119001

ANNUAL AND QUARTERLY REPORTS

Year 2

T/20P
Otway Basin

CONTENTS

Volume I Second Quarter Report

Volume II Final Report, Year 2, T20P – Otway Basin

TPR
OR-0124

119002

PETRECON AUSTRALIA PTY. LTD.

Petroleum Exploration Consultants

192 Macquarie Street
Hobart 7000 Australia
Ph. (002) 31 0122
Telex: AA58209

21st March, 1983.

Van Diemans Land Resources N.L.

The Director,
Department of Mines,
P.O. Box 56,
ROSNY PARK.
TASMANIA 7018

D of M	A.O.	C.G.	E.O.	D.S.M.E.
				Registrar
Received 24 MAR 1983 Answered				E & IL
DEPT. OF MINES REF. No. 2364/83				

Dear Sir,

Re: Second Quarter Report, Year 2, T20P

This report covers the period 11th December, 1982 to 10th March, 1983.

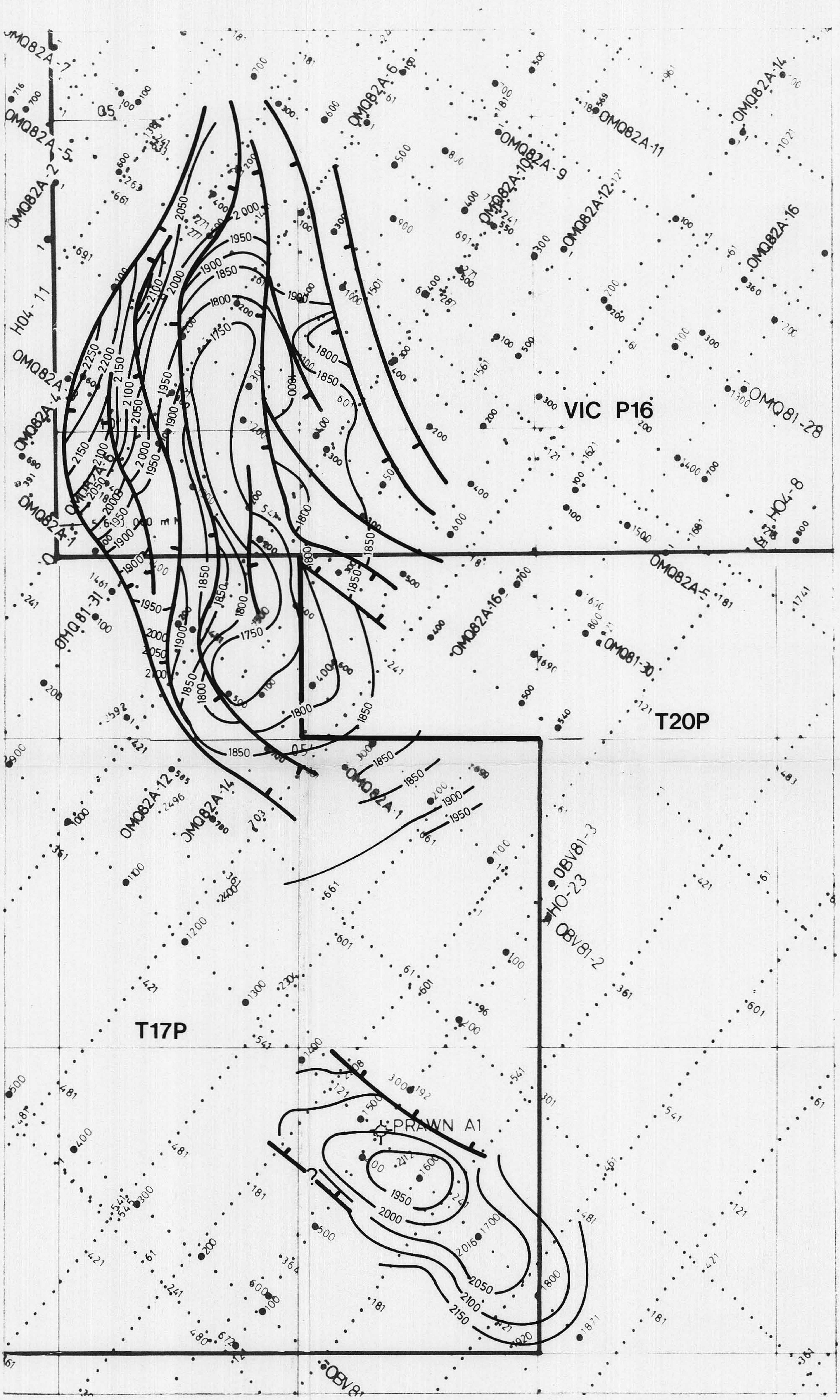
Geophysical

Interpretation of the prospect which overlaps the permits T20P, T17P and Vic P16 was finalised during the report period. A map at the Near Base Sherbrook horizon is included with this report.

The data is presently being reviewed by an operator with a rig in the southwest coastal area.

Yours faithfully,

J. K. DAVIDSON
for:
E.G. ALBERS
CHAIRMAN.



119003

PETRECON AUSTRALIA PTY LTD

OR-0124

OTWAY BASIN (BASS STRAIT OIL & GAS (HOLDINGS) N.L.)	83/1
VIC. P16 TIME STRUCTURE MAP NEAR BASE SHERBROOK GROUP (WAARRE)	COMPILED G.J.B.
	DRAWN M.R.D.
	DATE 11-1-'83
	SCALE 1:100 000
	FIGURE

5 cm

5 cm

VOL. 1.

PETRECON AUSTRALIA PTY. LTD.

Petroleum Exploration Consultants

192 Macquarie Street
Hobart 7000 Australia
Ph. (002) 31 0122
Telex: AA57019

119004

Van Diemens Land Resources N.L.,

Suite 4/67 Palmerston Crescent,

SOUTH MELBOURNE .. VIC .. 3205.

ANNUAL REPORT, YEAR 2, T20P

OTWAY BASIN

TASMANIA

FOR

VAN DIEMENS LAND RESOURCES N.L. CONSORTIUM.

October, 1983.

119005

CONTENTS

List of Plates

	Page No.
Introduction	1.
Geological Programs	2.
Geophysical Programs	3.
Second Permit Year Expenditure	4.
Work Program for Year 3	5.
Reports Submitted During the Second Permit Year	6.

Appendix 1:-

Vitrinite Reflectance Data : Whelk -1

: Mussel -1

: Prawn -1

Appendix 2:-

Burial and Thermal Geohistory Analysis of the Otway Basin.

Appendix 3:-

Stratigraphic Table Whelk -1.

119006

LIST OF PLATES

Plate No:

1/. Burial and Thermal Geohistory Diagram - Whelk -1

2/. Burial and Thermal Geohistory Diagram - Prawn -1

3/. Time Structure Map at Near Base Sherbrook Group.

INTRODUCTION

This report relates to work carried out by Van Diemens Land Resources N.L. as operator for the Consortium which holds title to T20P for the period 11 September, 1982 to 10 September, 1983. This is the annual report for the Second Permit Year.

