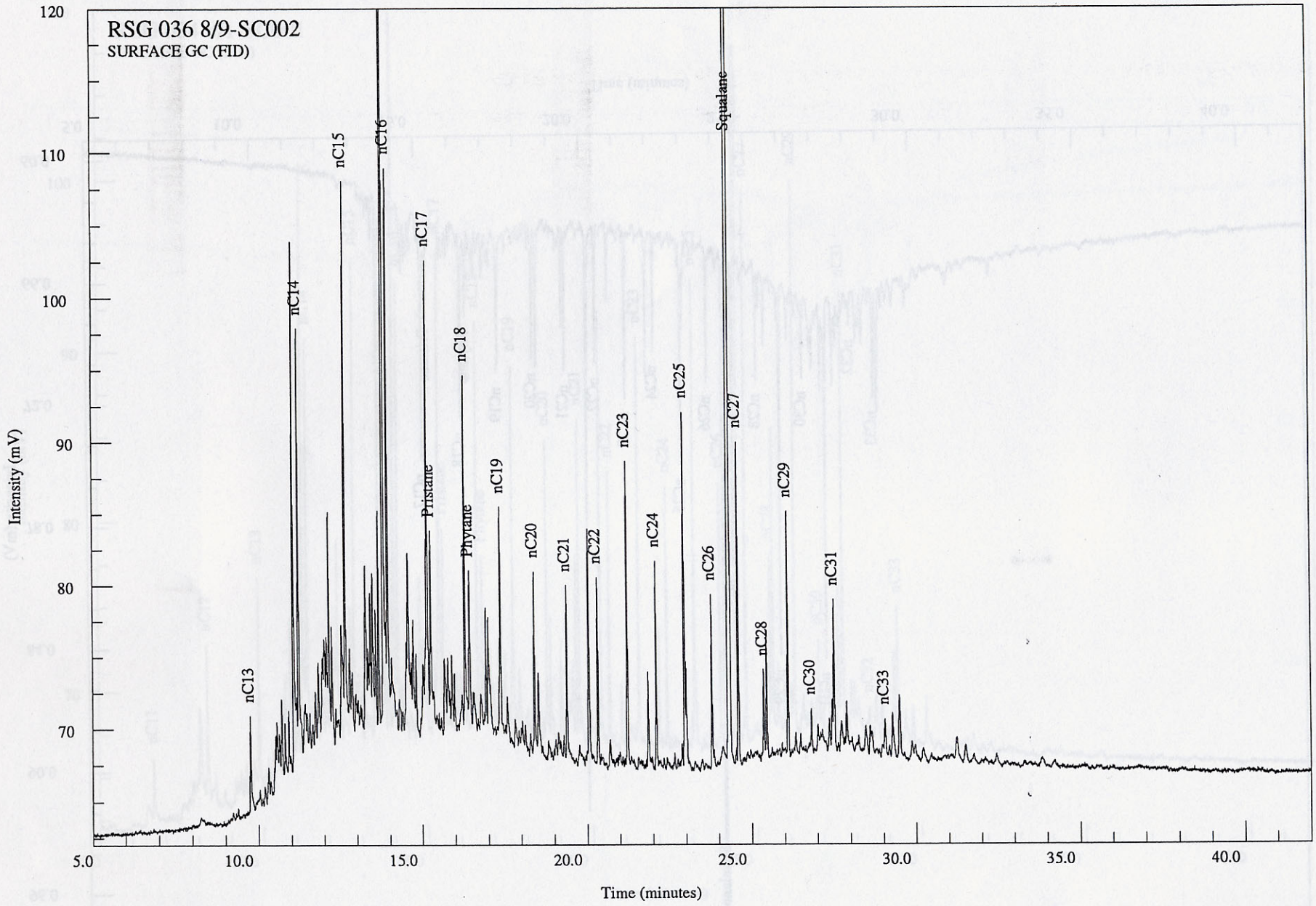
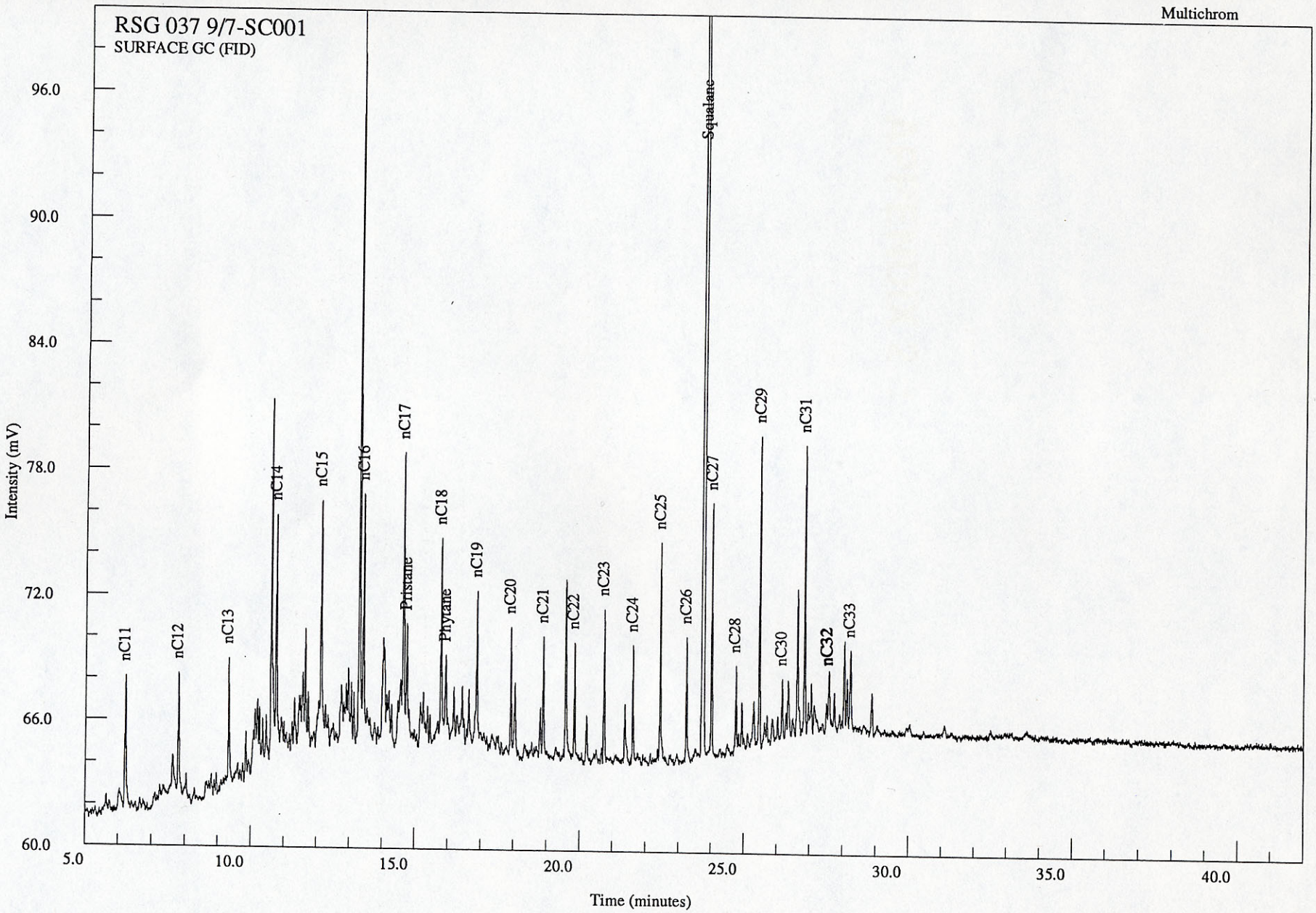


Analysis Name : [64049] 12 OV64049B,24,1.

Multichrom



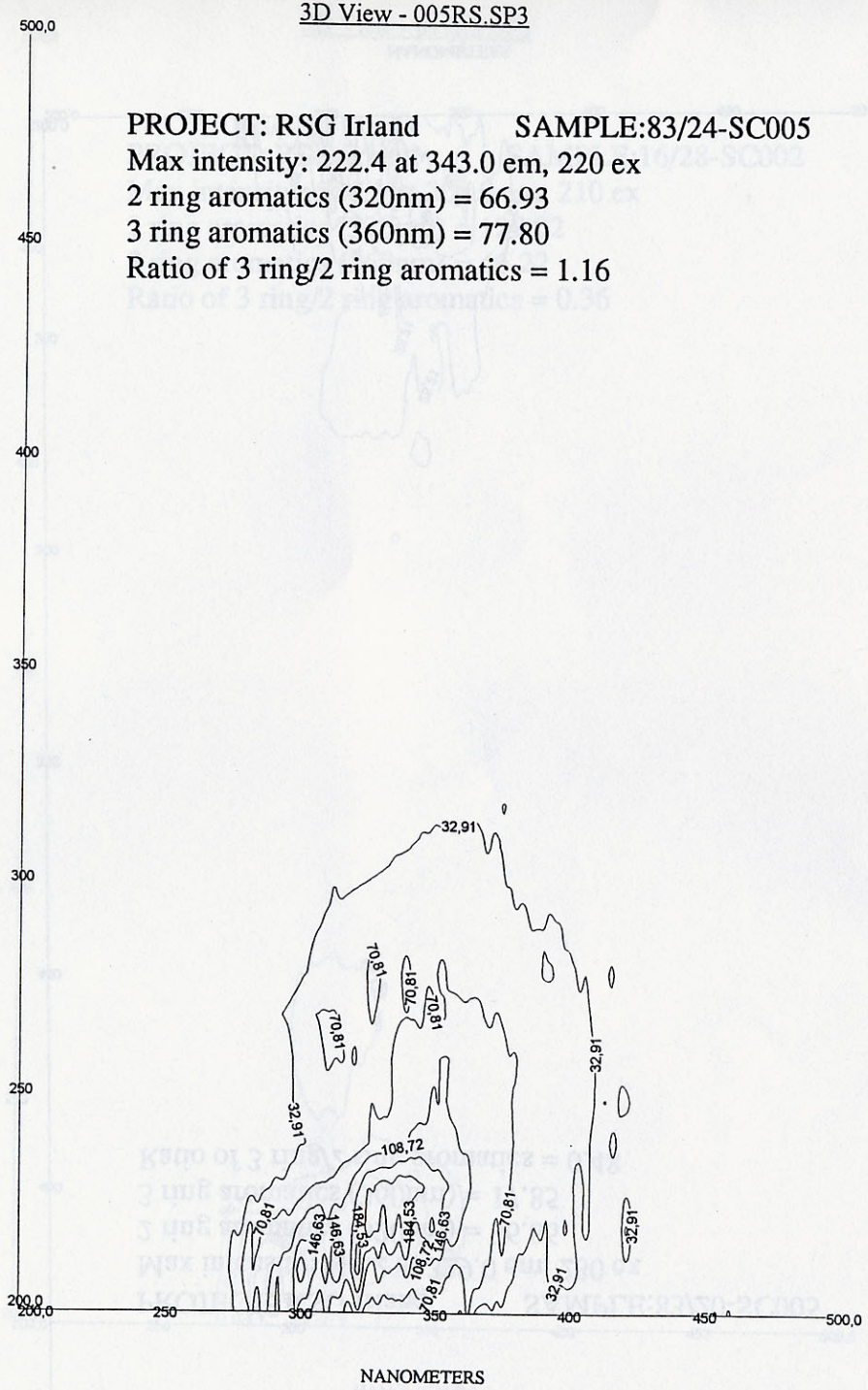
Analysis Name : [64049] 12 OV64049A,24,1.



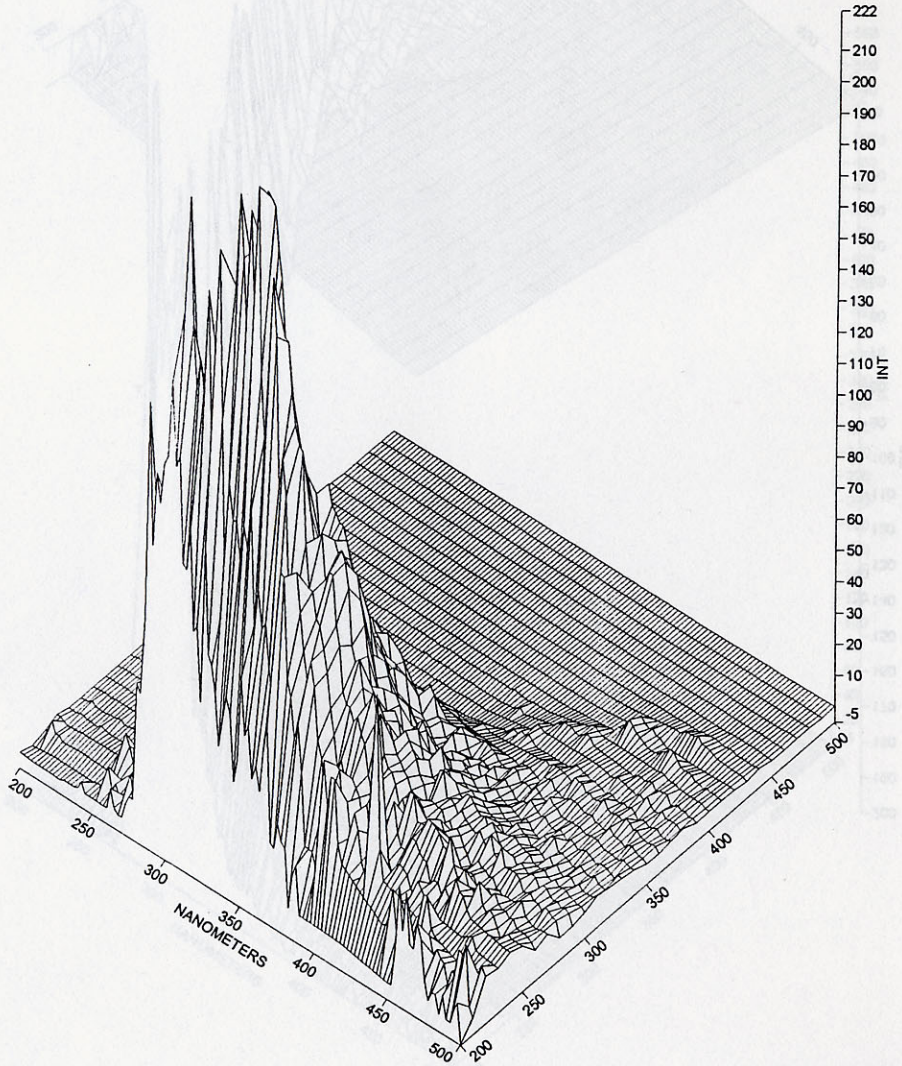
APPENDIX 2 :

3D View - 005RS.SP3

PROJECT: RSG Irland SAMPLE:83/24-SC005
Max intensity: 222.4 at 343.0 em, 220 ex
2 ring aromatics (320nm) = 66.93
3 ring aromatics (360nm) = 77.80
Ratio of 3 ring/2 ring aromatics = 1.16



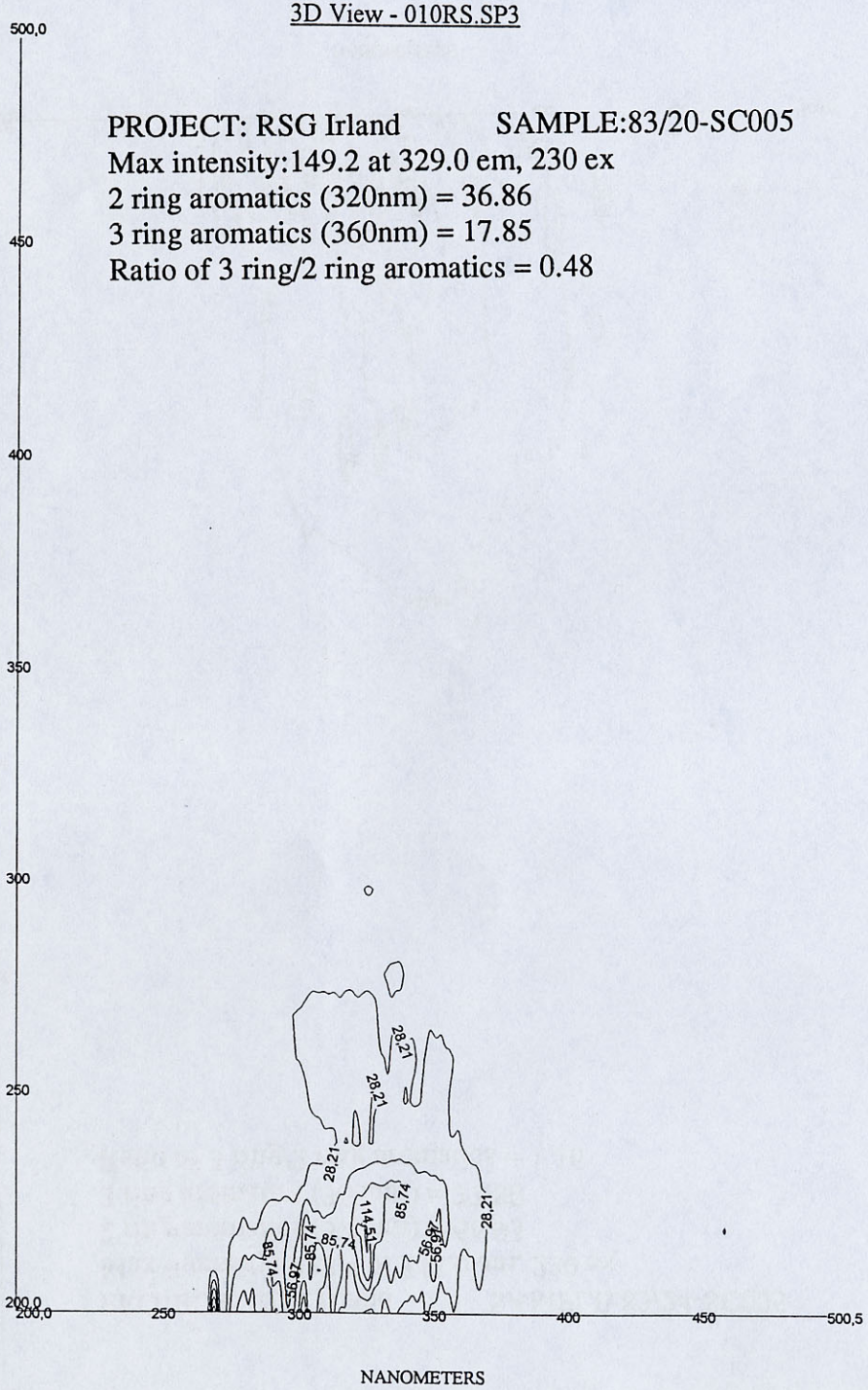
3D View - 005RS.SP3



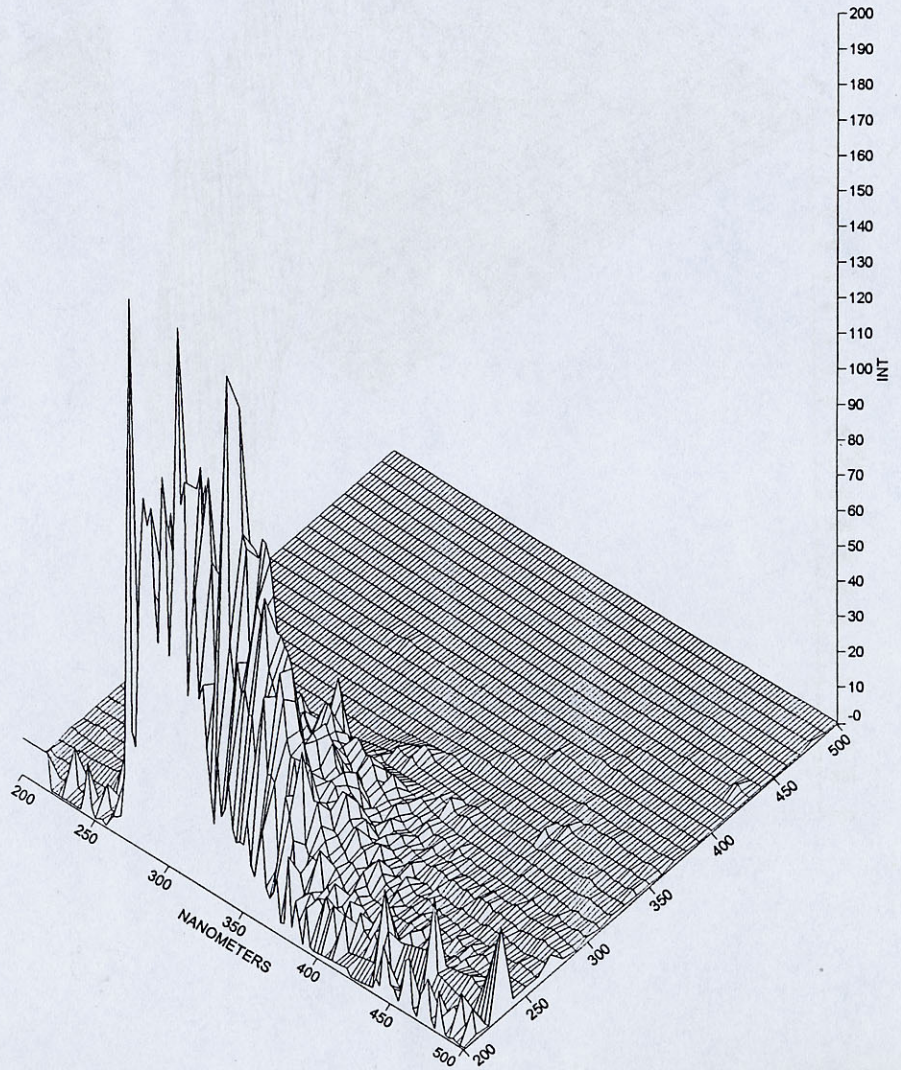
GEOLAB NOR

3D View - 010RS.SP3

PROJECT: RSG Irland SAMPLE:83/20-SC005
Max intensity:149.2 at 329.0 em, 230 ex
2 ring aromatics (320nm) = 36.86
3 ring aromatics (360nm) = 17.85
Ratio of 3 ring/2 ring aromatics = 0.48



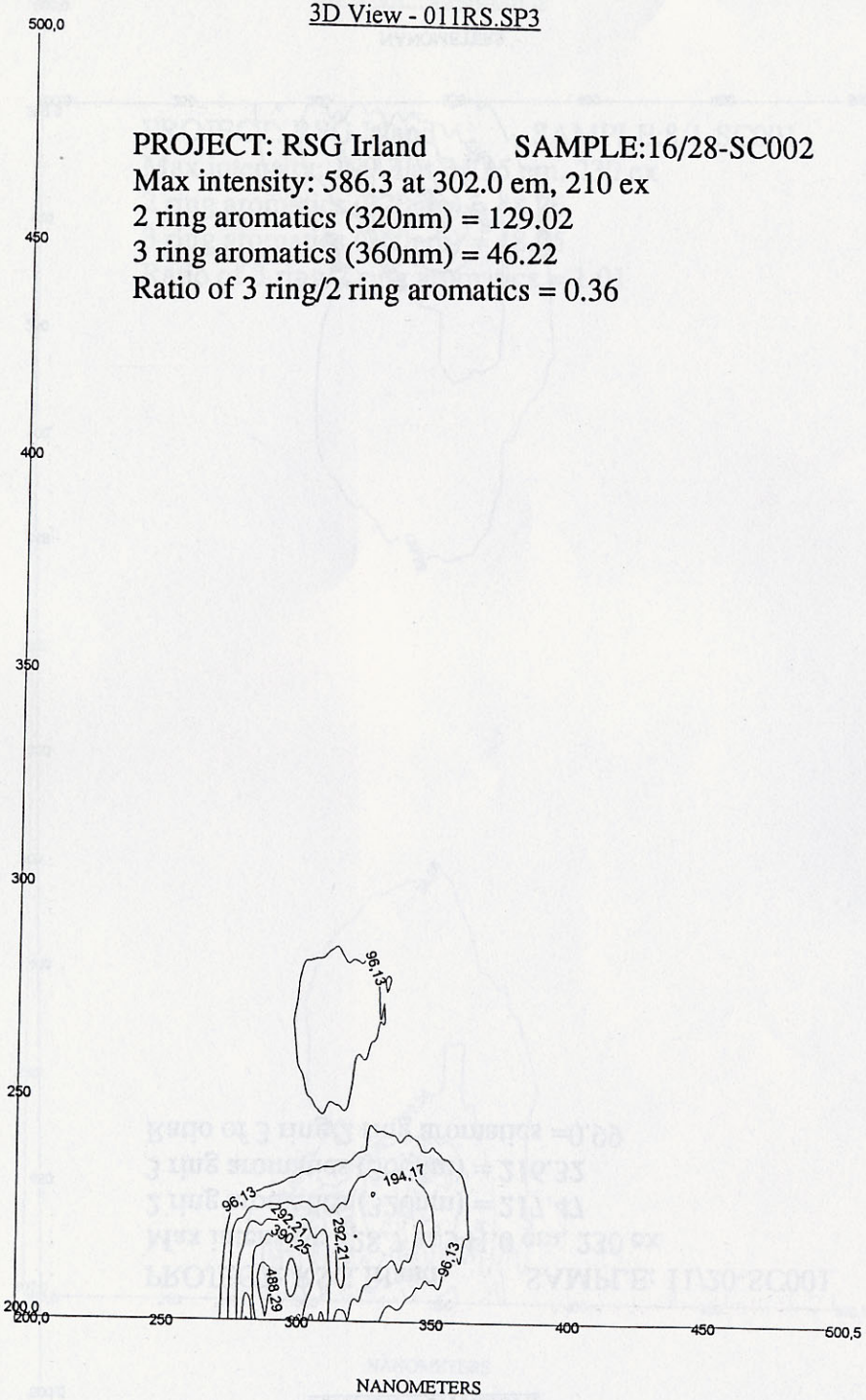
3D View - 010RS.SP3



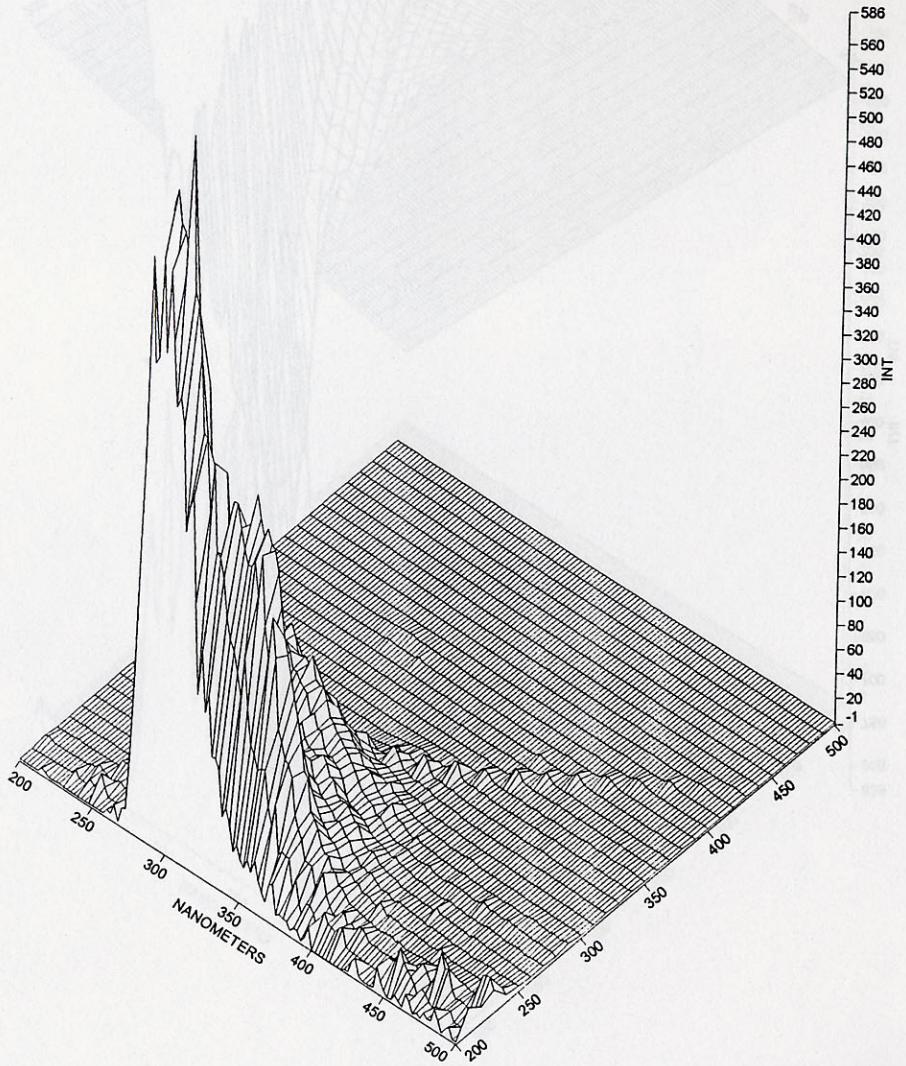
GEOLAB NOR

3D View - 011RS.SP3

PROJECT: RSG Irland SAMPLE:16/28-SC002
Max intensity: 586.3 at 302.0 em, 210 ex
2 ring aromatics (320nm) = 129.02
3 ring aromatics (360nm) = 46.22
Ratio of 3 ring/2 ring aromatics = 0.36



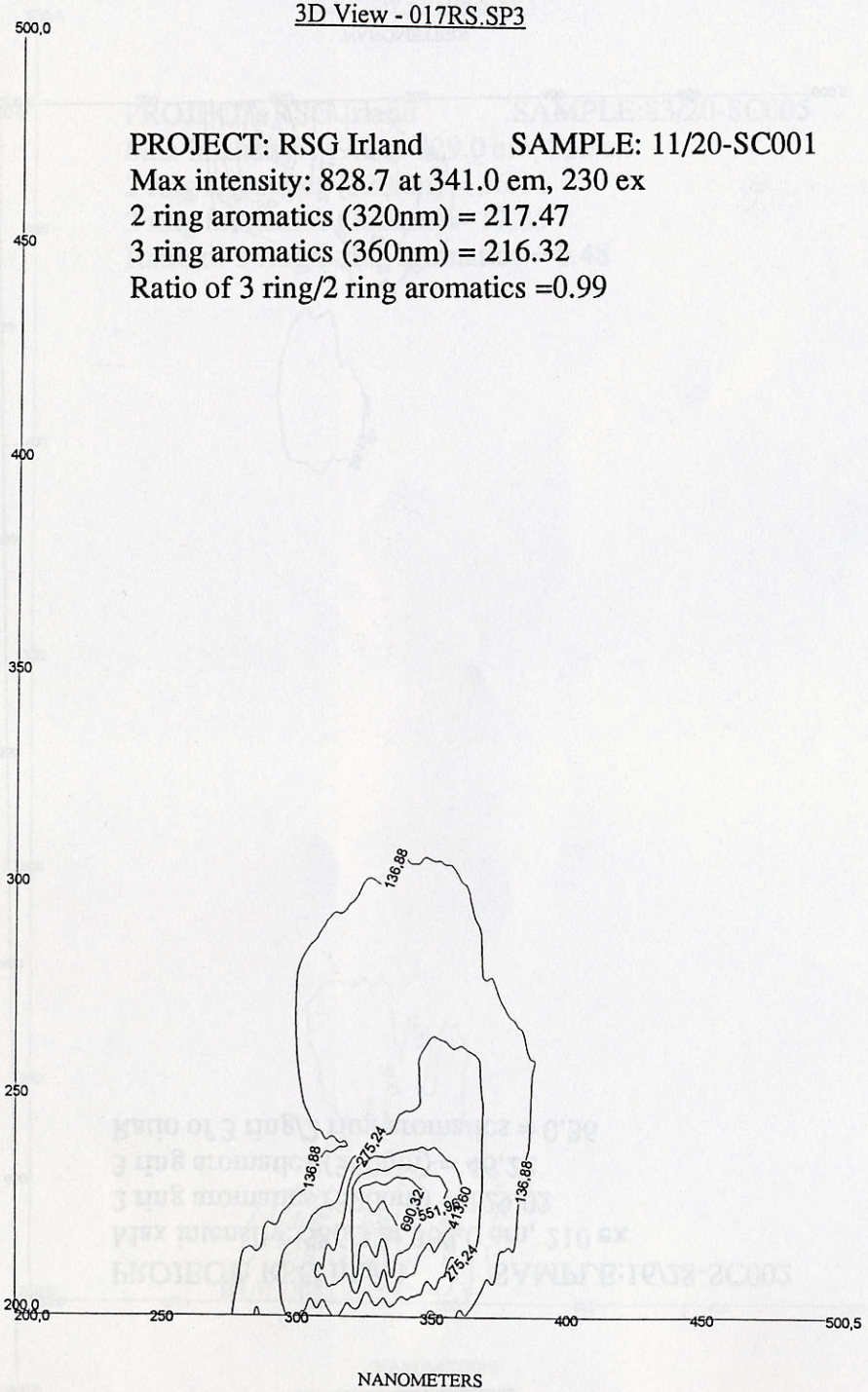
3D View - 011RS.SP3



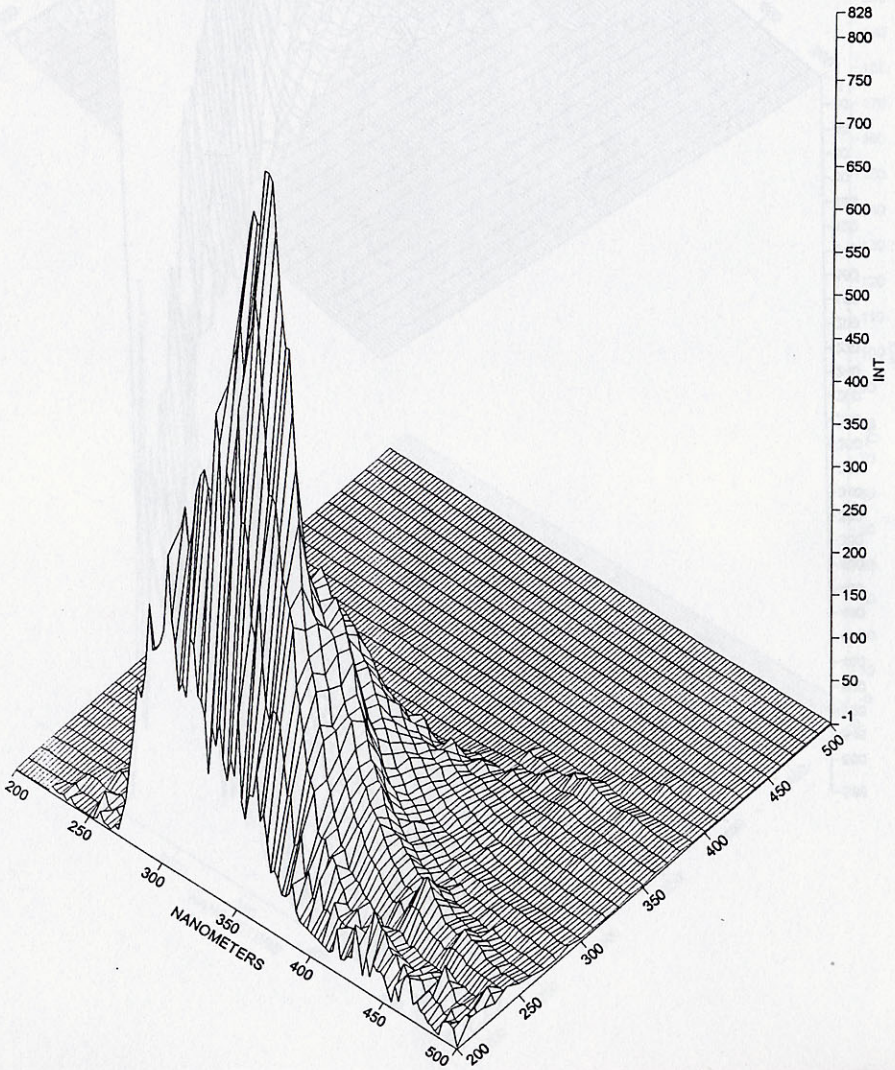
GEOLAB NOR

3D View - 017RS.SP3

PROJECT: RSG Irland SAMPLE: 11/20-SC001
Max intensity: 828.7 at 341.0 em, 230 ex
2 ring aromatics (320nm) = 217.47
3 ring aromatics (360nm) = 216.32
Ratio of 3 ring/2 ring aromatics =0.99



