W1064, 1065

WCR VOL 2

MOONFISH-1, ST1

W1064, W1065

WELL COMPLETION REPORT

MOONFISH-1 & 1 ST1
VOLUME 2

INTERPRETIVE DATA

GIPPSLAND BASIN
VICTORIA

ESSO AUSTRALIA LIMITED

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1. Introduction

Moonfish-1 was spudded on the 12th May, 1992 and is located approximately 5km north of the Snapper gas field (Figure 1). The Moonfish structure is a compressional force fold, developed along the zone of reactivation of a major basin bounding, east-west trending, normal fault.

The objective of Moonfish-1 was to test small fault independent closures within the Latrobe Group, at the N. asperus and L. balmei stratigraphic levels. A secondary objective was to test a deeper, fault independent closure at the T. longus stratigraphic level. After crossing the key prospect bounding fault, at 2363mSS before intersecting the secondary objective, the well was sidetracked to test the T. longus objective.

Moonfish-1 discovered a number of hydrocarbon zones in the N. asperus to L. balmei stratigraphic interval. A significant gas reservoir was intersected in an N. asperus sandstone, below the N-1.9 coal marker horizon. The most volumetrically significant oil reservoirs are the M-2 reservoir, located below the M. diversus M-1 coastal plain interval and the sub-volcanic reservoir below a sequence of L. balmei volcanics.

An additional minor oil reservoir was also intersected in Moonfish-1ST1 within the M. diversus M-1 coastal plain interval.

The well was plugged and abandoned as a new field oil and gas discovery well.

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2a. Moonfish-1 Formation Tops

Formation/Horizon	Forecast Depth m TVDSS	Actual Depth m MDRT	Actual Depth m TVDSS
Gippsland Limestone (water bottom)	52	75	52
Lakes Entrance Formation	-	845.0	800.0
Latrobe Group	1518	1640.6	1482.0
N-1.4 coal	1575	1725.9	1556.7
N-1.9 coal	1675	1830.1	1648.3
M-2 reservoir	-	1901.7	1712.3
L1 coal	1825	2023.0	1823.0
Volcanics	-	2207.0	1989.6
Sub-volcanic reservoir	-	2254.3	2031.3
Strezelecki (fault cut)	2750	2625.0	2363.0
T.D.	2800	3045.0	2704.0

2b. Moonfish 1 ST1 Formation Tops

Formation/Horizon	Actual Depth m MDRT	Actual Depth m TVDSS
Gippsland Limestone (water bottom)	75	52
Latrobe Group	1606.0	1478.6
N-1.4 coal	1694.4	1559.1
N-1.9 coal	1799.8	1655.6
M-1 reservoir	1857.0	1708.5
M-2 reservoir	1873.1	1723.4
Volcanics	2171.8	1998.4
Sub-volcanic reservoir	2216.0	2038.0
T.D.	2803.0	2577.2

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3. Stratigraphy

All depths referred to in this discussion are those intersected by the Moonfish-1 well, unless otherwise stated. The section intersected by the sidetrack well (Moonfish-1 ST1), located 500m to the south is approximately 6-8m down dip from that intersected in Moonfish-1. A correlation between the two wells over the interval 1640-2060mSS is included as Enclosure 1.

The Moonfish-1 well was expected to penetrate a similar section to that seen at Snapper, located 5km to the south. The youngest potential reservoirs were anticipated to be fluvio-estuarine and barrier beach sands of N. asperus age. Below the N. asperus targets the well was expected to encounter fluvial and point bar sands of the L. balmei palynological zone. The oldest target in the well comprised T. longus aged coastal plain sands.

The Top of Latrobe Group (TOL) was intersected at 1482.0mSS in Moonfish-1, 33m high to prognosis. The interval 1482.0mSS to 1495.0mSS consists of glauconitic sandstones and siltstones of the Gurnard Formation.

The Top of "Coarse Clastics" (TCC; 1495mSS) marks the top of a thick sequence of sandstone, shales and coal of probable N. asperus age. The N-1.4 coal and N-1.9 coal, correlated seismically from Snapper were intersected at 1566.7mSS and 1648.3mSS respectively. These horizons were intersected 9m and 27m high to prognosis respectively.

The N. asperus interval is of fluvial to coastal plain origin. The thick sandstone unit at TCC (1495.0 to 1513mSS) and between the N-1.4 and N-1.9 coal units most probably represents a sequence of stacked channel sands.

The interval from 1680-1712.3mSS is referred to as the M-1 section, a sequence of coals and shales with thin sandstones, deposited in a coastal plain environment. The sandstones are best developed in Moonfish-1 ST1, and tend to be thinner and of less frequent occurrence in Moonfish-1 (Enclosure 1). The M-1 sequence is thought to be of M. diversus age, however no samples were taken from this interval for biostratigraphic analysis.

The top of the M-2 reservoir at 1712.3mSS marks a change in lithofacies within the M. diversus section. The interval 1712.3-1823mSS consists of a sequence of thick (5-15m) upward fining units of sandstone, shale and coal. These sands are seen to thin (in Moonfish-1 ST1; Enclosure 1) to the south, away from the northern bounding prospect fault indicating that these fluvial units may be part of an alluvial fan, shedding sediment off the fault block located to the north of the Moonfish field.

The top of the L1 coal, provisionally picked at 1823mSS, is 2m high to prognosis. This unit marks the top of the L. balmei stratigraphic interval, which extends at least to 2149.2mSS is Moonfish 1 ST1 (Appendix 1).

The interval from 1823.0mSS to 1920mSS consists of predominantly shale and coal, indicating a period of low sediment input on the coastal plain during L. balmei time. The interval 1920.0mSS to 1986.6mSS consist of thick (5-20m) upward fining sandstone packages, similar in log character to the lower M. diversus interval. Core No 1, cut from 1809-1921mSS, consists of a fine to medium grained sandstone, commonly with silty and carbonaceous laminae and coal (Appendix 2; Volume 1). The environment of deposition is interpreted as fluvial.

Volcanics of basic composition occur within the Lower L. balmei coastal plain sequence between 1989.6 and 2013.0mSS.

The interval 2013.0-2149.2mSS (the sub-volcanic L. balmei zone) consists of upward fining sandstone units, and rare occurrences of thin coals. Cores 2, 3 and 4 from the interval 2033-2071mSS consist of medium to very coarse sandstone with a high feldspar content (Appendix 2; Volume 1).

Late Cretaceous sediments of the T. longus and T. lilliei palynological zones occur over the interval 2221 to 2577mSS (TD) in Moonfish-1 ST1. This section, again, consist of undifferentiated coastal plain facies with lithologies consisting of sandstone, shale and coal.

The oldest rocks penetrated intersected in Moonfish-1 between 2563 mSS (fault cut) and 3045 mSS (T.D.). These comprise a thick predominantly shaly unit of the P. mawsonii zone, and is correlated with the Kipper Shale Formation within the Golden Beach Group.

4. Structure

The Moonfish field lies on the south side of the Strezelecki Terrace between the Snapper and Emperor fields. The Moonfish field in on trend with the Wirrah and Sunfish fields, and formed as a result of two superimposed structural events; an early extensional basin forming phase followed by a Late Eocene to Oligocene compressional phase. Moonfish is the product of the compressional phase reactivating old normal faults associated with basin rifting. Force folds have developed in the hanging wall, along the zone of reactivation of an east-west trending, southerly dipping, basin bounding fault.

Less than 20m of closure was mapped predrill at the Top of Latrobe Group, with a similar structure at the Top of "Coarse Clastics". Critical closure was to the south for the primary play, however an increase in the thickness of the Latrobe Group sediments to the south results in an increase in closure for the deeper units. The deeper plays were prognosed to have fault dependent closure to the north, as rollover into the fault decreased with depth.

The northern bounding prospect fault was intersected in Moonfish-1 at 2353mSS, 397m higher than predicted, resulting in the fault plane being steeper than interpreted.

Post drill mapping of the Moonfish discovery results in closure at the intra-Latrobe M. diversus level to be partially fault dependent (Enclosure 7). The spill point at M. diversus level is a structural saddle to the south (Enclosure 7).

Closure at the deeper L. balmei interval is fault independent with the spill point corresponding to the location where closure becomes fault dependent, indicating the fault does not seal at this level.

5. Hydrocarbons

Moonfish-1 was designed to test structural rollovers within the Latrobe Group, N. asperus and L. balmei stratigraphic intervals. Highside potential was identified within fault dependent closure at the T. longus stratigraphic level.

A number of hydrocarbon intervals were discovered in the N. asperus to L. balmei stratigraphic interval with the most volumetrically significant oil reservoirs located below the M. diversus, M-1 coastal plain interval and below a sequence of L. balmei volcanics. No hydrocarbons were intersected at Top of Latrobe Group, or in the deeper T. longus sandstones.

The first hydrocarbons encountered by Moonfish-1 consists of a 10m net gas column in clean sandstones of N. asperus age, located below the N-1.9 coal marker horizon (N-1.9 reservoirs). The top of the N-1.9 gas reservoir was intersected at 1664.7mSS. A gas-water contact was intersected at 1674.7mSS.

The sidetrack well (Moonfish-1 ST1) intersected the N-1.9 Gas reservoir 8m structurally lower at 1672.3mSS resulting in a net column height of 2.0m. RFT pressure data confirms the reservoir is in communication with that intersected in Moonfish-1 (Appendix 4).

Between 1684.7 and 1696.5mSS in Moonfish-1 hydrocarbon shows were encountered in thin sandstones (Mud Log; Enclosure 2). Log analysis indicates the presence of three possible oil zones and one possible gas zone of between 0.2 and 1.0m net thickness (Appendix 4: Enclosure 3). A similar sequence of 6 hydrocarbon zones were identified by log analysis in the sidetrack well between 1690.3mSS and 1704.9mSS (Appendix 4). The sandstones are difficult to correlate between wells and appear to be of limited lateral extent.

At a depth of 1712.3mSS Moonfish-1 intersected an 18.2m gross oil column in a clean M. diversus aged sandstone (M-2 reservoir). An oil-water contact was intersected at 1731.3mSS. Log analysis calculates an average porosity of 21%, a net to gross of 74% and a mean oil saturation of 85% for this zone (Appendix 3). Analysis of RFT recoveries indicates the oil has a low GOR and high pour point (Appendix 4).

Moonfish-1 ST1 intersected the main M-2 oil reservoir 7.0m structurally lower at 1723.4mSS. Net reservoir section was substantially reduced within the oil column. At this penetration the M-2 reservoir consists of 3.9m of net section, base sealed with the lowest known oil established at 1727.7mSS. RFT analysis confirmed the reservoir is in communication with the M-2 reservoir intersected in Moonfish-1.

Moonfish-1 ST1 also established the presence of a new reservoir (M-1 oil reservoir) in the M. diversus coastal plain section, immediately above the main M-2 oil zone. The M-1 reservoir consists of a 2.9m (net), base sealed oil sand with lowest known oil established at 1712.0mSS (Appendix 3). Porosity and oil saturation over this interval are 22% and 71% respectively. RFT pressure data indicates that this pool is not in communication with the main M-2 reservoir and has an oil-water contact at 1721.0mSS (Appendix 4).

Between 1759.3 and 1929.9mSS in Moonfish-1, log analysis identifies up to nine oil and gas zones in thin M. diversus to L. balmei sandstones (Appendix 3), interspersed between shales and coals. The most significant of the oil zones, intersected at 1924.0mSS with an oil-water contact at 1929.9, contains 2.9m of net oil, with a net to gross ratio of 49% and an oil saturation of 60% (log Analysis; Appendix 3).

In the sidetrack well up to eleven hydrocarbon zones were identified by log analysis in the corresponding M. diversus to L. balmei section between 1762.5mSS and 1929.4mSS (Appendix 3). The sands in this section tend to be thinner than in Moonfish-1. The most significant of the oil zones over this interval was intersected at 1762.5mSS and consists of 2.1m of net oil sand with a high water saturation (74%) and an oil-water contact at 1764.7mSS.

At 2031.5mSS in Moonfish-1 and 2038.0mSS in Moonfish-1 ST1 an L. balmei sandstone contains 4.8m and 3.7m of net oil respectively. The reservoir underlies an interval of L. balmei aged volcanics and is referred to as the sub-volcanic reservoir. An oil-water contact for the sub-volcanic reservoir was intersected in both wells at 2043.3mSS.

No hydrocarbons were encountered below the sub-volcanic reservoir.

6. Geophysical Discussion

The post-drill mapping of the Moonfish area was carried out using two dimensional seismic data primarily from two grids. A more recent G88A and an older G77A survey provide grid coverage over the area at a line spacing of approximately one half a kilometre. Other data including G80A and G81A were also used where appropriate.

A well to seismic tie was achieved at the Moonfish-sidetrack-1 location via a check-shot corrected synthetic seismogram (Enclosures 4 & 5).

Whilst the character match of the synthetic seismogram with the G88A-2D seismic was very good, the actual well to seismic tie was somewhat difficult. Not only did the Moonfish-sidetrack-1 well path track exactly between the two nearest G88A seismic lines but it was also deviated. Therefore, a direct comparison between the well and seismic in the same location was not possible. However, a tie was achieved at shotpoint 2150 on line G88A-9082 by "jump correlating" between the synthetic and the seismic. The two way seismic time picks and a description of the reflection event for each interpreted horizon are listed below.

Event	Description	TWT(secs)
Top of Latrobe Group	Zero crossing-trough to peak	1.212
Base N-1.9 coal	Zero crossing-trough to peak	1.339
M-2 Reservoir seismic marker	Zero crossing-peak to trough	1.401
Base Volcanics seismic marker	Zero crossing-peak to trough	1.538

Post-drill analysis of the average velocity to the Top of Latrobe Group indicates that the pre-drill velocity was overestimated by 65 metres per second, resulting in the Top of Latrobe Group at Moonfish-1 being penetrated 36 metres shallower than predicted.

The 2.4 percent error in depth prognosis represented by this overestimation is almost entirely due to the error in calculating the average velocity to the Top of Latrobe Group.

Four key horizons were interpreted from seismic data in the post-drill mapping of the Moonfish area. Three of these were selected for time and depth mapping. Time structure maps to the Top of Latrobe Group, M-2 seismic marker and Base Volcanics seismic marker were generated (Enclosures 6, 7 & 8). Normal move-out velocity data to the Top of Latrobe Group from the G88A seismic grid were hand smoothed and contoured. This map was converted to average velocity using a borehole "correction factor" calculated at Moonfish-sidetrack-1.

A depth structure map to the Top of Latrobe Group (Enclosure 6) was produced by multiplying the average velocity map by the lagged one-way time map to the same surface. Isochrons between the Top of Latrobe Group and the deeper M-2 and Base Volcanics seismic markers were created and isopachs produced from constant well interval velocities measured at the sidetrack location.

Structure maps to the top of porosity for the two main hydrocarbon reservoirs (M-2 and Base Volcanics) were created by isopaching up from the M-2 seismic marker and down from the Base Volcanics seismic marker by 17 and 18.5 metres respectively (Enclosures 7 and 8).

7. Geological Summary

Moonfish-1 is located approximately 5km north of the Snapper platform (Figure 1). Moonfish is a compressional force fold that developed along the zone of reactivation of a basin forming normal fault. Closure is partly dependent on fault seal against the northern margin bounding fault.

The objective of the well was to test fault independent closures within the intra-Latrobe Group N. asperus to L. balmei aged section. A secondary objective was a deeper, fault dependent closure at the T. longus level. After intersecting the prospect northern bounding fault at 5363mSS before intersecting this lower target, the well was sidetracked to test the T. longus sands.

The Top of the Latrobe Group, N-1.4 coal and N-1.9 coal were intersected 33m high, 9m high and 27m high respectively. The Latrobe Group consists of fluvial sands, shales and coals of N. asperus to T. longus age.

A number of gas and oil accumulations were intersected in the N. asperus to L. balmei stratigraphics zone over the interval 1665.0-2043.3mSS, however only 4 are considered to be significant accumulations. These are:-

1. *N-1.9 Gas Reservoir* - underlies the N-1.9 coal marker horizon and consists of 10m of clean net gas sands with an oil-water contact of 1674.7mSS.

2. *M-1 Oil Reservoir* - intersected in the sidetrack well only and occurs in the M. diversus coastal plain sequence, consisting of 2.9m (net) of base sealed net oil sand.

3. *M-2 Oil Reservoir* - the major oil reservoir, consisting of 13.1m (net) of oil reservoired in clean fluvial sandstone, lying directly beneath the M-1 coastal plain section. An oil water contact was intersected at 1731.3mSS. Oil recovered in RFT samples has a low GOR and high pour point.

4. *Sub-Volcanic Oil Reservoir* - sealed by shales directly underlying volcanics at approximately 2000mSS. The reservoir contains 3.7m of net oil with an oil-water contact at 2043.3mSS.

Other oil and gas accumulations tend to be thin, of limited lateral extent (not able to be correlated between wells) and have high water saturations.

Moonfish-1 was plugged and abandoned as a new field oil and gas discovery well.

FIGURES

LOCALITY MAP
MOONFISH-1, 1ST

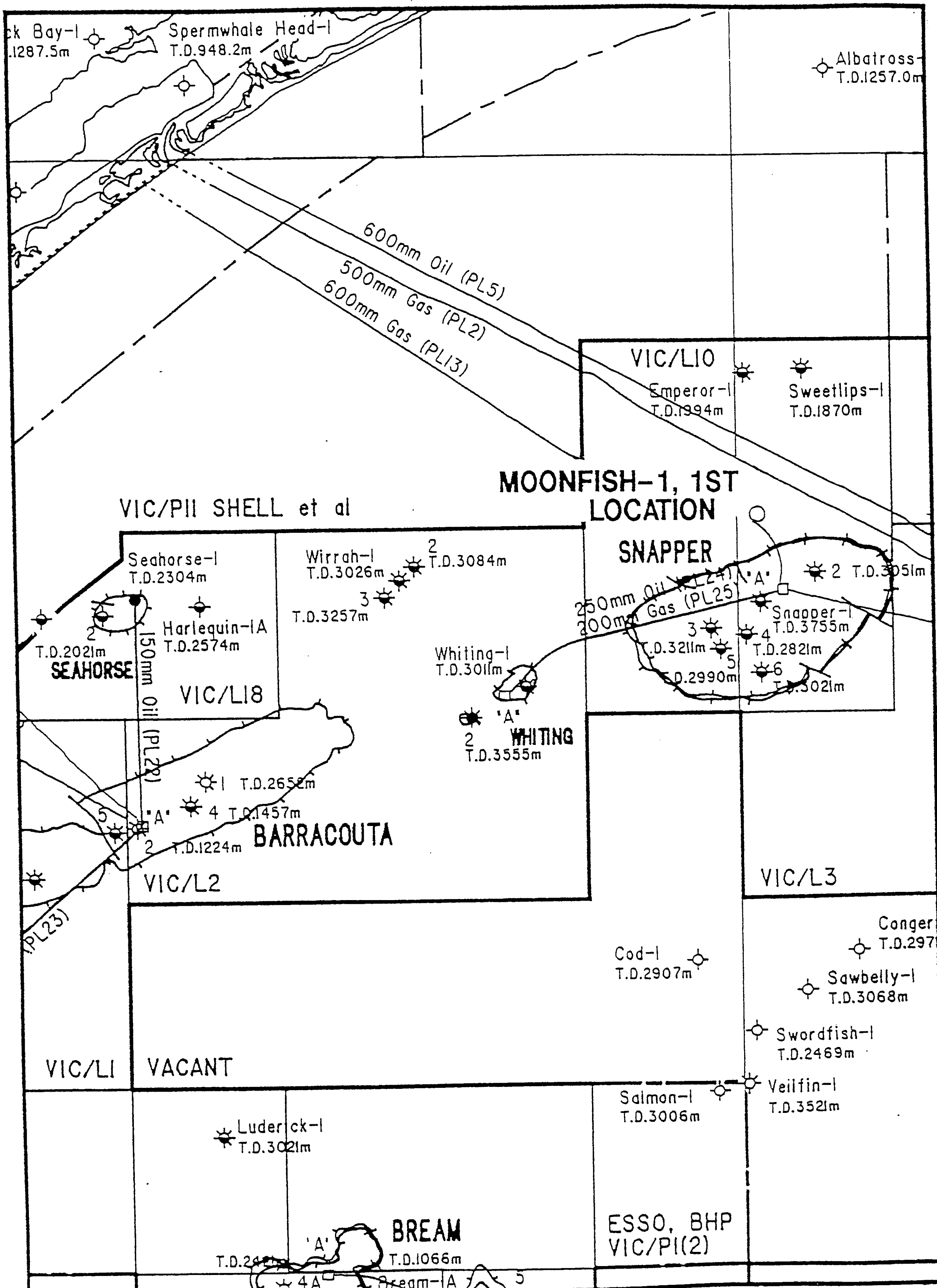

FIGURE 1

DWG. 2484/OP/15

APPENDIX 1

APPENDIX 1

PALYNOLOGICAL ANALYSIS OF MOONFISH-1 AND MOONFISH-1, SIDETRACK-1 GIPPSLAND BASIN

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TABLE-2: INTERPRETED DATA MOONFISH-1, SIDETRACK-1

CONFIDENCE RATINGS

INTRODUCTION

A total of 58 palynological samples have been analysed from the Moonfish-1 well. From the original Moonfish-1 hole 4 conventional core samples and 26 cuttings samples were analysed. From the Moonfish-1, Sidetrack-1 hole 21 sidewall cores and 7 cuttings samples were analysed.

A set of four urgent samples were processed at the Department of Geography at Monash University on 18 June 1992. All other samples were processed in Perth by Laola Pty Ltd between June and August 1992. From the cuttings and conventional cores approximately 15 or 20 grams of sample was processed, while from the sidewall cores, because of their limited size, between 7 and 16 grams (average 11g) of sample was processed. Overall residue yields from the samples was moderate to high, palynomorph concentration mostly moderate and preservation poor to fair.

In the Latrobe Group and basal Seaspray Group average spore-pollen diversity was 22+ species in the sidewall cores, 18+ species in the cuttings and a low 10 species in the conventional core samples. Microplankton diversity was consistently very low from the Latrobe Group with the most consistent species being caved or interpreted as contamination. In contrast the two sidewall cores from the Seaspray Group both contained moderate diversity assemblages. From the Kipper Shale of the Golden Beach Group *insitu* spore-pollen diversity averaged a low 9 species while associate microplankton averaged 5 species per sample.

Lithological units and palynological zones from the base of the Lakes Entrance Formation to Total Depth are given in the following summary. The interpretative data with zone identifications and Old and New Confidence Ratings are recorded in Tables 1 and 2 and basic data on residue yields, preservation and diversity are recorded in Tables 3 to 5. All species that could be identified with binomial names (and which are not obviously caved species) are tabulated on the six accompanying range charts for spore-pollen and microplankton. Relinquishment lists for palynological slides and residues from samples analysed in the original Moonfish-1 and the Sidetrack-1 are provided at the end of the report.

All depths given in the report are measured depths in the respective boreholes. No summary is provided of data as TVDSS (True Vertical Depth Subsea).

PALYNOLOGY SUMMARY FOR MOONFISH-1 AND SIDETRACK-1

ALL DEPTHS ON SUMMARY ARE MEASURED DEPTHS IN RESPECTIVE BOREHOLES

AGE	UNIT/FACIES	MOONFISH-1		SIDETRACK-1	
		SPORE-POLLEN ZONES (MICROPLANKTON ZONES)	DEPTHS (mKB)	SPORE-POLLEN ZONES (MICROPLANKTON ZONES)	DEPTHS (mKB)
MIOCENE?	SEASPRAY GROUP	NOT SAMPLED		*P. tuberculatus*	1548-1603
MIDDLE EOCENE	LATROBE GROUP Undifferentiated coastal plain facies of sands, shales & coals	NOT SAMPLED		Lower *N. asperus*	1662
EARLY EOCENE				Upper *M. diversus*	1699
EARLY EOCENE				Lower *M. diversus*	1872-1913
LATE PALEOCENE				Upper *L. balmei*	1971-2017
EARLY PALEOCENE		Lower *L. balmei*	2135-2315	Lower *L. balmei*	2093-2338
MAASTRICHTIAN		Upper *T. longus*	2450-2530	Upper *T. longus*	2415-2575
MAASTRICHTIAN		NOT INTERSECTED		Lower *T. longus*	2664-2670
CAMPANIAN				*T. lilliei*	2725-2755
CONIACIAN TO TURONIAN	GOLDEN BEACH GROUP Kipper Shale	*P. mawsonii* (*R. kipperii*)	2680-3040 (2680-3040)	NOT PENETRATED	

GEOLOGICAL COMMENTS

1. The oldest rocks penetrated in the Moonfish-1 well were intersected in the original deviated hole between approximately 2625m to T.D. The thick predominantly shaly unit over this interval was found to have a Coniacian to Turonian age based on a characteristic lacustrine algae assemblage referred to the *R. kipperii* Microplankton Zone. The associate spore-pollen assemblage is referred to the *P. mawsonii* Zone. The unit is therefore correlated with the Kipper Shale formation within the Golden Beach Group.

2. Two sets of cuttings from within the above Kipper Shale gave a spurious younger age and are now considered to have been poorly collected as they are dominated by down-hole cavings.

   The samples concerned at 2650-55m and 2770-75m were independently processed by the author (cuttings A) and Laola Pty Ltd (cuttings B) as urgent samples while the well was drilling. Both sets of cuttings gave good yields of diverse, well preserved spore-pollen assemblages which were confidently assigned to the Upper *T. longus* Zone. However cuttings samples processed subsequently have in marked contrast yielded good *P. mawsonii* and *R. kipperii* Zone assemblages as shallow as 2680m. The latter assemblages display a noticeable maturation increase reflected in a darkening or carbonisation of the spore-pollen compared to the overlying Upper *T. longus* and Lower *L. balmei* Zones. Based on this difference in maturation/carbonisation it is clear that the cuttings assigned to the *P. mawsonii/R. kipperii* Zones are only moderately contaminated with down-hole caving.

   When reinspection of the cuttings at 2650-55m and 2770-75m confirmed the original Upper *T. longus* Zone assemblages without any trace of a darker carbonised component it was surmised that these urgent samples, which were sent from the rig <u>before</u> they were washed and dried, had been poorly collected and are badly contaminated with down-hole cavings.

3. The algal cysts in the Kipper Shale in Moonfish-1 are dominated by the species *Rimosicysta concava, R. cucullata* and *Wuroia corrugata* which were described from Sunfish-1. The association of these three species has not been recorded from either Kipper-1 (Marshall, 1989) or Admiral-1 (Partridge, 1990b). Although there may be some environmental control which could explain the absence of this association from the latter wells it is considered more likely that the Kipper Shale intersected in Sunfish-1 and Moonfish-1 is stratigraphically **<u>either</u>** younger or older than the Kipper Shale intersected in Kipper-1 and Admiral-1.

4. Due to drilling difficulties sidewall cores were only shot in Sidetrack-1. Whilst coverage is adequate, but not good, through the Late Cretaceous and Palaeocene it is clearly inadequate to identify all the zones likely to be present in Eocene section from 1971m (top *L. balmei* Zone sample) to the top of the Latrobe Group at 1606m. Only 4 samples were available for analysis over this 365 metre interval which is likely to encompass 7 spore-pollen zones. These zones could be identified by selectively sampling the cuttings, especially the coals. The latter lithology tends to wash out the mud system fairly quickly and by using density separation techniques can be floated off from the other cuttings lithologies in the laboratory to give reasonably depth reliable samples for analysis.

5. Another interval worthy of additional analysis on cuttings is between 2338m (base of *L. balmei* Zone) to 2415m (top of *T. longus* Zone) as this interval must contain the K/T (Cretaceous/Tertiary) boundary. Better locating this boundary is important as a datum horizon for cross-sections and for correlation across the basin. From inspection of the gamma/bulk density/neutron porosity logs it is considered likely the boundary should lie in the shale package between 2401-2415m.

6. Because of the limited sampling the important *A. hyperacanthum* dinoflagellate Zone was not found. It should be present as it was found in the Sweetlips-1 well to the immediate north and more landward of Moonfish-1. The predominantly spore-pollen assemblages recorded from the sidewall core at 1913m is similar to the spore-pollen assemblage from the *A. hyperacanthum* Zone in Sweetlips-1 but lacks diagnostic dinoflagellates. It is suggested that in Sidetrack-1 the *A. hyperacanthum* Zone should lie within the shaly package between 1919-1939m. This shale is the most likely candidate for the "condensed marine section" associated with the zone as it lacks coals in contrast to the overlying and underlying shaly units.

7. The sidewall core at 1872m is unusual as it contained a suite of algae which are similar to those found in the Kipper Shale. It is interpreted to represent a fresh water lake. As the shale sampled is less than 8 metres thick (1865.6-1873m) and lie below a 1.5 metre coal it is likely the lake was of only short duration and therefore fairly local.

8. The Gurnard Formation was not sampled in Moonfish-1 but on log character it is likely to lie between 1605.5-1611.5m or 1605.5-1620.5m.

BIOSTRATIGRAPHY

Zone and age determinations are based on the spore-pollen zonation scheme proposed by Stover & Partridge (1973), partially modified by Stover & Partridge (1982) and Helby, Morgan & Partridge (1987), and a dinoflagellate zonation scheme which has only been published in outline by Partridge (1975, 1976). Other modifications and embellishments to both zonation schemes can be found in the many palynological reports on the Gippsland Basin wells drilled by Esso Australia Ltd. Unfortunately this work is not collated or summarised in a single report.

Author citations for most spore-pollen species can be sourced from Stover & Partridge (1973, 1982), Helby, Morgan & Partridge (1987) or other references cited herein. Author citations for dinoflagellates can be found in Lentin & Williams (1985, 1989). Species names followed by "ms" are unpublished manuscript names. Note also that certain zone names have not been altered to conform with recent nomenclature changes to nominated species such as *Forcipites* (al. *Tricolpites*) *longus* (Stover & Evans) Dettmann & Jarzen 1988.

Phyllocladidites mawsonii Zone	**Coniacian**
and	**to**
Rimosicysta kipperii **Microplankton Zone**	**Turonian.**

Spore-pollen assemblages characteristic of the *P. mawsonii* Zone in association with the highly characteristic algal cyst assemblages of the *R. kipperii* Microplankton Zone were found in the original Moonfish-1 hole where they are recorded in 10 cuttings samples between 2680-3040m.

The spore-pollen recorded on Chart 3 are those species considered to be *insitu* and not caved from higher in the well. Although individual samples have a low average diversity of 9+ species of spore-pollen the overall diversity in the zone (excluding obvious caved or reworked species) is high with 38 species recorded. Species considered restricted to or ranging no younger than this zone are unfortunately very rare and are considered to only be represented by *Rugulatisporites admirabilis* ms (at 2810m), *Interulobites intraverrucatus* (at 2680m) and the small variety of *Dilwynites granulatus* which was recorded from about half of the samples. The assemblages can, however, also be characterised by *P. mawsonii* in 80% of the samples, and the consistent presence of *Cyathidites australis*, *Cicatricosisporites* spp., *Corollina torosa* and the more frequent occurrence of reworked Permian spore-pollen than is typical of the overlying Latrobe Group sediments. Although some of these species are known to range into younger rocks the specimens recorded are considered to come from this section because they are more carbonised and therefore darker than specimens found in the overlying Upper *T. longus* and *L. balmei* Zones in Moonfish-1.

The microplankton assemblages are dominated by the algal cysts *Rimosicysta* spp. and *Wuroia* spp. characteristic of the Kipper Shale. Diversity in individual samples is very low at 5 species but overall diversity is moderate at 14 species. The eponymous species *R. kipperii* is present in 4 of the samples but more consistent is the occurrence of *R. concava*, *R. cucullata* and *Wuroia corrugata* which are recorded from Sunfish-1 but not from the "type" section of the Kipper Shale in Kipper-1 (Marshall, 1989).

***Tricolporites lilliei* Zone** **Late Campanian.**

The *T. lilliei* spore-pollen Zone is recorded from two sidewall cores and a cuttings sample over the interval 2752-2765m in Sidetrack-1. The samples contain the characteristic species *Tricolporites lilliei*, *Triporopollenites sectilis* and frequent to common *Nothofagidites senectus* but lack *T. longus* Zone indicators. The presence of *Forcipites stipulatus* Dettmann & Jarzen 1988 at 2752m which is not considered to range above the *T. lilliei* Zone is used to favour this zone assignment against a younger age based on the common occurrence of *Gambierina rudata* in the sample. The latter species is more typically abundant in the younger *T. longus* Zones.

The deepest cuttings sample at 2801m appears dominated by caved specimens and is best considered indeterminate, while the limited assemblage recorded from SWC-3 at 2730m is also zone indeterminate. The few microplankton recorded over the interval 2730-2801m are considered to be either caved or contaminants.

Lower *Tricolpites longus* Zone **Maastrichtian.**

The two samples referred to the Lower *T. longus* Zone in Sidetrack-1 between 2664-2670 metres are assigned on the presence of *Forcipites* (al. *Tricolpites*) *longus* and *Tetracolporites verrucosus* before the first or oldest appearance of *Stereisporites* (*Tripunctisporis*) sp. The assemblages are dominated by *Proteacidites* spp. *Phyllocladidites mawsonii* and *Stereisporites antiquisporites*. The algae sphere *Pseudoschizaea circula* at 2664m is the only *insitu* microplankton species recorded.

Upper *Tricolpites longus* Zone **Maastrichtian.**

The Upper *T. longus* Zone is recorded from 8 cuttings samples in the original Moonfish-1 hole and from 2 cuttings and 2 sidewall core samples in Sidetrack-1.

In the original hole the zone is recognised between 2450-2530m. The duplicate cuttings samples at 2650-55m (A&B) and 2770-75m (A&B) are interpreted as completely caved, and although assigned to this zone are stratigraphically out-of-place.

In the Sidetrack-1 the zone is recognised between 2415-2499m. In both holes the base of the zone is picked on the oldest occurrence of *S. (Tripunctisporis)* sp. and the top of the youngest occurrence of *F. longus*. The assemblages are also characterised by frequent to abundant *Gambierina rudata*. Other key index species for picking top of the zone are *Proteacidites otwayensis* ms, *P. reticuloconcavus* ms, *P. prepolus* ms and *Tetradopollis securus* ms.

All microplankton recorded in the samples are considered to be caved.

Lower *Lygistepollenites balmei* Zone **Early Paleocene.**

The Lower *L. balmei* Zone is recorded in the original Moonfish-1 hole from conventional core and cuttings samples over the interval 2135-2315m. It probably extends deeper to 2375m but the three cuttings samples between 2335-2375m lack diagnostic species of the Lower subzone and correctly can only be assigned to the broader *L. balmei* Zone.

In the Sidetrack-1 the zone is recorded from 3 sidewall cores and a single cuttings sample between 2093-2338m. An additional two sidewall cores within this interval only gave indeterminate assemblages.

In both holes the top of the zone is picked on the youngest occurrence of *Proteacidites angulatus* and/or *Tetracolporites verrucosus* whilst the base of the zone is picked on the oldest occurrence of *P. angulatus* or on the youngest occurrence of Upper *T. longus* Zone indicator species. Other accessory species whose presence increases the confidence of the zone assignment include *Australopollis obscurus, Integricorpus antipodus* ms and *Polycolpites langstonii*. There are also other species which range through the broader *L. balmei* Zone that are nevertheless characterised by their abundance and consistent occurrence. These include *Lygistepollenites balmei, Nothofagidites endurus* and *Gambierina rudata*. Finally there are a few species whose FADs (First Appearance Datums) are within the Lower *L. balmei* Zone. In the Sidetrack-1 hole, where FADs can be reliably picked in the sidewall cores, these are *Haloragacidites harrisii, Malvacipollis subtilis* and *Proteacidites adenanthoides* at 2096m and *Verrucosisporites kopukuensis* at 2051m.

Although microplankton occur sporadically through the zone as displayed on Charts 2 & 6 virtually all are considered to represent specimens orignally from the Seaspray Group which are either caved in the cuttings or introduced by mud contamination into the sidewall cores.

Upper *Lygistepollenites balmei* Zone **Late Paleocene.**

The Upper *L. balmei* Zone is recorded in two sidewall cores in the Sidetrack-1 over the interval 1971-2017m.

The deeper sample is assigned to the zone on the FAD for *Anacolosidites acutullus* while the shallow sample contains the important FADs for *Proteacidites annularis* and *P. grandis*. Both samples clearly are no younger than this zone based on the common occurrence of *Lygistepollenites balmei* and the rare occurrence of *Gambierina rudata* which range no younger than this zone.

The general spore-pollen assemblage composition are similar to those in the underlying Lower *L. balmei* Zone, and the dinoflagellates recorded from the deeper sidewall core are all considered to be contamination derived from the Seaspray Group via the drilling mud.

Lower *Malvacipollis diversus* Zone **Early Eocene.**

The Lower *M. diversus* Zone is recorded only in the Sidetrack-1 in two sidewall cores at 1872m and 1913m. Both samples contain common *Dilwynites granulatus* (12-18% of spore-pollen count), abundant fungal spores and hypae (28-52% of total count) as well as the eponymous species *Malvacipollis diversus*, but otherwise are quite distinct and are discussed separately.

The sidewall core at 1872m is dominated by a low diversity microplankton suite which comprises 40% of total palynomorph count. The assemblage consists predominantly of poorly preserved algae referred to *Rimosicysta* n.sp. (46% of microplankton count); a small diaphanous dinoflagellate species whose presence is recognised by its cingulum and occurrence of accumulation bodies within the cysts (39%); and finally, poorly preserved *Saeptodinium* sp. These microplankton are interpreted to indicate a lacustrine environment as there are no known marine dinoflagellates present in the assemblage. The associate spore-pollen assemblage is fairly non-descript but contains no species which would suggest an age younger than the Lower *M. diversus* Zone.

The sidewall core at 1913m is characterised by spores which could be considered "typical" of the marine condensed section found at the base of the Lower *M. diversus* Zone. The spores are *Crassiretitriletes vanraadshoovenii*, *Cyathidites gigantis* and *Polypodiaceoisporites varus* ms. Unfortunately the associated dinoflagellates consisting of *Deflandrea obliquipes* and *Spiniferites ramosa* are not diagnostic. Overall the assemblage is similar to the basal sample from the Lower *M. diversus* Zone in Sweetlips-1 which contains the *A. hyperacanthum* dinoflagellate Zone (see Partridge, 1990a).

Upper *Malvacipollis diversus* Zone **Early Eocene.**

A single sidewall core from Sidetrack-1 at 1699m can be assigned to the Upper *M. diversus* Zone on the presence of *Proteacidites pachypolus* (2%) and *Santalumidites cainozoicus*. The latter species suggests a position high in this zone and could perhaps indicate possible assignment of this sample to the younger *P. asperopolus* Zone. Although the sample contains a high diversity assemblage (34+ species) it lacks key species such as *Myrtaceidites tenuis*, and the abundance of species are not particularly diagnostic. The assemblage is dominated by fungal spores and hypae 38% (of total count) and *Proteacidites* spp. 62% (of spore-pollen count), while spores (3%) and gymnosperm pollen (<1%) are negligible. Other types or groups often typical of the Early Eocene were not significant. For instance, *Casuarina* pollen (=*Haloragaecidites harrisii*) was <2%, while *Malvacipollis* spp. was not recorded in the count, and *Nothofagidites* spp. was about 8%. The dinoflagellates recorded in the sample are most likely contaminants.

Lower *Nothofagidites asperus* Zone **Middle Eocene.**

A single sidewall core sample from the Sidetrack hole at 1662m is assigned with low confidence to the Lower *N. asperus* Zone on the dominance of *Nothofagidites* spp. (55%) and scarcity of Casuarina pollen (<2%). Although the assemblage recorded is of high diversity (32+ species) it lacks key species for the zone. The presence of *Proteacidites pachypolus* which usually indicates an age no younger than the Lower *N. asperus* Zone is favoured against the occurrence of *Verrucosisporites cristatus* which is usually indicative of the younger Middle *N. asperus* Zone. All the dinoflagellates recorded are considered contaminants from the overlying Seaspray Group in spite of the seemingly clean nature of the sidewall core sample. Undoubtedly there was some unrecognised mud penetration of the sample.

***Proteacidites tuberculatus* Zone** **Miocene?**

Two sidewall cores between 1548-1603 metres in Sidetrack-1 are confidently assigned to the *P. tuberculatus* Zone on the occurrence in both samples of the key spores *Cyatheacidites annulatus*, *Foveotriletes crater* and *F. lacunosus*. The occurrence of *F. lacunosus* which is in association with *Guettardidites ivirensis* Khan 1976 (= cf *Reticulataepollis* sp. of Partridge 1971), *Foraminisporis ozotus* ms and *Cyperacea* pollen from the shallower sample further suggests that both samples can be assigned to the Middle or Upper subdivisions of the *P. tuberculatus* Zone (Stover & Partridge 1973, p.243).

The samples were dominated by microplankton (69-73%) but still contained high diversity spore-pollen assemblages with a composite 38 species recorded. The microplankton were of moderate diversity with a composite 16 species recorded and were dominated by *Spiniferites* spp. (51-71%). Other common species are *Operculodinium centrocarpum* (4-7%) and *Protoellipsodinium simplex* ms (6-11%) both of which are considered characteristic of the informal "*Operculodinium* spp." microplankton association.

The presence of the dinoflagellate cyst *Tuberculodinium vancompoae* at 1603m suggest a Miocene age which is consistent with the identification of foraminiferal zones F and G at the base of the Seaspray Group over the adjacent Snapper field.

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TABLE-1: INTERPRETATIVE PALYNOLOGICAL DATA FOR MOONFISH-1, GIPPSLAND BASIN.

Sheet 1 of 2

SAMPLE TYPE	DEPTH (m)	SPORE-POLLEN ZONES	*CR OLD	*CR NEW	MICROPLANKTON ZONES	*CR OLD	*CR NEW	COMMENTS
Cuttings	2135.0	Lower *L. balmei*	3	D2				*Tetracolporites verrucosus* present.
Cuttings	2175.0	Lower *L. balmei*	3	D2				Fungal spore *Pesavis* present.
Cuttings	2215.0	*L. balmei*	3	D2				
Cuttings	2235.0	*L. balmei*	3	D2				*Integricorpus antipodus* ms present.
Core-2	2264.2	Indeterminate						Virtually barren.
Core-2	2273.6	*L. balmei*	1	A3				Palynomorphs degraded.
Core-4	2292.2	Lower *L. balmei*	2	A3				*Proteacidites angulatus* present.
Core-4	2297.3	Lower *L. balmei*	1	A2				*Proteacidites angulatus* 42%.
Cuttings	2315.0	Lower *L. balmei*	3	D2				Frequent *Australopollis obscurus*.
Cuttings	2335.0	*L. balmei*	3	D2				Caved palynomorphs common.
Cuttings	2360.0	*L. balmei*	3	D2				
Cuttings	2375.0	*L. balmei*	3	D2				
Cuttings	2450.0	Upper *T. longus*	3	D2				LAD *Forcipites longus*.
Cuttings A	2455.0	Upper *T. longus*	4	D5				Common *Gambierina rudata*.
Cuttings	2525.0	Upper *T. longus*	3	D3				Zone indicators rare.
Cuttings A	2530.0	Upper *T. longus*	4	D5				Several specimens of *G. rudata*.
Cuttings A	2650-55	Upper *T. longus*	3	D3				Sample interpreted as all caved.
Cuttings B	2650-55	Upper *T. longus*	3	D2				Sample interpreted as all caved.
Cuttings	2680.0	*P. mawsonii*	3	D3	*R. kipperii*	4	D5	*Interulobites intraverrucatus* present
Cuttings	2750.0	*P. mawsonii*	3	D3	*R. kipperii*	3	D3	LAD *Rimosicysta kipperii*.
Cuttings	2760.0	*P. mawsonii*	3	D3	*R. kipperii*	4	D5	

TABLE-1: INTERPRETATIVE PALYNOLOGICAL DATA FOR MOONFISH-1, GIPPSLAND BASIN.

Sheet 2 of 2

SAMPLE TYPE	DEPTH (m)	SPORE-POLLEN ZONES	*CR OLD	*CR NEW	MICROPLANKTON ZONES	*CR OLD	*CR NEW	COMMENTS
Cuttings A	2770-75	Upper *T. longus*	3	D2				Sample all caved!
Cuttings B	2770-75	Upper *T. longus*	3	D1				Sample all caved!
Cuttings	2790.0	*P. mawsonii*	3	D3	*R. kipperii*	4	D5	
Cuttings	2810.0	*P. mawsonii*	3	D3	*R. kipperii*	3	D3	*Rugulatisporites admirabilis* ms present.
Cuttings	2830.0	*P. mawsonii*	4	D5	*R. kipperii*	3	D3	*R. kipperii* present.
Cuttings	2850.0	*P. mawsonii*	3	D2	*R. kipperii*	3	D3	Common *Rimosicysta* spp.
Cuttings	2950.0	*P. mawsonii*	3	D2	*R. kipperii*	3	D3	Common *Wuroia corrugata*.
Cuttings	3015.0	*P. mawsonii*	3	D3	*R. kipperii*	3	D3	Common *Rimosicysta* spp.
Cuttings	3040.0	*P. mawsonii*	4	D5	*R. kipperii*	4	D5	

* CR = Confidence Ratings OLD & NEW
LAD = Last Appearance Datum

Cuttings A = Processed at Monash University.
Cuttings B = Processed by Laola Pty Ltd.

TABLE-2: INTERPRETATIVE PALYNOLOGICAL DATA FOR MOONFISH-1 SIDETRACK, GIPPSLAND BASIN.

SHEET 1 OF 2

SAMPLE TYPE	DEPTH (m)	SPORE-POLLEN ZONES	*CR OLD	*CR NEW	MICROPLANKTON ZONES (OR ASSOCIATION)	*CR OLD	*CR NEW	COMMENTS
SWC 37	1548	*P. tuberculatus*	0	B1	(*Operculodinium* spp.)	0	B2	Microplankton 69%.
SWC 36	1603	*P. tuberculatus*	0	B1	(*Operculodinium* spp.)	0	B2	Microplankton 73%.
SWC 33	1662	Lower *N. asperus*	2	B4				*Proteacidites pachypolus* present.
SWC 32	1699	Upper *M. diversus*	1	B4				FAD *Santalumidites cainozoicus*
SWC 30	1872	Lower *M. diversus*	1	B4				Microplankton 40%
SWC 29	1913	Lower *M. diversus*	1	B2				Fungal spores & hypae 52%
SWC 26	1971	Upper *L. balmei*	1	B1				*Proteacidites grandis* present.
SWC 24	2017	Upper *L. balmei*	1	B4				*Anacolosidites acutullus* present.
SWC 23	2033	Indeterminate						Meagre yield.
SWC 21	2051	*L. balmei*	1	B1				Subzone uncertain.
SWC 19	2093	Lower *L. balmei*	1	B1				LAD *Proteacidites angulatus*.
SWC 18	2096	Lower *L. balmei*	1	B1				*Nothofagidites* spp. 18.5%.
SWC 15	2250	Indeterminate						
SWC 14	2263	Indeterminate						Virtually barren.
CUTTINGS	2335	Lower *L. balmei*	3	D2				
SWC 11	2338	Lower *L. balmei*	1	B2				*Tetracolporites verrucosus*.
CUTTINGS	2415	Upper *T. longus*	3	D2				LAD *Forcipites longus*.
SWC 8	2441	Upper *T. longus*	1	D2				*Gambierina rudata* common.
CUTTINGS	2490	*T. longus*	3	D4				Limited assemblage.
SWC 7	2499	Upper *T. longus*	1	B2				*G. rudata* common.
CUTTINGS	2575	Upper *T. longus*	3	D2				*G. rudata* common.

TABLE-2: **INTERPRETATIVE PALYNOLOGICAL DATA FOR MOONFISH-1 SIDETRACK, GIPPSLAND BASIN.**

SAMPLE TYPE	DEPTH (m)	SPORE-POLLEN ZONES	*CR OLD	*CR NEW	MICROPLANKTON ZONES (OR ASSOCIATION)	*CR OLD	*CR NEW	COMMENTS
SWC 4	2664	Lower *T. longus*	1	B2				*F. longus* & *T. verrucosus* both present.
CUTTINGS	2670	Lower *T. longus*	3	D5				*F. longus* present.
SWC 3	2730	Indeterminate						SWC contaminated.
SWC 2	2752	*T. lilliei*	1	B2				*Forcipites stipulatus* present.
CUTTINGS	2755	*T. lilliei*	3	D4				
SWC 1	2765	*T. lilliei*	1	B1				FAD *Tricolporites lilliei.*
CUTTINGS	2801	Indeterminate						Dominated by caved species.

* CR = Confidence Ratings OLD & NEW
LAD = Last Appearance Datum
FAD = First Appearance Datum

CONFIDENCE RATINGS

The concept of Confidence Ratings applied to palaeontological zone picks was originally proposed by Dr. L.E. Stover in 1971 to aid the compilation of micropalaeontological and palynological data and to expedite the revision of the then rapidly evolving zonation concepts in the Gippsland Basin. The original or OLD scheme which mixes confidence in fossil species assemblage with confidence due to sample type has gradually proved to be rather limiting as additional refinements to existing zonations have been made. With the development of the STRATDAT computer database as a replacement for the increasingly unwieldy paper based Palaeontological Data Sheet files a NEW set of Confidence Ratings have been proposed. Both OLD and NEW Confidence Ratings for zone picks are given on Table 1, and their meanings are summarised below:

OLD CONFIDENCE RATINGS

0 SWC or CORE, Excellent Confidence, assemblage with zone species of spore, pollen and microplankton.

1 SWC or CORE, Good Confidence, assemblage with zone species of spores and pollen or microplankton.

2 SWC or CORE, Poor Confidence, assemblage with non-diagnostic spores, pollen and/or microplankton.

3 CUTTINGS, Fair Confidence, assemblage with zone species of either spore and pollen or microplankton, or both.

4 CUTTINGS, No Confidence, assemblage with non-diagnostic spores, pollen and/or microplankton.

NEW CONFIDENCE RATINGS

Alpha codes: Linked to sample type

A Core
B Sidewall core
C Coal cuttings
D Ditch cuttings
E Junk basket
F Miscellaneous/unknown
G Outcrop

Numeric codes: Linked to fossil assemblage

1 **Excellent confidence:** High diversity assemblage recorded with key zone species.

2 **Good confidence:** Moderately diverse assemblage recorded with key zone species.

3 **Fair confidence:** Low diversity assemblage recorded with key zone species.

4 **Poor confidence:** Moderate to high diversity assemblage recorded without key zone species.

5 **Very low confidence:** Low diversity assemblage recorded without key zone species.

BASIC DATA

TABLE 3: BASIC SAMPLE AND PALYNOMORPH DATA FOR MOONFISH-1

TABLE 4: BASIC SAMPLE DATA FOR MOONFISH-1, SIDETRACK-1

TABLE 5: BASIC PALYNOMORPH DATA FOR MOONFISH-1, SIDETRACK-1

RELINQUISHMENT LISTS OF PALYNOLOGY SLIDES & RESIDUES

PALYNOMORPH RANGE CHARTS

CHART-1: Spore-pollen in Moonfish-1 between 2135-2775mm

CHART-2: Microplankton in Moonfish-1 between 2135-2775m

CHART-3: Palynomorphs in Moonfish-1 between 2680-3040m

CHART-4: Spore-pollen in Moonfish-1, Sidetrack-1 by Highest Appearance

CHART-5: Spore-pollen in Moonfish-1, Sidetrack-1 by Lowest Appearance

CHART-6: Microplankton in Moonfish-1, Sidetrack-1

TABLE-3: BASIC SAMPLE AND PALYNOMORPH DATA FOR MOONFISH-1, GIPPSLAND BASIN.

SAMPLE TYPE	DEPTH (m)	SAMPLE WT (g)	RESIDUE YIELD	PALYNOMORPH CONCENTRATION	PRESERVATION	No. S-P*	MICROPLANKTON ABUNDANCE	NUMBER OF MP SPECIES*
Cuttings	2135.0	20.0	High	High	Poor-good	22	Rare/caved	1
Cuttings	2175.0	23.0	High	Moderate	Fair-good	21	Very rare	1
Cuttings	2215.0	20.0	Moderate	Low	Fair	12	Rare/caved	4
Cuttings	2235.0	20.0	Moderate	Moderate	Fair	21	Rare/caved	4
Core-2	2264.2	21.3	Moderate	Very low	Poor	4		
Core-2	2273.6	20.6	High	Moderate	Very poor	11		
Core-4	2292.2	22.0	Moderate	Low	Poor-fair	9		
Core-4	2297.3	21.6	High	High	Poor-fair	15		
Cuttings	2315.0	15.0	High	High	Fair	25	Rare/caved	4
Cuttings	2335.0	15.0	High	Moderate	Poor-good	17(6)	Frequent/caved	7
Cuttings	2360.0	15.0	High	Moderate	Fair	21	Frequent/mixed	1(5)
Cuttings	2375.0	15.0	High	Moderate	Fair	18(2)	Frequent/caved	4
Cuttings	2450.0	15.0	High	Low	Fair	15	Rare/caved?	(3)
Cuttings A	2455.0		Moderate	Low	Fair	7		
Cuttings	2525.0	15.0	Moderate	Low	Poor-fair	25	Rare/caved	3
Cuttings A	2530.0		Moderate	Low	Fair	4		
Cuttings A	2650-55		High	Moderate	Fair-good	(12)		
Cuttings B	2650-55	15.0	High	Moderate	Fair	(21)	Rare/caved	(4)
Cuttings	2680.0		High	Moderate	Poor-fair	11(18)	Rare/insitu	4
Cuttings	2750.0		High	Moderate	Poor-fair	10(13)	Rare/insitu	6

TABLE-3: BASIC SAMPLE AND PALYNOMORPH DATA FOR MOONFISH-1, GIPPSLAND BASIN.

SHEET 2 OF 2

SAMPLE TYPE	DEPTH (m)	SAMPLE WT (g)	RESIDUE YIELD	PALYNOMORPH CONCENTRATION	PRESERVATION	No. S-P*	MICROPLANKTON ABUNDANCE	NUMBER OF MP SPECIES*
Cuttings	2760.0	15.0	Low	Moderate	Poor	9(2)	Rare/insitu	4
Cuttings A	2770-75		High	Low	Fair	(21)	Rare/caved	(1)
Cuttings B	2770-75	15.0	High	Moderate	Poor	(29)	Rare/caved	(3)
Cuttings	2790.0	15.0	High	Moderate	Poor-fair	7	Frequent/insitu	4
Cuttings	2810.0	15.0	Moderate	Moderate	Poor-fair	3(5)	Common/insitu	7
Cuttings	2830.0	15.0	High	Low	Poor	7	Rare/insitu	6
Cuttings	2850.0	15.0	Moderate	Moderate	Poor-fair	13	Common	7
Cuttings	2950.0	15.0	Moderate	Moderate	Poor-fair	14	Common	5
Cuttings	3015.0	15.0	Moderate	Moderate	Poor-fair	9	Common	6
Cuttings	3040.0	15.0	Moderate	Low	Poor	8	Rare	2

NOTE: Numbers in brackets in columns for number of spore-pollen and microplankton species are for number of caved species recorded in assemblages. Not all of these species are recorded on the range charts.

***DIVERSITY:**
Very low = 1- 5 species
Low = 6-10 species
Moderate = 11-25 species
High = 26-74 species
Very High = 75+ species

Cuttings A = Processed at Monash University.
Cuttings B = Processed by Laola Pty Ltd.

TABLE-4: BASIC SAMPLE DATA FOR MOONFISH-1 SIDETRACK, GIPPSLAND BASIN.

SHEET 1 OF 1

SAMPLE TYPE	DEPTH (m)	LITHOLOGY	SAMPLE WT (g)	RESIDUE YIELD
SWC 37	1548.0	Med. gry calc. claystone	13.7	Low
SWC 36	1603.0	Med. gry calc. claystone	15.8	Moderate
SWC 33	1662.0	Lt. gry massive claystone	13.4	High
SWC 32	1699.0	Brn waxy claystone	13.9	High
SWC 30	1872.0	Dk gry fissile shale	11.3	High
SWC 29	1913.0	Gry-brn subfissile claystone	10.9	High
SWC 26	1971.0	Lt. gry claystone	11.2	High
SWC 24	2017.0	Gry-brn claystone	9.7	High
SWC 23	2033.0	Lt brn vf-f sandstone	10.4	Very low
SWC 21	2051.0	Gry-brn claystone	10.0	High
SWC 19	2093.0	Gry-brn claystone	7.7	High
SWC 18	2096.0	Brn-gry shale	9.7	High
SWC 15	2250.0	Lt gry subfissile claystone	10.3	Low
SWC 14	2263.0	Lt gry siltstone	11.0	Very low
CUTTINGS	2335.0		15.0	High
SWC 11	2338.0	Gry shale/Brn-gry sandstone	14.4	High
CUTTINGS	2415.0		15.0	High
SWC 8	2441.0	Med-gry shale	8.4	Moderate
CUTTINGS	2490.0		15.0	Moderate
SWC 7	2499.0	Dk brn fissile shale	7.5	High
CUTTINGS	2575.0		15.0	High
SWC 4	2664.0	Dk brn fissile shale	7.8	High
CUTTINGS	2670.0		15.0	Moderate
SWC 3	2730.0	Brn-gry silstone	11.5	Moderate
SWC 2	2752.0	Dk brn fissile shale	13.0	High
CUTTINGS	2755.0		15.0	Moderate
SWC 1	2765.0	Brn-gry fissile shale	9.7	High
CUTTINGS	2801.0		15.0	Moderate

TABLE-5: BASIC PALYNOMORPH DATA FOR MOONFISH-1 SIDETRACK, GIPPSLAND BASIN

SHEET 1 OF 1

SAMPLE TYPE	DEPTH (m)	PALYNOMORPH CONCENTRATION	PRESERVATION	NO. S-P*	MICROPLANKTON ABUNDANCE	NO. MP*
SWC 37	1548	High	Fair-good	28	Abundant	12
SWC 36	1603	High	Good	27	Abundant	13
SWC 33	1662	High	Fair	32	Rare/caved?	5
SWC 32	1699	High	Fair-good	34	Rare/caved?	2
SWC 30	1872	High	Poor-fair	30	Abundant	3
SWC 29	1913	High	Fair-good	25	Rare	2
SWC 26	1971	High	Fair-good	28		
SWC 24	2017	Moderate	Fair	27	Rare/caved	4
SWC 23	2033	Very low	Poor	4		
SWC 21	2051	High	Poor-fair	37		
SWC 19	2093	High	Fair-good	34	Rare/caved	1
SWC 18	2096	Moderate	Fair	29		
SWC 15	2250	Very low	Fair-poor	9	Rare/caved	1
SWC 14	2263	Very low	Poor	2		
CUTTINGS	2335	Moderate	Fair	21	Rare/caved	2
SWC 11	2338	High	Poor-fair	21		
CUTTINGS	2415	Moderate	Fair-good	20		
SWC 8	2441	Low	Poor-fair	15	Rare/caved	1
CUTTINGS	2490	Low	Fair	11	Rare/caved	1
SWC 7	2499	Low	Poor	18		
CUTTINGS	2575	Moderate	Fair	16		
SWC 4	2664	Moderate	Poor	18	Rare	1
CUTTINGS	2670	Low	Poor-very poor	11		
SWC 3	2730	Low	Poor-fair	10		
SWC 2	2752	Moderate	Poor	21		
CUTTINGS	2755	Low	Poor	13	Rare/caved	2
SWC 1	2765	Moderate	Fair	26		
CUTTINGS	2801	Low	Poor	22	Rare/caved	2

*DIVERSITY:
Very low = 1- 5 species
Low = 6-10 species
Moderate = 11-25 species
High = 26-74 species
Very High = 75+ species

RELINQUISHMENT LIST - PALYNOLOGY SLIDES

WELL NAME & NO: MOONFISH-1

PREPARED BY: A.D. PARTRIDGE

DATE: 14 DECEMBER 1992

SHEET 1 OF 2

SAMPLE TYPE	DEPTH (M)	CATALOGUE NUMBER	DESCRIPTION
Cuttings	2135.0	P196102	Kerogen slide sieved fraction
Cuttings	2135.0	P196103	Oxidized slide 2
Cuttings	2135.0	P196104	Oxidized slide 3
Cuttings	2175.0	P196105	Oxidized slide 2
Cuttings	2175.0	P196106	Oxidized slide 3
Cuttings	2215.0	P196107	Oxidized slide 2
Cuttings	2215.0	P196108	Oxidized slide 3
Cuttings	2235.0	P196109	Oxidized slide 2
Cuttings	2235.0	P196110	Oxidized slide 3
Core 2	2264.2	P196111	Kerogen slide 20 micron sieved
Core 2	2264.2	P196112	Oxidized slide 2
Core 2	2264.2	P196113	Oxidized slide 3
Core 2	2264.2	P196114	Oxidized slide 4
Core 2	2273.6	P196115	Oxidized slide 2
Core 2	2273.6	P196116	Oxidized slide 3
Core 2	2273.6	P196117	Oxidized slide 4
Core 2	2273.6	P196118	Oxidized slide 5
Core 4	2292.4	P196119	Oxidized slide 2
Core 4	2292.4	P196120	Oxidized slide 3
Core 4	2292.4	P196121	Oxidized slide 4
Core 4	2297.3	P196122	Kerogen slide 20 micron sieved
Core 4	2297.3	P196123	Oxidized slide 2
Core 4	2297.3	P196124	Oxidized slide 3
Core 4	2297.3	P196125	Oxidized slide 4
Core 4	2297.3	P196126	Oxidized slide 5
Cuttings	2315.0	P196127	Oxidized slide 2
Cuttings	2315.0	P196128	Oxidized slide 3
Cuttings	2315.0	P196129	Oxidized slide 4
Cuttings	2335.0	P196130	Oxidized slide 2
Cuttings	2335.0	P196131	Oxidized slide 3
Cuttings	2335.0	P196132	Oxidized slide 4
Cuttings	2360.0	P196133	Oxidized slide 2
Cuttings	2360.0	P196134	Oxidized slide 3
Cuttings	2360.0	P196135	Oxidized slide 4
Cuttings	2375.0	P196136	Kerogen slide 20 micron sieved
Cuttings	2375.0	P196137	Oxidized slide 2
Cuttings	2375.0	P196138	Oxidized slide 3
Cuttings	2375.0	P196139	Oxidized slide 4
Cuttings	2450.0	P196140	Oxidized slide 2
Cuttings	2450.0	P196141	Oxidized slide 3
Cuttings	2450.0	P196142	Oxidized slide 4
Cuttings A	2455.0	P196143	Oxidized slide 3b (in Silicon Oil)
Cuttings A	2455.0	P196144	Oxidized slide 3a (in Silicon Oil)
Cuttings	2525.0	P196145	Oxidized slide 2
Cuttings	2525.0	P196146	Oxidized slide 3
Cuttings	2525.0	P196147	Oxidized slide 4

RELINQUISHMENT LIST - PALYNOLOGY SLIDES

WELL NAME & NO: MOONFISH-1

PREPARED BY: A.D. PARTRIDGE

DATE: 14 DECEMBER 1992

SHEET 2 OF 2

Cuttings A	2530.0	P196148	Oxidized slide 4a (in Silicon Oil)
Cuttings A	2530.0	P196149	Oxidized slide 4a (in Silicon Oil)
Cuttings A	2650-55	P196150	Oxidized slide 1a (in Silicon Oil)
Cuttings A	2650-55	P196151	Oxidized slide 1b (in Silicon Oil)
Cuttings A	2650-55	P196152	Oxidized slide 1c (in Silicon Oil)
Cuttings B	2650-55	P196153	Oxidized slide 2
Cuttings B	2650-55	P196154	Oxidized slide 3
Cuttings B	2650-55	P196155	Oxidized slide 4
Cuttings	2680.0	P196156	Kerogen slide sieved/unsieved fractions
Cuttings	2680.0	P196157	Oxidized slide 2
Cuttings	2680.0	P196158	Oxidized slide 3
Cuttings	2680.0	P196159	Oxidized slide 4
Cuttings	2750.0	P196160	Kerogen slide sieved/unsieved fractions
Cuttings	2750.0	P196161	Oxidized slide 2
Cuttings	2750.0	P196162	Oxidized slide 3
Cuttings	2750.0	P196163	Oxidized slide 4
Cuttings	2760.0	P196164	Oxidized slide 2
Cuttings	2760.0	P196165	Oxidized slide 3
Cuttings A	2770-75	P196166	Oxidized slide 2a (in Silicon Oil)
Cuttings A	2770-75	P196167	Oxidized slide 2b (in Silicon Oil)
Cuttings A	2770-75	P196168	Oxidized slide 2c (in Silicon Oil)
Cuttings B	2770-75	P196169	Kerogen slide sieved fractions
Cuttings B	2770-75	P196170	Oxidized slide 3
Cuttings B	2770-75	P196171	Oxidized slide 4
Cuttings	2790.0	P196172	Oxidized slide 2
Cuttings	2790.0	P196173	Oxidized slide 3
Cuttings	2790.0	P196174	Oxidized slide 4
Cuttings	2810.0	P196175	Oxidized slide 2
Cuttings	2810.0	P196176	Oxidized slide 3
Cuttings	2810.0	P196177	Oxidized slide 4
Cuttings	2830.0	P196178	Kerogen slide sieved fraction
Cuttings	2830.0	P196179	Oxidized slide 2
Cuttings	2830.0	P196180	Oxidized slide 3
Cuttings	2830.0	P196181	Oxidized slide 4
Cuttings	2850.0	P196182	Oxidized slide 2
Cuttings	2850.0	P196183	Oxidized slide 3
Cuttings	2850.0	P196184	Oxidized slide 4
Cuttings	2950.0	P196185	Oxidized slide 2
Cuttings	2950.0	P196186	Oxidized slide 3
Cuttings	2950.0	P196187	Oxidized slide 4
Cuttings	3015.0	P196188	Oxidized slide 2
Cuttings	3015.0	P196189	Oxidized slide 3
Cuttings	3015.0	P196190	Oxidized slide 4
Cuttings	3040.0	P196191	Kerogen slide 20 micron sieved
Cuttings	3040.0	P196192	Oxidized slide 2
Cuttings	3040.0	P196193	Oxidized slide 3
Cuttings	3040.0	P196194	Oxidized slide 4

RELINQUISHMENT LIST - PALYNOLOGY RESIDUES

WELL NAME & NO: MOONFISH-1

PREPARED BY: A.D. PARTRIDGE

DATE: 14 DECEMBER 1992

SHEET 1 OF 1

SAMPLE TYPE	DEPTH (M)	DESCRIPTION
Cuttings	2135.0	Oxidized residue
Cuttings	2175.0	Oxidized residue
Cuttings	2215.0	Oxidized residue
Cuttings	2235.0	Oxidized residue
Core 2	2264.2	Oxidized residue
Core 2	2273.6	Kerogen residue
Core 4	2292.4	Oxidized residue
Core 4	2297.3	Kerogen residue
Cuttings	2315.0	Kerogen residue
Cuttings	2335.0	Kerogen residue
Cuttings	2360.0	Kerogen residue
Cuttings	2375.0	Oxidized residue
Cuttings	2450.0	Oxidized residue
Cuttings A	2455.0	Oxidized residue
Cuttings	2525.0	Oxidized residue
Cuttings A	2530.0	Oxidized residue
Cuttings A	2650-55	Oxidized residue (in Silicon Oil)
Cuttings A	2650-55	Oxidized residue (in Water)
Cuttings B	2650-55	Oxidized residue
Cuttings	2680.0	Oxidized residue
Cuttings	2750.0	Oxidized residue
Cuttings A	2770-75	Oxidized residue
Cuttings B	2770-75	Oxidized residue
Cuttings	2850.0	Oxidized residue
Cuttings	2950.0	Oxidized residue
Cuttings	3015.0	Oxidized residue
Cuttings	3040.0	Oxidized residue

RELINQUISHMENT LIST - PALYNOLOGY SLIDES

WELL NAME & NO: MOONFISH-1, SIDETRACK-1

PREPARED BY: A.D. PARTRIDGE

DATE: 14 DECEMBER 1992

SHEET 1 OF 3

SAMPLE TYPE	DEPTH (M)	CATALOGUE NUMBER	DESCRIPTION
SWC 37	1548.0	P196195	Kerogen slide sieved/unsieved fractions
SWC 37	1548.0	P196196	Oxidized slide 2
SWC 36	1603.0	P196197	Kerogen slide sieved/unsieved fractions
SWC 36	1603.0	P196198	Oxidized slide 2
SWC 36	1603.0	P196199	Oxidized slide 3 (1/2 cover slip)
SWC 33	1662.0	P196200	Kerogen slide sieved/unsieved fractions
SWC 33	1662.0	P196201	Oxidized slide 2
SWC 33	1662.0	P196202	Oxidized slide 3
SWC 33	1662.0	P196203	Oxidized slide 4
SWC 32	1699.0	P196204	Kerogen slide sieved/unsieved fractions
SWC 32	1699.0	P196205	Oxidized slide 2
SWC 32	1699.0	P196206	Oxidized slide 3
SWC 32	1699.0	P196207	Oxidized slide 4
SWC 30	1872.0	P196208	Kerogen slide sieved/unsieved fractions
SWC 30	1872.0	P196209	Oxidized slide 2
SWC 30	1872.0	P196210	Oxidized slide 3
SWC 30	1872.0	P196211	Oxidized slide 4
SWC 29	1913.0	P196212	Kerogen slide sieved/unsieved fractions
SWC 29	1913.0	P196213	Oxidized slide 2
SWC 29	1913.0	P196214	Oxidized slide 3
SWC 29	1913.0	P196215	Oxidized slide 4
SWC 26	1971.0	P196216	Kerogen slide sieved/unsievedfractions
SWC 26	1971.0	P196217	Oxidized slide 2
SWC 26	1971.0	P196218	Oxidized slide 3
SWC 26	1971.0	P196219	Oxidized slide 4
SWC 24	2017.0	P196220	Kerogen slide sieved/unsieved fractions
SWC 24	2017.0	P196221	Oxidized slide 2
SWC 24	2017.0	P196222	Oxidized slide 3
SWC 24	2017.0	P196223	Oxidized slide 4
SWC 23	2033.0	P196224	Kerogen slide sieved/unsieved fractions
SWC 21	2051.0	P196225	Kerogen slide sieved/unsieved fractions
SWC 21	2051.0	P196226	Oxidized slide 2
SWC 21	2051.0	P196227	Oxidized slide 3
SWC 21	2051.0	P196228	Oxidized slide 4
SWC 19	2093.0	P196229	Kerogen slide sieved/unsieved fractions
SWC 19	2093.0	P196230	Oxidized slide 2
SWC 19	2093.0	P196231	Oxidized slide 3
SWC 19	2093.0	P196232	Oxidized slide 4
SWC 18	2096.0	P196233	Kerogen slide sieved/unsieved fractions
SWC 18	2096.0	P196234	Oxidized slide 2
SWC 18	2096.0	P196235	Oxidized slide 3
SWC 18	2096.0	P196236	Oxidized slide 4
SWC 15	2250.0	P196237	Kerogen slide sieved/unsieved fractions
SWC 15	2250.0	P196238	Oxidized slide 2
SWC 15	2250.0	P196239	Oxidized slide 3 (1/2 cover slip)
SWC 14	2263.0	P196240	Kerogen slide sieved/unsieved fractions

RELINQUISHMENT LIST - PALYNOLOGY SLIDES

WELL NAME & NO: MOONFISH-1, SIDETRACK-1

PREPARED BY: A.D. PARTRIDGE

DATE: 14 DECEMBER 1992

SHEET 2 OF 3

SAMPLE TYPE	DEPTH (M)	CATALOGUE NUMBER	DESCRIPTION
Cuttings	2335.0	P196241	Kerogen slide sieved fractions
Cuttings	2335.0	P196242	Oxidized slide 2
Cuttings	2335.0	P196243	Oxidized slide 3
Cuttings	2335.0	P196244	Oxidized slide 4
SWC 11	2338.0	P196245	Kerogen slide sieved/unsieved fractions
SWC 11	2338.0	P196246	Oxidized slide 2
SWC 11	2338.0	P196247	Oxidized slide 3
SWC 11	2338.0	P196248	Oxidized slide 4
Cuttings	2415.0	P196249	Kerogen slide sieved fraction
Cuttings	2415.0	P196250	Oxidized slide 2
Cuttings	2415.0	P196251	Oxidized slide 3
Cuttings	2415.0	P196252	Oxidized slide 4
SWC 8	2441.0	P196253	Kerogen slide sieved/unsieved fractions
SWC 8	2441.0	P196254	Oxidized slide 2
SWC 8	2441.0	P196255	Oxidized slide 3
SWC 8	2441.0	P196256	Oxidized slide 4
Cuttings	2490.0	P196257	Kerogen slide sieved fraction
Cuttings	2490.0	P196258	Oxidized slide 2
Cuttings	2490.0	P196259	Oxidized slide 3
Cuttings	2490.0	P196260	Oxidized slide 4
SWC 7	2499.0	P196261	Kerogen slide sieved/unsieved fractions
SWC 7	2499.0	P196262	Oxidized slide 2
SWC 7	2499.0	P196263	Oxidized slide 3
SWC 7	2499.0	P196264	Oxidized slide 4
Cuttings	2575.0	P196265	Kerogen slide sieved fraction
Cuttings	2575.0	P196266	Oxidized slide 2
Cuttings	2575.0	P196267	Oxidized slide 3
Cuttings	2575.0	P196268	Oxidized slide 4
SWC 4	2664.0	P196269	Kerogen slide sieved/unsieved fractions
SWC 4	2664.0	P196270	Oxidized slide 2
SWC 4	2664.0	P196271	Oxidized slide 3
SWC 4	2664.0	P196272	Oxidized slide 4
Cuttings	2670.0	P196273	Kerogen slide unsieved fraction
Cuttings	2670.0	P196274	Oxidized slide 2
Cuttings	2670.0	P196275	Oxidized slide 3
Cuttings	2670.0	P196276	Oxidized slide 4
SWC 3	2730.0	P196277	Kerogen slide sieved/unsieved fractions
SWC 3	2730.0	P196278	Oxidized slide 2
SWC 3	2730.0	P196279	Oxidized slide 3
SWC 3	2730.0	P196280	Oxidized slide 4
SWC 2	2752.0	P196281	Kerogen slide sieved/unsieved fractions
SWC 2	2752.0	P196282	Oxidized slide 2
SWC 2	2752.0	P196283	Oxidized slide 3
SWC 2	2752.0	P196284	Oxidized slide 4
Cuttings	2755.0	P196285	Kerogen slide unsieved fraction
Cuttings	2755.0	P196286	Oxidized slide 2
Cuttings	2755.0	P196287	Oxidized slide 3
Cuttings	2755.0	P196288	Oxidized slide 4

RELINQUISHMENT LIST - PALYNOLOGY SLIDES

WELL NAME & NO: MOONFISH-1, SIDETRACK-1

PREPARED BY: A.D. PARTRIDGE

DATE: 14 DECEMBER 1992

SHEET 3 OF 3

SAMPLE TYPE	DEPTH (M)	CATALOGUE NUMBER	DESCRIPTION
SWC 1	2765.0	P196289	Kerogen slide sieved/unsieved fractions
SWC 1	2765.0	P196290	Oxidized slide 2
SWC 1	2765.0	P196291	Oxidized slide 3
SWC 1	2765.0	P196292	Oxidized slide 4
Cuttings	2801.0	P196293	Kerogen slide sieved fraction
Cuttings	2801.0	P196294	Oxidized slide 2
Cuttings	2801.0	P196295	Oxidized slide 3
Cuttings	2801.0	P196296	Oxidized slide 4

RELINQUISHMENT LIST - PALYNOLOGY RESIDUES

WELL NAME & NO: MOONFISH-1

PREPARED BY: A.D. PARTRIDGE

DATE: 14 DECEMBER 1992

SHEET 1 OF 1

SAMPLE TYPE	DEPTH (M)	DESCRIPTION
SWC 37	1548	Kerogen residue
SWC 32	1699	Kerogen residue
SWC 32	1699	Oxidized residue
SWC 30	1872	Kerogen residue
SWC 30	1872	Oxidized residue
SWC 29	1913	Oxidized residue
SWC 26	1971	Oxidized residue
SWC 24	2017	Kerogen residue
SWC 24	2017	Oxidized residue
SWC 21	2051	Kerogen residue
SWC 21	2051	Oxidized residue
SWC 19	2093	Oxidized residue
SWC 18	2096	Kerogen residue
SWC 18	2096	Oxidized residue
Cuttings	2335	Oxidized residue
SWC 11	2338	Oxidized residue
Cuttings	2415	Oxidized residue
SWC 8	2441	Oxidized residue
Cuttings	2490	Oxidized residue
SWC 7	2499	Kerogen residue
SWC 7	2499	Oxidized residue
Cuttings	2575	Oxidized residue
SWC 4	2664	Kerogen residue
SWC 4	2664	Oxidized residue
Cuttings	2670	Oxidized residue
SWC 3	2730	Oxidized residue
SWC 2	2752	Kerogen residue
SWC 2	2752	Oxidized residue
Cuttings	2755	Oxidized residue
SWC 1	2765	Kerogen residue
SWC 1	2765	Oxidized residue
Cuttings	2801	Oxidized residue

PE900468

This is an enclosure indicator page.
The enclosure PE900468 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900468 has the following characteristics:

ITEM_BARCODE = PE900468
CONTAINER_BARCODE = PE900991
NAME = Spore-Pollen Range Chart, 1 of 6
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Spore-Pollen Range Chart, 1 of 6, interval 2135-2775m, Moonfish-1
REMARKS =
DATE_CREATED = 31/12/1992
DATE_RECEIVED =
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR = BIOSTRATA PTY LTD
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE900469

This is an enclosure indicator page.
The enclosure PE900469 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900469 has the following characteristics:

ITEM_BARCODE = PE900469
CONTAINER_BARCODE = PE900991
NAME = Micro-Plankton Range Chart, 2 of 6
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Micro-Plankton Range Chart, 2 of 6, interval 2135-2775m, Moonfish-1
REMARKS =
DATE_CREATED = 31/12/1992
DATE_RECEIVED =
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR = BIOSTRATA PTY LTD
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE900470

This is an enclosure indicator page.
The enclosure PE900470 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900470 has the following characteristics:

ITEM_BARCODE =	PE900470
CONTAINER_BARCODE =	PE900991
NAME =	Palynmorph Range Chart, 3 of 6
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Palynmorph Range Chart, 3 of 6, interval 2680-3040m, Moonfish-1
REMARKS =	
DATE_CREATED =	31/12/1992
DATE_RECEIVED =	
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	BIOSTRATA PTY LTD
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE900471

This is an enclosure indicator page.
The enclosure PE900471 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900471 has the following characteristics:

ITEM_BARCODE = PE900471
CONTAINER_BARCODE = PE900991
NAME = Spore-Pollen Range Chart, 4 of 6
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Spore-Pollen Range Chart, 4 of 6, Moonfish-1/ST1
REMARKS =
DATE_CREATED = 31/12/1992
DATE_RECEIVED =
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR = BIOSTRATA PTY LTD
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE900472

This is an enclosure indicator page.
The enclosure PE900472 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900472 has the following characteristics:

ITEM_BARCODE = PE900472
CONTAINER_BARCODE = PE900991
NAME = Spore-Pollen Range Chart, 5 of 6
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Spore-Pollen Range Chart, 5 of 6, Moonfish-1/ST1
REMARKS =
DATE_CREATED = 31/12/1992
DATE_RECEIVED =
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR = BIOSTRATA PTY LTD
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

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PE900473

This is an enclosure indicator page.
The enclosure PE900473 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900473 has the following characteristics:

ITEM_BARCODE = PE900473
CONTAINER_BARCODE = PE900991
NAME = Micro-Plankton Range Chart, 6 of 6
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Micro-Plankton Range Chart, 6 of 6, Moonfish-1/ST1
REMARKS =
DATE_CREATED = 31/12/1992
DATE_RECEIVED =
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR = BIOSTRATA PTY LTD
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

APPENDIX 2A

APPENDIX 2A

OIL CHARACTERISATION STUDY

MOONFISH-1

Prepared for:

Esso Australia Limited

October 1992

GEOTECH GEOTECHNICAL SERVICES PTY LTD
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Telephone (09) 362 5222
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ACN 050 543 194

OIL CHARACTERISATION STUDY
MOONFISH-1

Introduction

Three oil samples from Moonfish-1, drilled by Esso Australia Ltd in Vic-L-10 in the Gippsland Basin, were analysed geochemically.

The purpose of this study was to characterise the oils in terms of the nature of their source material, to assess their maturity levels and to correlate them.

Analytical Procedure

The following three crudes were received at Geotech's laboratory:

Moonfish-1/ST-1	RFT, 1838.7m
Moonfish-1	RFT, 1914.5m
Moonfish-1	RFT, 2260.5m

API gravities were determined on all three samples and whole oil gas chromatography was run. The oils were subsequently submitted to liquid chromatography to separate saturate, aromatic and NSO compounds. and

GC was performed on the saturate fractions. The saturates were then separated into straight chain and branched/cyclic compounds and analysed by GC–MS. Aromatic fractions were purified by thin layer chromatography and also submitted to GC–MS biomarker analysis.

Analytical results are presented in the following figures and tables:

Type of Analysis	Figure	Table
GC whole oil	1	1
Physical properties and liquid chromatography	–	2
GC saturates	2	3
GC–MS aromatics	3	4
GC–MS branched/cyclics	4	5

Analytical procedures applied are summarised in the Theory and Methods chapter at the back of this report.

General Information

Two copies of this report have been sent to Mr. Adem Djakic of Esso Australia Limited. Any queries related to it may be directed to Dr. Birgitta Hartung–Kagi of Geotechnical Services Pty Ltd.

All data and information are proprietary to Esso Australia Limited and regarded as highly confidential by all Geotech personnel.

Geotechnical Services Pty Ltd shall not be responsible or liable for the results of any actions taken on the basis of the information contained in this study, nor for any errors or omissions in it.

Results and Interpretation

Liquid chromatography data obtained for oils from 1838.7m, 1914.5m and 2260.5m in Moonfish-1 characterise saturate-rich crudes (86.7% to 88.6%) with only very low levels of NSO compounds (2.4% to 3.1%).

GC and GC-MS results indicate that the oils are genetically related and were sourced from mature, terrestrial organic matter.

The overall picture of their GC traces, with prominent odd-even-predominances in the C_{23}+ range, reflect a strong input of higher plant-derived organic material. Pristane/phytane ratios between 6.31 and 6.67 suggest that the source sediment was deposited in an oxic environment.

Source-related biomarker distributions clearly support the GC-based assessment: The samples lack C_{27} steranes and diasteranes which are believed to be of algal/marine origin and are dominated by C_{29} compounds of most likely terrestrial origin. A complete suite of bi-, tri- and tetracyclic diterpanes are present in the oil in high quantities and suggest a strong input of resinous plant materials in the source: 19-norlabdanes, isopimaranes, kauranes, phyllocladanes, beyeranes, 17-nortetracyclanes and rinuanes.

Aromatic biomarker distributions also confirm the high level of terrestrial input, reflected eg in the presence of cadalene and retene.

Maturity parameters are available in the form of both branched/cyclic and aromatic markers. C_{29} 20S/20R ratios of 0.49 (1912.5m), 0.71 (1837.8m) and 0.81 (2260.5m) characterise maturity levels equivalent to approximately 0.6% V_R (1914.5m) and 0.85% to 0.9% V_R, whereas methylphenanthrene indices suggest maturities equivalent to around 1% V_R for all three samples. The measured MPI values are in agreement with other aromatic maturity parameters, like DNR-1 and DNR-6, and believed to be reliable. They are further regarded as being in reasonably good agreement with C_{29} 20S/20R ratios calculated at 1837.8m and 2260.5m. The low sterane value of 0.49 obtained at 1914.5m probably underestimates the true maturity of the crude, which overall is believed to be equivalent to about 0.9% to 1% vitrinite reflectance.

TABLE 1-1

SUMMARY OF WHOLE OIL ANALYSIS

WELL = MOONFISH 1 / ST1	DEPTH 1(m) = 1838.7	DEPTH UNIT = Metres	
COUNTRY = AUS	DEPTH 2(m) = 1838.7	DATE OF JOB =	Sep-92
BASIN = GIPPSLAND			

MOONFISH 1 / ST1, 1838.7m, RFT Oil

COMPOSITION BY CARBON NUMBER

Carbon No.	Rel.Wt%
1 - 3	0.02
4	0.13
5	0.37
6	1.52
7	4.32
8	5.21
9	3.04
10	4.16
11	3.97
12	4.56
13	4.88
14	6.06
15	6.56
16	4.74
17	6.08
18	3.95
19	3.93
20	3.86
21	3.95
22	3.64
23	3.70
24	3.68
25	3.63
26	3.19
27	3.03
28	2.27
29	1.99
30	1.32
31	1.12
32	0.62
33	0.49

COMPOSITION OF C4-C8 FRACTION

Compound	Rel.Wt%
isobutane (A)	0.36
n-butane (B)	0.92
isopentane (C)	1.37
n-pentane (D)	1.82
2,2-dimethylbutane (E)	0.13
cyclopentane (F)	0.43
2,3-dimethylbutane (G)	0.35
2-methylpentane (H)	1.64
3-methylpentane (I)	0.96
n-hexane (J)	3.20
methylcyclopentane (K)	2.39
2,4-dimethylpentane (L)	0.26
benzene (M)	1.69
cyclohexane (N)	4.45
1,1-dimethylcyclopentane (O)	0.51
2-methylhexane (P)	1.44
3-methylhexane (Q)	2.06
1 cis-3-dimethylcyclopentane (R)	0.63
1 trans-3-dimethylcyclopentane (S)	1.11
1 trans-2-dimethylcyclopentane (T)	0.15
n-heptane (U)	5.33
methylcyclohexane (V)	15.81
1 cis-2-dimethylcyclopentane (W)	0.27
toluene (X)	14.57
n-octane (Y)	7.58
ethylbenzene (Z)	2.35
M+P-xylene (AA)	23.61
O-xylene (BB)	4.62

CALCULATED DATA - C12+ FRACTION

Pristane/Phytane	6.53
Pristane/n-C17	0.58
Phytane/n-C18	0.09
TMTD/Pristane	0.49
(C21+C22)/(C28+C29)	1.83

NOTES :

TMTD = Trimethyltridecane

- = Below detection limit or not measured

CALCULATED DATA - C4-C8 FRACTION

Paraffin Index I	1.85
Paraffin Index II	16.92
N/K (Maturity)	1.87
C/D (Maturity)	0.75
J/K (Maturity)	1.34
I/M (Water washing)	0.57
I/J (Biodegradation)	0.30

Paraffin Index I = (P+Q)/(R+S+T)

Paraffin Index II = %U in listed compounds N to V

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TABLE 1-2

SUMMARY OF WHOLE OIL ANALYSIS

WELL = MOONFISH 1
COUNTRY = AUS
BASIN = GIPPSLAND

DEPTH 1(m) = 1914.5
DEPTH 2(m) = 1914.5

DEPTH UNIT = Metres
DATE OF JOB = Sep-92

MOONFISH 1, 1914.5m, RFT Oil

COMPOSITION BY CARBON NUMBER

Carbon No.	Rel.Wt%
1 - 3	0.29
4	0.54
5	0.78
6	2.18
7	5.18
8	4.98
9	3.25
10	4.05
11	4.05
12	4.86
13	4.61
14	5.79
15	6.47
16	4.73
17	6.03
18	3.99
19	3.91
20	3.94
21	3.91
22	3.61
23	3.72
24	3.64
25	3.76
26	2.83
27	2.77
28	1.81
29	1.56
30	1.00
31	0.85
32	0.50
33	0.41

COMPOSITION OF C4-C8 FRACTION

Compound	Rel.Wt%
isobutane (A)	1.33
n-butane (B)	2.81
isopentane (C)	2.54
n-pentane (D)	3.03
2,2-dimethylbutane (E)	0.14
cyclopentane (F)	0.44
2,3-dimethylbutane (G)	0.36
2-methylpentane (H)	1.90
3-methylpentane (I)	1.15
n-hexane (J)	4.02
methylcyclopentane (K)	2.69
2,4-dimethylpentane (L)	0.24
benzene (M)	1.80
cyclohexane (N)	4.63
1,1-dimethylcyclopentane (O)	0.40
2-methylhexane (P)	1.37
3-methylhexane (Q)	2.03
1 cis-3-dimethylcyclopentane (R)	0.61
1 trans-3-dimethylcyclopentane (S)	1.10
1 trans-2-dimethylcyclopentane (T)	0.09
n-heptane (U)	5.24
methylcyclohexane (V)	15.07
1 cis-2-dimethylcyclopentane (W)	0.26
toluene (X)	13.26
n-octane (Y)	6.91
ethylbenzene (Z)	2.20
M+P-xylene (AA)	20.46
O-xylene (BB)	3.92

CALCULATED DATA - C12+ FRACTION

Pristane/Phytane	6.53
Pristane/n-C17	0.60
Phytane/n-C18	0.09
TMTD/Pristane	0.47
(C21+C22)/(C28+C29)	2.39

NOTES :
TMTD = Trimethyltridecane
- = Below detection limit or not measured

CALCULATED DATA - C4-C8 FRACTION

Paraffin Index I	1.89
Paraffin Index II	17.15
N/K (Maturity)	1.72
C/D (Maturity)	0.84
J/K (Maturity)	1.50
I/M (Water washing)	0.64
I/J (Biodegradation)	0.28

Paraffin Index I = (P+Q)/(R+S+T)
Paraffin Index II = %U in listed compounds N to V

TABLE 1-3

SUMMARY OF WHOLE OIL ANALYSIS

WELL = MOONFISH 1	DEPTH 1(m) = 2260.5	DEPTH UNIT = Metres	
COUNTRY = AUS	DEPTH 2(m) = 2260.5	DATE OF JOB =	Sep-92
BASIN = GIPPSLAND			

MOONFISH 1, 2260.5m, RFT Oil

COMPOSITION BY CARBON NUMBER

Carbon No.	Rel.Wt%
1 - 3	-
4	0.40
5	0.54
6	1.73
7	3.83
8	3.43
9	2.10
10	2.63
11	2.97
12	4.05
13	3.77
14	6.00
15	5.76
16	4.58
17	6.09
18	4.49
19	4.55
20	4.34
21	4.48
22	4.24
23	4.27
24	4.15
25	4.64
26	3.76
27	3.77
28	2.79
29	2.55
30	1.50
31	1.32
32	0.73
33	0.56

COMPOSITION OF C4-C8 FRACTION

Compound	Rel.Wt%
isobutane (A)	1.36
n-butane (B)	2.78
isopentane (C)	2.33
n-pentane (D)	2.76
2,2-dimethylbutane (E)	0.16
cyclopentane (F)	0.52
2,3-dimethylbutane (G)	0.33
2-methylpentane (H)	1.59
3-methylpentane (I)	1.04
n-hexane (J)	3.47
methylcyclopentane (K)	2.61
2,4-dimethylpentane (L)	0.24
benzene (M)	3.73
cyclohexane (N)	5.23
1,1-dimethylcyclopentane (O)	0.33
2-methylhexane (P)	1.01
3-methylhexane (Q)	1.58
1 cis-3-dimethylcyclopentane (R)	0.53
1 trans-3-dimethylcyclopentane (S)	0.97
1 trans-2-dimethylcyclopentane (T)	0.09
n-heptane (U)	3.85
methylcyclohexane (V)	13.98
1 cis-2-dimethylcyclopentane (W)	0.24
toluene (X)	17.34
n-octane (Y)	4.83
ethylbenzene (Z)	2.49
M+P-xylene (AA)	19.98
O-xylene (BB)	4.62

CALCULATED DATA - C12+ FRACTION

Pristane/Phytane	5.31
Pristane/n-C17	0.50
Phytane/n-C18	0.09
TMTD/Pristane	0.40
(C21+C22)/(C28+C29)	1.69

CALCULATED DATA - C4-C8 FRACTION

Paraffin Index I	1.62
Paraffin Index II	13.96
N/K (Maturity)	2.00
C/D (Maturity)	0.84
J/K (Maturity)	1.33
I/M (Water washing)	0.28
I/J (Biodegradation)	0.30

NOTES :

TMTD = Trimethyltridecane

- = Below detection limit or not measured

Paraffin Index I = (P+Q)/(R+S+T)

Paraffin Index II = %U in listed compounds N to V

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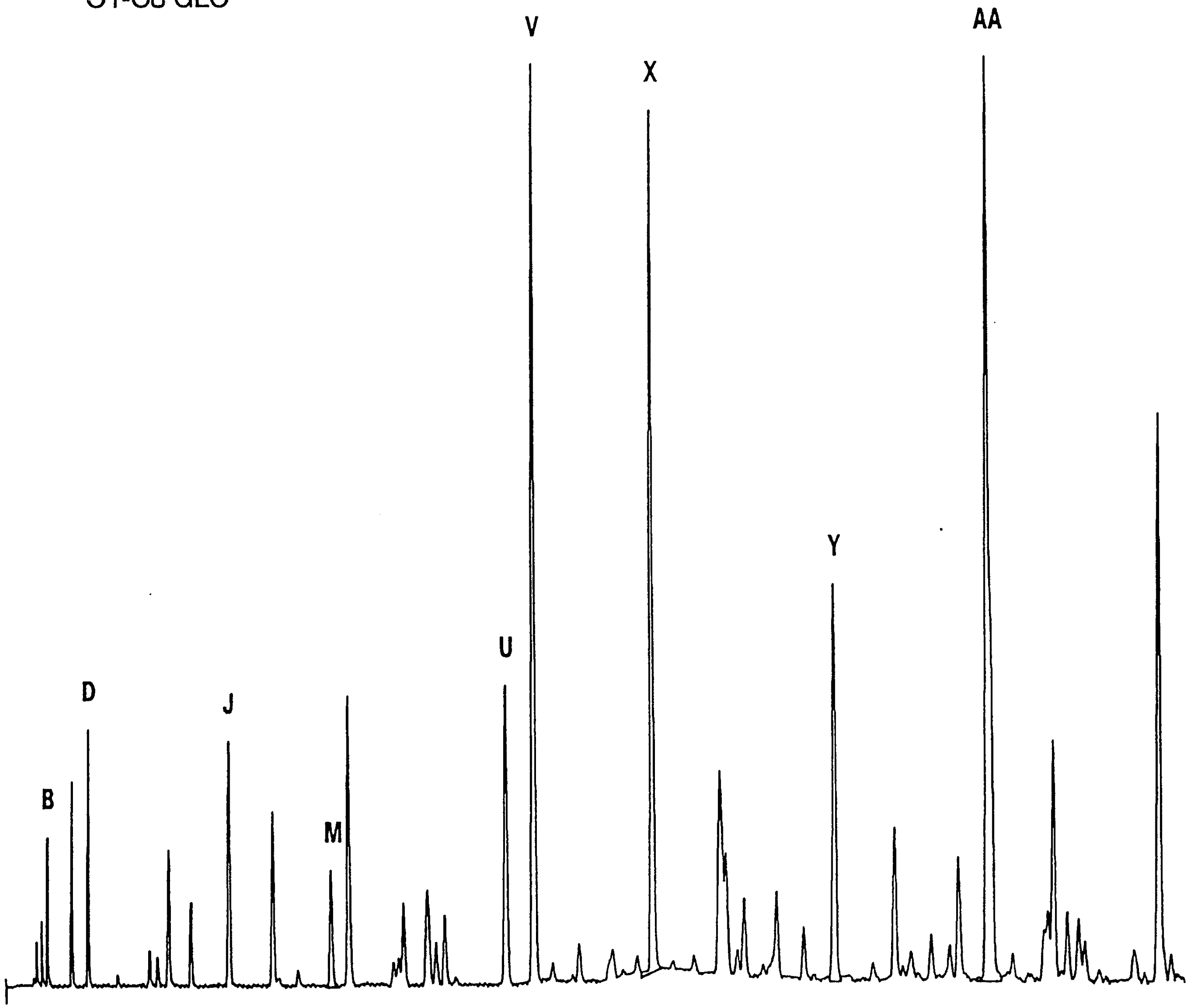
Figure 1.1.1

MOONFISH 1 / ST1, 1838.7m, RFT Oil

Gasoline Range Whole Oil

C1-C8 GLC



C4-C8 Compounds

A	isobutane
B	n-butane
C	isopentane
D	n-pentane
E	2,2-dimethylbutane
F	cyclopentane
G	2,3-dimethylbutane
H	2-methylpentane
I	3-methylpentane
J	n-hexane
K	methylcyclopentane
L	2,4-dimethylpentane
M	benzene
N	cyclohexane
O	1,1-dimethylcyclopentane
P	2-methylhexane
Q	3-methylhexane
R	1 cis-3-dimethylcyclopentane
S	1 trans-3-dimethylcyclopentane
T	1 trans-2-dimethylcyclopentane
U	n-heptane
V	methylcyclohexane
W	1 cis-2-dimethylcyclopentane
X	toluene
Y	n-octane
Z	ethylbenzene
AA	M + P-xylene
BB	O-xylene

Figure 1.1.2

MOONFISH 1 / ST1, 1838.7m, RFT Oil
Whole Oil
C1-C33 GLC

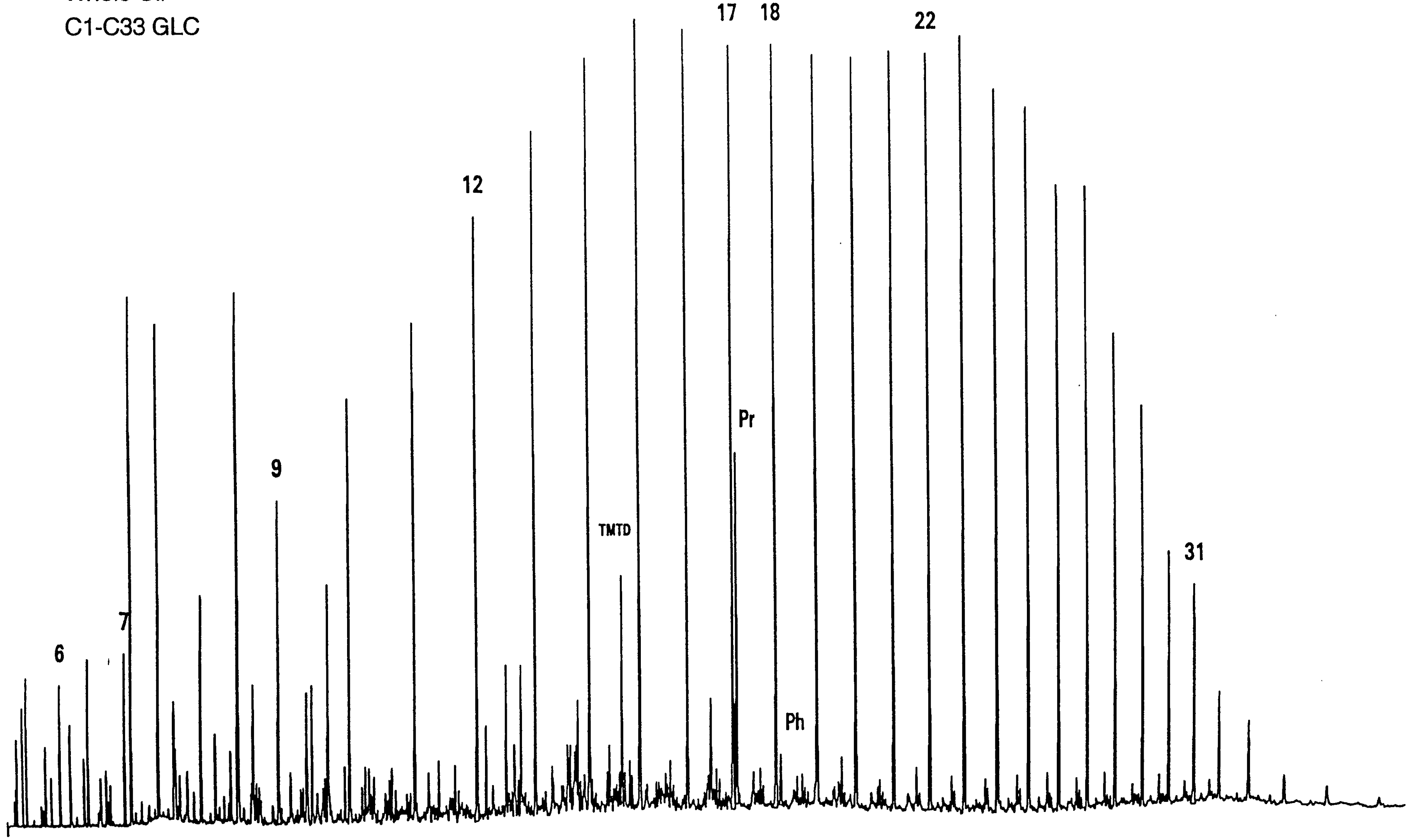


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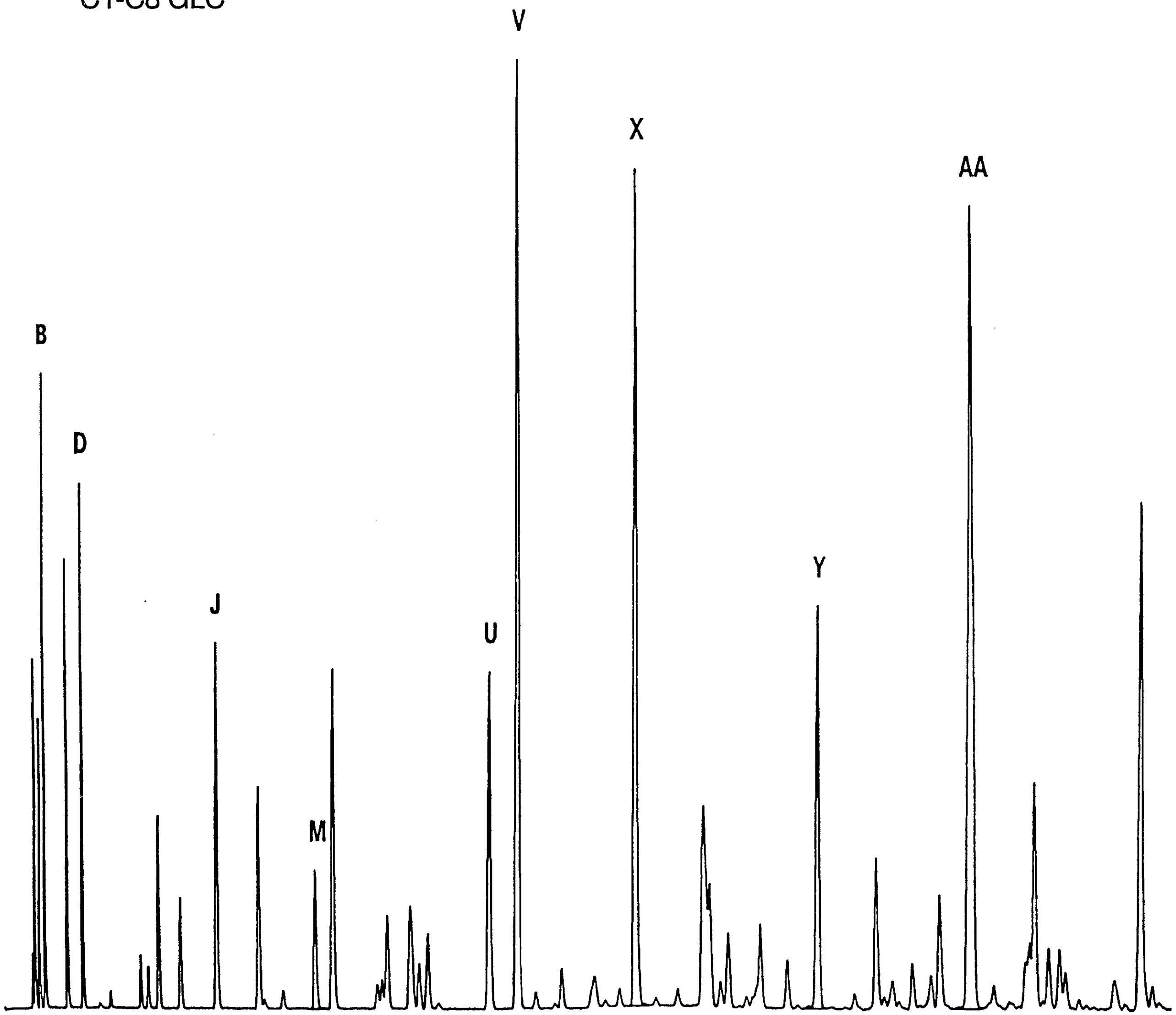
Figure 1.2.1