GEOLOGICAL PROGRAMS

Van Diemens Land Resources N.L. in association with Bass Strait Oil & Gas (Holdings) N.L. conducted a burial and thermal geohistory study in the central Otway Basin region and encompassing the Whelk -1 well in the permit T20P. Samples were collected and submitted to Keiraville Konsultants (Prof. A. Cook, Woolongong University) for vitrinite reflectance determinations and Paltech Pty. Ltd. (Dr. I. Deighton) for geohistory studies. The vitrinite reflectance data for the Whelk -1 and neighbouring Mussel -1 and Prawn -1 wells are included. Paltech's report on the Burial and Thermal Geohistory Analyses on the Otway Basin is included in Appendix 1. While they studied ten wells within the central Otway Basin only information for the wells included in Tasmanian waters are included. Their general conclusions based on all wells are presented.

The most important conclusion of their report is that the Belfast Mudstone is only transitionally mature. Although Paltech attributed this to "Shallow depth of burial", Petrecon feels that the unit was deposited during or even after, the first appearance of oceanic crust (according to the latest model of Cande et. al., 1982), their being insufficient heat for hydrocarbon generation since then. Their conclusion is relevant to the T20P permit. The stratigraphic table combined with the vitrinite relectance data (Appendix 2) for the Whelk -1 well shows that the penetrated section is immature. The Belfast Shale Formation which contains the best source rock potential is absent in the well.

GEOPHYSICAL PROGRAMMES

During the first quarter of 1981, Bass Strait Oil and Gas N.L. and Van Diemens Land Resources N.L. shot 506 kms and 137 kms of 48 fold seismic data in permits Vic P16 and T17P respectively. On the basis of their interpretation a significant closed anticlinal structure at or near the top of the Otway Group was mapped. This structure was shown to overlap onto permit T20P. From March 1st to May 3rd, 1982 the permit holders in Vic P16, together with the Consortium in Tasmanian permits T17P and T20P, conducted a seismic survey to provide further information over this structure.

Fifteen line kilometres of 48 fold data were collected on T20P, 22.5 line kilometres on T17P and 88 line kilometres over the structure were gathered in Vic P16. These data were processed by G.S.I. at their Sydney processing centre. Interpretation of this project was completed during the second permit year. A map at the Near Base Sherbrook horizon is included with this report.

T20P Exploration Expenditure

VAN DIEMENS LAND RESOURCES N.L.

YEAR	EXPENDITURE		WORK PROGRAM
	Required	Actual	
First	$100,000	$18,809	Data Review
Second	$200,000	$4,760	Seismic Survey
		$23,569	

Exploration Expenditure Permit Year 2

	Office Studies and Admin.	Geological Geophysical	Rental	Total
Quarter ended 10.12.82	600	1,854		2,454
Quarter ended 10.3.83	600	585	375	1,560
Quarter ended 10.6.83	300	116		416
Quarter ended 10.9.83	300	30		330
	$1,800	$2,585	$375	$4,760

WORK PROGRAM FOR YEAR 3.

The geological and geophysical data search and collation which was programmed in the first year has been accomplished. Following the delineation and interpretation of the prospect overlapping the T17P /T20P and Vic P16 permits in the second permit year, it is planned to reassess and reinterpret all existing data to find deeper prospects and to prepare a farmout package in order to find a farminee to participate in the well committment in permit year 3.

REPORTS SUBMITTED DURING THE SECOND PERMIT YEAR

First Quarter Report, Year 2, T20P

Second Quarter Report, Year 2, T20P

Third Quarter Report, Year 2, T20P

APPENDIX 1.

WHELK No. 1

K.K. No.	Depth (m)	$\bar{R}_V$max	Range	N	Exinite Fluorescence (Remarks)
					PEMBER FORMATION
15756	1091 Ctgs	0.39	0.31-0.49	16	Rare sporinite, dinoflagellates and resinite, yellow to orange. (Siltstone>sandstone, d.o.m. sparse, I>V>E. Inertinite and vitrinite rare. Some coal clasts are present. These contain I and suberinite in addition to V and resinite.)
					TIMBOON FORMATION
15755	1131 Ctgs	0.41	0.25-0.50	20	Exinite is similar to 15756. (Sandy claystone and rare sandstone. D.o.m. rare, I>V=E. V and I both rare. Coal fragments present. Very similar to 15756.)
					BELFAST MUDSTONE
15757	1250 Ctgs	0.45	0.36-0.58	26	Abundant sporinite, yellow to orange, sparse cutinite, common resinite and bituminite/suberinite. (Coal>siltstone>claystone=sandstone. Coal is dominantly duroclarite and vitrite but includes some canneloid liptite. The facies of the coals is similar to some of the coal types found in the Eastern View Coal Measures.)
					FLAXMAN FORMATION
15758	1292 Core	0.58	0.53-0.65	8	Rare cutinite, sporinite and resinite, orange, and rare dinoflagellates yellow to orange. (Clay-rich siltstone, d.o.m. common, I>>V=E. Inertinite sparse to common. Vitrinite rare.)
15759	1309 Ctgs	0.48	0.32-0.60	14	Rare sporinite, cutinite and resinite, yellow to orange. (Siltstone>claystone>sandstone>coal. D.o.m. rare to sparse, I>V>E. V>E>I in coal. Sample had been heat-altered during drying, but the results should not have been markedly affected by this artefact. Pyrite sparse. Inertinite sparse, and vitrinite rare.)
15760	1314 Ctgs	0.44	0.34-0.54	18	Rare sporinite and cutinite, yellow to orange. (Siltstone>claystone>sandstone, and rare coal, d.o.m. sparse, I>V>E. Coal chiefly clarite and duroclarite, V=E>>I. Fluorescing wood tissue present, presumed to be a drilling-mud additive.)
15761	1368 Core	0.47	0.39-0.55	21	Rare sporinite and cutinite, yellow orange to orange. Rare fluorinite, green and suberinite, dull brown. (Sandstone with d.o.m. abundant, V>I>E. Vitrinite abundant occurring as large phytoclasts, inertinite common to abundant, occurring as both large and small phytoclasts. Rare coal clasts with sporinite and bituminite.)