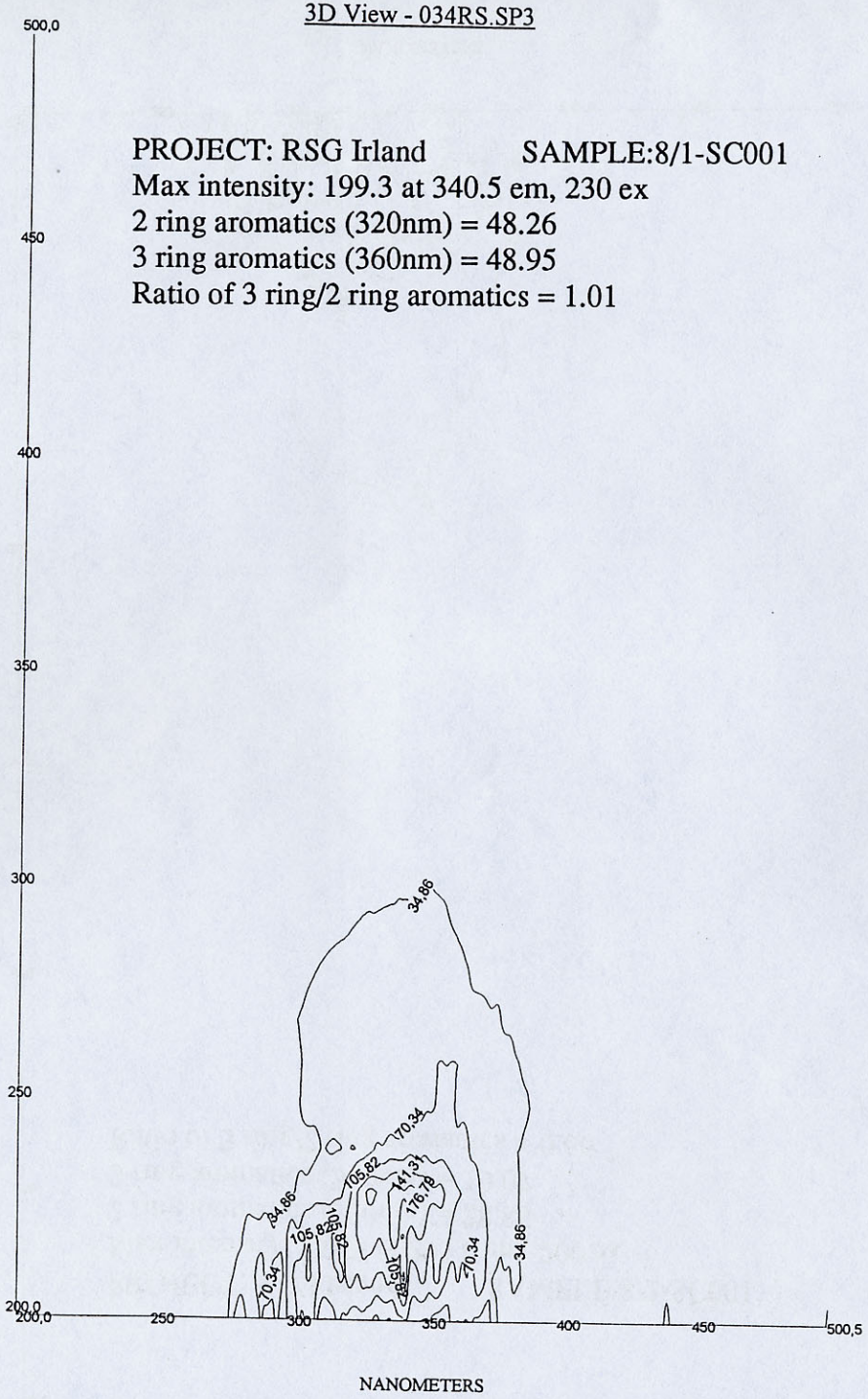
3D View - 017RS.SP3



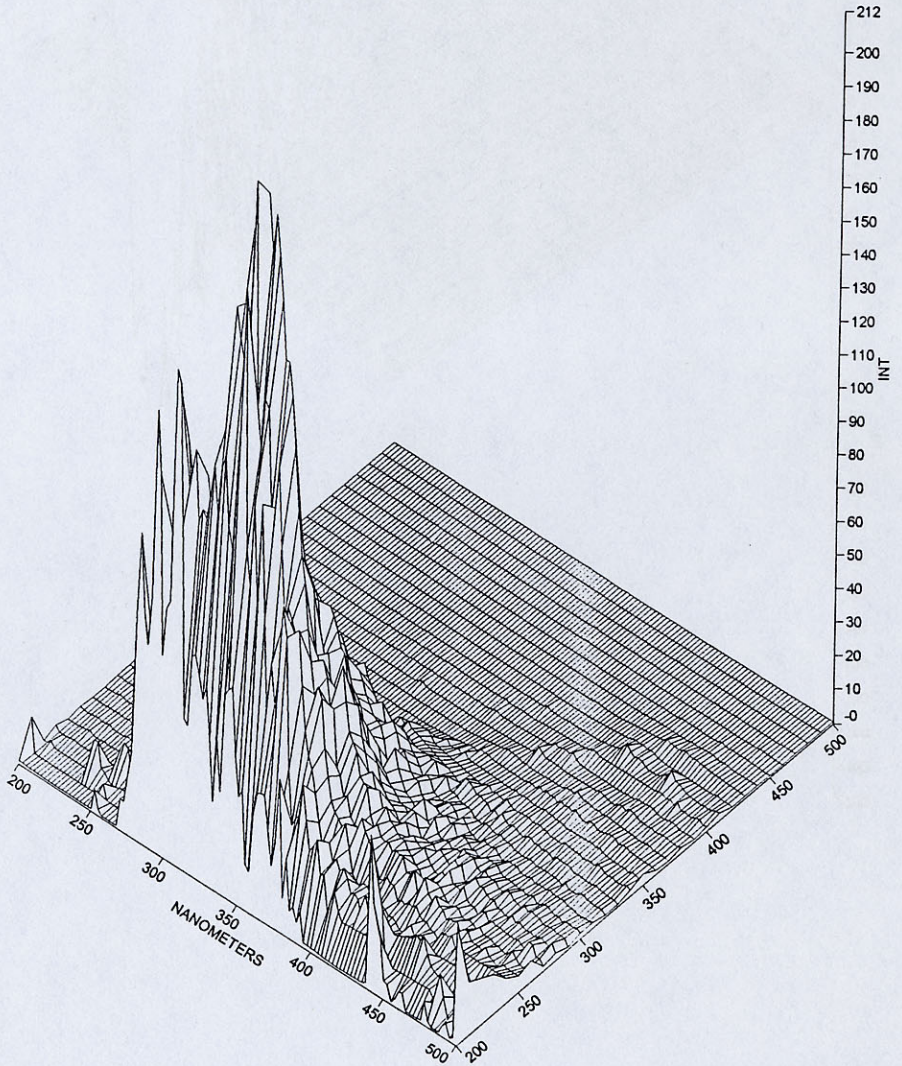
GEOLAB NOR

3D View - 034RS.SP3

PROJECT: RSG Irland SAMPLE:8/1-SC001
Max intensity: 199.3 at 340.5 em, 230 ex
2 ring aromatics (320nm) = 48.26
3 ring aromatics (360nm) = 48.95
Ratio of 3 ring/2 ring aromatics = 1.01



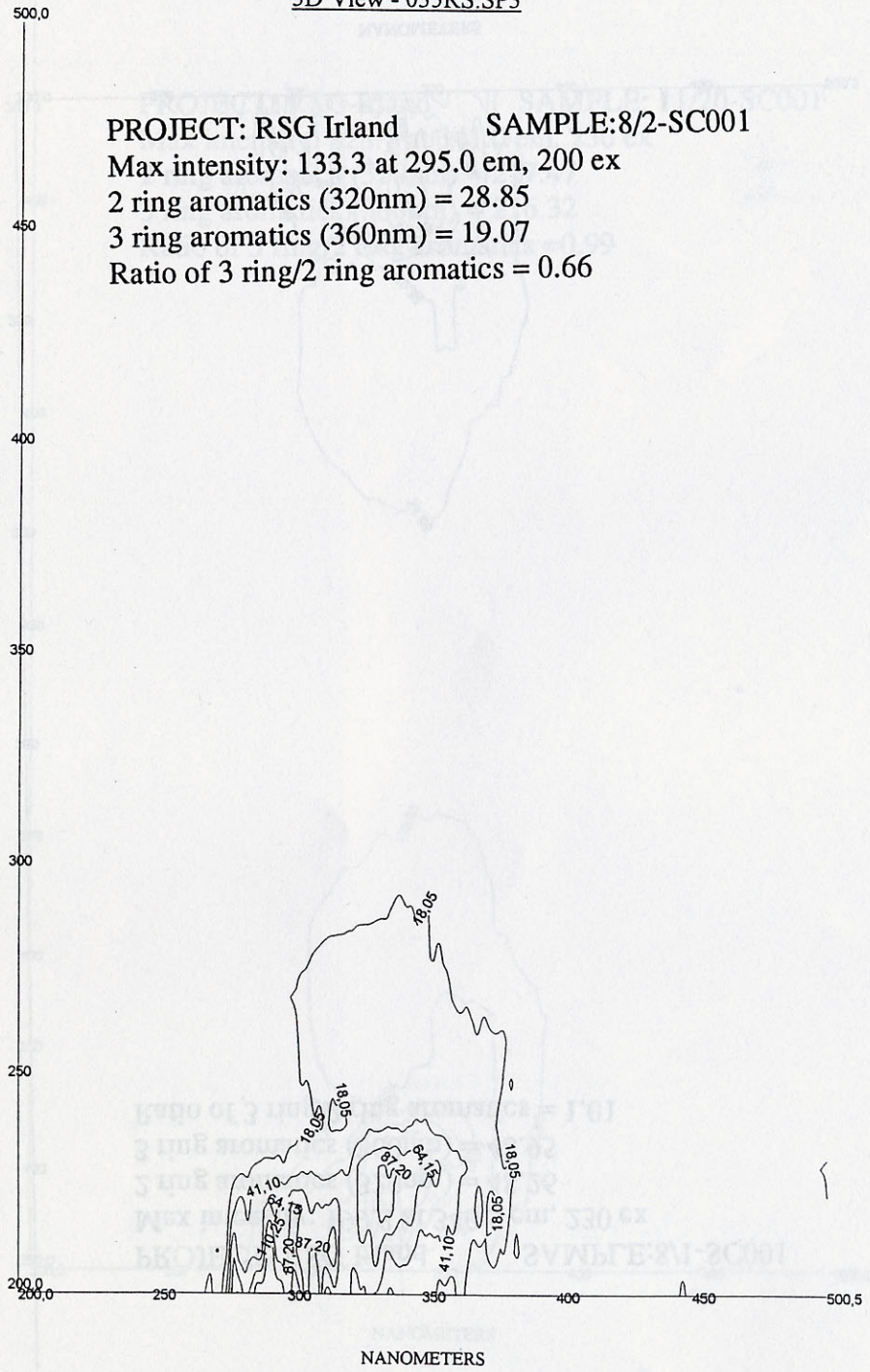
3D View - 034RS.SP3



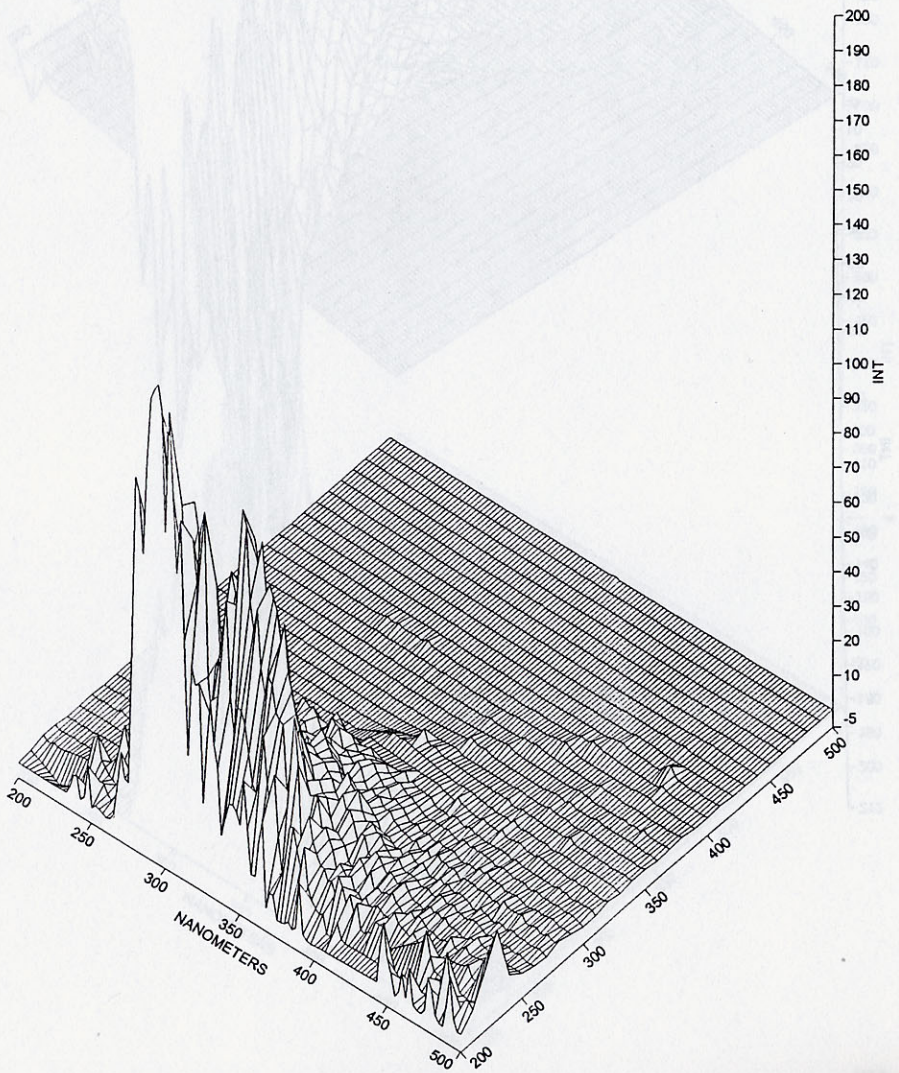
GEOLAB NOR

3D View - 035RS.SP3

PROJECT: RSG Irland SAMPLE:8/2-SC001
Max intensity: 133.3 at 295.0 em, 200 ex
2 ring aromatics (320nm) = 28.85
3 ring aromatics (360nm) = 19.07
Ratio of 3 ring/2 ring aromatics = 0.66



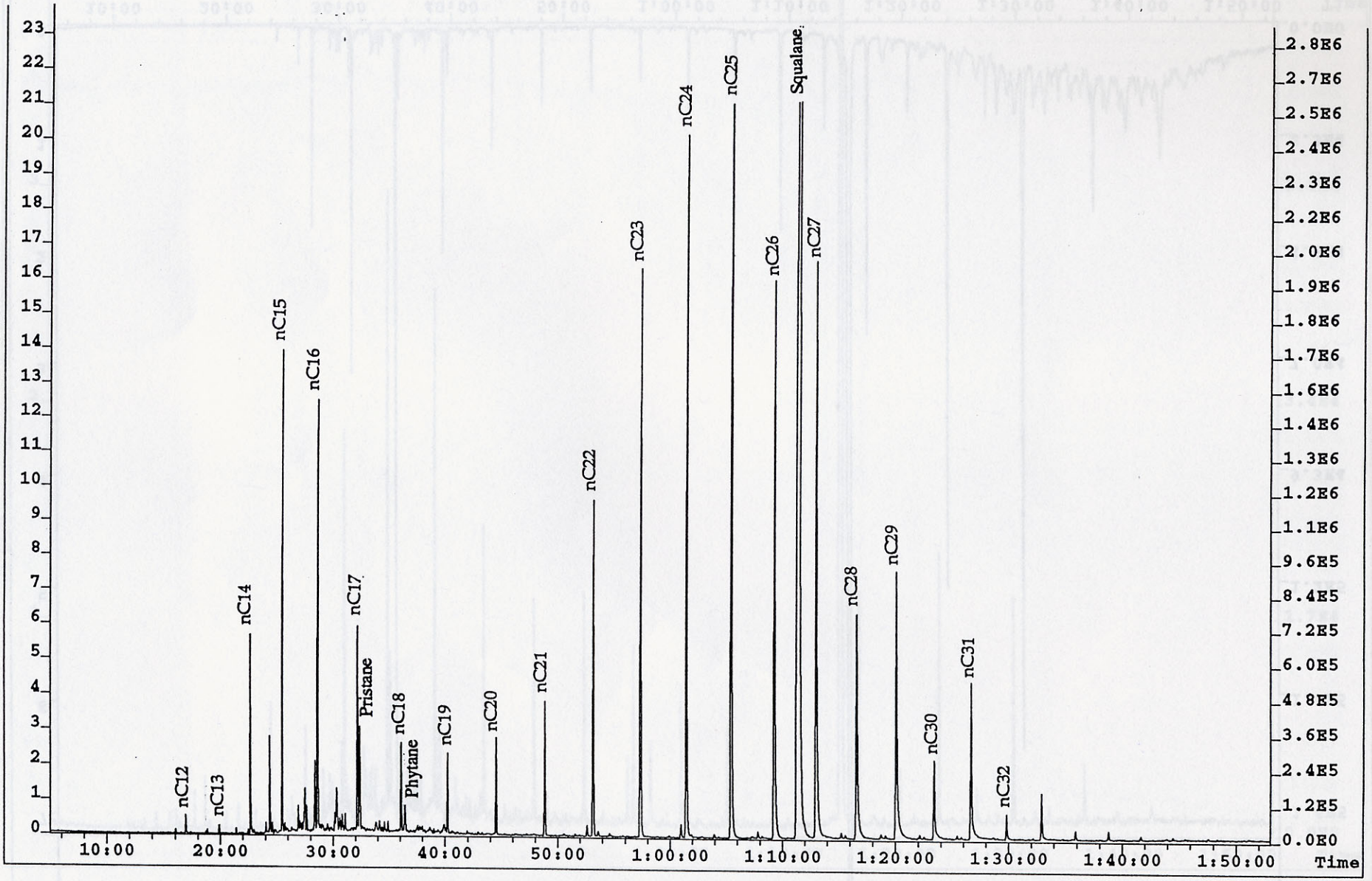
3D View - 035RS.SP3



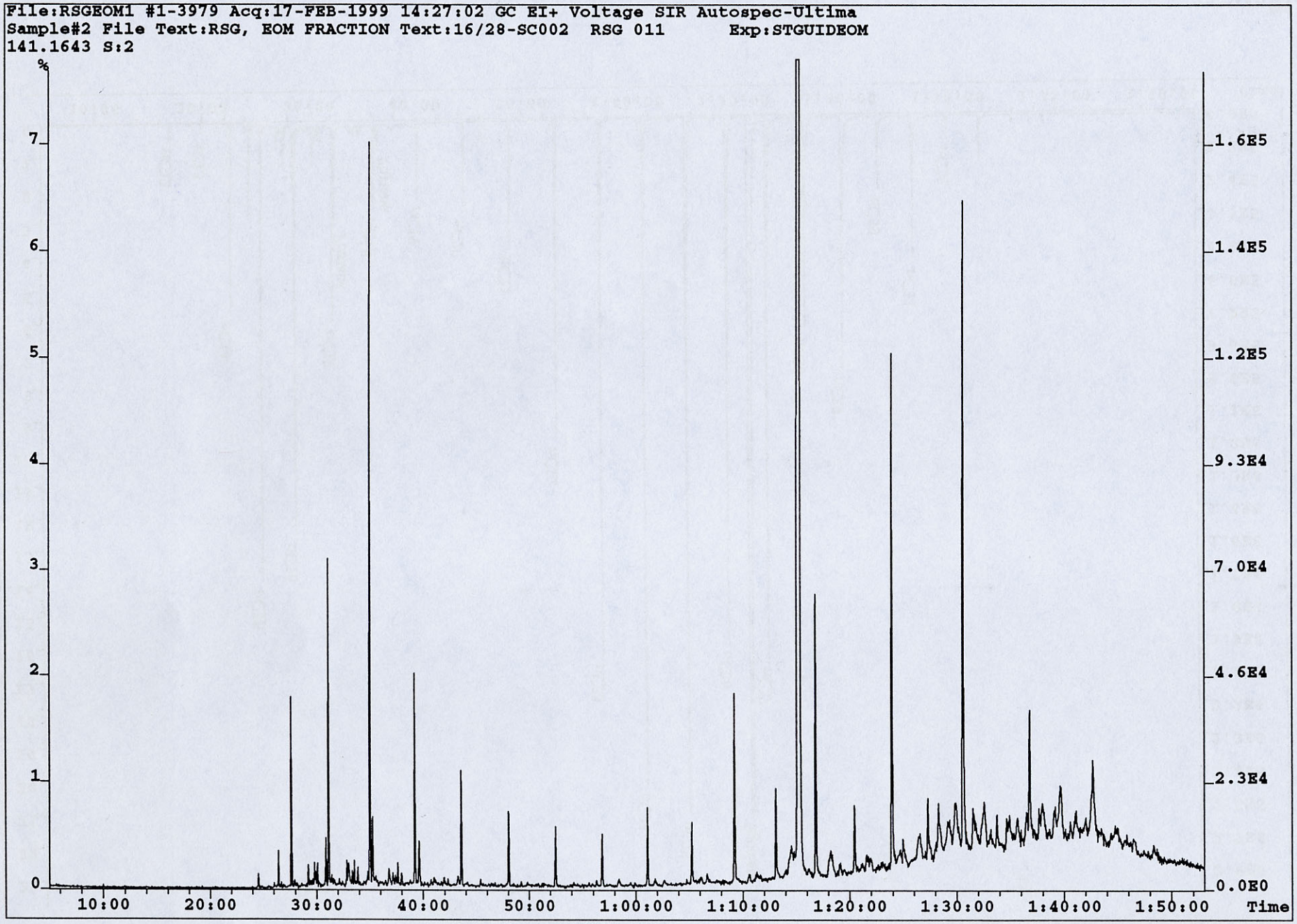
GEOLAB NOR

APPENDIX 3 :

EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 141 ALKANES



GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
141.1643 S:2
%
7
6
5
4
3
2
1
0
1.6E5
1.4E5
1.2E5
9.3E4
7.0E4
4.6E4
2.3E4
0.0E0
10:00
20:00
30:00
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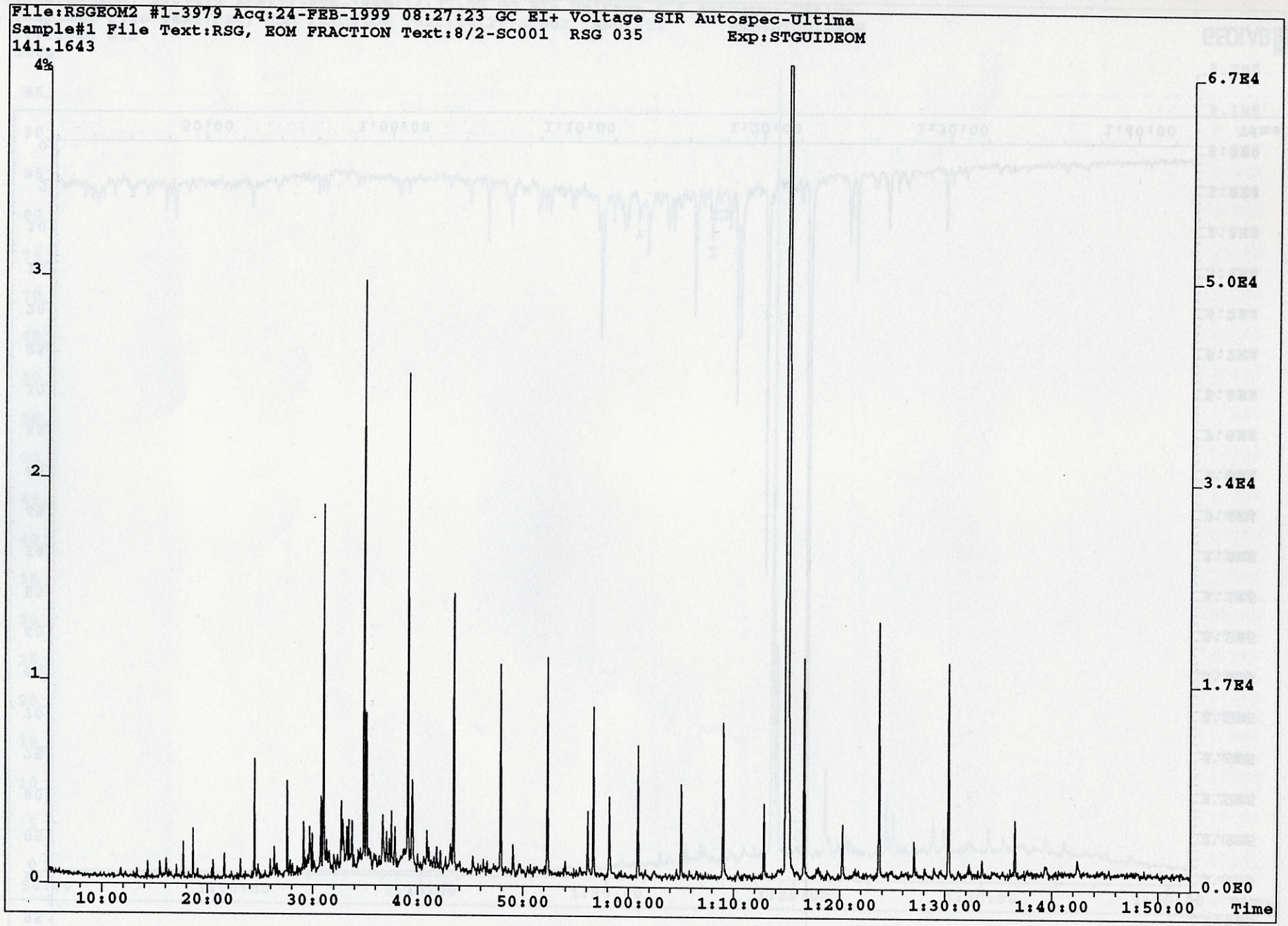
Time

GEOLAB NOR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4%
3
2
1
0
6.7E4
5.0E4
3.4E4
1.7E4
0.0E0
10:00
20:00
30:00
40:00
50:00
1:00:00
1:10:00
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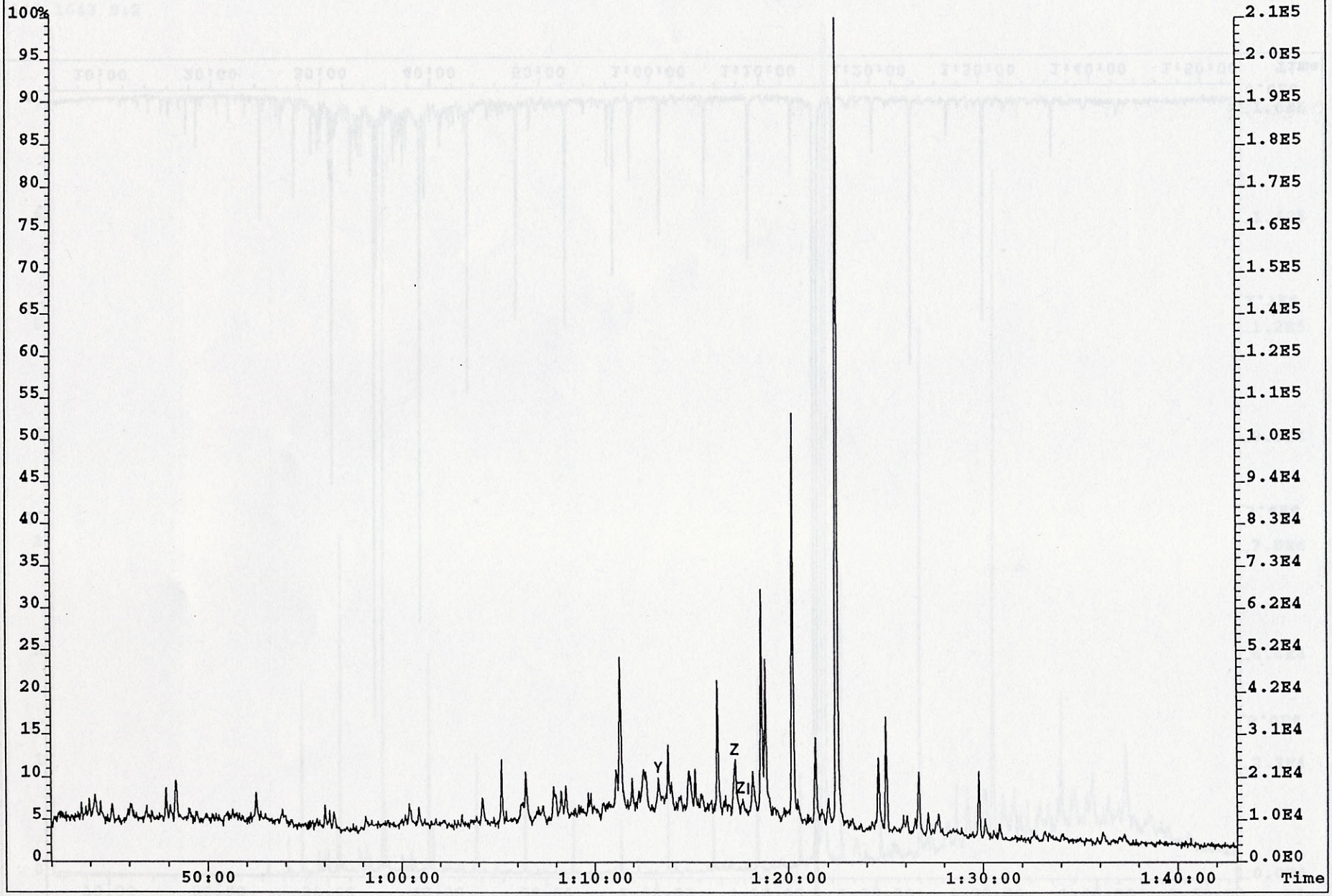
1:50:00
Time

