

APPENDIX M

**TOC, Rock Eval Results and Geochemistry
Ordovician Gordon Group limestone
Florentine Valley and Proterozoic dolomitic metasediments
Hunterston #1**

1. INTRODUCTION

Three samples were received for TOC analysis on 9 October 2002. This report is a formal presentation of results forwarded by e-mail on 29 October 2002.

2. PROCEDURE

2.1 Total Organic Carbon (TOC)

Total organic carbon was determined by digestion of a known weight (approximately 0.2g) of powdered rock in HCl to remove carbonates, followed by combustion in oxygen in the induction furnace of a Leco WR-12 Carbon Determinator and measurement of the resultant CO₂ by infrared detection.

3. RESULTS

SAMPLE	TOC (%)
H984.8	<0.02
H1041.9	<0.02
H1098.6	<0.02

Proterozoic dolomitic metasediments - Hunterston #1

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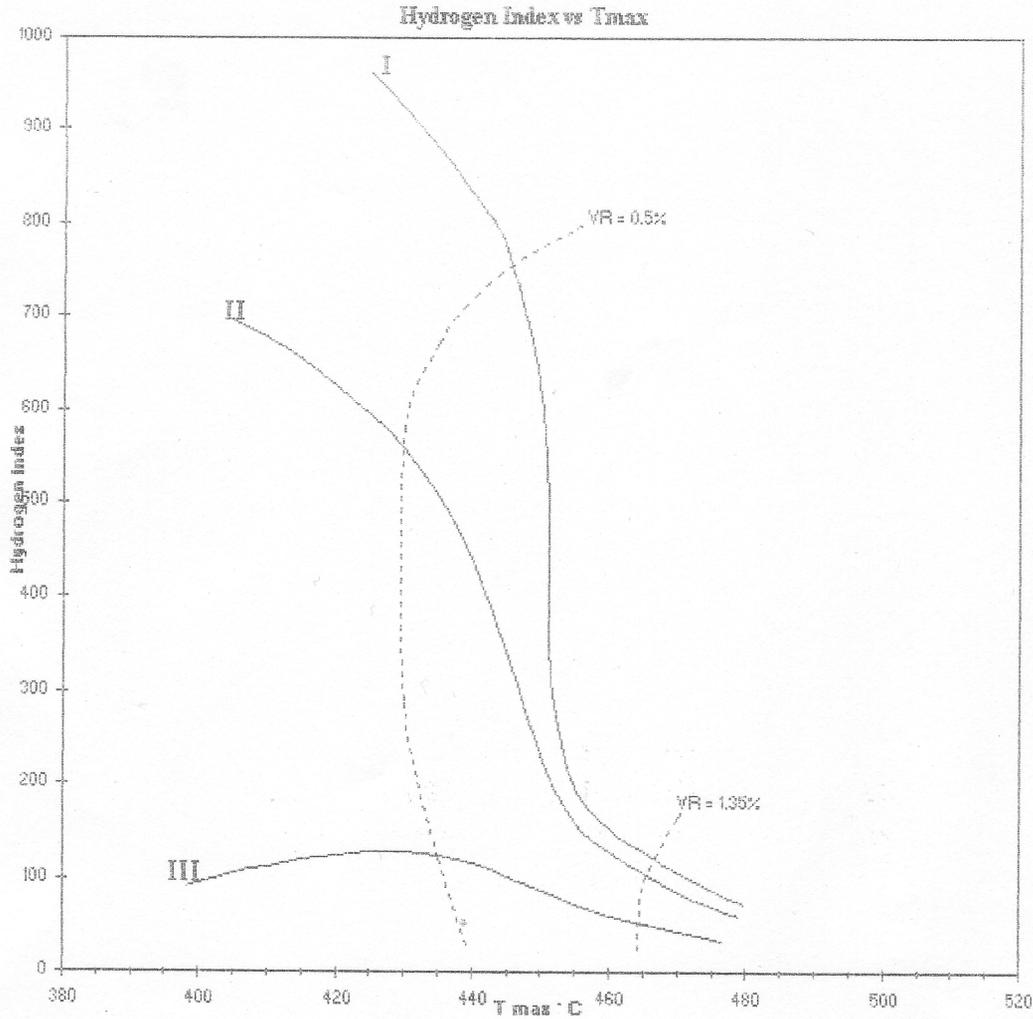
Attention: Alan Chester

Project 03PEAD00634
 Client Ref: Letter 20/01/03

Customer Sample ID 17/2 17/16

Test/Reference	Unit		
Rock-Eval Pyrolysis			
T Max	°C	522	439
S1- Volatile Hydrocarbons	mg/g	0.01	0.02
S2- HC Generating Potential	mg/g	0.31	0.41
S3- Organic Carbon Dioxide	mg/g	0.28	0.53
S1 + S2- Potential Yield	mg/g	0.32	0.43
PI - Production Index		0.03	0.05
S2/S3		1.10	0.77
PC- Pyrolyzed Carbon	mg/g	0.02	0.03
TOC - Total Organic Carbon	Weight %	0.57	0.80
HI- Hydrogen Index		54	51
OI- Oxygen Index		49	66
Total Organic Carbon			
Total Organic Carbon	Weight %	0.570	0.800

Graph



Authorised By: Carmelina Valente
Petroleum Chemist

Signature:

Final Report

- Indicates Not Requested

* Indicates NATA Accredited Test

Samples will be discarded after 30 days unless otherwise notified.

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12 March 2003

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Attention: Alan Chester

Project 03PEAD01044
Client Ref: Letter 04/02/03

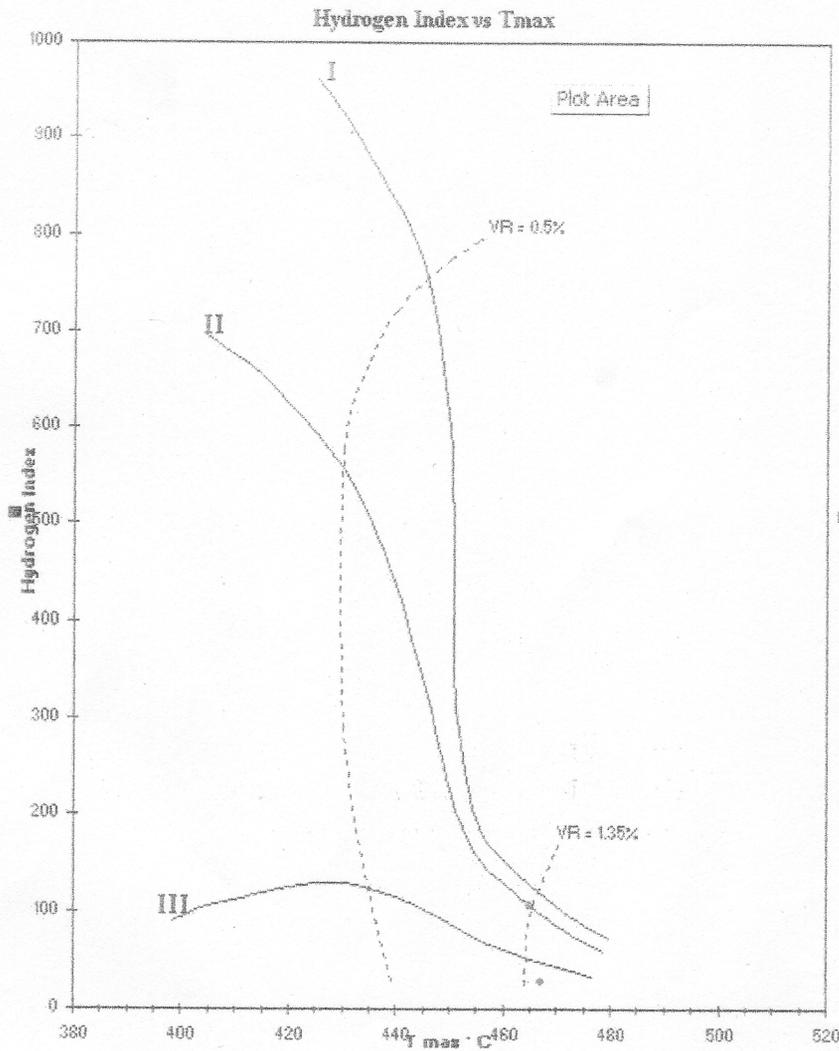
Customer Sample ID MC1 173 174

Test/Reference	Unit			
Rock-Eval Pyrolysis				
T Max	°C	467	-	-
S1- Volatile Hydrocarbons	mg/g	0.07	-	-
S2- HC Generating Potential	mg/g	0.23	-	-
S3- Organic Carbon Dioxide	mg/g	0.14	-	-
S1 + S2- Potential Yield	mg/g	0.30	-	-
PI - Production Index		0.23	-	-
S2/S3		1.64	-	-
PC- Pyrolyzed Carbon	mg/g	0.02	-	-
TOC - Total Organic Carbon	Weight %	0.80	-	-
HI- Hydrogen Index		28	-	-
OI- Oxygen Index		17	-	-
Total Organic Carbon				
Total Organic Carbon	Weight %	0.80	0.15	0.05