MOONFISH 1, 1914.5m, RFT Oil

Gasoline Range Whole Oil

C1-C8 GLC



C4-C8 Compounds

A	isobutane
B	n-butane
C	isopentane
D	n-pentane
E	2,2-dimethylbutane
F	cyclopentane
G	2,3-dimethylbutane
H	2-methylpentane
I	3-methylpentane
J	n-hexane
K	methylcyclopentane
L	2,4-dimethylpentane
M	benzene
N	cyclohexane
O	1,1-dimethylcyclopentane
P	2-methylhexane
Q	3-methylhexane
R	1 cis-3-dimethylcyclopentane
S	1 trans-3-dimethylcyclopentane
T	1 trans-2-dimethylcyclopentane
U	n-heptane
V	methylcyclohexane
W	1 cis-2-dimethylcyclopentane
X	toluene
Y	n-octane
Z	ethylbenzene
AA	M+P-xylene
BB	O-xylene

Figure 1.2.2

MOONFISH 1, 1914.5m, RFT Oil

Whole Oil

C1-C33 GLC

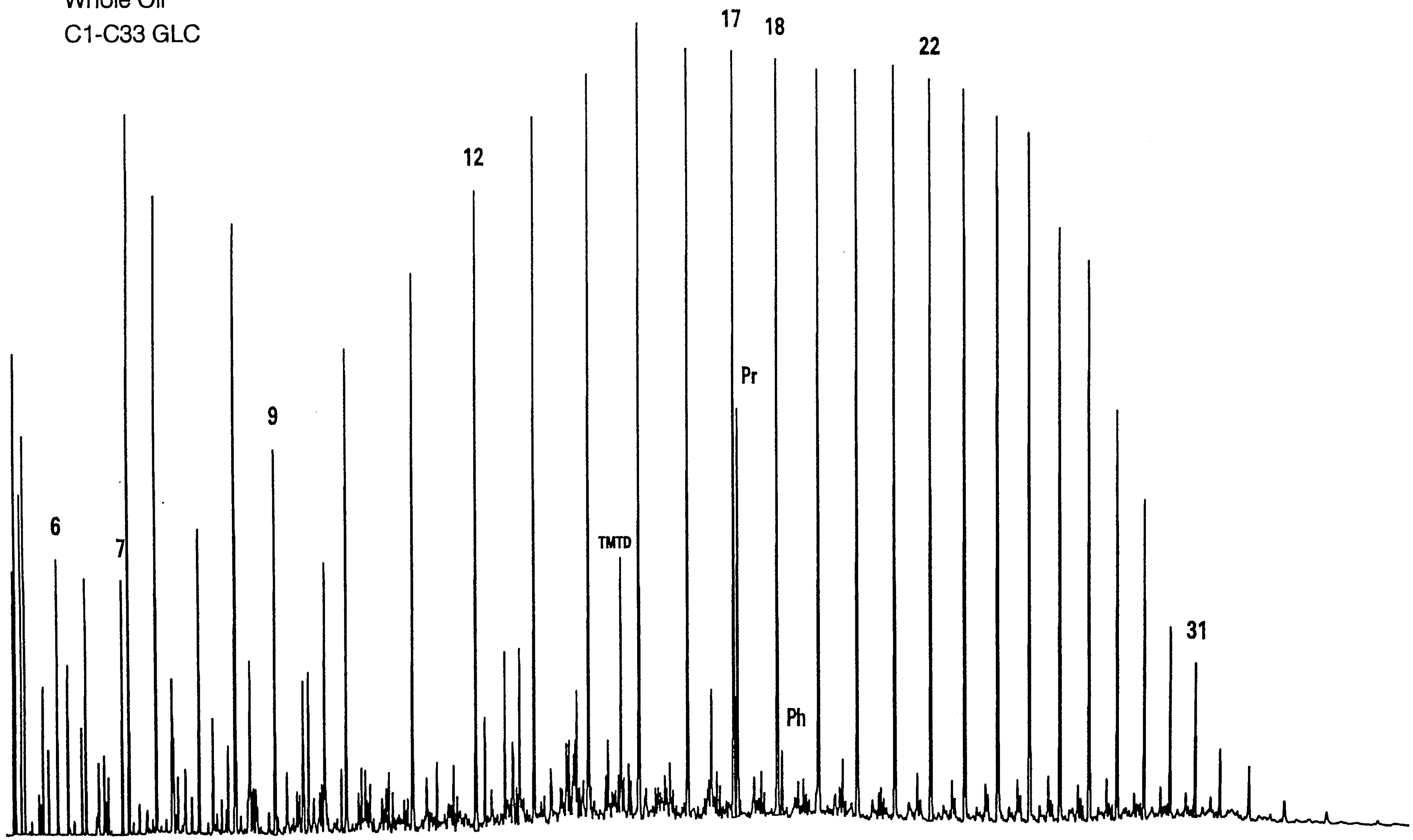


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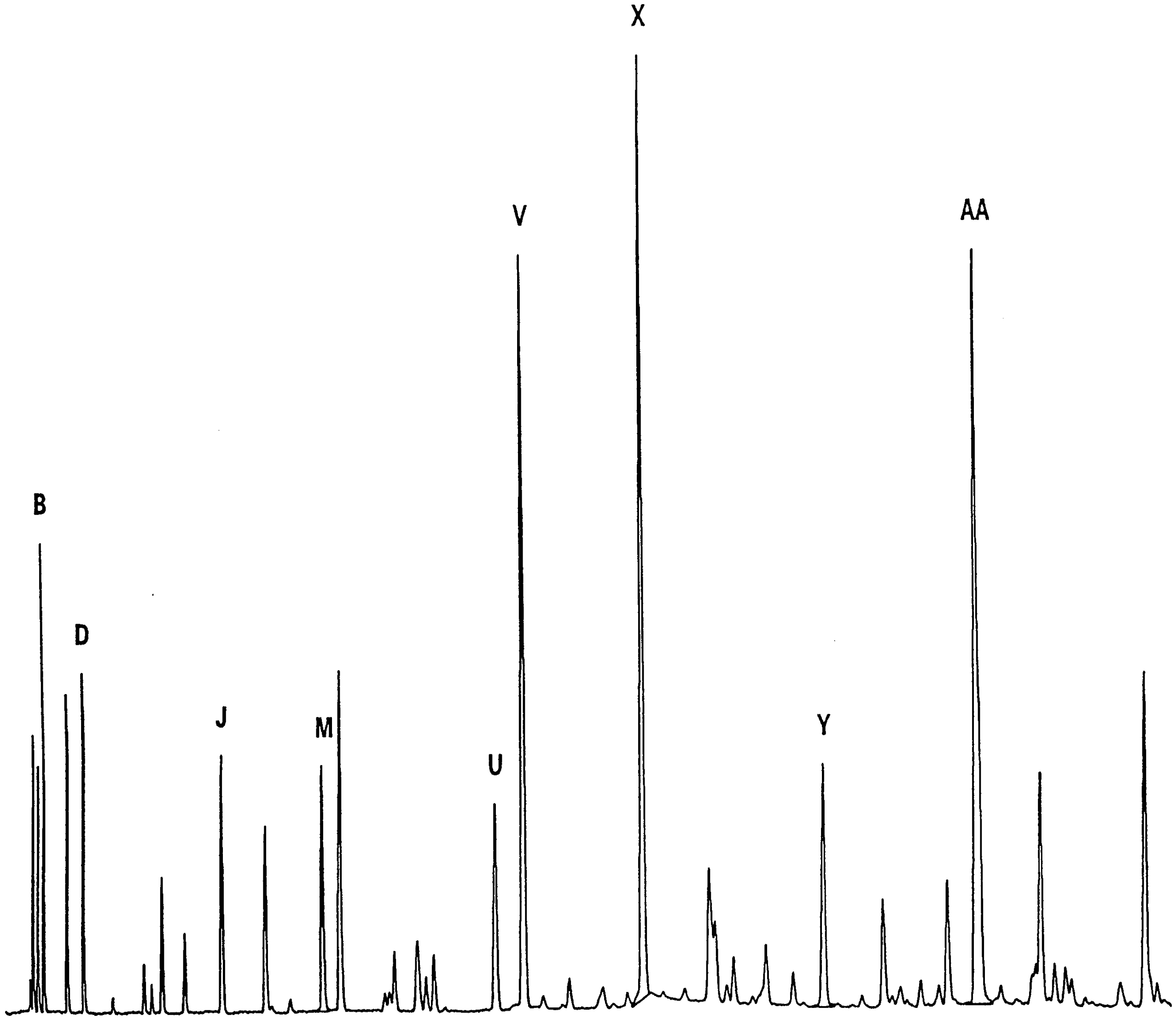
Figure 1.3.1

MOONFISH 1, 2260.5m, RFT Oil

Gasoline Range Whole Oil

C1-C8 GLC



C4-C8 Compounds

A	isobutane
B	n-butane
C	isopentane
D	n-pentane
E	2,2-dimethylbutane
F	cyclopentane
G	2,3-dimethylbutane
H	2-methylpentane
I	3-methylpentane
J	n-hexane
K	methylcyclopentane
L	2,4-dimethylpentane
M	benzene
N	cyclohexane
O	1,1-dimethylcyclopentane
P	2-methylhexane
Q	3-methylhexane
R	1 cis-3-dimethylcyclopentane
S	1 trans-3-dimethylcyclopentane
T	1 trans-2-dimethylcyclopentane
U	n-heptane
V	methylcyclohexane
W	1 cis-2-dimethylcyclopentane
X	toluene
Y	n-octane
Z	ethylbenzene
AA	M+P-xylene
BB	O-xylene

Figure 1.3.2

MOONFISH 1, 2260.5m, RFT Oil

Whole Oil

C1-C33 GLC

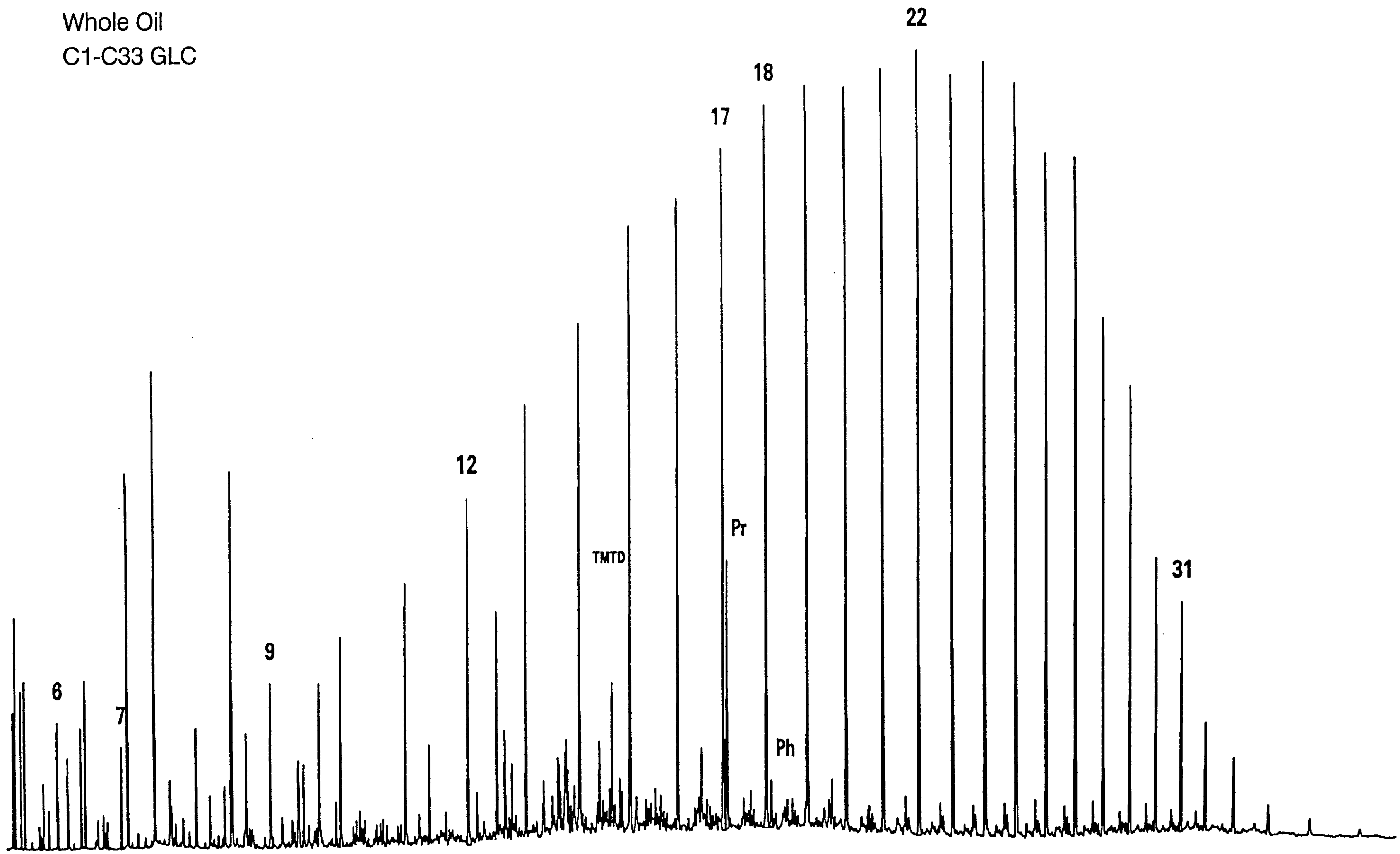


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TABLE 2

Summary of Physical Property and Sulphur Data

MOONFISH 1

Sep-92

DEPTH(m)	API GRAVITY	%SULPHUR (W/W)	VISCOSITY 25 Degrees	VISCOSITY 60 Degrees
1838.7 ST1	36.1	nd	nd	nd
1914.5	38.8	nd	nd	nd
2260.5	33.0	nd	nd	nd

TABLE 2

Summary of Liquid Chromatography (Compositional data)

MOONFISH 1

Sep-92

	---Hydrocarbons----			---Nonhydrocarbons-----			SAT	ASPH	HC
DEPTH(m)	%SAT	%AROM	%HC's	%NSO's	%ASPH	%Non HC's	AROM	NSO	Non HC
1838.7 ST1	88.5	8.5	96.9	3.1	nd	3.1	10.4	nd	31.8
1914.5	88.6	9.0	97.6	2.4	nd	2.4	9.8	nd	41.2
2260.5	86.7	10.5	97.2	2.8	nd	2.8	8.2	nd	35.3

nd = no data

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TABLE 3

Summary of Gas Chromatography Data

MOONFISH 1

A. Alkane Compositional Data

DEPTH(m)	Prist./Phyt.	Prist./n-C17	Phyt./n-C18	CPI(1)	CPI(2)	(C21+C22)/(C28+C29)
1838.7 ST1	6.58	0.59	0.09	1.10	1.08	1.77
1914.5	6.67	0.59	0.09	1.09	1.07	2.54
2260.5	6.31	0.50	0.08	1.09	1.07	1.50

TABLE 3

Summary of Gas Chromatography Data

MOONFISH 1

B. n-Alkane Distributions

DEPTH(m)	nC12	nC13	nC14	nC15	nC16	nC17	iC19	nC18	iC20	nC19	nC20	nC21	nC22	nC23	nC24	nC25	nC26	nC27	nC28	nC29	nC30	nC31
1838.7 ST1	4.0	4.7	5.2	5.4	5.4	5.7	3.4	5.7	0.5	5.7	5.6	5.6	5.8	5.9	5.6	5.8	4.9	4.9	3.5	3.0	1.9	1.6
1914.5	4.4	5.1	5.6	5.9	5.8	6.0	3.6	5.9	0.5	6.3	6.0	5.9	6.0	6.1	5.8	5.6	4.4	4.1	2.7	2.0	1.2	1.0
2260.5	3.2	3.8	4.6	5.1	5.8	5.9	2.9	5.7	0.5	5.6	5.6	5.5	5.7	5.9	5.9	6.1	5.4	5.5	4.0	3.5	2.1	1.9

nd = no data

Figure 2-1

MOONFISH 1 / ST1, 1838.7m, RFT Oil

Saturate Fraction

C12+ GLC

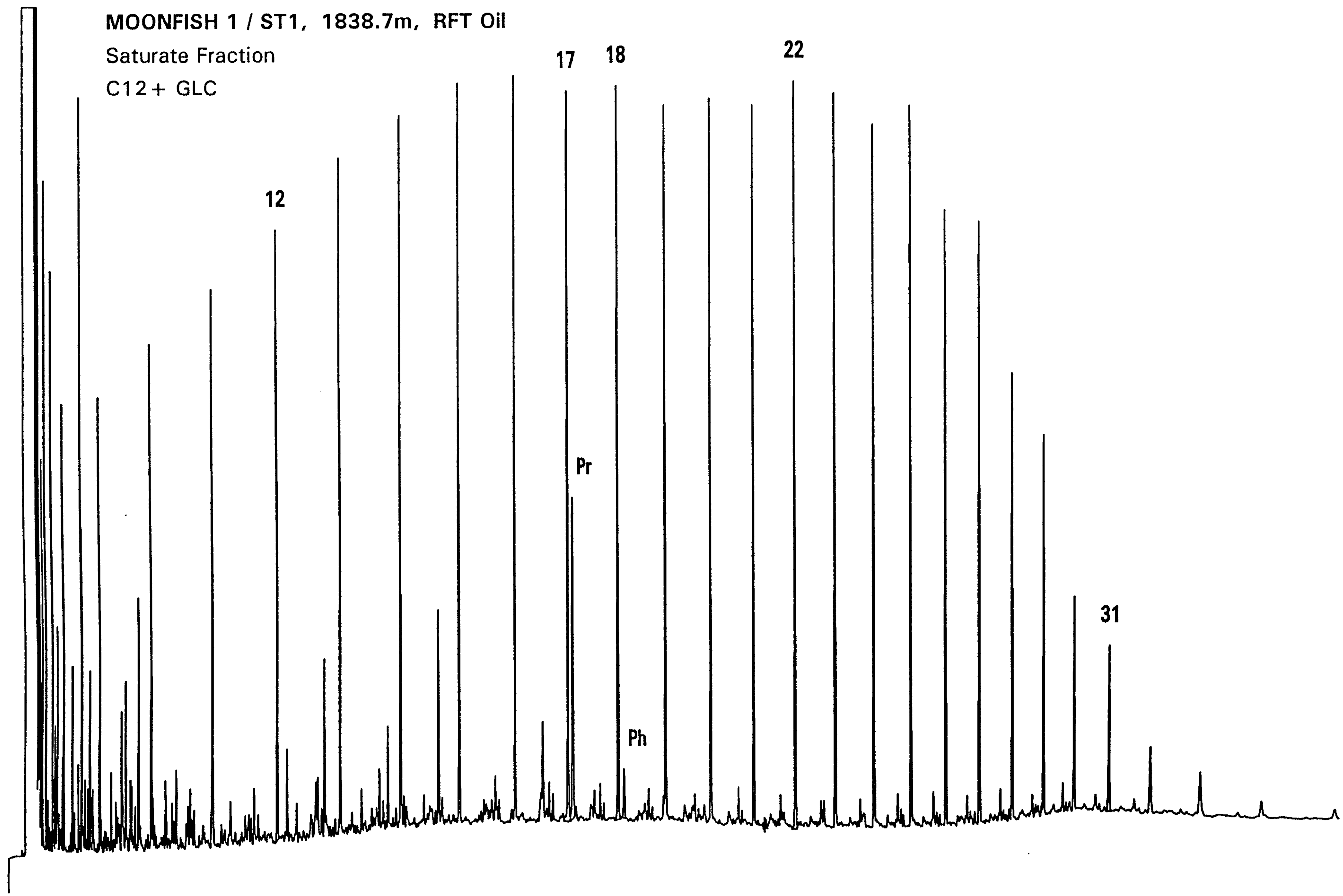

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Figure 2–2

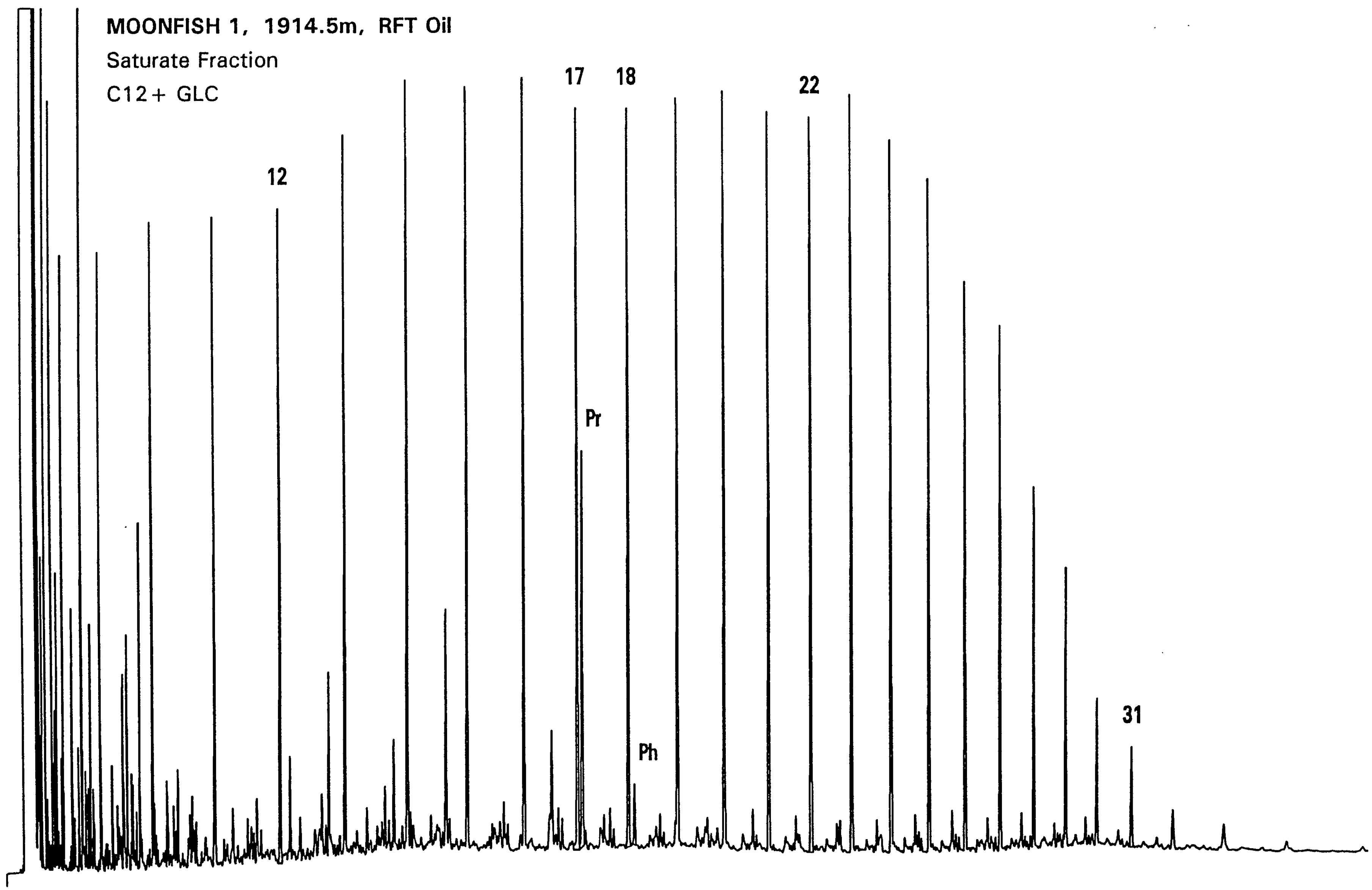
MOONFISH 1, 1914.5m, RFT Oil
Saturate Fraction
C12+ GLC
12
17
18
22
Pr
Ph
31

Figure 2-3

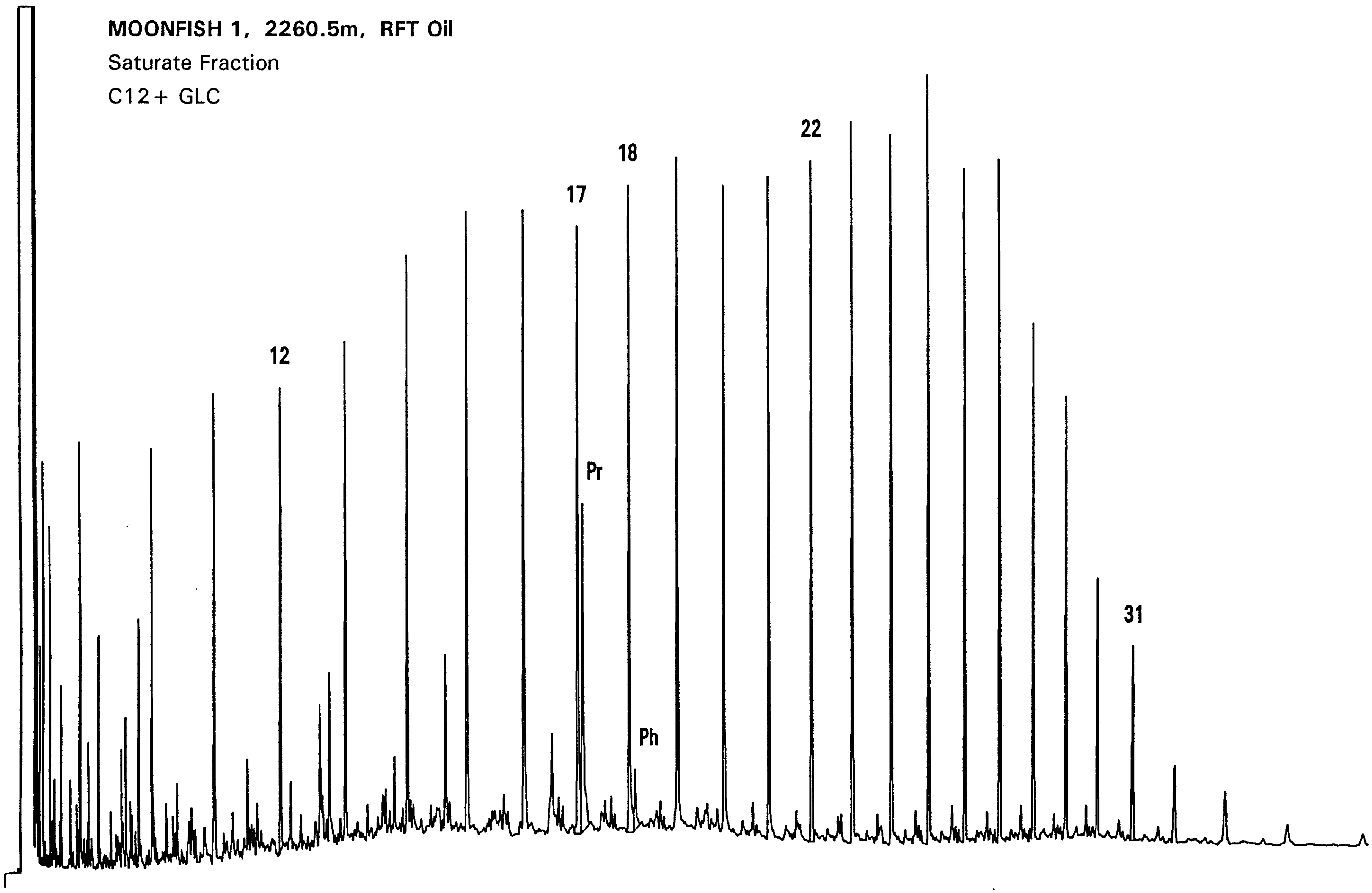

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TABLE 4

SELECTED AROMATIC PARAMETERS

MOONFISH OILS Sep-92

WELL	DEPTH	DNR-1	DNR-5	DNR-6	TNR-1	TNR-5	TNR-6	MPR-1	MPI-1	MPI-2	Rc(a)	Rc(b)
MOONFISH 1/ST	1838.7m	9.57	nd	3.29	0.79	0.41	0.35	2.38	1.11	1.16	1.06	1.64
MOONFISH 1	1914.5m	9.22	nd	3.41	0.78	0.44	0.33	2.56	1.13	1.20	1.08	1.62
MOONFISH 1	2260.5m	9.01	nd	2.91	0.83	0.41	0.35	2.49	1.02	1.12	1.01	1.69

response factors have been applied to DNR 6, TNR 1, TNR 5, MPI 1 and MPI 2

TABLE 4

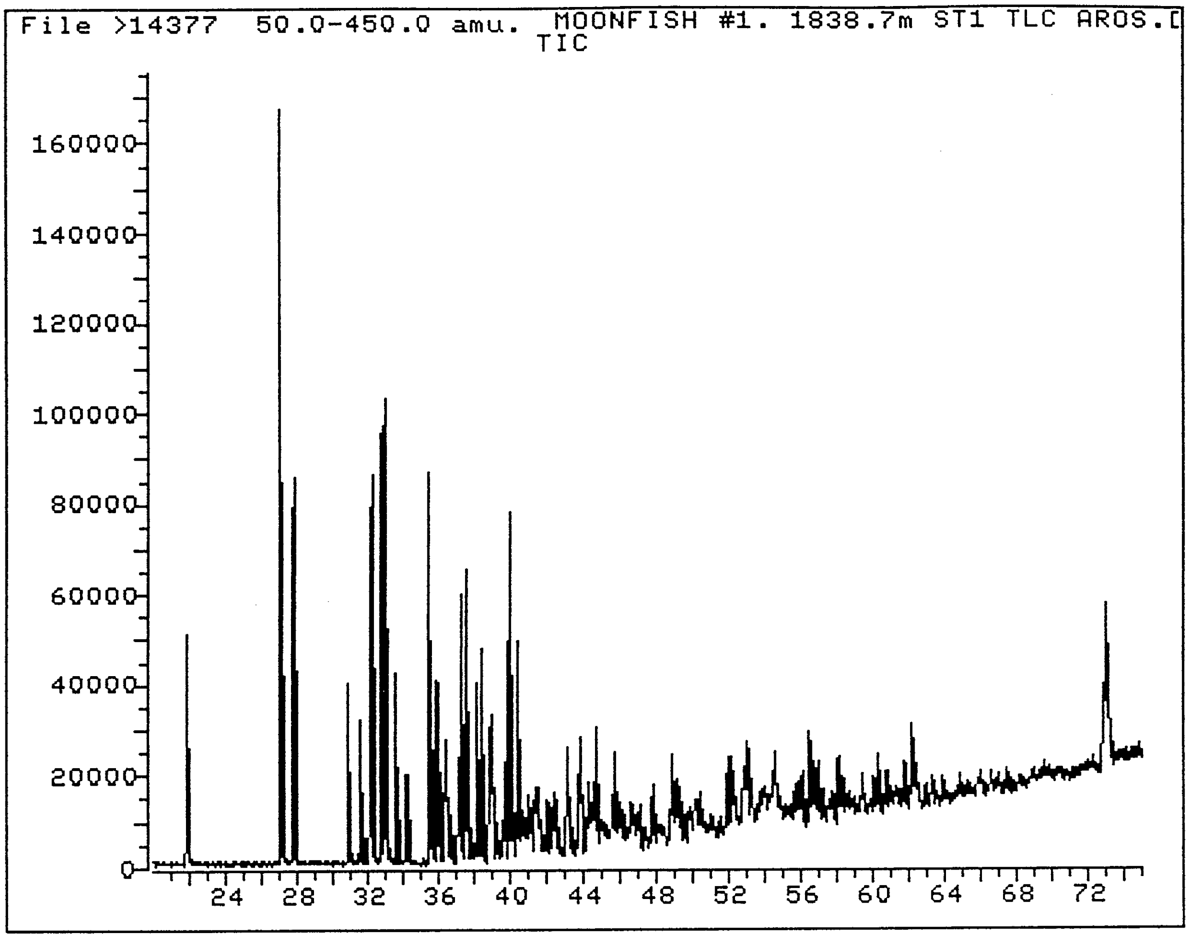
SELECTED AROMATIC PARAMETERS CONT.

MOONFISH OILS Sep-92

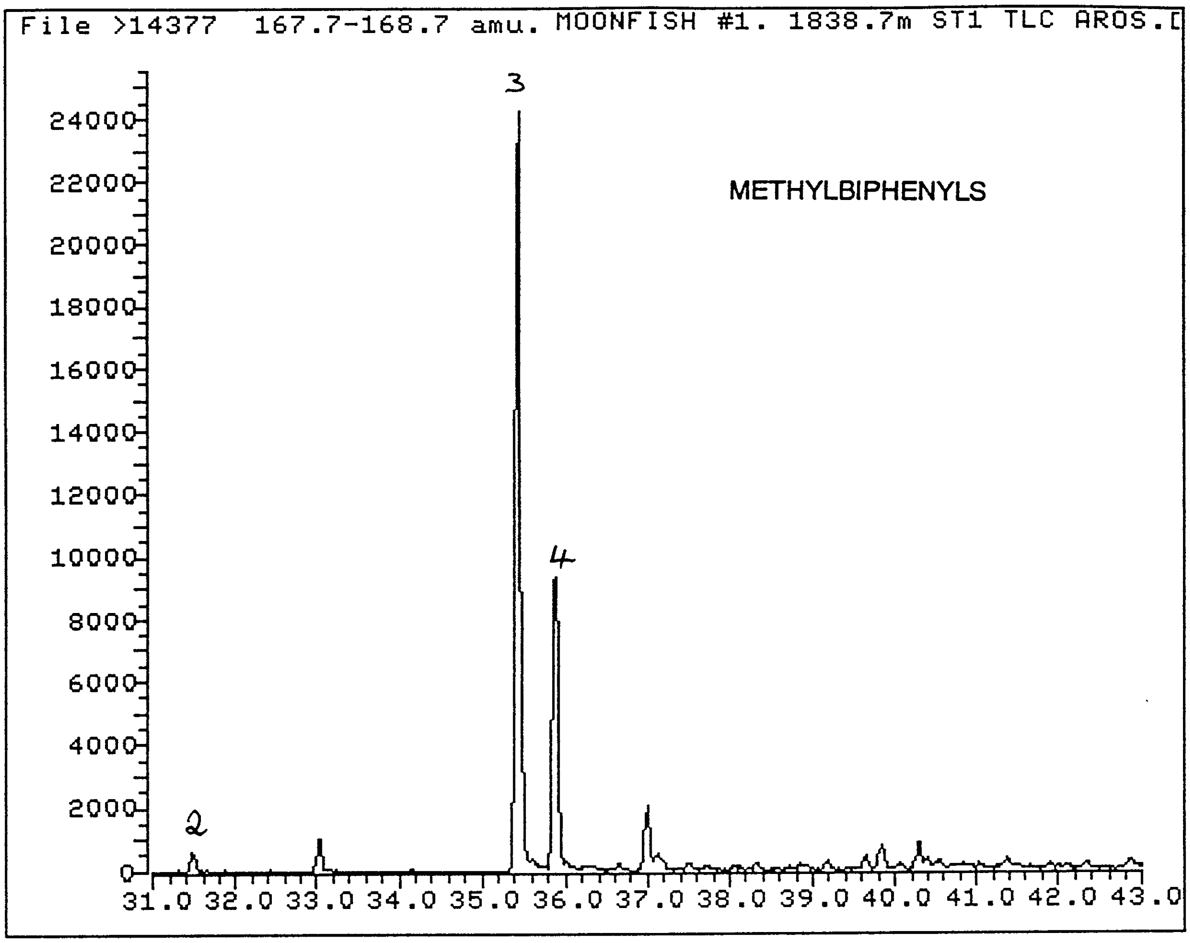
WELL	DEPTH	1,7-DMP/X (m/z 206)	RETENE/9-MP (m/z 219,192)	1MP/9MP
MOONFISH 1/ST	1838.7m	0.57	0.93	0.89
MOONFISH 1	1914.5m	0.56	0.88	0.80
MOONFISH 1	2260.5m	0.54	0.48	0.80

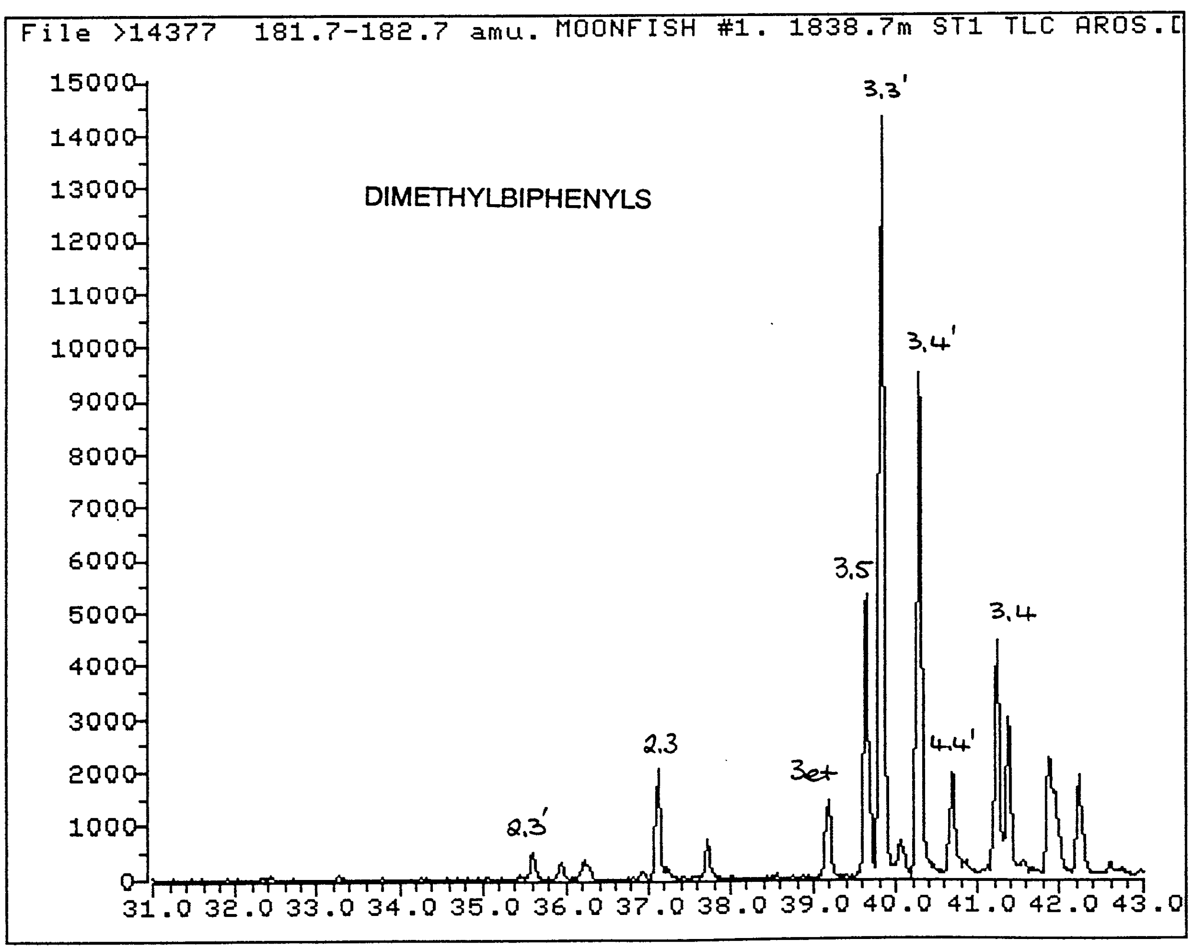
nd = no data

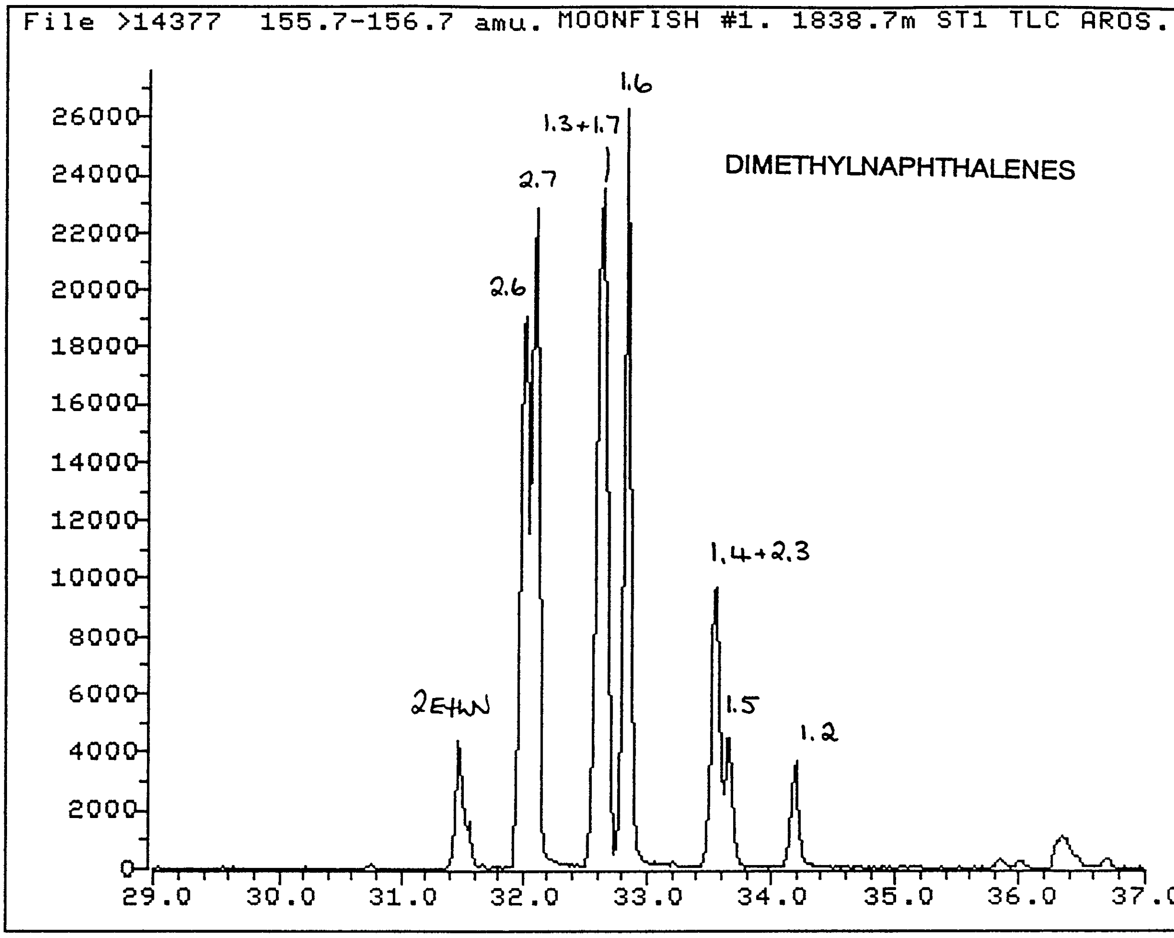
Figure 3-1

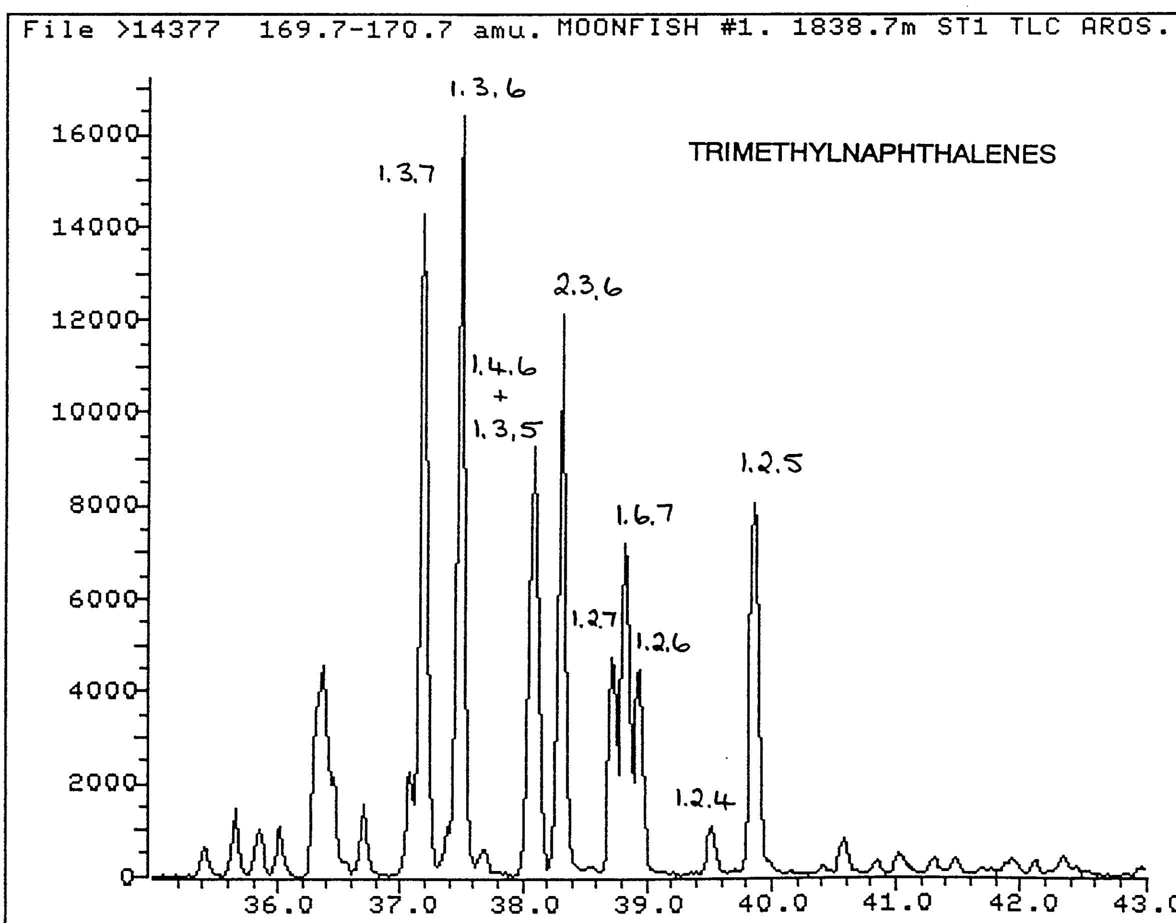


File >14377 50.0-450.0 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
TIC
160000
140000
120000
100000
80000
60000
40000
20000
0
24
28
32
36
40
44
48
52
56
60
64
68
72

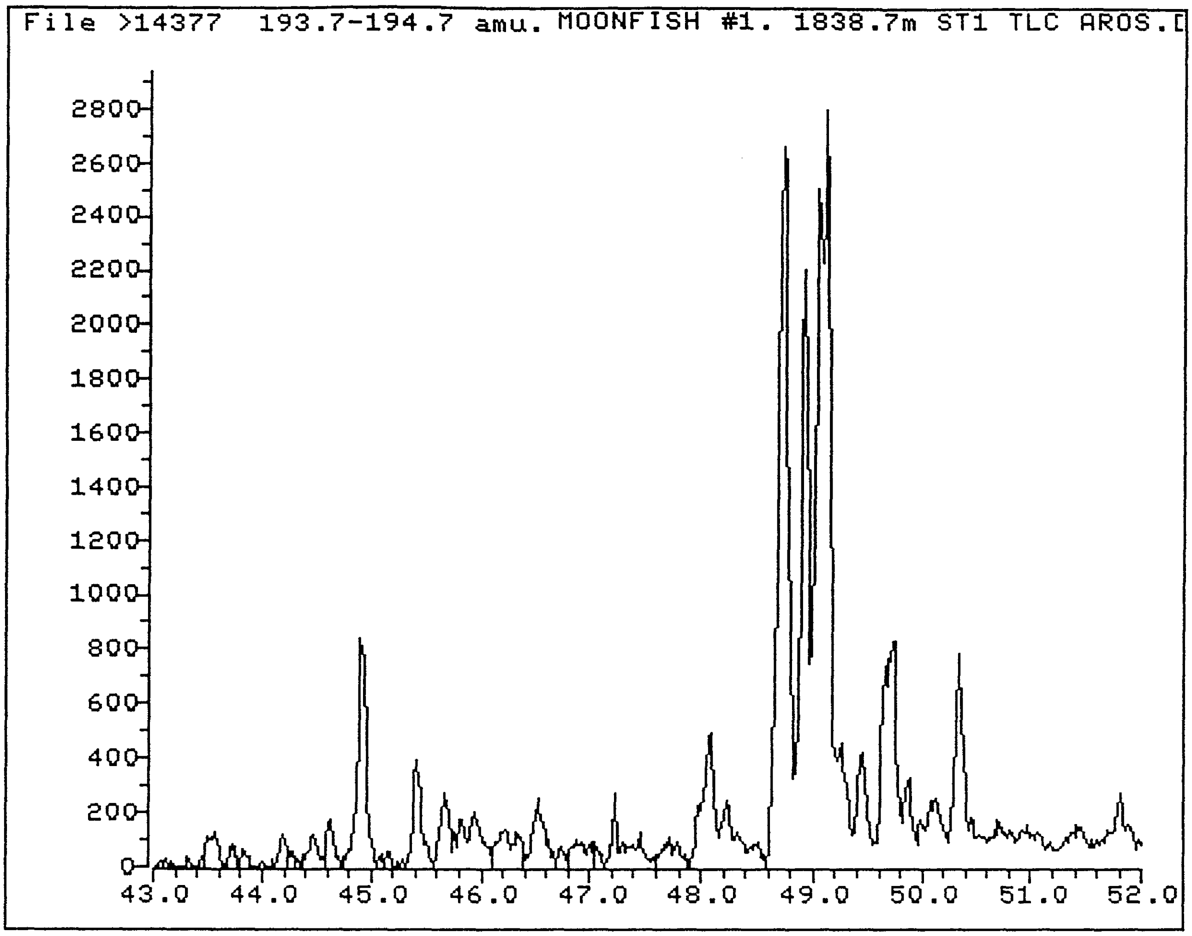

File >14377 167.7-168.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
METHYLBIPHENYLS
2
3
4
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0

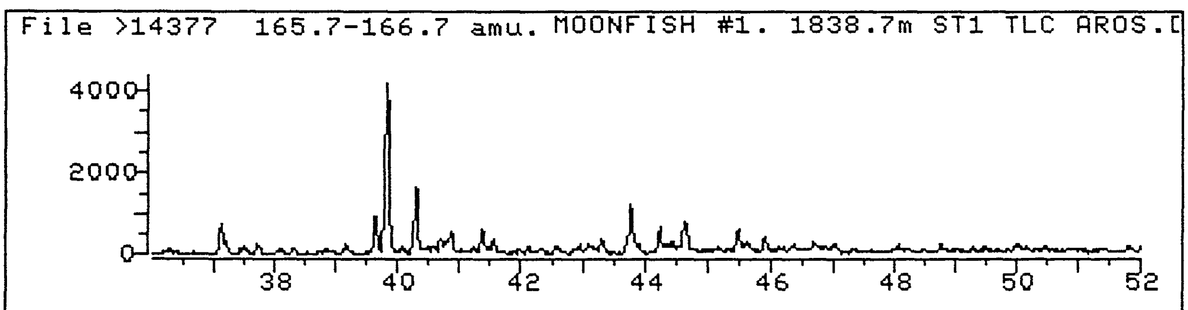

File >14377 181.7-182.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
DIMETHYLBIPHENYLS
2,3'
2,3
3et
3,5
3,3'
3,4'
4,4'
3,4
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0

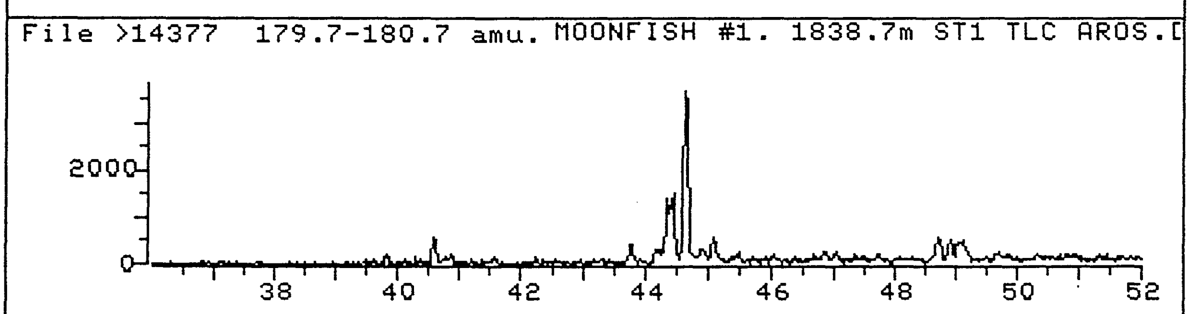

File >14377 155.7-156.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
DIMETHYLNAPHTHALENES
2EtN
2.6
2.7
1.3+1.7
1.6
1.4+2.3
1.5
1.2
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
29.0
30.0
31.0
32.0
33.0
34.0
35.0
36.0
37.0

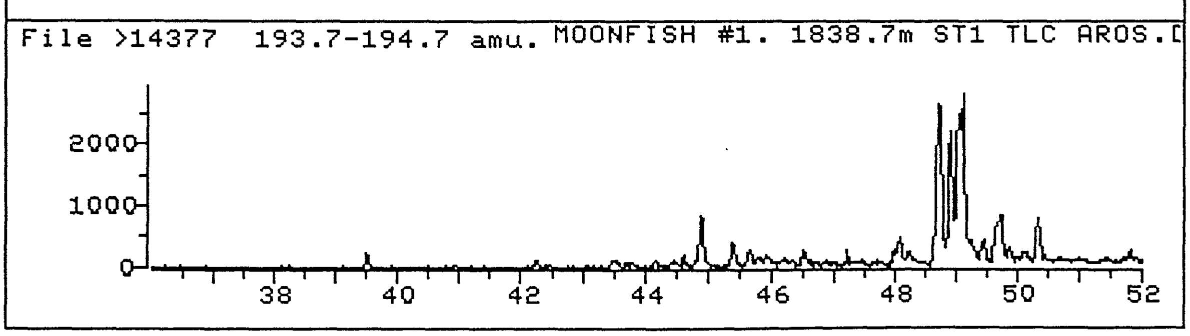

File >14377 169.7-170.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
TRIMETHYLNAPHTHALENES
1.3.7
1.3.6
1.4.6 + 1.3.5
2.3.6
1.2.7
1.6.7
1.2.6
1.2.4
1.2.5
16000
14000
12000
10000
8000
6000
4000
2000
0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0

FLUORENES


File >14377 193.7-194.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
43.0
44.0
45.0
46.0
47.0
48.0
49.0
50.0
51.0
52.0


File >14377 165.7-166.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
4000
2000
0
38
40
42
44
46
48
50
52


File >14377 179.7-180.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
2000
0
38
40
42
44
46
48
50
52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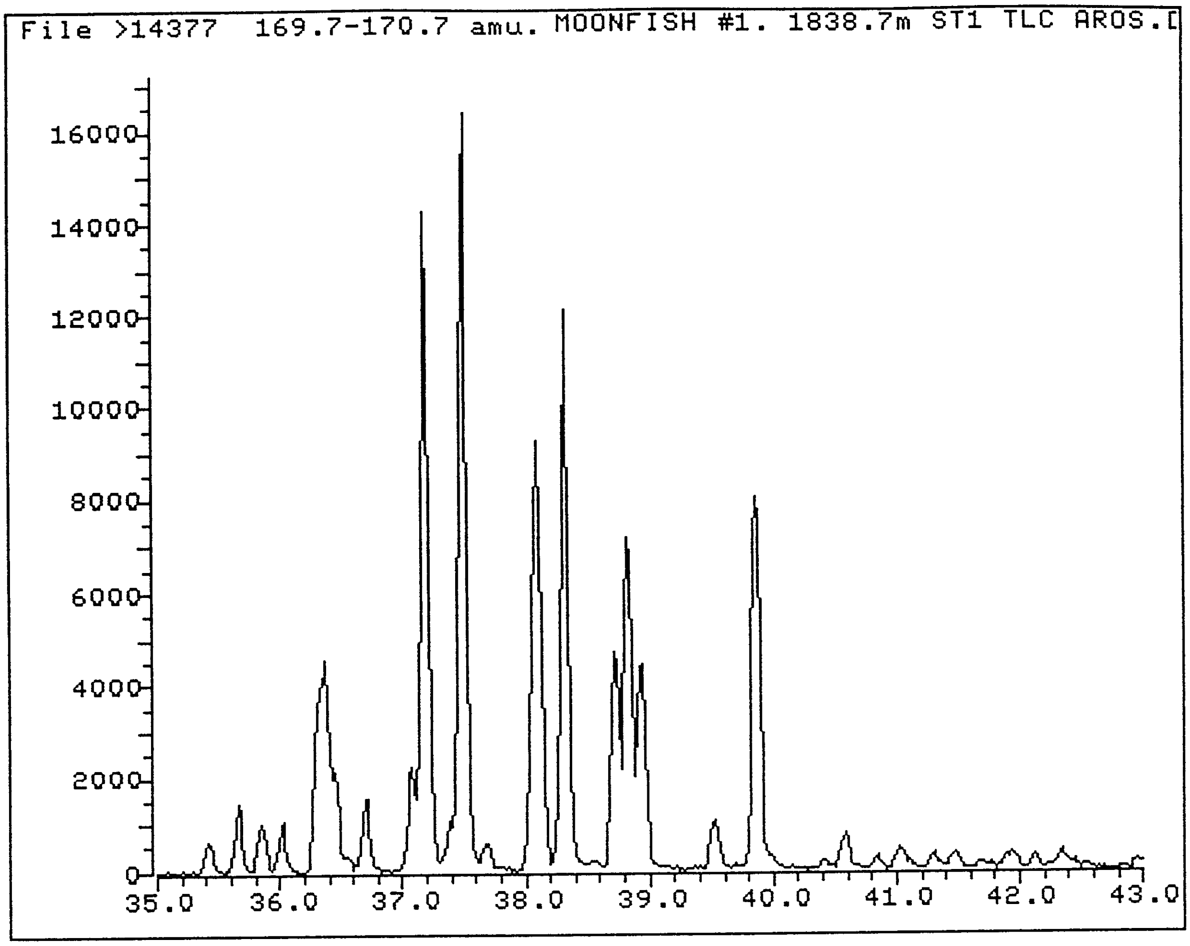
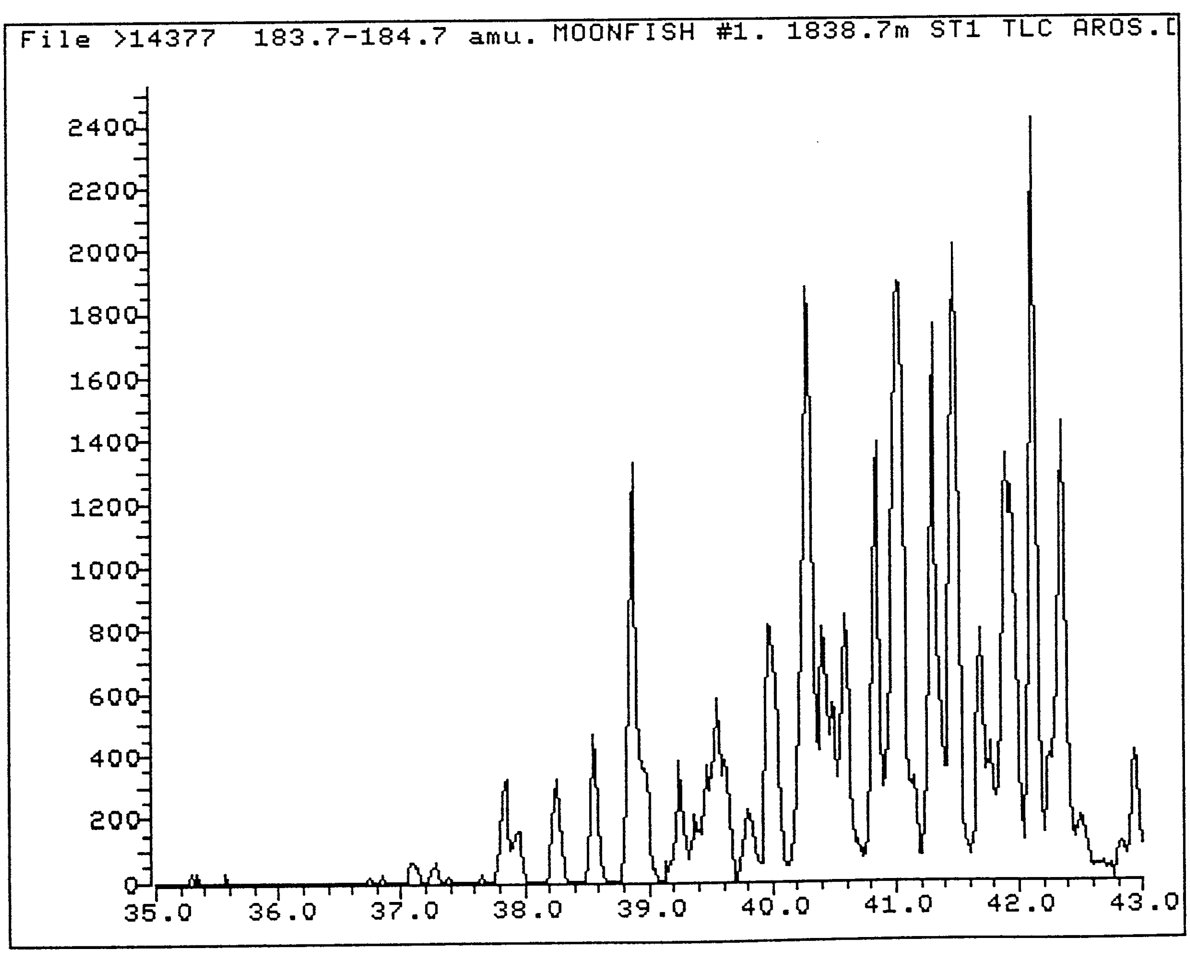
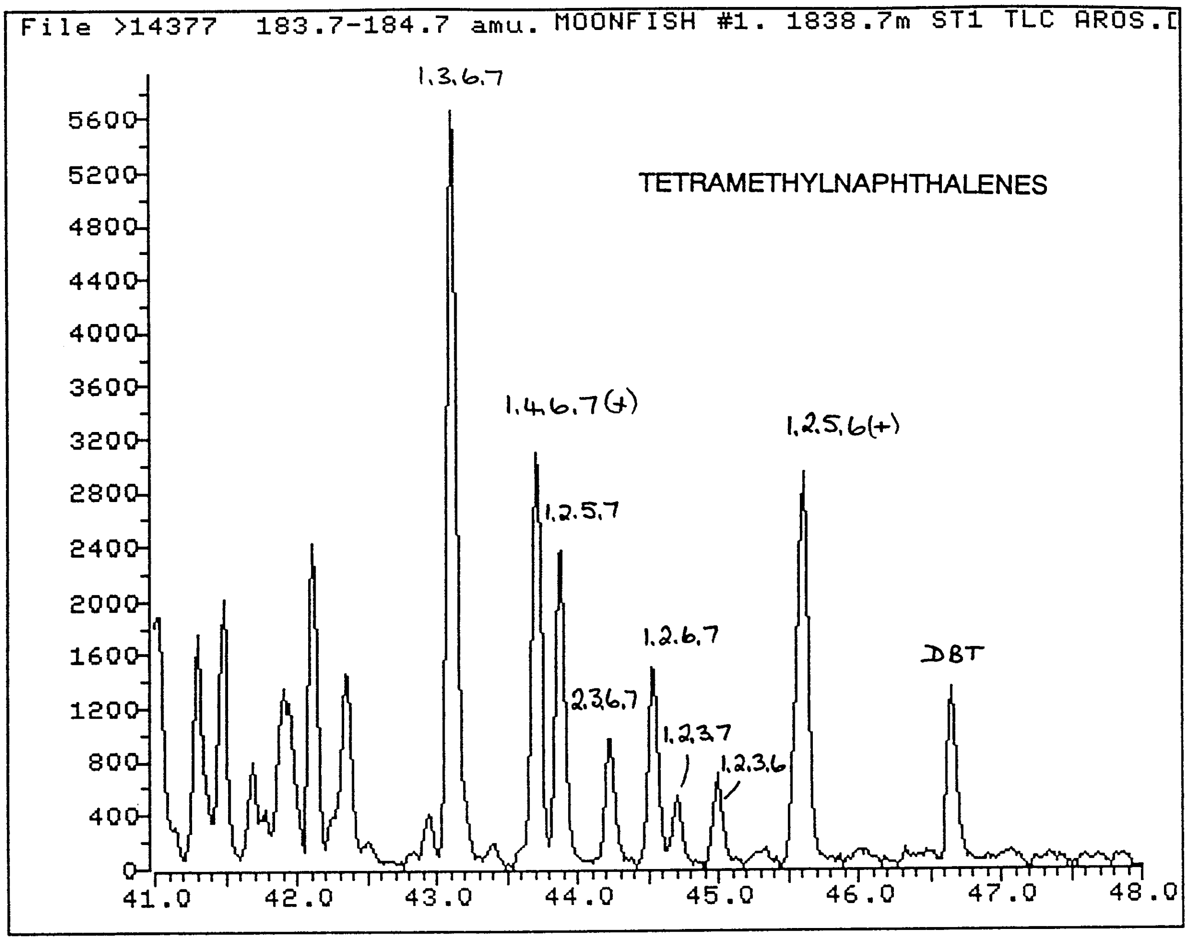
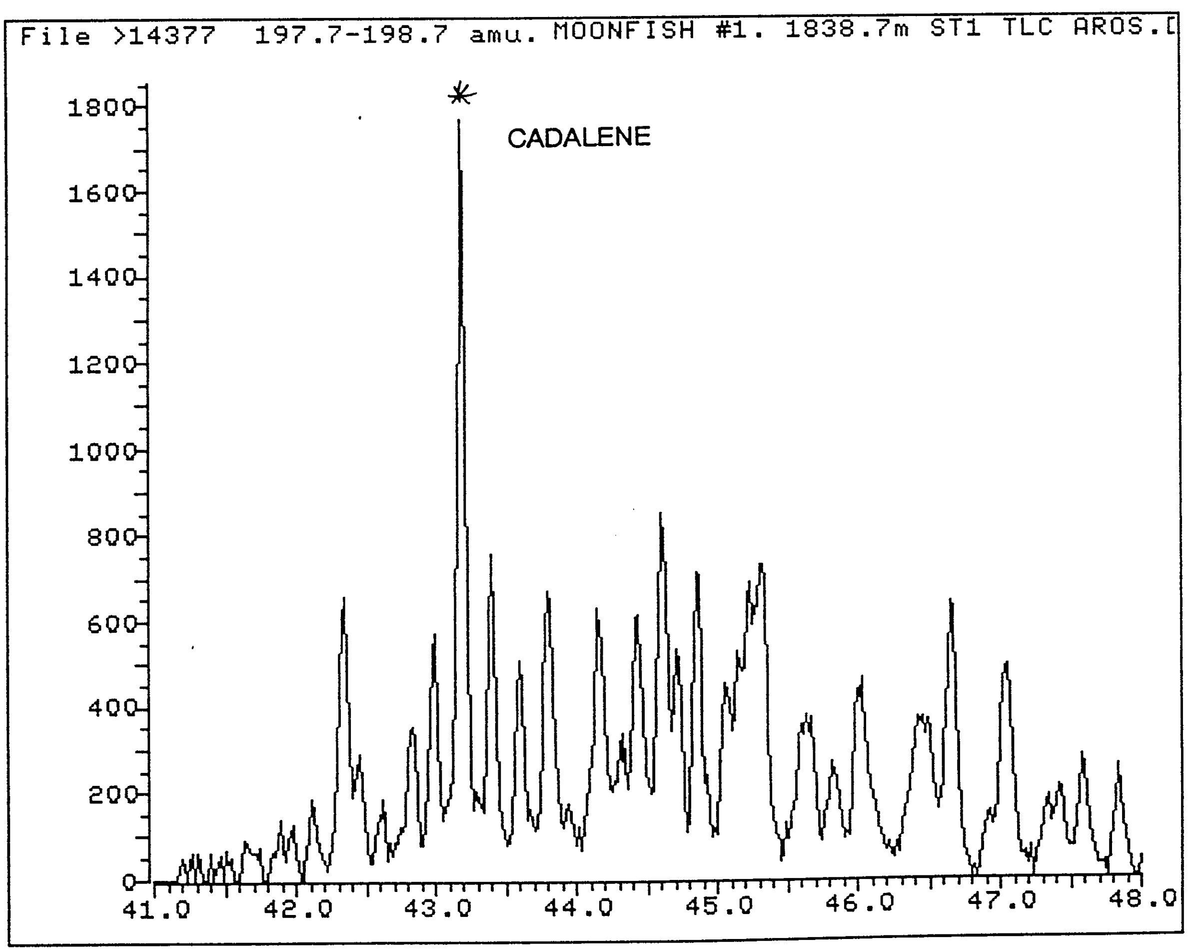
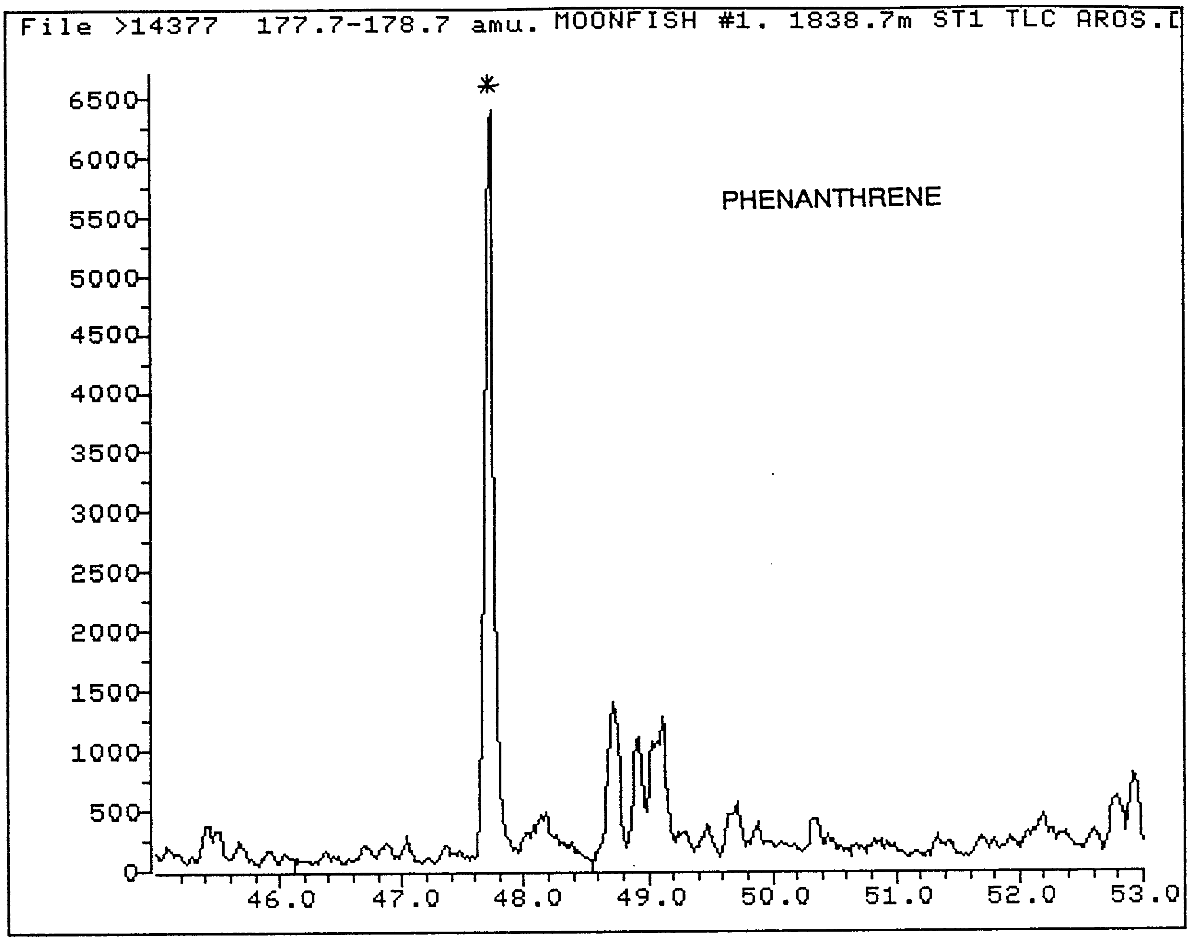
2000
1000
0
38
40
42
44
46
48
50
52


File >14377 169.7-170.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
16000
14000
12000
10000
8000
6000
4000
2000
0
35.0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0

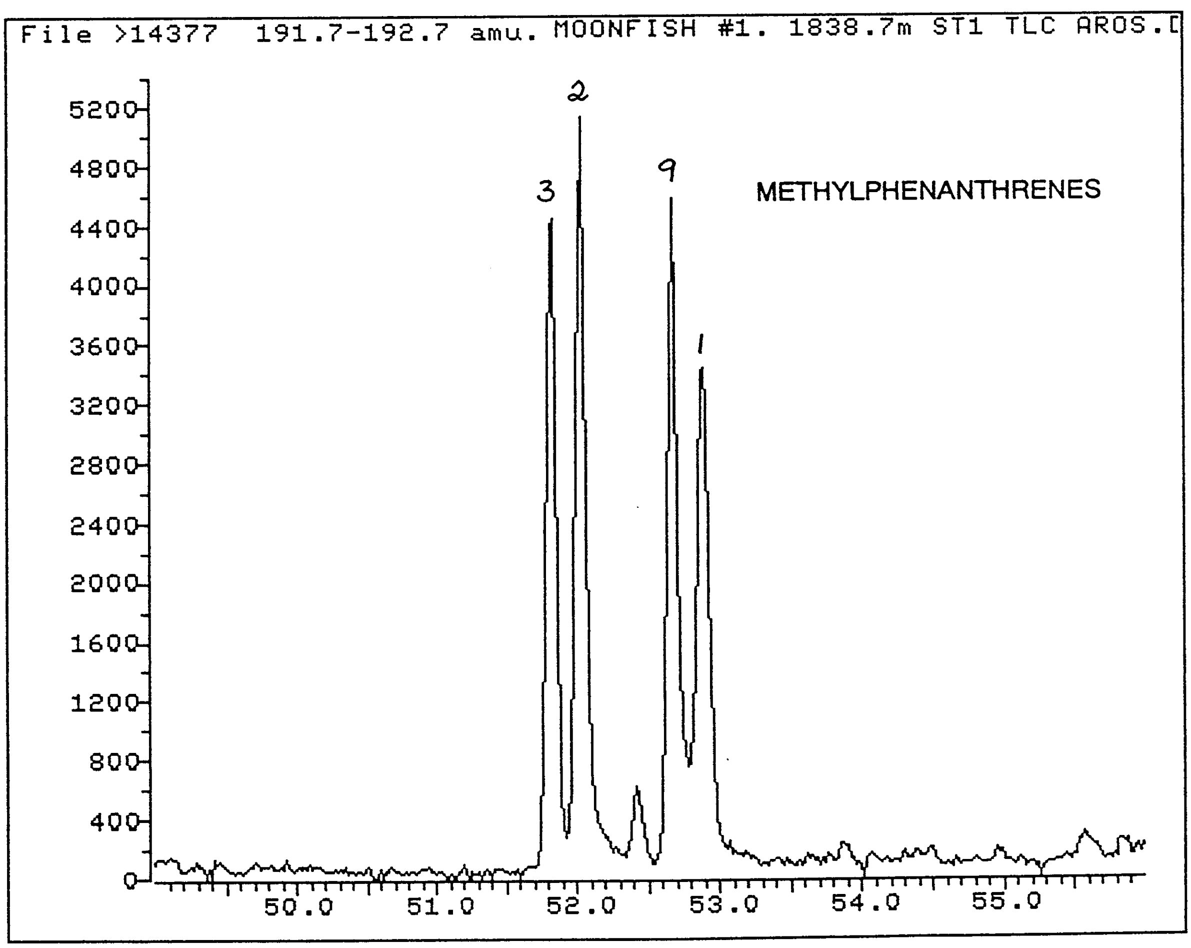

File >14377 183.7-184.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
35.0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0


File >14377 183.7-184.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
TETRAMETHYLNAPHTHALENES
1,3,6,7
1,4,6,7(+)
1,2,5,7
2,3,6,7
1,2,6,7
1,2,3,7
1,2,3,6
1,2,5,6(+)
DBT
41.0
42.0
43.0
44.0
45.0
46.0
47.0
48.0

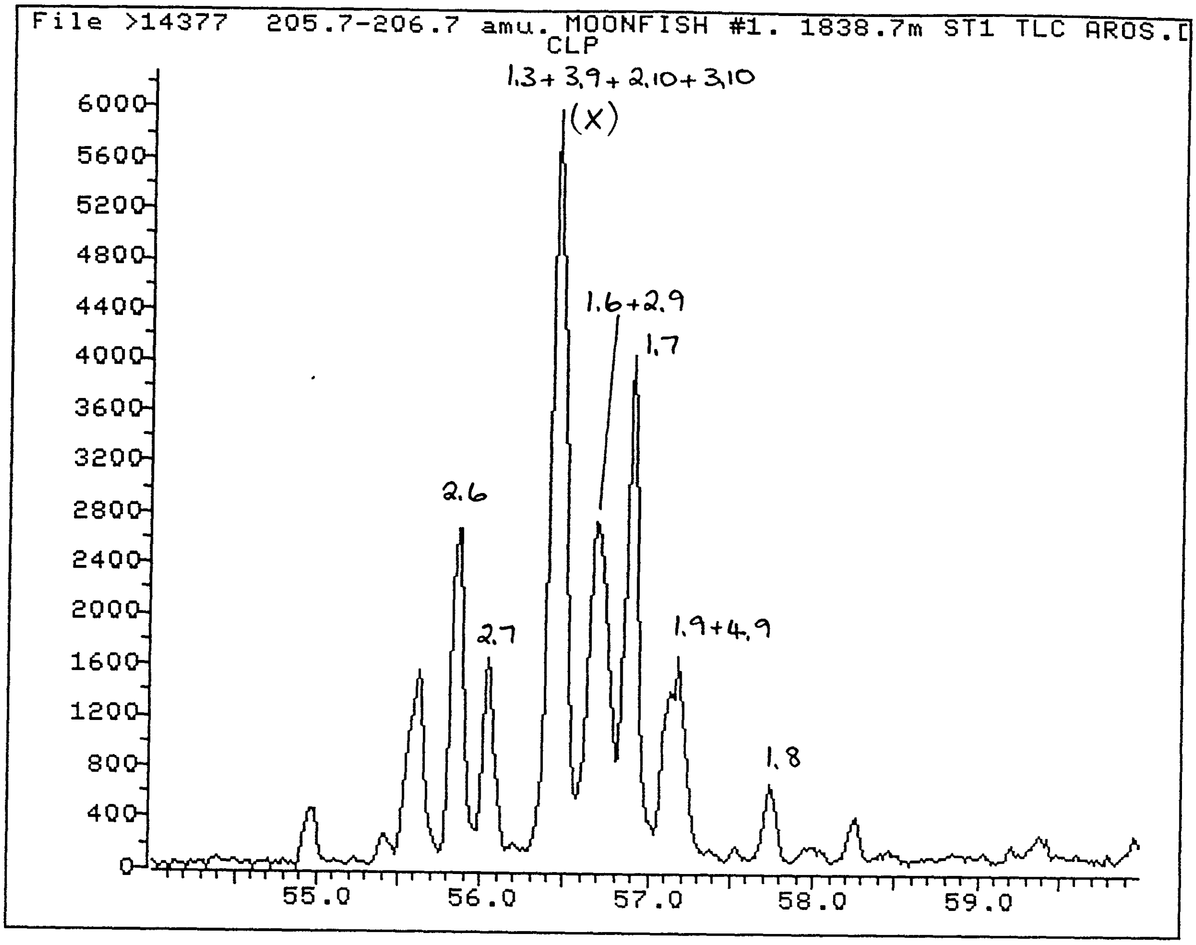

File >14377 197.7-198.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
*
CADALENE
41.0
42.0
43.0
44.0
45.0
46.0
47.0
48.0



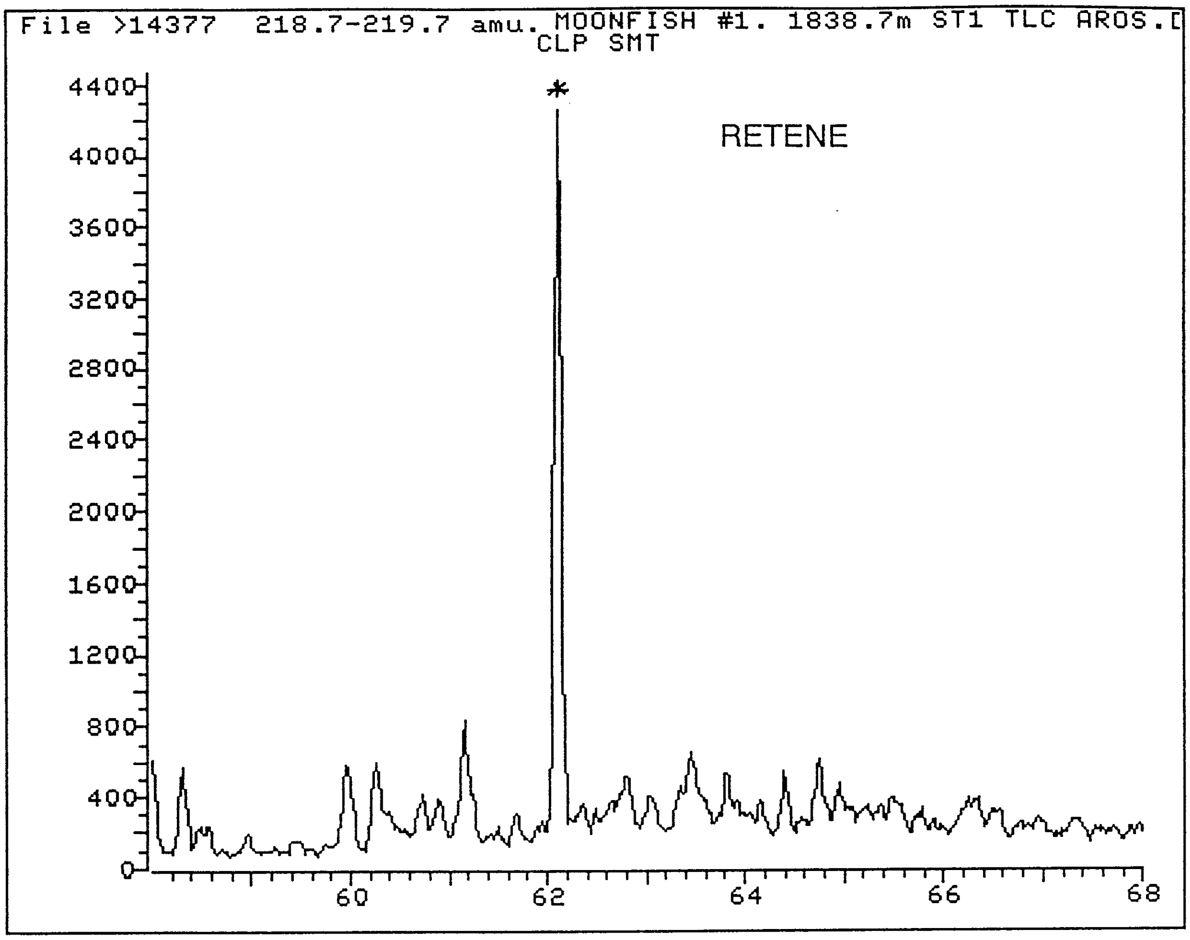
File >14377 177.7-178.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
PHENANTHRENE
*
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
46.0
47.0
48.0
49.0
50.0
51.0
52.0
53.0



File >14377 191.7-192.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
METHYLPHENANTHRENES
3
2
9
1
5200
4800
4400
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
50.0
51.0
52.0
53.0
54.0
55.0



DIMETHYLPHENANTHRENES


File >14377 218.7-219.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
CLP SMT
RETENE
*
4400
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
60
62
64
66
68

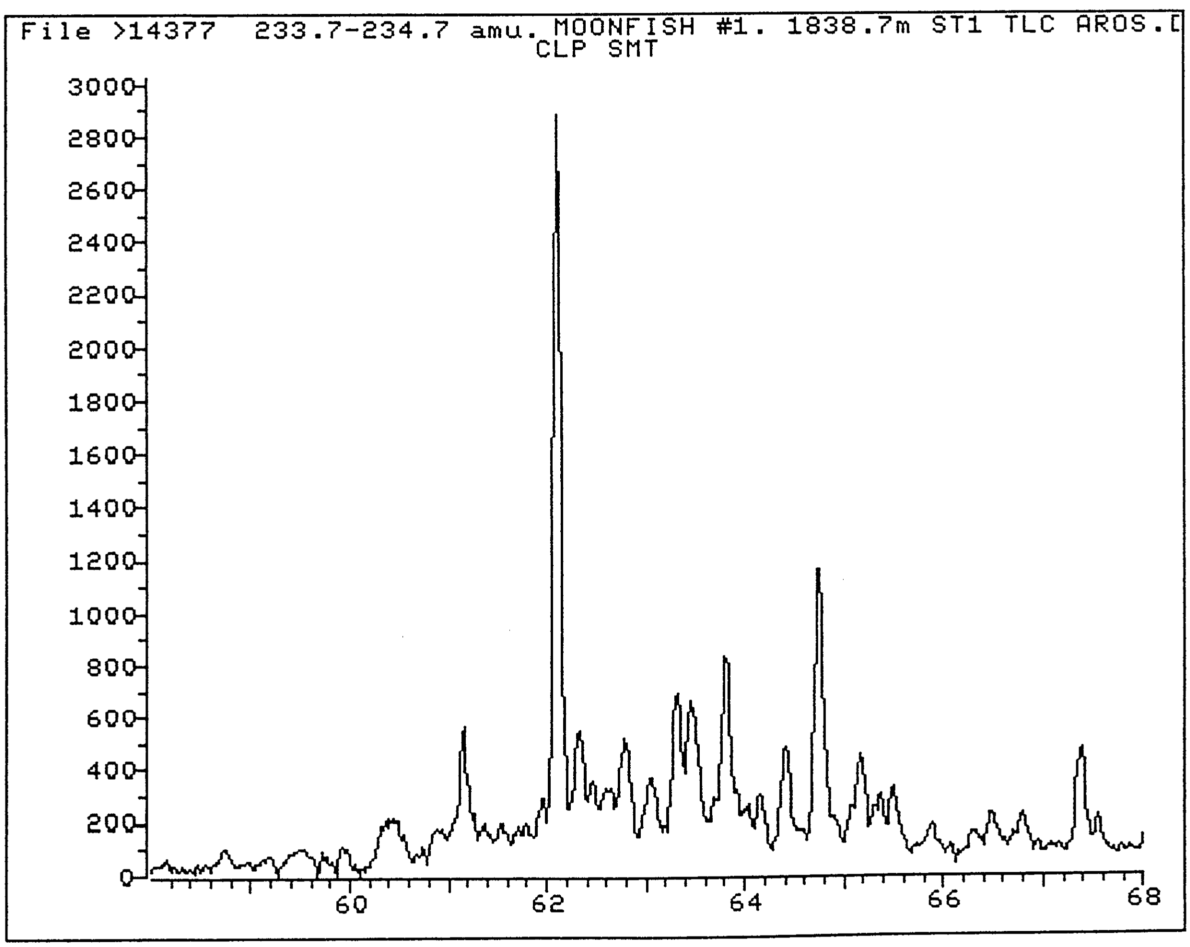
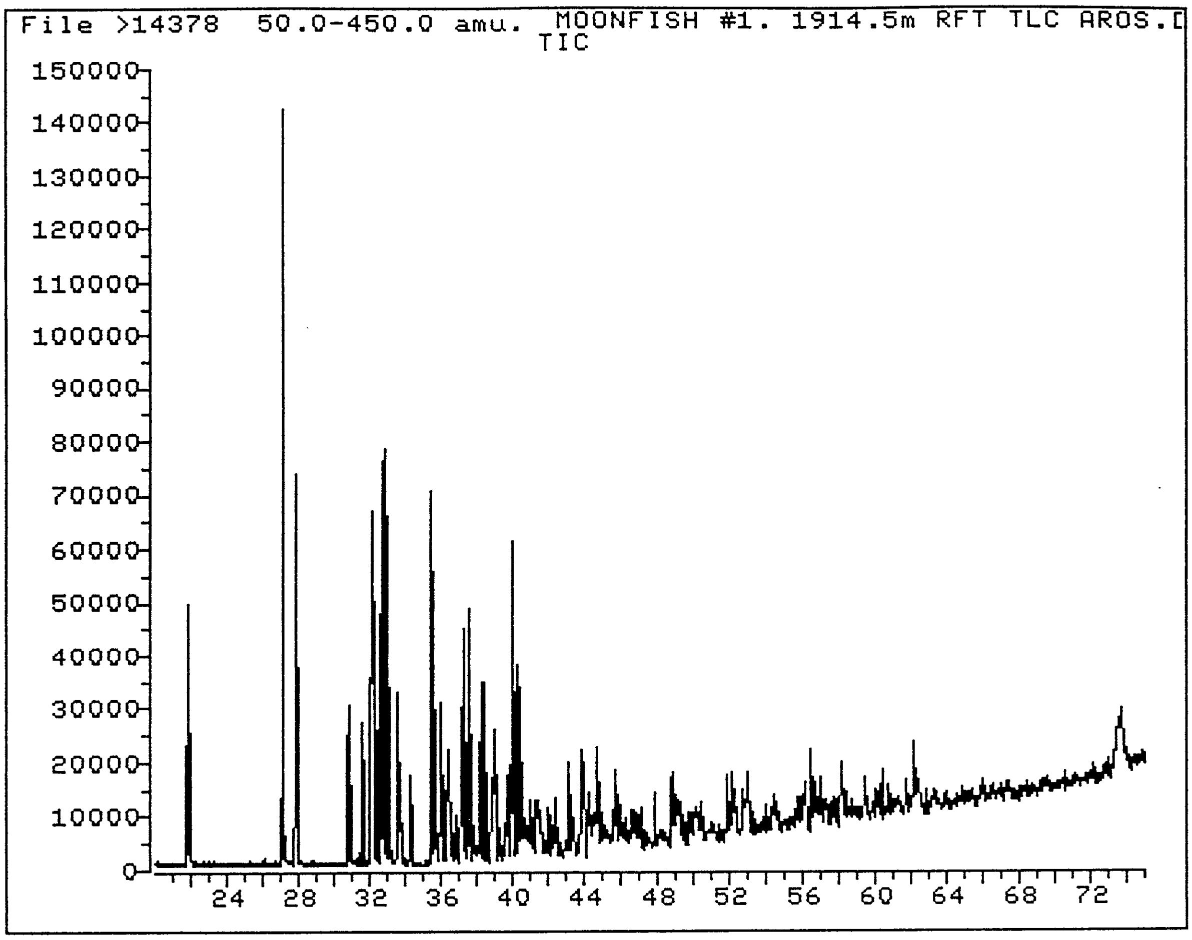
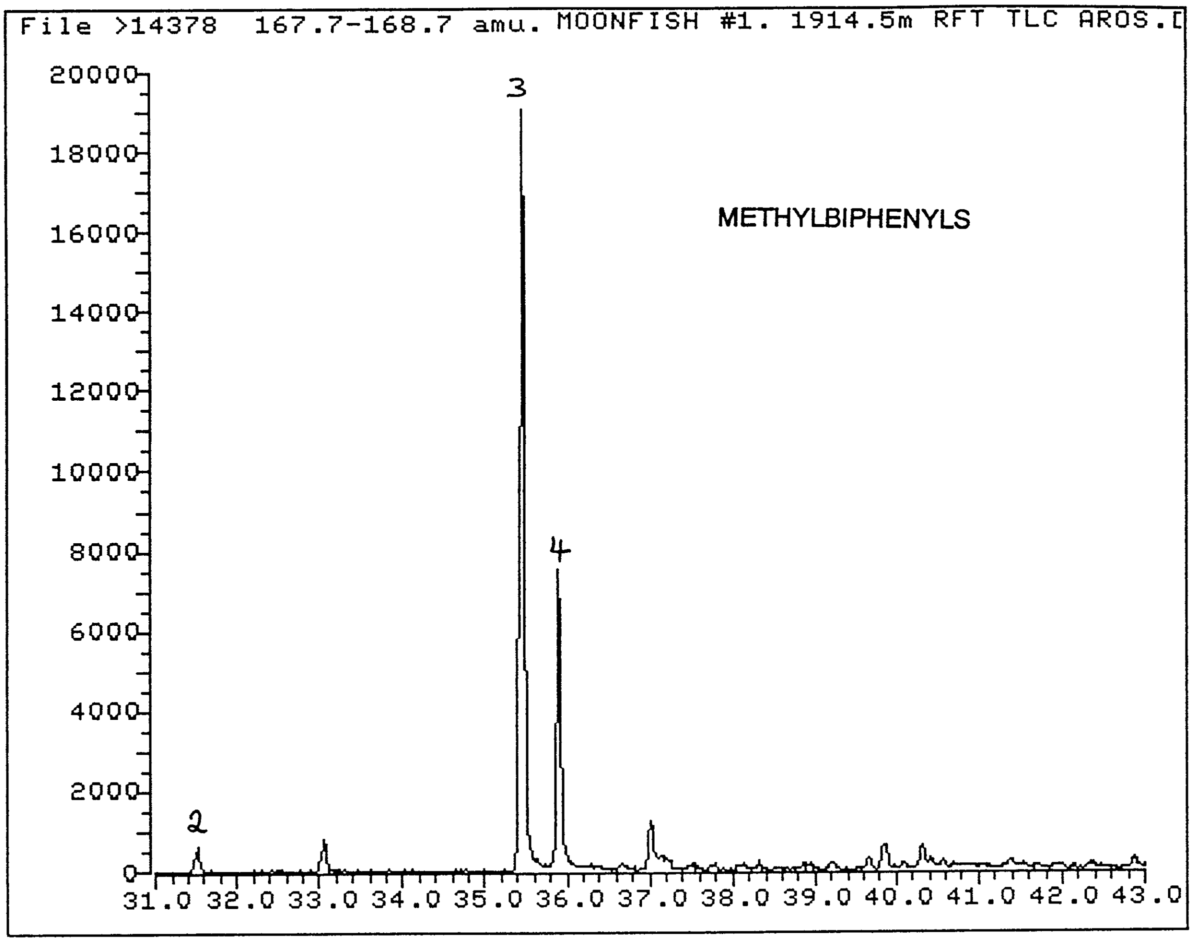
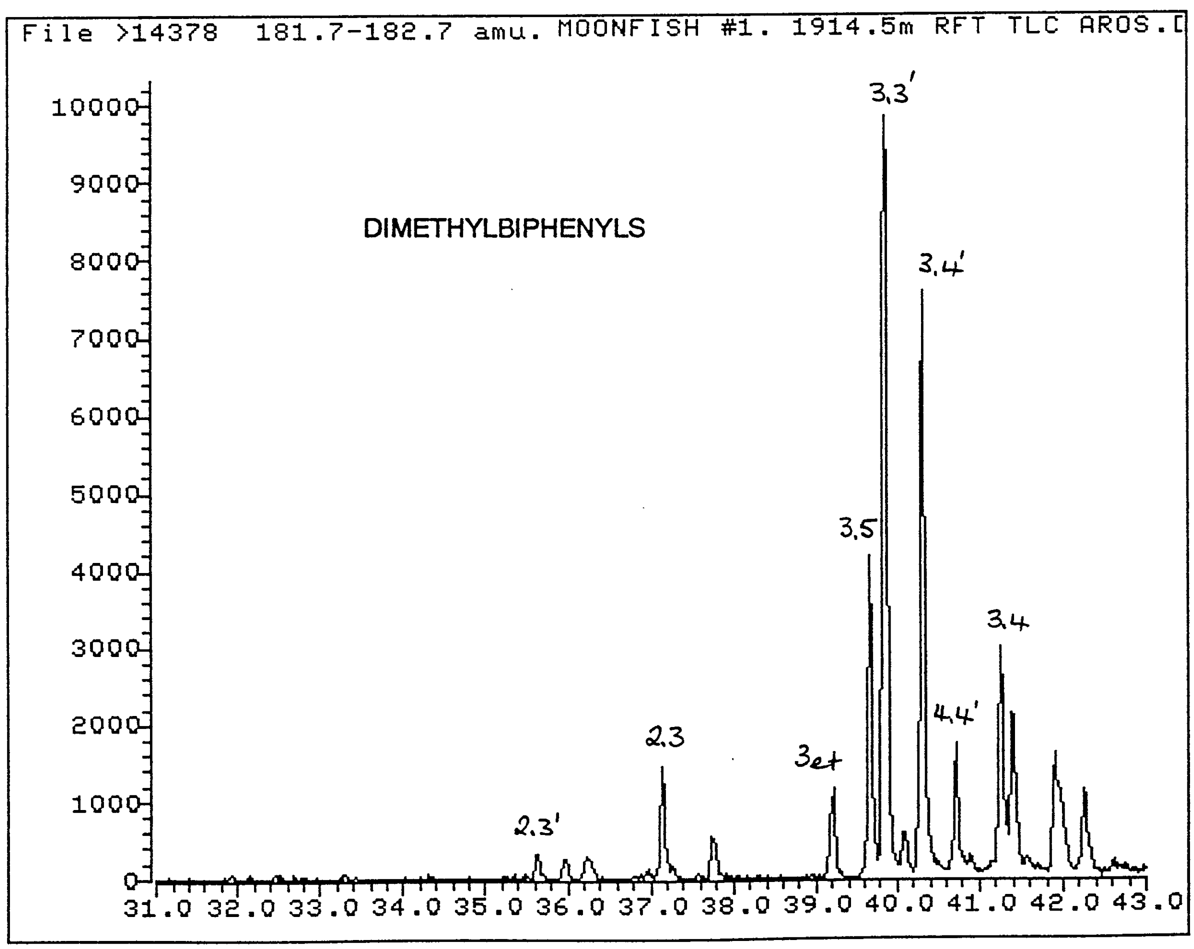
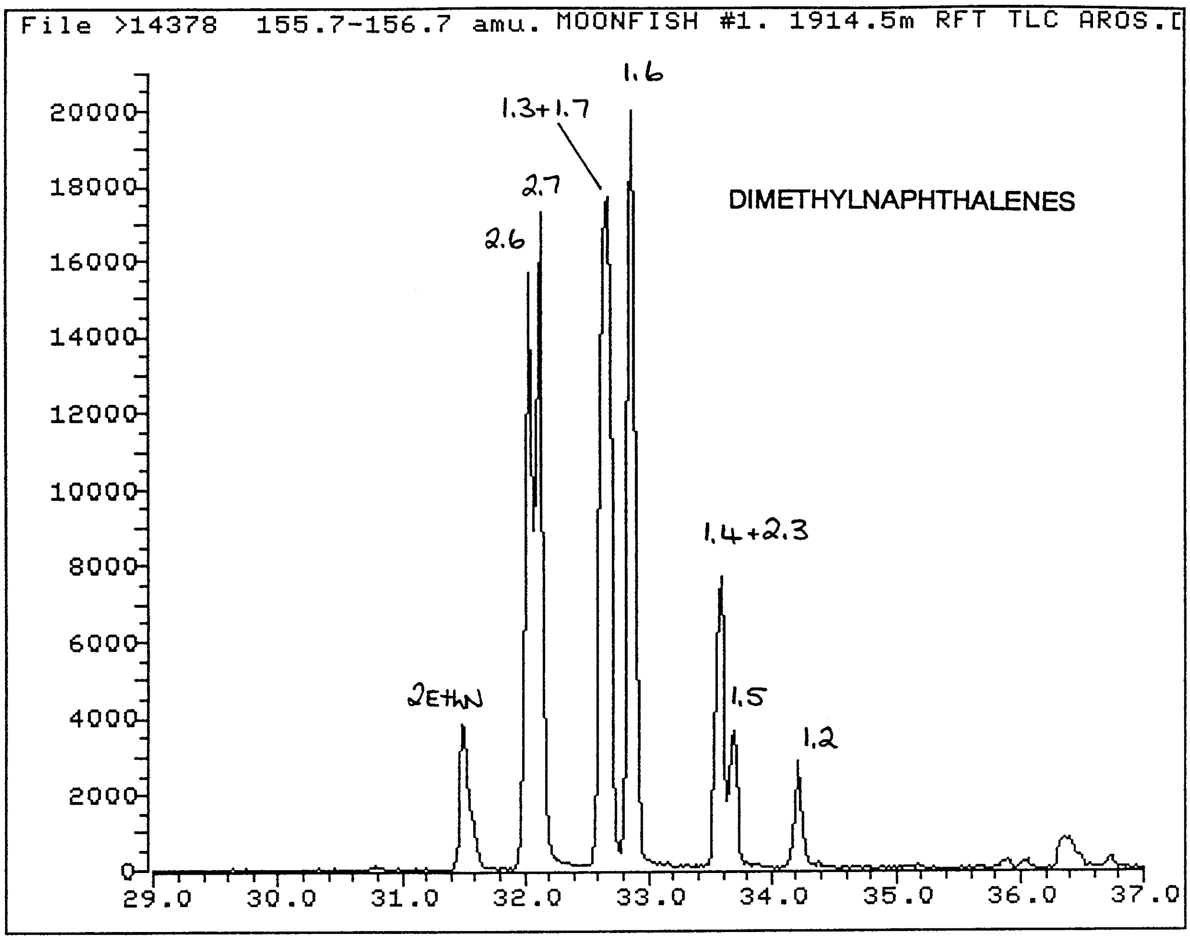

File >14377 233.7-234.7 amu. MOONFISH #1. 1838.7m ST1 TLC AROS.D
CLP SMT
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
60
62
64
66
68

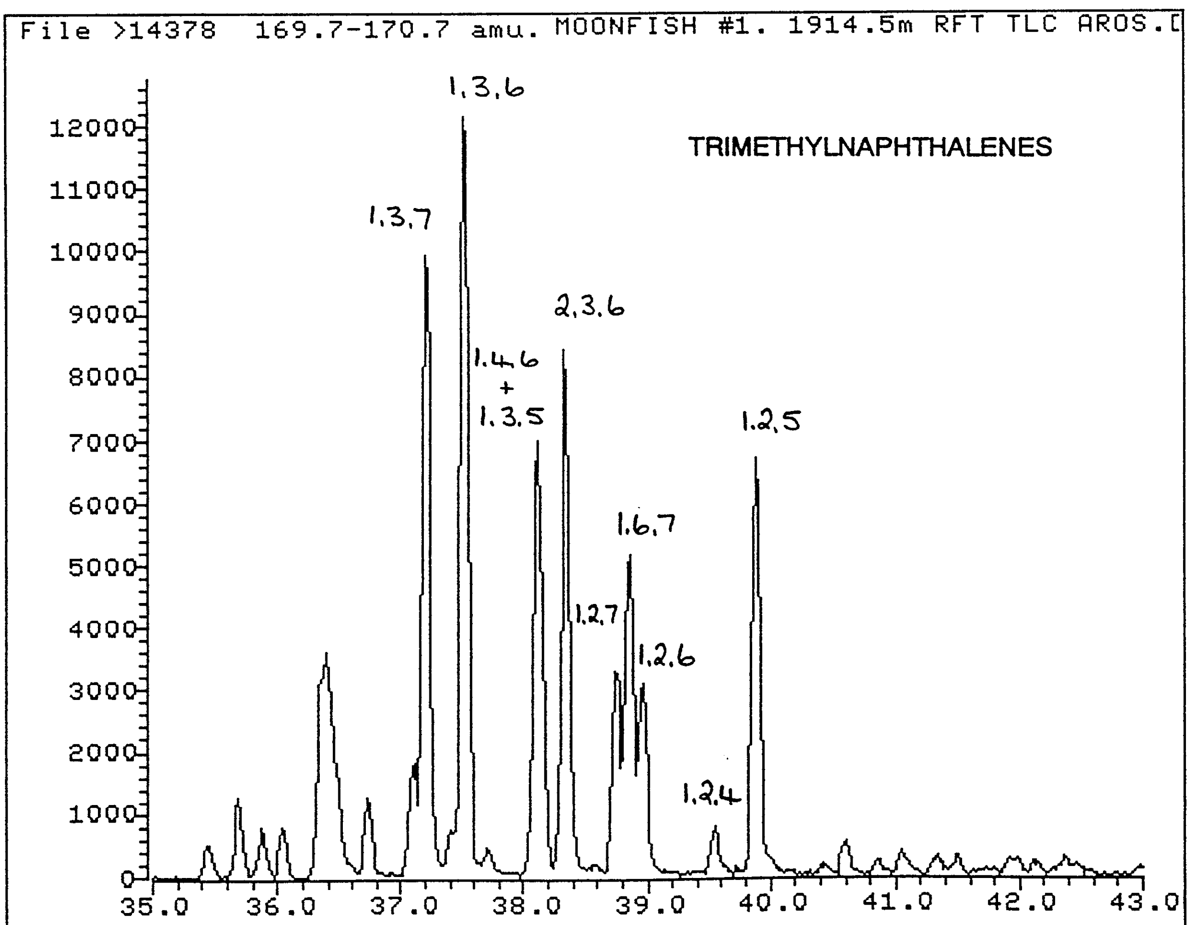
Figure 3–2


File >14378 50.0-450.0 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
TIC
150000
140000
130000
120000
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
24
28
32
36
40
44
48
52
56
60
64
68
72

