



**LOCH ARD-1, VIC/P31
Well Completion Report
Interpretive**



OTWAY BASIN, VIC/P31

LOCH ARD-1

INTERPRETIVE DATA

PREPARED BY: A. MUSTICA
TECHNICAL ASSISTANT

70843_1.WCR

DATE: JUNE 1994

BHP PETROLEUM PTY. LTD.
A.C.N. 006 918 832

Acknowledgements

This report was compiled and written with the help of the following:

- 1 Simon Horan, Basin Explorationist,
- 2 Chris Luxton, Petroleum Geophysicist,
- 3 Mark Lemaire, Database Administrator.

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HYDROCARBON CHARACTERISATION STUDY:

LOCH ARD-1

Preface

Following the drilling of Loch Ard-1 in 1993, a program of geochemical analyses was performed on samples from the well by Geotechnical Services (Geotech) Pty. Ltd. The report which follows represents an interpretation of the Loch Ard-1 geochemical data. The text of the report was prepared by Geotech on behalf of BHP Petroleum.

The figures which follow the text were prepared by BHP Petroleum; whilst they are not referred to directly in the text, they are intended as an additional interpretative aid to the reader.

PETROLEUM DIVISION

**HYDROCARBON
CHARACTERISATION STUDY
LOCH ARD-1**

Prepared for:

BHP Petroleum Pty Limited

July 1994

HYDROCARBON CHARACTERISATION STUDY LOCH ARD-1

1. Introduction and Analytical Procedures

Two sidewall cores (1050m, 1154m) from the well Loch Ard-1, drilled by BHP Petroleum in Vic/P31 in the Otway Basin, were solvent extracted and analysed by gas chromatography of the whole extract in an attempt to characterise the nature of their hydrocarbons.

Eleven SWCs between 548.5m and 1326m depth were submitted to vitrinite reflectance measurements and maceral characterisation.

The samples analysed are from the following formations:

<u>Sample depth (m)</u>	<u>Formation</u>	<u>Age</u>
548.5	Sherbrook	Late Cretaceous
668-1027	Upper Shipwreck	Late Cretaceous
1150-1128	Lower Shipwreck	Late Cretaceous
1326	Otway	Early Cretaceous

Analytical results are presented in the following figures and tables:

Type of Analysis	Figure	Table
Solvent extraction	1	1
Whole extract GC	2	2,3
Vitrinite reflectance/ maceral description	3	4,5

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

2. General Information

One copy of this report has been sent to Jim Preston from BHP Petroleum Pty 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 BHP Petroleum Pty 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.

3. Results and Interpretation

3.1 Extraction and Gas Chromatography

Upon solvent extraction, only 66.9 ppm of total extract were obtained for sample 1050m and no further analysis was performed due to the low level of free hydrocarbons present.

For sample 1154m, solvent extraction yielded 414.4 ppm of total extract which was sufficient for gas chromatography of the whole extract.

The overall picture of its GC trace, however, was inconclusive and did not allow any meaningful characterisation of these hydrocarbons.

A pronounced baseline hump in the high molecular weight range may suggest a biodegraded residue. Alternatively this unresolved complex mixture of compounds under the hump may reflect a drilling additive.

3.2 Vitrinite Reflectance

Measured vitrinite reflectance values increase steadily from 0.35% at 548.5m to 0.54% at 1205m and characterise this section as immature to possibly just marginally mature in the deeper part.

No vitrinite is present at 1228m and the V_R value measured at 1326m is only 0.41%. The reason for the low reflectance in this sample is not clear. On the other hand it is possible that the value of 0.54% obtained for 1205m is anomalously high, as this sample contains high proportions of inertinite, compared with 1186m and 1326m.

LC HD 1 / PE 900439 / P 62

TABLE 1

SUMMARY OF EXTRACTION AND LIQUID CHROMATOGRAPHY - SEDIMENTS

WELL NAME = LOCH ARD-1
 COUNTRY = Australia
 BASIN = Otway

DEPTH UNIT = Metres
 DATE OF JOB =

DEPTH 1	DEPTH 2	WEIGHT OF ROCK EXT (grams)	TOTAL EXTRACT (ppm)	LOSS ON COLUMN (ppm)	% REC.	SATURATES (ppm)	AROMATICS (ppm)	POLARS (ppm)	SATURATES (rel %)	AROMATICS (rel %)	POLARS (rel %)	EOM(mg)/ TOC(g)	SAT(mg)/ TOC(g)	SAT/ AHOM	HC/ non-HC
1050.00	1050.00	13.50	66.9	-	-	-	-	-	-	-	-	-	-	-	-
1154.00	1154.00	14.50	414.4	-	-	-	-	-	-	-	-	-	-	-	-