Customer Sample ID 175

Test/Reference	Unit	
Rock-Eval Pyrolysis		
T Max	°C	465
S1- Volatile Hydrocarbons	mg/g	0.12
S2- HC Generating Potential	mg/g	0.51
S3- Organic Carbon Dioxide	mg/g	0.43
S1 + S2- Potential Yield	mg/g	0.63
PI - Production Index		0.19
S2/S3		1.18
PC- Pyrolyzied Carbon	mg/g	0.05
TOC - Total Organic Carbon	Weight %	0.48
HI- Hydrogen Index		106
OI- Oxygen Index		89
Total Organic Carbon		
Total Organic Carbon	Weight %	0.48

MC1 and 175



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Petroleum Chemist

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First Reported: 12 March 2003

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Report Number: 28486

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Rock-Eval Pyrolysis

Report # LQ11847

Client: University of Tasmania

Well: -

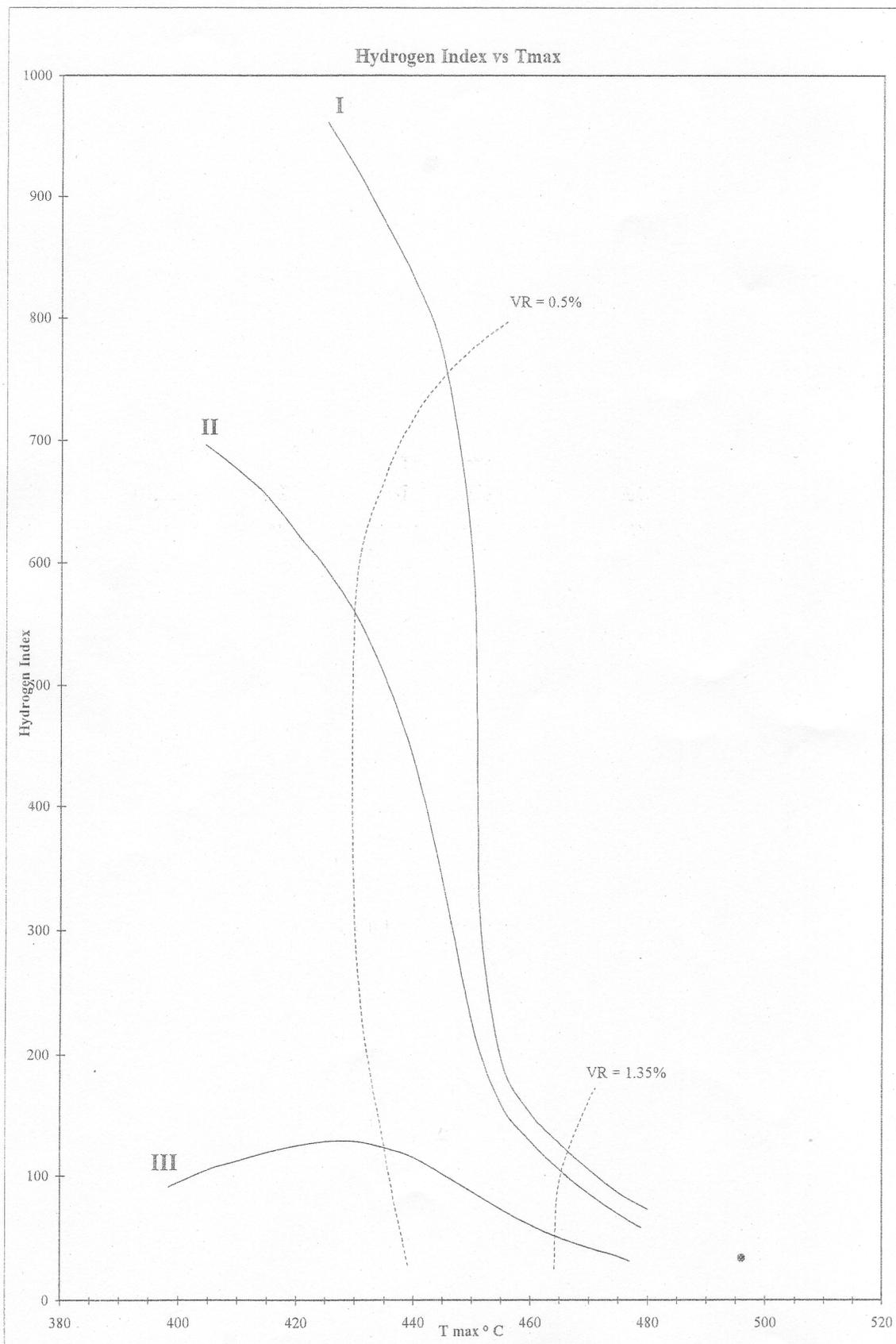
Sample ID	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
LR1									0.20		
LR2	496	0.14	0.24	0.16	0.38	0.37	1.50	0.03	0.70	34	22