MUSSEL No. 1

K.K. No.	Depth (m)	$\bar{R}_V max$	Range	N	Exinite Fluorescence (Remarks)
					WANGERRIP GROUP
					PEMBER/RIVENOOK 1242m
15358	1260 Ctgs	0.39	0.32-0.45	20	Rare dinoflagellates, cutinite and sporinite, yellow to orange. (Siltstone with minor limestone and sandstone. D.o.m. rare, V>E>I. Vitrinite phytoclasts typically small, some ?reworked coal. Sparse pyrite.)
					PEBBLE POINT 1296m
15359	1385 Ctgs	0.40	0.32-0.45	20	Rare dinoflagellates yellow to orange, rare sporinite in claystone, orange, rare resinite orange. (Claystone, siltstone, sandstone and limestone. D.o.m. rare to sparse, I>V>E. Phytoclasts small. Pyrite abundant.)
					BELFAST MUDSTONE 1400m
15360	1483 Ctgs	0.63 0.44	0.53-0.78 0.41-0.47	15 8	Rare sporinite, cutinite and resinite, orange. Rare dinoflagellates, yellow to orange. (Siltstone>sandstone, some limestone. D.o.m. sparse, I>E. Two populations are present which could be referred to vitrinite. In total abundance they approximately equal inertinite. Either mode may represent the matuation level at the horizon sampled. The higher mode may represent a weakly oxidized vitrinite population, or the lower mode may represent a cavings population. The reflectance found for 15359 suggests that the lower mode is more likely to be representative.)
					SHERBROOK GROUP
					FLAXMAN FORAMTION 2010m
15361	2013 Ctgs	?0.50	0.40-0.55	?3	Rare dinoflagellates, yellow, probably from the Belfast Mudstone. (Silty mudstone with minor sandstone and some limestone. D.o.m. sparse, I>E>?V. Much of the sample appears to be derived from the Belfast Mudstone. Thucholitic bitumen found, dull orange fluorescence on rim, rim reflectance 0.42%. Core is of low reflectance and is not zircon. Pyrite common.)
					WARRE FORMATION 2084m
15362	2102 Core	0.50	0.41-0.59	14	Sparse cutinite and sporinite yellow orange to orange. Rare fluorinite/resinite, green to yellow. (Sandstone with d.o.m. rare and siltstone abundant, I>E>V. Inertinite abundant, vitrinite rare, but vitrinite population well-defined.)
					OTWAY GROUP 2225m
15363	2238 Core	0.64	0.56-0.73	25	Sparse cutinite and rare sporinite, yellow to orange. Rare fluorinite/resinite, green to orange. (Siltstone with d.o.m. abundant, V>I>E. Vitrinite abundant, typically structured. Pyrite sparse.)
					T.D. 2450m

PRAWN No.1

K.K. No.	Depth (m)	$\bar{R}_v$max	Range	N	Exinite Fluorescence (Remarks)
15762	1306 Core	0.35	0.22-047	12	Rare cutinite and sporinite, yellow to orange. (Sandstone, silty with d.o.m. sparse to common, I>V>E. Inertinite sparse, vitrinite rare. Inertinite as large clasts, vitrinite as smaller and less abundant clasts.)
15763	2343 Core	0.49	0.44-0.61	20	Rare sporinite, cutinite and resinite, yellow orange to orange. (Fine sandstone, mudstone and carbonaceous claystone, d.o.m. common, V>I>E. The mudstone contains numerous small inertinite clasts. Vitrinite and inertinite, both common. Vitrinite typically as large clasts.)
15764	2831 Core	0.75	0.62-0.82	20	Rare cutinite and sporinite, orange to dull orange. (Siltstone with d.o.m. common, V>I>E. Vitrinite as extensive layers, possibly derived from in situ root tissue. Vitrinite common, inertinite sparse to common. Pyrite locally common as a replacement mineral in vitrinite and as framboids.)
15765	3008 Core	0.94	0.73-1.10	22	Cutinite>sporinite, rare overall but common in rare layers of clarite, orange to dull orange. (Sandstone with large phytoclasts of vitrinite and semifusinite. Thin layers of cutinite-rich clarite and duroclarite. The majority of the vitrinite occurs as isolated layers, but the presence of the coal suggests that the facies is transitional to coal. D.o.m. abundant V>I>>E. Vitrinite abundant, inertinite common.)
15766	3190 Core	0.90	0.79-1.10	20	Sporinite>cutinite, rare overall but locally abundant, orange to dull orange. (Sandstone with thin layers of claystone and vitrinite dominantly as large phytoclasts. Some micrinite present in the telocollinite. Inertinite rare, vitrintie abundant. V>>E>I.)

T.D. 3193m

APPENDIX 2.

BURIAL AND THERMAL GEOHISTORY ANALYSIS OF

FLAXMANS - 1
MUSSEL - 1
NAUTILUS A-1
NERITA - 1
PECTEN 1-A
PORT CAMPBELL -1
PRAWN A-1
SHERBROOK - 1
SNAIL - 1
WHELK - 1

OTWAY BASIN
VICTORIA.

For: GENERAL GEOLOGICAL SERVICES

August 20th, 1982.

Paltech Report
1982/27

PALTECH PTY LTD
MARINE MICROPALEONTOLOGISTS
SYDNEY NEW SOUTH WALES
MIDLAND WESTERN AUSTRALIA

CONTENTS

SECTION		PAGE
I	INTRODUCTION	3
	Previous Work	
	Aims of This Study	
	BURY II	
II	CONSTRUCTION OF BURIAL AND THERMAL GEOHISTORY DIAGRAMS FOR THE OTWAY BASIN.	4
	Data Input	
	Modelling Procedure.	
III	BURIAL AND THERMAL GEOHISTORY DIAGRAMS FOR THE OTWAY BASIN.	9
	Flaxmans - 1	
	Mussel - 1	
	Nautilus A-1	
	Nerita - 1	
	Pecten 1-A	
	Port Campbell - 1	
	Prawn A-1	
	Sherbrook - 1	
	Snail - 1	
	Whelk - 1	
IV	GENERAL CONCLUSIONS	17
	Basin Development	
	Maturation of Source Rocks.	
	REFERENCES	20
	APPENDIX I	22

TABLES

1 Age vs Biostratigraphic Datums and Conventional Stages. Pages 7 & 8.

FIGURES

1 to 10 BURIAL AND THERMAL GEOHISTORY DIAGRAMS:-

Scale	1:10 000	1:30 000
Location	(map roll or back pocket)	

FIGURE		WELL
1A	1B	FLAXMANS-1
2A	2B	MUSSEL-1
3A	3B	NAUTILUS A-1
4A	4B	NERITA-1
5A	5B	PECTEN 1-A
6A	6B	PORT CAMPBELL-1
7A	7B	PRAWN A-1
8A	8B	SHERBROOK-1
9A	9B	SNAIL-1
10A	10B	WHELK-1

11 BASEMENT SUBSIDENCE CURVES after page 17

NB. FIGURES 7A AND 10A ONLY AVAILABLE

SECTION I - INTRODUCTION.

PREVIOUS WORK.

Useful syntheses of the geology and petroleum prospectivity of the Otway Basin have been presented by Denham & Brown (1976), and Wopfner et al (1971).

The primary conclusions have been that:-

*The prime source in the Otway Basin for fluid hydrocarbons is the Belfast Mudstone.

*Other stratigraphic units including the Otway Group are fair to good source rocks for gas.

AIMS OF THIS STUDY.

The aim of this study is to determine the timing of maturation of prospective source rocks in 10 wells in the Otway Basin:-

FLAXMANS - 1
MUSSEL - 1
NAUTILUS A-1
NERITA - 1
PECTEN 1-A
PORT CAMPBELL - 1
PRAWN A-1
SHERBROOK - 1
SNAIL - 1
WHELK - 1

BURY II

The computer program BURY II (copyright D.A. Falvey, 1982) constructs a burial history diagram by successively stripping off sedimentary layers according to age. It then calculates the thermal maturation of each sedimentary layer through time in terms of vitrinite reflectance.

A full discussion of the theory of burial and thermal geohistory analysis is contained in Falvey & Deighton (1982).

Using BURY II, geohistory diagrams have been constructed for 10 wells drilled in the Otway Basin (including the Torquay Embayment). Discussion of the factors used in the construction of the diagrams (Section II), a discussion of each well diagram (Section III) and general conclusions (Section IV) follow.