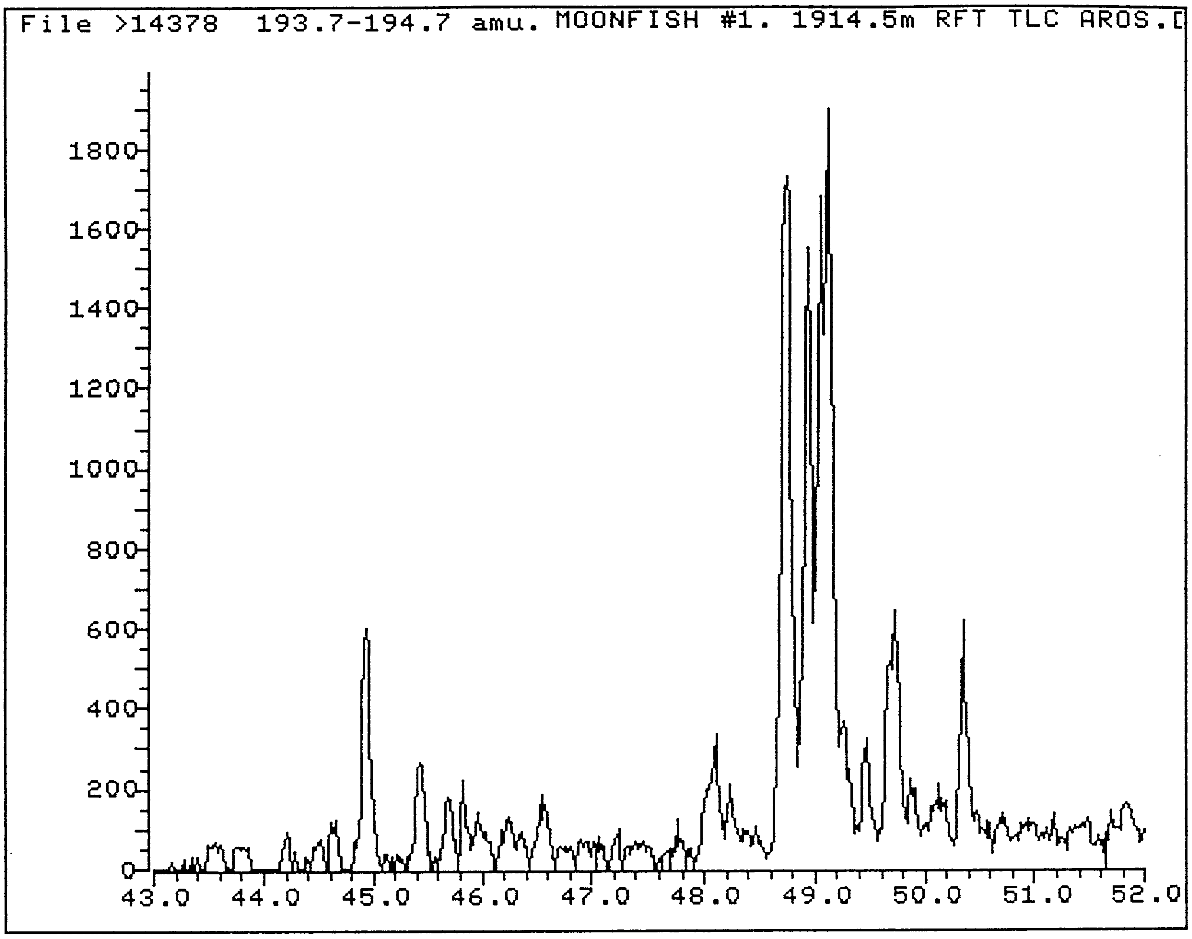

File >14378 167.7-168.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
METHYLBIPHENYLS
2
3
4
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0

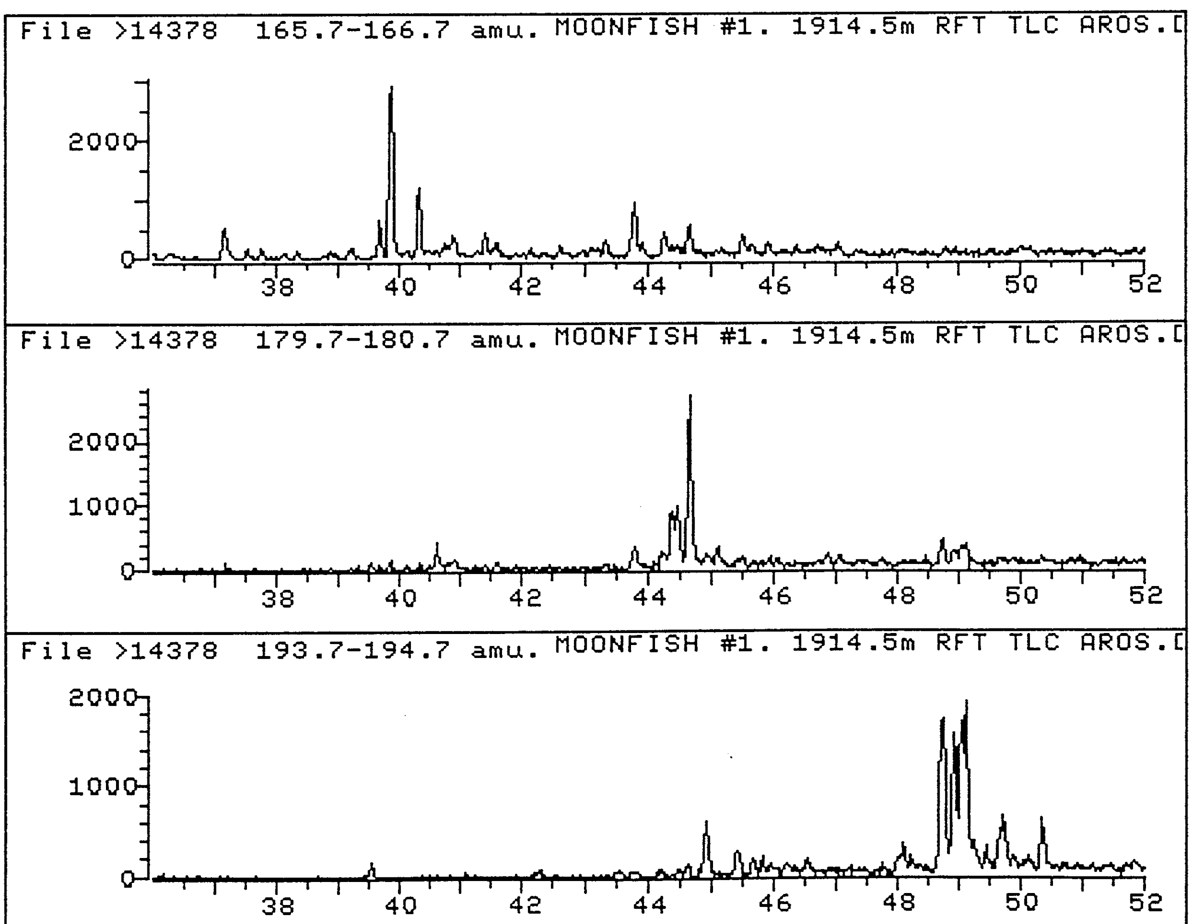

File >14378 181.7-182.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
DIMETHYLBIPHENYLS
3,3'
3,4'
3,5
3,4
4,4'
2,3
3et
2,3'
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0

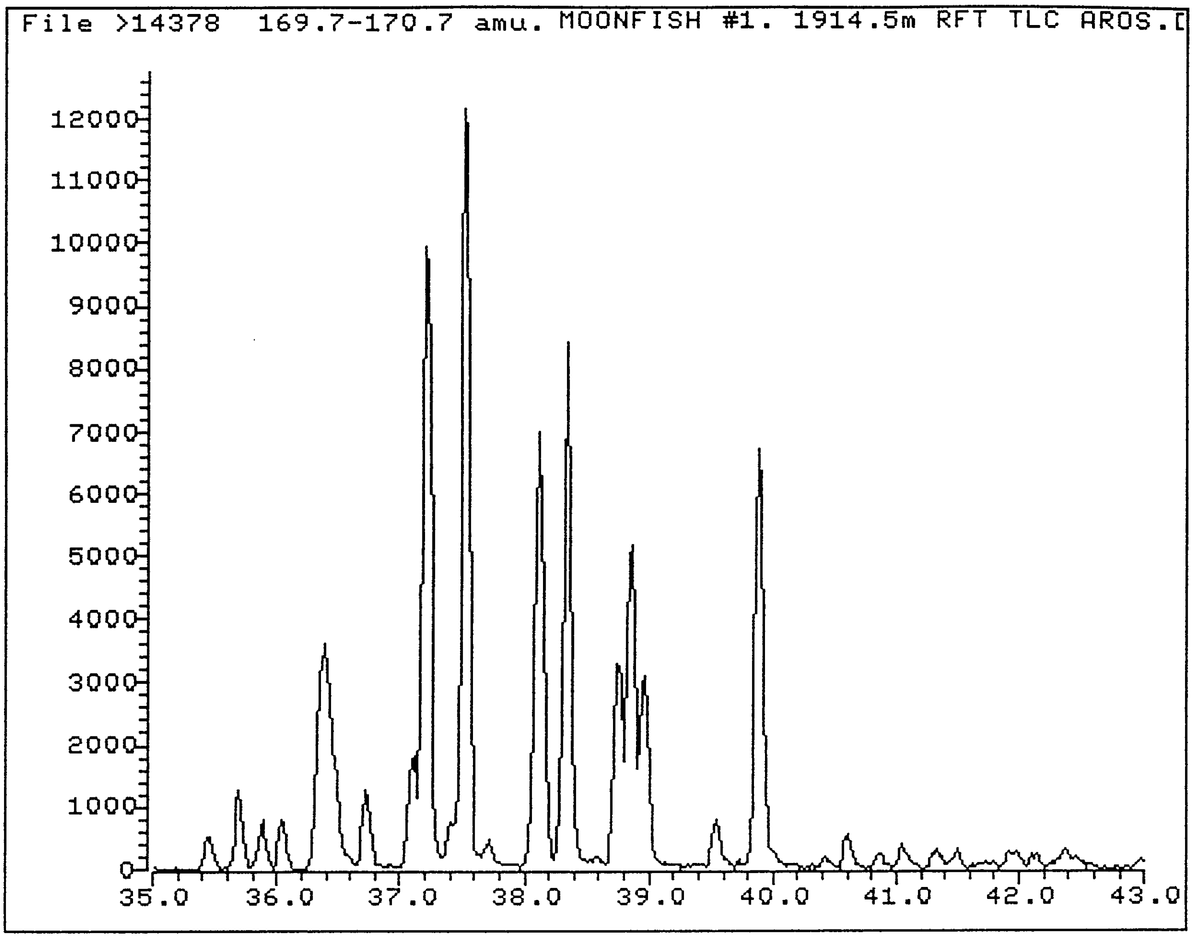

File >14378 155.7-156.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
DIMETHYLNAPHTHALENES
1.6
1.3+1.7
2.7
2.6
1.4+2.3
2EthN
1.5
1.2
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
29.0
30.0
31.0
32.0
33.0
34.0
35.0
36.0
37.0

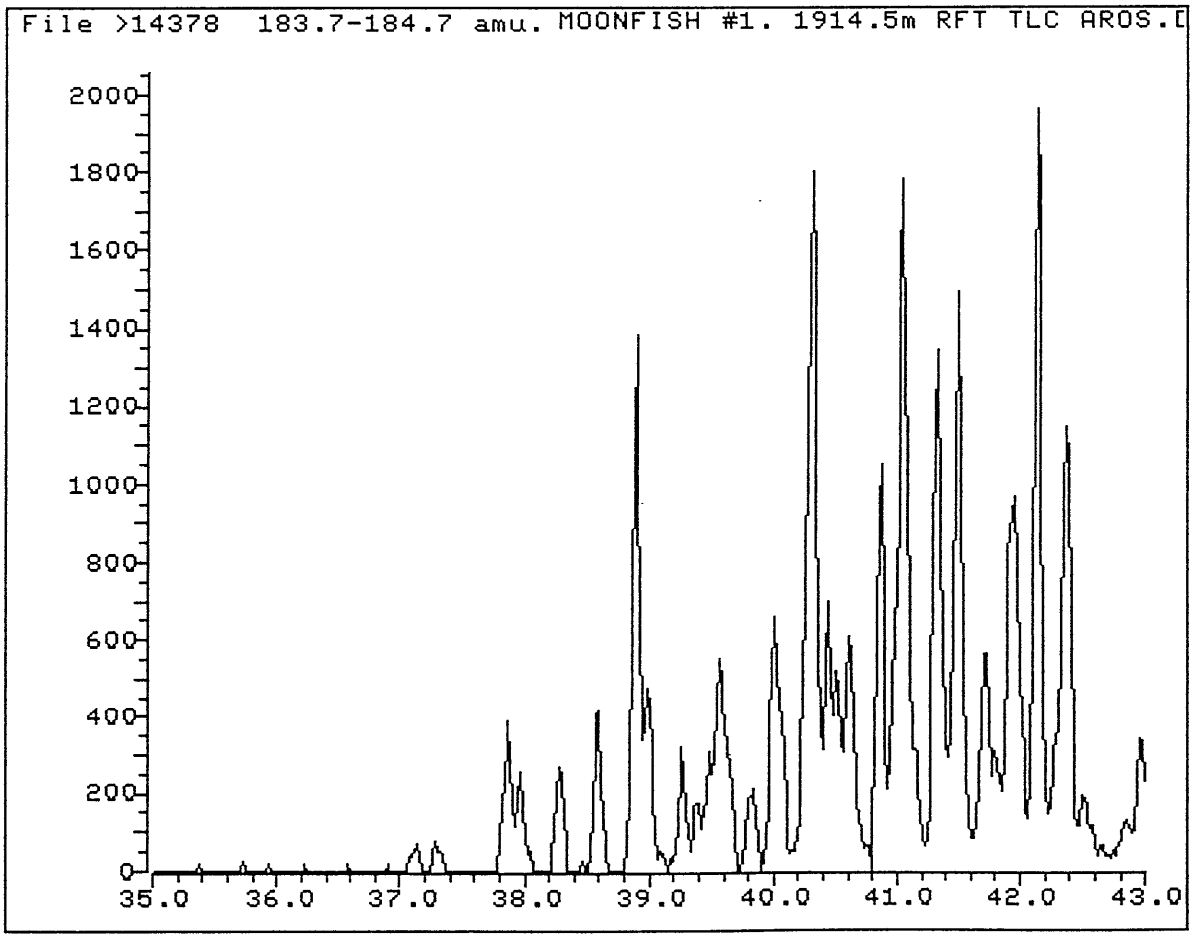

File >14378 169.7-170.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
TRIMETHYLNAPHTHALENES
1.3.6
1.3.7
2.3.6
1.4.6
+
1.3.5
1.2.5
1.6.7
1.2.7
1.2.6
1.2.4
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
35.0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0

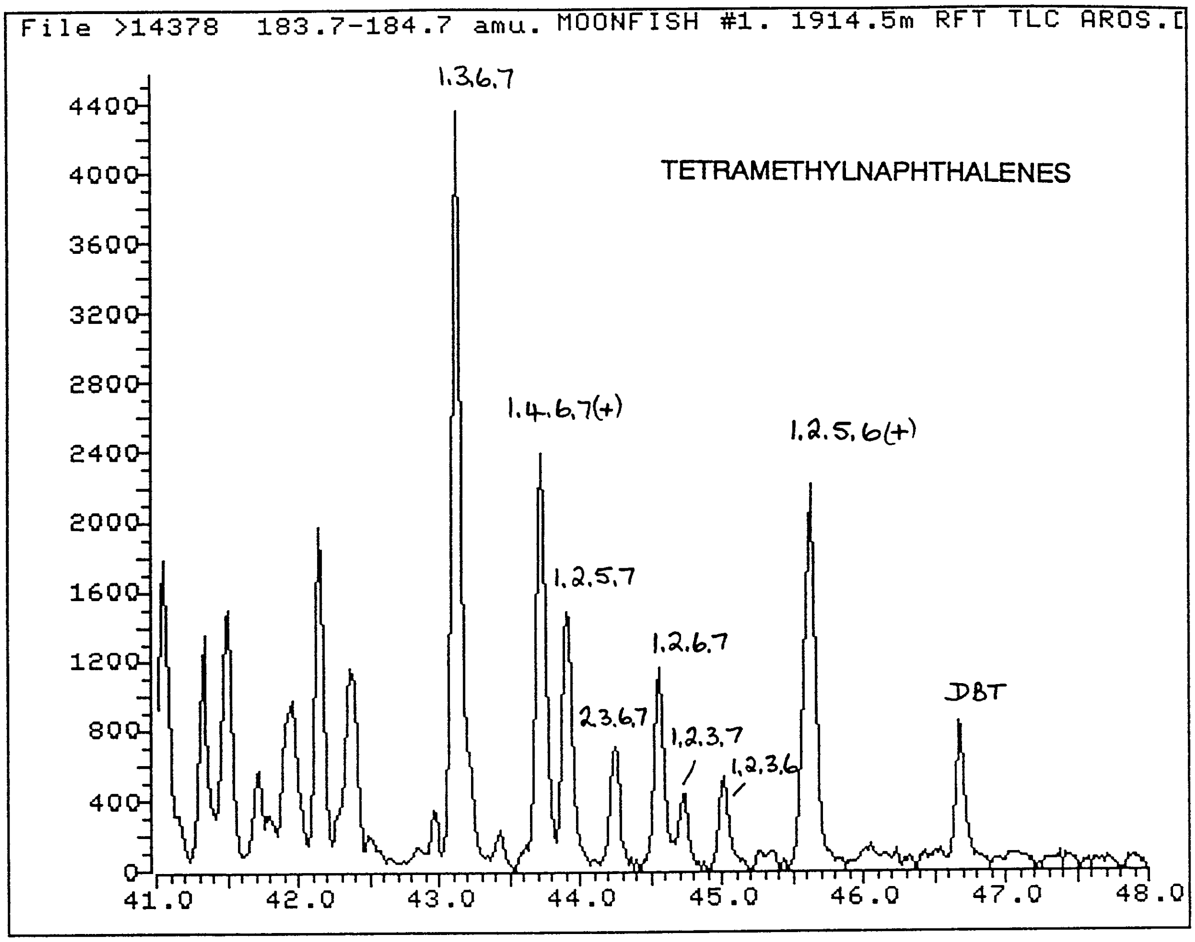
FLUORENES

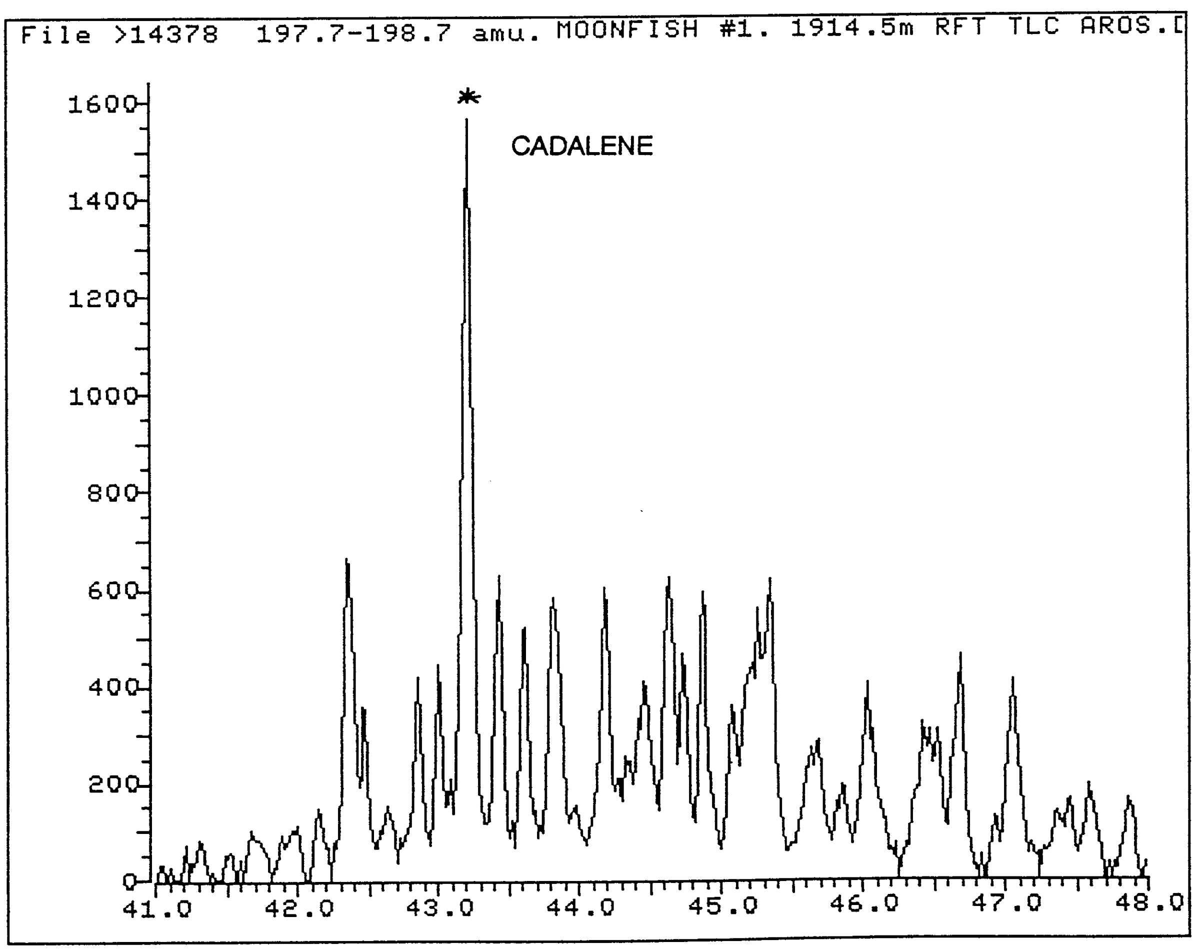

File >14378 193.7-194.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
1800
1600
1400
1200
1000
800
600
400
200
0
43.0 44.0 45.0 46.0 47.0 48.0 49.0 50.0 51.0 52.0


File >14378 165.7-166.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
2000
0
38 40 42 44 46 48 50 52
File >14378 179.7-180.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
2000
1000
0
38 40 42 44 46 48 50 52
File >14378 193.7-194.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
2000
1000
0
38 40 42 44 46 48 50 52


File >14378 169.7-170.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
35.0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0


File >14378 183.7-184.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
2000
1800
1600
1400
1200
1000
800
600
400
200
0
35.0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0


File >14378 183.7-184.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
TETRAMETHYLNAPHTHALENES
1,3,6,7
1,4,6,7(+)
1,2,5,7
2,3,6,7
1,2,6,7
1,2,3,7
1,2,3,6
1,2,5,6(+)
DBT
4400
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
41.0
42.0
43.0
44.0
45.0
46.0
47.0
48.0


File >14378 197.7-198.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
*
CADALENE
1600
1400
1200
1000
800
600
400
200
0
41.0
42.0
43.0
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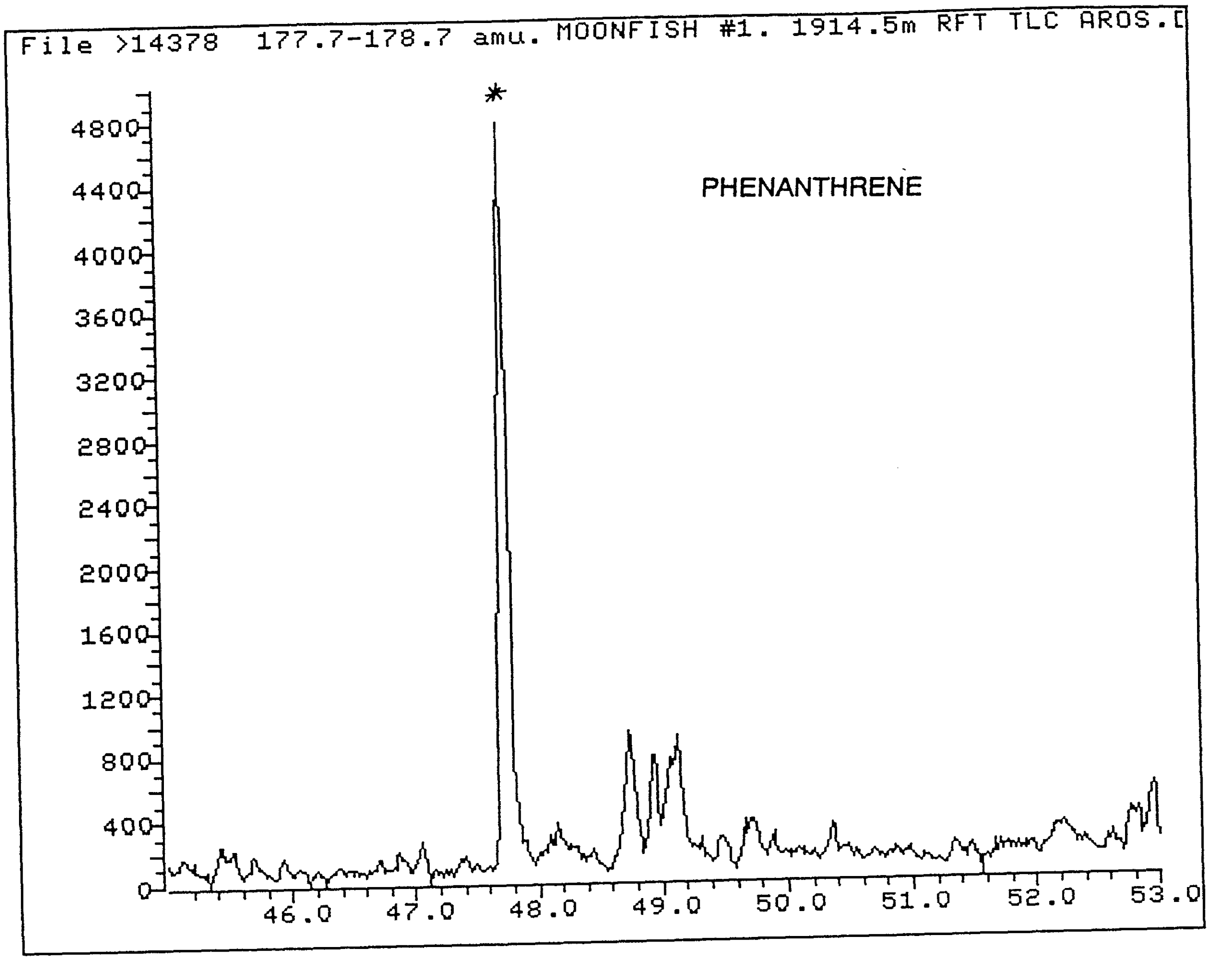
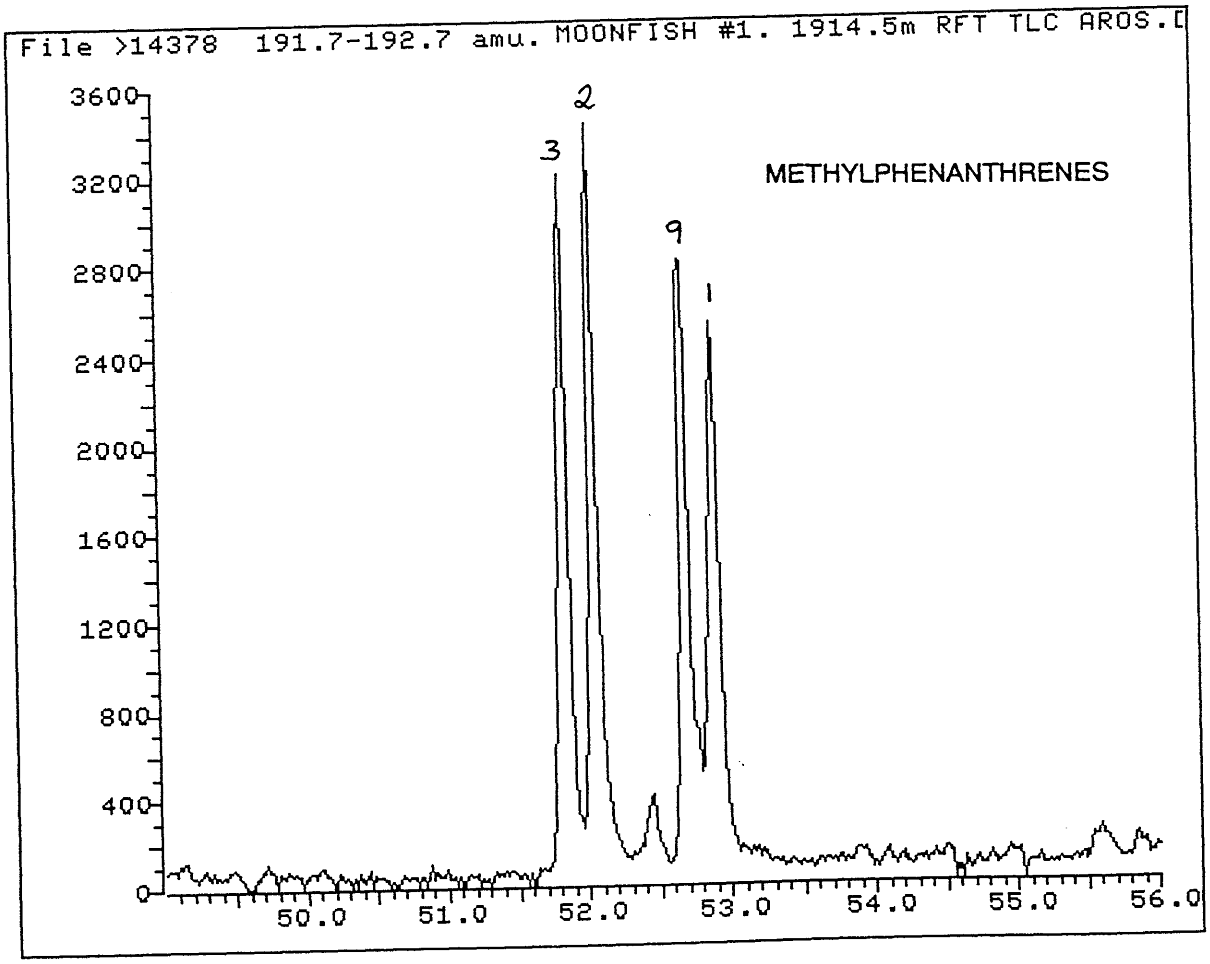
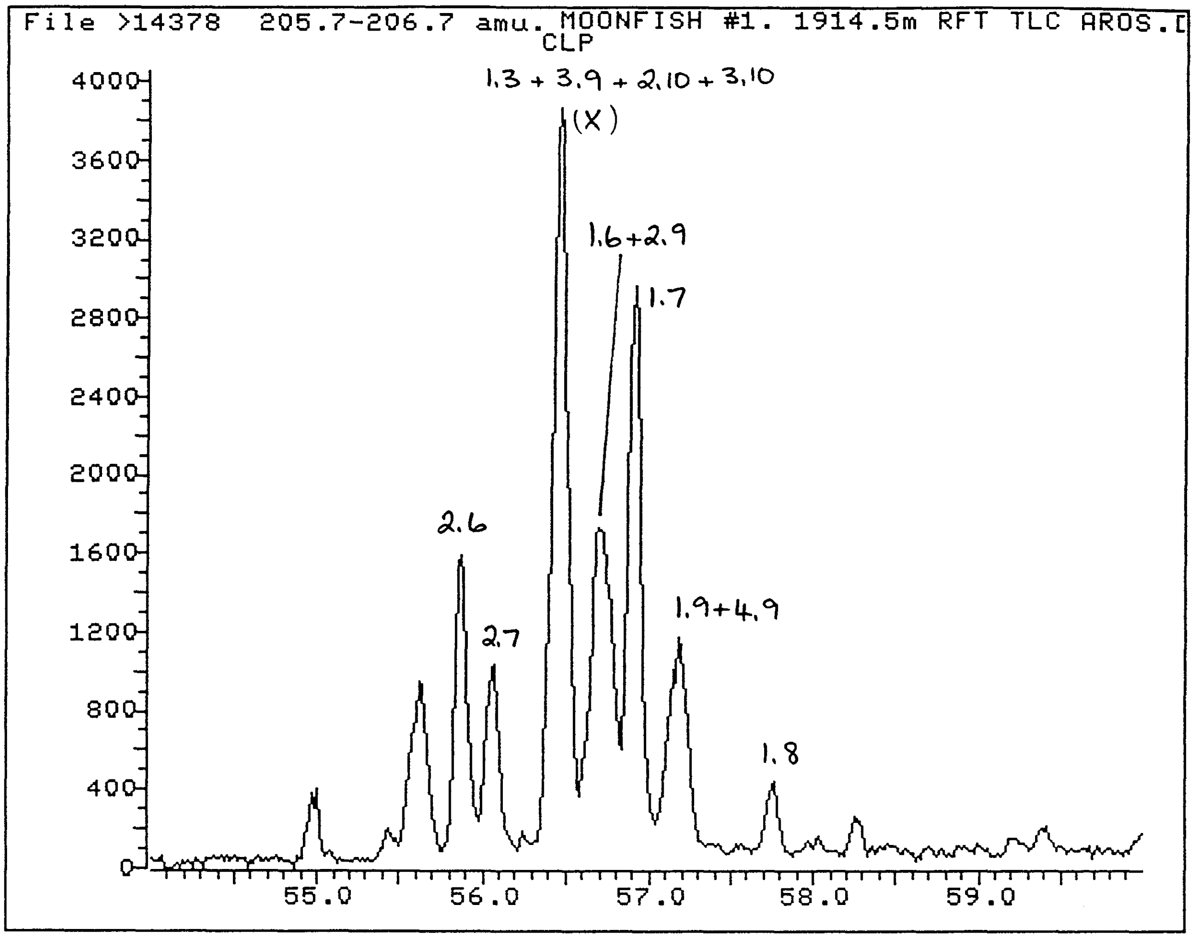
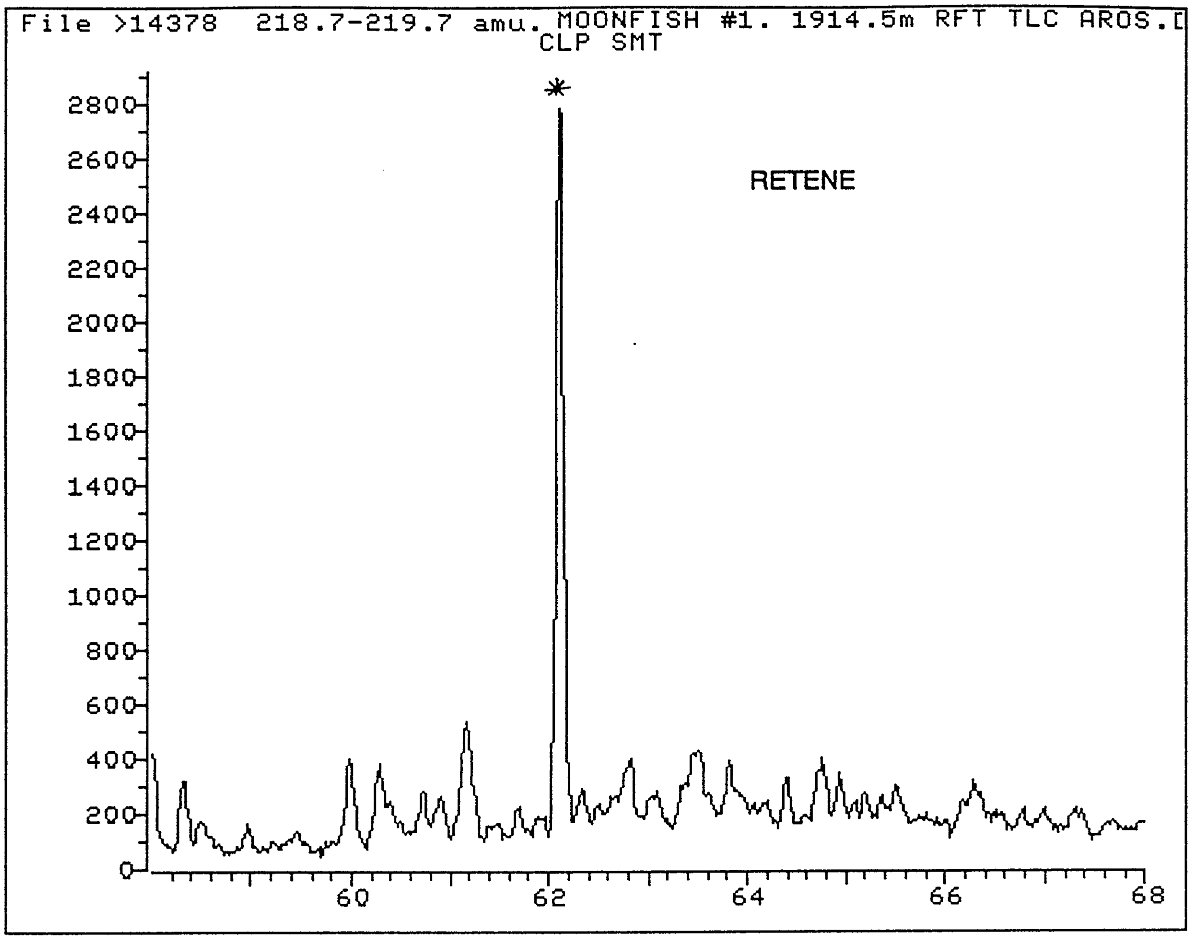
46.0
47.0
48.0


File >14378 177.7-178.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
PHENANTHRENE
*
4800
4400
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
46.0
47.0
48.0
49.0
50.0
51.0
52.0
53.0


File >14378 191.7-192.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
METHYLPHENANTHRENES
3
2
9
1
3600
3200
2800
2400
2000
1600
1200
800
400
0
50.0
51.0
52.0
53.0
54.0
55.0
56.0



DIMETHYLPHENANTHRENES


File >14378 218.7-219.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
CLP SMT
RETENE
*
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
60
62
64
66
68

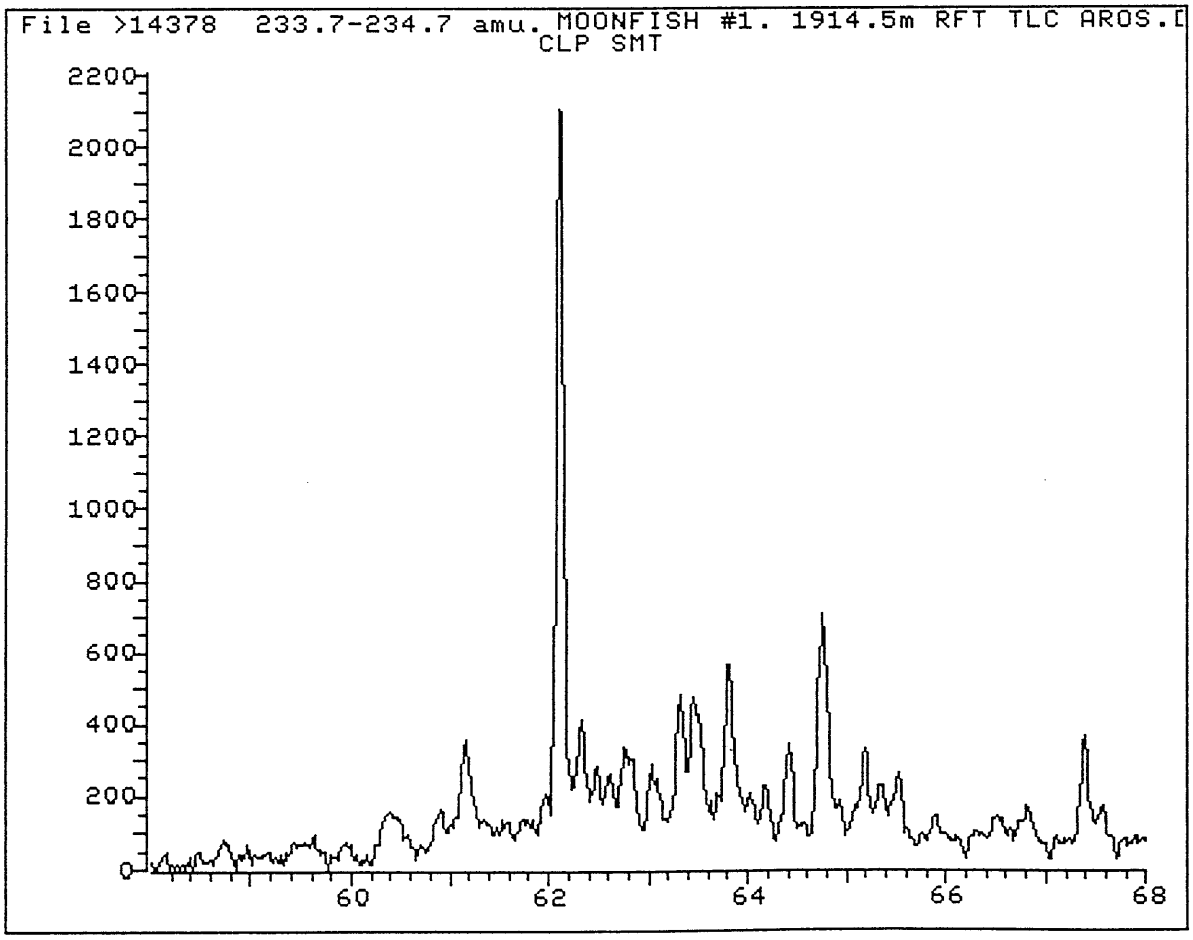
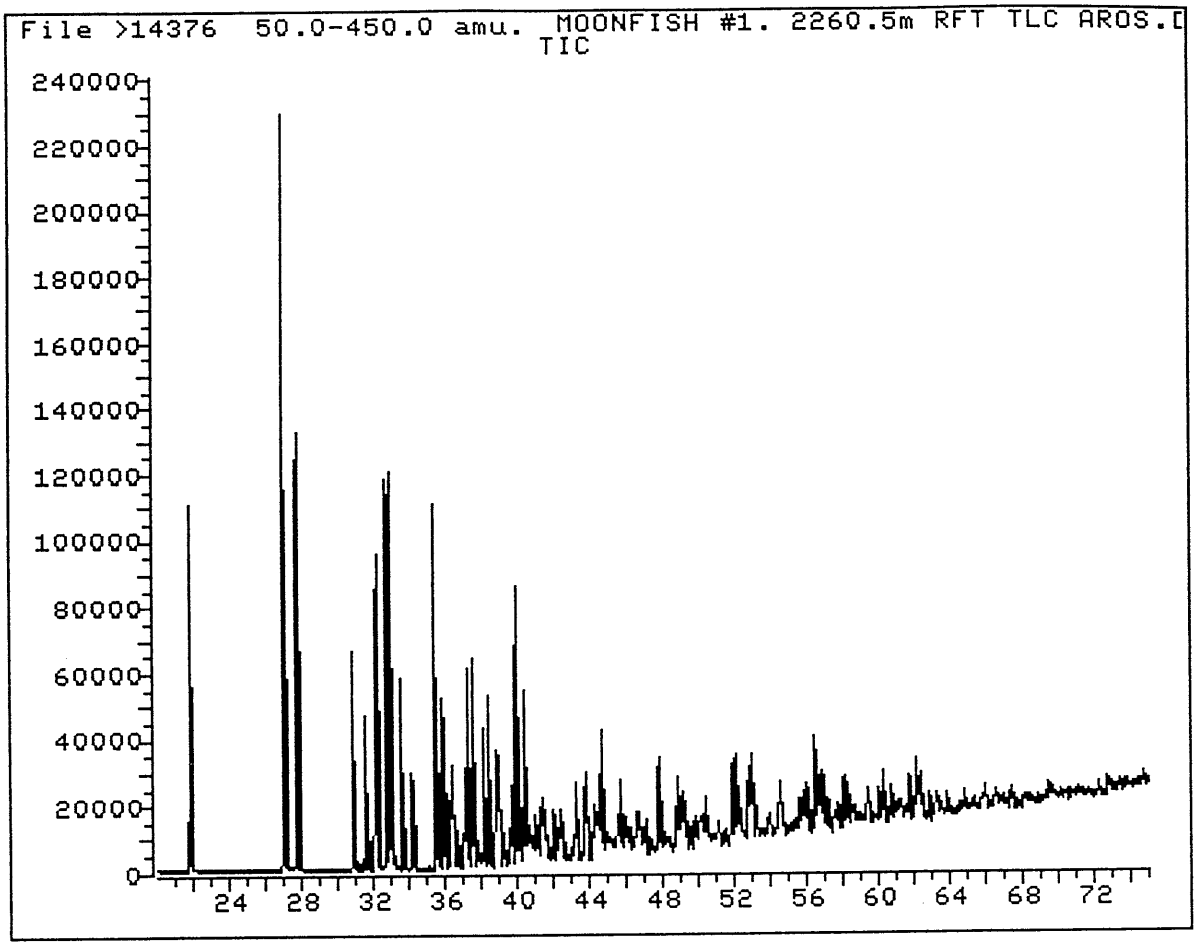
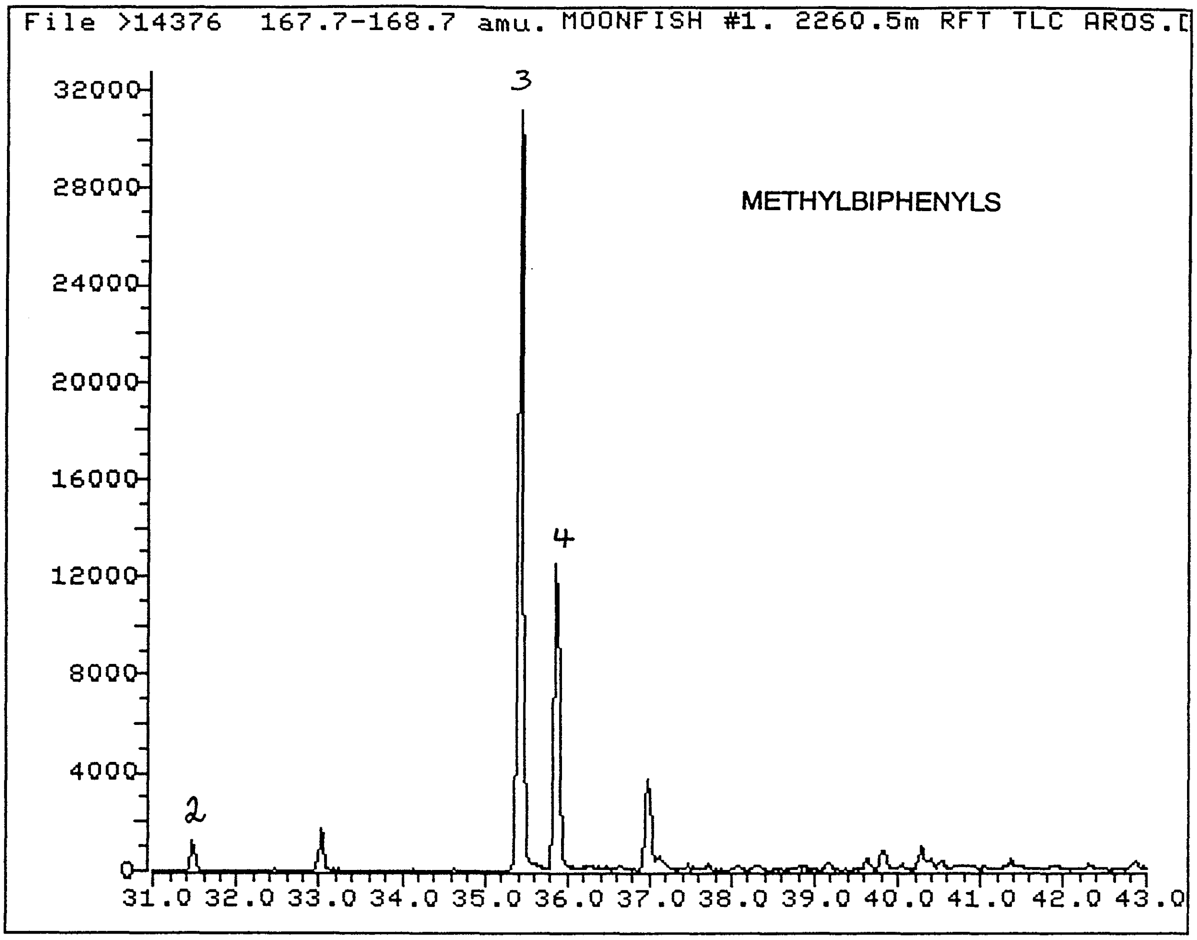
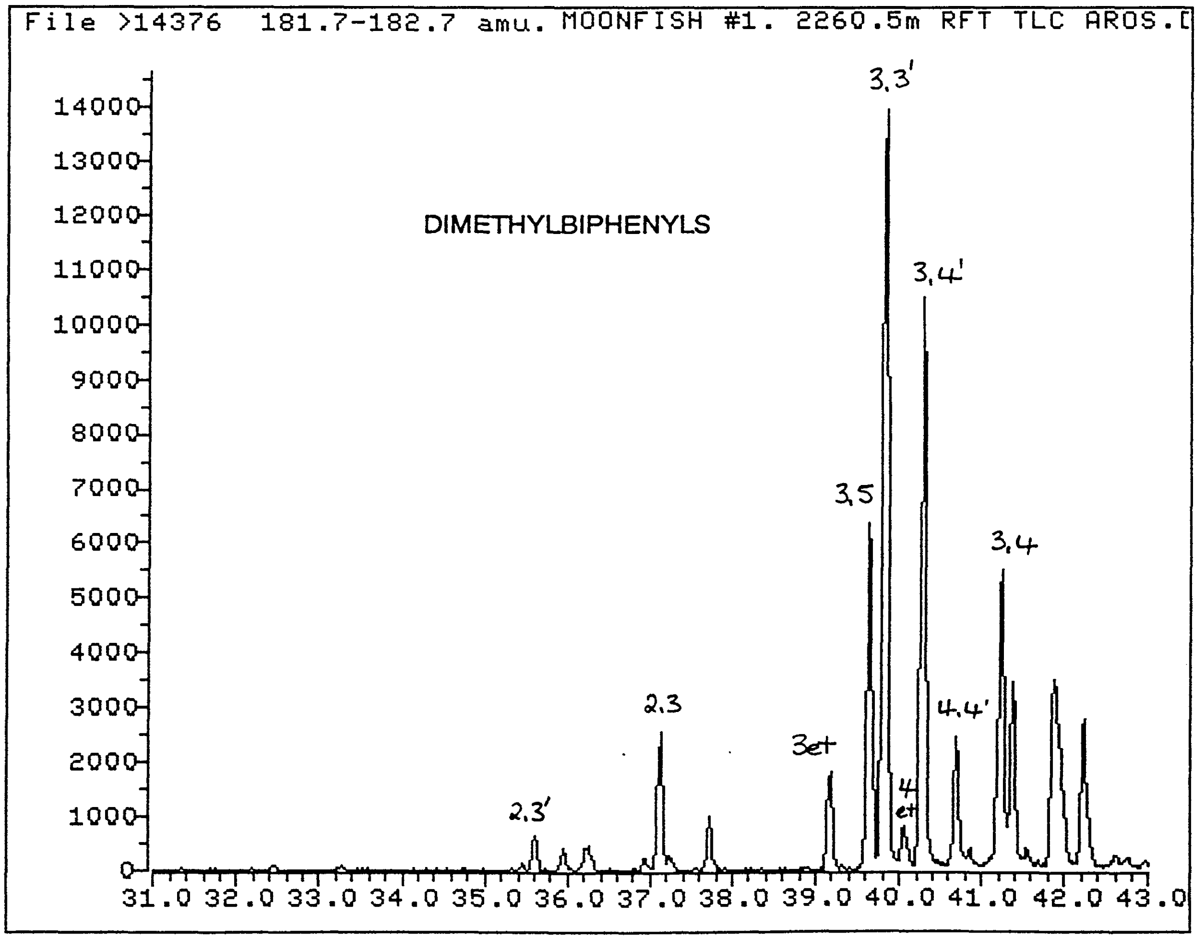

File >14378 233.7-234.7 amu. MOONFISH #1. 1914.5m RFT TLC AROS.D
CLP SMT
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
60
62
64
66
68

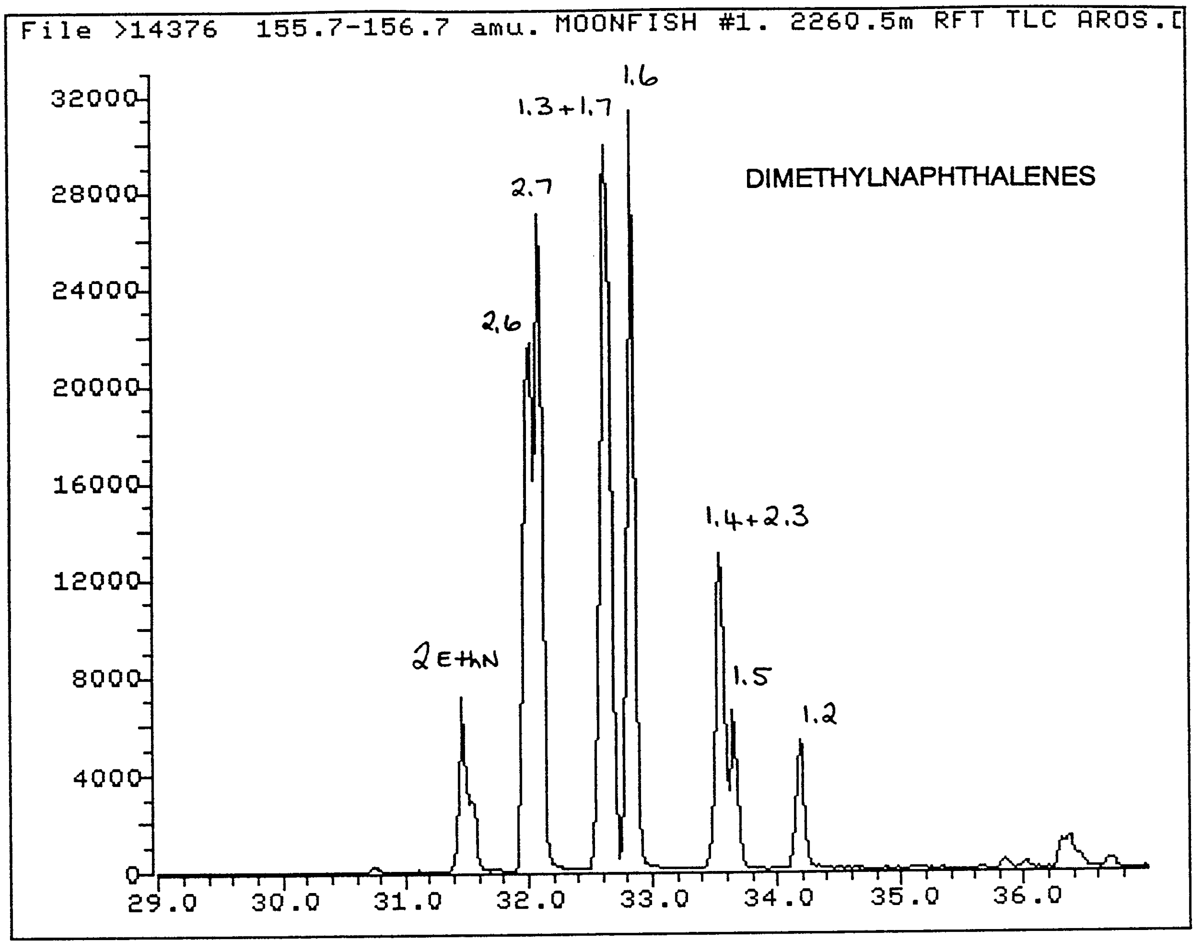
Figure 3-3

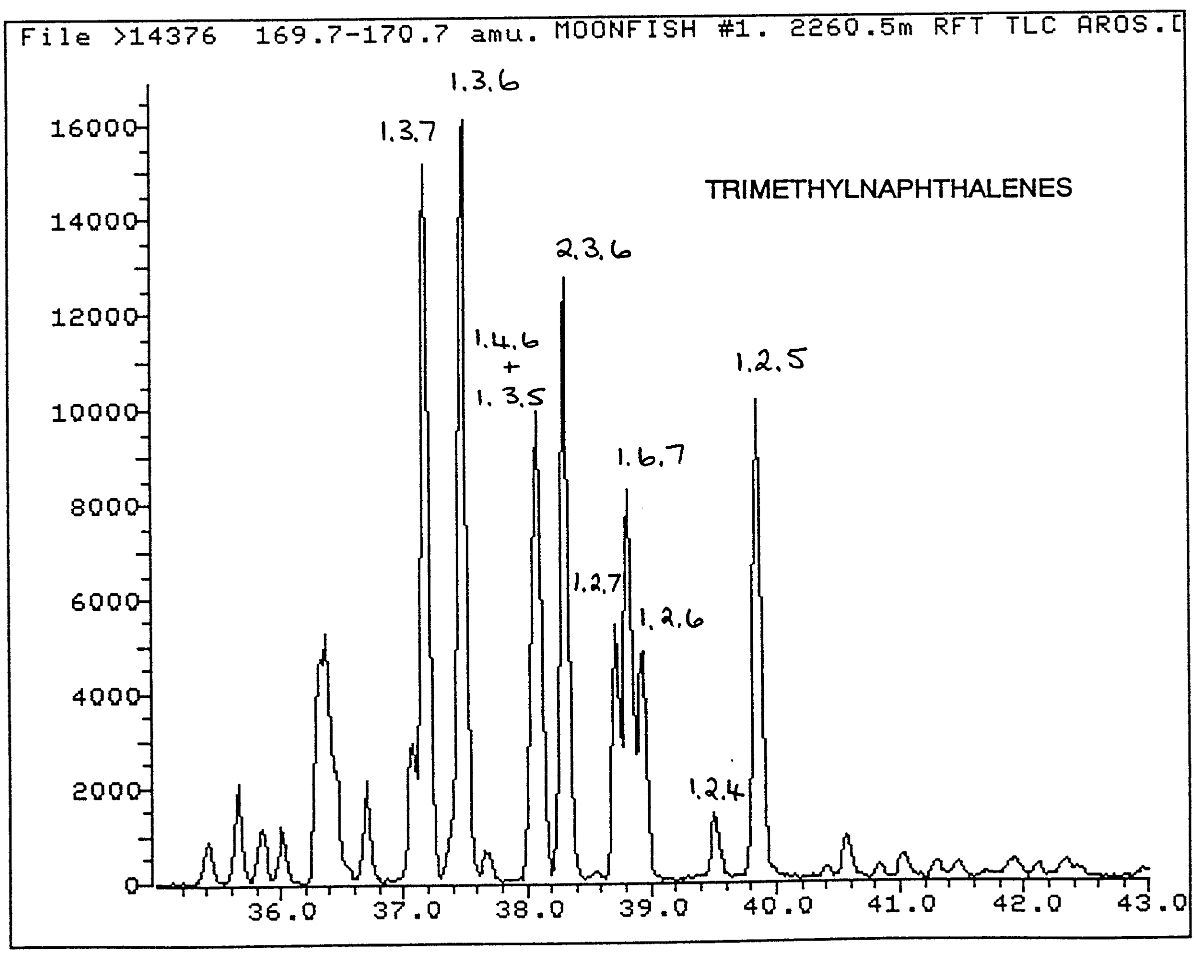


File >14376 50.0-450.0 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
TIC
240000
220000
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
24
28
32
36
40
44
48
52
56
60
64
68
72

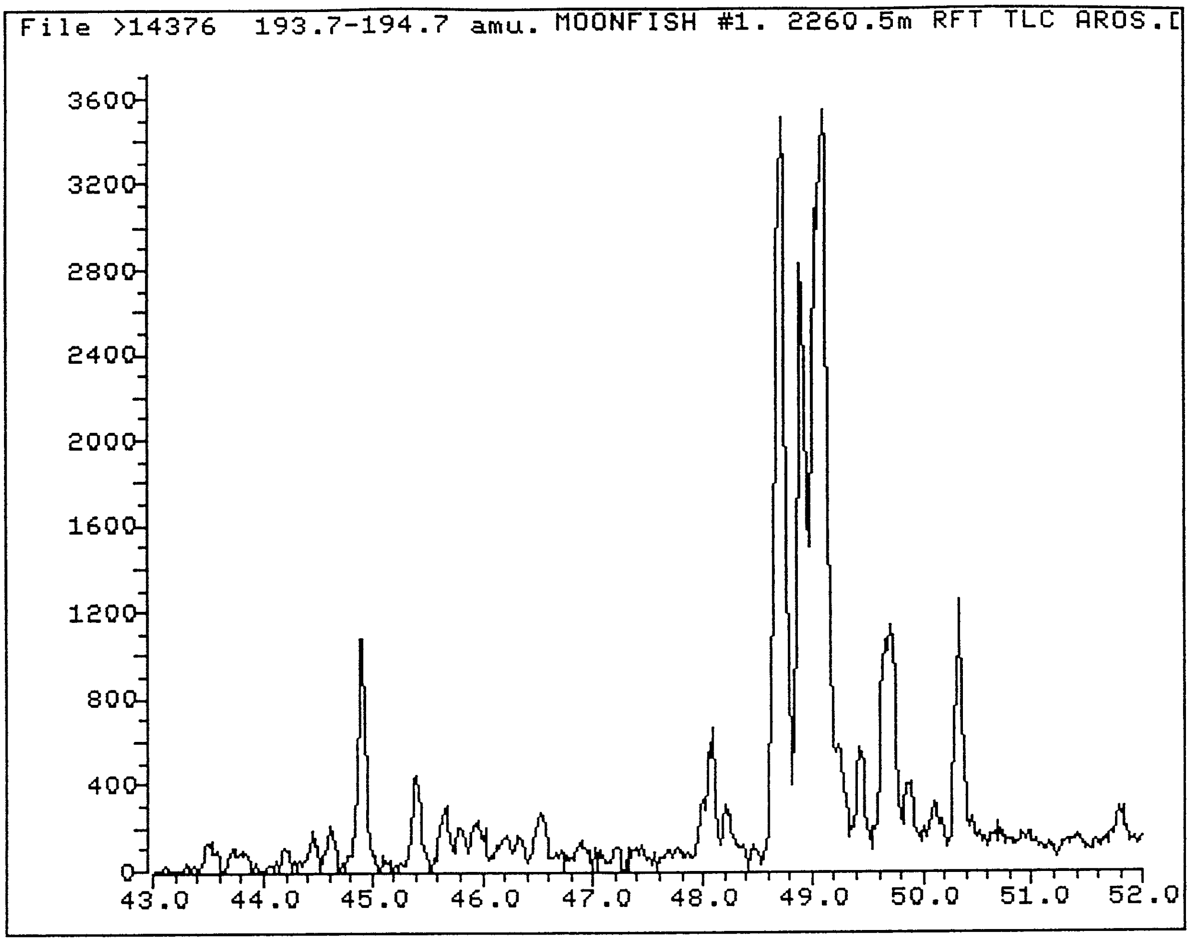

File >14376 167.7-168.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
METHYLBIPHENYLS
3
4
2
32000
28000
24000
20000
16000
12000
8000
4000
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0


File >14376 181.7-182.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
DIMETHYLBIPHENYLS
3,3'
3,4'
3,5
3,4
4,4'
2,3
3et
4 et
2,3'
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0

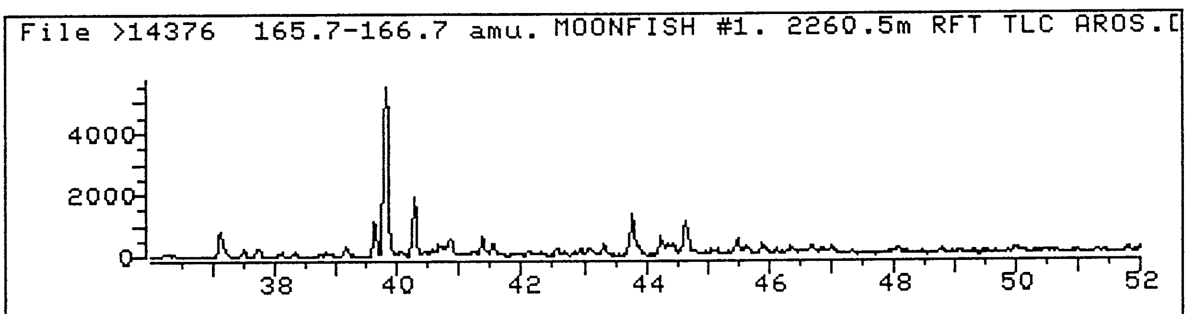

File >14376 155.7-156.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
DIMETHYLNAPHTHALENES
32000
28000
24000
20000
16000
12000
8000
4000
0
29.0
30.0
31.0
32.0
33.0
34.0
35.0
36.0
2EthN
2,6
2,7
1,3+1,7
1,6
1,4+2,3
1,5
1,2


File >14376 169.7-170.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
TRIMETHYLNAPHTHALENES
16000
14000
12000
10000
8000
6000
4000
2000
0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0
1,3,7
1,3,6
1,4,6 + 1,3,5
2,3,6
1,2,7
1,6,7
1,2,6
1,2,4
1,2,5

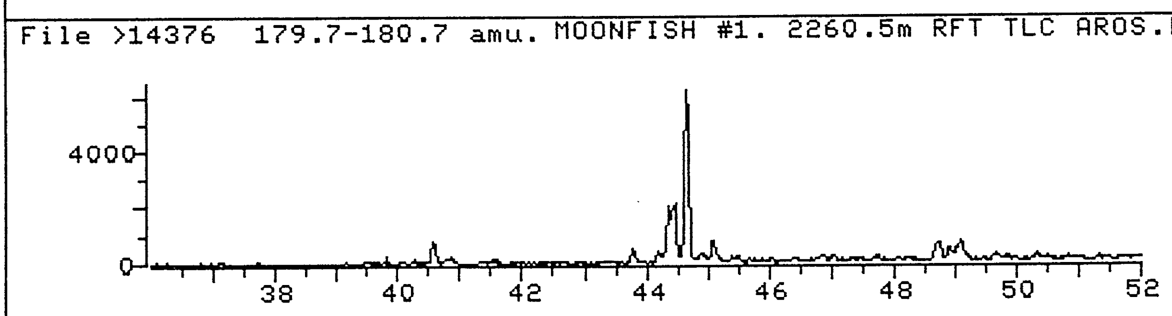
FLUORENES



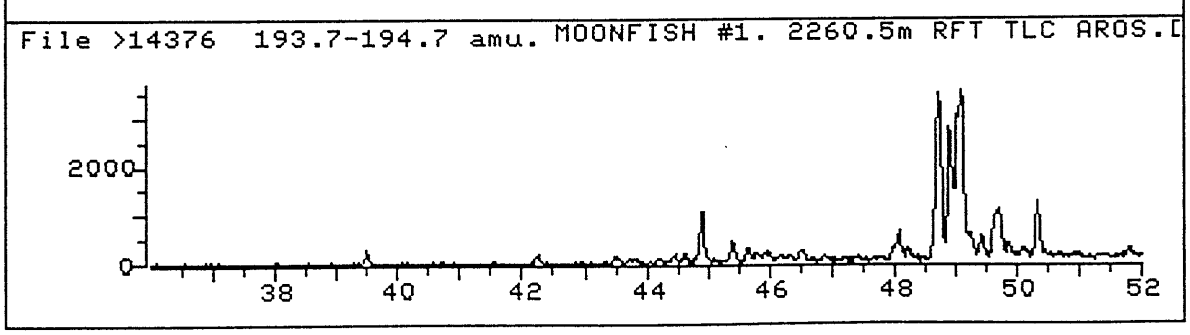
File >14376 193.7-194.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
3600
3200
2800
2400
2000
1600
1200
800
400
0
43.0 44.0 45.0 46.0 47.0 48.0 49.0 50.0 51.0 52.0



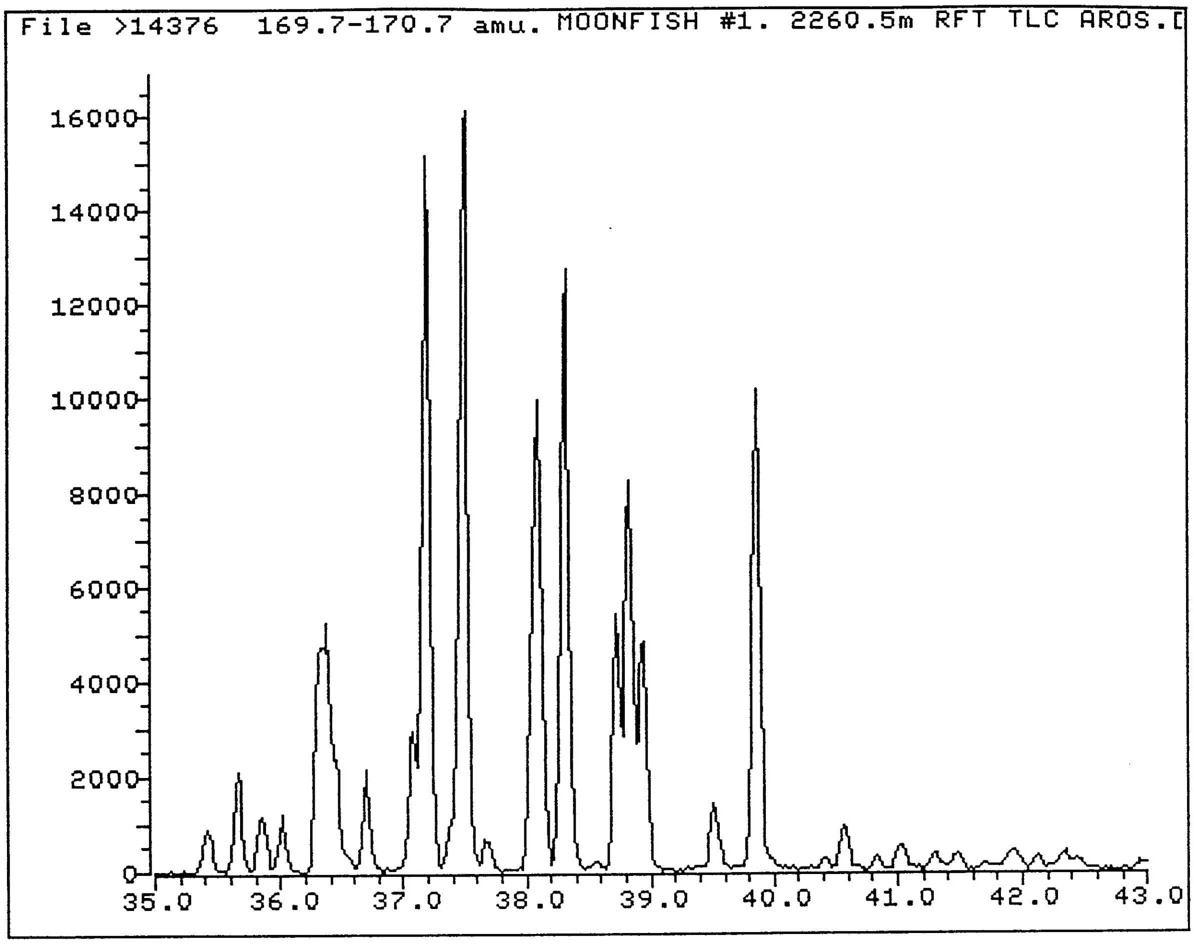
File >14376 165.7-166.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
4000
2000
0
38 40 42 44 46 48 50 52



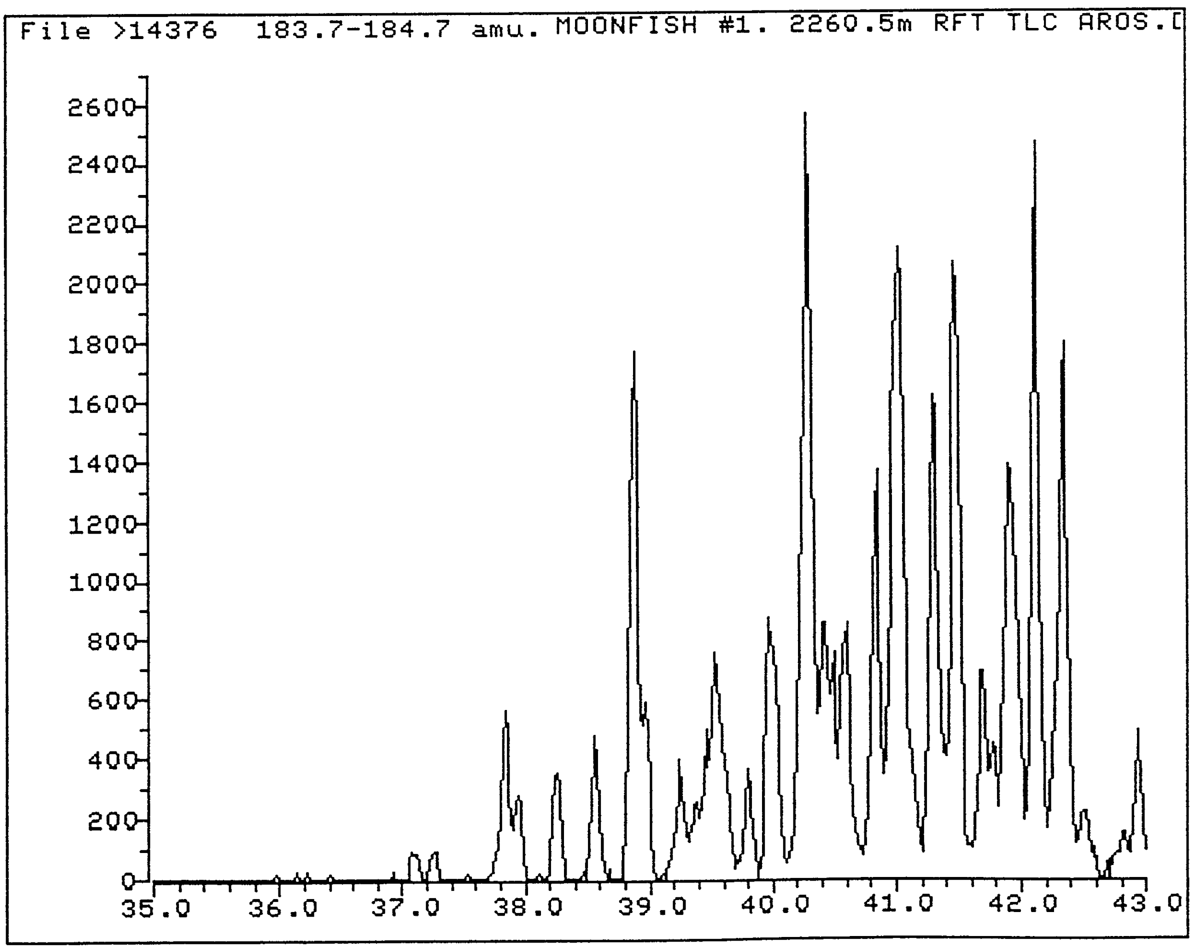
File >14376 179.7-180.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
4000
0
38 40 42 44 46 48 50 52



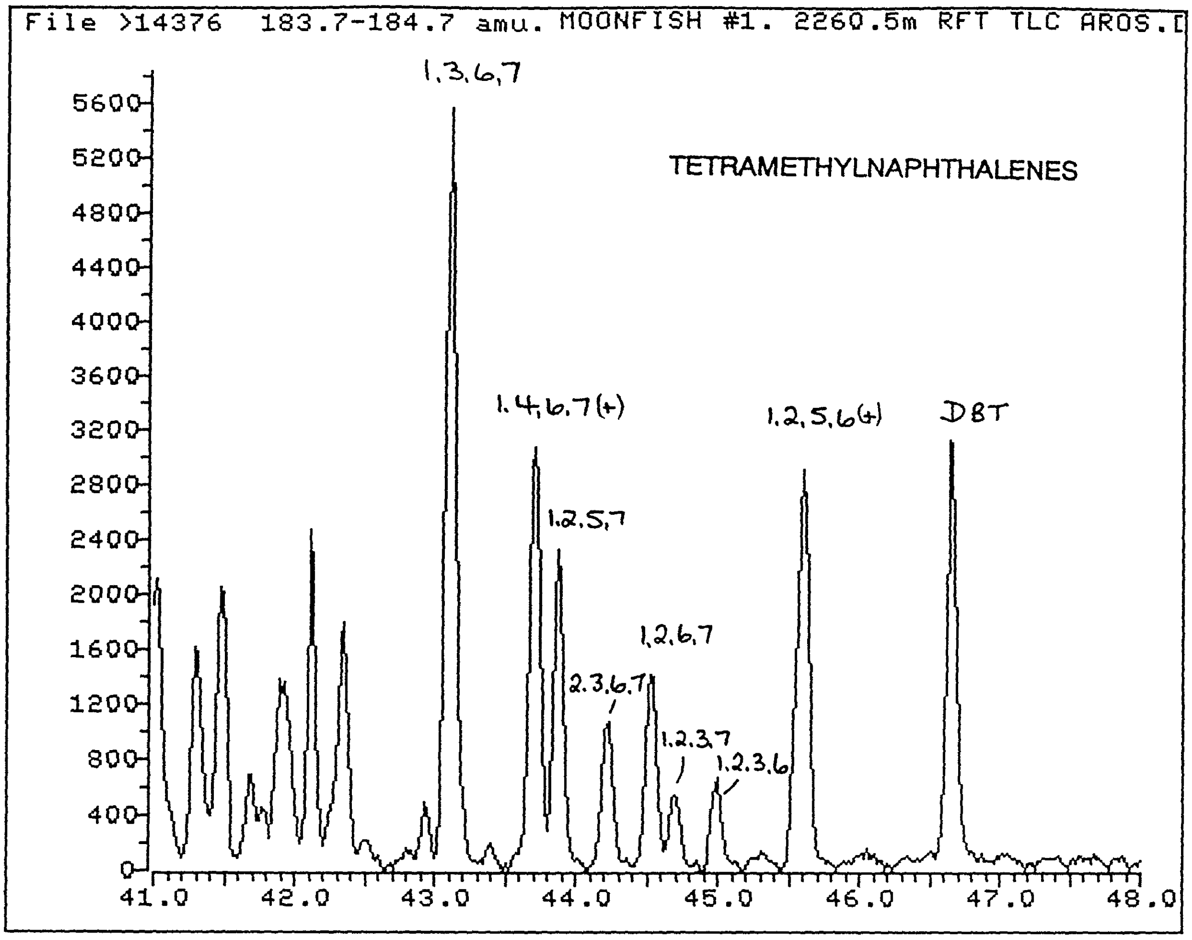
File >14376 193.7-194.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
2000
0
38 40 42 44 46 48 50 52

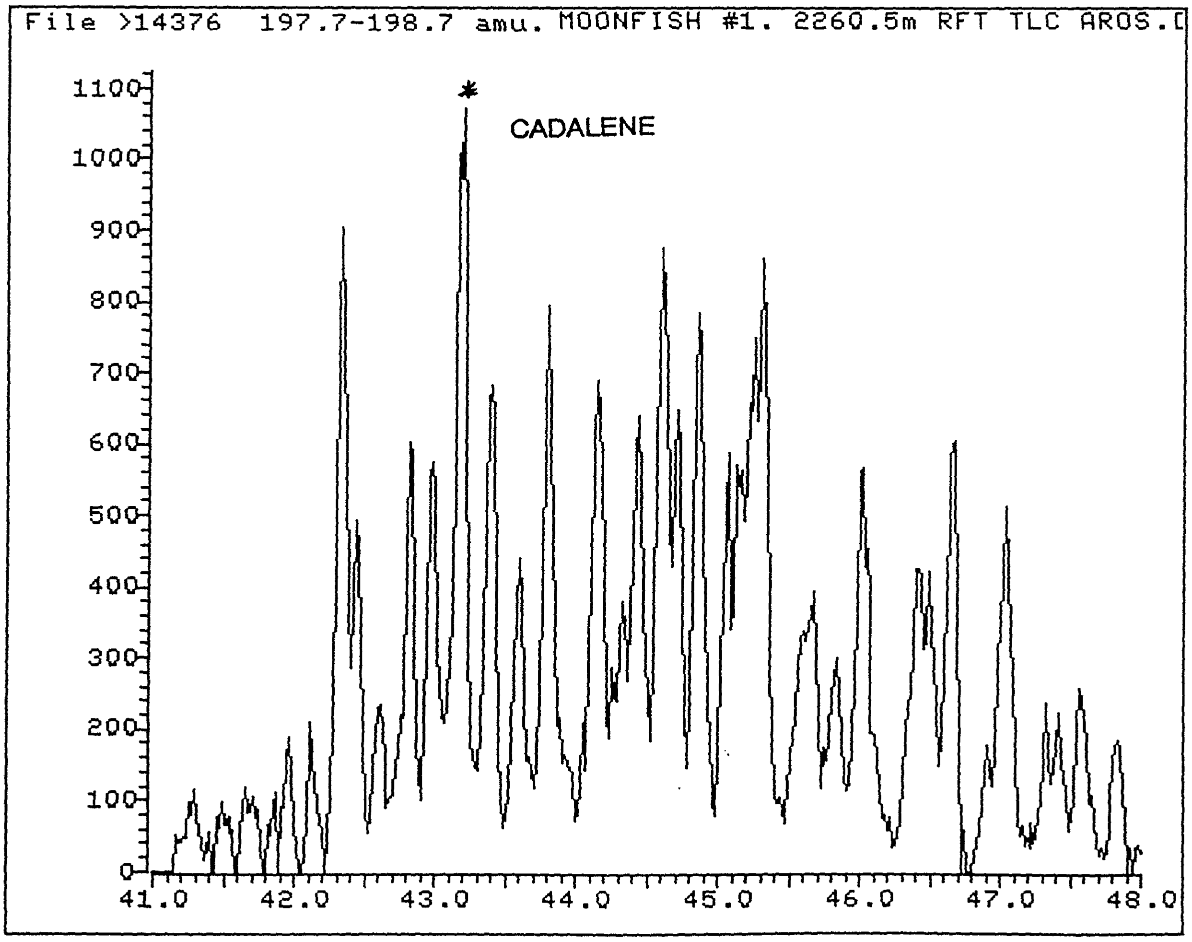


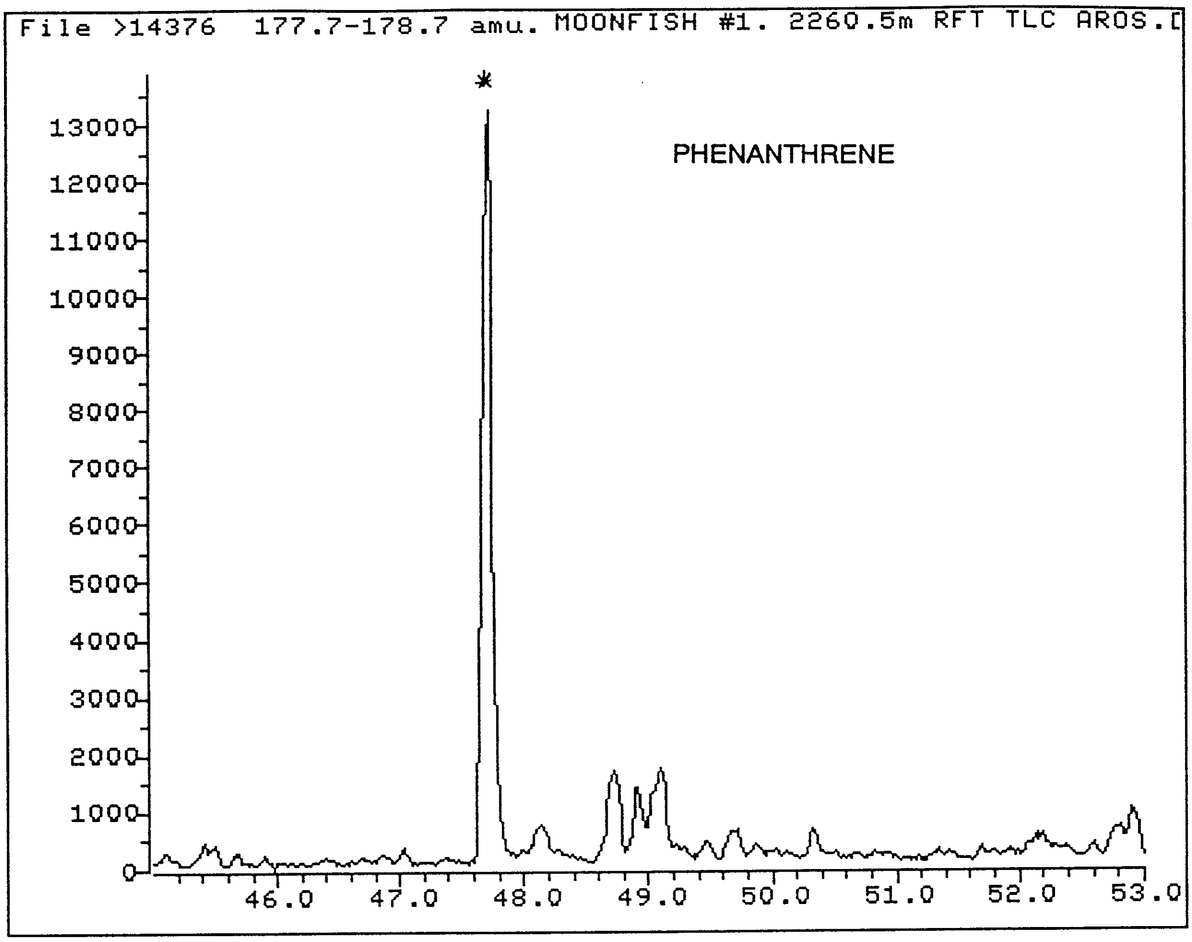
File >14376 169.7-170.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
16000
14000
12000
10000
8000
6000
4000
2000
0
35.0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0

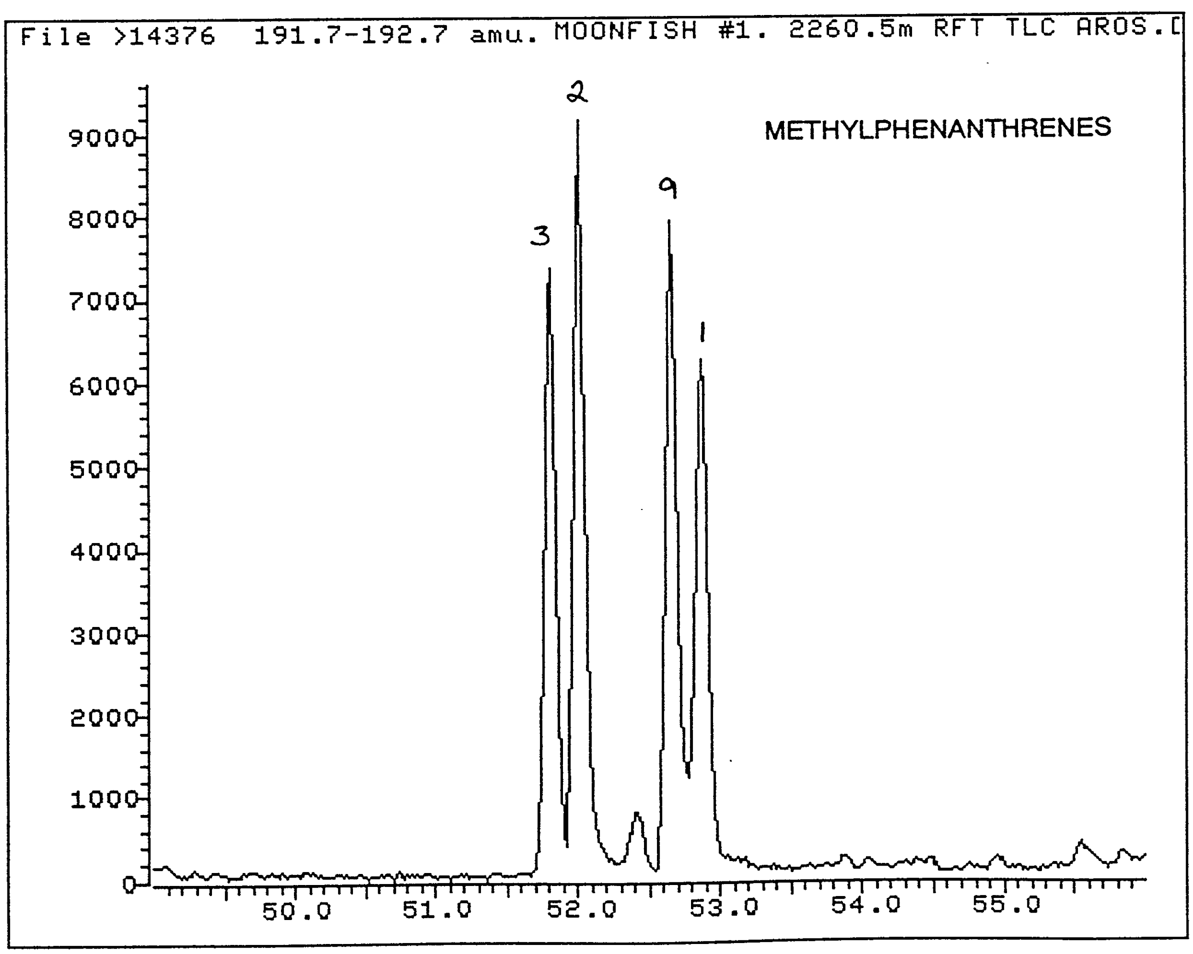


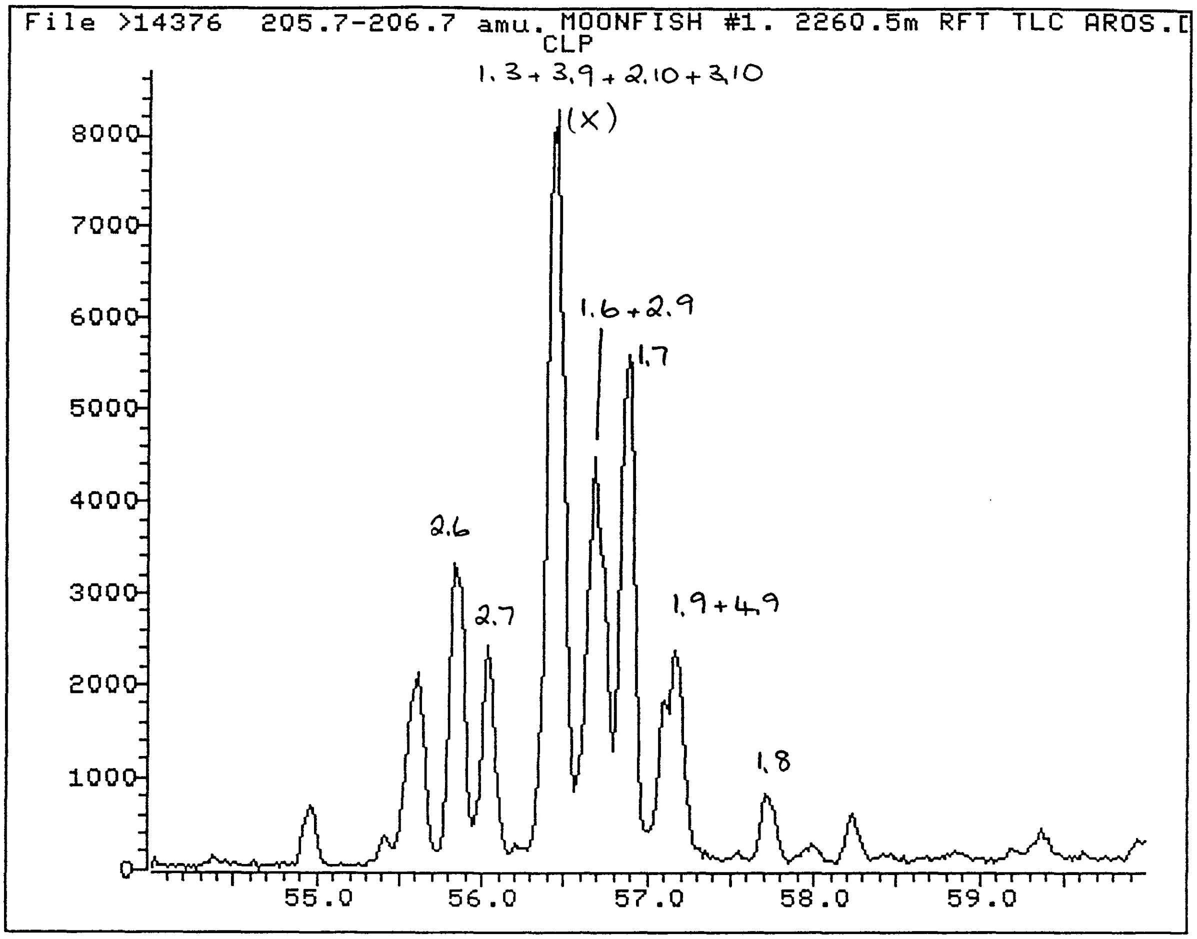
File >14376 183.7-184.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
35.0
36.0
37.0
38.0
39.0
40.0
41.0
42.0
43.0


File >14376 183.7-184.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
TETRAMETHYLNAPHTHALENES
1,3,6,7
1,4,6,7(+)
1,2,5,7
2,3,6,7
1,2,6,7
1,2,3,7
1,2,3,6
1,2,5,6(+)
DBT
5600
5200
4800
4400
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
41.0
42.0
43.0
44.0
45.0
46.0
47.0
48.0

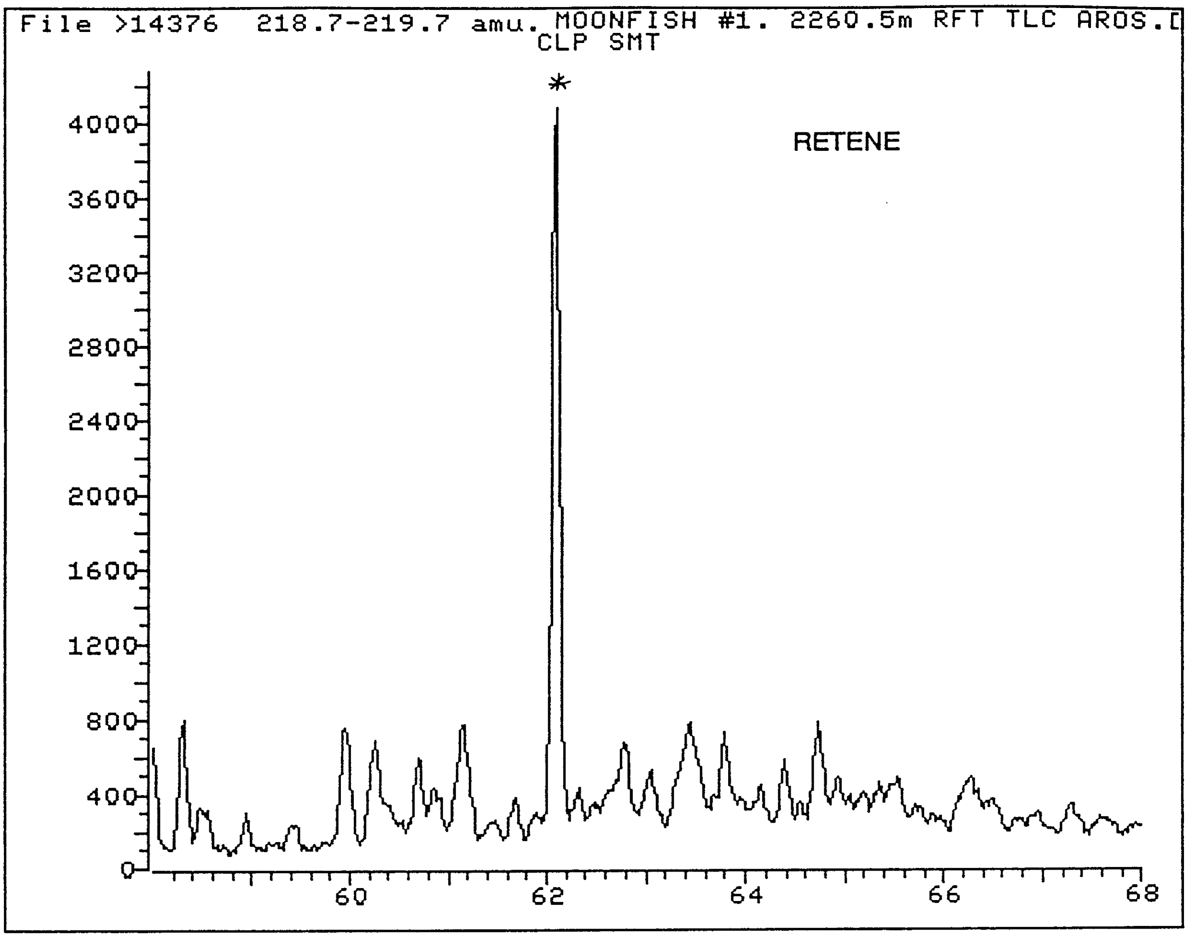

File >14376 197.7-198.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
*
CADALENE
1100
1000
900
800
700
600
500
400
300
200
100
0
41.0
42.0
43.0
44.0
45.0
46.0
47.0
48.0


File >14376 177.7-178.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
PHENANTHRENE
*
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
46.0
47.0
48.0
49.0
50.0
51.0
52.0
53.0


File >14376 191.7-192.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
METHYLPHENANTHRENES
2
3
9
1
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
50.0
51.0
52.0
53.0
54.0
55.0



DIMETHYLPHENANTHRENES


File >14376 218.7-219.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
CLP SMT
RETENE
*
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
60
62
64
66
68

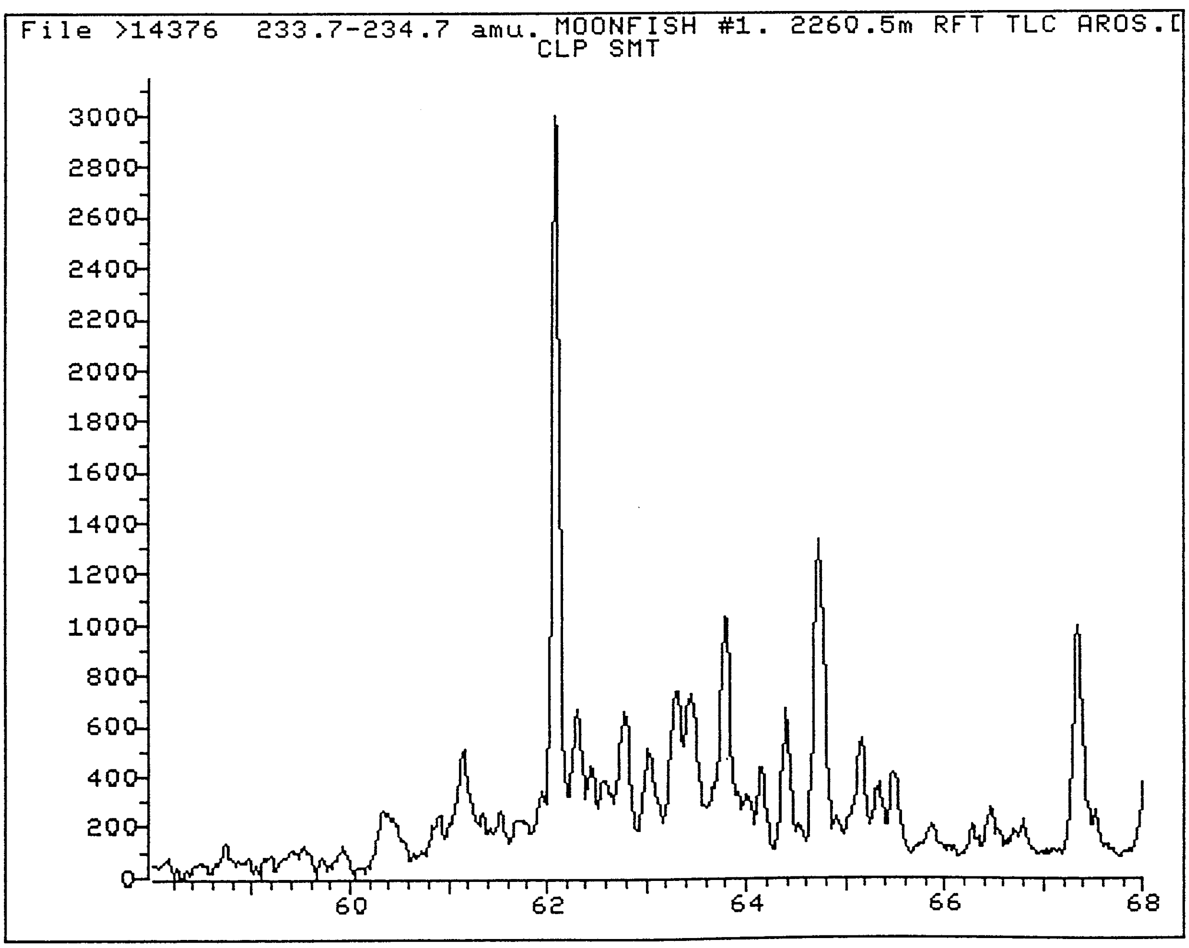

File >14376 233.7-234.7 amu. MOONFISH #1. 2260.5m RFT TLC AROS.D
CLP SMT
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
60
62
64
66
68