Report # LQ11847

Rock-Eval Pyrolysis

Client: University of Tasmania

Well: -



Rock-Eval Pyrolysis

Report # LQ11777

Client: University of Tasmania

Well: -

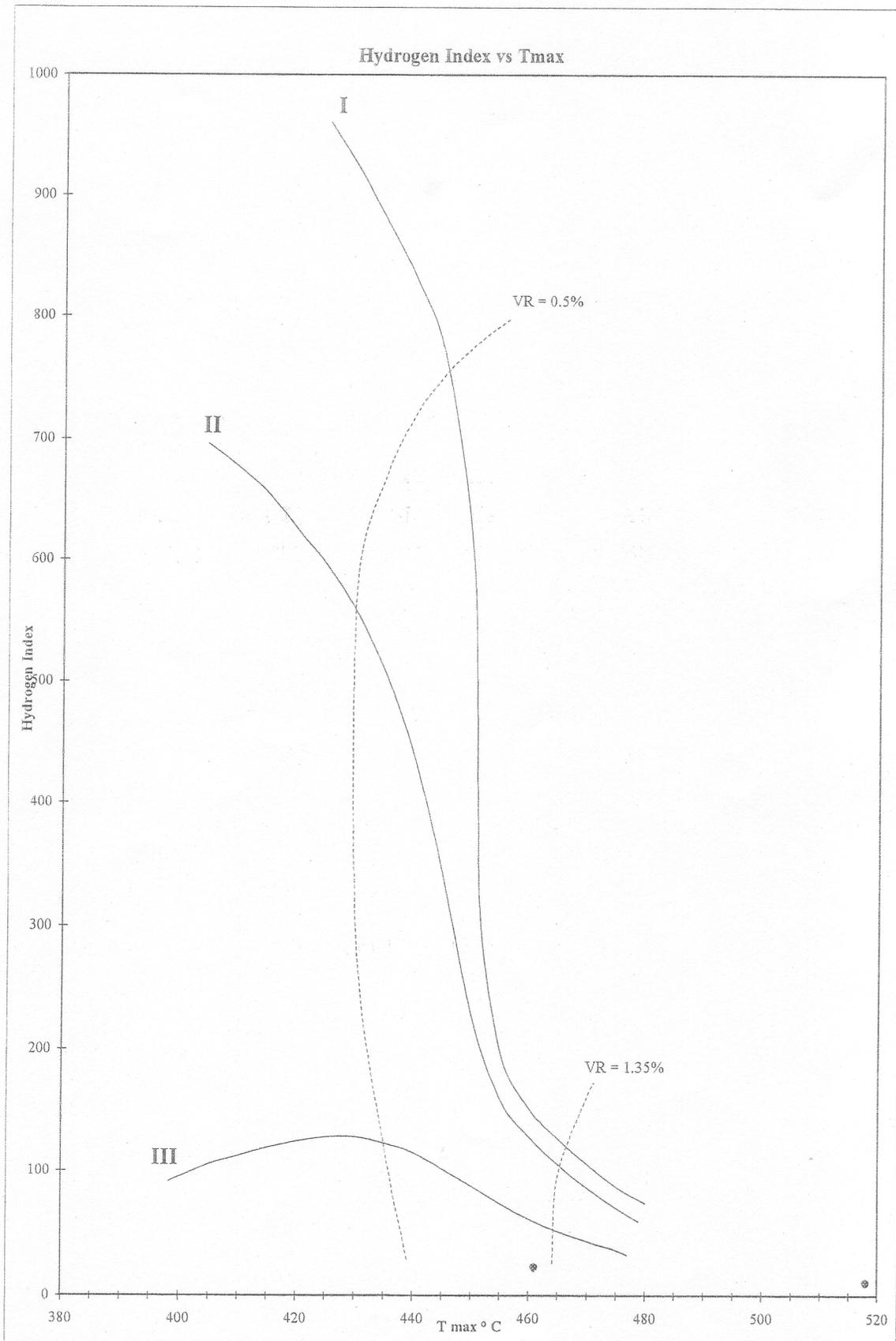
ID	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
SM1	461	0.02	0.09	0.23	0.11	0.20	0.39	0.00	0.40	22	57
11RO1	518	0.01	0.15	0.26	0.06	0.06	0.58	0.01	1.37	10	18
WQR1	544	0.03	0.26	0.38	0.29	0.11	0.68	0.02	1.83	14	20

Report # LQ11777

Rock-Eval Pyrolysis

Client: University of Tasmania

Well: -



Rock-Eval Pyrolysis

Report # LQ11562

Client: University Of Tasmania

Well: Gordon Limestone

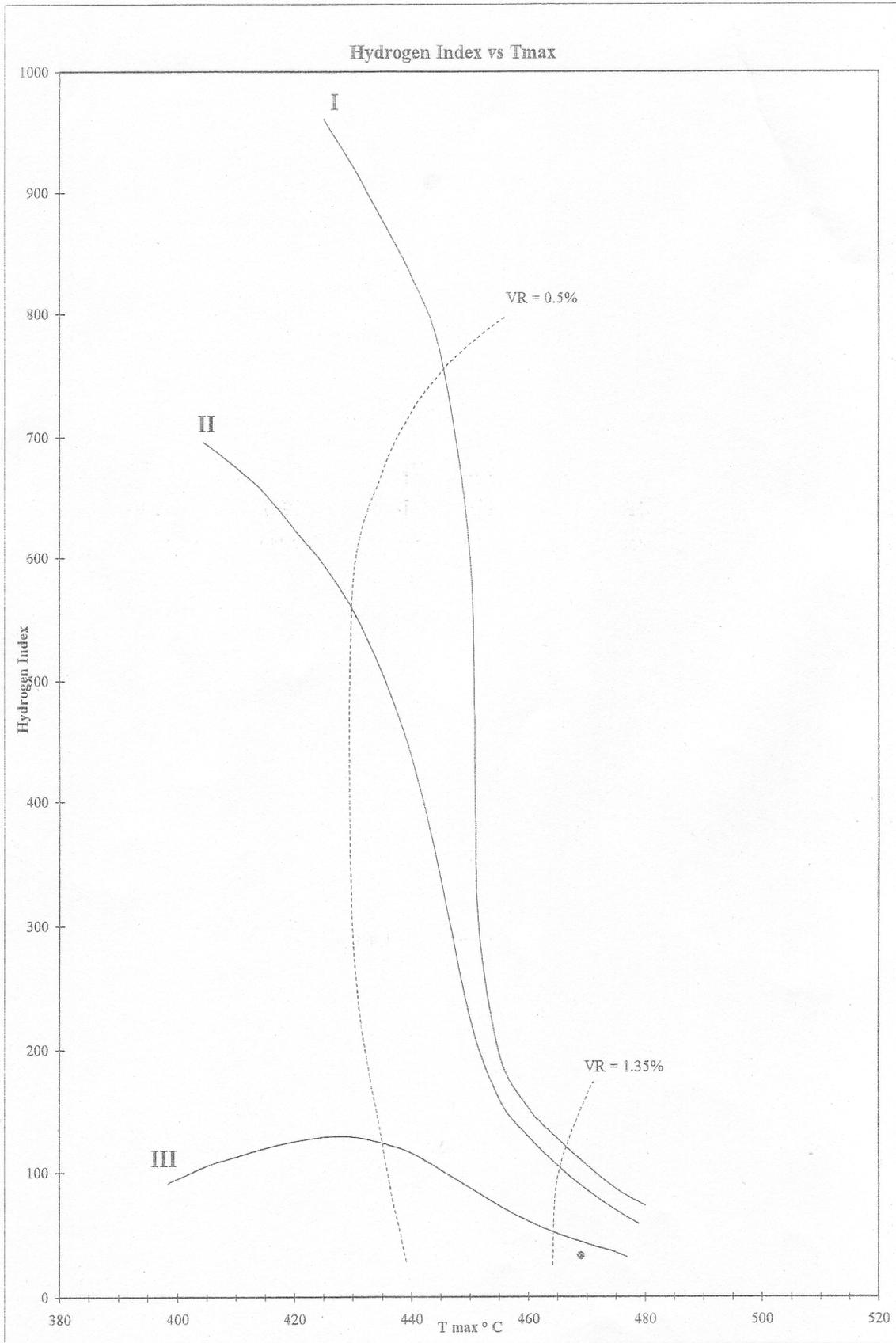
Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
UL01									0.34		
UL02									0.20		
UL03									0.08		
UL04									0.08		
UL05									0.10		
UL06									0.08		
UL07									0.18		
UL08									0.04		
UL09									0.10		
UL10									0.10		
UL11									0.12		
UL12									0.04		
UL13									0.06		
UL14									0.14		
UL15									0.08		
UL16									0.28		
UL17									0.16		
UL18									0.10		
UL19									0.06		
UL20									0.12		
UL21									0.18		
UL22									0.12		
UL23									0.18		
UL24									0.10		
UL25	469	0.02	0.26	0.4	0.28	0.07	0.65	0.02	0.78	33	51
UL26									0.26		
UL27									0.06		
UL28									0.10		
UL29									0.24		
UL30									0.24		
UL31									0.12		
UL32									0.14		
UL33									0.08		
UL34									0.12		
UL35									0.16		
UL36									0.10		
UL37									0.14		
UL38									0.16		
UL39									0.12		
UL40									0.20		

Rock-Eval Pyrolysis

Report # LQ11562

Client: University Of Tasmania

Well: Gordon Limestone



3. RESULTS

TOC and Rock-Eval data are listed in Table 1.

A plot of Hydrogen Index vs Tmax is presented in Figure 1.

The gas chromatograms are presented on the following pages.