SECTION II - CONSTRUCTION OF BURIAL AND THERMAL GEOHISTORY DIAGRAMS FOR THE OTWAY BASIN.

DATA INPUT

The data required for BURY II is as follows:-

*Basement depth - BMT

*Bottom hole temperature - BHT

*Sea bottom temperature - SBT

*Depth-age-paleowater depth data for biostratigraphic or stratigraphic datums.

*Depth - Observed Thermal Maturation Indices.

A list of the input data for each well is given in Appendix 1. A brief discussion of the source and quality of this data follows.

Basement Depth - BMT

Apart from WHELK - 1 which terminated in basement, all other basement depths are interpreted from general basin configuration as discussed by Deighton et al (1976). In their view and those of later authors, the Otway Group depocentre is north of the Sherbrook Group depocentre, see Boeuf & Doust (1975).

Bottom Hole Temperature.

Where possible, the bottom hole temperature was estimated from the empirical observation method of Dowdle & Cobb (1975). In many cases this resulted in unrealistically low values of heatflow for which the regional average is about 1.3 to 1.4. BHT's were generally raised to bring the heatflow between these values except for WHELK - 1 (higher conductivity due to shallow basement)

Discussion later shows the basic similarities between the basement subsidence histories of all wells in this study. This coupled with the fact that most of the wells are from the one embayment in the Otway Basin, indicates that heatflows for the wells should be fairly similar.

Sea Bottom Temperature.

Sea bottom temperature has been assumed constant at 15°C.

Depth - Age - Paleowater Depth

This information has been gleaned from various sources. In general, foraminifera provide control in the marine sequence. These are supplemented by palynologic data for the Belfast Mudstone. Palynologic data provides the control for the terrestrial parts of the sequence.

The sources for all data are presented in Appendix 1.

The biostratigraphy and palynostratigraphic vs age correlations are shown as Table 1.

Depth - Observed Thermal Maturation Indices.
A comprehensive study of vitrinite reflectances in the wells was specifically undertaken by A.Cook (Keiraville Konsultants) to provide data for geohistory analysis.

These are supplemented by some data from Middleton and Falvey (in press).

No thermal alteration index measurements were available for this study.

MODELLING PROCEDURE.

Because of the lack of comparable information for all wells, porosity changes and thermal conductivities were generally modelled identically for all wells except NAUTILUS A-1 (lower conductivity for Oligocene marl deposition) and WHELK - 1 (higher conductivities due to shallow basement).

Thus the variables which can cause differential thermal maturation between wells were restricted to:-

*Basement subsidence

*Paleo-heatflow

*Basement Subsidence.
Basement subsidence is quantified by the depth-age-paleowater depth data for all levels intersected by drilling. For levels deeper than T.D., a subsidence pattern was modelled according to the subsidence pattern for Fergusons Hill No.1, based on palynologic data presented by Evans (1966). Fergusons Hill No.1 penetrated basement below Otway Group and should be an indication of Otway Group subsidence.

*Paleo-heatflow.

Basement subsidence patterns for all wells are essentially exponential from 85-90 m.y. to present (Figure 11). This suggests that breakup in the eastern part of the Otway Basin occurred at about 85-90 m.y. This is supported by a recent re-identification of sea-floor spreading anomalies between Australia and Antarctica by Cande & Mutter (1982). Cande & Mutter (l.c.) found that a very slow period of spreading may have occurred from about 85 m.y. (possibly as early as 110 m.y. in the Great Australian Bight Basin) to about 45 m.y. when rapid spreading to form the Southern Ocean commenced.

Accordingly, paleo-heatflows were modelled as increasing from slightly less than the present day value at 131 m.y. to a maximum (during 80 to about 50 m.y.) then declining to the present day value. Paleo-heatflow increments were generally modelled as higher to the southwest (closer to the spreading ocean) during the 80-50 m.y. period.

TABLE 1(a) - AGE (M.Y.) VERSUS BIOSTRATIGRAPHIC DATUMS AND CONVENTIONAL STAGES - PLEISTOCENE TO EOCENE.

Boundary Age (m.y.)	Stage	Foram Zone	Boundary Age (m.y.)*
5.2	PLIO/PLEISTOCENE	A	4.5
10.4	LATE MIOCENE	B	10.4
	MID MIOCENE	C	12.0
		D	14.5
15.0		E-1	15.0
	EARLY MIOCENE	E-2	15.5-16.0
		F	17.5-18.0
		G	22.5
24.0		H-1	24.0
	LATE OLIGOCENE	H-2	25.0
		I-1	28.0
32.0		I-2	30.0
	EARLY OLIGOCENE	J-1	34.5
37.0		J-2	37.0
	LATE EOCENE	K	

*This column used for Data Input

from Taylor (in prep).

5 cm

TABLE 1(b) - AGE (M.Y.) VERSUS BIOSTRATIGRAPHIC DATUMS AND CONVENTIONAL STAGES - EOCENE TO CRETACEOUS.

Boundary Age (m.y.)	Stage	Forams Zones/ Datums	Boundary Age* (m.y.)	Spore/Pollen Zones	Dinoflagellate Zones
37.0					
	L. Eocene				
40.0		Base L	40.0		
	Middle Eocene		45.0		
				early P.pachpolus =early N.asperus	
			48.0		
49.0					
		Top R	50.0		
	Early Eocene		52.0		
				D.orthoteichus	
			53.0		
53.5		Top S-T	53.5		
	Paleocene		55.0-55.5	L.balmei, G.edwardsii	
65.0			65.0		
	Maastrichtian			T.longus	
			69.0		
70.0				T.lillei	
			72.5		
	Campanian		73.0	N.senectus	
			76.0		X.australis
78.0			78.0		
	Santonian	XA-1	80.0	T.pachyexinus	
82.0					N.aceras
	Coniacian		84.0		D.cretaceum
86.0		XA-2	86.0		
	Turonian		87.0	C.triplex	?
		XB	91.0		
		- - ? - -			
92.0			92.0	A.distocarinatus	A.parvum
	Cenomanian		99.0	P.pannosus	
100.0			100.0		
	Albian		104.0	K2b	
			106.0	C.paradoxa	
				K2a	
			107.0		
108.0				C.striatus	
	Aptian/ Neocomian		109.0		
			131.0	Assumed base of E.Otway Basin deposition	
135.0					

*This column used for Data Input

5 cm

SECTION III - BURIAL AND THERMAL GEOHISTORY DIAGRAMS FOR THE OTWAY BASIN.

For each well two Burial and Thermal Geohistory Diagrams have been provided. One at 1: 10,000 scale may be used for measuring, plotting and comparing with standard 1: 10,000 scale summary well logs produced by most oil exploration companies. A summary lithostratigraphic log has been provided. The source of the litholog is given in the discussion of each well. Hydrocarbon shows are after Wopfner et al (1971).

The other, at 1: 30,000 scale is in A-4 fold-out format and shows, in addition, the computer predicted vitrinite reflectance/depth curve and the observed values (log scale above horizontal axis, linear scale below). Assuming the observed values are accurate, this diagram is an indication of the validity of the thermal modelling.