TABLE 5.1

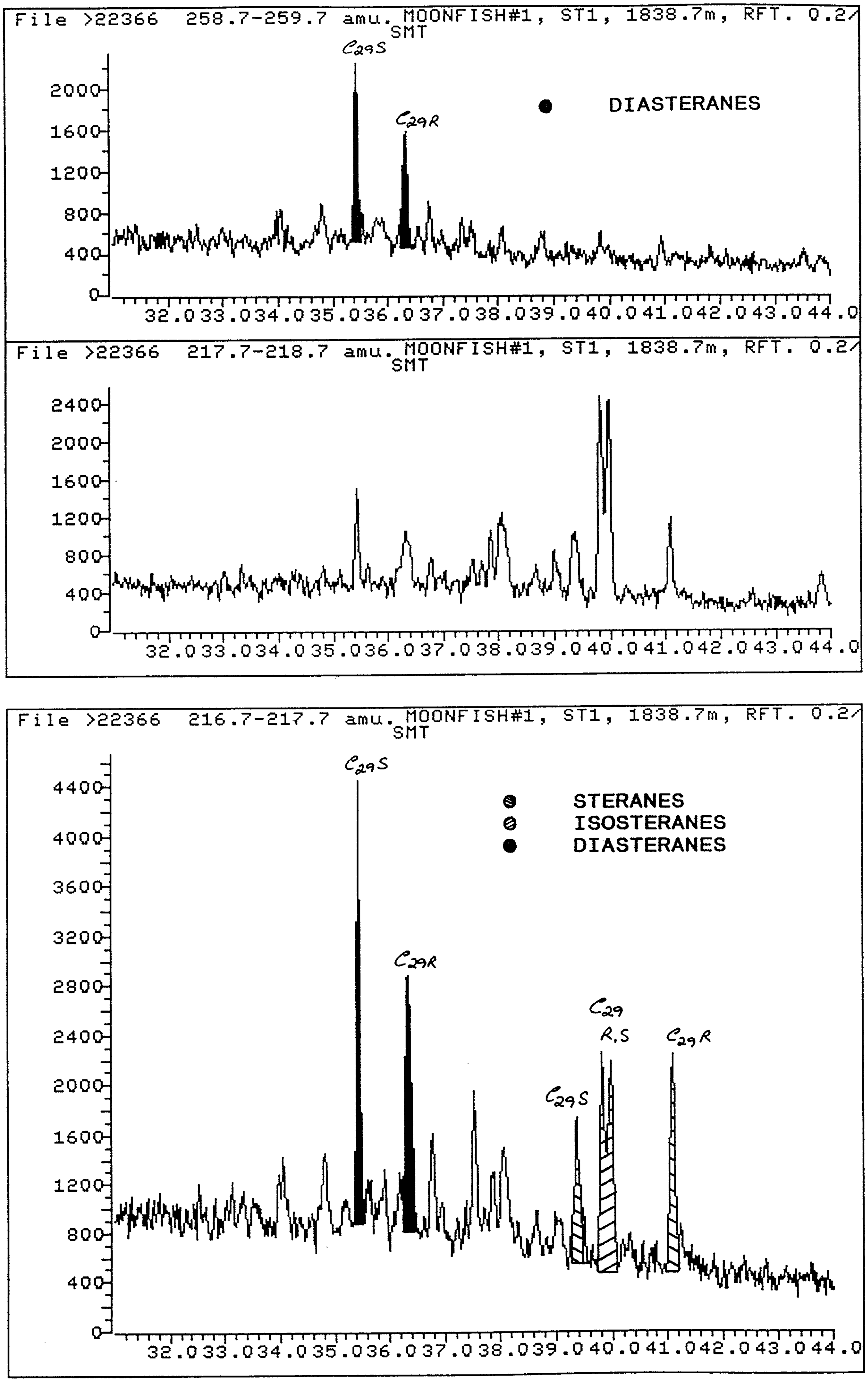
SELECTED PARAMETERS FROM GC/MS ANALYSIS

MOONFISH 1 / ST1, 1838.7m, RFT Oil

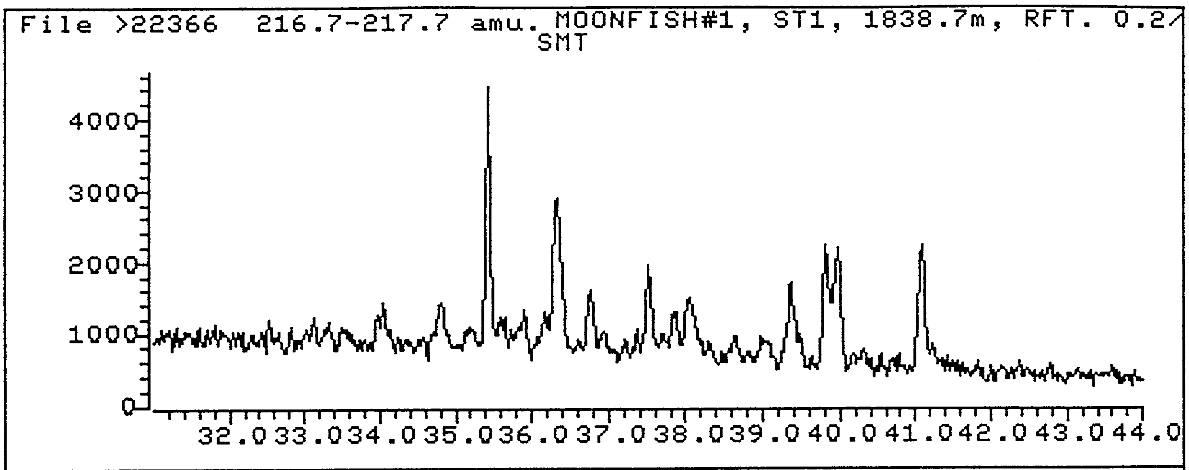
	Parameter	Ion(s)	Value
1.	18 α (H)- hopane/17 α (H)-hopane (Ts/Tm)	191	0.35
2.	C30 hopane/C30 moretane	191	6.28
3.	C31 22S hopane/C31 22R hopane	191	1.36
4.	C32 22S hopane/C32 22R hopane	191	1.30
5.	C29 20S $\alpha\alpha\alpha$ sterane/C29 20R $\alpha\alpha\alpha$ sterane	217	0.71
6.	C29 $\alpha\alpha\alpha$ steranes (20S / 20S+20R)	217	0.41
7.	C29 $\alpha\beta\beta$ steranes / (C29 $\alpha\alpha\alpha$ steranes + C29 $\alpha\beta\beta$ steranes)	217	0.52
8.	C27/C29 diasteranes	259	nd
9.	C27/C29 steranes	217	nd
10.	18 α (H)-oleanane/C30 hopane	191	nd
11.	C29 diasteranes / (C29 $\alpha\alpha\alpha$ steranes + C29 $\alpha\beta\beta$ steranes)	217	0.84
12.	C30 (hopane + moretane) / C29 (steranes + diasteranes)	191/217	0.65
13.	C15 drimane/C16 homodrimane	123	0.60
14.	Rearranged drimanes/normal drimanes	123	0.79

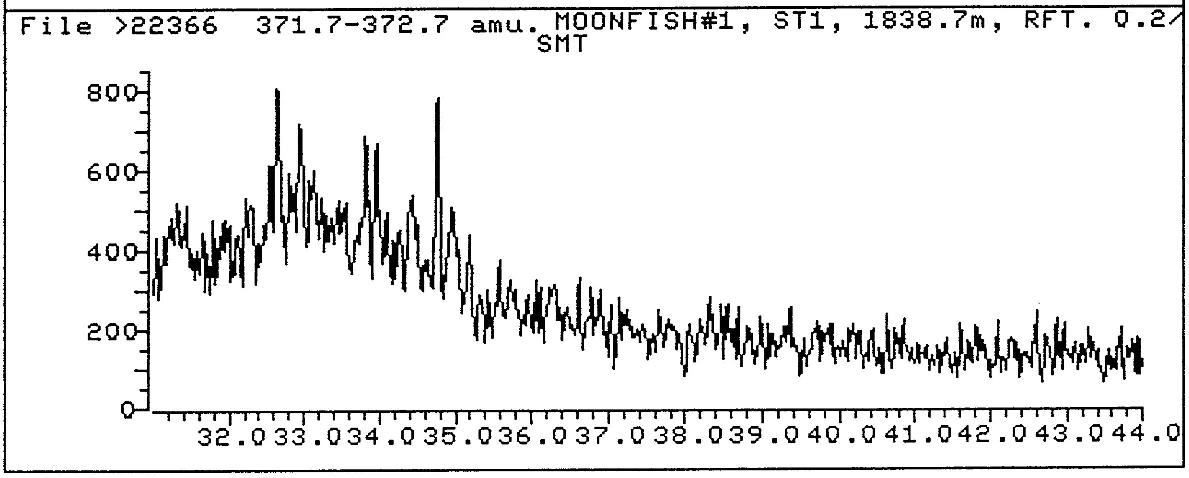
nd = not detectable

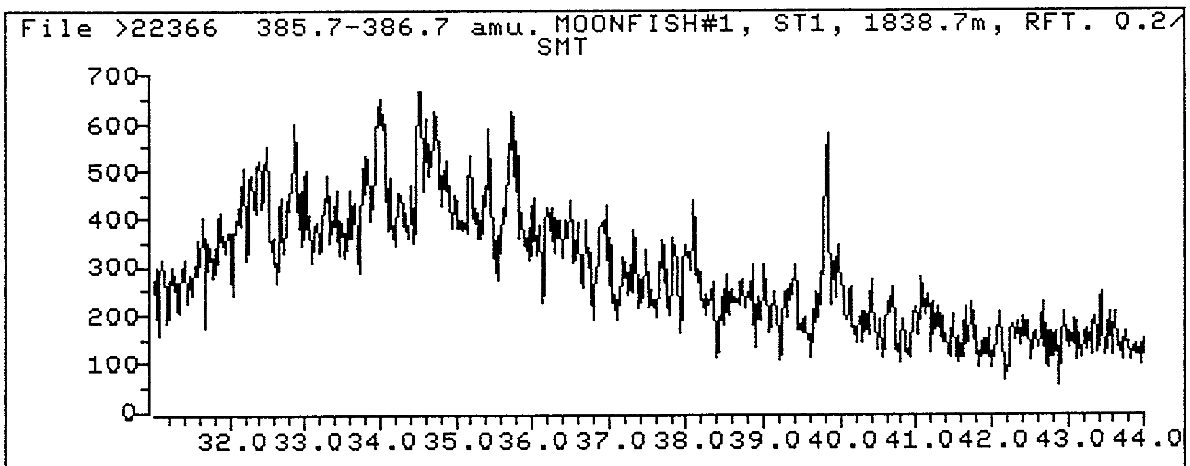
Figure 4-1

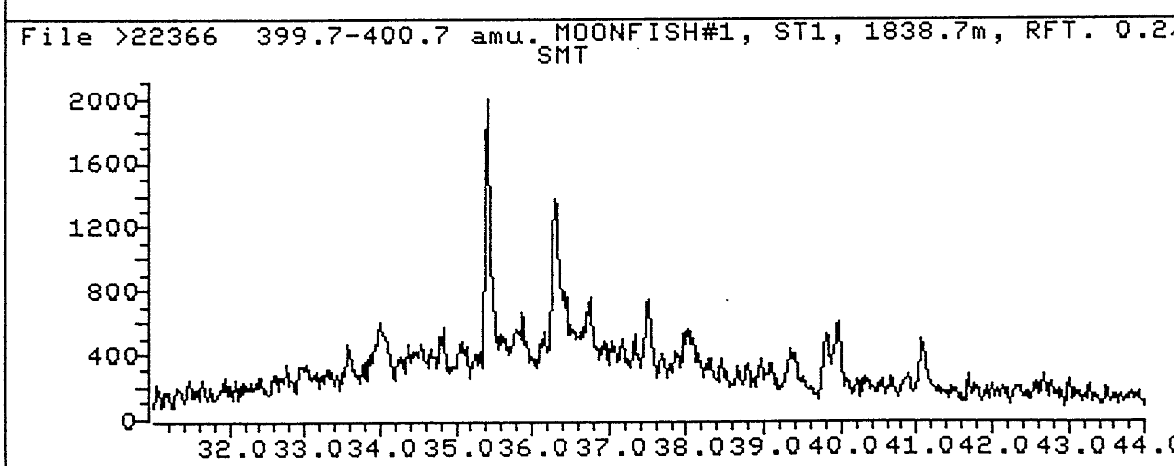


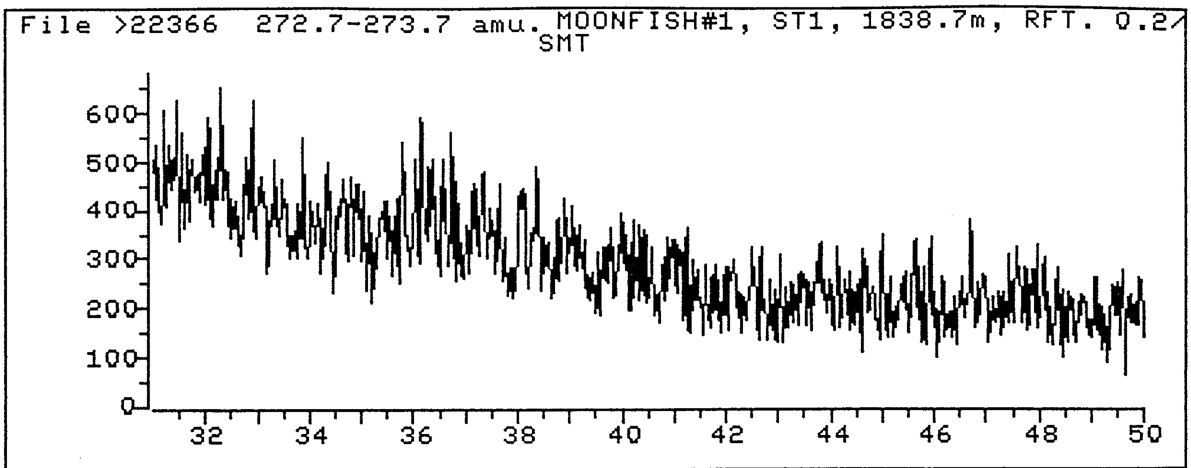
File >22366 258.7-259.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
C29S
C29R
DIASTERANES
0
400
800
1200
1600
2000
32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0
File >22366 217.7-218.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
0
400
800
1200
1600
2000
2400
32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0
File >22366 216.7-217.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
C29S
C29R
C29S
C29 R,S
C29R
STERANES
ISOSTERANES
DIASTERANES
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
4400
32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

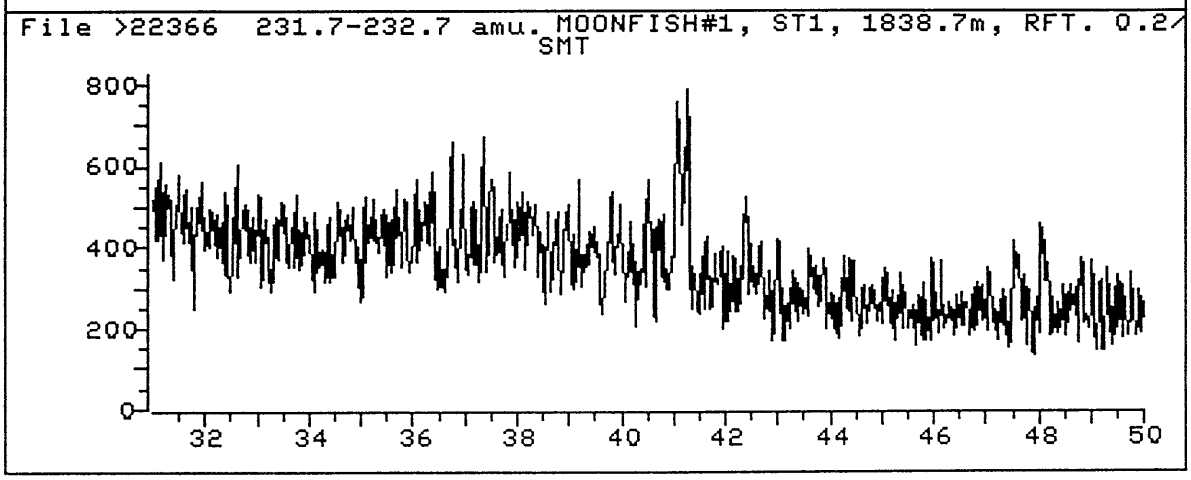

File >22366 216.7-217.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
4000
3000
2000
1000
0
32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0


File >22366 371.7-372.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
800
600
400
200
0
32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0


File >22366 385.7-386.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
700
600
500
400
300
200
100
0
32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0


File >22366 399.7-400.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
2000
1600
1200
800
400
0
32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0


File >22366 272.7-273.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
0
100
200
300
400
500
600
32
34
36
38
40
42
44
46
48
50


File >22366 231.7-232.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
0
200
400
600
800
32
34
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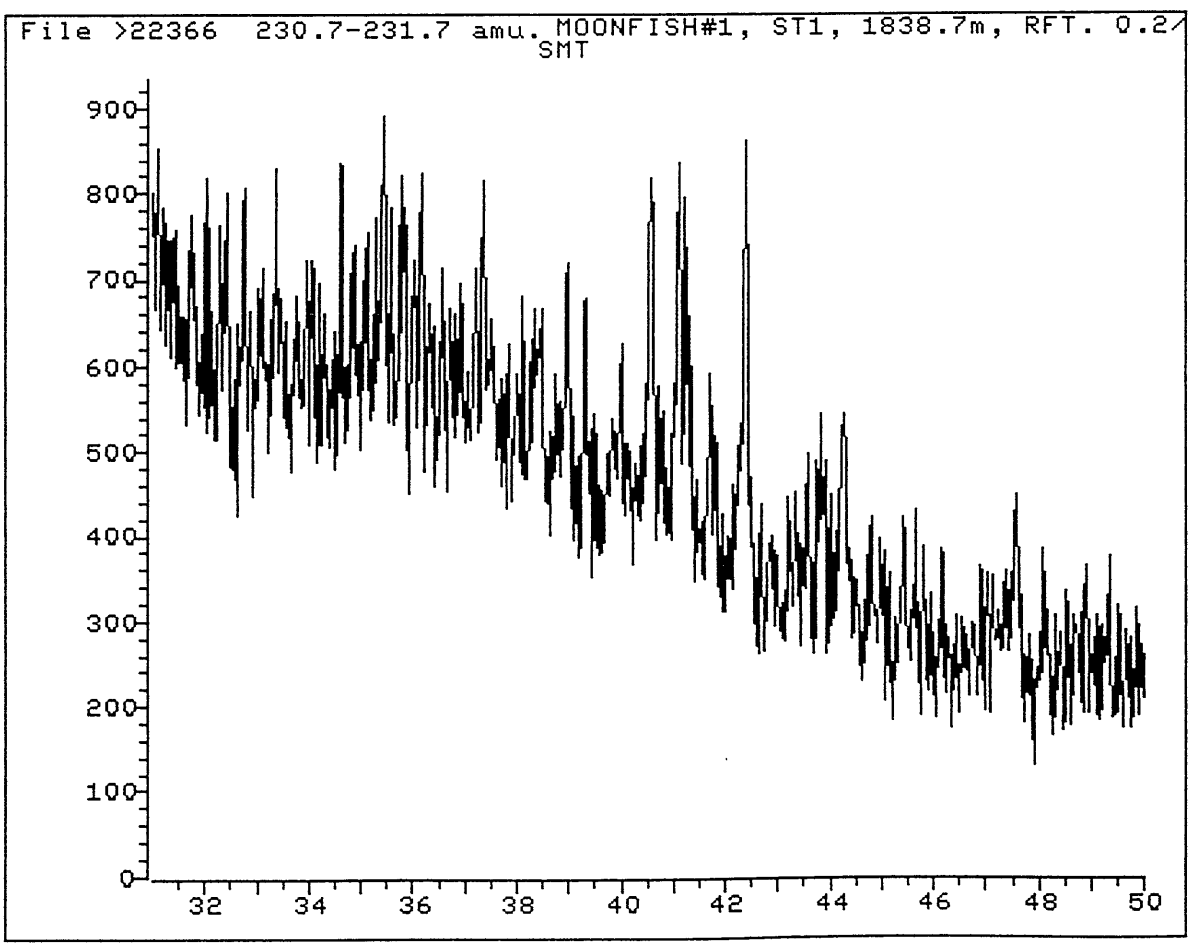
38
40
42
44
46
48
50


File >22366 230.7-231.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
0
100
200
300
400
500
600
700
800
900
32
34
36
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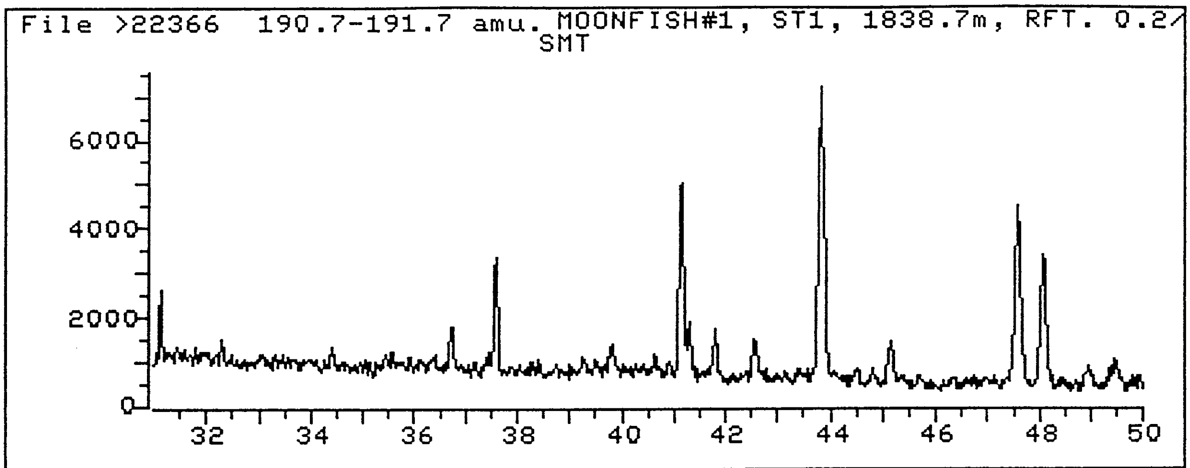
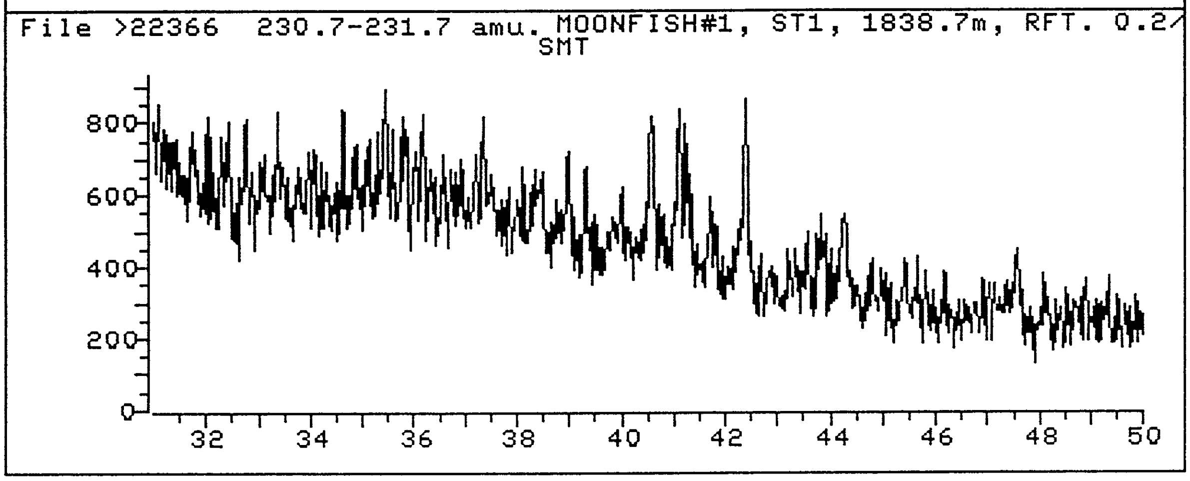
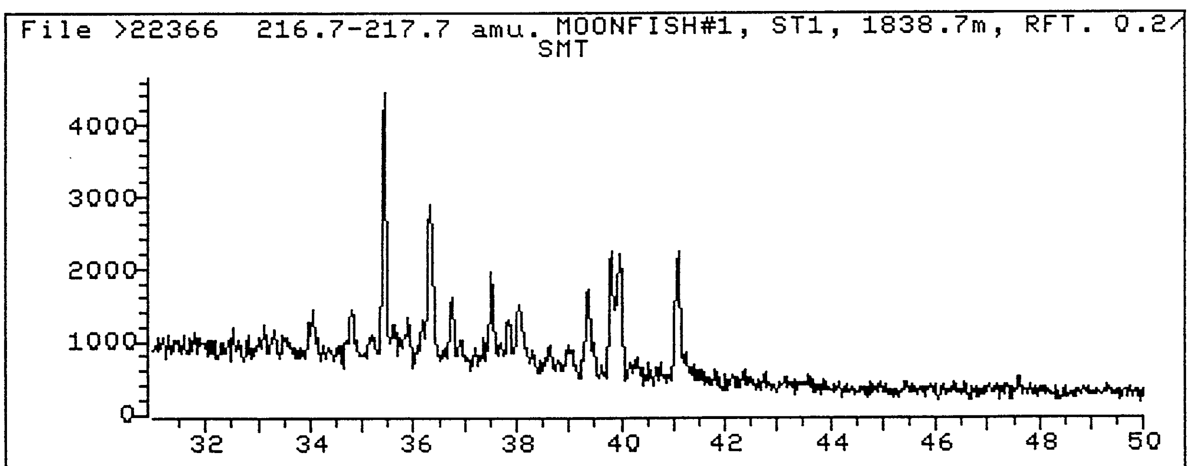
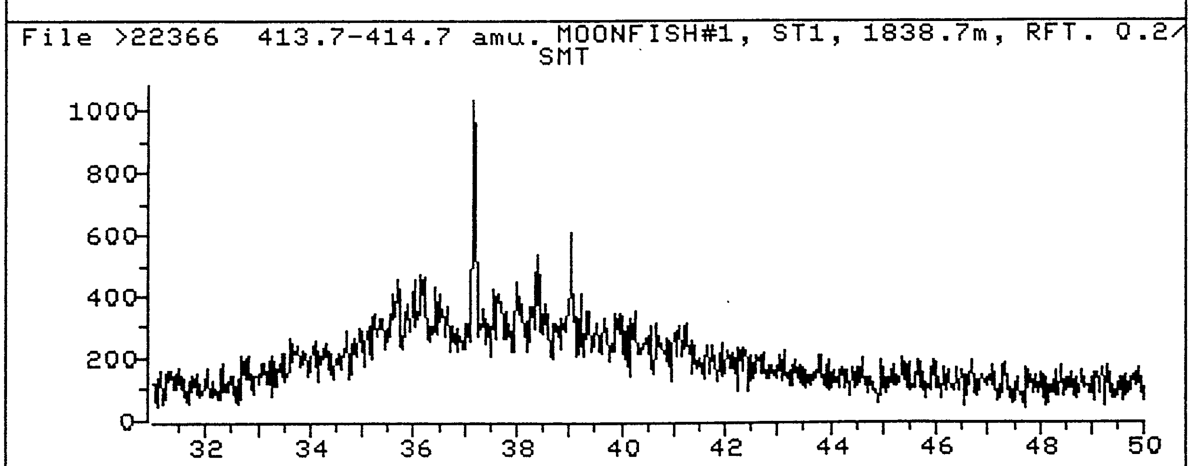
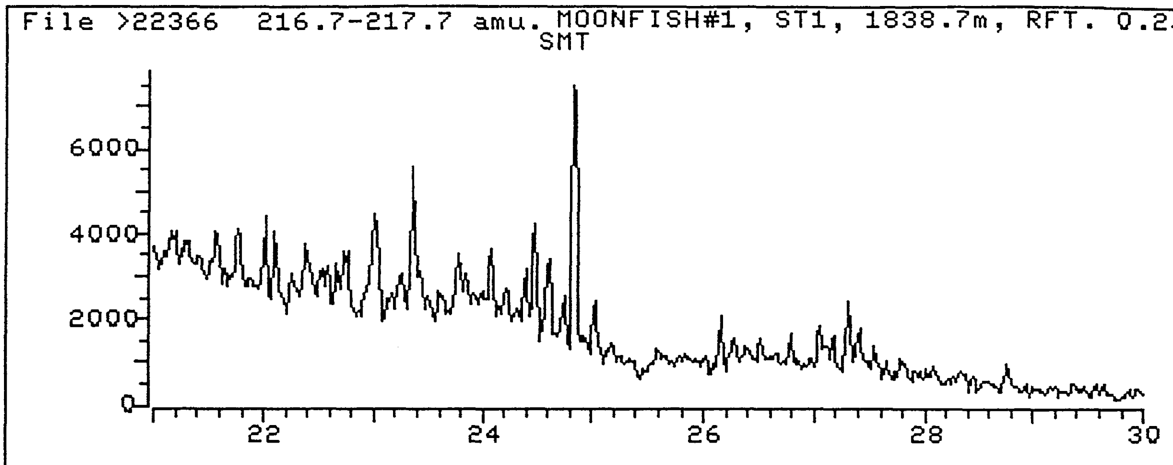
40
42
44
46
48
50

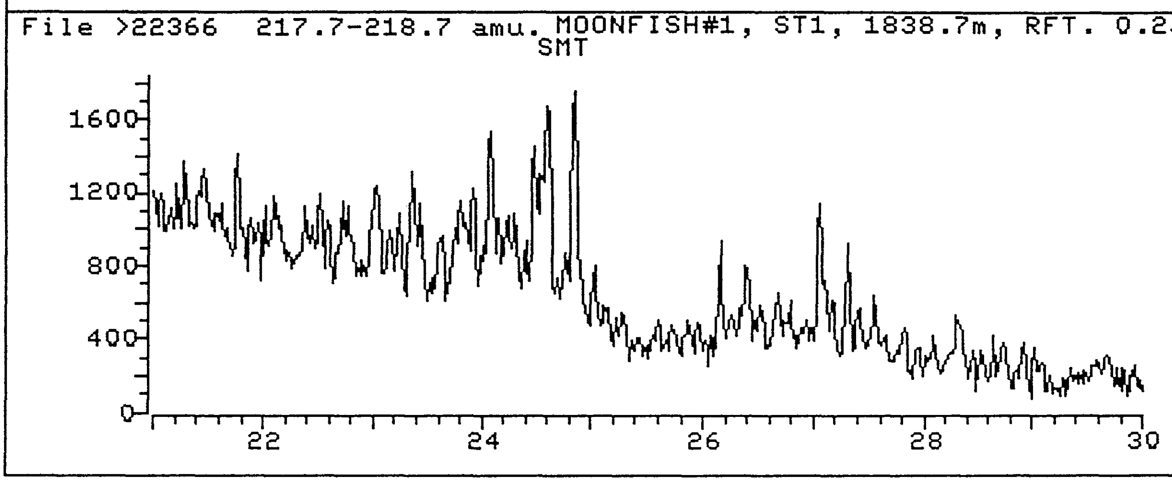

File >22366 190.7-191.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
6000
4000
2000
0
32 34 36 38 40 42 44 46 48 50

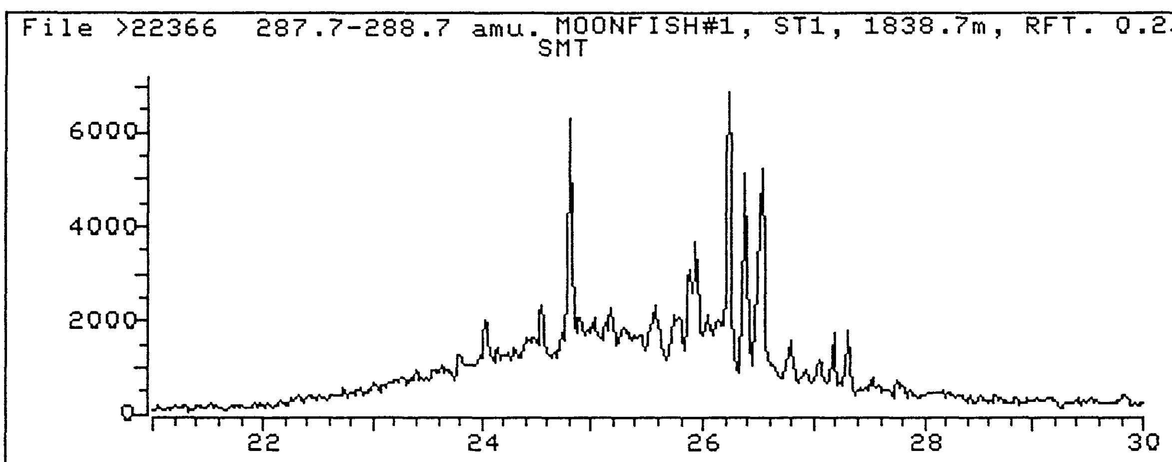

File >22366 230.7-231.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
800
600
400
200
0
32 34 36 38 40 42 44 46 48 50

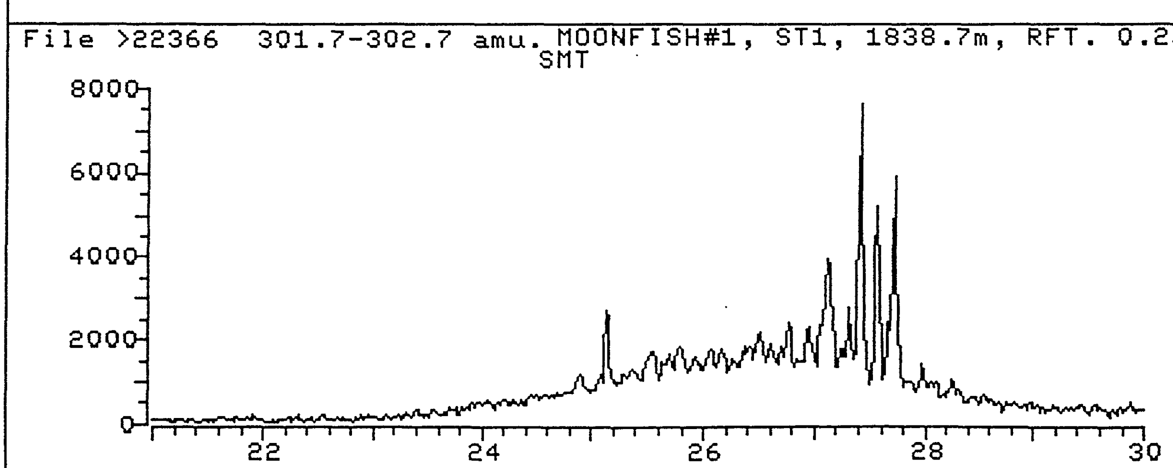

File >22366 216.7-217.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
4000
3000
2000
1000
0
32 34 36 38 40 42 44 46 48 50

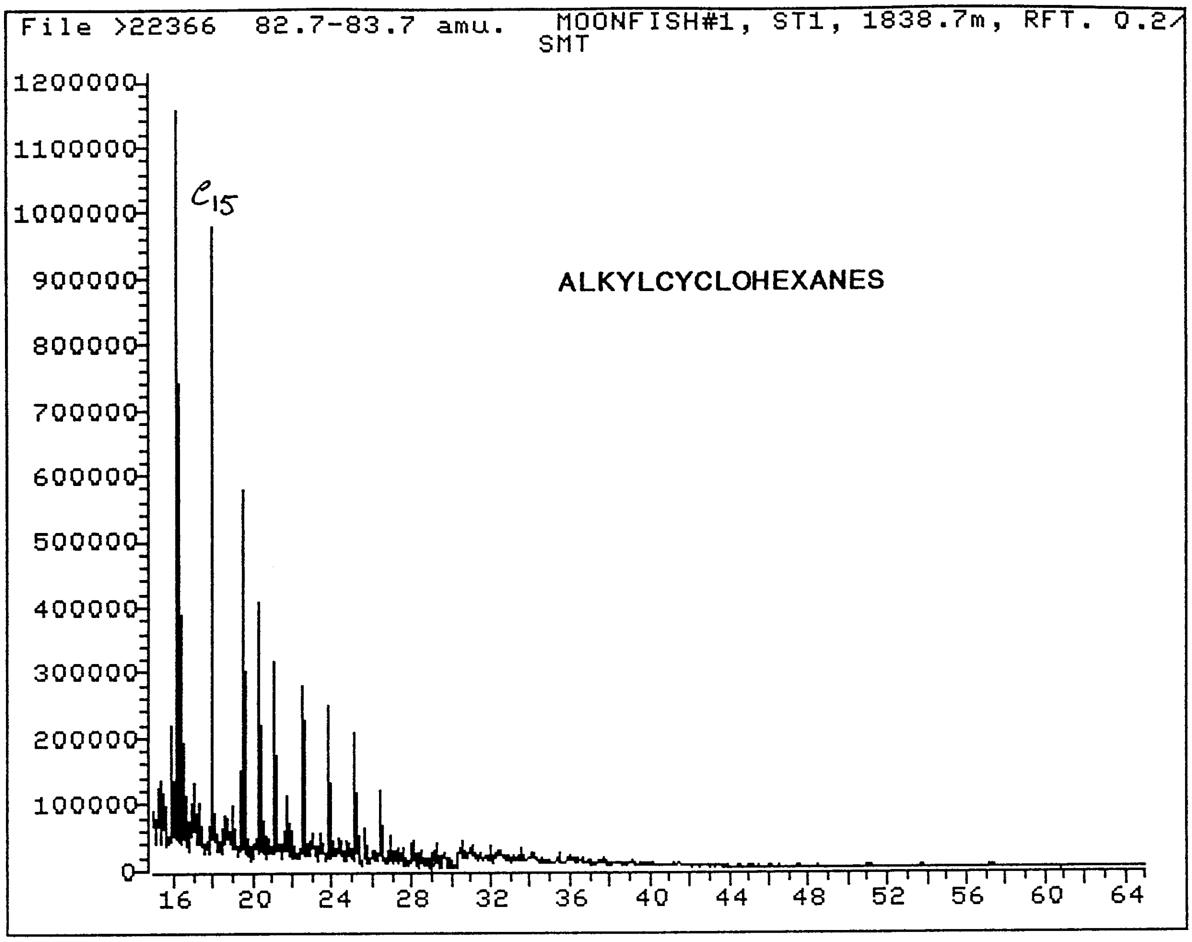

File >22366 413.7-414.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
1000
800
600
400
200
0
32 34 36 38 40 42 44 46 48 50

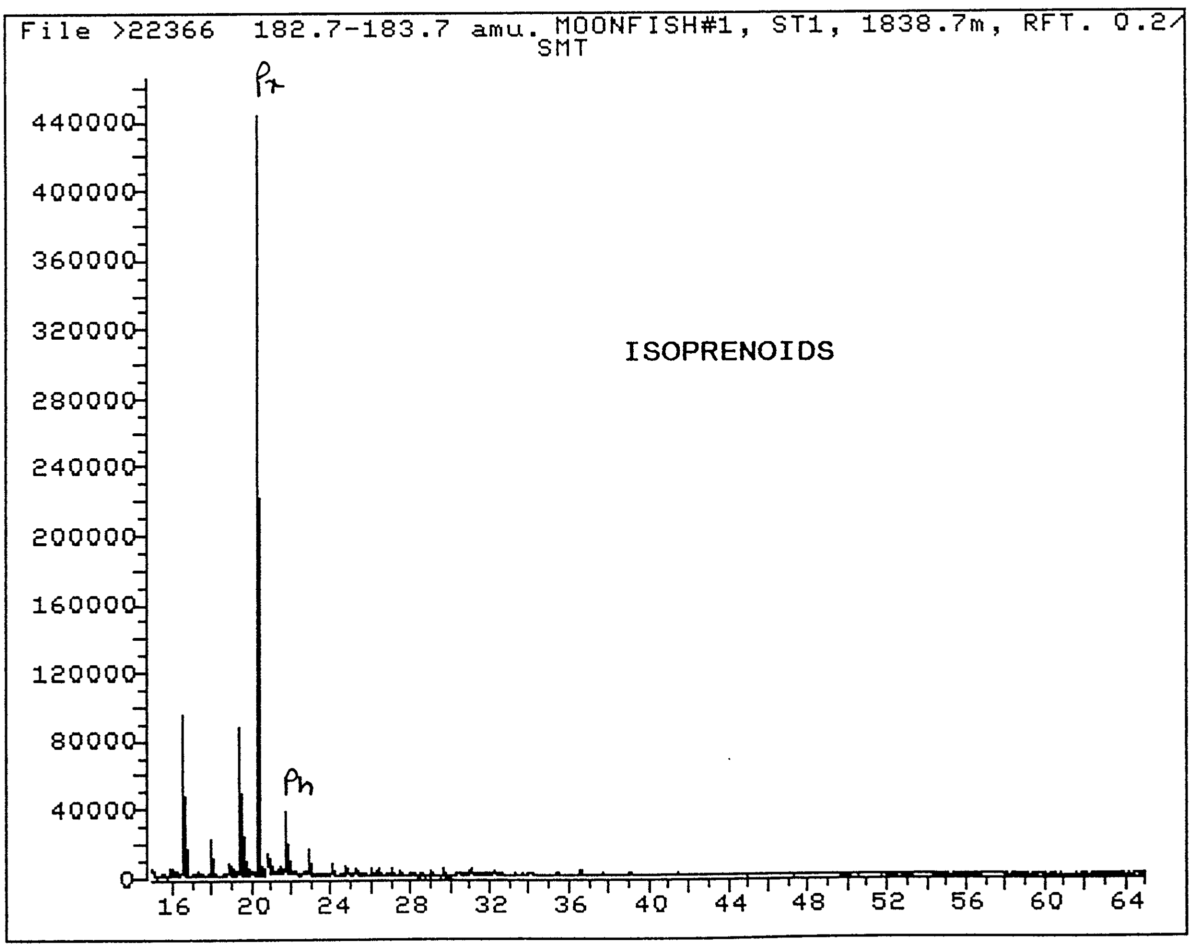

File >22366 216.7-217.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
6000
4000
2000
0
22
24
26
28
30

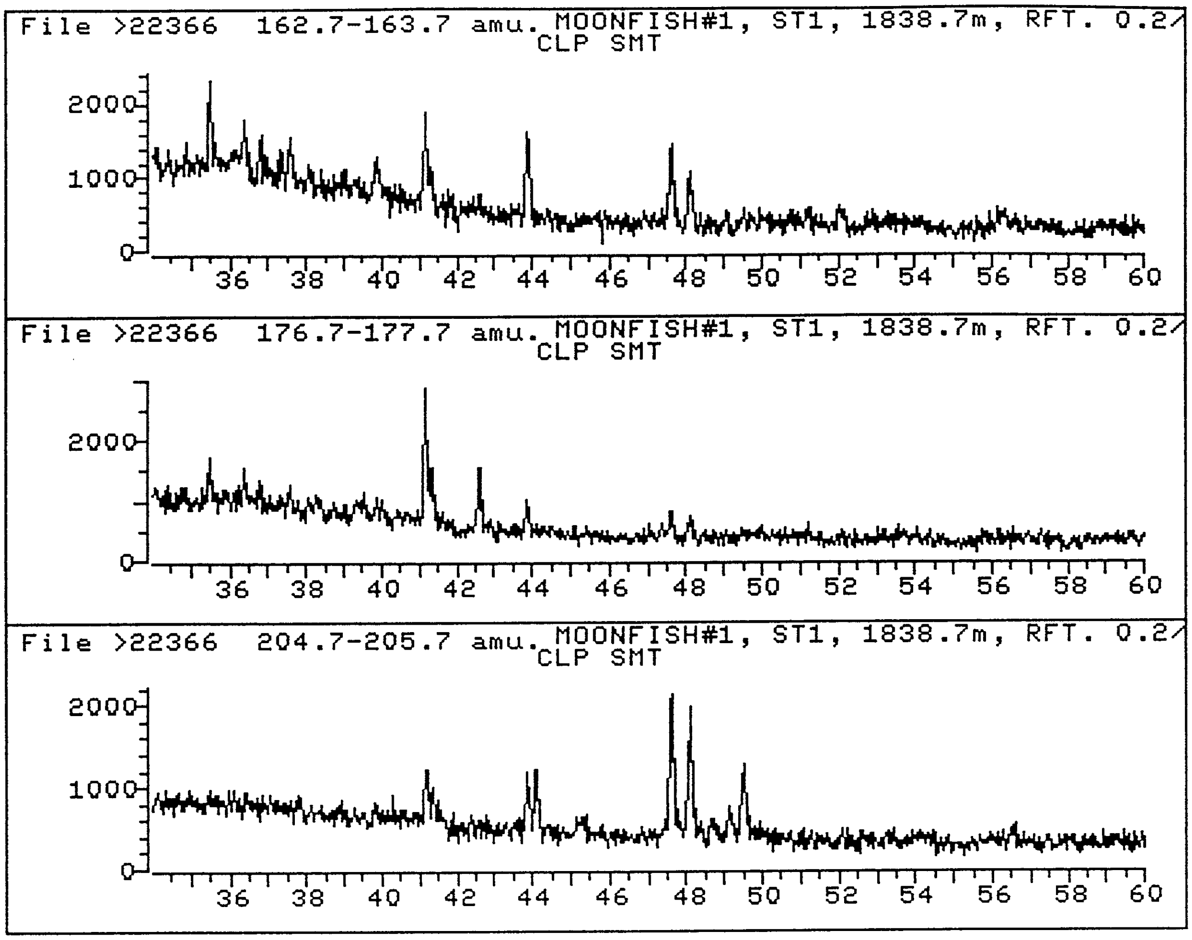

File >22366 217.7-218.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
1600
1200
800
400
0
22
24
26
28
30

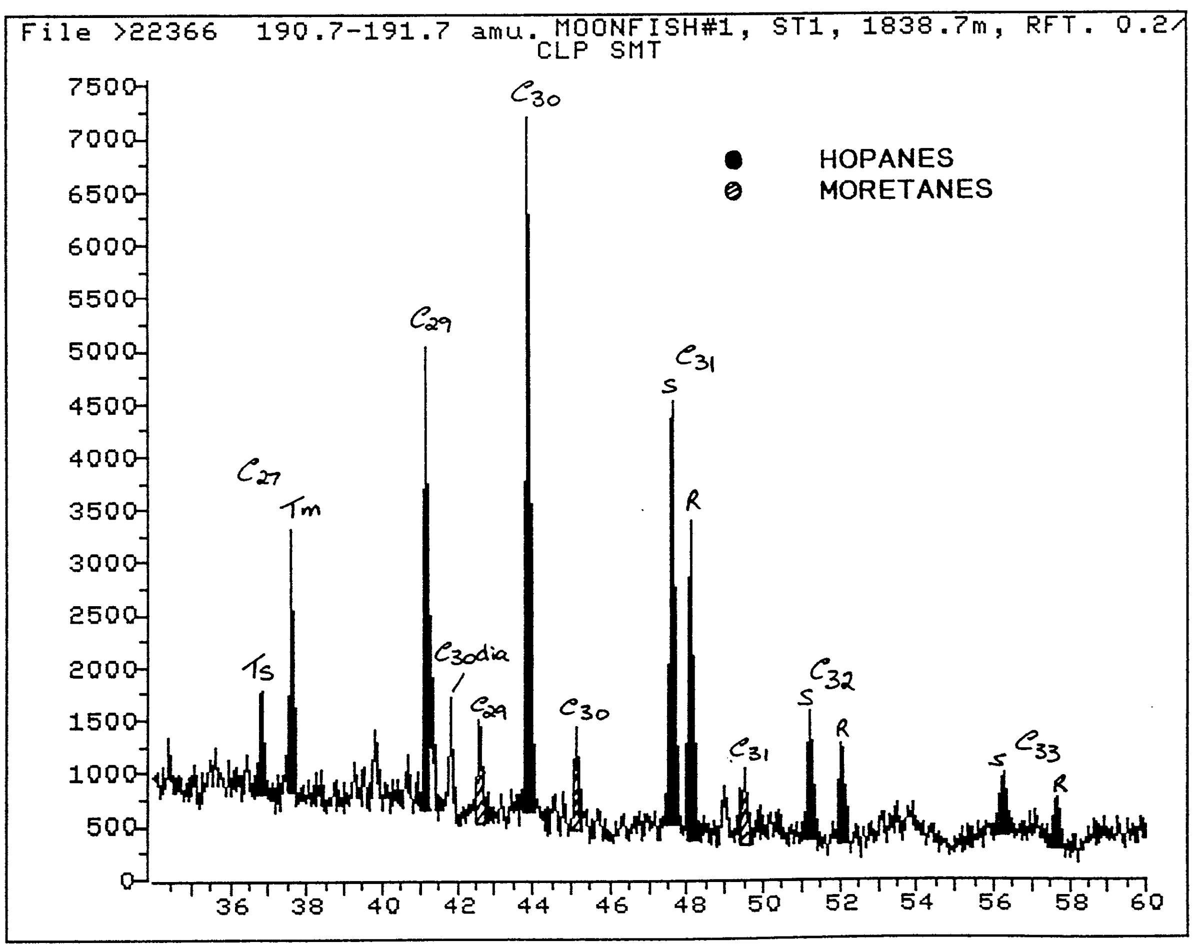

File >22366 287.7-288.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
6000
4000
2000
0
22
24
26
28
30

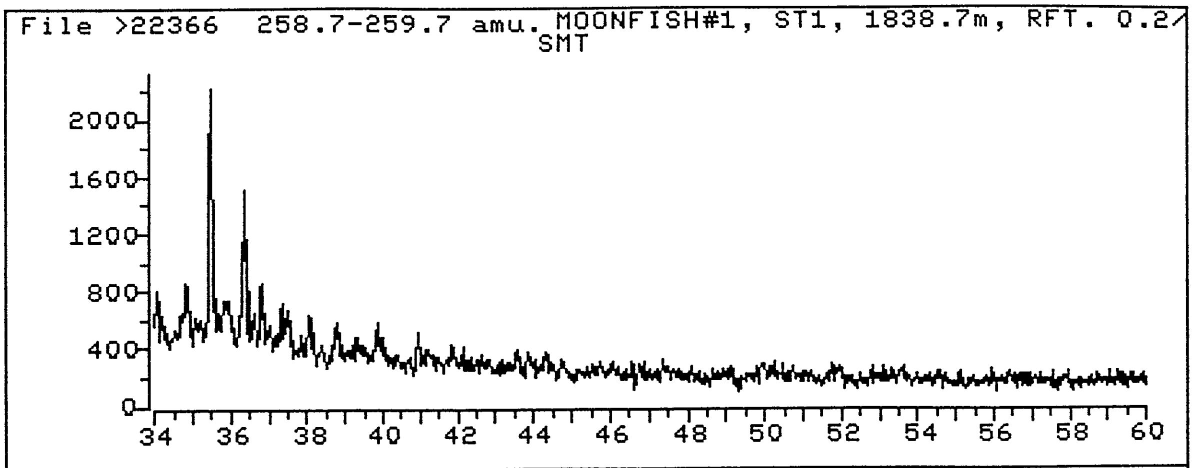

File >22366 301.7-302.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
8000
6000
4000
2000
0
22
24
26
28
30

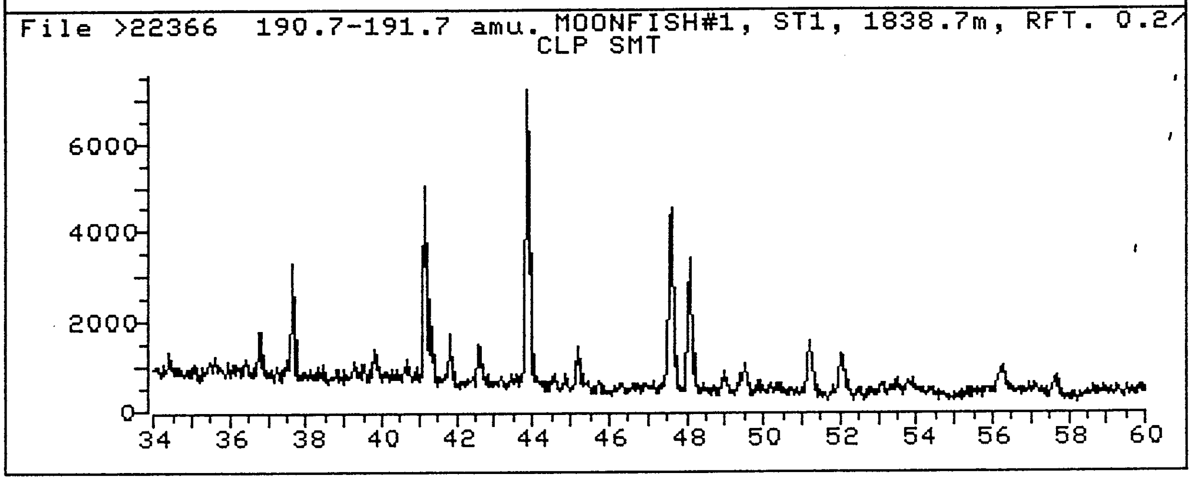

File >22366 82.7-83.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. Q.2/ SMT
ALKYLCYCLOHEXANES
C15
1200000
1100000
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
16 20 24 28 32 36 40 44 48 52 56 60 64

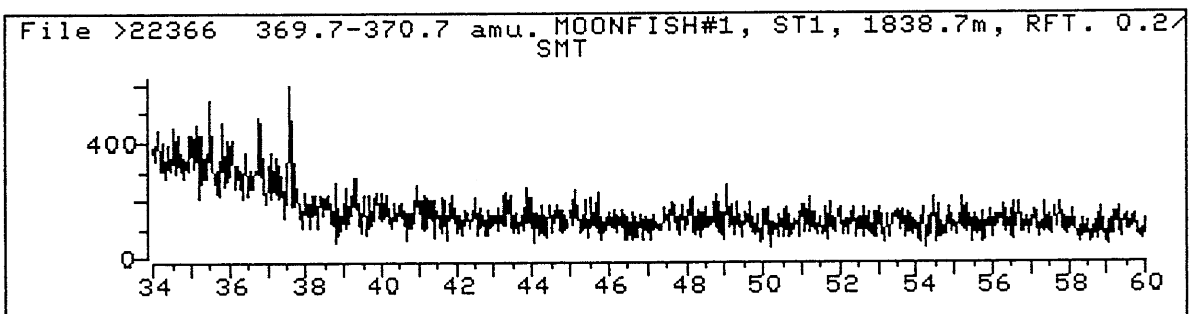

File >22366 182.7-183.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. Q.2/ SMT
ISOPRENOIDS
Pr
Ph
440000
400000
360000
320000
280000
240000
200000
160000
120000
80000
40000
0
16 20 24 28 32 36 40 44 48 52 56 60 64

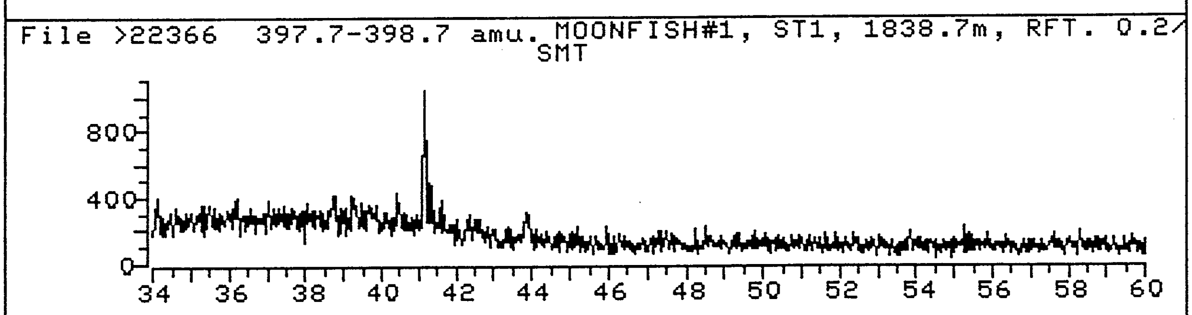

File >22366 162.7-163.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
CLP SMT
File >22366 176.7-177.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
CLP SMT
File >22366 204.7-205.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
CLP SMT

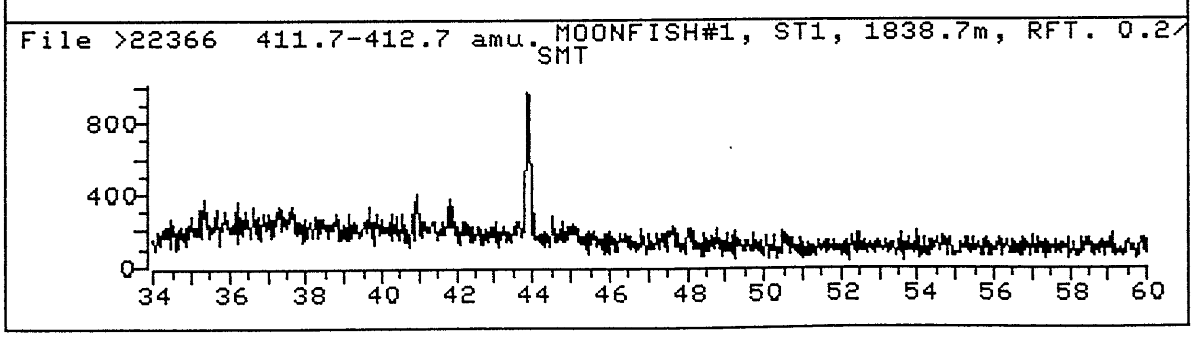

File >22366 190.7-191.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
CLP SMT
HOPANES
MORETANES
C30
C29
C31
S
R
C27
Tm
Ts
C30dia
C29
C30
C31
C32
S
R
C33
S
R

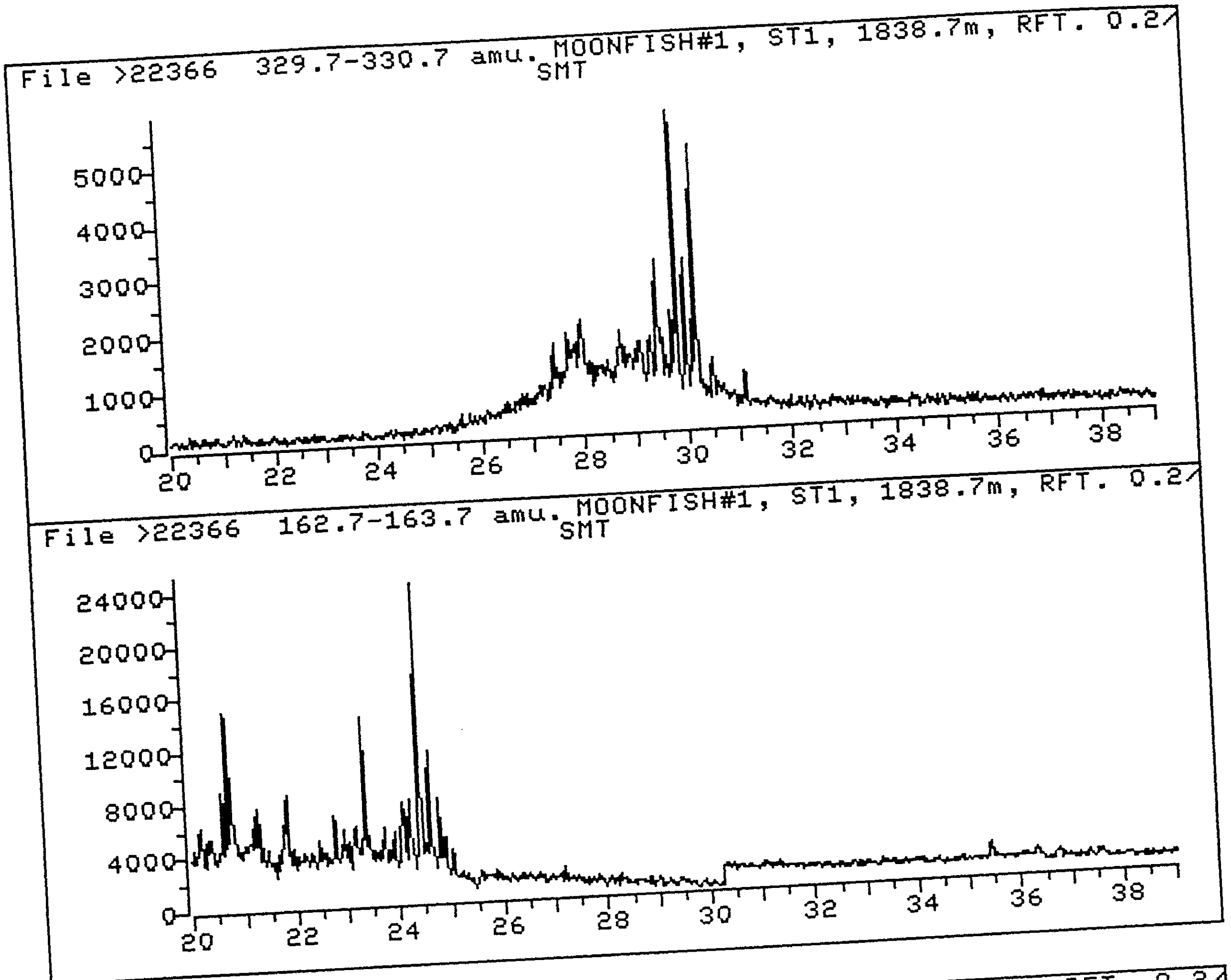

File >22366 258.7-259.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
2000
1600
1200
800
400
0
34 36 38 40 42 44 46 48 50 52 54 56 58 60

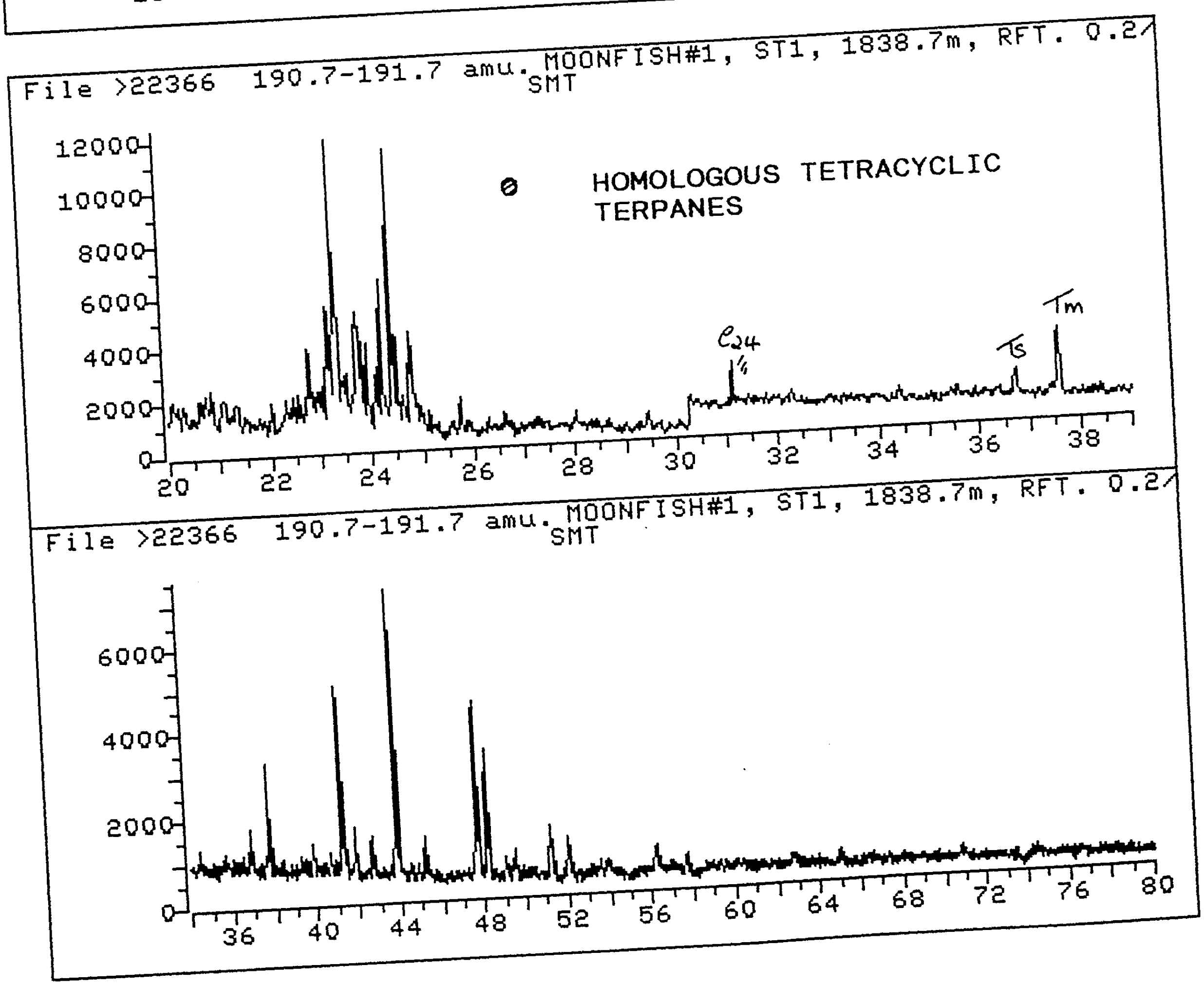

File >22366 190.7-191.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
CLP SMT
6000
4000
2000
0
34 36 38 40 42 44 46 48 50 52 54 56 58 60

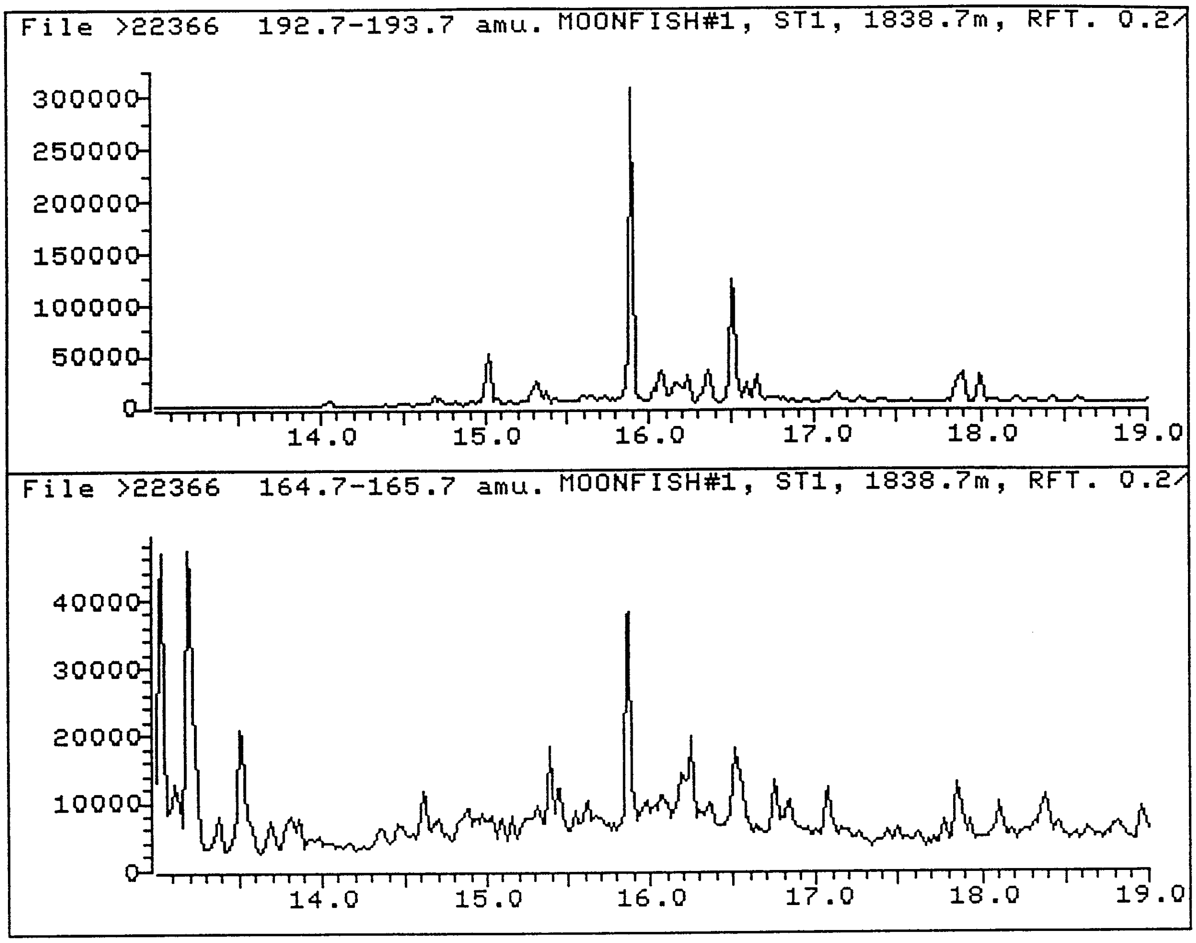

File >22366 369.7-370.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
400
0
34 36 38 40 42 44 46 48 50 52 54 56 58 60

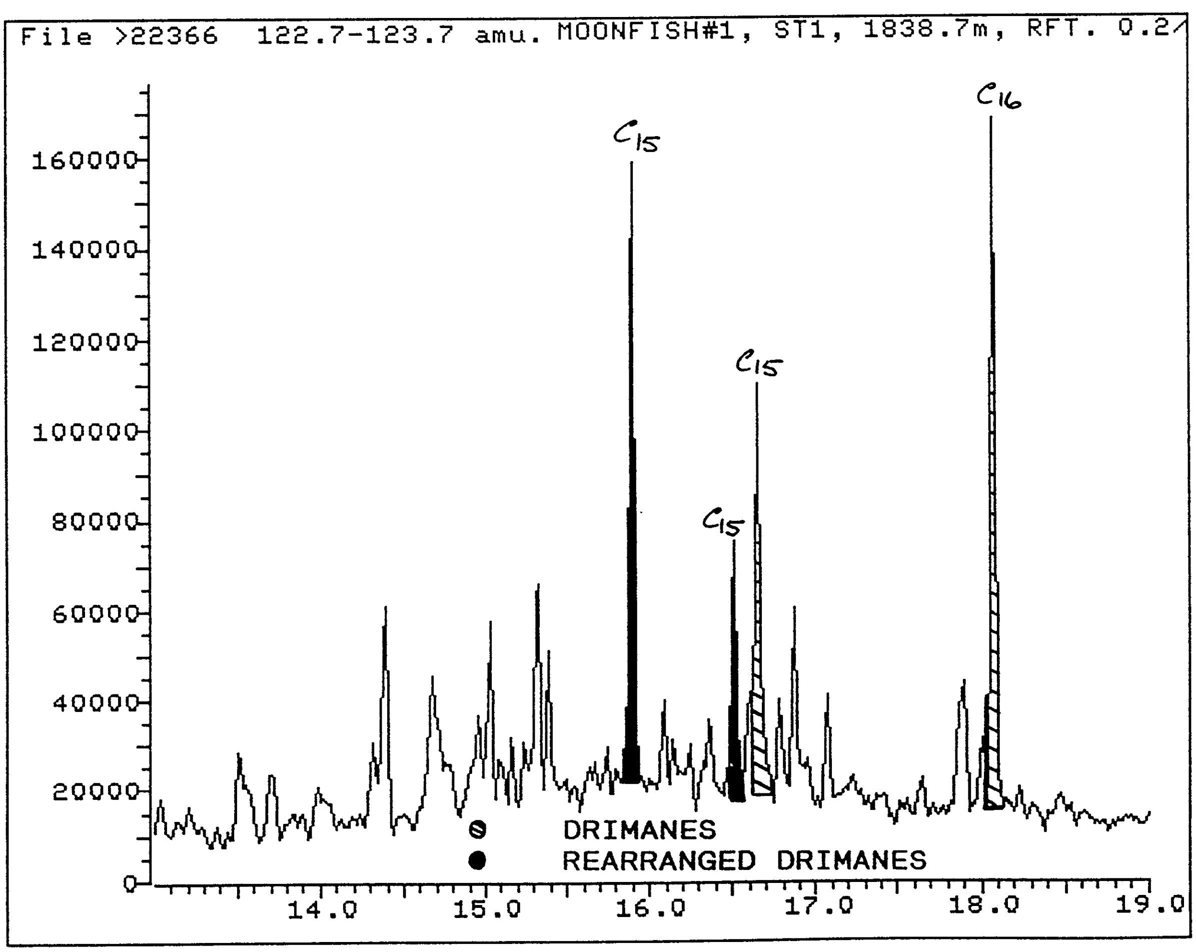

File >22366 397.7-398.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
800
400
0
34 36 38 40 42 44 46 48 50 52 54 56 58 60

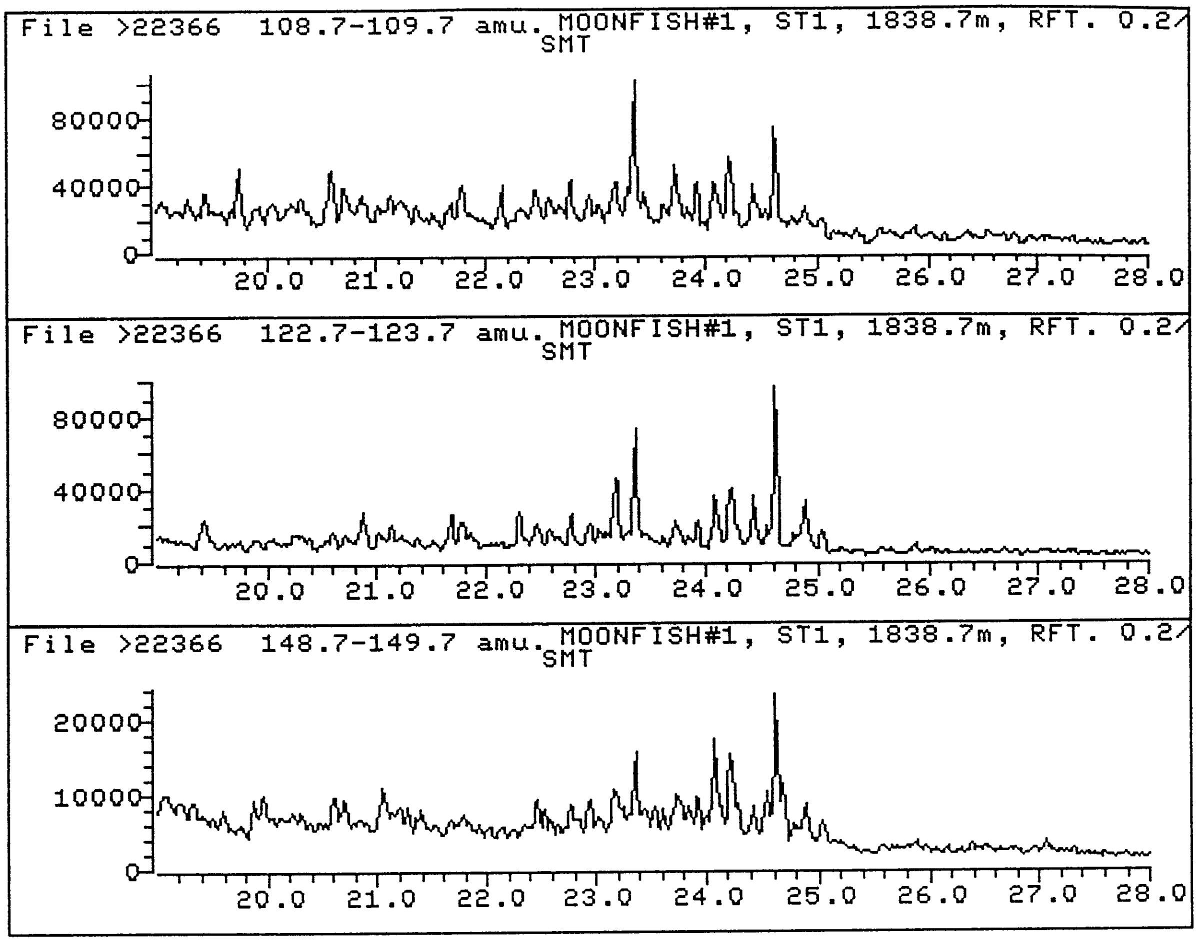

File >22366 411.7-412.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
800
400
0
34 36 38 40 42 44 46 48 50 52 54 56 58 60

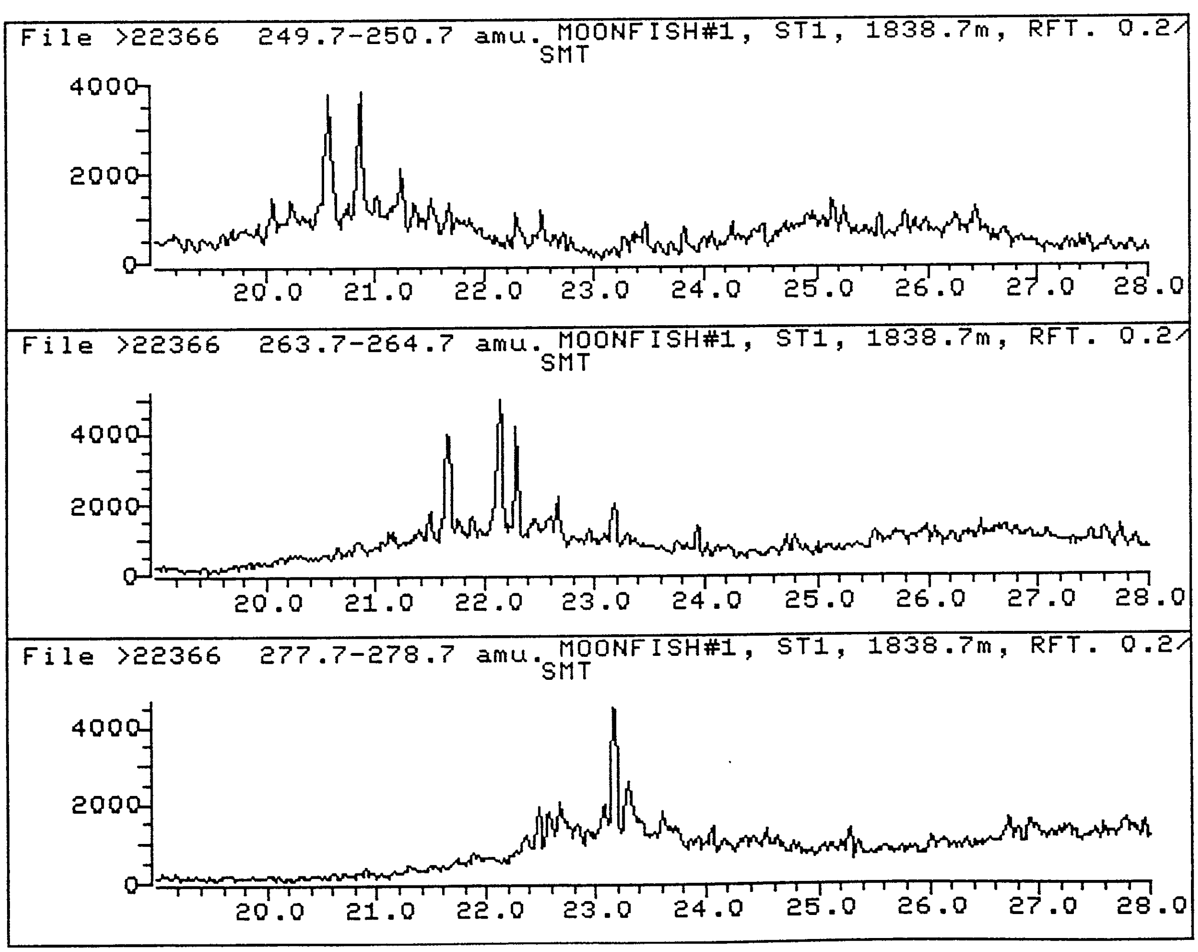

File >22366 329.7-330.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
File >22366 162.7-163.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT

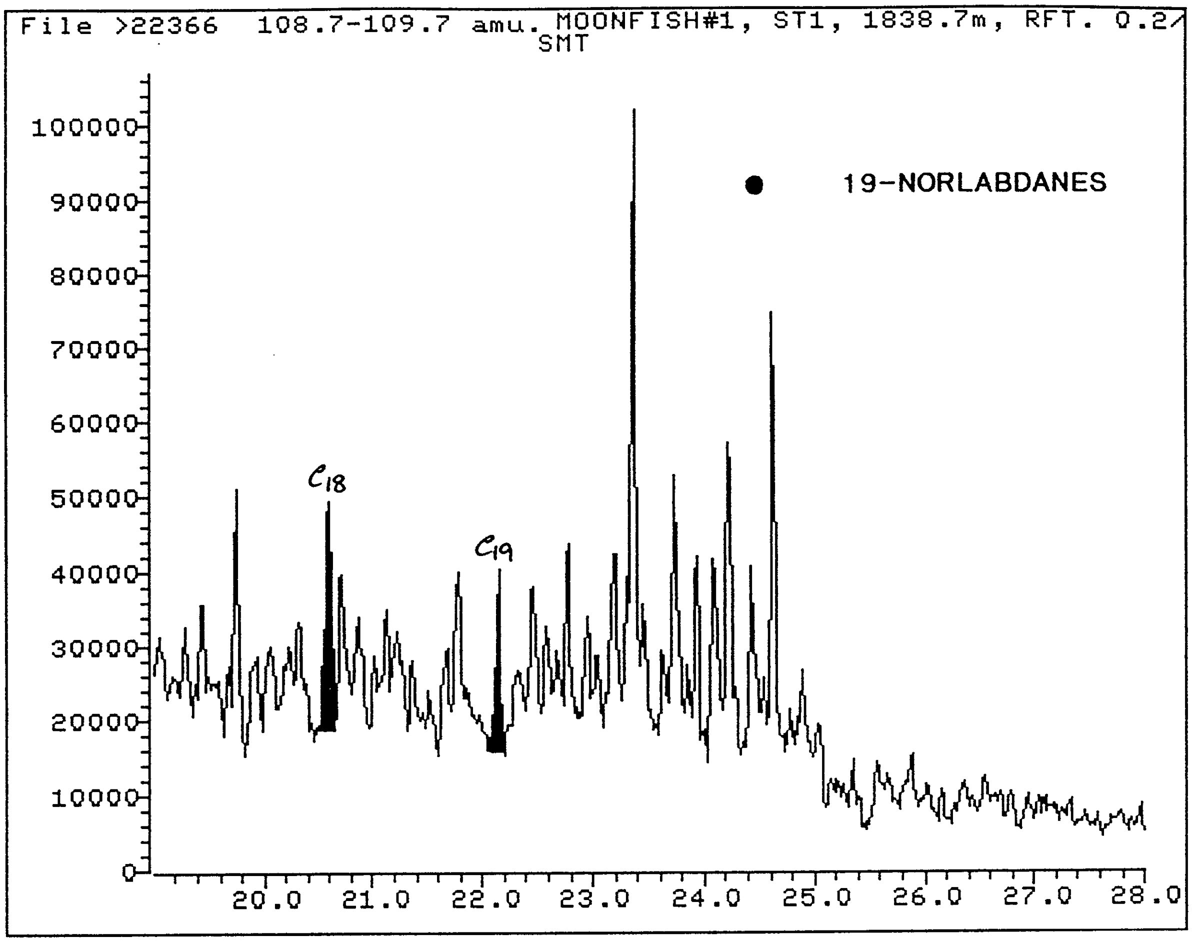

File >22366 190.7-191.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
ø HOMOLOGOUS TETRACYCLIC TERPANES
C24
Ts
Tm
File >22366 190.7-191.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT

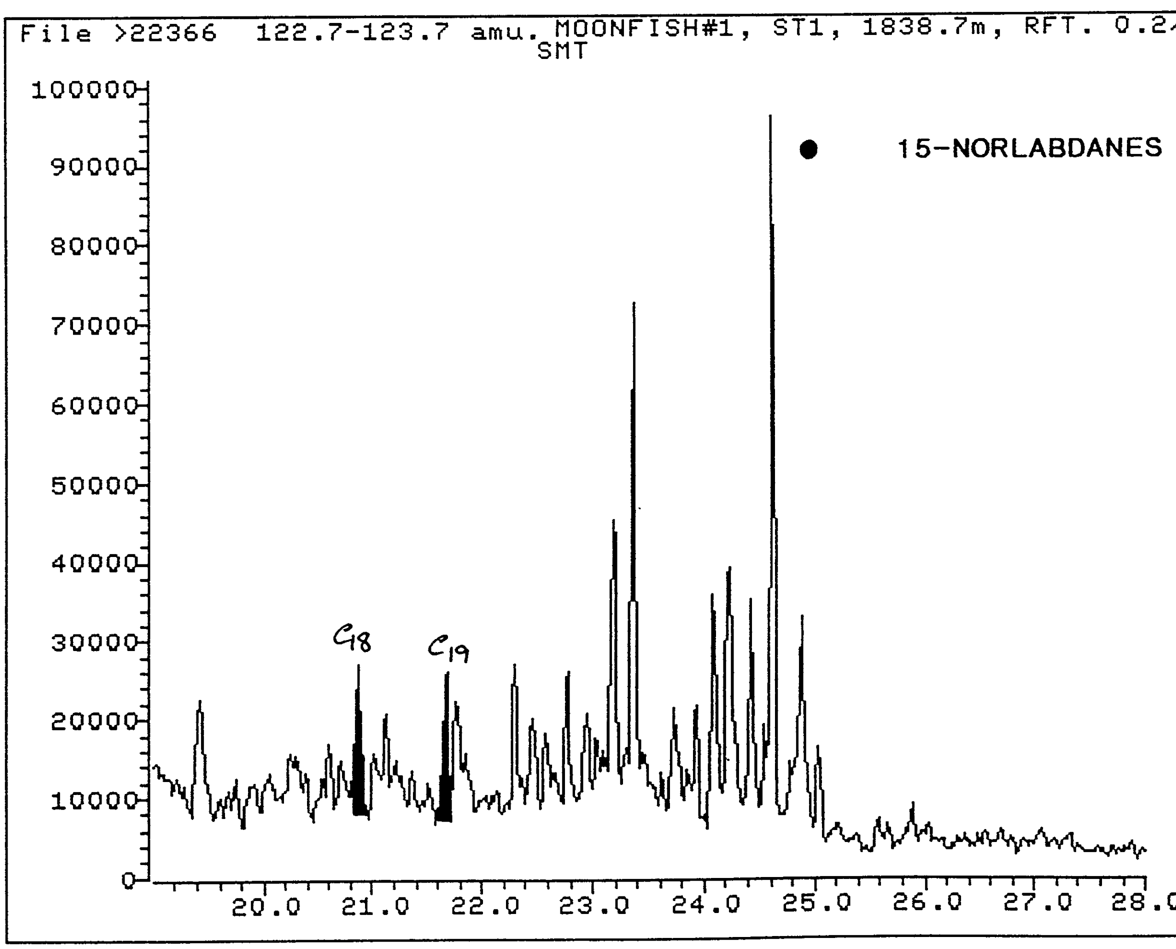

File >22366 192.7-193.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
300000
250000
200000
150000
100000
50000
0
14.0
15.0
16.0
17.0
18.0
19.0
File >22366 164.7-165.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
40000
30000
20000
10000
0
14.0
15.0
16.0
17.0
18.0
19.0

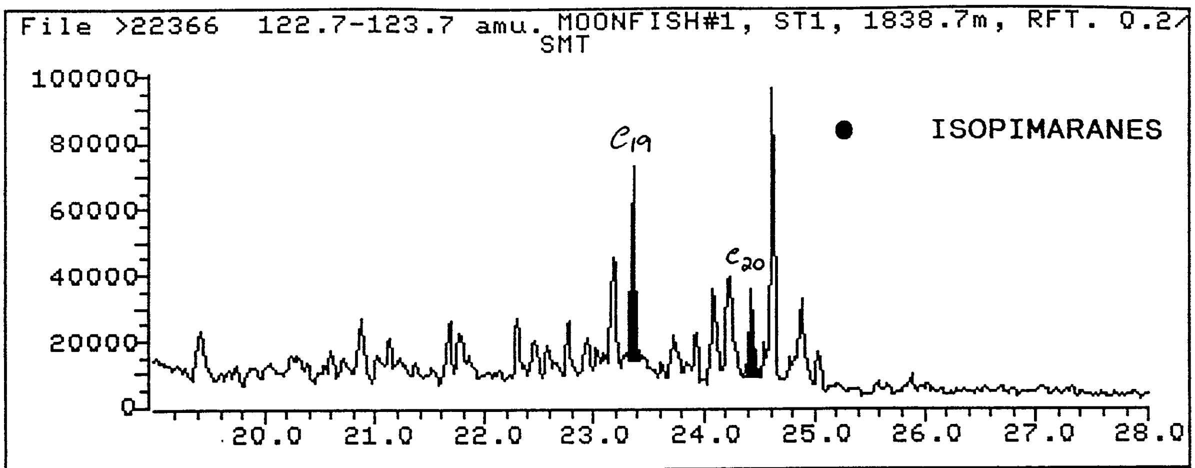
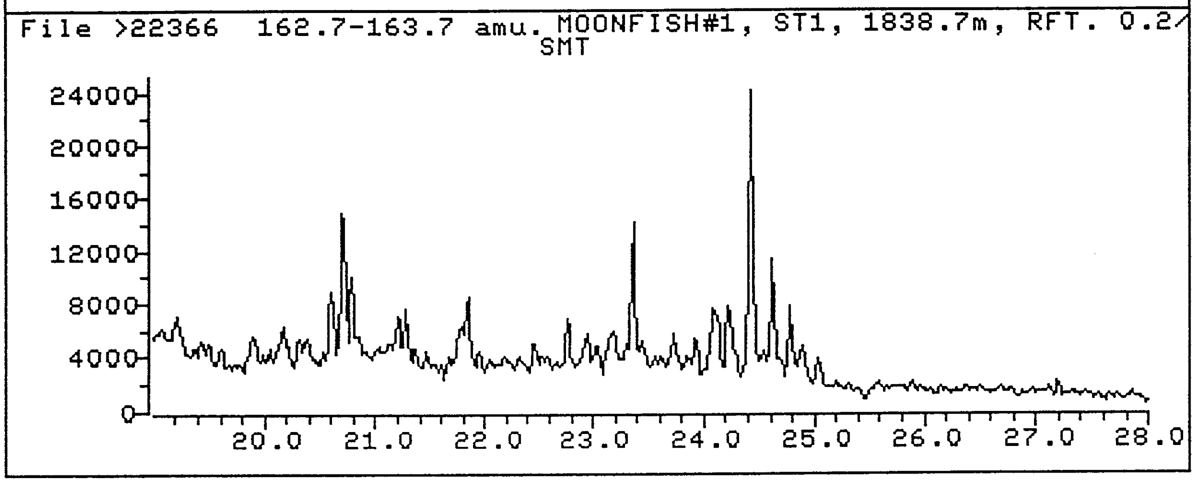
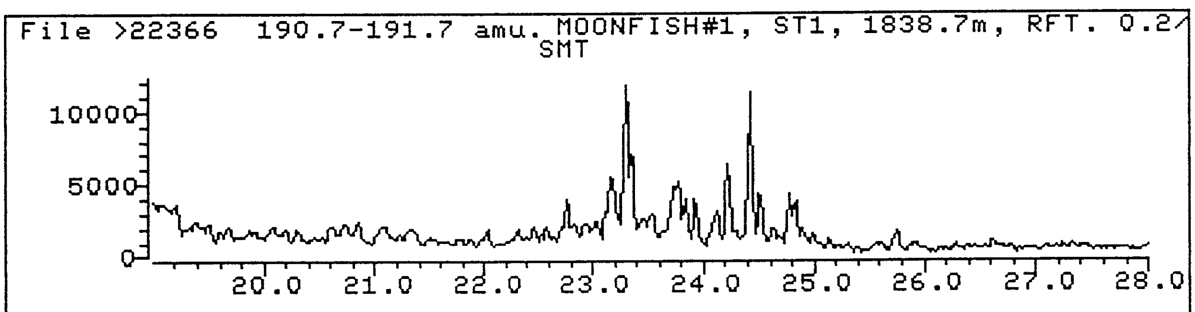
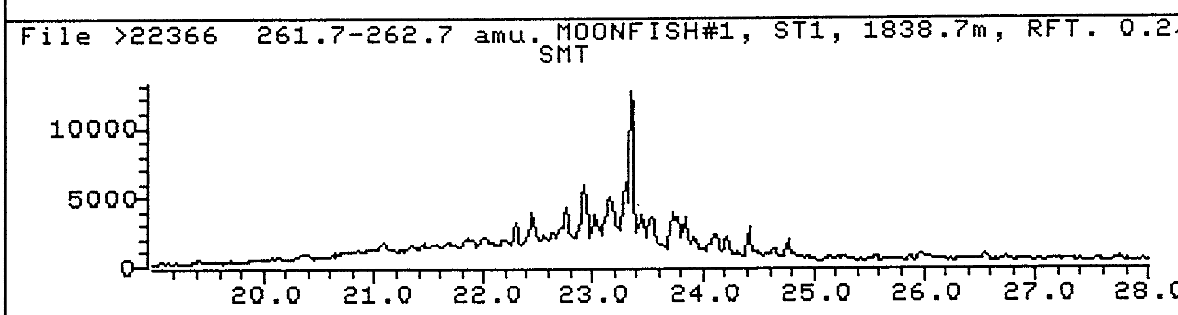
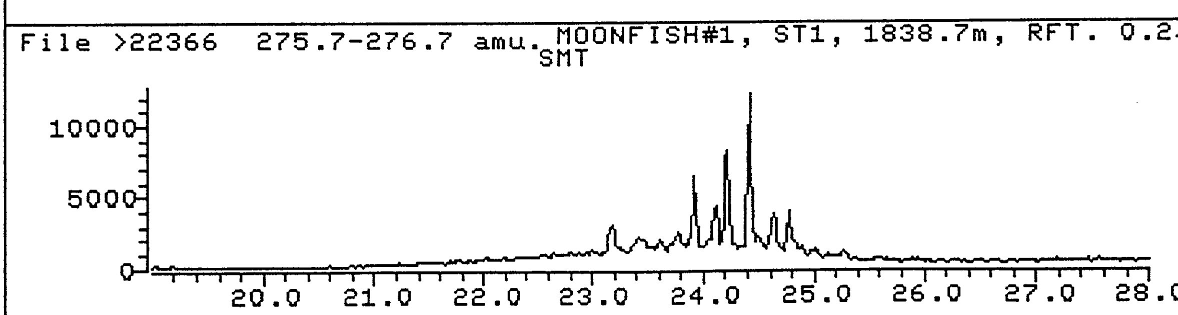

File >22366 122.7-123.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
C15
C15
C15
C16
160000
140000
120000
100000
80000
60000
40000
20000
0
DRIMANES
REARRANGED DRIMANES
14.0
15.0
16.0
17.0
18.0
19.0

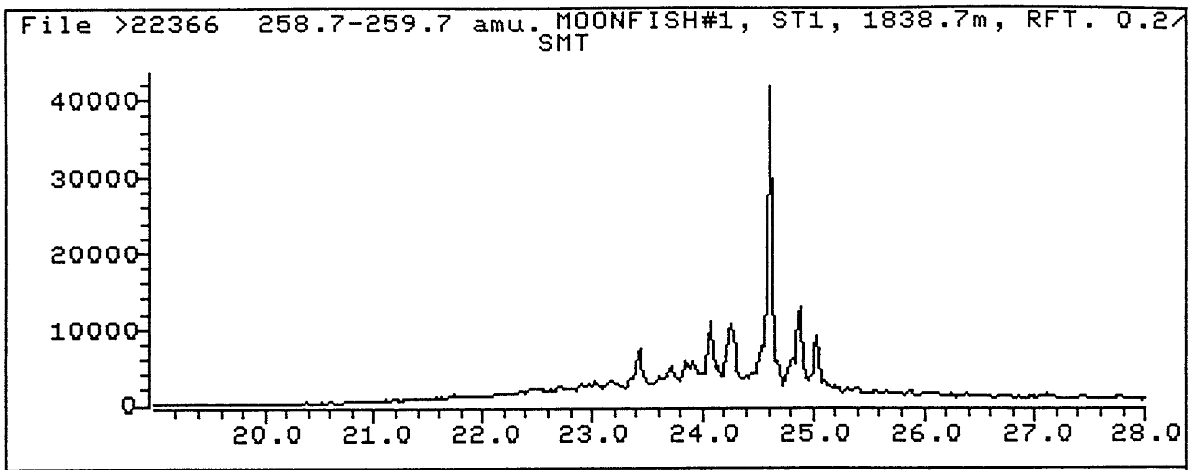

File >22366 108.7-109.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
80000
40000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0
File >22366 122.7-123.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
80000
40000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0
File >22366 148.7-149.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
20000
10000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0

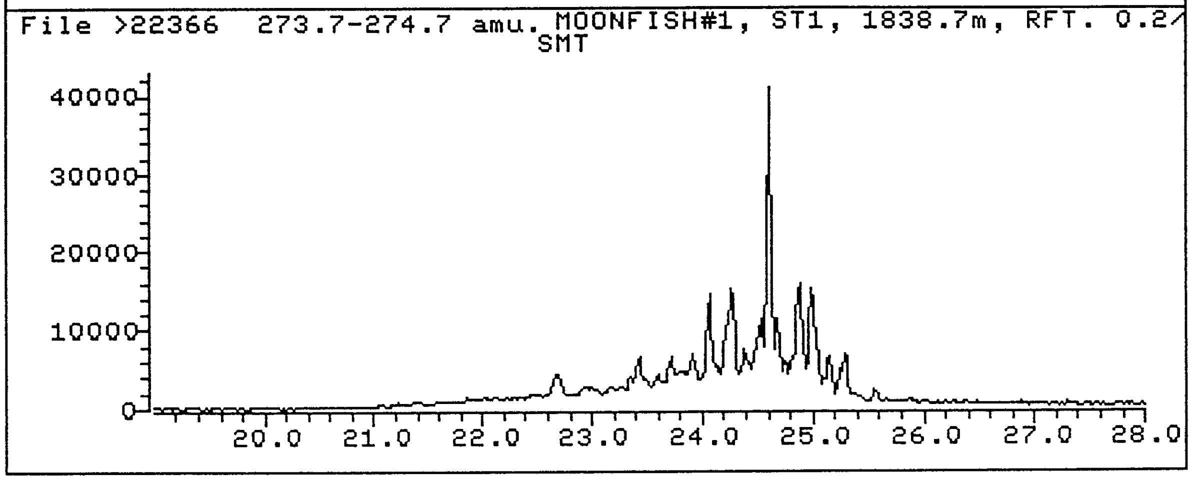

File >22366 249.7-250.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
4000
2000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0
File >22366 263.7-264.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
4000
2000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0
File >22366 277.7-278.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
4000
2000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0

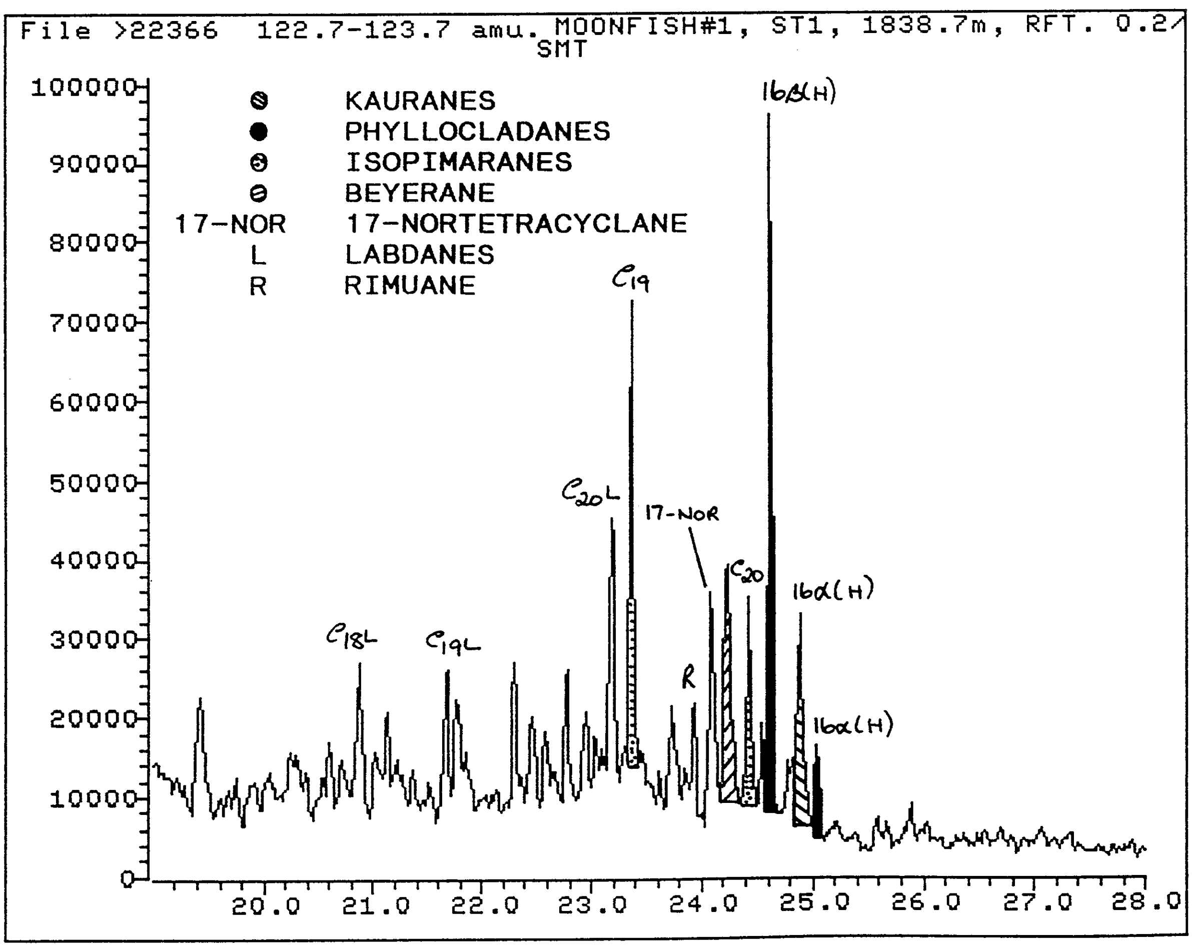

File >22366 108.7-109.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
19-NORLABDANES
C18
C19
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0


File >22366 122.7-123.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
15-NORLABDANES
C18
C19
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0


File >22366 122.7-123.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
100000
80000
60000
40000
20000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0
C19
C20
● ISOPIMARANES

File >22366 162.7-163.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
24000
20000
16000
12000
8000
4000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0

File >22366 190.7-191.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
10000
5000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0

File >22366 261.7-262.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
10000
5000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0

File >22366 275.7-276.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/SMT
10000
5000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0


File >22366 258.7-259.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
40000
30000
20000
10000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0


File >22366 273.7-274.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
40000
30000
20000
10000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0


File >22366 122.7-123.7 amu. MOONFISH#1, ST1, 1838.7m, RFT. 0.2/
SMT
KAURANES
PHYLLOCLADANES
ISOPIMARANES
BEYERANE
17-NOR 17-NORTETRACYCLANE
L LABDANES
R RIMUANE
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0

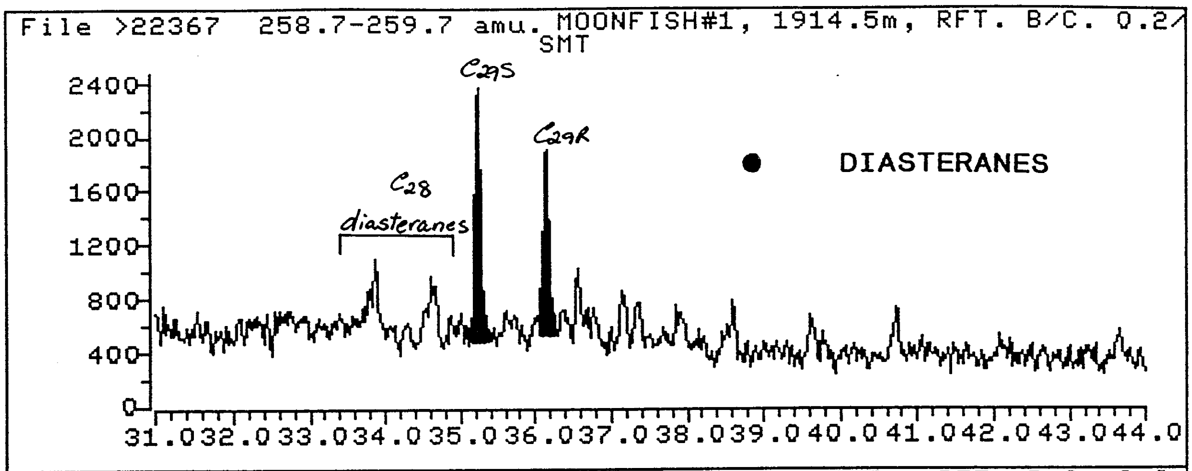
SELECTED PARAMETERS FROM GC/MS ANALYSIS

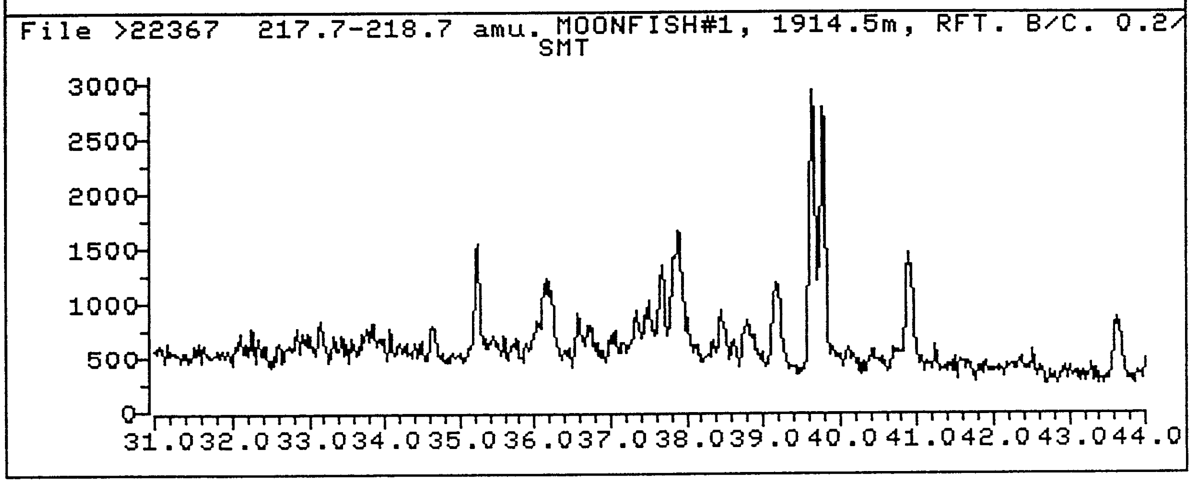
MOONFISH 1, 1914.5m, RFT Oil

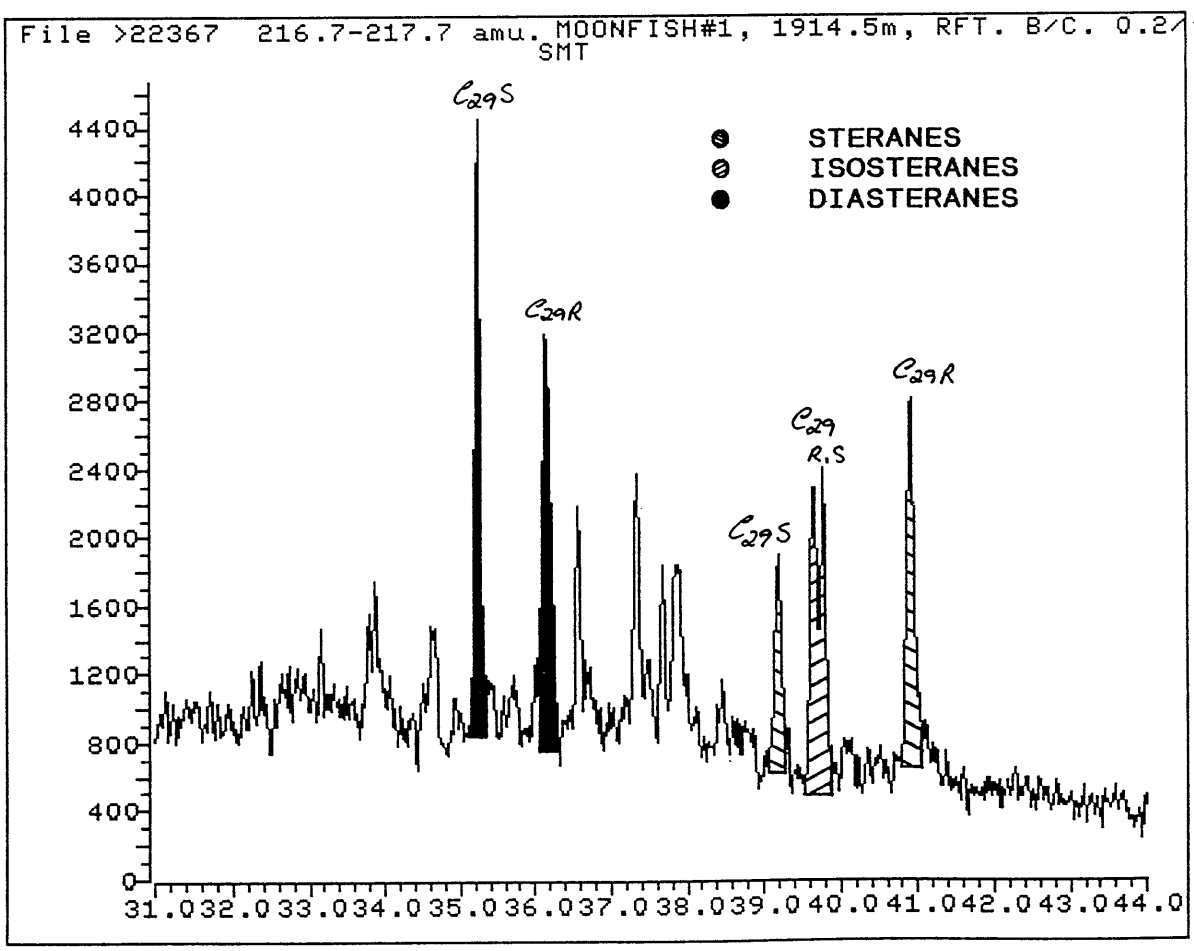
	Parameter	Ion(s)	Value
1.	18 α (H)- hopane/17 α (H)-hopane (Ts/Tm)	191	0.37
2.	C30 hopane/C30 moretane	191	5.00
3.	C31 22S hopane/C31 22R hopane	191	1.09
4.	C32 22S hopane/C32 22R hopane	191	1.31
5.	C29 20S $\alpha\alpha\alpha$ sterane/C29 20R $\alpha\alpha\alpha$ sterane	217	0.49
6.	C29 $\alpha\alpha\alpha$ steranes (20S / 20S+20R)	217	0.33
7.	C29 $\alpha\beta\beta$ steranes / (C29 $\alpha\alpha\alpha$ steranes + C29 $\alpha\beta\beta$ steranes)	217	0.51
8.	C27/C29 diasteranes	259	nd
9.	C27/C29 steranes	217	nd
10.	18 α (H)-oleanane/C30 hopane	191	nd
11.	C29 diasteranes / (C29 $\alpha\alpha\alpha$ steranes + C29 $\alpha\beta\beta$ steranes)	217	0.78
12.	C30 (hopane + moretane) / C29 (steranes + diasteranes)	191/217	0.73
13.	C15 drimane/C16 homodrimane	123	0.67
14.	Rearranged drimanes/normal drimanes	123	0.78