GEOLAB NOR

EXAMPLE OF IDENTIFICATION FOR M/Z 177 DEMETHYLATED TRITERPANES



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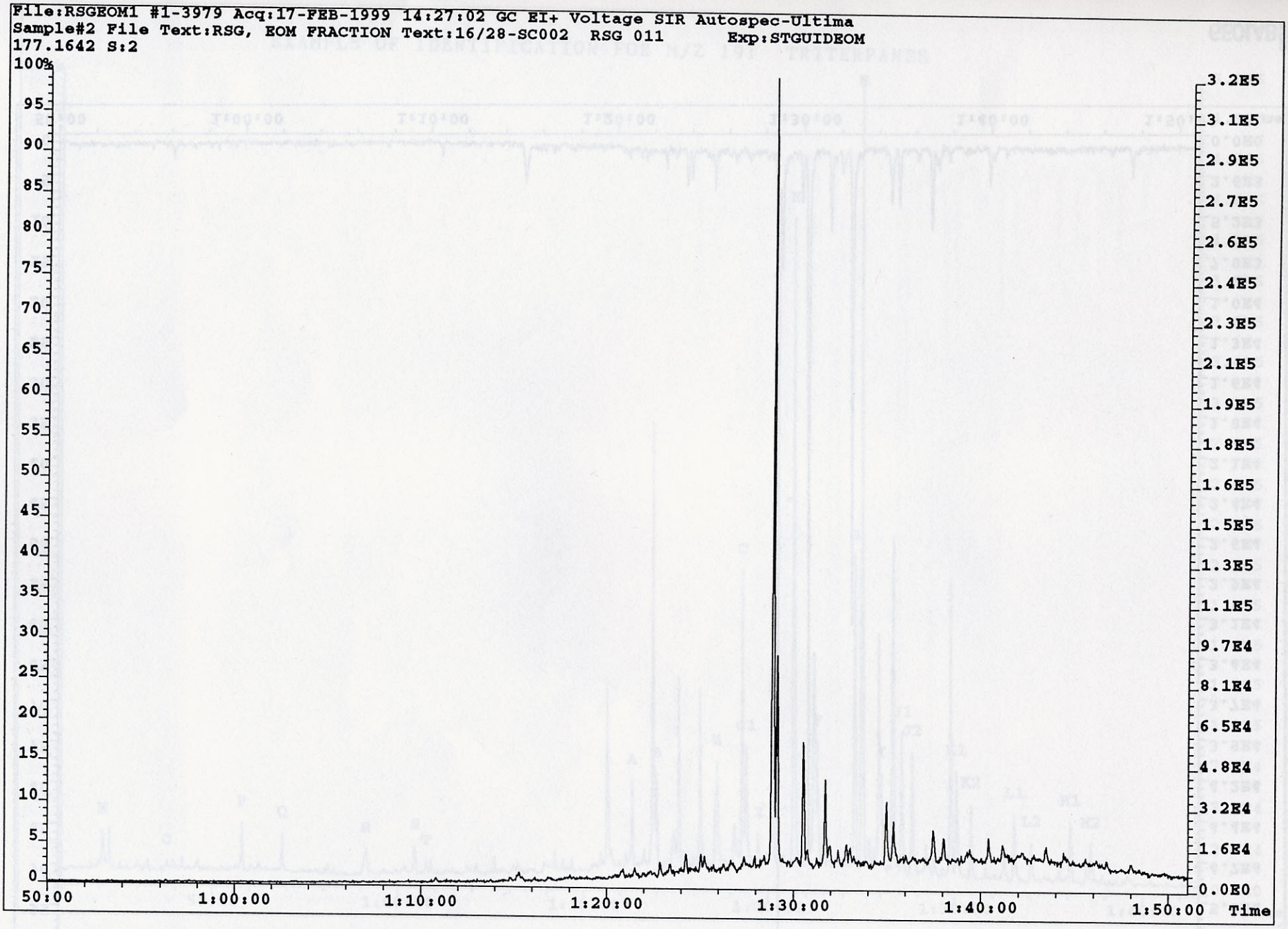
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90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3.2E5
3.1E5
2.9E5
2.7E5
2.6E5
2.4E5
2.3E5
2.1E5
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1.6E5
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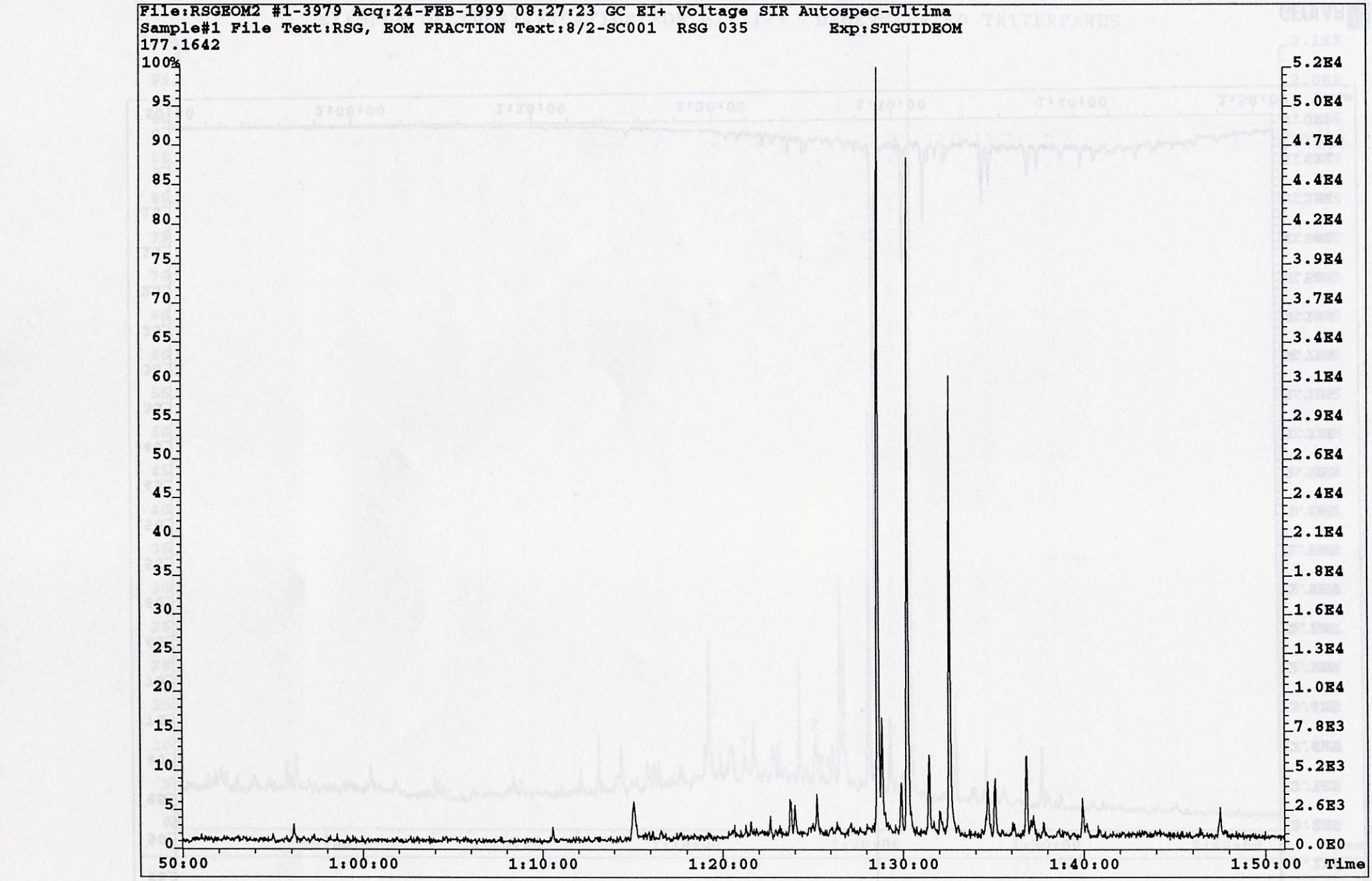
GEOLAB NOR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80
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10
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5.2E4
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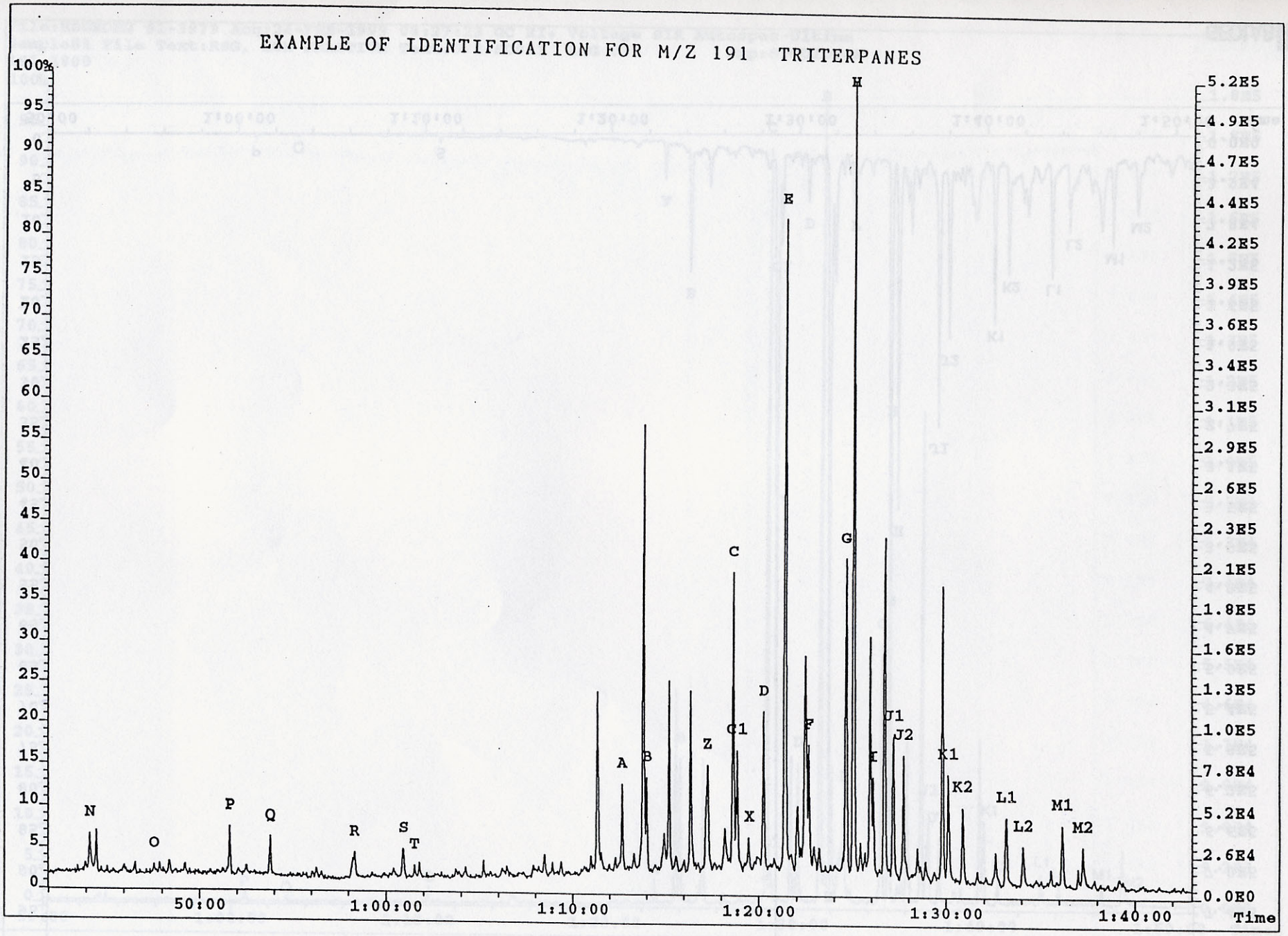
GEOLAB NOR


EXAMPLE OF IDENTIFICATION FOR M/Z 191 TRITERPANES
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4.9E5
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3.6E5
3.4E5
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O
P
Q
R
S
T
A
B
Z
C
C1
X
D
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F
G
H
I
J1
J2
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K2
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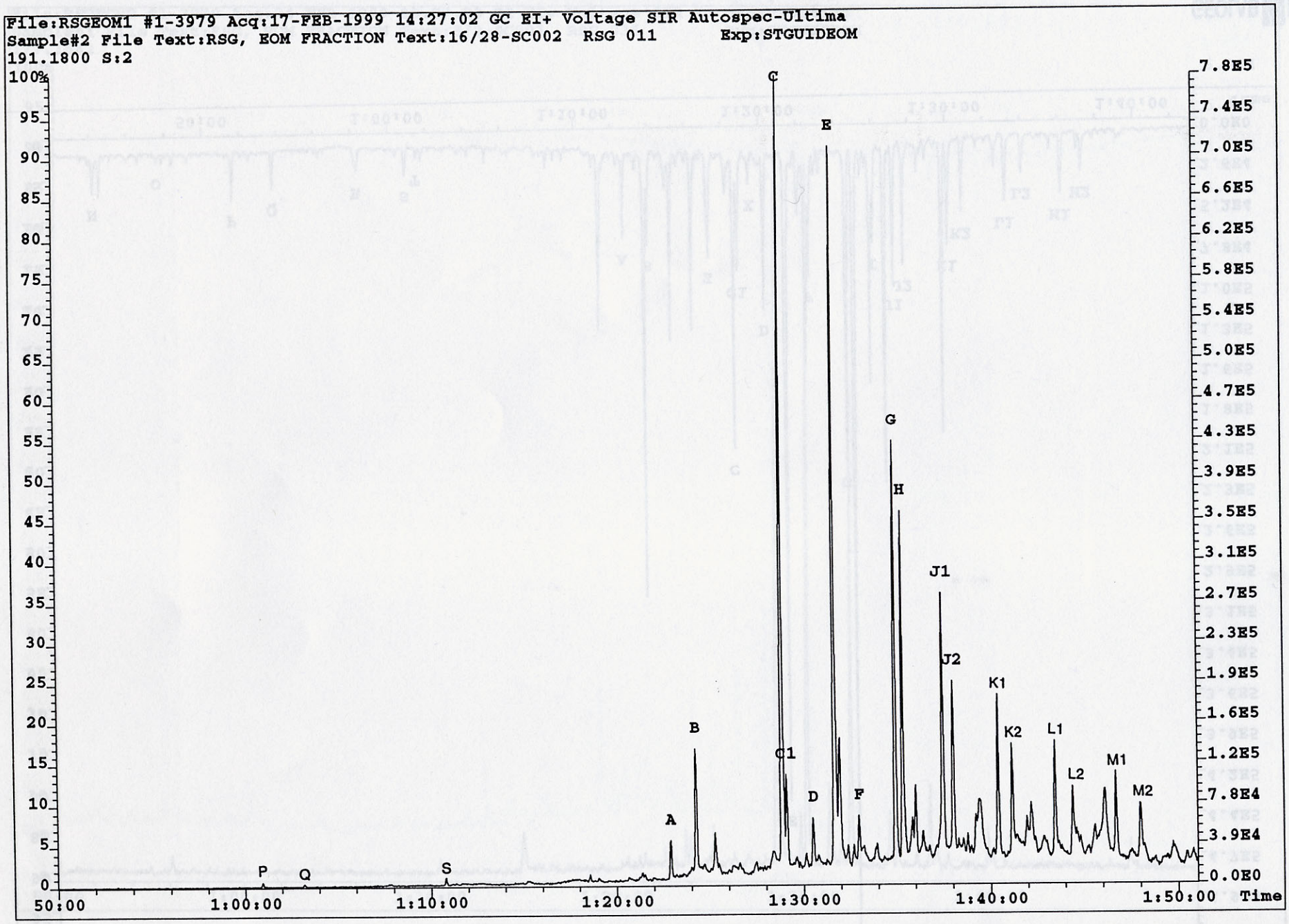
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
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90
85
80
75
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65
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P
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S
A
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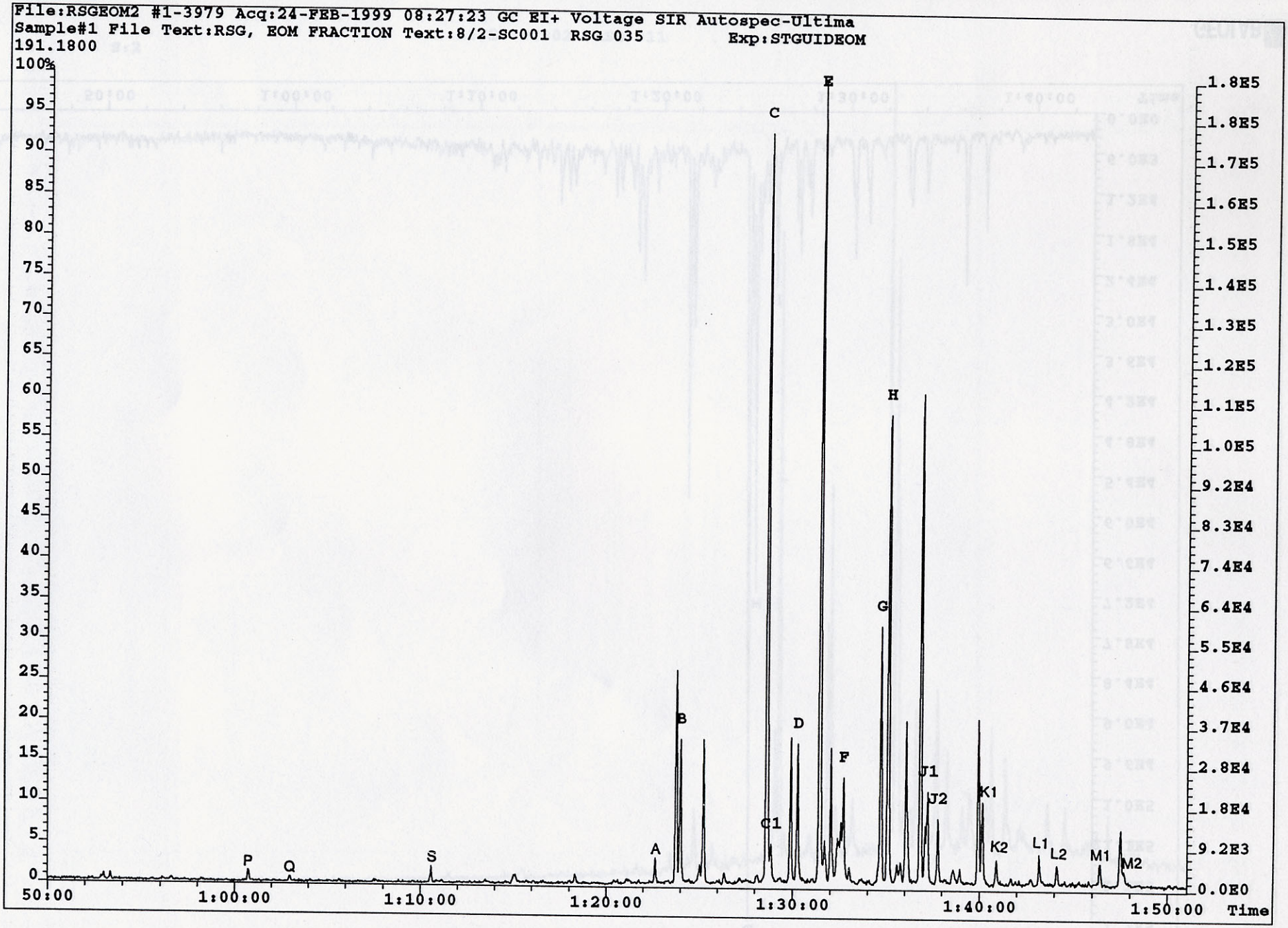
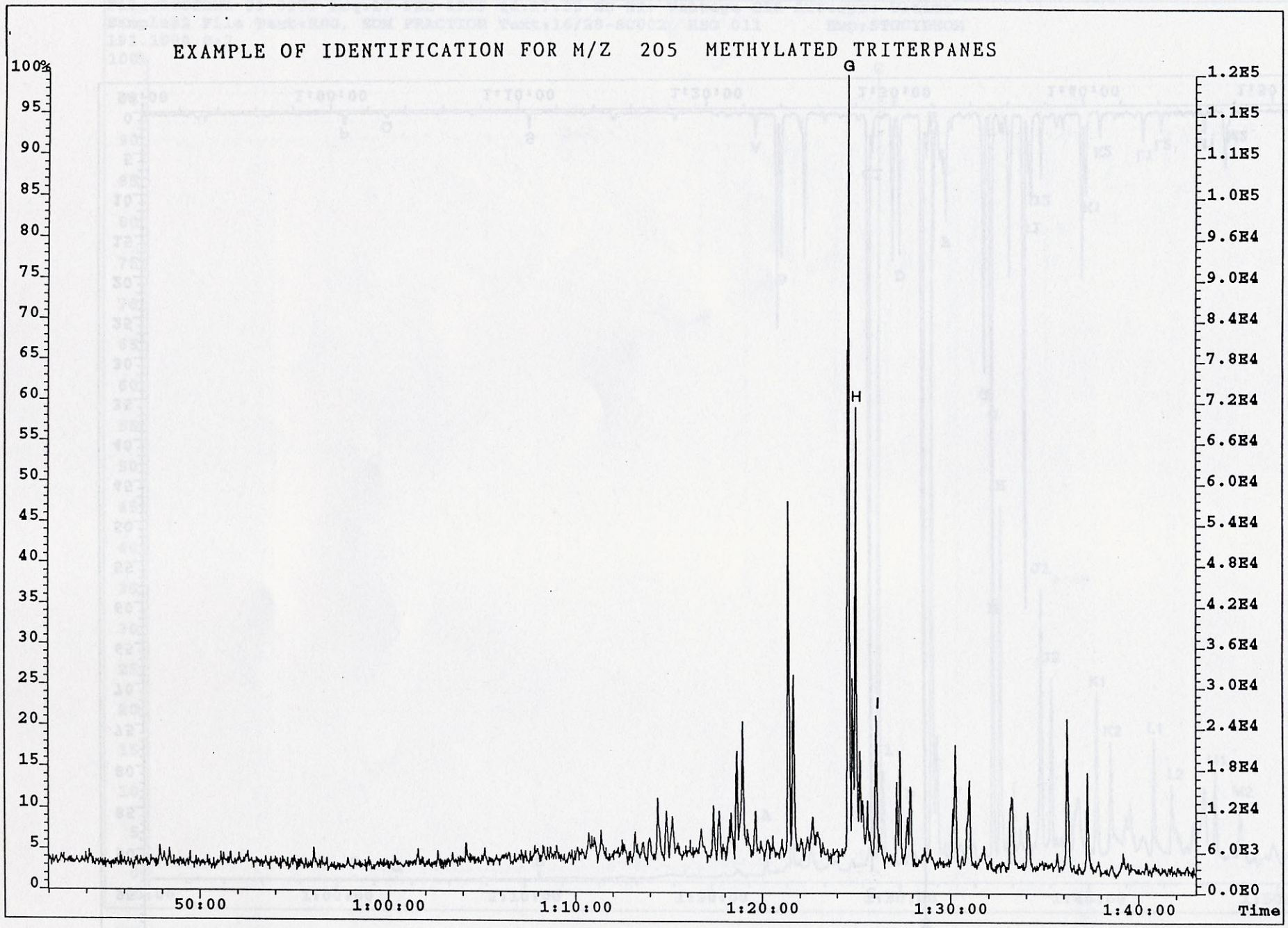
M2

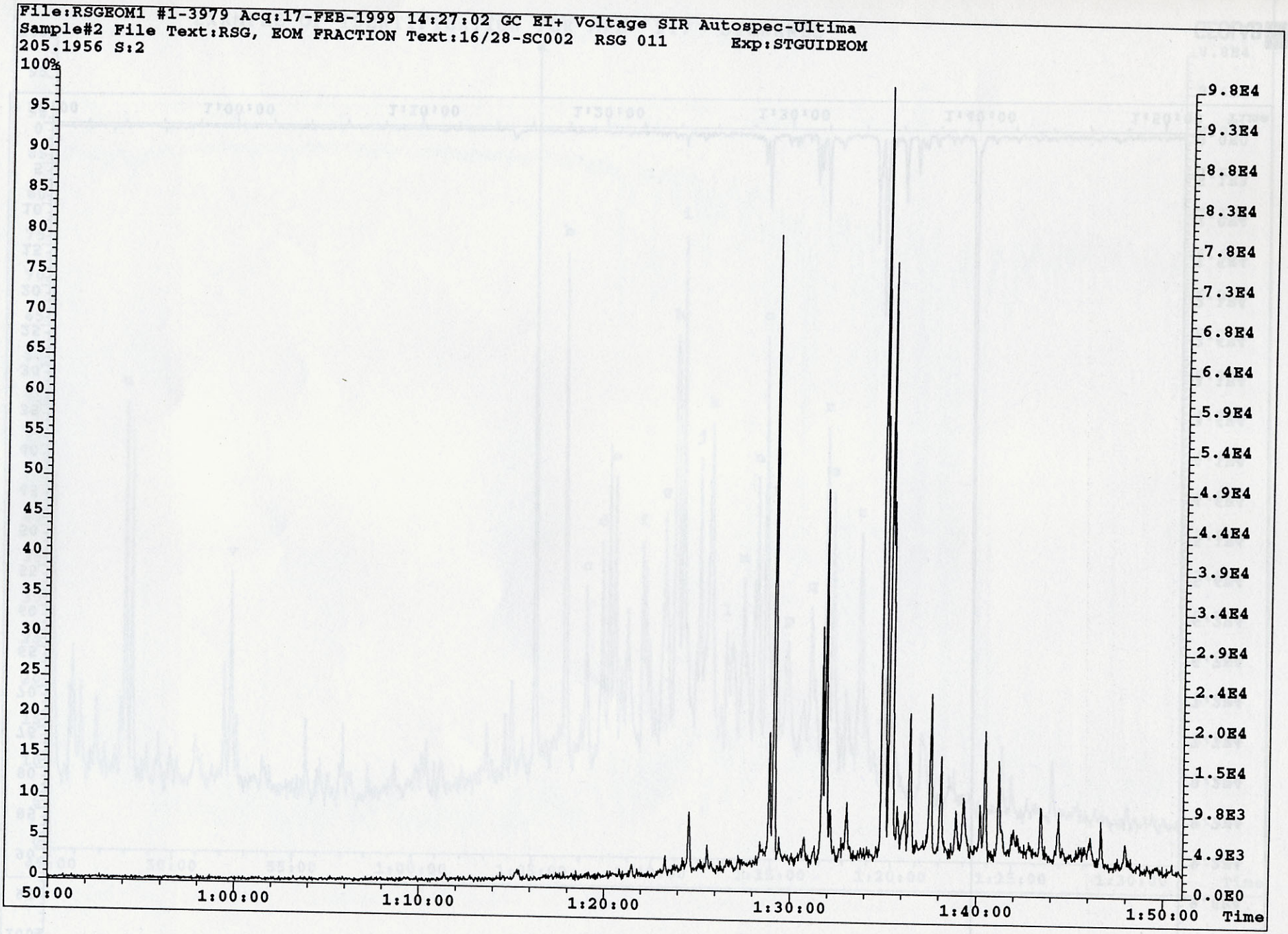
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035
Exp:STGUIDEOM
191.1800
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.8E5
1.8E5
1.7E5
1.6E5
1.5E5
1.4E5
1.3E5
1.2E5
1.1E5
1.0E5
9.2E4
8.3E4
7.4E4
6.4E4
5.5E4
4.6E4
3.7E4
2.8E4
1.8E4
9.2E3
0.0E0
50:00
1:00:00
1:10:00
1:20:00
1:30:00
1:40:00
1:50:00
Time
P
Q
S
A
B
C
C1
D
E
F
G
H
J1
J2
K1
K2
L1
L2
M1
M2

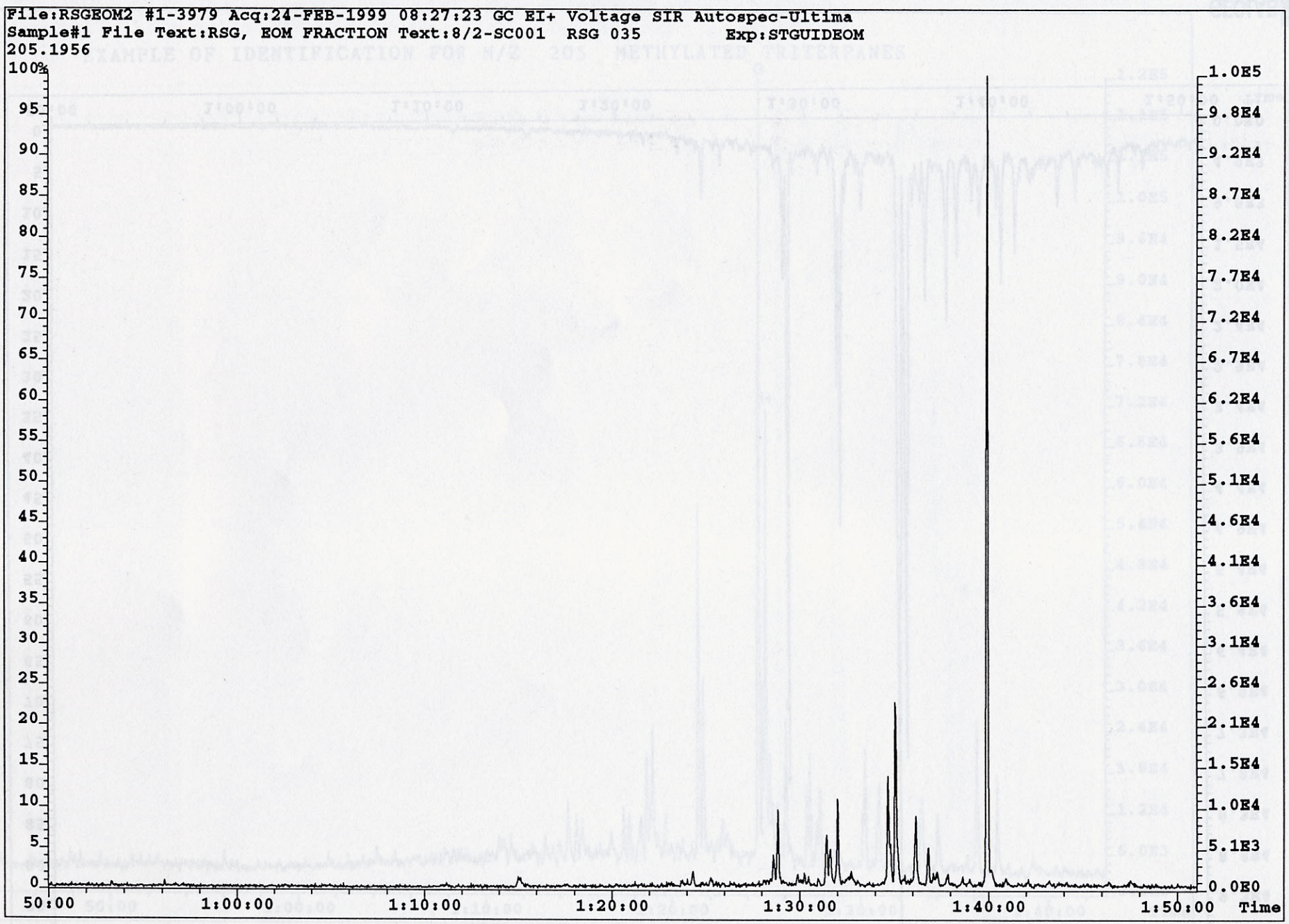
GEOLAB NOR


EXAMPLE OF IDENTIFICATION FOR M/Z 205 METHYLATED TRITERPANES
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
G
H
I
1.2E5
1.1E5
1.1E5
1.0E5
9.6E4
9.0E4
8.4E4
7.8E4
7.2E4
6.6E4
6.0E4
5.4E4
4.8E4
4.2E4
3.6E4
3.0E4
2.4E4
1.8E4
1.2E4
6.0E3
0.0E0
50:00
1:00:00
1:10:00
1:20:00
1:30:00
1:40:00
Time

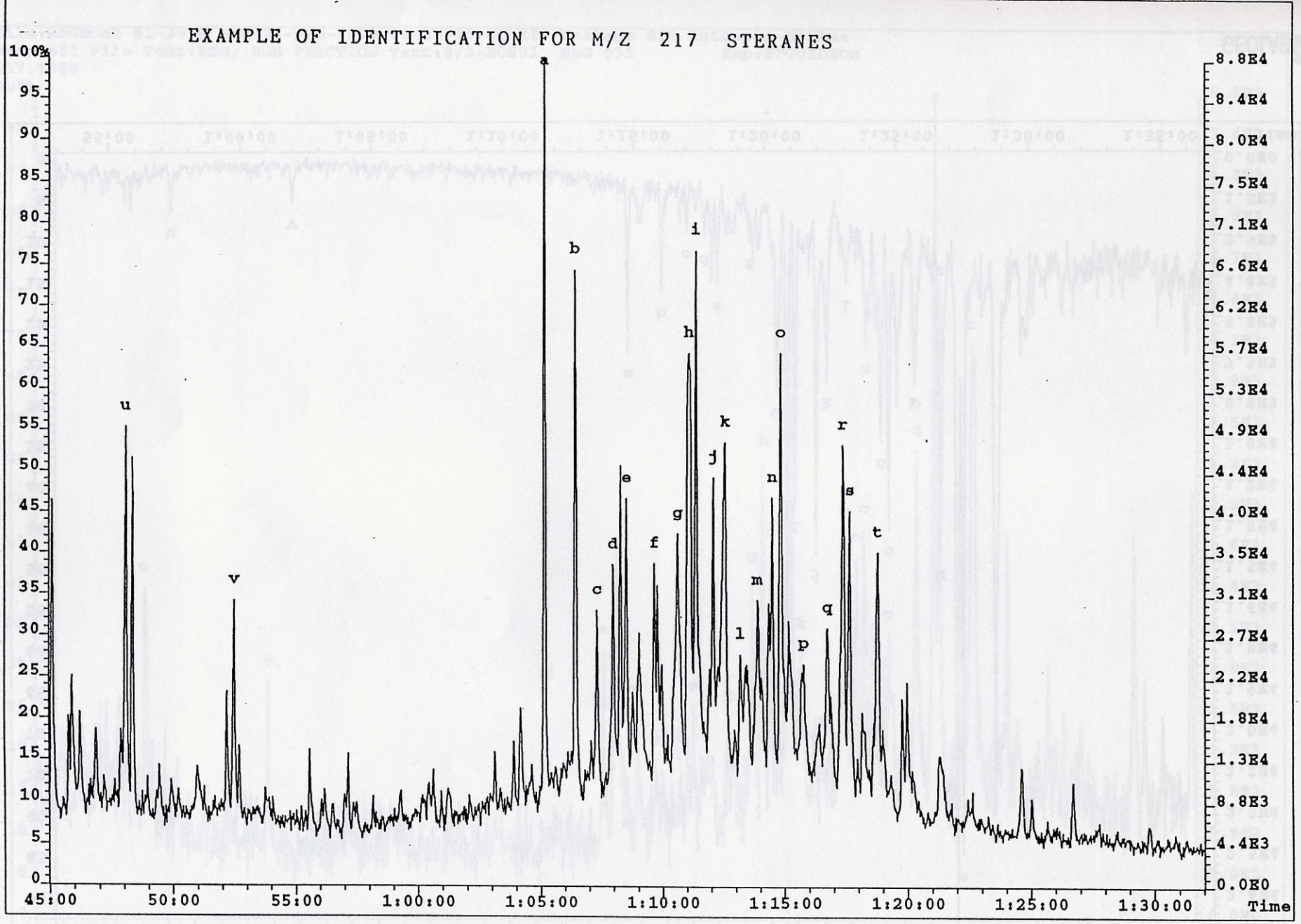
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
205.1956 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
9.8E4
9.3E4
8.8E4
8.3E4
7.8E4
7.3E4
6.8E4
6.4E4
5.9E4
5.4E4
4.9E4
4.4E4
3.9E4
3.4E4
2.9E4
2.4E4
2.0E4
1.5E4
9.8E3
4.9E3
0.0E0
50:00
1:00:00
1:10:00
1:20:00
1:30:00
1:40:00
1:50:00
Time