EOM = Extractable organic matter
 AROM = Aromatic compounds

POLARS = Polar (Asphaltenes + resins)
 HC = Hydrocarbon

TOC = Total organic carbon
 REC. = Recovered

SAT = Saturated compounds
 - = no data

LOCH ARD-1 Total Extract Yield vs Depth

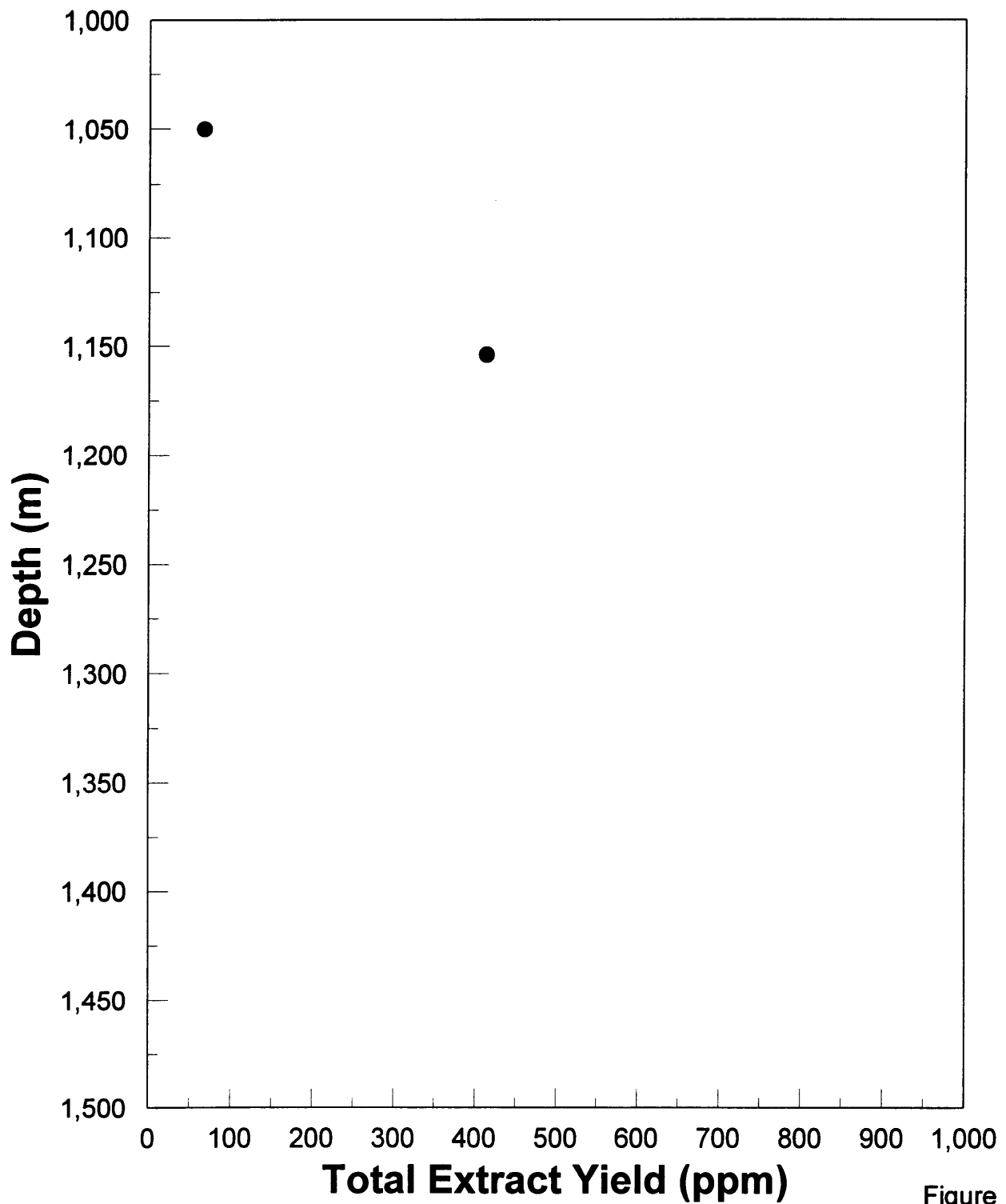


Figure 1

LCHD1 / PE900439 / P64

LOCH ARD 1, 1154.0m, SWC
Whole Extract
C12+ GLC

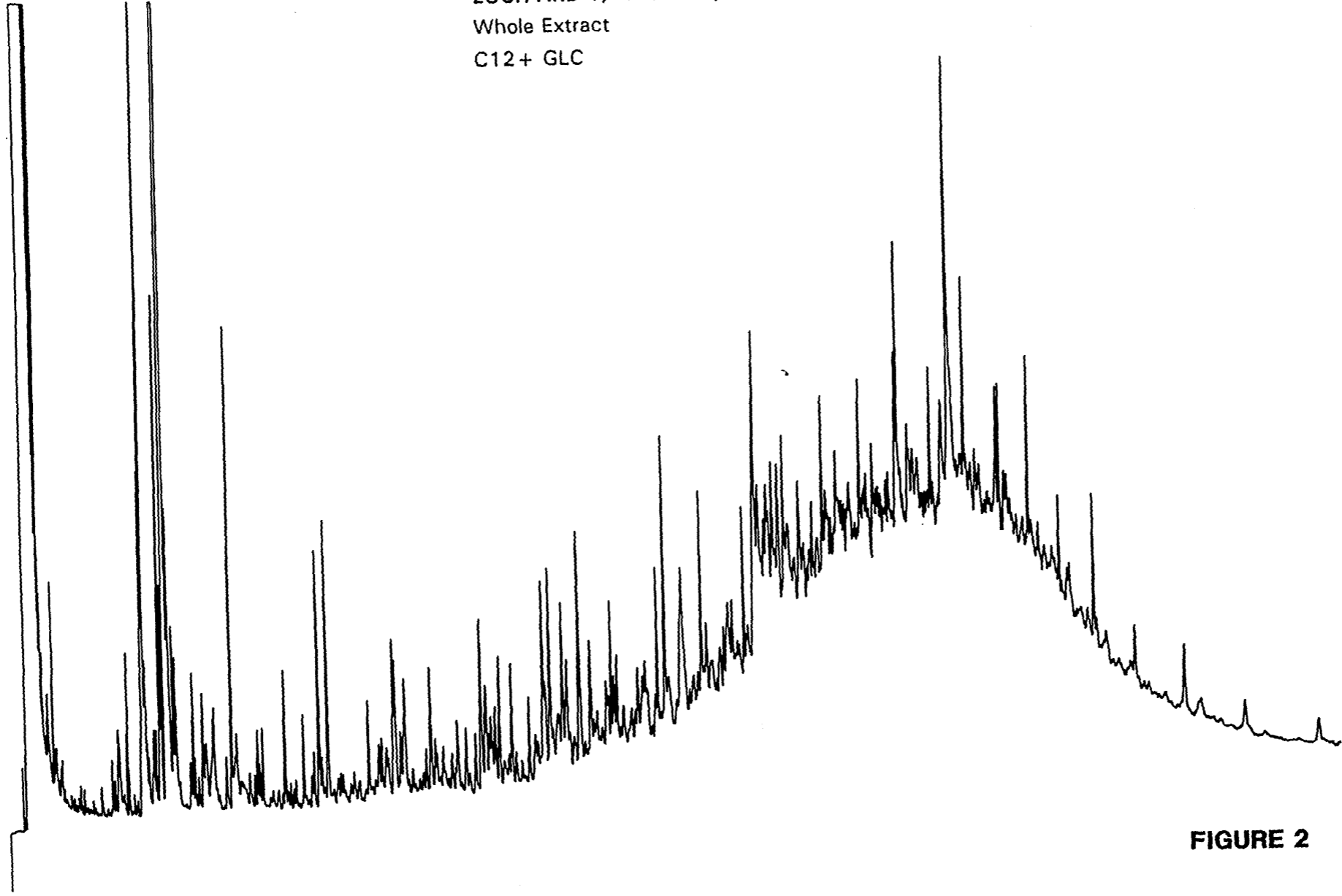


FIGURE 2

GEOTECHNICAL SERVICES PTY LTD

2033001

TABLE 2

SUMMARY OF GAS CHROMATOGRAPHY DATA - SEDIMENTS
ALKANE DISTRIBUTIONS

WELL NAME = LOCH ARD-1																DEPTH UNIT = Metres												
COUNTRY = Australia																DATE OF JOB =												
BASIN = Otway																												
DEPTH 1	DEPTH 2	nC12	nC13	nC14	TMTD	nC15	nC16	iC18	nC17	iC19	nC18	iC20	nC19	nC20	nC21	nC22	nC23	nC24	nC25	nC26	nC27	nC28	nC29	nC30	nC31	nC32	nC33	
1050.00		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1154.00		1050.00																										

i = iso n = normal N.B. Values are relative %
 - = no data TMTD = Trimethyltridecane