The chromatograms do not follow the normal trend for naturally occurring hydrocarbons, and could possibly be plant extract. *EOM is contamination, probably.*

Sample	EOM (mg/kg)
16	14
26	68
30	77
32	54

Rock-Eval Pyrolysis

Report # 02PEAD06307

Client: Uni of Tasmania

Well: -

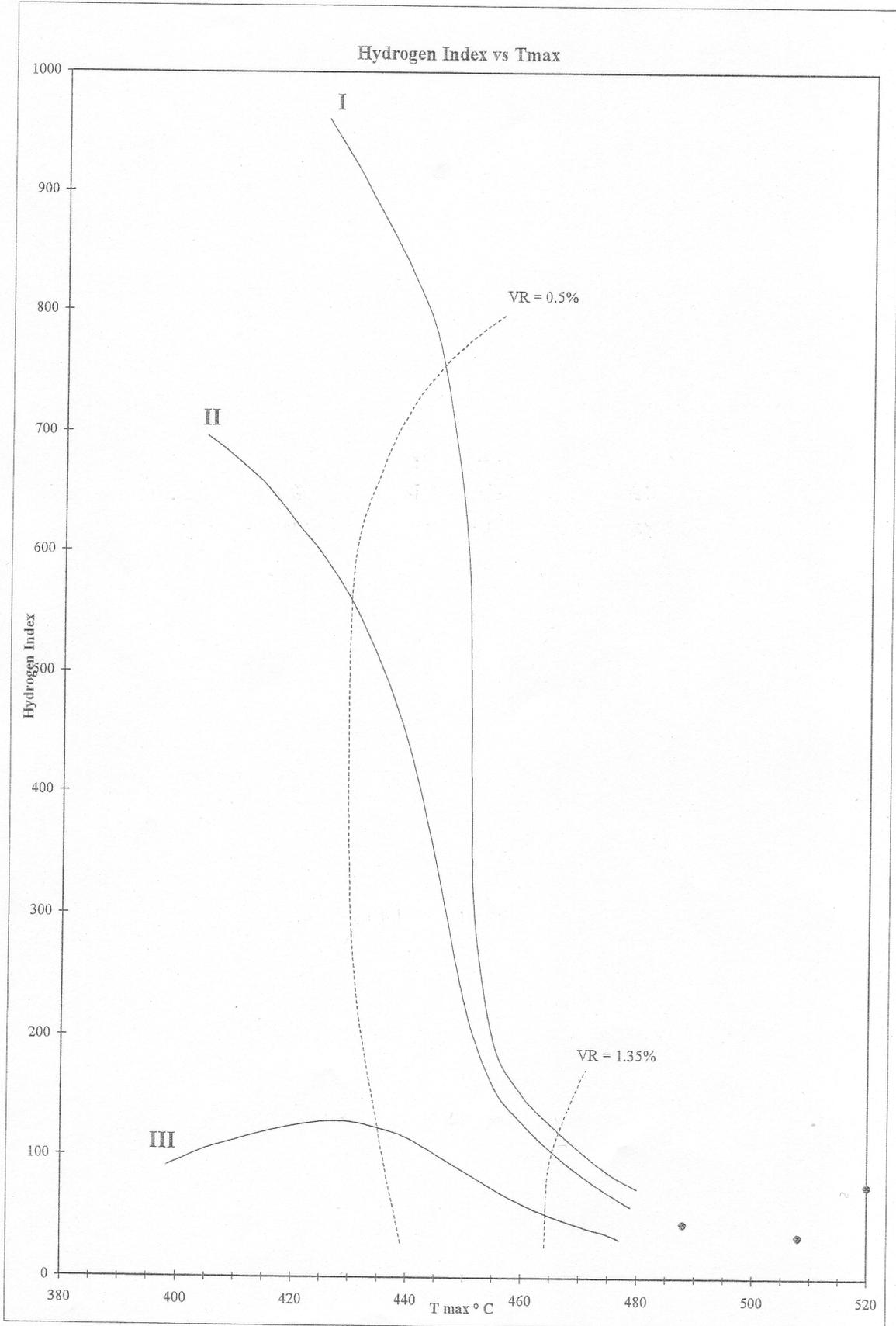
Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
16	545	0.03	0.43	0.51	0.46	0.07	0.84	0.03	0.58	74	87
17									0.37		
18									0.27		
19									0.09		
20									0.19		
25									0.07		
26	508	0.05	0.24	0.24	0.29	0.18	1.00	0.02	0.70	34	34
27									0.07		
29									0.10		
30	488	0.03	0.19	0.33	0.22	0.14	0.57	0.01	0.43	44	76
31									0.16		
32	520	0.06	0.49	0.75	0.55	0.11	0.65	0.04	0.64	76	117