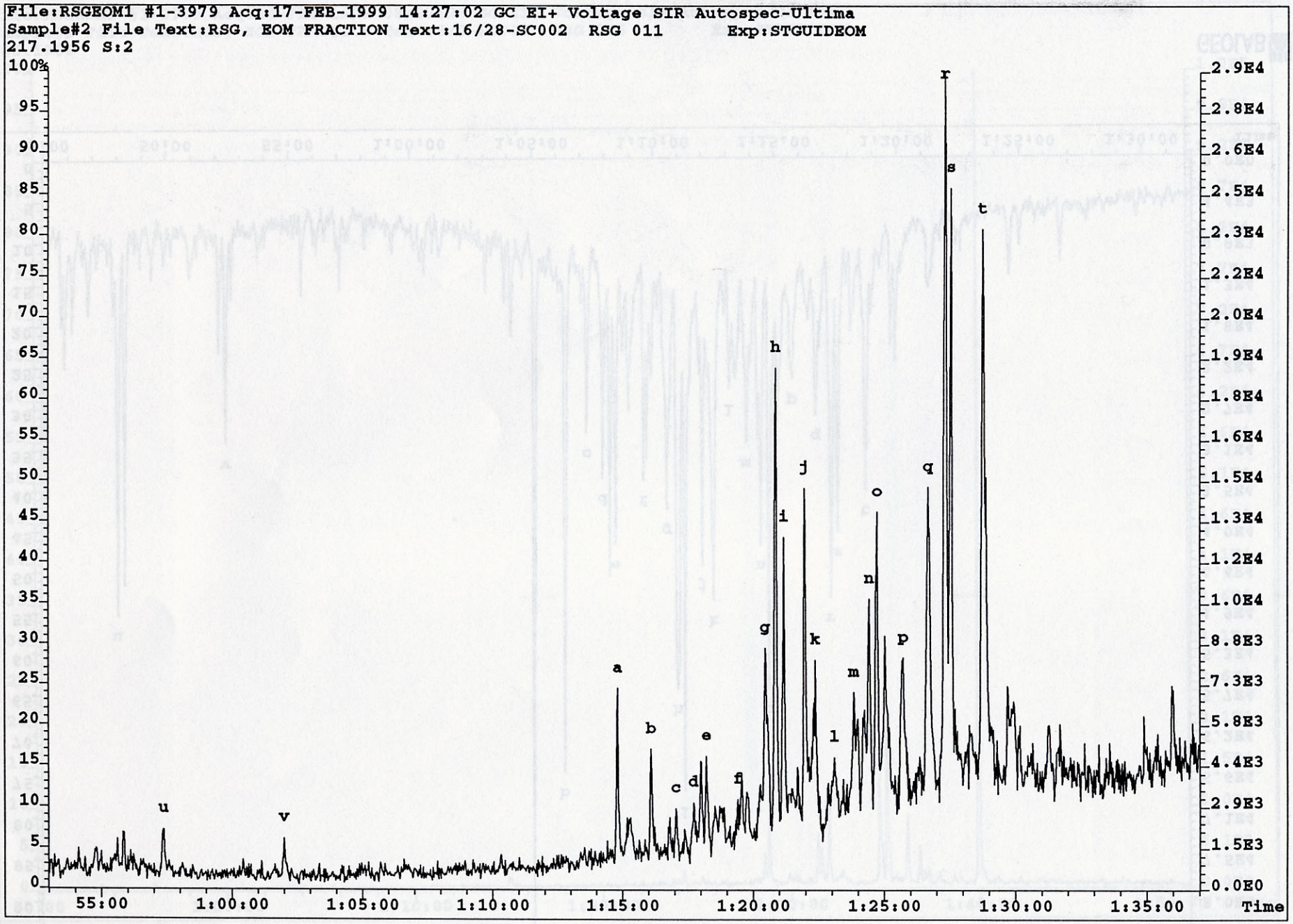
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
205.1956
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.0E5
9.8E4
9.2E4
8.7E4
8.2E4
7.7E4
7.2E4
6.7E4
6.2E4
5.6E4
5.1E4
4.6E4
4.1E4
3.6E4
3.1E4
2.6E4
2.1E4
1.5E4
1.0E4
5.1E3
0.0E0
50:00
1:00:00
1:10:00
1:20:00
1:30:00
1:40:00
1:50:00
Time

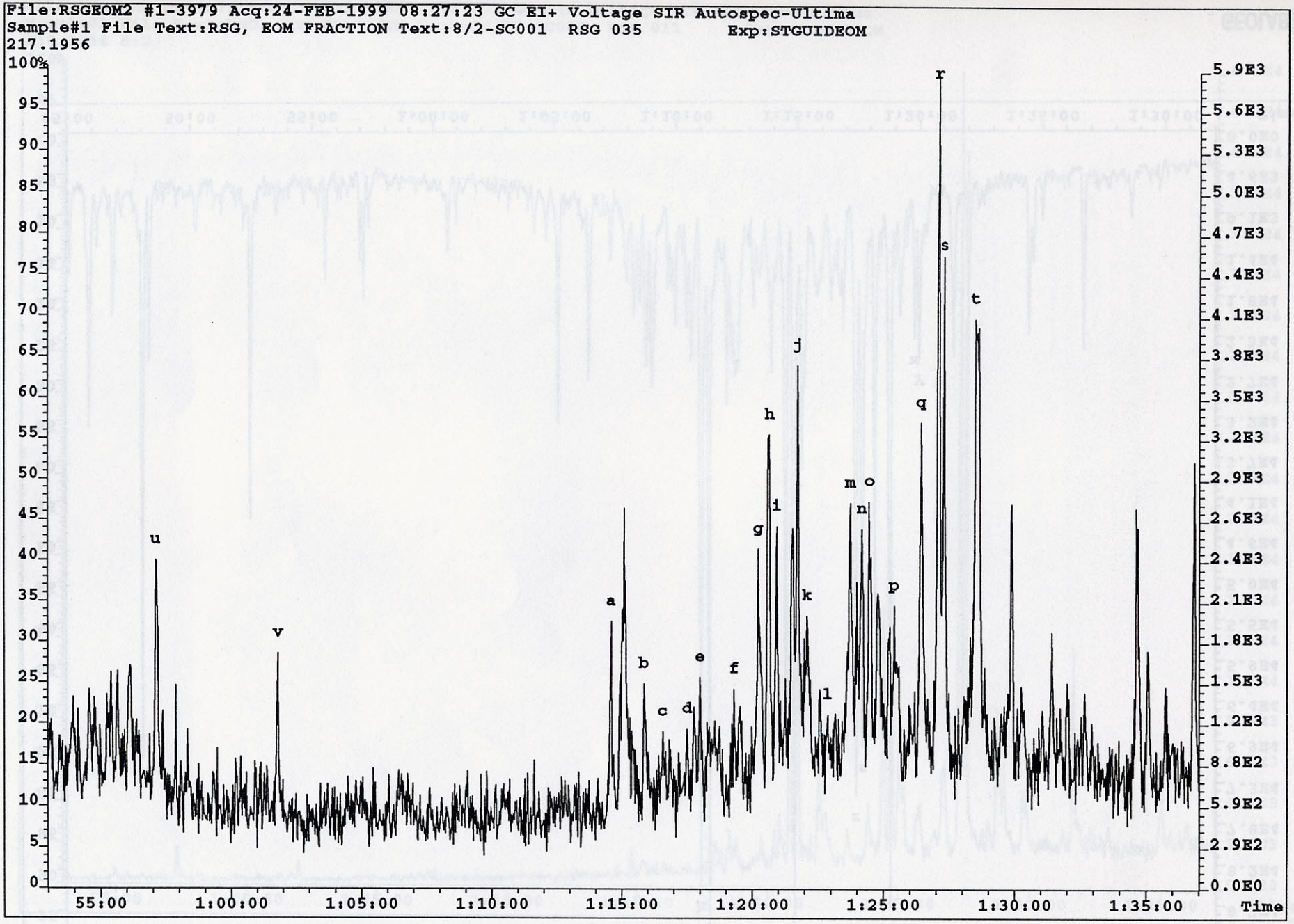
GEOLAB NOR


EXAMPLE OF IDENTIFICATION FOR M/Z 217 STERANES
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
8.8E4
8.4E4
8.0E4
7.5E4
7.1E4
6.6E4
6.2E4
5.7E4
5.3E4
4.9E4
4.4E4
4.0E4
3.5E4
3.1E4
2.7E4
2.2E4
1.8E4
1.3E4
8.8E3
4.4E3
0.0E0
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r
s
t
u
v
45:00
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
Time

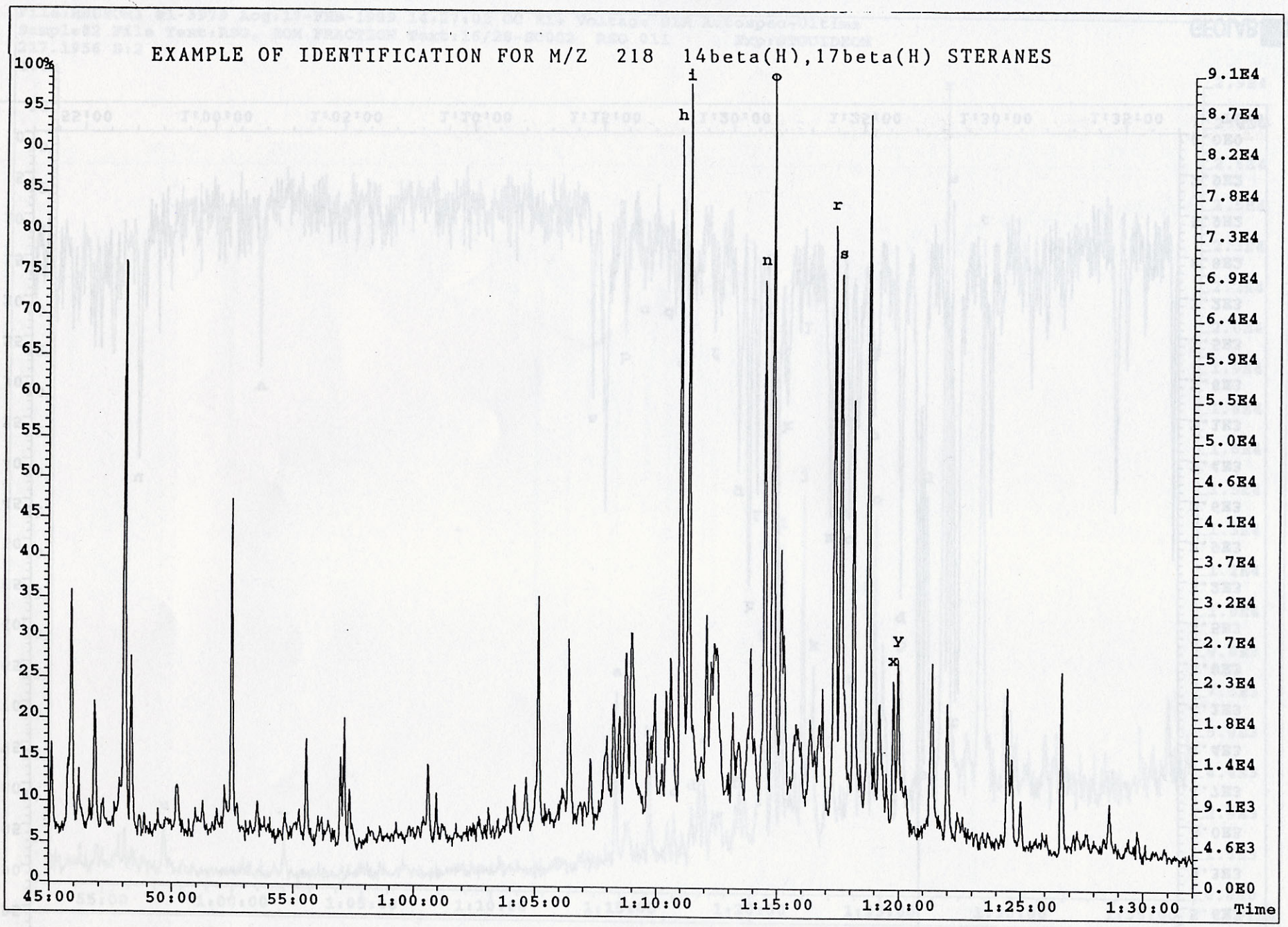
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
217.1956 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2.9E4
2.8E4
2.6E4
2.5E4
2.3E4
2.2E4
2.0E4
1.9E4
1.8E4
1.6E4
1.5E4
1.3E4
1.2E4
1.0E4
8.8E3
7.3E3
5.8E3
4.4E3
2.9E3
1.5E3
0.0E0
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time
u
v
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r
s
t

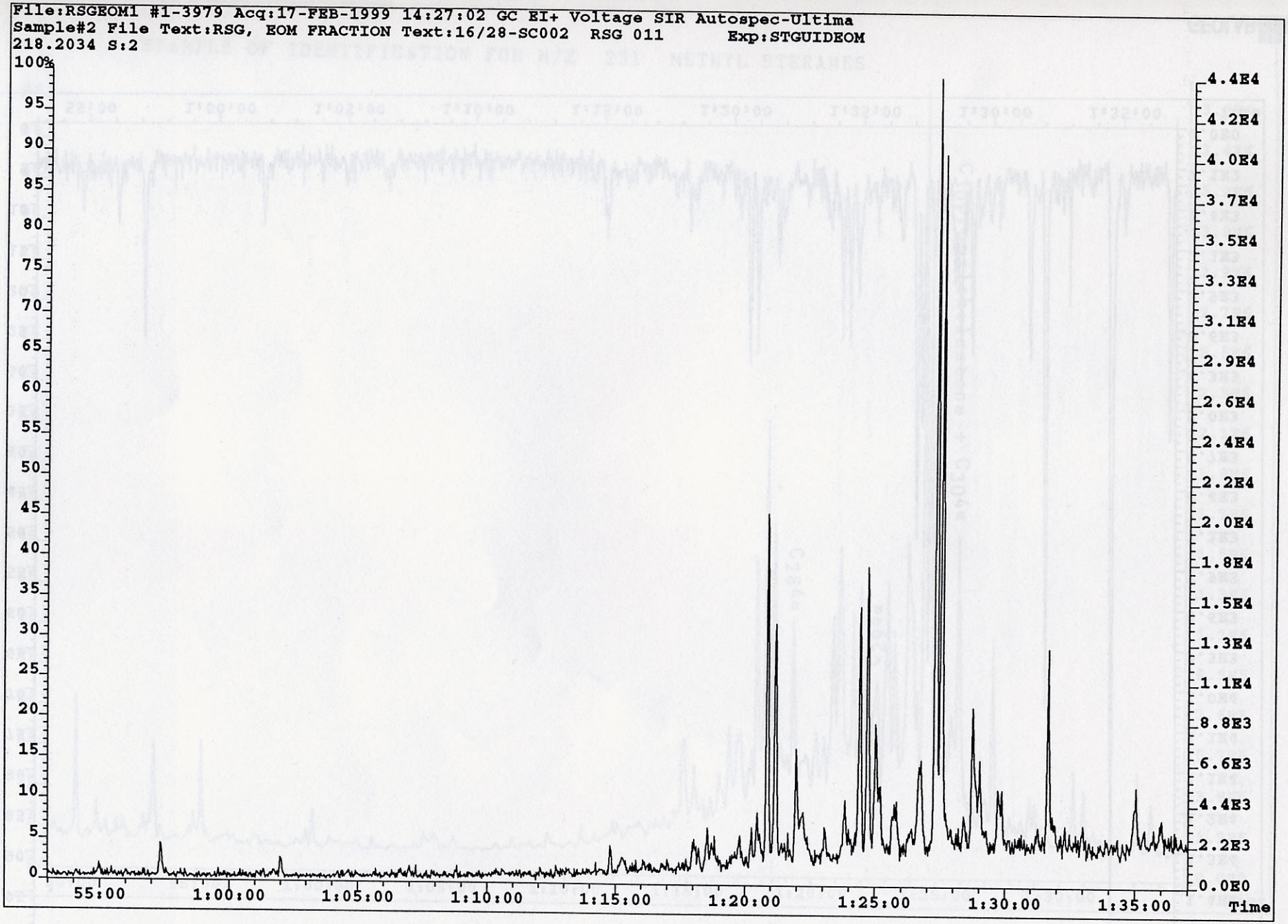
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
217.1956
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
5.9E3
5.6E3
5.3E3
5.0E3
4.7E3
4.4E3
4.1E3
3.8E3
3.5E3
3.2E3
2.9E3
2.6E3
2.4E3
2.1E3
1.8E3
1.5E3
1.2E3
8.8E2
5.9E2
2.9E2
0.0E0
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time
u
v
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r
s
t

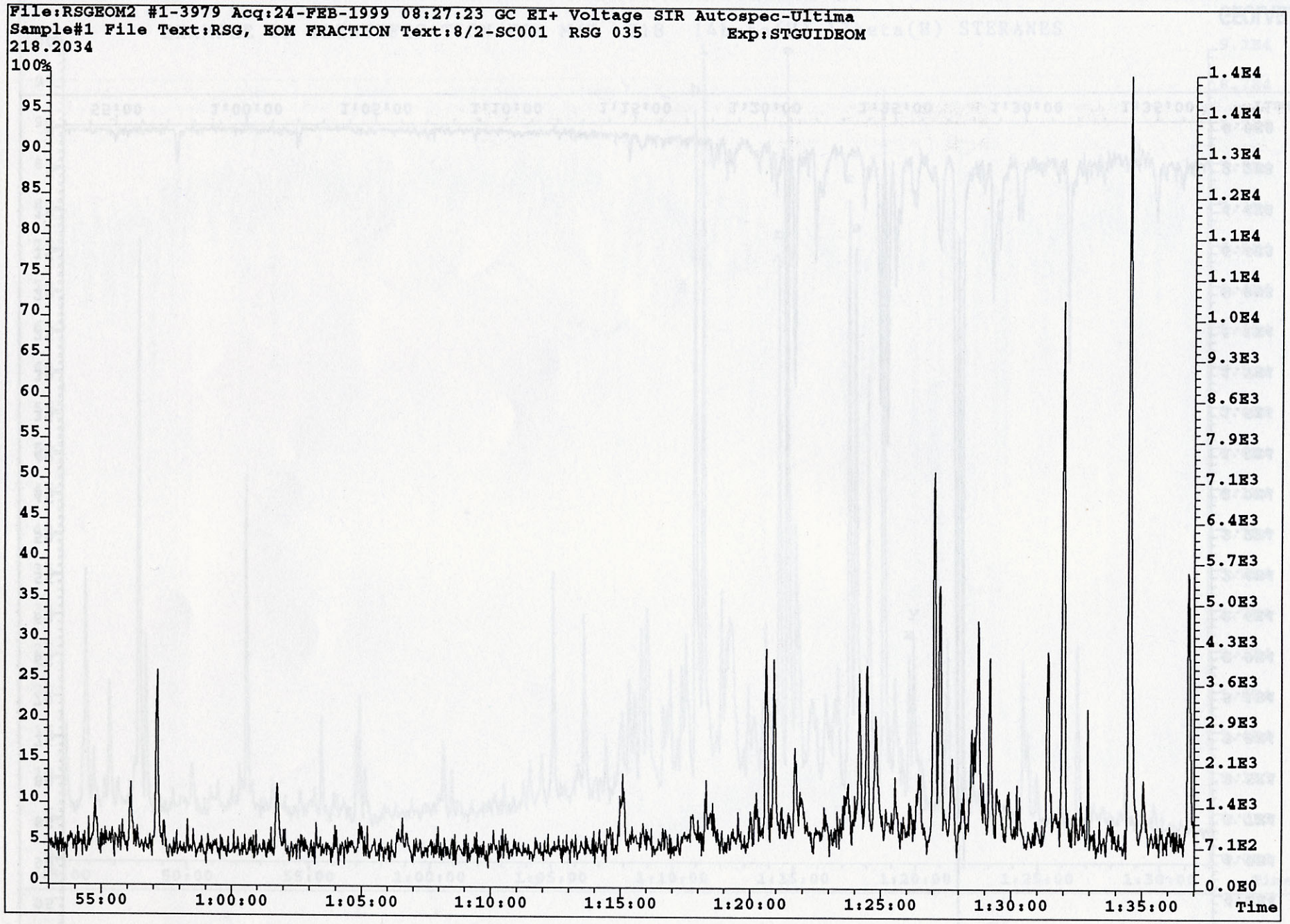
GEOLAB NOR


EXAMPLE OF IDENTIFICATION FOR M/Z 218 14beta(H),17beta(H) STERANES
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
h
i
n
o
r
s
y
x
9.1E4
8.7E4
8.2E4
7.8E4
7.3E4
6.9E4
6.4E4
5.9E4
5.5E4
5.0E4
4.6E4
4.1E4
3.7E4
3.2E4
2.7E4
2.3E4
1.8E4
1.4E4
9.1E3
4.6E3
0.0E0
45:00
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
Time

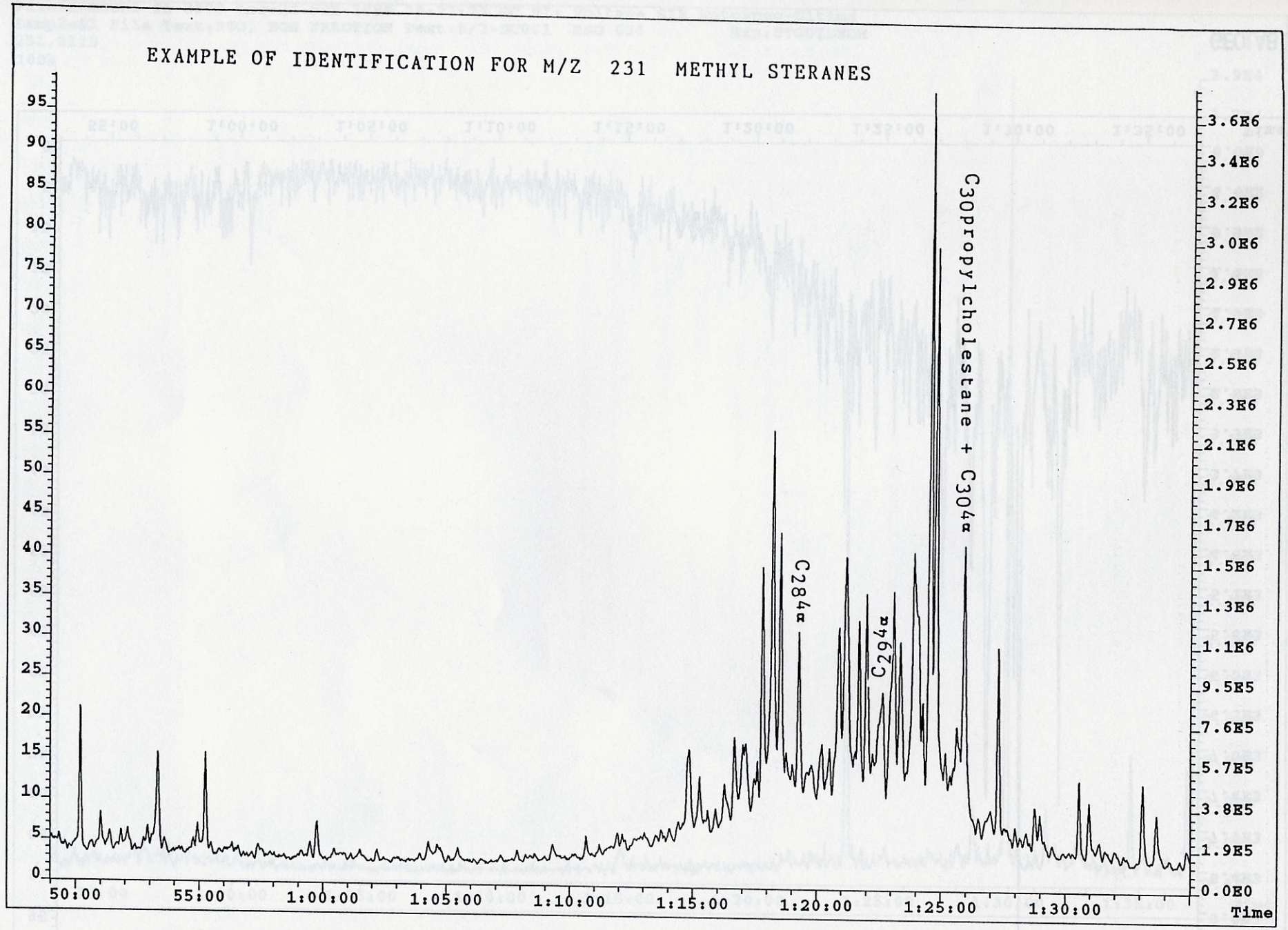
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
218.2034 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4.4E4
4.2E4
4.0E4
3.7E4
3.5E4
3.3E4
3.1E4
2.9E4
2.6E4
2.4E4
2.2E4
2.0E4
1.8E4
1.5E4
1.3E4
1.1E4
8.8E3
6.6E3
4.4E3
2.2E3
0.0E0
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

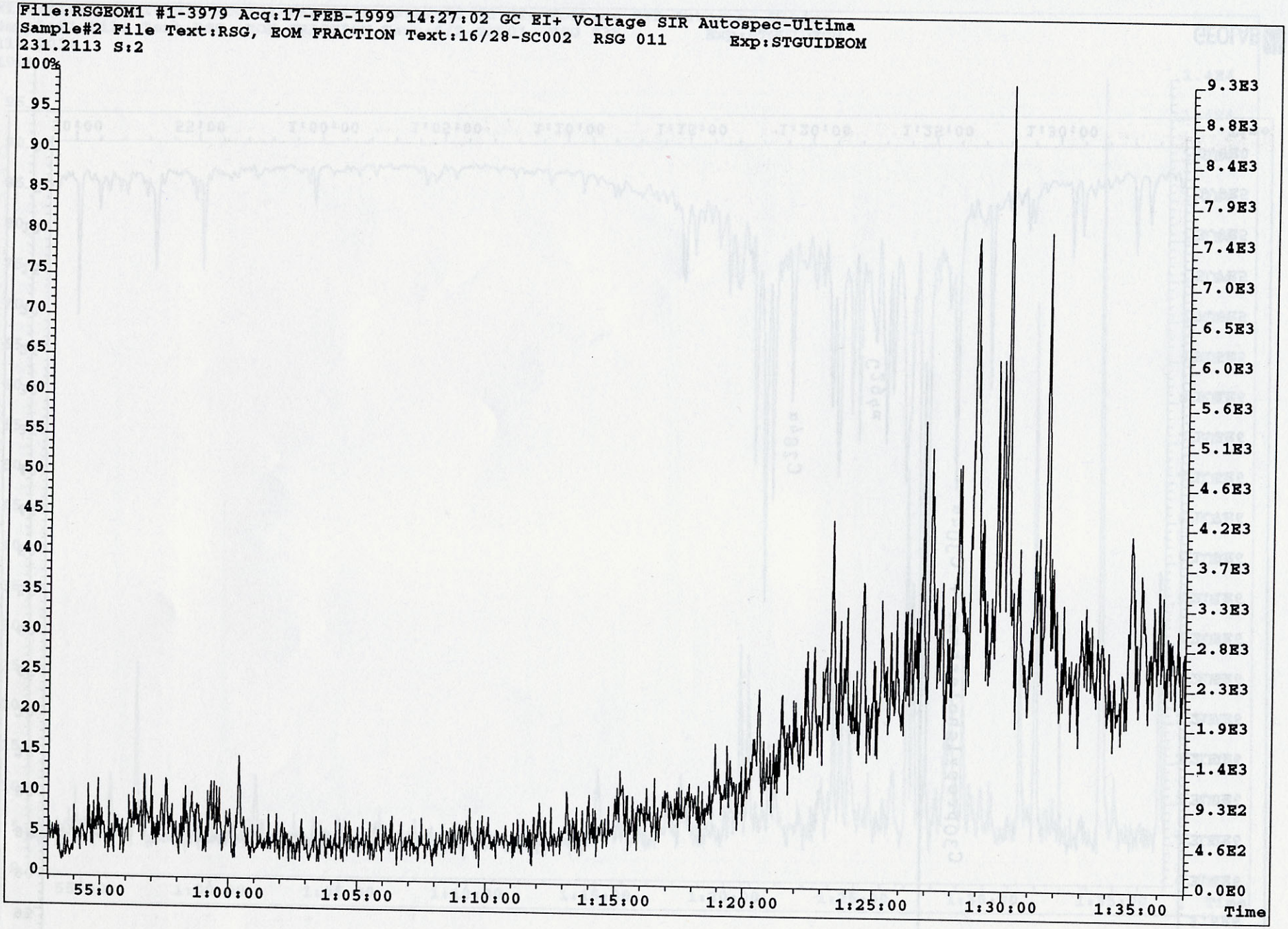
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
218.2034
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.4E4
1.4E4
1.3E4
1.2E4
1.1E4
1.1E4
1.0E4
9.3E3
8.6E3
7.9E3
7.1E3
6.4E3
5.7E3
5.0E3
4.3E3
3.6E3
2.9E3
2.1E3
1.4E3
7.1E2
0.0E0
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

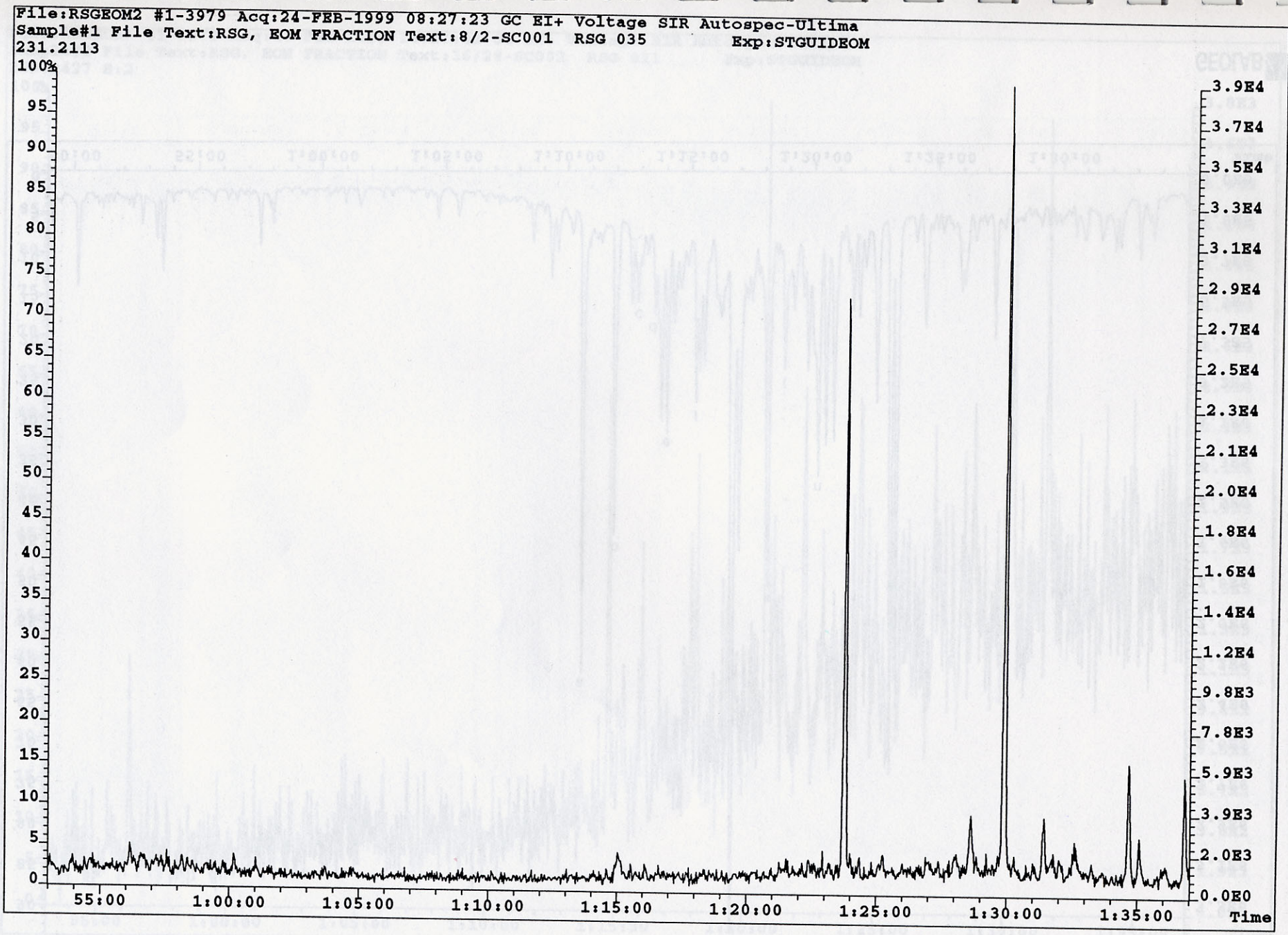
GEOLAB NOR


EXAMPLE OF IDENTIFICATION FOR M/Z 231 METHYL STERANES
C30propylcholestane + C304α
C284α
C294α
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3.6E6
3.4E6
3.2E6
3.0E6
2.9E6
2.7E6
2.5E6
2.3E6
2.1E6
1.9E6
1.7E6
1.5E6
1.3E6
1.1E6
9.5E5
7.6E5
5.7E5
3.8E5
1.9E5
0.0E0
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
Time