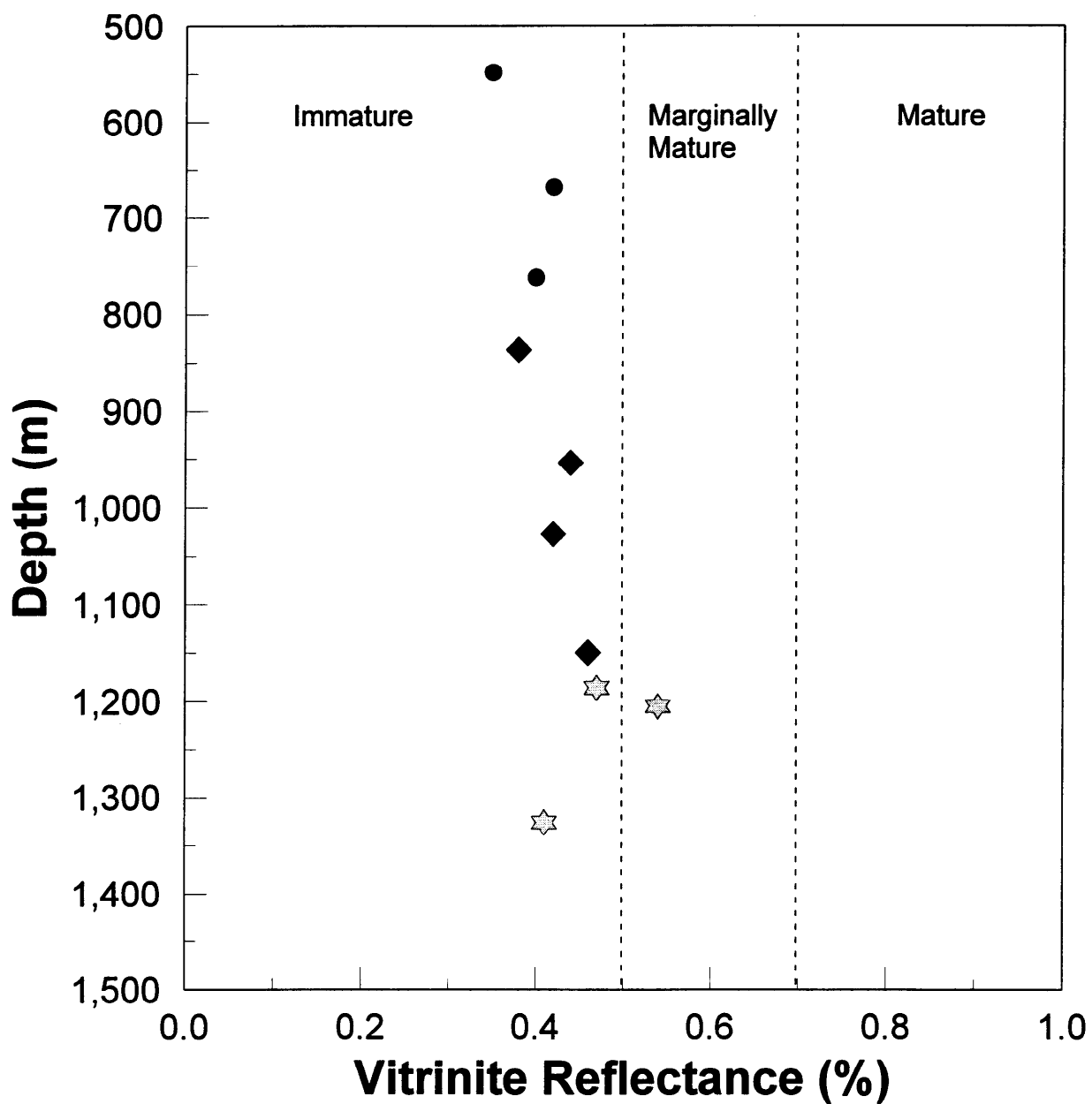
TABLE 3

SUMMARY OF GAS CHROMATOGRAPHY DATA - SEDIMENTS
 ALKANE COMPOSITIONAL DATA

WELL NAME	DEPTH 1	DEPTH 2	ANALYSIS TYPE	PRISTANE/PHYTANE	PRISTANE/n-C17	PHYTANE/n-C18	TMTD/PRISTANE	CPI (I)	CPI (II)	DEPTH UNIT
LOCH ARD-1										= Metres
COUNTRY = Australia	1050.00	1050.00								DATE OF JOB =
BASIN = Otway	1154.00	1154.00								

 CPI = Carbon preference index TMTD = Trimethyltridecane - = no data
 SF = Saturate fraction WE = Whole extract

LOCH ARD-1 Vitrinite Reflectance vs Depth



SHERGP SHIPGP OTWAGP

● ◆ ☆

Figure 3

JOB No.# 2030A, LOCH ARD-1, OTWAY BASIN.