This section of the report discusses the Burial and Thermal Geohistory diagrams for each well. The following points are emphasised:-

*Temperature models for BHT

*Tectonic development where different from normal Otway Basin development (see Section IV for a discussion of general Otway Basin tectonic vs stratigraphic development).

*Thermal maturation discussing the predicted vs observed maturation levels, hydrocarbon shows (if any) and general significance as far as hydrocarbon generation.

*Lithostratigraphic comments.

PRAWN A-1 BURIAL AND THERMAL GEOHISTORY DIAGRAM.

(Figures 7A & 7B).

BHT Model.

A nominal 6% was added to the observed BHT which brought the heatflow to 1.36 H.F.U.

Tectonic Development.

Abnormally high subsidence rates are indicated for Prawn A-1 during Waarre & Flaxmans deposition (Figure 11) and also a comparatively thin Belfast Mudstone. This pattern may be related to Mussel - 1 (Figure 2A). Subsequent tectonic development is normal for the basin area.

Thermal Maturation.

A good fit was obtained between predicted and observed reflectance values.

The reflectance lines indicate the Belfast Mudstone is transitionally mature while the Otway Group is mature below ∿2750 metres.

No hydrocarbon shows were recorded during drilling.

Lithostratigraphy.

After ESSO (Well Completion Report) except the Belfast Mudstone is indicated to be thinner by foraminiferal data.

WHELK - 1 BURIAL AND THERMAL GEOHISTORY DIAGRAM.

(Figures 10A & 10B).

BHT Model.

A nominal 5% has been added to the observed BHT. The heatflow is high because basement is very shallow.

Tectonic Development.

A fairly normal basement subsidence curve is observed, apart from an increased subsidence rate at 60 m.y.

Thermal Maturation.

Whelk - 1 was designed to test an updip pinchout of Waarre Formation on basement. It is not surprising that the predicted and observed reflectances are less than 0.5.

Lithostratigraphy.

After ESSO (Well Completion Report) but no Belfast Mudstone indicated by foraminiferal study.

SECTION IV - GENERAL CONCLUSIONS.

BASIN DEVELOPMENT.

FIGURE 11 shows a plot of Basement Subsidence curve for all wells in this study, compared with the rock stratigraphy observed in the Otway Basin. A correspondence between subsidence pattern and stratigraphy is apparent.

1. Otway Group. (131 to 100 m.y.).
Subsidence during Otway Group deposition was very rapid, characteristic of rift valley deposition. Sediments are poorly sorted, dominantly arkosic in character.

2. Waarre Sandstone (100 to 90 m.y.).
Subsidence during Waarre Sandstone deposition was very slow - a complete change in tectonic character from the previous Otway Group style. This slow subsidence is related to incipient spreading of the Southern Ocean and may thus be the expression of break-up. (Now considered to be somewhere between 110 and 85 m.y. by Cande & Mutter (1982)).

3. Post Waarre Sandstone (90 m.y. to Present).
This period is characterised by exponentially decreasing rates of subsidence. A minor increase in subsidence rates at about 55 to 45 m.y. may reflect a comtemporaneous increase in spreading rates in the Southern Ocean (Cande & Mutter, 1982). A minor inflection at about 30 m.y. is due to unloading of the shelf during the Oligocene sea level low (see Vail et al, 1977). Uplift at the margins in the late Tertiary (20 m.y. to present) may be seen in the curves for PORT CAMPBELL - 1 and SHERBROOK - 1.

Stratigraphic development during this time may be primarily determined by sea level fluctuations. However the minor tectonic influences mentioned in the preceding paragraph may be responsible for the breaks between the Wangerrip and Nirranda Groups (increase in subsidence at 55 to 45 m.y.), between the Nirranda and Heytesbury Groups (Oligocene sea level drop ~30 m.y.).

The break between the Sherbrook and Wangerrip Groups may be due to a combination of "moderate structural deformation" (Boeuf & Doust, 1975) and a sea level low in the Paleocene (Vail et al, 1977). The lack of change in

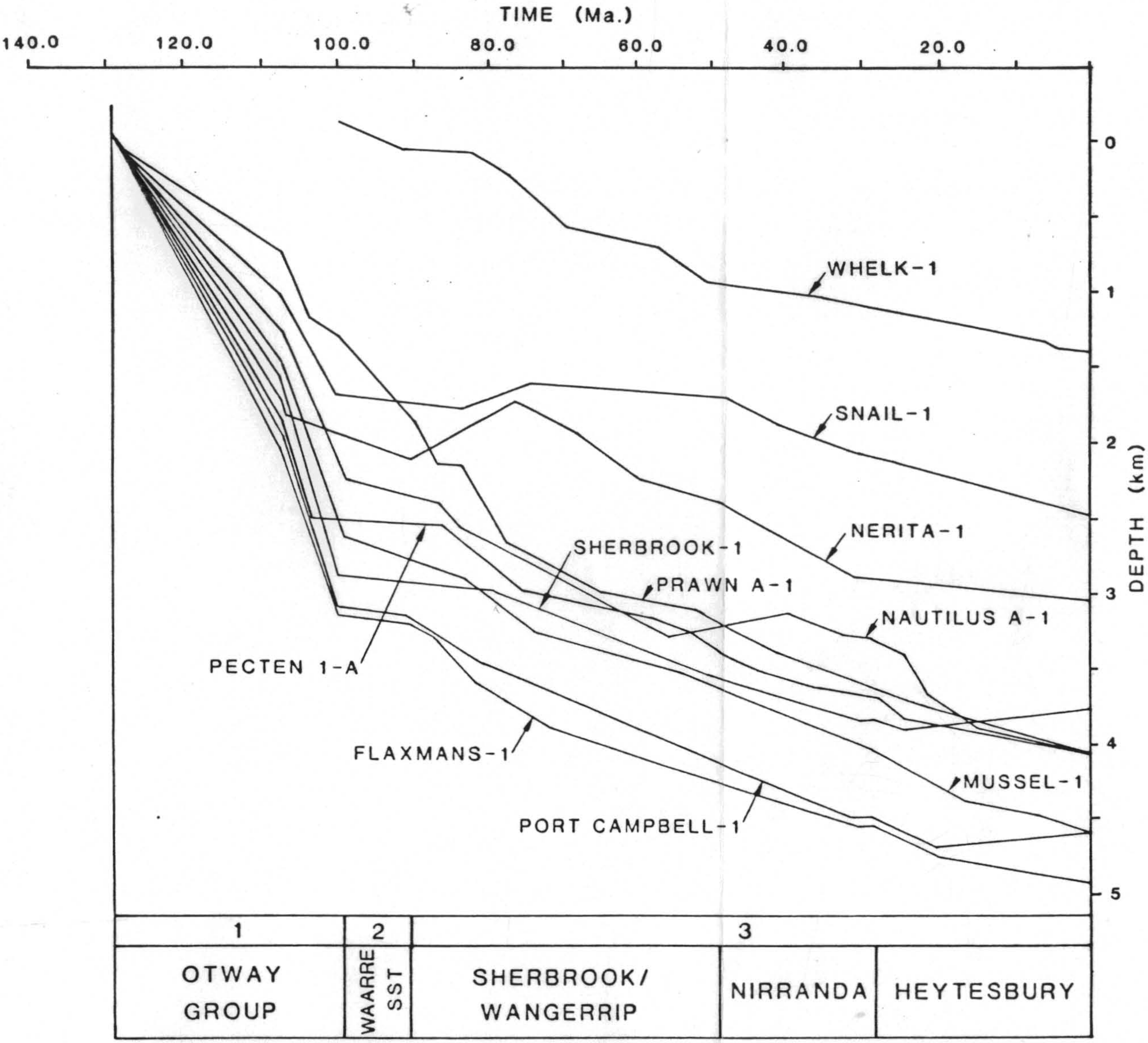


FIGURE 11 BASEMENT SUBSIDENCE CURVES PALTECH REPORT 1982/27

5 cm

sedimentological character at the Sherbrook/Wangerrip contact has been pointed out by many authors (refer Glenie, 1971 for discussion).