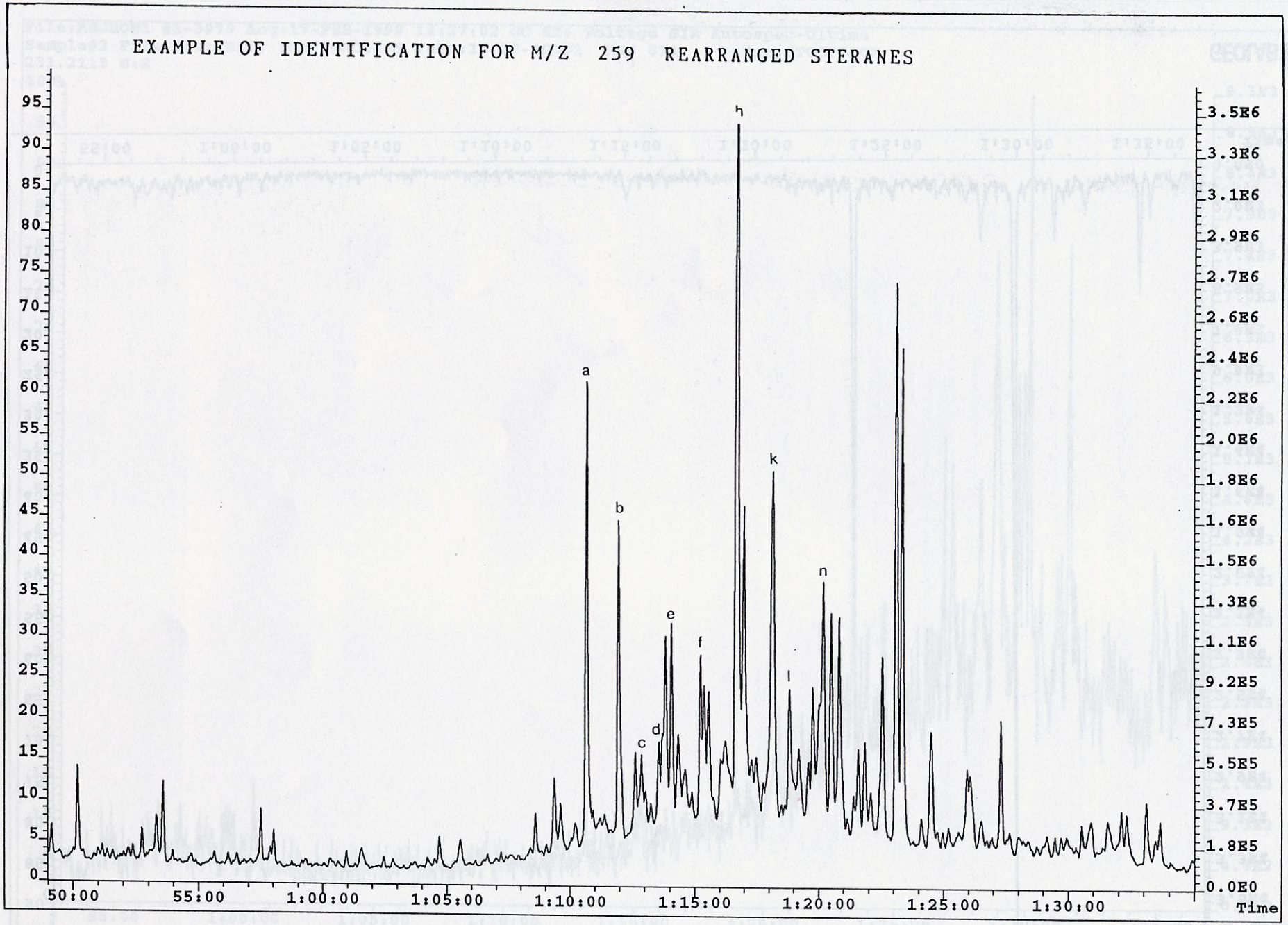
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
231.2113 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
9.3E3
8.8E3
8.4E3
7.9E3
7.4E3
7.0E3
6.5E3
6.0E3
5.6E3
5.1E3
4.6E3
4.2E3
3.7E3
3.3E3
2.8E3
2.3E3
1.9E3
1.4E3
9.3E2
4.6E2
0.0E0
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

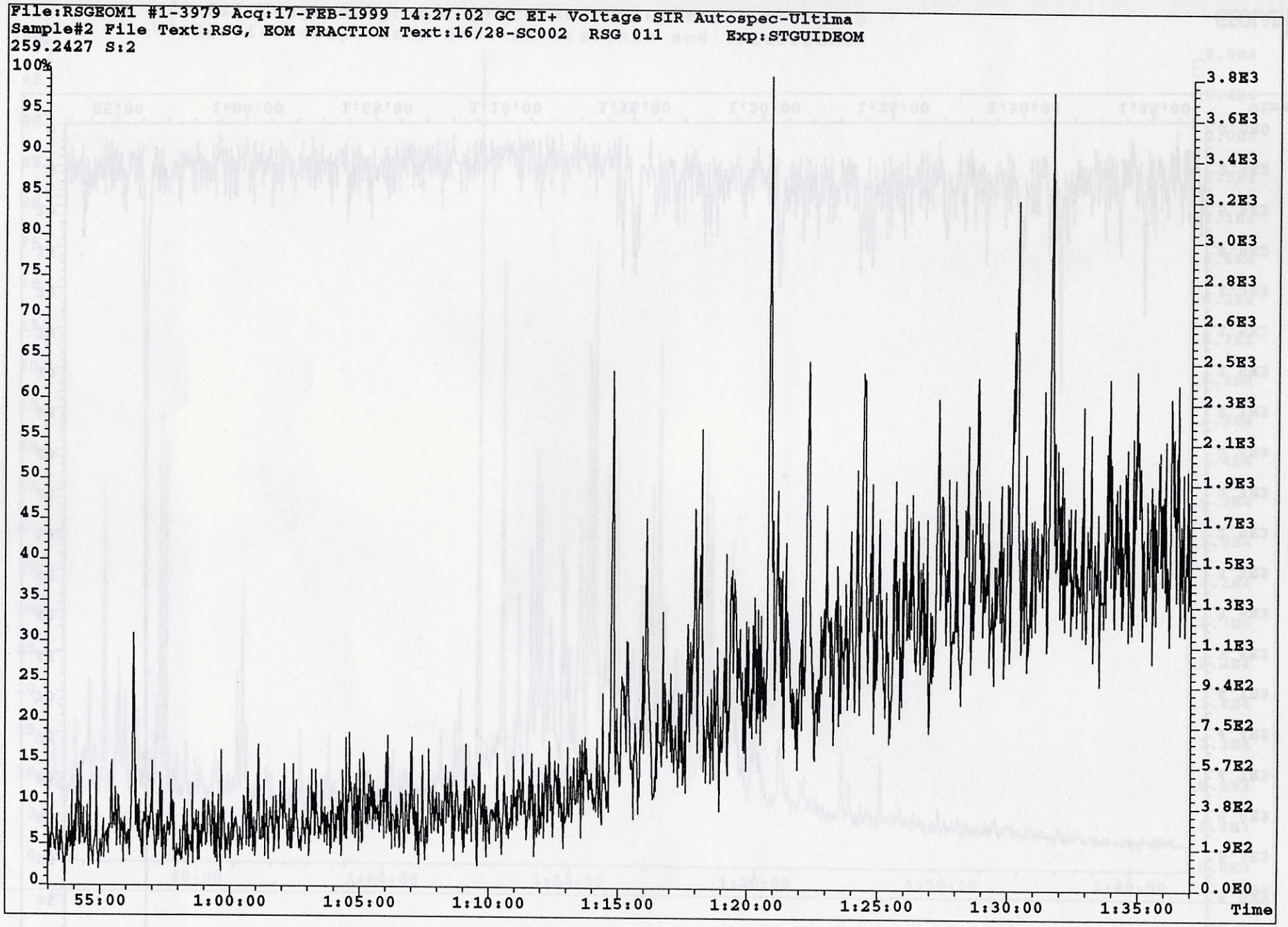
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035
Exp:STGUIDEOM
231.2113
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3.9E4
3.7E4
3.5E4
3.3E4
3.1E4
2.9E4
2.7E4
2.5E4
2.3E4
2.1E4
2.0E4
1.8E4
1.6E4
1.4E4
1.2E4
9.8E3
7.8E3
5.9E3
3.9E3
2.0E3
0.0E0
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

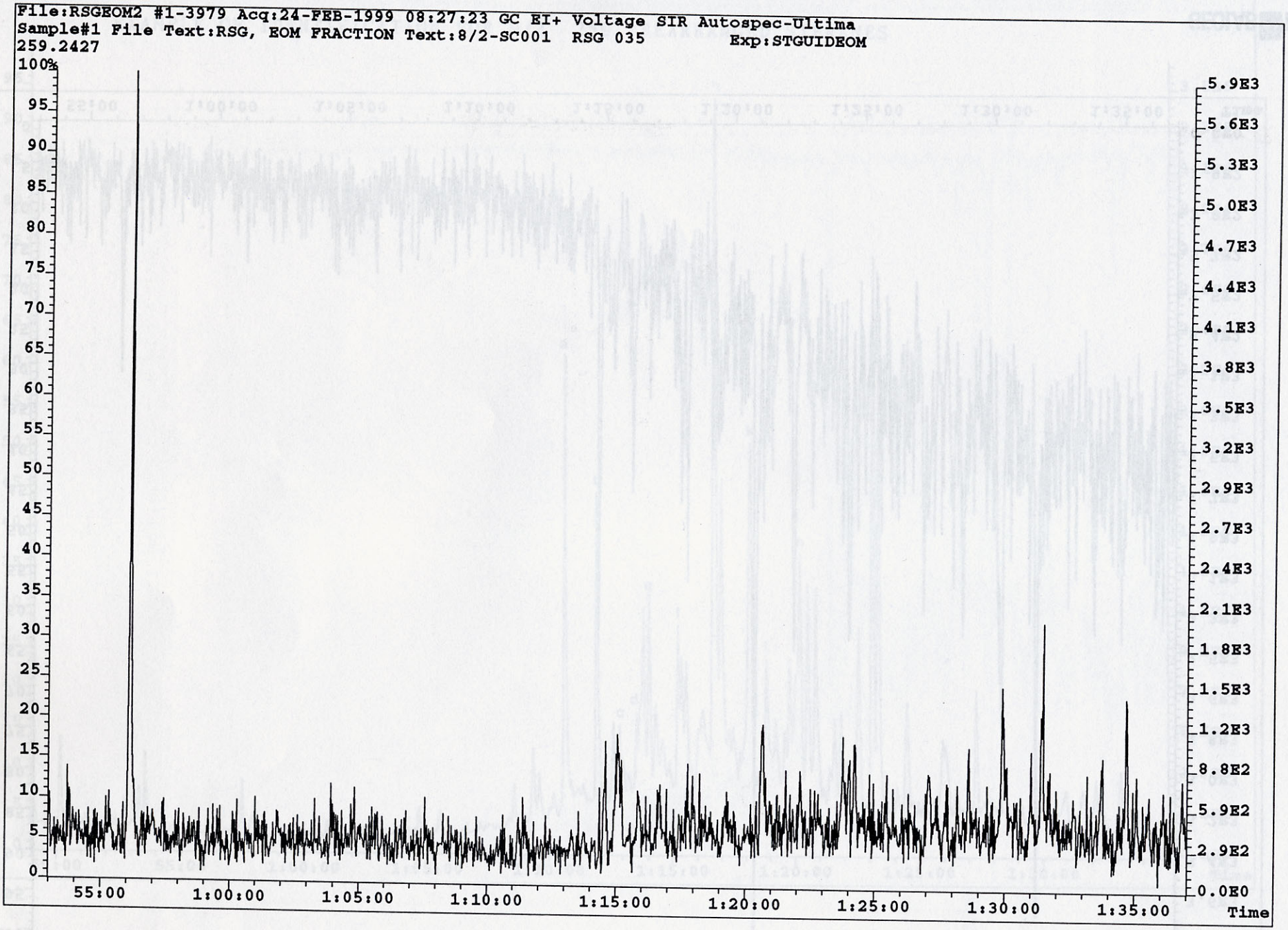
GEOLAB NOR


EXAMPLE OF IDENTIFICATION FOR M/Z 259 REARRANGED STERANES
a
b
c
d
e
f
h
i
k
n
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3.5E6
3.3E6
3.1E6
2.9E6
2.7E6
2.6E6
2.4E6
2.2E6
2.0E6
1.8E6
1.6E6
1.5E6
1.3E6
1.1E6
9.2E5
7.3E5
5.5E5
3.7E5
1.8E5
0.0E0
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
Time

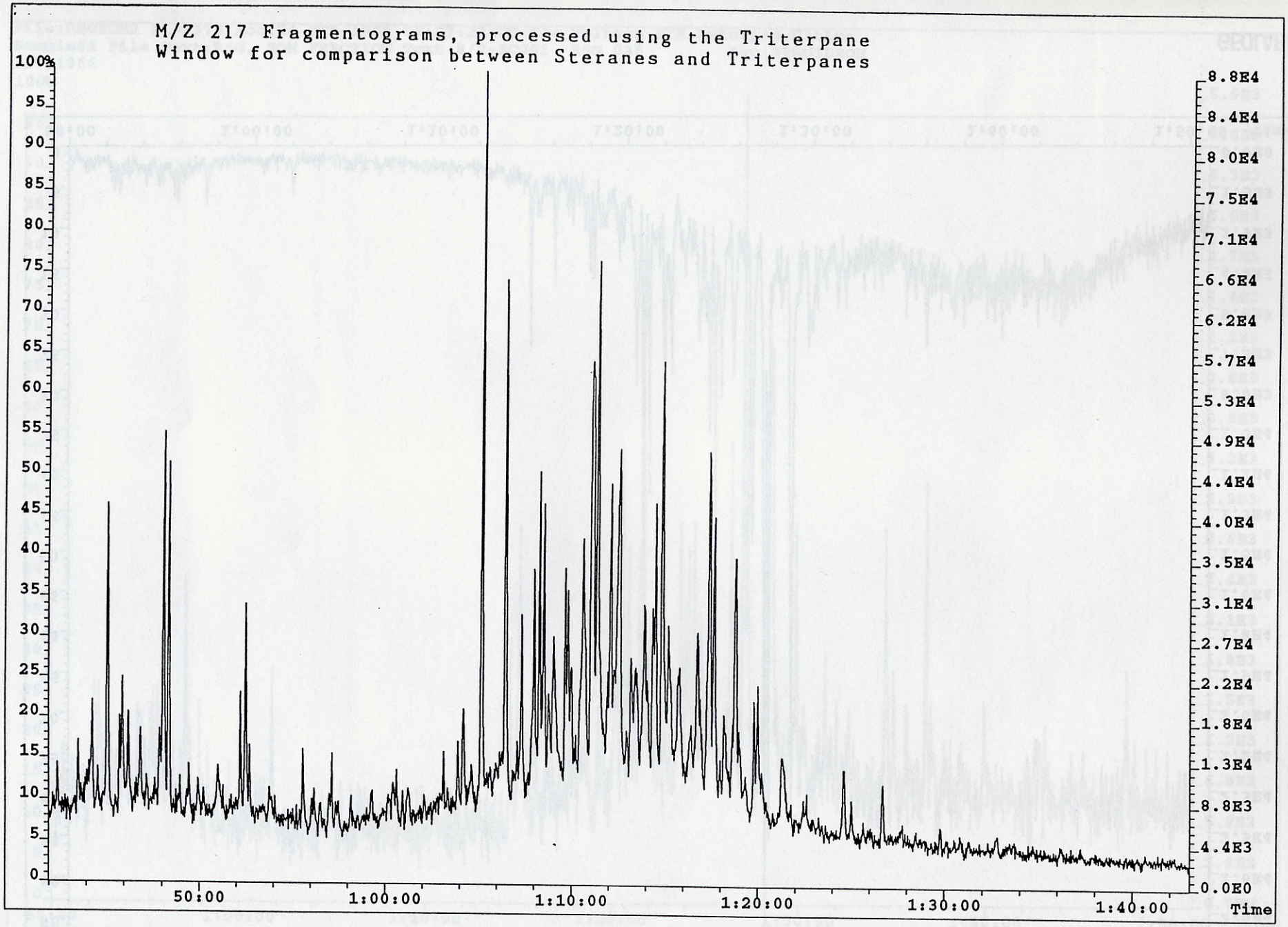
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
259.2427 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3.8E3
3.6E3
3.4E3
3.2E3
3.0E3
2.8E3
2.6E3
2.5E3
2.3E3
2.1E3
1.9E3
1.7E3
1.5E3
1.3E3
1.1E3
9.4E2
7.5E2
5.7E2
3.8E2
1.9E2
0.0E0
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

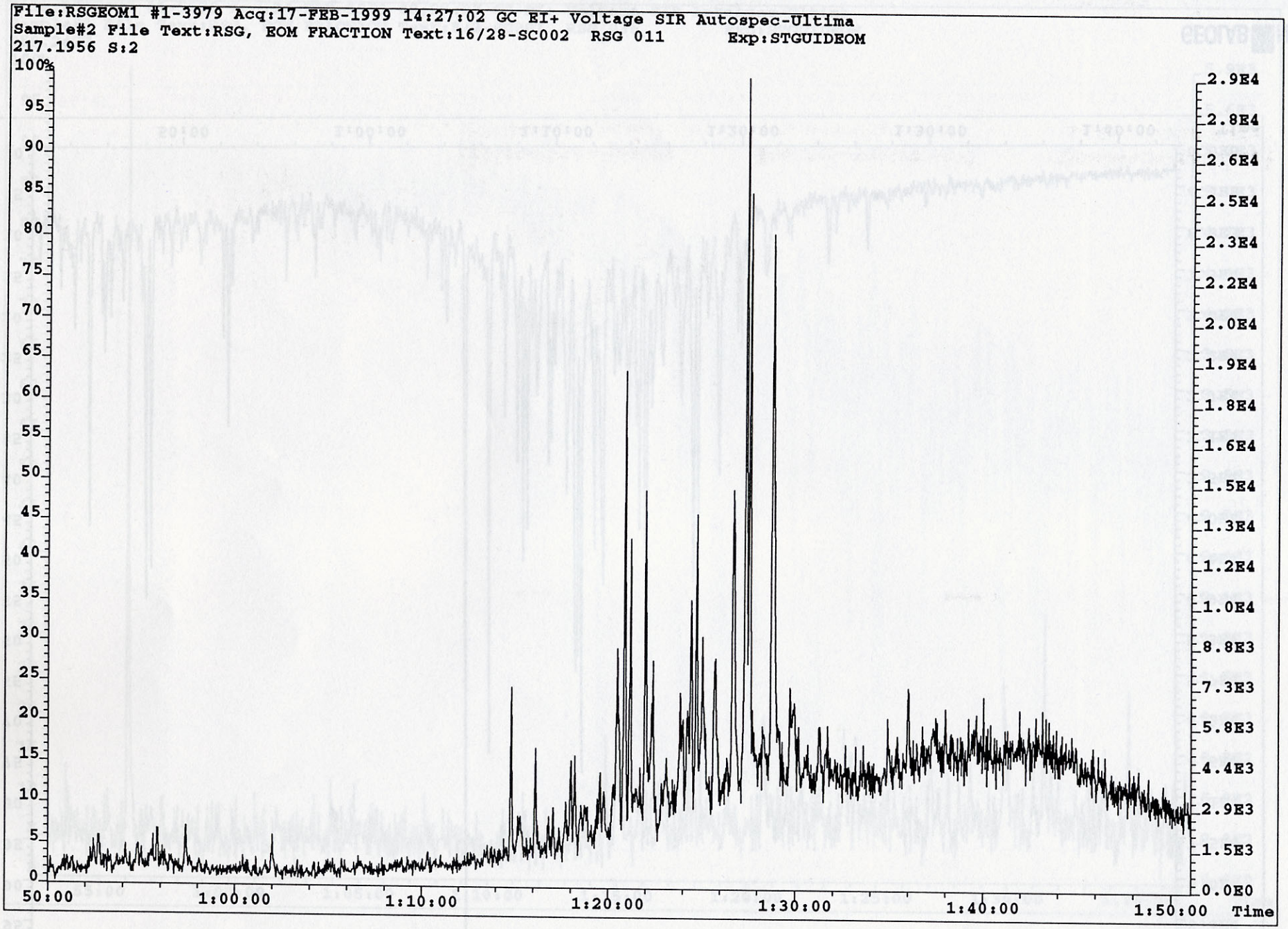
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
259.2427
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
5.9E3
5.6E3
5.3E3
5.0E3
4.7E3
4.4E3
4.1E3
3.8E3
3.5E3
3.2E3
2.9E3
2.7E3
2.4E3
2.1E3
1.8E3
1.5E3
1.2E3
8.8E2
5.9E2
2.9E2
0.0E0
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

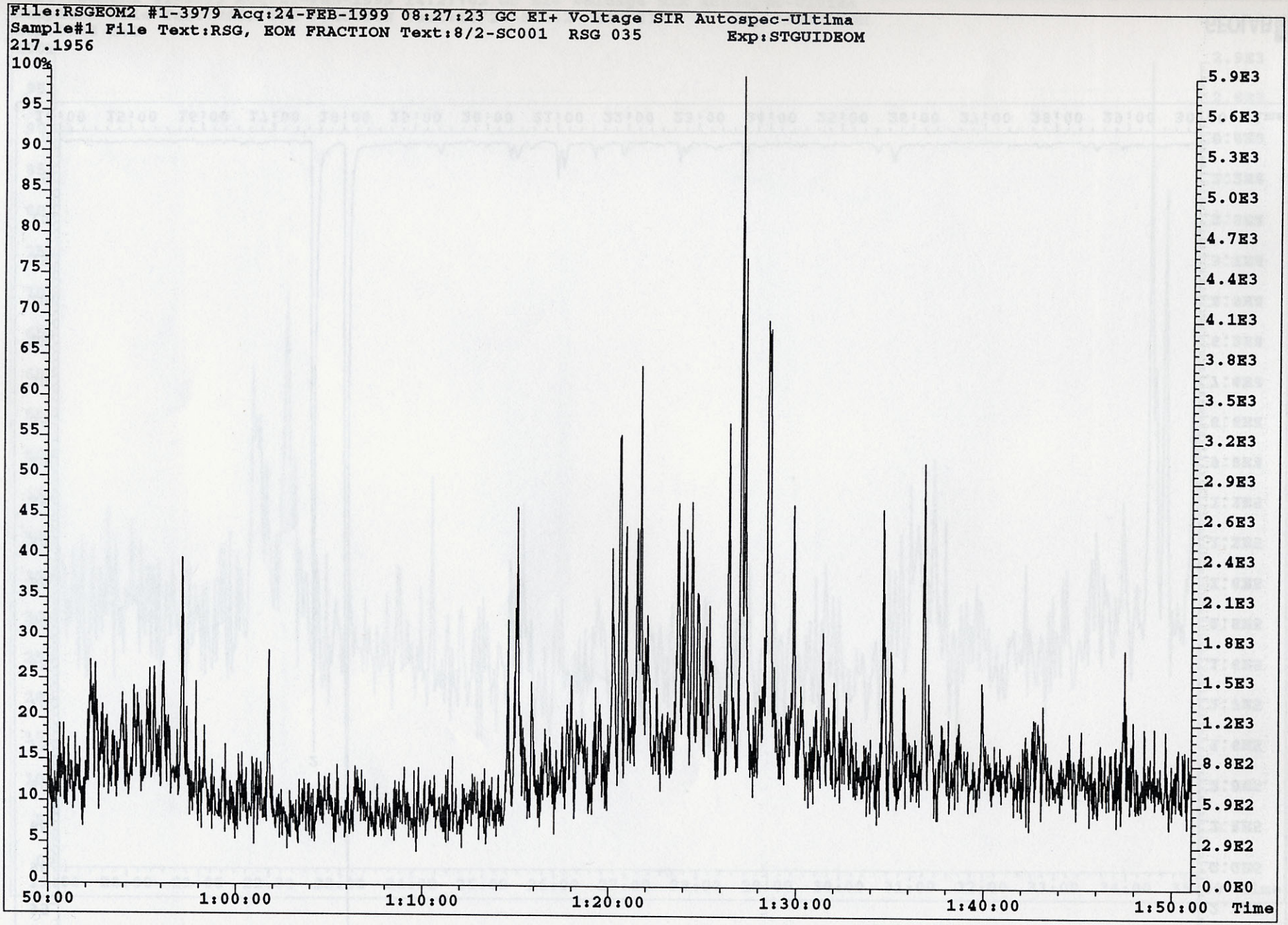
GEOLAB NOR


M/Z 217 Fragmentograms, processed using the Triterpane
Window for comparison between Steranes and Triterpanes
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
8.8E4
8.4E4
8.0E4
7.5E4
7.1E4
6.6E4
6.2E4
5.7E4
5.3E4
4.9E4
4.4E4
4.0E4
3.5E4
3.1E4
2.7E4
2.2E4
1.8E4
1.3E4
8.8E3
4.4E3
0.0E0
50:00
1:00:00
1:10:00
1:20:00
1:30:00
1:40:00
Time

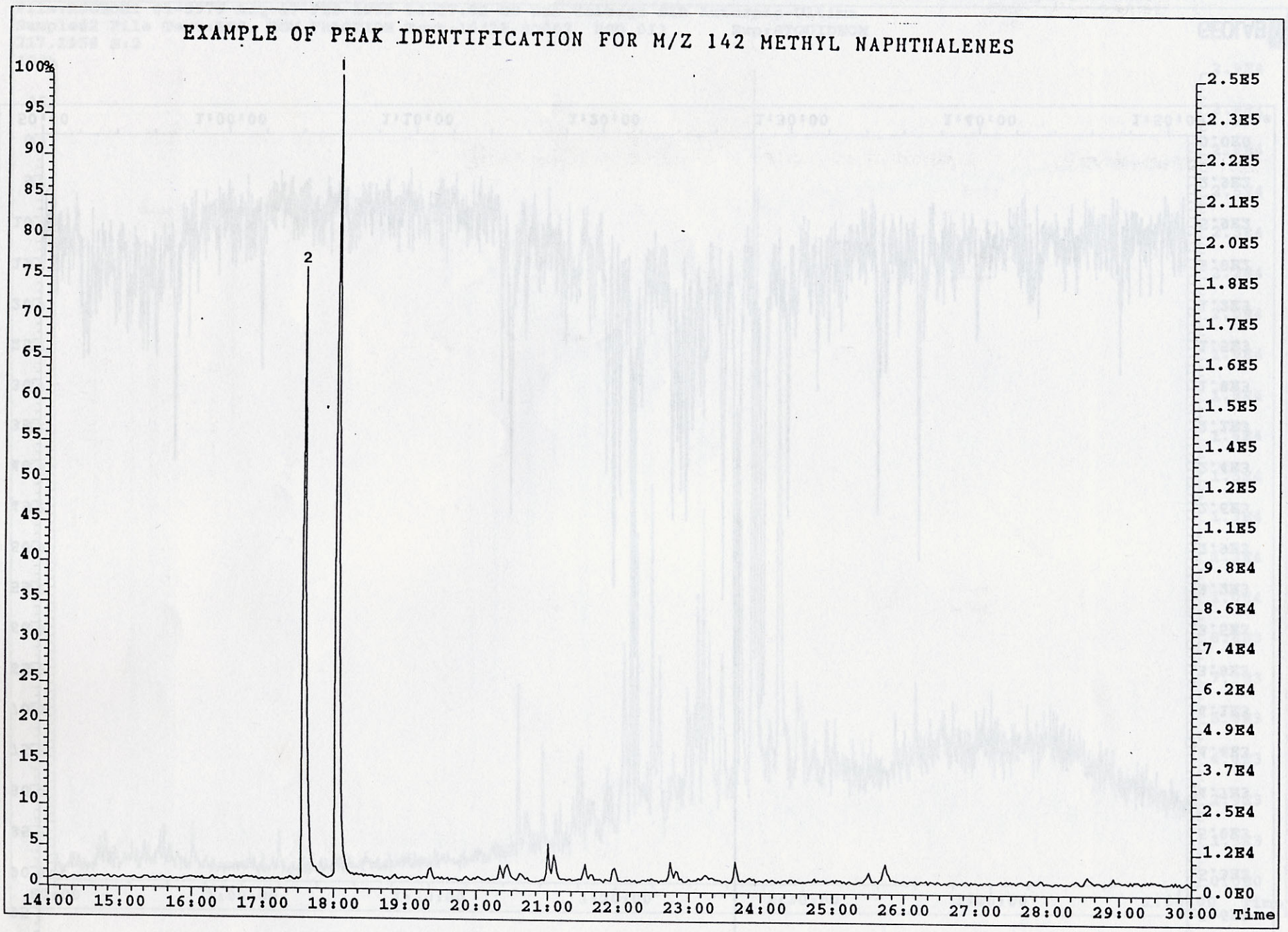
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
217.1956 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2.9E4
2.8E4
2.6E4
2.5E4
2.3E4
2.2E4
2.0E4
1.9E4
1.8E4
1.6E4
1.5E4
1.3E4
1.2E4
1.0E4
8.8E3
7.3E3
5.8E3
4.4E3
2.9E3
1.5E3
0.0E0
50:00
1:00:00
1:10:00
1:20:00
1:30:00
1:40:00
1:50:00
Time

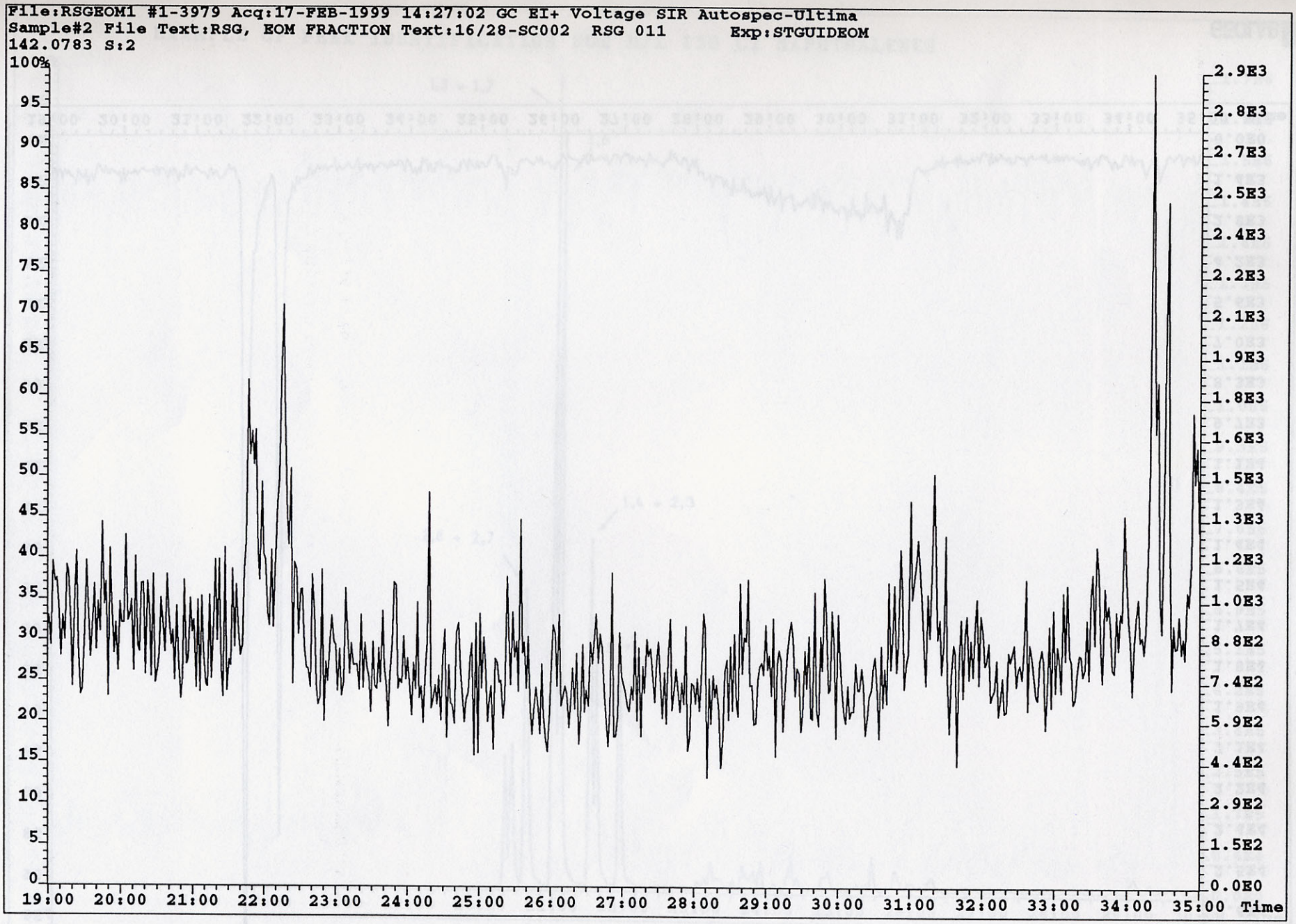
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
217.1956
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
5.9E3
5.6E3
5.3E3
5.0E3
4.7E3
4.4E3
4.1E3
3.8E3
3.5E3
3.2E3
2.9E3
2.6E3
2.4E3
2.1E3
1.8E3
1.5E3
1.2E3
8.8E2
5.9E2
2.9E2
0.0E0
50:00
1:00:00
1:10:00
1:20:00
1:30:00
1:40:00
1:50:00
Time