KK/Ref. No.	Depth(m) Type	\bar{R}_v max	Range	N	Description Including Liptinite (Exinite) Fluorescence
v9199 SWC23	548.5	0.35	0.29-0.43	26	Sparse cutinite, resinite and liptodetrinite, yellow to orange, rare sporinite, yellow to orange. (Sandstone>>Coal. Coal sparse, I>V>>L, inertite>vitrite. Dom abundant, I>V>>L. Inertinite abundant, vitrinite common, liptinite sparse. Mineral fluorescence pervasive, faint green to weak orange. Iron oxides common. Pyrite abundant.)
v9200 SWC18	668.0	0.42	0.31-0.52	26	Sparse sporinite, yellow to orange, rare cutinite, resinite, lamalginate and liptodetrinite, yellow to orange. (Clayey siltstone>sandstone>>carbonate. Dom abundant, I>V>L. Inertinite common, vitrinite and liptinite sparse. Mineral fluorescence pervasive, faint green to weak orange. Iron oxides common. Glauconite abundant. Pyrite abundant.)
v9201 SWC15	762	0.40	0.30-0.52	26	Sparse cutinite and liptodetrinite, yellow to dull orange, rare sporinite, resinite and lamalginate, yellow to dull orange. (Calcareous siltstone>carbonate>coal. Coal rare, V>I>>L, vitrite. Dom abundant, I>V>L. Inertinite abundant, vitrinite common, liptinite sparse. Shell fragments sparse. Mineral fluorescence pervasive, faint green. Iron oxides abundant. Pyrite abundant.)
v9202 SWC10	837	0.38	0.31-0.48	25	Sparse cutinite and liptodetrinite, yellow to dull orange, rare resinite, sporinite and lamalginate, yellow to dull orange. (Sandstone>carbonate>>coal. Coal rare, V>I>>L, vitrite>inertite. Dom abundant, I>V>>L. Inertinite abundant, vitrinite common, liptinite sparse. Shell fragments rare. Mineral fluorescence pervasive, faint green. Iron oxide common. Glauconite rare. Pyrite abundant.)
v9203 SWC60	954	0.44	0.36-0.50	28	Sparse lamalginate, bright yellow to orange, rare liptodetrinite yellow to orange. (Calcareous clayey siltstone>>coal. Coal sparse, V only. Vitrite. Texturally, the coal is immature to moderately mature ulminite with cell structures and some remnant cell lumens. Dom common, V>L>I. All three maceral groups sparse. Oil drops rare, bright greenish yellow. Mineral fluorescence pervasive, dull orange. Iron oxides common. Pyrite rare.)
v9204 SWC55	1027	0.42	0.36-0.48	26	Common cutinite, yellow to dull orange, sparse lamalginate, and liptodetrinite, yellow to orange, rare resinite, greenish yellow, rare sporinite, yellow to orange. (Calcareous clayey siltstone>>coal. Coal rare, V>>I. Inertite>vitrite. Dom abundant, I>V>L. Inertinite and vitrinite abundant, liptinite common. Bitumen rare, orange. Mineral fluorescence pervasive, dull orange. Iron oxides abundant. Pyrite sparse.)

JOB # 2030A, LOCH ARD-1, OTWAY BASIN

KK/Ref. No.	Depth(m) Type	\bar{R}_V max	Range	N	Description Including Liptinite (Exinite) Fluorescence
v9205	1150 SWC48	0.46	0.42-0.52	25	Common cutinite, yellow to orange, sparse sporinite and liptodetrinite, yellow to orange, sparse resinite, yellow, sparse suberinite, weak brown. (Clayey siltstone>>coal. Coal common, V>I>L. Vitrite>inertite. Dom abundant, V>I>L. Vitrinite abundant, inertinite and liptinite common. Mineral fluorescence pervasive, dull orange. Iron oxides common. Pyrite sparse.)
v9206	1186 SWC44	0.47	0.42-0.53	26	Abundant cutinite and liptodetrinite, yellow to dull orange, abundant resinite, greenish yellow, abundant sporinite, yellow to orange. (Coal>shaly coal. Coal dominant, V>L>>I. Vitrite>clarite. Mineral-free maceral group composition of the coal: vitrinite - 89.5%, inertinite - <0.1%, liptinite - 10.5%. Shaly coal dominant, V>L>>I. Clarite. Some open lumens present within telovitrinite, but coal is early mature in textural terms. Mineral-free maceral group composition of the shaly coal: vitrinite - 53.8%, inertinite - <0.1%, liptinite - 46.2%. Exsudatinite rare, yellow to orange. Iron oxides sparse. Pyrite sparse.)
v9207	1205 SWC40	0.54	0.48-0.65	28	Common cutinite, yellow to dull orange, common sporinite, yellow to orange, sparse resinite, greenish yellow, sparse liptodetrinite, greenish yellow to dull orange. (Clayey siltstone>>coal. Coal common, V>>I>L. Vitrite>clarite. Dom abundant, I>V>L. All three maceral groups abundant. Bitumen sparse, dull orange. Mineral fluorescence pervasive, weak brown. Iron oxides sparse. Pyrite abundant.)
v9208	1228 SWC38	\bar{R}_I max 1.51	1.07-2.02	5	Fluorescing liptinite absent. (Sandstone. Dom rare, I only. Mineral fluorescence patchy, weak orange. Iron oxides common. Pyrite sparse.)
v9209	1326 SWC32	0.41	0.35-0.48	28	Rare cutinite, sporinite and liptodetrinite, yellow to orange, rare resinite, greenish yellow. (Sandstone>>coal. Coal sparse, V only. Vitrite. Dom sparse, V>L>I. Vitrinite sparse, liptinite and inertinite rare. Mineral fluorescence pervasive, dull green. Iron oxides abundant. Pyrite sparse.)

The causes for low reflectances from SWC 32 are not clear. The vitrinite populations in samples v9207 and v9209 are both well defined. v9207 contains leaf tissue that would be expected to yield below average reflectances. Some leaf tissue is present in v9209 but the presence of mesophyll does not seem to be the cause of the low values for v9209. If a sample has been incorrectly labelled, this may be clear from the lithology as SWC 32 is a much more sandy lithology than most of the other SWC samples. It is also possible that v9207 is anomalously high, the sample containing a high proportion of inertinite compared with v9209 and v9206.