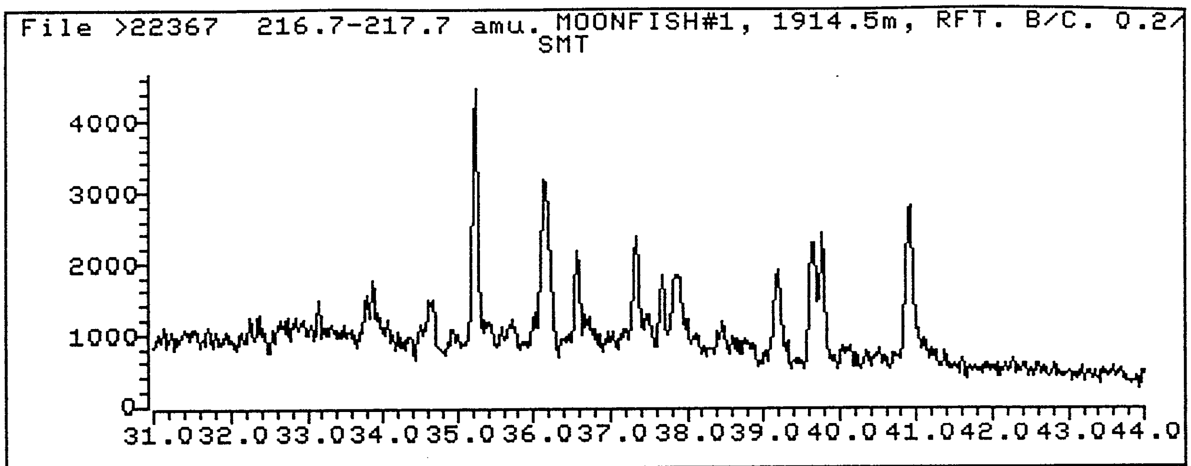
nd = not detectable

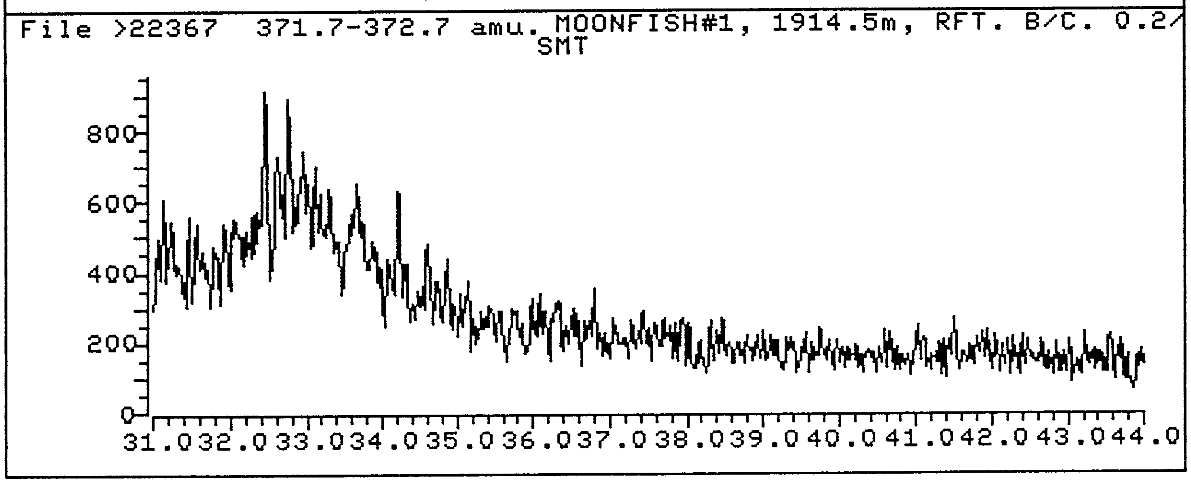
Figure 4–2

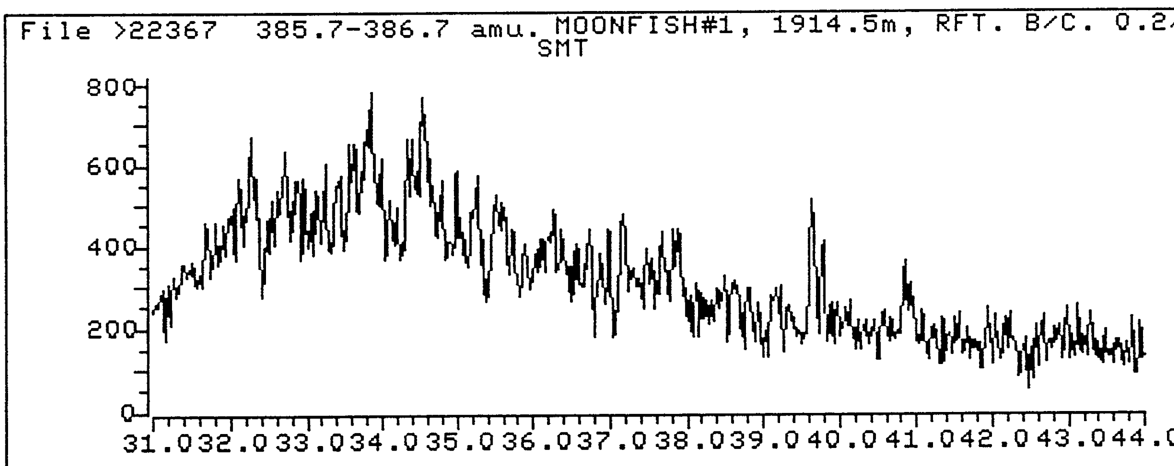

File >22367 258.7-259.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
C29S
C29R
C28 diasteranes
DIASTERANES
2400
2000
1600
1200
800
400
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

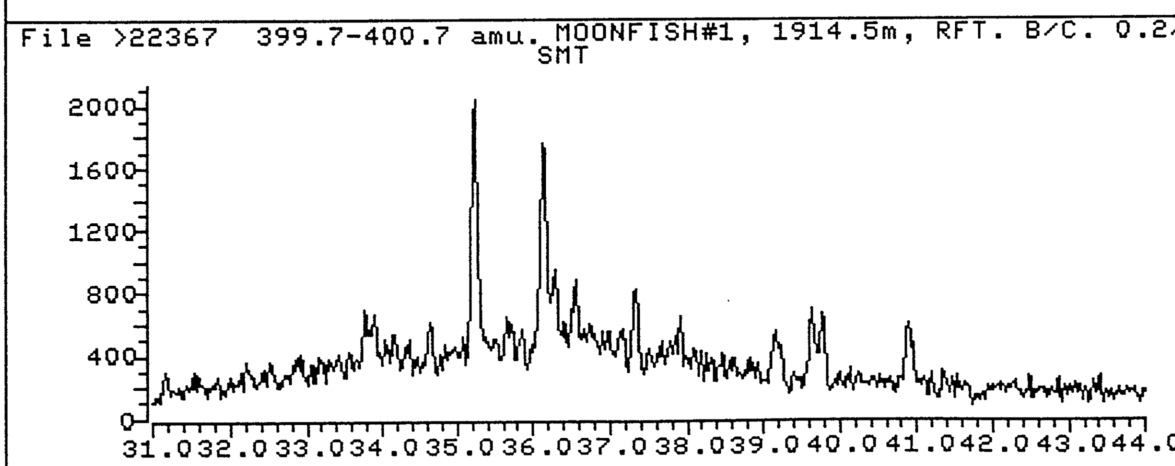

File >22367 217.7-218.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
3000
2500
2000
1500
1000
500
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

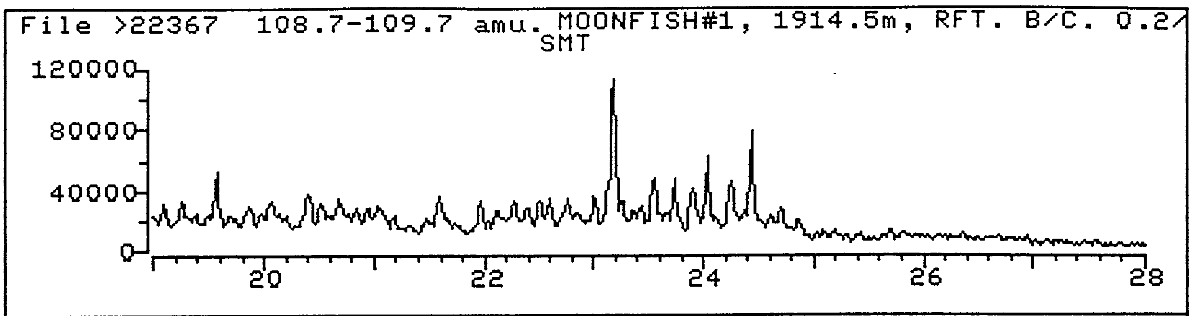

File >22367 216.7-217.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
C29S
C29R
C29S
C29 R,S
C29R
STERANES
ISOSTERANES
DIASTERANES
4400
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

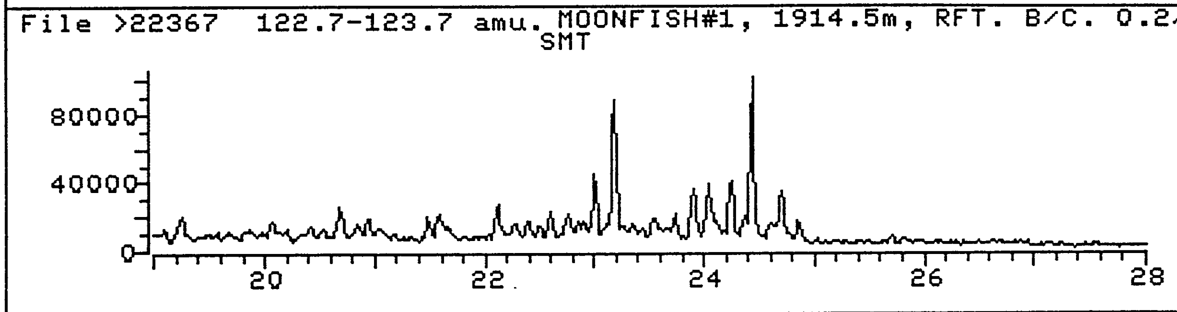

File >22367 216.7-217.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
0 1000 2000 3000 4000
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

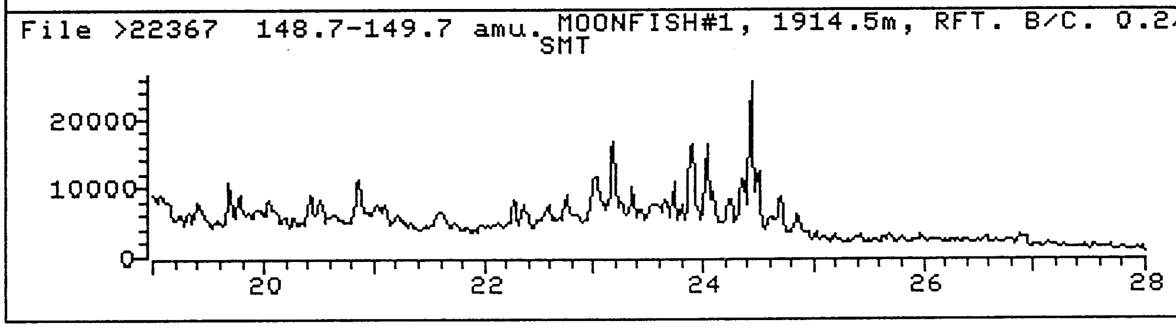

File >22367 371.7-372.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
0 200 400 600 800
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

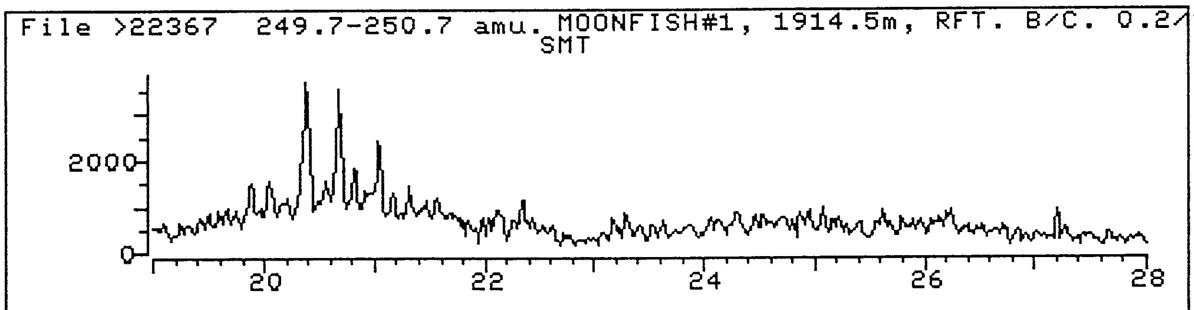

File >22367 385.7-386.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
0 200 400 600 800
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

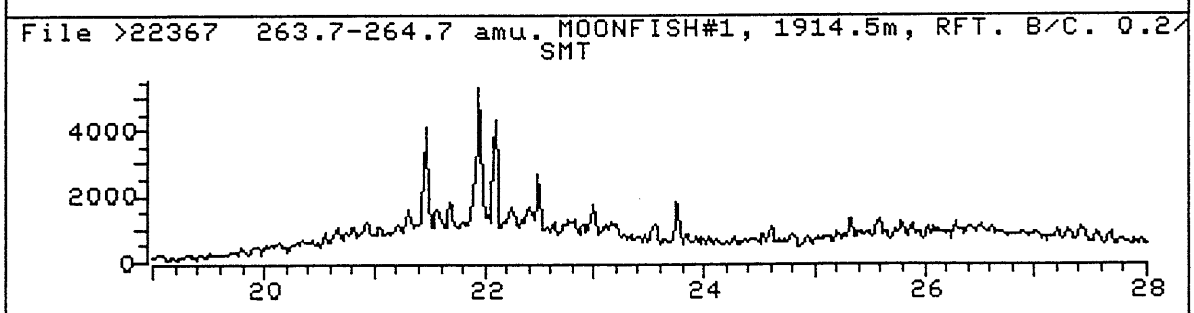

File >22367 399.7-400.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
0 400 800 1200 1600 2000
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0

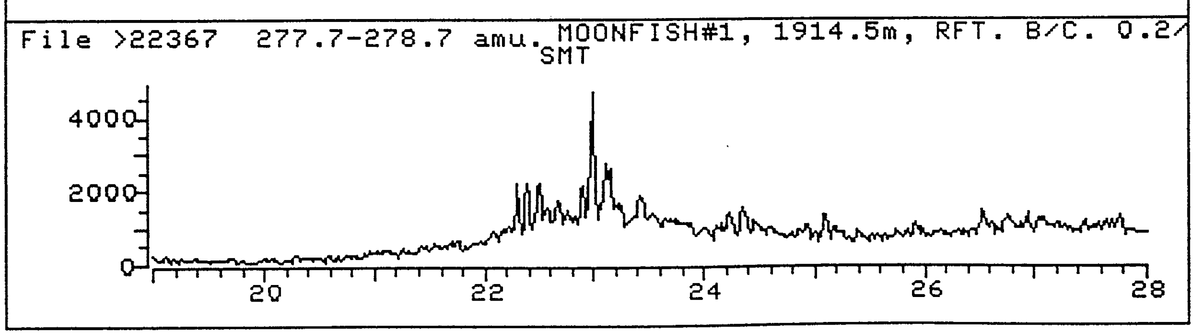

File >22367 108.7-109.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
120000
80000
40000
0
20
22
24
26
28

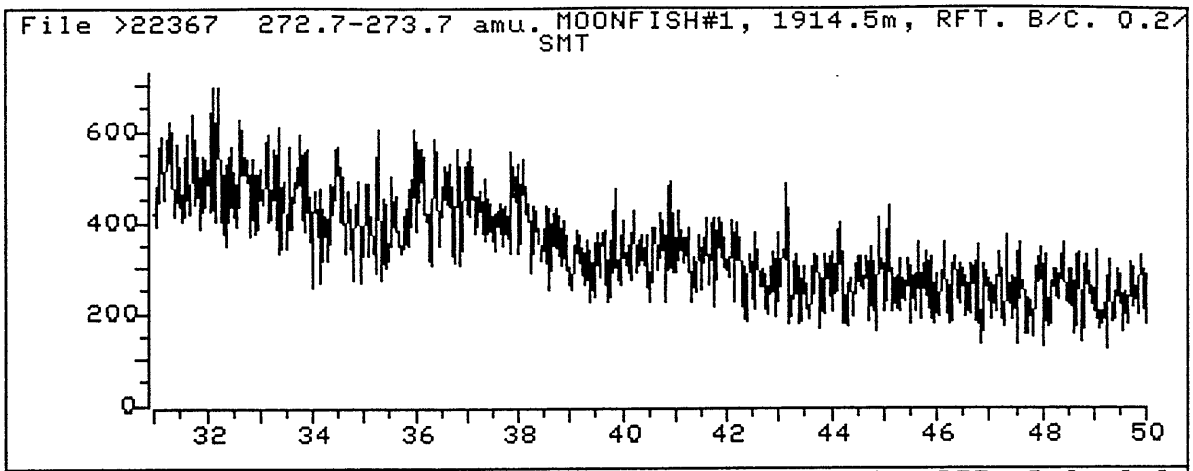

File >22367 122.7-123.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
80000
40000
0
20
22
24
26
28

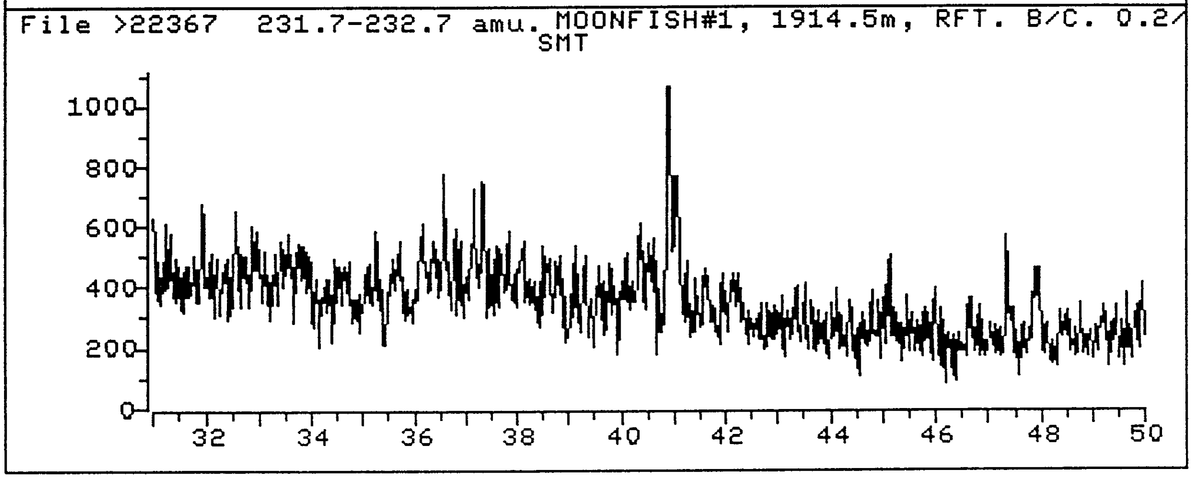

File >22367 148.7-149.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
20000
10000
0
20
22
24
26
28


File >22367 249.7-250.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
2000
0
20
22
24
26
28


File >22367 263.7-264.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
4000
2000
0
20
22
24
26
28


File >22367 277.7-278.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
4000
2000
0
20
22
24
26
28


File >22367 272.7-273.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
0
200
400
600
32
34
36
38
40
42
44
46
48
50


File >22367 231.7-232.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
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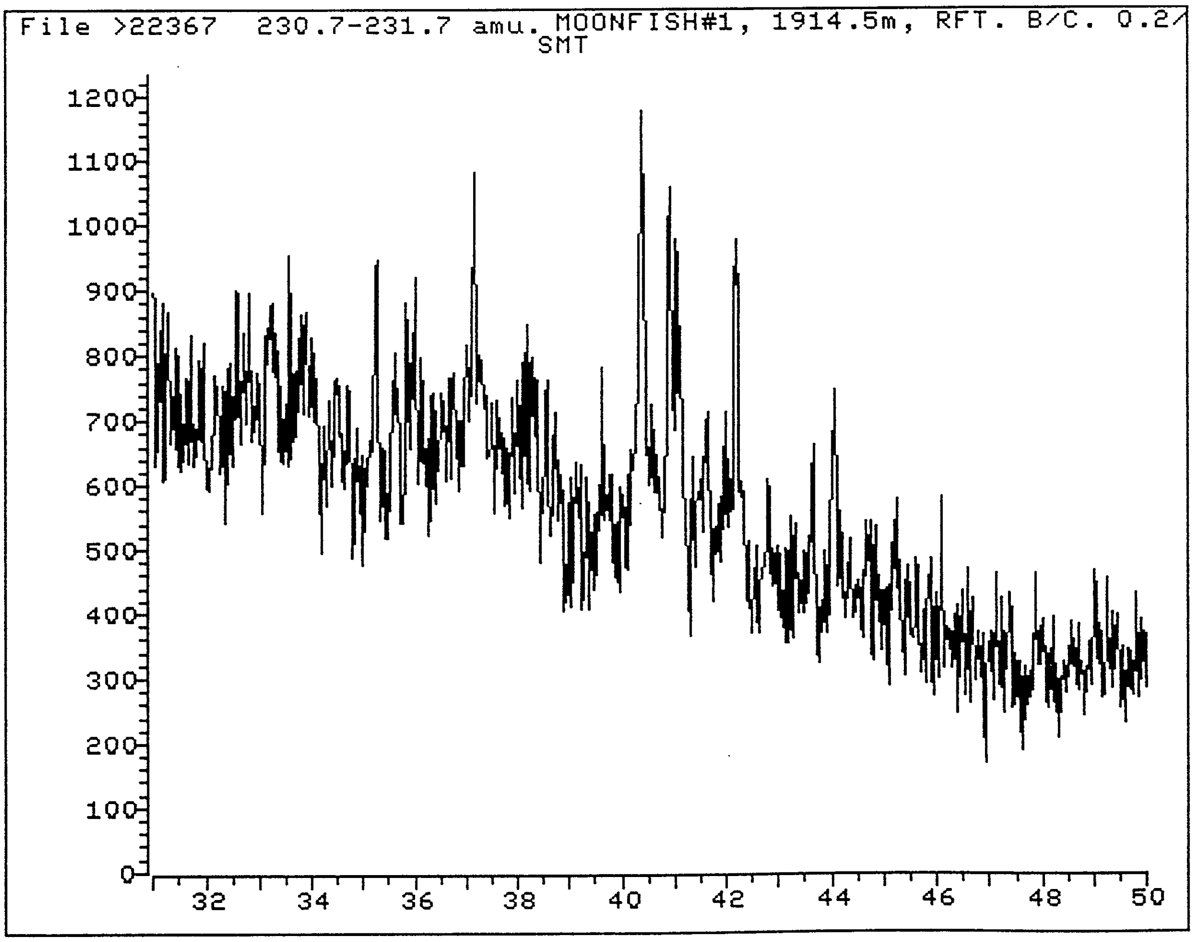
0
200
400
600
800
1000
32
34
36
38
40
42
44
46
48
50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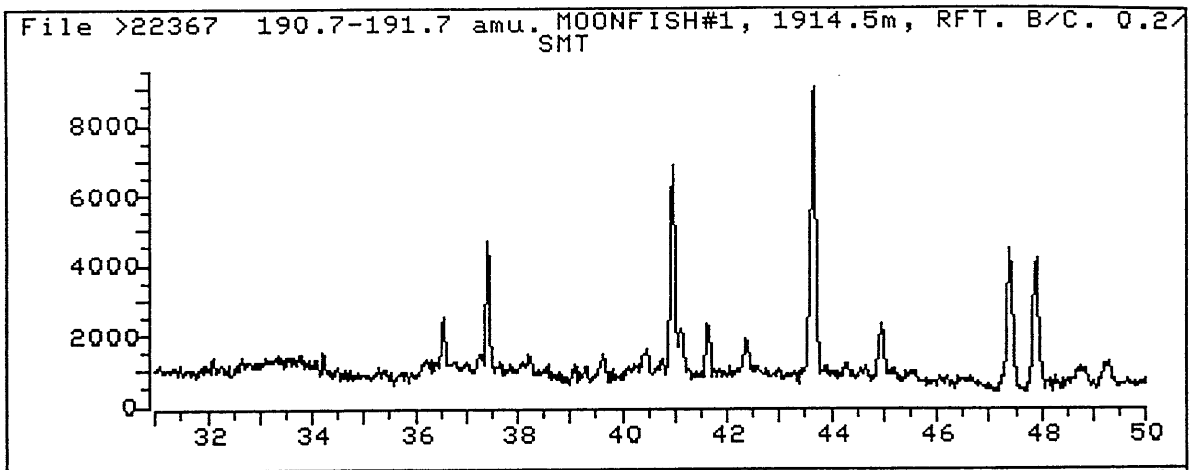
SMT
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
32
34
36
38
40
42
44
46
48
50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8000
6000
4000
2000
0
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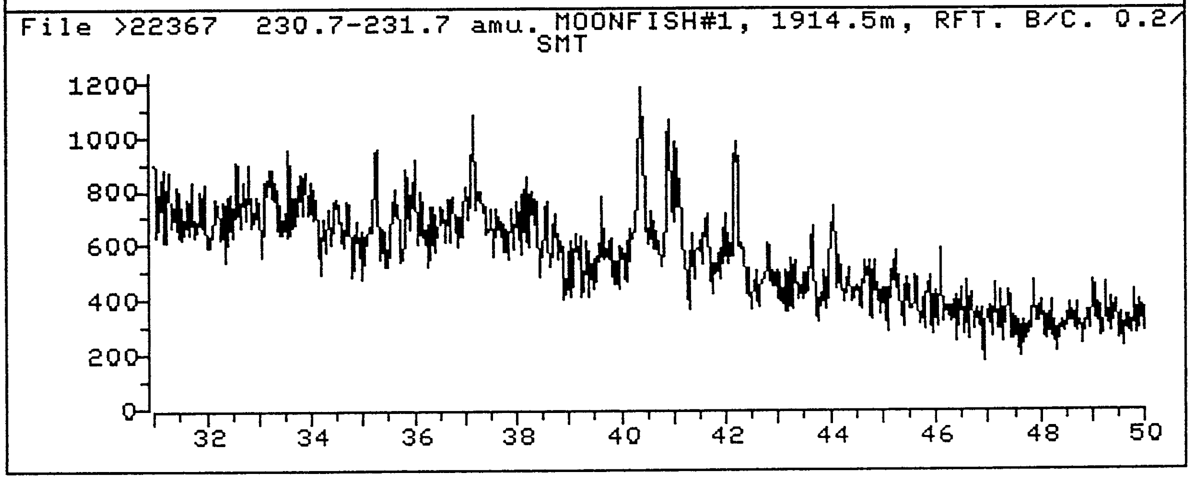
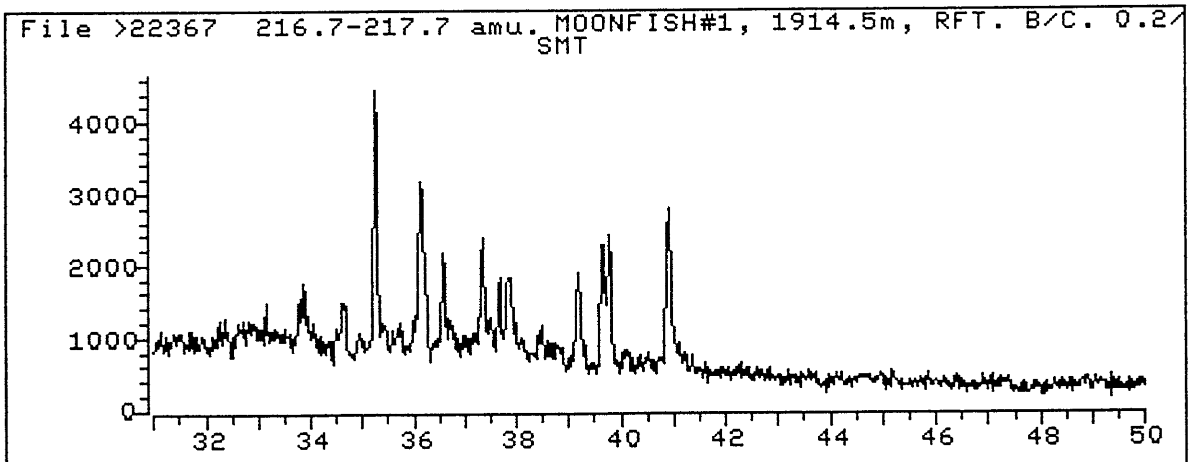
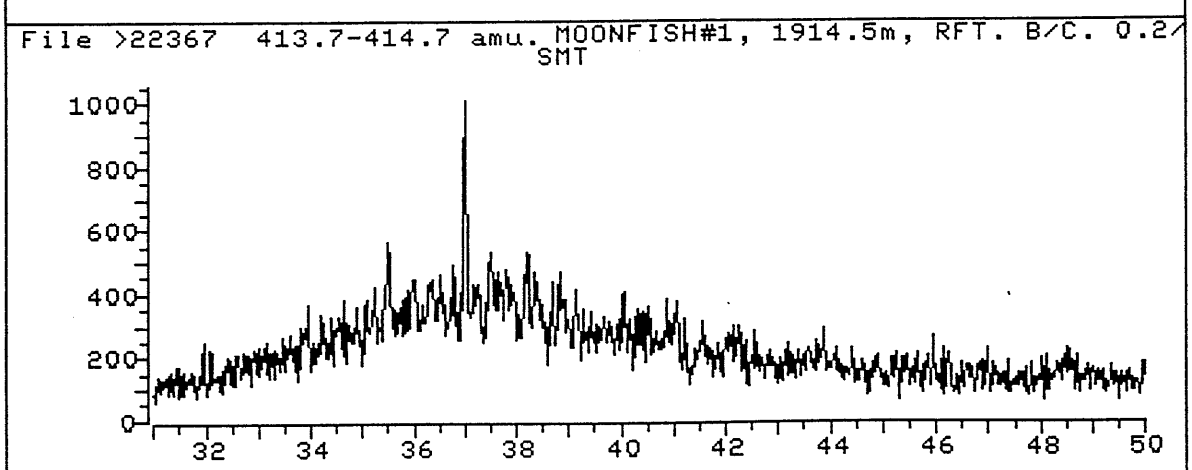
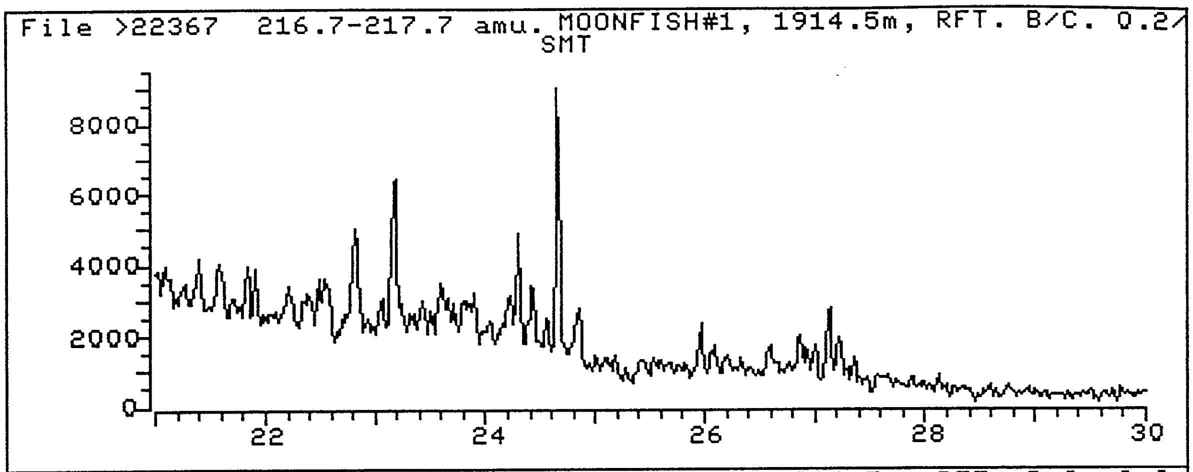
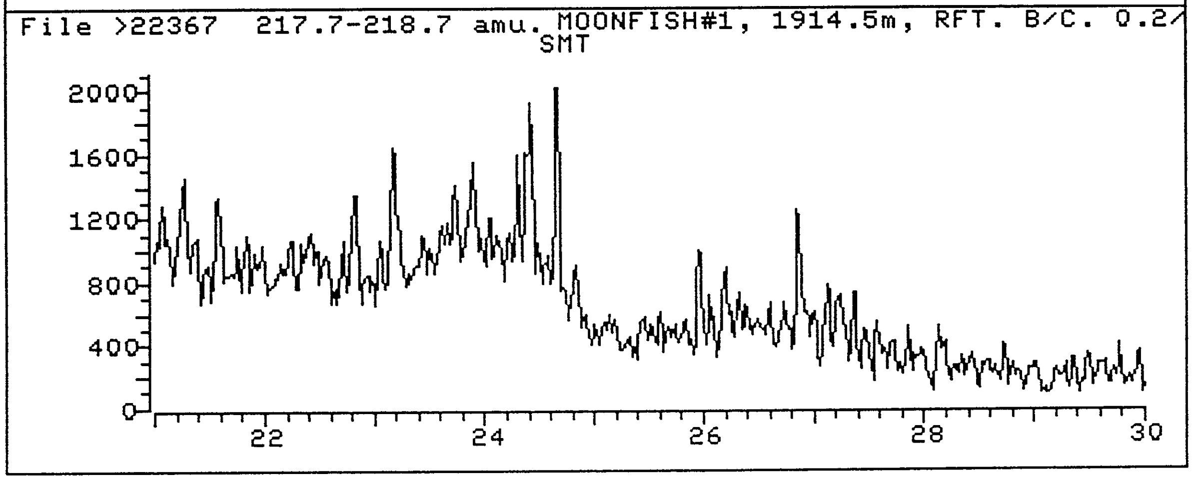
36
38
40
42
44
46
48
50

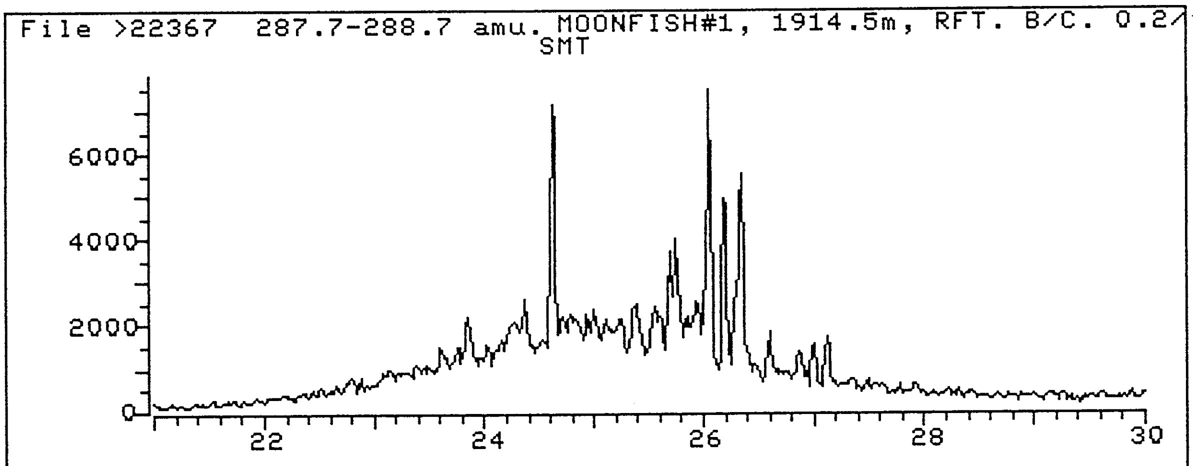

File >22367 230.7-231.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
1200
1000
800
600
400
200
0
32
34
36
38
40
42
44
46
48
50

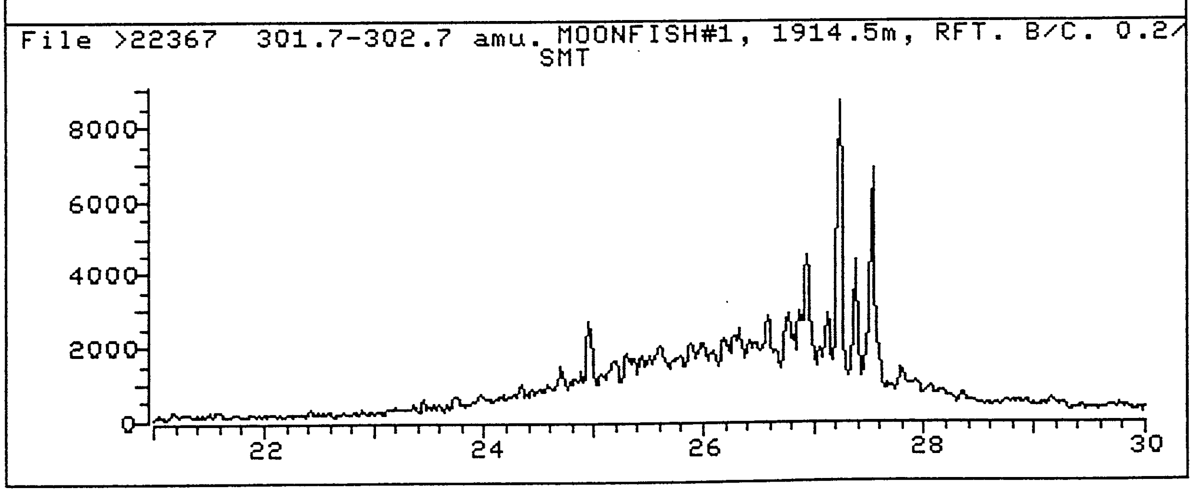

File >22367 216.7-217.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
4000
3000
2000
1000
0
32
34
36
38
40
42
44
46
48
50

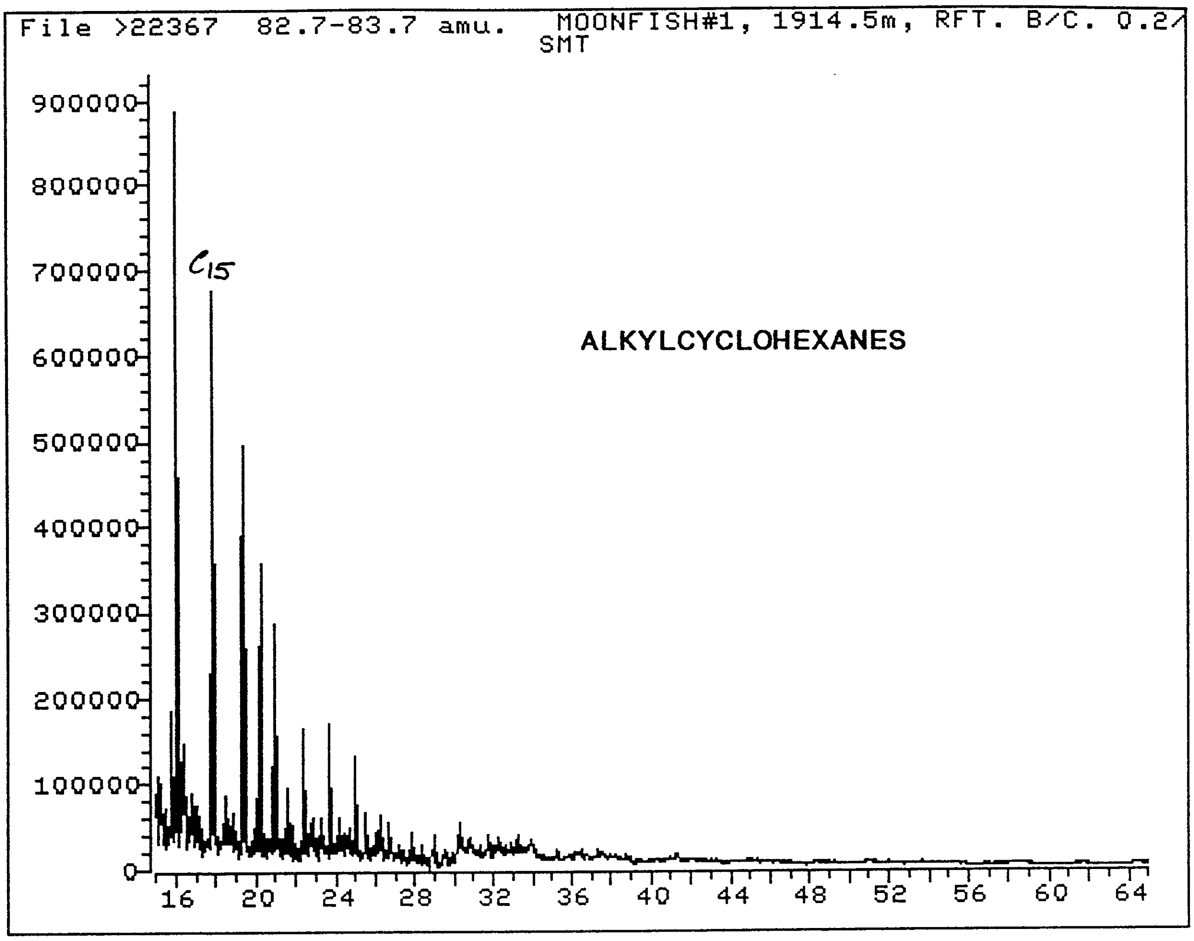

File >22367 413.7-414.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
1000
800
600
400
200
0
32
34
36
38
40
42
44
46
48
50

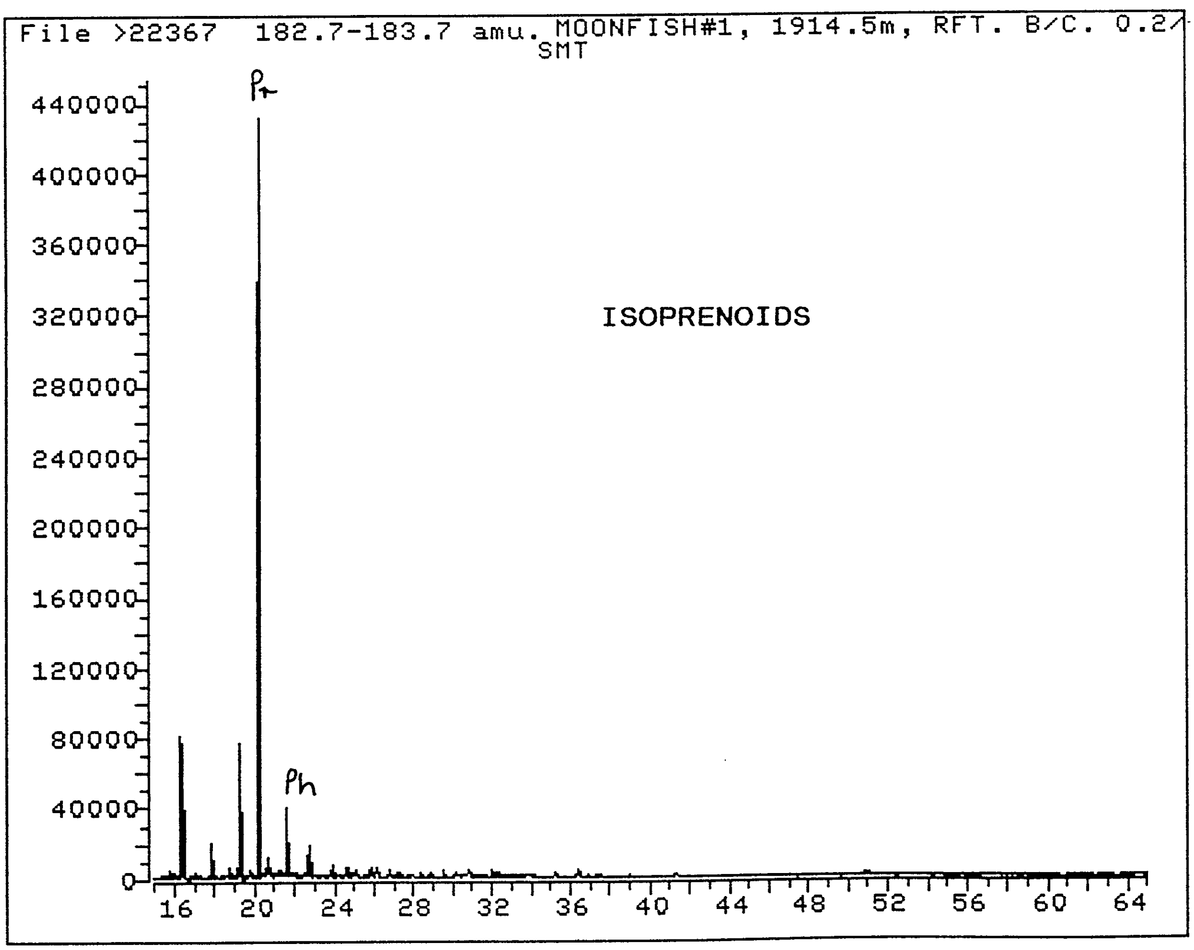

File >22367 216.7-217.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
8000
6000
4000
2000
0
22
24
26
28
30

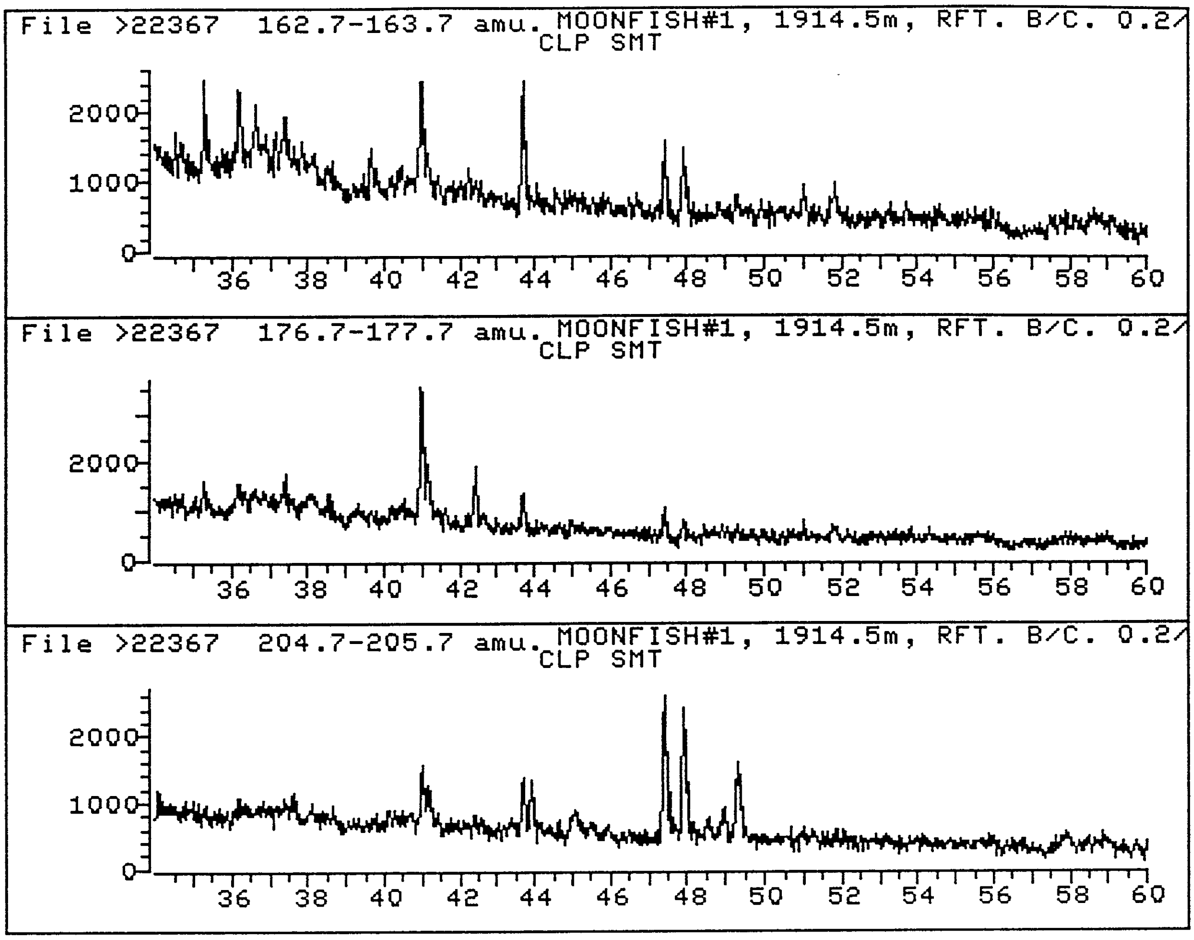

File >22367 217.7-218.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
2000
1600
1200
800
400
0
22
24
26
28
30

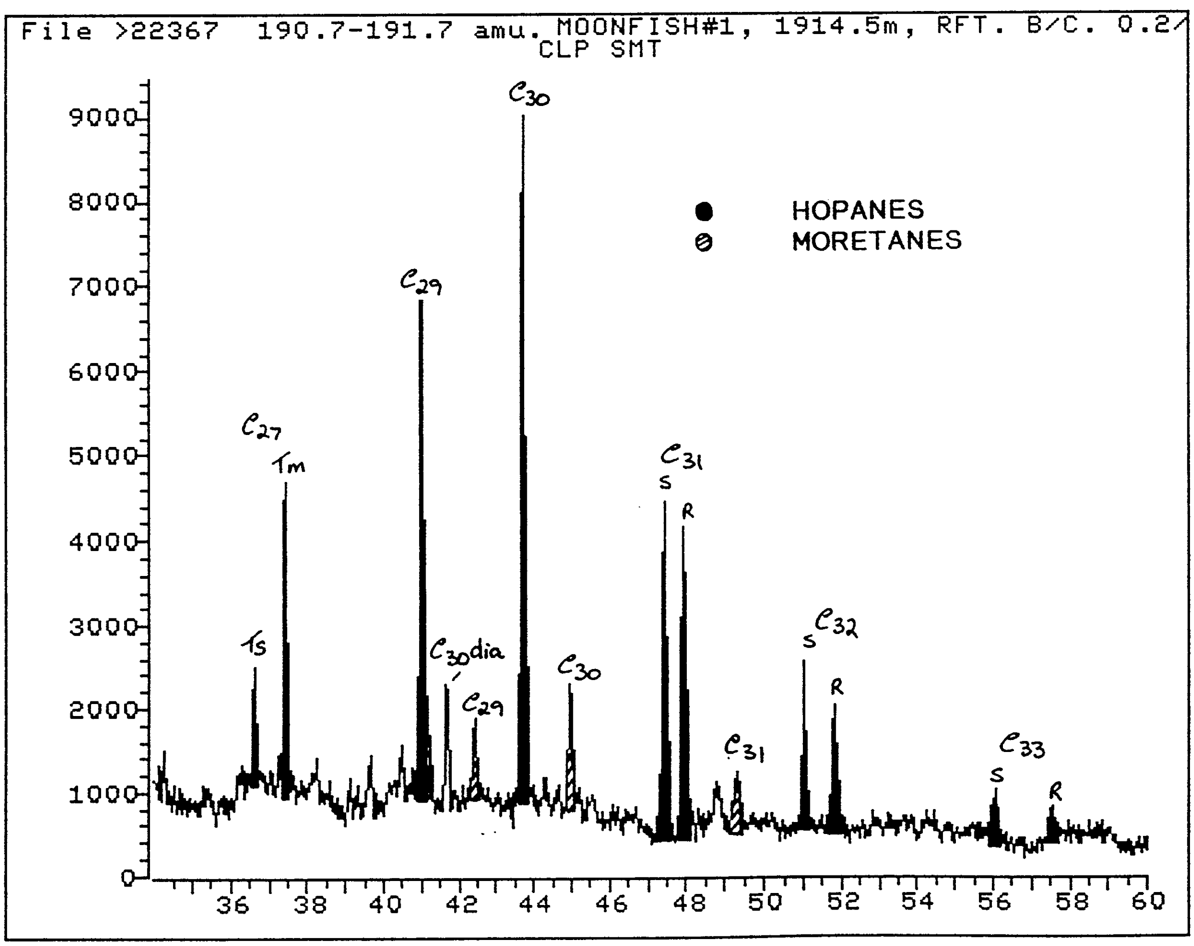

File >22367 287.7-288.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
6000
4000
2000
0
22
24
26
28
30

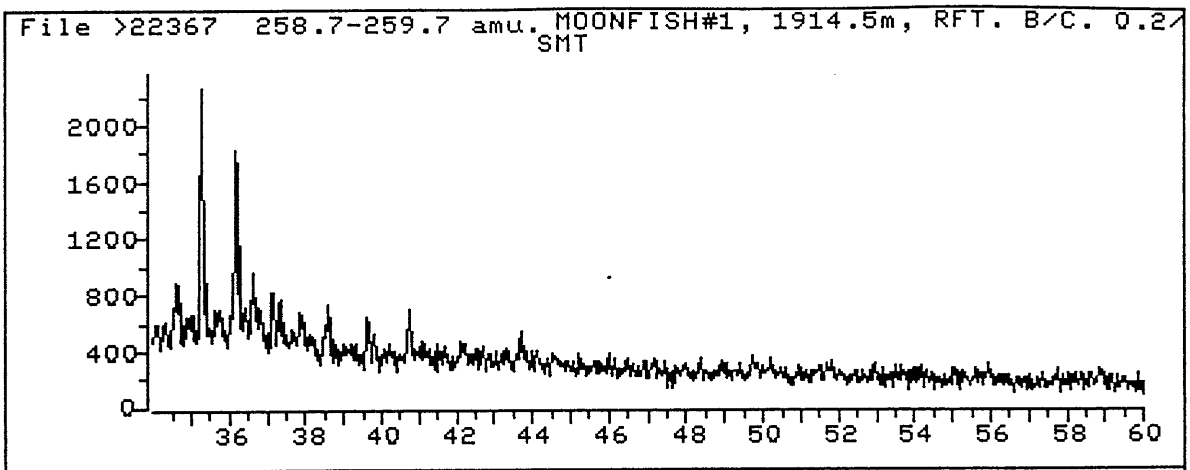

File >22367 301.7-302.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
8000
6000
4000
2000
0
22
24
26
28
30

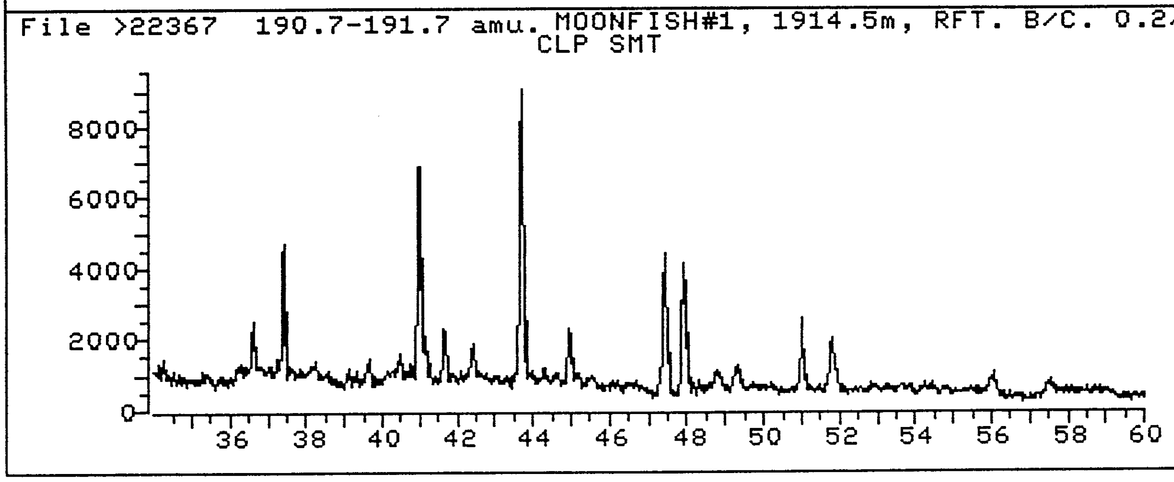

File >22367 82.7-83.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
ALKYLCYCLOHEXANES
C15
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
16
20
24
28
32
36
40
44
48
52
56
60
64

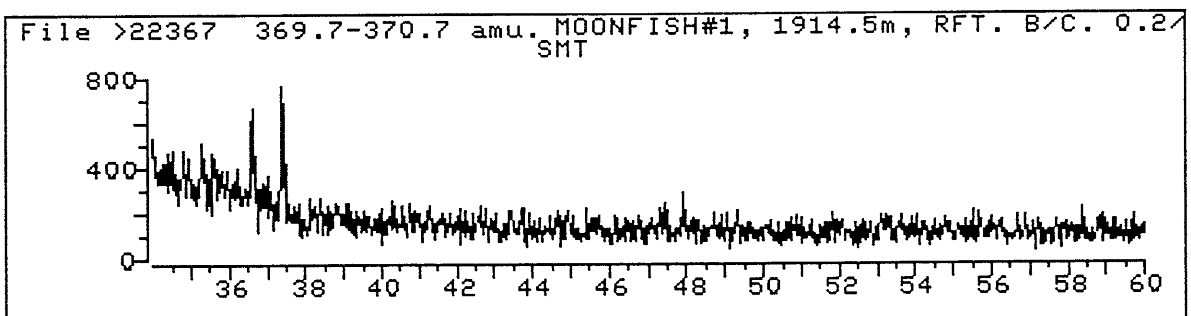

File >22367 182.7-183.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
ISOPRENOIDS
Pr
Ph
440000
400000
360000
320000
280000
240000
200000
160000
120000
80000
40000
0
16
20
24
28
32
36
40
44
48
52
56
60
64

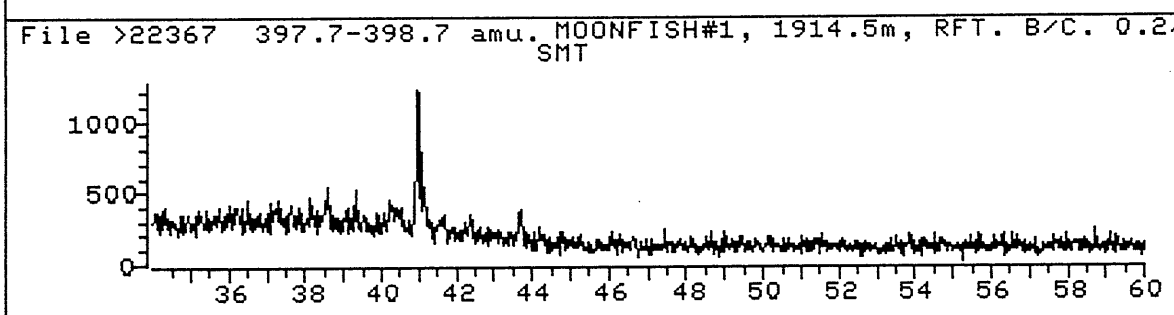

File >22367 162.7-163.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
CLP SMT
File >22367 176.7-177.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
CLP SMT
File >22367 204.7-205.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
CLP SMT

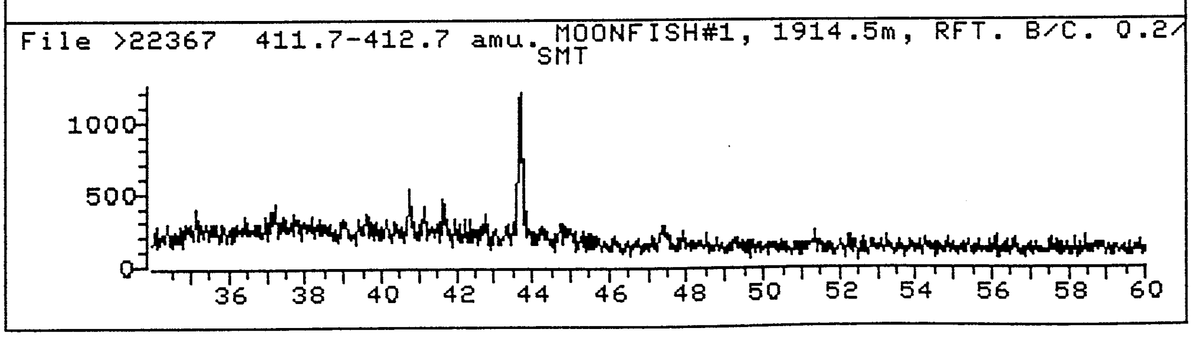

File >22367 190.7-191.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
CLP SMT
HOPANES
MORETANES
C27
Ts
Tm
C29
C30dia
C30
C31
S
R
C32
C33

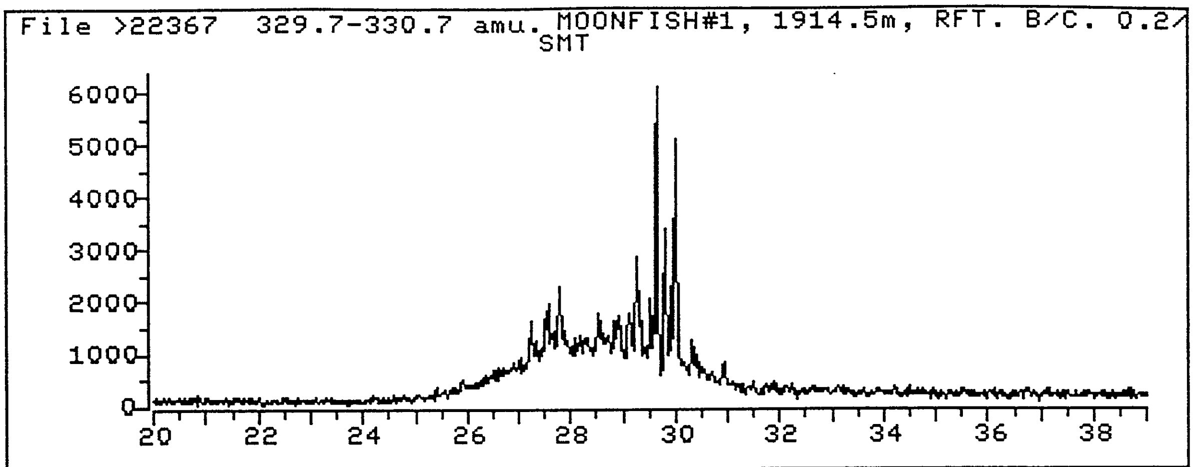

File >22367 258.7-259.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
2000
1600
1200
800
400
0
36 38 40 42 44 46 48 50 52 54 56 58 60

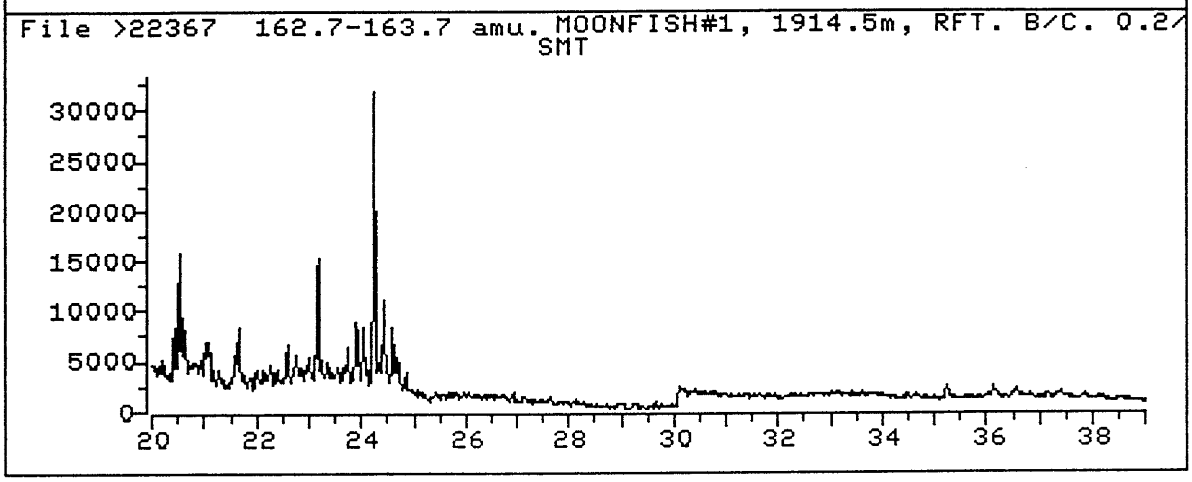

File >22367 190.7-191.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
CLP SMT
8000
6000
4000
2000
0
36 38 40 42 44 46 48 50 52 54 56 58 60

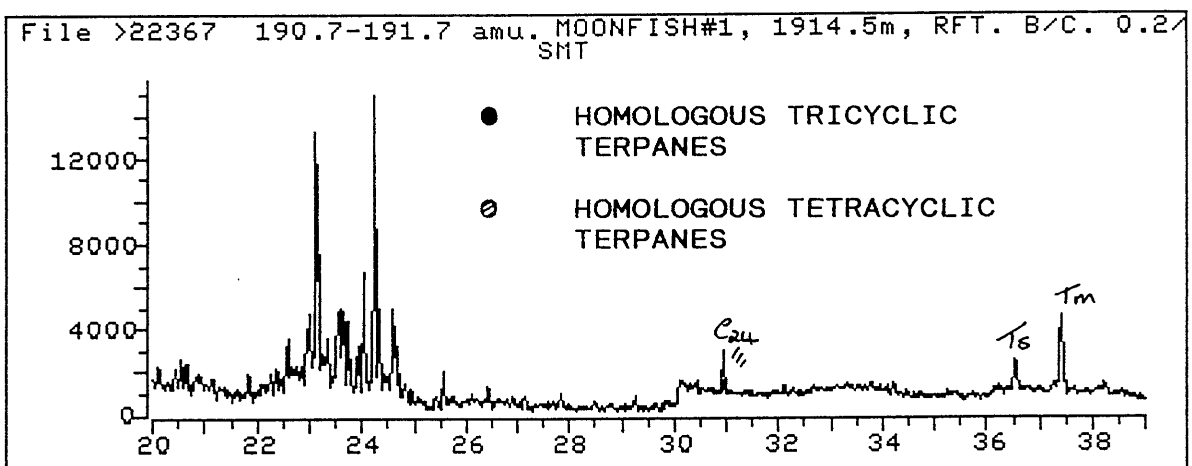

File >22367 369.7-370.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
800
400
0
36 38 40 42 44 46 48 50 52 54 56 58 60

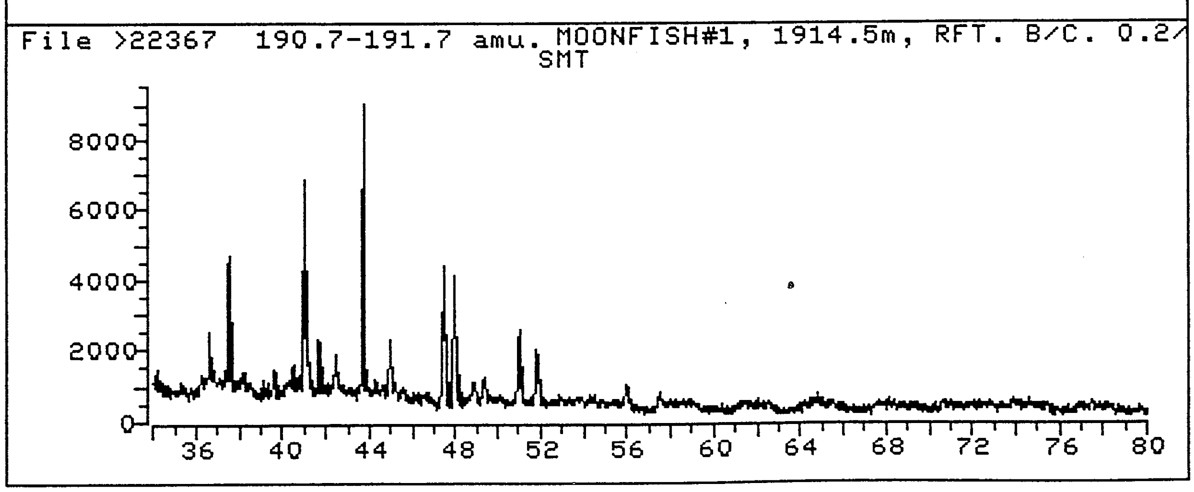

File >22367 397.7-398.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
1000
500
0
36 38 40 42 44 46 48 50 52 54 56 58 60

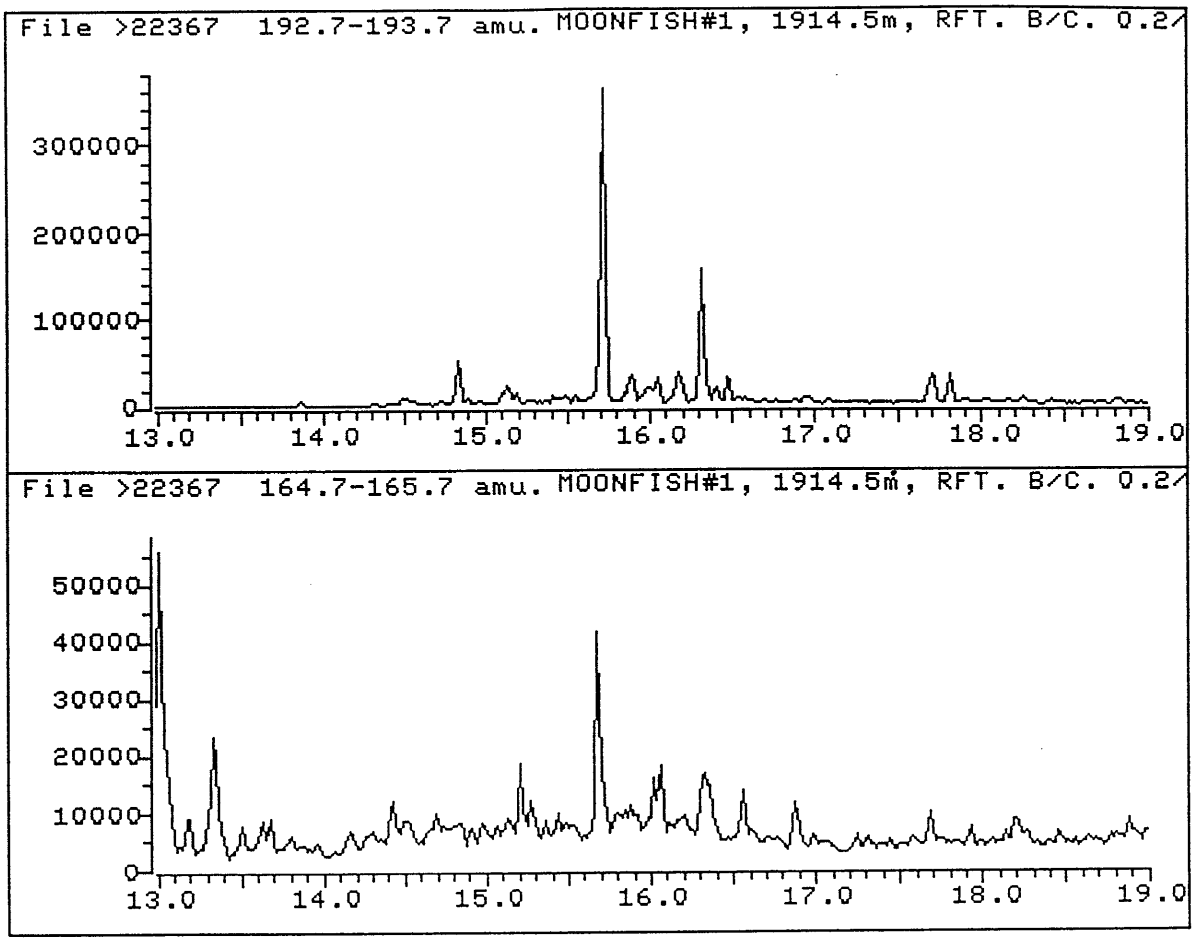

File >22367 411.7-412.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
1000
500
0
36 38 40 42 44 46 48 50 52 54 56 58 60

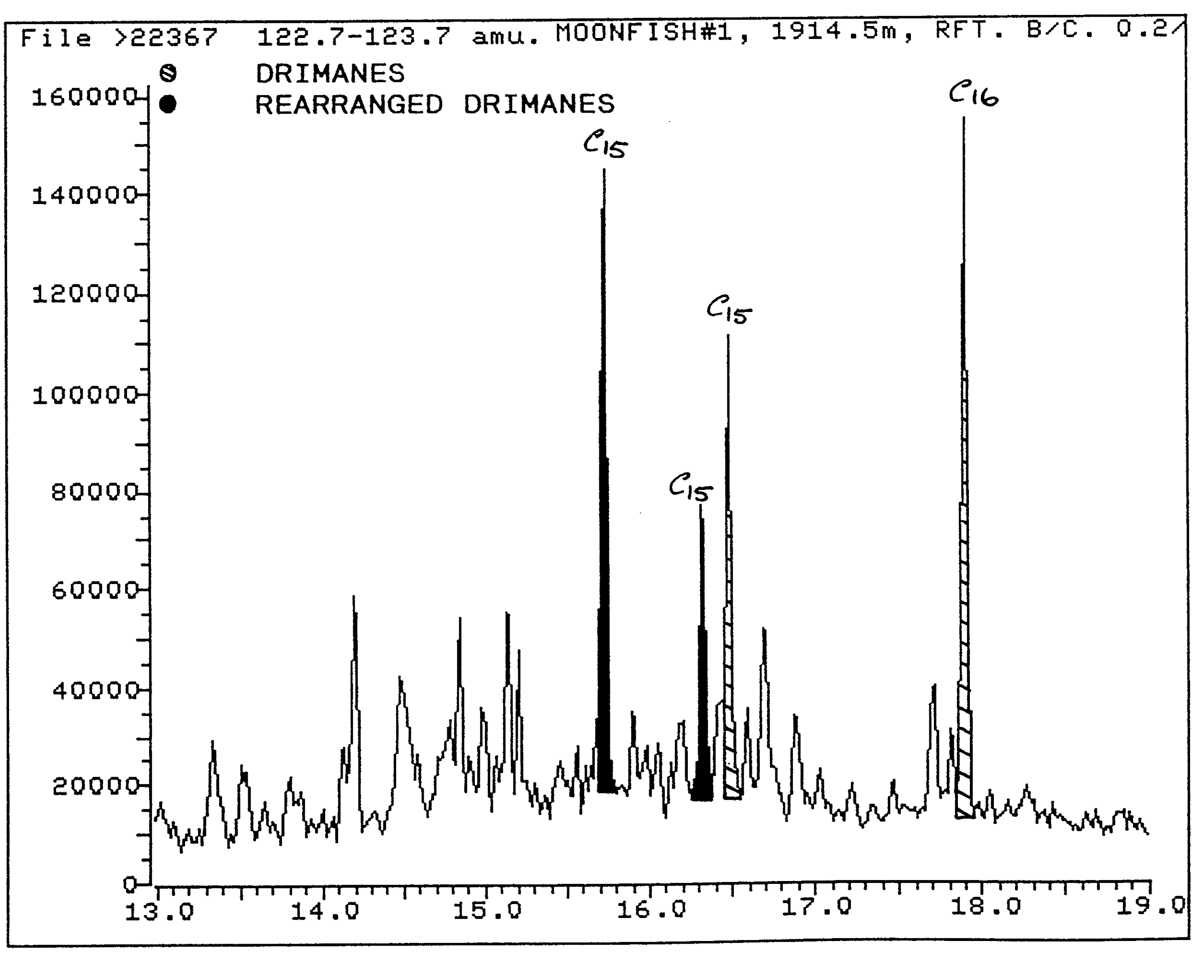

File >22367 329.7-330.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
6000
5000
4000
3000
2000
1000
0
20
22
24
26
28
30
32
34
36
38

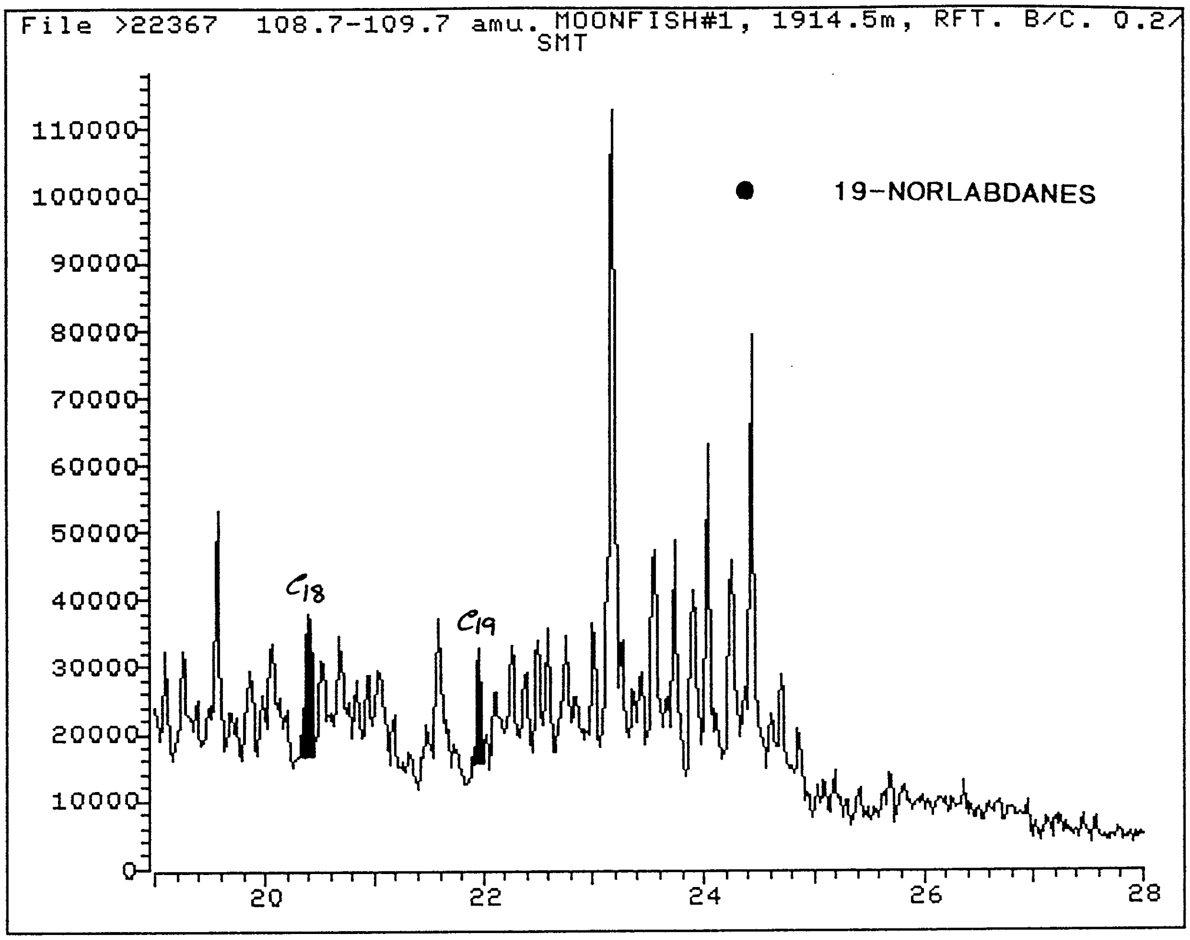

File >22367 162.7-163.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
30000
25000
20000
15000
10000
5000
0
20
22
24
26
28
30
32
34
36
38

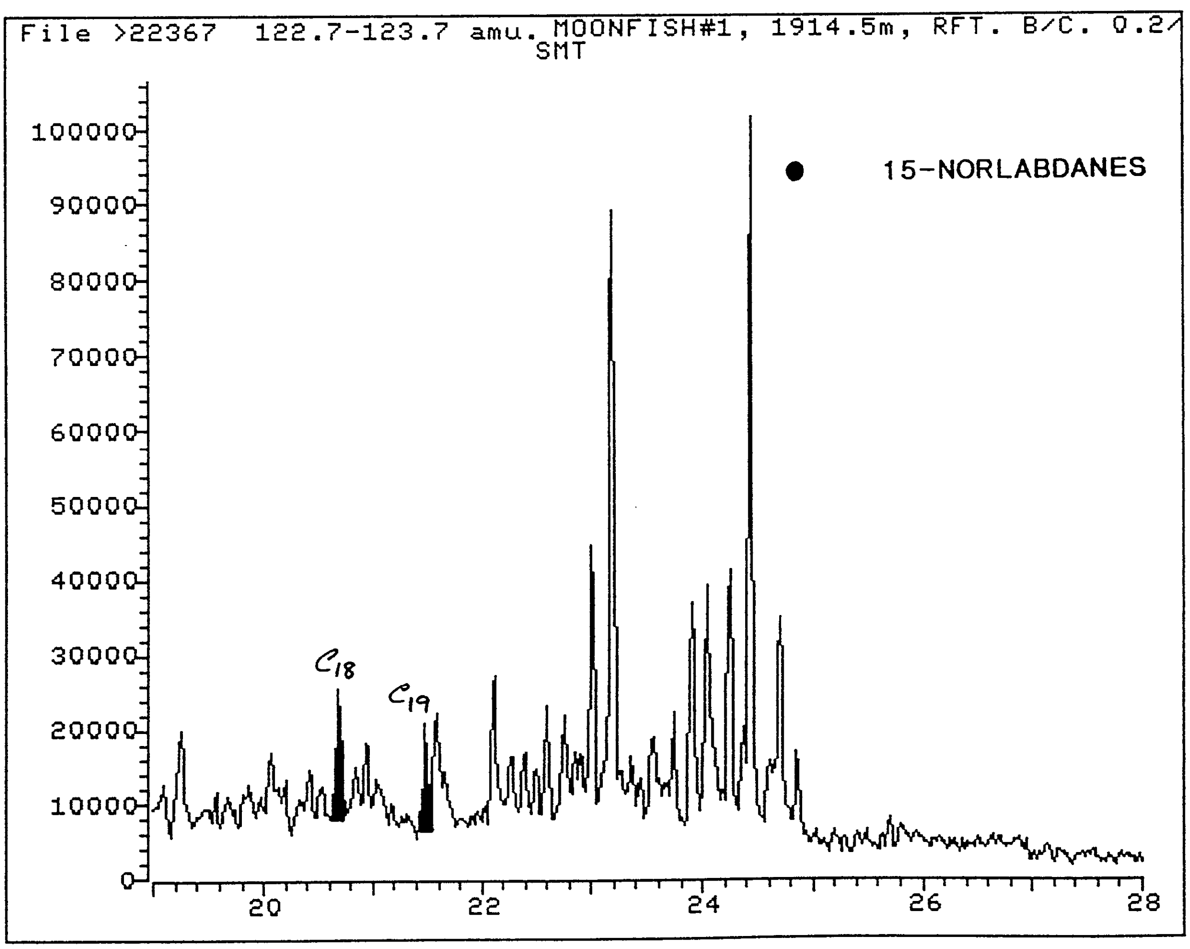

File >22367 190.7-191.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
● HOMOLOGOUS TRICYCLIC TERPANES
ø HOMOLOGOUS TETRACYCLIC TERPANES
12000
8000
4000
0
C24
Ts
Tm
20
22
24
26
28
30
32
34
36
38

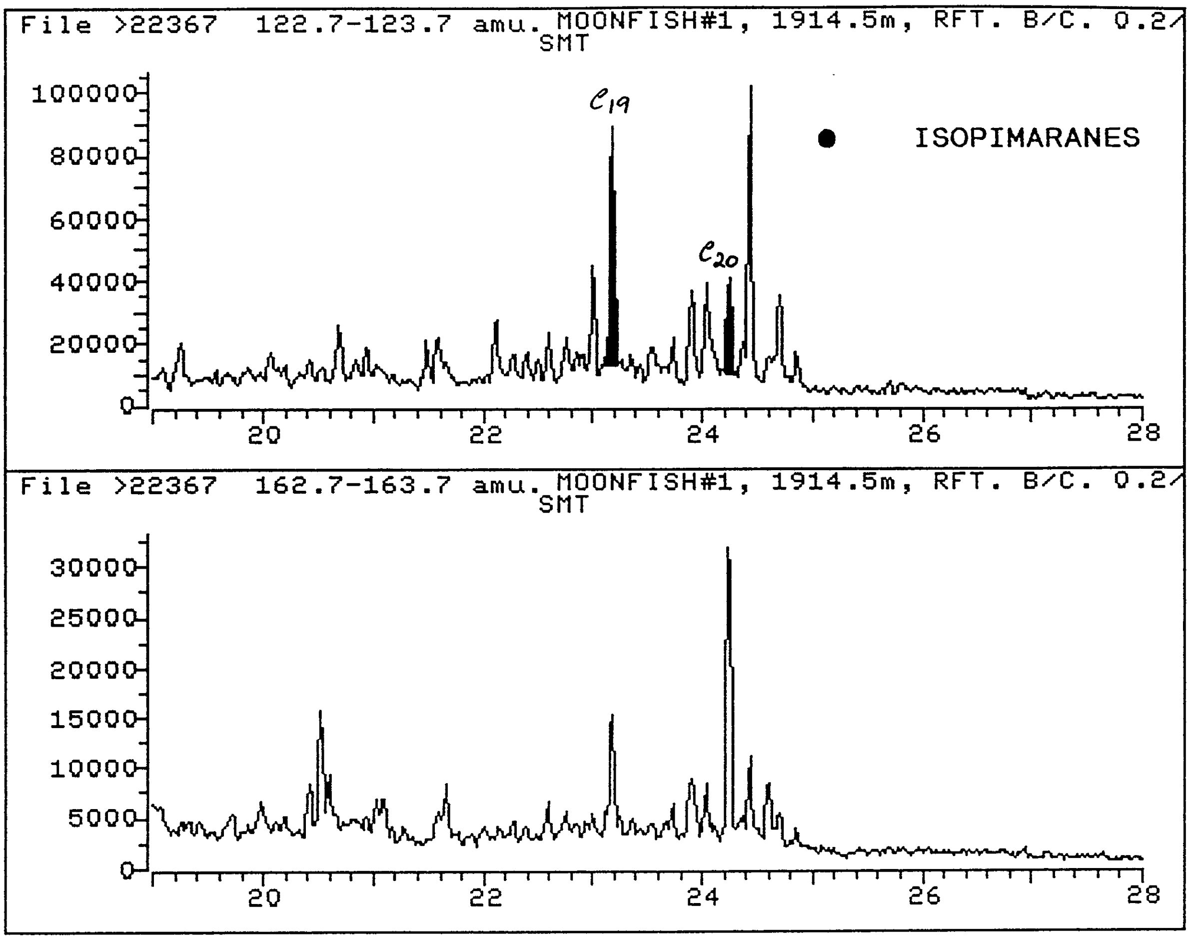

File >22367 190.7-191.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
8000
6000
4000
2000
0
36
40
44
48
52
56
60
64
68
72
76
80

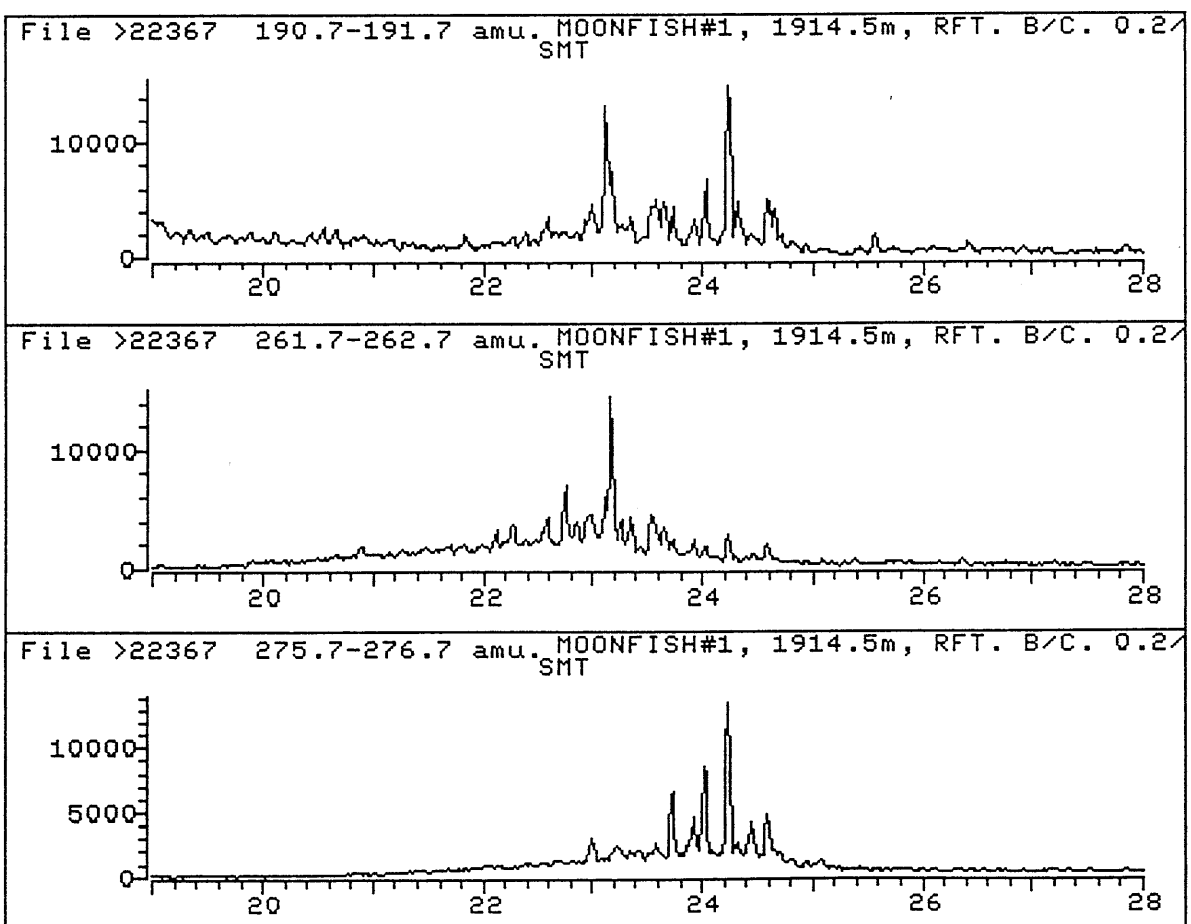

File >22367 192.7-193.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
300000
200000
100000
0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
File >22367 164.7-165.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
50000
40000
30000
20000
10000
0
13.0
14.0
15.0
16.0
17.0
18.0
19.0

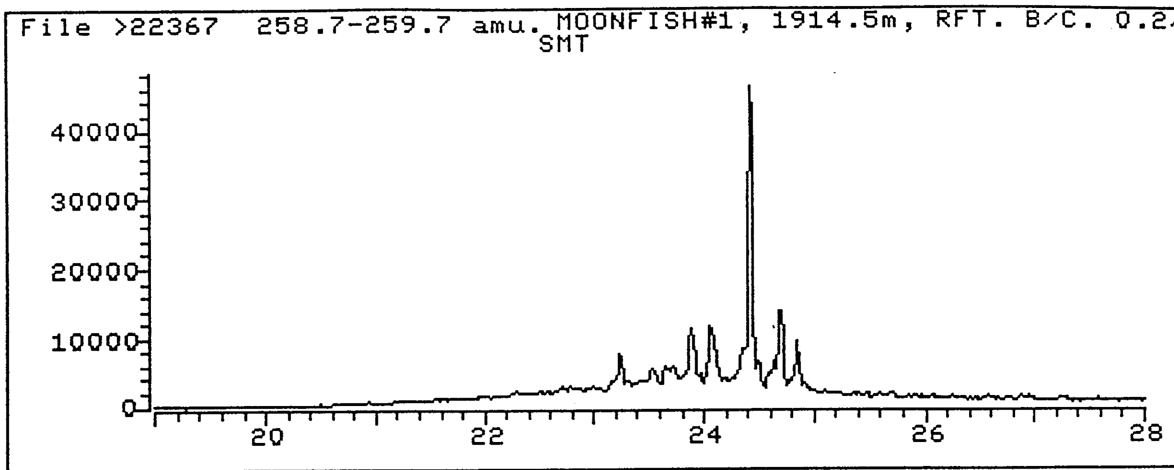

File >22367 122.7-123.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
DRIMANES
REARRANGED DRIMANES
C15
C15
C15
C16
160000
140000
120000
100000
80000
60000
40000
20000
0
13.0
14.0
15.0
16.0
17.0
18.0
19.0

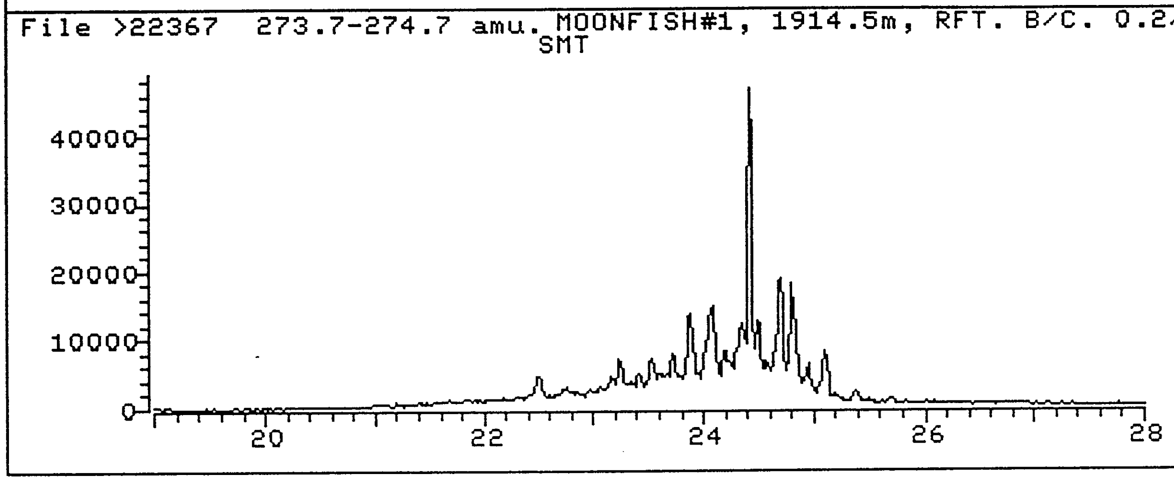

File >22367 108.7-109.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
19-NORLABDANES
C18
C19
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
20
22
24
26
28


File >22367 122.7-123.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/ SMT
15-NORLABDANES
C18
C19
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
20
22
24
26
28


File >22367 122.7-123.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
C_{19}
C_{20}
● ISOPIMARANES
100000
80000
60000
40000
20000
0
20
22
24
26
28
File >22367 162.7-163.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
30000
25000
20000
15000
10000
5000
0
20
22
24
26
28


File >22367 190.7-191.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
10000
0
20
22
24
26
28
File >22367 261.7-262.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
10000
0
20
22
24
26
28
File >22367 275.7-276.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
10000
5000
0
20
22
24
26
28


File >22367 258.7-259.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
40000
30000
20000
10000
0
20
22
24
26
28


File >22367 273.7-274.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
40000
30000
20000
10000
0
20
22
24
26
28

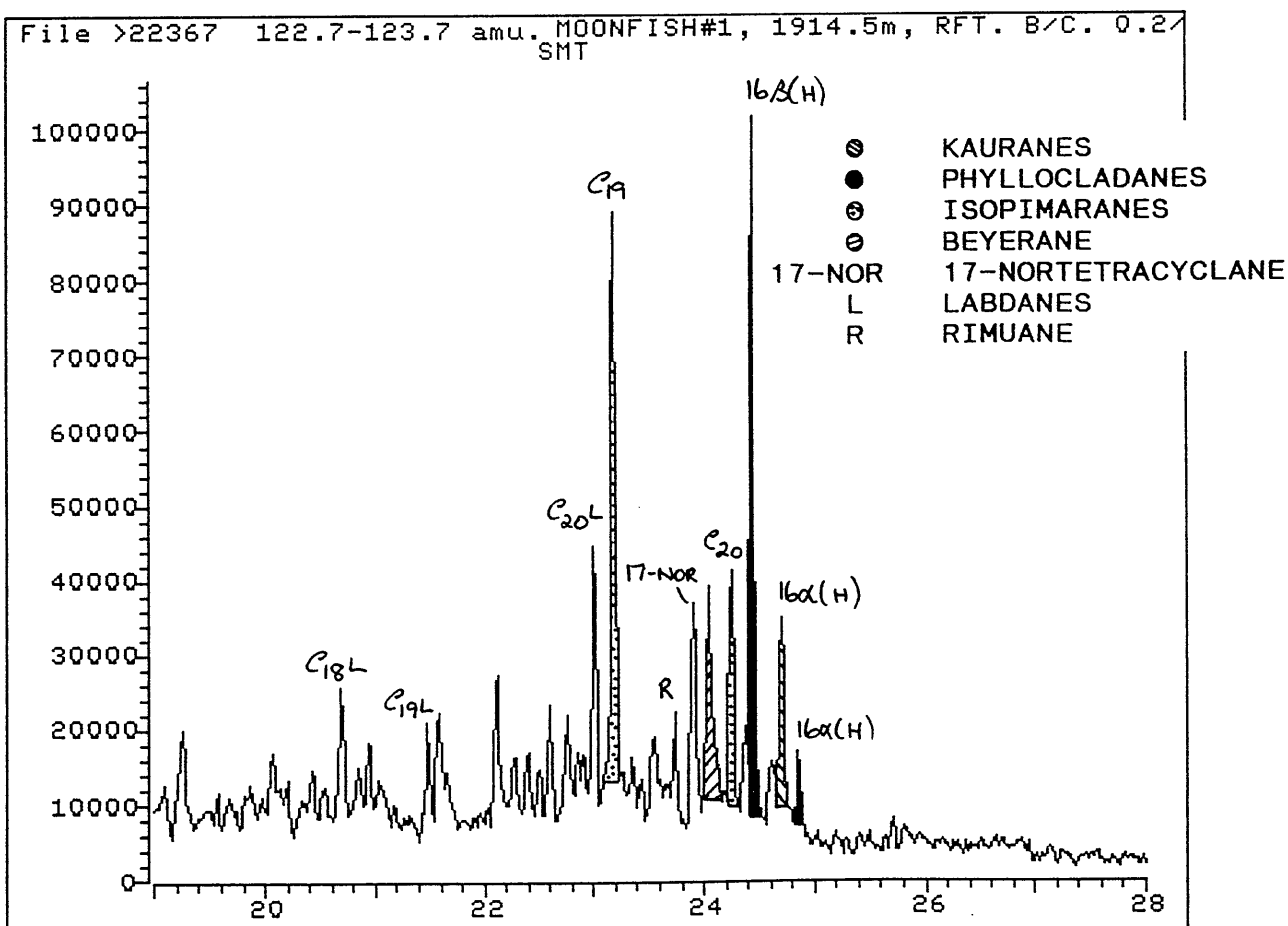

File >22367 122.7-123.7 amu. MOONFISH#1, 1914.5m, RFT. B/C. 0.2/
SMT
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
20
22
24
26
28
16β(H)
C19
C20L
17-NOR
C20
16α(H)
C18L
C19L
R
16α(H)
KAURANES
PHYLLOCLADANES
ISOPIMARANES
BEYERANE
17-NOR 17-NORTETRACYCLANE
L LABDANES
R RIMUANE