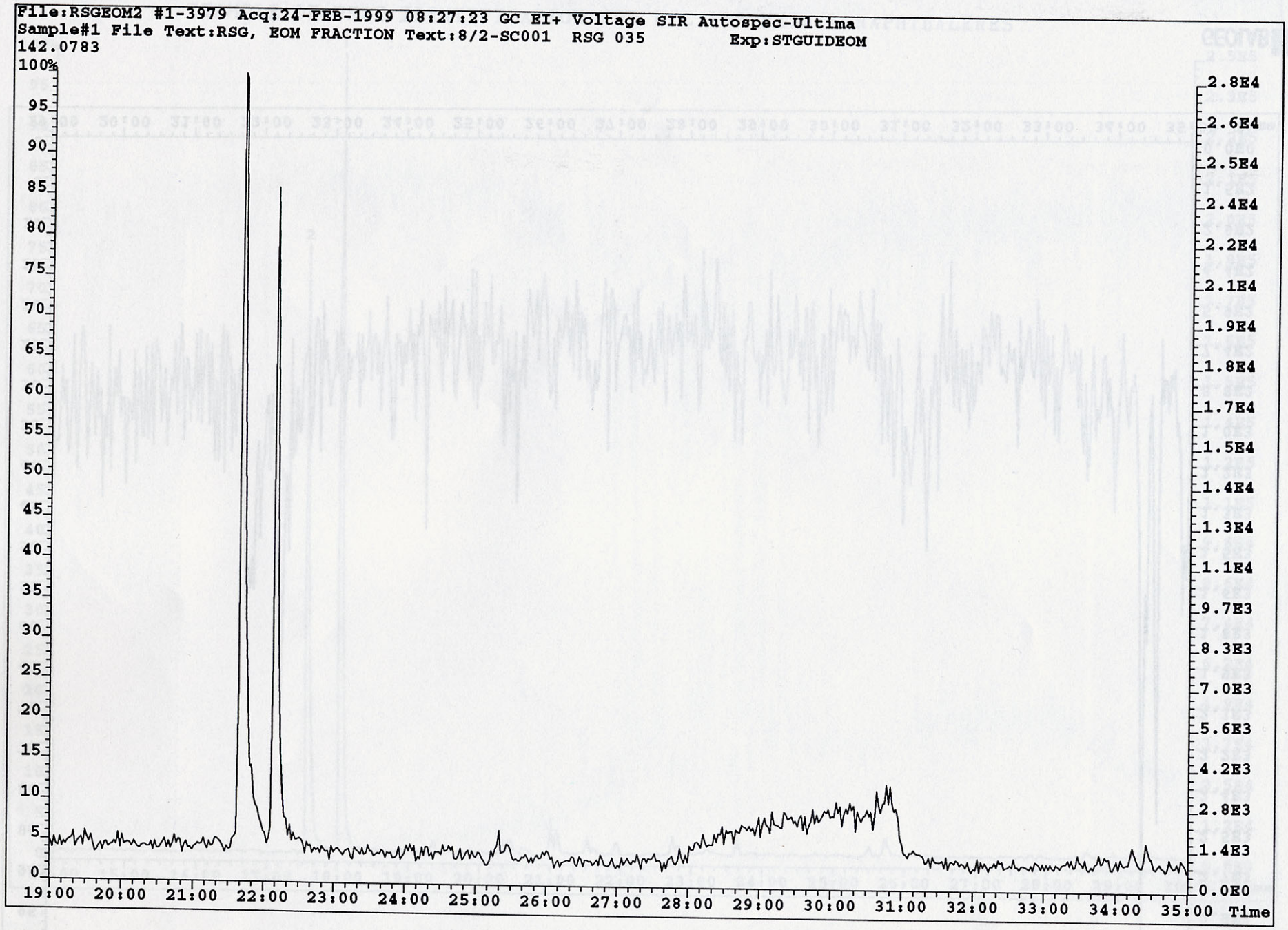
GEOLAB NOR


EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 142 METHYL NAPHTHALENES
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2
1
2.5E5
2.3E5
2.2E5
2.1E5
2.0E5
1.8E5
1.7E5
1.6E5
1.5E5
1.4E5
1.2E5
1.1E5
9.8E4
8.6E4
7.4E4
6.2E4
4.9E4
3.7E4
2.5E4
1.2E4
0.0E0
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00
25:00
26:00
27:00
28:00
29:00
30:00
Time

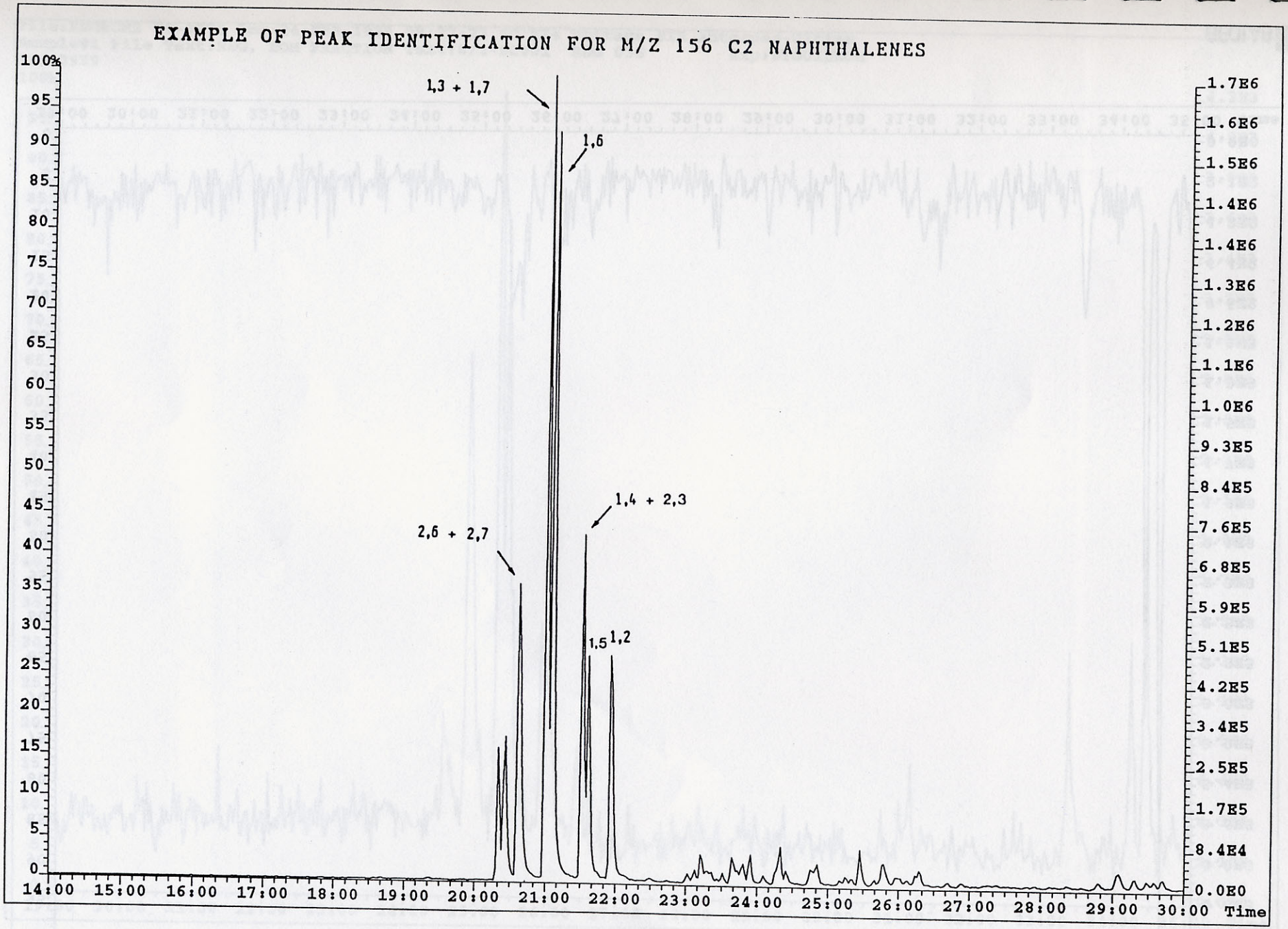
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
142.0783 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2.9E3
2.8E3
2.7E3
2.5E3
2.4E3
2.2E3
2.1E3
1.9E3
1.8E3
1.6E3
1.5E3
1.3E3
1.2E3
1.0E3
8.8E2
7.4E2
5.9E2
4.4E2
2.9E2
1.5E2
0.0E0
19:00 20:00 21:00 22:00 23:00 24:00 25:00 26:00 27:00 28:00 29:00 30:00 31:00 32:00 33:00 34:00 35:00 Time

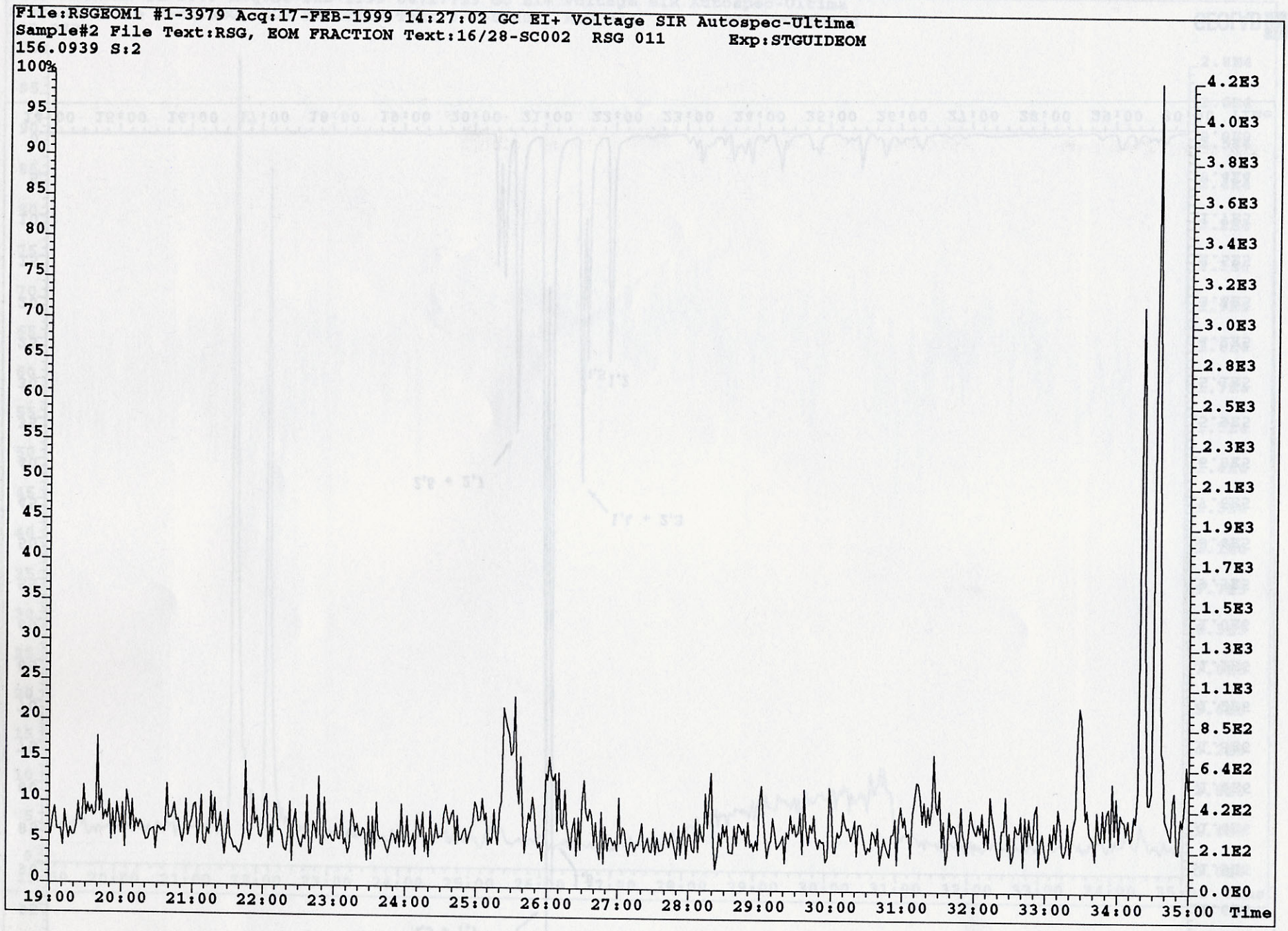
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
142.0783
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2.8E4
2.6E4
2.5E4
2.4E4
2.2E4
2.1E4
1.9E4
1.8E4
1.7E4
1.5E4
1.4E4
1.3E4
1.1E4
9.7E3
8.3E3
7.0E3
5.6E3
4.2E3
2.8E3
1.4E3
0.0E0
19:00 20:00 21:00 22:00 23:00 24:00 25:00 26:00 27:00 28:00 29:00 30:00 31:00 32:00 33:00 34:00 35:00 Time

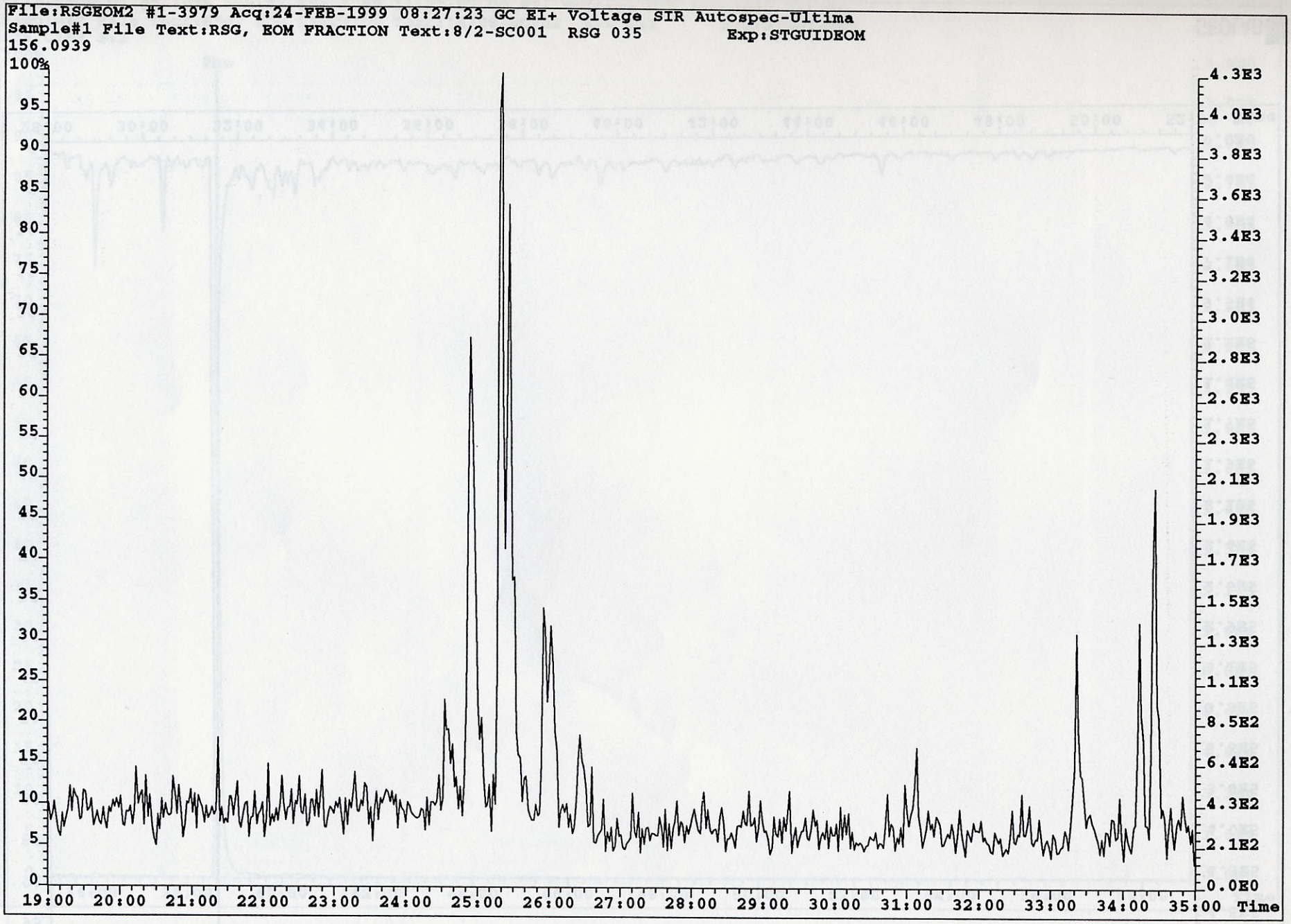
GEOLAB NOR


EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 156 C2 NAPHTHALENES
1,3 + 1,7
1,6
2,6 + 2,7
1,4 + 2,3
1,5
1,2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.7E6
1.6E6
1.5E6
1.4E6
1.4E6
1.3E6
1.2E6
1.1E6
1.0E6
9.3E5
8.4E5
7.6E5
6.8E5
5.9E5
5.1E5
4.2E5
3.4E5
2.5E5
1.7E5
8.4E4
0.0E0
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00
25:00
26:00
27:00
28:00
29:00
30:00
Time

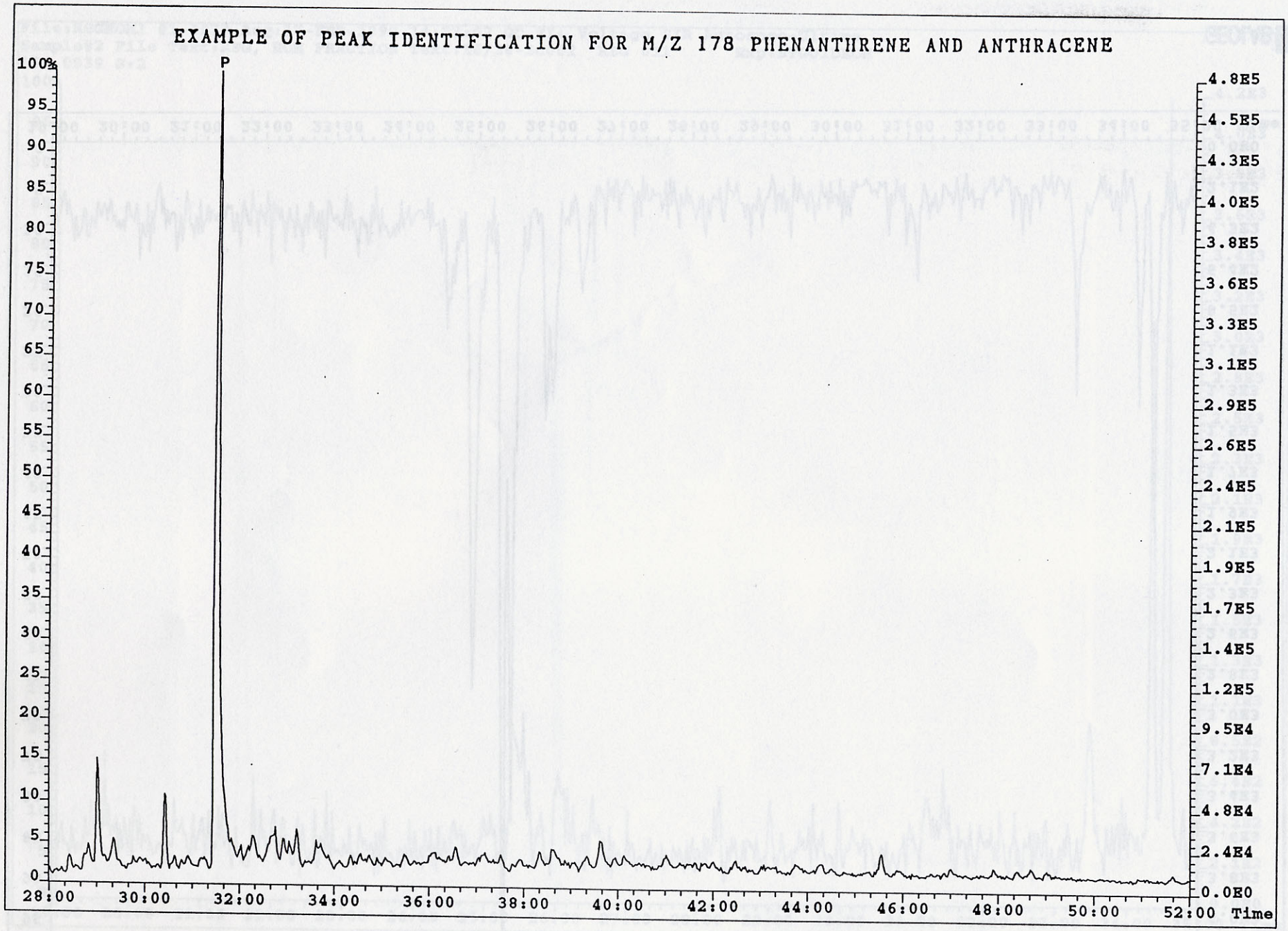
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
156.0939 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4.2E3
4.0E3
3.8E3
3.6E3
3.4E3
3.2E3
3.0E3
2.8E3
2.5E3
2.3E3
2.1E3
1.9E3
1.7E3
1.5E3
1.3E3
1.1E3
8.5E2
6.4E2
4.2E2
2.1E2
0.0E0
19:00 20:00 21:00 22:00 23:00 24:00 25:00 26:00 27:00 28:00 29:00 30:00 31:00 32:00 33:00 34:00 35:00 Time

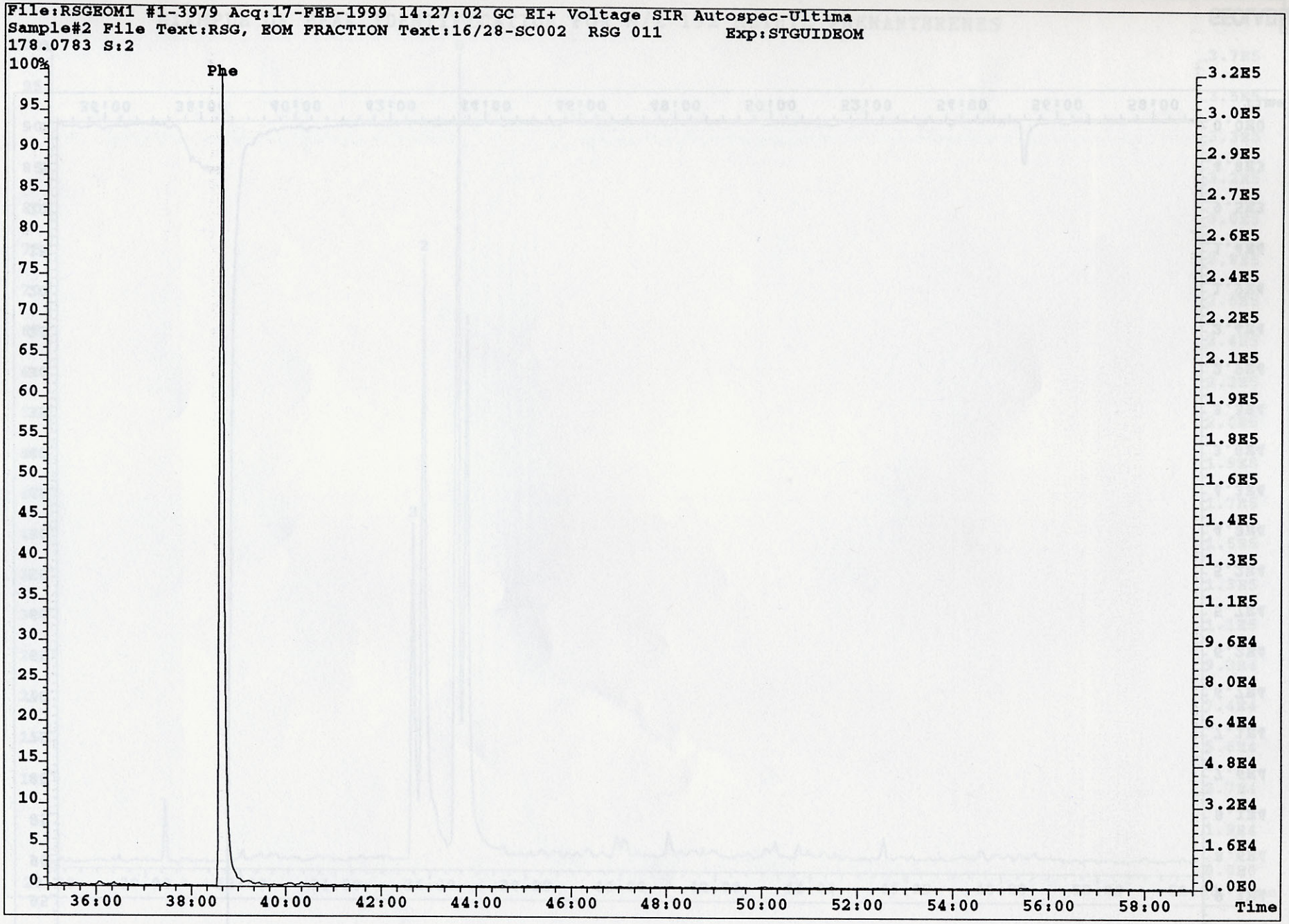
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
156.0939
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4.3E3
4.0E3
3.8E3
3.6E3
3.4E3
3.2E3
3.0E3
2.8E3
2.6E3
2.3E3
2.1E3
1.9E3
1.7E3
1.5E3
1.3E3
1.1E3
8.5E2
6.4E2
4.3E2
2.1E2
0.0E0
19:00 20:00 21:00 22:00 23:00 24:00 25:00 26:00 27:00 28:00 29:00 30:00 31:00 32:00 33:00 34:00 35:00 Time

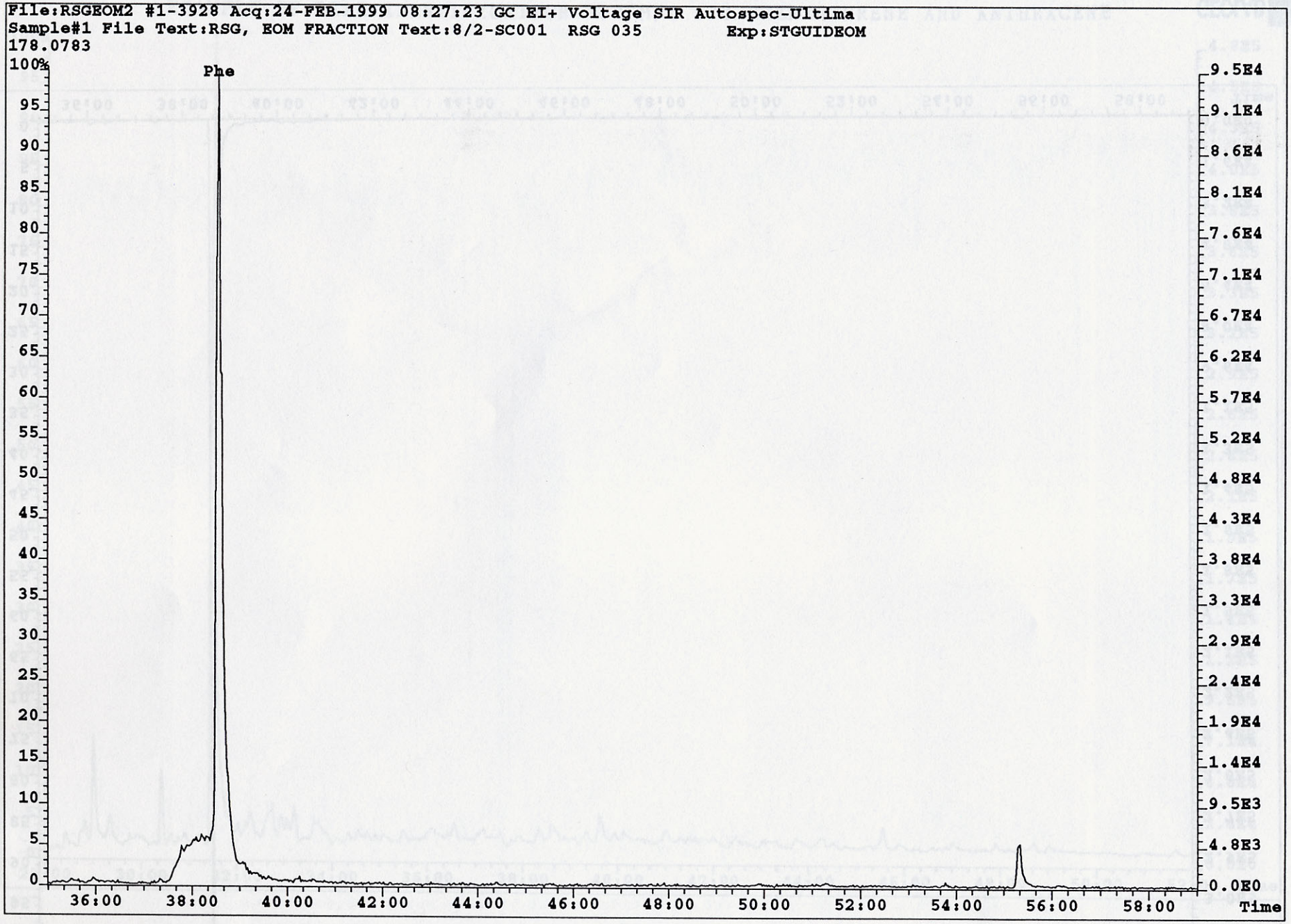
GEOLAB NOR


EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 178 PHENANTHRENE AND ANTHRACENE
P
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4.8E5
4.5E5
4.3E5
4.0E5
3.8E5
3.6E5
3.3E5
3.1E5
2.9E5
2.6E5
2.4E5
2.1E5
1.9E5
1.7E5
1.4E5
1.2E5
9.5E4
7.1E4
4.8E4
2.4E4
0.0E0
28:00
30:00
32:00
34:00
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
Time