TABLE 5

VITRINITE REFLECTANCE AND COAL MACERAL IDENTIFICATION

WELL: LOCH ARD-1

CLIENT: BHP PETROLEUM PTY LTD

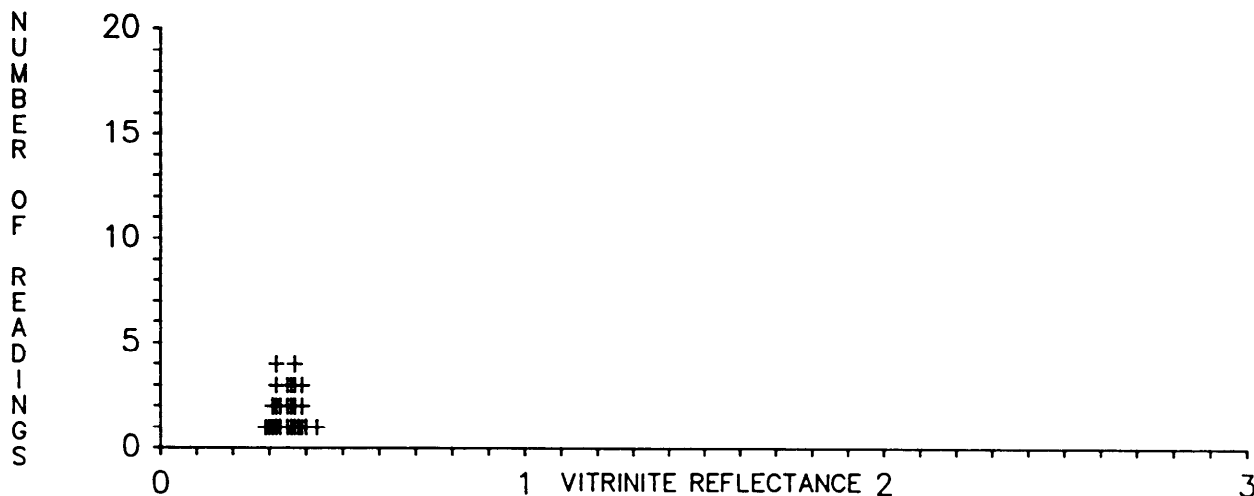
SAMPLE TYPE: SWC

SAMPLE ID: 548.5 METRES

DATE: APRIL 1994

(Total No. of Readings=26) 0.29 0.30 0.31 0.31 0.32 0.32 0.32 0.32 0.33 0.33 0.35 0.35 0.35 0.36 0.36 0.36 0.37
0.37 0.37 0.37 0.38 0.39 0.39 0.39 0.40 0.43

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	26	0.35	0.29	0.43	0.03	INDIGENOUS(+)	32.88	63.01	4.11	0.00



SAMPLE ID: 668.0 METRES

SAMPLE TYPE: SWC

(Total No. of Readings=26) 0.31 0.33 0.34 0.36 0.37 0.38 0.39 0.39 0.39 0.39 0.39 0.40 0.41 0.41 0.43 0.43 0.44
0.45 0.45 0.45 0.46 0.47 0.47 0.48 0.48 0.52

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	26	0.42	0.31	0.52	0.05	INDIGENOUS(+)	9.52	85.72	4.76	0.00

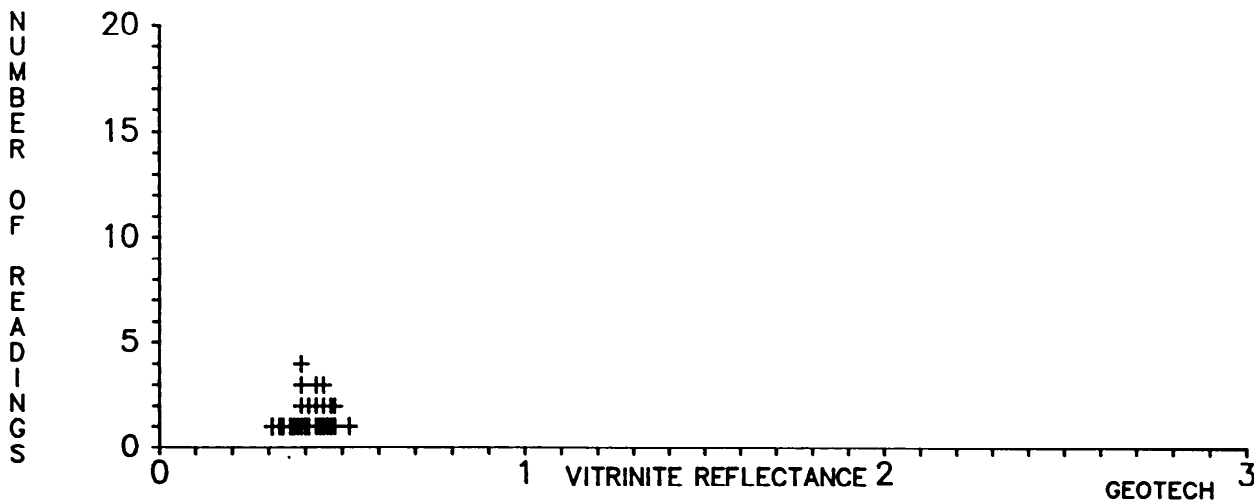


TABLE 5 (contd)

VITRINITE REFLECTANCE AND COAL MACERAL IDENTIFICATION

WELL: LOCH ARD-1

CLIENT: BHP PETROLEUM PTY LTD

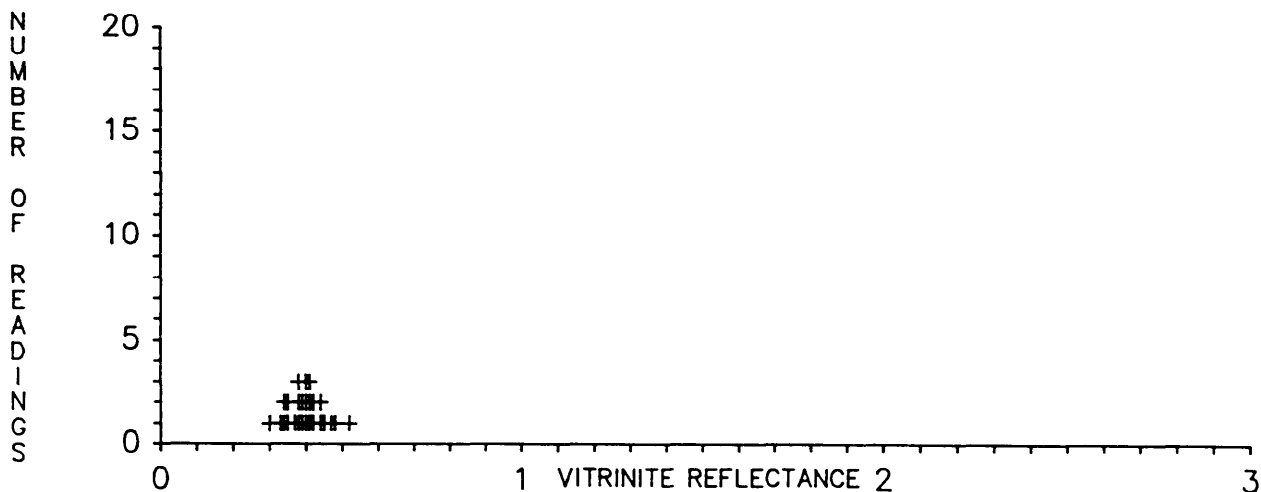
SAMPLE TYPE: SWC

SAMPLE ID: 762.0 METRES

DATE: APRIL 1994

(Total No. of Readings=26) 0.30 0.33 0.34 0.34 0.35 0.35 0.37 0.38 0.38 0.38 0.39 0.39 0.40 0.40 0.40 0.41 0.41
0.41 0.42 0.42 0.44 0.44 0.45 0.47 0.48 0.52