TABLE 5.3

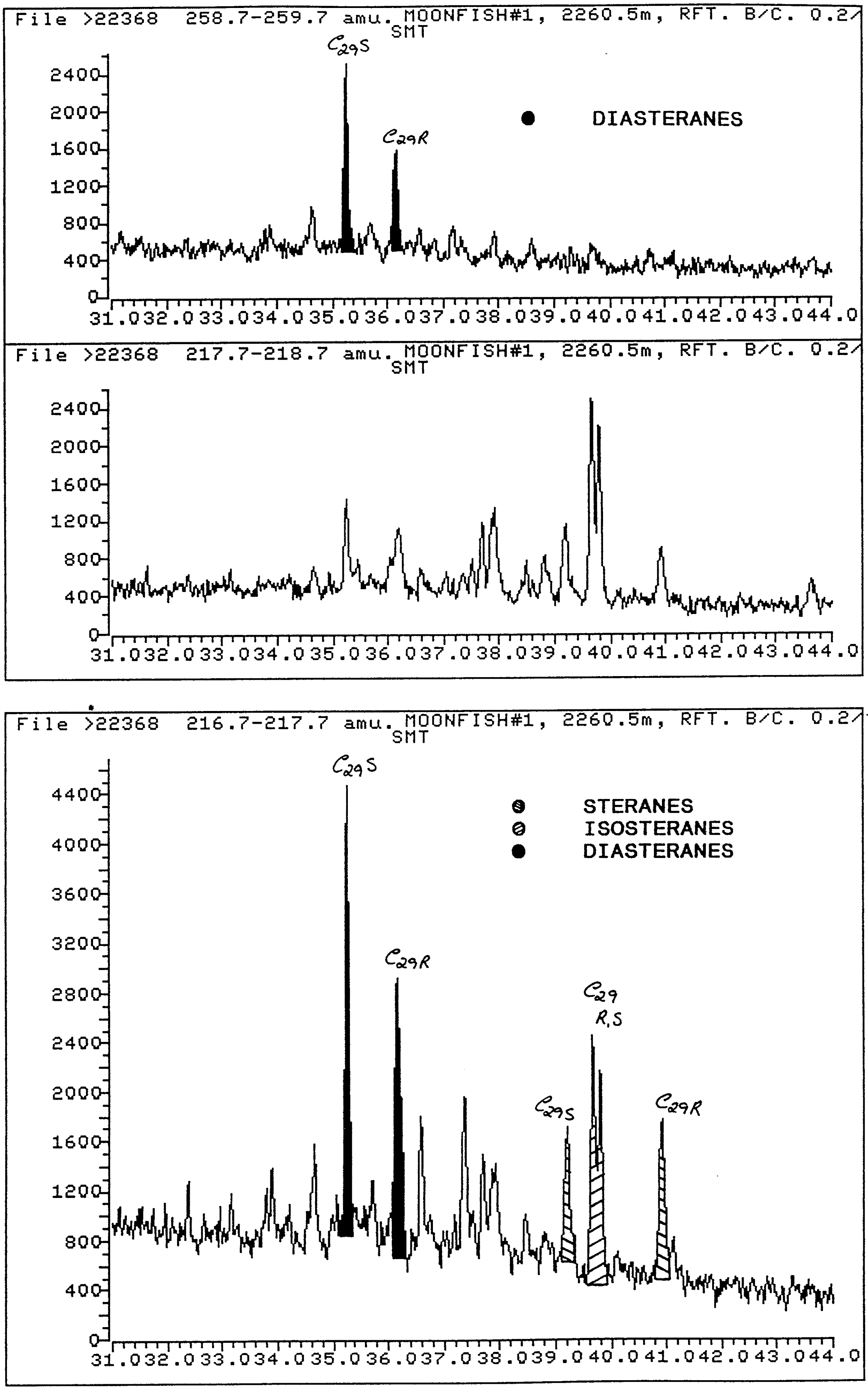
SELECTED PARAMETERS FROM GC/MS ANALYSIS

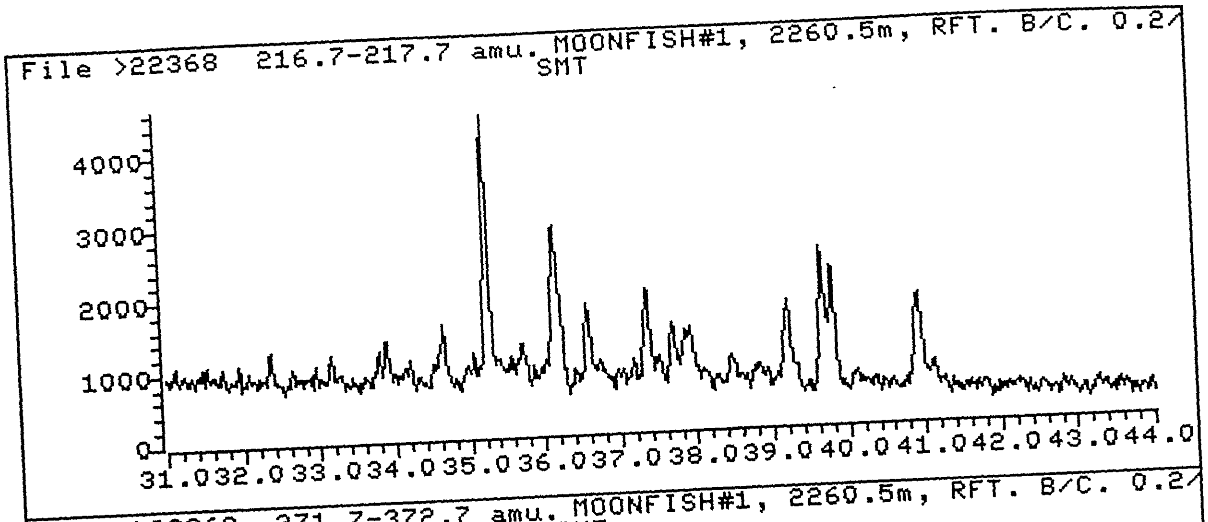
MOONFISH 1, 2260.5m, RFT Oil

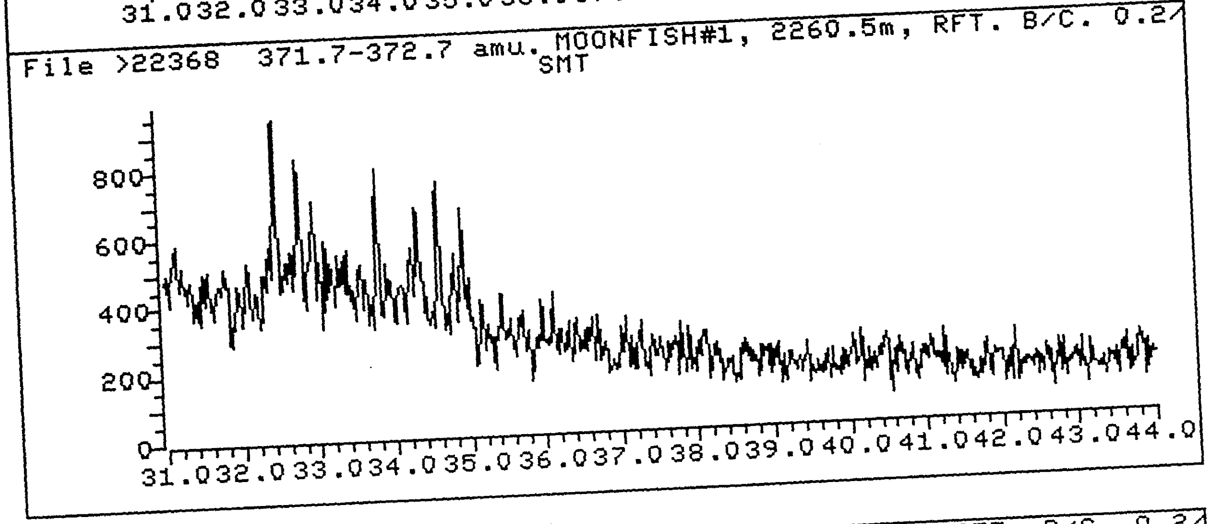
	Parameter	Ion(s)	Value
1.	18 α (H)- hopane/17 α (H)-hopane (Ts/Tm)	191	0.70
2.	C30 hopane/C30 moretane	191	7.07
3.	C31 22S hopane/C31 22R hopane	191	1.17
4.	C32 22S hopane/C32 22R hopane	191	1.41
5.	C29 20S ααα sterane/C29 20R ααα sterane	217	0.81
6.	C29 ααα steranes (20S / 20S+20R)	217	0.45
7.	C29 αββ steranes / (C29 ααα steranes + C29 αββ steranes)	217	0.61
8.	C27/C29 diasteranes	259	nd
9.	C27/C29 steranes	217	nd
10.	18 α (H)-oleanane/C30 hopane	191	nd
11.	C29 diasteranes / (C29 ααα steranes + C29 αββ steranes)	217	0.94
12.	C30 (hopane + moretane) / C29 (steranes + diasteranes)	191/217	0.58
13.	C15 drimane/C16 homodrimane	123	0.64
14.	Rearranged drimanes/normal drimanes	123	0.74

nd = not detectable

Figure 4-3


File >22368 258.7-259.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/SMT
C29S
C29R
DIASTERANES
File >22368 217.7-218.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/SMT
File >22368 216.7-217.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/SMT
C29S
C29R
STERANES
ISOSTERANES
DIASTERANES
C29S
C29 R,S
C29R
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0


File >22368 216.7-217.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
4000
3000
2000
1000
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0


File >22368 371.7-372.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
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600
400
200
0
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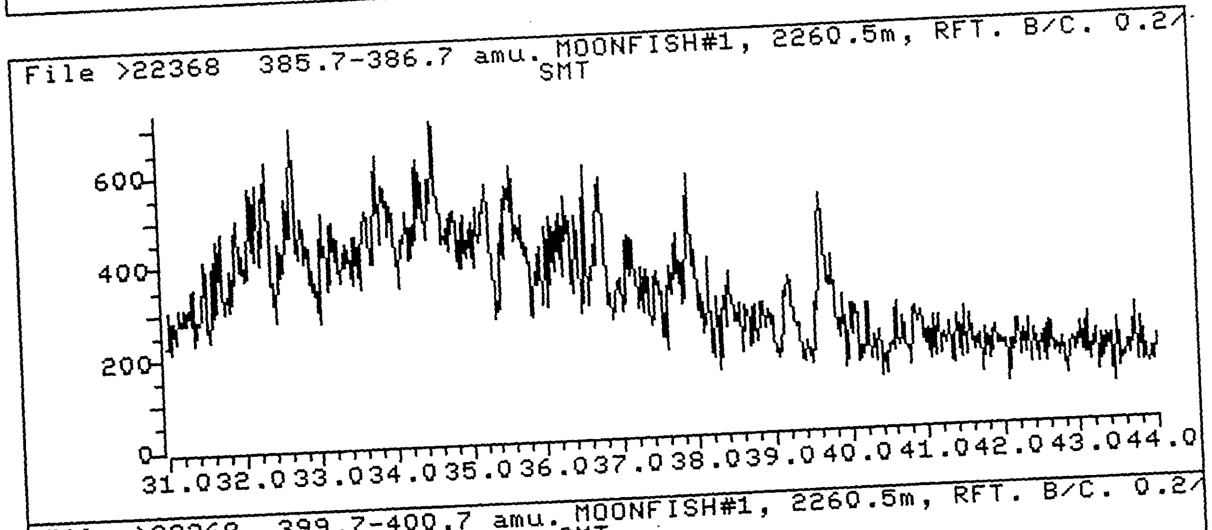
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SMT
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400
200
0
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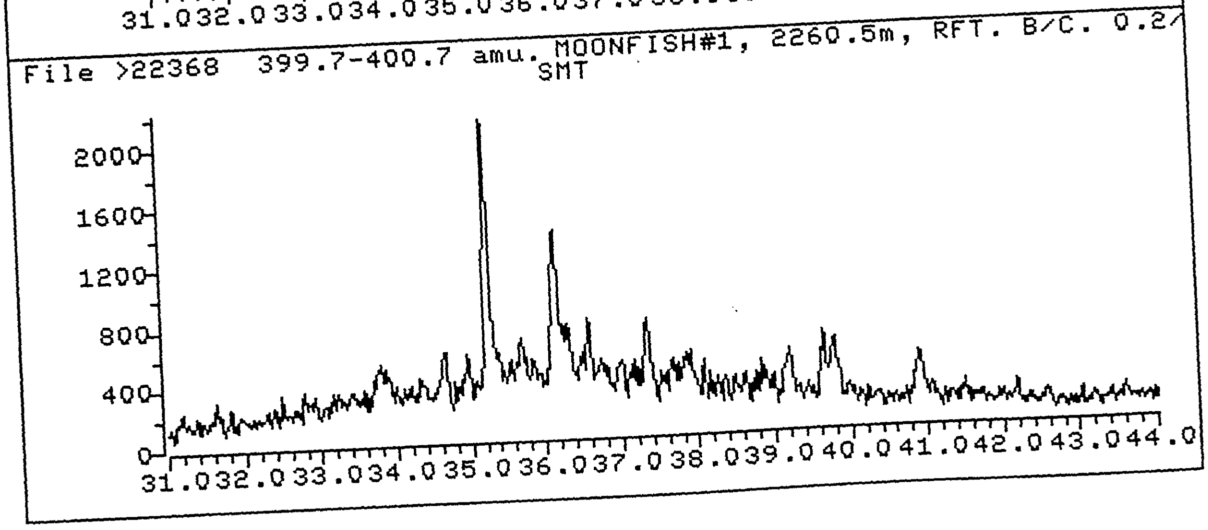
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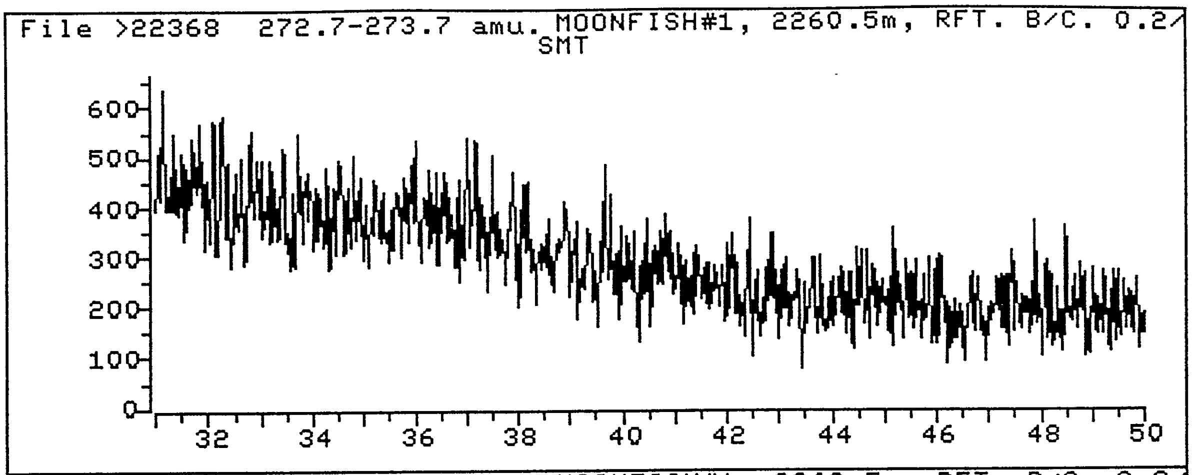
SMT
2000
1600
1200
800
400
0
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0


File >22368 272.7-273.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
600
500
400
300
200
100
0
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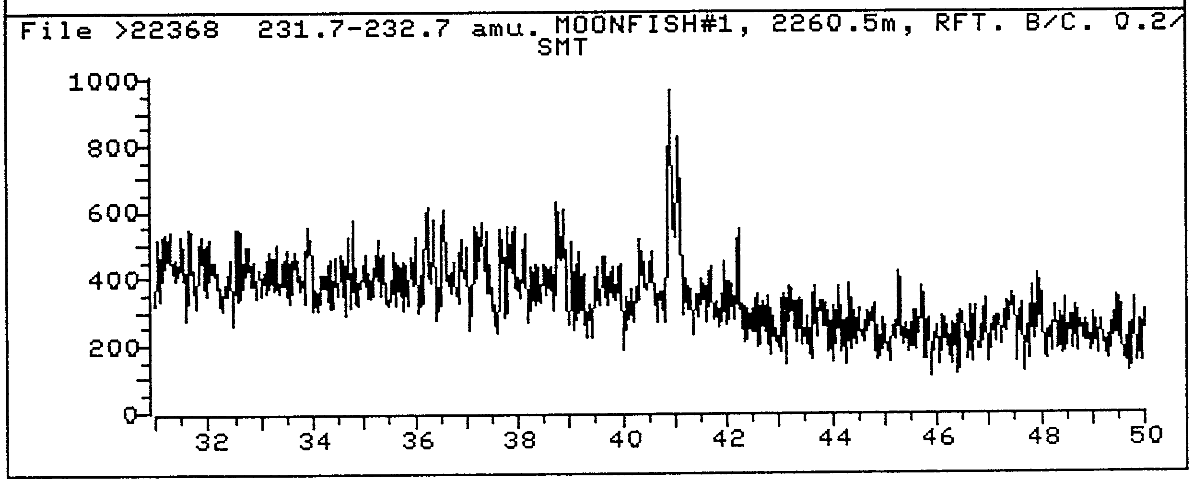
File >22368 231.7-232.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
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800
600
400
200
0
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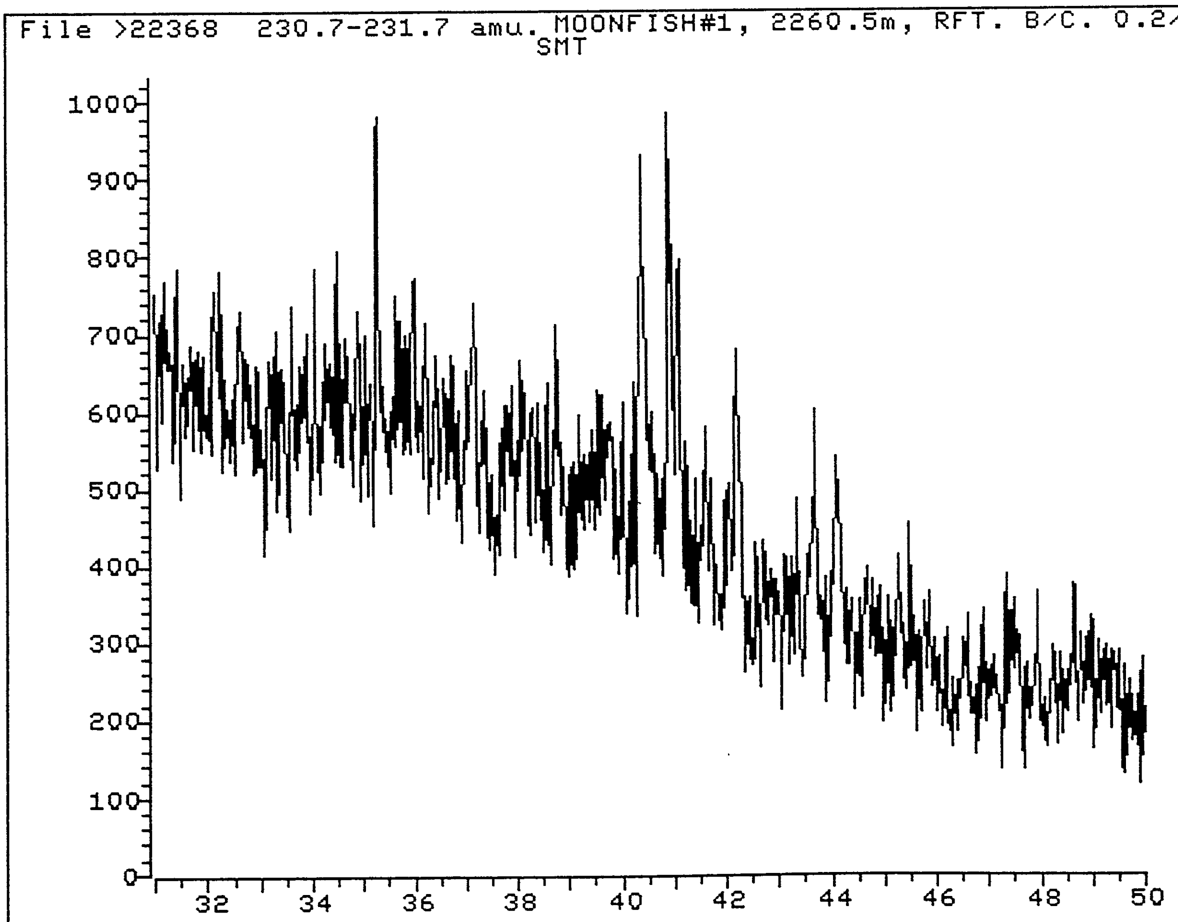
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SMT
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900
800
700
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500
400
300
200
100
0
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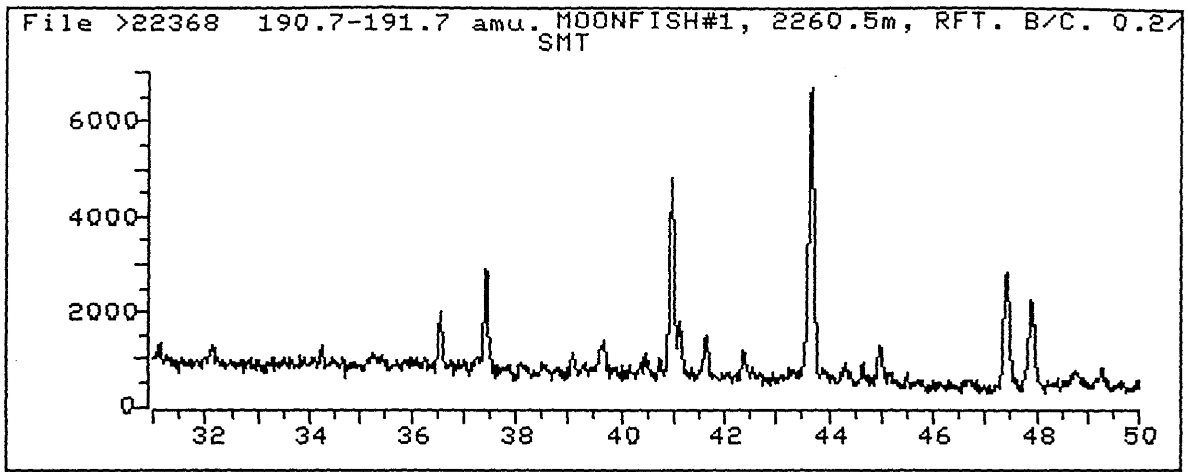
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2000
0
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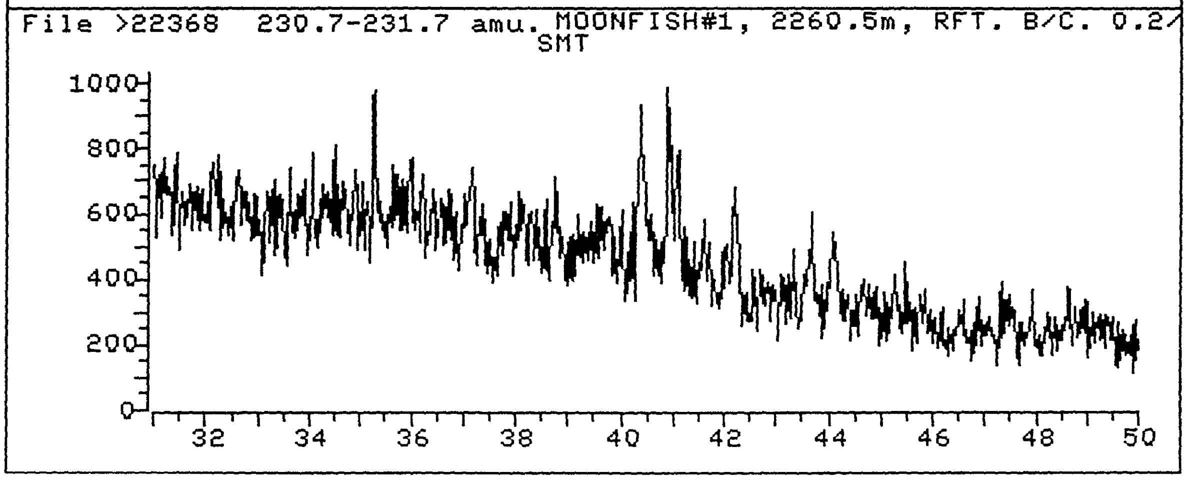
File >22368 230.7-231.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
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800
600
400
200
0
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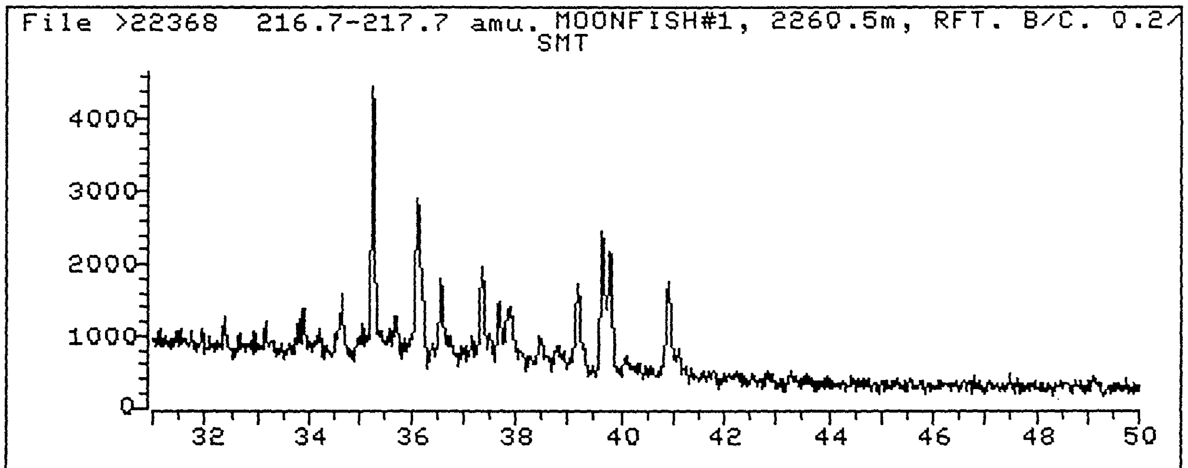
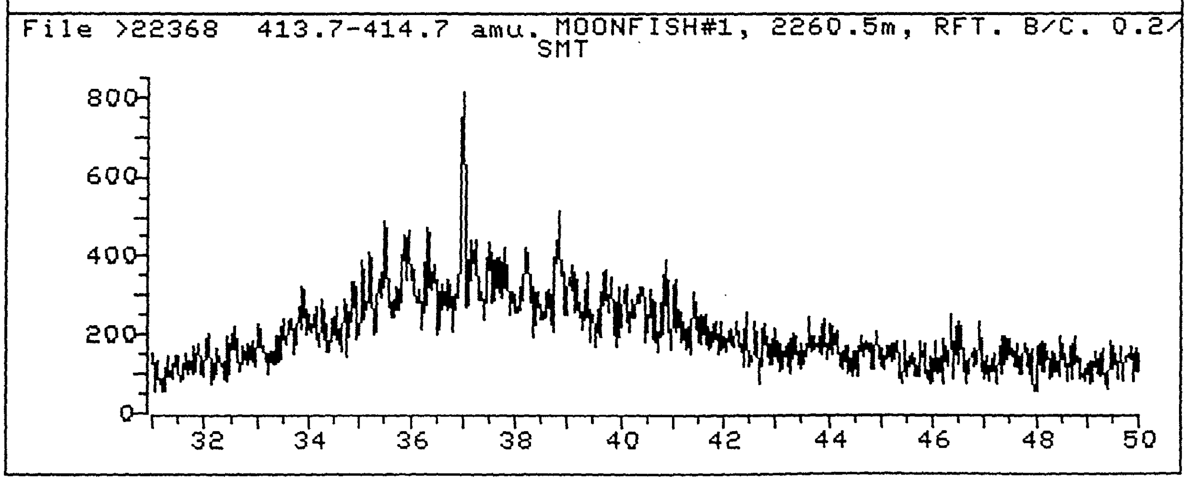

File >22368 216.7-217.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
4000
3000
2000
1000
0
32 34 36 38 40 42 44 46 48 50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SMT
800
600
400
200
0
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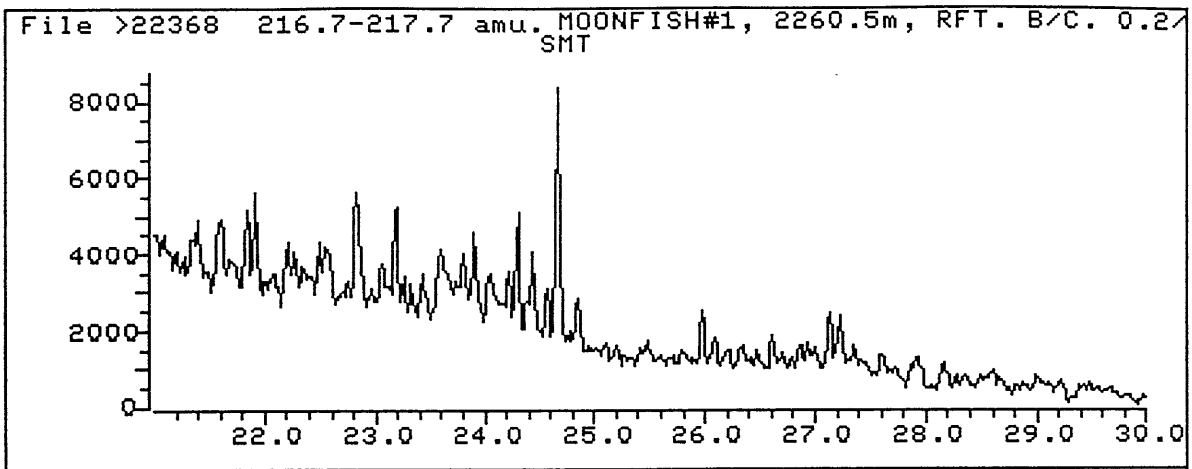
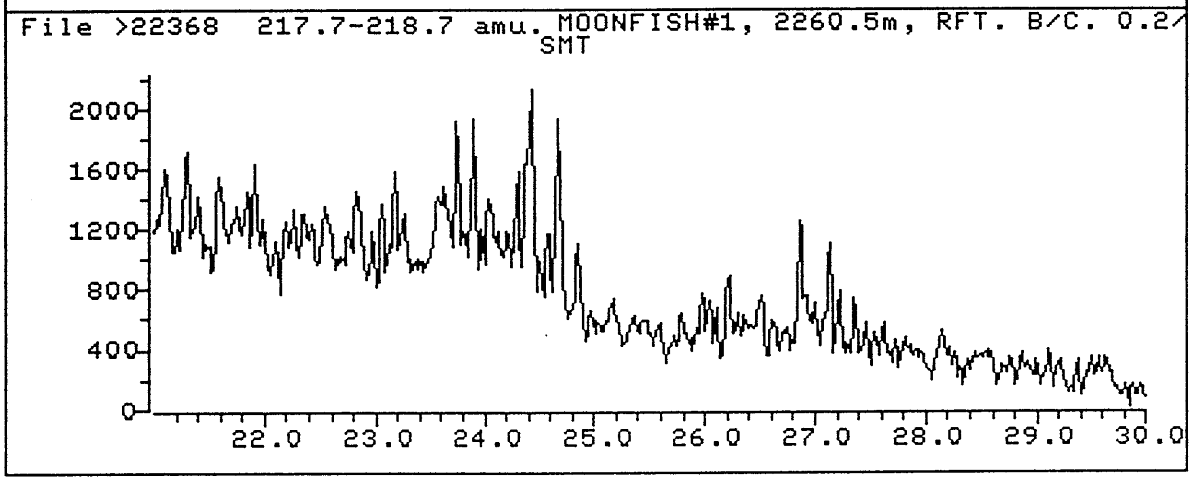

File >22368 216.7-217.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
8000
6000
4000
2000
0
22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0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2000
1600
1200
800
400
0
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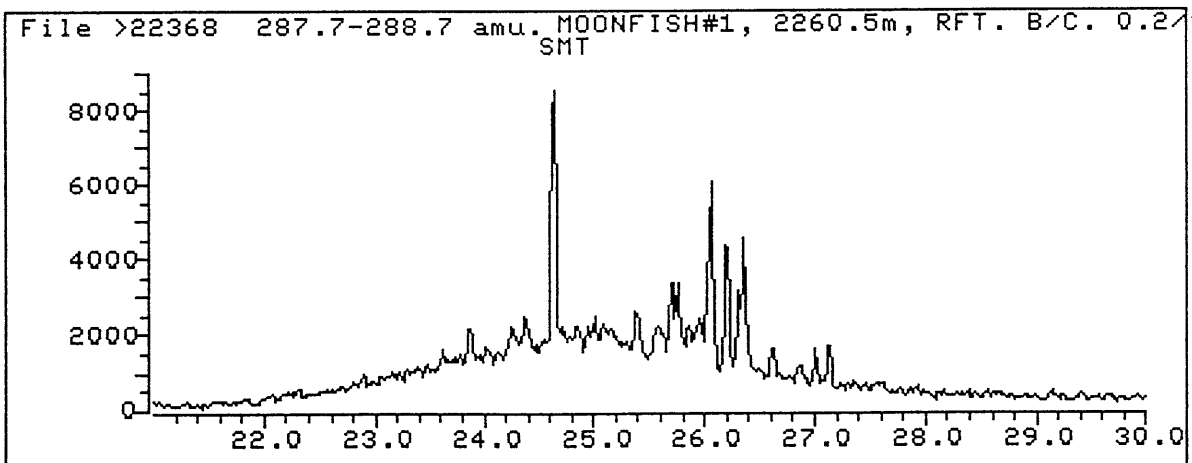
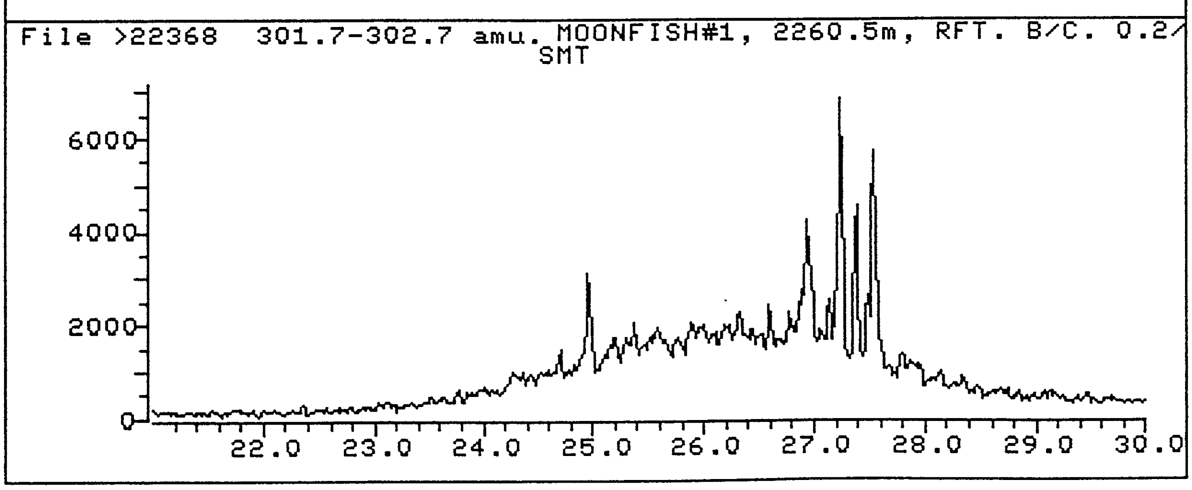
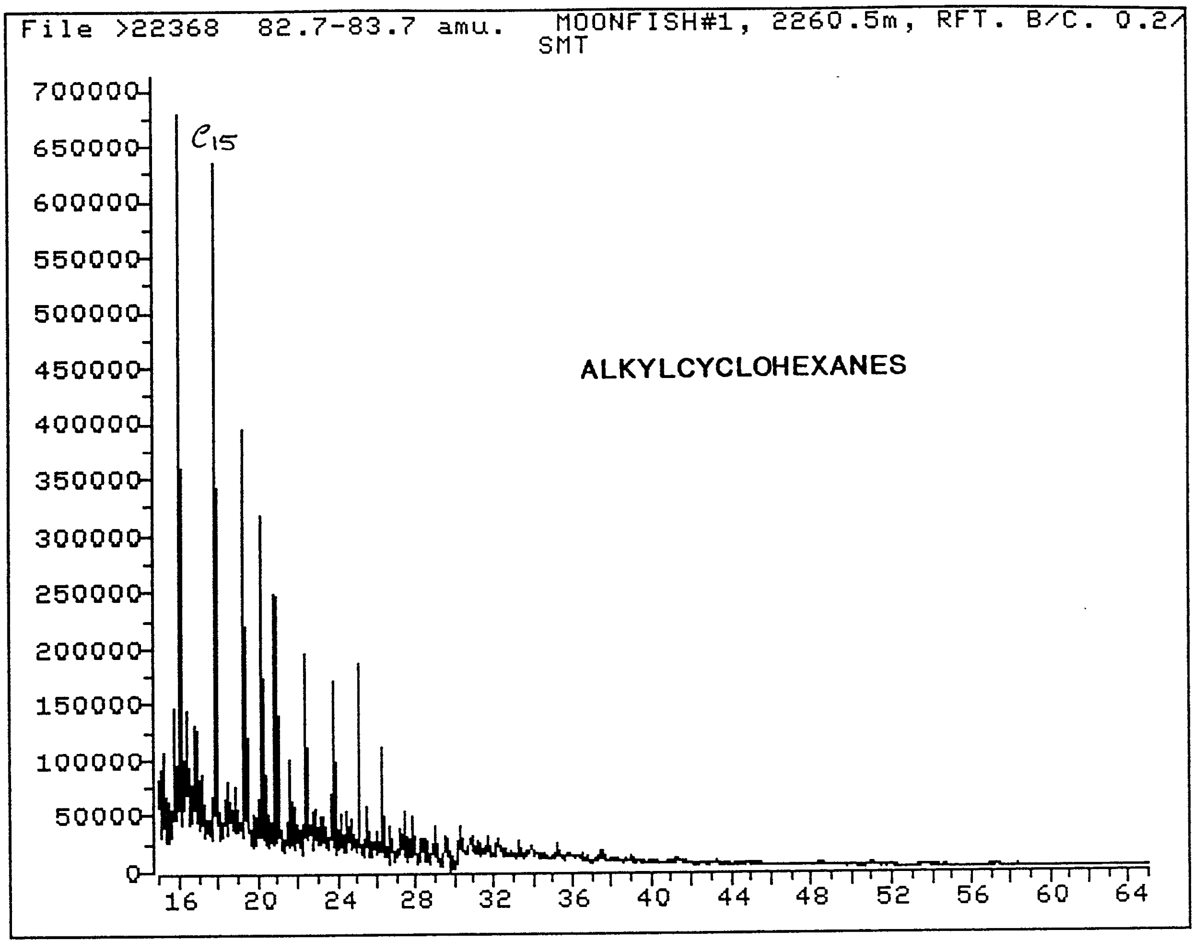

File >22368 287.7-288.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
8000
6000
4000
2000
0
22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0


File >22368 301.7-302.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
6000
4000
2000
0
22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0


File >22368 82.7-83.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
ALKYLCYCLOHEXANES
C15
700000
650000
600000
550000
500000
450000
400000
350000
300000
250000
200000
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100000
50000
0
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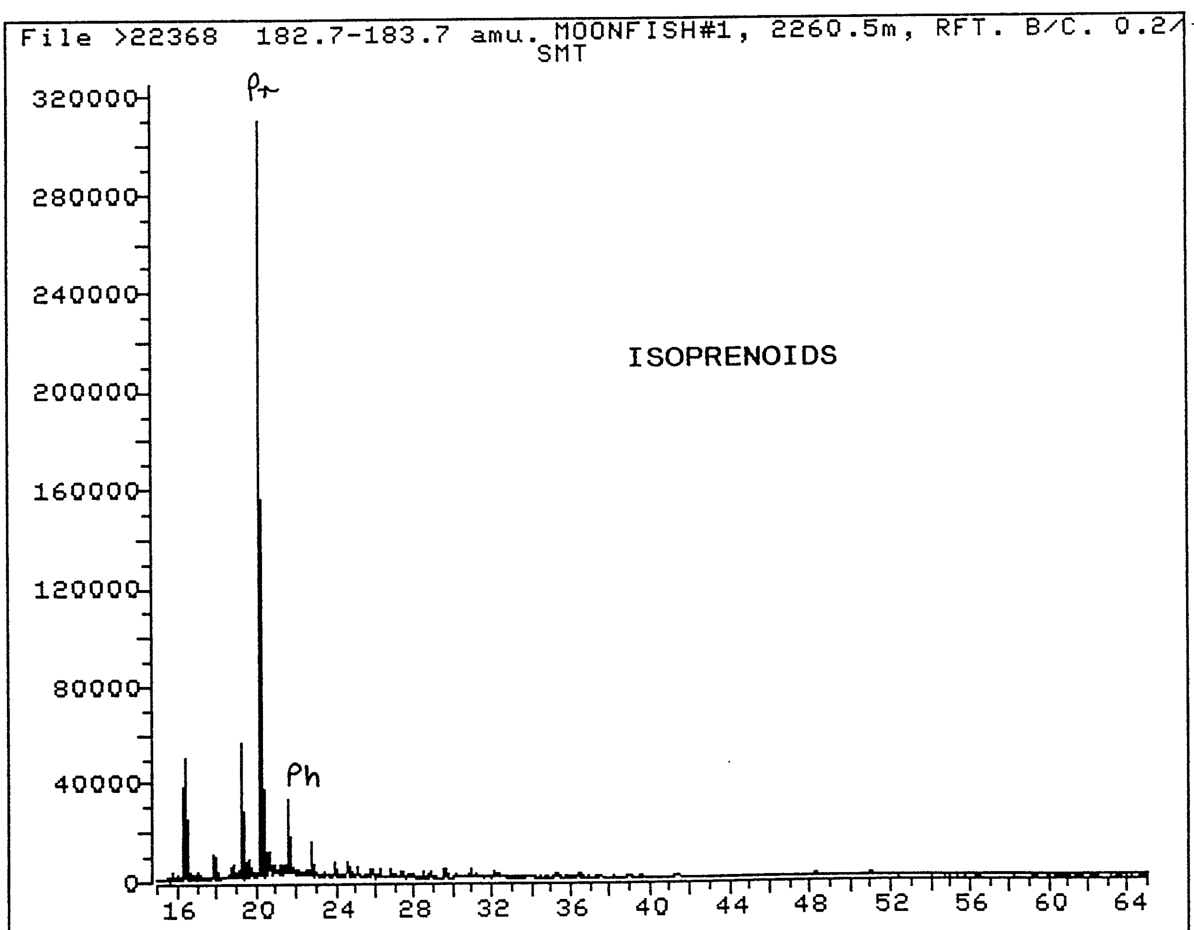
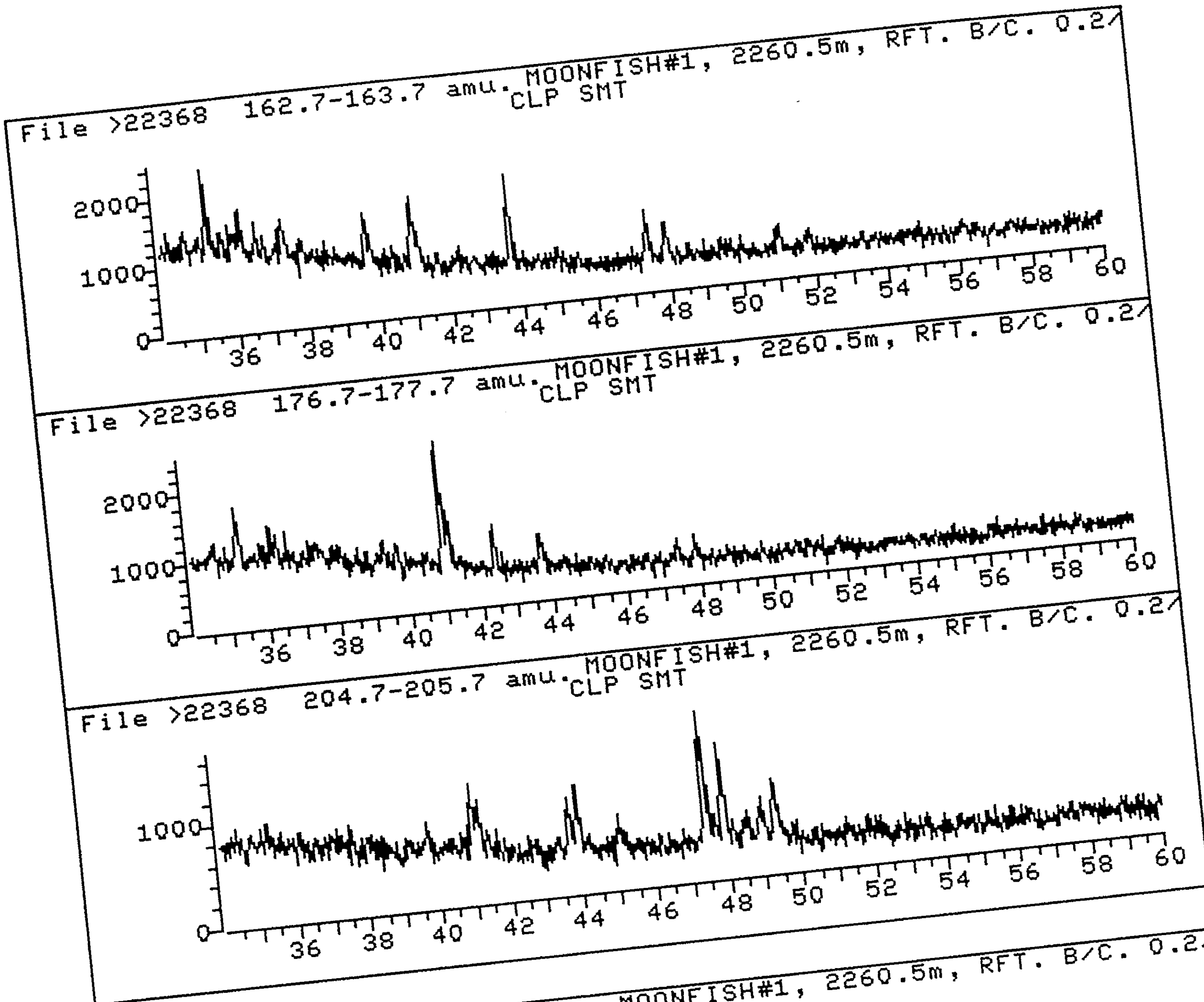
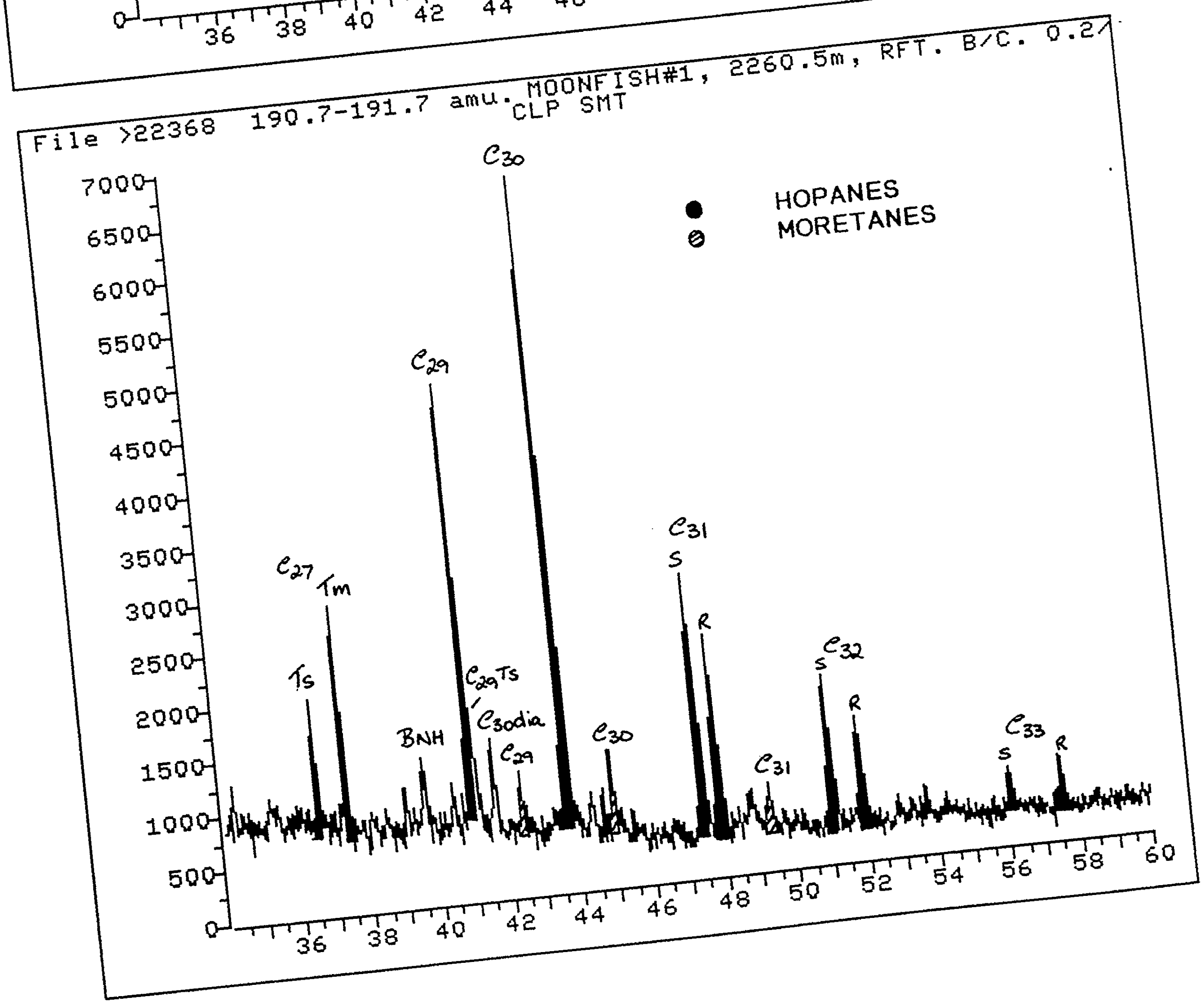
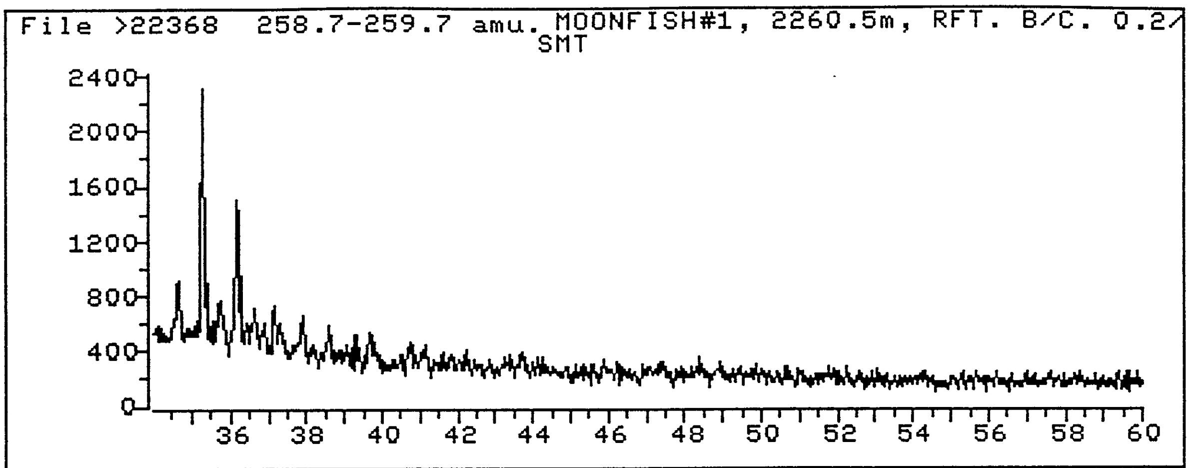
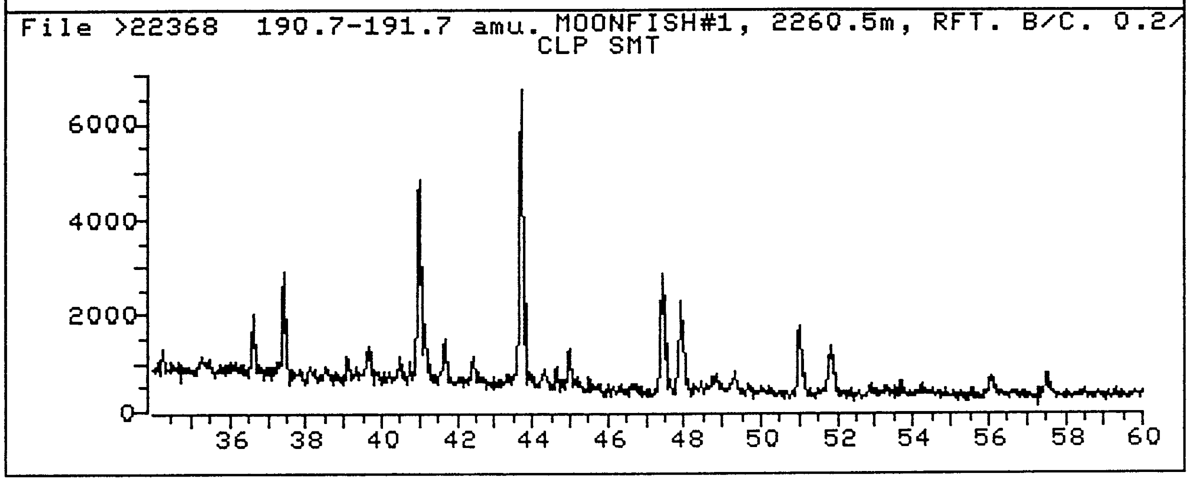
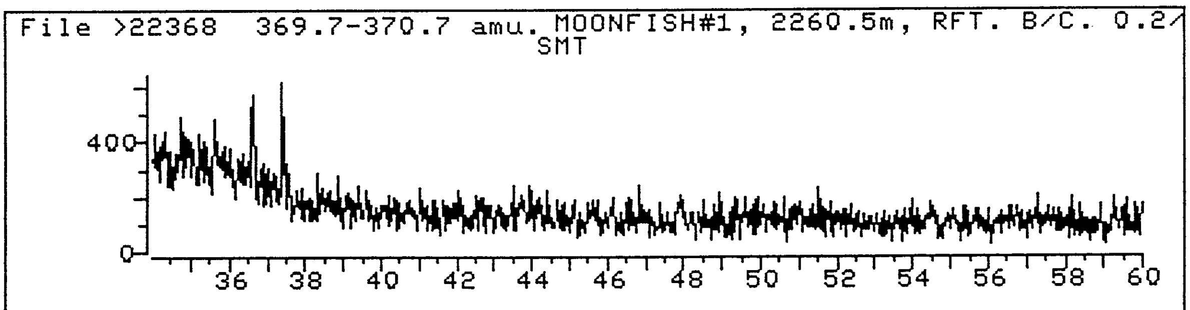

File >22368 182.7-183.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
ISOPRENOIDS
Pr
Ph
320000
280000
240000
200000
160000
120000
80000
40000
0
16 20 24 28 32 36 40 44 48 52 56 60 64

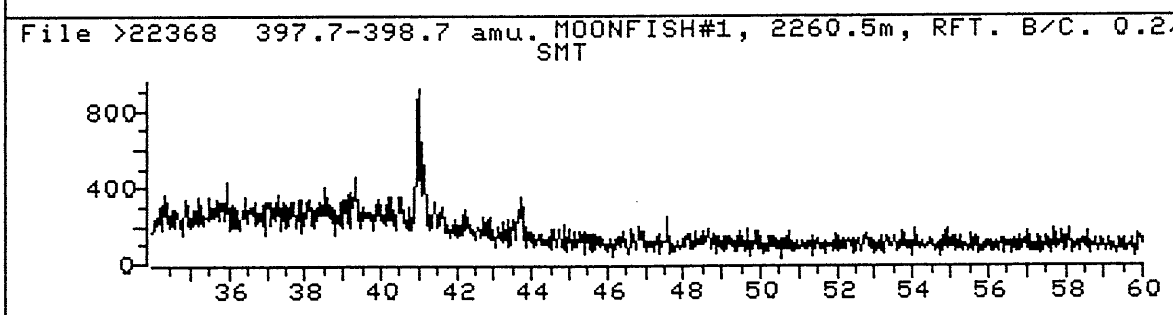

File >22368 162.7-163.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/ CLP SMT
File >22368 176.7-177.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/ CLP SMT
File >22368 204.7-205.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/ CLP SMT


File >22368 190.7-191.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/ CLP SMT
HOPANES
MORETANES
C30
C29
C27
Tm
Ts
BNH
C29Ts
C30dia
C29
C30
C31
S
R
C31
C32
S
R
C33
S
R


File >22368 258.7-259.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
2400
2000
1600
1200
800
400
0
36 38 40 42 44 46 48 50 52 54 56 58 60


File >22368 190.7-191.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
CLP SMT
6000
4000
2000
0
36 38 40 42 44 46 48 50 52 54 56 58 60


File >22368 369.7-370.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
400
0
36 38 40 42 44 46 48 50 52 54 56 58 60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SMT
800
400
0
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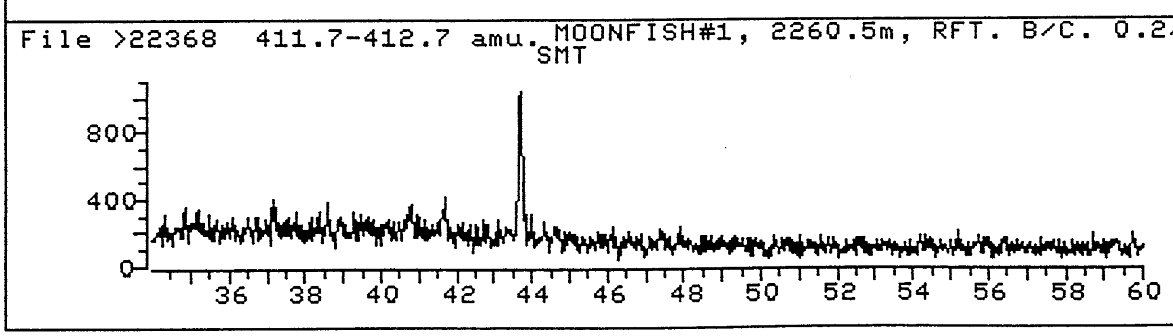
File >22368 411.7-412.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
800
400
0
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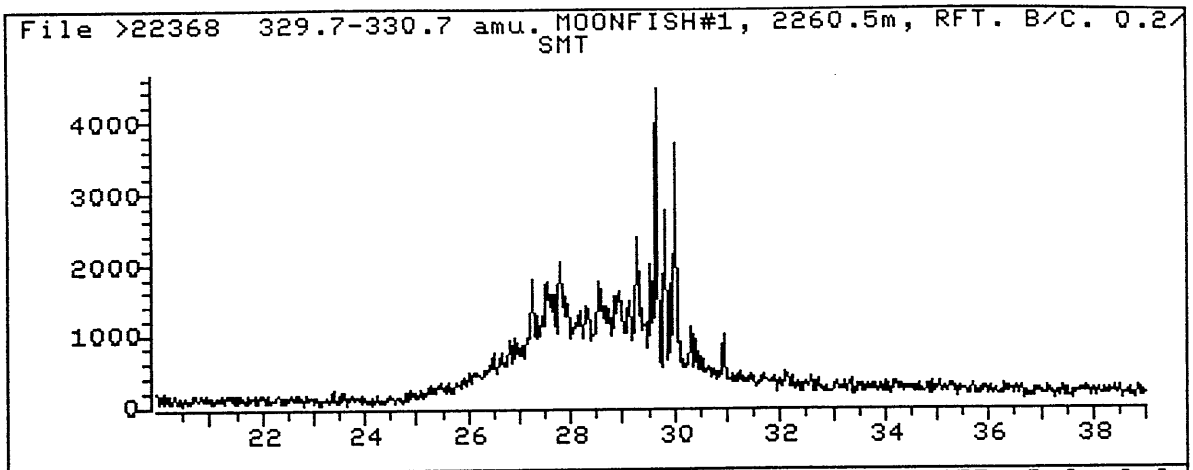
File >22368 329.7-330.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
4000
3000
2000
1000
0
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24
26
28
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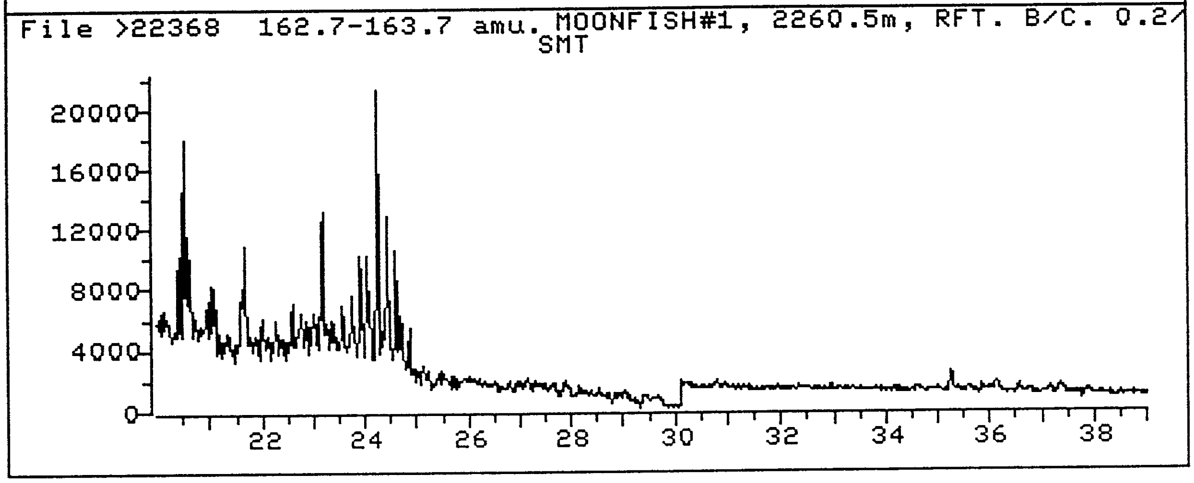
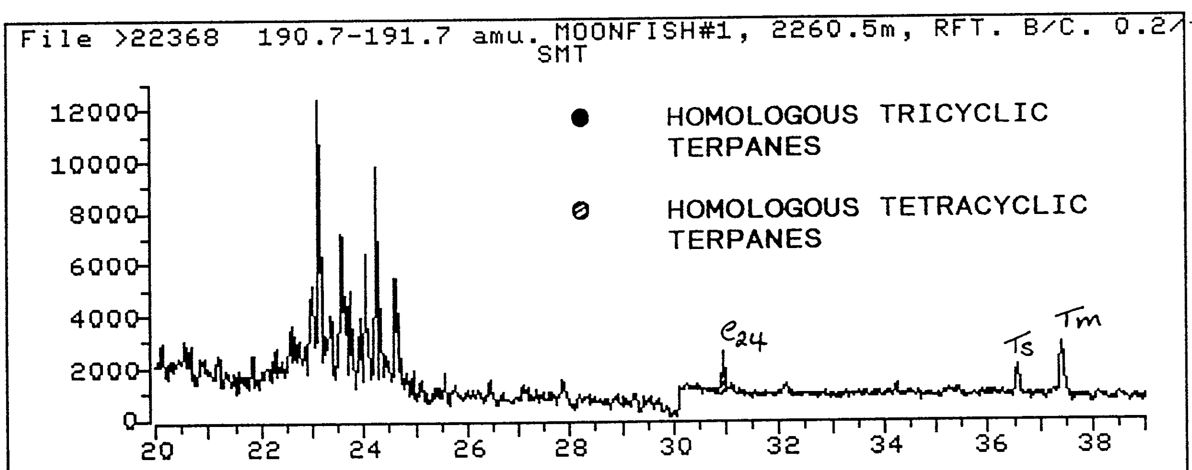
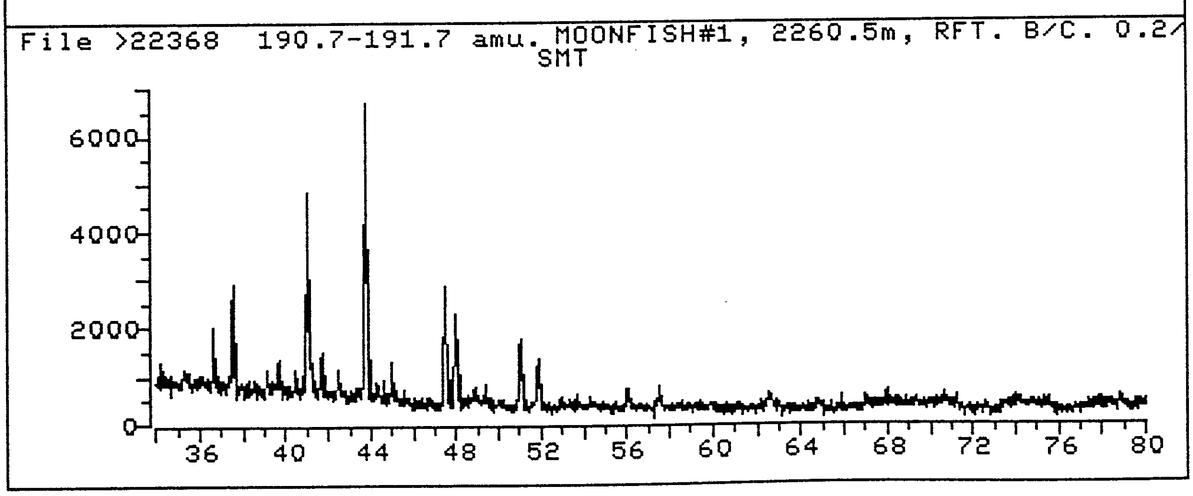
32
34
36
38


File >22368 162.7-163.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
20000
16000
12000
8000
4000
0
22
24
26
28
30
32
34
36
38


File >22368 190.7-191.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
● HOMOLOGOUS TRICYCLIC TERPANES
ø HOMOLOGOUS TETRACYCLIC TERPANES
C24
Ts
Tm
12000
10000
8000
6000
4000
2000
0
20
22
24
26
28
30
32
34
36
38


File >22368 190.7-191.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
SMT
6000
4000
2000
0
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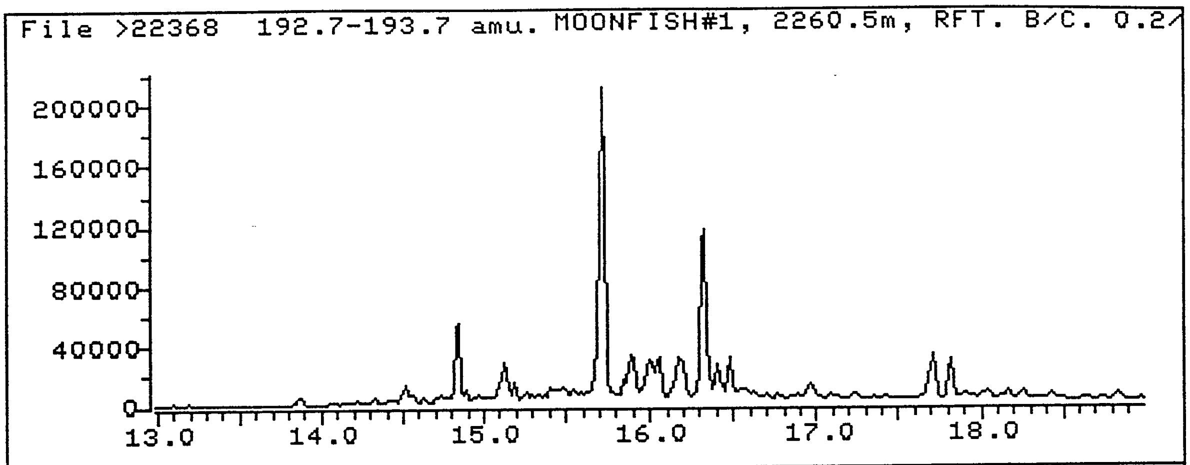
64
68
72
76
80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160000
120000
80000
40000
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13.0
14.0
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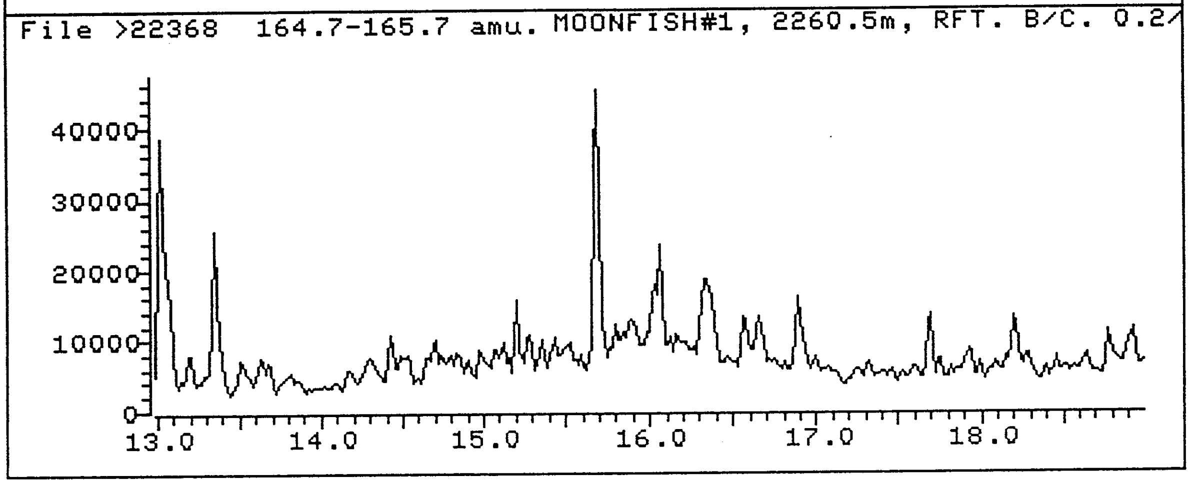
18.0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30000
20000
10000
0
13.0
14.0
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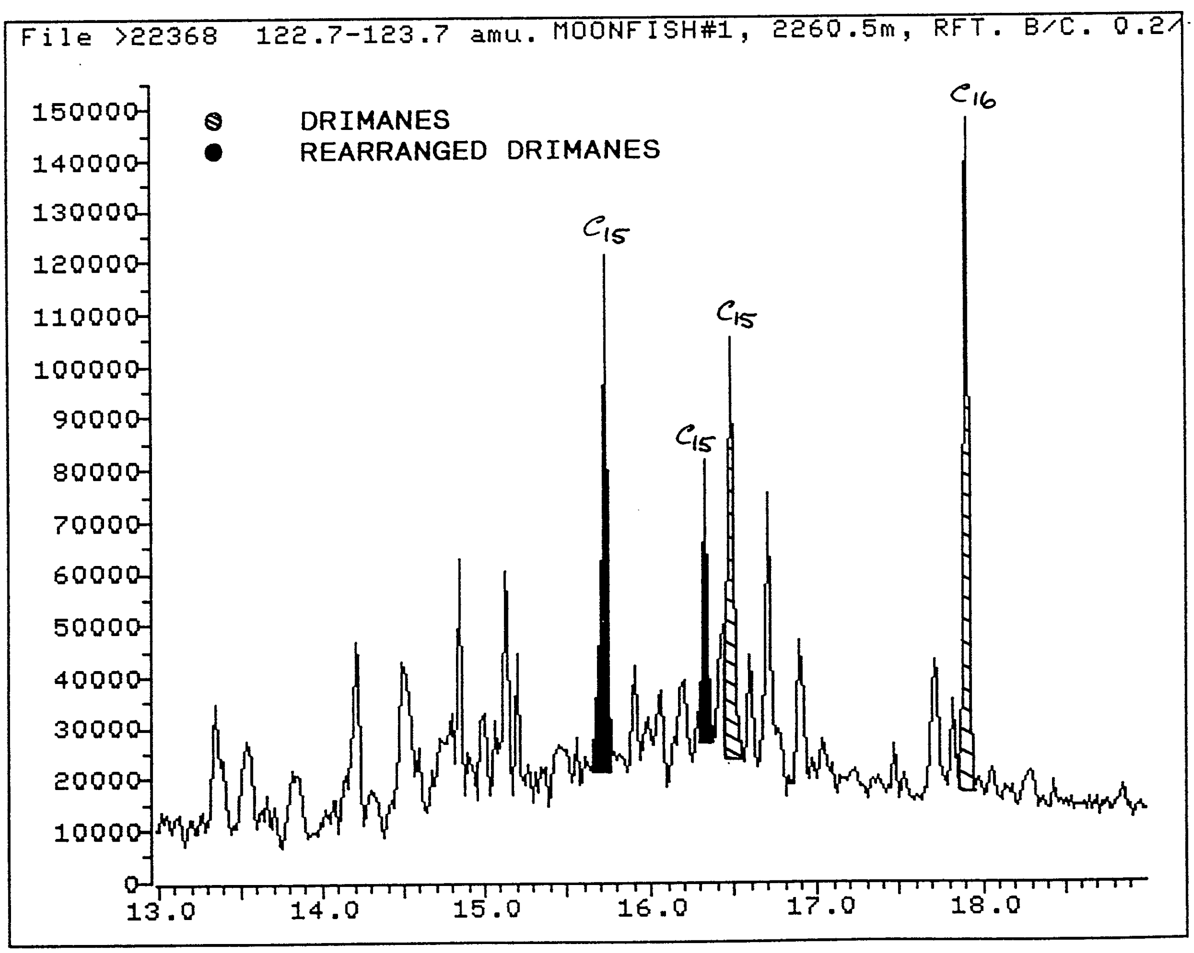
16.0
17.0
18.0


File >22368 122.7-123.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/
DRIMANES
REARRANGED DRIMANES
C16
C15
C15
C15
150000
140000
130000
120000
110000
100000
90000
80000
70000
60000
50000
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30000
20000
10000
0
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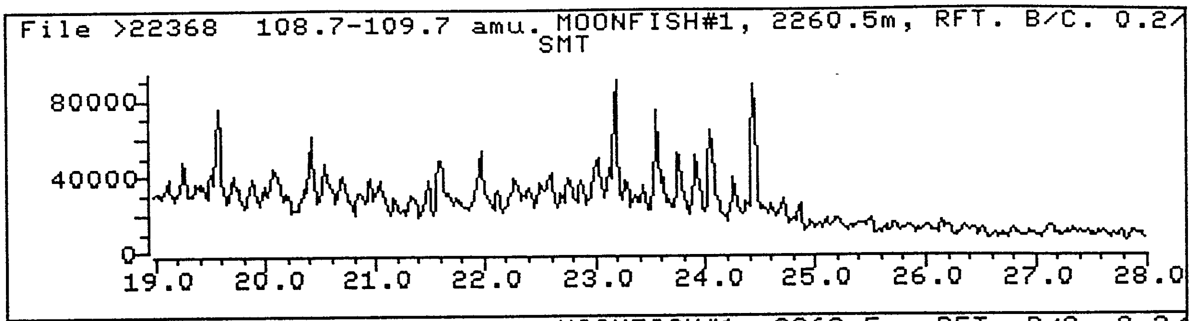
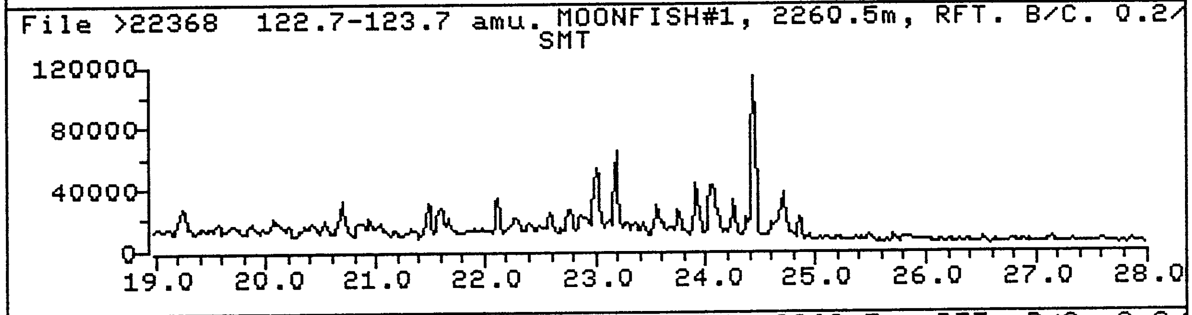
18.0


File >22368 108.7-109.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/ SMT
80000
40000
0
19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0

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120000
80000
40000
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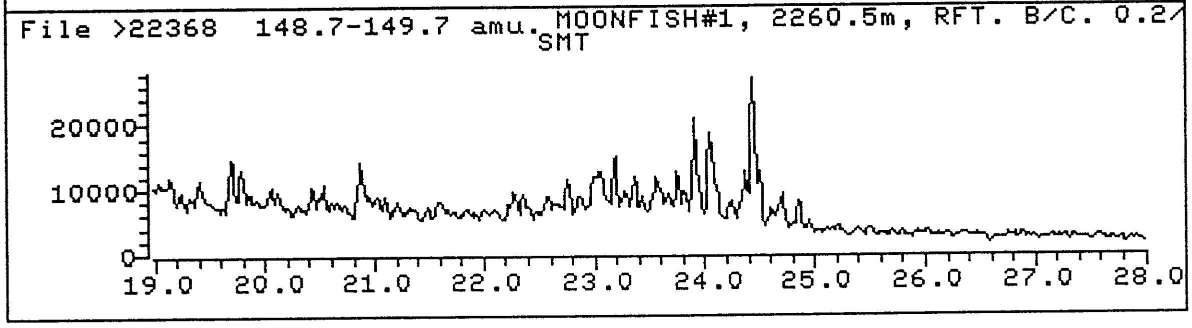
File >22368 148.7-149.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/ SMT
20000
10000
0
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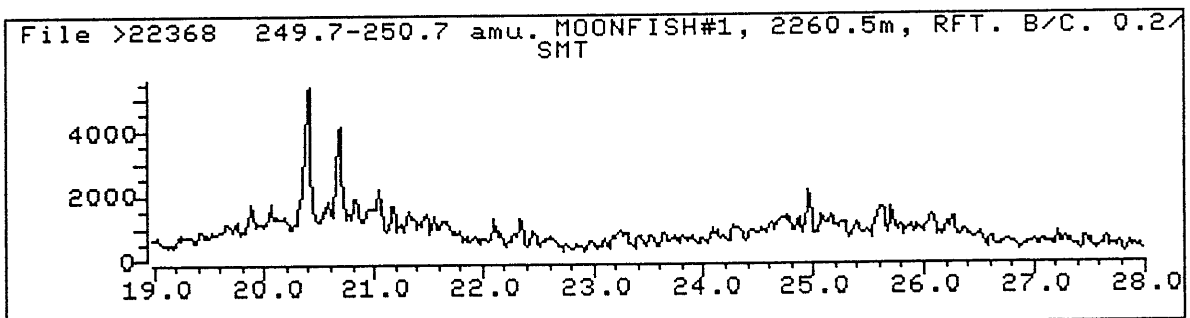
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4000
2000
0
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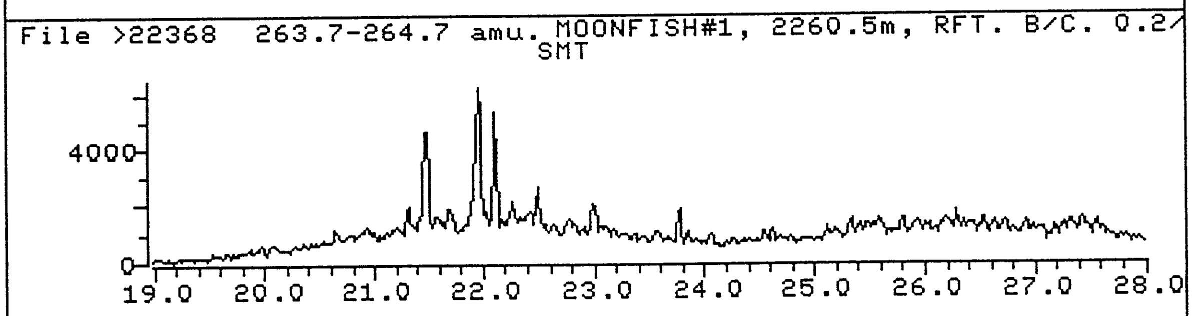
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4000
0
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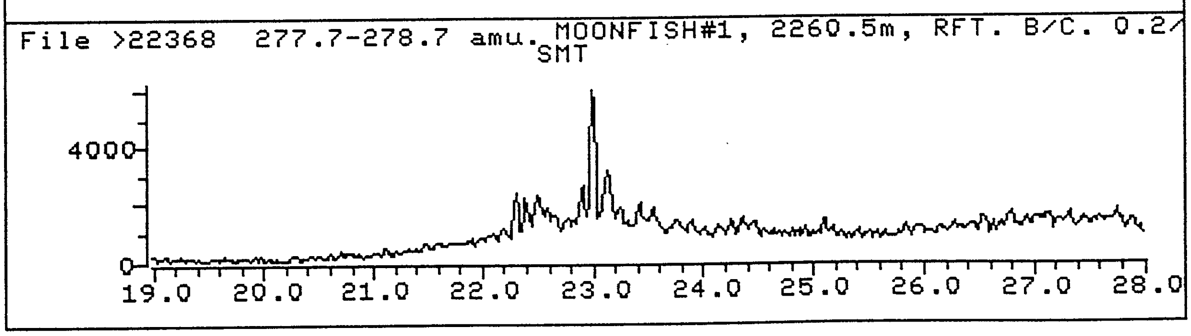
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4000
0
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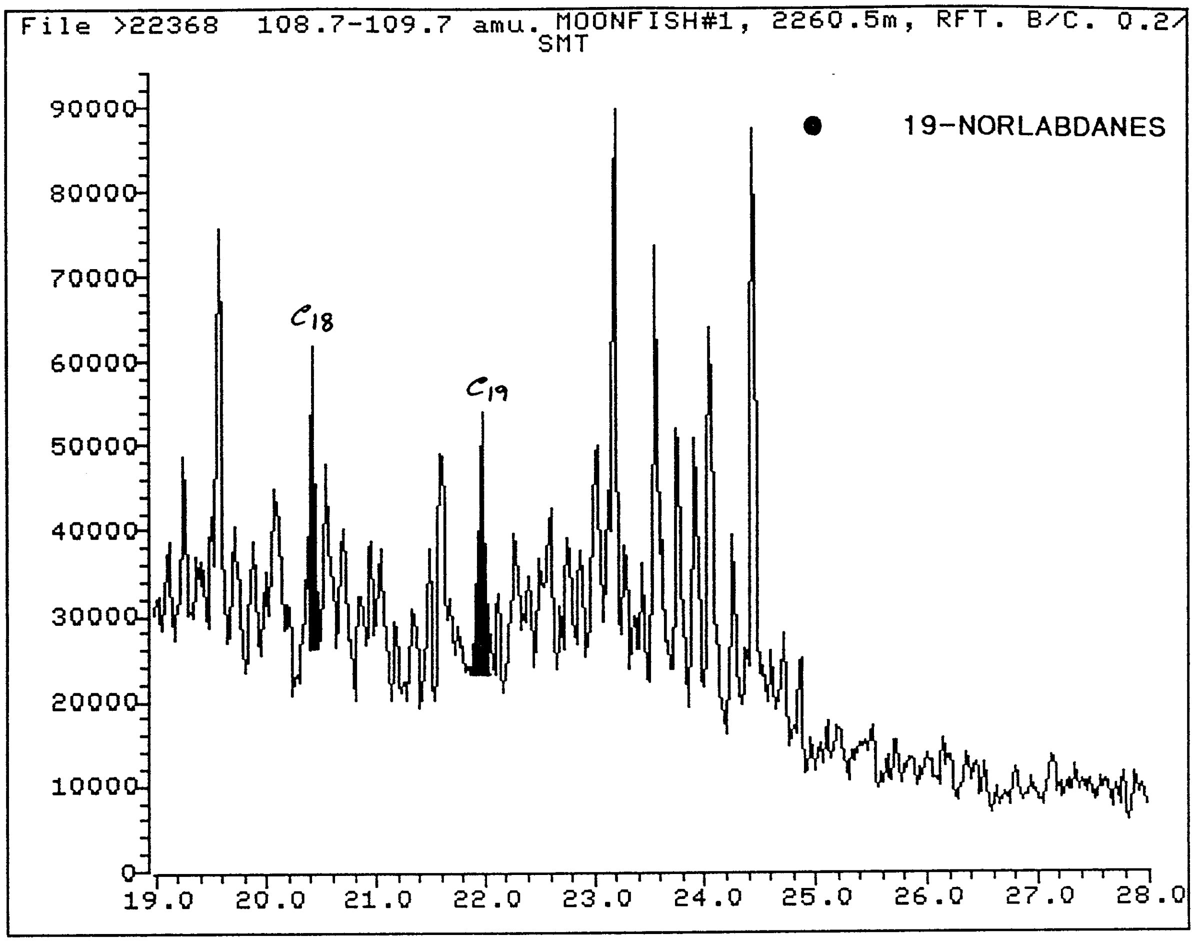
File >22368 108.7-109.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/SMT
19-NORLABDANES
C18
C19
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
19.0
20.0
21.0
22.0
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24.0
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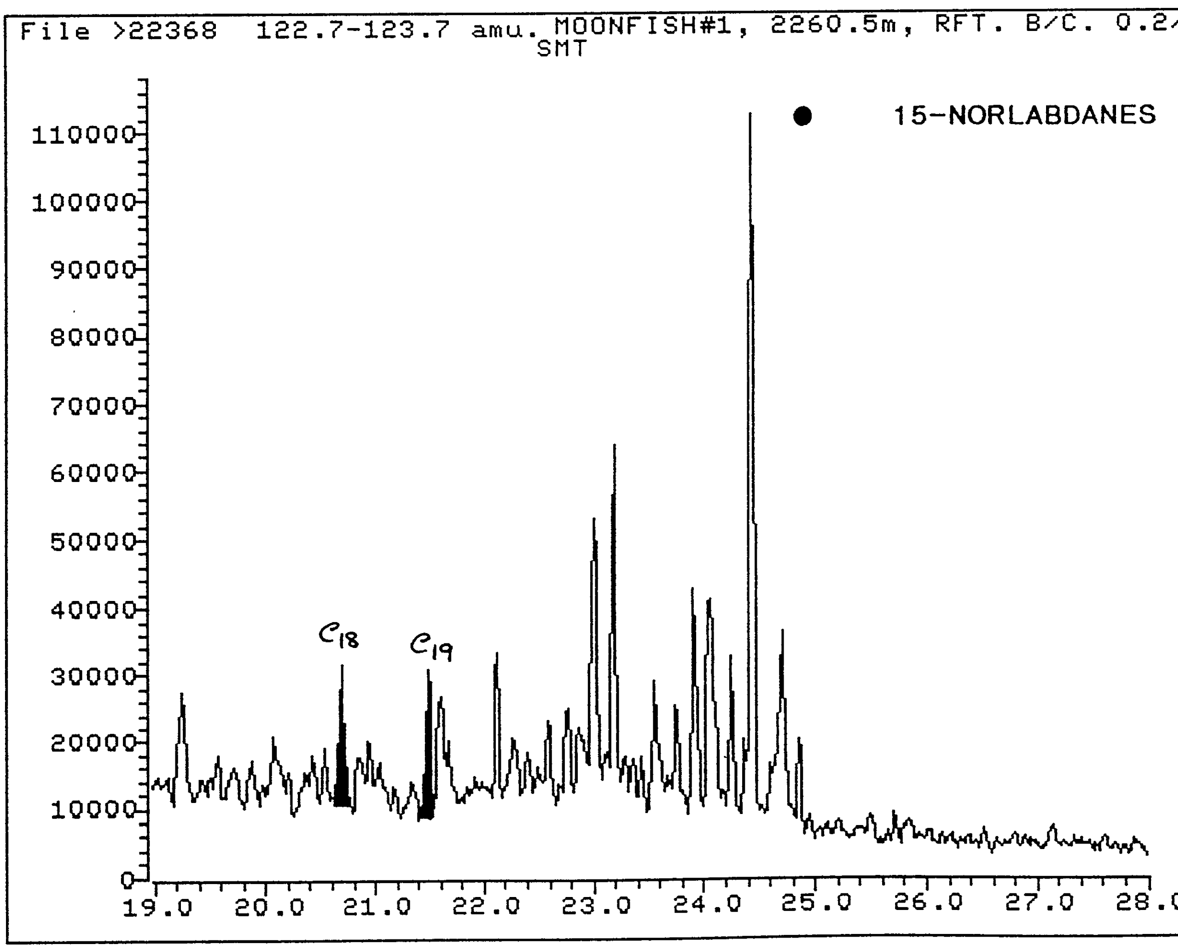
27.0
28.0


File >22368 122.7-123.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/SMT
15-NORLABDANES
C18
C19
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
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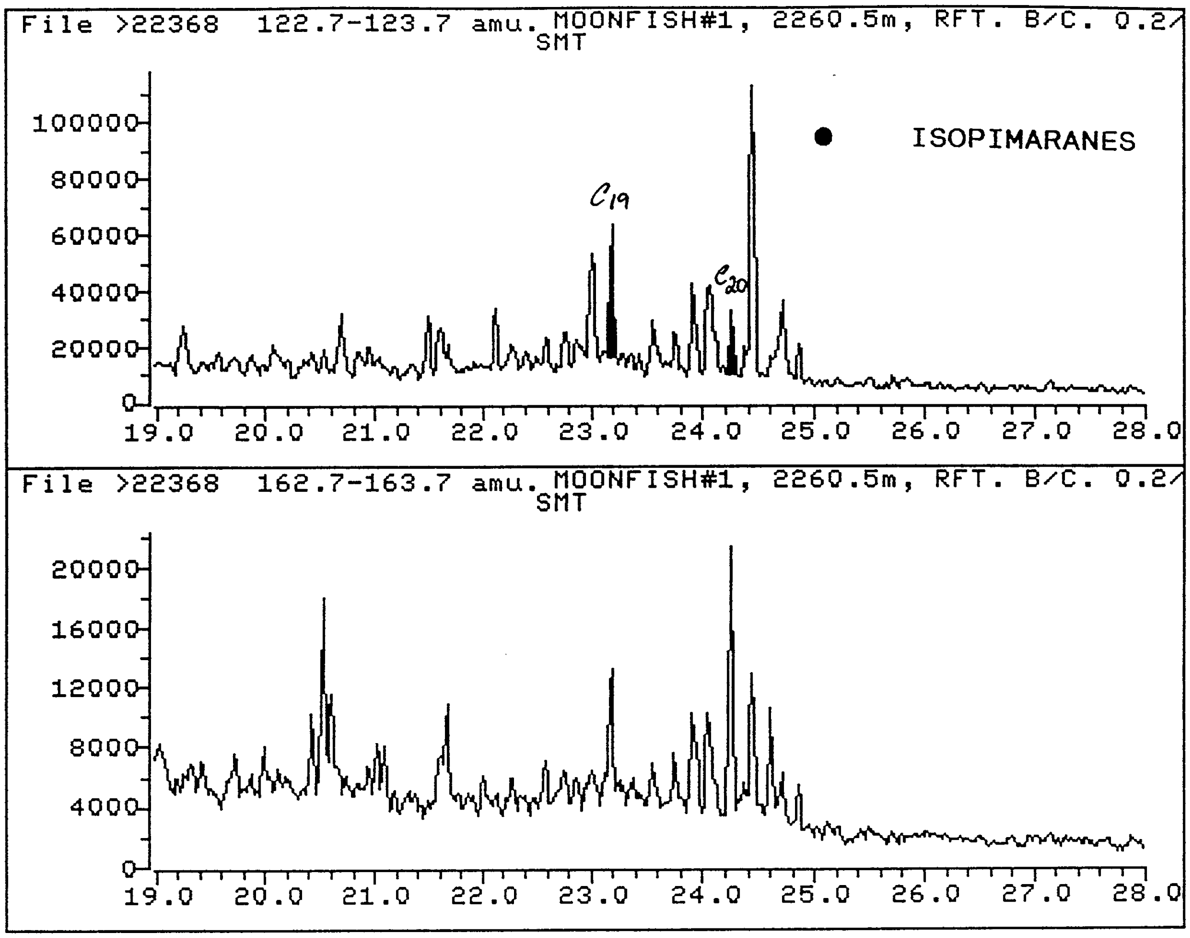
28.0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100000
80000
60000
40000
20000
0
19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0
ISOPIMARANES
C19
C20
File >22368 162.7-163.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/SMT
20000
16000
12000
8000
4000
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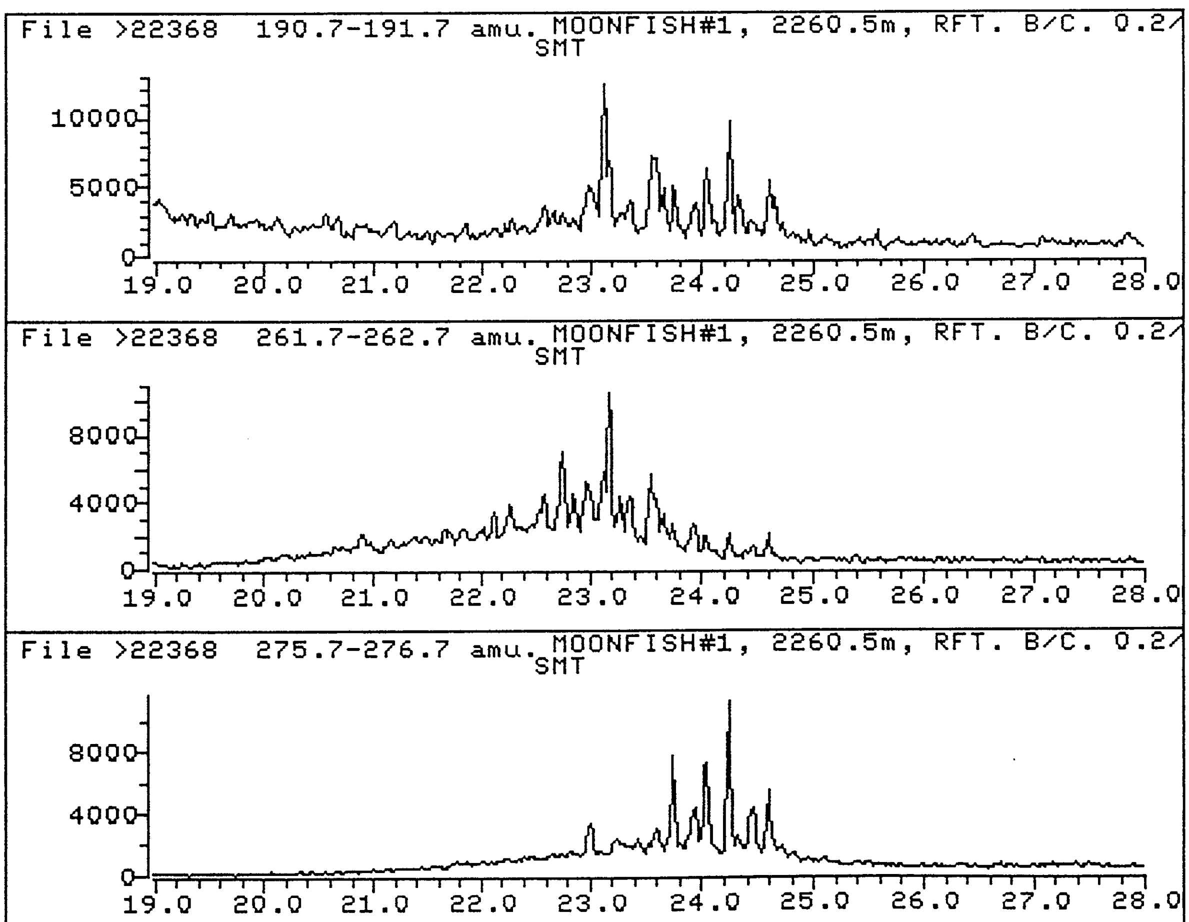
19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0


File >22368 190.7-191.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/SMT
10000
5000
0
19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0
File >22368 261.7-262.7 amu. MOONFISH#1, 2260.5m, RFT. B/C. 0.2/SMT
8000
4000
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19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0
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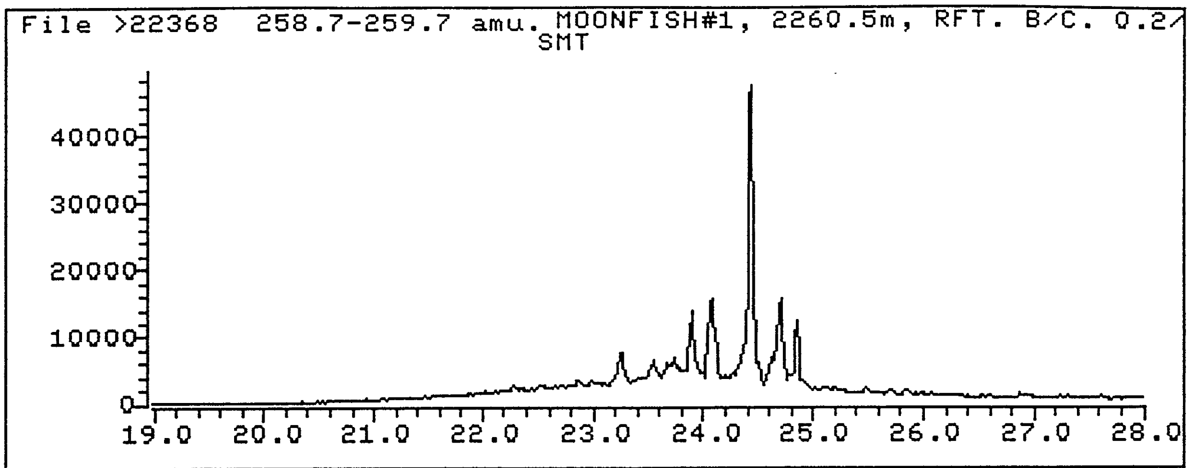
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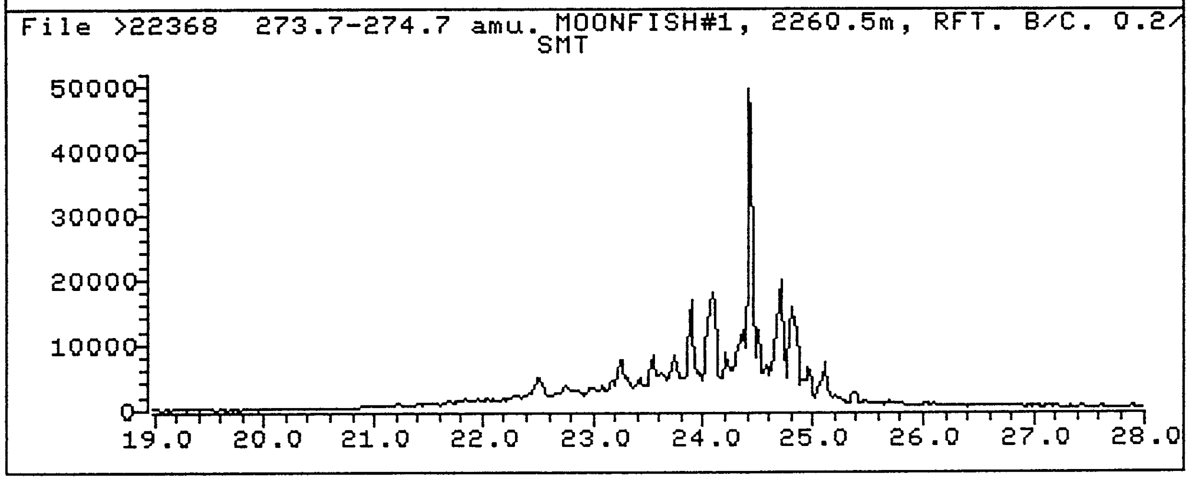
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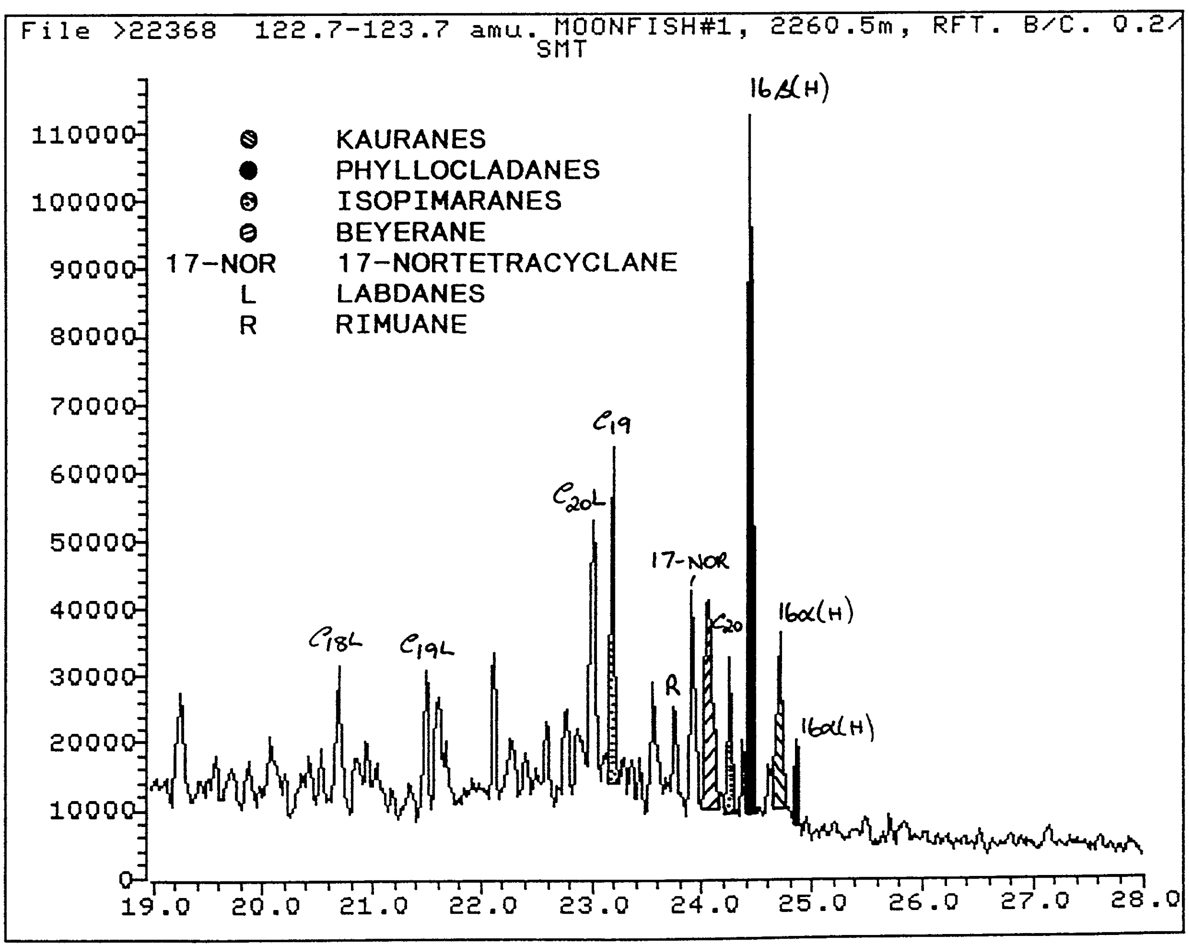
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SMT
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PHYLLOCLADANES
ISOPIMARANES
BEYERANE
17-NOR 17-NORTETRACYCLANE
L LABDANES
R RIMUANE
16β(H)
C19
C20L
17-NOR
C20
16α(H)
16α(H)
R
C18L
C19L
110000
100000
90000
80000
70000
60000
50000
40000
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PETROLEUM GEOCHEMISTRY

1.0 INTRODUCTION

Petroleum geochemistry is primarily concerned with the application of organic chemistry to samples of geological interest in hydrocarbon exploration.

Analyses can be carried out on cuttings, sidewall cores, conventional cores, relatively unweathered outcrop samples and fluid hydrocarbons (oil, condensate, gas).

Source rock evaluation is best performed on sidewall cores, since cuttings are more susceptible to contamination from both cavings and organic additives in the mud system. In petroleum geochemical studies it is vitally important for the geochemist/geologist to be aware of the type of mud additives used and the stage at which they are used during the drilling program. Any anomalous results must be carefully considered in conjunction with mud system records.

Petroleum geochemistry in exploration is applied for three major purposes:

1. First identification of richness, maturity and type of kerogen in (a large number of) whole rock samples by screening analyses.

2. Semi-detailed characterisation of kerogen in sediments from selected source intervals, to determine maturity, source type and genetic potential.

3. Detailed characterisation of petroleum fluids (extracts, oils and condensates) by assessment of thermal maturity, source type and depositional environment to enable oil-to-oil and oil-to-source rock correlation studies.

2.0 THEORY & METHODS

Samples are analysed according to the scheme illustrated in Figure 1 which shows the order and type of analysis for both screening and detailed tests.

2.1 <u>Screening Analyses of Whole Rock Samples</u>

2.1.1 Headspace/Cuttings Gas Analysis

The headspace sample is usually provided in a sealed tin can which holds both cuttings and water to approximately three quarters capacity. This allows the volatile hydrocarbons to diffuse easily into an appreciable headspace.

The gas is taken into a syringe through a silicone seal on the lid of the container and analysed by packed column gas chromatography using the following conditions:

Instrument:	Shimadzu GC-8APF
Column:	6'x ⅛" Chromosorb 102
Injector/Detector Temperature:	120°C
Column Temperature:	110°C
Carrier Gas:	Nitrogen

Cuttings gas analysis is performed in the same manner but on samples which do not liberate volatile gases readily. These sediments are subjected to very vigorous agitation prior to sampling.

Values are given as volume of gas per million volumes of sediment (ppm) for each hydrocarbon (methane, ethane, propane, iso- and n-butane), as composite values including C_5-C_7, and as ratios.