GEOLAB NOR

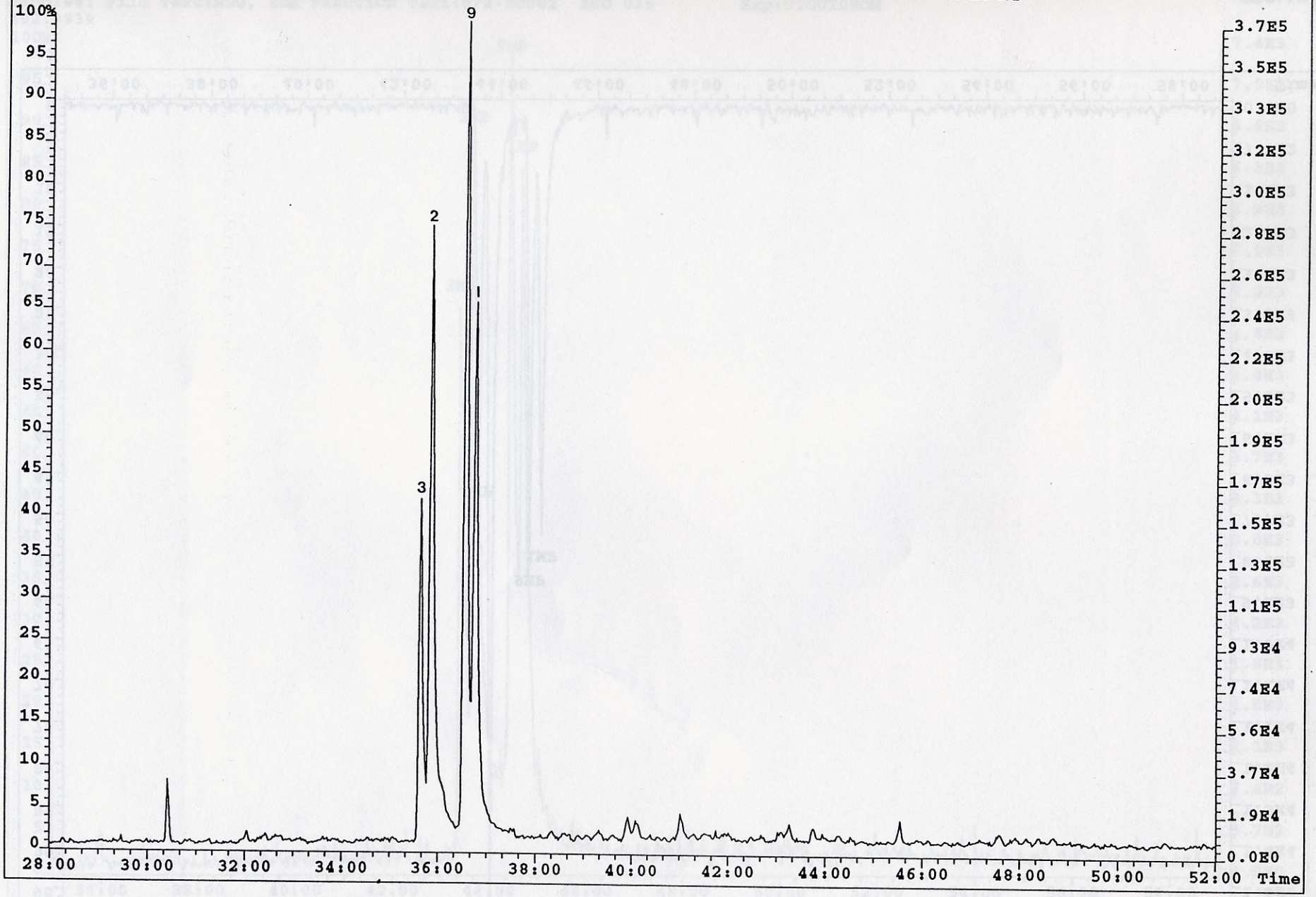

File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
178.0783 S:2
Phe
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3.2E5
3.0E5
2.9E5
2.7E5
2.6E5
2.4E5
2.2E5
2.1E5
1.9E5
1.8E5
1.6E5
1.4E5
1.3E5
1.1E5
9.6E4
8.0E4
6.4E4
4.8E4
3.2E4
1.6E4
0.0E0
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
54:00
56:00
58:00
Time

GEOLAB NOR

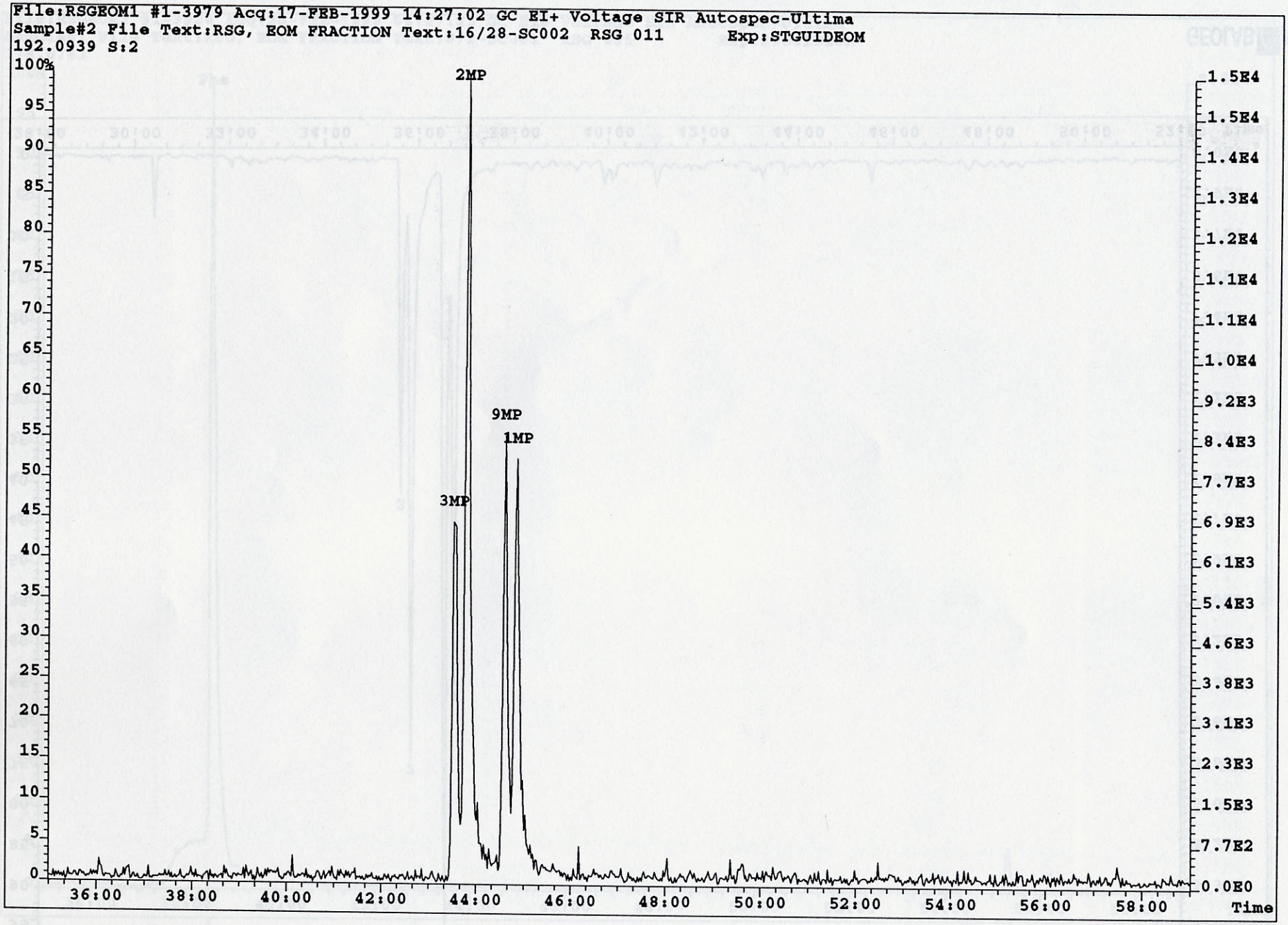

File:RSGEOM2 #1-3928 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
178.0783
Phe
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
9.5E4
9.1E4
8.6E4
8.1E4
7.6E4
7.1E4
6.7E4
6.2E4
5.7E4
5.2E4
4.8E4
4.3E4
3.8E4
3.3E4
2.9E4
2.4E4
1.9E4
1.4E4
9.5E3
4.8E3
0.0E0
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
54:00
56:00
58:00
Time

GEOLAB NOR

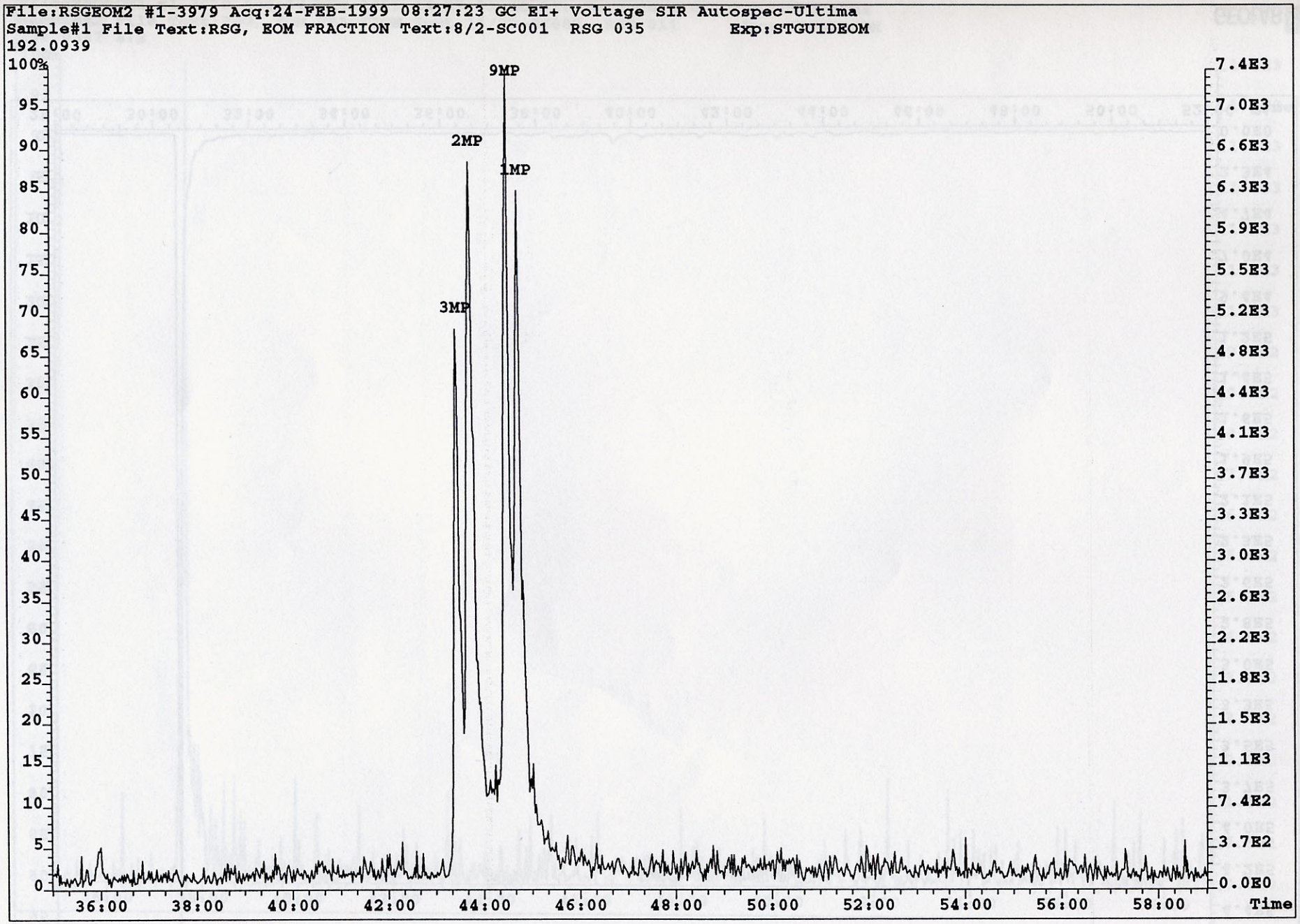
EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 192 METHYL PHENANTHRENES



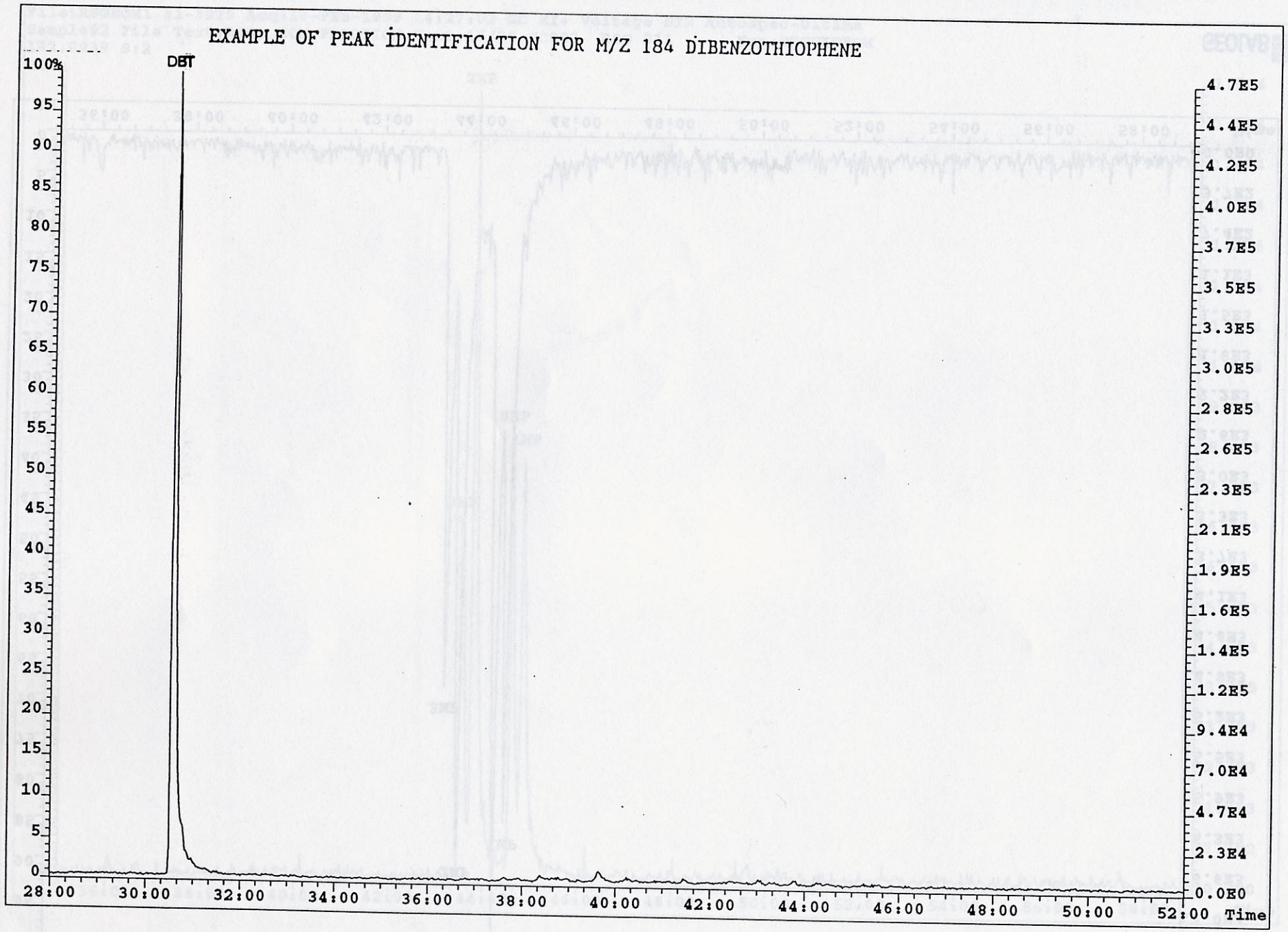
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
192.0939 S:2
2MP
3MP
9MP
1MP
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.5E4
1.5E4
1.4E4
1.3E4
1.2E4
1.1E4
1.1E4
1.0E4
9.2E3
8.4E3
7.7E3
6.9E3
6.1E3
5.4E3
4.6E3
3.8E3
3.1E3
2.3E3
1.5E3
7.7E2
0.0E0
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
54:00
56:00
58:00
Time

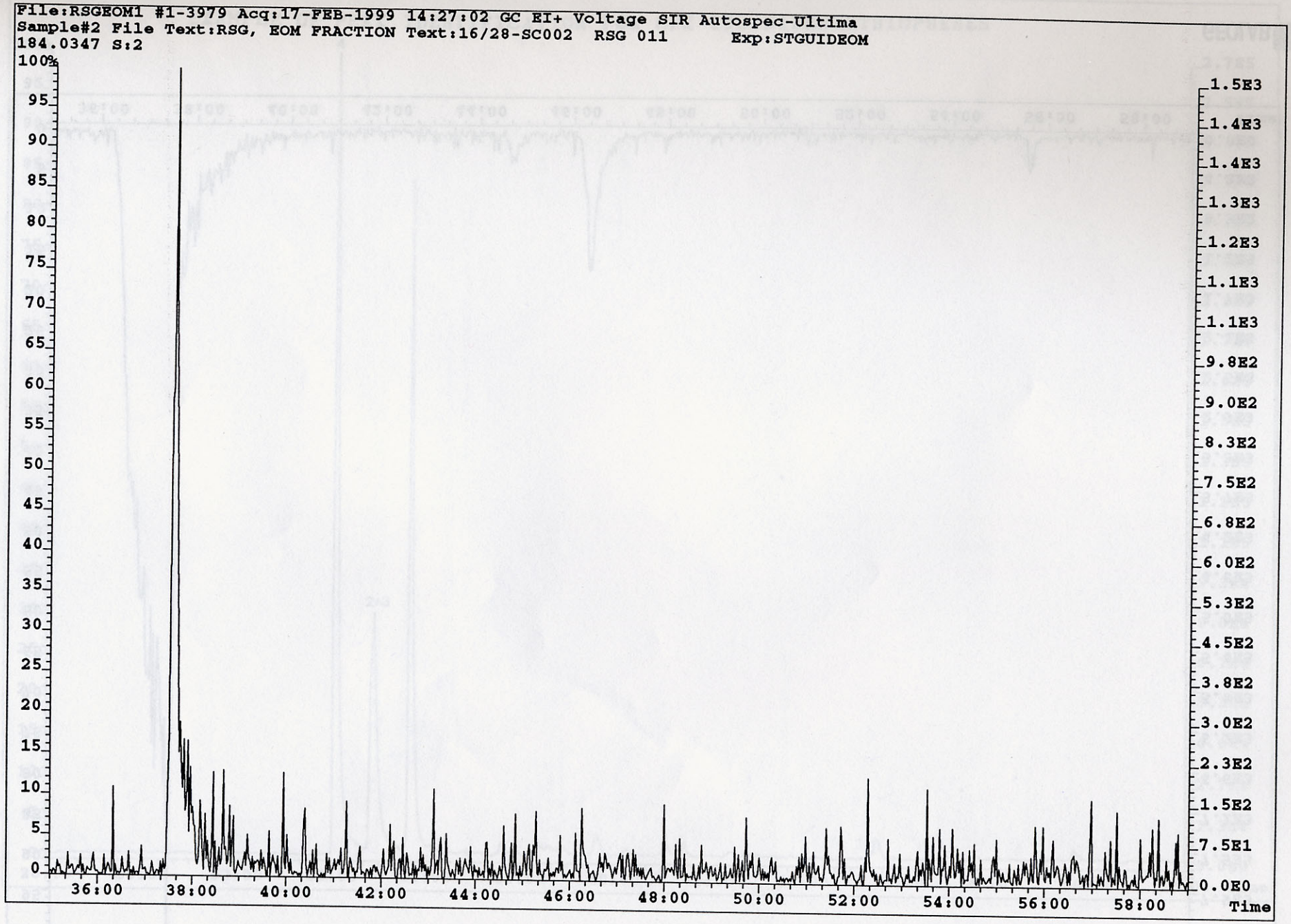
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
192.0939
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
9MP
2MP
1MP
3MP
7.4E3
7.0E3
6.6E3
6.3E3
5.9E3
5.5E3
5.2E3
4.8E3
4.4E3
4.1E3
3.7E3
3.3E3
3.0E3
2.6E3
2.2E3
1.8E3
1.5E3
1.1E3
7.4E2
3.7E2
0.0E0
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
54:00
56:00
58:00
Time

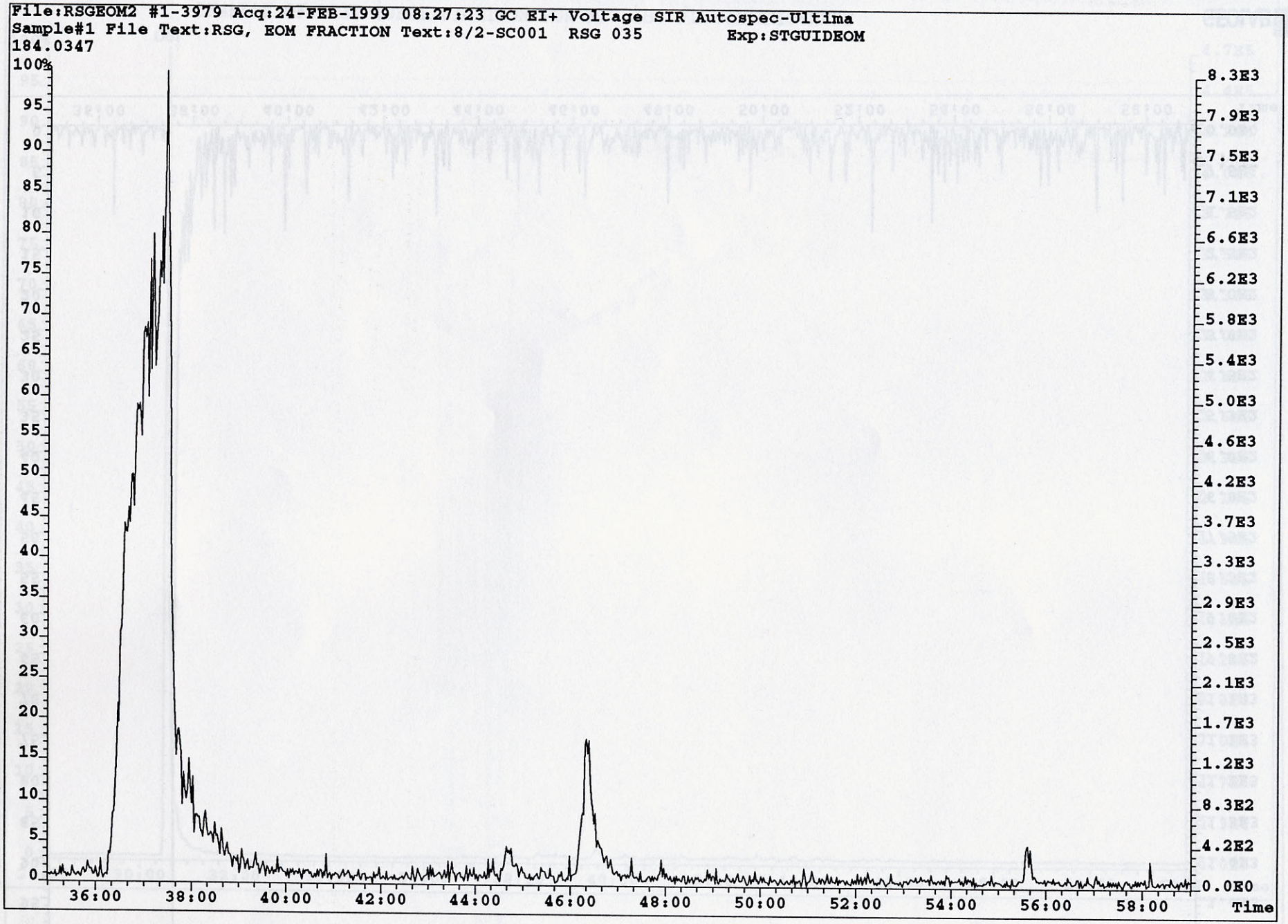
GEOLAB NOR


EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 184 DIBENZOTHIOPHENE
DBT
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4.7E5
4.4E5
4.2E5
4.0E5
3.7E5
3.5E5
3.3E5
3.0E5
2.8E5
2.6E5
2.3E5
2.1E5
1.9E5
1.6E5
1.4E5
1.2E5
9.4E4
7.0E4
4.7E4
2.3E4
0.0E0
28:00
30:00
32:00
34:00
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
Time

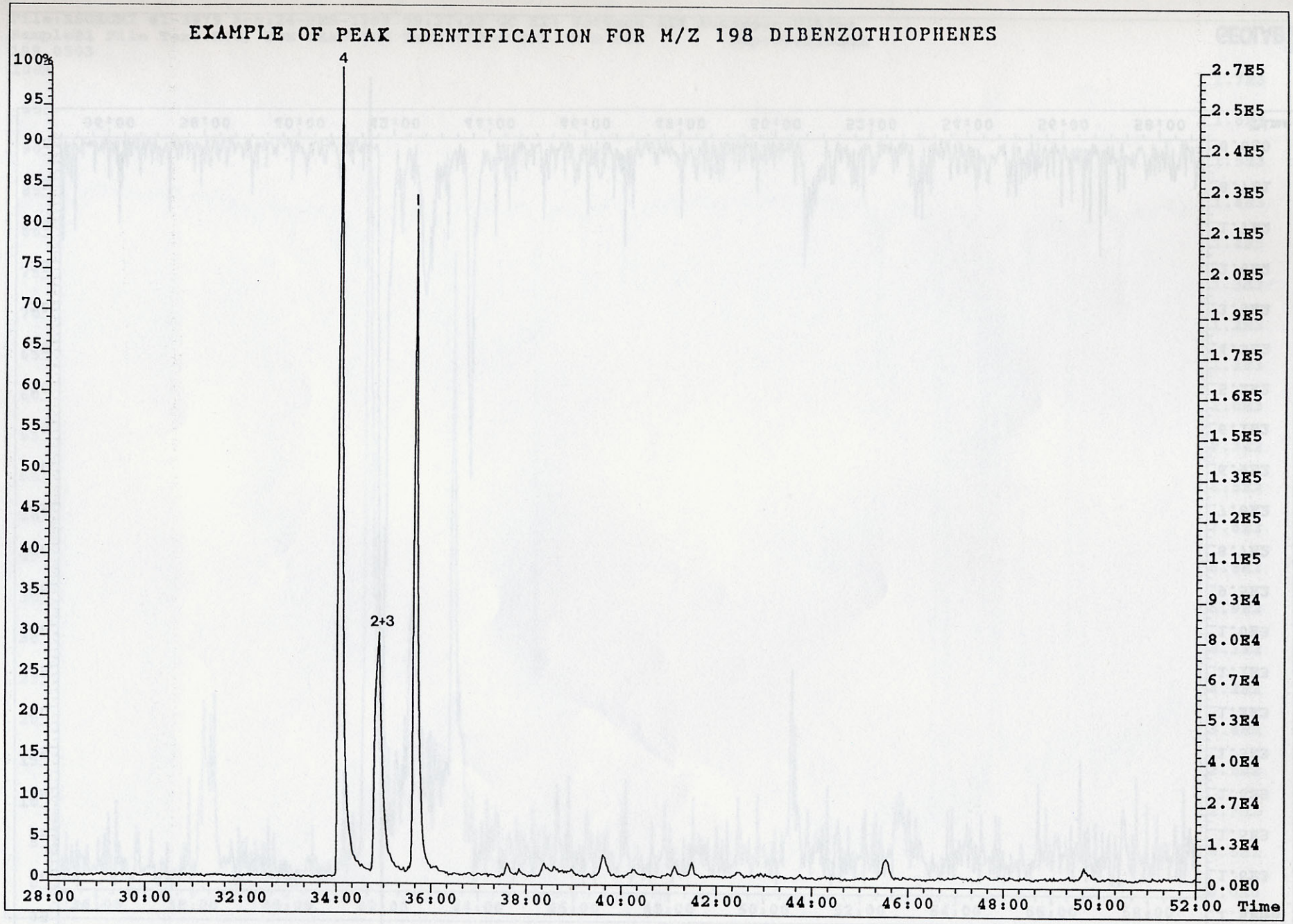
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
184.0347 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.5E3
1.4E3
1.4E3
1.3E3
1.2E3
1.1E3
1.1E3
9.8E2
9.0E2
8.3E2
7.5E2
6.8E2
6.0E2
5.3E2
4.5E2
3.8E2
3.0E2
2.3E2
1.5E2
7.5E1
0.0E0
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
54:00
56:00
58:00
Time

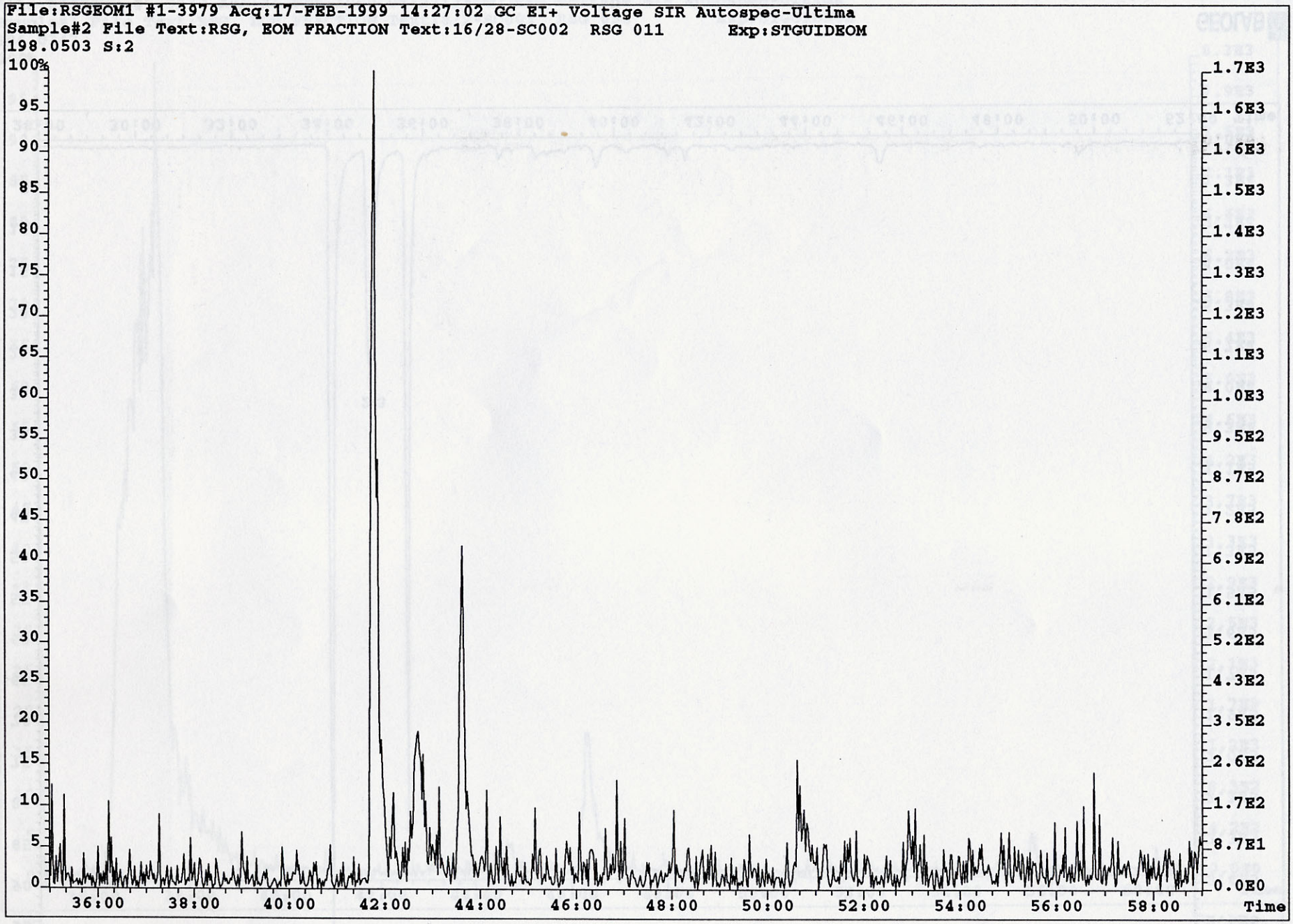
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
184.0347
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
8.3E3
7.9E3
7.5E3
7.1E3
6.6E3
6.2E3
5.8E3
5.4E3
5.0E3
4.6E3
4.2E3
3.7E3
3.3E3
2.9E3
2.5E3
2.1E3
1.7E3
1.2E3
8.3E2
4.2E2
0.0E0
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
54:00
56:00
58:00
Time

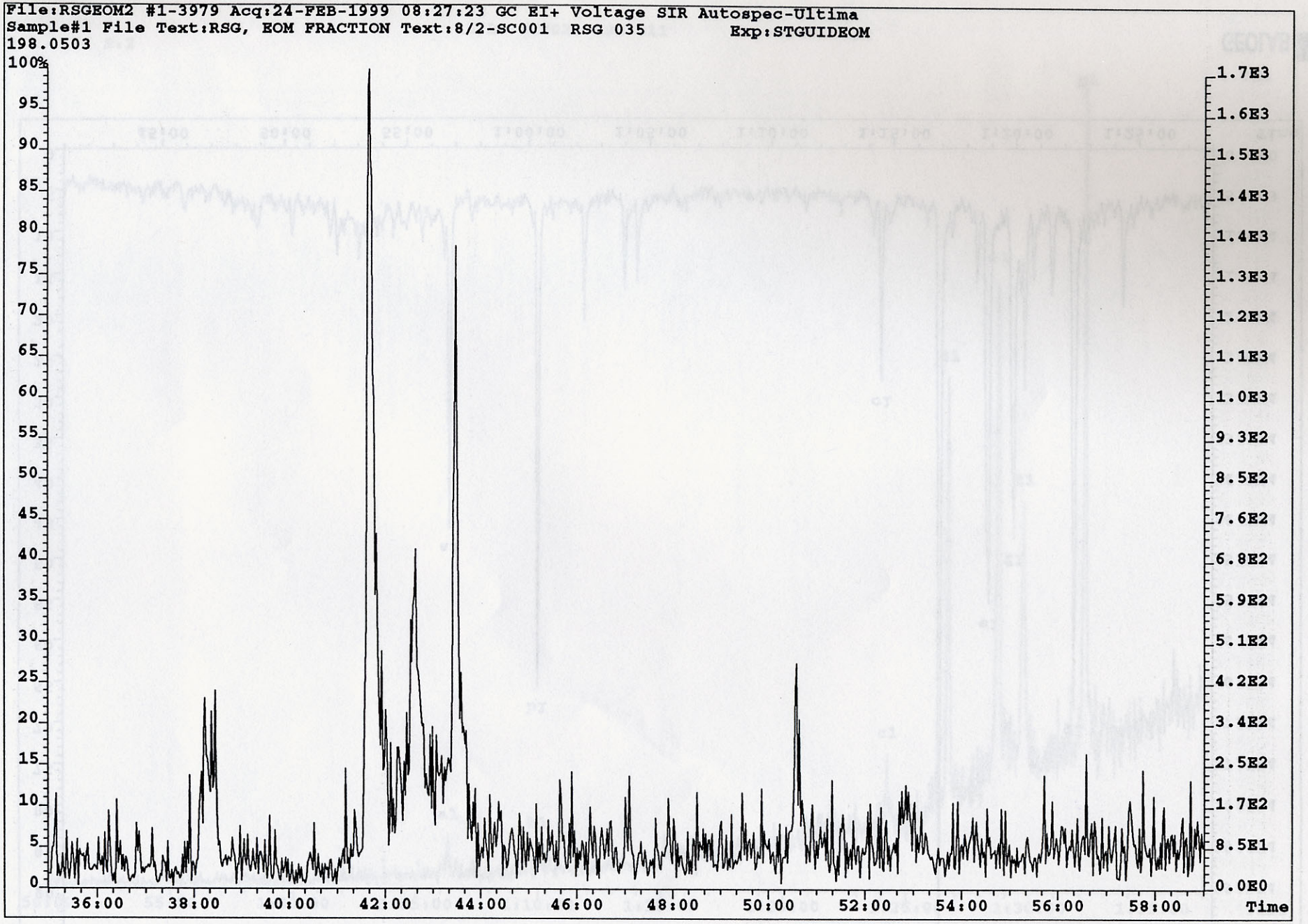
GEOLAB NOR


EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 198 DIBENZOTHIOPHENES
4
2+3
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2.7E5
2.5E5
2.4E5
2.3E5
2.1E5
2.0E5
1.9E5
1.7E5
1.6E5
1.5E5
1.3E5
1.2E5
1.1E5
9.3E4
8.0E4
6.7E4
5.3E4
4.0E4
2.7E4
1.3E4
0.0E0
28:00
30:00
32:00
34:00
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
Time