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	26	0.40	0.30	0.52	0.05	INDIGENOUS(+)	21.88	68.74	9.38	0.00



SAMPLE ID: 837.0 METRES

SAMPLE TYPE: SWC

(Total No. of Readings=25) 0.31 0.31 0.32 0.34 0.34 0.35 0.36 0.37 0.37 0.38 0.38 0.39 0.39 0.40 0.40 0.40 0.40
0.41 0.41 0.41 0.41 0.41 0.43 0.45 0.48

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	25	0.38	0.31	0.48	0.04	INDIGENOUS(+)	40.00	55.56	4.44	0.00

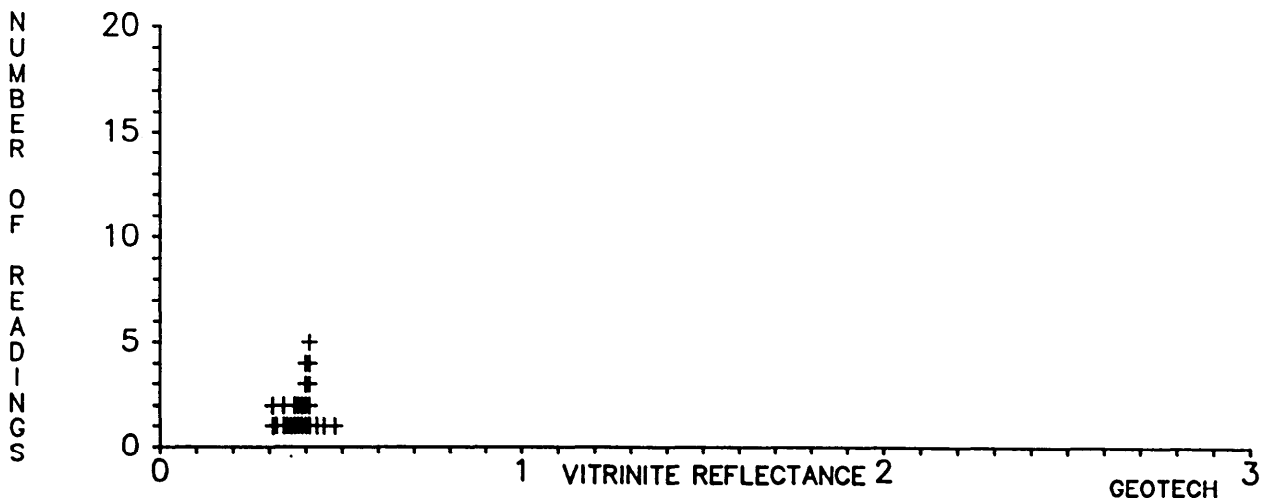


TABLE 5 (contd)

VITRINITE REFLECTANCE AND COAL MACERAL IDENTIFICATION

WELL: LOCH ARD-1

CLIENT: BHP PETROLEUM PTY LTD

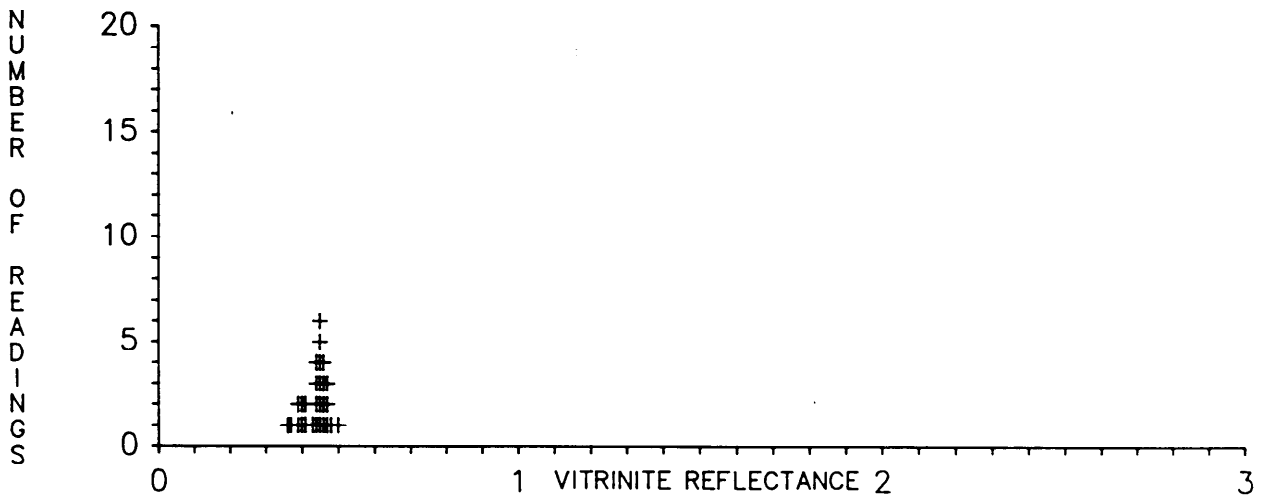
SAMPLE TYPE: SWC

SAMPLE ID: 954.0 METRES

DATE: APRIL 1994

(Total No. of Readings=28) 0.36 0.37 0.39 0.39 0.40 0.40 0.41 0.41 0.43 0.44 0.44 0.44 0.44 0.45 0.45 0.45 0.45
0.45 0.45 0.46 0.46 0.46 0.46 0.47 0.47 0.47 0.48 0.50

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Oil Drops
1	100.0	28	0.44	0.36	0.50	0.03	INDIGENOUS(+)	50.00	16.67	25.00	8.33



SAMPLE ID: 1027.0 METRES

SAMPLE TYPE: SWC

(Total No. of Readings=26) 0.36 0.36 0.38 0.38 0.38 0.40 0.40 0.40 0.40 0.40 0.42 0.42 0.42 0.42 0.42 0.42 0.42
0.42 0.43 0.43 0.45 0.45 0.45 0.46 0.47 0.48

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	26	0.42	0.36	0.48	0.03	INDIGENOUS(+)	35.21	42.25	21.13	1.41