Rock-Eval Pyrolysis

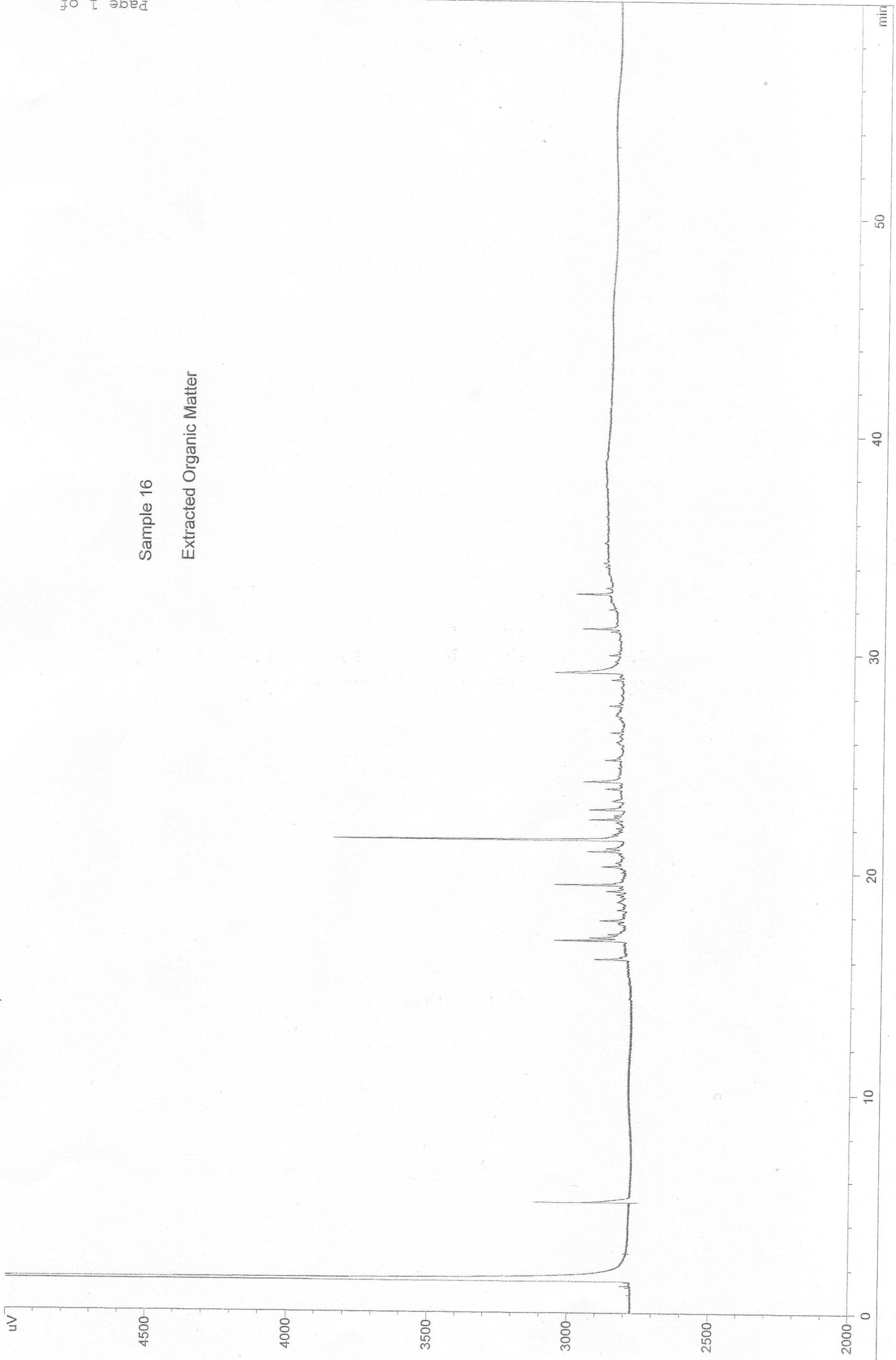
Report # 02PEAD06307

Client: Uni of Tasmania

Well: -

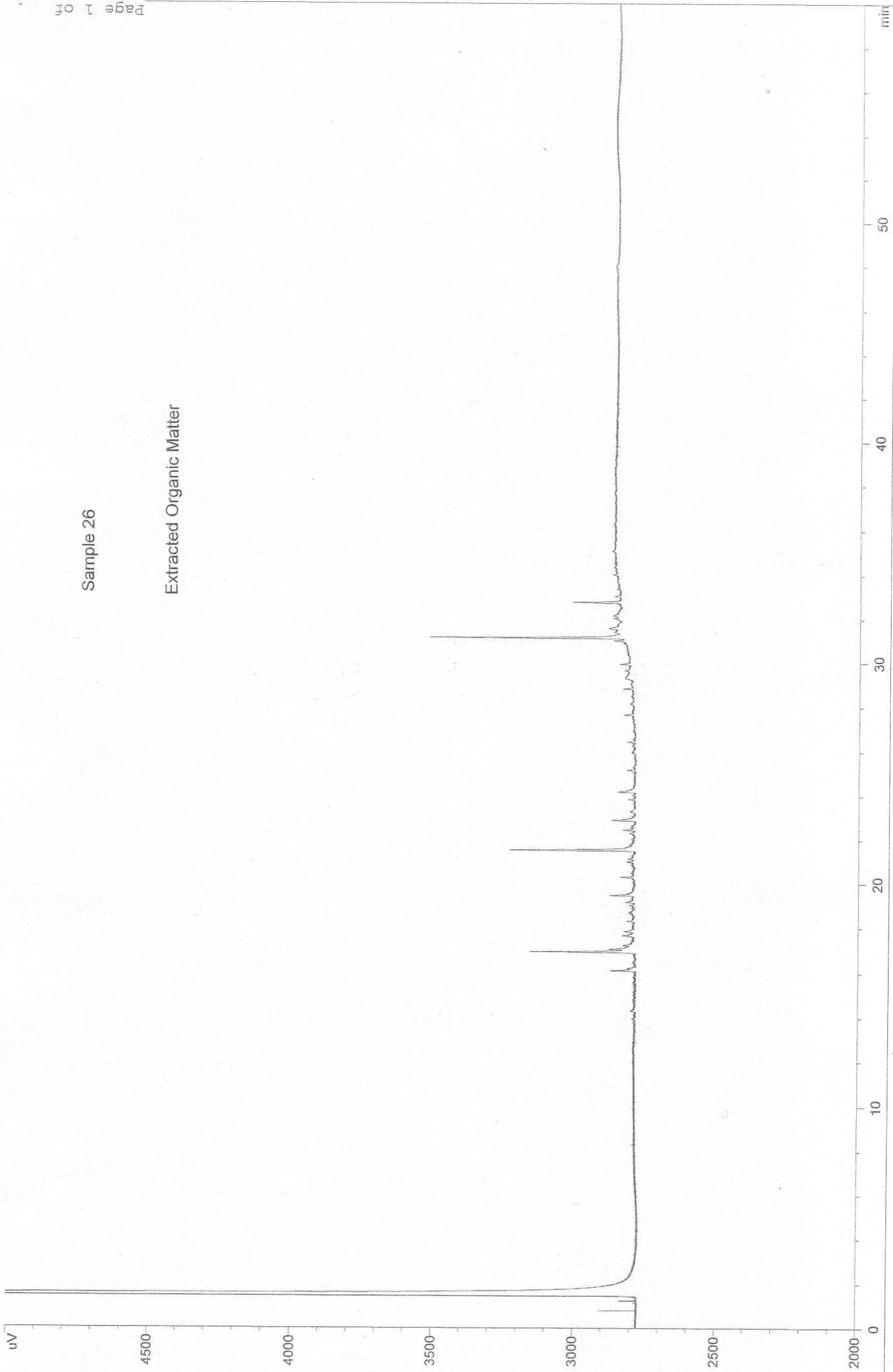


Sample 16
Extracted Organic Matter

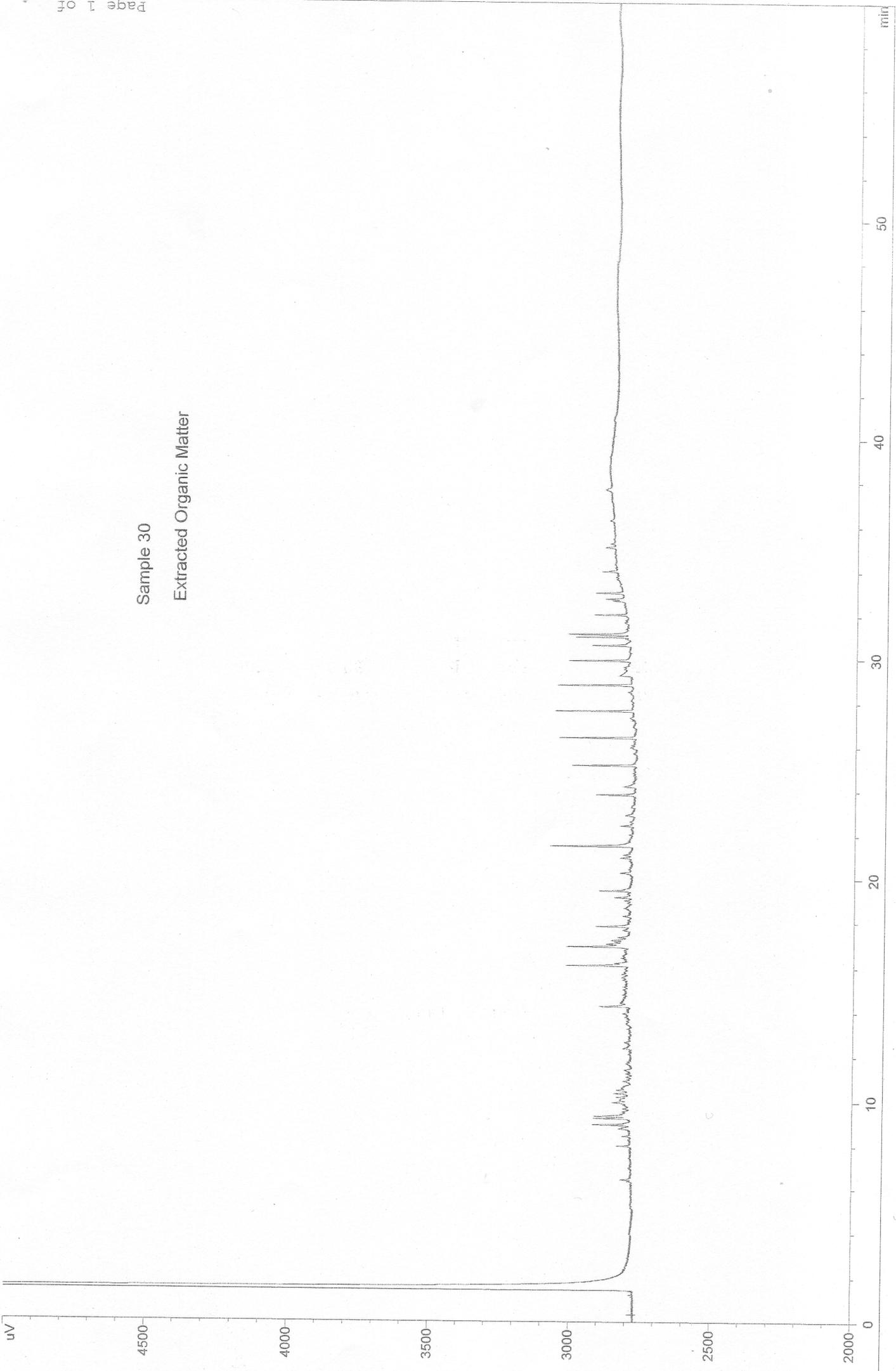


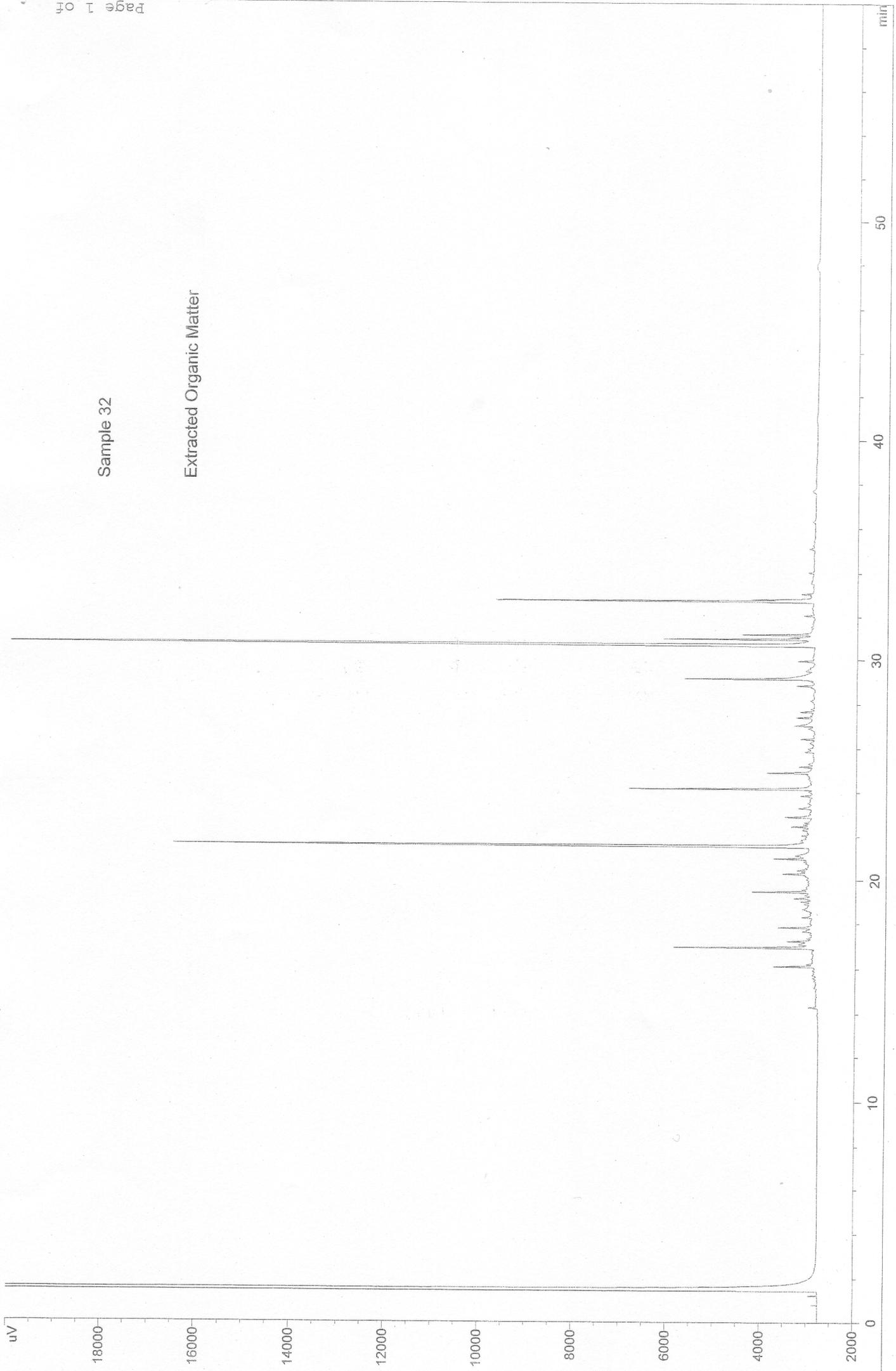
Sample 26

Extracted Organic Matter



Sample 30
Extracted Organic Matter





20 May 2003

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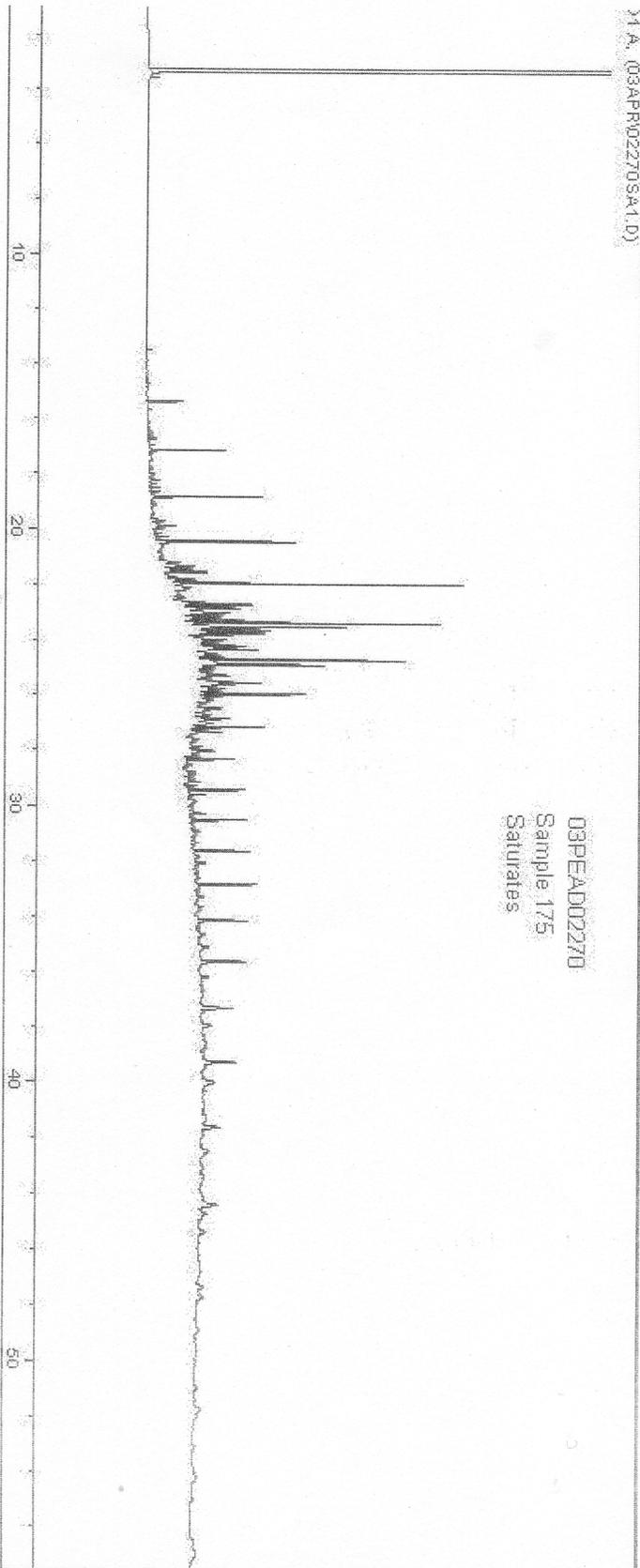
Attention: Alan Chester

Project 03PEAD02270

Customer Sample ID 175

Test/Reference	Unit	
Alkane Ratios		
Norpristane/Pristane		0.48
Pristane/Phytane		1.39
Pristane/n-heptadecane		0.58
Phytane/n-octadecane		0.53
Chromatogram Saturates		Attached
Extn Organic Matter		
EOM in Total Sample	mg/kg	28
Referred Tests		
Results		Attached
Liquid Chrom of EOM		
Total Saturates	%	38
Total Aromatics	%	19
Total NSO	%	43

175 Saturates



Authorised By: Carmelina Valente
Petroleum Chemist

Signature:



Final Report

- Indicates Not Requested

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The samples were not collected by Amdel staff.