Major faulting during this time is generally stated not to continue into the Tertiary. However, McPhee et al (1981), while making this statement, show the major Timboon Fault as extending into Nirranda levels (l.c., Fig.7).

Discussion.

The observation that the subsidence curves for all wells are very similar means that enhanced reliability is available for plotting paleo-migration potential between wells. This may be coupled with seismic stratigraphy to determine migration directions throughout the basin.

MATURATION OF SOURCE ROCKS.

Belfast Mudstone.

In all wells in this study, the prime Otway Basin source rock for liquid hydrocarbons, the Belfast Mudstone, is only transitionally mature. This is primarily because of its shallow depth of burial. Greater maturation levels for the Belfast Mudstone may obtain in the area south of NAUTILUS A-1 and west of WHELK -1 *if the Belfast Mudstone thickens in this direction.* Previous workers in the Otway Basin differ in their opinions on this matter.

Falvey (1974), Boeuf & Doust (1975) and Deighton et al (1976) all inferred that the Belfast Mudstone would thin to the south since, during the rift valley phase axial uplift should take place. This interpretation was strongly dependant on the assumption that sea-floor spreading commenced in the late Paleocene.

The geohistory curves presented herein suggest however that spreading first occurs in the Southern Ocean in the eastern Otway Basin area between 90 and 80 m.y. The revised spreading model of Cande & Mutter (1982) opens the possibility of rapid post-breakup subsidence at the continental margin during Belfast Mudstone deposition.

In this respect, it is notable that Denham & Brown (1976) show marked thickening of the Belfast Mudstone south of NAUTILUS A-1 in their "Voluta Trough". If this is the case, then primary generation of liquid hydrocarbons could take place in the "Voluta Trough" with subsequent migration towards the margins.

A synthetic geohistory diagram for a theoretical well site in the "Voluta Trough" would ascertain the timing of likely generation. Subsequent migration and entrapment models would need to take account of seismically determined structuring coupled with the paleodepths to migration horizons as quantified by the geohistory diagrams in this study.

Otway Group.

In most wells in this study the Otway Group is in the mature phase of hydrocarbon generation. Source rock analysis and observed shows indicate gas generation from the Otway Group has and is currently taking place.

Plays for gas discoveries may be generated throughout the Otway Basin, though it should be remembered that the thickest Otway Group sequences are probably to be found in the onshore and inner offshore areas.

REFERENCES.

BOEUF, M.G. & DOUST, H., 1975 - Structure and Development of the Southern Margin of Australia. *APEA Journ. 1975;* 33-43

CANDE, S.C. & MUTTER, J.C., 1982 - A revised identification of the oldest sea-floor spreading anomalies between Australia and Antarctica. *Earth & Planet. Sci. Letters 58;* 151-160.

COOK, A.C., 1982 - Study of vitrinite reflectances in ten Otway Basin wells for General Geological Services (unpubl.).

DEIGHTON, I.C., 1974 - Nautilus A-1 and the Tertiary development of the Otway Basin: an exercise in paleoecology and paleo-hydrodynamics, Unpub. M.Sc (Qual.) thesis, University of Sydney.

DEIGHTON, I.C., FALVEY,D.A. & TAYLOR, D.J., 1976 - Depositional environments and geotectonic framework: Southern Australia continental margin. *APEA J., v. 16,* 25-36.

DENHAM, J.I. & BROWN, B.R., 1976 - A new look at the Otway Basin. *APEA J., v. 16, pt.1;* 91-98.

DOUGLAS,J.G., ABELE,C., BENEDEK,S., DETTMAN,M.E., KENLEY,P.R., LAWRENCE,C.R., 1976 - Mesozoic in *Geology of Victoria. Spec. Publ. Geol. Soc. Aust.* 5; 143-176.

DOWDLE,W.L. & COBB,W.M., 1975 - Static formation temperature from well logs - An empirical method. *Journal of Petroleum Technology,* November, 1326-30.

EVANS, P.R., 1969 - A palynological report on F-B.H. Port Campbell No. 1 & 2 wells, Victoria. BMR Record No. 1961/63 (unpubl.)

EVANS, P.R., 1962 - Palynological observations on F-B.H. Flaxmans No. 1 Well - BMR Records 1962/57 (unpubl.).

EVANS, P.R., 1966 - Mesozoic stratigraphic palynology of the Otway Basin. BMR Record 1966/69 (unpubl.).

FALVEY, D.A., 1974 - The development of continental margins in plate tectonic theory. *APEA Journ;* 95-106.

FALVEY,D.A. & DEIGHTON, I.C., 1982 - Recent advances in Burial and Thermal Geohistory Analysis. *APEA Journ;* v.22, pt. 1, pp.65-81.

G.G.S., 1980 - Unpublished log picks for talk presented at PESA (Vic.) Symposium on Southeastern Australia Sedimentary Basins.

GLENIE, R.C., 1971 - Upper Cretaceous and Tertiary Rock Stratigraphic Units in the Central Otway Basin. in *The Otway Basin of Southeastern Australia, Spec. Bull.* Geol. Surv. S.Aust., Vict., 193-215.

McGOWRAN, B., LINDSAY,J.M. & HARRIS,W.K., 1971 - Attempted reconciliation of Tertiary biostratigraphic systems, Otway Basin. *in* The Otway Basin of Southeastern Australia. *Spec. Bull. Geol. Survs. Sth. Aust. & Vict;* 273-281.

McPHEE,I., McNICOL,M.D. & HARRISON,D.M., 1981 - The North Paaratte Gas Discovery. *APEA Journ,* v.21, pt.1, pp.78-84.

MIDDLETON,M.F. & FALVEY,D.A. (in press) - Maturation modelling in the Otway Basin, Australia.

PARTRIDGE, A.D., 1976 - The geological expression of eustacy in the Early Tertiary of the Gippsland Basin. *APEA Journ;* 73-79.

TAYLOR,D.J., 1971 - Foraminifera and the Cretaceous and Tertiary depositional history in the Otway Basin in Victoria. *in The Otway Basin of Southeastern Australia. Spec. Bull.* Geol. Survs. Sth. Aust. & Vict; 217-233.

VAIL,P.R., MITCHUM,R.M. & THOMPSON,S., 1977 - Global cycles of relative change in sea level. *AAPG Mem. 26;* 83-98.