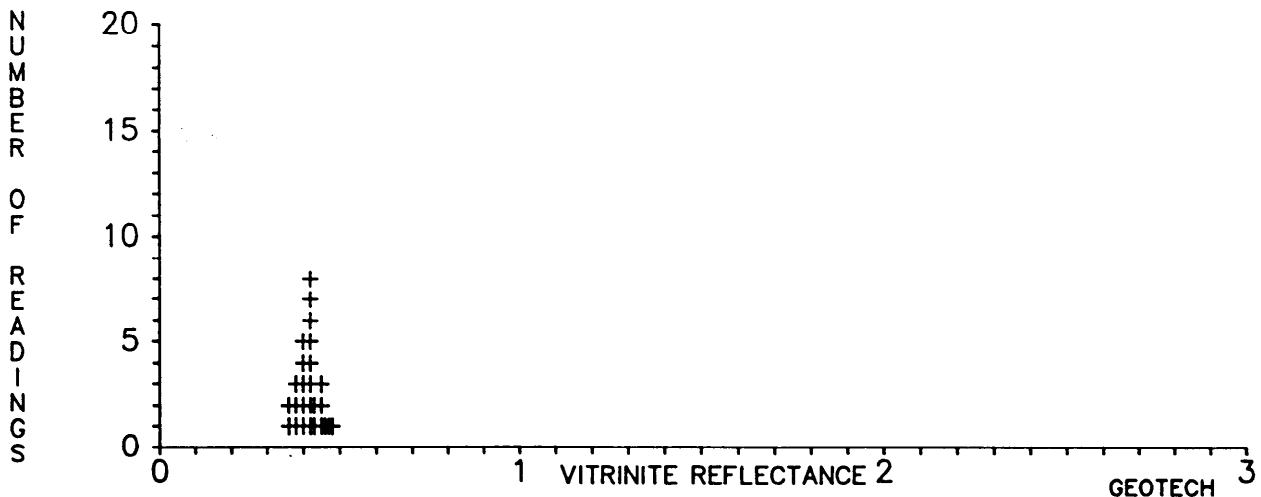


TABLE 5 (contd)

VITRINITE REFLECTANCE AND COAL MACERAL IDENTIFICATION

WELL: LOCH ARD-1

CLIENT: BHP PETROLEUM PTY LTD

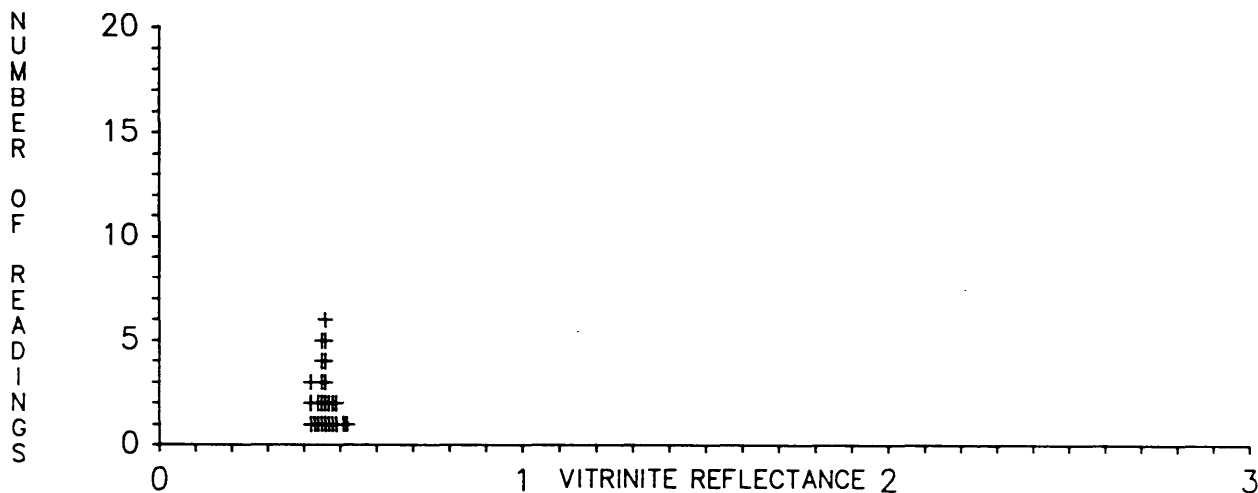
SAMPLE TYPE: SWC

SAMPLE ID: 1150.0 METRES

DATE: APRIL 1994

(Total No. of Readings=25) 0.42 0.42 0.42 0.43 0.44 0.44 0.45 0.45 0.45 0.45 0.46 0.46 0.46 0.46 0.46 0.46
0.47 0.47 0.48 0.48 0.49 0.49 0.51 0.52

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	25	0.46	0.42	0.52	0.03	INDIGENOUS(+)	50.00	27.94	22.06	0.00



SAMPLE ID: 1186.0 METRES

SAMPLE TYPE: SWC

(Total No. of Readings=26) 0.42 0.42 0.43 0.43 0.44 0.44 0.44 0.45 0.45 0.45 0.46 0.46 0.47 0.47 0.48 0.48 0.48
0.49 0.49 0.49 0.50 0.50 0.51 0.52 0.52 0.53

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	26	0.47	0.42	0.53	0.03	INDIGENOUS(+)	82.77	0.11	17.12	0.00

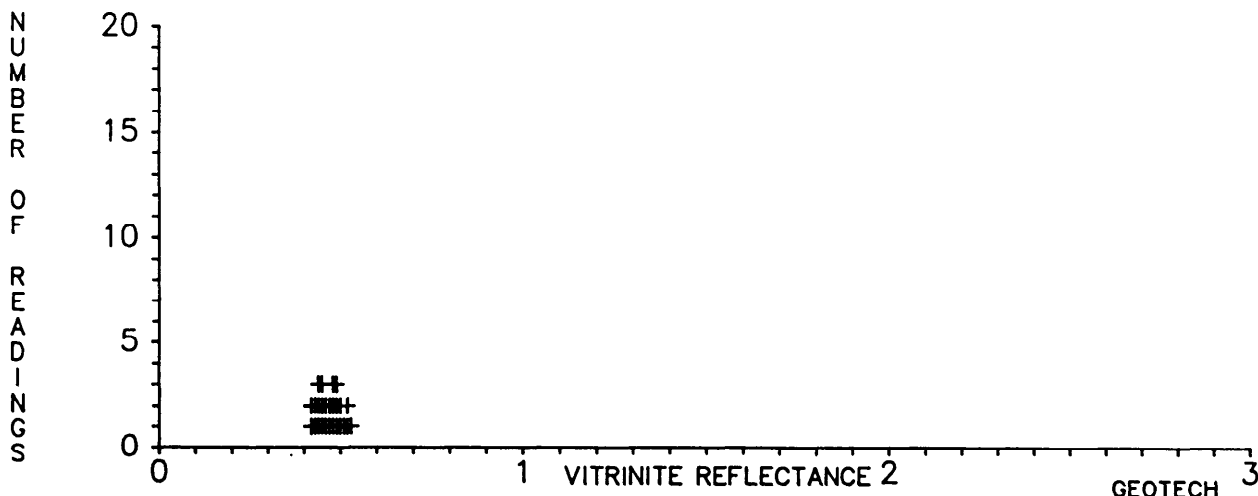


TABLE 5 (contd)