TABLE 1

BIOMARKER PARAMETERS OF SOURCE, MATURITY, MIGRATION AND BIODEGRADATION, ATP-269-P(1) OILS

Sample	Steranes							Terpanes							Acyclic Alkanes	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
#175	30	1.55	1.91	1.01	1.24	1.03	0.30	0.26	0.33	0.65	0.20	1.36	0.13	1.39	0.58	0.53

- = not determined

KEY TO BIOMARKER PARAMETERS OF SOURCE, MIGRATION AND BIODEGRADATION

Parameter	Derivation*	Specificity
1	$C_{27}:C_{28}:C_{29} 5\alpha(H)14\alpha(H)17\alpha(H) 20R$ steranes	Source
2	$C_{29} 5\alpha(H)14\alpha(H)17\alpha(H) 20R$ sterane/ $C_{27} 5\alpha(H)14\alpha(H)17\alpha(H) 20R$ sterane	Source
3	$C_{29} 13\beta(H)17\alpha(H) 20R$ diasterane/ $C_{27} 13\beta(H)17\alpha(H) 20R$ diasterane	Source
4	$C_{29} 5\alpha(H)14\alpha(H)17\alpha(H) 20S$ sterane/ $C_{29} 5\alpha(H)14\alpha(H)17\alpha(H) 20R$ sterane	Maturity, Biodegradation
5	$C_{27} 13\beta(H)17\alpha(H) 20S$ diasterane/ $C_{27} 13\beta(H)17\alpha(H) 20R$ diasterane	Maturity
6	$C_{29} 5\alpha(H)14\beta(H)17\beta(H) 20R$ sterane/ $C_{29} 5\alpha(H)14\alpha(H)17\alpha(H) 20R$ sterane	Maturity, Migration
7	$C_{29} 13\beta(H)17\alpha(H) 20R+20S$ diasteranes/ $C_{29} 5\alpha(H)$ steranes	Migration, Source
8	$18\alpha(H)-30$ -normeohopane ($C_{29}Ts$)/ $C_{29} 17\alpha(H)$ hopane + $C_{29}Ts$	Maturity, Source
9	$17\alpha(H)$ diahopane/ $18\alpha(H)-30$ -normeohopane ($C_{30}^*/C_{29}Ts$)	Source, Maturity
10	$C_{27} 18\alpha(H)-22,29,30$ -trisorhopane (Ts)/ $C_{27} 17\alpha(H)-22,29,30$ -trisorhopane (Tm) + Ts	Maturity, Source
11	$T_s/C_{30} 17\alpha(H)21\beta(H)$ hopane	Maturity
12	$C_{32} 17\alpha(H)21\beta(H) 22S$ homohopane/ $C_{32} 17\alpha(H)21\beta(H) 22R$ homohopane	Maturity
13	$C_{30} 17\beta(H)21\alpha(H)$ moretane/ $C_{30} 17\alpha(H)21\beta(H)$ hopane	Maturity
14	pristane/phytane	Source
15	pristane/n-heptadecane	Source, Biodegradation, Maturity
16	phytane/n-octadecane	Source, Biodegradation, Maturity

* Ratios calculated from peak areas as follows:

Parameters	1-7	$m/z = 217, 218, 259$	mass fragmentograms
Parameters	8-13	$m/z = 191$	mass fragmentogram
Parameters	14-16		capillary gas chromatogram of alkanes or whole oil/extract

TABLE 2

AROMATIC MATURITY DATA

Depth (m)	MPI	MPR	DNR	MPDF	VR CALC (%)					
					A	B	C	D	E	F
#175	0.781	1.707	-	0.582	0.87	1.83	1.17	-	0.77	1.14

KEY TO AROMATIC MATURITY INDICATORS

Methylphenanthrene index (MPI), methylphenanthrene ratio (MPR), dimethylnaphthalene ratio (DNR) and calculated vitrinite reflectance (VR_{calc}) are derived from the following equations (after Radke and Welte, 1983; Radke *et al.*, 1984):

$$\begin{aligned} \text{MPI} &= \frac{1.5(2\text{-MP} + 3\text{-MP})}{\text{P} + 1\text{-MP} + 9\text{-MP}} \\ \text{VR}_{calc} \text{ (a)} &= 0.6 \text{ MPI} + 0.4 \text{ (for VR} < 1.35\%) \\ \text{VR}_{calc} \text{ (b)} &= -0.6 \text{ MPI} + 2.3 \text{ (for VR} > 1.35\%) \\ \text{MPR} &= \frac{2\text{-MP}}{1\text{-MP}} \\ \text{VR}_{calc} \text{ (c)} &= 0.99 \log_{10} \text{ MPR} + 0.94 \text{ (VR} = 0.5\text{-}1.7\%) \\ \text{DNR} &= \frac{2,6\text{-DMN} + 2,7\text{-DMN}}{1,5\text{-DMN}} \\ \text{VR}_{calc} \text{ (d)} &= 0.46 \text{ DNR} + 0.89 \text{ (for VR} = 0.9\text{-}1.5\%) \end{aligned}$$

Where	P	=	phenanthrene
	1-MP	=	1-methylphenanthrene
	2-MP	=	2-methylphenanthrene
	3-MP	=	3-methylphenanthrene
	9-MP	=	9-methylphenanthrene
	1,5-DMN	=	1,5-dimethylnaphthalene
	2,6-DMN	=	2,6-dimethylnaphthalene
	2,7-DMN	=	2,7-dimethylnaphthalene

Peak areas measured from m/z 156 (dimethylnaphthalene), m/z 178 (phenanthrene) and m/z 192 (methylphenanthrene) mass fragmentograms of diaromatic and triaromatic hydrocarbon fraction isolated by thin layer chromatography.

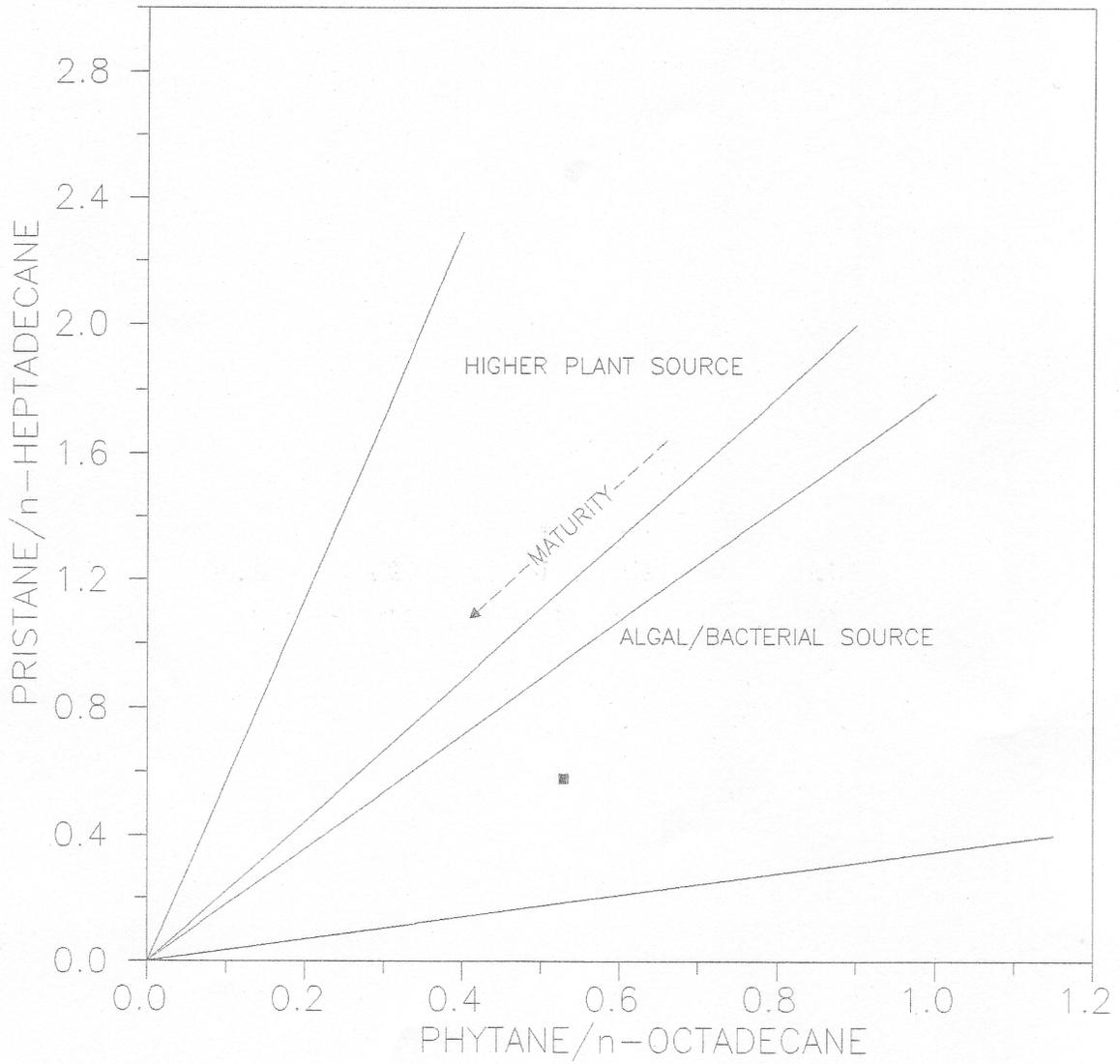
Recalibration of the methylphenanthrene index using data from a suite of Australian coals has given rise to another equation for calculated vitrinite reflectance (after Boreham *et al.*, 1988):