WOPFNER,H., KENLEY,P.R. & THORNTON,R.C.N., 1971 - Hydrocarbon occurrences and potential of the Otway Basin in *The Otway Basin of Southeastern Australia, Spec. Bull.,* Geol. Survs. S.Aust., Vic., 385-435.

APPENDIX I

Sources of Input Data.

The following pages give the data lists for each well used as input for BURY II. The sources are coded according to the following:-

SOURCE	CODE
WELL COMPLETION REPORT (including Appendices)	WCR
SPECIFIC REPORTS/PAPERS	
Evans (1961)	E1
Evans (1962)	E2
Evans (1966)	E3
Cook (1982)	C
Middleton & Falvey (in press)	M & F
Deighton (1974)	D
Taylor (1971)	T
OTHER	
Interpretation of this report	Interp.

WHELK - 1.

Depth to Basement: 1270 metres

K.B.: 30.5 metres

Bottom Hole Temperature: 62.0°C at 1466 metres

Sea Bottom Temperature: 15.0° C.

STRATIGRAPHIC DATA.

Depth (K.B.)	Age	Paleowater Depth	Source
134.0	0.0	103.5	
302.0	22.5	50.0	
325.0	25.0	30.0	
343.0	30.0	20.0	
393.0	40.0	10.0	
425.0	48.0	10.0	
440.0	50.0	10.0	
486.0	52.0	10.0	WCR
628.0	55.5	10.0	
729.0	58.5	10.0	
769.0	69.0	0.0	
1096.0	78.0	0.0	
1208.0	81.0	20.0	
1286.0	84.0	40.0	
1308.0	92.0	20.0	
1403.0	99.0	0.0	Interp.

THERMAL MATURATION DATA.

Depth	R_o Mean	Min.	Max.	
1091.0	0.39	0.31	0.49	
1131.0	0.41	0.25	0.50	
1250.0	0.45	0.36	0.58	C
1292.0	0.58	0.53	0.65	
1309.0	0.48	0.32	0.60	
1314.0	0.44	0.34	0.54	
1368.0	0.47	0.39	0.55	

Appendix 2.

STRATIGRAPHIC TABLE PRAWN A - 1

Water depth 108m

Depths are relative to R.T. (subtract 27m for M.S.L.)

Age and Formation	Depth	Thickness	Lithology	Depth	Vitrinite Reflectance	Range
Miocene-Oligocene:						
Gellibrand Marl	108 - 735	627	Marl interbedded with limestone: calcareous sandstones and siltstones.			
Oligocene:						
Clifton limestone	735 - 752	17	Skeletal Limestone: Slightly sandy.			
Upper Eocene:						
Narrawaturk Marl	752 - 922	170	Marl interbedded with limestone			
Eocene-Paleocene:						
Mepunga and Dilwyn	922 - 1186	264	Sand and sandstone: pyritic, carbonaceous.			
Paleocene:						
Rivernook	1186 - 1206	20	Silty mudstone			
Pebble Point	1206 - 1265	59	Sand and conglomerate			
Unconformity						
Upper Cretaceous:						
Sherbrook Group						
Curdies-Paaratte	1265 - 2175	910	Sandstone with occasional thin interbeds of shale.	1306	0.35	0.22 - 0.47
Belfast	2175 - 2228	53	Shale			-
Belfast-Flaxmans	2228 - 2857	628	Calcareous sandstones	2343	0.49	0.44 - 0.61
Waarre	2857 - 2444	88	Conglomerate	2831	0.75	0.62 - 0.82
Unconformity						
Lower Cretaceous:						
Otway Group	2944 - 3193	249+	Lithic sandstones	3008 3190	0.94 0.90	0.73 - 1.10 0.79 - 1.10

119038

APPENDIX 3.

STRATIGRAPHIC TABLE WHELK -1

WATER DEPTH 103m

AGE AND FORMATION	DEPTH (m)	THICKNESS (m)	LITHOLOGY	DEPTH	VITRINITE REFLECTANCE	RANGE
Oligocene-Miocene Heytesbury Group	103-329	196	marls and limestone			
Paleocene-Eocene Wangerrip Group	329-735	406	sandstone and silty mudstone			
Upper Cretaceous Curdies Fm.	735-1248	513	sandstone with associated shales	1091	0.39	0.31-0.49
Paaratte Fm.	1248-1279	30	sandstone and siltstones	1131	0.41	0.25-0.50
Waarre	1279-1466	187	course sandstone	1292	0.58	0.53-0.65
Basement	1466 +					

FIG. 10A PALTECH REPORT 1982/27

BURIAL and THERMAL GEOHISTORY DIAGRAM

WHELK-1

OTWAY BASIN

1:10,000

PREPARED FOR GENERAL GEOLOGICAL SERVICES

BY PALTECH P/L

LEGEND

Sea level curve

Subsidence lines

0·5 R_o (Vitrinite Reflectance)

SHOW	OIL	OIL & GAS	GAS & CONDENSATE	GAS
MAJOR (>50 Mcf/d)			☼	☼
MINOR (<50 Mcf/d)				○
TRACE	•	◡		◇

WHELK-1 OTWAY BASIN

HEAT FLOW = 1.88 H.F.U. PROCESSED ON :- 18/8/1982

*** PROGRAMME COPYRIGHT D.FALVEY ***

5 cm

1.

OR-0124.