VITRINITE REFLECTANCE AND COAL MACERAL IDENTIFICATION

WELL: LOCH ARD-1

CLIENT: BHP PETROLEUM PTY LTD

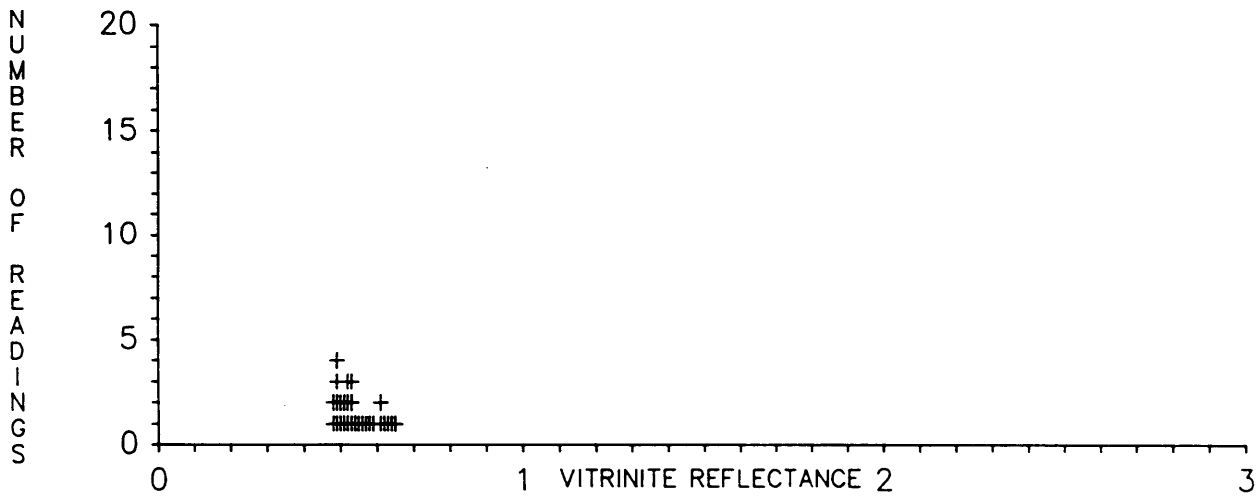
SAMPLE TYPE: SWC

SAMPLE ID: 1205.0 METRES

DATE: APRIL 1994

(Total No. of Readings=28) 0.48 0.48 0.49 0.49 0.49 0.49 0.50 0.50 0.51 0.51 0.52 0.52 0.52 0.53 0.53 0.53 0.54
0.55 0.56 0.57 0.58 0.59 0.61 0.61 0.62 0.63 0.64 0.65

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	28	0.54	0.48	0.65	0.05	INDIGENOUS(+)	34.40	36.80	28.00	0.80



SAMPLE ID: 1228.0 METRES

SAMPLE TYPE: SWC

(Total No. of Readings=5) 1.07 1.10 1.67 1.69 2.02

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	5	1.51	1.07	2.02	0.41	INERTINITE(X)	0.00	100.00	0.00	0.00

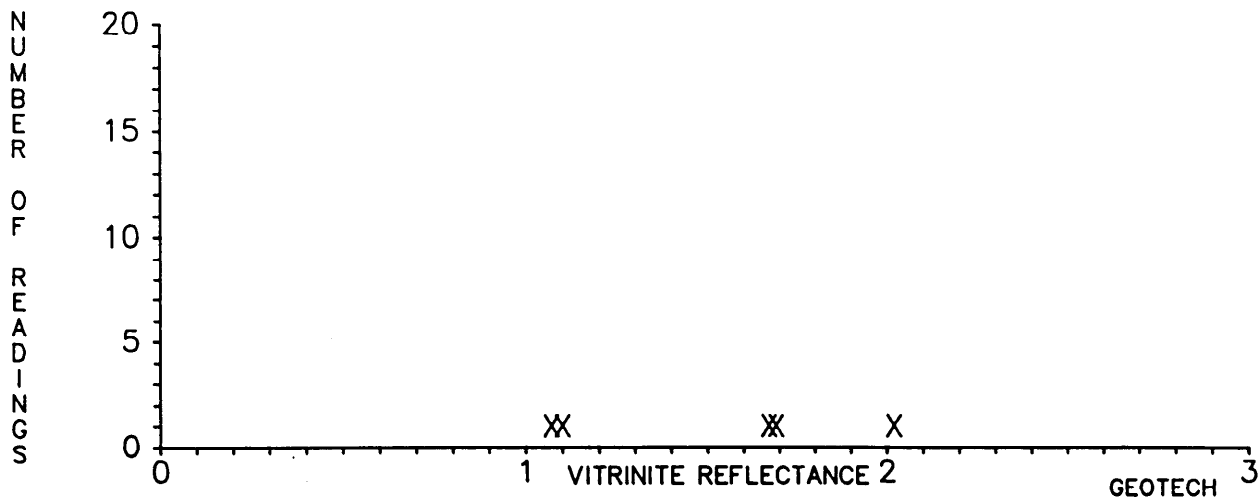


Table 5 (contd)

VITRINITE REFLECTANCE AND COAL MACERAL IDENTIFICATION

WELL: LOCH ARD-1

CLIENT: BHP PETROLEUM PTY LTD

SAMPLE TYPE: SWC

SAMPLE ID: 1326.0 METRES

DATE: APRIL 1994

(Total No. of Readings=28) 0.35 0.35 0.35 0.37 0.38 0.38 0.39 0.39 0.39 0.39 0.40 0.40 0.40 0.41 0.41 0.41 0.41
0.42 0.43 0.43 0.43 0.43 0.43 0.45 0.46 0.46 0.47 0.47 0.48

VITRINITE REFLECTANCE							MACERAL IDENTIFICATION				
POPULATION Number	%	No. of Readings	Mean Ro (%)	Min Ro (%)	Max Ro (%)	STD Dev (%)	Comments	% Vitrinite	% Inertinite	% Liptinite	% Bitumen
1	100.0	28	0.41	0.35	0.48	0.04	INDIGENOUS(+)	60.00	20.00	20.00	0.00