Headspace/cuttings gas analyses are used as a screening technique to identify zones of significant gas generation and out-of-place gas (Letran et al, 1974). The classification for gas content is listed below:

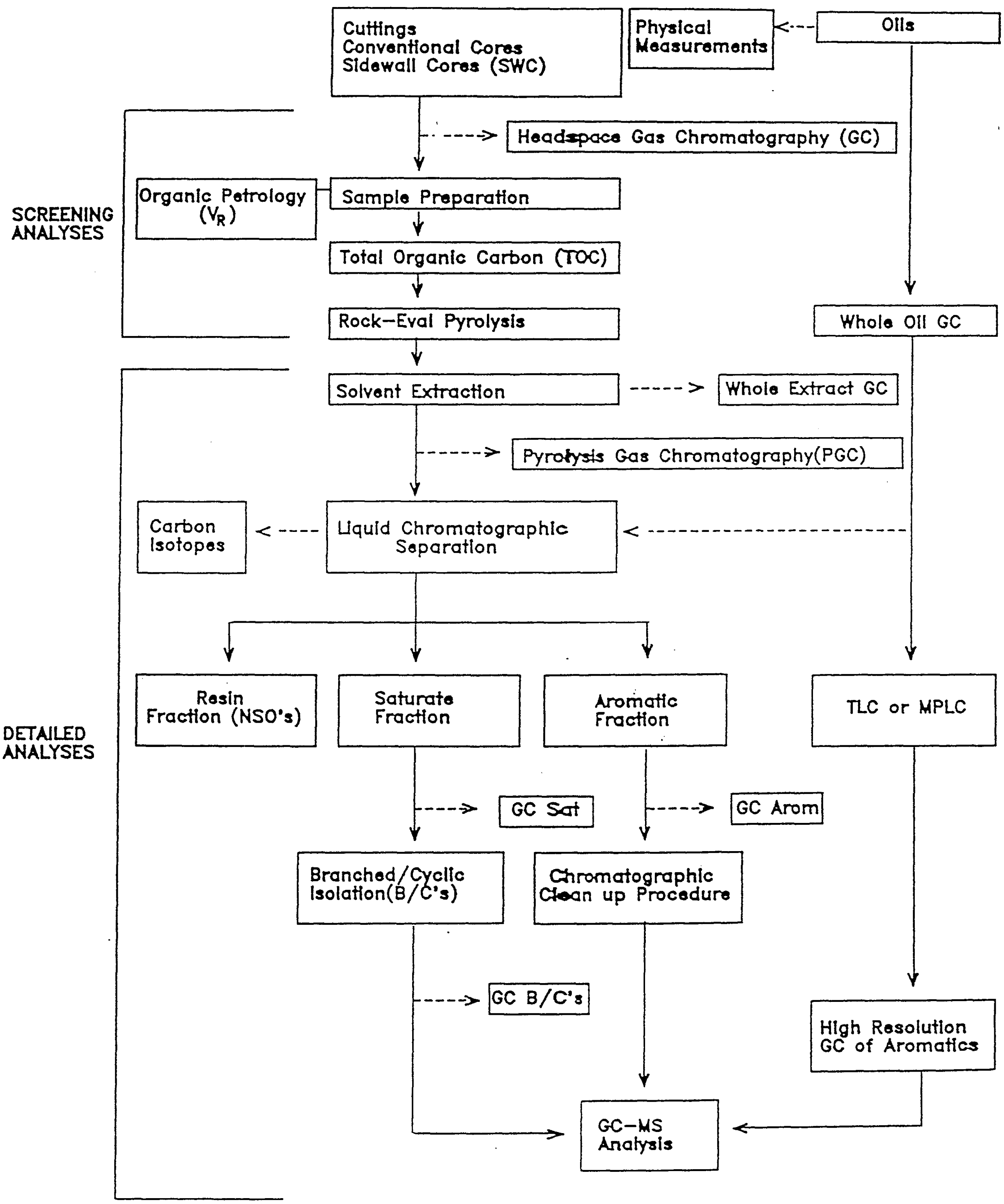
Total gas content (C_1; C_2-C_4; or C_5-C_7)	Description
10 - 100ppm	very lean - lean
100 - 1,000	lean - moderate
1,000 - 10,000	moderate - rich
10,000 - 100,000	rich - very rich

The abundance of C_2-C_4 components (wet gas) is used to locate the zone of oil generation, since wet gas is commonly associated with petroleum (Fuex, 1977).

It is important to ensure that the gases analysed are not of a biogenic origin, so an anti-bacterial agent must be added to the cuttings when they are stored in water.

FIGURE 1

FLOW DIAGRAM FOR PETROLEUM GEOCHEMICAL ANALYSES



2.1.2 Sample Preparation

Depending on drilling mud content, cuttings samples may be water washed before they are air dried, picked free of contaminants and cavings, and then crushed to 0.1mm using a ring pulveriser.

Sidewall cores are freed of mud cake and other visible contaminants, sampled according to homogeneity, air dried and hand crushed to 0.1mm grain size.

Conventional core and outcrop samples are inspected for visible contaminants and crushed to 1/8" chips using a jaw crusher. After air drying, the chips are crushed with a ring pulveriser to small particle size (0.1mm).

Petroleum aqueous mixtures are separated into oil and water/mud fractions by decanting off the oil layer and producing a clean separation by gently centrifuging the oil. If separation by this method is not effective, the petroleum is solvent extracted.

2.1.3 Total Organic Carbon (TOC)

The TOC value is determined on crushed sediment. The minimum sample requirement is one gram, however, results may be obtained from as little as 0.2gm in very rich samples. Carbonate minerals are first removed by acid digest (HCl) and the remaining sample heated to 1700°C (Leco Induction Furnace) in an atmosphere of pure oxygen. The CO_2 produced is measured with an infra-red detector, and values calculated according to standard calibration.

TOC is expressed as % of rock and is used as a screening procedure to classify source rock richness:

Classification	Clastics	Carbonates
Poor	0.00 - 0.50	0.00 - 0.25
Fair	0.50 - 1.00	0.25 - 0.50
Good	1.00 - 2.00	0.50 - 1.00
Very Good	2.00 - 4.00	1.00 - 2.00
Excellent	> 4.00	> 2.00

2.1.4 Rock-Eval Pyrolysis

Although a preliminary source rock classification is made using TOC data, a more accurate assessment of organic source type and maturity is possible by Rock-Eval pyrolysis. Two types of Rock-Eval analyses are offered: "one run" which involves pyrolysis of the crushed but otherwise untreated sediment and "two run" which involves pyrolysis of both the crushed, untreatment sediment and the decarbonated sediment. The "two run" method provides more accurate S_3 values than the "one run" method. S_1 and S_2 values are of the same accuracy in both methods.

The method requires 0.4g of sample material, although reliable results can often be obtained from smaller amounts.

The crushed sediment is heated in an inert atmosphere of helium over a programmed temperature range. The resulting pyrogram is shown in Figure 2.

Hydrocarbons present in the free or adsorbed state (S_1) are thermally distilled at 300°C and measured by a flame ionisation detector (FID). Hydrocarbons are then cracked from the kerogen (S_2) during a temperature ramp from 300° to 550°C and also measured by FID. CO_2 released during the kerogen cracking process (S_3) is trapped and subsequently measured by a thermal conductivity detector.

The amount of free hydrocarbons in the sediment (S_1) represents milligrams of hydrocarbons distilled from one gram of rock and is a measure of both in situ and out-of-place petroleum.

Free hydrocarbon richness is described by the following:

S_1 (mg/g or kg/tonne)	
0.20 - 0.40	fair
0.40 - 0.80	good
0.80 - 1.60	very good
> 1.60	excellent

The total amount of hydrocarbons present in the free state and as kerogen is a measure of the potential yield (genetic potential) of the sample ($S_1 + S_2$) and is expressed as mg/g of rock.

Source rocks are classified accordingly:

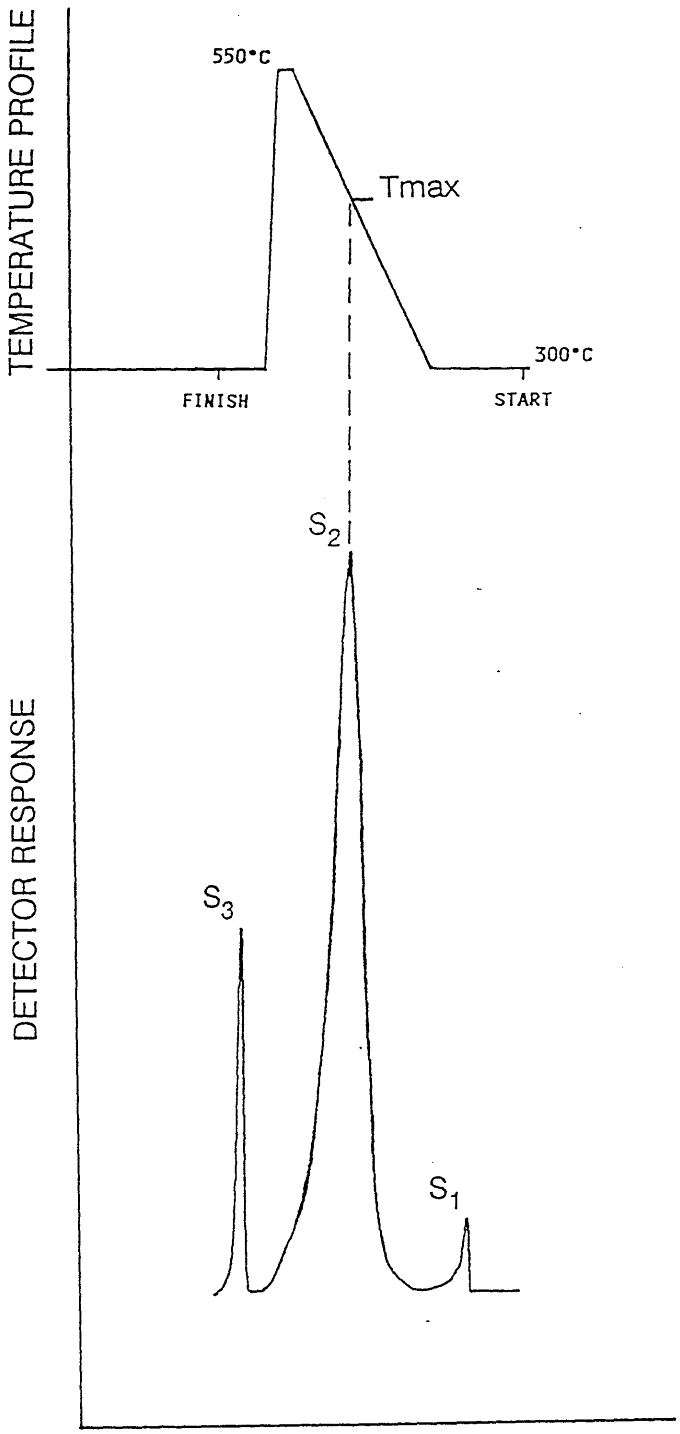
$S_1 + S_2$ (mg/g)	Source Rock Quality
0.00 - 1.00	poor
1.00 - 2.00	marginal
2.00 - 6.00	moderate
6.00 - 10.00	good
10.00 - 20.00	very good
> 20.00	excellent

The Production Index (PI) represents the amount of petroleum generated relative to the total amount of hydrocarbons present ($S_1/(S_1 + S_2)$. It is a measure of the level of maturity of the sample. For oil prone sediments PI ranges from 0.1 at the onset of oil generation to 0.4 at peak oil generation. For gas prone sediments, PI shows only a small change with increasing maturity.

The temperature at which the maximum amount of S2 hydrocarbons is generated is called Tmax (Figure 2). This temperature increases with the increasing maturity of sediments.

FIGURE 2

SCHEMATIC PYROGRAM OF ROCK-EVAL PYROLYSIS



The variation of Tmax is summarised as

< 430°C	immature
430/435° - 460°C	mature (oil window)
> 460°C	overmature

Hydrogen Index (HI = S2 x 100/TOC) and Oxygen Index (OI = S3 x 100/TOC), when plotted against one another, provide information about the type of kerogen and the maturity of the sample. Both parameters decrease in value with increasing maturity. Samples with high HI and low OI are dominantly oil prone and samples with low HI and high OI are gas prone.

2.2 Analysis of Kerogen

2.2.1 Organic Petrology - Vitrinite Reflectance

Vitrinite is a coal maceral which responds to increasing levels of thermal maturity. This response is measured microscopically by the percent of light reflected off the polished surface of a vitrinite particle immersed in oil.

Measurement of vitrinite reflectance can be carried out on uncrushed, washed and dried cuttings (10-50gms of sample material required), sidewall cores (2-10gms), conventional cores (2-10gms) or outcrop samples (2-10gms).

The values given are for standard lower size limits. In special cases, however, useful data may be obtained from as little as 0.1gm.

For each sample a minimum of 25 fields is measured in order to establish a range and mean for reflectance values.

Maturity classifications according to vitrinite reflectance values are:

% V_R (approx)	Maturity
0.2 - 0.55	immature
0.55 - 1.2	mature
1.2 - 1.8	overmature
> 1.8	severely altered

Following vitrinite reflectance measurements, microscopic examination in fluorescence mode allows the description of liptinite macerals and an estimate of their abundances. The amount of dispersed organic matter is reported and its composition described.

Vitrinite reflectance results and maceral descriptions are best obtained from coals or rocks deposited in environments which received large influxes of terrestrially derived organic matter. Vitrinite reflectance cannot be measured in rocks older than Devonian age, since land plants had not evolved prior to this time.

2.2.2 Pyrolysis Gas Chromatography

Pyrolysis gas chromatography (PGC) is performed on solvent extracted source rocks or isolated kerogens. The sample is pyrolysed by an SGE pyrojector which is coupled directly to a Hewlett Packard 5890 gas chromatograph. The operating conditions are:

Pyrolysis temperature:	600°C
Column:	25m x 0.22mm ID BP-1 (SGE)
Carrier gas:	helium
Oven conditions:	-20° to 280°C @ 4°/min

Data are collected and recovered using DAPA scientific software.

Pyrolysis GC allows the examination of kerogen on the molecular level and thereby a better classification of source rocks with regard to source type and generative capacity than conventional bulk pyrolysis (ie. Rock-Eval). Two analytical procedures are possible:

1. Semi quantitative (with yield related to S_2 of Rock-Eval)

2. Fully quantitative (with the inclusion of an internal standard)

Samples are characterised according to the amounts of aliphatic, aromatic and phenolic components in the kerogen. The aliphatic carbon content of a kerogen is the critical factor in determining catagenic hydrocarbon yields in the earth's crust, while the gas/oil ratio is dictated by the distribution of the various structural elements in the kerogen (Larter, 1985). Using pyrogram fingerprint data, it is possible to distinguish substantial variations between kerogens, even those of the same bulk chemical type.

A major strength of pyrolysis methods is that, while quantitative yields of kerogens are maturity related, the qualitative pyrogram fingerprints obtained are relatively rank independent over much of the oil window (Espitatlie et al, 1977; Van Graas et al, 1980; Larter, 1985). At high maturities (>1.2% V_R) characteristics for all kerogen types tend to converge (Horstfield, 1984).

Data are presented by percentage and mg/g of individual substances as well as groups of compounds.

Significant parameters are:

$(C_1 - C_5)/C_6$ + abundance	gas/oil ratio
$C_9 - C_{31}$ (alkenes + alkanes)	oil yield
Type Index R:	aromaticity

(Larter & Douglas 1979, Larter and Senftle, 1985).

2.3 Detailed Analyses of Petroleum Fluids

2.3.1 Solvent Extraction of Sediment

The finely crushed sample (up to 100g) is extracted with dichloromethane (300mL) using sonic vibration. After Buchner flask filtration, the filtrate is re-vibrated with activated copper powder (1g) to remove elemental sulphur. The extractable organic matter (EOM) is afforded by further filtration and fractional distillation of the solvent.

Source rock richness based upon EOM is classified accordingly:

Yield	ppm
Poor	< 500
Fair/Good	500 - 2000
Very Good	2000 - 4000
Excellent	> 4000

2.3.2 Liquid Chromatography Separation

Sediment extracts, crude oil and condensate samples are separated into fractions corresponding to three structural types:

saturated hydrocarbons	(SAT)
aromatic hydrocarbons	(AROM)
resins plus ashphaltenes	(NSO)

This separation is achieved by liquid column chromatography using activated silicic acid adsorbent and eluting solvents of varying polarity. Saturated, aromatic and NSO concentrates are recovered by fractional distillation/evaporation of the solvent and quantitative transfer to a small vial.

The amount of hydrocarbons (SAT plus AROM) can be used to classify source rock richness and the amount of saturates to classify oil source potential, according to the following criteria:

Classification	ppm HC	ppm SAT
Poor	0 - 300	0 - 200
Fair	300 - 600	200 - 400
Good	600 - 1200	400 - 800
Very Good	1200 - 2400	800 - 1600
Excellent	>2400	>1600

The composition of the extracts can also provide information about their levels of maturity and/or source type (LeTran et. al., 1974; Philippi, 1974). Generally, marine extracts have relatively low concentrations of saturated and NSO compounds at low levels of maturity, but these concentrations increase with increasing maturation. Terrestrially derived organic matter often has a low level of saturates and large amount of aromatic and NSO compounds, irrespective of the level of maturity.

Specific ratios are measured from solvent extraction and liquid chromatography data which give an indication of source type and maturity. EOM (mg)/TOC(g) can be used as a maturation indicator when plotted against depth for a given sedimentary sequence. Generally an EOM/TOC value of >100 indicates high maturity. If such a sample has a SAT (mg)/TOC (g) ratio <20, it is likely that the organic matter is gas prone. A value for SAT (mg)/TOC (g) >40 suggests an oil prone source type.

2.3.3 Capillary Gas Chromatography (GC)

C_{12}+ gas chromatography is most commonly carried out on saturate fractions, but in certain instances it is used to examine whole extracts/oils, aromatic or branched/cyclic fractions. It is also used as a tool to identify contamination. The analyses are performed under the following conditions:

Instruments:	Hewlett Packard 5890 Gas Chromatography
Injector:	SGE OCI-3 on column
Column:	25m x 0.2mm ID BP-1
Injector Temp:	280°C
Detector Temp:	320°C
Column Temp:	45°C to 280°C at 4°/min
Carrier Gas:	hydrogen

Data are collected using an IBM compatible PC and DAPA scientific software.

2.3.3.1 C_{12}+ Saturate Gas Chromatography

Saturate GC results provide information pertaining to source type, maturity and depositional environment.

The n-alkane distribution from n-C_{12} to n-C_{31} is determined from the area under the peaks representing each of these n-alkanes. The profile can yield information about maturity and source type and is quantified in the C_{21} + C_{22}/C_{28} + C_{29} ratio and Carbon Preference Indices (CPI 1 and 2).

$$CPI\ (1) = \frac{(C_{23}+C_{25}+C_{27}+C_{29})\ wt\% \ + \ (C_{25}+C_{27}+C_{29}+C_{31})\ wt\%}{2 \times (C_{25}+C_{26}+C_{28}+C_{30})\ wt\%}$$

$$CPI\ (2) = \frac{(C_{23}+C_{25}+C_{27})\ wt\% \ + \ (C_{25}+C_{27}+C_{29})\ wt\%}{2\ x\ (C_{24}+C_{26}+C_{28})\ wt\%}$$

- carbon preference indices are approximately 1 for marine samples, regardless of maturity
- decrease from 20 --> 1 for terrestrial samples as maturity increases

The C_{21} + C_{22}/C_{28} + C_{29} ratio is generally >1.5 for aquatic source material and <1.2 for terrestrial organic matter, however, the values increase with maturity.

Pristane/phytane (Pr/Ph) ratios can indicate depositional environments:

- <3.0 - relatively reducing depositional environments;
- 3.0-4.5 - mixed (reducing/oxidising) environments;
- >4.5 - relatively oxidising depositional environments.

2.3.3.2 C_1 - C_{31} Whole Oil Gas Chromatography

This analytical method is applied to oil and condensate samples. It provides a picture of the whole oil up to n-C_{31} and allows quantitation of components with more than 4 carbons atoms. Several parameters are measured which illustrate changes in the degree of biodegradation and water washing in the reservoir. Because these measurements are performed on very volatile components in the oil, care should be taken during sampling, transportation and storage of the fluid to minimise evaporation.

Whole oil analytical conditions are listed below:

Instrument:	Shimadzu GC-9A
Column:	25m x 0.2mm ID BP-1
Injector/Detector Temperature:	290°C
Column Temperature:	-20°C to 280°C at 4°/min
Carrier Gas:	hydrogen

2.3.4 Carbon Isotope Analysis

This measurement is normally carried out on one or more of the following mixtures: topped oil, saturate fraction, aromatic fraction, NSO fraction. The organic matter is combusted in oxygen to produce carbon dioxide which is purified and transferred to an isotope mass spectrometer. The carbon isotope ratio ($\delta C_{13}/\delta C_{12}$) is measured and compared to an international standard (the Peedee Belemnite Limestone - PDB).

Carbon isotope analysis is most commonly used to identify the source of methane according to the following criteria (Fuex 1977):

$\delta^{13}C$ ‰ PDB	
-75 to -55	Biogenic methane
-58 to -40	Methane associated with oil
-40 to -25	Thermal methane

Source rock-crude oil correlations have been attempted by observing the change in $\delta^{13}C$ values of components of oils and rocks (Stahl 1977). Source rock extracts are usually isotopically heavier than the corresponding crude oil but are lighter than the asphaltenes of the oil and the kerogen of the rock (Hunt 1979). It has also been observed that marine organic carbon is generally isotopically heavier than contemporaneous terrestrial organic carbon (Tissot & Welte 1978). However, it should be noted that increasing maturity and biodegradation produce a shift toward heavier isotope values.

2.3.5 Gas Chromatography - Mass Spectrometry (GC/MS)

GC/MS analysis is normally performed on the branched and cyclic alkane fraction and/or the aromatic fraction of oils, condensates and sediment extracts. The specific fraction is first isolated and then injected into a gas chromatograph which is linked in series with a mass spectrometer. As compounds are eluted from the chromatography column they are bombarded with high energy electrons. This causes them to fragment into a number of ions each with a molecular weight less than that of the parent molecule. Individual compounds give a characteristic fragmentation pattern (mass spectrum), the major ions of which are presented in a series of mass fragmentograms [ie. plots of ion concentration against GC retention time].

GC/MS analysis can be carried out using one of the following modes of operation:

(i) Acquire mode - in which all ions (within a broad range) in each mass spectrum are memorised by the data system.

(ii) Selective Ion Monitoring (SIM) mode - in which only selected ions of interest are memorised by the data system.

2.3.5.1 GC/MS Analysis of Branched/Cyclic Alkanes

The group of compounds to be analysed is first isolated from the saturate fraction by refluxing the sample with activated 5Å molecular sieves in cyclohexane for 24 hours. Branched/cyclic alkanes, including alkylcyclohexanes, are recovered from the solvent by fractional distillation.
For condensates, and samples where information about alkylcyclochexanes is not required, the saturate fraction is passed through a small column packed with silicalite adsorbent. The branched/cyclic alkanes are recovered from the eluting solvent by fractional distillation.

Analysis is carried out in the SIM mode with a total of 33 ions being recorded over different time spans.

Operating conditions are:

Instrument:	5987HP GC mass spec data system
Column:	60m x 0.25mm ID cross linked methyl-silicone DB-1 (J&W) column of 0.25 micron film thickness connected directly to the ion source
Injector:	OCI-3 (SGE)
Carrier gas:	hydrogen
Oven Conditions:	50° to 274°C at 8°/min 274° to 280°C at 1°/min
EM Voltage:	2,000 - 2,300V
Electron Energy:	70eV
Source temperature:	250°C

GC/MS mass fragmentograms are examined for particular 'biomarker' compounds which can be related to biological precursors. These allow the characterisation of petroleum with regard to thermal maturity, source, depositional environment and biodegradation.

The significance of selected parameters from branched/cyclic GC/MS analysis is outlined below:

1. 18α (H)-hopane/17α (H)-hopane (Ts/Tm)

   Maturity indicator. The ratio of 18α (H) trisnorhopane to 17α (H) trisnorhopane increases exponentially with increasing maturity from approximately 0.2 at the onset to approximately 1.0 at the peak of oil generation, ie. Tm decreases with maturity. This parameter is not reliable in very immature samples.

2. C_{30} hopane/C_{30} moretane

   Maturity indicator. The conversion of C_{30} 17β, 21β hopane to 17β, 21α moretane is maturity dependent. Values increase from approximately 2.5 at the onset of oil generation to approximately 10. Once the hopane/moretane ratio has reached 10, no further changes occur. A value of 10 is believed to represent a maturity stage just after the onset of oil generation and hopane/moretane ratios are therefore useful mainly as indicators of immaturity in a qualitative sense.

3&4. C_{31} and C_{32} 22S/22R hopanes

   Maturity indicator. An equilibrium between the biological R- and the geological S- configuration occurs on mild thermal maturation. A ratio of S:R = 60:40, ie, a value of 1.5, characterises this equilibrium which occurs before the onset of oil generation. The C_{32} hopane pair is often more reliable for this purpose since co-elution sometimes affects the C_{31} ratio.

5. C_{29} 20S $\alpha\alpha\alpha$/C_{29} 20R $\alpha\alpha\alpha$ steranes

<u>Maturity</u> indicator. Upon maturation, the biologically produced 20R stereoisomer is diminished relative to the 20S form and a stabilisation is reached at approximately 55% 20R and 45% 20S compounds. V_R equivalents are approximately 0.45% for a 20S/20R value of 0.2 and 0.8% for a 20S/20R value of 0.75. This parameter is most useful between maturity ranges equivalent to 0.4% to 1.0% V_R.

6. C_{29} 20S $\alpha\alpha\alpha$/C_{29} 20R $\alpha\alpha\alpha$ + C_{29} 20S $\alpha\alpha\alpha$ steranes

<u>Maturity</u> indicator. This ratio is a different way of expressing the relative abundance of the biological 20R to the geological 20S normal sterane (see parameter 5). Expressed as a percentage, a value of about 25% indicates the onset of oil generation, and of about 50% the peak of oil generation.

7. C_{29} $\alpha\beta\beta$/C_{29} $\alpha\alpha\alpha$ + C_{29} $\alpha\beta\beta$ steranes

<u>Maturity</u> indicator. The $\alpha\alpha$ form is produced biologically. Its abundance diminishes upon maturation until a mixture of 65% $\beta\beta$ (iso) steranes and 35% $\alpha\alpha$ (normal) steranes is reached, which is equivalent to approximately 0.9% V_R.

8&9. C_{27}/C_{29} diasteranes and steranes

<u>Source</u> indicator. It has been suggested that marine phytoplankton is characterised by a dominance of C_{27} steranes and diasteranes whereas a preponderance of C_{29} compounds indicates strong terrestrial contributions. Values smaller than 0.85 for C_{27}/C_{29} diasterane and sterane ratios are believed to be indicative for terrestrial organic matter, values between 0.85 and 1.43 for mixed organic material, and values greater than 1.43 for an input of predominantly marine organic matter.

It has been suggested, however, that marine sediments can also contain a predominance of C_{29} steranes, so the above rules have to be applied with caution. Any simplistic interpretation of C_{27}/C_{29} steranes and diasteranes can be dangerous and the interpretation of these data should be consistent with other geological evidence.

10. 18α (H) - oleanane/C_{30} hopane

<u>Source</u> indicator. Oleanane is a triterpenoid compound which has often been reported from deltaic sediments of Late Cretaceous to Tertiary age. It is thought to be derived from certain angiosperms which developed in the late Cretaceous. If the 18α (H) - oleanane/C_{30} hopane ratio is below 10, no significant proportions of oleanane are present. At higher values, it can be used as indicator for a reducing environment during deposition of land plant-derived organic matter.

11. C_{29} diasteranes/C_{29} $\alpha\alpha\alpha$ steranes + C_{29} $\alpha\beta\beta$ steranes

Source indicator. This parameter is used to characterise the oxidity of depositional environments. High values (up to 10) indicate oxic conditions, low values (down to 0.1) indicate reducing environments.

12. C_{30}. (hopanes + moretanes)/C_{29} (steranes + diasteranes)

Source indicator. Triterpanes are believed to be of prokariotic (bacterial) origin, whereas steranes are derived from eukariotic organisms. This ratio reflects the preservation of primary organic matter derived from eukariots, relative to growth and preservation of bacteria in the sediment after deposition.

13. C_{15} drimane/C_{16} homodrimane

Drimanes and homodrimanes are ubiquitous compounds most likely derived from microbial activity in sediments. The C_{15} drimane/C_{16} homodrimane ratio is a useful parameter for correlation purposes in the low molecular weight region, especially for condensates which lack most conventional biomarkers. Drimanes are also useful to assess the degree of biodegradation as the removal of C_{15} to C_{16} bicyclics characterises an extensive level of biodegradation.

14. Rearranged/normal drimanes

Like parameter 13, this ratio can be used for correlation purposes in samples without conventional biomarkers, and to assess levels of biodegradation.

15. C_{15} alkylcyclohexane/C_{16} homodrimane

Like parameters 13 and 14, this ratio is useful for correlation purposes.

2.3.5.2 GC/MS Analysis of Aromatics

The aromatic fraction or the oil to be analysed is first subjected to thin layer chromatography (TLC) or medium pressure liquid chromatography (MPLC), depending upon the analytical requirements.

1. Di- and tri- nuclear aromatic compounds are isolated by TLC. To effect this separation, the sample is applied to an alumina coated glass plate (0.6mm thickness). The plate is developed with hexane and the required band located using short wavelength UV light. The fraction is recovered by extraction and fractional distillation.

   This aromatic fraction may be analysed by GC-FID, but GC/MS is recommended because of possible co-elution problems during GC.

   Samples are analysed by GC/MS in the aquire mode scanning from 50 to 450 atomic mass units (amu).

Analytical conditions are:

Instrument: HP5970 MSD
Column: 60m x 0.25mm ID, 0.25 micron film thickness, 5% phenylmethyl silicone column DB-5 (J&W) connected directly to the ion source
Injector: automatic on-column
Carrier Gas: helium
Oven Conditions: 70°C for 1min
70°C --> 300°C at 3°/min
Data collection commences at 10 mins
Mass Spectrometry
Em Voltage 1500 - 1800V
Electron Energy 70eV

Mass fragmentograms are presented for alkylbiphenyls, alkylnaphthalenes, alkylfluorenes and alkylphenanthrenes from a comprehensive data base. Aromatic compounds provide valuable information concerning thermal maturity since they can be applied outside the dynamic range of saturate biomarker indicators and are particularly useful when conventional biomarkers are present in low amounts (Radke & Welte, 1983; Alexander et al, 1985). Maturity ratios are tabled below:

Aromatic Maturity Indicators

Abbrev.	Definition	Range oil onset	wet gas
DNR 1	(2,6DMN + 2,7DMN)/1,5DMN	1.5	10
DNR 2	2,7DMN/1,8DMN	50	2500
DNR 5	1,6DMN/1,8DMN	50	>3000
DNR 6	(2,6DMN + 2,7DMN)/(1,4DMN + 2,3 DMN)	0.8	2
TNR 1	(1,4,6TMN + 1,3,5TMN)/2,3,6TMN	0.5	4
MPR 1	(2MP + 3MP)/1MP	1.5	3
MPI 1	1.5 x (2MP + 3MP)/(PH + 1MP + 9MP)	0.3	1
MPI 2	(3 x 2MP)/(PH + 1MP + 9MP)	0.3	2
Rc(a)	0.6 (MPI-1) + 0.4 (for % Rm <1.35)		
Rc(b)	-0.6 (MPI-1) + 2.3 (for % Rm ≥1.35)		

(from Radke et al, 1982; Radke & Welte, 1983; Alexander et al, 1985)

Some aromatic marker compounds have specific natural product precursors and can be used as signatures for sediments of a particular source, depositional environment or geological age:

TNR 5	1,2,5TMN/1,3,6TMN	
TNR 6	1,2,7TMN/1,3,7TMN	(Strachan et al, 1988)
1,7/X	1,7DMP/(1,3 + 3,9 + 2,10 + 3,10 DMP)	
Retene/9MP		
1MP/9MP		(Alexander et al, 1988)

2. Mono- and triaromatic steranes are analysed by GC/MS under the same analytical conditions as used for di- and tri-nuclear aromatics. However, isolation of this fraction is performed by MPLC. To achieve this, the saturate plus aromatic mixture is injected onto a Merck Si60 column. The separation is monitored with a refractive index detector for saturates and a UV absorbance detector for aromatics.

As aromatic steranes are generally present in low abundances, especially in oils, samples are analysed in the SIM mode and 16 ions are recorded.

The conversion of monoaromatic steranes to triaromatic steranes and the dimethylation of triaromatic steranes in sediments are considered to be maturity dependent (Mackenzie et al, 1981; Mackenzie, 1984). The triaromatic sterane maturity indicator should, however, not be applied to crude oils because migration effects appear to selectively deplete the triaromatic steranes.

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APPENDIX 2B

APPENDIX 2B

APPENDIX 2b

Isotopic Analysis of Gas Samples

by CSIRO

Moonfish #1:-

Sample #1: 1914.5mMDRT (1724.0mTVDSS)
Sample #2: 2260.5mMDRT (2036.8mTVDSS)

Moonfish #ST1:-

Sample #1: 1819.0mMDRT (1638.0mTVDSS)
Sample #2: 1819.0mMDRT (1638.0mTVDSS)

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28th August 1992

Esso Australia Limited
360 Elizabeth Street
MELBOURNE VIC 3000

Attention: K. Kuttan

Dear Sir/Madam,

Please find attached the chemical and isotopic analyses of Moonfish No. 1 samples #1 and #2.

The isotopic composition of methane in Moonfish 1 sample #2 is more depleted in $\delta^{13}C$ than can be expected from isotopic differences between adjacent higher hydrocarbon pairs. This has been found in other natural gases from high maturity source that have been analysed in this laboratory. In both samples the isotopic differences that exist between adjacent higher hydrocarbon pairs in the C_1-C_5 range are not in the range expected from theoretical considerations and therefore the maturity of the samples cannot be determined by the method of James[1], 1983.

An estimate of the maturity of the source has been made using the empirical data of Faber[2], 1987. Based on the isotopic differences that exist between C_2 and C_3 the maturity of Moonfish 1 samples #1 and #2 equate to a vitrinite reflectance $R_{o(max)}$ of 1.6% and 1.7% respectively which places both samples in the middle of the condensate and wet gas window.

It can be concluded from the chemical and isotopic analyses of the gases that Moonfish 1 sample #1 is of lower maturity than Moonfish 1 sample #2. On the basis of the chemical composition sample #1 is "wetter" than sample #2.

Yours sincerely,

R. Pallasser

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[2] Faber, E. 1987. Zur Isotopengeochemie gasformiger kohlenwasserstoffe. Erdol, Erdgas and Kohle 103, p210-218.

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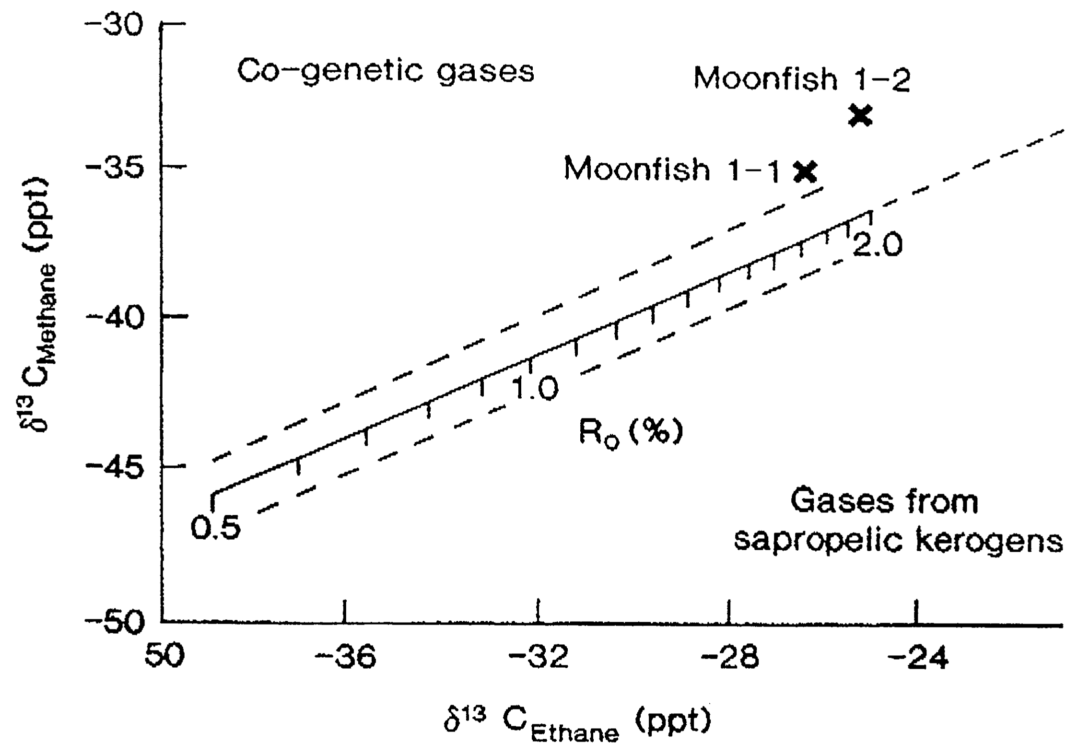
Moonfish #1

	Sample #1 1914.5 mD / 1724m TVD	Sample #2 2260.5m mD / 2036.2 TVD.
Chemical Analyses		
Methane	76.29	79.20
Ethane	9.60	5.83
Propane	4.63	2.51
i-butane	0.73	0.36
n-butane	0.96	0.44
i-pentane	0.20	0.08
n-pentane	0.20	0.10
C_6+	0.01	0.01
CO_2	6.75	11.23
O_2 (includes Ar)	0.08	0.01
N_2	0.55	0.23

Stable Isotope Analyses*

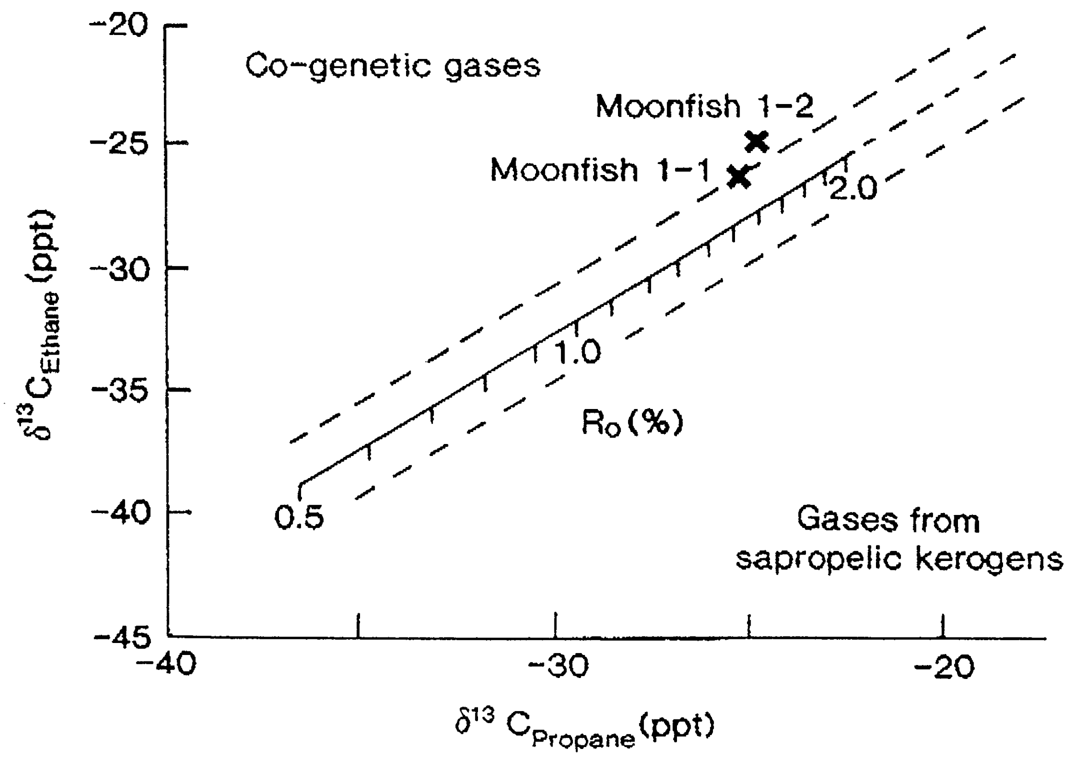
Methane	$\delta^{13}C$ °/oo	-35.2	-33.5
Ethane	"	-26.6	-25.4
Propane	"	-25.5	-24.9
n-butane	"	-25.3	-24.8
n-pentane	"	-25.5	-24.9

*determined on Finnigan MAT-252 mass spectrometer



Maturation line of co-genetic methane and ethane pairs

After Faber, 1987



Maturation line of co-genetic ethane and propane pairs

After Faber, 1987

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Chief: Dr B.E Hobbs

23rd December 1992

Esso Australia Limited
360 Elizabeth Street
MELBOURNE VIC 3000

Attention: Dr P. Moore

Dear Peter,

Please find attached the chemical and isotopic analyses of Moonfish 1 ST 1, Samples #1 and #2.

Please note that the isotopic compositions from these two samples resemble those of Moonfish 1, sample #1 (RFS AD 1131) analysed by us in August this year.

Yours sincerely,

R. Pallasser

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Moonfish 1 ST 1

Compositional Analyses

		Sample 1	Sample 2
Methane		87.72	86.77
Ethane		6.45	6.59
Propane		2.43	2.58
i-Butane		0.37	0.31
n-Butane		0.43	0.40
i-Pentane		0.12	0.14
n-Pentane		0.10	0.15
C_6+		tr	0.12
CO_2		2.2	2.28
O_2 (includes Ar)		-	-
N_2		0.19	0.67

Stable Isotope Analyses

Methane	$\delta^{13}C$ ‰	-35.4	-35.4
Ethane	"	-27.1	-27.0
Propane	"	-25.3	-25.5
n-Butane	"	-25.5	-25.5
n-Pentane	"	-25.0	-25.1

APPENDIX 3

APPENDIX 3

APPENDIX 3

MOONFISH-1

AND MOONFISH-1 SIDETRACK-1

QUANTITATIVE LOG ANALYSES

Analyst	:	A. A. Mills
Date	:	November, 1992

MOONFISH-1 AND MOONFISH-1 ST-1 QUANTITATIVE LOG ANALYSES

Wireline log data from the Moonfish-1 and Moonfish 1 ST-1 exploration wells have been quantitatively analysed for effective porosity and effective water saturation over the intervals 1650-2350m MDKB and 1600-2775m MDKB respectively. Results are presented in full as depth plots (MD and TVD) and tabular listings, and are summarised and discussed below.

Logs Used

Moonfish-1 was logged at 900' per hour with a combination of Schlumberger resistivity logs (6" sample rate) and high resolution neutron (2" sample rate) and density (1" sample rate) logs. As a consequence of loosing Moonfish-1 prior to logging to T.D. it was decided to run a standard logging suite (6" sample rate) at 1800' per hour in the sidetrack.

Moonfish-1		Moonfish-1 ST-1	
CGR	(gamma ray corrected for uranium)	CGR	(gamma ray corrected for uranium)
LLD	(deep laterolog)	LLD	(deep laterolog)
LLS	(shallow laterolog)	LLS	(shallow laterolog)
MSFL	(micro spherically focussed log)	MSFL	(micro spherically focussed log)
HRHO	(high resolution bulk density)	RHOB	(bulk density)
HNPO	(high resolution neutron porosity)	NPOR	(neutron porosity)
CALI	(caliper)	CALI	(caliper)

Resistivity logs were environmentally corrected and an invasion corrected Rt calculated for use in water saturation calculations. The neutron log was temperature corrected.

Log Quality

MOONFISH -1

Log quality was very variable due to the poor hole conditions. The borehole diameter in coals and shales was commonly washed out in excess of 16", giving rise to uninterpretable density-neutron responses. In this case these logs were set to constant values of 2.55 (g/cm^3) and 30 (p.u.) to reflect the shaly nature of the rocks as indicated by the GR and LLD logs and cuttings descriptions. Sandy intervals, including the hydrocarbon zones, were generally close to in gauge. Although the thin sands within the predominantly coal/shale interval 1865-1901m MDKB, do exhibit better hole conditions than the adjacent coals and shales, the thin nature of these sands (< 1m) and the adjacent bad hole conditions cast some doubt as to the accuracy of the calculated porosities. Saturations within these sands are not included as they are considered to be unrepresentative. The presence of hydrocarbons here is inferred from hydrocarbon recoveries from formation tests in thin sands from a similar stratigraphic position in Moonfish-1 ST-1.

MOONFISH-1 ST1

Log quality was generally good due to improved hole conditions (caliper rarely greater than 14") and the use of two knuckle joints above the density log and two below, which were inserted into the tool string to maximise pad contact.

Analyses Methodology

Porosities and water saturations were calculated using an iterative technique which converges into a preselected grain density window by appropriately incrementing or decrementing shale volume. Initial shale volume was calculated from the gamma ray response. The model incorporates porosity calculation from density-neutron crossplot algorithms, water saturation from the dual water relationship, hydrocarbon corrections to the porosity logs where applicable, and convergence upon the preselected grain density window (calculated from hydrocarbon and shale corrected density and neutron logs) by shale volume adjustment. Algorithms used are shown in Appendix 1.

Analyses Parameters

Parameters used in the analyses are tabulated below in Tables 1 and 2. Formation water salinity was estimated by using the Rwa method. In hydrocarbon zones underlain by fresh water, an apparent salinity of 25,000 ppm was used to approximate connate water salinity. Apparent water salinities varied from 3000 ppm in the fresh water zone to 25000 below.

Summary of Results

Quantitative log analyses indicate the following net oil and net gas columns in Moonfish-1 and Moonfish-1 ST-1 respectively.

	Oil		Possible oil		Gas		Possible Gas	
	MD	TVD	MD	TVD	MD	TVD	MD	TVD
Moonfish-1	25.1	(22.6)	6.4	(5.9)	16.9	(15.2)	0.9	(0.8)
Moonfish-1 ST1	15.8	(14.4)	5.2	(5.0)	5.4	(5.0)	0.2	(0.2)

Well Survey Data

Both analyses discussed above were performed on MD logs and the results and input curves then converted to true vertical depth sub sea (TVDSS) using well survey data. A comparison of TVDSS fluid contacts of the N-1.9 gas accumulation and the sub-volcanic oil accumulation revealed a discrepancy between the two surveys. As neither survey was known to be wrong, the Moonfish-1 survey was assumed to be right and the sidetrack survey was adjusted so that the two above mentioned contacts were aligned. The following adjustments have been made:

1. -23 < depth TVDSS < 1680.5 ...... TVD adjusted = TVD unadjusted -[(TVD unadjusted + 23)/283.95]
2. 1680.5 < depth TVDSS < 2051.6.. TVD adjusted = TVD unadjusted -[((TVD unadjusted - 1680.5)/185.55)+6]
3. 2051.6 < depth TVDSS .... TVD adjusted = TVD unadjusted -8

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TABLE 1

MOONFISH 1

ANALYSIS PARAMETERS

VSH and Porosity from DENSITY-NEUTRON (GR used for initial est. of VSH).

Tortuosity; "a"	: 1.00
Cementation factor; "m"	: 2.00
Saturation exponent; "n"	: 2.00
Fluid density	: 1.00
GRmin	: 20
GRmax	: 150
RSH	: 15-20
RHOBSH	: 2.55
PHINSH	: 30
RHOH	: 0.25 gas
	: 0.70 oil
Lower limit of grain density	: 2.645
Upper limit of grain density	: 2.675
Formation Water entered in terms of SALINITY	
SALINITY of fresh water (depth < 1950m)	: 3000 ppm
SALINITY of saline water (depth > 1950m)	: 25000 ppm
SALINITY of connate water	: 25000 ppm
Measured Rmf	: 0.060
Temperature at which Rmf measured	: 19.0 deg.C
Sxo derived from Sw (Sxo = Sw**z)	
z (where Sxo=Sw**z)	: 0.30
Logged TD	: 2373
Logged bottom hole temperature	: 78 deg.C
Est. sea bed temperature	: 10 deg.C
Water depth	: 52.0
KB height	: 23.0
Irreductible water saturation	: 0.025
Vsh upper limit for effective porosity	: 0.65
Minimum effective porosity for hydrocarbons	: 0.03

TABLE 2

MOONFISH 1 ST1

ANALYSIS PARAMETERS

VSH and Porosity from DENSITY-NEUTRON (GR used for initial est. of VSH).

Tortuosity; "a"	: 1.00
Cementation factor; "m"	: 2.00
Saturation exponent; "n"	: 2.00
Fluid density	: 1.00
GRmin	: 25
GRmax	: 130
RSH	: 12-25
RHOBSH	: 2.55-2.65
PHINSH	: 21-29
RHOH	: 0.25 gas
	: 0.70 oil
Lower limit of grain density	: 2.645
Upper limit of grain density	: 2.675
Formation Water entered in terms of SALINITY	
SALINITY of fresh water (depth <1910m)	: 3500-5500 ppm
SALINITY of saline water (depth > 1910m)	: 20000 ppm
SALINITY of connate water	: 25000 ppm
Measured Rmf	: 0.151
Temperature at which Rmf measured	: 15.0 deg.C
Sxo derived from Sw (Sxo = Sw**z)	
z (where Sxo=Sw**z)	: 0.30
Logged TD	: 2802
Logged bottom hole temperature	: 92 deg.C
Est. sea bed temperature	: 10 deg.C
Water depth	: 52.0
KB height	: 23.0
Irreductible water saturation	: 0.025
Vsh upper limit for effective porosity	: 0.65
Minimum effective porosity for hydrocarbons	: 0.03

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MOONFISH_1_ST1

ANALYSIS SUMMARY

Net porosity cut-off..........: 0.120 volume per volume
Net water saturation cut-off..: 0.800 volume per volume

Net Porous Interval based on Porosity cut-off only.
Both Porosity and Sw cut-offs invoked when generating Hydrocarbon-Metres.

	GROSS INTERVAL (metres) (top) -(base)	Gross Metres	NET POROUS INTERVAL Net Metres	Net to Gross	Mean Vsh	(Std.) (Dev.)	Mean Porosity	(Std.) (Dev.)	Mode Porosity	Mean Sw	INTEGRATED HYDROCARBON PORE VOLUME	FLUID TYPE	INTERPRETED CONTACTS MD(TVD)
MDKB	1817.8-1820.4	2.6	2.5										
TVDSS	1672.3-1674.7	2.4	2.3	98 %	0.04	(0.080)	0.28	(0.035)	0.29	0.29	0.461	GAS	GWC 1820.4(1674.7)
MDKB	1837.4-1839.2	1.8	0.8										
TVDSS	1690.3-1692.0	1.7	0.7	44 %	0.25	(0.054)	0.16	(0.020)	0.18	0.41	0.069	OIL	
MDKB	1840.7-1841.2	0.5	0.1										
TVDSS	1693.3-1693.9	0.5	0.1	18 %	0.33	(0.018)	0.13	(0.005)	0.12	0.53	0.006	POSSIBLE OIL	
MDKB	1845.2-1846.0	0.8	0.5										
TVDSS	1697.6-1698.3	0.7	0.5	62 %	0.24	(0.051)	0.17	(0.018)	0.19	0.44	0.044	OIL	
MDKB	1847.2-1848.8	1.6	1.1										
TVDSS	1699.4-1700.9	1.5	1.0	69 %	0.22	(0.057)	0.18	(0.019)	0.19	0.45	0.098	OIL	
MDKB	1850.6-1851.6	1.0	0.7										
TVDSS	1702.6-1703.4	0.9	0.7	74 %	0.26	(0.077)	0.15	(0.015)	0.15	0.56	0.042	GAS	
MDKB	1852.3-1853.2	0.8	0.2										
TVDSS	1704.2-1704.9	0.7	0.2	25 %	0.36	(0.070)	0.13	(0.005)	0.13	0.49	0.012	POSSIBLE GAS	
MDKB	1857.0-1860.8	3.8	3.2										
TVDSS	1708.5-1712.0	3.5	2.9	84 %	0.14	(0.099)	0.22	(0.030)	0.23	0.29	0.449	OIL	
MDKB	1873.0-1877.6	4.6	4.2										
TVDSS	1723.4-1727.7	4.2	3.9	91 %	0.04	(0.047)	0.22	(0.028)	0.25	0.26	0.637	OIL	
MDKB	1915.0-1917.3	2.3	2.3										
[redacted]SS	[redacted].5-[redacted].7	[redacted]2.2	[redacted]2.1	[redacted]6 %	[redacted].04	[redacted]102[redacted]	0.[redacted]	(0.[redacted]	0[redacted]	[redacted]74	[redacted]121 [redacted]	[redacted]IBL[redacted] OIL	OWC[redacted] 1917.3(1764.7)

ANALYSIS SUMMARY

Net porosity cut-off..........: 0.120 volume per volume
Net water saturation cut-off..: 0.800 volume per volume

GROSS INTERVAL (metres) (top) -(base)	Gross Metres	NET POROUS INTERVAL Net Metres	Net to Gross	Mean Vsh	(Std.) (Dev.)	Mean Porosity	(Std.) (Dev.)	Mode Porosity	Mean Sw	INTEGRATED HYDROCARBON PORE VOLUME	FLUID TYPE	INTERPRETED CONTACTS MD(TVD)
MDKB 1938.4-1942.3	3.9	2.5										
TVDSS 1784.2-1787.9	3.7	2.3	63 %	0.30	(0.057)	0.15	(0.021)	0.15	0.76	0.069	POSSIBLE OIL	OWC 1942.3(1787.9)
MDKB 2024.4-2025.0	0.6	0.0										
TVDSS 1863.6-1864.2	0.6	0.0	0 %	-	-	-	-	-	-	-	POSSIBLE OIL	
MDKB 2025.6-2026.3	0.8	0.0										
TVDSS 1864.7-1865.4	0.7	0.0	0 %	-	-	-	-	-	-	-	POSSIBLE OIL	
MDKB 2030.2-2033.6	3.4	1.5										
TVDSS 1868.9-1872.1	3.1	1.4	44 %	0.33	(0.073)	0.14	(0.019)	0.13	0.37	0.124	OIL	
MDKB 2035.2-2036.8	1.6	0.0										
TVDSS 1873.5-1875.0	1.5	0.0	0 %	-	-	-	-	-	-	-	POSSIBLE OIL	
MDKB 2038.6-2039.3	0.8	0.3										
TVDSS 1876.6-1877.4	0.7	0.2	31 %	0.33	(0.090)	0.14	(0.001)	0.14	0.52	0.015	POSSIBLE OIL	
MDKB 2046.8-2049.2	2.4	2.2										
TVDSS 1884.2-1886.4	2.2	2.0	90 %	0.05	(0.073)	0.21	(0.023)	0.22	0.30	0.291	GAS	
MDKB 2052.3-2052.6	0.3	0.0										
TVDSS 1889.2-1889.5	0.3	0.0	0 %	-	-	-	-	-	-	-	POSSIBLE GAS	
MDKB 2084.8-2086.1	1.3	0.0										
TVDSS 1919.0-1920.3	1.2	0.0	0 %	-	-	-	-	-	-	-	POSSIBLE OIL	
MDKB 2095.6-2096.1	0.6	0.3										
TVDSS 1928.9-1929.4	0.5	0.3	58 %	0.34	(0.124)	0.16	(0.020)	0.18	0.27	0.038	OIL	
MDKB 2216.0-2218.1	2.1	0.7										
TVDSS 2038.0-2039.8	1.8	0.6	32 %	0.32	(0.005)	0.13	(0.003)	0.13	0.77	0.014	OIL	
MDKB 2218.2-2222.0	3.8	3.5										
[redacted]	[redacted]	[redacted]	[redacted] %	[redacted]	[redacted]	0.23	(0.023)	0.21	0.41	0.419	OIL	OWC 2222[redacted]

MOONFISH_1

ANALYSIS SUMMARY

Net porosity cut-off.........: 0.120 volume per volume
Net water saturation cut-off..: 0.800 volume per volume

Net Porous Interval based on Porosity cut-off only.
Both Porosity and Sw cut-offs invoked when generating Hydrocarbon-Metres.

	GROSS INTERVAL (metres) (top) - (base)	Gross Metres	NET POROUS INTERVAL Net Metres	Net to Gross	Mean Vsh	(Std.) (Dev.)	Mean Porosity	(Std.) (Dev.)	Mode Porosity	Mean Sw	INTEGRATED HYDROCARBON PORE VOLUME	FLUID TYPE	INTERPRETED CONTACTS MD (TVD)
MDKB	1844.9-1845.8	0.9	0.0										
TVDSS	1661.4-1662.2	0.8	0.0	0 %	-	-	-	-	-	-	-		
MDKB	1846.7-1848.4	1.7	0.0										
TVDSS	1663.0-1664.5	1.5	0.0	0 %	-	-	-	-	-	-	-		
MDKB	1848.6-1859.9	11.3	11.3										
TVDSS	1664.7-1674.7	10.1	10.1	100 %	0.07	(0.077)	0.24	(0.031)	0.28	0.11	2.207	GAS	GWC 1859.9(1674.7)
MDKB	1871.0-1871.9	0.9	0.7										
TVDSS	1684.7-1685.5	0.8	0.6	78 %	0.04	(0.062)	0.20	(0.023)	0.20	-	-	POSSIBLE GAS	
MDKB	1876.5-1877.2	0.7	0.2										
TVDSS	1689.6-1690.2	0.6	0.2	29 %	0.19	(0.002)	0.15	(0.006)	0.14	-	-	POSSIBLE OIL	
MDKB	1881.1-1882.4	1.3	1.1										
TVDSS	1693.7-1694.9	1.2	1.0	85 %	0.27	(0.079)	0.17	(0.016)	0.18	-	-	POSSIBLE OIL	
MDKB	1883.2-1884.2	1.0	0.3										
TVDSS	1695.6-1696.5	0.9	0.3	30 %	0.13	(0.071)	0.23	(0.030)	0.25	-	-	POSSIBLE OIL	
MDKB	1897.3-1898.2	0.9	0.0										
TVDSS	1708.3-1709.1	0.8	0.0	0 %	-	-	-	-	-	-	-		
MDKB	1902.6-1922.7	20.1	14.8										
TVDSS	1713.1-1731.3	18.2	13.4	74 %	0.16	(0.104)	0.21	(0.040)	0.18	0.15	2.345	OIL	OWC 1922.7(1731.3)
MDKB	1953.6-1959.0	5.4	3.8										
[redacted]S	1[redacted]3-1[redacted]3	[redacted]9	[redacted].5	[redacted] %	[redacted]16	[redacted]91)	[redacted]0.20	[redacted].03[redacted]	0.[redacted]	[redacted]	[redacted]	PO[redacted]BLE OIL	OWC 1959.0[redacted]

ANALYSIS SUMMARY.

Net porosity cut-off.........: 0.120 volume per volume
Net water saturation cut-off..: 0.800 volume per volume

Net Porous Interval based on Porosity cut-off only.
Both Porosity and Sw cut-offs invoked when generating Hydrocarbon-Metres.

GROSS INTERVAL (metres) (top) -(base)		Gross Metres	NET POROUS INTERVAL Net Metres	Net to Gross	Mean Vsh	(Std.) (Dev.)	Mean Porosity	(Std.) (Dev.)	Mode Porosity	Mean Sw	INTEGRATED HYDROCARBON PORE VOLUME	FLUID TYPE	INTERPRETED CONTACTS MD (TVD)
MDKB	1981.8-1984.2	2.4	1.0										
TVDSS	1785.1-1787.3	2.2	0.9	42 %	0.39	(0.041)	0.13	(0.010)	0.12	0.55	0.053	POSSIBLE OIL	OWC 1984.2(1787.3)
MDKB	1995.2-1996.1	0.9	0.0										
TVDSS	1797.4-1798.2	0.8	0.0	0 %	-	-	-	-	-	-	-		
MDKB	1996.8-2000.0	3.2	1.6										
TVDSS	1798.9-1801.8	2.9	1.5	50 %	0.36	(0.030)	0.14	(0.010)	0.14	0.62	0.075	OIL	OWC 2000.0(1801.8)
MDKB	2007.2-2010.4	3.2	1.9										
TVDSS	1808.4-1811.4	2.9	1.7	59 %	0.36	(0.075)	0.15	(0.017)	0.13	0.57	0.112	GAS	
MDKB	2091.0-2092.2	1.2	0.2										
TVDSS	1885.2-1886.3	1.1	0.2	17 %	0.24	(0.056)	0.14	(0.001)	0.14	0.65	0.009	POSSIBLE GAS	
MDKB	2127.3-2128.1	0.8	0.2										
TVDSS	1918.2-1918.9	0.7	0.2	25 %	0.19	(0.007)	0.14	(0.000)	0.14	0.33	0.017	GAS	
MDKB	2129.4-2133.5	4.1	3.5										
TVDSS	1920.1-1923.8	3.7	3.2	85 %	0.09	(0.095)	0.24	(0.032)	0.24	0.17	0.628	GAS	GOC (approx) 2133.5(1923.8)
MDKB	2133.7-2140.2	6.5	3.2										
TVDSS	1924.0-1929.9	5.9	2.9	49 %	0.33	(0.056)	0.14	(0.017)	0.13	0.40	0.252	OIL	OWC 2140.2(1929.9)
MDKB	2254.5-2261.5	7.0	3.8										
TVDSS	2031.5-2037.7	6.2	3.3	54 %	0.13	(0.091)	0.20	(0.040)	0.13	0.24	0.525	OIL	
MDKB	2261.7-2267.9	6.2	1.7										
TVDSS	2037.8-2043.3	5.4	1.5	27 %	0.24	(0.057)	0.17	(0.018)	0.16	0.62	0.093	OIL	OWC 2267.9(2043.3)

FORMATION MICRO-SCANNER

INTERPRETATION SUMMARY

MOONFISH-1 SIDETRACK-1

The Formation Micro-Scanner (FMS) data has been interpreted for structural and stratigraphic information in the Moonfish 1 Sidetrack 1 well. The reservoirs analysed are in the upper hydrocarbon interval from 1813m to 1920m MDKB and the sub-volcanic reservoirs from 2215m to 2250m MDKB. The attached figures 1 through 20 show the interpretation results of analysing those reservoirs for structural orientation and stratigraphic cross bedding. All figures showing stratigraphic crossbedding have had the structural orientation removed so that their orientation are with respect to depositional slope. Table 1 summarises the FMS analyses.

This data was originally analysed by Scott Dodge and John Phillips using Schlumberger's FMS interpretation workstation in Melbourne. Final analysis was done by Scott Dodge and Mark Sloan using the FMS application software loaded in Esso's office at Melbourne Central.

STRUCTURAL ORIENTATION

The structural orientation for the upper hydrocarbon reservoirs is shown in Figure 1 and 2. Figure 1 shows a uniform orientation at 3.4° dip and 141° azimuth from 1813m to 1860m MDKB. Structural dip can be seen to increase below 1900 metres in Figure 2. The dip magnitude has increased to 8° and rotated SW to 192° azimuth. This dip rotation is conformable with the underlying subvolcanic reservoirs. The structural orientation of the subvolcanic reservoirs is 7.7° dip and 189° azimuth as shown in Figure 13. This structural orientation was removed from the crossbeds within the sub-volcanic sandstones between 2215m to 2250m MDKB.

STRATIGRAPHIC ANALYSIS

The remaining figures contain analyses of stratigraphic crossbedding in the two intervals of interest from 1813m to 1920m and sub-volcanic oil reservoir 2215m to 2250m MDKB. All crossbeds have had the structural orientation removed.

Crossbedding in the upper gas and oil reservoirs in addition to water sands are shown in Figures 3 through 12. The high energy environment in the fluvial channel sand is observed by high angle crossbeds from 1825m to 1828m indicating paleo-current flow SW at 211° azimuth. As the energy level decreases with decreasing depth the crossbeds are observed to rotate 90° to the W/NW direction. The lower energy crossbedding may reflect lateral flow relative to the channel axis oriented SW.

Crossbedding in the main oil reservoir is shown in Figure 4. The dip azimuth histogram shows this fluvial channel oriented north easterly at 34° azimuth. It is interesting to note this channel sand has the same strike orientation, NW/SE, as the gas reservoir but the paleo-flow direction is 180° out of phase. The strike orientation is useful to orient the channel flow direction or movement away or into a channel sand.

The sub-volcanic oil reservoir is shown in Figure 14. This overview of the structural and stratigraphic components show crossbedding to the parallel to structural dip to the south-west. Figure 15 shows the crossbed orientation after removing the structural component. The paleo-current flow is SW at 193°. Some lateral aggradational bedding is observed in this reservoir interval.

The detailed 1:10 scale FMS images and 1:200 FMS interpretation summary log are located in the Formation Evaluation Moonfish 1 Sidetrack 1 well file.

TABLE 1

MOONFISH-1 SIDETRACK-1

FMS STRUCTURAL AND STRATIGRAPHIC INTERPRETATION

	DEPTH	DIP	AZIMUTH
Structural	1813-1860mKB Strike - 51°/231° NE/SW	3.4°	141°
Structural	1875-1920mKB Strike - 102°/282° WNW/ESE	8°	192°
Structural	2225-2240mKB Strike - 100°/280° WMW/ESE	13.6°	190°
Structural	2215-2250mKB (Sub volcanics)	7.7°	189°

	DEPTH	DIP	AZIMUTH
	Upper Hydrocarbon Reservoirs		
Stratigraphic	1818-1825mKB	3.3°	272°
Stratigraphic	1825-1828mKB	12.3°	211°
Stratigraphic	1858-1860.5mKB	11°	34°
Stratigraphic	1874-1877mKB	12.9°	135°
Stratigraphic	1879-1886mKB	9.9°	118°
Stratigraphic	1886-1889mKB	8.6°	42°
Stratigraphic	1889-1895mKB	10.2°	193°
Stratigraphic	1895-1901.5mKB	18°	252°
Stratigraphic	1901.5-1904.4mKB	3.8°	40°
Stratigraphic	1915.8-1917.0mKB	21.3°	153°
Stratigraphic	1918.4-1919mKB	13.4°	42°
	Sub-Volcanic Reservoirs		
Stratigraphic	2219-2224mKB	10.9°178°	
Stratigraphic	2224.0-2226.5mKB	2.2°56°	
Stratigraphic	2226.5-2233.5mKB	15°	193°
Stratigraphic	2233.5-2235.5mKB	25°	242°
Stratigraphic	2239-2242mKB	11°	232°

(Note: Structural DIP Removed)

TABLE 2

MOONFISH-1 SIDETRACK-1

FMS INTERPRETATION NOTES

MKB	FMS NOTES
2121.2	OWC
1923	Dense shale pyritic
1921.4	Planer bedding
1918.8	Stratigraphic dips in sandstone
1918.5	Cross beds
1918.0	High angle cross beds
1916.4	High angle cross beds
1913.5	Structural dips in shale (10°-195°)
1912	Coal washout
1912.3-1911.6	Coal
1907.0	4m coal seam
1889.5	Carbonaceous streak
1873.8	Top M-2 sand
1827	High angle cross beds
1825.5	Featureless sand zone
1820.5	GWC
1818.5	Top N1.9 gas sand

PE904260

This is an enclosure indicator page.
The enclosure PE904260 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904260 has the following characteristics:

ITEM_BARCODE = PE904260
CONTAINER_BARCODE = PE900991
NAME = Structural Dip, Figure 1
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Structural Dip Diagram, Figure 1, for Moonfish-1
REMARKS =
DATE_CREATED = 30/11/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

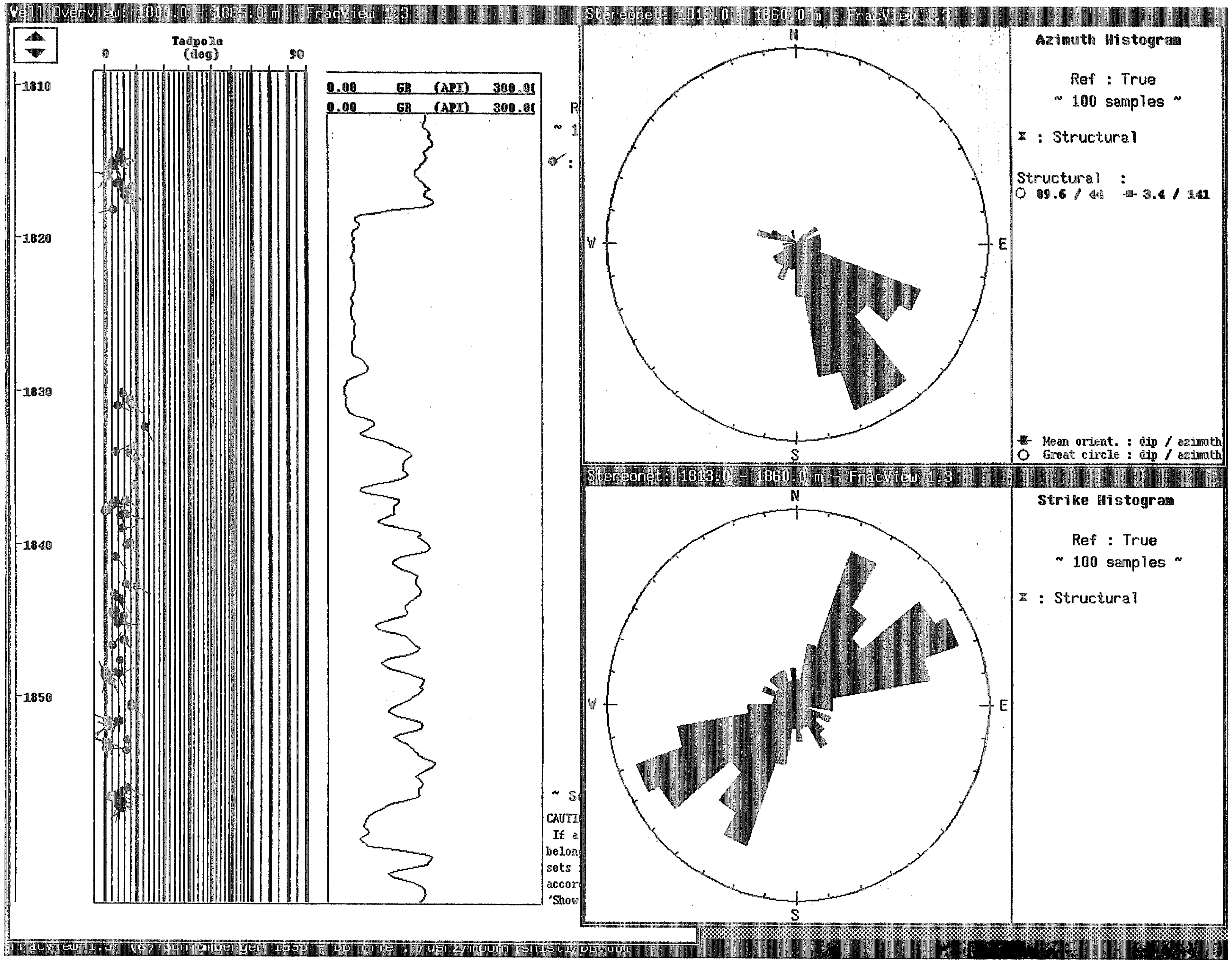

FIGURE 1 Structural Dip 3.4° Azimuth 141° Interval 1813m to 1860m.

PE904261

This is an enclosure indicator page.
The enclosure PE904261 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904261 has the following characteristics:

ITEM_BARCODE =	PE904261
CONTAINER_BARCODE =	PE900991
NAME =	Structural Dip, Figure 2
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 2, for Moonfish-1
REMARKS =	
DATE_CREATED =	30/11/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

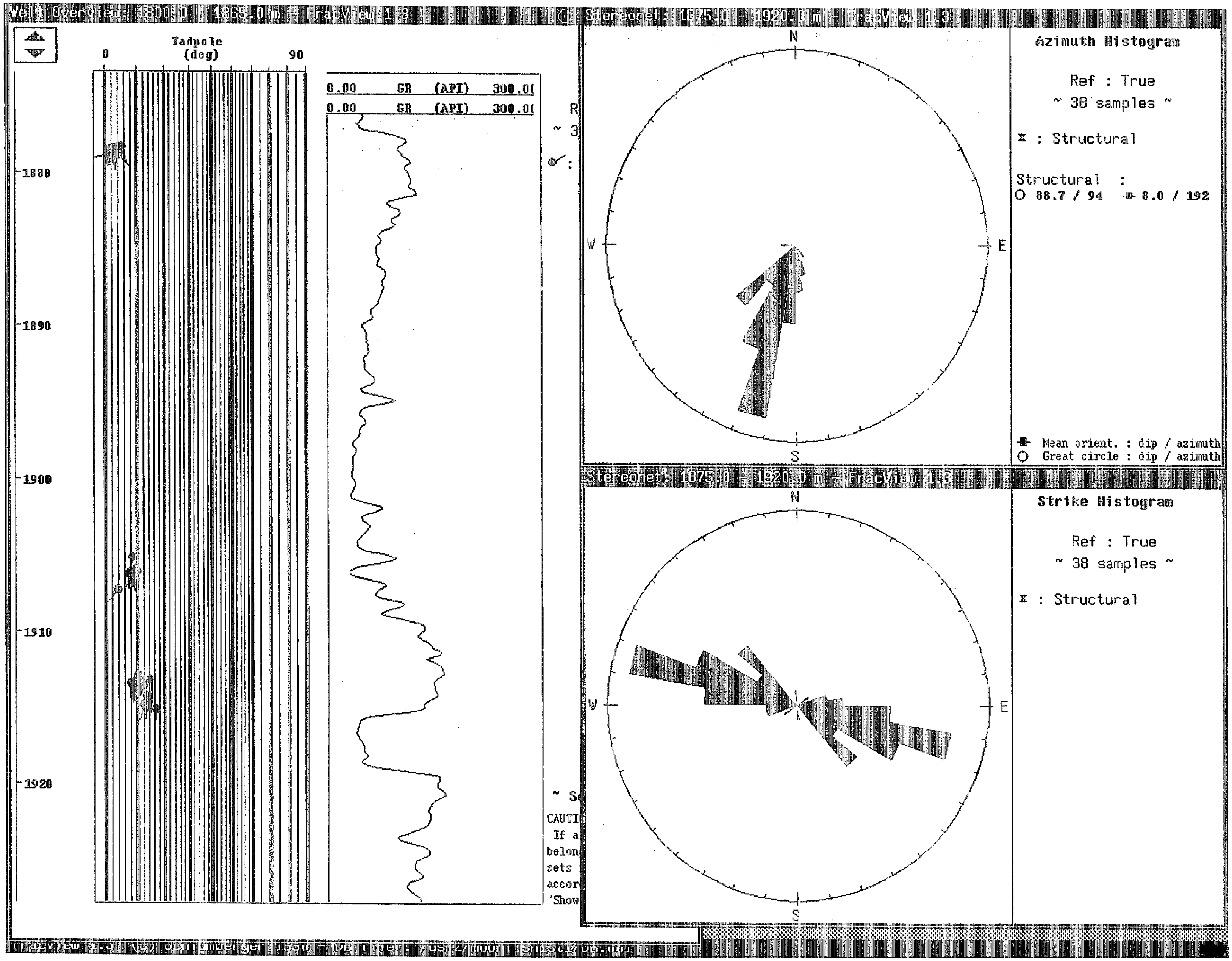

FIGURE 2 Structural Dip 8° Azimuth 192° Interval 1875m to 1920m.

PE904262

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The enclosure PE904262 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904262 has the following characteristics:

ITEM_BARCODE =	PE904262
CONTAINER_BARCODE =	PE900991
NAME =	Structural Dip, Figure 3
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 3, for Moonfish-1
REMARKS =	
DATE_CREATED =	30/11/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

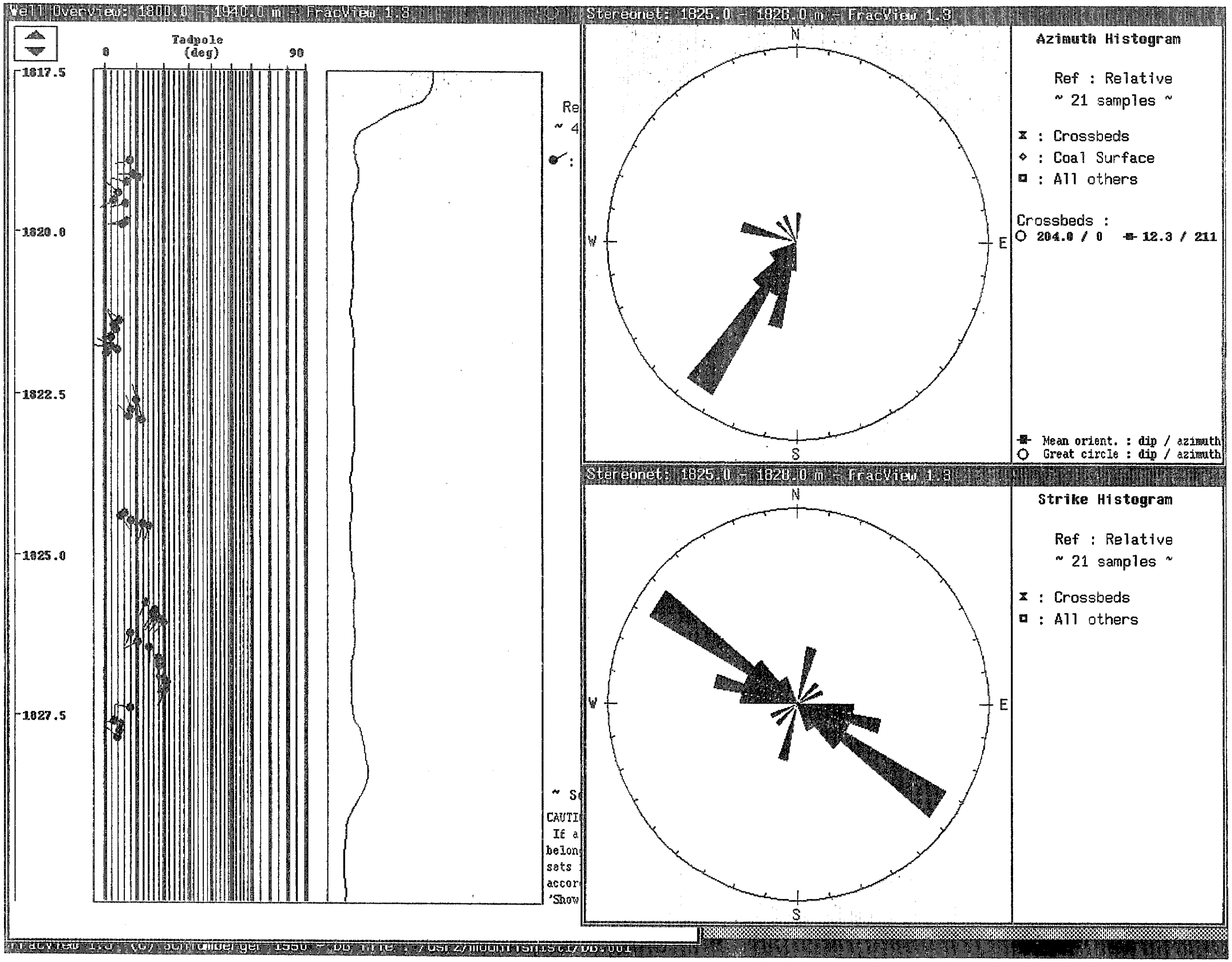

FIGURE 3 Crossbeds Structural Dip Removed SDR Dip Azimuth 211° Interval 1825m to 1828m.

PE904263

This is an enclosure indicator page.
The enclosure PE904263 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904263 has the following characteristics:

ITEM_BARCODE =	PE904263
CONTAINER_BARCODE =	PE900991
NAME =	Structural Dip, Figure 4
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 4, for Moonfish-1
REMARKS =	
DATE_CREATED =	30/11/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

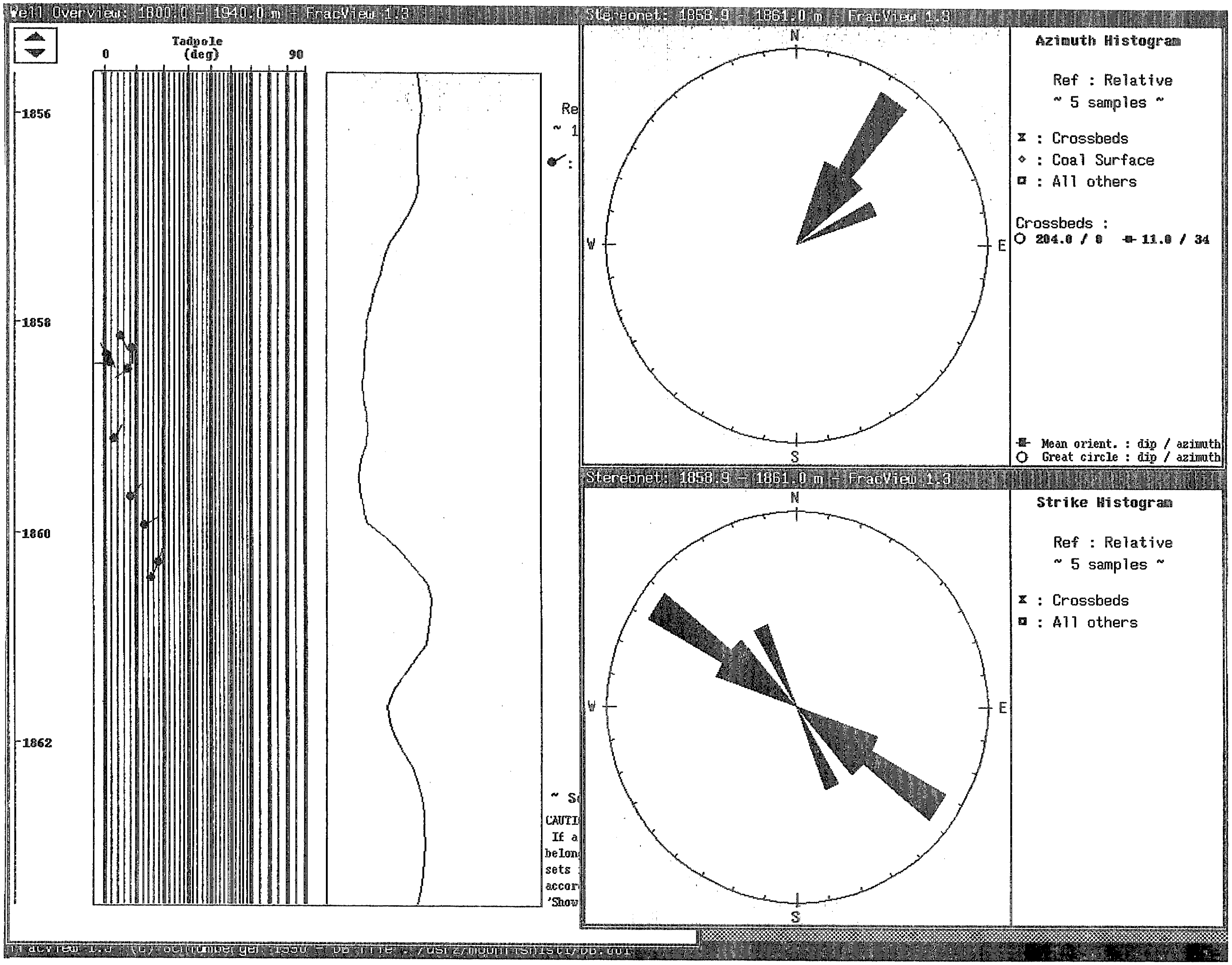

FIGURE 4 Crossbeds SDR Dip Azimuth 34° Interval 1858m to 1860.5m.

PE904264

This is an enclosure indicator page.
The enclosure PE904264 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904264 has the following characteristics:

ITEM_BARCODE = PE904264
CONTAINER_BARCODE = PE900991
NAME = Structural Dip, Figure 5
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Structural Dip Diagram, Figure 15, for Moonfish-1
REMARKS =
DATE_CREATED = 30/11/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

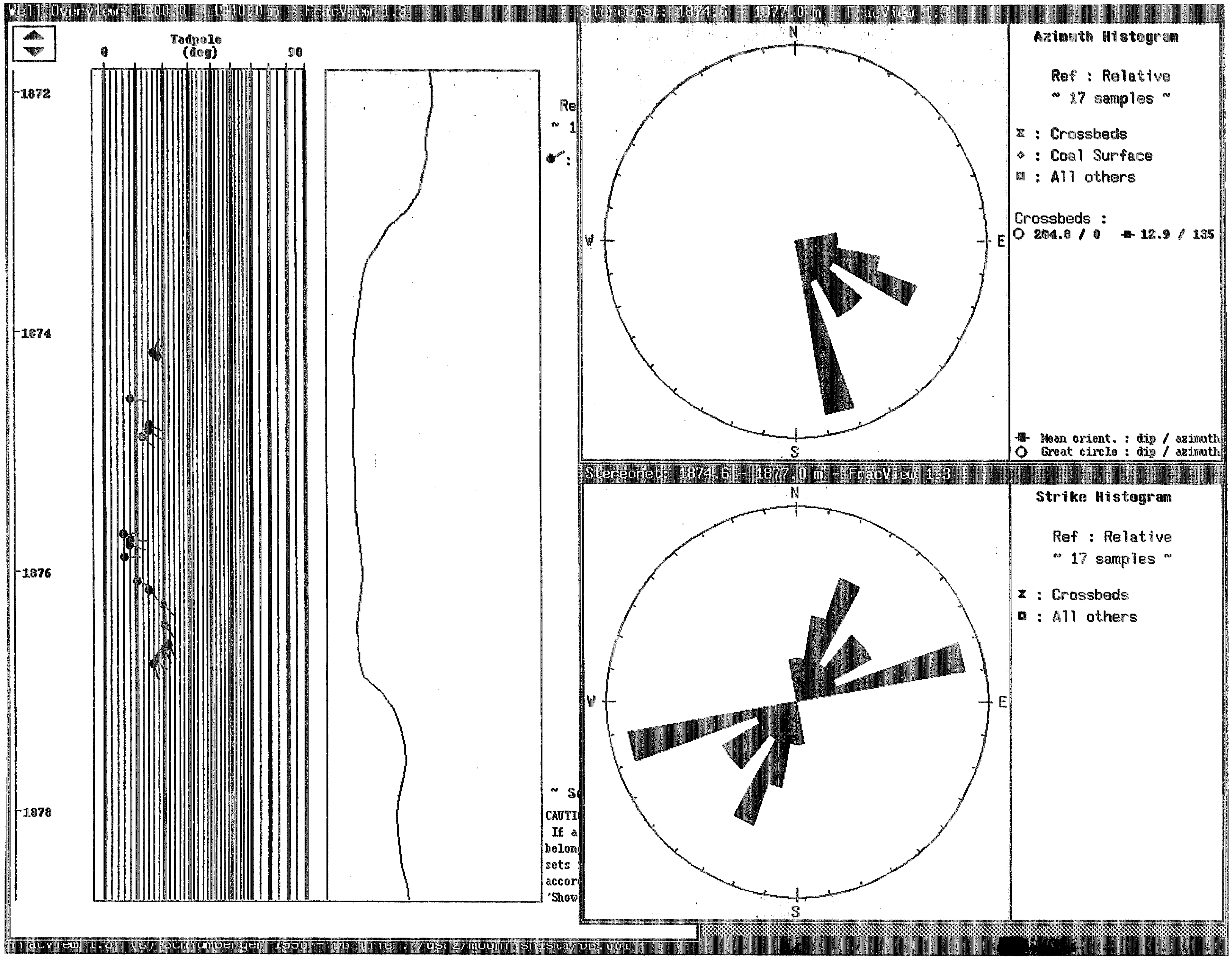

FIGURE 5 Crossbeds SDR Dip Azimuth 135° Interval 1874m to 1877m.

PE904265

This is an enclosure indicator page.
The enclosure PE904265 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904265 has the following characteristics:

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CONTAINER_BARCODE =	PE900991
NAME =	Structural Dip, Figure 6
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 6, for Moonfish-1
REMARKS =	
DATE_CREATED =	30/11/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

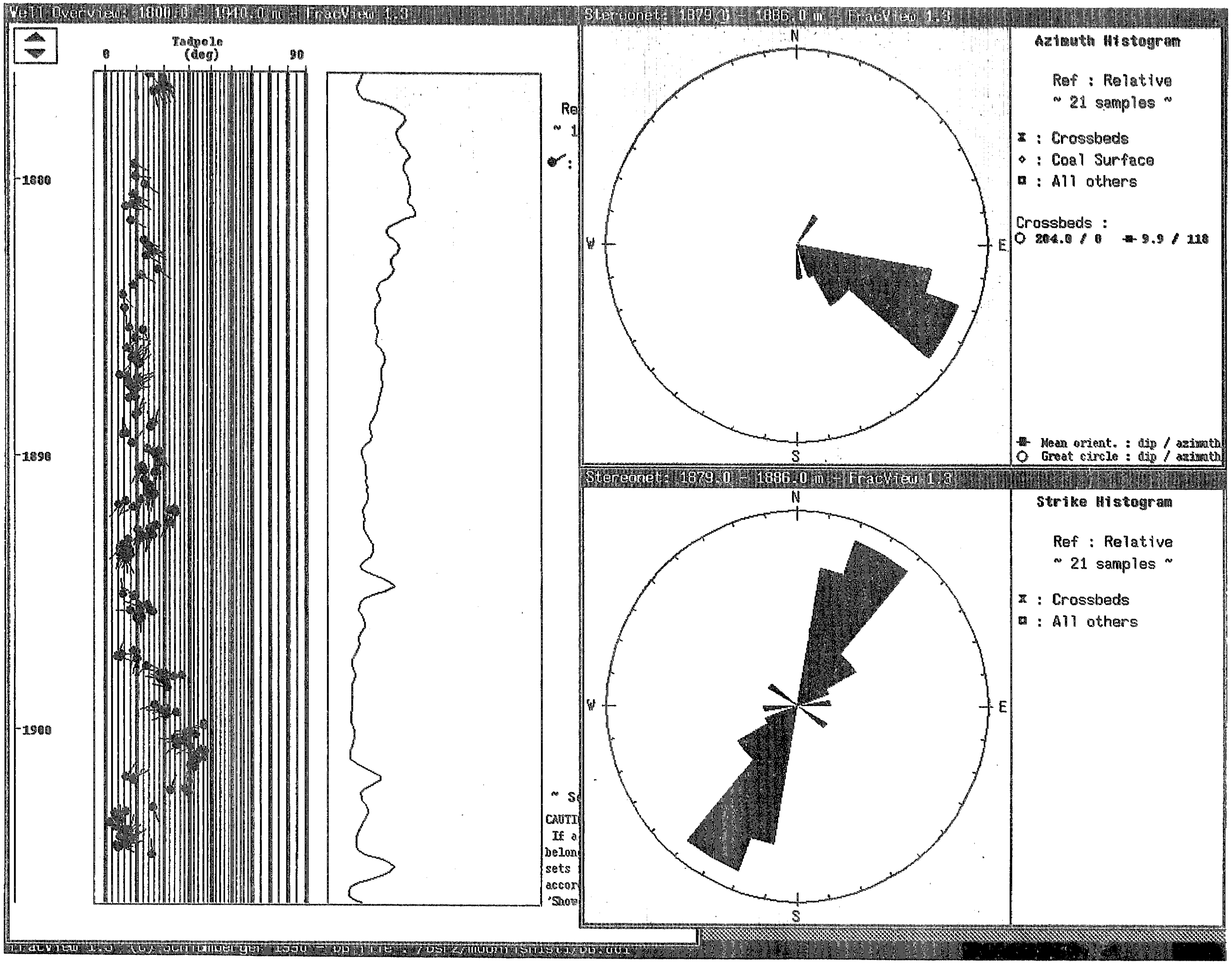

FIGURE 6 Crossbeds SDR Dip Azimuth 118° Interval 1879m to 1886m.

PE904266

This is an enclosure indicator page.
The enclosure PE904266 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904266 has the following characteristics:

ITEM_BARCODE =	PE904266
CONTAINER_BARCODE =	PE900991
NAME =	Structural Dip, Figure 7
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 7, for Moonfish-1
REMARKS =	
DATE_CREATED =	30/11/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

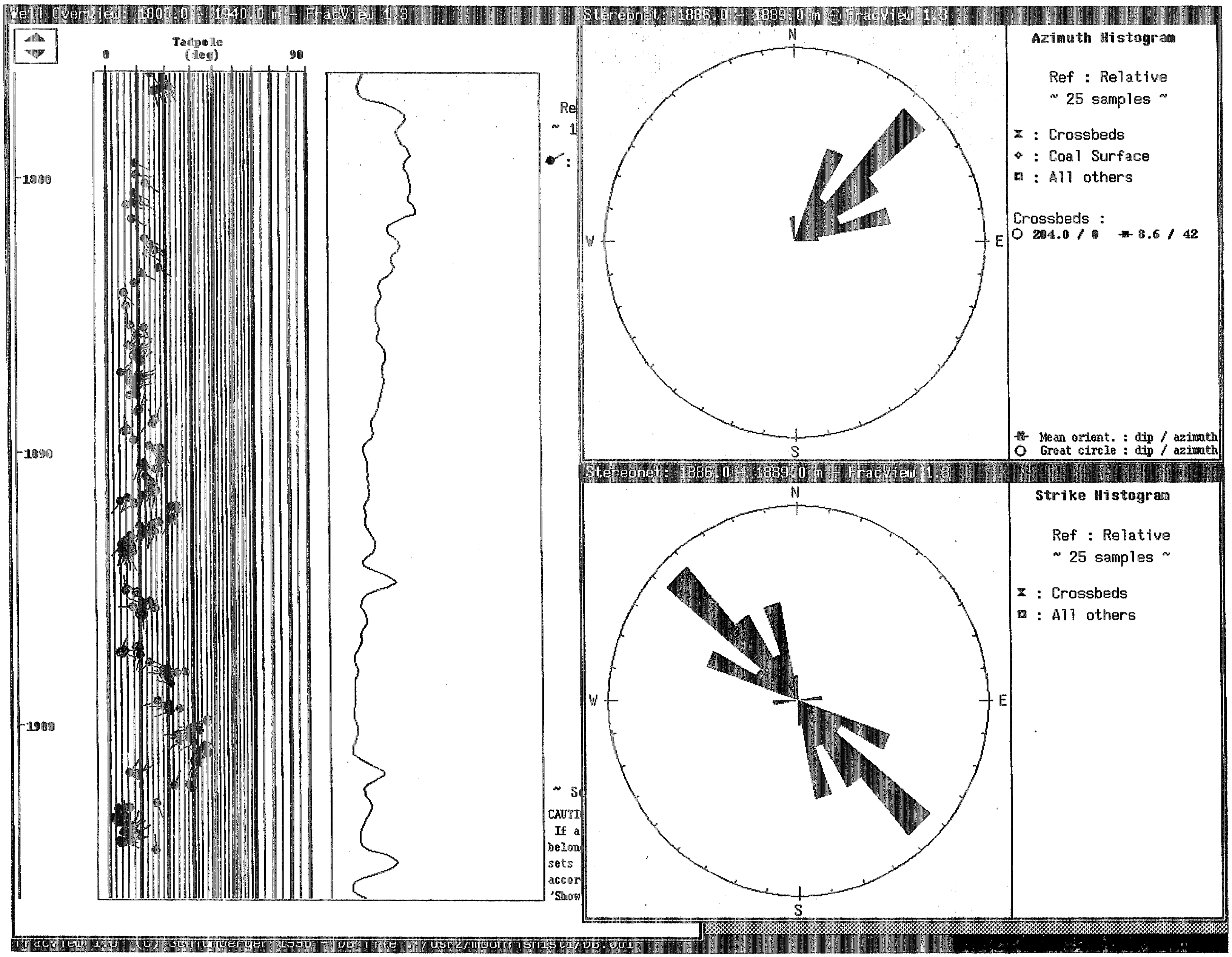

FIGURE 7 Crossbeds SDR Dip Azimuth 42° Interval 1886m to 1889m.

PE904267

This is an enclosure indicator page.
The enclosure PE904267 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904267 has the following characteristics:

ITEM_BARCODE = PE904267
CONTAINER_BARCODE = PE900991
NAME = Structural Dip, Figure 8
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Structural Dip Diagram, Figure 8, for Moonfish-1
REMARKS =
DATE_CREATED = 30/11/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

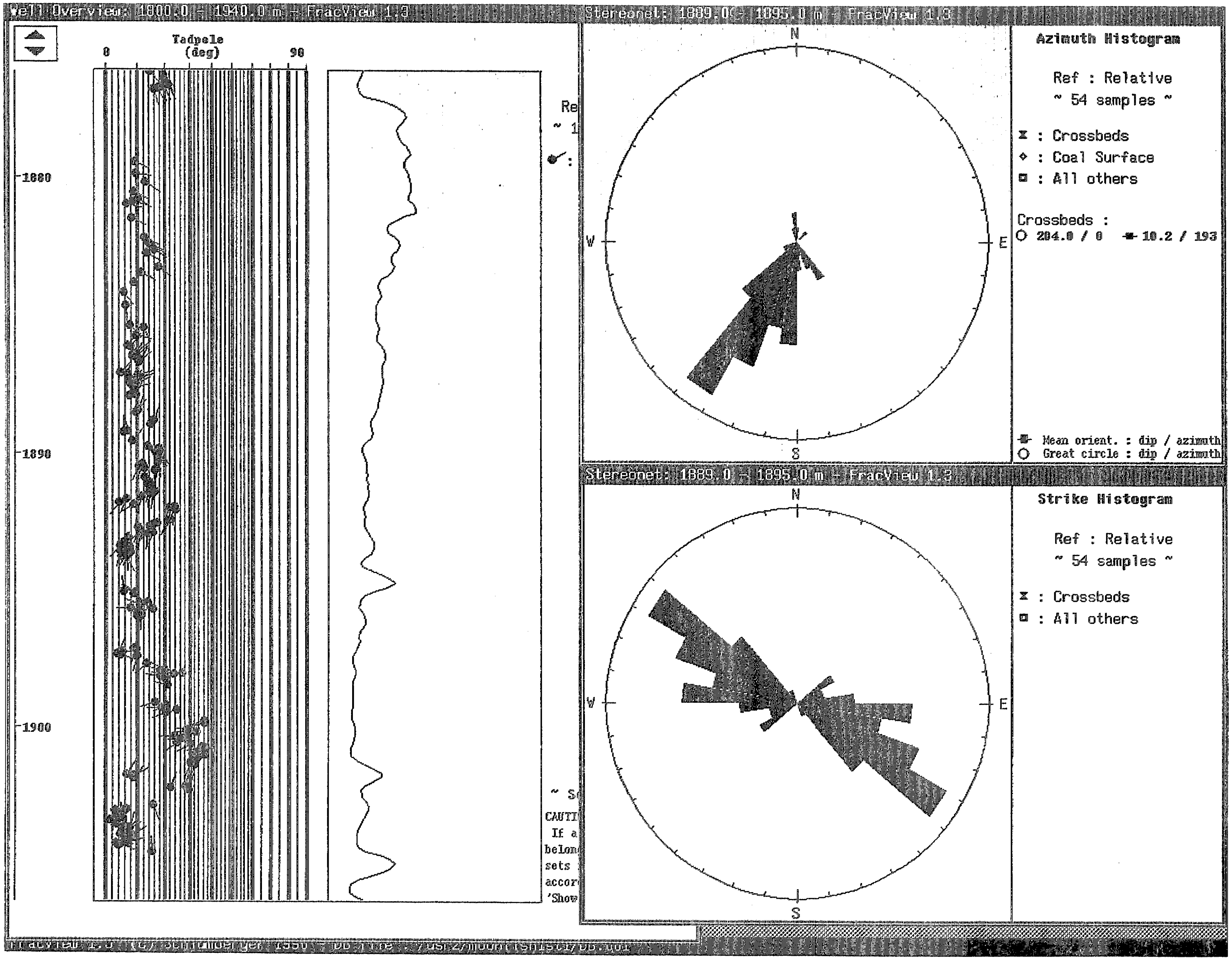

FIGURE 8 Crossbeds SDR Dip Azimuth 193° Interval 1889m to 1895m.

PE904268

This is an enclosure indicator page.
The enclosure PE904268 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904268 has the following characteristics:

ITEM_BARCODE =	PE904268
CONTAINER_BARCODE =	PE900991
NAME =	Structural Dip, Figure 9
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
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DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

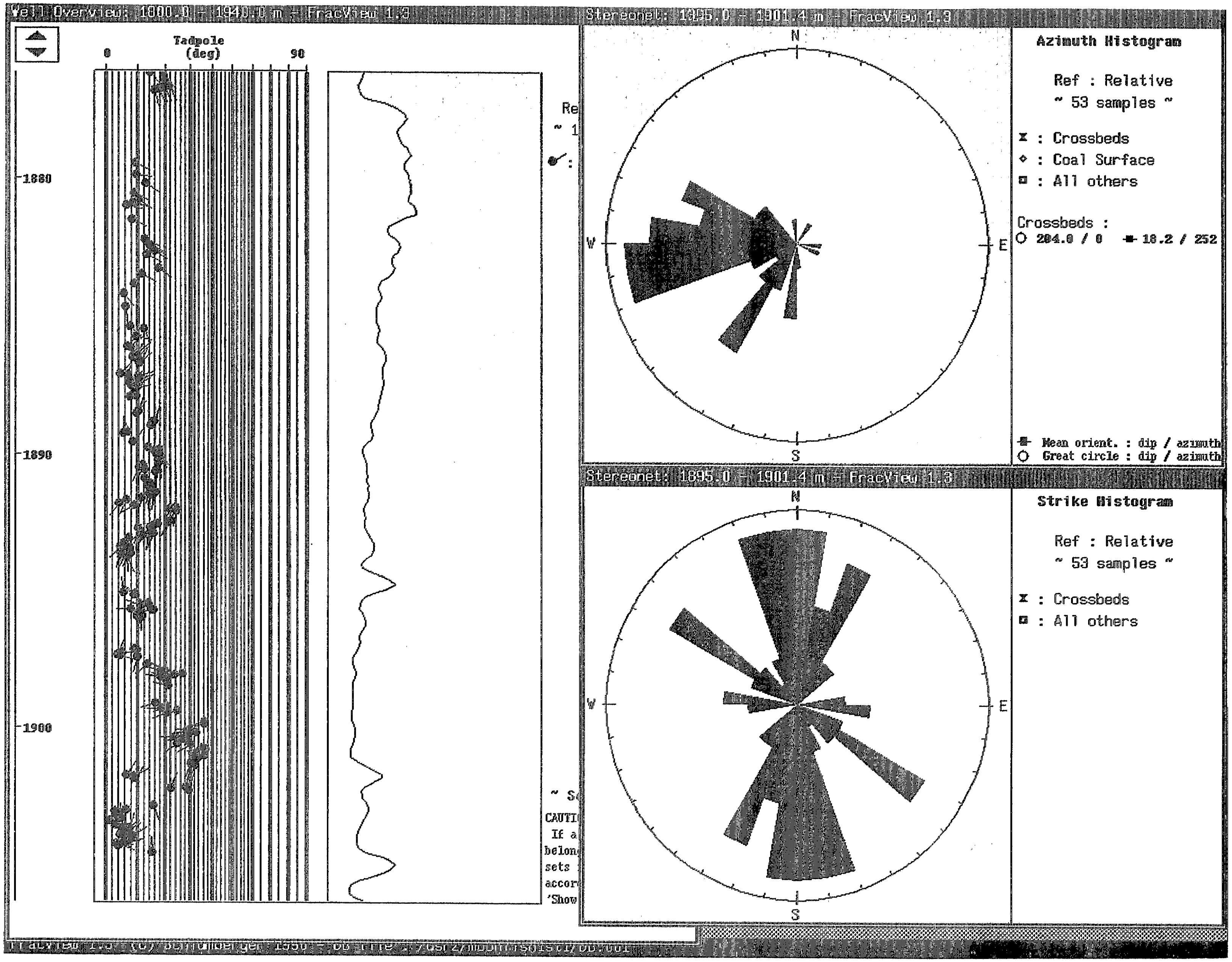

FIGURE 9 Crossbeds SDR Dip Azimuth 252° Interval 1895m to 1901.5m.