$$\text{VR}_{calc} \text{ (e)} = 0.7 \text{ MPI} + 0.22 \text{ (for VR} < 1.7\%)$$

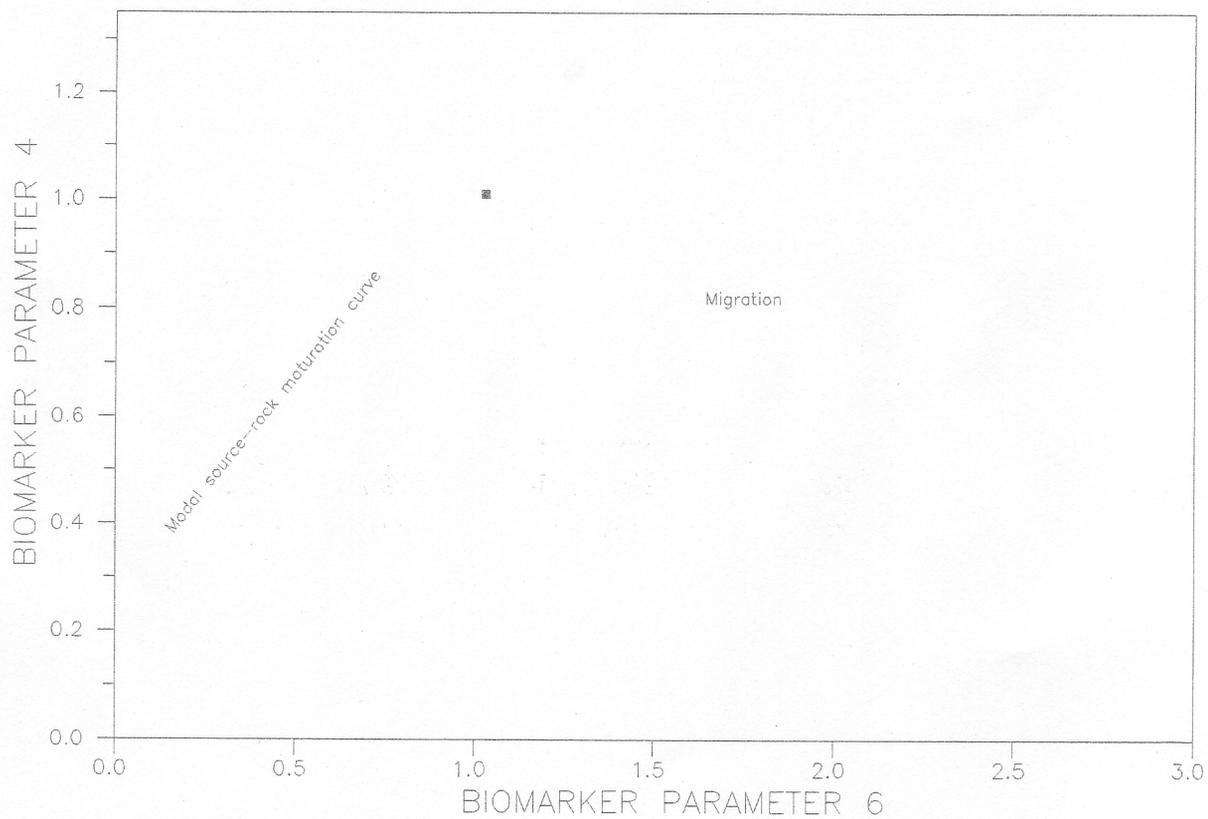
The methylphenanthrene distribution ratio (MPDF) and calculated vitrinite reflectance VR_{calc} (f) is derived from the following equation (after Kvalheim *et al.*, 1987):

$$\begin{aligned} \text{MPDF} &= \frac{(2\text{-MP} + 3\text{-MP})}{(2\text{-MP} + 3\text{-MP} + 1\text{-MP} + 9\text{-MP})} \\ \text{VR}_{calc} \text{ (f)} &= -0.166 + 2.242 \text{ MPDF} \end{aligned}$$

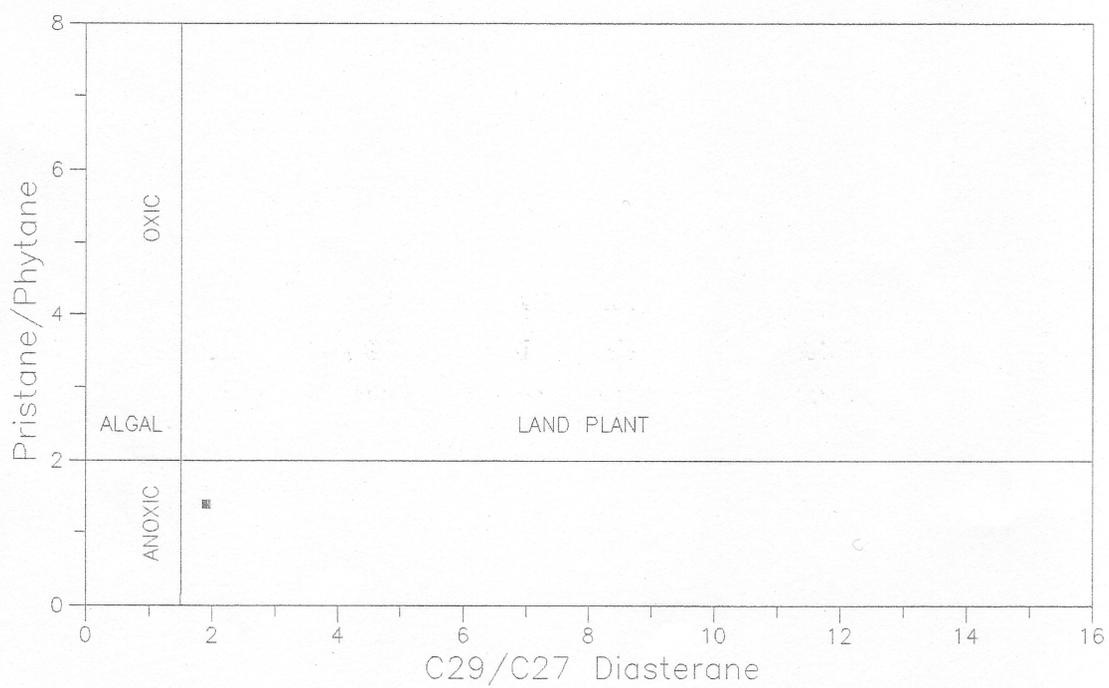
Sample 175
GENETIC AFFINITY AND MATURITY



29 STERANE MATURITY – MIGRATION PLOT
Sample 175



Sample 175
OIL SOURCE AFFINITY



STERANE DISTRIBUTIONS
Sample 175