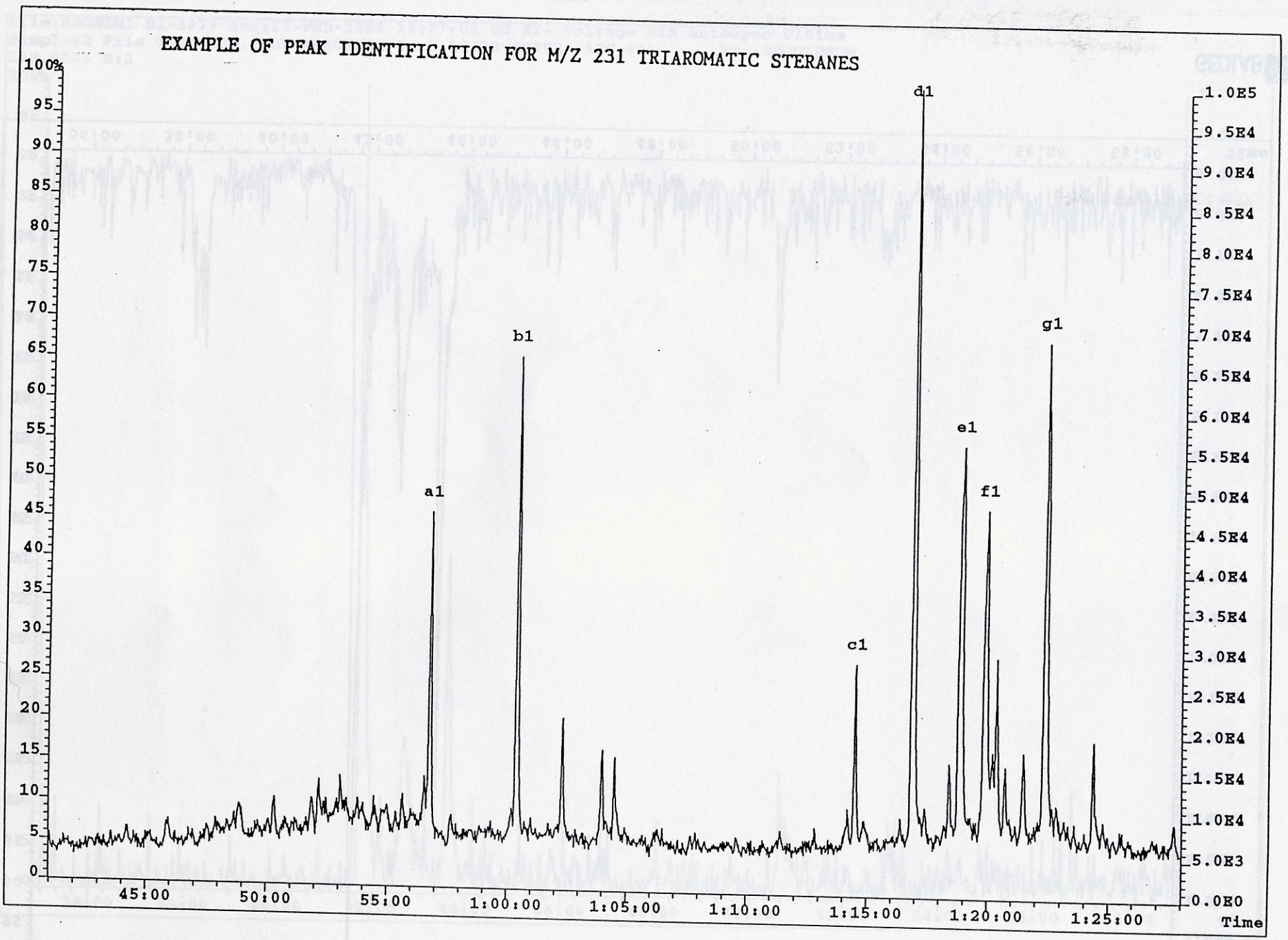
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
198.0503 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.7E3
1.6E3
1.6E3
1.5E3
1.4E3
1.3E3
1.2E3
1.1E3
1.0E3
9.5E2
8.7E2
7.8E2
6.9E2
6.1E2
5.2E2
4.3E2
3.5E2
2.6E2
1.7E2
8.7E1
0.0E0
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
54:00
56:00
58:00
Time

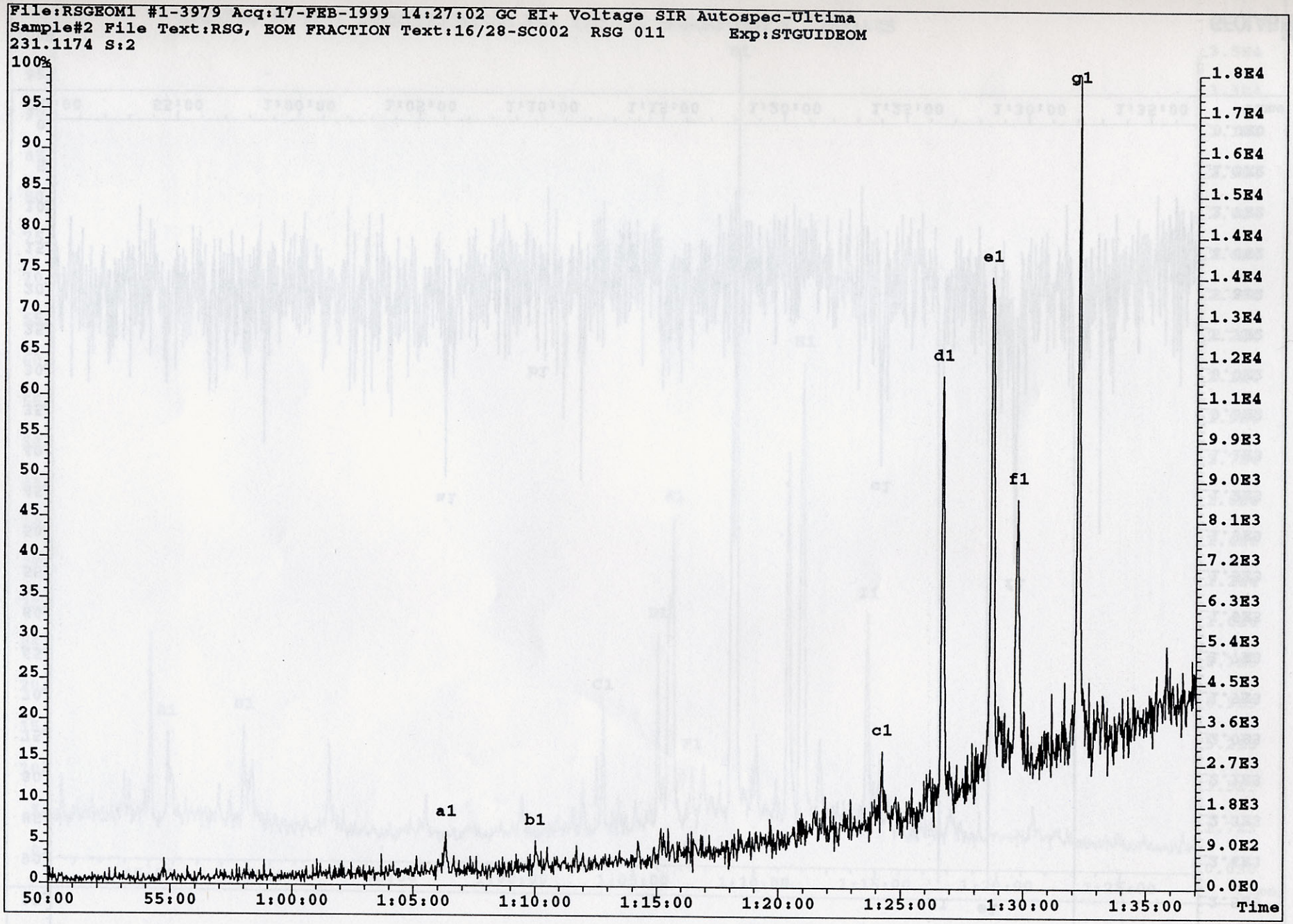
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
198.0503
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.7E3
1.6E3
1.5E3
1.4E3
1.4E3
1.3E3
1.2E3
1.1E3
1.0E3
9.3E2
8.5E2
7.6E2
6.8E2
5.9E2
5.1E2
4.2E2
3.4E2
2.5E2
1.7E2
8.5E1
0.0E0
36:00
38:00
40:00
42:00
44:00
46:00
48:00
50:00
52:00
54:00
56:00
58:00
Time

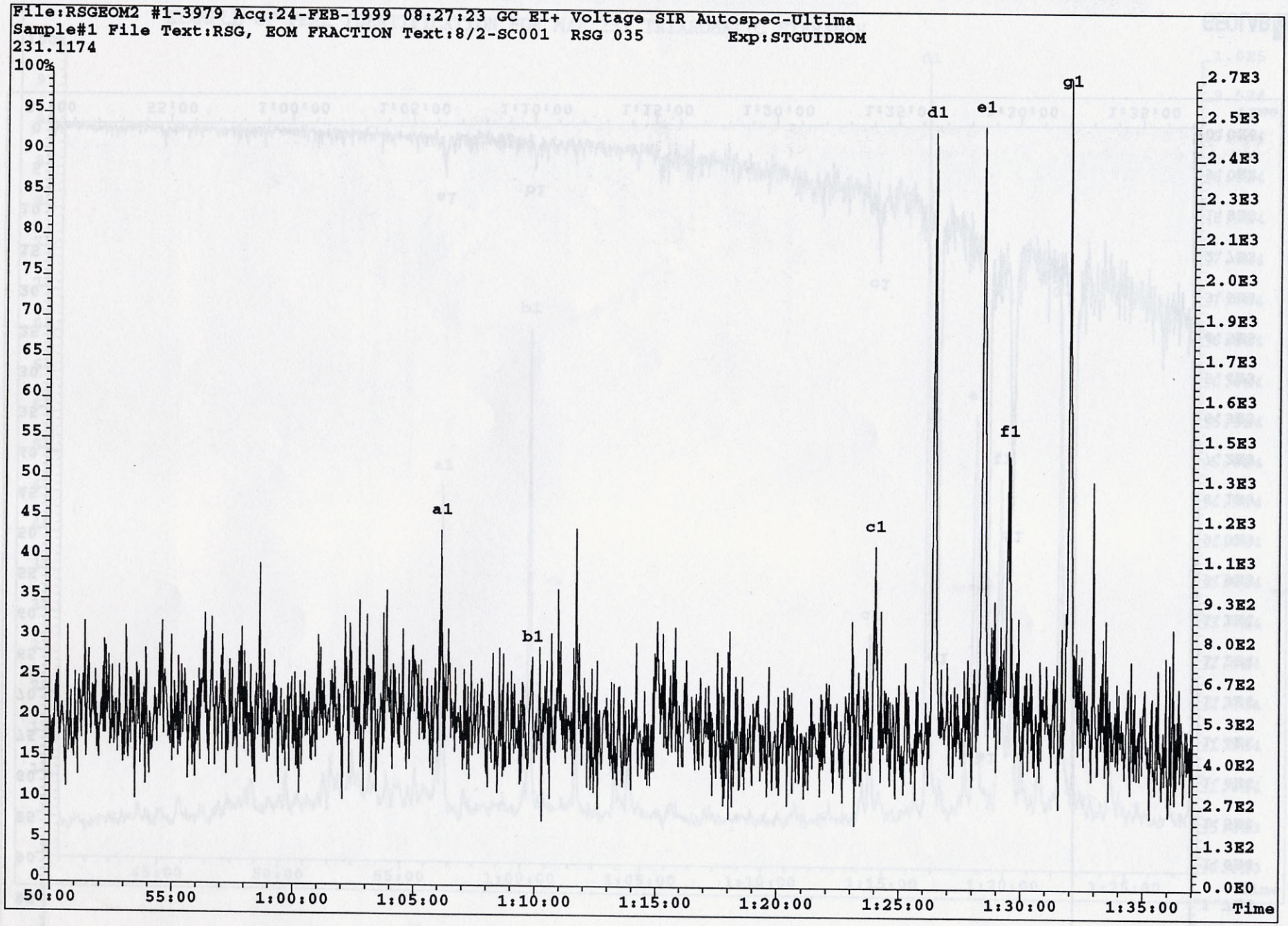
GEOLAB NOR


EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 231 TRIAROMATIC STERANES
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
a1
b1
c1
d1
e1
f1
g1
1.0E5
9.5E4
9.0E4
8.5E4
8.0E4
7.5E4
7.0E4
6.5E4
6.0E4
5.5E4
5.0E4
4.5E4
4.0E4
3.5E4
3.0E4
2.5E4
2.0E4
1.5E4
1.0E4
5.0E3
0.0E0
45:00
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
Time

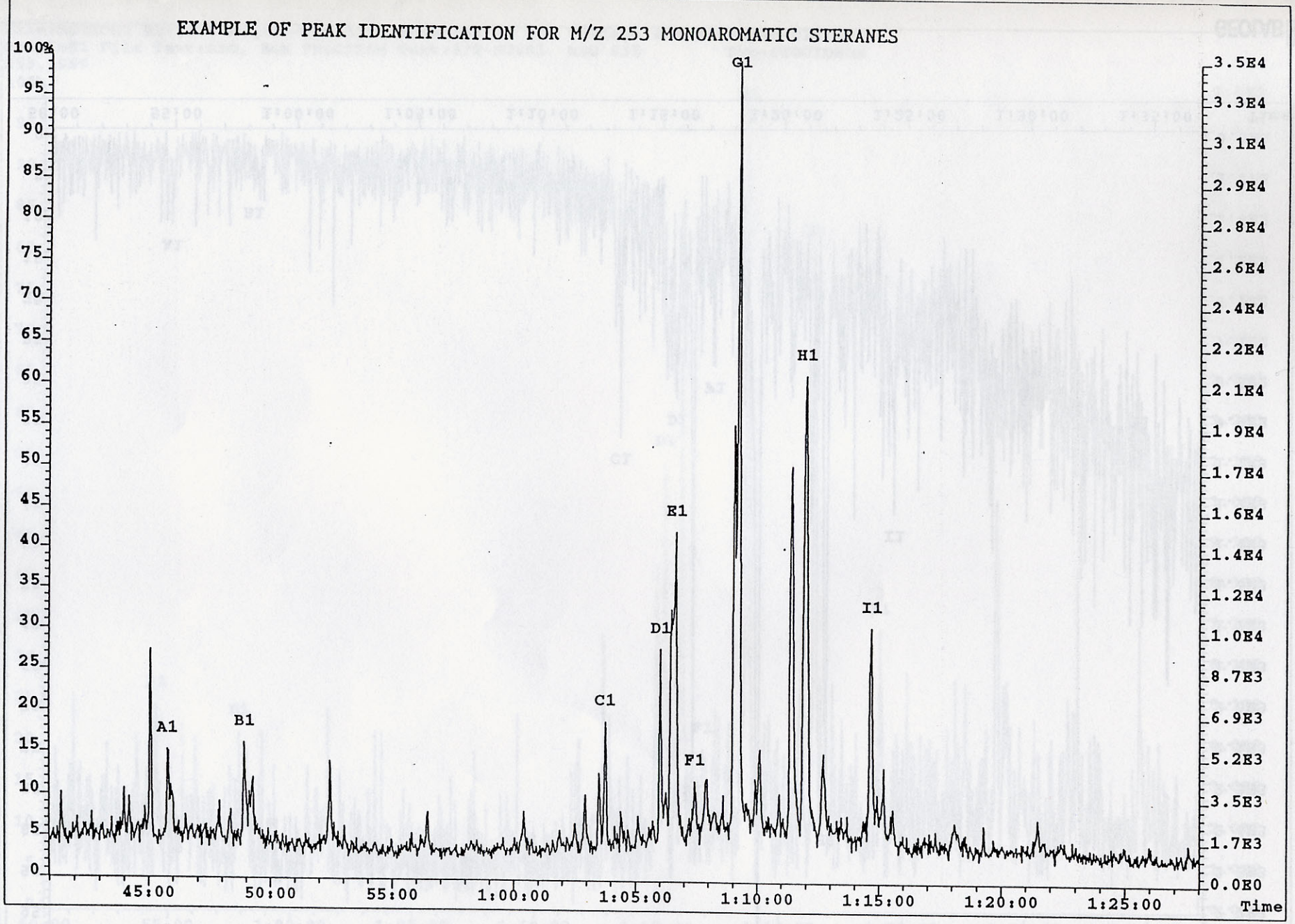
GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
231.1174 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1.8E4
1.7E4
1.6E4
1.5E4
1.4E4
1.4E4
1.3E4
1.2E4
1.1E4
9.9E3
9.0E3
8.1E3
7.2E3
6.3E3
5.4E3
4.5E3
3.6E3
2.7E3
1.8E3
9.0E2
0.0E0
a1
b1
c1
d1
e1
f1
g1
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

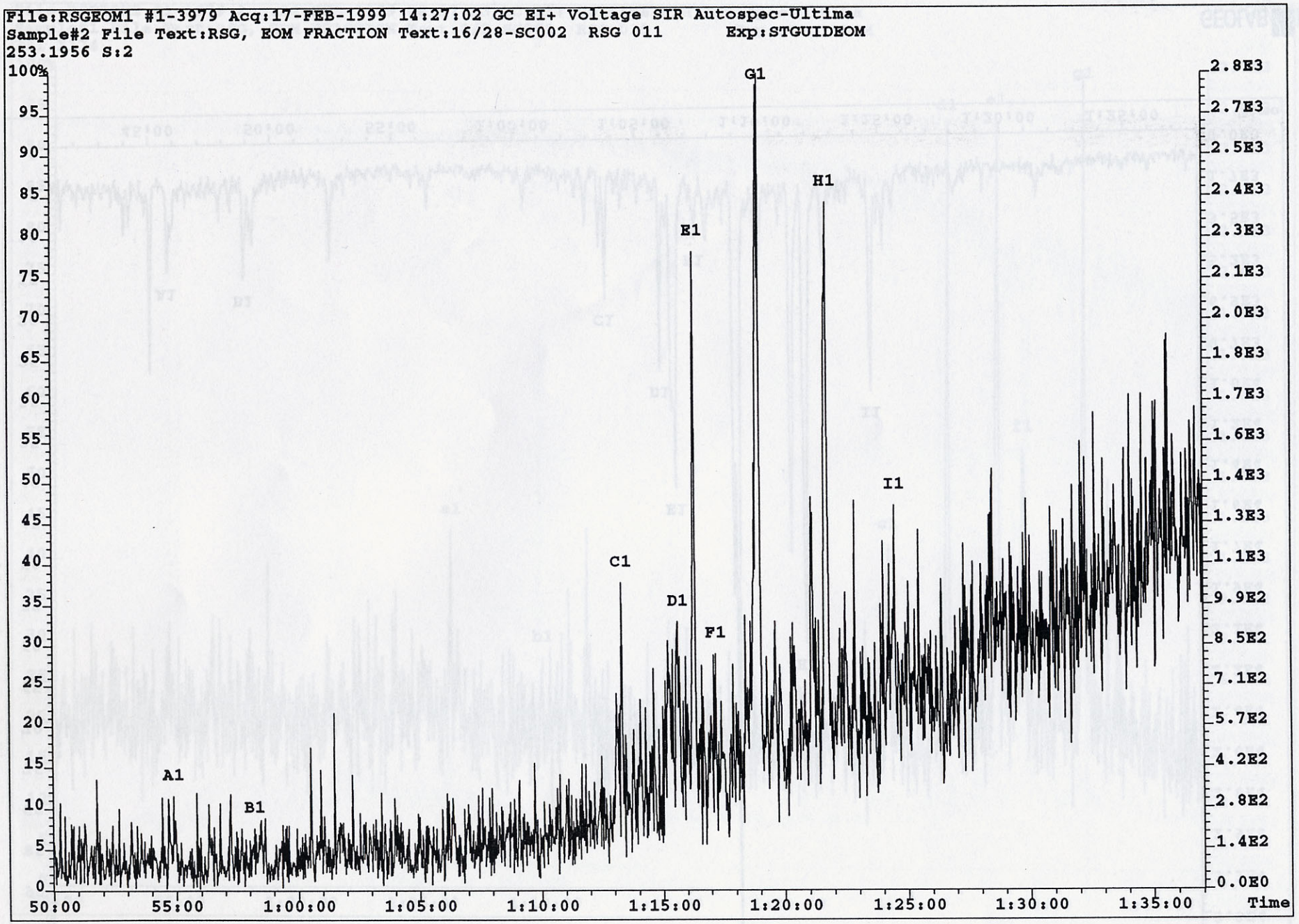
GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
231.1174
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2.7E3
2.5E3
2.4E3
2.3E3
2.1E3
2.0E3
1.9E3
1.7E3
1.6E3
1.5E3
1.3E3
1.2E3
1.1E3
9.3E2
8.0E2
6.7E2
5.3E2
4.0E2
2.7E2
1.3E2
0.0E0
a1
b1
c1
d1
e1
f1
g1
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

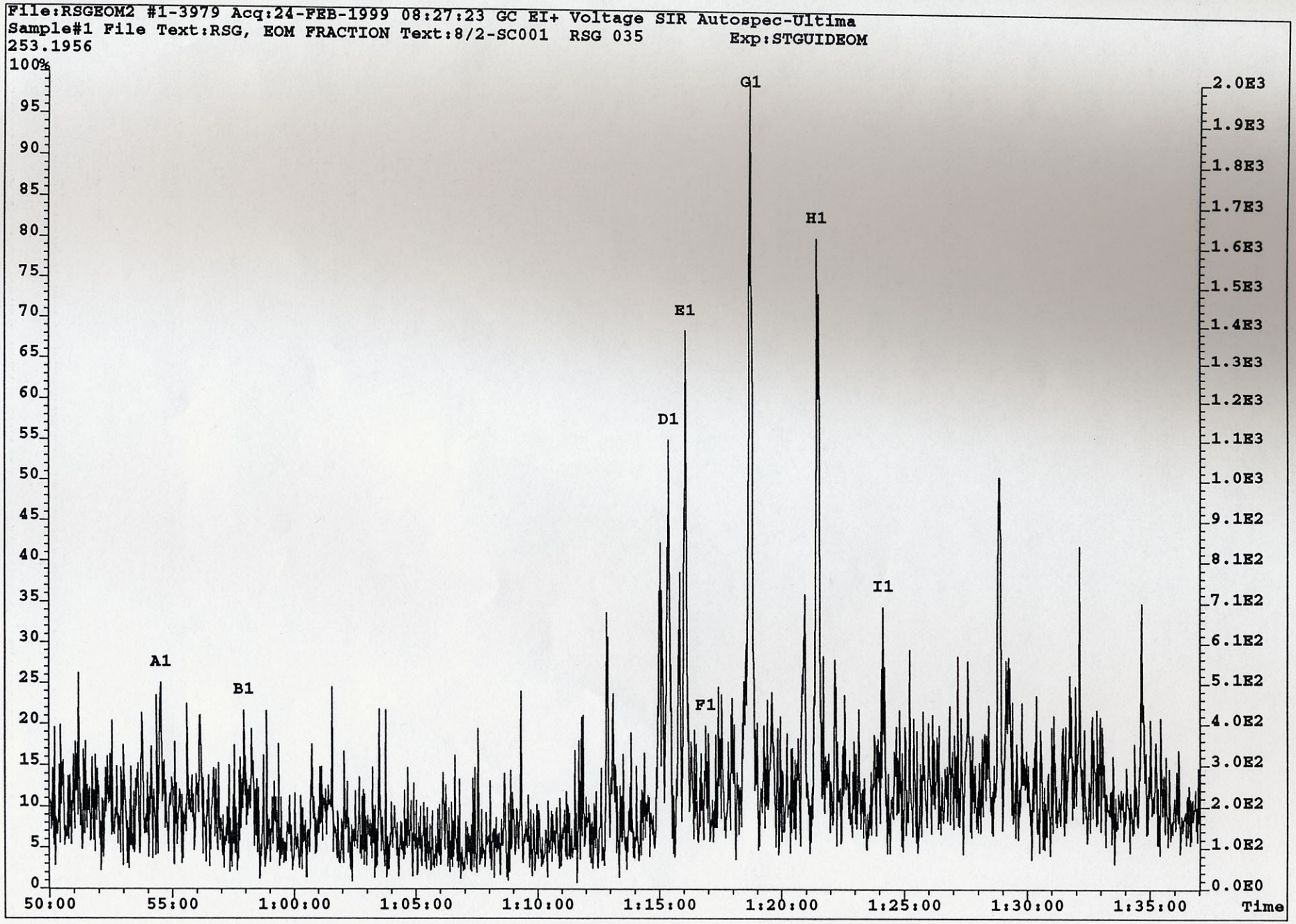
GEOLAB NOR


EXAMPLE OF PEAK IDENTIFICATION FOR M/Z 253 MONOAROMATIC STERANES
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
A1
B1
C1
D1
E1
F1
G1
H1
I1
45:00
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
Time
3.5E4
3.3E4
3.1E4
2.9E4
2.8E4
2.6E4
2.4E4
2.2E4
2.1E4
1.9E4
1.7E4
1.6E4
1.4E4
1.2E4
1.0E4
8.7E3
6.9E3
5.2E3
3.5E3
1.7E3
0.0E0

GEOLAB NOR


File:RSGEOM1 #1-3979 Acq:17-FEB-1999 14:27:02 GC EI+ Voltage SIR Autospec-Ultima
Sample#2 File Text:RSG, EOM FRACTION Text:16/28-SC002 RSG 011 Exp:STGUIDEOM
253.1956 S:2
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2.8E3
2.7E3
2.5E3
2.4E3
2.3E3
2.1E3
2.0E3
1.8E3
1.7E3
1.6E3
1.4E3
1.3E3
1.1E3
9.9E2
8.5E2
7.1E2
5.7E2
4.2E2
2.8E2
1.4E2
0.0E0
A1
B1
C1
D1
E1
F1
G1
H1
I1
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

GEOLAB NOR


File:RSGEOM2 #1-3979 Acq:24-FEB-1999 08:27:23 GC EI+ Voltage SIR Autospec-Ultima
Sample#1 File Text:RSG, EOM FRACTION Text:8/2-SC001 RSG 035 Exp:STGUIDEOM
253.1956
100%
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2.0E3
1.9E3
1.8E3
1.7E3
1.6E3
1.5E3
1.4E3
1.3E3
1.2E3
1.1E3
1.0E3
9.1E2
8.1E2
7.1E2
6.1E2
5.1E2
4.0E2
3.0E2
2.0E2
1.0E2
0.0E0
A1
B1
D1
E1
F1
G1
H1
I1
50:00
55:00
1:00:00
1:05:00
1:10:00
1:15:00
1:20:00
1:25:00
1:30:00
1:35:00
Time

GEOLAB NOR

RSG Project 98/21 Geochemical analysis of seabed cores. Presented by Steve Cawley (BP) on behalf of Geolab Nor.

Mr Cawley explained that Geolab Nor had carried out a series of geochemical analyses on the gravity cores collected by RRV Challenger (RSG project 97/50). This work was now complete and a final report had been received from Geolab Nor. Mr Cawley went on to explain how he had reinterpreted the results based on the experience of BP Amoco with geochemical analysis of seabed cores in the region. He concluded that Geolab's interpretation was perhaps optimistic in that some of the perceived "microseepage" could be from reworked source rocks in the sediments. He did however agree that sample 'F' in Quad 16 could contain seeped biodegraded oil.

Mr Cawley agreed to produce a brief overview, charts and map to go with the Geolab report and that this would be distributed to members during April 2000.

Comments on Geolab Nor's report by S. Cawley, BP Amoco:
Irish Rockall Area Surface Geochemical Survey.

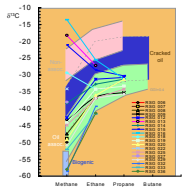
Gravity drop-cores were collected during site survey work for PIP's shallow (<200m below sea bed) coreholes drilled by the BGS in July 1999. Core samples were analysed by Geolab Nor. The views expressed below are based on my (plus BP colleague's) experience of sea bed coring detecting macro and micro-scale petroleum seepage. They do not coincide with Geolab Nor's conclusions.

Petroleum seepage which can be ground-truthed reduces risk of occurrence of a working petroleum system in a basin. *Macro*-seepage occurs in petroleum-rich, highly leaky basins with distinct focii of migration and is usually manifest as actively flowing seeps e.g. Gulf of Mexico. By its nature such seeepage dominates the organic signature at the point of sampling. *Micro*-seepage is much harder to identify and it's therefore much more probable to attach false positive conclusions. Inter-action between seeping petroleum and near-surface bacterial communities typically results in biodegradation of the oil. *Micro*-seepage is a slow-rate system allowing plenty of time to biodegrade the seeping oil.

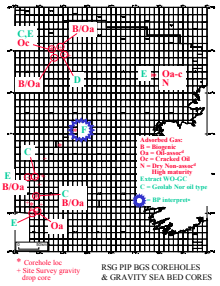
Under instruction from PIP STC Geolab Nor performed several different types of analysis on drop core samples from >1m depth. Headspace gas and Total Scanning Fluorescence did not show evidence of thermogenic petroleum seepage, showing only biogenic gas and recent organic matter (ROM) respectively.

Adsorbed Gas (analysed after sample disaggregation for gas composition and $\delta^{13}C$ isotopic value) - evidence that there may be *micro*-scale seepage of thermogenic gas. BP's experience is that while the data may be good quality, interpretation is not always straight forward. The occurrence of reasonable concentrations of nC2+ and ratios of Ethane/Methane, Propane/Methane, Wetness and iC4/nC4 governed selection of samples for $\delta^{13}C$ analysis. The attached figure (which can be enlarged by dragging corner handles) shows $\delta^{13}C$ data per nC1-nC4

RSG Sea Bed Cores Adsorbed Gas Isotope distributions:



fraction sitting in varied biogenic-thermogenic gas fields. Many of the samples show evidence of oil-associated gas seepage, whilst a few also suggest a contribution from a high maturity, dry gas (coaly?) source. 13 of 35 (35%) *suggest micro*-seepage of thermogenic gas. Distribution of such samples is shown in the map below figure (which can be enlarged by dragging corner handles).



Extract GC analysis - BP experience is that whole-oil GC analysis of extracts is the best screening tool to identify potential petroleum seepage in near-surface sediments. Geolab Nor hexane-extracted all samples and they identified several groups based on GC character:

Groups A &B : low extract concentrations dominated by Recent Organic Matter (ROM) and large amounts of unknown thermogenic (i.e. migrated oil) hydrocarbon (HC) compounds as well as n-alkanes.

Group C : bi-modal GC trace with significant low molecular weight HC's but very ROM-dominated in the heavier end. Interpreted as part thermogenic, possibly sourced from a lacustrine system.

Group D : very similar to Group C, interpreted as possibly containing marine source rock-derived mature thermogenic HC's.

Group E : flat GC baseline with mod-high concentrations; low levels of light HC's, dominantly ROM-derived heavier HC's but also significant amounts of thermogenic HC compounds.

Group F : low concentration extract with a large "hump" in the GC baseline of "unresolved complex mixture" (UCM) with a "top-up" of typically Group D or E material. ***Such UCM is typical of biodegraded oil.*** This is also noted in Geolab Nor's report but they conclude that the is most likely the result of ship-board contamination by lube oil and/or grease. GC-MS analysis of this sample suggested mature oil from a terrestrially-dominated source but low concentrations and biodegradation render these conclusions tentative at best.

- My interpretation is that the single Group F sample is the only migrated oil sampled by the drop-cores.

Conclusions

IF Geolab Nor's interpretation is correct then the success rate for sampling petroleum seepage in this:

1. unexplored basin
2. with site-survey cores which were ***not*** targeted at features thought to be seepage-related,

is 51% (19 samples out of 35)… this is highly unlikely.

A single reasonable extract sample (Group F) and 13 adsorbed gas analyses *hint* at the occurrence of a petroleum system in the Irish Rockall. A serious seepage study requires an integrated, fully targeted sea bed core programme of many hundreds of samples to identify background, variations within background and anomalies. Such work could be in addition to, or backed up by, satellite and airborne surveillance.

Steve Cawley
Senior Geochemist
BP Amoco Exploration, Aberdeen
17/4/00