113041

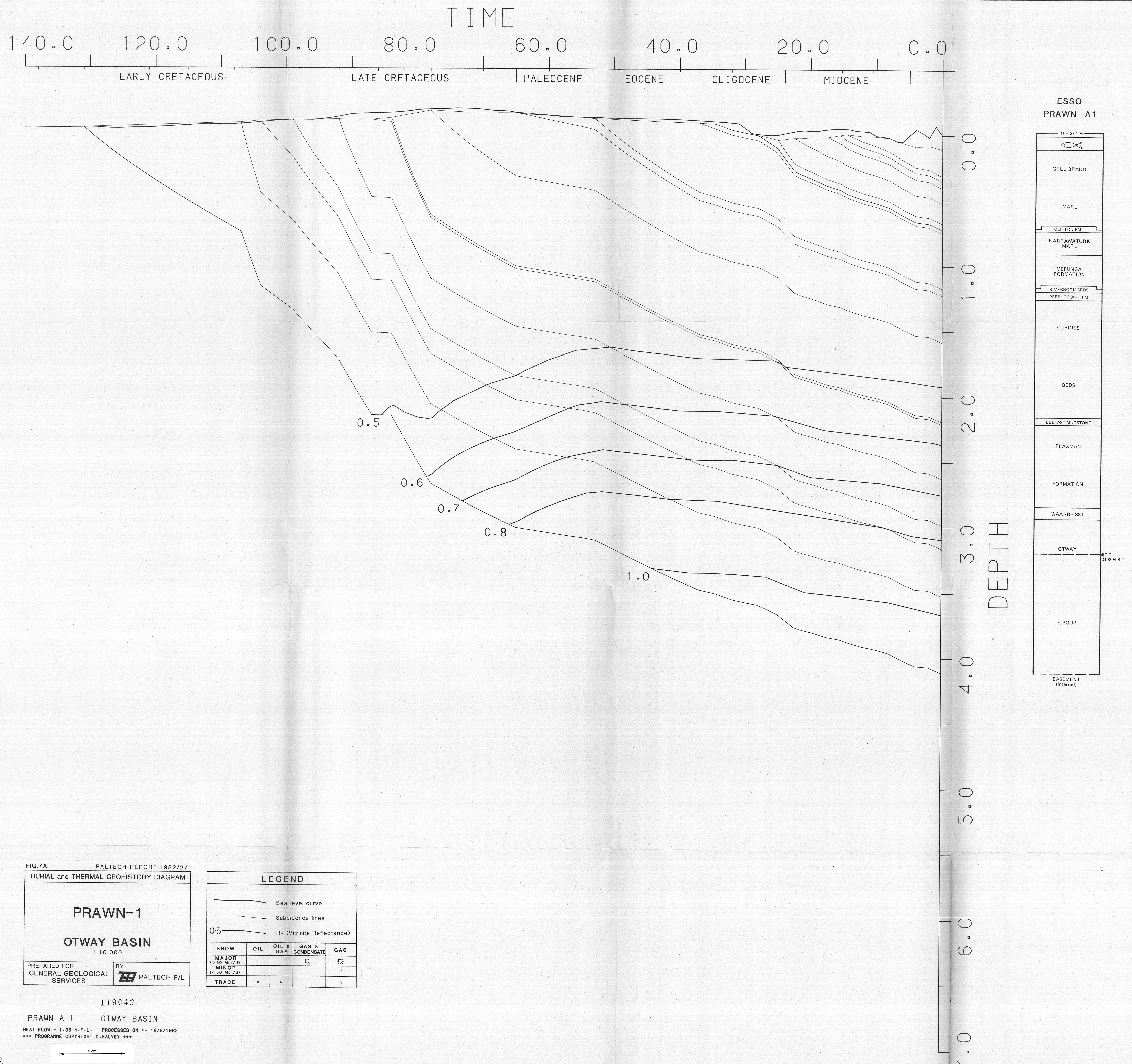


FIG.7A PALTECH REPORT 1982/27

BURIAL and THERMAL GEOHISTORY DIAGRAM

PRAWN-1

OTWAY BASIN

1:10,000

PREPARED FOR GENERAL GEOLOGICAL SERVICES

BY PALTECH P/L

LEGEND

Sea level curve

Subsidence lines

0·5 R_0 (Vitrinite Reflectance)

SHOW	OIL	OIL & GAS	GAS & CONDENSATE	GAS
MAJOR (>50 Mcf/d)			☼	☼
MINOR (<50 Mcf/d)				○
TRACE	•	◦		◦

119042

PRAWN A-1 OTWAY BASIN

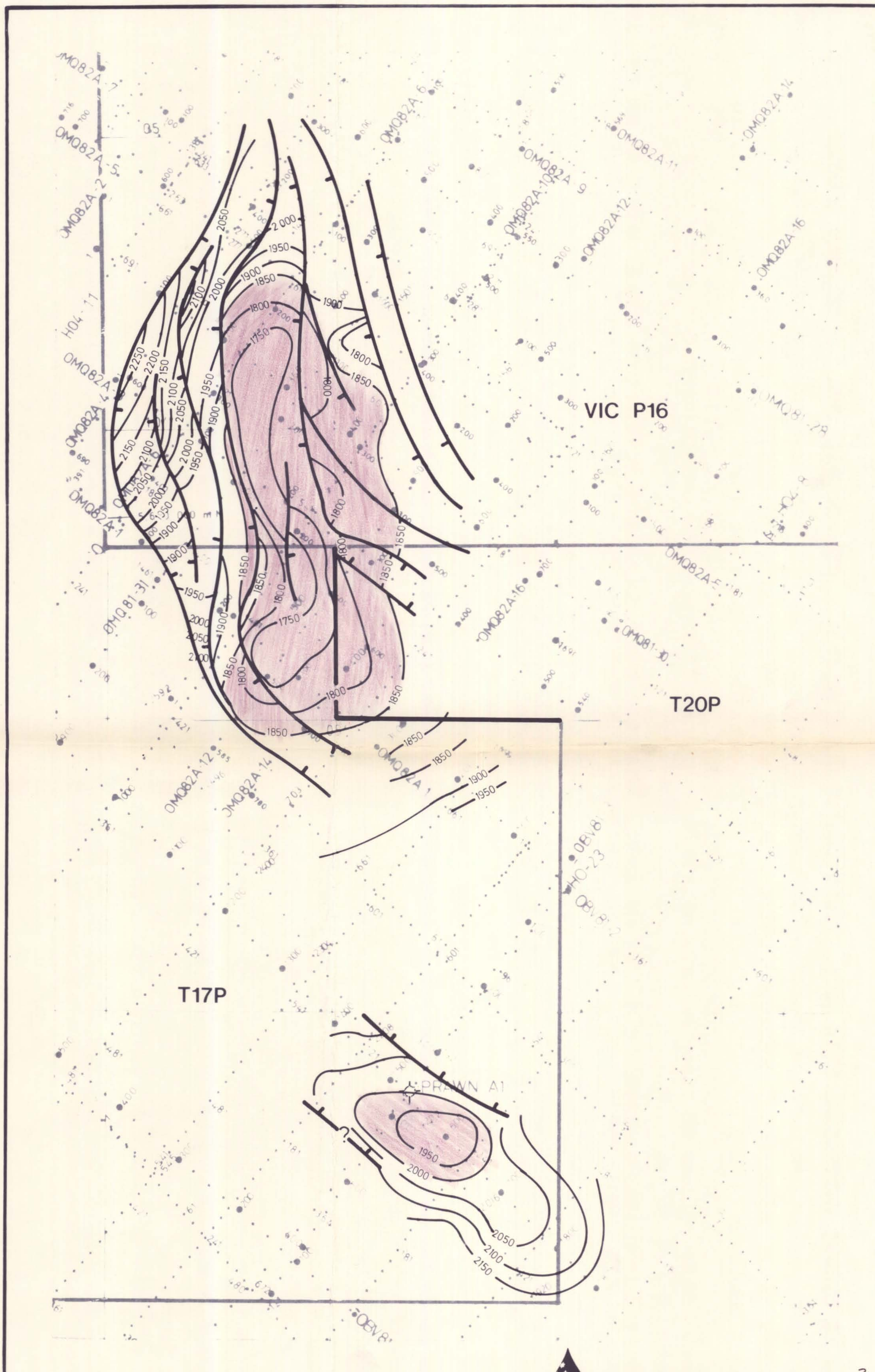
HEAT FLOW = 1.36 H.F.U. PROCESSED ON :- 18/8/1982

*** PROGRAMME COPYRIGHT D.FALVEY ***

5 cm

2.

OR-0124



PETRECON AUSTRALIA PTY LTD

3.

OTWAY BASIN (BASS STRAIT OIL & GAS (HOLDINGS) N.L.)	83/1
VIC. P16 TIME STRUCTURE MAP NEAR BASE SHERBROOK GROUP (WAARRE)	G.J.B. M.R.D. 11-1-83 1:100 000

5 cm

OR-0124

119043