PE904269

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PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 10, for Moonfish-1
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DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

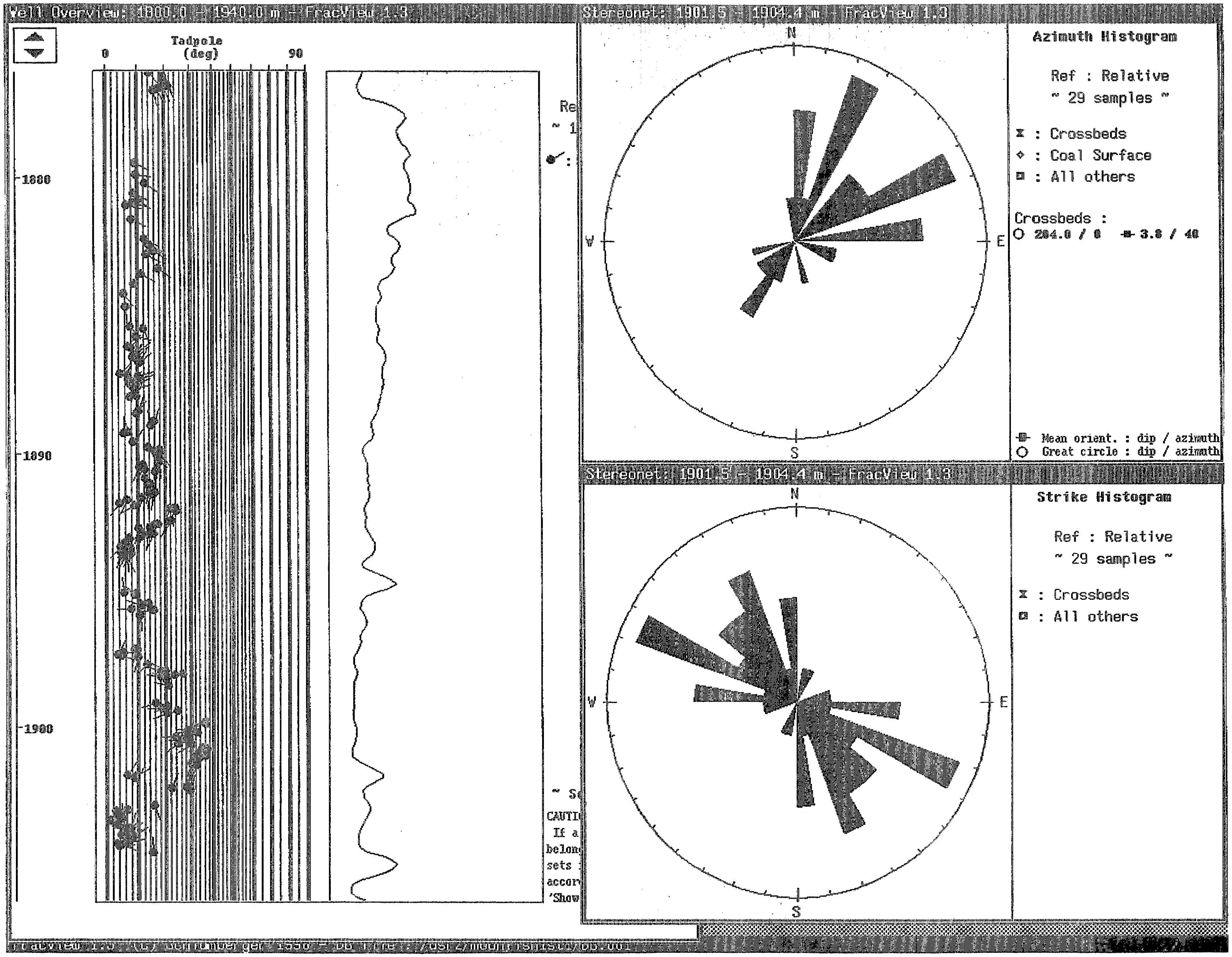

FIGURE 10 Crossbeds SDR Dip Azimuth 40° Interval 1901.5m to 1904.4m.

PE904270

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PERMIT =	VIC/L10
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DATE_RECEIVED =	23/03/1993
W_NO =	W1064
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CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

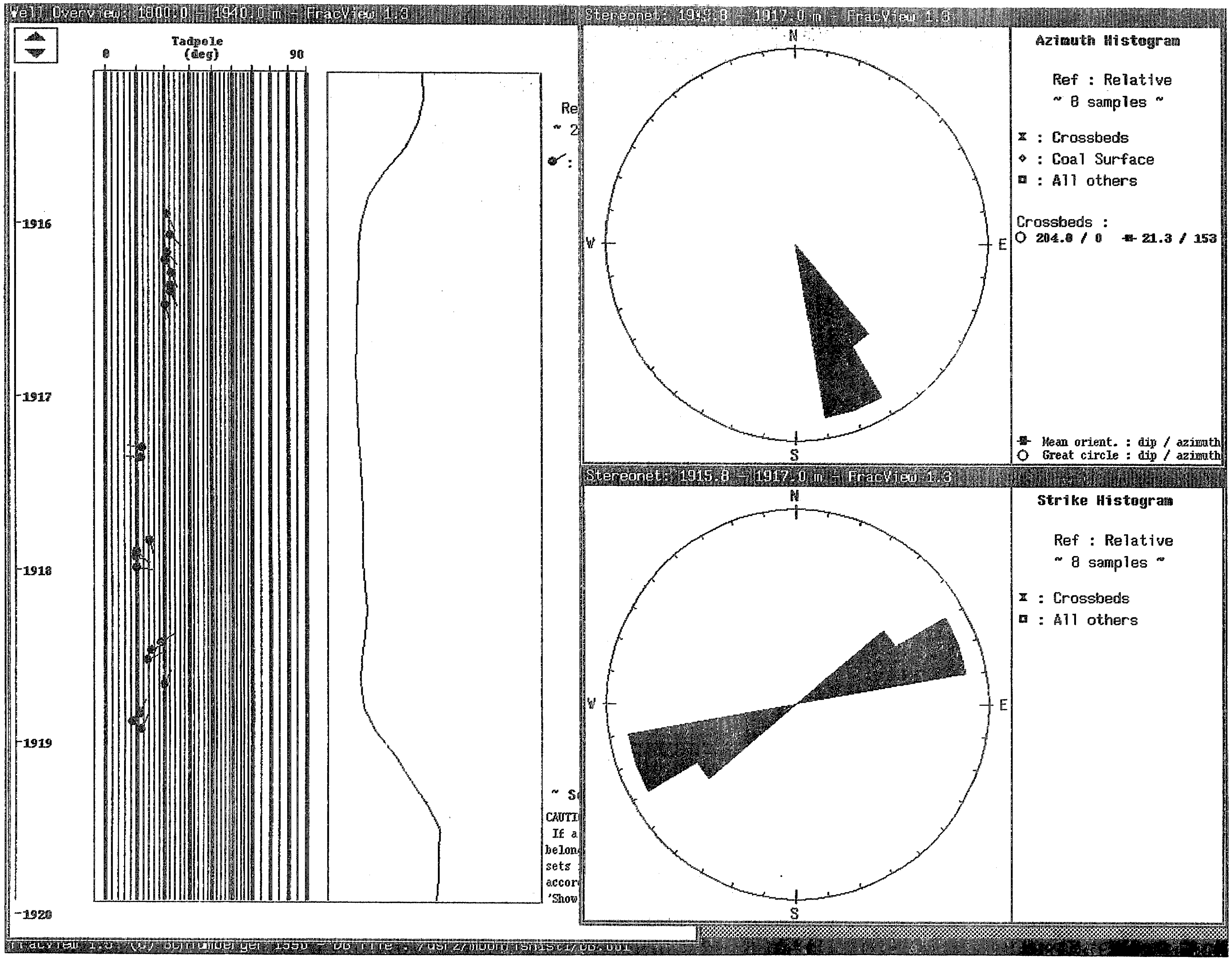

FIGURE 11 Crossbeds SDR Dip Azimuth 153° Interval 1915.8m to 1917m.

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PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Structural Dip Diagram, Figure 12, for Moonfish-1
REMARKS =
DATE_CREATED = 30/11/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

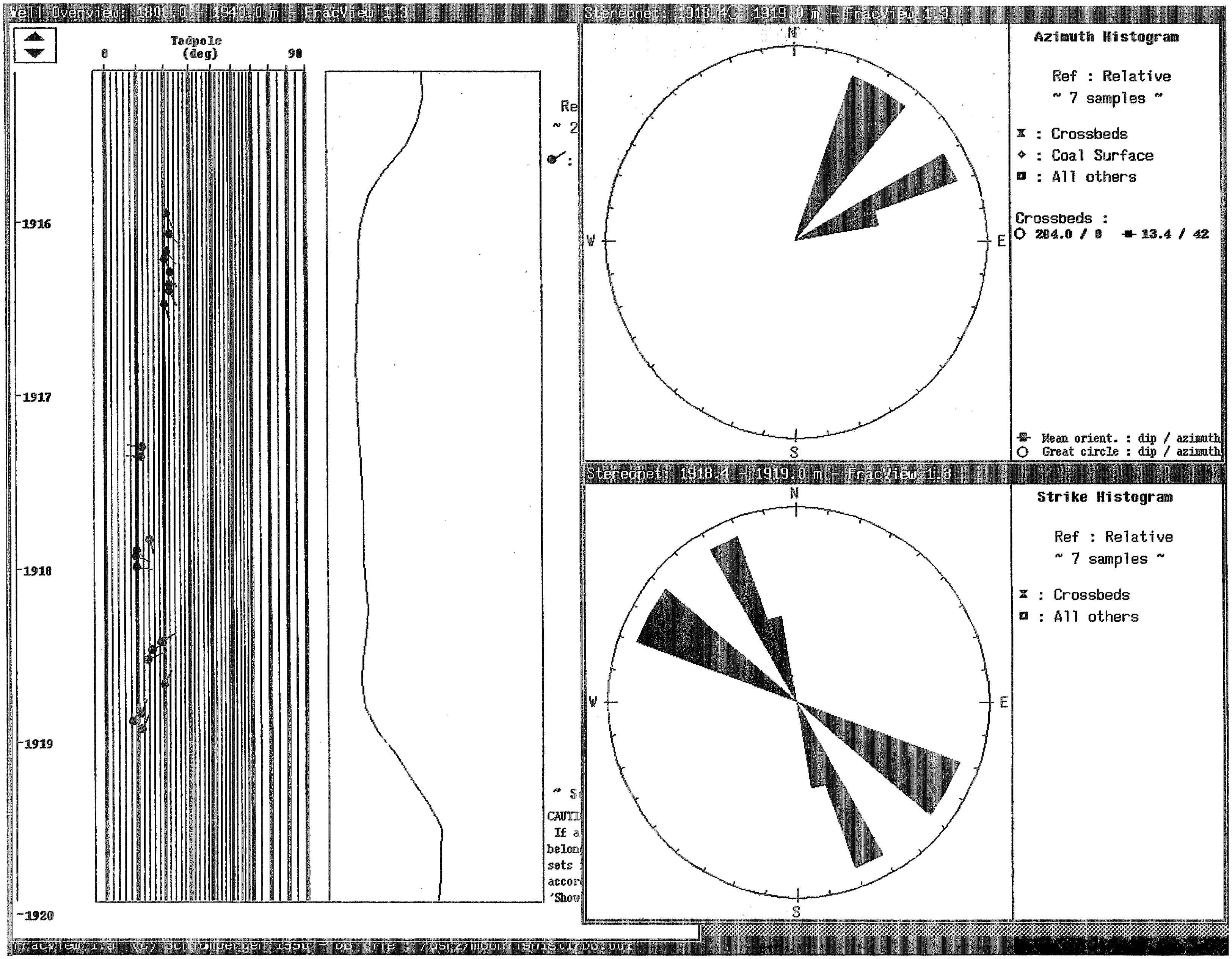

FIGURE 12 Crossbeds SDR Dip Azimuth 42° Interval 1918.4m to 1919m.

PE904272

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BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 13, for Moonfish-1
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DATE_CREATED =	30/11/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

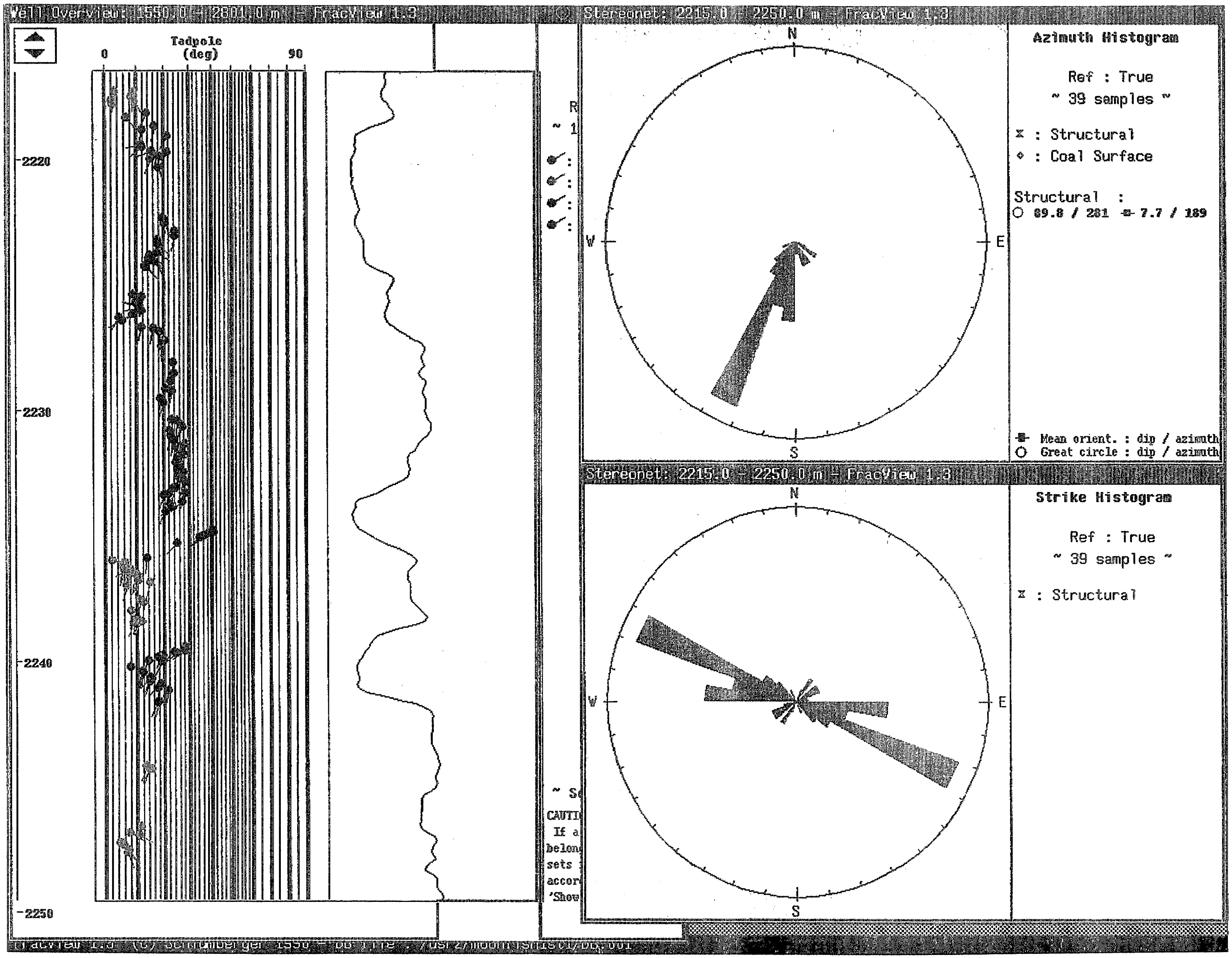

FIGURE 13 Structural Dip 7.7° Azimuth 189° Interval 2215m to 2250m.

PE904273

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CONTAINER_BARCODE =	PE900991
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BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 14, for Moonfish-1
REMARKS =	
DATE_CREATED =	30/11/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

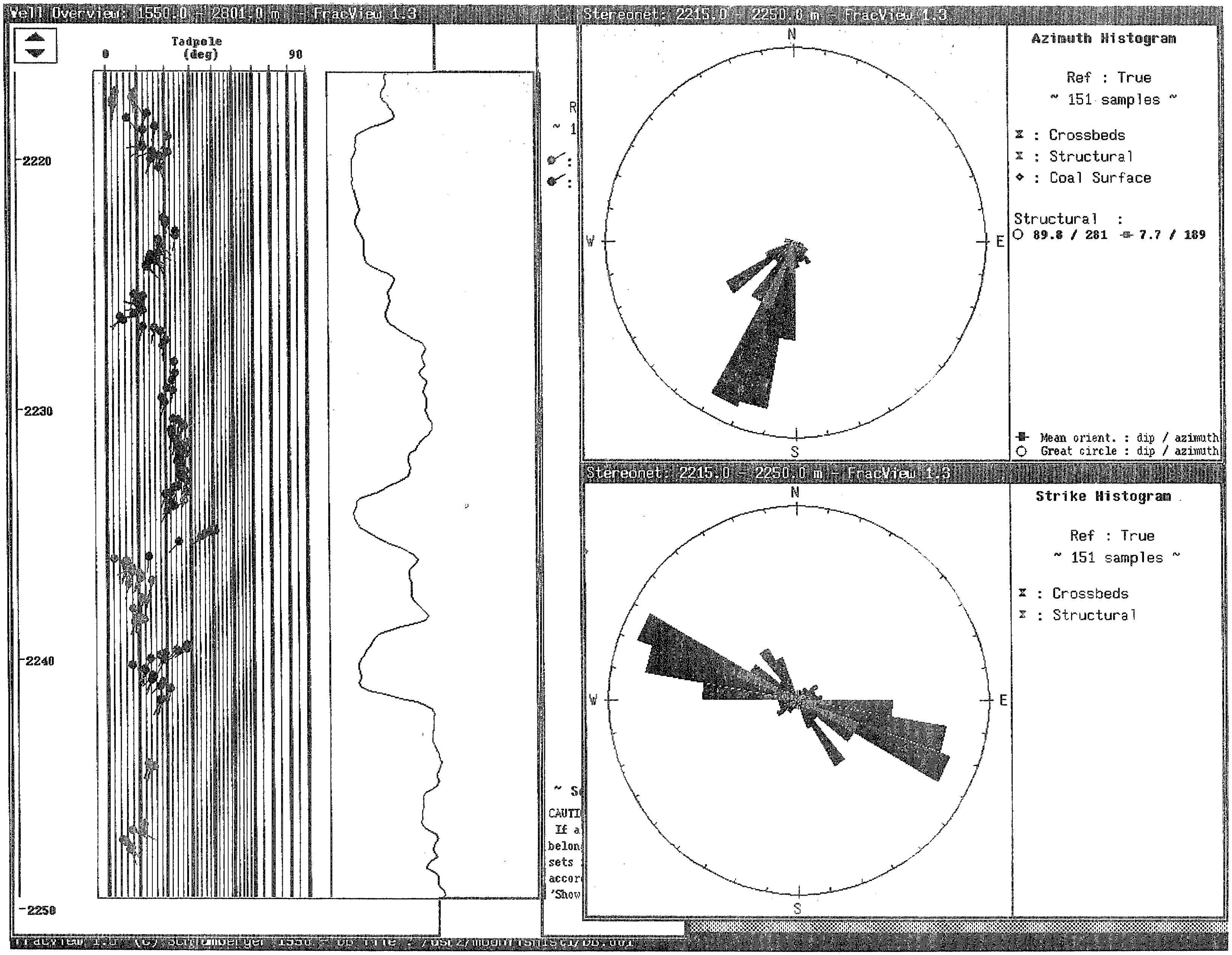

FIGURE 14 Sub-Volcanic FMS Interpretation Overview of Structural and Stratigraphic Components.

PE904274

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BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Structural Dip Diagram, Figure 15, for Moonfish-1
REMARKS =
DATE_CREATED = 30/11/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

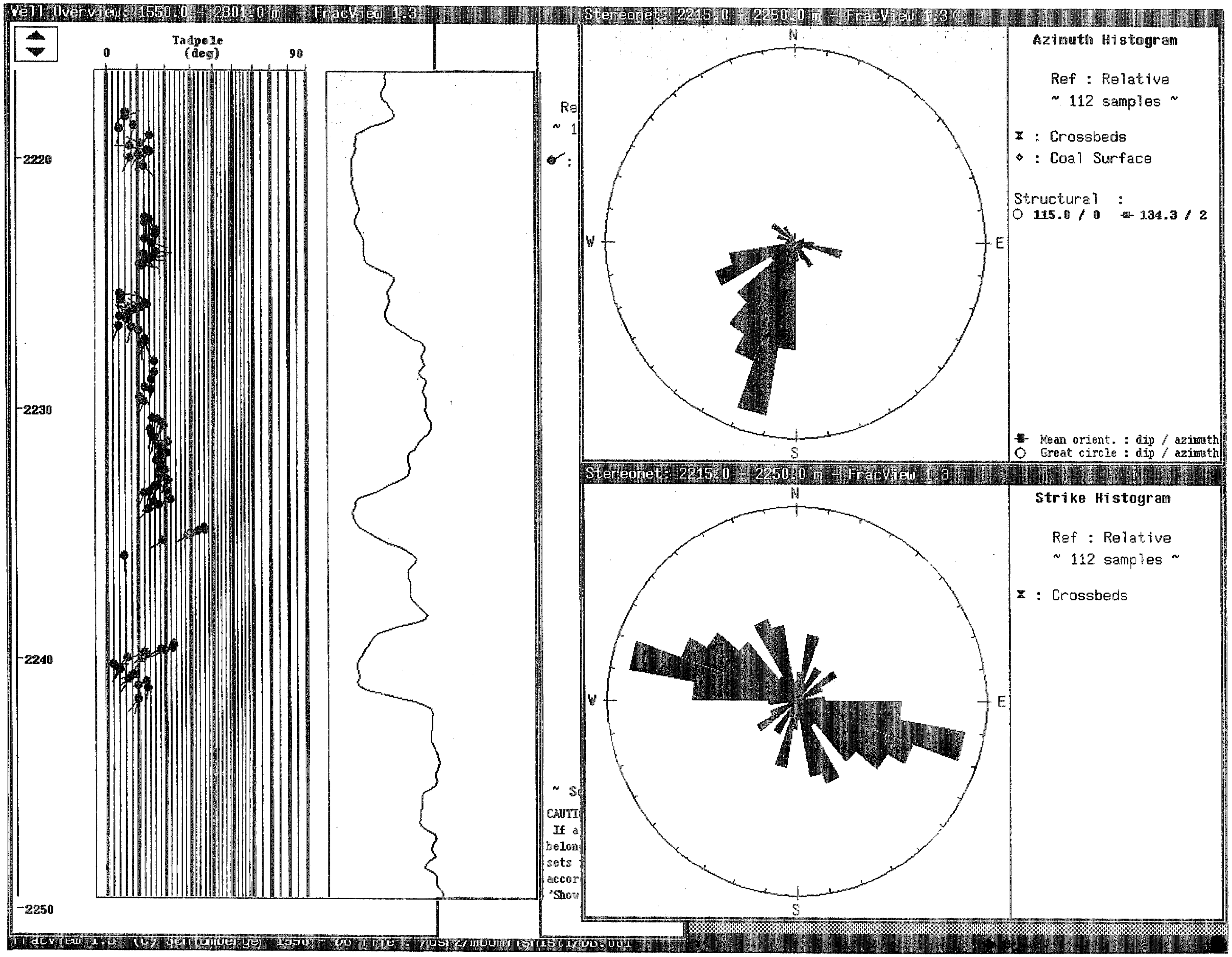

FIGURE 15 Overview of Crossbedding with Stuctural Dip Removed Interval 2215m to 2250m.

PE904275

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BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Structural Dip Diagram, Figure 16, for Moonfish-1
REMARKS =
DATE_CREATED = 30/11/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

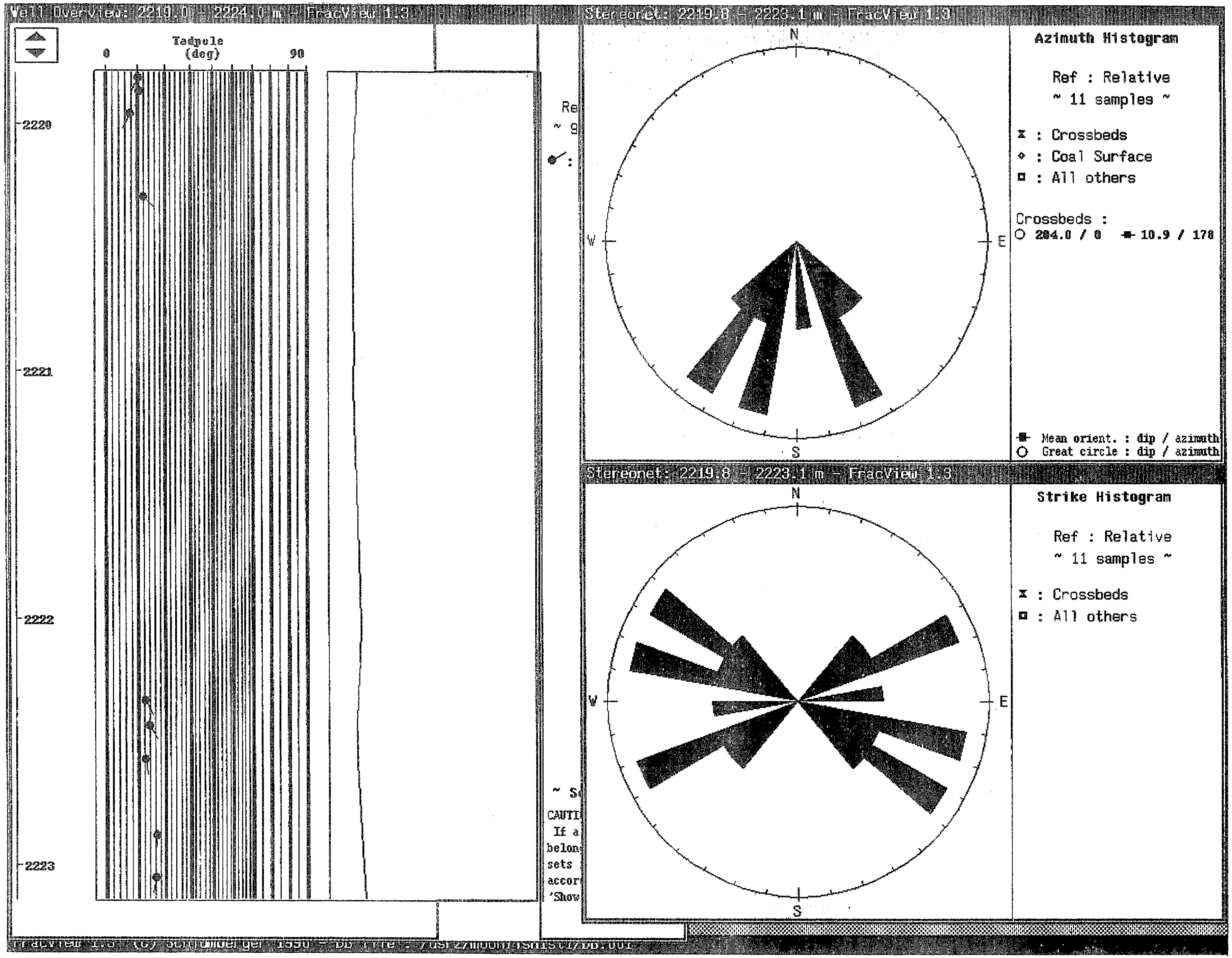

FIGURE 16 Crossbeds SDR Dip Azimuth 178° Interval 2219m to 2224m.

PE904276

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BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Structural Dip Diagram, Figure 17, for Moonfish-1
REMARKS =
DATE_CREATED = 30/11/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

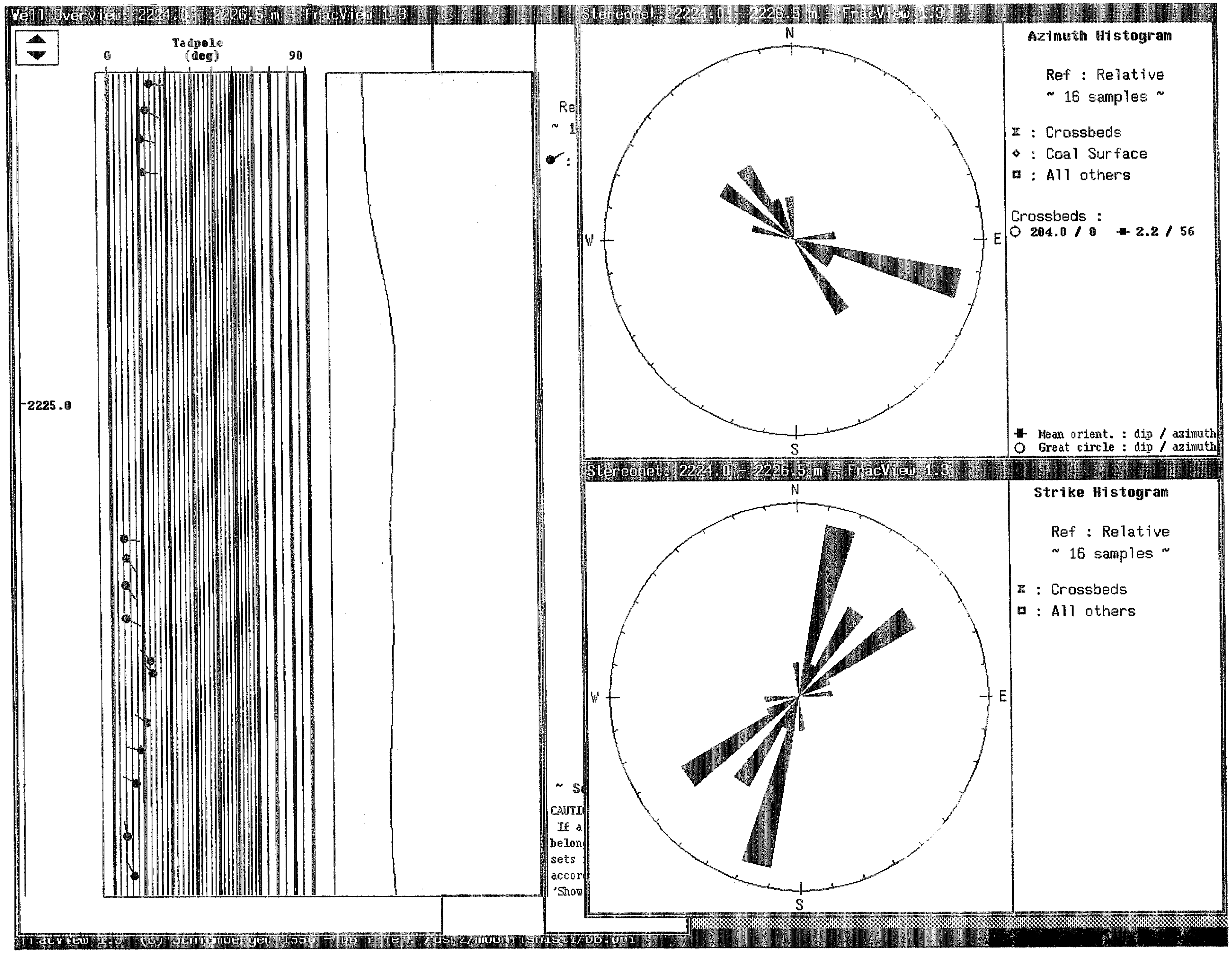

FIGURE 17 Crossbeds SDR Dip Azimuth 56° Interval 2224m to 2226.5m.

PE904277

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           PERMIT = VIC/L10
             TYPE = WELL
          SUBTYPE = DIAGRAM
      DESCRIPTION = Structural Dip Diagram, Figure 18, for
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          REMARKS =
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    DATE_RECEIVED = 23/03/1993
             W_NO = W1064
        WELL_NAME = MOONFISH-1
       CONTRACTOR =
     CLIENT_OP_CO = ESSO AUSTRALIA LIMITED
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(Inserted by DNRE - Vic Govt Mines Dept)

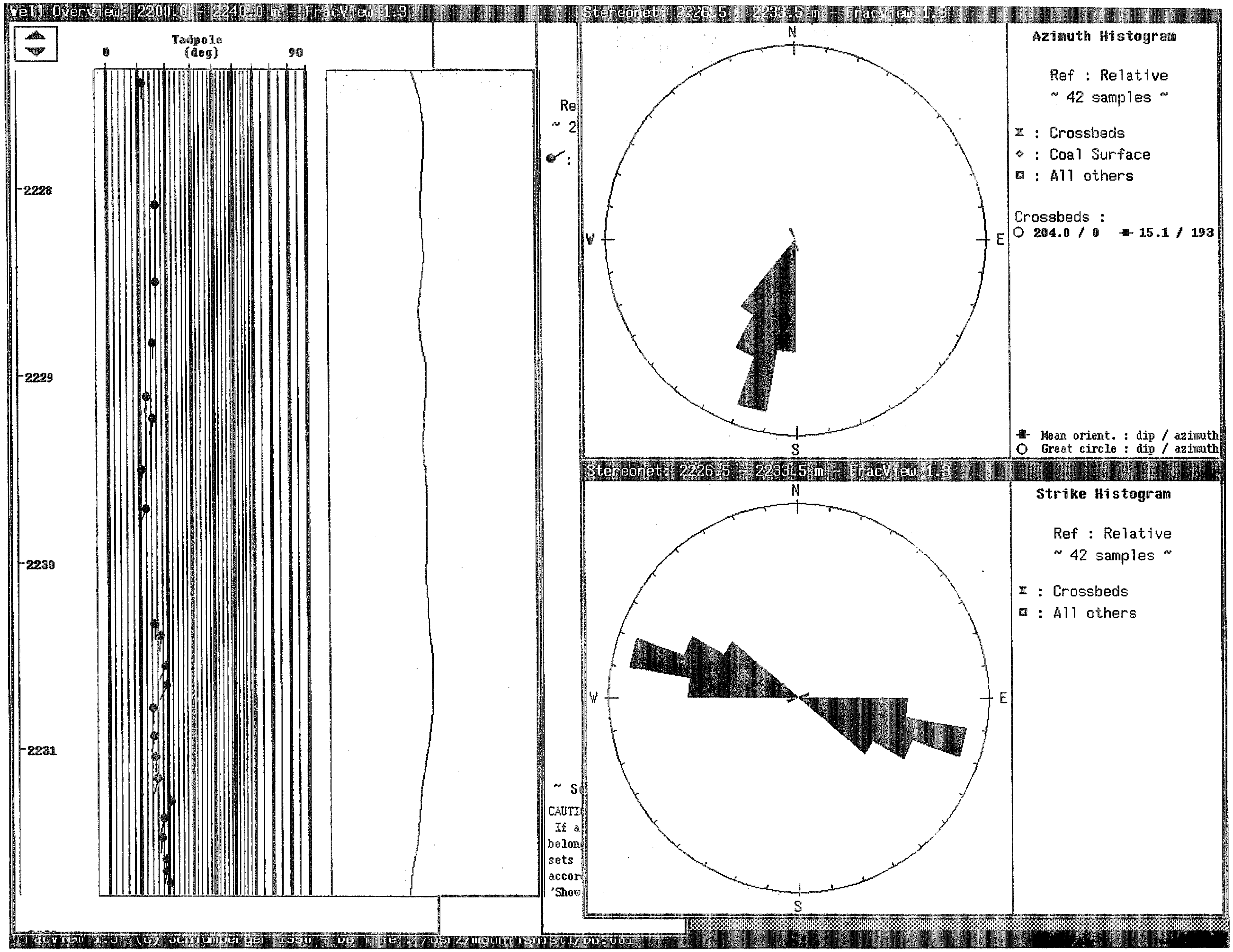

FIGURE 18 Crossbeds SDR DIP Azimuth 193° Interval 2226.5m to 2233.5m.

PE904278

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BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = DIAGRAM
DESCRIPTION = Structural Dip Diagram, Figure 19, for Moonfish-1
REMARKS =
DATE_CREATED = 30/11/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

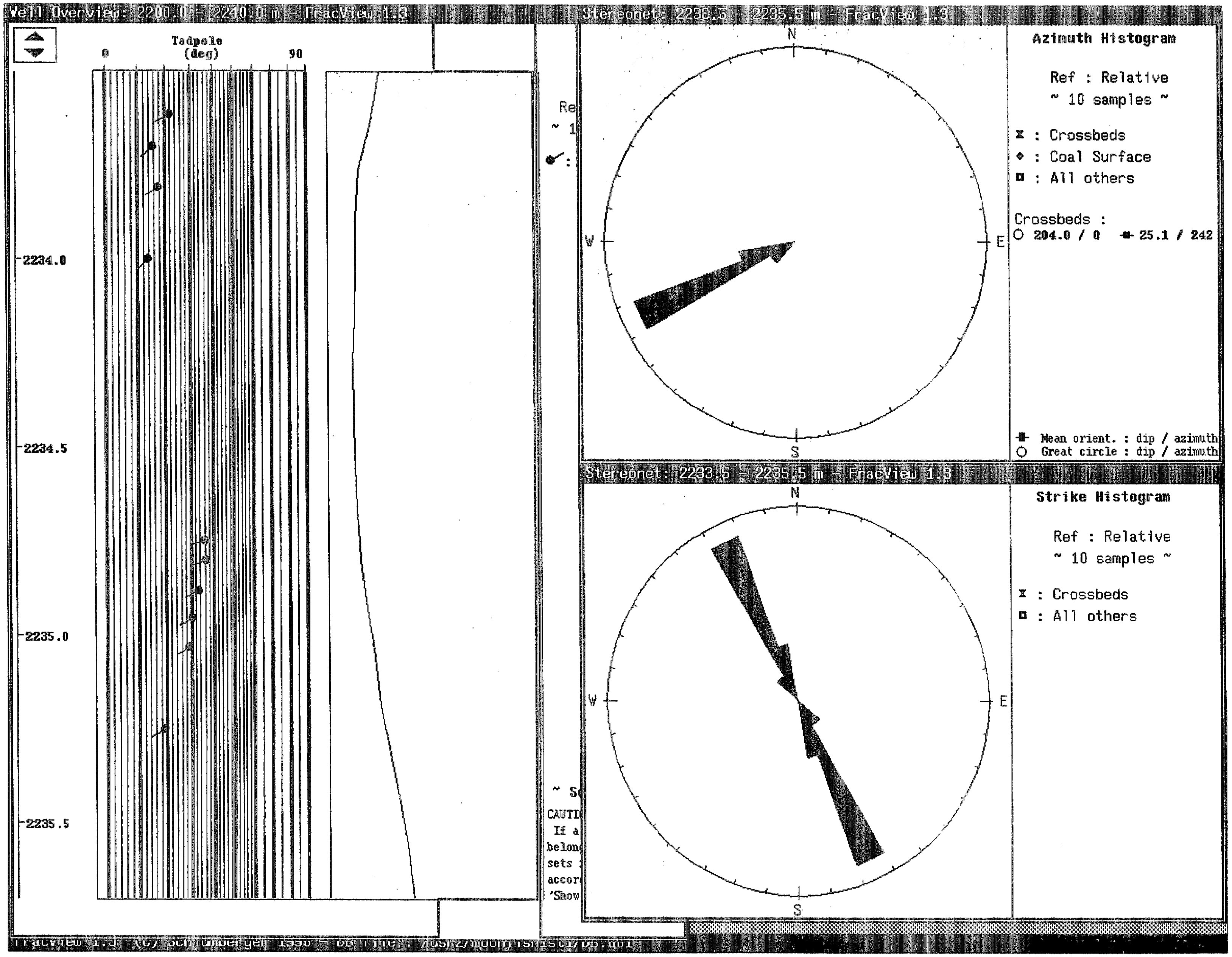

FIGURE 19 Crossbeds SDR Dip Azimuth 242° Interval 2233.5m to 2235.5m.

PE904279

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BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	DIAGRAM
DESCRIPTION =	Structural Dip Diagram, Figure 20, for Moonfish-1
REMARKS =	
DATE_CREATED =	30/11/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

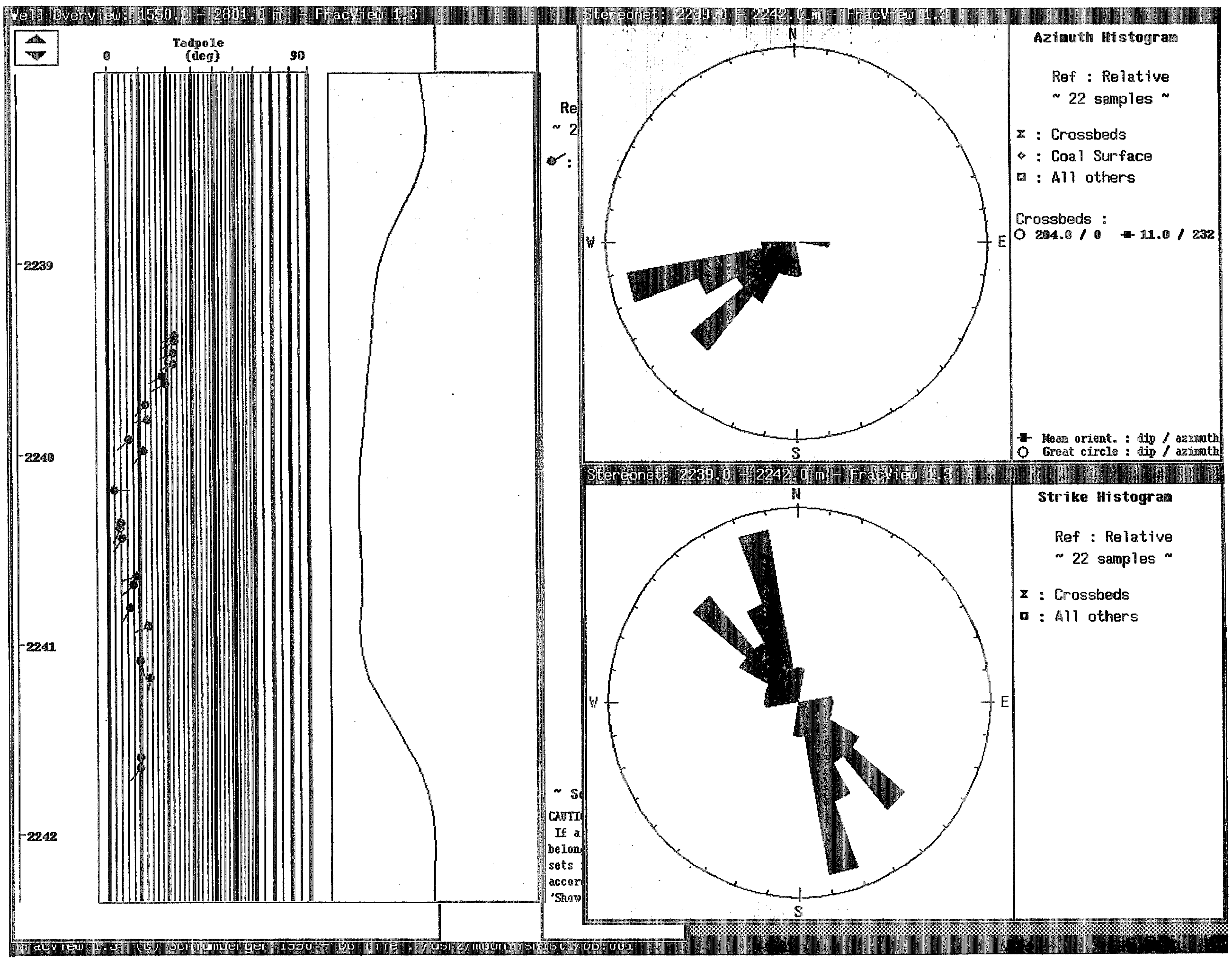

FIGURE 20 Crossbeds SDR Dip Azimuth 232° Interval 2239m to 2242m.

PE600815

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The enclosure PE600815 has the following characteristics:

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BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = WELL_LOG
DESCRIPTION = FMS Image Interpretation (enclosure from appendix 3 of WCR vol.2) for Moonfish 1 & st1
REMARKS =
DATE_CREATED = 25/08/1992
DATE_RECEIVED = 23/03/1993
W_NO = W1065
WELL_NAME = Moonfish-1
CONTRACTOR = SCHLUMBERGER
CLIENT_OP_CO = ESSO

(Inserted by DNRE - Vic Govt Mines Dept)

PE604655

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BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = WELL_LOG
DESCRIPTION = CPI Quantitative Log, 1 of 3, for Moonfish-ST1
REMARKS =
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DATE_RECEIVED =
W_NO = W1065
WELL_NAME = MOONFISH-ST1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE604656

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BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	WELL_LOG
DESCRIPTION =	CPI Quantitative Log, 2 of 3, for Moonfish-ST1
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DATE_CREATED =	15/12/1992
DATE_RECEIVED =	
W_NO =	W1065
WELL_NAME =	MOONFISH-ST1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE604657

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BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = WELL_LOG
DESCRIPTION = CPI Quantitative Log, 3 of 3, for Moonfish-1
REMARKS =
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DATE_RECEIVED =
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE605010

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           PERMIT = VIC/L10
             TYPE = WELL
          SUBTYPE = WELL_LOG
      DESCRIPTION = CPI Quantitative Log,
                    (enclosure from appendix 3 of WCR
                    vol.2)for Moonfish-ST1
          REMARKS =
     DATE_CREATED = 10/12/92
    DATE_RECEIVED =
             W_NO = W1064
        WELL_NAME = MOONFISH-1
       CONTRACTOR = SOLAR
     CLIENT_OP_CO = ESSO AUSTRALIA LIMITED
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APPENDIX 4

APPENDIX 4

APPENDIX 4

FINAL WELL REPORT

BLOCK VIC/L10

MOONFISH-1 AND MOONFISH-1ST

RFT AND FLUID ANALYSIS

MAY/JUNE/JULY 1992

PREPARED BY: MIKE SCOTT, RESERVOIR TECHNOLOGY

Introduction

This memorandum summarises the interpretation of the RFT data obtained in the Moonfish-1 well and its sidetrack and details the results of the fluid analysis which was carried out on three preserved samples taken during the program.

Moonfish-1 was drilled in Block Vic L/10 approximately 5km north of the Snapper gas field in 53m of water and was spudded on Monday 11th May 1992 by the Falcon semi-submersible exploration rig. Following a successful inclined drilling program to a TD of 3054m a number of hydrocarbon bearing zones were discovered within the intra-latrobe geological section. These zones were logged, a suite of RFT measurements were carried out and samples taken to more fully evaluate the discovery. After evaluating Moonfish-1, a sidetrack well was drilled to test for a possible larger accumulation on the North-West side of a major fault which had been intersected by Moonfish-1. The sidetrack well, drilled to a TD of 2803m, did not discover a larger accumulation. However, it did successfully prove the areal extent of the accumulations that had been already encountered. Further RFT and log measurements were made in the sidetrack before the well was finally plugged and abandoned on Monday 20th July 1992.

Summary

The logging program in Moonfish-1 and the Moonfish-1ST identified 11 main hydrocarbon bearing zones. These zones were evaluated via 115 RFT pressure tests (Table 1), 15 individual unpreserved fluid samples (Table 2) and 3 preserved oil samples (Table 3). The RFT pressure test quality varies greatly and makes the interpretation of some zones very difficult and questionable.

Although there are several potential production zones only one oil zone, the M-2, should be considered as the main Moonfish accumulation. This zone lies at approximately 1720 m TVDSS and contains a low GOR, high pour point waxy crude. Data pertaining to this sample is summarised in Table 2 (M-2 Oil), Table 3 (Sample: S1/2) and Figure 4.

Other oil zones sampled throughout the program also contained very similar low GOR, high pour point waxy crudes and gas. However, the RFT data quality from the majority of these zones were very poor possibly indicating poorer rock quality.

The aquifer pressure throughout the section is as expected with approximately 50 psi drawdown as compared to the original Gippsland aquifer in 1968. There does appear to be however a pressure discontinuity around 1850 m TVDSS. Below this depth the aquifer gradient is about 12 psi higher than the overlying section.

Well Survey Data

There appears to be a TVDSS discrepancy between the Moonfish-1 and the Moonfish-1ST wells. In the N-1.9 Gas accumulation, the GWC in Moonfish-1 is at 1674.3m TVDSS. This contact appears in the sidetrack well 6m deeper at 1680.7m TVDSS. Similarly, in the Sub-Volcanic Oil accumulation, the OWC appears in the Moonfish-1 well at 2043.4 m TVDSS and the same contact appears 8m deeper in the sidetrack well at 2051.4m TVDSS.

It is unknown whether the original or sidetrack well TVDSS depths are erroneous. In this evaluation the TVDSS measurements in the original well have been assumed to be correct and the adjustments have been made on the sidetrack.

All TVDSS measurements reported for the sidetrack well in this memorandum are adjusted depths.

The following equation, using simple trigonometry, gives the adjusted TVDSS measurement for the sidetracked well:

$$TVD_{adjusted} = TVD_{unadjusted} - [((TVD_{unadjusted} - 1680.7)/ 185.35) + 6]$$

NB: $TVD_{unadjusted}$ is positive

RFT Analysis

RFT pressure tests were taken in the 11 hydrocarbon bearing zones and associated aquifer over a true vertical depth interval of 1000m and are detailed in Table 2 and Figure 1.

Many of the RFT pressure tests are unsuitable for analysis because they do not exhibit classical RFT type responses. This may be due to supercharging, dynamic supercharging, tight formations or malfunctioning gauges. However, all the data has been included in the analysis and plots because they aid in reflecting the variability of the accumulation potential via the quality of the data. Additionally, there is serious concern over the validity of the sidetrack data as the HP and strain gauge pressure vary by as much as 8 psi on any single test. Although the reasons for this are currently undetermined it is thought that the strain gauges used in the sidetrack well were incorrectly calibrated.

The results of the RFT interpretations are reported in Table 2 and graphically illustrated in Figures 2 to 8.

In general all the zones were difficult to interpret. Many zones do not have clearly defined fluid gradients due to the poor pressure data and due to the similarity in water and oil gradients the fluid contacts were very difficult to clearly define.

Due to the number of hydrocarbon zones encountered and the total measured length of the logging suites, the logs for the Moonfish-1 and the Moonfish-1ST wells, demonstrating the hydrocarbon zones and RFT pressure test depths, have not been attached to this memorandum. The reader is advised to consult the final well and log analysis reports if additional information is required.

The following page details the RFT interpretation for each of the accumulations:

1. Figure 2 - N-1.9 Gas Accumulation.
Although the RFT pressure data is variable there exists a clear log GWC at 1674.3m TVDSS in both the Moonfish-1 and Moonfish-1ST wells. This log contact aids in tying down the gas gradient which has been evaluated to be 0.162 psi/m. This gradient demonstrates the gas to be very light. Both field gas chromatography and PVT hydrocarbon fraction analysis on associated gas demonstate a high percentage of methane and ethane hydrocarbon fractions supporting this interpretation.

2. Figure 3 - M-1 Oil and Gas Accumulations.
This data pertains to the small stringer sands that exist above the main M-2 oil accumulation. The sands are interspersed with coals and shales and due to the quality of the data it is unknown whether they are in communication. It should be noted that after RFT sampling the pressure in the formation always dropped by some nominal amount up to a maximum of 10 psi. This may indicate that the sands are completely isolated and that the zones have a poor production potential. A "best fit" interpretation has been presented in Figure 3 for which the confidence is low. No log contact data is available for these hydrocarbon zones. The zones appear in both the Moonfish-1 and Moonfish-1ST wells.

3. Figure 4 - M-2 Oil Accumulation.
The data for this zone is relatively good, possibly indicating its production potential, and a clear OWC exists on the Moonfish-1 logs. The RFT gives a contact matching the logs at 1731.1m TVDSS and a fluid gradient exactly the same as the reservoir condition density of fluid in the preserved fluid analysis. The zones appear in both the Moonfish-1 and Moonfish-1ST wells.

4. Figure 5 - L-1 Oil and L-2 Gas Accumulations.
RFT pressure data coupled with sampling and log analysis indicates that these are oil and gas sands. The shale between the lower gas and upper oil is obviously providing a seal. A log OWC and GWC exists for the relative accumulations which aids in locating the RFT fluid gradient. This accumulation is not evident in the sidetrack well.

5. Figure 6 - L-3 Oil and L-4 Gas Accumulations.
RFT pressure data in the two upper oil sands are not conclusive in demonstrating any oil gradients. A single point in gas sand gives a nominal downdip GWC with the aquifer using a similar gas gradient to the other gas sands. The accumulations only appear in the Moonfish-1ST well.

6. Figure 7 - Lower L-1 Oil and Gas Accumulations.
Poor data makes any interpretation difficult. An oil gradient similar to the upper accumulations used with the log OWC at 1929.8m TVDSS gives a reasonable interpretation. No pressure tests were taken in the gas cap of the accumulation but a clear GOC exists on the logs at 1924.3m TVDSS. The accumulation only appears in the Moonfish-1 well.

7. Figure 8 - Sub Volcanic Oil Accumulation.
Poor RFT data makes any RFT interpretation difficult. However, the preserved fluid analysis gives a reservoir condition fluid density which can be used with the Moonfish-1 log OWC at 2043.4m TVDSS to define the interpretation. Many of the pretests demonstrated supercharging which is generally related to tight formations. The accumulation appears in both the Moonfish-1 and Moonfish-1ST wells.

Fluid Analysis

RFT unpreserved fluid samples were used to confirm the type of fluids in place in Moonfish. These are tabulated alongside the relative accumulations in Table 2 and shown on the RFT plots, Figures 2-7. Care should be taken in not mistaking filtrate for formation water.

Three preserves samples were taken and the summarised results of these are presented in Table 3.

The wellsite measured fluid properties are not in good agreement with the preserved samples. It is thought that the higher API's, and lower pour points, measured at the wellsite are probably due to a dropout of wax in the RFT sampling chambers during the wellsite sampling thereby allowing the field oil measurements to appear lighter than that measured in the laboratory.

In general all the oil found in Moonfish has a low GOR and high wax and pour point. The oil is also relatively dense and more viscous as compared to other Bass Strait reservoirs.

Fingerprint analysis demonstrates that, although similar, the oils vary slightly in their hydrocarbon compositions. As can be seen from Figure 9 the deeper accumulations have a larger percentage of heavier hydrocarbons. This is reflected in laboratory analysis with the shallower oils having a greater GOR and lower density at reservoir conditions.

The slight differences in the oils are most likely caused by fractionation whereby the lighter components have migrated upwards. Although unlikely, the possibility of biodegradation or separate migration of the oil and gas phases should not be discounted.

Although H_2S was not deliberately sampled, field measurements indicate that Moonfish is sweet. There is however varying concentrations of CO_2 up to approximately 10% by field measurement and laboratory compositional analysis.

Table 1 – RFT Pressure and Sample Tests					Table 1 – Continued...				
Pretest #	Pressure psia	MDRKB (metres)	Depth TVDSS (m)	Adjusted TVDSS (m)	Pretest #	Pressure psia	MDRKB (metres)	Depth TVDSS (m)	Adjusted TVDSS (m)
1	2289.00	1800.00	1621.77	1621.77	32	2485.19	1956.05	1761.58	1761.58
2	2304.21	1812.04	1632.36	1632.36	ST–16	2489.44	1916.02	1769.96	1763.48
3	2323.58	1828.08	1646.51	1646.51	33	2491.86	1959.02	1764.28	1764.28
4	2359.75	1850.07	1665.98	1665.98	34	2496.60	1962.04	1767.03	1767.03
25	2359.58	1852.55	1668.20	1668.20	35	2525.93	1975.56	1779.42	1779.42
5	2360.68	1854.06	1669.55	1669.55	37	2519.99	1985.04	1788.11	1788.11
26	2360.21	1856.04	1671.31	1671.31	38	2527.65	1987.01	1789.91	1789.91
6	2360.90	1858.02	1673.08	1673.08	40	2541.66	1997.65	1799.67	1799.67
ST–S6/1	2358.90	1819.00	1679.37	1673.37	41	2544.41	1999.07	1800.98	1800.98
ST–S6/2	2359.20	1819.00	1679.37	1673.37	S8/2	2529.80	1999.40	1801.28	1801.28
7	2362.68	1860.53	1675.33	1675.33	42	2550.27	2001.20	1802.93	1802.93
27	2363.34	1861.52	1676.21	1676.21	ST–17	2540.02	1959.09	1810.06	1803.37
8	2364.50	1862.01	1676.65	1676.65	43	2549.06	2005.07	1806.48	1806.48
28	2365.48	1863.05	1677.58	1677.58	44	2557.26	2008.55	1809.66	1809.66
S2/1	2367.00	1864.00	1678.42	1678.42	S7/2	2557.00	2009.30	1810.35	1810.35
S2/2	2367.00	1864.00	1678.42	1678.42	45	2557.78	2009.53	1810.56	1810.56
9	2367.17	1864.03	1678.45	1678.45	48	2561.00	2010.96	1811.87	1811.87
10	2381.27	1871.53	1685.15	1685.15	50	2567.16	2020.77	1820.85	1820.85
ST–S5/1	2388.90	1838.70	1697.63	1691.54	ST–18	2627.18	2013.52	1860.56	1853.59
ST–S5/2	2389.40	1838.70	1697.63	1691.54	ST–S2	2674.00	2032.80	1878.40	1871.33
ST–1	2400.84	1838.76	1697.69	1691.60	ST–19	2675.05	2033.05	1878.63	1871.56
ST–2	2406.35	1841.37	1700.11	1694.01	ST–20	2681.14	2039.06	1884.18	1877.08
12	2401.75	1881.84	1694.41	1694.41	ST–21	2716.82	2047.74	1892.20	1885.06
ST–3	2404.56	1845.54	1703.99	1697.87	51	2755.00	2135.53	1925.64	1925.64
ST–S4/2	2402.70	1848.00	1706.29	1700.15	S6/2	2750.40	2135.70	1925.79	1925.79
ST–S4/1	2409.20	1848.00	1706.29	1700.15	52	2757.07	2139.03	1928.78	1928.78
14	2416.02	1888.24	1700.17	1700.17	53	2760.23	2141.52	1931.02	1931.02
ST–4	2409.40	1848.07	1706.35	1700.21	54	2771.72	2149.54	1938.24	1938.24
ST–S3	2407.90	1850.80	1708.90	1702.75	ST–30	2785.82	2109.53	1949.13	1941.68
ST–5	2416.00	1851.01	1709.09	1702.94	55	2778.56	2154.02	1942.27	1942.27
ST–6	2416.72	1853.07	1711.02	1704.85	56	2960.77	2256.02	2032.84	2032.84
ST–S1	2417.00	1858.50	1716.09	1709.90	60	2924.79	2256.58	2033.33	2033.33
ST–7	2418.79	1858.57	1716.15	1709.96	57	2906.67	2258.56	2035.07	2035.07
ST–8	2419.88	1859.72	1717.23	1711.03	58	2909.26	2259.55	2035.94	2035.94
S3/1	2427.00	1904.00	1714.36	1714.36	S9/2	2901.50	2260.50	2036.78	2036.78
S3/2	2427.00	1904.00	1714.36	1714.36	61	2906.92	2260.58	2036.85	2036.85
15	2428.88	1904.02	1714.38	1714.38	70	2905.79	2260.77	2037.02	2037.02
17	2432.71	1906.36	1716.49	1716.49	62	2916.94	2263.08	2039.05	2039.05
18	2430.86	1907.52	1717.54	1717.54	69	2915.30	2263.28	2039.22	2039.22
19	2433.06	1910.05	1719.83	1719.83	S5/1	2882.00	2265.50	2041.17	2041.17
S1/2	2437.00	1914.50	1723.86	1723.86	S4/1	2910.00	2265.50	2041.17	2041.17
S1/1	2437.00	1914.50	1723.86	1723.86	S4/2	2910.00	2265.50	2041.17	2041.17
25	2437.00	1914.50	1723.86	1723.86	S5/2	2911.80	2265.50	2041.17	2041.17
20	2436.88	1914.53	1723.88	1723.88	63	2913.13	2265.57	2041.23	2041.23
ST–9	2436.67	1873.52	1730.16	1723.89	ST–32	2912.05	2220.05	2049.62	2041.63
ST–10	2438.35	1874.54	1731.12	1724.85	ST–33	2914.95	2221.58	2051.00	2043.00
29	2437.05	1916.55	1725.71	1725.71	ST–34	2917.58	2223.05	2052.32	2044.31
ST–11	2440.80	1876.54	1733.00	1726.72	64	2917.24	2269.08	2044.32	2044.32
21	2444.32	1922.05	1730.69	1730.69	65	2919.19	2272.04	2046.92	2046.92
22	2448.14	1925.05	1733.40	1733.40	66	2928.21	2279.56	2053.54	2053.54
30	2450.67	1927.56	1735.68	1735.68	ST–35	2938.59	2239.58	2067.21	2059.12
23	2454.29	1930.04	1737.92	1737.92	67	2940.00	2287.56	2060.59	2060.59
ST–12	2455.90	1890.02	1745.65	1739.30	68	2950.96	2297.07	2068.97	2068.97
31	2457.83	1933.54	1741.09	1741.09	ST–37	2983.44	2275.09	2099.50	2091.24
24	2461.33	1935.55	1742.91	1742.91	ST–38	3232.60	2454.54	2266.55	2257.39
ST–13	2463.27	1895.35	1750.64	1744.26	ST–39	3501.47	2609.55	2412.06	2402.12
ST–14	2468.42	1899.02	1754.07	1747.68	ST–40	3622.83	2738.58	2528.86	2518.28
ST–15	2475.57	1904.03	1758.76	1752.34					

Notation and abbreviations:

#	Number indicates Moonfish–1 RFT pressure test
ST–#	Moonfish–1ST pressure test
S#/1	RFT Sample in Moonfish–1 well, 12 gallon chamber
S#/2	RFT Sample in Moonfish–1 well, 1 gallon chamber
ST–S#/1	Sample in Moonfish–1ST well, 12 gallon chamber
ST–S#/2	Sample in Moonfish–1ST well, 1 gallon chamber

(mts/moonfish.wk1)

Table 2 – Moonfish Hydrocarbon Accumulations and Samples

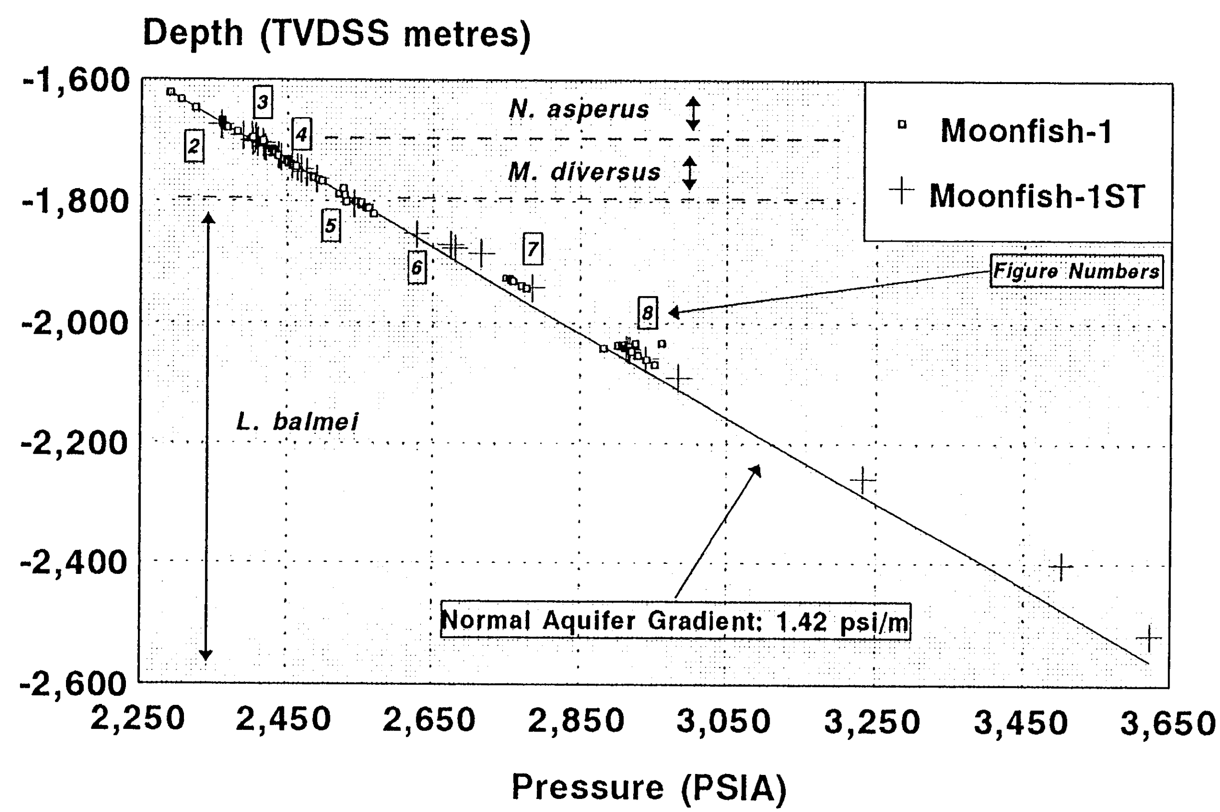
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Clear Log GWC in both wells. Possibility of very small oil leg on logs. Oil leg cannot be seen on RFT.				
N-1.9 Gas	2	Gas	0.162	GWC	1674.3	2361.1						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
ST-S6/1	1819.0	1673.4	2358.9	77.9	214.0	–	TR	–	–	–	2.0	
ST-S6/2	1819.0	1673.4	2359.2	77.9	18.0	–	TR	–	–	–	0.5	
MF-S2/1	1864.0	1678.4	2367.0	77.4	RTSTM	TR	20.0	–	–	–	7.0	
MF-S2/2	1864.0	1678.4	2367.0	77.4	RTSTM	SL TR	4.0	–	–	–	7.0	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in both wells. Poor data. May be isolated oil sands. No Log OWC. Possibly no communication.				
M-1 Upper Oil	3	Oil	0.7	OWC	1708.4	2411.9						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
ST-S5/1	1837.7	1691.5	2388.9	77.4	RTSTM	1.5	42.0	19.0	22.0	–	1.2	
ST-S5/2	1837.7	1691.5	2389.4	77.4	RTSTM	TR	3.5	–	–	–	0.5	
ST-S4/1	1848.0	1700.1	2409.2	77.2	17.7	8.0	33.0	37.2	22.0	352.0	2.0	
ST-S4/2	1848.0	1700.1	2402.7	77.2	10.0	0.3	3.0	37.2	22.0	6360.0	2.0	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in both wells. Poor data. May be isolated gas sands. No Log contact.				
M-1 Gas	3	Gas	0.162	GOC	1708.3	2417.1						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
ST-S3/1	1850.8	1702.7	2407.9	76.3	16.0	TR	19.5	25.3	27.0	–	2.5	
ST-S3/2	1850.8	1702.7	2407.9	76.5	8.0	0.0	1.2	–	–	–	4.0	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in both wells. Poor data. May be isolated oil sands. No Log OWC. Possibly no communication.				
M-1 Lower Oil	3	Oil	1.006	OWC	1720.8	2429.7						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
ST-S1/1	-1858.5	1709.9	2417.0	79.1	74.2	40.0	5.0	38.3	17.0	295.0	4.2	
ST-S1/2	1858.5	1709.9	2417.0	79.1	Preserved	Sample		n/a	27	504	6.3	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Main Moonfish accumulation. Appears in both wells. Log OWC in MF-1. Relatively good RFT and sample data.				
M-2 Oil	4	Oil	1.024	OWC	1731.1	2444.4						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
MF-S3/1	1904.0	1714.4	2427.0	78.0	RTSTM	TR	20.5	–	–	–	8.0	
MF-S3/2	1904.0	1714.4	2427.0	78.0	RTSTM	TR	4.0	–	–	–	8.0	
MF-S1/1	1914.5	1723.9	2437.0	79.0	38.8	22.7	0.0	47.6	20.5	271.5	5.0	
MF-S1/2	1914.5	1723.9	2437.0	79.0	Preserved	Sample		40.1	26	445	6.6	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in MF-1 only. Poor RFT data. Poorly defined Log OWC contact exists.				
L-1 Oil	5	Oil	1.024	OWC	1805.5	2547.7						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
MF-S8/1	1999.4	1801.3	2529.8	77.1	7.0	3.0	30.0	45.0	27.0	371.0	n/a	
MF-S8/2	1999.4	1801.3	2529.8	76.4	3.5	0.5	2.5	45.0	27.0	1122.5	n/a	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in MF-1 only. Poor RFT data. No Log contact.				
L-2 Gas	5	Gas	0.306	GWC	1813.1	2558.6						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
MF-S7/1	2009.3	1810.4	2557.0	76.9	222.5	0.3	0.0	52.2	-5.0	–	10.0	
MF-S7/2	2009.3	1810.4	2557.0	76.5	17.7	TR	0.0	–	–	–	n/a	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in sidetrack only. No evidence of oil gradient from RFT. No Log contacts. May be isolated.				
L-3 Oil	6	RFT not conclusive										
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
ST-S2/1	2032.8	1871.3	2674.0	78.6	RTSTM	0.5	42.0	32.2	26.0	–	4.0	
ST-S2/2	2032.8	1871.3	2674.0	78.8	RTSTM	1.5	2.0	32.8	26.0	–	4.6	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in sidetrack only. Single RFT gas point. No Log contact.				
L-4 Gas	6	Gas	0.162	GWC	1901.8	2719.5						
No samples taken												
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in MF-1 well only. Poor RFT data. Good Log OWC and GOC.				
Lower L-1 Oil	7	Oil	1.0214	OWC	1929.8	2759.6						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
MF-S6/1	2135.7	1925.8	2750.4	81.6	14.1	5.0	37.0	42.0	24.0	448.0	8.0	
MF-S6/2	2135.7	1925.8	2750.4	78.5	2.6	1.0	2.2	42.0	24.0	413.0	8.0	
Accumulation Name	Figure Ref.	Fluid Type	Gradient (psi/m)	Contact Type	Depth (TVDSS)	Pressure (psia)	Notes:	Appears in both wells. Very poor RFT data. Log OWC in MF-1 well only.				
Sub-Volcanic	8	Oil	1.066	OWC	2043.4	2913.7						
Sample #	MDRKB (metres)	TVDSS (metres)	P(res) (psia)	T(res) (deg C)	Gas (cuft)	Oil (litre)	Water (litre)	API deg (@15.6C)	Pour Pt. (deg C)	GOR (scf/stb)	CO2 (%)	
MF-S9/1	2260.5	2036.8	2902.0	86.6	9.2	35.0	0.0	48.0	26.0	42.0	n/a	
MF-S9/2	2260.5	2036.8	2902.0	86.6	Preserved	Sample		33.4	32.0	442.0	11.2	
MF-S4/1	2265.5	2041.2	2910.0	88.0	0.0	TR	20.0	–	–	–	–	
MF-S4/2	2265.5	2041.2	2910.0	88.2	0.0	0.0	3.5	–	–	–	–	
MF-S5/1	2265.5	2041.2	2882.0	80.0	5.3	1.0	41.0	33.0	28.0	843.0	10.0	
MF-S5/2	2265.5	2041.2	2911.8	81.2	RTSTM	0.5	2.5	40.0	12.0	–	0.0	

Notations and abbreviations:				
	MF	Moonfish-1 well	ST	Moonfish-1 Sidetrack well
	SLTR	Slight trace	RTSTM	Residual to small to measure
	TR	Trace	n/a	Was or could not be measured
	S#	Sample number: /1 – 45 litre chamber. /2 – 4 litre chamber.		mts/mfsamples

Table 3 – RFT Preserved Samples

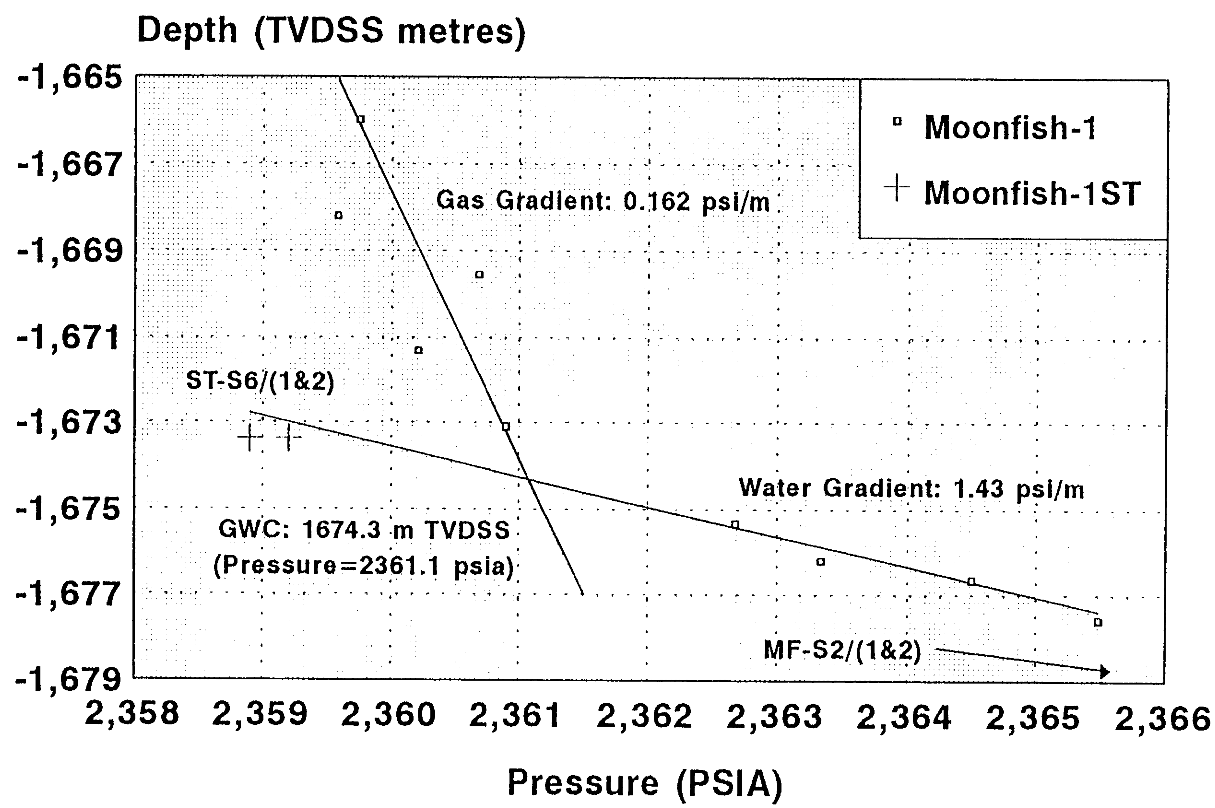
Well	Units	Moonfish–1	Moonfish–1	Moonfish–1ST
Accumulation		M–1 Lower Oil	M–2 Oil	Sub Volcanic Oil
Sample	#	S1/2	S9/2	ST–S1/2
MDRKB	(metres)	1858.5	1914.5	2260.5
TVDSS	(metres)	1709.9	1724.0	2036.8
Sample Pressure	(psia)	2417.0	2437.0	2902.0
Sample Temp	(deg C)	79.1	79.0	86.6
Bubble Point – Pb	(psia)	2260	2170	2514.7
API deg		40.7	40.1	33.4
Pour Point	(deg C)	27.0	26.0	32.0
GOR	(scf/stb)	504.0	445.0	442.0
FVF–Bo	(rb/stb)	1.263	1.254	1.247
Reservoir Viscosity	(cp)	Not measured	0.659	0.973
Wax Content	(%)	17.1	29.5	29.3
mts/mfsamples				

Figure 1 - All Moonfish RFT and Sample Points



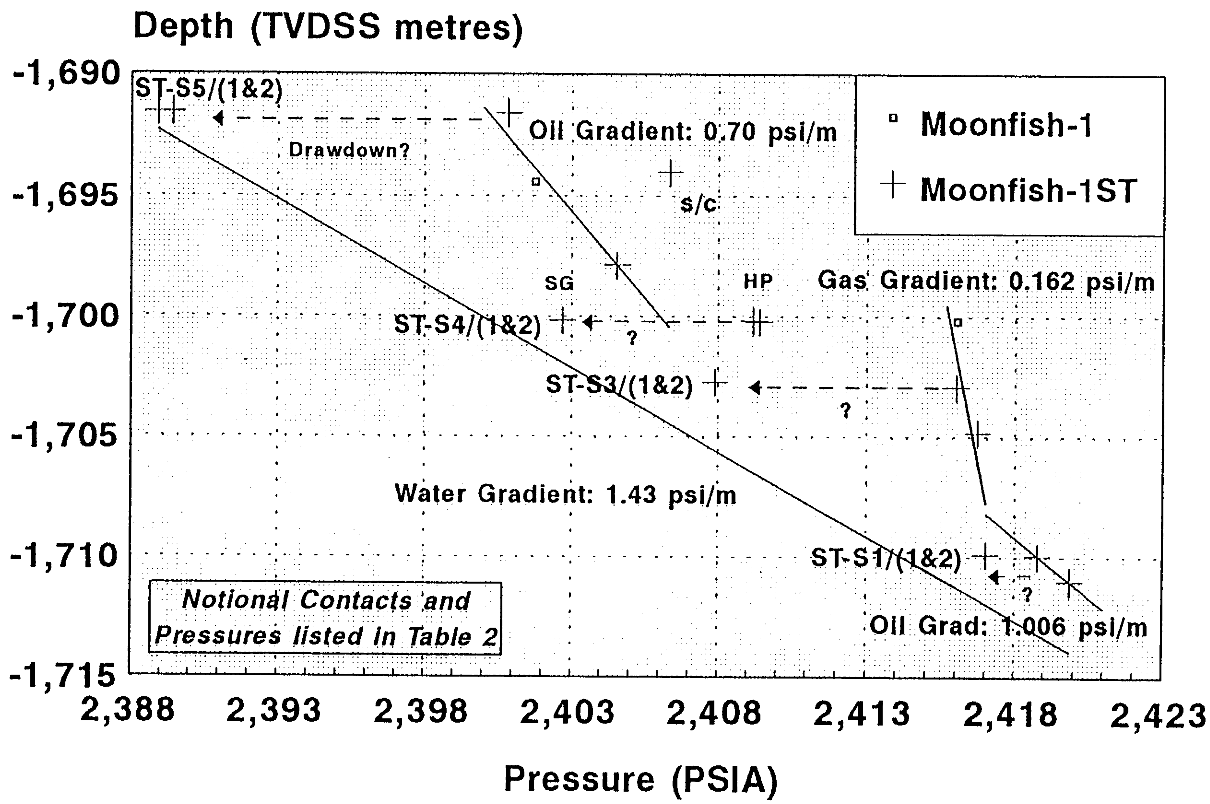
(mts/moonfish/moonrft1/july92)

Figure 2 - N-1.9 Gas Accumulation



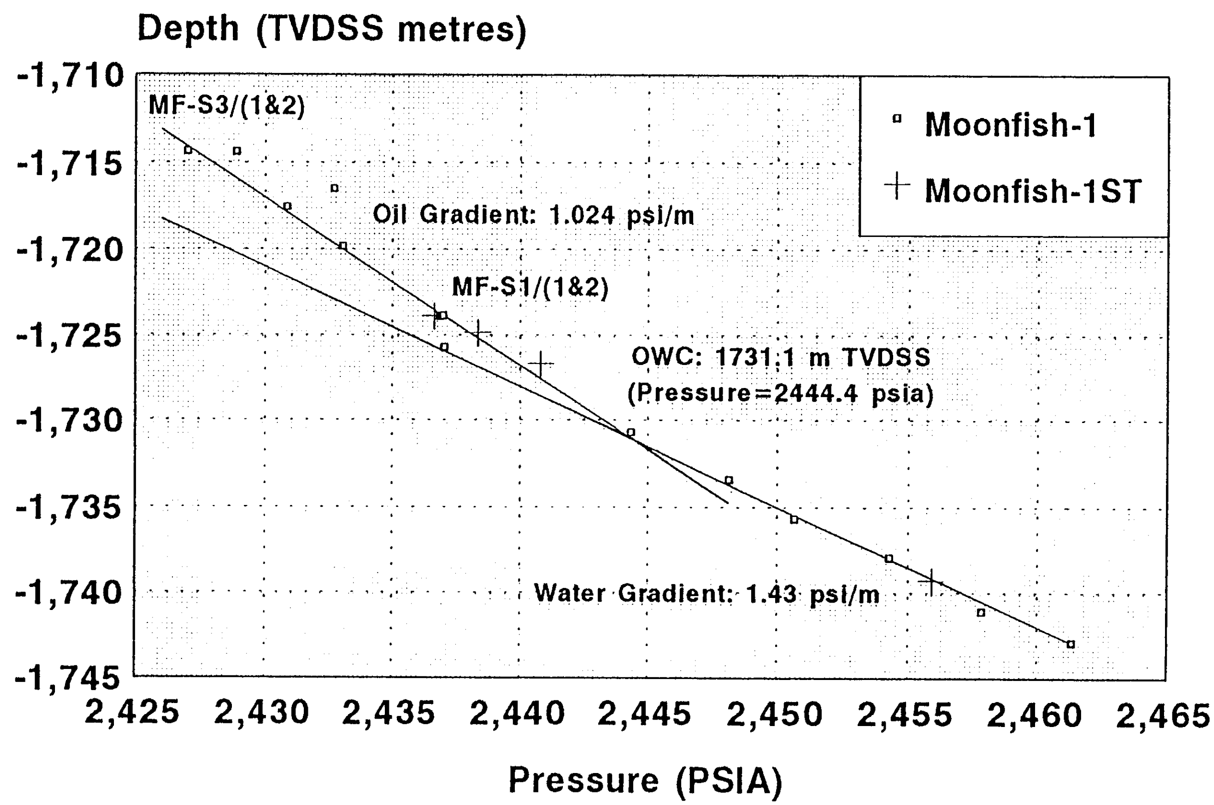
(mts/moonfish/moonrft2/july92)

Figure 3 - M-1 Oil and Gas Accumulations



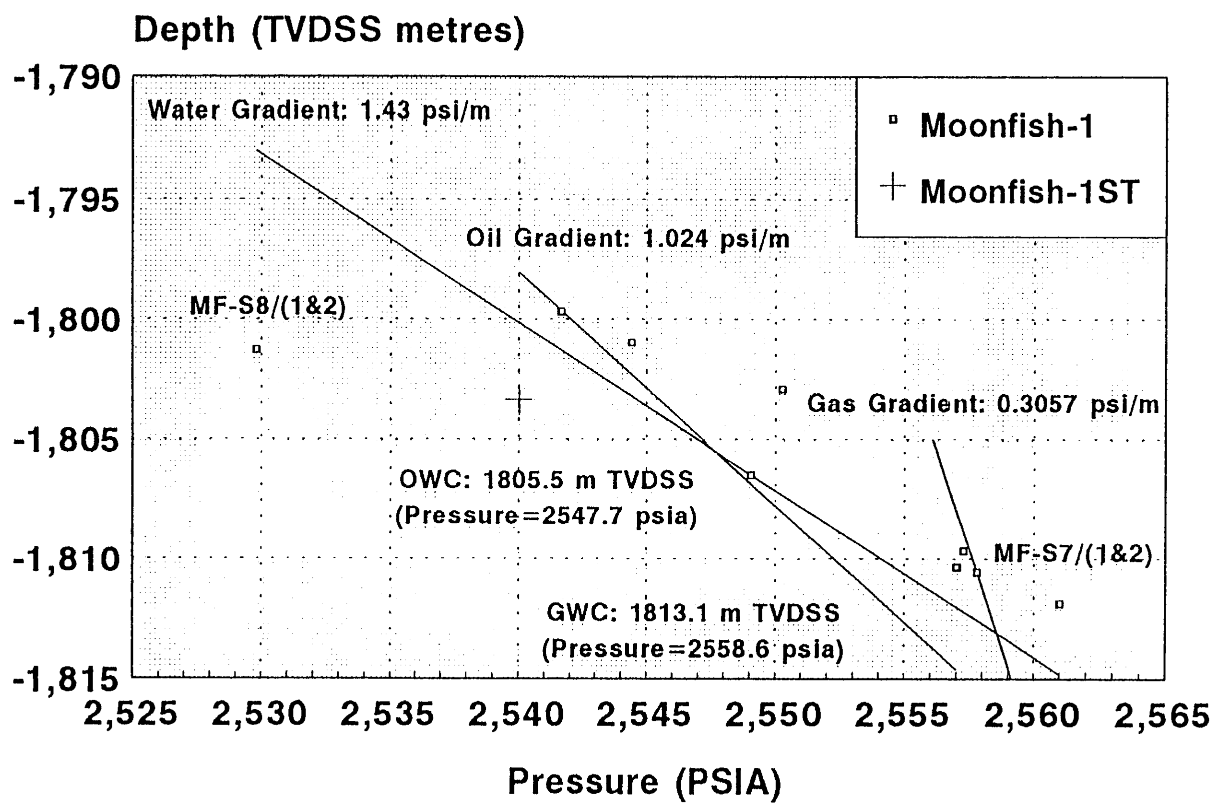
(mts/moonfish/moonrft3/july92)

Figure 4 - M-2 Oil Accumulation



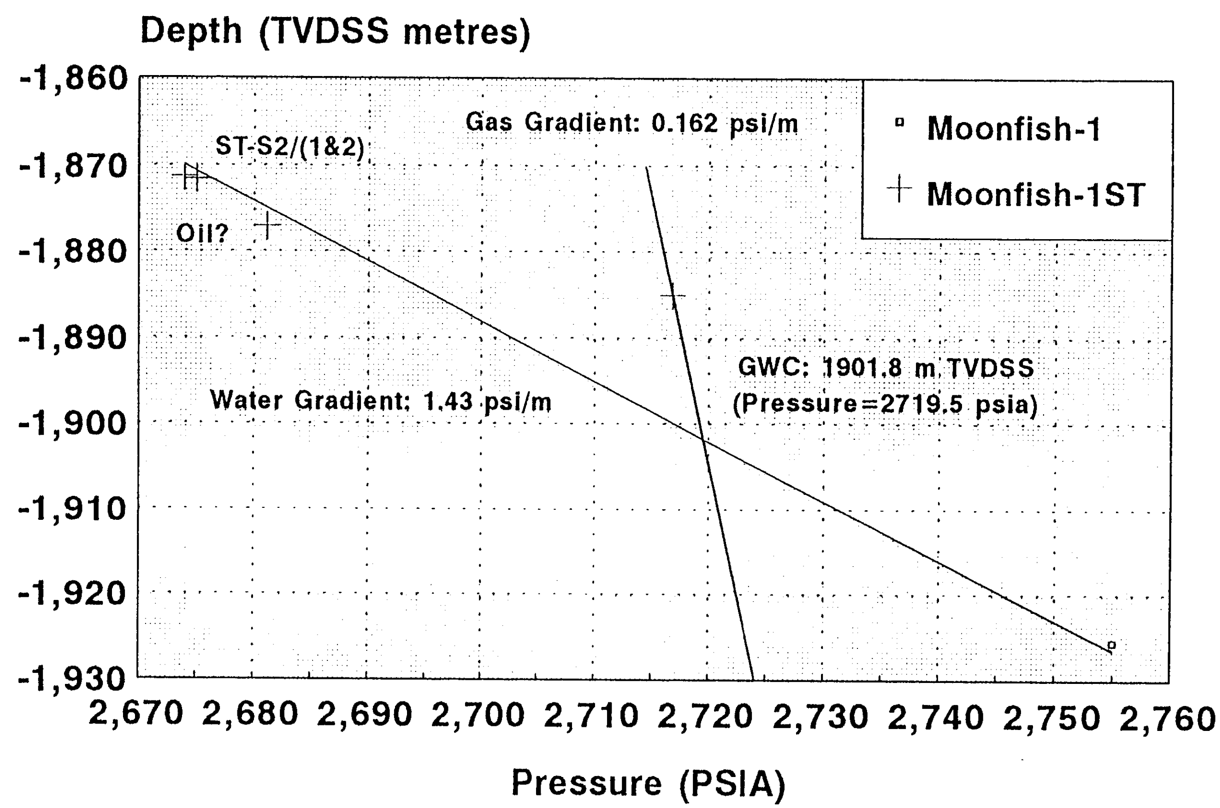
(mts/moonfish/moonrft4/july92)

Figure 5 - L-1 Oil and L-2 Gas Accumulations



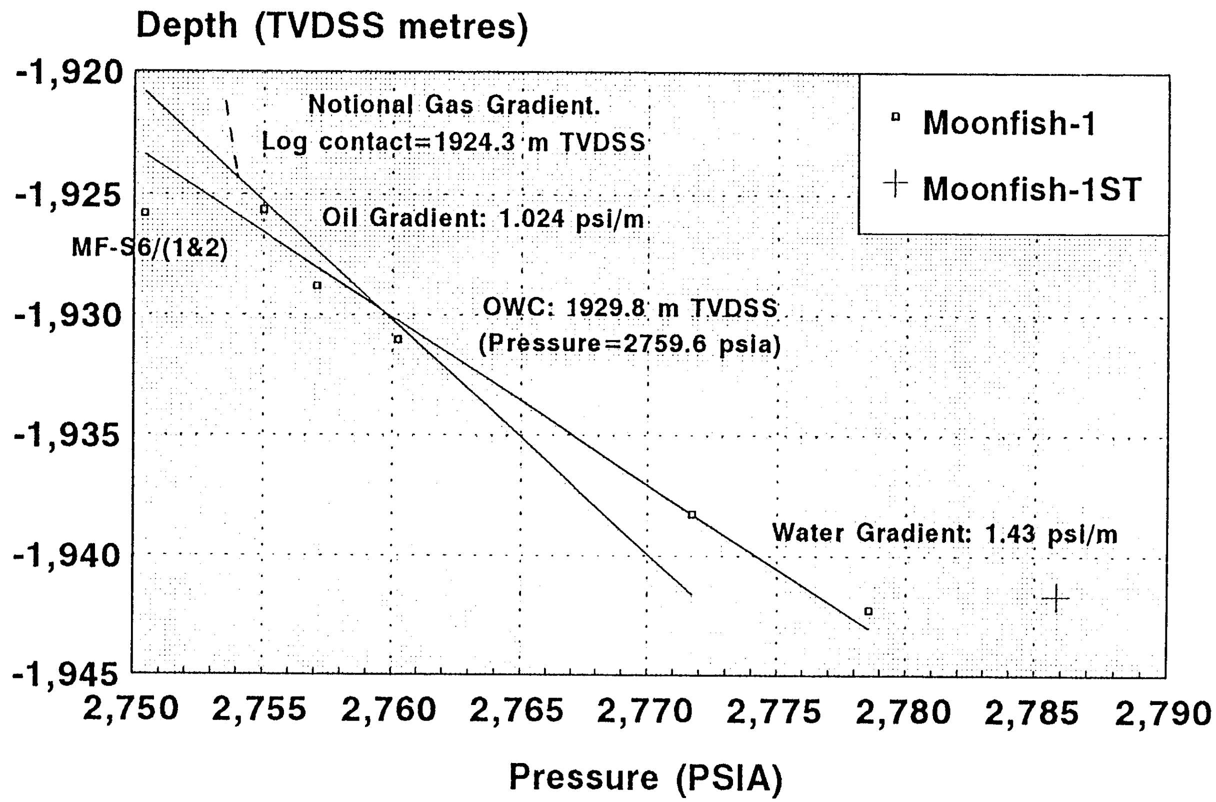
(mts/moonfish/moonrft5/july92)

Figure 6 - L-3 Oil and L-4 Gas Accumulations



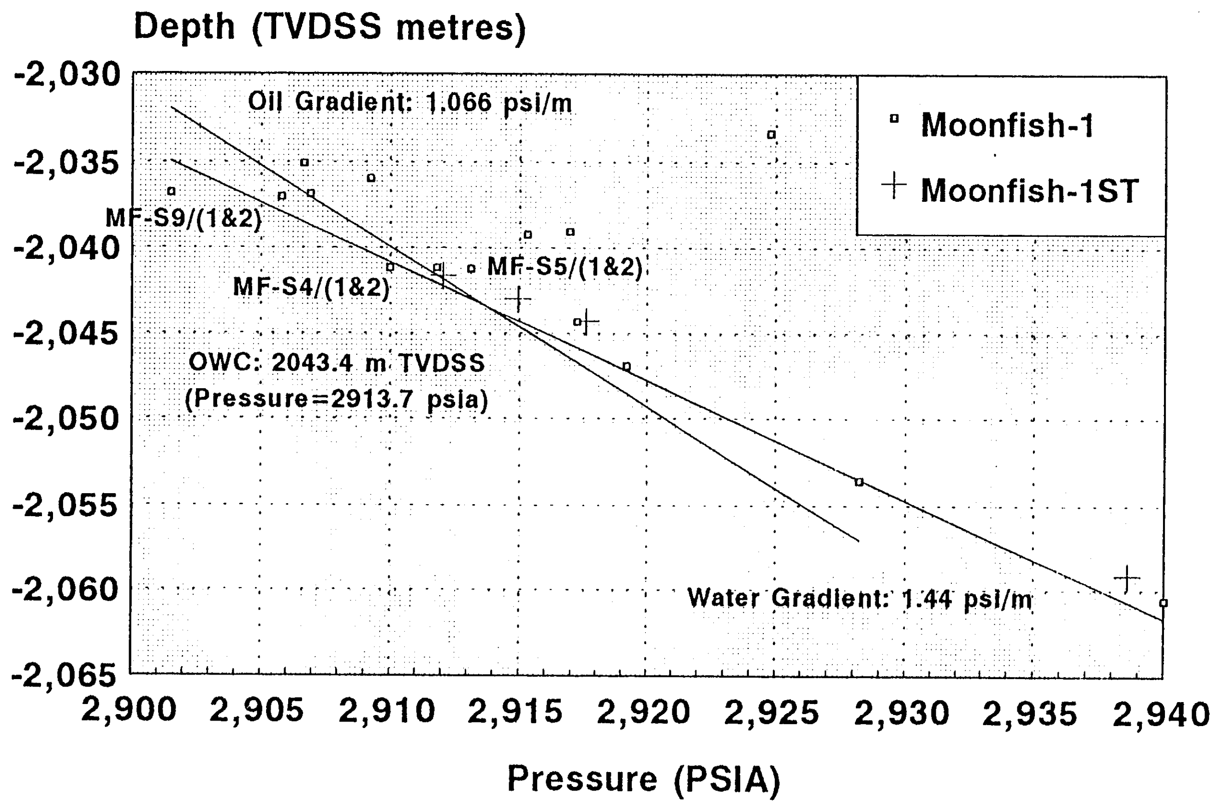
(mts/moonfish/moonrft6/july92)

Figure 7 - Lower L-1 Oil and Gas Accumulation



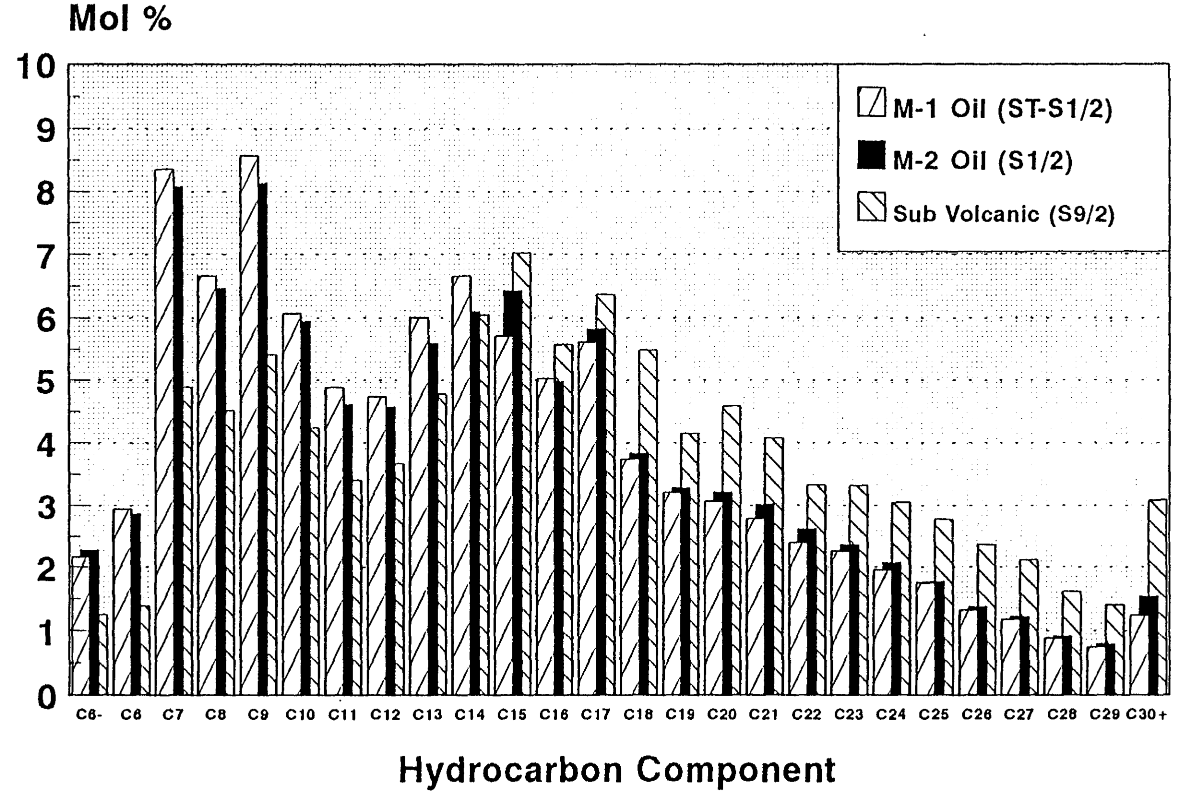
(mts/moonfish/moonrft7/july92)

Figure 8 - Sub Volcanic Oil Accumulation



(mts/moonfish/moonrft8/july92)

Figure 9 - Fingerprint Analysis



(mts/moonfish/mffinger/july 92)

ENCLOSURES

PE904280

This is an enclosure indicator page.
The enclosure PE904280 is enclosed within the container PE900991 at this location in this document.

The enclosure PE904280 has the following characteristics:

ITEM_BARCODE = PE904280
CONTAINER_BARCODE = PE900991
NAME = Well Correlation Section
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = CROSS_SECTION
DESCRIPTION = Correlation Section between Moonfish-1 and ST1
REMARKS =
DATE_CREATED = 31/01/1993
DATE_RECEIVED =
W_NO = W1064
WELL_NAME = MOONFISH-1
CONTRACTOR =
CLIENT_OP_CO = ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE600816

This is an enclosure indicator page.
The enclosure PE600816 is enclosed within the container PE900991 at this location in this document.

The enclosure PE600816 has the following characteristics:

ITEM_BARCODE =	PE600816
CONTAINER_BARCODE =	PE900991
NAME =	Formation Evaluation Log
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	MUD_LOG
DESCRIPTION =	Formation Evaluation Log/Mud log(enclosure from WCR vol.2) for Moonfish 1
REMARKS =	
DATE_CREATED =	21/06/92
DATE_RECEIVED =	23/03/93
W_NO =	W1065
WELL_NAME =	Moonfish-1
CONTRACTOR =	HALLIBURTON GEODATA SDL
CLIENT_OP_CO =	ESSO

(Inserted by DNRE - Vic Govt Mines Dept)

PE604653

This is an enclosure indicator page.
The enclosure PE604653 is enclosed within the container PE900991 at this location in this document.

The enclosure PE604653 has the following characteristics:

ITEM_BARCODE =	PE604653
CONTAINER_BARCODE =	PE900991
NAME =	Mud Log/Formation Evaluation Log
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	MUD_LOG
DESCRIPTION =	Mud Log (enclosure from WCR vol.2) for Moonfish-ST1
REMARKS =	
DATE_CREATED =	12/07/92
DATE_RECEIVED =	
W_NO =	W1065
WELL_NAME =	MOONFISH-ST1
CONTRACTOR =	HALLIBURTON GEODATA
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE604654

This is an enclosure indicator page.
The enclosure PE604654 is enclosed within the
container PE900991 at this location in this
document.

The enclosure PE604654 has the following characteristics:

ITEM_BARCODE =	PE604654
CONTAINER_BARCODE =	PE900991
NAME =	Well Completion Log
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	COMPLETION_LOG
DESCRIPTION =	Well Completion Log for Moonfish-1
REMARKS =	
DATE_CREATED =	12/12/1992
DATE_RECEIVED =	
W_NO =	W1064
WELL_NAME =	MOONFISH-1
CONTRACTOR =	
CLIENT_OP_CO =	ESSO AUSTRALIA LIMITED

(Inserted by DNRE - Vic Govt Mines Dept)

PE600817

This is an enclosure indicator page.
The enclosure PE600817 is enclosed within the container PE900991 at this location in this document.

The enclosure PE600817 has the following characteristics:

ITEM_BARCODE = PE600817
CONTAINER_BARCODE = PE900991
NAME = Well Completion log
BASIN = GIPPSLAND
PERMIT = VIC/L10
TYPE = WELL
SUBTYPE = COMPLETION_LOG
DESCRIPTION = Well Completion log, 900m-2803m, (enclosure from WCR vol.2) for Moonfish-ST1
REMARKS =
DATE_CREATED = 31/01/93
DATE_RECEIVED =
W_NO = W1065
WELL_NAME = Moonfish-1
CONTRACTOR = ESSO
CLIENT_OP_CO = ESSO

(Inserted by DNRE - Vic Govt Mines Dept)

PE600818

This is an enclosure indicator page.
The enclosure PE600818 is enclosed within the container PE900991 at this location in this document.

The enclosure PE600818 has the following characteristics:

ITEM_BARCODE =	PE600818
CONTAINER_BARCODE =	PE900991
NAME =	Synthetic Seismogram
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	SYNTH_SEISMOGRAM
DESCRIPTION =	Synthetic Seismogram (enclosure from WCR vol.2) for Moonfish-1, Sidetrack-1
REMARKS =	
DATE_CREATED =	
DATE_RECEIVED =	23/03/1993
W_NO =	W1065
WELL_NAME =	Moonfish-1
CONTRACTOR =	ESSO
CLIENT_OP_CO =	ESSO

(Inserted by DNRE - Vic Govt Mines Dept)

PE600819

This is an enclosure indicator page.
The enclosure PE600819 is enclosed within the container PE900991 at this location in this document.

The enclosure PE600819 has the following characteristics:

ITEM_BARCODE =	PE600819
CONTAINER_BARCODE =	PE900991
NAME =	Seismic Calibration Log
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	WELL
SUBTYPE =	VELOCITY_CHART
DESCRIPTION =	Seismic Calibration Log (enclosure from WCR vol.2) for Moonfish-1
REMARKS =	
DATE_CREATED =	27/07/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1065
WELL_NAME =	Moonfish-1
CONTRACTOR =	Schlumberger
CLIENT_OP_CO =	ESSO

(Inserted by DNRE - Vic Govt Mines Dept)

PE900992

This is an enclosure indicator page.
The enclosure PE900992 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900992 has the following characteristics:

ITEM_BARCODE =	PE900992
CONTAINER_BARCODE =	PE900991
NAME =	Depth map to tol
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	SEISMIC
SUBTYPE =	HRZN_CONTR_MAP
DESCRIPTION =	Depth map to tol (enclosure from WCR vol.2) for Moonfish-1
REMARKS =	
DATE_CREATED =	02/12/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1065
WELL_NAME =	Moonfish-1
CONTRACTOR =	ESSO
CLIENT_OP_CO =	ESSO

(Inserted by DNRE - Vic Govt Mines Dept)

PE900993

This is an enclosure indicator page.
The enclosure PE900993 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900993 has the following characteristics:

```
      ITEM_BARCODE = PE900993
 CONTAINER_BARCODE = PE900991
              NAME = Depth Structure Map Oil Reservoir
             BASIN = GIPPSLAND
            PERMIT = VIC/L10
              TYPE = SEISMIC
           SUBTYPE = HRZN_CONTR_MAP
       DESCRIPTION = Depth map to top of M-2 oil resevoir
                     (enclosure from WCR vol.2) for
                     Moonfish-1
           REMARKS =
      DATE_CREATED = 28/02/1992
     DATE_RECEIVED = 23/03/1993
              W_NO = W1065
         WELL_NAME = Moonfish-1
        CONTRACTOR = ESSO
      CLIENT_OP_CO = ESSO
```

(Inserted by DNRE - Vic Govt Mines Dept)

PE900994

This is an enclosure indicator page.
The enclosure PE900994 is enclosed within the container PE900991 at this location in this document.

The enclosure PE900994 has the following characteristics:

ITEM_BARCODE =	PE900994
CONTAINER_BARCODE =	PE900991
NAME =	Depth Map to Volcanic Reservoir
BASIN =	GIPPSLAND
PERMIT =	VIC/L10
TYPE =	SEISMIC
SUBTYPE =	HRZN_CONTR_MAP
DESCRIPTION =	Depth map to sub-volcanic resevoir (enclosure from WCR vol.2) for Moonfish-1
REMARKS =	
DATE_CREATED =	02/12/1992
DATE_RECEIVED =	23/03/1993
W_NO =	W1065
WELL_NAME =	Moonfish-1
CONTRACTOR =	ESSO
CLIENT_OP_CO =	ESSO